National Aeronautics and Space Administration

The first demonstration of passive sounding on Mars with existing SHARAD data

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Objective

Demonstrate, for the first time, passive sounding on Mars using Jovian radio bursts in publicly available SHARAD data (15-25 MHz).

Background

Passive sounding has been experimentally demonstrated on Earth using the Sun as a source [1-3]. Now extending to demonstrations in the Solar System with existing assets.

Approach

Flow chart in Figure 1: Model geometry with SPICE to find favorable sounding windows restricted by SHARAD acquisition windows (Fig. 2 and 3). Identify Io-driven Jovian burst opportunities predicted from Io-CML III phase diagram. Combine this information to find a list of candidate SHARAD tracks. Passive sounding via autocorrelation is applied.

Results

- The initial search for Jovian bursts with geometries compatible with passive sounding yielded a single Io-C candidate out of 225 potential tracks identified (Figure 4).
- Large sensitivity calibration uncertainties were identified.
- Searched and found Type III radio bursts to test sensitivity (Figure 5).
- Developed a pipeline for searching for Type III bursts using STEREO and WIND observations (Figure 6).
- Type III bursts observed from Mars in SHARAD band (15-25 MHz) can be used to study source propagation.
- The team continues to calibrate SHARAD and plans to go back to Jovian burst search and passive sounding.

Significance/Benefits to JPL & NASA

- We have successfully detected Type III radio bursts in SHARAD data which can be used for heliophysics studies of source propagation.
- We have demonstrated data from radar sounders across the Solar System can be used for additional heliophysics science studies.
- We have taken the first steps in developing passive sounding as an additional observing mode for active sounders across the Solar System.

