Lessons from MAD: From the Lab to the Sky

- Testing and optimization
- Problems... solved before the nights
- Observations

Beyond MAD
ESO Garching, June 8-10 2009

Johann Kolb
Enrico Marchetti
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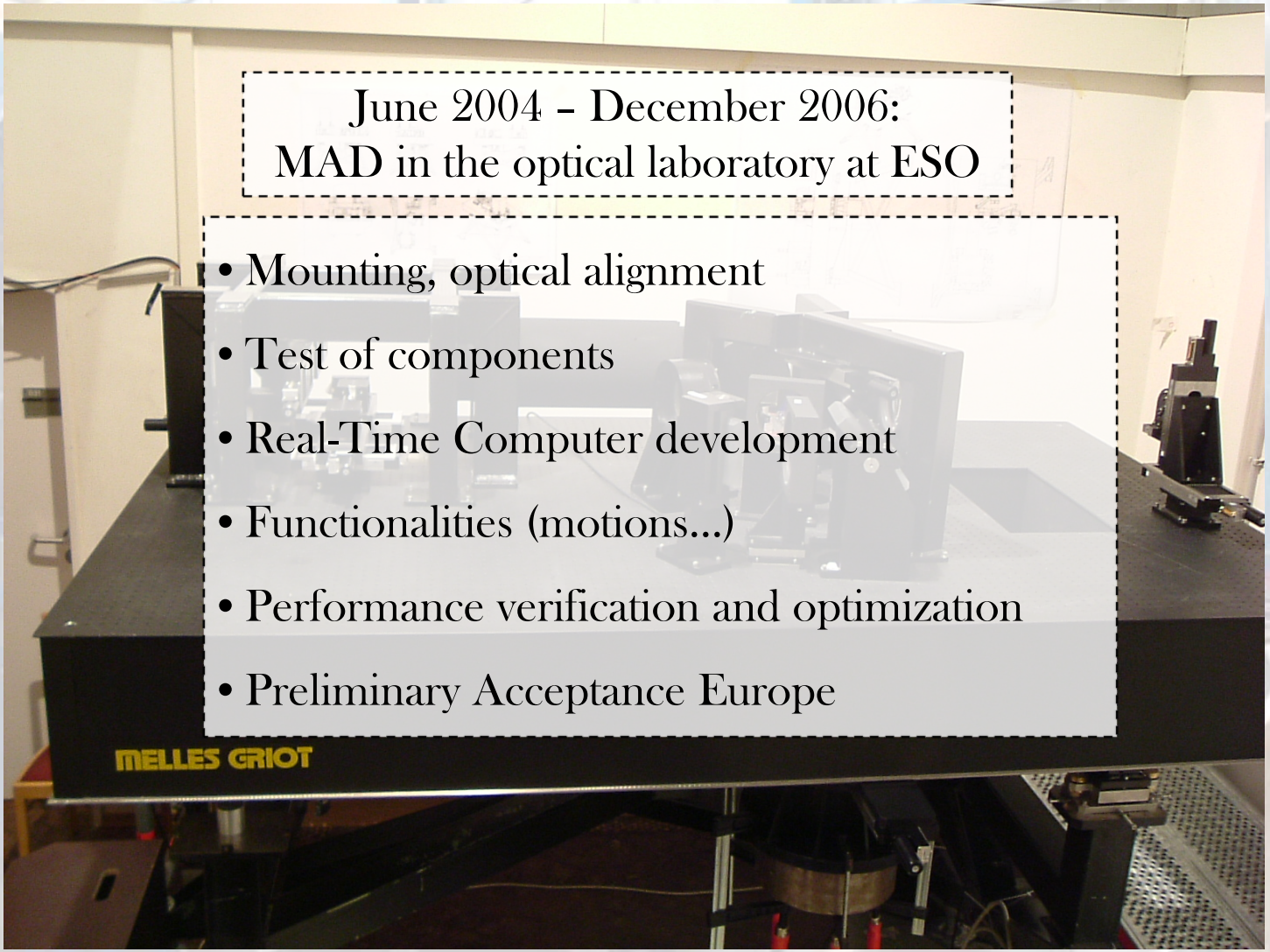
Testing and optimization...

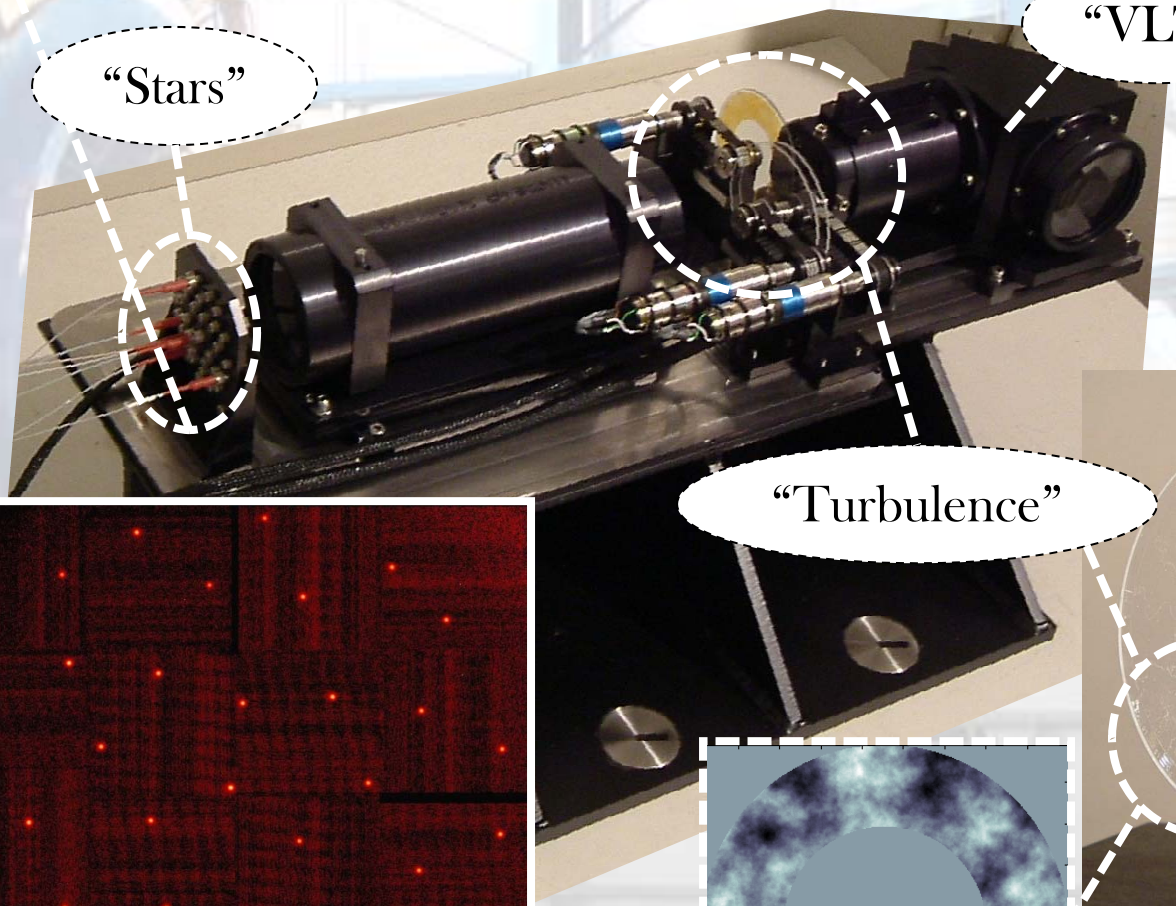
Once upon a time...



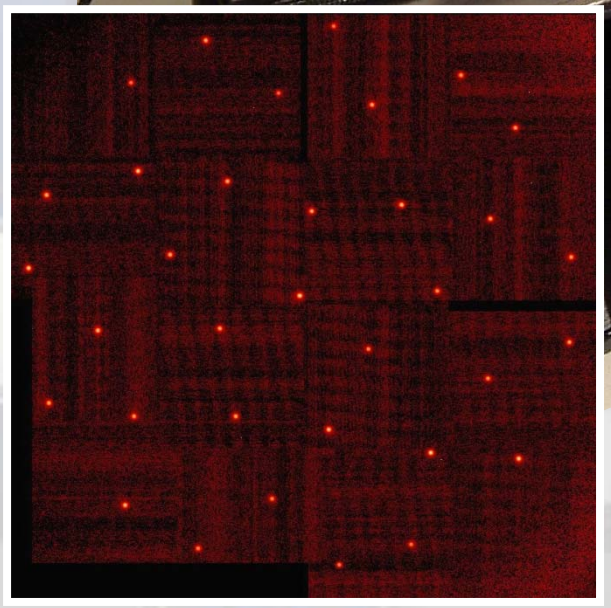
June 2004 – December 2006:
MAD in the optical laboratory at ESO

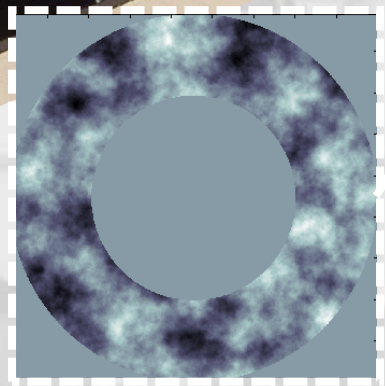
- Mounting, optical alignment
- Test of components
- Real-Time Computer development
- Functionalities (motions...)
- Performance verification and optimization
- Preliminary Acceptance Europe

