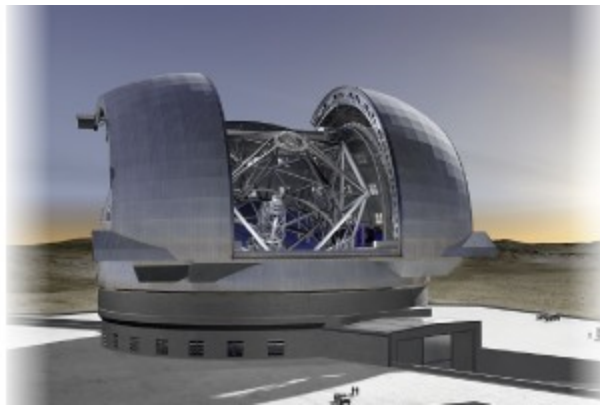


# METIS

Mid-infrared  
E-ELT Imager and  
Spectrograph

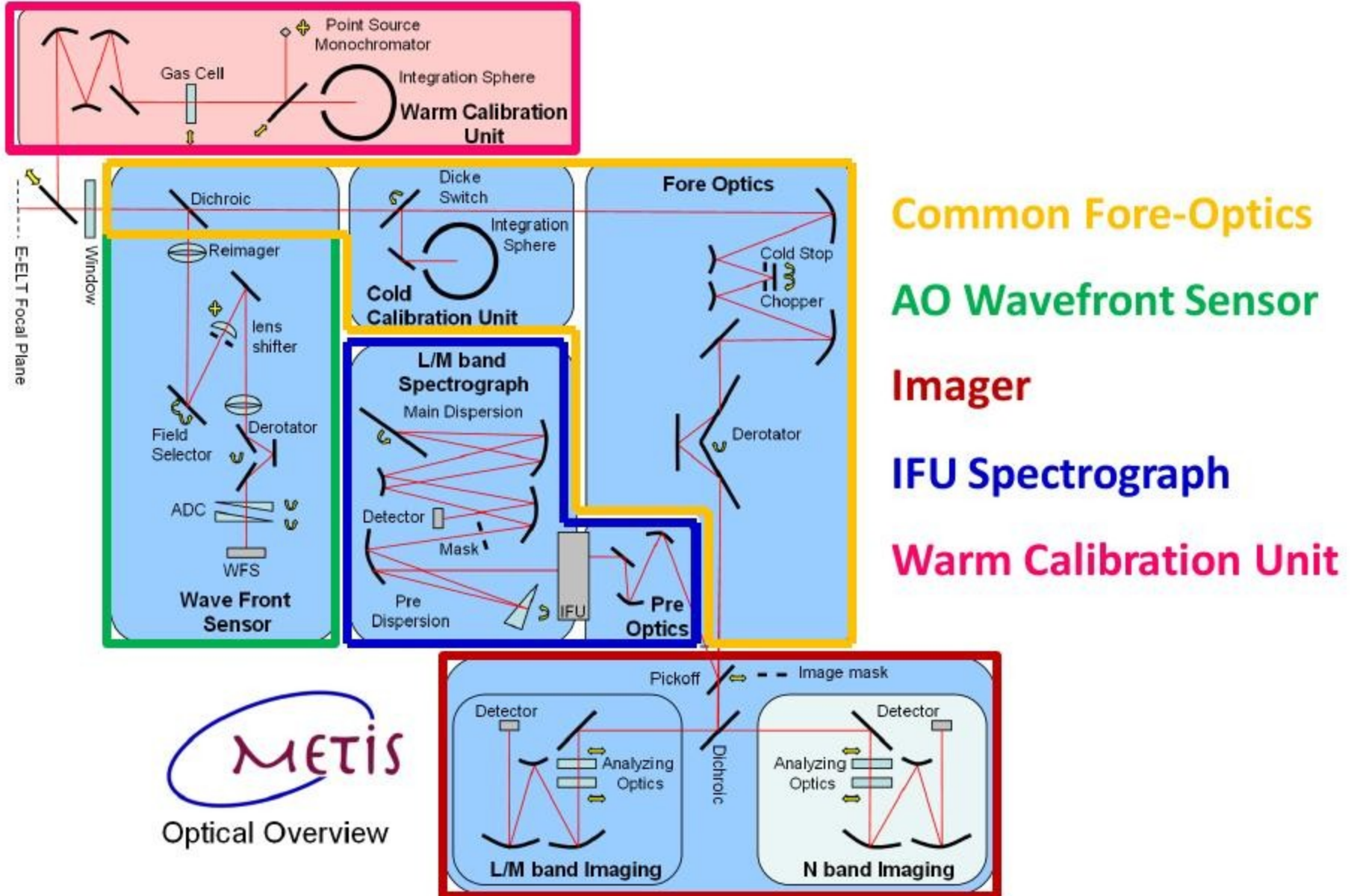


# METIS

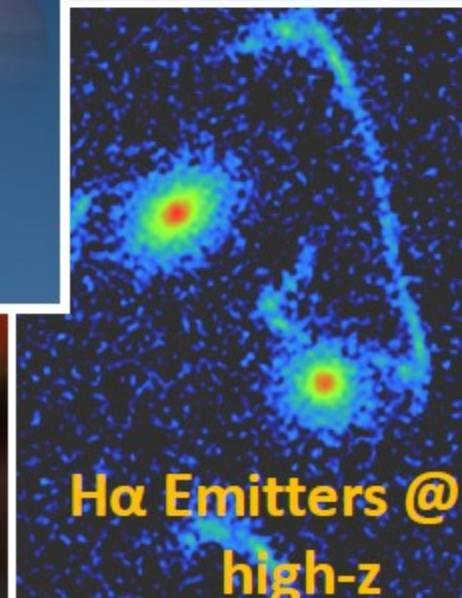
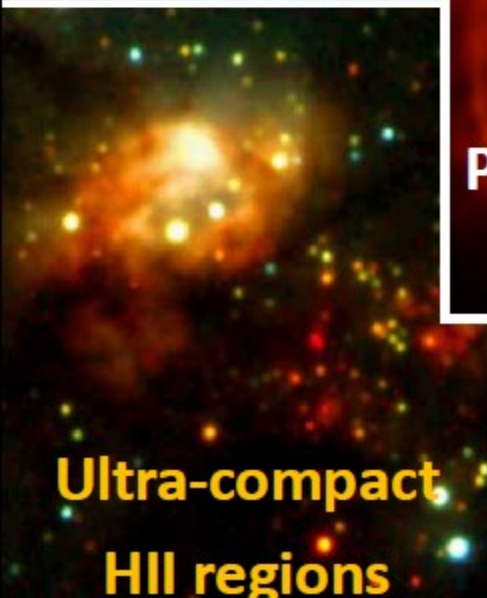
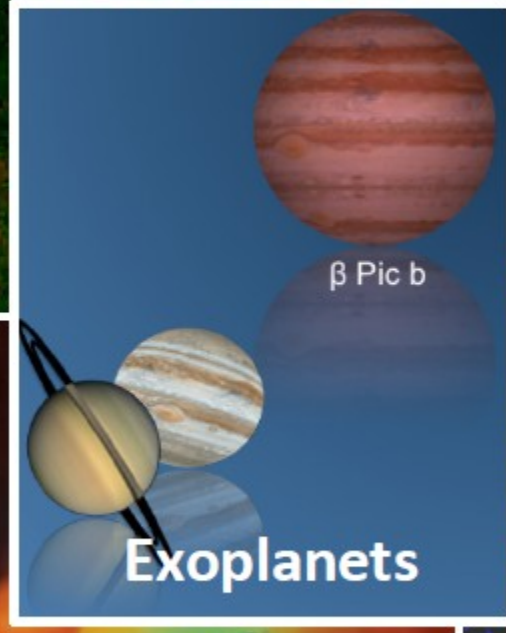
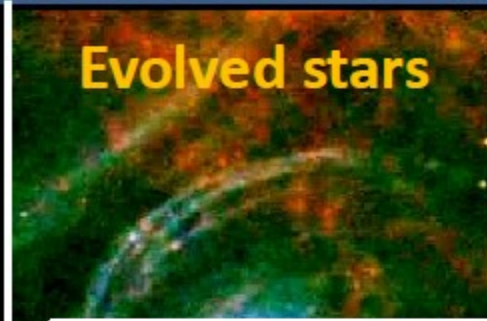
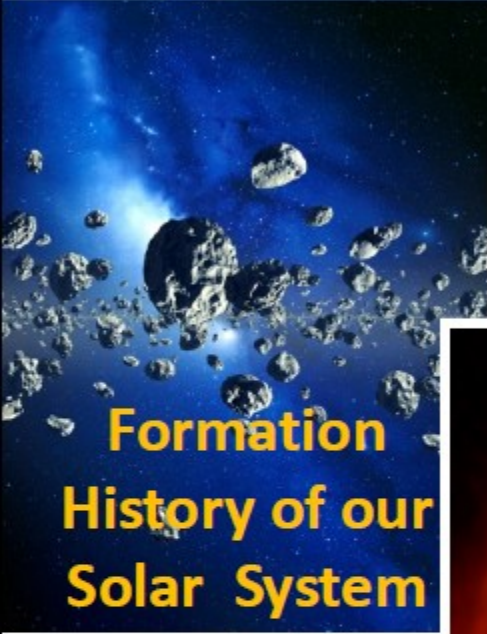
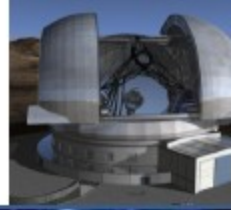


## Project Introduction

# METIS Optical Overview



**METIS**  
Optical Overview



# Evolution in (by) resolution

	Region	TW Hydrae Association	Taurus / Chamaeleon $\rho$ OPH	Orion BN/KL
	Distance	50 pc	150 pc	450 pc
Instrument ( $\lambda$ /Resol.)	Linear Resolution AU			
"Normal Telescope" ( $1\mu\text{m}$ , 1")		50	150	450
VLA (6cm, 0".4)		20	60	180
3.6m/AO ( $2\mu\text{m}$ /0".2)		10	30	90
HST ( $1\mu\text{m}$ , 0".1)		5	15	45
3.6m ( $10\mu\text{m}$ , 1")		50	150	450
ESO SEST (1mm, 23")		1000	3000	$10^4$
ESO VLT ( $10\mu\text{m}$ , 0. "34)		15	50	150
SPHERE/GPI ( $1.6\mu\text{m}$ , 0".04)		2	6	18
ESO VLTI ( $10\mu\text{m}$ , 0".03)		1	4	12
ALMA ( $300\mu\text{m}$ , 0".005)		0.25	0.75	2.25
LBT ( $10\mu\text{m}$ , 0".2)		10	30	90
METIS ( $3.7\mu\text{m}$ , 0".02)		1	3	9

