



Guido Agapito

# THE ERIS ADAPTIVE OPTICS SYSTEM





# ERIS



ERIS, the Enhanced Resolution Imager and Spectrograph, is an instrument for the Cassegrain focus of UT<sub>4</sub> at the ESO VLT.

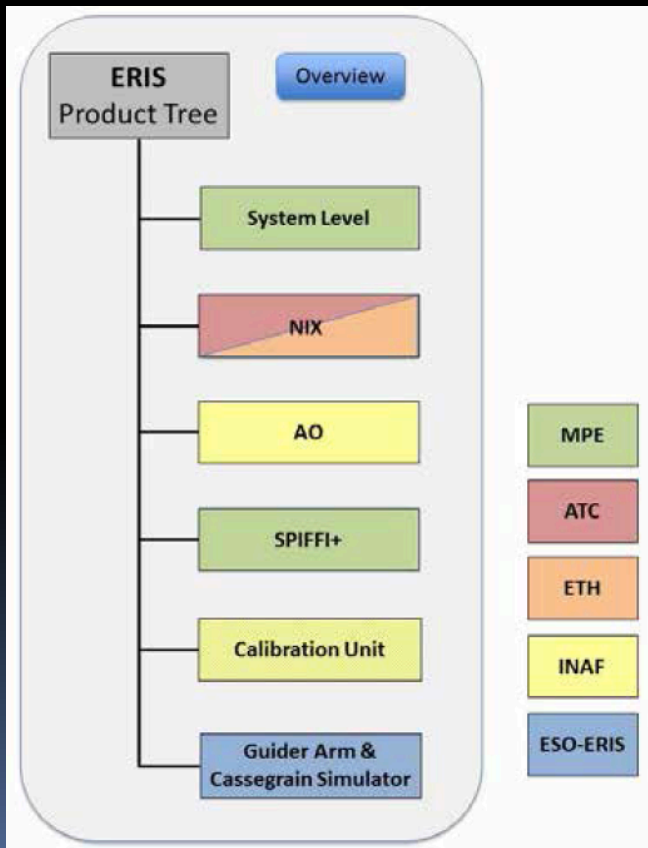
It comprises:

- **two science instruments:**
  - **NIX:** IR imager providing diffraction limited imaging, Sparse Aperture Masking (SAM) and pupil plane coronagraphy capabilities from 1 to 5  $\mu\text{m}$ .
  - **SPIFFIER** (SPectrometer for Infrared Faint Field Imaging with Enhanced Resolution): near-IR (1.08-2.43  $\mu\text{m}$ ) integral field spectrograph (upgraded version of SPIFFI).
- **An Adaptive optics module.**
- **A Calibration Unit (CU).**



