ASGARD

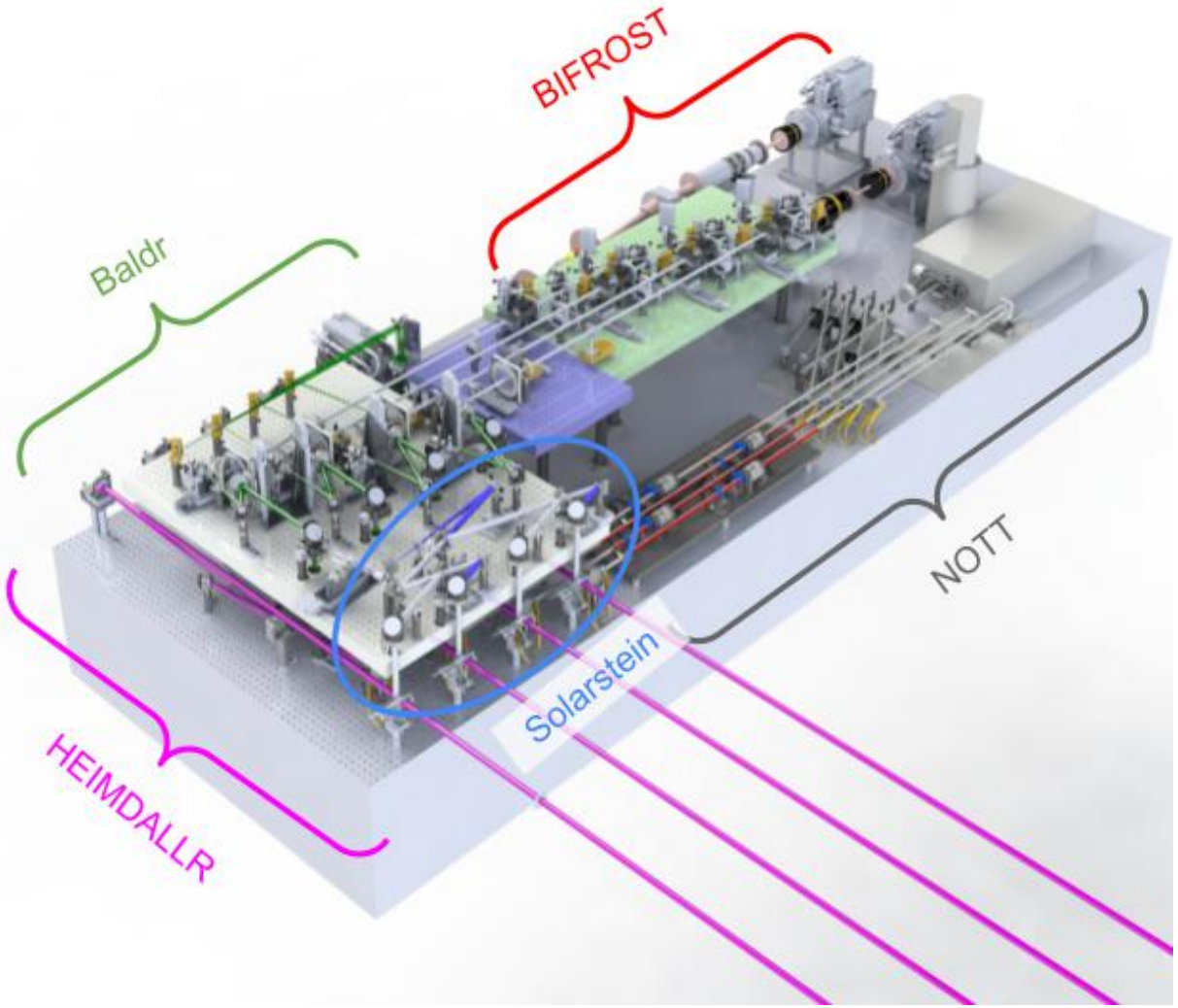
HEIMDALLR | Baldr | BIFROST | NOTT

Phase 1 AIT - status update

F. Martinache & Nice integration team: S. Robbe-Dubois, N. Cvetojevic, R. Ligi, J. Dejonghe, Y. Fantei Caujolle & **S. Lagarde** - on behalf of Asgard consortium

What is Asgard?

- Expanding scientific capabilities of the VLTI:
  - BIFROST: high-resolution YJH-band instrument, **new take on J-band VLTI instrument** (PI: S. Kraus, U Exeter)
  - NOTT: high-contrast L-band nuller, **first VLTI nuller** (PI: D. Defrère, KU Leuven)
  - HEIMDALLR: high-sensitivity fringe tracker in K band (PI: M. Ireland, ANU)
  - Baldr: Strehl Optimizer, Zernike WFS in H band (PI: M. Ireland, ANU)
- Recommended for the **visitor focus** of the VLTI by the STC (June 2023)

