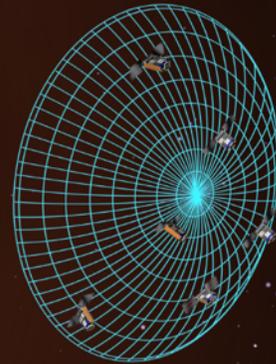


Jet Propulsion Laboratory
California Institute of Technology



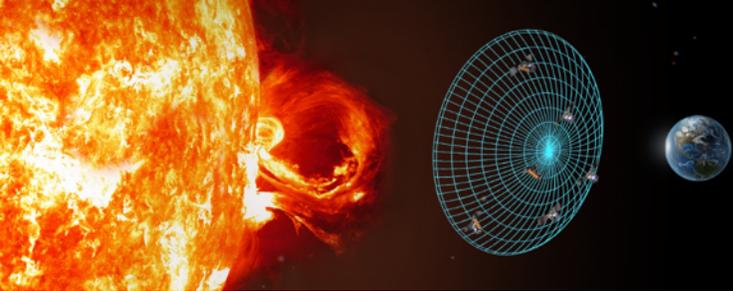
The SunRISE Observatory

Andrew Romero-Wolf
Jet Propulsion Laboratory,
California Institute of Technology
on behalf of the SunRISE Team
December 13, 2018



Sun Radio Interferometer
Space Experiment

PRINCIPAL INVESTIGATOR: Justin C. Kasper (University of Michigan)

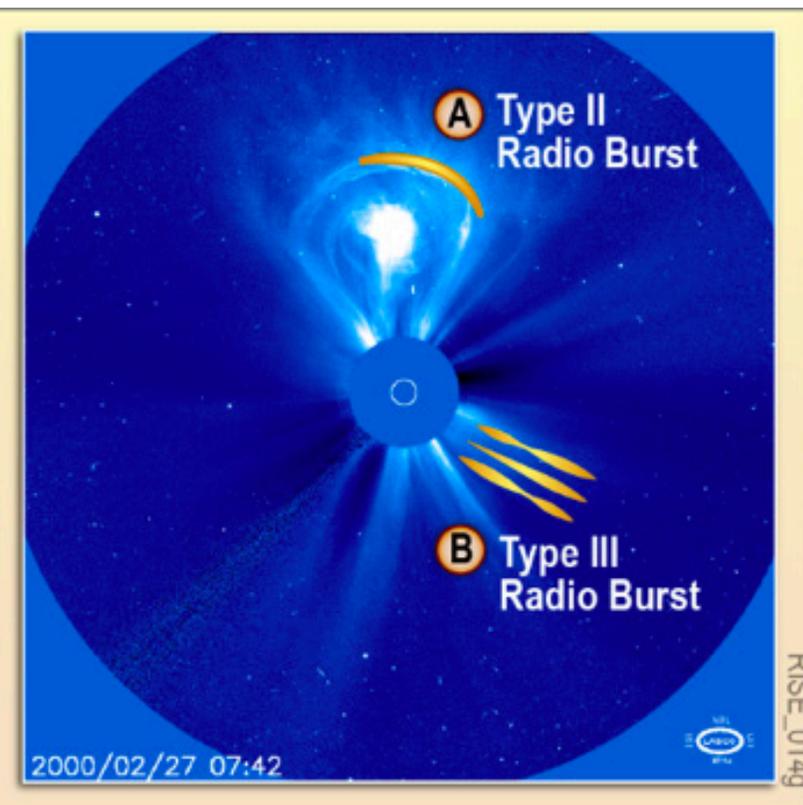
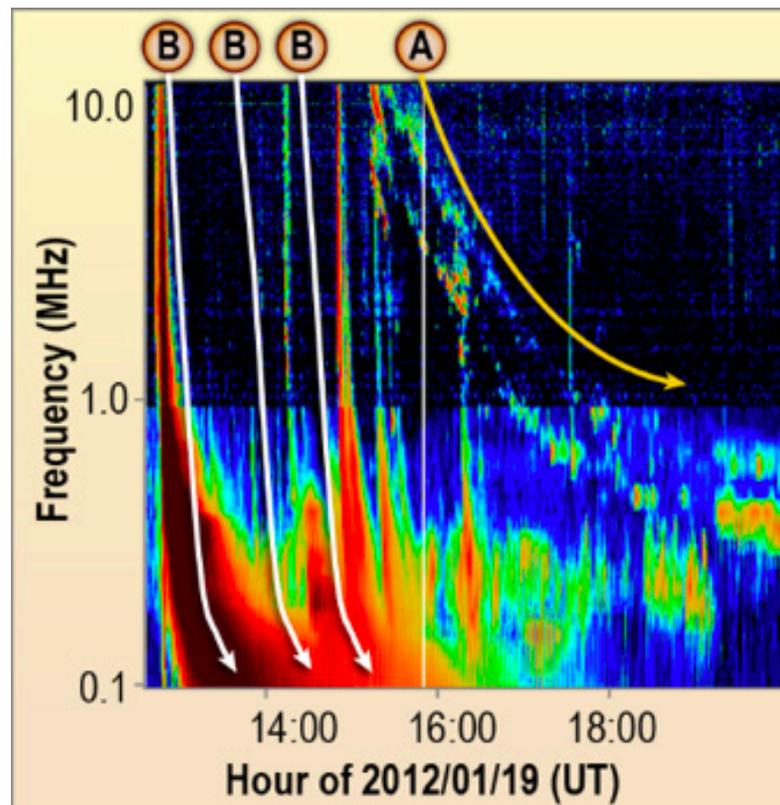


