

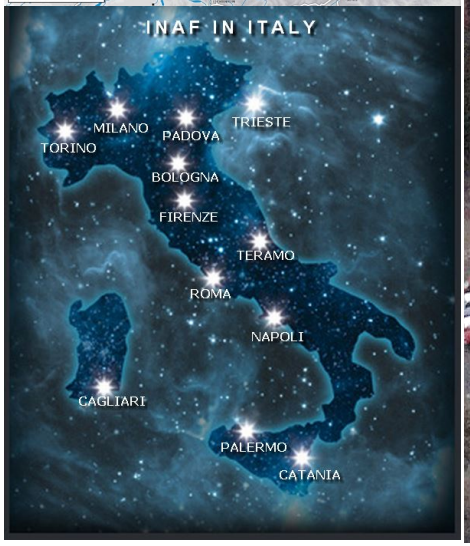
Planetary Science with the Large Binocular Telescope

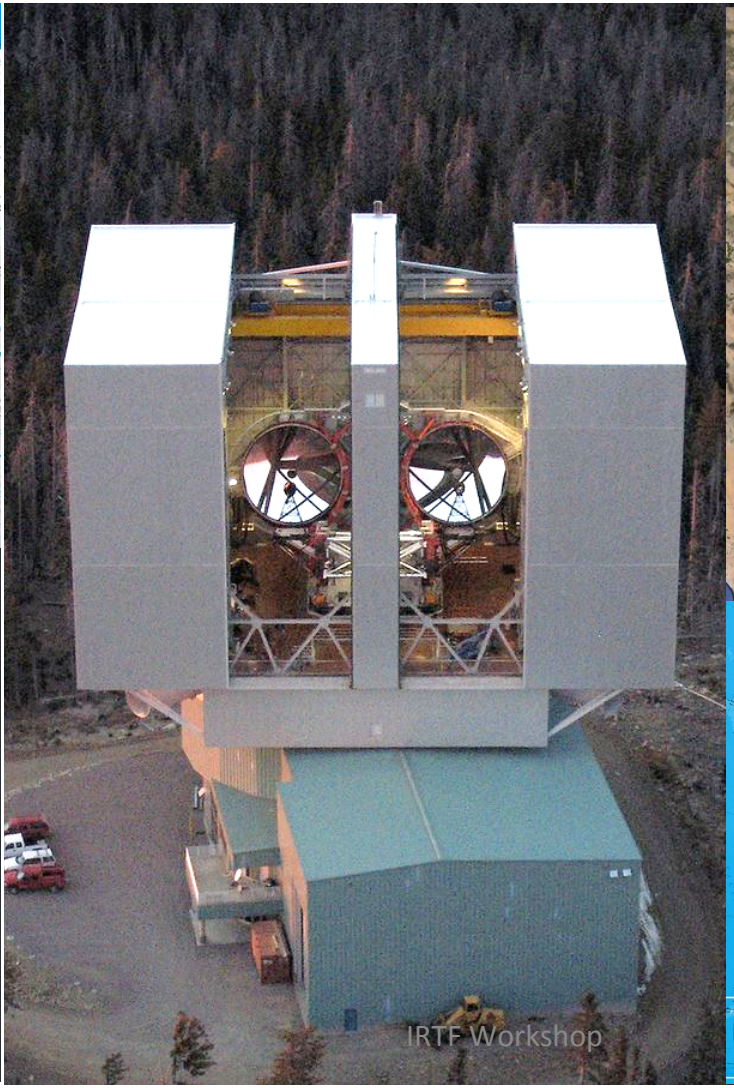
(Yes, Adaptive Secondaries Work)

Outline of the Talk

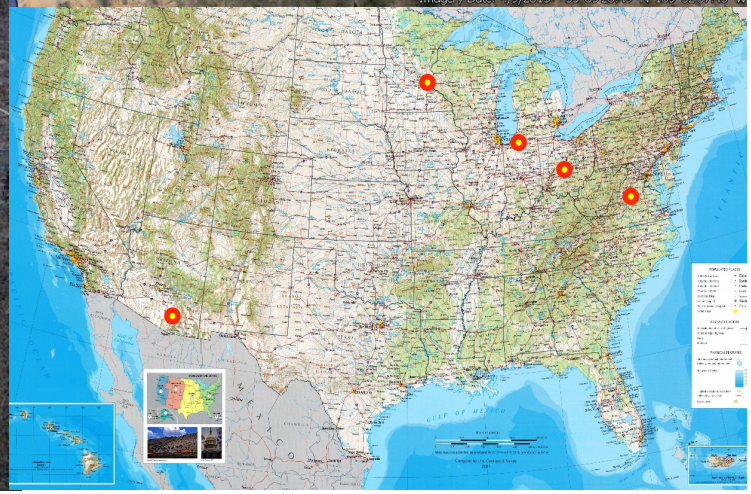
- LBT Overview
- High Spatial Resolution
  - Surface of Io
- Faint, small bodies
  - Osiris-Rex
  - Quasi-satellite
- Future
  - MOBIUS
  - Into the Blue
- Adaptive Secondaries

