Update on the Magdalena Ridge Observatory Interferometer

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On behalf of the NMT and Cambridge Teams

Magdalena Ridge Observatory

- Federally funded 2000-2011
- EIS completed in 2003
- Two facilities at MRO
  - Fast-tracking 2.4m
  - NIR/Optical 10-element interferometer

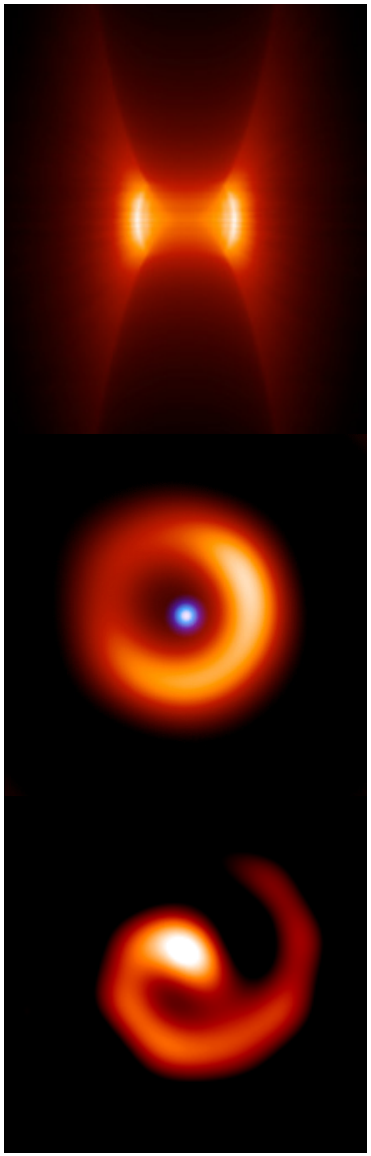
- MROI is 10 1.4m movable afocal telescopes in equilateral Y configuration
- Optical and near-IR operation
- Baselines from 7.8 to 340m
- Design optimized for imaging mission

MROI Key Science Mission

- AGN:
  - Verification of the unified model.
  - Determination of nature of nuclear/extra-nuclear starbursts.
  - H =14 gives >100 targets.

- Star and planet formation:
  - Protostellar accretion, imaging of dust disks, disk clearing as evidence for planet formation.
  - Emission line imaging of jets, outflows and magnetically channeled accretion.
  - Detection of sub-stellar companions.

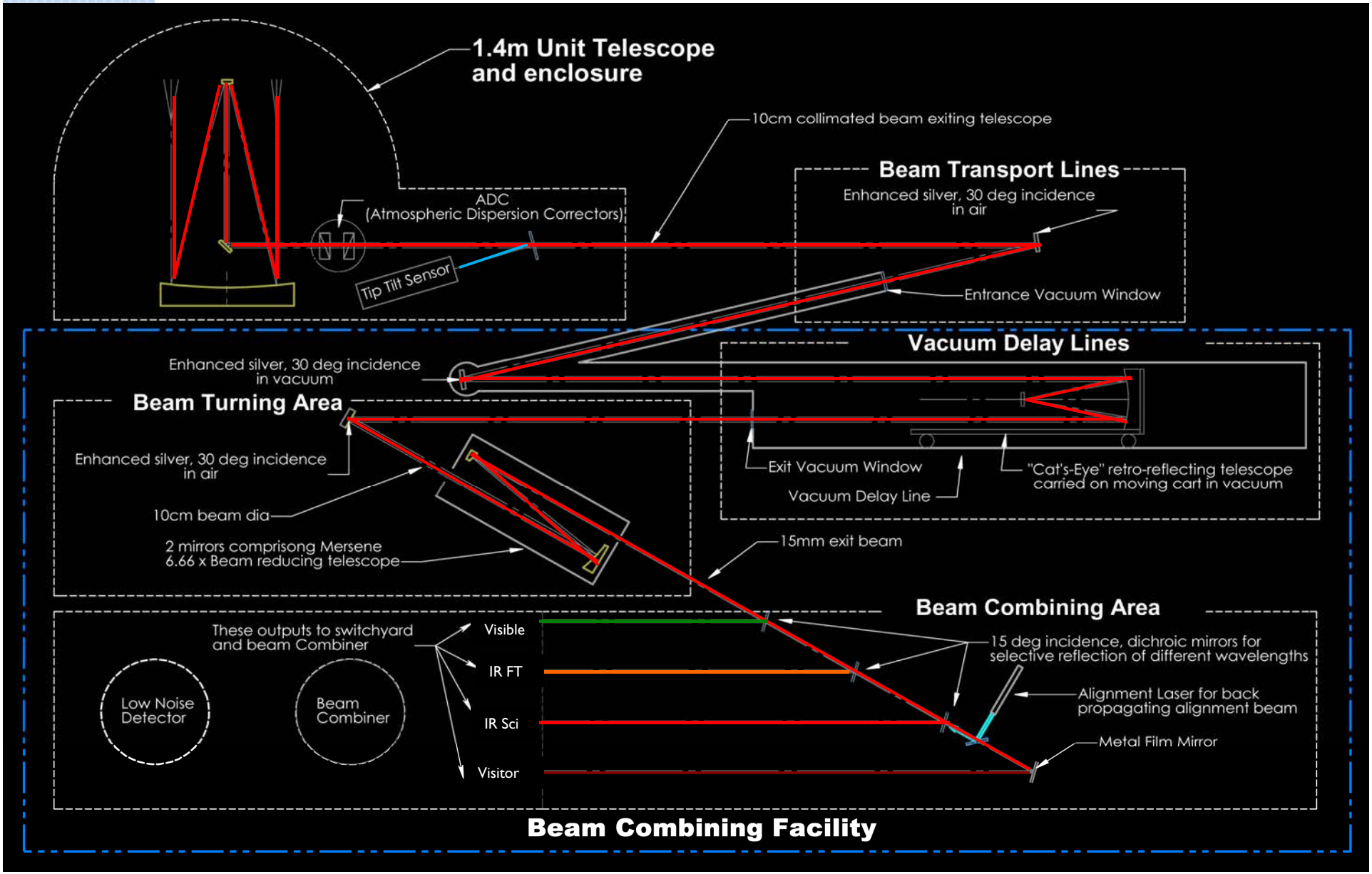
- Stellar accretion and mass loss:
  - Convection, mass loss and mass transfer in single and multi-star systems.
  - Bipolarity and collimation of circumstellar material, wind and shock geometries.
  - Pulsations in Cepheids, Miras, RV Tauris, etc.



