Cluster Active Archive:

Interface Control Document for EDI

	Name	Date	Signature
Prepared by:	Edita Georgescu Instrument team	30-04-2012	
Reviewed by:	PI/Technical manager Chris Perry/Harri Laakso		
Maintained by:	Mikhail Rashev Instrument team	14-05-2014	
Approved by:	Goetz Paschmann Roy Torbert / PI		
Accepted by:	Harri Laakso		

DOCUMENT STATUS SHEET

Issue	Date	Details
DRAFT Rev.0	2004-06-25	
DRAFT Rev.1	2004-12-07	
DRAFT Rev.2	2005-05-04	
Issue 1, Rev.0	2005-10-20	
Issue 1, Rev.1	2005-12-20	
Issue 1, Rev.2	2006-11-20	
Issue 1, Rev.3	2008-04-20	
Issue 1, Rev.4	2008-11-30	
Issue 1, Rev.5	2009-01-15	
Issue 2, Rev.0	2009-07-30	
Issue 2, Rev.1	2010-05-05	
Issue 2, Rev.2	2011-04-29	
Issue 2, Rev.3	2012-04-30	
Issue 2, Rev.4	2013-05-01	
Issue 2, Rev.5	2014-05-14	
Issue 2, Rev.8	2018-05-14	

DOCUMENT CHANGE RECORD

Issue	RID/Ref	Details
DRAFT	01/2004-12-07	Ch 5. Data provision: additional information, Ch 6
DRAFT	02/2005-05-04	Ch 5. Data provision: additional information
1.00	0100/2005-10-20	Ch 3 & 5 Ambient electron (AE) additional info
1.01	0101/2005-12-20	Ch 4.6.4 & 5.10 Instrument header files and Caveat list description changed
1.02	0102/2006-11-20	Ch 5.6 EGD data and header files changed Ch 3.3.3.3 & 5.7 AE info changed Ch MP metadata added
1.03	0103/2008-04-20	Contact information changed Ch 2. In Ch 3.4 Fig 3.4 was changed to include additional product. Ch 5.7 completed with DATASET header and 5.11 was added to describe the additional auxiliary product CRF. Ch 6 was updated with the software source codes description delivered for documentation
1.04	0104/2008-11-30	Fig 3.4 changed MP quality info was corrected Ch 3.3.3.3-4, Fig 3.2: AEC name changed, AE correction procedure extended, instrument frame defined. Ch 5.5.7 Minor changes in EGD and MP dataset metadata
1.05	0105/2009-01-15	Ch.3.3.3.2 Status byte description extended for electric field data, filter possibilities added
2.00	0200/2009-07-30	Updated emails in metadata; Ch 3 added 3 figures, updated and renumbered all; Ch 5 with QZC data description (Ch 5.12) and metadata; added Figure Captions (Ch 7)
2.01	0201/2010-05-05	Updated AE correction description with the new data product AEDC that is produced at CAA and new “Science” product SPIN. AED and MPD replaced with AE and MP.
2.02	0202/2011-04-29	New dataset names for CLIST and QZC. Some Info moved to Annex of UG.
2.03	0203/2012-04-30	CRF dataset description completed with code_flag info
2.4	024/2013-05-01	New maintainer, Mikhail Rashev
2.5	025/2014-05-14	Revisions for 9th Operations Review
2.8	028/2018-05-14	QZC related corrections: adding description of phi and theta fileds, changed MIN_TIME_RESOLUTION, bit1

Table of Content

1 PURPOSE

The purpose of this document is to provide an outline of the archiving of the data from the EDI instrument on Cluster in the ESA Cluster Active Archive (CAA) and to define the agreement of the CAA and PI of EDI on this broad outline. It contains a detailed description of the data products and the list of the documents to be delivered to the CAA.

The scientific rationale underpinning the CAA activities is as follows:

- Maximise the scientific return from the mission by making all Cluster data available to the worldwide scientific community.
- Ensure that the unique data set returned by the Cluster mission is preserved in a stable, long-term archive for scientific analysis beyond the end of the mission.
- Provide this archive as a major contribution by ESA and the Cluster science community to the “International Living with a Star” programme.

In the case of EDI, the main responsibilities will be:

- To deliver the instrument data products and documentation to the CAA and keep them up-to-date.

2 POINTS OF CONTACT

For the operation of archiving the high-resolution data from EDI the following contacts have been agreed:

- as scientific correspondents:
  - CAA: C. P. Escoubet/H. Laakso (Email: harri.laakso@esa.int)
  - EDI: Mikhail Rashev (Email: rashev@mps.mpg.de), Roy Torbert (Email: roy.torbert@unh.edu)
- as technical correspondents,
  - CAA: C. Perry (Email: C.H.Perry@rl.ac.uk), C. P. Escoubet/H. Laakso (Email: harri.laakso@esa.int) and the ”caateam” (Email: caateam@esa.int)
  - EDI: Mikhail rashev
- as managerial correspondents
  - CAA: Harri Laakso (Email: harri.laakso@esa.int)
  - EDI: Patrick Daly (Email: daly@mps.mpg.de)

3 INSTRUMENT DESCRIPTION

3.1 Science Objectives

The idea to use the difference in electron times-of-flight for drift velocity or electric field measurements was first applied by the ‘boomerang’ instrument on Geotail. That instrument was, however, limited to one measurement per spin, and could not accommodate all magnetic field orientations. EDI is the first instrument to combine the continuous triangulation and time-of-flight techniques, and can be operated for arbitrary magnetic field orientations. EDI was first flown on the Equator-S mission and valuable information concerning operations and on-board software was gained, although limited by the short duration of the mission.

The Electron Drift Instrument (EDI) on Cluster measures the drift velocity of artificially injected electron beams. From this drift velocity the electric field perpendicular to $\boldsymbol{B}$ can be deduced. EDI has proven its excellent capabilities to measure plasma convection:

- in the auroral regions (provided the auroral electrons do not constitute too high a background),
- at the boundary between the tail lobes and the plasma sheet,
- in the inner magnetosphere.

EDI complements the double-probe technique employed by the EFW instrument in that the EDI measurements are essentially unaffected by the spacecraft environment and always includes the total electric field perpendicular to B-field, regardless of its orientation with respect to the spacecraft spin plane (so even electric field along the spin axis can be measured). On the other hand, the EDI measurements have poorer time-resolution and by their very nature are subject to data outages when the ambient magnetic field becomes low, the magnetic and electric fields are highly variable, or the relative fluxes of ambient electrons become very large.

In its ambient electron mode, EDI measures electron counts at a fixed energy and pitch-angle with very high sensitivity and time resolution. These measurements can be used to

- probe the magnetic field topology,
- detect narrow field-aligned electron beams.

3.2 Hardware Overview

3.2.1 Introduction

The Electron Drift Instrument (EDI) measures the drift velocity of artificially injected electron beams. From this drift velocity that, by definition, is directed perpendicular to the magnetic field, the perpendicular electric field can be deduced using the simultaneous magnetic field measurements from the FGM experiment.

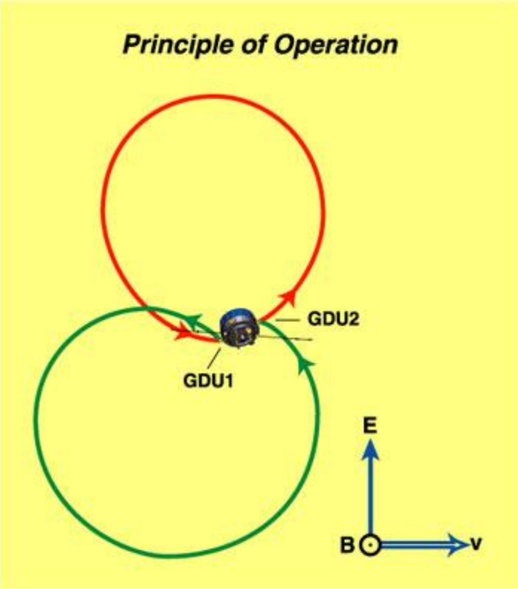
3.2.2 Principle of Operation

The electron-drift technique is based on the injection of weak beams of electrons and their detection after one or more gyrations in the ambient magnetic field. In the presence of a drift velocity $\boldsymbol{V}_d$, induced by an electric field $\boldsymbol{E}_\perp$ or a magnetic-field gradient $\nabla \mathbf{B}_\perp$, the circular electron orbits are distorted into cycloids. Their shape depends on whether the beam is injected with a component parallel or anti-parallel to the drift velocity. To be able to realize both types of orbits simultaneously, EDI uses two guns and two detectors. *Figure 3.1* shows examples of these two orbits in the plane perpendicular to $\boldsymbol{B}$.

The perturbation of electron orbits can be measured in two different ways in order to determine the magnitude and direction of the electron drift velocity. The first method, triangulation, uses the fact that the perturbed trajectory of an electron beam, fired perpendicular to the ambient magnetic field, returns to the spacecraft after one or more gyro orbits only when fired in unique directions. The second method measures the times-of-flight for the electron beams to return to the spacecraft, which in the presence of a drift, differ from the gyroperiod by amounts that are proportional to ±Vd .

The triangulation and time-of-flight techniques complement each other ideally. While triangulation naturally becomes increasingly inaccurate if the target moves further and further away, the time-of-flight technique becomes more accurate because, according to Eq. (3), ΔT increases with increasing drift steps, and thus becomes easier to measure. More details about the measurement technique can be found in the following references [A4, A5, A8].

Figure 3.1 Principle of EDI operation. Details of the measurement technique are presented in [A8].



3.2.3 Implementation

3.2.3.1 Gun-Detector Characteristics

EDI consists of two gun-detector units (GDUs) and a controller unit. The GDUs are mounted on opposite sides of the spacecraft and have oppositely directed fields of view. The guns are capable of firing in any direction within more than a hemisphere (0-96° polar angle) to accommodate arbitrary magnetic and electric field directions.

Similarly, the detectors can detect beams coming from any selectable direction within more than a hemisphere (0-100° polar angle). The detector system consists of an optics section, a programmable sensor, associated electronics, and voltage generators. Adjustment of the look direction is achieved in elevation by deflecting the incoming beam and in azimuth by selecting a contiguous set of 128 sectors (pads) of the annular image-region on the sensor micro-channel plate (MCP).

Beams have an angular width of approximately 1° at small polar emission angles, increasing to 4°-by-1° at large polar angles. Electron energies can be switched between 0.5 keV and 1.0 keV.

