

Some 'interesting' observations from PAS – for comparison with RPW

General info/Context

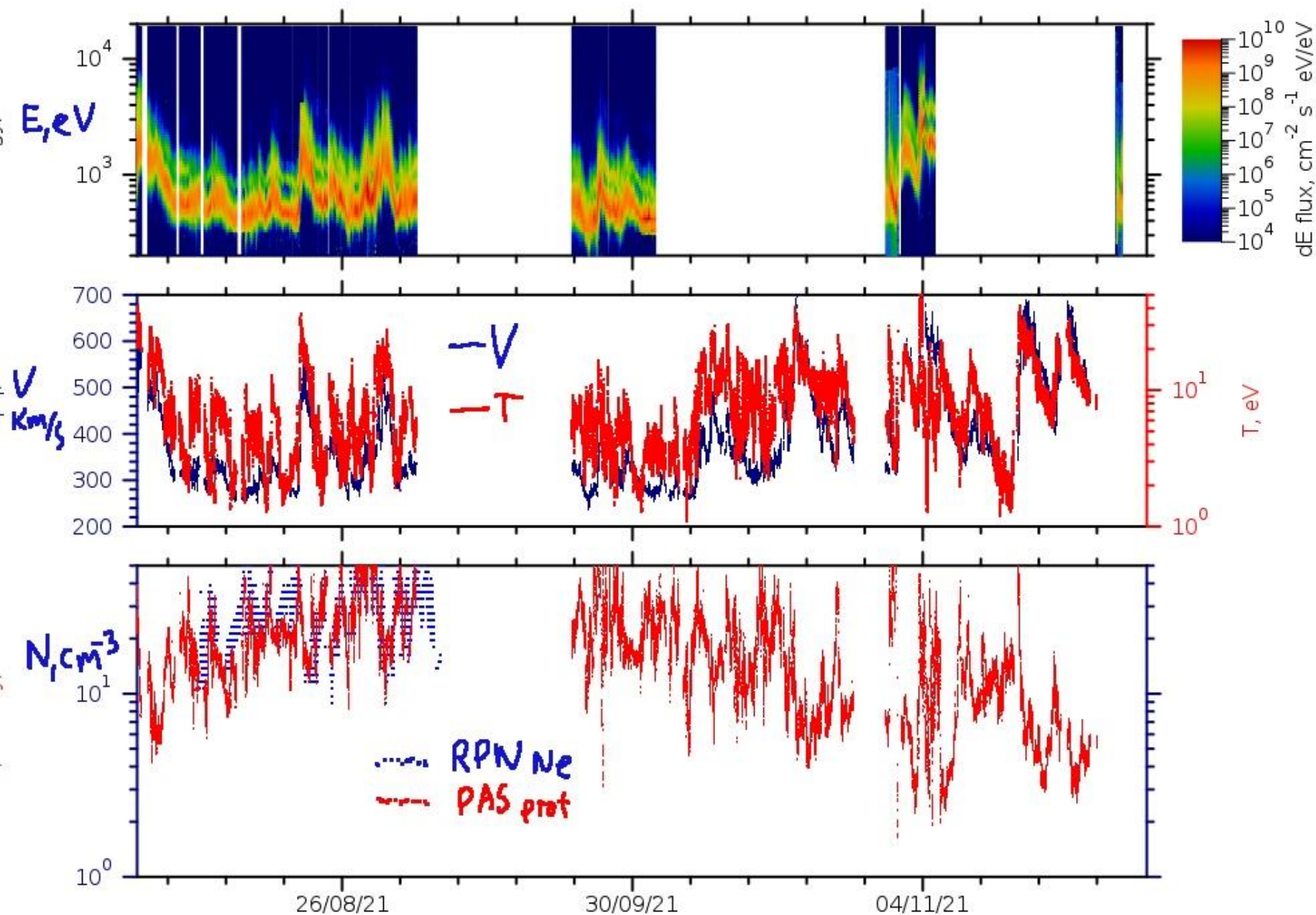
OPERATION: After a 'smooth' commissioning, we have a complex first year of operations (*DPU 1 difficulties, Soft to improve*). Things seem more stable, now, and we (PAS) are in continuous operation since June 2021. **Everything Ok except that we have no PAS burst presently (should be solved beginning of next year).**

SCIENCE: PAS is working well but present an unexpected low geometrical factor at low energy (~below 350 eV, typically). The calibration was then more difficult, especially in situation of very slow wind (below 320 km/s). An intensive optimization of the calibration was performed (Andrei Fedorov), taking into consideration several months of observations. *This recalibration was largely based on RPW density measurements.*

This was finalized last week. The whole data set is being reprocessed.

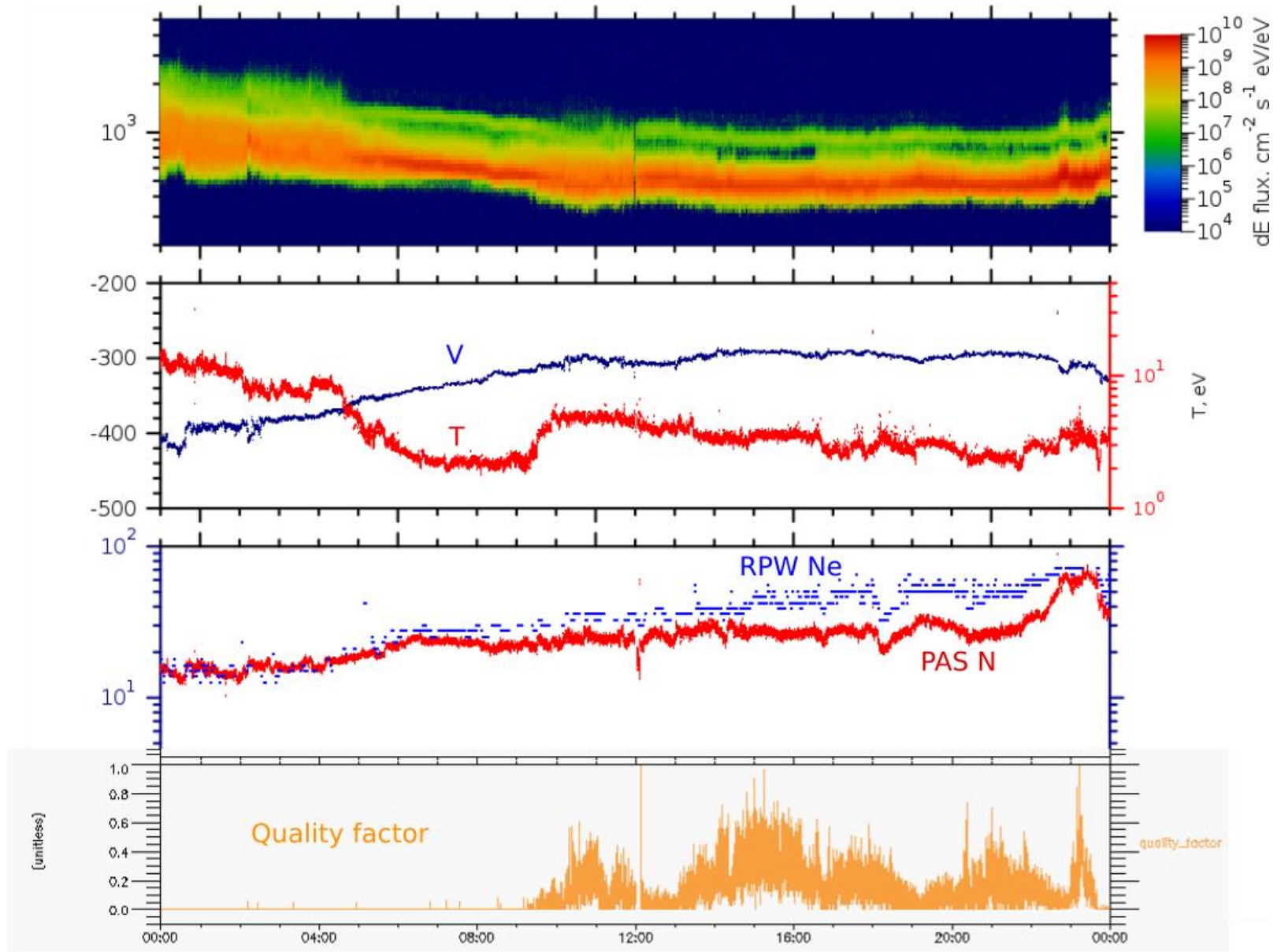
The complete set of PAS L2 data should be available very soon (backward reprocessing. Summer/autumn 2021 is available)

PAS L2 Data Processing. CALIBRATION WITH RPW (Andrei Fedorov)



