Joint Research Activity # 4 (JRA4)
Integrating optical Interferometry into mainstream of Astronomy

- ✓ **Objectives**
  - ✓ Maintain & reinforce european leadership in the next decade
  - ✓ Optimize the exploitation of the VLTI
  - ✓ Generate a long term european vision
  - ✓ Integrate emergent countries
  - ✓ Formation/exchange of students/investigators

- ✓ **Participants (~ 40 european laboratories)**

  - ✓ Allemagne (FRINGE:, Max Planck Garching, Bonn, Heidelberg, …)
  - ✓ Autriche (Université de Vienne)
  - ✓ Belgique (Université de Liège)
  - ✓ Espagne (IAC, Université de Madrid)
  - ✓ France (JMMC: CRAL, LAOG, LESIA, OCA, UNSA, …)
  - ✓ Hollande (NEVEC: Universités Amsterdam, Leiden, ASTRON, SRON)
  - ✓ Hongrie (Observatoire de Konkoly)
  - ✓ Italie (Observatoire de Turin)
  - ✓ Israel (TECHNION, Université Ben Gourion, Tel Aviv)
  - ✓ Pologne (Université Nicholas Copernic, Torun)
  - ✓ Portugal (Université de Porto)
  - ✓ République Tchèque (Académie des Sciences)
  - ✓ Royaume Uni (Université de Cambridge)
  - ✓ Suisse (Obervatoire de Genève)
  - ✓ ESA
  - ✓ ESO

- ✓ **14 Countries + ESA + ESO**

Interferometry: a mature field of astrophysics

- ✓ Development of AO in the 80's → boosts upward limiting mag.
- ✓ Access to new fields of astrophysics: Star formation & Extragalactic Astrop.

- ✓ Introduction of fibers → full control of the interferometric signal
- ✓ Precision of 1% on visibility

The VLTI → a service instrument

The Very Large Telescope Interferometer

- ✓ Telescopes: 4 AT (1.8m) + 4 UT (8m)
- ✓ Delay lines: 6
- ✓ Maximum baseline: 200m → few mas resolution

Instruments

- ✓ AMBER : 3 beams (2 µm) → 2004
- ✓ MIDI : 2 beams (10µm) → 2003
- ✓ PRIMA : Dual field instrument → ≥ 2006

Interferometric Observables

Visibility + Closure phase	Differential phase	PRIMA
High res. Measurements (mas)	Superresolution via modeling (µas) + Stellar rotation axis	Astrometry (10 µas) + Faint Objects (mas)
↓		
High Resolution Imaging ≥ 3 Telescopes (mas)		

Science cases

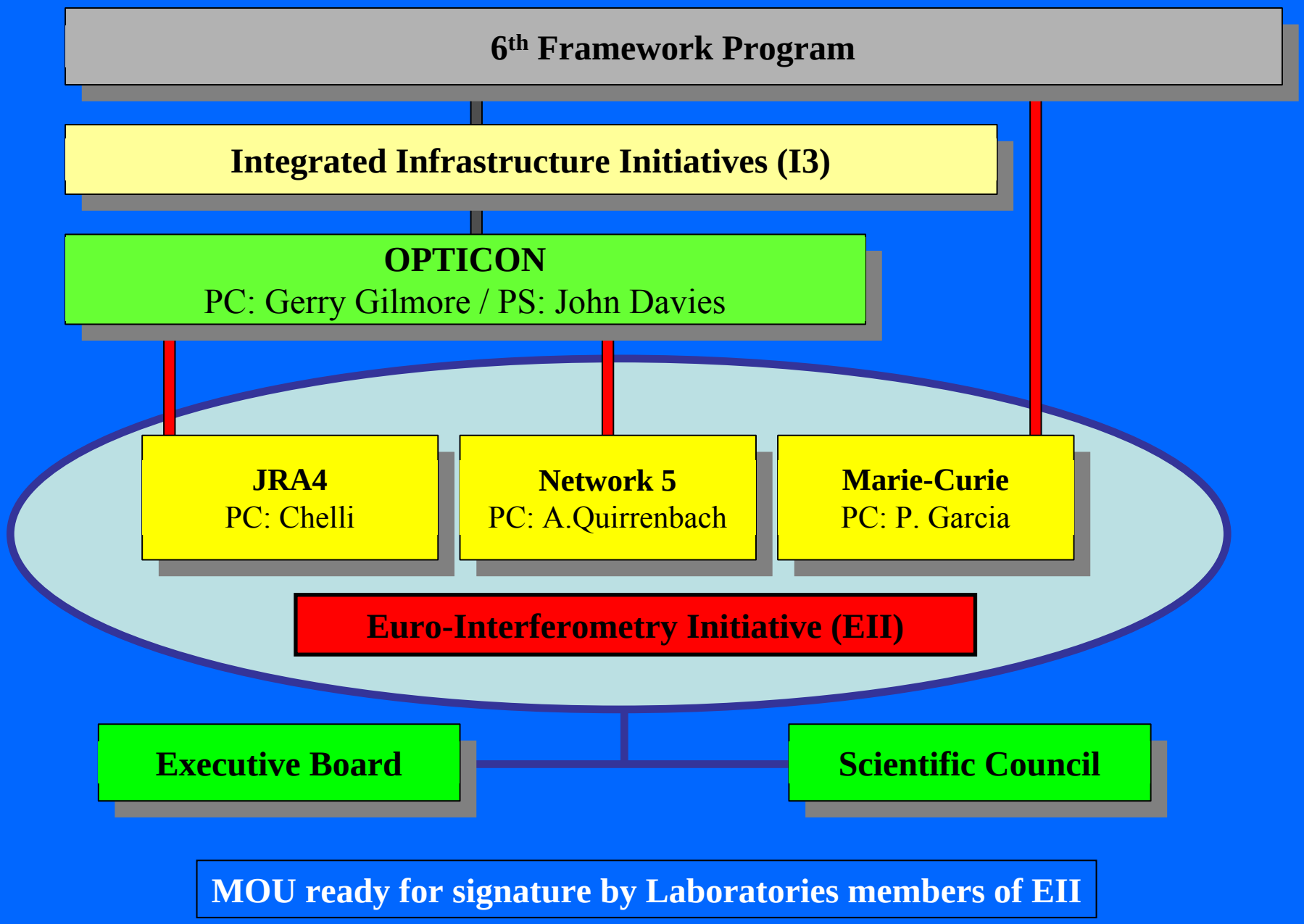
- ✓ Stellar astrophysics : stellar surfaces, limb darkening, mira, cepheid, …
- ✓ Star formation
- ✓ Extragalatic astrophysics : Seyfert galaxies
- ✓ Extrasolar planets
- ✓ **In practice : all fields of astrophysics**

