



W. M. Keck Observatory Adaptive Optics Science Capabilities

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AAS

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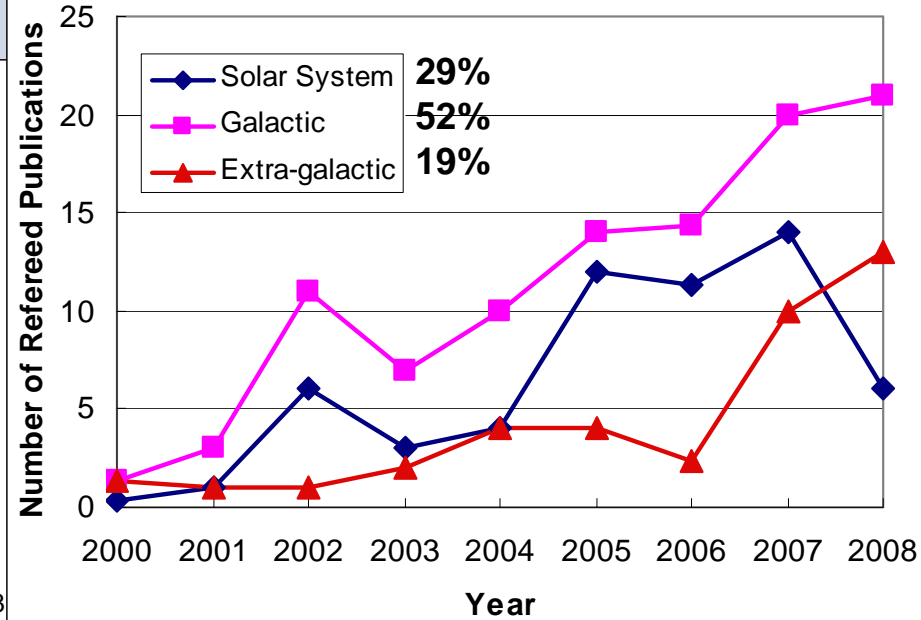
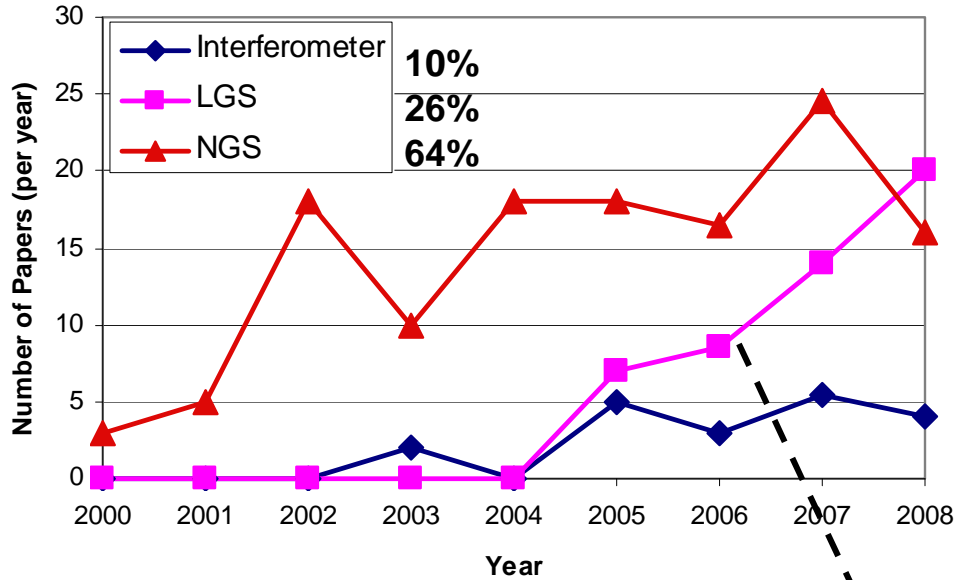
Presentation Sequence

- Science Product
- Science Instruments & Usage
- Performance
- Future Capabilities

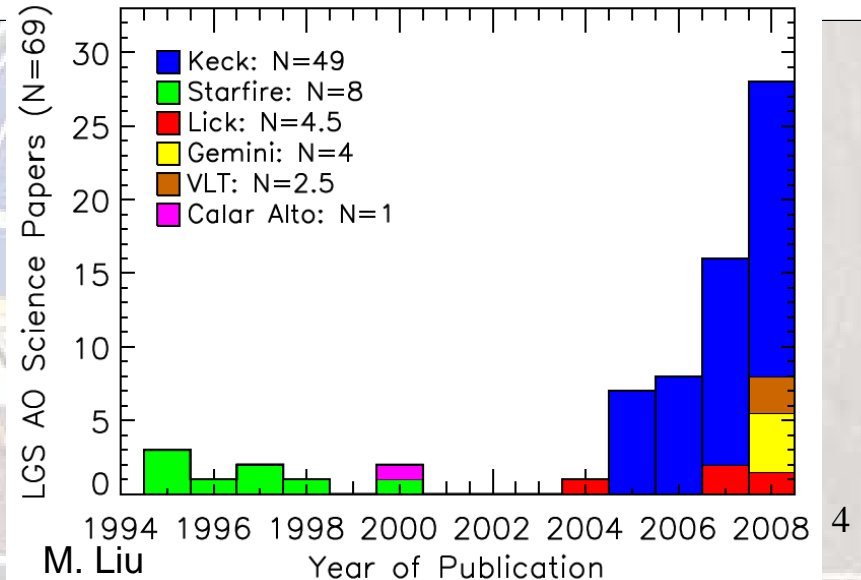
Science Product

Keck AO Science Product

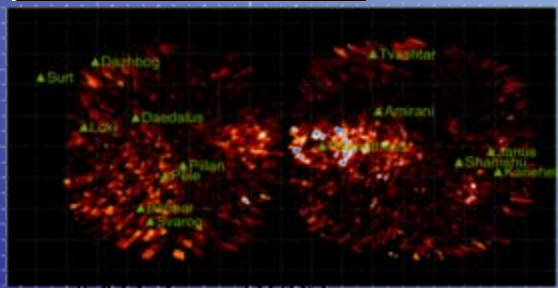
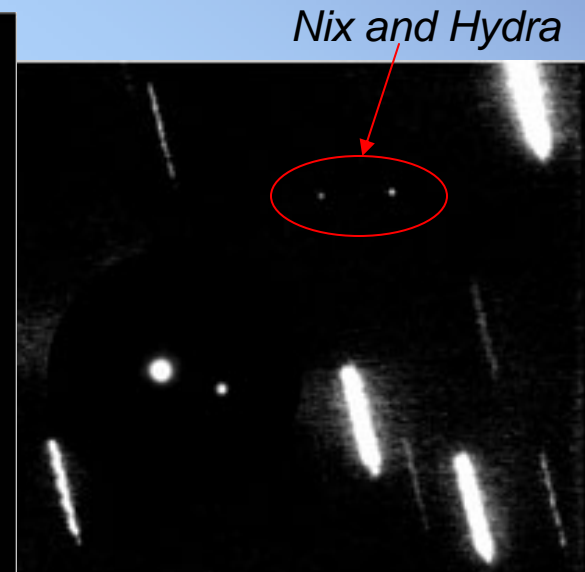
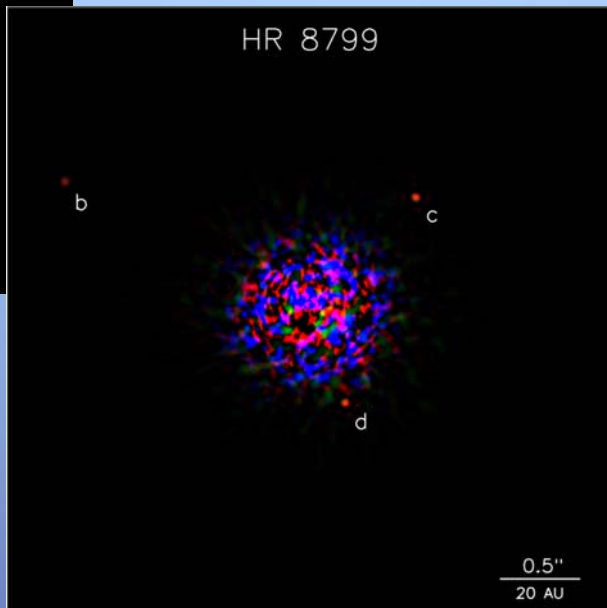
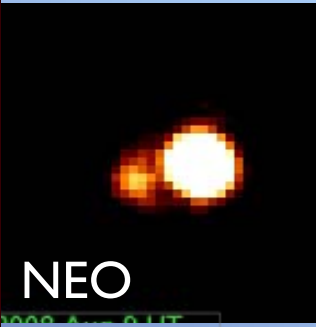
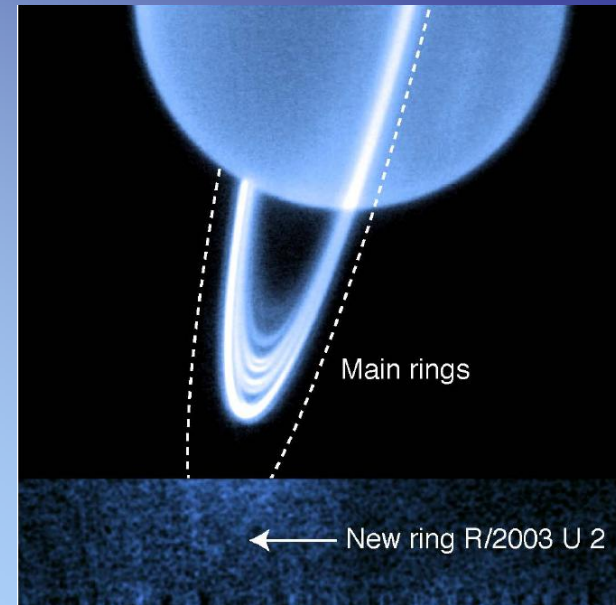
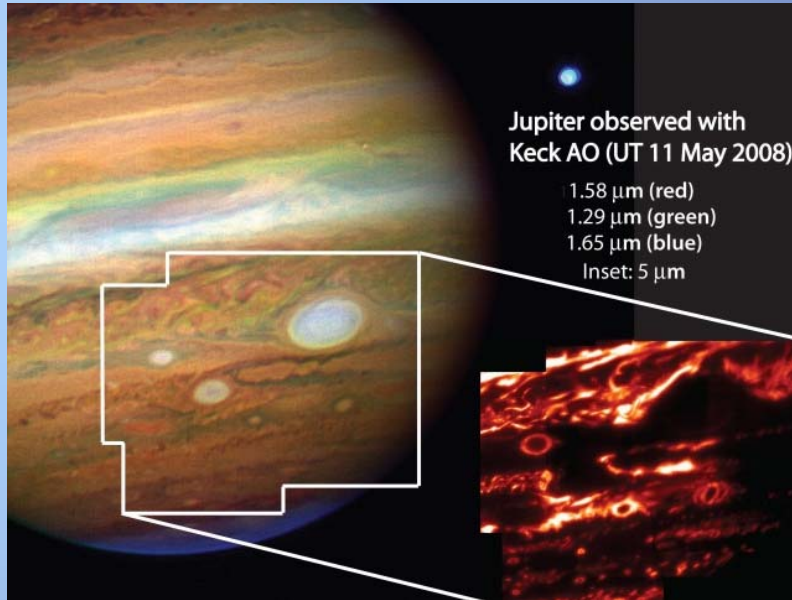
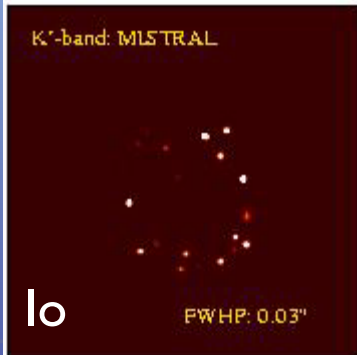
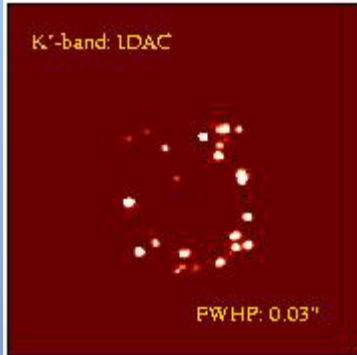
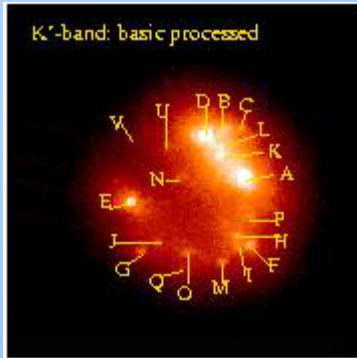
217 refereed science papers (thru May/09)



