



Jet Propulsion Laboratory
California Institute of Technology

The Sun Radio Interferometer Space Experiment (SunRISE)

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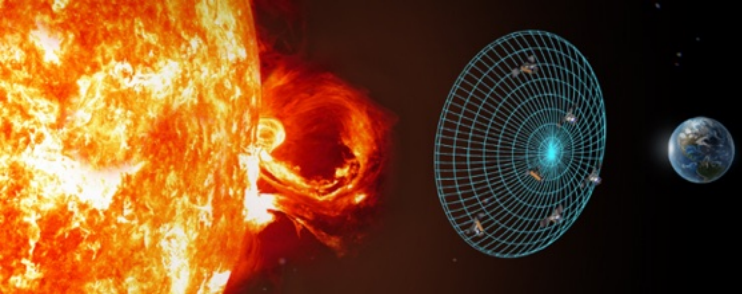
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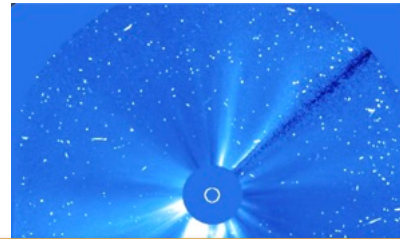
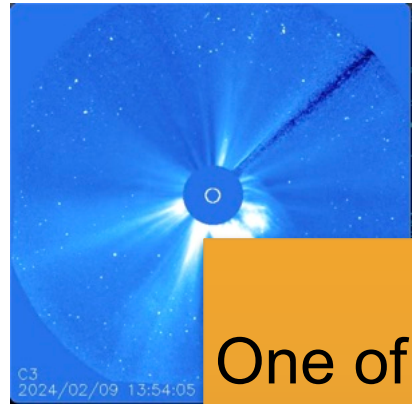


SUNRISE

SUN RADIO INTERFEROMETER SPACE EXPERIMENT



Particle Acceleration

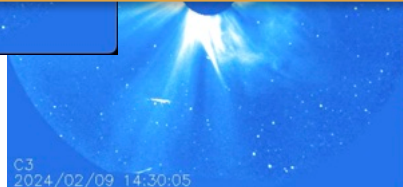


One of the greatest scientific challenges in Heliophysics is to understand how magnetic energy in the corona is converted into intense relativistic particles and how they propagate into interplanetary space

- Flares and coronal mass ejections (CMEs)
- CMEs responsible for most intense solar energetic particle (SEP) events, with order 10% of kinetic energy converted into high energy SEPs

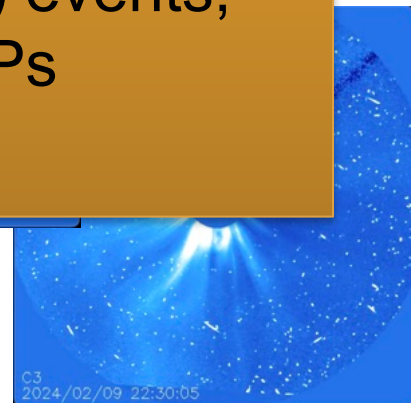
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2024/02/09 14:18:05

C3
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C3
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C3
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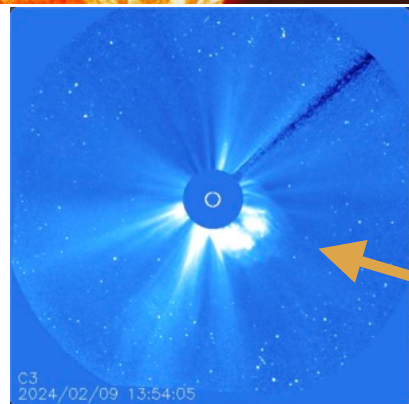
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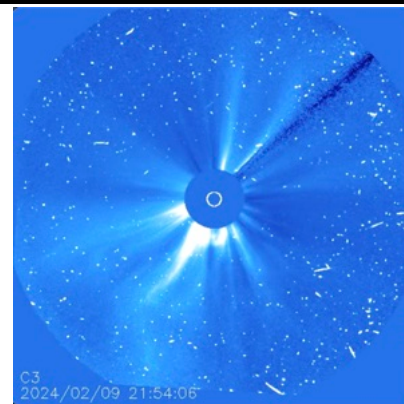
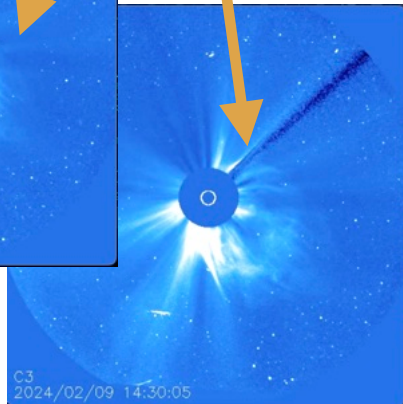
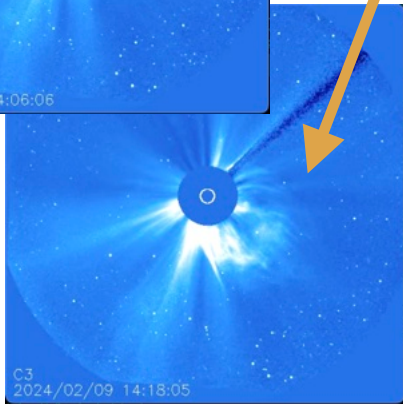
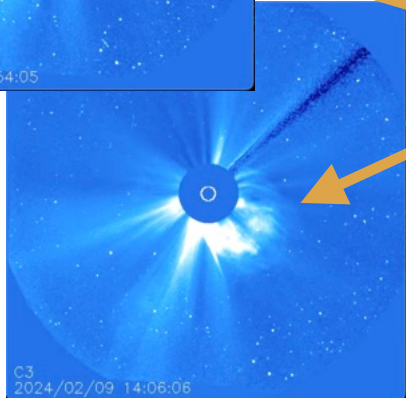
Particle Acceleration



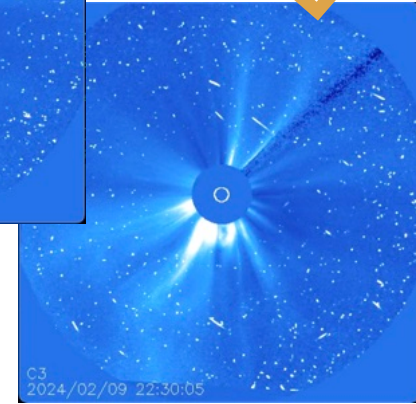
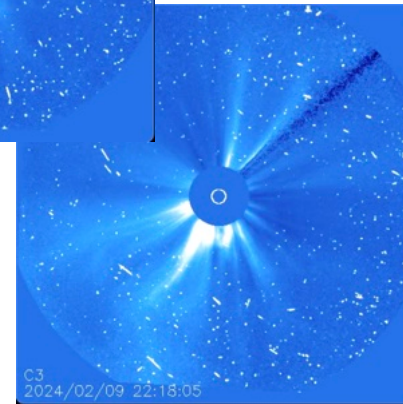
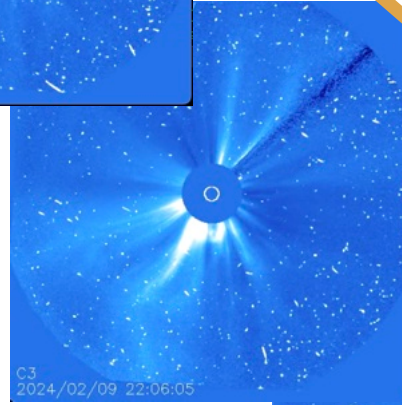
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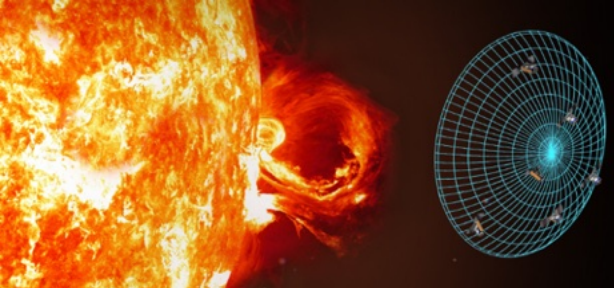


Coronal magnetic ejection (CME) heading toward the Earth ...



