



# Palomar Laser Guide Star Adaptive Optics

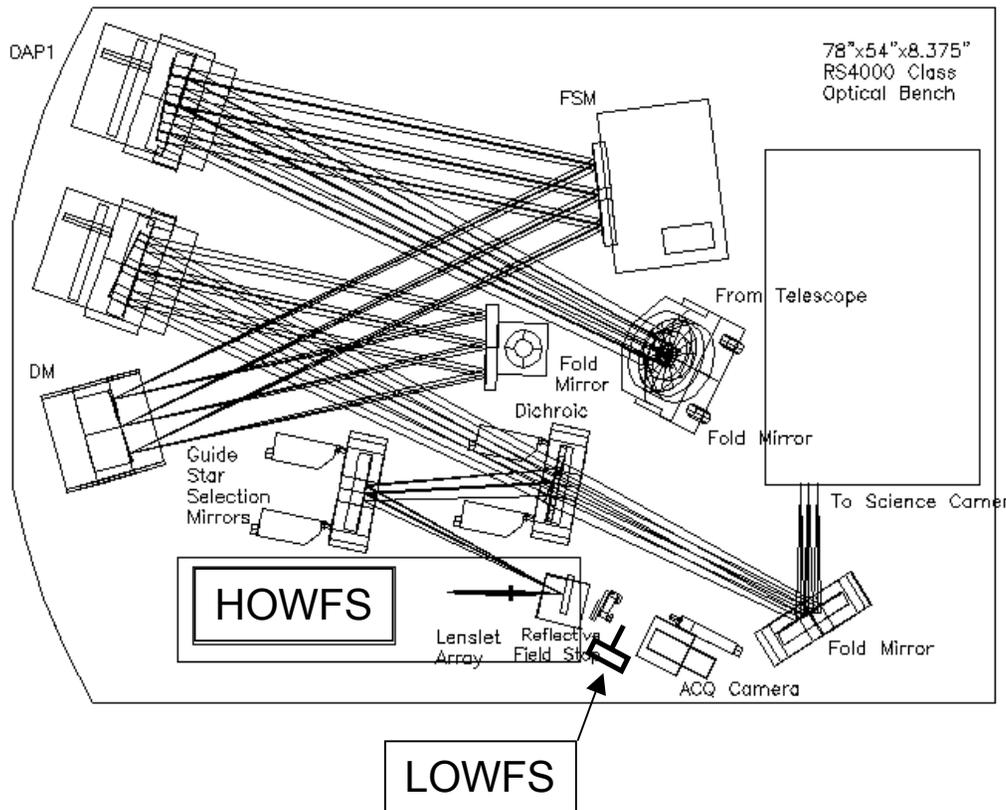
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September 14, 2006