Interferometry working group

- ✓ 9 face to face meetings in 2002/2003

→ 3 projects { JRA4, N5, Marie-Curie } = Euro-Interferometry Initiative (EII)

- ✓ Kick-off meeting : Nice 7 & 8 January 2004 (40 participants)
- ✓ JRA4 completely defined
- ✓ Dynamical Web page (updated by each PI) : http://eii-jra4.ujf-grenoble.fr
- ✓ Mailing lists
- ✓ To date: > 30 documents



MOU ready for signature by Laboratories members of EII

JRA4 “Integrating interferometry into mainstream astronomy”
PC: Alain Chelli

WP1.1: Advanced Instruments
Concept to feasibility studies
WPL’s: Uwe Graser (Heidelberg) / Denis Mourard (OCA)

WP1.2: Advanced Instruments
Cophasing & fringe tracking
WPL: Mario Gai (Torino)

550 k€

WP2: Software
WPL: Gilles Duvert (LAOG)
PM: Gerard Zins (LAOG)

510 k€

WP2: Software (1)

WPL: Gilles Duvert – PM: Gerard Zins

- ✓ **Objective** : facilitate the use of large modern interferometric facilities such ESO's VLTI to an end-user non specialist of optical interf.

- ✓ **Software** : will be developed under the supervision of a software project manager

- ✓ **5 sub work packages:**
  - ✓ WP2.1: Management & user support
  - ✓ WP2.2: Integration tool, data interpretation & mining tool
  - ✓ WP2.3: Model fitting
  - ✓ WP2.4: Astrometry
  - ✓ WP2.5: Image reconstruction

WP2: Software (2)

- ✓ **WP2.1: Management & User support**
  - ✓ Management: will provide rules of programming, data format, interface definition, detailed design
  - ✓ Team: JMMC/LAOG technical team (Duvert/PI, Zins/PM, Mella, Gluck, Lafrasse)
  - ✓ Helpdesk: Duchêne (JMMC/LAOG), Kervella (JMMC/LESIA)

- ✓ **WP2.2: Integration tool, data interpretation & mining tool**
  - ✓ Objective: provide utilities to help the design & development of other tools, to manage data formats, data retrievial. Will provide APIs and GUIs. Will provide the link with the virtual observatory.
  - ✓ Team: JMMC/LAOG technical team

WP2: Software (3)

- ✓ **WP2.3: Model fitting**
  - ✓ Objective: fit interferometric observables with achromatic (visibility & closure phase) or chromatic (differential phase) predefined or user models
  - ✓ Team: Tallon-Bosc/PI, Tallon, Thiebaut (JMMC/CRAL), Mourard (JMMC/OCA), Tatulli, Chelli (JMMC/LAOG), …

- ✓ **WP2.4: Astrometry (PRIMA)**
  - ✓ Objective: orbit fitting, parallax, proper motion
  - ✓ Team: Quirrenbach, Bakker (NEVEC/Leiden), Queloz (Unige)

WP2: Software (4)

- ✓ **WP2.5: Image reconstruction**
  - ✓ Objective: provide a set of algorithms for image reconstruction from optical interferometric observables
  - ✓ Team 1: Haniff/PI, Busher, Young (Cambridge)
  - ✓ Team 2: Thiebaut/PI (JMMC/CRAL), Mugnier, Meimon (JMMC/ONERA)
  - ✓ Team 3: Graser, Henning (FRINGE/MPIA), Weigelt (FRINGE/MPfR), …
  - ✓ Team 4: Lara/PI (UGR), Alberdi (IAA), Eiroa (UAM)
  - ✓ Team 5: Niedzielski/PI (Torun)