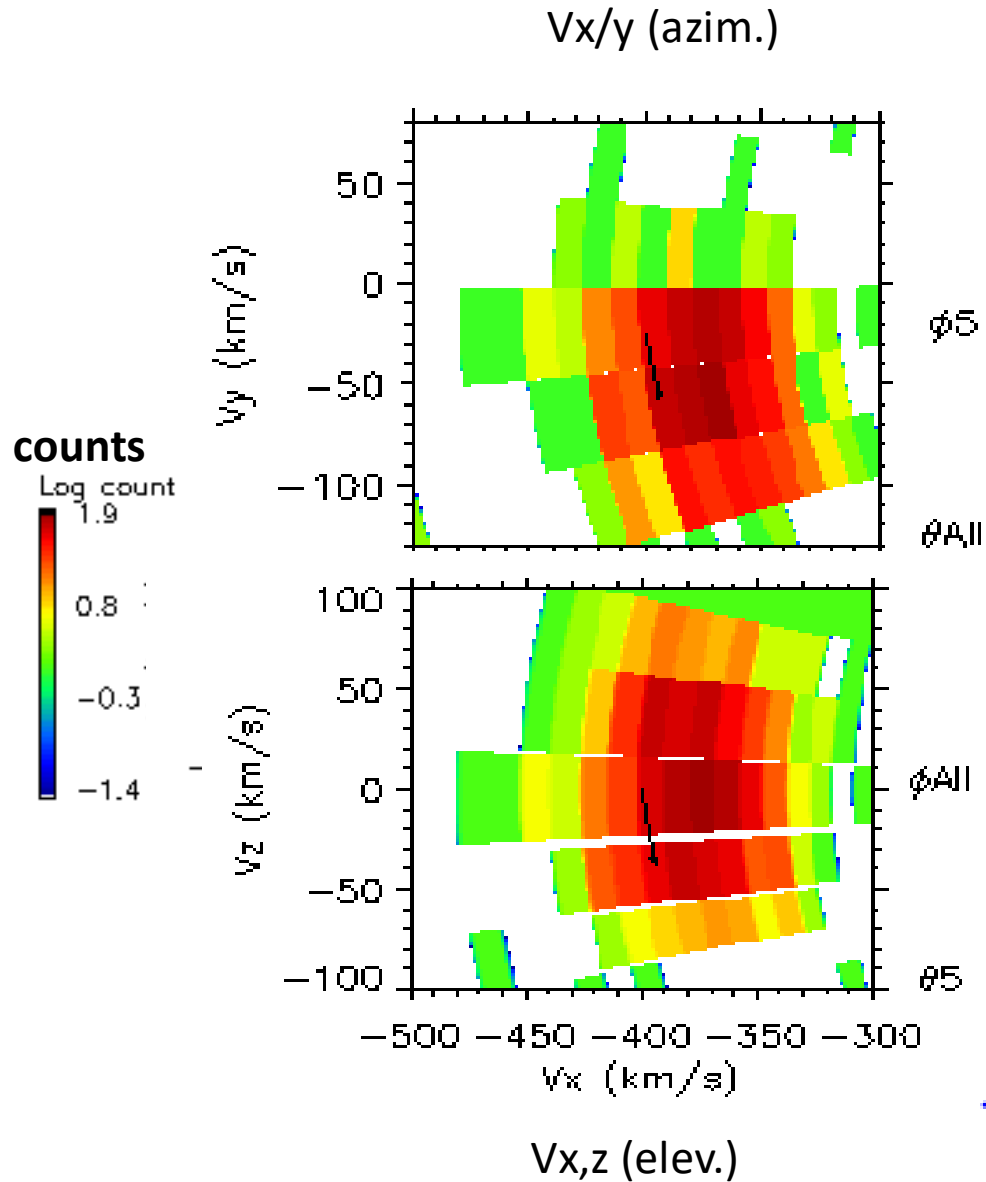
- 1) PAS data processing scripts V.9.0 are ready
- 2) PAS L2 V02 massive CDF processing is ready (Alain)
- 3) The CDFs V02 contains a special "Validity_factor"
- 4) August – Nov 2021 data are ready

PAS L2 Data Processing



- 1 PAS data processing scripts V.9.0 are ready
- 2 PAS L2 V02 massive CDF processing is ready (Alain)
- 3 The CDFs V02 contains a special "Validity_factor"
- 4 August – Nov 2021 data are ready

PAS : Example of measurements



Example of measurements (in counts). For a 'Normal' SW: 360 km/s, 9 cm⁻³, 10 eV. PAS gets a maximum counts/pixel ~ 80 and total counts ~ 2100.

statistical accuracy:

Density: 2400 counts corresponds to ~ 10 cm⁻³.

$dN/N \sim \text{Sqrt}(\text{cts})/\text{cts} \sim 0.02$ (2%)

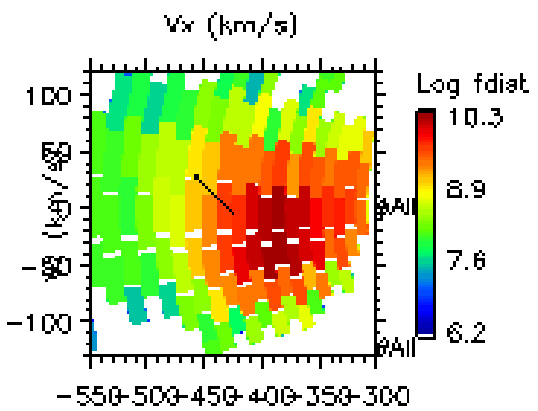
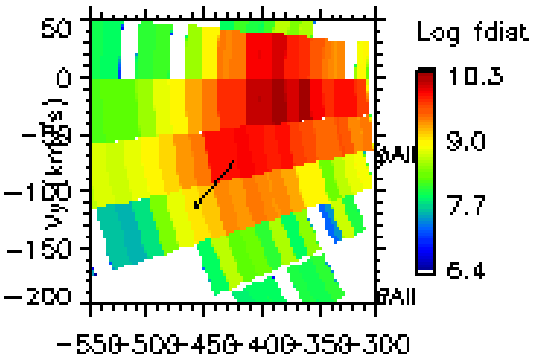
Typically, for 2 σ : 5 \pm 0.3 cm⁻³, 10 \pm 0.4 cm⁻³, 20 \pm 0.56 cm⁻³, 40 \pm 0.8 cm⁻³

Velocity: **$dV/V \sim \text{Sqrt}(T/\langle E \rangle)/\text{Sqrt}(N) \sim 0.25 \%$**

Typically, for 2 σ : 350 \pm 2 km/s and angular accuracy: ~ 2°

CAVEAT: be carefull at low energies ($V < 320$ km/s).

A typical proton VDF



Vr/Vt and Vr/Vn 2D slices

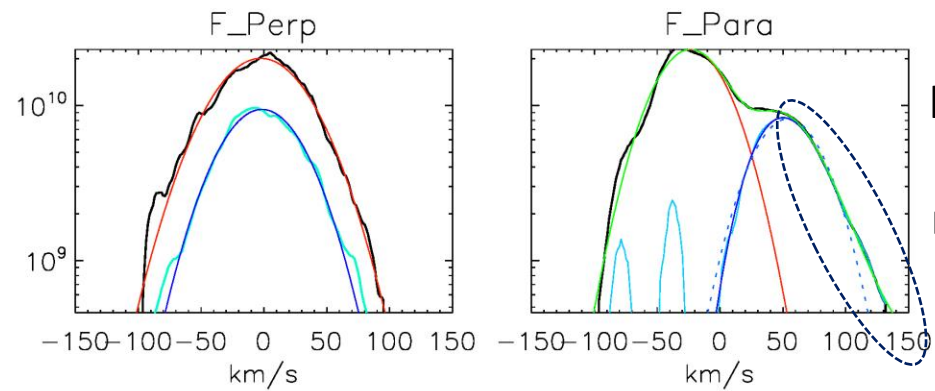
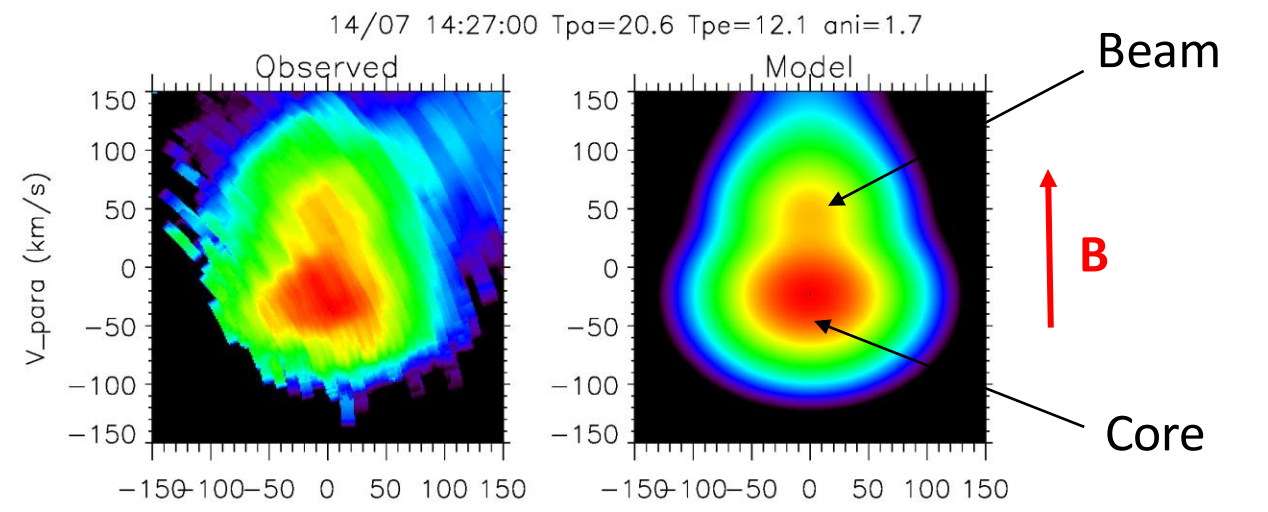
For total population : $T_{//} > T_{\perp}$.
 $T_{//} \sim 20.6$ and $T_{\perp} \sim 12.1$ eV

In reality, the VDF is most of the time a juxtaposition of a core and a beam populations
(well known from Helios, Marsch et al, 1981).