"Static" from solar energetic particles (SEPs), accelerated by the CME, hitting camera



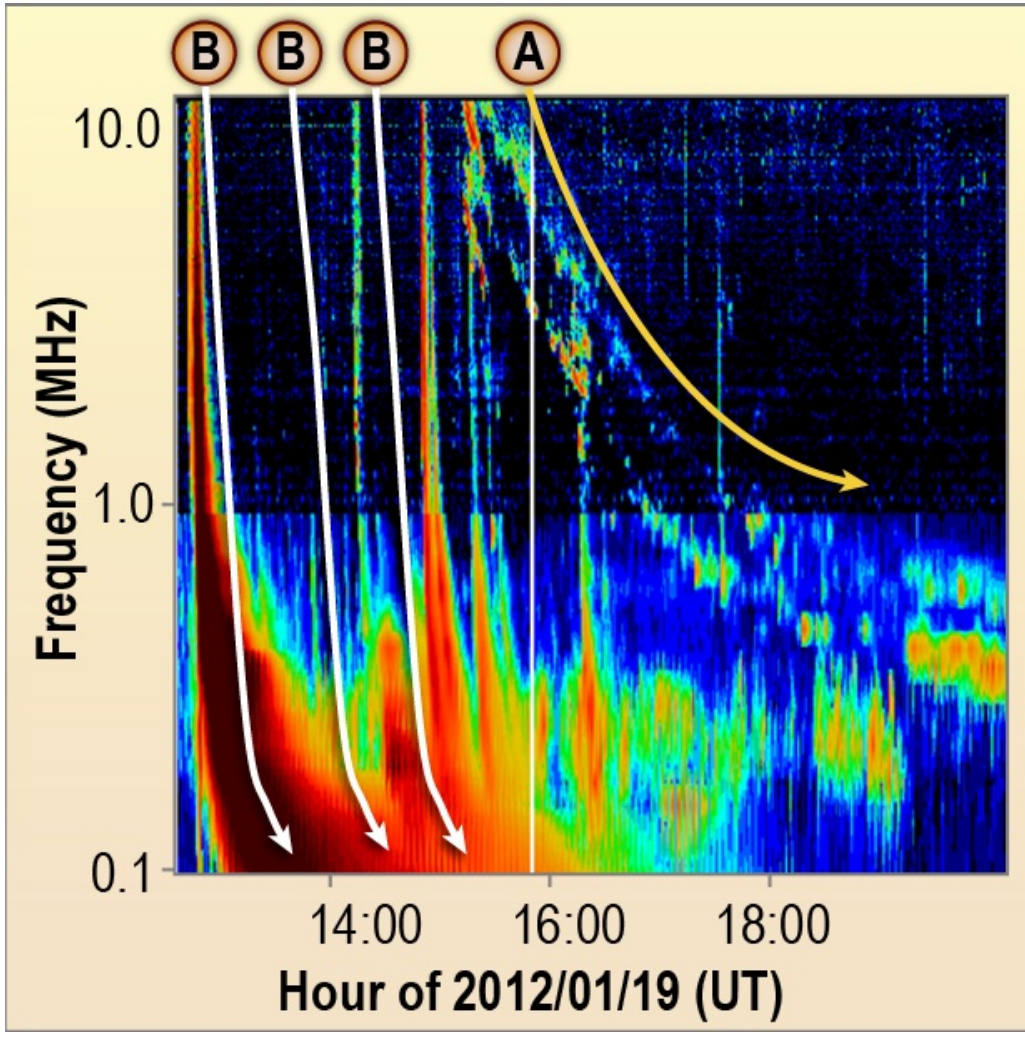


Solar Radio Bursts: Type II and III

A Laboratory in Space



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Type II and III radio bursts first identified ~ 75 yr ago

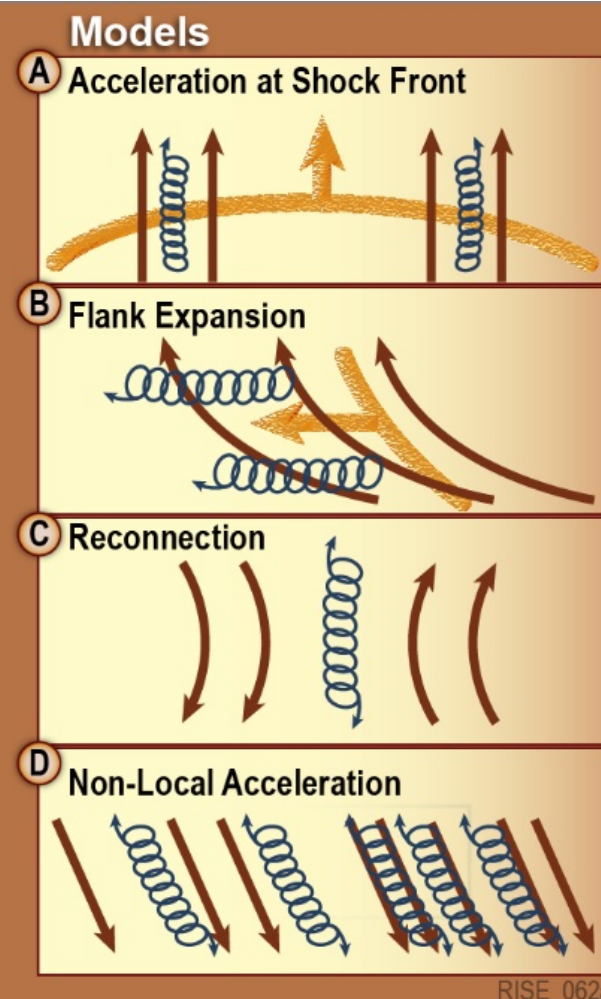
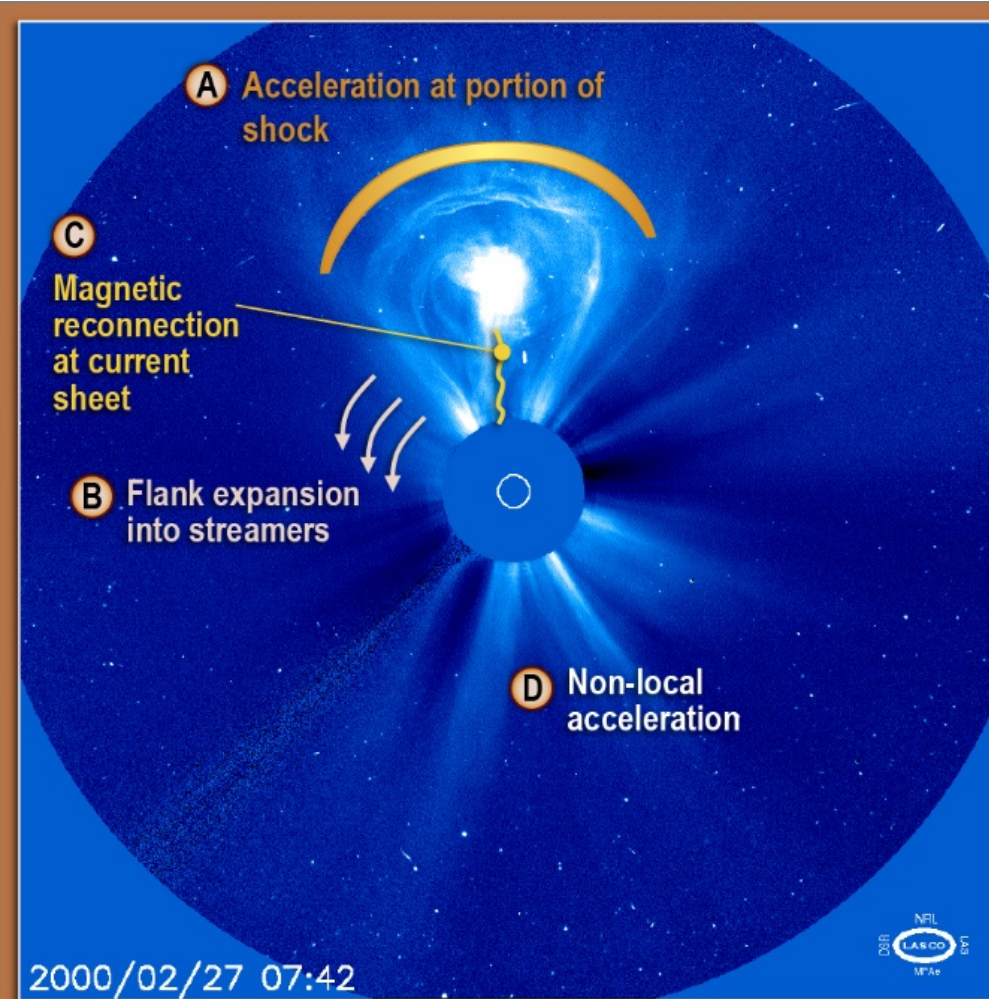
Connection between coronal mass ejections (CMEs), Type II bursts, and solar energetic particles (SEPs) identified ~ 25 yr ago

