Jet Propulsion Laboratory
California Institute of Technology

W.M. Keck Observatory
California Association for Research in Astronomy

National Aeronautics and Space Administration

Overview of the Keck Interferometer

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9-13 August 1999, Michelson Interferometry Summer School

http://huey.jpl.nasa.gov/keck

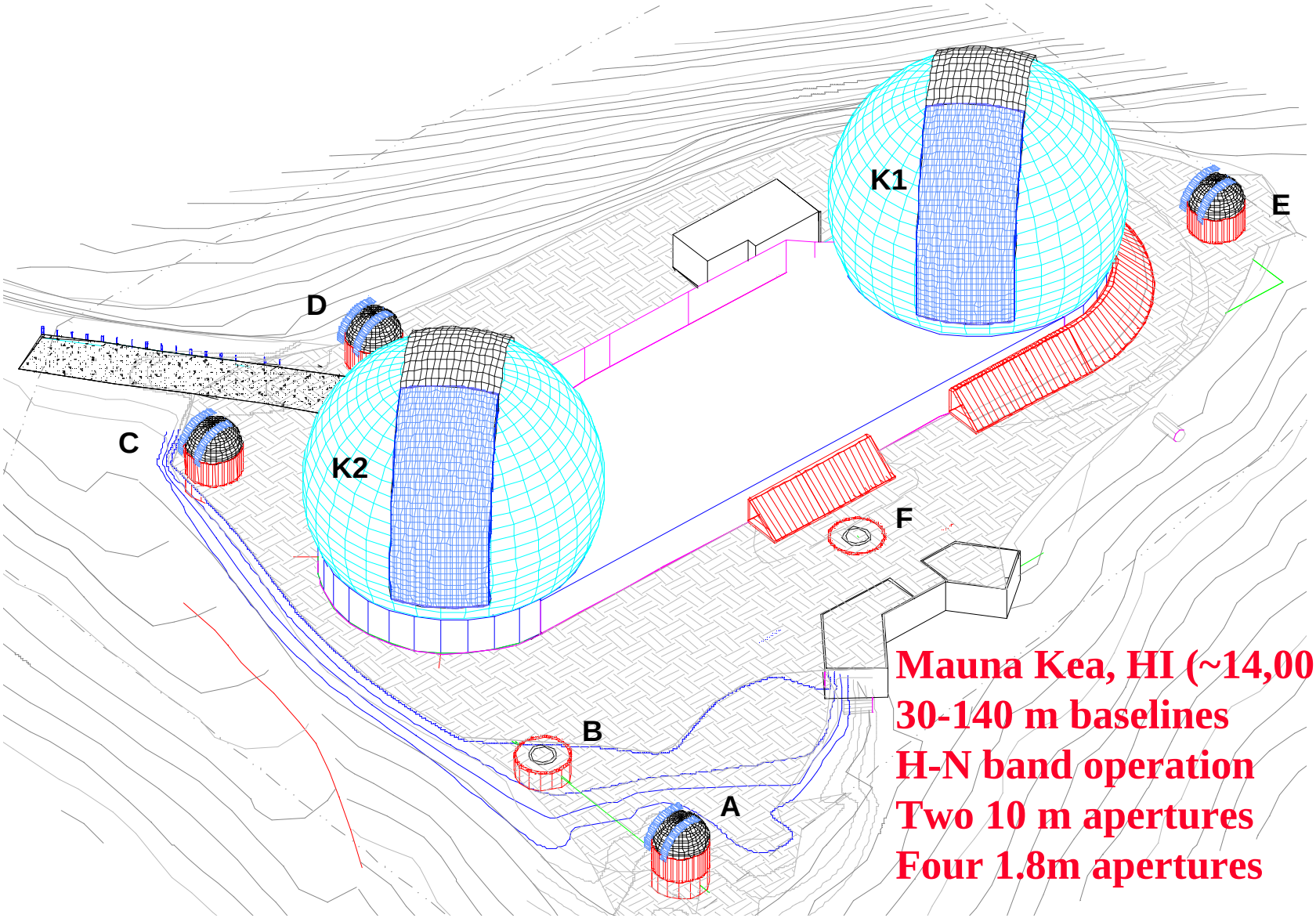
Palomar Testbed Interferometer (PTI)

© 1998 Gerard van Belle

Keck I, Keck II - Winter 97 (from North looking South)

© 1998 Richard Wainscoat

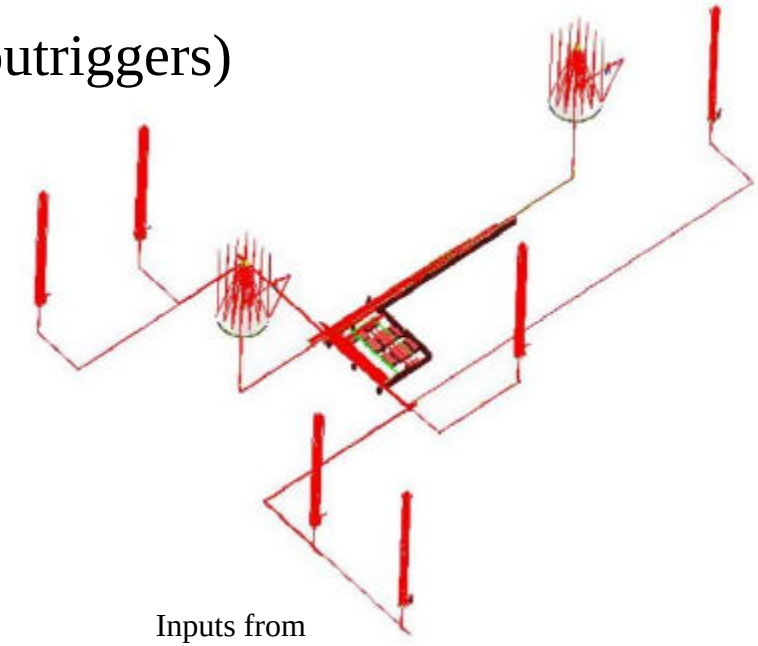
Keck Interferometer - Fall 2001

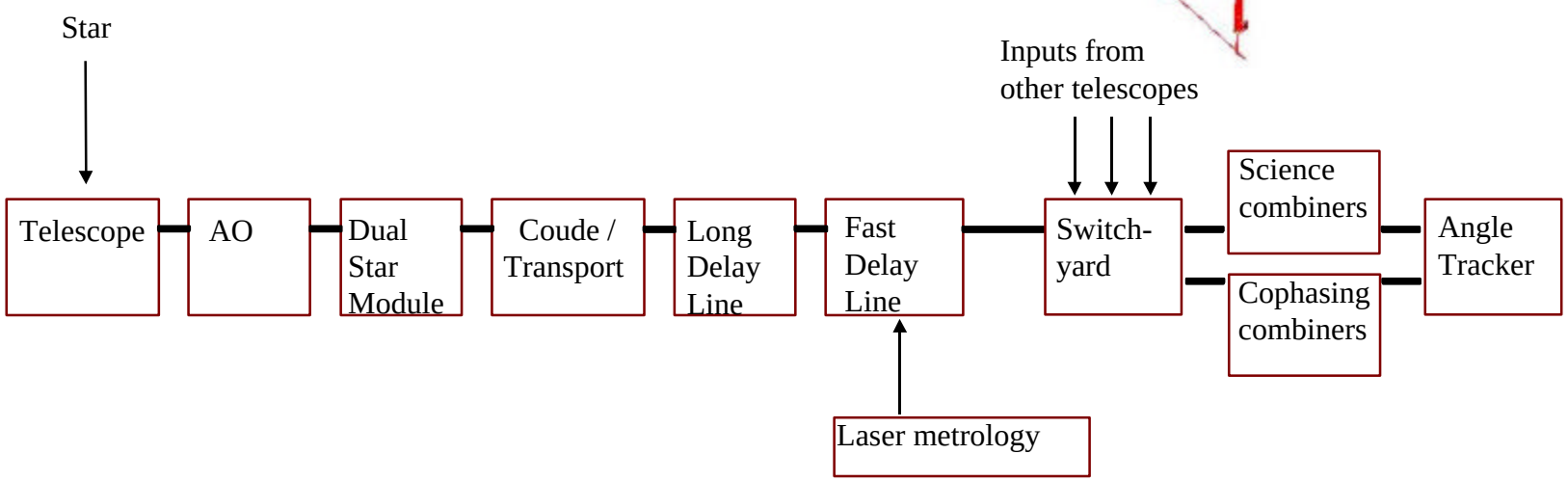


Mauna Kea, HI (~14,000')
30-140 m baselines
H-N band operation
Two 10 m apertures
Four 1.8m apertures

KI Beam Train

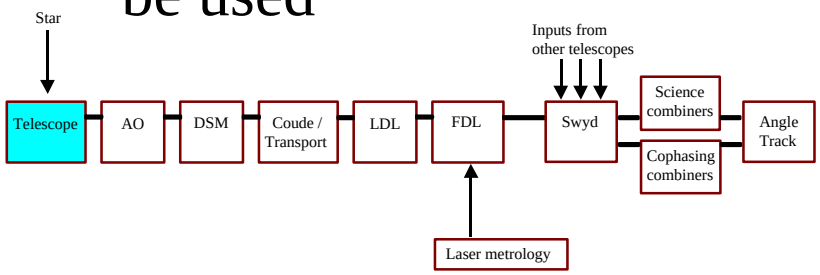
- Adaptive optics (Kecks) / tip tilt (outriggers)
- Dual star modules
- Autoaligned beam trains
- Laser metrology
- Delay lines
- Angle tracker
- Switchyard/stimulus
- 2-way, N-way combiners

