



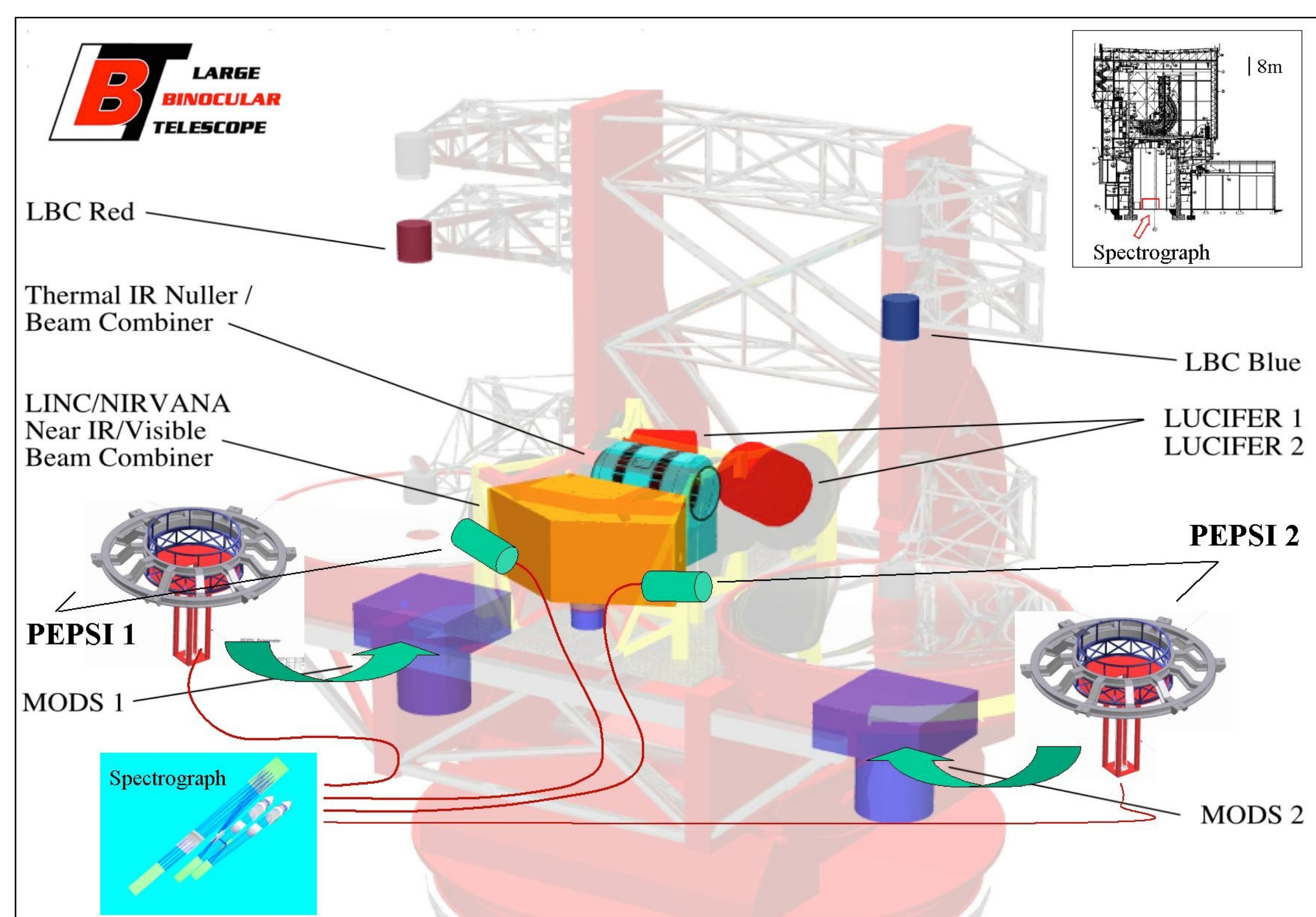
# Detector Systems at the Large Binocular Telescope Observatory\*

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Large Binocular Telescope Observatory

The Large Binocular Telescope Observatory is located in southeastern Arizona, in the Pinaleno Mountains (Emerald Peak), at an altitude of 3,191 meters (10,470 feet). The binocular design of the LBT has two identical 8.4 m telescopes mounted side-by-side on a common altitude-azimuth mounting for a combined collecting area of a single 11.8-meter telescope.