➔ Those CMEs that produce SEP events produce Type II bursts first (Gopalswamy et al. 2001, 2008), though not every Type II burst is associated with an SEP event.

Classes of Models for Ion and Electron Acceleration by Coronal Mass Ejections

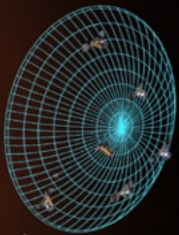


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Discriminate between different classes of models

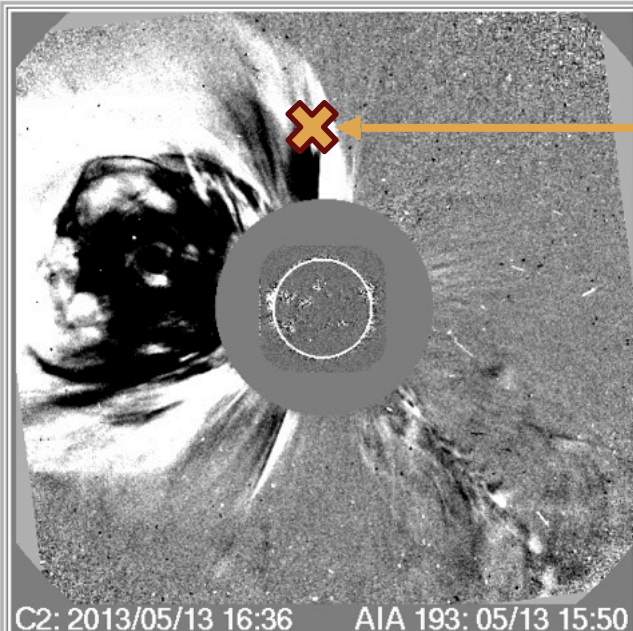
- A.** Shock and compression acceleration in front of CME expanding into corona (quasi-parallel acceleration)
- B.** Shock and compression acceleration on CME flanks expanding laterally (quasi-perpendicular acceleration)
- C.** Magnetic reconnection at current sheets formed behind ejecta
- D.** Non-local process occurring as plasma is diverted and compressed by expanding CME



Localization of Radio Emission! Need Space-based Imaging



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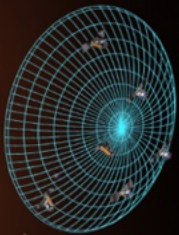


[Radio Image of
Inner Heliosphere
below 15 MHz]



Can make radio images
from ground ...
but radio frequencies are
too high to probe where
particles are accelerated

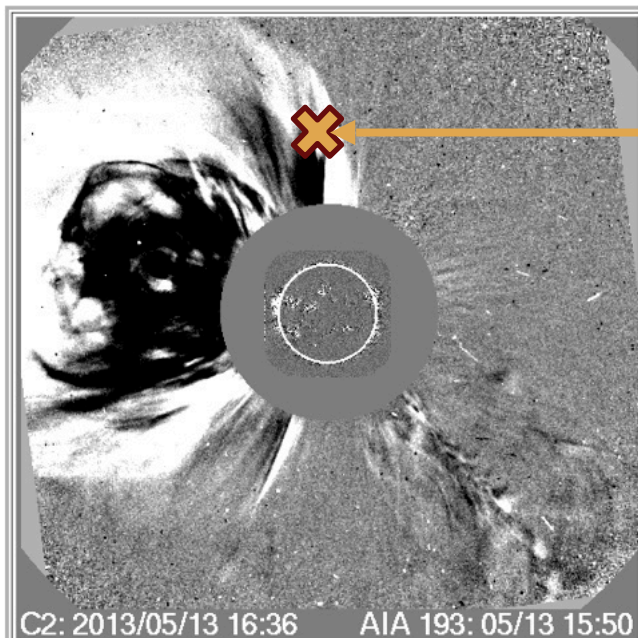
80 MHz Gauribidanur image
(Hariharan et al. 2014)



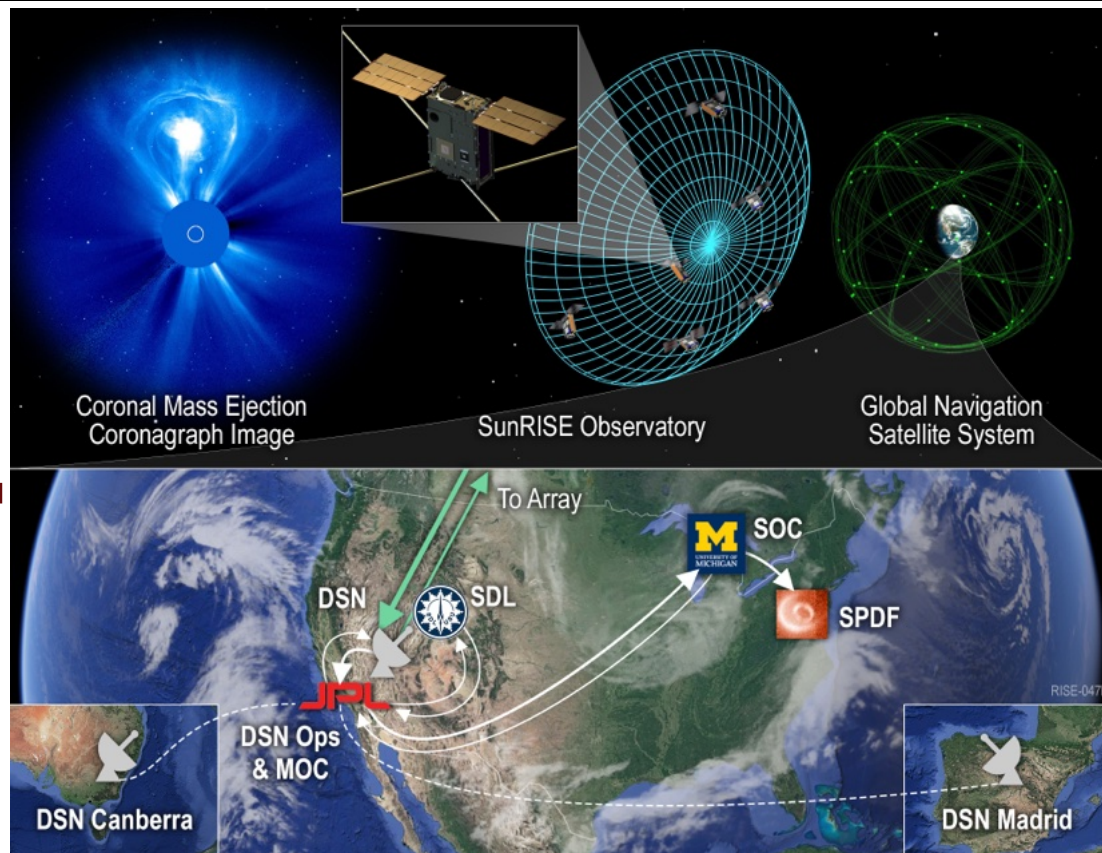
Localization of Radio Emission!



