T-Rex Unit for ELT-CAM and sub-Unit for MAORY

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T-Rex Project

ELT-CAM Unit

• Objective: support INAF contribution to first light instrument ELT-CAM (MAORY and MICADO)
  – For MICADO → talk by R. Falomo
  – For MAORY → this talk

• ELT-CAM Unit in numbers
  – Almost 40 persons involved
  – 6 INAF institutes
  – Budget
    • MAORY: 480 k€ Personnel
      1500 k€ Investment
    • MICADO: 160 k€ Personnel
    • General: 10 k€ Travel

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T-Rex Project
Integration room
MAORY Project
Instrument requirements

- Multi conjugate Adaptive Optics RelaY
  - Compensate atmospheric turbulence
  - Relay light to science instrument

- Main requirements related to client instrument MICADO
  - Wavelength range 0.8-2.4 µm
  - Field of view 53"×53"
  - Uniform adaptive optics correction with high sky coverage

- Other requirements
  - Lateral exit port for another possible instrument
MAORY Project
Multi conjugate Adaptive Optics

SCAO
Strehl Ratio maps @K (2.2 µm)

MCAO

Reference Stars
High Altitude Layer
Ground Layer
Ground Conj. DM
Altitude Conj. DM
WFS
Telescope
WFC

All pictures © European Southern Observatory
MAORY Project
Instrument architecture

E-ELT

Common Path Optics

Deformable Mirrors

Dichroic

Science Path Optics

LGS Objective

NGS Wavefront Sensor

LGS Wavefront Sensor

Exit Port (to client instrument)

MAORY Instrument

Telescope Control System

Real Time Control System

MAORY Instrumentation Software

Client Instrument Instrumentation Software
MAORY Project
Instrument layout

Pre-focal station
Nasmyth platform
MAORY
Lateral port
MICADO
Gravity invariant port
Area for detached instrument
MAORY Project
Post-focal relay optics

Phase A design

Baseline post-focal deformable mirrors are based on piezo-electric actuator technology (under review)
Why Laser Guide Stars?
- Sky coverage (and performance uniformity)
- Demonstrated by GeMS on Gemini Telescope in MCAO mode

Wavefront Sensor description
- 6 Sodium Laser Guide Stars (LGS)
- Wavefront Sensor type: Shack-Hartmann (~80×80 subapertures, 500 fps)
Laser Guide Stars issues
1. Tip-tilt indetermination
2. Variation of mean height of Sodium layer $\rightarrow$ LGS focus not fully reliable
3. Variation of Sodium layer density profile introduces low-medium order wavefront distortions

1, 2: fast; 3: slow
$\rightarrow$ Natural Guide Stars are required

Sodium layer data kindly provided by Paul Hickson, University of British Columbia
Tip-Tilt & Focus channel (1.5 - 1.8 μm)
- Shack-Hartmann, 2×2 subap
- 100-500 Hz frame rate

Reference channel (0.6 - 0.9 μm)
- Monitor low order aberrations induced by Laser Guide Star Wavefront Sensor due to Sodium layer properties
- Normal operation mode: ~10×10 subap, ~0.1 Hz frame rate
- Pyramid WFS
- Full Natural Guide Star mode for engineering purposes
MAORY Project
Adaptive optics performance
(Median atmospheric seeing 0.8")

Minimum field-averaged Strehl Ratio (53''×53'')

<table>
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<tr>
<th>Wavelength</th>
<th>2.16 µm Ks</th>
<th>1.65 µm H</th>
<th>1.215 µm J</th>
<th>0.9 µm I</th>
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<td>2.16 µm Ks</td>
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<td>0.9 µm I</td>
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Sky Coverage @Galactic Pole
- 39%
- 50%
- 80%
MAORY Project

Project overview

• Phase A study Nov 2007 – Dec 2009
• Management plan for next project phases under consolidation
  – Draft version delivered to ESO July 2012
  – Modified proposal delivered to ESO December 2012 (waiting for comments)
• Current Consortium organisation
  – INAF (Lead Institute, System responsibility, sub-systems: platform, NGS WFS, deformable mirrors TBC, auxiliary equipments, science support tools)
    Involved INAF Institutes: Bologna (OA + IASF), Arcetri, Brera, Capodimonte, Padova
  – Durham University (Real Time Control System)
  – Observatoire de Paris LESIA (LGS wavefront sensor)
  – ESO (hardware components e.g. cameras, deformable mirrors TBC)
• MAORY Project preliminary schedule

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MAORY Project Management Structure

- ESO
  - MAORY Co-I Science Steering Committee
  - MAORY Principal Investigator
  - MAORY Project Manager
  - MAORY Executive Funding Committee
  - MAORY Project Office (under coordination of Project Manager)
    - System Team (under technical supervision of System Engineer)
  - MAORY Local Project Managers
2\textsuperscript{nd} T-Rex proposal ELT-CAM Unit

- Include MOSE project in ELT-CAM Unit of T-Rex
- **MOSE: Modeling ESO Sites**
  - PI: E. Masciadri (INAF)
  - ESO Board: P.Y. Madec, H. Kuntschner, M. Sarazin, F. Kerber
  - GOAL: Feasibility study to set-up at Cerro Paranal (VLT) and Cerro Armazones (E-ELT) an automatic system for the forecast of
    - optical turbulence ($C_N^2$ profiles and integrated astro-climatic parameters)
    - all classical atmospheric parameters
- Support from T-Rex 2\textsuperscript{nd} year to cover personnel costs for development of MOSE project
2nd T-Rex proposal
ELT-CAM Unit

• Extend support to MAORY and MICADO (2nd year of T-Rex project could partially overlap with Phase B of instrument projects)

• Technical work in preparation for Phase B
  – Development of tools (simulations, wavefront sensor prototype)
  – Study of wavefront sensing strategies
  – Activities to be defined in collaboration with ESO related to hardware components considered critical items (deformable mirrors, LGS wavefront sensor cameras)

• T-Rex funds allocation
  – Personnel
  – Additional equipments if needed
  – Research & Development, including possibly involvement of Italian industry