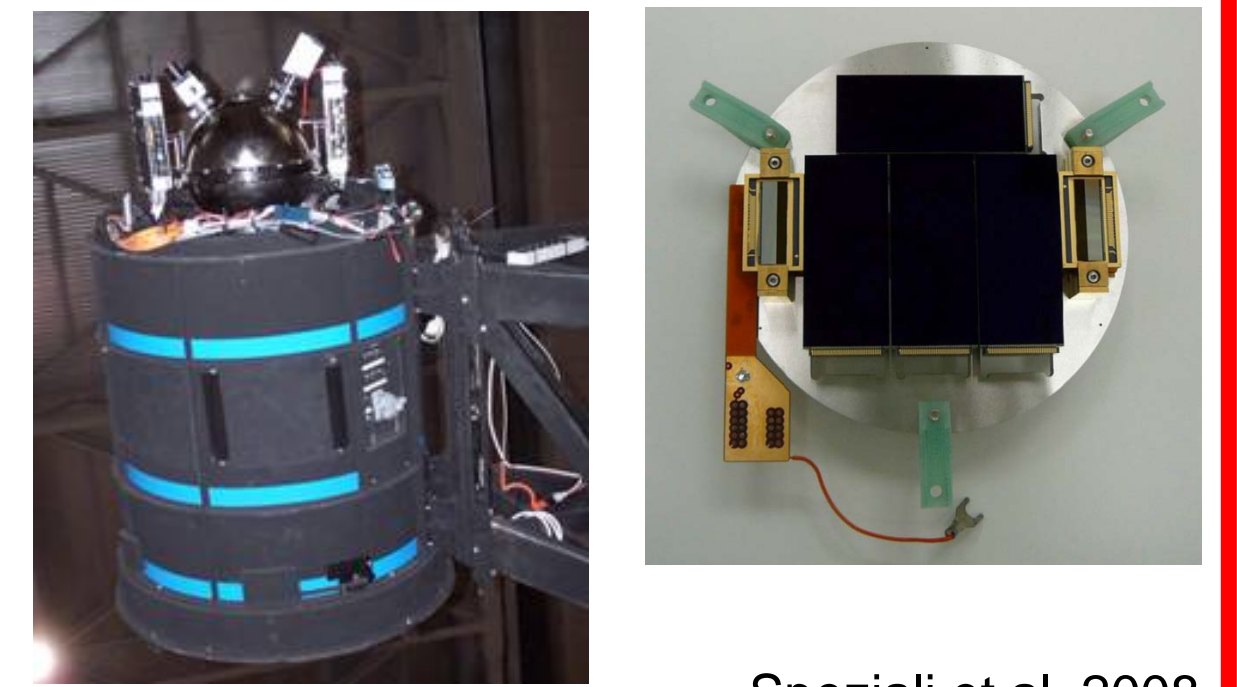
A unique feature of LBT is that the light from the two primary mirrors can be combined to produce phased-array imaging of an extended field. This coherent imaging along with adaptive optics (using two f/15 Gregorian Adaptive secondary mirrors with 672 actuators) gives the telescope the diffraction-limited resolution of a 22.65-meter telescope.

