URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

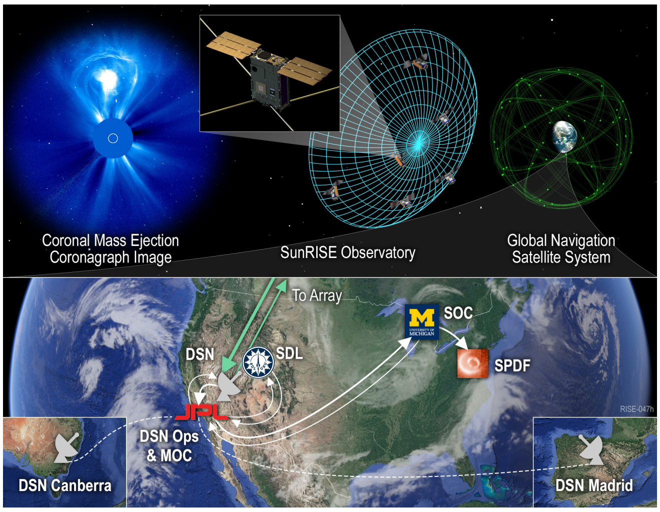
The Implementation of the Sun Radio Interferometer Space Experiment (SunRISE)

T. Joseph W. Lazio(1), J. C. Kasper(2)(5), Andrew Romero-Wolf(1), James Lux(1), Tim Neilsen(3),
L. B. Wilson III(4); The SunRISE Science Team; The SunRISE Project Team
(1) Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109 USA
(2) Department of Climate & Space Sciences & Engineering, University of Michigan, Ann Arbor, MI 48109 USA
(3) Space Dynamics Laboratory, Utah State University, 416 E. Innovation Ave., North Logan UT 84341 USA
(4) NASA Goddard Space Flight Center, Heliophysics Science Division, Greenbelt, MD 20771, USA
(5) BWX Technologies, Inc., Washington, DC 20002 USA

The Sun Radio Interferometer Space Experiment (SunRISE) will provide an entirely new view on particle acceleration and transport in the inner heliosphere by creating the first low radio frequency interferometer in space to localize heliospheric radio emissions. By tracking the location of decametric-hectometric (DH) radio bursts from 0.1 MHz to 25 MHz, SunRISE will provide key information on particle acceleration mechanisms associated with coronal mass ejections (CMEs), via DH Type II bursts, and the magnetic field topology from active regions into interplanetary space, via DH Type III radio bursts.

SunRISE is implemented using techniques developed for ground-based very long baseline interferometry (VLBI). The interferometer consists of six small Space Vehicles, with each carrying an identical Science Payload. Each Payload consists of antennas, an integrated Solar DH-Global Navigation Satellite System (GNSS) receiver, a digital processing system, and a shared oscillator. For receiving the Solar DH radio emissions, two orthogonal dipoles are used, with a dipole formed from two (deployed) STACERs. The Solar DH-GNSS receiver not only amplifies and digitizes the Solar DH signals, but it also receives GNSS signals that are post-processed on the ground to provide precise orbit determination. These precise orbit determinations are used to locate the Space Vehicles relative to each other. A common oscillator for the Solar DH and GNSS signal chains ensures that the solar radio emissions can be timestamped with sufficient precision to enable subsequent coherent combination between Payloads.

SunRISE uses an FX correlator. The `F` portion of the correlator is implemented via the on-board digital signal processing by transforming the received Solar DH radio emissions into the frequency domain using a polyphase filterbank. A subset of the frequencies then are transmitted to the ground, where the post-processing implements the `X` portion of the correlator.



Key aspects that enable SunRISE are that only position knowledge of the Space Vehicles is required, not active control, and that the architecture involves a modest amount of on-board processing coupled with significant ground-based processing for navigation, position determination, and science operations.

Kasper et al. (1) provide additional details about the science case and mission implementation of the SunRISE. At the time of the URSI GASS, the SunRISE Space Vehicles are planned to be in storage, awaiting launch.

Acknowledgments Part of this research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

References

[1] J. Kasper, T. J. W. Lazio, A. Romero-Wolf, J. P. Lux, and T. Neilsen. "The Sun Radio Interferometer Space Experiment (SunRISE) Mission." 2022 IEEE Aerospace Conference (AERO), Big Sky, MT, USA. 2022, pp. 1–8, doi: 10.1109/AERO53065.2022.9843607.