TDS status and recent operations

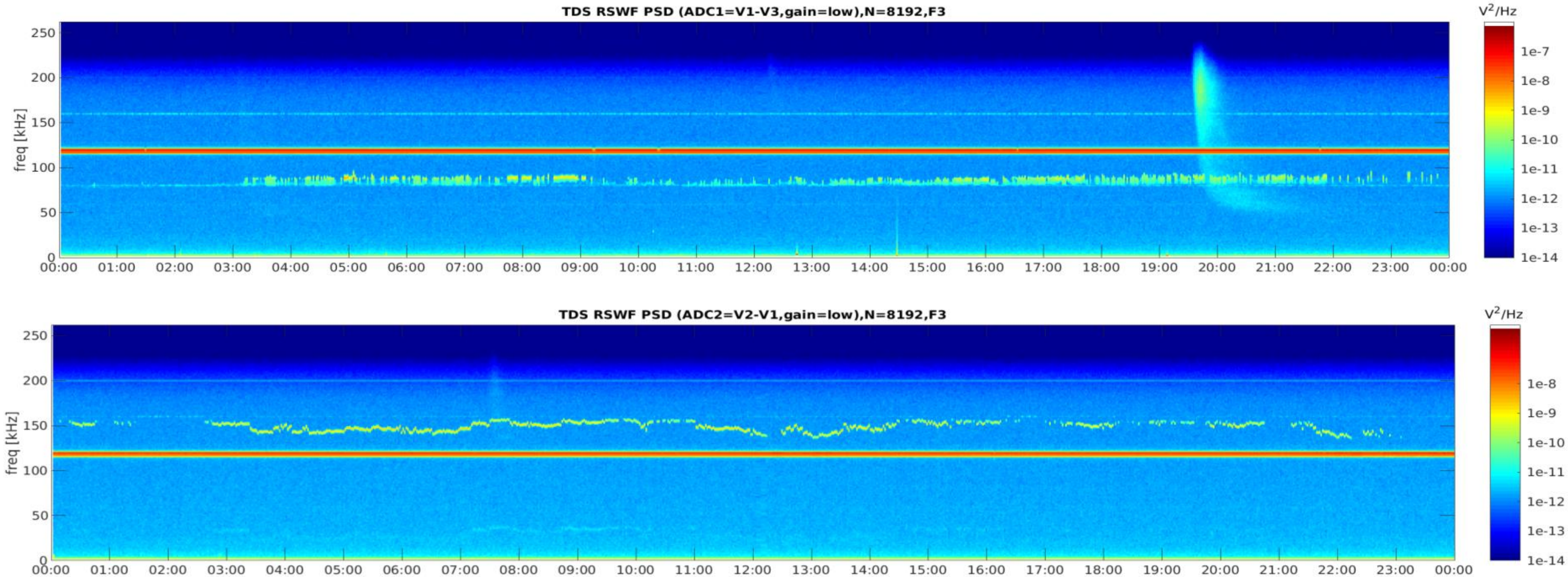
October 3rd, 2023

RPW consortium meeting in Prague

TDS operations

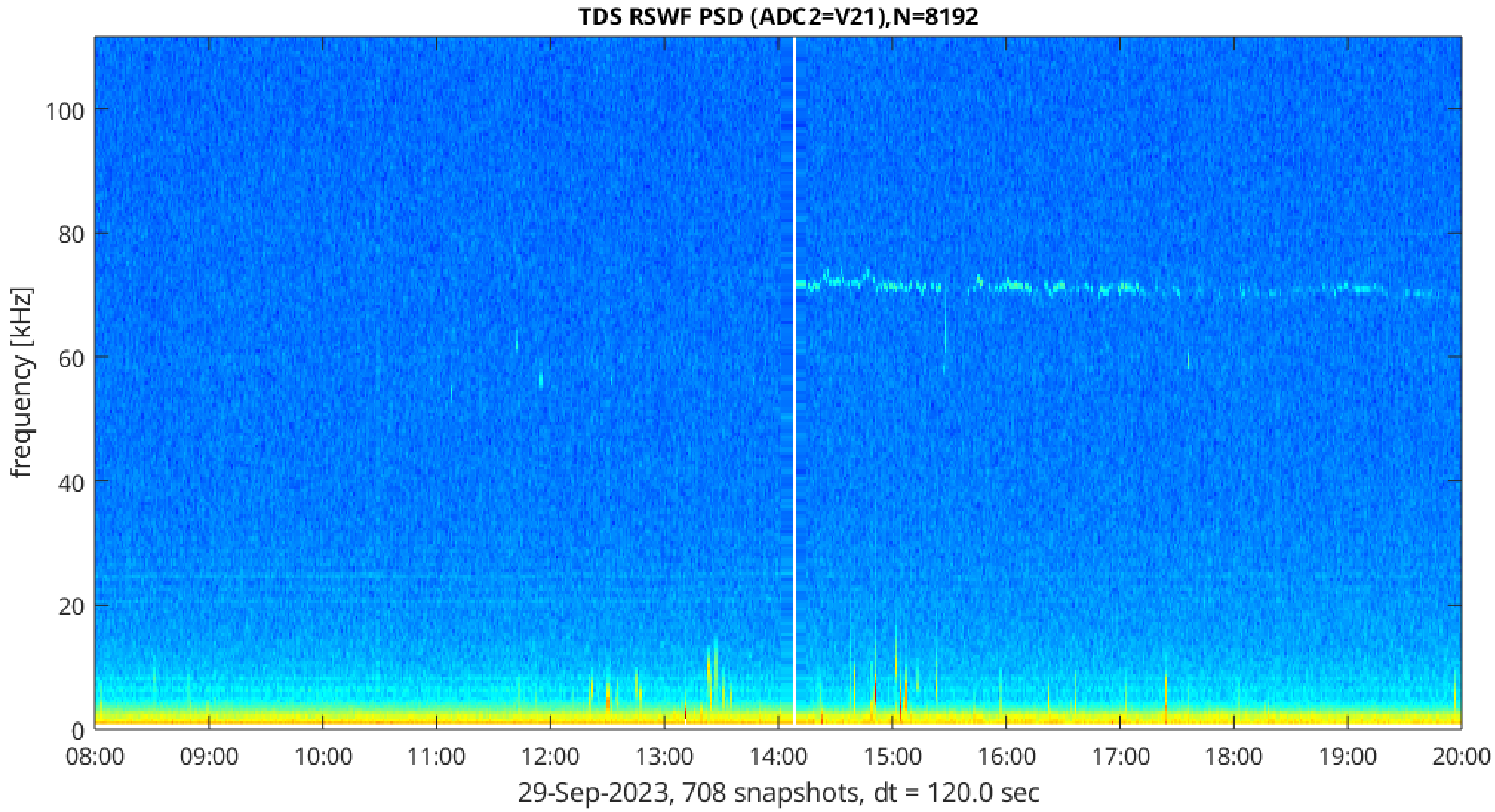
- TDS operates nominally with the wave and dust detection algorithm tuned for optimal efficiency.
- After the flight software updates in 2021 and early 2022, detection now works well both for 262 kHz and 524 kHz sampling.
  - The software patch implements a notch filter for the 120 kHz spacecraft interference which prevented TDS detection at 524 kHz sampling.
- Two standard operation configs defined and used since 2022
  - 524 kHz sampling used < 0.5 AU, 262 kHz sampling used otherwise
  - Combined dipole-monopole antenna config (V1-V3, V1-V3, V2)
  - Low gain mode used
- Depending on the available telemetry, following parameters are varied
  - Cadence and length of periodic snapshots (RSWF) varied from 4k points every 5 minutes to 16k every 11 seconds.
  - Triggered snapshots can be dumped every 2 hours down to every 30 minutes.
  - The maximum amplitude continuous product (MAMP) is enabled when high TM is available

Anomalies, issues



- Yet unexplained interference which first appeared in early 2021.
  - Found to be dependent on BIAS setting of bias current and on heliocentric distance.
  - Often disrupts TDS wave detection when present
  - Since late 2022, the BIAS team uses a more conservative bias current setting which dramatically reduced the occurrence and amplitude of this effect.

