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OBSERVATORY

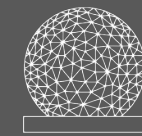
Radio Frequency Interference Detection and Measurements

13th IVS Technical Operations Workshop

May 4th – May 8th

John Swoboda, Samuel Thé, José A. López-pérez

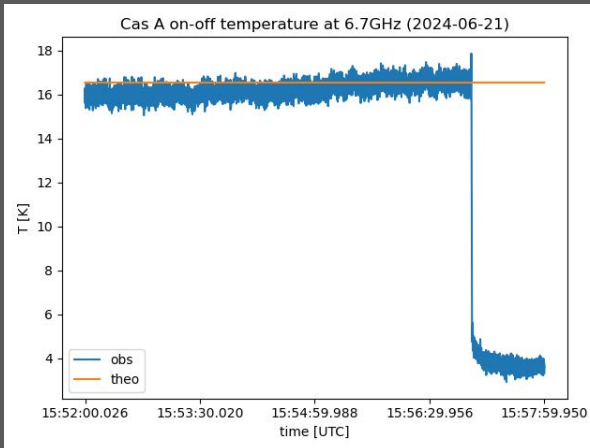
Radio Telescopes



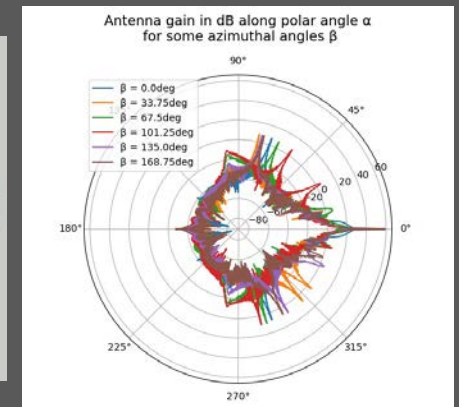
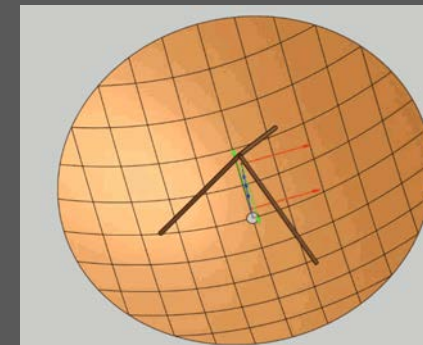
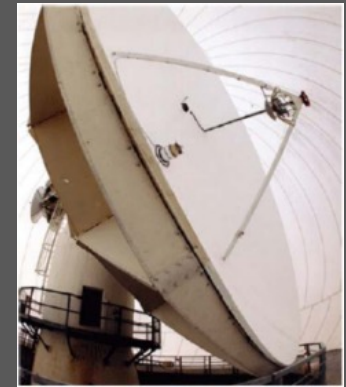
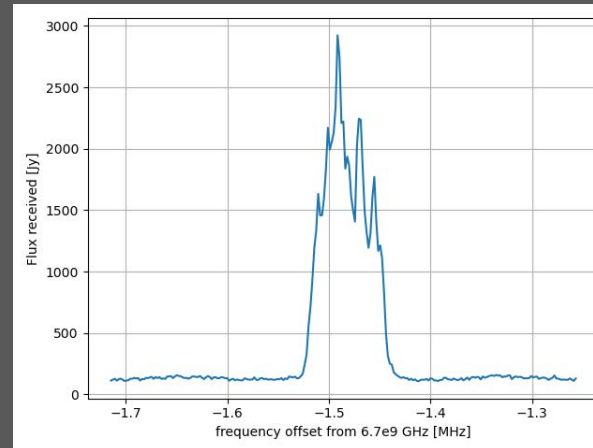
- Signals of scientific interest are very low ($\text{SNR} \ll 1$)
 - Sensitivity of instrument needs to be $< 10^{-26} \text{Wm}^{-2}\text{Hz}^{-1} = 1 \text{ Jy}$
- A cellphone on the Moon, transmitting 1 W with 30 kHz of bandwidth is $\sim 3600 \text{ Jy}$

