IMPACT Status and Data Updates

SWG, March 29, 2012

Janet Luhmann, Peter Schroeder, Dick Mewaldt, and Chris Russell for the IMPACT team

IMPACT Instrument Events Summary

- IMPACT triggered a spacecraft power consumption autonomy rule on 2011-09-19 on Ahead resulting in the power down of both IMPACT and PLASTIC (see following slide for details). Recovery proceeded efficiently by the next day.
- The STE-D door on Behind has had an issue with fully opening (see following slide for details) but STE's operation has since remained nominal.
- SWEA has been functioning nominally.
- MAG offsets slowly drifting but manageable.
- On 10 Feb 2011 a latch up (likely cosmic-ray induced) occurred in STB/SEPT NS. The instrument was restored to normal operation 3 days later.
- Large SEP events in 2010 and 2011 permitted final in-flight calibration of SIT lookup tables, with new uploads to SIT-A in April 2011 and SIT-B in May 2011.

IMPACT Instrument Events Summary (cont.)

- In June, 2011 the processors in LET-A and LET-B both crashed during a SEP event. A bug in the online analysis code was identified, a patch was uploaded, and both performed flawlessly in recent events >10x as large.
- In June, 2011 it was also discovered that the LET element resolution was degraded in "Dynamic Thresholds" mode by small shifts in the PHA offsets. Software patches were uploaded to both LETs in October 2011 that corrected for these shifts.
- In mid 2011 it was discovered that the bit identifying the HET dynamic threshold mode was not being set in the Beacon data (Use of this mode was rare until then). This was corrected by with a minor patch in early 2012.
- All four SEP sensors have since operated nominally

Detail: Sep 19, 2011 SEU/Power Shutdown of IMPACT and PLASTIC on STA

- On STEREO Ahead, IMPACT experienced a SEU on Sep 19, 2011, triggering a spacecraft autonomy rule (#64, when the IDPU/MAG circuit consumes more than 8 watts) which shut off power to the IMPACT and PLASTIC suites. This same rule was triggered on STEREO Behind on Jan 8, 2011, and the anomalies looked very similar. Other SEU's on both spacecraft have caused bit flips in memory or latch-ups in the SWEA and SEPT instruments. IMPACT (and PLASTIC) fully recovered by Sep 20, and no residual effects were observed.

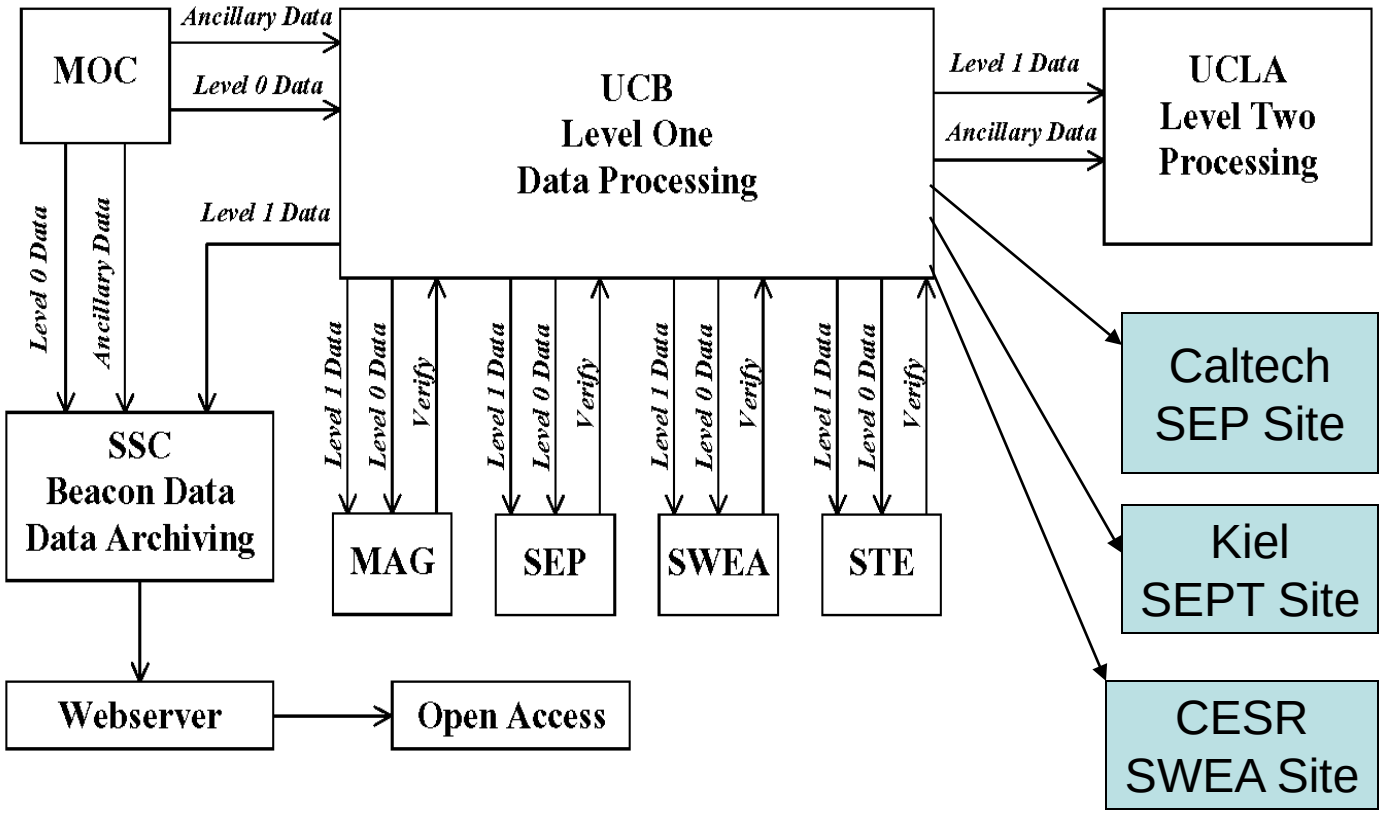
Detail: STE-D Door Anomaly on STB

- The STE-D instrument on each spacecraft has a small door designed to close during thruster firings to keep contaminants from accumulating on its surface.
- After the momentum dumps on 2011-04-20 and 2011-11-16, the STE-D door on STEREO Behind did not register as fully “open.” However, sending a manual command to open the door resolved the issue in both instances.
- Analysis of spacecraft and instrument housekeeping as well as STE science data indicates that the door did fully open in each case but was apparently not contacting the “open” sensor sufficiently. We continue to monitor this closely.

Data Status Report
SWG April 2012

From Peter Schroeder,
with inputs from the IMPACT Team

IMPACT Data Flow



Current IMPACT Level 1 Data Status

Instrument	1st Date (A)	1st Date (B)	Last Date
MAG	2006 Nov 2	2006 Nov 2	2011 Dec 31
SWEA	2006 Oct 28	2006 Oct 28	2012 Jan 31
STE	2006 Oct 28	2006 Oct 28	2012 Jan 31
LET	2006 Nov 14	2006 Nov 13	2011 Oct 31
SEPT	2006 Dec 12	2006 Dec 12	2011 Oct 31
SIT	2007 Mar 15	2007 Mar 15	2011 Oct 31
HET	1min, 15 min and 1hour averages thru 2012 March 31		

