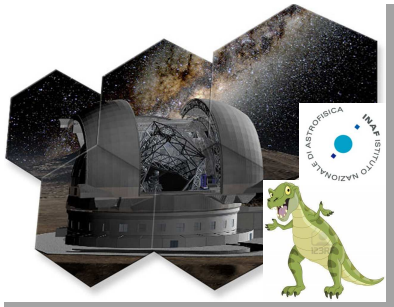


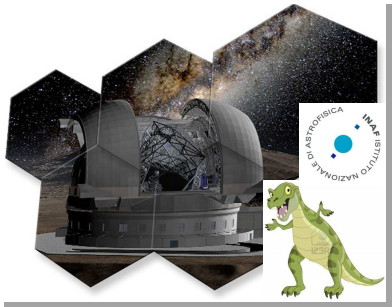
T-Rex Unit for ELT-CAM and sub-Unit for MAORY

Emiliano Diolaiti

Istituto Nazionale di Astrofisica –

Osservatorio Astronomico di Bologna

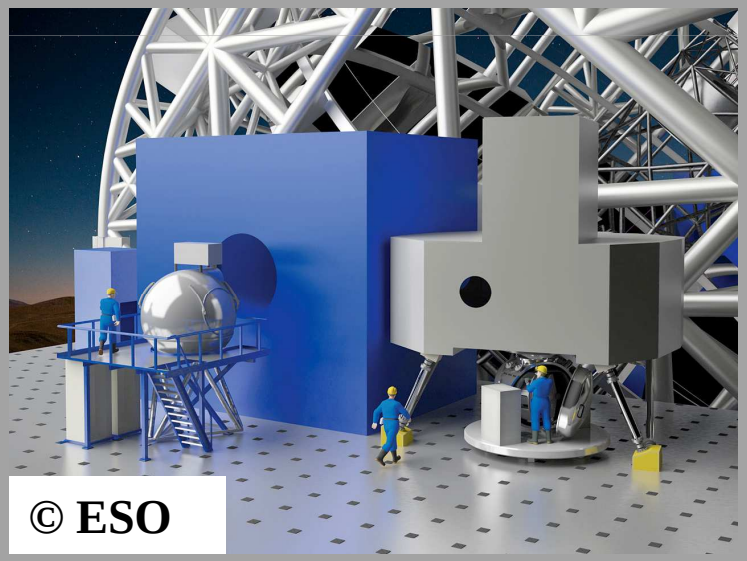
Bologna, January 14th 2013



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

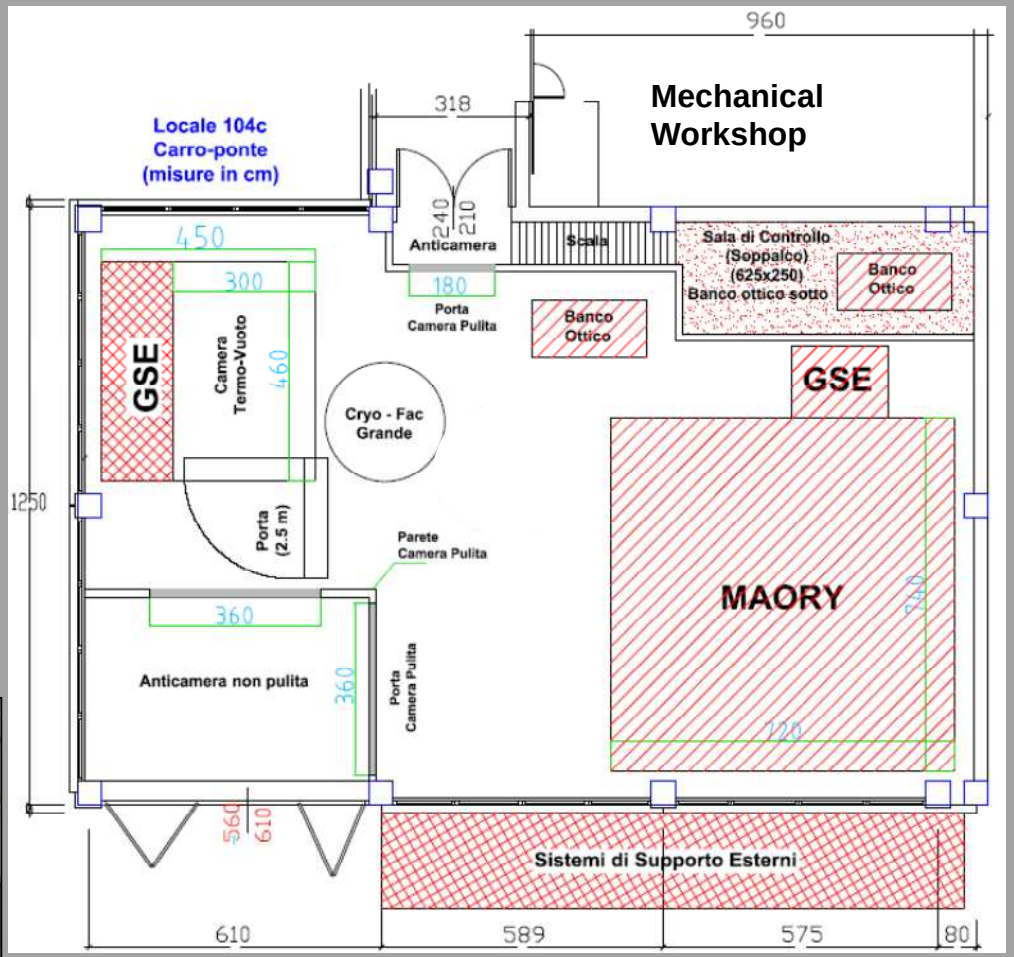
- ELT-CAM Unit in numbers
  - Almost 40 persons involved
  - 6 INAF institutes
  - Budget
    - MAORY: 480 k€ Personnel
      1500 k€ Investment
    - MICADO: 160 k€ Personnel
    - General: 10 k€ Travel