Figure 1: Approach & Methodology

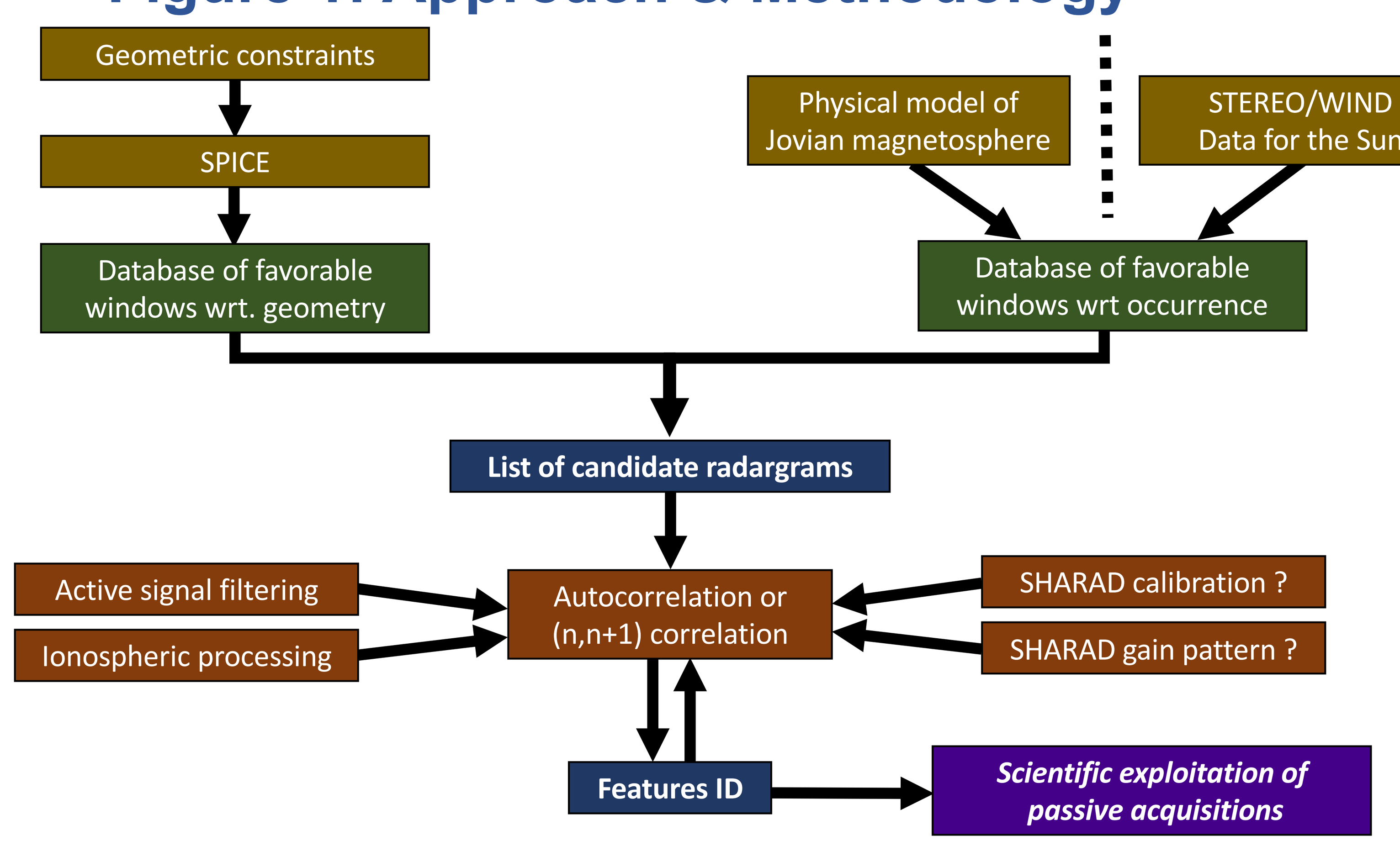
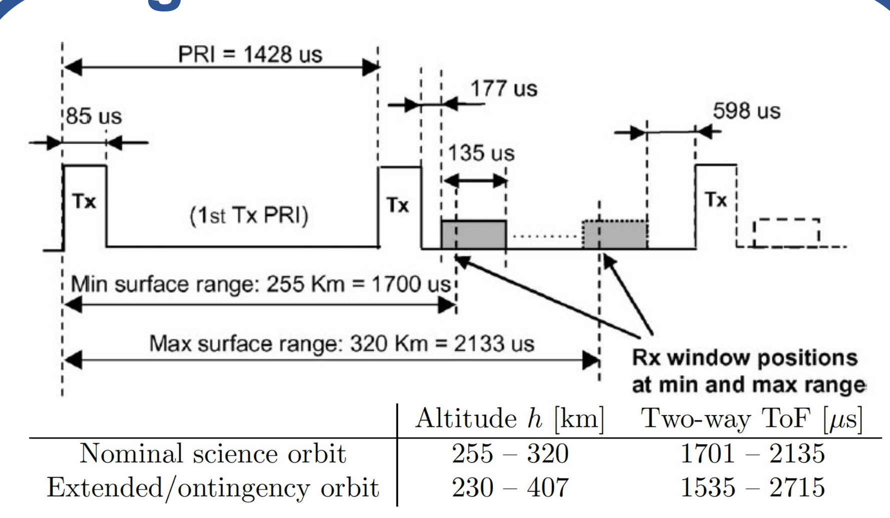
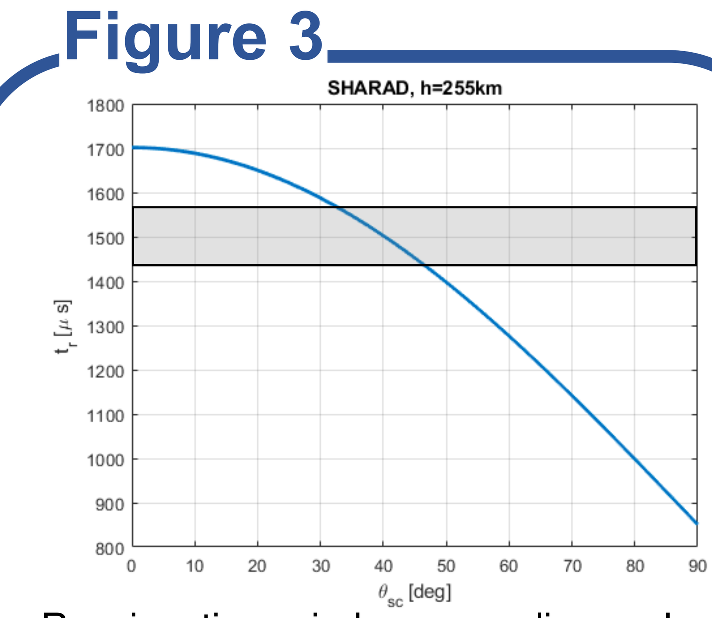


