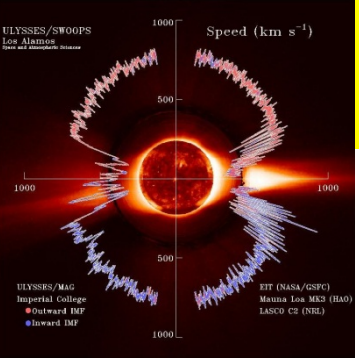
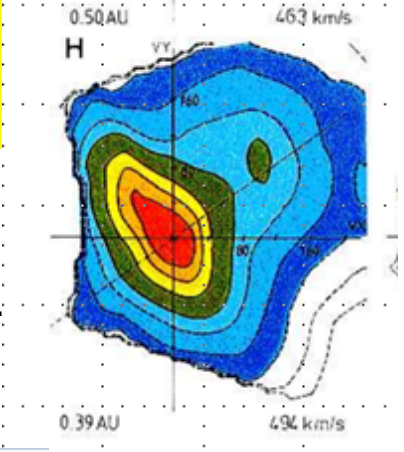


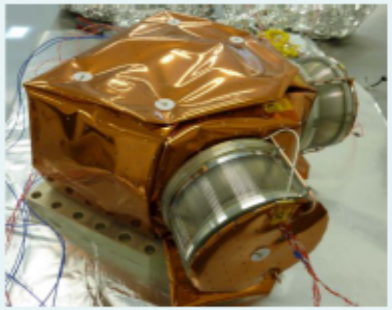
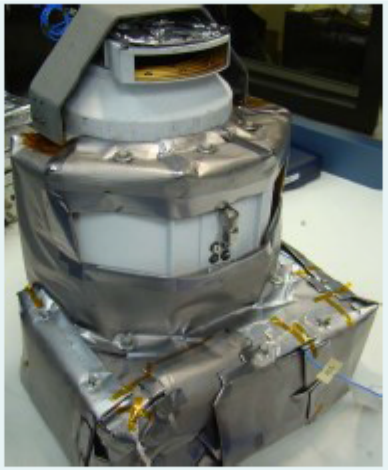
Solar Wind Analyzer (SWA)

Atelier SolarO, 11/2014



SWA: 3 sensors to measure the **distribution functions** of the solar wind, from ~10's ev to 10's keV.

Fundamental to characterize the Solar Wind Fluid and Kinetic

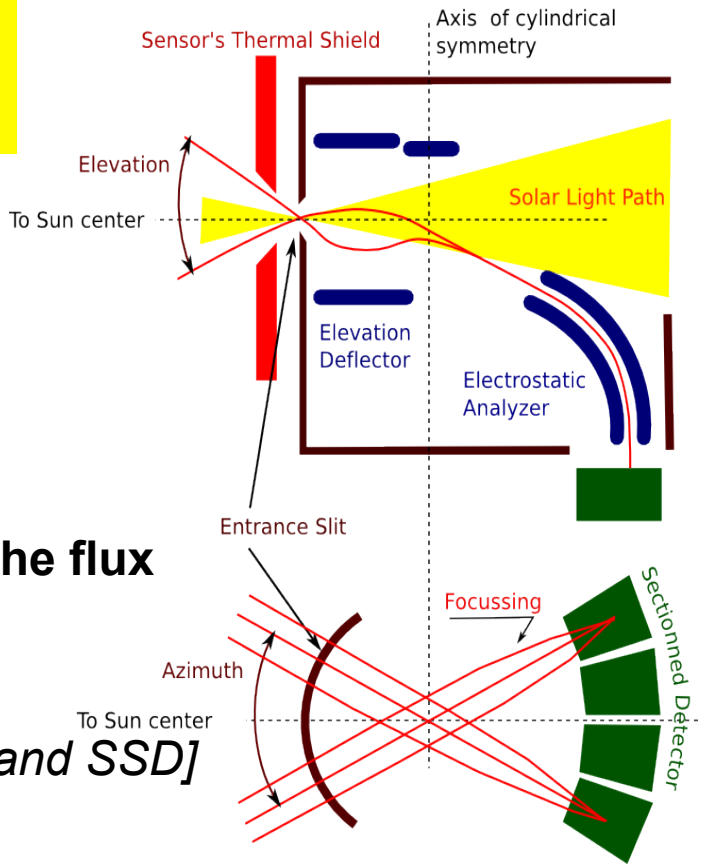
Electron Analyser system (EAS)	Heavy Ion sensor (HIS)	Proton & Alpha sensor (PAS)
		
Electrons	Heavy Ions	Protons & Alphas

Distributions of electrons (5 eV-5 keV). 4s, continuously, for n,V,P,Q. Distributions at 100 s (core, strahl, halo…).

