SWG 2009 Fall, Meredith (NH)

Solar wind electron results by SWEA

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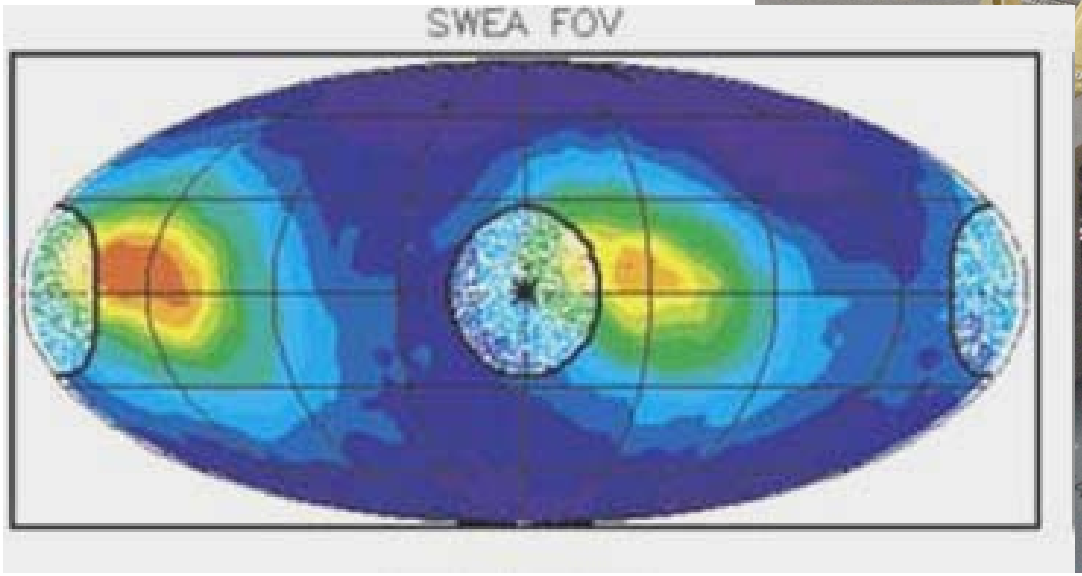
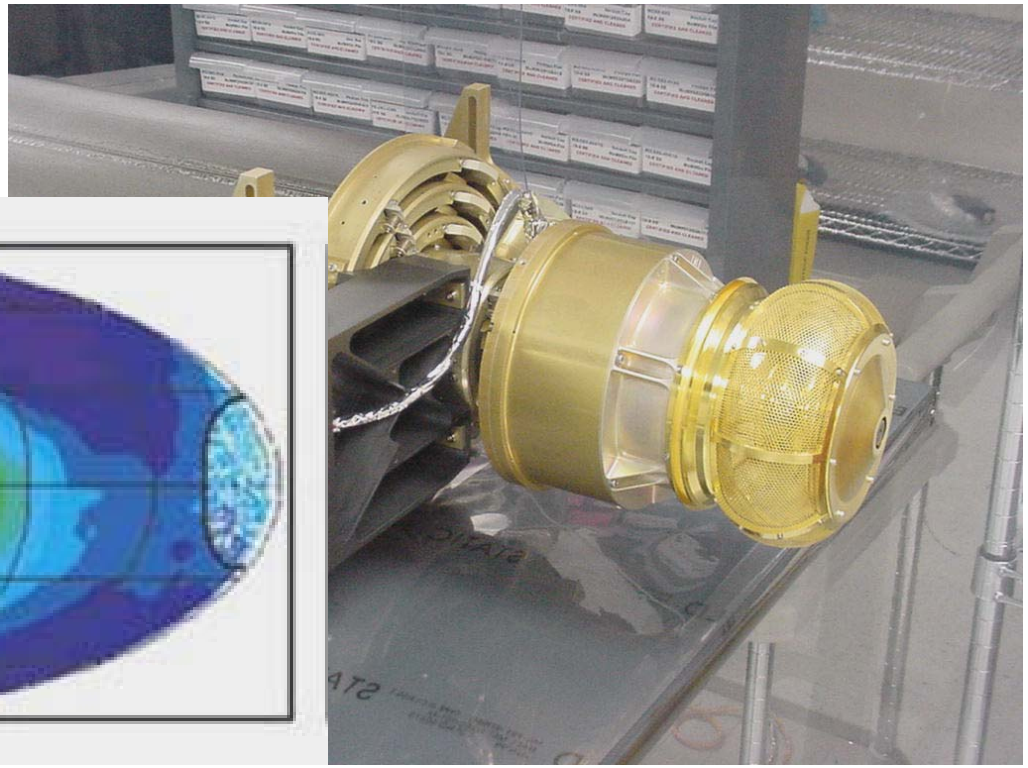
Solar Wind Electron Analyzer (SWEA)

- STEREO (Kaiser et al., 2008)
- IMPACT (Luhmann et al., 2008)
- SWEA (Sauvaud et al., 2008)

Sweep: 1 - 2000 eV





SWEA instrument status

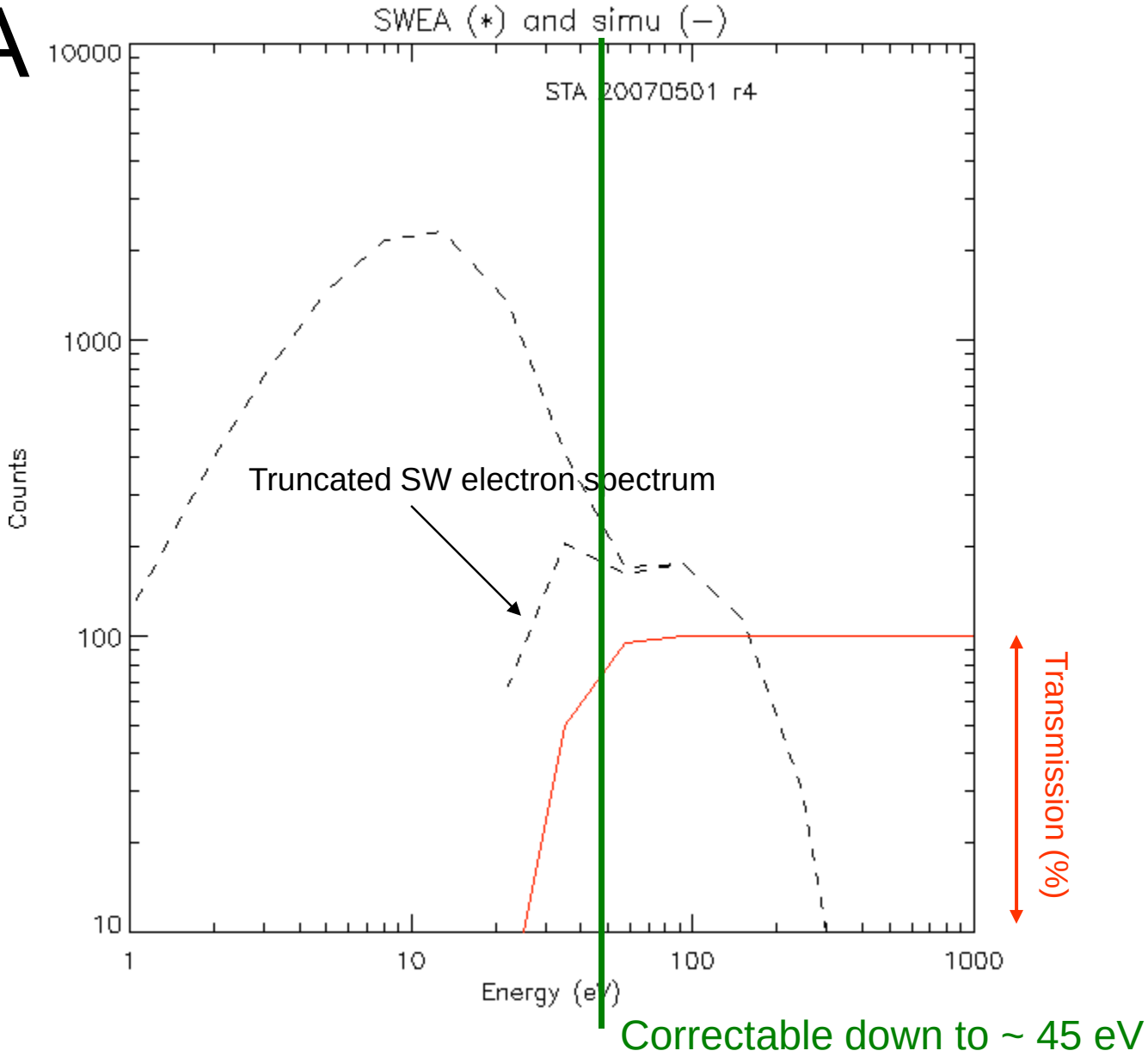
- Instrument charging on tophat (~-4V)