$$D = \frac{P_t G}{4\pi B R^2}$$

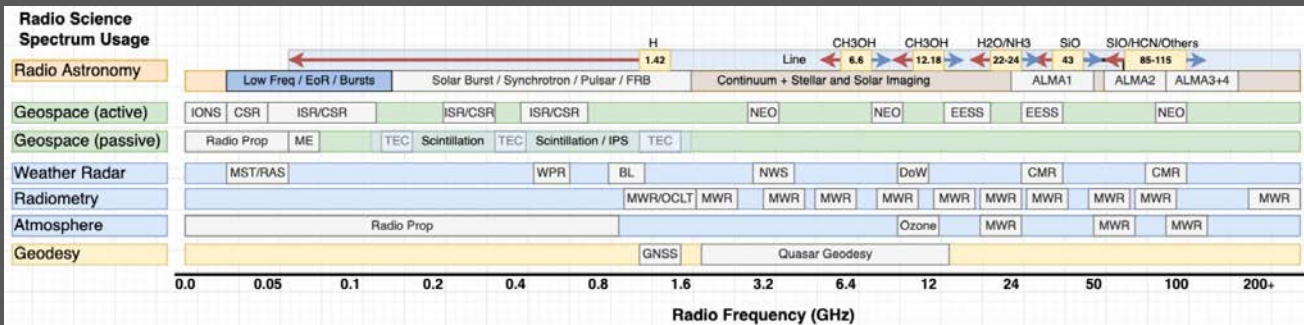
Cas A On-Off taken with the Westford antenna

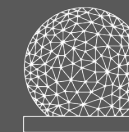


Maser W3(OH) taken with the Westford antenna



Westford Antenna

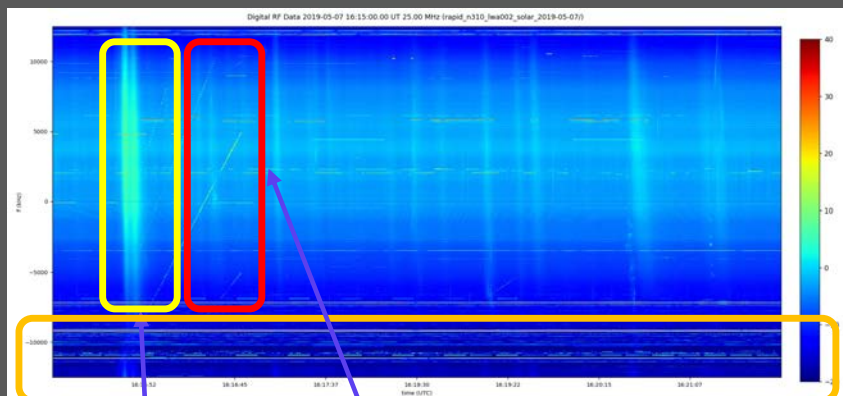




What is RFI?

- Different properties
 - Non-thermal origin
 - Variable in time: persistent, intermittent, burst-like
 - In space: stationary, mobile
 - In spectrum: narrowband, broadband
 - In polarization: horizontal, vertical, circular
- Different sources
 - Phones, IoT
 - Radio Tower
 - Radar
 - Satellites
 - Other (steering motors, kitchen microwave, switching power supplies)

