Project full title: Optical Infrared Co-ordination Network for Astronomy

Project acronym: Opticon

Type of funding scheme: Combination of Collaborative Project and Co-ordination and Support Action for Integrating Activities

Work programme topics addressed:
FP7-INFRASTRUCTURES-2012-1 Research Infrastructures for Optical/IR astronomy

Name of the co-ordinating person: Professor Gerard F Gilmore

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1. Scientific and technical quality, relevant to the topics addressed by the call

1.1 Concept and objectives

It is a truism that optical-infrared astronomy is in a "golden age". Public interest, manifested through such criteria as downloads of HST images and media interest, is higher than for almost any other subject. This follows naturally from scientific progress – there are new stories, new results, new Prizes to celebrate – and the intrinsic interest of the questions addressed by astronomy, which range from the origin of the Universe, through the nature of matter and existence, to exo-planets and life elsewhere. This story of scientific success has however not happened by chance – considerable planning and organisation, and continuing technical research and development, is required to develop the highly-skilled scientists and engineers trained to operate and exploit the state of the art facilities which deliver the scientific advances.

A decade ago planning assumptions for next-generation astronomical infrastructures took for granted that older facilities would become obsolete, would be closed, and their operational budgets would contribute to newer facilities. However, the number of new large expensive facilities is small – the number of extant facilities is large. This course would turn astronomy into a system which delivered research capabilities only to a small elite – inevitably the wealthier elite. In fact, this is the way astronomy was implemented earlier in the 20th century, when global domination was in the hands of a very few wealthy private institutions, all in the US. We do not wish to go down this road again. The obsolescence paradigm was based on two fundamental errors: first, that older facilities could not be upgraded affordably to retain cutting-edge competitiveness, and second, that all progress came from the new, large facilities. Optical-infrared telescopes are limited by their instruments and their users, not by themselves. The performance of astronomical detectors has been improved by orders of magnitude over the last two decades and can be further much improved, thus maintaining "small" facilities as cutting-edge capabilities. Spectrographs now perform very much better than they ever did, but are still orders of magnitude away from working at fundamental performance limits. We can, and are, continuing to improve.

Furthermore, astronomy, unlike most physical sciences, is still in discovery mode. Most of the topical exciting subjects which dominate public interest – dark energy, dark matter, exoplanets, super-massive black holes and so on – have been discovered in the last two decades and were unpredicted. Astronomy progresses by having very many inquisitive people exploring parameter space on many facilities, not by focussing on a single experiment.

The change from an assumption of obsolescence to an assumption of future opportunity came to be made by the development of a European-scale astronomical community. This community was able to make the case that facilities should be enhanced and shared, not closed, that technology developments were both achievable and affordable, that astronomers could deliver cutting edge science with those enhanced facilities and crucially that the talent, expertise and financial resources to deliver all this would be available if efforts were coordinated on trans-national scales. European astronomy, largely through the excellence of the European Southern Observatory, but also through the coordination, planning, development and technical R&D work supported by the EC via ASTRONET (Strategy) and Opticon (implementation) has made that case. In consequence, Europe has become the international leader in optical-infrared astronomy.

European optical-infrared astronomy is undergoing a dramatic transformation on two fronts, as foreseen in the ASTRONET *Infrastructure Roadmap*. First, the decision has been taken to turn the heterogeneous collection of national 2-4m telescopes into a rational, coherent European facility, with a stable long-term future delivering scientific excellence. Technical and organisational preparations for reaching this goal are underway. Second, the impending decision to construct the European

Extremely Large Telescope (E-ELT) will consolidate European global leadership in optical-infrared astronomy. Opticon has been a driving force in this development by:

(i) maturing the astronomical community to large-scale European cooperation;
(ii) preparing the factual and organisational basis for these breakthroughs;
(iii) coordinating the development of the enabling technologies that will underpin this transformation.

These strategic breakthroughs fundamentally change the role and environment for Opticon in 2013-2016. Specialising the 2-4m telescopes and their instrumentation will optimise the role of each of them in reaching their assigned goals in the ASTRONET *Science Vision*. Chief among these goals is the realisation of wide-field spectroscopic surveys to complement existing and impending imaging surveys from the ground and in space, as developed and formulated by the joint ASTRONET-Opticon Working Group working under the previous FP7 contract. Large European consortia are being assembled to construct the necessary advanced instruments for 4m-class telescopes in both hemispheres, with smaller-scale projects to equip other telescopes to fill their new roles within the overall system on a time scale of 4-5 years. In parallel, other consortia will embark on the construction of the first generation of the even larger instruments needed for the E-ELT - the decade-long, top-priority project in the ASTRONET Roadmap. The E-ELT is undertaken, funded and managed by ESO but the instruments, which will deliver the science, are the responsibility of the community. Cutting-edge technology must continue to be developed over the next decade to ensure the next generation instruments are as good as they can be. Maintaining the crucial role of Opticon as a driver of this process of change and essential provider of intellectual and financial seed capital is crucial at this critical juncture.

Each of the above instrumentation projects is comparable to or larger than the budget of an entire I3 grant and they will be funded by consortia of national funding agencies. In addition, conducting the planned surveys implies the commitment to operational costs for many hundreds of nights on dedicated telescopes, displacing the other types of science currently conducted there. The logical solution, spelled out in 2010 by the *European Telescope Strategy Review Committee*, managed by Opticon on behalf of ASTRONET, is to provide access for the whole European astronomical community to the common telescope system through a single time allocation process. This cannot happen overnight, given the time scales needed to build new instrumentation and overcome the considerable organisational, financial and cultural barriers separating the new system from the existing one; good will and hard work are required.

This leads to the strategy for Opticon in the period 2013-2016, focused on the following three main challenging but viable top-level objectives, which are the verifiable project objectives:

- Provide continued Trans-National Access to the existing 2-4m telescopes during the transition to their new scientific responsibilities and corresponding new complement of instruments. Notably, the prototype common observing proposal and time allocation procedure system must be developed and field tested to handle 100% of the time on all the telescopes. This involves management of User Fees, operating an International Time Allocation Committee, maintaining a Telescope Director's Forum and further developing and maintaining the NorthStar web-based application system prototyped by Opticon during the previous contract.

- Coordinate the common development of essential enabling technologies for the next generation of instruments on the existing system of European 2-4m and 8-10m telescopes and for the even more advanced second generation instruments that will populate the E-ELT later in the next decade. This involves the JRAs which develop detectors, which are basic to everything; adaptive optics, which is on the critical path for almost every instrument on large telescopes and for every application from cosmology to exoplanets; new potentially paradigm-changing applications of photonic systems and "smart optics" and innovative dispersive systems, applying capabilities developed in industry to astronomy and in turn delivering industrial spin-offs back to industry and society. Our six Work Packages deliver this effort.

- Nurture and optimise a set of networks to promote European synergy in astronomy education; coordinate a distributed telescope network to respond to transient-source event alerts, notably from the ESA mission Gaia, and facilitate other forms of time-domain astronomy, including asteroseismology; provide long-term foresight and prototyping on emerging technologies; and facilitate the integration of optical interferometry and the data expected from the E-ELT in the fabric of mainstream European astronomy in 2015-2020.

1.2 Progress beyond the state-of-the-art

The state of the art in the fields in which Opticon is investing has been, to a real extent, defined by previous work by the partners involved in Opticon. These partners are the European leaders in their respective fields and define the state-of-the-art. Thus although the workpackage structure looks similar to that of previous contracts, the *content* of those workpackages has been radically redesigned. Each detailed WP description introduces its relevant background/baseline, which we do not duplicate. We provide a brief overview here, for context. This provides the baseline against which progress is to be judged. That progress is quantified in the deliverables and milestones (separate lists) which the activity will produce, and against which its success will be judged.

1.2.1 Networking

Networking activities link people and communities and motivate future developments. To appreciate this context, it is perhaps helpful to imagine an (oversimplified!) story of how people are trained and motivated and how this maps onto the Opticon programme. It begins with training and motivation (via schools, exchange visits, outreach), and progresses via experience, often on existing medium sized facilities (TNA activity) whose operations are being rationalised to ensure viability and efficiency (Telescope Directors Forum, ASTRONET implementation activities, common time application system) and whose individual capabilities are being enhanced by new software and hardware (JRAs + exchange visits). These users may require experience of specialist skills (High Time Resolution astronomy, Time Domain astronomy, Interferometry). All this leads toward the E-ELT, for which the science case is being developed, evangelised and co-ordinated with other projects (ELT network and workshops) and for which the community is developing new hardware (JRAs, including photonics, VPH, AO). Some of this is being prototyped (JRAs), while a watching brief is maintained on far future technology (Innovation Network), some of which is already being considered now and for future JRA effort, in the light of science-industry developments in the next decade or more. As a specific example of the success of Opticon networks, we note that the ground-based Solar astrophysics community, previously included inside Opticon, are proposing their own I3, having “matured” into a viable independent community under Opticon support, and having benefited from seeing how a community develops and plans inside an EC-supported context. As a second specific example of success and the state of the art, we note the Opticon training and exchange Schools. These are so successful they are now a model for others. There are requests for help in setting up similar activities from China, Ukraine, the International Astronomical Union in Africa and from South America. Thirdly, we note that Opticon success in developing viable 2-4m telescope networks, assisting in developing state-of-the-art instrumentation for those facilities and in building communities through networking, has led Iran, which is building its first national observatory, to participate in the Canarian observatories, to send students to the UK for PhD training and to apply for observer status in relevant activities in Opticon, to help develop their own national research community. Apparently Opticon networking activities are a model which others consider worth following.

The service enhancement aspect of the networks is related to the efforts to deliver coordination and optimisation of the available telescopes, through the Telescope Directors’ Forum (an Opticon initiative), through the common Call for Proposal system, with standard web interfaces and through the activities of several networks, especially the Key Technology Network and all the JRA activities, which ensure potentially viable new technologies are brought into consideration at the earliest possible opportunity. Indeed, were it not for the Opticon activity, it is far from obvious that many infrastructures would be providing any services at all!

The culture of cooperation is built directly by all networks. Previous networks have learned how to involve wide communities, have developed appropriate contacts in many countries and projects, have strengthened communications and synergy with technologists, instrument builders and scientists and implemented successful series of workshops connecting the community, e.g. with a large workshop on the relation between complementary science projects, at other infrastructures and the E-ELT. The project will extend those activities to strengthen links between the E-ELT network and other Opticon activities in the JRAs. For example, one of our workshops will explore instrumentation concepts for the long-term future of E-ELT, with emphasis on developments for future instrumentation, which are being studied here, and which are being uniquely investigated inside Opticon (fast detectors, VPH gratings, astrophotonics). A particular strength of this forward-looking approach is the Innovation Network. The previous FP7 activity has been very much focussed on bringing new technology into optical and infrared astronomy. The Innovation Network will build on these activities to generate stronger interaction with industry, to enhance the economic and societal benefits of the Opticon programme and investigate possible future consumer applications.

1.2.2 Trans-National Access

The most fundamental aspect of the “integrated provision of infrastructure related services” is that there was no such provision for European-owned 2-4m telescopes, until it was initiated on a trial basis by Opticon. As noted above, plans until recently were to terminate several national infrastructures in favour of a very few, very large infrastructures, all provided through the European Southern Observatory, or various bilateral projects (e.g. the US-German-Italian Large Binocular Telescope). Opticon, working with ASTRONET, and the Opticon partner national funding agencies, sponsored a full detailed review of the capabilities of 2-4 telescopes in the future, including costs and requirements (the ETSRC or ‘Drew-Bergeron’ report). Following acceptance of that report’s recommendations by the national funding agencies, the owners and operators of the infrastructures, Opticon implemented a “proof of principle” implementation of a common mode of operation. This experiment will become mature under this contract. This activity has shown the benefits and practicalities of coordinating and specialising infrastructure operations across countries and has allowed the integration process to begin but it requires time to mature. Full implementation requires new specialist instrumentation – a benefit of the Opticon technology R&D work – and continuing community-building – the goal of the Opticon networking activities. Longer term viability also requires awareness of potential new technologies and technology roadmapping to retain topicality, both aspects of Opticon activity.

The beginning of rationalisation and optimisation of 2-4m telescopes has taken place in recent years and more is expected. The telescope network included in this contract has been adjusted to take account of these developments, for example the UKIRT has entered survey only mode and is no longer offered under the TNA programme. The telescope suite thus includes all the major (non-ESO) medium sized telescopes which will offer general user access during the contract period. This allows individual astronomers, especially those whose national facilities have been specialised in favour of campaign mode operations, access to a suite of resources which can support a wide range of projects. Crucially, it allows follow up and exploitation of interesting objects discovered in campaigns and surveys using the best possible tools for the job. The successful establishment of an Opticon common time allocation process has made it easier and simpler to apply for time on non-national facilities and crucially, to develop projects which require access to multiple facilities. By developing a process which is clearly not nationally based and applies a common process to all applications, it also encourages proposals from outside the traditional national user groups.

1.2.3 Joint Research Activities

The several JRAs in Opticon cover a wide range of challenges related to development of future astronomical instrumentation – the community contribution to E-ELT and next generation facilities, with complementary approaches including the range from technically challenging developments of systems, which are known to be on the critical path for next generation instrumentation, through investigations of new technologies of high potential impact but as-yet less certain practicality. The balance between these activities has been set in part by the development of the Opticon astronomical technology Roadmap, and in part by critical analysis of the very wide range of possible activities by the national funding agency scientific directors who make up the Opticon Executive Board. For clarity, we briefly consider each JRA area in turn.

Adaptive Optics (WP1)

Adaptive optics (AO) systems, using both natural and laser guide stars, are the key technologies for the next major advances in ground-based optical-IR astronomy in the next 20 years. Significant progress made over the past ten years in the field of AO has brought this observational technique to the maturity level where outstanding astronomical results can be obtained routinely. Astronomers are now looking toward the next generation of AO systems, which will allow them to extend this powerful technique to new observing modes. Previous Opticon activity aimed to design and develop Laser Guide Star Adaptive Optics systems for the existing large telescopes (Large Binocular Telescope, Very Large Telescope, William Herschel Telescope), to upgrade extent Adaptive Optics systems for the large Solar telescope (GREGOR solar telescope) and to upgrade the Very Large Telescope Planet Finder instrument (SPHERE) to maintain its competitiveness in the period 2012-2014. The primary goal of this contract is to develop the technologies and the knowledge required to improve the performance and operational efficiency of these existing AO facilities in Europe, as well as to develop the state-of-the-art second generation instrumentation required for the 40m European Extremely Large Telescope (E-ELT).

Fast Detectors (WP2)

Opticon activity defines the state-of-the-art in this field. Outstanding performance was obtained from the Opticon developed camera Ocam and its dedicated detector, the CCD220 (which has led to commercial spinoffs – see below). Ocam technology is currently used by the second generation of VLT Adaptive Optics (AO) instruments. Third generation AO instruments will be still more demanding in terms of frame rate and readout noise, and the detector controllers will be developed in this activity. This performance update is the baseline for the E-ELT AO systems.

Developing smarter, smaller, instruments (WP3, 5 & 6)

The global telecommunications industry has invested massively in photonic systems, with many applications available in biomedicine and sensing applications. There are as yet only preliminary investigations of astronomical capabilities. Given the tiny size and mass and relatively low cost of photonic systems, they could revolutionise astronomical spectrographs, if they prove compliant with astronomical requirements. The aim of WP3 is to develop and test possible systems built on integrated photonic technologies. This activity builds on the Astrophotonica Europa Network started in FP6 as an outcome of the Opticon Key Technologies Network and further developed in FP7, including development there of the first integrated waveguide based Photonic Couplers for astronomy. This illustrates the intimate connection between networking and JRA activity in Opticon.

Instruments based on current optical designs tend to get bigger and more complex, leading to increasingly tight requirements on the overall performance [cf. the Opticon technology roadmap]. The goal of WP5 is to reduce the complexity of future instruments by combining two innovative technologies namely: *freeform mirrors and active optics.* This could significantly simplify next generation instruments for the E-ELT and VLT.

The proposed programme of WP6 for novel optical materials is again possible only because of the successful results of the previous Opticon activities. It involves unanticipated discoveries made during those activities, and a successful Opticon-supported effort to recover knowledge and materials following collapse of the sole European industrial supplier. It is focused on enabling technologies (holographic and traditional gratings, innovative fibres, general holographic Optical Elements) that can potentially improve the performance and/or reduce the cost of future instrumentation.

Making optical interferometry a practical astronomical tool (WP4)
Opticon activity in recent years initiated the development of software tools for end-to-end processing of interferometric observations and data from calibration to model fitting. Since then, these tools have been continuously improved by the community and have encouraged more astronomers to make use of interferometry observations. The goal now is to go a step further, as the ability to reconstruct images is essential to exploit the very high angular resolution provided by the next generation multi-telescope instruments such as Matisse, Gravity and Pionier at Europe's Very Large Telescope Interferometer (VLTI), LINC-Nirvana at the Large Binocular Telescope (LBT) or Vega at the Chara interferometer.

1.3 Scientific and Technical methodology and associated work plan

1.3.1) Overall strategy and general description

The Opticon technological strategy is designed to improve the performance of the instruments – cameras, spectrographs, data processing algorithms – which collect and provide science-ready data from Europe's astronomical infrastructures. Enhancing state of the art systems and investigating critical high risk but potentially high-benefit new technologies are involved and will benefit all telescopes of all sizes, extant and planned.

The opportunity to contribute to the ultimate performance of a facility like the E-ELT is a prime motivation for top-talented researchers to come or to stay in Europe. The challenging opportunities also stimulate experts from other disciplines to contribute to the development of innovative technology and design tools and allow industry to demonstrate their capabilities.

