On the road to the Preliminary Design Review of the MAORY adaptive optics module for E-ELT

MAORY Road Crew:

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Speaker: Emiliano Diolaiti, INAF

Project overview

MAORY
- First light instrument for European ELT
  - HARMONI, MAORY, METIS, MICADO
- Adaptive optics module

Client instruments
- MICADO, near infrared camera and spectrograph
  - 0.8-2.5 µm, 53x53 arcsec^2
- 2nd instrument as yet undefined

Adaptive optics modes
- MCAO
- SCAO → joint development MICADO-MAORY
- Other
  - seeing-enhancer, calibration, engineering, …

Project status
- Phase B is in progress
- Kick-off February 2nd, 2016
- Preliminary Design Review planned Q1-2018

Wavefront control on E-ELT

E-ELT

- Adaptive telescope
- 5 mirror design (including adaptive M4 and tip-tilt M5)

Blind control layer embedded in telescope

- Maintains M1 figure
- Controls position of M2, M3, M4 at slow rate

Active optics

- Compensates quasi-static aberrations in the telescope

Adaptive optics

- Compensates fast aberrations (atmospheric turbulence, wind action on telescope, etc.)
- Relies on distributed resources in the telescope and in MAORY

MCAO architecture overview / 1

Wavefront compensation

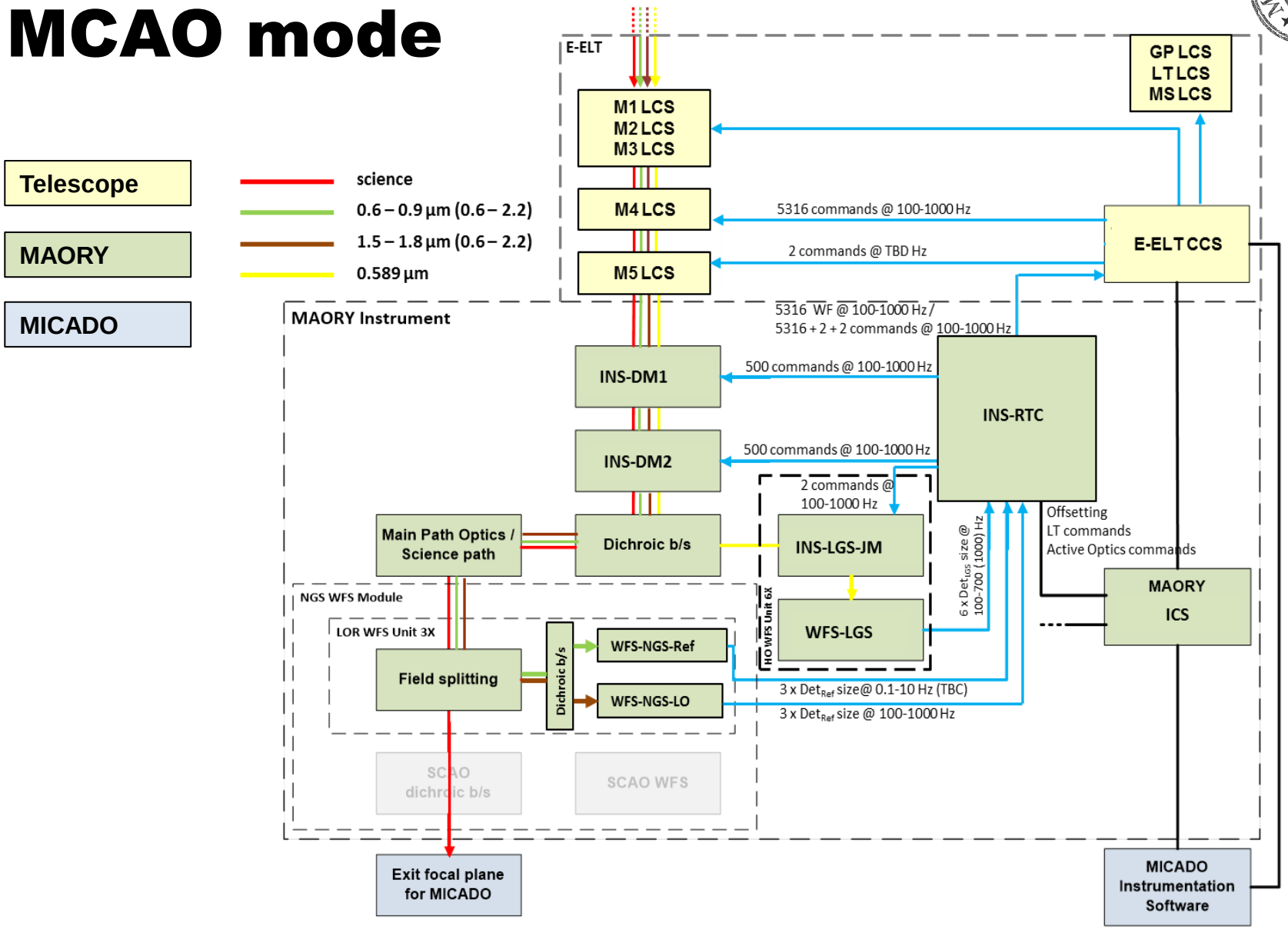
- Telescopes's adaptive mirror M4
  - Projected actuator spacing 0.5 m
- Telescope's tip-tilt mirror M5
- 1 or 2 post-focal DMs within MAORY
  - Projected actuator spacing 1.5-2 m

