GRAAL on-sky performance with the AOF

J. Paufique,

with the large AOF team

within ESO in Europe and Chile

the AOF and GRAAL:
who does it take?

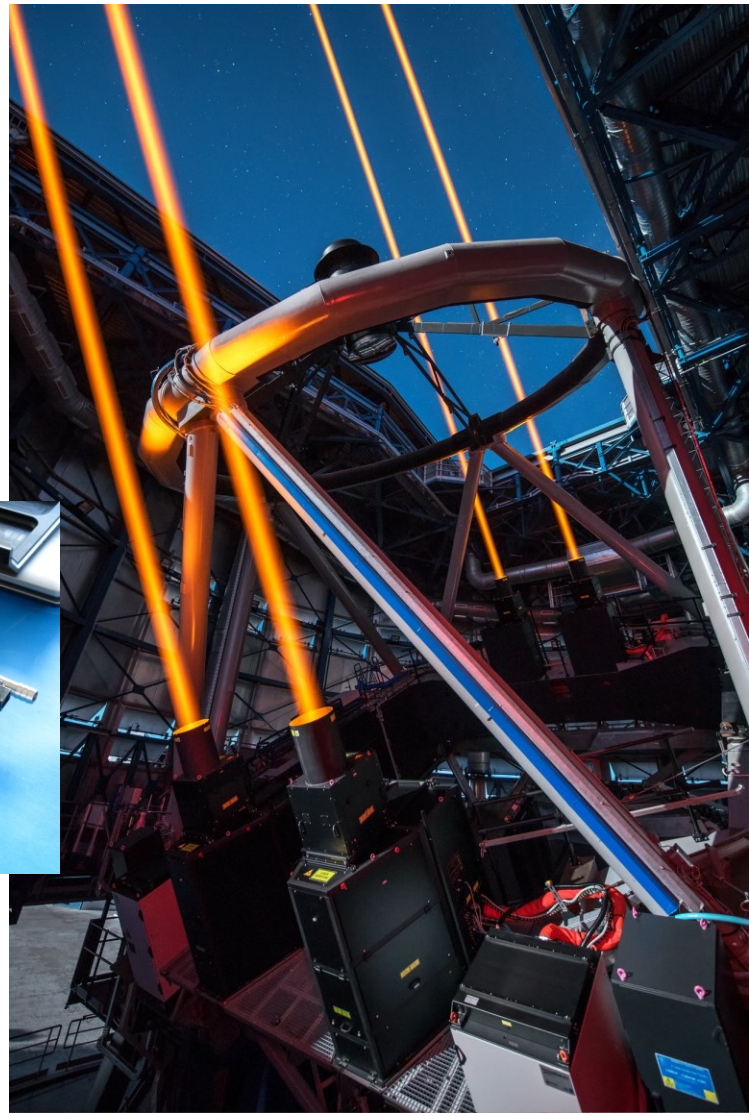
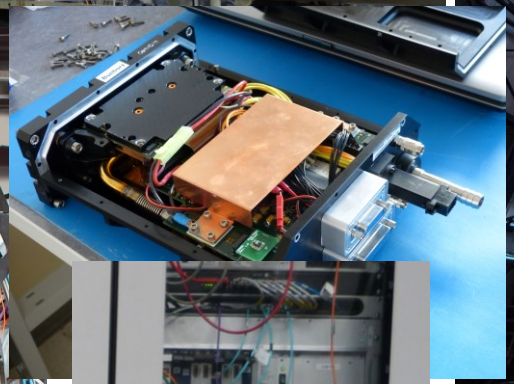
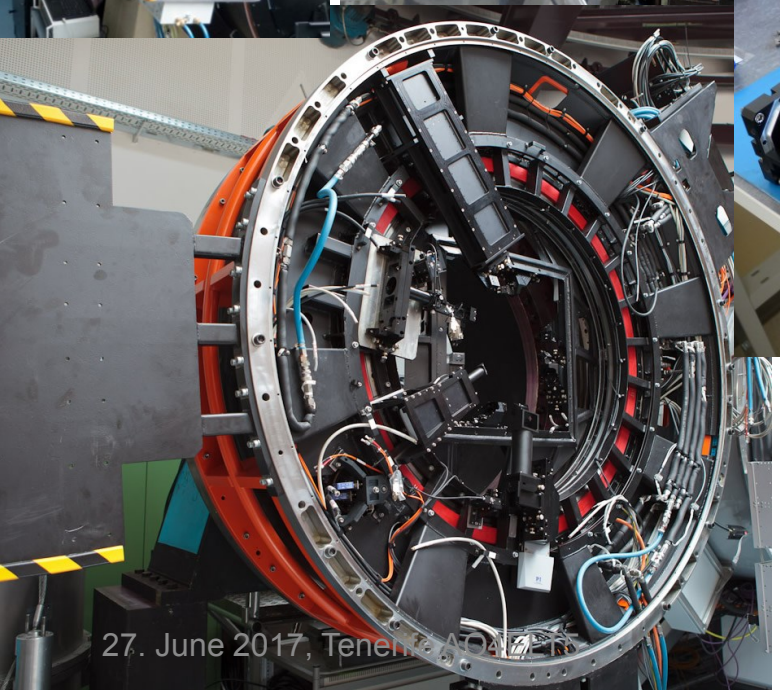
- Sub-Systems Responsible:
- **J.Paufique**, P.LaPenna, E.Vernet, W.Hackenberg
- AO Specialists:
- **M.LeLouarn**, S.Stroebele, **J.Kolb**, N.Muller, A.Garcia-Rissmann, E.Marchetti
- Laser Specialists:
- D.Bonaccini Calia, T.Pfrommer, S.Lewis, P.Amico
- Mechanics:
- **R.Conzelmann**, R.Guzman, M.Quattri, P.Jolley, R.Ridings, J.A.Abad, C.Frank, J.Quentin
- Optics: - Control:
- B.Delabre, B.Buzzoni L.Petazzi, S.Babak, F.Gago, S.Sandrock, **N.di Lieto**
- Electronics:
- M.Duchateau, **A.Jost**, I.Guidolin, L.Kern, G.Fischer, A.Haimerl, **C.Soenke**
- Detectors:
- **M.Downing, J.Reyes**, L.Mehrgan
- Software:
- **M.Kiekebusch**, M.Comin, **R.Donaldson**, P.Duhoux, **J.Argomedo**, D.Popovic, S.McClay
- Integration:
- **S.Tordo**, J.-L.Lizon, C.Dupuy, J.-P.Kirchbauer, S.Huber
- **Paranal Support:**
- P.Haguenauer, P.Sansgasset, V.Heinz, Ralf, Joel , J.L Alvarez, P. Hibon
- **Project Office:**
- P.-Y.Madec, H.Kuntscher, J.-F.Pirard, R.Arsenault