# Spatial Separation → High Contrast Imaging

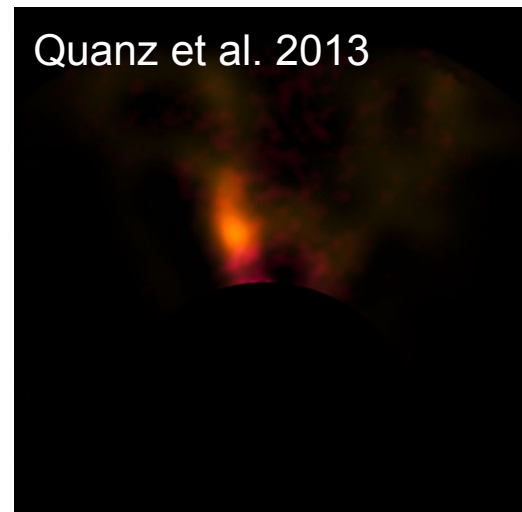
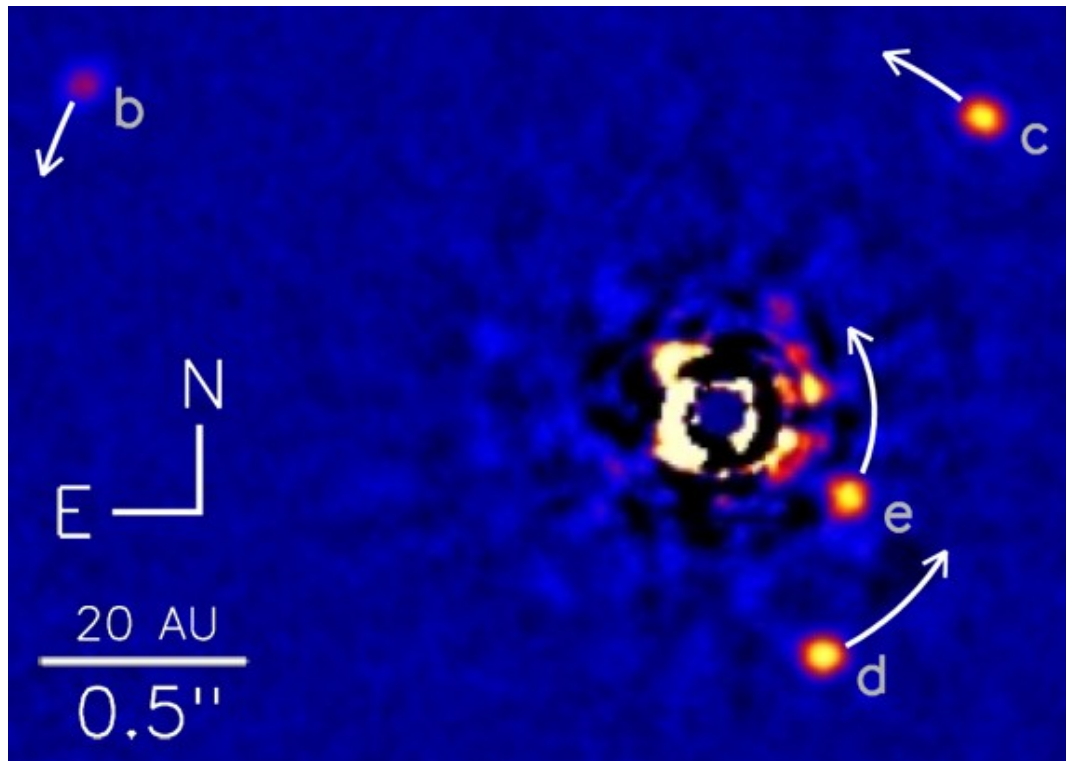
young, self-luminous planets: SPHERE & GPI are state-of-the-art

Key-aspects for METIS@E-ELT: - Planet flux →  $D^2$

- resolution →  $D^{-1}$

- background →  $D^{-2}$

- cooler planets brighter longer wavelengths



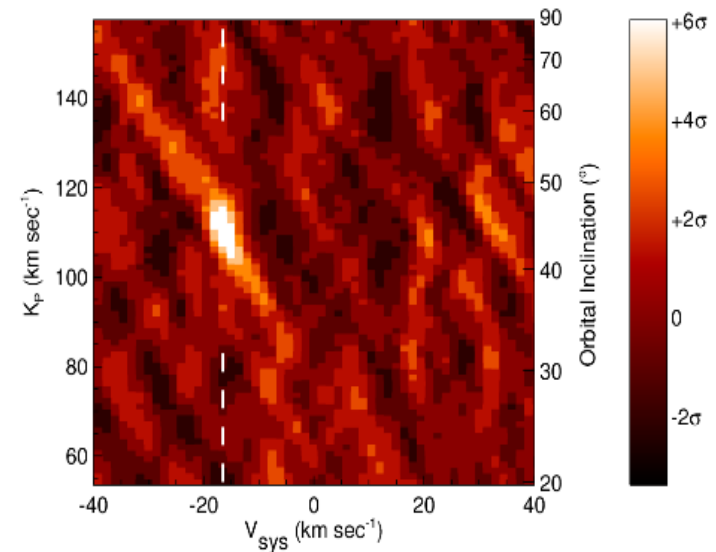
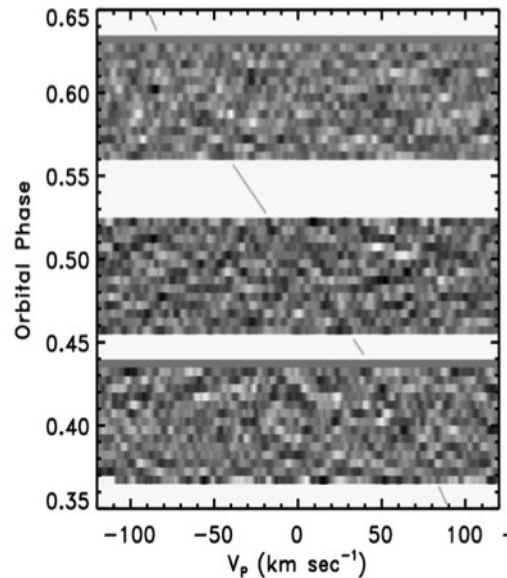
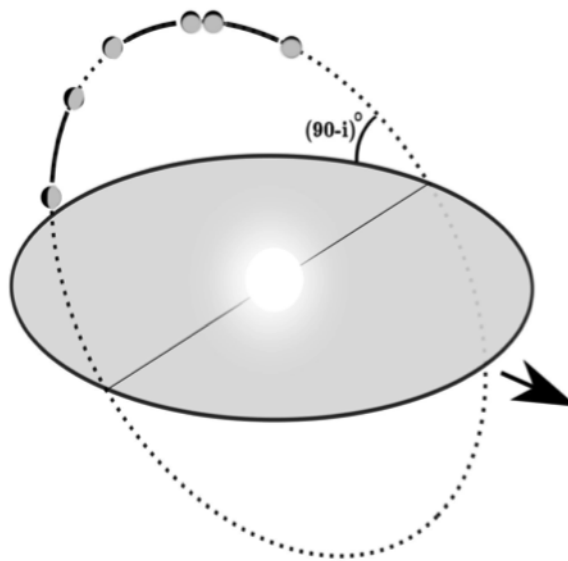
# Spectral + Temporal Separation → HDS

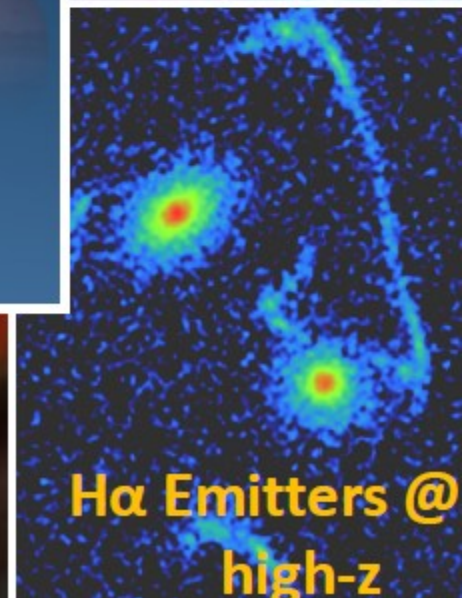
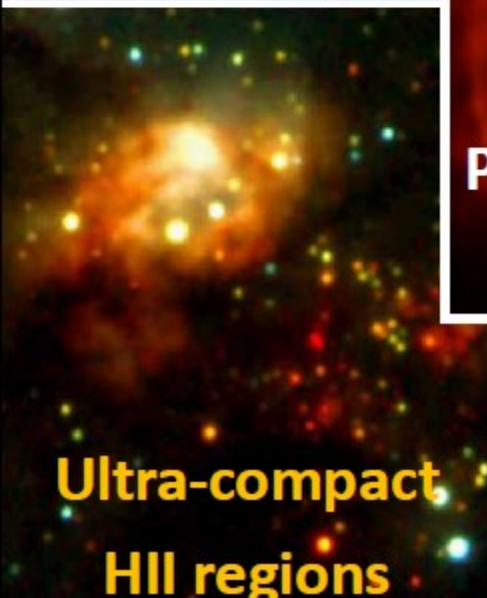
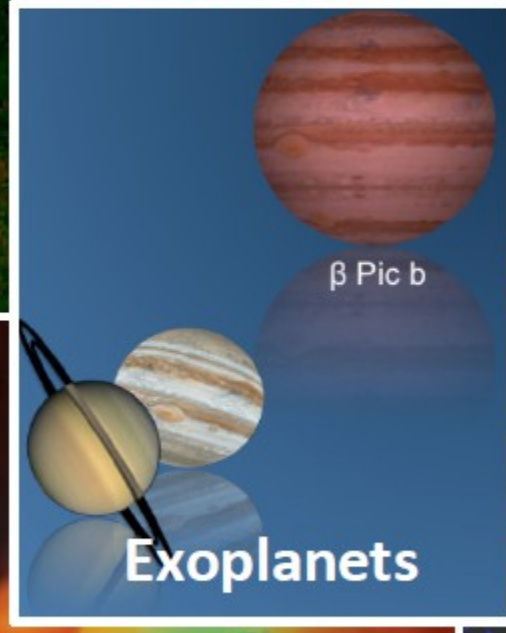
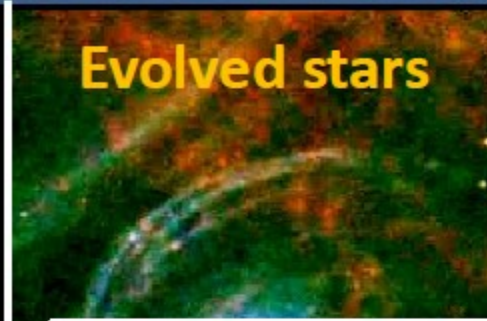
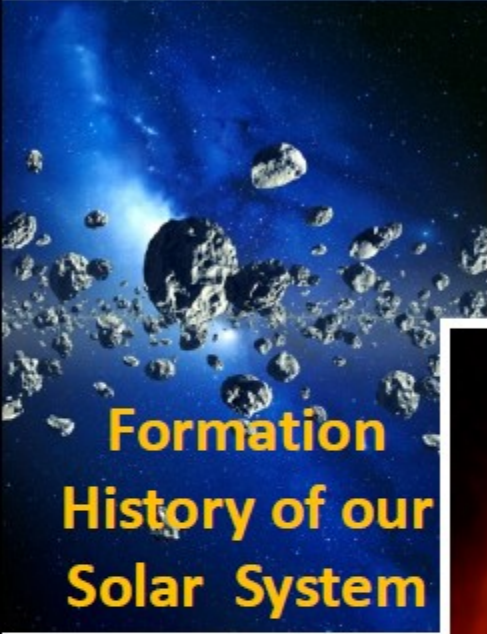
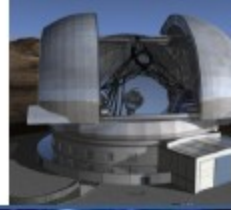
Hot Jupiters: CRILES is state-of-the-art