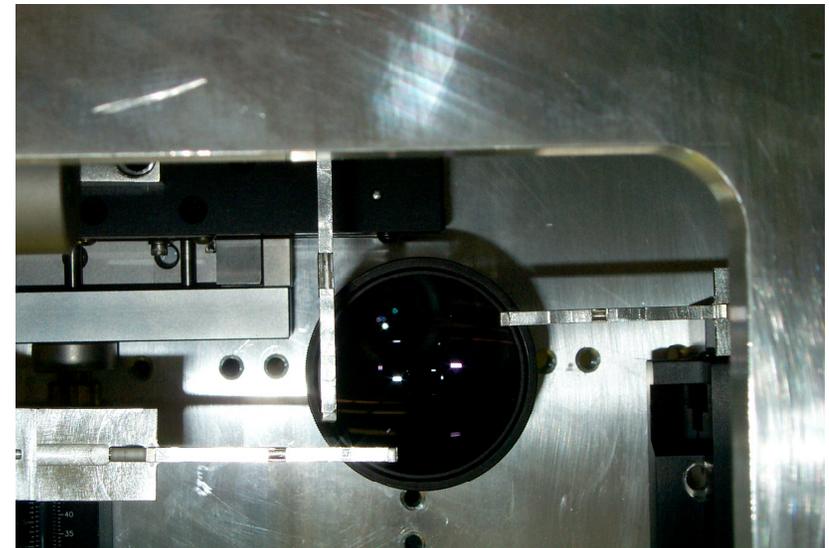


# LGS-AO system architecture



## AO Bench

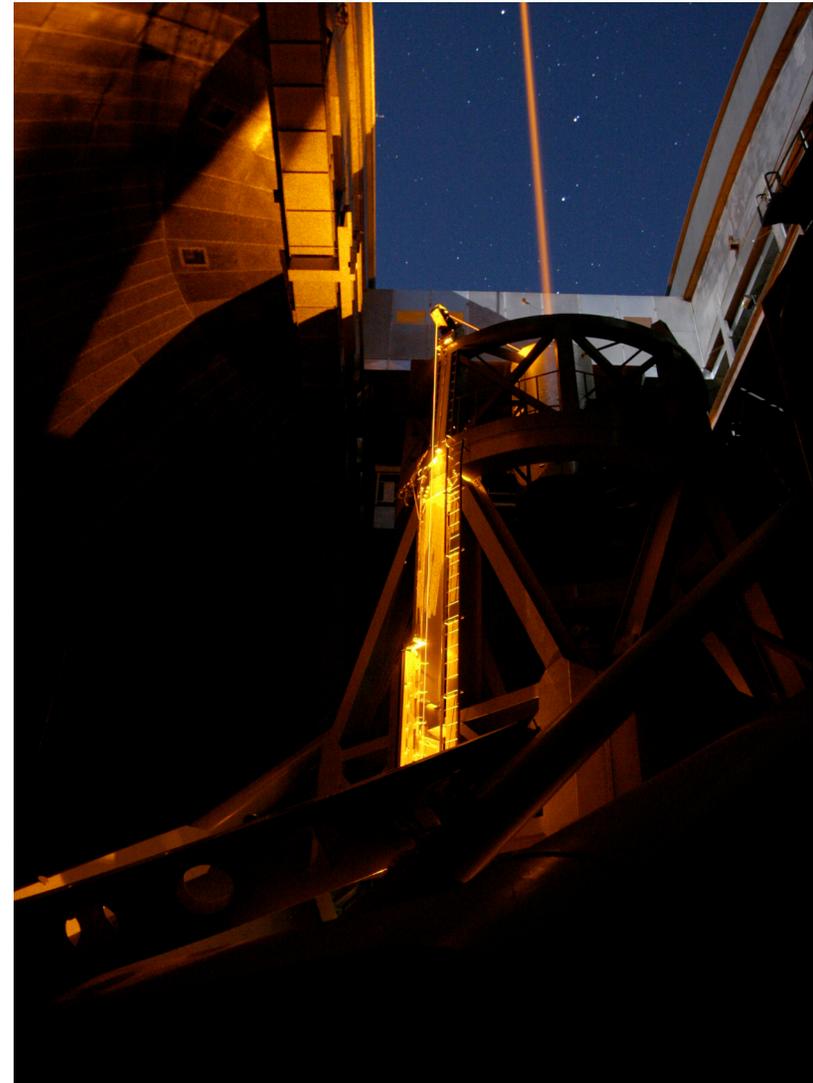
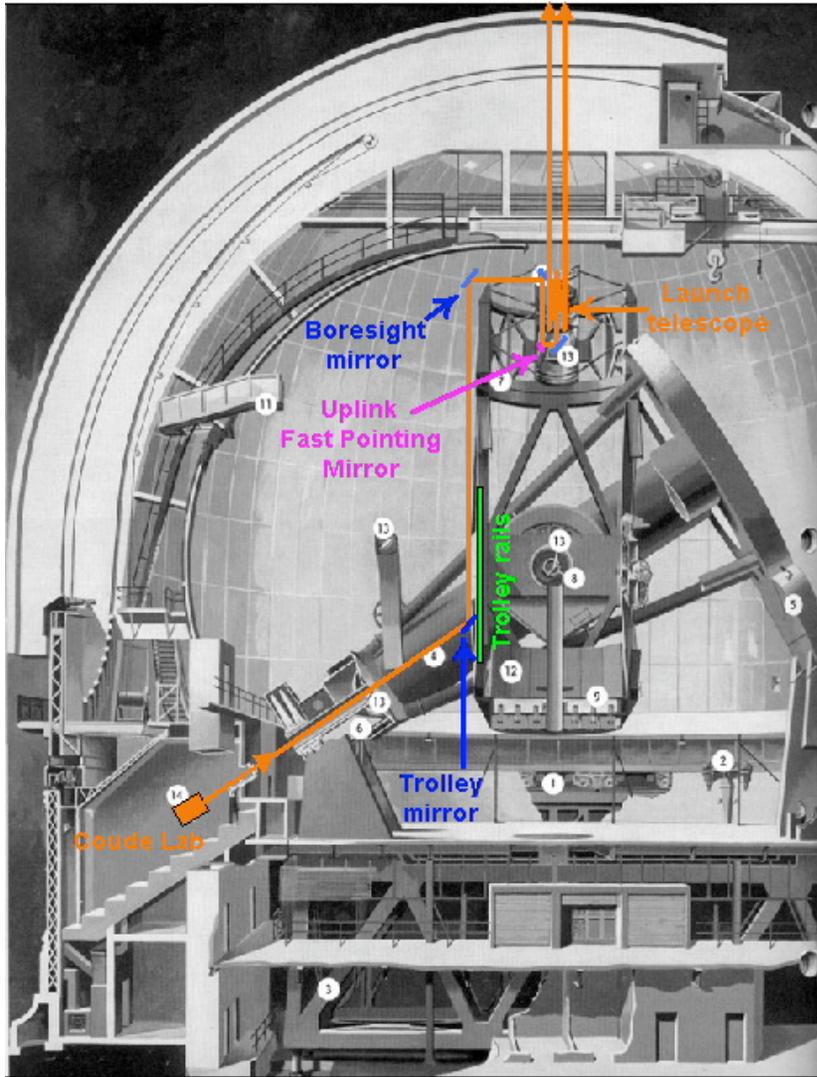
- High-order wavefront sensor observes LGS in reflection off a dichroic.
- Low-Order Wavefront Sensor patrols the focal plane behind this optic, providing tip/tilt and focus control.



