

Sun Radio Imaging Space Experiment (SunRISE)

Joseph Lazio for the SunRISE Team

Solar and Space Physics

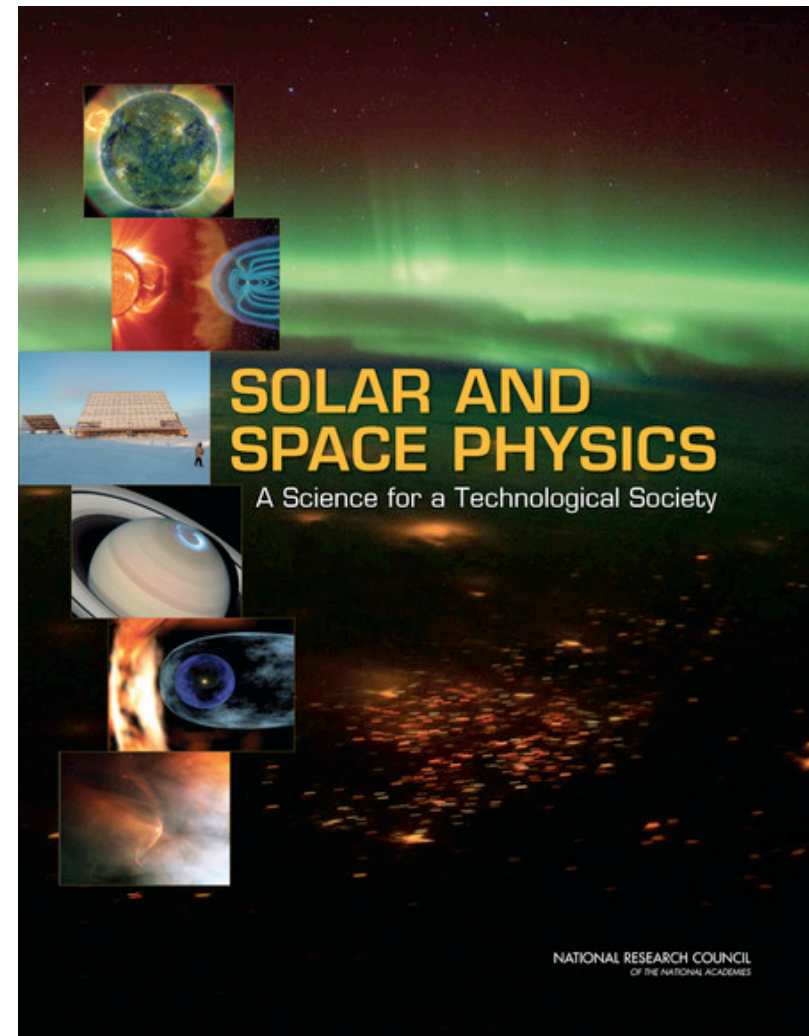
Goal 1. Determine the origins of the Sun's activity and predict the variations in the space environment.

Goal 2. Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere

Goal 3. Determine the interaction of the Sun with the solar system and the interstellar medium.

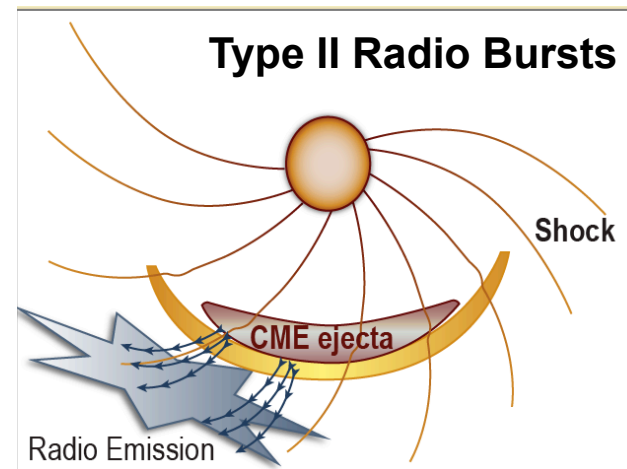
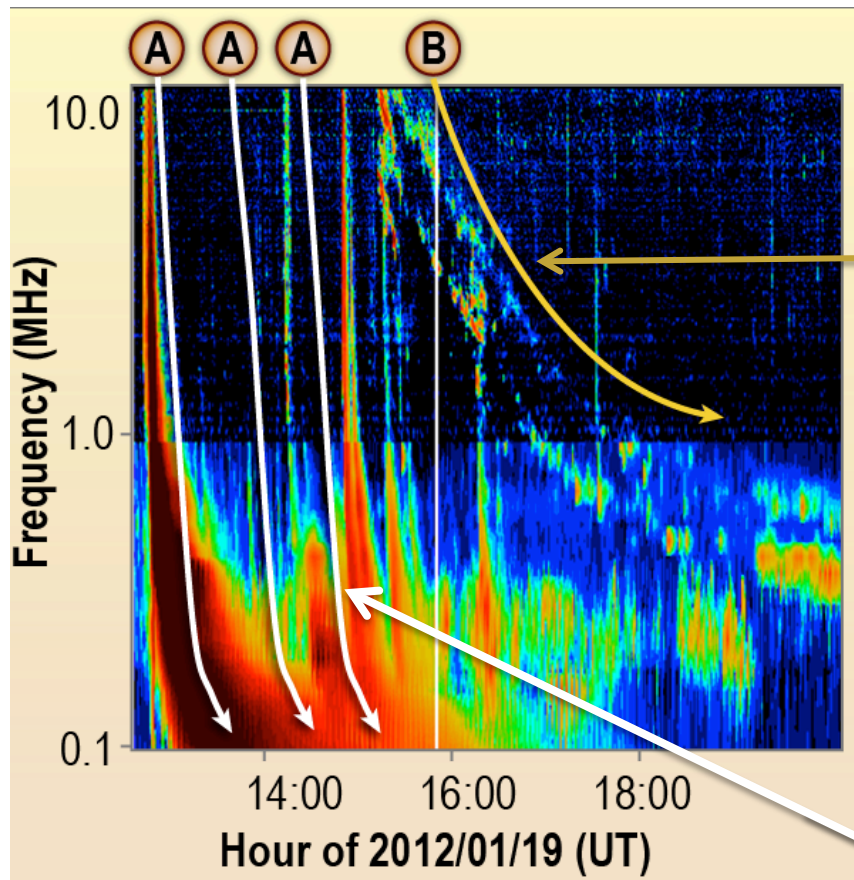
Goal 4. Discover and characterize fundamental processes that occur both within the heliosphere and throughout the universe.