TAC data

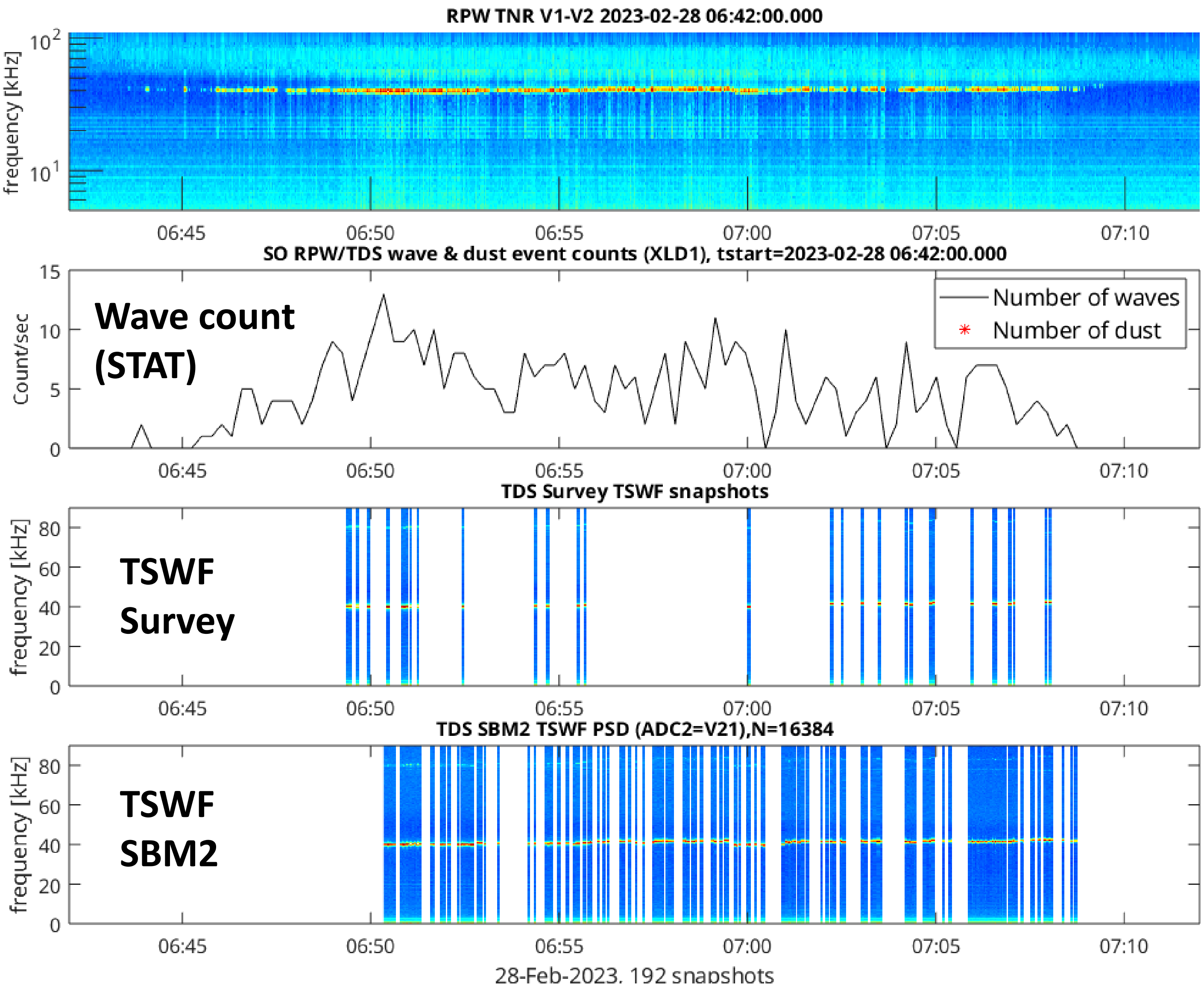


- Special TAC (Turn-Around Calibration) windows are used to check if current BIAS setting is OK and the 50 kHz interference is not excessive.
  - Above: TDS regular snapshot spectrum collected in a recent TAC window
  - low bias current (30% below the current setting) in the first half of the plot, higher in the second (30% above)