Multiple Guidestar Unit  
(1 low-order WFS + 3 high-order WFS)



# Laser Projection System



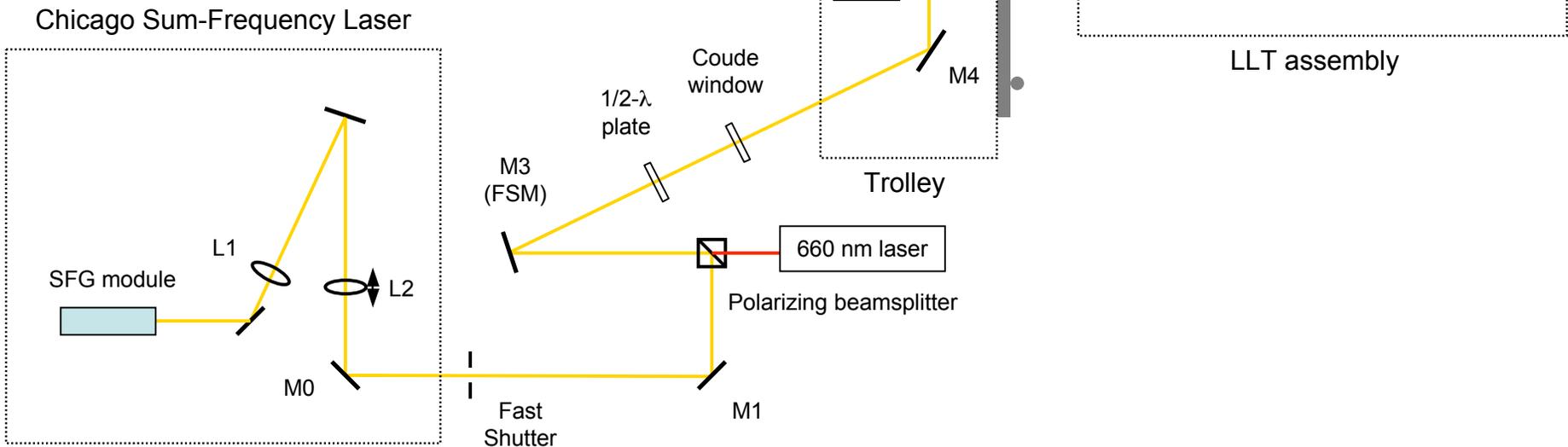


# Laser projection system schematic



After leaving laser bench  