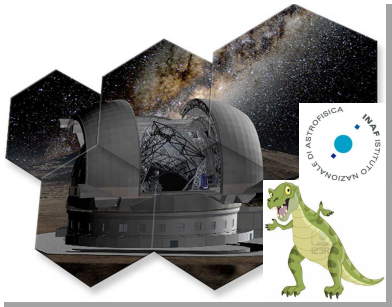


© ESO

T-Rex Project

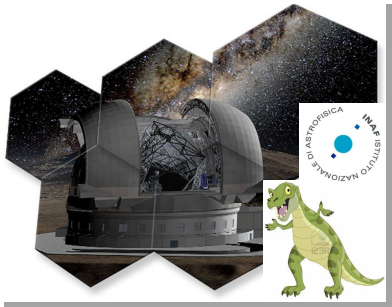
Integration room





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

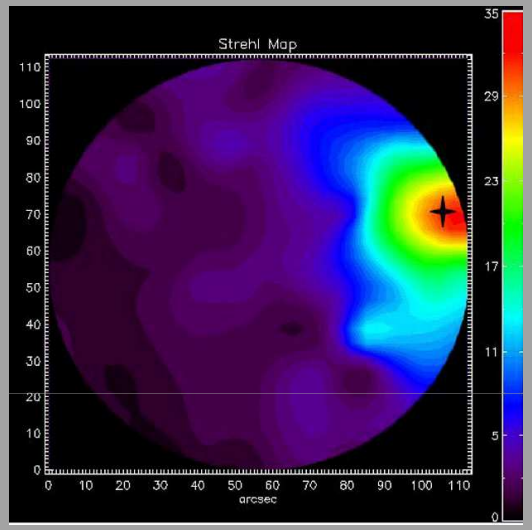


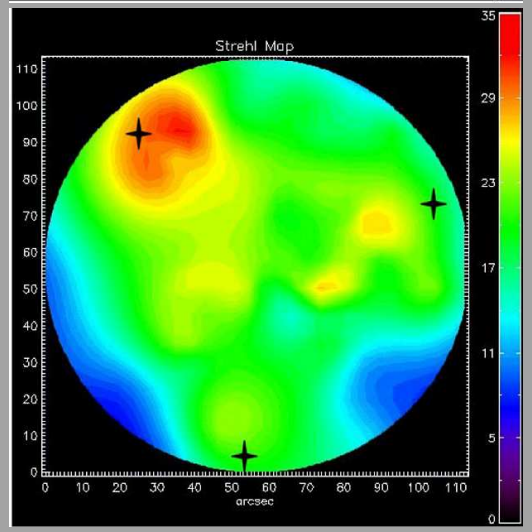
MAORY Project
Multi conjugate Adaptive Optics