MCAO architecture overview / 2

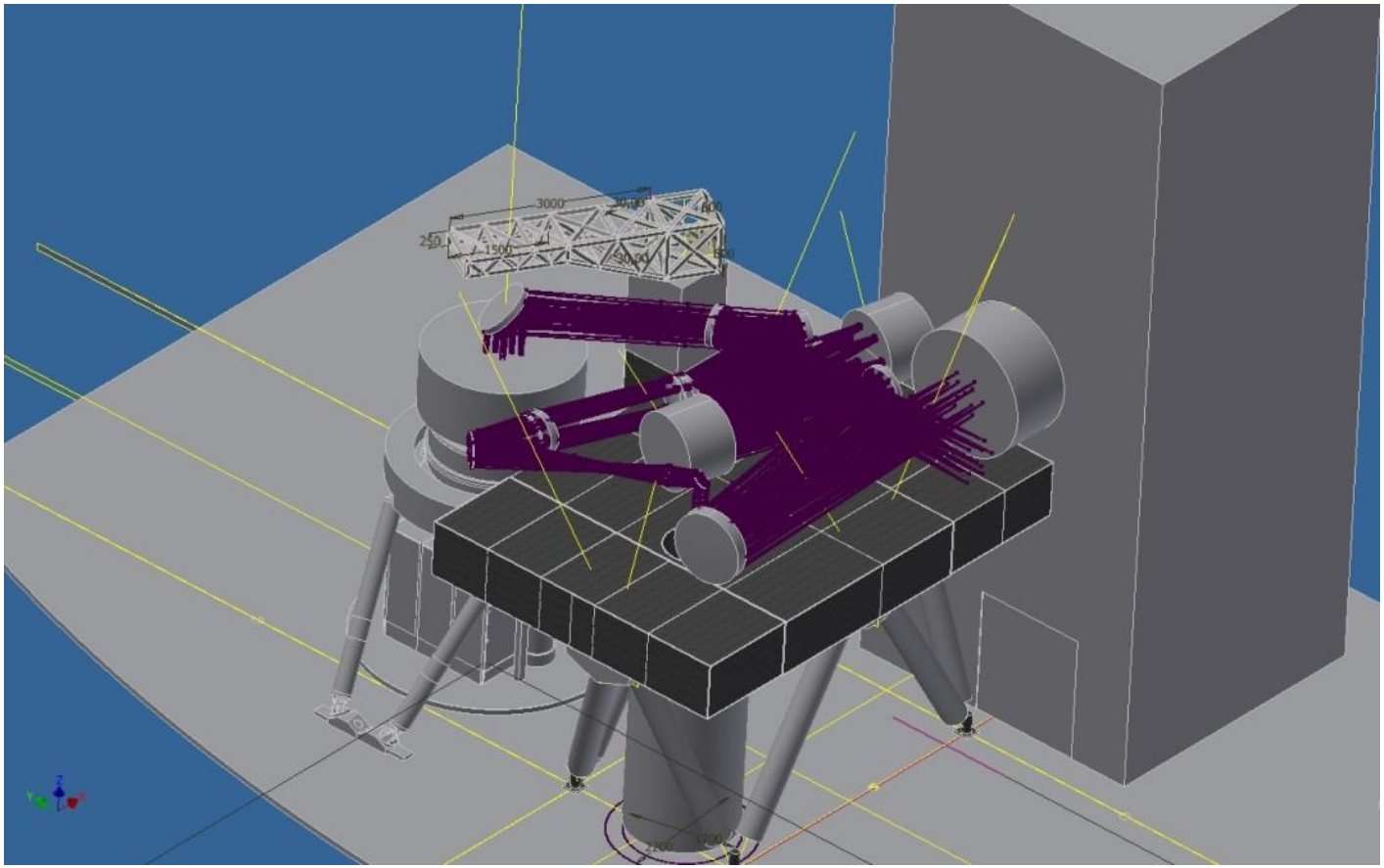
Wavefront sensing

- 6 sodium LGS wavefront sensors within MAORY
  - 80x80 subapertures, 500 fps
  - Fixed w.r.t telescope pupil, ∅90 arcsec on sky
- (Up to) 3 NGS wavefront sensors within MAORY
  - NGS patrol field of view ∅180-200 arcsec
  - Low-order channel, 1.5-1.8 µm, 2x2 subap, Tip-Tilt Focus & Astigmatism, 500 fps (or lower)
  - Reference/truth channel, 0.6-0.9 µm, 10x10 subap, 0.1-1 fps
- (Up to) 3 NGS wavefront sensors in the telescope
  - Active optics loop
  - Tip-tilt compensation in cascade control mode
    - Alternate mode: sequential handover
  - NGS patrol field of view ∅10 arcmin