Distribution of heavy ions (mass and charge: C,O, Fe…). 30s and 300s. Suprathermal up to 80 keV/q

Distributions of major ions (H et alfa: 200 eV-20 keV). 4s continuously. Up to 20 Hz in burst.

Principles of measurements
(example of PAS, valid for EAS and HIS)



1) Electrostatic deflector and **Energy analyzer** to select the **energy** and **direction** of incident particles (selection of a portion of phase space) . *Done by sweeping the **high voltages** applied on the electrodes.*

2) Detectors organized per azimuth sector to **measure the flux** of selected particles.

PAS and EAS: Counts (c) *[MCP or Channeltrons]*

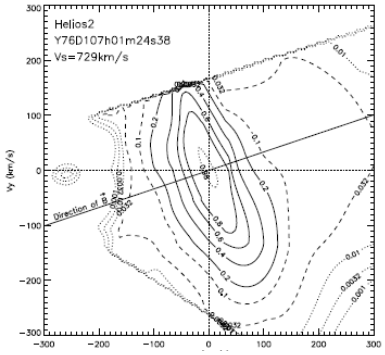
HIS: Counts, Mass and Charge (c,m,q) *[mass spectro and SSD]*

Basic product of PAS and EAS: 3D matrix (N_energy, N_elevation, N_azimuth) **of counts (c), measured at a given time.** From the **'geometrical factor'** of the instrument **(PAS: G_{eff}~ 5. 10^{-6}** cm^2 sr eV/eV per pixel), one then gets the measured distribution: **F =G_{eff} * counts / V^4** . **F(v_x,v_y,v_z,t) is the quantity that characterizes the plasma (fluid/kinetic)**

HIS: single ion events (PHA): (Elev, Azim, E/q,Time-of-Flight, SSD energy).
Used to construct 3D matrix of counts, organized per species.