SHP Panel Goal 3. Determine how magnetic energy is stored and explosively released.

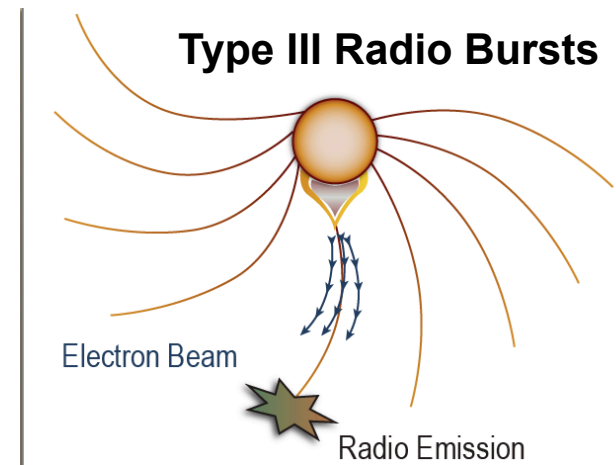


Solar Radio Bursts

Type II and III



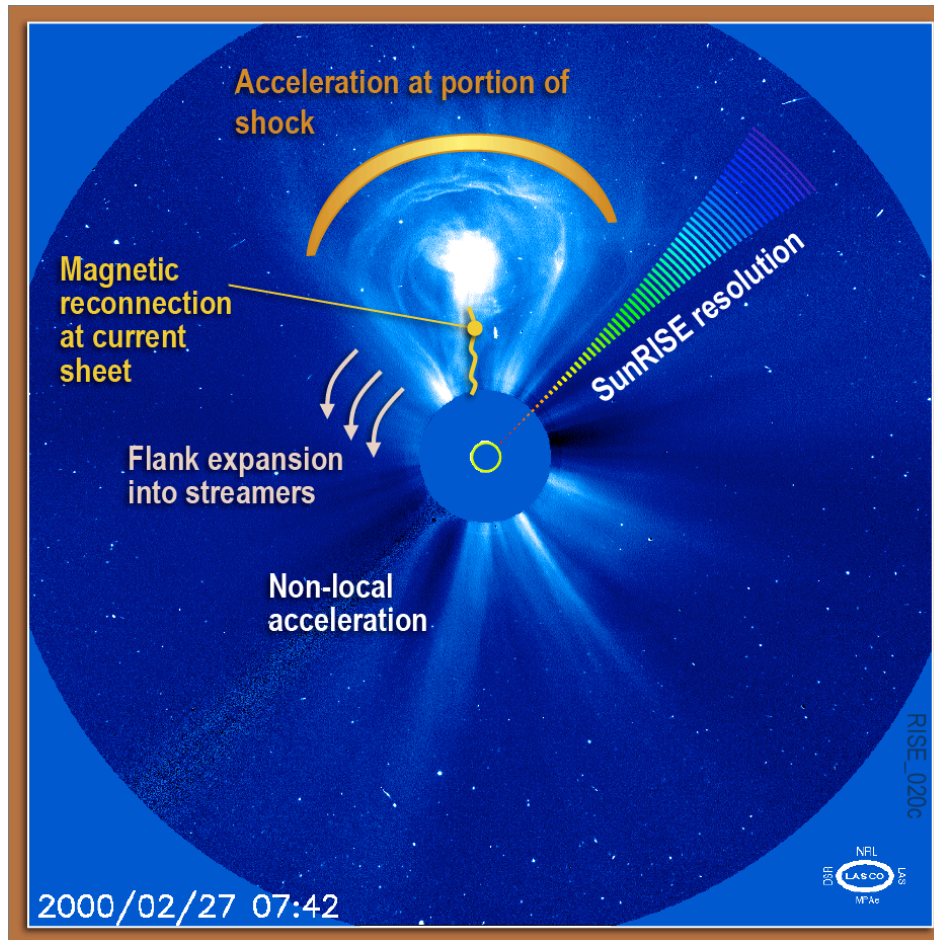
Slowly descending in frequency as coronal mass ejections expand into heliosphere



