

**Space Science  
at  
New Mexico Tech**

**NEW MEXICO TECH**

# Previous Work

**Video**



# Astrophysics

Space Weather, Planetary Atmospheres

Astro Chemistry, Molecular Clouds, HII Regions, Interstellar Medium

Star Formation, Exoplanets, High Mass Stars, Evolved Stars, Stellar Evolution

Dynamics of Spiral & Dwarf Galaxies

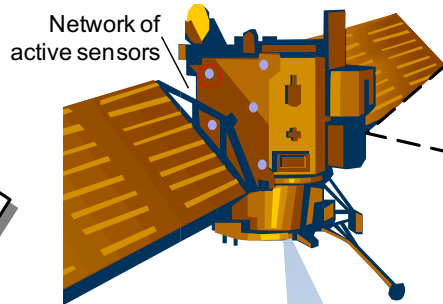


andrei.zagrai@nmt.edu

# Goal: Smart Spacecraft that feels and reports its condition

2024 work supported by:

- 3 SPACEWERX Ph-2 STTRs – OSAM related
- NASA – ISS SHM orbital experiment
- NASA – Ph-1 STTR optical sensing space app.
- NASA EPSCoR – Next generation additive manufacturing for space applications



### On-orbit Monitoring

- 1) Component identification and performance assessment.
- 2) Passive impact detection and active damage evaluation.
- 3) **On-orbit Servicing, Assembly, and Manufacturing (OSAM)** quality assessment, refueling monitoring, identification and optimization.
- 4) Elements of space weather and spacecraft operation monitoring.

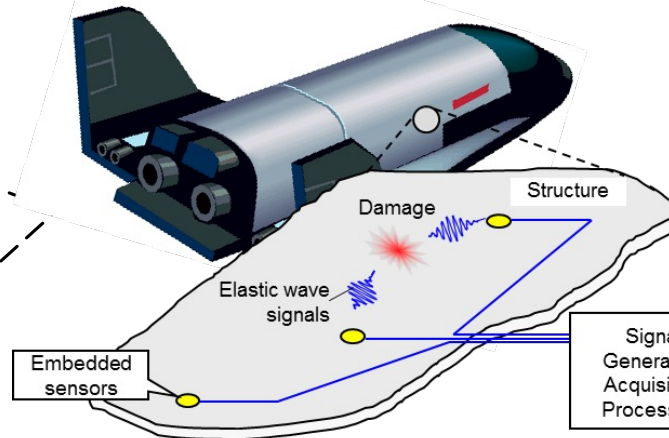
On-orbit structural, operational, and space weather data.

### Monitoring During Launch

- 1) Load monitoring during launch.
- 2) Monitoring of structural changes caused by exerted loads.

### Pre-launch Diagnosis

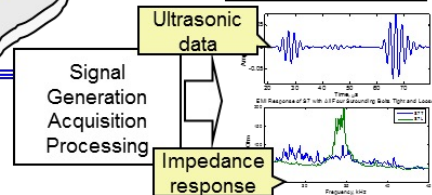
- 1) Component identification.
- 2) Damage assessment in bolted joints and adhesive bonds.
- 3) Characterization of structural interfaces for baseline FE model.



Damage Detection and Classification Results

Statistical Analysis  
Neural Network

Signal feature extraction

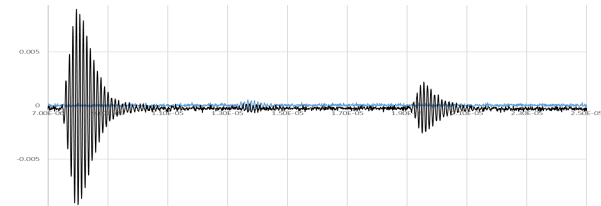
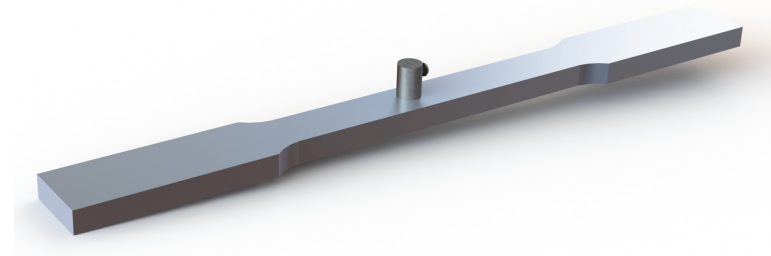
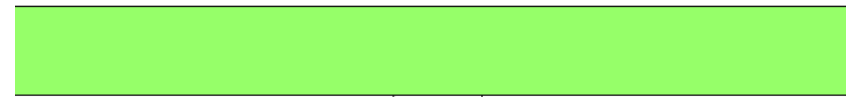
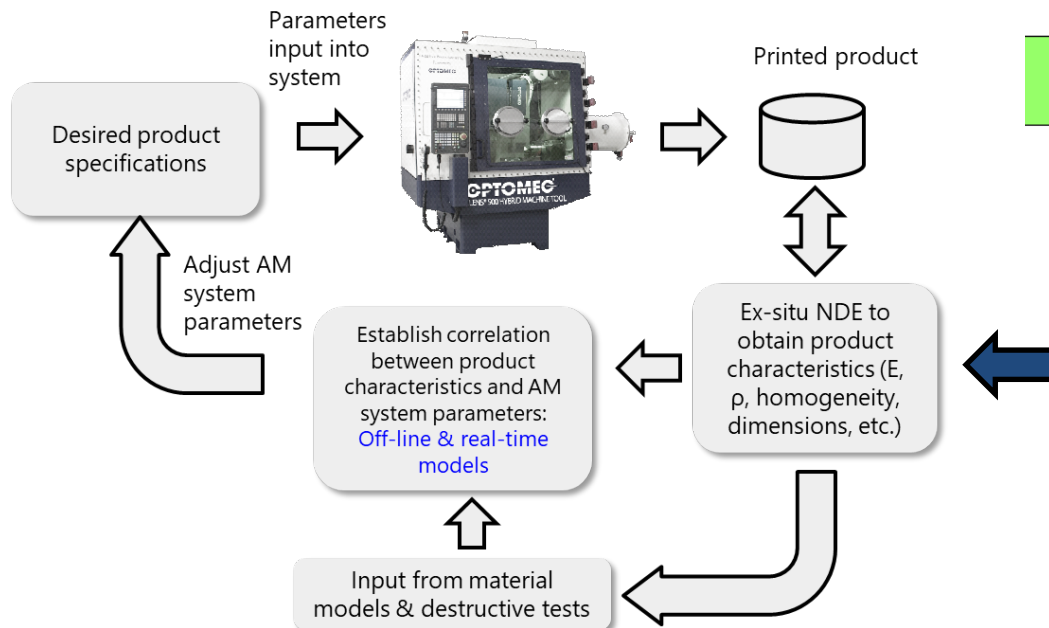
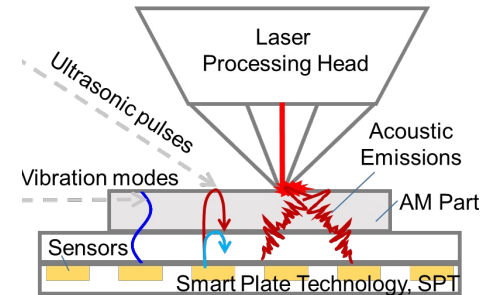