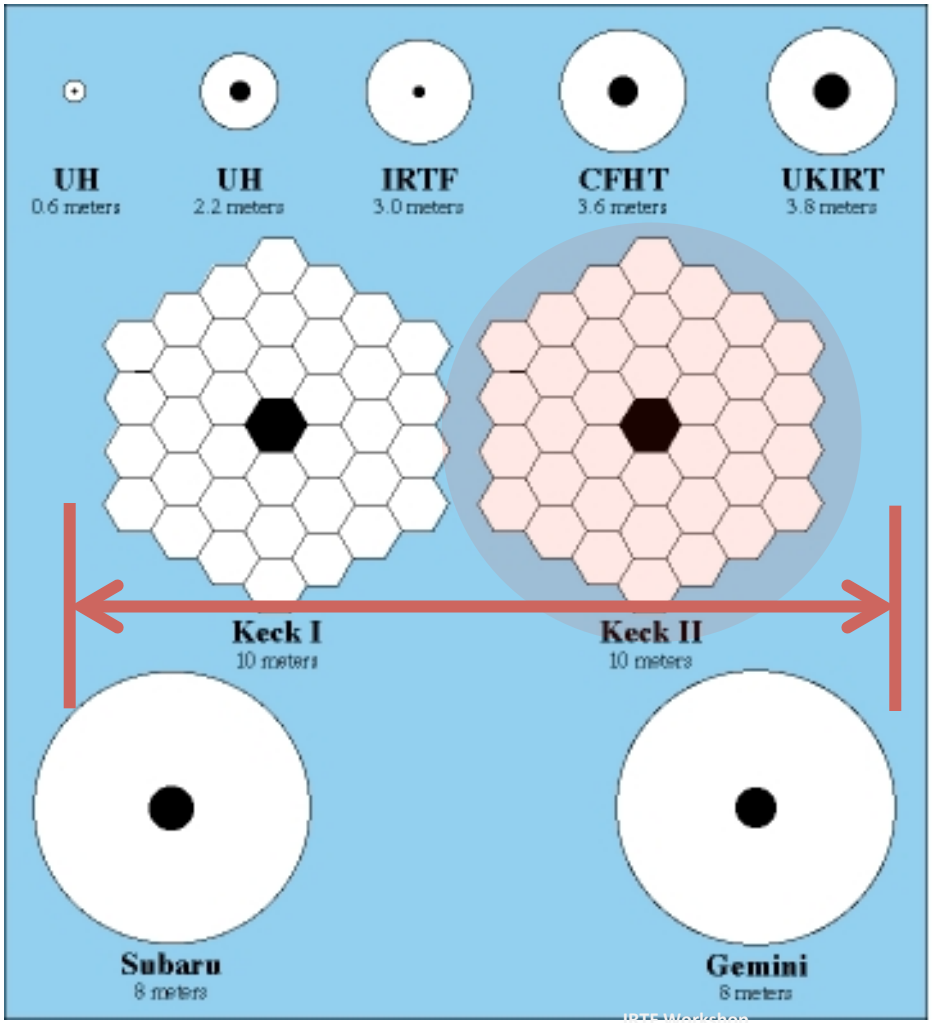

MER DU NORD
MER BALTIQUE
POLOGNE
PAYS-BAS
BELGIQUE
REP. TCHEQUE
FRANCE
AUTRICHE


INAF IN ITALY
MILANO
TRIESTE
PADOVA
TORINO
BOLOGNA
FIRENZE
TERAMO
ROMA
NAPOLI
CAGLIARI
PALERMO
CATANIA


IRTF Workshop

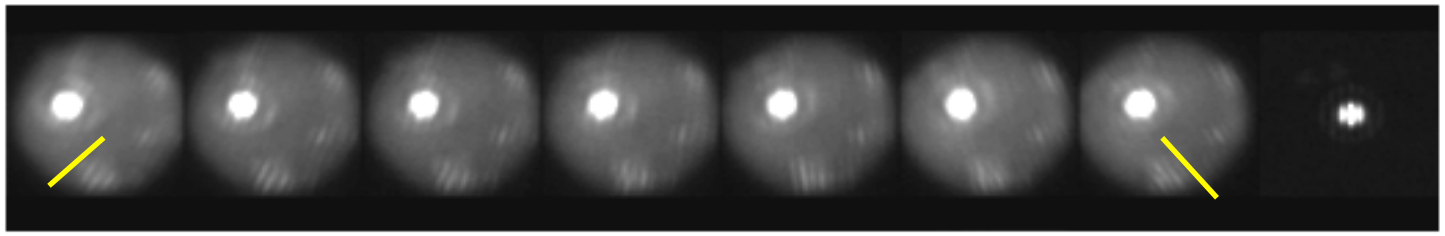

Discovery Channel Telescope
VLA
Magdalena Ridg
BioSphere
Apache Point - SDSS - NSO
LBT
Kitt Peak
Mt Hopkins - MMT
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat





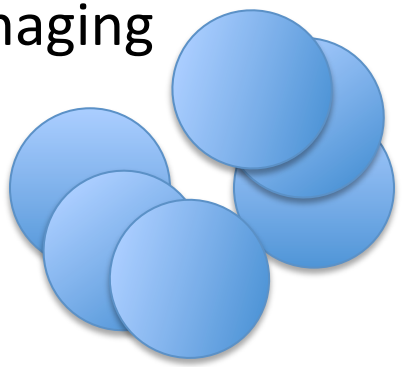
23 meter Resolving Power

One hour on Io



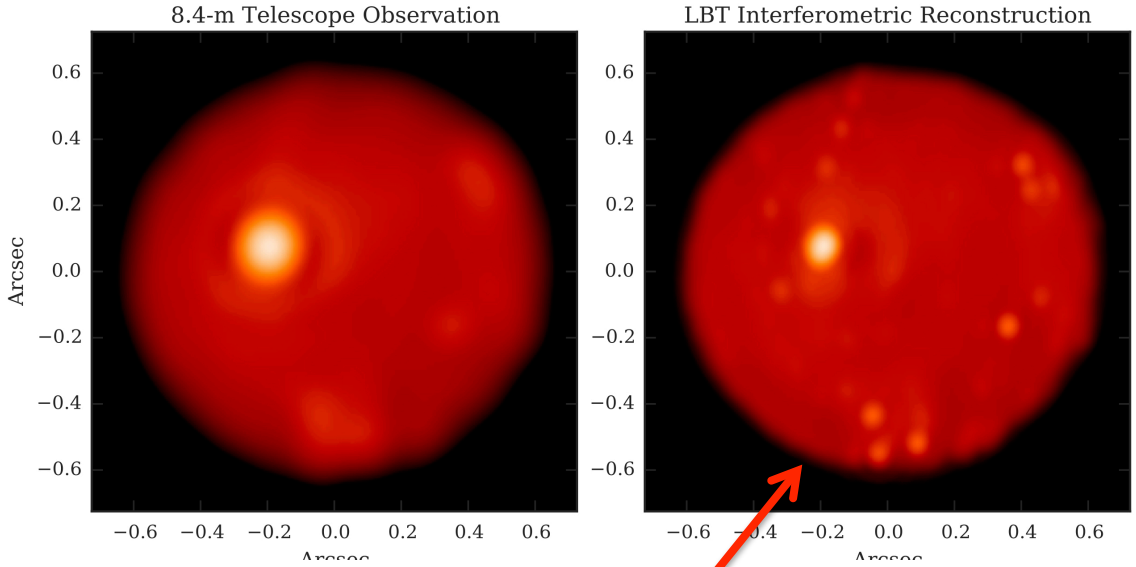
Epoch	Time (UT)	Hour Angle	Air-mass	SEL	Mean Parang
1	07:53	−0.47	1.022	286.59	−30.0
2	07:59	−0.37	1.020	287.44	−22.2
3	08:06	−0.25	1.018	288.43	−15.9
4	08:13	−0.13	1.016	289.42	−07.5
5	08:24	+0.05	1.016	290.97	+04.1
6	08:35	+0.23	1.017	292.53	+16.3
7	08:47	+0.43	1.021	294.22	+29.1

This value is critical for Fizeau imaging



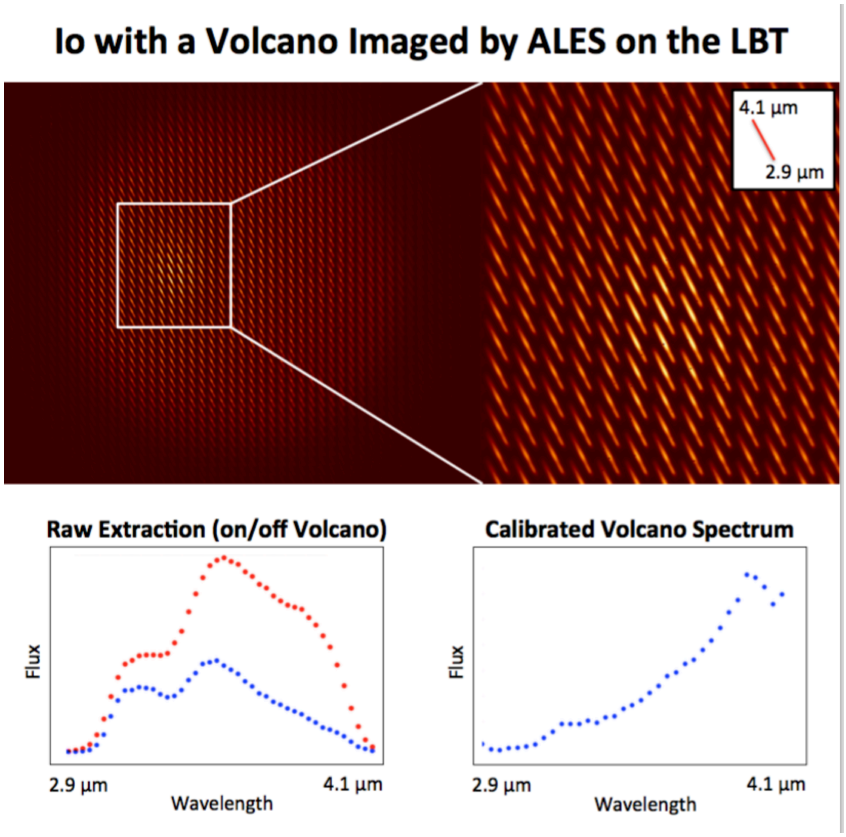
Conrad, et al *AJ* **149** 175 (2015)

