3rd Annual Report

OPTICON

Optical Infrared Co-ordination Network for Astronomy

Integrating Activity

implemented as

Integrated Infrastructure Initiative

Contract number:	*RII3-CT-2004-001566*
Project Co-ordinator:	*The Chancellor, Masters and Scholars of the University of Cambridge.*
Contact person:	*Professor Gerard Gilmore*
Project website:	*www.astro-opticon.org*
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Table of contents

A. ACTIVITY REPORT

1. PROGRESS REPORT

1.1 SUMMARY OF THE ACTIVITIES AND MAJOR ACHIEVEMENTS

1.2 MANAGEMENT ACTIVITY

1.3 NETWORKING ACTIVITIES (OTHER THAN MANAGEMENT)

1.3.1 NA2: COORDINATION AND INTEGRATION OF ENO FACILITIES
1.3.2 NA3: STRUCTURING EUROPEAN ASTRONOMY
1.3.3 NA4: MECHANISMS FOR SYNERGY IN SPACE-GROUND COORDINATION
1.3.4 NA5: INTERFEROMETRY FORUM
1.3.5 NA6: OPTICON TELESCOPE NETWORK

1.4 TRANSNATIONAL ACCESS ACTIVITIES

1.4.1 OPTICON TRANS-NATIONAL ACCESS PROGRAMME

1.4.1.1 Description of the publicity concerning the new opportunities for access
1.4.1.2 Description of the selection procedure
1.4.1.3 Trans-national Access activity
1.4.1.4 Scientific output of the users at the facilities.
1.4.1.5 User meetings

1.5 JOINT RESEARCH ACTIVITIES

1.5.1 JRA1: ADAPTIVE OPTICS
1.5.2 JRA2: FAST DETECTORS FOR AO
1.5.3 JRA3: FAST READOUT HIGH PERFORMANCE OPTICAL DETECTORS
1.5.4 JRA4: INTEGRATING OPTICAL INTERFEROMETRY INTO MAINSTREAM ASTRONOMY
1.5.5 JRA5: SMART FOCAL PLANES
1.5.6 JRA6: VOLUME PHASE HOLOGRAPHIC GRATINGS

1.6 UPDATE OF THE NON-CONFIDENTIAL PROJECT INFORMATION

2. LIST OF DELIVERABLES

3. USE AND DISSEMINATION OF KNOWLEDGE

ANNEXES

1. Progress report

1.1 Summary of the activities and major achievements

This is the third OPTICON annual report. It presents substantial progress in every aspect of the OPTICON program, delivering our ambitions with no significant disappointments or required major modifications. Of special note is the substantial technical progress in the JRA activities, which are providing much supporting technical development for the current generation of large European telescopes (VLT, GTC, LBT), enhancing their scientific performance, and also by doing so provide the proof of concept of the further technological advances required for the next generation Extremely Large Telescope.

The Executive and Board review of OPTICON's internal performance has confirmed considerable steady progress.

The Executive undertook a full review of progress and budget preparatory to the present (and last) 18-month plan, making some minor optimisations and rebalancing of budgets. This ensures adequate resources are delivered to the highest priority activities. Where desirable some rebalancing has been implemented, for exampled in the testing activities associated with the complementary fast photon-detector developments in JRA2 and JRA3. The major (fractional) change was to provide extra funding for science case and Design Reference Mission Development related to the European Extremely Large Telescope (E-ELT). That project, the science case development for which is co-ordinated by OPTICON, was adopted both by ESFRI and by the 12 countries which constitute the ESO Council as the highest strategic priority ground-based large project in astronomy. Extra funding was provided for OPTICON's science case work at this critical time for this exceptionally successful and important activity.

At this stage of OPTICON, when essentially all funding has been committed, it is useful to compare performance with initial ambition.

- To increase the quality of European astronomical research, by ensuring that the best European scientists have access to world-class facilities;
- To increase the quantity of European astronomy, by ensuring that all of Europe's astronomers have access to excellent facilities purely on merit;
- To sponsor and develop training systems to train young and/or inexperienced astronomers in the use of state of the art facilities;
- To strengthen the community overall by encouraging and supporting collaboration across traditional boundaries, whether geographical or technical;
- To gain economies of scale, and efficiencies in operational costs, though shared experience ('best practice') and through co-ordination of resources and facility access to allow optimum use of these investments.

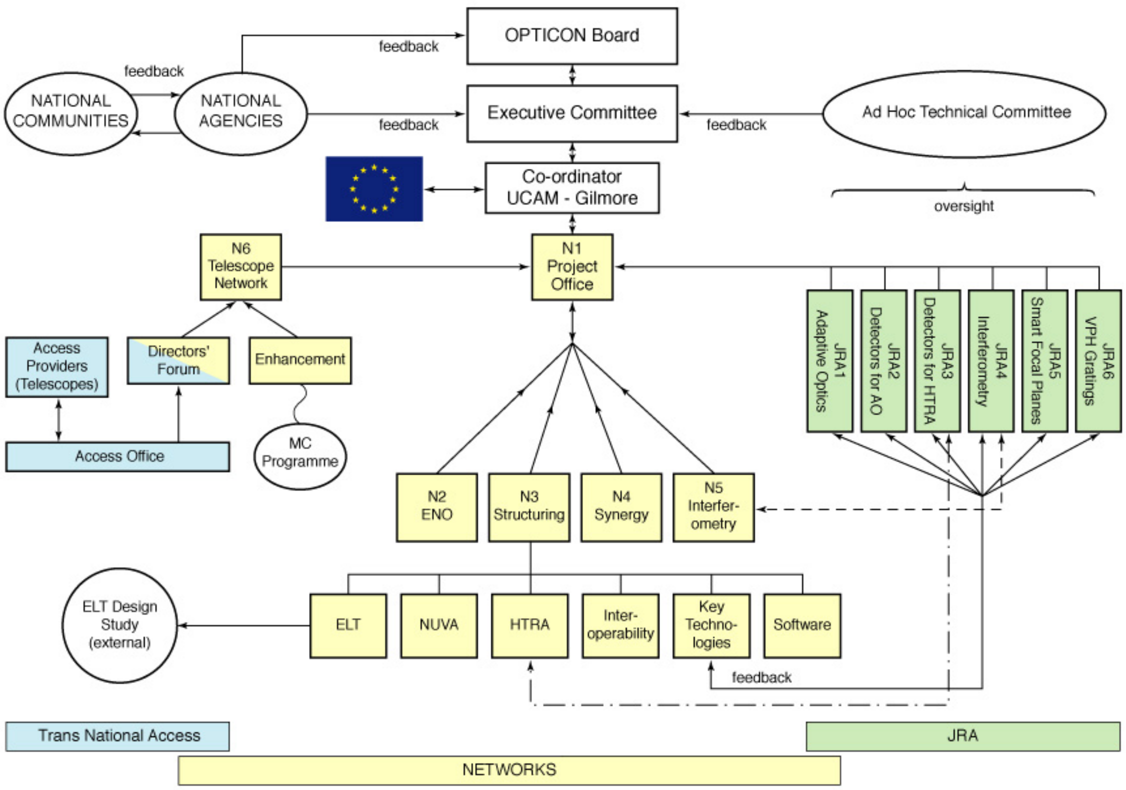
This set of goals is being delivered through the telescope Access program. It is worth emphasising that the OPTICON Access Program, and Telescope Director's Forum, brought together for the first time ever all the directors of all Europe's mid-sized telescopes. That process has led to considerable synergies, with real detailed proposals now under development to harmonise and merge operations between several facilities. All telescope operators have confirmed their enthusiasm for this activity, and intend it to continue. The users are equally happy, with available funded access being substantially over-subscribed. Our ambitions to strengthen and extend the community are proceeding very well, and are purely resource-limited.

- To develop scientific cases, initiate technical investigations, and being planning for next-generation world-class observational facilities, ensuring the continuing excellence and development of European astronomy on the world stage.

This aspect of OPTICON's and Europe's activities has been vastly successful. Thanks to many initiatives, of which the OPTICON activity in developing a common science case, and merging the various national and central technical planning work was a major part, Europe is now fully committed to developing a single European Extremely Large Telescope Project, an approved item on the ESFRI list. This is the first time in over 100 years that European astronomy planning for major new facilities has been competitive with planning and developments in the US. The importance of this activity will only increase.

- To identify those future technical developments which are most necessary to strengthen community scientific quality and productivity;
- To invest in those common technological developments which are critical for the development of the next generation facilities;
- To develop together those techniques, tools, instruments and enhancements which will add value across the whole community;
- To identify support tools, especially software, which can be developed to enhance scientific productivity, and to reduce technical restrictions on scientific use of specialised facilites.

A strong future for European astronomy needs not only a strong user community, and timely plans for excellent facilities, as noted above. Technology and creativity to support those developments is essential. This is the activity of our technology networks, and the JRA activities. These activities form a forward-looking and complementary set of approaches, focussed on developing the best technology in adaptive optics, fast detectors, gratings, interefrometric controls, and instrument designs, interfaces, and data reduction requirements. Progress is detailed in the report, and is simply remarkable. The Executive have been fortunate to be shown some of the developments during relevant meetings, and all are impressed with what Europe's astronomers are achieving.



1.2 NA1: Management Activity

OPTICON operates a distributed management structure. The Co-ordinator (G. Gilmore) is based at the Institute for Astronomy, Cambridge where he is supported by administrative and financial staff. The Project Scientist (J. Davies) and his assistant are based at the UKATC, Edinburgh. The Trans-National Access Office operates from the Instituto de Astrofísica de Canarias (IAC) in La Laguna, Tenerife. In addition the larger JRA and networks have there own local activity leaders with responsibility to ensure progress according to the defined work plan and deliverables. Tasks are clearly divided between these various elements and regular e-mail and telephone communications, supplemented by face to face meetings as needed, have ensured the smooth running of the project.

The primary management activity remains the co-ordination of the six JRA projects, the six complex and multi-activity networking activities, and the trans-national access programme. Note that the trans-national access programme includes every modern 2-4m telescope worldwide with even partial European ownership, as well as several more specialist facilities. These activities are spread across 47 full OPTICON partners, and involve some 70 laboratories and organisations.

Four formal management meetings were held, one of the OPTICON board, the overarching management body, and three of the smaller executive committee. These are detailed in the table below, with links to the minutes of these meetings. The project office, distributed between contractors nos. 1 and 2, provided support for these meetings, produced and circulated planning documents, minutes, etc.

The technical sections of the 2nd annual report were collated at Edinburgh and delivered in a timely manner to the Co-ordinator. The Co-ordinator and his team were then responsible for the integration of the financial information and the final delivery of the report. As in the previous year, this time consuming process included resolving open questions, correcting errors and misunderstandings, obtaining adequate audit certificates and resubmission of the report. Once the final issues were resolved, the management team calculated the correct payments to be made to each contractor, including supplying them with detailed information on how the amounts were calculated and how the delivered funds were to be allocated between work packages within each contractor.

The Project scientist attended the RadioNet FP7 planning meeting in Volterra (April) as part of our ongoing collaboration and subsequently organised an equivalent OPTICON FP7 planning meeting in Edinburgh in June to which several I3 and ERANET leaders were invited.

OPTICON was represented at the IAU General Assembly by a stand in the exhibition hall from which many copies of the ELT science case book/CD, handouts and promotional items (pens, etc) were distributed. A summary of OPTICON progress was presented by the Project Scientist at the half day session on European Activities organised by the EAS.

Figure 1 : OPTICON stand at the IAU Prague

We submitted a bid to be represented at the FP7 launch conference in Brussels scheduled for March 7-18, 2007 but this event was later cancelled.

Special efforts were made to promote the trans-national access programme both at the IAU General Assembly and in other fora.

The Project Scientist participated in meetings of N2, N3.1, N4, N6.1, JRA-1 and JRA5. He was in telephone and e-mail contact with the leaders of all the other activities.

The project office continued to maintain and expand the OPTICON web site. The series of paper handouts were revised and distributed at appropriate events, such as the IAU General

Assembly mentioned above. Articles on progress with the project have appeared regularly in the newsletter of the European Astronomical Society.

The Project Scientist and Scientific Coordinator were in frequent contact with their counterparts in RadioNet, and Astronet. They both participated in meetings of the I3NET forum to share information and discuss common issues with other project leaders.

Participant number[1]	1a	2b	
Participant short name[2]	UCAM - IoA	PPARC - UKATC	**Total**
Person-months[3]	18	15	**33**

Meetings and Workshops

Date	Title/subject of meeting	Location	Number of attendees	Website address
24 Feb 2006	4th Executive Committee meeting	Paris, France	7	
23June 2006	5th Executive Committee meeting	Edinburgh, UK	17	
09 October 2006	6th Executive Committee meeting	Thessanoliki, Greece	12	
27-28 October 2005	3rd Board meeting	Heidelberg, Germany	22	

There has been no general meeting of the entire consortium. It is too large, and its activities too diverse, to make such a meeting productive.

No specific consortium management problems have been encountered.

1 Lead participant first

2 Use the same contractor short names and numbers indicated in the table "list of participants" in Annex I of your contract.

3 AC contractors must include both the total estimated human effort (including permanent staff) and, in brackets, additional staff only.

1.3 NETWORKING ACTIVITIES (other than Management)

1.3.1 NA2: Coordination and Integration of ENO facilities

Contractors:

Participant number[4]	**Participant short name**[5]	**Department/faculty/institute/laboratory involved. SHORT NAME**	**Person-months**[6]
7	IAC	IAC	45 (9)
2	PPARC	ING: WHT/INT	10 (10)
27	IOA-KUL	IOA-KUL	0[7]
8	INAF	TNG	0[7]
25	THEMIS	THEMIS	0[7]
43	IFAE	IFAE	0[7]
17	KIS	KIS	0[7]
20	RSAS	RSAS-ISP	0[7]
22	Utrecht Univ	Utrecht University	0[7]
13	NOTSA	NOT / NOTSA	0[7]
24	Uni-Graz	IGAM	7 (6)
1	UCAM	CAV	0[7]

Other participants[8]:

- ✓ Laboratoire Universitaire d'Astrophysique de Nice (LUAN), France
- ✓ Jodrell Bank Observatory, United Kingdom

Summary of Objectives and progress made:

WP1.: Co-ordination of scientific communities at ENO:

WP1.1.: Dissemination of good practices:

Two general NA2 meeting were organized in 2006, according to the implementation plan approved. Assessment was focussed on the main achievements and challenges of the different working groups.

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4 Lead participant first

5 Use the same contractor short names and numbers indicated in the table "list of participants" in Annex I of your contract.

6 AC contractors must include both the total estimated human effort (including permanent staff) and, in brackets, additional staff only.

7 The staff effort of this participant was related to the attendance at meetings and working groups; no person-months are considered here for this participation.

8 No resources have been made available on the basis of prior agreements. Their participation is related to the attendance of meetings. No costs or resources are identified in Annex I of the contract for their participation

A proposal on science communication submitted to the Spanish Ministry of Education and Science was finally approved. This joint action will support additional initiatives proposed by the Public Outreach working group (WP3.2).

WP1.2.: Laser Traffic Control System (LTCS) for ORM:

Significant progress has been made in 2006 with the Laser Traffic Control System (LTCS) taking shape as initially planned.

After the collaboration with the W. M. Keck observatory to enhance the LTCS priority processing algorithm and display functions, the changes made should be sufficient to support LTCS software implementations at many different sites, current and future, where multiple laser/telescope configurations are planned.

The deliverable D4*: Software implementation* was achieved, and only the LTCS final installation remains to be carried out.

WP2.: Site Characterisation of the Canary Islands' Observatories:

There was a continuous site-testing campaign of night-time at the Degollada del Hoyo Verde at the ORM based on seeing and meteorological characterization.

Important progress has been made in the automatic procedure to obtain a quasi-online measurements of the turbulence profile.

The DIMMA installation has been completed and efforts are being focussed in its calibration. The working group has participated in the main forums related to the ELT Design Study and the organization of the SUCOSIP meeting in June 2006.

WP3.: Joint Information System and Transfer of Knowledge:

WP3.1.: Development of a Joint Information System for Solar Physics (JIS):

The main efforts have been focussed in the promotion of this tool among the international solar physics community at appropriate fora/meetings. As a consequence, the Joint Information System has now registered a considerable number of solar physicists across Europe.

WP3.2.: Co-ordinated actions on transfer of knowledge and public outreach:

Two meetings were organized in 2006. Among the ongoing actions we emphasize the following ones: The production of a DVD for the promotion of facilities at ORM & OT, the collection of content for a joint Public Outreach Website in order to improve the exchange and distribution of information related to the ENO facilities, Participation in the 26th IAU General Assembly, Open Days at ORM & OT during the summer, an Airport touring exhibition and the installation of permanent panels at the Teide Observatory

Achievements and their impact resulting from this activity during the reporting period

WP1: Co-ordination of scientific communities at ENO

WP 1.1 *Dissemination of good practices:*

In 2006 two coordination NA2-ENO meetings were organized: *Freiburg, June 06 and Tenerife September 06*.

VI ENO meeting, Tenerife Sept

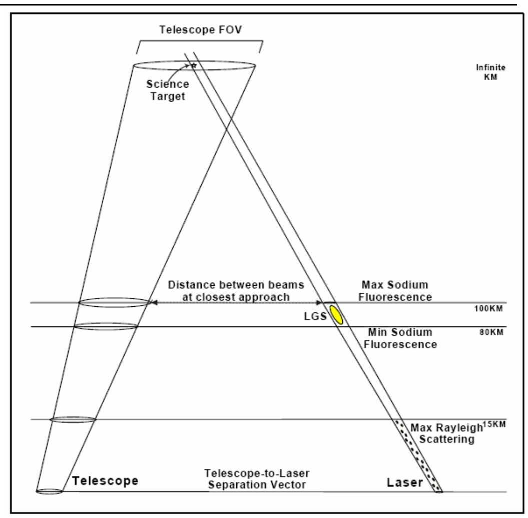
The progress made under the different work packages was addressed, with particular attention to the ongoing activities on Public Outreach, the promotion of the Joint Information System for Solar Physics (JIS), the assessment of the different Site Testing actions at both observatories and the latest news on the Laser Traffic Control System (LTCS) developments.

Spanish funding opportunities have been identified by the Public Outreach working group to support additional actions. Basically, these calls (supported by the Spanish Ministry of Education and Science) are focussed on the promotion of public scientific and innovation culture, and with the aim of increasing the impact of science and its uses on the daily lives of citizens. To this end, special efforts were focussed in the preparation of a proposal submitted in July. This proposal was finally approved, allowing the Public Outreach activities to carry out an additional set of actions that would not be feasible with solely OPTICON support.

WP1.2.: Laser Traffic Control System (LTCS) for ORM:

The laser traffic control work has progressed very well during 2006.

The key achievement has been the completion of all aspects of the software system development, and in terms of formal deliverables, completion of the goals up to, and including D4. The system has been installed at three telescopes: the 4.2-m William Herschel Telescope, the 2.5-m Isaac Newton Telescope, and the 2.5-m Nordic Optical Telescope. Extensive testing has taken place during the summer of 2006, proving the correct functionality of the core system, and the additional tools.



Example telescope and laser geometry

This OPTICON-funded development has now been implemented in a new generation laser traffic control system that will be put in use at a number of observatories around the world.

A paper was presented at the SPIE conference in 2006. Final closing out of the project awaits delivery of the laser hardware and integration of the hardware with the software, and final on-sky testing.

WP2: Site Characterisation of the Canary Islands' Observatories
WP2.1 Co-ordination of night-time seeing measurements with DIMMs:

A continuous site-testing campaign at the Degollada del Hoyo Verde (ORM) has been performed throughout 2006 with the IAC DIMM. This campaign includes seeing and meteorological characterization.

Night time seeing data and statistics are now also available from the project web page http://www.iac.es/project/sitesting/site.html under "Statistics and Data". To the best of our knowledge, this is the first dynamical seeing and meteorological database available at an observing site (Fig2a).

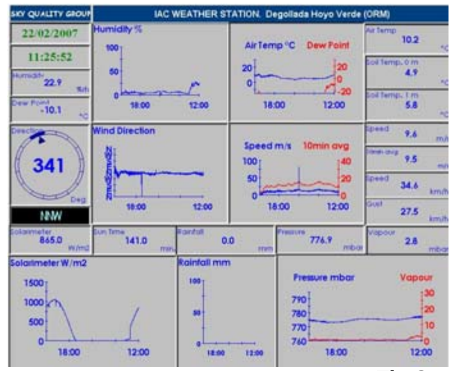


Fig 2a

The main conclusions with regard to the seeing are the following:

- The DHV satisfies the excellence optical conditions obtained at other sites of the Observatory in past years.
- Seeing distribution obtained in some months shows a peak function that is associated with a drastic change of wind regimes. The main symptoms are the large standard deviation of the mean values and therefore the large difference between the mean and the median seeing values obtained in this month.

Year	2006
Ndata	38322
Mean	0.71"
std	0.41"
Median	0.60
Minimun	0.15"
<0.5"	34%
<1"	84%
>2"	2%

Statistical results obtained at the DHV in 2006 are summarized in the table.

Excellent seeing conditions (better than 0.5") are reached 34% of the time. Moreover typical mean and median seeing values of order of 0.71" and 0.60" respectively point to the good quality astronomical conditions at the ORM.

More information about the DHV staion can be obtained at http://www.iac.es/project/sitesting/onlinepro/wstation.html

DIMMA

In June 2006 the DIMMA installation started at the ORM at Las Lajitas. The DIMMA has been mounted on a 5m tower, thus avoiding the surface layer effect on the seeing measurements. Next to the tower we have installed an Automatic Weather Station consisting of a Data Acquisition Unit (DAU) and a lattice tower equipped with standard meteorological sensors. The weather parameters will be stored to be used for climatological analysis and will be also provided on-line for telescope operations. The DIMMA area has been fenced in order to guarantee the security of the station.

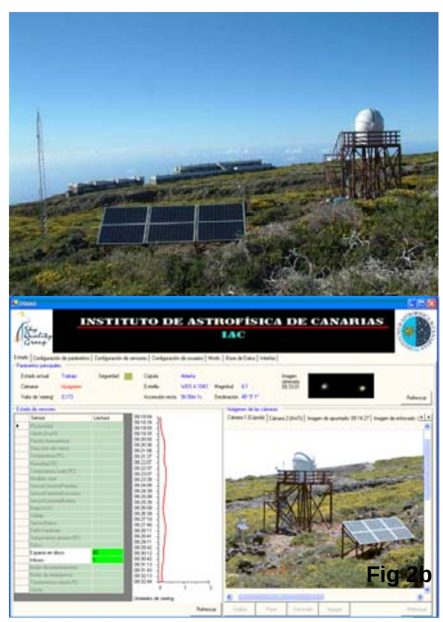


Fig 2b

In Figure 2b (top) we show the DIMMA station at the ORM. The DIMMA is now under calibration and validation and will be fully operative in spring 2007. Figure 2b (bottom) shows the DIMMA interface. There are two web cameras installed at the meteorological mast and another one inside the dome. The centre window shows the seeing profiles during the night. Sensor and operation status information, observed stars, statistical seeing values, etc., are also included.

WP2.2 Co-ordination of day-time seeing measurements at Teide Observatory (OT):

This work-package has been carried out with one of the instruments used for the ATST survey campaign, after installing it at Teide Observatory. Systematic measurements were made over six months. The Delta tropical storm caused severe damage to the instrument, causing the complete interruption of the measurements up to the present.

The analysis of measurements obtained during the systematic day-time site characterization last year has been carried out. Consequently the working group has delivered the statistical data of seeing measurements as planned (D1_WP2.2), available at the NA2 website.

Figure 1 shows, for each month, the fraction of observed hours during the day. Except for the early and late hours, the distribution is rather homogeneous for all cases. As expected, the hour fraction decreases, for September and October, in the early morning and late afternoon.

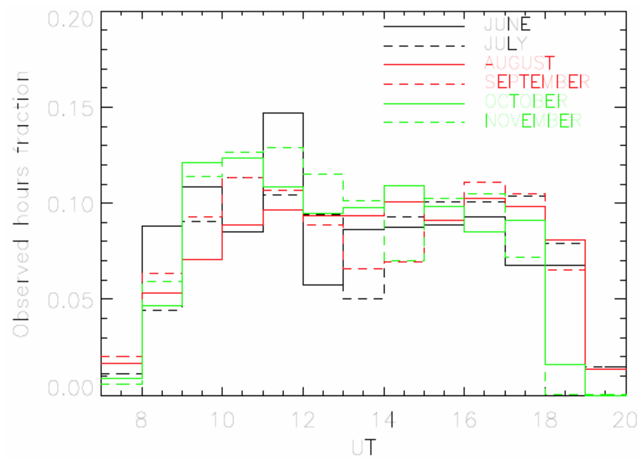


Fig 2c: Distribution of observed hours along the day

It is worth noting that the high number of observed hours and their homogeneous distribution during the day ensures that the data acquired are representative of the period over which the measurements were taken.

WP2.3 Joint actions for meteorology, dust, extinction and Sky Background:

ING, NOT, TNG, MAGIC, and IAC weather stations at the ORM and IAC, GONG and BRT weather stations at the OT remain in operation providing continuous meteorological data. Likewise, the new meteorological station of Mercator (put in operation during 2006) has joined the common platform which provides direct access to current weather conditions at the Canary Islands observatories (http://www.otri.iac.es/na2/weather_conditions.html). A total of nine weather stations are included in this new website.

Fig 2d: Joint meteo webs at both observatories

Dust:


Fig 2e: Airborne particle counter at NOT telescope

The airborne particle counter was installed at the NOT telescope and it is operating with a sample rate of 1 data point every minute.

The sensitivity of an airborne particle counter is determined by the size of the smallest particle the unit can detect. This one has sensitivity of 0.3microns with 95% efficiency.

For the time being data are being stored in a buffer and are not available on-line due to some setbacks with the interface to set up the transfer of data. To obtain real time data new software will be required.

Atmospheric extinction:

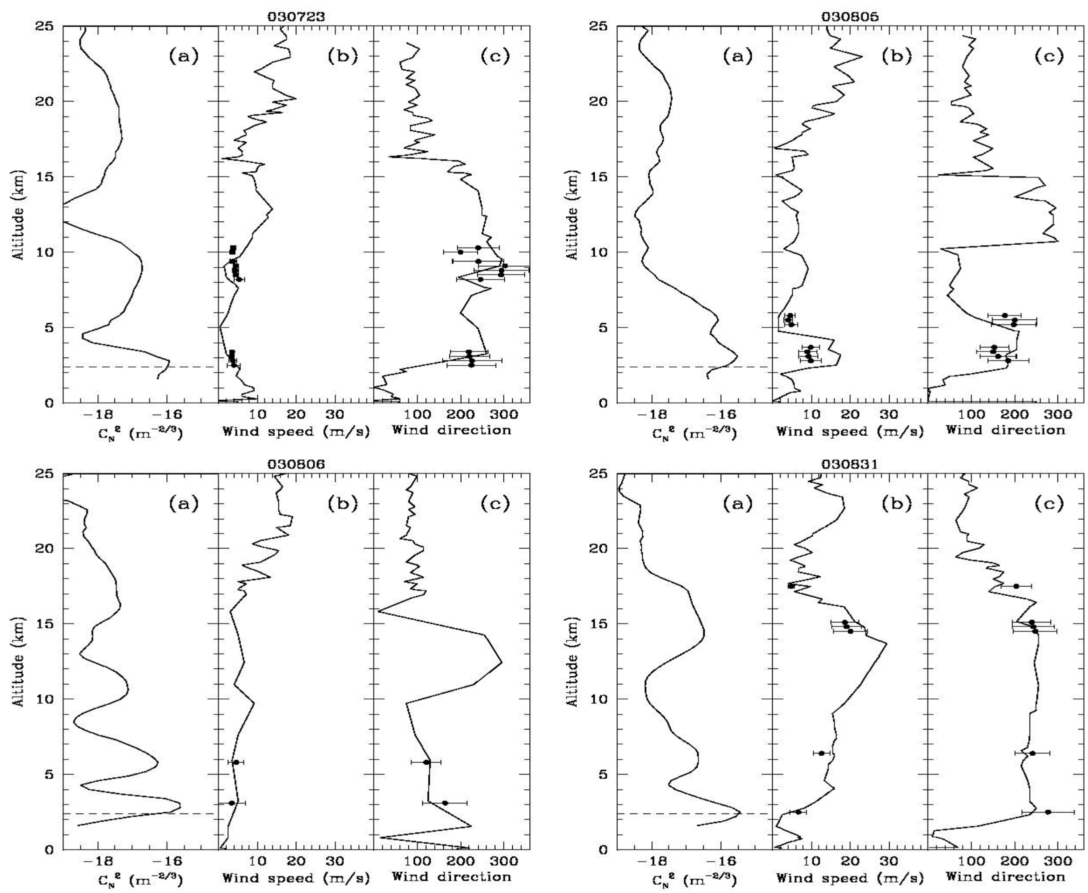
The aerosol index provided by the satellite borne TOMS (Total Ozone Mapping Spectrometer) is one of the most widely accepted tools to detect daily aerosol content. On the other hand, several techniques have been developed to characterize the in situ local presence of dust at the Canarian Observatories. In particular, a parameter related to sky transparency, the atmospheric extinction coefficient, has been measured at the Roque de los Muchachos Observatory (ORM-2396m) on La Palma since 1984 by the Carslberg Automatic Meridian Circle Telescope (CAMC or CMT) and more recently by MERCATOR. Previous work of the Site Testing group has shown that there is no linear correlation between aerosol index provided by the TOMS and atmospheric extinction coefficient provided by the CAMC. One of the main conclusions is that TOMS data alone are not sufficient for site characterization due to its low resolution.

Therefore, the usefulness of satellite data for characterizing the aerosol content above the atmosphere of an astronomical observatory is related to the correlation between the aerosol index (or aerosol optical thickness) and the atmospheric extinction. This is the main goal of a joint action started on April 2006 between the Sky Quality Group of the IAC and Padova University (Dr. S. Ortolani and C. Bertolin). This project consists of exploring the usefulness of data provided by different spectrographs onboard NASA and ESA satellites with better spatial and temporal resolutions than TOMS and centered on channels of astronomical interest. Data analysis will be complemented with those provided by "in situ" instruments (telescopes and particle counters).

In addition, from these satellite data it is possible to look back at the cloud coverage, the climatic trend or the atmospheric turbulence from troposphere winds. The main problem to use these values is their interpretation and their quantitative calibration. Data analysis needs to be complemented with those provided by in situ instruments (telescopes, airborne particles counters, ground meteorological stations, etc.).

WP2.4 Joint actions for Measurement of turbulence and wind vertical profiles (SCIDAR, GSM & DIMM):

Participants in this workpackage are improving the automatic procedure developed to analyse G-SCIDAR observations in order to obtain a quasi-online (with a delay of a few minutes) measurement of the turbulence profile. They are already analysing the turbulence profiles obtained with G-SCIDAR at the Roque de los Muchachos (ORM) during 2004 and 2005 (more than 100000 individual turbulence profiles). Systematic observations with the G-SCIDAR technique are taken at the Roque de los Muchachos and Teide Observatories.



Wind vertical profiles (right–hand panels) and the simultaneous vertical turbulence profile (left han panel) for four nights (dates are indicated at the top of each plot). Error bars only indicate the standard deviation of the G–SCIDAR measurements (around 130 individual profiles) during the ballon ascent. The solid line in the right–hand panels correspond to wind speed measurements with radiosondes launched 13 km away from the observatory and close to sea level. Filled dots are the derived velocities for turbulent layers from the G–SCIDAR measurements during the corresponding balloon ascet.

The participants have also developed new and completely automated software to derive the velocity of the turbulence layers based on wavelet transforms. The algorithm has already been tested with simulated data. These simulations, tests and results were presented at the SPIE meeting "Astronomical Telescopes and Instrumentation" held on Orlando (USA) and the contribution is already published (Garcia-Lorenzo & Fuensalida 2006, SPIE, 6267, 61, "Automatic determination of atmospheric turbulence wind profiles using wavelets"). The proposed algorithm and the first application to real data has been presented in a paper recently accepted for publication in the Monthly Notices of the Royal Astronomical Society (Processing of turbulent-layer wind speed with Generalized SCIDAR through wavelet analysis. García-Lorenzo & Fuensalida 2006, MNRAS, in press).

We have designed and developed a hybrid instrument (a G-SCIDAR and a Shack-Hartmann working simultaneously). The hybrid instrument has two arms, the G-SCIDAR arm (vertical arm) and the Shack-Hartmann arm (horizontal arm). The G-SCIDAR arm is already commissioned and we are obtaining turbulence profiles with a frequency of about six nights every month with this arm at the Teide Observatory. We are still testing the Shack-Hartmann arm. We have already obtained data with the Shack-Hartmann arm and we are developing the software to analyse such data. We have also obtained simultaneous data with the two arms during part of a few observing nights.

A SODAR (Sonic Detection And Ranging) instrument has been installed at the Teide Observatory in order to automatically check the lower layers of the atmosphere. We have started a package of activities to evaluate the characteristics of SODAR techniques in calibration with G-SCIDAR measurements.

We have participated in the Mini-workshop in Atmospheric Turbulence Profiling held in Galway (Ireland) last May (Talk: Profiling of atmospheric turbulence: activities at the Instituto de Astrofísica de Canarias).

WP2.5 Distribution and discussion of results and participation at the scientific forums

Representatives of the working group have participated on the following fora in 2006:

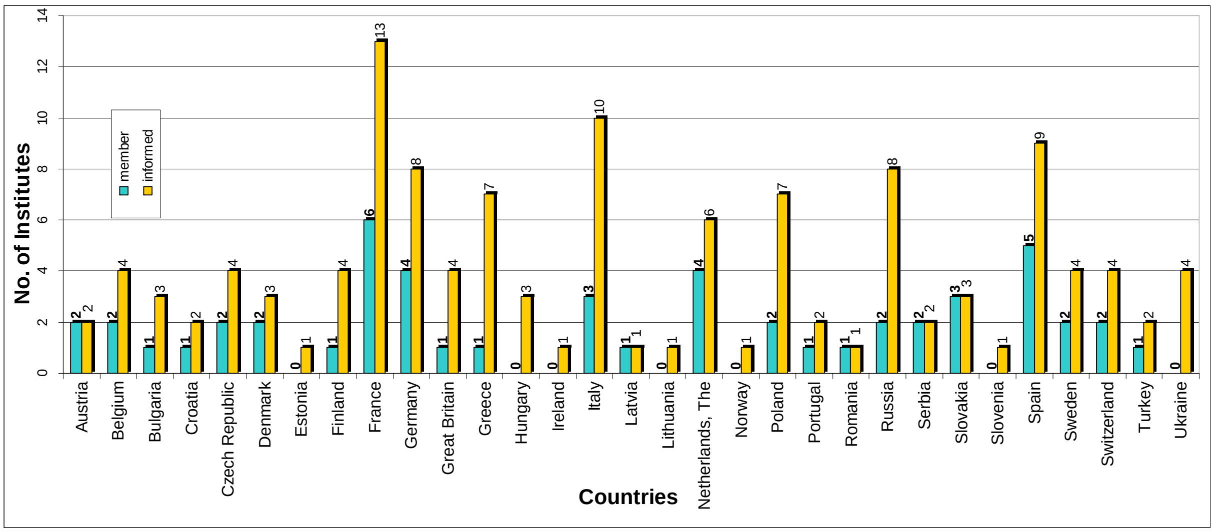
Name of Meeting	Date and Location	Web address
SUCOSIP Meeting	Freiburg, 1st June 2006	http://www.otri.iac.es/na2/
European ELT - WP12000 Progress Meeting,	Madrid, 19-Jan-2006	http://www.otri.iac.es/na2/
	Madrid, 2-May-2006	
OWL-ESO (ELT) GW	Garching 12-14 Jan 2006	
	Garching 6-7 Feb 2006	
	Garching 26-27 Apr 2006	
SPIE: Astronomical Telescopes and Instrumentation 2006	Orlando, Florida, USA. 24-31 May 2006	http://www.otri.iac.es/na2/documents.php?id_proyecto=3
European ELT - WP12000 Progress Meeting	Marseille , 30 November 2006,	http://www.otri.iac.es/na2/
OSC meeting	La Palma, 8 March 2006 Tenerife, 6 September 2006	http://www.otri.iac.es/na2/

WP3: Joint Information System and Transfer of Knowledge

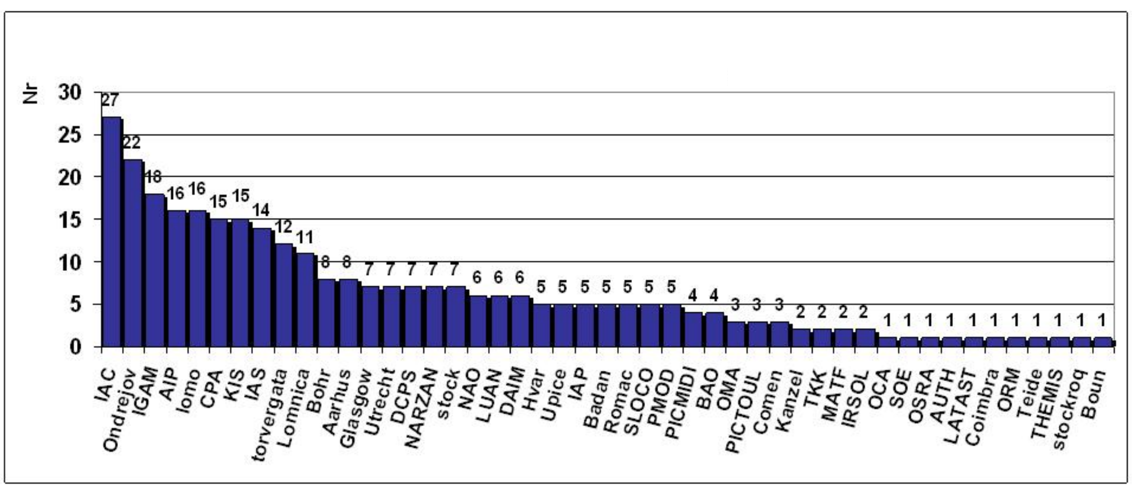
<u>WP3.1.: Development of a Joint Information System for Solar Physics (JIS):</u>

The Joint Information System (JIS) is a fully operational computing tool, which is a combination of a database and interactive web pages, accessible under the web address http://www.solarJIS.com. During 2006 the working group has concentrated its efforts on promotional and maintenance activities of this tool.

A total of 125 scientists have been notified about the JIS tool and how to proceed to register their institutions and researchers. At the end of 2006 a total of 52 institutions from 24 different countries have been included in our database (see next figure).



Around 306 researchers have been already registered from 47 different institutes/observatories (see next figure).



WP3.2.: Co-ordinated actions on transfer of knowledge and public outreach:

Two coordination meetings were organized in May 2006 and November 2006 respectively.

VI Public Outreach coordination meeting

Among the actions placed we emphasize the following ones: collection of contents for a joint Public Outreach Website in order to improve the exchange and distribution of information related to the ENO facilities, Open Days at ORM & OT during the summer, Airport touring exhibition and the Audiovisual (DVD) of the Canary Islands' Astronomical Observatories.

We have subcontracted external services to support the development of some public outreach activities. These services are provided by Rachael Miles, who knows the ORM facilities as well as the staff working there very well. The working group will have this additional support until the end of 2006, Rachael Miles is the contact person for the technical/ logistic issues of all the Public Outreach activities

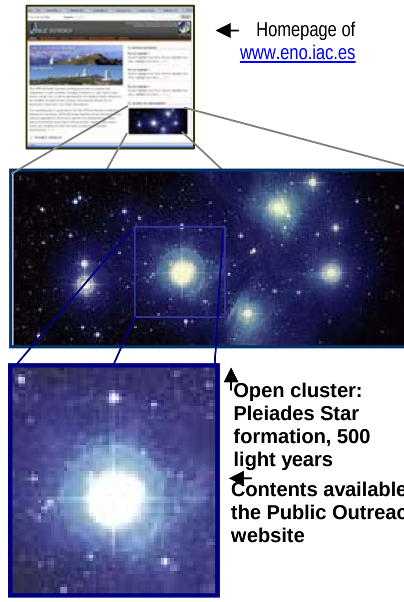
Open-doors Day at OT

The Open-doors Day proposed by Miquel Serra (OT Manager) were focussed in the communication of solar physics (Friday and Saturday 14th-15th July), although there was also a brief introduction to night-time telescopes and the OGS and CMB Experiment (VSA & COSMOSOMAS). Around 1800 visitors joined us during these Open-doors days.

Visit / Open-doors Day at ORM

Given that the model of Open-days proposed by J Carlos Pérez (ORM manager) was a success in 2005, the programme for 2006 was based on the same pilot experience. With the aim of keeping a high level in quality and security provided to visitors, the organizers established a limited number of visitors. The access to the different facilities was organized in groups using buses during four weekends of July / August.

The main facilities involved in the visits were WHT, MAGIC, INT, NOT, TNG



Public Outreach Website

The website's structure as well as the interface to update it is already available on line. The main contents have been uploaded including recent highlights achieved by several facilities at both observatories; activities organized by the working group, educational elements related to astronomy, webcams etc.

As proposed by the working group, the website includes a detailed list of links to the different facilities of the Canary Islands' Astronomical Observatories. The idea is to keep this website quite independent of daily maintenance. Content is available in Spanish and English. There are several sections that will require special collaboration by members of the ENO facilities.

Audiovisual of the Canary Islands' astronomical observatories

DVD Cover pages

The working group has already delivered an entertaining audiovisual (DVD) science show of the ENO facilities which is focussed on Science Communication for the general public.

With a duration of no more than 4 min, this DVD emphasizes the science carried out at each Observatory, with special mention of recent highlights, quality of the Canarian Sky and the promotion of the Public Outreach Website.

The audiovisual is already available in five languages (Spanish, English, Italian, German and French) and also can be downloaded through the Public Outreach Website.

Apart from the audiovisual, the DVD contains an ''extra section'' with detailed information about the facilities as well as an astro-gallery and the Sky Law documentary.

Deviations from the work planned in the last detailed implementation plan.

Deviations associated to specifics work packages:

WP1.2.: Laser Traffic Control System (LTCS) for ORM:

The delay in the arrival of the laser is unpredictable, but expectations are that this will take place in the summer of 2007. The remaining activity for 2007 will be directly linked to the installation and final test of the laser.

WP2. Site Characterization at the Canary Islands' Observatories:
WP2.1: Co-ordination of night-time seeing measurements with DIMMs

Regarding On line Seeing data:

The aerials purchased to put the DIMM seeing data online and mounted at the DHV did not have enough range to guarantee high performance of the signal. The receiver had been installed 1 km away, at the ORM Residence. To overcome this technical problem it was proposed to install a repeater between DHV and the receiver, just at the GTC facility. The corresponding licenses were requested as well as a feasibility study and security regulations. However, the near future installation of a new instrument (a MASS-DIMM) for the E-ELT site testing campaign at the DHV has introduced new communications requirements that will be also used for the DIMM. A new document of network and communications requirements is now being prepared and should be completed by Spring 2007.

WP2.3 Joint actions for meteorology, dust, extinction and Sky Background

Regarding the airborne particle counter:

New software was requested from Vertex to automatically store the measurements of particle numbers and to make it possible to access to the data file in real time. The application developed by Vertex did not satisfy the requirements delaying the previous plans. In February 2007 a new software designed by the NOT staff will be implemented and checked.

List of Milestones and Deliverables achieved in 2006:

Name of deliverable/milestone	Activity (NAx; JRAy)	Work-package /Task	Delivered by Contractor(s)	Planned (in months)	Achieved (in months)
D1. Updated Progress report and revised roadmap	NA2	WP1.1 Dissemination of good practices.	IAC	36	36
M1: Regular ENO meetings	NA2	WP1.1 Dissemination of good practices.	IAC, IOA-KUL, INAF, THEMIS, IFAE, UCAM, Jodrell Bank.	28	29
M1: Regular ENO meetings	NA2	WP1.1 Dissemination of good practices.	IAC, IOA-KUL, INAF, THEMIS, IFAE, UCAM, Jodrell Bank.	33	32
D4: Software implementation	NA2	WP1.2: A co-ordinated Laser Traffic Control System (LTCS) for the ORM	PPARC	25	36
D1. Report: Systematic measurements of seeing & meteorology	NA2	WP2.1: Co-ordination of night-time seeing measurements with DIMMs	IAC, INAF, PPARC, NOTSA	36	36

M1 Automate monitor DA/IAC	NA2	WP2.1: Co-ordination of night-time seeing measurements with DIMMs	IAC	25>>	25>>
D1: Report on systematic measurements using DIMM	NA2	WP2.2 Co-ordination of day-time seeing measurements at Teide Observatory (OT)	IAC	30	31
D1: Annual report on measurements of extinction and dust	NA2	WP2.3 Joint actions for meteorology, dust, extinction and Sky Background	IAC	36	36
D2: Annual report on stations already existing	NA2	WP2.3 Joint actions for meteorology, dust, extinction and Sky Background	IAC	30	30
D1. Report on techniques to get wind profiles	NA2	WP2.4 Joint actions for Measurement of turbulence and wind vertical profiles (SCIDAR, GSM & DIMM)	IAC	36	36
D1. Annual report on discussion forums for site-selection	NA2	WP2.5 Distribution and discussion of results and participation in the scientific forums	IAC	36	36
D3:Report on new institutions interested in JIS	NA2	WP.3.1 Development of a Joint Information System (JIS) on European Solar Physics Facilities.	IGAM, IAC,	30	30
D6: Annual report with the maintenance activities carried out.	NA2	WP.3.1 Development of a Joint Information System (JIS) on European Solar Physics Facilities.	IGAM, IAC,	36	36
M1: Open-doors days at OT and ORM	NA2	WP3.2: Co-ordinated actions on transfer of knowledge and public outreach.	IAC, PPARC, INAF, IOA-KUL, IFAE	30,31	31
D1: New editions of outreach material	NA2	WP3.2: Co-ordinated actions on transfer of knowledge and public outreach.	IAC, PPARC, INAF, IOA-KUL, IFAE	27	31
D2: ENO website. Updated version	NA2	WP3.2: Co-ordinated actions on transfer of knowledge and public outreach.	IAC, PPARC, INAF, IOA-KUL, IFAE	30	36
D4: Programme of activities for the next event	NA2	WP3.2: Co-ordinated actions on transfer of knowledge and public outreach.	IAC, PPARC, INAF, IOA-KUL, IFAE	36	36
D5: Exhibition elements and educational material	NA2	WP3.2: Co-ordinated actions on transfer of knowledge and public outreach.	IAC, PPARC, INAF, IOA-KUL, IFAE	33	31

Meetings and Workshops table

WP1.1 Dissemination of good practices

Name of Meeting	Date and Location	Web address
Fifth ENO meeting	Freiburg, 1st June 2006	http://www.otri.iac.es/na2/
Sixth ENO meeting	Tenerife, 25th September 2006	http://www.otri.iac.es/na2/

WP2 Site Characterisation of the Canaries Observatories

Name of Meeting	Date and Location	Web address
SUCOSIP Meeting	Freiburg, 1st June 2006	http://www.otri.iac.es/na2/
European ELT - WP12000 Progress Meeting,	Madrid, 19-Jan-2006	http://www.otri.iac.es/na2/
	Madrid, 2-May-2006	
OWL-ESO (ELT) GW	Garching 12-14 Jan 2006	
	Garching 6-7 Feb 2006	
	Garching 26-27 Apr 2006	
SPIE: Astronomical Telescopes and Instrumentation 2006	24-31 May 2006, Orlando, Florida, USA.	http://www.otri.iac.es/na2/documents.php?id_proyecto=3
European ELT - WP12000 Progress Meeting	Marseille , 30 November 2006,	http://www.otri.iac.es/na2/
OSC meeting	La Palma, 8 March 2006 Tenerife, 6 September 2006	http://www.otri.iac.es/na2/

WP3.1 Development of a Joint Information System (JIS) on European Solar Physics Facilities

Name of Meeting	Date and Location	Web address
JIS presentation	March 2006, 27-30, Mangavgat, Turkey	http://www.otri.iac.es/na2/
IHY Meeting	January 2006, Paris,	http://www.otri.iac.es/na2/
JIS presentation	May 2006, Potsdam, Germany,	http://www.otri.iac.es/na2/
Name of Workshop	Date and Location	Web address
Solar Flares and Inititialization of CMEs	13-15 Sep, Tatranska Lmonica, Slovakia	http://www.otri.iac.es/na2/

WP 3.2 Co-ordinated actions on transfer of knowledge and public outreach

Name of Meeting	Date and Location	Web address
6th Coordination meeting	Tenerife, 5th May, 2006	http://www.otri.iac.es/na2/
7th Coordination meeting	La Palma, 10th November, 2006	http://www.otri.iac.es/na2/

1.3.2 NA3: Structuring European Astronomy

Participant number	2	2b	
Participant short name	PPARC	UKATC	**Total**
Person-months	7	3	10

WP1: ELT

The objective of N3.1 is to develop the science case for an Extremely Large Telescope (ELT). The network involves over 100 astronomers from around Europe. The effort is coordinated by Isobel Hook. In previous years we have held a series of meetings, including annual meetings on the ELT science case, and produced science case brochure, documents and CDs to support ELT development in Europe.