From model, we get here:

Core: $T_{//} \sim 16.3$, $T_{\perp} \sim 25.3$ eV
 Tail: $T_{//} \sim 22$, $T_{\perp} \sim 8.9$ eV
 beam/core density: 0.32
 Drift: 72 km/s (1.3 Va)

$V_{//}/V_{\perp}$ 2D slice: Measured and model distribution



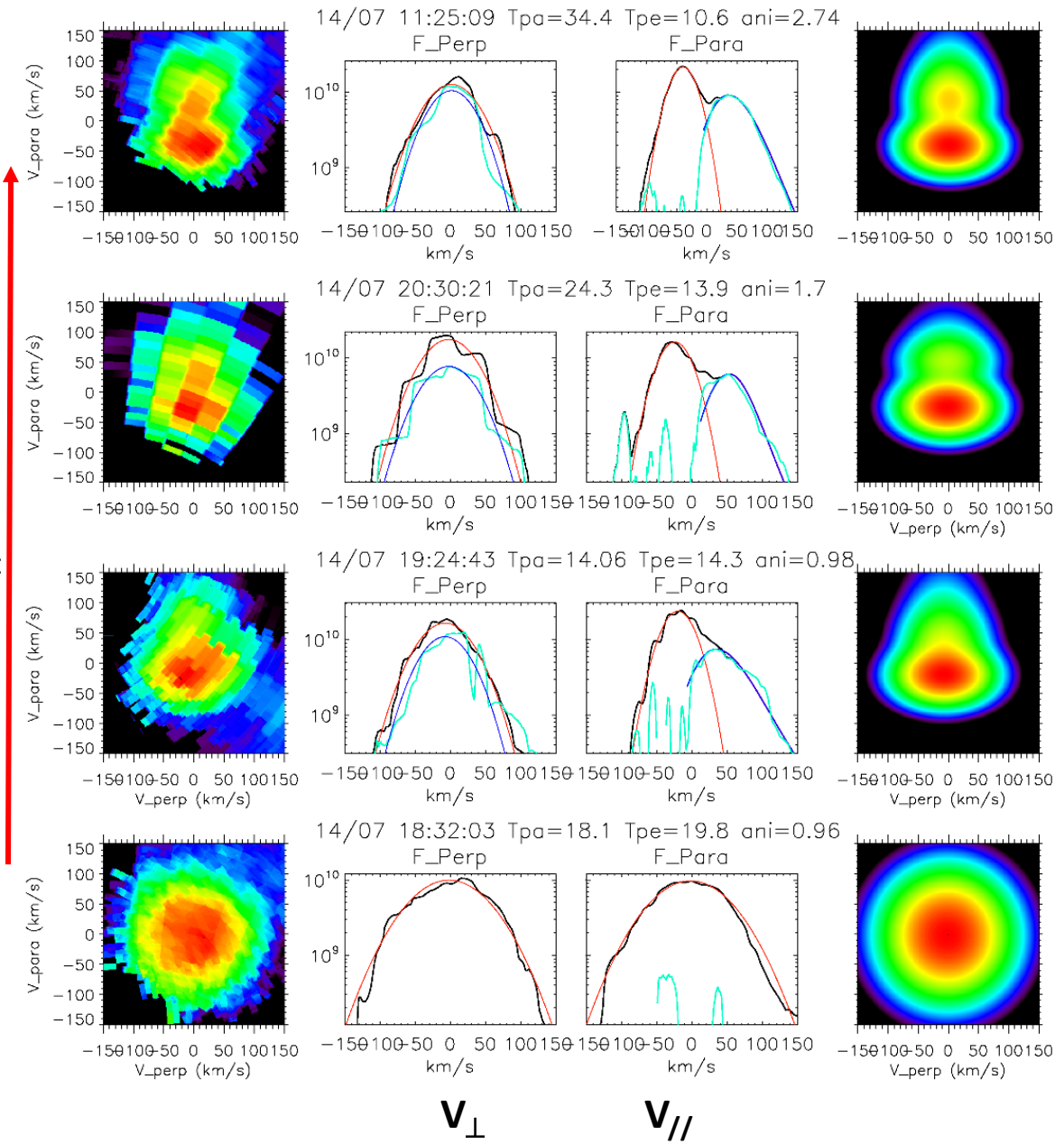
In $V_{//}$, the best model is a **kappa** rather than a Maxwellian.
Additional acceleration

V_{\perp} and $V_{//}$ profiles: Measured (black and light blue) and model (red and green).

Variability of proton VDF – several examples seen on 14/07

Increasing importance of the beam.

Total $T_{//} / T_{\perp} \sim 1$ to 3



Core: $T_{\perp} \sim 20-25$, $T_{//} \sim 10-15$ eV

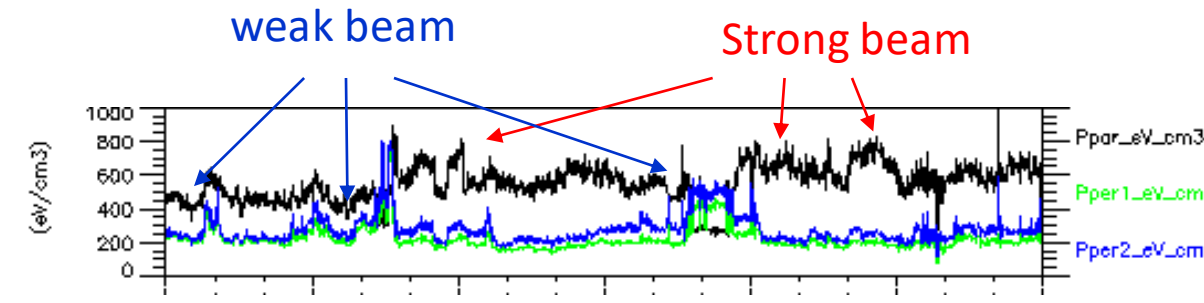
Beam: $T_{\perp} \sim 15-20$ eV but $T_{//}$ may vary from 15 to 30 eV

Relative density: 0.15 to 0.5

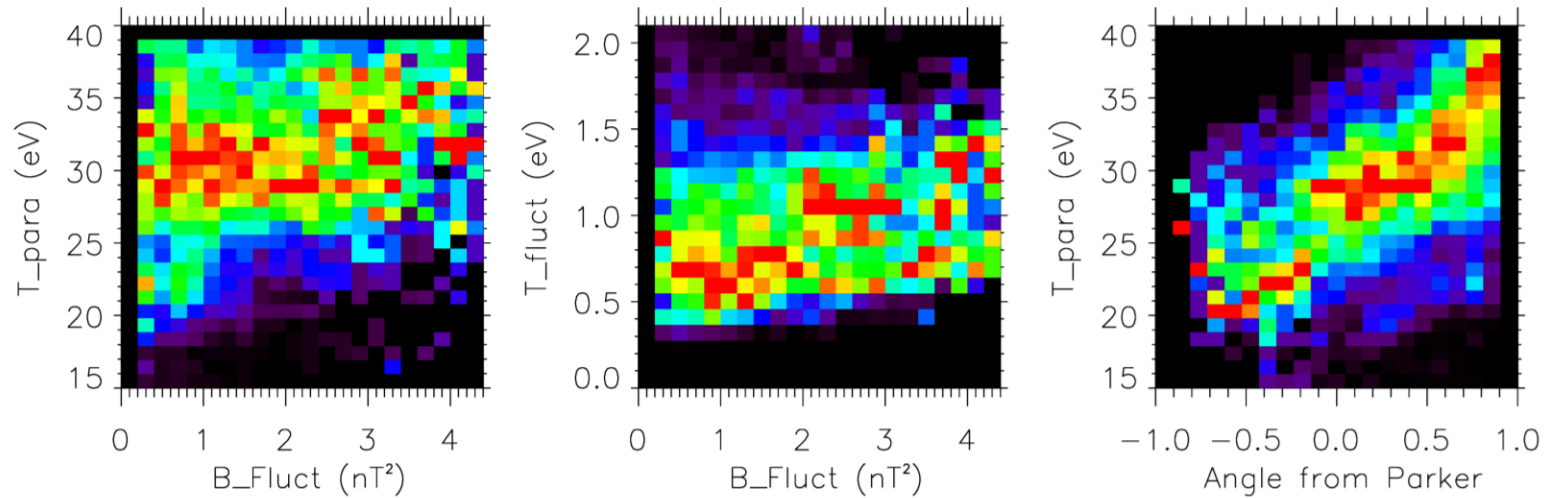
Drift: 50 to 75 km/s (0.9 to 1.4 Va)

The variability of the beam (mostly its density) has a direct impact on the total parallel pressure.