Key-aspects of

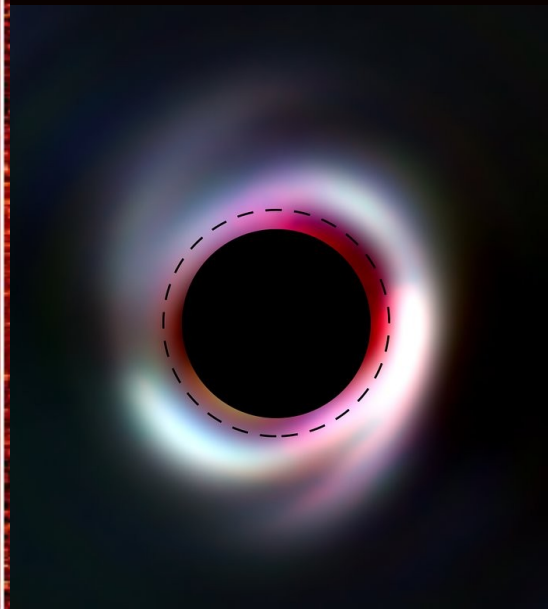
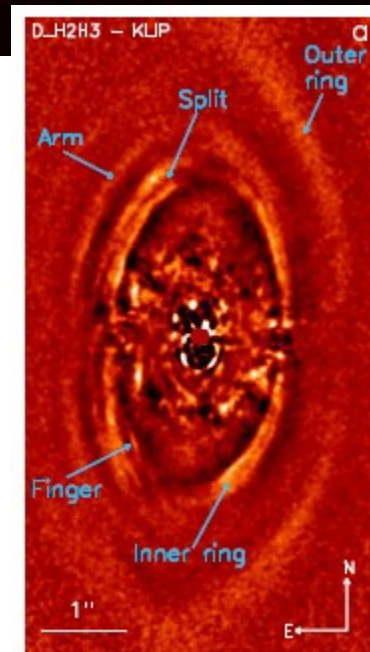
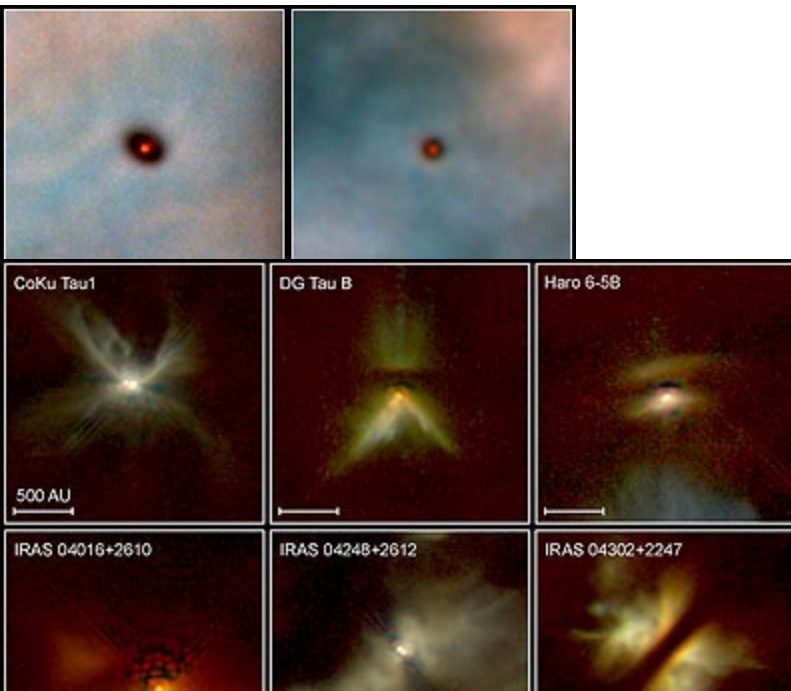
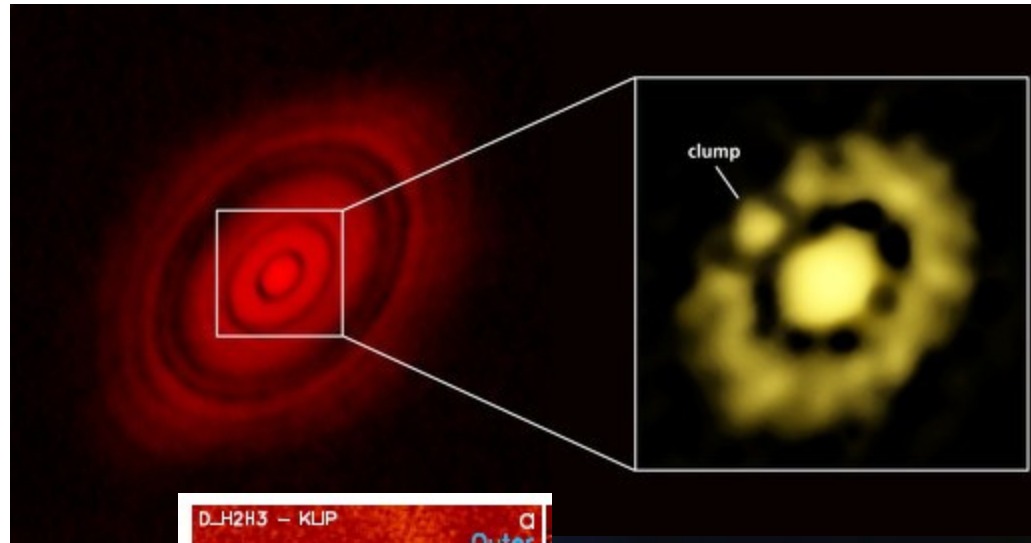
METIS@E-ELT: - Planet flux →  $D^2$

- cooler planets brighter at longer wavelengths
- high dispersion ( $R=100,000$ )



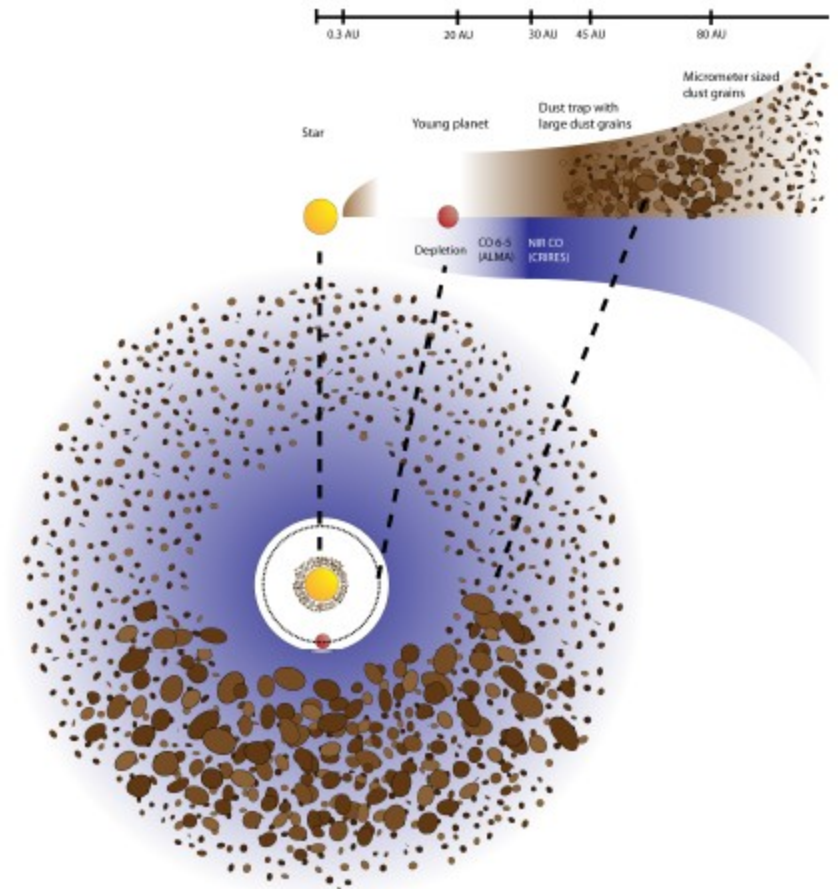
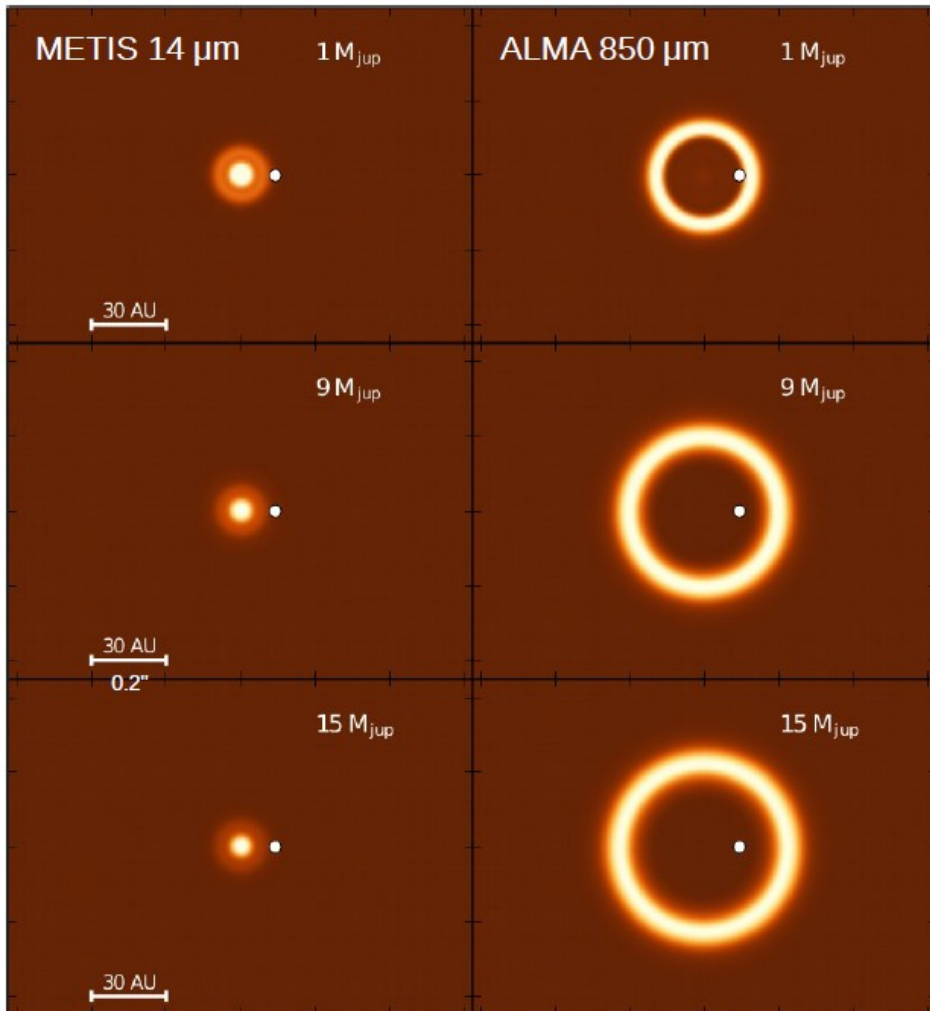