# Additive Manufacturing NDE for Space Systems

andrei.zagrai@nmt.edu

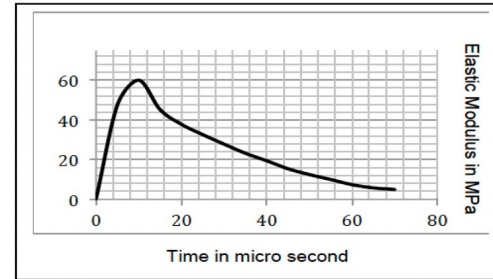
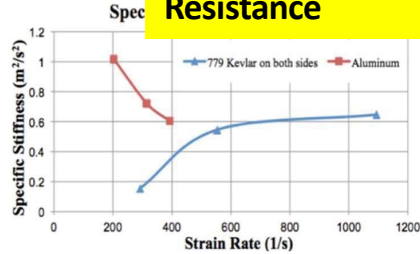
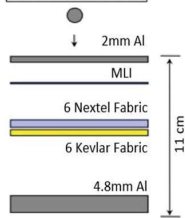
- Enable on-demand parts
- Improve quality of AM parts
- Reduce material waste and time



# Fluid Filled Cellular Composite – Past Investigations

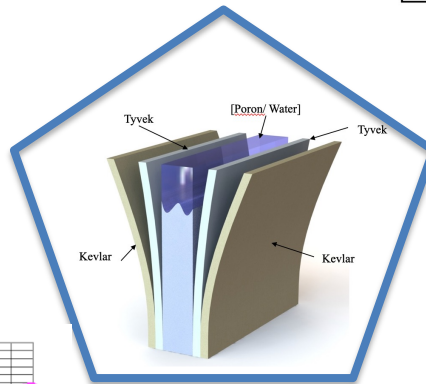
## Impact Resistance

NASA configuration

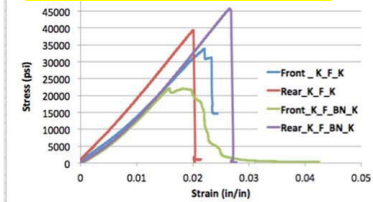


## Explosive Shock Resistance

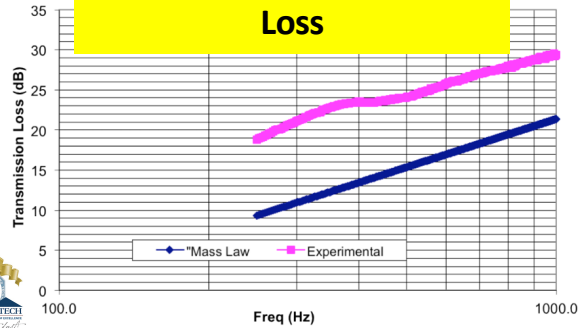
## Gamma Radiation



Cobalt 60 source  
BC Samples

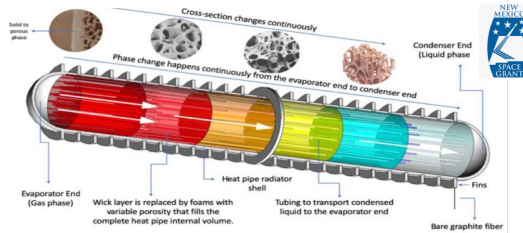
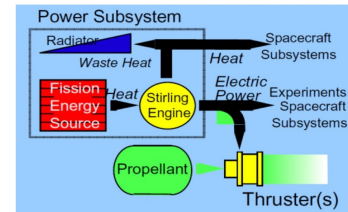


## Acoustic Transmission Loss



## Thermal Management

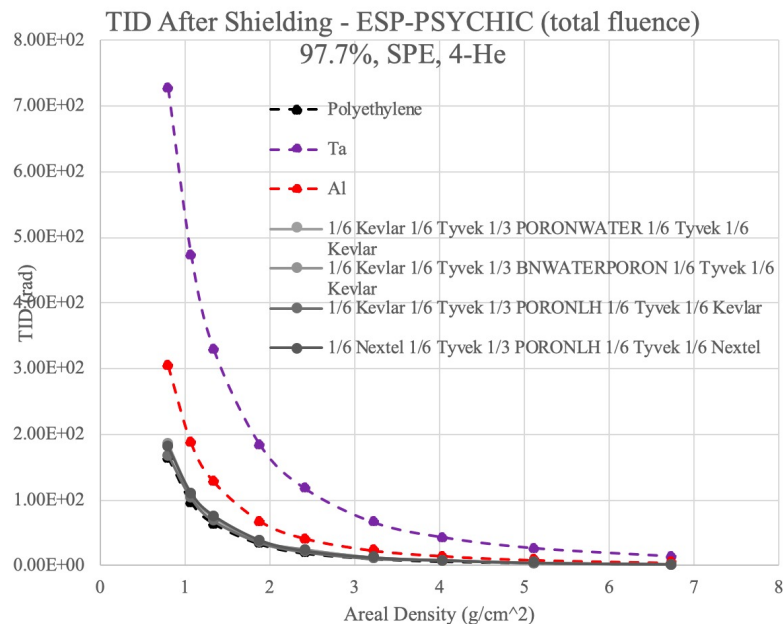
Heat pipe for Nuclear Powered Deep Space Thermal Management System





# Fluid Filled Cellular Composite – Ongoing Investigations

## Solar Particles- Optimal FFCCs



High Z materials and metals suffer from secondary radiation effects.