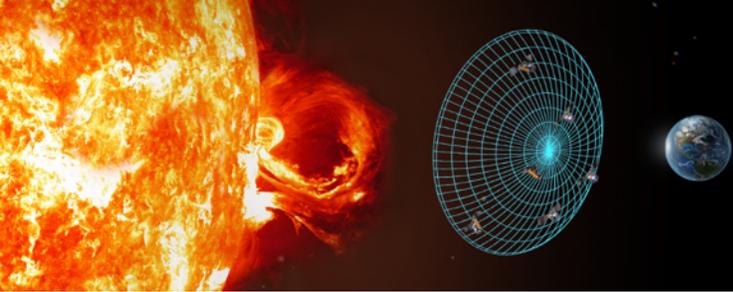
Science



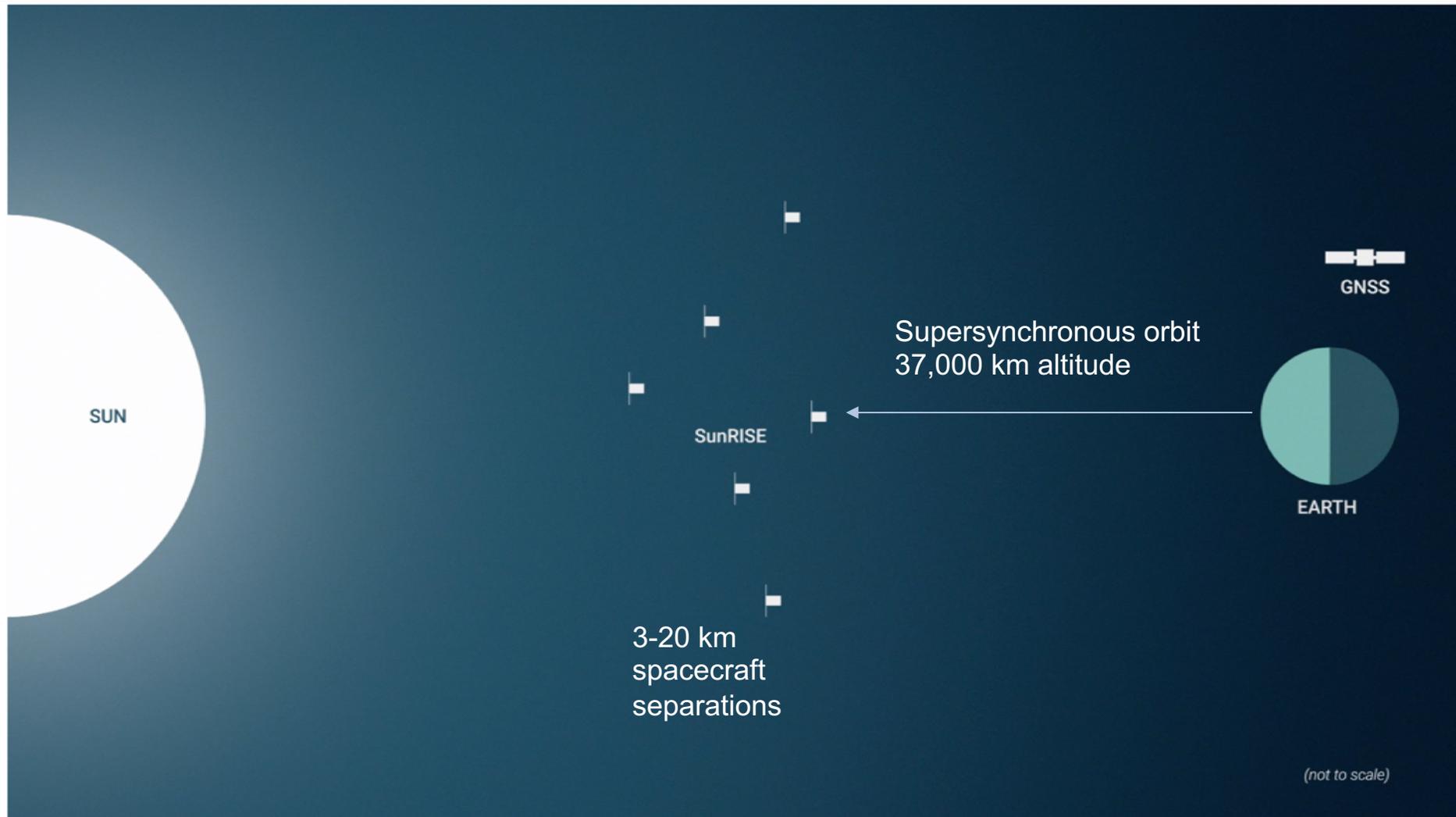
Sun Radio Interferometer
Space Experiment

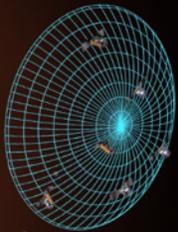
- SunRISE: Sun Radio Interferometer Space Experiment
- SunRISE localizes the radio emission as a function of time and frequency.
- Designed to discriminate competing hypotheses for:
 - The generation of solar energetic particles
 - The variable magnetic connection between active regions and the inner heliosphere.