Separate calibration tables for the two energies are used to convert beam firing directions into the corresponding deflection voltages. The flux-density of the returning electrons is proportional to $I_b B^3 / E$ (except when the drift step is small). To accommodate the large variations in B and E along the Cluster orbit, the beam currents, I_b can be changed over more than two orders of magnitude (from 1 nA to several hundred nA); I_b is given in the CRF dataset. Beam currents are initialized based on the ambient magnetic field strength and then varied automatically based on the tracking success. Similarly, by using different combinations of high-voltages for the detector optics, a large variety of effective aperture areas A, and geometric factors G, can be realized. A and G determines the sensitivity to beam and background electrons, respectively. By choosing the right combination of G and A, adequate signal and signal-to-noise-ratio (SNR) levels can be maintained over a wide range of field strengths and background electron fluxes. Tables of the optics voltages that achieve specific combinations of G and A are referred to as 'Optics States'. The automatic Optics-State navigation is based on measured flux levels and magnetic field strength. For the details of the used values of these parameters, see the EDI User manual [A2].

3.2.3.2 Time-of-Flight Measurements

In order to measure the electron times-of-flight, as well as to distinguish beam electrons from the background of ambient electrons, the electron beams are amplitude-modulated with a pseudo-noise (PN) code. Briefly, a set of 15 correlators analyzes the phasing of the detector counts relative to the beam code. Before beam acquisition has been achieved, all correlators will show the same counts (to within Poisson statistics) from the ambient electron background. Once the beam is acquired ('angle-track'), the correlator whose delay matches the electron flight-time will have the maximum number of counts. A delay-lock-loop continuously shifts the code-phases of the correlators to keep the maximum centred in a specific channel ('time-track'). By keeping track of the net change in code-phase, one obtains a measure of the changes in time-of-flight.

Commensurate with the number of correlators, EDI employs primarily a 15-chip code. This way the signal is recorded in one of the correlators regardless of the actual time-of-flight. But because the accuracy is related to the chip-length, Tchip, the code-duration is kept short, much shorter than Tg. The electron time-of-flight is therefore equal to an integer number of code-lengths plus a fraction, of which only the fraction is measured by the correlators directly. However, by choosing a code-length equal to Tg /5 or Tg /10, where Tg is estimated from the on-board FGM data, the number of complete wrap-arounds of the code can be recovered unambiguously. To track small time-of-flight variations, the code is shifted with a resolution of typically Tchip/32. Simulations of the correlator performance indicate that the accuracy of individual time-of-flight measurements is about Tchip/8. To account for the large variations in Tg along the Cluster orbit, the code-length can be varied between approximately 15 μs and 2ms.

A problem with the short code is that it does not discriminate against multi-runners. Regardless of how many times the electrons have gyrated before hitting the detector; the signal will appear in one of the 15 correlators. We therefore have introduced a second, much longer code. It has 127 chips, and its length can exceed 4Tg. By placing the 15 correlators at a time-delay near Tg only single-runners are detected (unless runners of order 5 or higher are present as well). As the increased chip-length implies lower accuracy in time-of-flight measurements, the long code is only used in strong (100 nT) fields where multi-runners most frequently occur.

3.2.3.3 Beam Acquisition and Tracking

To find the beam directions that will hit the detector, EDI sweeps each beam in the plane perpendicular to ***B***. at a fixed angular rate (typically 0.2°/ms) until a signal has been acquired by the detector. Once signal has been acquired, the beams are swept back and forth to stay on target. Beam detection is not determined from the changes in the count-rates directly, but from the square of the beam counts divided by the background counts from ambient electrons, i.e., from the square of the instantaneous signal-to-noise-ratio, ***SNR***^{2}. This quantity is computed from the counts recorded simultaneously in the matched and unmatched correlator channels. If it exceeds a threshold, this is taken as evidence that the beam is returning to the detector. If the threshold is not reached then the beams are recorded with **quality zero "q0" and are a proxy for the ambient electron counts in the "WW"-mode (**CAA product **QZC)**. The thresholds for ***SNR***^{2} are chosen dependent on background fluxes, and vary between 35 and 200. These values have been selected after extended experimentation during commissioning, and represent a compromise between getting false hits (induced by strong variations in background electron fluxes) and missing true beam hits. The basic software loop that controls EDI operations is executed every 4ms; two sampling modes are used: 2 times 2ms and 4 times 1ms acquisition. As the times when the beams hit their detectors are neither synchronized with the telemetry nor equidistant, EDI data have no fixed time-resolution. The maximum time resolution is limited by the telemetry to 1/8 s in NM and 1/64 s in BM, and so not all measurements recorded on-board are transmitted to the ground.

3.2.3.4 On-board Magnetic Field Data Handling

EDI searches for the drift-step target in the plane perpendicular to ***B***, and therefore needs information on the local instantaneous field as frequently as possible. Flux-gate magnetometer data are available on board over the inter-experiment-link (IEL) with the FGM instrument. These data must first be time-tagged, because FGM sampling is not synchronized to the spacecraft clock, and then corrected for calibration angles, sensitivities, and offsets, and finally rotated by 6.5°, to the spacecraft body axes. As the FGM data are available over the IEL only 16 times per second, the EDI controller constructs the field at higher frequencies using the analogue signals from the three axes of the search-coil data provided by the STAFF instrument also over the IEL. To first order, the search coil signal is integrated and added periodically to the FGM values, after rotations that account for the different coordinate systems of the two magnetometers. However, the frequency response of STAFF differs from a pure differentiator in two respects. First, there is a high frequency roll-off above 40 Hz. EDI accepts this frequency basically as the limit at which it can track ***B***. Second, there is a low-frequency cut-off that is inherent in the coil-pickup response. This reduces the signal primarily at the spacecraft spin frequency and is compensated by adding the properly phase-adjusted component at that frequency. An accuracy of better than 0.5 degree in the direction of ***B*** is required because the width of the beam is about 1°. Naturally, this poses stringent requirements on the calibration of the magnetometer data, as reconstructed by EDI from both the FGM and STAFF information, as described above. Errors of order 1 nT are of no concern to EDI if the total field is sufficiently large. However, for fields of 50 nT or less, beam-pointing errors can become larger than the beam width, causing loss of track if the error moves the beam off of the $B^{\perp}$ plane. The EDI controller must maintain this accuracy throughout four operational ranges of the FGM data, and this requires constant updates of the four calibration matrices, and four sets of offsets for each axis. As an overall constraint on these numbers, the magnitude of the field is determined by time-of-flight information whenever there are beam hits. As a starting point, the spin-axis offset is adjusted to be consistent with this magnitude. Furthermore, the plane perpendicular to B is determined by the continual series of gun vectors that are successful. But as the beam-width is about one degree, and the tracking algorithm is able to keep the gun pointing only to within about 0.5 degrees of perpendicular to the varying B field, this information must be compiled statistically and used to correct the supplied calibration matrices for accuracy in the EDI coordinate system. This process is iterated by ground processing, and then uplinked to the controller, to improve the success rate of beam hits.

3.2.3.5 Ambient Electron Monitoring

When the electron beams are off the EDI detectors allow for ambient electron measurements with very high sensitivity and time resolution, albeit at fixed energies of 0.5 or 1.0 keV. In this mode the two detectors which are facing opposite hemispheres are looking strictly into opposite directions. Either both detectors are looking in the plane perpendicular to B (pitch angle of 90 degrees), or one detector is looking along B while the other is looking antiparallel to B (pitch angles of 0 and 180 degrees). When looking in the plane perpendicular to B the two directions within the plane are determined by the cross product of the magnetic field vector B with a selectable but fixed vector P that is constant in the spinning instrument frame of reference. The instrument coordinate system for GDU1 is the same as the spacecraft body-build system, having the X-axis approximately aligned with the spin-axis and the Z-axis directed radially outward. Z is the symmetry axis of the EDI instrument. Y is perpendicular to both and is tangent to the spacecraft in the spin plane. The detector GDU2 coordinate system is rotated by 180 degrees around the spin axis relative to the GDU1 coordinate system. In order to characterize the detector look direction, we use the polar and azimuth angles in the spherical spacecraft system. A sketch of the EDI instrument frame is given in Figure 3.5.

When looking parallel/antiparallel to B the two detectors switch roles every half spin of the spacecraft as the tip of the B vector spins outside the field of view of one detector and into the field of view of the other detector. In nominal telemetry mode (NM) there are 16 counts samples per detector and per second. Each sample is accumulated over approximately 16 ms (1/64 seconds). In Burst mode (BM1) there are 128 counts samples per detector and per second, and the accumulation time is approximately 8 ms (1/128 seconds). Counts are accumulated synchronously by the two detectors and each counts sample pair is stored in telemetry with its corresponding look direction expressed in spherical coordinates (azimuth and polar angle) in the instrument frame which for GDU1 is identical to the spacecraft body-built frame. As the two look directions are antiparallel only one set of angles needs to be transmitted. As the spacecraft is spinning the look directions need to be maintained in order to point at a fixed pitch angle. The look directions reported in telemetry correspond to those used at the center of the respective sample accumulation time window.

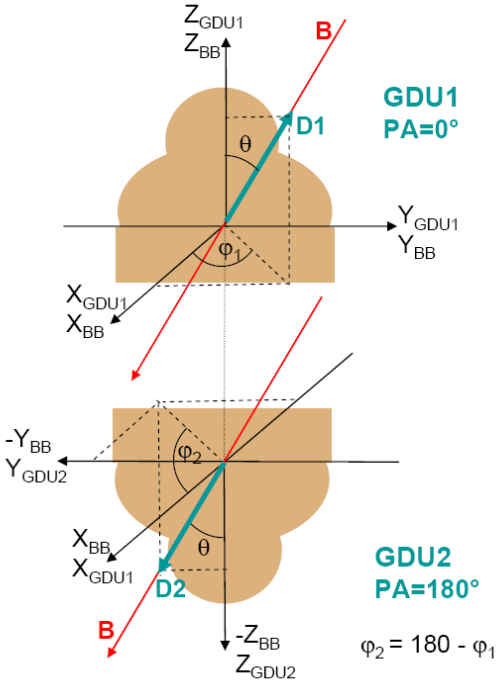


Figure 3.5 EDI instrument frame.

*The **GDU1** instrument frame has the same coordinate axes as the spacecraft BB:*
*X_{BB} = along the nominal spin axis; Z_{BB} = in spin plane; radially outward; symmetry axis for **GDU1***

***GDU2** frame is rotated with 180° around the spin axisi: Z_{GDU2} = - Z_{BB} and Y_{GDU2} = - Y_{BB};*

*The unit vector of the detector look direction for GDU1 in **spherical coordinates** is characterized by the polar angle θ and azimuth angle φ.*
$\theta = acos(Z_{BB})$
$\varphi = atan(Y_{BB}/X_{BB})$

In „AE“ mode: θ has the same value for both GDUs and φ are supplementary: $\varphi 2 = 180 - \varphi 1$

3.2.3.6 Operations and Limitations

The complex nature of the EDI operations and data processing has meant a long learning curve before the many control parameters, beam-recognition algorithms, and magnetometer calibrations had been adjusted sufficiently well that the instrument began to operate successfully under a wide range of ambient conditions. Still, when the magnetic field magnitude gets really low, and/or the background electron fluxes get high, tracking becomes difficult.