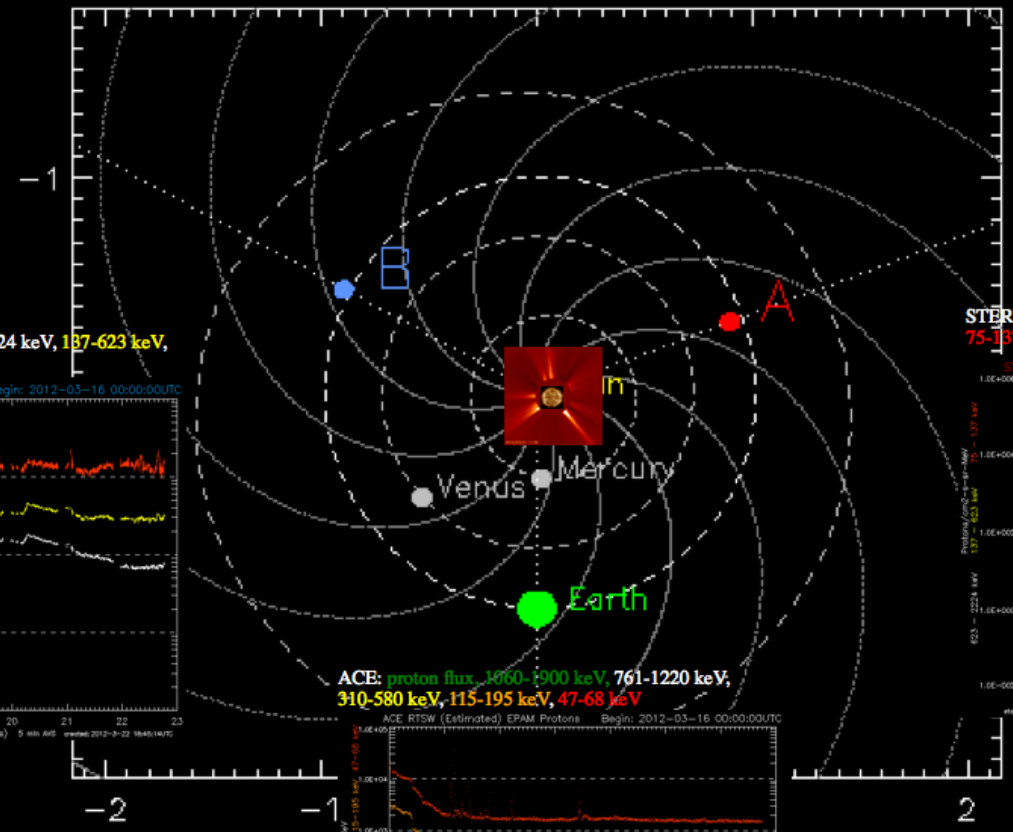
Level 2 merged IMPACT MAG and PLASTIC data and Level 3 Event Lists

- Level 2 merged 1 min MAG and PLASTIC ascii data available@ucla to 7/31/2011 for STA, and 12/31/2011 for STB
- Level 3 event lists at UCLA/STEREO site:
  - List of interplanetary shocks: STA updated to 4/30/2011, STB updated to 9/30/2011 (UCLA)
  - Lists of stream interaction regions (SIRs) and interplanetary CMEs: STA updated to 12/31/2010, STB updated to 9/30/2011 (UCLA)
  - List of SEP events observed by both STA and STB: updated to 12/31/2010
  - List of heliospheric current sheet crossings: in the to-do list

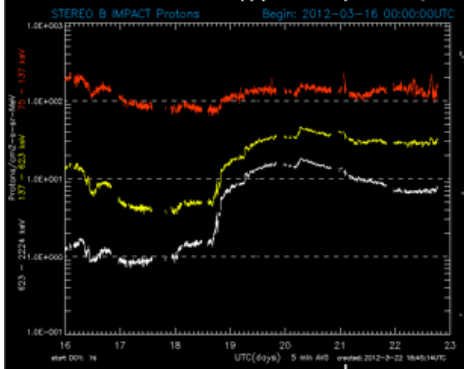
New Since Last Update

- The real-time browse page (http://stereo.ssl.berkeley.edu/multistatus.php) integrating selected SOHO and SDO 'latest' images with solar wind and SEP data plots from STEREO and ACE has been augmented to archive a daily snapshot of all data. The http://stereo.ssl.berkeley.edu/multihistory/index.php page allows the user to select a date starting with February 5, 2012 to the current day. The user may also select a display of the STEREO spacecraft locations zoomed in to Earth's orbit or out to Mars' orbit.

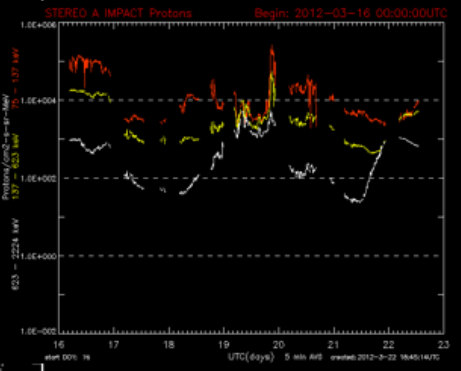
2012-03-22 Solar Activity and Heliospheric Solar Energetic Particle (SEP) Conditions



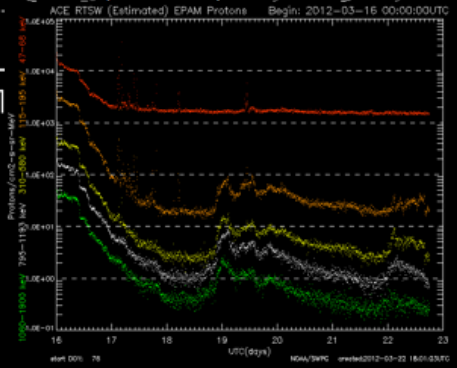
STEREO-B: proton flux, 623-2224 keV, 137-623 keV, 75-137 keV



STEREO-A: proton flux, 623-2224 keV 137-623 keV 75-137 keV



ACE: proton flux, 1060-1900 keV, 761-1220 keV, 310-580 keV, 115-195 keV, 47-68 keV



Spacecraft map out to Earth is here.
Sources of data/plots are here.
Background: Spacecraft and Planet locations.
Insets: SOHO outer corona image in white light (movie of past 2 days); inner corona EUV image from SDO (links to daily mpeg movie);
energetic particle flux time profiles from ACE (center), energetic particle flux time profiles from STEREO-A (right) and energetic particle flux time profiles from STEREO-B (left).
SEEDS solar events images link

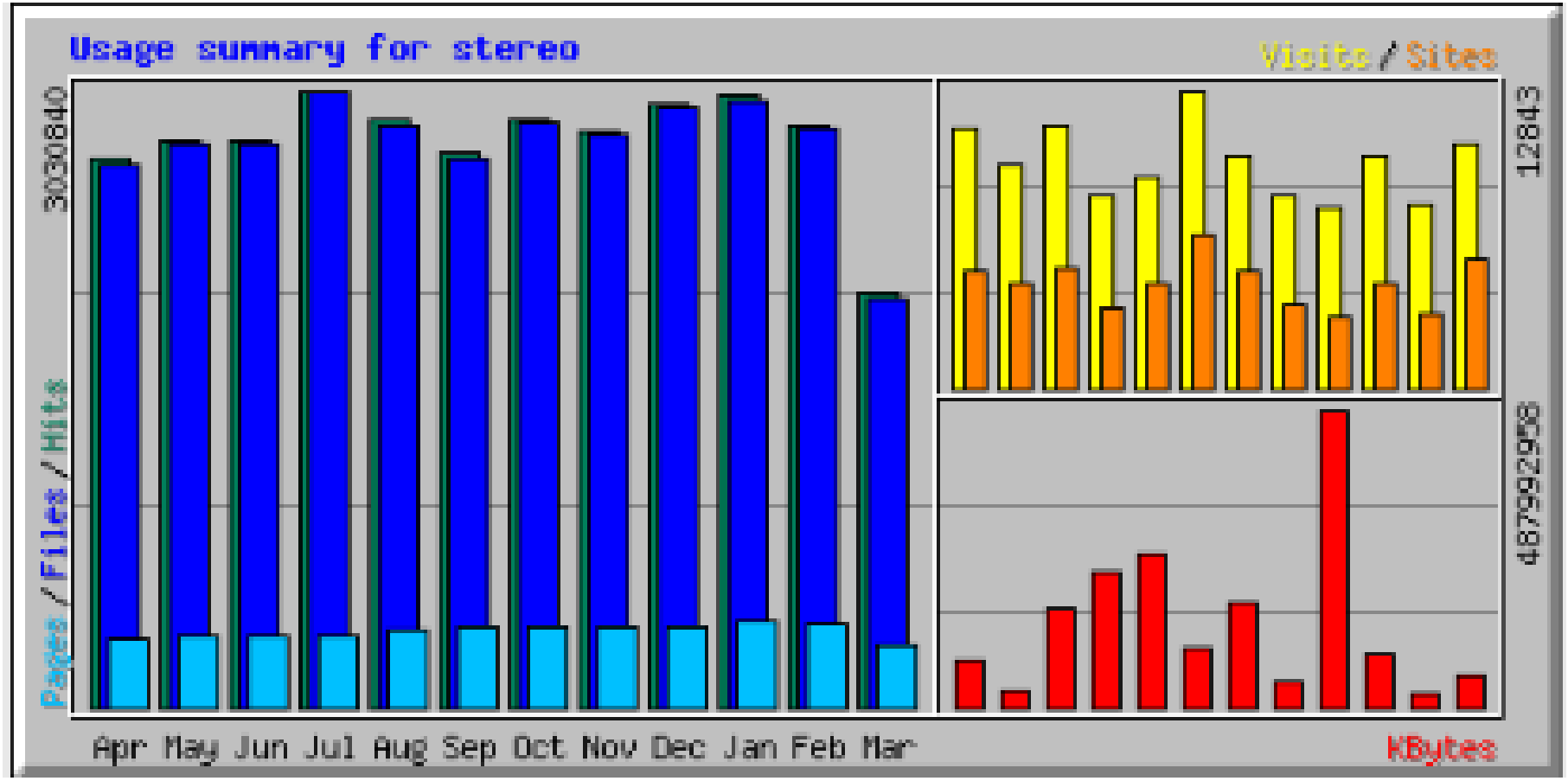
Select a set of plots from these options: SEP low | SEP high | e- and low p | Plasma

