

On-board processing of high frequency plasma wave measurements on Solar Orbiter RPW instrument

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Abstract

The Radio and Plasma Wave (RPW) instrument of the Solar Orbiter spacecraft will include a Time Domain Sampler module (TDS) dedicated to electromagnetic waveform measurements from about 100 Hz to 500 kHz. The primary science objective of the instrument is in-situ measurement of solar wind Langmuir waves associated with solar bursts and interplanetary shocks and the process of their conversion to electromagnetic radiation. Langmuir waves are observed at relatively high frequency (10-100 kHz) and appear in the form of short bursts (Fig. 1). A secondary science objective of TDS is the detection voltage spikes often observed on electric field antennas as a result of an impact of dust particle on the spacecraft (Fig. 2). Both phenomena are relatively rare and the data volume associated with the measurement is very large. On board detection and pre-processing of the data can thus greatly reduce the telemetry requirements and increase the science return of the experiment.

The instrument implements an advanced on-board digital signal processor which allows for pre-processing of captured waveform data by configurable digital filters and basic analysis of waveform snapshots (identification of wave packets and electric field signatures of impacts of dust particles on the spacecraft, calculation of basic signal characteristics). The results of the on-board analysis are used to select interesting wave events for downlink and to collect statistics on observed snapshots which cannot be transmitted to ground. The data filtering and decimation are implemented in FPGA firmware and the more complicated data processing is performed in software running on Leon 3 CPU.

We present the design of the instrument, basic overview of the algorithms used in event

identification, and the assessment of their performance on test datasets based data from STEREO spacecraft.

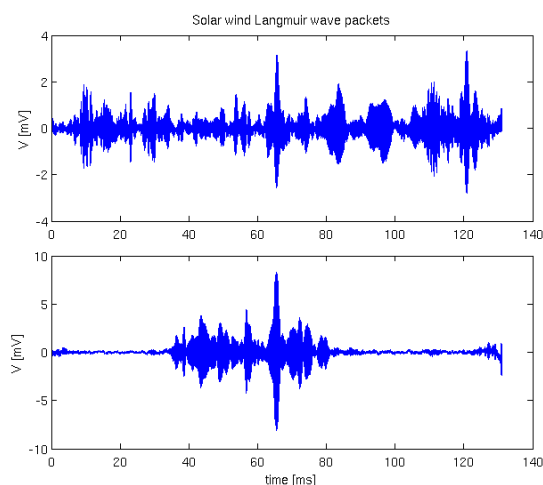


Figure 1: Examples of solar wind Langmuir wave-packets (data from STEREO S/WAVES instrument)

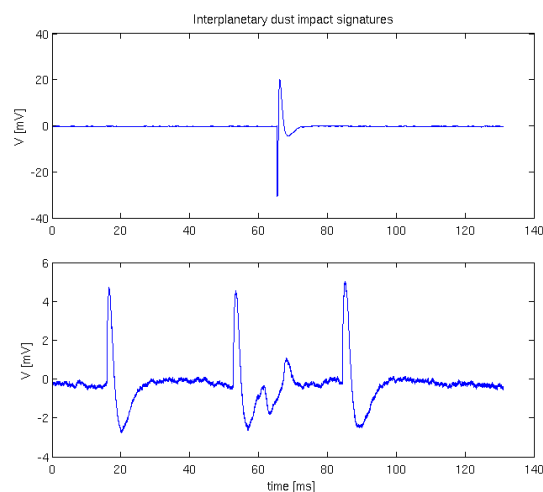


Figure 2: Examples spikes in antenna potential corresponding to impacts of interplanetary dust particles (data from STEREO S/WAVES instrument)

