PLASTIC
Level 2 Data Document

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November 21, 2007

Version: C
Last Modified: Jan. 28, 2021

Modification History

Version	Date	Modifications
A	Nov. 21, 2007	Original Version
B	May 17, 2018	Major Rewrite: Added Alphas, Iron, Update Protons
C	Jan. 28, 2021	Fix small things in definition of CDF variables.

Table of Contents

1. Overview of PLASTIC Instrument Operation

PLASTIC covers the full azimuthal range (ie. in the ecliptic plane) at all times, but needs to step through energies-per-charge and polar angles. The polar angle steps from +20 to – 20 degrees in 1.33 degree steps (32 steps). In normal mode, the ESA voltage is stepped in logarithmic increments in 128 steps. For each E/Q step, the ESA will sit at one voltage, while the deflector voltages sweep through their full set of values. Then the ESA voltage will continue to the next E/Q step in the cycle. Each deflection step takes 12.8 msec. The instrument sweeps across deflection steps first in one direction, and then in the opposite direction. Therefore, data is sent from the instrument to the DPU with deflection steps reversed on every odd ESA step. However, the DPU compensates for this reversal so that all science products including monitor rates (with the exception of the Memory Data – see section 3.5) arrive on the ground with the correct deflection steps. A full set of angles (32 steps, plus some overhead) takes 455.4 ms, and a full cycle will take 1 minute (128 ESA steps plus some overhead).

Because all solar wind ions flow with approximately the same speed, the E/q selection of the entrance system acts to separate solar wind ions by mass/q. Because the heavy ions are normally not fully ionized, their mass/q is normally larger than 2. Thus the heavy ions are observed at the higher E/q steps than H+, and to some extent, He++. Because there is a large difference in fluxes of H+, He++ and heavy ions, there are two entrance systems for the solar wind ions. One entrance has a large geometric factor, for the low abundance heavy ions, and one entrance has a small geometric factor for the H+ and possibly He++ ions. At the high E/q steps, when we are mainly measuring the heavy ions, we use the main, large geometric factor, aperture. At lower E/q steps, we need to switch to the "S-channel" ("small-aperture") low geometric factor aperture to measure the protons. The E/Q step at which to switch between the two entrance systems is determined by the DPU.

The PLASTIC instrument is functionally divided into two halves, one which has Solid State Detectors (SSD's) as well as MCP's, and one which just has MCP's. The length of the flight path is different for the two sides. There are two sets of time-of-flight electronics, one for each half.

2. Overview of CDF Files

All Level 2 data are stored in CDF (Common Data Format) files. See http://cdf.gsfc.nasa.gov/ for a description of CDF files, in general. Each day, for each spacecraft, we create one CDF file with the following filename:

STx_L2_PLA_MOM_yyyymmdd_doy_Vzz.cdf

In each filename, 'x' stands for 'A' or 'B' depending on the spacecraft; 'yyyymmdd' stands for the date; 'doy' stands for the three-digit day-of-year, and 'zz' gives the version number of the processing software. Files that begin STx_L2_PLA_MOM_ contain the level 2 moments products.

In each file, data records are linked to an ‘epoch’ variable that gives the time for each record in UTC. CDF epoch variables denote milliseconds since 01-Jan-0000 00:00:00.000. Specifics of the different epoch variables are listed below. Also, in each file, there are a ‘level1_file’ variable and a ‘processing_date’ variable which give the name of the level 1 file used to create this CDF, and the date on which this CDF was processed. There is also an ‘error’ flag used to indicate potentially bad data. If, for any record, the error variable has a value of 1, then the data in that record is suspect.

3. Data Products

3.1 Proton Moments

We have two distinct ways of calculating proton data. One uses a 1D Maxellian fit of the monitor rates data, and the other uses the on-board moments.

3.1.1 Proton Data Derived from 1D Maxwellian

Proton bulk parameters provided here (speed, density, thermal) are derived from a 1D Maxwellian fit to a single detector rate (no coincidence required), and are corrected for background and dead time. The N/S angle is derived from a peak fitting to the N/S (deflection) rate bins of the same rate. The E/W angle is derived from a separate double coincidence rate. The proton velocity components are corrected for spacecraft aberration and are derived using the N/S and E/W angles.