SBM2 events

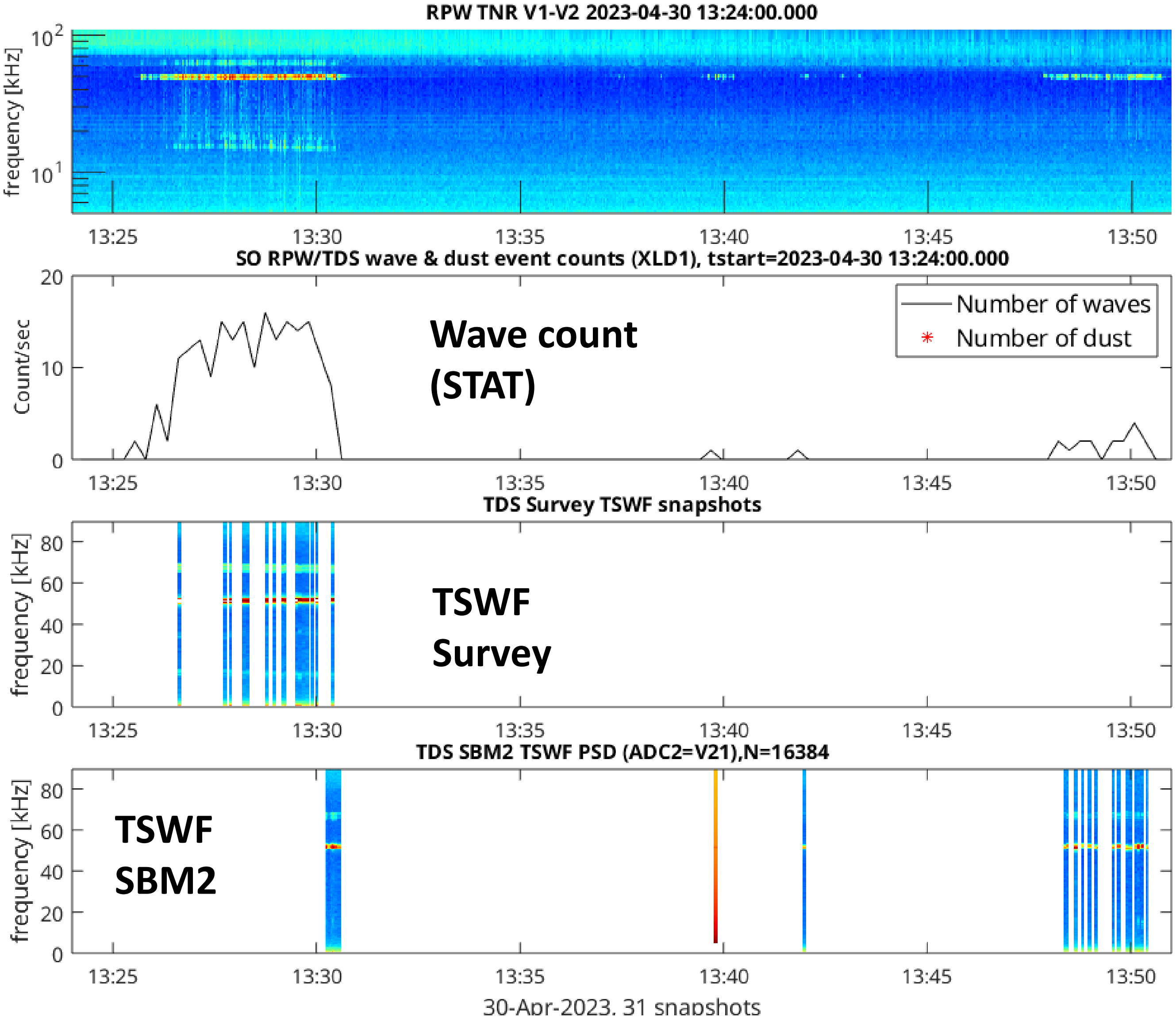
- RPW implements a dedicated triggered burst mode to capture in-situ Type III bursts.
  - The triggering is configured to activate when an extended interval of plasma wave activity is observed by TDS – depends on the TDS on-board wave detection.
  - The detection usually misses the start of the burst, but collects high resolution triggered data for 2 hours after trigger.
  - After the thresholds have been tuned, the algorithm now triggers about 5 times per year and nearly all events are real Type III bursts.
  - No selection is done, all SBM2 data is requested to be down
- The SBM2 triggers in the past 12 months (some of the events are unfortunately incomplete due to missing packets):
  - 2023-08-24T10:02:41.442 (157 TDS snapshots, no bad snapshots)
  - 2023-04-30T13:30:12.472 (35 TDS snapshots, 1 bad)
  - 2023-04-16T11:24:33.868 (240 TDS snapshots, no bad snapshots)
  - 2023-02-28T06:50:11.07 (192 TDS snapshots, no bad snapshots)
  - 2022-09-22T13:44:35.734 (703 TDS snapshots, 71% bad)
  - 2022-04-09T12:15:38.961 (894 TDS snapshots, 5% bad)
- Since the trigger accuracy is very good, but conservative, we may consider lowering the threshold a little to get more events.

