



# THE THR STATUS

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# The TNR-HFR receiver

**TNR-HFR** broadband and high-resolution spectrometer

## TNR:

- quasi-instantaneous spectra in 4 frequency band (32 log-spaced frequencies per band)
- 4 kHz to 1 MHz
- 6 electric + 1 MF magnetic

## HFR:

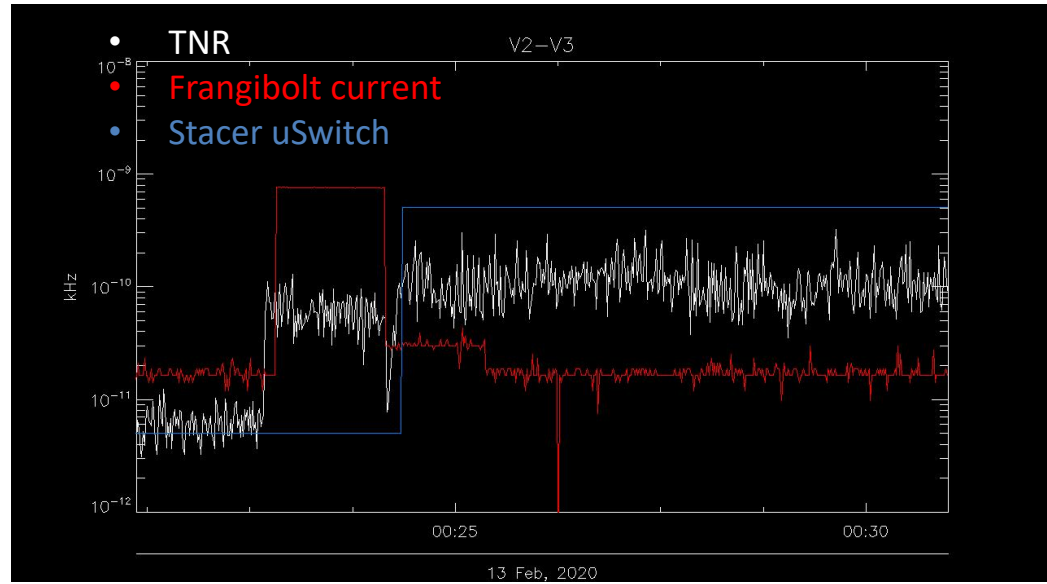
- Sweeping receiver
- 500 kHz to 16.4 MHz : 2 bands
- Only electric dipole measurements

Band	Frequency range	Bandwidth	Frequency resolution	Amplitude resolution	Sensitivity	Dynamic range
A	4 kHz – 16 kHz	12 kHz	32 log-freq. $\Delta f/f = 4.3 \%$	$\leq 0.5\text{dB}$	$\leq 20\text{nV}/\sqrt{\text{Hz}}$	$\geq 120\text{dB}$
B	16 kHz – 64 kHz	48 kHz				$\geq 114\text{dB}$
C	64 kHz – 256 kHz	192 kHz				$\geq 108\text{dB}$
D	256 kHz – 1024 kHz	768 kHz				$\geq 102\text{dB}$
HF1	0.4 MHz – 3.6 MHz	3.2 MHz	64x50kHz	$\leq 0.5\text{dB}$	$\leq 130\text{nV}/\sqrt{\text{Hz}}$	$\geq 80\text{dB}$
HF2	3.6 MHz – 16.4 MHz	12.8 MHz	128x100kHz	$\leq 0.5\text{dB}$	$\leq 130\text{nV}/\sqrt{\text{Hz}}$	$\geq 80\text{dB}$

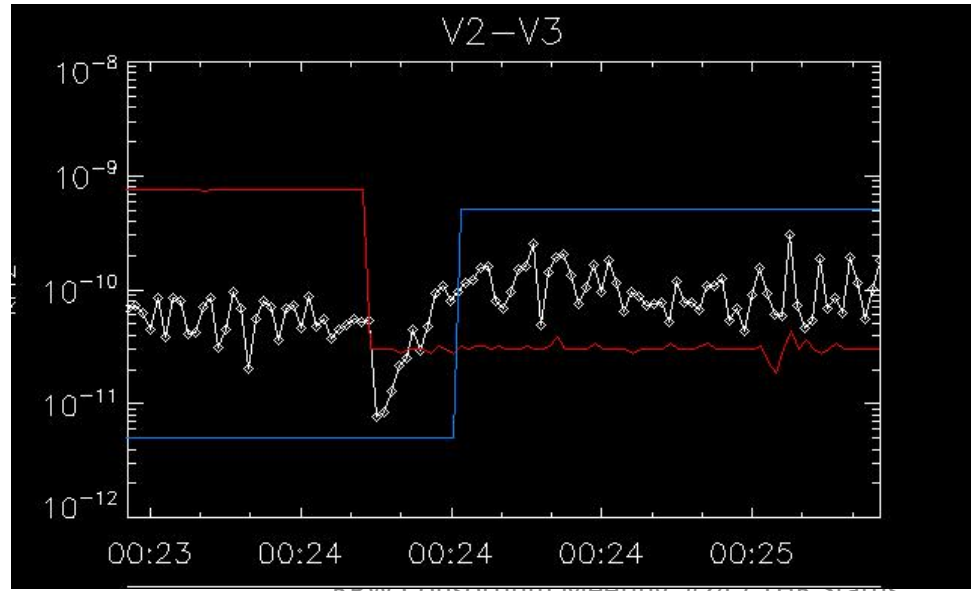
# Main science goals

- Measurement of the Quasi-thermal Noise produced by the motion of solar wind electrons around the electric antennas. The spectroscopy of this noise will provide electron properties such as their density and temperature.
- Measurement of Langmuir-like wave spectrum
- Measurement and tracking of solar radio bursts : by processing cross-correlations between two channels connected to different antennas, the TNR-HFR has direction-finding capabilities for tracking the solar radio bursts.
- TNR-HFR is sensitive to dust impacts via the corresponding plasma cloud and pickup signal on the electric field antennas.

