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CAVEAT
regarding use of STEREO/SEPT level 1 science data as staged at the IMPACT data portal at Berkeley

1. General Remark

The data are available in CDF format. The science data are contained in four 32-bin histograms labelled PDFE0 through PDFE3 which are associated with the SEPT telescopes according to Table 1. The units are particles/(cm^2 s sr MeV)$^{-1}$. The proton telescope is also sensitive to other nuclei which it cannot discriminate against, i.e. it measures indeed ions.

Table 1: Telescope Classification

Histogram	CDF Variable	STEREO-A	STEREO-B
PDFE0	Spec_0_E	electron tel. looking anti-sun	electron tel. looking Sun
	Spec_0_NS	electron tel. looking North	electron tel. looking South
PDFE1	Spec_1_E	proton tel. looking Sun	proton tel. looking anti-sun
	Spec_1_NS	proton tel. looking South	proton tel. looking North
PDFE2	Spec_2_E	electron tel. looking Sun	electron tel. looking anti-sun
	Spec_2_NS	electron tel. looking South	electron tel. looking North
PDFE3	Spec_3_E	proton tel. looking anti-sun	proton tel. looking Sun
	Spec_3_NS	proton tel. looking North	proton tel. looking South

The energy bins for electrons and protons are specified in the SEPT instrument description (see Table 12 in Space Sci. Rev., DOI 10.1007/s11214-007-9204-4). Due to limitations of storage capacity in the onboard FPGA, only one binning table for the quasi-logarithmic binning could be made available for both electron and proton energy measurements. Hence electron energies from 35 through 485 keV are mapped to histogram bins 1 through 17 only. Do not use electron histogram bins 18 through 31. However, also the electron bins up to 17 suffer – by design of the sensor – of some contribution from protons. The correction algorithm for this contamination is not yet implemented in Version 8 of the SEPT level 1 CDF generation software. The proton histograms are not contaminated.

Bin 0 in all histograms is not useful. Bins 1 and 2 are affected by noise for some sensors and they need an efficiency factor applied which is not yet determined. Bin 31 of all histograms accumulates particles above 2.2 MeV and stopping in the first detector (e.g. protons up to 6.5 MeV, alphas up to 26 MeV total energy).

2. SEPT data in the period prior to the STEREO Science Mission

Care shall be taken when trying to interpret SEPT histograms in the period prior to the second lunar swingby on 21-JAN-07, the start of STEREO Prime Science mission. Note that the spacecraft orientation may not be nominal during this period, and SEPT may not always be in nominal observation mode as shown in Table 2. This table also notes the changes in discriminator thresholds for the 16 detectors which may affect the counting rates in the lowest histogram bins 0 – 3.