  ⇨ SW electrons <45eV suppressed

  – No electron core distribution 👎
  – At low energies secondary electrons unveiled 👍
  – Excellent SW electron halo and strahl measurements 👍

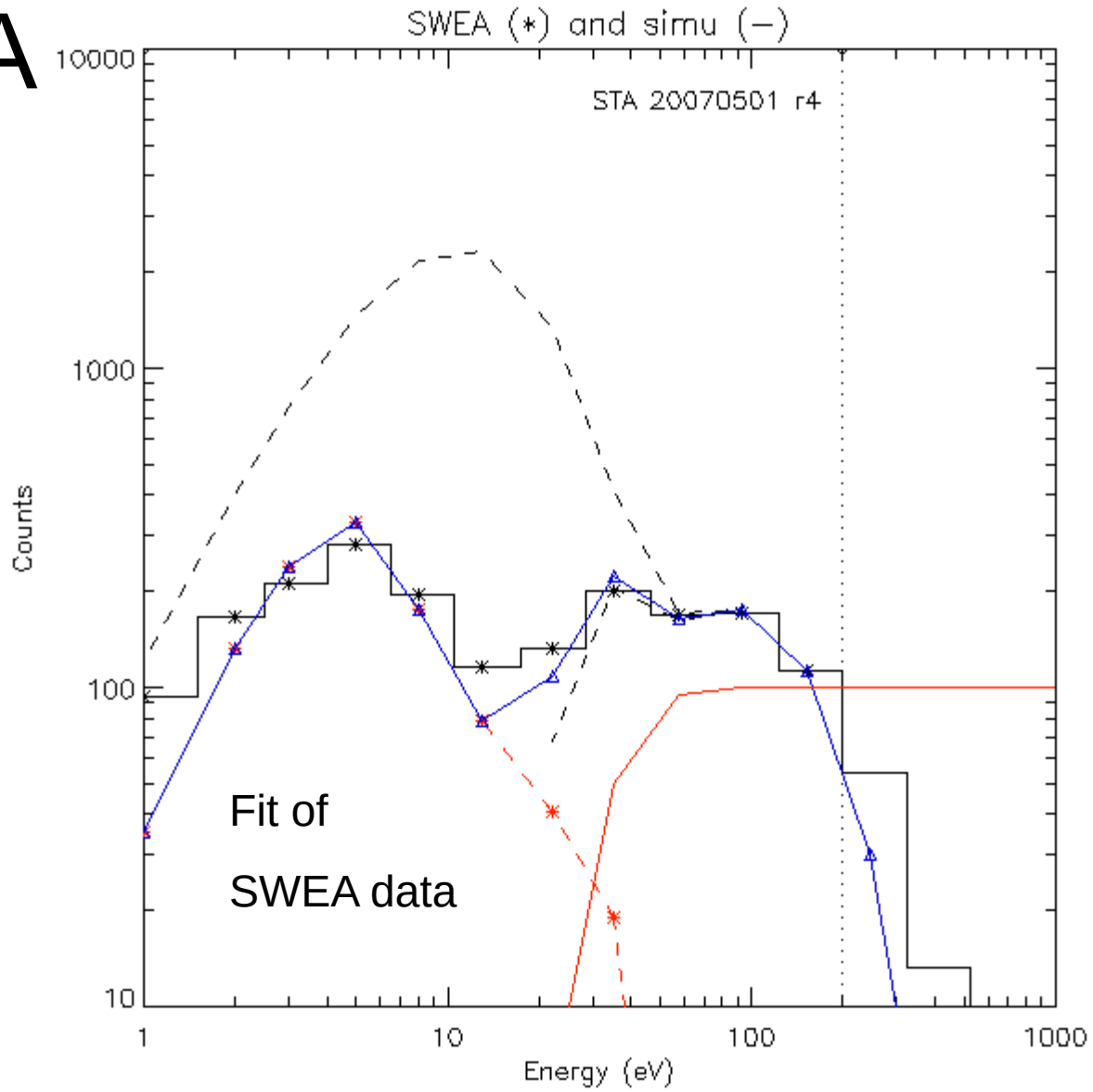
- Data products
  – Calibrated SW electron energy spectra (45 - 2000 eV) 👍
  – Pitch angle distributions (SWEA + MAG & PLASTIC) 👍
  – Moments >45eV: density, temperature, heat flux vector 👍
  – Halo properties from fit 👍
  – Core density proxy: full time series after 2007 January 👍
  – Core temperature proxy: 2007Jan - 2008Febr and after 2009Apr 👍