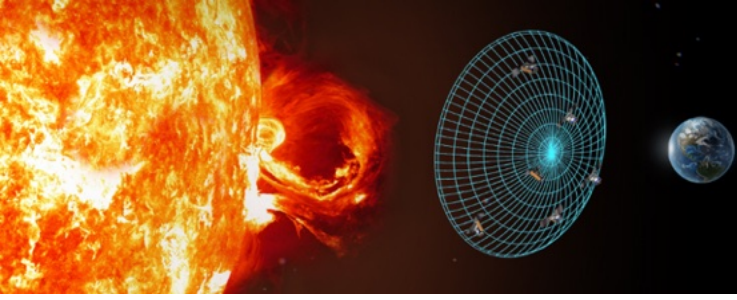
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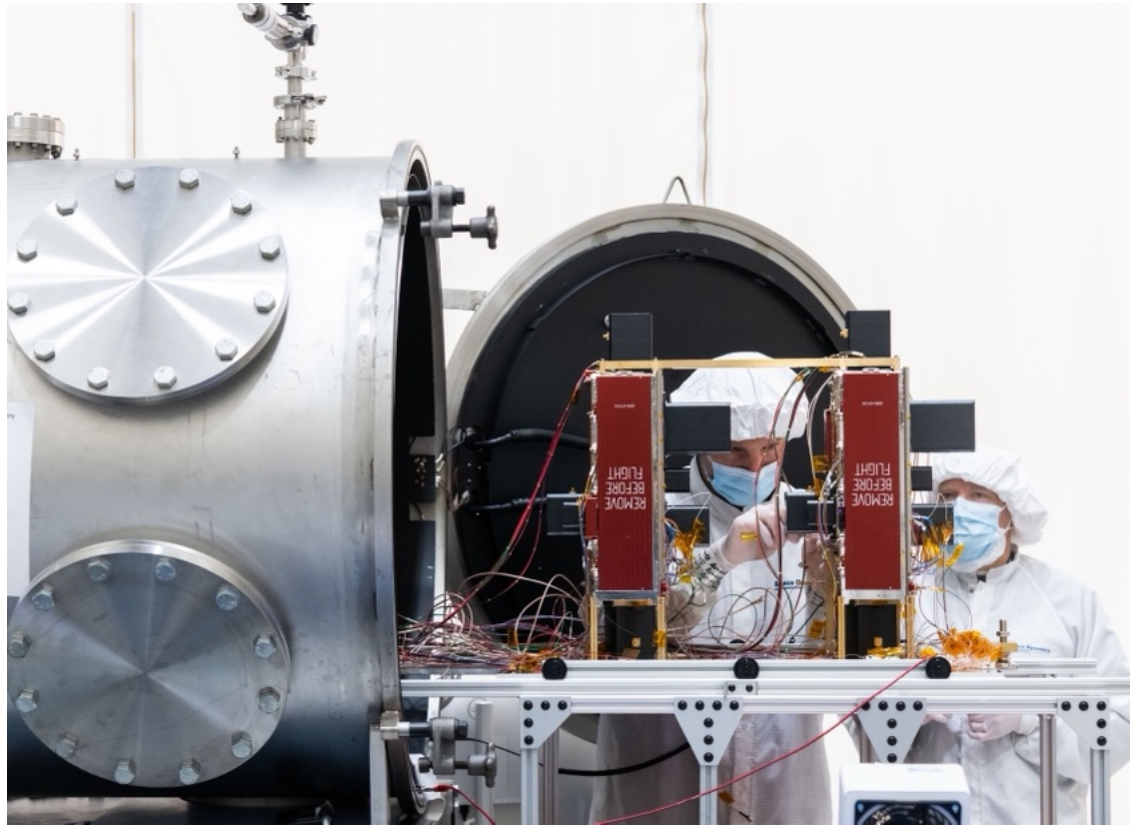
[Radio Image of Inner Heliosphere]



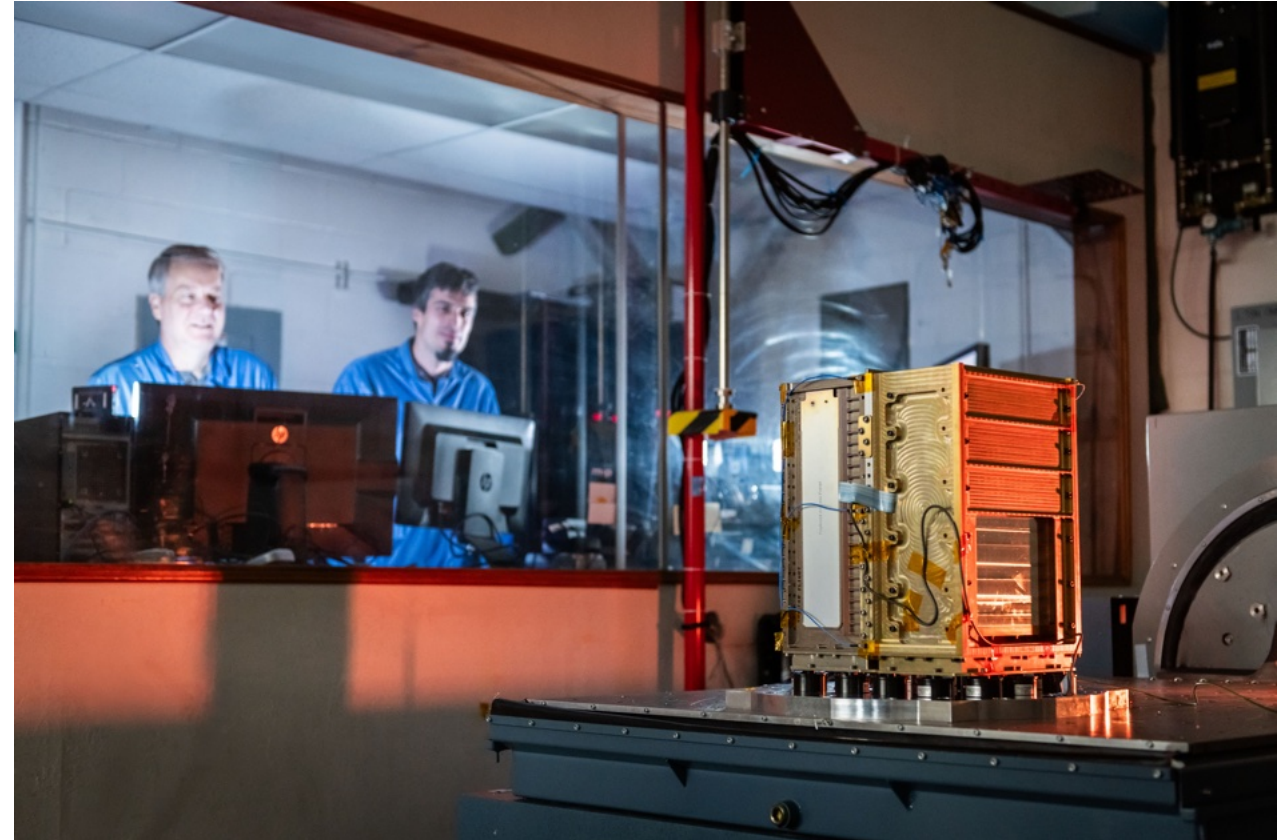
**Combine two well-developed technologies:
space-based decametric-hectometric (DH) measurements and
aperture synthesis (interferometry)**



Status of Spacecraft

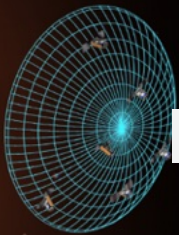


Thermal-vac testing at Space Dynamics Laboratory (SDL)



Vibration testing at Space Dynamics Laboratory (SDL)