Table 2: Activities prior to Start of Science Mission

Activity	STEREO-A	STEREO-B
SEPT turn on	14-NOV-06 17:50 UT (DOY 318, MJD 54053)	13-NOV-06 20:05 UT (DOY 317, MJD 54052)
SEPT cover release	14-DEC-06 17:32 – 18:10 UT (DOY 348)	16-JAN-07 20:32 – 21:06 UT (DOY 016)
Software patch upload	08-JAN-07 19:14 UT (DOY 008)	09-JAN-07 19:39 UT (DOY 009)
Change of thresholds (Setting at turn-on)	14-NOV-06 17:51 UT E : 15 13 11 15 – 17 16 11 16 NS: 15 15 14 12 – 17 16 13 16 14-NOV-06 18:31 UT E : 15 13 11 15 – 17 16 **13** 16 NS: 15 15 14 12 – 17 16 13 16 14-NOV-06 18:58 UT E : **20 20 20 20** – **20 20 20 20** NS: **20 20 20 20** – **20 20 20 20** 14-NOV-06 19:50 UT	13-NOV-06 20:07 UT E : 15 13 15 13 – 13 17 13 15 NS: 13 16 16 13 – 17 17 15 13 13-NOV-06 20:50 UT E : **20 20 20 20** – **20 20 20 20** NS: **20 20 20 20** – **20 20 20 20** 13-NOV-06 21:03 UT E : **25 25 25 25** – 20 20 20 20 NS: **25 25 25 25** – 20 20 20 20 13-NOV-06 21:40 UT
(Setting for calibration mode)	E : 20 20 20 20 – 20 20 20 20 NS: **25 25 25 25** – 20 20 20 20 15-NOV-06 17:25 UT	E : **20 20** 25 25 – 20 20 20 20 NS: **30 30 20 20** – 20 20 20 20 16-NOV-06 20:42 UT
(Setting for observation mode)	E : **15 13 11 15** – **17 16 13 16** NS: **15 15 14 12** – **17 16 13 16** 21-NOV-06 18:48 UT E+NS: turn-on setting 28-NOV-06 14:48 UT E+NS: obs. mode setting	E : **15 13 15 13** – **13 17 13 15** NS: **13 16 16 13** – **17 17 15 13**
	08-DEC-06 15:42 UT E + NS: cal mode setting 11-DEC-06 15 :54 UT E + NS : obs mode setting	08-DEC-06 19:04 UT E + NS: cal mode setting 11-DEC-06 14 :18 UT E + NS : obs mode setting
Inflight test pulse generator run	14-NOV-06 18:43-18:53 UT	13-NOV-06 20:38-20:48 UT
Calibration mode run	14-NOV-06 18:59 – 15-NOV-06 00:59 UT 29-NOV-06 15:58 – 16:10 UT 29-NOV-06 17:16 – 17:28 UT 08-DEC-06 15:42 – 09-DEC-06 15:39 UT	13-NOV-06 20:51 – 14-NOV-06 02:51 UT 29-NOV-06 15:23-15:35 UT 29-NOV-06 17:21-17:33 UT 08-DEC-06 19:12 – 09-DEC-06 19:11 UT

Orange: Threshold setting for calibration mode (coincidence with pair)
Green: Threshold setting for nominal observation mode (anti-coincidence with guard and pair and pair guard)
Bold: Change w.r.t. previous setting
The sequence of threshold settings is:
Main PDFE0, PDFE1, PDFE2, PDFE3 – Guard PDFE0, PDFE1, PDFE2, PDFE3