Industrial support:
NTE-SENER (main asse

”Sponsors”
N.Hubin, E.Fedrigo, G.Finger, M.Cayrel, and…
The HAWK-I IoT

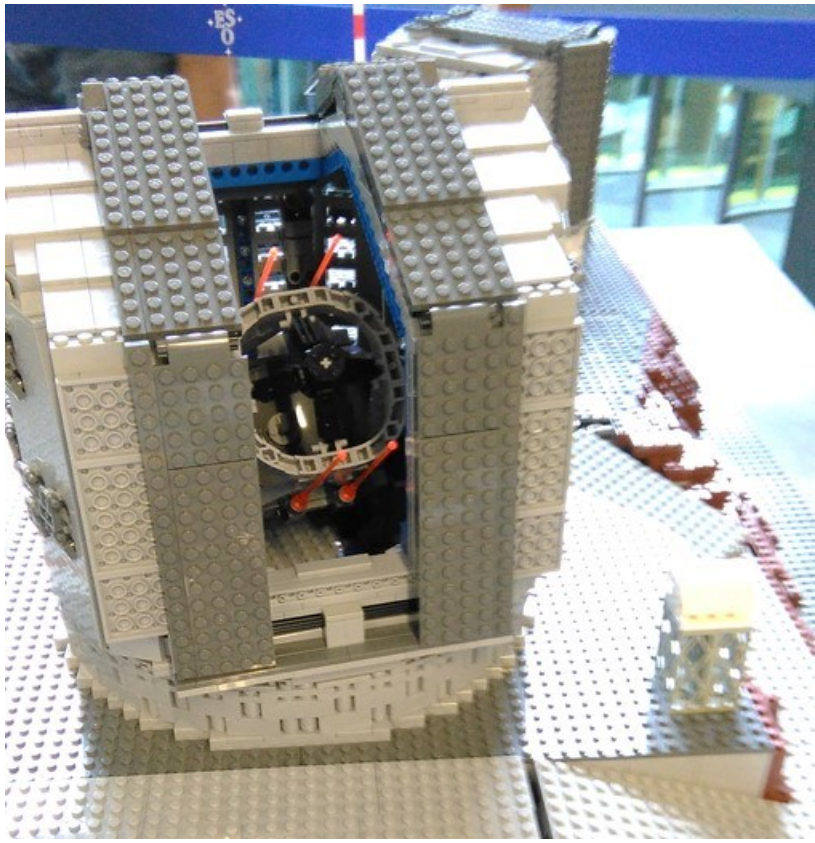
the AOF and GRAAL:
What does it take…




GRAAL:
a GReat Adaptive optics with Aof Lego

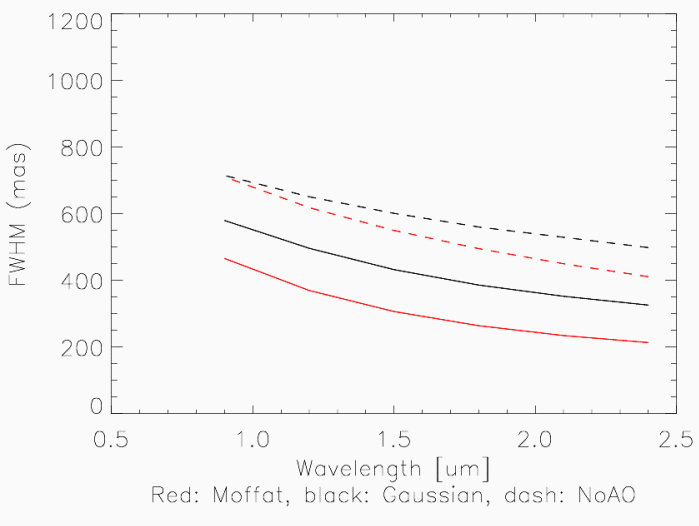
- 4 LGS, side-launched on a 11’ diameter constellation
- 40x40 LGS-WFS, Shack-Hartmann, 5” FoV (x4)
- Secondary deformable mirror, 1170 actuators
- 6 arcmin off-axis TT sensor
- Maintenance mode (MCM): NGS-SCAO
- SPARTA RTC