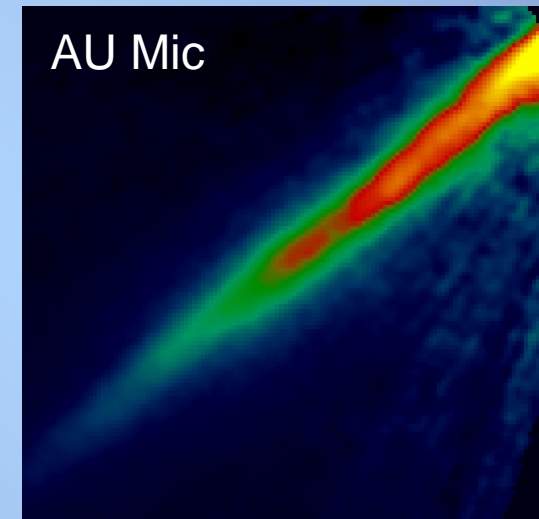
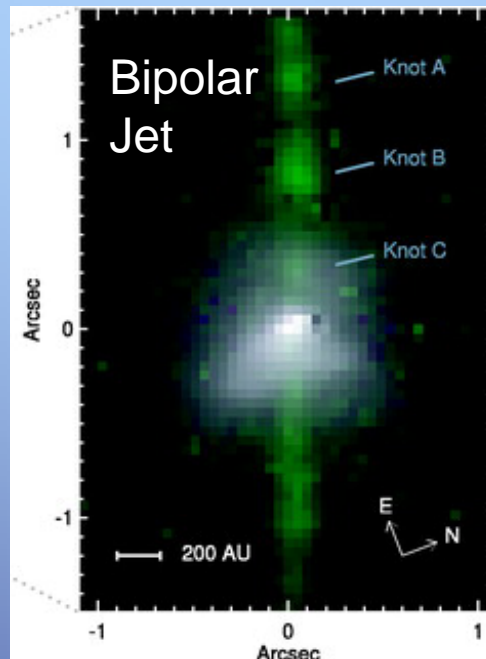
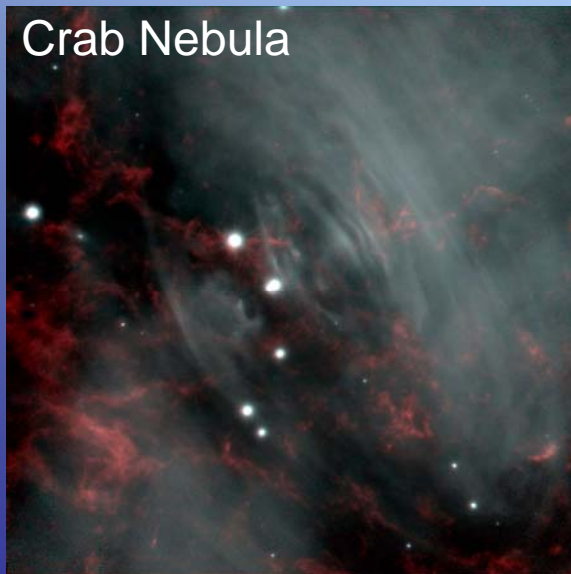
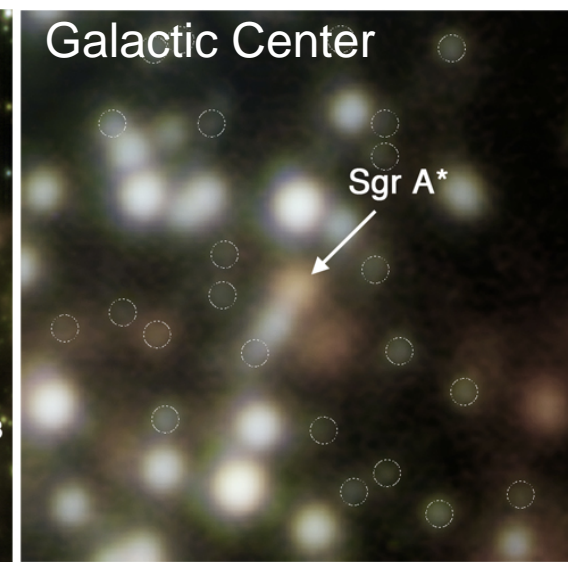
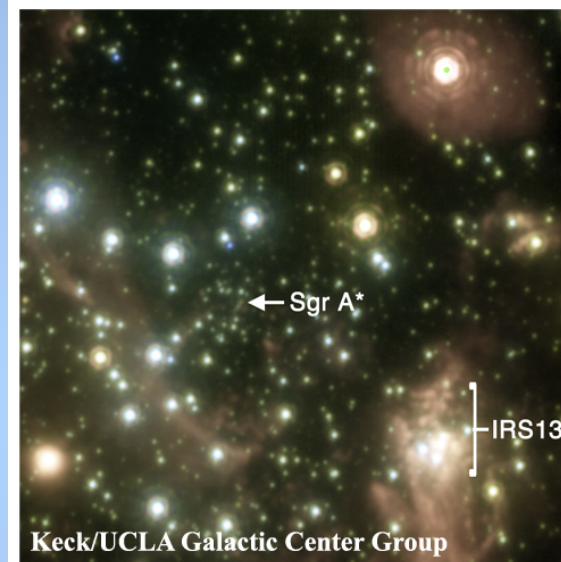
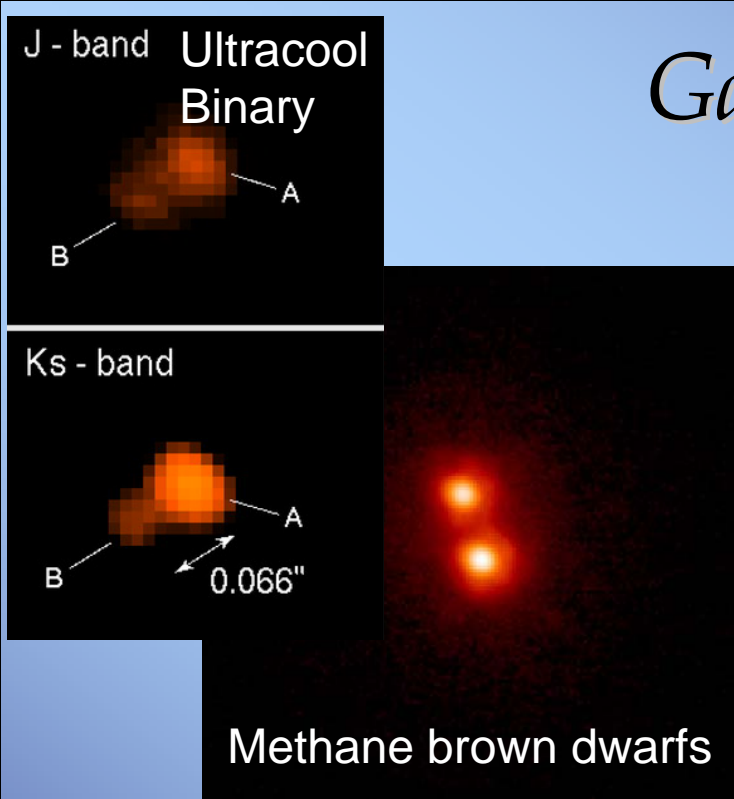
Area	Sub-Topic	Number of Papers
Galactic	Brown dwarfs & low mass stars	15
	Galactic Center	10
	Compact objects	2
	Star formation	1
Extra-galactic	High redshift galaxies	11
	Gravitational lensing	5
	Stellar populations	3
	Supernovae	5
Solar System	Kuiper Belt	4
	Asteroids	1