Rapidly drop in frequency as electron beams escape from active regions along open field lines

SunRISE Objective #1

The Acceleration of Solar Energetic Particles

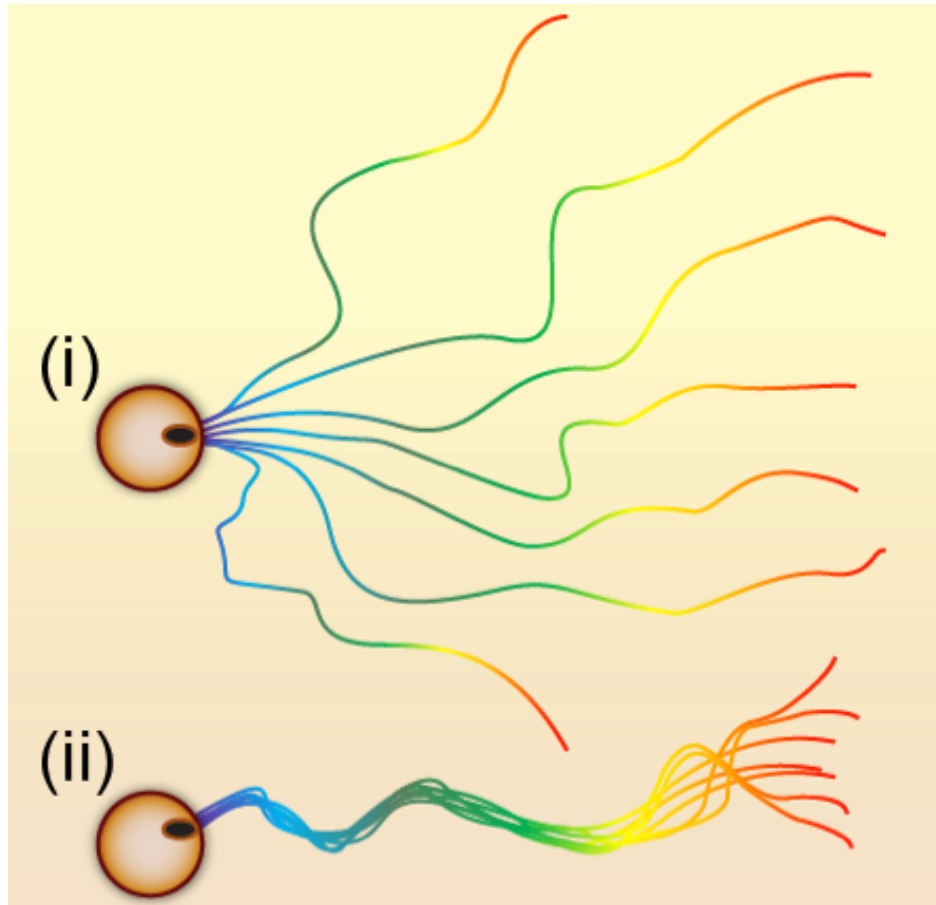


Discriminate competing hypotheses for the generation of solar energetic particles by measuring the **location and morphology of associated Type II radio emissions.**

Major solar energetic particle events proceeded (95% of time) by Type II radio burst below 15 MHz