RAPID Recording of Solar Radio Burst



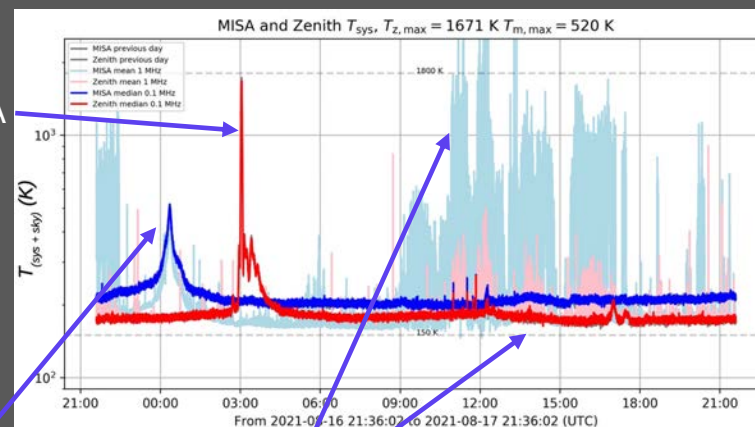
Solar Radio Burst

RFI: Radar

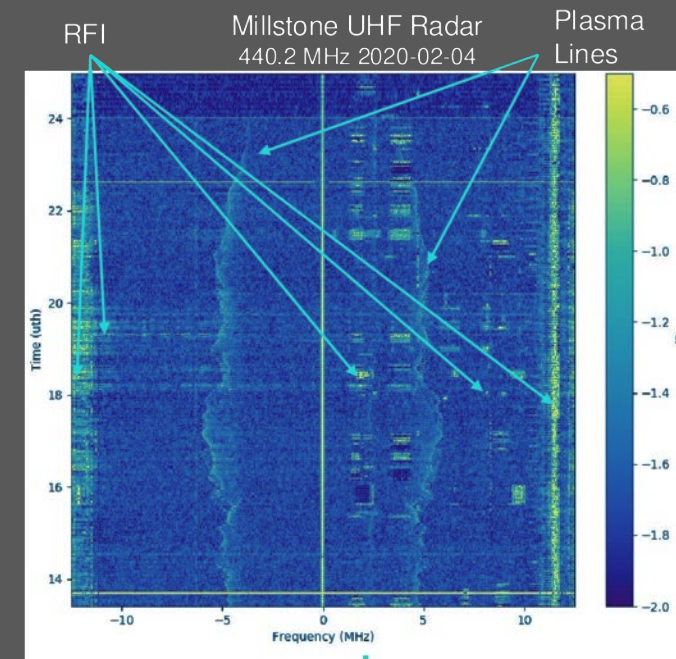
RFI: Power Regulators

Cygnus A

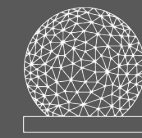
Sagittarius



RFI



What is RFI?

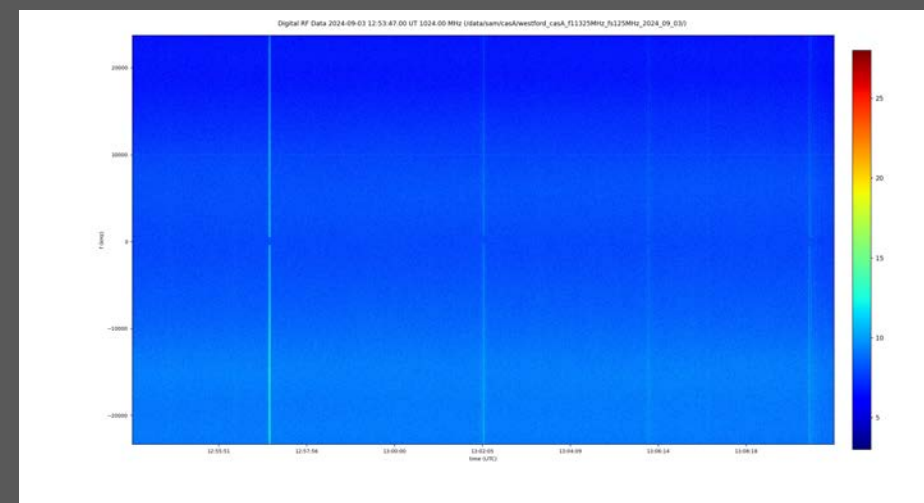
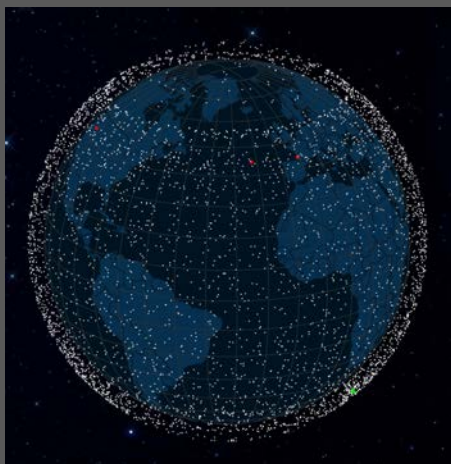
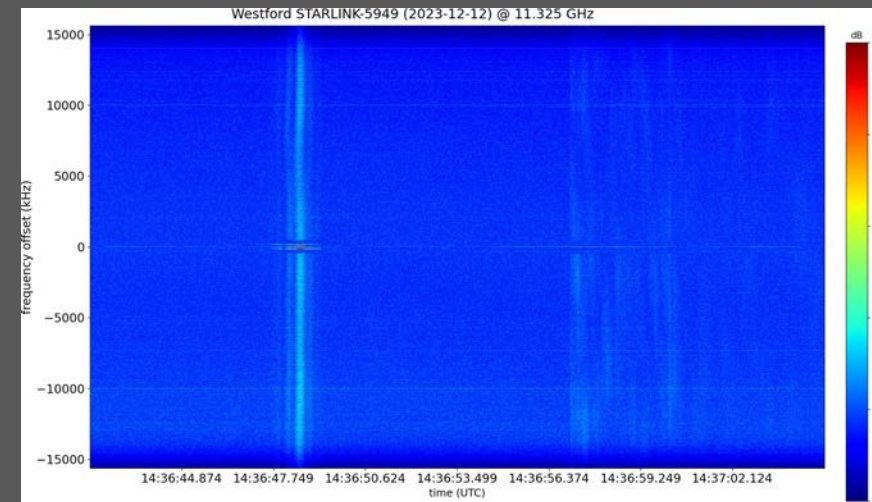
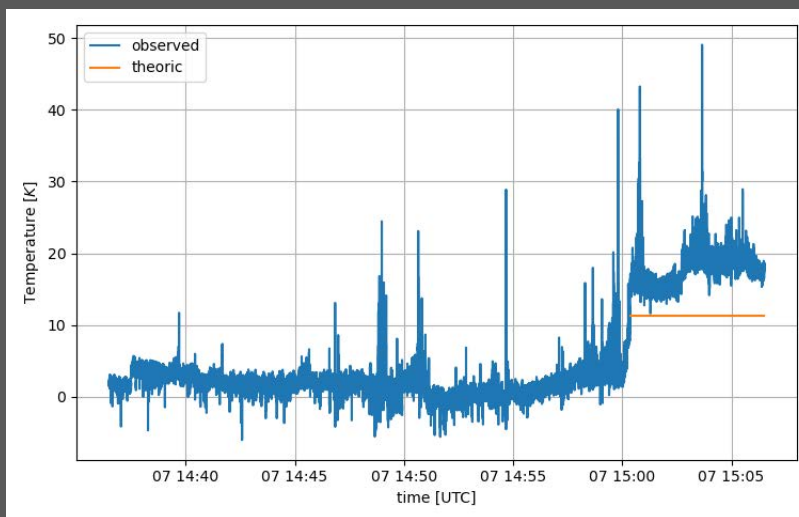