11 reflections, 16 transmissions

Measured transmission:  
65 % not including launch telescope

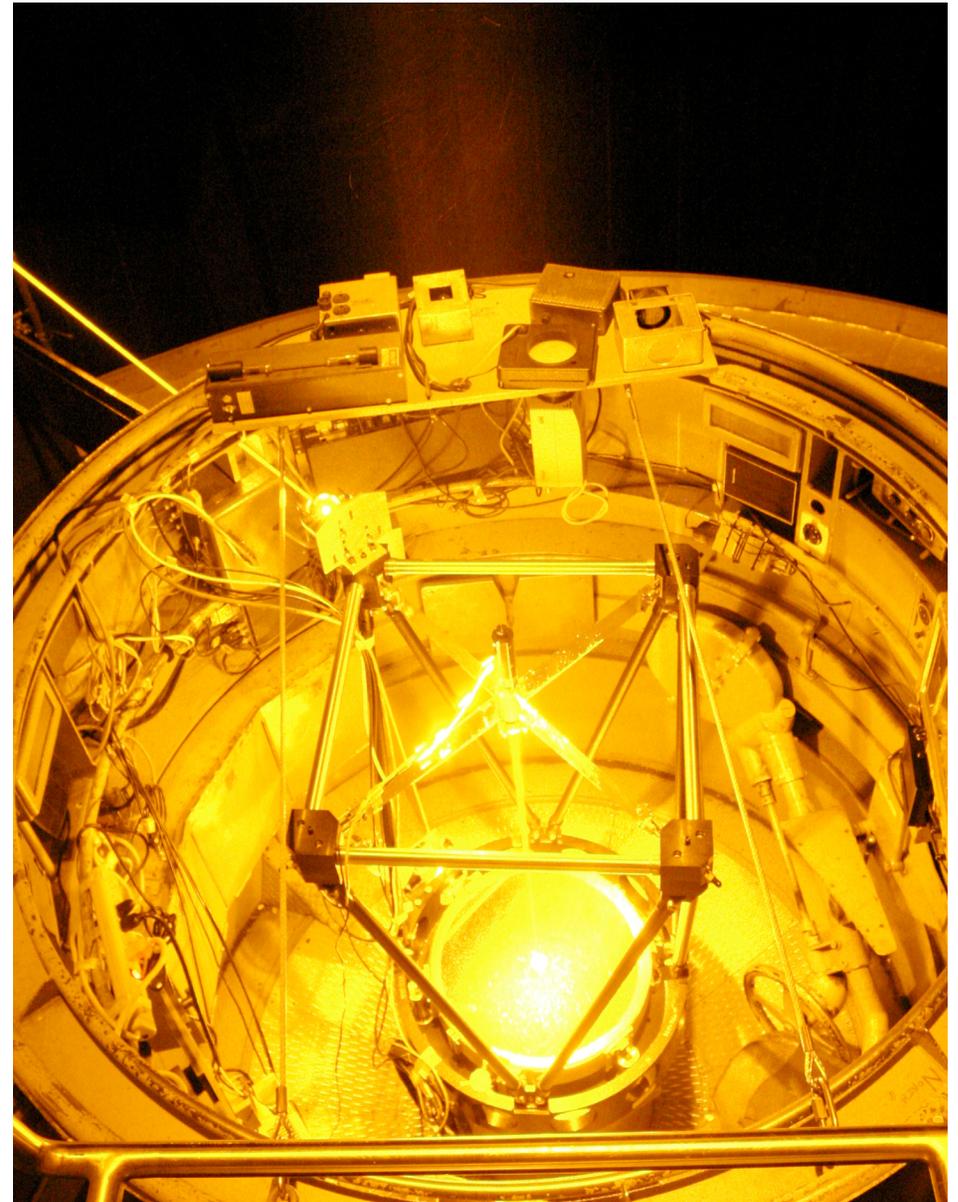
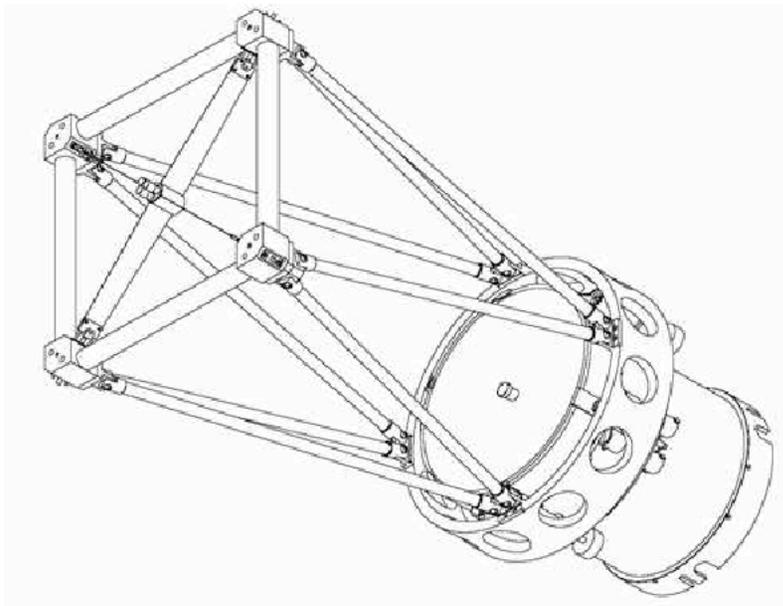