Since the 2005 annual report the following activities have been carried out or are underway:

The Working Group has aligned the science case development activity with the new European-ELT project. Shortly after the review of the OWL project in December 2005, ESO formed a Science Working Group (SWG) to re-assess the science case for a 30-60m telescope. In April 2006 this activity merged with that of OPTICON - the resulting joint SWG continues to provide close scientific guidance to the project, and the OPTICON ELT project scientist (I. Hook) has become joint Chair of the SWG. Since merging, the group has met four times, has produced a series of recommendations regarding instrumentation and other aspects of the observatory design, and has begun work on a Design Reference Mission. OPTICON has agreed to contribute to the funding of the SWG.

Information about the SWG activities and meetings can be found at http://www-astro.physics.ox.ac.uk/~imh/ELT/SWG/ (but note that this is password-protected because some documents are work-in-progress).

The Network Co-sponsored the Conference "Towards the European ELT", Marseilles, France, Nov 27-Dec 01 2006. Over 250 people attended the conference. I. Hook was one of the three Conference Chairs. The conference web site is http://www.elt2006.org

There was continued close interaction with the European ELT Design Study.

There was continued maintenance of the web site and the mailing list.

WP2: Network for UV Astronomy (NUVA)

The objectives for the Network for UltraViolet Astronomy are:

- Formulate and operate a UV astronomy Network
- Plan and execute a road mapping activity for UV Astronomy
- Exploratory analysis to define scientific requirements for the future of European UV astronomy and make a critical assessment of the publicly available information in various archives.

Activities during the first two years have produced a series of papers on the science cases for UV astronomy in the future. Emphasis is now on defining the best way of delivering these scientific objectives.

WP1: An instrumentation meeting was held in Madrid 17-18 of November to discuss/summarize the characteristics of the instrumentation required from the science case articles. A paper summarizing the results of the meeting is being prepared under the coordination of Norbert Kappelmann (IAAT, Tuebingen) and will be included in the White book of UV astronomy.

WP2: The UV science case book is published: "Fundamental problems in astrophysics: Guidelines for future UV observatories" by Astrophysics & Space Science/Kluwer-Springer (Vol 302). This book represents the draft of the "White book" for UV astronomy.

WP 2.2: D2 – The science case has been discussed during the "Joint Discussion" on "The Ultraviolet Universe: stars from birth to death" held at the IAU General Assembly in August 2006. A summary of the main aspects discussed during the session is published in the proceedings of the IAU GA.

WP3 D2: The NUVA web site has been established (www.ucm.es/info/nuva) . The web is handled by a contents manager so it works as an instrument for publication/interaction among the dispersed UV community.

The UV science case and the UV Instrumentation article was presented at the SPIE conference on: "**Astronomical Telescopes and Instrumentation"** held in Orlando, Florida in 24-31 May 2006

NUVA web continues be used as the contact point to refine the science case after the Joint Discussion at the IAU General Assembly.

WP3: High Time Resolution Astrophysics (HTRA)

Initially in early 2006, an external website was developed to facilitate communication amongst the HTRA community and to advertise an International High Time Resolution Astrophysics Workshop, http://www.htra.ie. The international workshop was held over 2 days on the 6th and 7th of June 2006 at NUI, Galway in Ireland. Over 20 experts were invited to attend and covered such topics as HTRA science drivers, instrumentation, detectors, software and future plans. More than 45 delegates attended from over 13 countries. The feedback that was received from the workshop was very positive.

In conjunction with the workshop, significant progress has been achieved on compiling a book on the state-of-the-art in HTRA. The book will be published as part of the Astrophysics & Space Science Library (ASSL) by the publishing house Springer-Verlag. A HTRA editorial board has been established to oversee the process, and ensure scientific relevancy and quality. All the chapters have been submitted and the refereeing process is in its final stages. Leading experts throughout the world have been selected in the refereeing process to ensure an authoritative review for what will be a benchmark reference volume of the current state-of-the–art research in high time resolution astrophysics. The final refereed manuscript will be submitted to the publisher in early 2007.

WP4: Astrophysical Virtual Observatory (AVO)

In 2006, the EURO-VO Project selected its Science Advisory Committee (SAC). It is composed of 17 leading European researchers outside mainstream VO projects and one representative from a non-European VO project. The EURO-VO Data Centre Alliance, Technology Centre, Facility Centre, and ESA-VO scientists are also de-facto members. The SAC meets twice a year and provides scientific input to the project, promotes VO science in Europe, and is the contact point between European astronomers and EURO-VO.

The first meeting of the EURO-VO SAC took place on April 27 – 28 at ESO, Garching, and was attended to by 18 people. SAC members were introduced to the different aspects of the EURO-VO through various presentations and discussed the way the SAC will function. A first set of recommendations was provided to the EURO-VO Executive. The meeting agenda with all presentations and minutes is available at http://www.euro-vo.org/twiki/bin/view/Fc/SacMeeting01.

WP5: Key Technologies Network

The principal objectives of the Key Technology Network (KTN) are to identify key technology needs, look for opportunities which technology developments in other sectors provide for astronomy, encourage European collaborative technology development projects, and provide a form for discussing potential routes for further development.

The scope of meetings and road-mapping activities of the Key Technology Network states that:

- The focus of the KTN activities is *enabling* technologies
- The KTN supports the development of facilities (telescopes) as well as instruments
- The core activity of the KTN is in the wavelength region 300 nm to 35 μm.
- The KTN supports a balanced portfolio of low risk and high risk technology developments
- The KTN supports the integration of telescope and instrument test facilities.

The four technical meetings (listed below) held during the last year have clearly fallen within the scope of the KTN. All dealt with enabling technologies which will be required for an ELT and other leading telescopes. Adaptive optics technology is clearly vital to telescopes as well as instruments. A new area of research has been opened up in terms of the Photonics Spectrometers – a high risk technique which offers great potential benefits in terms of functionality for future instruments. The Smart Focal Planes discussions on FP7 technologies covered a broad range of technologies from underpinning science on cryogenic materials to prototype devices for VLT third generation. The WHT AO addressed the last bullet point, with the proposed testing of technologies on sky.

An updated technology roadmap was presented at the major OPTICON meeting in June. Such techniques are clearly going to be vital as scarce resources are allocated between projects during the preparation in 2007 of the FP7 proposal. At the KTN meeting in Orlando, the members and associates were brought up to date on the activities, the schedule for FP7 preparation, and the opportunity for them to host KTN meetings. A new template was agreed which will be used to gather information in Spring 2007 for inclusion in the final 2007 roadmap.

WP6: Future Software

Scope and objectives for WP 6 were defined in 2004 and are available on the TWiki based Web site at URL: http://archive.eso.org/opticon/twiki/bin/view/Main which is also used for exchange of ideas and proposals. Monthly phone meetings were held to ensure that all members are update on discussions (minutes are on the TWiki).

Our final version of the detailed high-level requirements was finished on 01-08-2006 (milestone M2a) after a formal, written review procedure within the Network. It contains 192 explicit requirements in three priority levels for a future astronomical software environment (see TWiki). This version has been available for comments from a broad Internet community of astronomers until 2007-02-06 after which a final revision will be made.

The architectural concept including definition of parameter parsing was consolidated in a face-to-face meeting June 2006 and will be formally reviewed in 2007. A search for open source packages which could be used for the execution framework defined by the architecture was performed and several candidates were identified (e.g. Open RTE, and D-bus).

A set of simple prototype implementations was initiated and will be used for the specification of interfaces. They will also provide input for a final revision of the architectural concept.

The Network activities were presented at the IAU General Assembly in Prague and at the ADASS 2006 conference where a Birds-of-a-Feather session was devoted to it. This improved the awareness of our efforts in the community significantly.

The milestone M2a was achieved after the written review and the revision of the high-level requirements at the fourth face-to-face meeting. The final version of the requirements was posted on 2006-08-01 and an Internet wide review was conducted (deadline of 2007-02-06). The document is available at the URL: http://archive.eso.org/opticon/twiki/bin/view/Main/DetailedHighLevelRequirements

Milestone M3a was achieved at the fourth face-to-face meeting where the architectural concept was discussed and agreed upon. It is described on our Twiki at URL: http://archive.eso.org/opticon/twiki/bin/view/Main/ArchitectureAndFrameworks

The fourth face-to-face meeting was mostly devoted to two main topics, namely: a final discussion on the detailed high-level requirement based on the comments received through the written review, and consideration of a prototype which could demonstrate to feasibility of the architectural concept and help specifying interfaces. A short fifth face-to-face meeting was held just before the ADASS 2006 meeting in Tucson, USA, as several of the Network members also participated in this conference. Minutes of the meetings are available at the URL's.

The high-level requirements for a future astronomical software environment were finalized after a formal, written review procedure which included comments from a wider community of astronomers via the Internet.

The architectural concept was consolidated during our face-to-face meetings and will be used as a basis for several prototypes to be started in 2007. Several open source projects (e.g. OpenRTE and D-bus) were identified which could be used for the implementation of the environment.

Milestones And Deliverables Achieved During The Reporting Period

Activity	Deliverable/ Milestone No	Deliverable/Milestone Name	Work-package /Task No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
NA3	M1	ELT Science Meeting (Marseille)	WP1	PPARC	35	35
NA3	M1b	Meeting on Future of UV Astrophysics (held during IAU General Assembly)	WP2	PPARC	32	32
NA3	M5 (M4b)	HTRA conference	WP3	NUIG	30	30
NA3	D1	Book on the state-of-the-art in HTRA	WP3	NUIG	34	>>38
NA3	D2	Present Technology Report	WP5	UK ATC	30	30
NA3	M2a	High-level Requirements version 1.0	WP6	ESO, PPARC, ESA, RDS, NOVA, INSU/CNRS, NOTSA, INAF	30	32
NA3	M3a	Draft architecture	WP6	ESO, PPARC, ESA, RDS, NOVA, INSU/CNRS, NOTSA, INAF	30	30 (first draft)

Major Meetings And Workshops Organised During The Reporting Period

-

Date	Title/subject of meeting /workshop	Location	No. of attendees	Website address
27th – 28th April 2006	WP4: EURO-VO SAC	Garching, Munich	18	http://www.euro-vo.org/twiki/bin/view/Fc/SacMeeting01.
17-18th May 2006	WP5: Adaptive Optics	Munich	14	http://www.astro-opticon.org/meetings.html
24 – 31 May 2006	WP2: UV science case and the UV Instrumentation article presented at the SPIE conference	Orlando, Florida	~20	http://www.htra.ie.
29th May	WP5: Framework 7 Roadmap	Orlando	21	http://www.astro-opticon.org/meetings.html
6 – 7 June 2006	WP3: HTRA Workshop	NUI, Galway, Ireland	~45	
12 June 2006	WP6: 4th face-to-face meeting	ESO, Munich, Germany	13	http://archive.eso.org/opticon/twiki/bin/view/Main/FaceToFaceMeeting20060612
21/22nd June	WP5: OPTICON	Edinbugh	35	
17 Aug 2006	WP2: IAU Joint Discussion in UV Astronomy at IAU General Assembly	Prague, Czech Republic	~40	UV meetings website
14 – 24 Aug 2006	WP6: Network presentation at IAU General Assembly	Prague, Czech Republic		
23-24th Aug	WP5: Photonics Spectrometers	Edinburgh	12	
15 – 18 October 2006	WP6: 5th face-to-face meeting at Astronomical Data Analysis Software & Systems (ADASS) Conference	Tucson, USA	5	http://archive.eso.org/opticon/twiki/bin/view/Main/FaceToFaceMeeting20061015
20-21st Oct	WP5: WHT as AO testbed	La Palma	13	
27 Nov – 1 Dec 2006	WP1: ELT Science Meeting	Marseille, France	~250	http://www.elt2006.org
17 – 18 Nov 2006	WP2: NUVA Instrumentation Meeting	Madrid, Spain	7	See Chapter by Kappelman in the UV "White Book"
7th Dec	WP5: Smart Focal Planes	Neuchatel	12	

1.3.3 NA4: Mechanisms for synergy in space-ground coordination

OPTICON network N4 was set up to develop proposals to enhance synergies between space and ground-based astronomy. Under this umbrella, two activities were undertaken :

- **Scientific Support**: to analyze the situation regarding scientific support for exploitation of European space- and/or ground-based astronomical infrastructures, and to propose mechanisms to improve situation by (a) reinforcing competitiveness of the European astronomical community in the face of international competition and (b) supporting groups carrying out "key" programmes.

- **Test Facilities**: to make a census of the unique test facilities developed by European institutes and investigate possible synergies.

Meeting of each work package were held in the Spring, but due to lack of progress in the discussions with the EC regarding opportunities for FP7 the planned follow-up meetings in June were cancelled. After further consideration by the Executive and the board meetings in 2006 it was concluded that this activity was unlikely to achieve any further progress before the FP7 calls began and it was terminated in late 2006 with the remaining resources being re-allocated to other activities.

Meetings and workshops

	Date	Title/subject of meeting /workshop	Location	No of attendees	Website address
1	23/11/2006	Synergy meeting	Paris, France	5	N/A
2	24/11/2006	Test Facilities meeting	Paris, France	5	N/A

1.3.4 NA5: Interferometry forum

Participant number[9]	Participant short name	Person-months[10]
12	NOVA	1 (0.5)
21b	ULg	1 (0.5)
34	NCU/UMK	0.5

Table N5.1: Effort of participants' personnel in network.

Although the group has been very active, no staff efforts (Table N5.1) have been charged to the project. Only travel and material cost have been charged to the project.

The flyer on the Network activities, which had been produced in 2005, was distributed at a number of venues.

The European Interferometry Web-site that contains the most up to date information about the European Interferometry Initiative (EII) activities and the Network Activities (www.strw.leidenuniv.nl/~eurinterf) has been updated. Migration of the web page to a server in Heidelberg has been initiated.

Fizeau exchange visitors program

New announcements of the Fizeau Exchange Visitors Program have been widely distributed through relevant mailing lists, web-pages (http://www.strw.leidenuniv.nl/~eurinterf), and direct mailing. A poster with the announcement was mailed to a long list of astronomical institutions in Europe.

On 15 March (call 2006A) and 15 September (call 2006B) 2006 two new application rounds for the Fizeau Exchange Visitors Program were closed. The applications were reviewed by the Network Board and suitable candidates were identified. This has resulted in four exchange visits. Most exchange visits involve scientists from institutions that do not have much expertise in interferometry; many of these are from central European countries. Several participants in previous exchanges have applied again; this means that longer-term collaborations between institutions with little expertise in interferometry and expert institutions are being established.

Applicants name		Home country	Host country	Host city
First	**Last**			
Erez	Ribak	Israel	Italy	Torino
Mosoni	Laszlo	Hungary	Germany	Heidelberg
Krzysztof	Gozdziewski	Poland	France	Paris
Tomasz	Laczkowski	Poland	France	Nice

Table: N5.2: Participants of Fizeau Exchange Visitors Program in 2006.

Working groups

[9] Lead participant first

[10] AC contractors must include both the total estimated human effort (including permanent staff) and, in brackets, additional staff only.

Three working groups hade been established in 2004. These were: "Interferometric scientific council", "Radiative transfer", and "Atmospheric modelling". The latter two groups were merged by request of the group members in 2005. This group met in Paris in June 2006. A new working group on "Interferometry and asteroseismology" was established in 2005 and met for the first time in November 2005 in Porto. The members of the group worked on an extensive report during 2006; it will be released in 2007.

Scientific Council

The "Scientific Council" met several times by teleconference; subgroups of the Scientific Council met in May in Orlando and in August in Prague, on the occasion of the SPIE Conference on Astronomical Instrumentation and of the IAU General Assembly, respectively. The representatives (one for each participating country and the two international organisations ESO and ESA), who were elected in 2004, continued to serve on the Scientific Council. Minutes of the meetings have been compiled and distributed.

Country	Member	Status
Austria	Josef Hron	
Belgium	Jean Surdej	
Switzerland	Didier Queloz	
Czech Republic	Pavel Koubsky	
Germany	Thomas Henning	President
Spain	Carlos Eiroa	
France	Christian Perrier	
United Kingdom	David Buscher	
Hungary	Lajos Balazs	
Italy	Mario Gai	
Israel	Erez Ribak	
Netherlands	Eric J. Bakker	Deputy-president
Poland	Andrzej Niedzielski	
Portugal	Paulo Garcia	
ESO	Guy Monnet	
ESA	Malcolm Fridlund	Observer

Table: N5.3: participants of working group "EII scientific council".

Next-generation interferometric infrastructure

The proceedings from the second workshop on next-generation interferometers, which had taken place in Liège in 2005, appeared in print ("Technology roadmap for future interferometric facilities", edited by J. Surdej, D. Caro, & A. Detal). A group with European and US participants met in May in Orlando on the occasion of the SPIE Meeting on Astronomical Instrumentation to discuss possibilities for transatlantic coordination and collaboration in the preparation of a next-generation interferometer. It was decided that representatives of the OPTICON Interferometry Forum would be invited to a workshop held at NOAO (Tucson) in November 2006. At that workshop, the results from the two Liège workshops and other work done by the participants in the Interferometry Forum were presented to the US interferometric community. In the ensuing discussions, it was pointed out that further collaborations in this field would be highly desirable both from the US and European viewpoints. A detailed report from the NOAO meeting is currently being prepared for release in 2007. Participants in the OPTICON Interferometry Forum participated in a number of meetings on plans for FP7 during the year 2006 in order to prepare for a proposal to be submitted in 2007.

Milestones and deliverables

Milestones/ Deliverables	Deliverable/Milestone Name	Workpackage/ Task no.	Lead Contractor(s)	Planned (month)	Achieved (month)
WP1					
M2	Annual call for applications	1	NCU	30	27 &33
M3	Collate list of applicants	1	NCU	32	28 & 34
M4	Selection of exchange visitors	1	NCU	34	28 &34
D1	Report from participants	1	NCU	36	36

Table N5.5: milestones and deliverables for interferometry forum during 2006 (copied from 0318-CONTRACT-ANNEX_1.doc)

Milestone WP1.M2, WP1.M3, and WP1.M4 occur twice in the year 2006 since applications for the Fizeau Exchange Visitors Program were accepted every 6 months.

Meetings and workshops

Date	Title/subject of meeting /workshop	Location	No of attendees
26 May 06	Subgroup of "Future Facilities"	Orlando	5
22-23 Jun 06	Working Group "Radiative Transfer"	Paris	20
13-15 Nov 06	Subgroup of "Future Facilities"	Tucson	8 (+60 US)

Table N5.6: overview of meetings.

1.3.5 NA6: OPTICON Telescope Network

Participant number	7	
Participant short name	IAC	**Total**
Person-months	27 (24)	27 (24)

WP1 : Telescope Directors Forum

The telescope directors forum comprises the directors of all those telescopes in the Trans-national access programme, and hence represents all modern 2-4m telescopes with European involvement. The primary responsibilities of the group are oversight of the trans-national access programme, planning for future co-operation and preparing for FP7 opportunities. The group is chaired by the Project Scientist whose time is accounted to management effort.

A splinter meeting of this group was held in Freiberg on May 31 and June 2 2006 to prepare for the OPTICON FP7 planning meeting. An outcome of this was the presentation by R. Rutten and B. Nordstrom at the Edinburgh meeting. The main Annual meeting was held in Tenerife on September 29th.

Highlights of the year's activities included:

- The report of the review panel confirming that the Liverpool telescope now fully meets our requirements for entry to the access programme

- Demonstration of a proof of concept software package for common telescope submission software. This is based on the Northstar system developed by ASTRON for RadioNet. The demonstrator was designed to show the capability for the system to support a set of four telescopes operating with a common TAG. An additional module to support UKIRT service observing has also been developed. These two activities appear to have shown no obstacles to further developing the system and then adopting it at several of the OPTICON supported telescopes.

- A review of the allocations under the access programme was made and an agreement was reached to plan a smooth spend profile reaching ~80% in 2007 and ~100% 2008. The rationale for this was to avoid a sudden break in the programme between FP6 and FP7 and in particular to avoid a situation where new communities, who were just now being to appreciate the programme, were denied access in the final year of the contract for financial reasons.

There was further discussion of our FP7 plans, and agreements to have three small sub-groups develop these ideas in more detail.

WP2: Operation of the Trans-national Access Office

In 2006 the Access Office has devoted a total human effort of 18 person-months. During this year its two main objectives (management of the Trans-national Access Programme and interface between the bodies and communities involved) have been accomplished.

As a complement to the assistance provided to the Telescope Operators in the fulfilment of their obligations (according to Annex I of the *Basic Contract*, page 45) the Access Office has implemented the following actions during 2006:

Maintenance of the database powered website of the Access Programme

The Access Office staff has periodically updated the contents of this key interface with users for sharing relevant information, application forms, reports, documents, statistics, etc.

Publicity for the Trans-national Access Programme

As a complement of the publicity made through the website of the Access Programme (and through the OPTICON site), a set of publicity actions has been carried out during 2006: participation in conferences such as the IAU 2006 conference in Prague, attendance at info days, meetings, etc.

4. Trans-national Access Programme. Impact, progress and output

As well as the daily operation and promotion of the Access Programme, the Access Office is committing significant effort to meet EC requirements (annual reports, etc.) and to analyse the impact and progress of this activity by assessing the scientific output, user questionnaires and feedback, identifying new users, analyzing the procedure for awarding time, etc.

4.1 Progress reports to be delivered in accordance to Annex I of the contract.

Every four months the Access Office has delivered standardised progress reports by collecting and providing detailed statistics to the Telescope Directors' Forum about the type and characteristics of observing runs supported under the Access Programme (see table with such deliverables).

4.2 User questionnaires and feedbacks

User groups awarded telescope time under this Access Programme have been invited to complete a user questionnaire.

Information from these questionnaires and feedback tells us more about the various users of the Access Programme. This information helps us to understand our users' needs and their opinion about the services provided. It enables us to meet those needs by making the Access Programme as useful as possible.

4.3 International partnership. Analysis of current situation and trends.

As part of the analysis carried out by the Access Office to monitor the impact of the Access Programme among the Astronomical Community, we have analyzed the establishment of international partnerships in those observing projects submitted for telescope time, with special attention to those with awarded time under this Trans-national Access Programme.

4.4 Scientific fields addressed by OPTICON user teams.

The astronomical research carried out under the OPTICON Access Programme is focussed in optical and infrared observing projects as well as in solar physics. As part of the progress and outputs of the Access Programme in this period, the Access Office has collected all the projects summary reports of such observing projects asking astronomers for their corresponding scientific fields

4.5. Evaluation of the common proposal submission system options

After the analysis of procedures for awarding time carried out by the Access Office, detailing the current situation and possible scenarios for a better coordination and optimisation of telescope time, we have collaborated in the first steps to evaluate a joint proposals submission tool for telescopes under the OPTICON Access Programme.

Milestone and deliverables for this WP, as defined by the implementation plan, have been successfully achieved.

NOTE: See the reports about the Access Programme for further details about this WP.

WP3: Enhancement
Network N6.3 operates in collaboration with a Marie-Curie action (NEON) aimed at improving the access of young researchers to hands on experience at research grade telescopes. The activity continued in 2006 as planned, with a steady growth in the activities. Two Neon schools were held during the summer, with additional support from OPTICON in the form of brief visits by experienced astronomers to work with the NEON students.

The first school was held in the Observatorie Haute-Provence from July 23 to August 5. A dozen lecturers and tutors gathered with twenty-two PhD students of 16 different nationalities (with an exact distribution of gender!), to conduct small practical projects during the two-week school. The participants were distributed into five small groups, for efficient transmission of experience and used four different telescopes ranging from the 80cm one used to master the target acquisition techniques, to the 1.93m used for spectroscopy. In addition, the presence on the site of a strong instrument development group and of large geophysical activities allowed also the participants to be introduced to the novel techniques now being developed for VLT's and ELT's: adaptive optics, characterisaton of the properties of the atmosphere and laser developments for both ranging and laser guide star production.

The second school was held at ESO-Garching from August 30th to Sept. 9 and concentrated more on the exploitation of archival data, from ground or space facilities. This was particularly important to show the necessary complementarities between the various facilities available to astronomers, and the power of multi-wavelength analysis. Here also, under the direction of expert astronomers, small research projects were conducted by 20 students distributed in 5 groups, representing 13 different nationalities, with a majority of females.

Feedback from participants indicated that the schools were a success and the pressure factor, already up to 4 this year, may well rise even more in the future. Besides the enhancement of the efficiency of research on the technical side, the participants also welcomed the possibility of exchanges with colleagues from other countries, and the discussions and guidance given on the job opportunities in the various EU countries.

A full report on these two schools has been given in the ESO Messenger (n.126, Dec.2006 issue, p. 52) and some of the work done is already in press in scientific journals. On the organisational side, M. Dennefeld attended the annual meeting of the SREAC (Sub-Regional European Astronomical Committee for south-eastern european countries) in March. He presented the possibilities offered by OPTICON and its Enhancement activities and collected wishes and ideas from those countries. As a result, many more applications from Bulgaria, Turkey, Romania, Serbia, etc, were received for the Neon schools and several good candidates could be selected.

A small enhancement meeting was also held on May 30 in Strasbourg, together with a Eon meeting, to discuss future activities and plans.

Milestones and Deliverables

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Task No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
M2	Annual Directors' Meeting	WP1	PPARC	33	33
M4A	Peer review of Liverpool telescope	WP1	PPARC	21	33
D1	Promote Access programme at IAU meeting in Prague	WP2	IAC	32	32
M2	3rd Report to Directors forum	WP2	IAC	36	27 (preliminary report) 32 (1st update) 36 (2nd update)
M4B	Peer review of Aristachos telescope			21	Postponed to month 40
M3a	Working group Meeting	WP3	CNRS,IAP	29	29

Meetings and workshops

Date	Title/subject of meeting /workshop	Location	No of attendees	Website address
30 May 2006	WP3: Enhancement WG	Strasbourg, France	5	http://www.astro-opticon.org/meetings.html
31 May/02 June 2006	WP1: Splinter meeting to discuss FP7 plans	Freiberg, Germany	8	http://www.astro-opticon.org/meetings.html
22/23 June 2006	WP1: Presentation on behalf of TDF given at OPTICON in FP7 Meeting	Edinburgh, UK	65	http://www.astro-opticon.org/fp7/index.html
29 September 2006	WP1: Telescope Directors Forum meeting	La Laguna, Tenerife, Spain	22	http://www.astro-opticon.org/meetings.html

1.4 TRANSNATIONAL ACCESS ACTIVITIES

1.4.1 OPTICON Trans-national Access Programme

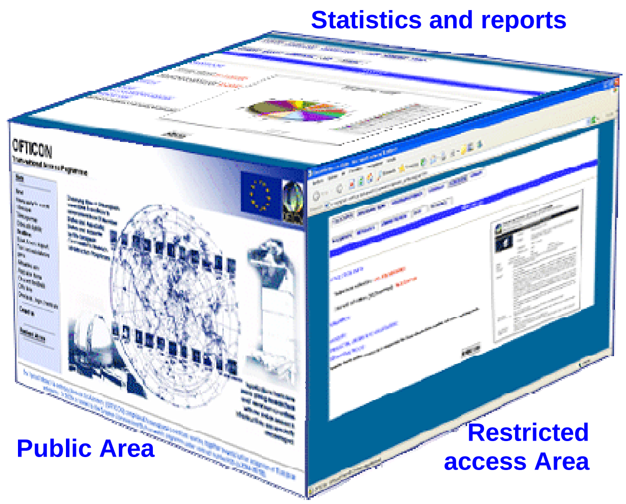
1.4.1.1 Description of the publicity concerning the new opportunities for access

The Trans-national Access Programme is already well known among the international scientific community, especially by new users and young European researchers. The oversubscription of eligible teams at most of the OPTICON telescopes provides clear evidence that the appropriate dissemination of information is being achieved. For example, it should be noted that this opportunity for Access under the auspices of this EC contract has been widely publicised through the Trans-national Access Programme Website (http://www.otri.iac.es/opticon/).

Both the Public and the restricted access areas of the Access Programme website have been maintained and updated:

Public Area:

In the Public area, one of the important elements is the section where the next application deadline for each telescope is available with a direct link to the corresponding announcement of opportunity and application form. In addition, a complete contact list of scientific and technical support is available, guaranteeing the most suitable advice level for users.



Similarly, we have updated brief descriptions of each telescope (location, instruments, full address, funding sources, etc.), a guideline on how to apply for access, criteria of eligibility, travel and subsistence grants, information on allowable expenses, etc.

As a complement of the information available in the Public Area, this website provides users with a list of useful links to Observatories, Survey data / Catalogues, Literature / Directories, astronomical and physics links, as well as a section of the OPTICON facilities' newsletter and a download section of the Access Office with promotional material about the Access Programme.

2. Restricted-access Area:

The information accessible through the public area is automatically powered and updated from the restricted-access area. This area also allows the management of the programme and tracking of observing runs awarded, providing tools for the cross-correlation of information like composition of user groups, telescopes, grants, payments, statistics, etc.

Three different levels of access are established to entry into this area:

Level 1: OPTICON Users
Level 2: Telescope Operators

Level 3: Access Office and administrator of the system.

Promotion of the Trans-national Access Programme at other Websites:

Information about the Access Programme can be found on the corresponding web sites of each of the 22 participant telescopes. Each observing campaign is widely advertised there. Announcements of Opportunity are normally published twice a year via the Internet as well as via extensive distribution to the international astronomical community.

As a complement, other activities to advertise this Programme were carried out during 2006:

General publicity: participation in conferences, info days, meetings, etc

Further efforts at advertising this Programme were made at the 26th General Assembly of the International Astronomical Union (Czech Republic, Prague August 14th - 25th). Personalized advice was provided to those present at the IAU conference, detailing how to apply for time. Results of participation in the first two years of this contract were also shown. Handouts were made available during the conferences and posters summarising the Programme were exhibited.

Posters presented at the IAU General Assembly *(Prague, August 06)*

1.4.1.2 Description of the selection procedure

Observing time is awarded following standard selection procedures at each telescope or group of telescopes, which are mainly based on scientific merits and feasibility.

Since 22 medium-sized telescopes are offered under the contract, and they are operated by different legal entities / countries, specific criteria of eligibility differ from one telescope to another. The procedure to apply for telescope time under this EC contract is to do it in response to the different Announcements of Opportunity for observing time at each telescope.

Once the deadline for submission of proposals has been closed, Time Allocation Committees (TACs)[11], composed of experts of international reputation, evaluate the proposals received

[11] See Annex 2: Selection Panel members list.

and approve a ranked list for distributing the observing time available among the most highly rated proposals.

The prime consideration of these TACs in making awards is scientific merit and technical feasibility. Teams compete on the basis of equal opportunity. However, new users, young researchers and users from countries with no similar research infrastructures are especially encouraged to apply for observing time.

Following EC guidelines, criteria of eligibility of the astronomers who want to benefit from this Access Programme are mainly based on the country of origin of the user group (as defined below), and the ownership of the telescope for which observing time is applied to (or country of the entity/ies responsible for its operation). These criteria apply separately to each telescope.

To be eligible to benefit from access to a particular telescope under the contract, a user group[12] must satisfy the following conditions:

- both the user group leader and the majority of the users must come from Member States or Associated States;
- both the user group leader and the majority of the users must come from a country other than the country(ies) where the legal entity(ies) operating the infrastructure is(are) established;

In order to prioritize applications from actual external users (specially new users), i.e. users not having access by right to these telescopes because of any formal agreement signed between their institutions and the telescope operator, two other additional criteria were considered when awarding time under the EC contract:

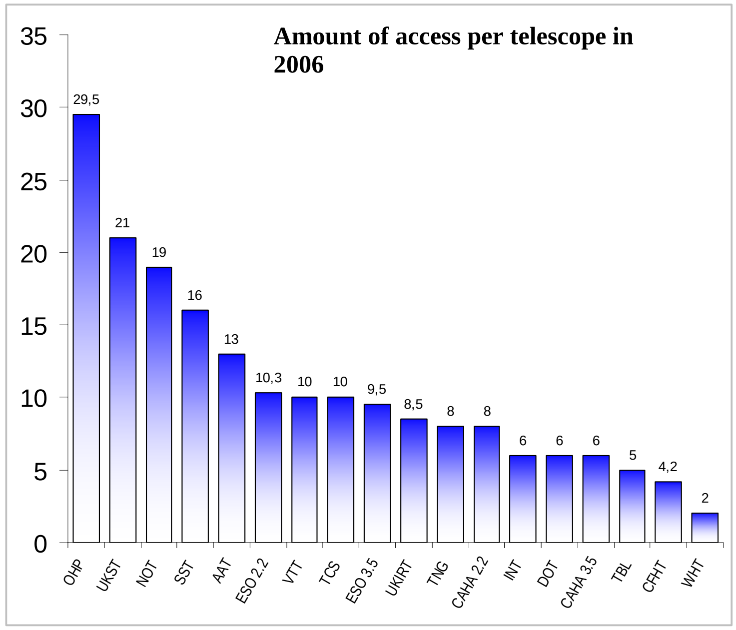
- the institution of affiliation of the user group leader and the majority of the users shall not have access by right to the facility being applied to.
- in no case shall a user be eligible for travel and subsistence support to access his/her own facility through this programme.

User groups meeting EC criteria of eligibility, and awarded telescope time by these TACs, are informed by the Trans-national Access Office (located at Instituto de Astrofisica de Canarias, Spain) about this funding opportunity. They receive full information about how to apply for travel and subsistence grants, how to get scientific and technical support to carry out their observations, application forms, etc. Application forms and reports can be completed on-line.

[12] **User:** means a researcher within a user group, including the user group leader. **User group:** means a research team of one or more researchers given access to the infrastructure under the project. Each user group is led by a user group leader.

1.4.1.3 Trans-national Access activity

Amount of Access delivered:

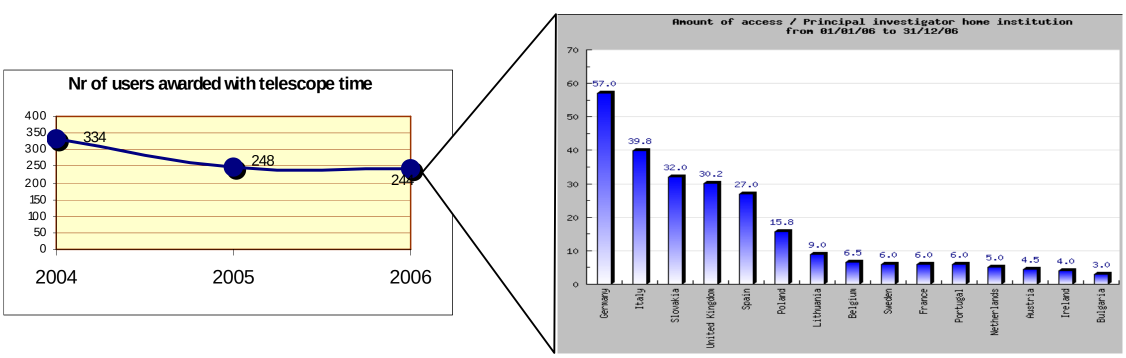


In the first period the amount of access provided was a large proportion of the 5 year plan. Accordingly, in subsequent periods the amounts of qualifying nights were restricted to avoid exceeding the allowable budget. 17.5 % of the total amount of access to be provided under this five-year contract was delivered in 2006. This means 251.8 units of access (days/nights/hours) in 2006 and a total of 738.6 days/nights/hours during the first three years of the contract.

The OHP 1.93m Telescope (Observatoire de Haute Provence), the United Kingdom Schmidt Telescope, 1.2m (UKST) and the Nordic Optical Telescope (NOT) have been those telescopes which have delivered more observing time during 2006 (29,5, 21 and 19 nights respectively).

Most of the telescopes have offered observing time under the contract during 2006.

Fig1



User Groups and projects

In 2006 a total of 244 users have been awarded time in 18 different telescopes. Germany and Italy have been those countries with the most users awarded time. In addition, it should be noted that the number of users estimated for the whole contract has been already surpassed with a total of 826 users (131.3%) for the first three years of the contract.

50 projects have been awarded time in 2006:

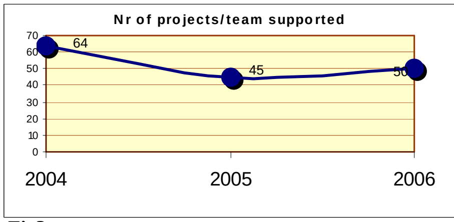


Fig3a

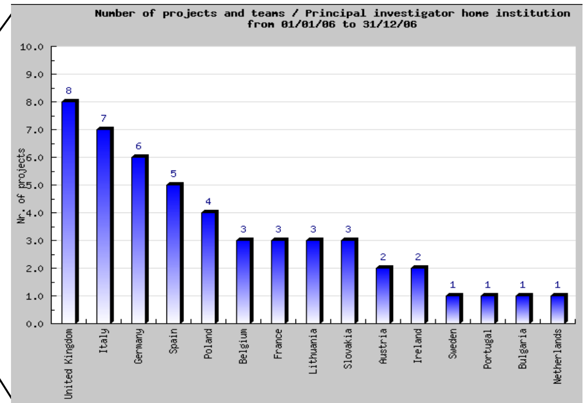


Fig3b

Around 50% of these projects have been submitted and awarded to user groups lead by PIs from UK, Italy, Germany and Spain (Fig 3b).

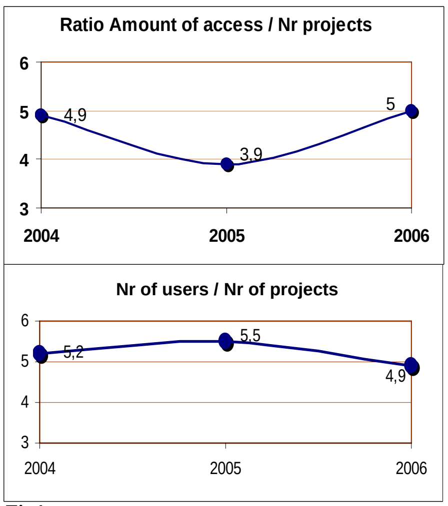
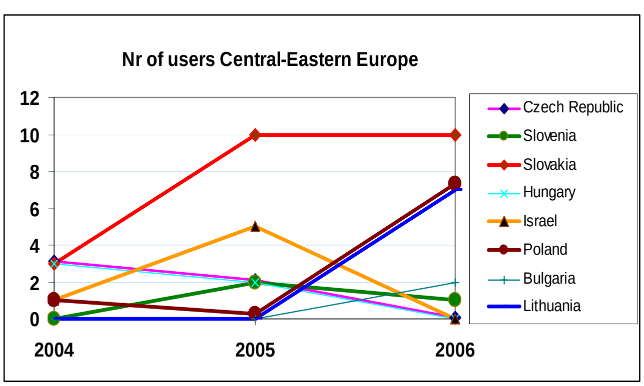
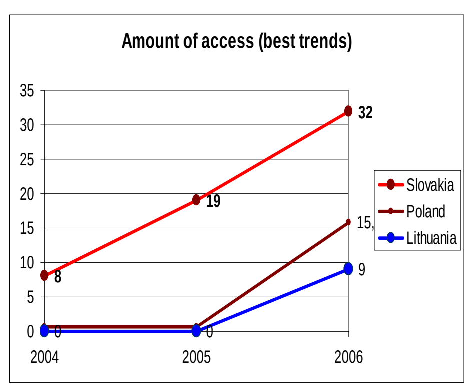


Fig4

Comparing the amount of access allocated in 2006 with the number of projects and users (Fig4) we obtain two significant ratios pointing out that projects have, on average, **fewer users** and **more units of access** that in 2005. Similar values had been obtained after the first year of the contract but the trend changed in 2005. This was mainly due to the low allocation of time by the solar telescopes which usually carry out observing runs of 10-14 days each one (91 days in 2004 versus 26 days in 2005). However, the solar time allocation in 2006 is similar to the last year (32 days in 2006). Therefore, the increase of the ratio (*amount of access/ Nr projects*) can be explained because the night time allocations in 2006 have increased, on average, the duration of its observing runs.

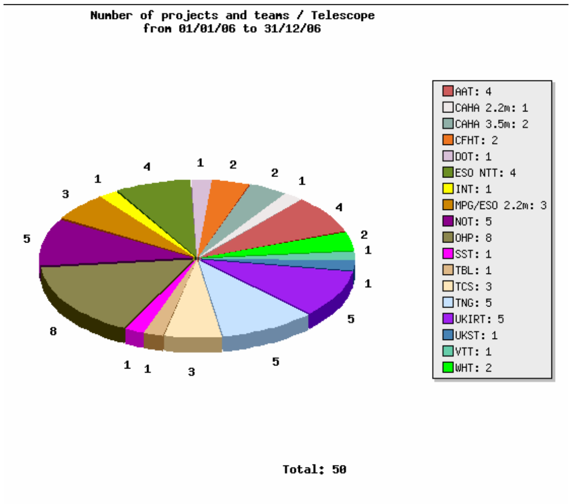
Observing time for astronomers from Central-Eastern Europe: The Access Office promotes the participation of new users, young researchers and specially, of users from Central and Eastern Europe. In this way, it should be remarked the high take up of astronomers coming from Slovakia, as already mentioned in the previous report. The following figures show the take up for the different Central-Eastern European astronomers as well as the positive trends of units allocated to PIs from Slovakia, Poland and Lithuania.

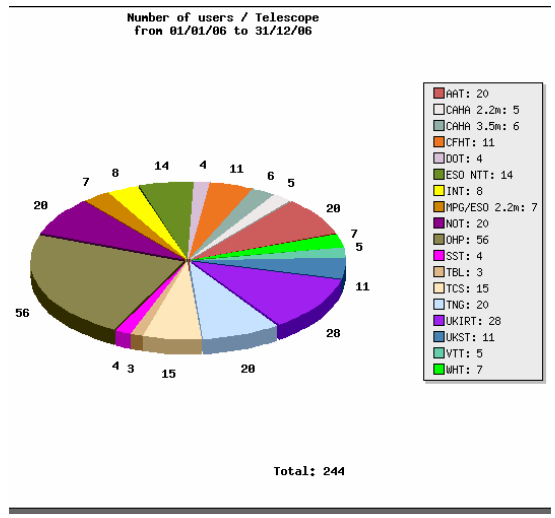




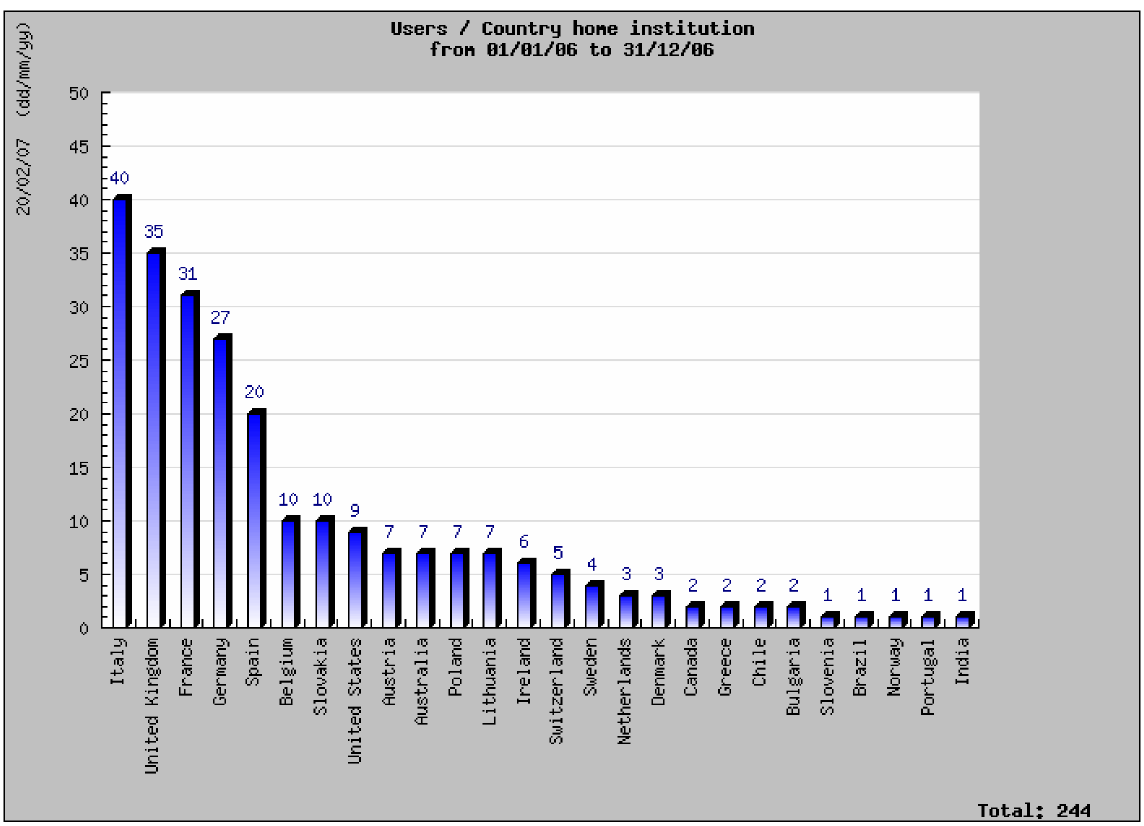
More detailed information about these user-projects can be found in Annex 3 of this report

Statistics on users awarded with telescope time:
244 users from 26 different countries have benefited from this Access Programme during this period (members of the user groups). 35 % of these users were awarded observing time at two telescopes: OHP and NOT.





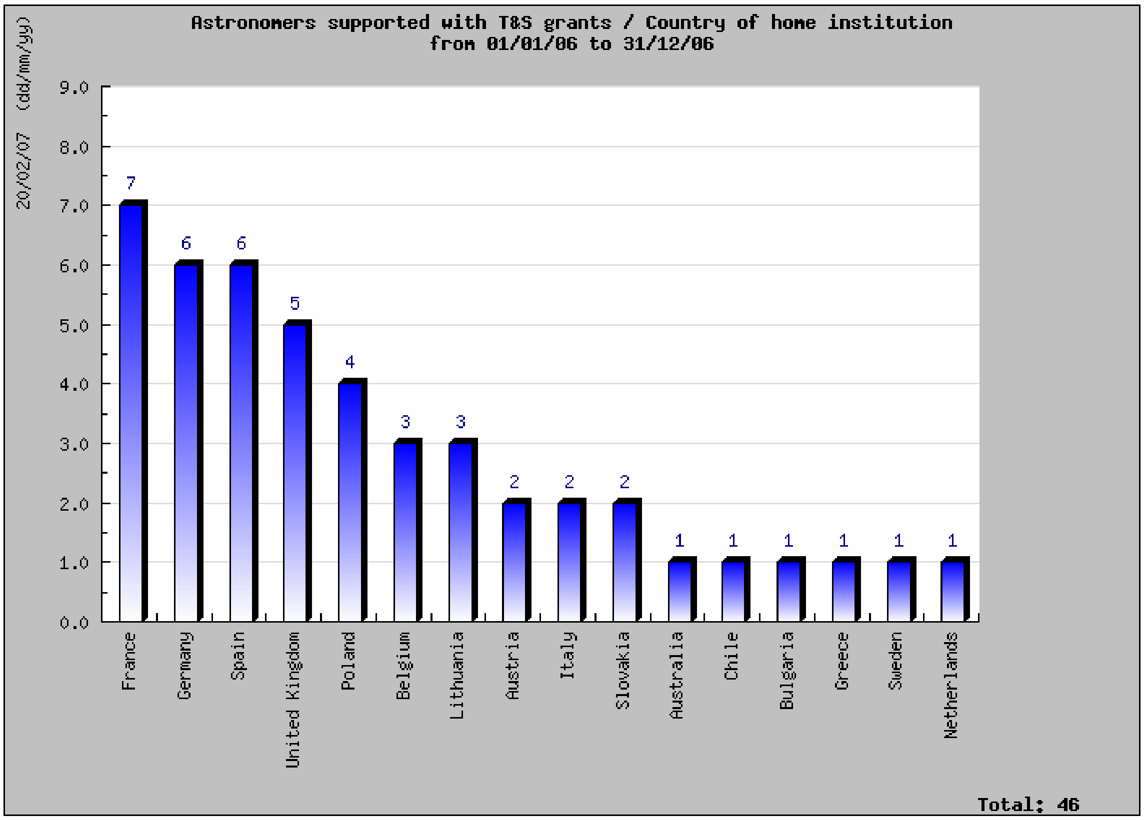
Italy, United Kingdom, France, Germany and Spain were those EU countries involving more users. (*see next figure*)



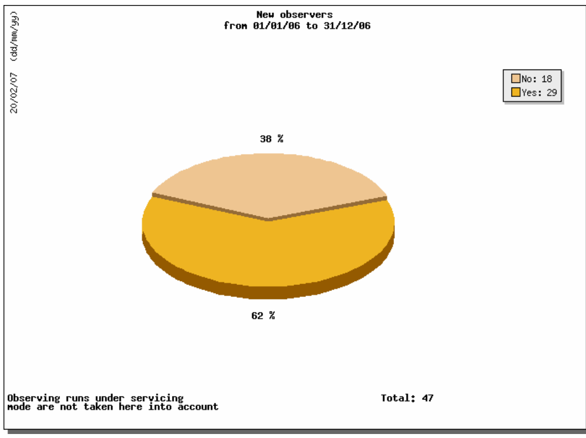
Travel and subsistence grants:

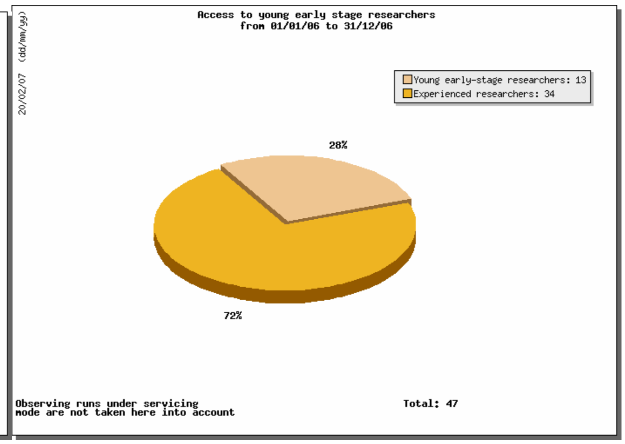
46 of these 244 users have been granted Travel and Subsistence (T&S) support when visiting the facility to carry out the observations (basically one observer per project, apart from those special cases in which two grants were needed and awarded). See Annex 4.