SWEA



Correctable down to ~ 45 eV

SWEA

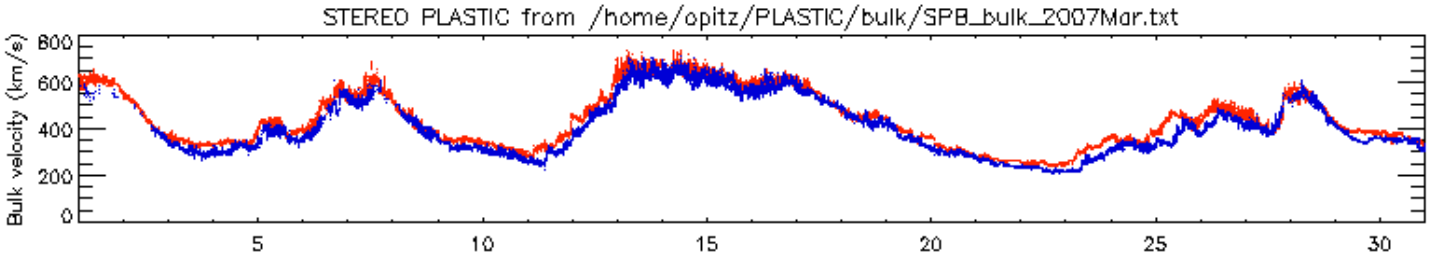


☞ core and halo density and temperature

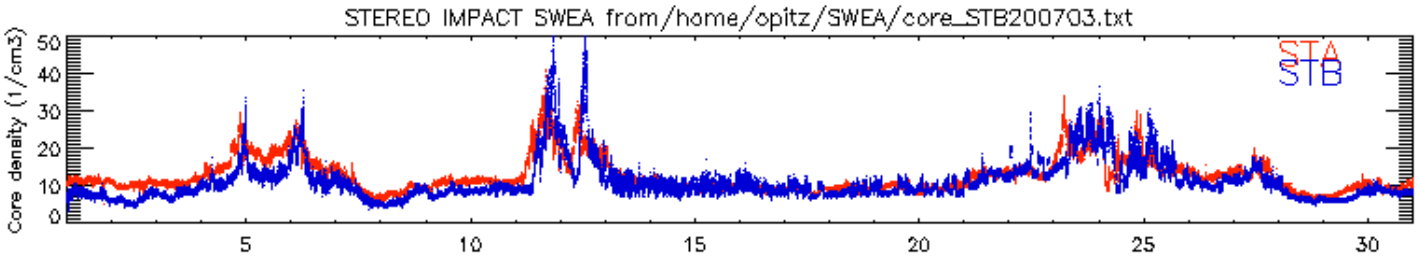
Solar wind bulk properties

STA
STB

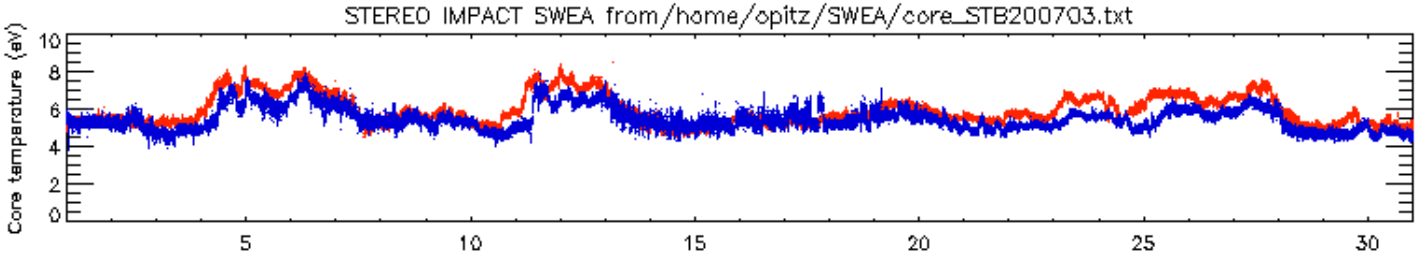
Proton
bulk velocity



Electron core
density proxy



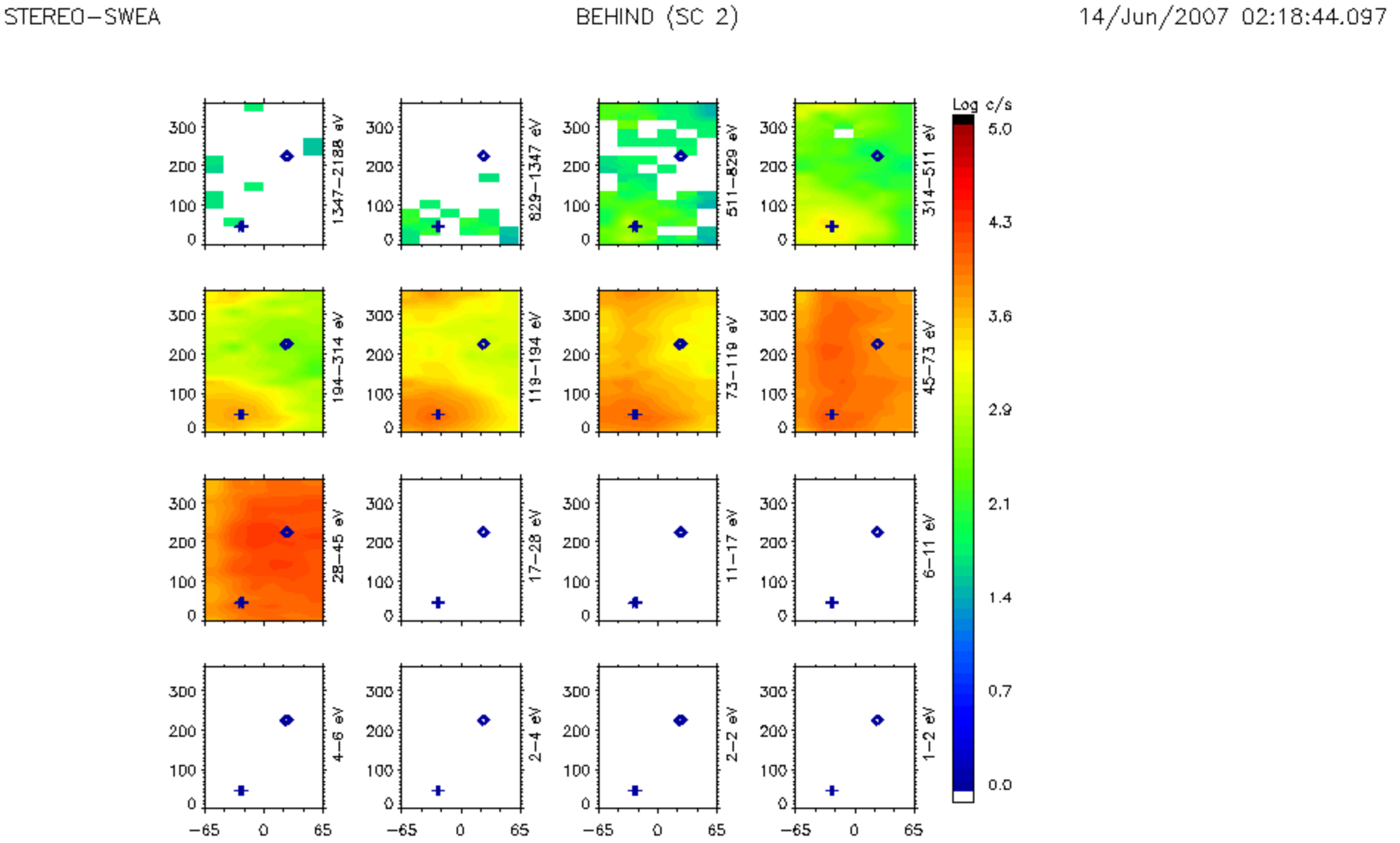
Electron core
temperature proxy



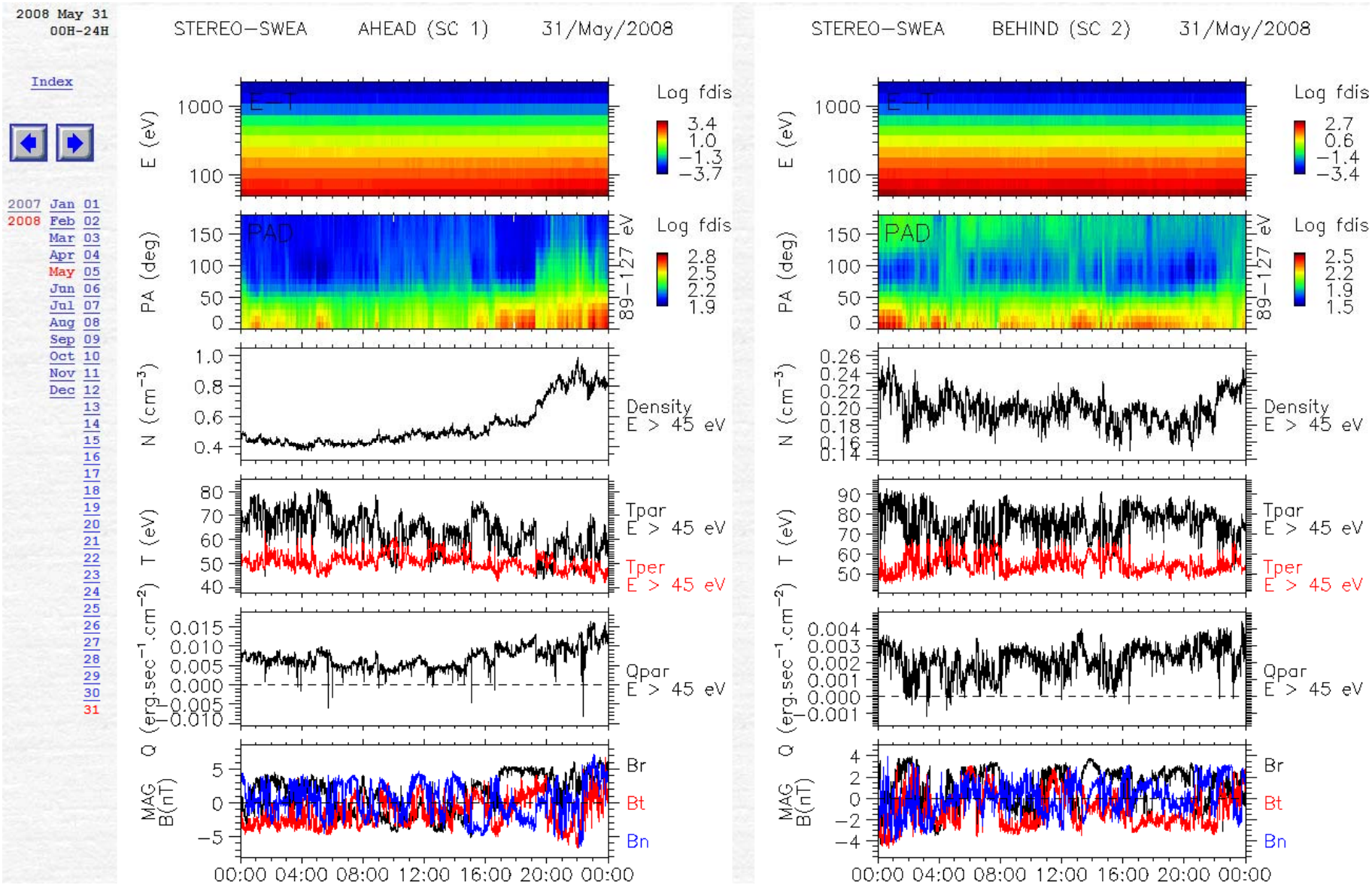
Day of March 2007

☞ density cross-calibration with SWAVES (Kellogg, Malaspina, Briand, Henri)

SWEA strahl vs. magnetic field



SWEA data site in Toulouse ☞ http://stereo.cesr.fr



SWEA data products

- Public
  - http://stereo.cesr.fr
    - present: plots of E spectra, PADs, moments >45eV (routinely produced by CL software at CESR)
    - future: + ASCII (produced by CL software at CESR) and CDF (produced by Berkeley), halo fit results, core density and temperature proxies
  - http://stereo.cesr.fr/clweb
    - CL software and SWEA binary data on server