Low $\boldsymbol{B}$ magnitudes require high beam currents to overcome the beam divergence along large gyro orbits, and to get sufficient signal-to-background ratio. But large beam currents, in conjunction with the beam-modulation and –coding, lead to interference with the electric wave measurements by the WHISPER instrument. Moreover, the smaller B gets, the higher the requirement for very precise on-board magnetometer calibrations. Last but not least, rapid time-variations in magnetic and/or electric fields, as well as large fluxes of background electrons can also cause loss of track.

Because of the noted interference with the WHISPER measurements, EDI beam operations has been subject to a 6-orbit cycle: “high-nominal-low-high-low-low”, where high beam currents (up to 300 nA) were allowed in only two out of six orbits, while currents have been limited to about 100 nA the other orbits and no beam operation was allowed outside 4.5 hours of perigee in three of these four orbits. Starting 2004-10-17 (PP 231) this scheme “high-nominal-low-high-low-low” has been changed to a 2 orbit cycle “high-low”. High beam currents (300 nA limit) in even orbits alternate with “100 nA limit and no beam operations 4.5 h outside of perigee” in the odd ones.

Whenever EDI is not in electron drift mode it uses its ambient electron mode to detect ambient electrons at pitch angles of 0, 90 and 180 degrees and fixed energy (mostly 0.5 keV). Once in each orbit a basic setup is performed where the parameters of the mode are defined. These parameters are the electron energy (0.5 or 1 keV) and the pitch angle. For the pitch angle it is possible to choose between three alternatives: either fixed at 90 degrees or fixed at 0/180 degrees, or alternating between 90 and 0/180 degrees at a selectable frequency which is limited in principle only by the sample accumulation time.

From October 14, 2004 until Dec 3 2005 (including PP 289) a 3 orbit-cycle has been used in the “AE”-mode:

orbit 1:	0.5 keV, fixed at 90 deg. pitch angle
orbit 2:	0.5 keV, fixed at 0/180 deg. pitch angle
orbit 3:	1.0 keV, alternating 0/180 with 90 degrees pitch angle with dwell time ~64 sec.

Starting 2005-12-03 (PP290) a 6-orbit cycle is being used:

orbit 1:	0.5 keV, fixed at 90 deg. pitch angle
orbits 2, 4, 5:	0.5 keV, fixed at 0/180 deg. pitch angle
orbits 3 and 6:	0.5 keV, fast alternating 0/180 with 90 (dwell time 32 BCIs (=62.5 ms))

where BCI (Basis Cycle Interrupt) is a time unit equal to 1/512 second.

3.3 Data Processing Chain

The data processing chain consists of onboard, ground and science processing. The onboard processing writes to telemetry the measured quantities and instrument parameters. The telemetry data: housekeeping (HK TM), science normal mode (NM TM) and science burst mode (BM TM), after having a DDS-header attached on ground – processing performed in ESOC, are input in the ground processing software.

The ground processing software consists of Merged Science File (MSF) production and the Pick-Library. The first merges the TM-packets and orders them in time and the second extracts the quantities needed by the science processing as input. The Pick Library is written in IDL and a similar library has been written in C and is included in the sketch below with the name of its most used function “wwconv”. While the EDI-PISO and AE software is using the Pick Library, the software which produces the support data: CRF, QZC, CLIST and EGD uses the functions included in the C Library.

A schematic representation of the data processing chain is given in Figure 3.6

The output of the science processing should consist of time series of physical quantities contained in the science data products. However this is true only for the output of the EDI PISO software and its output: PP, PPPlus and MP files.

All the other data products are uncalibrated or raw. The section of SCIENCE processing includes also the processing of “Support” data

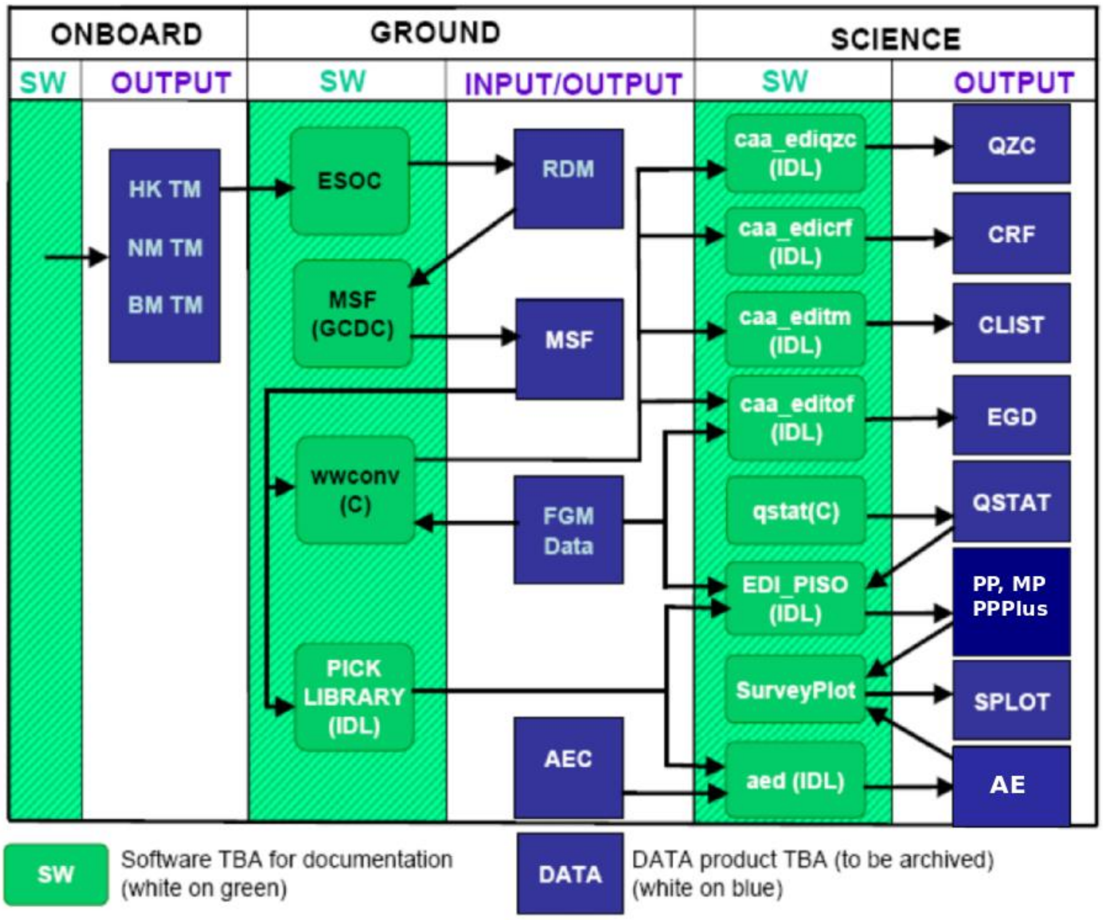


Figure 3.6 EDI data processing chain and output

3.3.1 Onboard Processing

The on-board software has two main components:

- PROM based firmware (Mode 0) provides startup testing, telecommand handling, watchdog and current monitor functions, housekeeping data collection, manual instrument control, and transmission of HK and Science data via telemetry.
- EEPROM based software (Modes 1 and higher) provides for actual science operations and allows additional commanding. Mode 8 is an upgraded EEPROM version of Mode 0.

A complete description of the on-board software is made in the “EDI / Cluster-II User Manual” [A2] and the description of the telemetry formats is described in its Appendix [A3], see Table 6.1. This is the output of the onboard processing software and constitutes the input for the ground processing software. The telemetry contains housekeeping (HK) and science data in both normal (NM) and burst modes (BM).

HK telemetry contains all information needed at power-on and routine checkout.

Science Telemetry data are needed besides for scientific data production also for performance monitoring in the Commissioning Phase, after Critical Software patches, or for some contingency operations.

3.3.2 Ground Processing

3.3.2.1 MSF Production

The Merged Science Files (MSF) provide a means of having all relevant raw data needed for the production of the Level 0 and the GCDC data products accessible in one single file regardless of the number of CD-ROMs issued for a particular day. The fact of having to deal with only a single file considerably simplifies the programming tasks. As these files are kept in the Raw Data Disk Archive, this concept also permits easy reproduction of the data products should this become necessary. The MSF are written by concatenation of the DDS headers and data packets from the various raw data files in a defined sequence.
It is important to notice that only science packets with accompanying experiment and spacecraft housekeeping data (i.e., with an identical DDS header time stamp) are included in the MSF (even if the latter are not required for the production of the CSDS data products) because science data without corresponding housekeeping information is considered unreliable. In this case, the S/C and the experiment housekeeping data will be written to MSF followed by an artificial DDS header for science data indicating that there is no data following.

The contents of several RDM data files are needed: EDI HK (instrument housekeeping), S/C HK (spacecraft housekeeping), EDI NM (normal mode science data), EDI BM (burst mode science data). The data packets must be sorted by Spacecraft Event Time. EDI science packets (from NM and BM) contain all necessary information to produce the scientific parameters without the need for EDI HK.

However, to avoid a different handling of the raw data between EDI and RAPID, all data packets are placed in the MSF’s covering one complete day. However in order to calculate the spin-corrected time tag, S/C Housekeeping packets must be available.

The naming convention of MSF follows the naming on the RDM[A10]:
yymmddem.0vc
Explanation of the various filename elements:

yymmdd	6 digit date
v	RDM version letter a - z (lower case)
c	spacecraft number
e	instrument type (e for EDI)
m	stands for merged

More details can be found in the technical note DS-MPA-TN-0017 from 2000-07-28.

3.3.2.2 PICK Library

Purpose:	The EDI Pick Library extracts and converts raw quantities from one telemetry record (TMR - 5.1522 seconds) of the EDI Merged Science Files.
Input:	MSF
Output:	Structures used by Science Processing or instrument diagnostics software.
Language requirements**:**	IDL

Description of Output Structures

Quantities of scientific interest are returned in either the structure called sc_pick_enm_struct (for telemetry modes NM 1, 2, and 3 or BM 2) or sc_pick_ebm1_struct (for burst mode 1). The data in these two structures is essentially the same, but there is more data in the sc_pick_ebm1_struct structure. There are many quantities in these structures pertaining to the onboard operation and diagnostics of EDI. Only quantities required to understand the scientific data will be described.