For STEREO-A: Obs. Mode setting = Turn-on setting except SEPT-E Guard PDFE2
For STEREO-B: Obs. Mode setting = Turn-on setting

3. SEPT Onboard Software Bug

The onboard software to process SEPT science data into CCSDS telemetry packets is written in the Forth language and resides in the SEP-Central firmware. It contained three bugs, one in the module for logarithmic compression and two in the module for data packaging. The bugs affect only certain bits in the 32 counters of each of the four histograms PDFE0 through PDFE3. They went unnoticed prior to launch because no SEP-Central was used during high rates tests on unit level while during integrated tests no systematic high rates tests were performed. The bugs were detected during the STEREO radiation belt passages where they became manifest as irregular jumps at certain intensity levels in an otherwise monotonously increasing intensity-time profile on the inbound leg or decreasing profile on the outbound leg.

- The bug in the logarithmic compression algorithm affects **all histogram counters** but will **only** show up **at decompressed values ≥ 2048 (2^{11})** counts per minute, because smaller values will not be compressed. This translates to intensities between 600 and 26,200 (cm^2 s sr MeV)$^{-1}$ depending on the product of $\Delta t \cdot \Delta E \cdot$ GeoFactor (i.e.species and energy window) of the channel. Its effect is that bit 2^8 of the 10-bit mantissa is forced to zero in each compressed rate, resulting in to low a counting rate by 20 % in those channels where the original bit was set to 1. Examples are shown in Figure 1.
- The bug in the packaging routine is twofold:
  - Bit 2^4 of the mantissa is forced to zero **only in histogram counters for bins 0, 4, 8, 12, 16, 20, 24, 28**. Its effect is easily seen in irregular jumps at counting results just above 16, but less apparent (and less detrimental) at higher rates. An example is shown in Figure 1.
  - Bit 2^2 of the exponent is forced to zero **only in histogram counters for bins 3, 7, 11, 15, 19, 23, 27, 31**. Its effect is seen at counting results above 2^{13} (8,192) per minute. This translates to intensities between 2,400 and 105,025 (cm^2 s sr MeV)$^{-1}$ depending on species and energy window of the channel. An example is shown in Figure 1.