Type in a new date from 20120205 to 20120322: 20120322 Change date

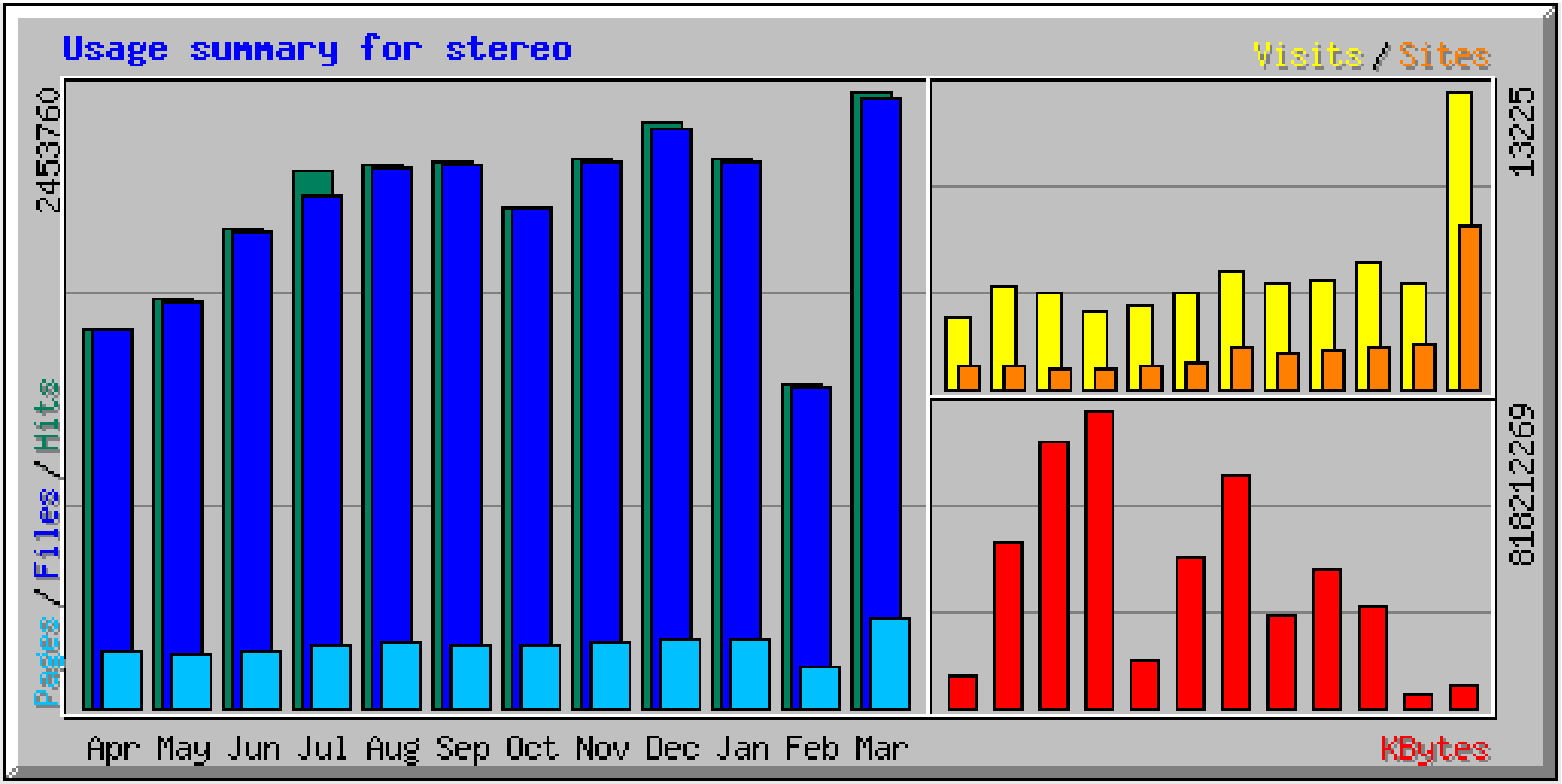
IMPACT website/data access@UCB

Summary by Month										
Month	Daily Avg				Monthly Totals					
	Hits	Files	Pages	Visits	Sites	KBytes	Visits	Pages	Files	Hits
Mar 2012	97168	95701	14691	500	5580	52453188	10520	308515	2009721	2040548
Feb 2012	98746	97868	13992	272	3231	23444716	7894	405776	2838175	2863635
Jan 2012	96810	95976	13781	323	4584	85153843	10030	427220	2975280	3001119
Dec 2011	95401	94951	12963	250	3111	487992958	7752	401878	2943508	2957451
Nov 2011	94523	93922	13412	279	3562	44753544	8371	402373	2817671	2835708
Oct 2011	93164	92566	12969	325	5048	170554726	10079	402064	2869554	2888090
Sep 2011	90843	90006	13394	428	6589	95530433	12843	401846	2700193	2725296
Aug 2011	93032	92462	12246	293	4513	250103343	9084	379651	2866351	2884007
Jul 2011	97769	97443	11411	268	3493	220288615	8332	353763	3020759	3030840
Jun 2011	92678	92226	11881	379	5235	162269671	11399	356452	2766801	2780350
May 2011	89950	89541	11194	311	4476	28457228	9667	347044	2775778	2788459
Apr 2011	89588	89080	11228	373	5029	75420850	11210	336848	2672411	2687653
Totals						**1696423115**	**117181**	**4523430**	**33256202**	**33483156**

IMPACT website/data access@UCB prior SWG



IMPACT website/data access@UCB update



IMPACT Boom Suite Status Details (MAG, SWEA, STE)

STEREO Magnetometer Data Issues

- STEREO-A MAG X-axis has a stepping problem. A sophisticated routine was programmed in 2011 and run on all STEREO A data. This is labeled version 6. While the algorithm is successful most of the time, it is not perfect, and steps are still getting through.
- STEREO-B MAG data were reprocessed too to fix other small bugs such as a uniform small timing shift and some occasional/second errors.
- Recently we discovered an averaging error in our 1-second data. All these data will have to be re-averaged. This is not a difficult problem as it requires only one pass through the 8 Hz data re-averaging them. However, the cognizant programmer has been on medical leave.

STEREO Magnetometer Issues *(new)*

- The x-sensor of the STEREO magnetometer has a random step that occurs with an amplitude of about 0.2 nT, or a multiple of this value. The field decreases and then shortly recovers, steps down, and then returns shortly afterwards.
  - We developed an algorithm to detect and correct the data and applied it. The corrected data are still noisier than unaffected measurements but not much noisier than other noise sources.
  - In 2008, the properties of the stepping changed, and the algorithm was no longer as successful. We did not detect the change in operation until 2009.
  - *The data are no longer as easy to correct. A completely new way of doing the corrections was instituted, but it took much of a year to optimize the algorithm. We are now using the new algorithm with nearly optimized parameters.*
- *We also found a small timing error in all the IMPACT data as well as some times when our timing was off by one second due to the time of the clock tick relative to the sampling of the data. We have developed the algorithm to fix these timing issues. We need to apply these to all the data from launch. Version 6 of the processing code has all these new corrections. These corrections should only affect those doing high-time resolution studies (waves). Average values (1m, 10m) will not change noticeably.*

Zero Level Determination *(new)*

- We use the Alfvenic fluctuations in the solar wind to determine the zero levels of the magnetometer. Over a day, this is probably good to about 0.2 nT and over a week to about 0.1 nT. We assume that the offsets are slowly drifting and therefore average them over several days to maintain a 0.1 nT accuracy. This technique does not require rolls.
- Since launch, the zero levels have varied over the following ranges:

A Sensor 1	4.0 nT	B Sensor 1	3.1 nT
A Sensor 2	1.7 nT	B Sensor 2	2.1 nT
A Sensor 3	4.0 nT	B Sensor 3	5.6 nT

- *In 2011, the zero levels varied over the following ranges:*

A Sensor 1	*0.2 nT*	*B Sensor 1*	*0.5 nT*
A Sensor 2	*0.4 nT*	*B Sensor 2*	*0.3 nT*
A Sensor 3	*0.3 nT*	*B Sensor 3*	*0.4 nT*

- Lessons learned:
  - STEREO A sensors zero-level are relatively stable and STEREO B slightly less so.
  - Zero level determination continues to be essential to maintaining accuracy.
  - *Since Beacon-mode data require several months of data acquisition before the zero levels can be adjusted, they can be in error by about 0.4 nT in any component for STEREO B, and within 0.3 nT on STEREO A.*
- The level 1 data meet the measurement objectives of the mission.

