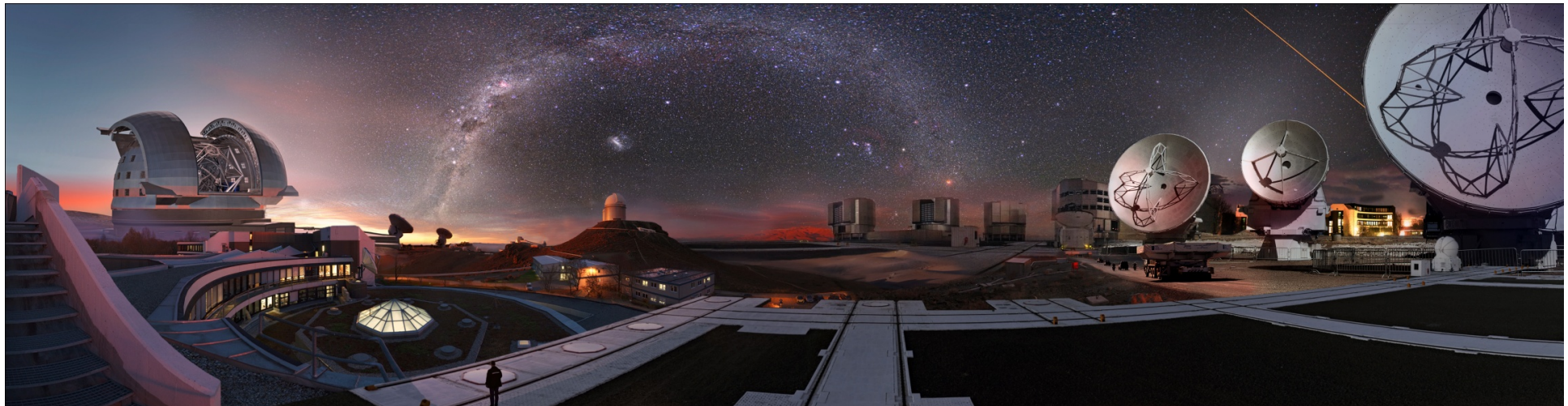


# The European Southern Observatory



AOF – Hawk-I/GRAAL

AO meeting 20./21. Sep 2016



# Outline

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- What is the AOF?
- General progress & highlights
- Hawk-I/GRAAL + 4LGSF
- AOF Hawk-I operational aspects - GL
- Conclusions

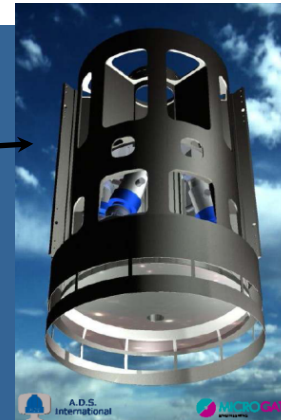
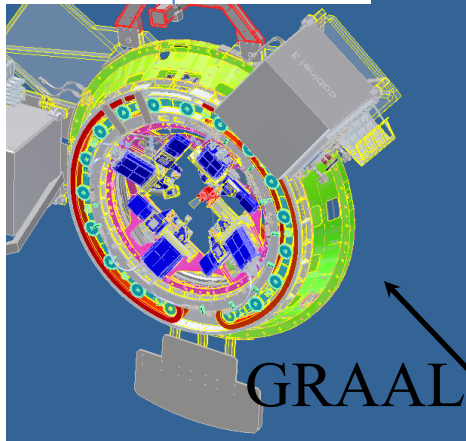