Figure 2



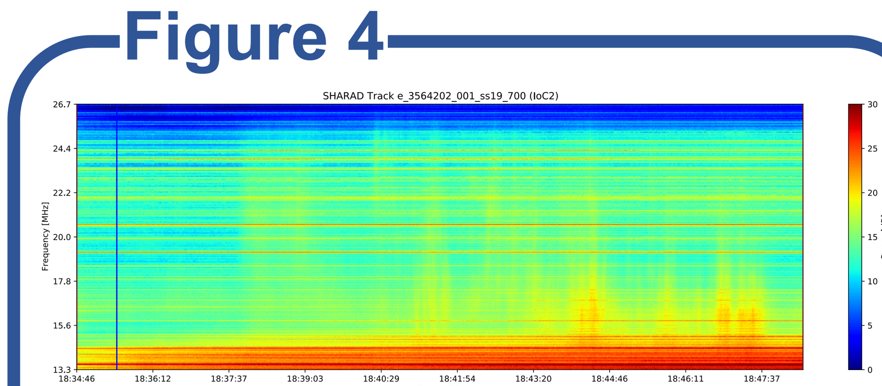
Pulse repetition interval of SHARAD (Croci+ 2011). Receive window lengths and positions determine which geometries can be passively sounded.

Figure 3



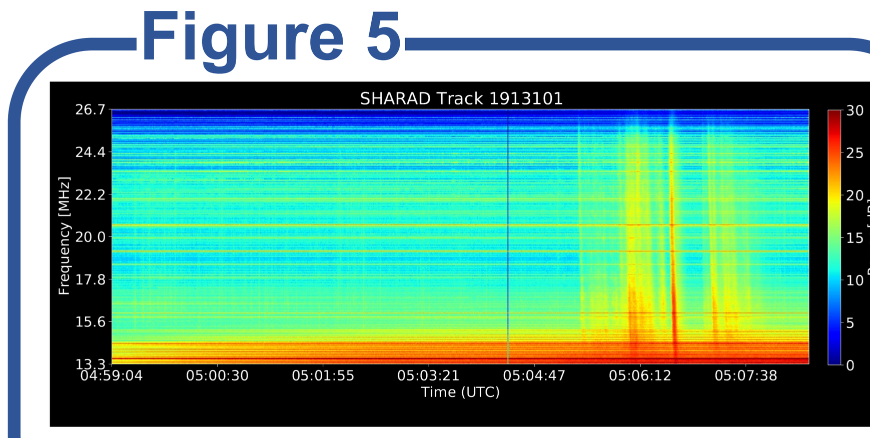
Receiver time windows sounding vs Jovian burst incidence angle. Gray region is compatible with sounding (Fig. 2).