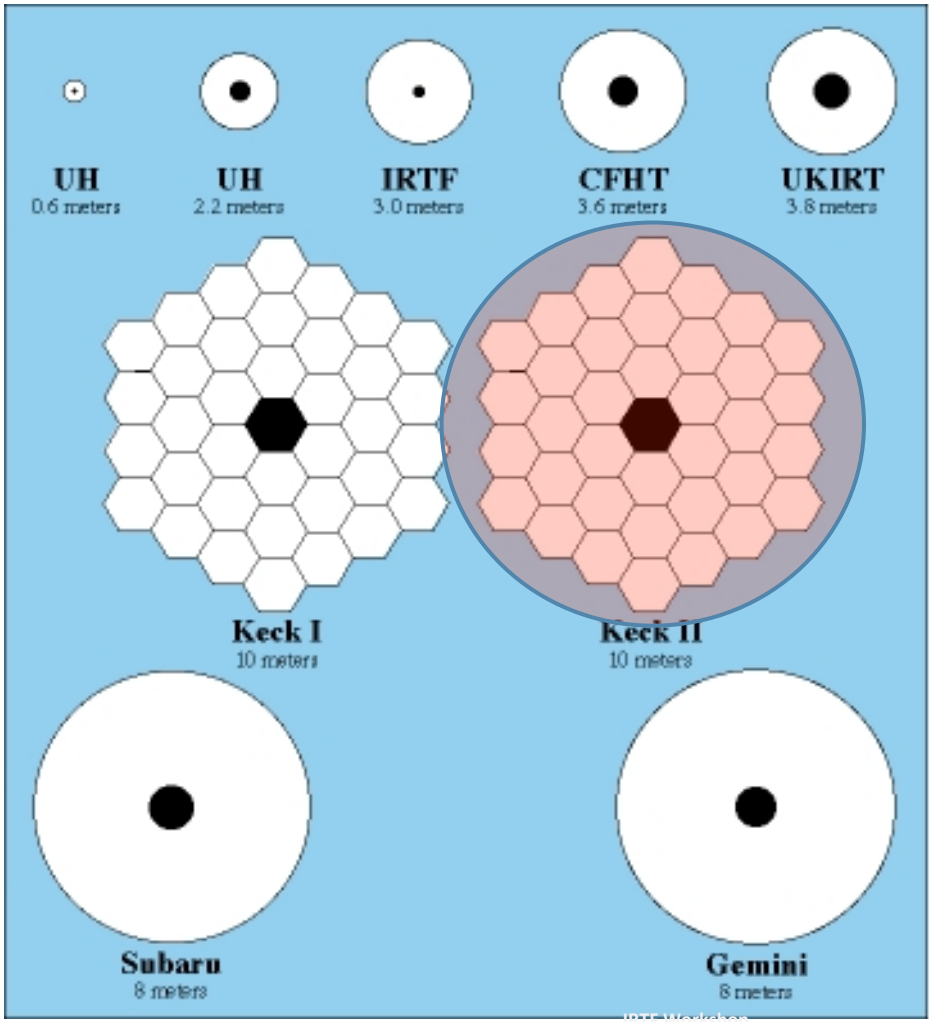
The reconstructed image provides twice better resolution over a telescope with a single 8.4 meter aperture.



The resolution in this M-band image is like K-band on 8-10 meter telescopes (at K-band most volcanoes are invisible)

Conrad, et al *AJ* **149** 175 (2015)


Io with a Volcano Imaged by ALES on the LBT
4.1 µm
2.9 µm
Raw Extraction (on/off Volcano)
Flux
2.9 µm
4.1 µm
Wavelength
Calibrated Volcano Spectrum
Flux
2.9 µm
4.1 µm
Wavelength