# AOF: why...what...

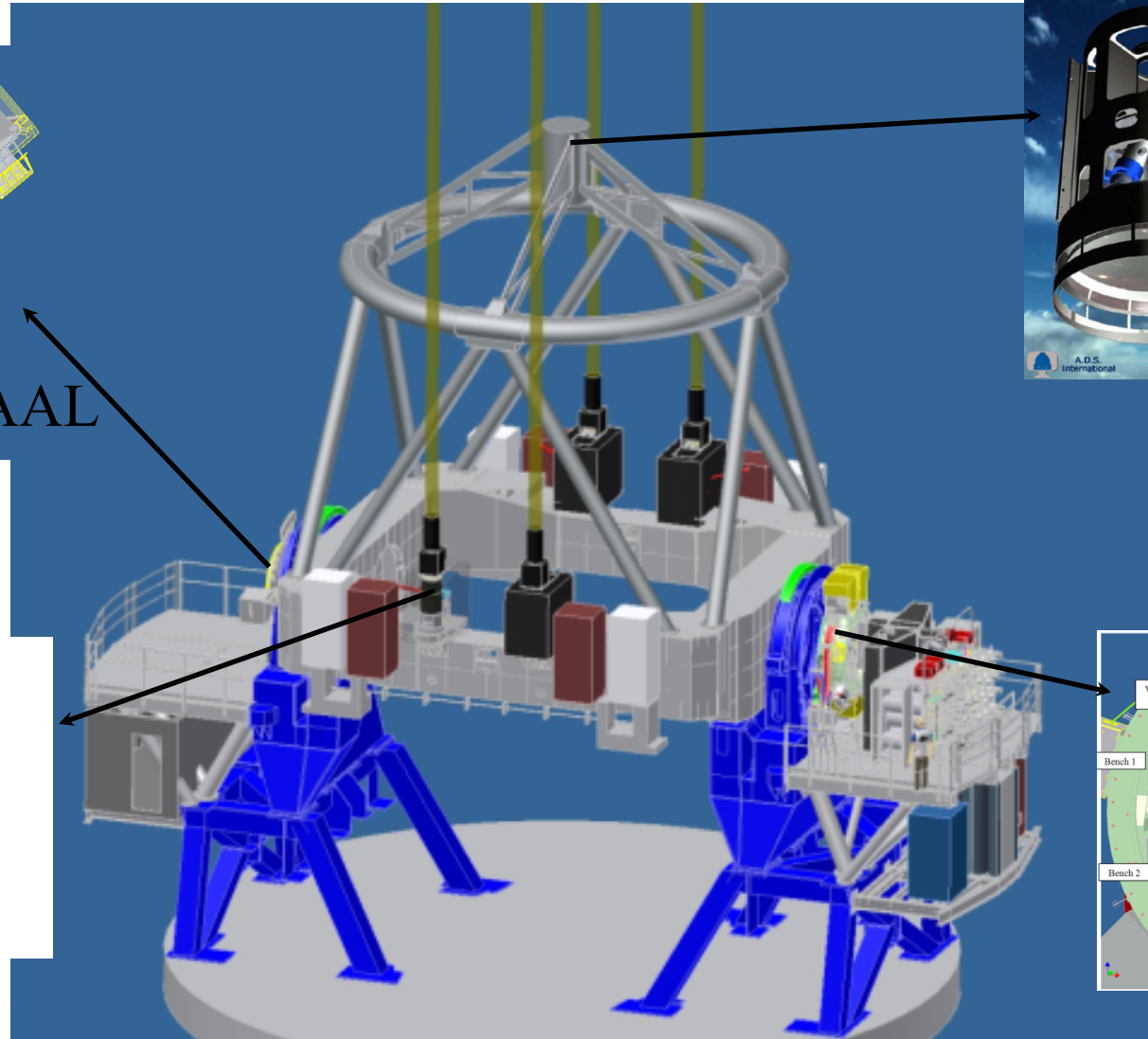
- To improve the observing conditions for the UT4 instruments by delivering
  - A better seeing in a Wide Field of View (Ground layer)
  - Diffraction limited images in one direction (LTAO; SCAO with ERIS)
  - But also allow for seeing-limited observations
  
- With ... as constraints
  - Not to degrade the Instruments throughput/emissivity
  - High sky coverage
  
- To turn-out UT4 in an Adaptive Telescope
  - To replace M2 by a Deformable Secondary Mirror (DSM, ~1000 actuators)
  - To provide a Multi-Laser Guide Star Facility (4LGSF – 20W per Laser)
  - To build two post-focal LGS/NGS WFS Modules to serve Hawk-I & MUSE
  - [To serve Cassegrain in form of ERIS (-> 2020)]