Strong beam -> Large $P_{//} / P_{\perp}$



Link between magnetic structure and VDF



Tpar versus B fluctuations
no clear relationship

T fluctuations versus B fluctuations
A possible relationship: more T
fluctuations when B fluctuation
increase

Tpar versus B angle from Parker
Clear relationship: the maximum
Tpar are observed when B is
aligned with Parker spiral.

As large T_{par} are linked to a strong beam, this means that **the beam is particularly well developed when B is aligned with Parker spiral**. In reverse, the beam is reduced in situations of transverse B.

List of potential 'interesting' periods

July 2020 14-16: A slow Alfvénic wind (see Louarn et al 2021, D'Amicis et al 2021).

August 2020 27-28: Other example of Alfvénic wind.

October 2020 10: Very dynamical wind

-> In all cases, propagation and crossing of magnetic structures, with strong variability of VDF.

Discontinuities and shocks:

July 2021 18-20 : link with a solar eruption 17/07 ?

October 2021 11: link with a solar eruption 9/10 ?

October 2021 30 – November 6: A festival, several shocks, link with CME.

10/Oct/2020

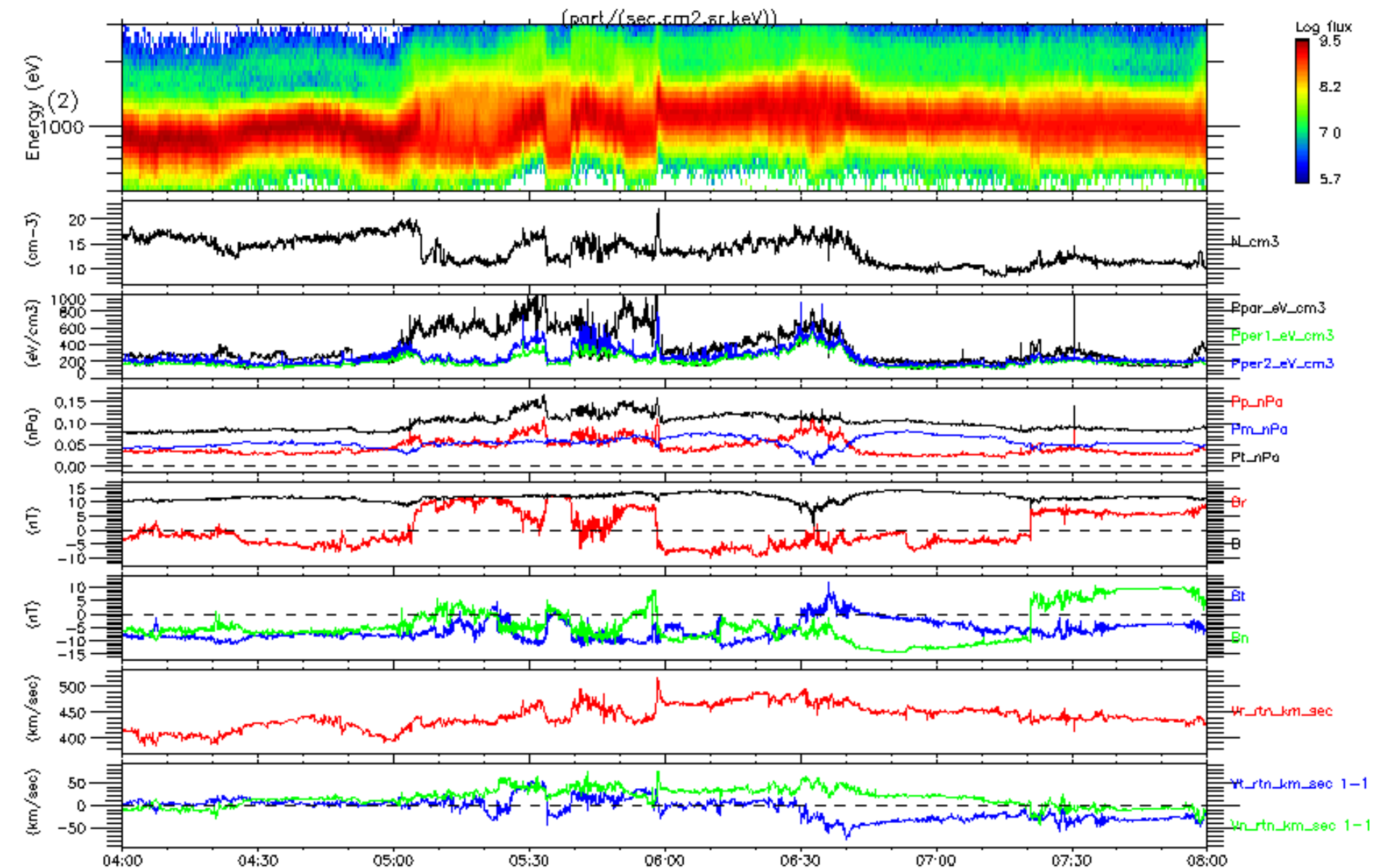
10/10 – 2020

3 hours of very dynamical
SW : 4:30 – 7:30.

Sharp changes in
spectrogram

Variations of Pper and
Ppara

Reversals of B, current
sheets and discontinuities.