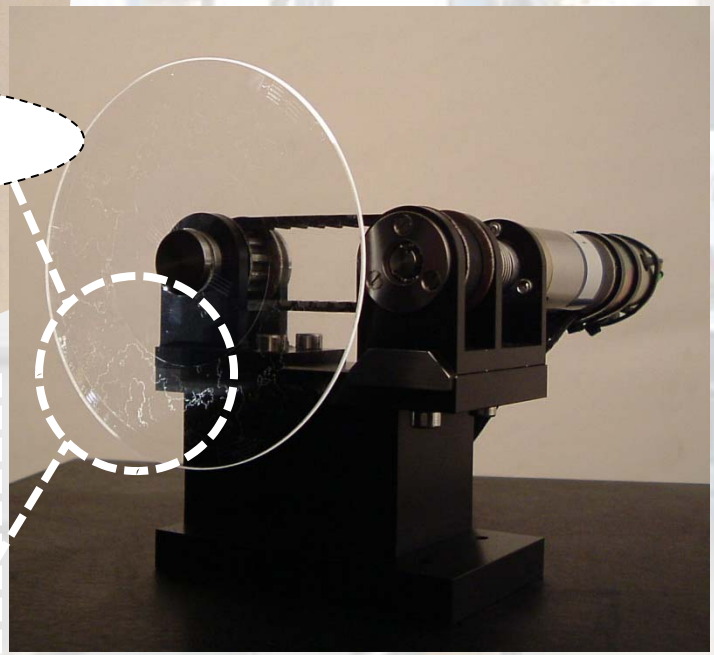
The turbulence generator MAPS



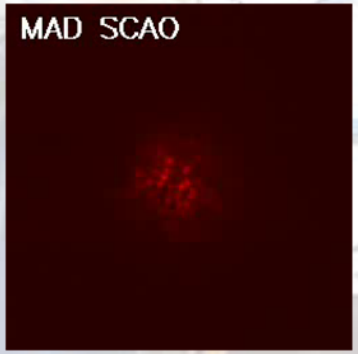
For MAD: equivalent to being at the VLT

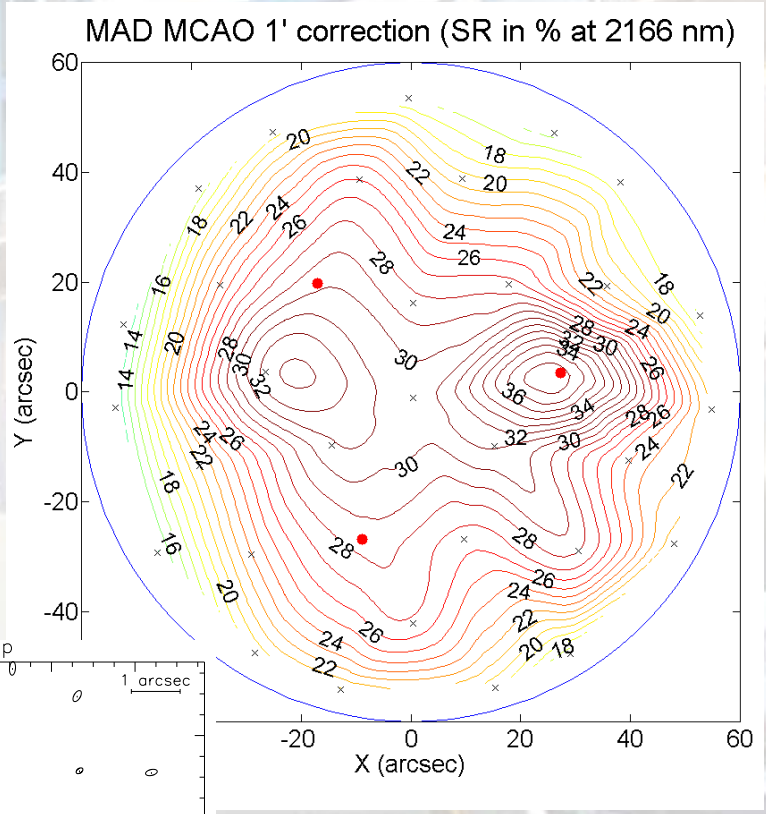






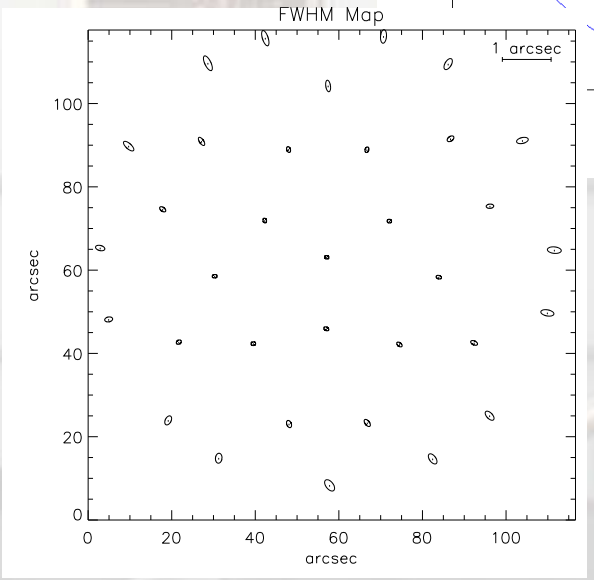
MAD performance in the lab





37 Technical reports, including one on performance evaluation (and optimization) under different:

- Guide Stars asterisms
- Guide Stars magnitudes
- Seeing conditions



Installation at Paranal: Feb-Mar ’07

http://www.eso.org/projects/aot/mad/Paranal/Paranal.html

MAD: Multi-Conjugate Adaptive Optics Demonstrator

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MAD Installation at Paranal

The MAD dismounting has been completed on January 26th and the demonstrator has been shipped to Paranal Observatory on January 30th. The MAD boxes have been delivered in Paranal on February 6th the installation started on February 10th. In this page we will show a daily update of all the MAD installation activities lasting for about 1 month. MAD is being installed at the Nasmyth Focus A of the VLT UT3 (Melipal) telescope. The first observing night has been scheduled for March 26th and the observing run will consist of 8 nights in total.

JANUARY

26

FEBRUARY

10	11	12	13	14
15	16	17	18	19
20	21	22	23	24
25	26	27	28	

MARCH

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15

MAD: Multi-Conjugate Adaptive Optics Demonstrator

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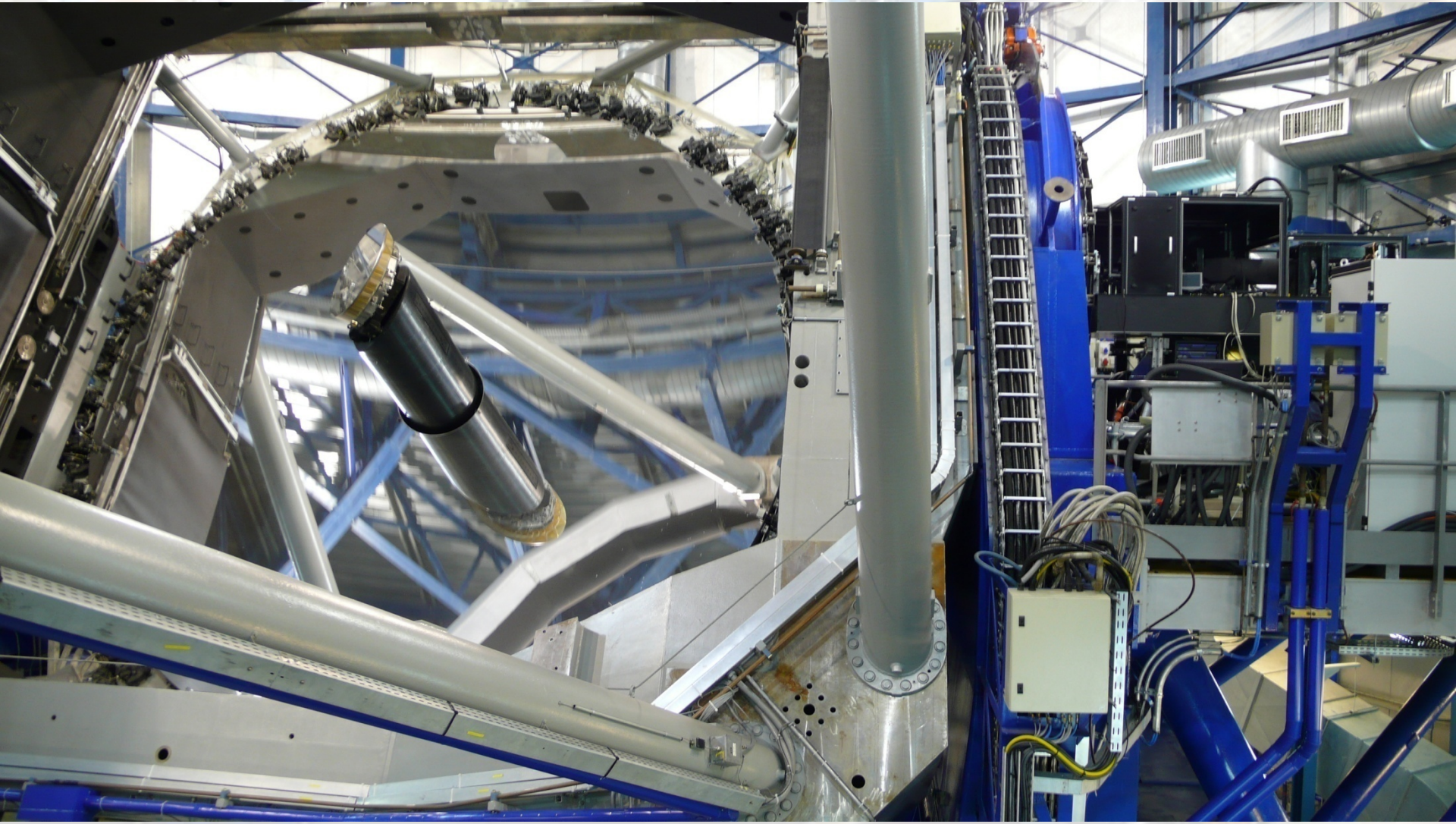
MAD dismounting: January 26th

