Update on the ERIS–AO and MAORY-NGS Control Systems

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Extending Collaborations within INAF

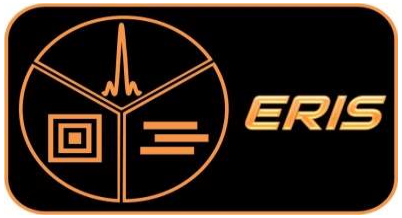
LABORATORIO NAZIONALE ADONI OTTICA ADATTIVA

Attività di collaborazione:

- **ERIS**
  - ✓ **Elettronica AO (NGS+LGS)**
  - ✓ **Calibration Unit (CU)**
  - ✓ **ICS (software)**
- **MAORY**
  - ✓ **Elettronica & Software LORs**
  - ✓ **LORs FMECA (*Failure Mode, Effects, and Criticality Analysis*)**
- **Science**
  - ✓ ***M. Cantiello*, ADONI 2017**

ERIS

(Enhanced Resolution Imager and Spectrograph)



- **UT4@VLT (Cassegrain focus): AOF + 4LGFS**
- **Two Science Instruments:**
  1. **NIX (ATC+ETH)**: IR imager providing diffraction limited imaging, Sparse Aperture Masking (SAM) and pupil plane coronagraphy capabilities from 1 to 5 μm.
  2. **SPIFFIER** (SPectrometer for Infrared Faint Field Imaging with Enhanced Resolution, **MPE**): near-IR (1.08-2.43 μm) integral field spectrograph (upgraded version of SPIFFI).
- **An AO System (LGS + NGS)**
- **A Calibration Unit (CU) for all ERIS instrumentation**

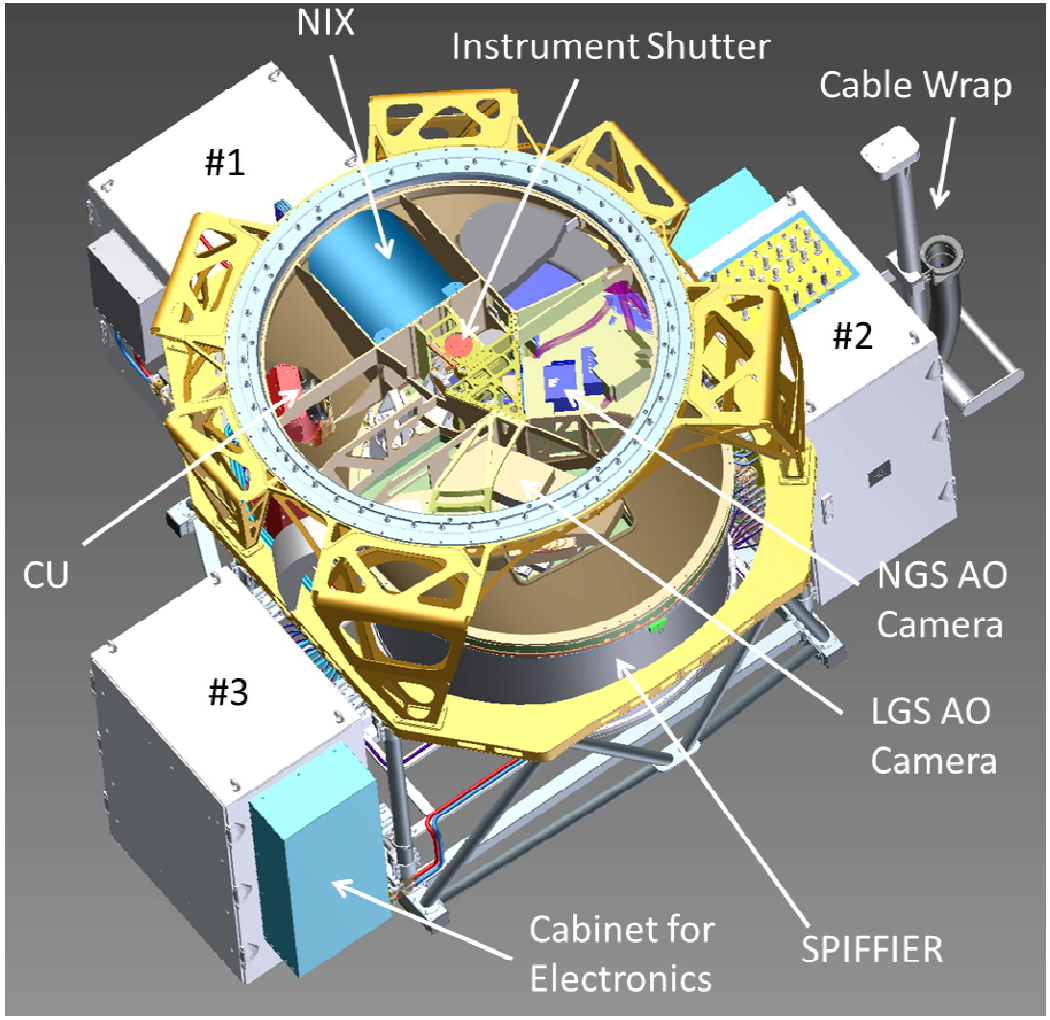
FDR 29/05/2017

First Light 2020

(ERIS AO Performance: *G. Agapito*, ADONI2016)

ERIS

(Enhanced Resolution Imager and Spectrograph)



All Control Electronics in 3 corotating cabinets:

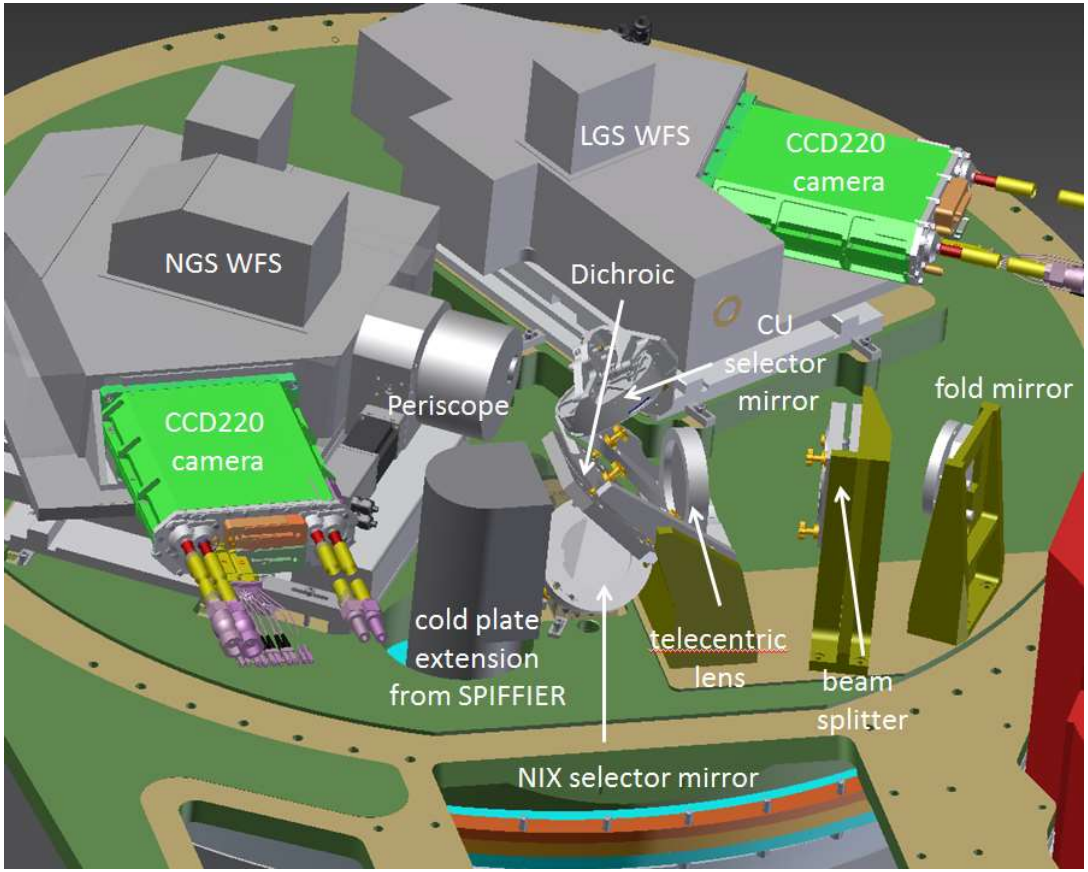
- ✓ **WFSs CCD controllers**
- ✓ **AO+CU PLC based ICE**
- ✓ **Piezo Controllers**
- ✓ **NIX electronics**
- ✓ **SPIFFIER electronics**
- ✓ **Power Supplies**
- ✓ **Thermal Control, Fans,...**