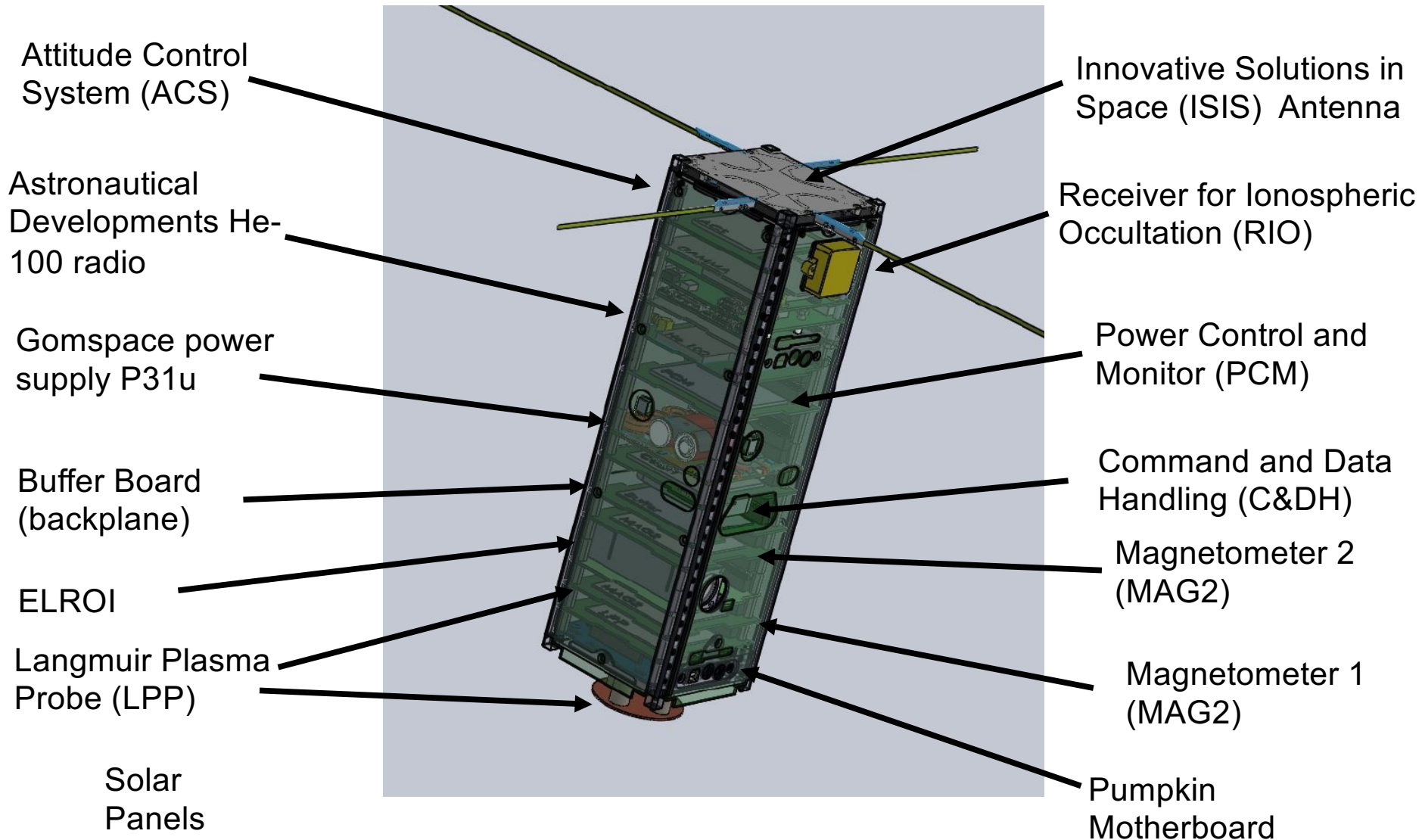
Hydrogen is excellent for radiation shielding.

FFCC compositions with the highest hydrogen density near the performance of polyethylene.

The structure of the FFCC has been modified for radiation shielding

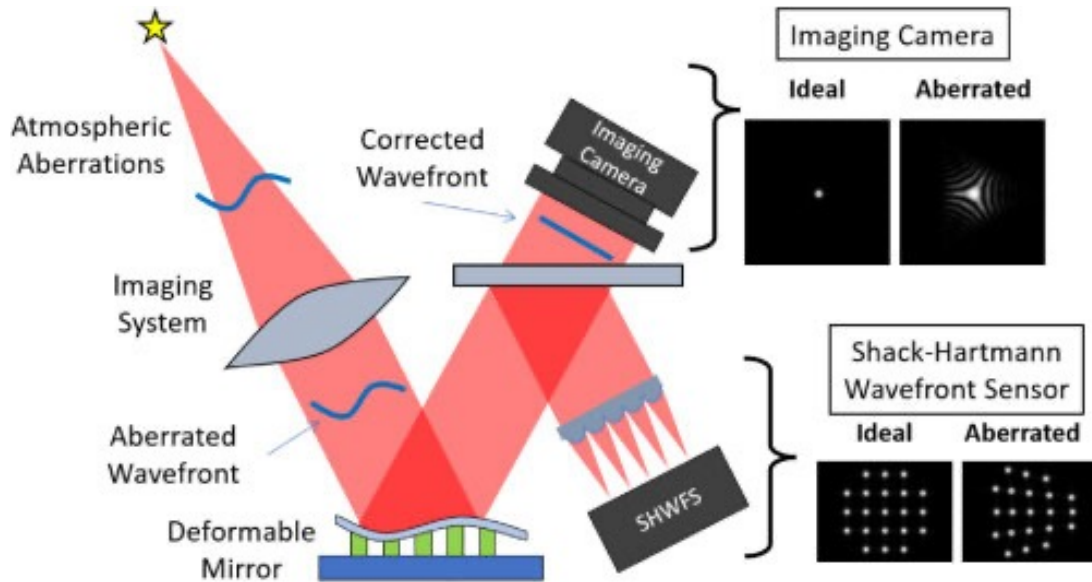
- Analysis is necessary to reconcile the multiple other properties.
- Multivariate optimization of FFCC composition for mechanical structure, radiation shielding, impact resistance.

# NMTSat



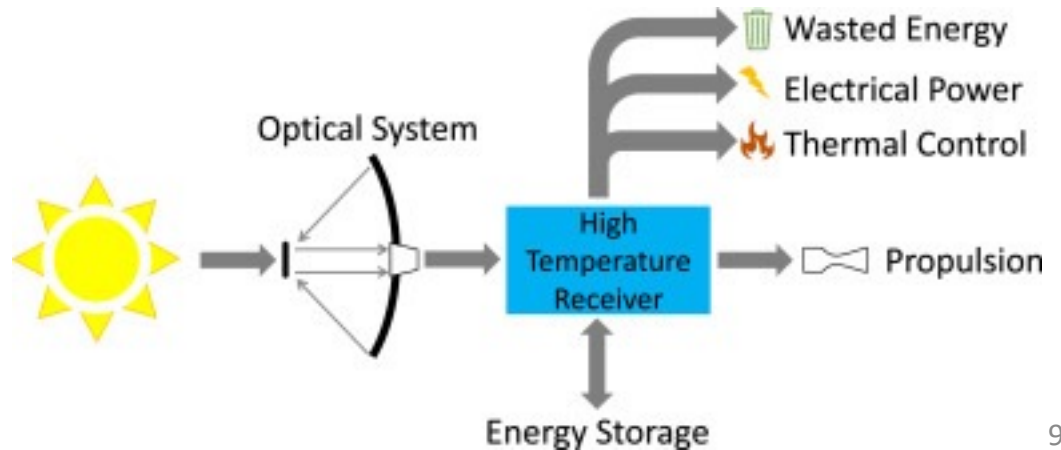


# Electro-optics



Adaptive optics & wavefront sensing

Energy harvesting

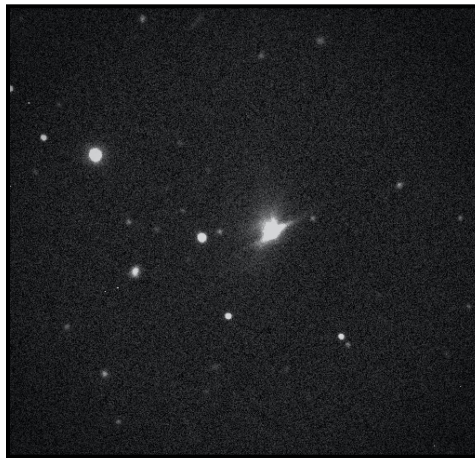
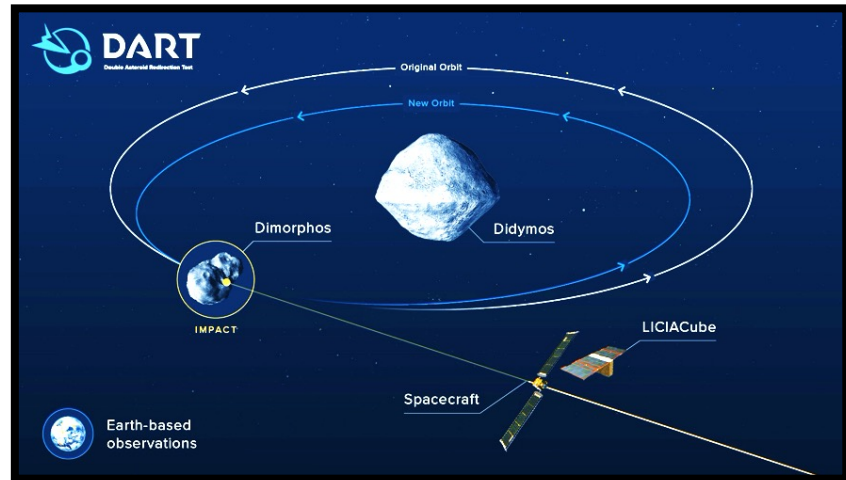