The Opticon networking strategy is designed to bring together distributed communities to optimise their participation in planning future capabilities, and train the otherwise disadvantaged parts of the community in state-of-the-art research using state of the art facilities. The Opticon infrastructure strategy is designed to ensure the continuing availability and productivity of medium-sized observatories, by improving their cost-effectiveness and science impact and improving the ease and openness of community access to their use. There is considerable synergy between the networks and the TNA programme. Activities of the training network regularly take place in collaboration with larger telescopes in the TNA programme (e.g. remote access to NOT during training schools) and will do so with smaller ones in the new Time Domain network. The robotic and quick response facilities of the larger telescopes in the Access (TNA) programme will support the activities of the Time Domain programme, a process which is assisted by the linking of the Time Domain and Access programmes through the Telescope Directors' Forum.

All these activities are integrated both through project management (described in Section 2.1), and through close internal communications and mutual decision making. They are planned through careful analysis of the large number of potential activities placed before the Executive, which is made up of leaders of national funding bodies and supplemented by experts from national and ESO strategic planning forums. All strategic planning is informed at the top level by the AstroNet strategic plan, at a local level by the Roadmap, and at a national resource availability level by the national agencies, each of which is of course fully aware of nationally-funded capabilities and activities. There is continuing involvement of senior Opticon participants in strategy forums and in annual review of funding proposals, in national agencies across Europe, ensuring continuing information flow and internal awareness of developments. In essence, Opticon has developed, and maintains, a holistic approach to the technological, infrastructure, and community challenges facing optical-infrared astronomy, by bringing together all the key players at strategic planning level, and maintains this synergy at implementation level through excellent internal communications.

1.3.2) Timing of work packages and their components

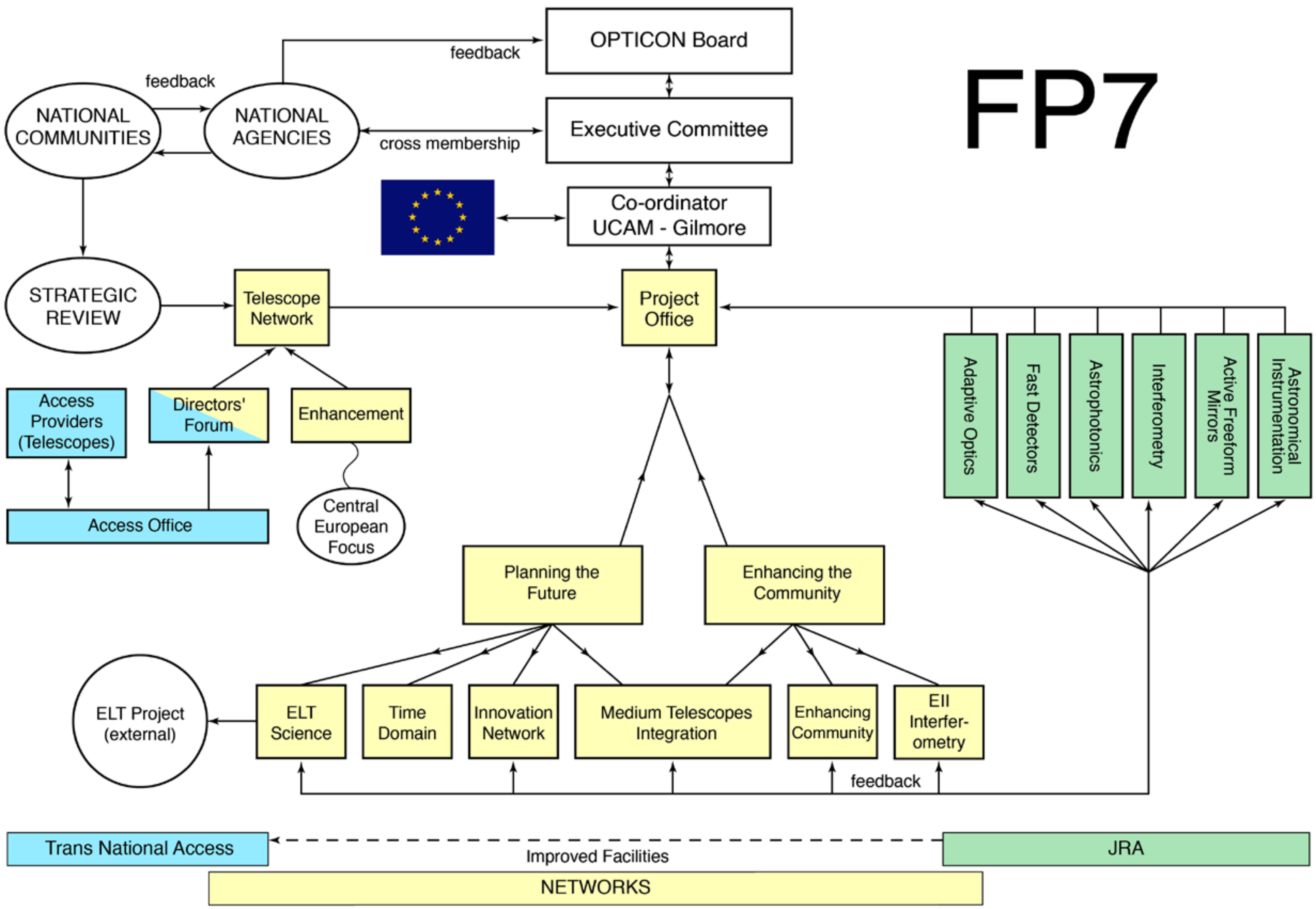
A standard Gantt chart showing the duration of each activity is a valuable, though only partial management and review tool for this project. All 14 Work Packages continue through the whole project. While some have internal milestones which affect later work, most involve parallel activities which in turn continue through the whole contract. All activities are designed to maximise synergy, but to minimise risk dependency on each other. There are of course milestones and decision points in some work packages – identified where appropriate.

The primary decision points and down-selects, and major milestone decision points, mostly affect what activities will continue beyond FP7, not how resources are distributed inside this contract. This is the same philosophy adopted, with considerable success, in previous Opticon activities, and in the associated complementary activities supported by the national funding agencies which make up Opticon. Promising developments which arose from earlier activities form the work packages implemented here.

Throughout the Opticon project, the Opticon Executive Committee will monitor progress in all activities, and where necessary, can and has terminated an activity which was clearly not making progress and proposed re-deployment of the resources through a contract amendment. This review process happens annually, for all activities.

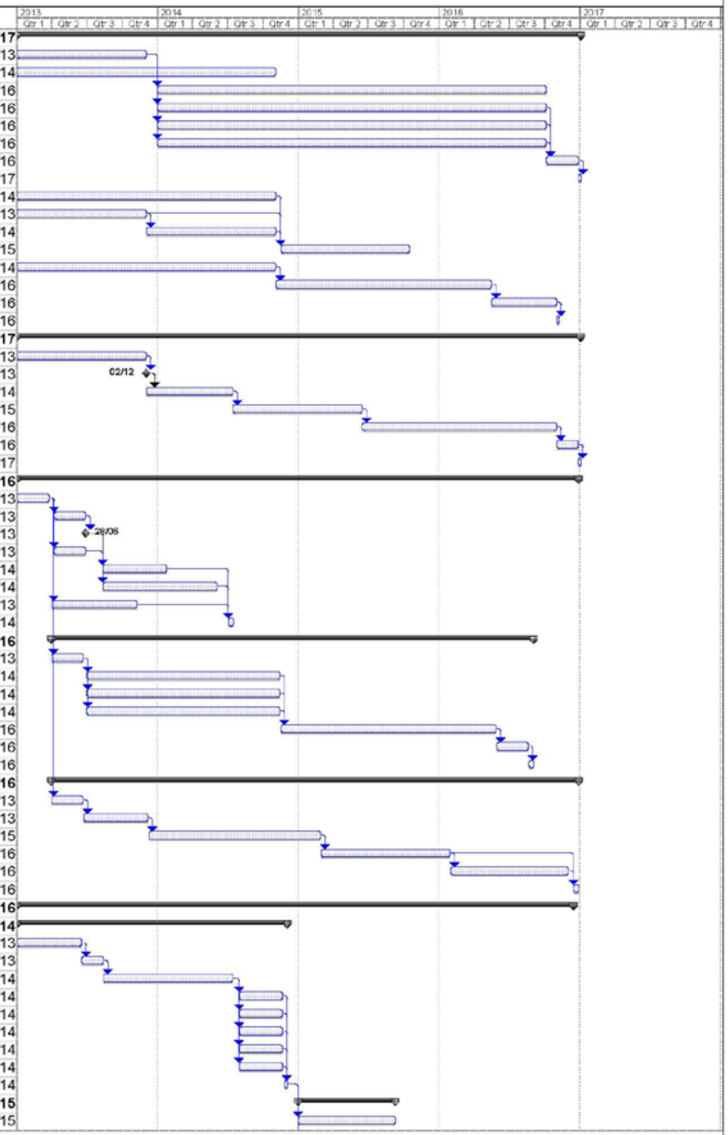
All activity progress is judged against, and monitored by, the set of deliverables and milestones provided in the relevant tables (WT1, WT2, WT3, WT4, WT5). Full WP descriptions are provided in Tables WT3.

iv) Pert-like diagram: Opticon is not a single project, so we illustrate the global structure and connections here



FP7-2 Opticon Project Master Schedule

ID	Task Name	Start	Duration	Finish
1	**WP1: Towards Adaptive Optics for the E-ELT**	**Tue 01/01/13**	**52.3 mons**	**Tue 03/01/17**
2	Prepare Technical Specifications for the DM developments	Tue 01/01/13	12 mons	Mon 02/12/13
3	Development of demonstration bench for educational outreach	Tue 01/01/13	24 mons	Mon 03/11/14
4	Build large open-loop deformable mirror	Wed 01/01/14	36 mons	Tue 04/10/16
5	Design wireless mirror control electronics	Wed 01/01/14	36 mons	Tue 04/10/16
6	Perform feasibility study to drive a piezoelectric DM using the wireless mirror control electronics	Wed 01/01/14	36 mons	Tue 04/10/16
7	Build a cryogenic active mirror	Wed 01/01/14	36 mons	Tue 04/10/16
8	Prepare deformable mirror report	Wed 05/10/16	3 mons	Tue 27/12/16
9	Review DM Report	Wed 28/12/16	1 wk	Tue 03/01/17
10	Develop efficient calibration algorithms	Tue 01/01/13	24 mons	Mon 03/11/14
11	Design laser assisted wide field AO wavefront sensing system	Tue 01/01/13	12 mons	Mon 02/12/13
12	Develop a laser assisted wide-field AO wavefront sensing system simulation model	Tue 03/12/13	12 mons	Mon 03/11/14
13	Test laser assisted wide-field AO wavefront sensing system in laboratory	Mon 17/11/14	12 mons	Fri 16/10/15
14	Prepare CANARY Bench for on-sky tests	Tue 01/01/13	24 mons	Mon 03/11/14
15	Test laser assisted wide-field AO wavefront sensing system	Tue 04/11/14	20 mons	Mon 16/05/16
16	Prepare laser assisted wide-field AO wavefront sensing system on-sky test report	Tue 17/05/16	6 mons	Mon 31/10/16
17	Review laser assisted wide-field AO wavefront sensing system on-sky test report	Tue 01/11/16	1 wk	Mon 07/11/16
18	**WP2: Fast Detectors and Cameras**	**Tue 01/01/13**	**52.25 mons**	**Mon 02/01/17**
19	Develop NGSD imaging system specifications	Tue 01/01/13	12 mons	Mon 02/12/13
20	Review NGSD imaging system specification (MS1)	Mon 02/12/13	0 mons	Mon 02/12/13
21	Design NGSD imaging system	Tue 03/12/13	8 mons	Mon 14/07/14
22	Manufacture NGSD imaging system detectors	Tue 15/07/14	12 mons	Mon 15/06/15
23	Test NGSD imaging system	Tue 16/06/15	18 mons	Mon 31/10/16
24	Prepare NGSD imaging system test report	Tue 01/11/16	2 mons	Mon 26/12/16
25	Review NGSD imaging system final design and test report	Tue 27/12/16	1 wk	Mon 02/01/17
26	**WP3: Astrophotonics**	**Tue 01/01/13**	**52.1 mons**	**Wed 28/12/16**
27	Develop Science Case and use cases	Tue 01/01/13	3 mons	Mon 25/03/13
28	Analyse science requirements and capture device requirements	Mon 08/04/13	3 mons	Fri 28/06/13
29	Review Science Requirements and Implementation Plan (MS2)	Fri 28/06/13	0 mons	Fri 28/06/13
30	Derive system and sub-system requirements	Mon 08/04/13	3 mons	Fri 28/06/13
31	Develop system architecture	Mon 12/08/13	6 mons	Fri 24/01/14
32	Develop system performance simulation models	Mon 12/08/13	10.65 mons	Wed 04/06/14
33	Develop concept design	Mon 01/04/13	8 mons	Fri 08/11/13
34	Review design concept	Fri 04/07/14	2 wks	Thu 17/07/14
35	**Photonic Couplers Development**	**Mon 01/04/13**	**44.75 mons**	**Fri 02/09/16**
36	Develop of sub-system requirements	Mon 01/04/13	3 mons	Fri 21/06/13
37	Optimise waveguide geometries	Mon 01/07/13	18 mons	Fri 14/11/14
38	Optimise waveguide reflective index contract	Mon 01/07/13	18 mons	Fri 14/11/14
39	Optimise laser "tool path"	Mon 01/07/13	18 mons	Fri 14/11/14
40	Develop science grade photonic couplers	Mon 17/11/14	20 mons	Fri 27/05/16
41	Evaluate science grade photonic couplers	Mon 30/05/16	3 mons	Fri 19/08/16
42	Review Photonic Coupler Technology Readiness Level	Mon 22/08/16	2 wks	Fri 02/09/16
43	**Integrated Photonic Spectrograph (IPS) Development**	**Mon 01/04/13**	**48.9 mons**	**Wed 28/12/16**
44	Develop of sub-system requirements	Mon 01/04/13	3 mons	Fri 21/06/13
45	Develop detailed fabrication specification and tune process	Mon 24/06/13	6 mons	Fri 06/12/13
46	Fabrication and characterisation of IPS devices	Mon 09/12/13	16 mons	Fri 27/02/15
47	Develop test bench instrument	Mon 02/03/15	12 mons	Fri 29/01/16
48	Optimisation and mass fabrication of science capable devices	Mon 01/02/16	10.9 mons	Wed 30/11/16
49	Review test results	Thu 15/12/16	2 wks	Wed 28/12/16
50	**WP4: Image reconstruction in optical intererometery**	**Tue 01/01/13**	**51.6 mons**	**Wed 14/12/16**
51	**Prepare a unified image reconstruction description**	**Tue 01/01/13**	**25.1 mons**	**Wed 03/12/14**
52	Develop images of astrophysical object	Tue 01/01/13	6 mons	Mon 17/06/13
53	Develop algorithm interface specifications	Tue 18/06/13	2 mons	Mon 12/08/13
54	Collate real data or simulate synthetic data	Tue 13/08/13	12 mons	Mon 14/07/14
55	Create object file using synthetic data for Gravity	Fri 01/08/14	4 mons	Thu 20/11/14
56	Create object file using synthetic data for Matisse	Fri 01/08/14	4 mons	Thu 20/11/14
57	Create object image file using synthetic and real data for LINC-Nirvana	Fri 01/08/14	4 mons	Thu 20/11/14
58	Create object file using real data from Pionier	Fri 01/08/14	4 mons	Thu 20/11/14
59	Create object filed using data from Vega/Chara	Fri 01/08/14	4 mons	Thu 20/11/14
60	Review object models	Thu 27/11/14	1 wk	Wed 03/12/14
61	**Development of image reconstruction algorithms**	**Thu 01/01/15**	**9 mons**	**Wed 09/09/15**
62	Prototype reconstruction algorithm derived from BSMEN	Thu 01/01/15	9 mons	Wed 09/09/15