    - access by requesting password

SWEA calibration and scientific results

- SWEA calibrated PADs, halo properties, strahl, heat flux
- Core density and temperature proxies (Opitz and Fedorov)
- SWEA calibration paper (Fedorov, Opitz, Sauvaud et al.)
- Strahl temporal variability (Louarn et al.)
- Strahl - halo relationship (Opitz et al.)
- Small-scale transient (Rouillard et al.)
- Apparent layered structure of HCS (Foullon et al.)
- Interchange reconnection (Baker et al.)
- Reconnection and 90º PA depletion (Lavraud et al.)
- Temporal and spatial evolution of SW (Opitz et al.)
- SW prediction in the heliosphere (Opitz et al.)
- Terrestrial magnetotail (Sauvaud et al.)

Temporal variability of the ‘strahl’

Louarn et al, Solar Phys. 2009

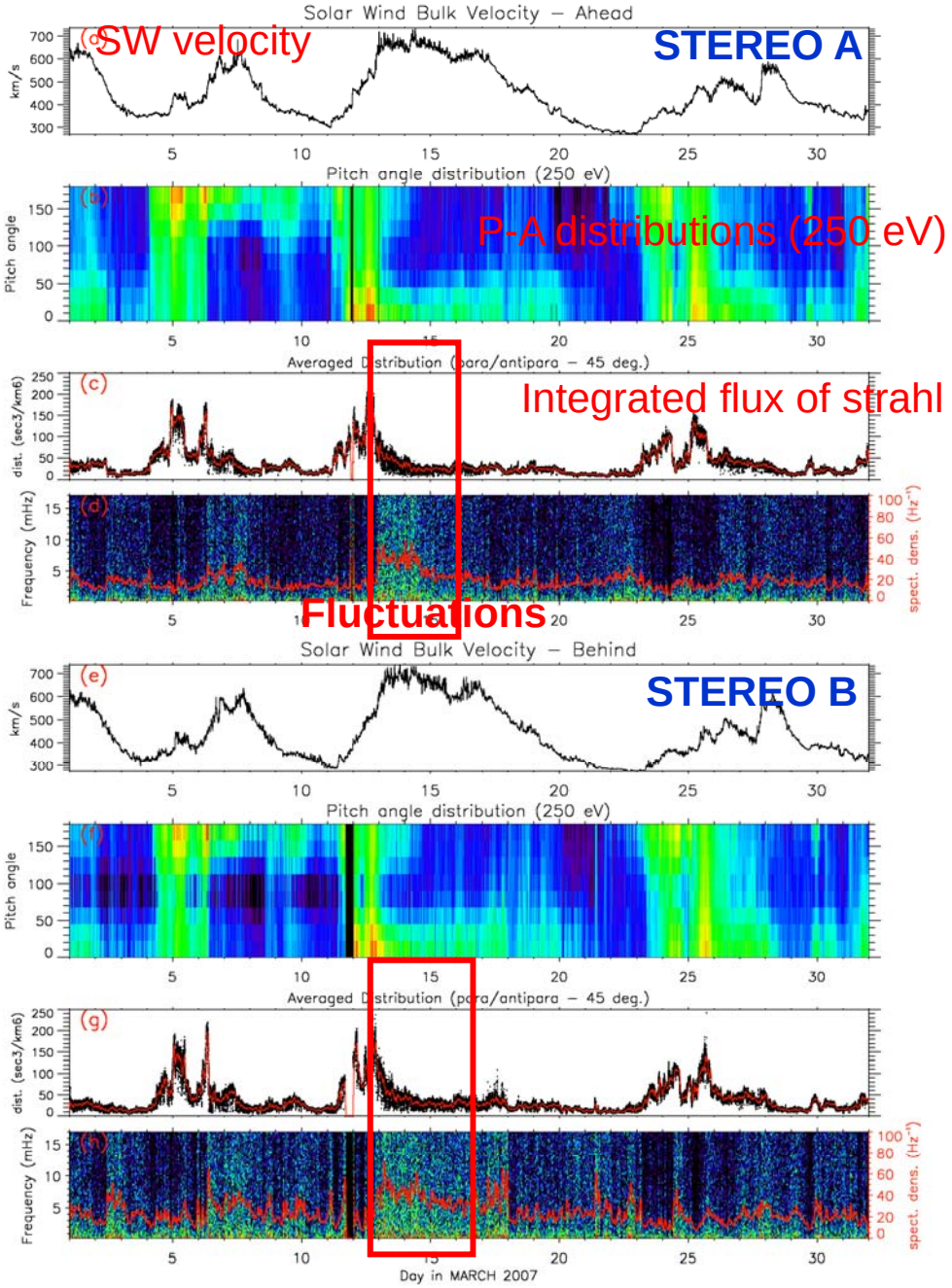
- Study of the strahl : Observation of phase space density (PSD) fluctuations larger than 50 % at scales of ~ minutes

- Particularly strong in high speed streams, following crossing of CIR.

