



# MAORY

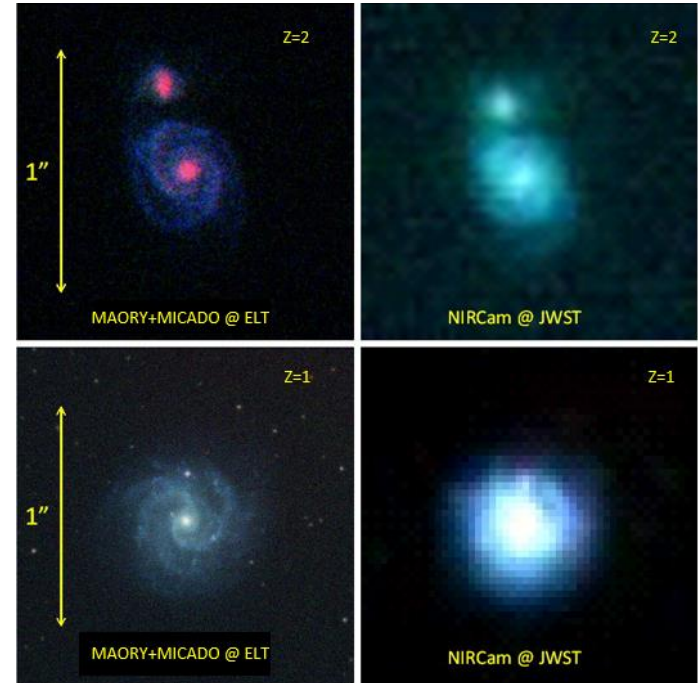
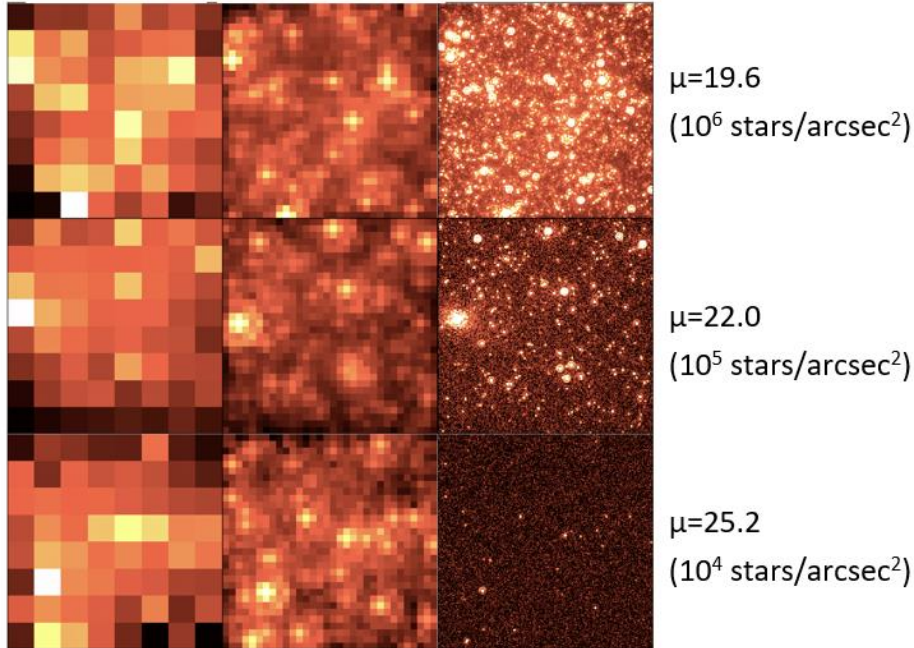
## The Adaptive Optics Module for ELT