Each sc_pick_enm_struct and sc_pick_ebm1_struct contains a header structure. The EDI header structure, sc_pick_ehdr_struct, contains information about EDI's operational mode. The science mode tells whether EDI is in windshield wiper (WW) mode, used for the collection of Electron Drift Data, Ambient GEOS (AG) mode, used for the collection of Ambient Electron Data, or some other mode, such as quiescent. The secondary header, sc_pick_eshd_struct, contains data specific to each science mode. WW and AG have their own substructures, sc_pick_esm5_struct and sc_pick_esm1_struct, respectively.

When EDI is in WW mode, the scientifically useful quantities are stored in sc_pick_npacmo5_struct for NM 1, 2, 3 and BM 2 and sc_pick_bpacmo1_struct for BM 1. Each of these structures contains substructures, sc_pick_gd_struct, with gun and detector quantities. N.B., quantities for gun 1 correspond with quantities for detector 2, and vice versa. The important members of this structure are:

beam_time1: firing time in seconds since Jan. 1, 1970 for detector 1
beam_time2: firing time in seconds since Jan. 1, 1970 for detector 2
t1: time of flight for gun 1 in nanoseconds
t1m2: difference in time of flight between guns 1 and 2 (t1 – t2)
tof_over: overflow in ToF, do not use ToF data
ftof_p_over: overflow in ToF, do not use ToF data
dtof_n_over: overflow in ToF, do not use ToF data
vax1: gun 1 firing x direction in terms of deflection voltage
vay1: gun 1 firing y direction in terms of deflection voltage
vax2: gun 2 firing x direction in terms of deflection voltage
vay2: gun 2 firing y direction in terms of deflection voltage
word14_1: SMAX +/- for detector 1; used for s2b calculations
word14_2: SMAX +/- for detector 2
word15_1: ALL for detector 1; used for s2b calculations
word15_2: ALL for detector 2
sq1: quality for detector 1
    0 means no beam received
    1 means angle track, no time track (sig/bck > limhi)
    2 means angle and time track
    3 means angle and time track, sig/bck > limhi
sq2: quality for detector 2
e: beam and detector energy (0 for 1 KeV; 1 for 500 eV)

When EDI is in “AE” = “Ambient Electrons” or “AG” = “Ambient GEOS” mode, the interesting quantities are in the substructure called sc_pick_amb_geos_struct of pacmo0 :

time: time in seconds since Jan. 1, 1970

theta:	gun pointing theta in degrees (gun current is zero in “AE” or Ambient GEOS, but determines detector look direction)
phi:	gun pointing phi in degrees
b_perp:	set if pitch angle = 90 degrees

bz_gz:	if b_perp = 0 and bz_gz = 0:
	detector 1 has pitch angle = 0 degrees
	detector 2 has pitch angle = 180 degrees
	if b_perp = 0 and bz_gz = 1:
	detector 1 has pitch angle = 180 degrees
	detector 2 has pitch angle = 0 degrees

data29_1:	raw counts from detector 1
data29_2:	raw counts from detector 2

3.3.3 Science Processing

3.3.3.1 Overview

EDI sends back the gun firing directions, detector count rates, measured times-of-flight, correlator settings, and some signal-quality information once every telemetry record, i.e., every 128ms or 16ms in nominal (NM) and burst (BM) telemetry, respectively. Additional auxiliary information (beam currents, optics states, control-loop parameter settings) is transmitted once in every telemetry record (5.2 s). Beam currents and correlator settings (code length and repetition frequency) are relevant for interferences with wave instruments, as mentioned in 3.2, and are archived in the CRF data product.

As EDI operates asynchronously, time-tags are added to every data record. From the information reported in telemetry, the beam directions and gun positions in spacecraft-sun (SCS) or SR2 coordinates are computed, based on the Sun Reference Pulse (SRP). Our standard analysis is then to select all beams within a certain time-interval (called the ‘analysis interval’), typically one spacecraft spin (4 s) and to perform an automated determination of the drift step. For higher time resolution analysis, shorter intervals can be chosen. The standard processing uses 1, ½, ¼ spin periods as the analysis interval, although the software allows the selection of shorter time intervals. The conditions for data quality “good” that uses a number of at least 7 beams per analysis interval limits the time resolution to 1s, since the NM data have a maximum time resolution of 1/8s. The results are presented either as drift velocities or as electric fields, and in the geocentric solar ecliptic (GSE) system. We correct for the spacecraft velocity when showing data in GSE.

As mentioned in Section 3.2, beam tracking is adversely affected by low magnetic field strength, highly variable magnetic or electric fields, or by high backgrounds of ambient electrons. Before processing the electron drift data, we first determine what fraction of spins has a sufficient number of beams of adequate quality. The results are recorded in the QSTAT files discussed later. Only those 10-minute intervals, where the percentage of such spins is at least 10%, are then analysed further.

Triangulation Analysis

We have developed an analysis procedure that determines the drift step by searching for the target-point that minimizes an appropriate 'cost-function'. The cost-function is constructed, for each grid-point in the plane, by adding up the (squared) angle-deviations of all beams in a chosen time interval from the direction to that grid-point. Each beam contribution to the cost-function is normalized by the (squared) error in the firing directions, which is a function of beam pointing direction and varies between 1° and 4°. The grid-point with the smallest value of the cost-function is taken as the target. If a beam has been identified as a multi-runner of order N by the time-of-flight analysis, it is associated with a grid-point at N times the radial distance. When identification of the order from the time-of-flight analysis is ambiguous, there is an alternate method where beams whose firing direction is closer to the direction towards the grid-point at N times the radial distance are counted as runners of order. To speed up the search, the procedure uses a coarse grid to identify a restricted range in which the final search is performed with a much finer grid. The present software approximates the electron trajectories by circles whose radius is based on the magnetic field strength.

The presence of multi-runners complicates the analysis. Multi-runners are identified either from the resulting differences in time-of-flight or by their direction towards multiples of the drift step.

The analysis fails if the drift step and/or the magnetic field significantly vary within the chosen time interval. We can identify such cases by the variance in the magnetic field, by the quality of the fit (as measured by its reduced χ^2, and by the angle- or magnitude errors in the computed drift step. If those quantities exceed certain limits, no output is generated.

Time-of-Flight Analysis

The time-of-flight analysis serves three purposes. First and foremost, it is used to determine the drift velocity when the drift step becomes too large for the triangulation analysis. Second, it helps to identify multi-runners and thus can support the triangulation analysis, and third, it is equivalent to a measurement of B.

Deduction of the drift step (and the drift velocity) from analysis of the difference in the times-of-flight of the two beams (eq. 3 in Section 3.2) is, in principle, straightforward. If the drift step is large enough such that the firing directions become nearly parallel, then one can easily group all the beams in the analysis interval (e.g., the spin period) into two oppositely directed sets. The set with the larger times-of-flight then must contain the beams directed towards the target, the other set those directed away from the target. This assignment settles the drift direction, and the drift magnitude is then computed from the magnitude of the difference in the times-of-flight.

This simple scheme requires that conditions are stable over the analysis interval. If this is not the case, one should only use nearly simultaneous towards- and away-beam pairs for the analysis. But as we do not always have simultaneous hits from the two guns, we often have to resort to a method where we take the instantaneous difference between each measured time-of-flight and the gyro-time, T_g, computed from the high-resolution magnetic field data from FGM. According to Eq. 2 (Section 3.2), the times-of-flight of the towards- and away-beams are symmetric around T_g, so that, in principle, either would be sufficient to compute the magnitude of the drift. But because the times-of-flight differ from T_g by a percent at most, this scheme would work only if were known precisely. In practice, the T_g computed from the actual magnetic field measurements, $T_{g,est}$ will not be properly centred, and we therefore cannot apply this scheme directly. Instead, we average the differences between any measured time-of-flight and the corresponding $T_{g,est}$ separately for the two sets of beams. This way any fixed magnitude offset in $T_{g,est}$ will cancel out. The set with the larger average is identified with the towards-beams, the other with the away-beams, as above. The difference between the two averages is then the quantity to use for ΔT in Eq. 3 (Section 3.2).

The identification of multi-runners from the times-of-flight proceeds as follows. As described in Section 3.2, the PN-code duration, T_{chip}, is much shorter than the gyro time T_g. The electrons having gyrated twice have therefore an apparent increment in time-of-flight of 2 T_g modulo the T_{chip} relative to the single-runners. The same increment applies to each higher multiple. Increments that are larger than half the code-length lead to apparent multi-runner times-of-flight that are actually smaller. Applying this simple rule one can then identify the multi-runner order. Naturally, this method fails when T_g is itself a multiple of the code-length, which happens periodically when $\boldsymbol{B}$ changes.
For Ambient Electron Analysis see 3.3.3.3

3.3.3.2 EDI – PISO: EDI PI Software

The main science processing software package for the Cluster EDI instrument is known as EDI_PISO (PISO = Principal Investigator Software).
Purpose: To calculate and output the perpendicular drift velocity and convection electric field starting from the EDI raw data contained in the Cluster merged science files (MSF).
Language requirements: UNIX/Linux (csh, bash, CDF tools), IDL
External software dependencies: PICK library (IDL), FGM scripts and binaries (UNIX/Linux)
External data file dependencies: MSF files, ATT/ORB History files, FGM cal files, EDI-QSTAT files, FGM raw data files (RDM)
Major Components and Flow of EDI_PISO Software Program:
The following list illustrates the major components and flow of the EDI_PISO software. Only the most important routines are listed here, with a brief description of their main function.

ep_run.csh – Top level script that runs EDI_PISO
- ep_control_gcdc.csh – Set all input/control parameters
- edi_piso_wrapper.pro – csh to IDL liaison
- ep_envar_con.pro – Env. Variable/control parameter handler
- edi_piso.pro – main EDI_PISO IDL program

ep_get_spinfgm.pro – Produce spin-resolution FGM file
pickst_sc.pro – PICK Library function; get EDI data packets
ep_augment_oh_data.pro – Collect EDI data as we loop over hours
ep_get_hrfgm_oh.pro – Produce 1-hour high resolution FGM file
runEst.pro – Calculate runner orders and ESRTOFs for 1 hour of data
edi_piso_onechunk.pro – Collect EDI data as we loop over “chunks”
bestarg.pro – Calculate drift step using TRI and TOF for 1 chunk
    ep_calc_chisurf.pro – Calculation of TRI method penalty function
    ep_richmans_tof_sa.pro – Drift step calculation using TOF method
ep_calculate_dp.pro – Calculate derived parameters from drift step
ep_prep_iff_data_write.pro – Collect all data to write to IFF and PP-Plus files
edi_piso_write_iff_data.pro – Write data to IFF file (for GCDC)
ep_write_cdf_data.pro – Write data to PP-Plus file (for CAA)

This flow is described in more detail below for the following main components:

a. Description of required input
b. Calculation of probable runner orders, estimated single-runner time-of-flight (ESRTOF) – RunEst.pro
c. Calculation of the drift step – bestarg.pro
d. Description of output

a. Description of required input

The details pertaining to input requirements, control parameter management and software execution are contained in the document “EDI_PISO_README.doc”[CL_CD_EDI_PISO_SW_DOC1] which is currently a part of the EDI_PISO software distribution.

b. Calculation of probable runner orders RunEst.pro

This function is intended to support the BESTARG program by providing information about the runner order of beam hits. The information about the runner order is obtained by looking at long stretches of data, typically 1 hour. First, the gyro time T_g, obtained from B data, is fitted to the time-of-flight data (ToF). An offset for B is derived in order to minimize the average deviation of ToF from the T_g curve. Second, probabilities are calculated for each ToF, for being a single- or multi-runner, up to the order which is passed in keyword MAXORDER (default 6).

