

The Magdalena Ridge Observatory Interferometer – New Path to First Light

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On behalf of the NMT and Cambridge Teams

Magdalena Ridge Observatory Interferometer

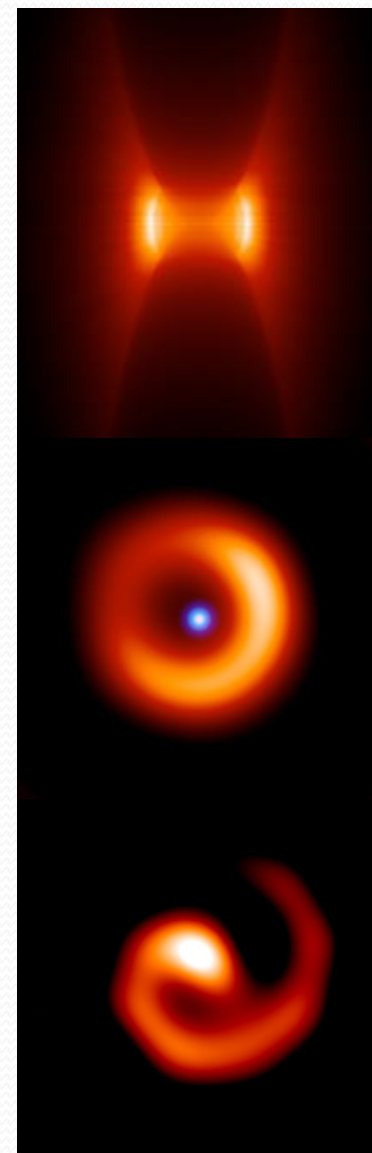
- Federally funded 2000-2011, 2015-2020
- EIS completed in 2003
- Two facilities at MRO
 - NIR/Optical 10-element interferometer:
 - 10 1.4m afocal telescopes in equilateral Y
 - Opt/NIR operation
 - Baselines: 7.8-343m
 - Design optimized for imaging faint/complex targets



TAE Photographic

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 343 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

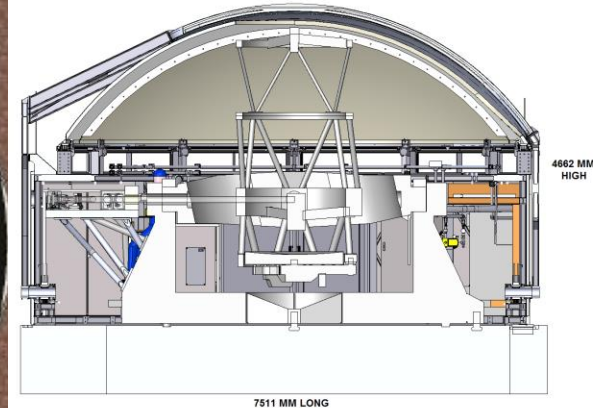
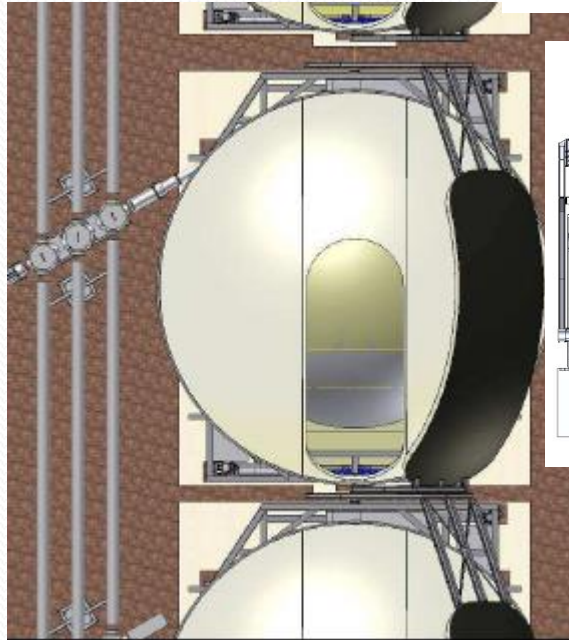
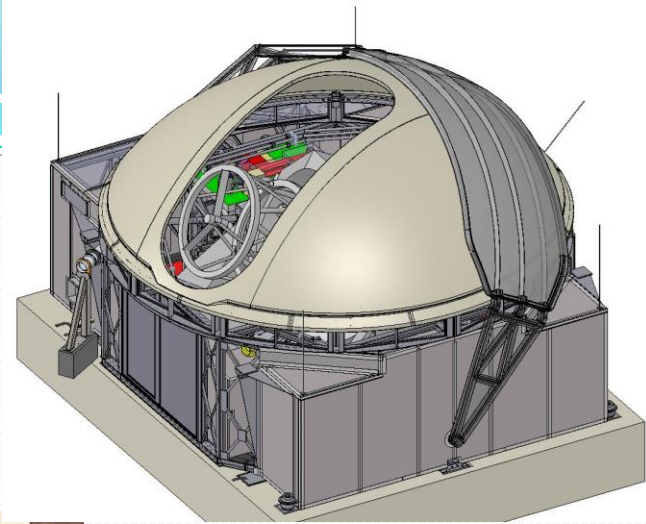
Unit Telescopes