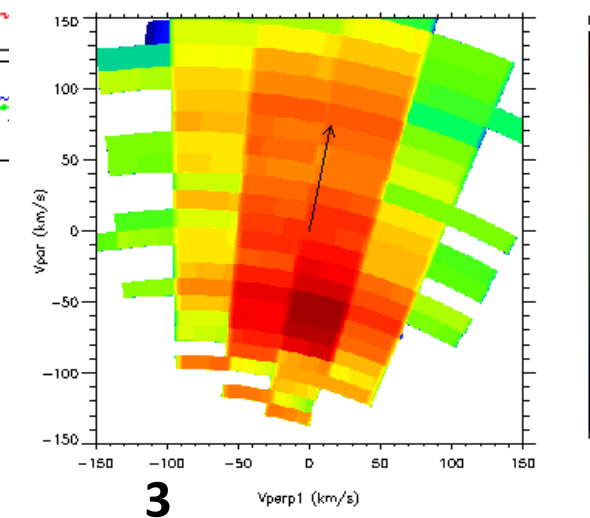
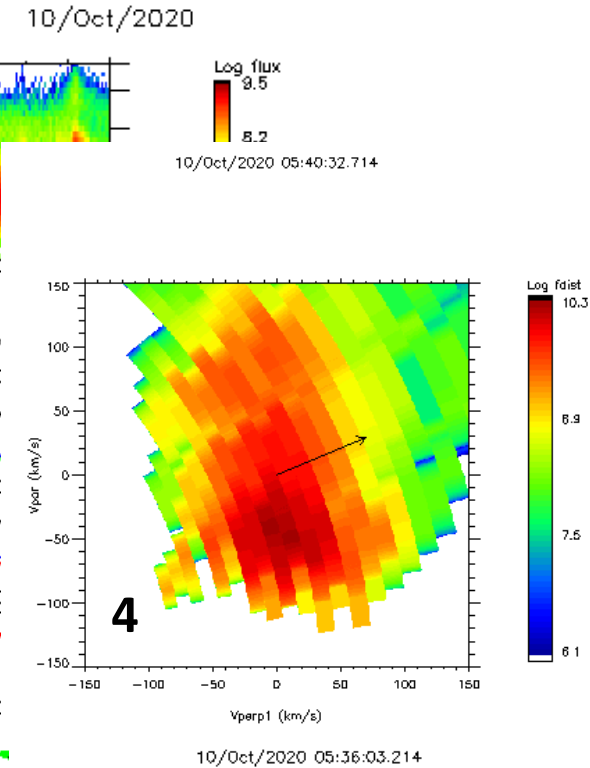
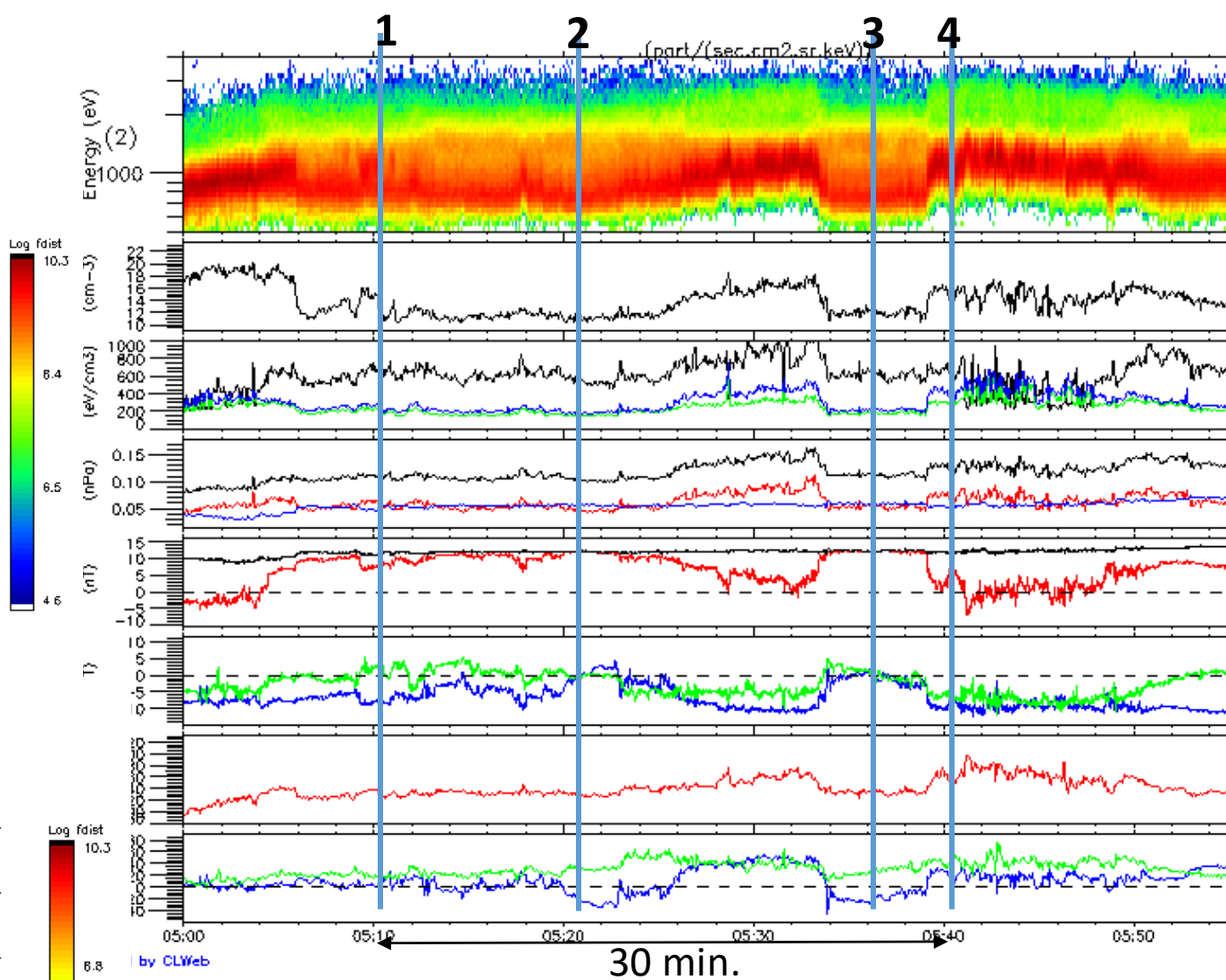
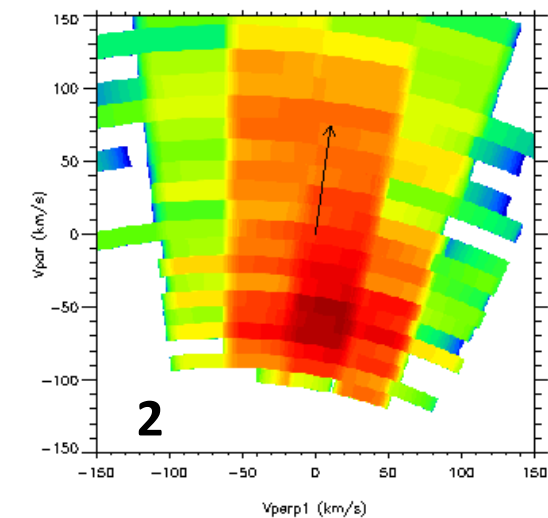
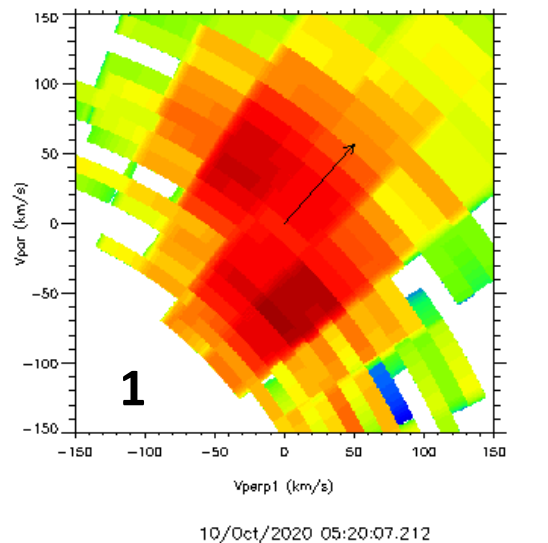
Produced by CLWeb

3 hours

10/10 - 2020

10/Oct/2020 05:10:11.211

$V_{//}/V_{\perp}$ 2D slice

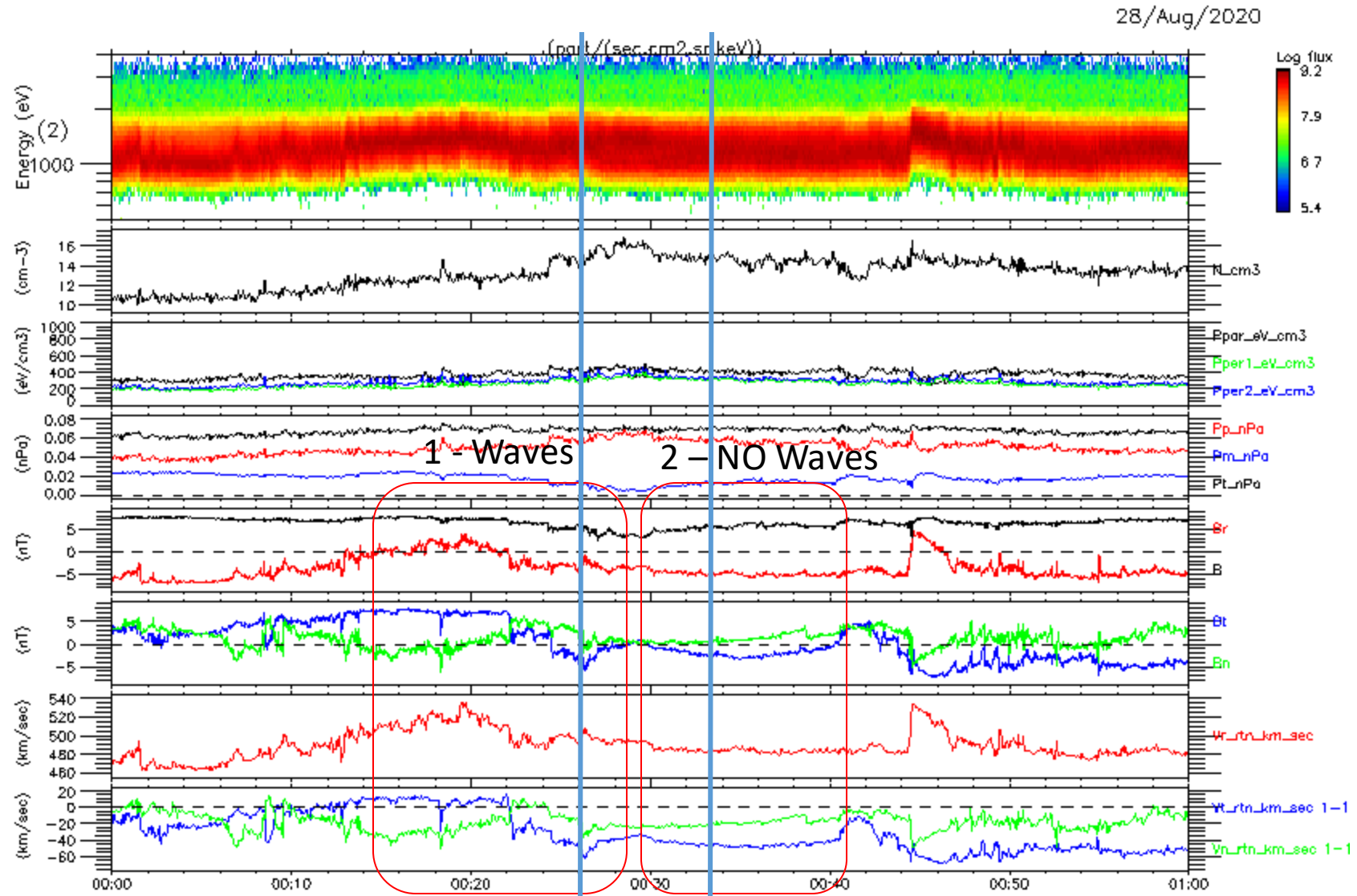


2 & 3 are typical of situations of radial field: very developed beam, with large $T_{\text{par}} (> 25 \text{ eV})$.
1 & 4 show structured secondary populations. B is not radial.