Observatory

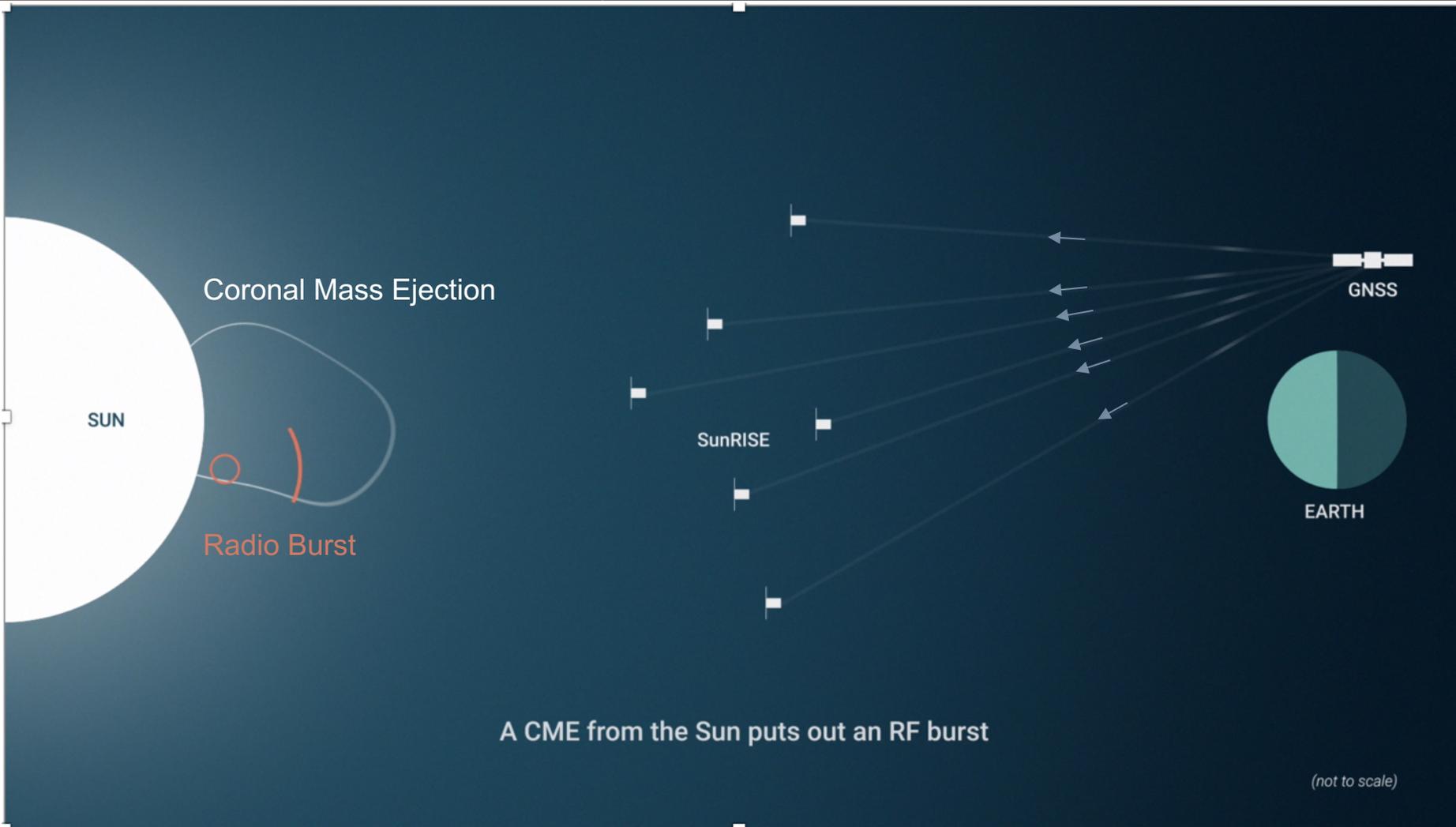


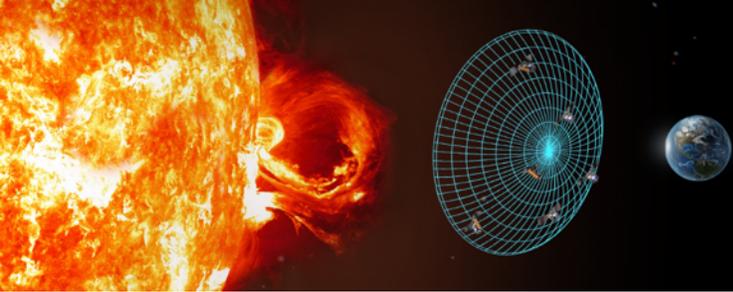


Observatory

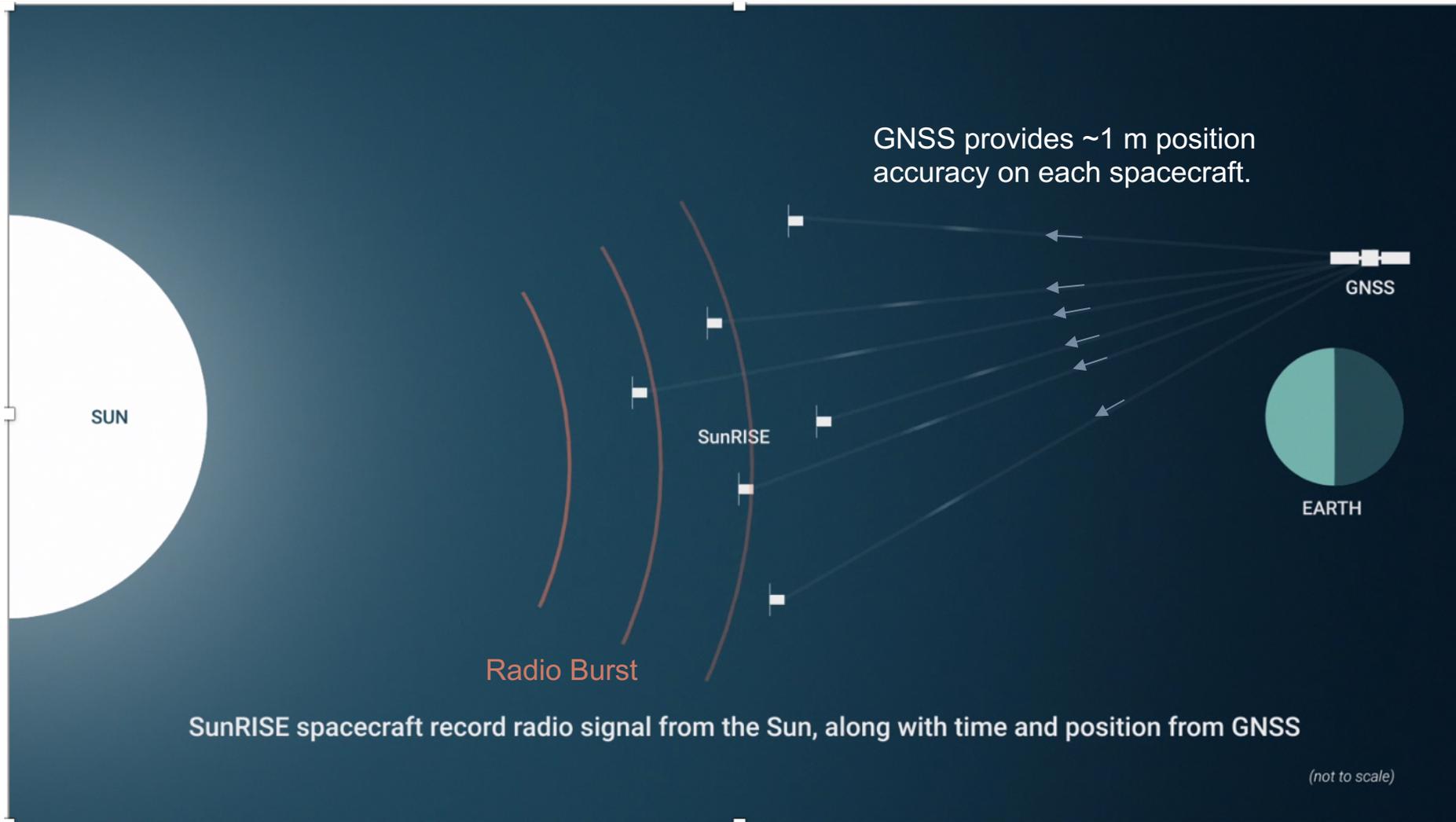


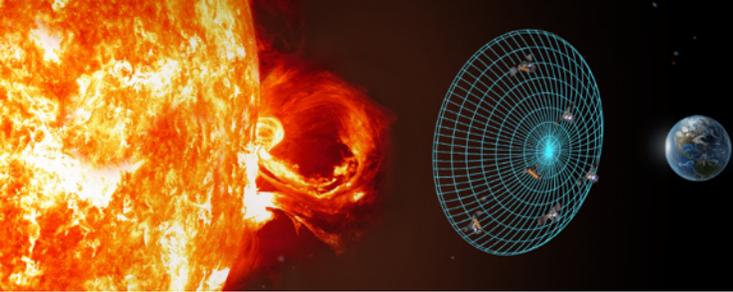
Sun Radio Interferometer
Space Experiment





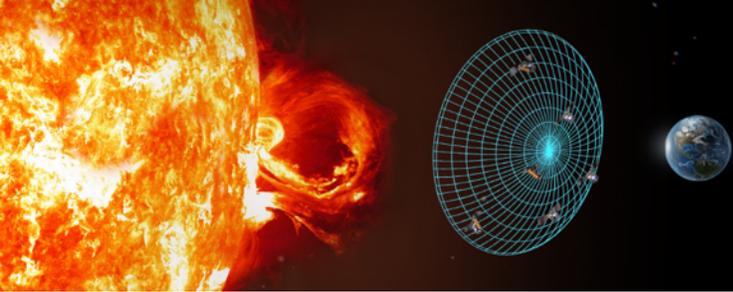
Observatory





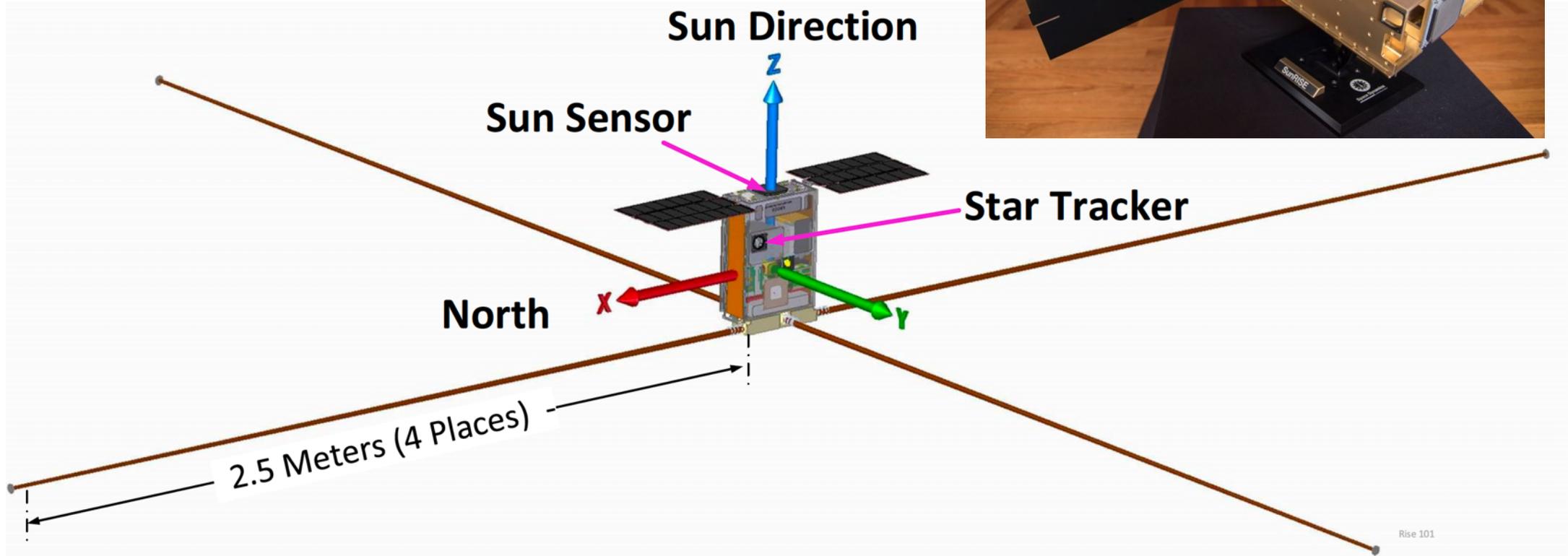
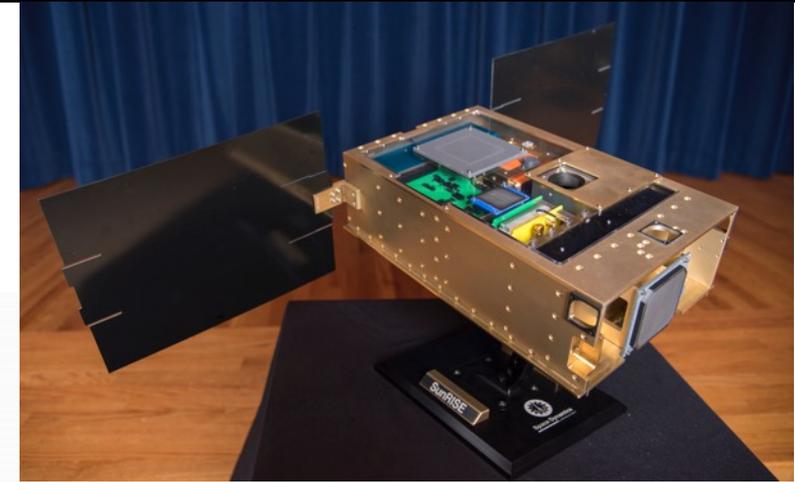
Observatory