Technical Requirements Flowdown

- Telescope diameter of 1.4 m
  - H magnitude = 14th for group delay tracking limit
- Spatial scales of 0.3 to 30 mas
  - Baselines from 7.8 to 340 m (for 0.6-2.4 microns)
- Moderate-to-high spectral resolutions
  - Separate fringe tracking and science cameras
- High throughput to achieve sensitivity limit
  - Fifteen reflections from primary to detectors
  - Optimized coatings for 0.6-2.4 microns
- Large number of telescopes rapidly combined
  - Optimized for model-independent imaging

Walk through the Optical Path

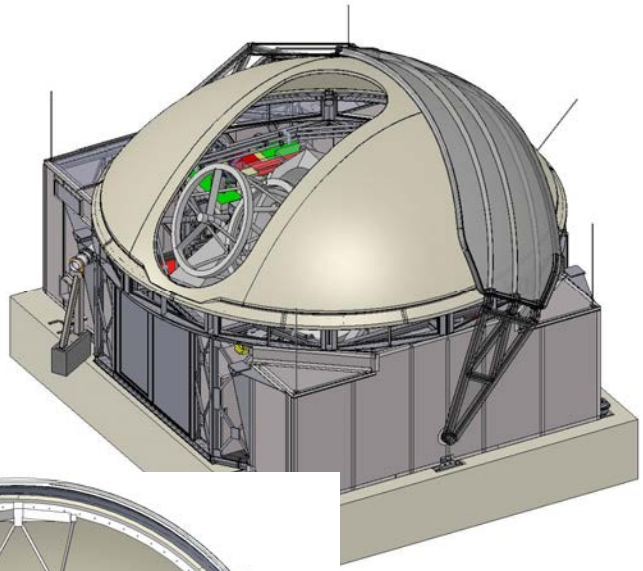


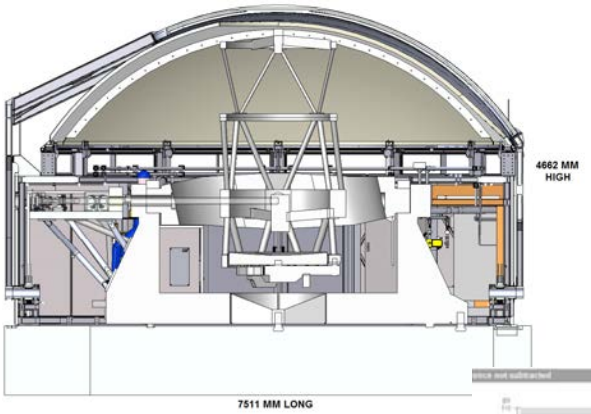
Unit Telescopes

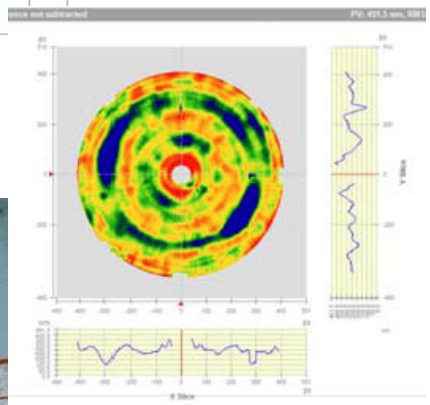
- Designed/built by AMOS
  - 1.4m aperture
  - afocal alt-alt design
  - polarization preserving
  - 44 nm WFE rms after three mirrors
  - UT1 expected to arrive late this year
  - UT2-3 long-lead items ordered and being assembled