# Magdalena Ridge Observatory Interferometer (MROI)





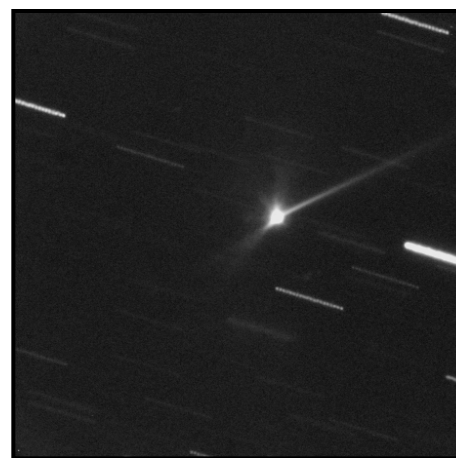
# Planetary Defense: The DART Spacecraft Mission



09/27/22  
(10 hrs. post-impact)



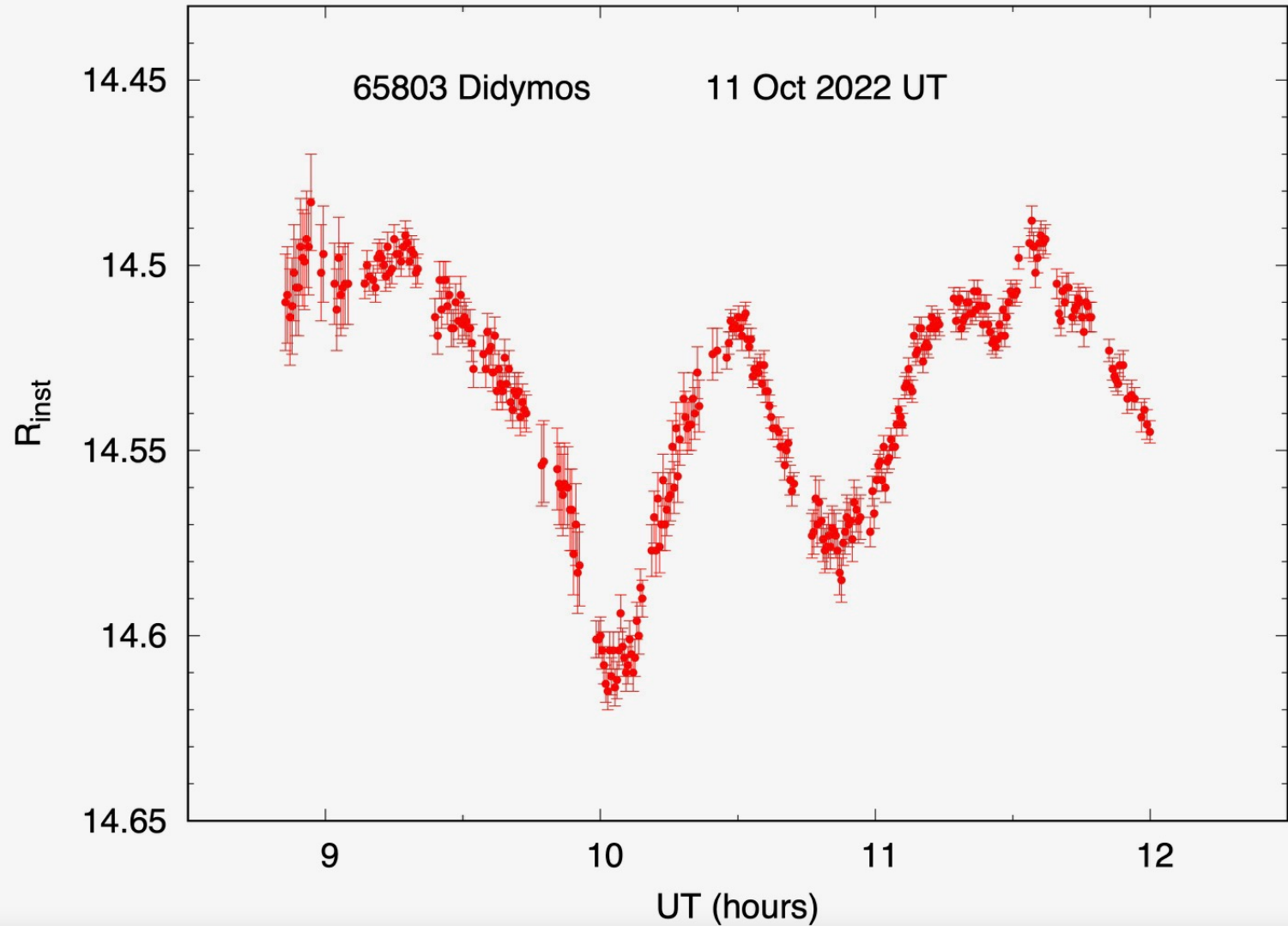
09/28/22  
(34 hrs. post-impact)



09/29/22  
(58 hrs. post-impact)