Solar System Science

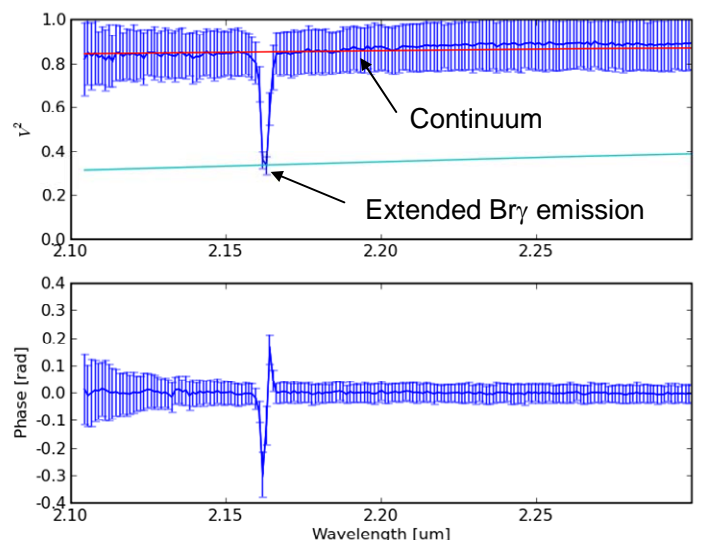
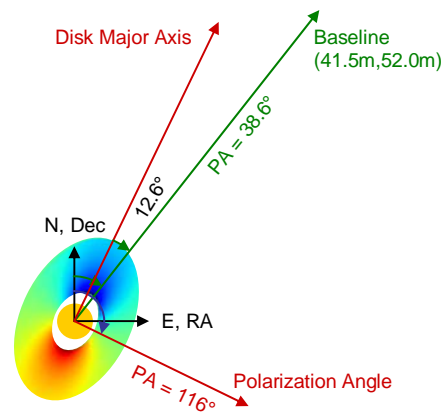
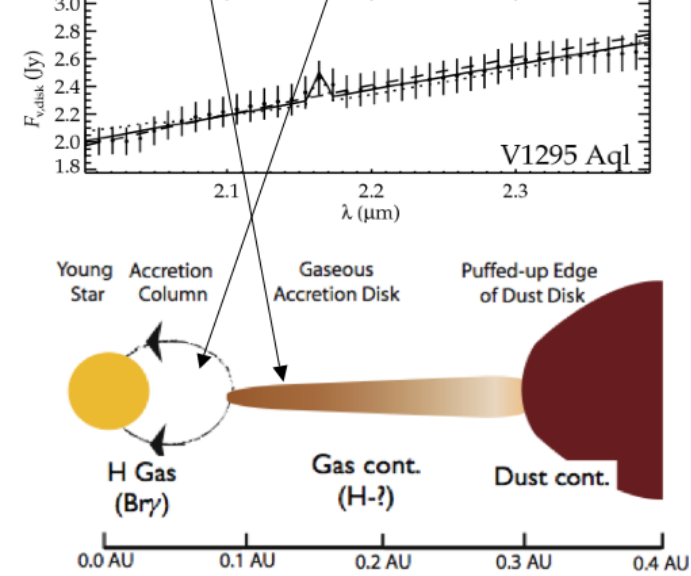
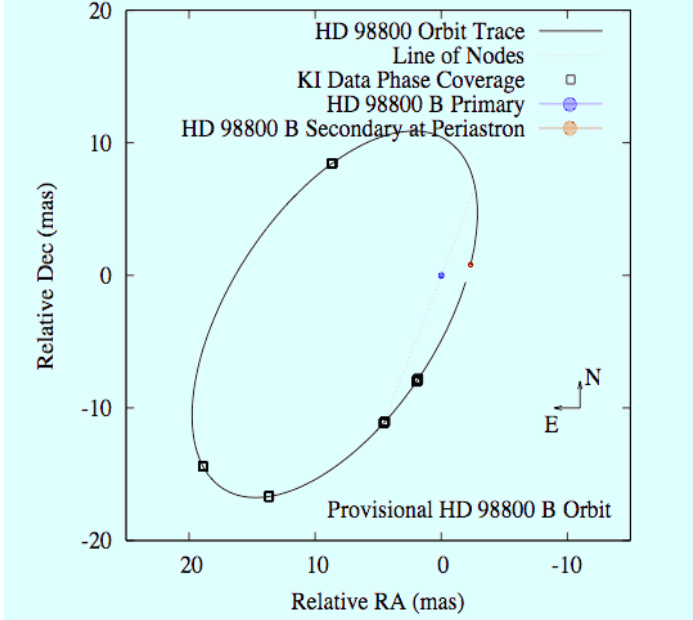
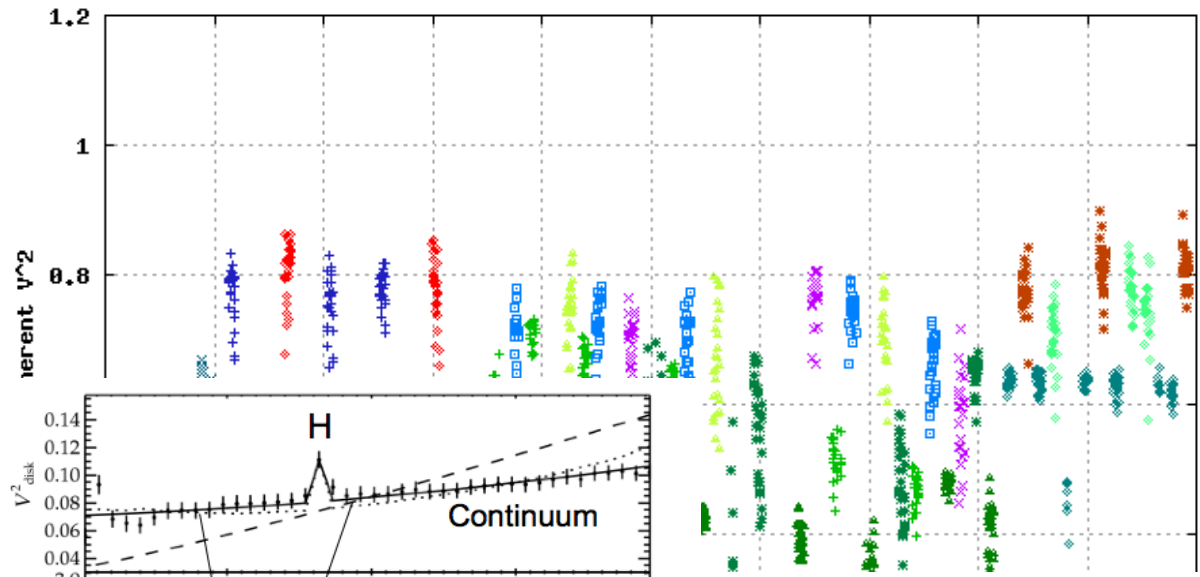


Galactic Science



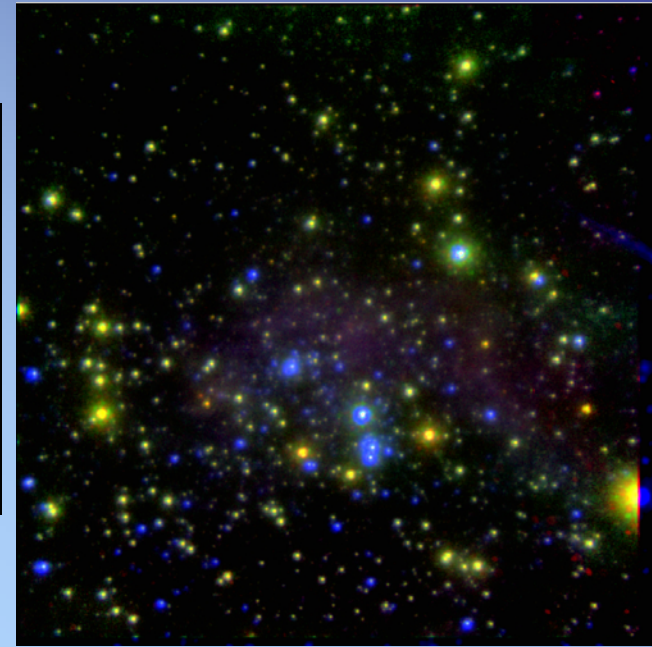
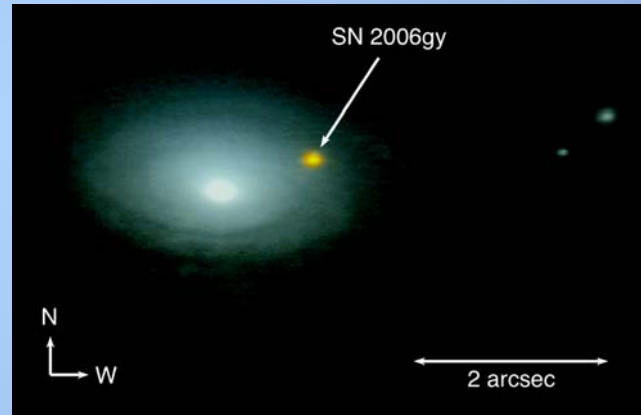
Interferometer Galactic Science

Wideband Incoherent V^2 Time Trace

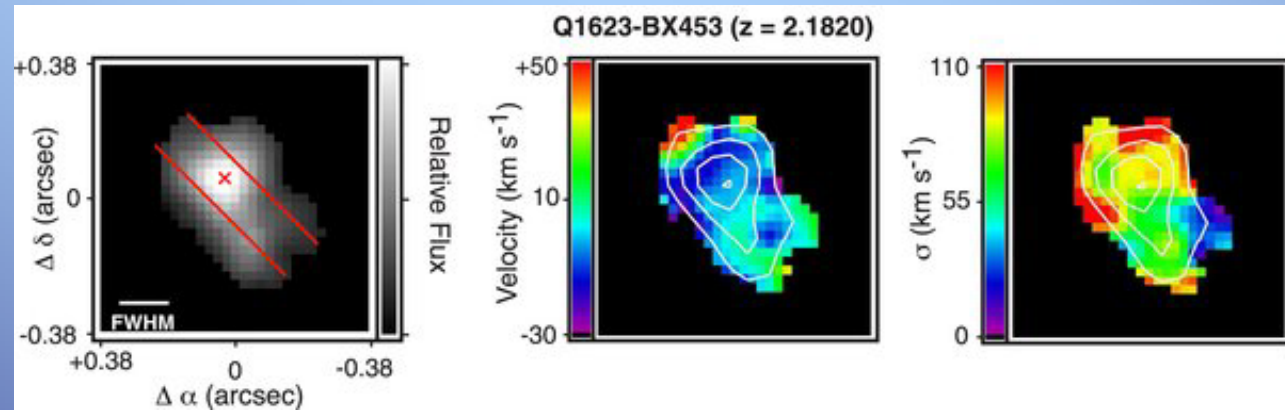
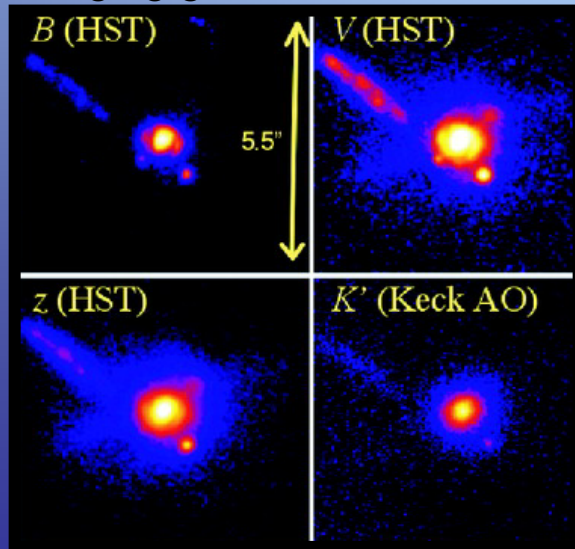