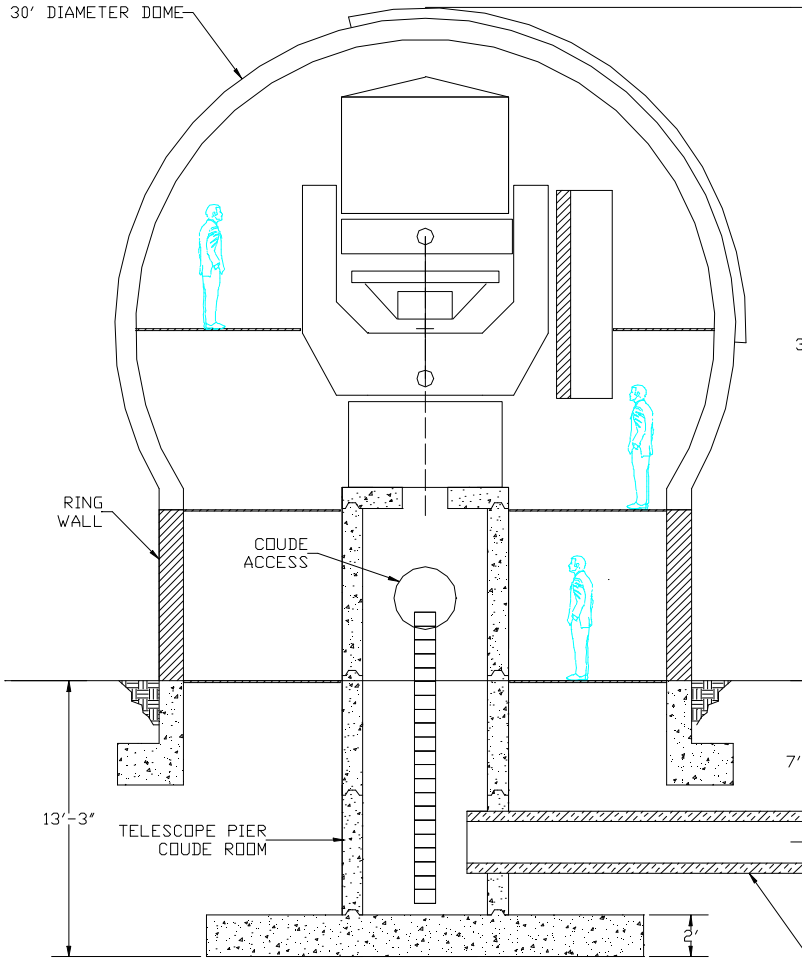




Telescopes

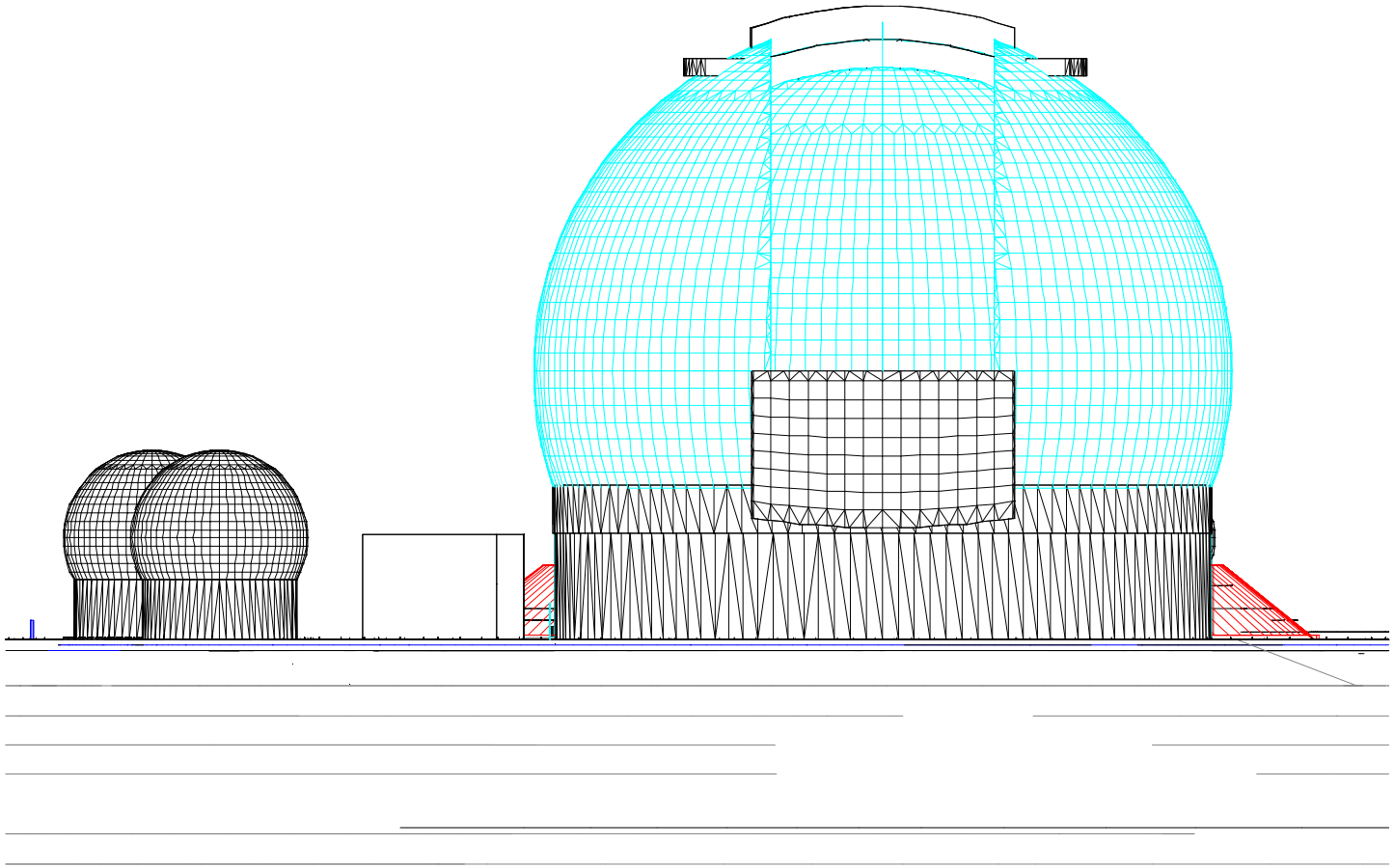
- Four 1.8-m outrigger telescopes
  - Used with Kecks for imaging
  - Used separately for astrometry
  - Key specifications
    - » 10-cm collimated output (after DSM)
    - » Stable pivot for astrometry
- For instrument debugging, 40-cm siderostats (like on PTI) will be used