Home >>> Next day

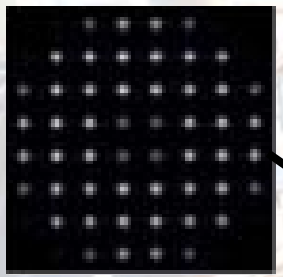
Despite the snow, the dismounting and packing of MAD has been completed well in schedule. A total of 18 boxes, 7.3 tons, are waiting for shipment to Paranal Observatory.

Done

Installation at Paranal: Feb-Mar ’07



Interaction Matrix, the heart of AO

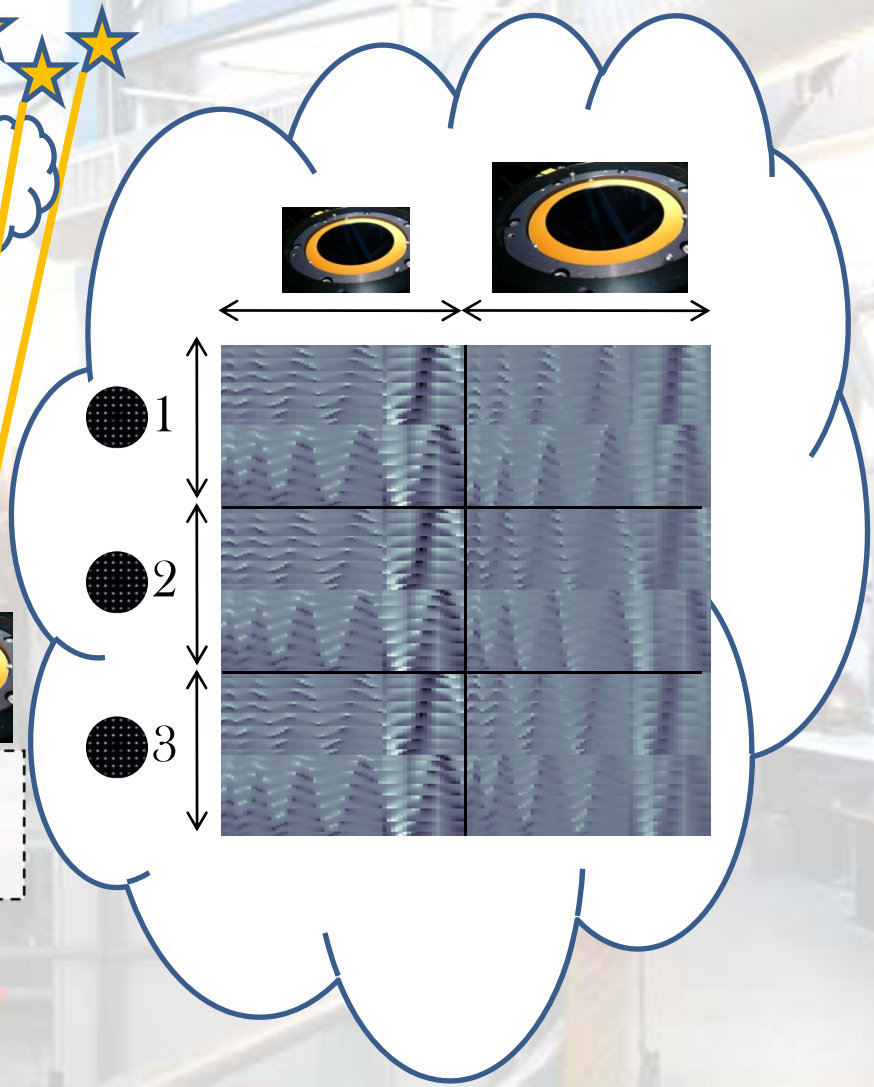


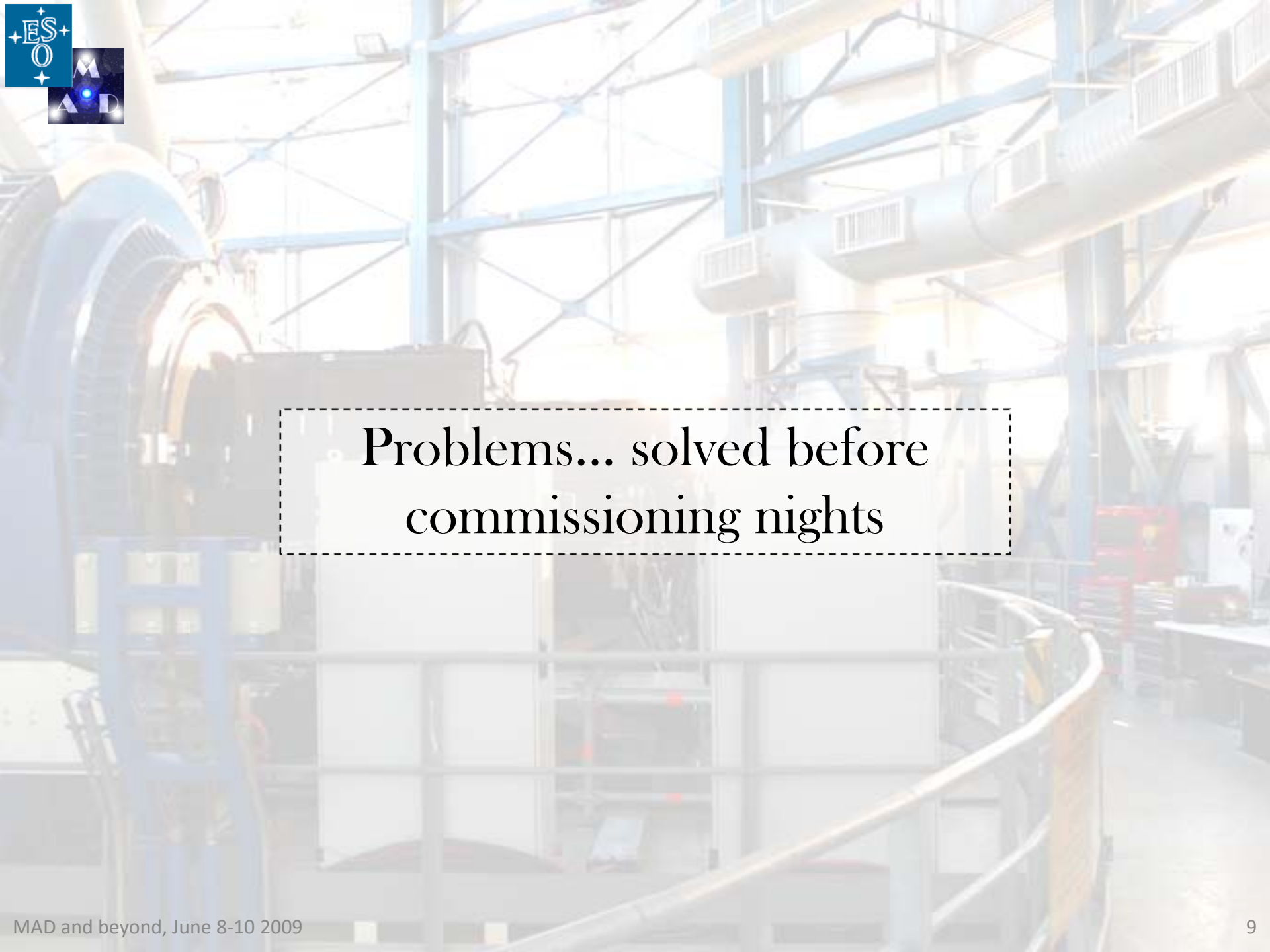
Shack-Hartmann Wavefront sensor spots

MAD

Ground Deformable Mirror

Altitude Deformable Mirror

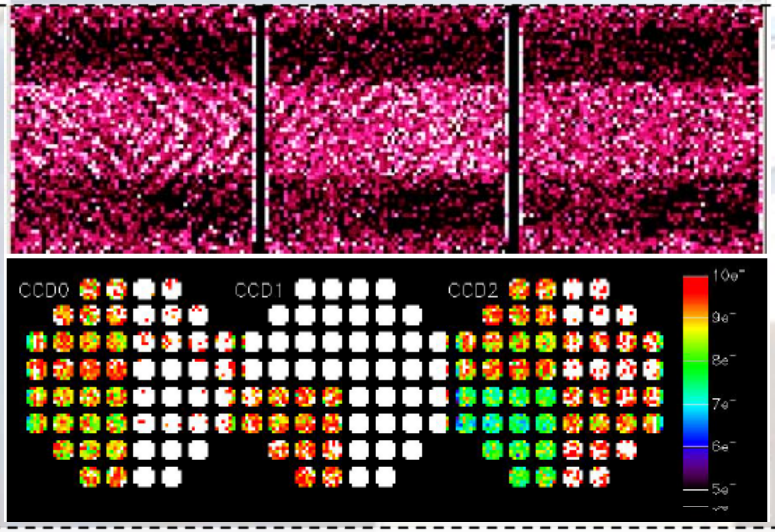


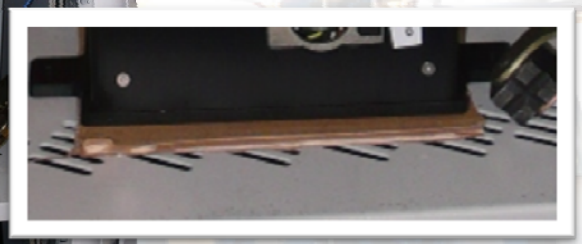


Problems… solved before commissioning nights

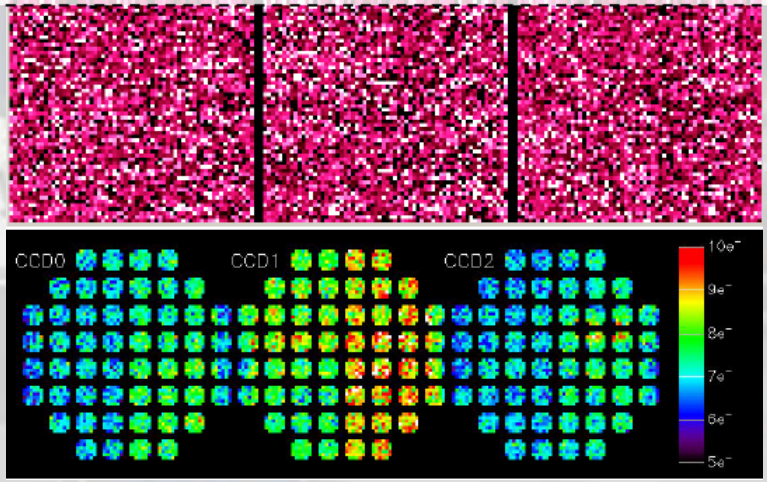
Problems... solved before commissioning nights