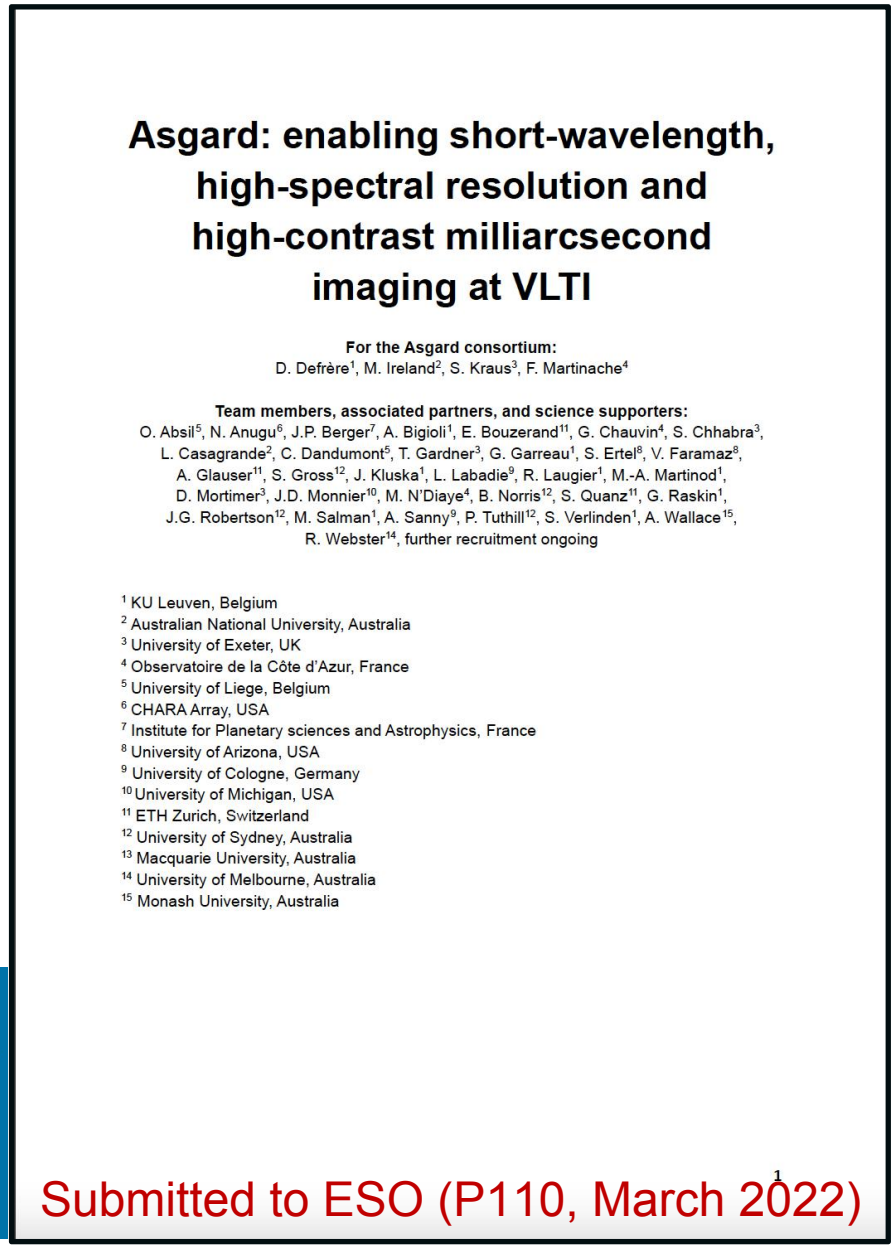


First system that integrates together AO & FT for astrophysics

Science cases

- BIFROST (**J-band VLTI instrument**)
  - GAIA binary survey
  - Exoplanet orbit obliquity and spectroscopy
  - Mass accretion and ejection

- NOTT (**first nuller @ VLTI**):
  - Exozodiacal disks
  - Young GAIA exoplanets within the snow line
  - Forming exoplanets in transition disks
  - Hot jupiters, binaries, …



Asgard: enabling short-wavelength, high-spectral resolution and high-contrast milliarcsecond imaging at VLTI

For the Asgard consortium:
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Team members, associated partners, and science supporters:
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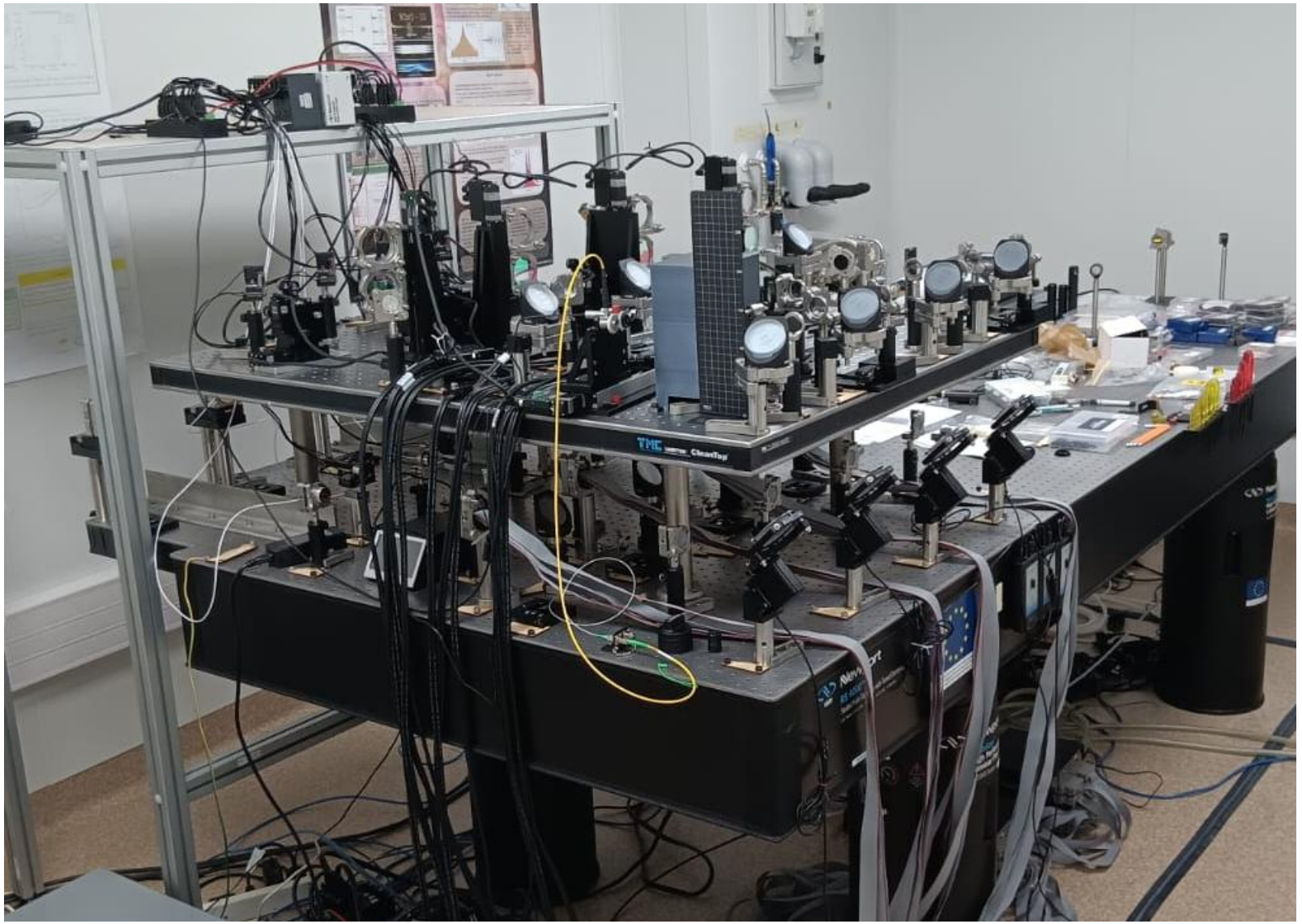
[7] Institute for Planetary sciences and Astrophysics, France
[8] University of Arizona, USA
[9] University of Cologne, Germany
[10] University of Michigan, USA
[11] ETH Zurich, Switzerland
[12] University of Sydney, Australia
[13] Macquarie University, Australia
[14] University of Melbourne, Australia
[15] Monash University, Australia

Submitted to ESO (P110, March 2022)

Asgard's expected specifications

Feature	BIFROST	Heimdallr/Baldr	NOTT
Magnitude Limit	H=9.6 (AT) or 12.9 (UT) limited by Baldr	K=11.5 (AT) or 13.5 (UT)	L'=11 (AT) or 13 (UT)
Field of view (diameter)	155 mas (AT), 34 mas (UT) @1.35 um	222 mas (AT), 49 mas (UT) @ 1.94 um	430 mas (AT), 94 mas (UT) @3.75 um
Precision on V^2	3% (Low resolution mode)	5%	-
Precision on closure phase	1° (Low resolution mode)	1°	-
Precision on differential phase	0.5° (High resolution mode)	-	-
Residual piston RMS (nm)	-	<100 (UT) <50 (AT)	-
Injection stabilisation (in Strehl, in J band)	-	>50% Strehl (AT)	-
RMS of injection (in Strehl, in J band)	-	<10% (AT)	-
Inner Working Angle (@3.75 um)	-	-	2 mas (AT), 3 mas (UT)
Precision on null depth (@Lmag=4 & R=18)	-	-	5×10^{-5} (UT) 3×10^{-4} (AT)