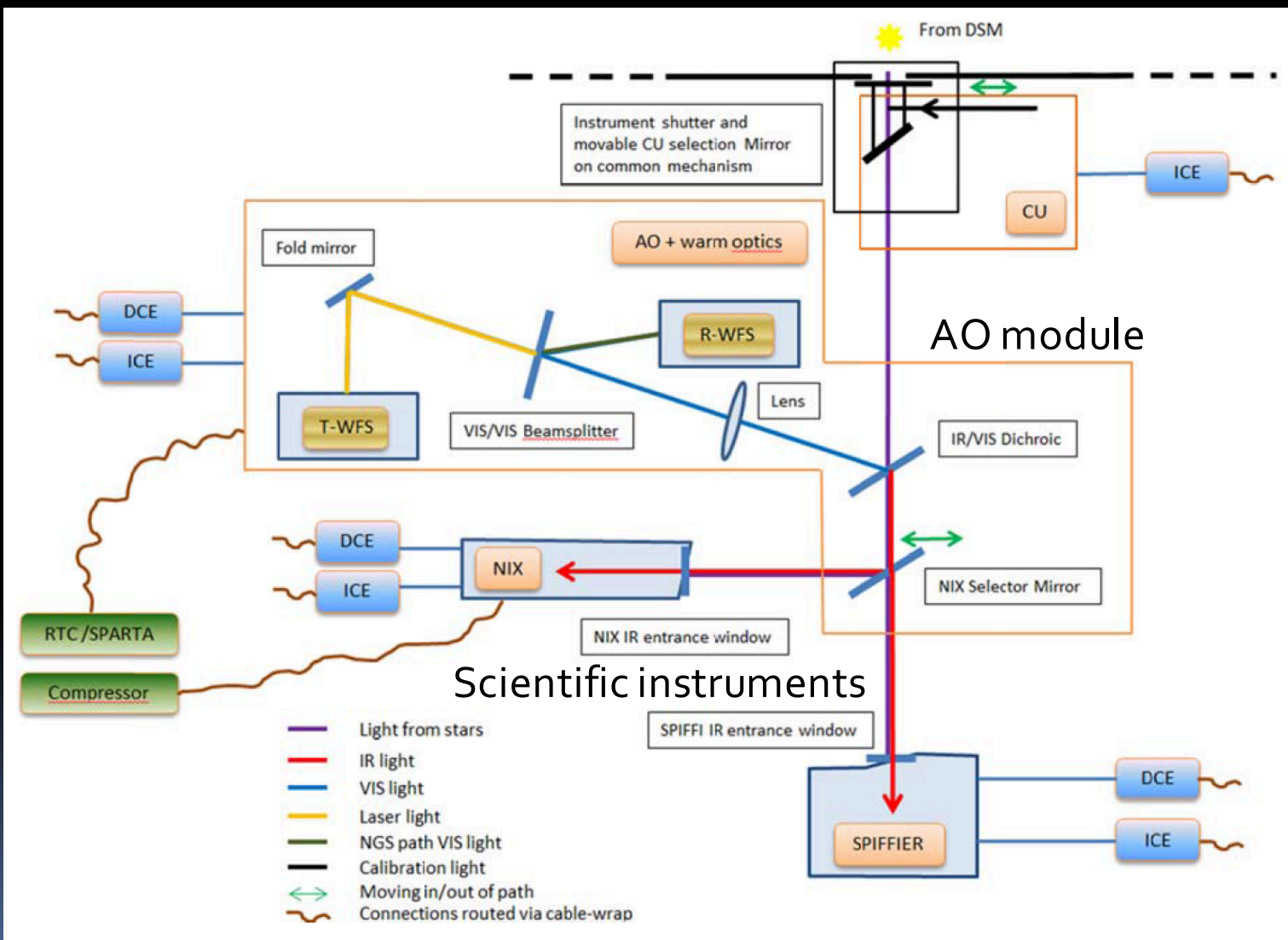
# ERIS – Consortium

- Max Planck Institute for Extraterrestrial Physics (MPE, with contributions from ETH Zürich)
- INAF (Arcetri, Padova, and Teramo)
- UK Astronomy Technology Centre (ATC)
- ESO



Institute	Tasks
MPE	PI and Project Management System Engineering System Optics, Electronics, Mechanics, Cryogenics & Vacuum, System MAIT and Commissioning SPIFFI+ Science
ATC	NIX (Optics, Electronics, Mechanics, Cryogenics, data pipeline)
INAF	Warm Optics and Mechanics, AO (Arcetri) Calibration Unit (Teramo) Instrument Control Software (Padova) Science
ETH	NIX Filters and Masks NIX Mechanisms (with ATC) NIX Tools (with ATC) Science
ESO-ERIS	System Handling Tool NIX and SPIFFI+ detectors AO Cameras and RTC Guider Arm and Cassegrain Simulator