Credit: SDL/Allison Bills

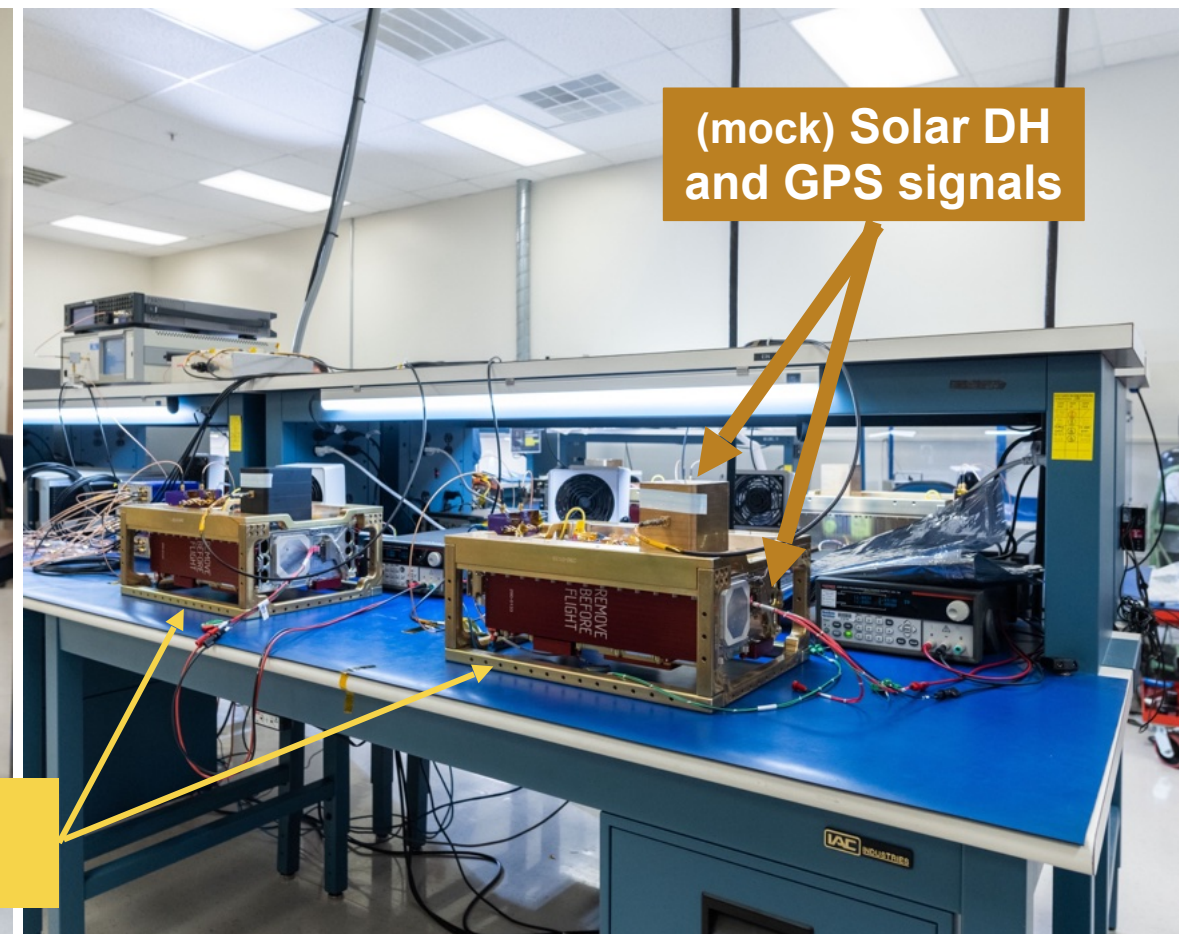
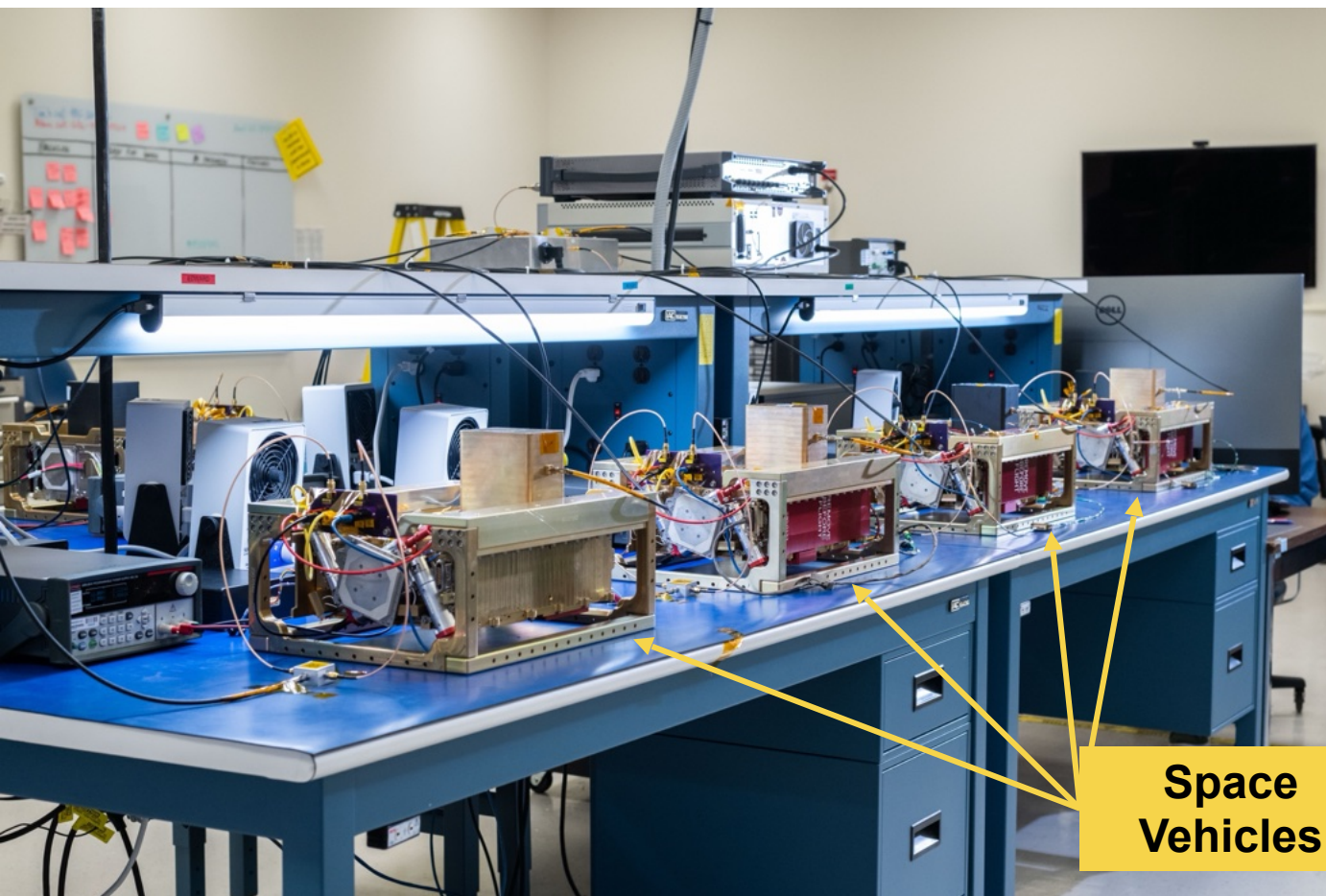


Mission Status

Interferometer-Level Performance Test



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SUN RADIO INTERFEROMETER SPACE EXPERIMENT



(mock) Solar DH and GPS signals

Space Vehicles

All six Space Vehicles tested together!
As close to flight-like as we could make it ...