28/08 - 2020

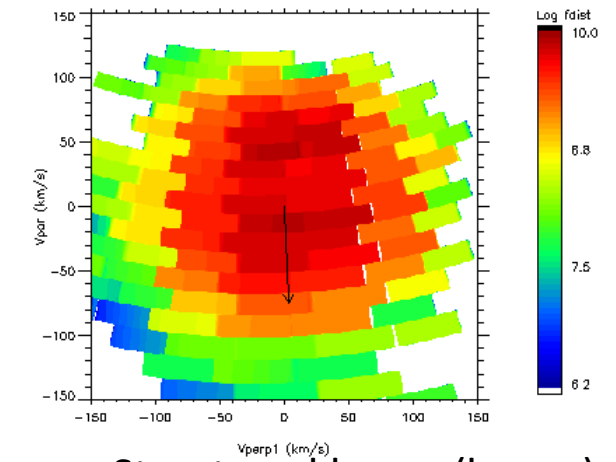
Another Alfvénic wind

Relationships between waves and VDF ?



28/Aug/2020 00:29:13.157

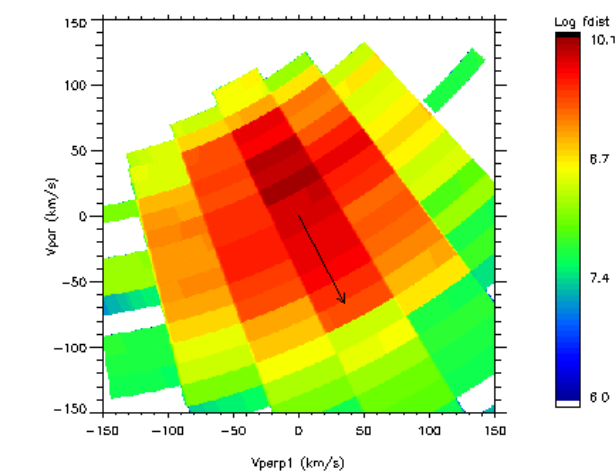
1 - Waves



Structured beam (bump)