CARA

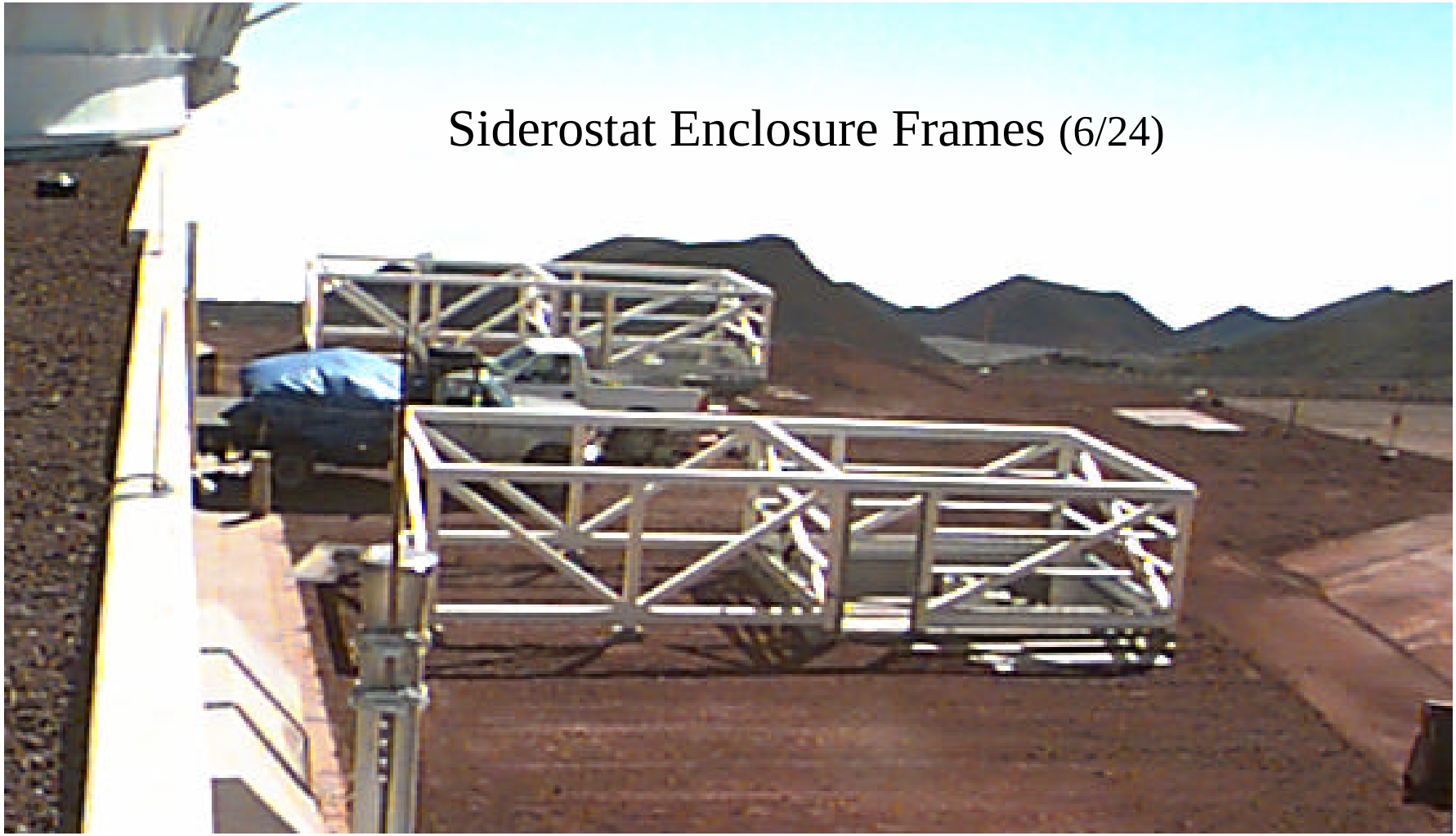
0.4 m « 1.8 m « 10 m



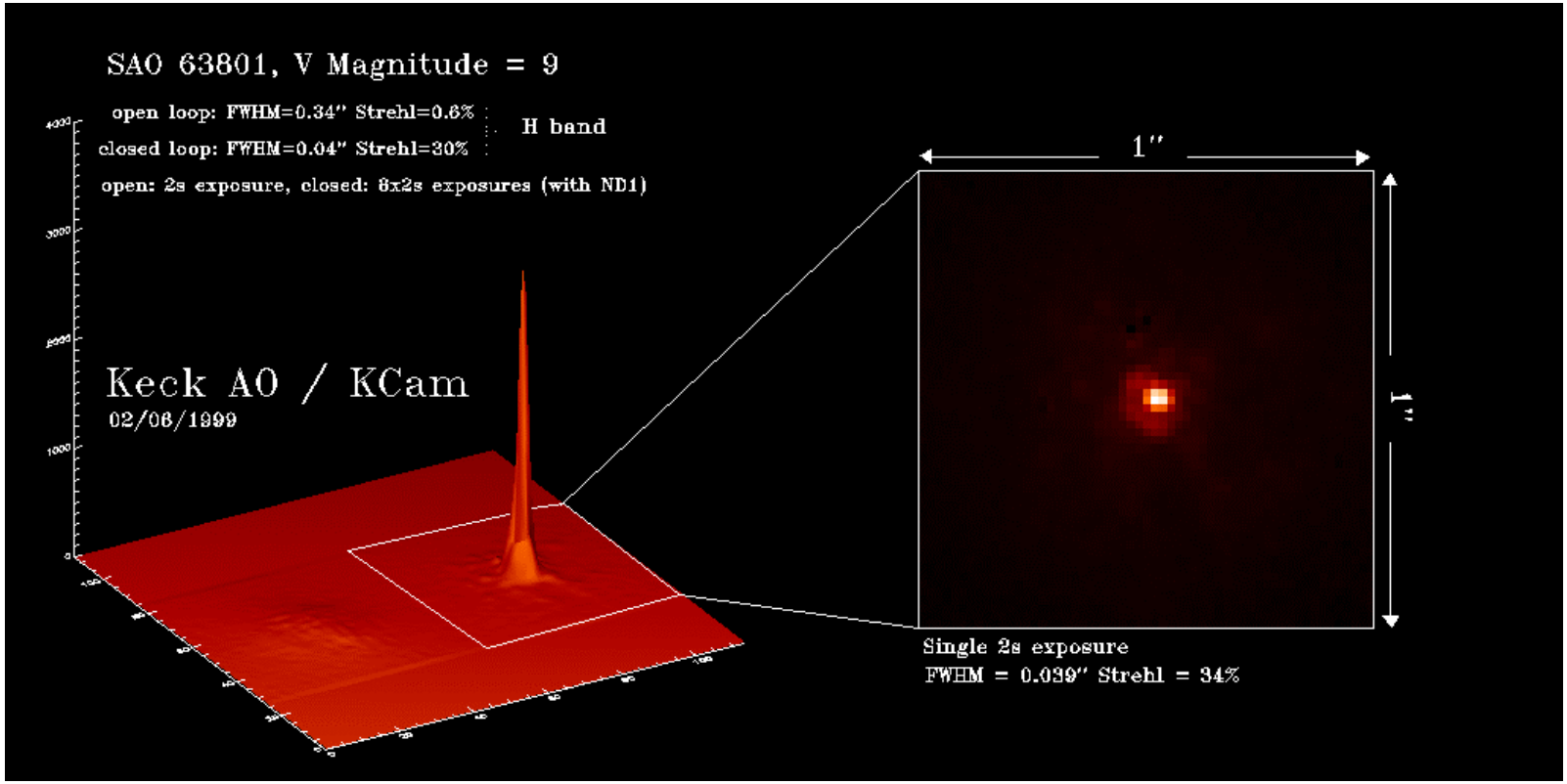
Siderostats

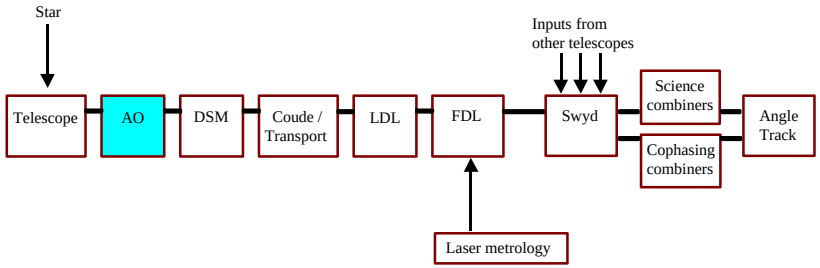
CARA

- Site work complete (tunnel, junction boxes, light pipes & enclosures are complete)
- Roll-off roofs to arrive in Sept.



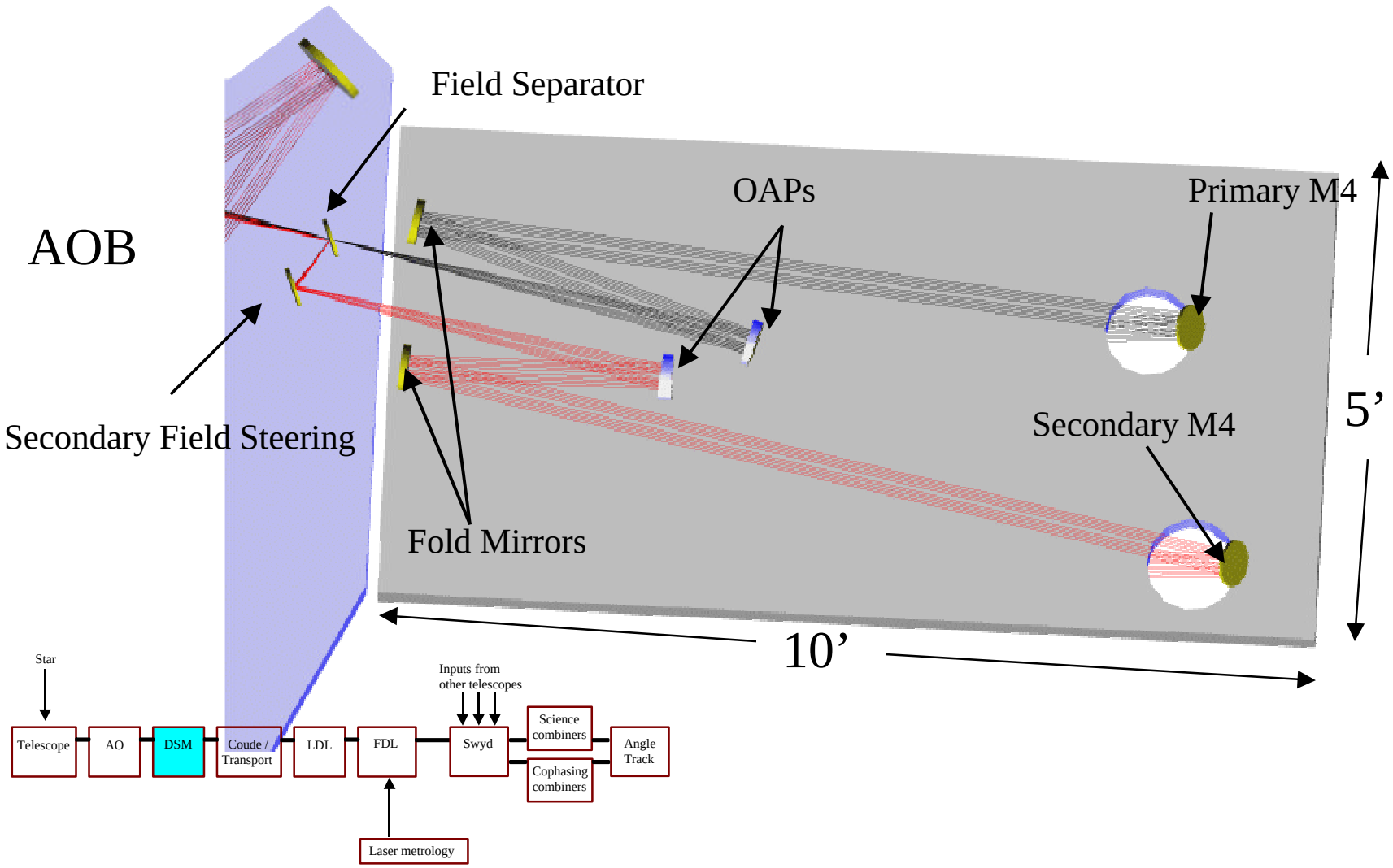
Keck AO First Light





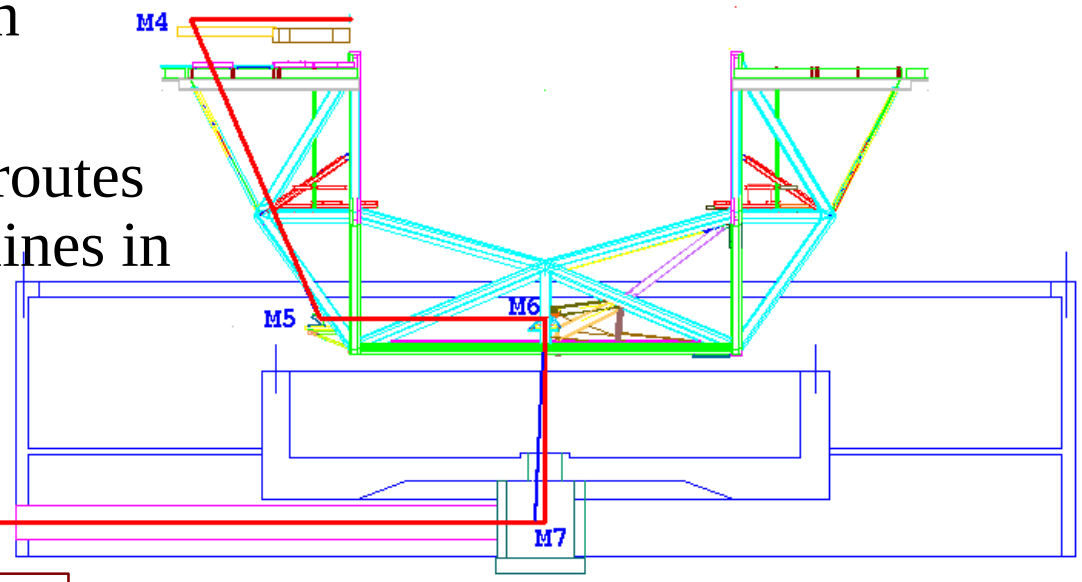
- V = 9 star, 2s exposure
- *First night* results
- 39 mas FWHM
- Strehl = 30% (50x better)