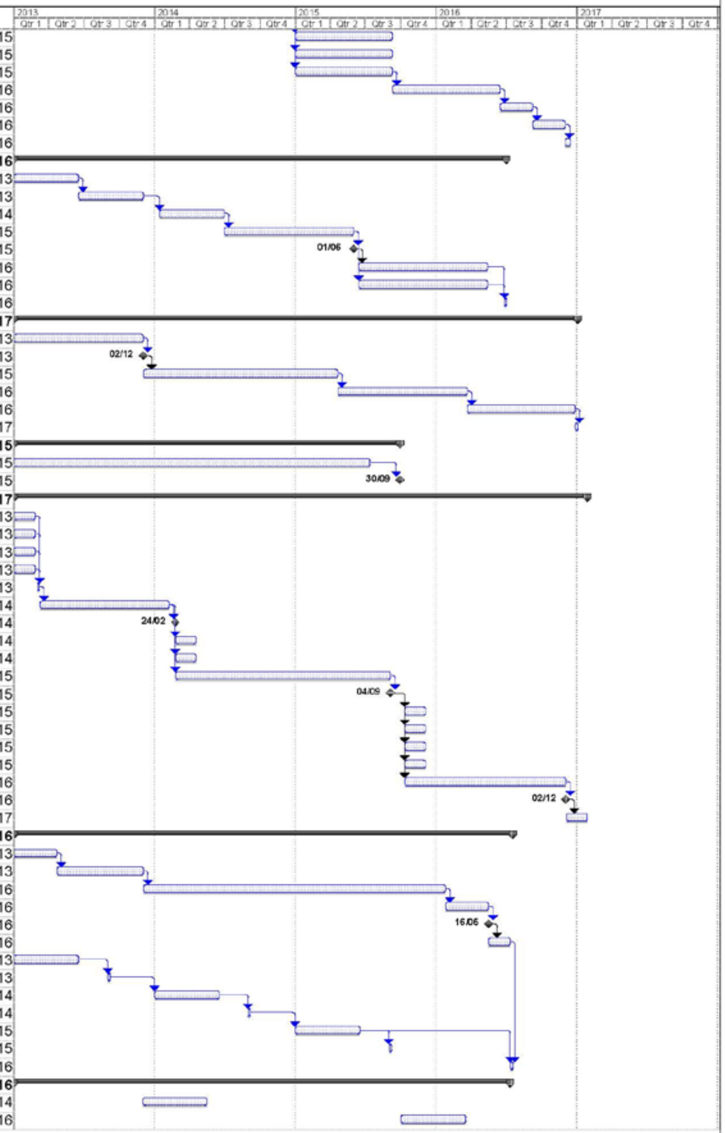


Project: FP7-1 Opticon
Date: Thu 03/05/12

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

FP7-2 Opticon Project Master Schedule

ID	Task Name	Start	Duration	Finish
63	Develop data reduction tools for Fizeau interferometry	Thu 01/01/15	9 mons	Wed 09/09/15
64	Prototype reconstruction algorithm derived from Wisard	Thu 01/01/15	9 mons	Wed 09/09/15
65	Prototype reconstruction algorithm derived from MiRA	Thu 01/01/15	9 mons	Wed 09/09/15
66	Develop Graphical user interface (GUI)	Thu 10/09/15	10 mons	Wed 15/06/16
67	Prepare documentation and cookbooks	Thu 16/06/16	3 mons	Wed 07/09/16
68	Test and benchmark results	Thu 08/09/16	3 mons	Wed 30/11/16
69	Review Test Results	Thu 01/12/16	2 wks	Wed 14/12/16
70	**WP5: Development of Active Freeform Mirrors**	**Tue 01/01/13**	**45.7 mons**	**Fri 01/07/16**
71	Develop Active Freeform Optical Critical Component Specification	Tue 01/01/13	6 mons	Mon 17/06/13
72	Design actuator structure and system metrology	Tue 18/06/13	6 mons	Mon 02/12/13
73	Conduct a trade-off study between conventional and active freeform mirrors	Tue 14/01/14	6 mons	Mon 30/06/14
74	System demonstrator with optimized free form surface, adjustable array and control loop system	Tue 01/07/14	12 mons	Mon 01/06/15
75	Review Active Freeform Optical Component Critical Specification (MS3)	Mon 01/06/15	0 mons	Mon 01/06/15
76	Prepare final design report	Mon 15/06/15	12 mons	Fri 13/05/16
77	Prepare industrial manufacturing report	Mon 15/06/15	12 mons	Fri 13/05/16
78	Demonstrate AFM at SPIE 2016	Mon 27/06/16	1 wk	Fri 01/07/16
79	**WP6: New Materials and Processes in Astronomical Instrumentation**	**Tue 01/01/13**	**52.25 mons**	**Mon 02/01/17**
80	Conduct trade-off study	Tue 01/01/13	12 mons	Mon 02/12/13
81	Review Specification and select best option	Mon 02/12/13	0 mons	Mon 02/12/13
82	Manufacture demonstrator	Tue 03/12/13	16 mons	Mon 20/04/15
83	Test and characterise demonstrator	Tue 21/04/15	12 mons	Mon 21/03/16
84	Prepare Demonstrator Design Dossier and Test Report	Tue 22/03/16	10 mons	Mon 26/12/16
85	Review Demonstrator Design and Test Results	Tue 27/12/16	1 wk	Mon 02/01/17
86	**WP7: Transnational Access**	**Tue 01/01/13**	**35.8 mons**	**Wed 30/09/15**
87	Transnational Access programme	Tue 01/01/13	33 mons	Mon 13/07/15
88	Review TNA Programme methology and outputs (MS4)	Wed 30/09/15	0 mons	Wed 30/09/15
89	**WP8: Management**	**Tue 01/01/13**	**53.2 mons**	**Fri 27/01/17**
90	Create and publish Opticon Management Website	Tue 01/01/13	2 mons	Mon 25/02/13
91	Prepare project Kick-Off Meeting	Tue 01/01/13	2 mons	Mon 25/02/13
92	Prepare risk register	Tue 01/01/13	2 mons	Mon 25/02/13
93	Prepare project master schedule and spending profiles	Tue 01/01/13	2 mons	Mon 25/02/13
94	Project Kick-Off Meeting	Mon 04/03/13	1 wk	Fri 08/03/13
95	Monitor Project	Mon 11/03/13	12 mons	Fri 07/02/14
96	Review Project Period 1 (MS5)	Mon 24/02/14	0 mons	Mon 24/02/14
97	Update project master schedule, spending profiles and risk register	Mon 24/02/14	2 mons	Fri 18/04/14
98	Prepare Project Period 1 report	Mon 24/02/14	2 mons	Fri 18/04/14
99	Monitor Project	Mon 24/02/14	20 mons	Fri 04/09/15
100	Review Project Period 2 (MS6)	Fri 04/09/15	0 mons	Fri 04/09/15
101	Update project master schedule, spending profiles and risks	Mon 12/10/15	2 mons	Fri 04/12/15
102	Prepare Project Period 2 Report	Mon 12/10/15	2 mons	Fri 04/12/15
103	Update project master schedule, spending profiles and risks	Mon 12/10/15	2 mons	Fri 04/12/15
104	Prepare Project Period 1 report	Mon 12/10/15	2 mons	Fri 04/12/15
105	Monitor Project	Mon 12/10/15	15 mons	Fri 02/12/16
106	Review final project period (MS7)	Fri 02/12/16	0 wks	Fri 02/12/16
107	Prepare final project report	Mon 05/12/16	2 mons	Fri 27/01/17
108	**WP9: Innovation Network**	**Tue 01/01/13**	**46.25 mons**	**Mon 18/07/16**
109	Generate Technology Roadmap	Tue 01/01/13	4 mons	Mon 22/04/13
110	Design, develop and publish Industry Club Website	Tue 23/04/13	8 mons	Mon 02/12/13
111	Development of industry club showcase	Tue 03/12/13	26 mons	Mon 25/01/16
112	Update Technology Roadmap	Tue 26/01/16	4 mons	Mon 16/05/16
113	Review Technology Roadmap (MS8)	Mon 16/05/16	0 mons	Mon 16/05/16
114	Final Report	Tue 17/05/16	2 mons	Mon 11/07/16
115	Plan and prepare Year 1 Workshop	Tue 01/01/13	6 mons	Mon 17/06/13
116	Innovation Network Year 1 Workshop	Mon 02/09/13	1 wk	Fri 06/09/13
117	Plan and prepare Year 2 Workshop	Wed 01/01/14	6 mons	Tue 17/06/14
118	Innovation Network Year 2 Workshop	Mon 01/09/14	1 wk	Fri 05/09/14
119	Plan and prepare Year 3 Workshop	Thu 01/01/15	6 mons	Wed 17/06/15
120	Innovation Network Year 3 Workshop	Tue 01/09/15	1 wk	Mon 07/09/15
121	Review Innovation Network Activities and Report	Tue 12/07/16	1 wk	Mon 18/07/16
122	**WP10: ELT Science and Tools**	**Tue 01/01/13**	**46 mons**	**Mon 11/07/16**
123	Instrumentation Conference Proceedings	Mon 02/12/13	6 mons	Fri 16/05/14
124	E-ELT Science Conference Proceedings	Fri 02/10/15	6 mons	Thu 17/03/16



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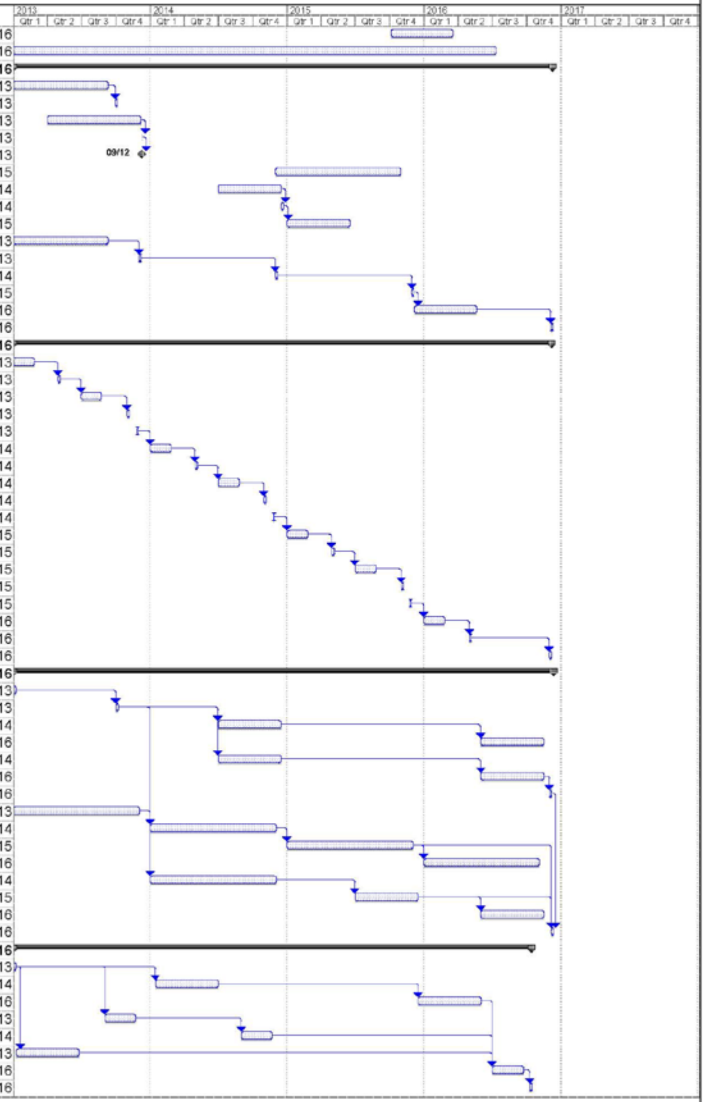
FP7-2 Opticon Project Master Schedule

ID	Task Name	Start	Duration	Finish
125	Summer School report	Mon 05/10/15	6 mons	Fri 18/03/16
126	Papers/White paper : Data Analysis Methodologies Tools for E-ELT and HTRA	Tue 01/01/13	46 mons	Mon 11/07/16
127	**WP11: Time Domain Astronomy**	**Tue 01/01/13**	**51.45 mons**	**Fri 09/12/16**
128	Execute robotic telescope survey	Tue 01/01/13	9 mons	Mon 09/09/13
129	Review and approve robotic telescopes network list	Mon 30/09/13	1 wk	Fri 04/10/13
130	Define file standard and data reduction protocols	Mon 01/04/13	9 mons	Fri 06/12/13
131	Review and agreed list of standard files and data reduction protocols	Mon 09/12/13	2 mins	Mon 09/12/13
132	Complete survey of robotic telescopes for inclusion in network (MS9)	Mon 09/12/13	0 mons	Mon 09/12/13
133	Enhance existing facilities	Mon 01/12/14	12 mons	Fri 30/10/15
134	Prepare for lessons learned workshop 1	Tue 01/07/14	6 mons	Mon 15/12/14
135	First Lessons learned workshop	Tue 16/12/14	1 wk	Mon 22/12/14
136	Prepare for lessons learned workshop 1	Thu 01/01/15	6 mons	Wed 17/06/15
137	Web-based interface and software for homogeneous data storage and calibration	Tue 01/01/13	9 mons	Mon 09/09/13
138	Annual meeting of robotic telescopes network for transients and variable stars follow-up 1	Mon 02/12/13	1 wk	Fri 06/12/13
139	Annual meeting of robotic telescopes network for transients and variable stars follow-up 2	Mon 01/12/14	1 wk	Fri 05/12/14
140	Annual meeting of robotic telescopes network for transients and variable stars follow-up 3	Mon 30/11/15	1 wk	Fri 04/12/15
141	Reports and documentation on developed software and other tools	Mon 07/12/15	6 mons	Fri 20/05/16
142	Annual meeting of robotic telescopes network for transients and variable stars follow-up 4	Mon 05/12/16	1 wk	Fri 09/12/16
143	**WP 12: Medium Sized Telescope Integration**	**Tue 01/01/13**	**51.3 mons**	**Tue 06/12/16**
144	TNA call 1 for observing proposals	Tue 01/01/13	2 mons	Mon 25/02/13
145	CTAC Meeting 1	Tue 30/04/13	1 wk	Mon 06/05/13
146	TNA call 2 for observing proposals	Mon 01/07/13	2 mons	Fri 23/08/13
147	CTAC Meeting 2	Thu 31/10/13	1 wk	Wed 06/11/13
148	Directors Y1 Review Forum	Wed 27/11/13	2 days	Thu 28/11/13
149	TNA call 3 for observing proposals	Wed 01/01/14	2 mons	Tue 25/02/14
150	CTAC Meeting 3	Wed 30/04/14	1 wk	Tue 06/05/14
151	TNA call 4 for observing proposals	Tue 01/07/14	2 mons	Mon 25/08/14
152	CTAC Meeting 4	Fri 31/10/14	1 wk	Thu 06/11/14
153	Directors' Y2 Review Forum	Wed 26/11/14	2 days	Thu 27/11/14
154	TNA call 5 for observing proposals	Thu 01/01/15	2 mons	Wed 25/02/15
155	CTAC Meeting 5	Thu 30/04/15	1 wk	Wed 06/05/15
156	TNA call 6 for observing proposals	Wed 01/07/15	2 mons	Tue 25/08/15
157	CTAC Meeting 6	Mon 02/11/15	1 wk	Fri 06/11/15
158	Directors Y3 Review Forum	Wed 25/11/15	3 days	Fri 27/11/15
159	TNA call 7 for observing proposals	Fri 01/01/16	2 mons	Thu 25/02/16
160	CTAC Meeting 7	Mon 02/05/16	1 wk	Fri 06/05/16
161	Directors Final Review Forum	Wed 30/11/16	1 wk	Tue 06/12/16
162	**WP 13: Enhancing Community Skills - Integrating Communities**	**Tue 01/01/13**	**51.5 mons**	**Mon 12/12/16**
163	Kick-Off Meeting	Tue 01/01/13	1 wk	Mon 07/01/13
164	Steering Committee meeting 1	Tue 01/10/13	1 wk	Mon 07/10/13
165	Prepare LaCaille exchange scheme report (2014)	Tue 01/07/14	6 mons	Mon 15/12/14
166	Prepare LaCaille exchange scheme report (2016)	Wed 01/06/16	6 mons	Tue 15/11/16
167	Prepare and deliver "Awareness" conferences in eastern EU countries	Tue 01/07/14	6 mons	Mon 15/12/14
168	Prepare and deliver "Awareness" conferences in eastern EU countries	Wed 01/06/16	6 mons	Tue 15/11/16
169	Steering Committee meeting 2	Thu 01/12/16	3 days	Mon 05/12/16
170	Preparing and deliver Y1 Annual Observing School	Tue 01/01/13	12 mons	Mon 02/12/13
171	Preparing and deliver Y2 Annual Observing School	Wed 01/01/14	12 mons	Tue 02/12/14
172	Preparing and deliver Y3 Annual Observing School	Thu 01/01/15	12 mons	Wed 02/12/15
173	Preparing and deliver Y4 Annual Observing School	Fri 01/01/16	11 mons	Thu 03/11/16
174	Prepare and Deliver AO specific instrument training workshop	Wed 01/01/14	12 mons	Tue 02/12/14
175	Prepare and deliver Instrument construction workshop	Wed 01/07/15	6 mons	Tue 15/12/15
176	Prepare and deliver training workshops on specific instruments (IFU)	Wed 01/06/16	6 mons	Tue 15/11/16
177	Review WP 13 activities	Tue 06/12/16	1 wk	Mon 12/12/16
178	**WP14: The European Interferometry Initiative**	**Tue 01/01/13**	**49.45 mons**	**Fri 14/10/16**
179	European Interferometery Initiative Kick-Off	Tue 01/01/13	1 wk	Mon 07/01/13
180	Observing with the VLTI School 1	Wed 15/01/14	6 mons	Tue 01/07/14
181	Observing with the VLTI School 2	Thu 17/12/15	6 mons	Wed 01/06/16
182	Annual report of the Fizeau exchange programme Y1	Mon 02/09/13	3 mons	Fri 22/11/13
183	Annual report of the Fizeau exchange programme Y2	Mon 01/09/14	3 mons	Fri 21/11/14
184	Interferometry Web site	Tue 08/01/13	6 mons	Mon 24/06/13
185	Prepare "The future of interferometry in Europe" report	Fri 01/07/16	3 mons	Thu 22/09/16
186	Review European Interferometery Report and Activities	Mon 10/10/16	1 wk	Fri 14/10/16



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2. Implementation

2.1 Management structure and procedures

The Opticon management structure is based on standard methodology and involves an experienced administration team which has proven robust, effective and efficient over the whole duration of the Opticon activities through FP6 and previously in FP7. It has been consistently highly rated in Mid-Term Reviews and consistently delivers all the necessary reporting and financial management requirements to the EC. The structure has proven robust enough to identify, review and change the resource allocation for an activity which was not meeting internal review standards and to terminate a network activity when it was clear that it could not achieve its objective due to circumstances beyond its control(in FP6). It has managed to retain support inside the Opticon partnership during the robust selection process when very many excellent ideas had to be reduced to a viable balanced sub-set for this contract. It has shown sufficient strength that the startup SME Alpao has been enthusiastic to join the consortium for this contract. Equally importantly, it meets the requirements of the Opticon partners and is that management system which they wish to implement.