Extended analysis of in-flight data indicates a major variance in the performance of the Schannel instrumental response (geometrical factor, E/Q, and polar and azimuth angular response) from expectations based upon the pre-flight testing and calibrations. The effect is attributed to insufficient fringe-field control within the aperture section of the Entrance System. The results provided here are based upon an extensive in-flight calibration of the S-channel response which has been performed by the PLASTIC team utilizing Main channel data (which is unaffected) and confirming results through cross-calibrations of early mission data with Wind SWE (courtesy K. Ogilvie and A. Lazarus) and SOHO PM (courtesy F. Ipavich). We extend special thanks to our Wind and SOHO colleagues for the use of their data.

The spacecraft were ‘flipped’ by 180-degree roll angle after solar conjunction. Different detectors or areas of detectors were then exposed in the instrument, resulting in different efficiencies. A new calibration function is incorporated in v10 onwards.

3.1.1.2 Level 2 Data Format

The time variables in the Level 2 CDFs are:

‘epoch’	gives time for record – start of cycle
‘epoch_1kev’	Time within cycle corresponding to E/Q =1 keV/e (format yyyy-mm- dd/hh:mm:ss). This parameter is only provided for the 1-minute data sets.

The next set of parameters give the solar wind proton data:

‘proton_number_density’

[1/cc]: Solar wind proton number density (protons per cubic centimeter)

‘proton_bulk_speed’

[km/s]: Proton bulk speed (in the s/c frame)

‘proton_temperature’

[deg K]: Proton kinetic temperature

‘proton_thermal_speed’

[km/s]: Proton thermal speed, defined here as sqrt(2kT/m)

‘proton_n_s_flow_angle_inst’

[deg]: Proton North-South flow angle in the INSTRUMENT COORDINATE SYSTEM. This coordinate system does not compensate for aberration (spacecraft movement) nor for spacecraft attitude. This parameter is included for verification purposes, only. In v10 onwards, a three-period moving average is used to reduce ‘jitter’.

‘proton_e_w_flow_angle_inst’

[deg]: Proton East-West flow angle in the INSTRUMENT COORDINATE SYSTEM. This coordinate system does not compensate for aberration (spacecraft movement) nor for spacecraft attitude. This parameter is included for verification purposes, only. In v10 onwards, a boxcar moving accumulation is used to obtain sufficient statistics.

‘proton_Vr_HERTN’

[km/s]: Proton radial velocity component in the HERTN system. The effects of aberration and spacecraft attitude have been removed.

‘proton_Vt_HERTN’

[km/s]: Proton tangential velocity component in the HERTN system. The effects of aberration and spacecraft attitude have been removed.

‘proton_Vn_HERTN’

[km/s]: Proton normal velocity component in the HERTN system. The effects of aberration and spacecraft attitude have been removed.

‘proton_n_s_flow_angle_HERTN’

[deg]: Proton North-South flow direction in the HERTN system. The effects of aberration and spacecraft attitude have been removed.

‘proton_e_w_flow_angle_HERTN’

[deg]: Proton East-West flow direction in the HERTN system. The effects of aberration and spacecraft attitude have been removed.

‘proton_Vr_RTN’

[km/s]: Proton radial velocity component in the RTN system. The effects of aberration and spacecraft attitude have been removed.

‘proton_Vt_RTN’

[km/s]: Proton tangential velocity component in the RTN system. The effects of aberration and spacecraft attitude have been removed.

‘proton_Vn_RTN’

[km/s]: Proton normal velocity component in the RTN system. The effects of aberration and spacecraft attitude have been removed.

‘proton_n_s_flow_angle_RTN’

[deg]: Proton North-South flow direction in the RTN system. The effects of aberration and spacecraft attitude have been removed.

‘proton_e_w_flow_angle_RTN’

[deg]: Proton East-West flow direction in the RTN system. The effects of aberration and spacecraft attitude have been removed.

The next set of parameters is for data quality information:

‘error’

0 = No known issues
1 = Processing error, data removed
2 = Data Level 1 (input data) error
3 = Data overflow (rate compression code saturated)
4 = Data outside 3-sigma limit (1 hr window)
5 = Data gap (usually due to operations), data removed
6 = Jump in thermal speed, use caution on all parameters
8 = Removed through manual check
9 = Fitting to 1-D Maxwellian indicated one or more cautions
11 = Background levels (usually due to entrance system ops), data removed

‘caution’

The caution code is an indication of how sensitive the density value is to the method used for determining the background correction.