A simple patch corrected the problem. The patch was uploaded to STEREO-A on January 8, 2007, 19:14 UT and to STEREO-B on January 9, 19:39 UT. All SEPT data beyond these dates are uncorrupted.

4. SEPT data during the STEREO Science Mission

Table 3 shows the changes and problems affecting the instrument during the Science Mission. As stated above, the changes in the discriminator thresholds may affect the counting rates in the lowest histogram bins 0 – 3.

4.1 Transient disturbances in the low energy ion bins

Ions above 2.2 MeV produce large pulses which are counted in the last energy bin of SEPT. A pulse-height overflow can cause extra-trigger of lower energy bins because the analog electronics is not reset fast enough. Due to this limitation in the electronics, SEPT low energy measurements can be occasionally disturbed when large pulses become dominant. This effect is easy to recognize as narrow horizontal “strips” in the low energy part of the ion dynamic spectrum (<350 keV). All SEPT telescopes are affected by this issue, however the effect is only important during periods showing a flat energy spectrum (reduced rate at low energies) accompanied by an ion increase above 2.2 MeV, for instance during the early phase of a SEP event showing velocity dispersion and a significant ion rate above 2.2 MeV. An example of period strongly affected by this effect is shown in Figure 2.

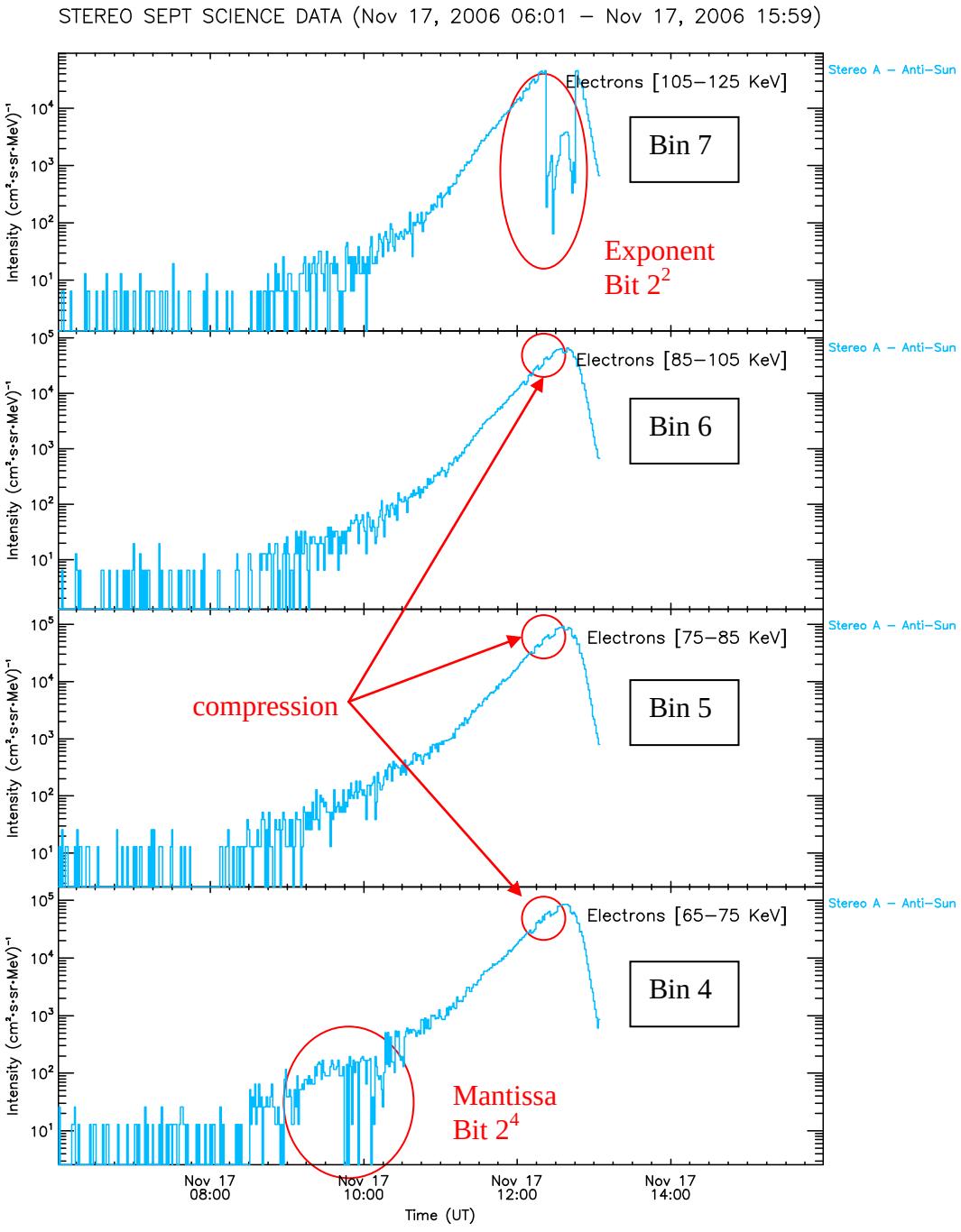

Figure 1: Example of effects of three onboard software bugs on DOY 321, 2006 (radiation belt passage, inbound)