Credit: SDL/Allison Bills

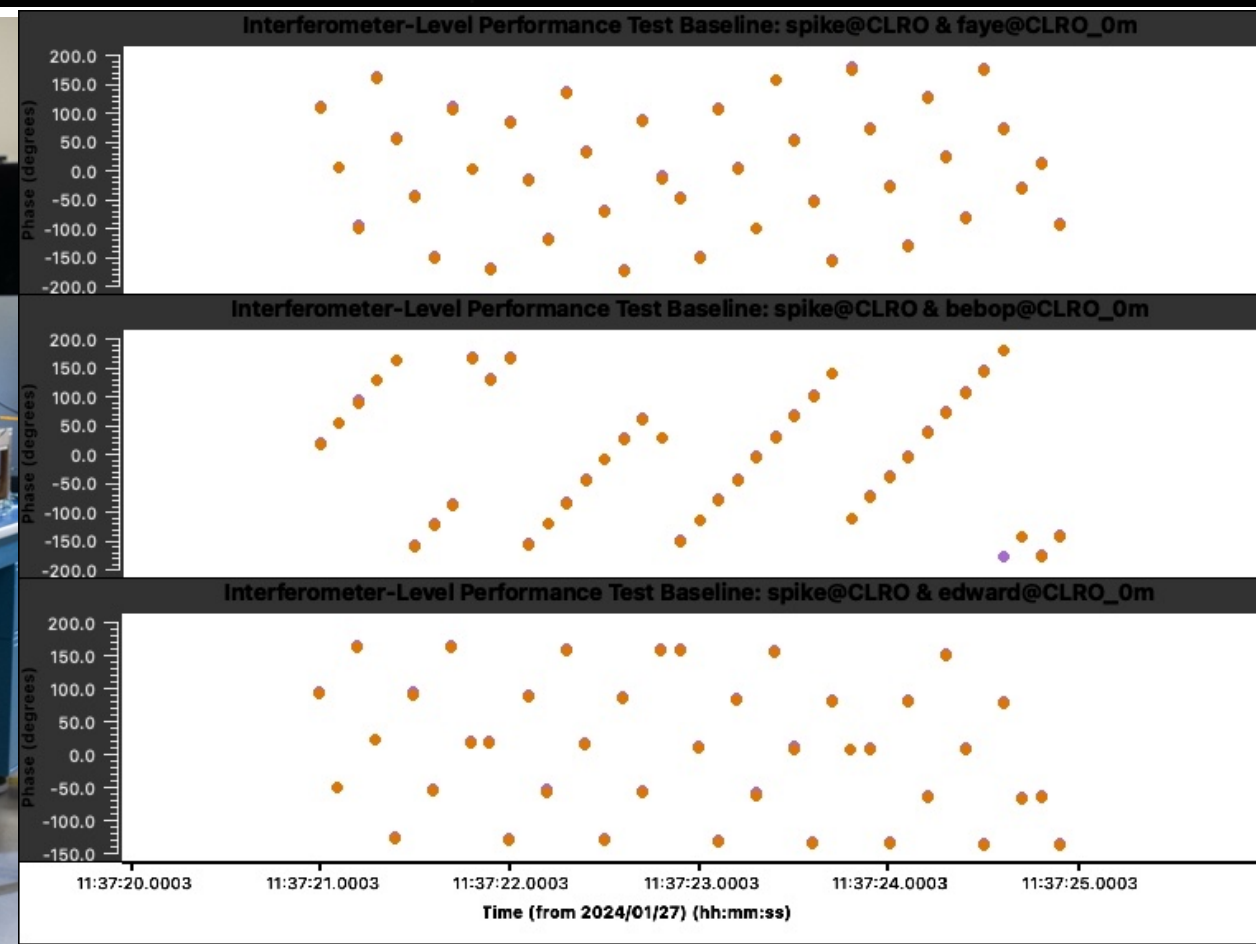
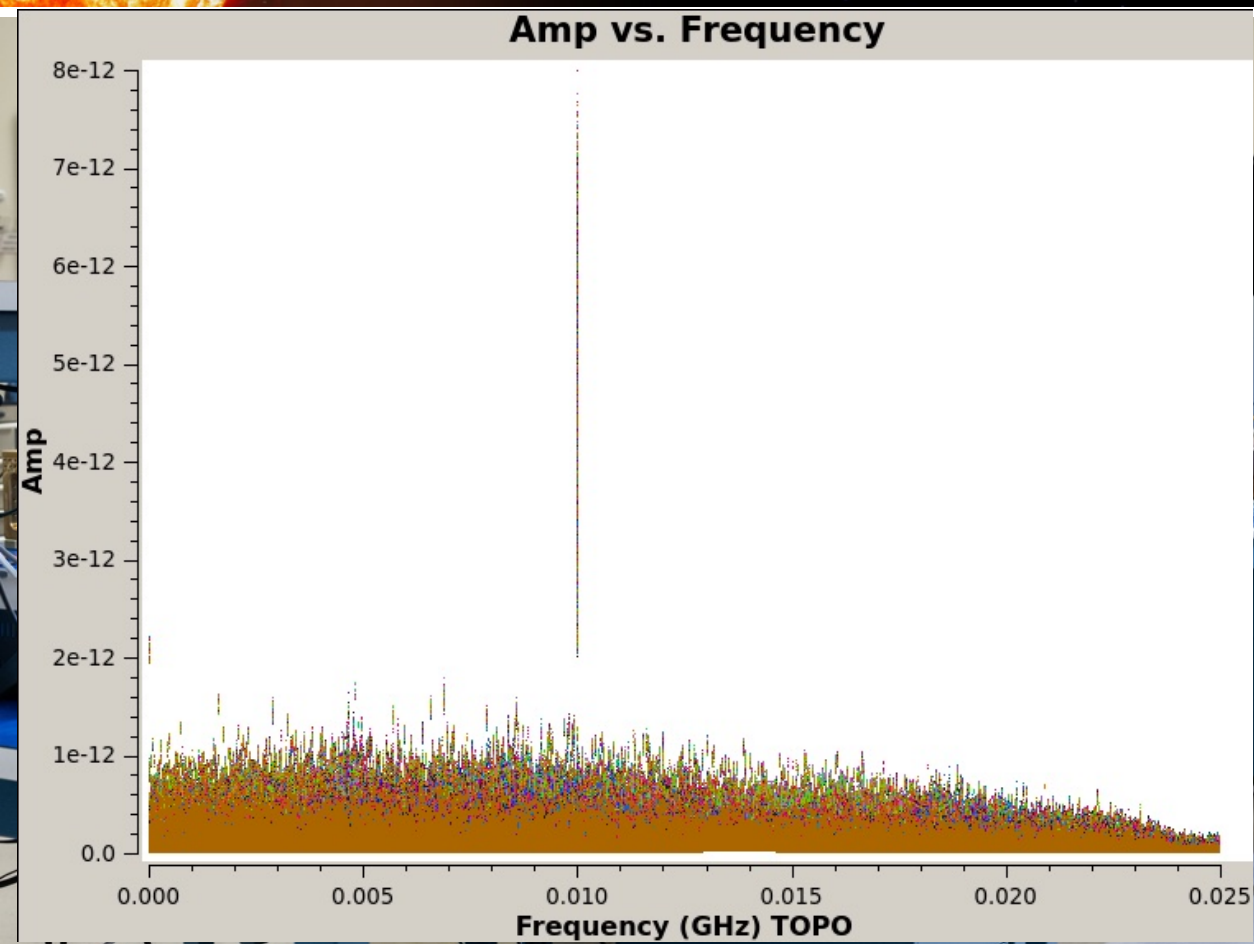


Mission Status

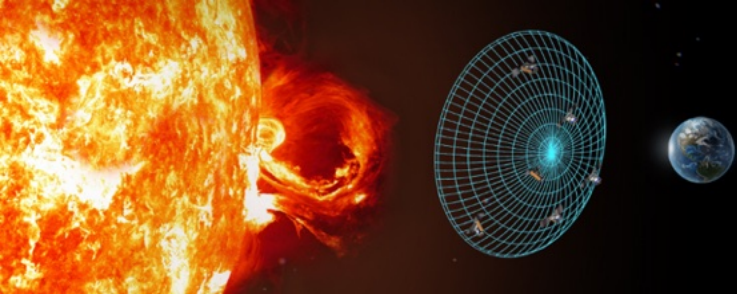
Interferometer-Level Performance Test



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SUN RADIO INTERFEROMETER SPACE EXPERIMENT



All six Space Vehicles tested together!
As close to flight-like as we could make it ...



Go for Launch!