MCAO mode

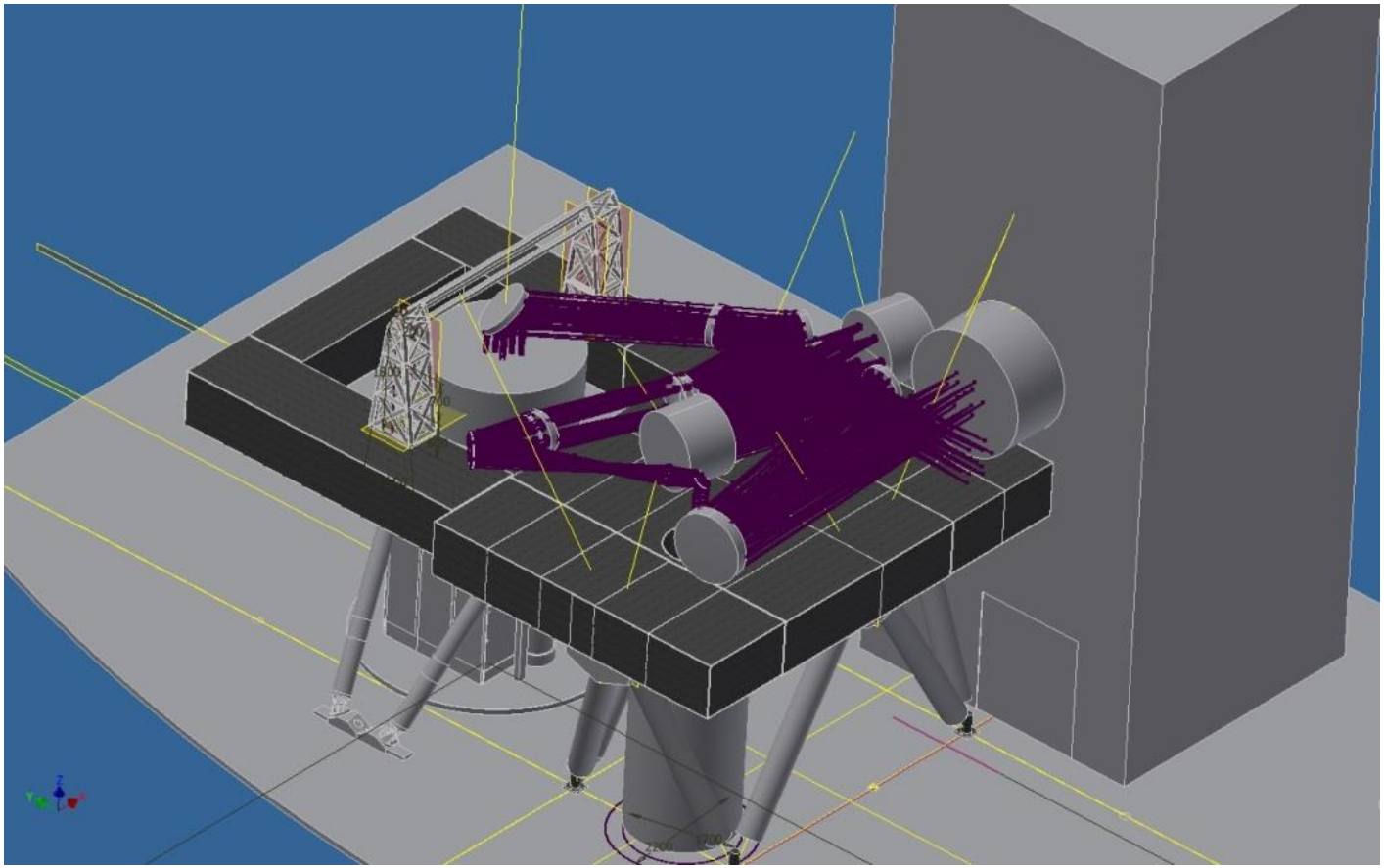

Telescope
MAORY
MICADO
science
0.6 – 0.9 µm (0.6 – 2.2)
1.5 – 1.8 µm (0.6 – 2.2)
0.589 µm
E-ELT
M1 LCS
M2 LCS
M3 LCS
M4 LCS
M5 LCS
GP LCS
LT LCS
MS LCS
5316 commands @ 100-1000 Hz
2 commands @ TBD Hz
E-ELT CCS
MAORY Instrument
5316 WF @ 100-1000 Hz /
5316 + 2 + 2 commands @ 100-1000 Hz
INS-DM1
500 commands @ 100-1000 Hz
INS-RTC
INS-DM2
500 commands @ 100-1000 Hz
2 commands @
100-1000 Hz
Main Path Optics /
Science path
Dichroic b/s
INS-LGS-JM
Offsetting
LT commands
Active Optics commands
6 x Det_LGS size @
100-700 (1000) Hz
MAORY
ICS
NGS WFS Module
LOR WFS Unit 3X
HO WFS Unit 6X
WFS-LGS
Field splitting
Dichroic b/s
WFS-NGS-Ref
WFS-NGS-LO
3 x Det_Ref size@ 0.1-10 Hz (TBC)
3 x Det_Ref size @ 100-1000 Hz
SCAO
dichroic b/s
SCAO WFS
Exit focal plane
for MICADO
MICADO
Instrumentation
Software