SBM2 – February 28, 2023



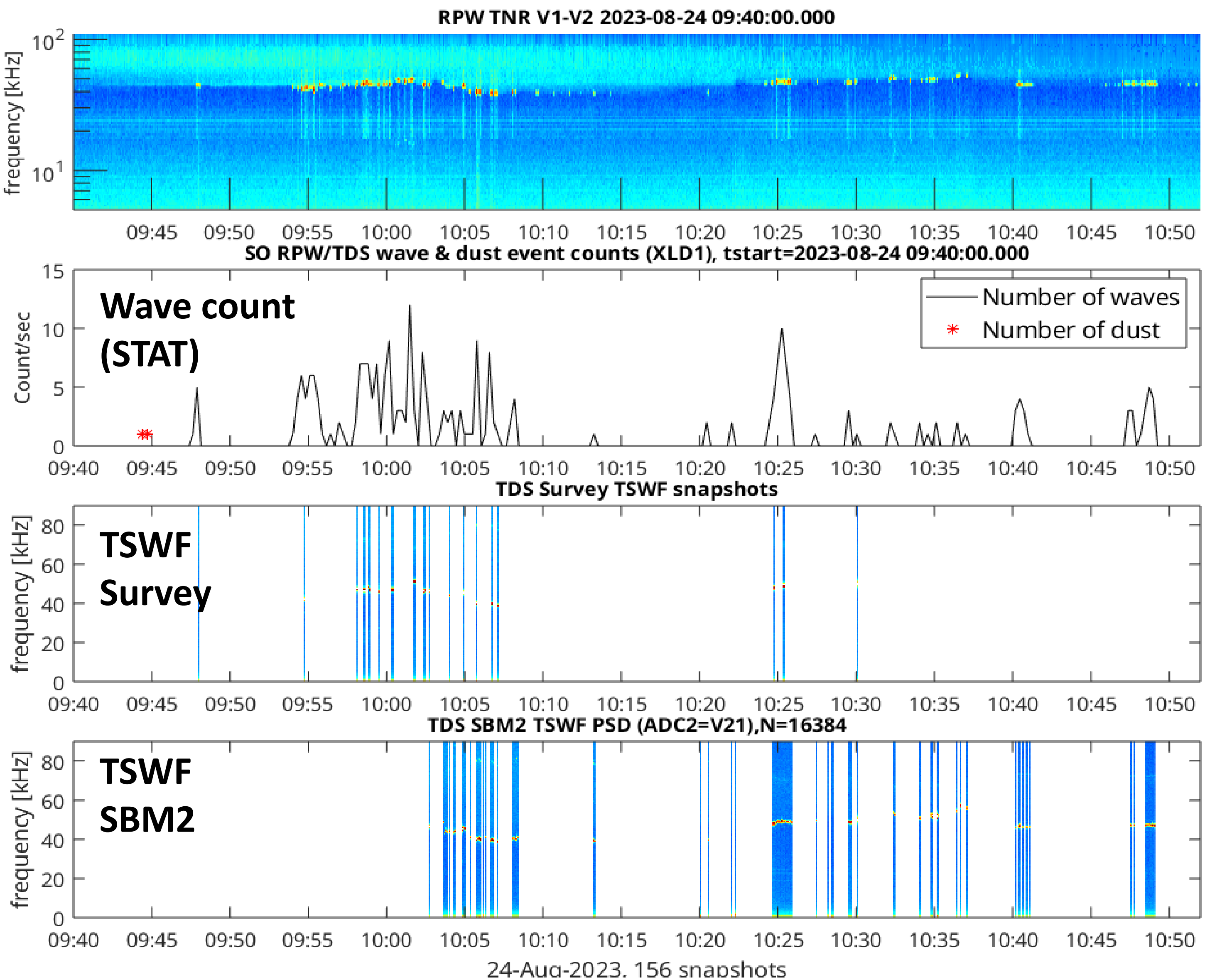
- A Type III burst with ~20 minutes of continuous Langmuir waves
- SBM2 triggers only a few minutes after onset, provides detailed coverage of most of the event.
- Survey data is collected in parallel, so the Survey triggered snapshots provide some coverage of the early phase.