- Designed/built by AMOS
 - 1.4m aperture
 - afocal alt-alt design
 - polarization preserving performance
 - 62 nm rms wavefront after three reflections
 - UT1 is on campus
 - UT2-3 long-lead items ordered and being assembled



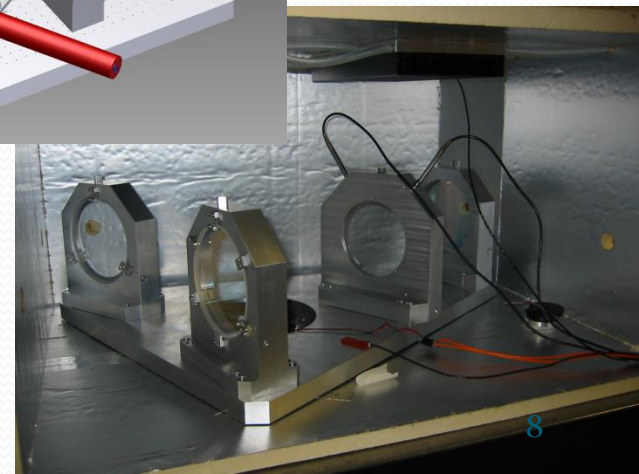
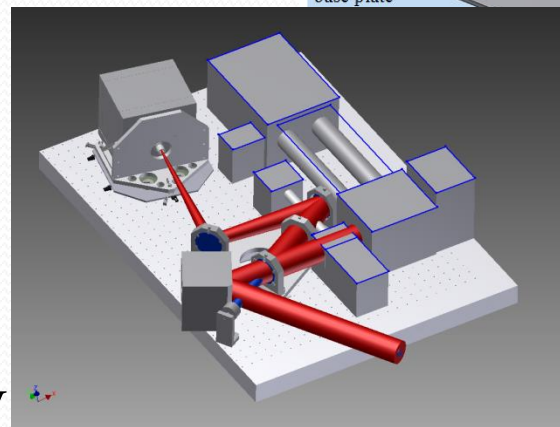
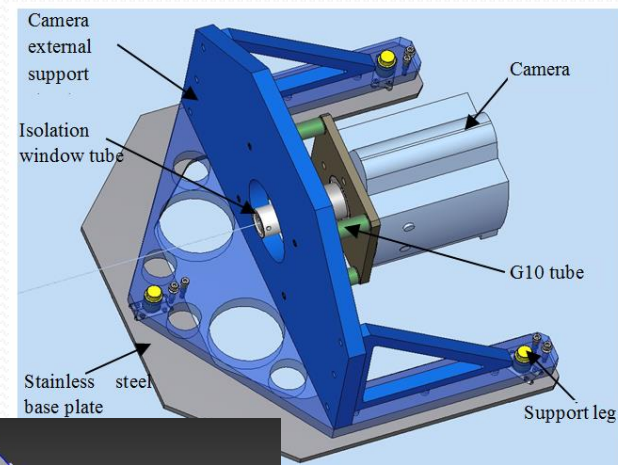
Optics & UT Enclosures

- Enclosures Designed and to be Built by EIE
- Houses and transports UTs
- Allows close-packed configuration to 30 deg elevation without vignetting for 6 hour tracks
- Expect UTM+E: 6/17
- 6 full sets of optics in warehouse
 - All M2's and M3's completed
 - First 3 M1's in various states of completion