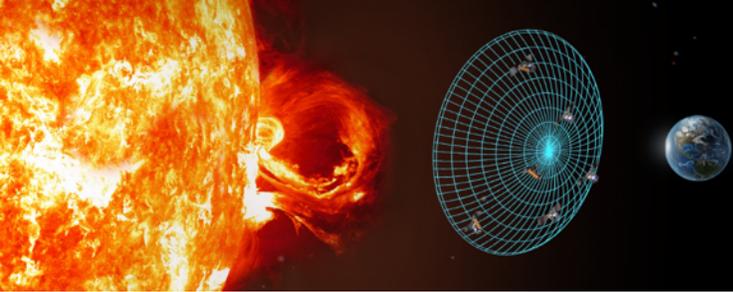




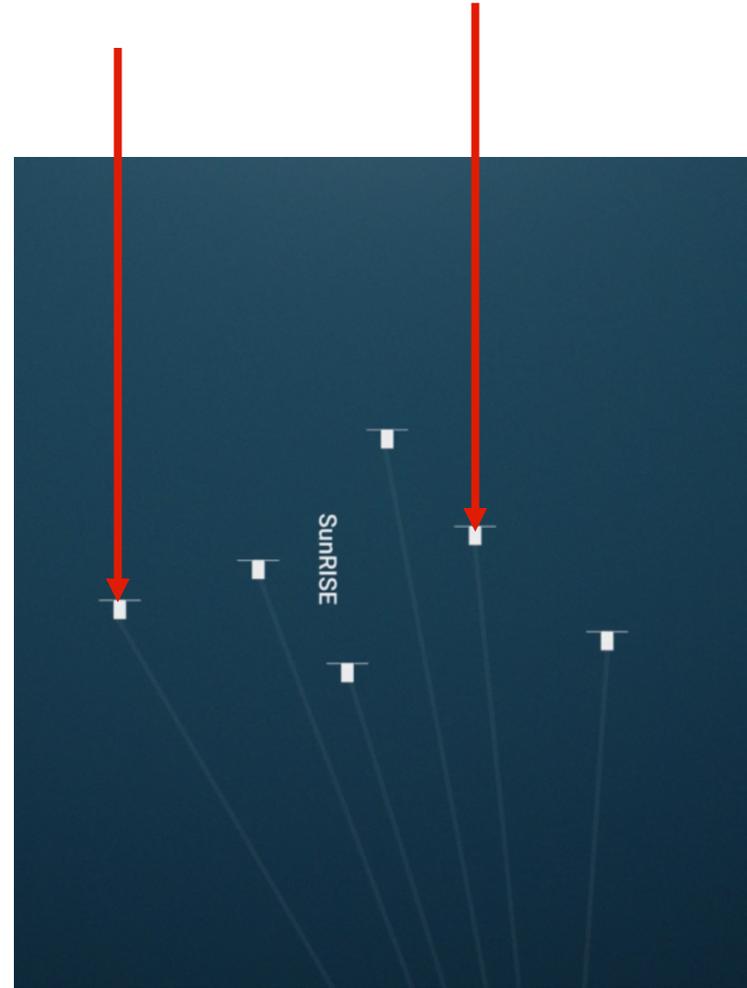
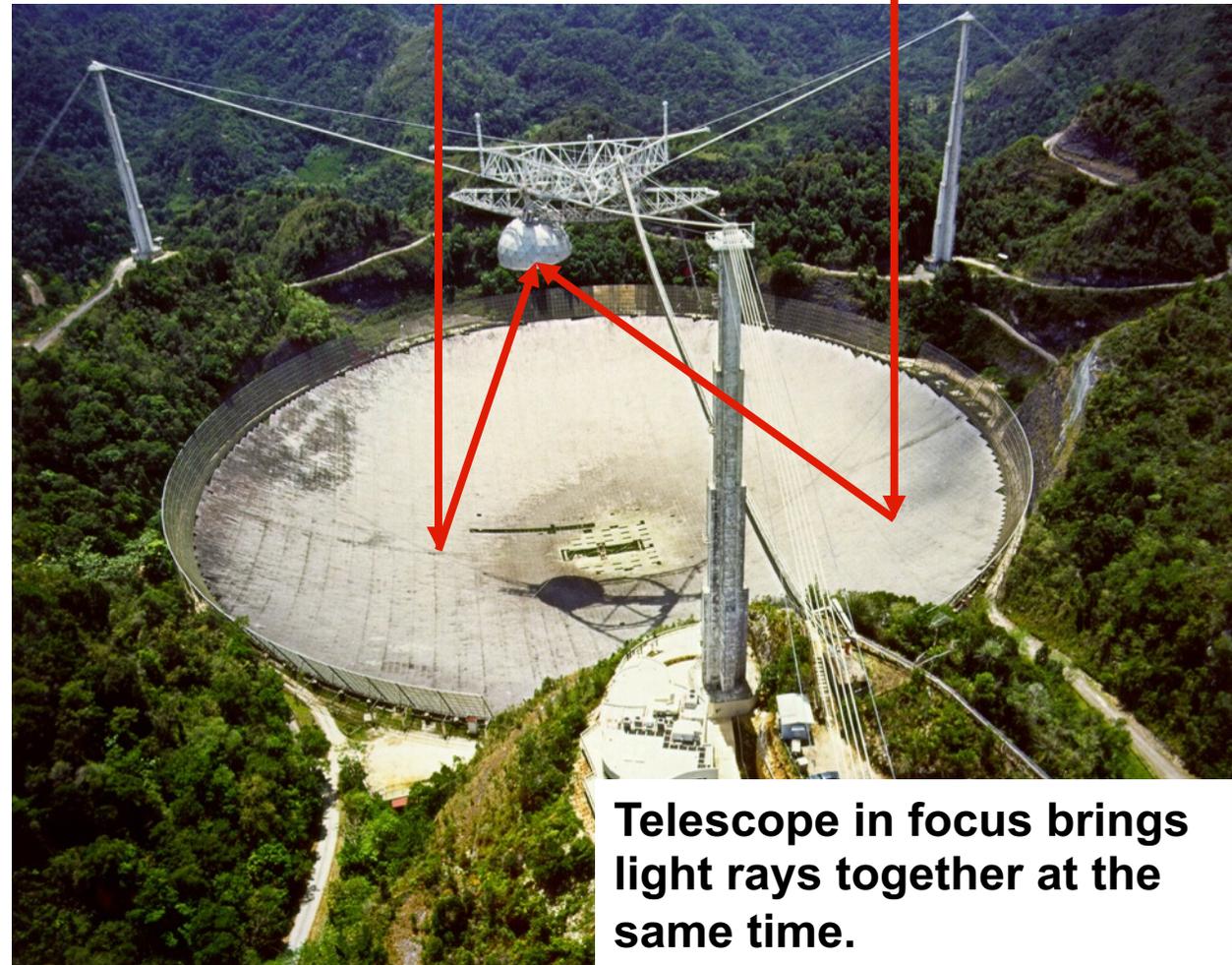
SunRISE Spacecraft

- Electrically short antenna for 0.1-25 MHz deca-hectometric (DH) receiver.
- Dual-polarized receiver.
- Integrated DH and GNSS receiver fits in 6U CubeSat form factor.