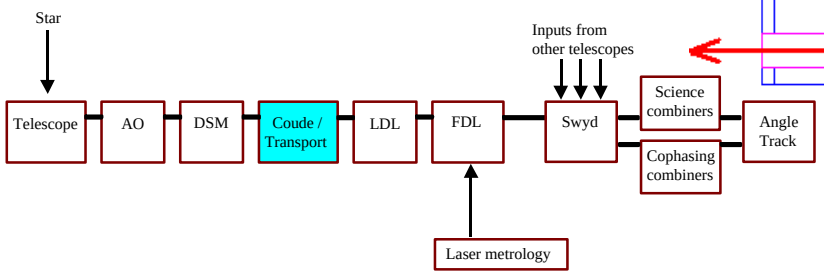
Keck DSM


Field Separator
AOB
OAPs
Primary M4
Secondary Field Steering
Secondary M4
5'
Fold Mirrors
10'
Star
Inputs from other telescopes
Telescope
AO
DSM
Coude / Transport
LDL
FDL
Swyd
Science combiners
Cophasing combiners
Angle Track
Laser metrology

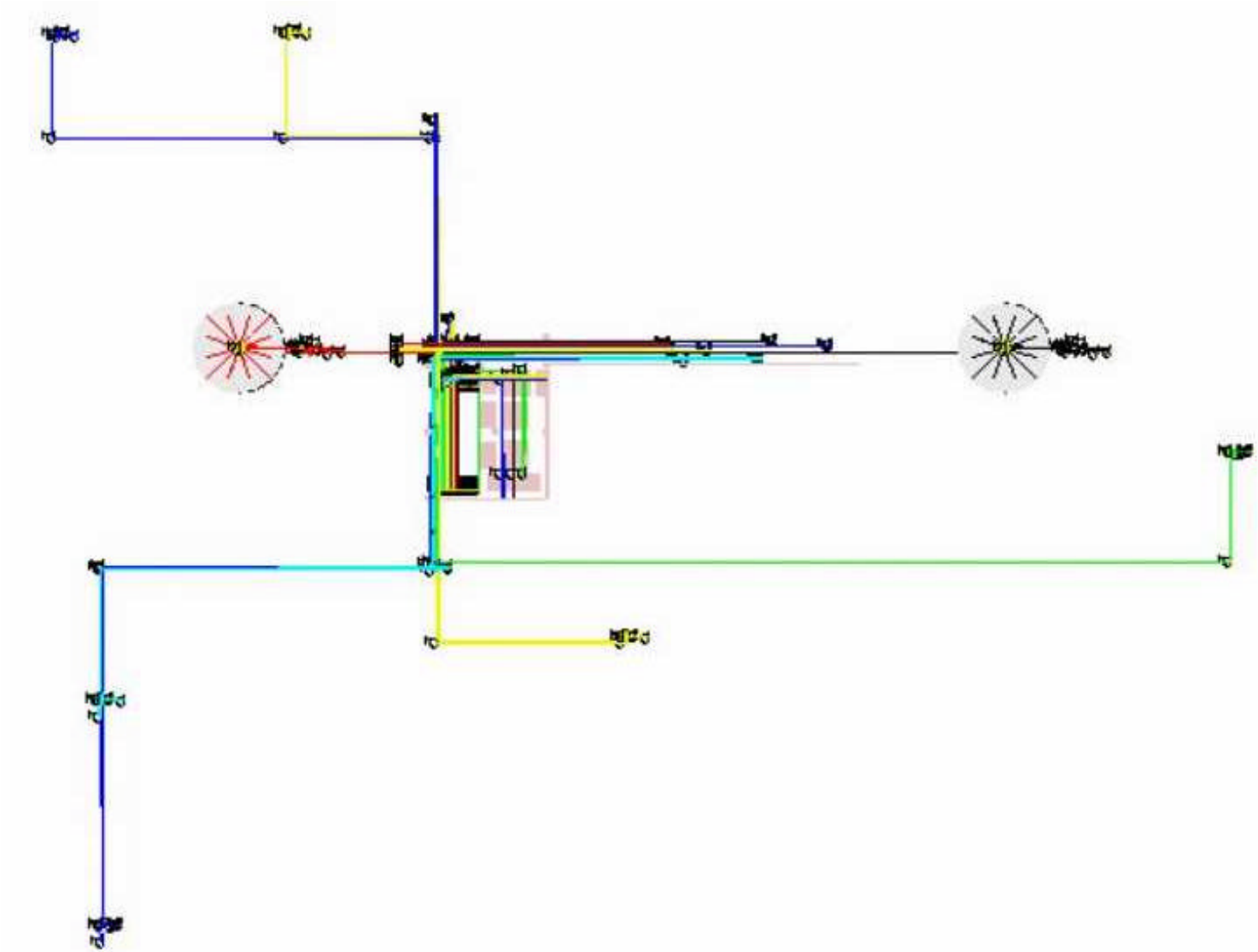
Coude Train and Beam Transport

- Keck coude train needs to be completed to bring light from DSM to base of telescope (M7)
  - Also need to derotate secondary beam
- Similar coude needed on outriggers
- Beam transport system routes light from M7 to delay lines in interferometry lab