# ERIS - Conceptual scheme

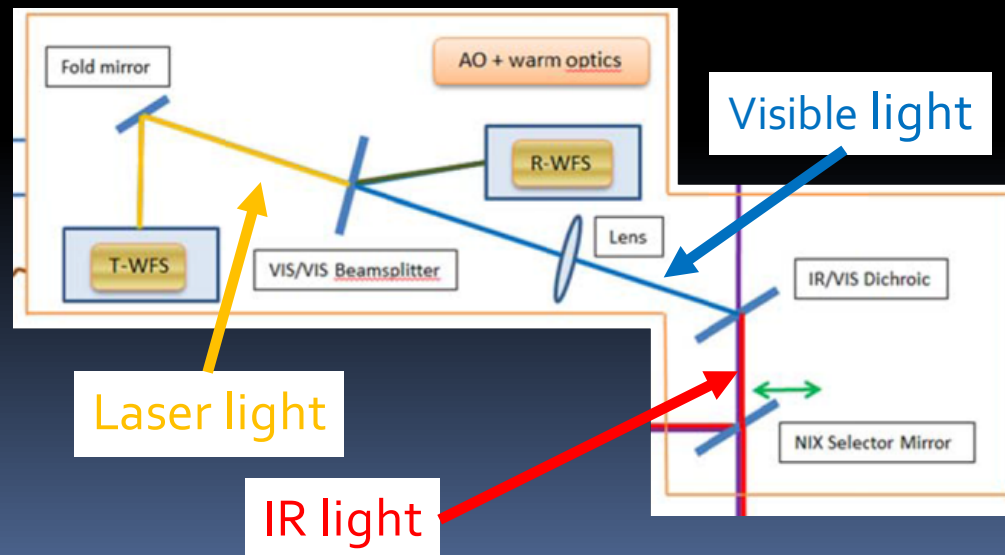


# ERIS - AO module

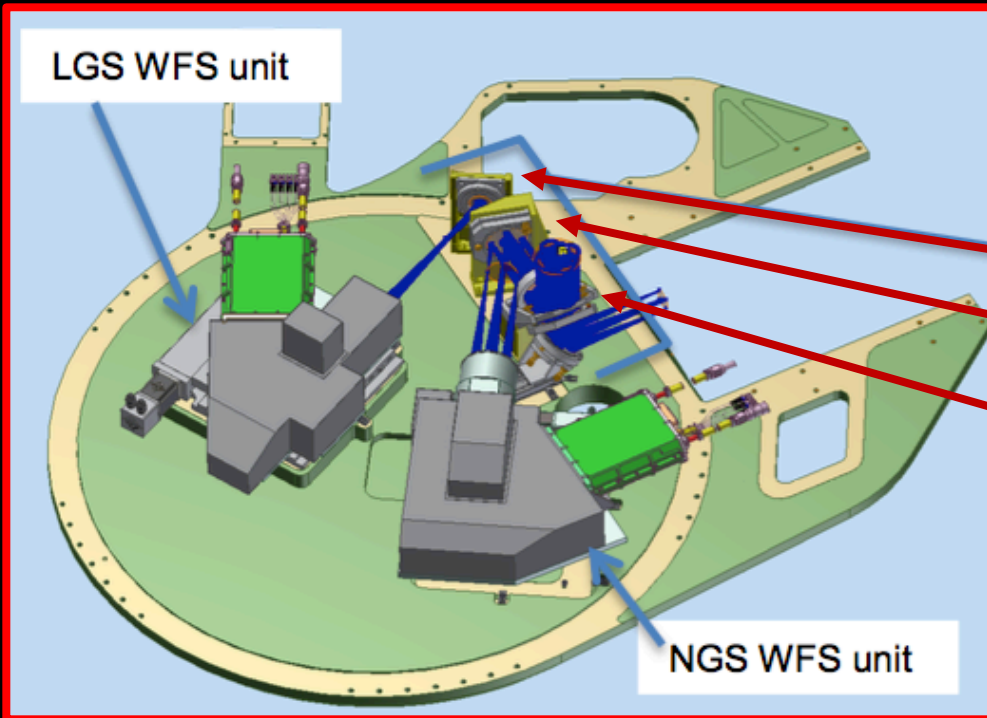


The **AO module** has wavefront sensing and real-time computing capabilities. It interfaces to the AOF infrastructure and provides the following observing modes:

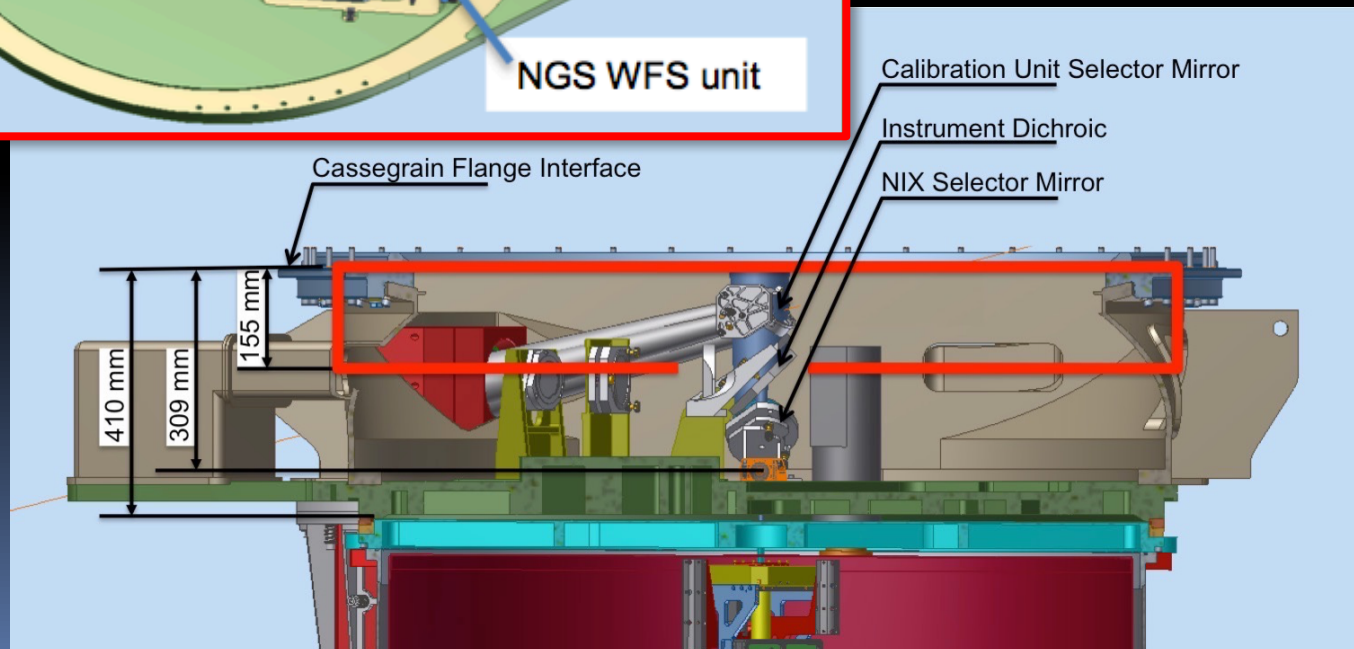
- **LGS-mode:** a WFS provides high-order AO correction using a LGS on-axis (T-WFS) and a second WFS provides low-order correction using a NGS (R-WFS) in the patrol field ( $R \leq 1'$ ).
- **NGS-mode:** a WFS provides high-order AO correction using a NGS (R-WFS) in the patrol field;