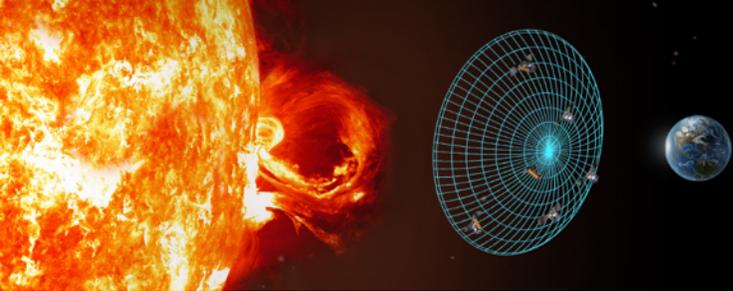




Building the SunRISE Telescope

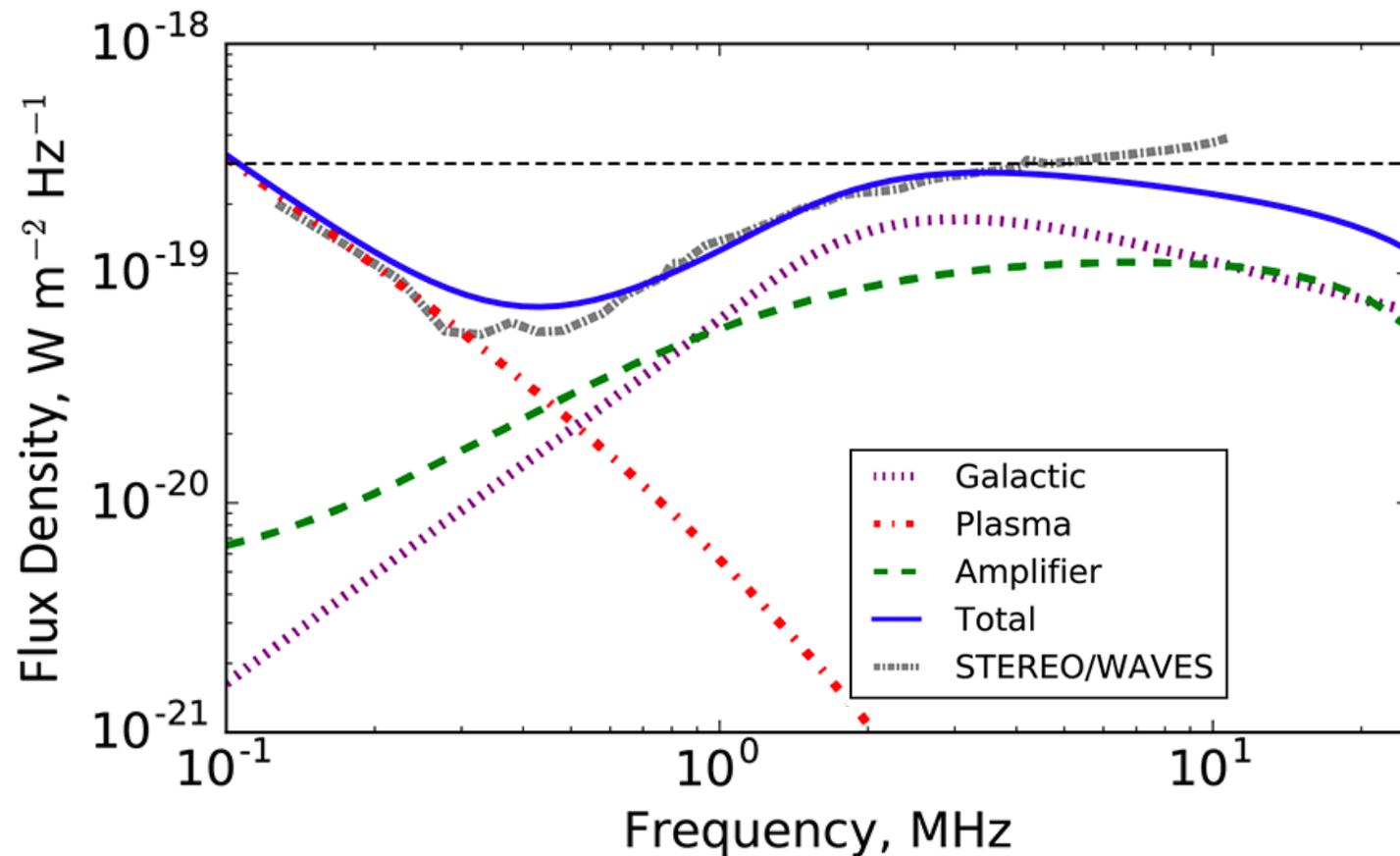


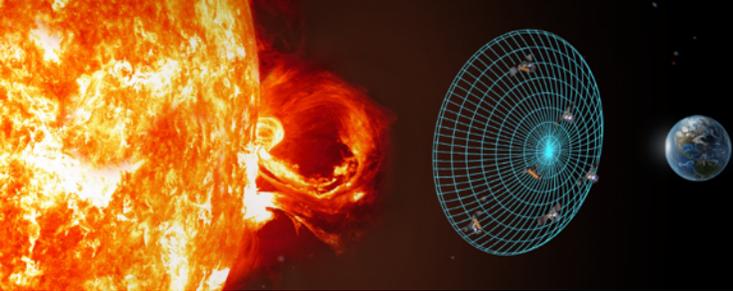
1. Record Solar DH (amplitude, phase) and GNSS
2. Send to ground
3. “Play back,” multiplying signals together with delay.



Sensitivity

- Each “snapshot” (0.66 ms integration time, 6.1 kHz bandwidth) is background noise limited.
- SunRISE sensitivity is comparable to Wind/WAVES and the STEREO/WAVES receivers.
- Array: 6 spacecraft, 2 polarizations improves the sensitivity by a factor of 8.5