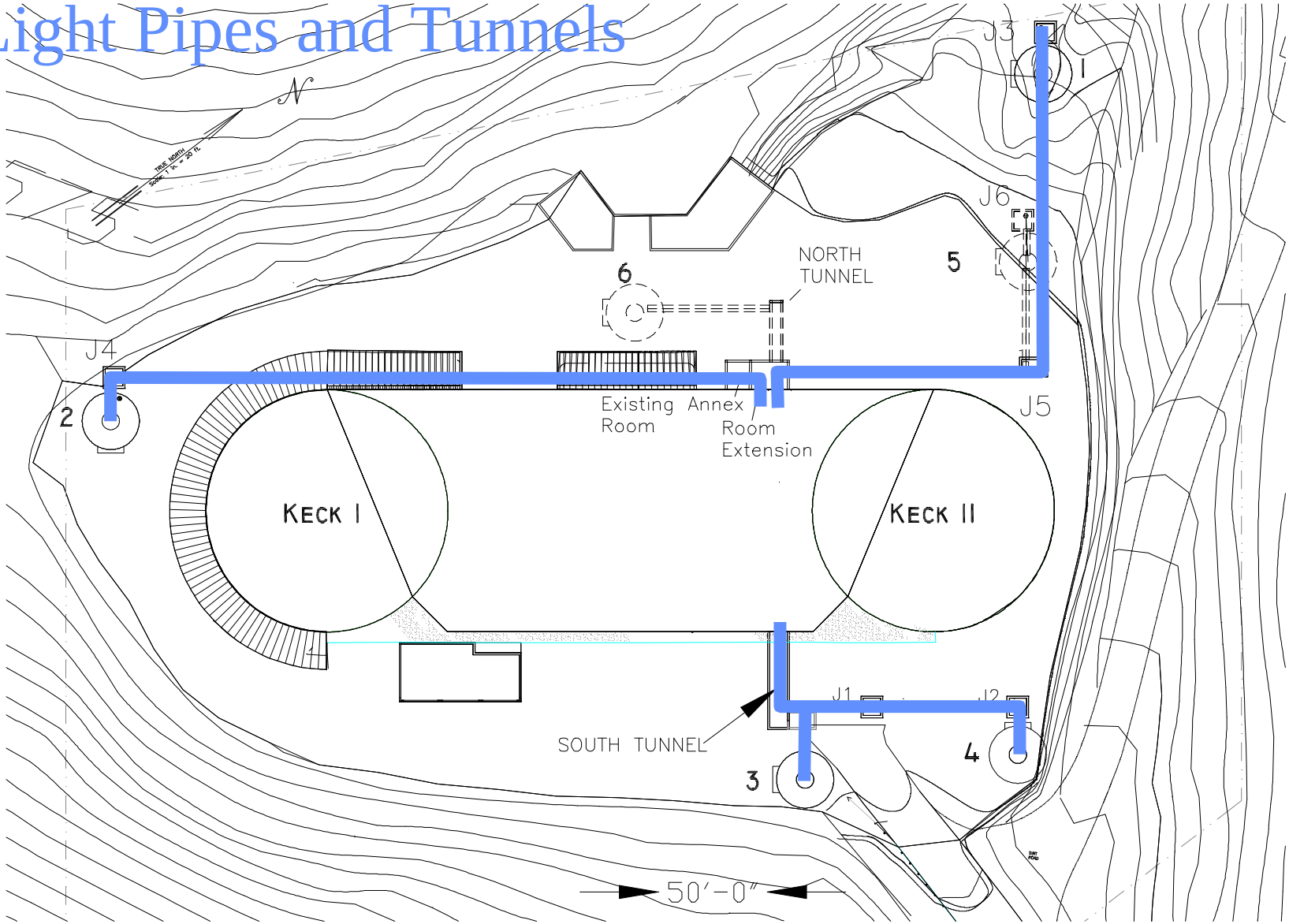




Site Overview

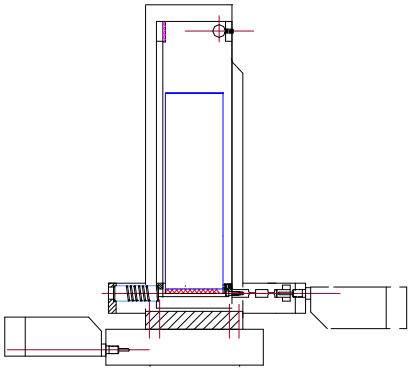


Light Pipes and Tunnels

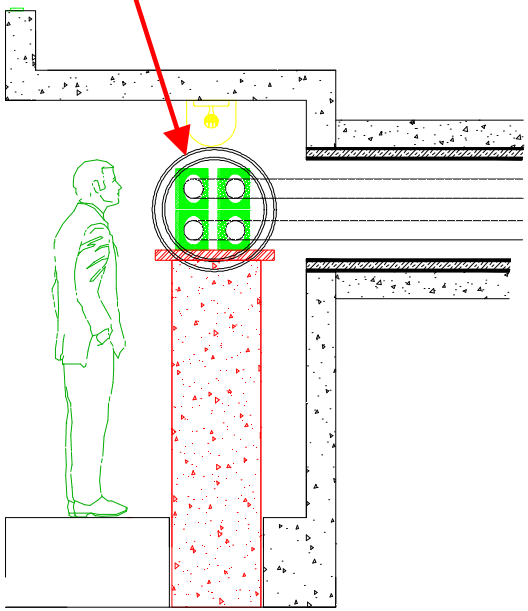


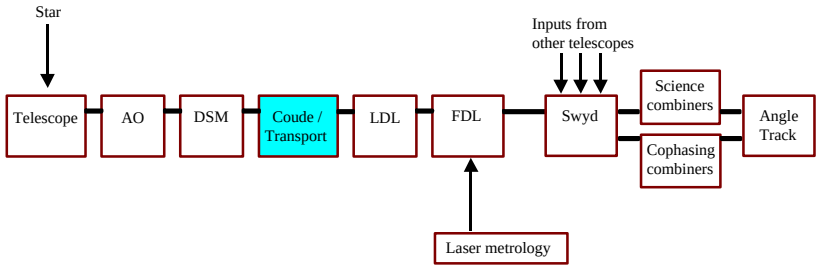
Transport Optics

- Transports star light from telescope bases to observatory basement
- Single mirror for primary and secondary starlight



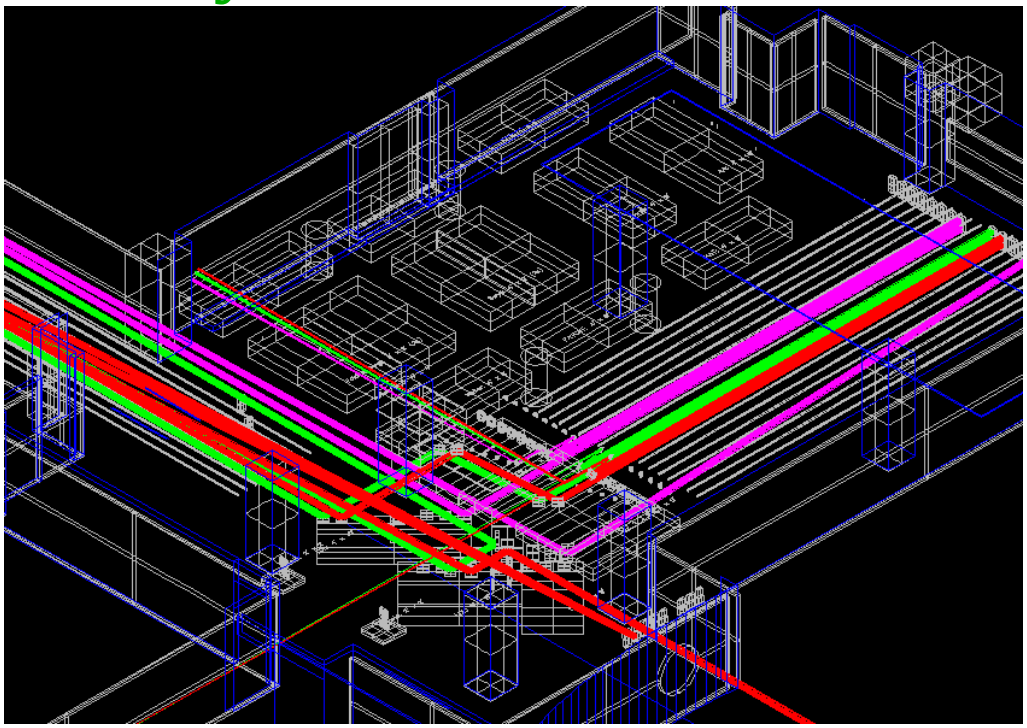
Transport Optic in Mount

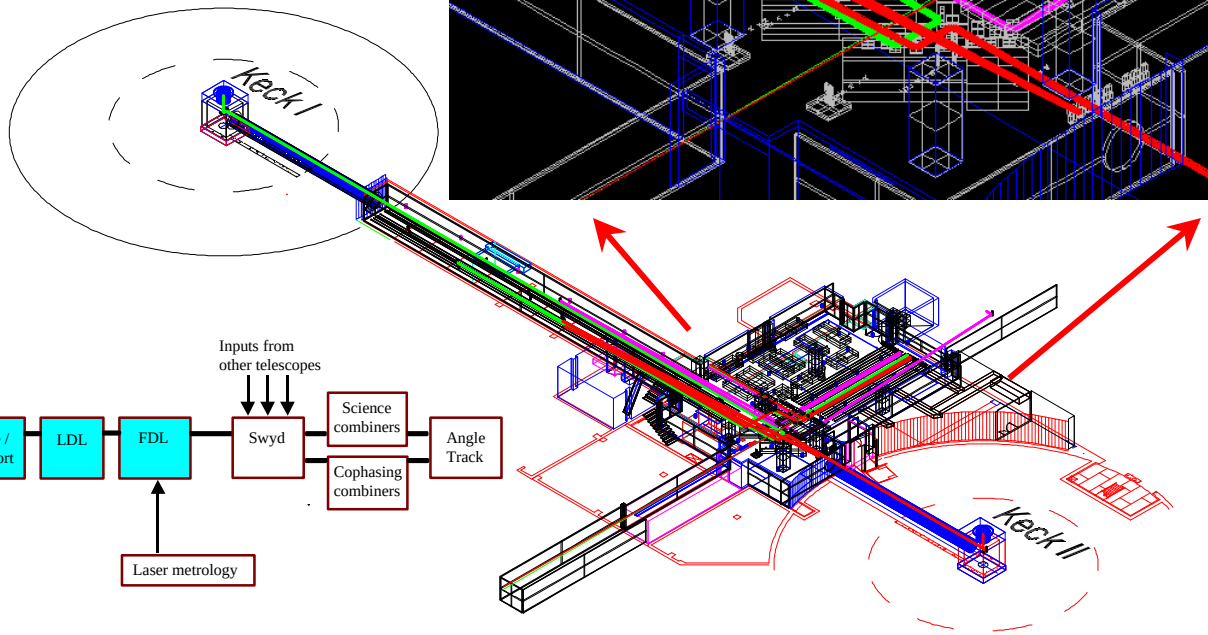


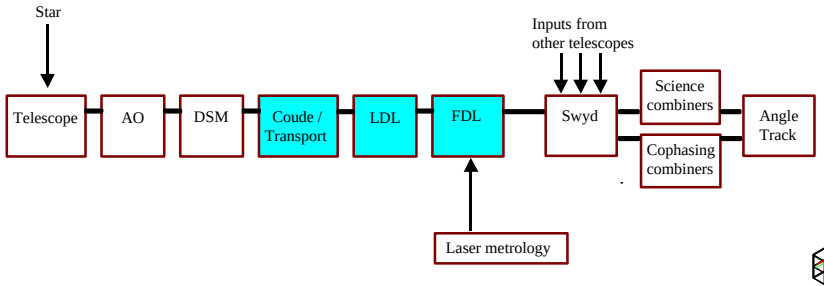


Basement Layout Summary

- Transport Optics
- Long delay line (LDL)
- Fast delay line (FDL)
- Switchyard

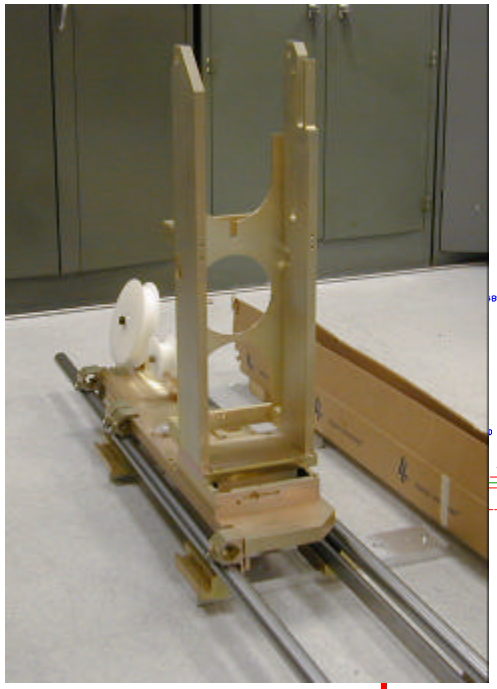


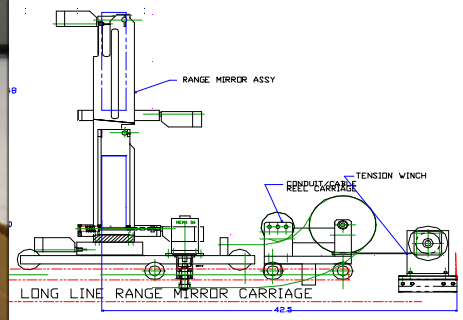




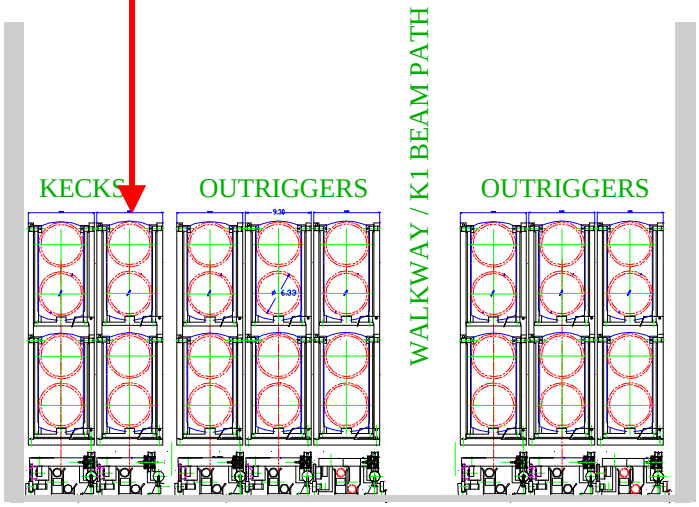
Long Delay Line

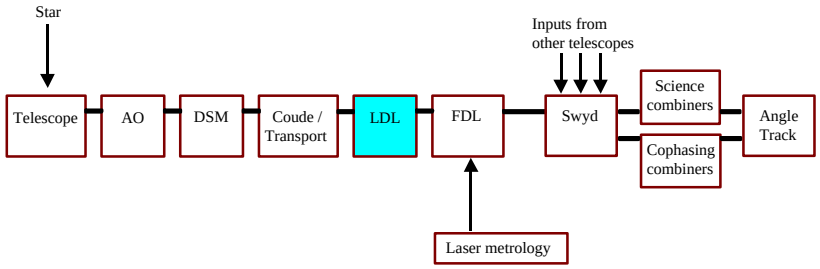
- LDL sleds move along tunnel in basement
  - ‘Move and clamp’ operation to provide static amounts of optical path
  - Hold two 352mm x 161mm mirrors