24 RU 1200 mm
Air flowing / Water cooling

ERIS

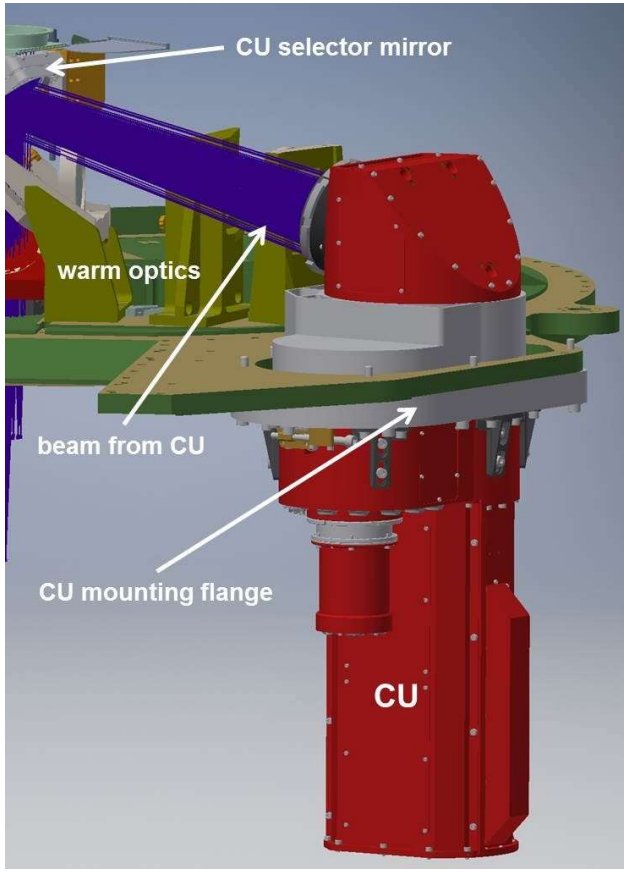
(Enhanced Resolution Imager and Spectrograph)

AO



LGS + NGS + WO

CU

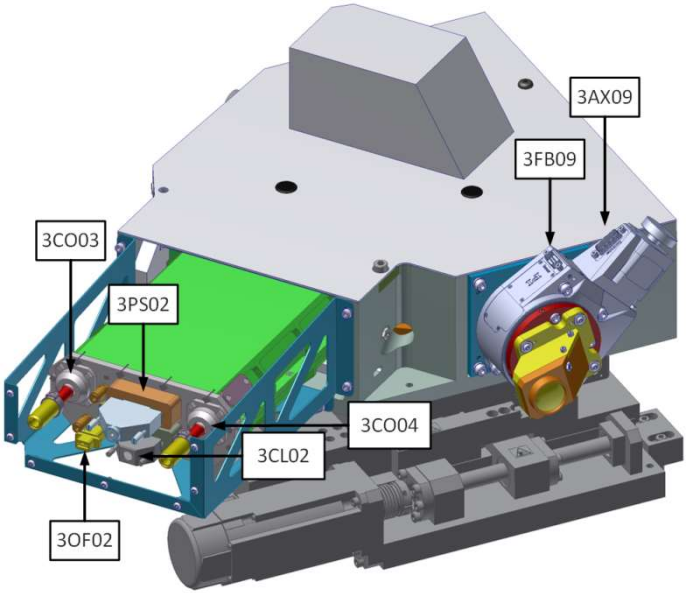


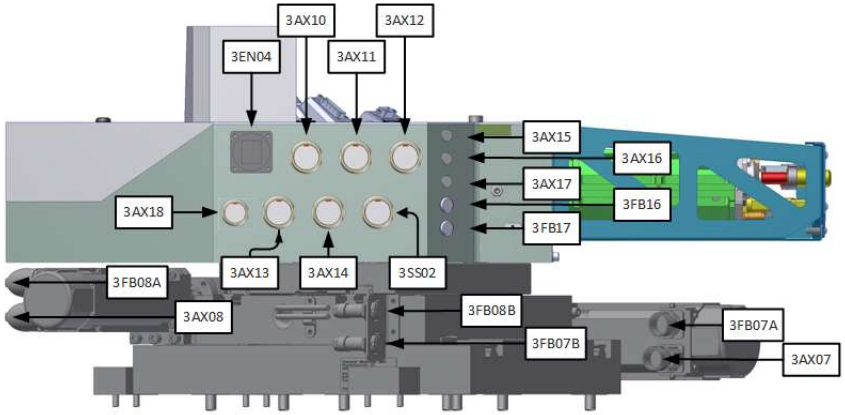
CU Main Bench

ERIS

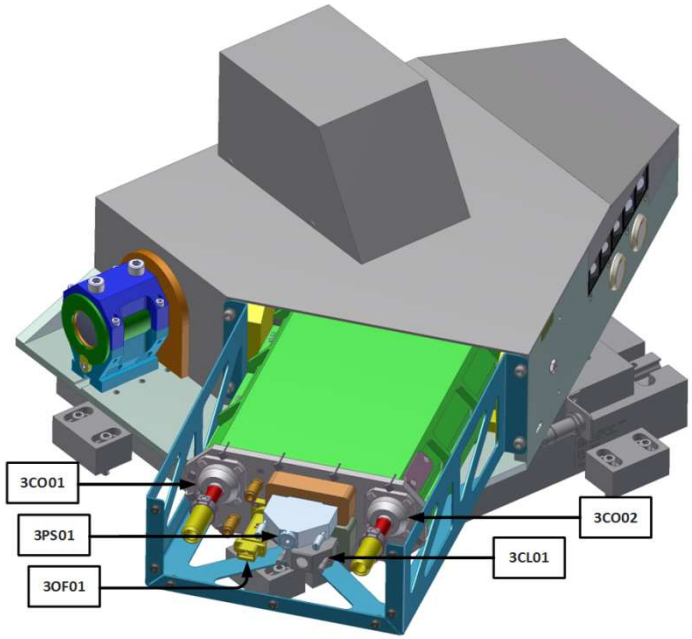
(Enhanced Resolution Imager and Spectrograph)