Extragalactic Science

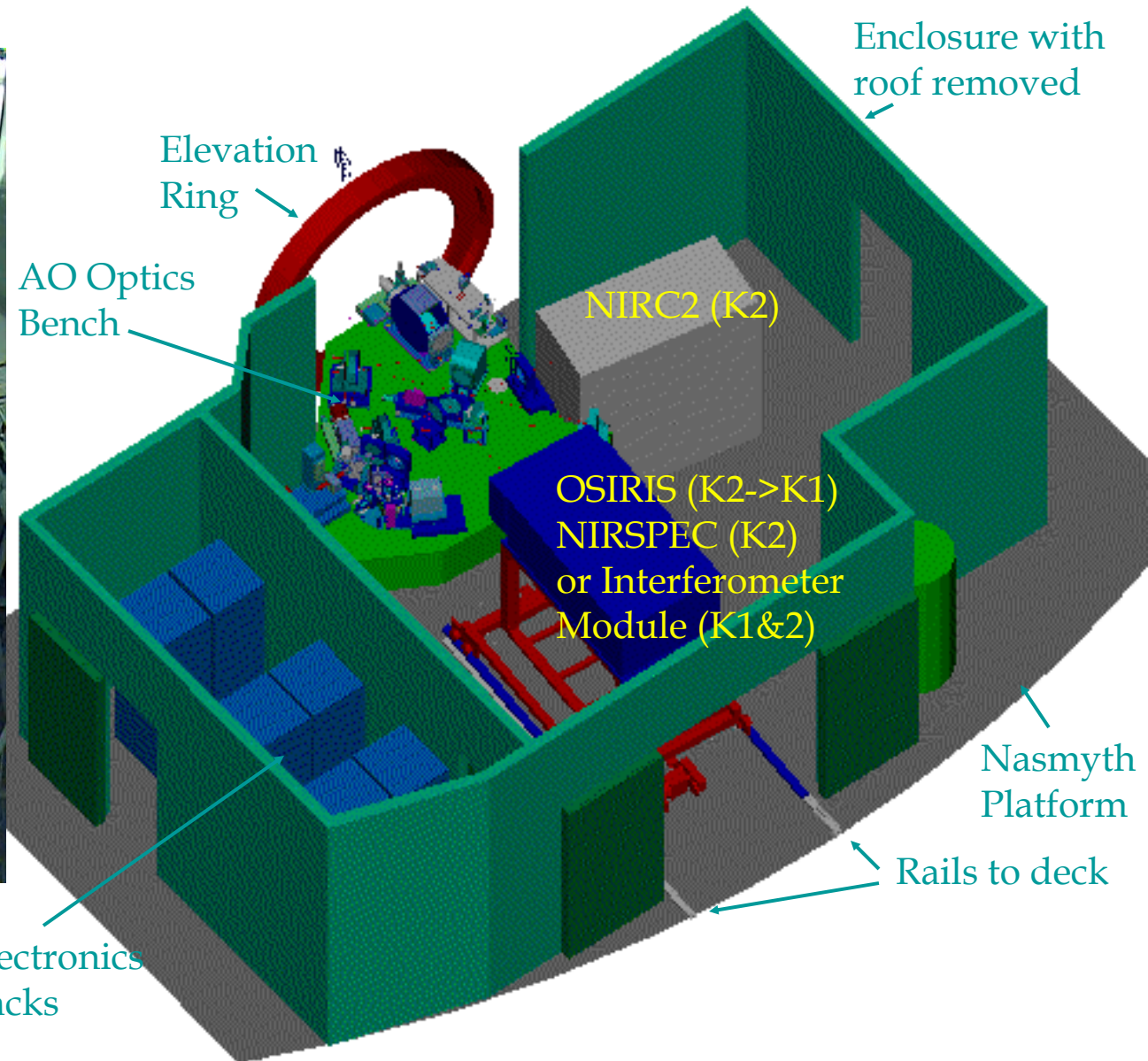
IC 10 Irregular dwarf galaxy



Merging galaxies

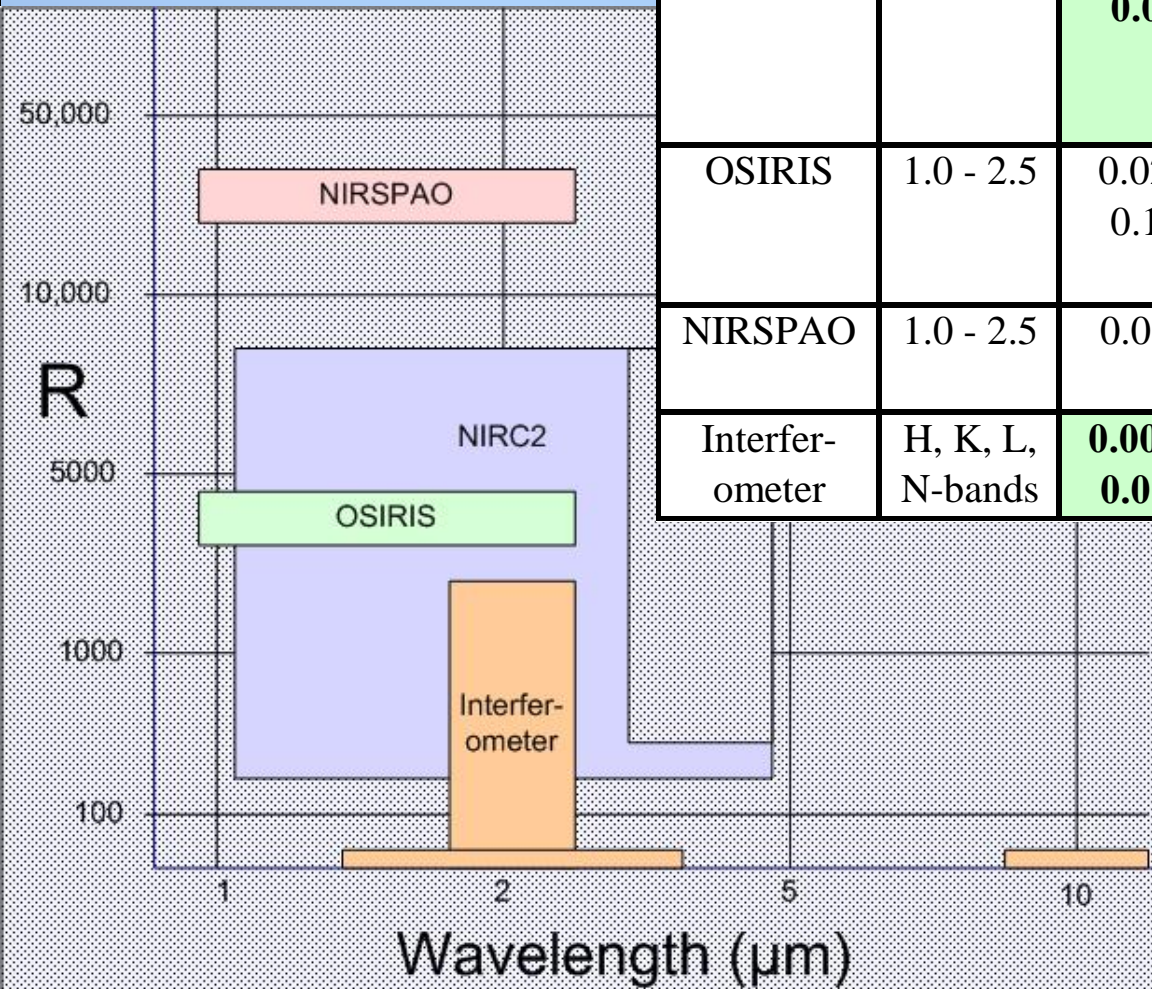


AO Science Instruments



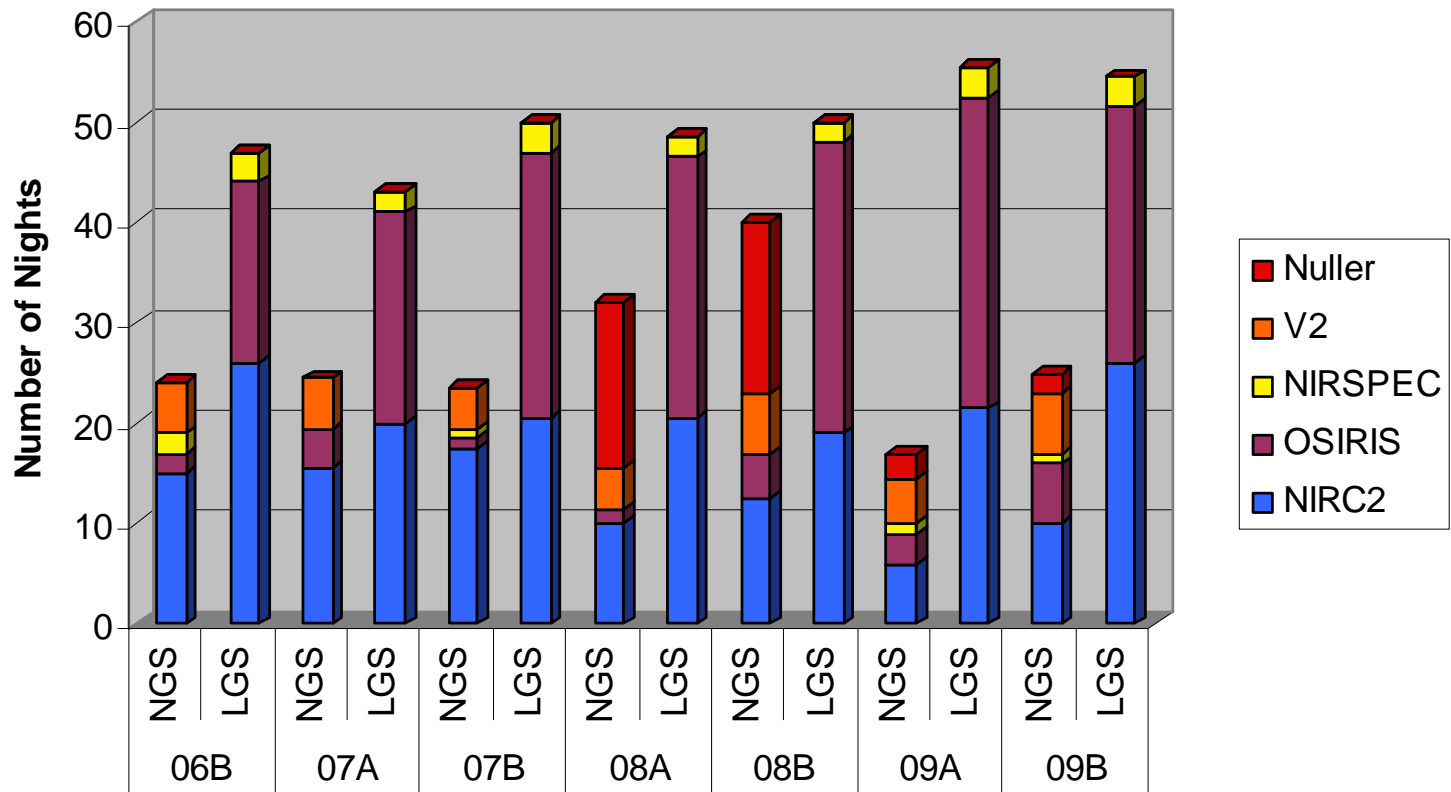
AO Science Instruments

Instrument	λ (μm)	Plate Scale (")	Image FOV (")	Spectral Resolution	Other
NIRC2	1.0 - 4.8	0.01 or 0.04	10 or 40	500 - 9000	Imager Coronagraph Aperture Masks Slit + Grisms
OSIRIS	1.0 - 2.5	0.02 - 0.10	0.3x1.3 - 4.8x6.4	3800	Integral Field Spectrograph + Imager
NIRSPA0	1.0 - 2.5	0.018	4.6	25000	Echelle Slit Imager
Interferometer	H, K, L, N-bands	0.002 - 0.012	0.05 - 0.2	30 - 1800	Visibility Nulling