## SCIENCE INSTRUMENTS



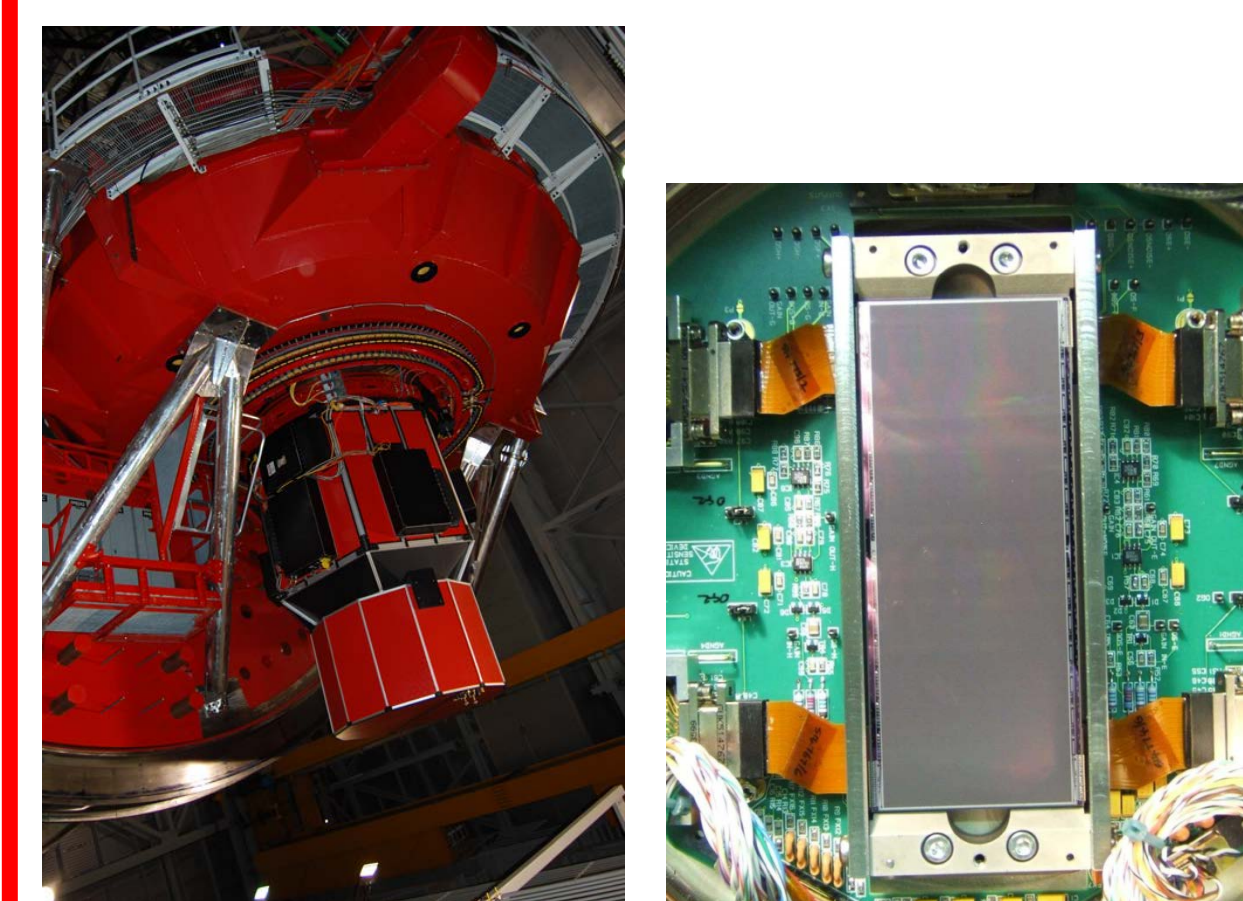
## A LARGE BINOCULAR CAMERA (LBC)

- INAF: Rome, Padua, Trieste.
- 2 PF imaging cameras: Blue and Red.
- Blue: UB bands; Red: VRIZ bands.
- Wide field: 27' x 27'.
- 4 CCD mosaic + 2 aux CCDs.