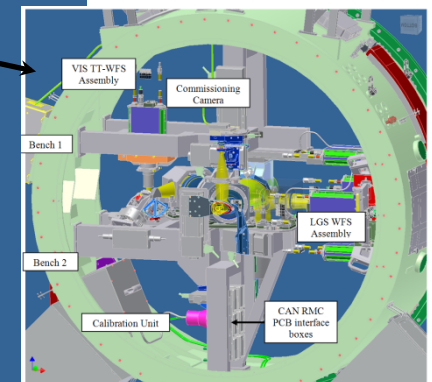
# AOF main subsystems



LGS Unit(s)

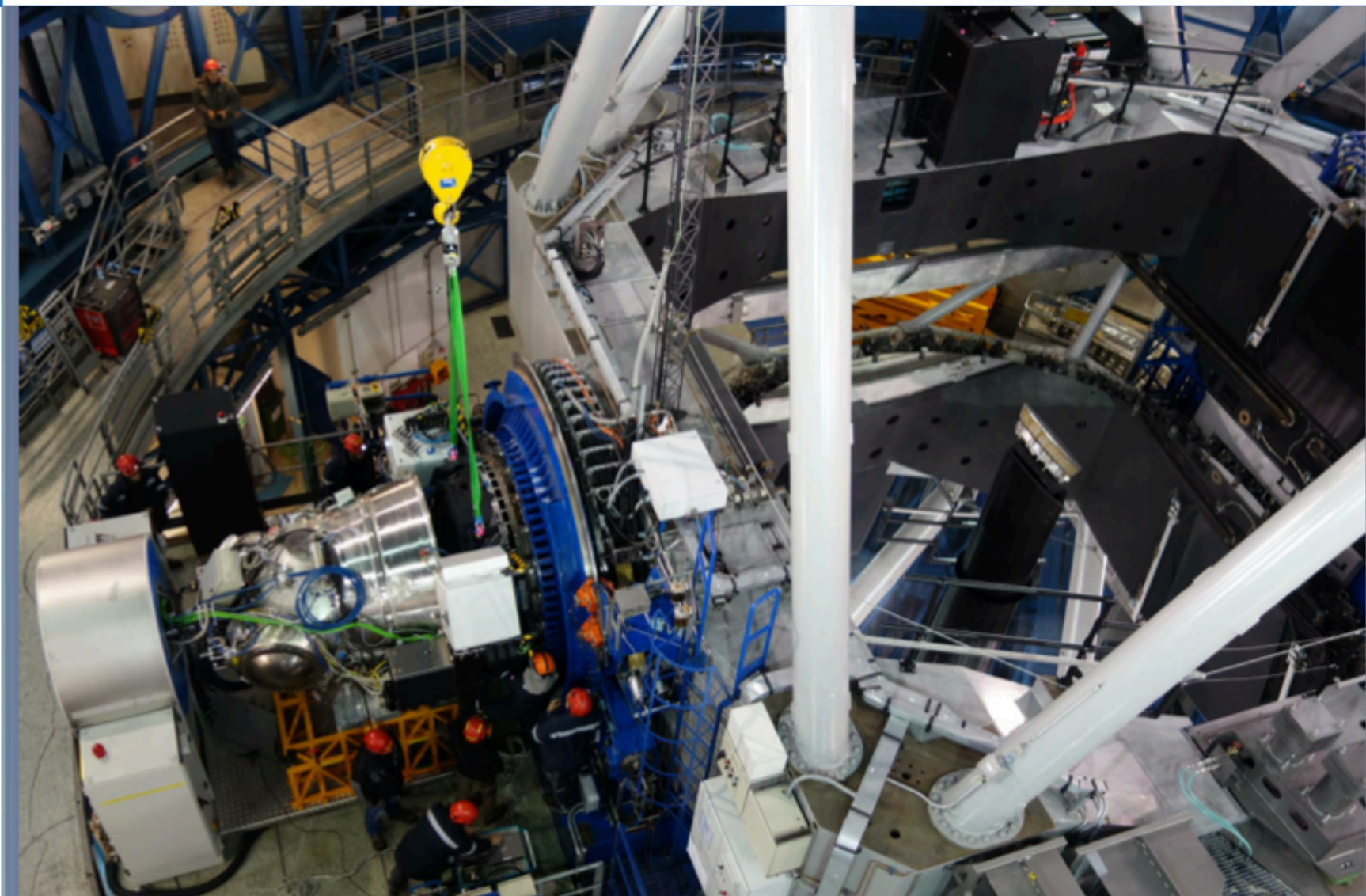


GALACSI





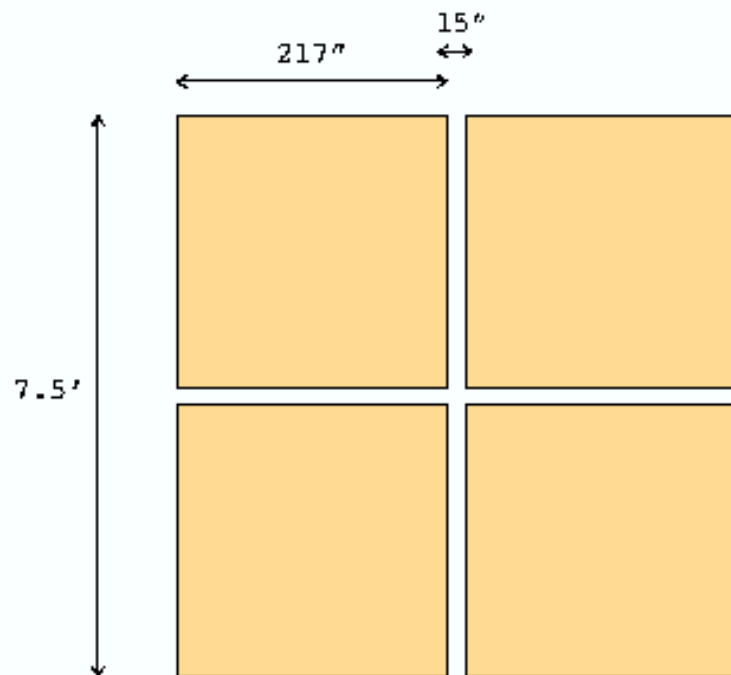
# Hawk-I/GRAAL on Paranal



J. Paufique et al., SPIE 9909-91



# Hawk-I ... Wide Field IR-imager



Since 2007

4x Hawaii-2RG

0.1 arcsec per pixel

## Limiting mag (Vega)

- J = 23.9
- H = 22.5
- K = 22.3

S/N = 5, 3600s, seeing 0.8", airmass 1.2



## Current AOF timeline

- GRAAL at Paranal 2015
- 4LGSF at Paranal early 2016
- DSM at Paranal – **"NOW"**
- MUSE / Galacsi WFM ready – **Sep 2017**
- Hawk-I / GRAAL ready – **~Q2 2018**
- AOF completed and operational – **mid 2018**
- Fully open community science – **end of 2018**



# HAWK-I + GRAAL

## ■ HAWK-I, a Wide FoV IR Imager (0.9 – 2.5 $\mu\text{m}$ )

- 7.5 x 7.5 arcmin<sup>2</sup> FoV – 0.1 arcsec pixel size
- Requirement towards AOF, in K band
  - Gain of  $\approx 2$  in EE in 0.1" (seeing reducer: x  $\sim 0.8$ )
  - 4 Lasers and TT-star (Rmag = 6 – 14.5 ... 17)
  - 4 Lasers and TT-free mode (performance TBD)