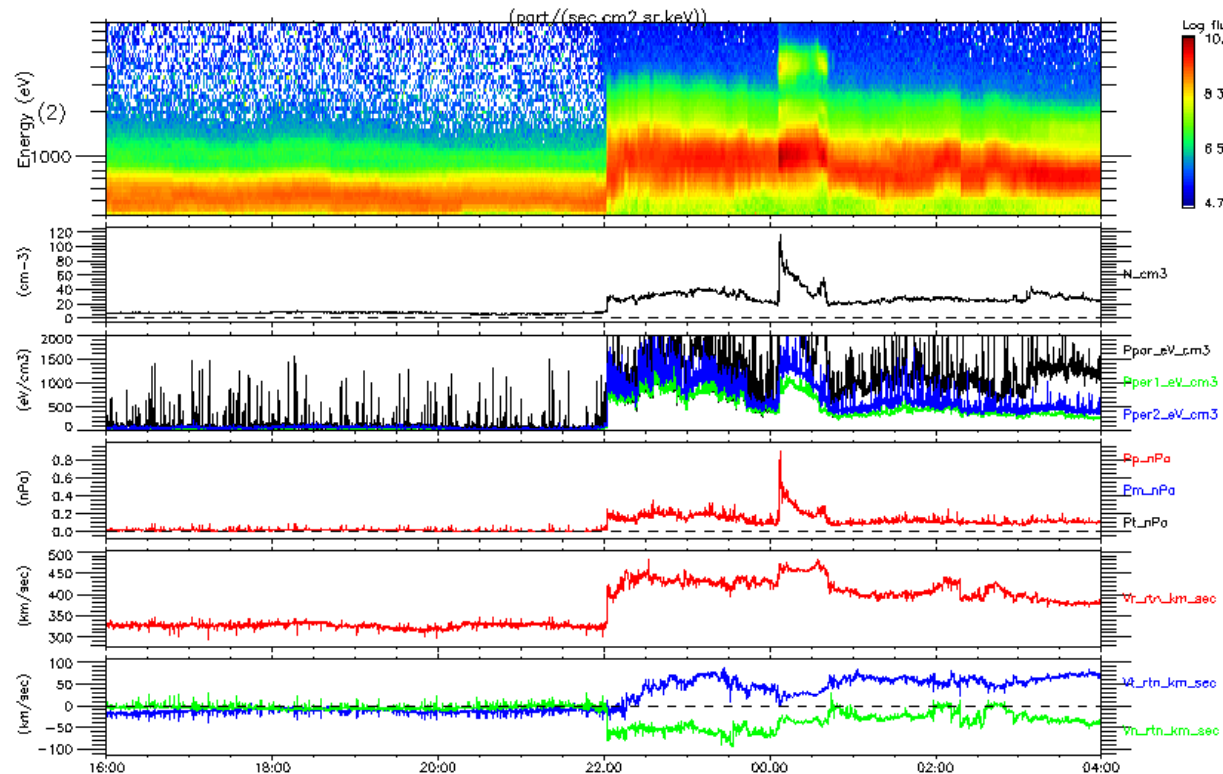
28/Aug/2020 00:31:45.158

2 - NO Waves



'simple' elongated tail

30/Oct/2021



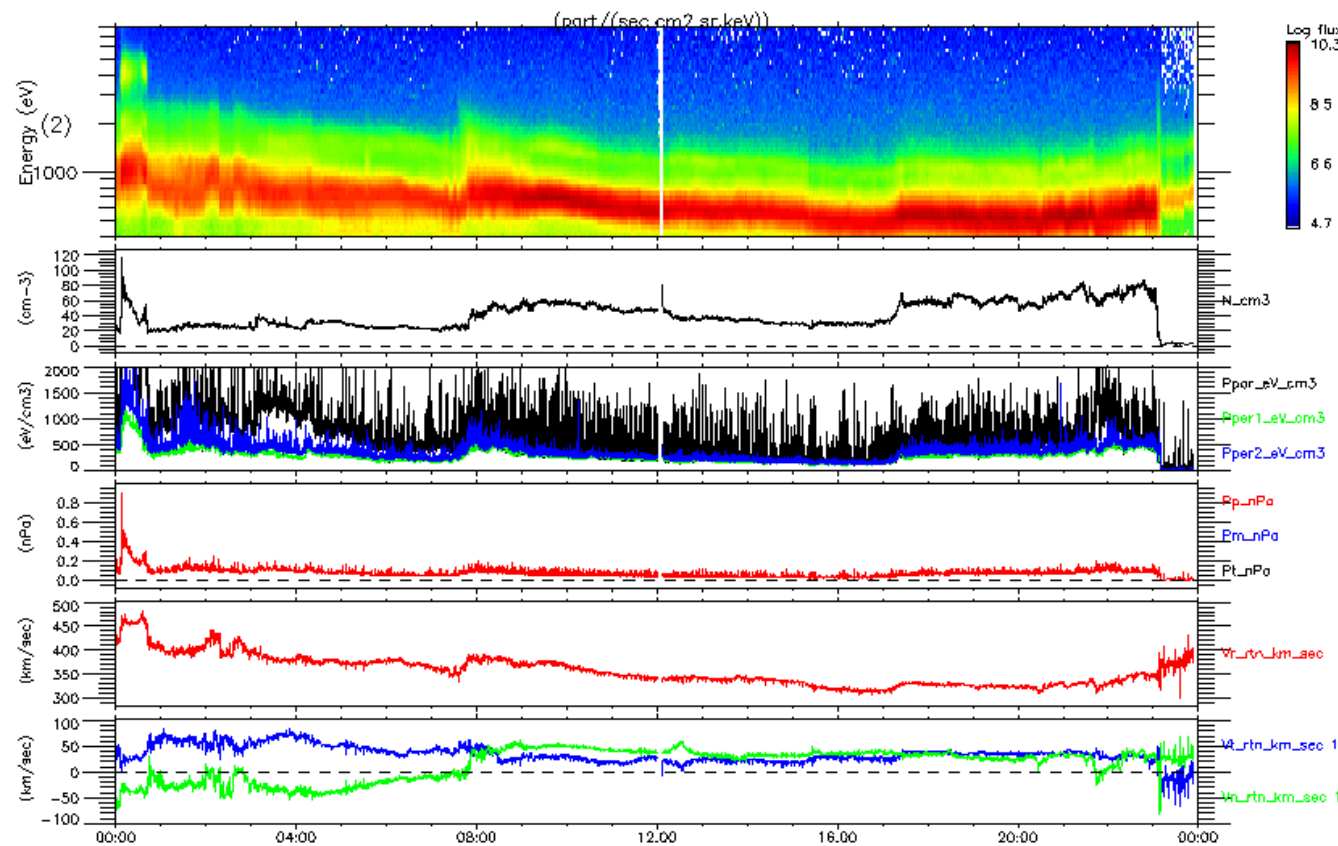
Shocks 30/10 at ~ 22:00

Produced by CLWeb

Shocks and fast wind – 31/10 – 6/11/2021

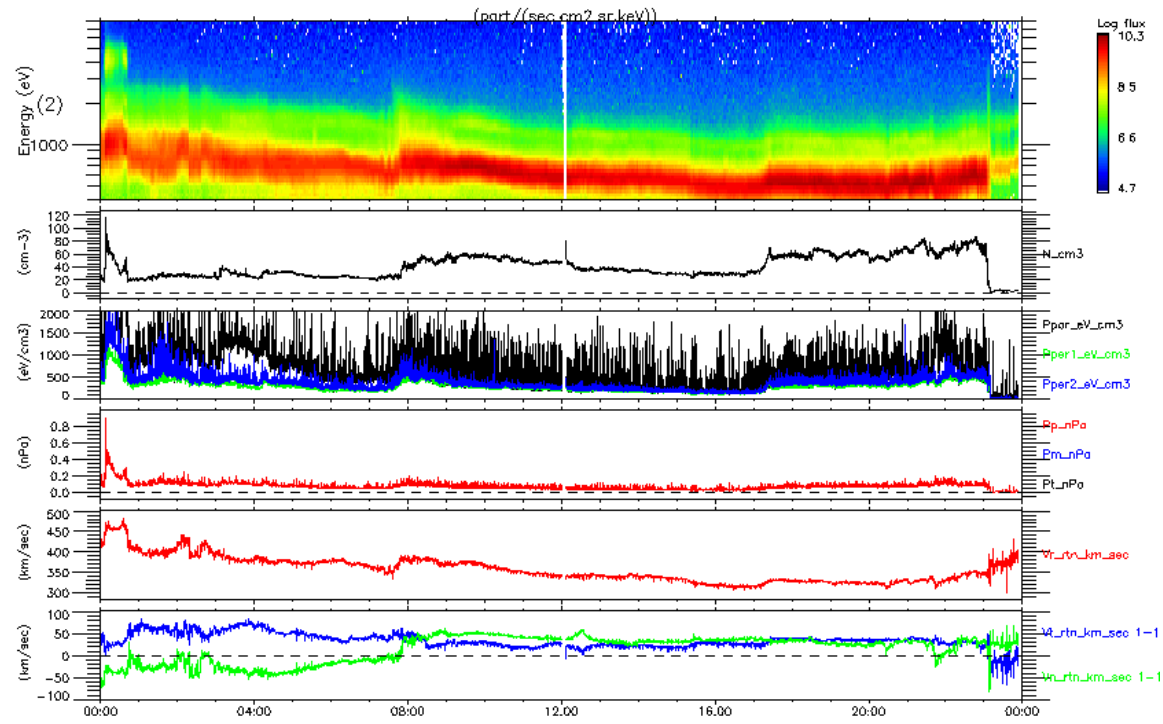
The most perturbed period since launch...