SBM2 – April 30, 2023



- A shorter Type III event with two Langmuir wave intervals.
- Survey and SBM2 data complementary

SBM2 – August 24, 2023



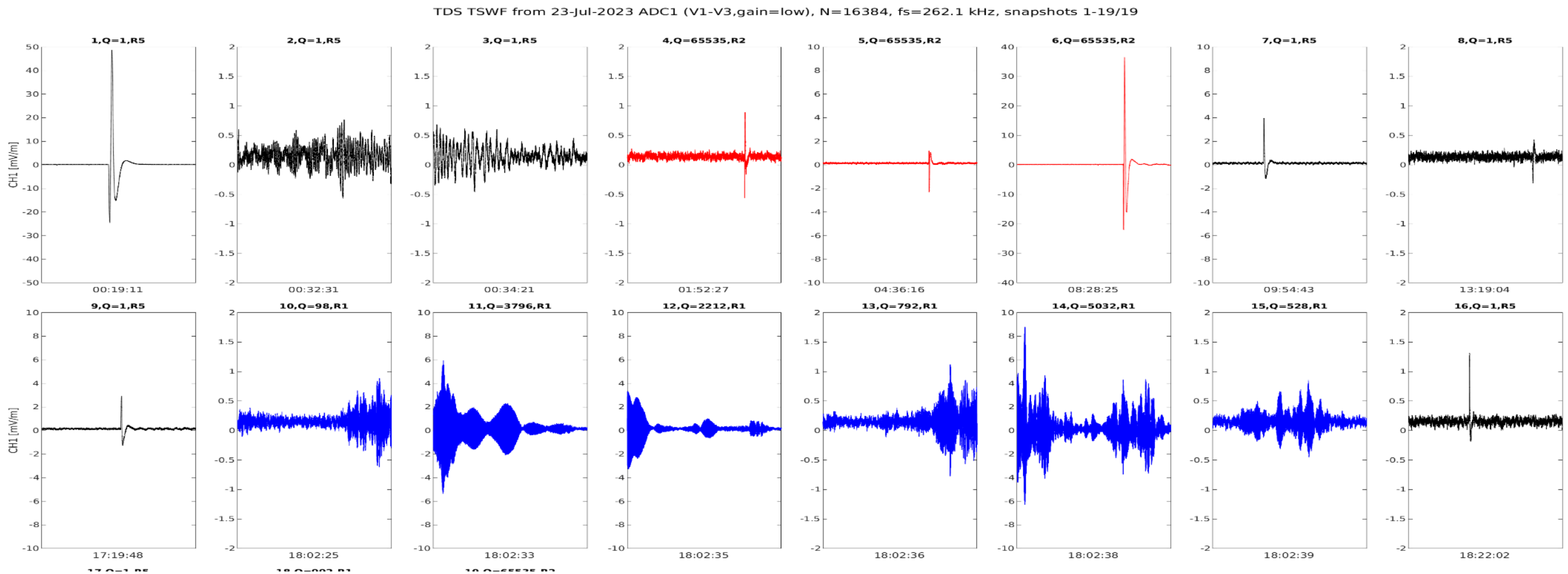
- A long type III event with intermittent Langmuir wave activity
- Survey and SBM2 data complementary

Possible L3 products and improvements to TDS data usability.