Analysis of Burst Mode Trigger Used on STEREO

- In June 2011, we stop collecting MAG burst data for 01-04 UT because the telemetry rate was reduced
- In Sept 2011, we removed STE use in burst trigger calculations
- The current trigger captures about 70% of shocks, 7 times better than the random data acquisition
- We are in the process of submitting a paper on the burst mode capture with scientific content added

IMPACT/STE (SupraThermal Electron) Instrument Status:

STE-Ds on both STEREO A & B are presently operating nominally

Suprathermal electron (superhalo) population in quiet-time solar wind

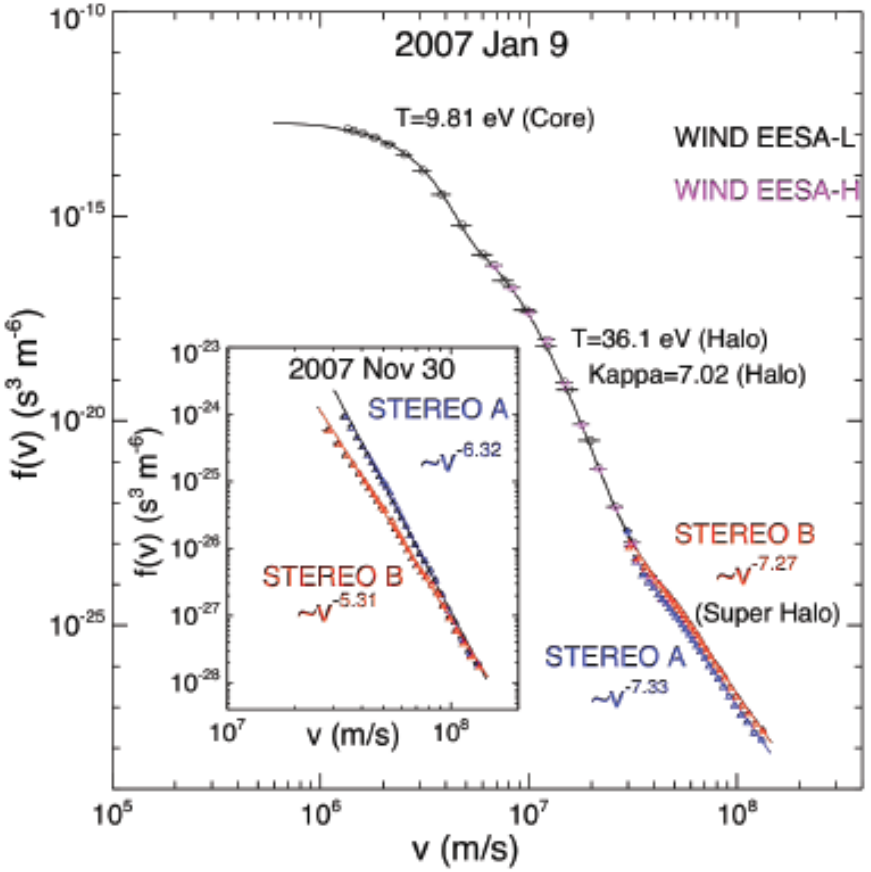


Fig. 3 Omnidirectional electron VDF measured from ~10^6m/s (~5eV) to ~10^8m/s (~60keV) during a quiet period in the interplanetary medium on 9 January 2007, The black line gives the Maxwellian fit to the solar wind (SW) core and Kappa fit to the SW halo, measured by the Wind spacecraft. The pink and blue lines are power-law fit to the solar wind superhalo measured by the STEREO A & B spacecraft. The three spacecraft are located within ~140 R_E (0.06 AU) of each other, near L1, ~200 R_E upstream of the Earth. The inset shows the superhalo electron spectra measured on 30 November 2007 by STEREO A & B, separated by ~0.7 AU (20.6 deg ahead of, and 21.1 deg ecliptic longitude behind, the Earth, respectively).

SWEA status - 2012 April

- Public data available at CESR website: http://stereo.cesr.fr
  - Energy spectrogram: ~45 eV - 2000 eV
  - Pitch angle distribution at ~150 eV
  - Density by moment calculation from electrons >45 eV
  - Temperature (parallel and perpendicular) for electrons >45 eV
  - Heat flux for electrons >45 eV
  - (Preparation of core electron density proxy, available Summer 2011)
- Other SWEA information:
  - Data base and analysis software: http://stereo.cesr.fr/clweb/
- Instrument update paper on SWEA calibration and performance by Fedorov et al. has now appeared (Space Sci. Rev., vol. 161, p. 49, 2011)
- New email for Toulouse: *Jean-Andre.Sauvaud@irep.omp.eu*

IMPACT SEP Suite Status Details (LET,HET,SEPT,SIT)

Other IMPACT/SEP Suite Updates

- **A. Klassen has taken over for R. Gomez-Herrero as lead Investigator for the SEPT sensor group at Kiel**

- **SIT, SEPT and HET data have been released through February of 2012. LET data have been processed through January of 2012 but their release has been delayed by the failure of a disk that supports LET data analysis at Caltech. HET data are now updated automatically within a few days of receipt.**

- **Anisotropy data from LET and SEPT are now being used in science analyses.**

IMPACT Team Bibliography: Updates since April 2011

Recent papers

- Aguilar-Rodriguez E., X. Blanco-Cano, C. T. Russell, J. G. Luhmann, L. K. Jian, J. C. Ramirez Velez, Dual observations of Interplanetary Shocks Associated with Stream Interaction Regions, J. Geophys. Res., 2011.
- Kajdič, P., Blanco-Cano, X., Aguilar-Rodriguez, E., Russel, C. T., Jian, L. K., Luhmann, J. G., 'Waves upstream and downstream of interplanetary shocks driven by coronal mass ejections', submitted to J. Geophys. Res., 2011.
- Velez-Ramírez., Blanco-Cano, X., Aguilar-Rodriguez, E., Kajdič, P., Russel, C. T., Jian, L. K., Luhmann, J. G., Whistler waves associated with weak Interplanetary shocks, submitted JGR, 2012.
- Lai, H., C.T. Russell, L.K. Jian, X. Blanco-Cano, B.J. Anderson , J.G. Luhmann, A. Wennmacher, The radial variation of interplanetary shocks in the inner heliosphere: observations by Helios, MESSENGER, and STEREO, submitted to Solar Physics, 2012.
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- Riley, P. and J.G. Luhmann, Interplanetary Signatures of Unipolar Streamers and the Origin of the Slow Solar Wind, Sol. Phys. 277, 355-373, 2012.
- Ruffenach A., Lavraud B. et al. *Multi-spacecraft observation of magnetic cloud erosion by magnetic reconnection during propagation* JGR, submitted, 2012

Recent papers (cont.)

- L.K. Jian, C.T. Russell, J.G. Luhmann, Comparing Solar Minimum 23/24 with Historical Solar Wind Records at 1 AU, Solar Phys., "The Sun-Earth Connection near Solar Minimum" special issue, 274, 321-344, doi: 10.1007/s11207-011-9737-2, 2011.
- L.K. Jian, C.T. Russell, J.G. Luhmann, P.J. MacNeice, D. Odstrcil, P. Riley, J.A. Linker, R.M. Skoug, J.T. Steinberg, Comparison of Observations at ACE and Ulysseswith EnlilModel Results: Stream Interaction Regions during Carrington Rotations 2016 -- 2018, Solar Phys., 273, 179-203, doi: 10.1007/s11207-011-9858-7, 2011.
- P. Riley, Lionello, R., Linker, J.A., Mikic, Z., Luhmann, J.G., Wijaya, J., Global MHD modeling of the solar corona and inner heliosphere for the Whole Heliosphere Interval, Sol. Phys. 274, 361-377, 2011.
- E.K.J. Kilpua, L. Jian, Y. Li, J.G. Luhmann, C.T. Russell, Multipoint ICME Encounters: Pre-STEREO and STEREO Observations, Atmo. Solar-Terr. Phys., 73, 1228-1241, doi:10.1016/j.jastp.2010.10.012 , 2011.
- E.K.J. Kilpua, L.K. Jian, Y. Li, J.G. Luhmann, C.T. Russell, Observations of ICMEs and ICME-like Solar Wind Structures from 2007-2010 Using Near-Earth and STEREO Observations, Solar Phys., accepted, 2011.
- Farrugia C. J. *et al*. *Multiple, distant (40 degree) in situ observations of a magnetic cloud and a corotating interaction region complex* J. Atmos. Solar-Terr. Phys. (ILWS), vol. 73, p1254, 2011.