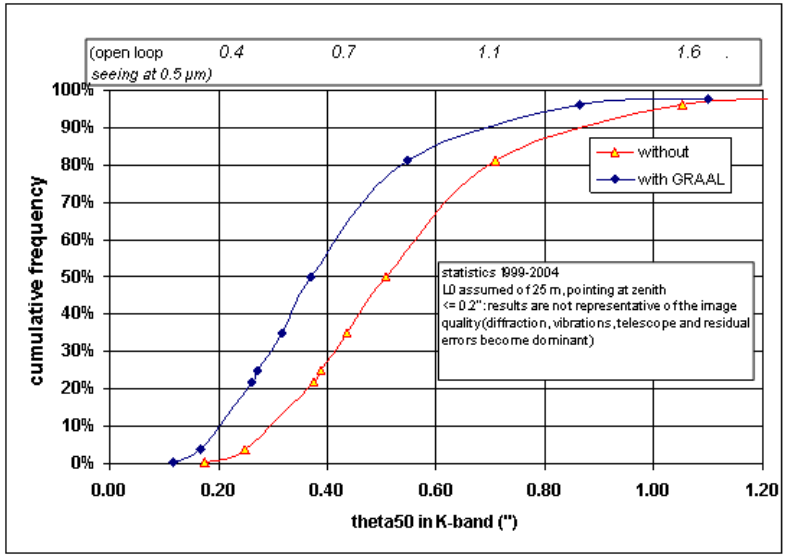


A GLAO-SCAO system at the VLT

expected performance

- Wide-field AO:
  Unobstructed field of view 7.5x7.5 arcmin²
- 30-40% reduction of FWHM (K-band)
- Enables an image quality better than 0.3” in K-band 25% of the time
- 100% sky coverage



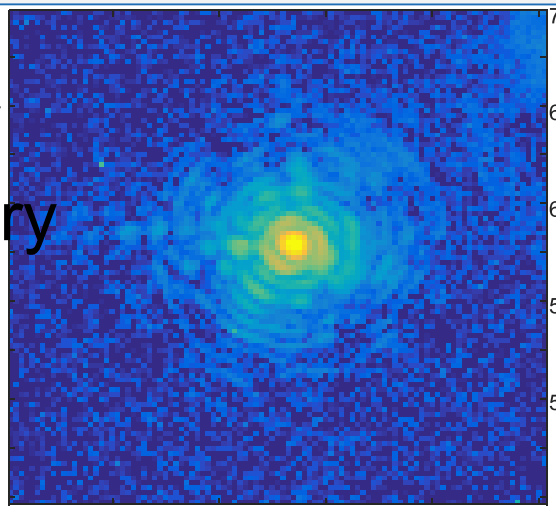


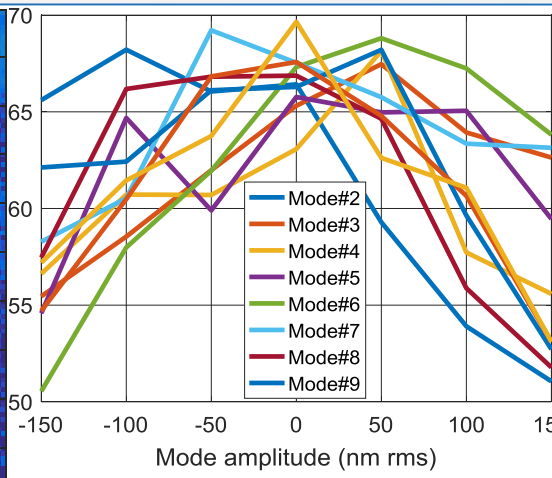
A GLAO-SCAO system at the VLT
design

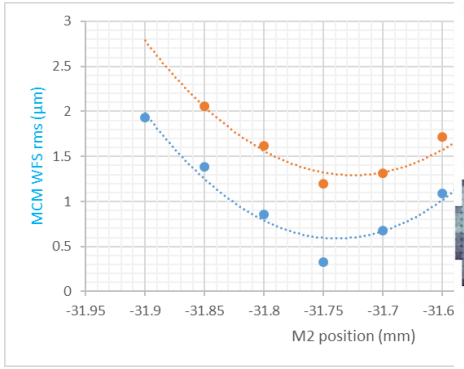
- GRAAL embedded in HAWK-I:
  - rotates with the field
  - Is a very thin cylinder (300 mm thick)
- LGS on a pupil-tracking co-rotator => large motor and crammed cable wrap
- TT-sensor on a 6-7 arcmin radius
  - Crosses Rayleigh beams
  - Complicated observation preparation
- SCAO mode including
  - 40x40 WFS (identical to LGS)
  - Focal extender x6, maintaining back focal distance