Speziali et al, 2008

## B MULTI-OBJECT DOUBLE SPECTROGRAPH (MODS)

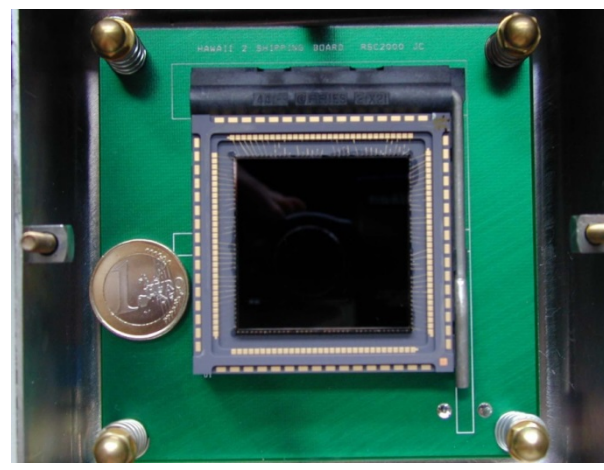
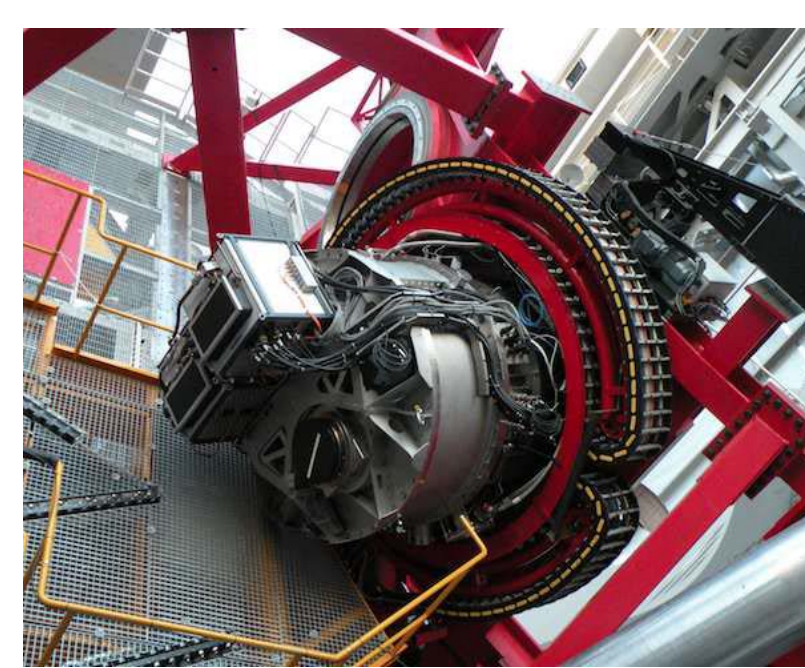


- OSU Imaging Sciences Lab.
- 2 double-beam optical spectrographs.
- f/16 Direct Gregorian foci.
- Three observing modes: long-slit, multi-slit with curved masks and direct imaging.
- Blue channel: CCD 15 μm thick.
- Red channel: CCD 40 μm thick deep-depletion.

Pogge et al, 2012 ; Atwood et al, 2008

## C NEAR-INFRARED IMAGER AND SPECTROGRAPH (LUCI)

- LBTB: LSW, MPIA, MPE.
- 2 cryogenic NIR imager and spectrographs.
- Observing modes: seeing-limited imaging, long-slit and multi-object; diffraction-limited imaging and long-slit.
- f/15 Front-bent Gregorian focal station.
- Full cryogenic mask handling unit.
- NIR detectors: Hawaii-2 and H2RG.



Buschkamp et al, 2012

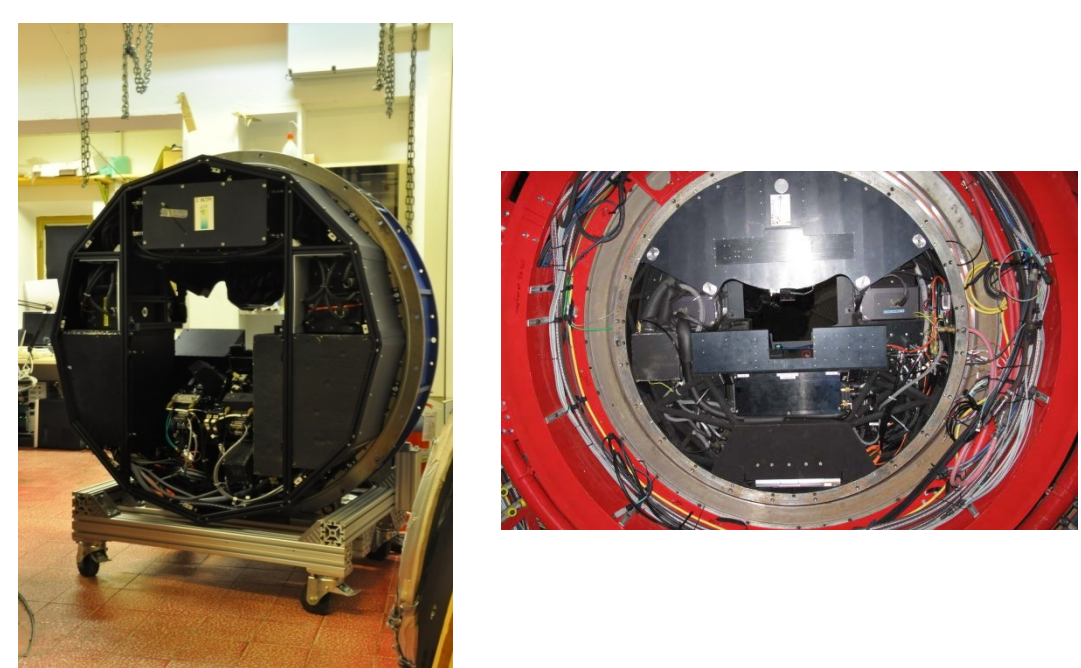
## D LBT INTERFEROMETER (LBTI)