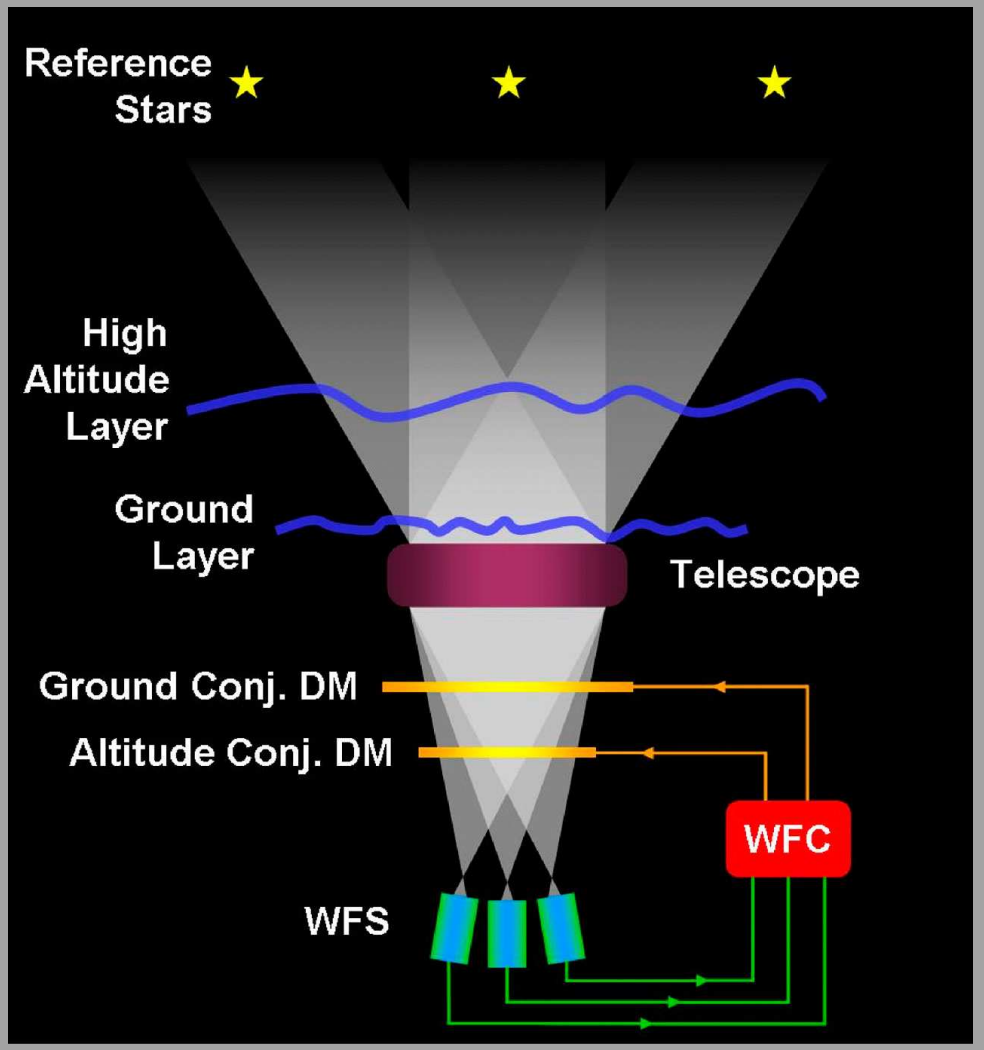
SCAO

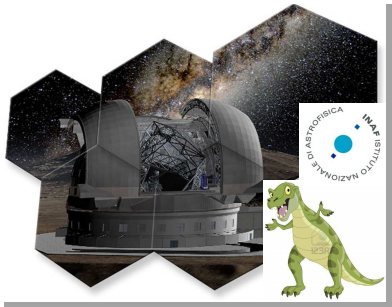
Strehl Ratio maps @K (2.2 µm)