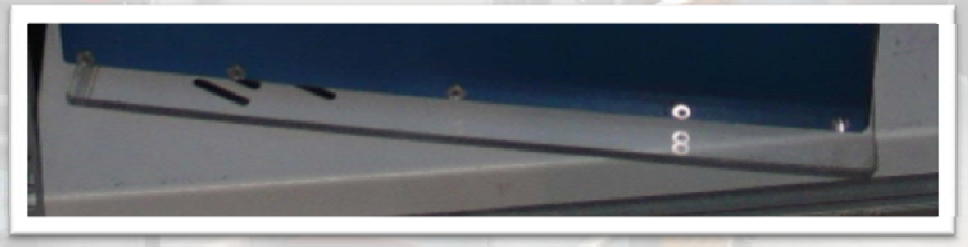
Before: Interference on the WFS detector





After isolation of detector electronics



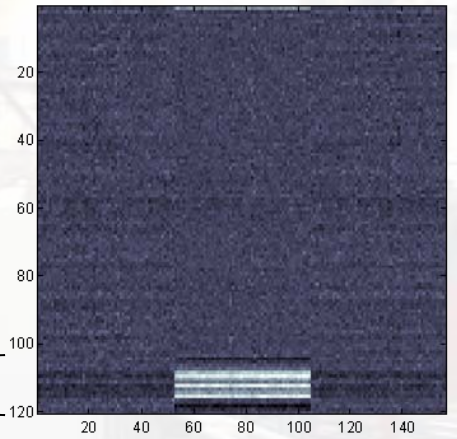


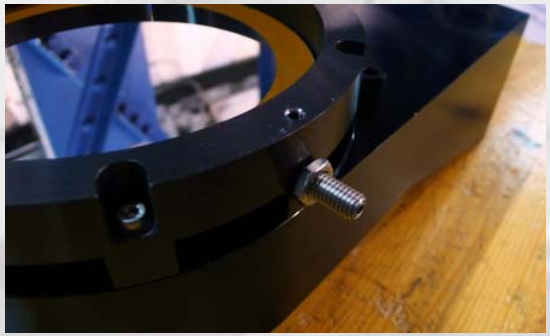
Problems... solved before commissioning nights

DM backplate unscrewed during transport: severe risk of damage
→ Dismounting and testing

Difference of 2 Interaction Matrices separated by a few minutes shows pattern

IM on the x axis

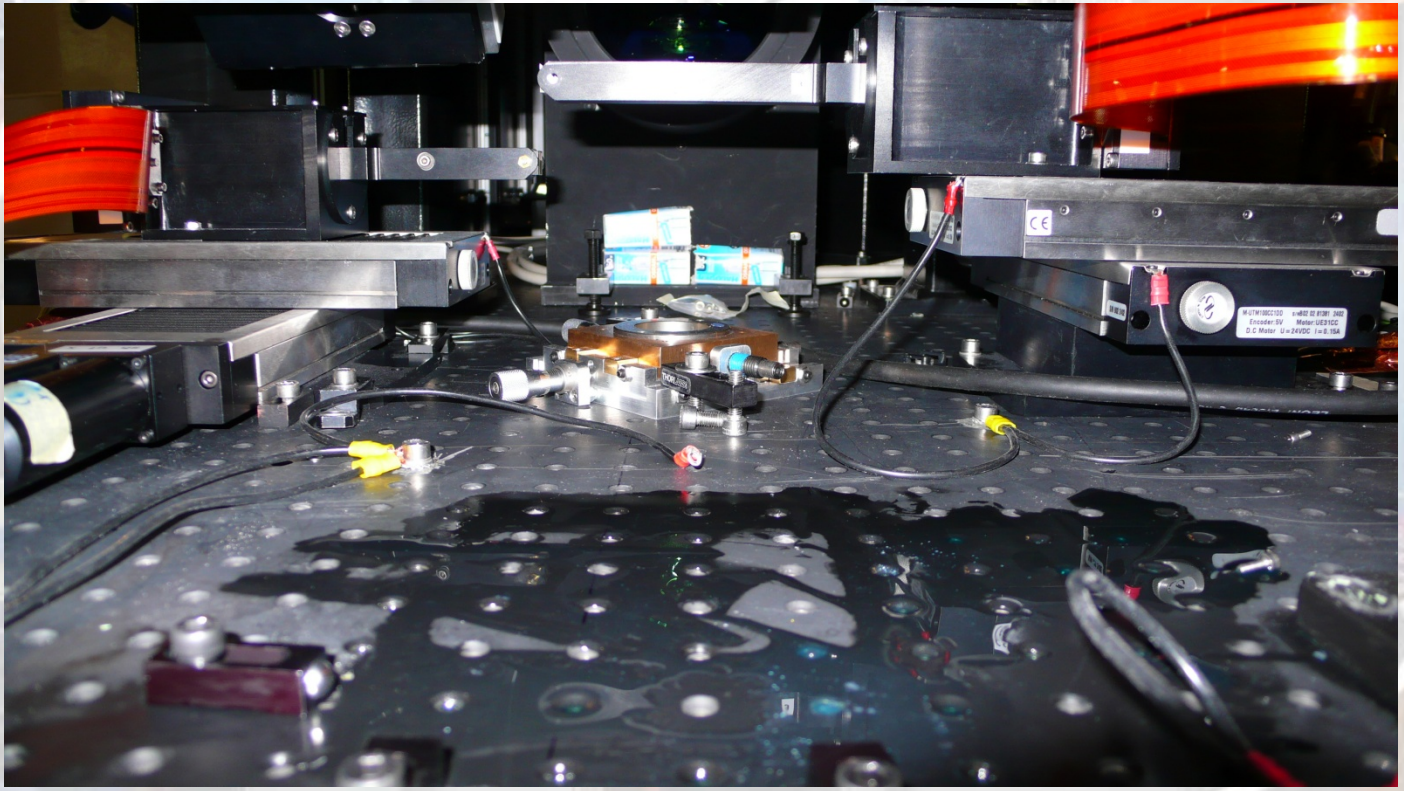




The origin was a fixation screw to be better adjusted

Problems... solved before commissioning nights

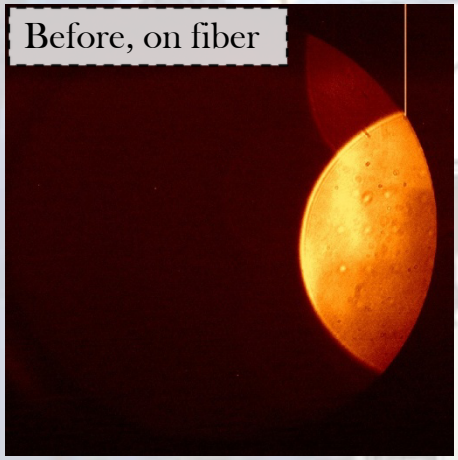
Wavefront sensor head coolant leak! 4 days before the first light