- steering motors, kitchen microwave, switching power supplies.

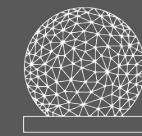


What is RFI?

- Low-Earth Orbit (LEO) satellites

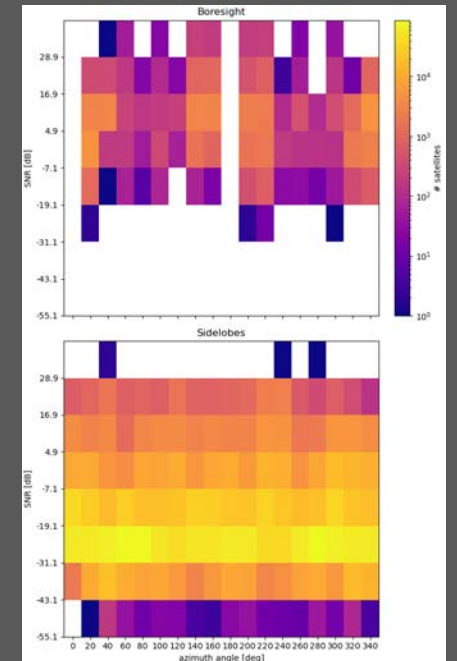
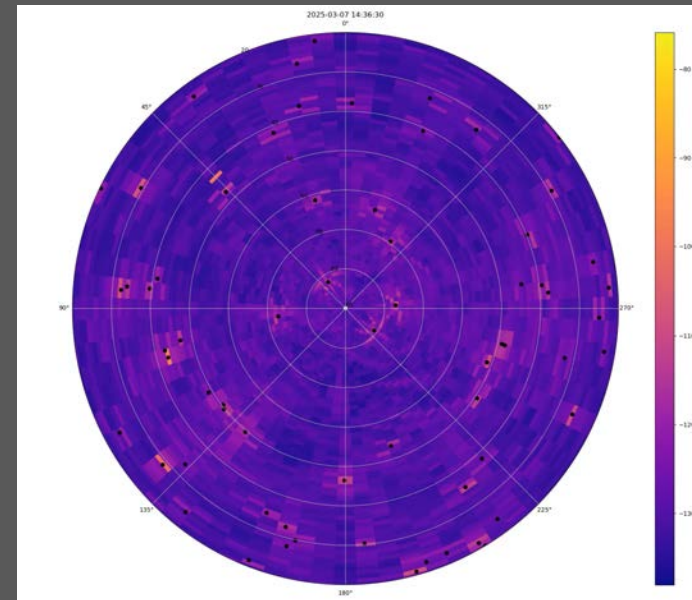
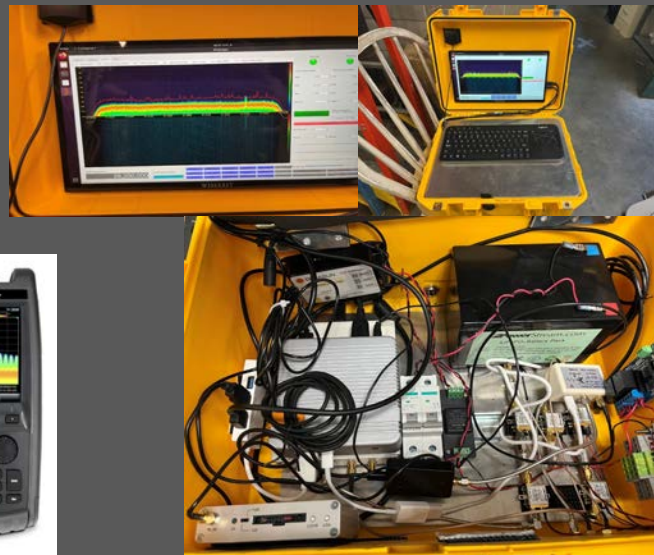