# ERIS - A0 module design



Folding mirror  
 VIS dichroic  
 IR/VIS dichroic

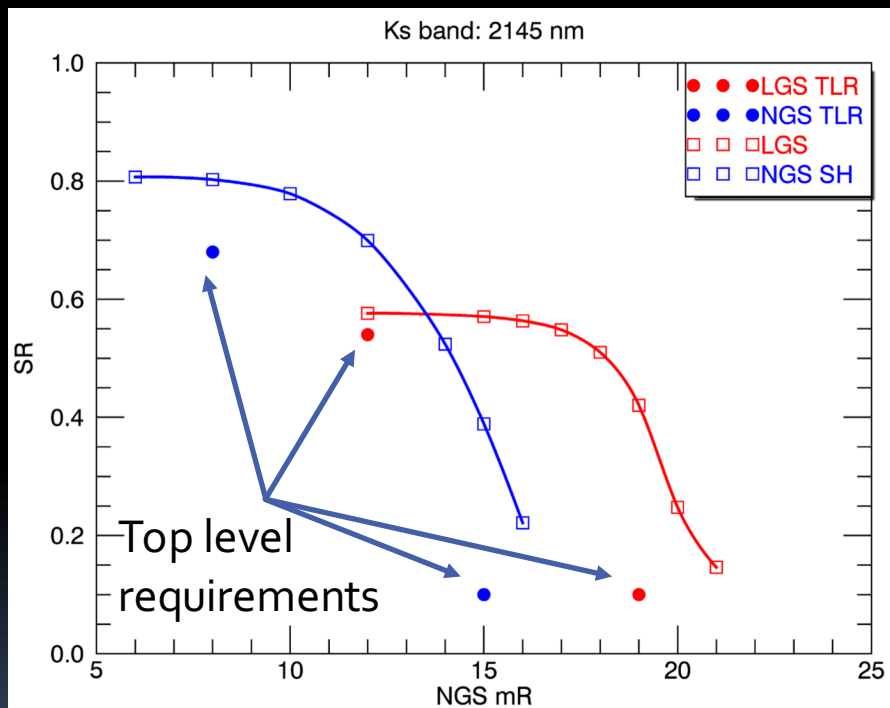


Calibration Unit Selector Mirror  
 Instrument Dichroic  
 NIX Selector Mirror

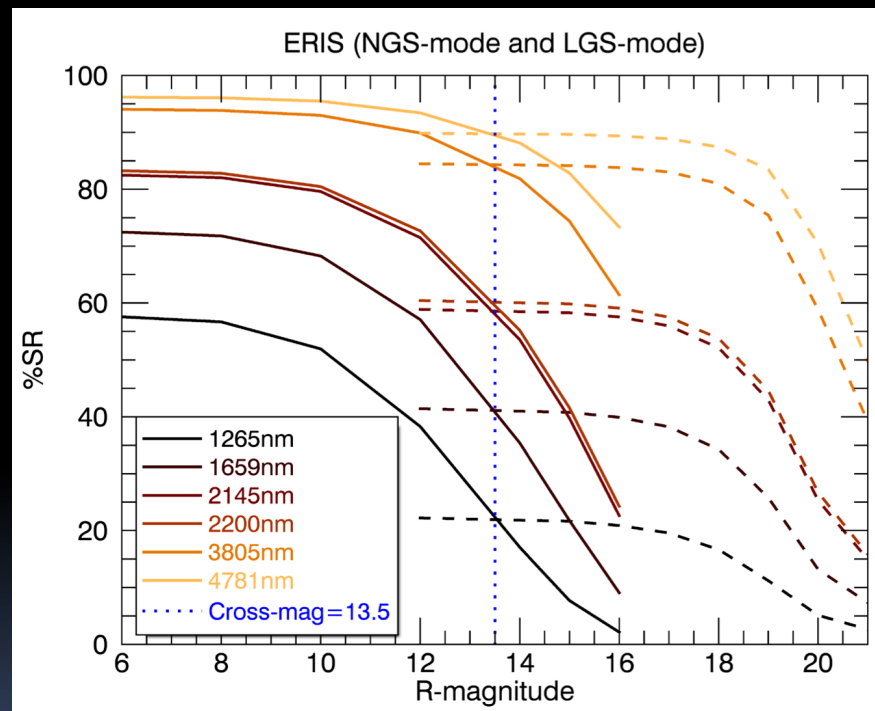
# ERIS - A0 performance



Performance w/ full error budget



Performance from E2E simulations



On-axis NGS (seeing 0.87")