Recent papers (cont.)

- Liu, Y., J. G. Luhmann, S. D. Bale, and R. P. Lin, Solar Source and Heliospheric Consequences of the 2010 April 3 Coronal Mass Ejection: A Comprehensive View, 2011, Astrophys. J., 734, 84
- Liu, Y. D., et al., Interactions between Coronal Mass Ejections Viewed in Coordinated Imaging and In Situ Observations, 2012, Astrophys. J. Lett., 746, L15
- Fang, F., W.B. Manchester, W.P. Abbett and B. van der Holst, Dynamic coupling of convective flows and magnetic field during flux emergence, Astrophys. J., 757, 37, doi:10.1088/0004-637X/745/1/37, 2012.
- Jin, M., W.B. Manchester, B. van der Holst, J.R. Gruesbeck, R.A. Frazin, E. Landi, A.M. Vasquez, P.L. Lamy, A. Llebaria, A. Fedorov, G. Toth and T.I. Gombosi, A global two-temperature corona and inner heliosphere model: A comprehensive validation study, Astrophys. J., 745, 6, doi:10.1088/0004-637X/745/1/6, 2012.
- Riley et al., "Interpreting Some Properties of CIRs and their Associated Shocks during the Last Two Solar Minima using Global MHD Simulations," in press, Journal of Atmospheric and Solar-Terrestrial Physics, 2012.
- Riley et al., "Corotating Interaction Regions during the Recent Solar Minimum: The Power and Limitations of Global MHD Modeling," in press, Journal of Atmospheric and Solar-Terrestrial Physics, 2012.

Recent Papers (cont.)

Recent and Submitted STEREO/SEP Publications

"STEREO Observations of the Energetic Ions in Tilted Corotating Interaction Regions", R. Bučík, et al., *J. Geophys. Res.* 116, A06103, doi: 10.1029/2010JA016311 (2011).

"Electron Spikes, Type III Radio Bursts and EUV Jets on 22 February 2010", A. Klassen, et al., *Solar Physics*, 273, 413-419, 2011.

"The Almost Monoenergetic Ion Event on 19 October 2009: SEPT/STEREO observations", A. Klassen et al. *Astron. Astrophys.*, 528, A84, 2011.

"Large Anisotropies in the 18 August 2010 Solar Particle Event Observed at STEREO-A", R. A. Leske, et al., *Proc. 32nd Internat. Cosmic-Ray Conf.* (Beijing), 10, 197-200, 2011 (see http://www.ihep.ac.cn/english/conference/ic rc2011/paper/).

"Observations of Broad Longitudinal Extents of ^{3}He-rich SEP Events", M. E. Wiedenbeck et al., *Proc. 32nd Internat. Cosmic Ray Conf.* (Beijing), 10, 205, 2011 (online at http://www.ihep.ac.cn/english/conference/icrc2011/paper/).

"Abundances of Suprathermal Heavy Ions in CIRs on STEREO during the Minimum of Solar Cycle 23", R. Bucik et al., *Proc. 32nd Internat. Cosmic-Ray Conf.* (Beijing) 10, 222, 2011 (see http://www.ihep.ac.cn/english/conference/icrc2011/paper/).

"Multi-spacecraft observations during a series of three solar energetic particle events in May, 2009, N. Dresing et al., *Proc. 32nd Internat. Cosmic Ray Conf.* (Beijing) 10, 115, 2011 (see http://www.ihep.ac.cn/english/conference/icrc2011/paper/).

"Interpreting the Properties of Solar Energetic Particle Events by Using Combined Imaging and Modeling of Interplanetary Shocks", A. P. Rouillard et al., *Astrophys. J.,* 735, doi:10.1088/0004-637X/735/1/7, 2012.

"Corotating Interaction Region Associated Suprathermal Helium Ion Enhancements at 1 AU: Evidence for Local Acceleration at the Compression Region Trailing Edge", R. W. Ebert, et al., *Astrophysical Journal,* Volume 749, doi:10.1088/0004-637X/749/1/73 (2012).

"Energy Spectra, Composition, and other Properties of Ground-Level Events during Solar Cycle 23", R. A. Mewaldt, et al. *Space Science Reviews,* in press, 2012.

"Evolution of Suprathermal Seed Particle and Solar Energetic Particle Abundances", R. A. Mewaldt, et al., in *Physics of the Heliosphere: A 10 year Retrospective* , J. Heerikhuisen, et al. editors, AIP Conf. Proc., in press, 2012.

"Large Proton Anisotropies in the 18 August 2010 Solar Particle Event", R.A. Leske, et al., Solar Physics, 2012 (in press).

"Solar Neutron-Decay Protons", E. E. Chollet and R. A. Mewaldt, submitted to Solar Physics Sun -360, Special Issue, 2012.

"Observations of the Longitudinal Spread of Solar Energetic Particle Events in Solar Cycle 24", C. M. S. Cohen et al., in *Physics of the Heliosphere: A 10 year Retrospective* , J. Heerikhuisen, et al., editors, AIP Conf. Proc., in press, 2012.

"The large longitudinal spread of solar energetic particles during the January 17, 2010 solar event", N. Dresing et al., *Solar Physics*, submitted, 2012.

"Solar origin of in-situ near-relativistic electron spikes observed with SEPT/STEREO", A. Klassen, et al., *Astronomy and Astrophysics*, submitted, 2012.

Recent papers (cont.)

- L. Wang, K. Schmidt, and R.P. Lin, Heliospheric, ~5-15 keV Hydrogen ENAs by STEREO/STE, in preparation, 2012.
- L. Wang, R.P. Lin, Chadi Salem, and Marc Pulupa, Quiet-time Interplanetary ~2-20keV Superhalo Electrons at Solar Minimum, Astrophys. J., submitted, 2012.
- Peter H. Yoon, L.F. Ziebell, R. Gaelzer, R.P. Lin, and L. Wang, Langmuir Turbulence and Suprathermal Electrons, Space Sci. Rev, DOI 10.1007/s11214-012-9867-3, 2012.
- P. H. Yoon, L. F. Ziebell, R. Gaelzer, L. Wang, R. P. Lin, Solar Wind Electron Acceleration by Langmuir Turbulence, in press in Terrestrial, Atmospheric and Oceanic Sciences.
- M. Palupa, S.D. Bale, A. Opitz., A. Fedorov, R.P. Lin, J-A. Sauvaud, STEREO measurements of electron acceleration beyond fast Fermi at the bow shock, submitted to JGR.
- Foullon C. *et al*. *Plasmoid releases in the heliospheric current sheet and associated coronal hole boundary layer evolution* Astrophysical Journal, vol. 737, 16, 2011
- Nieves-Chinchilla T. *et al*. *Analysis and study of the in situ observation of the June 1st 2008 CME by STEREO* J. Atmos. Solar-Terr. Phys. (ILWS), vol. 73, p1348, 2011

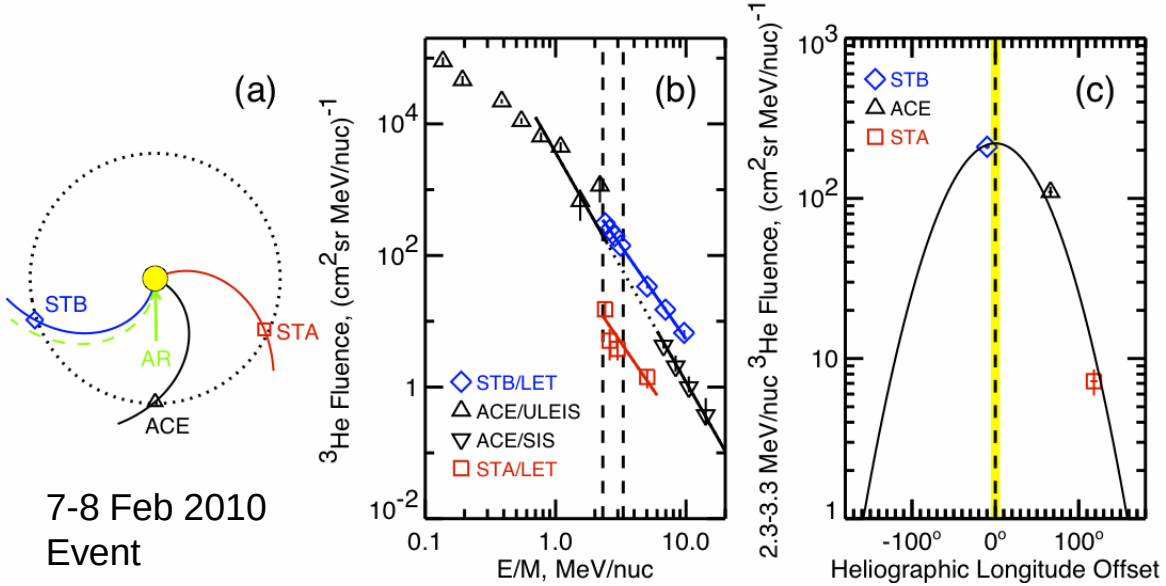
IMPACT science updates: April 2012

Organization of "Sun-360", July 25 – 29, 2011, Kiel (Germany)