0 = no issues (<5% effect on density calculation)
1 = minor issues (5-10% effect on density calculation)
>1 = use with caution (>10% effect on density calculation)
5 = 5 minute cadence data, use with caution

‘attitude flag’: 3 dimensional array [roll, yaw, pitch]:

This flag indicates the s/c roll angle is not nominal, possibly due to a spacecraft maneuver. Although efforts are made to correct the data, use all data with caution, particularly component and density values.

‘ew_source_flag’

Indicates which solar wind sector channel (Main or analysis. Main Channel = 0, S-channel = 1. (Main channel has better statistics, but may include additional species.)

‘Reduced_Chi2’

Reduced Chi-square of the 1D Maxwellian fit.

‘stat_uncertainty_angle’

(%): An indication of the relative uncertainty from the number of counts available in determining the E/W flow direction (sqrt(n)/n), where n is the number of counts in the peak of the position array. Higher % indicates higher statistical uncertainty.

The next set of parameters provide Carrington Rotation and spacecraft trajectory information:

‘carrington_rotation’

Carrington Rotation Number relative to the given spacecraft.

‘spcrft_lon_carr’

[Carr, degrees]: Carrington Longitude relative to the given spacecraft.

‘heliocentric_dist’

[km]: Distance of the spacecraft from the center of the Sun.

‘spcrft_lon_hee’

[HEE, degrees]: Spacecraft longitude in the HEE coordinate system.

'spcrft_lat_hee'

[HEE, degrees]: Spacecraft latitude in the HEE coordinate system.

'spcrft_lon_heeq'

[HEEQ, degrees]: Spacecraft longitude in the HEEQ coordinate system.

'spcrft_lat_heeq'

[HEEQ, degrees]: Spacecraft latitude in the HEEQ coordinate system.

'spcrft_lon_hci'

[HCI, degrees]: Spacecraft longitude in the HCI coordinate system.

'spcrft_lat_hci'

[HCI, degrees]: Spacecraft latitude in the HCI coordinate system.

Coordinate Systems used here: HCI Heliocentric Inertial

HEE Heliocentric Earth Ecliptic

HEEQ Heliocentric Earth Equatorial (or HEQ) Carrington

RTN Radial-Tangential-Normal

R is the Sun to SC vector, T = (Omega x R)/|(Omega x R)|, where omega is the Sun's spin axis (in J2000 GCI), i.e., roughly the orbital direction; N is the right-handed normal to complete the triad, essentially "north". The RN plane contains the solar rotation axis.

HERTN Heliocentric Ecliptic RTN

The RT plane is parallel to the ecliptic plane.

3.1.2 Proton Data Derived from On Board Calculation

3.1.2.1 Input: Level 1 Data

From the instrument, there are two arrays that contain the solar wind proton data. The first array (SW-all) contains the proton/alpha data together, with only angular binning. The second (SW-H/alpha-Doubles) contains data classified using the time-of flight: there is a 32-azimuthal bin x 32-polar bin array for each of the two species.

By command, we can choose which array, SW_all or SW_H, is used for calculating proton moments. Default is SW_H. The moments are calculated using a commandable energy range. Default is steps 39-127 (step 39 is 15 keV). The moments calculation uses all odd position bins. For deflection, it uses deflection bins DP-3 to DP+4 where DP is the deflection peak from the previous cycle (i.e. the deflection bin in which the most counts were received, taking into account switching to the S-channel).

Level 1 proton moments are stored in CDFs with the prefix STx_L1_PLA_yyyymmdd_, where 'x' is either 'A' or 'B', depending on the spacecraft. The moments are collected and sent down in telemetry once per minute, when we are in science or proton mode. The level 1 data includes raw values only. All moments products are tied to the epoch1 product, which contains the time for each record. The data in the CDF is uncompressed.

The level 1 moments variables are:

'density_main'	density for main channel
'density_s'	density for s channel

‘velocity_main’	3 element array: x,y,z
‘velocity_s’	3 element array: x,y,z
‘heat_flux_main’	3 element array: x,y,z
‘heat_flux_s’	3 element array: x,y,z
‘temperature_main’	6 element array: xx,xy,xz,yy,yz,zz
‘temperature_s’	6 element array: xx,xy,xz,yy,yz,zz

The level 1 moments are tied to the following variables (i.e. the same record number will give you the appropriate data for any given value):

‘epoch1’	gives time for record – start of cycle
‘cycle1’	gives cycle number for record (for synchronization)
‘s_chan1’	gives the step on which the s-channel switched for this record (0 = didn’t switch)
‘moment_meta’	4 elements:[Emin, Emax, Schan conversion factor, Array (0:SW-All, 1:SW-H)]
‘error1’	if 1, there was a possible error with this cycle’s data