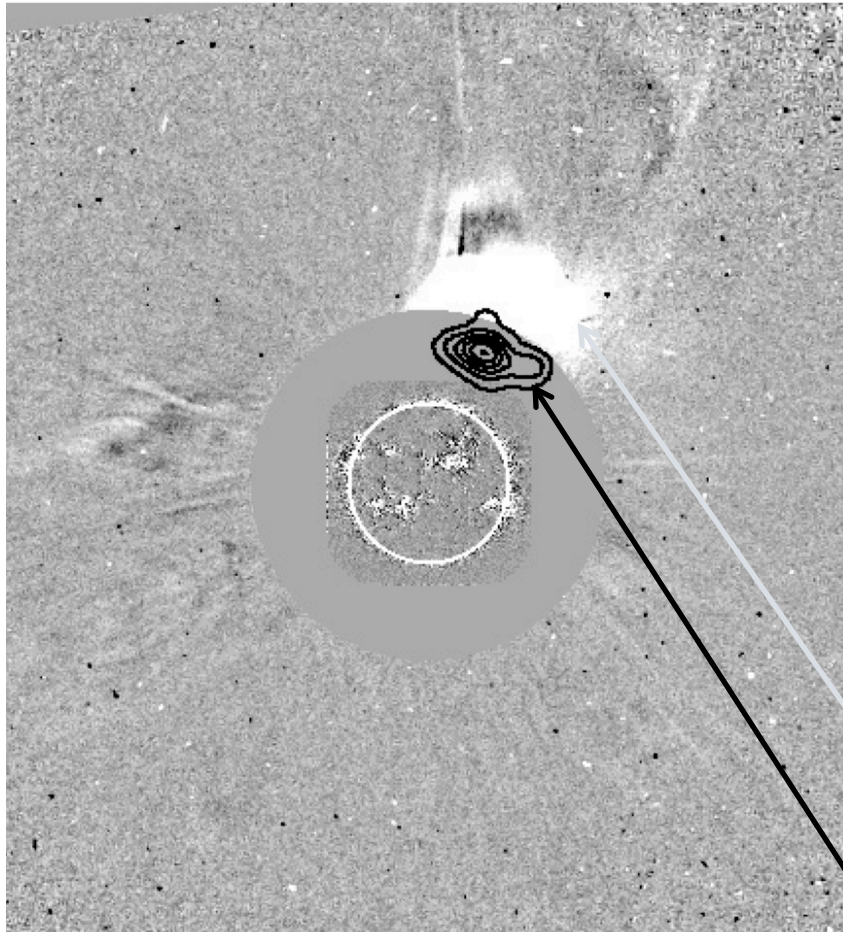
SunRISE Objective #2

The Release of Solar Energetic Particles into Space



Discriminate competing hypotheses for the variable magnetic connection between active regions and the inner heliosphere by **reconstructing magnetic field lines associated with Type III radio bursts.**

CME Evolution and Particle Acceleration



SDO-AIA 193 Å and SOHO-LASCO C2
images

**Ground-based measurements
limited to $r \sim 2 R_{\odot}$**

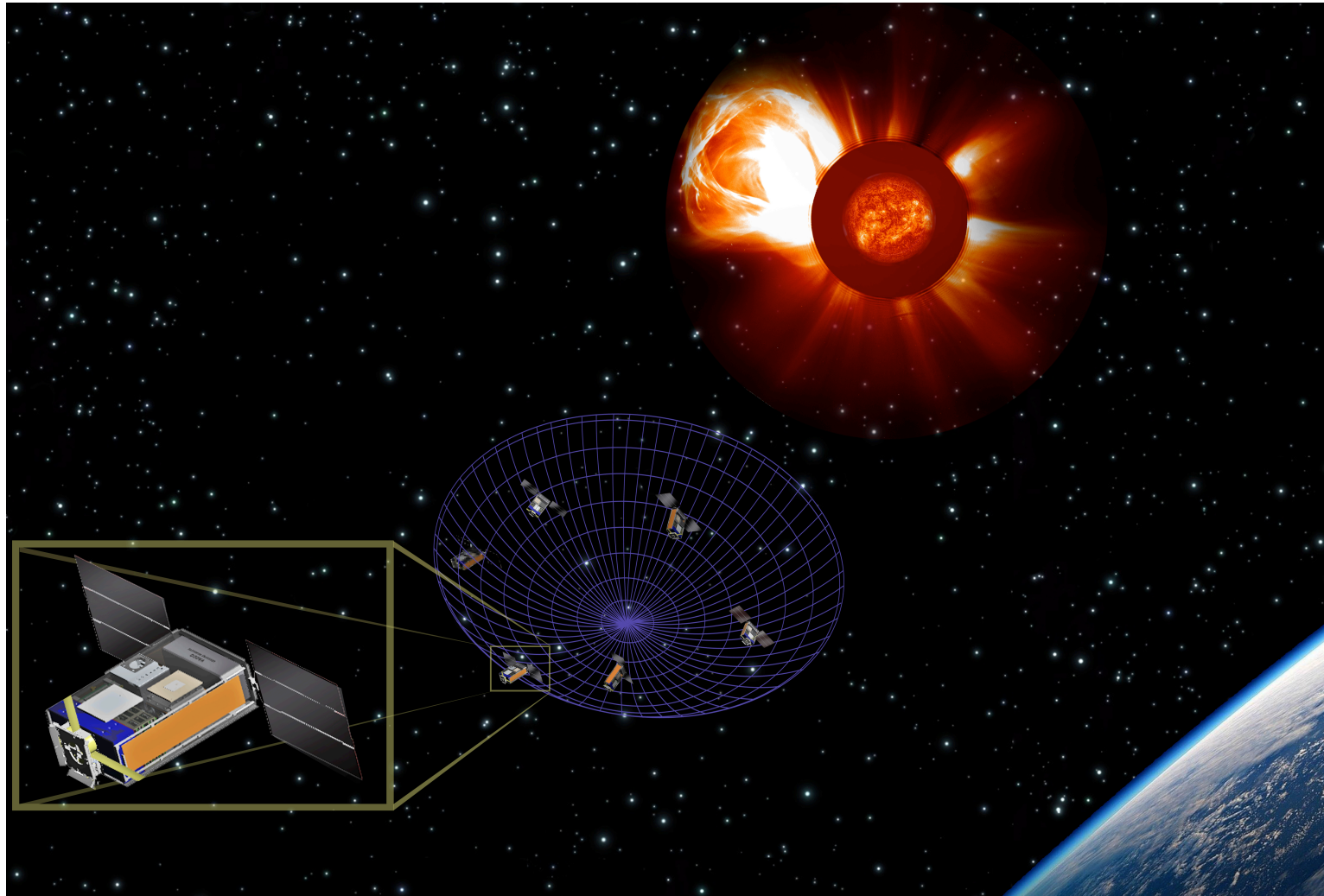
Limited frequency range cannot
track evolution, limits extent to
which radio-optical images can be
aligned /correlated

CME (white light)

80 MHz Gauribidanur image

Science Implementation Concept

Synthetic Aperture!