LBTO

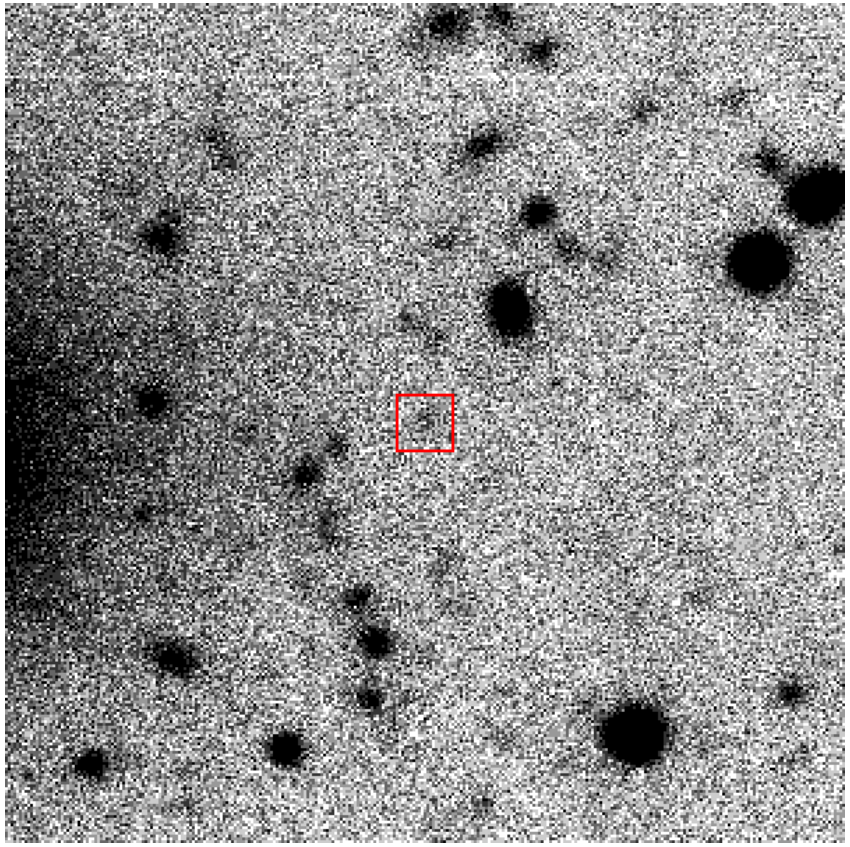
11.8 meters

Light Gathering Power

Detecting faint moving bodies

OSIRIS-Rex imaged with LBC ~2 weeks ahead of closest approach for gravity assist

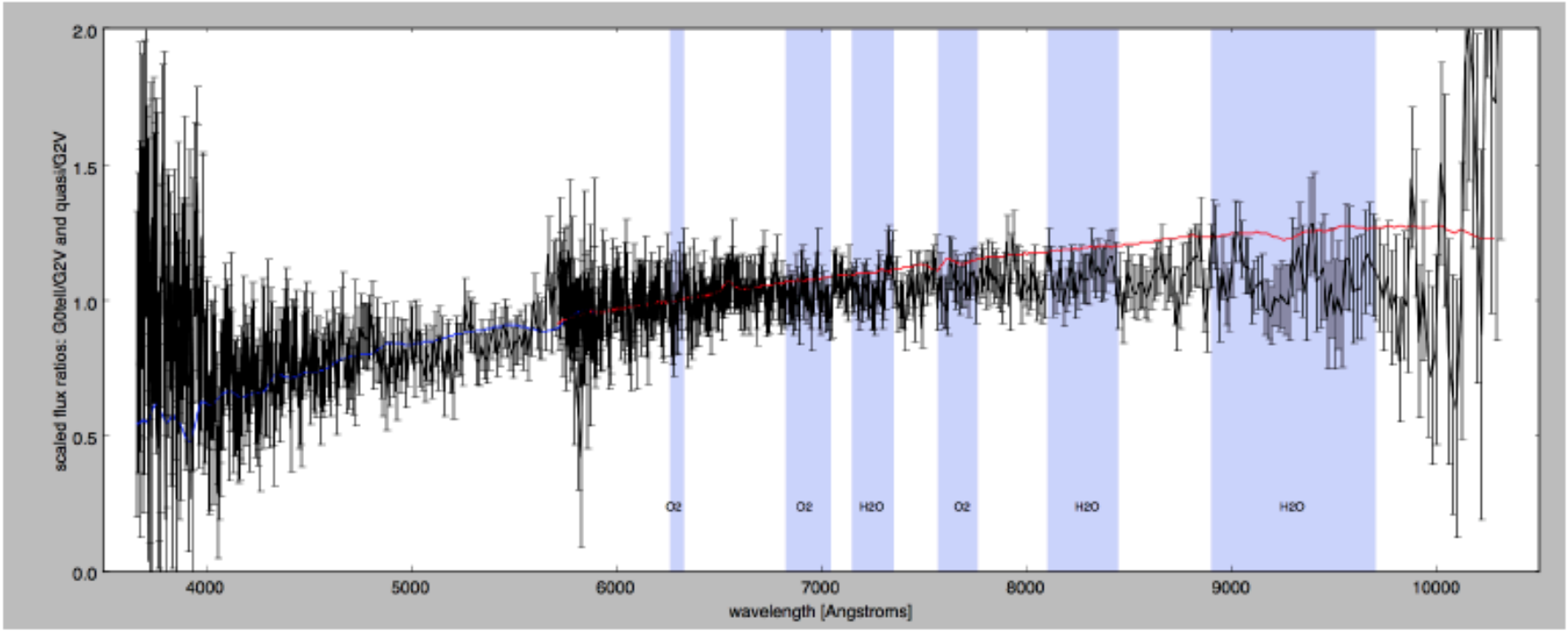
11-million kilometers away from Earth V~25