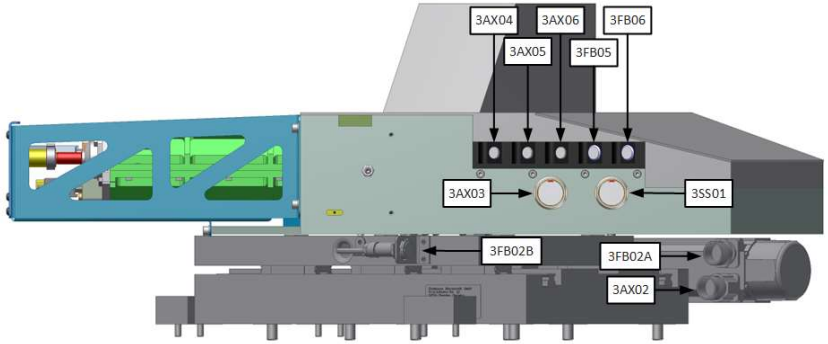
NGS





LGS

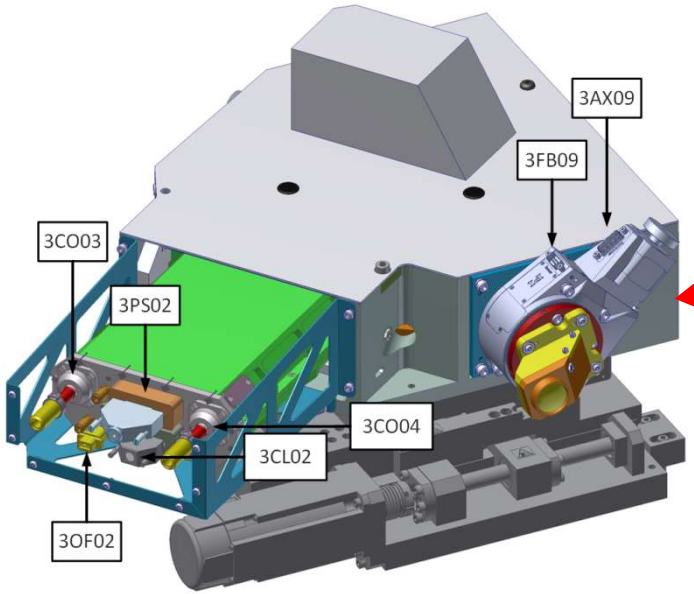


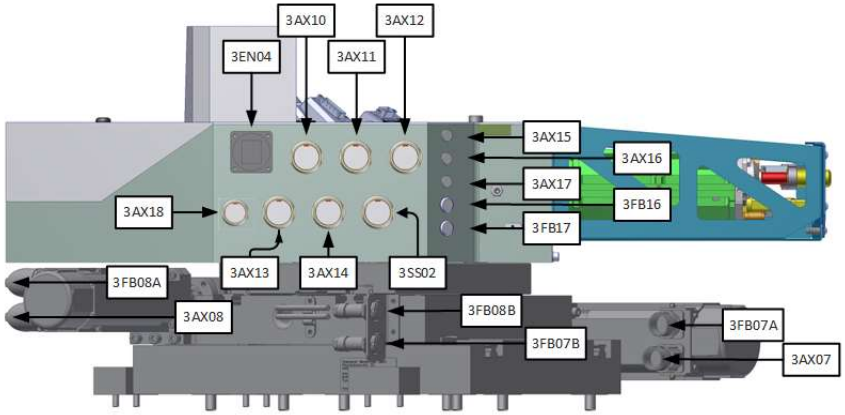


ERIS

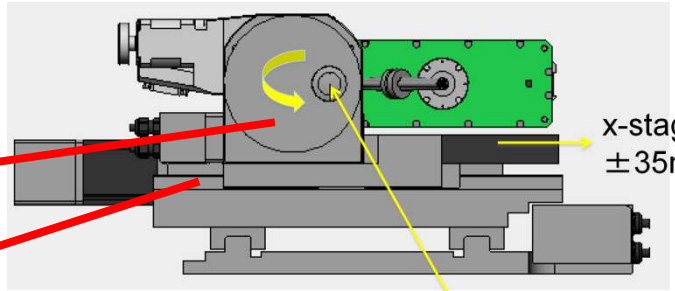
(Enhanced Resolution Imager and Spectrograph)

NGS





Combined Coordinated motion for XY patrolling and tracking on the focal plane



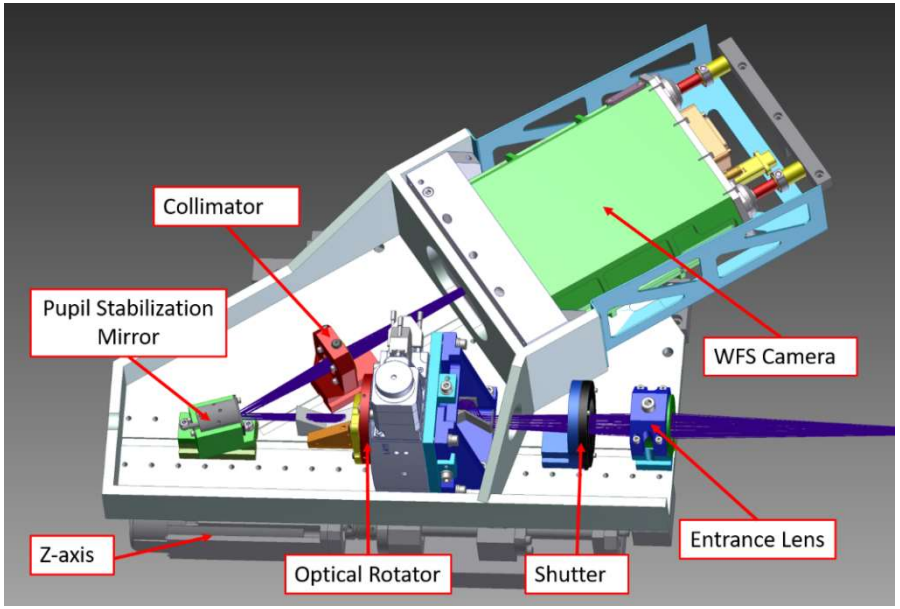
[AODEV-003] Differential tracking. In any AO mode, the NGS WFS must be able to perform one of several possible differential trackings (TS-ERIS-OPS-013, TS-ERIS-OPS-014):

1. Any sidereal / non-sidereal combination between science target and AO reference star
2. Circular following of sidereal NGS when observing in pupil-tracking mode.