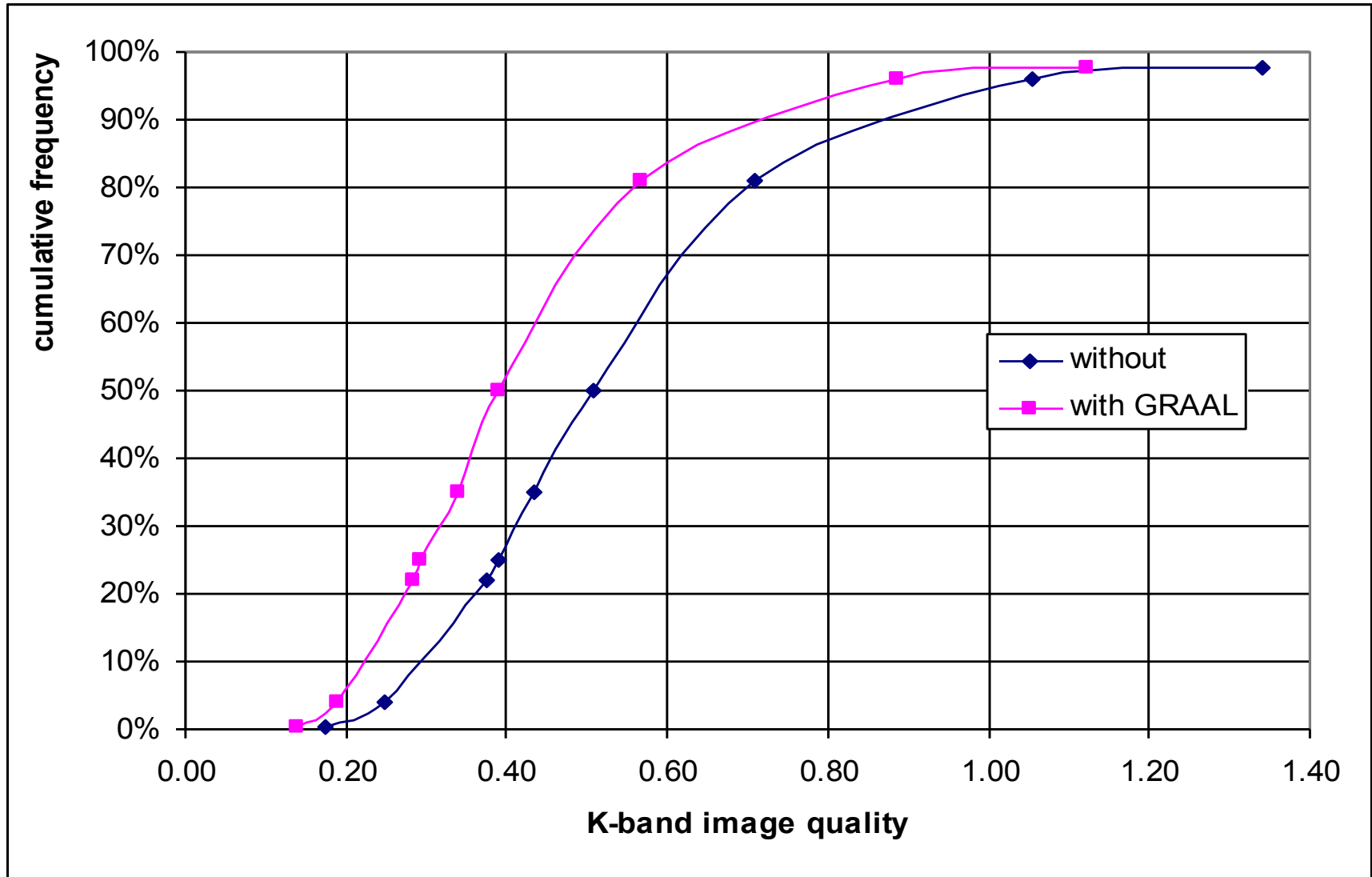
## ■ MUSE, a visible 3D Spectrograph (465-930 nm)