Keck AO Science Usage

Keck TAC-Allocated Science Nights

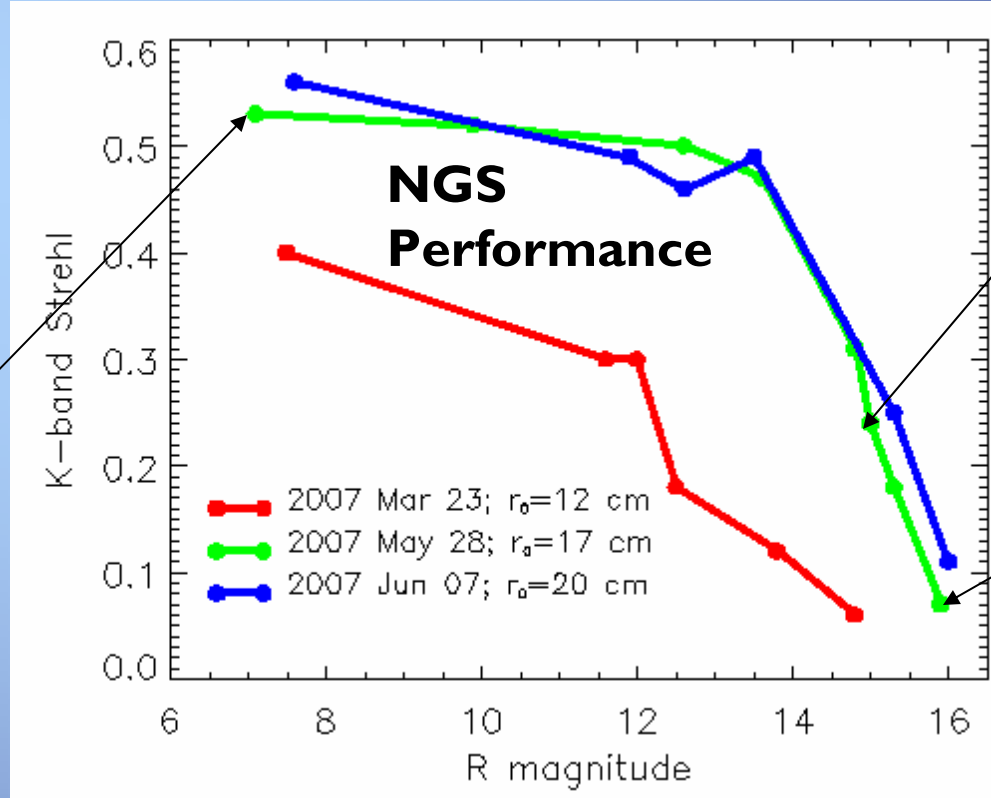


49% of K2
science nights

Community Access to Keck (& Keck AO)

- Broad US community has peer-reviewed access via the NASA and NOAO TACs
 - NASA has a 14.5% share in Keck
 - ~90 nights/year
 - Represents ~25% of US community open access time available on 6.5-10m telescopes
 - Note: science scope greatly expanded
 - NSF/NOAO TSIP program has ~24 nights/year
- Caltech, UC, UH, Yale & Swinburne have direct access

AO Performance

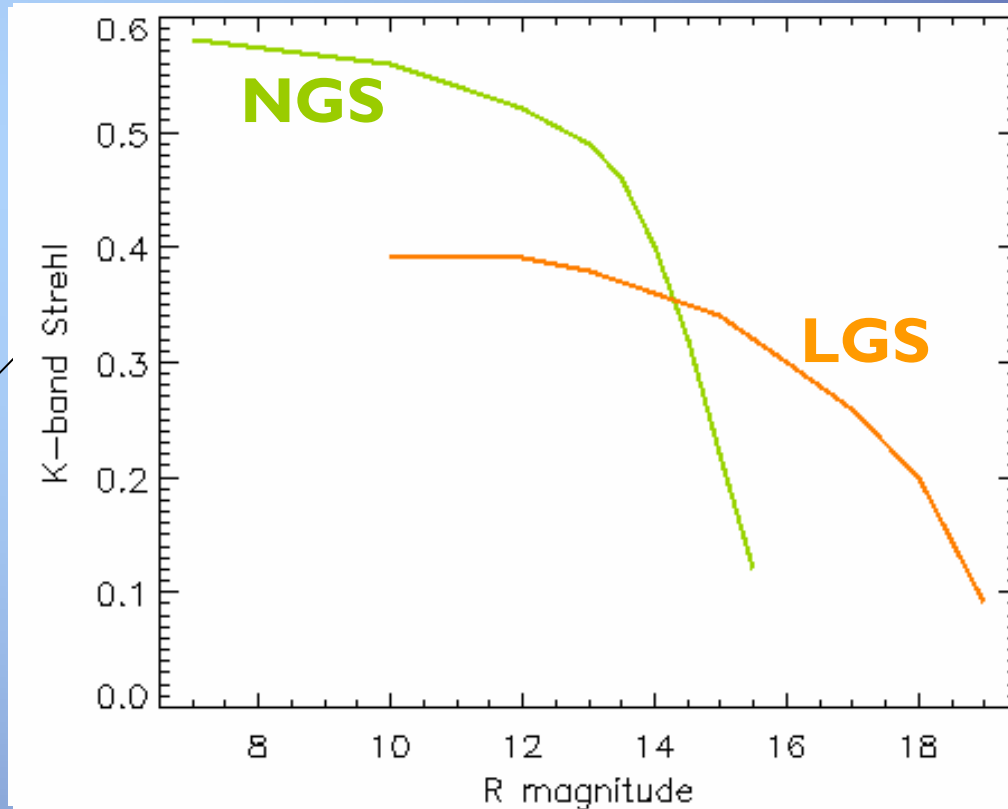


J, SR=0.22

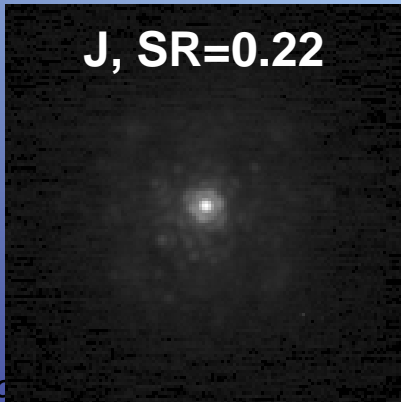
H, SR=0.41

K, SR=0.62

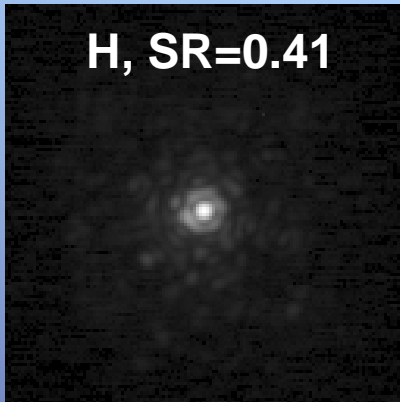
AO Performance



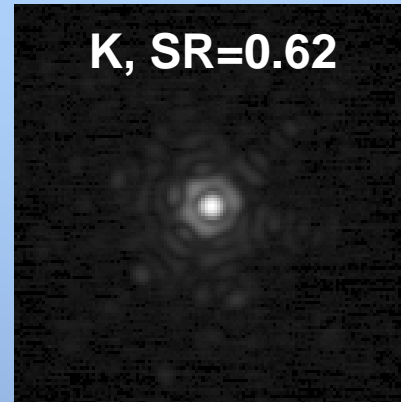
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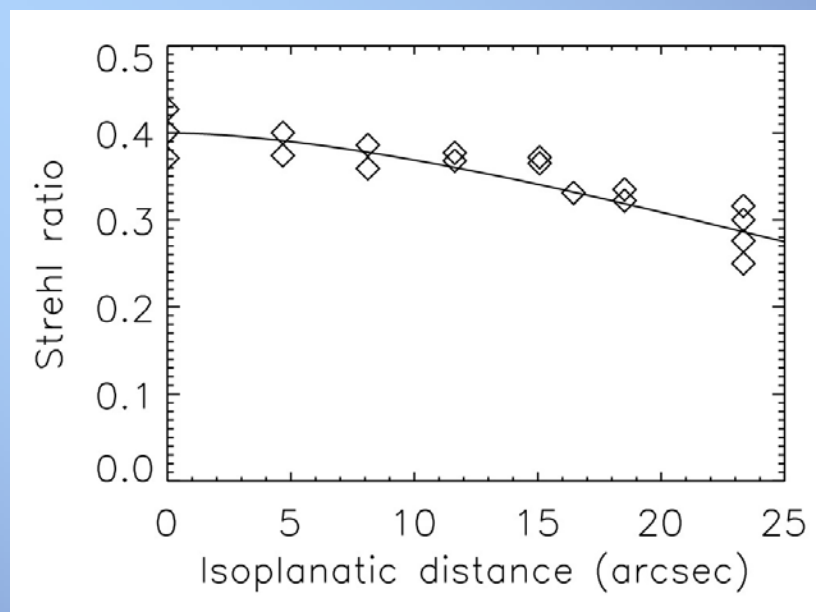
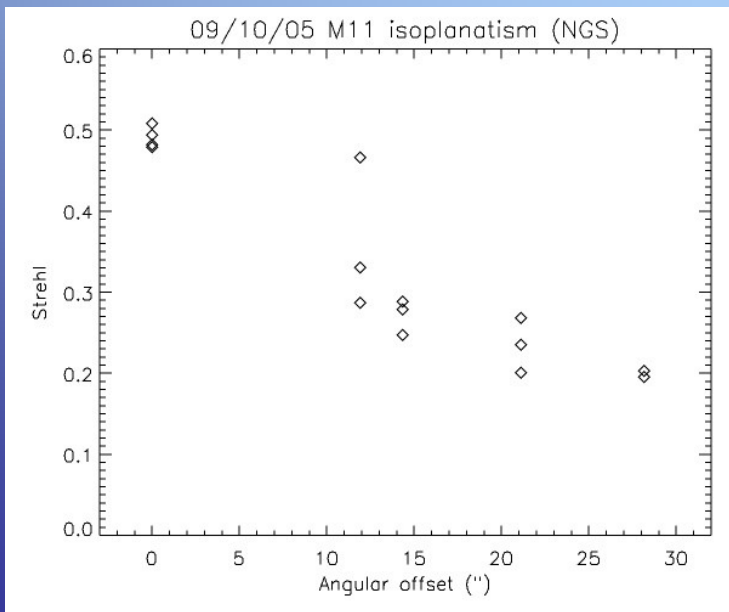
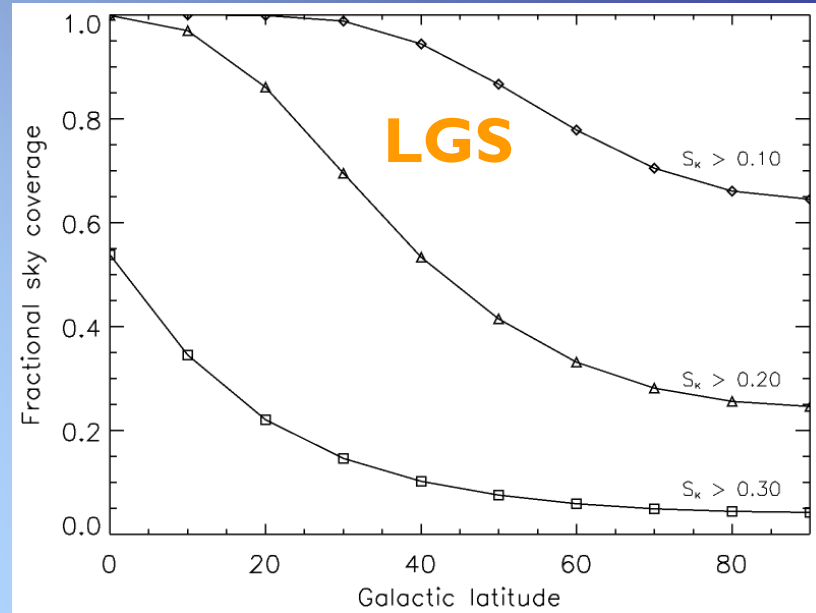
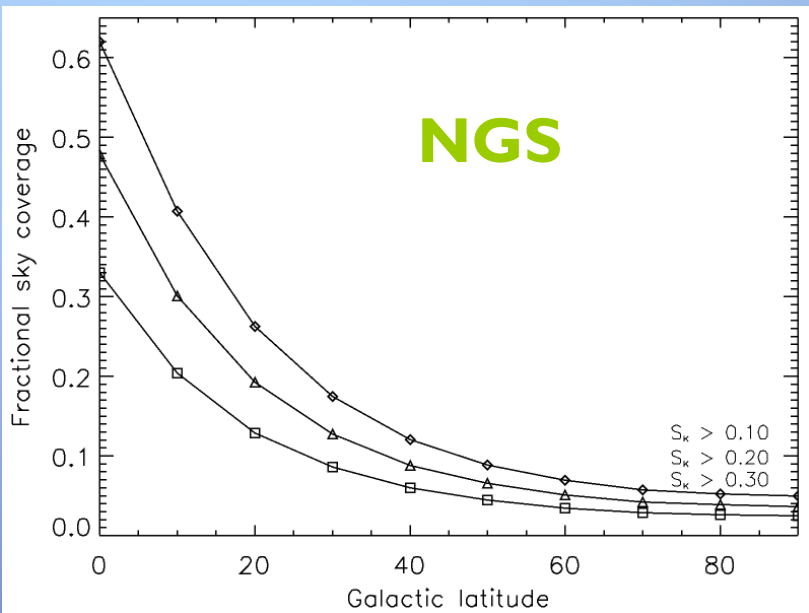
H, SR=0.41