Optics & UT Enclosures

- Enclosures Designed by EIE
- Houses and transports UTs
- Allows close-packed configuration to 30 deg elevation without vignetting for 6 hour tracks
- 6 full sets of optics in house
  - All M2's and M3's completed
  - First 3 M1's in various states of completion – none done yet



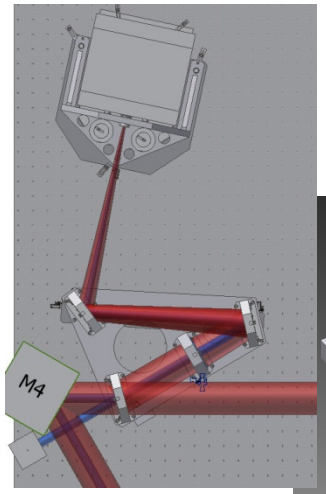


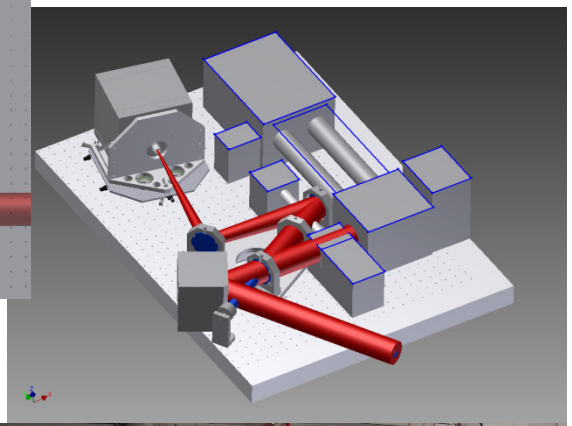


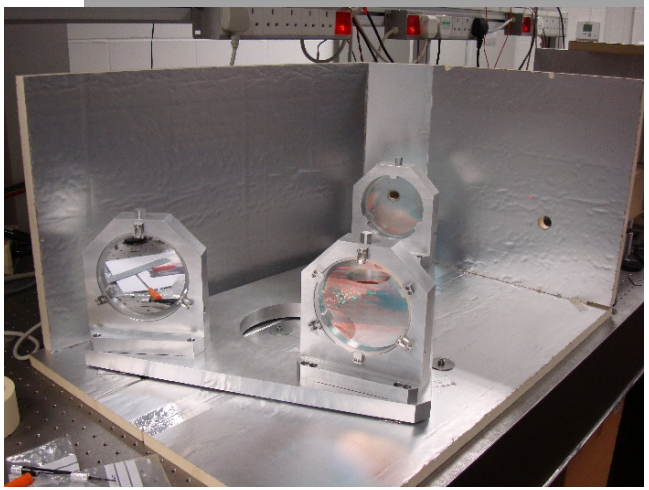
48 nm RMS when contract closed

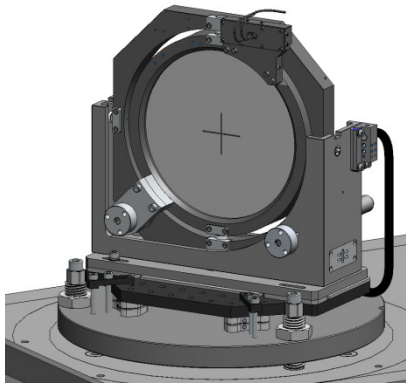
Fast Tip-tilt & Acquisition System

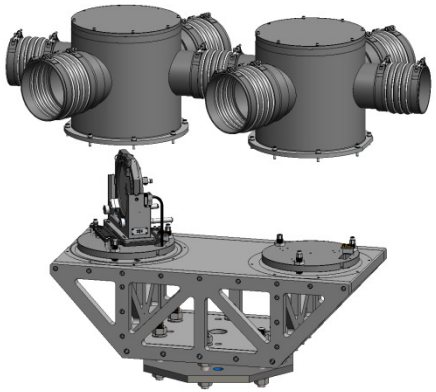
- At an advanced stage of construction in Cambridge:
  - Full-scale prototype under test
  - Majority of software complete
- Uses Andor EM CCD head
- Transmissive optics
  - High throughput and relaxed tolerances
- Fully passive opto-mechanical design:
  - No actuation to meet stability requirements
- V-band sensitivity of 16th mag:
  - Good match to reddest targets