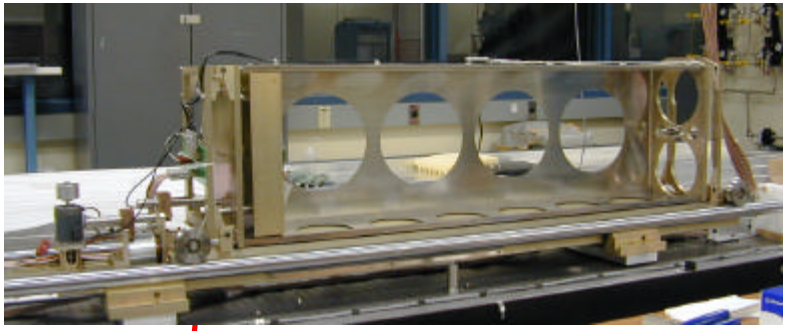
LDL Sled (1 of 6)



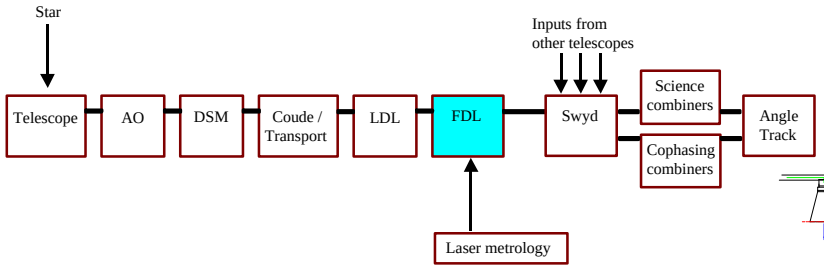


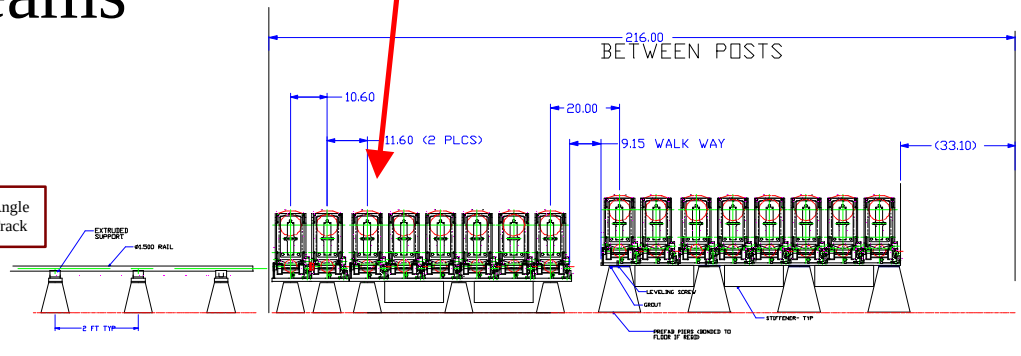
Fast Delay Line

- FDL carts move along rails in basement
  - Continuously moving operation to provide static amounts of optical path
  - Holds one 14.2” x 6.4” mirror
- Separate FDLs for primary, secondary starlight beams



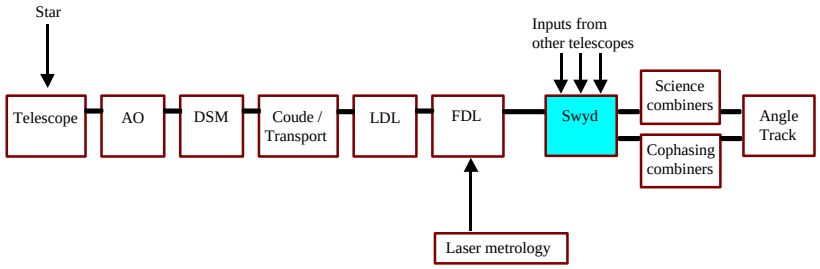
FDL Cart (1 of 12)

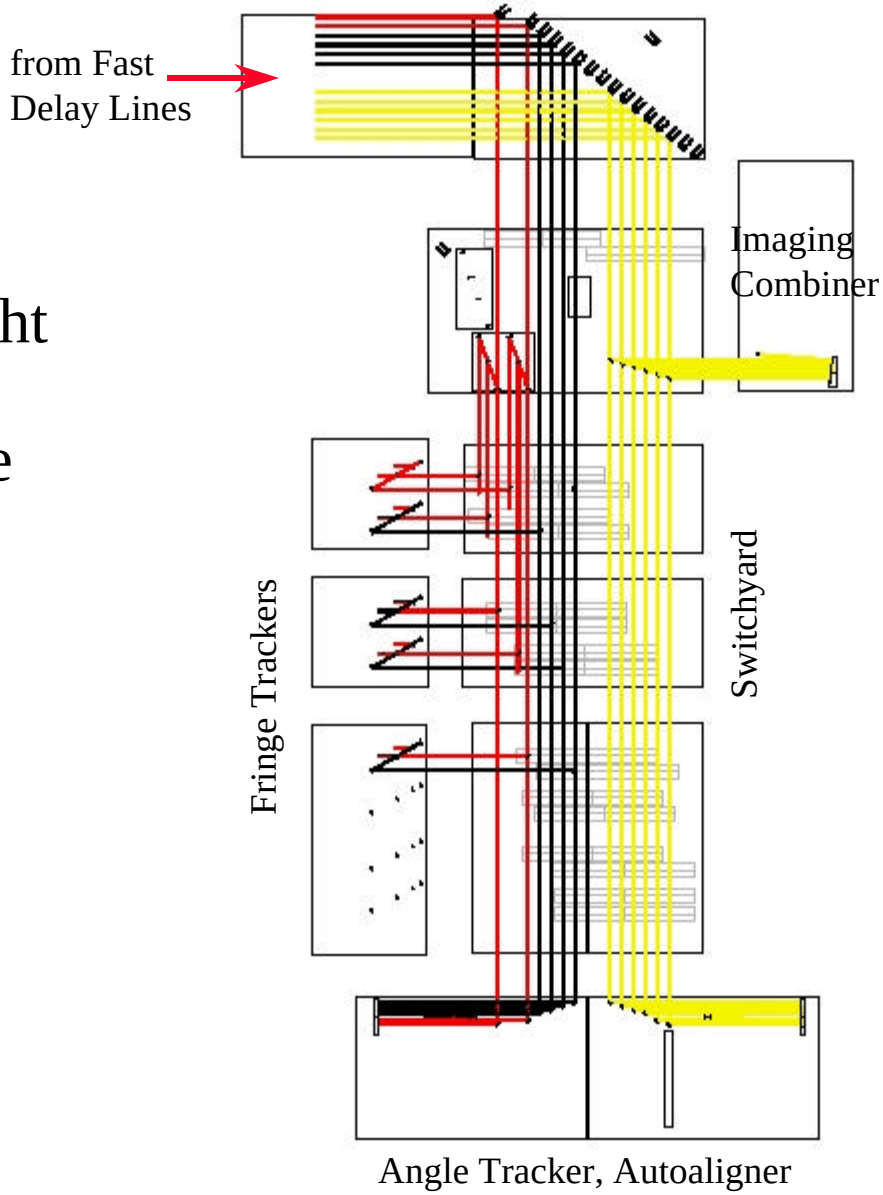




Switchyard

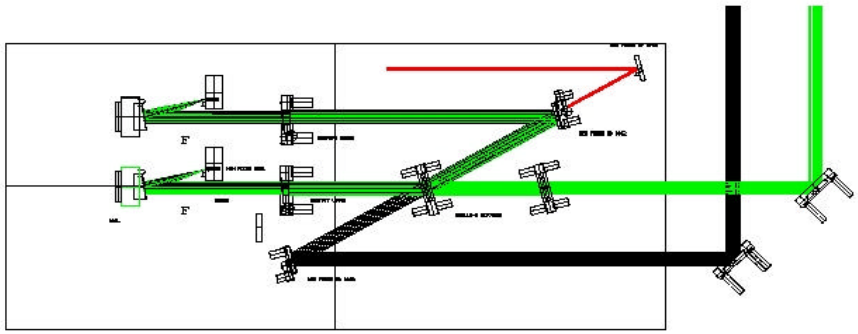
- Switchyard
  - Accepts 12 delayed starlight beams and directs to beam combiner for desired mode
- Stimulus
  - Star simulator to test all starlight subsystems