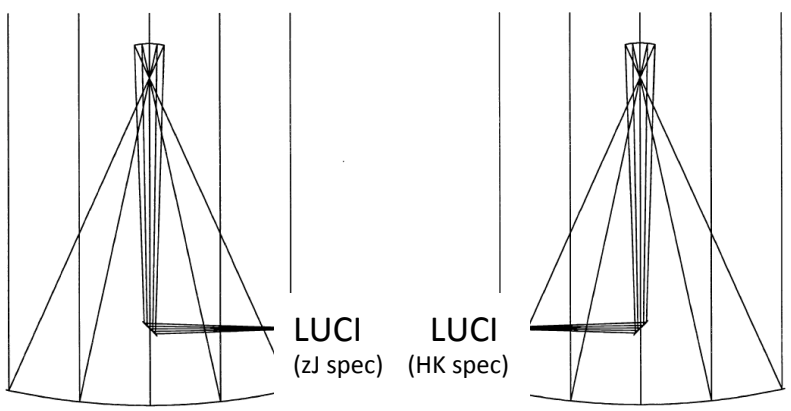
2016 H03 – a quasi-satellite of the Earth



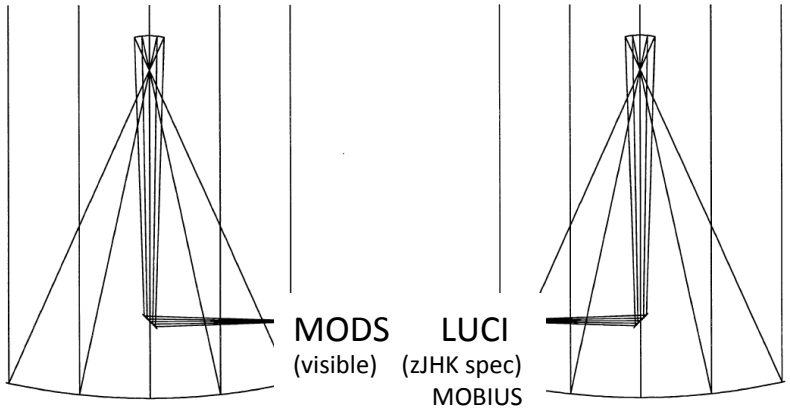
(469219) 2015 HO3 Visible Spectra Acquires with MODS



For the future, we seek full Visible + IR wavelength coverage …



LUCI on both sides this April on the Quasi to compliment existing visible spectra …



In about a year, using MOBIUS: contemporaneous 0.3 to 2.2 micron coverage on Quasi (and other small, faint bodies).

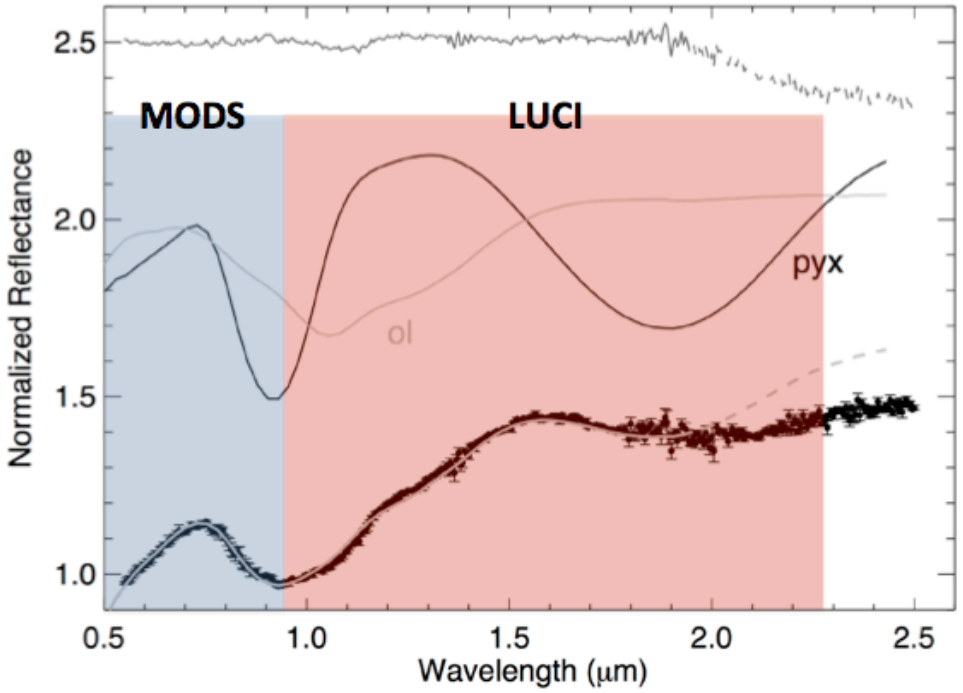
Simultaneous visible + IR spectra

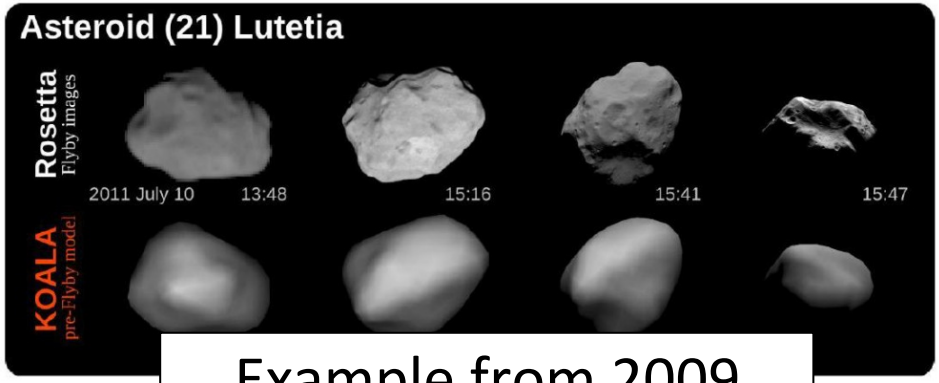
Using MODS on one side and LUCI on the other

LUCI to be slightly modified to enable such observations

COMING SOON

2018?