**Paolo Ciliegi on behalf of the MAORY CONSORTIUM**

# MAORY : ADAPTIVE OPTICS MODULE FOR ELT



HST / WFC3    JWST / NIRCam    ELT/MAORY+MICADO

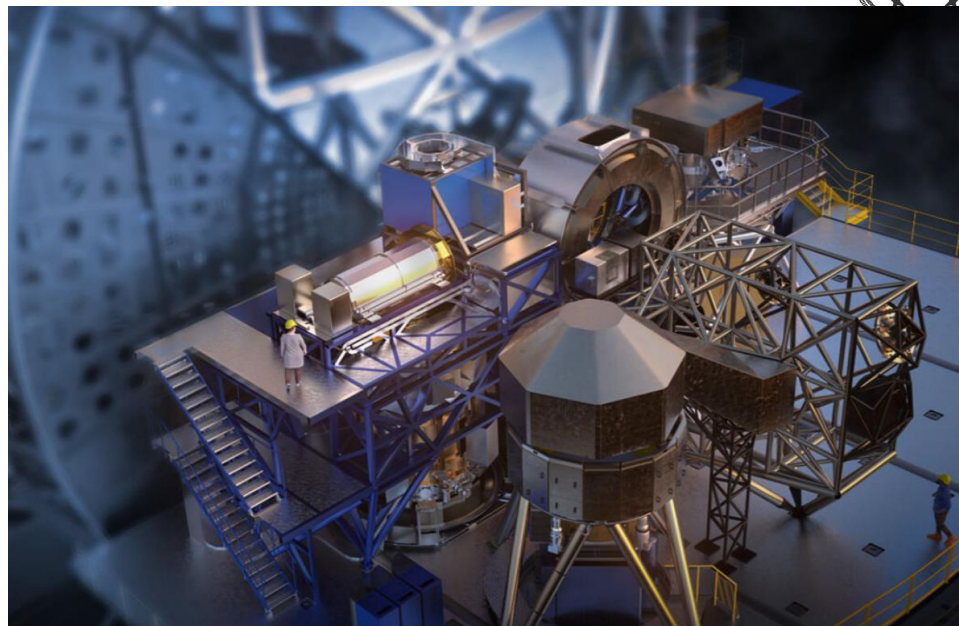
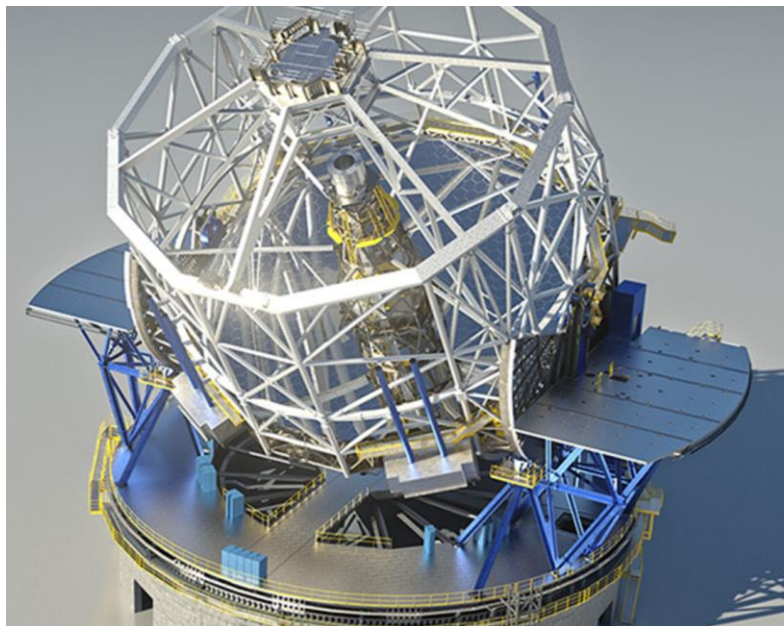