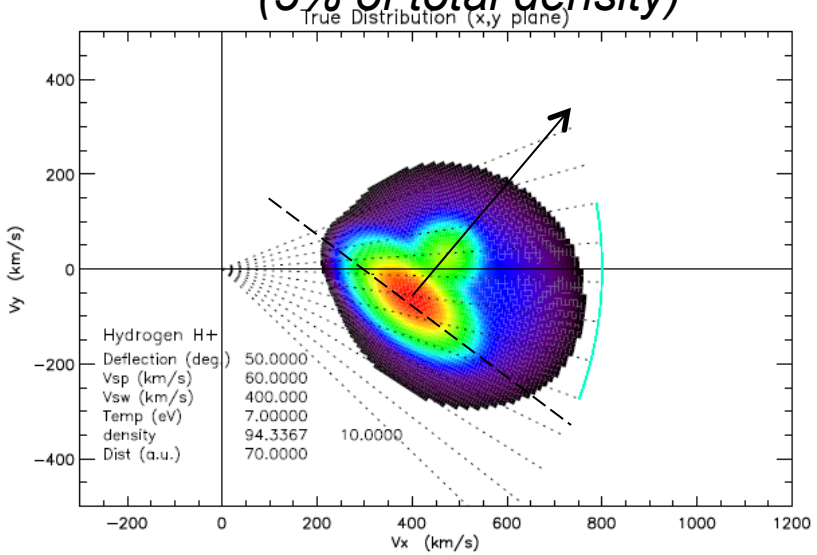
An example from PAS

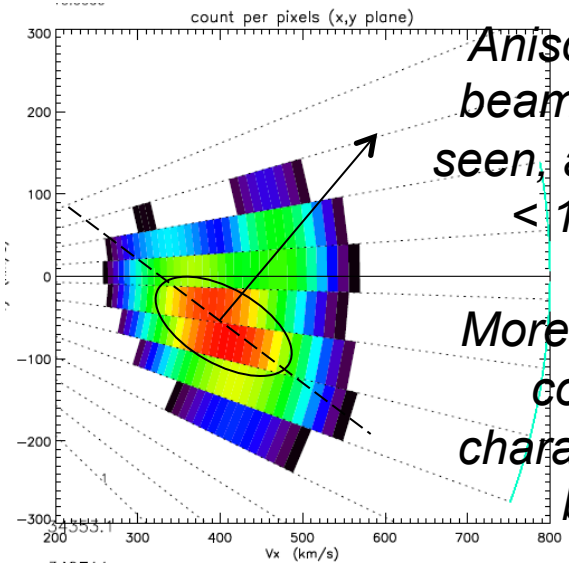
Tpe=2 Tpa; tiny beam along B (5% of total density)



Highly anisotropic distribution from Helios

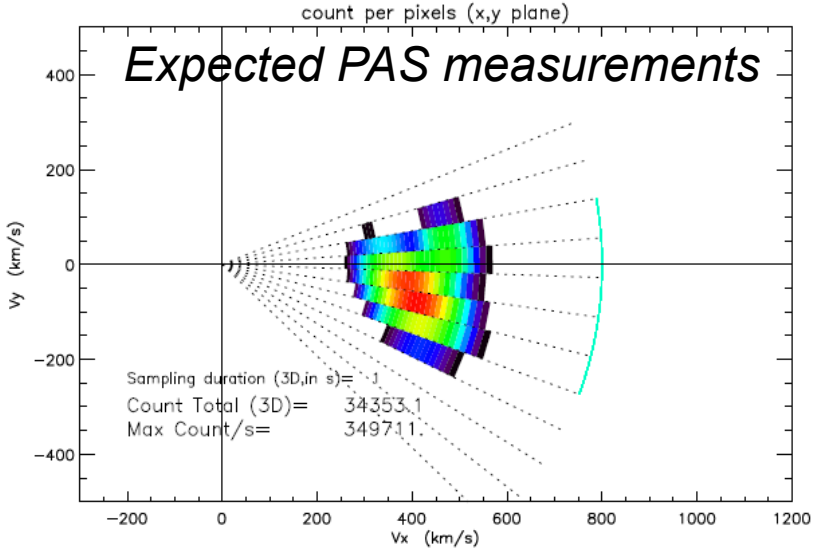
(Tu and Marsch, 2002)