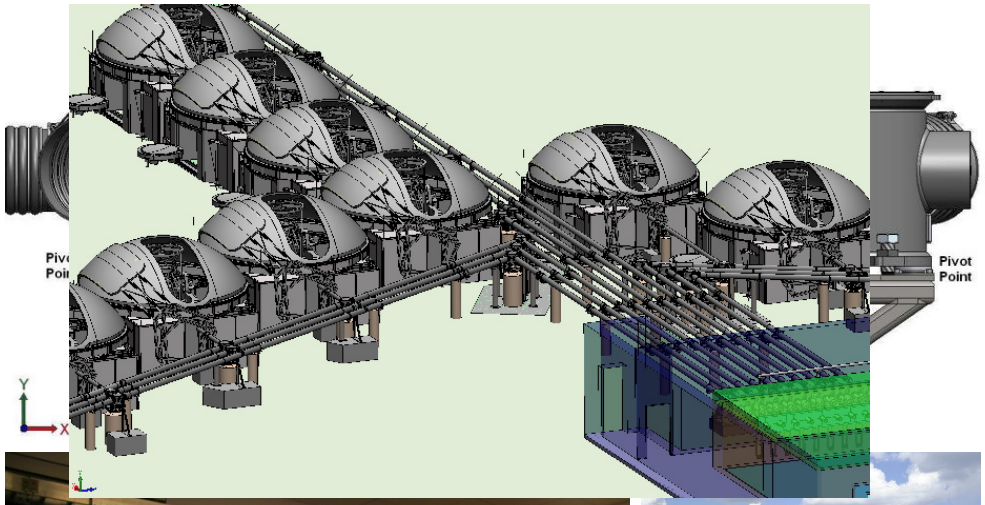


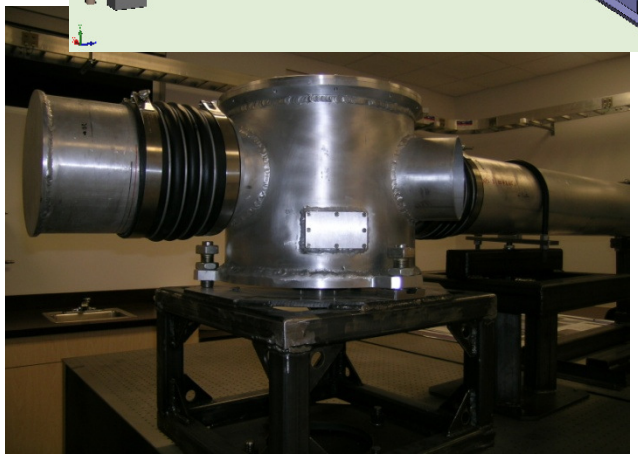












Foundations and Beam Relay System

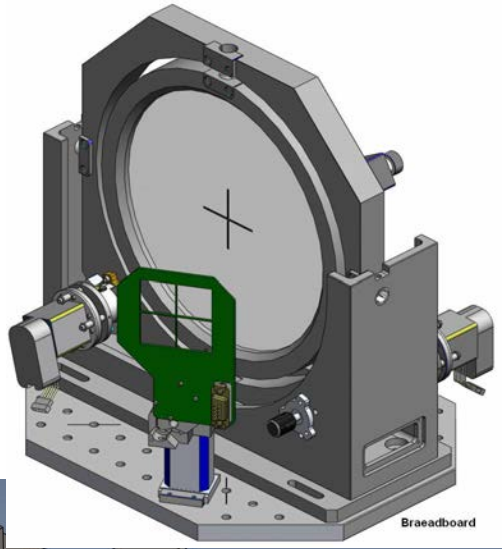
- Recently completely redesigned by M3 and built by MRO
- Meets stringent thermal, wind stability and subsidence requirements
- Supports 3 UTs per beamline with 0.5 mbarr vacuum from UT to BCA
- Install for piers for inner array began 2010
- Houses all components of automated alignment system

