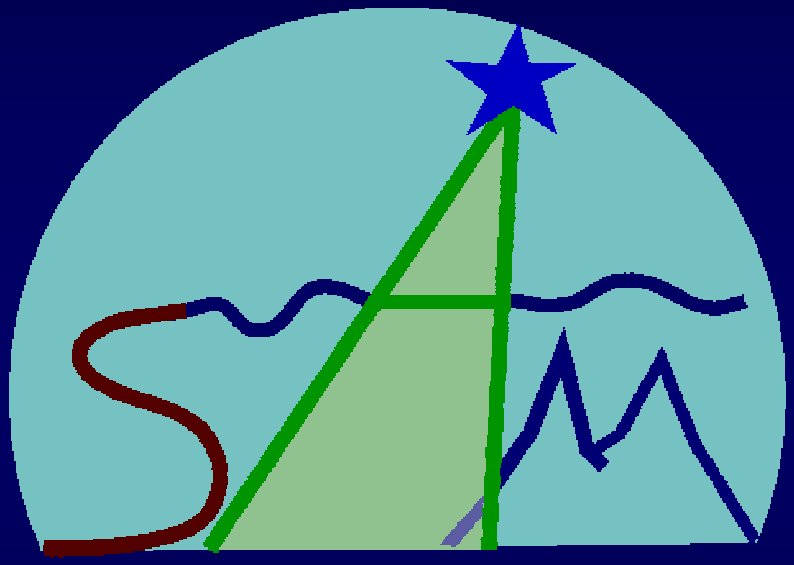


SOAR Adaptive Module

Seeing-limited

(>90% of ground-based astronomy!)

Ground Layer Adaptive Optics

=

Better seeing in wider field

- **GLAO works in the visible**
- **Complete sky coverage**

Diffraction limit

(full AO or MCAO)

Matches SOAR strategy!

GLAO systems

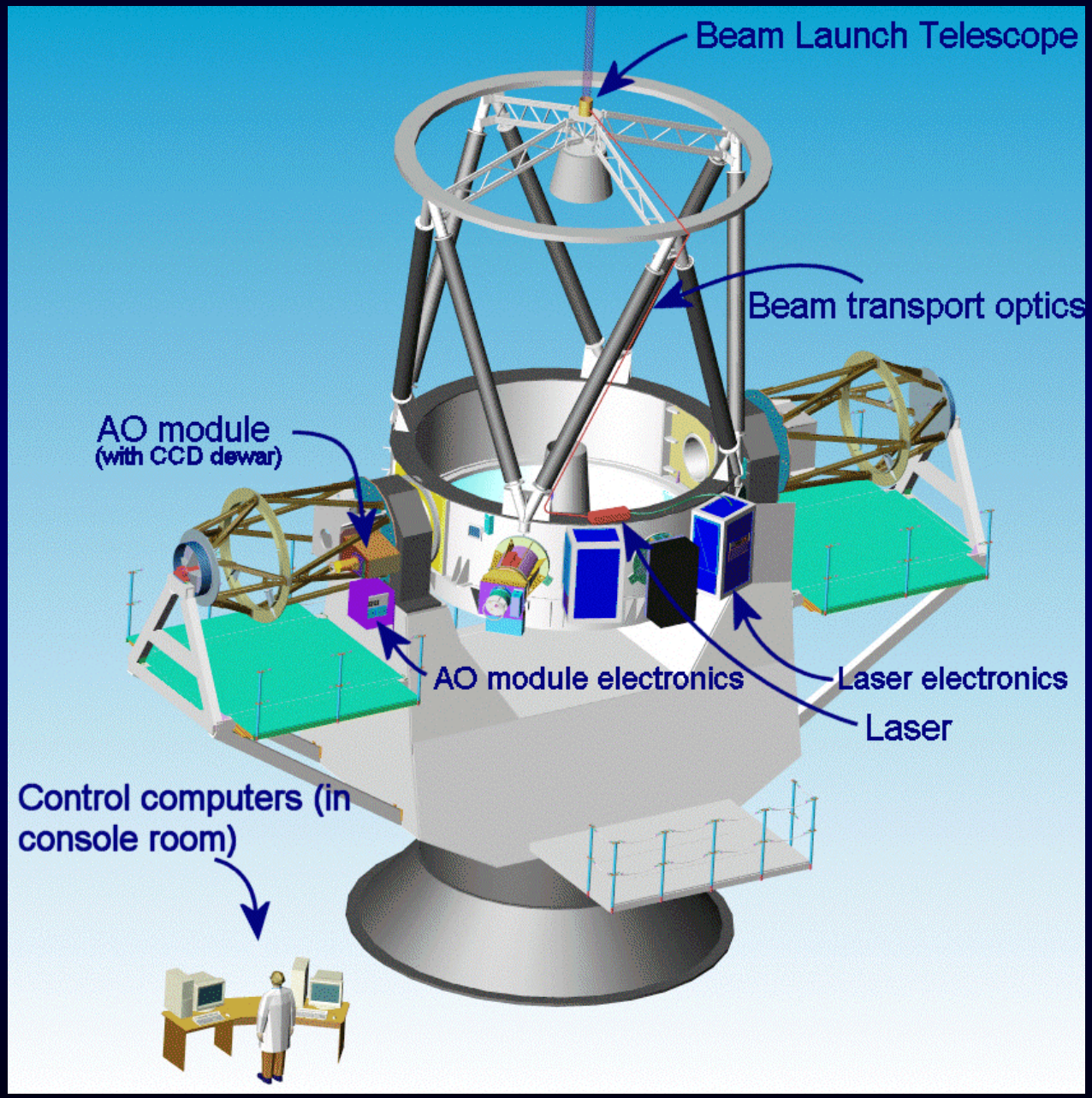
Different ways to sense and correct the ground layer…

