LINC-NIRVANA
Pre-commissioning and first photons from sky...

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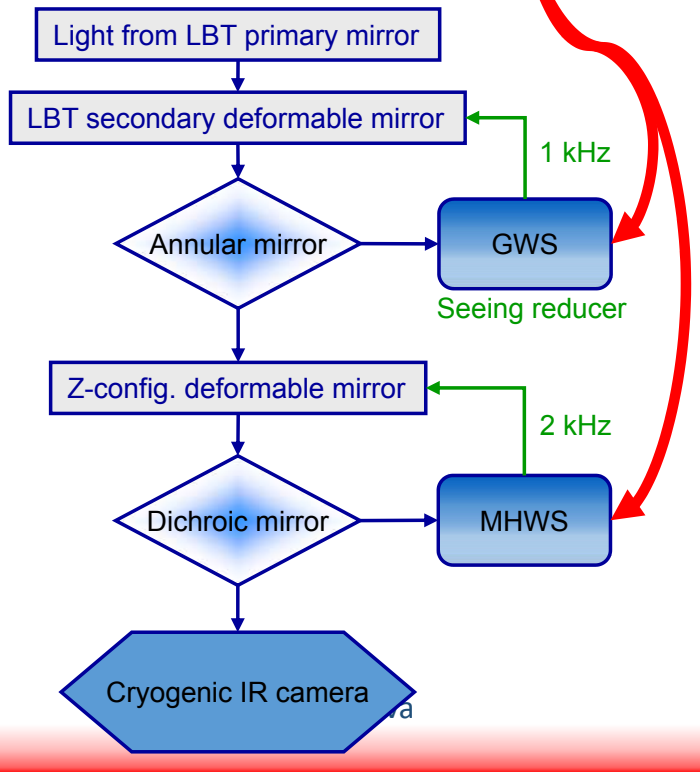
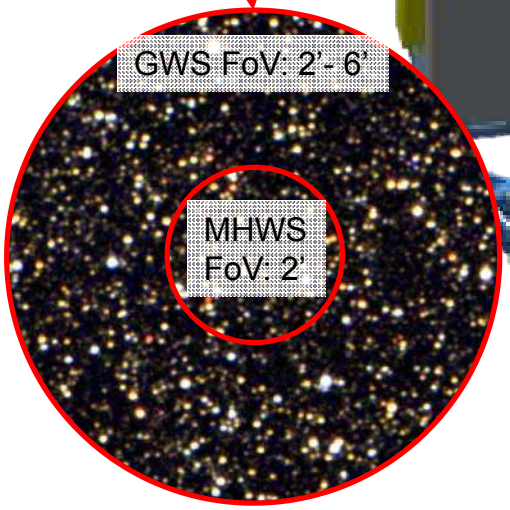
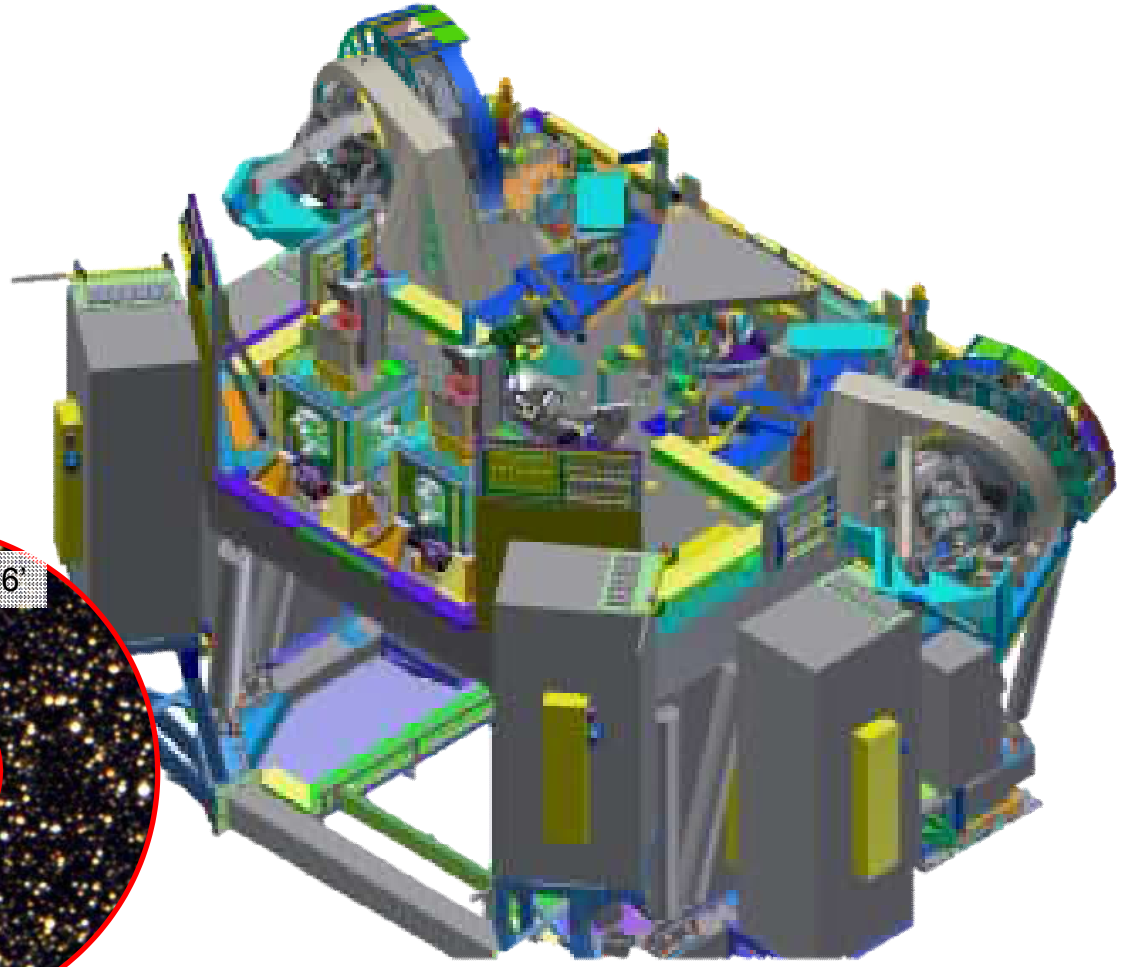
and the LINC-NIRVANA Team

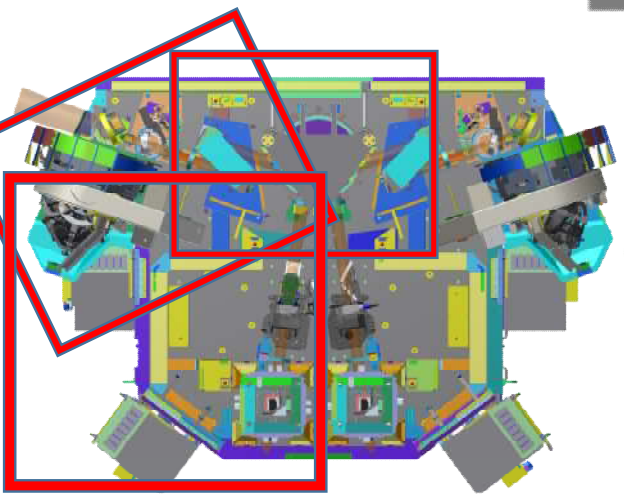
LINC-NIRVANA summary

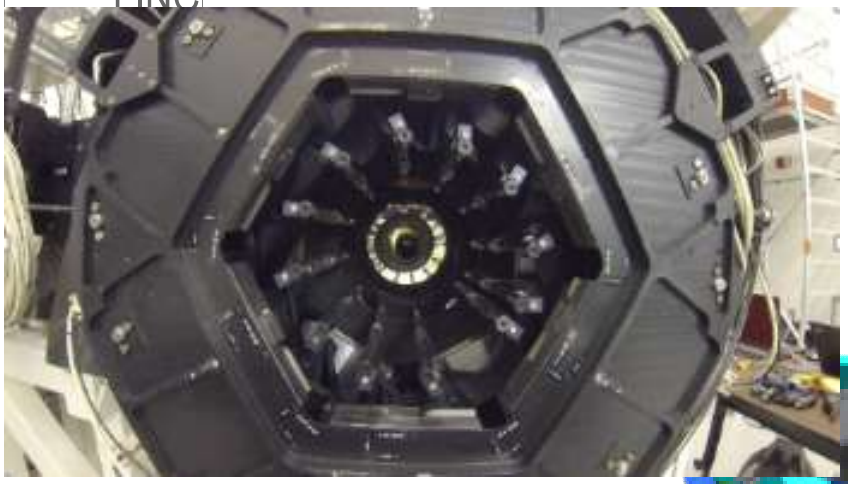
LBT NIR Imager equipped with
L-O MCAO MFoV

