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:
  - Detectors:
    - M.Downing, J.Reyes, L.Mehrgan
  - Software:
  - Integration:
  - 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 assembly)

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

27. June 2017, Tenerife AO4ELT5
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

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27. June 2017, Tenerife AO4ELT5
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

27. June 2017, Tenerife AO4ELT5
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**

1. **Preset of telescope, 4LGSF, motors, RTC, HAWK-1**
   - 4LGSF FS Preset
   - Telescope Preset
   - Set DSM in TF mode
   - Deploy GALACSI mode
   - Disable DSM simulation on RTC
   - 4LGSF LPC Preset (set asterism)
   - AOF Preset
   - LGS WFS initial setup

2. **NGS acquisition**
   - Tip/Tilt Sensor Bootstrap
   - Tip/Tilt Sensor Camera Bootstrap
   - Sky map measurement
   - NGS Detection and Centering

3. **Wait for 1 Act. Opt. correction**

4. **LGS acquisition**
   - LGS WFS Camera Bootstrap
   - Set AODRIVEN
   - LGS Set Search Mode
   - LGS JM Search
   - LGS Apply Corrections
   - LGS Unset Search Mode
   - LGS Check Flux
   - LGS Focus bootstrap
   - LGS Skymap Measurements

5. **Close NGS TT loop**
6. **Take control of telescope**
7. **Close LGS WFS loops**
8. **Close auxiliary loops**

**GRAAL Acquisition sequence**

50 sec
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)
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
A GLAO system at the VLT

single point of failure
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
Pupil alignment: large variations (+/-70%), -> compensated by SW

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Coming soon:

- 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