In both modes, the NGSX and NGPE need to move continuously during integration following a predefined trajectory. In both cases, the maximum speed of this movement will be 100 arcsec/hour (28 mas/sec), and the tolerance on positioning is +/-1 mas

ERIS

(Enhanced Resolution Imager and Spectrograph)

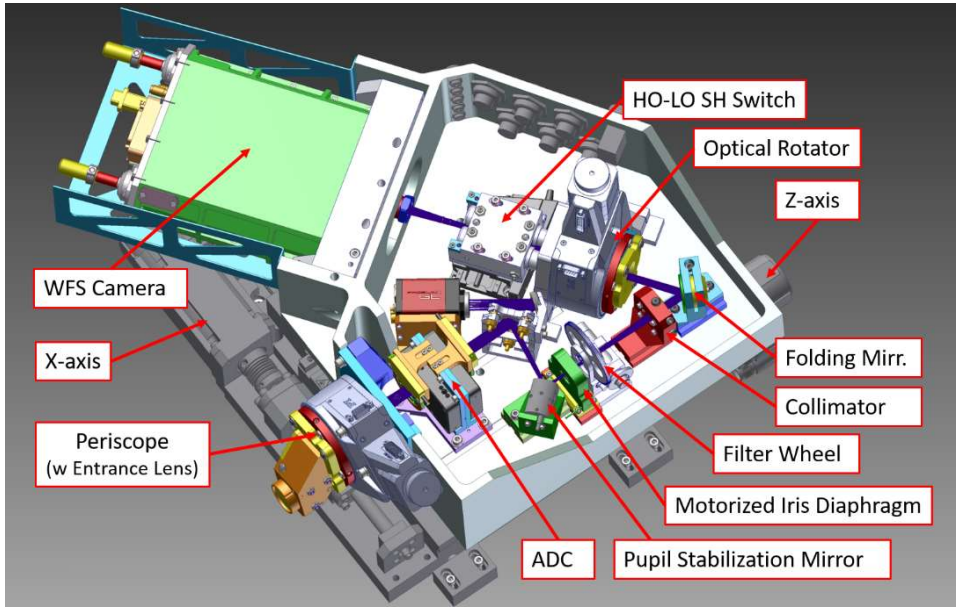


LGS

- 3 motorixed axes (1 tracking)
- 1 piezo (PSM)
- 1 beam shutter
- 1 CCD220
- Sensors (T+RH)

NGS

- 8 motorized axes
  (K-mirr + ADC + diff. tracking)
- Technical camera
- 2 piezo (PSM + Iris)
- CCD220
- Sensors (T+RH)

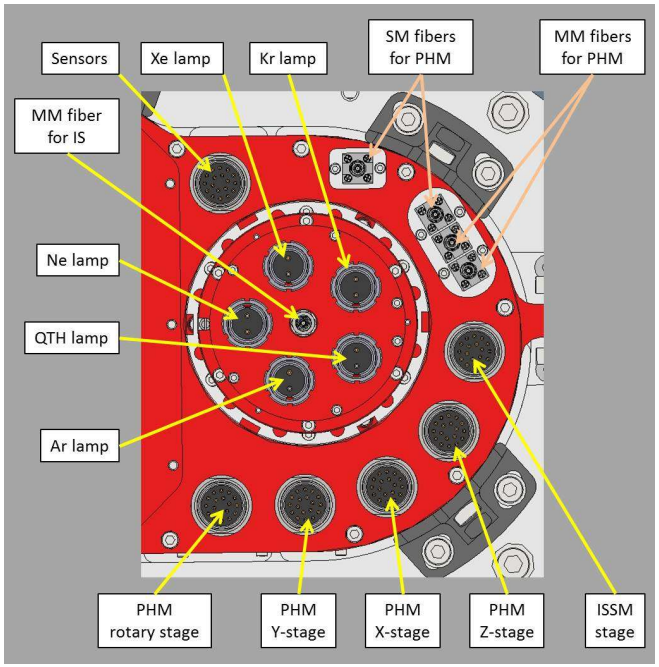


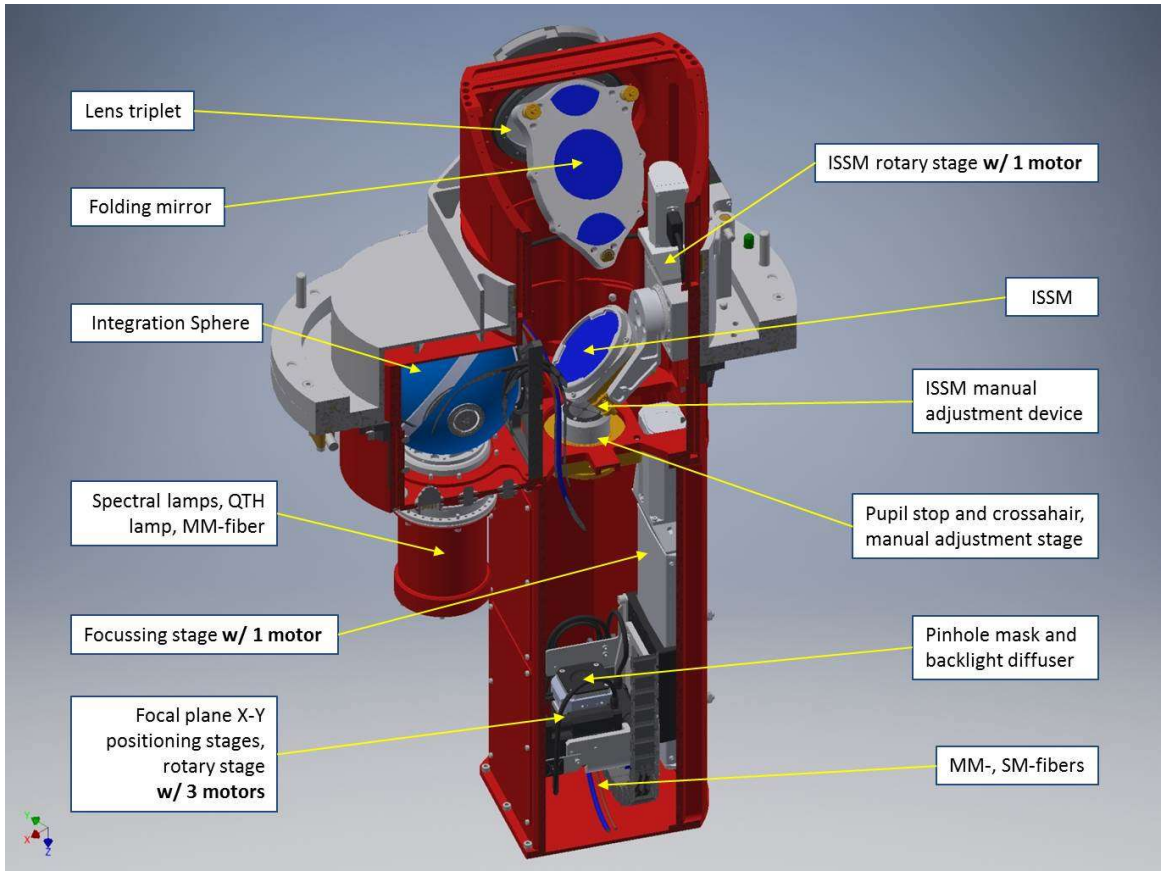
ERIS

(Enhanced Resolution Imager and Spectrograph)

CU

- 7 motorixed axes
- 1 piezo (PHM rot)
- 5 spectral lamp
- 2 FF lamps (LDLS +QTH)
- Sensors (T+RH+Flux)