- **Gemini: 5 sodium lasers, Deformable Mirrors**
- **ESO/MUSE: 4 sodium lasers, adaptive secondary**
- **Magellan: several wide NGS**
- **GLAS: Rayleigh LGS at ~20km, green**
- **SAM: Rayleigh LGS at ~10km, UV**

Rayleigh LGS senses preferentially low, strong layers

→ wide-field correction

SAM at a glance

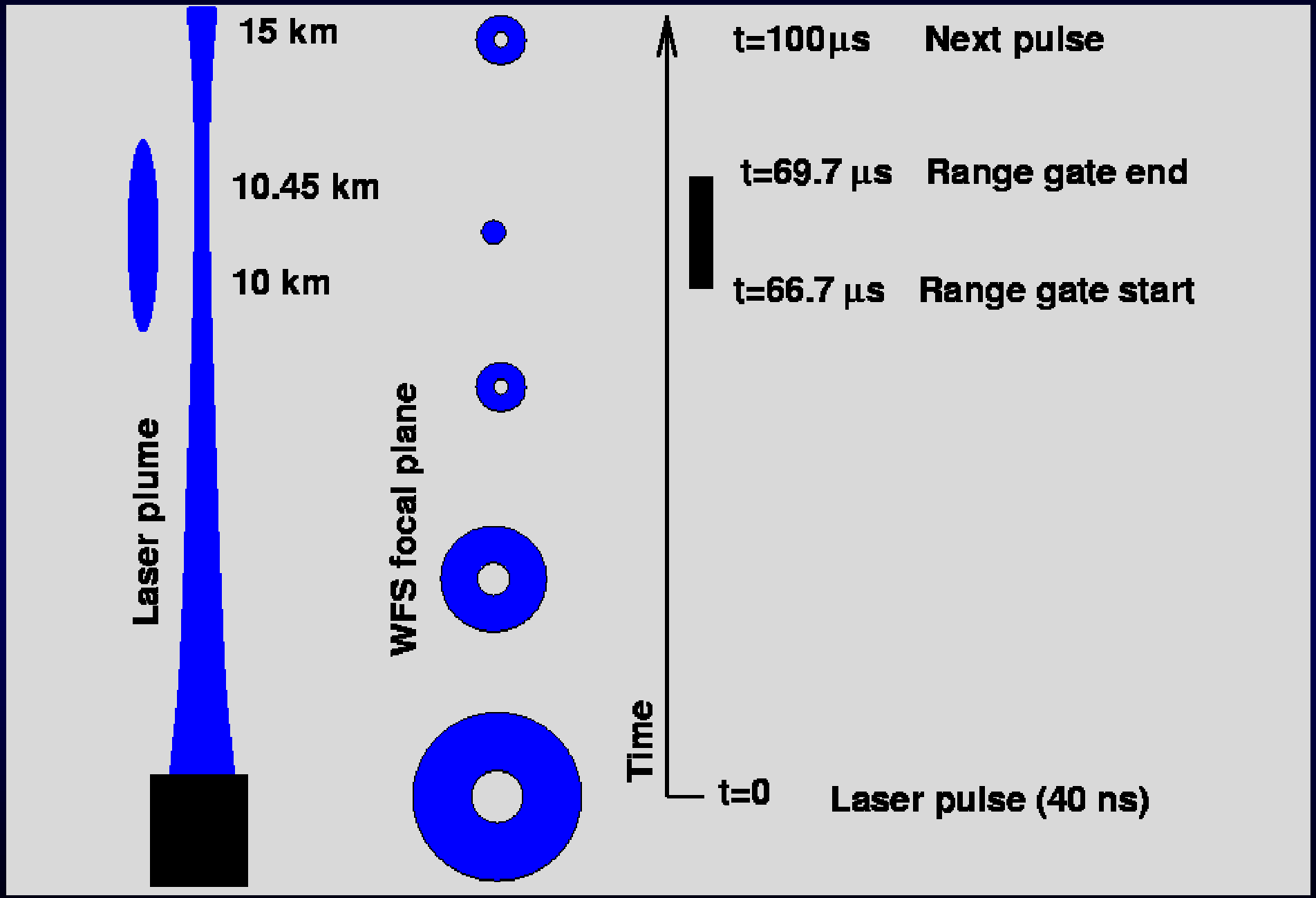


1:1 re-imaging

3'x3' field

feeds a "Visitor Instrument" & internal imager