Monitoring and Detecting RFI

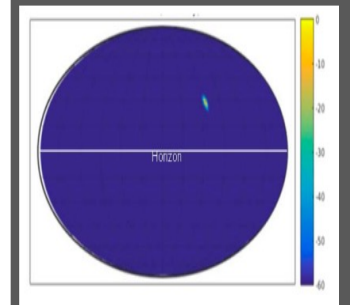
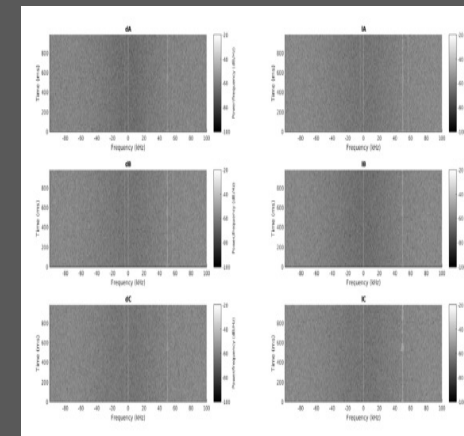
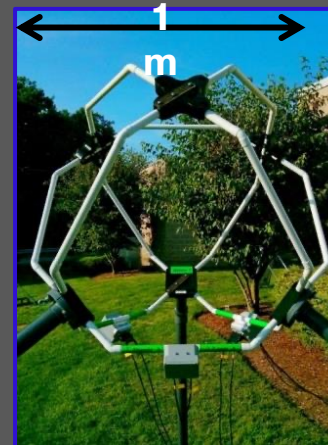


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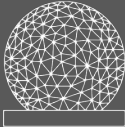
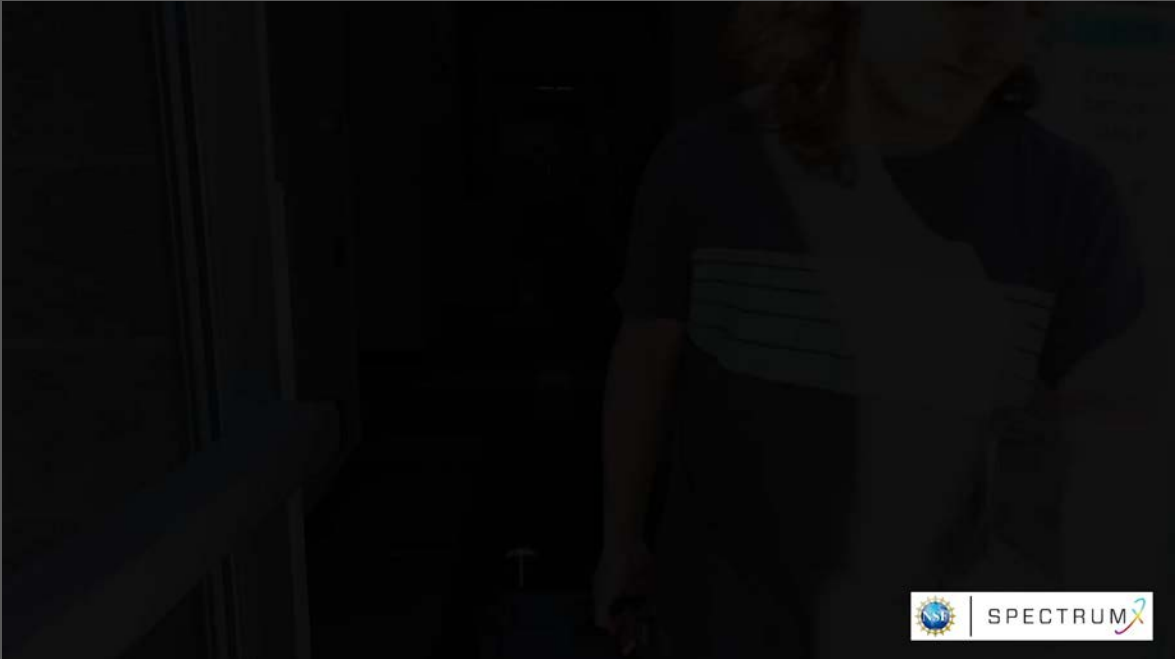
- Modeling:
 - Positions of satellites
 - Link budget between known sources
 - Account for sidelobes interactions
- Measuring:
 - Different Antennas
 - TinySA, FieldFox
 - SDR
 - HF box