Example from 2009 using lower resolution



Forerunner experiment on sky

SHARK-VIS instrument

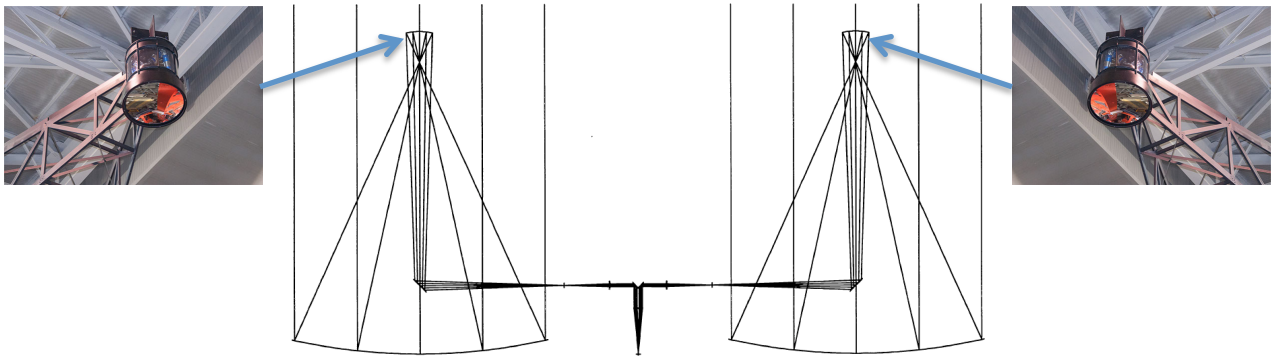
COMING SOON

2019

Future Missions

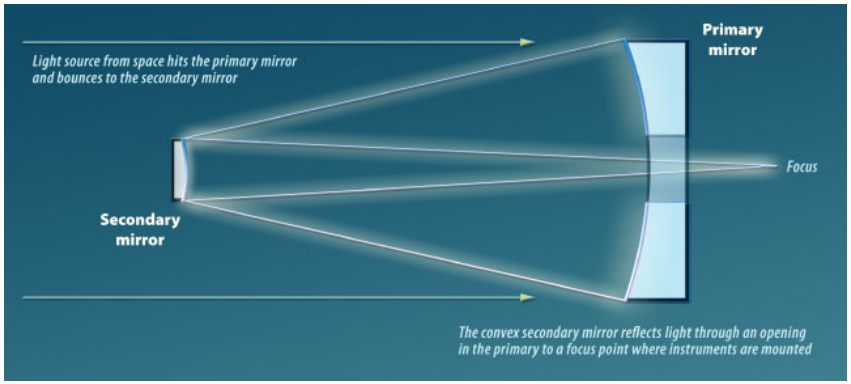
Mission	Target	V mag	Size (mas)
DAWN	*Adeona*	11.0-13.6	56-133
DESTINY	*Phaeton*	10.2-19.1	4-101
PSYCHE	*Psyche*	10.9-12.2	85-156
LUCY	*Eurybates*	16.8-17.7	13-20
	Orus	16.9-17.9	11-16
	Patroclus	15.9-16.5	33-39