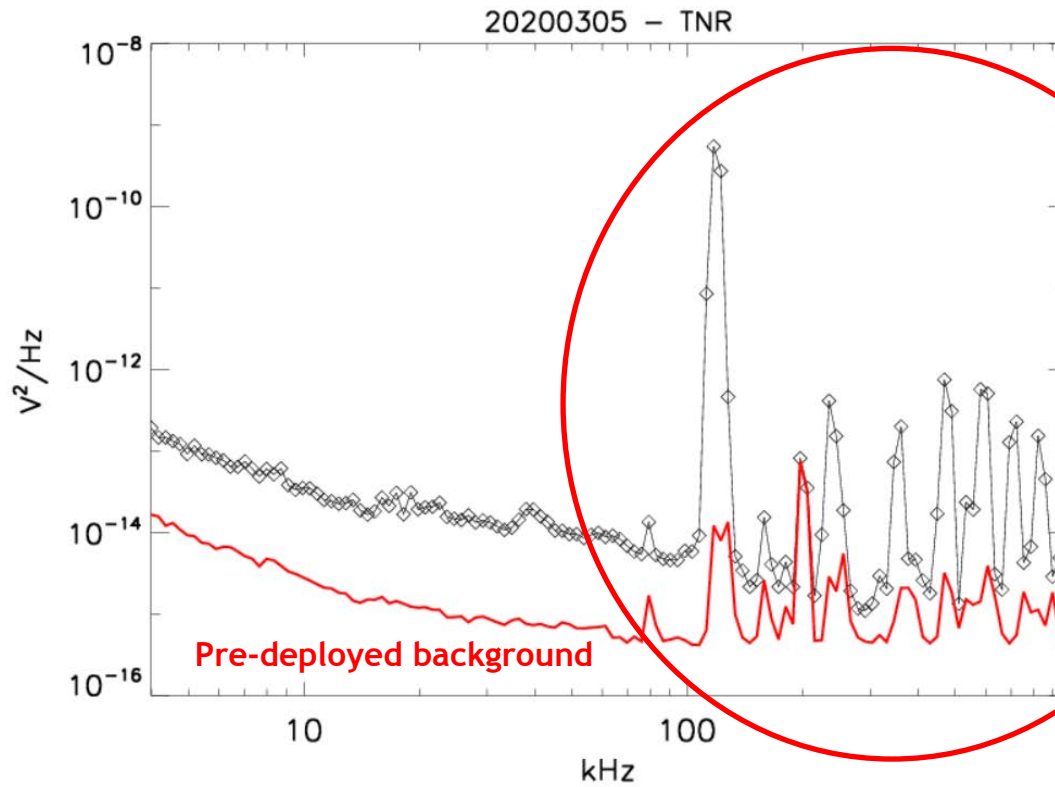
# Antenna's deployment



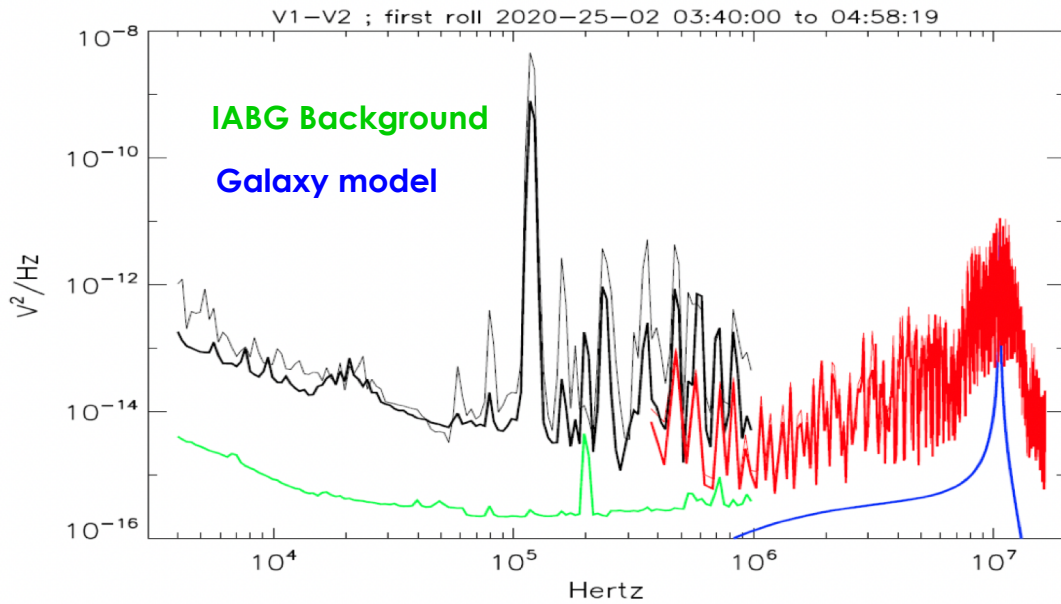
Switching on the power supply for the FB and after some seconds triggering of the current into the FB.