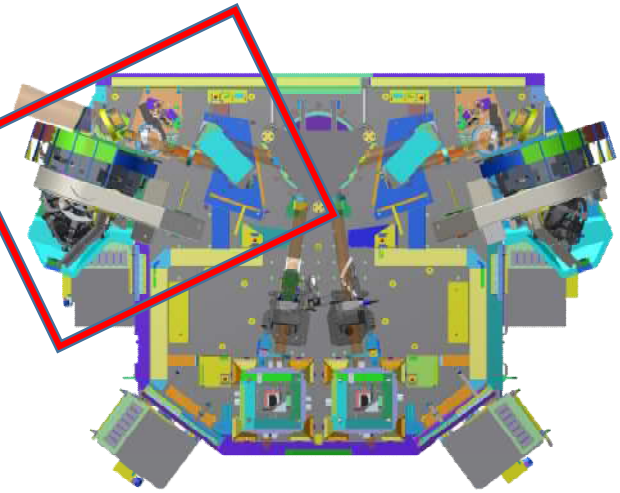


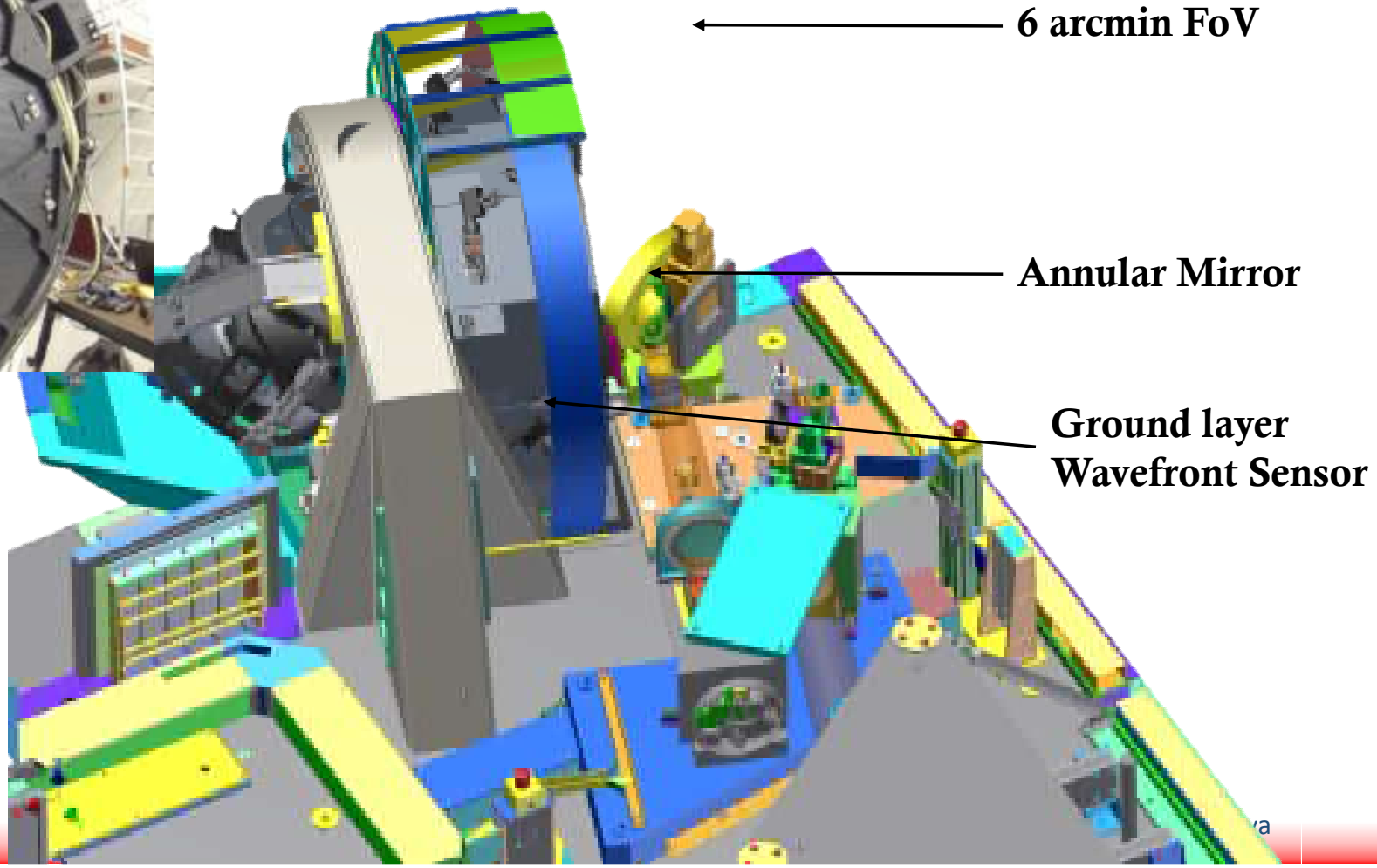


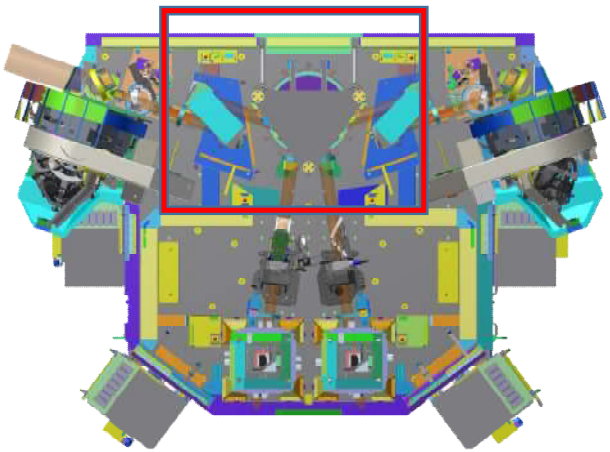


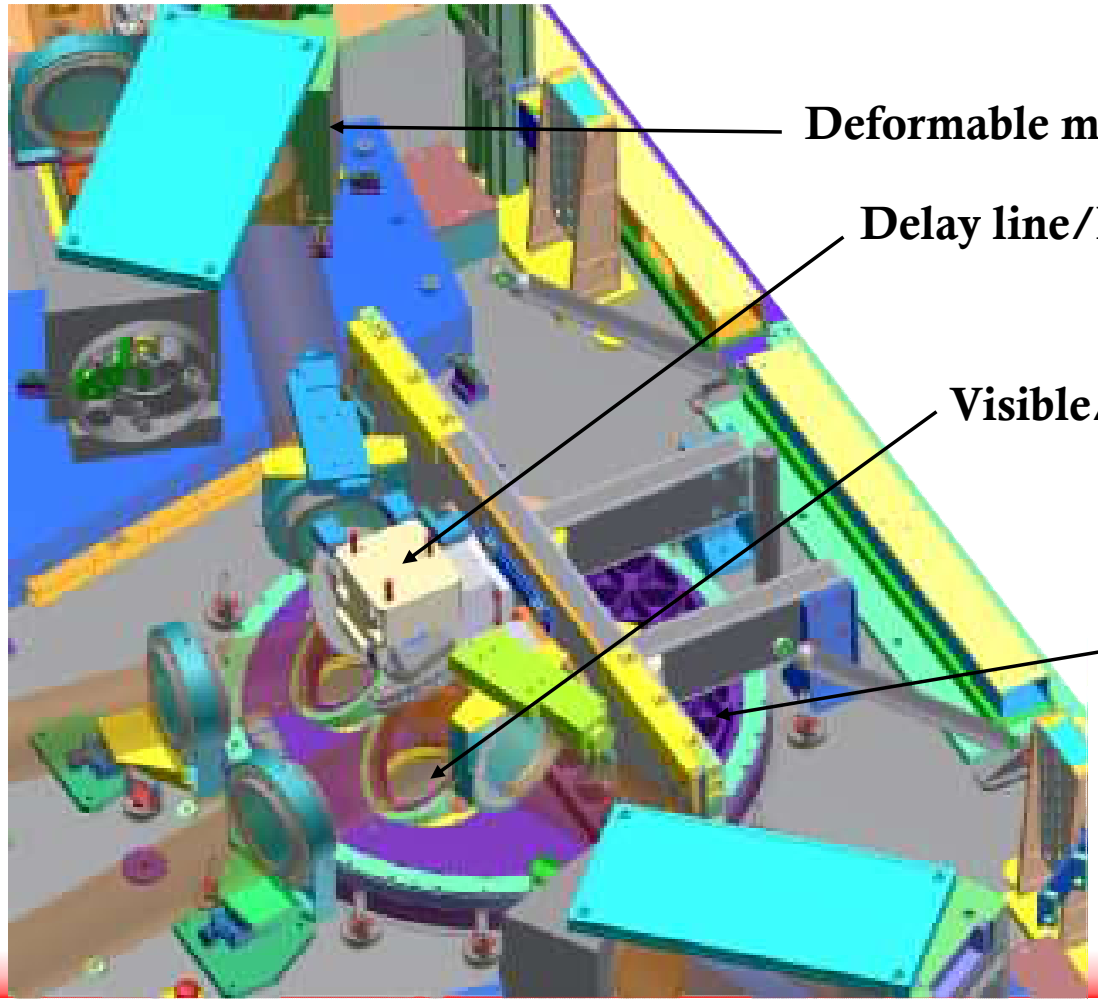


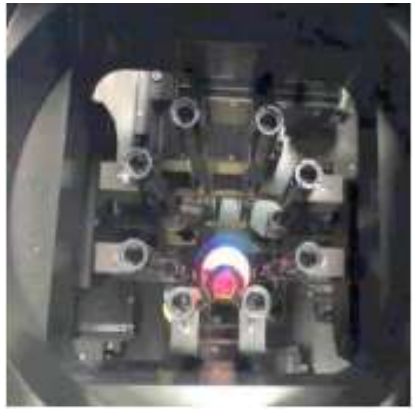


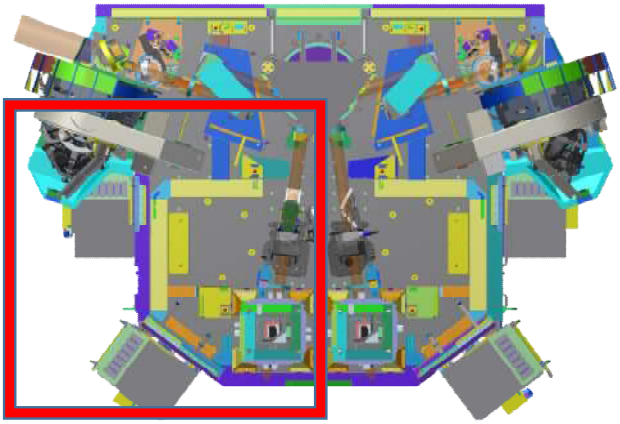



6 arcmin FoV
Annular Mirror
Ground layer
Wavefront Sensor



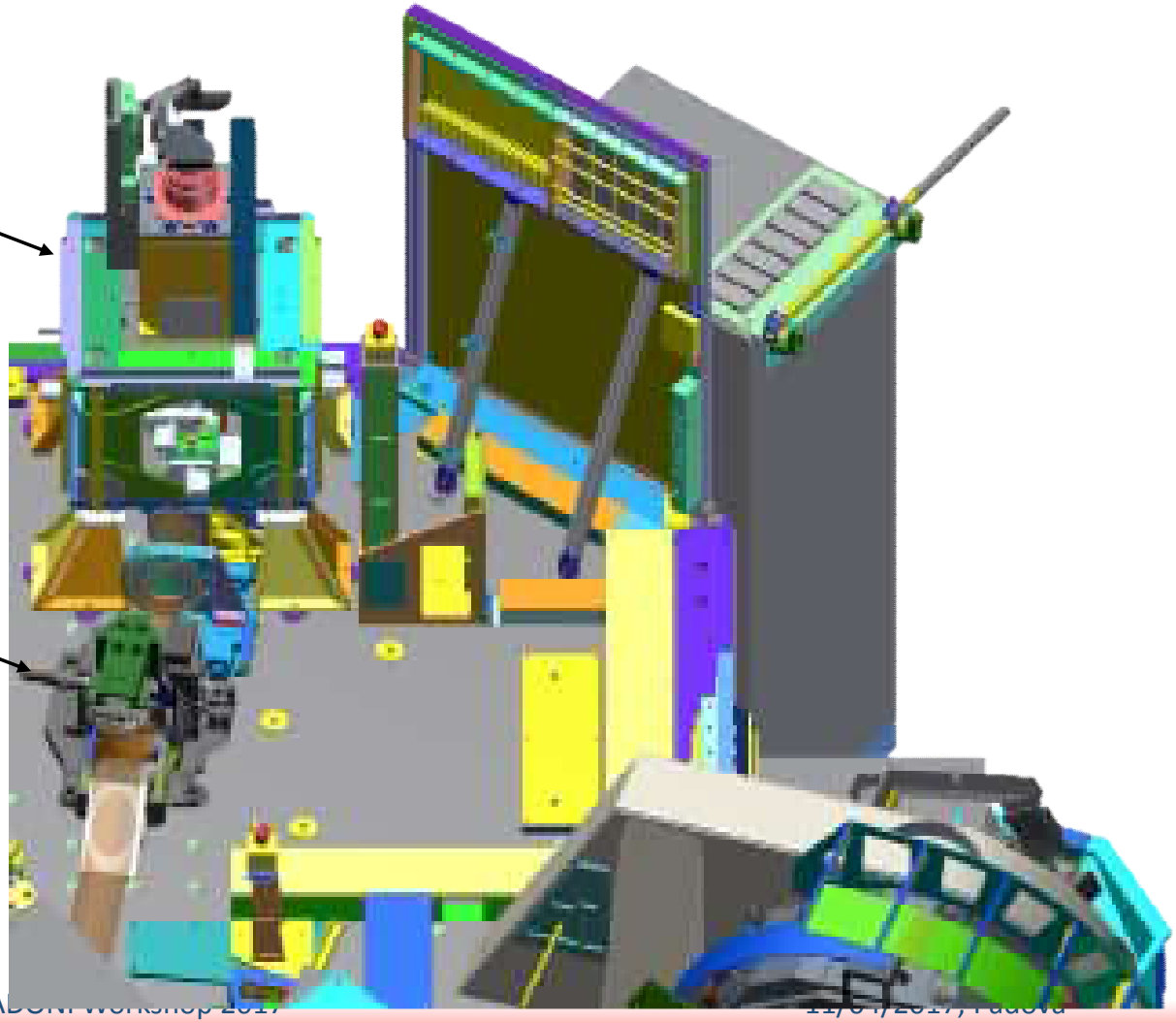

Deformable mirror
Delay line/Piston mirror
Visible/NIR dichroic
Science channel cryostat