# From fuzzy specks to structured disks

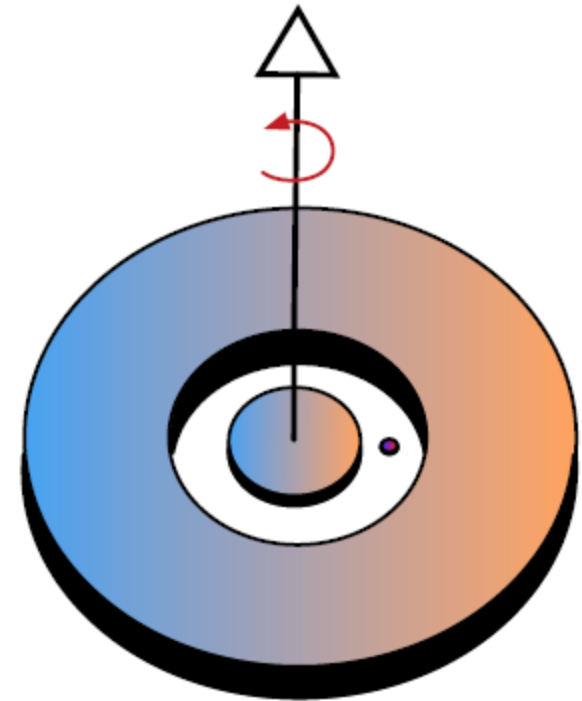
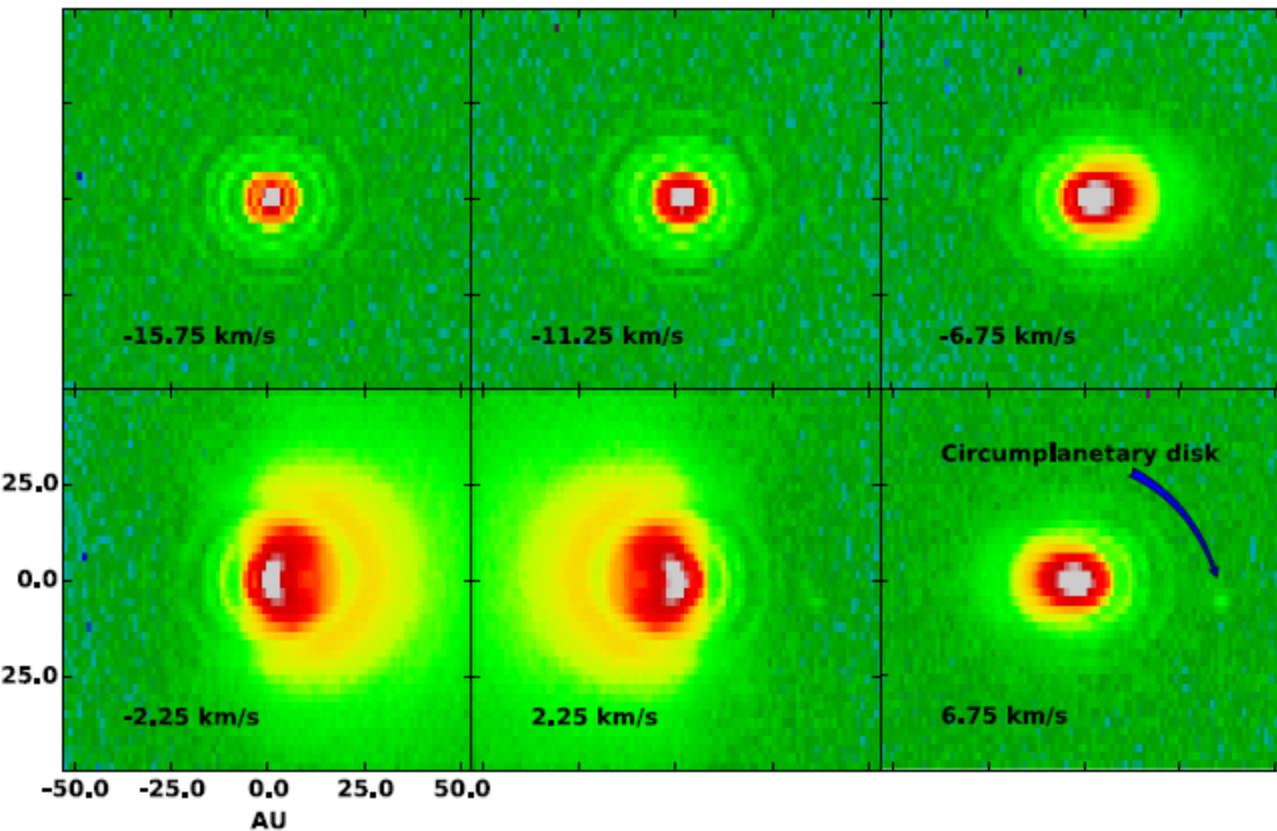




# Solids in protoplanetary disks



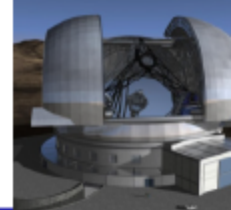
# Forming gas giant planets



Pontoppidan+

# METIS

# Consortium



**B. Brandl**  
(PI)

**M. Feldt**

**E. Pantin**

**A. Glasse**

**C. Waelkens**

**M. Meyer**

**M. Guedel**

### Board of Directors:

*W. Boland (NOVA)*  
*P. Chomaz (CEA Saclay)*  
*T. Henning (MPIA)*  
*G. Wright (UK-ATC)*  
*M. Meyer (ETH Zürich)*  
*C. Waelkens (KU Leuven)*  
*M. Guedel (U Vienna)*  
*A. Russell (ESO)*

### Principal Investigator

*B. Brandl (U Leiden/NOVA)*

### Co-Investigators:

*E. Pantin (CEA Saclay)*  
*M. Feldt (MPIA)*  
*A. Glasse (UK-ATC)*  
*M. Guedel (U Vienna)*  
*M. Meyer (ETH Zürich)*  
*C. Waelkens (KU Leuven)*

### METIS Project Office:

*R. Jager (Consortium PM)*  
*S. Quanz (Project Scientist)*  
*R. van Boekel (Instrument Scientist)*  
*L. Venema (Systems Engineer)*  
*E. Pauwels (PA/QA manager)*

### Systems Team:

AIT lead	<i>R. Roelfsema (NOVA)</i>
Mechanical lead	<i>G. Kroes (NOVA)</i>
Optical lead	<i>T. Agocz (NOVA)</i>
Thermal lead	<i>S. March (ETH)</i>
Adaptive optics lead	<i>M. Feldt (MPIA)</i>
Calibration lead	<i>TBD (NOVA)</i>
Electrical & control lead	<i>G. Raskin (KU Leuven)</i>
Detectors	<i>O. Boulade (CEA)</i>

### Science Team:

<i>J. Alves (U Vienna)</i>	<i>P-O. Lagage (CEA Saclay)</i>
<i>M. Baes (U Gent)</i>	<i>E. Le Floch (CEA Saclay)</i>
<i>H. Bönhardt (LINMPI)</i>	<i>M. Meyer (ETH Zürich)</i>
<i>W. Brandner (MPIA)</i>	<i>T. Moore (JMU Liverpool)</i>
<i>L. Decin (KU Leuven)</i>	<i>R. Oudmaijer (U Leeds)</i>
<i>E. van Dishoeck (U Leiden)</i>	<i>S. Quanz (ETH Zürich)</i>
<i>Th. Henning (MPIA)</i>	<i>I. Snellen (U Leiden)</i>
<i>U. Käufel (ESO)</i>	<i>B. Ziegler (U Vienna)</i>
	<i>P/Co-Investigators</i>

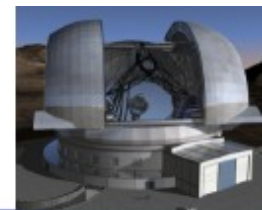


Interest also from:

- U Cologne
- Portugal (Lisbon/Porto)
- MPE Garching
- Konkoly Observatory (Hungary)