3.1.2.2 Level 2 Data Format

The level 2 moments products that are valid so far are:

‘density’	calculated density
‘velocity_inst’	4 element array: x,y,z,bulk in instrument coordinates (only bulk valid so far)
‘velocity_spcrft’	4 element array: x,y,z,bulk in spacecraft coordinates (only bulk valid so far)
‘velocity_gse’	4 element array: x,y,z,bulk in GSE coordinates (only bulk valid so far)
‘velocity_hgrtn’	4 element array: x,y,z,bulk in HGRTN coordinates (only bulk valid so far)

The level 2 moments are tied to the following variables (i.e. the same record number will give you the appropriate data for any given value):

‘epoch’	gives time for record – start of cycle
‘cycle’	gives cycle number for record (for synchronization)
‘s_chan’	gives the step on which the s-channel switched for this record (0 = didn’t switch)
‘moment_meta’	4 elements:[Emin, Emax, Schan conversion factor, Array (0:SW-All, 1:SW-H)]
‘error’	if 1, there was a possible error with this cycle’s data
‘error_poor_stats’	if 1, then poor statistics and data is suspect

3.1.2.3 Calculation of Level 2 Data

The algorithm for creating the level 2 moments is complicated. For a scientific explanation, see Lynn Kistler’s Conversion of On-board Moments to Physical Units (9/28/2006).

Values that are taken from calibration files are:

1) Step_variable: This covers the constants associated with stepping the integral over v, dtheta (elevation) and dphi. They are the same for all moments and for both spacecraft. Step_variable = dtheta*dphi*dV/V / tacc, where

dtheta = 1.25 degrees = 0.0218 radians
dphi = 1.41 degress * 2 = 0.0246 * 2 radians = 0.0492 (the factor of 2 is because we only use every other step)
dv/v = 0.049/2 = 0.0245
tacc = 12.8 ms
step_variable = 2.05E-3 ster/s

2) Normalization Constant, B: This parameter takes out the normalization factors from the onboard velocity tables, and includes any other necessary unit changes and mass functions. These are different for each moment, but should be the same for each spacecraft.

B_D: 4.335E-11 s/cm
B_V: 1.950E-08 km/cm
B_P: 2.939E-20 kg m/s (cm/m)^2
B_H: 1.324E-14 kg (m/s)^2 (cm/m)^2

3) Geometric factors: Each unit has two geometric factors for the Solar Wind sector: one for the S-channel and one for the main channel. Here, the geometric factor is given for one angule bin (1.41 degrees in position).

Geom_S: 1.850E-7 cm2-ster-dV/V
Geom_M: 2.219E-5 cm2-ster-dV/V

4) A set of ra_trig efficiencies, one for each ESA step (128 total). These efficiencies vary over time and by spacecraft.

5) Two velocity tables. For each ESA step, we have a table that gives the velocity that the DPU Moments calculation uses (based on a maximum of 100 keV), and a table of what we believe the actual velocities for each ESA step to be.

6) svalid_ratio. This is a daily ratio (for each spacecraft) of the svalid rate / ra_trig rate for each esa group. It is calculated daily for the ESA steps representing valid velocities for that day. If there is not a valid ratio for a given esa group, we use the nearest esa group that has a valid ratio. Because this derives from our normal monitor rates, which are summed over 4 ESA steps, there are 32 values per day, one for each group of 4 ESA steps.

7) pri0_ratio. This is a daily ratio (for each spacecraft) of the priority 0 events / (pri 0 + pri 1 + pri 2 + pri 3) events. It is calculated daily for the ESA steps representing valid velocities for that day. If there is not a valid ratio for a given esa step, we use the nearest esa step that has a valid ratio. There are 128 values per day. This value is only used when the moments calculation is using the SW-H array.

Bulk Velocity Calculation:

1) For each record, we calculate the velocity components, using the formula:

$$v_i = \frac{B\_V\left[\frac{1}{Geom\_S}V\_S_i + \frac{1}{Geom\_M}V\_M_i\right]}{B\_D\left[\frac{1}{Geom\_S}D\_S + \frac{1}{Geom\_M}D\_M\right]}$$

V_i is either the x, y, or z component of the velocity. B_V, B_D, Geom_S, and Geom_M are constants (see above). D_S and D_M are the Level 1 density values for the S-channel and the Main channel, respectively, and V_S and V_M are the Level 1 velocity values for the S and Main channels.

