T-REX Operating Unit 3

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OU3 Overview

• Main objective: support INAF activities related to MAORY+MICADO system and to E-ELT adaptive optics instrumentation

• OU3 breakdown
  – WP3.1 MAORY
  – WP3.2 MICADO
  – WP3.3 Atmospheric parameters
  – WP3.4 Technology developments for adaptive optics
OU3 People

- **MAORY**
  - **OA-Bologna**: R. Abicca, C. Arcidiacono, M. Bellazzini, G. Bregoli, P. Ciliegi, F. Cortecchia, G. Cosentino, E. Diolaiti, I. Foppiani, M. Lombini, M. Patti, L. Schreiber
  - **OA-Brera**: M. Riva et al.
  - **OA-Capodimonte**: E. Cascone, V. De Caprio
  - **OA-Cagliari**: I. Porceddu
  - **OA-Padova**: A. Baruffolo, D. Fantinel, E. Giro, R. Ragazzoni, B. Salasnich

- **MICADO**
  - **OA-Padova**: R. Falomo, L. Greggio, M. Gullieuszik, D. Fantinel, S. Paiano, L. Schreiber, S. Zaggia
  - **IASF-Milano**: M. Uslenghi

- **Atmospheric parameters**
  - **OA-Arcetri**: L. Fini, F. Lascaux, E. Masciadri, A. Turchi
  - **OA-Padova/OA-Bologna**: S. Cavazzani, S. Ortolani, V. Zitelli

- **New development for adaptive optics**
  - **OA-Padova**: C. Arcidiacono, M. Bergomi, M. Dima, J. Farinato, M. Gullieuszik, D. Magrin, L. Marafatto, E. Portaluri, R. Ragazzoni, V. Viotto
MAORY / Instrument overview

- First-light adaptive optics module to support MICADO
  - Multi-Conjugate Adaptive Optics
  - Single-Conjugate Adaptive Optics
- Laser Guide Stars
  - Sky coverage
  - Performance uniformity
  - Natural stars needed anyway
- Deformable mirrors
  - Telescope M4/M5
  - One or two DMs in MAORY

© ESO

MAD Strehl Ratio maps

SCAO

MCAO

Telescope DM (M4/M5) → MAORY DMs → WFS
MAORY / Consortium

- **INAF (Italy)**
  - OA-Bologna, IASF-Bologna, OA-Arcetri, OA-Brera, OA-Capodimonte, OA-Padova
  - System design, integration and delivery to ESO
  - Adaptive optics engineering
  - Sub-systems
    - Platform
    - Adaptive optics sub-systems (optical relay with adaptive mirrors, NGS & SCAO wavefront sensor, real-time computer)
    - Auxiliary equipment
    - Science support tools

- **IPAG (France)**
  - LGS wavefront sensor

- **ESO**
  - Wavefront sensor cameras
  - Common specifications & toolkit for real-time computer development
  - Software simulator of telescope control system
MAORY / Deformable Mirrors

- Voice-coil motor actuator
- Pros
  - Technology Readiness Level
  - Tolerant to actuator failure
  - Commonalities with M4
- Main features
  - 700 mm diameter
  - 24 actuators across diameter
  - Two equal mirrors (flat or curved)
- Feasibility study funded by T-REX to support MAORY Phase B
MAORY / Optical design

Talk by Matteo Lombini
Optical design of the post focal relay of MAORY
MAORY / NGS & SCAO

• Natural Guide Star wavefront sensor
  – Essential complement to LGS wavefront sensor in MCAO mode
  – 3 (faint) stars on 2.5 arcmin field of view

• SCAO wavefront sensor / mode
  – Permanent SCAO mode in MAORY
  – MICADO stand-alone mode for risk mitigation
  – Joint development between MICADO and MAORY

Talk by Simone Esposito
NGS WFS and operations of MAORY/MICADO
MAORY / System modelling

- End-to-end simulation code
  - System modelling and design
  - Modular structure
  - Accelerated by use of GPUs
  - Accurate mode / fast mode

Talk by Laura Schreiber

*Modeling the multi-conjugate adaptive optics system of the E-ELT*
MAORY / Lab demonstration

- Laboratory prototype
  - Emulation of realistic LGS images under different working conditions
  - High-order wavefront sensor (40x40 subapertures)
  - Experimental support to simulations

Talk by Mauro Patti

*Laboratory prototype for the demonstration of sodium laser guide star wavefront sensing on the E-ELT*
MAORY / Real Time Computer

• Under INAF responsibility
  – Originally to be supplied by Durham University
  – Project Management Plan under revision

• Role of ESO
  – Requirements capture in collaboration with MAORY consortium
  – Supply of common specifications and toolkit
MAORY / Facilities for AIV

• Laboratory for MAORY instrument integration
  – Refurbishment of existing laboratory at IASF-Bologna
  – Tools and equipments
    • Interferometer
    • Laser tracker
    • Optical lab tools
    • Electronics instrumentation

• Laboratory for NGS & SCAO WFS integration
  – Refurbishment of existing laboratory at Arcetri
MICADO

- WP coordinator: Renato Falomo
- E-ELT high angular resolution infrared camera
- Study of MICADO science cases by simulation and analysis of synthetic images
- Consolidation of INAF involvement in MICADO Consortium
- 2 research grants (M. Gullieuszik, S. Paiano)

Talk by Marco Gullieuszik
Exploring the stellar populations of nearby and high redshift galaxies with ELTs
Atmospheric parameters

- WP coordinator: Elena Masciadri
- MOSE project for ESO
  - Feasibility study to setup an automatic system at Cerro Paranal and Cerro Armazones for the forecast of optical turbulence and atmospheric parameters
  - MOSE Phase B June 2014 - July 2015
- 1 research grant co-funded (F. Lascaux)

Talk by Elena Masciadri

*MOSE: operational optical turbulence forecast for the EELT flexible scheduling*
Atmospheric parameters

• WP coordinators: S. Ortolani, V. Zitelli
• Evaluation and forecast of weather conditions from ground-based and satellite data
  – Cloud cover
  – Photometric quality of atmosphere
• 1 research grant funded (S. Cavazzani)

Talk by Stefano Cavazzani
Analysis and forecasting of weather conditions from satellite data and correlation with astronomical parameters for the E-ELT site
Technology development for AO

• WP coordinator: Roberto Ragazzoni
• Global Multi-Conjugate Adaptive Optics (GMCAO)
  – Wavefront sensing by natural stars only on a wide field of view at the telescope focal plane
  – Metrology to "see" post-focal deformable mirrors
• 2 research grants (M. Gullieuszik, E. Portaluri)

Talk by Roberto Ragazzoni
Global Adaptive Optics and beyond
Conclusions

• Support from T-REX to E-ELT activities at INAF has been essential
• Grants for young researchers
  – 13 young researchers + 1 PhD supported by T-REX / OU3
• Travels
• For MAORY project
  – Facilities and equipment for instrument integration
  – Support to instrument design