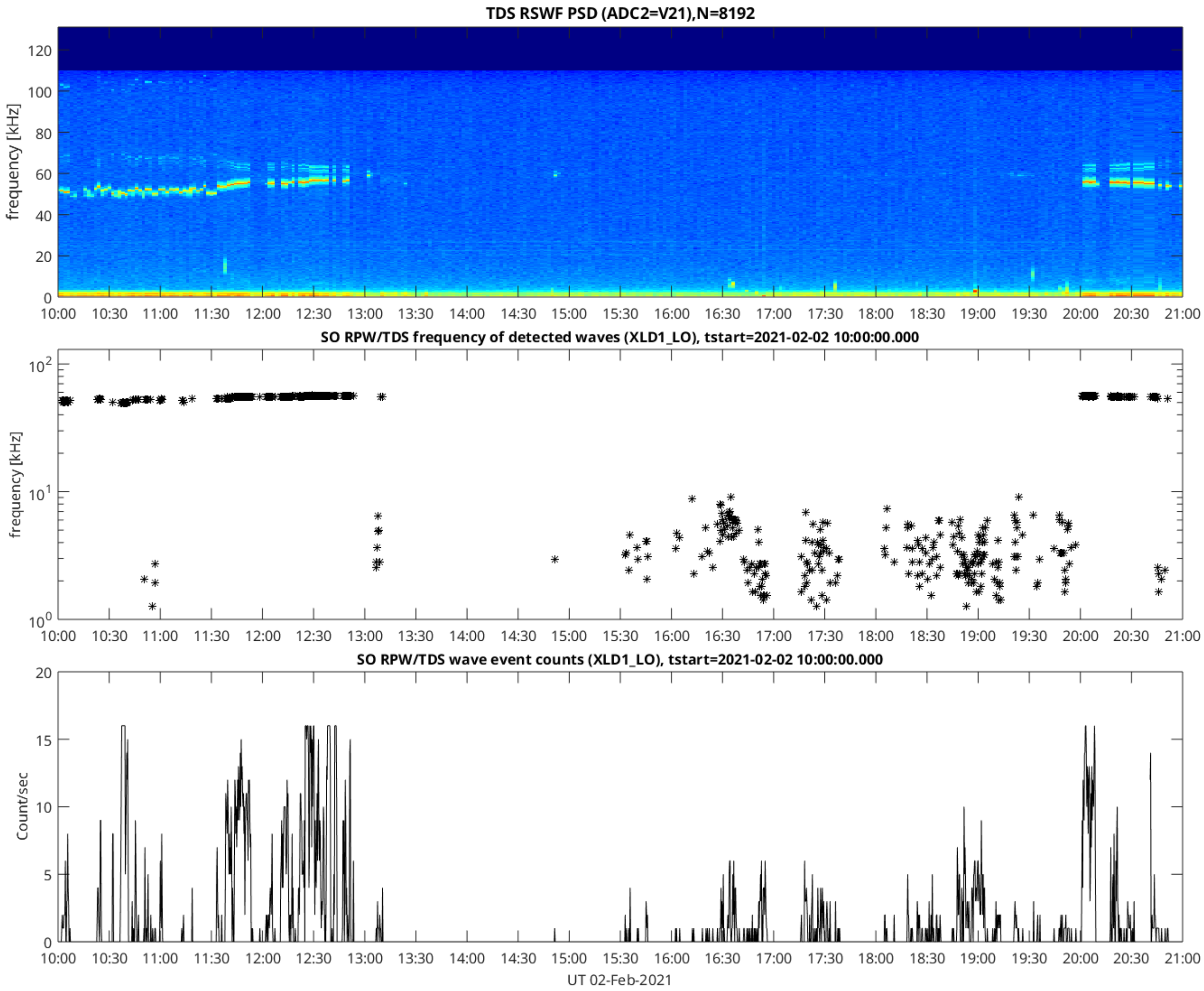
- TDS snapshot data is provided in the form of calibrated time series
  - Data is in sensor coordinates, but the CDF files contain effective antenna directions
  - Conversion to orthogonal frame (e.g SRF) is thus straightforward and can be left to the user.
  - We believe the snapshots are easy to use and no L3 product is needed
- What can be improved:
  - Documentation! Overall, this is a problem for RPW. No good user guide to the data exists.
  - Quality flags and corrected classification
  - Perhaps the STAT data could be improved with information from ground processed snapshots and MAMP. This would be a basis for a new L3 product. This is labor-intensive, so it will take a while.

Corrected classification

- TDS algorithm classifies snapshots as waves / dust / other.
  - This classification is present in the data and useful for statistical studies
  - However, the algorithm is not perfect and in particular, quite a few dust spikes are mis-identified.
  - **Plan:** to add a ground-adjusted category to the data, correcting the mistakes of the algorithm.



Corrected and cleaned statistics



- TDS statistical data is a popular dataset exploited by many papers.
- Relies on detection algorithm correctness and is sometimes broken due to interference or bad other factors.
- A quality factor indicating valid data points should be included.

Planned operations and data

- TDS modes and configuration changes we are considering:
  - We plan to keep the triggering algorithm and antenna config the same for consistency of statistical data.
  - Possibly increase the statistical data cadence to 8 seconds (from 16s).
  - Use high gain electric field measurements above ~0.8 AU
  - Longer triggered snapshots (32k) when telemetry is available.
- Short term data update plans (~1 year)
  - Release a TDS data user manual
  - Add corrected classification to triggered snapshots
  - Add quality factor to STAT data
- Long term: possible new datasets (? years)
  - Enhanced statistics – STAT data complemented with information from triggered snapshots and MAMP.