The top level of the management system is the Opticon Board, with a representative from each partner, and a Chair, elected from the partners and independent of the management team. Representatives of all the astronomy-related EC-funded activities are invited. All Opticon WP leads are expected to attend. The Board will meet approximately annually. This meeting will receive progress reports on all activities – partly to ensure progress is being maintained at the expected rate and partly to ensure optimal communications across all activities. The Board will receive the Opticon reports to the EC, the budget progress and a detailed analysis by the project scientist on the state of the activities. Any significant modifications in Opticon activity to be proposed as contract amendments for EC approval must be agreed and authorised by the Board. The Board approves all WP leads. The Board is also responsible for initiating regular reviews of the performance of the management team.

More urgent business and detailed financial monitoring, is delegated to an Executive Committee. This Executive is made up of representatives of all the key national funding agencies, whose roles as members is arguably the greatest strength of the Opticon management. The agencies involved include all the largest agencies which fund optical-infrared astronomy in Europe: CNRS (France), CSIC (Spain), INAF (Italy), NOVA (Netherlands), Max Planck (Germany), STFC (UK), and ESO (International). The individuals who attend the Opticon Executive are the senior directors of research funding and strategy for those national funding agencies. Thus the Opticon Executive is not only made up of very senior and experienced research managers, it is inevitably fully informed of national complementary funding capabilities and relevant strategic development opportunities and constraints. The Executive will monitor work package progress, reporting and decides on any modifications required. It also monitors the Consortium Agreement, IPR issues and outreach. The Executive will meet as required, at minimum twice per year.

A special feature of such a senior membership of the Executive is that the Executive also functions as an Opticon Advisory Committee. In practise the Executive members consult senior advisory groups within their agencies on an *ad hoc* basis as appropriate, and report the corresponding advice to the Executive. These is considerable overlap of the Executive membership with other European and Global level astronomy projects, including ESO, ASTRONET, and the Boards of the national 2-4m observatories which are involved in the TNA activities. This further ensures maximal knowledge of and responsiveness to all the political and financial factors which are involved in major infrastructural developments. A review of the performance of the CTAC system will be held in late 2014. Since this is so new, we feel such a review could be of benefit.

Coordination, coherence and integration of these complementary activities occur at every level of Opticon. The several technical JRA activities have many cross members and many coordinated activities. The JRA work is of considerable potential importance to current and future telescopes (4-m, 8-m, E-ELT) and instruments, so national and international (ESO) facility planning involves the same team leaders as do Opticon activities. At the management level, the Opticon Executive consists of the same people and organisations that lead national strategic development and investment programmes and fund the infrastructures. Comprehensive and timely information flow is thus assured. As examples, several leading participants in JRA developments are leading participants in planned or proposed next generation instruments, the coordinator of the training schools is in attendance at Telescope Directors' Forum meetings considering lessons learned from observing proposal cycles, the Time Domain Astronomy coordinator leads the work package inside the Gaia consortium delivering time-domain discoveries, and the European Interferometry planning group is represented on the Executive of the European Interferometry Initiative.

Day-to-day responsibility for activity management is delegated to WP leaders. Every leader is both highly motivated and of proven competence. They are chosen for their personal interest in the relevant activity, as well as for competence, on the nomination of relevant national (and ESO) agencies. The TNA activities are coordinated by the dedicated Project Office, discussed below. The networks are built round dedicated teams, used to collaboration, and mostly manage with informal internal management, supplemented by regular (typically quarterly) progress reporting to the Project Scientist and Coordinator. The exception is the European Interferometry Initiative, which involves many people and institutions, and organises itself formally with its own Board and Executive. The JRAs involve large distributed teams and so each requires a formal internal management structure. Each activity has its project manager, responsible to the Opticon Executive. The JRAs will each have one full team annual meeting (which the project scientist normally attends), to ensure good communications, technical review and budget progress monitoring. The several sub-WPs provide formal internal reporting (and project deliverables) at relevant deadlines, with in each case the external projects to which the specific work is contributing being the immediate technical performance assessment system. This provides the design and study reviews in the most objective and expert way practical.

Specific sub-WP progress meetings are held as appropriate for each activity – in practise this ranges from several times per year to once per year. Day-to-day communications are managed through telecons and email. This process minimises duplication of reporting, micro-management, and ensures clarity of decision making, and responsibility. It has proven to work extremely well over the past several years.

The management team is small but dedicated and experienced. At its heart is the Project Scientist, who has a double role. He leads the implementation of the Access programme, manages the Calls for Proposals, the Allocation Review process, the implementation and funding of successful applications, the feedback to unsuccessful applicants, the complementary feedback to the Training Networks, to learn from and respond to lessons learned, and the interface to the Telescope Directors' Forum. His second role is to attend regularly the JRA and network team meetings. Through these attendances information transfer between activities is assisted and an objective assessment of the actual state of progress in each WP is made available to the management team. The second key aspect of the management is the Coordinator's PA. She manages the reporting and communications between the EC and the Consortium, especially the Periodic Reports, and organises Board and Executive meetings. Both the Project scientist and the Coordinator's PA have been in post for several years, and have considerable proven experience. Importantly, they have built robust personal relationships with the very many administrative and technical management groups involved in Opticon. This structure leaves the Coordinator to focus on strategy, top-level communications with agencies and financial monitoring. In this last he is supported by the UCAM Finance Team.

The formal remit of the central management team will continue as at present, with the following (continuing) remit:
The project office will undertake the following tasks:

- Provide secretariat support for the Opticon Board and the Opticon Executive Committee – prepare and/or commission papers, reports, etc; organise meetings; take minutes, etc.
- Commission from the various elements of the Opticon programme the reports, forward projections and other documentation required for EU reporting.
- Receive financial and progress reports from the various elements of the Opticon programme.
- Assemble and collate the commissioned reports and provide any covering or overview documentation for EU reporting and submit to the Opticon Co-ordinator for approval and submission to the EU.
- Ensure that plans, schedules and forward projections for the various elements of the Opticon programme are reviewed annually.
- Create and maintain the central Opticon Web page and presence.
- Promote the activities of Opticon in international forums.
- Receive reports for the Executive Committee from the Access programme, including the financial reports and reconciliation of expenditure against advances.
- Receive annually proposals and cost estimates outlining the planned programme of networking activities.
- Prepare the Coordinator papers for the Executive Committee for decisions on which programmes and activities will be supported.
- Receive progress reports, financial reports and forward projections of activity and financial requirements from the Network Chairpersons.
- Receive details (schedules and documentation) of Project Management Committees from the Principal Investigators of each Work Package.
- Attend Work Package meetings as appropriate.

In summary, the Opticon management structure applies proven best-practise, has been successfully in operation for several years, is regularly reviewed by national agency representatives, minimises duplication of effort and maximises efficiency and robust review of performance. The key feature is that the proven management structure is matched, by experience, to the complexity and scale of the project.

2.2 Individual participants

Partner 1: UCAM: Cambridge University, UK

Cambridge University is a large teaching and research University with a high international reputation. Cambridge has a significant involvement in scientific research leadership, and in technological developments. Managerially, a central Research Support Division provides legal, financial management and transfer services, and management support as needed to support proposals and projects. This specific activity is based in the Institute of Astronomy (IoA), a large research and teaching institute with a very high international reputation, and its own management support team. The relevant staff include the project Coordinator, Prof Gerry Gilmore, Professor of Experimental Philosophy and Opticon Coordinator through FP5 and FP6, and Suzanne Holland, Opticon PA. Both have experience in coordinating and managing Opticon, and delivering EC reports and audited accounts as required. The technical involvement in Interferometric image reconstruction involves the very strong research group in the Cavendish physics department. This group has been in place since the first applications of interferometry in astronomy (under Sir Martin Ryle) and leads Europe's participation in the Magdalena Ridge interferometer.

Partner 2: CNRS: Centre National de la Recherche Scientifique, France

Since CNRS hosts many groups with leading roles in 5 JRA activities, we provide a full description here. CNRS is the French national research organisation, funded by the Ministry of Research. Among its many constituent laboratories, several play leading roles in Opticon. These include Marseille, Lyon, Nice, Grenoble and Paris. CNRS is also operating in collaboration with its academic partners the 2-metre class Bernard Lyot and Haute-Provence telescopes, and is a partner in the CFHT, which participate in the TNA Access programme.
CRAL (Centre de Recherche Astrophysique de Lyon) is a joint laboratory of CNRS, University of Lyon 1 (Université Claude Bernard Lyon 1) and École Normale Supérieure de Lyon. CRAL has a well-known track record in instrumentation for major observatories, particularly in the field of 3D spectroscopy. CRAL has also strong expertise in high resolution imaging techniques, adaptive optics, laser guide stars, MCAO, image deconvolution, etc. The group involved in Opticon belongs to the AiRi team (Astrophysique et Imagerie aux Résolutions de l'Interférométrie), focused on high angular resolution astronomy, from instrumental developments, control and signal processing, to the astrophysics of the observed objects. The AiRi team has always been involved into interferometric projects, working on interferometers (mono-pupil like SPID, multi-pupils like GI2T, AMBER and now CHARA/VEGA), on photon-counting detectors (required at visible wavelengths) and on analysis and processing of the interferometric signal and data. Its expertise in interferometric data processing has led to major achievements in model fitting and image reconstruction.
Key staff members at CRAL include E. Thiébaut who will coordinate WP4 and M. Tallon who will actively contribute to WP1 activities.
IPAG (Institut de Planétologie et d'Astrophysique de Grenoble) is a joint research unit of CNRS and Université J. Fourier. IPAG was created in 2010 from the merging of two distinct research laboratories, LAOG (Laboratoire d'Astrophysique de Grenoble) and LPG (Laboratoire de Planétologie de Grenoble), with research themes spanning from planetary subsurfaces to the edge of the universe. IPAG has also developed over the past 15 years a strong expertise in the fields of high angular resolution and high contrast imaging, using both adaptive optics coupled with coronagraphy and stellar interferometry. IPAG has significantly contributed to several instruments for ESO. Research and development activities have been led by IPAG in parallel to instrument deployment, mainly related to integrated optics for interferometry, mini/micro deformable mirrors for adaptive optics and fast low-noise detectors for wave front sensing, the latter two being substantially supported by EC, through Opticon JRA1/JRA2, during FP6 and FP7. IPAG is currently the leading institute of the consortium in charge of the development of the SPHERE second-generation instrument for the ESO VLT, to be delivered by mid-2012, and was also the Co-PI for the phase A study of the future EPICS instrument for the E-ELT.

Key IPAG staff include: Dr. Jean-Luc Beuzit will coordinate the WP1 activities (adaptive optics concepts and technology). He has been involved in the development and deployment of several adaptive optics systems for astronomy and is currently the Principal Investigator of the SPHERE project. Dr. Philippe Feautrier will be the manager of the WP2 (detector development). He has coordinated these efforts since the very beginning of the Opticon activities related to the development of fast and very low noise detectors for astronomy.

LAM (Laboratoire d'Astrophysique de Marseille) is one of the most important public research institutes in Europe in the area of astrophysics. It associates fundamental research in astrophysics with technological research in instrumentation. LAM has internationally recognized expertise in Active Optics, Adaptive Optics, Micro Optics, Detectors and has a significant involvement on the ESO E-ELT project, as PI of two E-ELT instruments phase A studies (EAGLE and OPTIMOS-DIORAMA).

Key members of staff for WP1, WP2, WP5 and WP6 are: E. Hugot, Researcher in optics and instrumentation for future large ground based and space borne observatories, Active Optics specialist; S. Vives, Research engineer in optical design, PM of ESA second STARTIGER initiative, ASPIICS system engineer; F. Zamkotsian, Researcher and head of the optics and instrumentation R&D group; J.L. Gach, Research engineer and detectors and controllers specialist; B. Leroux, Lecturer, responsible of the adaptive optics activities; M. Ferrari, Astronomer, LAM deputy director, in charge of the R&D department; J.G. Cuby, Astronomer, LAM Director, PI of an ESO E-ELT Instrument (EAGLE) Phase A Study.

LESIA (Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique) develops scientific instruments both for ground-based telescopes and for space missions. The laboratory has 146 permanent staff members including 70 engineers and technicians. LESIA has a long experience in adaptive optics (AO) system developments and on-sky tests: COME ON in 1990, ESO 3.6-m ADONIS, CFHT 4-m PUEO and VLT 8-m NAOS in 2001. LESIA has also studied large field AO concepts like the multi object AO, built the Sesame AO bench for laboratory R&D, developed AO-aided Retina imaging techniques for human eye and is more recently contributing to the development of the AO system of the SPHERE instrument for the VLT. The LESIA is also involved in the study of stellar coronagraphy for exo-planet detection since 2000.

Lagrange laboratory is a new merging (effective on 1st January 2012) between CNRS Cassiopée and Fizeau laboratories at the Observatoire de la Côte d'Azur, which have been involved in optical interferometry for more than 35 years. After pioneering developments, Fizeau developed the AMBER instrument on VLTI, and is now responsible for the MATISSE second-generation instrument for the VLTI. Fizeau has also developed the VEGA visible instrument on the CHARA Array (PI D. Mourard). Many prospective studies are developed in the field of optical interferometry and science cases, through important skills in conceptual designs, physical modelling of astrophysical sources, and through collaborations on advanced tools for interferometric image reconstruction: locally with a Signal Processing team, nationally (JMMC, collaboration through French ANR) and on the European level (collaboration Opticon). The new Lagrange laboratory will have about 124 permanent staff members, including 40 engineers and technicians.

Partner 3: Istituto Nazionale di Astrofisica, Italy

INAF is the National Institute for research in astronomy in Italy. It runs 19 research institutes in the country. It coordinates and directly finances the astronomical research for the whole non-university based community, therefore more than 90% of the researchers in the field belong to INAF; the large majority of University professors are associated to INAF. It has more than 1000 permanent staff, of which about 600 are researchers. Presently, about 300 postdoctoral, graduate students, fellows and consultants are involved in INAF research activities.

All national astronomical ground-based facilities are built, maintained and run by INAF; among these it is worth mentioning the 4-meter Galileo Telescope in the Canary Islands, which is part of the TNA Access programme, the twin 8-meter LBT Telescope in Arizona (25% share), the two 32-meter VLBI antennas in Sicily and Bologna, the 60-meter antenna being presently built in Sardinia (SRT). Several INAF institutes are activity leaders in Opticon. Among these, Brera and Padova Observatories are involved in Opticon FP7 (2009-2012).In the field of ground-based instrumentation development relevant to this project, Brera took part in the realisation of the 3 VLT instruments, several instruments of the TNG telescope and others for telescopes of smaller size. Expertise developed in this field covers the field of Optics, mechanics, finite element analysis, system engineering and project management. Brera has specialised in the area of new materials and processes in optics for Astronomical Instrumentation. Among those are ion beam figuring for the final shaping of complex optical surfaces and the introduction of polymers with non-linear optical properties in the design and development of instrumentation.

Brera was the leading institute of JRA6 of Opticon FP6. The PI of this JRA is Filippo Maria Zerbi. He was PI of the REM project (2000-2005), Italian National Project Manager of the X-shooter@VLT spectrograph (2002-date) and Coordinator of the JRA6 in Opticon FP6 (2004-2008). In Opticon FP7, Brera coordinates WP6 instrumentation.

Padova Observatory has a history in the development of ground-based telescopes and instrumentation, mainly due to a leading role in the Telescopio Nazionale Galileo (TNG) project. The Galileo experience started the growth of technological skill in most of the Italian Astronomical Institutes, but leaving strong footprints in Padova in the field of System Engineering, Optics, Opto-mechanics and detector technologies. Padova Observatory headquarters are equipped with recently refurbished laboratories for Optics and Opto-electronics with clean rooms and cyro-thermal facilities. Padova is a leader in Italy for the research and development in the area of Infrared Detectors controllers. The Observatory is also very active in the area of innovative processes for optics fabrication. A key team member is Favio Bortoletto, PI of the atmospheric tip-tilt real-time corrector of the ESO-MPIA 2.2M at La Silla Observatory (1986-1988), responsible for the hardware and software development for the Observing Ground Segment (OGS) of the IR camera (ISOCAM) mounted in the ISO satellite (1988-1990), appointed director of TNG (1998-2000). Padova took part in JRA5 of the Opticon FP6 project (2004-2008) and in WP6 of Opticon FP7.

The Observatory of Rome (Osservatorio Astronomico di Roma, OAR) is one of the astronomical observatories and institutes of INAF and is characterised by a broad interest in a variety of fields of astronomical research and instrumentation. 41 research staff work at the OAR together with 29 (plus 7 temporary positions) administrative and technical staff. A total of 20 PhD students and 11 Post-Docs are currently involved in the research activity.

Dr. Isobel Hook has led the Opticon E-ELT science network in both FP6 and the current FP7 programme. In the proposed programme, she will lead the ELT science component of WP10 "E-ELT Science and Tools". She has been closely involved in the E-ELT project since 2003. She was Deputy Project Scientist and later Project Scientist for the EU FP6 "ELT Design Study" programme (2003-2008) and WP manager for the Design Reference Mission WP within the FP7 "ELT Preparatory Phase" programme 2008-2009 (both programmes led by ESO). She also currently chairs the Science Working Group for the E-ELT project.