Orbital  
period  
change:  
Faster by  
~32 min

# Light Curve





The international journal of science / 20 April 2023

# nature

**MRO 2.4m  
staff members  
(B. Ryan and  
E. Ryan) co-  
authors on  
(Thomas et al.  
2023):**

**“Orbital  
Period Change  
of Dimorphos  
Due to the  
DART Kinetic  
Impact”**



# The Magdalena Ridge Observatory Interferometer

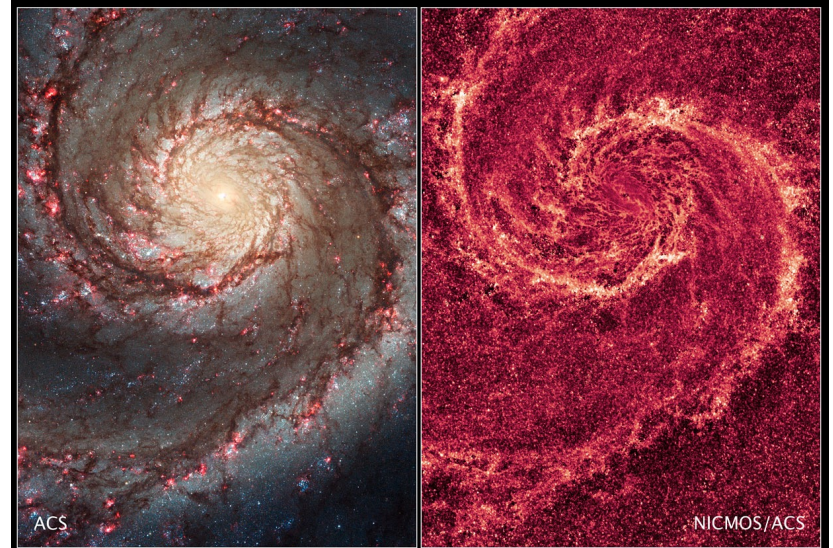
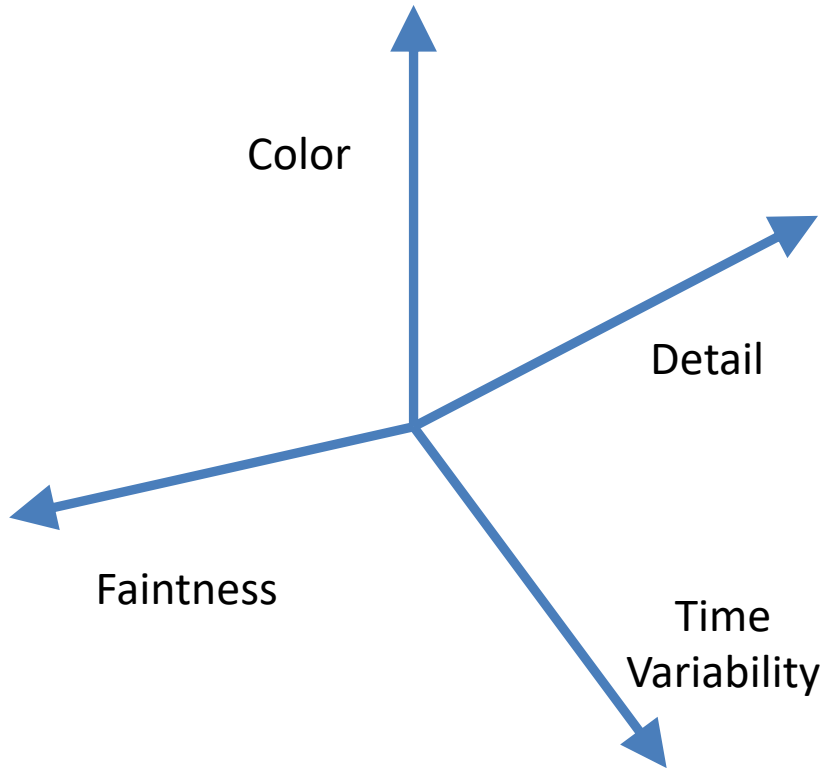
10 x 1.4m diameter  
optical telescopes  
mimicking a 350m  
diameter mirror.