Main structure / 1



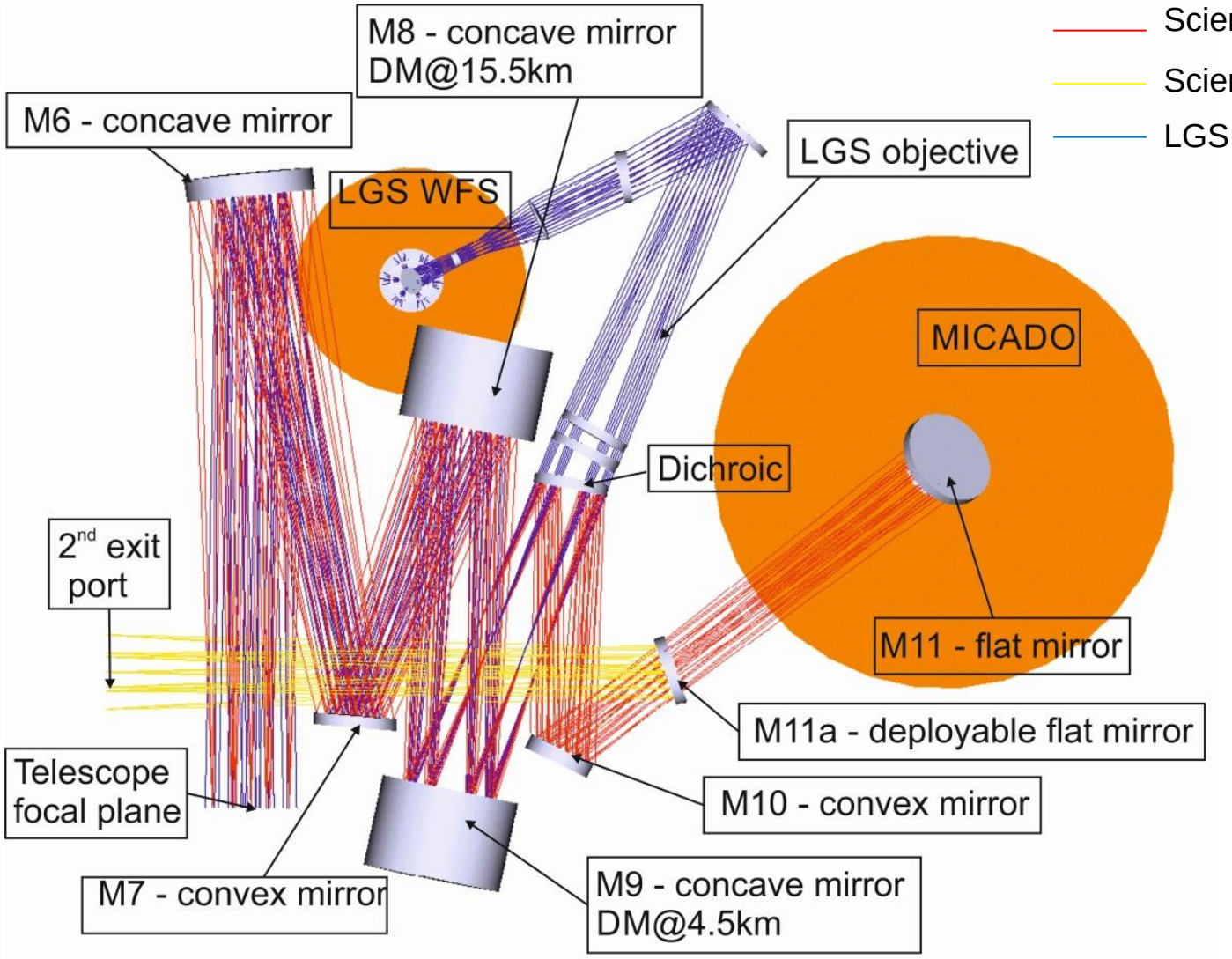
M11 “swing arm” concept

Main structure / 2

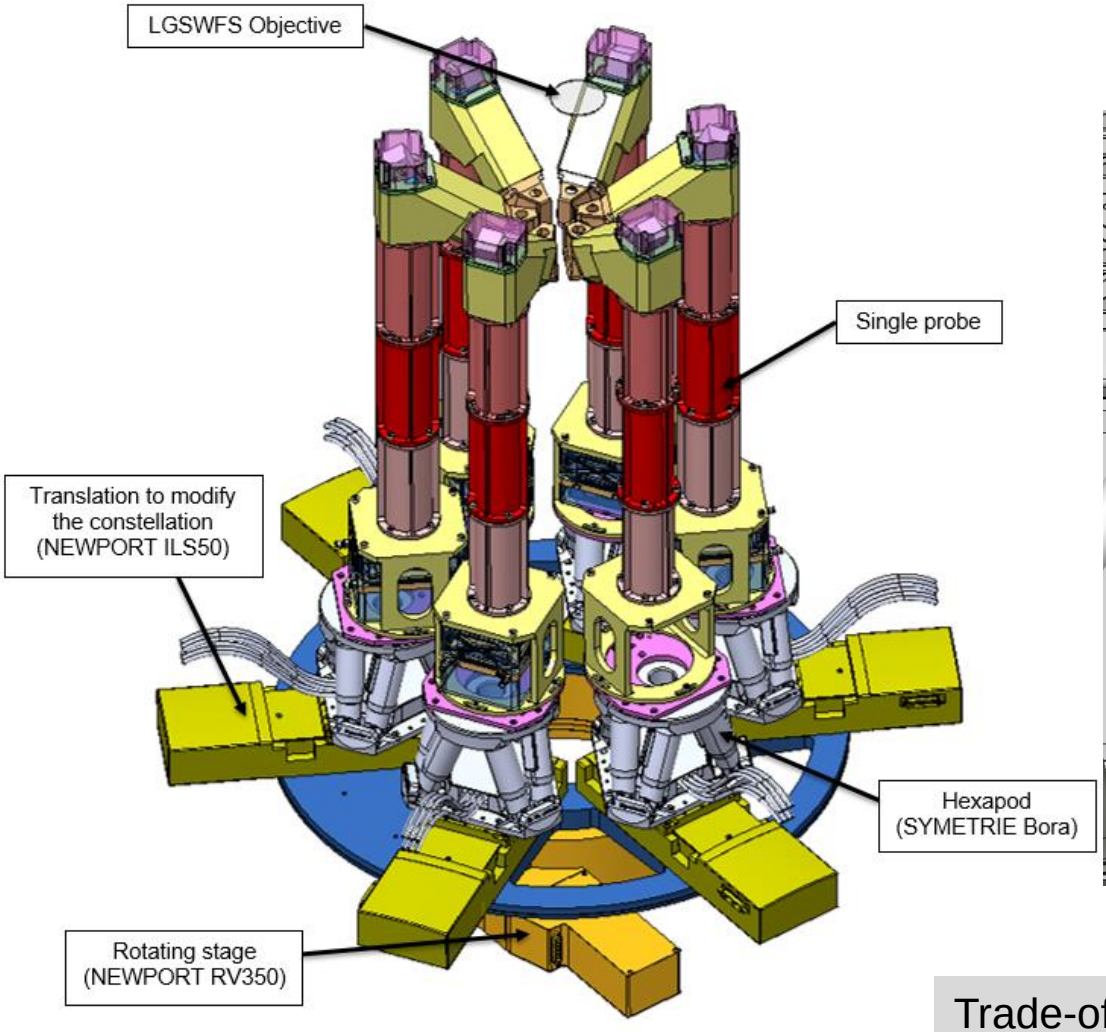


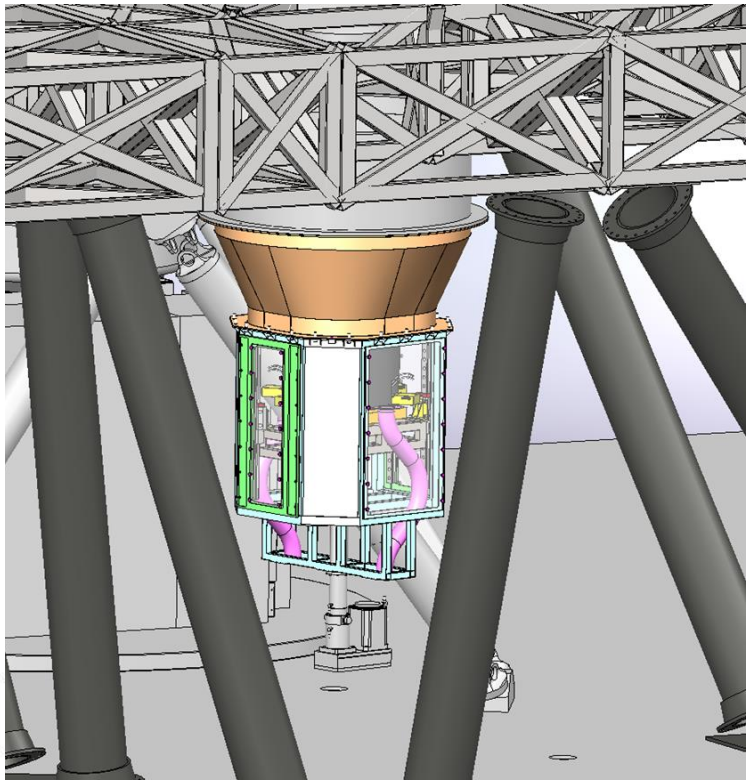
M11 “bridge” concept