METIS

# Schedule



Signature agreement: 28 September 2015

Formal kick-off phase B: 14 October 2015

start phase B  
Sep 2015

FDR 2019

E-ELT 1st  
light 2024

PDR 2017

Start AIV  
2021

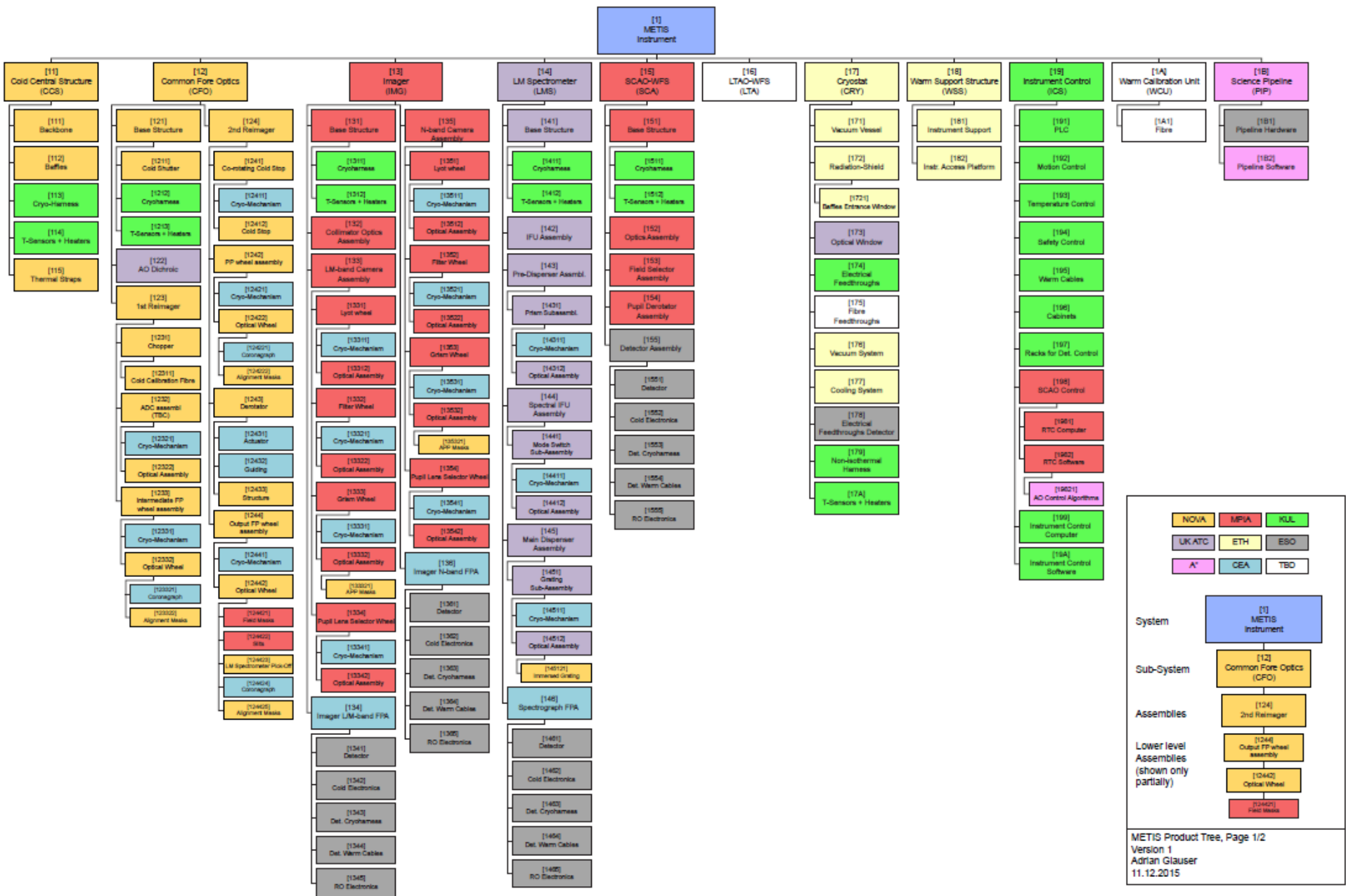
**METIS 1st  
light 2025**

# Current status

- Requirements breakdown still in progress
- CFO concept, IMA and WFS optics concept frozen, detailed design starting
- Mechanical concept in progress
- PDR date Oct 17 => shift +6m under discussion
- Regular system team, management, and progress meetings tri-monthly
- Consortium meetings twice yearly
- ESO involved with several key support persons

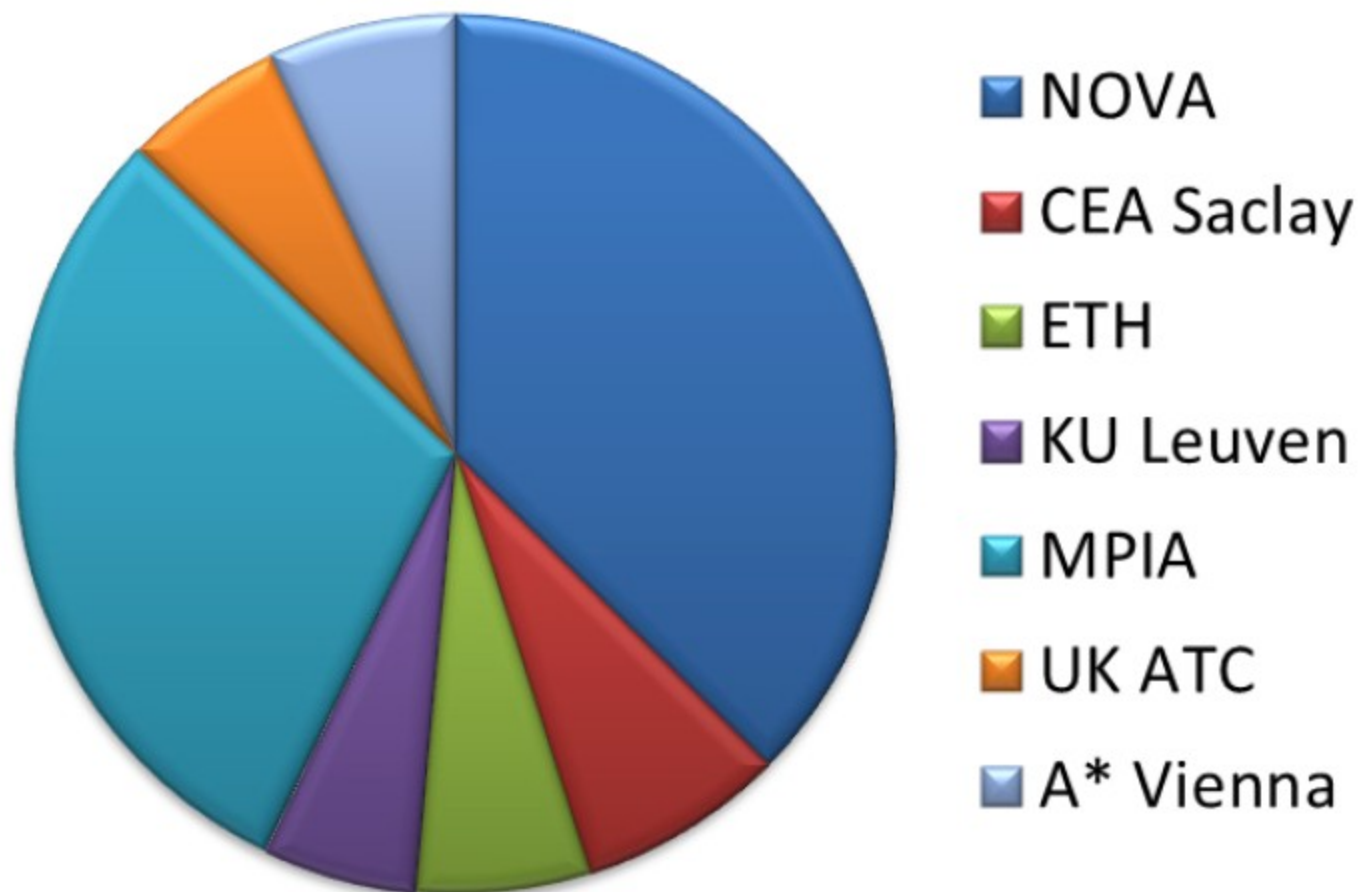
# Cost

- Cost cap 12.5 M€ for instrument except manpower
- All hardware paid by ESO
- Overhead and travel also reimbursed by ESO
- No financial contribution from consortium foreseen
- Contingency budget at NOVA ~ 25%