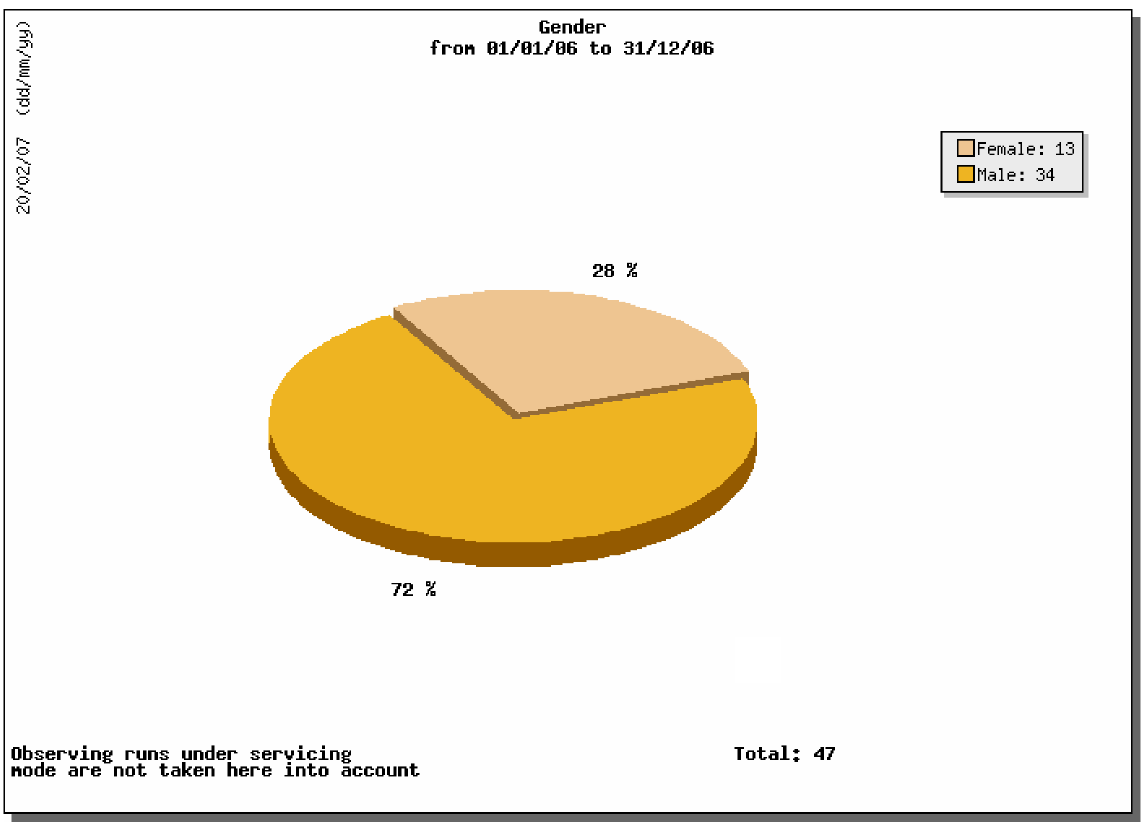
Following charts offer more information about these travel and subsistence grants:



More than 60% of these visiting astronomers were new observers, and 28 % were young-early stage researchers[13]. The gender ratio among users with T&S grants is 28% female and 72% male. Women observers in 2006 has increased their participation up to 116% (6 in 2005 versus 13 in 2006).







13 **Young-early stage researchers** are those users supported with T&S grants that have less than four years of research experience.

1.4.4 Scientific output of the users at the facilities.

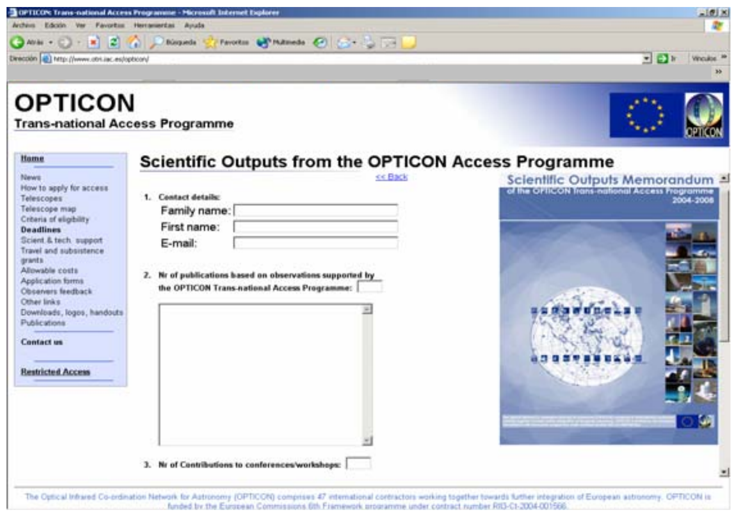
During this year the Access Office has gathered many publications related to observations based on results of observing projects carried out with the OPTICON Trans-national Access Programme support, mainly in 2004 and 2005.

As expected for our science field, feedback provided by users suggest that gathering all these scientific outputs arising from the first years of the contract will take a couple of years starting from now.

The Access Office is facing up to this challenge by half-yearly surveys to our users as well as by tracking possible acknowledgement of our Access Programme in papers (ASTRONOMICAL JOURNAL, ASTRONOMY & ASTROPHYSICS, ASTROPHYSICAL JOURNAL, etc).

Moreover, we have uploaded to our website an online-form to compile these scientific outputs (http://www.otri.iac.es/opticon/frame.php?pagina=output). Users can easily fill out this form, collaborating with the Access Office to elaborate the first Scientific Output report which hopefully will be available at the end of 2007.

Delivering this report at present would be premature and not useful.



1.4.5 User meetings

No user meetings during the whole contract are expected to be organised.

1.5 JOINT RESEARCH ACTIVITIES

1.5.2 JRA1: Adaptive Optics

The Total human effort deployed during this reporting period for JRA1 is summarized in the following table (in parenthesis additional manpower only for AC cost model):

Participant number[14]	4	6	8b	11a	12	19	31	35	
Participant short name[15]	ESO	INSU/CNRS	INAF-Arcetri	MPIA	NOVA	GRANTECAN	ONERA	Univ Durham	**Total**
Person-months[16]	100	52.91	26.71	9.6(8.4)	30 (18)	0	10.018	19.6 (19.6)	**248.84 (46)**

<u>WP 1: Coordination of JRA1</u>

Background:

This JRA1, managed by ESO, was launched in March 2004. ESO created a dedicated web page to disseminate the information and reports produced by JRA1 (http://www.eso.org/projects/aot/jra1/). Some documents are password protected. General meetings have been organised every 9 months as planned (see meeting table). Dedicated meetings or video-conferences have allowed accurate monitoring of the individual WPs. Close interactions between JRA1 & 2 have been maintained since the beginning of the contract as JRA2 R&D (Adaptive Optics CCD detector) is one of the key elements of the projects developed within JRA1.

The management (ESO) of JRA1 has been busy since the beginning of OPTICON preparing the subcontract technical specifications/Statement of Works, negotiating the contracts and monitoring the progress of the key Adaptive Optics components (1370 actuator piezo deformable mirror, Thin Zerodur glass shell, 1170 actuator Adaptive secondary design, piezo DM Drive electronics, micro and mini deformable mirrors, wavefront sensor CCD).

In 2006, two General meetings 3 & 4 (deliverables M1 and M2 of this WP 1) were organised by ESO: March 30th & 31st at Observatoire de Paris and in December 11 &12th at LAM in Marseille. ESO has continued the monitoring of the JRA1 FTE and hardware expenditures.

Subcontracts for the piezo DM drive electronics (SHAKTIWARE), the 100 actuator electrostatic micro deformable mirror (LETI) and 100 actuator electromagnetic micro deformable mirrors (FLORALIS-ALPAO) developments have been negotiated and placed in 2006.

An audit of the ESO accounting & procedures requested by the EC was conducted in December: a document set was produced for that audit. The outcome of this audit (draft report received beginning of February 2007) is very positive with a recommendation for a small positive adjustment of the eligible costs related to JRA1 declared by ESO in 2004 and 2005.

[14] Lead participant first

[15] Use the same contractor short names and numbers indicated in the table "list of participants" in Annex I of your contract.

[16] AC contractors must include both the total estimated human effort (including permanent staff) and, in brackets, additional staff only.

WP 2: System design

WP2.1: XAO system Study

Background:

Following two competitive feasibility and conceptual design studies of the VLT XAO system carried out by INSU and MPIA-INAF and reviewed by ESO in the fall of 2004, the ESO Scientific and Technical Committee (STC) recommended in April 2005 a merger of both teams under the leadership of INSU-LAOG as the P.I. institute. The main goal of this collaboration was to enhance Planet Finder's scientific capabilities by the inclusion of the science instruments (integral field spectrograph and differential polarimeter) proposed by the former MPIA led consortium. To support this merging, in 2005 ESO launched a Post-phase A contract with the aim of providing enough resources to perform the R&D activities between the end of the phase A and the start of the VLT Planet Finder design and construction phase.

The newly merged Consortium submitted a consolidated instrument concept and a strong coherent system and project management plan to the ESO STC in October 2005. Documentation presenting the efforts of the two former Consortia towards these goals including an executive summary has been produced. The STC recommended to the ESO Council that this project should be continued. The new Consortium consists of: INSU-LAOG, INSU-LAM, ONERA, INSU-LESIA, MPIA, ETH Zurich, INAF-Padova, Geneva Observatory, University of Amsterdam, Utrecht University, ASTRON, and ESO. The re-named VLT SPHERE project (standing for Spectro-Polarimetric High-Contrast Exoplanet Research) has successfully been able to accrete several new European Institutes outside the original JRA1 partners. This interest is due to the potential high scientific return of this future facility: the direct detection of Extrasolar Planets.

In 2006:

In June 2006, ESO Council decided to proceed with and fund the full development of SPHERE as part of the 2nd Generation instrument program of the Very Large Telescope and to allocate 260 Guaranteed Observing nights to the Consortium building this facility. These observing nights on the VLT will actually be used to start a large scale survey for the direct detection of exoplanets. In 2006, the Consortium has continued the preliminary design of SPHERE with the aim of completing the Preliminary Design Review (deliverable of this WP) by mid 2007. An Advanced optical Preliminary Design Review is planned at the beginning of March 2007. Several key prototypes and demonstration experiments crucial for SPHERE have been pursued. For example, Apodised Lyot coronagraph, four quadrant phase mask coronagraph, low crosstalk lenslet array for high contrast 3D Spectroscopy, low aberration differential filters etc…

Apart from the preliminary design activities, the OPTICON funded activities directly related to SPHERE have been pursued and include in particular:

- ESO follow-up of the 1370 actuator deformable mirror from CILAS (France) related to WP3.3. The development is proceeding as planned and should be delivered mid 2007.
- ESO follow-up of the development of the 240x240 pixels CCD detector (from e2V**,** UK) for wavefront sensing equipped with 8 outputs and based on L3CCD technology with 0.2 e RON **(**JRA2). Science grade chips are expected to be delivered in the 2nd half of 2007.
- Selection by ESO of SHAKTIWARE (France) for the development of the piezo Deformable mirror drive electronics WP 3.4. The contract was signed in 2006 and

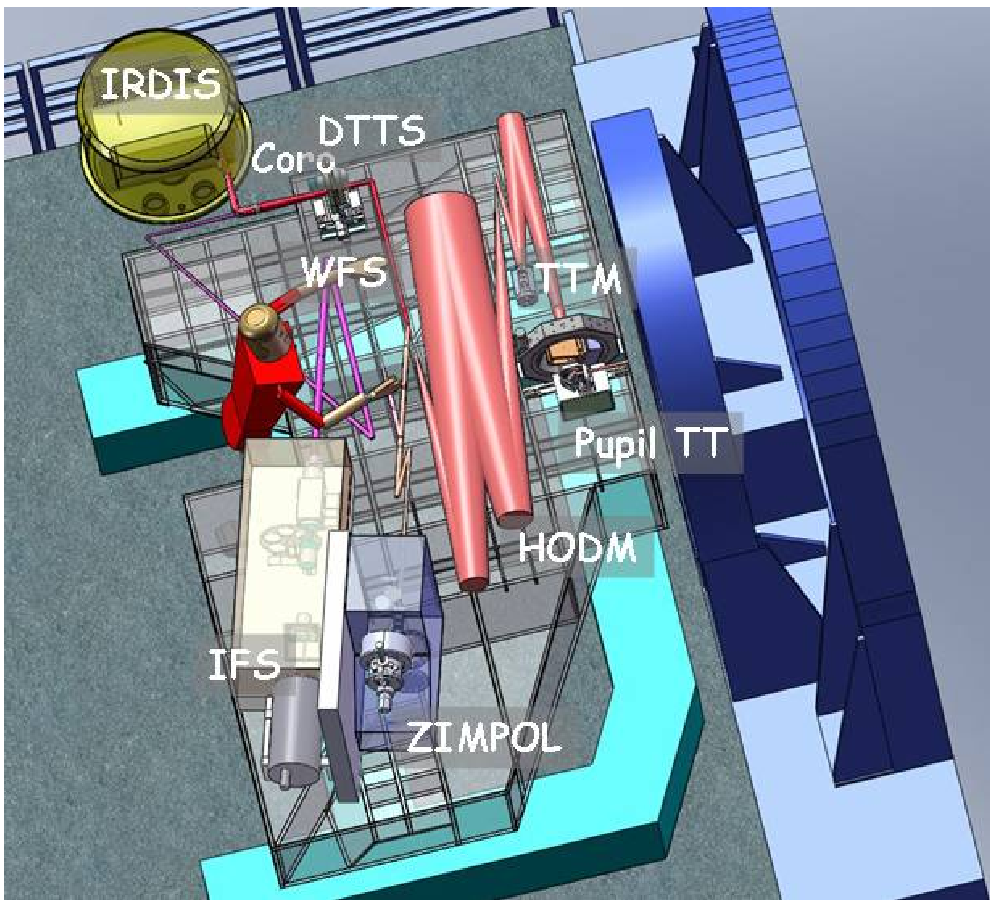
design review was achieved in December 2006. Delivery of the unit is expected in 2007.

- Real Time Computer Platform (SPARTA) design has been pursued by ESO and Durham WP 3.1. Procurement of hardware has been carried out and part of the hardware has been tested in the laboratory.

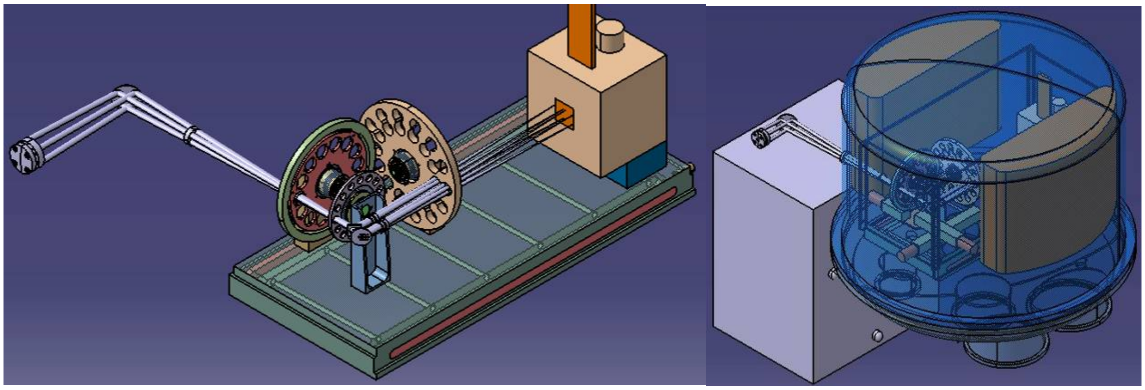
SPHERE, as a planet hunter machine to be installed on the VLT, is considered as an important pathfinder for the European Extremely Large Telescope, E-ELT) (new European facility included in the ESFRI roadmap). Research efforts which have been invested on SPHERE are crucial for the development of the high contrast instrument required to meet the challenging scientific objectives of the E-ELT: detection of cold Jupiters or of rocky planets around other stars.

3 meetings have been organized in the period.

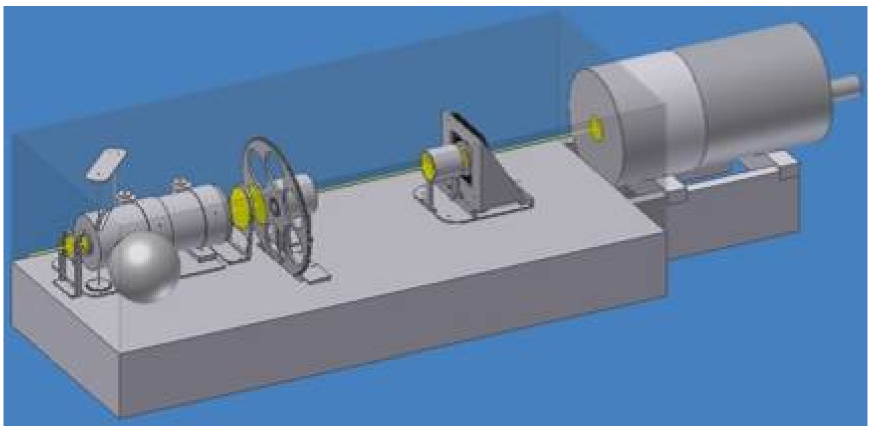
The documents produced in the frame of this WP are provided in CD-ROM JRA1/WP2.1.



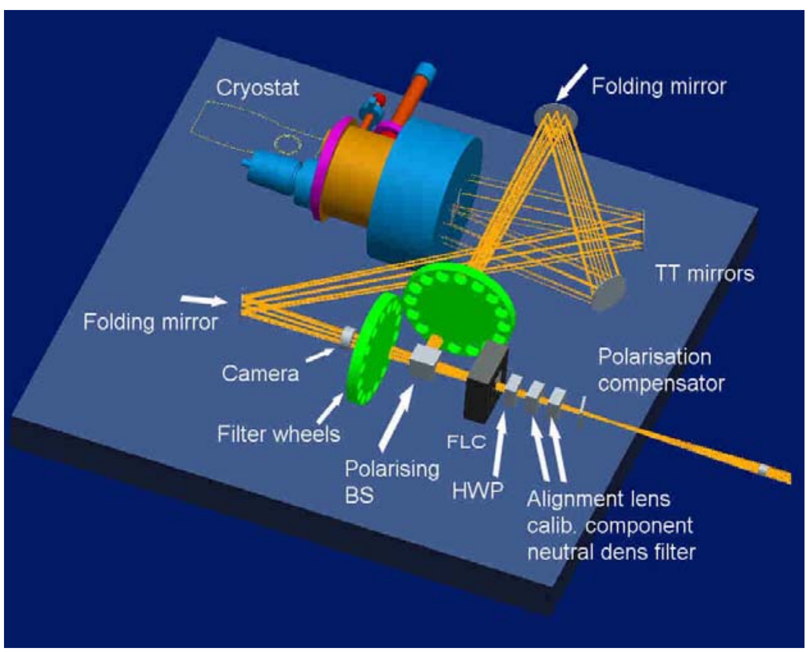
Preliminary implementation of SPHERE on the Nasmyth platform



Design of the differential imager (IRDIS)



Design of the NIR 3 D Spectrograph (IFS)



Design of the differential polarimeter: ZIMPOL

WP2.2: GLAO System Study

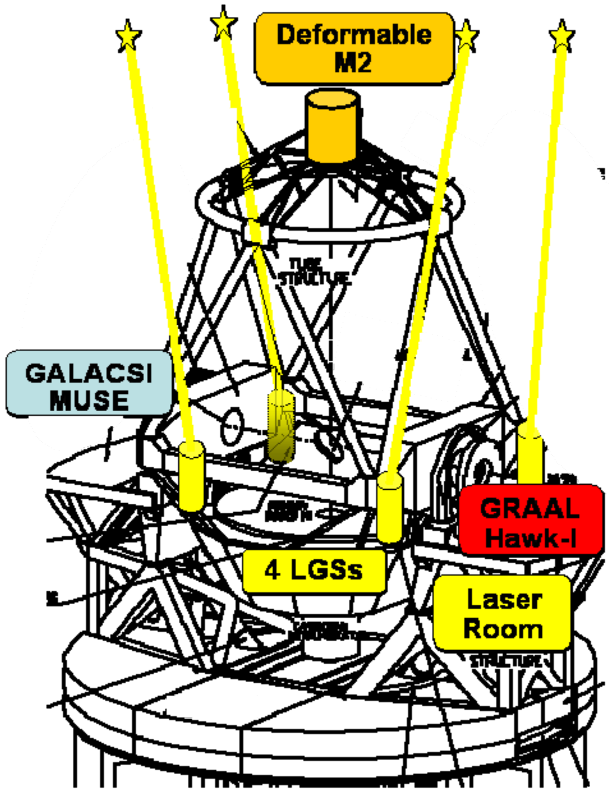
Background:

Following the two GLAO conceptual designs (GALACSI and GRAAL) performed in 2004, work started on the feasibility of the VLT Deformable Secondary Mirror (DSM), WP3.5. The ESO-INAF-NOVA/Leiden project team was requested to provide the design of a fully integrated VLT Adaptive Optics Facility (AOF) consisting of GALACSI, GRAAL, DSM as a full secondary unit, the laboratory test facility (ASSIST) and the Laser Guide Star Facility with 4 laser projectors. The goal was to have a better understanding of the whole project and a better estimate of the cost to completion of this new European Facility for approval by the ESO committees.

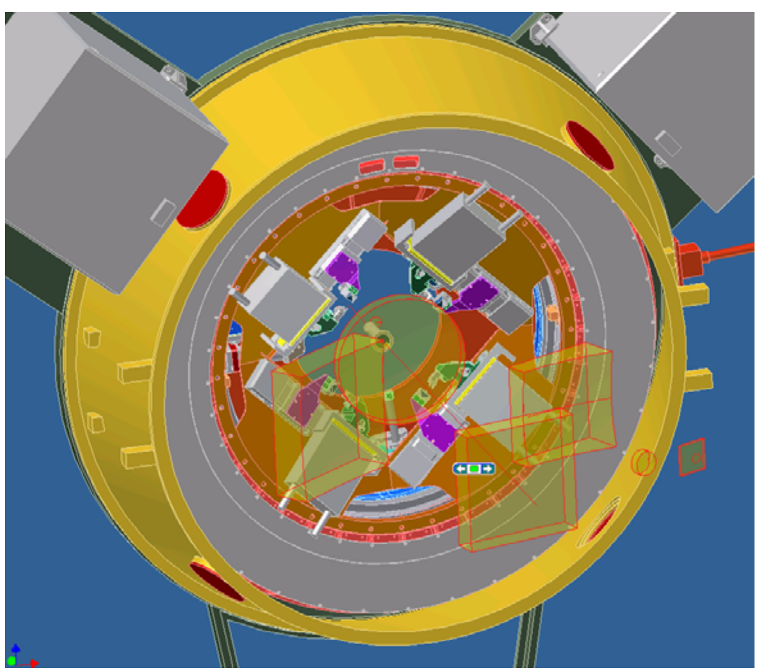
In 2005 the new Adaptive Optics Facility conceptual design was performed and the design documentation package was produced by ESO-INAF-NOVA/Leiden. A conceptual design review involving ESO and international reviewers was conducted on September 29th-30th. The outcome of this design review was that AOF was technically feasible and scientifically worthwhile while risks were considered acceptable and controlled. Following this recommendation from the review board, the ESO Scientific and Technical Committee and ESO Council (respectively in October & December 2005) have decided to proceed with the development and construction of this new facility.

In 2006:

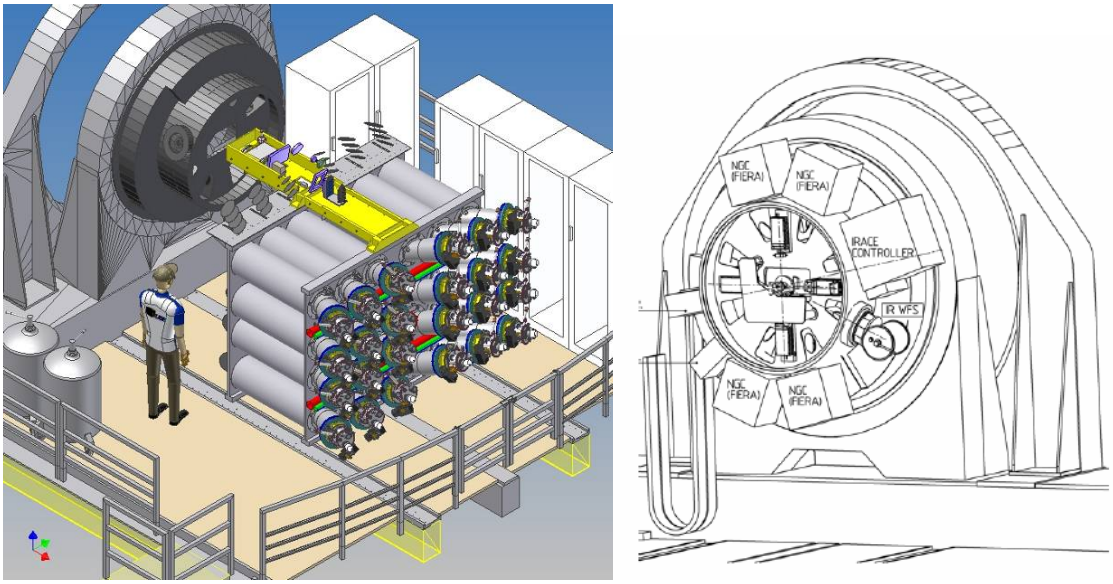
ESO Adaptive Optics team, NOVA/Leiden and INAF have pursued the Preliminary design of this facility. NOVA/Leiden has focused its effort on the design of the test facility ASSIST while ESO has worked on the design of the Ground layer AO modules (GRAAL and GALACSI) and on the 4 Laser Guide Star Facility (4LGSF). Preliminary design documentation for GRAAL was completed end of 2006 and can be considered as a partial delivery of Milestone D1 of WP 2.2 (CD-ROM JRA1/WP2.2). Deformable Secondary Mirror design activities are included in WP 3.5 and have been supported partially by INAF. Design documentation of GALACSI, ASSIST, 4LGSF completing the work expected within this WP are planned 2-3 Quarter 2007.



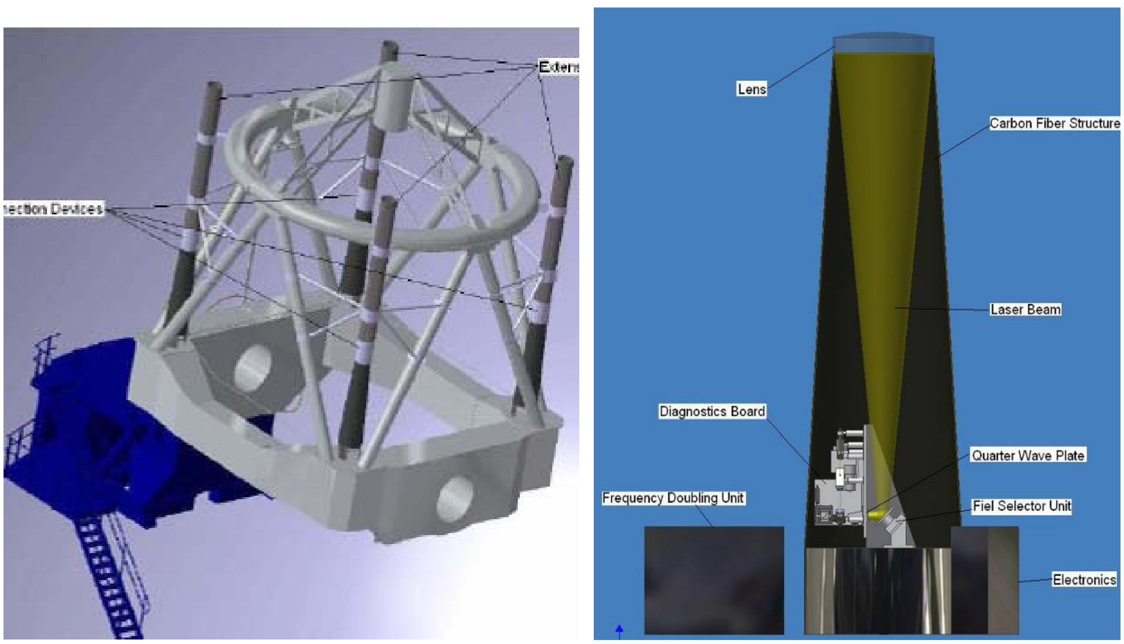
Overview of the VLT Adaptive Optics Facility included the two Ground Layer Adaptive Optics systems: GRAAL, and GALACSI (WP2.2), the Deformable Secondary Mirror (WP3.5) and the 4Laser Guide Stars.



Overview of the GRAAL, Ground Layer Adaptive Optics for the VLT. On the left: HAWK-I NIR imager; on the right: GRAAL attached to the VLT Adapter-Rotator.



Overview of the GALACSI, Ground Layer Adaptive Optics for the VLT. On the left: MUSE visible 3D spectrograph, in dark grey GALACSI attached to the Adapter-Rotator. On the right: GALACSI design overview.



Overview of the Laser Guide Star Facility at the VLT. Right: The four tubes are the launch telescopes for the laser beams; Left: Design of the individual launch telescope

Overview of the Adaptive Optics test facility (ASSIST): on top in red the Deformable Secondary mirror, on the left in Green the GALACSI or GRAAL during testing, on the right in green the turbulence generator, in the center in blue and red the telescope simulator.

The documents produced by this WP are provided in CD-ROM JRA1/WP2.2.

WP2.3: Multi-Object WFS for GTC

Background:

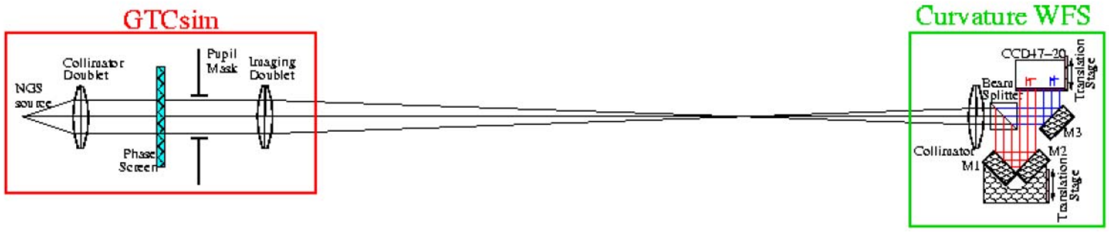
The original work proposal of the GTC Project Office (GTC PO) consisted on the conceptual study, design and fabrication of a multi-object wavefront sensor based on the concept of curvature wavefront sensing. In 2004, GTC carried out the simulation software development to test the conceptual feasibility of the multi-object curvature wavefront sensor concept.

Simulations conducted at the beginning of 2005 showed that multi-object curvature wavefront reconstruction using several randomly distributed objects in the Field of View (FoV) with free-noise measurements was not good enough. The interpretation is that a better sampling of the recorded images will greatly improve the reconstruction (i.e. deconvolution) of the defocused pupil images which constitute the input to the wavefront reconstruction algorithm. In addition, the defocused pupil images reconstruction algorithm is based on at least square minimization algorithm which might benefit from a more sophisticated constrained linear least squares minimization where the "non-negativeness" of images is explicitly imposed.

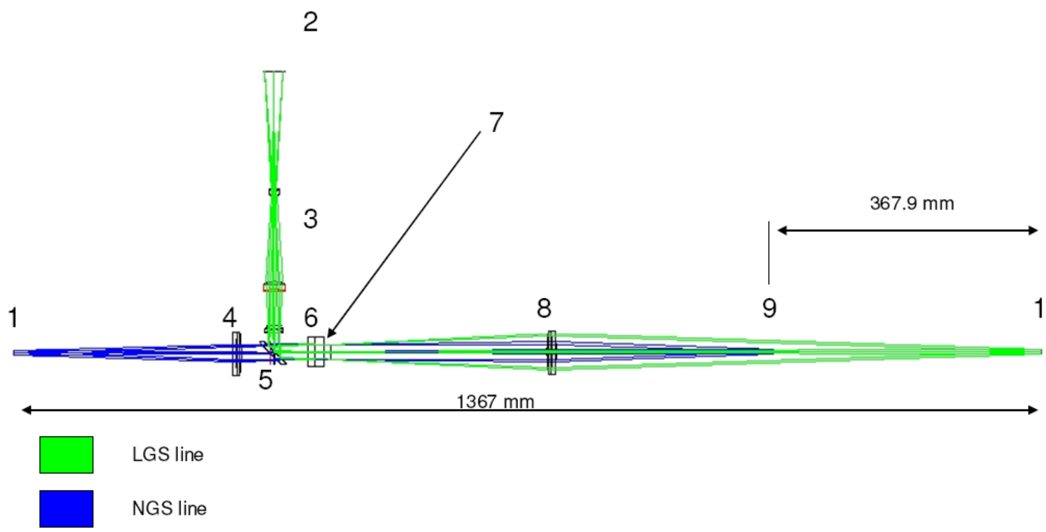
Based on the results obtained so far, it is essential to address the reasons leading to the degradation of the reconstruction with a laboratory single object curvature wavefront sensor in which the problem is similar to the multi-object wavefront sensor. In addition, this approach fits better the plans and the needs of the GTC Adaptive Optics Facility.

In 2006:

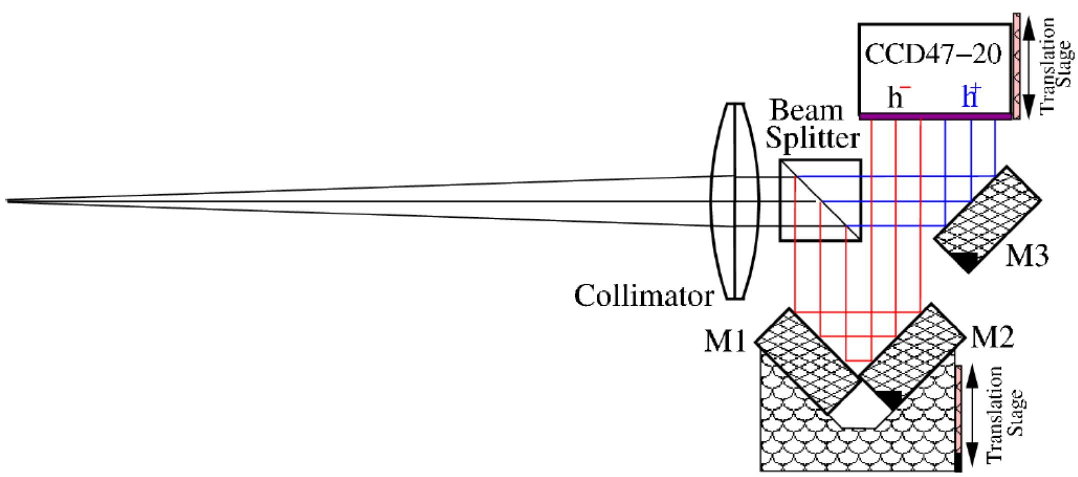
GTC team has developed the design of the GTCsim system which should provide a beam at the entrance focus of the GTCAO system with the same focal ratio as the nominal beam from the GTC telescope. The GTCsim is compatible with both the Natural and Laser Guide star. The GTCsim design is provided in figure below. The GTCsim is intended to feed the single curvature wavefront sensor also shown in the figure below. The optical design of the GTCsim is provided in the second figure below.



GTC curvature prototype; Left GTCsim (calibration system), Right: Curvature wavefront sensor



GTCsim turbulence generator Optical design



Curvature wavefront sensor conceptual design

A design report has been produced by GTC and is included in **CD-ROM JRA1/WP2.3.** This design report represents **deliverable M1 of WP2.3**.

WP2.4: Multiple FOV System with NGS

The objective of this WP is to develop a Multiple Field of View AO wavefront sensor

(MFoV-WFS) prototype to be tested on the AO system of LINC-NIRVANA: a Fizeau Interferometer for the Large Binocular Telescope (LBT). The prototype system consists of a Ground Layer Wavefront Sensor (GWS), a High Layer Wavefront sensor (HWS), de-rotation units for the sensors (bearing and K-mirror), one deformable mirror, collimation and imaging optics (Collimator, FP20) for the HWS and a patrol camera for monitoring the acquisition field of the HWS.

Background:

In the first 12 months of the JRA we have been working on sky coverage and performance simulation. In parallel, we received a 349 actuator deformable mirror which was tested and characterized. At the end of this period we delivered the GWS design report (M1) and the CCD and control electronics was ordered.

In the second 12 month period of the activity we conducted a Final Design Review of the complete LINC-NIRVANA instrument including the MFoV-WFS systems. The HWS translation stages have been tested and found out of specifications. The manufacturer started to re-work the stages to fix the problem. In parallel a re-evaluation of the sensor performance was conducted. The performance degradation for the HWS was found as 5% or less (depending on wavelength) while for the GWS the performance degradation will reach up to 10%.

In 2006:

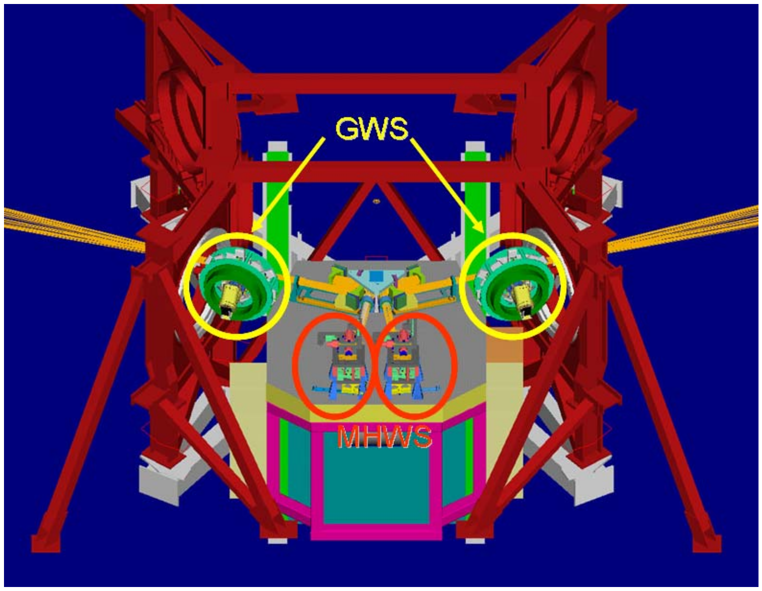
In 2006, the re-work of the stages by the manufacturer was evaluated, but did not show satisfactory behaviour. Therefore the decision was made to continue the HWS with the original delivered stages and start the assembly of the full HWS in Bologna, which is still ongoing. As the degradation due to the misbehaviour of the stages for the GWS was much higher, a study for alternative designs has been launched with two companies. The overall envelope of the translation stages was kept the same therefore the manufacturing of the GWS could be begun.

In parallel to the opto-mechanical activities development of instrument control software is conducted in the framework of the overall LINC-NIRVANA instrument.

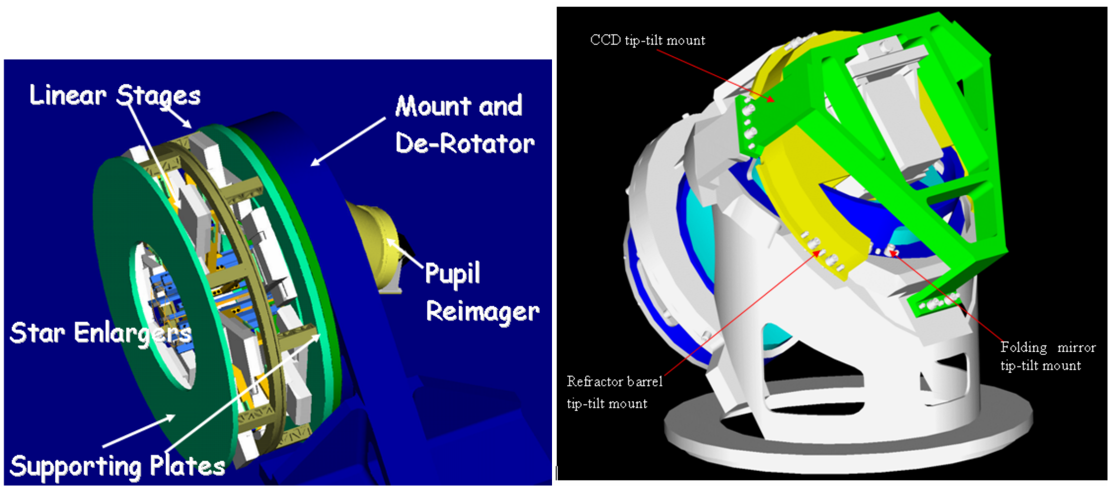
The delivery of the CCD and control electronics is still outstanding. Last year (2006), the CCD manufacturer did finally produce the ordered CCD, but is still testing them. The delivery is expected within the coming 12 month period.

The documents produced by this WP are provided in CD-ROM JRA1/WP2.4.

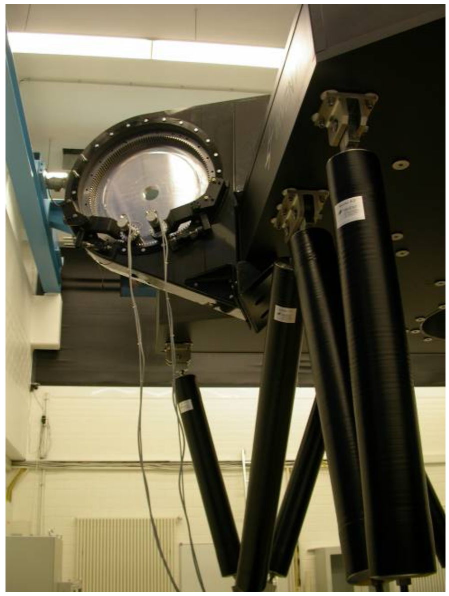
3 meetings have been organised in 2006.



Overview of the LINC-NIRVANA Multi-Conjugate Adaptive Optics system: In yellow the Ground layer wavefront sensor to be delivered in the frame of JRA1



Left: design of the Ground layer Wavefront sensor; Right: Detailed view of the pupil re-imager of the Ground Layer WFS.



Ground layer wavefront sensor bearing test on NIRVANA bench at MPIA

WP 3: ENABLING TECHNOLOGY FOR 2nd GENERATION/ELT AO SYSTEM

WP3.1: 2nd Generation RTC Platform

Background:

SPARTA (Standard Platform for Adaptive optics Real Time Applications) went through different phases of evolution in which ESO and Durham tried different solutions of increasing complexity. With the guidelines of using only COTS components and keeping the development of the platform as simple as possible, SPARTA started off in 2004 with an all-CPU solution. The participation of Durham into the WP brought expertise of FPGAs, which were included into the design through available commercial products. Given the difficulty of programming an FPGA, the choice was to assign to Durham the development of well-known process like the “input machinery” (later called WPU for Wavefront Processing Unit) and statistical machinery.

The first concept presented in 2004 included all these features, but an issue with board-to-board latency had already been identified.

In the course of 2004 and 2005 we performed all the foreseen benchmarks and we realized that the architecture could not meet the requirements, for two reasons: the computing power of the CPU did not meet the expectations and the measured communication latency was too high. Results were shown in 2005 at the JRA-1 general meeting where the shift to the second architecture was announced.

The second SPARTA concept addressed the concerns of computing power and communication latency by increasing the use of FPGAs. We proposed a 2-layer architecture with FPGAs running all the real-time part and CPUs supervising their functions. A suitable commercial product had not been identified yet, but the concept was very similar to the forthcoming VMETRO VPF1. We ran an internal conceptual design review between Durham and ESO to consolidate the architecture.

However the architecture seemed too biased towards FPGAs: the difficulty of their programming and the long development cycle raised concerns about their widespread use.

Towards the end of 2005 the SPARTA team produced a third version of the concept which still uses FPGAs, but only where necessary: communication and data compression (i.e.: the WPU, used as front-end). The other functions in the real-time pipeline are now taken by DSPs. A suitable commercial product had been identified in the Bittware T2V6 and links with the manufacturer had been established, the product not yet being available. We then prepared the complete documentation to describe the third concept in preparation for a review.

In 2006:

After the change of direction taken in 2005, we produced a new concept for SPARTA that we presented to an external board of reviewers, who approved it in May 2006. We then completed the procurement of the necessary hardware and we completed the definition of all the interfaces.

The new concept developed by ESO and Durham is based on a hybrid architecture that uses three different technologies for different purposes. FPGA (Field Programmable Gate Array) are used to pre-process the large incoming data stream to more manageable sizes (i.e.: from pixels to gradients) and to implement the high-speed communication infrastructure that runs serial FPDP. DSP (Digital Signal Processors) are in charge of the main mathematical operations developed by Durham. General-purpose CPUs (Central Processing Unit) perform more complex tasks or high level operations developed by ESO. Each technology is employed where it is best suited.

These computing elements are organized within two types of SBC (Single Board Computer) boards. The first features 2 CPUs and 2 FPGAs (VMETRO VPF1) and it is used as front-end and back-end. The second features 8 DSPs and 2 FPGAs (Bittware T2V6). The same type of FPGA is present on both boards and this enables board-to-board communications. The high-speed communication layer runs over a VXS bus, a follow-on of the VME standard. The rack is completed by an ESO-standard LCU used to monitor the rack and control the T2V6 boards and a Zero-Latency-Switch (from VMETRO) that connects the VXS slots with each other and also features several optical transceivers that can be directly routed to any VXS slot.

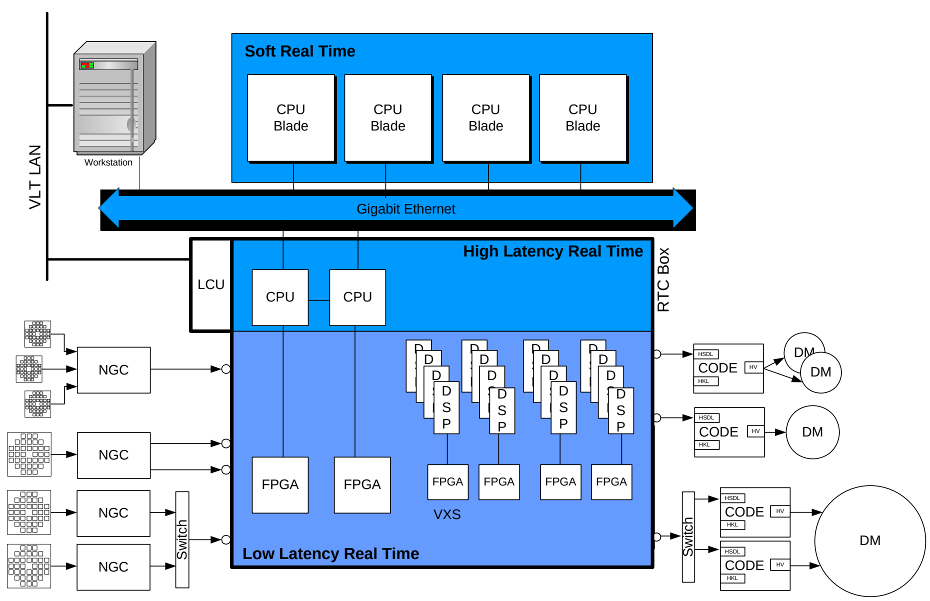


Figure 1: SPARTA concept. The platform is scalable in the number of computing elements. The computing elements are divided into three areas: a low-latency real-time domain mainly populated with FPGAs and DSP, a high latency real-time domain mainly populated by general purpose CPUs and a soft real-time domain populated by CPUs. The low-latency real-time domain is connected directly to the external world from which it receives detector data and to which it sends mirror commands. The FPGAs constitute

the communication framework, while also implementing part of the processing pipeline. DSPs complement the FPGAs for floating point mathematical operations. The internal communications run over an electrical VXS backplane, while the external interfaces are fibre-based. The upper level, soft real time domain, is in charge of statistical analysis and loop monitoring, all computationally intensive but with lower real-time requirements. The two top levels are connected together through a gigabit Ethernet interface. A standard LCU is provided to control each crate and a standard Instrument Workstation is provided to offer a CCS-standard interface.