31/Oct/2021



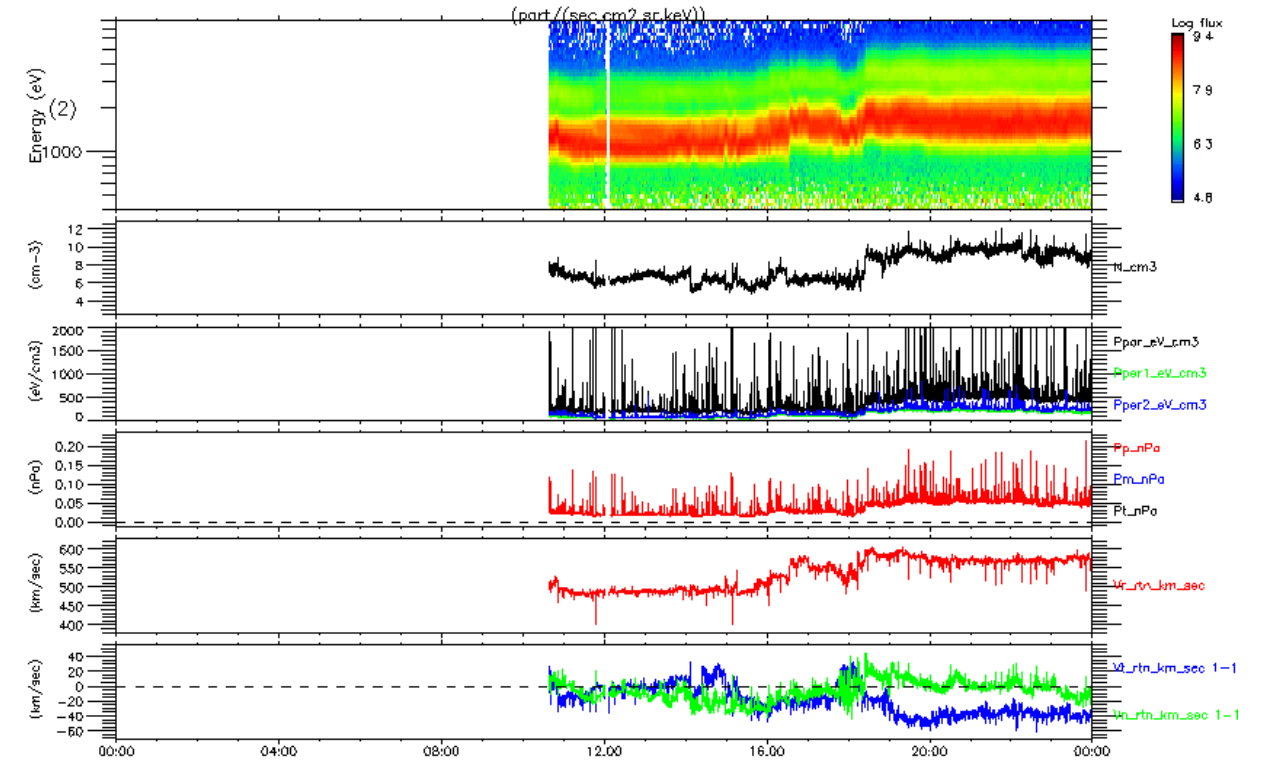
Produced by CLWeb

31/Oct/2021



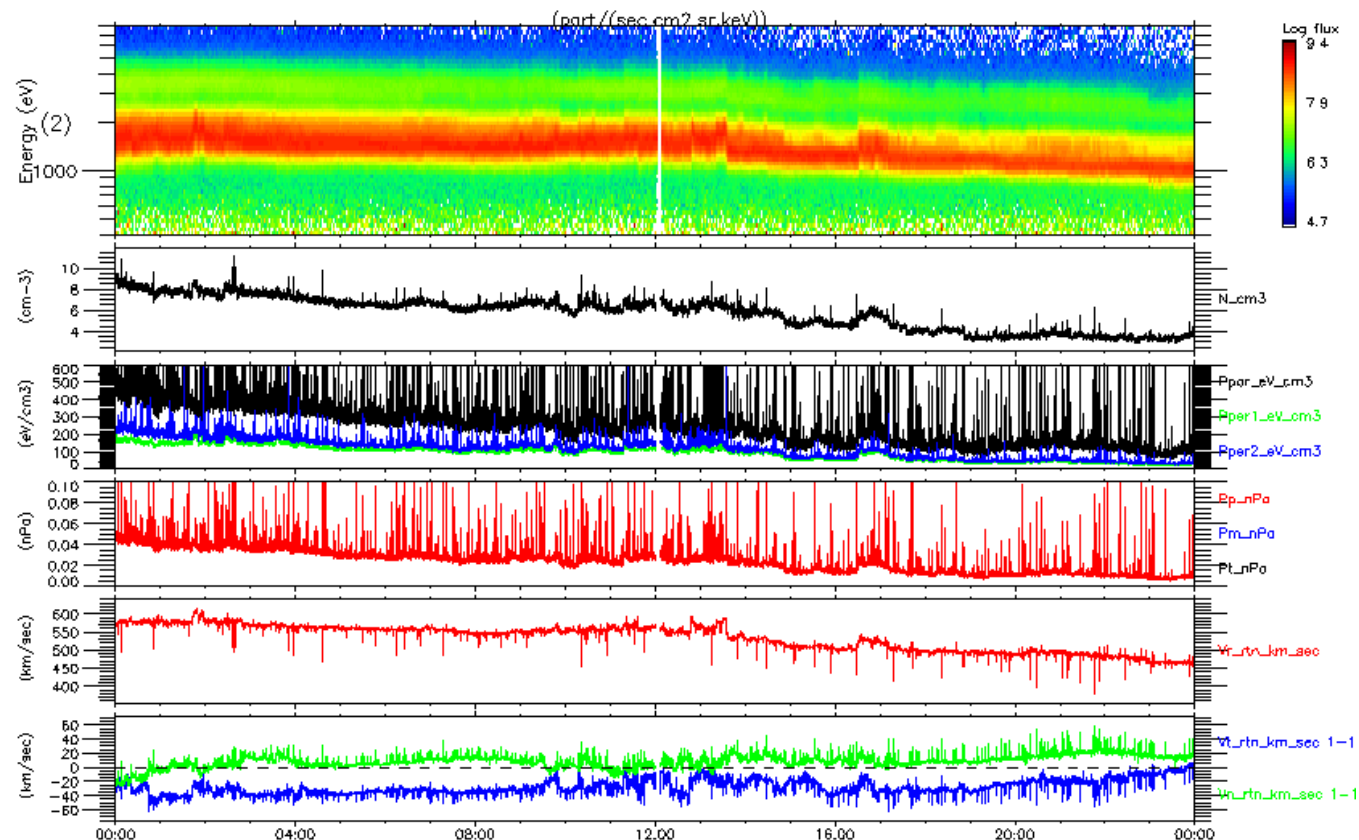
Produced by CLWeb

01/Nov/2021



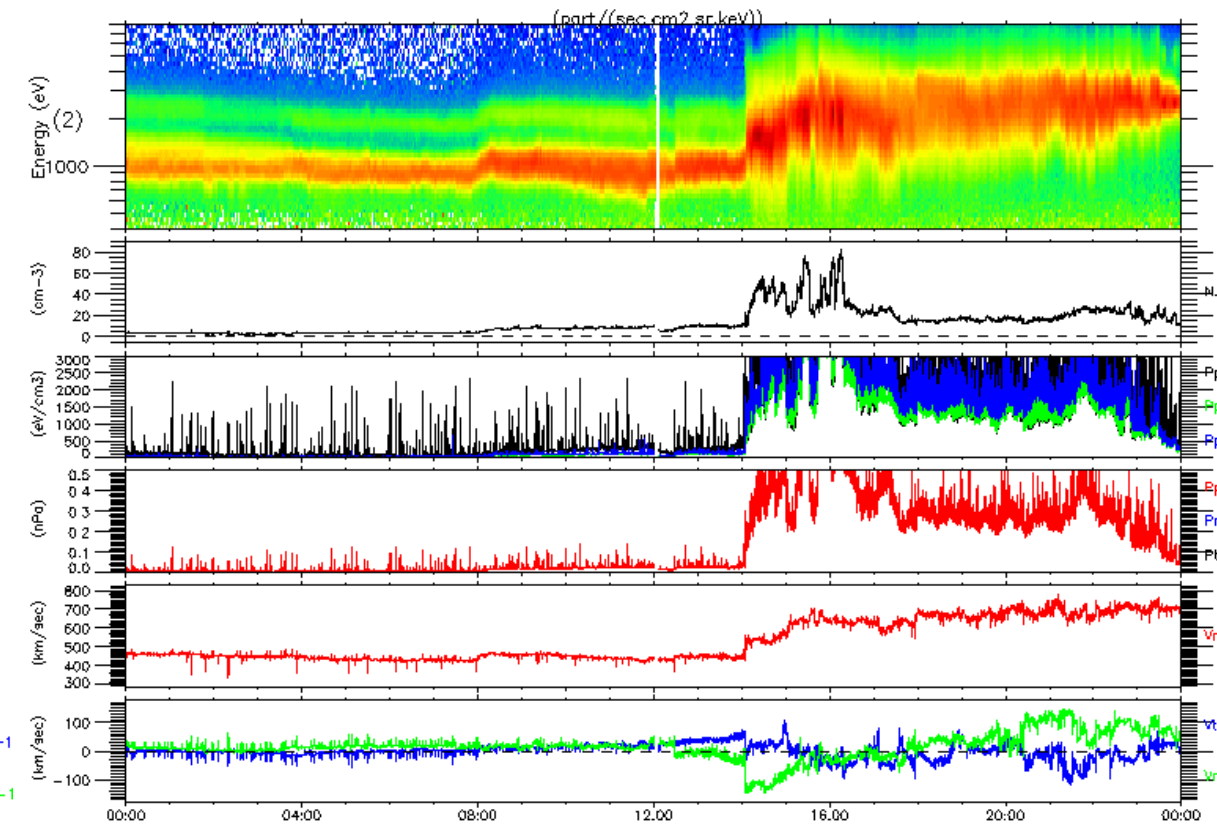
Produced by CLWeb

02/Nov/2021



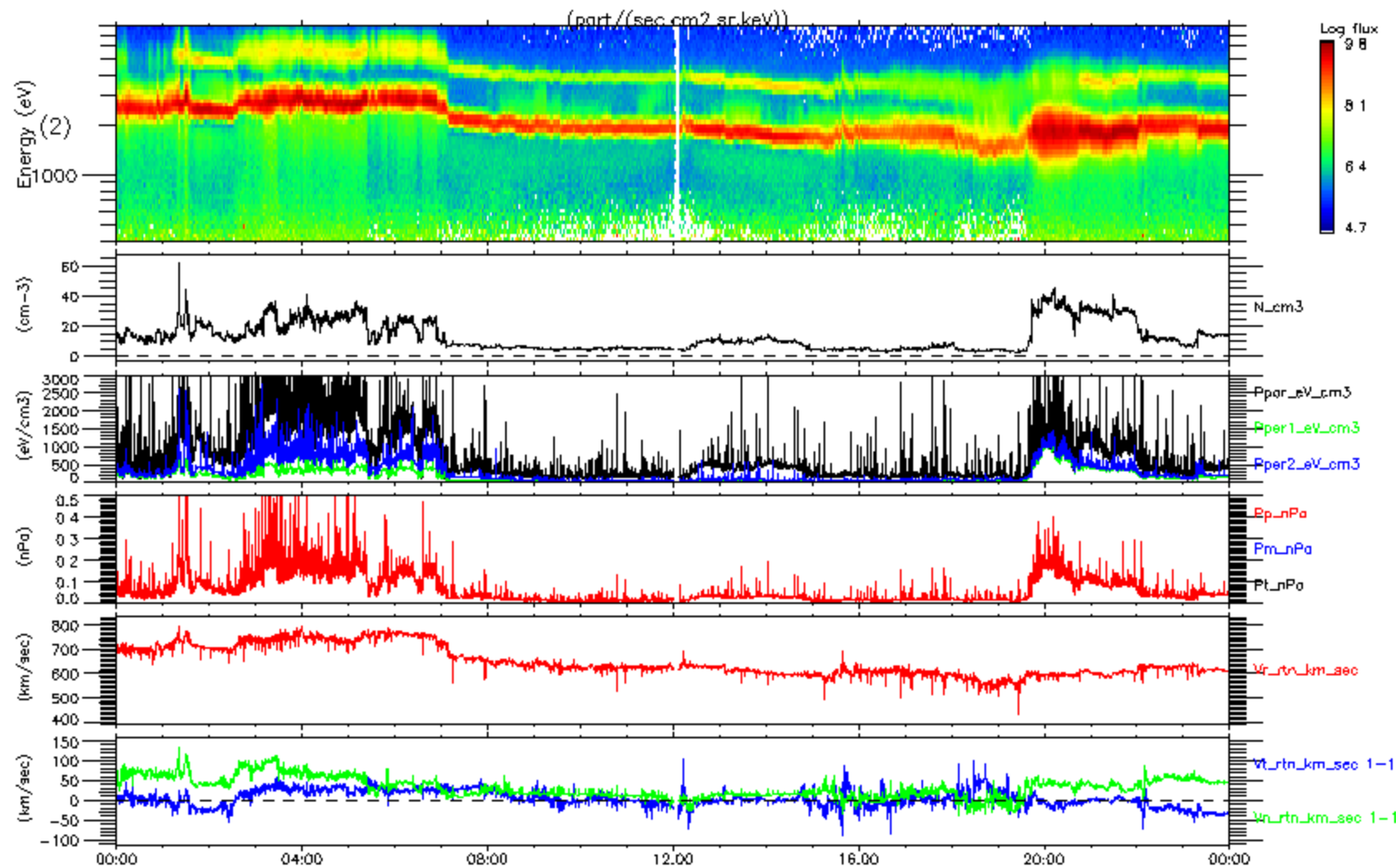
Produced by CLWeb

03/Nov/2021



Produced by CLWeb

04/Nov/2021



Produced by CLWeb

Conclusions

PAS working well (L2 available) and very good PAS/RPW calibration

Alfvénic wind: Core+beam is almost systematic. **Beam shows a strong variability at few tens seconds time scale (and sometime less).** Core is by comparison more constant.

Link with direction of B. Much more developed beam (or elongated tail) in situation of radial B.

Several example of highly dynamical wind (at scales less than minutes) -> What is observed with RPW ?

August 2020 27-28, October 2020 10: Very dynamical wind

-> In all cases, propagation and crossing of magnetic structures, with strong variability of VDF.

Discontinuities and shocks: October 2021 30 – November 6: A festival, several shocks, link with CME.

And also: **July 2021 18-20** : link with a solar eruption 17/07 **October 2021 11**: link with a solar eruption 9/10 ?