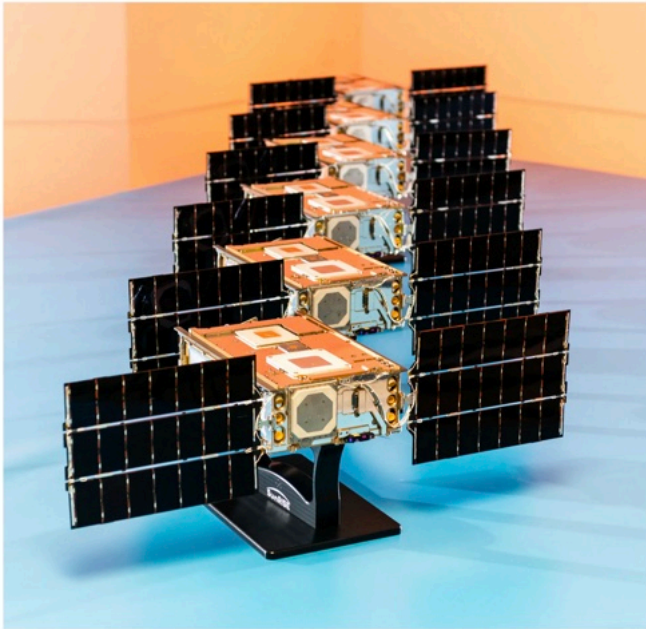


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SUN RADIO INTERFEROMETER SPACE EXPERIMENT

4 MIN READ

NASA's 6-Pack of Mini-Satellites Ready for Their Moment in the Sun



The six satellites that make up NASA's SunRISE mission are each only about the size of a cereal box, flanked by small solar panels. This fleet of six SmallSats will work together to effectively create a much larger radio antenna in space. Space Dynamics Laboratory/Allison Bills

SunRISE

NASA Science Editorial Team

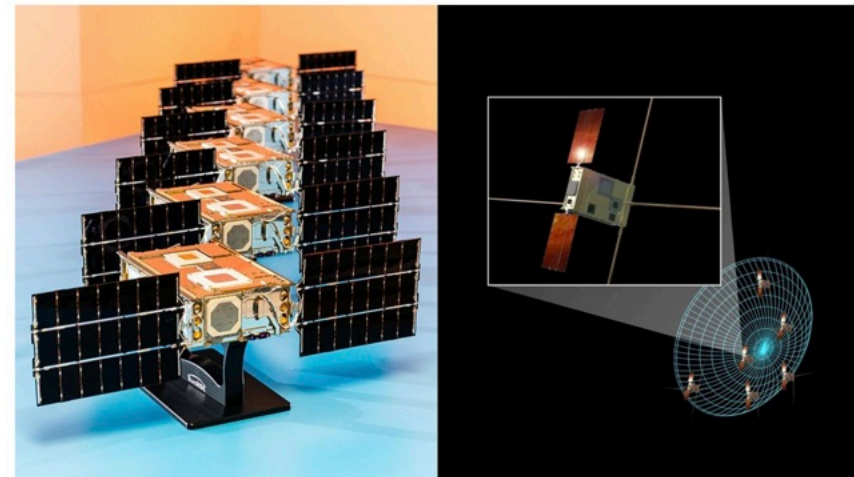
SEPTEMBER 30, 2025 1:00PM

Categories

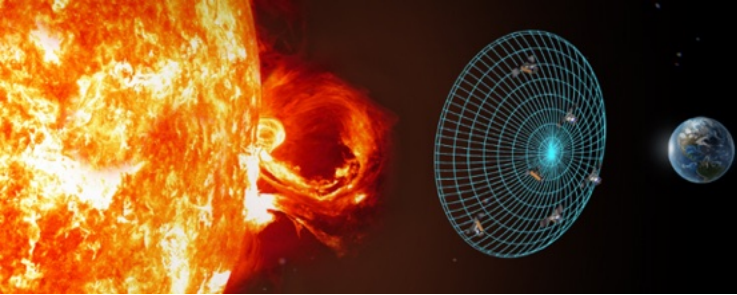
SunRISE (Sun Radio Interferometer Space Experiment)



NASA's SunRISE Set to Launch in 2026



NASA's SunRISE comprises six small satellites, seen at left lined up in a clean room, with solar arrays deployed. They will fly in formation, as depicted in the artist's concept at right, working as one large radio telescope in Earth orbit. Space Dynamics Laboratory/Allison Bills (photograph); NASA/JPL-Caltech

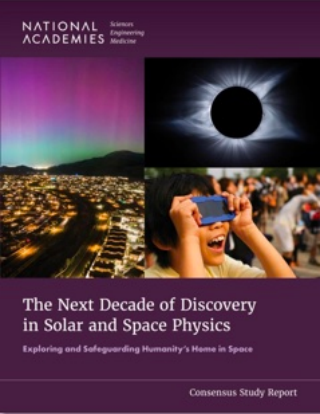


After the SunRISE



SUNRISE

SUN RADIO INTERFEROMETER SPACE EXPERIMENT



Heliophysics Science Theme: A Laboratory in Space

- ➔ Guiding Question: How Do Fundamental Processes Create and Dissipate Explosive Phenomena Across the Heliosphere?
- ➔ Research Focus Area: Consequences of the aggregation of individual explosive events
- ➔ SunRISE!

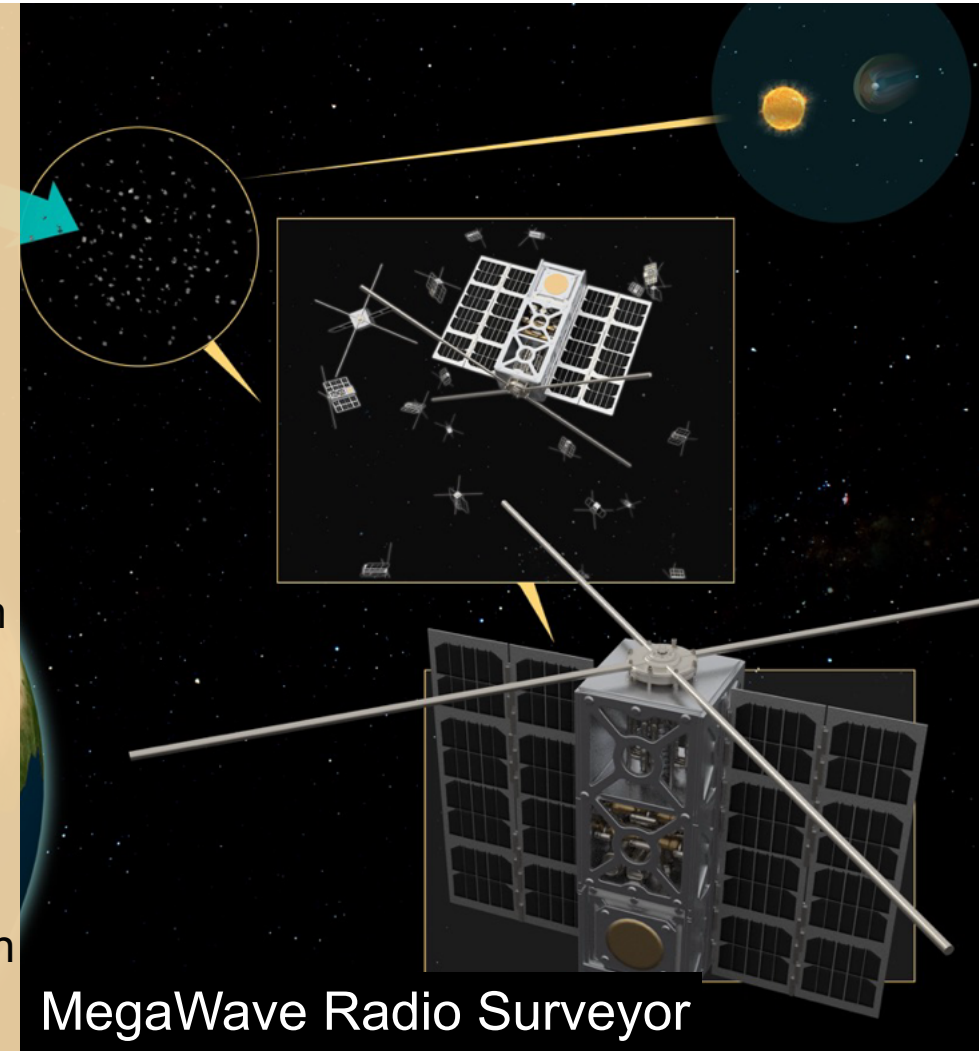
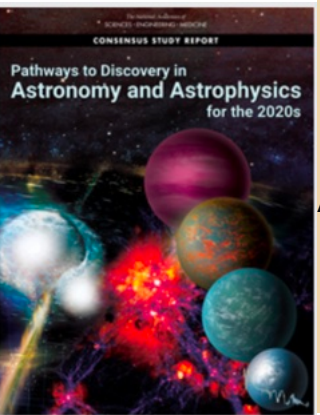
Heliophysics Space Weather Theme: System of Systems: Drivers of Space Weather

Astronomy & Astrophysics Science Theme: Worlds and Suns in Context

- ➔ Science Question: How do the Sun and other stars create space weather?