MCAO



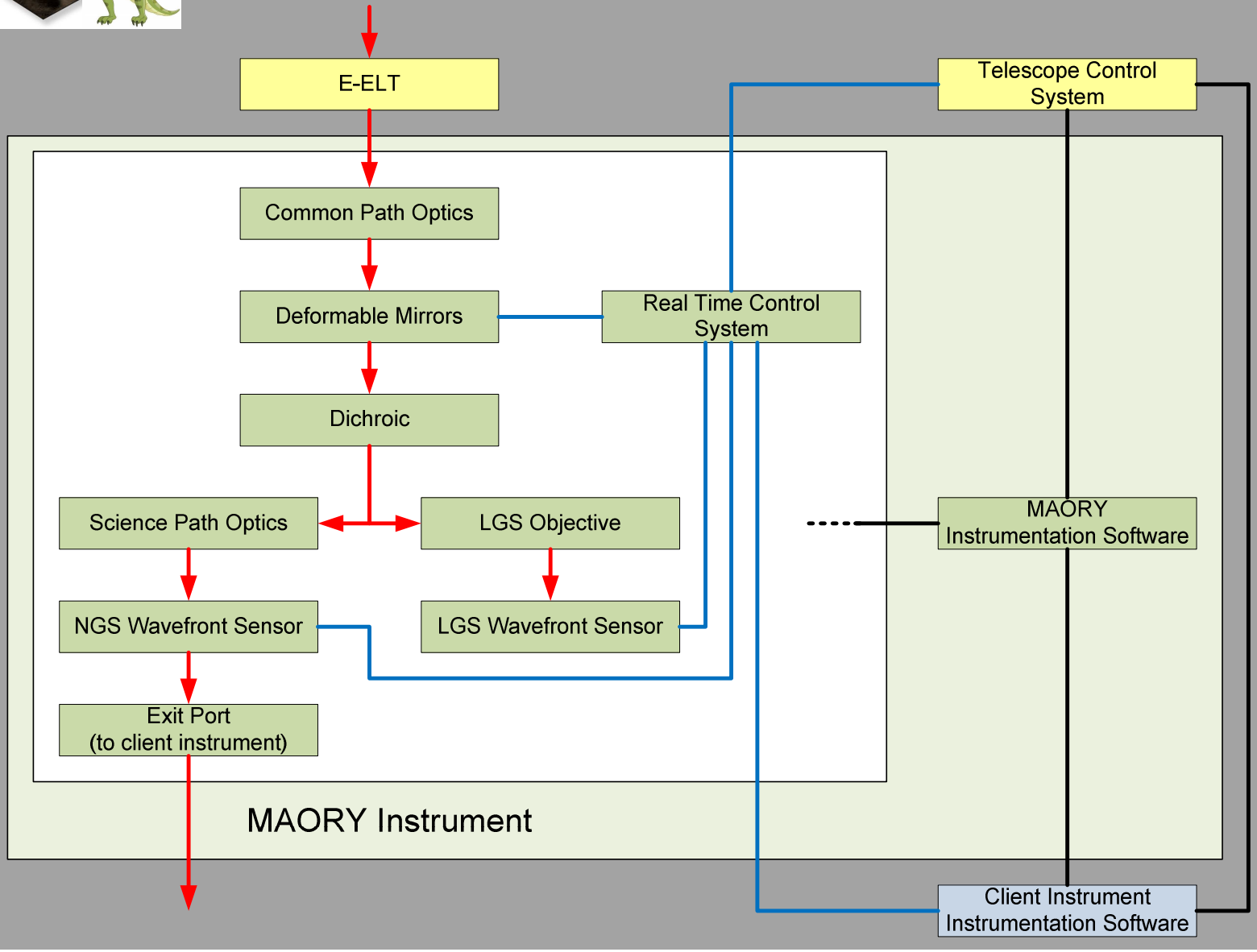






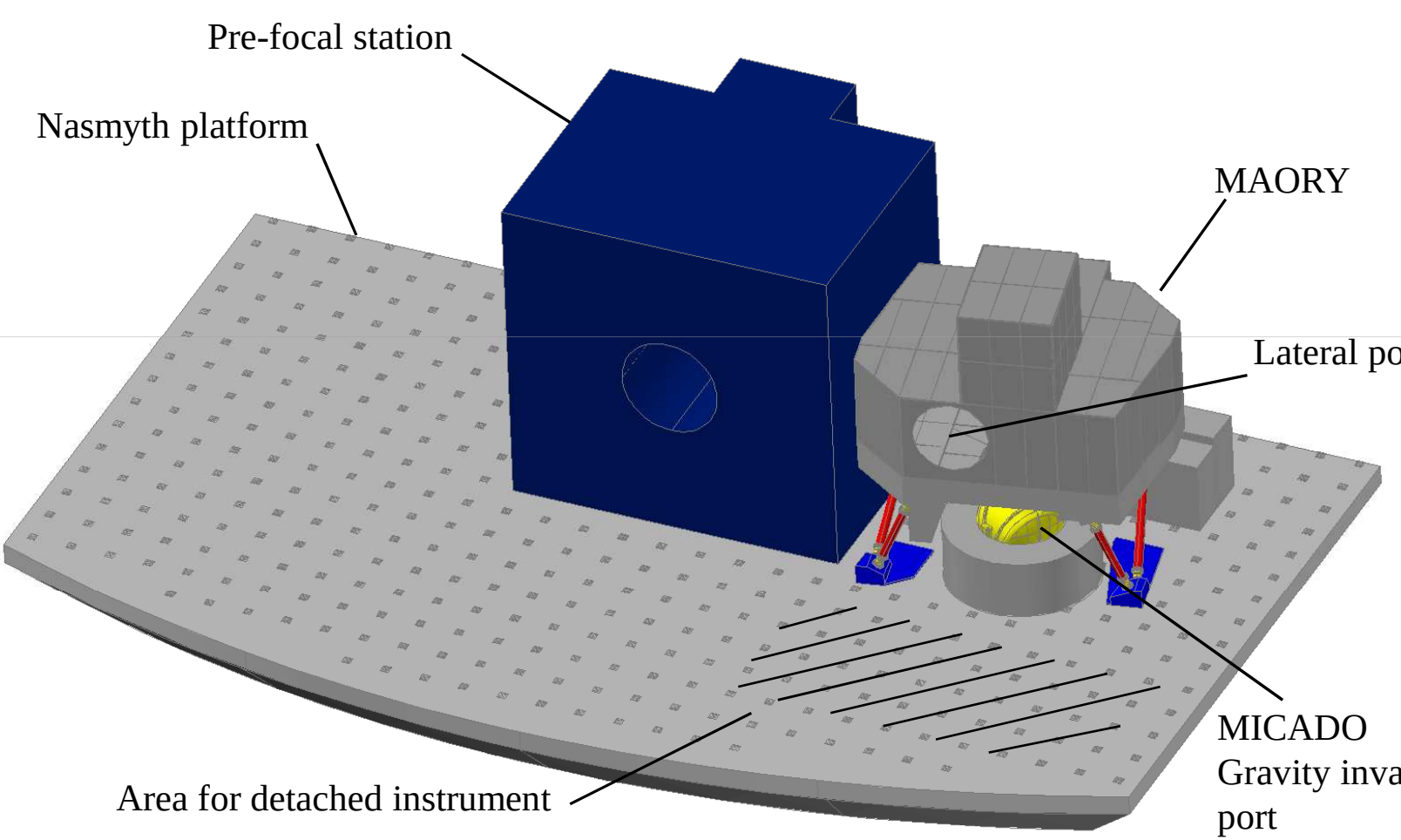
MAORY Project

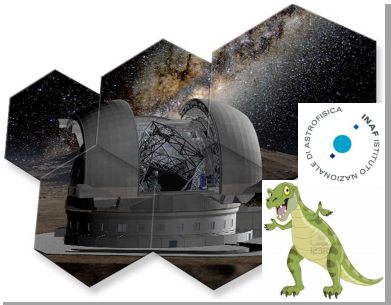
Instrument architecture



MAORY Project

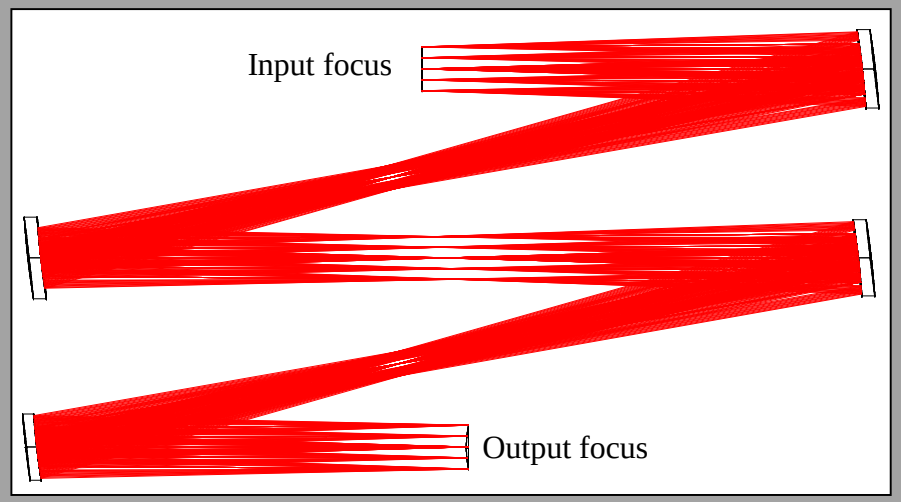
Instrument layout



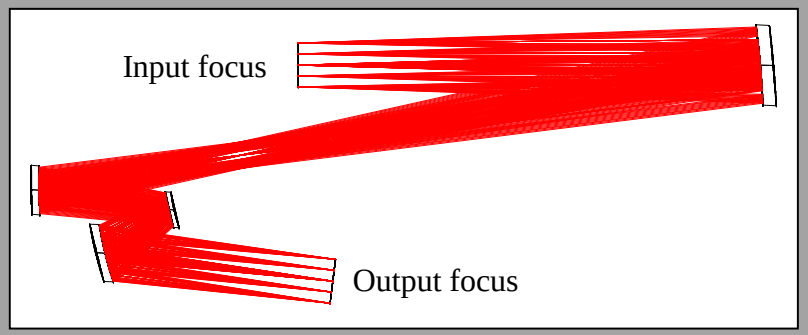