Optical relay



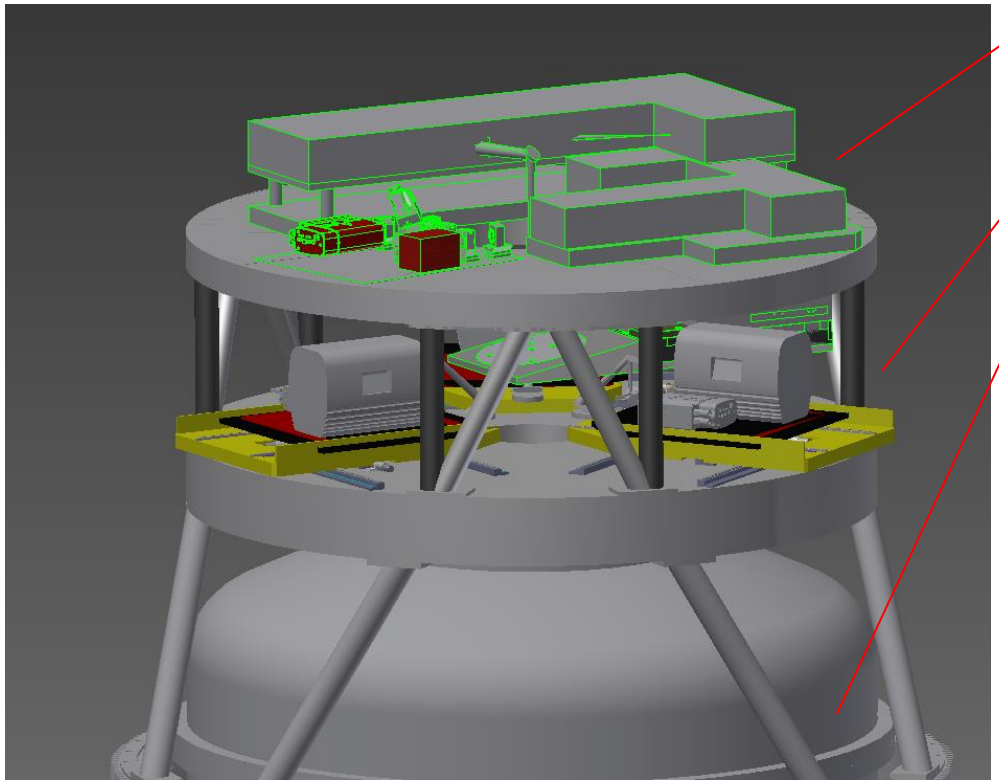
LGS wavefront sensor





Trade-off FoV vs. LGS spot sampling

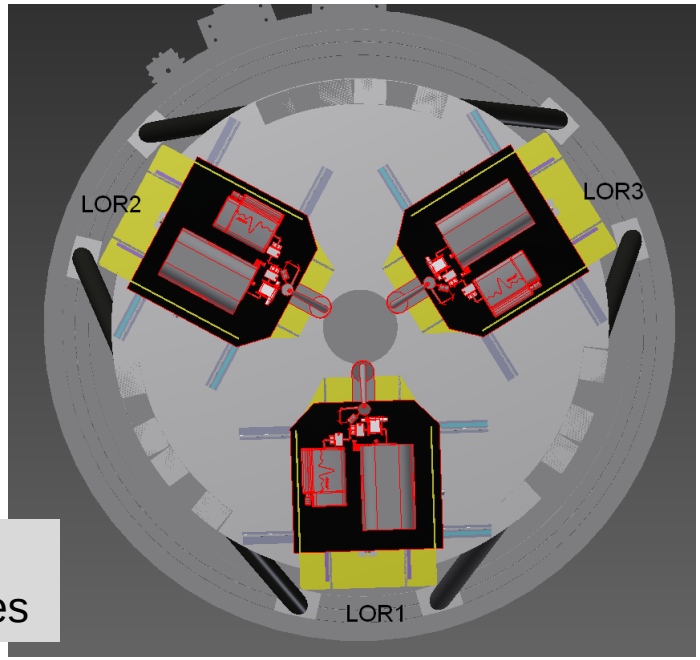
NGS wavefront sensor module



SCAO plate (SCAO mode)