K, SR=0.62



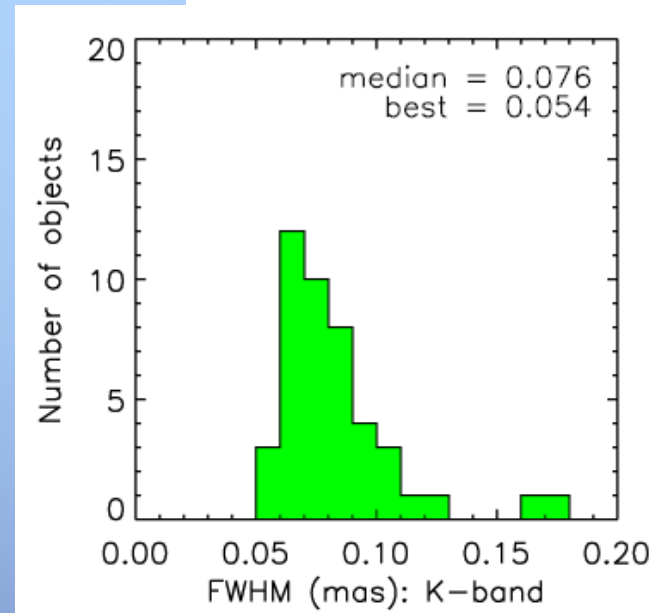
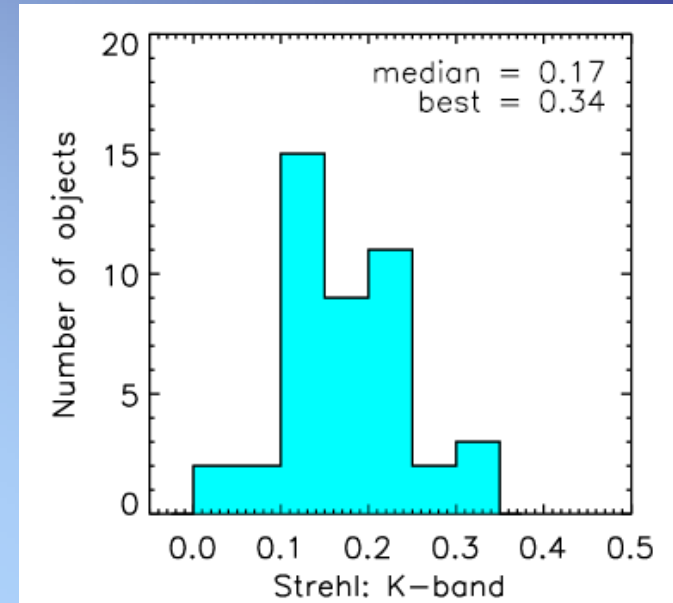
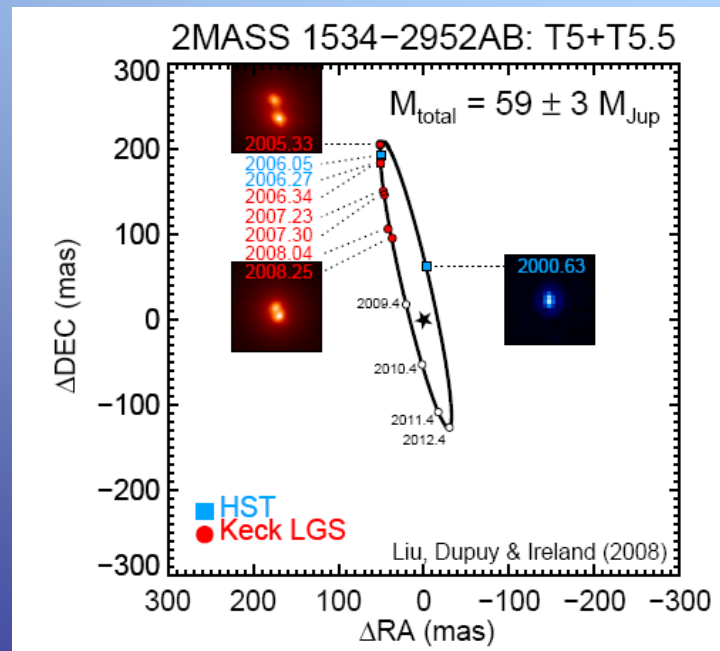
Sky Coverage



LGS AO Performance Variability

2005-07 Survey of field brown dwarfs (Liu et al.)

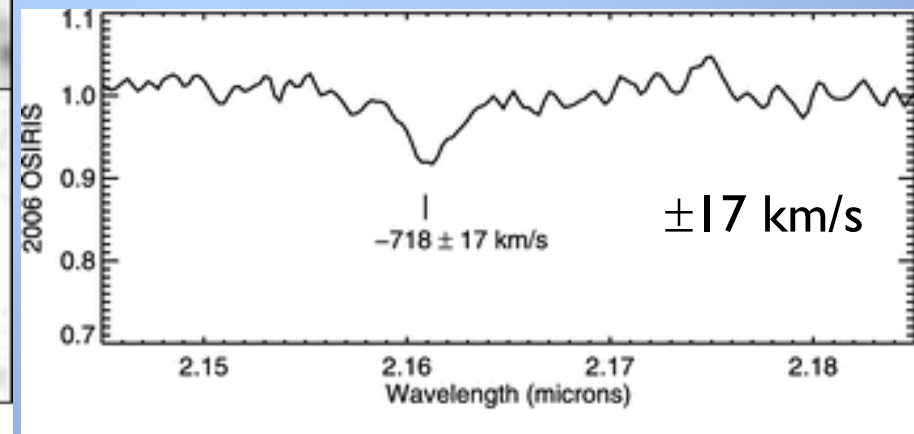
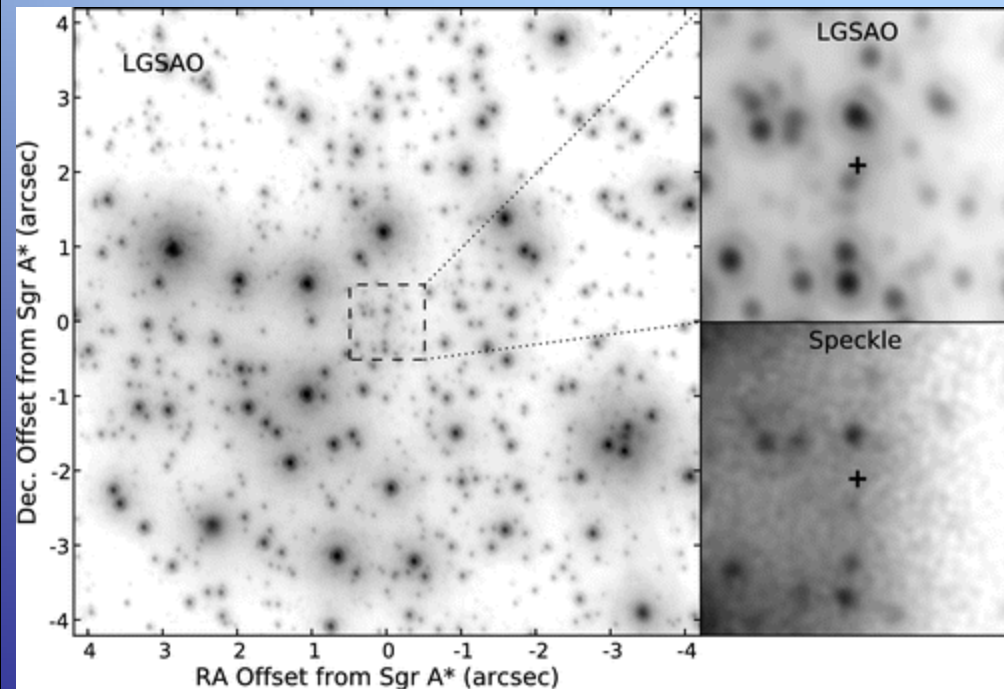
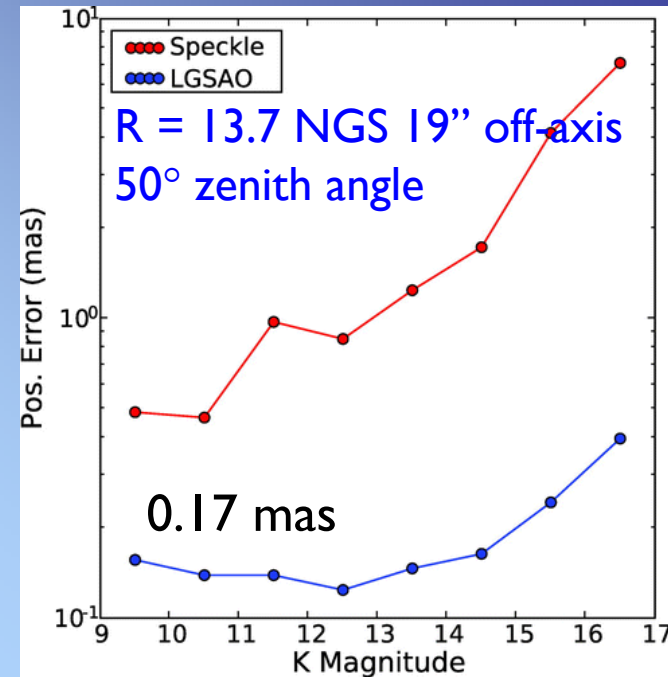
- No data censored. Mix of seeing conditions, off-axis tip-tilt properties & technical performance
- ~2/3 sky coverage with 60" off-axis radius & Strehl $> \sim 0.2$