High layer Wavefront Sensor

K-mirror



LINC NIRVANA

PC runs

Daytime Testing

Instrument Status

- D.1 Instrument States and Transitions
  1. Activate Instrument
  2. Powering up Hardware Subsystems
  3. Starting up Services and Initialize
  4. Shutting down Services
  5. Powering off Hardware Subsystems
  6. Deactivate Instrument
  7. Emergency Shutdown
- D.2 Instrument Operability
  - D.2.1 GWS
  - D.2.2 MHWS
  - D.2.3 Patrol Camera
  - D.2.4 Xinetics Deformable Mirror
  - D.2.5 Warm Optics Positioning
  - D.2.6 Piston Mirror
  - D.2.7 Warm Dichroics
  - D.2.8 K-Mirror
  - D.2.9 Calibration Unit
  - D.2.10 Bench Cover
  - D.2.11 Cryostat Secondary Mirror
  - D.2.12 Cryostat Dichroic Wheel
  - D.2.13 Cryostat Filter Wheel
  - D.2.14 Science Detector Positioning
  - D.2.15 Science Detector Readout
  - D.2.16 Pupil Imager
  - D.2.17 Annular Mirror
- D.3 TCS Communication
- D.4 FLAO / BCU Fast Link Communication
- D.5 GWS Calibration
  - D.5.1 SEs alignment
  - D.5.2 Reconstructor calculation
- D.6 MHWS Calibration
  - D.6.1 Reconstructor Calculation
  - D.6.2 Sparse Metapupil Mask
- D.7 Instrument Telemetry
  - D.7.1 Cryostat Sensor Services
  - D.7.2 Auxiliary Sensor Services
  - D.7.3 Cabinet Temperature Monitoring
- D.8 Acquire and Observe Sequence

Calibration

- C.1 Science Detector Calibration
  - C.1.1 Gain
  - C.1.2 Bad Pixels
  - C.1.3 Read Noise
  - C.1.4 Linearity
  - C.1.5 Dark Current
  - C.1.6 Flat Field
  - C.1.7 Cross-Talk
  - C.1.8 Persistence
  - C.1.9 Pattern Noise
- C.2 Deformable Mirror Flat
- C.3 Parasitic Background Light

Nighttime Testing - Functionality

- N.1 Telescope Control
  - N.1.1 Preset
  - N.1.2 Focus
  - N.1.3 Telescope Mode and Offset
  - N.1.4 Focal Plane Geometry - Science Detector and Patrol Camera
  - N.1.5 Focal Plane Geometry - GWS and MHWS
- N.2 GWS Single Star Acquisition
- N.3 GWS Single Star Closed Loop
- N.4 MHWS Single Star Acquisition
- N.5 MHWS Single Star Closed Loop On-Axis
- N.6 MHWS Single Star Closed Loop Off-Axis
- N.7 GWS Multiple Star Acquisition
- N.8 GWS Multiple Star Closed Loop
- N.9 MHWS Multiple Star Acquisition
- N.10 MHWS Multiple Star Closed Loop
- N.11 MCAO Operation
- N.12 Open Loop Offset and Resume
- N.13 Closed Loop Offset and Resume
- N.14 Tip-Tilt Offload

Nighttime Testing – Performance

- P.1 Asterism Acquisition Efficiency
- P.2 Bright Asterism Strehl
- P.3 Faint Asterism Strehl
- P.4 Photometric Performance
  - P.4.1 Instrument Throughput
  - P.4.2 Filter Zero Points
  - P.4.3 Filter Sky Background
  - P.4.4 Limiting Magnitude (all filters)
  - P.4.5 Photometric Uniformity
- P.5 PSF Uniformity
- P.6 Image Scale and Distortion
- P.7 Ghost Images and Scattered Light
- P.8 Airmass Dependent Performance
- P.9 Seeing Dependent Performance
- P.10 Asterism Dependent Performance

Commissioning Overview

- Commissioning Overview Table

Commissioning Checklist

(to be filled out as commissioning proceeds)

- Commissioning Checklist

Com runs

Pre-commissioning activities

- LN Internal Alignment fine-tuning
- LN Integration on the telescope
- Alignment of telescope to LINC-NIRVANA
- GWSs Interaction Matrices calibration
- A lot of debugging…

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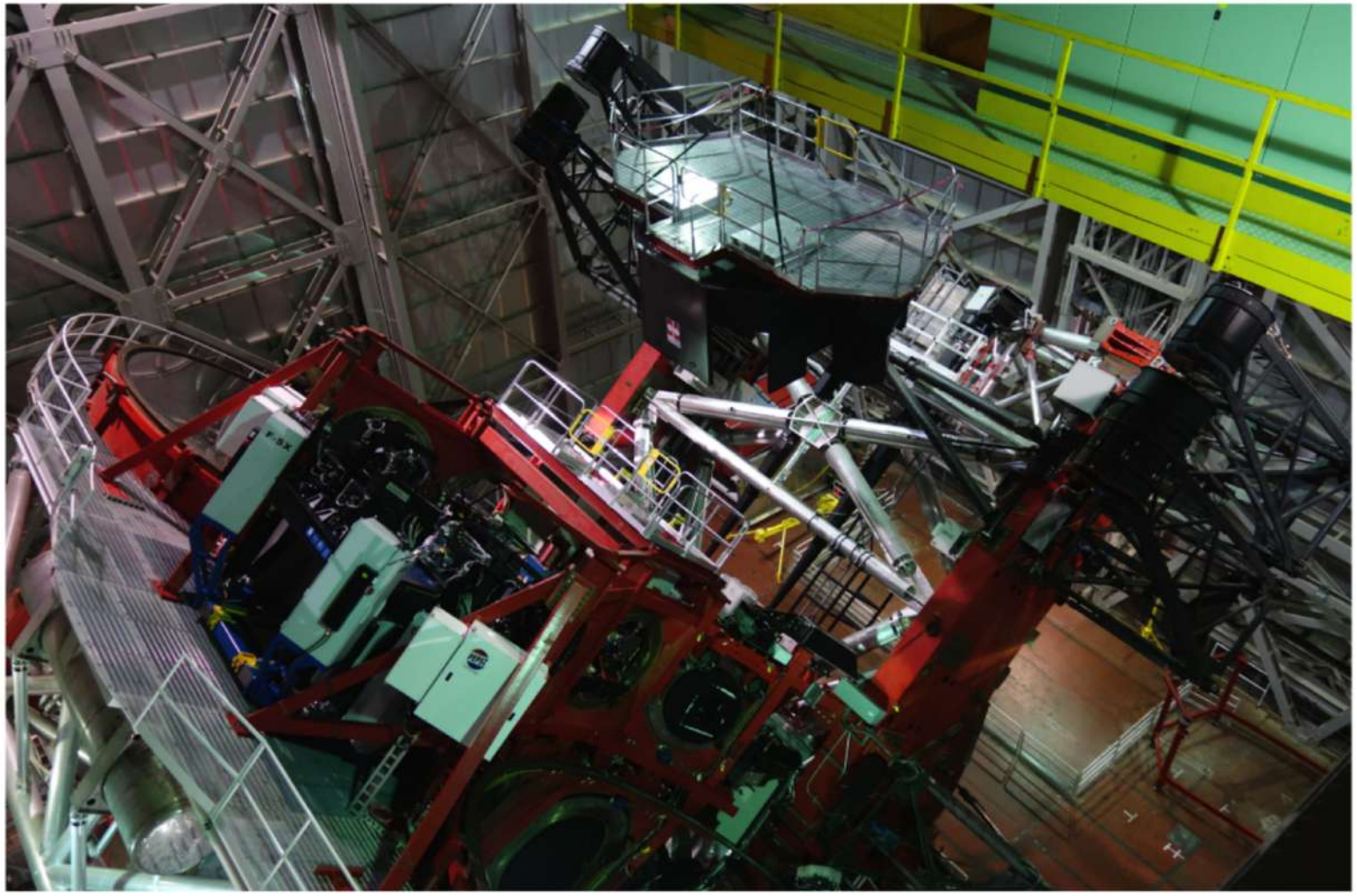