About the LBT adaptive secondaries …

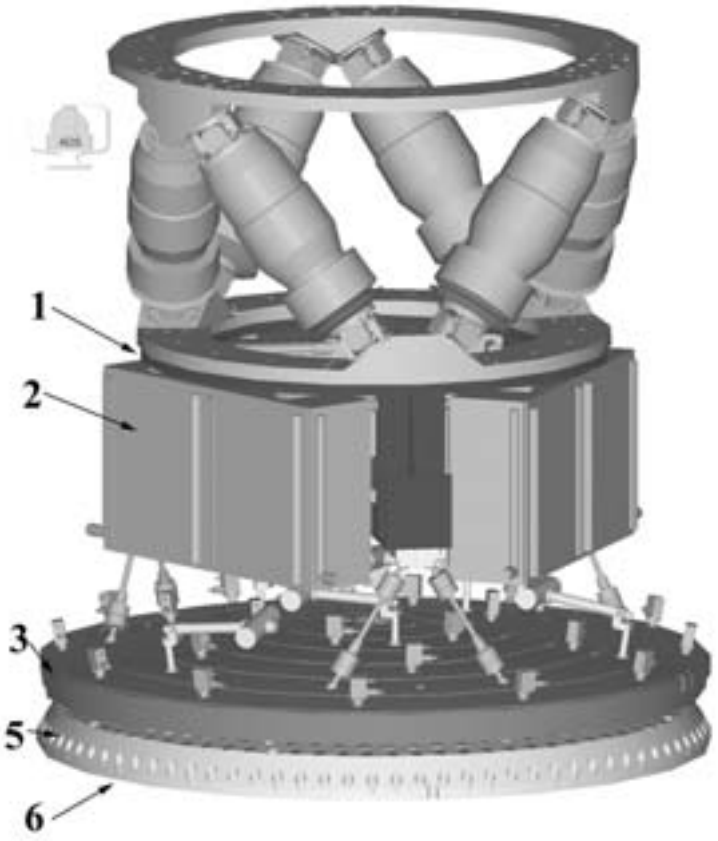




… and how our experience might assist IRTF with future directions …



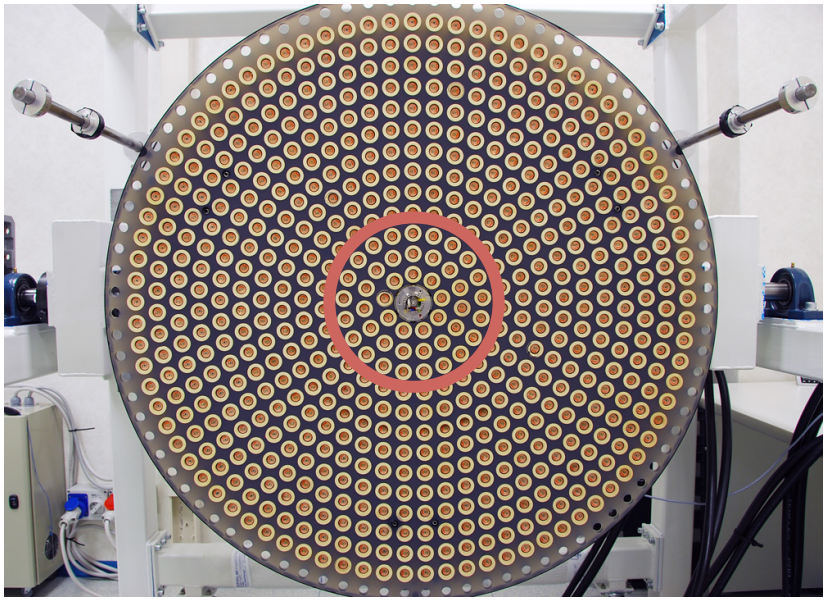
- 911 mm diameter
- 672 actuators
- 500 mm thick shell (5)
- 1.6 mm thin shell (6)
- ~100 um air gap



What's different?

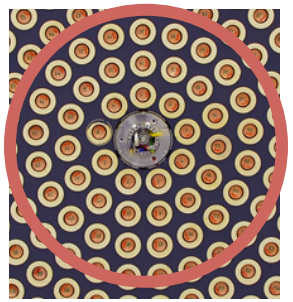
LBT

- D = 911mm
- # of Actuators = 672



IRTF

- D = 244mm
- # of Actuators = ~50



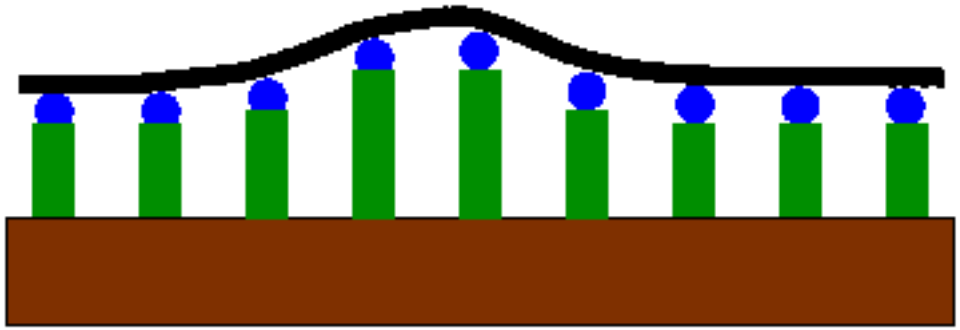
What's different?

LBT

- Thin Shell Thickness = 1.6 mm

IRTF

- Thin Shell Thickness = 1.6 (?)



Is an Adaptive Secondary for IRTF feasible?

- Yes, if …

1. Low Strehl (few actuators) is indeed OK
2. Close collaboration with (and inheritance from) MMT, LBT, and MagAO for lessons learned
   - Note the MagAO experience

Benefits

- "Light down the slit"
  - Fainter limits => more targets (e.g., Ellen's comment about comets)
  - ~ 2 magnitude gain for NEO is significant (e.g., Visnhu's comment about NEO)
- Angular resolution
  - Pluto/Charon example (Sylvia's comment)
- AO at longer (> 3um) wavelengths requires Adaptive Secondary (to minimize warm surfaces)
  - N.B. – Chopping not needed <3 um
- Adaptive Secondary acts as a rigid secondary easily
- Keeps IRTF 'work horse' instruments in tact
- Reliability now proven
- First adaptive secondary on Mauna Kea (?)

Conclusions

- Planetary science is in ascendance at LBT
- Complimentary to IRTF (e.g., spectra beyond Vmag = 21)
- LBT can assist in IRTF should an Adaptive Secondary be considered

Mahalo!