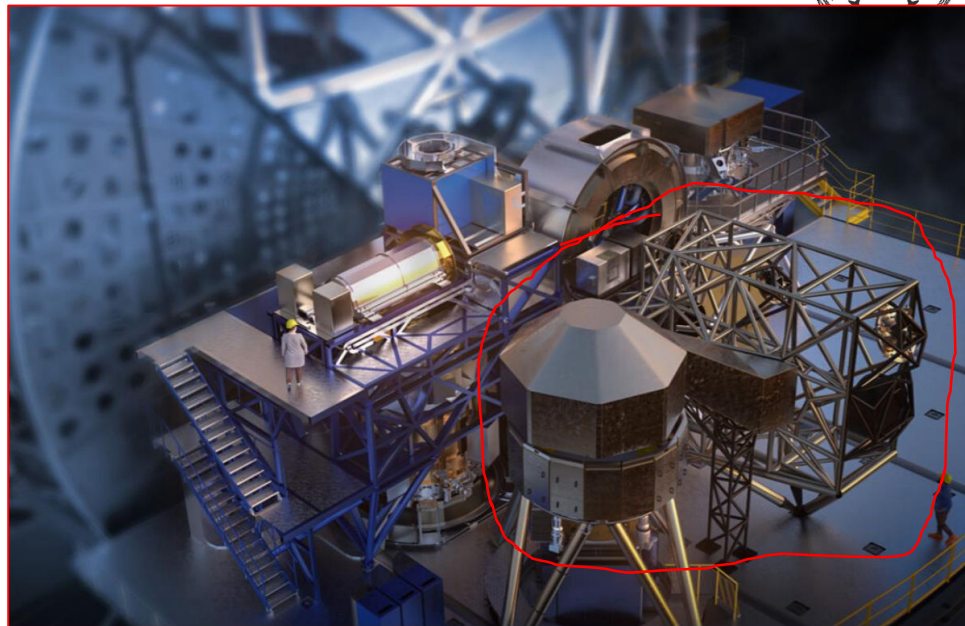
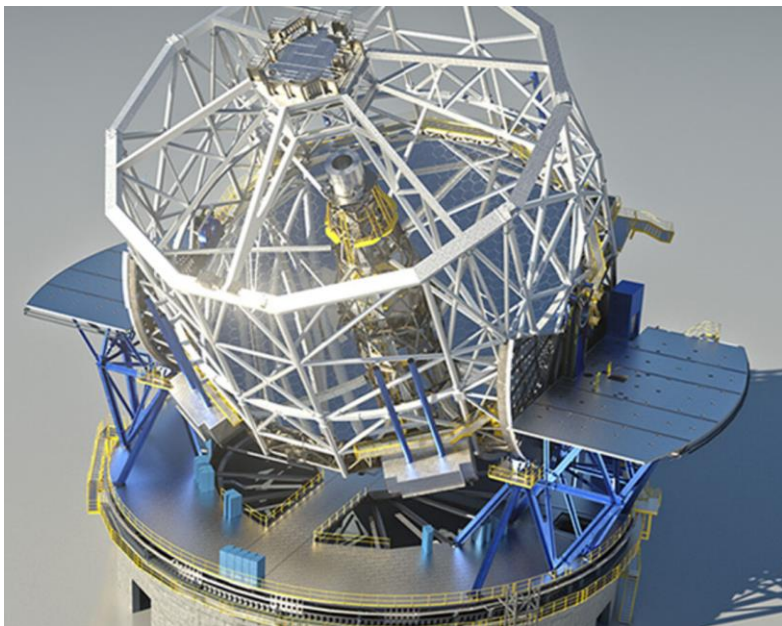
# MAORY : ADAPTIVE OPTICS MODULE FOR ELT



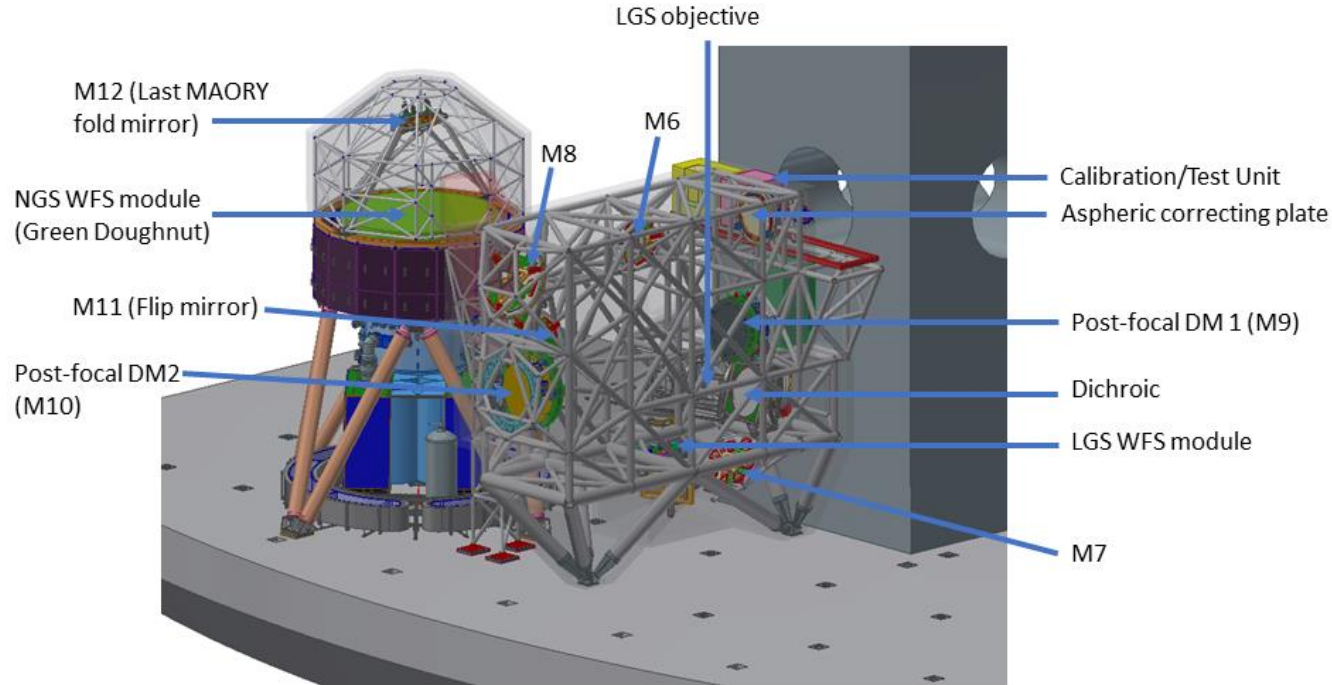
# MAORY : ADAPTIVE OPTICS MODULE FOR ELT