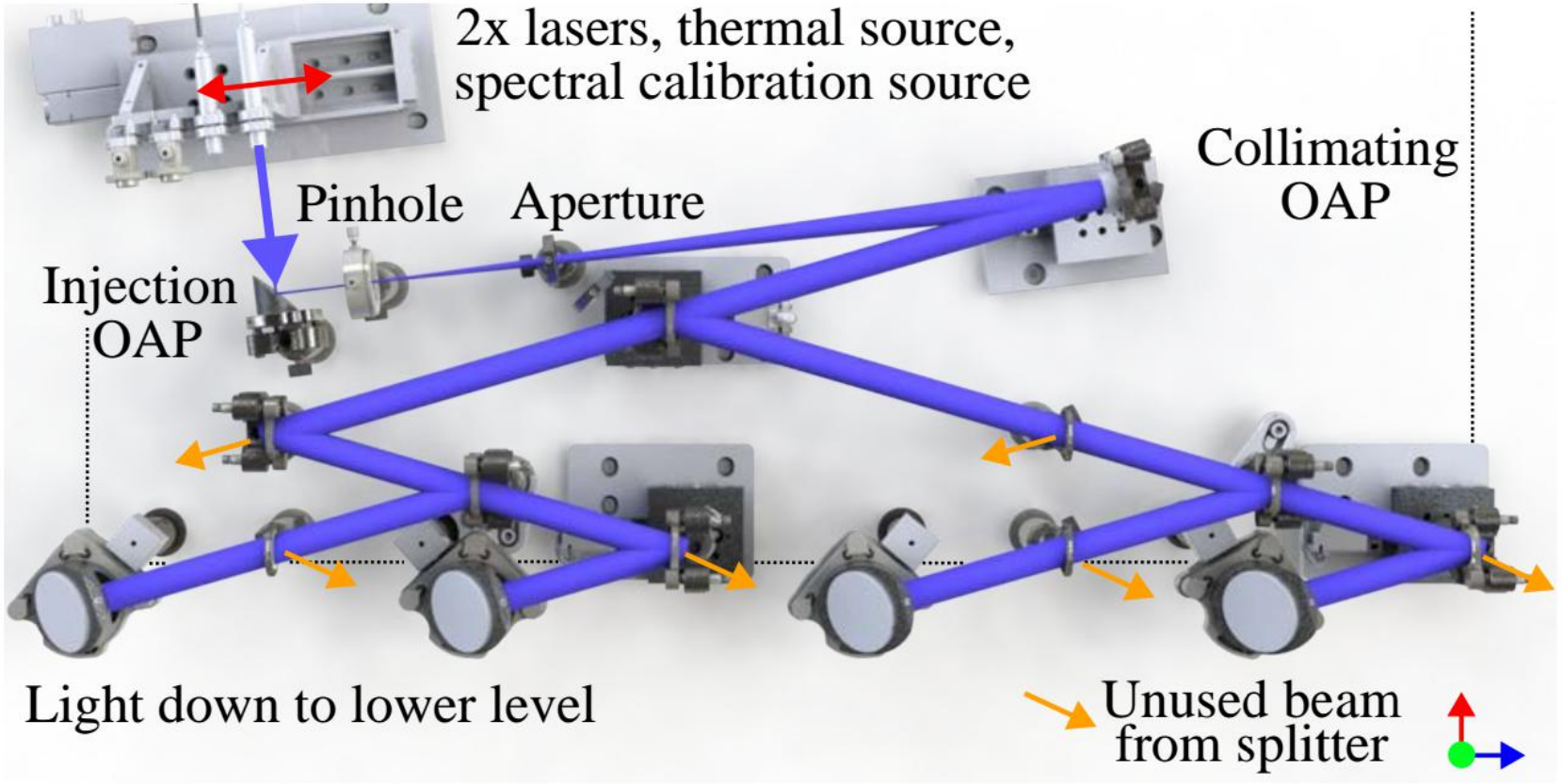
Asgard phase 1 on-going AIT

- Solarstein calibration source
- BALDR Adaptive Optics
- HEIMDALLR fringe-tracker and interferometric instrument
- BIFROST fore-optics

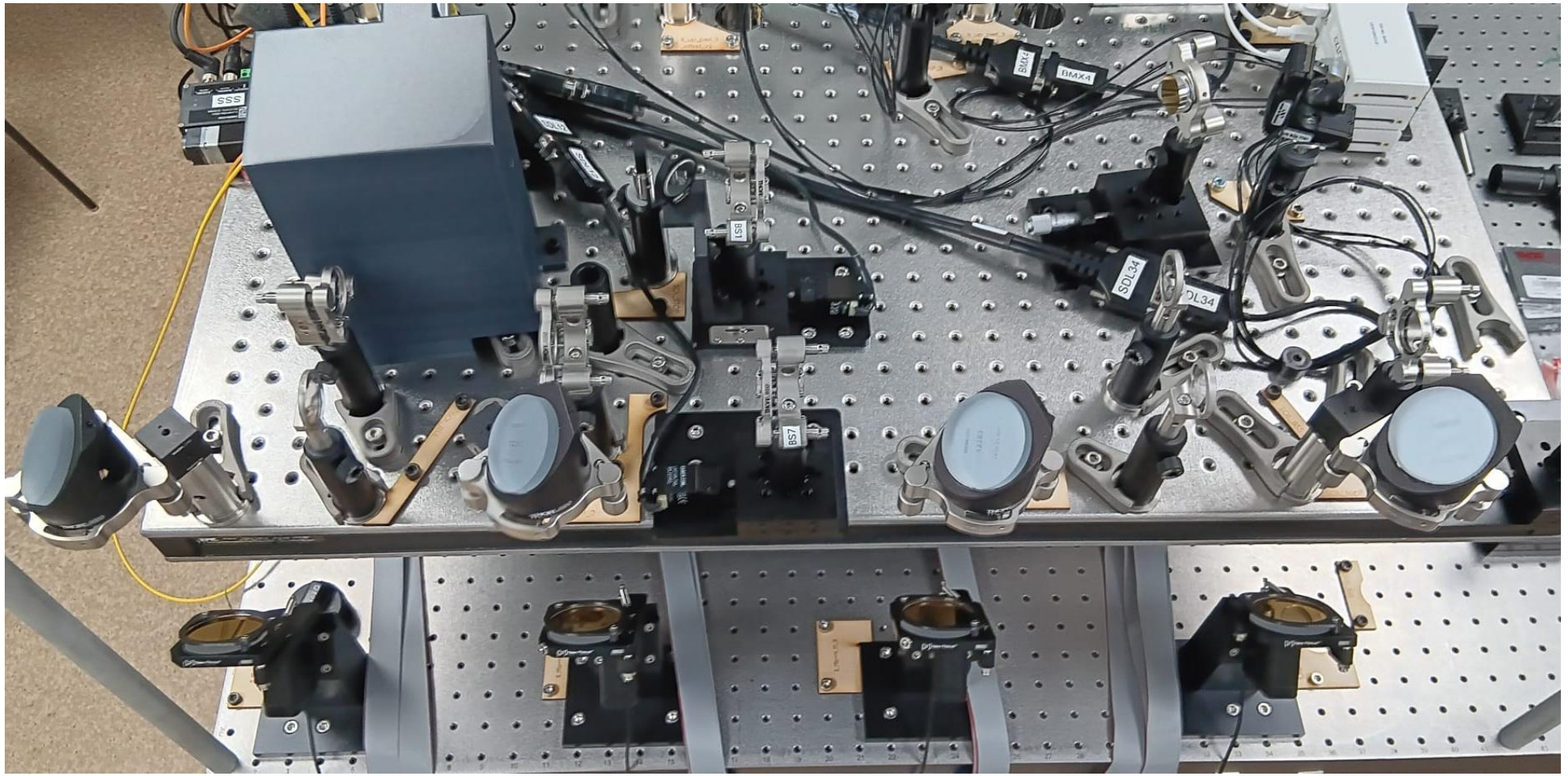
Implement lessons learned from XAO experience - with **wavefront control ACAP to the final detector**