MAORY Project

Post-focal relay optics

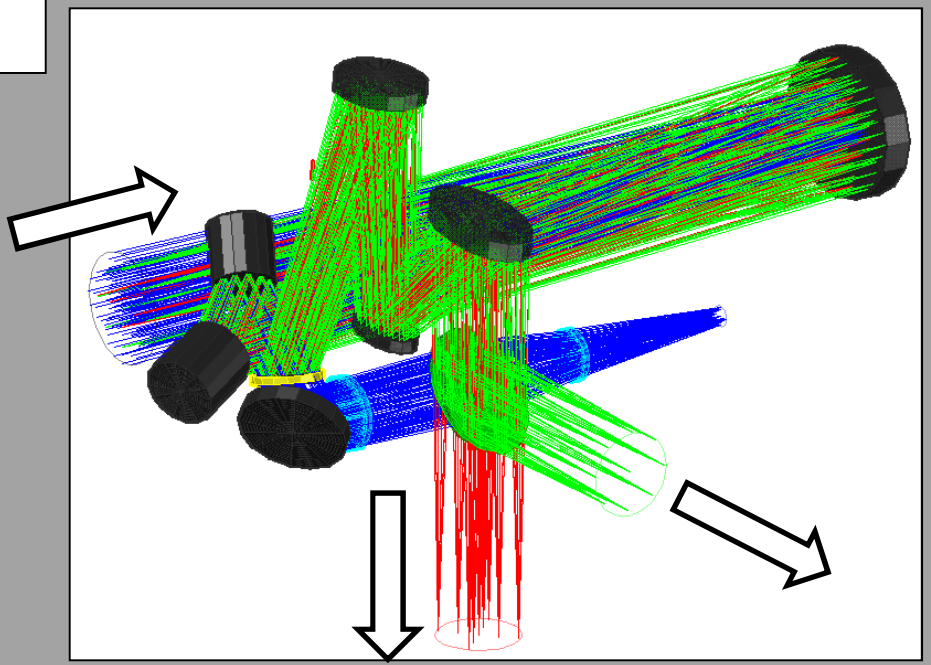


Phase A design

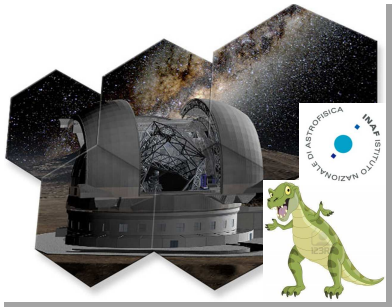


1000 mm

Alternate design under discussion



Baseline post-focal deformable mirrors are based on piezo-electric actuator technology (under review)