# ERIS – NGS-mode contrast

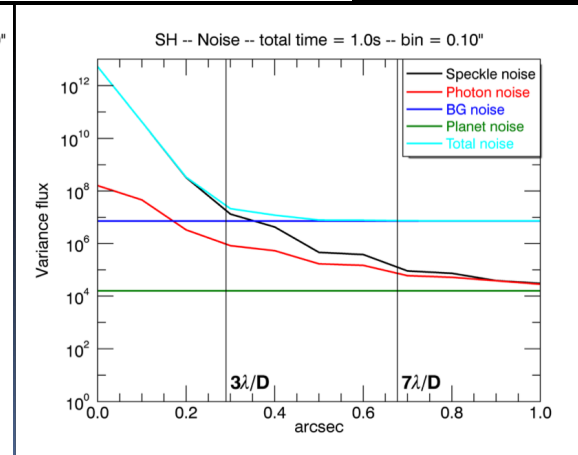
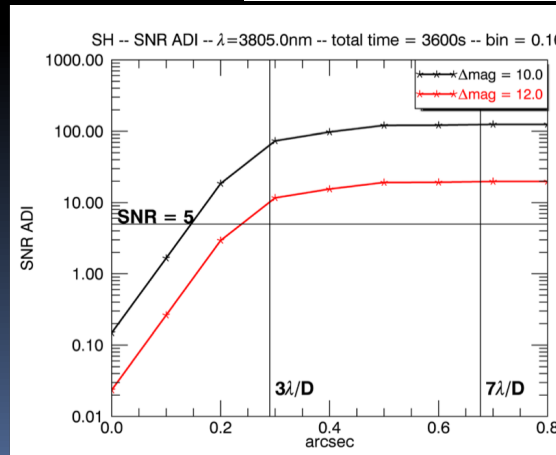
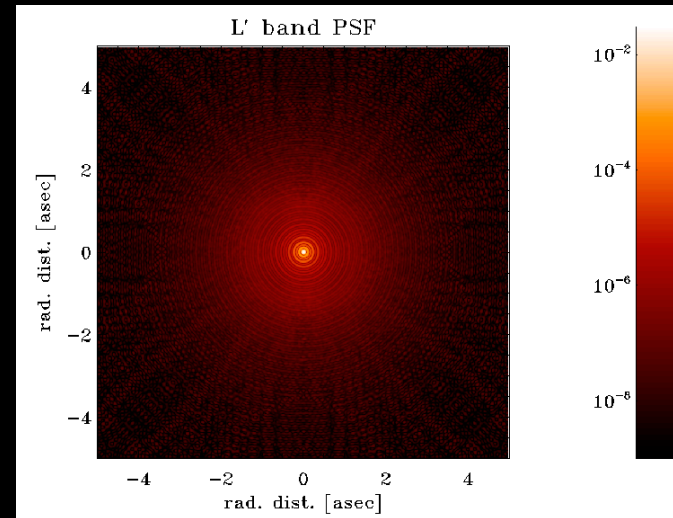
TLR: “... a contrast ( $5\sigma$  after post-processing) of more than 10 magnitudes in L'-band and M'-band shall be achieved over at least the radial range  $3-7\lambda/D$  ...”

L' band:

- Star mag. 5
- BG mag. 3.9

$$ADI\ SNR = \frac{N_{planet}}{\sqrt{\sigma_{diff}^2 + 2 N_{planet} + 2 N_{star} + 2 N_{BG}}} \sqrt{n_{diff}}$$