We have called this part the Real-Time Box, since only the core of the application runs here, the high-speed, low-latency, high-throughput hard real-time computation.

On the Real-Time Box we have already reached a high degree of detail on the design and many architectural blocks have already been prototyped, tested and benchmarked. We do have a prototype of the WPU (Wavefront Processing Unit) that runs on the FPGA and converts pixels to gradients; a fully working prototype of the FPDP module. At the moment those modules are not running on the VPF1 but they will do so shortly. We also tested the applications running on the T2V6 board and verified that they run according to expectations. We are also testing more high-level functions performed by the CPUs. SPARTA also needs to process data in real-time and to control the whole system, so a Supervisor computer has been introduced. This takes the form of a blade server featuring several 'standard' Linux-based computers in a small form factor. The Supervisor will control the RT-box and will perform additional tasks as performance analysis, statistic and data recording. Finally an ESO-standard workstation completes the architecture, providing the user interface and the real-time displays.

This second part of the system is less advanced, since we mostly concentrated on the core of the system where the most important requirements are set. Once the design of the RT-box is fully completed, we will concentrate on the Supervisor, which, at the moment, does not cause any concern.

With the separation between the RT-box and the supervisor, the project is now on schedule. The final design report (limited to the RT-box) will be done in June instead of August 2007. A number of benchmark plans have been established and their results will be reported at the PDR (e.g. 4015). ESO also produced or is in the process of producing a series of documents for the projects in which SPARTA is involved, GRAAL (documents 4135, 4136 and 4134). ESO also launched and completed and external development for a SPARTA testing tool (documents 4112 and 4113).

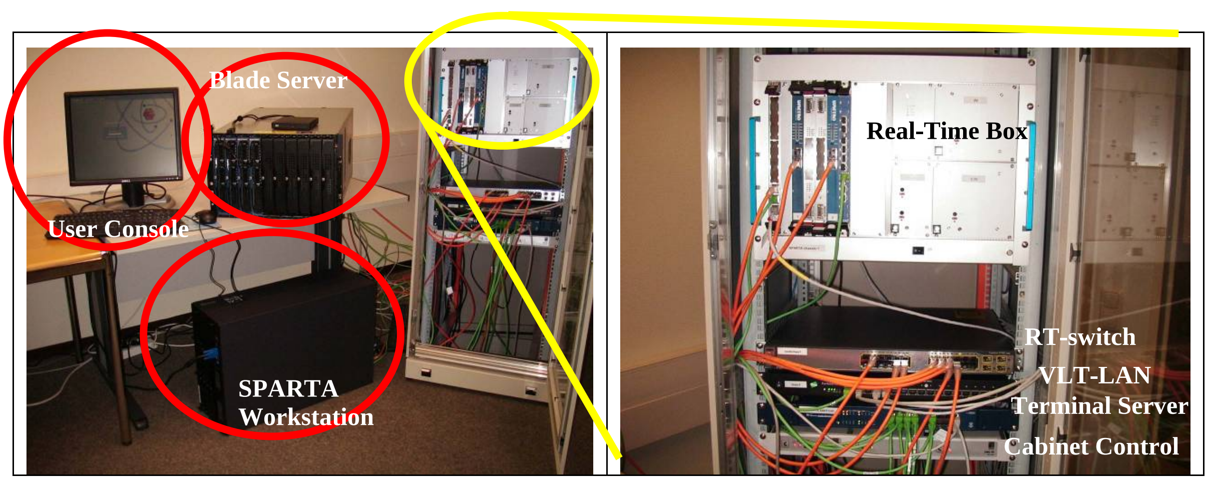


Figure 2: **Overall SPARTA system (left) and closed-up for the Real-Time box (right). In the picture the SPHERE prototype is shown. On the left side one can see the Blade server (the SPARTA Supervisor), the SPARTA Instrument Control Workstation and a User Console. On the right side one can see the real-time rack with, from left, one ESO-standard LCU, one front-end VPF1, two T2V6, one back-end VPF1 and the Zero-Latency-Switch. Below the rack one can see the real-time network switch (a Cisco Catalyst), a standard switch simulating the VLT LAN, a terminal server and the Rittal cabinet control system.**

2 meetings have been organized in 2006 by this WP.

The documents produced in the frame of this WP are provided in **CD-ROM JRA1/WP3.1.**

WP3.2: ***Optimal Control Methods for MCAO Systems***

Background:

The activity of 2004 and 2005 for WP 3.2 performed by **ONERA** consisted of the following:

Optimal Control Methods for MCAO

The details can be found in the associated report delivered in November 2005.The theoretical study of an optimal control approach for MCAO has been completed. A code based on Kalman approach has been developed. The code has been used to validate the Kalman based control in the case of Off-Axis-AO. Completed and results have been delivered in the report of Theoretical Results milestone (November 2005);

Code experimental validation was performed on the AO bench BOA available at ONERA. Activities run for to the BOA up-grade and calibration. The first off-axis optimization results were obtained in static mode. A comparison with the numerical simulations with the code developed has shown that the experimental results are very close to the expected ones. The intermediate results presented in the report of Theoretical Results milestone (November 2005);

Theoretical studies on high performance WFS in MCAO

The activities of WP3.2.2 consisted of the theoretical study of the high performance wavefront sensing for MCAO and the development of an end-to-end simulation. The strategy to tackle the problem has been to divide it in three distinct topics: Sky coverage; Comparison and optimisation of WFS measurement concepts (based on Star Oriented and Layer Oriented approaches); Studies and optimisation of WFS devices

All these studies have led to 1 paper in peer-reviewed journals (plus 2 in preparation) as well as 4 communications in international conferences or workshops.

In the following sections, we briefly present each study with their main results and their likely developments.

2004 was devoted to the system up-grade and calibration. First off-axis optimization results were obtained in static mode. In 2005 the new RTC was tested and the first dynamic tests with closed-loop Kalman based optimal control were performed.

In 2006:

In 2006 the WP 3.2 activities have been focused on two aspects:

- Optimal Control Methods for MCAO (OCM)
- High performance WFS in MCAO (HP-WFS)

The promising simulations and theoretical studies in Optical control methods for MCAO developed in 2005 have been tested experimentally at ONERA**.** This validation was performed on the AO bench BOA available at ONERA. This pioneering experimental work will then help the specification and implementation of the future MAD optimal control. The performance has been improved, the impact of adjustment parameters such as the noise variance has been evaluated, and an extension of the approach to vibration filtering has been demonstrated.

These work-packages are aimed at specifying the optimal control for the ESO MCAO demonstrator MAD and at testing the approach on MAD in the laboratory. A specification document has been written and was provided to ESO in May 2006.

However the planning of MAD has shifted, it has recently been shipped to Paranal and the date of return in the laboratory remains to be confirmed. Consequently it is unlikely that the optimal control can be tested before the end of JRA1. We propose instead to perform VLT-like MCAO and Tomographic AO simulations with the optimal control approach to demonstrate its interest. We will also analyse the computational cost of such techniques and give ideas on how to limit this cost. This is an important issue for VLT and even more for ELT instruments. These results will be presented in the final JRA1 report planned for beginning of 2008.

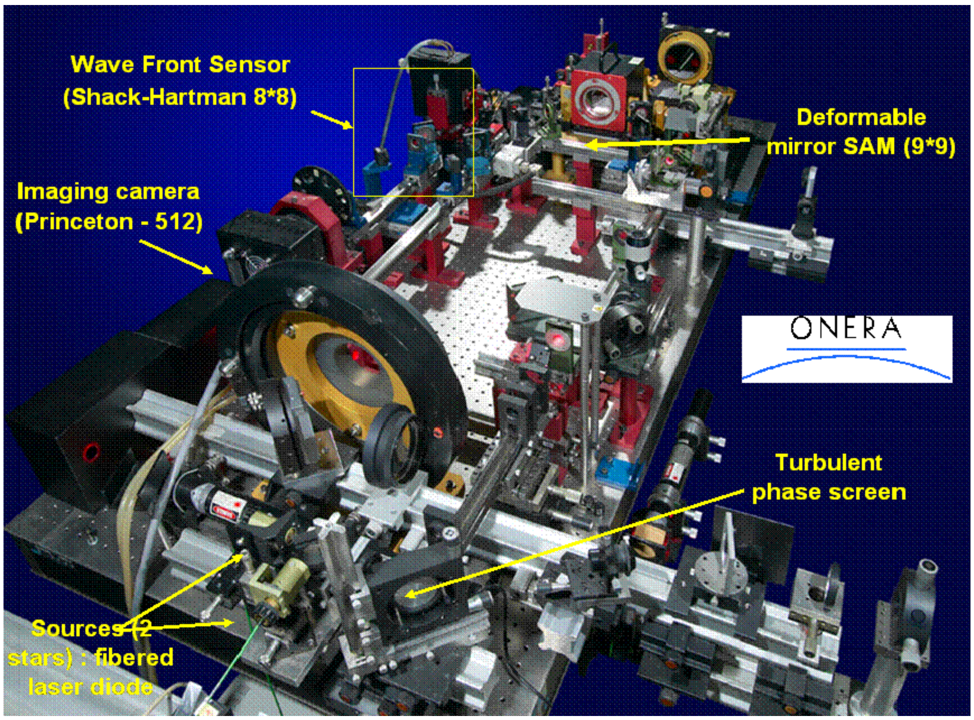
In the field of high performance WFS in MCAO, this 3rd year has been dedicated to the theoretical studies in three topics:

Sky coverage studies: The optimization of the new algorithm developed for sky coverage estimation with MCAO developed during the previous year. This new approach, called the Surface Sky Coverage (SSC) takes into account the number and the magnitude of the guide stars (GS) as well as the observing field of view defined by the GS position and the telescope diameter. The SCS refines the estimation of the fraction of sky which is observable for a given MCAO system. These results were published in MNRAS [4]

Comparison and optimization of WFS measurement concepts (based on Star Oriented and Layer Oriented approaches): Two main WFS approaches have been proposed so far to deal with wave-front sensor measurements and reconstructions in the MCAO framework. The most classical one is the so-called “Star Oriented” (SO) concept in which the wave-front deformations are measured in each GS direction. In this case, one dedicated WFS per GS is required. The wave-front information is then recombined in order to control the deformable mirrors (DM) which are conjugated to given turbulent layers. R.Ragazzoni has recently proposed a new concept called “Layer Oriented” (LO) in which one WFS is conjugated to each turbulent layer to be compensated for. Each WFS adds the light coming from all guide stars (GS) available in the field of view (FOV). In 2006, we have followed up the analytical comparison of these two concepts in the simplest case of a ground layer AO system. We have also proposed two optimization approaches for SO and LO concepts. We have shown that such an optimization allows a gain of more than one order of magnitude in terms of performance from a WFS noise propagation point of view. We have also finalized and optimized the end-to-end model developed during the previous years. These results have been published in a peer-reviewed article in JOSA A [5]. Experimental results have confirmed the analytical developments. They have shown that accurate calibration of the WFS model is essential if one wants to optimize the GLAO-WFS performance. It has also shown that even small magnitude differences between GS (one or two) is enough to greatly degrade the performance of non-optimised SO or LO concepts. An article summarizing these results is in preparation.

Study & optimisation of Wavefront sensor devices: After the comparison of the WFS devices (Shack-Hartmann and Pyramid) made during the previous years we have focused our study on the optimization of the slope measurement in the case of Shack-Hartmann-WFS. Various spot position estimators have been studied and compared (Center of Gravity, Weighted Center of Gravity, Quad Cell and Correlation). After the definition of a global merit function the behavior of each estimator as a function of system (sampling, sub-aperture FoV, Signal to Noise Ratio, spot size) and turbulence parameters has been intensively studied. Modification and derivation of analytical expressions have been proposed to describe each behavior. This work has been performed in collaboration with Sandrine Thomas (from CTIO) in the framework of her PhD thesis. An article has been published in MNRAS [6].

An experimental validation of the WFS optimisation for GLAO systems has been performed using the MAD bench at ESO.



ONERA BOA bench used for the testing of the Optimal Control Method in MCAO

The report regarding the "implementation of the optimal control methods developed on a simplified laboratory system and performance evaluation" of WP 3.2 is included in **CD-ROM JRA1/WP3.2.** This represents **deliverable M2 of the WP 3.2.**

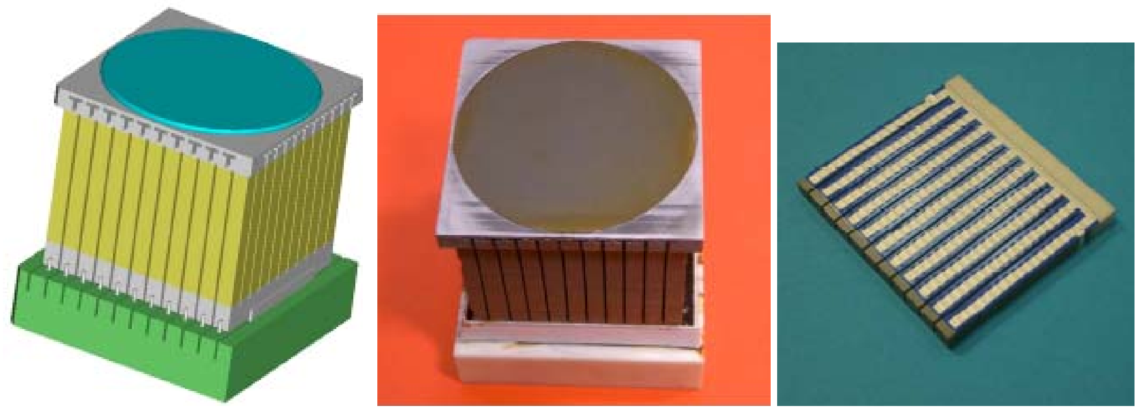
WP3.3: 2nd Generation Piezo DM

Background:

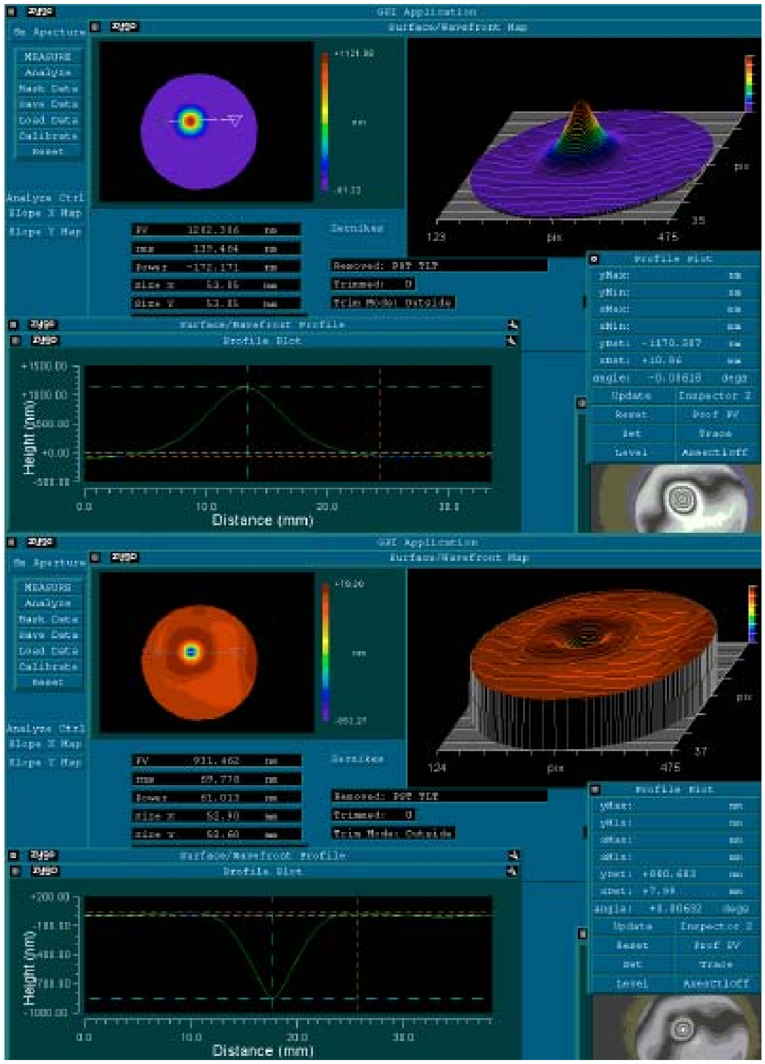
Following the VLT Planet phase A studies (**WP 2.1**), a set of top level specifications for the development of the 1370 actuator piezo deformable mirror prototype was produced by **the SPHERE Consortium** in 2004. These top level requirements have been integrated into a Technical specifications and Statement of Work by ESO. In 2005 a Call for Tender has been issued by **ESO**, and two proposals were received and evaluated. After difficult negotiations the contract was granted and signed with **CILAS** (France) in March 2005. The Kick-off meeting took place in April 2005. **CILAS** has developed the design of the 1370 actuator piezo-deformable mirror and a design review was organized by ESO in November 2005 (**deliverable D1 of WP 3.3**).

In 2006:

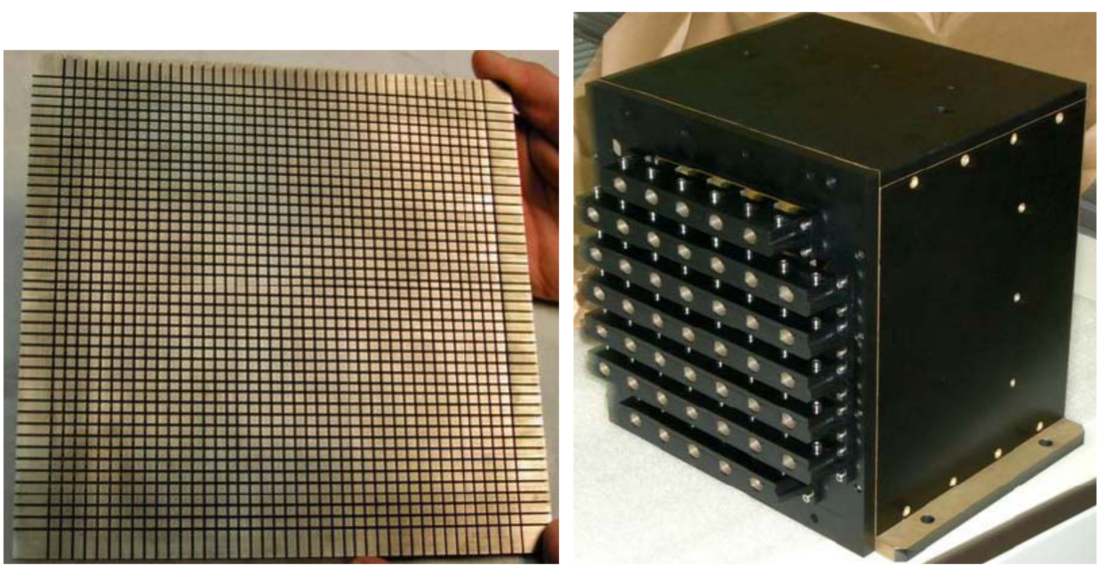
CILAS has developed a 57 actuator mockup to validate design parameters of the final unit. This mockup has been extensively tested to check the actuator stroke and inter-actuator stroke, the coupling between actuators, the optical quality of the best flat, hysteresis and dynamic characteristics. Results obtained on the mockup have shown that the performances conform to the **ESO** technical specifications. Based on that, a “green light” has been given to CILAS to proceed to the manufacturing of the final 1370 actuator piezo deformable mirror. A progress meeting was organized in December 2006 during which **CILAS** has presented to **ESO** the progress of this manufacturing. Pictures are provided below to show the key elements of the DM. Assembly of the deformable mirror will be pursued in 2007.



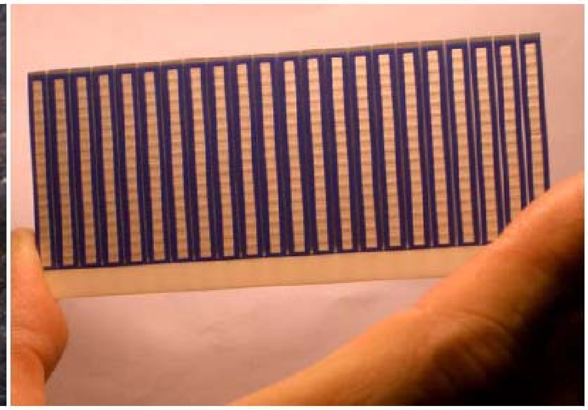
Mockup design, mockup unit and line of actuator developed by CILAS



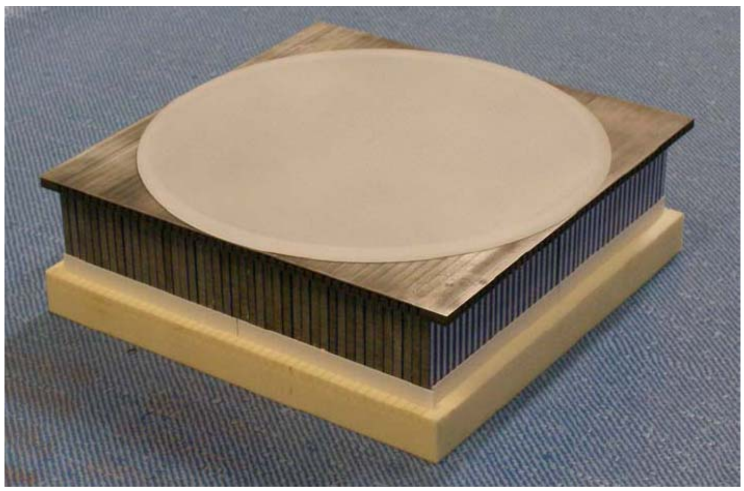
Measurements made on the Mockup mirror: Actuator stroke



Left: 41x41 deformable mirror head; Right: housing

Base plate and line of actuators



Preassembly of the 41x41 actuator piezo DM

Two Progress Meetings have been organized in the frame of this WP.

The documents produced by this WP are provided in CD-ROM JRA1/WP3.3.

WP3.4: 2nd Generation Piezo DM drive Electronic

Background:

The delay which occured in the selection process of the piezo Deformable Mirror (WP3.3) contractor and the resulting late design review did not permit us to finalise the specifications of the corresponding drive electronics – which should include the piezo DM electronic interfaces- as originally planned. Following the design review of the piezo DM, ESO finalised these specifications and Statement of Work.

In 2006:

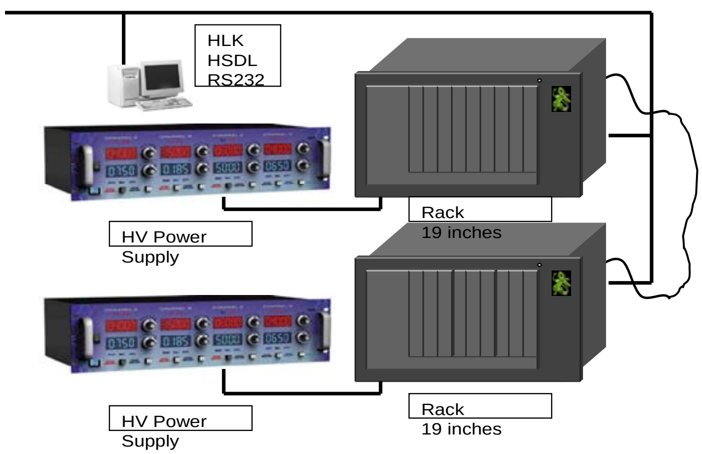
On 31 March 2006 a Call for Tenders for the development and supply of one Corrective Optics Drive Electronics (CODE) was sent to 17 companies and 7 industrial liaison officers within ESO member states and the USA. The specifications are listed in VLT-SPE-ESO-14690-3712, High Order Corrective Optics Drive Electronics, Technical Specifications, Issue 2, January 13, 2006. The statement of work is given in VLT-SOW-ESO-14690-3713, High Order Corrective Optics Drive Electronics, Statement of Work, Issue 2, January 13, 2006 that was attached to last year's report. In the CFT the suppliers were asked to quote for the design of one High Order Corrective Optics Drive Electronics (CODE) with 1500 channels and for the development of one CODE with at least 500 channels for a fixed price of 230k€. Two offers, from Shaktiware (France) and from 4D Engineering (Germany) were received.

The proposal from Shaktiware was based on innovative technology that should achieve the specification goals in the critical areas power dissipation and latency. Moreover, Shaktiware would deliver a system with 760 channels for the fixed price while 4D Engineering is offering 500 channels. Based on these findings, the evaluation board recommended the selection of Shaktiware for the supply of the CODE and the contract was placed and the project kicked off in October 2006.

The first project phase aimed at developing the design and possibly a mockup to verify the concept. This phase was concluded by a design review held at the Shaktiware premises in December 2006.

One Kick-off, one progress meeting and one design review have been organized by this WP in 2006.

Design documentation (deliverable M1 of WP 3.4) is included in **CD-ROM JRA1/WP3.4**



1500 channels piezo DM drive electronic architecture

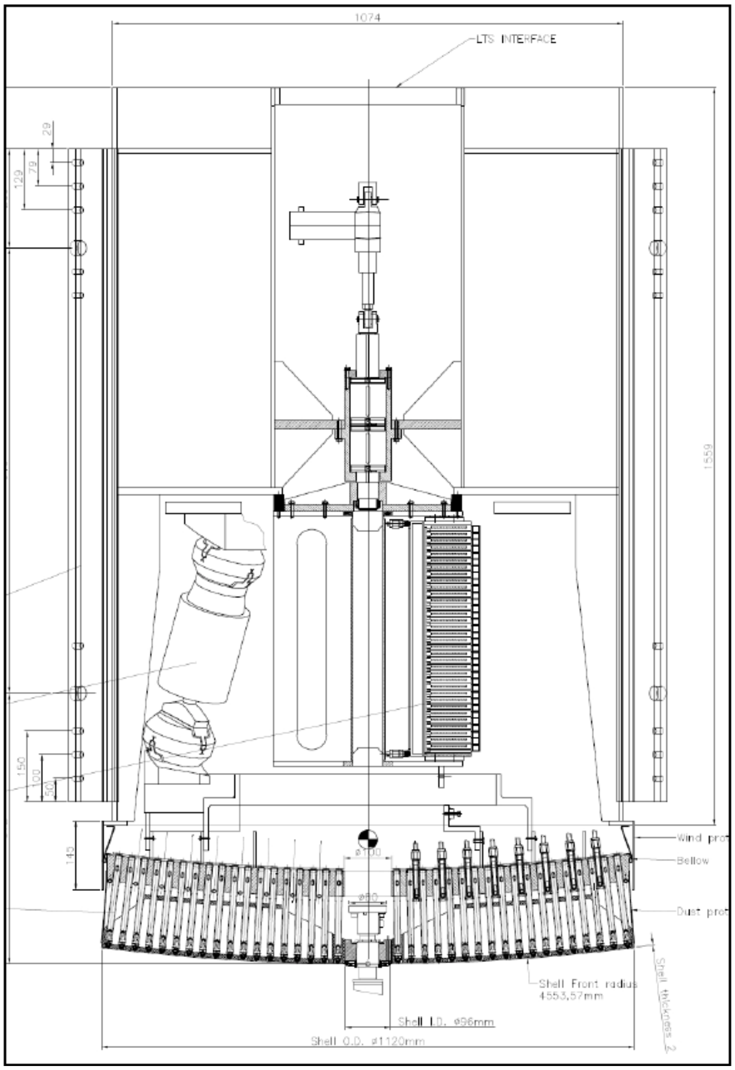
WP3.5: VLT Adaptive Secondary

Background:

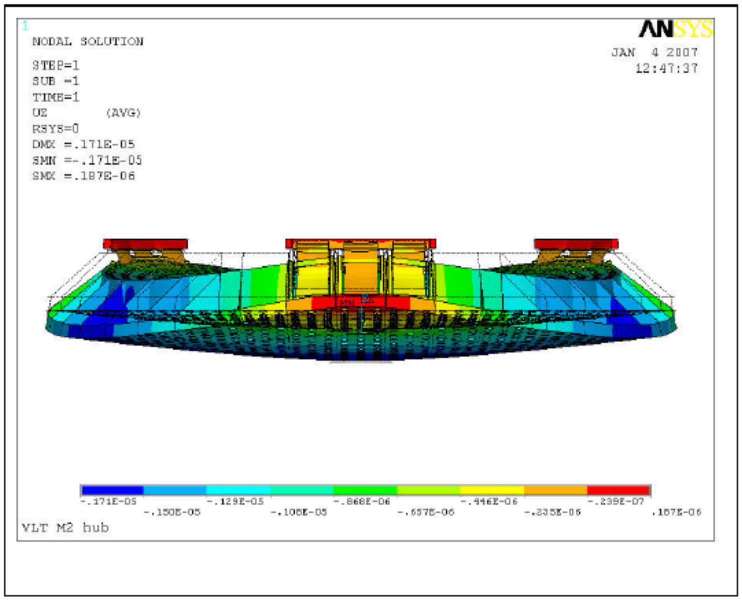
In 2004 ESO, in collaboration with INAF, prepared the detailed technical specification and Statement of Work for the development of the VLT Adaptive Secondary. The contract (s) for the feasibility and conceptual design study part of this development was signed with Microgate (Italy) in July 2004. Microgate (Italy) delivered a straw man design report including a review of the critical interfaces and a corresponding design review has taken place. INAF has produced the preliminary evaluation of the performance of the VLT adaptive secondary for this straw man design phase. In March 2005 the consortium of MicroGate, ADS and INAF Arcetri presented a straw-man design for a complete VLT Deformable Secondary Mirror (DSM). In August 2005, the conceptual design of the VLT Adaptive Secondary was presented to ESO. The feasibility study was considered to have demonstrated the feasibility of the VLT DSM.

In 2006: This first phase has shown that there is no show stopper identified for the production of a Deformable Secondary Mirror meeting all the specifications issued. The preliminary design is in full swing since the kick-off early 2006 and the preliminary design review is planned for March. 2007. Detailed progress has been made with thin shell wind loads, maintenance and mechanical issues (reference body made of Zerodur). Important prototyping activities are planned for mid-2007 to ensure low power consumption.

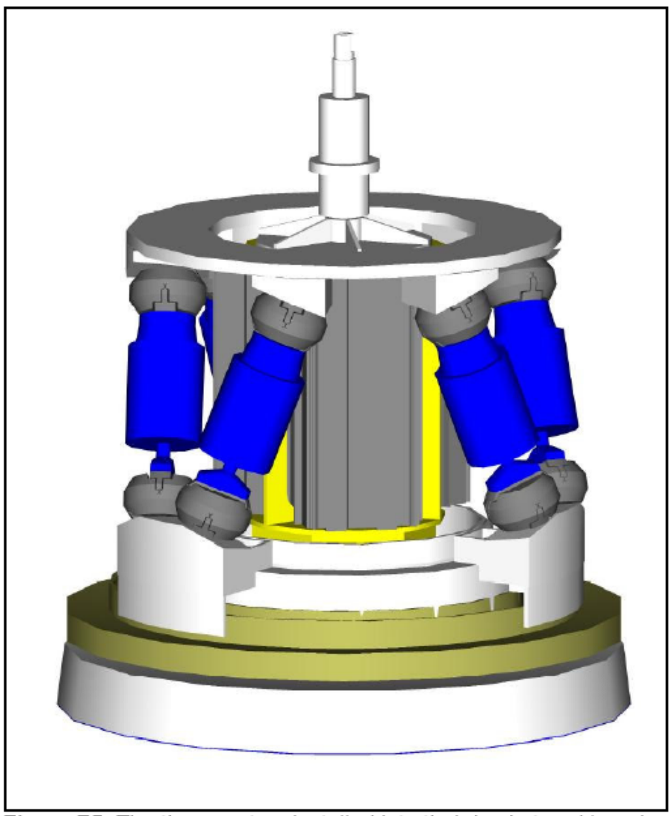
Documentation of WP 3.5 is included in CD-ROM JRA1/WP3.5.



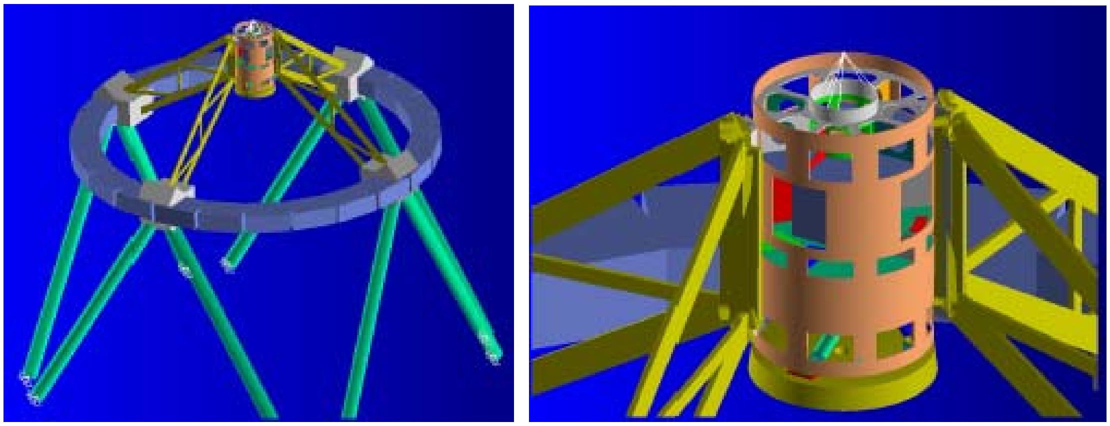
VLT Deformable Secondary mirror components layout into the M2 hub



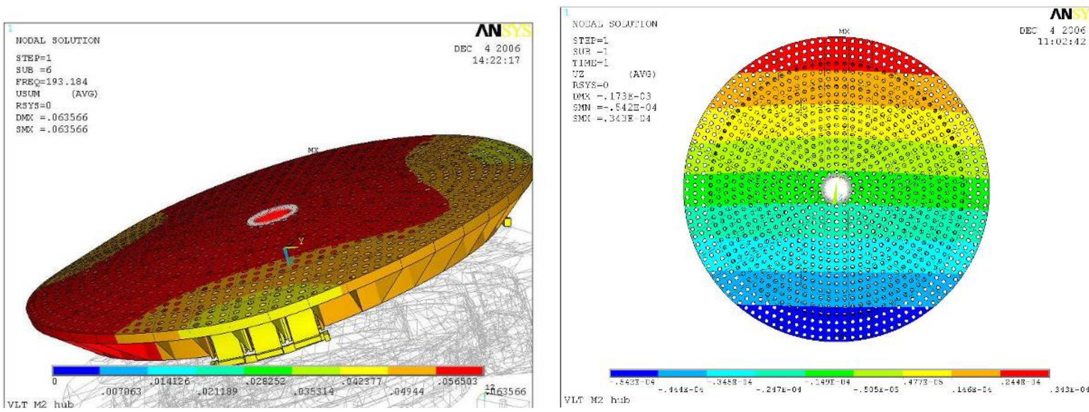
Gravity load analysis of the back plate



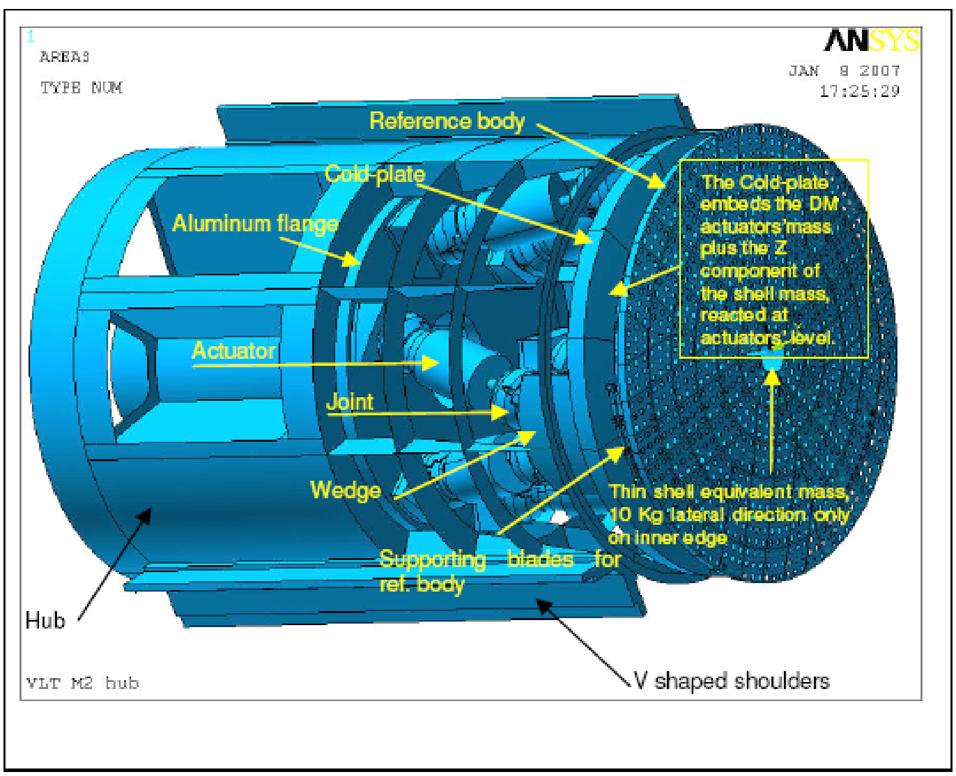
Deformable mirror mounted on the Hexapod and control electronics



Deformable secondary Mirror mounted on the VLT



Left: Vibration modes of the reference body (piston); Right: mechanical stability under gravity load



Geometrical solid model of the entire M2 unit. The main subsystems are highlighted

WP3.6 Manufacturing and Demonstration of a large convex glass shell

Background:

In 2005 ESO issued a Call for Tender for the "Manufacturing, Testing and Delivery of one 1.1m Glass Thin Shell at a firm price of EUR 300.000". Two answers were received but were considered non-compliant. The tender was closed and negotiations were conducted with both potential suppliers to identify areas of compromise. ESO issued an updated CfT in December 2005 to the 2 above mentioned suppliers. The compromises are that ESO will provide a supplementary blank (funded from outside OPTICON funds) and the surface errors versus linear scale have been relaxed.

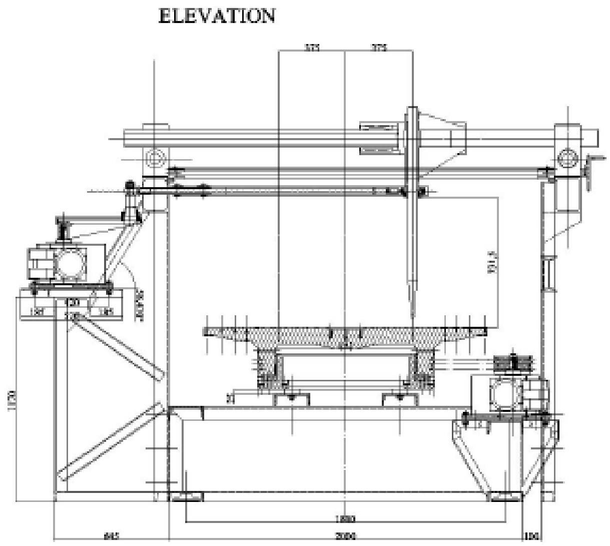
In 2006:

Answers to the second CFT were received in January 2006; ESO Finance Committee approved the selection of the SESO (France) for the manufacturing of the 1.1m thin shell in collaboration with LAM.

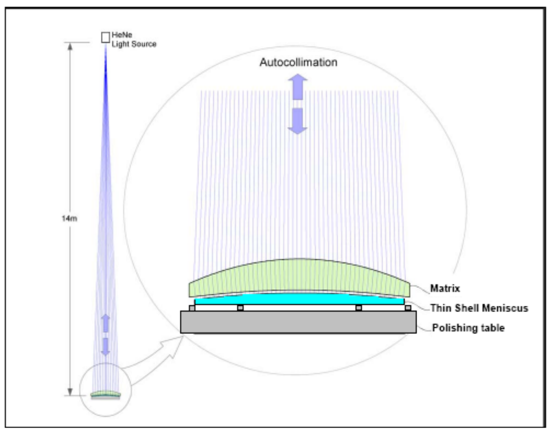
A kick-off meeting took place at SESO in last April when iterations on the fabrication process were still going on. It was frozen during summer and a final design review took place in September. Process is well defined and the first Zerodur blank has been received at SESO's premises while the 2nd blank (spare) has been ordered from SCHOTT by ESO. Delivery is planned for the end of 2007.

Design documentation (deliverable M1 of WP 3.6) is included in CD-ROM JRA1/WP3.6.

1.1 m Zerodur blank



Aspheric polishing machine at LAM



Planned optical test setup using the ESO test matrix

WP3.7 2k Actuator & low order Micro-Deformable Mirrors (MDM) R&D

Background:

The first activity of work-package 3.7 was the development of a prototype of a magnetic deformable mirror. This prototype was delivered in 2005 by LAOG, and we received a lot of requests for this device from the adaptive optics community (both astrophysics and ophthalmology). LAOG had to quickly find a solution to manufacture and commercialize these deformable mirrors, and in 2005 we decided to create a business unit called ALPAO within FLORALIS, a subsidiary company of Grenoble University dedicated to technology transfer. ALPAO will become a stand-alone company in June 2007 and is now employing 3 people. A second patent license was granted to the Imagine Eyes Company for non-astrophysics applications.

The second activity of work-package 3.7 is the development of a MEMS-based 2k actuator deformable mirror. A call for tender has been issued (JRA1-SPE-LAO-0003) and sent to 23 companies and research centres selected with the help of a private consulting company (Yole Development). Due to the lack of satisfactory answers and the late availability of funding, we decided to adapt our strategy to both the available cash-flow and to the technical capabilities of possible subcontractors. After discussions with LETI, ALPAO and OKO/IPMS we decided to launch 2 smaller contracts in 2006:

- One with LETI for the development of a smaller MEMS-based deformable mirror.
- One with ALPAO for the development of an improved magnetic deformable mirror.

The third activity of work-package 3.7 was the development of drive-electronics to for the MEMS prototype (deliverable M3). The call for tender has been issued (doc. JRA1-SPE-LAO-0005) and a contract has been signed in 2005 with the ShaktiWare company for a first set of 1024 channels drive electronics (CNRS contract N ° M051104).

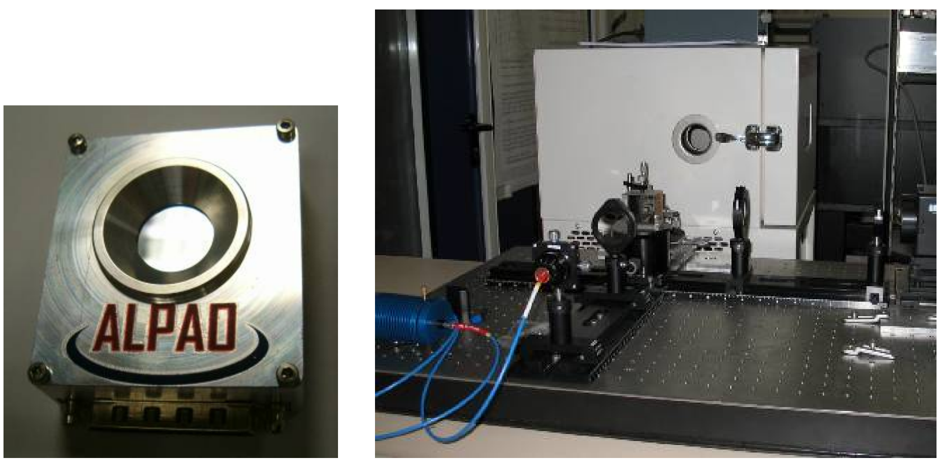
In 2006:

Magnetic Deformable Mirror

Technical specifications and a statement of work have been prepared by ESO and LAOG for the development of a 100 actuator electro-magnetic deformable mirror. A contract as been signed with ALPAO (JRA1-SOW-INS-0003) to study the feasibility of a magnetic DM optimized for MOAO (Multi Object Adaptive Optics). This requires special development to:

- Reduce actuator pitch and packaging size
- Improve stability down to cryogenic temperatures
- Analyze the link between stroke, bandwidth and membrane geometry

The kick-off meeting took place in August 2006 (JRA1-MIN-ALP-0001), and a first progress report has been delivered end of 2006 (JRA1-PRO-ALP-0001). The final deliverable is expected in April 2007. Based on the results from this feasibility study, a second contract is expected in 2007 for the manufacturing of a new prototype.



The new ALPAO compact packaging and a picture of the test bench developed for low-temperature characterization

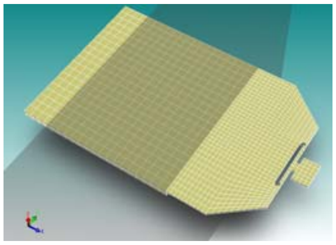
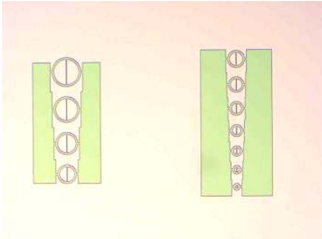
MEMS Deformable Mirror

Technical specifications and a statement of work have been prepared by ESO and LAOG for the development of a 100 actuator electrostatic deformable mirror. A contract has been signed with LETI (JRA1-SOW-INS-0001) to study the feasibility of a large stroke MEMS deformable mirror. The goal of this contract is to:

- Validate the required process steps in the new LETI clean room (200mm wafers)
- Improve actuator design with extensive FEM simulations

• Define the final layout and design all mask levels required for the process

The kick-off meeting took place in September 2006 (JRA1-MIN-LET-0001), and a first progress report was delivered end of 2006 (JRA1-PRO-LET-0001). The work done by LETI is currently not at the expected level, and the planning has already shifted by 3 months. This shift is mainly due to the startup of the new LETI clean room, which has more impact than expected on our project. The final deliverable is now expected in March 2007. Based on the results from this feasibility study, a second contract may or may not be launched in 2007 for the manufacturing of a new prototype.

Left: The new optimized FEM model of an actuator; Right: a set of silicon test devices made in the new clean room.

MEMS drive electronics

The prototype subcontracted to Shaktiware has been delivered and is now fully operational (acceptance test report JRA1-SPE-LAO-0006). We managed to keep the requirements and the design compatible with other MEMS devices, and the Shaktiware electronics is now used at **ESO** to drive a MEMS device manufactured by Boston-Micromachine.

Mini deformable mirror based on Piezo material

Discussions have been ongoing between ESO and CILAS for the development of a 30x30 actuator mini-DM with 1 mm pitch using a piezo-electric actuator. This actuator will make use of the transverse effect of the piezo material. This will in principle allow us to reach 3 micron stroke with a 1 mm pitch and will be sufficient for Extreme Adaptive Optic applications after a first stage of correction with a low order large stroke DM (electromagnetic DM for instance). A contract is planned to be finalised 1st quarter 2007.

The documents produced by this WP are provided in CD-ROM JRA1/WP3.7.

WP3.8 High Order wavefront sensor experimental study

Background:

In 2004 & 2005, a theoretical study was performed by ONERA comparing the Shack Hartmann and the pyramid wavefront sensors for high order adaptive optics.

The top-Level requirements of the High Order Test bench (HOT) document was finalized by ESO in collaboration with Durham and INAF-Arcetri. The design of the HOT bench was developed by ESO, Durham and INAF-Arcetri, although some tunings were necessary during integration to cope with interface issues between the different subsystems. A survey of coronagraphs was done in order to determine which coronagraph could be implemented in the future.

Key components were ordered, the 1k actuator Micro Deformable Mirror from **Boston Micromachine,** the CCD cameras for the shack Hartmann and Pyramid WFSs from **ANDOR** and the micro-deformable mirror drive electronics from **Shaktiware**.

In 2006:

The design of the whole system was finalized during the first months of 2006. All the components have then been ordered. The electronic drive for the micro mirror arrived at ESO in April at the same time as the first Boston micro mirror. The Shack-Hartmann wavefront sensor was delivered to ESO in May and a second Boston micro mirror arrived at ESO in June. The first one was not functional and we sent it back to the company. In parallel the Boston micro mirror and the Andor camera arrived at ESO. The second Boston micro mirror has been characterized using a Fisba interferometer and a report describing all the measurements and uncertainties has been produced. The mirror was globally characterized but no influence function was obtained.