Partner 4: Max Planck Gesellschaft, Germany

MPG participation in Opticon is managed through the MPIA. MPIA is the Max-Planck Institute for Astronomy in Heidelberg which is an astronomical research institute with more than 260 staff. MPIA runs a vast instrumentation programme for ground based observatories such as the Very Large Telescope (VLT) and the Large Binocular Telescope (LBT). Present activities include Prima, Sphere, Gravity, and Matisse for the VLT, and Luci and the Linc-Nirvana interferometer for the LBT.

MPIA is a member of consortia building the E-ELT instruments METIS and MICADO. Together with the IAA in Granada, MPIA is a partner in the operation of the Calar Alto observatory. Apart from instrumentation developed for ground based observatories, MPIA participates in international consortia that provide instruments for Herschel, JWST, and other space missions. MPIA is responsible for the operation of the 2.2m telescope on LaSilla which partakes in the Access programme. Roland Gredel from MPIA is participating in WP8 as a member of the Executive and is Chairman of the Board.

Partner 5: Science and Technology Facilities Council, UK

STFC is the UK national funding agency for astronomy, particle and nuclear physics. Its involvement in Opticon includes several telescopes in the Trans-National Access programme, and technical leadership roles in several WPs, including hosting the Opticon Project Scientist. These activities are all managed through the UKATC.

The UK Astronomy Technology Centre (UKATC) is the UK's National centre for the design and production of world leading astronomical telescopes, instruments and systems. It has delivered hardware to both space missions (e.g. Herschel and JWST) and the telescopes of the European Southern Observatory (Chile), the Isaac Newton Group of Telescopes (La Palma), Gemini (Chile/Hawaii) and the UK Infrared Telescope (Hawaii), the James Clerk Maxwell Telescope (Hawaii) and the ALMA telescopes (Chile). To meet the needs of these customers the UKATC employs staff with specialist expertise including: systems engineering and project management; infrared/sub-mm optical design; cryogenics and low-temperature engineering; mechanism design and analysis; stiff structures with low vibration. Key members of staff for Opticon are:

Dr John Davies is the Opticon FP7 Project Scientist, a role which he has successfully carried out in previous FP contracts. He has considerable operational and scheduling experience of the UKIRT 4m telescope and has used most of the telescopes in the TNA programme. He has driven the formation and execution of the Opticon Common Time Allocation process which has been implemented during the existing contract. John Davies has a PhD in Astronomy and experience of the commercial aerospace sector as well as academia. **Prof C. Cunningham:** PI for WP9 Colin Cunningham (CEng, FIET) is an electronic and systems engineer with 35 years experience in the development of scientific instrumentation and interactions with industry. He has a major role with the UK E_ELT project. **Dr H. Schnetler:** Systems Engineer. Participant in WP5, Dr Schnetler has a PhD in Software Engineering, an MIng in Systems Engineering and a BIng in Electronics Engineering. She has worked for several high-tech engineering companies including aerospace and is currently the Head of Systems Engineering at the UK ATC. **Dr C. Evans**: has a PhD in Astronomy (2001) and is the instrument scientist for the EAGLE study for a near-IR, multi-object spectrograph for the E-ELT, and for new studies for multi-object spectrographs for the WHT in La Palma and for ESO's VLT. He is the PI of an ESO Large Programme with VLT-FLAMES. He will play a key role in WP9, the Innovation Network.

Partner 6: European Southern Observatory, Germany

ESO is the intergovernmental European Organisation for Astronomical Research in the Southern Hemisphere. On behalf of its fourteen member states, ESO operates a suite of the world's most advanced ground-based astronomical telescopes located at the La Silla Paranal Observatory in the Atacama desert in Chile. The ESO Headquarters are situated in Garching near Munich, Germany. ESO's 14 member states are: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland and the United Kingdom. Brazil membership is under negotiation.

ESO is the largest observatory in Europe and is coordinating the construction of large infrastructures and instruments like the Very Large Telescope (VLT), the VLT interferometer, ALMA and is designing and planning construction of the future 42m European Extremely Large Telescope.

Representatives from the ESO Adaptive Optics and Detector Departments will actively participate in the scientific committees of JRA1 and 2 and will provide advice in technical areas directly related to the ESO existing and future facilities. ESO will also be part of the Opticon Board. Rowena Sirey is the ESO management link. Technical leads are nominated as appropriate in each instance.

Partner 7: Consejo Superior de Investigaciones Cientificas, Spain

The Spanish National Research Council (CSIC) is the largest public institution dedicated to research in Spain and the third largest in Europe. Belonging to the Spanish Ministry of Science and Innovation through the Secretary of State for Research, its main objective is to develop and promote research that will help bring about scientific and technological progress, and it is prepared to collaborate with Spanish and foreign entities in order to achieve this aim. According to its Statute (article 4), its mission is to foster, coordinate, develop and promote scientific and technological research, of a multidisciplinary nature, in order to contribute to advancing knowledge and economic, social and cultural development, as well as to train staff and advise public and private entities on this matter. CSIC plays an important role in scientific and technological policy, since it encompasses an area that takes in everything from basic research to the transfer of knowledge to the productive sector. Its research is driven by its centres and institutes, which are spread across all the autonomous regions, and its more than 12,000 staff, of whom more than 3,000 are staff researchers and the same number again are doctors and scientists who are still training. CSIC has 6% of all the staff dedicated to Research and Development in Spain, and they generate approximately 20% of all scientific production in the country. It manages a range of important facilities the most complete and extensive network of specialist libraries, and also has joint research units. David Barrado is the key interface link with Opticon.

Partner 8: Office National d'Etudes et de Recherches Aerospatiales, France

ONERA (Office National d'Etudes et Recherches Aerospatiales) is the French national aerospace research laboratory. It is a public research establishment, with eight major facilities in France and about 2,000 employees, including 1,500 scientists, engineers and technicians. ONERA is both an active participant in research and coordination. ONERA develops scientific knowledge in its own laboratories and as a project leader, it uses this knowledge, combined with that of other French and European research teams, to lead multi-disciplinary research projects that are application focused. The ONERA Optics department gather more the 120 scientists who work on new and innovative optical concepts and systems over a wide wavelength range (from UV to far IR) for aeronautic, space and defence applications. In that context, it has developed, for more than thirty years, a unique expertise in high angular resolution and more specifically in the active and adaptive optics domain. Hence, after being in charge of COME-ONE, the very first astronomical AO system ever implemented on a large telescope, ONERA has successfully design developed and integrated NAOS, the first AO system of the VLT, the 8-m class telescope of ESO, in 2001. ONERA is now in charge of the extreme AO system for SPHERE (the future VLT planet finder instrument). In the meantime ONERA is deeply involved in the study and management of three E-ELT concept studies namely ATLAS, MAORY and EAGLE. ONERA also participates in the large adaptive optic mirror (M4) phase B study, led by CILAS. All these developments have been realized in close collaborations with our privileged academic partners (Observatoire de Paris, Grenoble and Marseille) which are now gathered in the GIS-PHASE partnership. ONERA is already deeply involved in FP6 and FP7 Opticon-JRA1 activities at system (preliminary design activities) and sub-system (control, wavefront sensor and DM) levels. Key members of staffs for this new FP7-Opticon JRA are T. Fusco: project manager of SAXO, the Extreme AO system of SPHERE instrument, PI of ATLAS, the Laser tomographic AO system of the E-ELT, AO responsible of EAGLE, the 3D multi-object spectrograph of the E-ELT, J-M Conan: Co-PI of MAORY, the phase A study for the MultiConjugate AO system of the E-ELT, in charge of AO control aspects in FP6 and FP7, C. Petit: responsible of SAXO integration and tests and in charge of wide field AO experimental validations, L. Mugnier : in charge of innovative AO post processing development

Partner 9 : Stichting Astronomisch Onderzoek in Nederland, The Netherlands

ASTRON is the Netherlands Institute for Radio Astronomy, and is part of the Netherlands Organisation for Scientific Research (NWO). It provides front-line observing capabilities (e.g. WSRT and LOFAR) for Dutch and international astronomers across a broad range of frequencies and techniques. It has a strong technology development programme, encompassing both innovative instrumentation for existing telescopes and the new technologies needed for future facilities. ASTRON also conducts a vigorous programme of fundamental astronomical research. ASTRON provides overall coordination and management of RadioNet. Between 1995 and 2008, the optical instrumentation group was part of the ASTRON research and development department. From 2008 onwards, this group was taken over by NOVA (partner 21), but ASTRON provides the housing, support and infrastructure for the NOVA-ASTRON instrumentation group. This group developed in collaboration with other European partners instruments for the VLT and VLTI of ESO, the William Herschel Telescope of ING at La Palma and JWST.

Role in Opticon FP7 Phase 2: Dr. Lars B. Venema leads the Active Freeform Mirror JRA. He is senior researcher and system engineer in astronomical instrumentation. He has been involved in the definition and start up of the projects MIRI for JWST, X-Shooter for the VLT, SPHERE for VLT, and Matisse for the VLTI. He is also our system engineer for the Dutch contribution to E-ELT instruments like METIS and EPICS. Gabby Kroes is a mechanical lead engineer of the optical instrumentation group and is specialised in cryogenic precision mechanics.

Partner 10: Instituto de Astrofisica de Canarias, Spain

The Instituto de Astrofísica de Canarias (IAC) is an internationalised Spanish research centre. It is responsible for the operation of the Canary Islands' Observatories (Teide and Roque de los Muchachos Observatories), where more than 60 international research institutions from 19 countries have installed and operate their telescopes. The IAC main headquarters, located in La Laguna, is the normal workplace for the main part of its staff. A secondary HQ is located in La Palma at sea level. Scientific research in astrophysics, the operation of the Canary Island's observatories, development of advanced instrumentation, training of young researchers/ technicians and public outreach, are the main objectives of this organisation.

This institution have been an active member of the Opticon Board from the very beginning of the coordination network, and participates in many of the Opticon activities. The IAC is also involved in the Access programme, as well as in the activities related to the study of new materials and processes for astronomical instrumentation (VPHGs). Francisco Garzon Lopez leads the Opticon activities.

Partner 11: Department of Innovation, Industry, Science and Research, Australia

The Australian Astronomical Observatory (AAO), a division of the Australian Government's Department of Innovation, Industry, Science and Research, operates the Anglo-Australian Telescope (AAT) and the UK Schmidt telescope (UKST) on behalf of the astronomical community of Australia. The Observatory is part of and funded by the Australian Government. Its function is to provide world-class observing facilities for Australian and international optical astronomers. The AAO has been managed by the current Director, Professor Matthew Colless, since 2004. Prof. Colless is an internationally recognised expert in observational cosmology and team leader for a number of large galaxy surveys that have made major contributions to measuring the constituents of the universe and the properties of galaxies. Other key staff are the AAO's General Manager, Mr Neville Legg, who will be responsible for the financial administration of the Opticon programme, and the AAO's Opticon liaison, Dr Gayandhi De Silva, who will manage the AAO's involvement in the Access programme for FP7 and also sits on the TDF sub-committee which validates the outcome of the Common Opticon time allocation process.

AAO staff pioneered the concept and early development of integrated photonics spectrographs, including the first prototype array waveguide spectrograph developed for astronomy, and are currently developing OH-suppression fibres for near-infrared spectroscopy. AAO partnered Durham University in two projects aimed at applying photonics to critical problems of astronomical instrumentation for current and future extremely large telescopes. AAO has extensive experience with the design, manufacture, integration, test, operation, and scientific exploitation of fibre optical instrumentation (e.g. 2dF, 6dF, OzPoz, FMOS-Echidna, AAOmega, SPIRAL, CYCLOPS, HERMES, GNOSIS, KOALA). Staff have particular experience in the investigation of the properties of infrared optical fibres and developing infrared fibre instrument concepts. Dr Jon Lawrence leads the AAO's astrophotonics research and fibre-optic instrumentation, including OH-suppression fibres and photonic spectrograph development.

Partner 12: Nordic Optical Telescope Scientific Association, Sweden

The Nordic Optical Telescope (NOT) Scientific Association (NOTSA) was founded in 1984 to construct and operate a Nordic telescope for observations at optical and infrared wavelengths. The current Associates (ie, members of the entity) of NOTSA are the relevant Nordic country national funding agencies:

- Forskningsrådet for Natur og Univers (Denmark)
- Suomen Akatemia (Finland)
- Háskóli Íslands (Iceland)

- Norges forskningsråd (Norway)
- Vetenskapsrådet (Sweden)

NOTSA represents these agencies in AstroNet (chairing the Board 2005-2010), ensuring the link to the overall AstroNet planning, and has participated in Opticon since FP5. The NOT telescope is a heavily oversubscribed participant in the current Opticon Access programme, and has developed an advanced set of training programmes as well. The director, Johannes Anderson, is the Opticon work leader.

Partner 13: National Observatory of Athens, Greece

NOA-IAA operates two Observatories; Helmos and Kryoneri Observatories where a 2.3m and a 1.2m telescope exist, respectively. NOA-IAA staff have experience in specific site characterisation measurements (DIMM). At Helmos Observatory there is the 2.3m “Aristarchos” telescope which is being developed, preparatory to being offered under the Opticon Trans-national Access programme. NOA-IAA are part of this project in order to provide site characterisation measurements as well as to gain important knowledge from more experienced Observatories. Staff: Panayotis Boumis, scientist, optics, coordinator from NOA-IAA, Emmanuel Xilouris, scientist, optics, Athanassios Katsiyannis, scientist, site testing.

Partner 14: Liverpool John Moores University, UK

LJMU is a major university which operates the Liverpool Telescope, which is part of the Access programme.
The Liverpool Telescope is a fully robotic 2 metre aperture optical and near infra-red telescope. It is the largest fully robotic telescope in the world, and offers unique rapid-response capabilities for optical studies of transient sources or follow-up of sources detected at other wavelengths. The instrumentation offered consists of two optical CCD cameras (one optimized for high time-resolution studies), an infra-red camera, an optical single-shot polarimeter and an optical, fibre-fed double-beam spectrograph. The Institute on the basis of this expertise has a leading role in WP11, Time Domain Astronomy, as the Telescope is one of the leading facilities which are involved in that science. The programme director, Ian Steele, leads the Opticon work effort.

Partner 15: Universidade do Porto, Portugal

The University of Porto is the largest Portuguese University. The School of Engineering (UPORTO) being its main school. The school has 24 R&D/interface units ranging from chemistry to precision mechanics and biomechanics.
Dr. P.J.V.Garcia is a tenured associate professor at UPORTO where he heads the Porto SIM Pole (Laboratory for systems, instrumentation and modelling for environment and space). SIM is a joint Porto University and Lisbon University research unit focused on instrumentation, essentially for the European Southern Observatory and European Space Agency. SIM has built the CAMCAO camera for the multi-conjugate adaptive optics system MAD, it leads the Portuguese Very Large Telescope Interferometer instrumentation programme including the participation in the consortium of GRAVITY and participates in the ESPRESSO radial velocity instrument consortium. The unit leads the Portuguese participation in the GAIA mission.
Dr. Garcia has coordinated and participated in several European projects as well as nationally funded projects totalling over 1M€ of directly managed funds. He served at the ESO scientific and technical committee closely following the implementation of the second generation monolithic instrumentation, is a board member of the European Interferometry Initiative.

Partner 16: Politecnico di Milano, Italy

The Politecnico di Milano was established in 1863 with the name of "Istituto Tecnico Superiore" under the leadership of Francesco Brioschi. Deliberately planned along the lines of the polytechnics in German speaking countries by a group of academics and professors, local administrations (The City of Milan, the Province of Milan, the Chamber of Commerce and the Cassa di Risparmio delle Provincie

Lombarde), cultural associations and entrepreneurs from the most prominent Milan families, the university was first located in the Collegio Elvetico in today's Via Senato. It was opened on November, 29th, 1863 and started out with 36 students.
The Politecnico di Milano is now a science and technology university producing engineers, architects and industrial designers through a variety of innovative specialist courses, with great attention being devoted to all aspects of education. The Politecnico di Milano has always been based on quality and innovation in teaching and research, resulting in a prolific relationship with the economic and manufacturing worlds through experimental research and the transfer of technology. For many years POLIMI played a major and highly successful part in new materials modeling and creation under Prof Zerbi. This work will continue under Dr Chiara Bertarelli.

Partner 17: University of Durham, UK

Durham is one of the UK’s leading universities, with specific expertise in astronomical instrumentation through its Centre for Astronomical Instrumentation, housed in a large modern facility. CfAI has a long heritage in design and construction of innovative facility-class instruments: it pioneered robot multifibre systems (with AAO); developed monolithic techniques for image-slicing integral field spectroscopy; produced the first integral field spectroscopic facility on an 8/10m telescope; and is very experienced with multiple fibre systems. Recent instrument projects include GMOS (Gemini), FMOS (Subaru), KMOS (ESO-VLT) and NIRSpec-IFU (JWST). It is also a major centre for Adaptive Optics (real-time systems, on-sky demonstration and numerical modelling and laser beacons), and has recently adapted astronomical techniques to the life sciences. It has produced extensive publications on astronomical applications in photonics, is a partner with AAO on two Astrophotonics projects, and has extensive test and metrology facilities and a precision optics micro-optics facility. The group has also hosted the laboratory integration and test of experimental and facility AO systems (ELECTRA, NAOMI, RTD, and the Durham contributions to CANARY) and will re-use the laboratory facilities and expertise in WP 1.
Staff Profile: Jeremy Allington-Smith, PhD, FRAS, mIAU : Associate Director of CfAI and university Reader (leader of many integral field and multi-object spectroscopy projects). Coordinator of AstroPhotonica Europa. WP3 co-leader. Senior engineer and project manager. Graham Murray: Experienced fibre system scientist, constructor of first 8/10m-class IFU. Richard Myers: Associate Director of CfAI and university Reader, PI for the CANARY project.