- U Arizona and Research Corporation.
- Cryogenic all-reflective Universal Beam Combiner.
- Center-bent Gregorian focal station.
- Nulling IR Camera (NIC) with 2 science channels:
  - NOMIC (7-25 μm).
  - LMIRcam (2-5 μm).



Hinz et al, 2008

## G ACQUISITION, GUIDING AND WAVEFRONT SENSING UNITS (AGW)

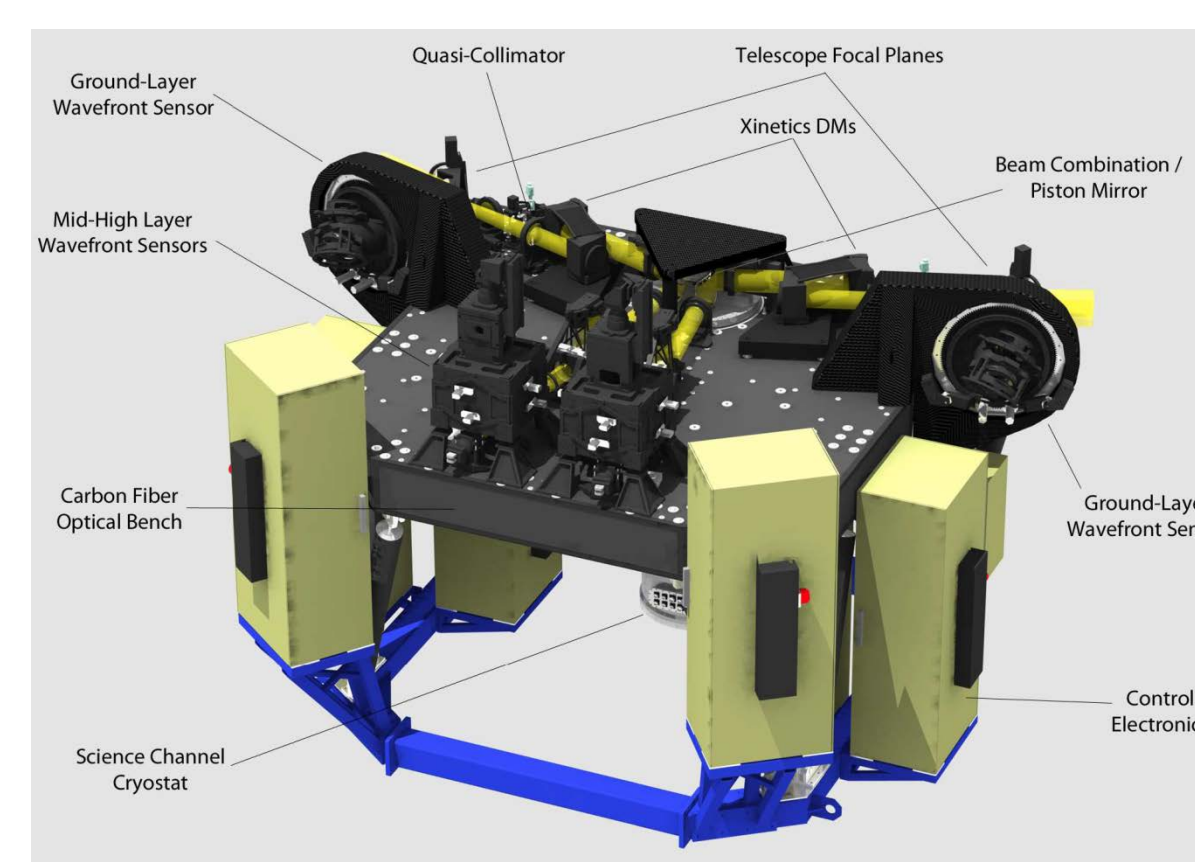


- AIP (Potsdam).
- Units are located at each focal station.
- Each unit consists of an off-axis probe with a guide camera and a wavefront sensor (Shack-Hartmann).
