An Introduction to the E-ELT Instrumentation and Post-focal Adaptive Optics Module Studies

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The following eleven articles provide short summaries of the conceptual design studies for the European Extremely Large Telescope instruments and post-focal adaptive optics modules. The background and scope of these studies is outlined in this introduction.

As part of the study for the 42-metre European Extremely Large Telescope (E-ELT), ESO initiated ten conceptual design studies into the instruments and post-focal adaptive optics (AO) modules that could deliver the science case for the telescope. This extraordinary effort was undertaken in more than forty institutes in ten member states and Chile, involving several hundred engineers and scientists. There were eventually eleven studies, as one concept, for the multi-object spectrograph OPTIMOS, was split into two separate studies. The eleven studies varied in duration from 15 to 30 months, and therefore in the depth of the study (see Table 1 for an overview). All the studies had the common goals of exploring the science case for the instrument, determining whether it was technically feasible and could be delivered at a reasonable cost and timescale, and identifying any preparatory R&D work required. For the two post-focal AO modules, the scientific performance was demonstrated in collaboration with the instrument teams that plan to exploit those AO modules.

The studies were formally organised along similar lines to all ESO instrument projects: a statement of work and technical specification was agreed and signed at a "Kick-off" meeting and the study concluded with the delivery of a final report and a formal review. The final reports consisted of 10–20 documents specified in the statement of work and were in total 500–1000 pages in length. The reports covered all major aspects of the instrument design including: a science case and analysis of the scientific performance; an operation and maintenance plan; a verification matrix including information on compliance with the telescope interfaces; a system design covering optomechanical design, detector systems, cryogenic or thermal design, instrument control electronics and software; a management plan for the design and construction of the instrument including R&D plans, risk analysis, schedule and budget. The review, coordinated by the Instrumentation Project Office of the E-ELT Programme, was conducted by a board consisting of ESO experts in all these areas and including an external reviewer from a non-ESO member state. Members of the E-ELT Science Working Group (SWG) also participated as observers and were able to question the teams. All of the studies were considered successfully closed: the high quality of the delivered reports show the strength of the instrument development capabilities in the European astronomical community and the great interest in the E-ELT project.

The articles following are a snapshot of the instrument concepts written by the Principal Investigators (PIs) of the studies at this important phase for ESO and the E-ELT project. With strictly limited space they can only give a flavour of the science cases, the technical concept and the expected performance of each instrument. A straightforward comparison of the quoted performance of different instruments in the bands in common has to be made with great caution. It requires a full understanding of the many underlying assumptions, such as AO performance or image quality in general, integration time and sky subtraction strategy, assumed light distribution of the sources and instantaneous spectral coverage. Anyone who is interested in more information on a particular study should contact the corresponding PI.

The next step is the development of an instrumentation plan for the first generation of instruments at the telescope. This plan will form part of the construction proposal for the E-ELT Project to be presented to the ESO Council at the end of 2010 and will outline the capabilities for the instruments to be delivered within the first ten years of telescope operations. The instrument concepts presented here provide a basis for this plan, but there will not necessarily be a one-to-one correspondence between these studies and the instruments that will be built or the consortia that will build them. There will be a need to simplify and improve some of the instrument concepts according to the results of the reviews and there will be the possibility to reshape the consortia in order to distribute the effort, with the possibility for new partners to step in.

For a telescope with such a highly innovative design as the E-ELT, the proof of the feasibility of the instruments to carry out the ambitious science programme was a crucial step. Thanks to the successful effort by the PIs of the studies and to their teams, we can now look forward with confidence and great anticipation to the final design and construction phases of the project.

Table 1. An overview of the instrument studies for the E-ELT instruments and post-focal adaptive optics modules in alphabetical order.

Name	PI	Institutes	ESO Responsible	Kick-off	Final Review
ATLAS	T. Fusco (ONERA)	ONERA, LESIA, GEPI, LAM, UK ATC	J. Paufique	19/09/08	02/02/10
CODEX	L. Pasquini (ESO)	ESO, INAF–OATS and OA Brera, IAC, IoA Cambridge, Obs. Genève.	N/A	16/09/08	23/02/10
EAGLE	J.-G. Cuby (LAM)	LAM, GEPI, LESIA, ONERA, UK ATC, Univ. Durham	S. Ramsay	27/09/07	27/10/09
EPICS	M. Kasper (ESO)	ESO, LAOG, INAF–OAPd, LESIA, NOVA ASTRON, Uni. Utrecht, ETHZ, ONERA, Univ. Oxford, FIZEAU, LAM	N/A	24/10/07	16/03/10
HARMONI	N. Thatte (Oxford)	Univ. Oxford, CRAL, CSIC–DAMIR, IAC, UK ATC	J. Vernet	1/04/08	28/01/10
MAORY	E. Diolaiti (INAF–OABo)	INAF–OABo and Univ. Bologna, ONERA, INAF–OAPd, INAF–OAA, INAF–IASFBo	E. Marchetti	09/11/07	10/12/09
METIS	B. Brandl (Leiden)	NOVA Leiden and ASTRON, MPIA, CEA Saclay, KU–Leuven, UK ATC	R. Siebenmorgen	07/05/08	17/12/09
MICADO	R. Genzel (MPE)	MPE, MPIA, USM, INAF–Padova, NOVA ASTRON, Leiden, Groningen, LESIA	A. Richichi	28/02/08	30/10/09
OPTIMOS–DIORAMAS	O. Le Fèvre (LAM)	LAM, STFC RAL, INAF IASF–Milano and OATs, Obs. Genève, IAC, Obs. Haute Provence	S. Ramsay	03/11/08	30/03/10
OPTIMOS–EVE	F. Hammer (GEPI)	GEPI, NOVA ASTRON, RUN, Uni. Amsterdam, STFC RAL, INAF–OATs and Brera, NBI Copenhagen	S. Ramsay	03/11/08	30/03/10
SIMPLE	L. Origlia (INAF–OABo)	INAF–OABo, Arcetri, Roma, Univ. Bologna, UAO, TLS, PUC	H. U. Käufl	30/10/08	04/03/10