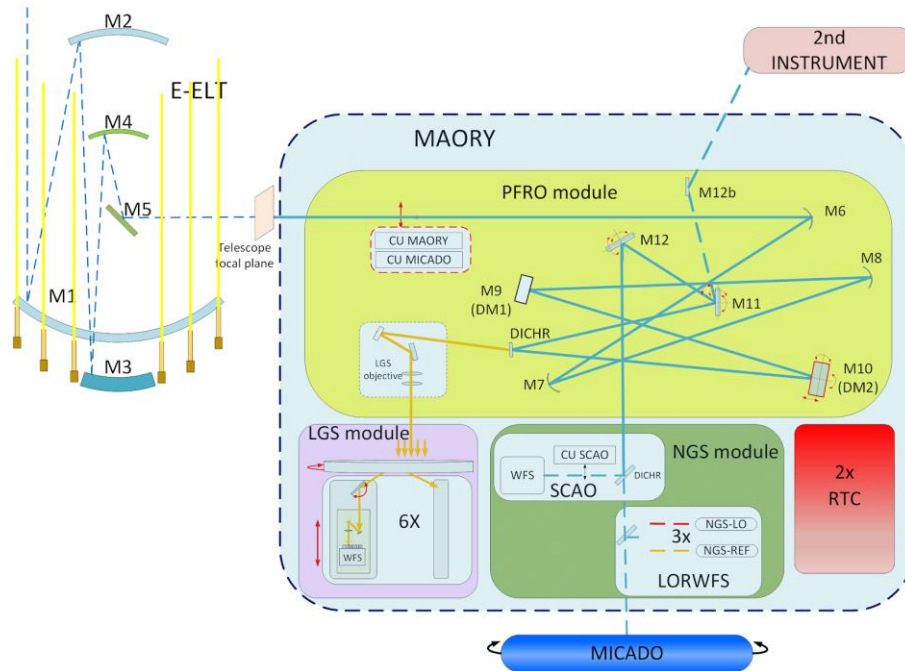




# MAORY GENERAL OVERVIEW



# FUNCTIONAL OVERVIEW





## Key Capabilities

MAORY and MICADO will be used to provide:

### □ Imaging

- 0.8-2.4 $\mu$ m with 30 broad/narrow filters
- 1.5 & 4mas pixels for 19" & 51" FoV at 6-12mas
- Similar sensitivity to JWST, and 6 $\times$  better resolution

### □ Astrometric imaging

- 50 $\mu$ as precision for 2 sources 1" apart
- 10 $\mu$ as/yr = 5km/s at 100 kpc after only a few years

### □ High Contrast imaging

- focal & pupil plane coronagraphs
- angular differential imaging
- small inner working angle

### □ Spectroscopy

- for compact sources
- fixed configuration for 0.84-1.48 $\mu$ m & 1.48-2.46 $\mu$ m
- $R \sim 20000$  for point sources ( $R \sim 10000$  across slit)