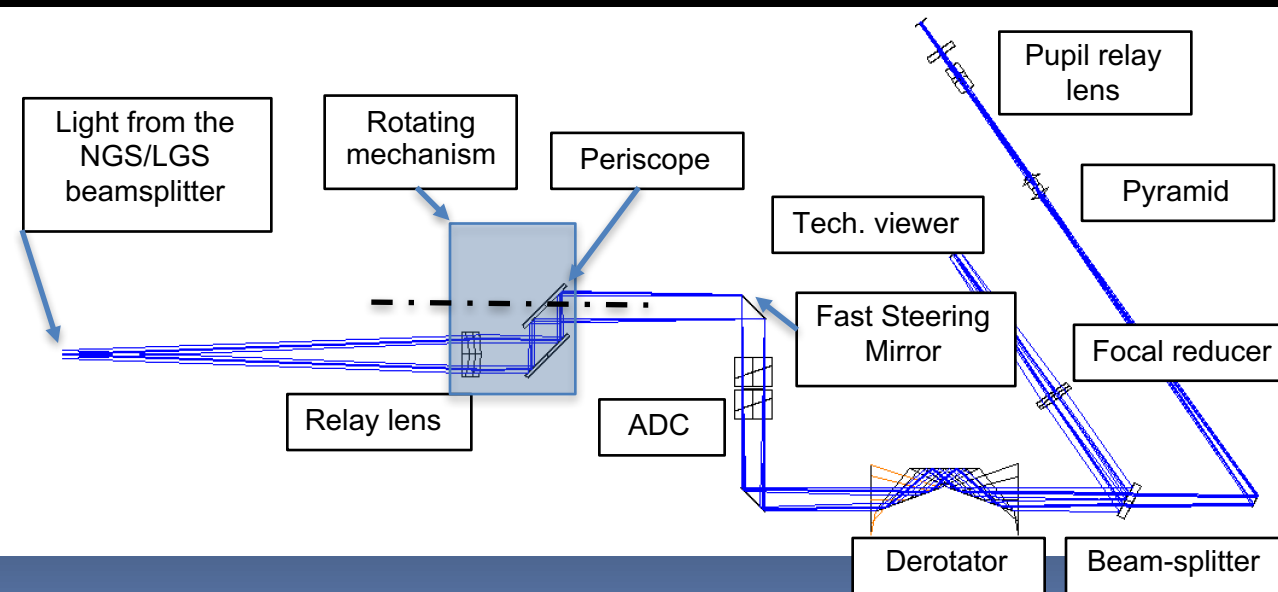
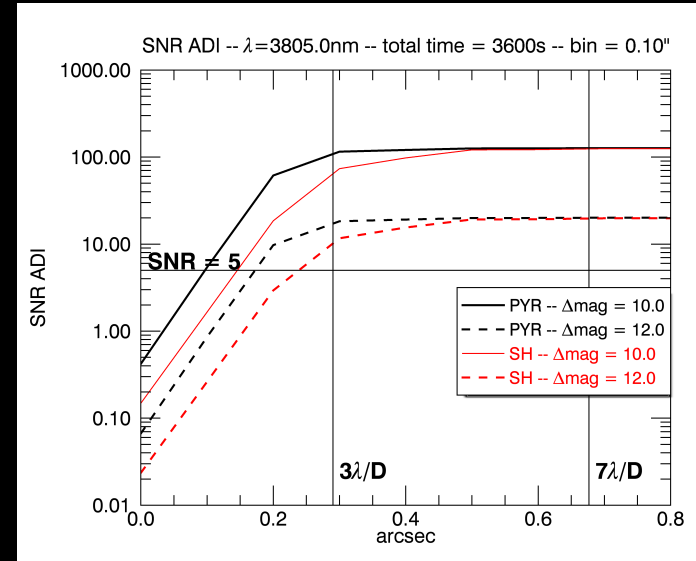
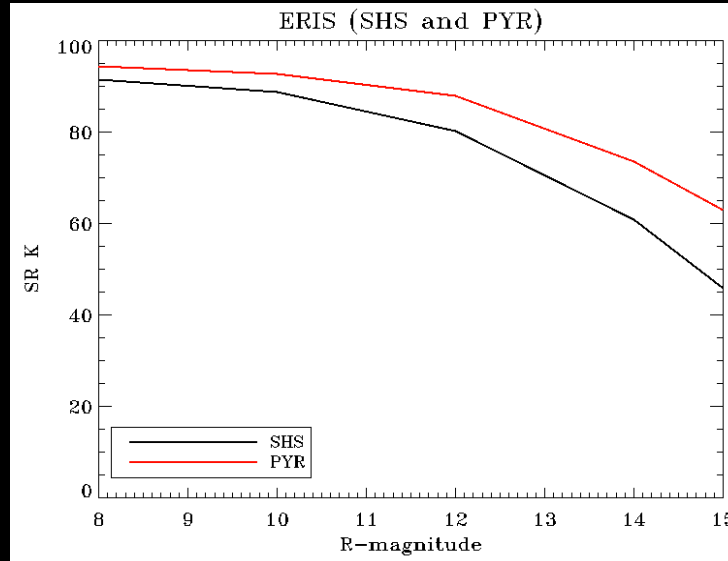
Where  $\sigma_{diff}(r)$  = RMS of difference between two uncorrelated PSF in the bin,  $N_{planet}$ ,  $N_{star}$ ,  $N_{BG}$  are respectively the photon noise, from the planet and the star, and the sky background noise in the considered bin.





# ERIS - Pyramid WFS upgrade

Performance NGS-mode



Pyramid WFS optical layout



# ERIS - schedule



2016	Jan	SPIFFI upgrade
	Feb	Preliminary Design Review
2017	Feb	Final Design Review
2018	Feb	Delivery of central structure to Arcetri for integration of warm optics, WFSs, & CU
2019	Jan	AO+CU acceptance test at Arcetri
	Feb	NIX acceptance test at ATC
	Mar	Delivery of central structure (with warm optics, AO, & CU) and NIX to MPE
	Jun	Delivery of SINFONI (SPIFFI) to MPE
	Jul	Preliminary Acceptance Europe part 1 (NIX, warm optics, AO, CU)
	Dec	Preliminary Acceptance Europe part 2 (SPIFFIER; ERIS tested as a complete instrument before shipping to Paranal)
2020	Feb	ERIS in integration hall at Paranal
	Apr	ERIS first light on sky