Space-based Low Radio Frequency Arrays

Astron. Astrophys. 195, 372–379 (1988)

ASTRONOMY
AND
ASTROPHYSICS

A low frequency radio array for space

K.W. Weiler¹, B.K. Dennison^{1,2}, K.J. Johnston¹, R.S. Simon¹, W.C. Erickson³, M.L. Kaiser⁴, H.V. Cane⁴, M.D. Desch⁴, and L.M. Hammarstrom¹

¹ E.O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375-5000, USA

² Virginia Polytechnic Institute and State University, Department of Physics, Blacksburg, VA 24061, USA

³ University of Maryland, Astronomy Program, College Park, MD 20742, USA

⁴ NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

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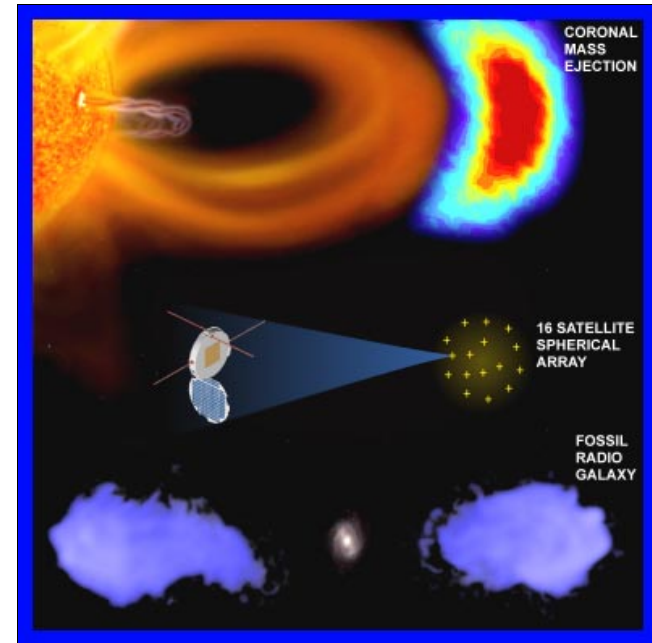
Summary. At the lowest radio frequencies (<30 MHz), the Earth's ionosphere transmits poorly or not at all. This relatively unexplored region of the electromagnetic spectrum is thus an area where high resolution, high sensitivity observations from space can open a new window for astronomical investigations. An array of free flying spacecraft which work as a coherent interferometer will be able to probe this frequency range. Operating from ~ 1 to ~ 30 MHz, such a telescope will extend astronomy from just above the ionospheric cutoff, where ground based observations can still be done, down to the fundamental physical limit where observations at still lower frequencies from within the Milky Way are impossible due to absorption by diffuse, ionized interstellar hydrogen.

telescopes. Only a few dedicated workers have continued to study the dekameter-hectometer wavelength radiation.

The most extensive investigations at the very lowest frequencies have been carried out with the Radio Astronomy Explorer (RAE) satellites 1 and 2 (Weber, Alexander, and Stone, 1971; Alexander and Novaco, 1974) in Earth and lunar orbit, respectively. They were launched at different dates and used as single survey antennas with their travelling wave V-antennas yielding only steradian resolution. Ground-based observations are normally confined to frequencies > 10 MHz during solar minimum or > 20 MHz during solar maximum, and only under special conditions at preferred locations does the ionosphere transmit radiation at frequencies as low as 2 to 5 MHz (Reber, 1968; Ellis

The Astronomical Low Frequency Array

Viewing the Sun and Universe in a New Light



The scientific rewards of such a space mission are likely to be great. ... a low frequency telescope in space can ... study the impulsive low frequency emission from Jupiter and the Sun

Dr. Dayton L. Jones
Principal Investigator
Mail code 238-332
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109-0899
Phone: (818) 354-7774
Fax: (818) 393-6890
E-mail: dj@bllac.jpl.nasa.gov