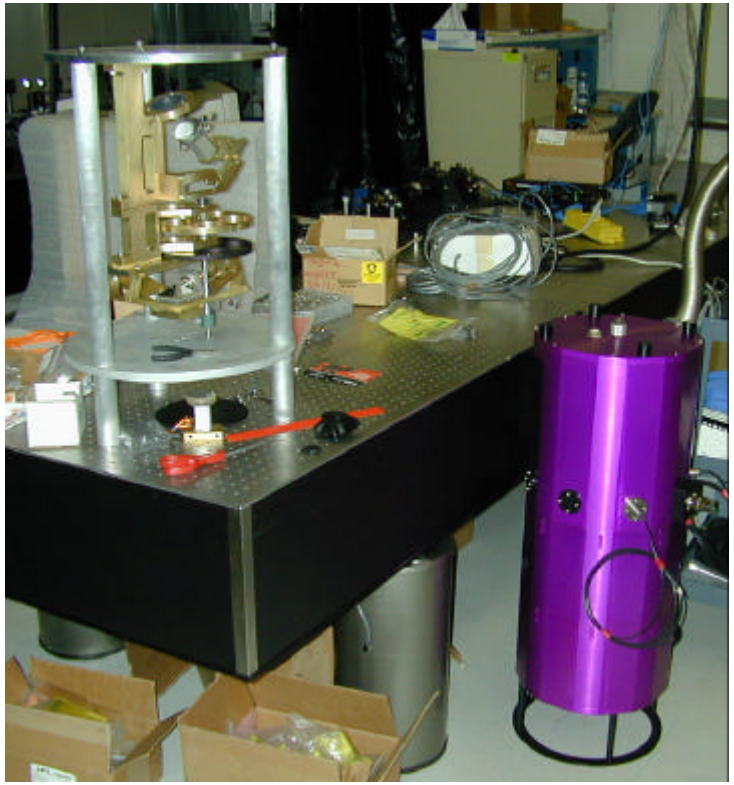


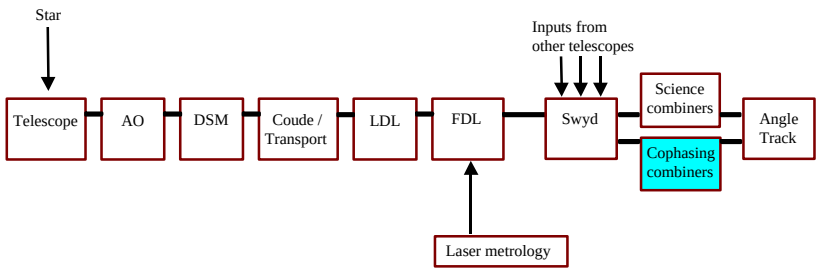


Cophasing (2 μm) Combiner

- Provide 5 two-way 2-μm combiners to support pairwise telescope cophasing
- Uses two fiber-fed dewars

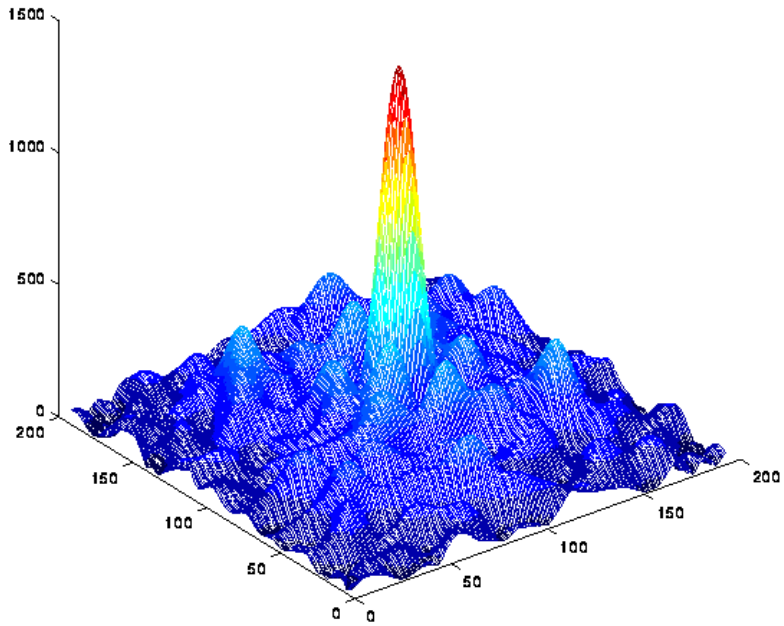


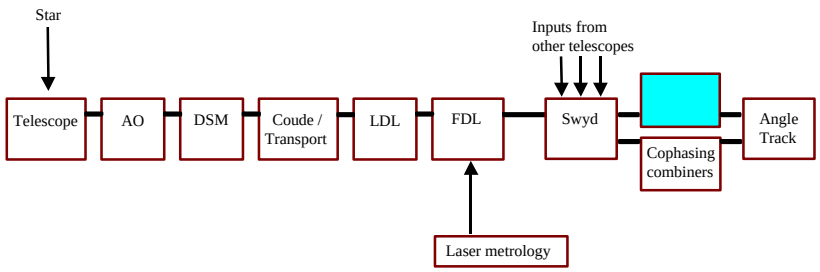


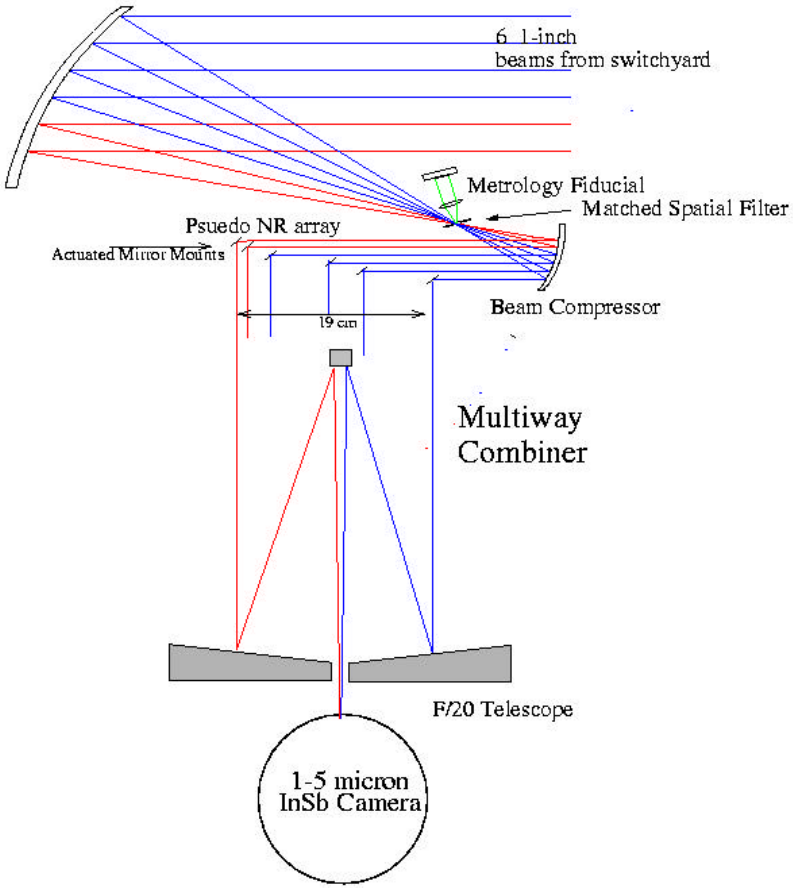


Multi-way Science Combiner

- Pair-wise measurements on up to 15 baselines simultaneously

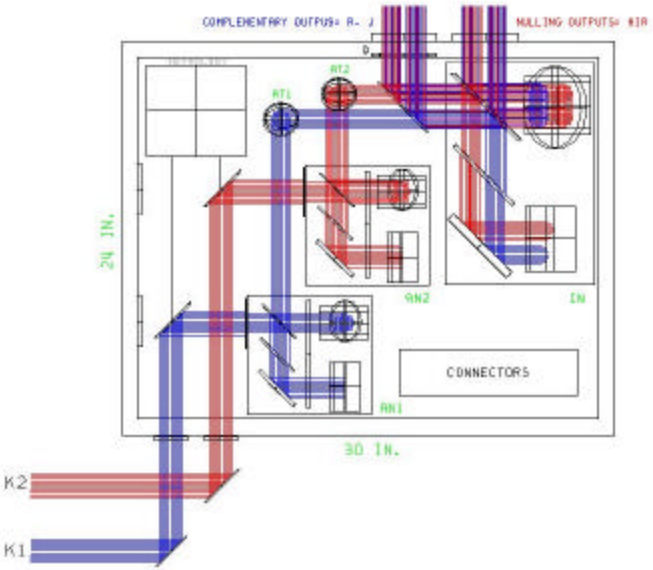


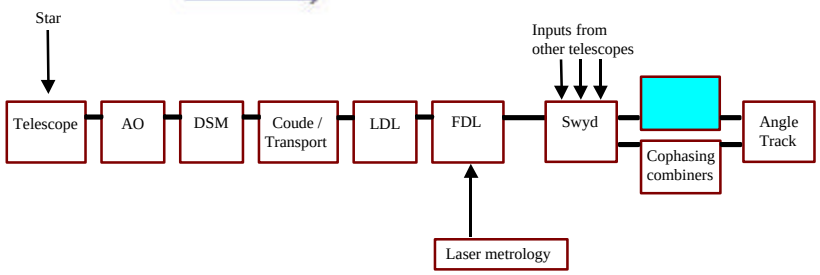


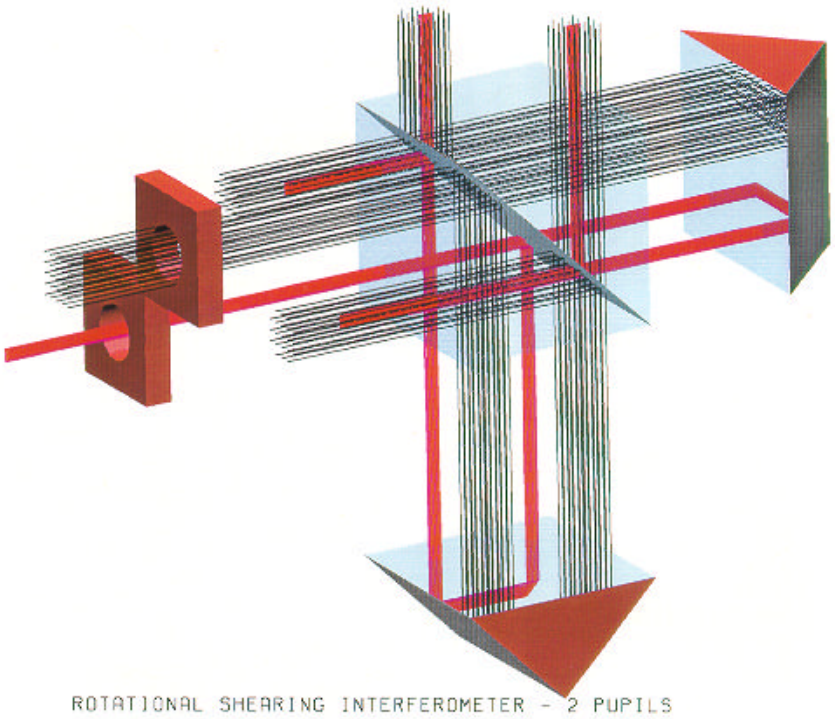


10 μm Nulling Combiner

- Destructive beam combination for single apertures and pairs
- Primary instrument for stellar zodiacal characterization