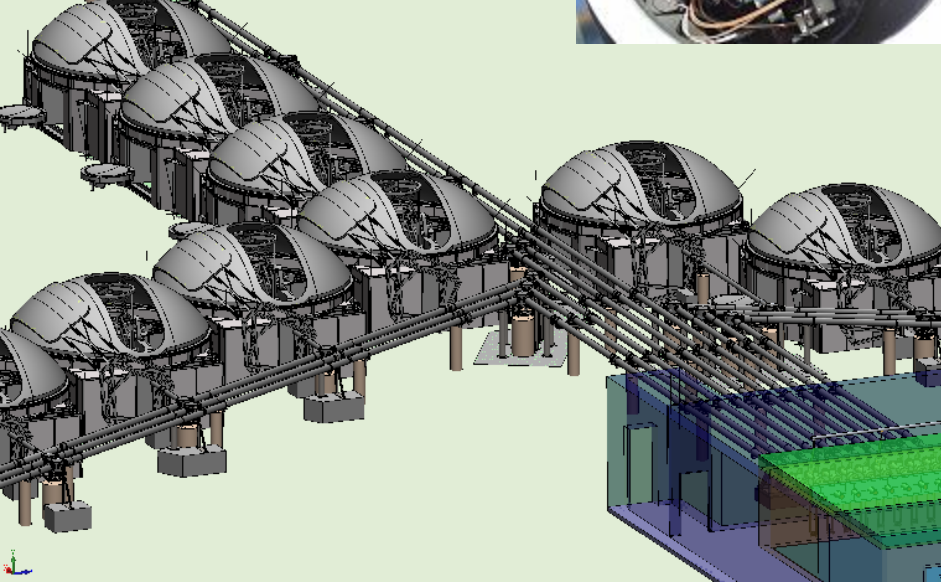
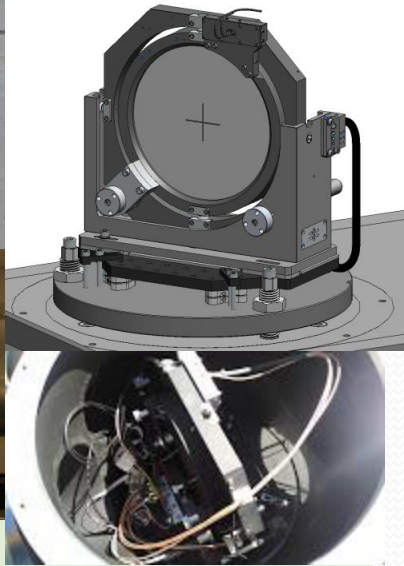


Fast Tip-tilt & Acquisition System

- Nearing completion at 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 16 at MROI:
 - Good match to reddest targets



Foundations, Beam Relay & Inner Array



- Completely redesigned by M3 and built by MRO/NMT
- Meets stringent thermal, wind stability and subsidence requirements
- Supports 3 UTs per beamline with 0.5 mbarr vacuum from UT to BCA
- Install of 7 inner piers complete – utilities soon
- Houses all components of automated alignment system