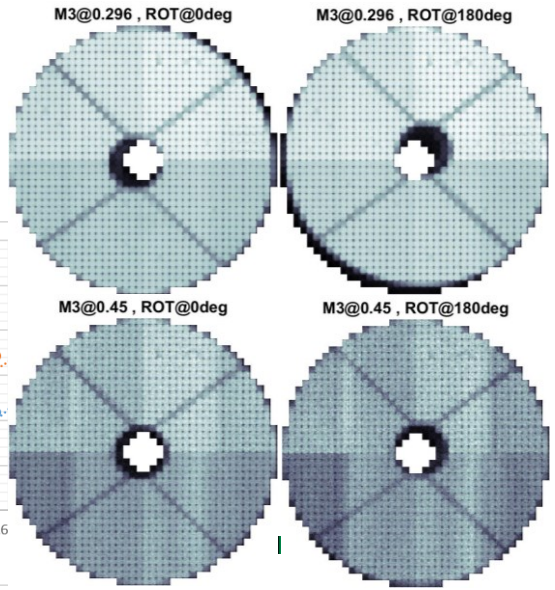
A SCAO system at the VLT
results

- Very first results obtained last December
- second run in February
- 70% on Naos for 1”seeing
- Removed faulty actuators SW-wise
- Best flat obtained and used in operation since then
- UT4 has now a (better) pupil sensor -> better UT4





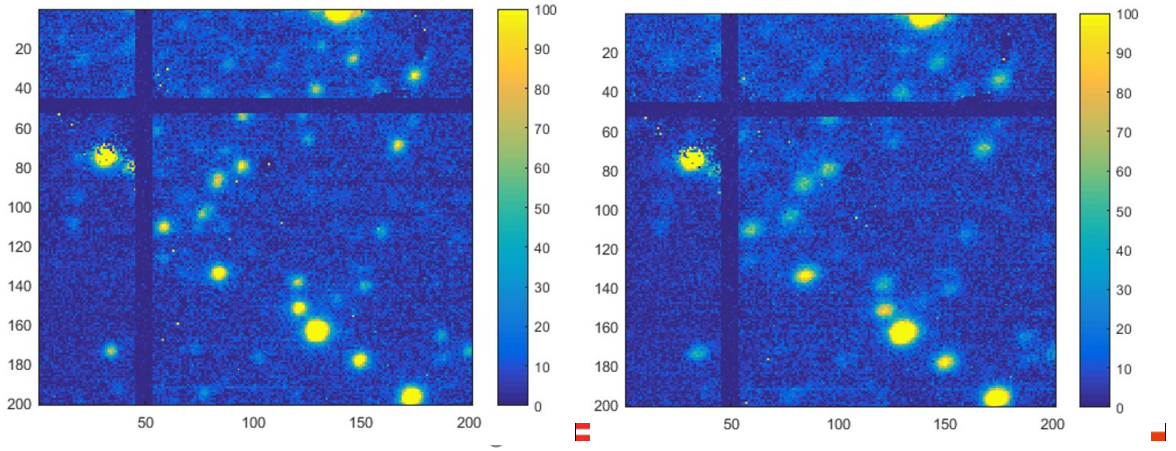




A GLAO system at the VLT

Status: the tip of the iceberg

- Most done in December, resuming in October
- Large gain in FWHM, no surprise expected (confirmed with GALACSI, see J. Kolb's talk)