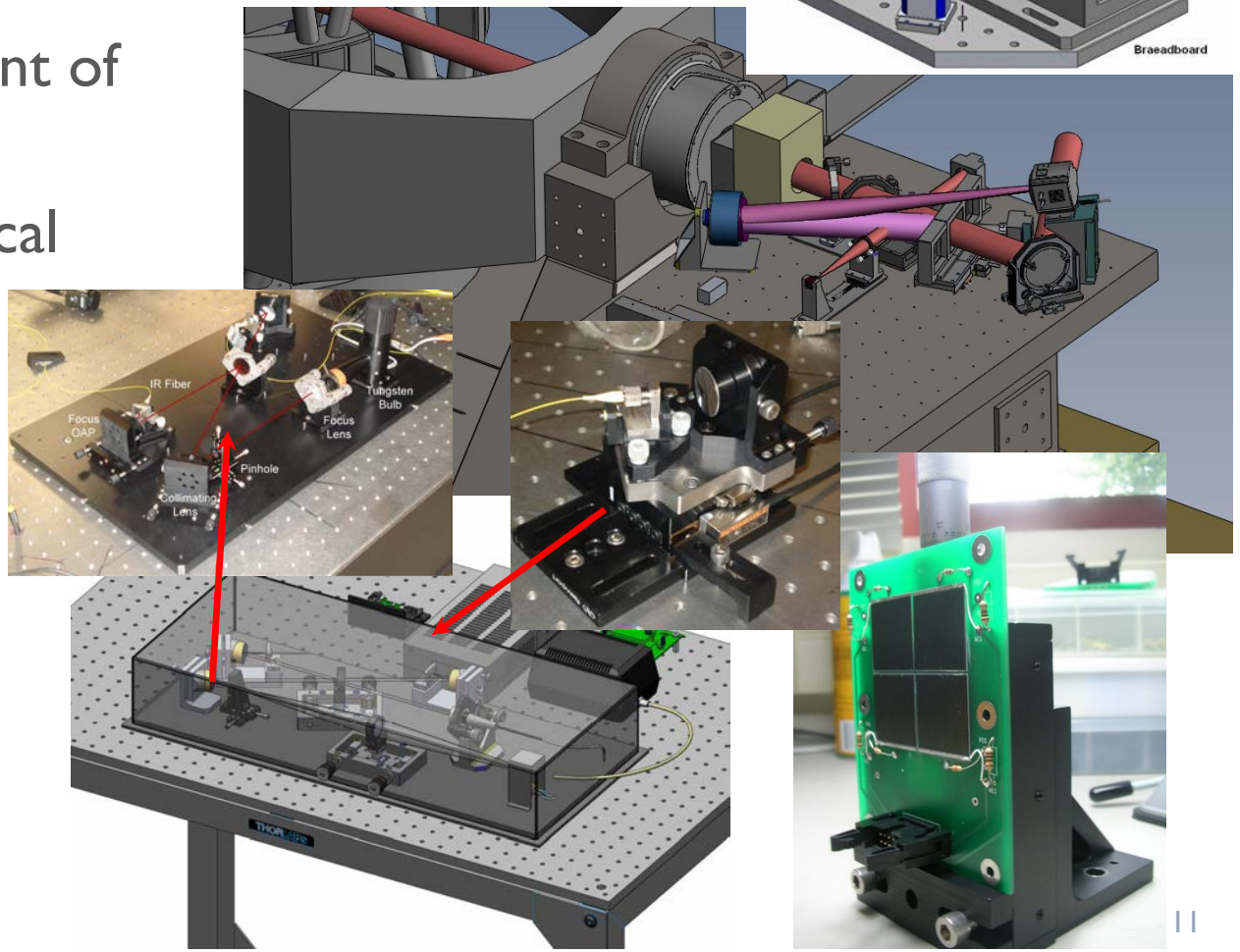
Inner Array Install

Today 7 piers installed with infrastructure being added as funds become available

Automated Alignment System

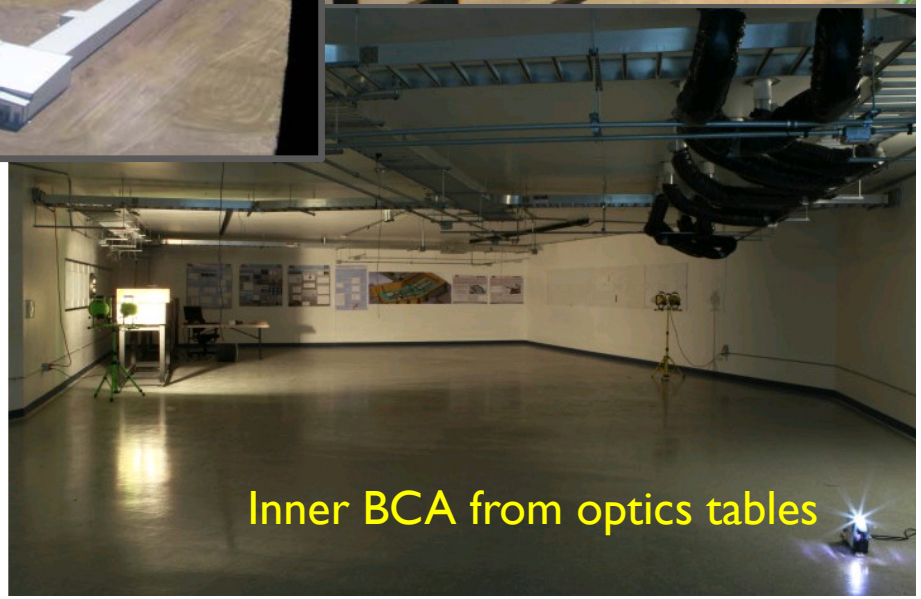
- Designed and built by MRO
- End-to-end alignment of tilt and shear
- Enclosed in a "Magical Optical Box"
- Custom quad cell and beam injection via fibers
- Ongoing CLFE -- part of a thesis and dissertation