- 2 CCD cameras per unit.

Storm et al, 2004

## E LINC-NIRVANA

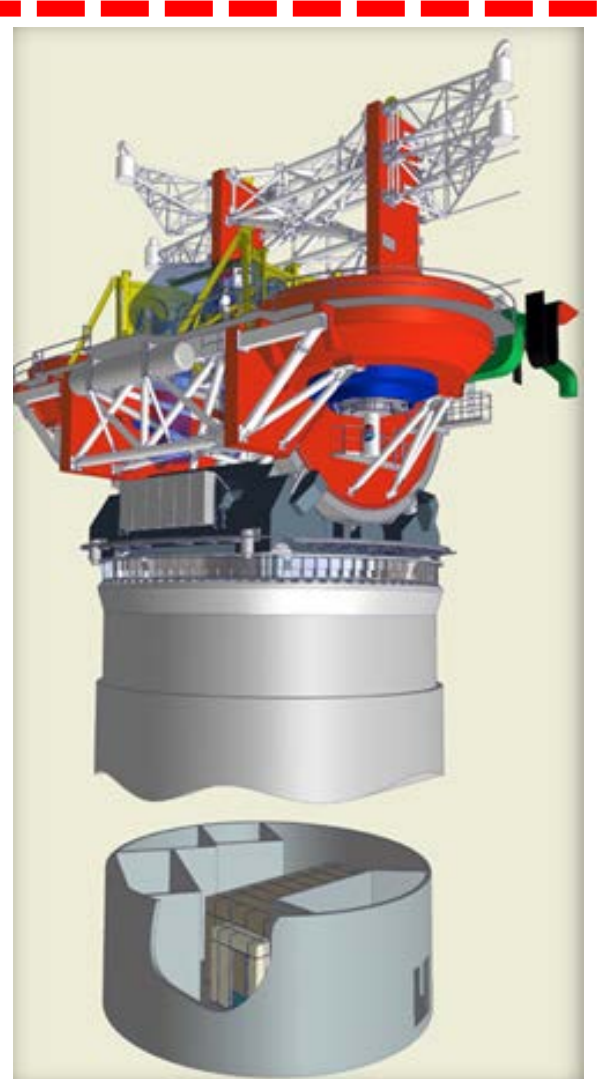
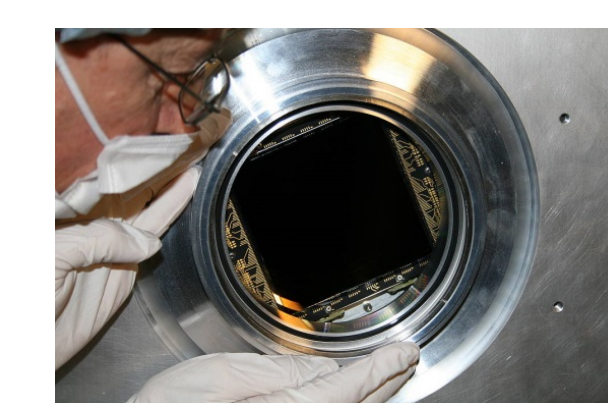
- MPIA, INAF, Köln, MPIfR.
- NIR Fizeau-mode imaging interferometer.
- Back-bent Gregorian focal station.
- LBT's largest instrument.
- MCAO with up to 12 NGS (Pyramid WFS).
- NIR science channel (Hawaii-2)
- NIR Fringe/Flexure Tracker.
- CCDs for AO WFS (MHWS: Mid-High Layer and GWS: Ground Layer) and Patrol Cameras.