All the sub-systems tests were done between April and July. Then the system was integrated in parallel from May to July. The first results for the SHS were obtained in static open loop in July. In parallel the Andor camera arrived at ESO. A complete characterization of the camera was made and a report has been produced.

INAF has delivered the pyramid wavefront sensor at ESO and has integrated it on the bench in September. A static closed loop on few actuators was obtained the same month.

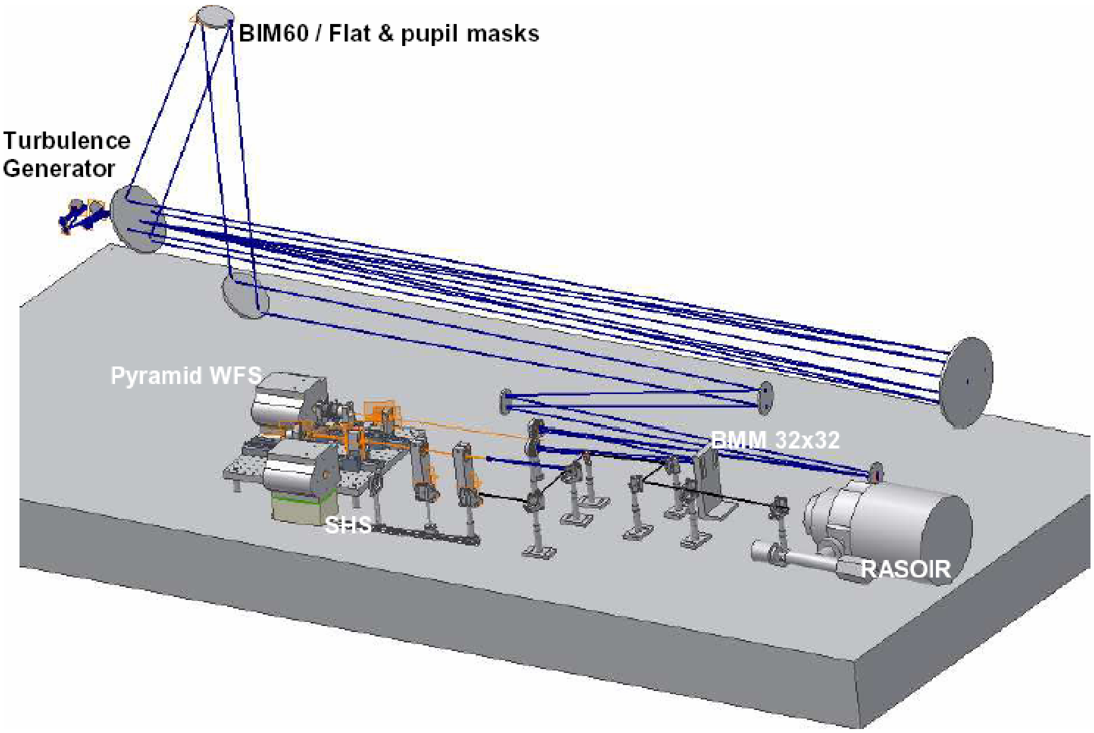
A design review of the High Order Test Bench was also organized in September to present to external reviewers the design and to discuss possible improvements to reach the top level requirements. Eight documents were presented to this review.

The first stage deformable mirror has been characterized and integrated on the bench in October.

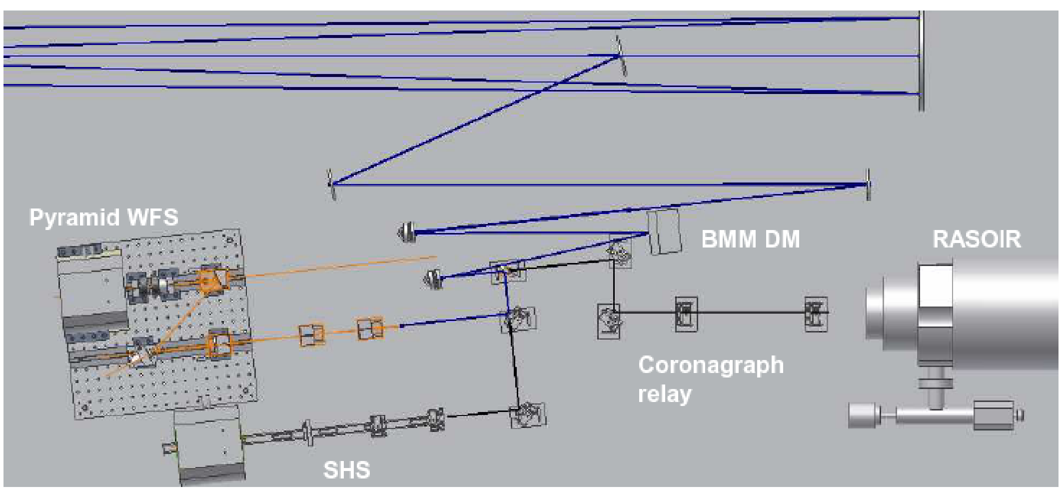
Then the alignment was tuned and during the second pyramid run in November, the loop was closed on all the actuators. A second characterization campaign took place in December-January using a Fisba with more resolution to obtain the influence function of each actuator.

A first version of the HOT coronagraph specifications was produced by Meudon in order to contact the possible suppliers.

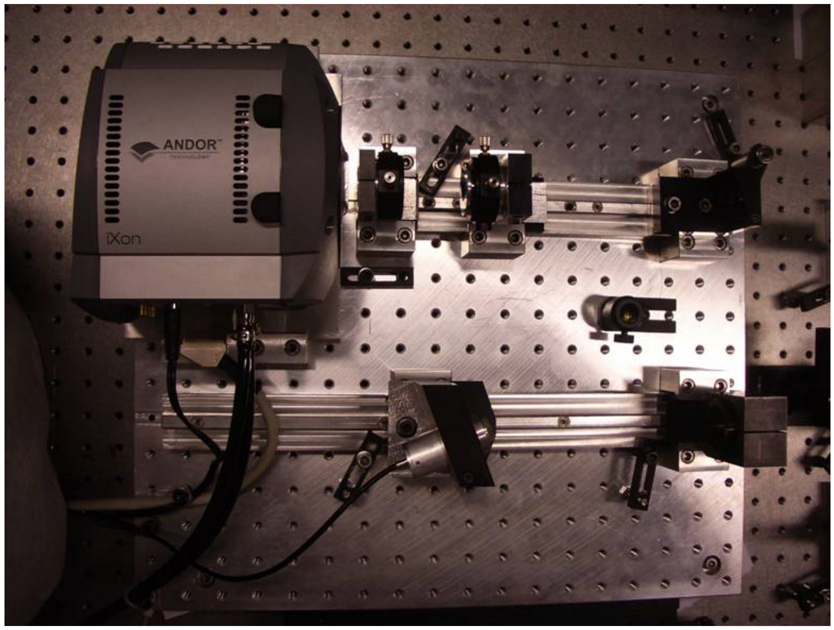
All documents produced in the frame of this WP are included in CD-ROM JRA1/WP 3.8/.



Overview of the High Order Test bench (HOT) design. On the left, the turbulence generator, on top, the first stage deformable mirror, on the right, the 1000 actuators Boston Micromachine DM and the IR imager RASOIR, in the central area the two wavefront sensors (Pyramid and Shack Hartmann)



Top view of the HOT Wavefront sensor and imaging area with the coronagraph relay



Pyramid wavefront sensor developed by INAF

Integration of the Pyramid wavefront sensor on the HOT bench at ESO

2 progress meetings have been organized in 2006 in WP 3.8 plus one design review involving international reviewers.

The following table summarises the Milestones and deliverables achieved during the 2006 reporting period by JRA1:

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Task No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
M1	JRA1 General Meeting 3	**1**	**ESO**	**27**	**27**
M2	JRA1 General Meeting 3	**1**	**ESO**	**36**	**36**
M1	Complete design of the single object WFS for GTC	**2.3**	**GTC**	**33**	**36**
M2	Implementation of the optimal control methods developed above on a simplified laboratory system and performance evaluation.	**3.2**	**ONERA**	**30**	**30**
M1	Complete design of fast drive control electronics for the piezo stack deformable mirror developed above	**3.1**	**ESO**	**33**	**36**
M1	Specifications of the electro-magnetic micro deformable mirror prototype; contract signature with ALPAO-Floralis	**3.7**	**INSU**	**31**	**33**
New	Specifications of a electrostatic micro deformable mirror prototype; contract signature with LETI	**3.7**	**INSU**	**N/A**	**33**
M3	Delivery of a MDM control electronic prototype	**3.7**	**INSU**	**27**	**30**

The table below summarises the major JRA1 meetings:

Date (2006)	Title/subject of meeting /workshop	Location	Number of attendees	Website address
March 30-31st	General Meeting 3 JRA1	Paris	20	http://www.eso.org/projects/aot/jra1/
Dec. 11-12th	General Meeting 4 JRA1	Marseille	12	http://www.eso.org/projects/aot/jra1/
weekly	Weekly telecom WP 2.1	Telecon	10	
March 13-14th	Kick-Off SPHERE project	Paris	30	CD-ROM
June 26-27th	SPHERE progress meeting 1 (WP2.1)	Paris	25	CR-ROM
Oct. 12-13th	SPHERE progress meeting 2 (WP2.1)	Paris	26	CDROM
Oct. 26th	ASSIST optical PDR (WP2.2)	Garching	10	CDROM

Oct. 25th	LINC-NIRVANA Progress meeting (WP 2.4)	Heidelberg	15	CDROM
April 24-25th	LINC-NIRVANA Progress meeting (WP 2.4)	Heidelberg	15	CDROM
Feb 27th – March 1st	LN Science case and Technical meeting (WP 2.4)	Heidelberg	20	CDROM
February 12th	Telecon WP 3.1	Telecon	6	CDROM
February 1st	Telecon WP 3.1	Telecon	6	CDROM
July 20th	Progress meeting WP 3.1	Durham	6	CDROM
Dec. 9th	Progress meeting WP 3.1	Durham	6	CDROM
April 11th	Progress meeting 1 WP 3.3	Videocon	5	CDROM
Dec. 8th	Progress meeting 2 WP 3.3	Videcon	4	CDROM
Sept. 15th	Kick-Off meeting WP3.4	Marseille	6	CDROM
Nov. 8th	Progress meeting 1 WP 3.4	Marseille	6	CDROM
Feb. 24th	Kick-off meeting VLT DSM WP 3.5	Videoconf	10	CDROM
August 30th	VLT DSM Progress meeting WP 3.5	Garching	8	CDROM
Oct. 12th	VLT DSM Progress meeting WP 3.5	Lecco	6	CDROM
Dec 8th	VLT DSM Progress meeting WP 3.5	Bolzano	6	CDROM
April 11th	Zerodur thin Shell Kick-off WP 3.6	Marseille	7	CDROM
July 20th	Final design review thin shell WP 3.6	Videoconf	5	CDROM
Sept. 18th	Progress meeting thin shell WP 3.6	Marseille	5	CDROM
Sept. 4th	Kick-off meeting electrostatic mirror WP 3.7 (LETI)	Videcon	5	CDROM
August 1st	Kick-off meeting electromagnetic mirror WP 3.7 (ALPAO-FLORALIS)	Grenoble	5	CDROM
Feb 08th	Telecon WP3.8	Telecon	8	CD-ROM
May 19th	Telecon WP 3.8	Telecon	5	CD-ROM
Sept. 22nd	HOT design Review WP 3.8	Garching	12	CDROM

1.5.3 JRA2: Fast detectors for AO

I Human effort

Participant number[17]	40	4	7	31	
Participant short name[18]	INSU/CNRS	ESO-INS	IAC	ONERA	**Total**
Person-months[19]	21.9	3.59	1.9	0	**27.39**

II Progress report

In this section, what is referred to as the "Test Camera" and "OCam" is the synthesis of the WP3 and the WP4 products from the Opticon contract Annex I.

The progress report given here is split by Work- Packages.

WP1: Management

Several meetings were organised, see list of meetings at the end of this report for JRA2. We had some issues with funding but fortunately we managed to control these. The JRA2 financial situation remains tight, but should be manageable.

WP2: Detector specification and fabrication work package.

<u>Progress and Schedule</u>

The following table highlights the major milestones and deliverables achieved in 2006 plus future ones until work package completion. Note that milestones names provided in this table do not correspond to those in Annex I of the OPTICON contract. They are internal to JRA2 WP2.

[17] Lead participant first

[18] Use the same contractor short names and numbers indicated in the table "list of participants" in Annex I of your contract.

[19] AC contractors must include both the total estimated human effort (including permanent staff) and, in brackets, additional staff only.

Table 1: Milestones (internal JRA2 WP2 milestones)

Ref.	Description	Predicted / Actual Date.	Status
M1	Date of Constitution of Contract	22nd April 2005	Complete
M2	Kick-off meeting	3rd March 2005	Complete
M3	CDR	22nd September 2005	Complete
M4	Package Design Review	13th January 2006	Complete
M5	Delivery of mechanical samples (4 off)	28th September 2006	Complete
M6	ESO supplies test equipment	5th March 2007	Delay
M7	Delivery of Electrical Samples (4 off)	5th July 2007	Delay (Note 1)
M8	Delivery of Engineering Devices (4 off)	2nd August 2007	Delay(Note 1)
M9	Delivery of Science Grade Devices (4 off)	28th September 2007	Delay(Note 1)

Note 1. Delayed due to ESO supplied test equipment delay.

During 2006, fabrication of the CCD die continued, the package design review was completed satisfactorily and fabrication begun.

On 13th January 2006, the package review meeting was held at e2v. The majority of the design was accepted and approval given to begin ordering parts. e2v accepted the recommendation of the review board and redesigned the CCD carrier to provide more substrate ground planes. All the package parts have been ordered and received except the Sapphire window assemblies which require remanufacture after failing incoming inspection.

The CCD wafers have been manufactured and front-face probed. Two wafers (one standard silicon and one deep-depleted) have completed back-thinning. These will be probe tested once the image test facilities have been commissioned. The front-face image probe test results have been analysed and additional wafers identified for back-thinning. The assembly of back-thinned devices will start in January 2007. Five potential Front-Faced devices (i.e. electrical samples) were delivered in September 2006 for Test Camera controller development and testing. Four of these were delivered in place of mechanical samples.

Delivery date of final devices is dependent on the delivery of the Test Camera. With the current expected delivery date of 5 Mar 2007 of the Test Camera, the science devices will be delivered on 28 Sep 2007.

Detector Design

The detector design (Figure 3) is a 24 µm square 240x240 pixel split frame transfer 8-output back illuminated L3CCD, designated as CCD220 (AD7 for the design report). The image and store area are built with metal-buttressed parallel clock structures to enable line shifts of 10 Mlines/s for total transfer time from image to store of 12 µs and low smearing of under 1.5% at 1,200 fps. Two phase clocking was chosen for simplicity, lower power dissipation, and symmetry of drive.

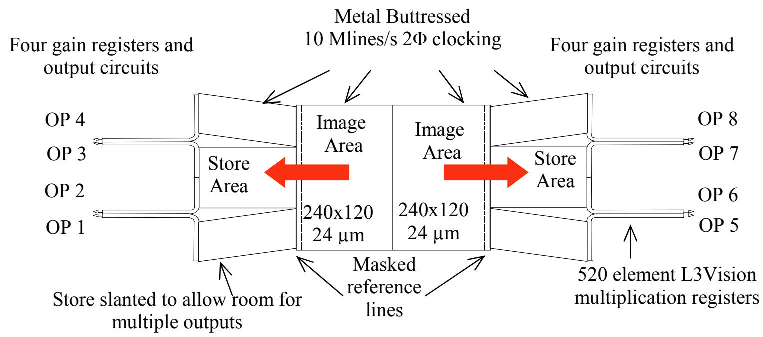


Figure 3: Schematic of CCD220.

The store area is slanted out to make room for the standard serial registers (three phase clocking) to curve around (Figure 4) and provide space for the output circuitry. Each output has a 520 element 16 µm standard L3Vision gain register whose gain is controlled by the voltage of the multiplication phase. The output amplifier is a 2-stage source follower (Figure 5 and Figure 6) and of similar design to that was employed on recent L3V CCDs (CCD97). The gain register is to be optimized for a gain of 200-300, a value typically expected for AO applications. With an expected output amplifier read out noise (RON) of 50e, this will provide an overall effective read noise of under 0.2 e- (50 e- RON/250 of gain register). The serial registers, gain registers, and output amplifiers are designed to operate up to 15 Mpixel/s to achieve a full goal frame rate of over 1,500 fps.

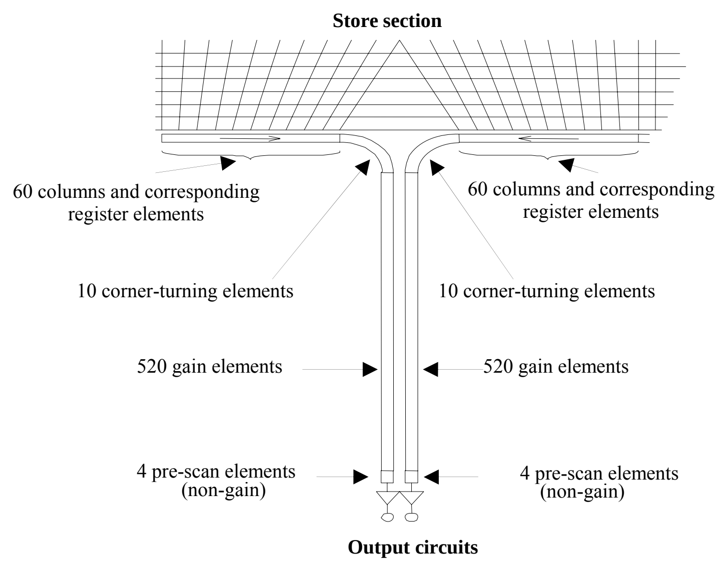


Figure 4: Details of serial and gain register.

Feature	CCD220
Overall responsivity	1.0 µV/electron
Node capacitance	100 fF
RON (rms with CDS ~ 15 MHz)	50 electrons
Reset rms noise (dominates without CDS)	125 electrons
Saturation (3V swing at node)	1.9 M electrons
Output impedance	350 Ohms
Maximum frequency (settling to 1%, load ≤ 10pf)	15 MHz
Maximum frequency (settling to 5%, load ≤ 10pf)	25 MHz
Power dissipation	50 mW

Figure 5: Nominal specifications of the output amplifier.

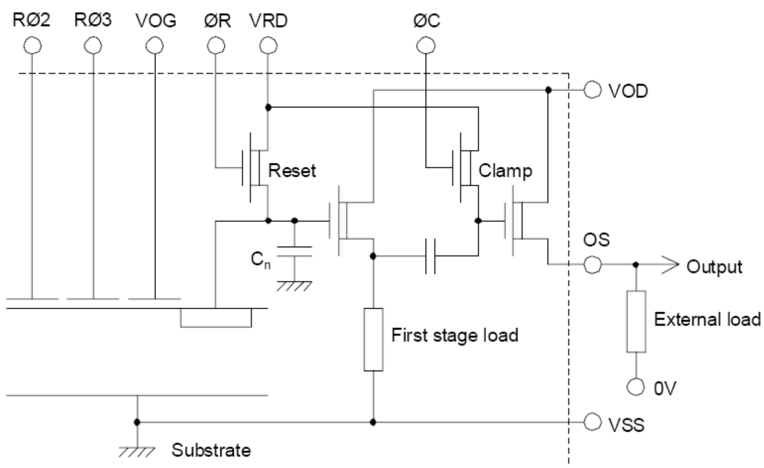


Figure 6: Output amplifier schematic.

The baseline device is built in standard silicon and is low risk with guaranteed delivery of devices that meet minimum requirements. A split wafer run has enabled a speculative variant in deep depletion silicon to be built. Deep depletion improves the "red" response and is important for applications that rely on natural guide stars such as VLT SPHERE.

Package

The CCD220 is encapsulated in a 64 pin package (Figure 7 and Figure 8) with a custom-designed 2-stage integral thermo-electric cooler. Thermally conductive epoxy adhesive (50 µm of ABLEBOND) glues the Peltier cooler, ceramic chip carrier (Figure 9) and CCD die together. The package is sealed and back-filled with 0.9 bar of Krypton gas to minimize heat transfer to the outside and ingress of moisture.

The CCD220 die has four fiducial crosses in the region of the bond pads, two on either side of the device image area, in the region of the bond pads. These are clearly visible through the package window for attaching and aligning lenslet arrays. An AD590[20] temperature sensor is glued to the ceramic chip carrier to provide the sensor for temperature regulation. The

[20] http://www.analog.com/en/prod/0,,764_811_AD590,00.html

sapphire entrance window is of high optical quality (double path focus removed wavefront error of < 50 nm rms), good surface quality (defects meet 5/2x0,05 DIN3140), and AR coated with transmission > 98% over range 400-950nm.

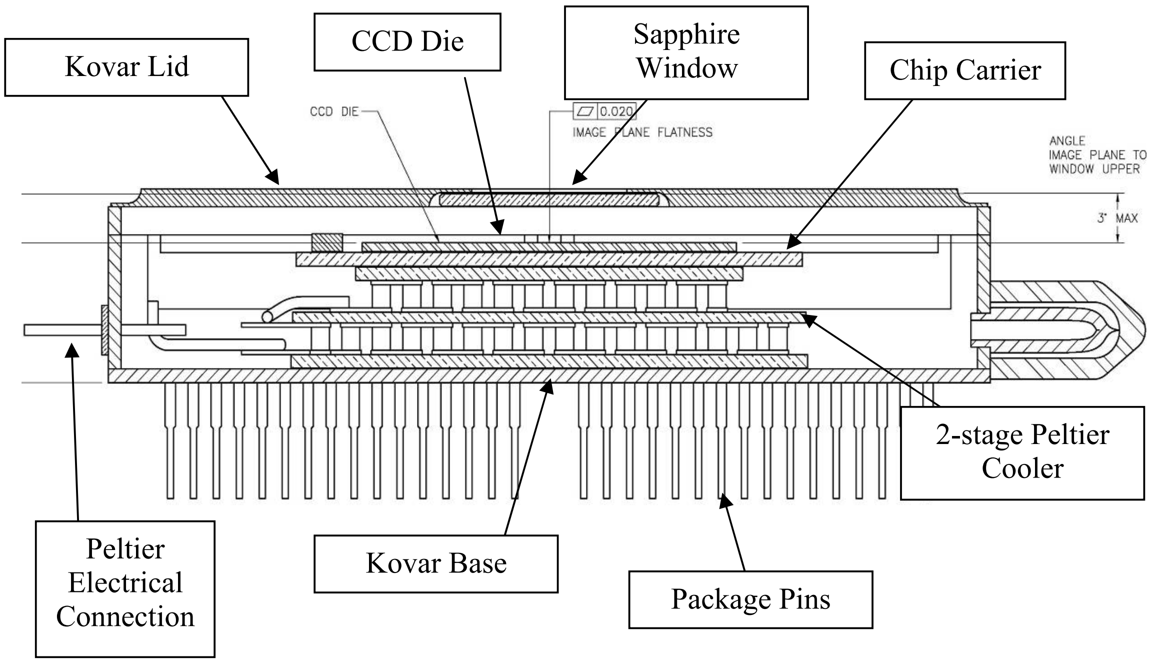


Figure 7: Cross-section of the CCD220 Integral Peltier Package.

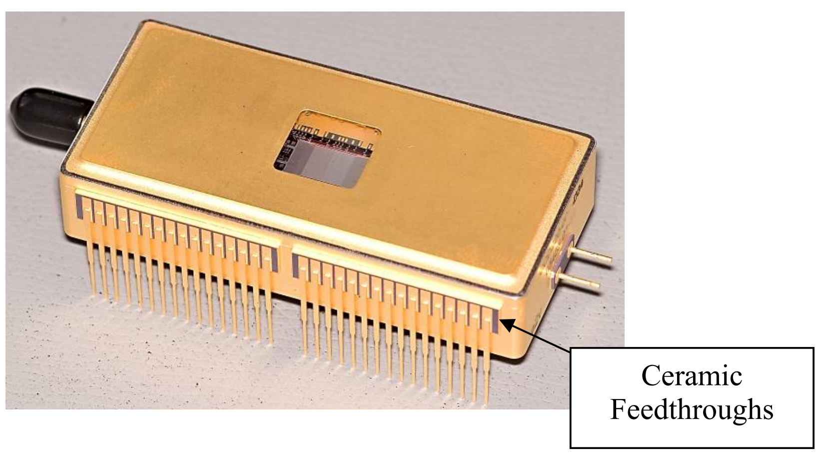


Figure 8: Photograph of a delivered electrical (Front-Face) grade CCD220.

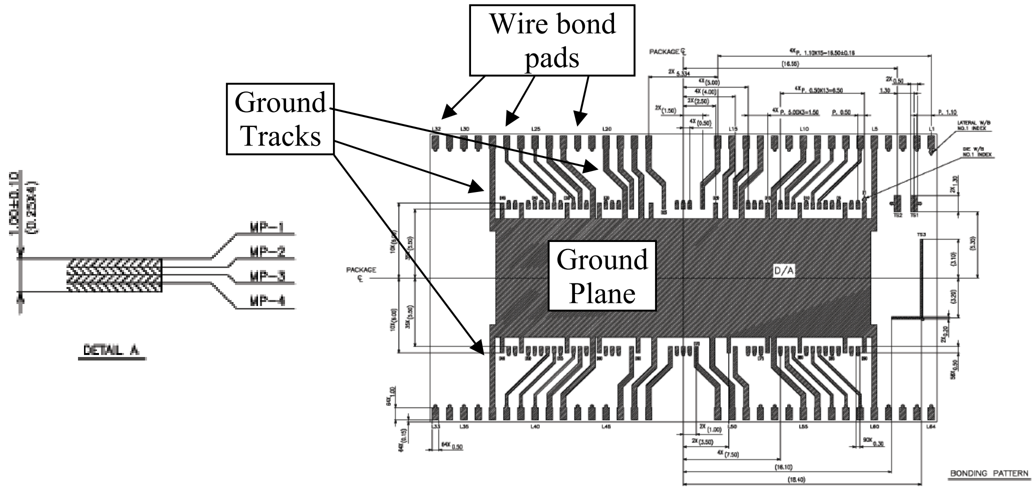


Figure 9: Left: The four layer design of the ceramic chip carrier. Right: Layout of MP-1 layer of the ceramic chip carrier showing the ground connection between the two sides of the package.

WP3: Controller workpackage

All parts of the electronic boards have been successfully built, with the associated spares.

MCU board

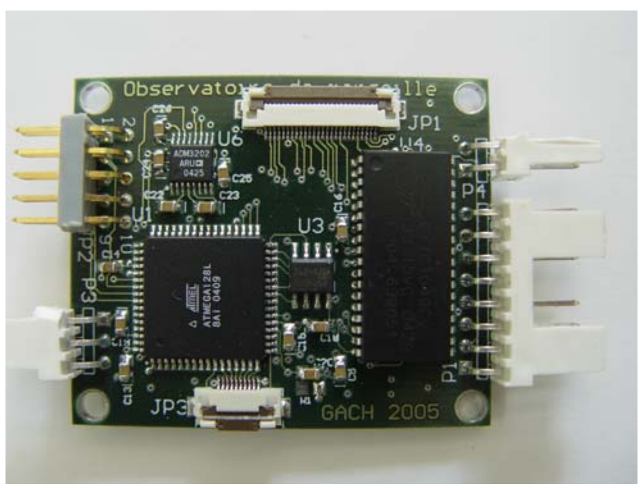


Figure 10: view of the MCU board

The MCU board was built in advance (end 2005) and has been tested early (see Figure 10). It has been successfully integrated to the rest of the design. The CPLD microcode has been improved to extend RAM memory to 4Mb in order to make life easier for sequencer update. Firmware has been developed and is now under tests.

Cameralink interface

The cameralink interface board has also been developed at the end of 2005 and has been successfully tested in 2006 (see Figure 11). It meets the requirements of sending 1600 FPS to the acquisition system (220 MB/s). It has been successfully integrated to the rest of the design in 2007. The cameralink embedded serial link has been tested in 2007 in conjunction with the sequencer and the MCU boards and needed a minor revision on the routing (2 tracks misplaced). No new fabrication batch is foreseen for the moment and the patch is done with 2 wires added to the board.

Figure 11: view of the cameralink board

Sequencer board

The sequencer board is the most complex and challenging board of the WP3 design. It was developed in 2006 and successfully tested. The sequencer board showed results in accordance with the simulations especially for the timing resolution and the ability to do multi-level clocking. The 2 next figures show the ability of the sequencer to provide 1.5ns features. The first one is a 327MHz clock fully generated by the sequencer (level is LVDS signaling). The second one shows a pulse of 1.5ns wide in a 109MHz clock. Figure 14 and the Figure 15 show the ability of the sequencer to provide very fast multi-level clocking necessary for the deep depletion variants of the CCD219/220. The jitter was a major concern to ensure good gain stability. We measured a period to period jitter of 15ps which is at the measurement limit of the Tektronix DPO7254 scope. The sequencer board showed a flash memory footprint error (giving bad connections) and 2 missing connections. A new batch is foreseen although the current boards produced are useable.

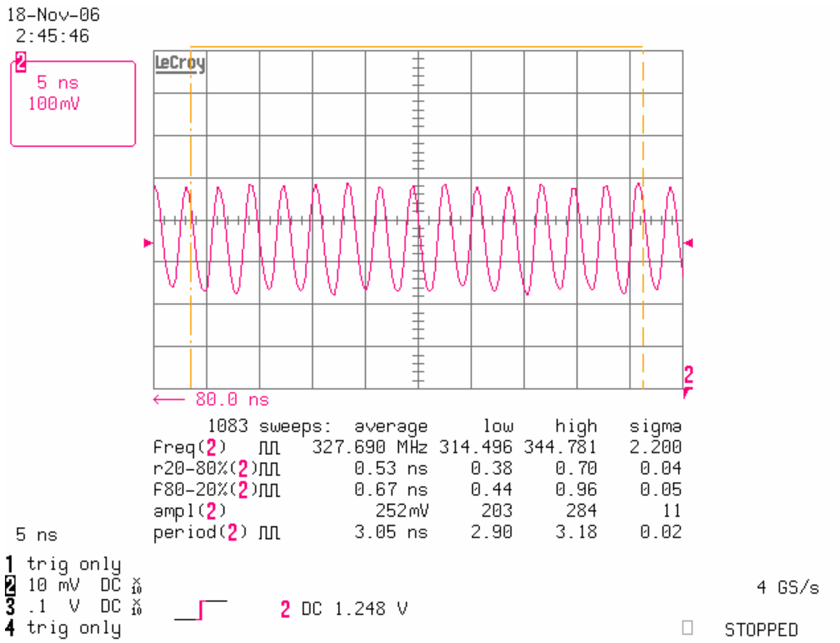


Figure 12: 327 MHz clock generated by the sequencer

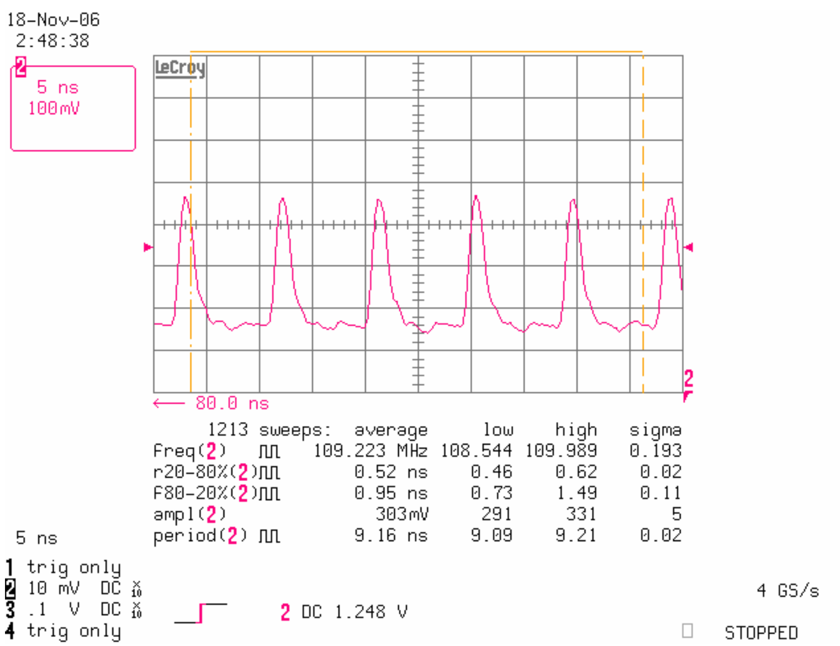


Figure 13: 1.5ns pulses in a 109MHz generated clock

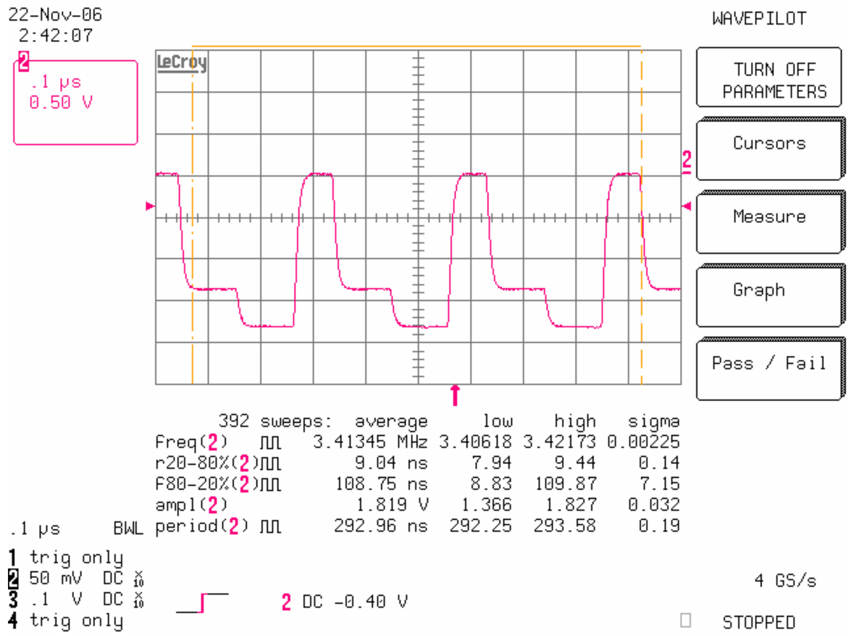


Figure 14: multi-level clocking example at 3.4 MHz

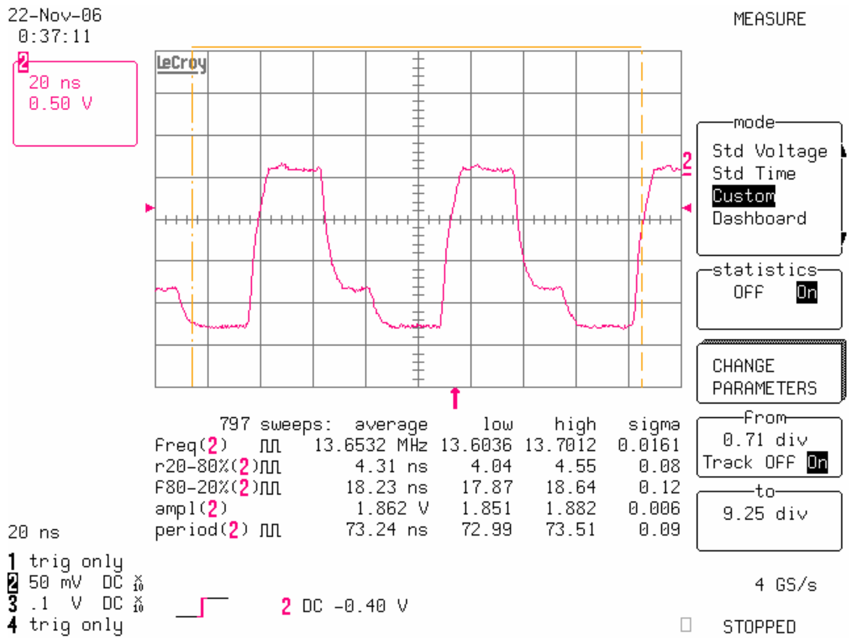


Figure 15:multi-level clocking example at 13.6 MHz

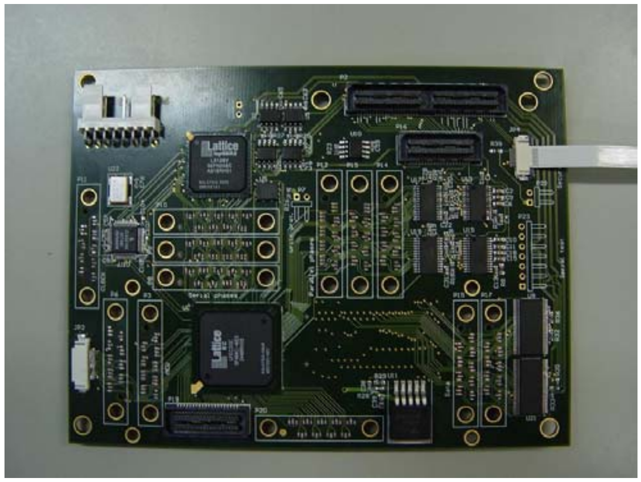


Figure 16: view of the sequencer board

Bias board
The bias board was developed in 2006 and is now under test (see Figure 17). We had a fabrication batch problem on the first batch (there was a failure on the boards, a shortcut between a power supply and ground). We needed a new fabrication run that delayed the tests by 1 month. The bias board has not been fully tested yet. The voltage generations have been tested OK with 14 bit resolution.

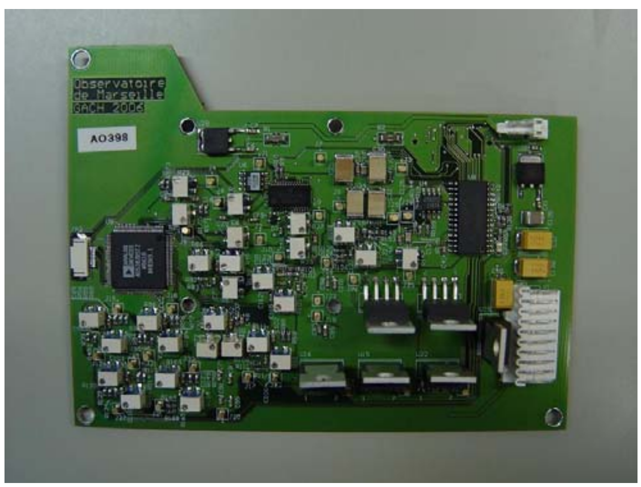


Figure 18: view of the bias board

The A/D conversion boards

The A/D conversion board was developed in 2006 and is now under test. Preliminary tests showed a normal behavior in static mode. These boards must be tested in conjunction with the front end boards.

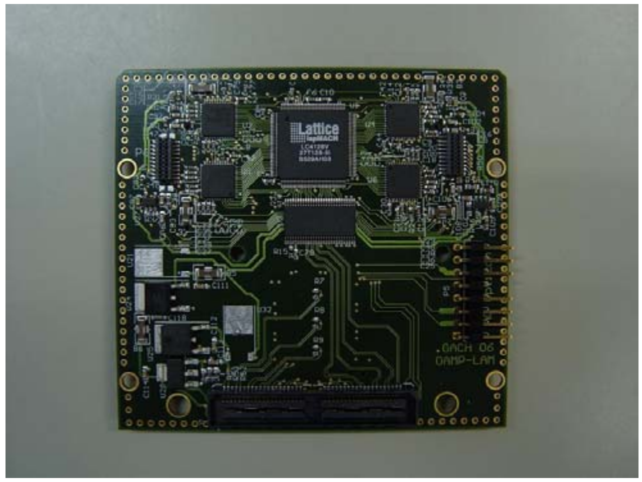


Figure 19: view of the AFE board

Front end boards

The front end boards have been developed at OHP and are now under test. The early tests showed that the static behavior is OK.

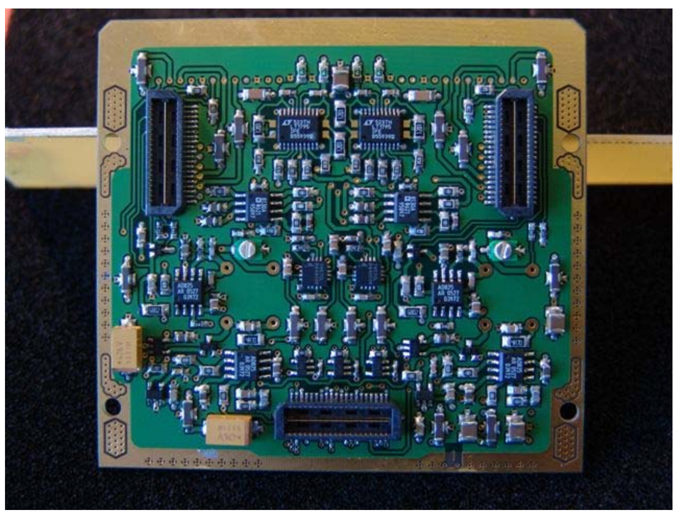


Figure 20: View of the front end board

Full assembly of the electronics boards

The next picture shows the full assembly of the electronics.

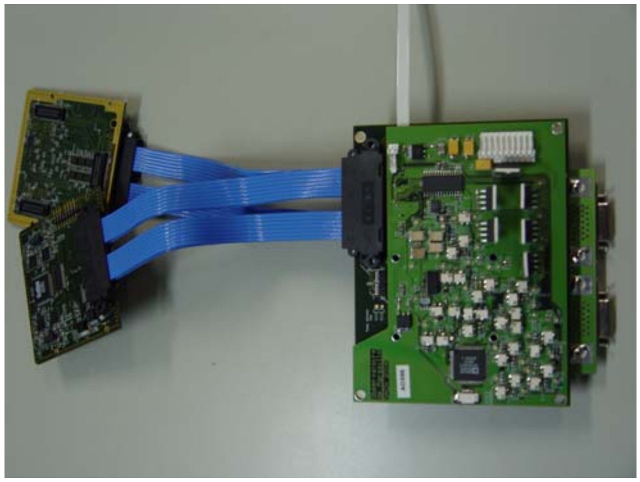


Figure 21: view of the fully assembled electronics

<u>Updated schedule for controller delivery to the Test Camera.</u>

The completion of tests of the front end boards is not foreseen before the end of March 2007. The tests of the other remaining boards (AFE and IRD) and the development of sequencer files should also be carried out up to the end of March. The expected date for delivery of the controller for AIT in the Test Camera is then updated to end of April 2007.

WP4: Cryogenic system

<u>Status of the camera head</u>

The camera head is now complete.

<u>Experimental set-up</u>

The first cryogenic tests have been done without flushing the camera head with dry nitrogen. Figure 22 (left) shows the water chiller that has been used for the heat sink cooling. Figure 22 (right) shows the camera head with the dummy front end board open. These dummy boards are used for the cryogenic test. They have the same dimensions as the final ones, they are used to connect the Keithley TEC controller to the AD590 temperature sensor glued on the CCD ceramic. This was also a first attempt to test the front board to the package pins using the spring contacts that were chosen for the camera.

The chiller and its accessories allow the water temperature and water flow to be varied.

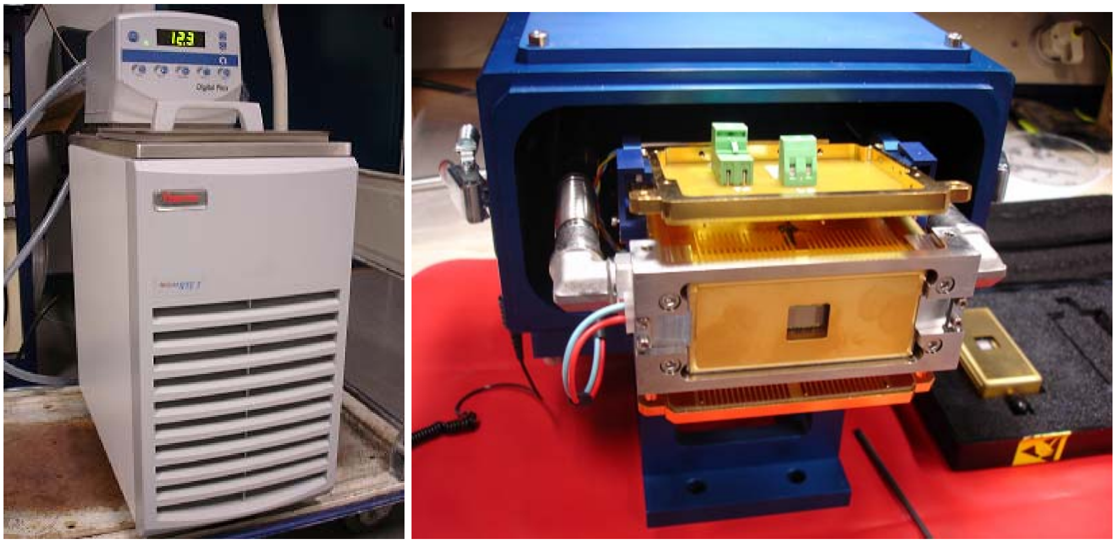


Figure 22: (left) The Neslab water chiller used to cool down the heat sink; (right) Camera head, with the dummy front end board open.

Temperature measurements

For the measurements of this section, we took the following data parameters:

- Water temperature: 10 °C
- Water flow: 1.75 l/min
- Thermal Interface: Gap Pad 1000SF (Silicon Free, thickness 0.25 mm)

Figure 23: (left) The camera head with the dummy front end board in the closed position allowing the CCD temperature to be sensed; (right) The lowest temperature achieved here is -39.7 °C as shown on this picture of the Keithley TEC controller.

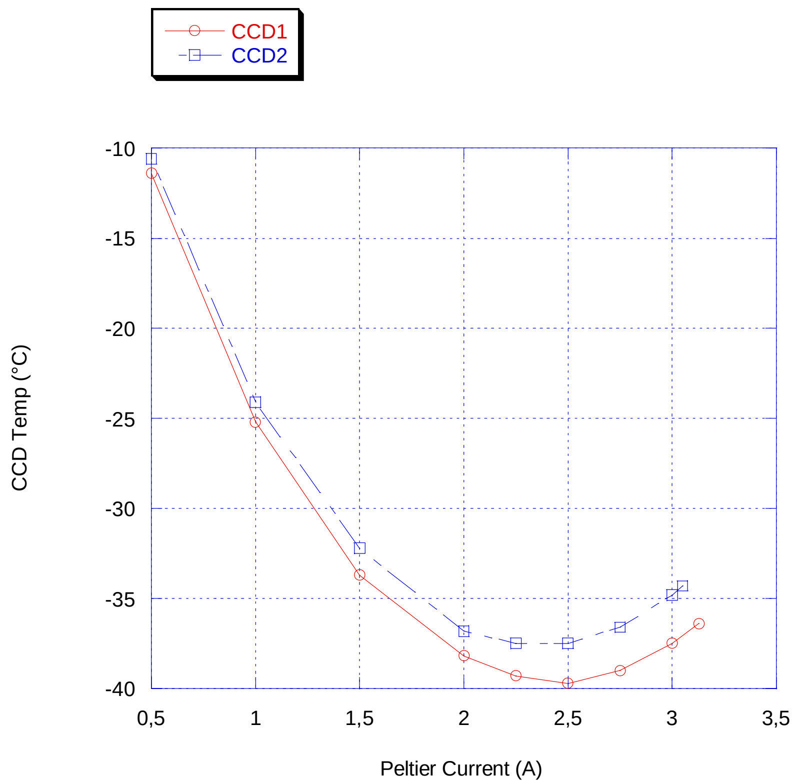


Figure 24: CCD temperature measurement as a function of Peltier current for the 2 mechanical samples sent to Grenoble.

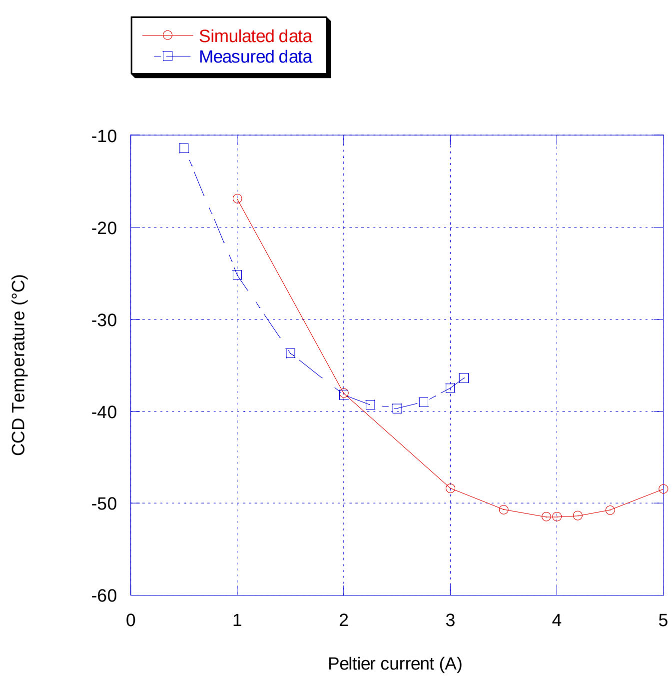


Figure 25: CCD temperature as a function of Peltier current: comparison between measured data (for CCD1) and simulated data. Note that simulated data plotted here are with a CCD active load of 1.4W and the Sil Pad A2000 thermal interface.