Partner 18: National University of Ireland, Galway, Ireland

The National University of Ireland, Galway was established in 1845 and currently has over 15,000 students undertaking a range of taught programmes and research throughout its seven faculties and many Research Centres. The university currently manages over 70 EU projects and since 2000 NUI, Galway has won over €70m in research funding. The main task that is attributed to NUI, Galway is the principal investigator of the HTRA component of the ELT Science Network, Dr. Andrew Shearer.

Partner 19: Astrophysical Institute Potsdam, Germany

The Leibniz Institute for Astrophysics Potsdam (AIP) is registered under German Law as a non-profit governmental research organisation in Brandenburg, Germany. The key research topics are cosmic magnetic fields and extragalactic astrophysics, with a considerable part of the institute's efforts aim at the development of research technology in the fields of Astrophotonics, spectroscopy, robotic telescopes, and e-science.
The AIP is the successor of the Berlin Observatory founded in 1700 and of the Astrophysical Observatory of Potsdam founded in 1874. The latter was the world's first observatory to emphasize explicitly the research area of astrophysics. In this project AIPs main efforts are:
(i) Leading the Astrophotonics work package (WP3); (ii) Photonic Spectroscopic System design; (iii) Leading the development of Photonic OH-Suppression filters; (iv) Integrated Photonic Spectrograph development; (v) Leading the system prototype development; (vi) Engagement in outreach, innovation and dissemination activities. Expertise: AIP staff have extensive experience with Astrophotonics, Photonic OH-Suppression Filters development, Integrated Photonic Spectrograph development; System

design, manufacture, integration, test, operation, and scientific use of fibre optical instrumentation (PMAS-LARR, PMAS-PPak, VIRUS-P, VIRUS-P2); Data reduction and analysis software for fibre-optical IFUs (PMAS, SPIRAL, INTEGRAL, VIMOS, FLAMES, VIRUS, IMACS); Coordination of EC-funded Euro3D Research Training Network (FP5) on the subject of integral field spectroscopy (IFS), involving fibre-coupled lens array IFUs Relevant Staff: Roger Haynes (Head of Astrophotonics at innoFSPEC Potsdam); Martin M. Roth (Founder of innoFSPEC Potsdam); Bernhard Roth (InnoFSPEC Centre manager and laser scientist; Jose Chavez-Boggio (photonic scientist in non-linear photonics); Harendra Fernando (photonic scientist in integrated photonics); Jean-Christophe Olaya (optical engineer and optical fibre transitions expertise); Emil Popow (manufacture, integration and test of astronomical instrumentation); Additional photonic scientist with background in fibre Bragg grating, design and manufacture.

Partner 20: Uniwersytet Warszawski

Warsaw University Astronomical Observatory (OAUW) is part of the largest university in Poland – University of Warsaw. The Observatory was funded in 1825 and it continuously carries out the scientific research and educational work. OAUW is a relatively small institute, with 12 astronomers with the positions corresponding to Associate Professor and higher, plus typically 2-3 astronomers with research position. The institute conducts the undergraduate and graduate studies in astronomy, with usually about 10 PhD students.

OAUW hosts headquarters to the two major Polish astronomical projects: Optical Gravitational Lensing Experiment (OGLE) and All Sky Automated Survey (ASAS). OGLE has been operating continuously since 1992 and is now in its fourth phase collecting time-domain photometric data for nearly a billion stars in the densest regions of the sky using a dedicated telescope in the Las Campanas Observatory, Chile. The scientific outcomes of the OGLE include detections of the first microlensing events and discoveries of planets with microlensing and transit methods. OGLE is supported by the European Research Council grant under the European Community's FP7 programme. ASAS is another long-term photometric monitoring survey, conducting all sky observations from two stations in Chile and Hawaii since 1997. The staff of the Warsaw Observatory is also involved in many other observational leading world projects, including Araucaria Project, the Planck and Gaia satellite missions, HESS and VIRGO collaborations.

The expertise in the time-domain astronomy gained over many years by the Warsaw astronomers makes the OAUW an ideal place to conduct the Opticon- tasks within the time-domain activities.

Key staff members: Łukasz Wyrzykowski (Gaia alerting system, studies of transient events), Andrzej Udalski (PI of the OGLE), Igor Soszyński (variable stars), Grzegorz Pojmański (PI of the ASAS), Szymon Kozłowski (data reductions, time-domain quasar studies).

Partner 21 : Universiteit Leiden on behalf of Nederlandse Onderzoekschool Voor Astronomie (NOVA), Netherlands

NOVA is a federation of the astronomical institutes at the universities of Amsterdam, Groningen, Leiden, Nijmegen and Utrecht, currently legally represented by the Leiden University. NOVA is one of the six national top research schools. NOVA's status and funding are secured by the Dutch Minister of Education, Culture and Science through at least 2018. NOVA astronomers have experience in the chain from scientific idea, instrument concept, design and construction to successful science data collection and analysis for instruments at international facilities on the ground and in space. For The Netherlands, NOVA was the prime contract partner for ESO for scientific instrumentation projects for the VLT, the VLT Interferometer, ALMA, and for the E-ELT and for ESA on JWST-MIRI and Gaia-DPAC. The NOVA Optical Infrared Instrumentation Group hosted at ASTRON is the national expertise centre for optical-infrared astronomical instruments. Its expertise also includes working experience on systems aspects of astronomical instruments, opto-mechanical design, cryogenics and construction and testing of complex instruments. The group designed and constructed many scientific instruments such as VISIR, MIDI, X-Shooter, Matisse and MIRI, in cooperation with ASTRON, SRON, industry and international partners. UL-NOVA's task within WP5 comprises the development of active freeform mirrors to enable reduction of complexity of future instrumentation with applications in various disciplines. UL-NOVA's involvement in this project is led by Dr. Lars Venema. He is senior researcher and system engineer in astronomical instrumentation. He has been involved in the definition and start up of the projects MIRI for JWST, X-Shooter for the VLT, SPHERE for VLT and Matisse for the VLTI. He is also our system engineer for the Dutch contribution to E-ELT instrumentation like METIS and EPICS.

Partner 22: Heriot Watt University, United Kingdom

Heriot Watt University (HWU) is a world leader in many areas of photonic science, including Ultrafast laser inscription (ULI) - one of the key technologies required for astrophotonics. Dr Robert Thomson is based in the Physics department at HWU and is an expert in the technology and applications of ULI – a revolutionary 3D photonic device fabrication technology. In 2009 he proposed (together with Jeremy Allington-Smith at the Centre for Advanced Instrumentation at the University of Durham) that the unique capabilities of ULI would make it an enabling technology for astrophotonics. In June 2010, Thomson started a 5-year STFC Advanced fellowship aimed at investigating the astrophotonic applications of ULI. Recent highlights of the fellowship include a post-deadline paper at the 2010 Frontiers in Optics Conference in Rochester-NY, the first conference to feature a dedicated session to astrophotonics, and the first demonstration of an integrated photonic lantern [R. R. Thomson et al, "Ultrafast laser inscription of an integrated photonic lantern," Opt. Express 19, 5698 (2011)]. Thomson currently operates a dedicate ULI laboratory, and has access to a suite of photonic device characterisation equipment. These will be used extensively during the Astrophotonics project.

Partner 23: University of Bath, United Kingdom

The University of Bath is one of the UK's leading universities, with an international reputation for research and teaching at the highest academic standards. It has a distinctive approach that emphasises the education of professional practitioners and the promotion of original inquiry and innovation in partnership with business, the professions, public services and the voluntary sector. The University has 2707 staff, of whom 1542 are academic or academic-related. 60% of the work submitted for the 2008 Research Assessment Exercise was judged to be "world leading" or "internationally excellent".The value of our research portfolio is over €120 million and annual research income is in the region of €37 million. The University has strong international links and has been involved in many European Commission funded projects through the various Framework Programmes and the Marie Curie schemes.
The PI at the Centre for Photonics and Photonic Materials (CPPM) is Prof Tim Birks. He has 25 years' experience in optical fibre technology, including a pioneering role in the development of the photonic crystal fibre, and invented the "photonic lantern" upon which the proposed PSS is based. The CPPM has world-class facilities for the design, fabrication and characterisation of novel optical fibres.

Partner 24: Alpao, France

ALPAO is a spin-off company of the Universit Joseph Fourier (Grenoble) and Floralis. It is a fast growing company proposing adaptive optics solutions for astronomy, vision science, microscopy and low power LASER. Alpao commercializes off-the-shelf and custom deformable mirrors for those fields of application. Furthermore, ALPAO proposes an original open toolbox called Alpao Core Engine for reducing the time-to-market of adaptive solutions.
Thanks to a unique portfolio of patents and licenses, ALPAO keeps innovating and introducing new breakthrough technologies.
In 2006 and 2008 ALPAO was recognised by the French Ministry of Research for its innovative technology. Other partners include the Institut de Planétologie et d'Astronomie de Grenoble, OSEO (French agency for the innovation), ANR, Region Rhone-Alpes, Grenoble Alpes Incubation, the Reseau Entreprendre and UBIFrance. Alpao CEO V. Tempelaere manages the Opticon activities.

2.3 Consortium as a whole

The Opticon consortium involves all the major national research infrastructure funding organisations which support optical-infrared astronomy infrastructures with telescopes larger than 2m aperture. It involves the national and multinational agencies which own and operate the infrastructures (observatories) which deliver the access, and allow the science. It involves the major technology research groups, in Institutes and Universities across Europe, which have proven capability to deliver successful R&D in advanced astronomical technology across Europe. It involves research groups in Universities and Institutes which provide specialist technical expertise, specifically relevant to new technologies not yet mainstream in astronomical applications. It involves industrial partners, in several countries, which can provide the specialist industrial-scale production facilities not available in research groups. Six of the 25 partners are newly introduced to the partnership specifically for activities in this contract, viz CSIC, AIP, UNIWARSAW, HWU, UBAH, and Alpao.

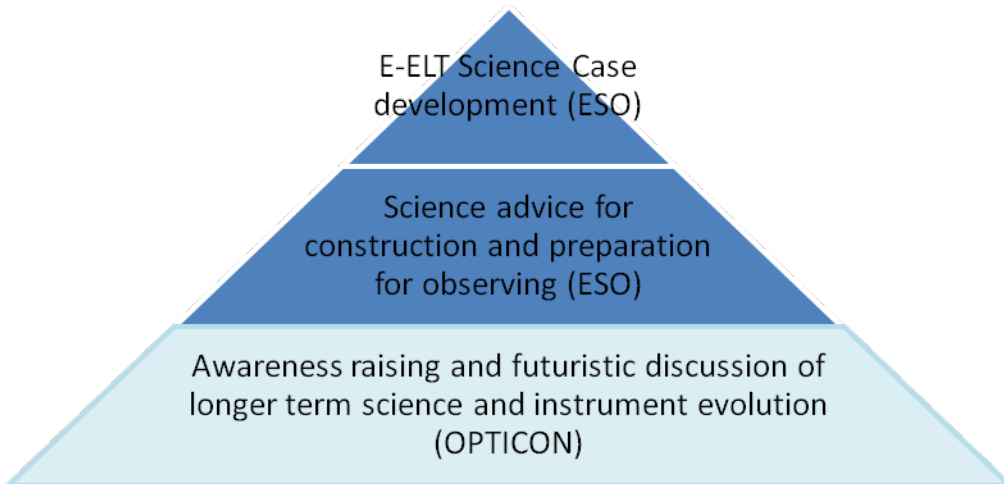
A key aspect of the Opticon consortium is inclusivity. It is this which makes Opticon a large community. This structure has been adopted after extensive review, with a goal to ensure that a coherent approach to the range of challenges facing next-generation astronomy technology can be delivered. Retaining involvement of apparently diverse communities is important, to allow synergies. An example is inclusion inside Opticon of the European Interferometry Initiative community (WP4, WP14). It may seem to a non-expert that interferometry is complementary to single-mirror telescope astronomy, but in practise both subjects are photon-starved, and need (and use) the same detector technology. Both subjects demand precision phase-stable opto-mechanical systems, in fringe-tracking and in adaptive optics. Thus it is maximally beneficial to integrate the communities for mutual advantage.

This situation evolves, and is monitored, to ensure the partnership is best-balanced at every time. For this contract, high spatial resolution ground based solar astrophysics has been judged to have reached critical mass, and to be clearly focussed on its own new major infrastructure, a new large solar telescope. Thus those activities, previously part of the FP7-1 Opticon, and contributing to and benefitting from Opticon developments in high-resolution adaptive optics, proposed to have their own I3 funding. ESO are now preparing to approve and implement construction of the European Extremely Large Telescope (E-ELT), the flagship future ambition for European astronomy. This is such a huge commitment ESO Council has been forced to limit all external commitments on its staff, to prevent possible timetable disruption. Thus ESO staff no longer lead Opticon work packages. Nonetheless, all relevant work continues in close collaboration with ESO, ESO staff continue to provide strategic direction, technical support, and to be available for technical reviews. ESO senior management continue to be represented on the Opticon Executive. Thus excellent communications, collaboration and consistency in developments is maintained.

In the construction phase of the E-ELT, ESO will be required to establish its own arrangements for obtaining scientific advice and guidance directly from the scientific communities of its Member States on all aspects related to the implementation of the project, including updates to the science case and assessment of evolving issues (such as assessing trade-offs between performance and technical or financial feasibility); and the direct issues regarding preparations for observing. This cannot be handled outside ESO. However, there will also be a need for activity relating to the development of a broader awareness of the scientific opportunities of the E-ELT and a more futuristic debate about the longer term development of the science and the instrumentation. During construction, ESO will not have the resources to pursue these debates, and Opticon activity in this area will be very beneficial.

The exact details of the ESO science advisory arrangements cannot be finalised until the ESO Council has approved the final construction proposal. ESO will work closely with the Opticon WP manager as these arrangements develop to ensure that maximum benefit is delivered to the science community by ensuring complementarity and avoiding duplication and unnecessary overlap.

The interface between ESO and Opticon is summarised in the figure below, developed by ESO.



ESO-Opticon Science Interface during E-ELT Construction

A new agency partner for this project is the Spanish national funding agency CSIC. Their involvement follows the evolving ownership of Europe's observatories, under the plan – described elsewhere – to coordinate and optimise operation of Europe's 2-4m telescopes. Many of these telescopes are located in Spain, and are making the transition from non-Spanish national facilities to jointly owned and operated facilities in new partnerships. Thus CSIC has a growing role in their future and is naturally involved as a full partner in Opticon. In addition, in the spirit of helping integration into the international astronomical community of new national developments, we provide observer status (at their expense) in relevant telescope operation/ access/ science exploitation discussions to representatives of the Iranian National Observatory, which is building a 3.4m telescope and which is collaborating in operation of the UK/NL/Spain facilities on the Canary Islands.

Specialist technology partners, complementary to the experienced astronomy research organisations, provide uniquely valuable expertise when potential applications of new technologies are being considered. This is especially true of photonics, where the technology is mature, yet new to astronomy. Here three partners (AIP, HWU, UBAH) have been identified which contribute expertise not otherwise available in the consortium. We anticipate very considerable mutual benefits from these new working partnerships. Industrial partnerships can have very special advantages in cutting edge R&D. In particular, there are, especially in optics manufacture and opto-electronics, industrial scale processes which are critical for technical developments, but which are simply unavailable on non-industrial scales. Here the continuing partnership of the high-tech industry ONERA is invaluable. The specialist SME Alpao is a very major participant in WP1, integrating this cutting edge R&D with its commercial innovation and application. A further mutual advantage, involving industrial spin-off, is described in Section 3.2.

Overall, and the real reason for the large number of partners in Opticon, is that RTD developments are pointless unless there is an optimised viable set of telescopes to benefit from the technologies. The programmes to push those facilities to their limits, and the number of facilities required, are determined by proposals to funding agencies which are based on the community's research ambitions. The community's research ideas are made robust and most wide-ranging by enabling and empowering the whole community. It is delivery of that joined-up vision which defines the Opticon consortium, and which is enabled by that consortium.

2.3.i) Subcontracts

The Opticon consortium has been structured to make available all key capabilities through partners. Nonetheless, some highly specialised system control expertise must be provided through external subcontracting, as this approach is very much more cost-effective, and utilises experience available only in specialist contractors. The work foresees only two external subcontracts.

1) One, to be managed by ONERA, is for development of specialist algorithms in real-time control, with value 16Keuro. Prospective suppliers with suitable capability have been identified.
2) The second, to be managed by ALPAO, with value 100Keuro, for the study of an optimised control method to limit the effects of mechanical resonances in large deformable membranes. Discussions with potential suppliers are underway, to ascertain possible suppliers and their competence level.

2.3.ii) Other Countries

There is no funding requested for countries outside the list of those approved for participation in EU funded activities. Inclusion of the Australian Astronomical Observatory delivers access to the AAT telescope, a capability specifically endorsed during the EC review process.

2.3.iii) Additional Partners

The Opticon partnership has been developed to include all necessary capabilities to complete the project, and to gain full value from its activities. No new additional partners are anticipated.
Third parties associated with the main parties include:
INAF has established the wholly-owned organisation FGG to manage the TNG telescope, and its TNA involvement. FGG access costs 114.738.40
CNRS has third-party agreements with its joint research units, specifically here UJF-Grenoble (IPAG), UCBL-Lyon (CRAL), Marseille (LAM), Obs de Paris (LESIA), Univ Paris Diderot-V (LESIA), and Univ Nice-Sophia Antipolis (LAGRANGE). All these, and their activities, are fully described in the relevant WP text. All relevant Opticon-related costs are managed through CNRS – these agreements are a formal requirement to support staff involvement. The third parties are fully described in \S2.2.

```
OBS       costs 523.200,00;   EU contribution 349.890,00
IPAG      costs 462.502,40;  EU contribution 346.876,00
UPD       costs 298.032,00;   EU contribution 223.524,00
CRAL      costs   44.998,40;   EU contribution   33.748,00
LAM       costs 688.550,40;   EU contribution 516.412,00
UNS       costs  333.000,00;  EU contribution 249.750,00
```

2.4 Resources to be committed

This section should be read in conjuction with the budget breakdown (Part A) and the several work effort distribution WT tables.