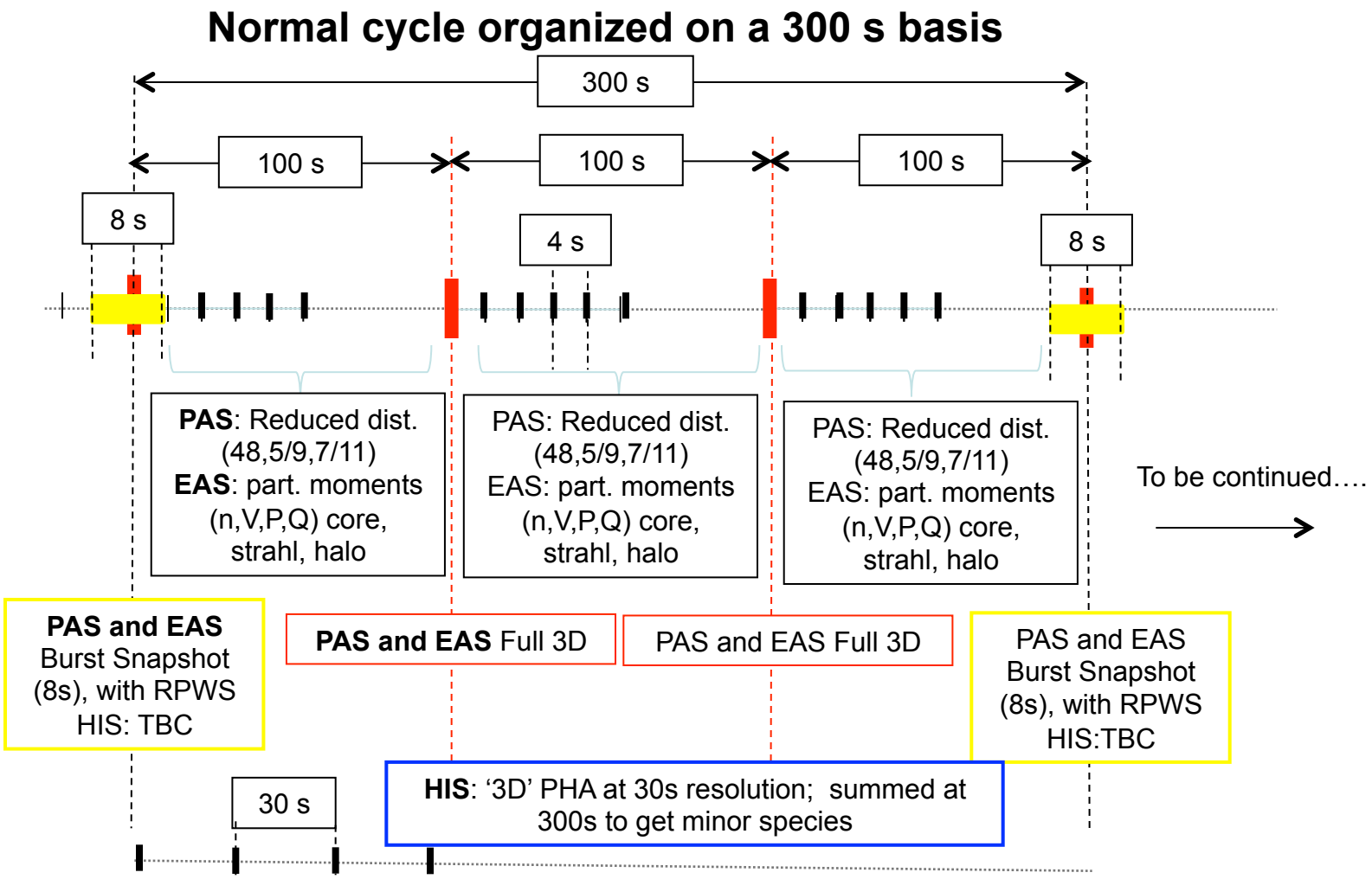


Anisotropy and beam are easily seen, at resolution < 1 second

More than 1000 counts to characterize the beam.



Operations



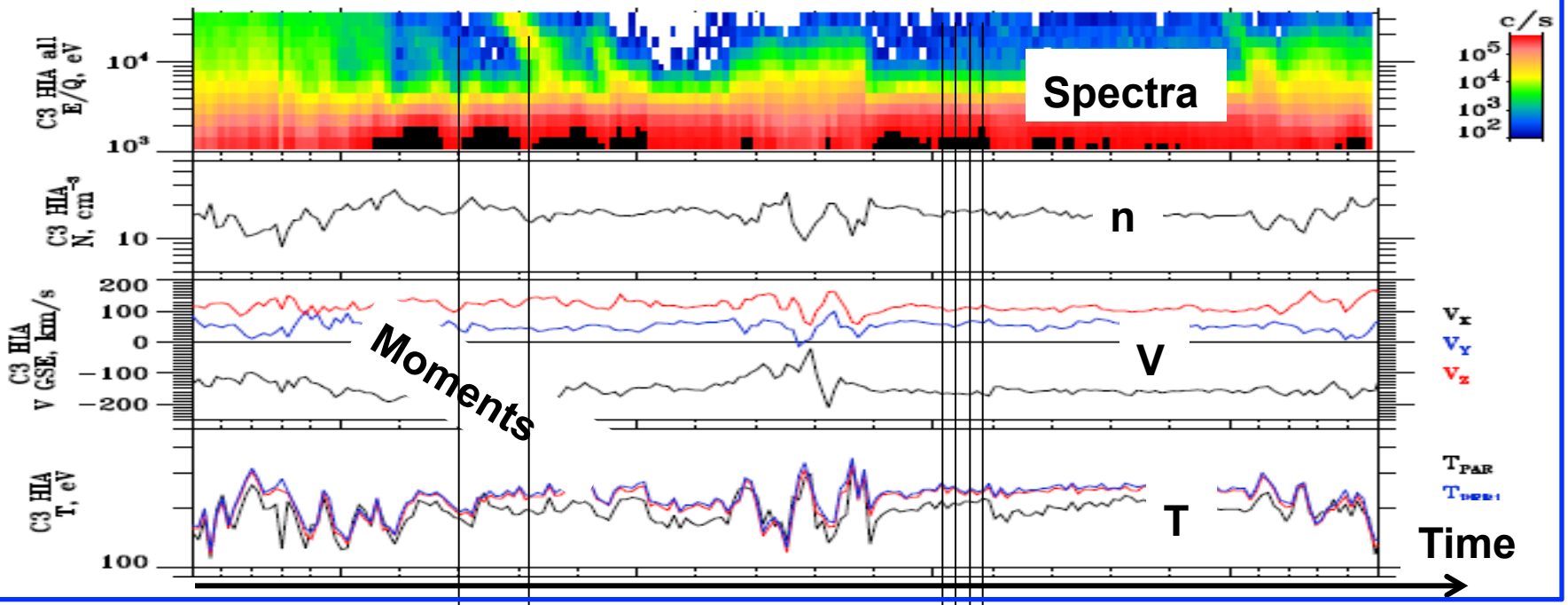
Burst (about 5-10 min/day; scheduled or triggered):