Solarstein design

- Calibration unit
- 4 cophased beams
- 4 sources
  - 2x lasers
  - blackbody source
  - spectral lamp



Solarstein - IRL

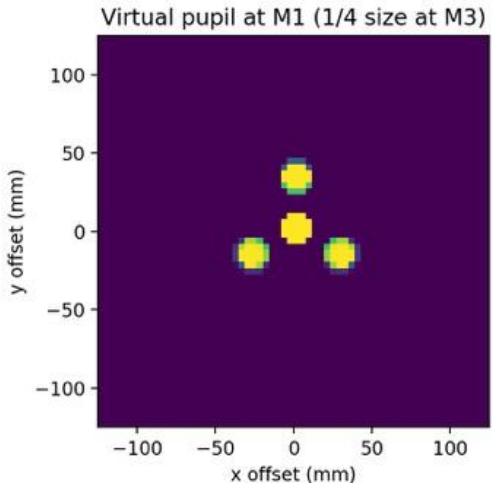


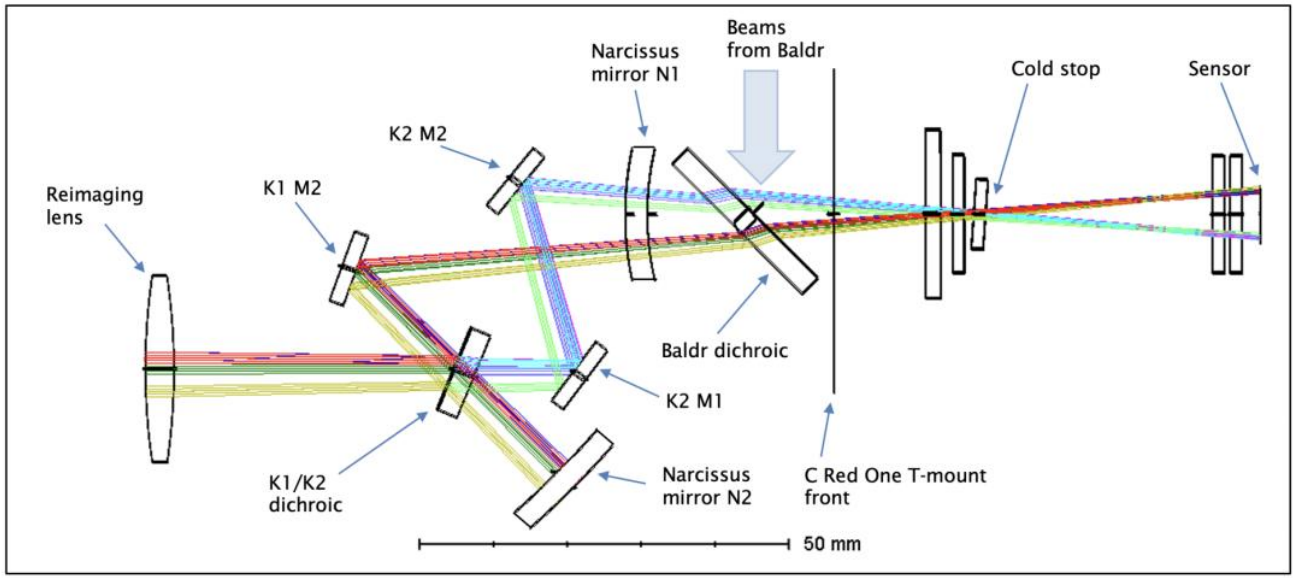
Asgard common optics

Four 12x12 actuator DMs (BMC)
Fast AO + piston control

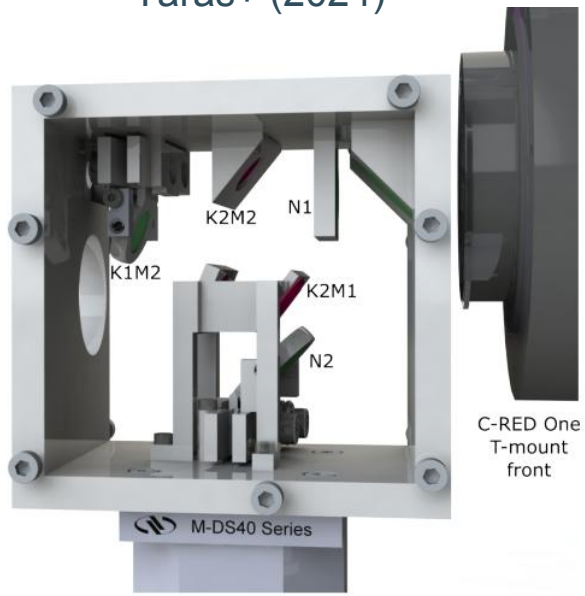
Heimdallr design

- High-Efficiency Multiaxial Do-it ALL Recombiner
- Aperture mask interferometry
- Piston, Tip-tilt, pupil alignment and focus are simultaneously sensed