Visitor's Center and Maintenance Facility

View from N



View from S



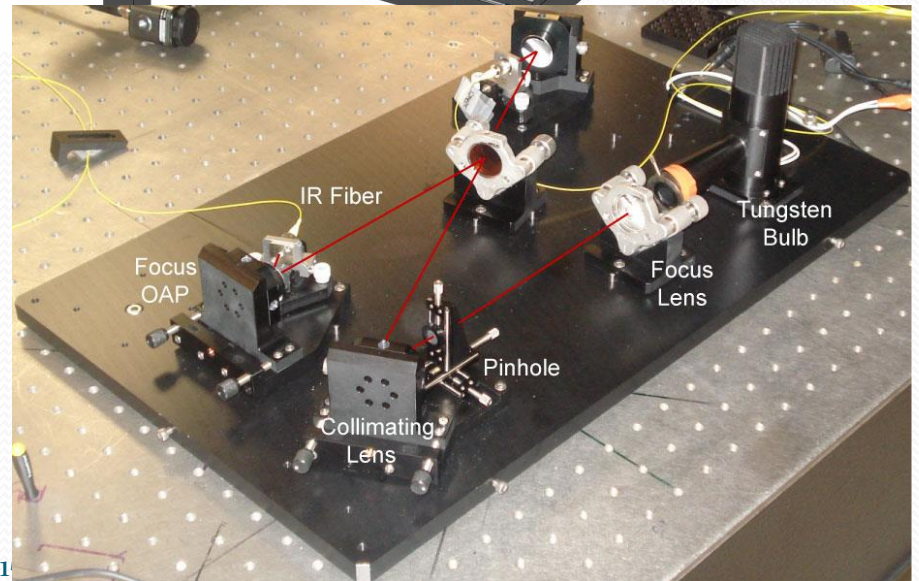
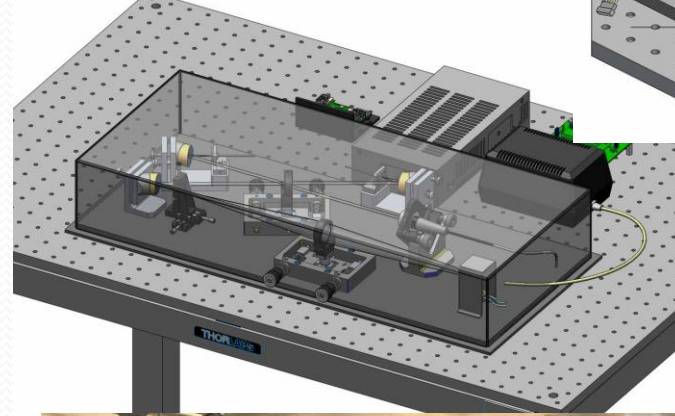
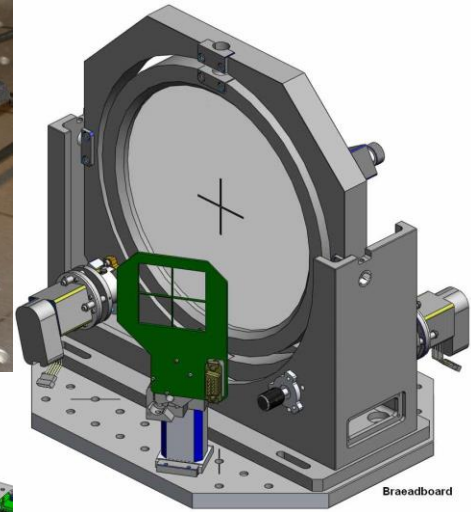
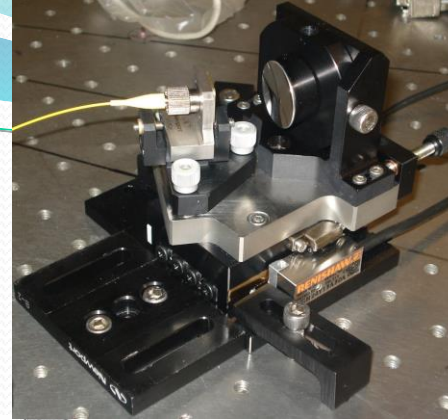
Looking out toward the N - view from telescope



- State DOT funded
- Visitor's Center (red): giftshop, displays, observing window
- Maintenance facility (beige): small machine shop, control room, overhead crane, telescope pad + all facility needs
- UTM₁ SAT April-June 2016
- FOV to N: $\sim 35^\circ \times 40^\circ$

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
- Undergoing redesign to optimize for Ridge