EAS: 2D pitch angle distributions at **8 Hz**; **PAS:** Reduced distribution, up to **20 Hz**

HIS: 3D distributions of alfas and major heavy ions at **3s**

Products (L2, L3)

In many cases, the moments (n,V,P,Q) and energy spectra will be sufficient.

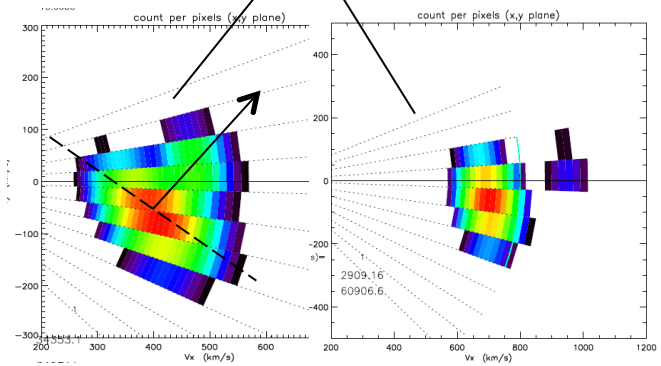


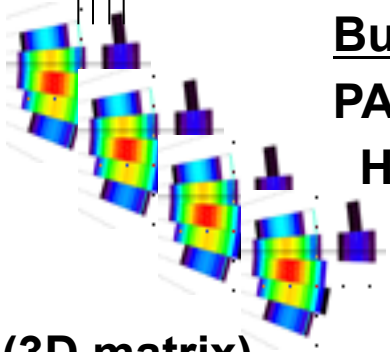
Normal:

PAS: 4s

HIS: 30s

EAS: 100s.





Burst:

PAS: up to 20 Hz

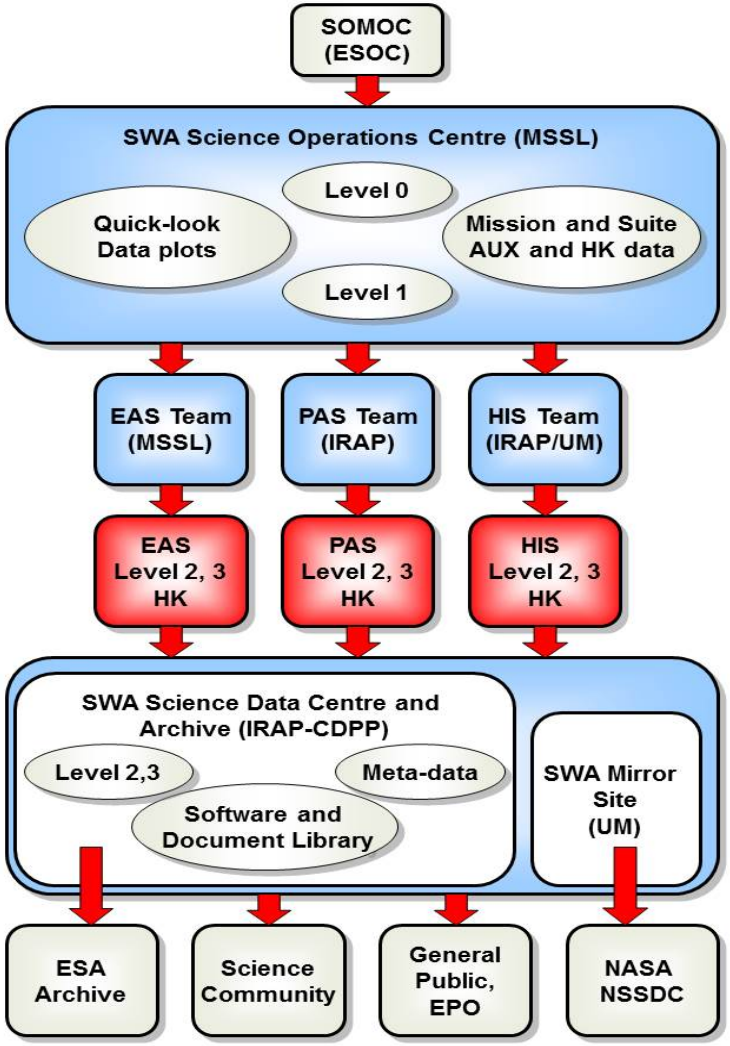
HIS: 3s

EAS: 8Hz.

Distribution functions (3D matrix).

Ground data handling

(from a slide presented at SWA CDR)



- SWA Operations Centre will be implemented at UCL/MSSL;
- Will provide routine PoC and manage SWA operations inputs for the ESA SOC;
- Will also manage distribution of low-level data products to the sensor teams for assessment/calibration.

- *Important role of CDPP for combining SWA data and distribute them, including to ESA.*

SWA and other measurements: (1) In-Situ

1) **Moments (n, V, P, *Q*) of key species shall be 'universally' accessible and easy to plot**. Protons, Electrons and representative Heavy Ions (low/high FIP). This should be extended to **energy spectra** (4s for PAS, 30 s HIS, 100s EAS)

2) **These quantities shall be easy to combine with other in-situ data to get common plots**. MAG, EPD, RPWS, *STIX*. (example of AMDA/ROSETTA). *Special link with EPD for a complete 'particle view' ? Do we define/produce 'default' common plots with SWA,MAG,EPD,RPWS, STIX ? Would it be interesting to have a catalog of 'structures/transients' ?* (shocks, CIR, …) . ***Essential also to make the connection with Solar Probe***

3) **Distributions Functions** are less intuitive to study. **Need dedicated visualising software** (example of CL, with various types of 2D cuts of the 3D distributions). *Would it be interesting to have a catalog of 'kinetic' features seen in distributions ?* *(Beams, bi/mono directional strahl, variations in concentration, acceleration ...)*

4) **Burst modes: Need to define common plots for burst modes.** *What is important to show from fast measurements of distribution functions (turbulence)?*

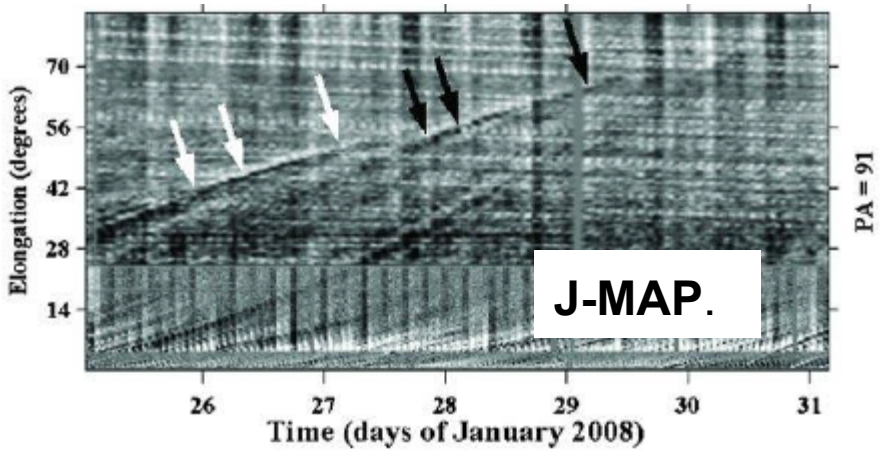
5) Low latency data *(not discussed here): common plots should be defined and available on a daily basis.*

SWA and other measurements: (2) remote sensing

1) SoloHi: fundamental to link remote and in-situ measurements.