The total velocity is found by the equation:

$$V_t = \sqrt{V_x^2 + V_y^2 + V_z^2}$$

We then use linear interpolation to derive the bulk velocity (based on the velocity table of actual velocities) from the total velocity (based on the velocity table used by the DPU which starts at 100 keV).

Finding Efficiencies and Velocity Standard Deviation

Our efficiencies are based on velocity. In order to avoid sharp peaks, for each record, we determine an average velocity, which is used to find the efficiencies. This average velocity is based on the total velocity, not the interpolated bulk velocity. The average is taken over the 19 points closest to each given record. However, if a given velocity is below our lowest velocity step, it is removed from the average. Therefore, for a given record, the number of points averaged may be less than 19, if some are removed. We also find the standard deviation for the points included in the average. If this standard deviation divided by the total velocity for that point is less than 0.05, then the error_poor_stats flag is set. Efficiencies are then found for each record. Two efficiencies are found:

1) pri_efficiency: This is only used when the moments calculation uses the SW-H array. The pri0_ratio from the next lowest velocity is selected, checking the average velocity for each record against the DPU velocity table (100 keV).

2) general_efficiency: First, we find an interpolated svalid_ratrig ratio. To do this, we take the average velocity for a record and use linear interpolation based on the 4-ESA-step velocity groups (using the DPU velocity table), to find an appropriate svalid_ratrig ratio. Then, the ra_trig_efficiency from the next lowest velocity is selected, checking the average velocity against the DPU velocity table. These two values (interpolated svalid_ratrig_ratio and selected ra_trig_efficiency) are multiplied to create the general_efficiency.

Density Calculation

Density is then calculated for each record using the following equations:

$$n\_l2\_main = \frac{n\_l1\_main * step\_\mathrm{var} * B\_D}{geom\_m * general\_efficienc}$$

$$n\_l2\_s = \frac{n\_l1\_s * step\_var * B\_D}{geom\_s * general\_efficienc}$$

$$n = n\_l2\_main + n\_l2\_s$$

If the moments array being used for any record is SW-H, then the density for that record is then divided by the pri0_ratio for that record.

3.2 Alpha Data

Alpha bulk parameters provided here are derived from a 1D Maxwellian fit to a single coincidence (the “RA”) rate that is measured in both the S-channel and Main Channel. Background and dead-time corrections are applied.

Data are processed at the ~1 minute instrument cadence and then averaged into 10 minute and 1 hour resolution products.

Alpha_RA versions 3 and below are limited to S-channel data. Versions 4 and above incorporate the Main channel.

Alpha data are available for both STA and STB 2007-2010.

3.2.1 Level 2 Data Format

The Level 2 parameters are:

- ‘epoch’
    - Time for record – start of cycle
- ‘alpha_density’
    - [1/cc]: Solar wind alpha number density in [alphas per cubic centimeter]
- ‘alpha_bulk_speed’
    - [km/s]: Alpha bulk speed (s/c frame) in kilometers per second
- ‘alpha_thermal_speed’
    - [km/s]: Alpha thermal speed in kilometers per second, defined here as sqrt(2kT/m)
- ‘Na_Np’
    - Ratio of alpha to proton number densities (a unitless quantity)
- Va_Vp’
    - [km/s]: The scalar difference between the alpha and proton bulk speeds in kilometers per second (s/c frame)
- ‘alpha_cycles’ (Version 3 and below)
    - The number of instrument cycles averaged together to create the alpha parameter records.
- ‘alpha_cycles_den_vth’ (Version 4 and above)
    - The number of instrument cycles averaged together to create Na and Vtha.

‘alpha_cycles_vel’ (Version 4 and above)
    The number of instrument cycles averaged together to create Va and Va - Vp.
‘alpha_cycles_na_np’ (Version 4 and above)
    The number of instrument cycles averaged together to create Na/Np.
‘alpha_caution’ (Version 3 and above)
    0 – no known issues
    1 – use with caution, Na/Np may be omitted
    2 – alpha and/or proton density is suspect, Na/Np is omitted
    3 – data removed after visual inspection, Na/Np is omitted -1 – no data

3.3 Iron Data

3.3.1 Iron Abundance and Kinetic Data

Due to unexpected issues involving the entrance system’s variable geometric factor (Opitz, 2007), an extensive in-flight calibration (Simunac, 2009) and post-launch determinations with the engineering model have been performed. Solar wind iron is typically contained fully within the main channel geometric factor, and only main channel data are provided here.