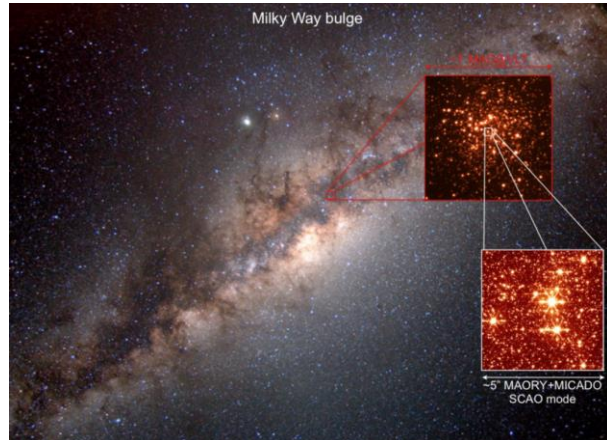
# SCIENTIFIC IMPACT

## - Potential to address a large number of science topics

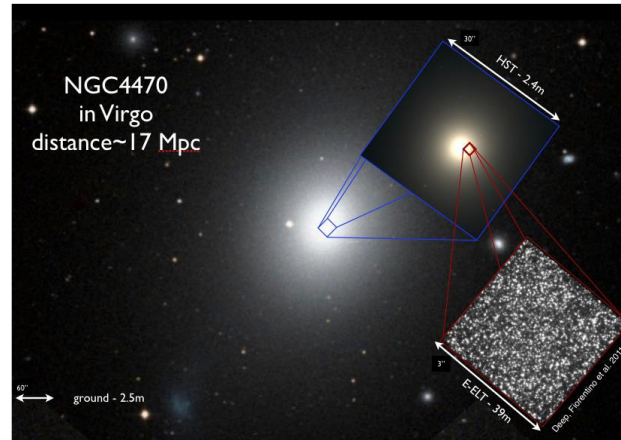


- Dynamics of dense stellar systems,
- Black holes in galaxies and the centre of the Milky Way,
- Formation and evolution of galaxies in the early universe,
- Star formation history of galaxies through resolved stellar populations,
- Planets and planet formation,
- The solar system.

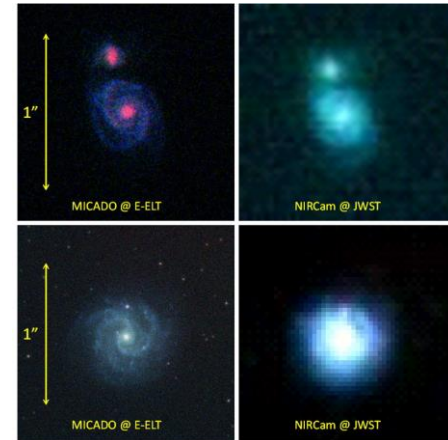
### Nearby Stellar System



### Local Universe



### High Redshift Universe





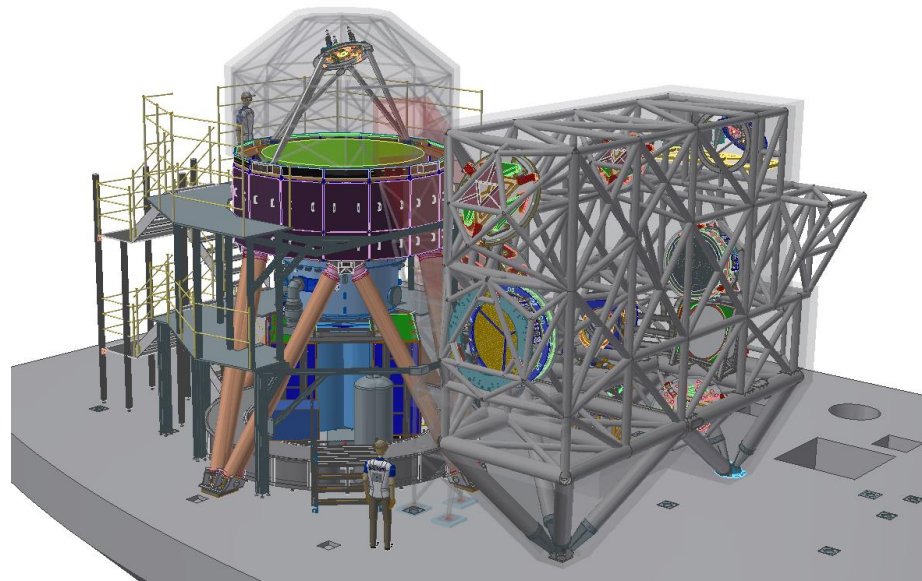
# Technological Aspects

High technology project in many sectors (optics, mechanics, electronics, real time computers, control )

At the edge of technological knowledge in different fields:

- Deformable Mirrors
- Optical Components
- Real Time Computer
- Main Structure

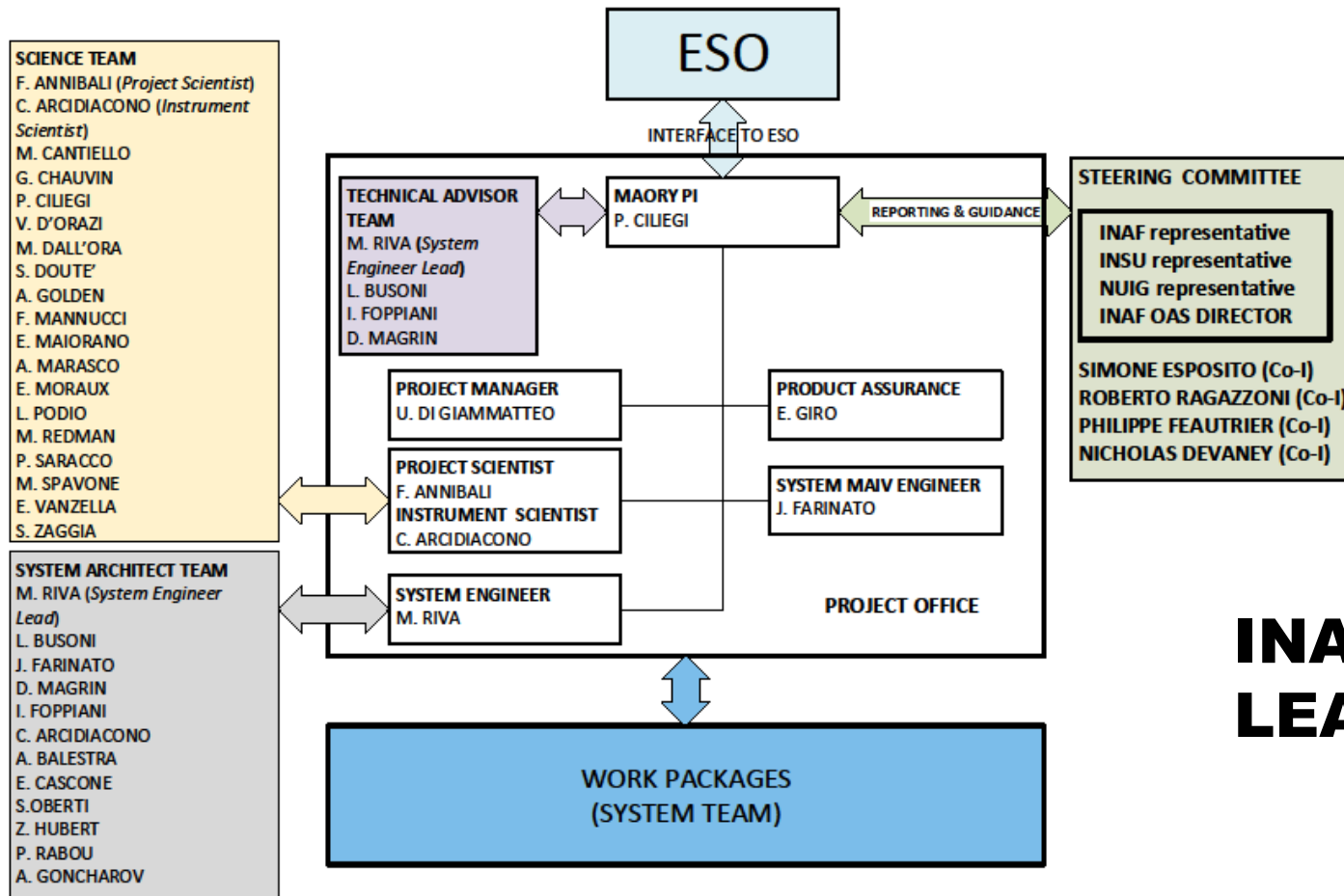
Strong interaction with industries  
(including Italian industries in all strategic sectors)