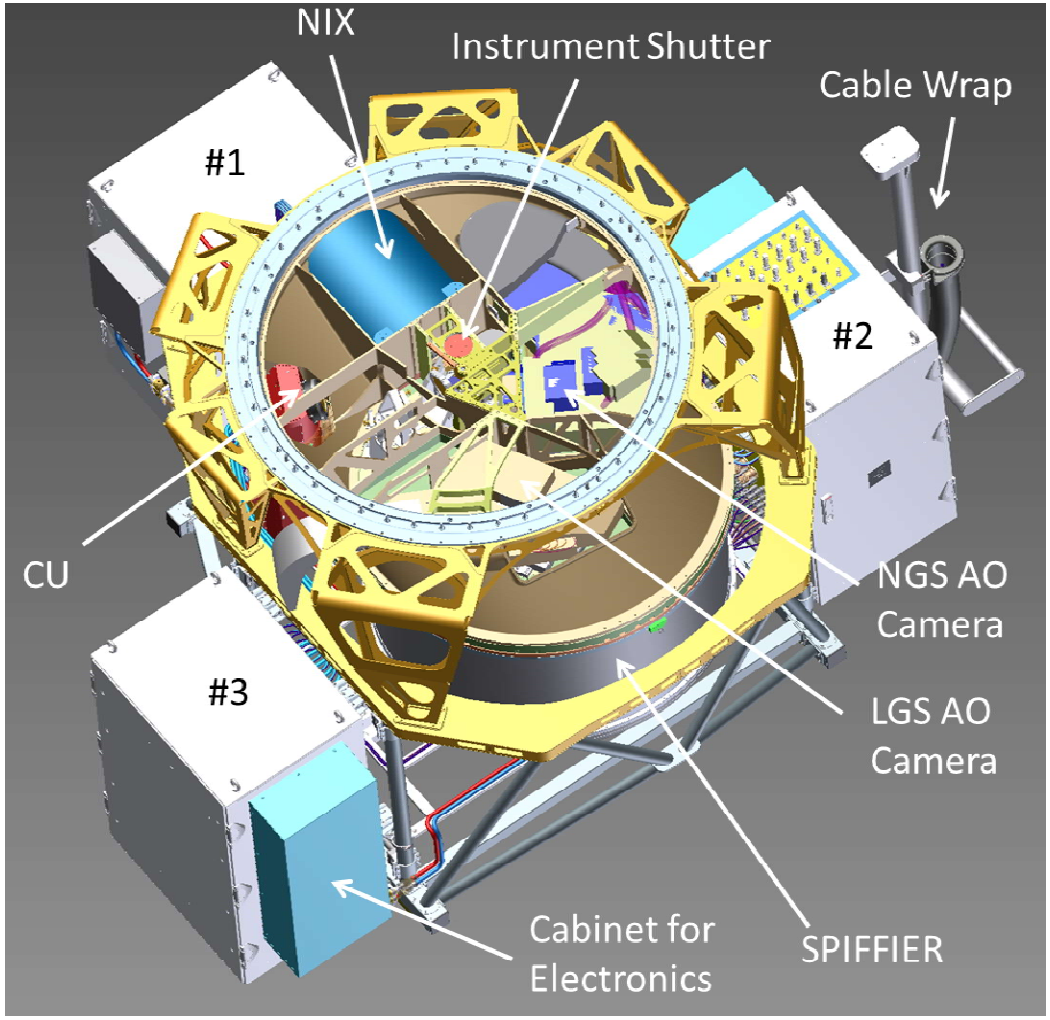




FF+DL+Ex. Sources capabilities for NIX+SPIFFIER+AO (0.8-2.4 um)

ERIS

(Enhanced Resolution Imager and Spectrograph)



Main Constraints (E-DAR)

- ✓ Volume at the optical bench
- ✓ Volume inside Cabinets
- ✓ Mass and Power budget
- ✓ Cable routing (size, bending)

ESO Specs compliance

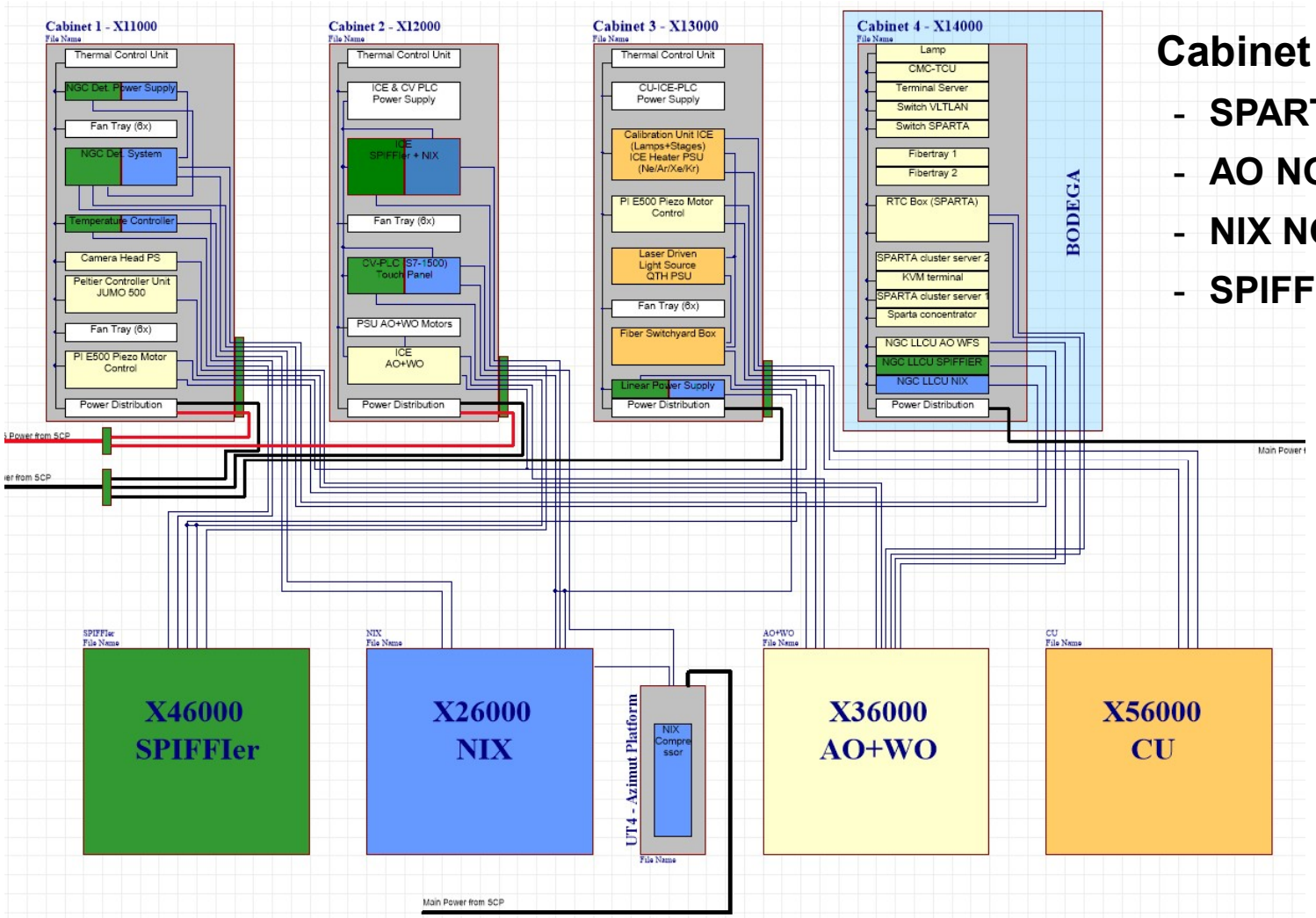
- ✓ Instrument Electronics
- ✓ Control Electronics
- ✓ Cables & Connectors
- ✓ Interfaces definition
- ✓ Documentation …