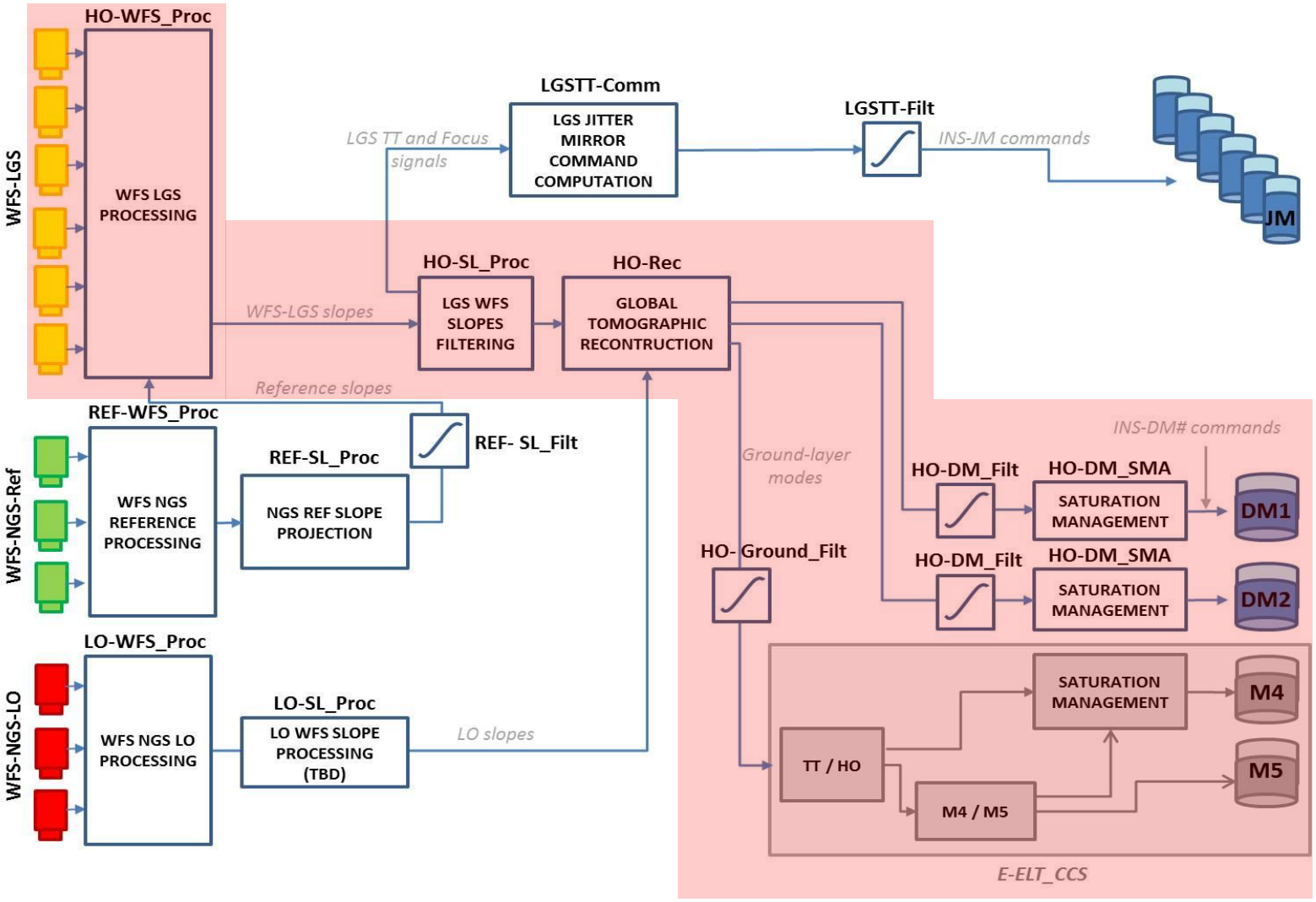
LOR plate (MCAO mode)