100x the detail seen  
by the HST and  
JWST





# Dimensions of discovery space

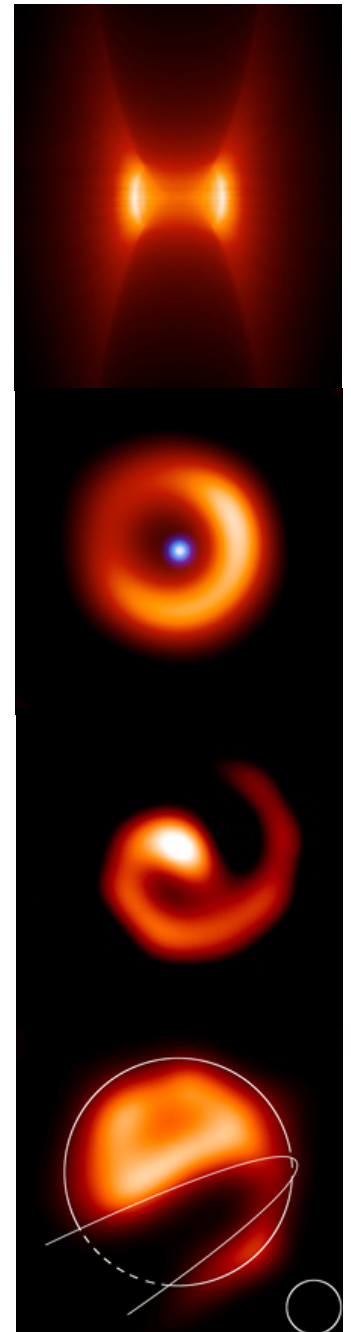


Different axes explore different problems and give new insights

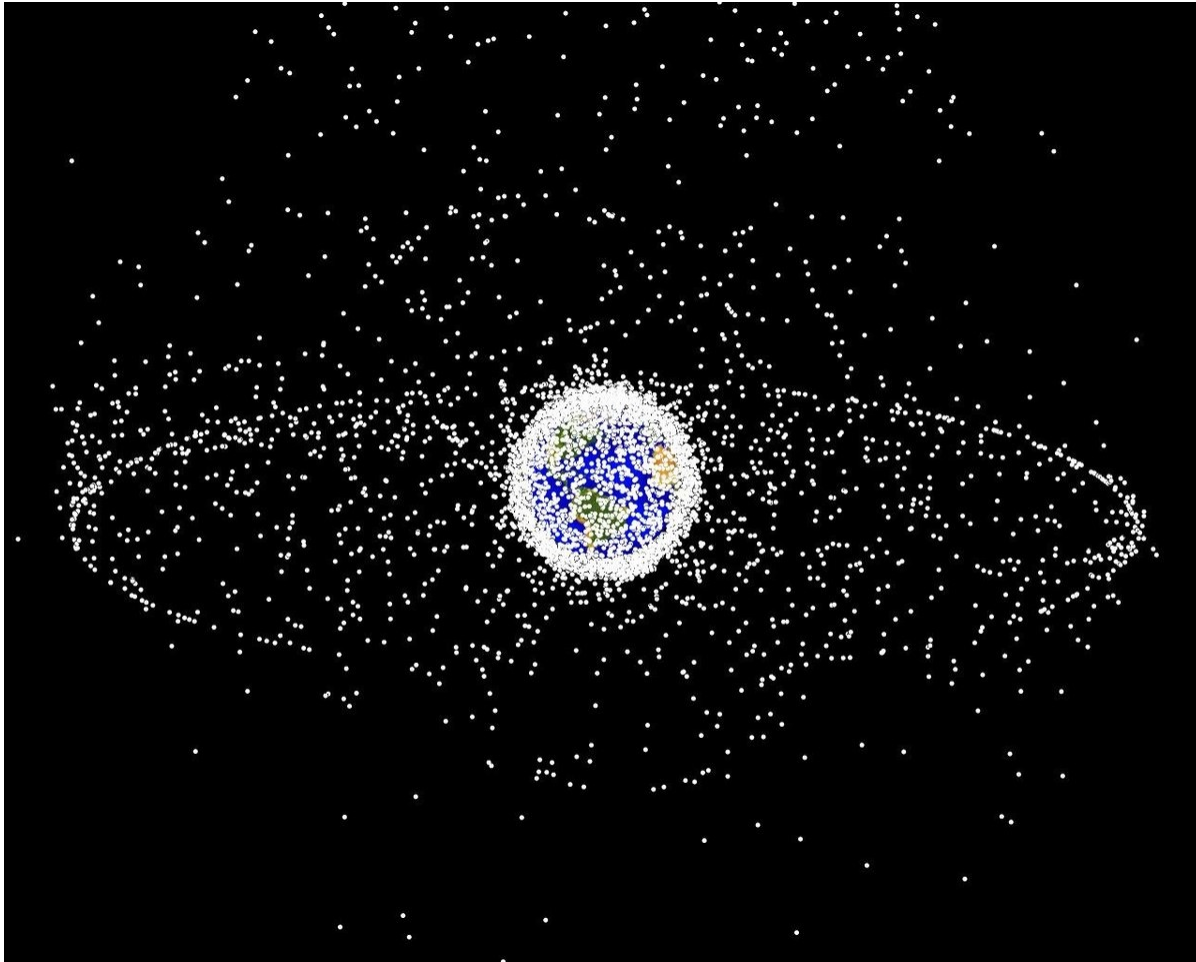


# MROI Science Case

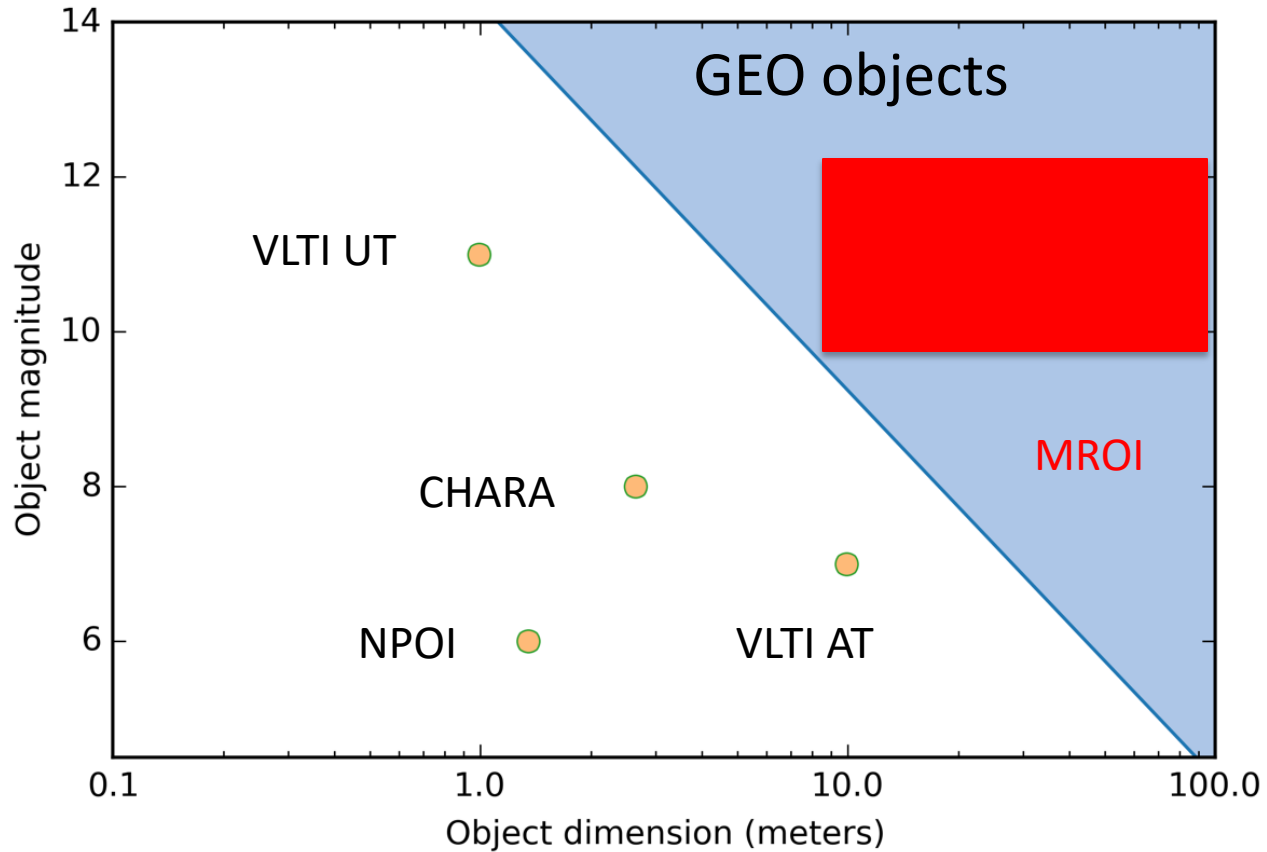
- AGN:
  - Verification of the unified model.
  - Determination of nature of nuclear/extra-nuclear starbursts.
  - $H = 14$  gives  $>100$  targets.
- Star and planet formation:
  - Protostellar accretion, imaging of dust disks, disk clearing as evidence for planet formation.
  - Emission line imaging of jets, outflows and magnetically channeled accretion.
  - Detection of sub-stellar companions.
- Stellar accretion, mass loss and B fields/circulation:
  - Convection, mass loss and mass transfer in single and multi-star systems.
  - Bipolarity and collimation of circumstellar material, wind and shock geometries, interacting binary systems
  - Pulsations in Cepheids, Miras, RV Tauris, etc.
  - Star spots, oblateness, asymmetric properties



# Space Debris



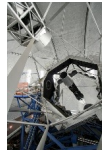
# Current Interferometers Have difficulty imaging GEO Objects



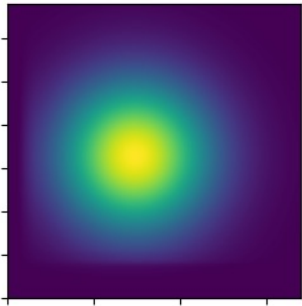
MROI is configured to be in the sweet spot of GEO objects

# Other interested stakeholders

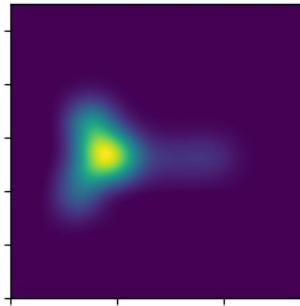
- GEO assets – defense and commercial (\$B annual market)