Matrix Rate (MR) data consist of count rates in pre-defined species (mass, mass/charge) ranges that are calculated by table look-up in the onboard processing. Full resolution matrix rates (5-minute, 10-minute) covering major solar wind elements are provided to the public domain through the STEREO Science Center as Level-1 data sets.

Iron kinetic properties provided here are derived from the matrix rates associated with iron, that is, MR08 through MR11. The raw rates are converted into densities using the geometrical factor determined in pre-launch calibrations (see Karrer 2007 and Galvin et al. 2008). Iron detection efficiencies are based on internal efficiency ratios and the start efficiency. As iron was not an available species at the calibration facility, the start efficiency used here is based on argon data (see Galvin et al., 2008 for argon curves). This may affect the absolute density determination.

The Fe speed and thermal speed are derived from a 1D Maxwellian fit to the dominant peak in the MR09 matrix rate. The charge state of the peak used in the fitting process is derived from the proton speed.

Time series monthly plots provided include the color contour of the scaled distribution function (directly from the matrix rate MR09) as a function of speed, the bulk speed derived for Fe (brown line) and the proton speed (black line), the thermal speed derived for Fe, the scalar bulk speed difference (vFe – vH), the number density ratio of Fe/H (scaled by 1E6), and the total density of iron (brown) and protons (black). The dashed lines in the Fe/H plot indicate the range of photospheric Fe/H cited by Howeger (2001, in *Solar and Galactic Composition*).

3.3.1.1 Level 2 Data Format

The Level 2 parameters are:

‘epoch’
    Time for record – start of cycle
‘iron_Q’
    Iron charge state used in the v and vth fitting algorithm.
‘iron_bulk_speed’
    Bulk speed for solar wind Fe, [km/s], spacecraft frame. Derived from a 1D Maxwellian fit to the distribution function.
‘iron_thermal_speed’
    Thermal speed derived for solar wind Fe, [km/s]. Derived from a 1D Maxwellian fit to the distribution function.
‘iron_density’
    Number density derived for solar wind Fe , [cm-3].
‘iron_density_ratio’
    Number density ratio derived for solar wind Fe and protons, scaled to 1E6.
‘qf_iron_bulk_speed’
‘qf_iron_thermal_speed’
‘qf_iron_denisty’
‘qf_iron_density_ratio’
    Quality flags:
    0 = no identified issues
    1 = caution: used second fit
    2 = caution: low statistics
    3 = caution: post acceleration less than nominal (efficiencies used for densities may be affected)
    4 = wrong track selected, data deleted

3.3.2 Iron Charge State Data

Pulse height analysis (PHA) data consist of single event information, including the time of the event, the energy-per-charge (E/Q), the polar and azimuth position, the measured energy (Essd), and the measured time-of-flight (TOF). The Essd, TOF, and E/Q are used to identify the ion species, including the calculation of the ionic charge state for each ion. Charge state histograms are formed from these calculations.

Only a fraction of the PHA data for the heavy ions is brought to the ground because of telemetry limitations. However, all ions are counted and classified into four categories, known as priorities. In case of limited telemetry, the distribution of charge states for ions entering the instrument may be recovered from the downloaded set by normalizing the downloaded set with these priority rates. This is done by multiplying the downloaded histograms of each priority by the ratio of the number of PHA events counted by the instrument in each priority, to the number of PHA events actually brought down.

The iron charge state distribution histograms are formed by binning the calculated charge states along the iron species track. Presently, the binning standard counts the integer value of a calculated charge state. For example, the histogram bin 10 includes all calculated charge states greater than or equal to 10.0, but less than 11.0. An average charge state may be calculated from the histogram by combining the counts at each bin with the bin value of bin+0.5. For example, the number 10.5 would best represent bin 10.

Iron charge state distributions and average charge state provided here are derived from the PHA data from the "main channel" accumulated over 2 hours. Data are acquired from ESA steps 2-100. This is approximately E/Q = 0.8-79 keV/e, which for Fe+10 is the velocity range 165 – 1670 km/s.

3.3.2.1 Level 2 Data Format

The Level 2 parameters are:

'epoch'
  Time for record – start of cycle
'Fe_aveQ'
  Average charge state for iron calculated as described below. Typical uncertainty is half a charge unit.
'Qty'
  Normalized counts used in the fitting process. Provided as a measure of counting statistics.
'Fe_Q': 21 element array
  Counts for each ionic charge state "Q" of iron, taken over the E/Q range.