Design Optimization Considerations for MROI

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On behalf of MROI team in NM, USA and Cambridge, UK
Overview of Talk

• Quick Introduction to MROI
• Design Philosophy
• Error Budget
• Subsystem Examples
• Recent Updates
• Quick Movie
• Conclusions
Magdalena Ridge Observatory Interferometer

- Federally funded 2000-2011
- EIS completed in 2003
- Two facilities at MRO
  - Fast-tracking 2.4m
  - NIR/Optical 10-element interferometer
- MROI is 10x 1.4m movable afocal telescopes in equilateral Y configuration
- Optical and near-IR operation
- Baselines from 7.8 to 343m
- Design optimized for imaging faint/complex targets
Interferometric Considerations

- Sensitivity
- Speed of Data Collection
- Accuracy
- Precision
- Scalability
- Mobility

- Polarization Purity
- Expert/Novice User Base
- Astrometry
- Imaging
- High Resolution Spectra
- Nulling
- Costs
MROI Considerations

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MROI Innovations

- Sensitivity = many components in overall design – factor of a few in most cases
- Speed of data collection = simple architecture with very few moving components
- Scalability/mobility = site location & design of building/infrastructure
- Polarization purity = telescopes & beam train
- Imaging = number of telescopes, FT architecture, separated FT/science
Conceptually

Three subsystems – very few mirrors to adjust
Start with an Error Budget

Assign *achievable* errors (factors of a few improvement) to each component of the overall system, and then “hold the line” on each

WFE = wavefront errors

λ/90 at 1.6um or λ/35 at HeNe
Array Layout

- Equilateral Y Configuration
  - 5:1 within a configuration
  - 44:1 overall angular scaling
- Multiple Telescopes
  - UV points & CP triangles
- Speed data collection
- Scalability
- Imaging
- Cost - infrastructure

09/24/2013
Telescopes

• Alt-alt design
  – 3 mirrors
  – 1 reflection > 30°
  – OPD vibrations <40nm RMS tested
  – <350um radial pupil motion tested

• Sensitivity, Scalability, Mobility, Polarization Purity, Imaging

• Cost – specifications
FTT and Beam Relay Systems

- Transmissive design
- Located on Nasmyth platform – commands 2ndary
- EM CCD
- TT error of 60.8mas RMS at $m_v = 16$ in 0.7” seeing
- Sensitivity, Speed of Data Collection
- Cost

- Vacuum transport large beams (cheap)
- No longitudinal dispersion correction needed
- Multiple wavelengths simultaneously
- Sensitivity
- Cost

Young et al. 2012 SPIE
Santoro et al. 2012 SPIE
Delay Lines

- Single stroke system with novel features
  - 380m continuous delay compensation
  - Vacuum vessel and track are same component
  - No “on-board” cabling
  - COTS laser metrology
  - $\lambda/40$ RMS DL jitter over $2t_o$ tested on 25m
Delay Lines

- Sensitivity, Speed of Data Collection, Polarization Purity, Imaging
- Cost ($275K after NRE)
FT - ICoNN

- Nearest-Neighbors for all 10 beams
  - Maximizes per baseline SNR
  - Accepts 5 beams per dewar
- No adjustments, precision plates
- Reflective outside, refl/trans inside
- Stays aligned for days in campus lab
- Sensitivity, Scalability, Speed of Data Collection
- Cost
Recent MROI Updates

• UTM1 shipped last week
• DL1 cart delivered few months back and lab tested; will be installed on Ridge in 2 months
• Visitor/maintenance building on Ridge under construction
• First BR system installed outside building
• University searching for more $$$ - Fed & State

Last full talk at Flagstaff meeting in Feb 2013 if you want more MROI details.
MOVIE HERE!!
Conclusions

• Sensitivity = 14$^{th}$ mag at H for FT
• Polarization purity = 1 reflection >30° AOI
• Scalability = Entire design for 10 telescope array – add on components as $ comes
• Mobility = 28 pads, 4 “intrinsic” configurations
• Speed of imaging = 10 min/calibrated UV snapshot

Snapshot Imaging Machine!

See Ifan Payne if you are interested in joining.
Thank you for your attention!