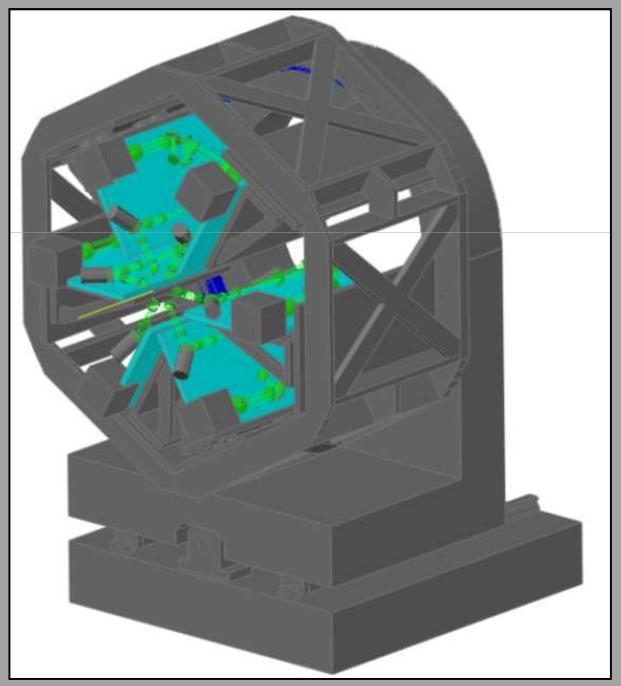
MAORY Project
LGS Wavefront Sensor

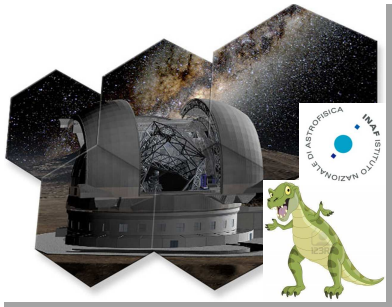
Why Laser Guide Stars?

- 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)





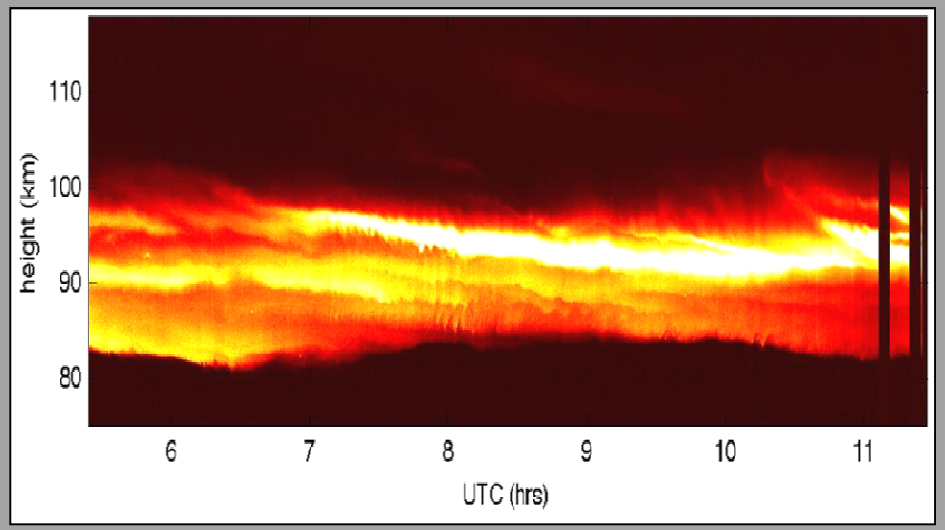
MAORY Project
LGS & Sodium layer issues

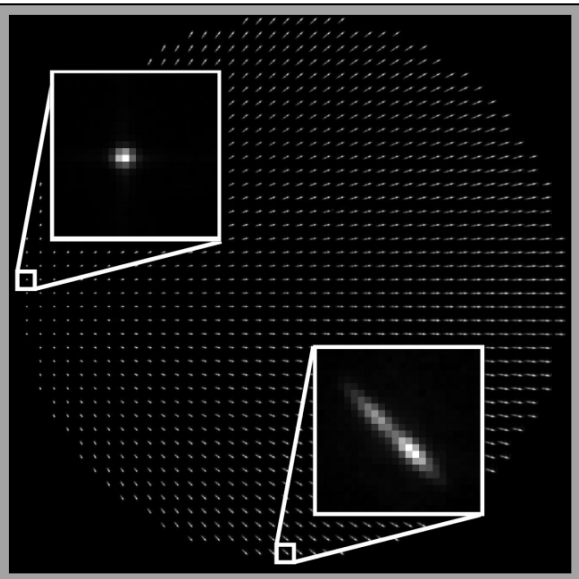
Laser Guide Stars issues

1. Tip-tilt indetermination
2. Variation of mean height of Sodium layer → LGS focus not fully reliable
3. Variation of Sodium layer density profile introduces low-medium order wavefront distortions