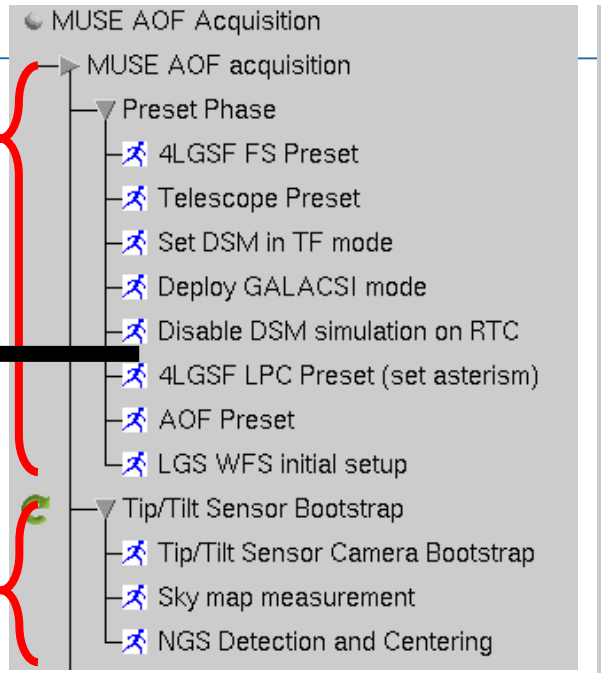


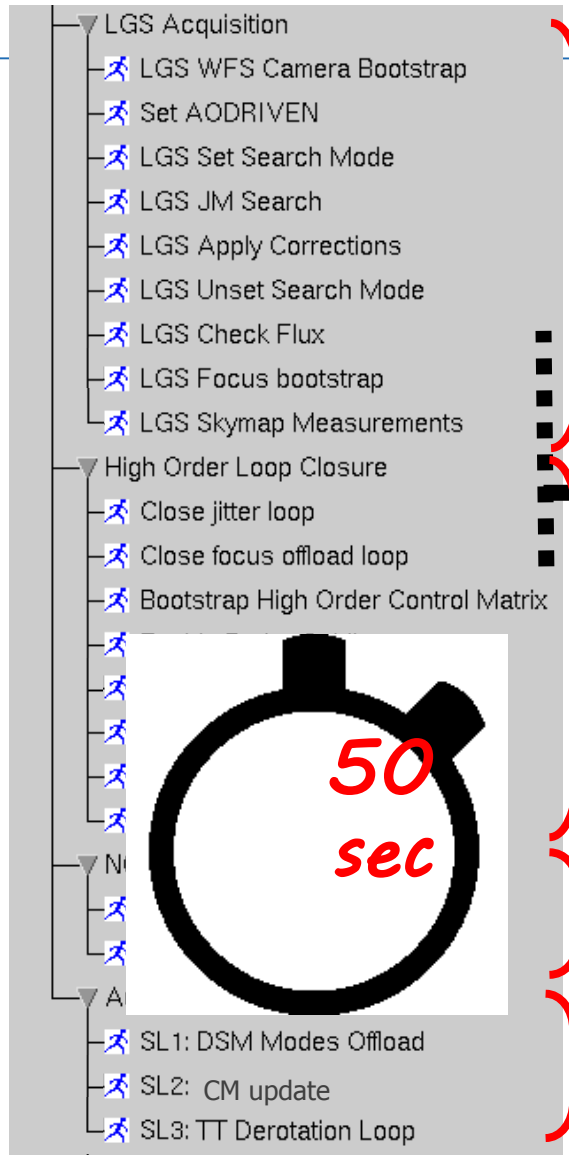
GRAAL Acquisition sequence

Preset of telescope, 4LGSF, motors, RTC, HAWK-I

Wait for 1 Act. Opt. correction

NGS acquisition





LGS acquisition

2 Act. Opt. correction

Close LGS WFS loops. Take control of telescope

Close NGS TT loop

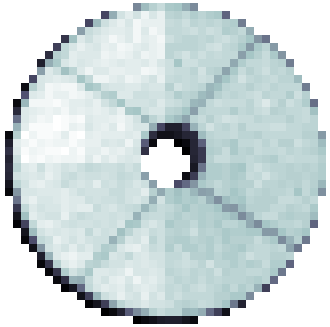
Close auxiliary loops

A GLAO system at the VLT

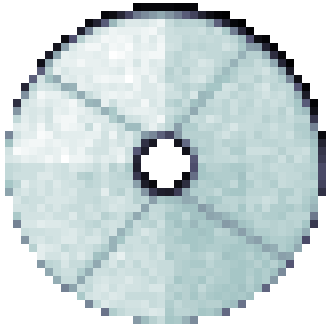
Status: the submerged part

- Pupil alignment: large variations (+/-70%), -> compensated by SW
- 4LGSF acquisition extremely robust with GRAAL, improved with GALACSI
- Degraded mode of operation tested (on purpose!) with 3 LGS-WFS, co-rotator components
- TT sensor focusing far from ideal, -> mechanical intervention
- Safety features glitches (WFS, cooling) -> adjusted
- Natural ageing of EM-CCD (gain loss of 40%), re-calibrated
- 4LGSF system availability not ideal (AAC, LPC, cables)

M3@0.4, ROT@0deg



M3@0.4, ROT@180deg

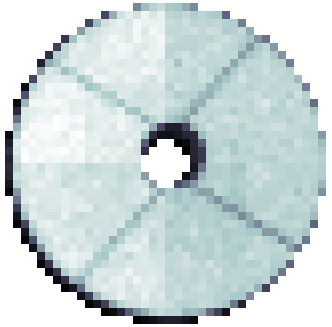


A GLAO system at the VLT

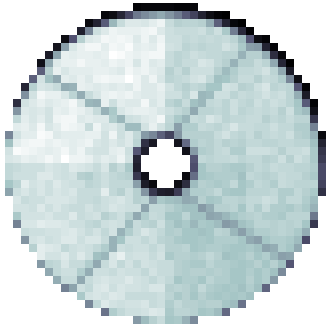
Status: the submerged part

- Pupil alignment: large variations (+/-70%), -> compensated by SW
- 4LGSF acquisition extremely robust with GRAAL, improved with GALACSI

M3@0.4, ROT@0deg



M3@0.4, ROT@180deg