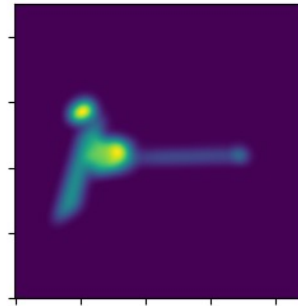
300 mas



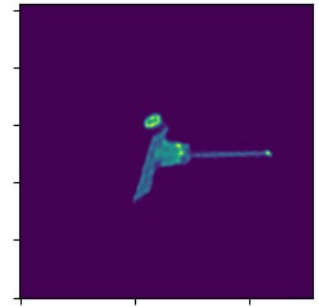
30 mas



8.5 mas



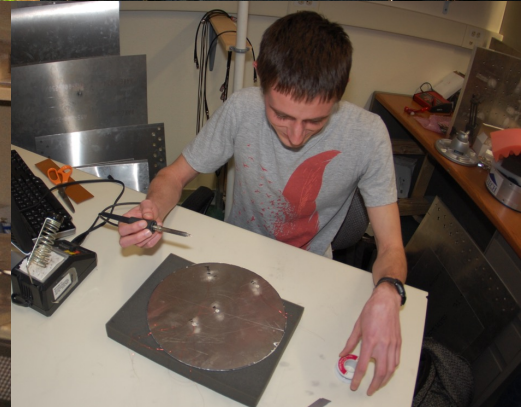
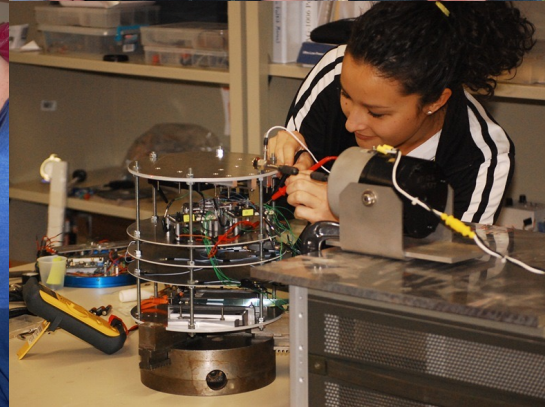
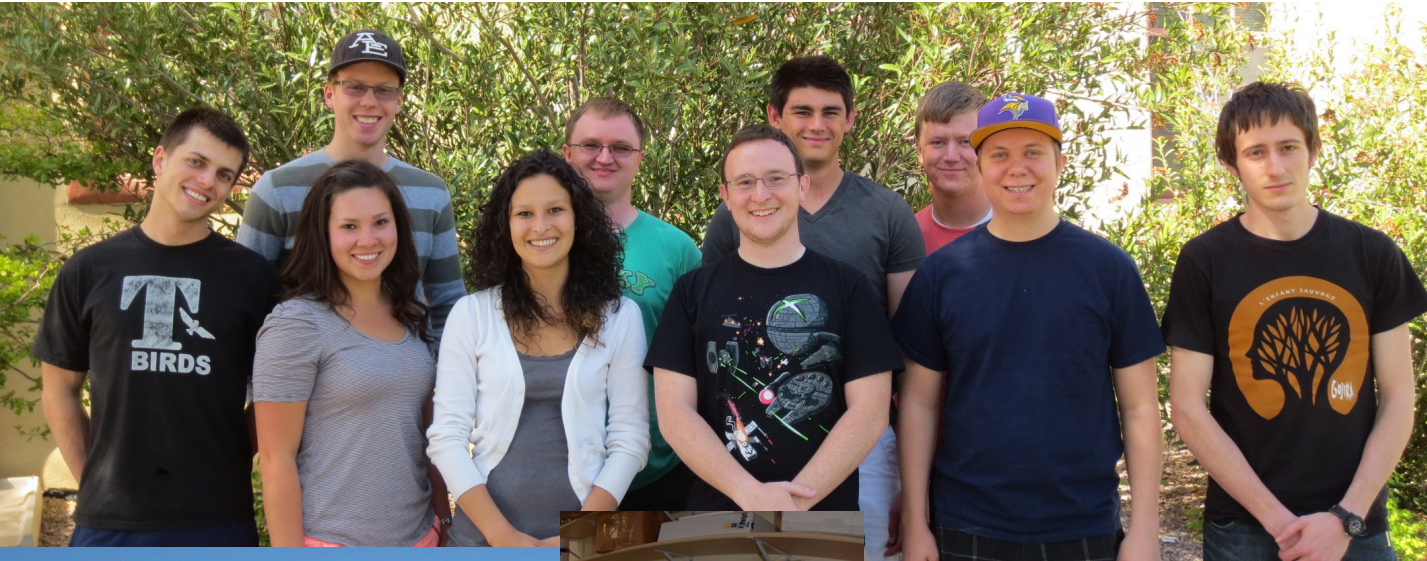
MROI - 10T



Even perfectly operating 35m-class telescopes will have little ability to image GEO assets usefully