Identify whether 'something' will hit SolO.

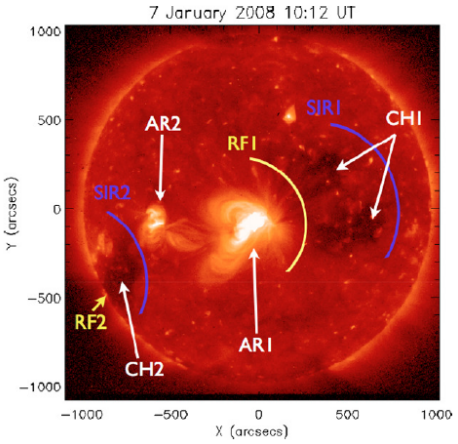
Provide key information on the 'something' to search counterparts in in-situ data…

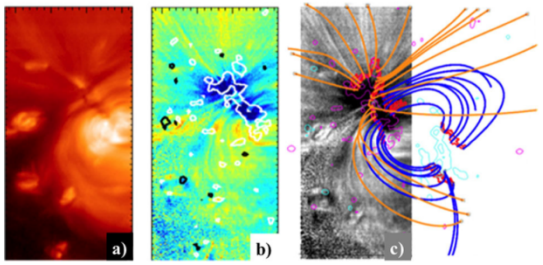


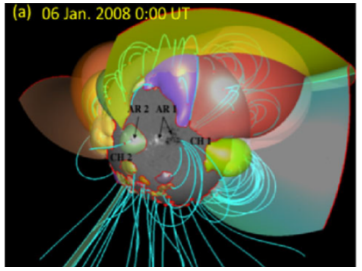
2) SPICE, EUI, METIS, PHI.

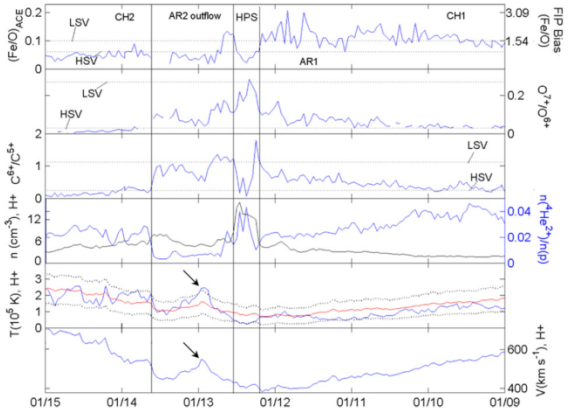
Van Driel, 2012. From structures seen on the disc to solar wind characteristics.

Importance of modeling (Potentiel Field Source Surface modeling, Linear Force Free Field modeling)









A possible example of what we will have to do routinely… *What tools do we need ?*

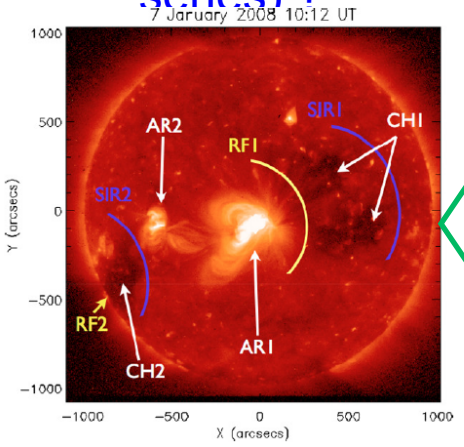
Conclusion

1) Most of SWA measurements are organized as time series and should be easy to combine with other in-situ measurements and plot together ‘à la AMDA’.
Fundamental and highly desirable. Would be also essential for

2) Distribution functions will be available. Need a dedicated software for their analysis. *IRAP will use CL , the soft developed for CLUSTER and, since, for all IRAP plasma projects*. Can be distributed (CL-Web)

3) Burst mode could demand specific tools

4) Combining SWA with remote-sensing: How can we translate features seen on the solar disc (images) into a ‘perturbation’ in in-situ measurements (time series) ?



Could a catalog of features/ structures seen in data be useful ?

Is automatic identification possible ?