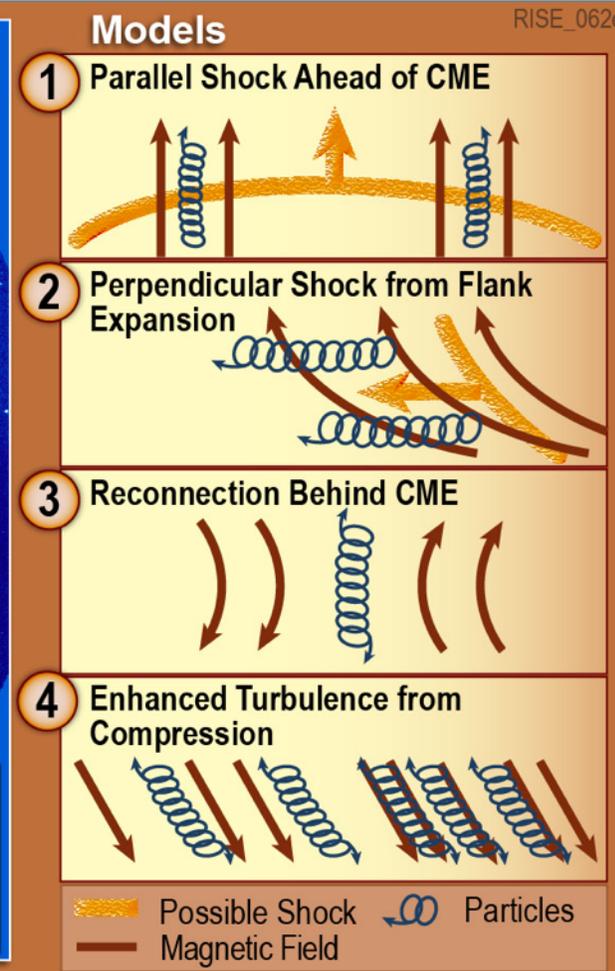
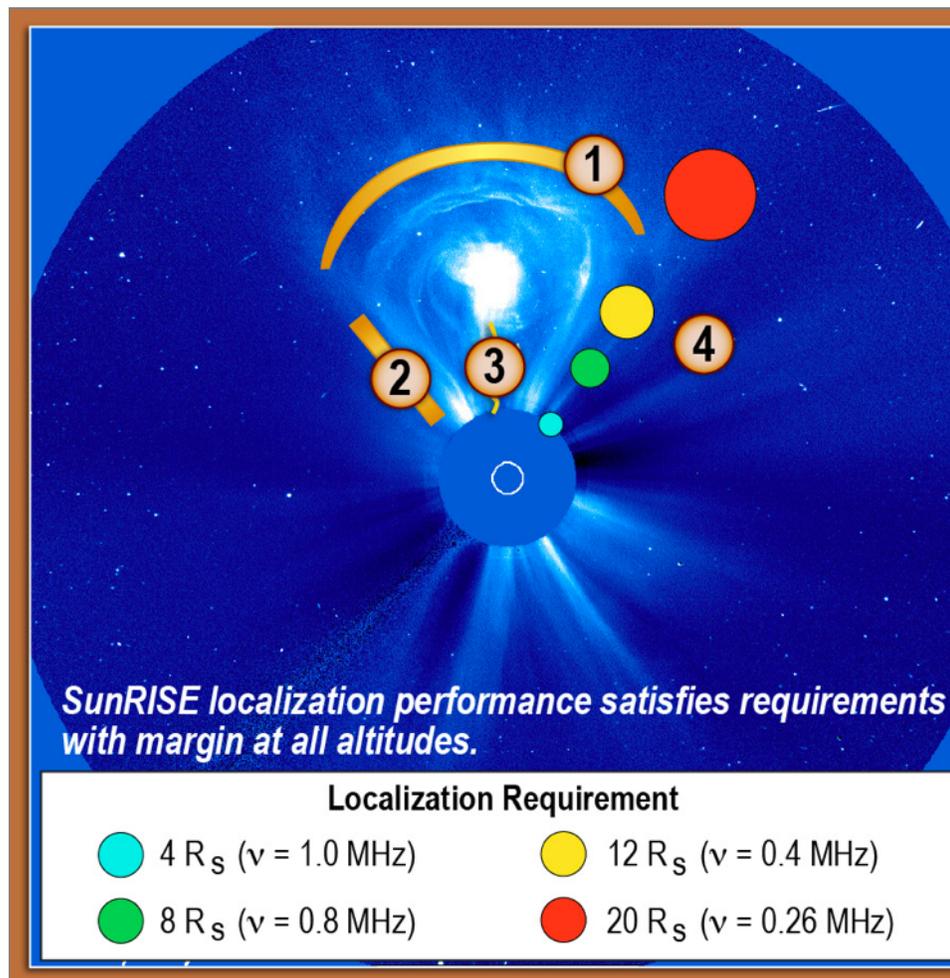


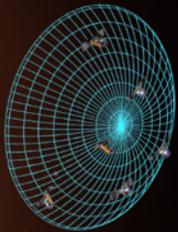
Localization Resolution



Sun Radio Interferometer
Space Experiment

- Localization resolution tuned to discriminate between different hypotheses of the origin of Type II radio bursts.
- Localization resolution determined by array configuration and frequency.
- SunRISE localization resolution ranges from 0.01 – 0.1 degrees (or 0.6 – 6 arcminutes) depending on frequency.