Astronomy & Astrophysics Science Theme: Cosmic Ecosystems

- ➔ How are cosmic structure formation and particle acceleration coupled? (clusters of galaxies, galaxy-group interactions, ...)



MegaWave Radio Surveyor



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SUN RADIO INTERFEROMETER SPACE EXPERIMENT

The Next Decade of Discovery in Solar and Space Physics

Exploring and Safeguarding Humanity's Home in Space



NATIONAL ACADEMIES *Sciences
Engineering
Medicine*

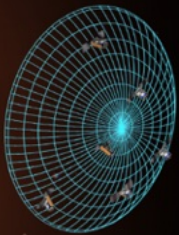
**The Next Decade of Discovery
in Solar and Space Physics**

Exploring and Safeguarding Humanity's Home in Space

Consensus Study Report

Science Themes

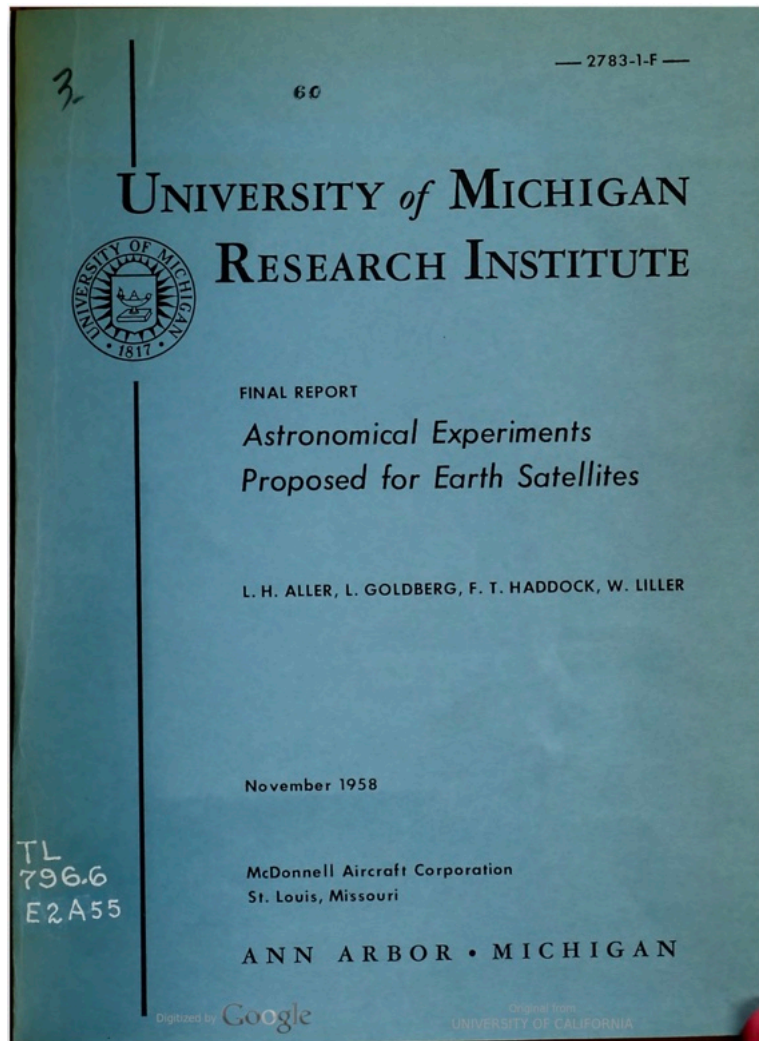
	Sun-Earth-Space: Our Interconnected Home	A Laboratory in Space: Building Blocks of Understanding	New Environments: Exploring Our Cosmic Neighborhood and Beyond
Guiding Questions	<ul style="list-style-type: none">• How does our Heliosphere function as a nested system?• How do Heliosystem boundaries manifest themselves?• How do the Sun-Earth system parts interact with each other?	<ul style="list-style-type: none">• How is the Sun's global magnetic field created and maintained, and what causes its cyclical variation?• How are explosive phenomena created and dissipated across the heliosphere, and what are the fundamental processes that contribute to energy conversion?• How do the fundamental processes govern the cross-scale coupling and what are the global properties and consequences of the processes?	<ul style="list-style-type: none">• What can we learn from comparative studies of planetary systems?• Why does the Sun and its environment differ from other similar stars?• What internal and external characteristics have played a role in creating a space environment conducive to life?



There is nothing new under the Sun.



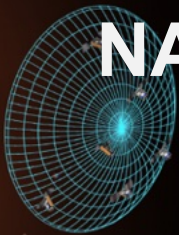
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SUN RADIO INTERFEROMETER SPACE EXPERIMENT



“Satellite observations would also overcome this limitation in resolution [imposed by the Earth’s ionosphere] but would require very large antennas or interferometers. For example, to resolve one minute of arc at 100 Mc, one would need an antenna system extending over 10 km.”

Jennison (1963) also discusses space-borne interferometers at long wavelengths, but appears not to consider free-flying spacecraft to be viable.

First (unclassified) publication of low radio frequency interferometer in space is Weiler et al. (1988, “Low Frequency Astrophysics with a Space Array”)



NASA's 6-Pack of Mini-Satellites Ready for Their Moment in the Sun



SUNRISE

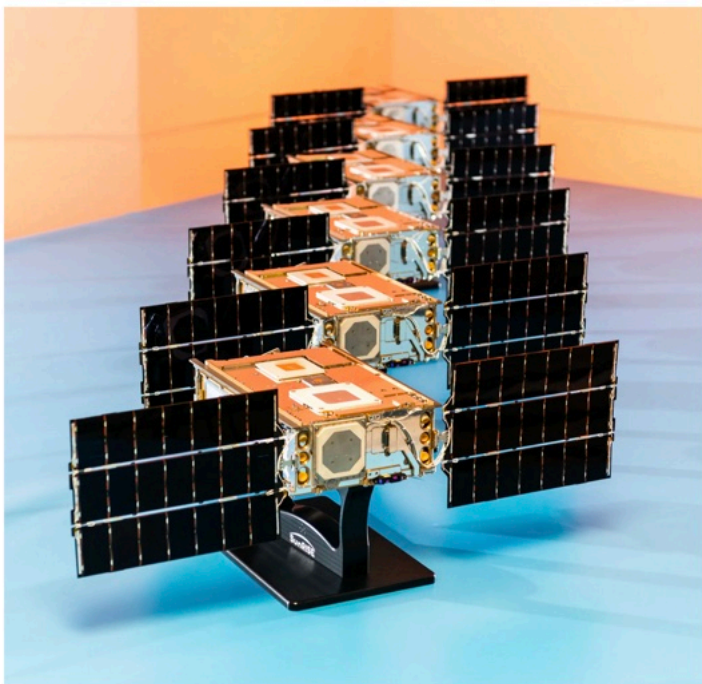
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Space Dynamics Laboratory/Allison Bills



Credit: SDL

* apologies to Philip K. Dick