Rayleigh LGS timing

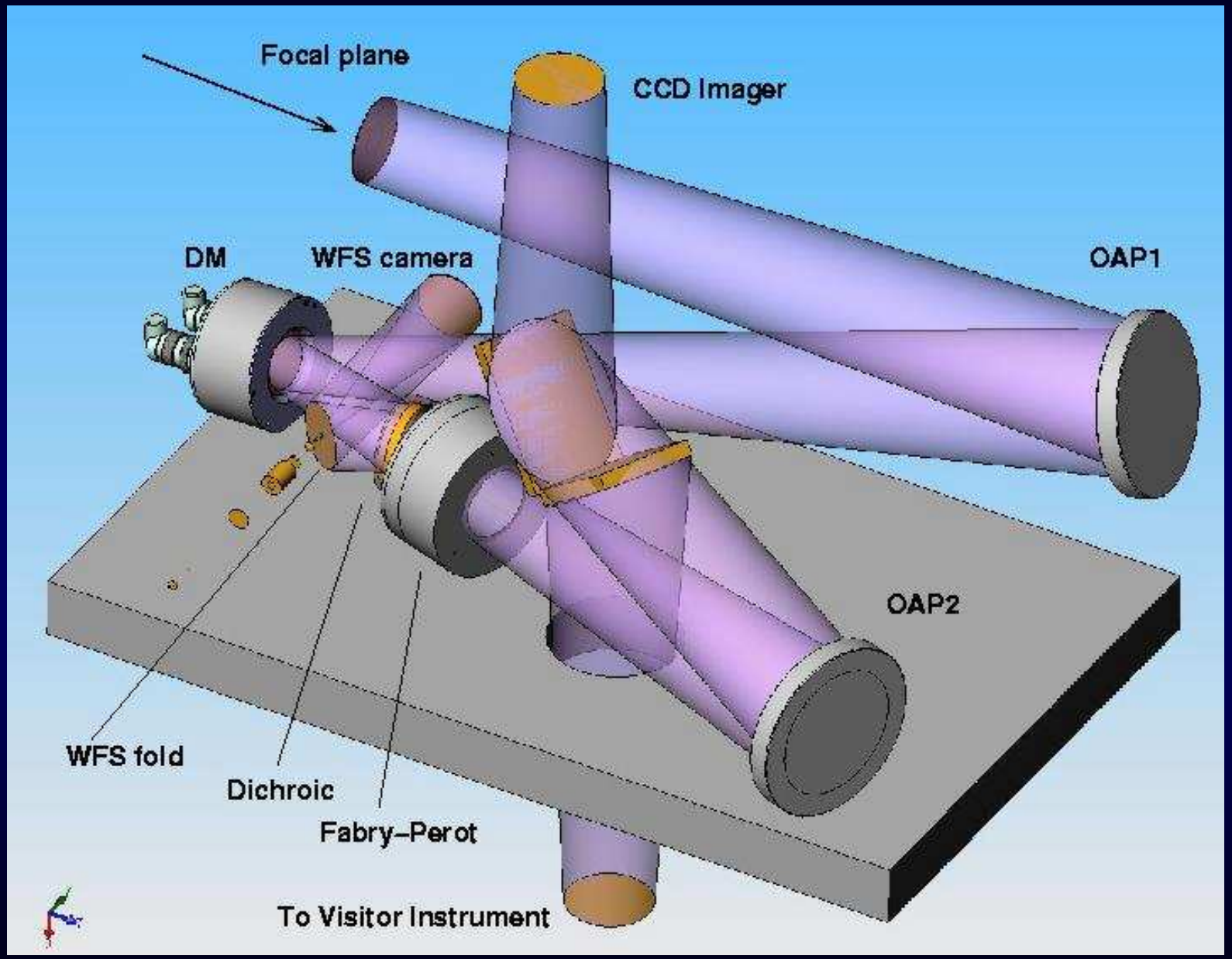


Optics

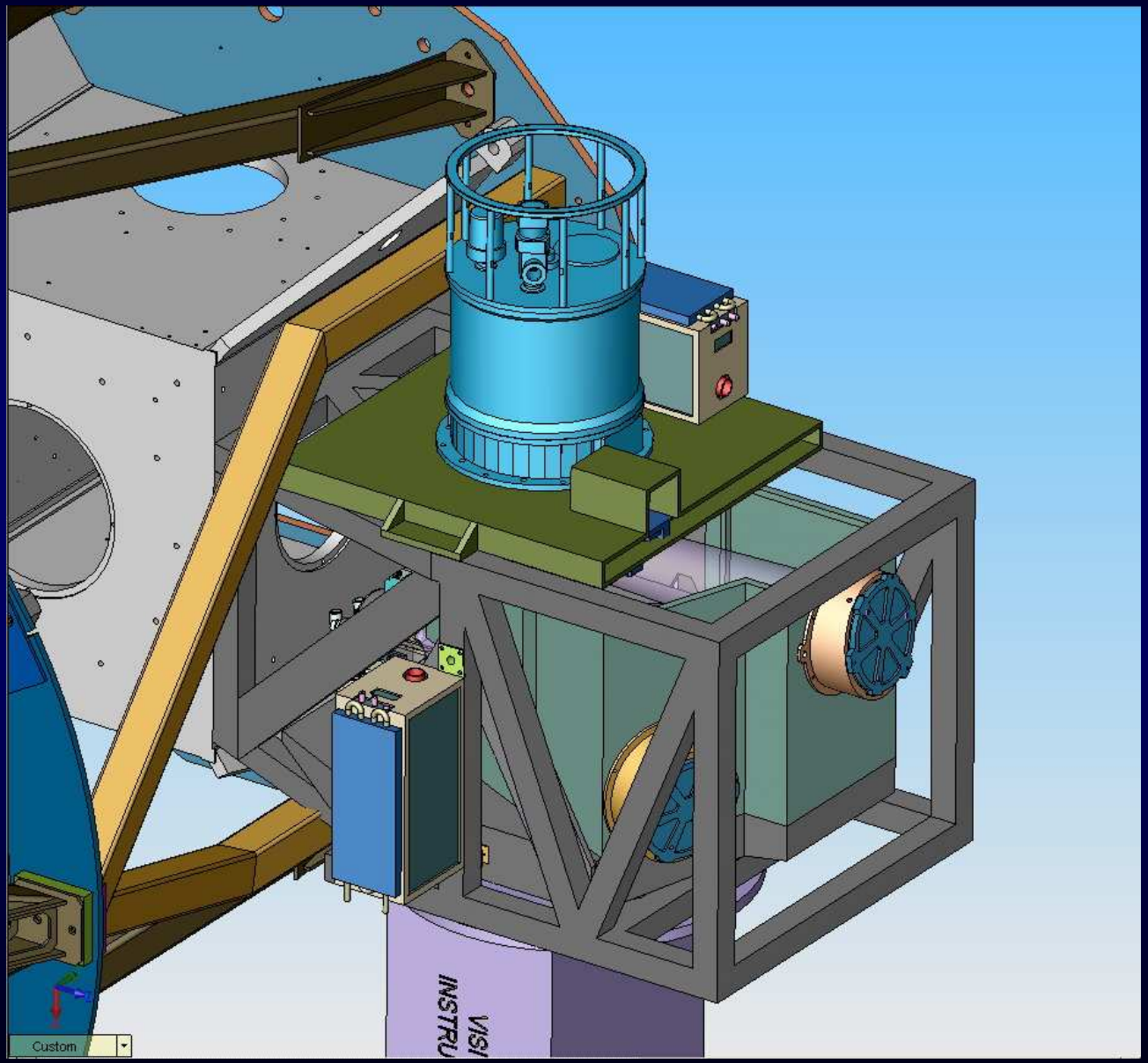
Throughput 0.85-0.9

at

wavelengths 0.4 to 0.9 μm