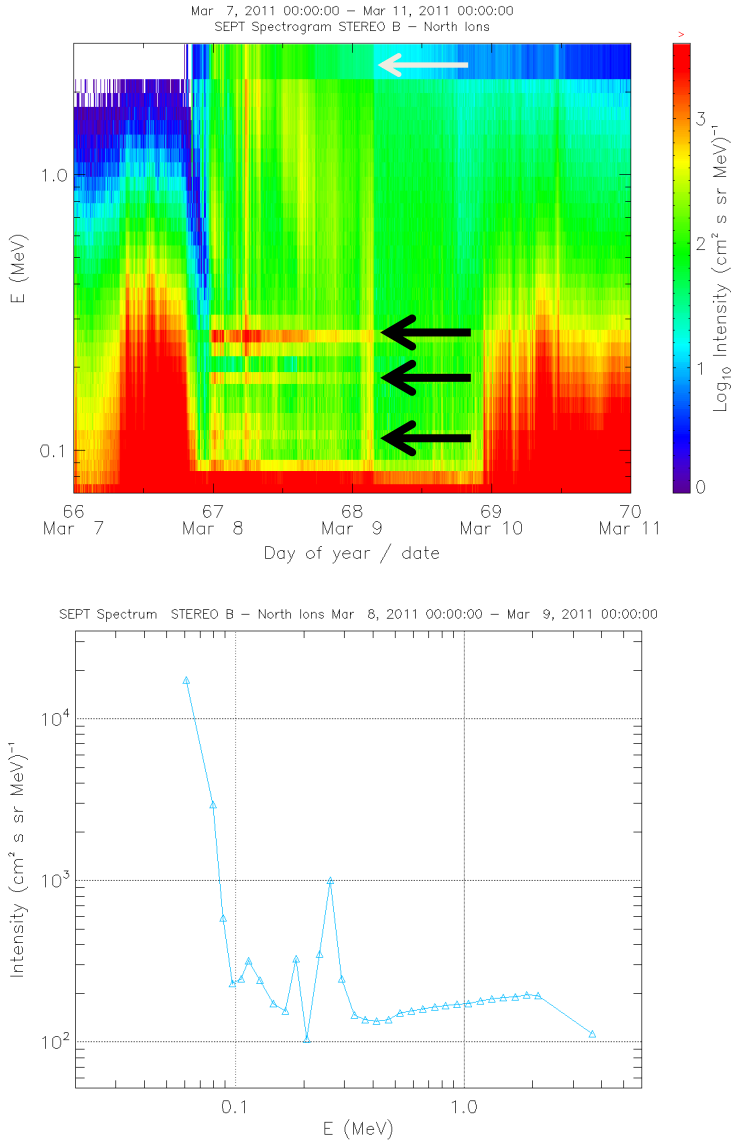

Figure 2: Example of a period with disturbed low-energy ion measurements. The top panel shows the spectrogram and the bottom panel the energy spectrum during March 8, 2011. Note the increase in the last energy bin (white arrow) accompanied by a pattern of narrow strips in certain low energy bins (black arrows).

Table 3: Changes and problems during the Science Mission (I)

Activity	STEREO-A	STEREO-B
Data gap (Ground System problem)		Affects all telescopes 27–MAR-07 07:19-08:25 UT
Data gap (Ground System problem)	Affects all telescopes 16-JUN-07 15:58 – 17–JUN-07 08:32 UT 17–JUN-07 10:48-11:25 UT	
Calibration mode run*	02-OCT-07 14:24 – 04-OCT-07 14:31 UT	06-NOV-07 17:50 – 08-NOV-07 17:55 UT
Data gap (latch-up)		Affects E: PDFE2, PDFE3 27-MAY-08 22:17 – 02-JUN-08 20:57 UT
Data gap (Ground System problem)		Affects all telescopes 16- SEP-08 05:30-12:06 UT
Change of thresholds (Setting for observation mode)		26-SEP-08 17:00 UT E : 15 13 15 13 – 13 17 **14** 15 01-OCT-08 12:01 UT E : 15 13 15 **14** – 13 17 14 15 03-OCT-08 16:54 UT E : 15 13 15 **15** – 13 17 14 15 06-OCT-08 17:16 UT E : 15 13 15 **14** – 13 17 14 15
Data gap (no DSN coverage, ground antenna failure)	Affects all telescopes 21-OCT-08 14:36 – 22-OCT-08 07:52 UT	
Data gap (no DSN coverage)		Affects all telescopes Intermittent gaps during: 17-DEC-08 22:25 – 18-DEC-08 00:05 UT
Data gap (Ground System problem)		Affects all telescopes 14- APR-09 09:42-13:12 UT
Data gap	Affects all telescopes 13-MAY-09 16:05-17:46 UT	
STEREO-B s/c reset and subsequent commanding **Data gap** **Bad data** **Change of thresholds** (Setting at turn-on) **Software patch upload** **Change of thresholds** (Setting for observation mode)		 12-MAY-09 22:59 – 13-MAY-09 04:14 UT 13-MAY-09 04:14 – 13-MAY-09 05:08 UT 13-MAY-09 05:08 UT E : 15 13 15 13 – 13 17 13 15 NS: 13 16 16 13 – 17 17 15 13 13-MAY-09 05:21 UT 15-MAY-09 01:57 UT E : 15 13 15 **14** – 13 17 **14** 15 NS: 13 16 16 13 – 17 17 15 13

Table 3: Changes and problems during the Science Mission (II)

