Magdalena Ridge Observatory Interferometer: Geosynchronous Target Imaging Capabilities

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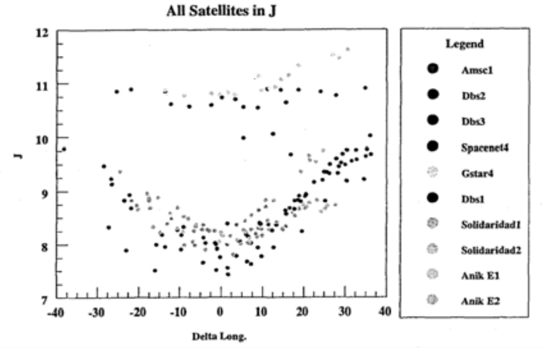
MROI

- A world-beating high-sensitivity optical/near-infrared interferometer on the Magdalena Ridge in New Mexico.
- Delivers 100x the angular resolution of the Hubble Space Telescope and 10x that of TMT
- Sensitivity 50-100x greater than the current best optical/IR interferometers.
  - MROI will be able to image satellites as faint as a magnitude of H = 14; no existing interferometer (e.g., KeckInt/CHARA/VLTI)can image targets fainter than H = 10.
- Efficiencies of 20-100x the number of images/night compared to the current interferometers.
  - MROI's multiple telescopes will enable quicker imaging than any existing interferometer.
- Reliable model independent imaging of faint and complex targets.
  - To date, imaging on interferometers has been confined to bright targets or to fitting *a priori* models..
- MROI is a powerful tool for imaging both military and commercial geosynchronous satellites.



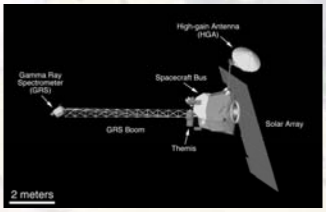
Measurements of infrared magnitudes of a number of GEO satellites from Sanchez et al (2000). In the H-band (1.6 micron wavelength) the objects were measured to be approximately 0.3-0.8 magnitudes brighter. The MROI with, an H-band limiting magnitude of 14, should be able to track fringes on all these targets, providing they have significant amounts of compact (<5m) structure.

Ability of MROI to "see" Geo Targets

- Based on data from Payne (1998) and Payne et al (2006) we estimate that 50% of GEO satellites are brighter than K=12.5 magnitude.
- MROI is designed to track targets up to 0.5 magnitudes fainter than this.
  - Assumes compact sources: at GEO, "compact" implies most of the light comes from a region less than 5 meters across.
  - Can see more extended sources if they are correspondingly brighter but some of the structure on scales above ~10 meters may be "washed out" in images
  - H-band tracking is possible on fainter sources providing they are more compact
- A significant proportion of the GEO population is likely to be accessible.
- The ability to distinguish colors allows for characterization of the target.
- Multiple telescopes (10) compensate for the inability to use Earth Rotation Synthesis in creating images of GEO targets.

Key Design Features Unique to MROI

- Up to 10 fully transportable 1.4m telescopes to support multiple array configurations, which enables the selection of the optimal resolution for the target of interest.
- Baselines from 7.5 to 350m to give sub-milliarcsecond (~10cm) angular resolution
- Operation from 600nm to 2400nm (RIJHK bands) to enable key science. Multi-waveband imaging gives extra diagnostic power.
- Separate fringe tracking and science beam combiners to improve sensitivity.
- Automated end-to-end alignment to achieve high-level of efficiency in the imaging operation.
- Vacuum beam transport from telescope through single-stroke delay lines to beam combiners which ensures minimum coherence loss.



An idea of the type of imaging which may be possible with MROI. The image shows an artist's rendition of the 2001 Mars Odyssey orbiter (above) and an actual image of the orbiter as taken by the Mars Global Surveyor from a range of 90 km (below). The resolution of the lower image is comparable to that which could be obtained from MROI at GEO range (36,000km). The orbiter is approximately 2-3 meters in dimension. Spectrally resolved imaging might be able to distinguish the gold-covered spacecraft bus from the solar panel material. Images courtesy NASA.

What Kind of Imaging Will be Possible?

- Full 10-telescope complement will be able to make 7x7pixel images routinely.
  - Could distinguish 70cm features on a 5-meter satellite, or 30cm features on a 2-meter satellite.
- First phase of MROI with 6 telescopes will have similar resolution but be less able to separate out complex image structure.
- Simultaneous imaging in multiple spectral channels giving a "hyperspectral" image cube.
  - 5-70 channels across either 1.2-1.3 microns, 1.5-1.8 microns, or 1.9-2.4 microns waveband
- May be possible to extract key diagnostics on features as small as 10cm, depending on image structure.
- Need realistic simulations of satellite appearance at infrared wavelengths to make more detailed predictions of likely diagnostic capabilities (contrast ratios etc).

References

•Payne 1998. "Target selection database" Schafer Corporation
•Payne et al 2006. "Electro-Optical Signatures Comparisons of Geosynchronous Satellites" Aerospace Conference, 2006 IEEE
•Sanchez et al 2000. "Photometric measurements of deep-space satellites", SPIE 4091, 164.

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