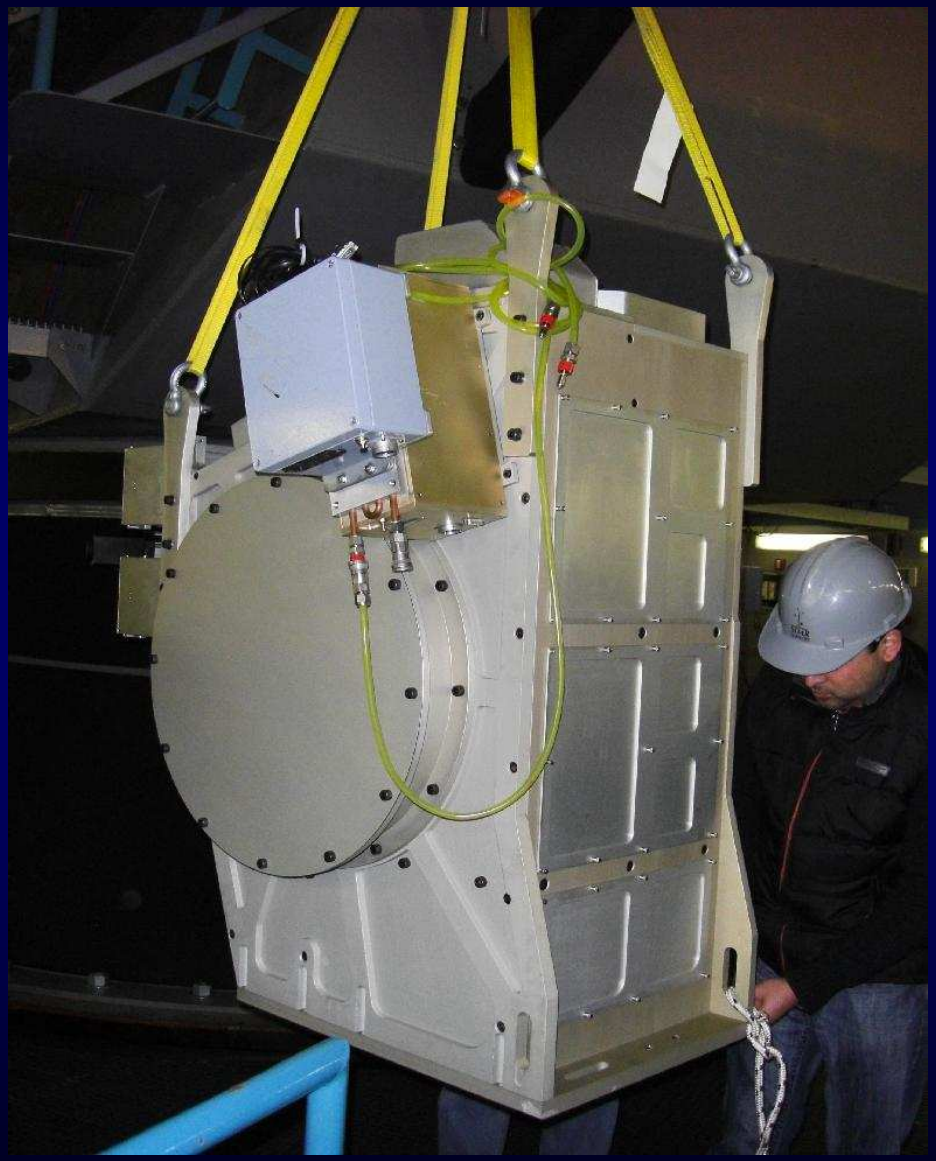


Mechanics

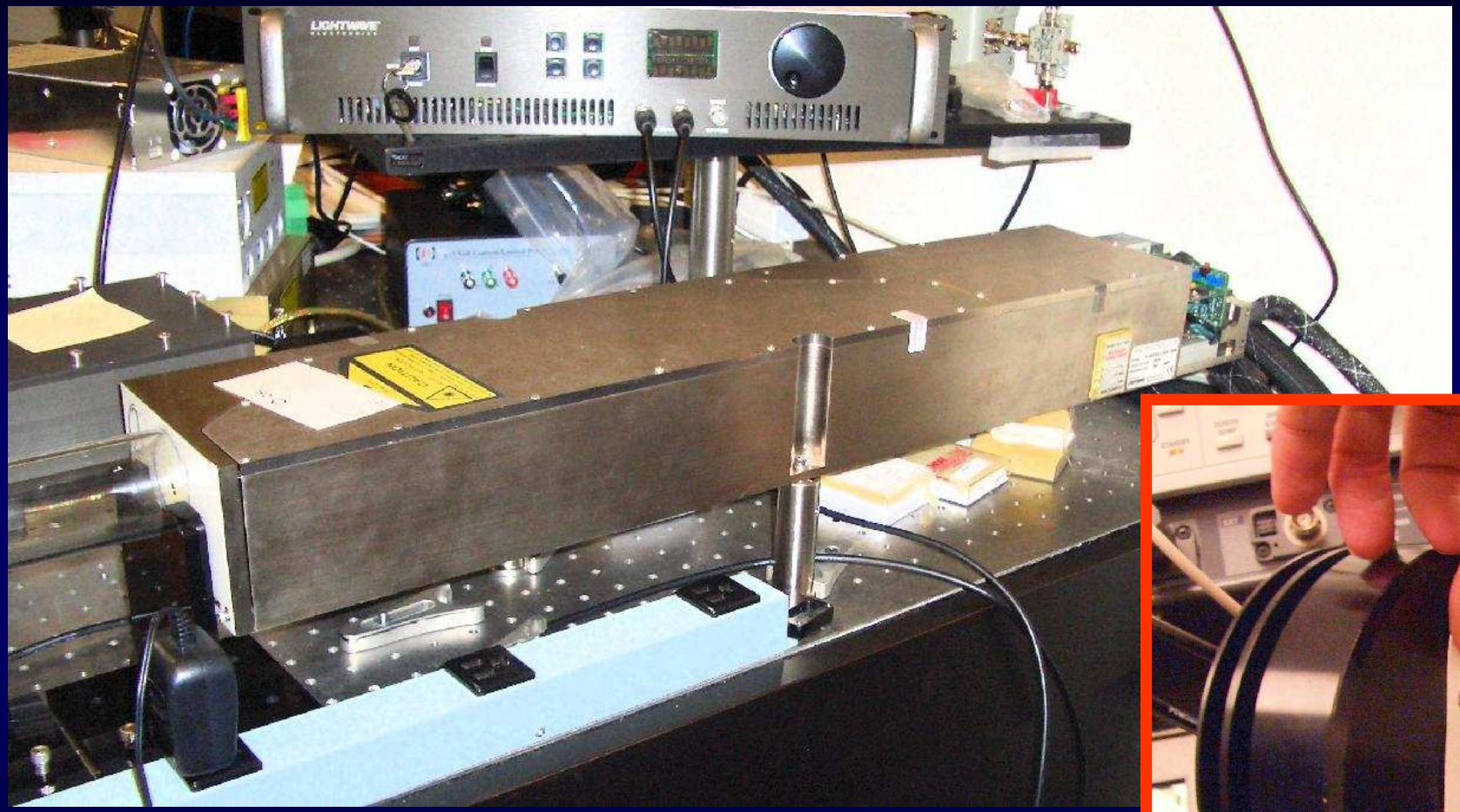


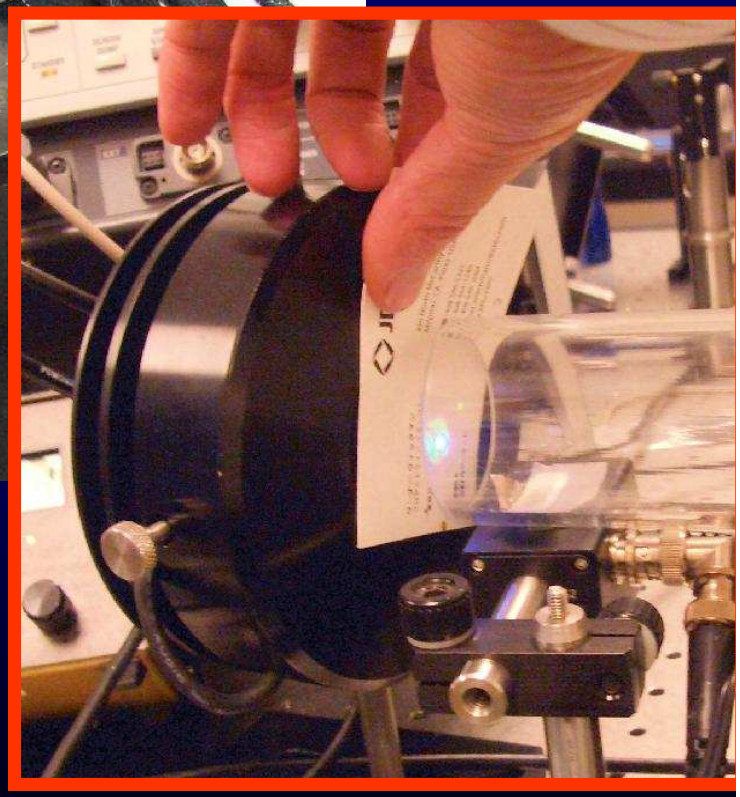
- Bench
- Frame
- Displaced axis
- Modified truss

Reality



Laser