- Joel Vernet's talk

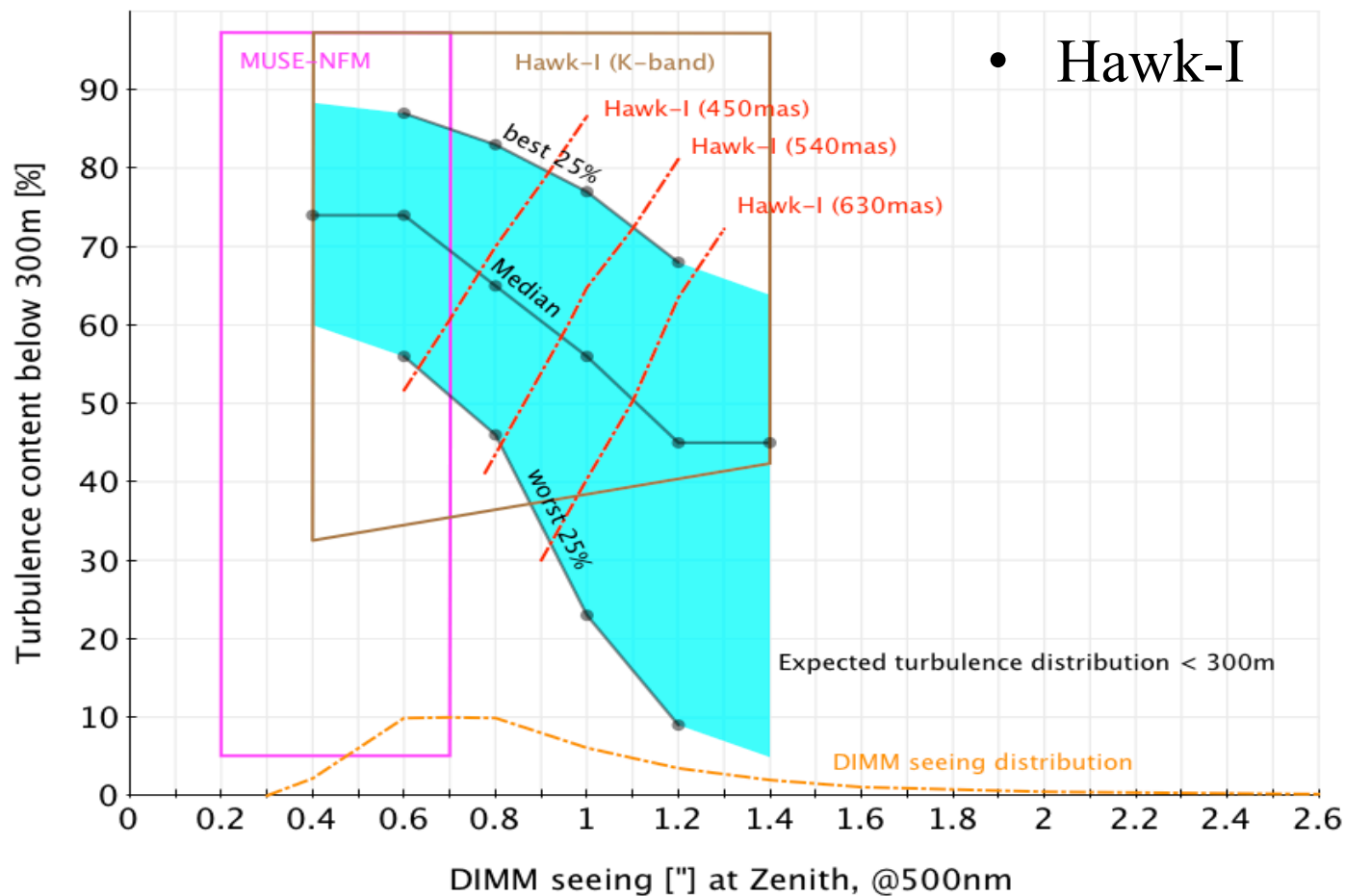




# HAWK-I + GRAAL



# Hawk-I + GRAAL



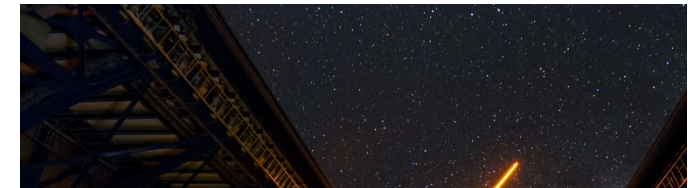
- Hawk-I

- ✓ Fainter magnitude limits for point sources
- ✓ Better spatial resolution for extended sources



# Project Highlights: LGSU#1 Comm.

- ◆ Comm.: Apr/May + Aug/Sep 2015
- ◆ LGSU#1 successfully commissioned !
- ◆ Good behavior of the hardware
- ◆ **Return Flux – OK**
- ◆ **Spot Size – OK**
- ◆ **Pointing model – OK**