Figure 23 shows the camera head and the Keithley front panel displaying the -39°C achieved with a current of 2.5 A in this configuration.

Figure 24 shows the CCD temperature measurement as a function of the Peltier current for the 2 mechanical samples sent to Grenoble. The conclusion is that with this configuration, the minimum temperature that is achieved is -37°C, this one is obtained for a Peltier current of 2.5 A. The Figure 25 shows the comparison between measured data (for CCD1) and simulated data. Note that simulated data plotted here are with a CCD active load of 1.4W and the Sil Pad A2000 thermal interface. This shows that with the Gap Pad SF1000 (0.010" thick) thermal interface, we obtained results far worse than the expected performances.

Influence of thermal interface

To better understand why we have these bad thermal performances of the Peltier, we investigated the following:

- Decrease the resistance of the wires connecting the Keithley to the Peltier.
- Change the thermal interfaces between the package and the heat sink:

We tested the following thermal grease:

- Spire SP-700 (or also Stars-700) from Spire. See more details on this product here:

http://www.spirecoolers.com/main/product_acc_detail.asp?ProdID=458

- Thermal conductance: 2.17 W/m.K.

We ordered also other products from Arctic Silver that are silicon free and that should not take long to be delivered. They will be tested when we receive them.

We plan also to order thicker Gap Pad 1000SF.

There are also silicon free thermal greases that are qualified for space applications. They should also have the required properties.

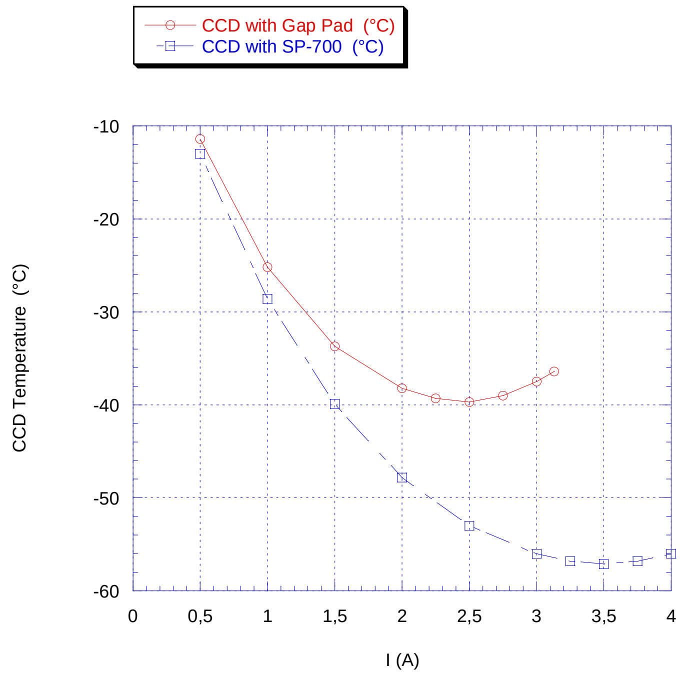


Figure 26: CCD temperature as a function of the Peltier current for 2 different thermal interfaces between the heat sink and the package: in red, the Gap Pad interface, in blue the Spire SP-700 thermal grease.

The Figure 26 shows the temperature dependence of the CCD for the 2 thermal interfaces: the Gap Pad and the SP-700 thermal grease. With the thermal grease, the minimum temperature obtained is -57°C, as shown on this figure.

<u>Miscellaneous: OCam, a new name for the Test Camera</u>

The Test Camera designers decided to give a name to the Test Camera, now called "OCam", for Opticon Camera. We also designed the following logo for this camera:

WP5: detector testing activity

The detector test plan at the IAC has been developed. A meeting was held at the IAC to address different issues with particular emphasis to the detector test plan and testing facilities. A testing lab is almost ready as part of a more challenging activity to provide an Optical Detector Test facility at the IAC whose first objective is to test the CCD220 for OPTICON. Most of the components are already available and there is an integration and automation plan to ease detector characterization. This will take place during 2007 before the arrival of the camera and detectors.

By the end of 2007 it is planned to receive the first devices and the camera to start the detector testing.

III Conclusion

During 2006, the JRA2 overall activity made good progress and the scientific results are good. The finance situation is still tight, due to late arrival of funding and a slight under-estimation of the total cost at the beginning of the contract. Note that at this date (Feb. 2007), the milestone M2 of WP4 will also be achieved.

Milestones and Deliverables achieved

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Task No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
M4	Delivery of demonstration device detector.	WP2	ESO	18	32

Meetings and Workshop Table

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
January 13th, 2006	CCD Package design review	Chelmsford e2v	15	http://www-laog.obs.ujf-grenoble.fr/JRA2
March 8 and 9th, 2006	Test Camera Design Review	ESO Garching	20	http://www-laog.obs.ujf-grenoble.fr/JRA2
July 11th to 13th, 2006	JRA2 progress meeting	IAC Tenerife	8	http://www-laog.obs.ujf-grenoble.fr/JRA2

1.5.4 JRA3: Fast Readout High Performance Optical Detectors

A. Contractors:

Participant number	1	2	4	11d	11e	13	28	37	39	40	
Participant short name	UCAM	PPARC	ESO	MPG MPA	MPG MPE	NOTSA	NUIG	LSW	USFD	Warwick	**Total**
Person-months	19 (19)	9.6(9.6)	0(0)	0.5(0)	18(12)	0(0)	9(0)	0(0)	6.53(0.53)	6(0)	68.63 (41.13)

NB. As decided in December 2005 and reported previously, the tasks of NOTSA have been taken over by UCAM. As in previous years, ESO contributes to the other packages only by participation in meetings.

WP1: Management

Management of JRA3 proceeded smoothly, as the critical workpackages of JRA3 are well under way and producing excellent results, often significantly exceeding target performance. These are detailed further below in reports from the individual work packages. Exceptions are WP4, where progress with the development of an APD array is experiencing larger than expected delays, WP6 (common high level software), and WP8 (common software testbed). In the case of WP4, the preliminary conclusion by JRA3 management is that APD technology, in comparison with the other two technologies under development in JRA3, is now likely to be the least competitive of the three. This is due mostly to the rapid evolution of the CCD-based devices, which are beginning to encroach on application areas that were once specific to APDs. Final conclusions, however, must await a more detailed analysis of the technical developments currently taking place in JRA3. The higher level software envisaged under WP6 has now been developed for the EMCCD technology (WP2). Due to the differences in technologies involved, it is not directly useful for the APD technology. This software is, however, expected to be directly useful for the avalanche-amplified pn-CCDs (WP3), which are currently in the hardware development phase. The targets for WP8 (the common software testbed for comparison of the 3 technologies) have been shifted forward since meaningful comparison depends of technological variables that are still subject to change at the moment. JRA3 manager expects that the final deliverable of JRA3 (comparison of the three HTRA technologies) can still be achieved, in reduced scope, by efforts of JRA3 management alone, as part of WP1.

WP2: EMCCD developments

The integration of the science-grade EMCCD with the ESO cryostat and UKATC data acquisition system was completed during the reporting period. The first stage of laboratory characterisation of the science-grade device was completed. This involved tweaking the thermal and electrical connections, the clock waveforms, and the clock speeds so as to minimise the dark current, clock-induced charge and readout noise.

The on-sky characterisation of the science-grade device was then successfully completed in four nights of Director's Technical Time on the EFOSC2 spectrograph of the ESO 3.6m telescope during December 2006. The run was a great success, with over 100 GBytes of data obtained on standard stars and demonstration science targets. The results show that EMCCDs are likely to revolutionise certain types of (i.e. readout-noise limited) astronomical spectroscopy. See the figure below for the example spectra that we obtained during the on-sky tests. The spectra are of the AM CVn-star ES Cet, a binary of magnitude V~17 consisting of two helium-rich white dwarfs in a very close 10-minute orbit. One of the white dwarfs is filling its Roche lobe and transferring material to its companion, producing the strong HeII emission at 4686 Angstroms visible in its spectrum. Top: A 10-second spectrum using the avalanche output of the EMCCD camera. Bottom: A 10-second spectrum taken using the normal output of the EMCCD camera. The latter is identical to what would be obtained using a conventional CCD on EFOSC2. The gain in signal-to-noise is approximately a factor of 3. Given that these are readout-noise limited observations, using an EMCCD on the ESO 3.6-m is therefore equivalent to using a conventional CCD on a 6.3-m telescope!

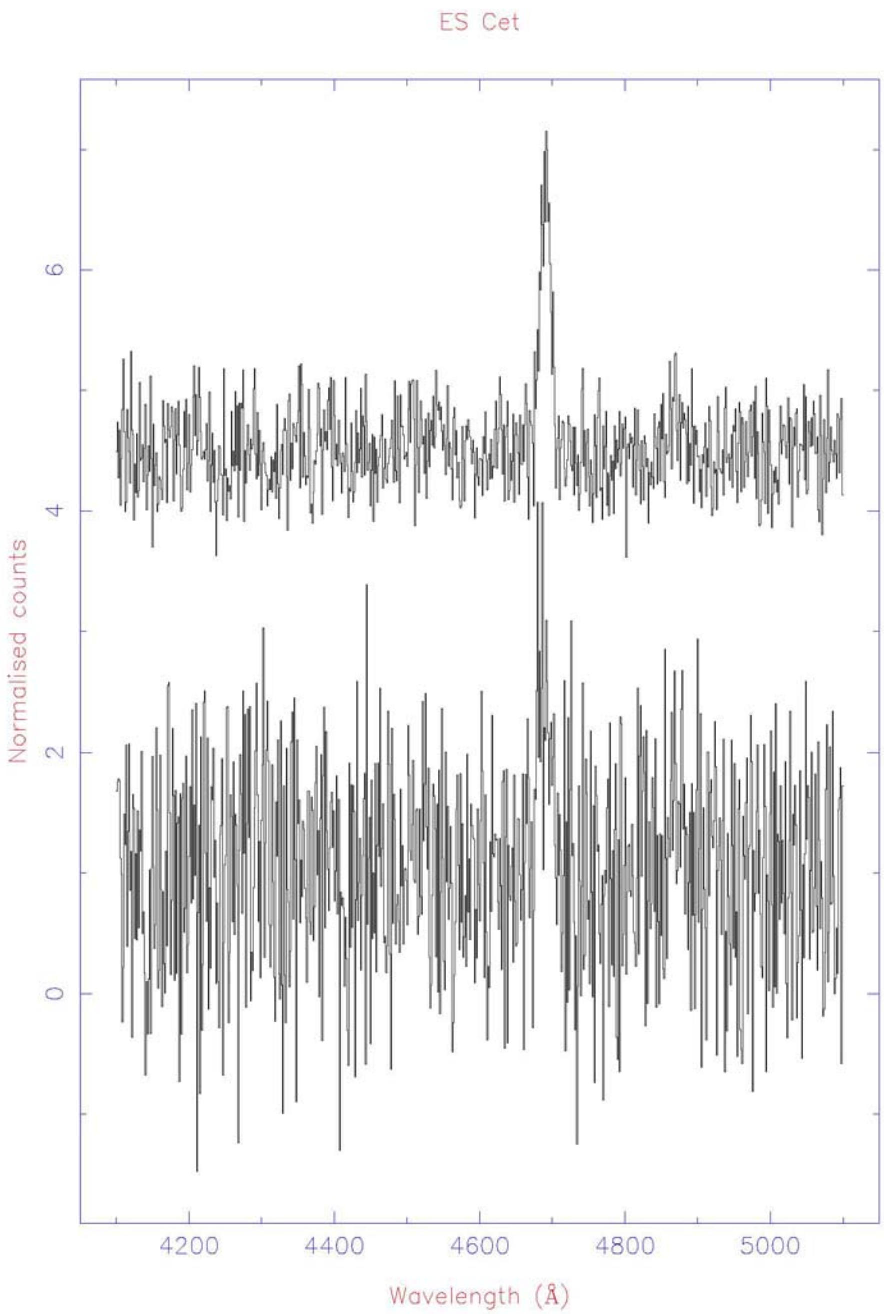


Fig 1. Spectrum of ES Cet

Milestones and deliverables

WP2 D1: Integration L3CCD on testbed - COMPLETED in November 2006.

WP3: PN-sensor development
The major achievement in 2006 was the successful qualification of test structures for the avalanche amplification elements which are to be integrated on-chip of the pn-CCDs. In a

technology study the fabrication and experimental evaluation of about 50 different dopant profiles were analyzed with respect to the internal field distributions under defined electrical boundary conditions. Those results were convoluted with the simulation tools to get as close as possible to the expected performance of the avalanche cells, The simulations, compared with the recently measured device characteristics, show very good agreement. The detection of single optical photons in single avalanche cells was demonstrated experimentally and first studies of the stability of operational parameters and gain were performed. Measurements of about 100 different cells on a single wafer have shown an excellent homogeneity and uniformity in their onset of avalanche amplification. This will be important to operate many cells with a common voltage on a monolithic device. Cross-coupling between avalanche cells, which could be caused by light emission during the avalanche breakdown, was investigated with a newly commissioned emission microscope and was found to be easily controllable. First measurements were performed to develop the coupling and operation of the AA cells and the readout MOSFET stages. These achievements complete milestone M3.

In a parallel development the pnCCD was produced with pixel sizes of 36 µm and 51 µm in a fabrication process fully compatible with the Avalanche Amplifier elements. The devices were characterized with respect to their imaging capabilities and stability and ease of operation. Those tests were very successful and completed an important internal milestone of the programme.

The ASIC development for the further processing of the preamplified signals is already close to the performance finally required. The CMX chip performing further amplification, gain selection, signal filtering sample and hold and multiplexing has been characterized with respect to readout speed, noise, power dissipation, stability, linearity, output compatibility to the subsequent ADC etc. All functions are ok, details like linearity e.g. need to be improved in the next version. The data acquisition system for the readout, controller, and data storage was qualified.

The layout and last technology tests and definitions for the next fabrication run, which will include pnCCDs integrated with avalanche amplifiers, has been started. Start of production is foreseen for March 2007.

After the final wording of the contract for support of the AApnCCD development by ESO was agreed in May 2006 and the MPG signalled its concurrence we are still waiting for the formal signature from ESO. Negotiations on the administrative level are ongoing.

WP4: APD array development

Research is progressing on the new Geiger-mode avalanche photodiode arrays. Over the past 12 months an 8 x 1 dimensional array has been tested and characterised successfully. Along with these developments, the design layout of the die mounting and board architecture is continuing for a 2 dimensional array. This research specifically includes optimisation of the active quench circuit, temperature control circuit, housing and mounting design, and time tagging and pipelining consideration based on a FPGA system.

Results during this period have shown a 650nm peak response (43% photon detection probability), with variable dead times from 10 ns to 1 µs. Under thermo electric cooling, dark counts are below 10 counts per second for a 20 µm device. With room temperature arrays device elements of 10 and 15 µm have shown excellent performance of < 10 counts per second. The design parameter of a 100 µm spatial separation between device elements has proven successful with negligible optical cross-talk. Other issues dealing with pin layout are being addressed, while optimisation of the fabrication process is on going by our collaborators in the University College Cork.

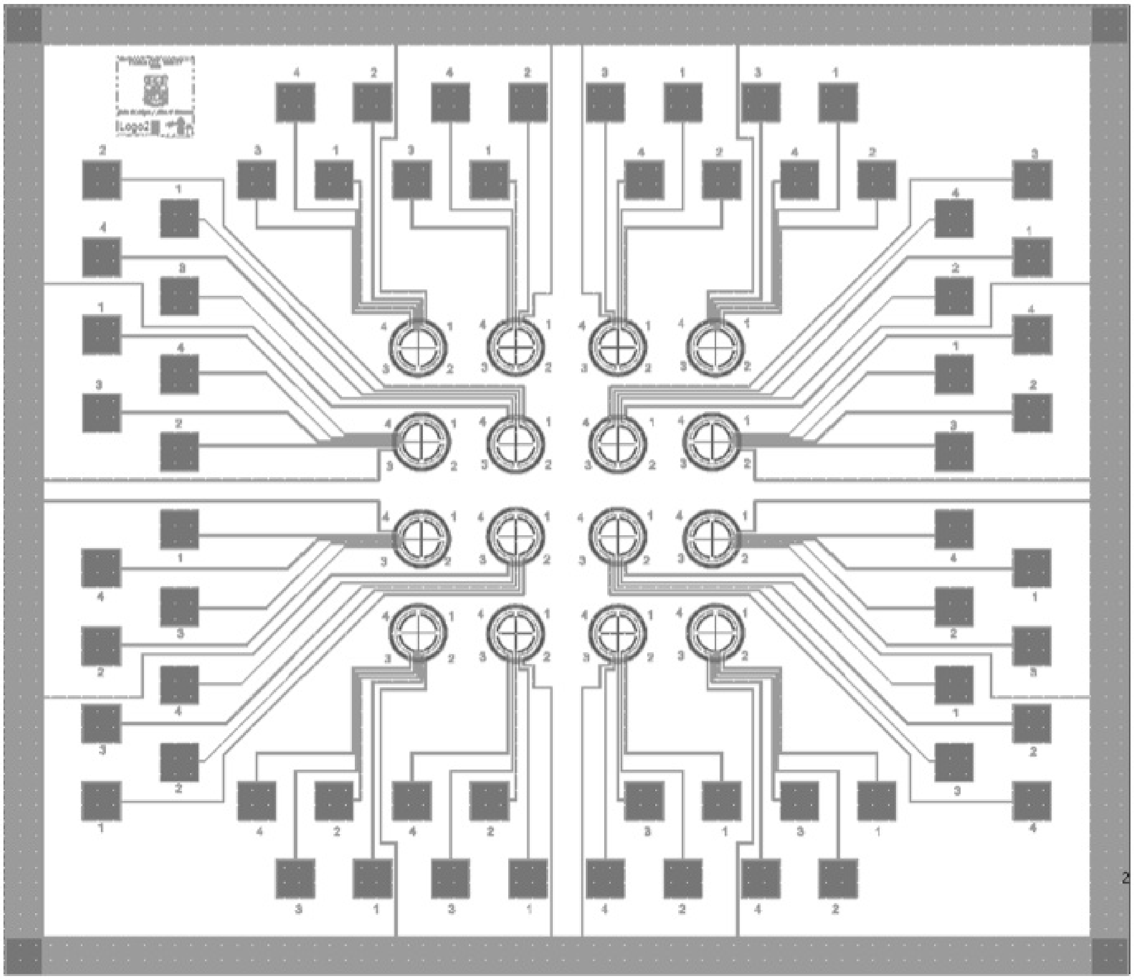


Fig 2. A 2 dimensional Geiger Mode APD Array.

WP5: Controller Development

A third generation high-voltage clock driver board was designed and fabricated at the UKATC, providing excellent stability, low noise and fast edges on the clock pulses. This board was used in the SDSU-III controller for the lab and on-sky characterisation of the science grade EMCCD chip.

Alongside the above hardware developments, the low-level software (DSP) was tested with the science grade EMCCD and modified in order to provide the full functionality required, including GPS timestamping, windowing, binning, the ability to turn chip clearing on and off, different readout speeds and different avalanche gain settings.

Fig 3 shows the third version of the high-voltage clock board.

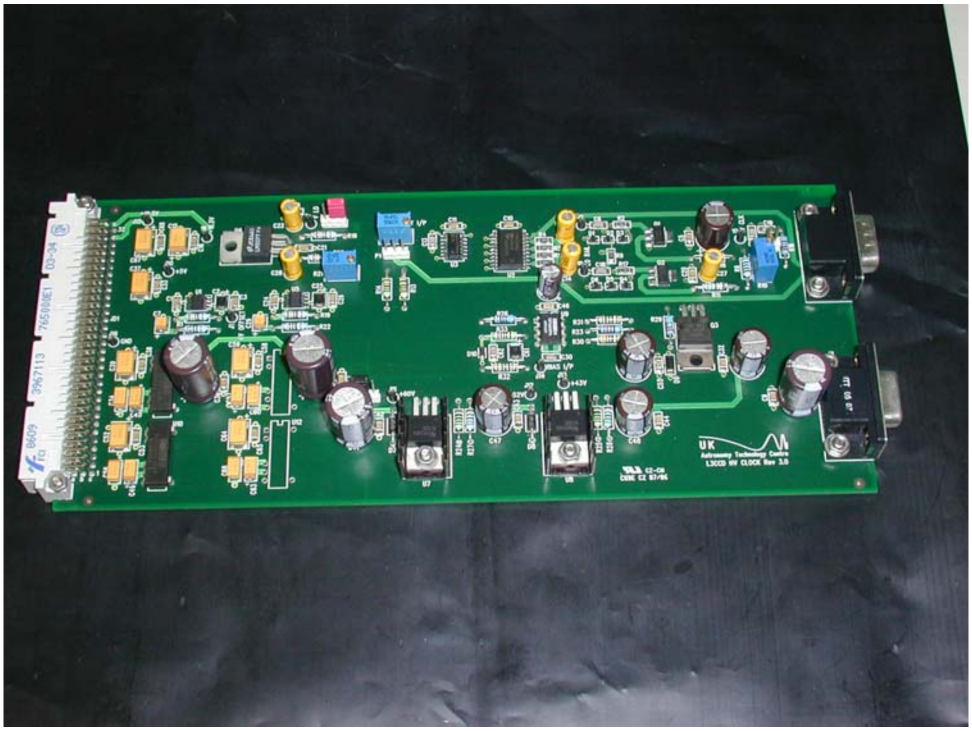


Fig 3. High-voltage clock board for WP5

The experience of controller developers whose background is in astronomy very much puts the emphasis onto precision readout at relatively slow pixel rates. At the high pixel rates of EMCCDs, an entirely new technical approach is required in order to clock the charge efficiently and reliably at these high pixel rates without compromising other parameters such as the readout noise, dynamic range and the linearity of the CCDs. The areas that are technically rather difficult include the creation of a controller structure that allows not simply high pixel rates but can control the precise timing of the clock edges (and particularly those used by the analog to digital conversion circuitry) to a very small fraction of the pixel period. The clock drivers themselves need to be able to produce very fast clean waveforms and the signal processing system must allow the full dynamic range of the CCD even at the highest pixel rates.

The development of a controller dedicated to L3CCDs and to EMCCDs has been under development in the Institute of astronomy, University of Cambridge for some while. Progress here was slow until we obtained approving of a technician in Cambridge. We were very fortunate in having Keith Weller join the team in May, 2006. He has an extensive background in electronic hardware design with considerable analogue electronics experience. Since then excellent progress has been made.

The basic specification of the controller is unchanged and we are progressively improving its performance and getting closer and closer to the goal performance. We are now using an ARM- based microcomputer with a USB interface to provide camera control from the computer. The on- board microprocessor manages a new high-speed sequencer ASIC from Kodak that allows sophisticated waveform generation at pixel rates up to 60 MHz. Using these components we now have a prototype camera taking pictures of reasonable quality at pixel rates in excess of 20 MHz. The present design needs a further refinement to improve a number of aspects of its performance but there is no doubt that we have already made very good progress in the year under report. Indeed in a number of areas we have already managed to exceed the performance specification of the controller and we can see plenty of scope for improving it further, particularly in respect of the general noise performance and immunity to interference. In particular pixel rates of up to 60 MHz now appear to be quite realistic as we have information that some devices will perform satisfactorily at these pixel rates. Our work over the next 18 months therefore will be dominated by pushing ahead on the development of the EMCCD controller, work will be carried out by Keith Weller.

The current specification of the camera system is:

EMCCD Controller System: must operate full frame, frame transfer and interline transfer CCDs with a high-voltage multiplication gate, and with up to four phase parallel clocks in both image and store registers.

High-voltage clocks must be able to provide 45 volt swing with 16MHz pixel rate (for e2V L3CCDs) and 25 volt swing for 35MHz pixel rate (Texas Instruments EMCCDs).

To operate at a pixel rate of at least 15MHz (35MHz foal). To provide clock drivers capable of working with at least 15 centimetres of track length between driver and CCD chip. To provide 14 bit digitisation at the maximum pixel rate with full double correlated sampling signal processing. To have the complete analog signal processing chain self calibrating and balancing to guarantee negligible fixed pattern noise.

The structure of the controller must allow it to be expanded to cope with significant numbers of detectors (of the order of 256) being operated in parallel and simultaneously.

The controller must be able to be operated via an industry standard ethernet/USB connection on both Windows and Linux. The data produced by the camera controller is to be transmitted with high- speed LVDS drivers so that it may be attached to any industry standard frame grabber hardware that uses the AIA frame grabber interface standard.

CCD Camera Postprocessing: Fast readout high-performance optical detectors need software at a number of different levels. At the lowest levels, the software that is required to set up and programme the controller has to be at a machine code level and closely integrated with the controller hardware development effort itself. Software at this level cannot be considered to be common in any useful sense although it is important to establish communication standards between the higher level software that needs to grab the camera resource and control it properly.

The EMCCDs are capable of producing very large amounts of data indeed. The sort of volume of data produced by a single Texas Instruments EMCCD is greater than can be handled by a PCI interface card and very quickly any real computer system will become overwhelmed. The consequence of this is that it is essential to integrate the hardware with some kind of high-speed processing system that can extract the information required from the images in real time and pass the results to the host computer with a greatly reduced data bandwidth requirement. JRA3 provided the funding in principle for two-man years of effort but the delay in the funds actually becoming available and then the delays in actually recruiting someone meant that we were unable to get anyone in post until November, 2004, when Frank Suess joined our group for a 2-year appointment which has just come to an end. Frank has considerable experience in writing software for CCD systems used in the physical and life sciences as well as having a lot of experience of dealing with digital signal processor systems such as will be important for some of the work with L3CCDs. Frank's initial work was on the software to download controlling microcode into the EMCCD controller. In addition, Frank Suess has made some progress in investigating a variety of commercially available DSP hardware solutions which have sophisticated development software packages as well. We are currently working with a promising board manufactured by Matrox called the Odyssey. This uses a custom FPGA on board to provide a good number of DSP elements within the chip. The overall processing power looks very promising and it is well integrated with a frame grabber part of the hardware which is important for these applications. It has a further advantage that the library sold with the board is very well developed and compatible with other frame grabbers. This allows the camera to be used with either a standard frame grabber or with the DSP interchangeably. Although we have made good progress there is still a lot to be done. Unfortunately we have no further funding for this work beyond the end of 2006 so progress will be slow in this area.

We are using a commercially written software package for controlling the camera which runs under Windows quite satisfactorily at present. The overall common software development of a system that can control a wide range detectors is being handled elsewhere but it is important that whatever is done is able to operate both under Linux as well is under Windows since the most advanced technical solutions in DSP hardware and FPGA programming all require their development to be done under Windows, the environment in which all the development software operates.

Overall Hardware Design

This has not changed significantly over the last year. The boards of the EMCCD controller are mounted on a third printed circuit board which is extended into the vacuum enclosure of the dewar. It is important when designing high-speed camera electronics to minimise the distance between the clock drivers and the CCD, and also to minimise the distance between the CCD and the signal processing and electronics. This latter problem can be avoided by using a buffer transistor adjacent to the CCD and this is what we have chosen to do.

We can make a high-quality vacuum seal by bringing all the signal tracks through the wall of the dewar on an internal PCB layer and by using a gold plated copper area to provide a reliable vacuum seal. We have used this method successfully and found that it gives a good and reliable platform for driving the CCD as well as providing a structure that is easy to work with both when it is outside the dewar and when it is within it. It also appears to have good vacuum integrity and very low out-gassing rates.

Scientific Results

The camera system we have developed has been used extensively on the Nordic Optical Telescope (NOT) on La Palma and, in June 2006 on the NTT telescope at La Silla Observatory in Chile as part of a programme of Lucky Imaging. Several research papers have been published and a number of talks at international conferences and other venues have been given. The system has routinely allowed us to produce images with resolution very similar to that obtained with the Hubble Space Telescope, but from ground-based telescope and had an incredibly small fraction of the total cost of Hubble. Examples of the images obtained were included in the report last year. We have now carried out preliminary experiments on a new technique which should deliver routinely images with about three times the resolution of the Hubble space telescope. It uses an extension of the Lucky Imaging techniques developed in Cambridge for use with larger aperture telescopes where normally the chance of a "lucky" image is negligible. However by breaking the aperture into a number of smaller sub apertures and recombining them we find that each star image is then crossed by Michaelson interference fringes. Closure phase techniques developed by radio astronomers may then be applied provided there is a moderately bright reference source in the field. We used the NTT to demonstrate a resolution in the blue of about 30 milli-arc seconds using these techniques. Unfortunately less than one night out of 10 was usable for this work and so only the most basic trials were completed. Nevertheless it was clear that the principal goal of this work was indeed achieved. Some pictures demonstrating the concept and the first results are given here:

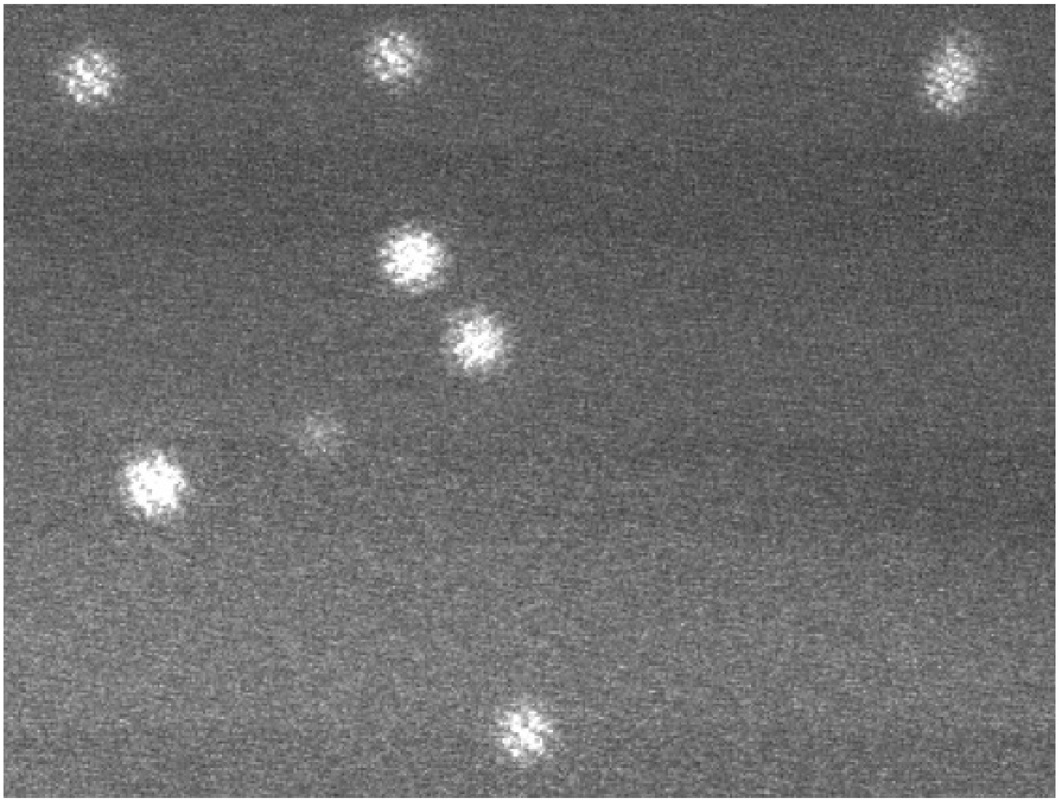


Fig 4. Each star is detected as it would be if imaged by one sub-aperture, but now crossed by Michaelson interference fringes from the spacings of the sub-apertures. The fringe peaks coincide, showing the closure phase here is zero. Each star has identical fringe patterns across it. This image was taken in the laboratory, showing instrumental diffraction limited performance on a mock globular cluster, at 400 nm.

Fig 5. The multi-aperture LuckyCam-HighRes mounted on the Nasmyth focus of the NTT 3.6m in Chile, June 2006.

WP6: Common Software Development

Development of higher level software continued as part of WP5 (controllers) and WP2 (EMCCDs). This included functional test under realistic conditions. Characterization of this software for common applications is delayed due the individual properties and advantages of the different technologies under development in JRA3.

As detailed further in the report elsewhere, the commonality of higher level software has been reduced by the fact that the APD technology is sufficiently different from the CCD-based ones that little need for common software is to be expected. Commonality remains between the software for AApn-CCDs (WP3) and EM-CCDs (WP2, WP5), but since emphasis in WP3 has shifted to hardware development, common higher level software between the two has become a more distant priority. It is expected, however, that the current higher-level software developments at UCAM and and Warwick in connection with the other workpackages will be applicable also to the AApn-CCD technology.

WP7: Cooled Camera Head Development

We took delivery of an ESO cryostat at the beginning of the reporting period. A new PCB was designed on which our EMCCD chip was mounted, and the cryostat interior was modified to accept this PCB and its associated thermal and electrical connections. The EMCCD chip then had to be aligned to an absolute accuracy of 100 microns with respect to the front flange of the cryostat. This was achieved in the lab using a travelling microscope. The resulting cryostat was successfully mounted on the EFOSC2 spectrograph on the ESO 3.6-m telescope during December 2006. The cryostat performed extremely well on-sky, exhibiting a hold time of approximately 20 hours and providing excellent image quality across the entire chip (indicative of good chip alignment).

Photographs of the EMCCD chip on its PCB in the ESO cryostat and of the cryostat mounted on the EFOSC2 spectrograph of the ESO 3.6-m telescope are below:

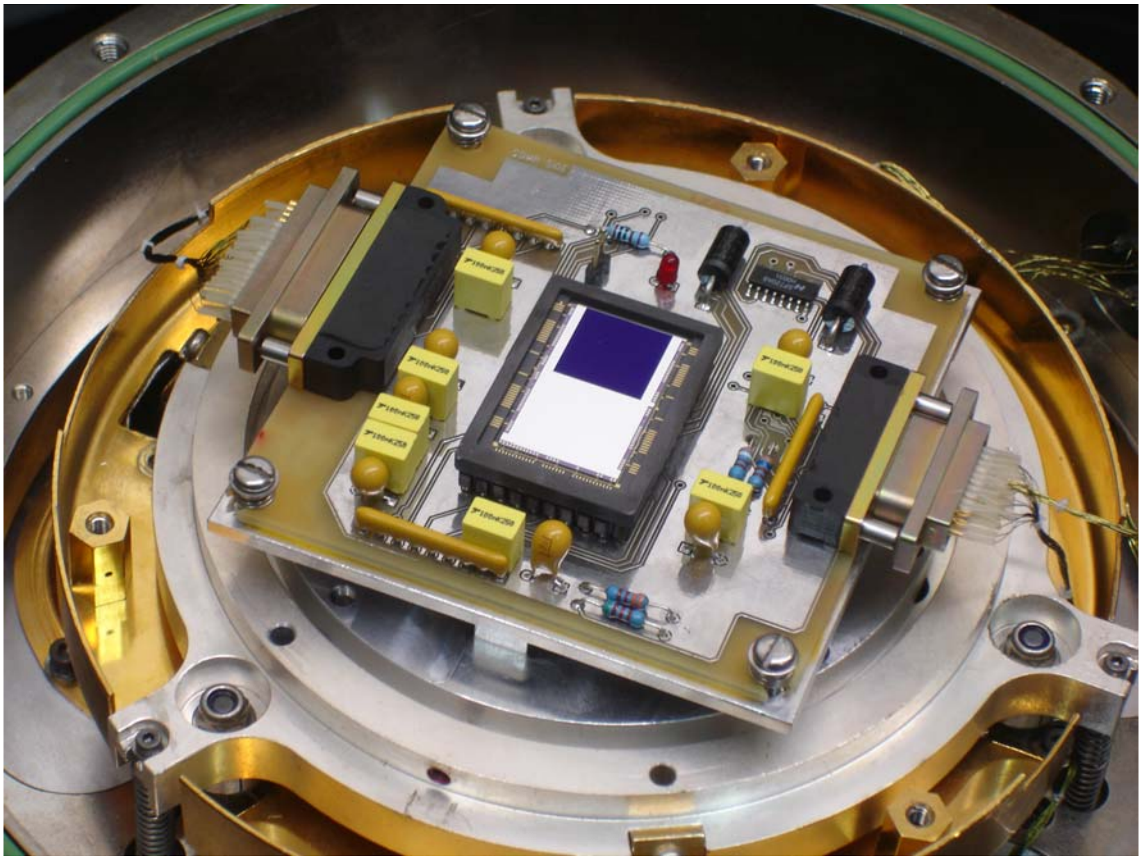


Fig 6. EMCCD chip in ESO cryostat

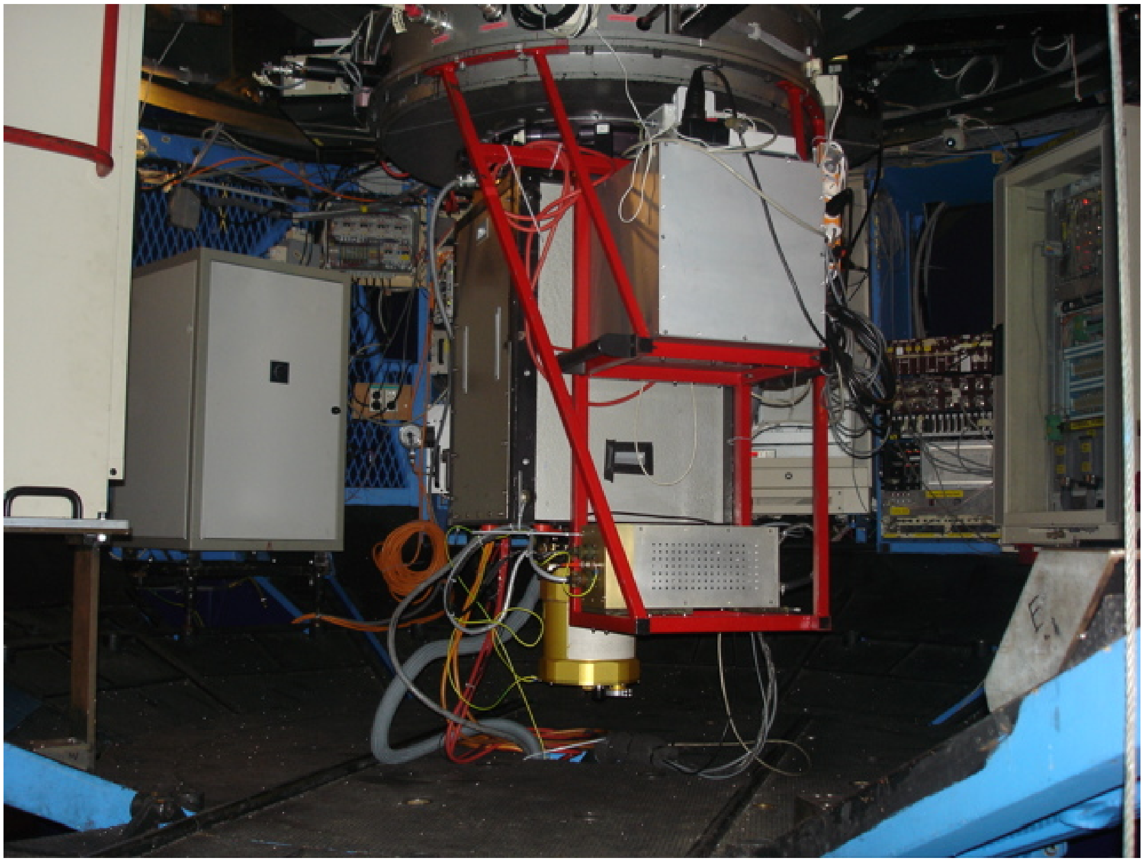


Fig 7. EMCCD chip in ESO cryostat. Cryostat mounted on the EFOSC2 spectrograph of the ESO 3.6-m telescope

WP8: Common testbed

In view of the developments in the other workpackages, some of the deliverables of WP8 have become obsolete (in particular the hardware testbed), while others can be integrated into WP1, and accounted for under final deliverable WP1 D2. Allocation of some of the funds intitially projected for LSW to MPG-MPA may be needed for the resulting additional work in WP1.

Milestones and Deliverables:

Activity (NAx; JRAy)	Deliverable/ Milestone No	Deliverable/milestone name	Work-package /Task	Lead Contractor(s)	Planned (in months)	Achieved (in months)
JRA3	M3	Integration Review	WP1	MPG-MPA	30	36
JRA3	D1	Test and instrument verification plan	WP1	MPG-MPA	30	36
JRA3	M3	Integration and test L3CCD camera	WP2	USFD	30	34
JRA3	D1	Test report L3CCD camera	WP2	USFD	30	36
JRA3	M3	Fabrication critical AA-pnCCD elements	WP3	MPG-MPE	24	30
JRA3	M4	Functional test and characterization AA-stage	WP3	MPG-MPE	30	32

Notes:

M3-WP3 redefined, delay due to expansion of scope to include development of avalanche

amplification, as described in annual report 2005.
M4-WP3 redefined, delay due to expansion of scope to include development of avalanche amplification, as described in annual report 2005.
D2-WP3 (planned 24 mo) now expected at 60 mo (same reason).
D3-WP3 (planned 36 mo) now expected at 60 mo (same reason).
M2-WP4 (Delivery APD array, planned @ 12 mo). Delayed, expected at 48 mo.
D1-WP4 (AIT APD array, planned @ 12 mo). Delayed, expected 48 mo.
D1-WP5 (Fast timing controller L3CCD). 3rd generation version delivered and successfully tested under realistic conditions, final version expected at 45 mo.
D2-WP5 (Fast timing controller PN-CCD) functional version for AA-CCDs expected at mo 48.
D1-WP6 (common high level software). Delayed, expected 60 mo.
D8-WP8 (Completion software testbed). Delayed, expected at 48 mo.

List of Meetings

None were held, all necessary communication has taken place electronically.

1.5.5 JRA4: Integrating optical interferometry into mainstream astronomy

The total human effort deployed during the year 2006 for JRA4 is summarized in the following table:

Participant number[21]	**Participant short name**[22]	**Person-months**[23]
6a	INSU/CNRS	50 (0)
1b	UCAM/CAV	24 (12)
8e	INAF/OATo	25.6 (12.8)
11a	MPG/MPIA	12 (9.5)
11f	MPG/MPIfR	6 (0)
12	NOVA	4 (4)
21b	Ulg	0 (0)
30	Konkoly Observatory	6 (1.5)
31	ONERA	0 (0)
32	CAUP	33.1 (8)
33	Technion	6 (2)
34	NCU/UMK	19.5 (13.5)
36	UNIGE	3 (3)
38	OO	0 (0)
41	UNIVIE	4 (2)
Total		

1. ***WP1.1: Concept to feasibility studies***

During the ESO/EII meeting of April 2005, the interferometric community had the possibility to review a list of about 10 proposals for second generation instruments for the VLTI. Among these projects 7 were part of the first phase of WorkPackage 1.1 (Advanced Instruments). After the meeting, it took some time to converge towards a decision of starting 3 phase A studies. This delay is mainly due to the heavy workload of ESO regarding the enhancement of the VLTI capacities. The decision for phase A (deliverable D4) was taken in autumn 2006 and the reports are due in June 2007 for consideration by ESO at the end of 2007. The three selected projects are MATISSE (formerly APRES-MIDI), VSI (Formerly VITRUV) and GRAVITY. GRAVITY is not part of JRA4 but contacts are maintained, especially for the needs of GRAVITY about general VLTI infrastructure (adaptive optics, fringe sensing, control...).

MATISSE (PI: B. Lopez, OCA, F) and VSI (PI: F. Malbet, LAOG, F) are the follow-on of APRES-MIDI and VITRUV, proposed in the first phase of the JRA as feasibility studies. APRES-MIDI was just an extension of the performances of MIDI whereas MATISSE is a whole new instrument including 4 beam combination, spectral capabilities as well as extended spectral coverage. VSI is a project based on the VITRUV (F) and BOBCAT (UK) proposals, aiming at high performance imaging in the near infrared with the VLTI. Both projects are now in phase A study and the role of the WorkPackage of the JRA4 has been to convince all

[21] Lead participant first
[22] Use the same contractor short names and numbers indicated in the table "list of participants" in Annex I of your contract.
[23] AC contractors must include both the total estimated human effort (including permanent staff) and, in brackets, additional staff only.

the participants in the work package to contribute to VSI and MATISSE. This is now clearly the case with, in both cases, consortia regrouping a large numbers of European countries and especially laboratories where the interferometry expertise is very new. This is clearly a great success for JRA4.

The phase A studies will finish by June 2007. From the WP1.1 point of view, we consider that our work is complete with the feasibility and then the phase A studies. We are now working in coordination with ESO for the follow-up of these studies. The continuation of this work will mainly take place in the next framework programme of the European Union in order to accompany the development of the selected second generation instruments for the VLTI.

2. *WP1.2: Cophasing and Fringe Tracking*

The groups involved in the WP1.2 working group are currently involved in different ongoing experiments. Below we provide details on the main activities carried out, focused on the following topics:

Multiple beam combination schemes
The collaboration between OATo (I) and Technion (IL), also taking advantage of the Fizeau Exchange Visitor Program of NA5, progressed with lab experiments in Haifa and in Torino, testing pair-wise combinations (all-with-all and in minimum redundancy) based on bulk optics. Some of the initial results are already published.

Fringe tracking for second generation VLTI instruments
The collaboration between OATo and Cavendish Labs on the fringe tracker (FT) for the VLTI Spectro-Imager (VSI) has produced two alternative implementation concepts, discussed within the VSI consortium in a meeting at OATo on January, 2007. They are considered approximately equivalent in terms of performance.

The OATo team is also keeping contacts with the consortium for the mid-IR instrument (MATISSE) on fringe tracking aspects.

Current Fringe tracking facilities at the VLTI
After mitigation of infrastructure problems, as per the recommendations of the FINITO Tiger team (including OATo), the Interferometry task force at ESO was able to close the loop with FINITO on both ATs and UTs. In 2006, the two PRIMA FSU units (A and B) were installed at ESO - Garching; the system integration and the tests for preliminary acceptance in Europe are in progress. Some modifications to the alignment system were implemented to improve the beam injection stability. Currently, the linearity and bias stability are tested and optimised. The instrument modelling is being updated with the lab results and is used for performance assessment (work in progress with the support of the OATo team).

Evaluation of the effects of residual atmospheric turbulence on fringe tracking
Investigations on the limiting measurement performance associated with residual atmospheric turbulence after adaptive optics correction are in progress, referred either to the ESO fringe sensor model, or to a general beam combining instrument (in collaboration with G. Daigne, Obs. Bordeaux).

The deliverable D3 (Second Progress Report on CFT) which was planned for month 36 was achieved in month 36. See http://eii-jra4.ujf-grenoble.fr/doc/approved/JRA4-TRE-1200-0002.pdf.

3. ***WP2: Off-line data reduction software***

Project overview

The work package is aimed at delivering software facilitating the use of large modern interferometric facilities such as ESO's VLTI to an end-user who is a non specialist in Optical interferometry. The software aims at integrating in an easy manner the basic tools used by optical interferometry specialists: comparison of observables with geometrical models, blind image reconstruction from observables, astrometry-related measurements from phase-referenced interferometry. Due to the complexity of the task the work is split into 5 tasks. Workpackages 2.3, 2.4 and 2.5 evolve quite independently from each other, and provide an aspect of the whole package. Workpackages 2.1 and 2.2 coordinate and provide common tools for the three other packages and are responsible for the software integration and tests. All the tasks are scheduled to arrive at the same time at each software acceptance release.

WP2.1: General Management and User Support 2006

This activity consists now only in maintaining the Web services on http://eii-jra4.ujf-grenoble.fr (including documentation and reporting). Costs are negligible. No further deliverables are associated with this task.

WP2.2: Common Software 2006

This activity has been halted mid-2006 due to the growing discrepancy between the state of this WP (waiting to be used by others WPs' software developments) and the state of the client WPs, 2.3, 2.4 and 2.5. Accordingly, we decided to replace the next deliverables for this WP by a single deliverable:

D2 (next deliverable): Software Package and User Manual, planned at month 42.

WP2.3: Model Fitting

Mrs Tallon-Bosc has been replaced by Mr. Duvert as coordinator of this WP2.3. A prototype C/C++ version of the software, using the WP2.2 common software package, was built in 2006. However this version has been abandoned following a complete rewriting of the Yorick original code by the Lyon group, in order to properly include chromatic models. It was decided that this Yorick-based version will be the base version of the final software. A client/server interface in Java is now developed at JMMC to facilitate the use of the Yorick model-fitting engine. Separately, the Yorick engine is being tested by a number of users on real data. Convergence of the two developments should permit us to release software on time to fulfill the user's needs. Accordingly, we decided to replace the next deliverables for this WP by a single deliverable:

D2 (next deliverable): Software Package and User Manual, planned at month 48.