A GLAO system at the VLT

single point of failure

A GLAO system at the VLT

Status: the submerged part

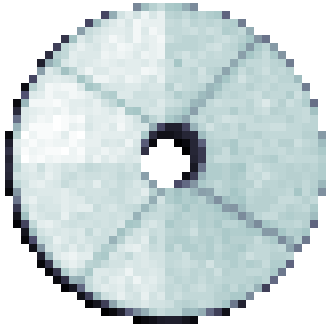
- Pupil alignment: large variations (+/-70%), -> compensated by SW
- 4LGSF acquisition extremely robust with GRAAL, improved with GALACSI
- Degraded mode of operation tested (on purpose!) with 3 LGS-WFS, co-rotator components

A GLAO system at the VLT

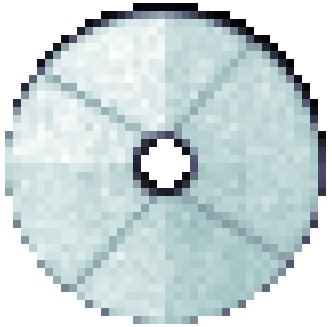
Status: the submerged part

- Pupil alignment: large variations (+/-70%), -> compensated by SW
- 4LGSF acquisition extremely robust with GRAAL, improved with GALACSI
- Degraded mode of operation tested (on purpose!) with 3 LGS-WFS, co-rotator components
- TT sensor focusing far from ideal, -> mechanical intervention
- Safety features glitches (WFS, cooling) -> adjusted
- Natural ageing of EM-CCD (gain loss of 40%), re-calibrated
- 4LGSF system availability not ideal (AAC, LPC, cables)

M3@0.4, ROT@0deg



M3@0.4, ROT@180deg



Coming soon:
resumed commissioning

- GRAAL installed in 2015, progressing very slowly since then (organization had higher priorities set elsewhere)
- GLAO briefly tested, will be really commissioned over Oct-Dec 2017
- SCAO demonstrated the capability of the DSM
- HAWK-I (adaptive) facility operation planned for Oct-2018