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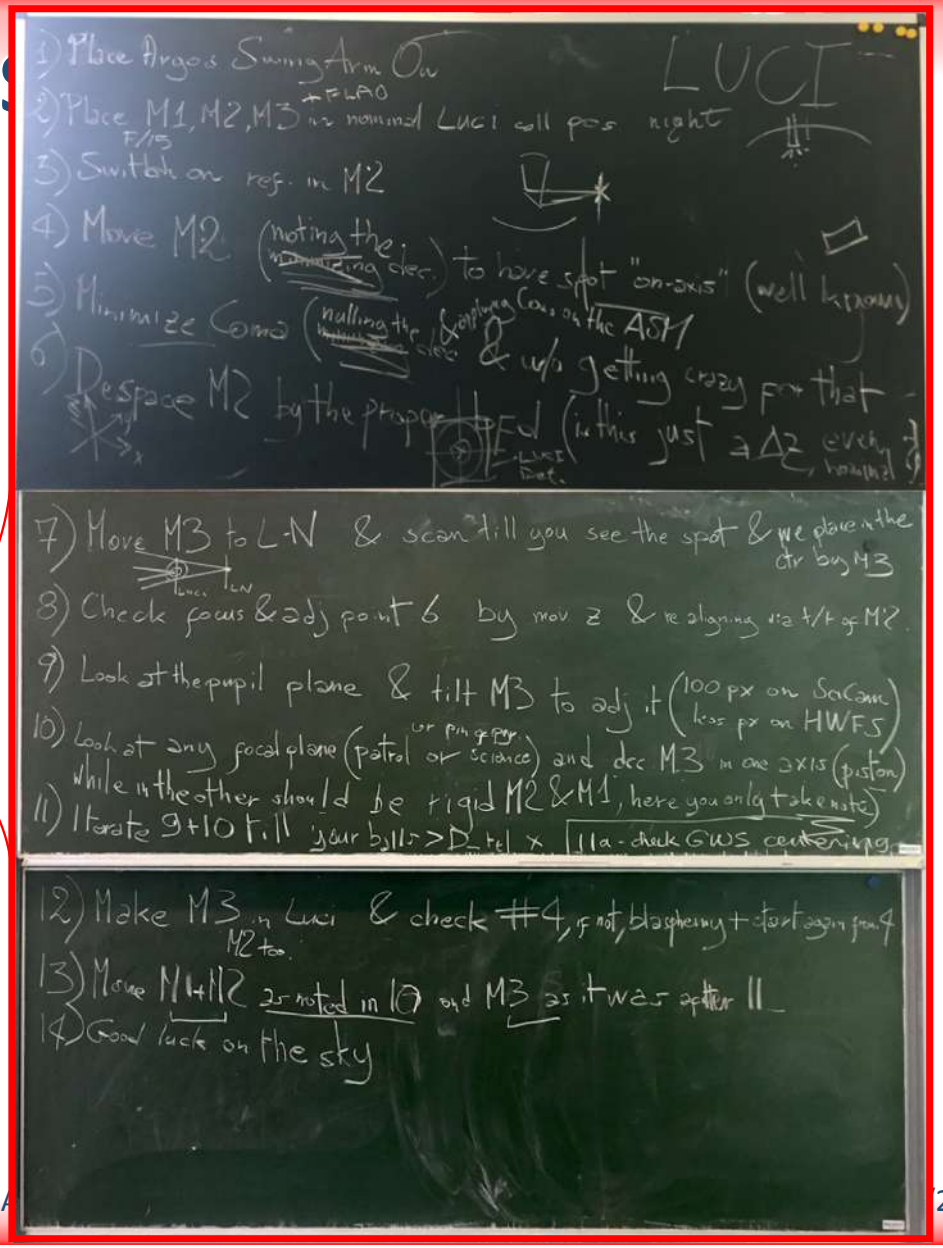

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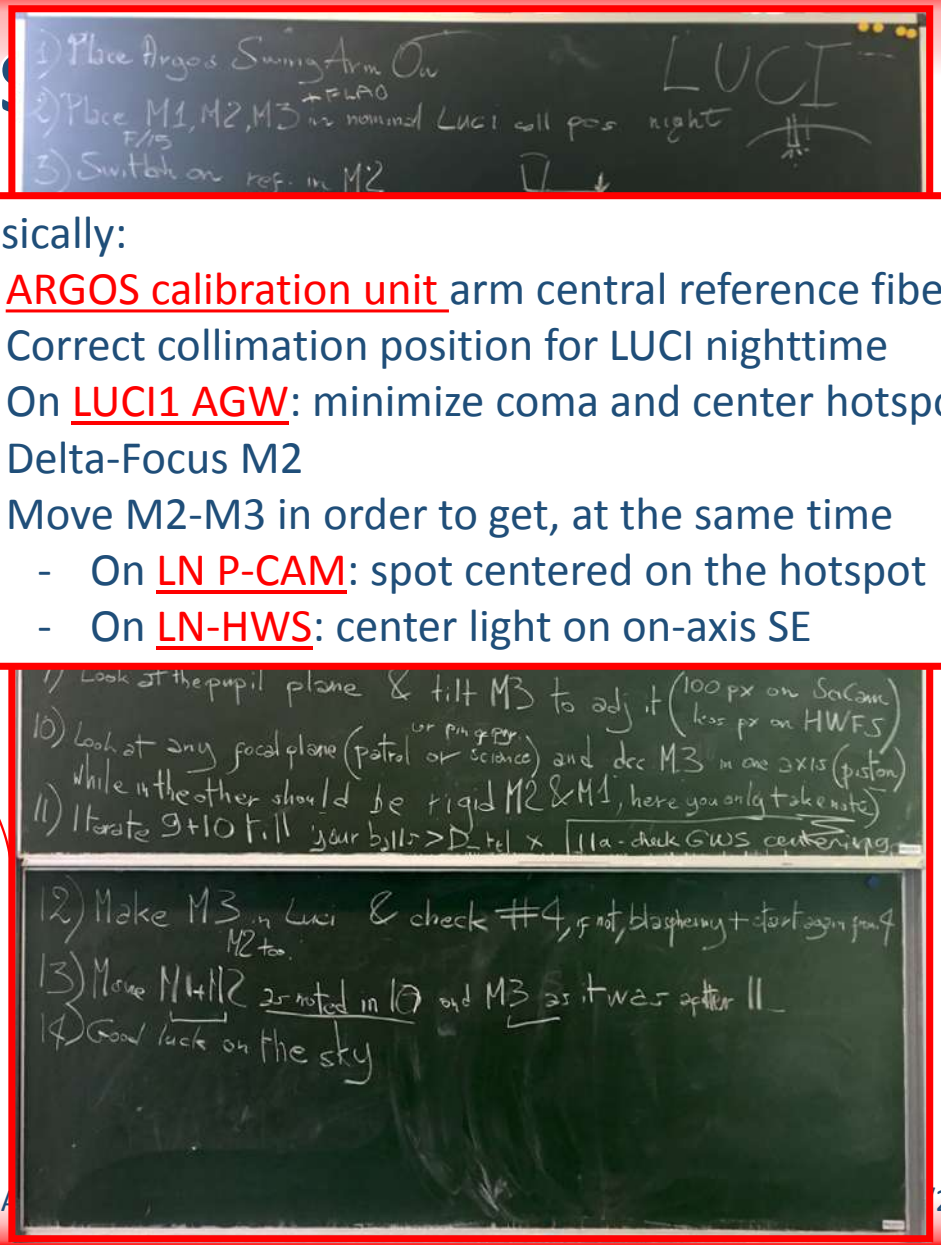

Basically:

- ARGOS calibration unit arm central reference fiber
- Correct collimation position for LUCI nighttime
- On LUCI1 AGW: minimize coma and center hotspot (M2)
- Delta-Focus M2
- Move M2-M3 in order to get, at the same time
  - On LN P-CAM: spot centered on the hotspot
  - On LN-HWS: center light on on-axis SE

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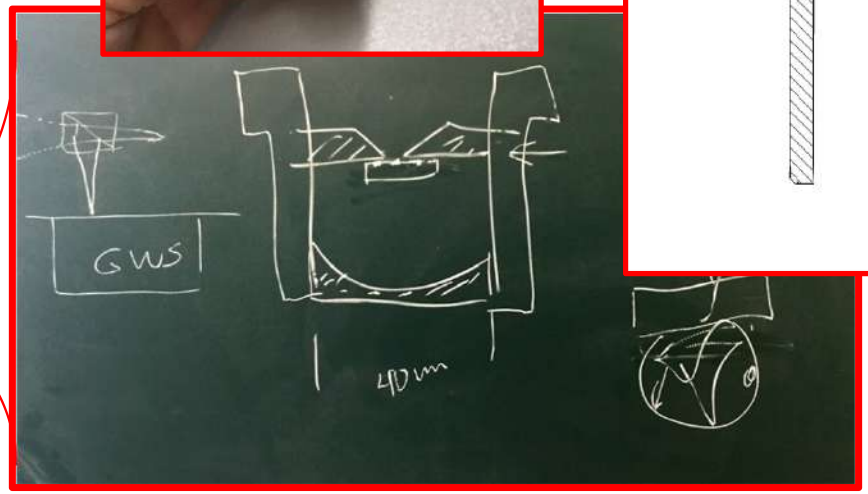