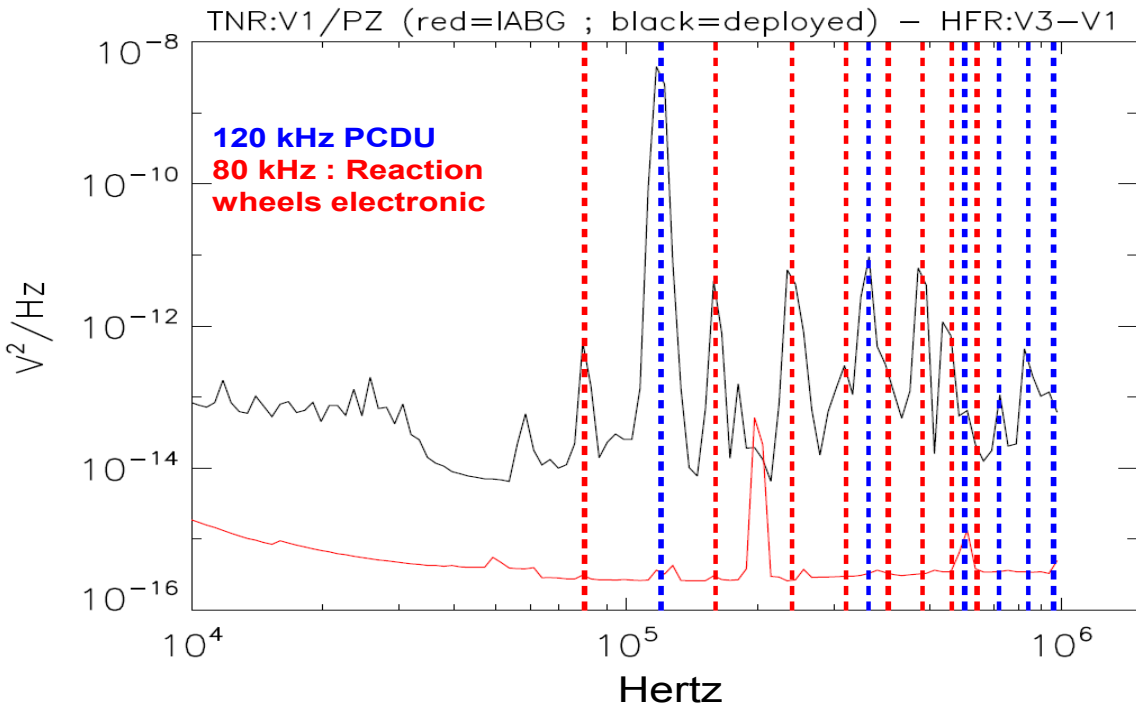
Time resolution 0,4 s



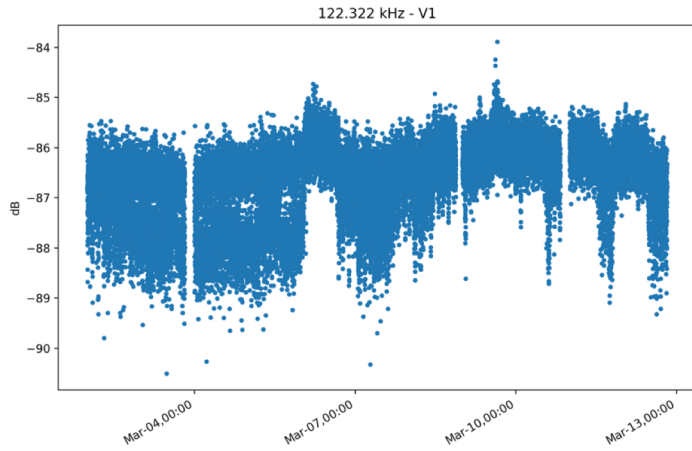
Strong interferences both before and after deployment



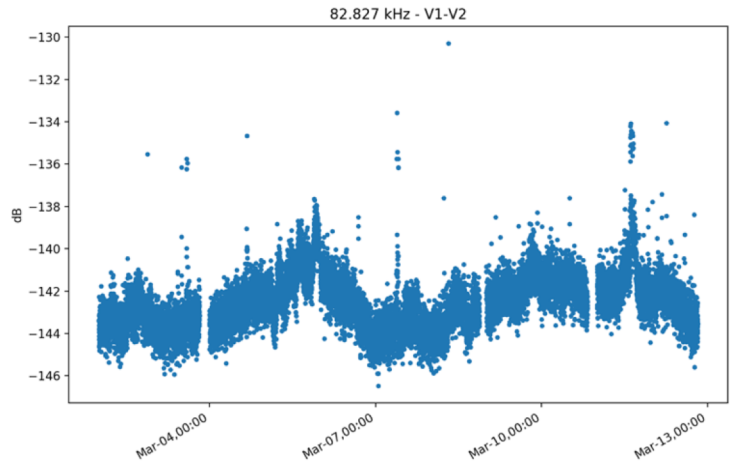
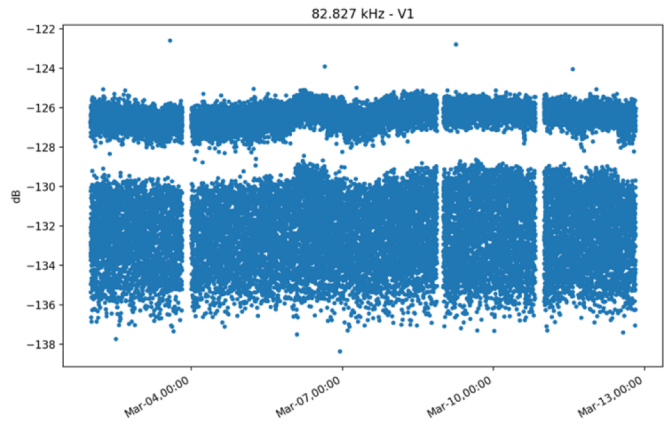
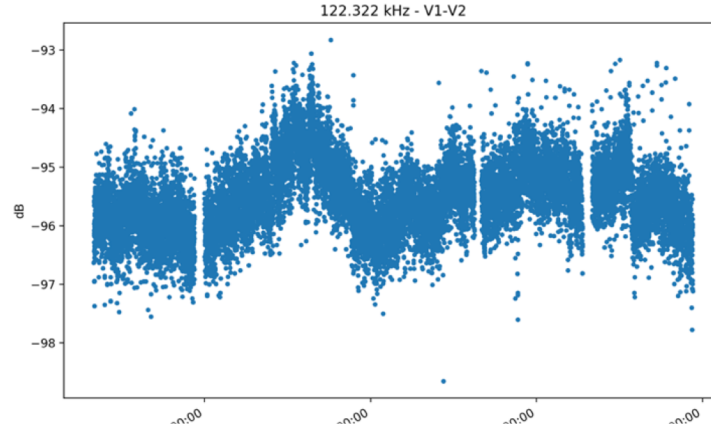
EMC perturbations  
on TNR- HFR