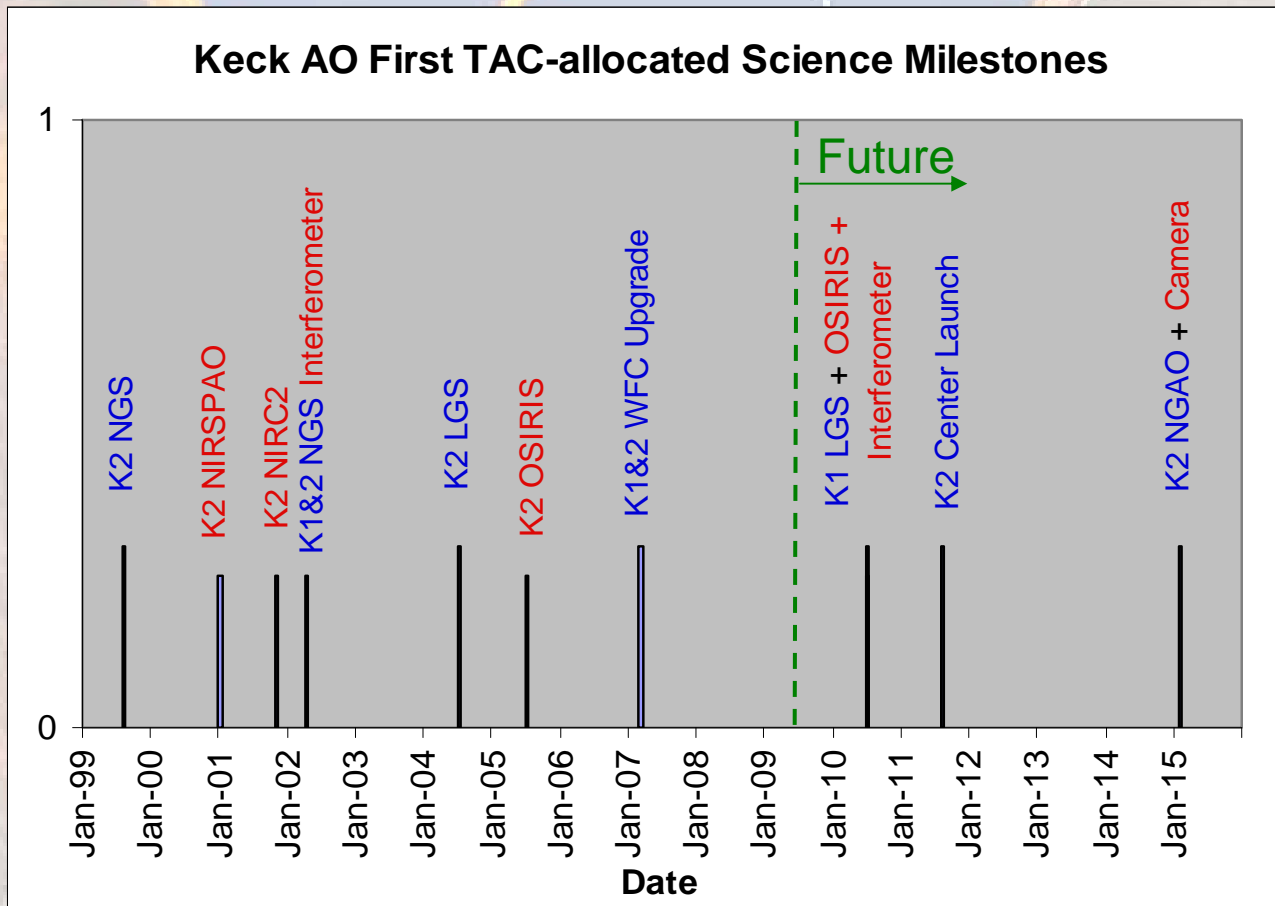
LGS AO Performance

Galactic Center:

- Measuring distance & properties of supermassive black hole with stellar orbits (Ghez et al.)
- Proper motion uncertainties of 0.07 mas/yr (3 km/s) for young stars < 3.5'' (0.14 pc) of black hole (Lu et al.)

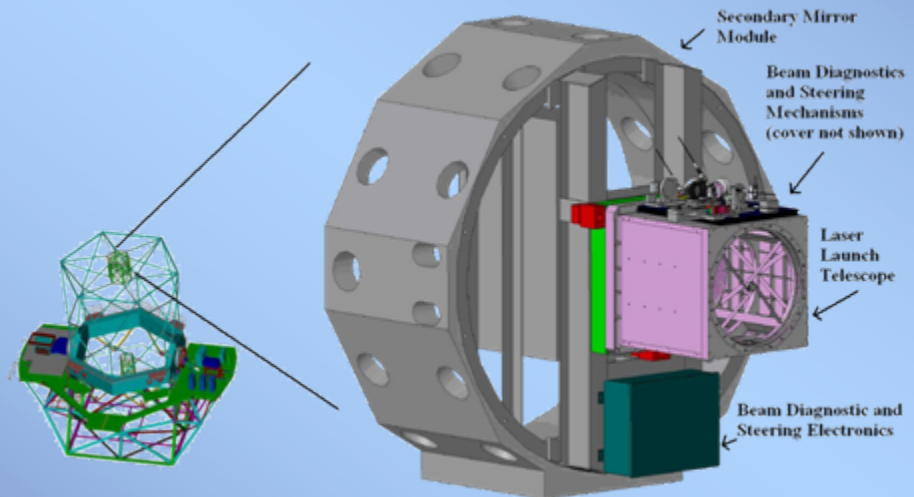


Future Capabilities



Keck I LGS AO

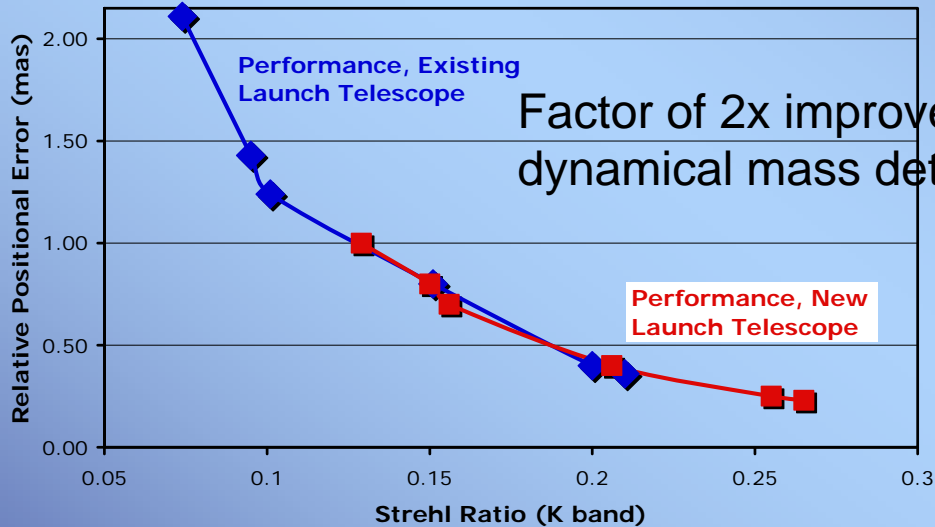
- LGS AO for Keck I telescope (2010)
 - Higher performance than Keck II LGS AO
 - Higher power laser + center launch telescope
 - OSIRIS at fixed location with 1 less reflection
 - LGS AO for Keck Interferometer & redundancy of key science capability



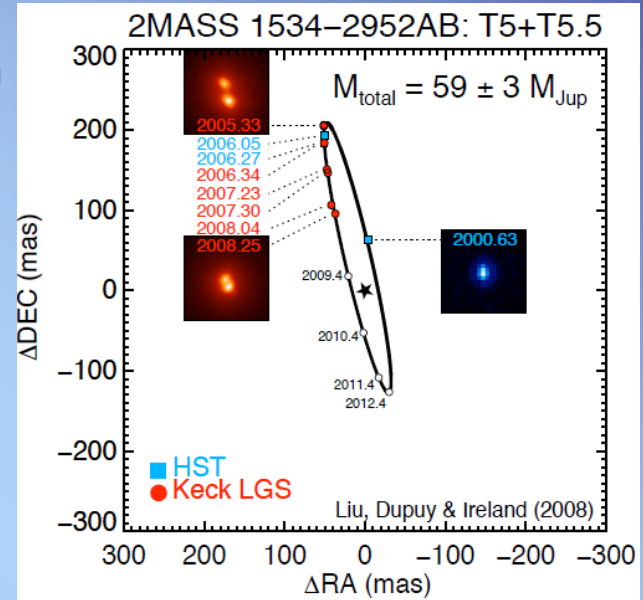
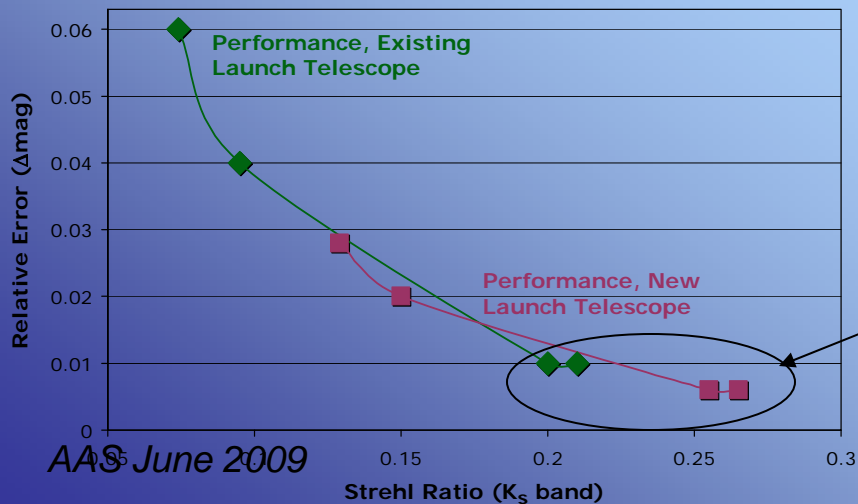
Center versus Side Launch

Predicted Performance for T Dwarf Binary Case

Relative Positional Error



Relative Magnitude Error



R = 16.2 NGS 31" off-axis
 50° zenith angle

NGAO - Next Generation AO



Key Science Goals

Understanding the Formation and Evolution of Today's Galaxies since $z=3$

Measuring Dark Matter in our Galaxy and Beyond

Testing the Theory of General Relativity in the Galactic Center

Understanding the Formation of Planetary Systems around Nearby Stars

Exploring the Origins of Our Solar System

Key New Science Capabilities

Near Diffraction-Limited in Near-IR (K-Strehl $\sim 80\%$)

AO correction at Red Wavelengths ($0.65\text{-}1.0\ \mu\text{m}$)