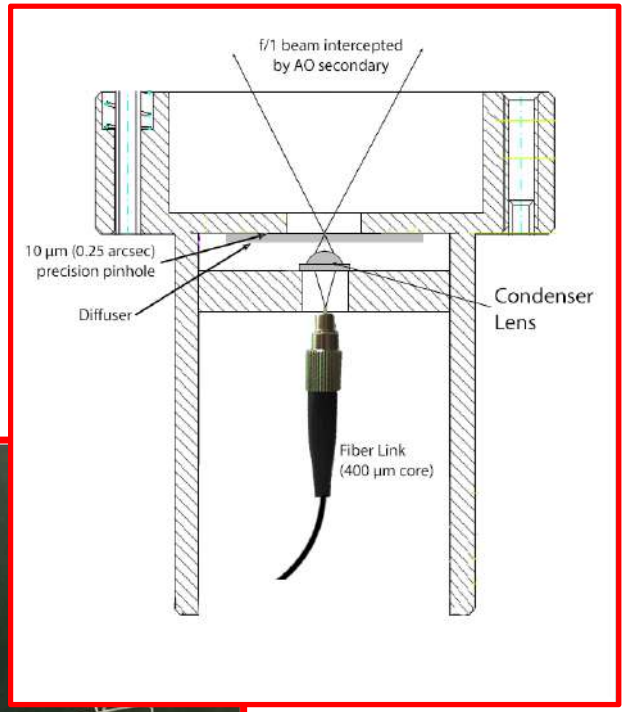

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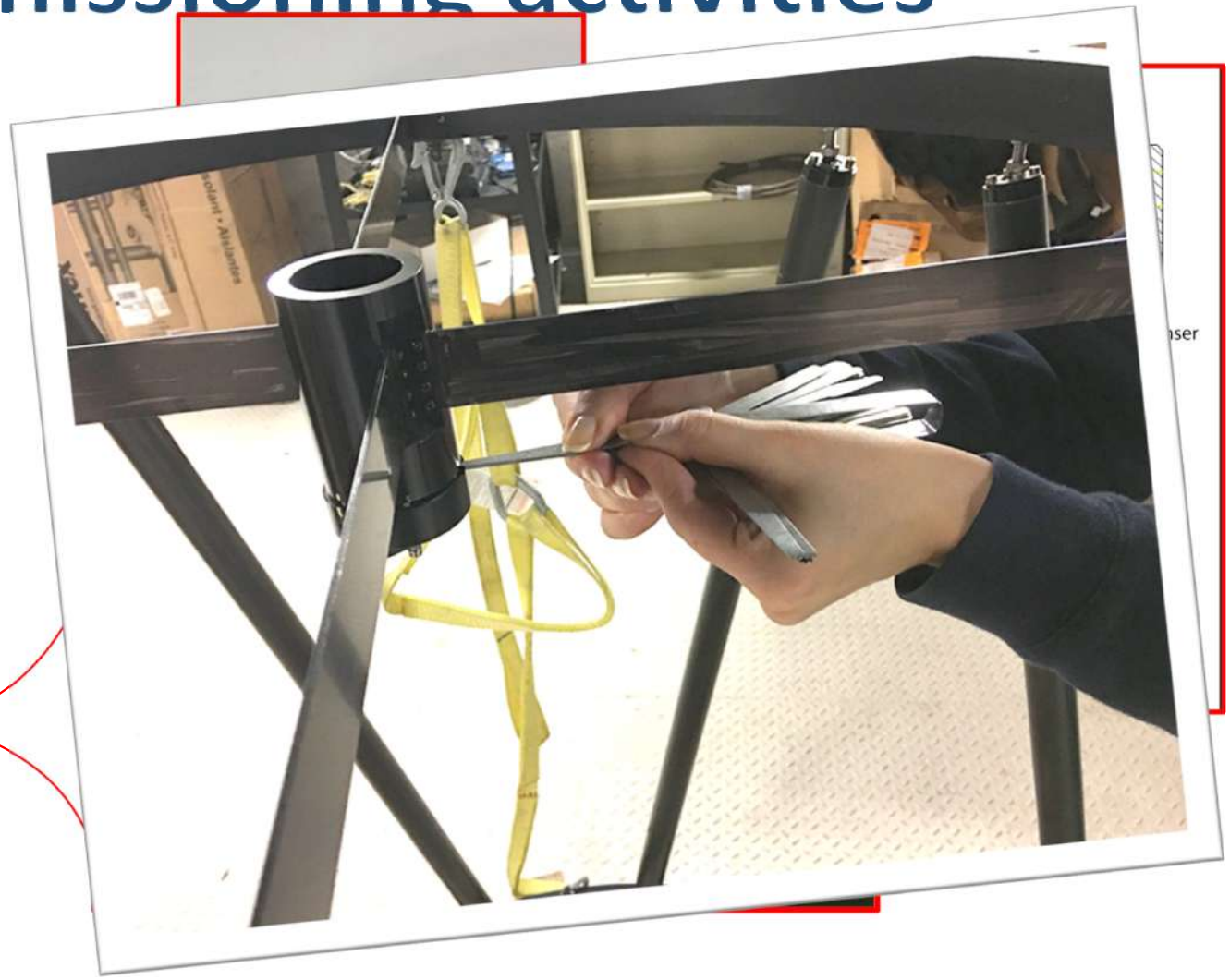
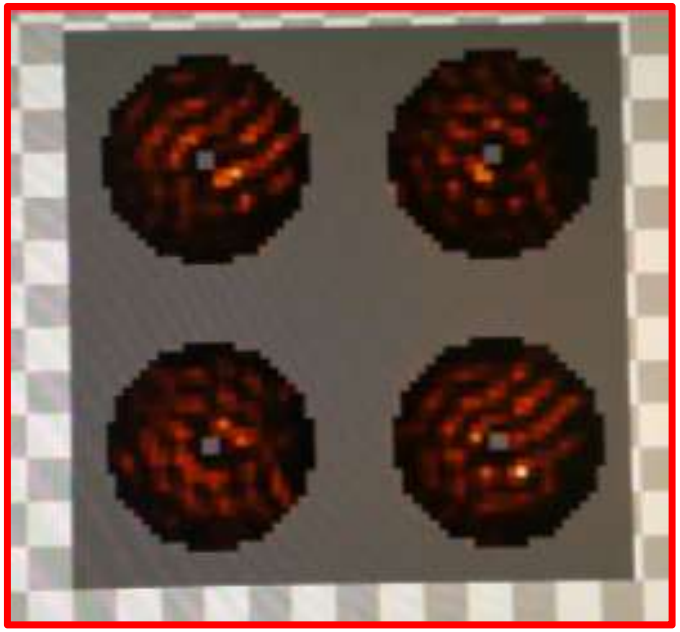
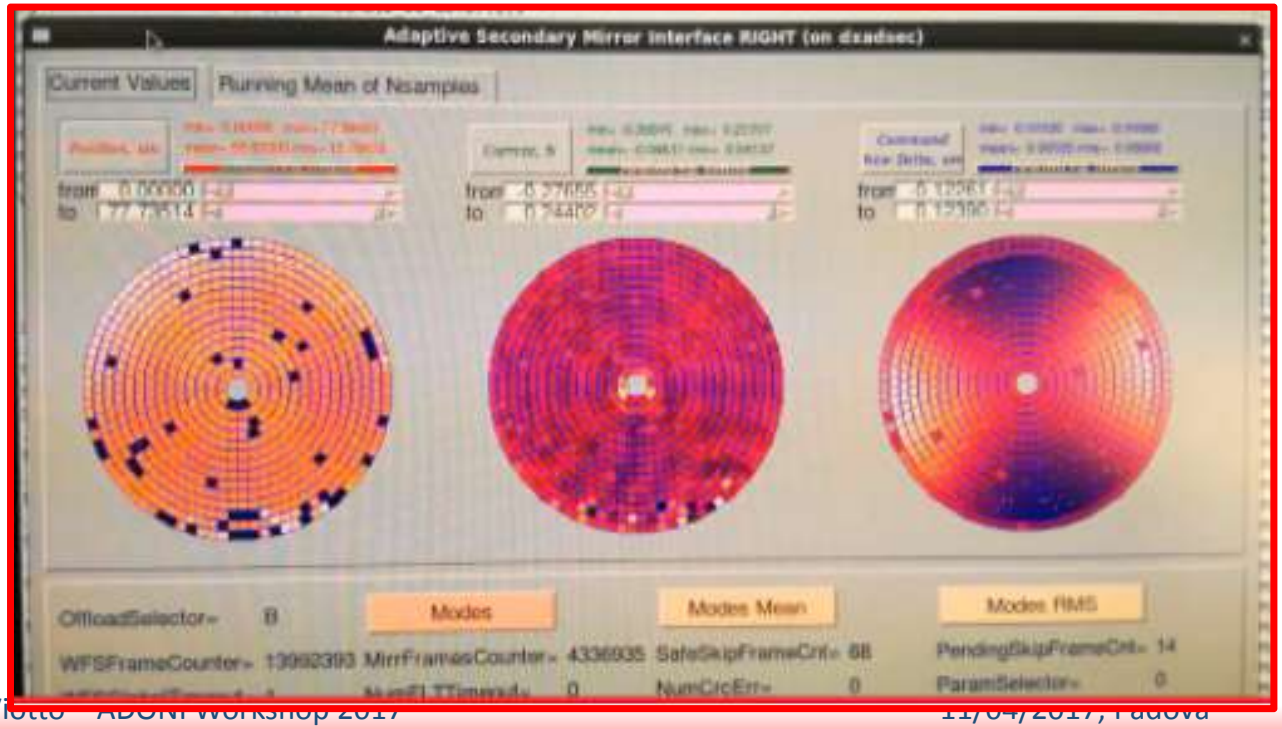


GWSs IM calibration

Push-pull method to compute the mapping between ASM modal basis (Karhunen-Loève) and GWS signals.
Average of up to 15-20 Interaction Matrices to increase signal (100 modes)





GWSs IM calibration

Automatic Rotating IM upload is needed

Sky rotates

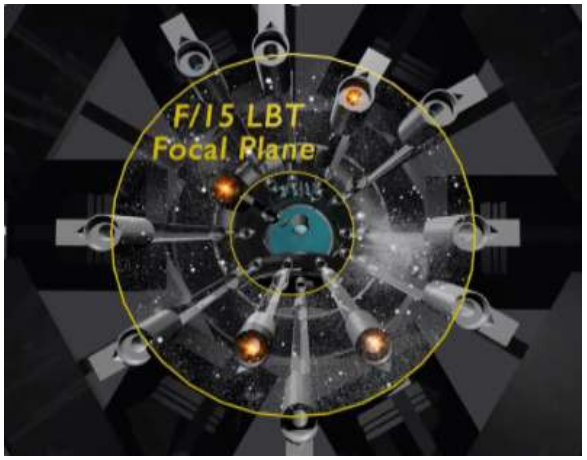
↓

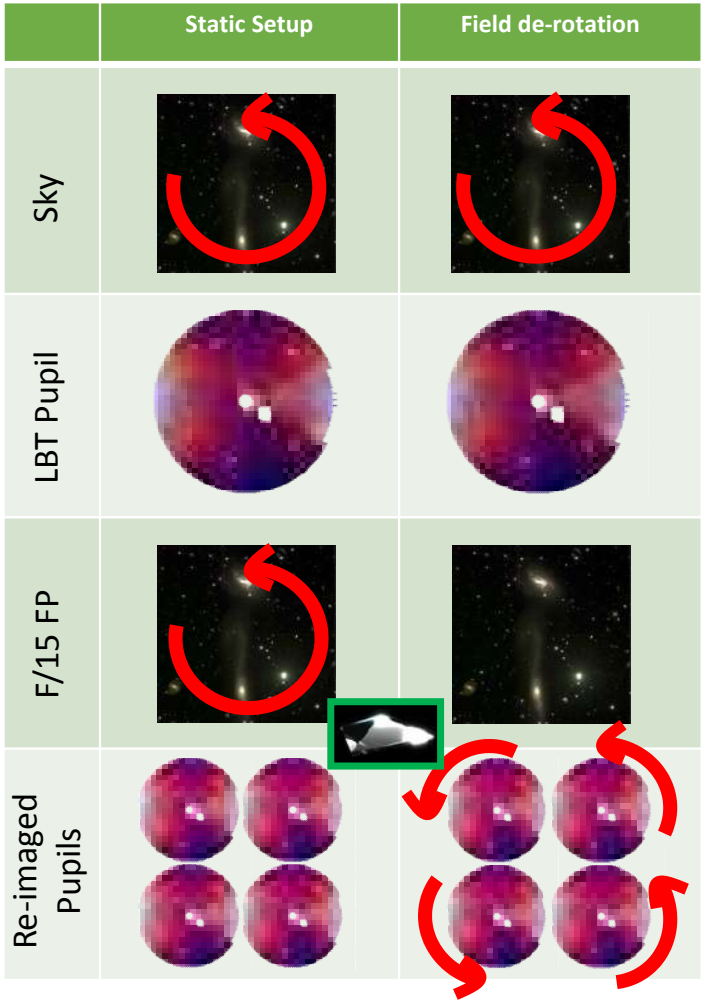
GWS de-rotator follows the sky rotation (to keep pyramids on the stars images)

ASM is fixed (hopefully ☺)

↓

Relation between WFS sub-apertures and ASM actuators depends on the de-rotation angle





Pre-commissioning activities

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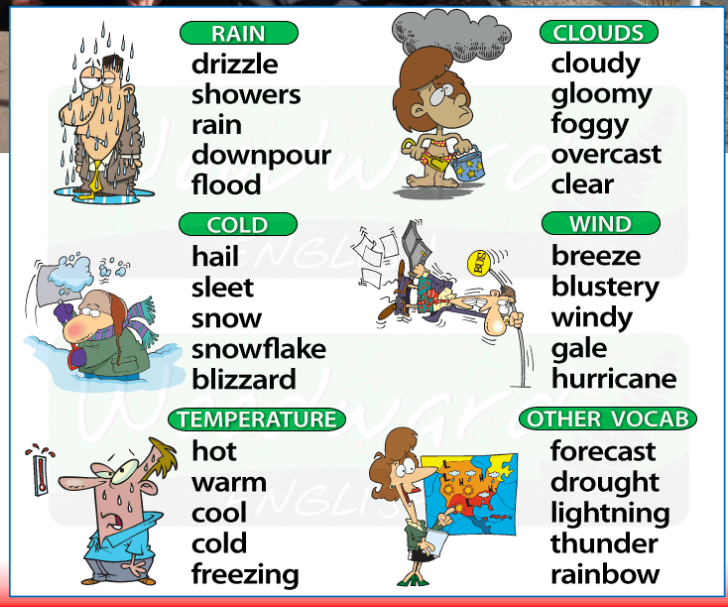
HW:
- Insufficient M2 illumination ⟹ Opal diffuser
- Failure of DX Fast Link ⟹ Replaced
- CCD39 noise/behavior ⟹ Temperature issue -> solved