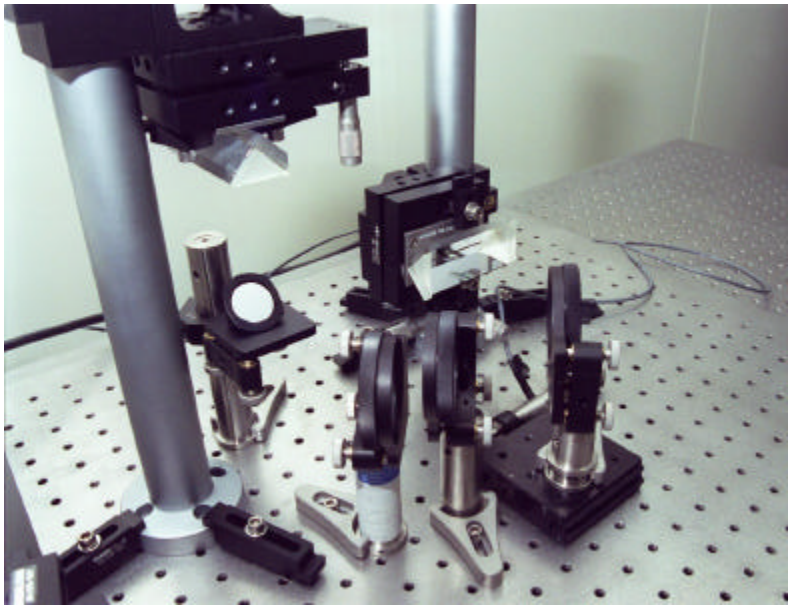


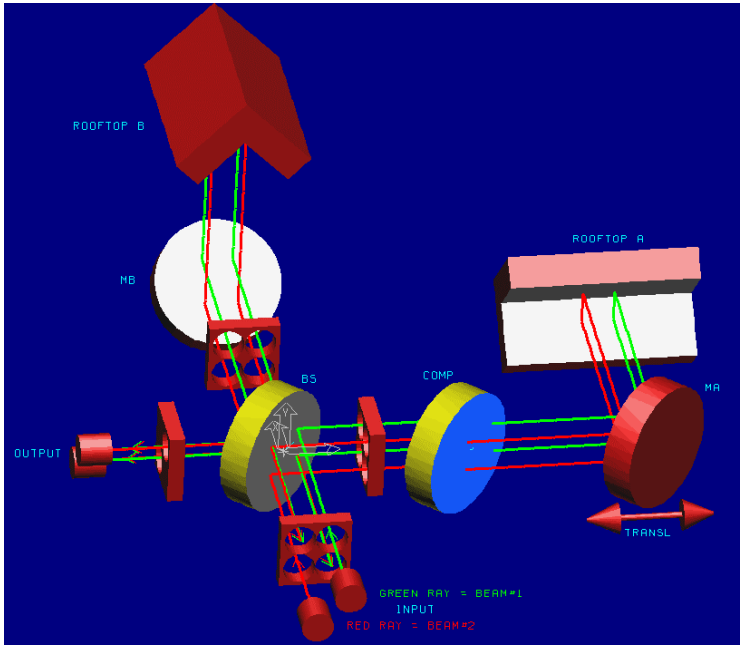


CARA

10 μm Nulling Combiner: Current Lab Results

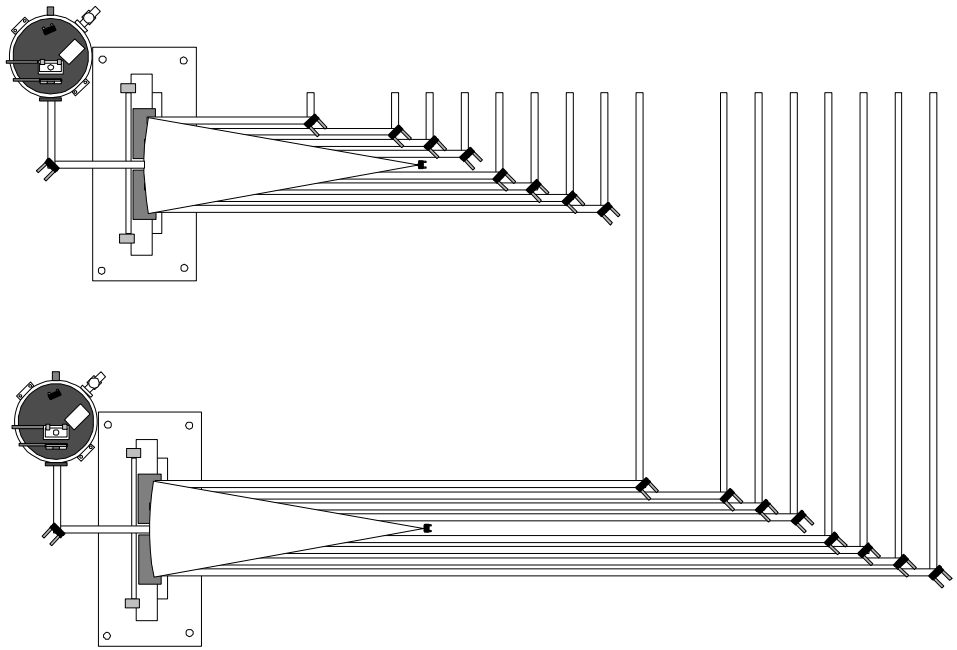
- Tabletop setup for initial testing
- Red laser diode null depths: 1/25,000
- Working on white light nulls
- Details to be discussed in Serabyn, Wallace & Nguyen (1999, in prep.)
- Future operational challenges
  - Mid-IR
  - Cryogenic temperatures
  - Null stabilization

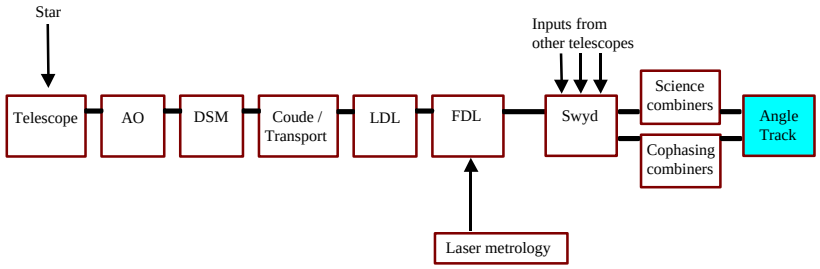


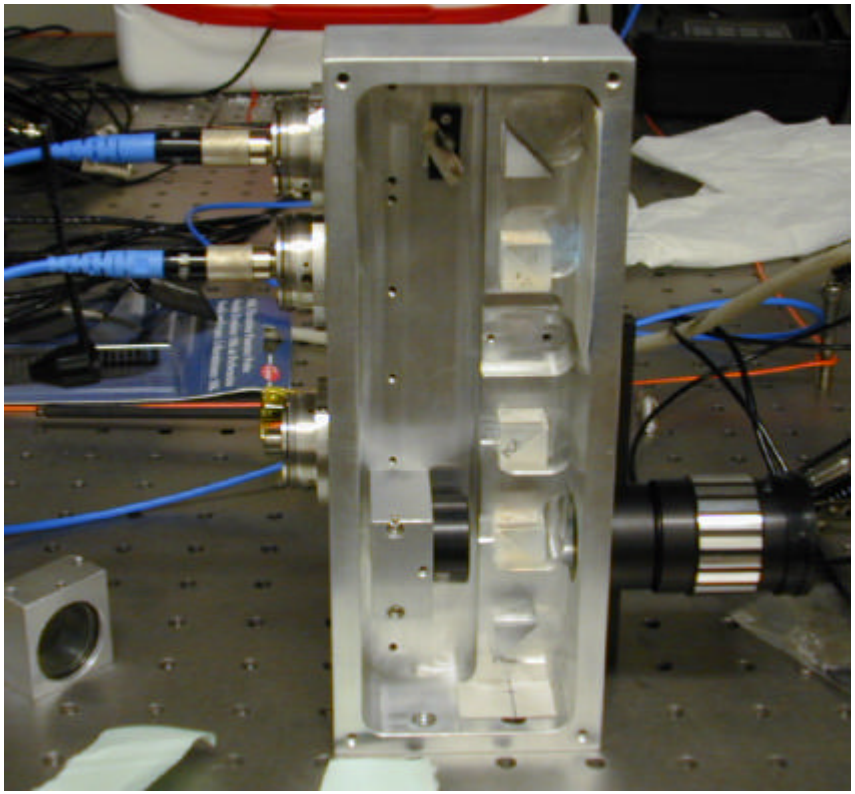
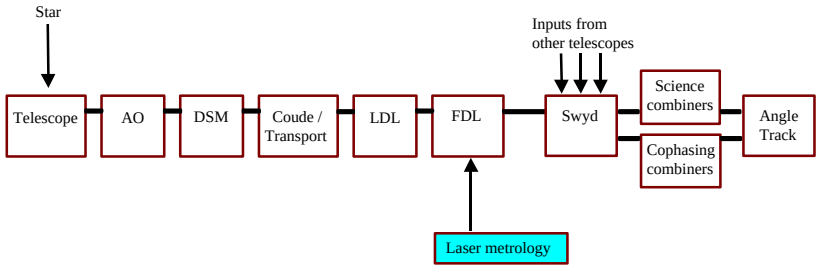


Angle Tracker

- For outriggers
  - Primary (high bandwidth) and secondary (low bandwidth with feedforward)
  - Correction via active secondary





Laser Metrology

- Three types of metrology
  - Local metrology of delay lines for servo control
  - End-to-end metrology of optical path for astrometry and cophasing
  - Accelerometer sensing of common-mode telescope optics
- Single unified launcher design