## monopole



## dipole



High frequency interference : 3-4 min (mHz) → this is however affected by the low time resolution of TNR

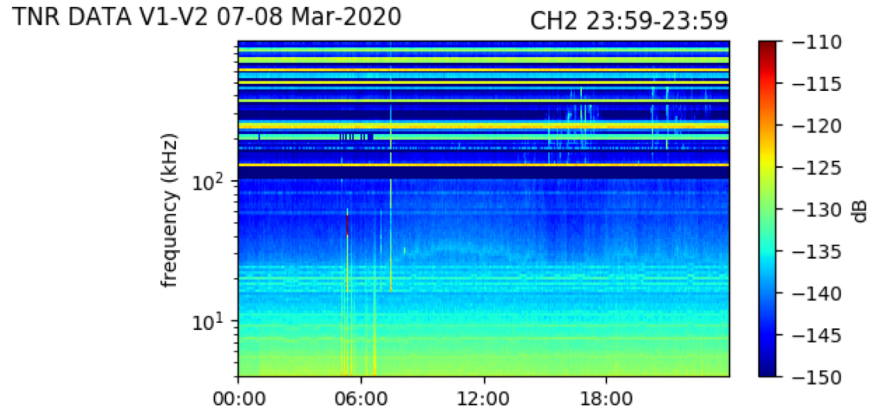
TDS shows that low frequency interference is reduced in Dipole

## THR team:

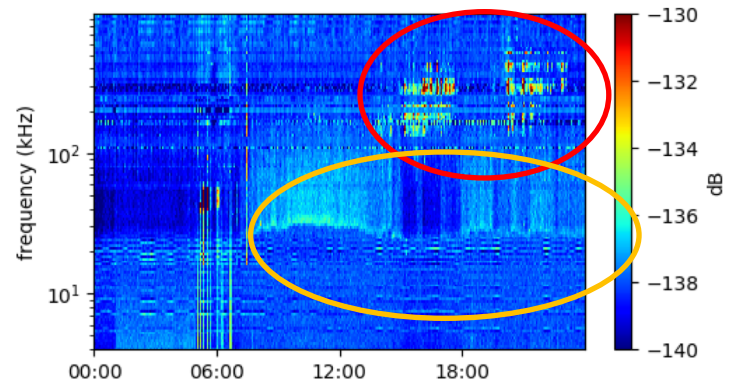
- Working on developing of filtering procedure (on ground) on the data (examples in the following)
- Discussion ongoing for changing the parameters of the TNR digital filter to reduce the effect of interference → need of flight software patch
- Analysis ongoing on targeted measurement campaigns to define the less polluted frequencies of HFR.



The presence of EMC disturbances does not mean that very precise scientific measurements cannot be made with TNR-HFR:



Raw TNR data

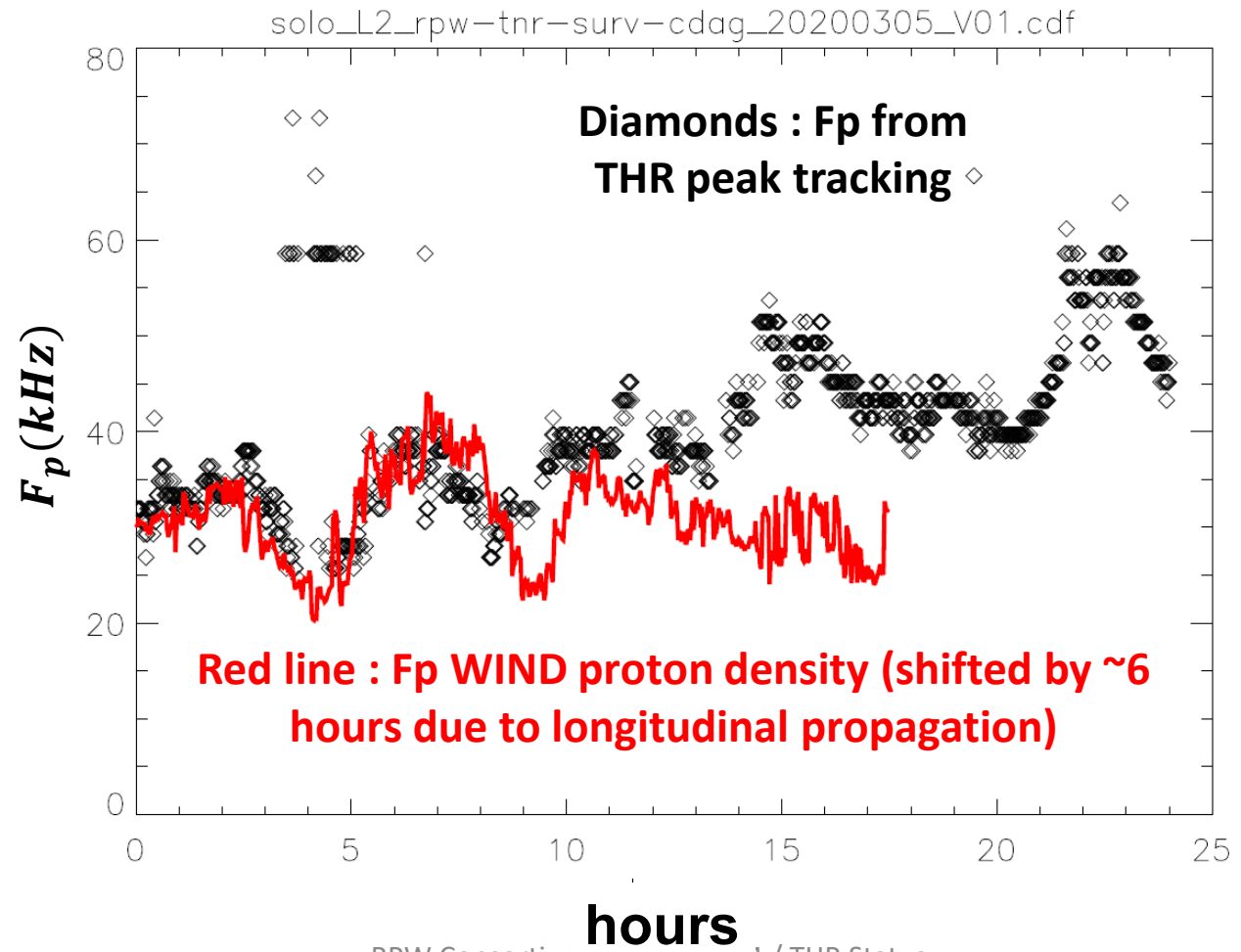


AKR signals

Very clear plasma peak

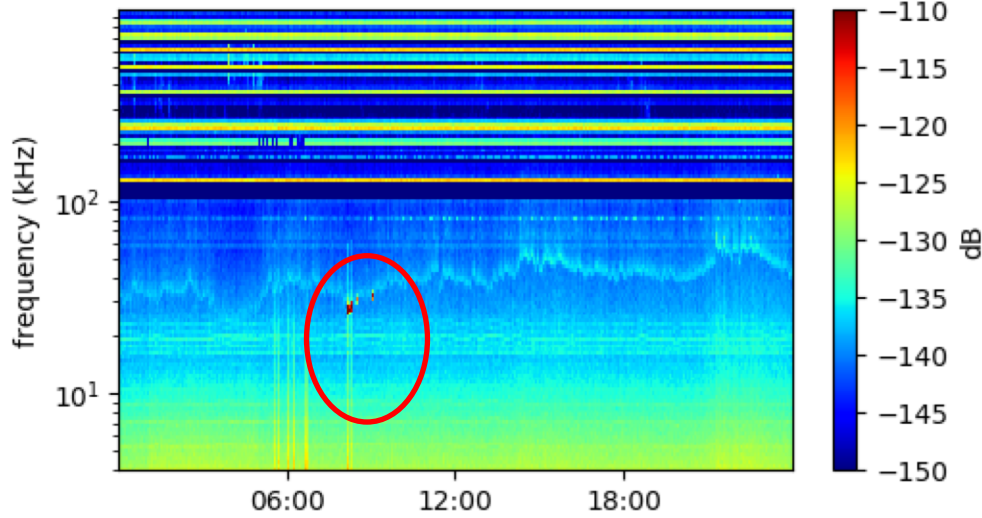
Passband filtered data

# $f_p$ evaluation in the solar wind

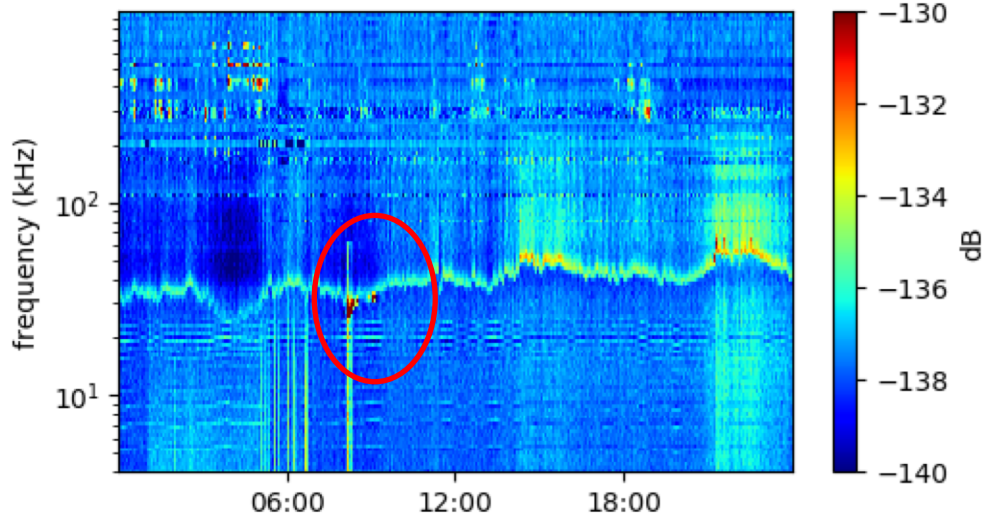


NR DATA V1-V2 05-05 Mar-2020

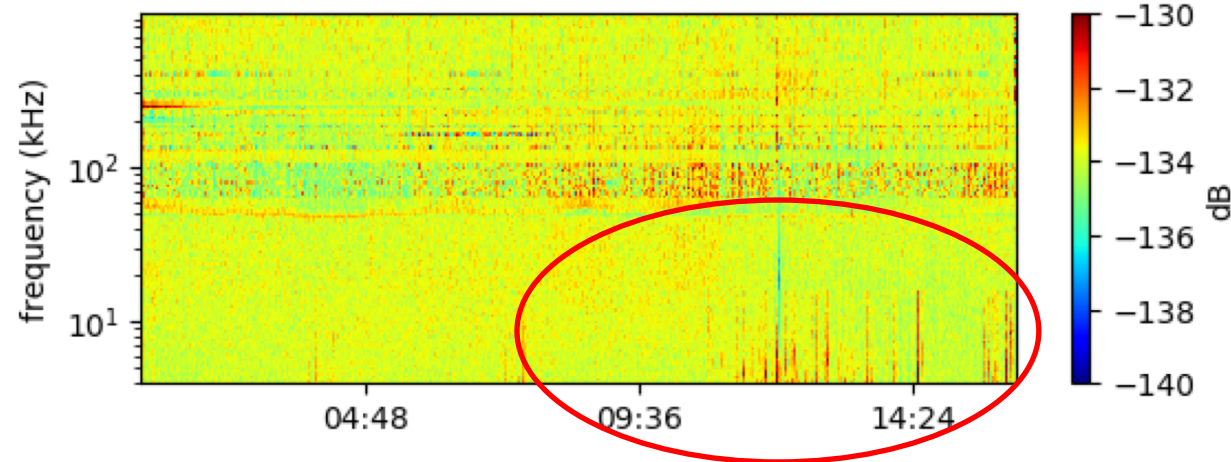
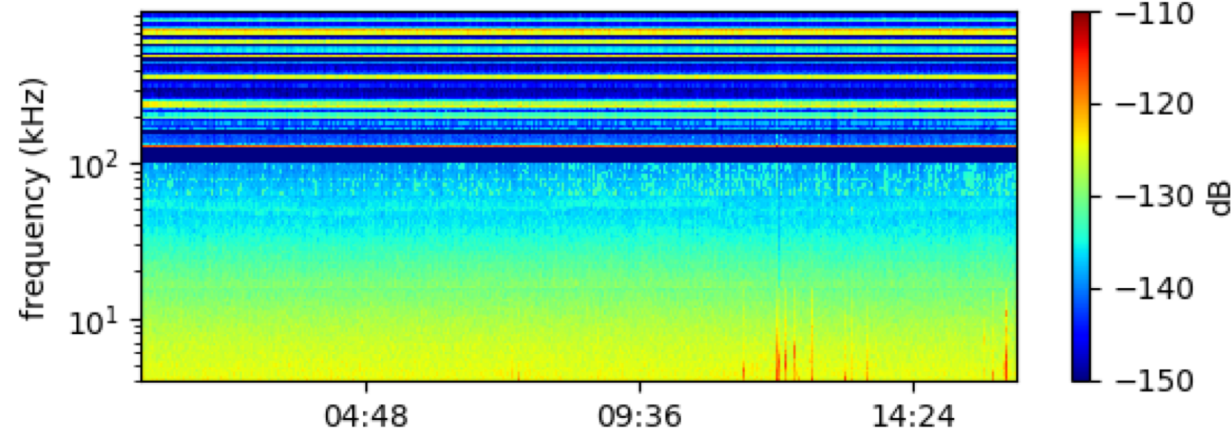