SW:
- Failure of DX Fast Link (no feedback)
- Communication with ASM ⟹
- Rotating matrices upload

Weather forecast



Commissioning activities

- Verification of Geometries
- Measurements to get preliminary instrument throughput
- Testing and verification of auto-guiding (including offset, auto-center)
- Verification of GWS de-rotation trajectories (both SX and DX)
- Verification of SX K-mirror and science channel de-rotation trajectories
- single star acquisition with SX and DX GWS
- single on-axis star acquisition with SX HWS
- single star closed loop with SX GWS
- multiple star acquisition with SX GWS
- multiple star closed loop with SX GWS

Com-1 weather:

Scheduled: 7 half-nights

Open dome: 4 half-nights

- Seeing < 1’’

Comparison: Pathfinder

Scheduled: 14 half-nights

Open dome: < 5 half-nights

- very fractioned
- Seeing: ~ 1’’- 3’’

Commissioning activities

- Verification of Geometries
  - GWS entrance FoV and de-rotator
  - HWS entrance FoV and K-mirror
  - Science channel
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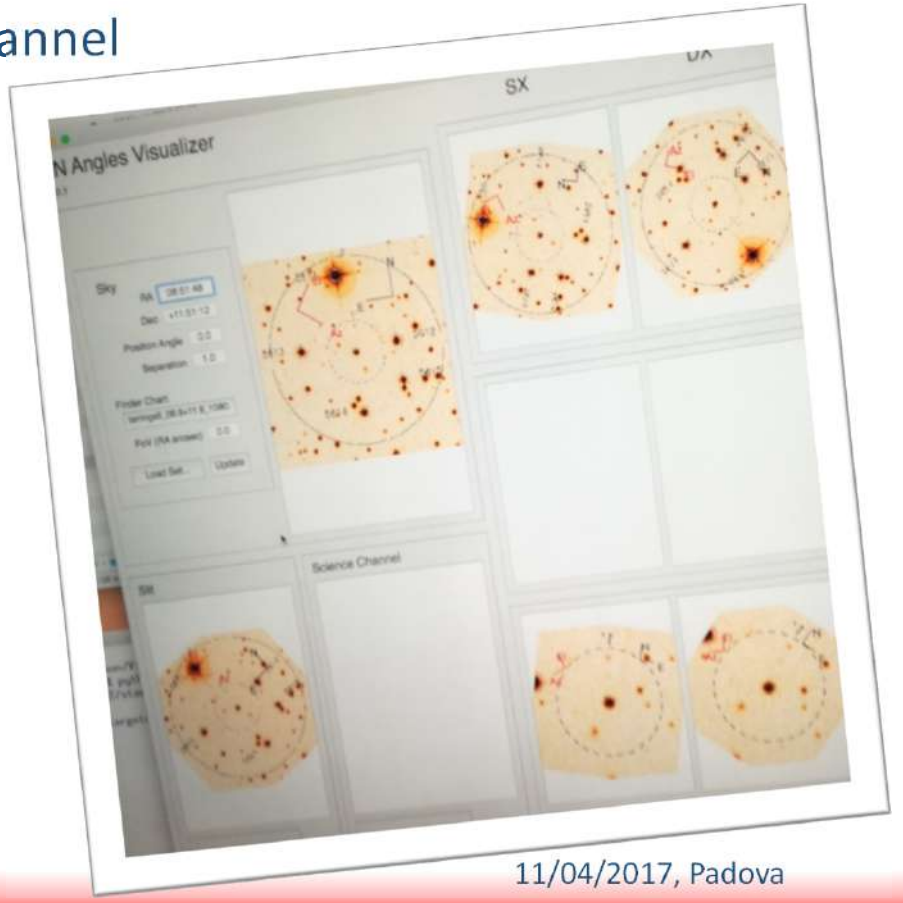

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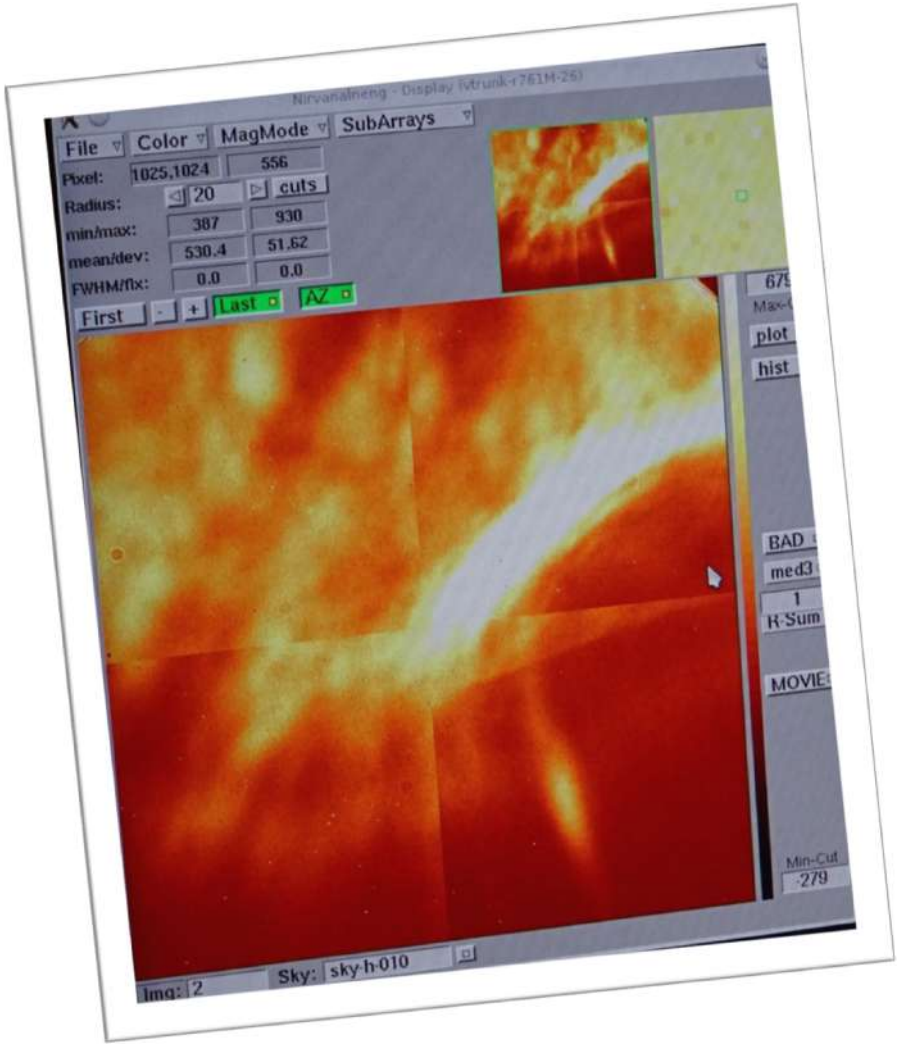

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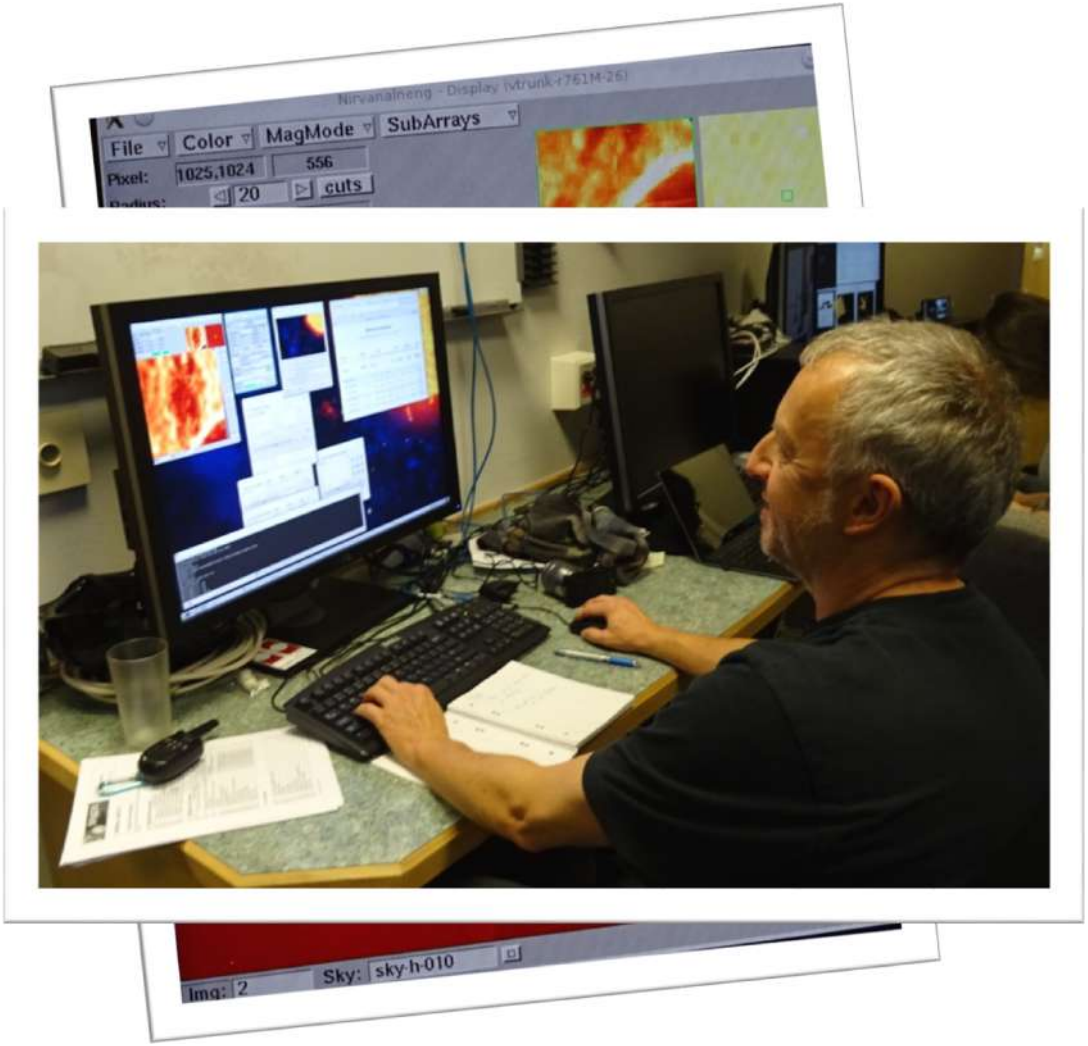