The Opticon partners are major institutions, industries, and funding agencies. All partners with leading responsibilities have a proven record of delivery of networks, organisations and technological R&D over many years. The newer partners have been elected to deliver specific expertise, and to widen the industrial involvement. All partners have been involved in the detailed development of their respective work package descriptions, staff effort allocations and resource allocations. Each partner has confirmed that they are fully aware of the detailed work plans and that they indeed have available all relevant resources, commitments and internal authority as appropriate. All partners are sufficiently large organisations, and are sufficiently committed to the Opticon work plan, that each will ensure appropriate resources are available. The project resources will not be centralised – rather effort and responsibility is invested at sub-WP level, so that local responsibility and resource management is optimal. The project coherence is delivered coherently, while resources are managed locally. There are no major equipment costs other than as described in the WP descriptions.

Calculation of the Unit Cost for Transational Access

Participant number	**2**	**Organisation short name**		**CNRS**	
Short name of Infrastructure	**CFHT**	**Installation number**	**1**	**Short name of Installation**	**CFHT**
Name of Installation	**Canada-France-Hawaii telescope**			**Unit of access**	**Night**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .	**Eligible Costs (€)**
	Summit building operation and maintenance	246,154
	Summit workshops and labs operation	80,000
	Telescope operation and maintenance	230,769
	Instruments – operation and maintenance	307,692
	Summit utilities (electricity – communications - …) + mid-level access (Hale-Pohaku)	2000000
	Base (vehicles, transportation, shipments, processing, data storage for observers)	1846153.846
	Total A	**4,710,769**
	of which subcontracting (A')	

B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Engineers (tech)	116,480	57.3846154	6,684,160
	Technicians (tech)	91520	37.8461538	3463680
	Resident Astronomers (sci)	49920	48.9230769	2442240
	Remote Observers (sci)	33280	40.4615385	1346560
				0
				0
				0
				0
				0
			Total B	**13,936,640**

C. Indirect eligible costs = 7% x ([A-A']+B)	1,305,319
D. Total estimated access eligible costs = A+B+C	19,952,728
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time	1,280
F. Fraction of the Unit cost to be charged to the proposal [1]	100%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)	**15588.07**
H. Quantity of access offered under the proposal (over the whole duration of the project)	12
I. **Access Cost [2] = G x H**	**187,056.84**

Calculation of the Unit Cost for Transational Access

Participant number	**2**	**Organisation short name**		**CNRS**	
Short name of Infrastructure	**OHP**	**Installation number**	**2**	**Short name of Installation**	**OHP193**
Name of Installation	**Observatoire de Haute Provence 193cm telescope**			**Unit of access**	**Night**

A. **Estimated direct eligible costs of providing access within the project life-time excluding personnel costs**	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Utilities (phone, energy, cleaning…)			120,000
	Consumables (nitrogen, DVDs, …)			120,000
	Computer maintenance			120,000
	Telescope maintenance			16,000
	Instrument maintenance			120000
	Total A			**496,000**
	of which subcontracting (A')			***0***
B. **Estimated personnel direct eligible costs needed to provide access within the project life-time**	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Astronomers in charge (planning and support)	3,400	57.14	194,276
	Technical manager, maintenance	640	61.89	39609.6
	Maintenance officer	1930	39.84	76891.2
	Operationnal support (day)	6400	35.15	224960
	Night assistants	14400	58.12	836928
	Computer engineers (maintenance)	3800	52.83	200754
	Mechanical staff (maintenance)	3800	35.15	133570
	Electrical engineers (maitenance)	3800	45.21	171798
	Administrative support (planning, missions…)	3800	36.33	138054
	Total B			**2,016,841**
C. Indirect eligible costs = 7% x ([A-A']+B)				175,899
D. Total estimated access eligible costs = A+B+C				2,688,740
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time				1,420
F. Fraction of the Unit cost to be charged to the proposal [1]				100%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)				**1893.48**
H. Quantity of access offered under the proposal (over the whole duration of the project)				60
I. **Access Cost [2] = G x H**				**113,608.80**

Calculation of the Unit Cost for Transational Access

Participant number	**2**	**Organisation short name**		**CNRS**	
Short name of Infrastructure	**TBL**	**Installation number**	**3**	**Short name of Installation**	**TBL**
Name of Installation	**Telescope Bernard Lyot**			**Unit of access**	**Night**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .	**Eligible Costs (€)**
	Maintenance contract (t° asserv dôme, lift, gas ,safety, cleaning, quality control, ,,,)	61,000
	Maintenance consumables (oil, glycol, small hardware , electronic components ,,,)	33,000
	Maintenance operations (dome, equipment and repairs)	45,000
	Computer consumables	18,000
	Communications (phone, fax)	10000
	Staff accomodation (at Pic du Midi) and gasoline and vehicule maintenance	139000
	electric bill	126000
	Total A	**432,000**
	of which subcontracting (A')	

B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Night Assistant (6) 50%	19,200	29.6	568,320
	Technical operations (6) (50%*2/3)	12800	29.5	377600
	Maintenance Staff (instrument, electronics, ,,,)	21600	33.49	723384
	Software Engineer (50%narval +20%upgrade)	3200	33.49	107168
	Software Assistant Engineer (50%narval +10%upgrade)	3200	29.6	94720
	Administration (50%)	3200	29.6	94720
				0
				0
				0
	Total B			**1,965,912**

C. Indirect eligible costs = 7% x ([A-A']+B)	167,854
D. Total estimated access eligible costs = A+B+C	2,565,766
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time	960
F. Fraction of the Unit cost to be charged to the project [1]	100.0%
G. **Estimated Unit cost charged to the project** = F x (D/E)	**2672.67**
H. Quantity of access offered under the project (over the whole duration of the project)	32
I. **Access Cost charged to the project [2][3] = G x H**	**85,525.44**

Calculation of the Unit Cost for Transational Access

Participant number	**3**	**Organisation short name**		**FGG (INAF 3rd party)**	
Short name of Infrastructure	**TNG**	**Installation number**	**1**	**Short name of Installation**	**TNG**
Name of Installation	**Telescopio Nazionale Galileo**			**Unit of access**	**Night**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Equipments			519,732
	Consumables			188,176
	Maintenance			583,240
	Operational costs			629,852
	Information Technology			77,872
	Total A			**1,998,872**
	of which subcontracting (A')			
B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Astronomers, 10.4 FTE	62,899	51.0570777	3,211,449
	Telescope Operators, 4 FTE	26400	30.5281818	805,944
	Technical staff, 11 FTE	66528	30.4556097	2,026,151
				0
				0
				0
				0
				0
				0
	Total B			**6,043,544**
C. Indirect eligible costs = 7% x ([A-A']+B)				562,969
D. Total estimated access eligible costs = A+B+C				8,605,385
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time				1,200
F. Fraction of the Unit cost to be charged to the project [1]				100.0%
G. **Estimated Unit cost charged to the project** = F x (D/E)				**7171.15**
H. Quantity of access offered under the project (over the whole duration of the project)				16
I. **Access Cost charged to the project [2][3] = G x H**				**114,738.40**

Calculation of the Unit Cost for Transational Access

Participant number	**4**	**Organisation short name**		**MaxPlanck**	
Short name of Infrastructure	**MPG2.2m**	**Installation number**	**1**	**Short name of Installation**	**MPG/2.2m**
Name of Installation	**Max Planck 2.2m Telescope**			**Unit of access**	**Night**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .	**Eligible Costs (€)**
	Full site support contract with site owner: fixed contract 405 kEuro/yr	1,620,000
	Telescope support T. Anguita/R.Lachaume 80 kEuro/yr including travel to LaSilla	320,000
	Total A	**1,940,000**
	of which subcontracting (A')	

B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	MPIA support 0.1 FTE at 80kEuro/yr	800	40	32,000
				0
				0
				0
				0
				0
				0
				0
				0
	Total B			**32,000**

C. Indirect eligible costs = 7% x ([A-A']+B)	138,040
D. Total estimated access eligible costs = A+B+C	2,110,040
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time	1,000
F. Fraction of the Unit cost to be charged to the project [1]	100.0%
G. **Estimated Unit cost charged to the project** = F x (D/E)	**2110.04**
H. Quantity of access offered under the project (over the whole duration of the project)	12
I. **Access Cost charged to the project [2][3] = G x H**	**25,320.48**

Calculation of the Unit Cost for Transational Access

Participant number	**4**	**Organisation short name**		**MaxPlanck**	
Short name of Infrastructure	**CAHA**	**Installation number**	**2**	**Short name of Installation**	**CAHA 2.2m**
Name of Installation	**CAHA 2.2m**			**Unit of access**	**Night**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Maintenance			553,608
	Utilities			564,062
	Consumable			413,424
			Total A	**1,531,094**
			of which subcontracting (A')	
B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Scientific	9,831	100	983,094
	Technical	21998.24	100	2199824
				0
				0
				0
				0
				0
				0
				0
			Total B	**3,182,918**
C. Indirect eligible costs = 7% x ([A-A']+B)				329,981
D. Total estimated access eligible costs = A+B+C				5,043,993
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time				1,360
F. Fraction of the Unit cost to be charged to the proposal [1]				100%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)				**3708.82**
H. Quantity of access offered under the proposal (over the whole duration of the project)				24
I. **Access Cost [2] = G x H**				**89,011.68**

Calculation of the Unit Cost for Transational Access

Participant number	**4**	**Organisation short name**		**MaxPlanck**	
Short name of Infrastructure	**CAHA**	**Installation number**	**1**	**Short name of Installation**	**CAHA 3.5m**
Name of Installation	**CAHA 3.5m**			**Unit of access**	**Night**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Maintenance			1,496,792
	Utilities			1,525,058
	Consumable			1,117,776
	Total A			**4,139,626**
	of which subcontracting (A')			
B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Scientific	24,577	100	2,457,734
	Technical	59395.248	100	5939524.8
				0
				0
				0
				0
				0
				0
				0
	Total B			**8,397,259**
C. Indirect eligible costs = 7% x ([A-A']+B)				877,582
D. Total estimated access eligible costs = A+B+C				13,414,467
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time				1,360
F. Fraction of the Unit cost to be charged to the proposal [1]				100%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)				**9863.58**
H. Quantity of access offered under the proposal (over the whole duration of the project)				30
I. **Access Cost [2] = G x H**				**295,907.40**

Calculation of the Unit Cost for Transational Access

Participant number	**5**	**Organisation short name**		**STFC**	
Short name of Infrastructure	**ING**	**Installation number**	**1**	**Short name of Installation**	**WHT**
Name of Installation	**William Herschel Telescope**			**Unit of access**	**Night**

A. **Estimated direct eligible costs of providing access within the project life-time excluding personnel costs**	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Utilities and consumables (water,electricity,nitrogen,gasoline,storage media,rent etc)			2,692,000
	Maintenance (spares, repairs, aluminizing, computing, licenses etc)			1,384,000
	Subsistence at the observatory			344,000
			Total A	**4,420,000**
			of which subcontracting (A')	***0***
B. **Estimated personnel direct eligible costs needed to provide access within the project life-time**	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Scientific staff	30,368	43.69	1,326,778
	Observing Support Assistants	26992	35.86	967933.12
	Technical operations staff	53984	33.91	1830597.44
	Engineering staff	66132	37.82	2501112.24
				0
				0
				0
				0
				0
			Total B	**6,626,421**
C. Indirect eligible costs = 7% x ([A-A']+B)				773,249
D. Total estimated access eligible costs = A+B+C				11,819,670
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time				1,300
F. Fraction of the Unit cost to be charged to the proposal [1]				100%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)				**9092.05**
H. Quantity of access offered under the proposal (over the whole duration of the project)				10
I. **Access Cost [2] = G x H**				**90,920.50**

Calculation of the Unit Cost for Transational Access

Participant number	**5**	**Organisation short name**		**STFC**	
Short name of Infrastructure	**ING**	**Installation number**	**2**	**Short name of Installation**	**INT**
Name of Installation	**Isaac Newton Telescope**			**Unit of access**	**Night**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Utilities and consumables (water,electricity,nitrogen,gasoline,storage media,rent etc)			300,000
	Maintenance (spares, repairs, aluminizing, computing, licenses etc)			152,000
	Subsistence at the observatory			40,000
	Total A			**492,000**
	of which subcontracting (A')			
B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Scientific staff	6,748	43.69	294,820
	Technical operations staff	13496	33.91	457649.36
	Engineering staff	28340	37.82	1071818.8
				0
				0
				0
				0
				0
				0
	Total B			**1,824,288**
C. Indirect eligible costs = 7% x ([A-A']+B)				162,140
D. Total estimated access eligible costs = A+B+C				2,478,428
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time				1,300
F. Fraction of the Unit cost to be charged to the proposal [1]				100%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)				**1906.48**
H. Quantity of access offered under the proposal (over the whole duration of the project)				11
I. **Access Cost [2] = G x H**				**20971.28**

Calculation of the Unit Cost for Transnational Access

Participant number	**10**	**Organisation short name**		**IAC**	
Short name of Infrastructure	**TCS**	**Installation number**	**1**	**Short name of Installation**	**TCS**
Name of Installation	**TELESCOPIO CARLOS SÁNCHEZ**			**Unit of access**	**Night**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .	**Eligible Costs (€)**
	Utilities (electricity, water, telephone/fax, cleaning, nitrogen, etc.)	121,770
	Consumables (gasoline, etc.)	11,643
	Replacement informatics' equipment	17,557
	Mountain high equipment for personnel	8,071
	Residencia	58,908
	Subsistence	37,291
	Data storage	9,020
	Summit workshops and labs operation	16,912
	Telescope operation and maintenance	139,810
	Instruments – operation and maintenance	16,912
	Common services of the observatory	108,240
	Time Allocation Committee	3,383
	Base (vehicles)	23,780
	Total A	**573,297**
	of which subcontracting (A')	

B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff**		**Person-Months**	**Personnel Costs (€)**
	Head of Telescope Operation		35.5	77,615
	Support Astronomers		31.2	294,727
	Telescope Operators		24.2	108,790
	Technicals in Telescopic Operations		16.1	115,798
	Head of Technical/Maintenance Staff		39.6	71,438
	Workshop Masters IM		22	79,376
	Workshop Assistants IM		17.3	62,418
	Head of the Observatory Technical Service		60.4	14,178
	MOT Technicians		60.4	42,470
	MOT Technicians b		60.4	42,470
	Optical engineer		31.2	7,995
	Workshop Technicians		16.1	4,126
			Total B	**921,401.00**

C. Indirect eligible costs < = 7% x ([A-A']+B) [1]	**max**	**104628.86**	104,629.00
D. Total estimated access eligible costs = A+B+C			1,599,327.00
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time			1,104
F. Fraction of the Unit cost to be charged to the project [2]			100.0%
G. **Estimated Unit cost charged to the project** = F x (D/E)			**1448.67**
H. Quantity of access offered under the project (over the whole duration of the project)			16
I. **Access Cost charged to the project [3][4] = G x H**			**23,178.72**

Calculation of the Unit Cost for Transational Access

Participant number	**11**	**Organisation short name**		**AAO**	
Short name of Infrastructure	**AAT**	**Installation number**	**1**	**Short name of Installation**	**AAT**
Name of Installation	**Anglo Australian Telescope**			**Unit of access**	**Night**

A. **Estimated direct eligible costs of providing access within the project life-time excluding personnel costs**	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Support staff travel to and accomodation at telescope			614,738
	Telescope Repairs and Maintenance			335,581
	Occupancy costs			1,603,664
	Consumables			381,613
	Communication costs			61,993
	Vehicle leasing and running costs			210,852
	Fees for services			62,365
			Total A	**3,270,806**
			of which subcontracting (A')	
B. **Estimated personnel direct eligible costs needed to provide access within the project life-time**	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Scientific/Technical	148,800	49	7,223,699
				0
				0
				0
				0
				0
				0
				0
				0
			Total B	**7,223,699**
C. Indirect eligible costs = 7% x ([A-A']+B)				734,615
D. Total estimated access eligible costs = A+B+C				11,229,121
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time				1,184
F. Fraction of the Unit cost to be charged to the proposal [1]				100%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)				**9484.05**
H. Quantity of access offered under the proposal (over the whole duration of the project)				56
I. **Access Cost [2] = G x H**				**531,106.80**

Calculation of the Unit Cost for Transnational Access

Participant number	**12**	**Organisation short name**		**NOTSA**	
Short name of Infrastructure	**NOT**	**Installation number**	**1**	**Short name of Installation**	**NOT**
Name of Installation	**Nordic Optical Telescope**			**Unit of access**	**Nights**

A. **Estimated direct eligible costs of providing access within the project life-time excluding personnel costs**	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .		**Eligible Costs (€)**
	Observatory operations		385,200.00
	Observatory infrastructure and utilities		642,000.00
	Telescope operations and maintenance		107,000.00
	Instrument maintenance and data management		171,200.00
	Directorate operations		192,600.00
	Total A		**1,498,000.00**
	of which subcontracting (A')		***0.00***
B. **Estimated personnel direct eligible costs needed to provide access within the project life-time**	**Category of staff**	**Person-Months**	**Personnel Costs (€)**
	Scientific	187.8	1,754,800.00
	Operations, maintenance and engineering	172.8	1,134,200.00
	Software	81	642,000.00
	Total B		**3,531,000.00**
C. Indirect eligible costs < = 7% x ([A-A']+B) [1]	**max**	**352030**	352,030.00
D. Total estimated access eligible costs = A+B+C			5,381,030.00
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time			1,256
F. Fraction of the Unit cost to be charged to the project [2]			100.0%
G. **Estimated Unit cost charged to the project** = F x (D/E)			**4284.26**
H. Quantity of access offered under the project (over the whole duration of the project)			80
I. **Access Cost charged to the project** [3][4] **= G x H**			**342,740.80**

Calculation of the Unit Cost for Transational Access

Participant number	**14**	**Organisation short name**		**LJMU**	
Short name of Infrastructure	**LT**	**Installation number**	**1**	**Short name of Installation**	**LT**
Name of Installation	***Liverpool Telescope***			***Unit of access***	***Hours***

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Service Charges made by IAC and Common Services contribution			163,692
	Electricity and Telephones / other Comminication charges			58,032
	Consumables (oil, fuel, refrigerant gas, computer consumables, cleaning materials, paint)			23,052
	Spare parts for Telescope			20,000
	Equipment hire : Crane / Skip / Lifting Equipment hire (including aluminising mirror)			48,378
	Vehicle costs : Car insurance / Maintenance / any other costs associated with Vehicle			26,400
	Maintenance Contracts and Specialist Engineering Consultants			288,380
	Staff Training			4,000
	Travel and subsistence for technical staff, and shipping of equipment			96,360
	Total A			**728,294**
	of which subcontracting (A')			**288,380**
B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Scientific & Management Staff			
	Professor Mike Bode	599	127.02	76,085
	Professor Iain Steele	2,996	71.89	215,382
	Research Staff			
	J Marchant	5,992	40.77	244,294
	R Smith	5,992	48.15	288,515
	Technical Staff			
	S Bates	5,992	39.77	238,302
	S Fraser	5,992	41.17	246,691
	N Clay	5,992	39.33	235,665
	C Mottram	5,992	42.32	253,581
	Total B			**1,798,515**

C. Indirect eligible costs = 7% x ([A-A']+B)	156,690
D. Total estimated access eligible costs = A+B+C	2,683,499
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time	9,600
F. Fraction of the Unit cost to be charged to the proposal [1]	100%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)	**279.53**
H. Quantity of access offered under the proposal (over the whole duration of the project)	320
I. **Access Cost** [2] **= G x H**	**89,449.60**

3 Impact

3.1 Strategic Impact

We address each element of the Call impacts in turn.