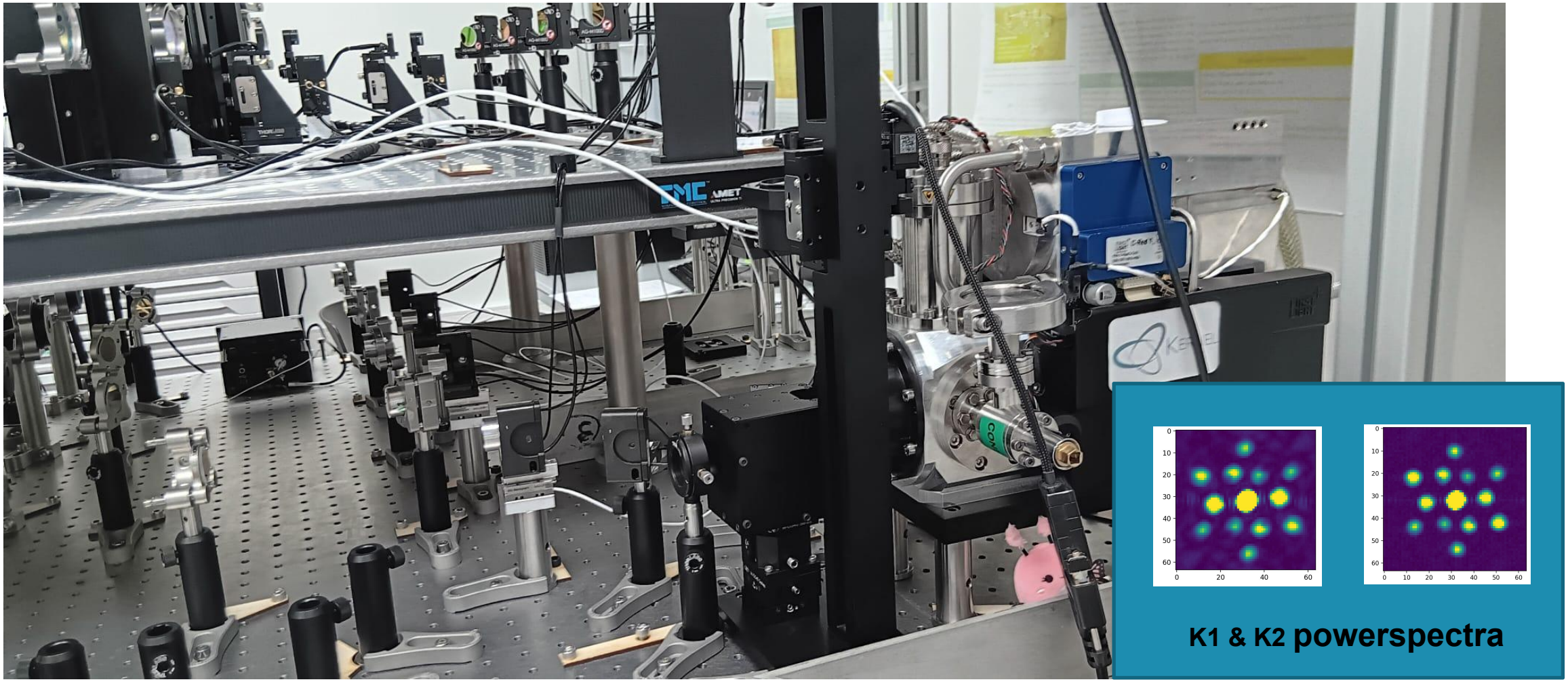




Taras+ (2024)



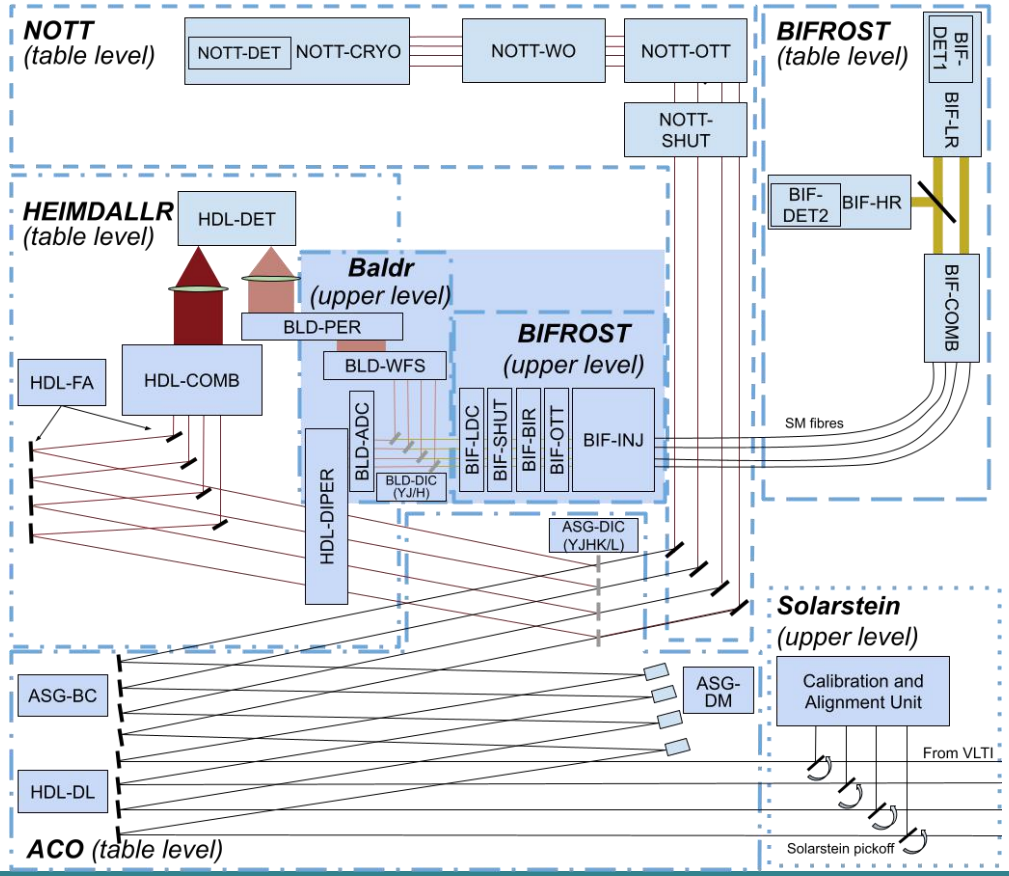
Heimdallr - IRL

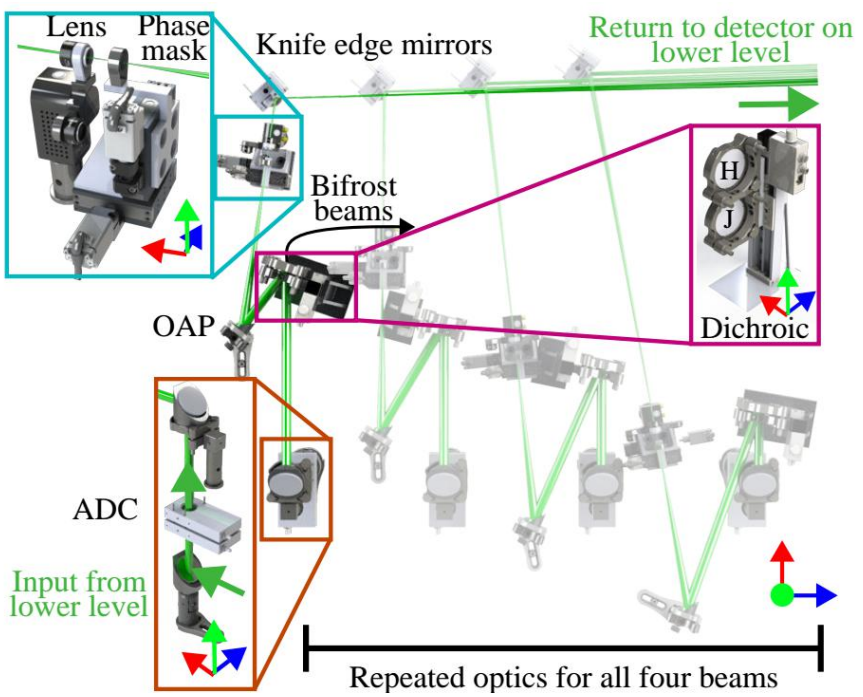


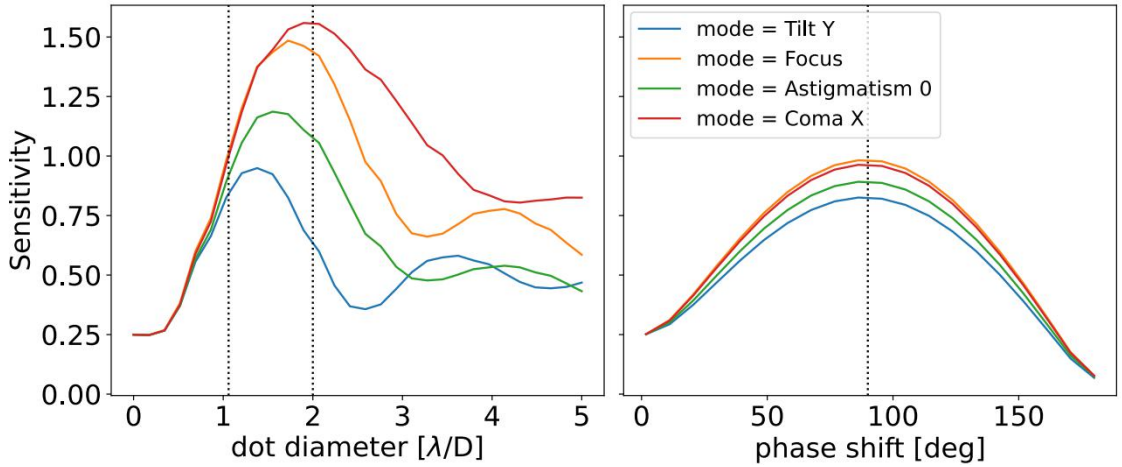
Baldr design

Taras+ (2024)