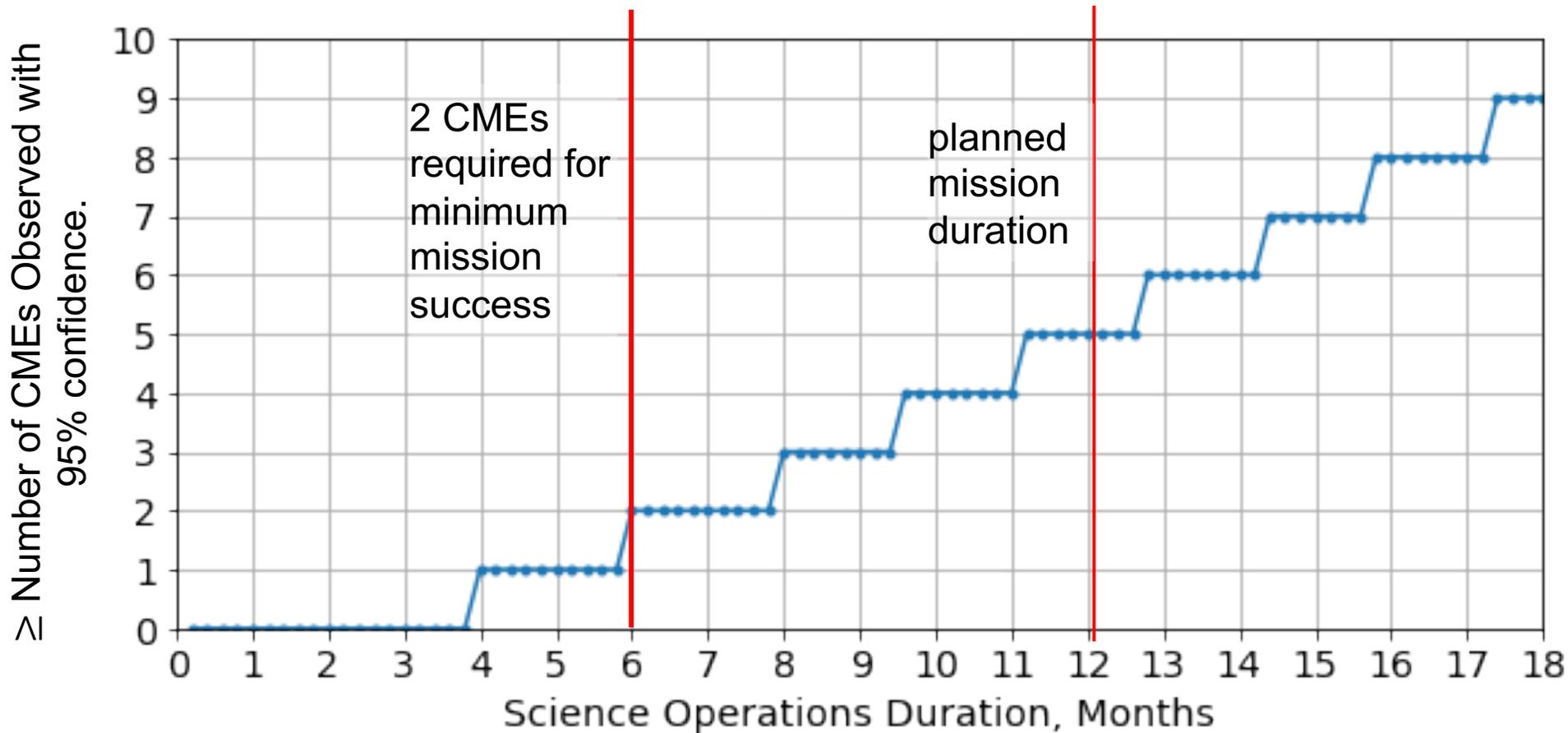


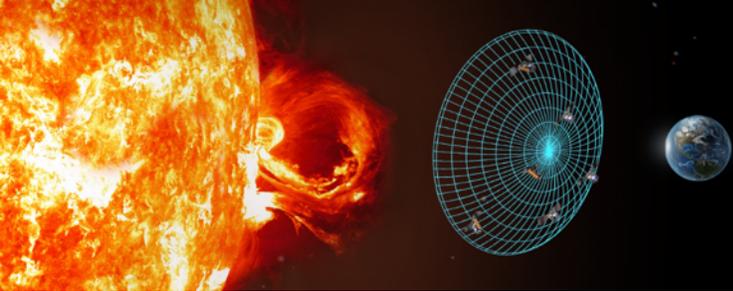


Number of CMEs and Mission Duration



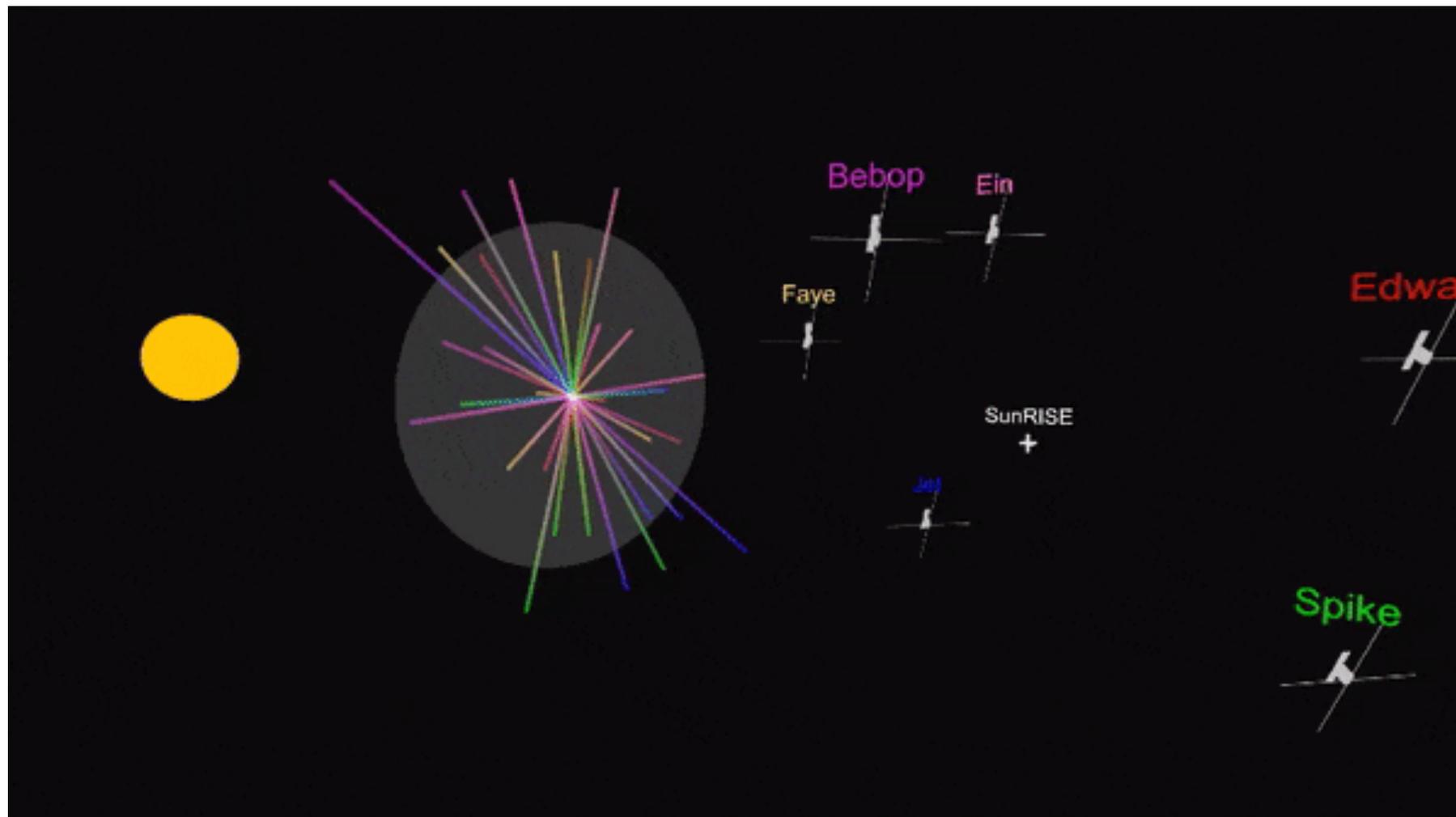
Sun Radio Interferometer
Space Experiment

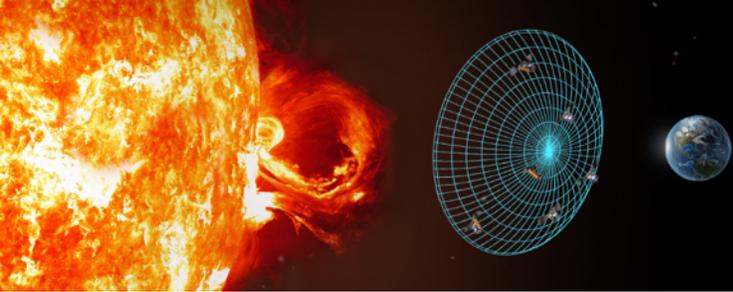




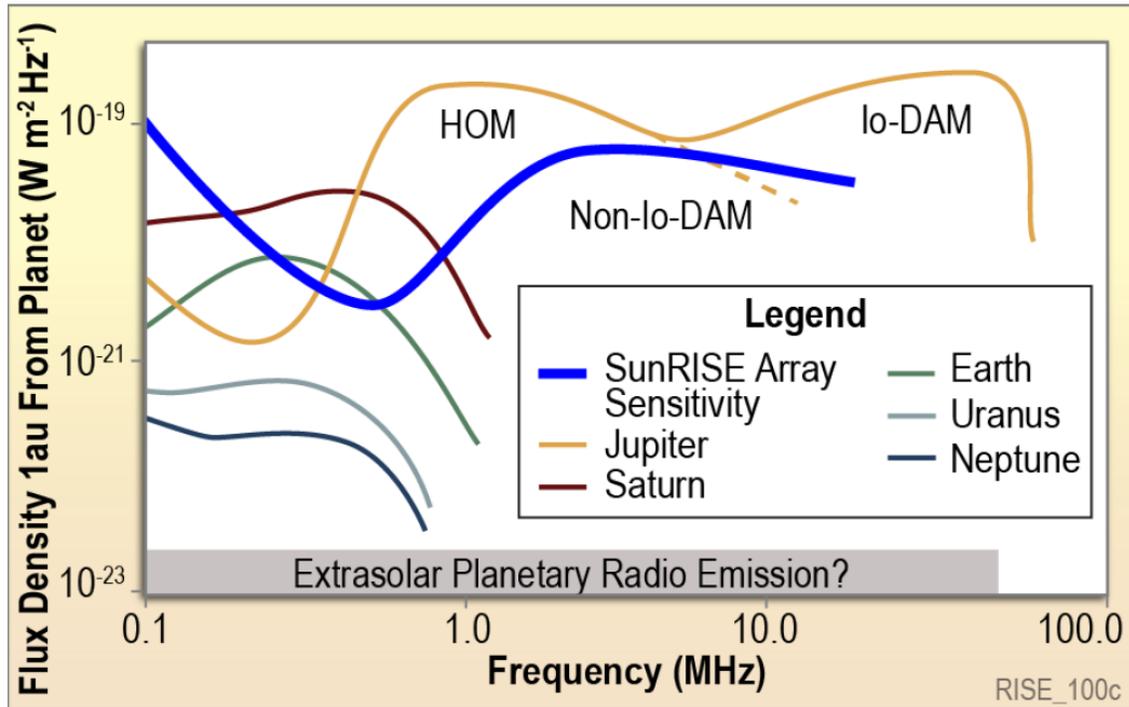
Orbits and Baseline Coverage

- 6.5 km radius disk in the projected plane of the Sun
- SunRISE orbits are designed so that 2 orthogonal projected baseline lengths are >6.5 km.
- This enables the resolution needed.
- SunRISE is a digitally steerable radio telescope allowing for comparable resolution anywhere in the sky.