Troubles…

- Discontinued products from manufacturers pre-FDR, …

ERIS

(Enhanced Resolution Imager and Spectrograph)



Cabinet 4 (BODEGA)

- **SPARTA (RTC)**
- **AO NGC LLCU (x2)**
- **NIX NGC LLCU**
- **SPIFFIER NGC LLCU**

ERIS

(Enhanced Resolution Imager and Spectrograph)

Beckhoff EtherCAT (ESO/VLT Standard)

- ✓ PLC based Control System
- ✓ Embedded (Win) PC with RT kernel
- ✓ Flexible Distributed Architecture
- ✓ Fieldbus Communication
- ✓ TwinCAT/OpenMC motion control libraries

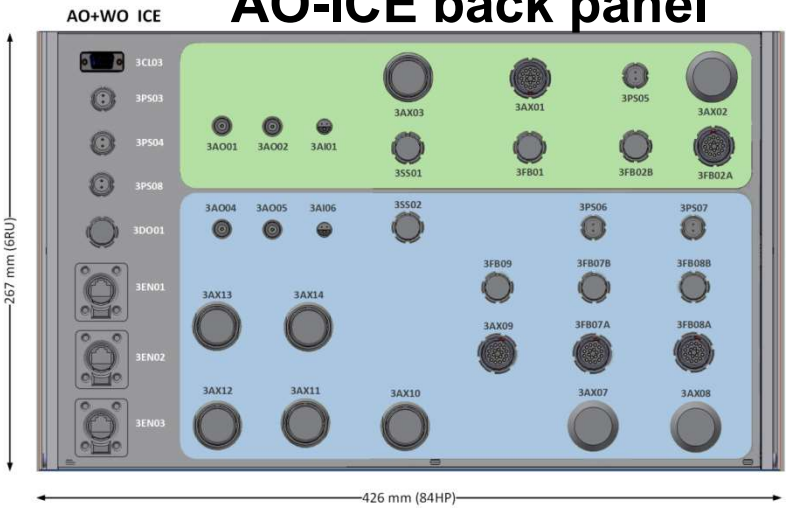
Applied to ERIS Electronics:

- ✓ Stepper / DC / Brushless motors (terminals + EtherCAT servodrives)
- ✓ Several feedback type (SinCos, RS-422, SSI) for all axes
- ✓ Digital I/0 for discrete control signal and status monitoring
- ✓ Analog I/O for continuos control signal and status monitoring
- ✓ IEEE5588 Time Synchronization
- ✓ Compact Architecture with modular control lines

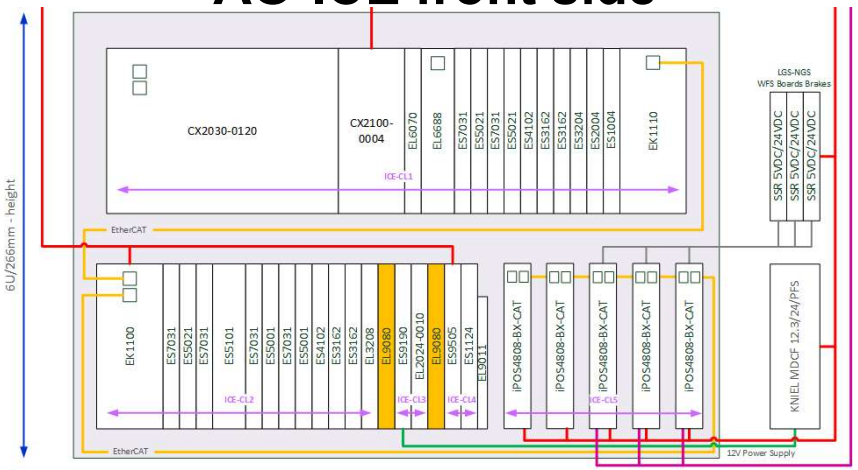
ERIS

(Enhanced Resolution Imager and Spectrograph)