Herbst et al, 2010 ; Schreiber et al, 2008

## F POTSDAM ECHELLE POLARIMETRIC AND SPECTROSCOPIC INSTRUMENT (PEPSI)

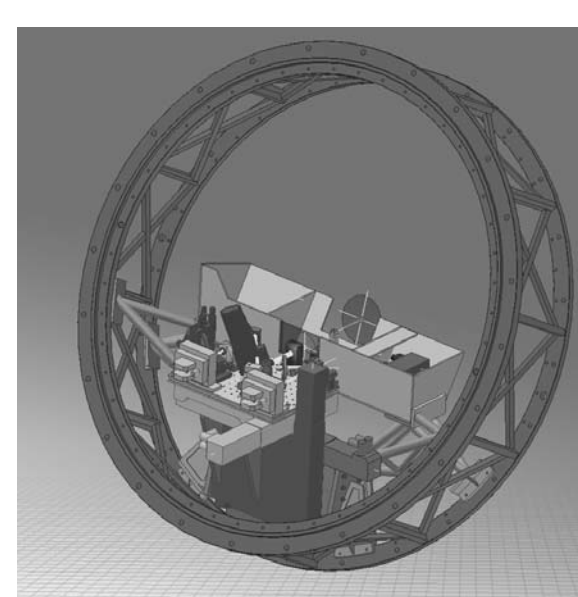
- Fiber-fed echelle spectro-polarimeter.
- Extremely high spectral resolution (up to 130,000).
- Spectrograph is housed at the base of the telescope pier.
- Two focal stations:
  - Polarimeters at the f/15 direct Gregorian.
  - Fiber focus next to LINC-NIRVANA.
- 2 10.6x10.6K for science.
- 10 CCD cameras for AGW.



Strassmeier et al, 2008

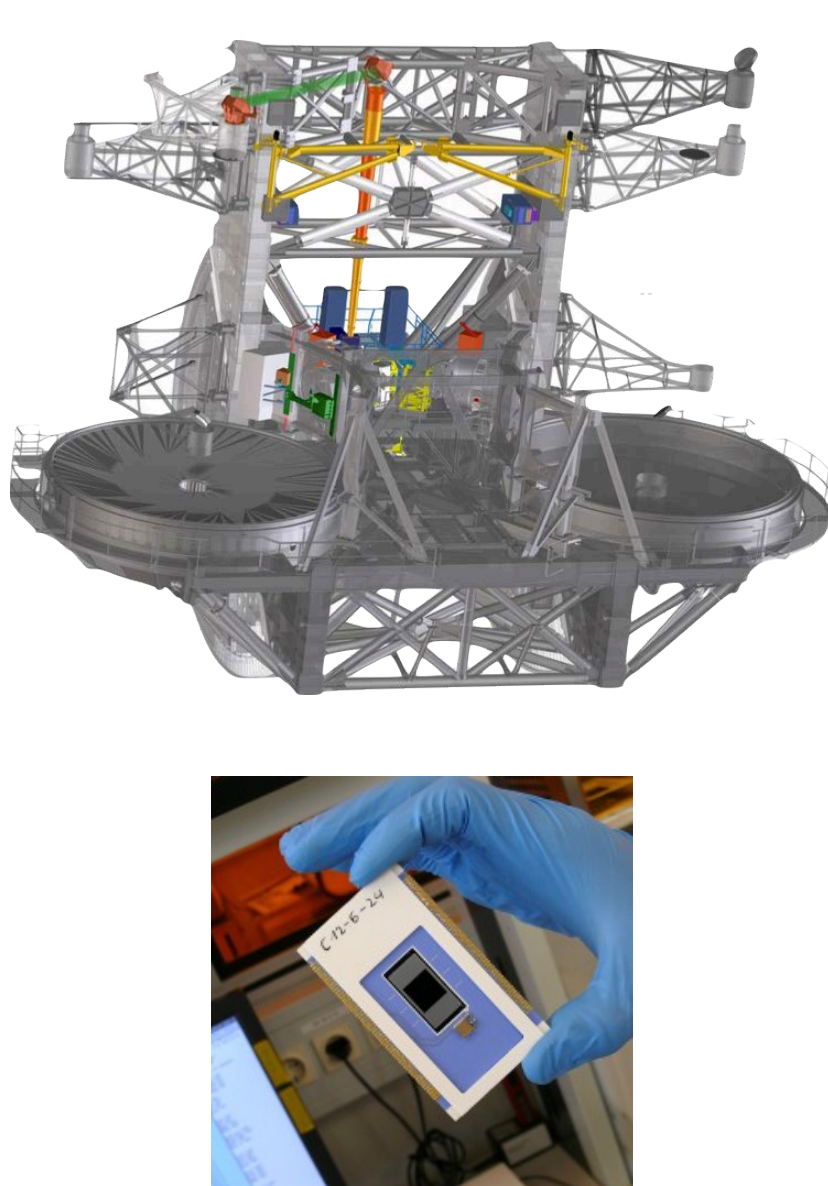
## H FIRST LIGHT AO SYSTEM (FLAO)