For a description of the returned information see the return structure definition in the code.

c. Calculation of the drift step – bestarg.pro

The following flow chart (see *Figure* 3.7) illustrates the primary logic of the IDL routine bestarg.pro. The triangulation method (on the left) involves constructing a penalty function (χ^2-surface) on a predefined, 2-D grid located in “virtual spacecraft space”, and assigning the “Target” to be the location (*r, phi*) of the minimum of the penalty function. This minimum value is part of the output and is called reduced_chisq.

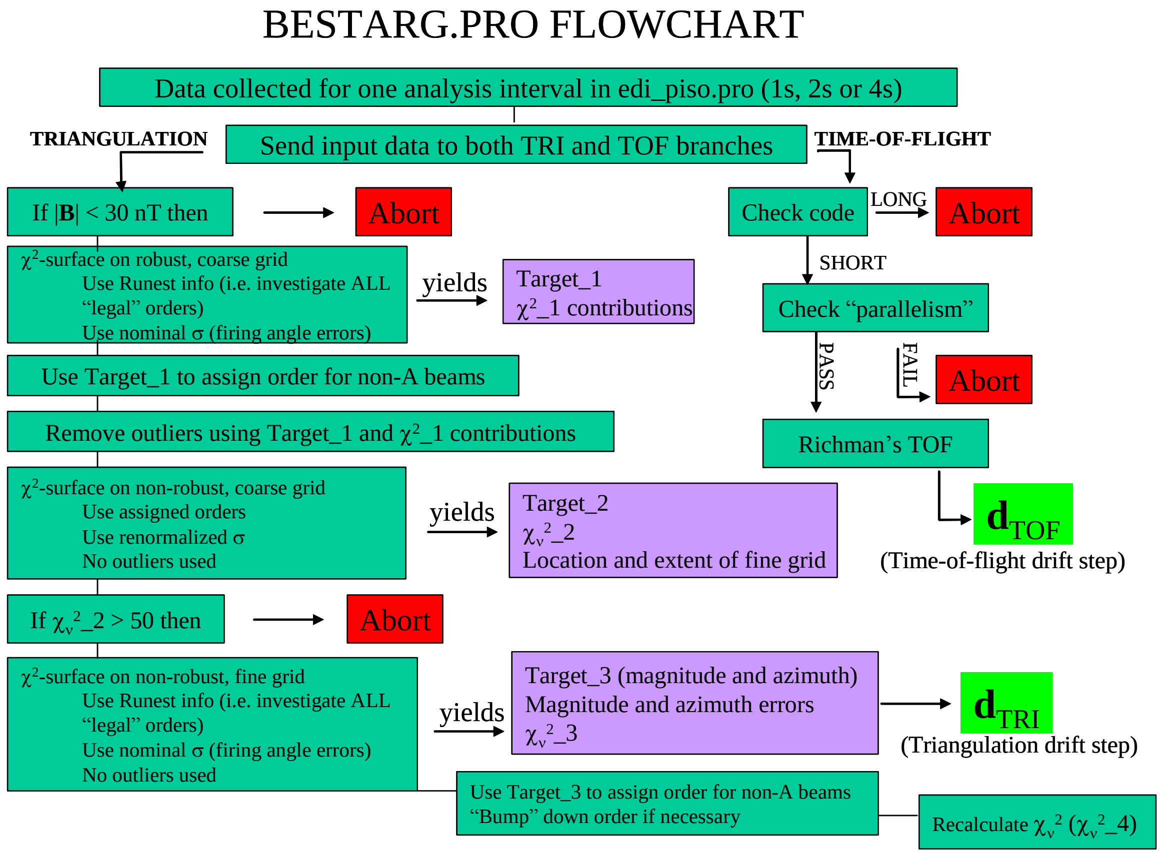


Figure 3.7 Bestarg flow chart.

The "reduced_chisq" is used only during the processing of the triangulation data as an upper threshold for acceptance of a data interval. If the reduced_chisq is greater than 50 then the data are discarded. The coordinate pair, (*r, phi*), defines the magnitude and direction of the "drift step", ***d***, which is the perpendicular distance that the emitted 1keV (or .5keV) electron beam has drifted during its gyro-trajectory back to the spacecraft. The time-of-flight method (on the right) involves constructing a statistically significant difference between the average times-of-flight of those beams which are emitted "away" from the Target, and those emitted "towards" the Target. This delta time-of-flight, combined with knowledge of the average firing angle, also yields the drift step.

d. Description of output

As illustrated in *Figure* 3.7, both the triangulation and time-of-flight methods are attempted for every analysis interval. Both drift step results are assigned a quality flag (good/caution/bad) based on the criteria defined in the document "EDI_PISO_OUTPUT_DEFS.txt" [CL_CD_EDI_PISO_SW_DOC2] which is distributed with the EDI_PISO software package. In addition, the two results are compared to one another, and based on estimated error measurements; one will be assigned the "winner" and the other the "loser". Only the "winners" who have quality "good" or "caution" are output to the IFF files (used by the GCDC to create the PP-files). However, both winners and losers, of any quality are output to the PP-Plus files. The IFF and PP-Plus files are described below.

The EDI_PISO currently creates two main output files:

***IFF files*:**
These are ASCII files used by the GCDC to create the prime parameter (PP) CDF files for the Cluster Data Centres. Each line contains information from a successful analysis interval, and includes the centre time of the interval (“Epoch” in the PP-file), seven status bytes (“Status”), the three GSE (inertial frame) components of the “winning” drift velocity (“V_ed_xyz_gse”), the three GSE components of the corresponding “winning” electric field (“E_xyz_gse”), and the reduced-chi-squared value (“Reduced_chi_sq”) from the triangulation analysis (if available). All of these variables are further described in the EDI_PISO software document “EDI_PISO_OUTPUT_DEFS.txt” [CL_CD_EDI_PISO_SW_DOC2]. Only “good” and “caution” data quality are written to the IFF-file (and subsequently the PP-file).

***“PP-Plus” files*:**
Currently in CDF format, PP-Plus files contain all of the IFF-file (and subsequently PP-file) information, as well as all of the “bad” data quality records, and also all of the “loser” information for each analysis interval. In other words, for each data record in the PP-Plus file (for each “Epoch” value), there is a set of variables containing the “winner” information (identical to the set within the PP-files), and a corresponding set of variables whose names differ only by a “_loser_” suffix which contain the “loser” information. In addition to the variables described above, each record contains four new variables, “Drift_step_mag”, “Drift_step_mag_error_inertial”, “Drift_step_azi_error_inertial” and “Nbeam” (for both “winners” and “losers”) which are described further in [CL_CD_EDI_PISO_SW_DOC2]. These PP-Plus files are for advanced users that have the software to filter the data. They have a different number of variables and different skeleton files than the regular PP data files. A comparison of the variables in the PP-Plus versus the PP CDF files is given in Table 3.3.1.

SPIN file variables **(“winners” only)** __C#_CP_EDI_SPIN (good/caution)	**File variables (“winners” only)** **PP:** __C#_PP_EDI (good/caution) **SP:** __C#_SP_EDI (good/caution) **MP:** __C#_MP_EDI (all qualities)	**PP-Plus file variables** **(“winners” and “losers”)** __C#_PPP_EDI (all qualities)
Epoch	Epoch	Epoch
Status	Status	Status
V_ed_xyz_gse	V_ed_xyz_gse	V_ed_xyz_gse
E_xyz_gse	E_xyz_gse	E_xyz_gse
	Reduced_chi_sq	Reduced_chi_sq
		Drift_step_mag
		Drift_step_mag_error_inertial
		Drift_step_azi_error_inertial
		Nbeam
		Status_loser
		V_ed_xyz_gse_loser

		E_xyz_gse_loser
		Reduced_chi_sq_loser
		Drift_step_mag_loser
		Drift_step_mag_error_interial_loser
		Drift_step_azi_error_inertial_loser
		Nbeam_loser

Table 3.3.1. The drift velocity, $\boldsymbol{V}_d$, and the convection electric field, $\boldsymbol{E}_\perp$, are corrected for the spacecraft motion, and output to the IFF and PP-Plus files as *V_ed_xyz_gse__* and *E_xyz_gse__*, respectively.

***"MP" files*:**

The Merged Parameter Data (MP) files contain the same variables as the PP files, but with higher time resolution and all qualities. Data from spin, half spin and quarter spin IFF files are merged by an algorithm that can be thought of as a "use more if not lower quality" algorithm. The analysis is performed on each spin's worth of data starting with spin resolution. If there is more data of half spin resolution with equal or better quality, it replaces the spin resolution data. Likewise, if there is more data of quarter spin resolution with equal or better quality, it replaces the half spin resolution data. The program that performs the merging requires the following input files:

- FGM PP data (for more complete spin period coverage)
- Spin Resolution IFFALL files
- ½ Spin Resolution IFF files
- ¼ Spin Resolution IFF files

The output is a merged IFF file with 1 second maximum resolution. This output IFF file is then used to create CDF files using the same skeleton files as the PP data.

***Filtering possibilities using the Status bytes in the PP, PPPlus and MP files*:**

The EDI PP data, PPPlus and Merged Parameter Data (that is, all the files that contain electric field and drift velocity data) contain a status parameter which consists of 7 bytes. These 7 status bytes exist for each data point. They contain information such as the data quality (GOOD, CAUTION, BAD), but also more refined information that can be used for filtering. A complete description of the criteria used to define these quantities is given in "EDI_PISO_OUTPUT_DEFS.txt" [CL_CD_EDI_PISO_SW_DOC2].

Here are the quantities one can filter the data on:

Status[0]: Quality

The values are: 0 for 'BAD', 1 for 'CAUTION', 2 for 'GOOD'

The default criteria for the quality assignment for the two processing methods (triangulation and time-of-flight) are given in the Table 3.3.2. This default was used for the processing of all data.