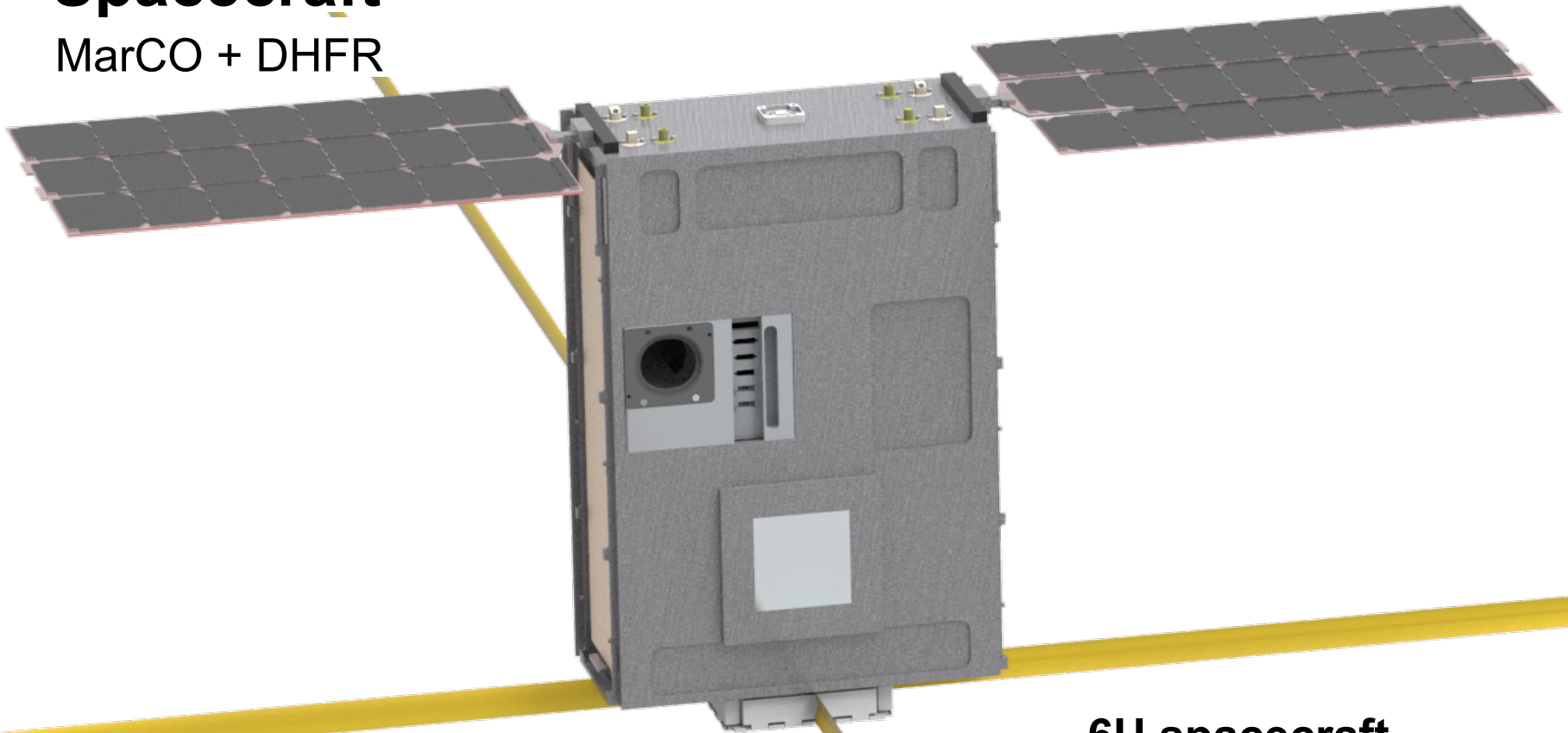
Dr. Charles Elachi
Space and Earth Sciences Directorate
Mail code 180-704
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109-0899
Phone: (818) 354-5673
Fax: (818) 354-2946
E-mail: Charles.Elachi@jpl.nasa.gov

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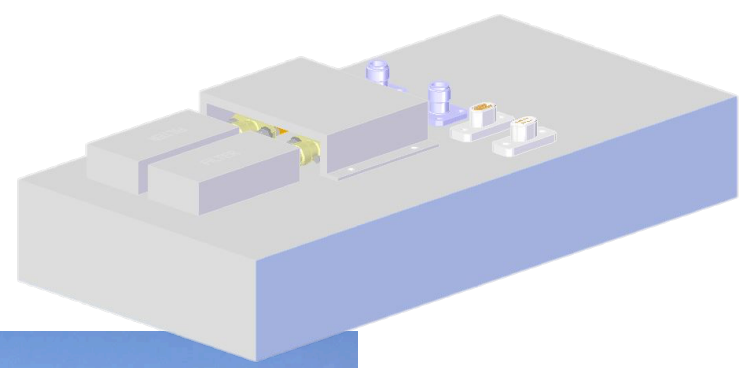
Spacecraft