WP2.4: Astrometry

LEIDEN group: The original Leiden/NOVA group has disbanded. The IDAF people, including Drs Köhler and Quirrenbach, have moved to Heidelberg (Germany) in 2006. Heidelberg University is not a contractor of this project. The NOVA contractor has decided to stop this project for the present time.

GENEVA group: The group has released the user requirement document (D2) in 2006, and a review of the document is in progress prior to its archiving on the website. However, the Geneva work depends on the products of the NOVA deliverables so this activity has been put on hold for the time being.

The activity of this WP is now stopped. The deliverables D3 and D4 are cancelled and the deliverable D2 (User Requirements) planned on month 30 is scheduled on month 39.

WP2.5: Image Reconstruction

JMMC/CRAL/ONERA group (change of responsibility: Mr. Eric Thiebaut is replaced by Mr. Gilles Duvert as responsible for this task). Status: Two prototypes, WISARD and MIRA, have been developed, tested by several users on real data and improved during the year 2006.

ONERA is currently documenting the WISARD code for public release through JMMC, with delivery in 2007. This code fulfills the user's needs. Accordingly, we decided to replace the next deliverables for this WP by a single deliverable:

D2 (next deliverable): Software Package and User Manual, planned at month 48.

CAMBRIDGE group: Activity this work package has been good over the period 1 Jan 2006 – 31 Dec 2006. The key elements of the work completed have included the debugging and optimization of the BSMEM image reconstruction code. A report describing the tests of the robustness of the code under varying levels of noise and uv-sparseness has been prepared and is being reviewed internally prior to release.

D2 (next deliverable): Software package and User Manual, planned at month 48.

MPIFR/MPIA group: Within the JRA4 activities in 2006, the MPIfR group carried out computer and laboratory simulations of image reconstruction from LBT data, and studied in detail the deconvolution of images with space-variant point spread functions (PSFs). For the image reconstruction, the newly developed Building Block method (BB) with regularization was used. In addition to the studies of space-variant image deconvolution, the MPIfR group performed a series of computer simulations in the context of the science case studies for LINC-NIRVANA. These simulation studies will be continued in 2007.

Deliverables by 2007: Most of the groups will have reached the release point of their software. The integration of the group's software within the WP2.2 framework having being abandoned, only one release (D2) is now planned and this deliverable will consist of at least two fully documented image reconstruction programs. (Since the LBT is not yet operational, a delay in the delivery of its related image reconstruction programme is not significant).

Conclusion:

Since the beginning of the WP2, definite progress has been made on the algorithms for image reconstruction and model fitting, in a half dozen of research groups throughout the E.U. Although the different software developed by WPs 2.3 to 2.5 will not, at the end of the period, be based on a common architecture, the WP2 package makes it possible to make definite progress towards the goal of providing the user community with the necessary tools for interferometric data interpretation.

The coordinator believes that the emerging VO techniques will permit the necessary interoperability of these packages. The related effort could be managed through a future FP7 program.

Milestones and Deliverables

The Table below summarized the milestones and deliverables achieved during the year 2006:

Deliverable/ Milestone	Name	Work Package	Lead contractor (s)	Planned (months)	Achieved (months)
D4	ESO project selection for phase A	1.1	ESO	30	34
D3	Second Progress Report on CFT	1.2	INAF/OATo	36	36

Meetings and workshops

Date	Workshop/Meeting	Location	Number of attendees	Website address
May 10-12	1st Joint ARENA / OPTICON JRA4 Workshop on Ultimate HAR from Dome C	Nice	40	http://arena.unice.fr/
June 28-30	VSI kick-off meeting	Grenoble	36	http://www-laog.obs.ujf-grenoble.fr/twiki/bin/view/Laog/Projets/VSI/WebHome
October	Matisse kick-off meeting	Nice	30	http://www.obs-nice.fr/matisse

1.5.6 JRA5: Smart Focal Planes

Participating Contractors and Effort Deployed

Participant number	**1**	**2b**	**5**	**6c**	**6d**	**7a**	**8d**
Participant short name	UCAM-IOA	PPARC	CSEM SA	CRAL	LAM	IAC	Padua
Person-months	NA	43.54	NA	0	49.2	11.0	7.56
Participant number	**10**	**26**	**35**	**44**	**45**	**47a**	
Participant short name	ASTRON	UNI BREMEN	UNIV DURHAM	Reflex s r	TNO/TPD	AAT Board	**Total**
Person-months	2.9	0	TBD	4.0	0	0.62	**118.82**

Introduction

The project goal is the development of technologies to gain maximum scientific benefit from the information dense focal planes of Extremely Large Telescopes by targeting the objects observed in the most effective manner. The strategy to achieve this has been to develop a Smart Focal Plane roadmap to identify technologies to target, and to develop instrument concepts which link scientific goals with specific parameters for these technologies. This has required the bringing together of partners that have complementary expertise to progress these technologies and to focus on increasing the Technology Readiness Level of all the technologies under development.

2006 was a very productive year with defined and substantive progress on the important technologies of image slicers, MOEMs arrays and deformable mirrors. Perhaps the most striking achievement, however, was the successful test of the Star-Picker system for picking off target objects. This system was demonstrated in continuous operation at the major SPIE conference in May 2006. This required that the three participating partners work effectively together against a very tight deadline.

In the programme the following work packages have been completed. WP 1.0 covering Management and Systems within Phase A of this work (to 18 months). Also completed are WP 2.0 Image Slicer Replication, WP 3.1 Fibre Systems, WP 3.2 MOEMS Phase A studies, and WP 4.0 Pick-off Technology Trade-off Study.

WP 3.2 Cryo-mechanisms (ASTRON)

A low cost commercial available piezo-motor, suitable for room environment applications, was analysed to ensure that it was suitable for cryogenic temperatures. Modification of the motor and electronics were made and tested at 77K. The results were very good and conformed to specification. As a consequence of the investigation within OPTICON, there is in conjunction with the Technical University of Twente (NL), a project submitted to a Dutch funding agency to continue with our research on material testing in relation to friction and wear under cryogenic circumstances.

WP 3.2 Cryo-mechanisms (IAC)

We have maintained during the first half of 2006 the development effort of past years in the field of designing and testing high precision mechanisms for use in cryogenic conditions. Full evaluation at system level of a successful material combination (tested previously at lower level) has been accomplished. By so doing, we have characterised an advanced system for braking large size turning wheels, loaded with heavy components. The relative diameter of the friction discs to that of the wheel has been kept much lower than customarily in this type of design, so that the available space for the wheel mounted components increases accordingly.

WP 5.0 Management and Systems Engineering (PPARC)

The provision of the 3rd 18 month plan was successfully completed at the start of the year. Continued use has been made of the restricted web-page https://ssl.roe.ac.uk/twiki/bin/viewauth/Smartfp/ for JRA5 participants and the use of e-mail and telecons for managerial purposes.

The specifications for the technologies being developed within JRA5 have been set by two "Smart " instrument concepts that were developed within this work-package, principally by the UKATC (PPARC) with additional support from LAM and IAC. The first is an Integral Field Unit (IFU) based Multi-Object Spectrograph (MOS) called Smart-MOMSI and the second is a multi-slit based MOS, called Smart-MOS.

The technology developed for the Smart-MOMSI demonstrator has provided valuable knowledge of technology capabilities and new options for the engineers in relation to both MOMSI and WFSPEC instruments, and will be carried forward into a combined Phase A study for the ELT.

The second instrument concept, Smart-MOS, we have developed to drive technology requirements for inclusion within a large field of view NIR MOS instrument for ELT. Such an instrument would likely employ seeing-limited conditions or ground layer adaptive optics. The science/technology tradeoff for a Smart–MOS instrument points to a NIR instrument with FOV of ~1 arcmin, capable of obtaining spectra from a large number of faint, point sources. The two options for the slits that we have developed are 1) mechanically reconfigurable multi-slit masks and 2) programmable micro-mirrors based on MOEMs devices. The information and technologies developed will be key drivers of the design of a MOS instrument within anticipated ESO ELT Instrument Phase A studies.

WP 6.1 IFU Prototype: Image Slicers (Univ Durham)

University of Durham have continued to manage the investigation of electrochemical replication of integral field unit image slicers, and to provide technical guidance and to undertake comparative measurements on the mandrels and test pieces.

Goal specifications were formulated at the start of the programme based upon the preliminary considerations of the MOMSI concept which is to be the subject of a FP6 point-design study.

The project moved on from the "challenger" test mandrels to realistic slicer hardware. Chemical tweaking (change of chemical concentrations in the bath) causes different stresses and can be used to minimize surface bending. Comparision between mandrel-mother, mother-daughter and finally mandrel-daughter tend to show up compensation effects. Surface bends introduced by mandrel-mother replications are partially healed out in the subsequent mother-daughter process. Radii of curvatures change, e.g. GNIRS: Mandrel 150.5mm, mother 145.8 mm (measured using Taylor-Hobson machine). Total shape deviation of GNRIS prototype replication reveals bends of +/- 300 nm PTV. For 1 micron wavelength the lambda/4 criterion is widely met. Surface corners are the worst parts in terms of shape deviation. Potential input for mandrel design: Oversize whenever possible.

WP 6.1 IFU Prototype: Image Slicers (Padua)

During 2006 the following main activities have been carried out:

A. Activities concerning epoxy-resin replication of "challenger" mandrels
B. Activities concerning Silicon-Carbide PECVD replication of "challenger" mandrels
C. Optical design of realistic image-slicer assemblies

Activities A end B are concerned with the replication concept, ie an already available image-slicer or test-model (mandrel) made in different materials (zerodur, Al) is coated with a metallic reflecting thin layer (Al, Gold) and `copied' by direct replication. This activity has already been verified during the first JRA5 phase making nickel galvanic replications of challenger and slicer mandrels.

The B replication case is based on a recent and innovative technology where hydrogenated silicon-carbide is deposited on the mandrel under vacuum. This technology, namely plasma enhanced chemical vapour deposition (PECVD), allows the RF excited plasma to be obtained at moderate temperatures so minimizing the amount of stresses on the mandrel. We hope to obtain soon the first replicas of the 'challenger' mandrel. The major progress obtained here is the replication of a flat reference surface with a self-sustained layer (0.5 mm thickness) of hydrogenated SiC. This activity is still in progress.

Activity C has recently been concluded. It allows us to design specific slicing mirrors and associated re-imaging optics systems using Zemax optical CAD. A set of general modelling macros developed inside the JRA5 group have been inserted into the system allowing a more general and efficient approach to the specific design of image slicers. A demonstrated optical design has been developed for the Dolores visual spectrograph mounted on the TNG national telescope.

WP 6.1 IFU Prototype: Image Slicers (Reflex sro)

The GNIRS slicing mirror array and the MIRI slicer mirror were prepared by electroplating techniques at Reflex s.r.o. Reflex made a few double replicas from GNIRS and MIRI mandrels. Reflex performed test measurements of these double replicas by atomic force microscopy (surface roughness), Taylor Hobson contact profilometer (surface shape) and Zygo optical interferometer (surface roughness). The optical tests on the optical bench were undertaken with double replicas. Tests on reflectivity with infrared radiation were done for the first replicas from challenger as the device can measure only flat samples. Reflectivity was around 100% of gold standard. Reflex continues with improvements of the bath chemistry in order to reduce the stress and to minimize the shape deformations of replicas.

WP 6.2 Pick-Off Prototype - Starbugs (AAO)

In 2006 the AAO wrote and submitted two Starbugs papers to the May 2006 SPIE meeting on work carried out in 2005, in addition to management effort to finish off reporting on 2005 activities.

WP 6.2 Pick-Off prototype- Starpicker System (PPARC)

This WP involved the design, manufacture and test of a Smart Focal Plane robotic positioner to work at cryogenic temperatures to arrange passive pick-off mirrors (POMs) on the focal plane. The Star-Picker System demonstrated consisted of a gripper assembly (CSEM) which provides a means of closing two jaws on to the POM with a controlled force and lifting the POM. A new patented three axis rotational positioner (UKATC/ASTRON) is used to ensure that the gripper is precisely placed perpendicular to the curved focal surface. A target metrology system was also constructed to enable the repeatability tests to be carried out (UKATC). Each POM is moved by being gripped, lifted clear of the other POMs, moved to a new location, given a new orientation, lowered and released.

The repeatability of positioning the POM using the gripper and rotary mechanisms is accurate to <2μm. This exceeds the ±17μm requirement which would be the case if an independent metrology system is used by almost an order of magnitude. It does in fact exceed the requirement of ±3.5μm for a 100m class ELT in the absence of an independent metrology system. We have demonstrated the ability of the system to meet the stringent requirements on repeatedly placing optics on a focal plate, with our room temperature tests.

WP 6.2 Pick-off prototype – Focal Surface and Cable Wraps (ASTRON)
ASTRON have participated in the technology demonstrator of the Planetary Positioner Pick-off System and delivered the final products for the rotation stages of the pick-off demonstrator: cryogenic cable wraps and polished focal surface.

WP 6.2 Pick-off prototype – Gripper (CSEM)
CSEM has participated in the Planetary Positioner Pick-off System by way of the design and build of the integrated gripper/linear translation unit. This is designed to be able to place a pick-off mirror on a curved focal plane, at any gravity vector, and at any temperature down to 77 K, to an accuracy of 1 micron. While the design of the gripper was done in 2005, most parts were manufactured in 2006 then the gripper was assembled and tested at CSEM. A dedicated electronic rack was designed with the control boards demanded by the application.
The gripper was then shipped to ATC where it was integrated in the Planetary Positioner Pick-off System, which was demonstrated at the SPIE conference in Orlando (USA) with great success.

WP 6.3 Beam Manipulator Prototype – Deformable Mirror (LAM)
The objective of this work was to deform a thin optical surface using 4 piezoelectric actuators. This deformation adapts the curvature radius of the surface in X and Y directions independently. For the SMART-MOMSI design, the requirement is for a mirror diameter of 200 mm, with a toroidal surface of nominal curvature radius of 4000 mm, adjustable to plus or minus 400 mm in each axis of the toroid.

This work package will result in the development of prototypes of the optical elements, supports and actuator control mechanisms required for the optical chain between field selection and the IFU. The challenge for the field selection optics is to be very small to enable maximum clustering of the selected fields, but the optic must be controllable very precisely to maintain a diffraction limited image at the IFU over a long period

Detailed design of the prototype including optics, mechanics and control electronic was undertaken in 2006. All individual parts excluding the mirror were characterised. All procurements needed for the prototype and the test bench were undertaken. The mirror itself has been manufactured and is currently in the last polishing phase. The test bench was mounted and is ready for the test.

WP 6.4 MOS Technology Prototype – Systems Engineering (IAC)
During 2006 the IAC provided scientific, systems and mechanical input to guide the development of the MOEMs devices. This has taken most of the available resources at the IAC, consisting in a co–operational effort to develop Smart–MOS, an instrumental exemplar for a large FOV NIR slit MOS with imaging capabilities. This will be an extremely powerful near IR muti-object spectrometer / imager, considerably in advance of anything currently available. During 2006, opto-mechanical studies were undertake to derive updated technology specifications in relation to instrument technologies such as MOEMs arrays (see below).

Technology progress achieved in this JRA may well have been a factor in ESO's decision to included a Smart-MOS type instruments in their list of instruments to be taken to phase A late in 2007.

WP 6.4 MOS technology prototype- MOEMS array (LAM)

First prototypes of a 5x5 micro-mirror arrays have been developed for use as reflective slit mask in Multi Object Spectrographs. They show very good performance, fulfilling our requirements. The micro-mirrors are etched in bulk single crystal silicon whereas the cantilever type suspension is realized by surface micromachining. One micro-mirror element is 100µm x 200µm in size. The micro-mirrors are actuated electro-statically by electrodes located on a second chip. The use of silicon on insulator (SOI) wafers for both mirror and electrode chip ensures thermal compatibility for cryogenic operation. A system of multiple landing beams has been developed, which passively locks the mirror at a well defined tilt angle when actuated. The mechanical tilt angle obtained is 20° at a pull-in voltage of 90V. Measurements with an optical profiler showed that the tilt angle of the actuated and locked mirror is stable with a precision of one arc minute over a range of 15V. This locking system makes the tilt angle independent from process variations across the wafer and thus provides uniform tilt angle over the whole array. The precision on tilt angle from mirror to mirror measured is one arc minute. The surface quality of the mirrors in actuated state is better than 10nm peak-to-valley and the local roughness is around 1nm RMS.

Milestones And Deliverables Achieved During The Reporting Period

Deliverables / Milestones No	Deliverable/Milestone Name	Work package / Task No.	Lead Contractor (s)	Planned (in months)	Achieved (in months)
D4	Mid Year Report	5	PPARC	30	30
D5	Year End Report	5	PPARC	36	36
M1	Prototype of replicable slicer	6.1	DUR	30	29
M1	Prototype of scalable field selection device	6.2	PPARC	30	29
D1	Report on Warm Tests	6.2	PPARC	36	31
M1	Prototype of active mirror	6.3	LAM	30	36
D1	Report on Warm and Cold Tests	6.3	LAM	36	Warm 39 Cold 42
M1	Prototype reconfigurable slit	6.4	LAM	30	30
D1	Report on Warm and Cold Tests	6.4		36	Warm 33 Cold 42

Major Meetings And Workshops Organised During The Reporting Period

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
06th Apr	Replication Meeting	Prague	8	SFP Twiki - restricted
25th May	Smart Focal Plane Meeting	Orlando	15	SFP Twiki - restricted
26th/27th Sept	Smart MOMSI and Smart MOS	Marseille	10	SFP Twiki - restricted
6th/7th Dec	Smart Focal Planes/ KTN SFP workshop	Neuchatel	12	SFP Twiki - restricted

1.5.7 JRA6: Volume Phase Holographic Gratings (VPHG)

A. Contractors:

Participant number	4a	7a	8c	21b	23	
Participant short name	ESO - INS	IAC	INAF - Brera	ULg – CSL-AOHL	POLIMI	**Total**
Person-months	1.16(0)	4(4)	8.18	7.5	0(0)	20.84(4)

B. Summary of Objectives and progress made:

The JRA is organized in 5 main work packages (referred to also as *research lines*) which are:

1. Management
2. IR Volume Phase Holographic gratings development
3. Non-traditional VPHG-based configurations
4. Photochromic Polymers based VPHGs
5. UV Volume Phase Holographic gratings development

The first 18 months of activity, completed in June 2005, was dedicated to the production of Laboratory prototypes with specific characteristics inherent to the WP objectives. A full description of this prototyping activities is given in the 18 months report available on the JRA web-site. The time since this important milestone has been devoted to a critical analysis of the prototypes toward the definition of the specification for the final science grade devices. This activity is described in the Annual Report III technical annex available on the JRA6 web-site. We report in these pages a brief outline of the work carried out in each work package. A more extensive description can be found in the aforementioned reports available from the web-site. Information contained in the web-site is not public and the access to the document is password protected. OPTICON Board members have the password, other authorities entitled to access the documents can request the password from the JRA-6 leader.

WP 1 – Management

The activity of this Work Package concerned mainly leading the interconnection and intercommunication between the Work Packages. This is especially necessary in JRA6 because each of the contractors contributes to more than one Work Package offering its specific expertise to each research line. The coordination activity, e.g. making everyone aware of the expertise, infrastructure and facilities available in the team has been extremely important for the success of the research. The interconnection and intercommunication has been managed via frequent bilateral conversations with WP leaders and a number of plenary progress meeting (at least one per year). The following meetings have been organized so far (minutes available in the JRA6 Web-site)

- Kick Off meeting March 2004 Milan (Italy)
- Progress Meeting October 2004 Liege (Belgium)
- 18 Month Review meeting July 2005 Tenerife (Spain)
- Progress Meeting April 2006 ESO-Garching (Germany)

The next progress meeting is scheduled for Spring 2007 (date to be defined) in Merate (Italy).

The management activity also provides links between the JRA and the OPTICON board and the executive board. This has been done via participation of the JRA leader in the relevant meetings and by assuring the preparation and delivery of the technical document in a timely manner.

JRA6 Manager attended the following OPTICON Board and Executive Board meetings (the presentations are available in the JRA6 Web-site)

- 2004 April Ghent (Belgium)
- 2004 October Grenoble (France)
- 2005 September Leiden (the Netherlands)
- 2006 June Edinburgh (UK)
- 2006 October Heidelberg (Germany)

WP-1 takes care of the dissemination of the JRA-6 results. This is done via encouraging and coordinating the participation of the team members to attend congresses, conferences, etc. The texts of the most relevant publications are available on the JR6 web-site.

WP 2 – IR VPHGs

The general goal of WP2 within JRA6 is to enable the technology needed to manufacture Science grade VPHGs working at Near Infrared Wavelengths in cryogenic environments.

The activity has been scheduled in 3 main phases:

a) Definition and fabrication of laboratory grade prototypes (18 months)
b) Characterization of the prototypes and definition of the specifications for the science grade final device (24 months)
c) Fabrication and characterization of the science grade prototype. (18 months)

WP 2 is slightly late in milestones achievements due to staff problems at IAC. The delay is estimated as 3-6 months with respect to the original schedule and is expected to be recovered during the next reporting period.

A detailed description of the research carried out and achievements obtained can be found in the Annual report III technical annex available from JRA6 Web-site. Below we report a summary of the results obtained so far in this WP:

- Three fully functional laboratory prototypes have been produced for the three near infrared J, H and K bands.
- Expected Efficiency of each of the prototypes has been computed via RCWA
- Diffraction Efficiency was measured at room temperature
- Diffracted wavefront was measured at room temperature
- Cryogenic measurements of the diffraction efficiency have been done (more detailed measurements are planned for the near future).
- Cryogenic measurements of the transmitted wave-front have been done (more detailed measurements are planned for the near future).
- A first draft of the specification for the science grade device has been written.

WP 3 – Non Traditional VPHG-based configurations

WP3 is dedicated to the study and realisation of non-traditional configurations making use of

VPHGs. The reason is that the use of existing VPHGs has not been pushed to the maximum to date. So far, they have only been used up to now as replacement of grisms in straight-through geometry spectrographs, with a few remarkable exceptions.

The activity has been scheduled in 3 main phases:

a) Trade off selection of possible representative non-traditional configurations (18 months).
b) Demonstration of the feasibility via prototypes and characterization of a possibly innovative device at a laboratory level (24 months).
c) Design, construction and characterization of a science grade device (18 months).

This WP is expected to be currently in the phase b. in transition toward the phase c. WP 3 is slightly late in milestones achievements due to unexpected down-time at the Brera Observatory mechanical workshops. The delay is estimated at 3-6 months with respect to the original schedule and is expected to be recovered during the next reporting period.

A detailed description of the research carried out and achievements obtained can be found in the Annual report III technical annex available from the JRA6 Web-site. Below we report a summary of the results obtained so far in this WP :

- Definition and design of a number of innovative VPHGs assemblies in the visible wavelength domain.
- Out of many possible configurations the selection of the most representative cases to study:
  - VPHG based tunable photometric filters
  - Use of VPHGs for High Resolution spectroscopy in multi λ-range by optimizing the Focal Plane Array filling.
- Preliminary design study for each of the two configurations completed.
- Industrial-ready design for each of the two above configurations completed.
- Fabrication and testing in progress.

WP 4 – Polymer based VPHGs

WP 4 is meant to investigate possible alternatives to DCG as photosensitive layer in the fabrication of VPHGs.

Due to limited resources that do not allow us to investigate all possible DCG alternatives, attention has been concentrated on a class of polymers, purposely synthesised in our laboratories, with linear and non-linear optical properties of already proven interest for astronomical instrumentation. These polymers are referred to by the general term of "Photochromic polymers" although many different species can be used for our purposes.

The activity has been scheduled in 3 main phases:

a) Design, study and fabrication at laboratory level of the first VPHG based on photochromic polymers (24 months).
b) Tests and characterization of the prototype with examination of critical fabrication points and feed back to technology enabling (24 months).
c) Design, study and fabrication of a science grade photochromic VPHG (12 months).

WP 4 is proceeding according to schedule.

A detailed description of the research carried out and achievements obtained can be found in the Annual report III technical annex available from the JRA6 Web-site. Below we report a summary of the results obtained so far.

- Study and synthesis of a polymer with specific optical and mechanical properties
- Study and perform the optimal coating process to obtain the substrates for grating preparation
- Study the optimal exposure parameters to obtain an efficient grating.
- A variety of chemical compounds with increased molecular polarizability (enhanced diffraction index contrast) and molecular weight (simple mechanical properties) have been synthesised and tested
- The first ever prototype of re-writeable photochromic based VPHG for NIR wavelength was successfully produced and tested.
- The characterization of the prototype prompted a better coating technique that has been defined and applied. New better photochromic films have been obtained.

WP 5 – UV VPHGs

The general goal of WP5 is to enable the technology needed to manufacture Science grade VPHGs working at UV Wavelengths with special attention to their use as cross dispersers in High Resolution Spectroscopy.

The activity has been scheduled in 3 main phases:

d) Definition and fabrication of laboratory grade prototypes (18 months)
e) Characterization of the prototypes and definition of the specifications for the science grade final device (24 months)
f) Fabrication and characterization of the science grade prototype. (18 months)

WP 5 is slightly late in milestones achievements due to over-commitment of ESO laboratories. The delay is estimated in 3-6 months with respect to the original schedule and is expected to be recovered during the next reporting period.

A detailed description of the research carried out and achievements obtained can be found in the Annual report III technical annex available from the JRA6 Web-site. Below we report a summary of the most outstanding results obtained so far in this WP

- Three fully functional laboratory protypes have been produced working with different dispersions at UV wavelengths.
- A double pass single diffraction configuration has been designed and manufactured to use UV VPHGs to replace reflecting cross-dispersers in high resolution spectroscopy.
- The expected efficiency of each of the prototypes (including the double-pass device) has been computed via RCWA
- The diffraction efficiency was measured at room temperature
- Diffracted wavefront was measured at room temperature
- A first draft of the specification for the science grade device has been written.

Milestones and Deliverables achieved

Deliverable/ Milestone No	Name of deliverable/milestone	Activity (NAx; JRAy)	Work-package /Task	Delivered by Contractor(s)	Planned (in months)	Achieved (in months)	Doc #
M4	Review of Prototype Critical Points	JRA6	WP4	ALL	30	30	ARIII
M5	Science Grade Device Specifications	JRA6	WP2	ALL	30	36	ARIII
M5	Construction Plan and Material trade-off selection	JRA6	WP3	ALL	30	36	ARIII
M5	Science Grade Device Specificaions	JRA6	WP5	ALL	30	36	ARIII

Meetings and Workshop Table

Date	Title/subject of meeting	Location	# att.	Website address
March 04	Kick-Off meeting	POLIMI-Milano	15	JRA6 Web-site
October 04	Progress Meeting	CSL- Liege	10	JRA6 Web-site
July 05	Progress Meeting	IAC- Tenerife	15	JRA6 Web-site
October 05	KTN Workshop	INAF-Rome	40	Workshop website
April 06	Progress Meeting	ESO-Garching	10	JRA6 Web-site

Significant achievements and their impact resulting from this activity during the reporting period

1. Fully functional J,H,K NIR Laboratory prototypes
2. Fully functional UV devices and Cross Dispersing Assemblies
3. The first VPHG based Tunable filter
4. The first polymer-based NIR VPHG

2. List of deliverables

Activity	Deliver--able No	Deliverable Name	Workpackage /Task No	Delivered by Contractor(s)	Planned (in months)	Achieved (in months)
NA1		Consortium Agreement		UCAM	60	60
NA2	D1	Updated Progress report and revised roadmap	WP1.1	IAC	36	36
NA2	M1	Regular ENO meetings	WP1.1	IAC, IOA-KUL, INAF, THEMIS, IFAE, UCAM, Jodrell Bank.	28	29
NA2	M1	Regular ENO meetings	WP1.1	IAC, IOA-KUL, INAF, THEMIS, IFAE, UCAM, Jodrell Bank.	33	32
NA2	D4	Software implementation	WP1.2	PPARC	25	36
NA2	D1	Report: Systematic measurements of seeing & meteorology	WP2.1	IAC, INAF, PPARC, NOTSA	36	36
NA2	M1	Automate monitor DA/IAC	WP2.1	IAC	25>>	25>>
NA2	D1	Report on systematic measurements using DIMM	WP2.2	IAC	30	31
NA2	D1	Annual report on measurements of extinction and dust	WP2.3	IAC	36	36
NA2	D2	Annual report on stations already existing	WP2.3	IAC	30	30
NA2	D1	Report on techniques to get wind profiles	WP2.4	IAC	36	36
NA2	D1	Annual report on discussion forums for site-selection	WP2.5	IAC	36	36
NA2	D3	:Report on new institutions interested in JIS	WP3.1	IGAM, IAC,	30	30
NA2	D6:	Annual report with the maintenance activities carried out.	WP3.1	IGAM, IAC,	36	36
NA2	M1	Open-doors days at OT and ORM	WP3.2	IAC, PPARC, INAF, IOA-KUL, IFAE	30,31	31
NA2	D1	New editions of outreach material	WP3.2	IAC, PPARC, INAF, IOA-KUL, IFAE	27	31
NA2	D2	ENO website. Updated version	WP3.2	IAC, PPARC, INAF, IOA-KUL, IFAE	30	36
NA2	D4	Programme of activities for the next event	WP3.2	IAC, PPARC, INAF, IOA-KUL, IFAE	36	36
NA2	D5	Exhibition elements and educational material	WP3.2	IAC, PPARC, INAF, IOA-KUL, IFAE	33	31
NA3	M1	ELT Science Meeting (Marseille)	WP3.1	PPARC	35	35

NA3	M1b	International Conference on Astrophysics	WP3.2	PPARC	32	32
NA3	M5 (M4b)	HTRA conference	WP3.3	NUIG	30	30
NA3	D1	Book on the state-of-the-art in HTRA	WP3.3	NUIG	34	>>38
NA3	M2a	High-level Requirements version 1.0	WP6	ESO, PPARC, ESA, RDS, NOVA, INSU/CNRS, NOTSA, INAF	30	32
NA3	M3a	Draft architecture	WP6	ESO, PPARC, ESA, RDS, NOVA, INSU/CNRS, NOTSA, INAF	30	30 (first draft)
NA5	M2	Annual call for applications	WP1	NCU	25	27& 33
NA5	M3	Collate list of applicants	WP1	NCU	26	28 & 34
NA5	M4	Selection of exchange visitors	WP1	NCU	28	28 &34
NA5	D1	Report from participants	WP1	NCU	36	36
NA6	M2	Annual Directors' Meeting	WP1	PPARC	33	33
NA6	M4A	Peer review of Aristachos telescope	WP1	PPARC	21	33
NA6	M4B	Peer review of Liverpool telescope	WP1	PPARC	21	Postponed to month 40
NA6	M3a	Working group Meeting	WP3	CNRS,IAP	29	29
NA6	D1	Promote Access programme at IAU meeting in Prague	WP2	IAC	32	32
NA6	M2	3rd Report to Directors forum	WP2	IAC	36	27 (preliminary report) 32 (1st update) 36 (2nd update)
JRA1	M1	JRA1 General Meeting 3	1	ESO	3	3
JRA1	M2	JRA1 General Meeting 3	1	ESO	12	12
JRA1	M1	Complete design of the single object WFS for GTC	2.3	GTC	9	12
JRA1	M2	Implementation of the optimal control methods developed above on a simplified laboratory system and performance evaluation.	3.2	ONERA	6	6
JRA1	M1	Complete design of fast drive control electronics for the piezo stack deformable mirror developed above	3.1	ESO	9	12
JRA1	M1	Specifications of the electro-magnetic micro deformable mirror prototype; contract signature with ALPAO-Floralis	3.7	INSU	7	9
JRA1	New	Specifications of a electrostatic micro deformable mirror prototype; contract signature with LETI	3.7	INSU	N/A	9
JRA1	M3	Delivery of a MDM control electronic prototype	3.7	INSU	3	6

JRA2	M4	Delivery of demonstration device detector.	WP2	ESO	18	32
JRA3 JRA3	M3 D1	Integration Review Test and instrument verification plan	WP1 WP1	MPG-MPA MPG-MPA	30 30	36 36
JRA3	M3	Integration and test L3CCD camera	WP2	USFD	30	34
JRA3	D1	test report L3CCD camera	WP2	USFD	30	36
JRA3	M3	Fabrication critical AA-pnCCD elements	WP3	MPG-MPE	24	30
JRA3	M4	Functional test and characterization AA-stage	WP3	MPG-MPE	30	32
JRA4	D4	ESO project selection for phase A	1.1	ESO	30	34
JRA4	D3	Second Progress Report on CFT	1.2	INAF/OATo	36	36
JRA5	D4	Mid Year Report	5	PPARC	M0+30	M0+30
JRA5	D5	Year End Report	5	PPARC	M0+36	M0+36
JRA5	M1	Prototype of replicable slicer	6.1	DUR	M0+30	M0+29
JRA5	M1	Prototype of scalable field selection device	6.2	PPARC	M0+30	M0+29
JRA5	D1	Report on Warm Tests	6.2	PPARC	M0+36	M0+31
JRA5	M1	Prototype of active mirror	6.3	LAM	M0+30	M0+36
JRA5	D1	Report on Warm and Cold Tests	6.3	LAM	M0+36	Warm M0+39 Cold M0+42
JRA5	M1	Prototype reconfigurable slit	6.4	LAM	M0+30	M0+30
JRA5	D1	Report on Warm and Cold Tests	6.4		M0+36	Warm M0+33 Cold M0+42
JRA6	M4	Review of Prototype Critical Points	WP4	ALL	30	30
JRA6	M5	Science Grade Device Specifications	WP2	ALL	30	36
JRA6	M5	Construction Plan and Material trade-off selection	WP3	ALL	30	36
JRA6	M5	Science Grade Device Specificaions	WP5	ALL	30	36

*[In addition to being described in the Activity Report, achieved deliverables, if not yet provided to the Commission services, will be gathered in a CD-ROM in **Annex 7**. When the deliverable is not a report provide any available supporting material that can document it (e.g. photographs of a prototype).]*

3. Use and dissemination of knowledge

NA 1. Management

Stand, posters, handouts and presentations at Prague IAU General Assembly

NA2: Coordination and Integration of ENO facilities
WP2.4 Joint actions for Measurement of turbulence and wind vertical profiles (SCIDAR, GSM & DIMM):

Garcia-Lorenzo & Fuensalida 2006, SPIE, 6267, 61, **"Automatic determination of atmospheric turbulence wind profiles using wavelets"**

García-Lorenzo & Fuensalida 2006, MNRAS, in press, **Processing of turbulent-layer wind speed with Generalized SCIDAR through wavelet analysis.**

NA3: Structuring European Astronomy

WP1: ELT

Proceedings of the Marseilles ELT meeting being circulated on CD-Rom.

WP2: Network for UV Astronomy (NUVA)

Summary of the Joint Discussion: "UV Astronomy: Stars from Birth to Death"
Ana I. Gomez de Castro & Martin A. Barstow
Highlights of Astronomy, Volume ??
XXVIth IAU General Assembly, August 2006
K.A. van der Hucht, ed., c ° 2006 International Astronomical Union

Fundamental problems in astrophysics: Guidelines for future UV observatories.
Ana I. Gómez de Castro & Willem Wamsteker, eds, 2006
Springer, ISBN 1-420-4836-6
Table of contents:

Fundamental problems in modern astrophysics requiring access to the ultraviolet range
Gómez de Castro, Ana I.; Lecavelier des Étangs, Alain; Reimers, Dieter, 2006
Proc. of SPIE: Space Telescopes and InstrumentationII: Ultraviolet to Gamma Ray, Ed. By Turner, Martin, Hasinger, Guenther, Vol, 6266

WP4: Astrophysical Virtual Observatory (AVO)

WP6: Future Astronomical Software Environments

NA5: Interferometry forum

"Technology Roadmap for Future Interferometric Facilities" Surdej, J; Caro, D; Detal, A. Liege University, Institute of Astrophysics and Geophysics. Proceedings of the European Interferometry Initiative Workshop organized in the context of the 2005 Joint European and National Astronomy Meeting "Distant Worlds" 6 – 8 July 2005

NA6: OPTICON Telescope Network

WP3: Enhancement

A full report on two NEON schools (which operate in conjunction with a Marie-Curie action) has been given in the ESO Messenger (n.126, Dec.2006 issue, p. 52)

JRA1: Adaptive Optics

WP2.1: XAO system Study

The documents produced in the frame of this WP are provided in CD-ROM JRA1/WP2.1.

Five papers related to the WP 2.1 have been produced in this period.

[1] " *A Planet Finder instrument for the VLT*", Beuzit, J.-L.; Feldt, M.; Mouillet, D.; Moutou, C.; Dohlen, K.; Puget, P.; Fusco, T.; Baudoz, P.; Boccaletti, A.; Udry, S.; Ségransan, D.; Gratton, R.; Turatto, M.; Schmid, H.-M.; Waters, R.; Stam, D.; Rabou, P.; Lagrange, A.-M.;

Ménard, F.; Augereau, J.-C.; Langlois, M.; Vakili, F.; Arnold, L.; Henning, T.; Rouan, D.; Kasper, M.; Hubin, N., Direct Imaging of Exoplanets: Science & Techniques. Proceedings of the IAU Colloquium #200, Edited by C. Aime and F. Vakili. Cambridge, UK: Cambridge University Press, 2006., pp.317-322.

[2] "*SPHERE: A planet finder instrument for the VLT*", Dohlen, Kjetil; Beuzit, Jean-Luc; Feldt, Markus; Mouillet, David; Puget, Pascal; Antichi, Jacopo; Baruffolo, Andrea; Baudoz, Pierre; Berton, Alessandro; Boccaletti, Anthony; Carbillet, Marcel; Charton, Julien; Claudi, Riccardo; Downing, Mark; Fabron, Christophe; Feautrier, Philippe; Fedrigo, Enrico; Fusco, Thierry; Gach, Jean-Luc; Gratton, Raffaele; Hubin, Norbert; Kasper, Markus; Langlois, Maud; Longmore, Andy; Moutou, Claire; Petit, Cyril; Pragt, Johan; Rabou, Patrick; Rousset, Gerard; Saisse, Michel; Schmid, Hans-Martin; Stadler, Eric; Stamm, Daphne; Turatto, Massimo; Waters, Rens; Wildi, Francois, Ground-based and Airborne Instrumentation for Astronomy. Edited by McLean, Ian S.; Iye, Masanori. Proceedings of the SPIE, Volume 6269, pp. 62690Q (2006).

[3] "*Design of the extreme AO system for SPHERE, the planet finder instrument of the VLT*", Fusco, T.; Petit, C.; Rousset, G.; Sauvage, J.-F.; Dohlen, K.; Mouillet, D.; Charton, J.; Baudoz, P.; Kasper, M.; Fedrigo, E.; Rabou, P.; Feautrier, P.; Downing, M.; Gigan, P.; Conan, J.-M.; Beuzit, J.-L.; Hubin, N.; Wildi, F.; Puget, P., SPIE Proc., Volume 6272, pp. 62720K (2006).

[4] "*Custom CCD for adaptive optics applications*", Downing, Mark; Arsenault, Robin; Baade, Dietrich; Balard, Philippe; Bell, Ray; Burt, David; Denney, Sandy; Feautrier, Philippe; Fusco, Thierry; Gach, Jean-Luc; Diaz Garcia, José Javier; Guillaume, Christian; Hubin, Norbert; Jorden, Paul; Kasper, Markus; Meyer, Manfred; Pool, Peter; Reyes, Javier; Skegg, Michael; Stadler, Eric; Suske, Wolfgang; Wheeler, Patrick, High Energy, SPIE Proc. Volume 6276, pp. 62760H (2006).

[5] "*Thermal modeling of cooled instrument: from the WIRCam IR camera to CCD Peltier cooled compact packages*", Feautrier, Philippe; Stadler, Eric; Downing, Mark; Hurrell, Steve; Wheeler, Patrick; Gach, Jean-Luc; Magnard, Yves; Balard, Philippe; Guillaume, Christian; Hubin, Norbert; Diaz, José Javier; Suske, Wolfgang; Jorden, Paul, SPIE Proc., Volume 6271, pp. 62710S (2006).

WP2.2: GLAO System Study

The documents produced in the frame of this WP are provided in **CD-ROM JRA1/WP2.2.**

Nine papers describing the result of this WP have been written [1-9]

[1] *"Optical design for the adaptive secondary setup and instrument stimulator (ASSIST)",* P. Hallibert, R Arsenault, B. Delabre, S. Esposito, N. Hubin, A. Quirrenbach, A. Riccardi, S. Stroebele, R. Stuik, R. Vink, SPIE Proc. 6288, pp62880C, 2006

[2] "*ASSIST: the adaptive secondary setup and instrument stimulator*", R. Stuik, R. Arsenault, B. Delabre, S. Esposito, P. Hallibert, N. Hubin, A. Quirrenbach, A. Riccardi, S. Stroebele, R. Vink, SPIE, Proc. 6272, pp. 62720Z, 2006.

[3] "*A deformable secondary mirror for the VLT*", R. Arsenault, R. Biasi, D. Gallieni, A. Riccardi, P. Lazzarini, N. Hubin, E. Fedrigo, R. Donaldson, S. Oberti, S. Stroebele, R.

Conzelmann, M. Duchateau, SPIE, Proc. 6272, pp. 62720V, 2006.

[4] "*The ESO Adaptive Optics Facility*", S. Stroebele, R. Arsenault, R. Bacon, R. Biasi, D. Bonaccini-Calia, M. Downing, R. Conzelmann, B. Delabre, R. Donaldson, M. Duchateau, S. Esposito, E. Fedrigo, D. Gallieni, W. Hackenberg, N. Hubin, M. Kasper, M. Kissler-Patig, M. Le Louarn, R. McDermid, J. Paufique, A. Riccardi, R. Stuik, E. Vernet, SPIE, Proc. 6272, pp. 62720B, 2006.

[5] "*The VLT Adaptive Optics Facility Project: Adaptive Optics Modules*", Arsenault, Robin; Hubin, Norbert; Stroebele, Stefan; Fedrigo, Enrico; Oberti, Sylvain; Kissler-Patig, Markus; Bacon, Roland; McDermid, Richard; Bonaccini-Calia, Domenico; Biasi, Roberto; Gallieni, Daniele; Riccardi, Armando; Donaldson, Rob; Lelouarn, Miska; Hackenberg, Wolfgang; Conzelman, Ralf; Delabre, Bernard; Stuik, Remko; Paufique, Jerome; Kasper, Markus; Vernet, Elise; Downing, Mark; Esposito, Simone; Duchateau, Michel; Franx, Marijn, Myers, Richard; Goodsell, Steven, The ESO Messenger, volume 123, page 11, 2006.

[6] "*The VLT Adaptive Optics Facility Project: Telescope Systems*", Arsenault, Robin; Hubin, Norbert; Stroebele, Stefan; Fedrigo, Enrico; Oberti, Sylvain; Kissler-Patig, Markus; Bacon, Roland; McDermid, Richard; Bonaccini-Calia, Domenico; Biasi, Roberto; Gallieni, Daniele; Riccardi, Armando; Donaldson, Rob; Lelouarn, Miska; Hackenberg, Wolfgang; Conzelman, Ralf; Delabre, Bernard; Stuik, Remko; Paufique, Jerome; Kasper, Markus; Vernet, Elise; Downing, Mark; Esposito, Simone; Duchateau, Michel; Franx, Marijn, Myers, Richard; Goodsell, Steven, The ESO Messenger, volume 123, page 6.

[7] "*Improving the seeing with wide-field adaptive optics in the near-infrared*", Le Louarn, M.; Hubin, N., Monthly Notices of the Royal Astronomical Society, Volume 365, Issue 4, pp. 1324-1332.

[8] "*GALACSI The ground layer adaptive optics system for MUSE*", Stuik, Remko; Bacon, Roland; Conzelmann, Ralf; Delabre, Bernard; Fedrigo, Enrico; Hubin, Norbert; Le Louarn, Miska; Ströbele, Stefan, New Astronomy Reviews, Volume 49, Issue 10-12, p. 618-624.

[9] "*FALCON: Extending adaptive corrections to cosmological fields",* Puech, M.; Hammer, F.; Jagourel, P.; Gendron, E.; Assémat, F.; Chemla, F.; Flores, H.; Laporte, P.; Conan, J.-M.; Fusco, T.; Liotard, A.; Zamkotsian, F., New Astronomy Reviews, Volume 50, Issue 4-5, p. 382-384.

WP2.3: Multi-Object WFS for GTC

A design report has been produced by GTC and is included in **CD-ROM JRA1/WP2.3.** This design report represents **deliverable M1 of WP2.3**.

WP2.4: Multiple FOV System with NGS

The documents produced in the frame of this WP are provided in **CD-ROM JRA1/WP2.4.**

3 meetings have been organised in 2006

Six papers have been published in the frame of this WP:

[1] Sky coverage for layer oriented MCAO: a detailed analytical and numerical study, C. Arcidiacono, E. Diolaiti, R. Ragazzoni, J. Farinato, E. Vernet. SPIE Vol. 5490 pp.563 (2004)

[2] LINC-NIRVANA: the single arm MCAO experiment, S. E. Egner, W. Gaessler, T. M. Herbst, R. Ragazzoni, D. R. Andersen, H. Baumeister, P. Bizenberger, H. Boehnhardt, S. Ligori, H. Rix, R. Soci, R. Rohloff, R. Weiss, W. Xu, C. Arcidiacono, J. Farinato, E. Diolaiti,

P. Salinari, E. Vernet-Viard, A. Eckart, T. Bertram, C. Straubmeier. SPIE Vol. 5490 pp. 924, (2004)

[3] LINC-NIRVANA: mechanical challenges of the MCAO wavefront sensor Soci, Roberto; et. al. SPIE 5490, pp. 1286 (2004)

[3] "Arbitrarily Small Pupils in Layer-Oriented Multi-Conjugate Adaptive Optics" Ragazzoni, Roberto; Diolaiti, Emiliano; Vernet, Elise; Farinato, Jacopo; Marchetti, Enrico; Arcidiacono, Carmelo The Publications of the Astronomical Society of the Pacific, Volume 117, Issue 834, pp. 860-869. (PASP Homepage).

[4] "LINC-NIRVANA: MCAO toward ELTs" Gaessler, W.; et. al., Comptes Rendus Physique, Volume 6, Issue 10, Pages 1129-1138, 2005

[5] "The MCAO wavefront sensing system of LINC-NIRVANA: status report" Farinato, J; et. al SPIE Vol. 6272 pp. 70 (2006).

[6] "Integration, testing, and laboratory characterization of the mid-high layer wavefront sensor for LINC-NIRVANA" Lombini M., Foppiani I., Diolaiti E., Farinato J., Ragazzoni R., Bregoli G., Ciattaglia C., Cosentino G., Innocenti G., Schreiber L., Arcidiacono C., De Bonis F., Egner S., Gaessler W., Herbst T., Kuerster M., Schmidt J., Soci R., Rossettini P., Tomelleri R., SPIE Proceedings 6272, pp. 149, (2006).

WP 3: ENABLING TECHNOLOGY FOR 2nd GENERATION/ELT AO SYSTEM

WP3.1: 2nd Generation RTC Platform

The documents produced in the frame of this WP are provided in **CD-ROM JRA1/WP3.1.**

List of papers:

1. **Fedrigo, E.;** Donaldson, R.; Soenke, C.; Myers, R.; Goodsell, S.; Geng, D.; Saunter, C.; Dipper, N., "*SPARTA: the ESO standard platform for adaptive optics real time applications*", SPIE 2006
2. Goodsell, S. J.; **Fedrigo, E.**; Dipper, N. A.; Donaldson, R.; Geng, D.; Myers, R. M.; Saunter, C. D.; Soenke, C., "*FPGA developments for the SPARTA project*", SPIE 2006
3. Goodsell, S. J.; Geng, D.; **Fedrigo, E.**; Soenke, C.; Donaldson, R.; Saunter, C. D.; Myers, R. M.; Basden, A. G.; Dipper, N. A, "*FPGA developments for the SPARTA project: Part 2*", SPIE 2006

WP3.2: *Optimal Control Methods for MCAO Systems*

The report regarding the "implementation of the optimal control methods developed on a simplified laboratory system and performance evaluation" of WP 3.2 is included in **CD-ROM JRA1/WP3.2.** This represents the **deliverable M2 of the WP 3.2.**

Six papers have been published in the frame of the WP 3.2 in 2006:

[1] "*Kalman Filter based control loop for Adaptive Optics*", C. Petit, F., F. Quiros-Pacheco, J.-M. Conan, C. Kulcsár, H.-F. Raynaud, T. Fusco and G. Rousset, *Advancement in Adpative Optics*, **5490**, D. Bonaccini, B. Ellerbroek, R. Ragazzoni eds, SPIE conf. 2004

[2] "*Optimal control for Multi-Conjugate Adaptive Optics*", C. Petit, J.-M. Conan, C. Kulcsár, H.-F. Raynaud, T. Fusco, J. Montri and D. Rabaud, C. R. Physique 6 (2005).