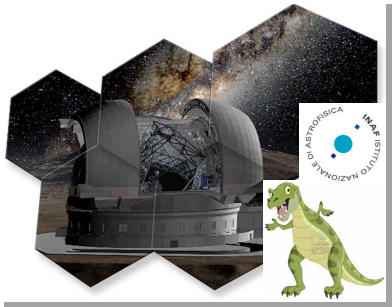
1, 2: fast; 3: slow

→ Natural Guide Stars are required





Sodium layer data kindly provided by
Paul Hickson, University of British Columbia



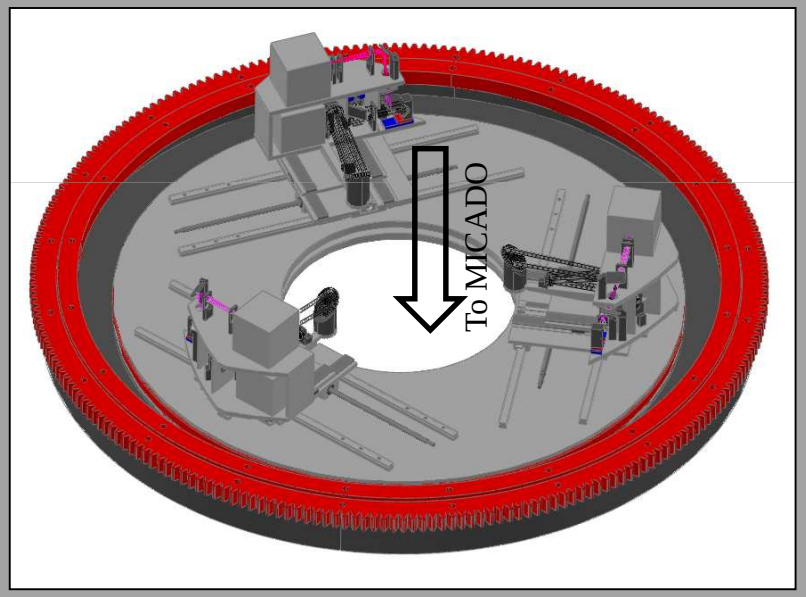
MAORY Project
NGS Wavefront Sensor

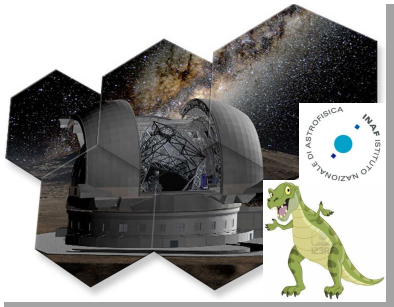
Tip-Tilt & Focus channel (1.5 - 1.8 µm)