# Space Science Education





# Astrophysics

Space Weather, Planetary Atmospheres

Astro Chemistry, Molecular Clouds, HII Regions, Interstellar Medium

Star Formation, Exoplanets, High Mass Stars, Evolved Stars, Stellar Evolution

Dynamics of Spiral & Dwarf Galaxies

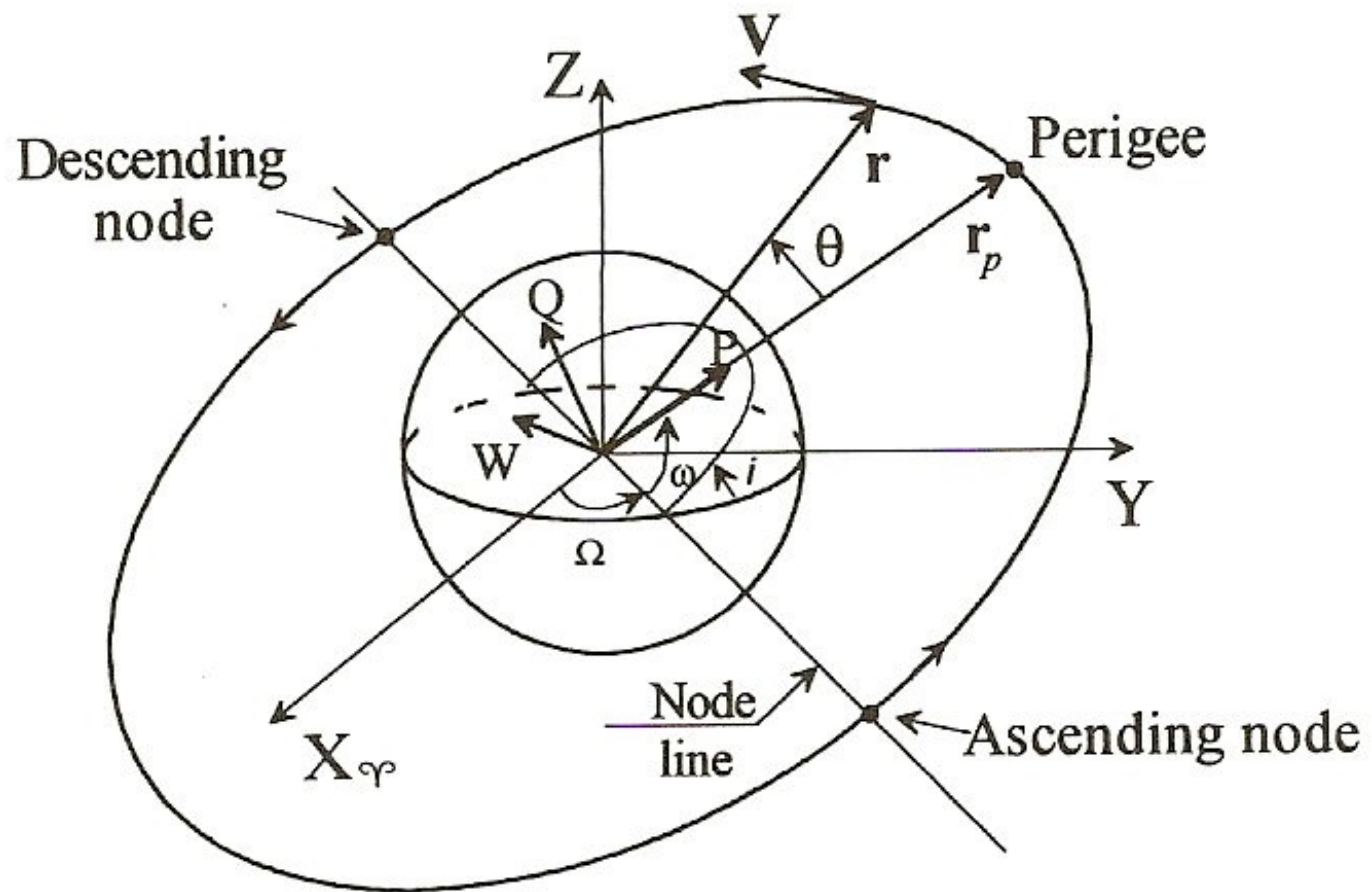


# Space Resources Management Initiative at NMT

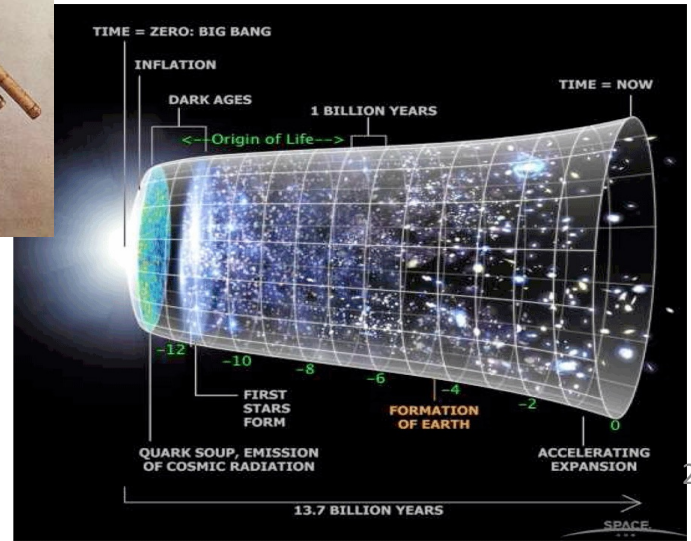
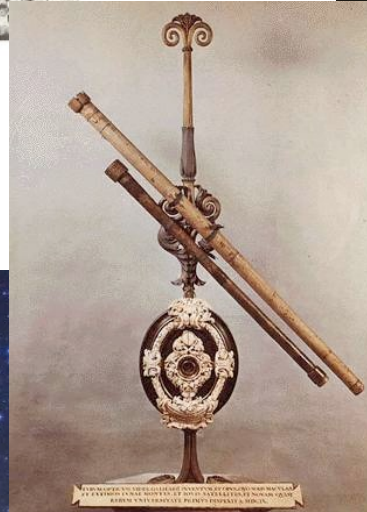
- It is a **joint effort** among NMT, AFRL, and Space Valley Coalition (now SpaceValley Foundation) from the very beginning.
- Why **space resources management** at NMT?
  - NM has comparative advantages in growing a commercial space industry;
  - NMT's existing programs present natural synergies in developing such a program, e.g., engineering management + aerospace engineering + astronomy sciences;
  - To prepare for the emerging workforce demand along the space valley.
- A **space resources management curriculum** has been developed:
  - Two graduate-level principle courses have been offered:
    - Fall: Introduction to Space Industry (Bryce Kennedy, esq., Executive Director of SpaceValley Foundation)
    - Spring: Space Technology History (Matt Fetrow, Director of Communications at AFRL)
  - A new course (and mini certificate) to be offered summer 2025 through collaboration:
    - Space Business Development (lead instructor: Dr. Haoying Wang, with collaborating instructors from NMT faculty, AFRL, and other Space Force facilities in NM)
  - A space resources management certificate program to be launched next year (AY 25-26).



# Orbital Mechanics



# Origin of the Universe



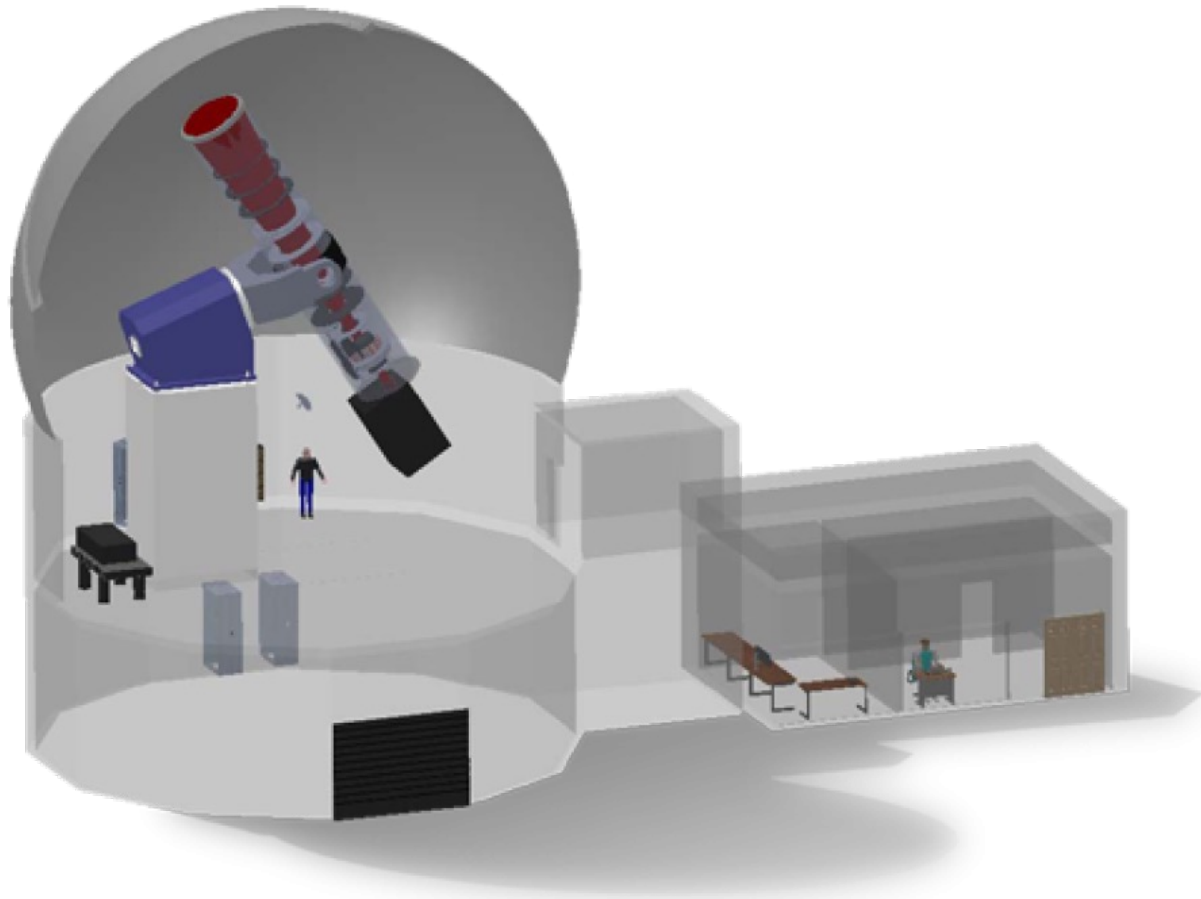


# TURBO – U of Minnesota





# COSMO - NCAR



# Chaco and the Sun