- **355nm, 10W tripled Nd:YAG Laser**
  - **Standard industrial LASER**
  - **Similar (532nm) LASER used for MMT AO system**

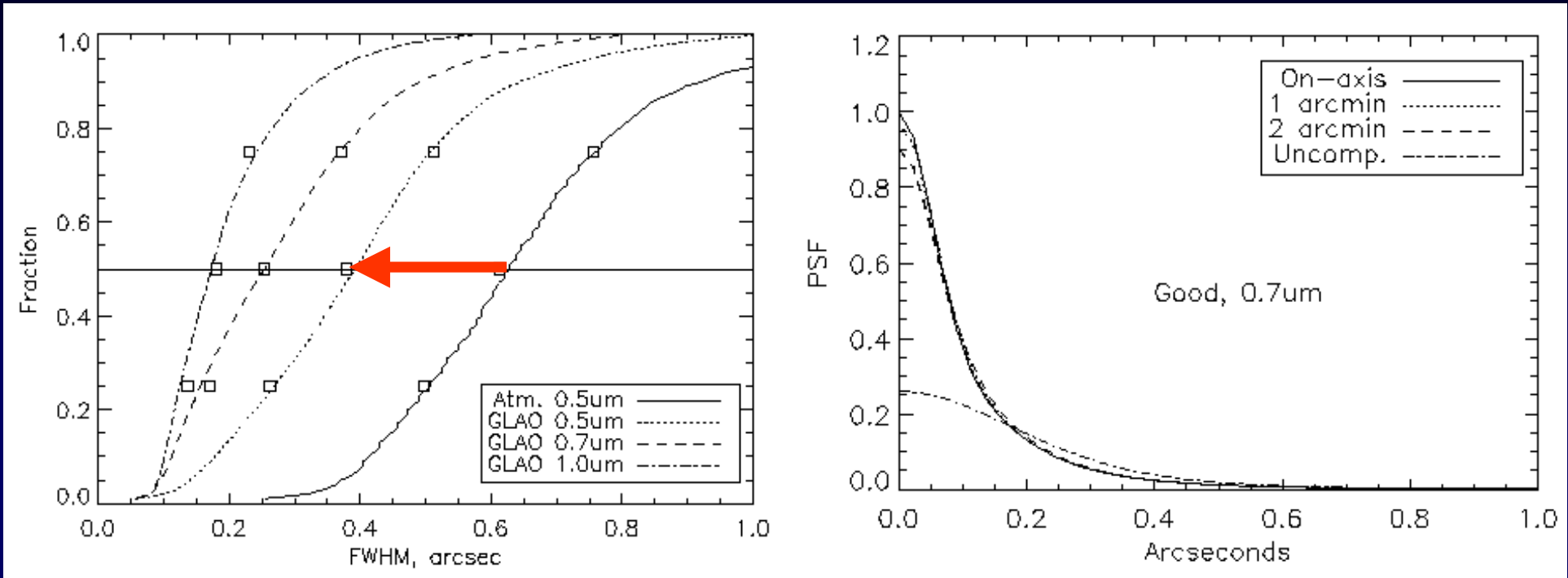
Q301-HD is used in the microprocessor industry 24/7.