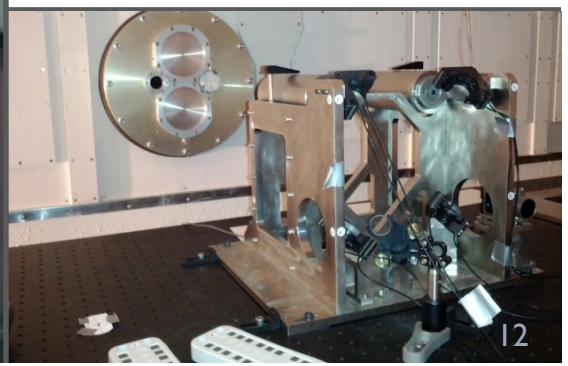




Beam Combining Facilities

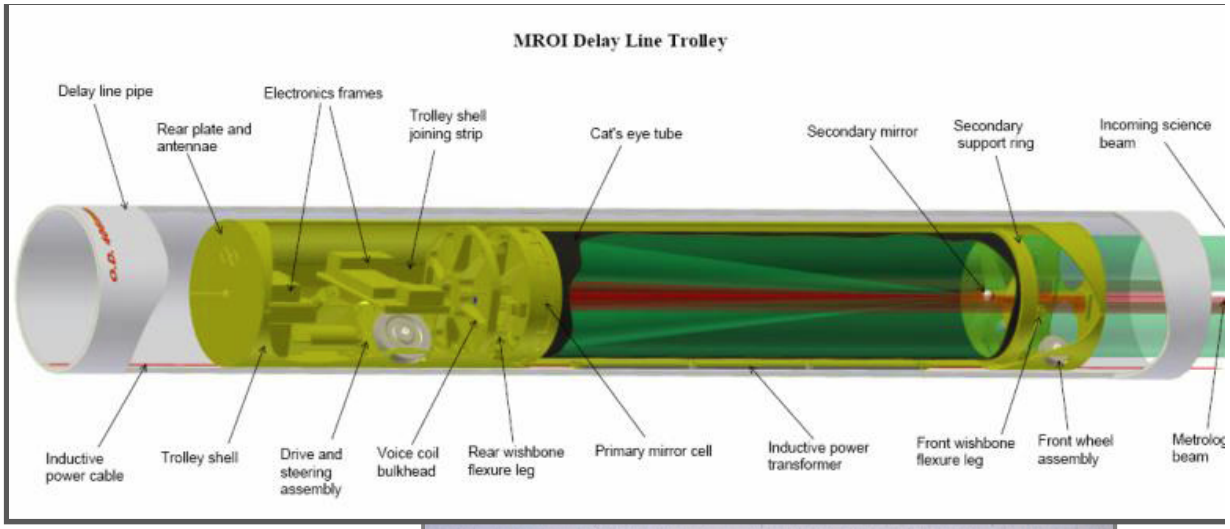
- Design by M3/built KL House – delivered in 2008
- Thermal & vibrational stability
  - 1.0deg diurnally DL
  - 0.1 deg diurnally BCA
- Supports full 10 DL array
- Single-pass DL section 190 m long