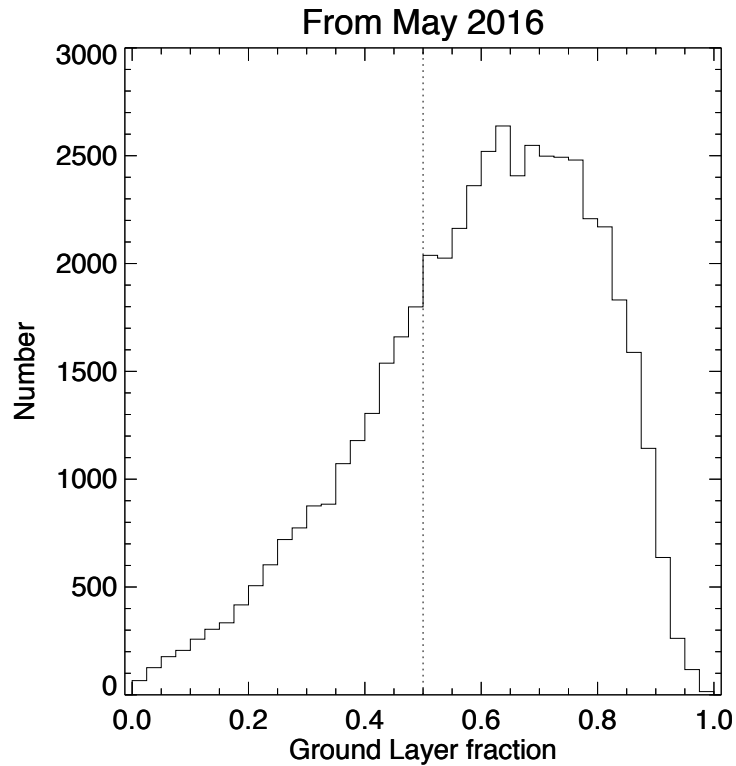




# ASM - Ground Layer

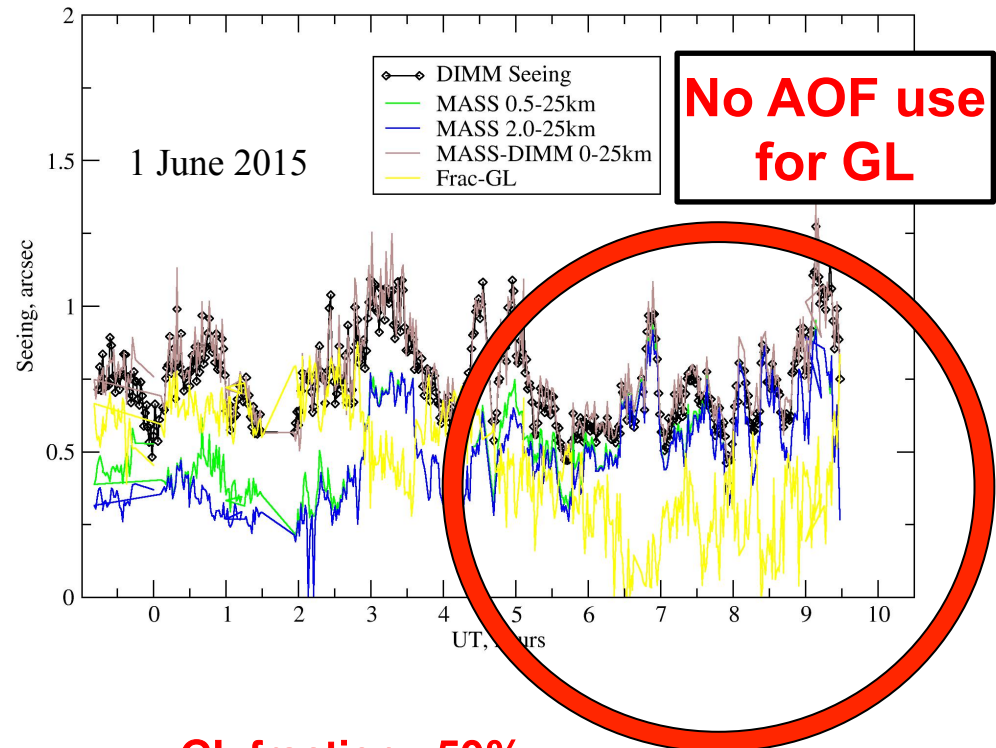
## Ground Layer Fraction as of May 2016

Occurrence in time



**About ~60% of time  
useful for AOF GL**

Cerro Paranal, MASS-U & DIMM-U  
on 7m high tower



**GL fraction <50%**



# ASM – “Weather”

- Completed upgrade (some documentation to come)
- **New: Ground Layer (GL) strength**
- Ground Layer (GL) on average  $\sim 0.6$  BUT  $\sim 30\%$  of time  $< 0.5$ .
- AOF needs GL strength  $> \sim 0.5$ .



# Possible science targets for Hawk-I ...

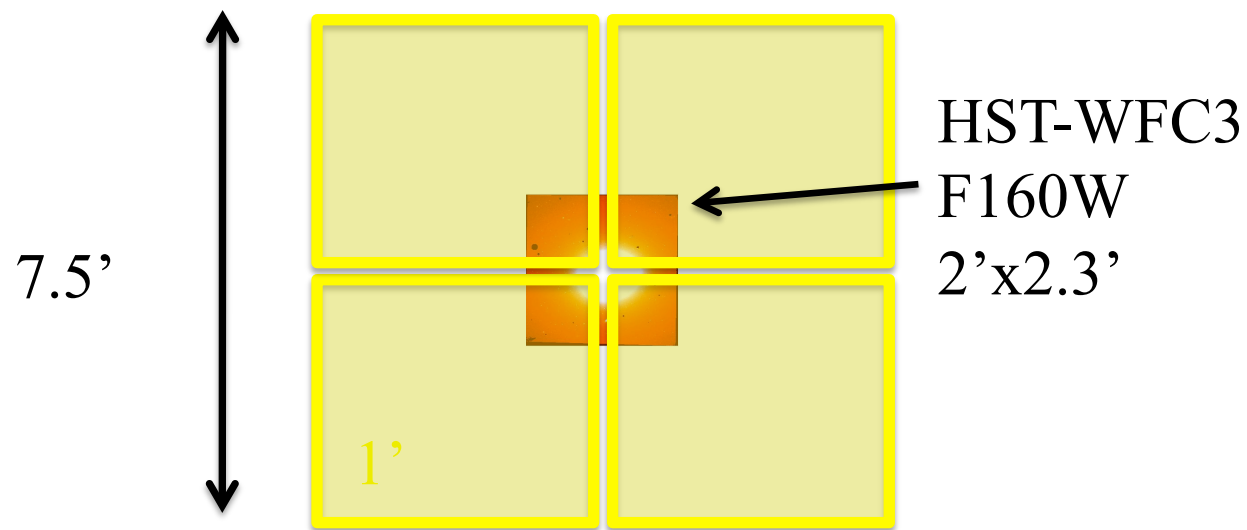
- Cosmology
  - Epoch of re-ionization; search with NB around  $z \sim 7-9$
- Galaxy & AGN
  - Probing black holes at  $z \sim 2-3$  with improved spatial resolution
- Star formation, PNs
  - Using large ( $7.5 \times 7.5$  arcmin) corrected FoV
- Stellar evolution
  - Large FoV and K-band (vs HST)
- Nearby galaxies, GCs
  - Shapes of galaxies in clusters, GC around nearby galaxies

P. Hibon et al.; SPIE





# Complementing HST - Hawk-I K-band globular clusters around NGC1399





What is the next instrument?

Science goals?

Nasmyth focus of Hawk-I?







# Conclusions

- AOF - excellent progress of project and good accomplishments
  - Starting soon with exchange of M2 with the DSM
  - 4LGSF already working to spec – tests with AO instruments to come
  - ASM operational
- Hawk-I/GRAAL offers excellent science opportunities



**2018**