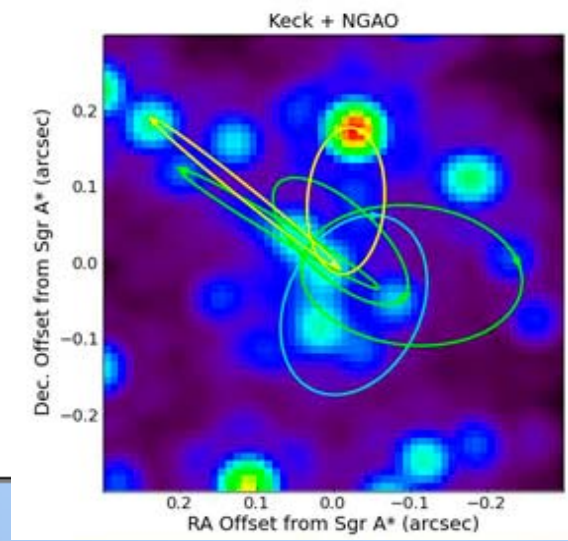
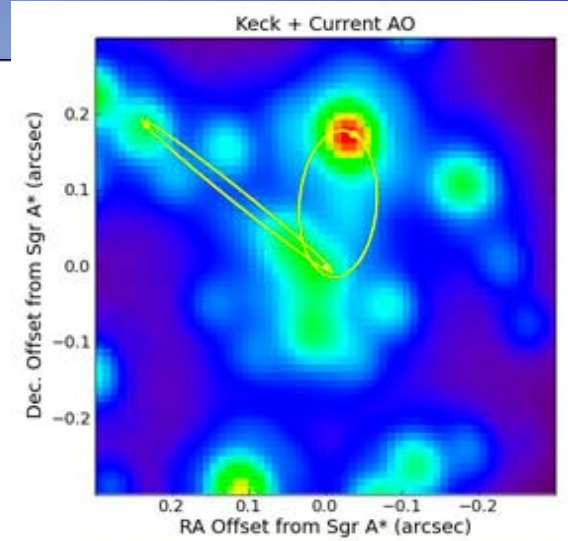
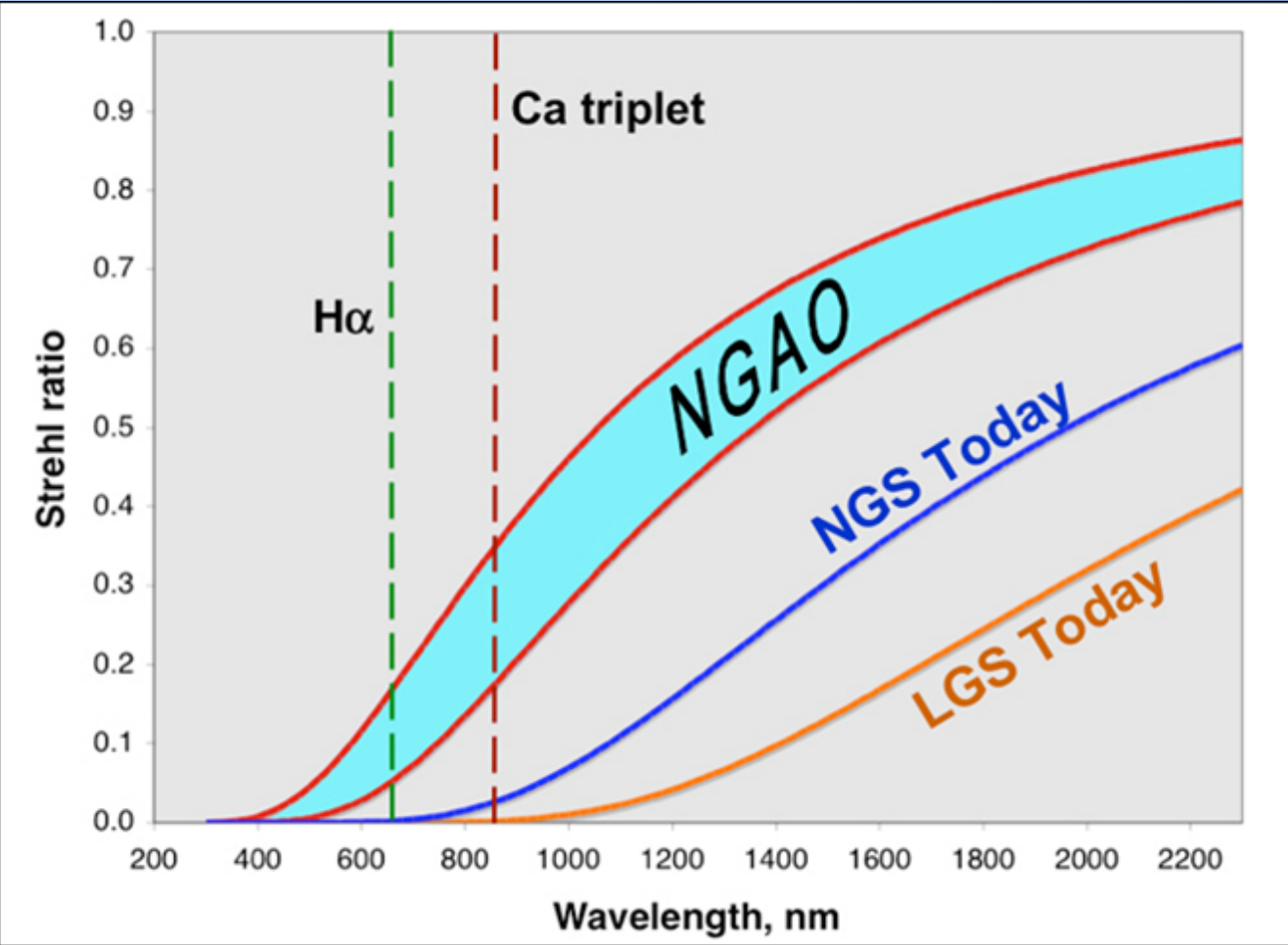
Increased Sky Coverage

Improved Angular Resolution, Sensitivity and Contrast

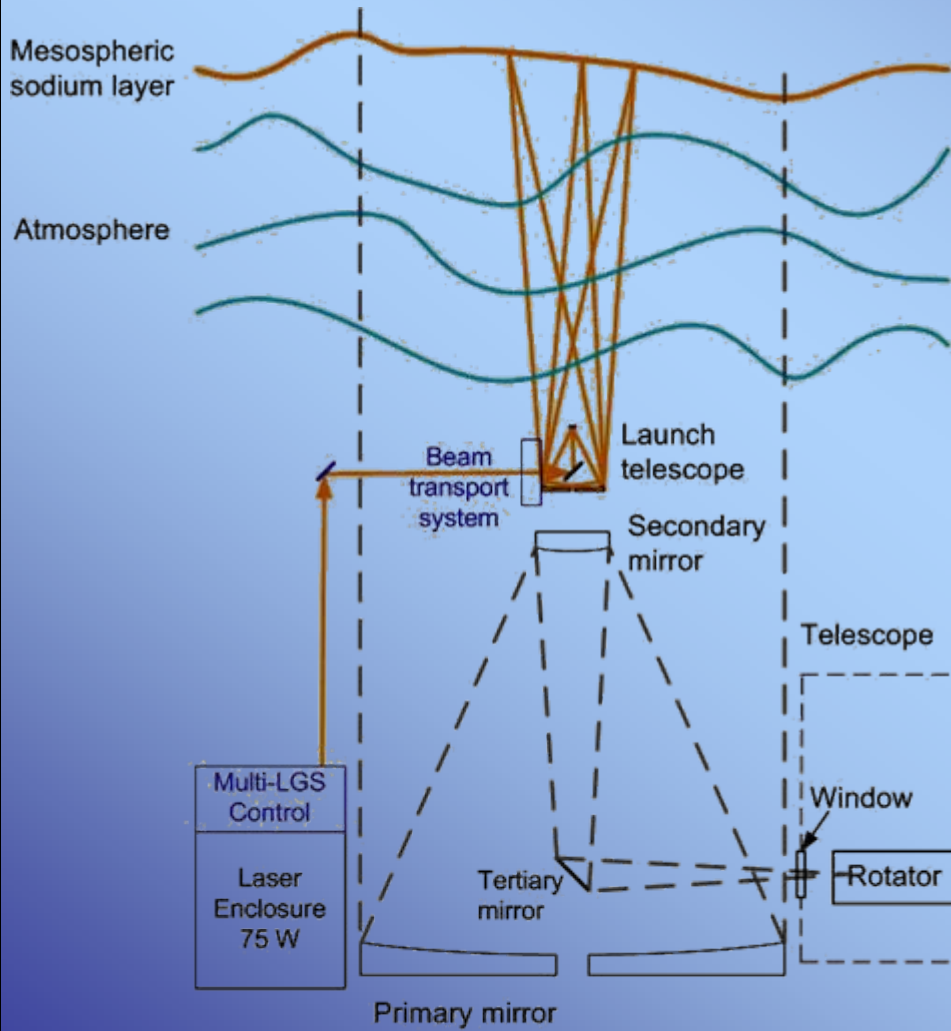
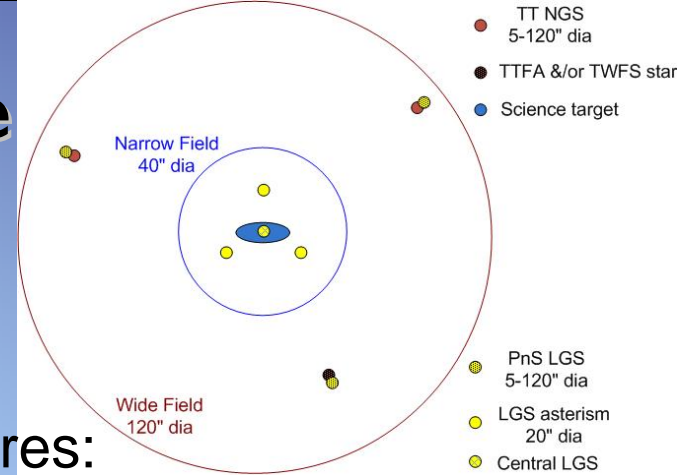
Improved Photometric and Astrometric Accuracy

Imaging and Integral Field Spectroscopy

How is NGAO different from Keck's AO today?



NGAO System Architecture

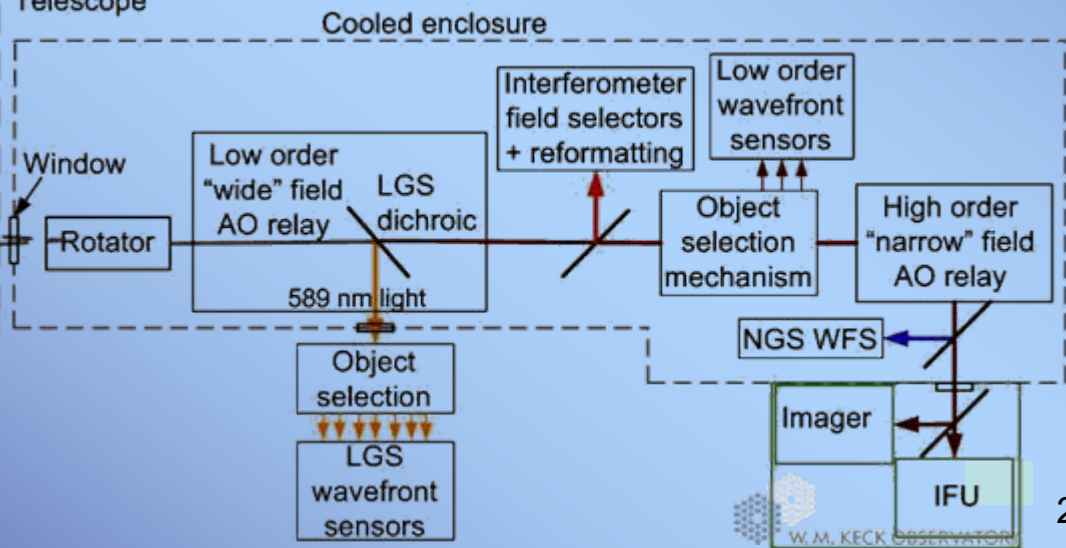


Key Features:

1. Fixed narrow field laser tomography
2. AO corrected NIR TT sensors
3. Cooled AO enclosure smaller
4. Cascaded relay
5. Combined imager/IFU instrument

Multi-LGS Control

Laser Enclosure 75 W



In Closing

- Keck AO has been a tremendous success so far
- We will continue to improve our AO capabilities to ensure cutting edge high angular resolution science for the US community