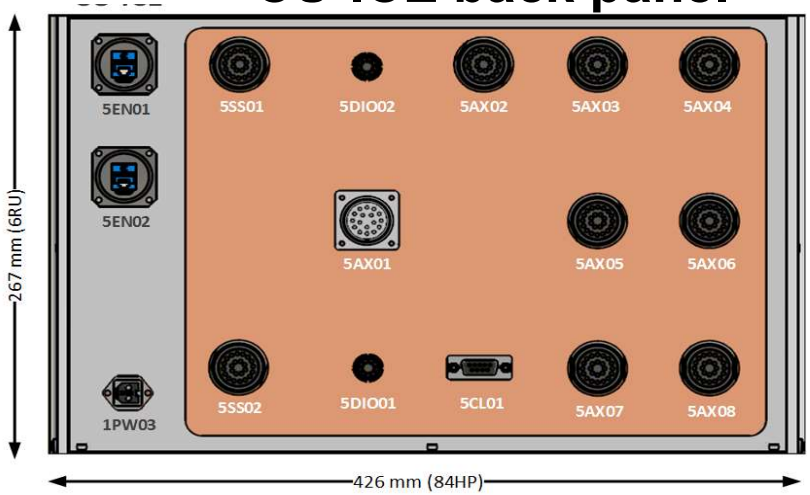
AO-ICE back panel



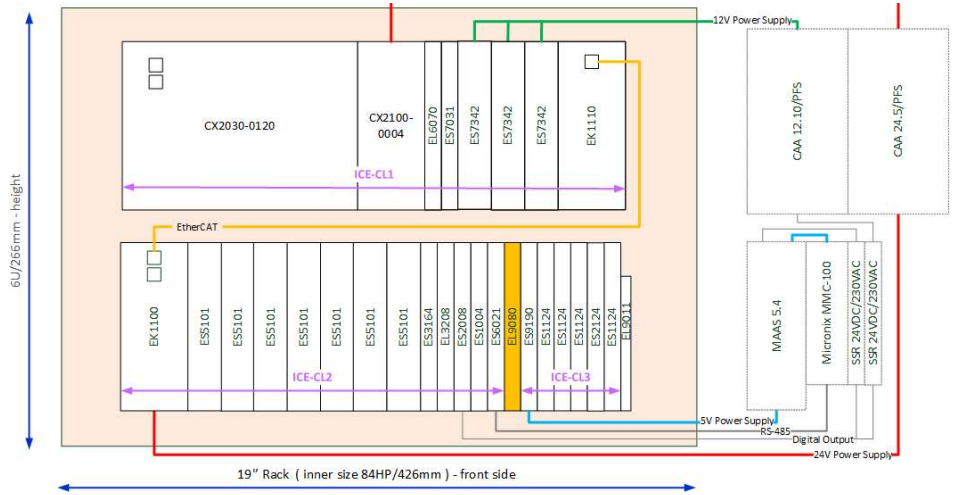
AO-ICE front side



CU-ICE back panel

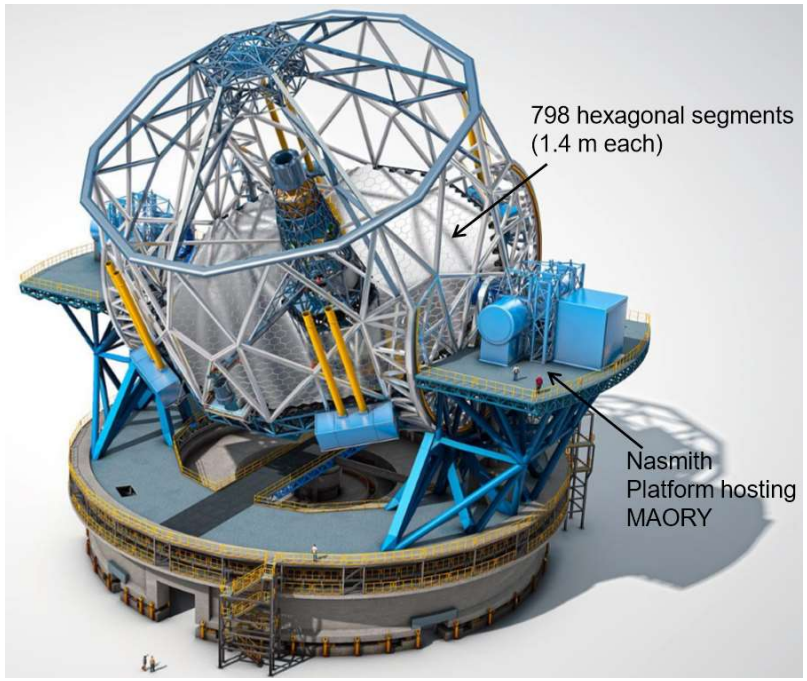


CU-ICE front side



MAORY

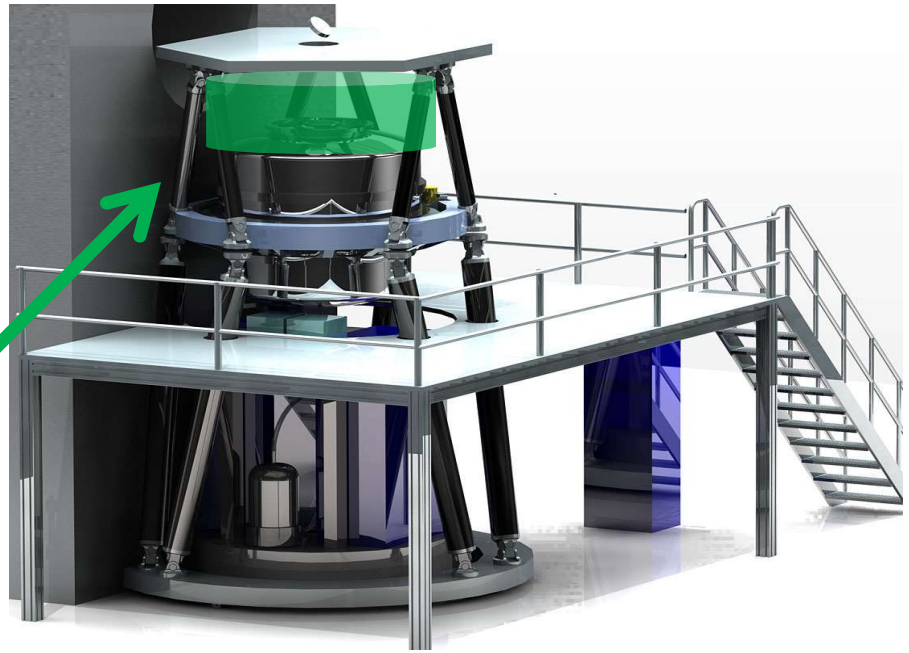
(Multi-conjugate Adaptive Optics RelaY)



MCAO

- **6 LGSs**
- **3 Low Order and Reference (LORs)**

***M. Lombini*, ADONI2017**



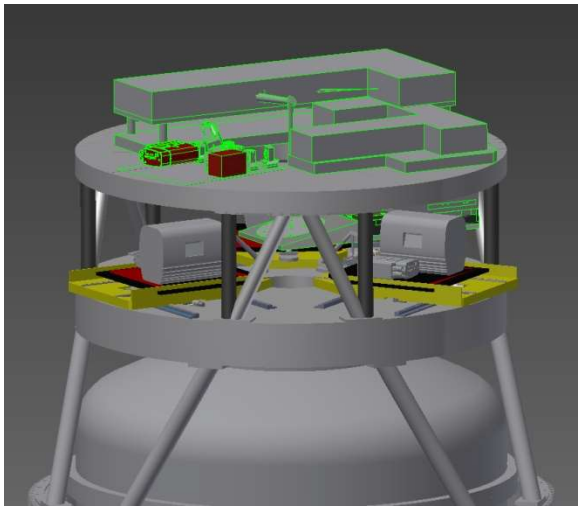
Green Doughnut

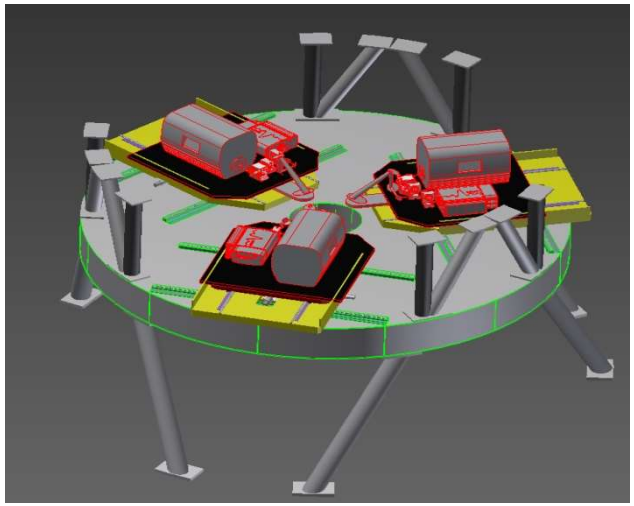
- **below the MAORY PF Relay**
- **2.4x1 m (60%-40% SCAO-LORs)**
- **Co-rotating with MICADO**

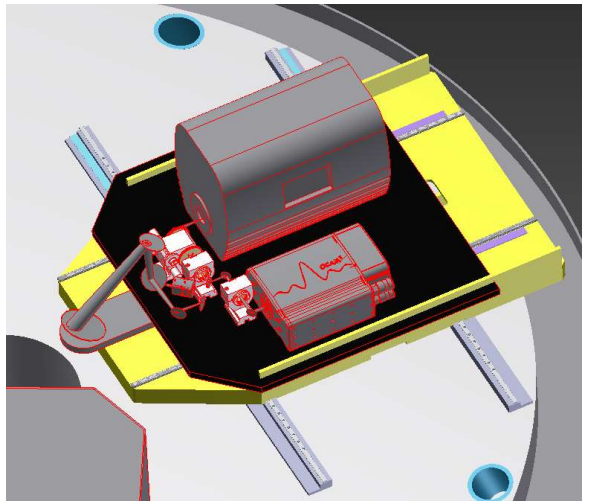
LORs OptoMech: *M. Bonaglia*, ADONI 2017

MAORY

(Multi-conjugate Adaptive Optics RelaY)