-Observed in conjunction with strong magnetic fluctuations.

-Crucial that SWEA can do fast 3D measurements: *can be demonstrated that the fluctuations are not an artifact due to changes in B direction*

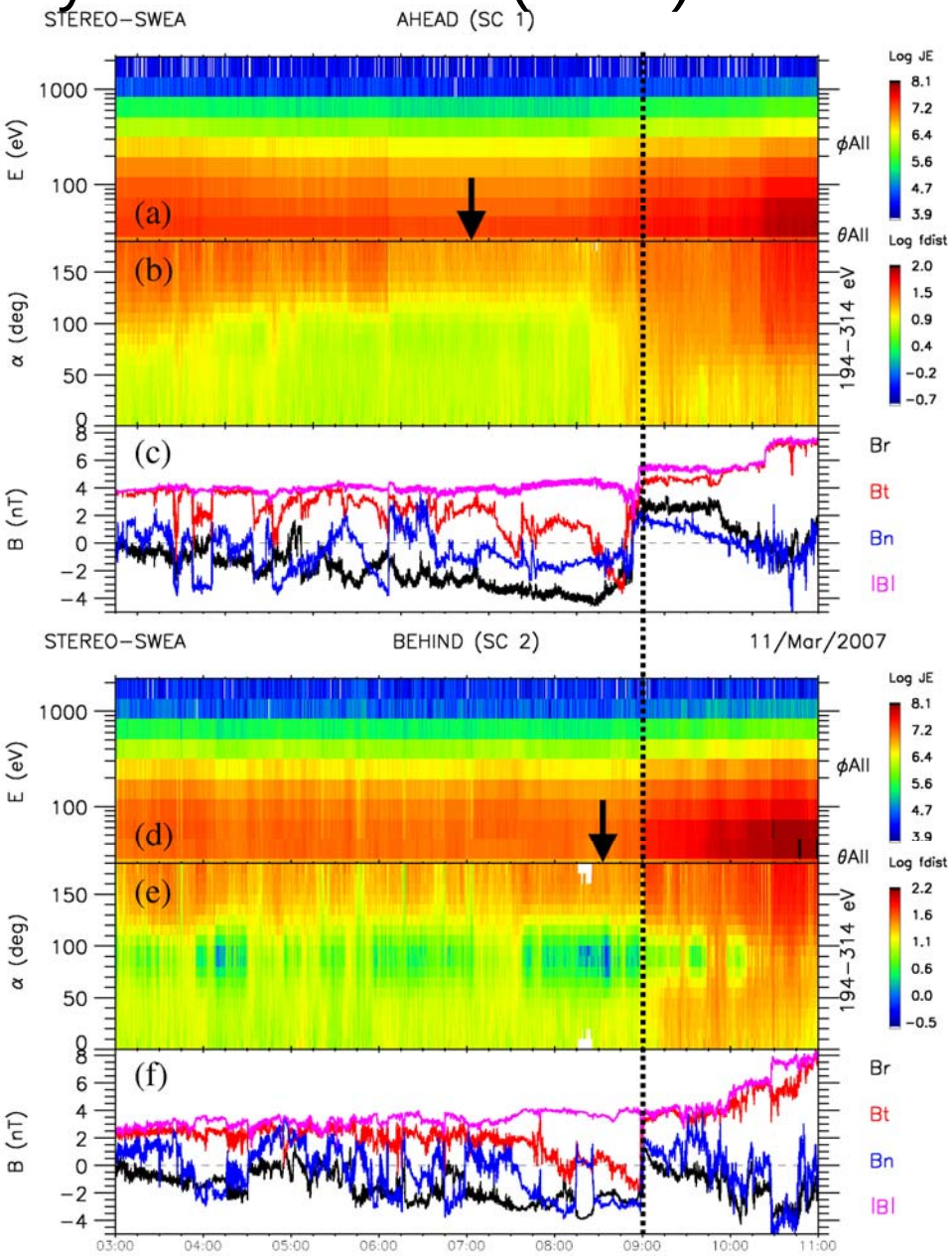
-Burst mode measurements are being investigated.



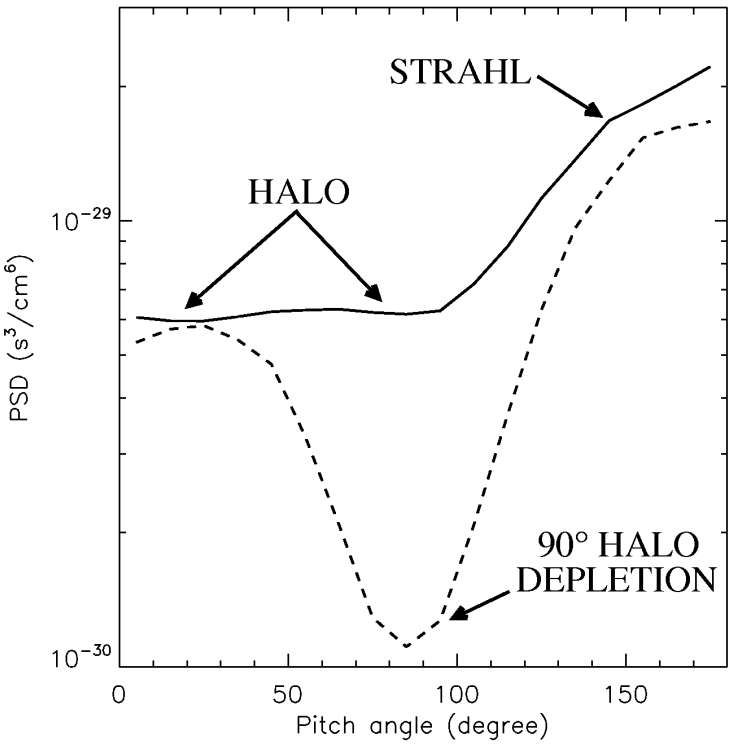
One month of data

Suprathermal electron depletion at 90° PA

by Lavraud et al. (2009)