# Laser Launch Telescope

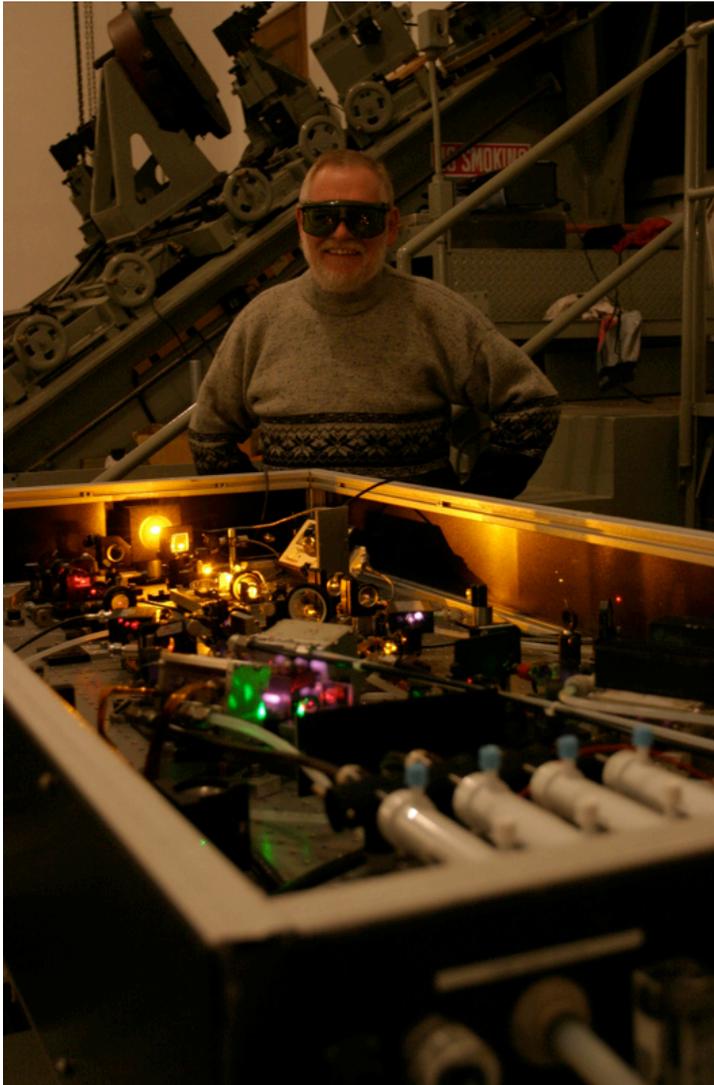


- New 46 cm diameter, F/1.8 primary
- Installed on-axis behind 200" secondary.
- Transmission 87%.