Atom Antenna



Monitoring and detecting RFI



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Who We Are

A diverse and interdisciplinary group of scientists, engineers, and educators with backgrounds in EE, CS, Aero, Astronomy, Geoscience, Economics, Policy, and Workforce Development.

What We Do

Conduct strategic research and workforce development projects to transform spectrum management.

Why It Matters

Radio frequency spectrum has become a vital resource in need of balance that can be achieved through innovative advancements in policy and technology.

Collaboration is Key to the SpectrumX Mission



30
Partner
Institutions

56
Researchers
and Staff

82
Students

12
Active
Collaborations

RC - Economics,
Rights, & Policy

RC - Technology &
Measurements

RC - Models,
Algorithms, & AI/ML

Research
Communities (RC)

FP1 - Spectrum
Awareness

FP2 - Scientific
Coexistence

Flagship Projects
(FP)

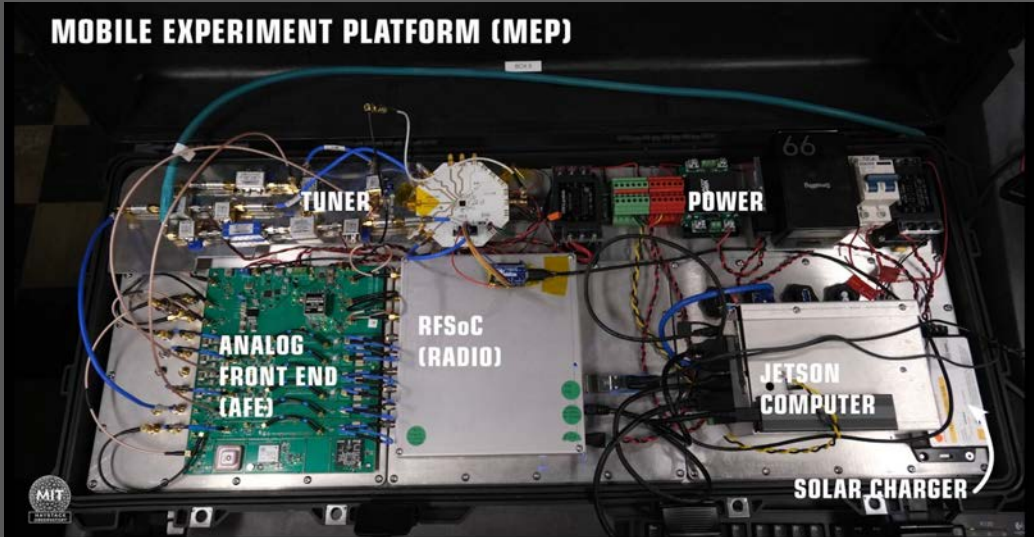
5G Sharing

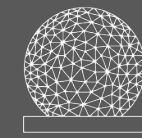
Valued-Based
Spectrum Mgmt

AI/ML for Spectrum
Mgmt

Interference
Analysis

NTIA Liaisons





What's next for telescope users?

- Remote location no longer an option
- Robust receiver
- Policies, Spectrum Management
- Mitigation and coexistence