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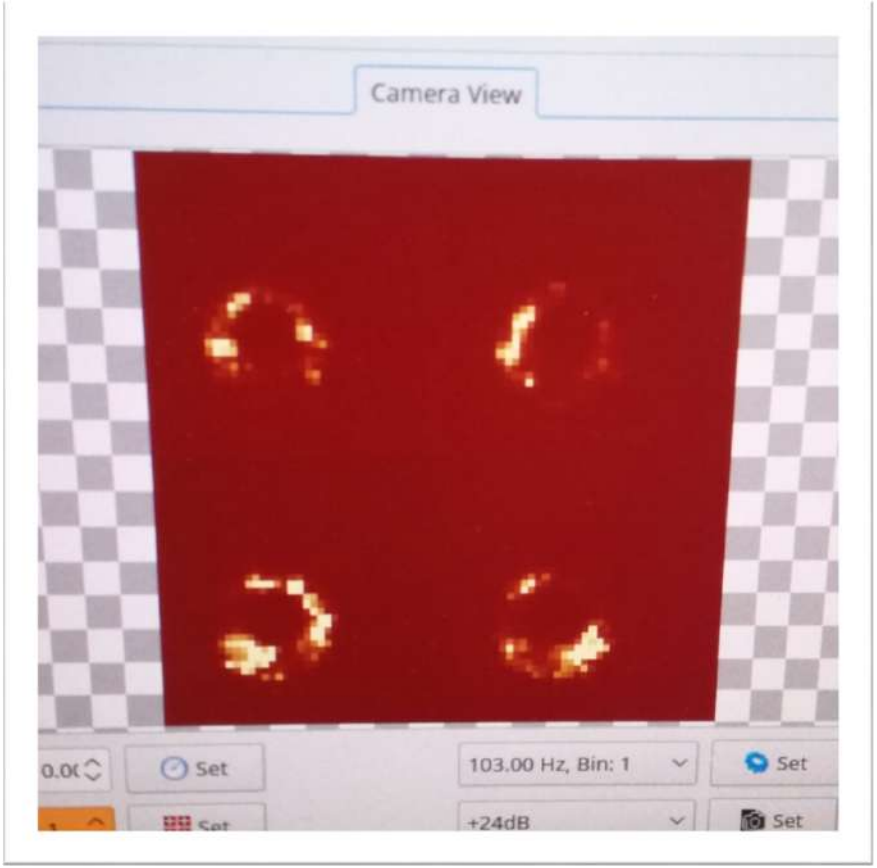

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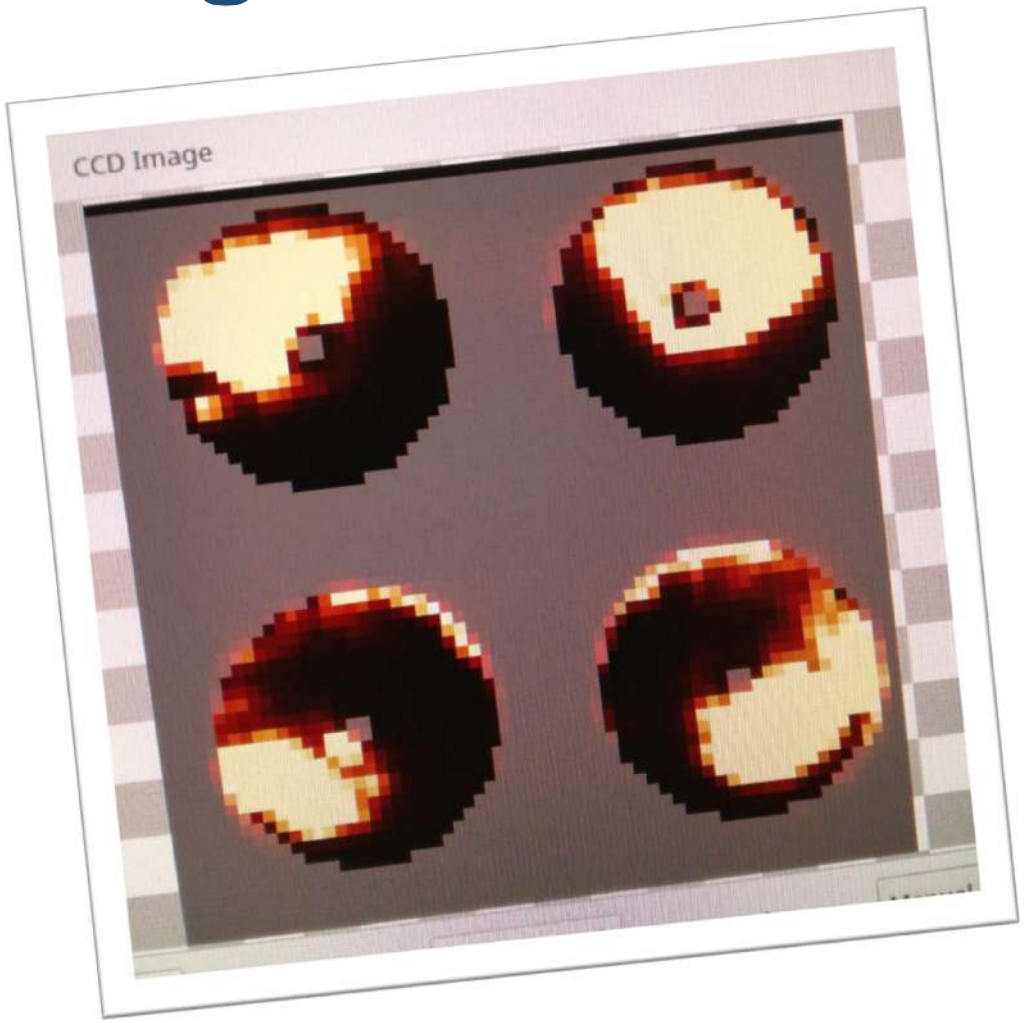

Commissioning activities

- Single star closed loop with SX GWS
- Multiple star acquisition with SX GWS
- Multiple star closed loop with SX GWS

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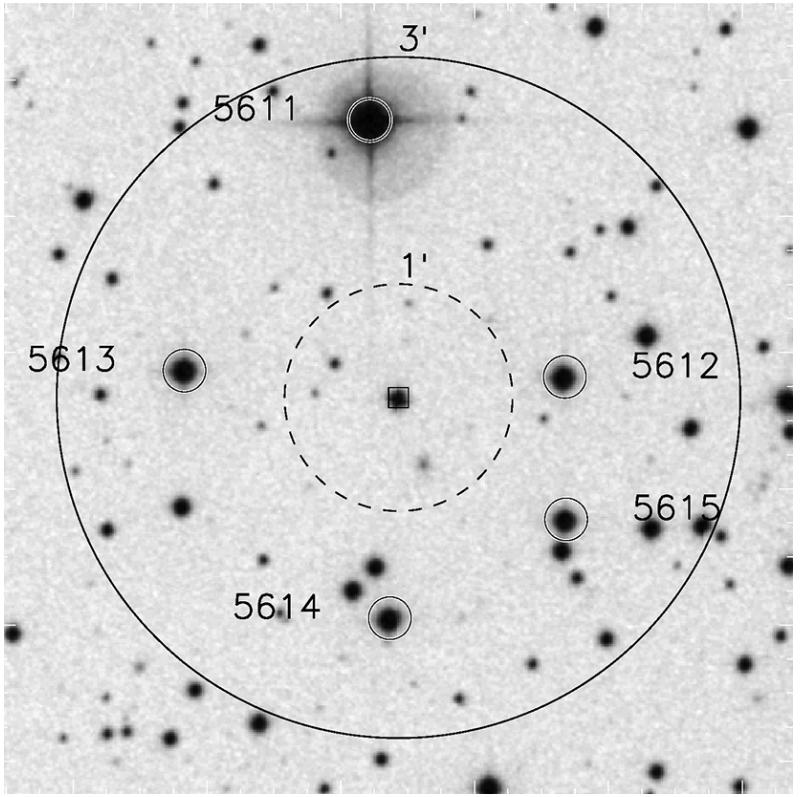

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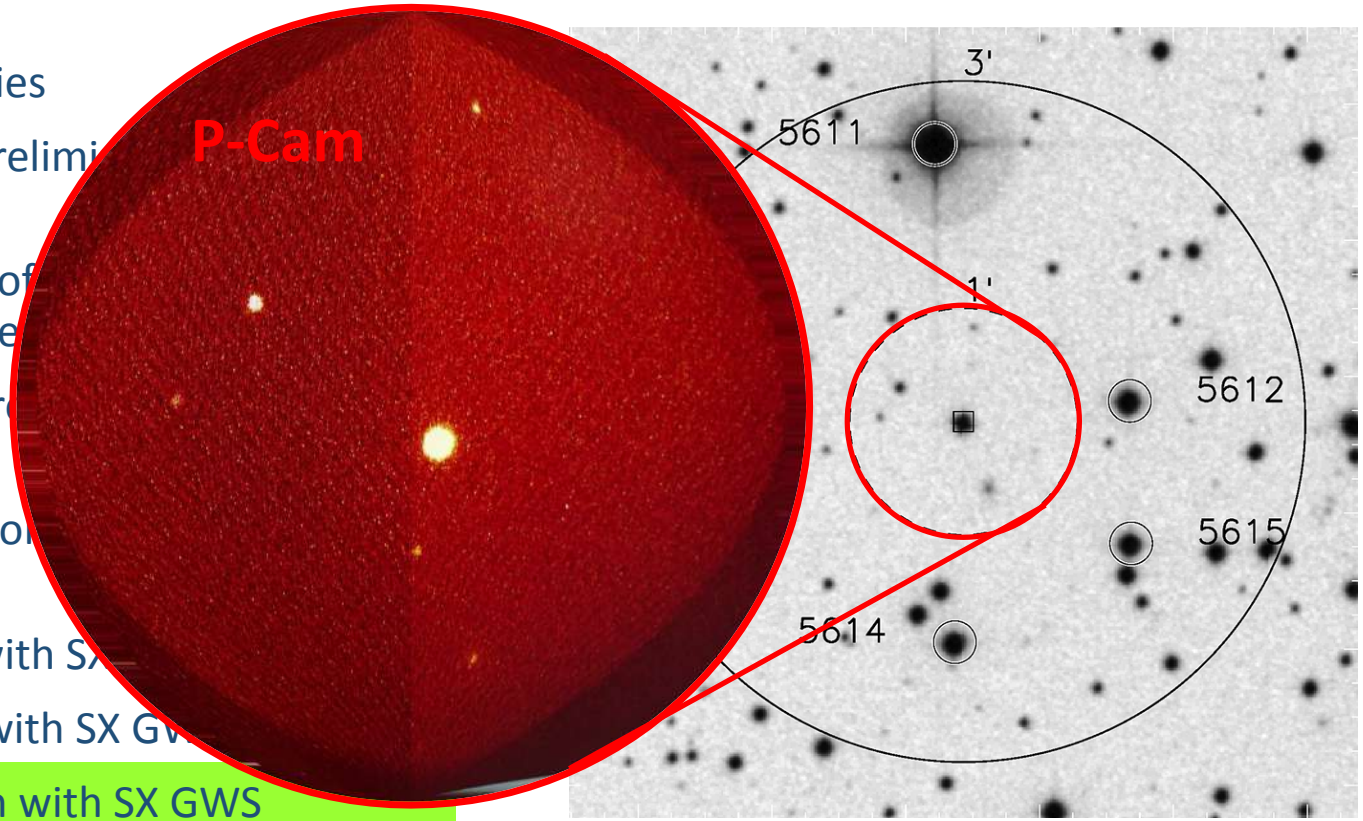