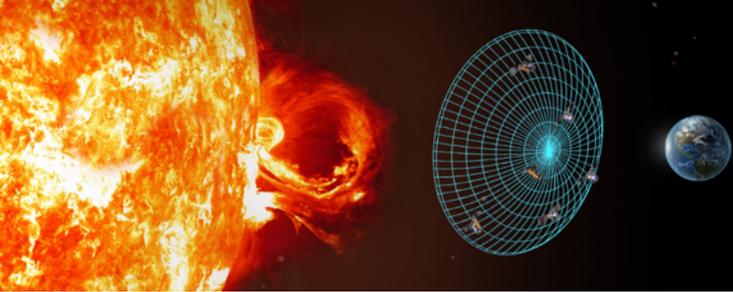




Planetary Science

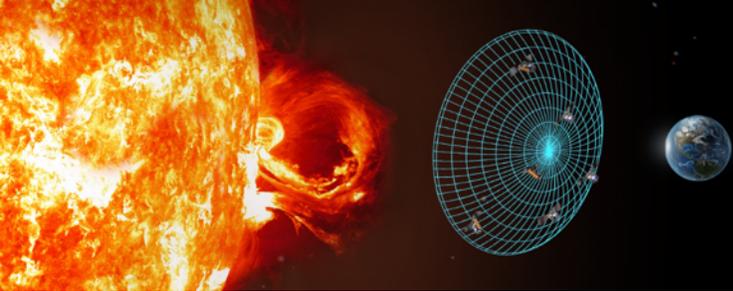


- Typical planetary radio emission seen from 1 au distance compared to SunRISE sensitivity in 1 second, 1 Hz measurement. Ten minute, 2 MHz integrations would be up to 10,000x more sensitive
- Jupiter should be detectable most of the time
- Saturn, Uranus, and Neptune are a stretch but would be very exciting if detected

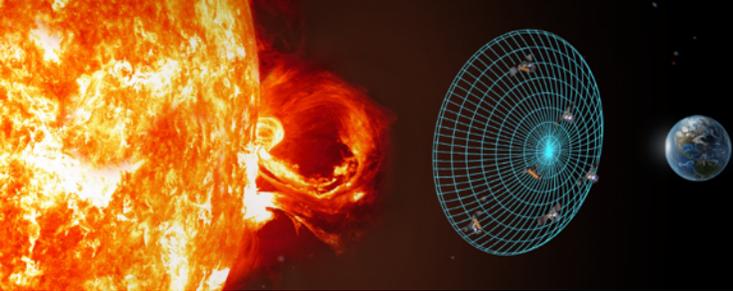


Conclusions

- The SunRISE observatory could be a first of a kind deca-hectometric (DH 0.1-25 MHz) radio space-based interferometer, enabling radio astronomical observations below the ionospheric cutoff.
- The SunRISE observatory would make the first images of DH (0.1-25 MHz) radio emission from solar flares and CMEs.
- SunRISE is a digitally steerable array and the data can be used to image any part of the sky.
- See also:
 - SH51C-2841 “Tracking Solar Type II Bursts with the Sun Radio Interferometer Space Experiment” (Hegedus, et al., Friday, December 14, Poster Hall @ 08:00 - 12:20)
 - SH51A-05 “The Sun Radio Interferometer Space Experiment (SunRISE) Mission Concept” (Kasper, Lazio et al., Friday, 14 December 2018 09:00 - 09:12 Walter E Washington Convention Center - 207B)

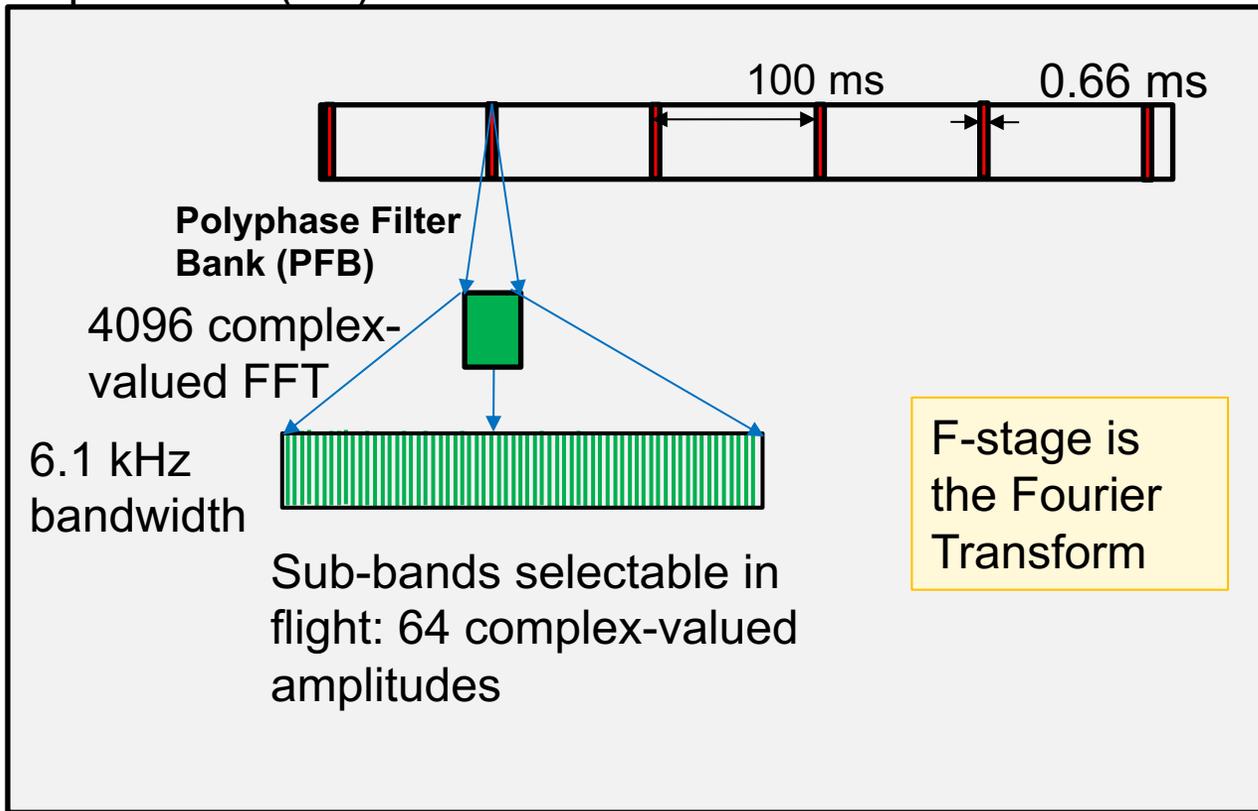


BACKUP



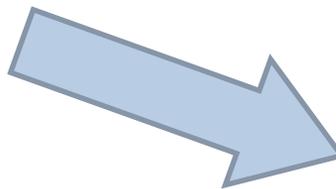
FX Correlation

Spacecraft (×6)



All spacecraft synchronized by GNSS.

Data telemetered to ground



X-stage is the Correlation

Fourier amplitudes are combined to form visibilities to form the CLEANed image.