- ✓ **Beauty Contest for image reconstruction algorithms**:
  - ✓ Specification and generation of simulated images in the first 6 months

WP2: Software (5)

- ✓ **Documents:**
  - ✓ Software survey
  - ✓ Documentation management plan
  - ✓ Software preliminary concept description

- ✓ **Deliverables (first 18 months)**
  - ✓ User requirements (December 2004)
  - ✓ Software functional specifications (June 2005)

WP1.2: Cophasing & Fringe tracking (1)

WPL: Mario Gai (Torino)

- ✓ **The sensitivity of interferometric instrumentation** is critically based on the performance of co-phasing & fringe tracking sub system
- ✓ **Objectives of WP1.2**:
  - ✓ Optimization of current cophasing instrumentation performances
  - ✓ Optimization of measurement operations
  - ✓ Co-phasing schemes for advanced instruments (multi beam, LBT)

Task list

- T1: analysis of performances of current fringe tracking systems
- T2: Fringe sensors hardware improvements
- T3: High sensitivity operation
- T4: Fringe sensors detection schemes
- T5: OPD measurements filtering
- T6: High precision astrometric calibration
- T7: Baseline & wavelength bootstrap
- T8 Multi beams fringe sensor concepts
- T9: Identification of technology developments requirements
- T10: Analysis of applicability of advanced detectors (e.g. NIR STJ)
- T11: Analysis of applicability of integrated optics (in bands J, K, …)

WP1.2: Cophasing & Fringe tracking (2)

- ✓ A call for Interest in participation to the WP1.2 activity was circulated in January → Constitution of a Working Group

Working Group & Tasks

Institute	Contact point	Tasks
INAF-OATo	M. Gai	T1, T3, T5; T2, T4; T6
Technion	E. Ribak	T4, T7, T8, T9, T11
OHP	V. Borkowski	T4, T5, T6, T7, T8
ONERA	F. Cassaing	T8; T4
Obs. Bordeaux	G. Daigne	T1, T3, T6, T8, T9
Koln	C. Straubmeier	T1, T4, T5

- ✓ **Deliverables (first 18 months)** : 6 monthly progress reports

WP1.1: Concepts to Feasibility studies (1)

WPL's: U. Graser (FRINGE/Heidelberg)
D. Mourard (JMMC/OCA)

- ✓ **Objective:** prepare the next generation of advanced interferometric focal-plane instruments to take advantage of the wide range of capabilities offered by the new large facilities

- ✓ **Two phases**
  - ✓ Phase A: Concept studies (first 18 months)
  - ✓ Phase B: Feasibility and pre-design studies of the highest priority concepts

WP1.1: Concepts to Feasibility studies (2)

7 projects selected for concept studies

A1. PRIMA (phase reference imaging)	Perrin/PI (OCA/LAOG/Bordeaux/MPE)
B1. IFSPEC with CRIRES/UVES	Quirrenbach/PI (Leiden/Vienna/Hamburg)
B2. APRESMIDI (VLTI mid IR 4 beams)	Lopez/PI (OCA/CRAL/LAOG/MPIA/MPfR/Leiden)
C1. VITRUV (8 beams comb. with IO)	Malbet/PI (LAOG/CRAL/CAUP/LETI/IMEP)
C2. VIDA (8 beams with DP)	Lardiere/PI (LESIA/OCA/ONERA/IRCOM)
C3. 8 beams with bulk optics	Haniff/PI (Cambridge)
C4. 6 homothetic beams (DARWIN, VLTI)	den Herder/PI (SRON/Leiden/Delft)

A: Related to already planned developments at ESO
B: Extension to or usage of already existing instruments (not in ESO planning)
C: Multi beams combiner projects

WP1.1: Concepts to Feasibility studies (3)

Coming events

- ✓ September 2004: EII Scientific Council first meeting (Heidelberg)
- ✓ Nov 2004: prog. meeting centered on WP1 (Grenoble): merging concepts
- ✓ April 2005: Joint EII/ESO workshop on 2nd generation VLTI instruments
  - ✓ 2 coordinated announcements coupled with open call for concepts by ESO
  - ✓ Joint organizing committee
  - ✓ Invited reviews on Science with Interferometry
  - ✓ Review of present VLTI status and planned developments
  - ✓ Concepts presentations / General discussion
  - ✓ Immediately after the WS an evaluation of the concepts will be done under the responsibility of the EII Scientific Council and transmitted to the ESO STC

✓ The highest priority concepts will be selected by the ESO STC

Deliverables: Final concept report studies (June 2005)

Monitoring procedures

- ✓ Bimonthly teleconferences between coordinator & WPL's
- ✓ A formal progress report will be requested from each PI each 6 months
- ✓ Annual progress meetings
- ✓ Dynamical WEB page (updated each month)

Summary of main deliverables

Interferometry WG: Final report (April 2004)
WP1.1: Final concept report studies (June 2005)
WP2: User requirements (December 2004)
WP2: Software functional specifications (June 2005)