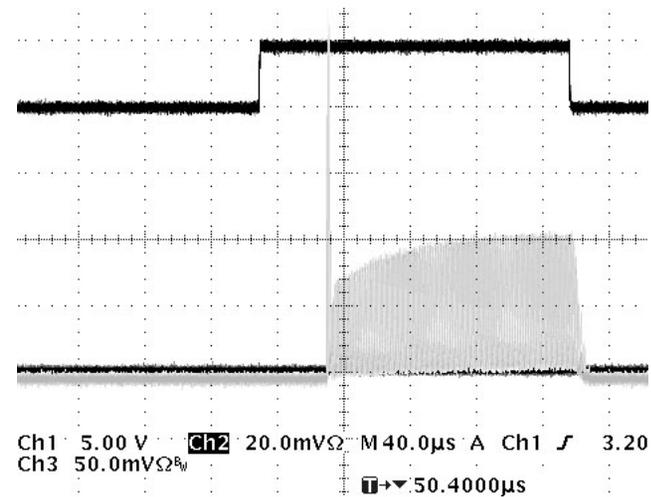




# Chicago Sum-Frequency Laser



- 589nm solid-state sum-frequency laser.
- Built at U. Chicago by E. Kibblewhite.
- Up to 8.5 W demonstrated.



## Pulse format

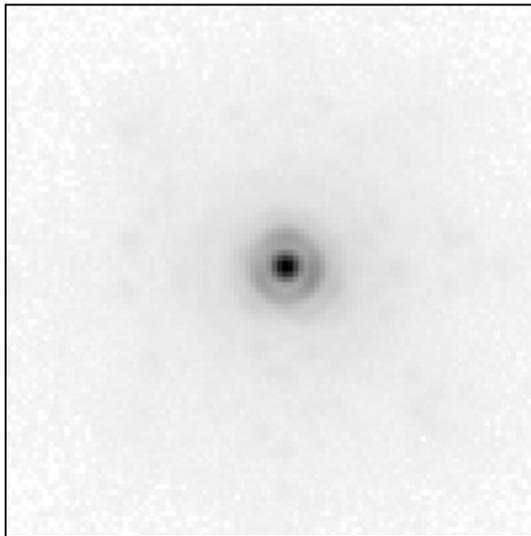
- 160  $\mu$ s macropulse every 2 ms.
- Composed of 2  $\mu$ s micropulses.
- Round-trip time to Na layer is  $\geq 590 \mu$ s
- Raleigh detected only in first  $\sim 90 \mu$ s.



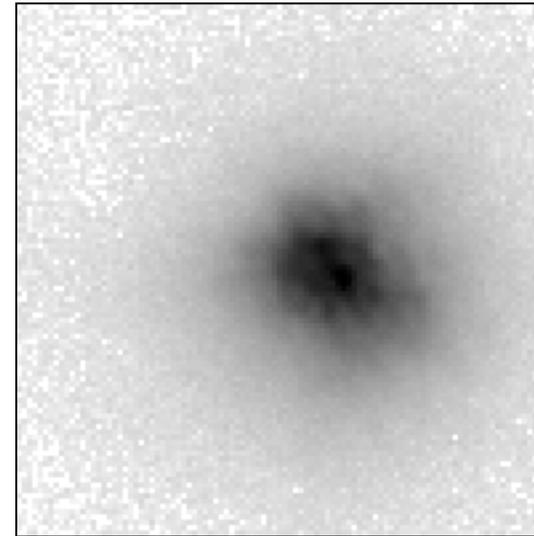
## Progress to date



- Laser shipped to Palomar May 2004
- First laser projection: October 2004
- First high-order correction: June 2006
- First high Strehl images: September 2006



Loops closed, BrG, 30s  
FWHM=0.098", Strehl=34%



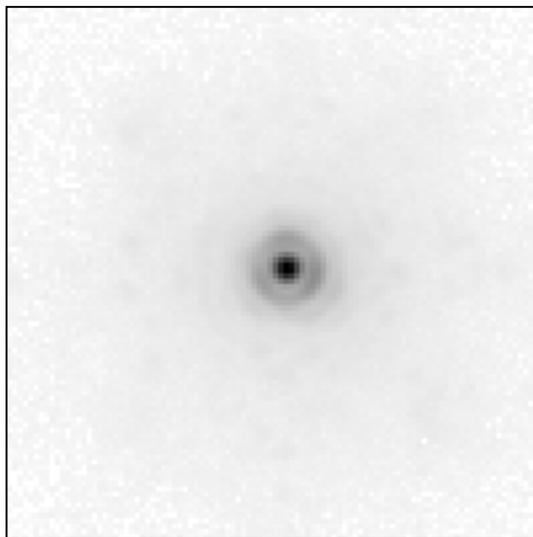
Loops open, BrG, 30s  
FWHM=0.54"