CH2 00:00-23:59



Langmuir waves



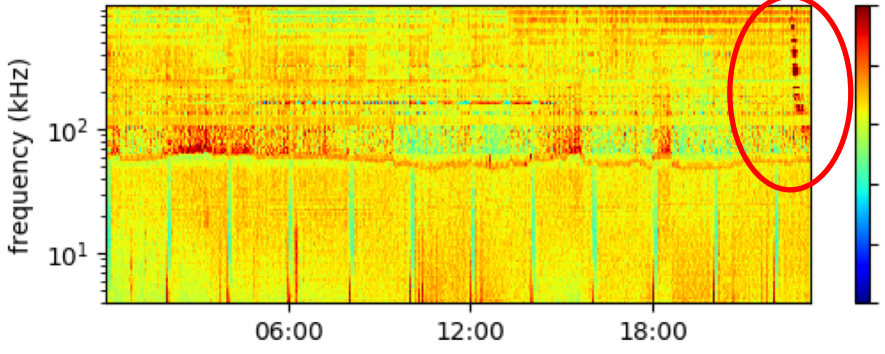
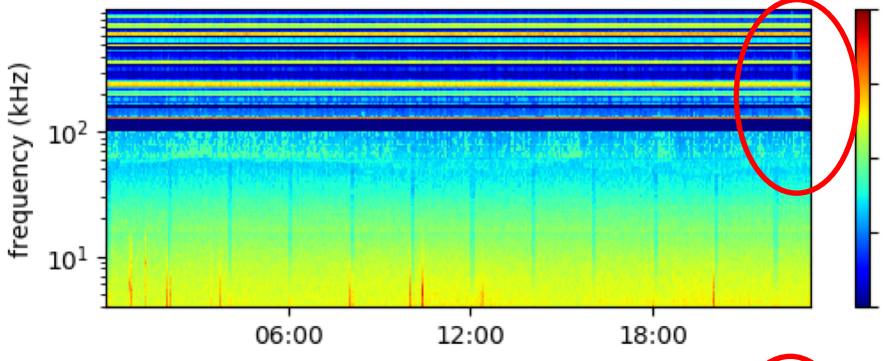
TNR DATA 30-May-2020 (00:50:28)-30-May-2020 (16:13:00)  
V1-V2 CH=1



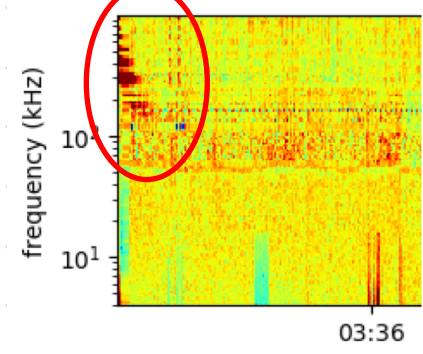
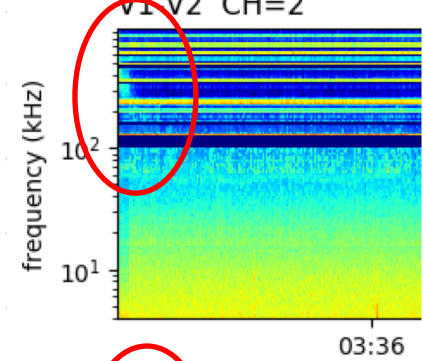
Comet ion tail transit:  
Increased dust activity