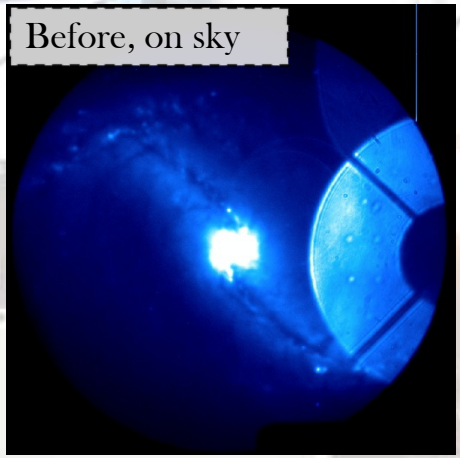


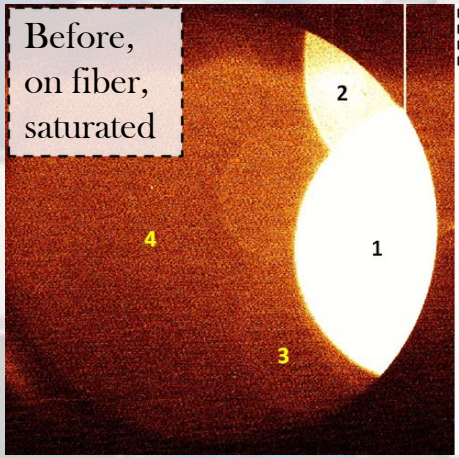
→ Dismounting, replacing head, cleaning, remounting and re-alignment
→ No liquid cooling used for WFS heads during all MAD observations

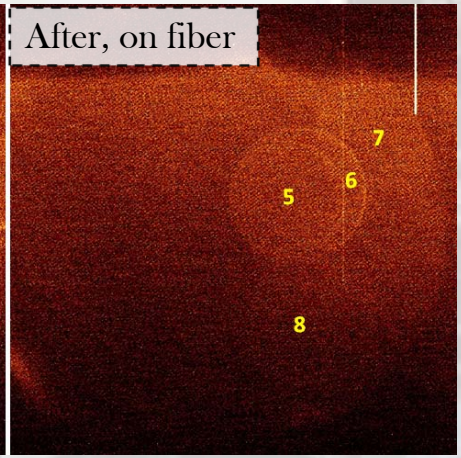
Problems... solved before commissioning nights

Static ghosts on the acquisition camera: disturb the acquisition of Guide Stars

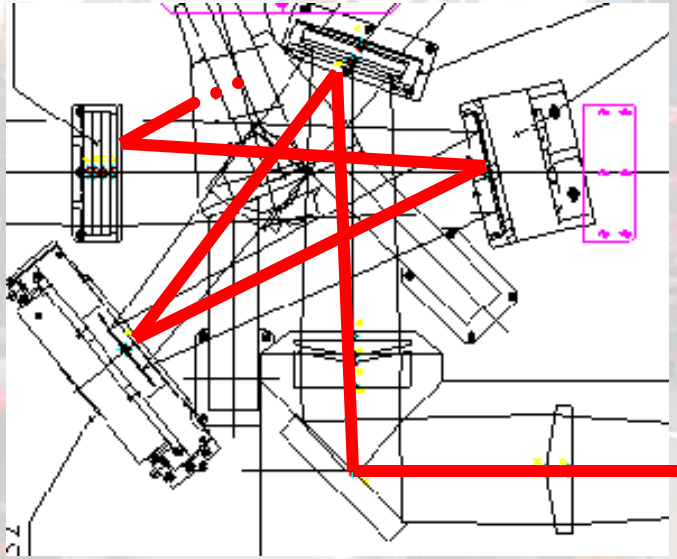






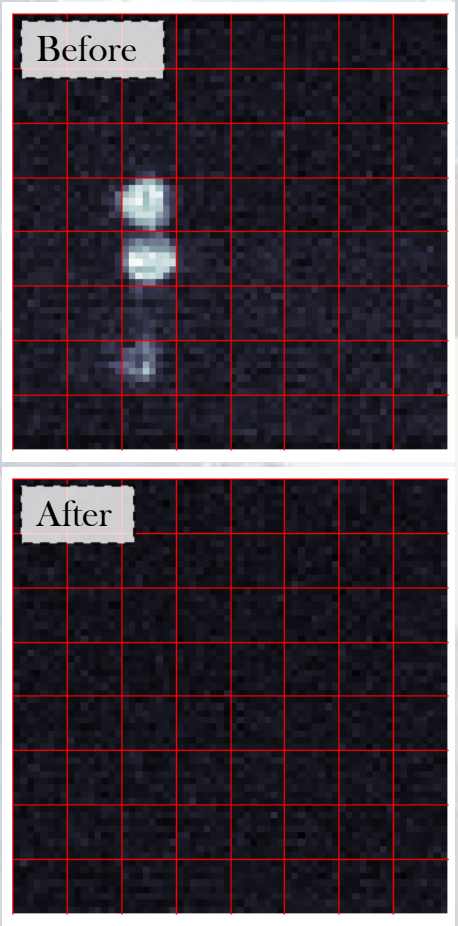


→ Cause: Light from a linear stage limit switch LED, after multiple reflections on MAD optics

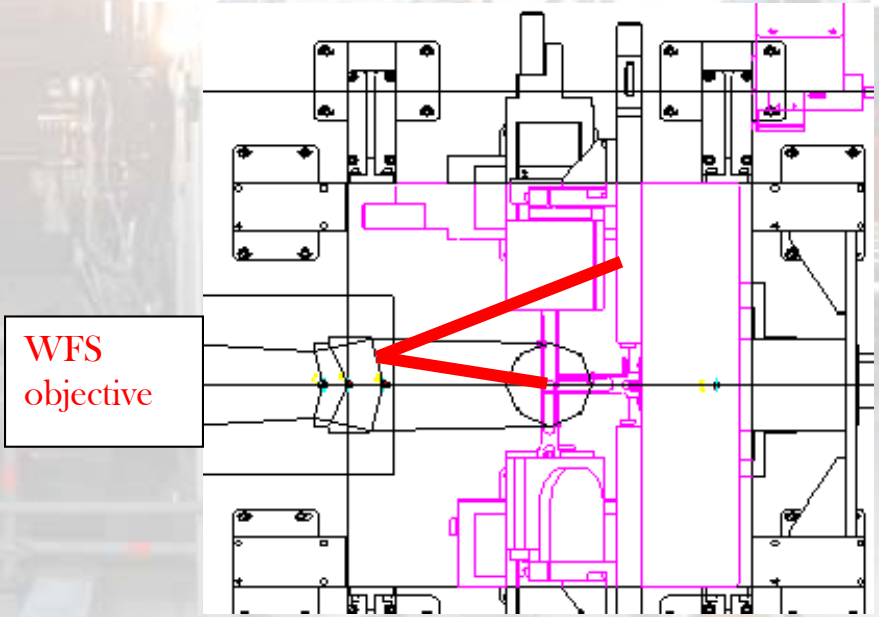


Problems... solved before commissioning nights

Ghosts on the Wavefront sensors: disturb AO close loop for certain GS positions



→ Cause: Light from another linear stage limit switch LED, after one reflections on MAD WFS objective