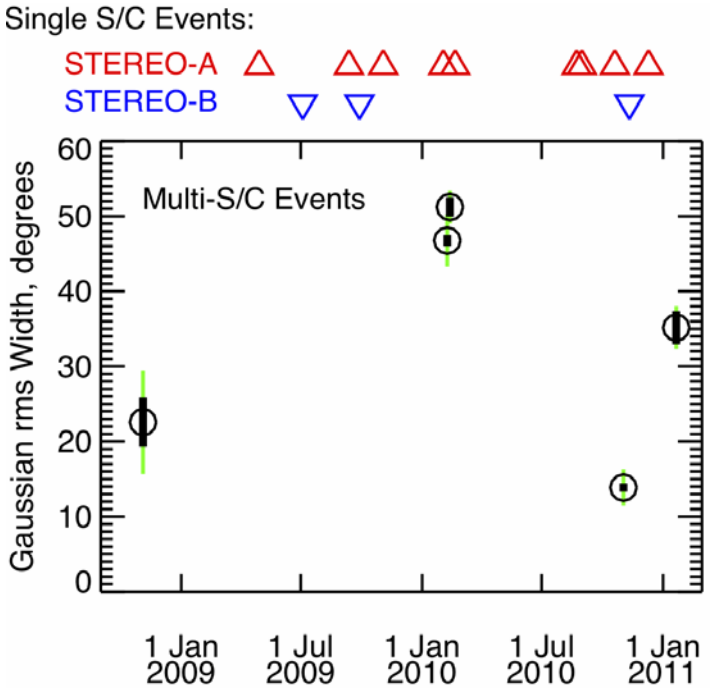
This meeting was very successful. A related special issue of Solar Physics Journal is currently in the review process.

A 2012 meeting focused on in-situ science with STEREO, ACE and WIND is planned for Sept 18-20 at APL.

Longitudinal Spreads of ^{3}He-rich Solar Energetic Particle Events

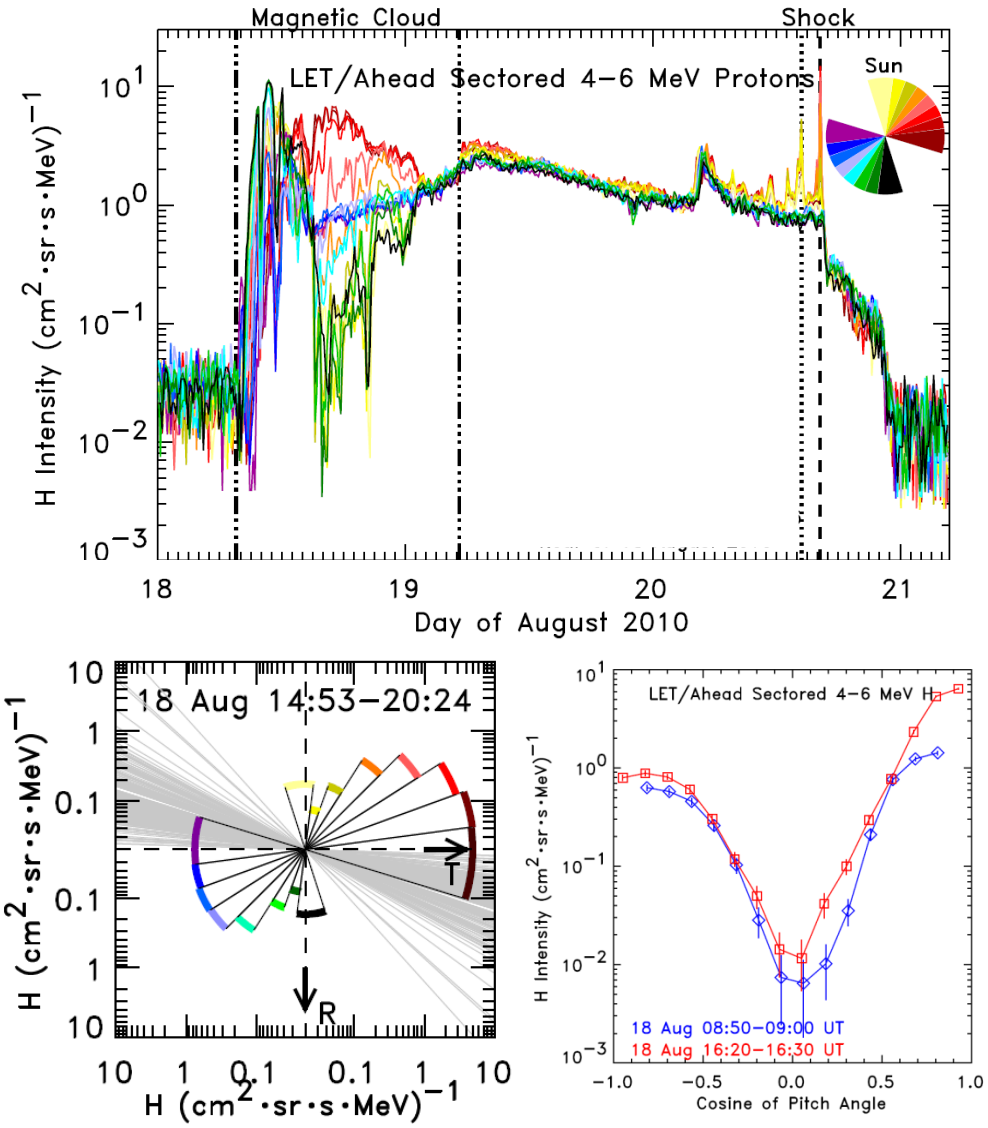


7-8 Feb 2010 Event



- STEREO/LET-A & -B data searched for ^{3}He-rich events between Jan 2007 and Jan 2011 when solar activity was low
- Data from the other STEREO and from ACE checked to determine if the same events were also detected there
- ~30% of the events were detected at 2 or 3 spacecraft
- The measured ^{3}He fluence was found to decrease strongly with separation from the longitude of best connection to the active region where the associated flare occurred
- Approximating the longitudinal distribution of fluence as a Gaussian centered on the best-connected longitude, rms widths ranging between ~15° and ~50° have been observed
- Comparisons with STEREO/SEPT and ACE/EPAM data show that the multispacecraft detections of ^{3}He are generally accompanied by multispacecraft electron detections

STEREO Sees Enormous Proton Anisotropies in a Solar Energetic Particle Event

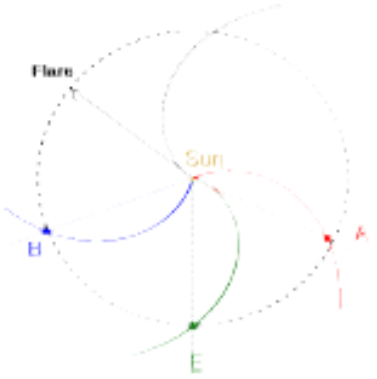


Figures from *Leske et al., Solar Physics,* 2012 (in press)