- 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

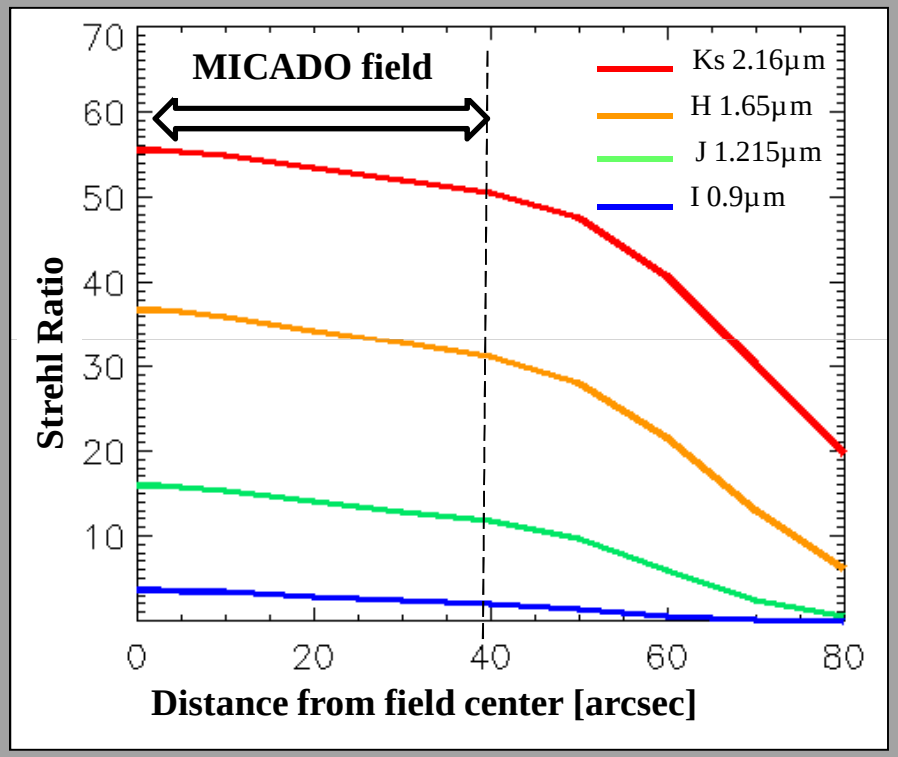


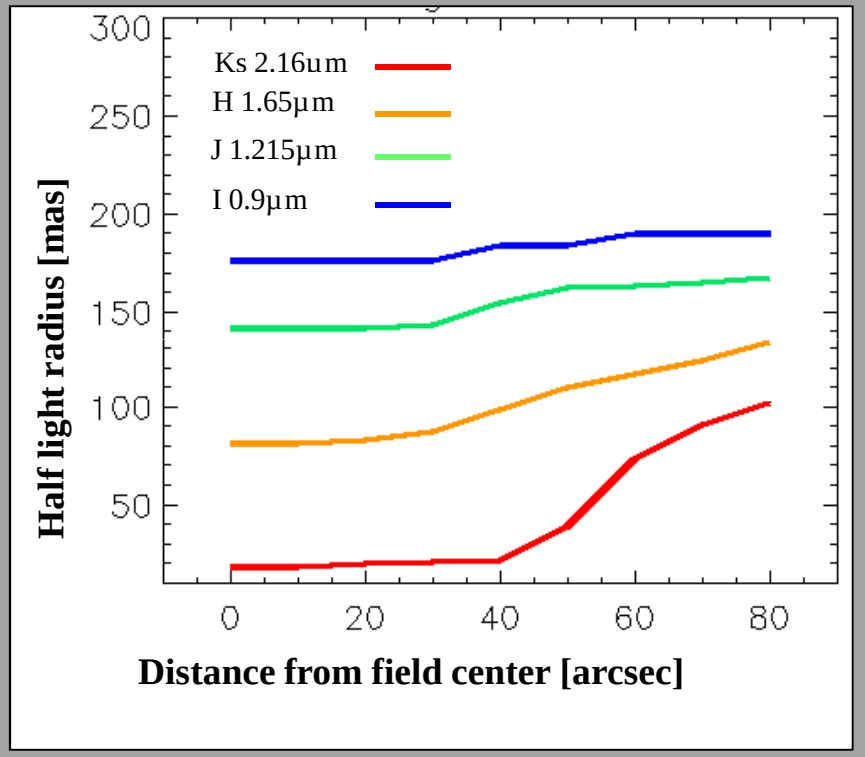


MAORY Project

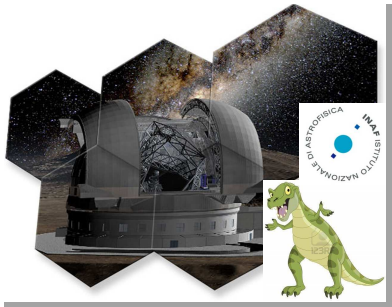
Adaptive optics performance

(Median atmospheric seeing 0.8")





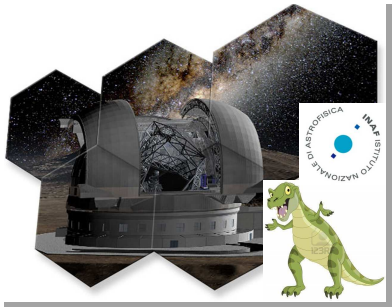
Minimum field-averaged Strehl Ratio (53"×53")				Sky Coverage
2.16 µm Ks	1.65 µm H	1.215 µm J	0.9 µm I	@Galactic Pole
0.53	0.34	0.14	0.03	**39%**
0.51	0.32	0.13	0.03	**50%**
0.41	0.22	0.06	<0.01	**80%**



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

	Y01		Y02		Y03		Y04		Y05		Y06		Y07		Y08		Y09		Y10	
Phase B																				
Phase C																				
Phase D																				
Phase E																				



MAORY Project
Management Structure

ESO

MAORY Co-I Science Steering Committee

MAORY Principal Investigator

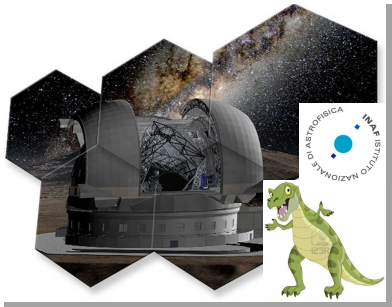
MAORY Executive Funding Committee

MAORY Project Manager

MAORY Project Office
(under coordination of Project Manager)

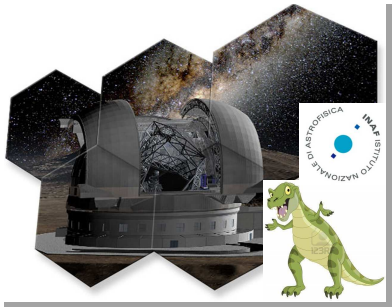
System Team
(under technical supervision of System Engineer)

MAORY Local Project Managers



2nd T-Rex proposal ELT-CAM Unit

- Include MOSE project in ELT-CAM Unit of T-Rex
- **MOSE: Modeling ESO Sites**
  - PI: E. Masciadri (INAF)
  - Phase A: 4/2011-4/2013
  - 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 atmospherical parameters
- Support from T-Rex 2nd 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