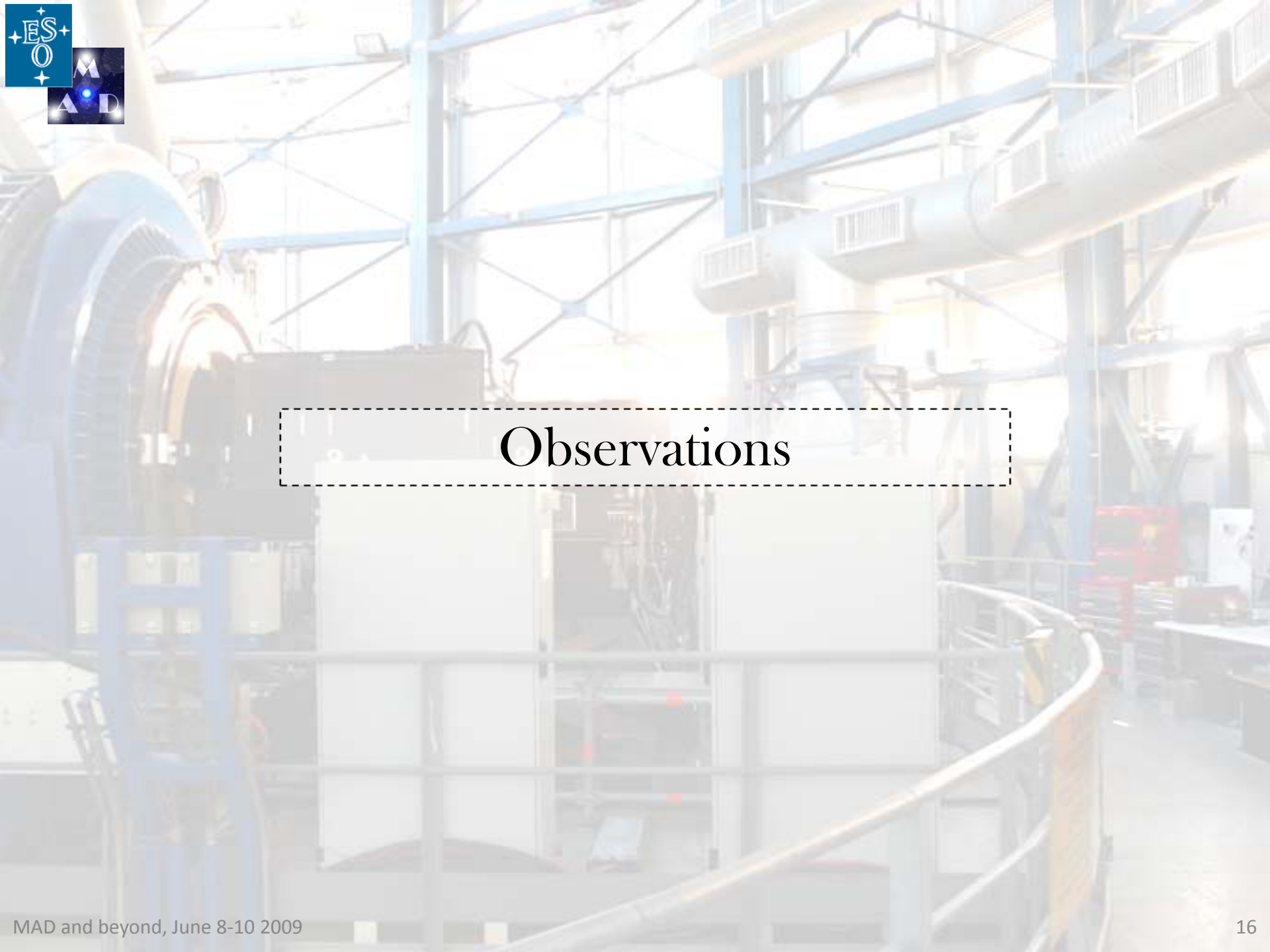


Problems… solved before commissioning nights

2 days before SD2 first night:

"a SIMM module blew up in one of the clock boards causing likely a short circuit and made the +15V power supplier module not working and the +5V one providing only 2V and this was visualized by the LED #6 on in the commboard. The error message from the selftest about a problem with the communication with the DSP was somehow misleading. We replaced the broken SIMM module and everything got back to normality"

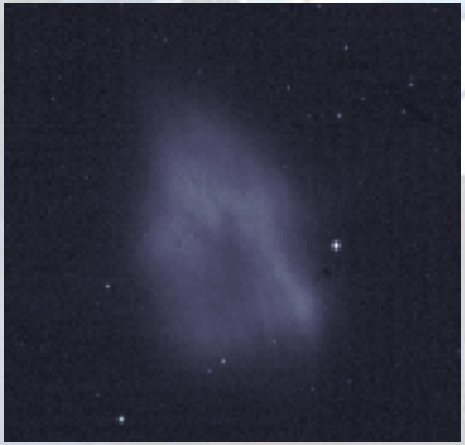
- Solved at 17:00
- Telescope open at 19:00 for on-sky flats
- 2 hours later: MCAO closed loop with 75 mas resolution in K band over the full 2 arcmin FoV…



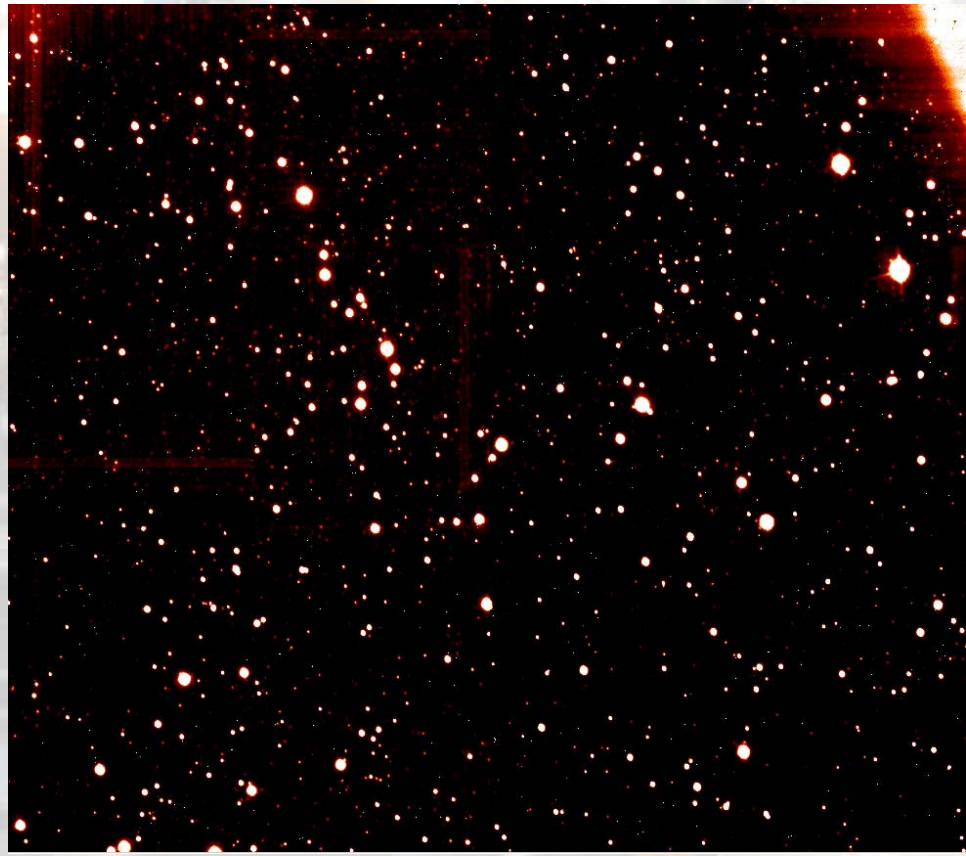
Observations

First light: without Deformable Mirrors

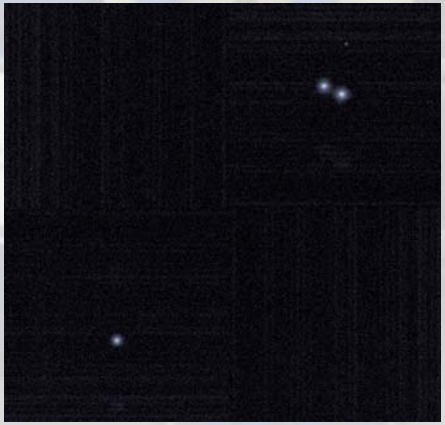
First blobs without and with VLT active optics



Omega Centauri – open loop

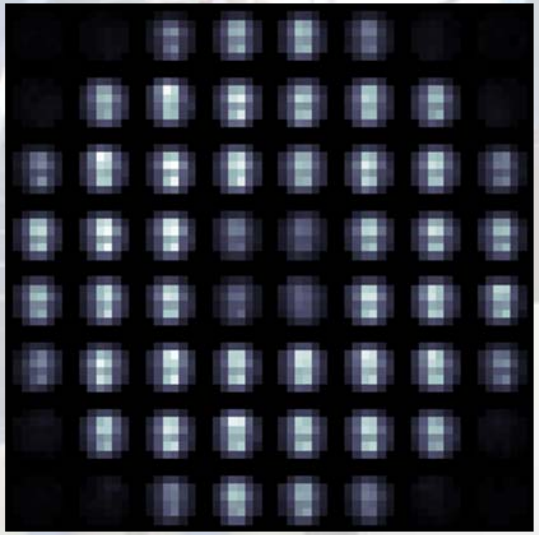


Targets for the derotator tracking test

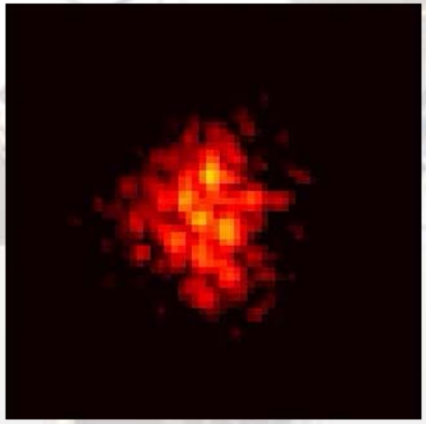


Double stars...