LORs configuration:

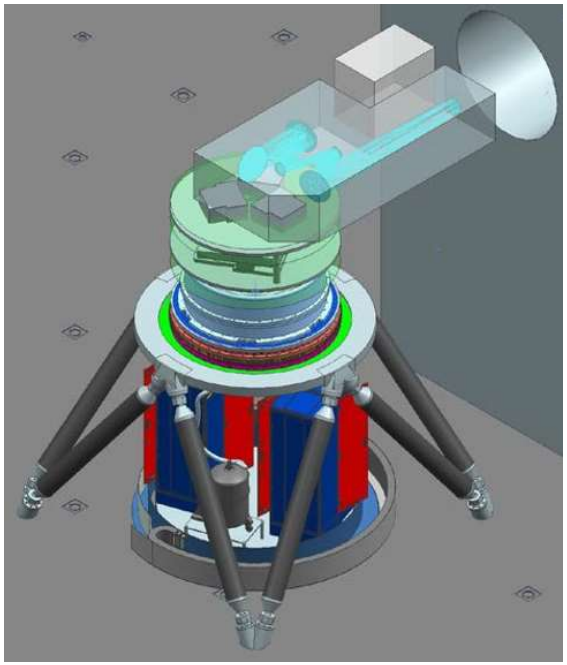
- ✓ Linear stage (focus)
- ✓ TT-mirror (piezo positioner)
- ✓ Atmospheric Dispersion Corrector (ADC)
- ✓ C-RED (infrared channel, SH 3x3)
- ✓ OCAM2 (visible channel, SH 10x10)
- ✓ XY support board (600x300 mm travel)

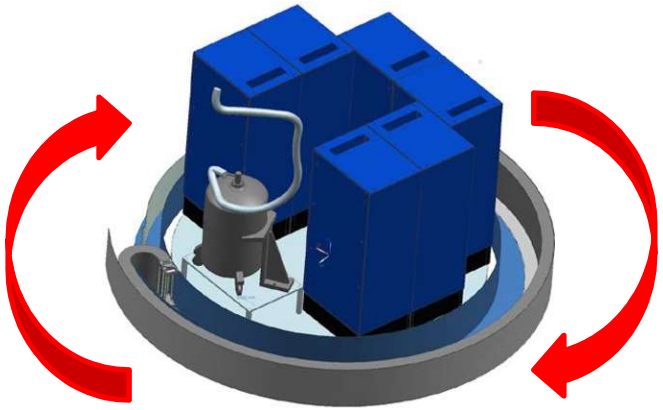
Main Constraints for Electronics Design

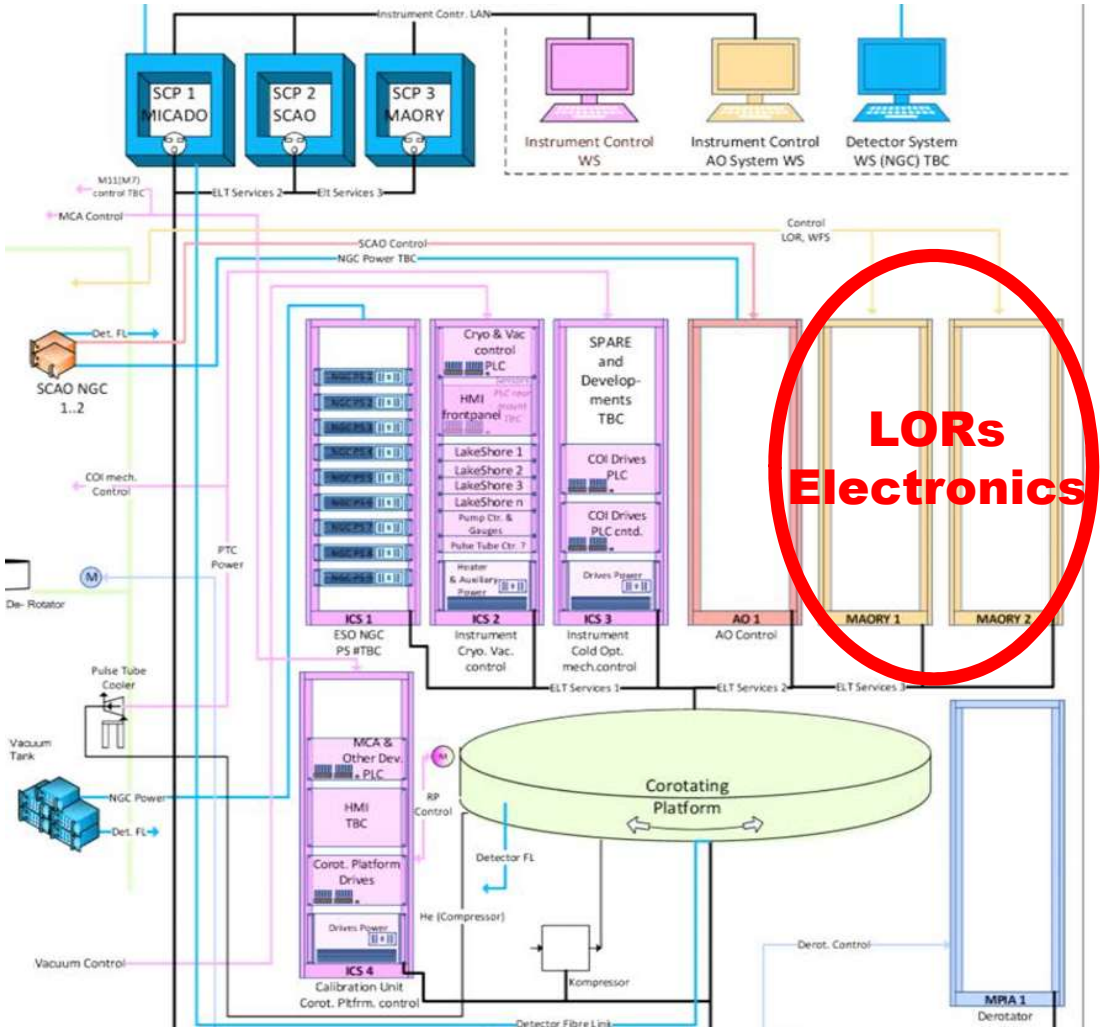
- ✓ Volume and mass budget
- ✓ Heat dissipation, air conditioning
- ✓ Safety Interlocks to avoid collisions
- ✓ SCAO-LORs interdependencies
- ✓ Cables lenght (max 10m for cameras)
- ✓ Cables and pipes routing to PF
- ✓ ICE cabinets volume

MAORY

(Multi-conjugate Adaptive Optics RelaY)







Extending Collaborations within INAF

LABORATORIO NAZIONALE ADONI OTTICA ADATTIVA

Summary

- **ERIS**
  - ✓ **AO (LGS+NGS) Electronics DAR+ICD to ESO**
  - ✓ **Calibration Unit full design to ESO**

(FDR 29/05/2017)

- **MAORY**
  - ✓ **LORs Electronics Design (in progress)**
  - ✓ **LORs FMECA (first f2f meeting on 05/05/2017)**

(PDR 02/02/2018)

M. Cantiello **(science)**
A. Di Cianno **(electronics)**
M. Dolci **(system engineering)**
A. Valentini **(mechanics)**

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