[3]: "First laboratory demonstration of closed-loop Kalman based optimal control for

vibration filtering and simplified MCAO." C. Petit, J.-M. Conan, C. Kulcsár, H.-F. Raynaud, T. Fusco, J. Montri, D. Rabaud, *Advances in Adaptive Optics II,* **6272,** D. Ellerbroek and D. Bonaccini eds, SPIE conf. 2006.

[4] " Improvement of sky coverage estimation for MCAO systems: strategies and algorithms ", T. Fusco, A. Blanc, M. Nicolle, G. Rousset, V. Michau, J.-L. Beuzit and N. Hubin, MNRAS, **370**, 1, 2006

[5] "Optimization of star oriented and layer oriented wave-front sensing concepts for ground layer adaptive optics", M. Nicolle, T. Fusco, V. Michau, G. Rousset and J.-L. Beuzit, JOSA A, **23**, 2006

[6] "Comparison of centroid computation in a Shack Hartmann Sensor", S. Thomas, T. Fusco, A. Tokovinin, M. Nicolle, V. Michau and G. Rousset, MNRAS, **371**, 1

WP3.3: 2nd Generation Piezo DM

The documents produced in the frame of this WP are provided in **CD-ROM JRA1/WP3.3.**

WP3.4: 2nd Generation Piezo DM drive Electronic

Documentation of WP 3.5 is included in **CD-ROM JRA1/WP3.5**

WP3.6 Manufacturing and Demonstration of a large convex glass shell

Design documentation (**deliverable M1 of WP 3.6**) is included in **CD-ROM JRA1/WP3.6**

WP3.7 2k Actuator & low order Micro-Deformable Mirrors (MDM) R&D

LAOG had to quickly find a solution to manufacture and commercialize these deformable mirrors, and in 2005 we decided to create a business unit called ALPAO within FLORALIS, a subsidiary company from the Grenoble University dedicated to technology transfer. ALPAO shall become a stand-alone company in June 2007 and is now employing 3 people. A second patent license was granted to the Imagine Eyes Company for non-astrophysics applications.

The documents produced in the frame of this WP are provided in **CD-ROM JRA1/WP3.7.**

WP3.8 High Order wavefront sensor experimental study

All documents produced in the frame of this WP are included in **CD-ROM JRA1/WP 3.8/**.

Publications: Vernet et al, SPIE 6272, 2006

JRA2: Fast detectors for AO

WP2: Detector specification and fabrication work package.
The following table contains the major documents which have been produced as part of this work package.

AD1	Technical specifications for the Adaptive Optics Wavefront Sensor Detector	VLT-SPE-ESO-14690-3320, issue 3, 19 April 2005.
AD2	Statement of work for the Adaptive Optics Wavefront Sensor Detector	VLT-SOW-ESO-14690-3383, issue 4, 15 April 2005.
AD3	e2v technical and management proposal	E2V-PR-679, Issue 4, 10 March 2005.
AD4	CCD Design Definition	VLT-SPE-E2V-14690-0001, Issue 1, 25th February 2005.
AD5	Test Equipment Requirements	VLT-SPE-E2V-14690-0002, Issue 6, 10th April 2006.
AD6	CCD Test Plan	VLT-PLA-E2V-14690-0008, Issue 3, 26th October 2005.
AD7	CCD Design Report	VLT-PLA-E2V-14690-0014, Issue 3, 3rd October 2005.
AD8	Test Equipment ICD	VLT-PLA-E2V-14690-0012, Issue 3, 15th February 2006.
AD9	CCD Compliance Matrix	VLT-SPE-E2V-14690-0016, issue 1, 26th August
AD10	Adaptive Optics Wavefront Sensor Detector, Critical Design Review Report	VLT-TRE-ESO-14690-3814, Issue 1, 14 November 2005.
AD11	CCD220 Camera System Verification Matrix	VLT-SPE-ESO-14690- 3736, Issue 1.0, 5th July 2005.
AD11	CCD220 Data Sheet (preliminary)	6th January 2006
AD12	CCD220 Package Design Review Report	13th January 2006

Two papers describing the progress of this WP have been written:

[1] M. Downing et al, “A Dedicated L3CCD for Adaptive Optics Applications”, proceedings of the Scientific Detector Worshop 2005, Taormina June 2005, Springer editions, editors: P.Amico and J. Beletic.

[2] M. Downing et al, “Custom CCD for adaptive optics applications”, SPIE 62760H, SPIE Orlando 24-27 May 2006.

JRA3 : High Time Resolution Astronomy

JRA4: Interferometry

JRA5: Smart Focal Planes

JRA6: Volume Phase Holographic Gratings

Annexes

ANNEX 1: General Meetings

Full minutes of all OPTICON Board and Executive meetings are available at the www site http://www.astro-opticon.org/meetings.html

D. DETAILED IMPLEMENTATION PLAN FOR THE NEXT 18 MONTHS

1.1 NA1: Management Activity

During Month 37 the project office will be represented at the ASTRONET Science vision colloquium. Nominations will be made for the panels producing the ASTRONET Infrastructures Roadmap. During Month 37 and 38 the management team will work with the Network, Access and JRA leaders and the contractors' financial departments to complete the 3rd annual report to the commission.

During Month 39 the executive committee will meet to review the progress set out in the annual report, consider and revise where necessary the future plans and budgets of all activities.

During month 44 the executive committee will meet again (if required) to monitor progress and prepare any recommendations to the board on future plans

During month 45 the annual board meeting will take place.

The project office will distribute funds from the next advance when they become available.

The Project Scientist and other members of the management team will constantly monitor progress of the various activities to ensure the planned programme can be delivered.

The project team will continue to make presentations and write articles where appropriate to publicise the activities of the project.

Workpackage	**Milestones/ Deliverables**	**Project Month**	**Description**
1	M14	39	Executive meeting. Venice
1	M15	39	Complete Annual report to EU
1	M16	44	Executive meeting.
1	M18	46	OPTICON Board meeting. Autumn 07

1.2 NA2. Coordination and Integration of ENO facilities

WP1.: Co-ordination of scientific communities at ENO:

WP1.1.: Dissemination of good practices: The working group will establish and update the roadmap of future projects; identifying complementarities between ENO telescopes. International funding opportunities will be identified as well as contacts of interest at European level. The next general NA2 meeting will be organized in Spring 2007 (Rome). Some special working groups may also be set up to analyse and discuss very specific and common issues affecting subsets of astronomical community, as a result of being located at the same site. These working groups will be set up only if well-defined and specific objectives to approach are identified by the participants at the NA2 meetings.

WP1.2.: Laser Traffic Control System (LTCS) for ORM:

A final report of the LTCS will be delivered by the middle of 2007 (Deliverable D5). No longer term plans are expected under the OPTICON project given that this workpackage will finish once the LTCS hardware is installed (summer 2007).

WP2.: Site Characterisation of the Canary Islands' Observatories:

A continuous comparison and complementarities of the simultaneous data provided individually by the different DIMMS are planned. Main objective to be accomplished are:

- DIMMA and IAC DIMM calibration.
- To put the DIMMA in routine mode at the ORM (Spring 2007)
- MASS-DIMM and IAC DIM calibration.
- Cross-calibrations and distribution of data and results will be also addressed under this task.
- DIMMA installation at the OT
- Increase the availability of seeing data in real time mode.

In addition, the followings report/studies will be undertaken:
Reports on techniques to get wind profiles
Report on discussion forums for site-selection

Likewise, the following specific actions will be addressed during the next 18 months (January 2007 – June 2008):

WP2.1 Co-ordination of night-time seeing measurements with DIMMs:
Analysis of systematic seeing measurements and meteorology will be carried out by the participants; results will be made available and a progress report on these measurements will be delivered. The Automatic Differential Image Motion (DIMMA) will be operative by spring 2007 to reinforce the Site Characterization at Roque de los Muchachos Observatory (ORM).

WP2.2 Co-ordination of day-time seeing measurements at Teide Observatory (OT):
This work package has already delivered its final report and it is not expected to extend the day-time measurements at Teide Observatory.

WP2.3 Joint actions for meteorology, dust, extinction and Sky Background:
The Automatic weather station (AWS) will be full operative in early 2007.
The study of dust pollution monitoring and dust particles will continue being undertaken by the participants (The distribution of data and results will be presented in a new web page)

Under a collaboration with the INM we are organizing the installation at the ORM of a Multi-

Filter Rotating Shadowband Radiometer (*MFRSR*) to measure the aerosol scattering. We will continue the analysis of satellite data in order for it to be used for site characterization (larger spatial resolution than existing is required). In collaboration with the NOT staff we are planning to store all meteorological data provided by different ORM weather stations in a common database. A study of the climatology conditions at the ORM will be published.

WP2.4 Joint actions for Measurement of turbulence and wind vertical profiles (SCIDAR, GSM & DIMM):

The following actions summarise the plans under WP2.4:

- Analysis of turbulence profiles obtained with G-SCIDAR at the ORM
- Derive the velocity of turbulence layers and make a comparison with balloon measurements
- Statistical analysis of turbulence profiles and winds at the ORM
- Presentation of the hybrid instrument in International meetings
- Complete and test the algorithm to analyse the data from the Shack-Hartmann arm of the hybrid instrument
- Comparison of turbulence profiles obtained from simultaneous data with the two arms of the hybrid instrument
- Comparison of the derived velocities of turbulent layers with the results from SODAR measurements.
- Development of a code to obtain the turbulence and the wind profiles from G-SCIDAR measurements.

WP2.5 Distribution and discussion of results and participation at the scientific forums:
The discussion forums for Site-Selection of large astronomical and solar telescopes and site characterization will be attended when scheduled and contributions will be prepared. In the near future it is expected to participate in:

- The Site Characterization / ELT scientific forums
- Site Testing Design for the European ELT

An annual report will be delivered with all the actions carried out.

WP3.: Joint Information System and Transfer of Knowledge:

WP3.1.: Development of a Joint Information System for Solar Physics (JIS):

Appropriate maintenance activities will be carried out for the whole system. An updated report on new institutions interested in JIS will be produced. Efforts will be focussed in promotional activities to guarantee a high impact among the Solar physics community (meetings, workshops, leaflets, etc).

WP3.2.: Co-ordinated actions on transfer of knowledge and public outreach:
New sections for the joint ENO Website will be implemented, including new promotional material, an online agenda as well as news related to the Canary Islands' astronomical observatories.

A pilot activity consisting of several lesson plans for children and teenagers will be carried out in different secondary schools of the Canary Islands . The class activities will be followed by a guided visit to the Canary Islands' astronomical observatories and Planetariums.
Some of the activities already carried out, such as the Open Days, edition of promotional

material and expositive units will be organized periodically, in order to optimize the real impact among the general public. Audiovisual contents to promote the observatories, their facilities and basic astronomical concepts will be produced. A new astronomy touring exhibition will be deployed in several Canary Islands airports.

Moreover, the working group will install displays for public events related to exceptional astronomical phenomena. Efforts will be focussed to support only those astronomical events visible from the Canary Islands

Finally, the working group will get in contact with other networks to coordinate public outreach activities, such as the case of UNAWE (a network of Astronomy outreach/education professionals and volunteers worldwide). Attendance to international astronomical events such as the Communicating Astronomy with the Public 2007 will be also planned.

A report on public outreach activities carried out will be delivered.

Table with breakdown of human effort for next 18 months (person/months)

Laboratory	WP1	WP2	WP3	Total Effort
24. IGAM	0	0	2.5	2.5
7. IAC	4	7	3	14
2. PPARC	5	0	0	5
Total effort	9	7	5.5	21.5

The deliverables and Milestones expected to be achieved during the next 18th months are listed in the following table:

List of Milestones and Deliverables scheduled (Jan 07 - Jun 08 / Months: 37 to 54)

Work package	Milestones/ Deliverables	Project Months	Description
WP1.1	D1	48	Updated progress report and revised roadmap
WP1.1	M1	42,47	M1: Regular ENO meetings
WP1.1	M2	47	M2: Working Groups meeting
WP1.2	D5	44	D5: Final report
WP2.1	D1	48	D1: Report: Systematic measurements of seeing & meteorology
WP2.3	D1	48	D1: Annual report on measurements of extinction and dust
WP2.3	D2	42,54	D2: Annual report on stations already existing
WP2.4	D1	48	D1: Reports on techniques to get wind profiles
WP2.5	D1	48	D1: Annual report on discussion forums for site-selection
WP3.1	D6	48	D6: Annual report with the maintenance activities carried out.
WP3.1	D7	48	D7: Report of the promotional activities related to JIS
WP3.2	D1	48	D1: New editions of outreach material
WP3.2	D3	48	D3: Annual report on ENO website and public outreach
WP3.2	D4	40	D4: Programme of activities for the next event
WP3.2	M2	39, 43,47,52	M2: Public Outreach meetingds
WP3.2	M1	43, 44	M1: Open-doors days at OT and ORM
WP3.2	D5	44	D5: Exhibition elements and educational material

1.3 NA3: Structuring European Astronomy

WP1: ELT
OPTICON is making a significant contribution to the Joint ESO/OPTICON Science Working Group activity which is central to the E-ELT project.

Dedicated effort on simulations is needed for development of DRM to understand trade-off decisions. We will investigate ways of providing this effort and implement it if it is possible.

Science case book: Continued development of the full science case is necessary (noting new scientific results and technical developments). This will be required when the telescope design and budget are better known and the project is in a position to seek construction funds. We are aiming towards a final science case document to be produced in 2008 (corresponding to WP1 D2).

Science meetings - Annual meetings will be held in November 2007, 2008 as originally planned (WP1 M1).

We will send scientists involved in the ELT SWG to conferences to promote ELT capabilities and raise interest among active researchers who have not yet been exposed to the ELT planning process.

WP2: Network for UV Astronomy
The scientific proceedings of the IAU GA "The Ultraviolet Universe: stars from birth to death" will be published on the NUVA web (as well as the NUVA Guidelines for future observatories).

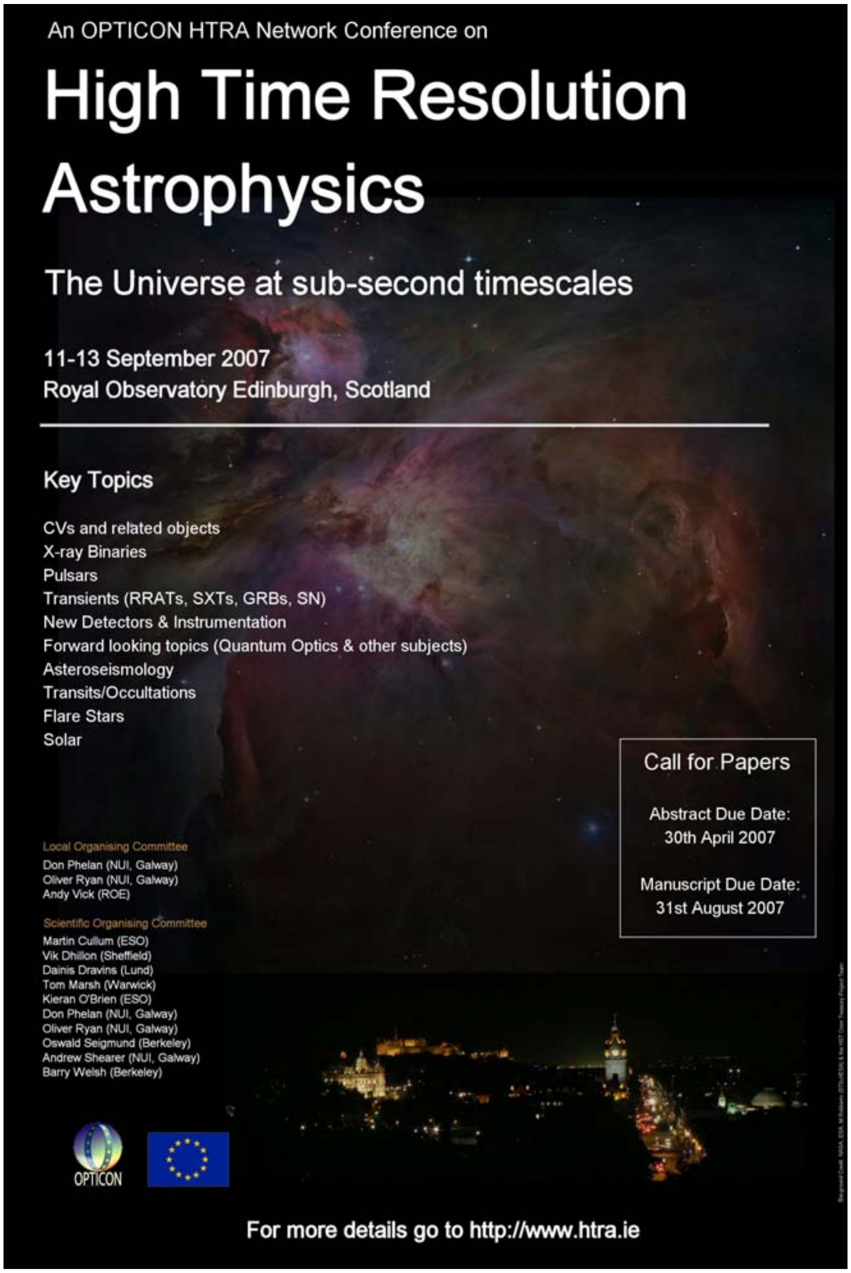
Numerical simulations will be used to re-evaluate the high energy radiation field in the young Solar System. This is a crucial issue for the UV science case.

Numerical simulations will be used to evaluate the expected spectrum from diffuse baryonic matter in galactic halos (and intergalactic medium).

WP3 M3 – A large conference on UV astronomy is being organized (URL:www.mat.ucm.es/UVConf) and will be held in El Escorial (Madrid) at the end of May 2007. The conference is entitled: "Space Astronomy: the UV window to Astrophysics".

WP3: High Time Resolution Astrophysics (HTRA)

In the next 18 months, NUI Galway will spend significant effort in finalising the HTRA book, the organisation aspects, planning and execution of the planned HTRA conference at the ROE (11 -13 September 2007) and the publication and preparation of the conference proceedings.



Conference details - Edinburgh 2007

WP4: Astrophysical Virtual Observatory
This activity is complete.

WP5: Key Technologies Working Group
The next 12 months is the crucial period in the planning for Framework 7 – and the Key Technologies Network has an important role in bringing together the various individuals and institutions; scientists, instrument builders, technologists from both institutions and companies. The goal is to arrive at topics, goals and deliverables for new Joint Research Activities that address the most critical challenges for astronomy by playing to combined European strengths.

The following topics will be the subject of meetings to further flesh out the roadmap by identifying the way ahead for technology development. There will in addition be an overall roadmap meeting.

- Detectors
- IR Fibre Optics
- Instrument Level Adaptive Optics
- Multi-Object Spectroscopy Technologies
- Industry Meeting
- Photonics Spectrometers

WP6: Future Software

The high-level requirements have been defined and general agreement on the architectural concept was achieved. The next major item to be defined is the interface specification for the environment. It was decided to base these specifications on a set of small prototype implementations which follow the architecture outlined. Most of the prototype work will be done in 2007 which will allow us to define a draft of the interfaces by December 2007 (Milestone M3b). A formal review will be conducted before the final report.

It was felt important that the Network not only details requirements and top-level design but also provides a skeleton plan for an implementation of the environment. This has been added as a new Milestone (M4) for June 2007. Since this was not included in the original plan, the Network WP6 will extend its work by 6 months till July 2008 when the final report will be delivered (Milestone M6).

After the first experience with prototypes, we may revise the architecture slightly. Thus, we plan to conduct a final review of the architectural concept document by October 2007 (Milestone M5).

Three face-to-face meeting are planned for the next 18 months. The first (March 2007) will start the discussions on the interface specifications and a skeleton implementation plan. At the next meeting (September 2007), we aim to make the draft interface specification and finalize the architectural concept document. The final face-to-face meeting is expected to be in the late spring of 2008 where the final report will be considered.

List of Milestones and Deliverables scheduled:

Workpackage	Milestones/ Deliverables	Project Month	Description
WP1	M1	35	Science Meeting
WP1	D2	60	Science Case Book
WP2	M3	41	Conference on UV Astronomy (URL:www.mat.ucm.es/UVConf)
WP3	D1	48	Publication of High Time Resolution Astrophysics Book as part of the Astrophysics & Space Science Library
WP3	D2	45	International conference at the Royal Observatory Edinburgh, Scotland
WP3	D3	52	Publication of conference proceedings
WP6	M3b	48	Draft interface specifications
WP6	M4	42	Implementation project plan

WP6	M5	45	Architectural concept document
WP6	M6	54	Final report

1.4 NA4: Synergy in space-ground coordination

This activity is complete.

1.5 NA5: Interferometry

N5 Interferometric Forum

WP 1: Fizeau exchange visitors program

Two calls per year are planned for the Exchange program.
In the following 18 months there are three scheduled deadlines for the FEVP: 15 March 2007 (2007A), 15 September 2007 (2007B), and 15 March 2008 (2008A).

WP 2: Working groups

At least two meetings of the Scientific Council are planned to make critical decisions in the program of the network and the associated joint research activity. The Scientific Council will also discuss options for a potential FP7 proposal on interferometry.

The "Radiative Transfer / Atmospheric Modelling" and the "Interferometry and Asteroseismology" working groups are planning to meet at least once in 2007, and once in 2008 to discuss progress and enhance the networking activities.

WP 3: Next-generation interferometric infrastructure

We are currently in the process of preparing an FP7 proposal for a Design Study for a next-generation interferometric facility.

Workpackage	Milestones/ Deliverables	Project Month	Description
1	M1	39	Deadline FEVP 2007A
1	D1	40	List of accepted candidates 2007A
1	M2	45	Deadline FEVP 2007B
1	D2	46	List of accepted candidates 2007B
1	M3	51	Deadline FEVP 2008A
1	D3	52	List of accepted candidates 2008A

1.6 NA6: OPTICON Telescopes network

WP1: Telescope Director's Forum

The telescope directors will have a further meeting in the autumn of 2007. If possible this will be held to coincide with the accession of the Greek Aristarchos telescope into the trans-National Access programme

A sub-committee of the director's forum will convene at an appropriate time in 2007 to review the operation of the Aristarchos telescopes (whose long delayed commissioning is now expected this year, with a view to incorporating them into the trans-national access programme.

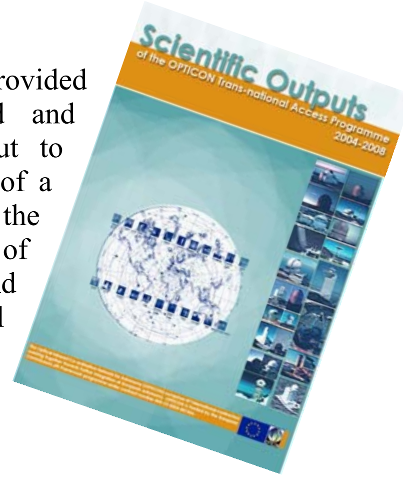
WP2: Operation of the Trans-national Access Office

This office will perform the tasks defined by the Telescope Directors' Forum in support of the Access Programme (Activity NA6: OPTICON Telescope network, defined in the Annex 1 of the contract). In particular, assessment of the qualifying telescope time awarded and the consequent User Fees due to the telescopes, in accordance with the cash flow approved by the Telescope Directors' Forum.

In addition to the activities related to the daily operation of the Trans-national Access Programme, our Plan for the next 18 months also includes the following special activities:

- PROMOTION OF THE ACCESS PROGRAMME: Special efforts will be made to enhance the participation of new users, young researchers, users from Central and Eastern Europe, and users from countries with no similar research infrastructures. New promotional material will be produced and widely distributed among the international scientific community, according to the following list:

- SCIENTIFIC OUTPUT: Output from the access provided under this contract will be closely compiled and monitored. Special measures will be carried out to achieve this objective, including the maintenance of a thematic section on the Access Office Webpage of the scientific output compiled, as well as the request of publications in refereed journals, press released and participation in conferences: (Poster & oral contributions).



Participants

The Trans-national Access Office will continue being operated from the Instituto de Astrofisica de Canarias, IAC. The following table shows, in person months, the total effort needed to carry out the running of this Office for the next 18 months.

Laboratory	WP2	Total Effort (person/month)
IAC	27	27

WP3: Enhancement

Three more Neon schools are scheduled up to the end of FP6 in 2008, and preparation is going on in parallel for two specific OPTICON workshops, specifically aiming at training active astronomers on new types of instrumentation: Integral Field Spectroscopy, and Adaptive Optics. A mid-term meeting of the Enhancement Working Group is planned in Romania for the spring of 2007, to collect lessons from the first years of activity, see how to implement the wishes of the south-eastern community, and prepare the development of further activities well into the FP7.

Expected outcomes and deliverables

Work - package	**Milestones/ Deliverables**	**Project Month**	**Description**
1	M2	46	Annual Directors Meeting
1	M3B	46	Peer review of Aristarchos Telescopes
2	M2	46	4rd Report to Directors forum
2	D3	46	1st Report on Scientific Output.
3	M1	41	Working Group Meeting

1.7 JRA1: Adaptive Optics

WP 1: Coordination of JRA1

JRA1 General meeting 5 will be organised in October 2007. Depending on the status of the activities in October 2007, it will be decided to have a final General meeting or not in the 2nd Quarter 2008. In addition, ESO will provide the necessary information for the planned mid term review.

The JRA1 web page will be updated with the documentation produced by the JRA1 partners. Regular teleconferences between the principal work package managers will be held to ensure progress and coordination between the packages. The interim 12 months report will be prepared and will include detailed work plans for the ensuing period.

WP 2: System design

WP2.1: XAO system Study

In the next 18 months, the SPHERE consortium will complete the Preliminary design (2nd Quarter 2007). ESO will organize a Preliminary Design Review. This will complete the work planned in this WP. In parallel, ESO will pursue the development of the AO key components (Piezo deformable mirror, drive electronics, fast CCD, detector controller, Real Time Computer).

WP2.2: GLAO System Study

In the next 18 months, ESO will complete the preliminary designs of GRAAL (1st Quarter), GALACSI (3rd Quarter), and 4LGSF (4th Quarter). NOVA will complete the preliminary design of ASSIST in collaboration with ESO (3rd Quarter 2007). Microgate-ADS will complete the Preliminary design of the VLT Deformable Secondary Mirror 2nd Quarter 2007.

These designs will be reviewed during dedicated design reviews. These will complete the activity planned in this WP.

WP2.3: Multi-Object WFS for GTC

In the next 18 months, Grantecan will perform the following tasks:

- Component selection for the mono-object curvature wavefront (MO-CWFS) sensor prototype by mid March 2007.
- Source system design of the calibration system for the MO-CWFS.
- Following acquisition of components, a short period for assembly. Two experiments will be done 3 Quarter 2007 and 4th quarter 2007.
    - 1st Experiment: Using the calibration system for the MO-CWFS. The MO-CWFS calibration system will make use of a known aberration plate and will determine the level of accuracy of the reconstruction.
    - 2nd Experiment: Using MO-CWFS with real-life atmospheric conditions. The MO-CWFS will be fed by GTCsim (the calibration system of the GTCAO module).
- Analysis of data collected from the two experiments. We do not expect major difficulties in adapting the software developed for the simulation work (beginning of WP 2.3) to analyse the data collected during the two runs.

WP2.4: Multiple FOV System with NGS

Within the next 18 months we will continue the assembly and testing of the HWS. In month 45 the sensor will be shipped to MPIA, where the integration on the bench will follow and first closed loop tests can be conducted. The GWS is supposed to arrive in Padua in month 47, delivery of the K-mirror by month 44 and the Patrol Camera by month 44 to MPIA.

The on-sky testing of the prototype strongly depends on the availability of the LBT and its adaptive secondary. The delivery of the adaptive secondary is delayed to the spring of 2008 and will not be available before end of 2008 to do any on-sky testing of the MFoV-WFS. The late delivery of the LBT Adaptive Secondary at project level shifts the on-sky testing out of the current timeline of the JRA1. Milestone M2 and the final delivery have therefore to be changed. Another problem is the continuous delay on the translation stages for the GWS by the manufacturers and the same for the CCD. Therefore we propose to change the Milestone M2 to following: Delivery of GWS optomechanics without translation stages and base plate. The date would be beginning of third Quarter 2007 (month 46). In month 48 at the end of this year the final delivery would than be the test report on component and sub-unit tests.

WP 3: ENABLING TECHNOLOGY FOR 2nd GENERATION/ELT AO SYSTEM

WP3.1: 2nd Generation RTC Platform

In the next 18-months, ESO and Durham will bring the project to completion as follows:

- Complete design of RT-box, complete unit benchmarks of RT-box, advance design of Supervisor, unit benchmark of network and supervisor, review design.
- Complete end-to-end prototype, benchmarking and performance verification, complete design of Supervisor.

WP3.2: *Optimal Control Methods for MCAO Systems*

In 2007 ONERA and ESO will implement the optimal control method developed in 2006 on the ESO MCAO demonstrator MAD when it is back from Paranal Observatory. In case MAD needs to remain at Paranal for testing beyond the end of 2007, ONERA will perform VLT-like MCAO and Tomographic AO simulations with the optimal control approach to demonstrate its potential. ONERA will also analyse the computational cost of such techniques and give ideas on how to limit this cost. This is an important issue for VLT and even more for ELT instruments. These results will be presented in the final JRA1 report planned for beginning of 2008.

WP3.3: 2nd Generation Piezo DM

In the next 18-months CILAS will complete the manufacturing assembly and testing of the 1370 actuator piezo deformable mirror. Provisional acceptance of the DM is foreseen for July 2007 about 28 months after Kick-Off. This will complete the activities planned in this WP.

WP3.4: 2nd Generation Piezo DM drive Electronic

In the coming year, **Shaktiware** will manufacture assemble and test the CODE (piezo drive electronics) and **ESO** will organize the provisional acceptance 4th quarter 2007. This will complete the activities planned in this WP.

WP3.5: VLT Adaptive Secondary

Microgate-ADS will finalize the preliminary design of the VLT Deformable Secondary Mirror. Preliminary Design Review will be organized by ESO 2nd Quarter 2007 and Optical Final design soon after. This will complete the activities planned in this WP.

WP3.6 Manufacturing and Demonstration of a large convex glass shell

In the next 18 months, SESO and LAM will continue the manufacturing and testing of the 1.1 m Zerodur thin shell. Delivery time is planned for end 2007 (end delivery of this WP). ESO will deliver the test matrix mounted in a newly designed mechanical mount matching the polishing machine mechanical interfaces.

WP3.7 2k Actuator & low order Micro-Deformable Mirrors (MDM) R&D

Both contract with LETI and ALPAO are feasibility studies, and the baseline plan is to launch 2 new contracts in 2007 for the manufacturing of the actual prototypes (one magnetic and one MEMS). But this strategy may be revised in March 2007 for the following reasons:

- Some of the technical results obtained by ALPAO show that the magnetic technology may not be able to meet all our requirements. ALPAO showed that a trade-off must be made between actuator pitch, stroke and bandwidth. Based on these data, discussion are ongoing between JRA1 members to check if this trade-off is acceptable for all applications.
- The new planning presented by LETI for a possible delivery of a final prototype is now ending in April 2008, which is barely compatible with JRA1/FP6 planning. Moreover, the work done up to now show that due to process complexity, the level of technological risk is still very high, and more resources may be needed to obtain a fully working device. Discussions are ongoing to check if we have the resources to maintain this MEMS activity.
- We asked the CILAS Company to see how they could improve their piezo technology to provide better deformable mirrors, and to issue a proposal for a possible contract in 2007. They came back with a very interesting proposal, including a true technological break-through related to piezo actuators in transverse mode. Coupled with the new drive electronics made by Shaktiware, this new piezo technology is potentially the best one for extremely large telescope and extreme-AO, and may even be more interesting that MEMS-based devices.

This WP may be short of funding to complete the work originally planned.

WP3.8 High Order wavefront sensor experimental study

In the next 18 months, the HOT bench alignment will be finalized; in particular residual wavefront errors measured recently in the common path of HOT will be reduced. The first closed loop with the Shack-Hartmann WFS should be obtained 2nd Quarter 2007. The tuning of both wavefront sensors will be performed 2 and 3rd quarter 2007. Testing of HOT should then be possible 3 and 4th quarter 2007.

In parallel the coronagraph set-up should be aligned and extensively tested from June 07. It should be integrated to the HOT bench fall 07 in order to test the complete HOT bench including coronagraph end 07-beginning 08. This will end the activity planned in this WP.

Milestones and Deliverables

Workpackage	Milestones/ Deliverables	Project Month	Description
1	**M1**	45	JRA1 general Meeting 5
1	**M2**	54	JRA1 General Meeting 6 (Final)
2.1	**D1**	42	Design of SPHERE
2.2	**D1**	48	Design of the VLT multi-LGS GLAO facility
2.3	**M1**	51	Delivery of the curvature wavefront sensor for GTC
2.4	**M2**	46	Delivery of the multi object wavefront sensor opto-mechanics without translation stages and base plate.
2.4	**D1**	48	Test report on component and sub-unit tests of the multi object wavefront sensor
3.1	**M2**	48	Complete development of the Real Time Computer Platform and performance testing
3.2	**M2**	42	Implementation of the optimal control methods on the ESO MCAO demonstrator (MAD) and testing
3.3	**M1**	48	Testing of the 1370 actuator piezo-stack deformable mirror prototype
3.4	**M1**	48	Complete development of the deformable mirror drive electronics and testing
3.5	**M2**	42	Complete preliminary design of the VLT Adaptive secondary design review
3.6	**M2**	48	Manufacturing of a convex glass shell prototype for an adaptive secondary
3.7	**New M2**	42	Design of the 100 actuators electromagnetic deformable mirror
3.7	**New M4**	42	Design of the 100 actuators electrostatic deformable mirror
3.7	**New**	45	Design of a 700 piezo actuators mini deformable mirror
3.7	**New**	51	Delivery of a 100 actuators electromagnetic deformable mirror
3.7	**New M6**	54	Delivery of either 100 actuators electrostatic deformable mirror or of 700 piezo actuators deformable mirror (depending on success of the design reviews)
3.8	**M2**	48	High order Test bench test report

1.8 JRA2: Fast Optical Detectors for AO

As already mentioned in the previous annual report, a delay of at least 6 months is expected for the total duration of the JRA2 due to late signature of the contract.

In the next 18 months period, the following activities are planned:

- WP1: management

Two general meetings are planned during this period. The JRA2 will also be represented at the next OPTICON board meeting.

- WP2: detector procurement

The work plan for the next 18 months will involve monitoring the progress of the engineering and science grade detector delivering.

- WP3: controller

The controller will be delivered before summer 2007, this will complete the activity of this work-package.

- WP4: cryogenic system

Activity of this work-package will be finished in 2007: a first cryogenic system will be delivered in Feb. 2007, the second one in May 2007. This will complete the activity of WP4.

- WP5: detector test

Activity for this work-package started in 2006. Laboratory test benches are ready at the IAC and detector testing will start around summer 2007 when the detectors of WP2, the WP3 camera and the WP4 cryogenic system will be delivered to the IAC.

This detector with the OCam camera will be tested on the telescopes of the Canarian islands during 2008:

- One test is foreseen on the next IAC AO system.
- One other test is foreseen on the first Grantecan AO system, the biggest telescope in the world, which will have its first light in 2007.

Contrary to what was mentioned in previous JRA2 reports for WP5, we decided to come back to the original JRA2 plan written in the Annex I which mentioned real tests on a telescope. The opportunity to test the CCD220 and the OCam camera (WP3 and WP4) on the biggest telescope of the world is a unique opportunity that we cannot miss. Therefore, it is planned to ask for additional funding to cover travels and missions between France and the Canarian Islands to ensure the scientific success of these tests. Going as far as possible in the tests on sky to demonstrate the performances of the JRA2 products is extremely important for our astronomical community.

Milestones and Deliverables for the JRA2 for the next 18th months:

Work package	Milestones/ Deliverables	Project Month	Description
2	M5	38	Frontside device test.
2 2	M6 D2	40 48	Backside device test Final detector acceptance report
3	M3	33	Delivery of detector controller.
3	M4	39	Complete controller test
3	D1	39	Controller acceptance report.
4	M2	38	Cryogenic system acceptance
5	M1	54	Complete detector tests in laboratory.

1.9 JRA3: Fast detectors for astronomy

WP1 (management)
Milestones and deliverables: The developments in the individual workpackages has made clear that integration of the different devices onto a common test platform is not necessary to achieve the final deliverable WP1 D2 (assessment report on the relative merits of the technologies developed under JRA3). In view of this, WP1 M3 (due 30mo) and WP1 D1 will be moved to 48mo, and merged with the final deliverable WP1 D2.

WP3: PN-sensor development expects the fabrication of the first integrated AApnCCD devices (up to 128x128 pix) to occur from March to October 2007. The tests and characterization of these devices will be achieved in the first quarter of 2008 and lead to the completion of the third phase of WP3 ('Electrical Test'). The final phase ('Array Test') will start in the 3rd quarter of 2007 with the design and layout of the full scale AApnCCDs (256x256 pix). Fabrication is planned to start in the 2nd quarter of 2008.

Milestones and deliverables
As reported in annual report 2005, an early decision in WP3 has been to skip the technology originally envisaged, and instead concentrate all efforts on a next level technology (PN-sensors with avalanche amplification). While these efforts are already proceeding beyond expectation, this decision also implies a delay of the critical deliverables WP3 D2 (planned 24 mo) and WP3 D3 (planned 36 mo). Both are now expected to be realized at 60mo.

WP4: APD array development. In the next 18 months, NUI Galway will spend significant effort in successfully building and testing a new 2 dimensional Geiger mode avalanche photodiode array for high time resolution astrophysics. With the development and operation of a 2 dimensional photon counting array, the initial phase of the process will concentrate on device packaging of the die on a ceramic substrate along with the automated wire bonding of the device. Following the successful completion of this, the ancillary quenching circuits will be employed, and together with FPGA control and time stamping electronics, a working laboratory prototype will be constructed. The testing and verification of the device will take place and a final test report and publication of results will be available in the final phase of the next 18 months. Milestones and deliverables still due for WP4 are: WP4 M2-Development of a 2 dimensional Geiger mode APD array (planned 12mo, now expected 48mo) WP4 D1- Test Report on the APD array (planned 12mo, now expected 48mo) Budget plan for next 18 months: Based on the spending profile for the next 18 months, a total projected spend during the next 18 months of 83,747 Euro is estimated.

WP5: Controller Development

Milestones and deliverables
The controller development has been divided internally within WP5 into two generations of hardware and software. The milestones and deliverables for the first generation have all been met in 2006, including verification under realistic application conditions (see report JRA3 elsewhere in this volume). Current efforts concentrate on the same milestones for the second generation. Completion is expected by contract month 54 (mid-2008). With this, the specifications defined internally in WP5 as technical content of the contract milestones and deliverables will have been met.

WP2: EMCCD developments; WP6: Common Software Development; WP7: Cooled Camera Head Development

USFD, Warwick and UKATC have collaborated closely and highly successfully for workpackages WP2, WP7 and WP6, with result that most of the milestones and deliverables of these workpackages have been achieved in the reporting period. Remaining activity is expected to be completed with the achievement of all milestones and deliverables by contract month 45 (October 2007).

WP8: Common testbed

Due to the developments for the 3 different technologies under JRA3 the main deliverable of WP8, the integration onto a common testbed, has become obsolete. In part, this is due to the redefinition of WP3 to a next level technology (see above), with the consequence that integration of the device onto a common testbed is not a realistic goal any more for this workpackage. In addition, it has turned out that the second technology, APDs (WP4) is sufficiently distinct in its possible applications that integration with other technologies onto a common testbed is not an urgent goal any more.

With these developments, remaining deliverables have been transfered to WP1, with the work to be done to be transfered in part to WP1 as well. Details are to be decided in early 2007.

1.10 JRA4: Integrating optical interferometry into mainstream astronomy.

The activities described in detail in the progress report are now approaching completion.

In the Table below, the milestones and deliverables for the rest of the project are redefined according to the current progresses:

List of Milestones and Deliverables scheduled:

Workpackage	**Milestones/ Deliverables**	**Project Month**	**Description**
WP1.1	D5	48	Selection by ESO of second generation of VLTI instruments
WP1.2	D4	48	3rd Progress Report on CHT
WP2.2	D2	42	Software Package and User Manual
WP2.3	D2	48	Software Package and User Manual
WP2.4	D2	42	User Requirements
WP2.5	D2	48	Software Package and User Manual

1.11 JRA5: Smart Focal Planes

WP 3.2 Cryomechanisms –Tip-Tilt Focal Plane ASTRON

Good performance from both imagers and spectrometer instruments requires that the detectors are placed accurately in the focal plane. This requires both tip, tilt and z control. In a room temperature instrument this is routinely accomplished through the use of spacers. For cryogenic instruments, particularly large cryogenic instruments of the type that will be used in an ELT, the repeated warm up and cool down of the instrument required by placing spacers is a major drawback. This work package will take advantage of the cryogenic piezo characterisation, to design, build and test a focal plane mount. Input on the requirements of this will be drawn from both the Smart MOS and Smart MOMSI instrument requirements.

WP 5.0 Management and Systems Engineering – PPARC / IAC

Continuation of evaluation of risks and challenges in the provision of enabling technologies, including identifying routes for further development, culminating in a report which details the way forward to multi-object and multiple field spectroscopy with Extremely Large Telescopes and current facilities.

The Smart-MOS and Smart-MOMSI instrument concepts will be updated in light of the advancement of the ELT instrument concept to tailor technology developments in the coming year, and the roadmap for technology developments in the following years. Systems engineering will be an important discipline in bringing together the Star-Picker and the Active Mirrors in an integrated demonstrator.

WP 6.2 Pick-off Prototype – Gripper Cold Tests – CSEM/PPARC

The Gripper will undergo preparation work for cold tests in the first two months of 2007, with cold tests scheduled for the cryostat at the UKATC for March 2007.

WP 6.2 Pick-off Prototype – Star-Picker Cold Tests -PPARC

The StarPicker rotation stages will be prepared for cold operation with tests to be undertaken in May and June. These tests will use a metrology system working on the same principle of target centroiding that was successfully used in the earlier rotation stage and star-picker characterisation. If gripper and rotation stage tests are successful the complete star-picker system will also be tested. Warm operation bearings will be purchased to enable the integration tests to conducted without damage to the cold bearings used in these tests.

WP 6.3 Beam manipulator prototype - active optics – LAM

An active Beam Steering Mirror according to the specifications required on an ELT instrument has been designed. The prototype is now realized. This prototype will be polished. In parallel the support will be manufactured and the study of the tip/tilt platform will be finalized. This will be followed by the development of a working test-bench consisting of an end to end demonstrator of the target selection system with a closed loop operation.

The target selection simulation will be done by using optical source in place of the pick-off mirror to operate the BSM in a realistic environment. An important effort will be given to reduce the mirror pre-stressing, in order to keep the maximal useable stroke. Deformations depend on the BSM behaviour which is thermal sensitive and is linked to the piezoelectric effect, that's why several position and thermal sensors will be used in order to create a control/command model of the overall system.

WP 6.3 Beam manipulator prototype- cryo-mirror - TNO
The objective of this work package is the development and test of cryogenic beam steering mirror suitable for inclusion in the path length compensator in the integrated Star-Picker / Active mirror tests.

WP 6.4 MOEMS mirror array prototype - LAM
Arrays will be designed and fabricated using principles demonstrated, but extended to 100 * 100 elements (~20*20 mm). In order for this to be driven successfully, a new method must be adopted which will involve having a single bias line in one direction with a delta signal in the orthogonal direction. Also to be undertaken during this phase of work is the first evaluation of operation at cryogenic temperatures. This will in the first instance involve functional testing at 77K.

WP 6.4 MOEMS mirror array prototype – CSEM
CSEM will be responsible for the systemisation of the MOEMs arrays, including an analysis of the opto/thermal/electrical/mechanical properties required in a working environment.

WP6.5 Integration of Star-Picker and Cryo-Mirrors in Smart Focal Plane Demonstrator
The UK ATC will design an integrated system in conjunction with LAM which will prove the principle of operation of the Star-Picker combined with Active Optics to select objects from the sky and place them at the input to spectroscopic/imaging systems in which the optical quality is maintained to a sufficient level. This will involve two distinct star simulators, the light from which will be picked off by spherical mirrors and fed to the Active Mirror. This will provide coma and astigmatism compensation as well as variable focal length. A tip-tilt mirror will be used to feed this light to a wavefront sensor, which will confirm the positioning accuracy of the system, the path length compensation and the degradation of the point spread function.

JRA5 Milestones and Deliverables for the third 18 month period

Work package	Deliverables Milestones	Project Month	Description
3.2	D2	48	Report on tip-tilt cryogenic focal plane
5.0	D6	42	6 month report
	D7	48	JRA5 Final Report
6.2	M2	42	Cryogenic tests of Gripper
	M3	42	Cryogenic tests of Rotation Stages
	M4	42	Cryogenic tests of StarPicker System
6.3	D2 a	39	Report on warm tests from Active Mirror
	D2 b	42	Report on cryogenic tests from Active Mirror
	D3	42	Report on Planar BS Mirror
6.4	D1	42	Report on cryogenic tests from MOEMs
	M2	42	2nd Generation MOEMs devices.
6.5	M1	42	Develop system for characterisation of integrated SFP system
	D1	48	Report on performance of integrated SFP system

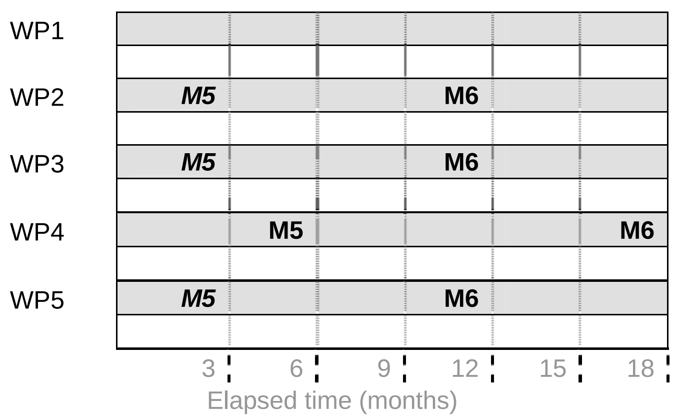
1.12 JRA6: Volume Phase Holographic Gratings

During the activity carried out in the last reporting period no need emerged for major changes in the work packages activity nor in the distribution of milestones and deliverables. Some of the milestones expected to be completed in the reporting period were not. This was mainly due to delays in acquisition of laboratory equipments needed for the test.

The presence of "left-over" activities is expected to have no impact on the final deliverables and the plan for the activity in the next 18 months will catch up the plan presented in Annex I of the contract. An extract of the milestones and deliverable list form Contract Annex I and the timeline for their achievement are reported in the following 2 tables:

The most important milestones of the next period consist in the definition and fabrication of the final science grade devices.

Workpackage	**Milestones/ Deliverables**	**Project Month**	**Description**
2	*M5*	*39*	Science Grade device specification document
3	*M5*	*39*	Definition of construction plan and materials trade off analysis
4	M5	42	Production and analysis of the material for the science grade device.
5	*M5*	*39*	Science Grade device specification document
2	M6	48	Science Grade Manufacturing Dossier
3	M6	48	Assemby and functional tests dossier
4	M6	54	Study of the behaviour of the selected material
5	M6	48	Science Grade Manufacturing Dossier



WP1 will continue the activity of coordination, interaction with the OPTICON Board and collection and dissemination of the results. At least 2 plenary meetings are foreseen in the next 18 months aimed to compare results and decide future steps into the activity. The link with NA3.5, the KTN, is also expected to be strengthened in this period in order to better focus the JRA activity with the overall aims of the OPTICON Program.

Among the activity of WP1 there will be as well the discussion, preparation and possibly writing of a proposal for the continuation of the activity intro the FP7.

Two major milestones are defined in the research activity of WP2 and WP 5. One is a leftover from the previous period and concerns the science grade specification definition (M5) and the other concerns the fabrication of the science grade devices (M6). These milestones and the corresponding deliverables are expected to be achieved on the original timescale.

Also for WP3 we have as a leftover from the previous reporting period, the definition and construction plan and materials trade-off analysis (M5). Once completed WP3 will move to the realisation of the final assembly and its characterization (M6). These milestones and the corresponding deliverables are also expected to be achieved in the original timescale.

WP 4 has 2 main milestones to achieve in the next 18 months: the production and analysis of the material for the science grade device (M5) and the study of the behaviour of the selected material (M6). These milestones and the corresponding deliverables are expected to be achieved on the original timescale.