Quality	Quality assignment for Triangulation Method		Quality assignment TOF
	d > 33 cm	d < 33 cm	

GOOD	Nbeam>=7 and Delta_d/d >0.3	Nbeam >7 and Delta_d<10 cm	Delta_d/d < 0.30
BAD	Nbeam <7 or Delta_d/d >1.0	Nbeam <7 or Delta_d >33 cm	Delta_d/d >1.0
CAUTION	Everything else	Everything else	Everything else

Table 3.3.2 The quantities used in the quality assignment are: d = drift step, Delta_d = error on the drift step magnitude (Status[5] gives the ratio Delta_d/d in %) in EDI frame, Nbeam = number of beams available for analysis

Status[1]: Percentage of 1keV beams used in entire spin

The vales are: 100 for E = 1 keV, no energy switching mode;
0 for E = 0.5keV;
Everything else for energy switching mode

This byte is usually not used for filtering data quality; but it could be used to filter for energy. In practise we have used 500eV energy only rarely.

Status[2]: Percentage of Class-A beams used in entire spin

Not used for filtering data quality

Status[3]: Method Papertrail and Ambiguity Flag

Bits 0-4 reflect the value of the ground software control parameter
pp_method which determines the logic behind which analysis method (either triangulation or time-of-flight) is used. The three current methods are: triangulation (TRI), poorman's time-of-flight (PMT), and simultaneous time-of-flight (SMT). Various "logic chains" have also been defined in which the most suitable method is chosen depending on various parameters. The default : bit 3 is set, meaning pp_method= 4, TRI/PMT/SMT examined, Logic Chain 3.

If Bits 5-6 are not set, then method used in the end was Triangulation (TRI)
Bit 5: Set if method used in the end was Poorman's ToF (PMT)
Bit 6: Set if method used in the end was Simultan ToF (SMT

The Method papertrail is usually not used for filtering; The ambiguity flag (bit 7) can be used for filtering. This flag is set for ToF method: if the error in the drift step magnitude is larger than 100% and for TRI method: if the azimuthal error of the Chi-squared surface on the coarse grid is larger than 90 degrees.

Bit 7: 0 = No 180-degree ambiguity in drift step
1 = 180-degree ambiguity exists

Status[4]: Percentage of Triangulation outliers (only reported for triangulation results)

Not used for filtering

Status[5]: Fractional drift step magnitude error (percent) in SC frame (0-254)

Can be used for data quality filtering

Status[6]: Drift step azimuthal error in degrees in SC frame (0-254)

Can be used for data quality filtering

3.3.3.3 Ambient Electron Data Processing

Purpose: To extract ambient electron counts from EDI merged science files

Language requirements: IDL

External software dependencies: Pick Library (IDL)

External data file dependencies: EDI MSFs

Software Components:

ambient_electron_cdf.pro: This routine extracts the ambient electron counts and separates them by pitch angle, detector look directions in the instrument frame, energy, and sub mode from EDI MSFs. The data returned by this routine is essentially raw data.

This data is then written to a CDF files which contain the variables listed in Table 3.3.3. The detector look direction is given for detector 1 in two coordinate systems: (1) Cartesian GSE and (2) spherical coordinates (θ,φ) in the instrument frame. θ is the polar and φ the azimuth angle.

Name	**Type**
Epoch__C#_EDI_AE	CDF_EPOCH
AE_counts_CL#_GDU1_PA_0	CDF_INT2
AE_counts_CL#_GDU1_PA_90	CDF_INT2
AE_counts_CL#_GDU1_PA_180	CDF_INT2
AE_counts_CL#_GDU2_PA_0	CDF_INT2
AE_counts_CL#_GDU2_PA_90	CDF_INT2
AE_counts_CL#_GDU2_PA_180	CDF_INT2
AE_status_C#	CDF_UINT1
AE_theta_CL#	CDF_UINT1
AE_phi_D1_CL#	CDF_UINT1
AE_D1_GSE_CL#	CDF_FLOAT[3]

Table 3.3.3

The 6 “counts” variables are signed 2 byte integers. The fill value for these counts is -32768.

The “theta” variable contains an index between 0 and 137 and each step corresponds to 0.703125 degrees. Theta is the same for both of the EDI detectors. The “phi” variable contains an index between 0 and 127 and each step corresponds to 2.8125 degrees. The phi reported is the phi look direction for detector 1. The phi look direction for detector 2 is in the opposite direction from detector 1, or 64-phi1, and then adjusted so that it is between 0 and 127 if necessary. Only 2 bits, of the status byte, are used. Bit 0 indicates the energy: a value of 1 is used for 1 keV, and a value of 0 is used for 0.5 keV. Bit 1 indicates sub mode: if it is set, the data is from BM1 data; otherwise, the data is from NM123 or BM2. AE_D1_GSE_CL#, where #=1, 2, 3 is the spacecraft_id, is the detector 1 look direction in Cartesian GSE coordinates.

The raw data counts need to be corrected for the look direction dependence and for the differences in the efficiency of the two detectors; we call the first one intra-detector, the latter inter-detector correction.

The intra-detector correction uses the AEC-files and requires 2 multiplications per “counts” variable; the inter-detector correction requires one multiplication. The multiplication factor will be provided by the team or can be determined by computing the ratio of the minute-averages of the intra-detector corrected counts of the two detectors. In order to transform the corrected “counts” to relative electron fluxes a calibration, i.e. a comparison with measurements of a calibrated instrument must be performed. This can be done using PEACE differential electron fluxes selected for the EDI energy and pitch angles.

The Cluster Active Archive will be asked to provide the following capabilities:

- It will apply the angular corrections to the raw data.
- It will divide the NM data by 2 because the NM accumulation interval is twice that of BM 1.
- It will optionally filter for energy.
- It will have the option of providing raw counts, i.e., not dividing NM counts by 2 and not applying the correction.

The data corrected by applying the **AEC** files are currently produced at the CAA and with the product ID: **AEDC**, while the raw data are called **AE.**

3.3.3.4 Ambient Electron Data Correction

Purpose: to create correction files for the intra-detector correction; the AEC-files are used to remove the look direction (theta and phi) dependency in the ambient electron counts. The corrections in the CAA are the best available at the time submitted to the CAA, but they may be improved in the future. Updated correction files will be submitted to the CAA when they become available.

Language requirements: IDL

External software dependencies: Pick Library (IDL)

External data file dependencies: EDI MSFs

Software components:

cal_ae.pro: This routine uses intervals of BM1 data where the count rate is fairly constant to compare detector response for different theta and phi.

3.4 Instrument Data Products

As we have learned from the instrument description section EDI operates in two modes: (1) an active one called **WW** (windshield wiper), or, **EF** (electric field), where electrons emitted by the guns are detected; and (2) a passive one called ambient electron mode (**AE**), where the guns are not emitting. Whenever EDI operates in its active mode, the electric field and the drift velocities of the electrons are measured. The data are analyzed with two techniques: **triangulation** and **time-of-flight**. The technique which gives better results based on some error criteria produces the **winners**, the other the **losers**. All results are assigned a **quality** flag (**good / caution / bad)**.

- **Main data** products contain:
  - for the WW mode: time series of the 3 components of the electron drift velocity and of the 3 components of the electric field in Cartesian GSE coordinate system, inertial frame (corrected for

spacecraft motion) with different qualities and time resolution (PP, PPP, MP). **SPIN** is a CAA version of the PP files that doesn't contain the chi_squared variable.

- for the **AE** mode: time series of ambient electron counts for the 3 pitch angles (0º/180° and/or 90º), the detector look direction in the spacecraft frame and in GSE and the status for **AE** mode. Note that the **AE are essentially raw data**. They can be used for boundary determination, but for scientific studies they have to be corrected using AEC files and if possible calibrated relative to PEACE electron fluxes. Currently CAA offers a product called **AEDC** that applied the angular correction from the AEC files to the original raw data.
- overview plot of the main parameters for both modes for every 3 hours for one reference spacecraft (usually C3). In addition to the main data products, raw and auxiliary data are being archived.

MAIN DATA PRODUCTS

PP SPIN	**Prime Parameter** - spin resolution Winners with good/caution quality FORMAT = CDF/CEF (PP) and CEF (SPIN)
PPplus	**Prime Parameter plus –** spin resolution Winners plus losers with all qualities (good/caution/bad) FORMAT = CDF **only!**
MP	**Merged Parameter Data** Merged one-, half- and quarter- spin resolution, only winners with all qualities FORMAT = CDF -> CEF
AE AEDC	**Ambient Electron Data** Raw Electron Counts at PA: 0º/180°, 90º Energy=0.5/1keV, FORMAT = CDF -> CEF
SUMM PLOT	**3-hourly Survey Plots** for one spacecraft (usually C3) MP+AE, FORMAT = PNG

RAW DATA

MSF	**Merged Science Files** HK+NM+BM Telemetry FORMAT = binary

AUXILIARY DATA

QSTAT	**Quality STATistics Files** Beam tracking performance FORMAT = ASCII
EGD	**Electron Gyrotime Data** Electron Time-Of-Flight FORMAT = CEF
AEC	**AE Correction files** Used to correct raw counts dependence on look direction FORMAT = ASCII
CLIST	**Caveat List** Time intervals of EDI WW & AE operation modes FORMAT = CEF
CRF	**CodeRepetitionFrequency** EDI HK info: code frequency code length & beam currents FORMAT = CEF
QZC	**Quality Zero Counts** Raw electron counts at PA=90° Energy: 1/0.5 keV, WW-mode FORMAT = CEF

Figure 3.8 EDI data products in the CAA

- **Raw data** consist of merged science files (MSF); they are obtained by merging the housekeeping and science (burst (BM) and normal (NM) mode) telemetry files. They are in binary format and are input for the Pick-Library that is used by all science processing programs.
- **Auxiliary or Support** are either data used internally by the main data production software (QSTAT) or data dedicated to inter-calibration between instruments (EGD, CRF), data for correction (AEC), survey data (QZC) or time-interval lists of the EDI operation modes (CLIST).

- QSTAT contains a table of 24 rows (for each hour of the day) and 6 columns (for each 10 minutes of an hour) with detection efficiencies. The detection efficiency is defined as the percentage of the number of spin periods with at least 4 successful measurements per spin to the total number of spin periods.

- AEC (ambient electron correction file) are used to correct raw, ambient electron counts for the internal, theta/phi dependence of the individual detectors. Transformation of the corrected counts to a particle flux is a non-trivial matter, and has only been performed (to-date) on a case-by-case basis.

- CLIST are monthly files; they contain a listing of time intervals with the two possible operation modes of EDI: **WW** and **AE**.