Pitch angle distributions



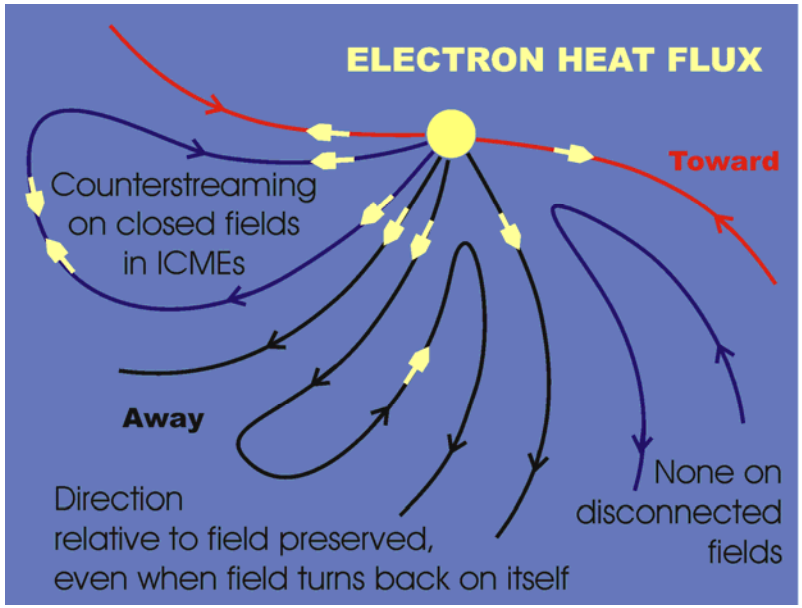
→ No depletion at ST-A
Note: no depletion at ACE either

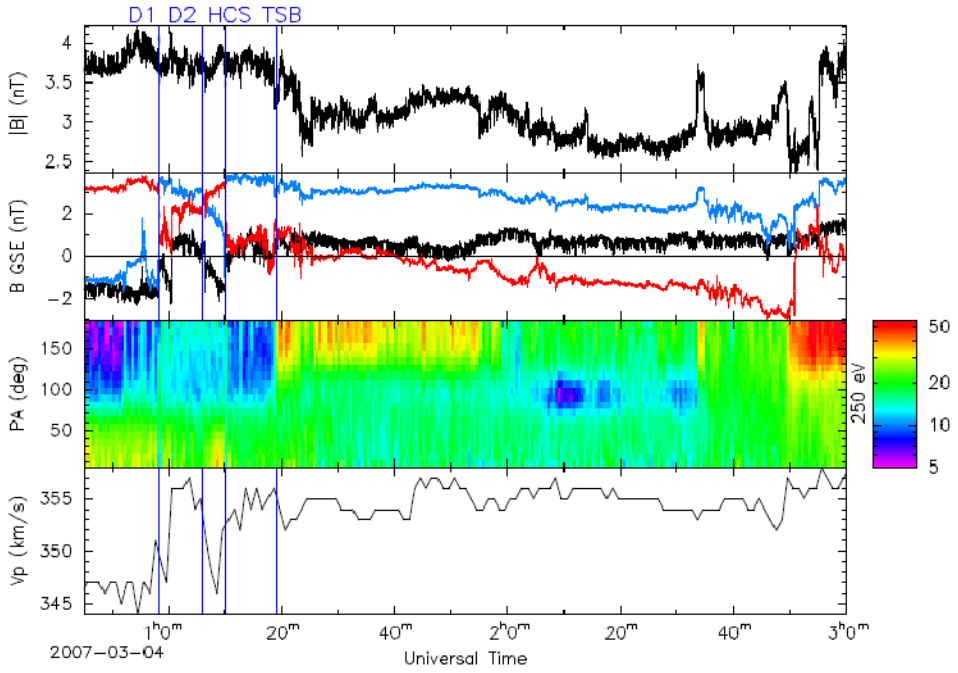
→ Clear, order of magnitude depletions at ST-B

Apparent layered structure of the HCS by Foullon et al. 2009

Multi-spacecraft study of substructures in the solar wind

Attempt to resolve spatial scales and temporal variations





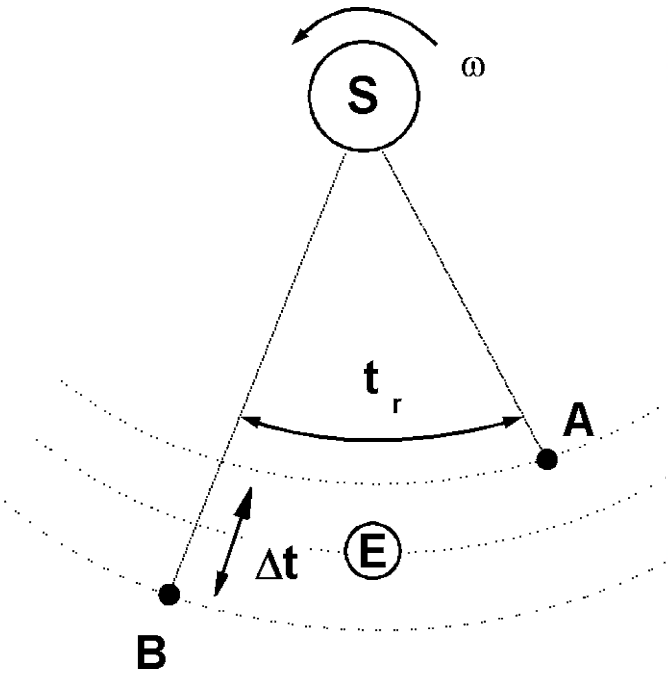
To correctly identify the HCS crossing(s), we use suprathermal electrons as sensors of magnetic topology.

Foullon et al. 2009, Sol. Phys.

STEREO timelag (Opitz et al.)