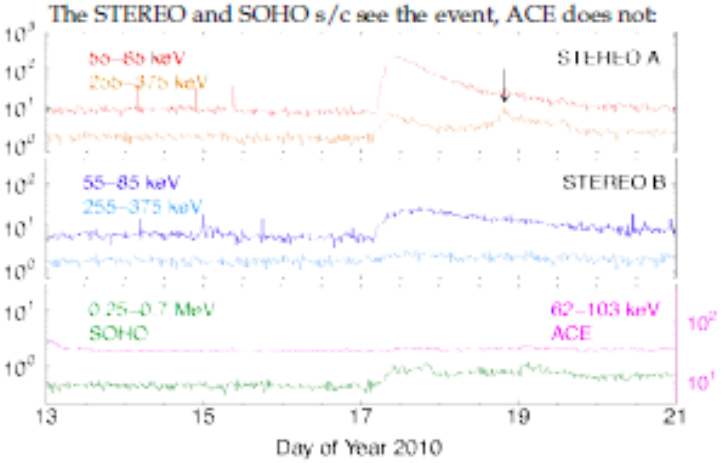
- Usually Solar Energetic Particles (SEPs) are mostly isotropic, with nearly equal intensities coming from all directions, although sometimes a "beam" of particles may appear for a few hours at the start of an event as particles stream outward from the Sun along magnetic field lines.
- The Low Energy Telescope (LET) onboard the twin Solar Terrestrial Relations Observatory (STEREO) spacecraft measures particle intensities in 16 viewing directions in the ecliptic (as illustrated by the color wheel in the top plot). During an SEP event on 18 August 2010, LET on STEREO-Ahead saw vastly different proton intensities in different directions, with intensities in some directions nearly 1000 times higher than those in others. These large anisotropies persisted for a long time, nearly 17 hours into the event.
- Particle intensities were highest along the magnetic field direction (shown by gray lines in the lower left plot) and lowest perpendicular to the field, and they traveled in both directions along the field (bottom two figures).
- 4 days earlier, the same solar active region produced a coronal mass ejection with a magnetic cloud, a structure of magnetic field lines twisted like a rope, with both footpoints anchored at the Sun. STEREO-Ahead was passing through this magnetic cloud when the 18 August event went off, sending particles down both legs of this conduit in a tight beam. The structure of the cloud caused the unusual distribution of particle intensities.

The large longitudinal spread of energetic particles during the January 17, 2010 SEP event

N. Dresing, R. Gómez-Herrero, A. Klassen, B. Heber, Y. Kartavykh, and W. Dröge
Submitted to Solar Physics (TI: Sun 360)



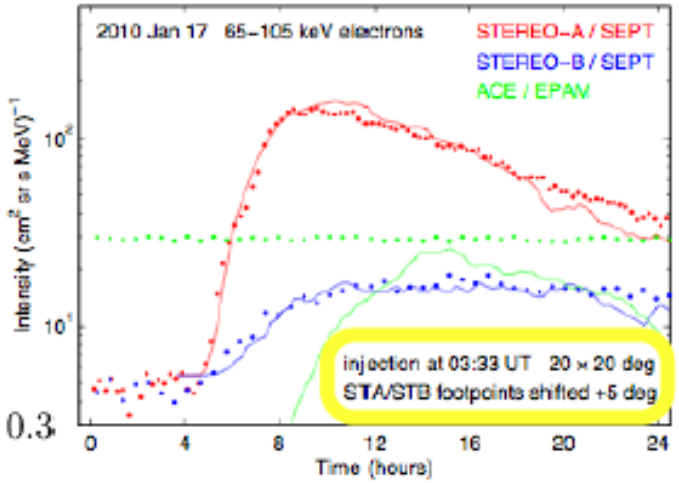
On January 17, 2010 both STEREO s/c and SOHO detect energetic electrons and protons associated to the same flare. The AR is on the backside as seen from Earth and STEREO A suggesting a nearly 360° SEP spread in longitude at 1AU.



The event was accompanied by type III radio bursts, a type II burst (seen only by STEREO B and Earth), EUV wave, and CME. Energetic particles arrive the s/c delayed, poor pitch-angle coverage and statistics restrict a good anisotropy determination.

In order to characterize the observations in terms of perpendicular diffusion in the IP medium we applied a 3D propagation model (Dröge et. al, 2010). The results reproduce the observations well and reveal a high ratio of perpendicular to parallel diffusion of 0.3.

$$\lambda_{\parallel} = 0.1\,\mathrm{AU}$$
$$\alpha = \lambda_{\perp}/\lambda_{\parallel} = 0.3$$



A. Klassen, R. Gómez-Herrero, B. Heber, Y. Kartavykh, W. Droege, K.-L. Klein (submitted to A&A, 2011)

Solar origin of *in-situ* near-relativistic electron spikes. During 2010 - 2011 the Solar Electron Proton Telescope (SEPT) on board the twin STEREO spacecraft detected a number of typical impulsive electron events showing a prompt intensity onset followed by a long decay, as well as several near-relativistic so-called electron spike events. These spikes detected at energies < 300 keV are characterized by very short duration (below 10 - 20 min at FWHM), almost symmetric time profiles, velocity dispersion and strong anisotropy revealing a very weak particle scattering during the propagation from the Sun to 1 AU (STEREO) (Klassen et al., 2010; 2011 submitted). Using particle, EUV and radio imaging observations we prove, that electrons, forming the spikes, are accelerated during the same time and at the same location as the accompanying type III emitting electrons and narrow coronal EUV jets.

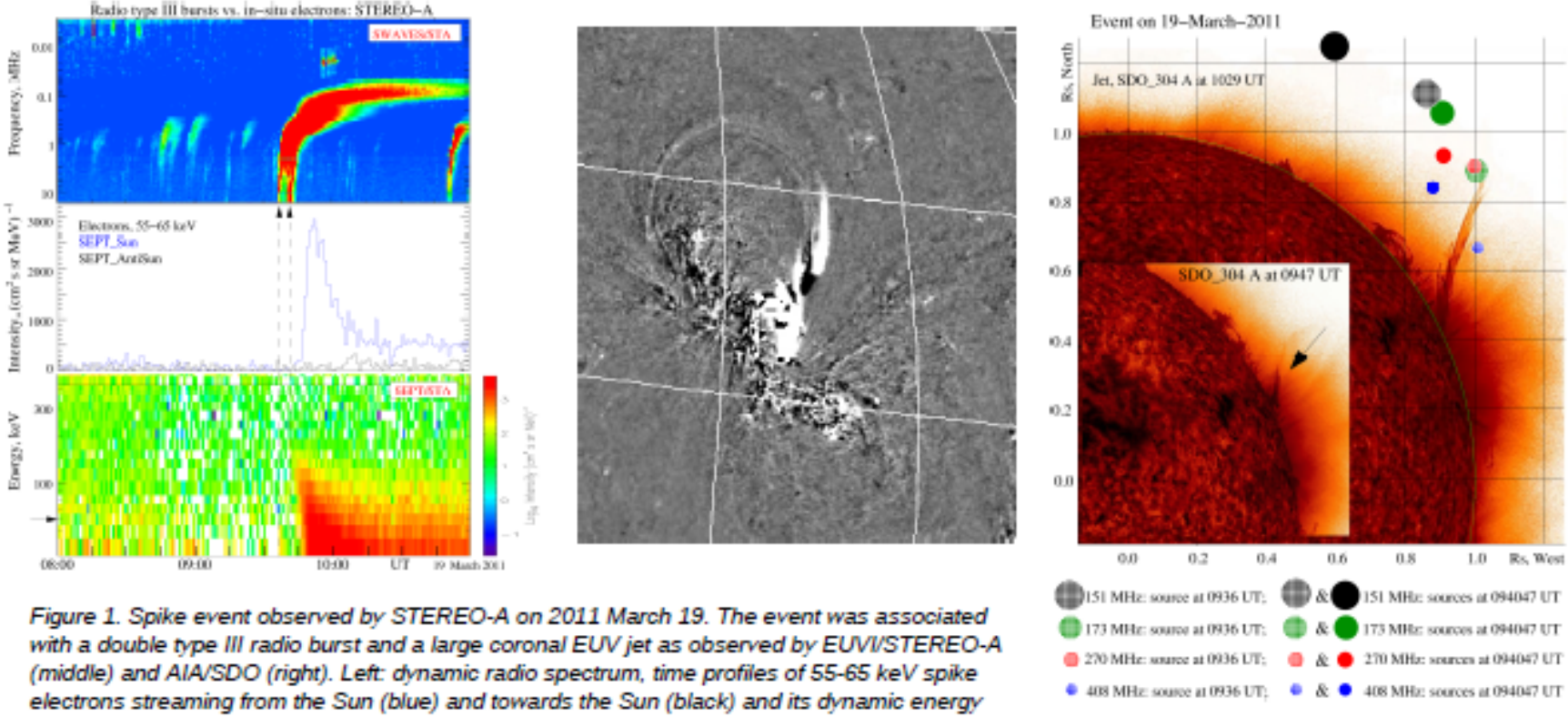
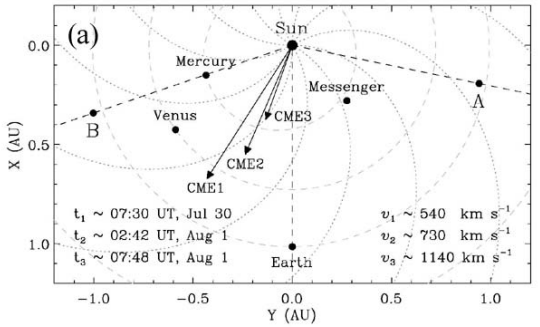
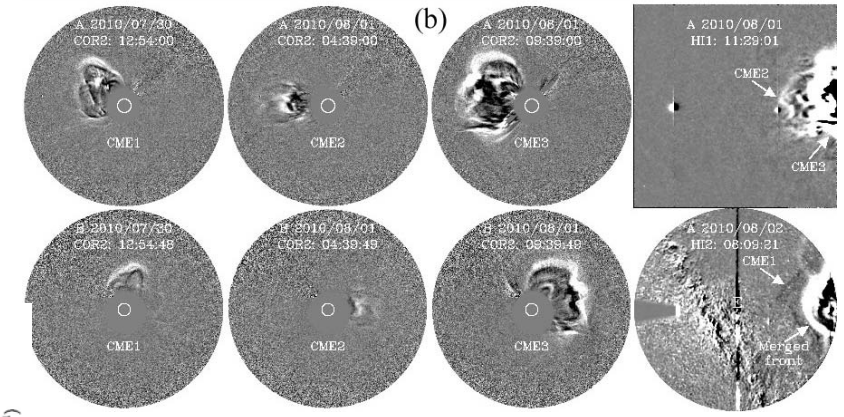