MICADO cryostat

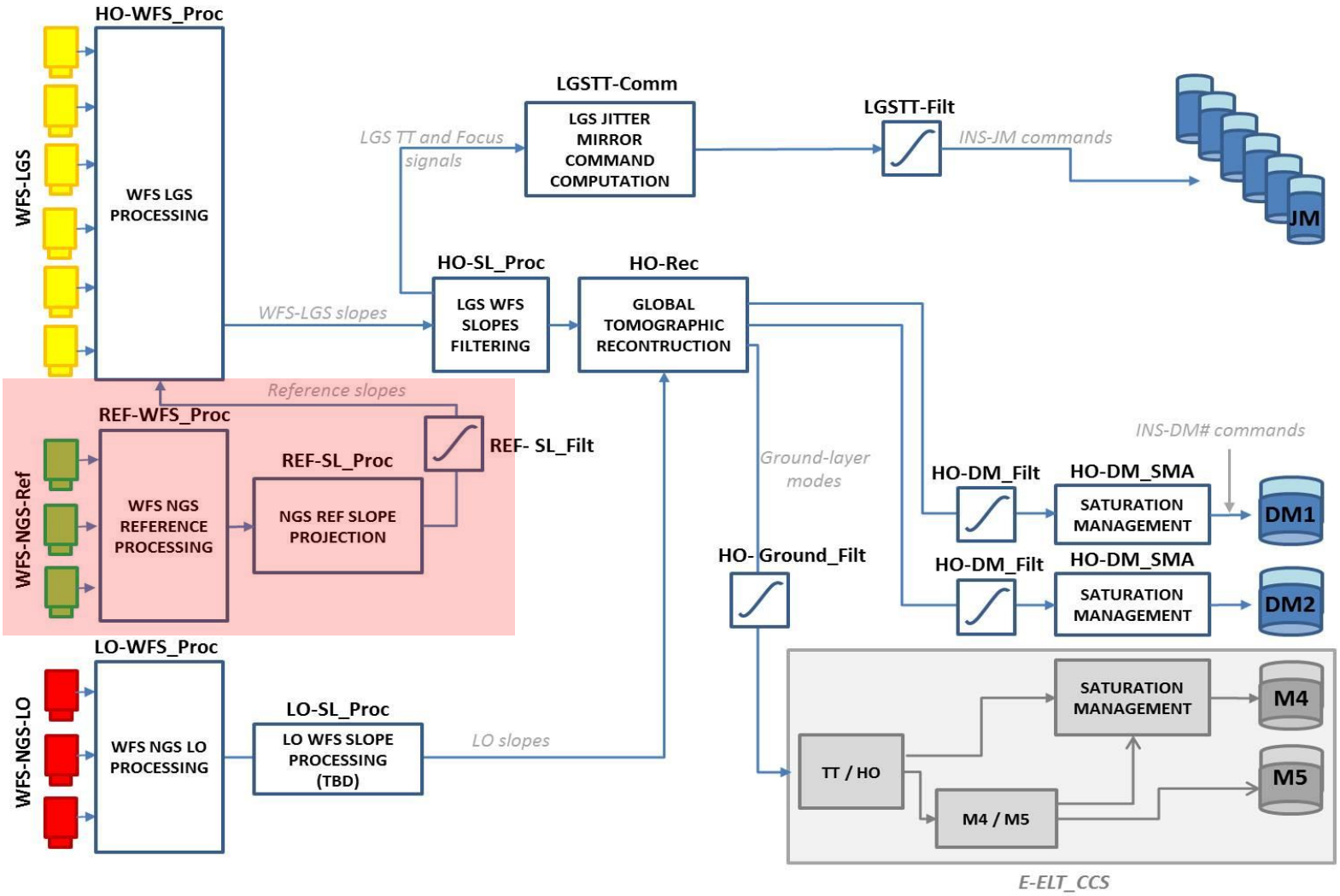


Relative astrometric accuracy system requirement
→ 2 mas differential positioning error among NGS probes