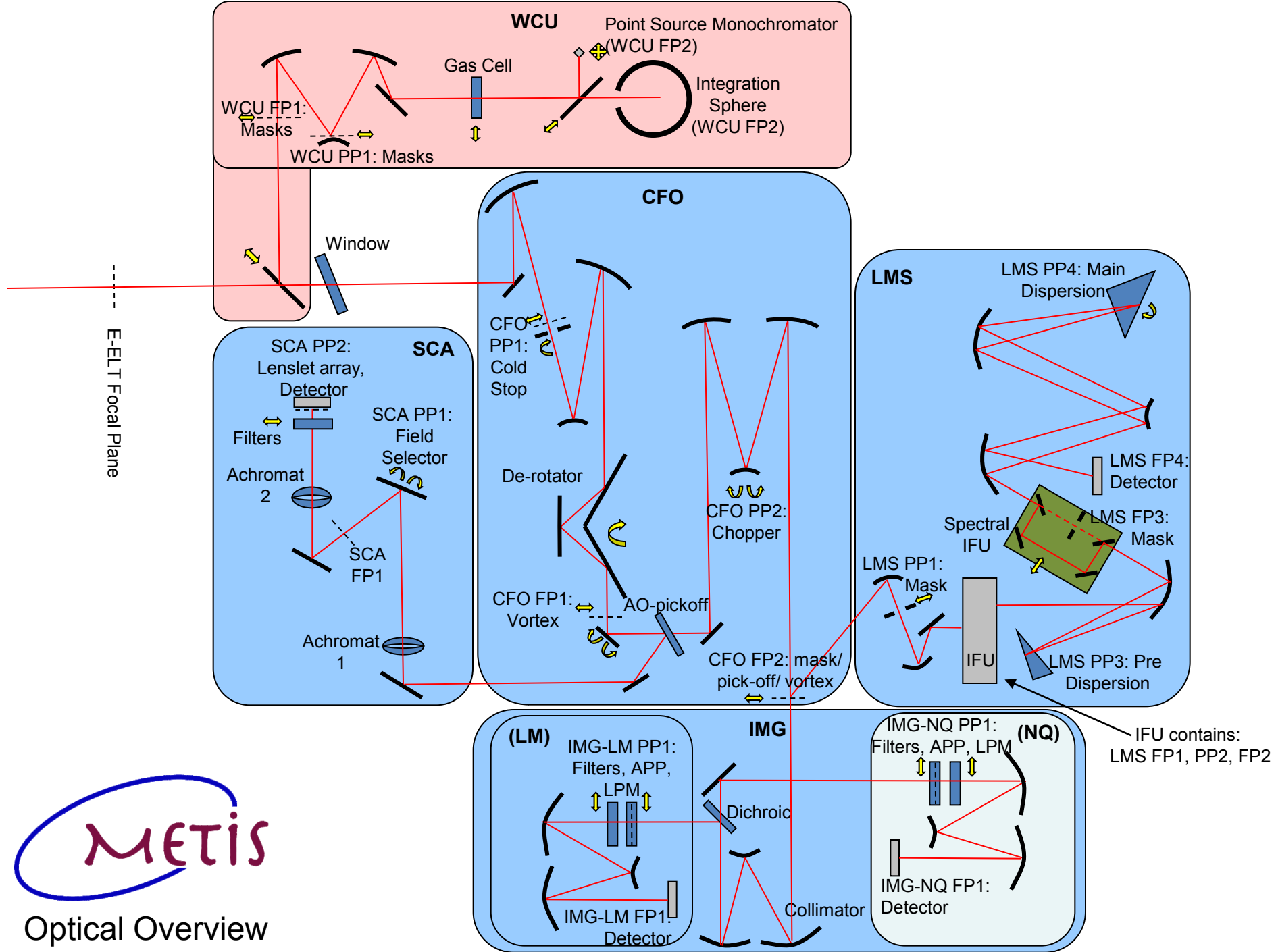


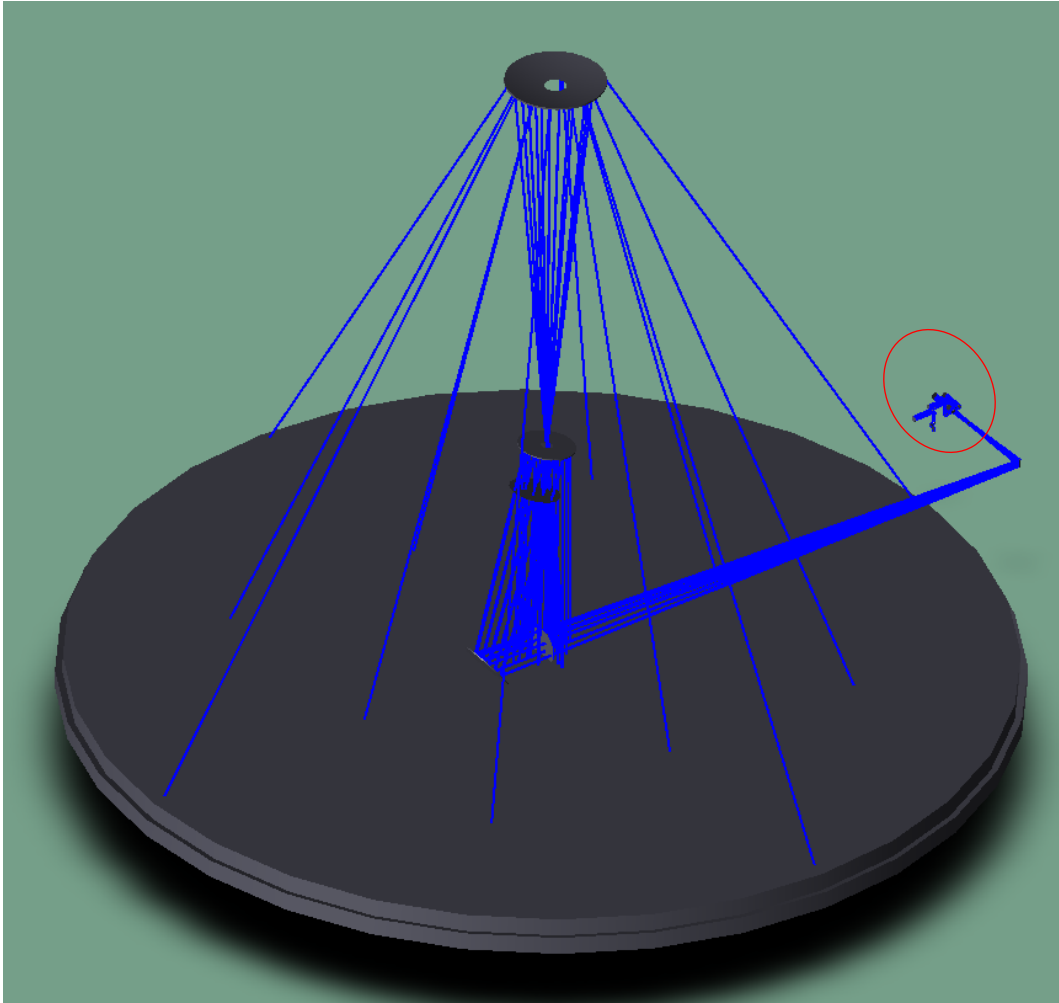
Total work: 4872 person-months (402 FTE)

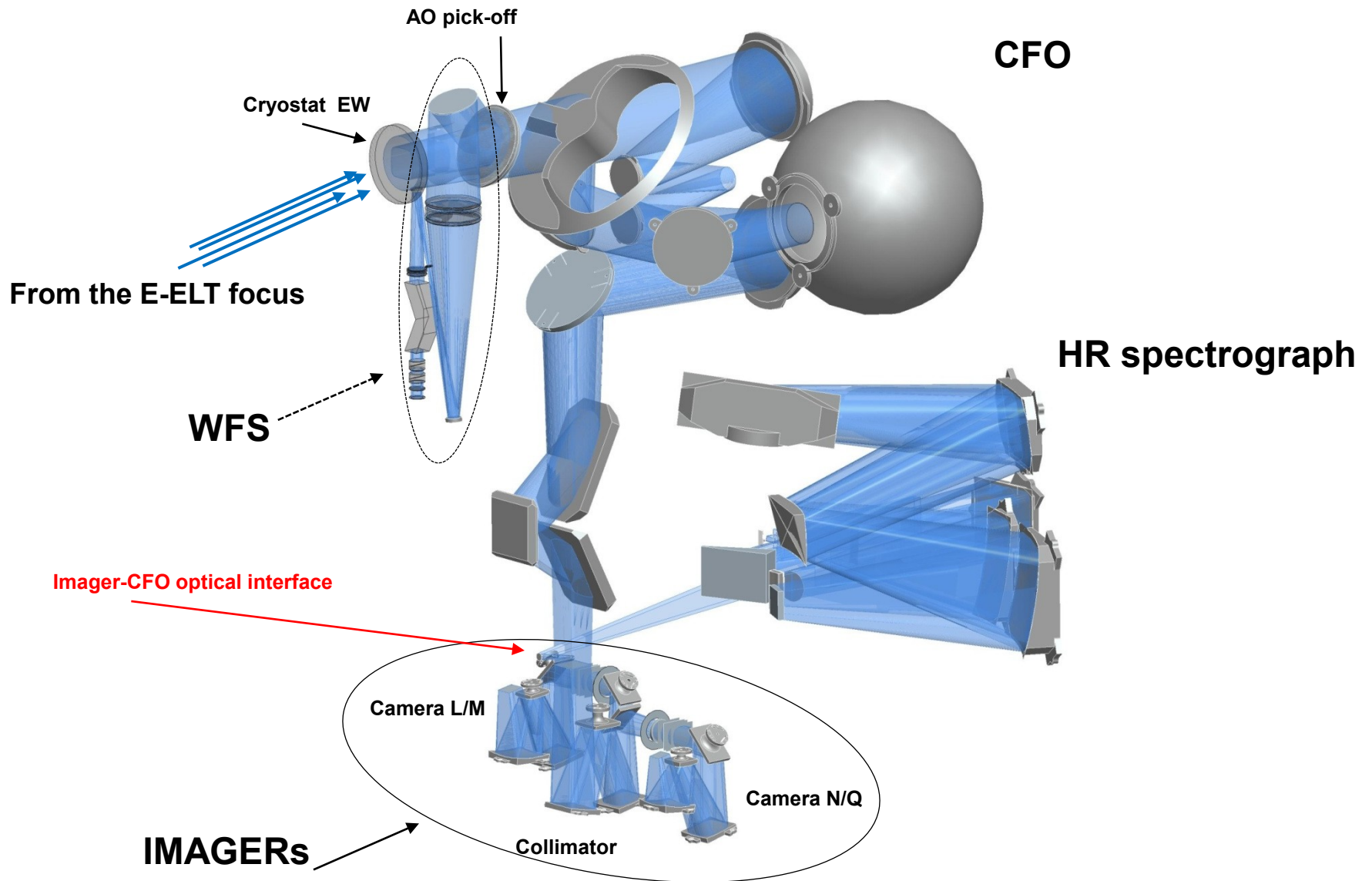
Total hardware and travel: 13,343 k€ (12.5 M€ guaranteed by ESO)