Beam Combining Facilities

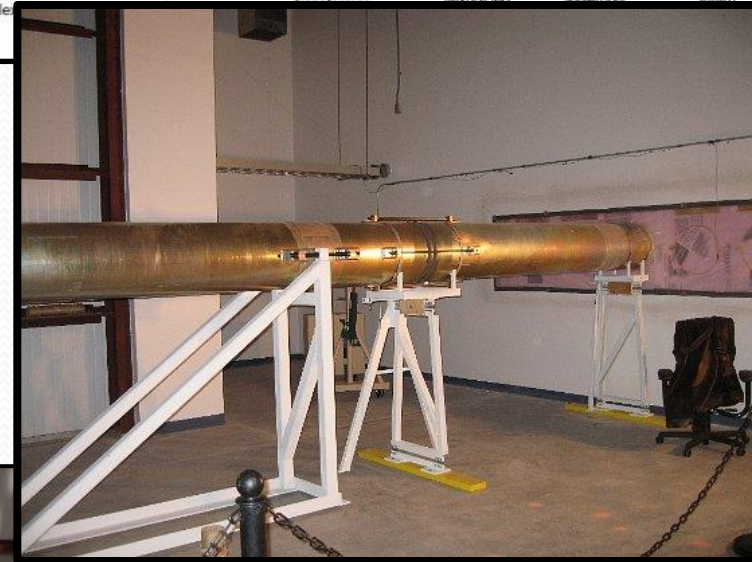
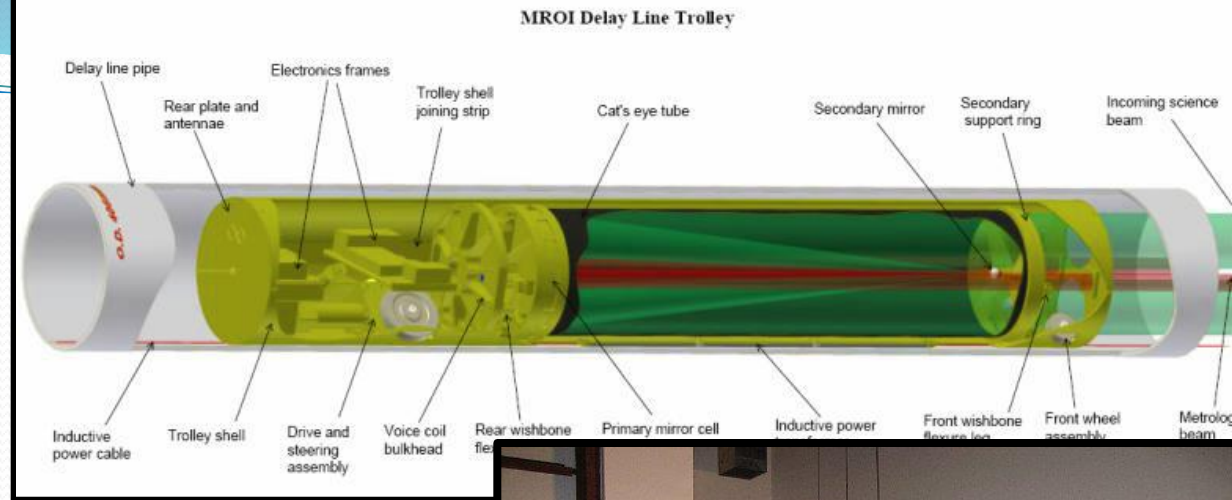
- Design by M3/built KL House – delivered in 2008
- Thermal & vibrational stability
- Supports full 10-telescope array
- Single-pass DL section 190 m long