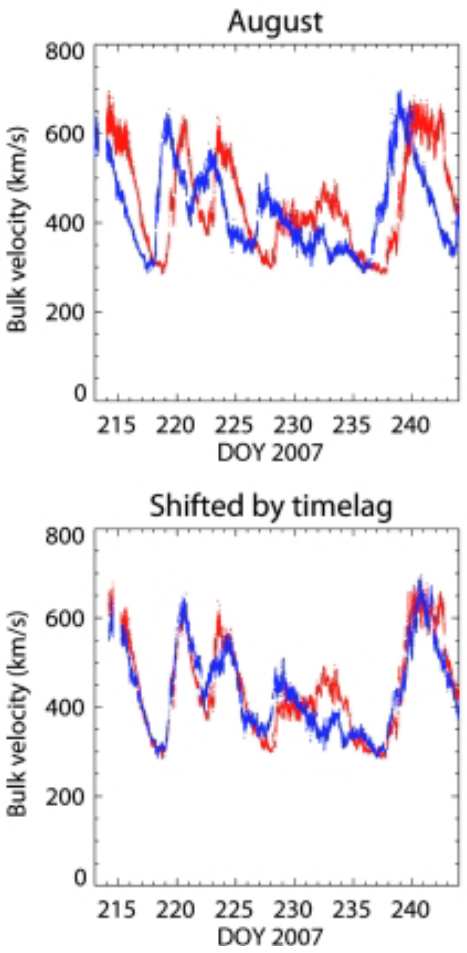
STA

STB

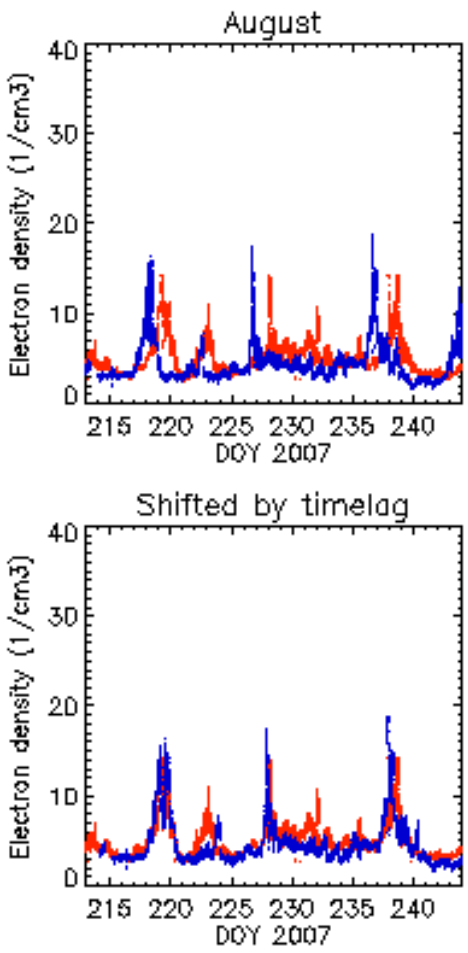


Opitz et al. 2009, SolPhys

PLASTIC velocity



SWEA density



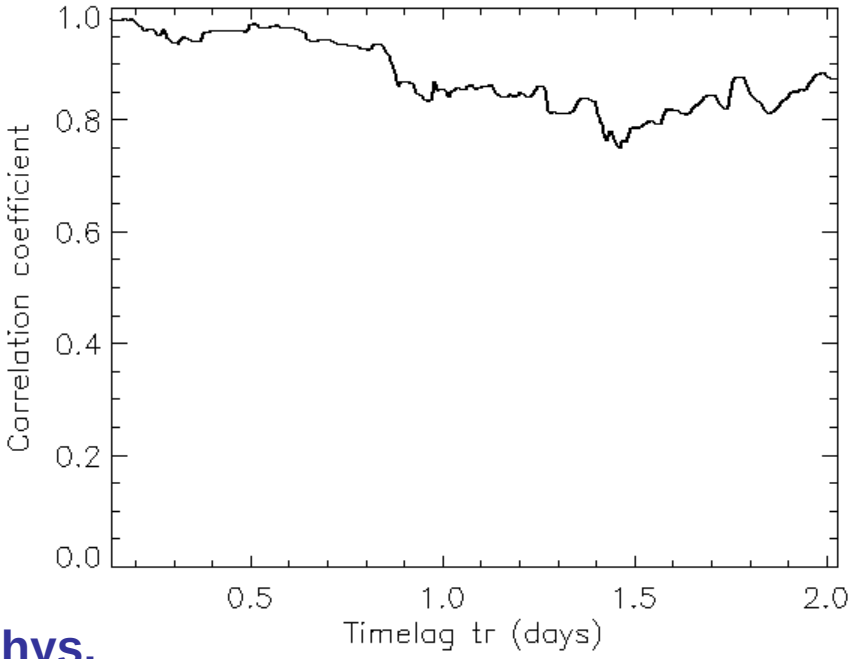
Temporal evolution of the solar wind

Opitz et al. 2009a, Solar Physics

PLASTIC velocity ⇨

0.5 day: ~0.95

2 days: ~0.85

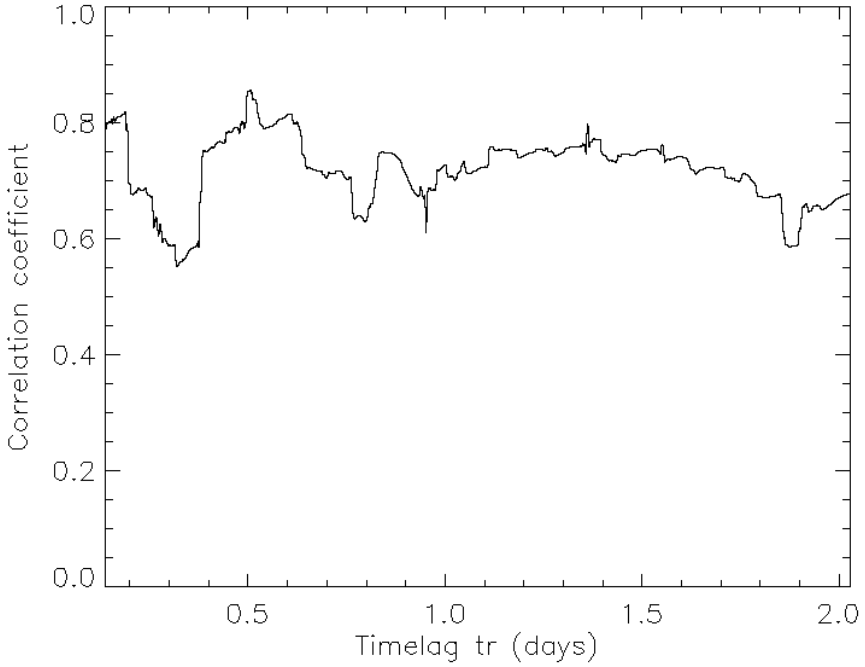


Opitz et al. 2009b, submitted at Sol. Phys.