- Zernike Wavefront sensor
- up to 70 modes corrected

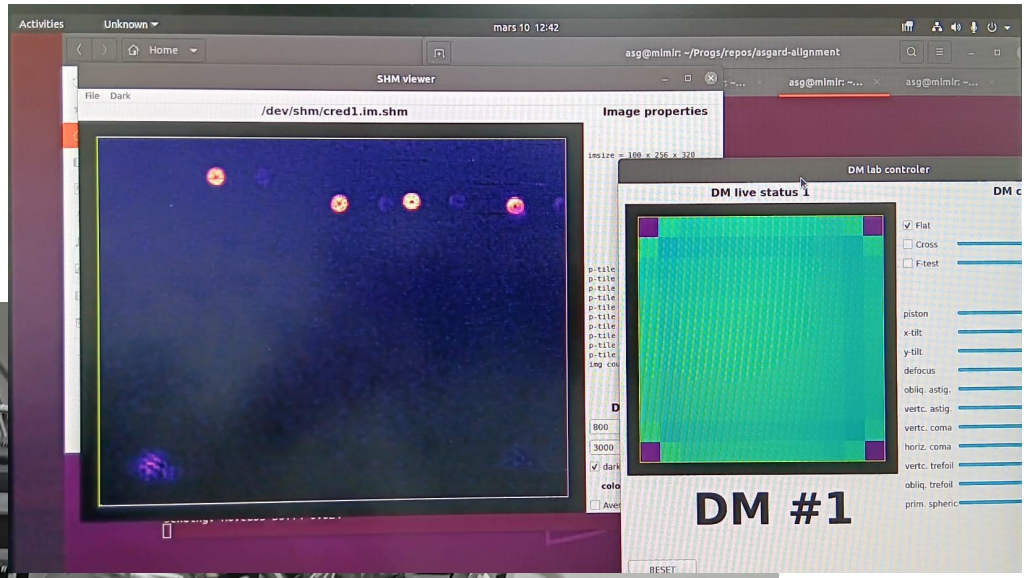


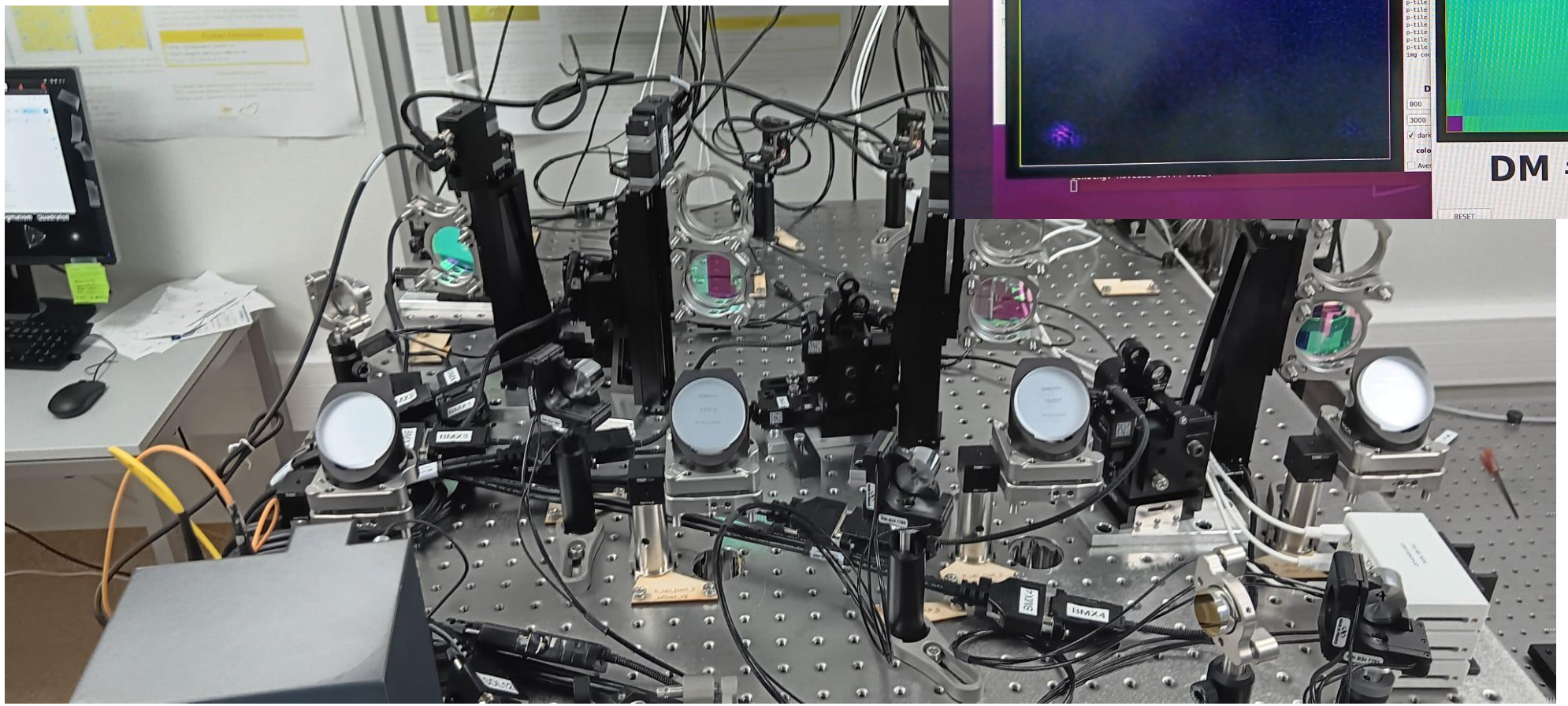




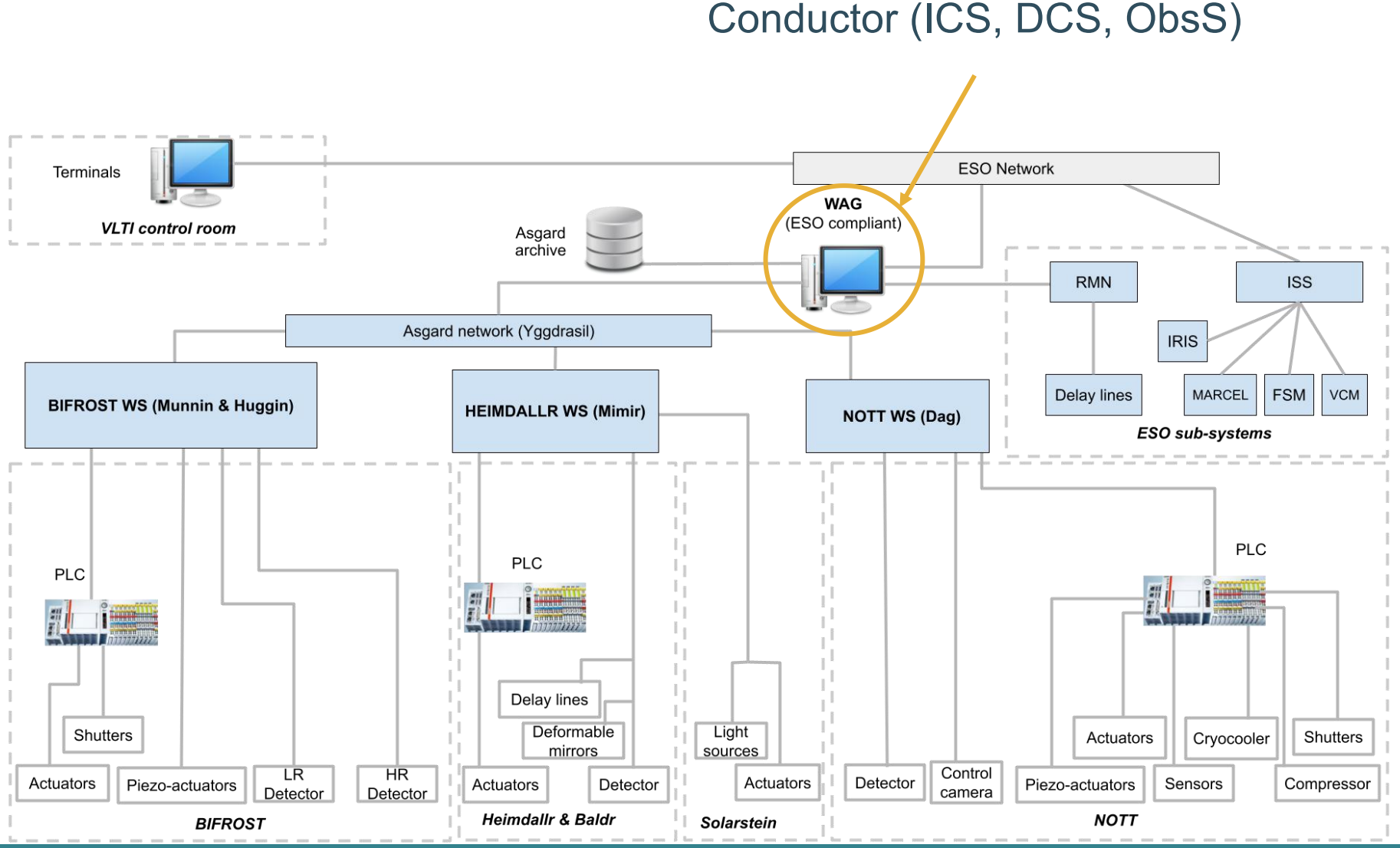
Baldr - IRL

Control of 30 modes validated
Tip-tilt sensing sensitivity < 0.1 mas

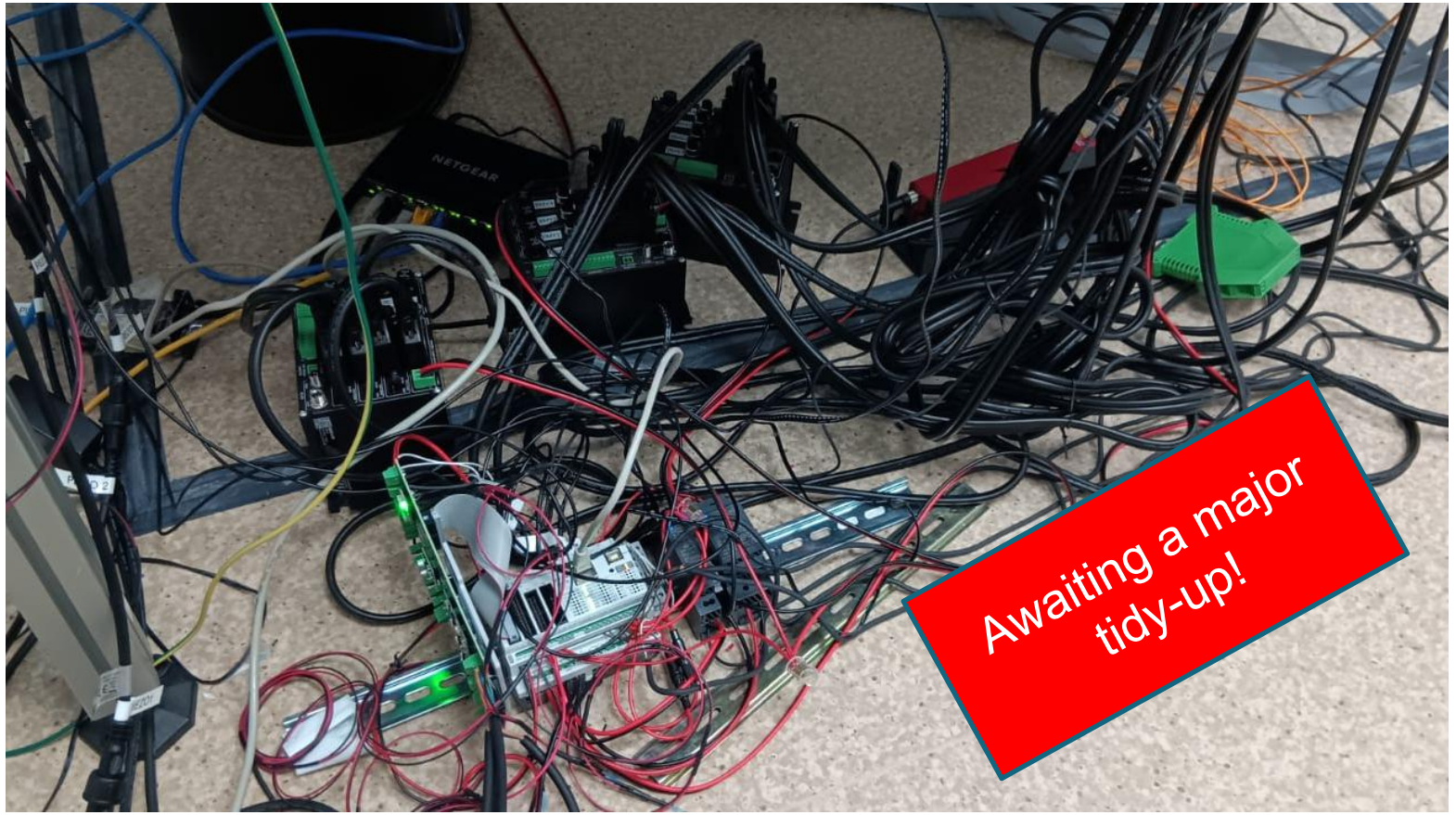




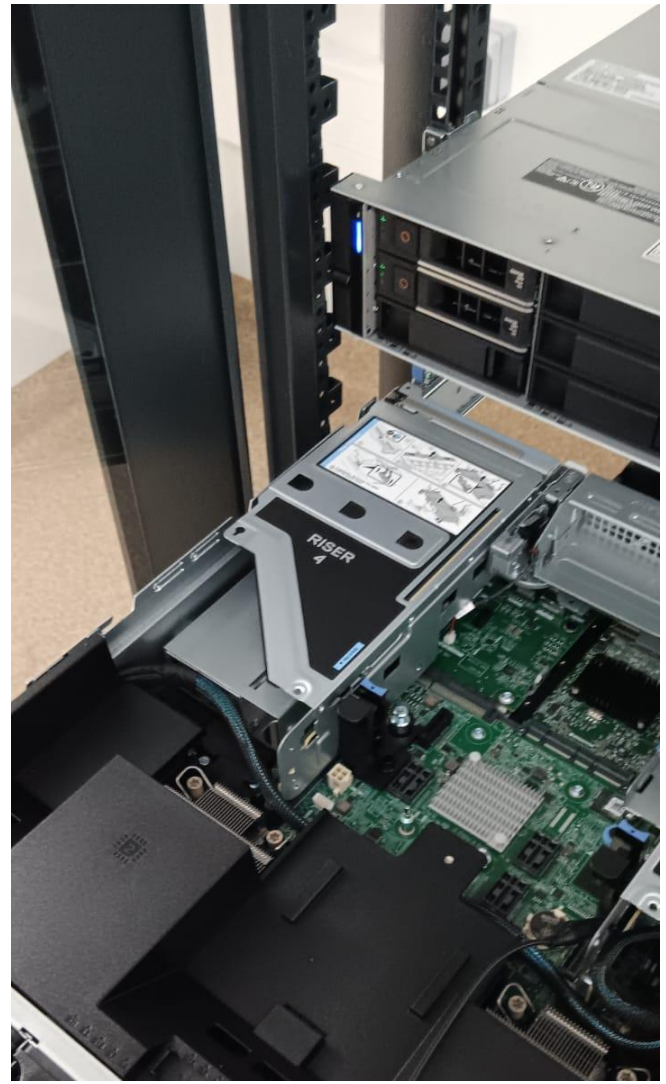
Control architecture



Control IRL



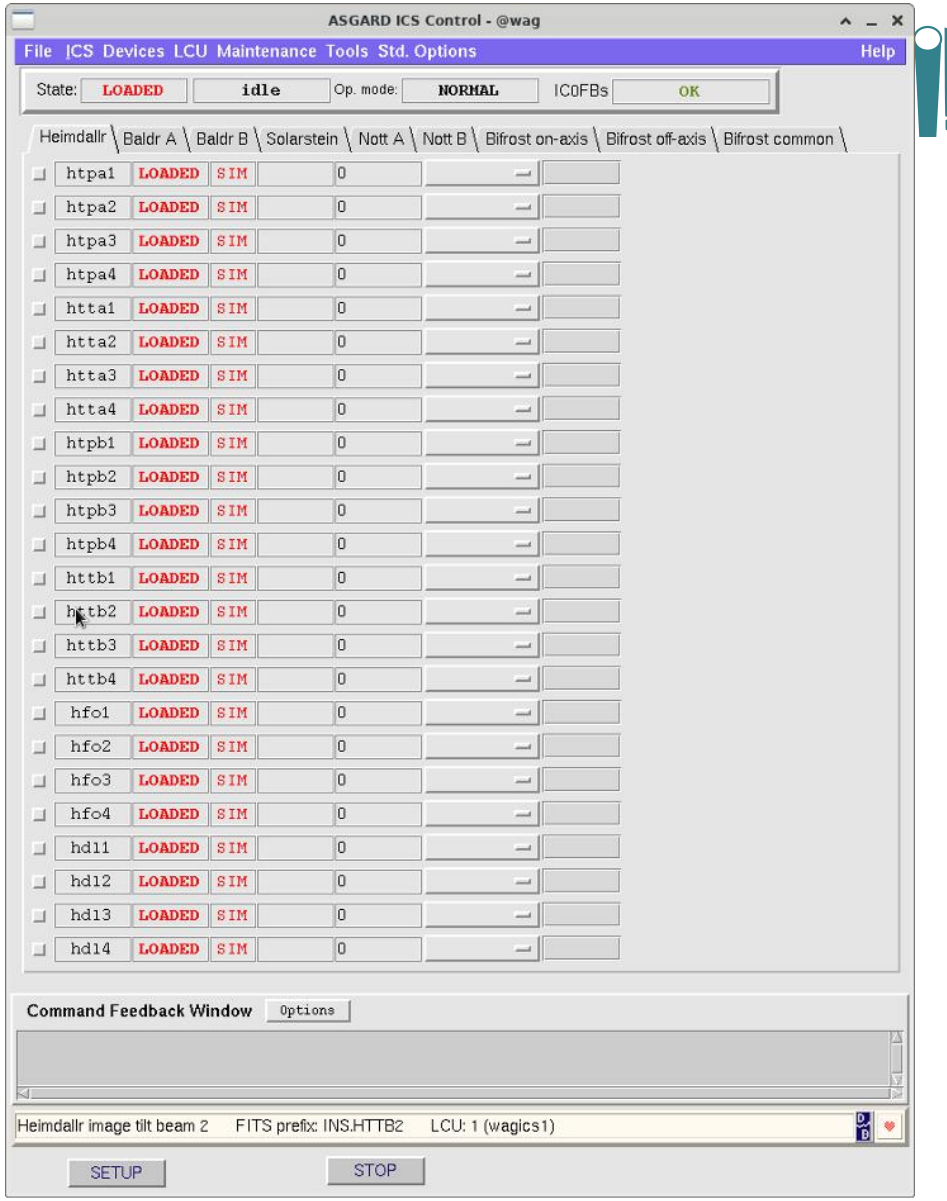
Custom PLC (Controllino) and devices power supplies



WAG & MIMIR workstations

Software

- ESO-compliant ICS developed by Sebastien Morel with support of Observatory Sciences (OSL, UK)
- Virtual machines deployed on module server operating ESO-compliant ICS to test functionality
- Detector control software (DCS) under development
- Motor control (~90 at the moment, close to 200 in phase 3) on MIMIR, compatible with WAG operational
- **Successful installation of WAG at Paranal last week (Sebastien Morel), including RMN interface tests!**



Asgard: a great international team!

Asgard-Nice: a team that values safety!

Asgard: a project that benefits from prior experience with VLTI & CHARA instruments

Project update and timeline

- March 2022: science case submitted to ESO (P110)
- March 2023: technical feasibility documentation submitted to ESO
- June 2023: accepted as officially visitor instrument by ESO
- Automne 2024: begin AIT in Nice & prep in Paranal
- April 2025: planned PAE in Nice
- July 2025: AIV in Paranal
- September 2025: phase 1 commissionning run
- 2026 - onwards: phase 2 & 3 - begin science operation for Heimdallr

Right now: **still lots to do** - simultaneous real-time closed-loop demo of fringe-tracking & AO - completing our electronics assembly (temperature controlled boxes) - pressure test of the cooling circuit - put together the cover ... - and **plan the shipping to Paranal !!**