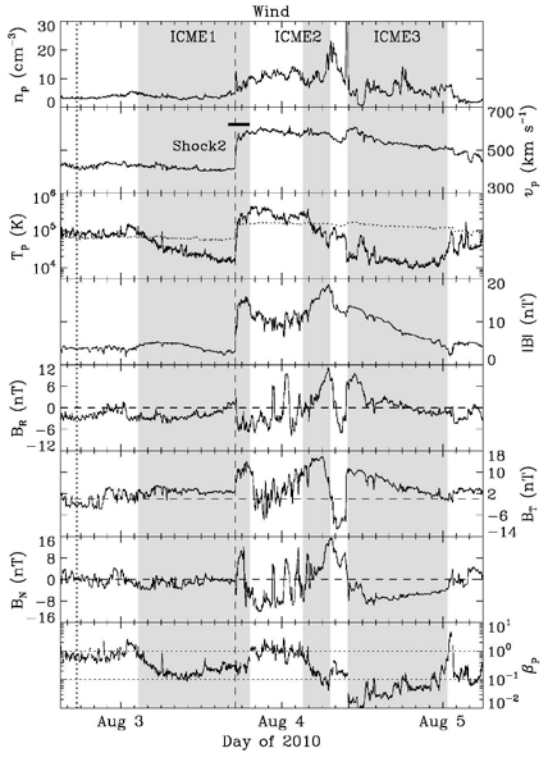
Figure 1. Spike event observed by STEREO-A on 2011 March 19. The event was associated with a double type III radio burst and a large coronal EUV jet as observed by EUVI/STEREO-A (middle) and AIA/SDO (right). Left: dynamic radio spectrum, time profiles of 55-65 keV spike electrons streaming from the Sun (blue) and towards the Sun (black) and its dynamic energy spectrum showing a clear velocity dispersion. Middle: a colimated EUV 195 A jet at 09:43 UT. Right: the same jet as observed by SDO 304 A at two different times in superposition of the metric type III sources (filled & hatched circles, Nancay Radioheliograph). The jet footpoint was located ~25° behind the west limb from the SDO point of view.

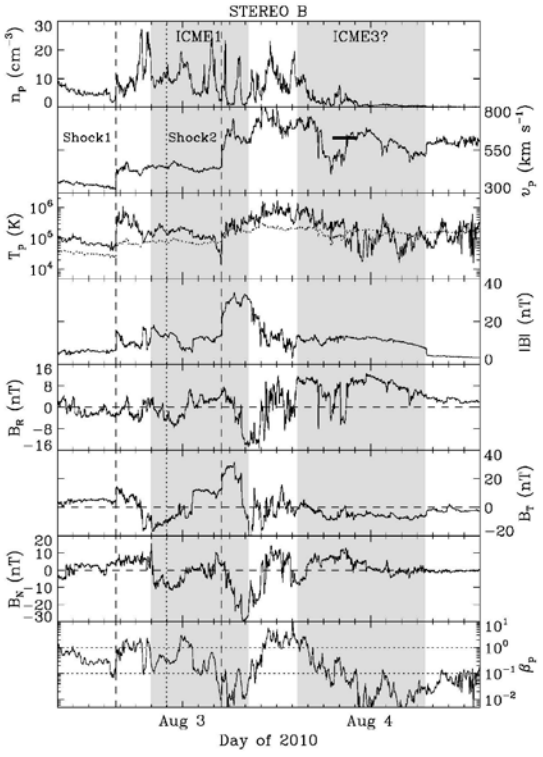
CME-CME Interactions

Interactions between CMEs are of importance for both space weather and basic plasma physics: they can produce or enhance southward magnetic fields, reveal crucial shock physics and imply significant energy and momentum transfer between the interacting CMEs where magnetic reconnection may take place.









Two CMEs from 2010 Aug 1 merged around 55 solar radii into a broad wave. Connections with in situ signatures suggest that the merged front is a shock, followed by two ejecta observed at Wind which seem to have already merged. The shock is propagating into the CME from July 30 near 1 AU, and the preceding ejecta is significantly compressed, accelerated and heated as shown by in situ measurements. The interaction also modifies the shock strength and structure on a global scale as indicated by widely separated in situ measurements from Wind and STEREO B.

H.R. Lai (UCLA Student) Projects: Shocks and IFEs

- Formation of shocks inside 1 AU.
  - Survey of Occurrence 0.3-1.0 AU includes new STEREO data sets
  - Determines cause of interplanetary shocks inside 1 AU
    - ICME driven-solar activity dependent
    - SIR-driven
  - The Radial Variation of Interplanetary Shocks in the Inner Heliosphere: Observations by Helios, MESSENGER and STEREO
- Interplanetary Field Enhancements
  - Survey of occurrence 0.3-1.0 AU includes new STEREO data sets includes STEREO A, B, 2006-2009, 44 IFEs
  - Location distribution
    - Generally uniform in HAE latitude
  - Pressure compensation
    - No significant disturbance in plasma velocity, density, and temperature
    - Most of the total pressure enhancement comes from the magnetic field
  - Size/Mass Distribution
    - Size: Most IFEs are around 10^5 km in radial dimension
    - Mass: Most IFEs are around 10^8 kg in mass
    - Currently studying multi-spacecraft observations

EXTRA SLIDES

IMPACT Magnetometer: Level 1 MAG Data Processing Summary

- UCLA is in charge of calculating the zero levels of the magnetometer, processing the level 1 (full resolution) magnetic records, rotating from spacecraft to rtn coordinates, averaging to lower resolution and displaying level 2 data.
- We process the data monthly, once a full month becomes available. Thus we are at least about 2 months behind real time.
- We make the data available via plots and ascii files on our website. We also make CDF files at full resolution and send them to Berkeley.
- We maintain a level 2 data server that has PLASTIC data at 1 minute, 10 min and 1 hour resolution together with magnetometer data at the same cadence. We intend to add SWEA and SEP data shortly but still have magnetometer work in progress at higher priority. We have added Wind and ACE magnetometer data in RTN coordinates for correlative studies to our STEREO data base. We also have wind and ACE plasma and magnetic field data as near-Earth data.

IMPACT / SEPT – Data Products

- Data products (generated at Kiel) available at:

  http://www2.physik.uni-kiel.de/stereo/

  This URL includes links to:

  –SEPT browse plots available online through March 14, 2012:
  http://www2.physik.uni-kiel.de/stereo/browseplots/

  –Latest 10-days browse data summary plots:
  http://www.ieap.uni-kiel.de/et/data/stereo/latest_browse_plots/
  (generated using the latest telemetry data available, normally ~2 days delay)

  –Latest ASCII data (27 days , ~2 days delay, 10 min resolution, not verified):
  http://www.ieap.uni-kiel.de/et/data/stereo/latest_ascii_data/

  –Verified level 2 ASCII files available online through March 14, 2012:
  http://www2.physik.uni-kiel.de/stereo/data/sept/level2/

  –Electron event list updated through January 2012:
  http://www2.physik.uni-kiel.de/stereo/downloads/sept_electron_events.pdf

  –Pitch-angle distribution plotter (under development):
  http://www2.physik.uni-kiel.de/stereo/padplots/index.php