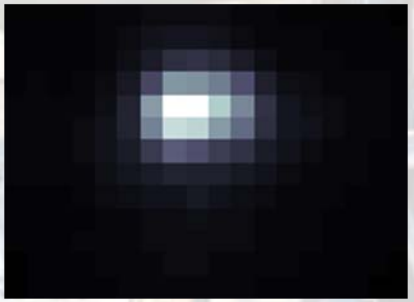
WFSing on a double star, ≈0.6” separation



SCAO on double star 07508+0317, 173 mas separation



SCAO on a double star, 78 mas separation

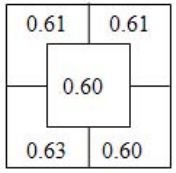


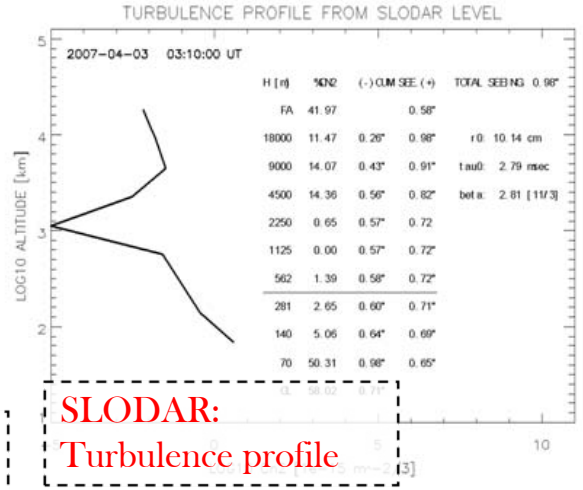
SCAO on a double star in J band, ≈0.54” separation

Turbulence profiling

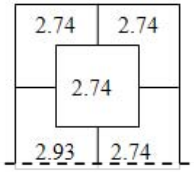
MCAO performance dependant on turbulence strength and profile