MarCO + DHFR



**6U spacecraft
(10 cm × 20 cm × 30 cm)
+ 6 m antennas**

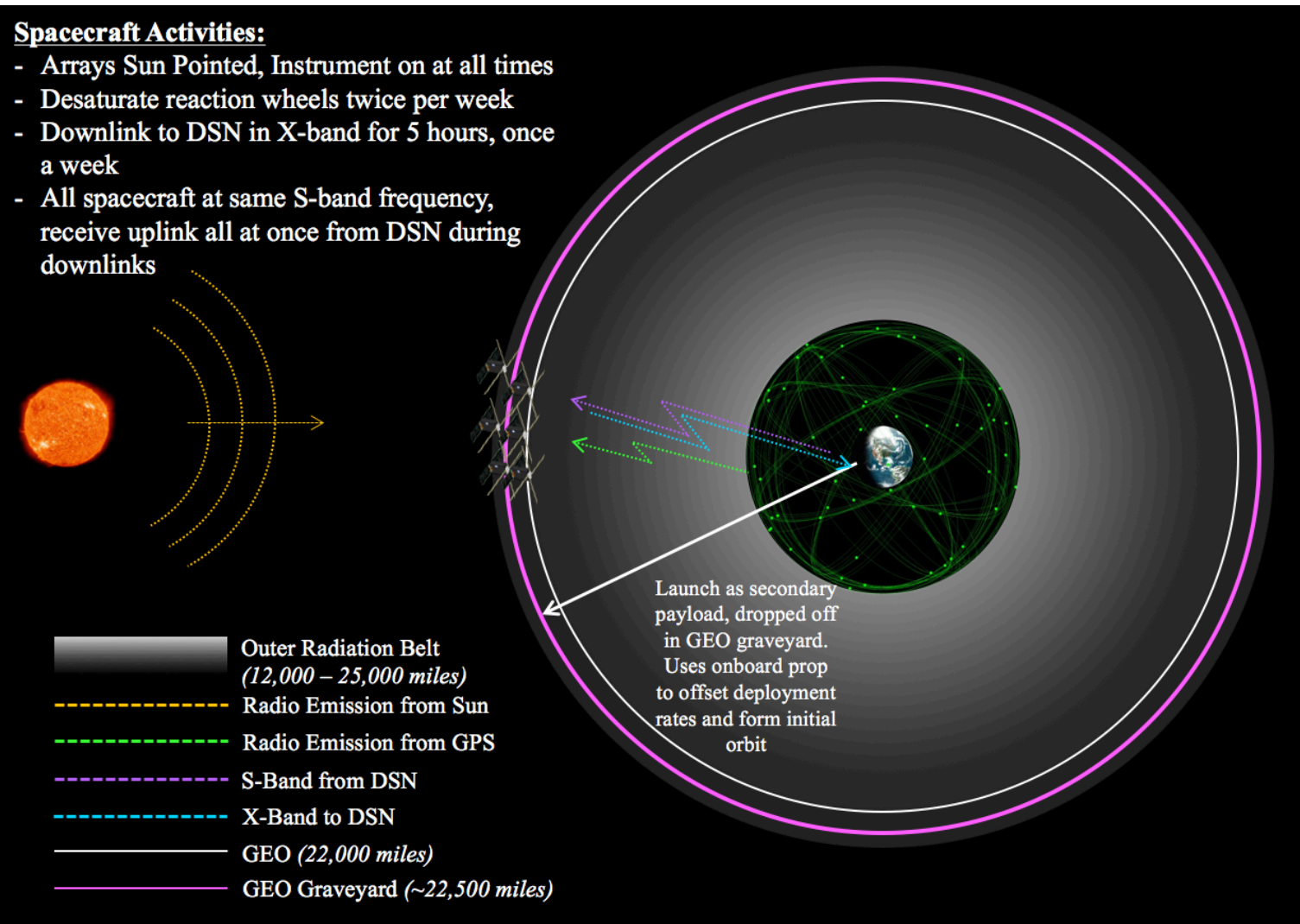
Science Payload Testing



Concept of Operations

Spacecraft Activities:

- Arrays Sun Pointed, Instrument on at all times
- Desaturate reaction wheels twice per week
- Downlink to DSN in X-band for 5 hours, once a week
- All spacecraft at same S-band frequency, receive uplink all at once from DSN during downlinks