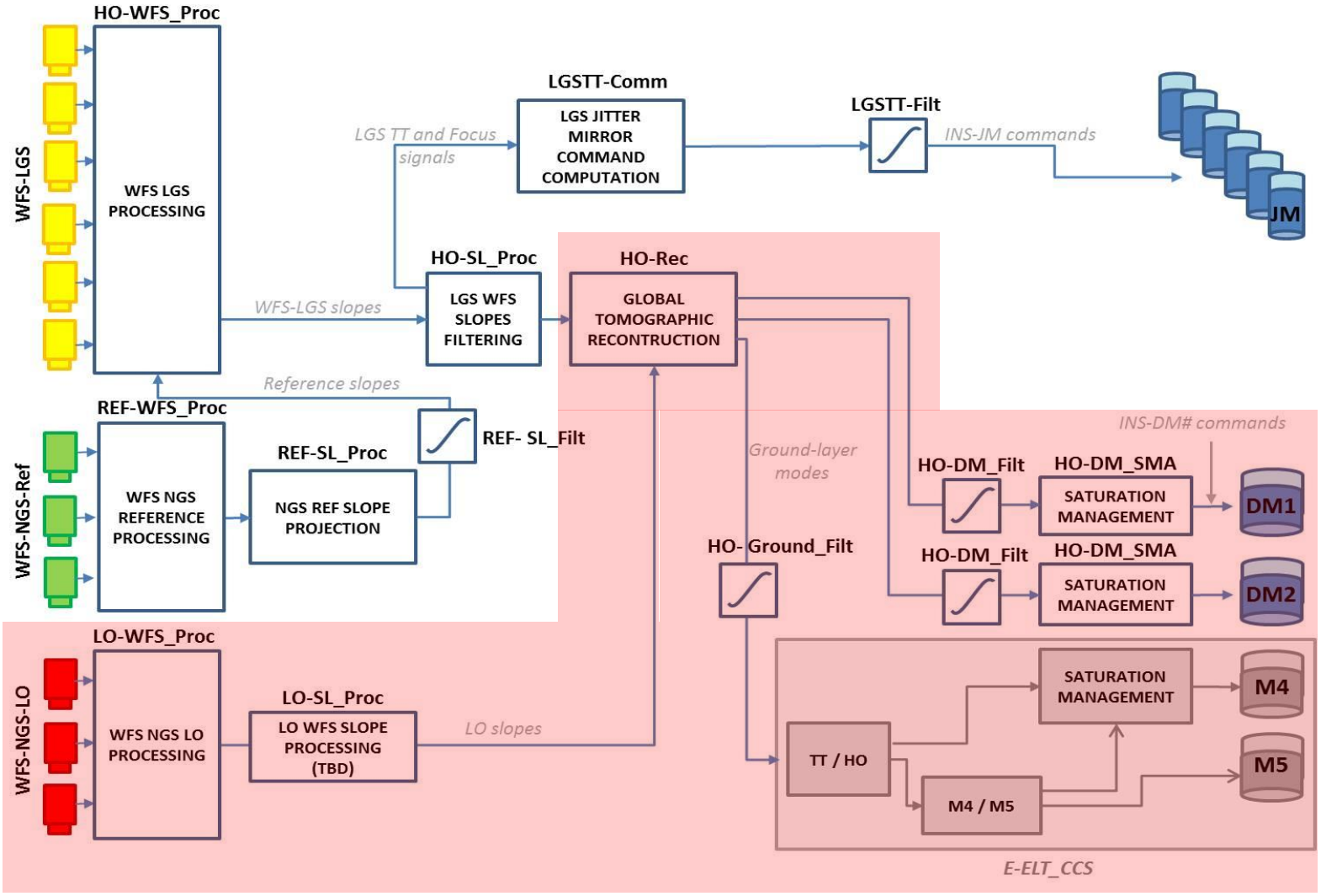
RTC LGS high-order control loop



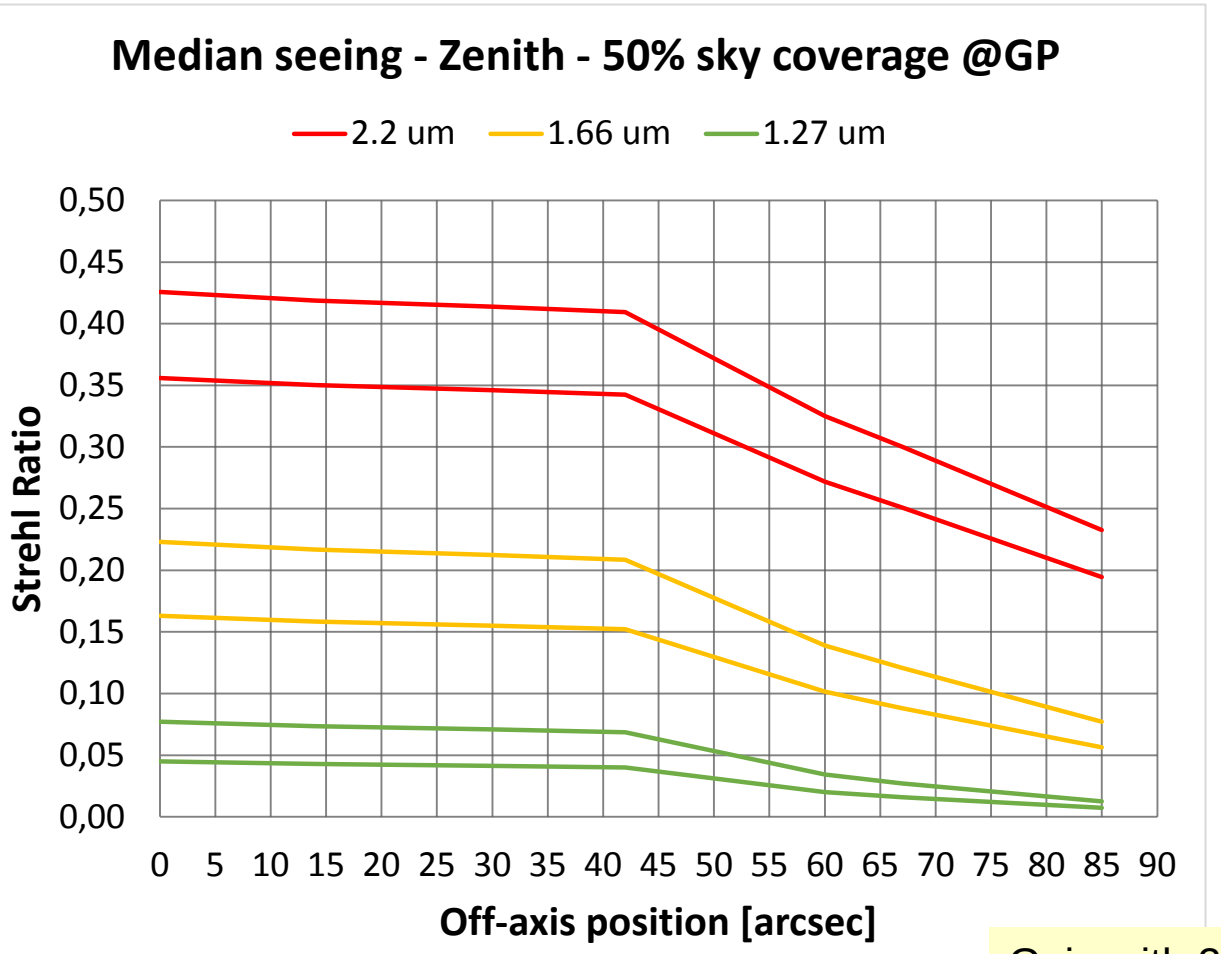
RTC NGS reference control loop



RTC NGS low-order control loop



MCAO performance



Sub-system	WFE nm
E-ELT	145
MCAO architecture	217
Post-focal relay	102
NGS WFS	99
LGS WFS	98
RTC	163
Contingency	48
Total	**356**

Gain with 2nd post-focal DMs
- Sky coverage
- Robustness to Cn2 profile variations

Related talks/posters

Mauro Patti - Exploring MAORY performances through tolerance analysis [P1012]

Carmelo Arcidiacono - Status of the MAORY numerical simulation tool [P1053]

Gabriele Rodeghiero - Towards an overall astrometric error budget with MICADO-MCAO

Marco Bonaglia - Design and status of the NGS WFS of MAORY [P2035]

Matteo Lombini - Laser Guide Star Objective of MAORY [P3009]

Sylvain Oberti - MAORY design trade-off study: tomography dimensioning