- EGD parameters are measurement time tags with microsecond precision, time-of-flight (TOF) and its error (sigma_TOF) in microseconds, and the label of the used detector unit (GDU).

- CRF files contain essentially EDI housekeeping information: code repetition frequencies and beam current indices in the “WW”-mode. They are meant for other instruments to help recognize interferences with EDI beam operations. The resolution of the timeline is 5.12 s.

- QZC is a timeline of raw electron counts for 90° pitch angle and 1 or 0.5 keV energy, gun directions in instrument frame and GSE. The counts correspond to “quality zero” beams and are background ambient electrons contaminated with beam electrons.

A summary of the instrument data products in the CAA is presented in the *Figure* 3.8. Metadata and more details about each data product are described in Chapter 5.
The classification of the data products in the CAA, is somewhat different from this since it is trying to accommodate the data products of all instruments
An overview of the filenames and formats at delivery and in the CAA and the acronyms for the data products is given in the Table 3.4.1:

CNR	Product acronym	File-type @delivery	Filename @ delivery	CAA filenames
1	PP	CDF	C#_PP_EDI_yyyymmdd_Vvv.cdf	C#_PP_EDI CL_SP_EDI_PP
2	SPIN	CEF	C#_CP_EDI_SPIN_yyyymmdd_Vvv.cef	C#_CP_EDI_SPIN
3	PPP	CDF	C#_PPP_EDI_yyyymmdd_V00.cdf	C#_CE_EDI_PPPLUS_CDF
4	MP	CDF	c#_mp_edi_yyyymmdd_v13.cdf	C#_CP_EDI_MP(_CDF)

5	AE	CDF	c#_amb_edi_yyyymmdd_vii.cdf	C#_CP_EDI_AE(_CDF)
6	AEDC	CEF	C#_CP_EDI_AEDC__ yyyymmdd_Vvv.cef	C#_CP_EDI_AEDC
7	SPLOT	PNG	EDI_hh_hh_yyyymmdd_Caution.png	CL_CG_EDI_SUMMPLOT
8	EGD	CEF	C#_CP_EDI_EGD__yyyymmdd_Vvv.cef	C#_CP_EDI_EGD
9	CLIST	CEF	C#_CQ_EDI_yyyymmdd_Vvv.cef	C#_CQ_EDI_CLIST
10	QSTAT	ASCII	yymmddeq.0a#	C#_CE_EDI_QSTAT_TXT
11	AEC*	ASCII	C#_yyyymmdd_Vxx.edi_ae_cor	C#_CE_EDI_AEC_TXT
12	MSF	Binary	yymmddem.0a#	C#_CE_EDI_MSF_BIN
13	CRF	CEF	C#_CP_EDI_CRF__yyyymmdd_Vvv.cef	C#_CP_EDI_CRF
14	QZC	CEF	C#_CP_EDI_QZC__yyyymmdd_Vvv.cef	C#_CP_EDI_QZC

Table 3.4.1.# = 1, 2, 3 (4) is the spacecraft id-number, vv or ii = version number, yy & yyyy = 2, resp. 4 digits for year, mm = month, dd = day, hh = start and end time (hour)
* The old version of this dataset was called C#_CE_EDI_AECAL_TXT

4 DATA PROVISION – GENERAL CONVENTIONS

To avoid repetitions in Chapter 5 that describes specific data products, the following general conventions apply. Only deviations from these are given.

4.1 Formats

Following formats are used for the data products delivery (some of the CDF products are converted into CEF by the CAA team):

- BINARY: raw data, PNG for C3- SPlots and
- CDF for the main data products: PP, SP, PPplus, MP.
- ASCII: plain for QSTAT and AECorrection files,
- CEF for EGD, CRF, AE, QZC and CLIST.

The Cluster Exchange Format is defined in the reference document: [B1] and the NASA Common Data Format (CSDS Implementation) in [B2]. The Portable Network Graphics Format is presented on the web-site:

www.libpng.org/pub/png/. A description of the binary format of the raw data (MSF) is given in the [B3] technical note, see Ch 6.

The QSTAT files and the AECorrection files are auxiliary data products and don't have a standard format. They are used internally in the production of the main EDI data products.

4.2 Standards

The vector quantities, like electron drift velocities and electric field are in GSE coordinate system, the units are in SI. Both vector quantities have been corrected for spacecraft velocity.

Time standards are as defined in the CDF and CEF references.

4.3 Production Procedures

CAA produces generally no data, pre-generated data products are being ingested. Exception is the AEDC, where the correction of AE using AEC files is done at CAA.

4.4 Quality Control Procedures

Data will be checked for integrity after transfer, by comparing the size of the files.

4.5 Delivery Procedures

Data will be delivered by **s**ecure **f**ile **t**ransfer **p**rotocol (**sftp)** to the CAA-server.

4.6 Metadata

Metadata definitions comply with CEF-2 and the CAA_Metadata_Dictionary (CAA-CDPP-TN-0002) for the CEF-files. Only dataset-level metadata are described in sub-sections of Chapter 5.

The higher level metadata for: MISSION, OBSERVATORY, EXPERIMENT and INSTRUMENT are contained in the corresponding header-files and are included in the DATASET-header-file which is included on its turn in the CEF-files. The MISSION and OBSERVATORY metadata are common to all CAA products, whereas the EXPERIMENT and INSTRUMENT set characterize all EDI data products.

The hierarchy is: CEF <- DATASET <- INST <- (OBS, (EXP <- MISSION)), where <- means "includes". The CEF-files include the DATASET metadata, which includes INST. INST includes both OBS and EXP and EXP includes MISSION.

The header files at the MISSION and OBSERVATORY levels are maintained by the CAA.

The filenames for the header-files containing the higher level metadata are summarized in the following Table 4.6 (# = 1,2,3,4 is the spacecraft number):

Metadata	Header filename	Example	Nr of files
MISSION	CL_CH_MISSION.ceh	4.6.1	1
OBSERVATORY	C#_CH_OBS.ceh	4.6.2	4
EXPERIMENT	CL_CH_EDI_EXP.ceh	4.6.3	1
INSTRUMENT	C#_CH_EDI#_INST.ceh	4.6.4	4

4.6.1 Mission Metadata

The mission level metadata are given in the file called “CL_CH_MISSION.ceh” . It is provided and maintained by the CAA team at ESTEC

4.6.2 Observatory Metadata

The observatory level metadata are given in the file Ci_CH_OBS.ceh, where i is cpacecraft id. There is one file for each spacecraft, and they are provided/maintained by the CAA team at ESTEC.

4.6.3 Experiment Metadata

```
!------------------- EXPERIMENT HEADER FILE--------------------
! INCLUDE MISSION HEADER FILE
 include = "CL_CH_MISSION.ceh"
!
START_META = EXPERIMENT
   ENTRY = "EDI"
END_META = EXPERIMENT
!
START_META = EXPERIMENT_DESCRIPTION
   ENTRY = "Electron Drift Instrument"
   ENTRY = "Electric field measured by the drift velocity "
   ENTRY = "of monoenergetic artificial electron beams "
   ENTRY = "injected perpendicularly to the ambient magnetic field"
END_META = EXPERIMENT_DESCRIPTION
!
START_META = INVESTIGATOR_COORDINATES
   ENTRY = "Goetz Paschmann>PI>goetz.paschmann@mpe.mpg.de"
   ENTRY = "Roy Torbert>PI>roy.torbert@unh.edu"
   ENTRY = "Jack Quinn>CoPI>jmquinn@bu.edu"
END_META = INVESTIGATOR_COORDINATES
!
START_META = EXPERIMENT_REFERENCES
   ENTRY = "*CL_CD_EDI_CAAICD"
   ENTRY = "*CL_CD_EDI_USERMAN"
   ENTRY = "AnnGeo_FirstResults.pdf"
   ENTRY = "AnnGeo_JQuinn1669.pdf"
   ENTRY = "http://www.mps.mpg.de/3882985/EDI"
END_META = EXPERIMENT_REFERENCES
!
START_META= EXPERIMENT_KEY_PERSONNEL
   ENTRY = "Mikhail Rashev>Archive Scientist>rashev@mps.mpg.de"
   ENTRY = "Hans Vaith>Experiment Engineer>hans.vaith@unh.edu"
   ENTRY = "Mark Chutter>Software Engineer>mark.chutter@unh.edu"
   ENTRY = "Pamela Puhl-Quinn>Software Engineer>pamela.puhlquinn@aer.com"
END_META = EXPERIMENT_KEY_PERSONNEL
!
START_META = EXPERIMENT_CAVEATS
   ENTRY = "EDI experiment is operated in 2 modes 'Electric Field'"
   ENTRY = "and 'Ambient Electron' mode, see CaveatList files for"
   ENTRY = "specific time intervals"
   ENTRY = ""
```

```
  ENTRY = "Large data gaps may occur due to: "
  ENTRY = "- highly variable magnetic and/or electric fields"
  ENTRY = "- high ambient electron fluxes"
  ENTRY = "- radiation induced hardware failures"
  ENTRY = ""
  ENTRY = "Smaller data gaps occur in MCP calibration mode or "
  ENTRY = "at regularly scheduled BM3 dumps"
  ENTRY = ""
  ENTRY = "Data availability in 'Electric field' mode is documented"
  ENTRY = "in the QSTAT files with 10 min resolution"
  ENTRY = ""
END_META = EXPERIMENT_CAVEATS
```

4.6.4 Instrument Metadata

The example is given for spacecraft 1; similar files exist for the other ones.

```
!------------------- INSTR HEADER FILE EDI1 --------------------
! INCLUDE OBSERVATORY and EXPERIMENT HEADER FILE
! EXPERIMENT HEADER FILE contains MISSION HEADER
 include = "C1_CH_OBS.ceh"
 include = "CL_CH_EDI_EXP.ceh"
!
START_META = INSTRUMENT_NAME
   ENTRY = "EDI1"
END_META = INSTRUMENT_NAME
!
START_META = INSTRUMENT_DESCRIPTION
   ENTRY = "EDI Experiment on Cluster C1"
END_META = INSTRUMENT_DESCRIPTION
!
START_META = INSTRUMENT_TYPE
   ENTRY = "Electron_Drift"
END_META = INSTRUMENT_TYPE
!
START_META = MEASUREMENT_TYPE
   ENTRY = "Electric_Field"
END_META = MEASUREMENT_TYPE
!
START_META =INSTRUMENT_CAVEATS
   ENTRY = "EDI1: Gun of GDU1 is not used because the beam modulation"
   ENTRY = " is not working"
END_META = INSTRUMENT_CAVEATS
```

The below are instrument caveats for spacecrafts #2,#3,#4, because they are different.