Instruments with SAM

- SAM-I – a Simple Optical imager matched to AO corrected images
  - 3 x 3 arcmin FOV @ 0.07 arcsec/pixel
  - E2V 4k x 4k CCD
  - Filter wheel for 7 filters

- Visitor Instruments – SAM reproduces the SOAR focal plane at 1:1 scale, and the provides a copy of the ISB bolt circle allowing any (relatively small and light weight) instrument to be mounted
  - HR cam – commercial EM CCD camera for fast time series & speckle
  - SIFS
  - BTFI
  - Spartan
  - ……
- Accessible space has been reserved in the collimated beam to allow the installation of e.g. a Fabry-Perot Etalon

SAM Performance Predictions



- New data for Cerro Pachon (MASS+DIMM)
- Models representative of good, typical, bad conditions
- LGS @ 10km, two tip-tilt NGS at 2.5'

Detailed predictions

Wavelength 0.7 μm, SOAR→ SAM

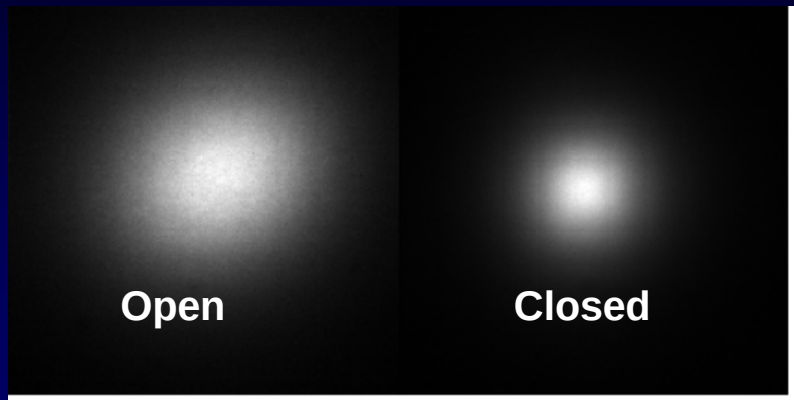
Conditions	FWHM, arcsec	EE(0.3”)
Good, z=0º	0.45 → 0.17	0.20 → 0.39
Good, z=50º	0.60 → 0.28	0.12 → 0.25
Typical, z=0º	0.55 → 0.25	0.14 → 0.28
Typical, z=50º	0.74 → 0.43	0.09 → 0.16
Bad, z=0º	0.68 → 0.37	0.10 → 0.19
Bad, z=50º	0.91 → 0.60	0.06 → 0.10

FWHM gain ~2x; EE(0.3”) gain ~2x

SAM First Light

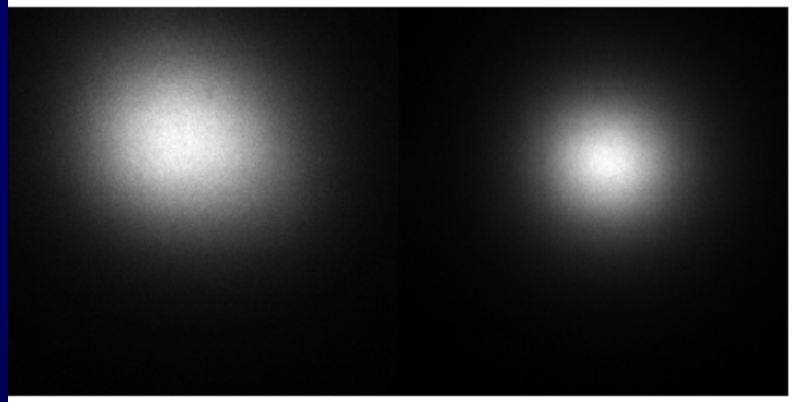
- SAM was installed on SOAR on 3 Aug 2009
  - Goal was to test closure of AO loop in NGS mode
- The weather did not cooperate
  - Aug 6 – 7: two cloudy nights
  - Aug 31 – Sep 3: 2nd run, some data with mostly bad seeing
- Nonetheless served to whet everyone's appetites ….

NoAO → YesAO



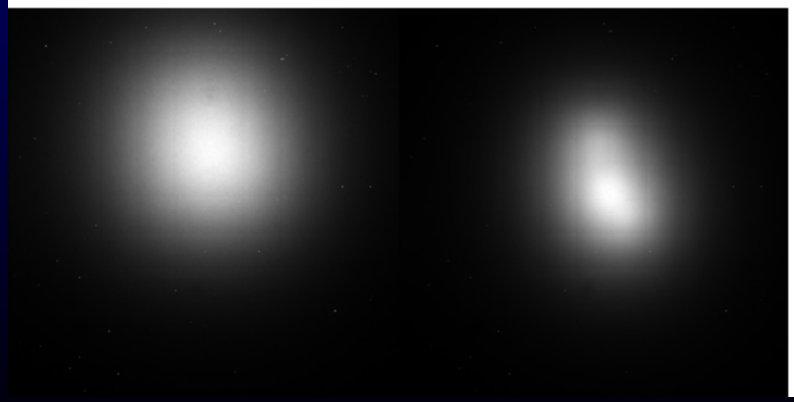
HIP 86846, 550nm

(1.29",1.09") –> (0.73",0.75"