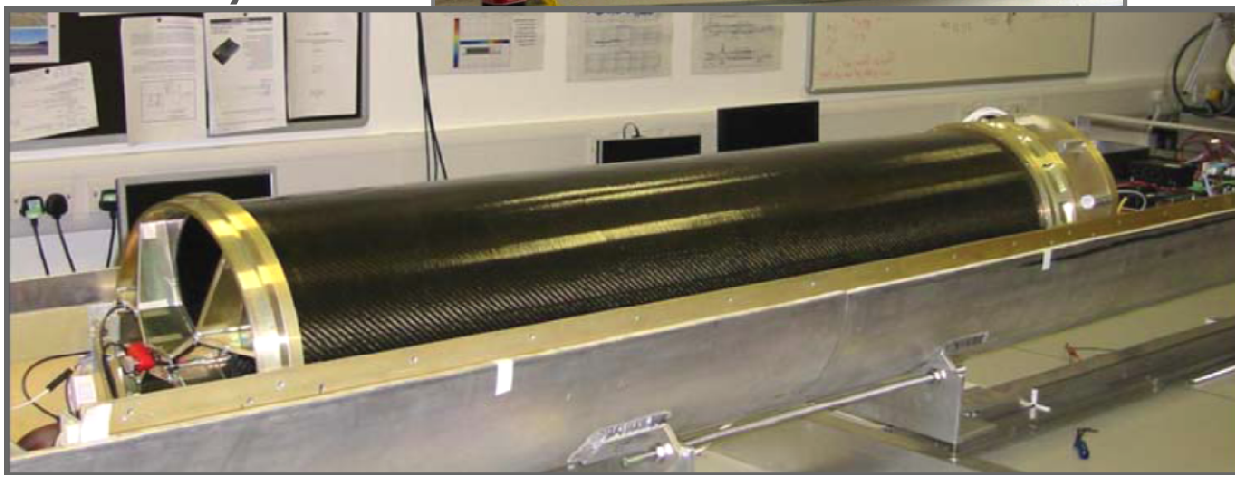




Delay Lines

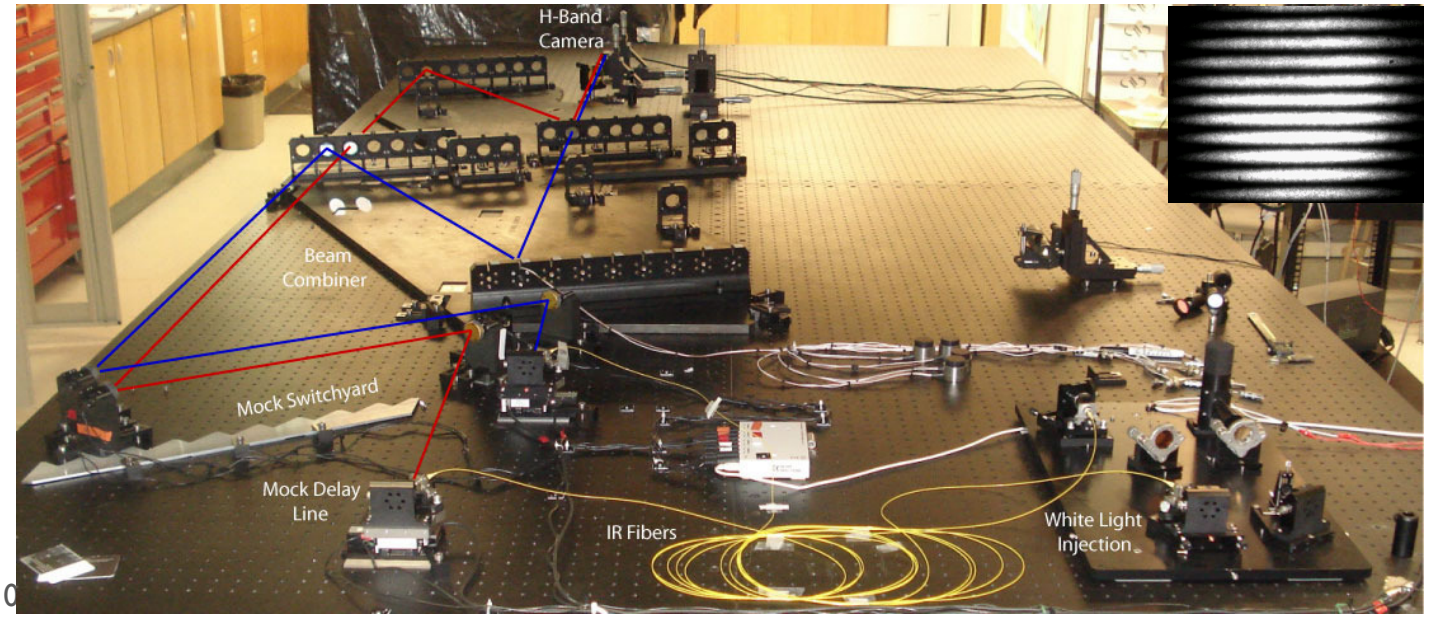
- Designed/built Cambridge
- Innovative approach
- Inductive pick-up & wireless communications
- DL1 install to about 100m
  - <0.5mm subsidence over 1 year
  - <0.5” metrology pointing stability over weeks