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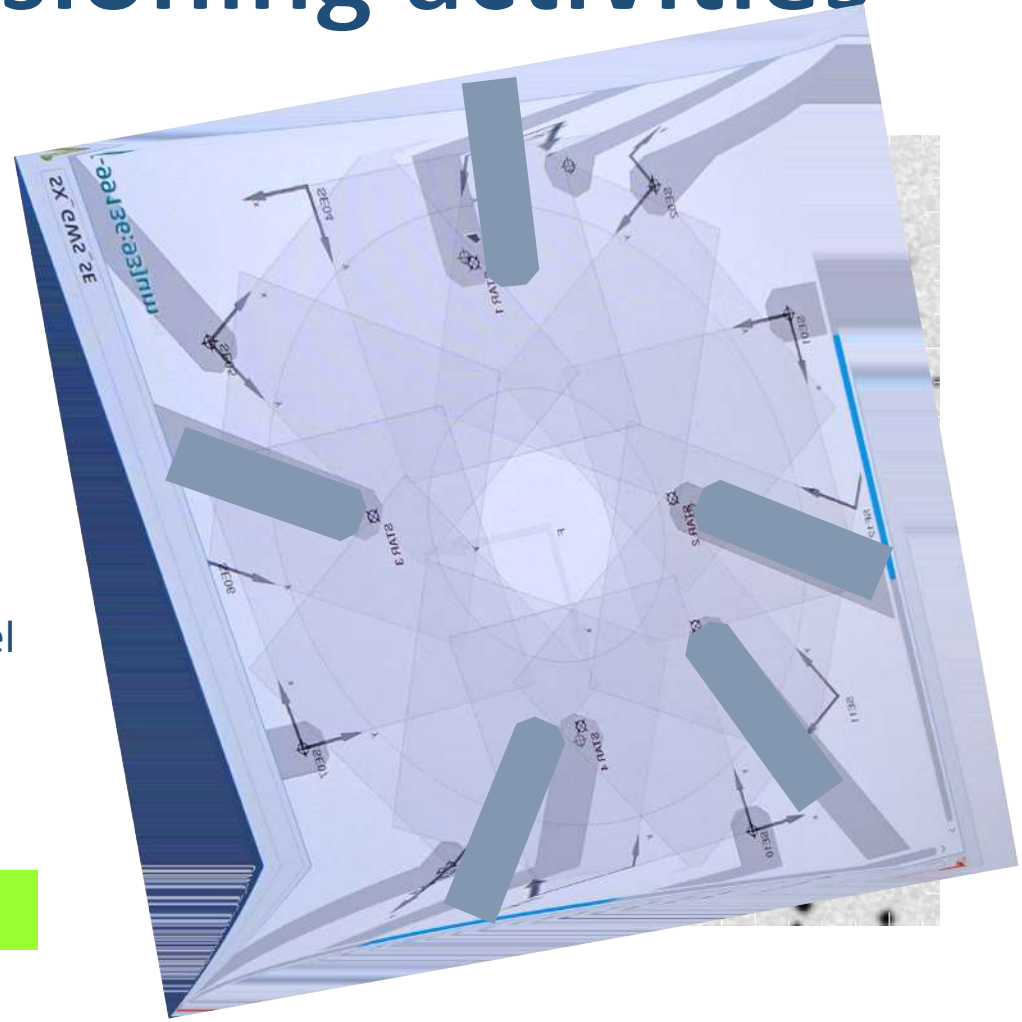

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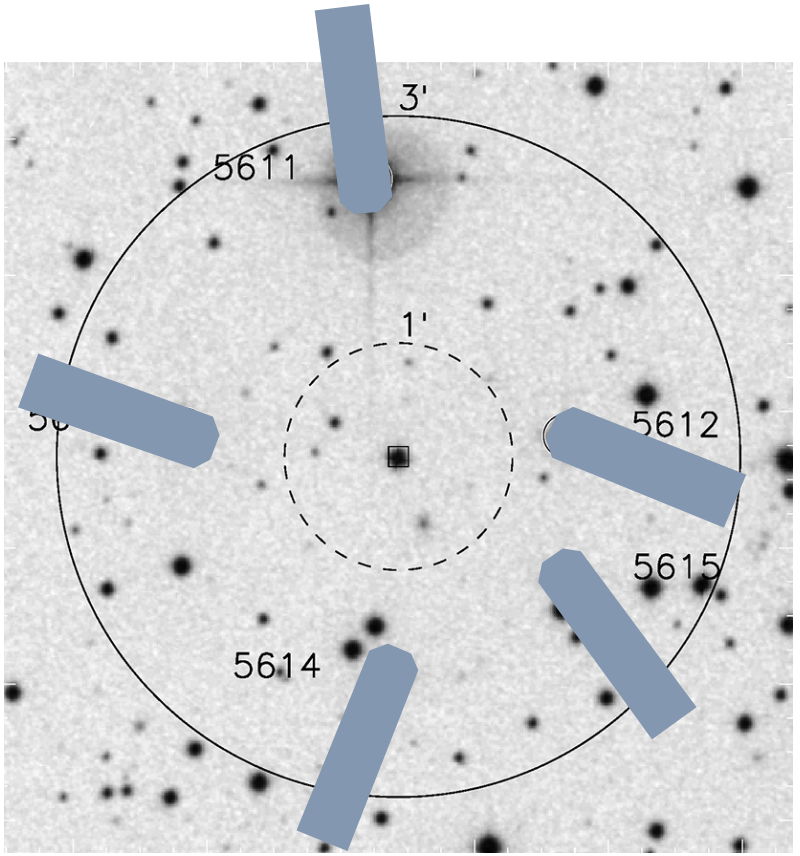

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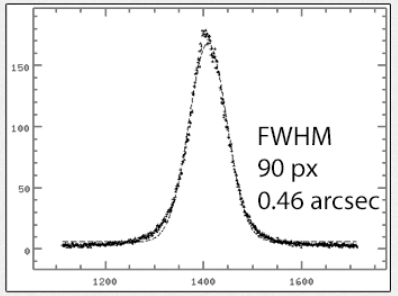
- Multiple star closed loop with SX GWS

Source 08.9+11.9 - 29 March 2017
1.0 arcsec seeing at 1.5 airmasses
K' filter

DX - No AO
(uncollimated)

SX - GLAO with 5 reference stars and 20 modes



Everybody'… up to now…!

Everybody'… …up to now…!

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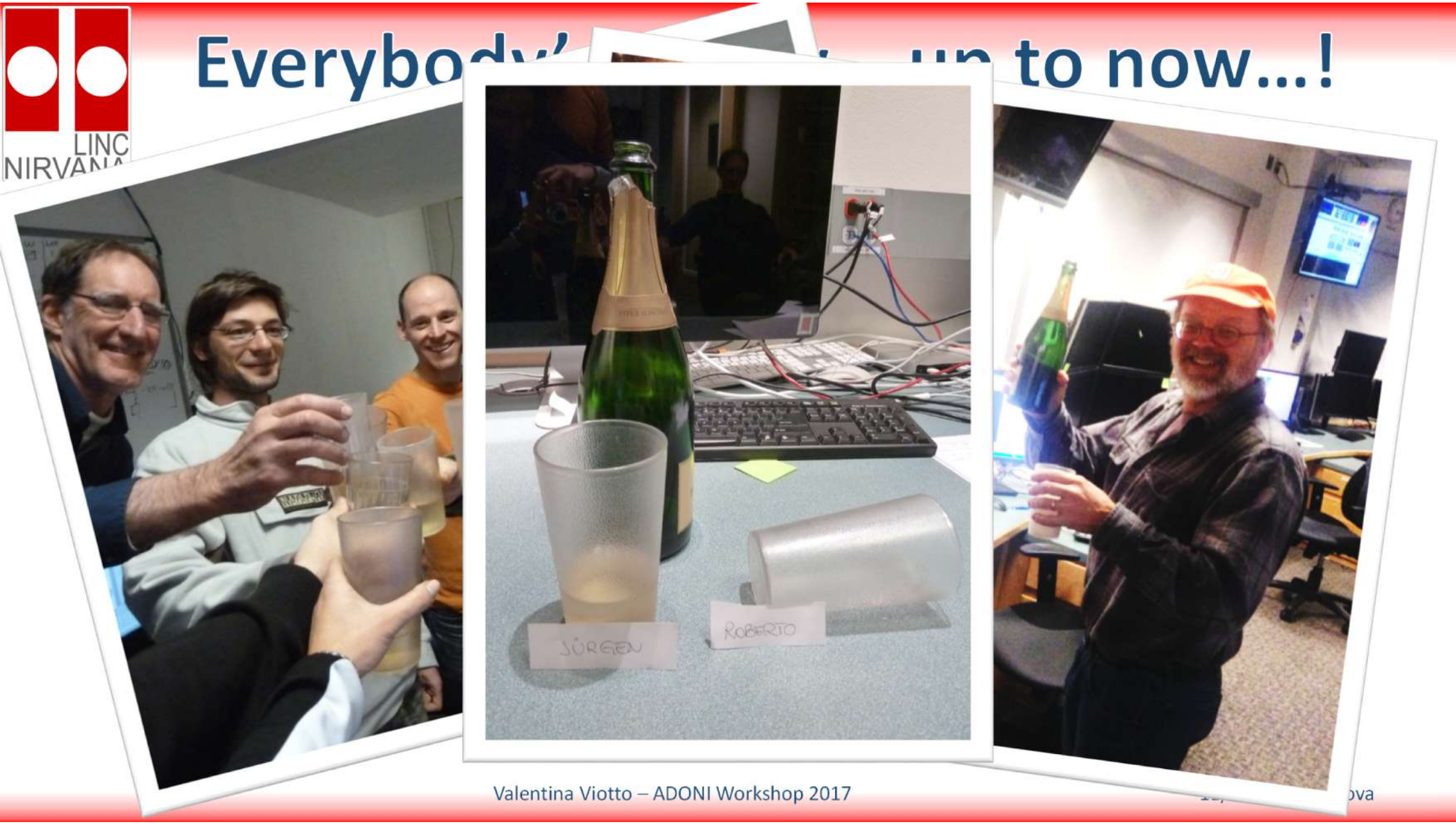

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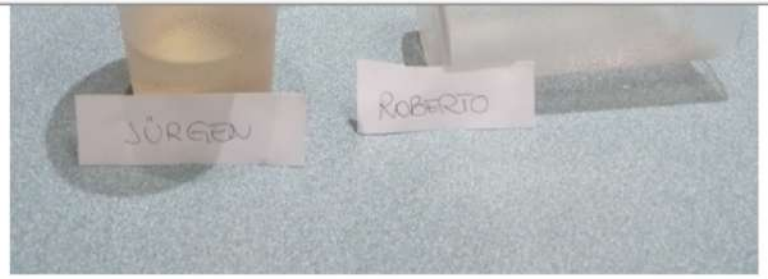

o now…!