# Cryostat

# Functional Overview

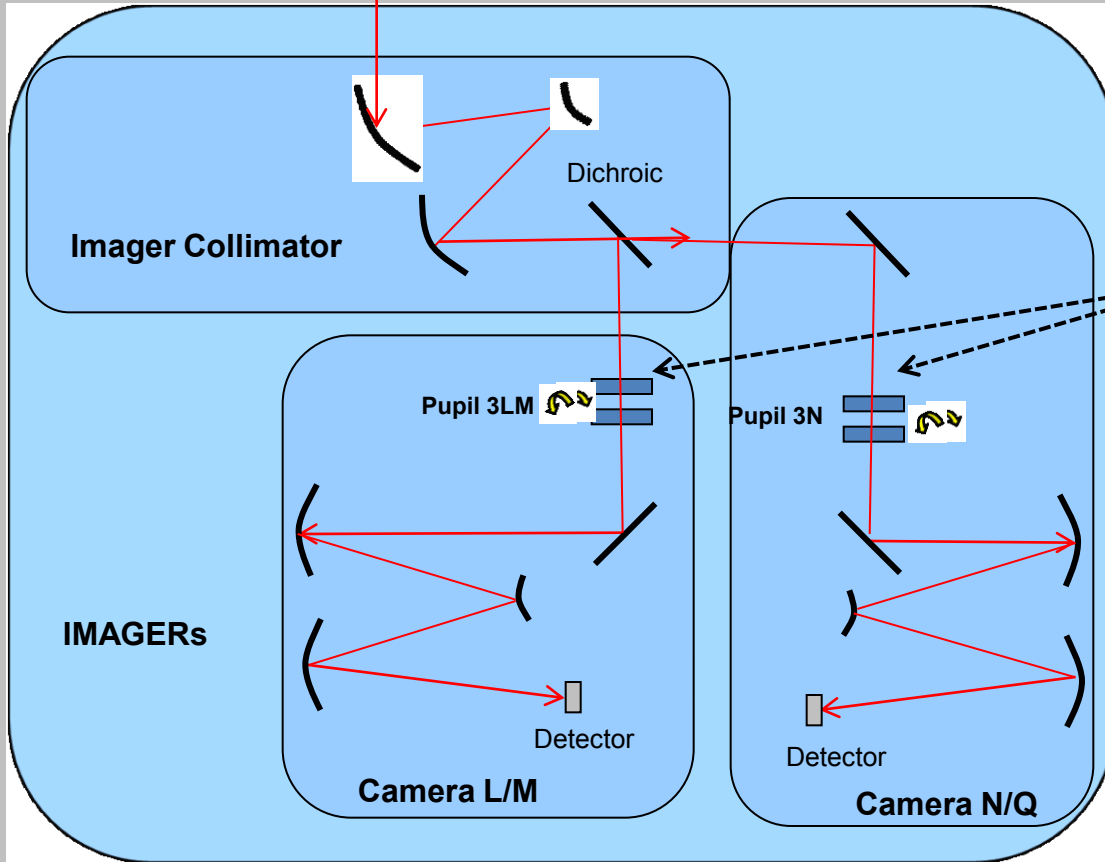
L/M HR Spectrograph

CFO

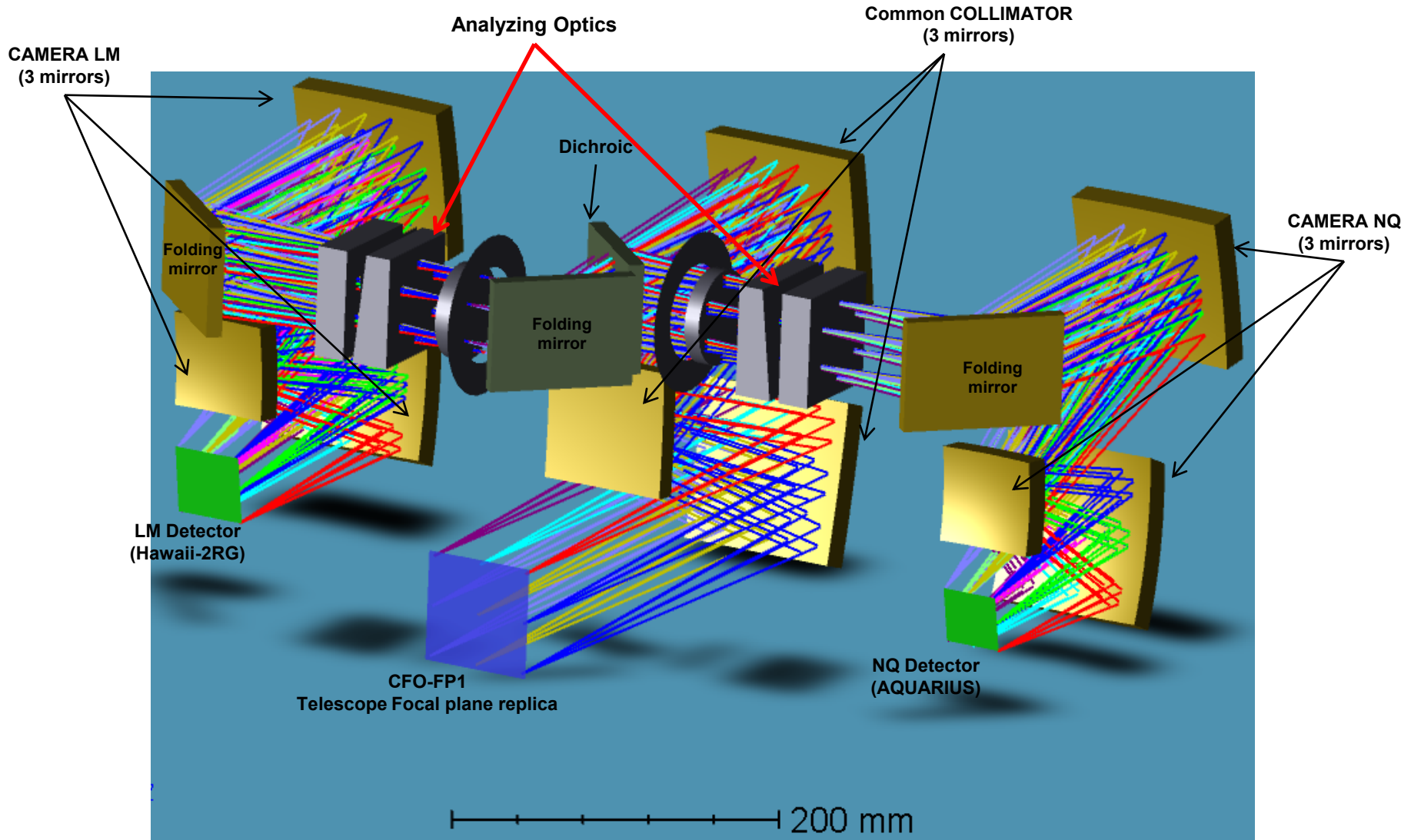
Pick-off

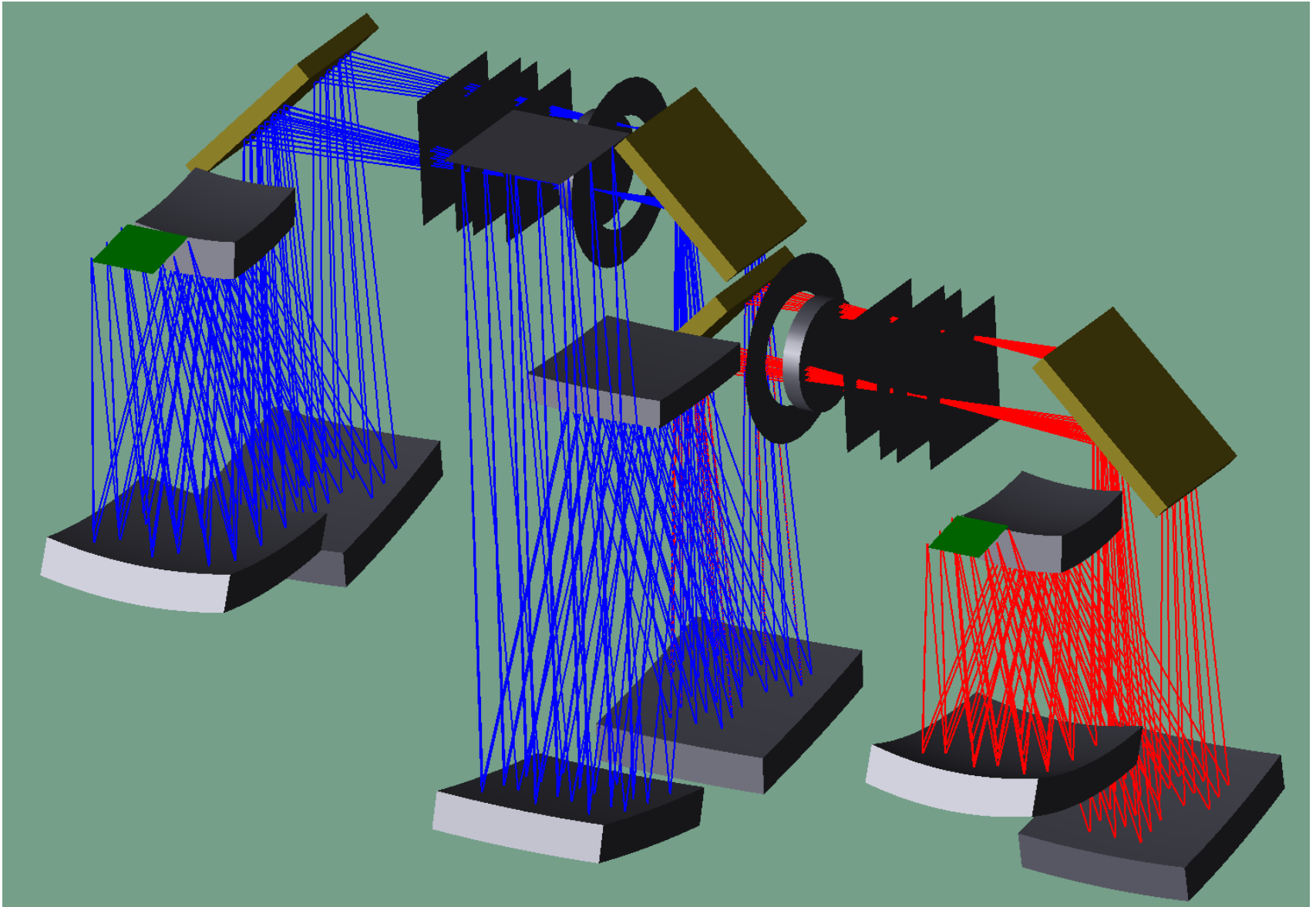
Output focus: E-ELT replica  
Focus 2

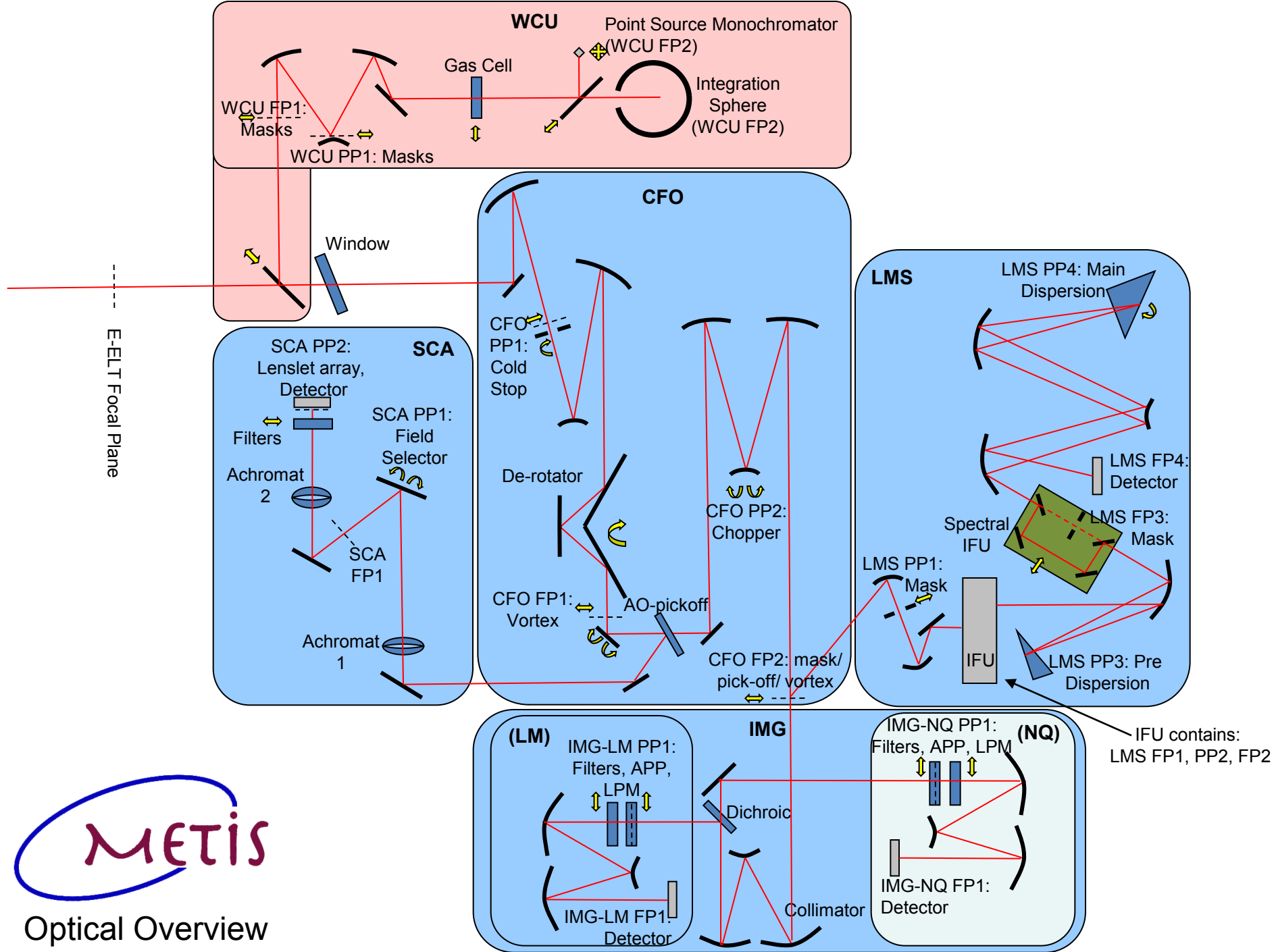
Focal Plane wheel/s:  
FOV masks  
Slit masks  
Coronagraphic masks