# Type III radio bursts

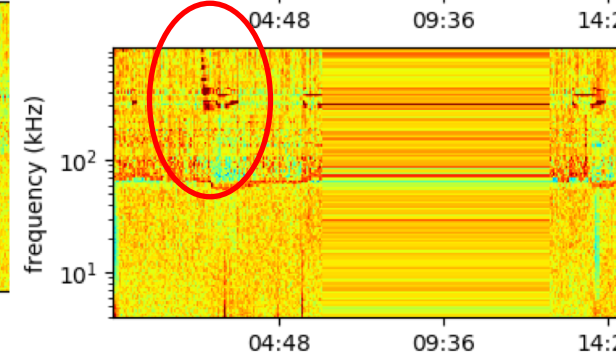
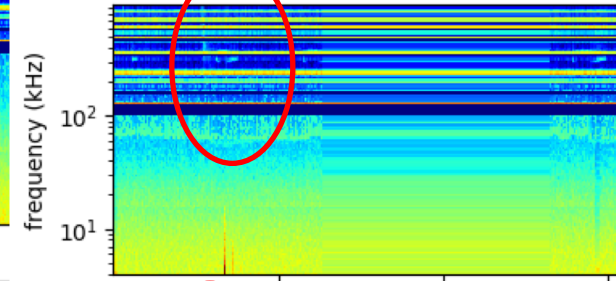
TNR DATA 01-Jun-2020 (00:00:20)-01-Jun-2020 (23:10:00)  
V1-V2 CH=1



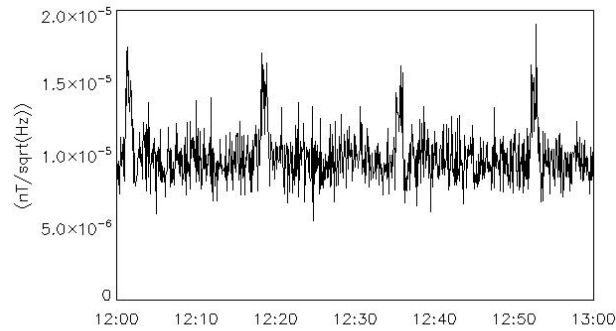
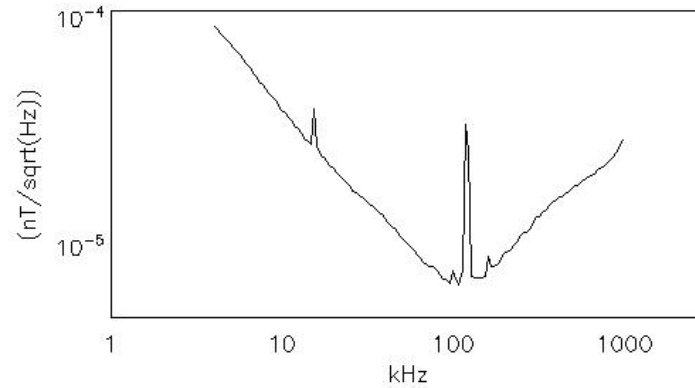
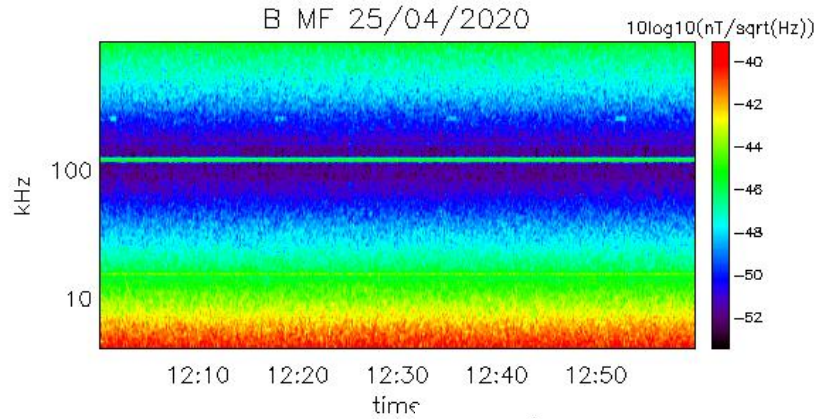
TNR DATA 05-Jun-2020 (00:00:05)-05-Jun-2020 (04:35:33)  
V1-V2 CH=2



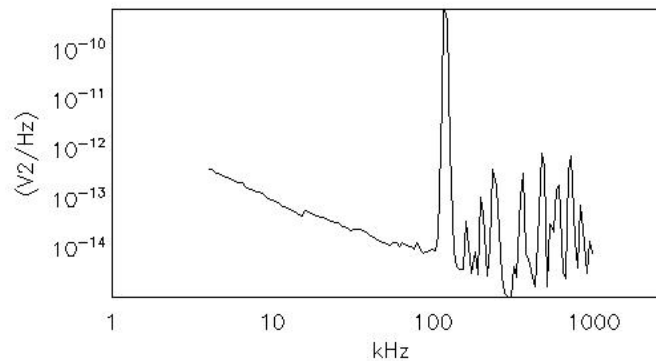
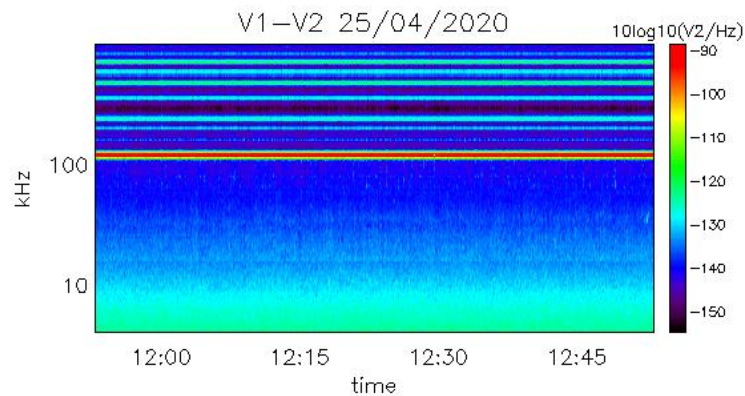
TNR DATA 06-Jun-2020 (00:00:18)-06-Jun-2020 (04:35:33)  
V1-V2 CH=2