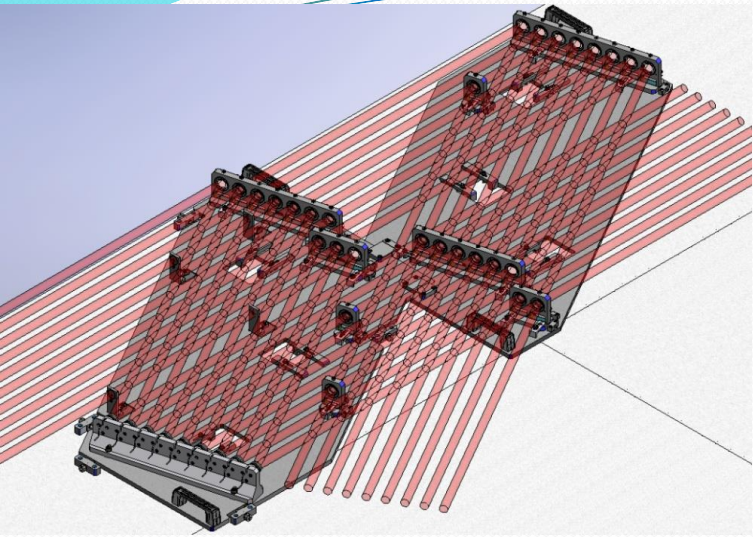
TAE Photographic

Delay Lines

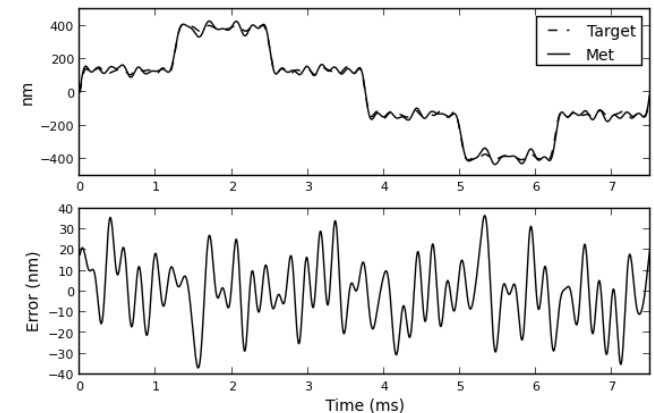
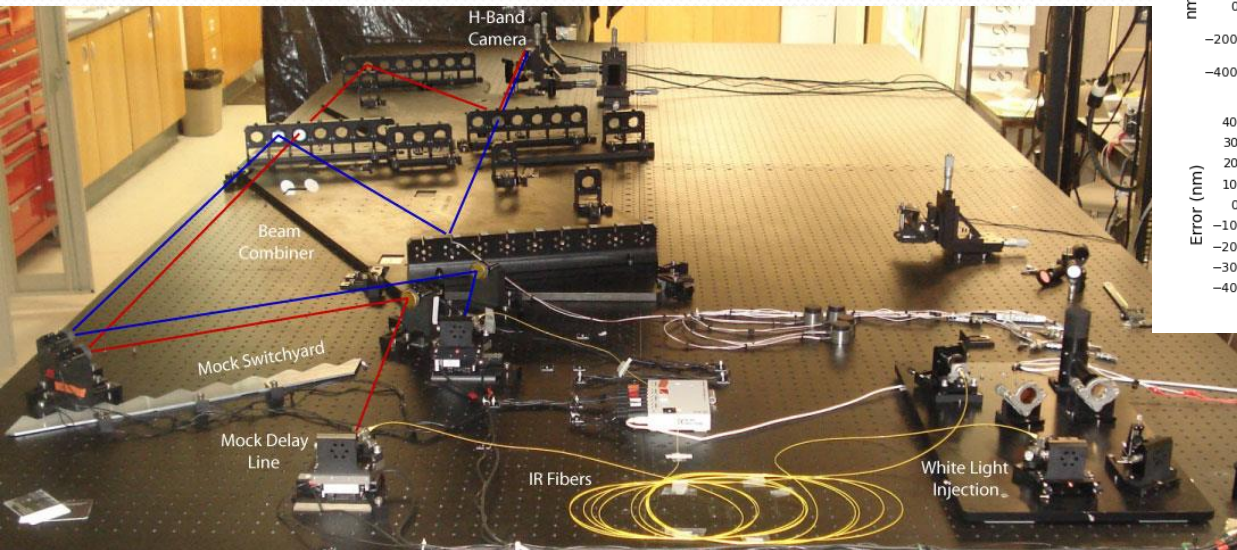
- Designed/built Cambridge
- Inductive power pick-up & wireless communications
- DL₁ pipe install to about 100m length
- DL₁ Site Acceptance Testing to be finished 3/16



Fringe Tracker - ICoNN

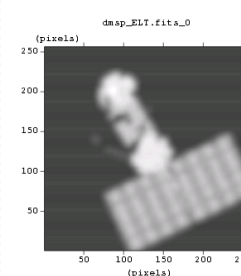


- Designed/built by MRO
- Operates H or Ks
- Uses nearest-neighbors combination
- Closed loop FT in the lab using step modulation and “fake atmosphere”
- Adding all dewar internal optics for first 6 telescopes

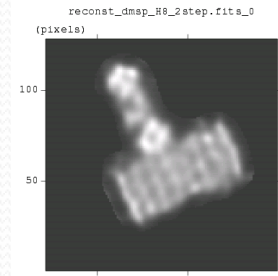


Preliminary Plans forward:

- AFRL Cooperative Agreement (FA 9453-15-2-0086):
Sept 30, 2015 – Sept 29, 2020 for *Imaging Geosynchronous Satellites*
 - Kick-off Meeting – Nov 24, 2015
 - Partners: Univ. of Cambridge, NRAO, Lockheed Martin and several subcontractors
- Current Milestones:
 - UTM1 first light (VCMF) – 5/16
 - UTM1+E first light on Array – 6/17
 - First fringes – 3/19
 - Closure phase (3 UTs) with Science Combiner – 6/20



Truth image

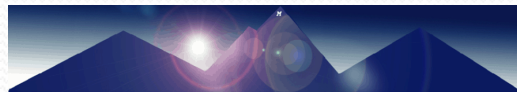


10 element MROI +
smaller telescope

Young, Haniff & Buscher (2013)

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
- Visitor's Center: M. Stanley
- NMT Team: M. Edwards, A. Farris, D. Klinglesmith, A. Olivares, J. Pino, C. Salcido, L. Schmidt, J. Trueblood
- Students: R. Kelly, M. Napolitano, J. Riker, S. Rochelle, B. Vestergren
- Cam. Team: R. Boysen, M. Fisher, B. Seneta, D. Sun, D. Wilson, J. Young



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