Seeing in image mosaics

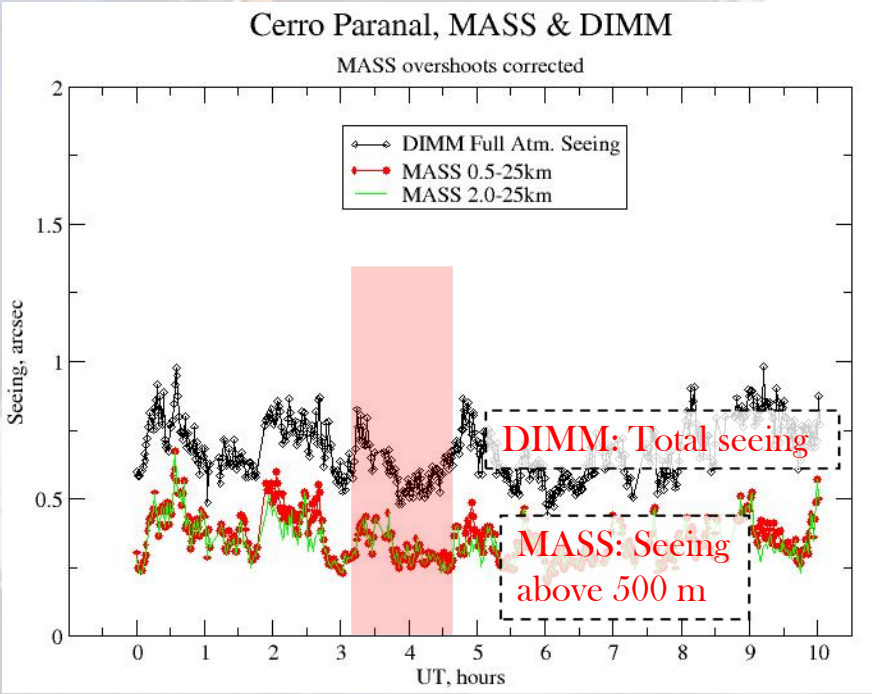




SLODAR: Turbulence profile

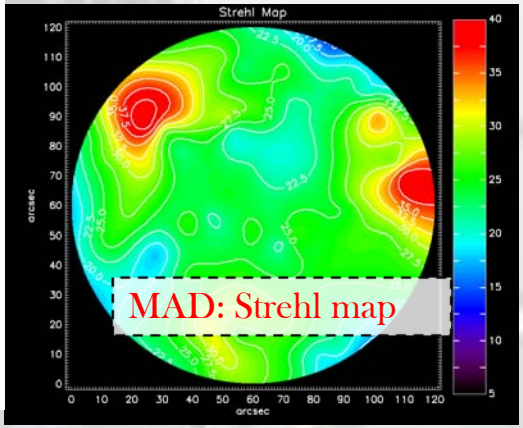


Tau_0 in image mosaics

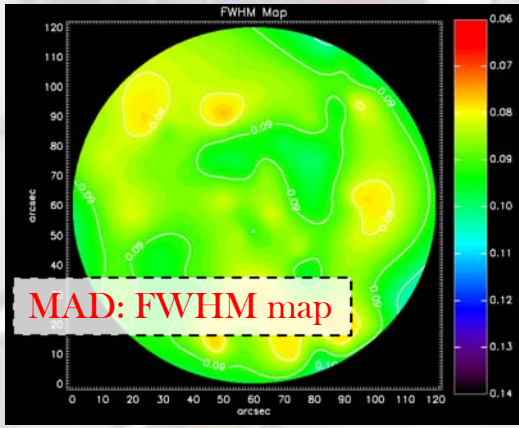


DIMM: Total seeing

MASS: Seeing above 500 m



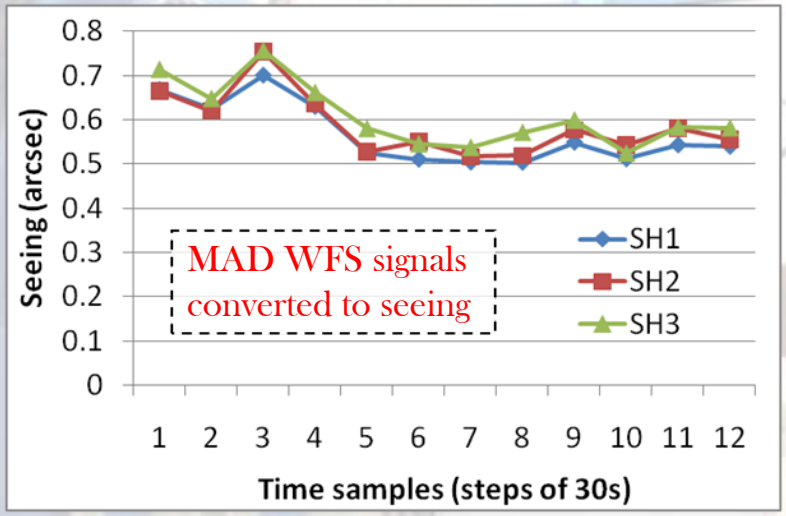
MAD: Strehl map

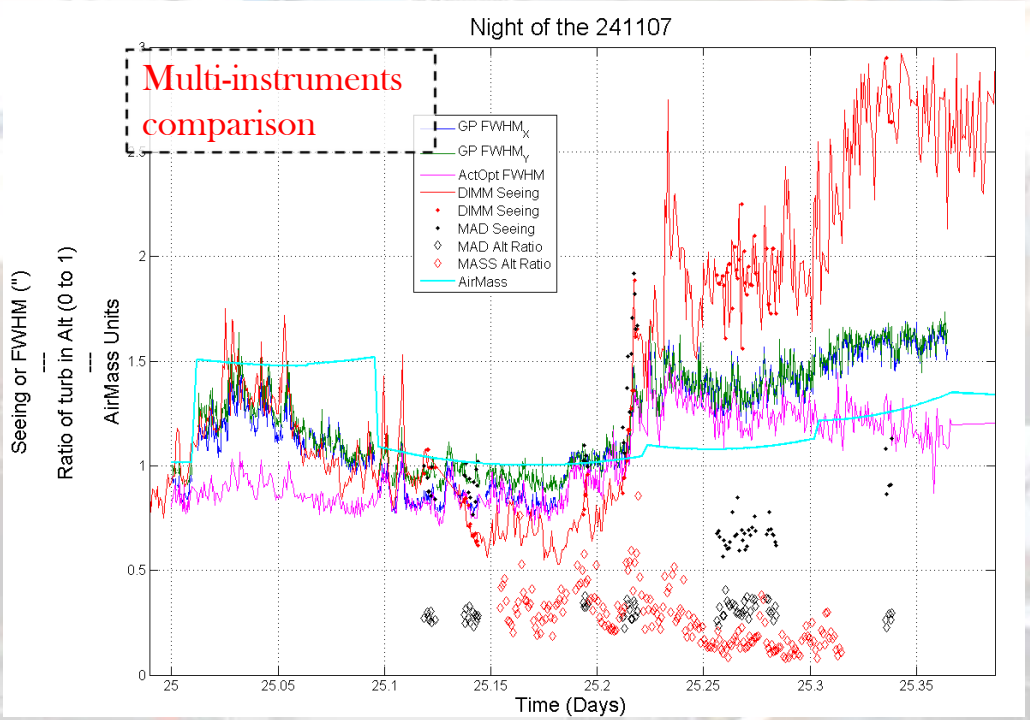


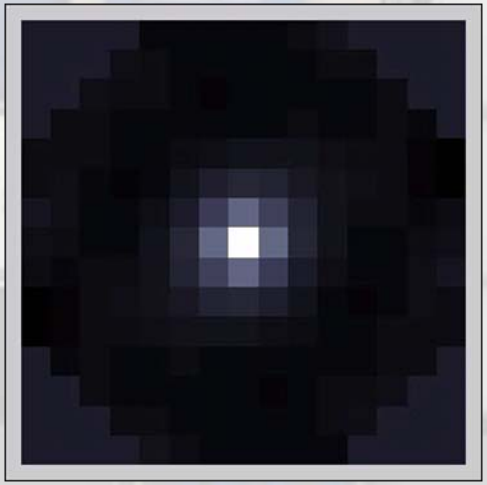
MAD: FWHM map

Turbulence study

Use MAD and other VLT tools as seeing estimators…



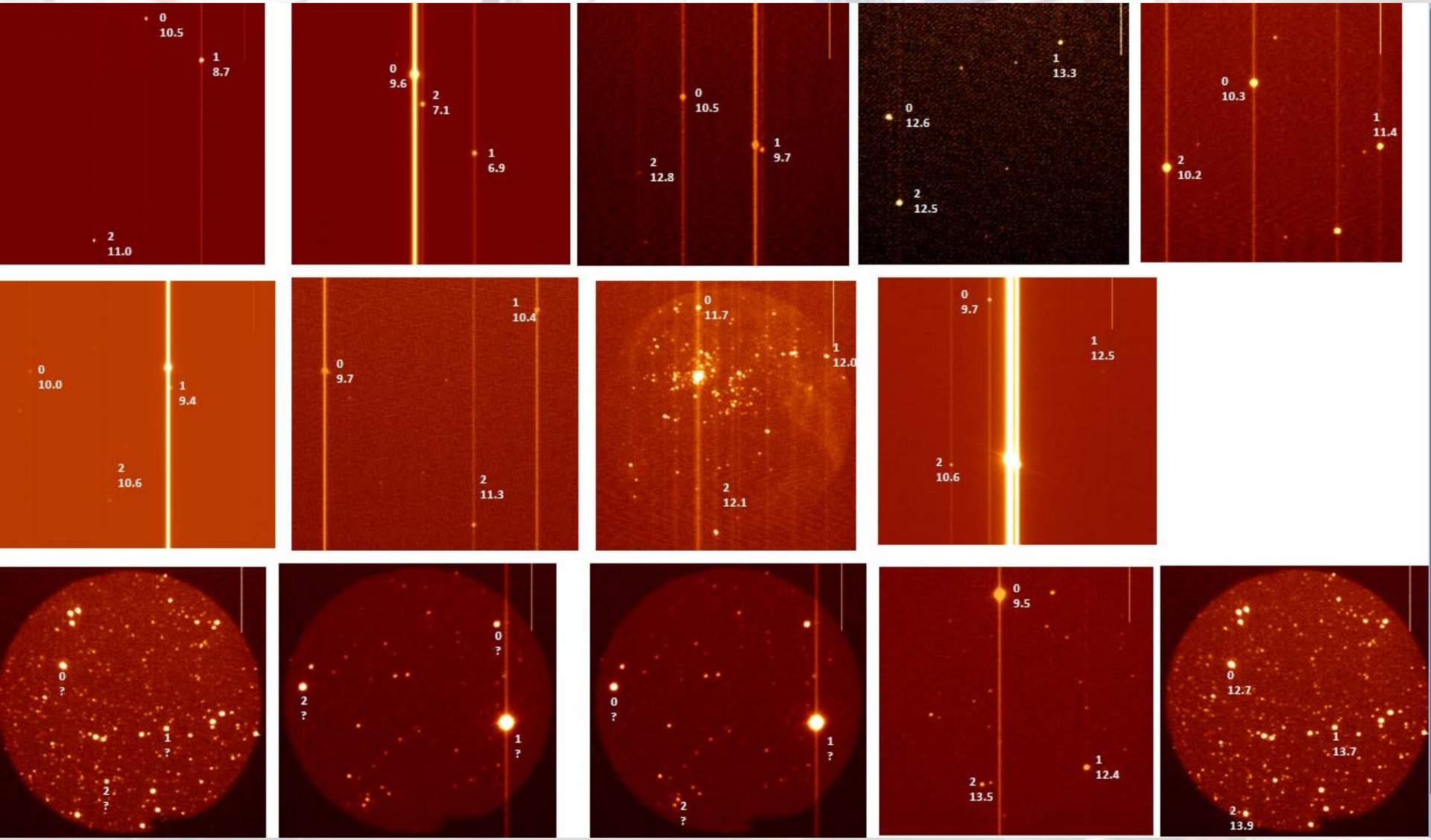




Temporal cross-correlation → turbulence layers strength and speed (T. Butterley, Durham)

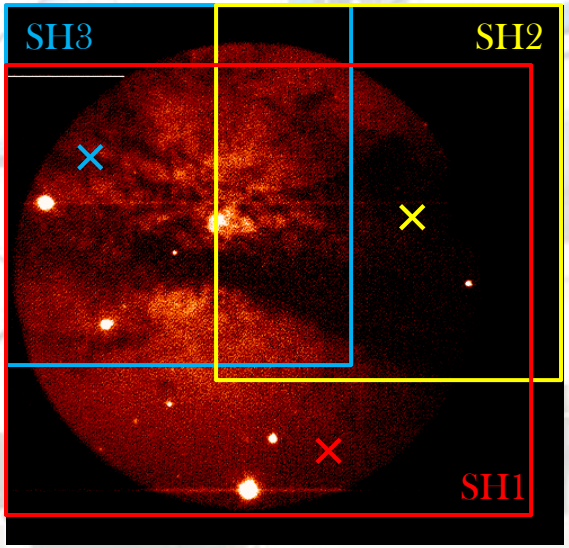
Manual filter change on CAMCAO...

Acquisition camera



Acquisition with MAD

Acquisition of the 2 arcmin FoV with a visible CCD



Position the WFSs

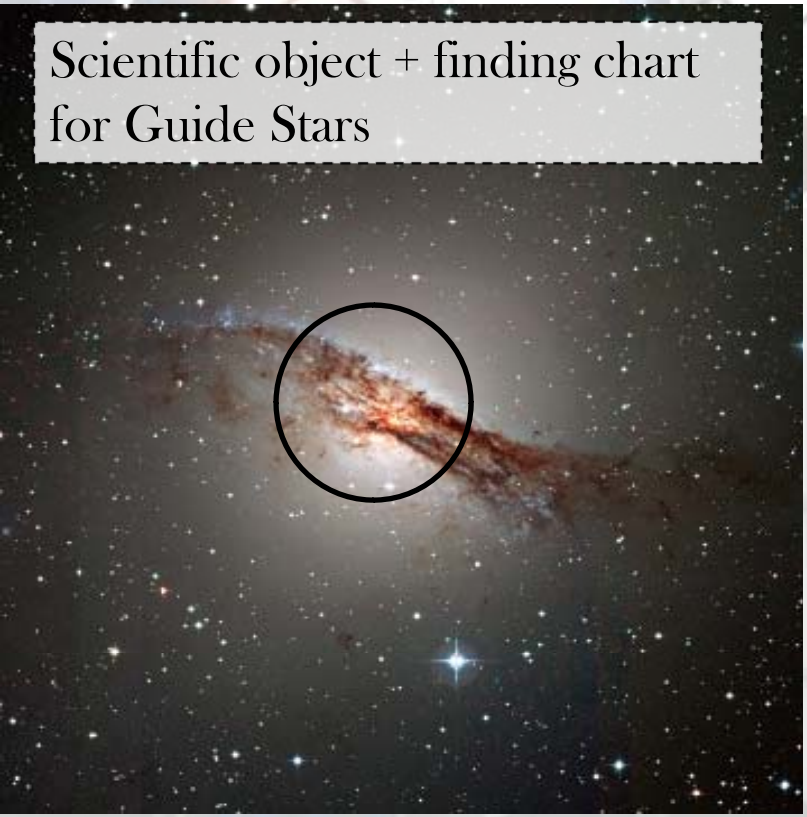
Center the WFSs

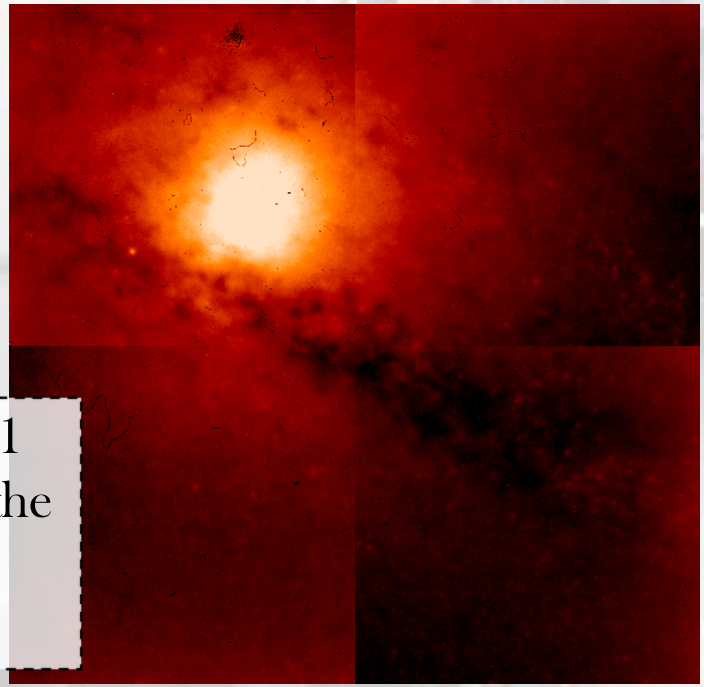
Record the IM

Invert the IM

CLOSE THE LOOP

Scientific object + finding chart for Guide Stars





Imaging of 1 arcmin on the IR camera CAMCAO

To be continued...

Lessons from MAD: From the Lab to the Sky

Paola Amico