Simultaneous measurements of electric and magnetic spectra → phase



244.6 and 255.5 kHz

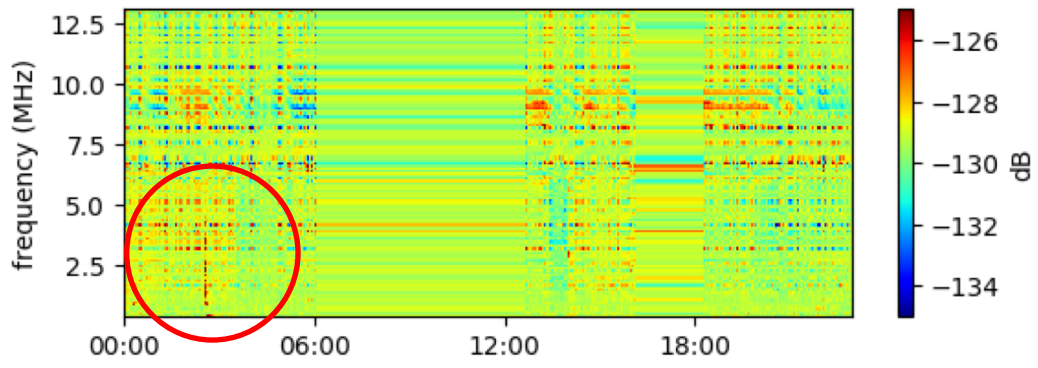
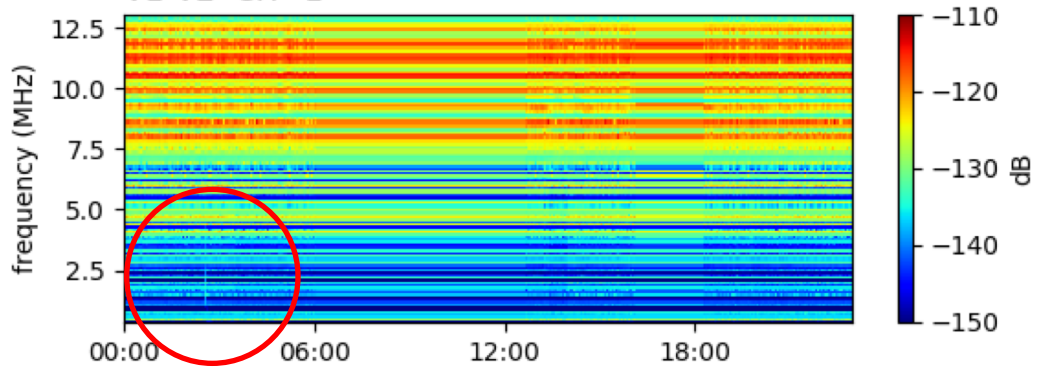


# HFR spectra



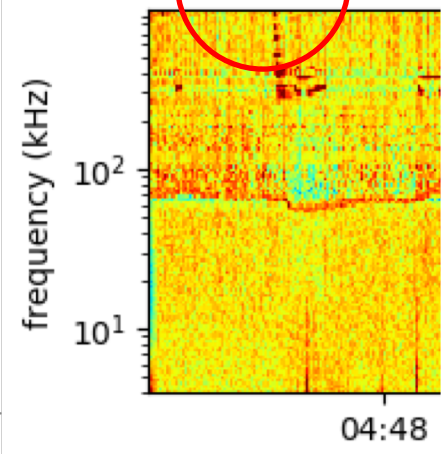
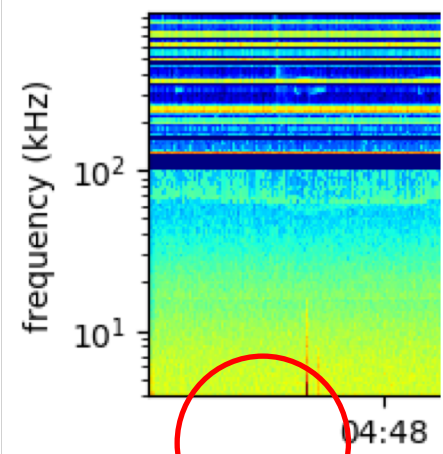
Very noisy  
Spectra: need of a efficient filter and observing strategies

TNR DATA 05-Jun-2020 (23:58:35)-06-Jun-2020 (22:57:12)  
V1-V2 CH=1



Physical signals visible:  
High frequency part of the type III

TNR DATA 06-Ju  
V1-V2 CH=2



# TNR-HFR Calibrations Software **CALBAR**

- Convert TNR-HFR L1 files to L2 (system level calibration + Antennas/SCM)
- Written in IDL
- wrapper script for execution by ROC framework
  
- CALBAR software currently allows to convert TNR and HFR electric data in physical units [ $V^2/Hz$ ] and TNR magnetic data [ $B^2/Hz$ ]
- System level calibration parameters implemented in the software (these allow to account for both **THR** and **PA** temperatures, and **SCM** temperatures).
- Correction of the effect of 75 Ohm cable, used during system level calibration measurements, on HFR data.
- wrapper script for execution by ROC framework.
- Conversion from [ $V^2/Hz$ ] to [ $W/m^2Hz$ ] is present: need of the effective length of antennas.



# OPEN ISSUES

- Detected problem on the THR flight software: sometimes the TNR time value is incorrect → waiting for an upgrade of the THR flight software the problem will be addressed in the CALBAR by calculating the right times through an interpolation with the neighbor times
- Inversion of the data between channel 1 and 2 when both channels measure TNR. The issue is now in the process of being analyzed by the ROC to create the correct L1 files.
- Provide summary plots on regular basis

# Upcoming activities

- Analysis of data acquired during the S/C calibration rolls
- Starting the fitting of QTN spectra from TNR data
- Analysis on the monopole data to look for dust impact

Validate the LL products → coarse part of the CUC time, AGC and median value of the radio flux (around 1 MHz), plasma frequency index )

# Possible publications

- Multi-spacecraft analysis of Type III emissions
- Study of dust impacts during the Cometary crossing and in the heliosphere in general
- Coordinated observations with STIX & EPD (TBC)
- Supporting data for several other studies