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
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

- 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: ~35° X 40°
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

- Thermal & vibrational stability
- Supports full 10-telescope array
- Single-pass DL section 190 m long
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:

  - 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
Thank you for your attention!

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