- Arcetri Observatory.
- Modules located inside the AGW unit at each LUCI station.
- 2 CCD cameras per unit (acquisition and wavefront sensing).
- Pyramid wavefront sensor with adjustable pupil sampling.



Esposito et al, 2010

## I GLAO LASER GUIDE STAR SYSTEM (ARGOS)



- MPE, MPIA, AIP, Arcetri, U Arizona.
- 3 "Rayleigh beacons" at 12 Km (above each mirror).
- Each laser: Nd:YAG, 18 W, pulsed @10KHz, 532 nm.
- On-axis launch behind secondary mirrors.
- For use with LUCI as science instrument.
- Shack-Hartmann wavefront sensor.
- LGS pulse gating with Pockels cell shutters.
- WFS cameras by PNSensor GmbH.

Orban de Xivry et al, 2010

Science (in use)      Technical (in use)  
Science (in development)      LGS (in development)

Ref	System	Detector	Format	Pixel size (μm)	Controller
A	LBC Science LBC Auxiliary	e2v 42-90 (mosaic of 4) e2v 42-10 (2)	4.6K x 2.5K 512 x 2K	13.5 13.5	Rome + Skytech Rome + Skytech
B	MODS	e2v 231-68	8K x 3K	15.0	OSU MkIX
C	LUCI1 LUCI2	Hawaii-2 (2.5 μm) H2RG (2.5 μm)	2K x 2K 2K x 2K	18.0 18.0	MPIA MPIA
D	LBTI - NOMIC LBTI - LMIRcam LBTI - Phasecam	Aquarius (25 μm) H2RG (5 μm) PICNIC (2.5 μm)	1K x 1K 1K x 1K 256 x 256	30.0 18.0 40.0	Cornell / FORCAST Cornell / FORCAST SciMeasure Little Joe
E	LINC-NIRVANA Sci LN Fringe/Flex Track LN MHWS LN GWS LN Patrol Cameras	Hawaii-2 (2.5 μm) Hawaii-1 (2.5 μm) e2v CCD39 e2v CCD50 e2v CCD47-20	2K x 2K 512 x 512 (1 quad) 80 x 80 128 x 128 1K x 1K	18.0 18.5 24.0 24.0 13.0	MPIA MPIfR SciMeasure Little Joe SciMeasure Little Joe SciMeasure Little Joe
F	PEPSI Science PEPSI AGW	STA 1600TA e2v CCD57-10	10.6K x 10.6K 512 x 512	9.0 13.0	ARC Magellan
G	AGW	e2v CCD57-10	512 x 512	13.0	ARC
H	FLAO	e2v CCD39 e2v CCD47-20	80 x 80 1K x 1K	24.0 13.0	SciMeasure Little Joe SciMeasure Little Joe
I	ARGOS	PnCCD	248 x 256	48.0	PNSensor GmbH

\* The LBTO is an international collaboration of the University of Arizona, Italy (INAF: Istituto Nazionale di Astrofisica), Germany (LBTB: LBT Beteiligungsgesellschaft), The Ohio State University, and the Tucson-based Research Corporation.