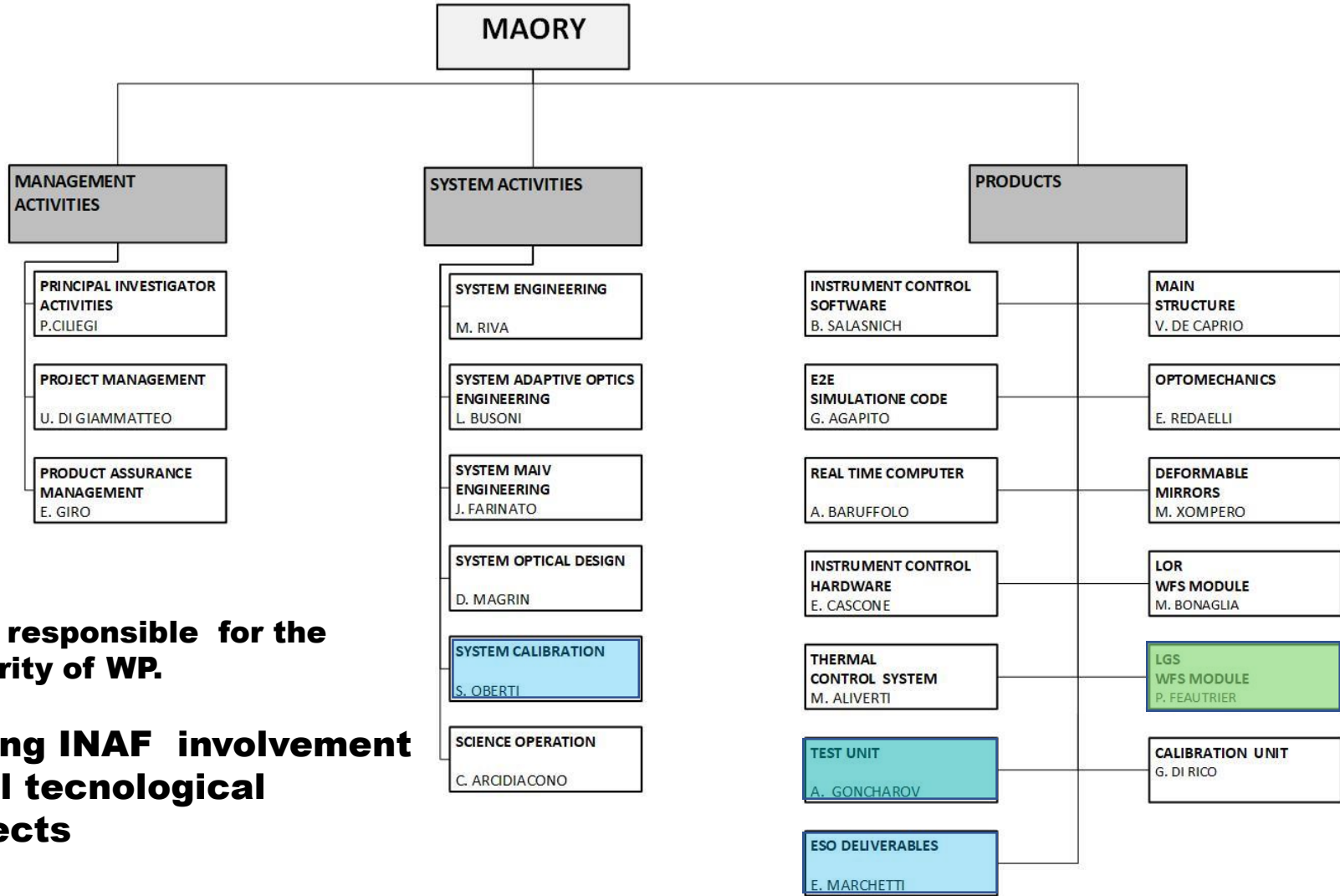
# MAORY CONSORTIUM



| COUNTRY | INSTITUTE   | PRINCIPAL SUPPLIES  |
|---------|---|---|
| ITALY   | INAF  | PI : <b>PAOLO CILIEGI</b><br>Co-I : <b>ESPOSITO - RAGAZZONI</b><br>Project Office<br>Sub-system level: ICS software, instrument control hardware, main structure, post-focal relay optics, opto-mechanics, LOR WFS module, RTC, DMs, calibration unit, science support tools<br><br>Contribution to SAT, System Team and Science Team |
| FRANCE  | CNRS/INSU representing IPAG (Grenoble)                                | Co-I : <b>FEAUTRIER</b><br>Sub-system level: LGS WFS<br>Contribution to SAT System Team and Science Team  |
| IRELAND | School of Physisc at the National University of Ireland Galway (NUIG) | Co-I : <b>DEVANEY</b><br>Subsystem level : Test and Wavefront Correction Verification<br>Contribution to SAT and System Team and Science Team   |