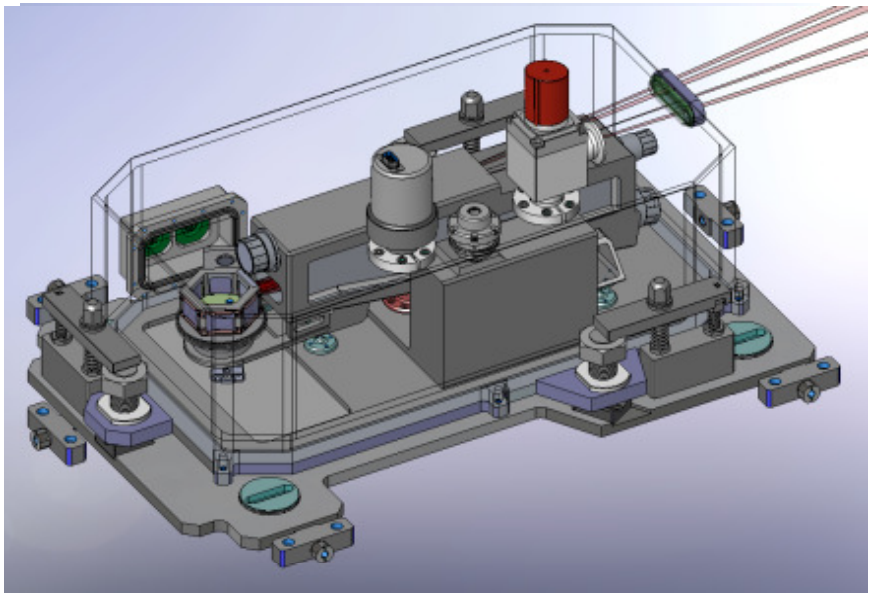
Fringe Tracker - ICoNN

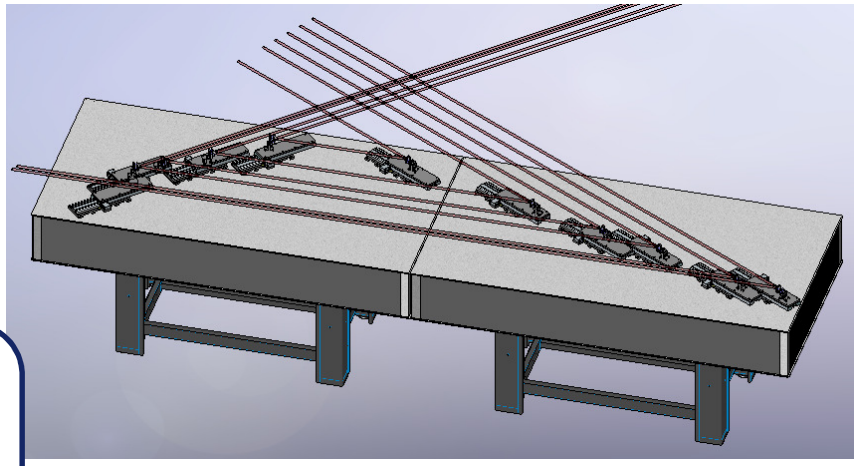
- Designed/built by MRO
- Operates H or Ks
- Coatings designed in-house
- Uses nearest-neighbors combination to bootstrap
- Dewar from Univ. Cryogenics



Science Instrument - SIRCUS

- MRO design at conceptual phase
- J,H,K with R~30 and 300; studying higher R
- Potential design: 4-way image plane combination with fast-switching to combine 6 beams in ~100 sec



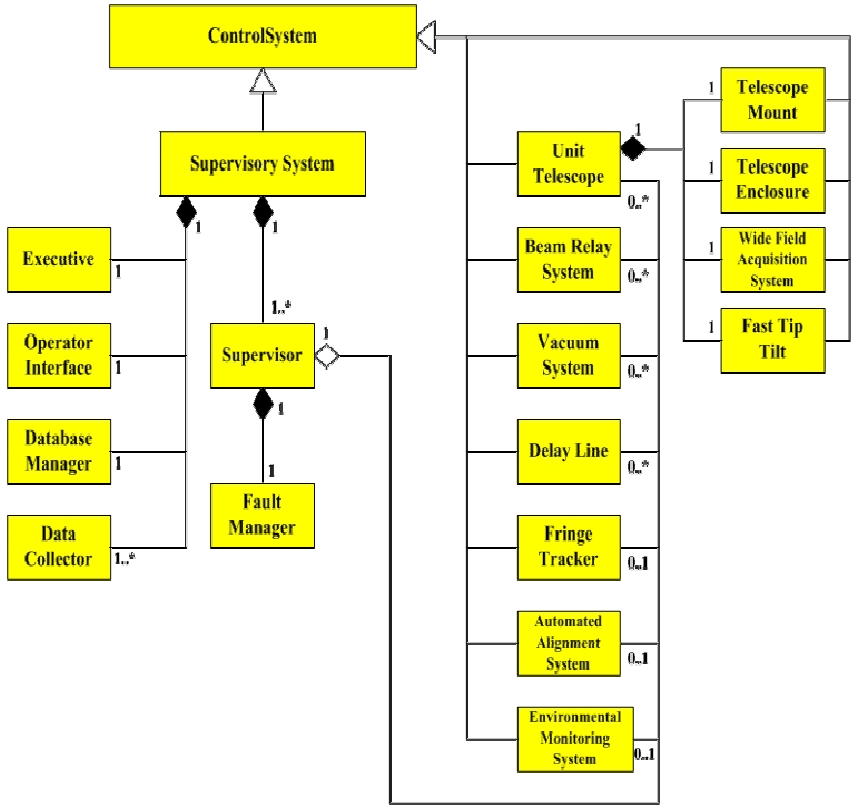


Mag	J	H	K
13	0.45	0.54	0.53
11	17.6	20.8	18.4
9	195	207	159

Performance:
SNR per spectral channel in 100 sec at R~30 with 0.7" seeing and RN=5e-

Software infrastructure

- Architecture and Framework:
  - Centralized Supervisory System controls distributed systems
  - Automatic Interface code generation based on sub-system descriptions
  - Sub-system s/w developed in Java or C
  - Standalone testing of sub-system s/w
  - Comprehensive simulation framework
- Status of major sub-system software:
  - UT mount complete (via simulator)
  - WAS complete
  - Environmental Monitoring System complete
  - FTT in development
  - Fringe Tracker system in development/test
  - Enclosure software designed, not yet implemented



Funding & Schedule Issues

- Need $45M over next 6 years to get 4 telescope facility operational – mix of Federal, State, institutional, philanthropic and partner funding
- Have DOT fund to build a visitor center and maintenance facility on Ridge → allow testing of UT#1 later this year
- **Looking for university or potential consortium partners for telescopes, instruments and operations.**

New Video made for Sen. Heinrich's visit:
http://www.youtube.com/watch?v=yqtJJxMh04o

Thank you for your attention!

- PI: Van Romero
- Deputy PI: R. Cervantes
- Prog. Director: I. Payne
- System Architects: C. Haniff, D. Buscher
- Proj. Scientist: M. Creech-Eakman
- Proj. Manager: R. Selina

- NMT Team: M. Edwards, A. Farris, D. Klinglesmith, T. McCracken, A. Olivares, C. Salcido, A. Shtromberg, a few student assistants
- Cam. Team: R. Boysen, J. Coyne, M. Fisher, B. Seneta, D. Sun, D. Wilson, J. Young

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