FIN 307, 550nm

(1.28", 1.08") –> (0.90", 0.83"



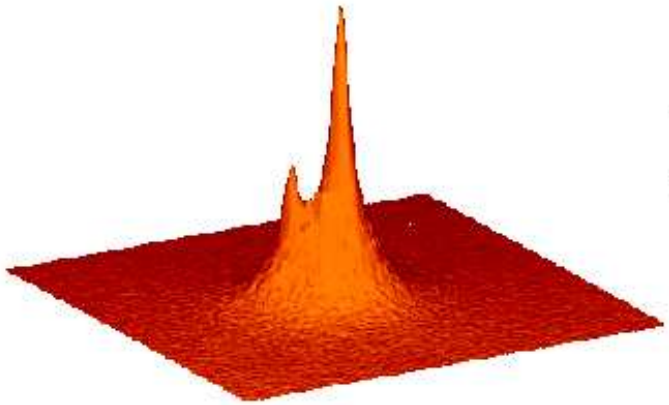
I 385, R–band

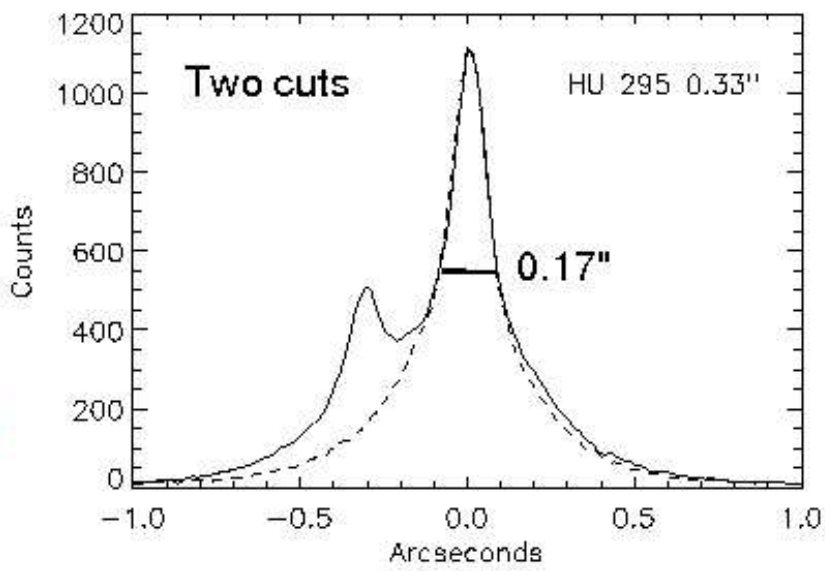
1.12" –> 0.75"

Stable, centered PSF

Focus and astigmatism are corrected!

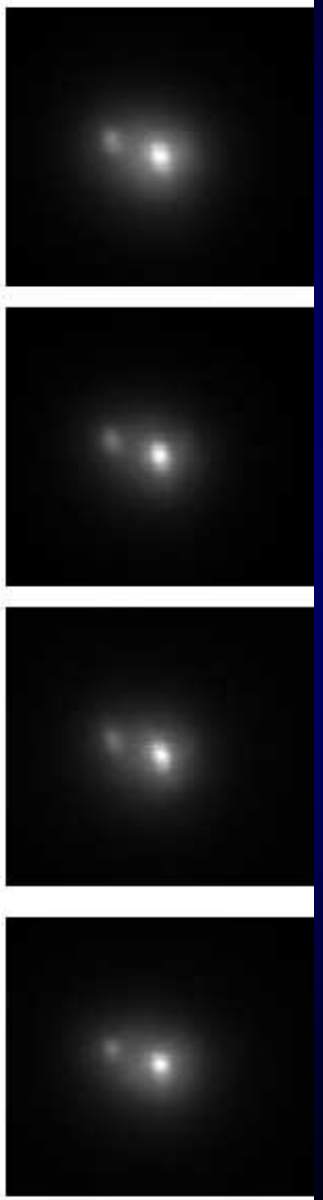
Best Images





HU 295 0.33"
I–band, 200x0.02s = 2s
SAM, September 3, 2009

Four 2–s images →



I 22 0.41"
I–band, 200x0.1s = 20s
SAM, August 31 2009

Next Steps

- SAM is now back in the lab
  - Integration & test of Tip-Tilt Sensors & ADC
  - Fabrication of SAM-I Dewar nearing completion
    - E2V 4kx4k CCD in hand
- LASER under test in Lab
- Waiting for delayed delivery of optics for LASER launch telescope
  - All mechanical parts designed and being fabricated

- Anticipate going back to the telescope in July/August
  - Full shake down of SAM in NGS mode
  - First Laser Launch

- Commissioning during 2010B/2011A …..