Activity	STEREO-A	STEREO-B
STEREO-A s/c reset and subsequent commanding **Data gap** **Bad data** **Change of thresholds** (Setting at turn-on) **Change of thresholds** (Setting for observation mode) **Software patch upload**	 4-AUG-09 09:40 – 4-AUG-09 16:04 UT 4-AUG-09 16:04 – 4-AUG-09 16:26 UT 4-AUG-09 16:26 UT E : 15 13 11 15 – 17 16 11 16 NS: 15 15 14 12 – 17 16 13 16 4-AUG-09 17:05 UT E : 15 13 11 15 – 17 16 **13** 16 NS: 15 15 14 12 – 17 16 13 16 4-AUG-09 17:23 UT	
Data gap (no DSN coverage)	Affects all telescopes Intermittent gaps during: 07-AUG-09 18:03 – 08-AUG-00:22 UT	Affects all telescopes 07-AUG-09 02:46 – 07-AUG-04:25 UT
Data gap (no DSN coverage)	Affects all telescopes Intermittent gaps during: 09-SEP-20:25 – 10-SEP- 08:37UT	
Change of thresholds (Setting for observation mode)	29-SEP-09 15:00 UT E : 15 **14 12** 15 – 17 16 13 16 NS: **16** 15 14 12 – 17 16 13 16	29-SEP-09 14:45 UT E : **16** 13 15 14 – 13 17 14 15 29-SEP-09 14:46 UT NS: **14 17** 16 13 – 17 17 15 13 08-OCT-09 11:14 UT NS: **15** 17 16 13 – 17 17 15 13
Data gap (no DSN coverage – MESSENGER mission)	Affects all telescopes 13-OCT-09 01:10-01:51 UT	
Data gap (no DSN coverage)	Affects all telescopes Intermittent gaps during: 20-DEC-09 23:24 – 21-DEC-09 10:15 UT	Affects all telescopes 21-DEC-09 17:06 – 22-DEC-09 19:49 UT 26-DEC-09 05:54 – 26-DEC-09 09:33 UT
Data gap (no DSN coverage)		Affects all telescopes 12-FEB-10 07:59-10:14 UT 13-FEB-10 01:51-03:44 UT
Data gap (Ground System problem)		Affects all telescopes 11- MAR-10 02:45-04:38 UT
Data gap (Ground System problem)		Affects all telescopes Intermittent gaps during: 5-APR-10 00:00-07:00 UT
Data gap (Insufficient track coverage)	Affects all telescopes 12-MAY-10 23:41 – 13-MAY-10 03:02 UT	

Table 3: Changes and problems during the Science Mission (III)

Activity	STEREO-A	STEREO-B
Data gap (Ground System problem)	Affects all telescopes 30-MAY-10 00:41 – 03:10 UT Intermittent gaps during: 30-MAY-10 06:27 – 07:22 UT	
Data gap (no DSN coverage)	Affects all telescopes 8-JUN-10 08:19-10:19 UT	
Data gap (Ground System problem)		Affects all telescopes 01-AUG-10 10:53 – 02-AUG-10 03:58
Data gap (Ground System problem)		Affects all telescopes 16-SEP-10 06:59-08:13 UT
Data gap	Affects all telescopes Intermittent gaps during 5-DEC-10 13:40-19:15 UT	
Data gap (Ground System problem)	Affects all telescopes Intermittent gaps during 10-DEC-10 01:18-02:28 UT	
Data gaps	Affect all telescopes 28-DEC-10 18:47-20:05 UT 29-DEC-10 19:51-22:32 UT	
Data gap (Ground System problem)		Affects all telescopes Intermittent gaps during DEC 16-23, 2010
STEREO B IMPACT and PLASTIC power-off due to problems at IMPACT IDPU/MAG **Data gap** **Bad data (restoring thresholds and software patch)**		Affects all telescopes 8-JAN-11 21:27 – 11-JAN-11 16:54 11-JAN-11 16:54-18:27
Data gap (Ground System problem)		Affects all telescopes 24-JAN-11 12:28-13:54 UT
Data gap	Affects all telescopes 8-FEB-11 03:19-05:19 UT	
Data gap	Affects all telescopes Intermittent gaps during 15-FEB-11 07:00-08:25 UT	
Data gap		Affects all telescopes Intermittent gaps during 14-MAR-11 09:35-19:05 UT

Table 3: Changes and problems during the Science Mission (IV)

Activity	STEREO-A	STEREO-B
Data gap		Affects all telescopes 18-JUN-11 04:21-09:55 UT

*Threshold values for turn-on and calibration mode settings are shown in Table 2.
Green: Threshold setting for nominal observation mode (anti-coincidence with guard and pair and pair guard)
Bold: Change w.r.t. previous setting
The sequence of threshold settings is:
Main PDFE0, PDFE1, PDFE2, PDFE3 – Guard PDFE0, PDFE1, PDFE2, PDFE3

For additional information and data products visit http://www2.physik.uni-kiel.de/stereo/