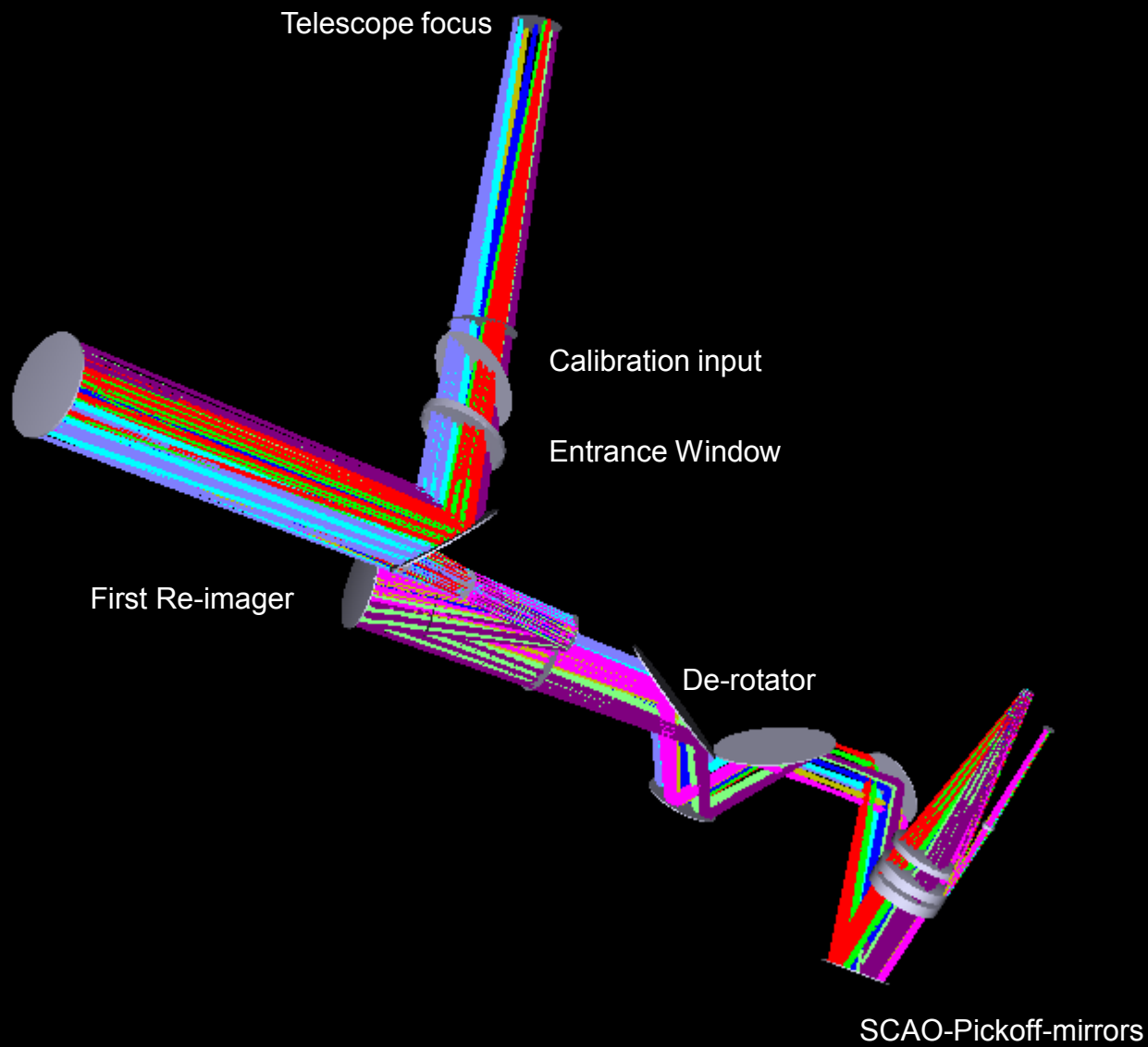


Collimated beam wheel/s:  
Pupil masks  
Filters  
Grisms  
Coronagraphic masks  
Pupil imager lens

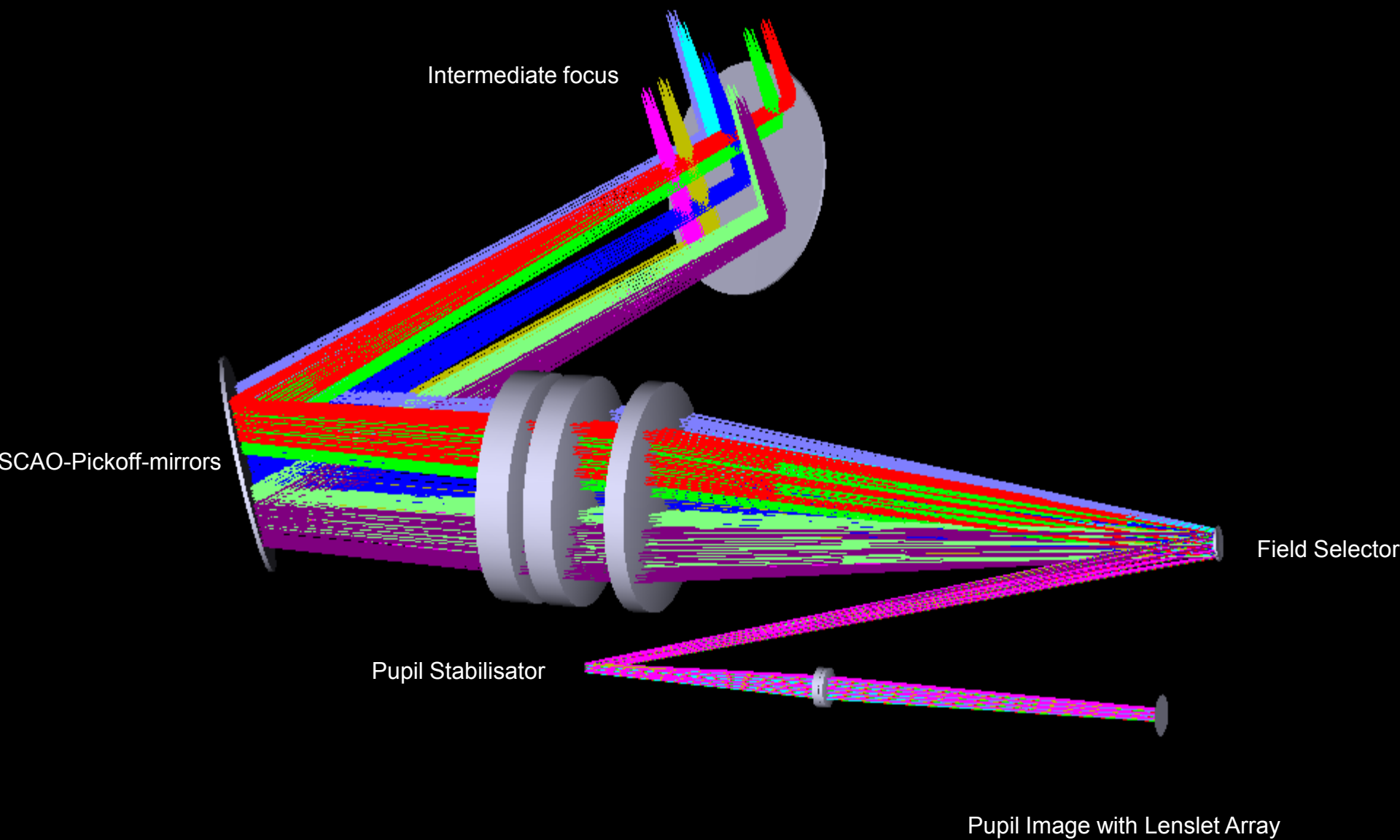












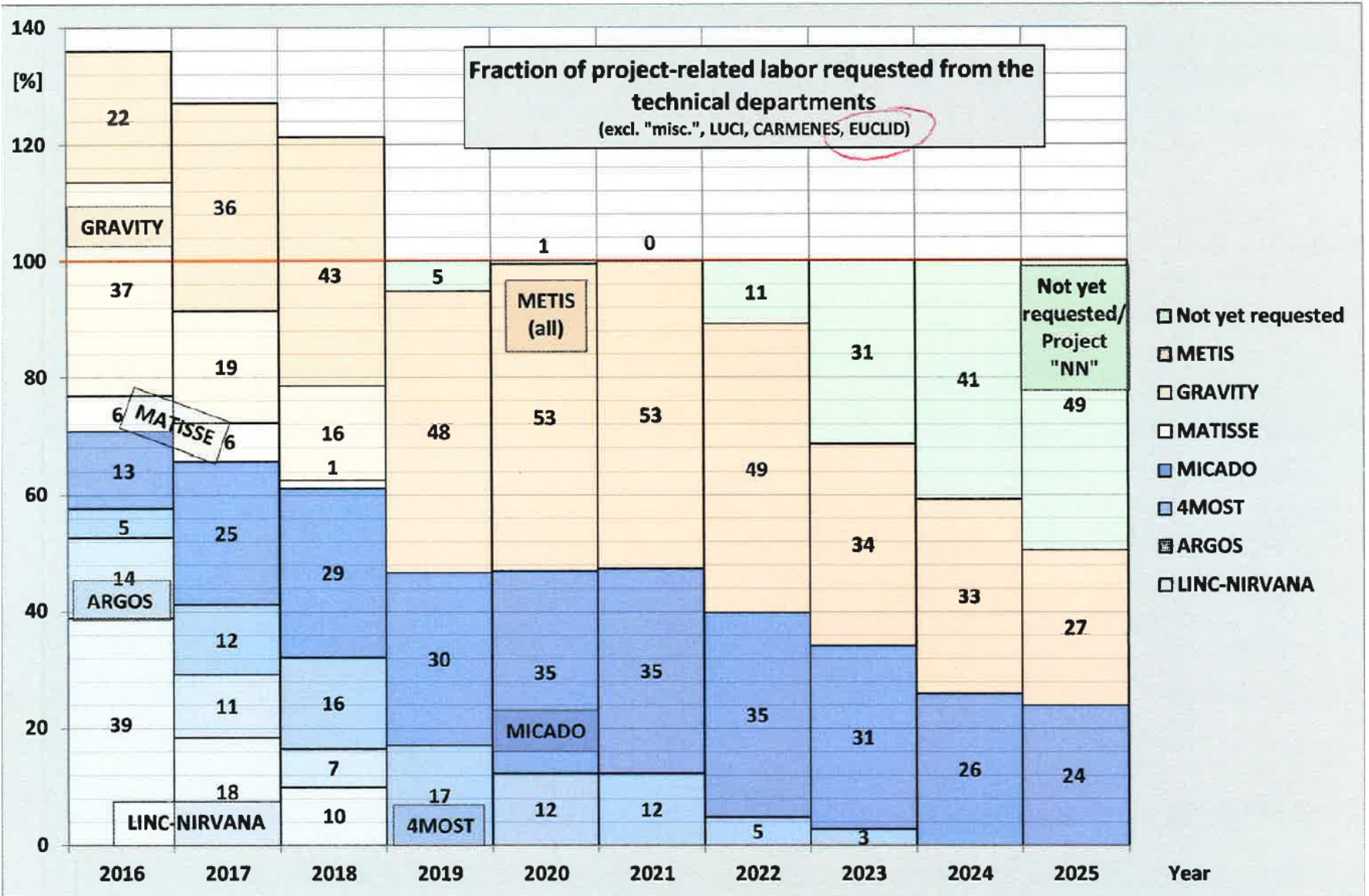
# People at MPIA

S. Scheithauer (Project Management)  
R. v. Boekel (Instrument Scientist)  
Th. Bertram (Subsystem Engineer / SCAO lead)  
P. Bizenberger (Imager lead)  
S. Hippler  
F. Briegel  
R.R. Rohloff  
W. Brandner  
Th. Henning  
...

## Current Issues

Manpower requirements  
Manpower requirements  
Manpower requirements

schedule



# Solutions to internal issues:

- Delay PDR by 6 months
- 1 engineer from Konkoly Observatory to support design phase
- 1 PostDoc from PSF department to support WFS AIV
- Delay WFS delivery by 12 months
- 1 Engineer from NOVA to lend 2FTE to MPIA during imager AIV
  - To be reimbursed during system AIV / commissioning (across 4-5 years)

# Consortium-wide issues

- System engineering not fully staffed
- Project management vacant
- Calibration scientist position vacant (interviews done!)
- Components / work packages being redistributed up to now
- Additional consortium members taken aboard (Cologne / Portugal)
- ETH Co-I leaving
- NOVA existence secured until 2022 only

# Conclusions

- METIS on its way, first light foreseen by 2025/26
- Exoplanets and disk design driving science cases
- MPIA second largest partner, difficulties in providing manpower contribution
- Cost 12.5M€
- Detailed design work beginning
- Consortium not fully stable, issues exist