"*Provide and facilitate access to the key research infrastructures*; *integrate these facilities and resources with a long term perspective.*"

This is the heart of the Opticon TNA programme . Over recent years Opticon has worked in partnership with the ASTRONET strategic planning group and individual national and international agencies which own and operate infrastructures to carry out a full review of the scientific potential of Europe's medium-sized telescopes. These facilities were threatened with closure, while at the same time being the only facilities which were both capable of cutting-edge science and which were open to non-national use. That review (the European Telescope Strategic Review Committee or "Drew-Bergeron report") made clear that their full scientific potential could be realised only if fundamentally new modes of operations could be identified and implemented to deliver long-term viability at much reduced cost. The urgent need to identify and implement proof of principle trials of these new modes of operation is the challenge being successfully met under the current Opticon contract. The process, described above, involves a series of Opticon initiatives, all new to optical-infrared astronomy. Opticon established the Telescope Directors' Forum, which brings together observatory directors to share best practise and explore common challenges for the first time. Opticon developed software essential to allow a common interface for applications to any available telescope and did so at mimimum cost by enhancing software developed by RADIONET. That software is implemented in the first ever multi-facility, multi-agency, multi-country integrated proposal review and application processing system implemented in optical-infrared astronomy. A crucial aspect of the Opticon observing system is that unsuccessful proposers receive more than just a rejection, constructive feedback from the committee is always provided to the individual. On a wider scale the requirements identified to improve community proposal standards are harnessed to inform special training schools, especially focussed on relatively small and new communities, so these communities can take their full place in the future research area (WP13). It is this system which delivers the long-term perspective. Much more importantly is financial viability. Here Opticon has been able to work, with ASTRONET, towards the essential reorienting of the roles of national telescopes. Traditionally, every telescope must deliver access to every popular type of instrument required by its national community. Vastly expensive duplication and inefficiency resulted. Obviously, a system whereby each telescope specialised in the one or two things it does best and access to speciality instruments is provided through telescope access rather than instrument changes, is much more efficient and cheaper. By working with agencies, and equally importantly with the national user communities, through the Telescope Directors' Forum, the first agreements to reduce duplication, are now in place. Proving that system can and will work, and can and will deliver cost and efficiency savings, and can and will deliver better science, is the ambition of this current project. If Opticon succeeds in delivering that evidence, the community will be well on the way to longer-term viability. We note, for comparison, that the US observatory system, which has failed to implement radical change along the lines being implemented through this contract in Europe, is currently under serious risk of complete closure (the US "Portfolio Review", and system roadmap, is being developed as an urgent response after threat of funding cuts, rather than proactively planned, as in Europe). These activities are delivered through WP7, WP12, in aspects of WP9, WP11, and WP13. The coordination with ASTRONET is funded through WP8.

"stimulate new scientific activities aimed at taking full advantage of new experimental possibilities which will be offered by the future European Extremely Large Telescope.

This is the objective of the whole of the rest of the Opticon I3 programme, as introduced in Section 1. As with every I3, Opticon includes networking and technical R&D activities. The balance of and complementarity between those activities is summarised in the Organogram diagram, in Section **1.3.iv.**

The networking activities deliver impact at many levels, including explicit efforts to maintain the integration of the wider community in the continuing development of the scientific potential of the E-ELT (WP10). This WP includes not only general developments, but specific efforts to prepare for and to realise unique new experimental possibilities which are not possible with existing facilities, but will be with an E-ELT, including ultra-high time resolution astronomy, probing the unexplored quantum optics regime. In addition to ultra-high time resolution science, E-ELTs will be the first opportunity to study transients at faint magnitudes. Learning about transient science is a whole exciting and fast developing subject, currently being pioneered using specially-modified medium-sized telescopes (see above) including some of those in the Opticon telescope network. The big future opportunity is the European Space Agency mission Gaia, scheduled for launch in 2013, which will raise the subject to a new level and new challenges. Preparing the community, both the scientific community and the infrastructure community, to take full advantage of this new opportunity in parameter space is a completely new challenge, for which Opticon will establish the completely new WP11, Time Domain Astronomy. This science will certainly develop over the next decade, so this work, while of intrinsic interest, will certainly start to prepare the community for E-ELT-scale challenges. Of course, extremely large telescopes deliver extremely high spatial resolution imaging – and so does interferometry. A critical learning curve for the community in readiness for an order of magnitude improvement in spatial resolution is developing knowledge of what might be visible, and how complex the Universe might seem. This is delivered through WP14 and the technical developments in WP4, which support the European Interferometry community, and scientific algorithmic developments which are of enormous immediate value, and will be vital for exploit of the innovative E-ELT science. An I3 also delivers technology R&D, where the impact will come from enhancing the performance of the infrastructures, by improving the instrumentation on all telescopes, from the medium-sized telescopes in the Opticon suite to the giant instruments which the community is preparing to build for the E-ELT. A major factor in assuring high impact from technology R&D is of course to understand how the specific activities have been identified, from the very many possible. The Opticon technology developments have been identified after extensive analysis, with all of the basic technology communities, the experienced instrument builder groups, the national funding agencies, and the potential beneficiary infrastructures being involved. The process starts inside Opticon, where current activity supports a Technology Roadmapping programme. This network, involving experts from the wide astronomy and space communities and associated industrial experts, identifies future technology developments which have the potential for significant future impacts. We emphasise this process already involves industry at the early stage, to ensure maximal innovation, cross fertilisation and socio-economic potential.

Concepts identified through this roadmap are the basis of all activity in the current Opticon contract. We consider these in turn. WP1 develops adaptive optics systems, in particular moving beyond the basic operational systems now starting to come on line (themselves significantly advanced by previous Opticon efforts). The challenge here is to develop ambitious adaptive optics systems which meet the wide range of scientific requirements to which the community aspires. These enhanced adaptive optics systems will become workhorses on all medium to large telescopes as they become available, but are critically required for the instruments the community is designing to deliver the ambition of the E-ELT. The involvement of the industrial partners, ONERA and especially Alpao, ensures that the future provision of these advanced systems, which are required globally not just in Europe, will involve new work in European industry. Adaptive optics systems, high-time resolution astronomy, faint-object astronomy, high-dispersion astronomy, all demand noise free efficient and fast photon detectors. WP3, astrophotonics, aims to deliver to astrophysics the benefit of vast global investments in photonics by the telecom, biomedical and sensing applications communities. This WP allows the astronomy community to collaborate as full partners with very large industrial research activities, so delivers impact disproportionally. If photonic systems prototyped in the existing contract can be enhanced and brought to maturity based on work in this contract then adapted to astronomy the potential impacts are paradigm changing. Similarly, the potential industrial applications are very large indeed, hence the large industrial interest.

Our interferometry activities, (WP4 is described above), have moved on from investigating infrastructure issues and into the key area of delivering user friendly high-resolution imaging reconstruction. Again we note potential industrial applications, especially in image processing for process quality control and security and medical diagnostics. WP5, another spinoff from the Key Technologies Roadmap exercise, is working to test the viability of controllable complex optical surfaces in cryogenic spectrographs. If these can be built cheaply and reliably they would allow much simpler, smaller, cheaper instruments to be built to meet a variety of needs, especially in relation to off-axis optics. WP6 investigates new materials. This field – holograms, programmable crystals, polymer fibres, laser-etched gratings – encapsulates the new materials dominating discussion of future applications, from flat screens to intelligent screens. It is a consumer technology of the future, as well as a scientific material of the near future. The dramatic impact of this WP in the current Opticon in saving European industrial VPH grating production capability is mentioned below.

3.2 Dissemination and/or exploitation of project results, and management of intellectual property

The management of Intellectual Property Rights (IPR) is specified in the Opticon Consortium agreement, which is closely based on the EC standard model and approved by the industrial and agency partners who have considerable expertise in this area. In essence, those who develop new processes, concepts and patents own the IPR. During the contract activity, the benefits of the IPR are preferentially made available to all contractors.

In practise, the overwhelming majority of new knowledge resulting from the EC activities is made publicly available. The major vehicle of dissemination of intellectual property is via scientific publications in peer reviewed journals or communication to relevant congresses and conferences. The authorship of these publications is agreed inside the relevant WP and supervised by the WP management. Opticon and EC funding will always be acknowledged in the standard form when the publication/communication is totally or partially a result from this programme.

The aspects of new knowledge of widest interest fall in two groups – scientific publications resulting from the telescope access programme, disseminated through the standard scientific literature, and technical advances presented at the relevant (usually international, SPIE) conferences and published in conference proceedings. All these publications are reported in the Opticon reports to the EC and are of course generally disseminated as widely as is feasible by the authors. In special cases, major scientific journal articles present significant technical results

A recent example of special note is the pair of articles describing the Opticon fast camera, OCAM. This work led to two major publications, one technical in SPIE ("Characterization of OCam and CCD220: the fastest and most sensitive camera to date for AO wavefront sensing", Feautrier, Philippe; Gach, Jean-Luc; Balard, Philippe; Guillaume, Christian; Downing, Mark; Hubin, Norbert; Stadler, Eric; Magnard, Yves; Skegg, Michael; Robbins, Mark; and 15 coauthors, 2010SPIE.7736E..32F), and one for the astronomical community, in PASP ("OCam with CCD220, the Fastest and Most Sensitive Camera to Date for AO Wavefront Sensing", Feautrier, Philippe; Gach, Jean-Luc; Balard, Philippe; Guillaume, Christian; Downing, Mark; Hubin, Norbert; Stadler, Eric; Magnard, Yves; Skegg, Michael; Robbins, Mark; and 15 coauthors. 2011PASP..123..263F).

The OCAM development is an especially positive, but not unique, example of the effort made inside Opticon to maximise dissemination of information, and the considerable success that such dissemination can have. First, we emphasise that OCAM is a technical success, delivering wide direct impact. Copies have been bought by ESO, for VLT use, and by GranteCan, the Spanish 12m telescope, for their adaptive optics use. Demand is so high that a spinoff company has been created, “Firstlight Imaging”, with 15 FTE staff, to develop and market such imaging systems in order to give access to this high level technology to every European astronomical infrastructures, especially when they do not have in house a strong enough detector group with the required skills. Moreover, this spin off will investigate fast imaging markets outside astronomy. The target in the medium term is to recruit 10 to 20 staff in the spin off.

Part of this success follows effort at dissemination. OCAM was presented to the press, following its successful testing, through a set of Press Releases. One was presented on French TV3 national news, was noticed by a senior Civil Aviation person, and led to a current project, DROP. This uses OCAM plus a small commercial telescope plus some robotics, plus smart special purpose image analysis software to monitor active airport runways for debris which might present a risk to departing aircraft, as so tragically demonstrated by the July 2000 Concorde crash. Such safety systems are mandatory, but are currently supplied only by North American firms. This establishes a European presence in a large and important market and shows the potential for societal impact of our research outside astronomy.

This is an impressive but not unique example. A second follows from the work of WP6, focussing on Volume Phase Holographic Gratings (VPHG). These are polymer gratings, essential for the largest high-efficiency astronomical spectrographs, and also with many industrial process control applications. In May 2010 the only European-based VPHG producer (ATHOL) became bankrupt – through loss of key personnel, headhunted to US competition. The Opticon Executive, with the WP6 leadership, judged the retention in Europe of the critical IPR as of the highest priority. The key people identified the remaining production capability for VPHGs which would allow access as being a research group working with Japanese industry (Nippon Paint) based in Tokyo Women’s University. An extensive training visit to Japan followed, leading to a documented VPHG production training course, available in Europe, with Opticon IPR. The polymers themselves are provided by a Brazilian company (Polygrama). All other processes are controlled inside the relevant Opticon WP6 activity. Again, a key technology has been delivered to Europe.

There are other examples. Astrophotonics activity has already revolutionised interferometric instrumentation in astronomy with fully integrated coherent fringe-tracking beam combiners and the SWIFTS-Lipmann interferometer providing simple, compact and robust performance enhancing technologies. These illustrations show the seriousness with which the Opticon partners have, and continue, to take IPR and dissemination issues. The national agencies which are members of Opticon all manage significant IPR exploitation efforts inside their organisations, with which communications are established (below). The industrial partners of course work closely with the technical developments primarily to enhance their own knowledge, for other applications.

We are hopeful for similar advances from the current project, and are confident the relevant dissemination and IPR will be managed well.

We clarify here a common query regarding Opticon’s target audience for outreach. Much of astronomy appeals to, and is marketed to, the general public, schools, educational groups, public media, and so on. HST and VLT images are everywhere. All Opticon participants are actively involved in this work through their organisations, who commit considerable resources to this task. It would not be cost effective to duplicate this effort, although we feed ideas and information into it where possible. Where it is appropriate, and uniquely interesting systems are available, we do make the direct effort, and invest resources, in outreach. One specific example here is WP1.5. Opticon activities themselves however do not produce science results directly – access users may produce science of PR interest, but it is their science. Enabling that science, delivering management systems for infrastructures, and such like, has (very) limited public appeal, though we noted above the highly effective OCAM PR releases and their impact. Rather the target audience for Opticon activity and to publicise success, are the funding agencies, their funding sources, which are governments, and industry. Communication at that level, which can be very effective in delivering results, is where Opticon focuses its efforts. This is productive, as the continuing survival of the Medium sized telescopes attests. It is effective, as the new industrial partner Alpao, attest. It is worthwhile, as the continuing support for Opticon R&D by the national funding agencies, which in turn can convince their governments that this type of R&D delivers societal value, illustrates.

INNOVATION

In line with the political context set out by Innovation Union a specific work package on innovation is requested in all Integrating Activities projects to increase the potential for innovation, including social innovation, of the related infrastructures. This work package would cover activities to reinforce the partnership with industry, e.g. transfer of knowledge and other dissemination activities, activities to foster the use of research infrastructures by industrial researchers, involvement of industrial associations in consortia or in advisory bodies.

Opticon has already earned a reputation for innovation, for productive partnerships with industry, including as consortium members, for knowledge dissemination, and for effective exploitation of appropriate IPR.

Even before this new requirement Opticon had an activity meeting exactly this ambition. The Key Technology Network (under FP7, now WP9, Innovation Network) was established for this. The specification for that activity included Roadmapping workshops, with attendance from a wide range of backgrounds, maintenance of the Roadmap, including coordination with ESA, Two-way Technology Transfer, to and from Industry, and an activity to develop industrial awareness of the astronomical community's needs. The Roadmap from this work was presented at an invited plenary talk at the largest international meeting of relevance, SPIE at San Diego (US), 2010. The relevant WP lead has become a member of the Scientific Committee of ESF-ESA TECHBREAK: Technological Breakthroughs for Scientific Progress, along with ESA, ESF, and industrial (Thales Alenia Space; ASD-EUROSPACE) members.

The objective of this continuing network is to coordinate efforts in Europe to benefit Optical and Infrared Astronomy by stimulating the timely development of key technology, and to maximise knowledge transfer with industry in this field. As such it is expected that both scientific and economic impact will be high, as has been demonstrated in previous Opticon programmes. The operation of the network is described under WP9. As in the case of public outreach, we will leverage this effort by working with the innovation and industry groups of our partner organisations.