# INAF LEADERSHIP



**INAF responsible for the majority of WP.**

**Strong INAF involvement in all technological aspects**

# INAF STAFF



70 MEMBERS 49 TI 3 TD 18 AdR

Total FTE per/year 15.3 1.7 12.5

INAF OAS BOLOGNA  
INAF OAPD PADOVA  
INAF OAA ARCETRI  
INAF OACN NAPOLI  
INAF OAB MERATE  
INAF OAAB TERAMO  
INAF OAC CATANIA

GTO (65 total)

3 NUIG  
11 IPAG  
51 INAF

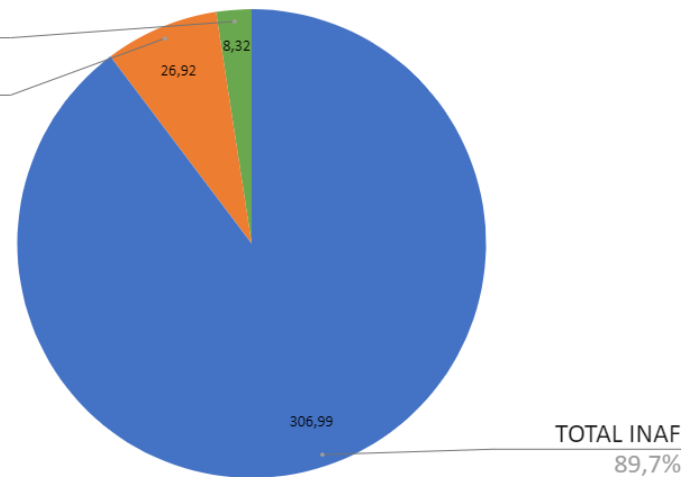
TOTAL FTE per Partners (ESO Excluded)

TOTAL NUIG

2,4%

TOTAL IPAG

7,9%



# SCHEDULE



- 1) Kick Off Meeting February 2016
- 2) Preliminary Design Review : documents delivery January 2021 and April 2021, reviews April 2021 and June 2021.
- 3) Final Design Review (end of Phase C) February 2023
- 4) Start of activities in the integration room in Bologna (start of Phase D) September 2023
- 5) Preliminary Acceptance in Europe (PAE) (end Phase D) February 2028
- 6) MAORY expedition to Chile : March to June 2028
- 7) Installation of the instrument on ELT's Nasmyth platform : July --> September 2028
- 8) First technical light September 2028
- 9) Start of Commissioning (start of Phase E) September 2028
- 10) Provisional Acceptance in Chile (PAC) (end of Phase E) May 2029

# RESULTS



After a period of controversy, mainly due to the change of management structure and the introduction of changes to the requirements by ESO, the consortium managed to compact around the project and to address the complex technical-management issues.

**The major result was the arrival of the project at the Preliminary Design Review (PDR) in a very short time.**

The PDR was split into two parts. All the documents delivered to ESO (January 2021, April 2021)

During the PDR1 reviews ESO provided extremely positive feedback on the quality of the documentation received confirming the excellent work done by the MAORY team.

# FUNDS



**ESO – INAF Contract for MAORY F.O. E-ELT MAORY ESO (Investment & Project expenses)**

Each partner would contribute with:

- the cost of its own staff (including overheads, software licenses, personal computers etc)
- the cost of contracts with external companies (if needed)
- the travel expenses
- running cost of its own laboratories necessary for integration test and verification of all MAORY components including new equipments
- any other expenses related to the MAORY project

In addition, the INAF institute, as leader institute is in charge also to provide (and to maintain) the integration hall.

**F.O. E-ELT MAORY INAF**

# CRITICALITIES



The most critical element for the project is the huge difference between the cost initially planned and financed by ESO and the estimated cost to the PDR. This difference amounts to several million euro. The estimated costs to the PDR were analysed and discussed with ESO during the PDR.

A discussion is ongoing between ESO and the MAORY Consortium to finance this extra cost.

Administrative expertise for the management of large and innovative procurements

Strengthening of the team with particular attention to the integration phase in Bologna. For this type of activity we will need technologists/engineers with different qualifications. Moreover we will need qualified personnel to work in a mechanical and electronics laboratories and to manage activities in the integration room (crane , maintenance, etc.). For this type of activity we will need laboratory technicians.

Stability in the renewal of contracts. Many staff are research contracts. Problem of keeping in INAF the people trained in the project

Career progressions. It is essential in such a long-term project, where the opportunities for publication are reduced, to ensure that the people involved have the right career opportunities to ensure a stimulating working environment