Figure 4



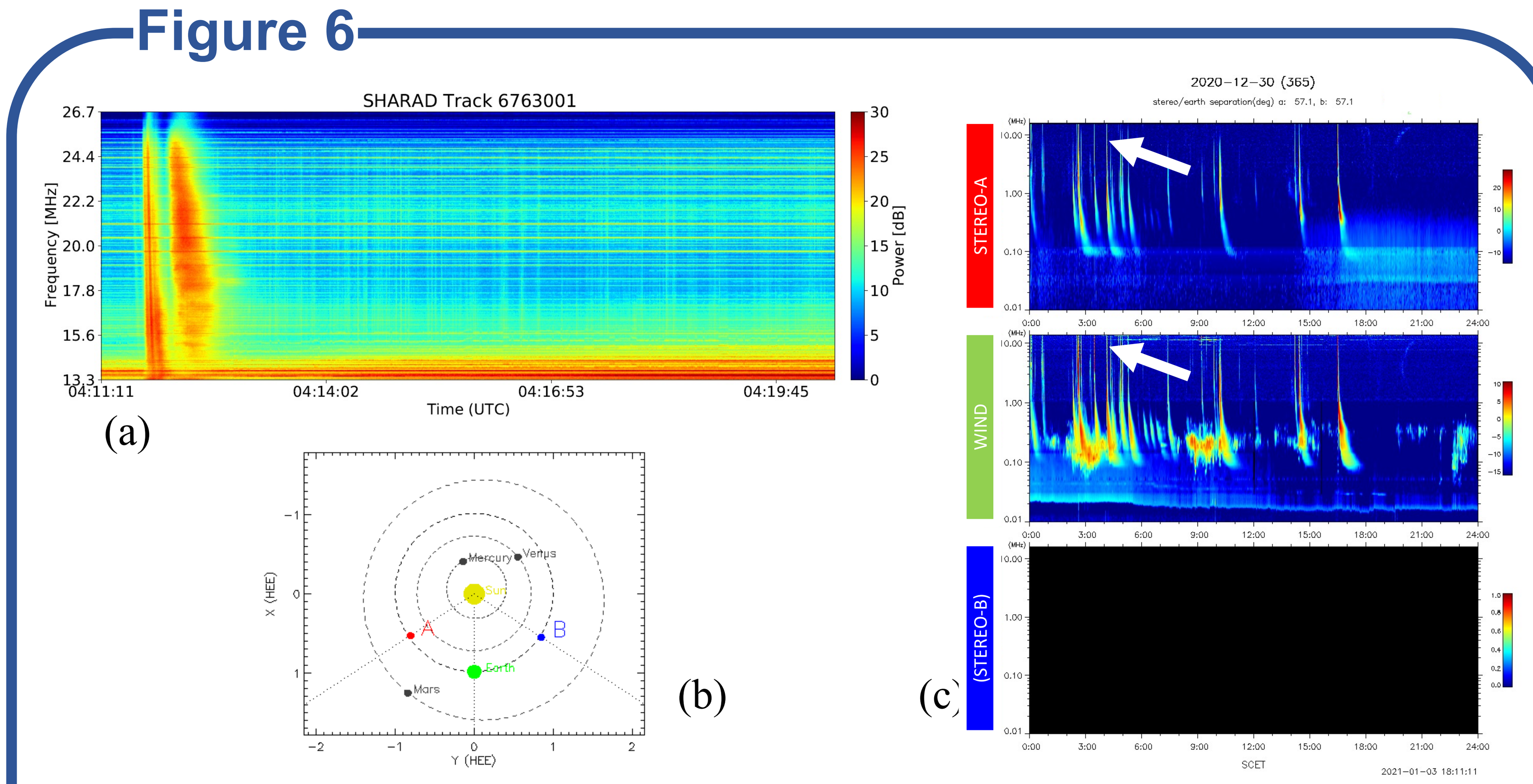
Candidate jovian radio burst of type Io-C detected with SHARAD.

Figure 5



Type III solar radio bursts detected with SHARAD

Figure 6



Detection pipeline for Solar Radio Bursts with SHARAD: (a) radio bursts detected with SHARAD, (b) inner Solar System and STEREO A/B geometry, (c) coincident radio bursts detected with STEREO & WAVES

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References:

[1] Peters+ 2018, ITGRS, 56, 7338
[2] Peters+ 2021, GRL 48 e2021GL092450
[3] Croci+ 2011, Proceedings of the IEEE 99, 794-807

Publications:

Gerekos et al., “Solar radio burst detection with SHARAD” article in preparation.

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