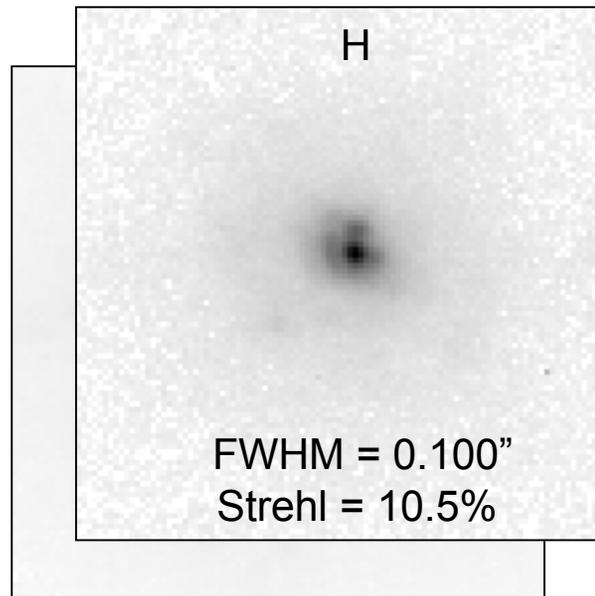
# Current performance (9/7/06)



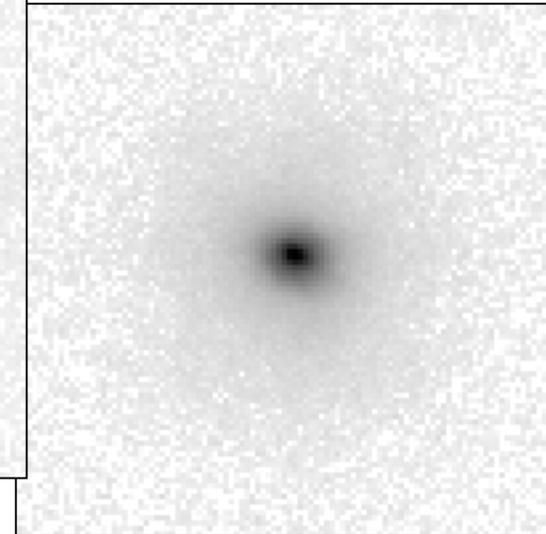
- V seeing was  $\sim 0.75''$
- Laser power 5.5 W.
- K band PSFs:



V = 10.1  
FWHM =  $0.098''$   
Strehl = 34%



V = 13.0  
FWHM =  $0.115''$   
Strehl = 21.8%



V = 15.3  
FWHM =  $0.131''$   
Strehl = 20.8%

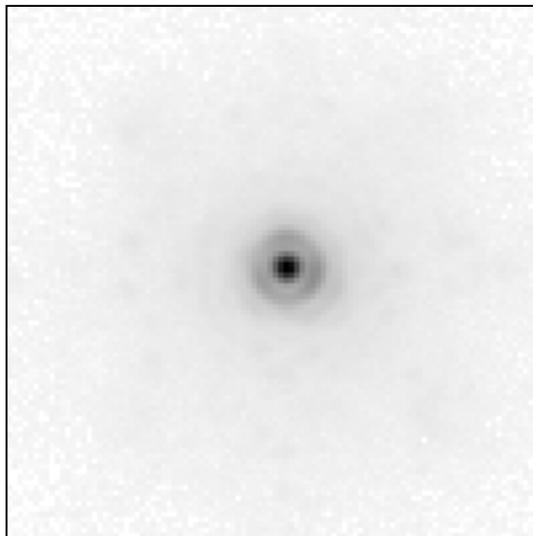


# Error budget (9/8/06)



Atmosphere:

- $r_0 = 17$  cm
- $v_0 \sim 7$  m s<sup>-1</sup>
- Palomar mean  $C_n^2$  profile



$V = 10.1$   
FWHM = 0.098"  
Strehl = 34%

Error term	RMS (nm)
Telescope	96
Fitting	65
Bandwidth (200 Hz)	102
Measurement (5.5 W)	336
AO + instrument	101
Focal anisoplanatism	64
Tip/tilt ( $V=10.1$ )	34
<b>Total</b>	<b>391</b>

Predicted K Strehl: 29%  
(42% if we had run HOWFS at 100Hz)



# LkHa 101

**JPL**