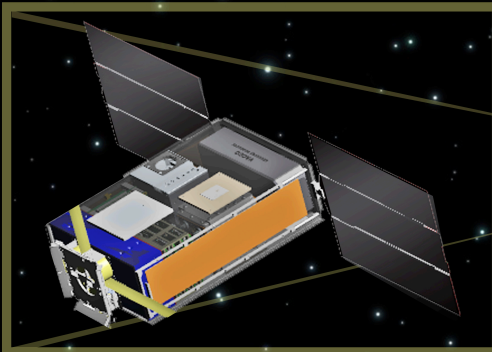
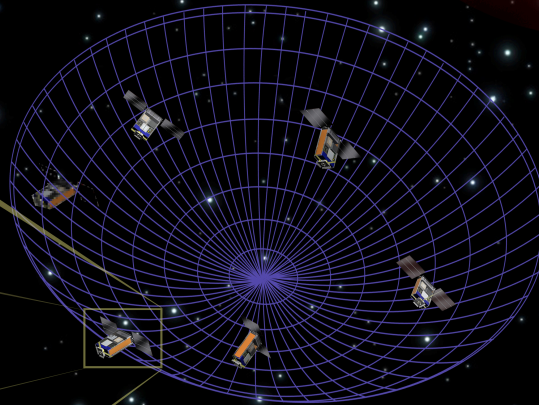
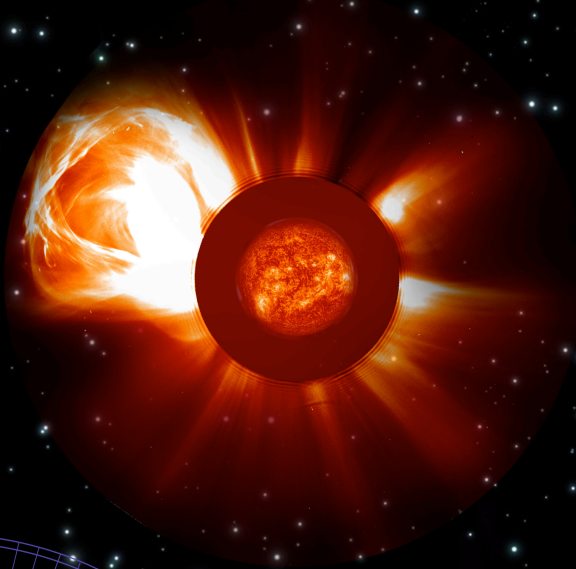
SunRISE Science Team

Justin Kasper (PI)	Univ. Michigan
Joseph Lazio	JPL
Nikta Amiri	JPL
Tim Bastian	NRAO
Christina Cohen	Caltech
Enrico Landi	Univ. Michigan
Ward Manchester	Univ. Michigan
Alysha Reinhard	NOAA
Nathan Schwadron	Univ. New Hampshire
<i>Baptiste Cecconi</i>	<i>CNES</i>
<i>Vratislav Krupar</i>	<i>Imperial College London</i>
<i>Milan Maksimovic</i>	<i>CNES</i>
<i>Arnaud Zaslavsky</i>	<i>CNES</i>
<i>Gregg Hallinan</i>	<i>Caltech</i>

Sun Radio Imaging Space Experiment

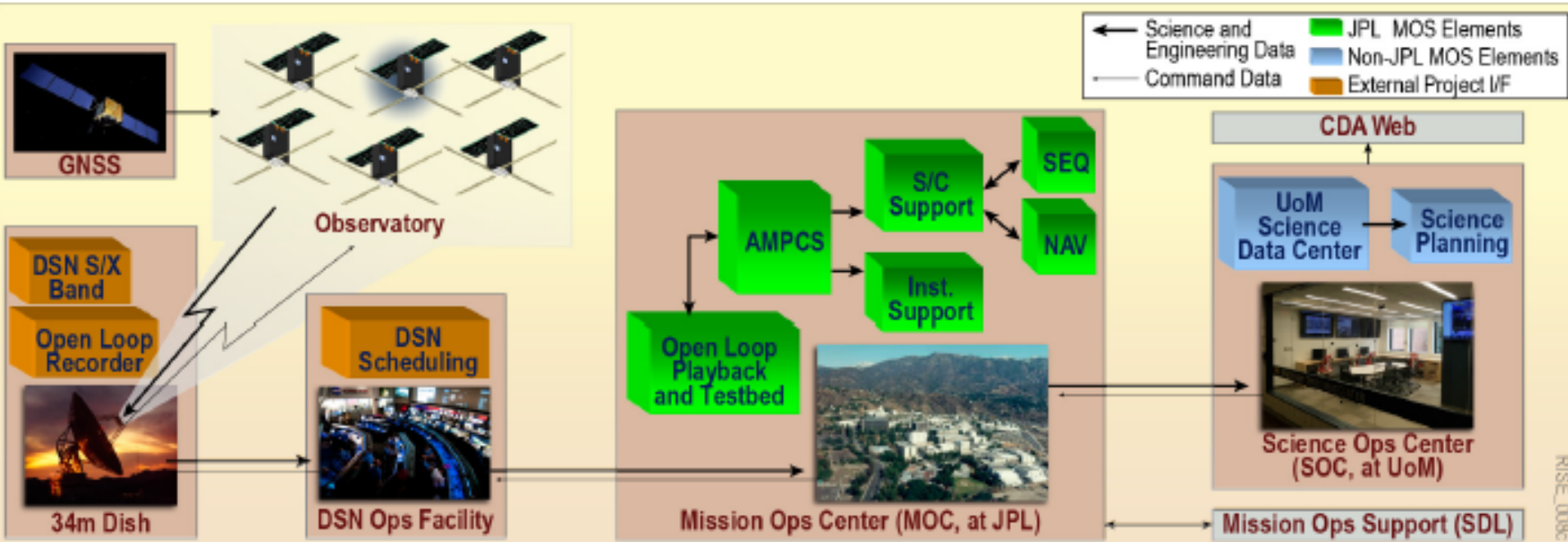
Mission Concept

- Use radio emission to track particle acceleration and transport
- 6 spacecraft synthetic aperture
- Simple science payload
- Robust concept of operations



backup

End-to-End Information System



Position Determination