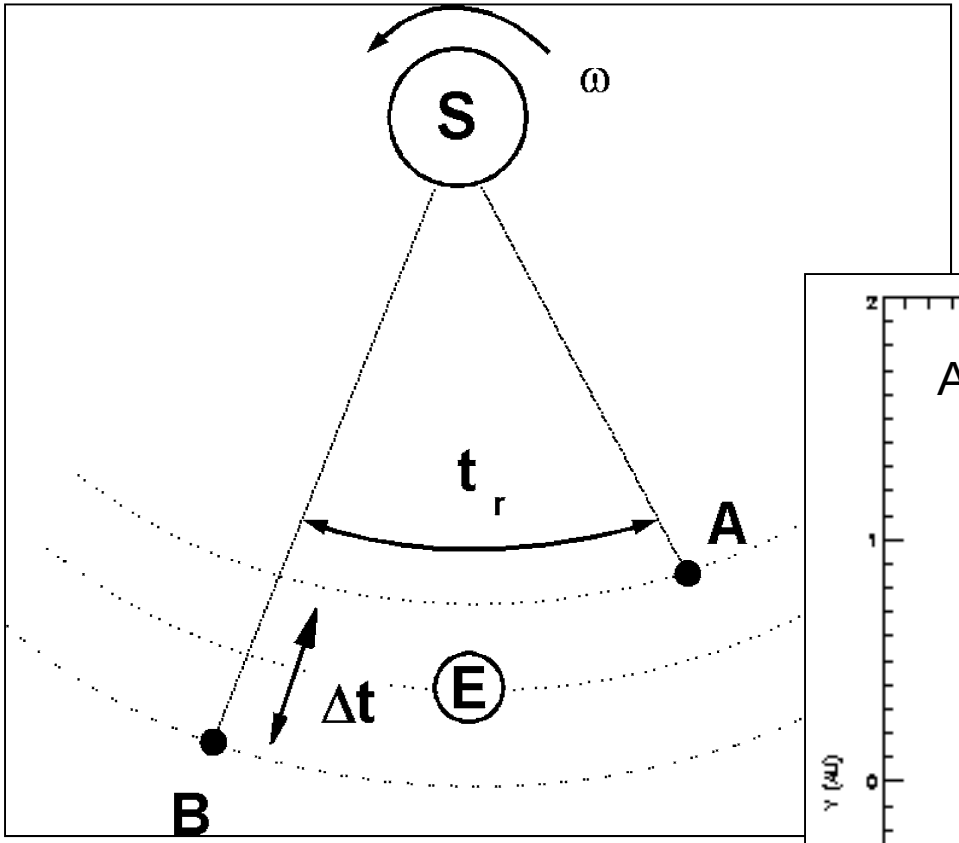
SWEA density ⇨

0.5 day: ~0.8

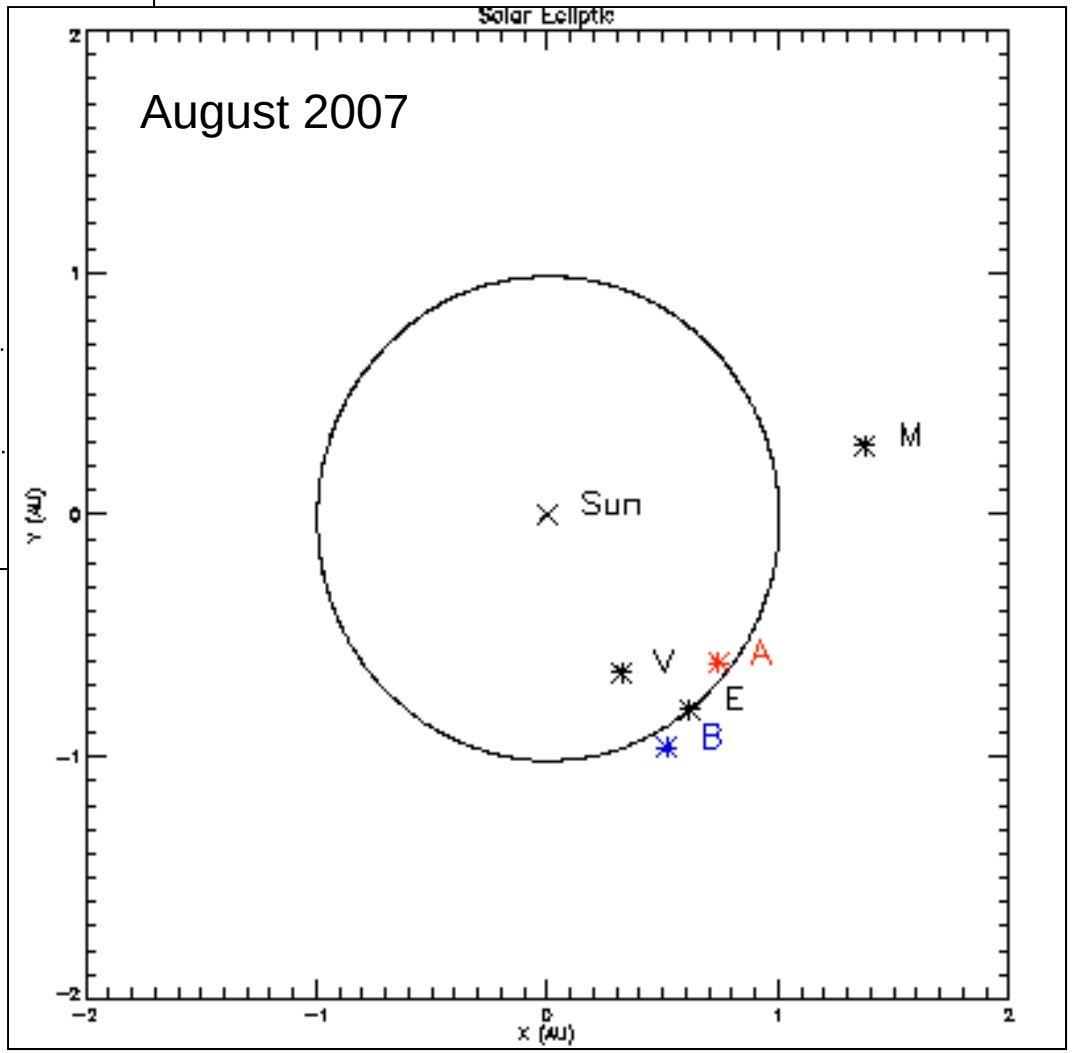
2 days: ~0.65



SW prediction for heliosphere



Opitz et al. 2009a, SolPhys



Opitz et al. 2009c, in prep.

SWEA publication list

- **Sauvaud J-A., Larson D., Aoustin C., Curtis D., Medale J-L., Fedorov A.,Rouzaud ., Luhmann J., Moreau T., Schroeder P., Louarn P., Dandouras I., and Penou E.** *The IMPACT Solar Wind Electron Analyzer (SWEA)* Space Sci. Rev., vol. 136, p227, **2008**
- **Rouillard A. P., Savani N. P., Davies J. A., Lavraud B., Forsyth R. J., Morley S. K., Opitz A., Sheeley N. R., Burlaga L. F., Sauvaud J-A., Simunac K. D. C., Luhmann J. G., Galvin A. B., Crothers S. R., Davis C. J., Harrison R. A., Lockwood M., Eyles C. J., Bewsher D., and Brown D. S.** *A Multispacecraft Analysis of a Small-Scale Transient Entrained by Solar Wind Streams* Solar Physics, vol. 256, p307, **2009:** DOI 10.1007/s11207-009-9329-6
- **Lavraud B., Gosling J. T., Rouillard A. P., Fedorov A., Opitz A., Sauvaud J-A., Foullon C., Dandouras I., Genot V., Jacquey C., Louarn P., Mazelle C., Penou E., Phan T. D., Larson D. E., Luhmann J. G., Schroeder P., Skoug R. M., Steinberg J. T., and Russell C. T.** *Observation of a Complex Solar Wind Reconnection Exhaust from Spacecraft Separated by over 1800 RE* Solar Physics, vol. 256, p379, **2009**
- **Louarn P., Dieval C., Genot V., Lavraud B., Opitz A., Fedorov A., Sauvaud J-A., Larson D., Galvin A., Acuna M. H., Luhmann J.** *On the temporal variability of the strahl and its relationship with solar wind characteristics: STEREO SWEA observations* Solar Physics, vol. 259, p311, **2009:** DOI 10.1007/s11207-009-9402-1
- **Foullon C., Lavraud B., Wardle N. C., Owen C. J., Kucharek H., Fazakerley A. N., Larson D. E., Lucek E., Luhmann J. G., Opitz A., Sauvaud J-A., and Skoug R. M.** *The apparent layered structure of the heliospheric current sheet: multi-spacecraft observations* Solar Physics, vol. 259, p389, **2009:** DOI: 10.1007/s11207-009-9452-4
- **Baker D., Rouillard A. P., van Driel-Gesztelyi L., Demoulin P., Harra L. K., Lavraud B., Davies J. A., Opitz A., Luhmann J. G., Sauvaud J-A., and Galvin A. B.** *Signatures of interchange reconnection: STEREO, ACE and Hinode observations combined* Ann. Geophys., vol. 27, p3883, **2009**
- **Lavraud B., Opitz A., Gosling J. T., Rouillard A. P., Meziane K., Sauvaud J-A., Fedorov A., Dandouras I., Genot V., Jacquey C., Louarn P., Mazelle C., Penou E., Larson D. E., Luhmann J. G., Schroeder P., Jian L., Russell C. T., Foullon C., Skoug R. M., Steinberg J. T., Simunac K. D. and Galvin A. B.** *Statistics of counter-streaming solar wind suprathermal electrons at solar minimum: STEREO observations* Ann. Geophys., submitted, **2009**
- **Opitz A., Sauvaud J-A., Fedorov A., Wurz P., Luhmann J. G., Lavraud B., Russell C. T., Kellogg P., Briand C., Henri P., Malaspina D. M., Louarn P., Curtis D. W., Penou E., Karrer R., Galvin A. B., Larson D. E., Dandouras I., and Schroeder P.** *Temporal evolution of the solar wind electron core density at solar minimum by correlating the STEREO A and B SWEA measurements* Solar Physics, submitted, **2009**