Spacecraft #2

```
START_META =INSTRUMENT_CAVEATS
   ENTRY = "EDI2: Since Apr.10th, 2004, only AE mode is used,"
   ENTRY = " because  of strong interferences with WHISPER"
END_META = INSTRUMENT_CAVEATS
```

```
Spacecraft #3

START_META =INSTRUMENT_CAVEATS
   ENTRY = " "
END_META = INSTRUMENT_CAVEATS

Spacecraft #4

START_META =INSTRUMENT_CAVEATS
   ENTRY = "EDI4: Experiment turned off in Feb 2001,"
   ENTRY = " because of over-current problems "
END_META = INSTRUMENT_CAVEATS
```

5 DATA PROVISION – SPECIFIC DESCRIPTIONS

5.1 Raw Data: MSF

The Merged Science Files (MSFs) consist of merged telemetry files: S/C-HK, EDI-HK and EDI-Science data. These files, one per day and S/C, are produced routinely by the GCDC and exist for the already delivered CD-ROMs. See Section 3.3.2.1.

5.1.1 Format

Binary

5.1.2 Standard

No deviation from general conventions.

5.1.3 Production Procedure

This is a pre-generated data product from raw science and housekeeping data, see 3.3.2.1

5.1.4 Quality Control Procedure

As described in Section 4.4

5.1.5 Delivery Procedure

As described in Section 4.5.

5.1.6 Product Specification

yymmddem.0a#, where # =1,2,3,4 is spacecraft number. See 3.3.2.1.

5.1.7 Metadata Specification

No DATASET metadata defined. Higher level metadata valid, as described in Section 4.6

5.2 Auxiliary Data: Quality Statistics for Electron Drift Velocity measurements (QSTAT)

The **Q**uality **STAT**istics Files (QSTAT) characterize the beam tracking performance of EDI. They are used by the main processing software to decide whether a data interval is worth to be processed.

The QSTAT files contain statistical information about the number of recorded electron beam data in EDI science telemetry. The percentage of spins characterized by at least 4 beams of quality 2 or higher are computed for each 10-minute interval. These numbers are named minbeams and min_q in the program description below.

The input to „qstat“ is the daily EDI MSF file (merged science file). There is one file per spacecraft and per day. The files are produced by running a C-program called "qstat".

5.2.1 Format

Non-standard ASCII. This format is fixed because the QSTAT files serve as input for main data production.

The generic format for the QSTAT file names is adopted from the MSF input files: yymmddeq.0xi, where

yy = two-digit year (e.g. 03 for 2003)
mm = month (01-12)
dd = day (01 - 31)
eq = fixed part ('e' for EDI, 'q' for qstat)
x = version (a,b,c,...)
i = spacecraft identifier (1,2,3,4)

Each QSTAT file has an introductory comment line that starts with a semicolon (;). The comment line contains the parameters that have been used when running the "qstat" program. There are two parameters:

- min_q : the minimum quality required for recorded beams in telemetry.

There are four quality values :

0 = no beam
1 = return beam detected, no time-of-flight information available
2 = return beam detected, time-of-flight information is available, signal-to-noise ratio is below upper threshold level
3 = like 2, but signal-to-noise ratio is above upper threshold level

- minbeams : the minimum number of recorded beams of quality >= min_q per spacecraft spin. Any spin with a lower number of recorded beams will be considered as unsuitable for processing by EDI_PISO.

Below the introductory comment line are 24 lines, one for each hour of the day. Each line contains eleven columns which are separated by one or more whitespaces. The contents of the columns is:

col 0 : date in format yyyy-mm-dd (identical for all 24 lines)
col 1 : hour of day (an integer ranging between 0 and 23)
col 2 : a flag (an integer that is either 0 or 1). This flag signals if EDI has been in the electron-drift mode (called Windshield Wiper mode) at all during the current hour.
col 3 : the total number of spacecraft spins within the current hour (an integer)
col 4 : the number of spacecraft spins within the current hour for which the number of recorded beams of quality >= min_q is larger than or equal to minbeams.

col 5-10 : for six adjacent 10-minute intervals within the current hour, the percentage of spins with number of recorded beams of quality >= min_q is larger than or equal to minbeams.

5.2.2 Standard

N/A

5.2.3 Production Procedure

See 4.3

5.2.4 Quality Control Procedure

As described in Section 4.4.

5.2.5 Delivery Procedure

As described in Section 4.5

5.2.6 Product Specification

yymmddeq.0xi, pre-generated auxiliary data product, see Section 5.2.1.

5.2.7 Metadata Specification

No DATASET metadata defined. Higher level metadata valid, as described in Section 4.6

However following metadata definitions could be applied:

FileTime_span = 1day
Time_resolution = 10 min
Data_type=”other”
Parameter = WW_detection_efficiency
Sizes=1 !scalar
UNIT=”Unitless”
Si_conversion=”1.E-2>1(percentage)”
Value_type=”Integer”

5.3 Electron Drift Data: Preliminary Electron Drift Velocity (GSE), spin resolution (PP)

The electron drift data are obtained by two techniques: triangulation and time-of-flight. The PP data contain the results from the ‘winning’ technique from each analysis interval, as described in Section 3.3.3.2.

All data are classified also by quality, like number of hits, magnitude and angle errors in good/caution/bad categories. PP data use spin period analysis intervals and contain only winners with good and caution quality.

5.3.1 Format

CDF

5.3.2 Standard

As described in Section 4.2

5.3.3 Production Procedure

As described in Section 4.3

5.3.4 Quality Control Procedure

As described in Section 4.4

5.3.5 Delivery Procedure

As described in Section 4.5

5.3.6 Product Specification

C#_PP_EDI_yyyymmdd_Vii.cdf, where # =spacecraft number(1,2,3), ii version number. See 3.3.3.2

5.3.7 Metadata Specification

Higher level metadata valid, as described in Section 4.6

Metadata are in the skeleton tables: C#_PP.skt, where # =spacecraft number(1,2,3).

CEF DATASET header files were produced by the UK center.

5.4 Electron Drift Data: Electron Drift Velocity and Electric Field (GSE), spin resolution (SPIN)

Since the PP data is a CSDS product it is considered preliminary. A corresponding “Science” product, produced for the CAA, is called SPIN. SPIN data have spin time resolution and contain only winners with good and caution quality. The SPIN data product is produced in CEF format and contains a subset of the PP data without chi_squared variable.

5.4.1 Format

CEF

5.4.2 Standard

As described in Section 4.2

5.4.3 Production Procedure

As described in Section 4.3

5.4.4 Quality Control Procedure

As described in Section 4.4

5.4.5 Delivery Procedure

As described in Section 4.5

5.4.6 Product Specification

C#_CP_EDI_SPIN__yyyymmdd_Vii.cef, where # =spacecraft number(1,2,3), ii version number. See 3.3.3.2

5.4.7 Metadata Specification

Higher level metadata valid, as described in Section 4.6

Example of DATASET header files is given for C3.

```
INCLUDE = "C3_CH_EDI3_INST.ceh"

START_META    =  DATASET_ID
  ENTRY      =  "C3_CP_EDI_SPIN"
END_META      =  DATASET_ID

START_META    =  DATA_TYPE
  ENTRY      =  "PP>SPIN_Resolution"
END_META      =  DATA_TYPE

START_META    =  DATASET_TITLE
  ENTRY      =  "Electron Drift Velocity and Electric Field (GSE), spin resolution"
END_META      =  DATASET_TITLE

START_META    =  DATASET_DESCRIPTION
  ENTRY      =  "This dataset contains spin resolution measurements of the"
  ENTRY      =  "electron drift velocity and electric field with GOOD/CAUTION qualities"
  ENTRY          =  "from the EDI experiment on the Cluster C3 spacecraft."
  ENTRY      =  "These data have been converted into Cluster Exchange Format from the orignal"
  ENTRY      =  "Cluster Science Data System Common Data Format (CDF) Prime Parameter files"
  ENTRY      =  "that were made available through the Cluster Science Data System."
END_META      =  DATASET_DESCRIPTION

START_META    =  CONTACT_COORDINATES
  ENTRY      =  "MikhailRashev>Archive Scientist>rashev@mps.mpg.de"
END_META      =  CONTACT_COORDINATES

START_META    =  TIME_RESOLUTION
  ENTRY      =  4
END_META      =  TIME_RESOLUTION

START_META    =  MIN_TIME_RESOLUTION
  ENTRY      =  4.412
END_META      =  MIN_TIME_RESOLUTION

START_META    =  MAX_TIME_RESOLUTION
  ENTRY      =  3.636
END_META      =  MAX_TIME_RESOLUTION

START_META    =  PROCESSING_LEVEL
  ENTRY      =  "Derived"
END_META      =  PROCESSING_LEVEL

START_META    =  ACKNOWLEDGEMENT
```

```
  ENTRY      =  "Please acknowledge the EDI team and ESA Cluster Active Archive in any publication based
upon use of this data"
END_META      =  ACKNOWLEDGEMENT

START_META    =  DATASET_CAVEATS
  ENTRY      =  "Spin resolution data with GOOD/CAUTION qualities."
  ENTRY      =  "The values 2/1 for GOOD/CAUTION are in Status[0]."
  ENTRY      =  "The electric field and drift velocity measurements are given"
  ENTRY      =  "in the inertial frame (a correction has been applied for the"
  ENTRY      =  "spacecraft velocity)."
END_META      =  DATASET_CAVEATS

START_META    =  DATASET_VERSION
  ENTRY      =  "01"
END_META      =  DATASET_VERSION

START_META    =  FILE_TYPE
  ENTRY      =  "cef"
END_META      =  FILE_TYPE

START_META    =  METADATA_TYPE
  ENTRY      =  "CAA"
END_META      =  METADATA_TYPE

START_META    =  METADATA_VERSION
  ENTRY      =  "2.0"
END_META      =  METADATA_VERSION

START_VARIABLE  =  time_tags__C3_CP_EDI_SPIN
   PARAMETER_TYPE      = "Support_Data"
   CATDESC             = "Interval centred time tag"
   UNITS               = "s"
   SI_CONVERSION       = "1.0>s"
   SIZES               = 1
   VALUE_TYPE          = ISO_TIME
   SIGNIFICANT_DIGITS  = 24
   FILLVAL             = 9999-12-31T23:59:59Z
   FIELDNAM            = "Universal Time"
   LABLAXIS            = "UT"
   DELTA_PLUS          = half_interval__C3_CP_EDI_SPIN
   DELTA_MINUS         = half_interval__C3_CP_EDI_SPIN
END_VARIABLE    =  time_tags__C3_CP_EDI_SPIN

START_VARIABLE  =  half_interval__C3_CP_EDI_SPIN
   PARAMETER_TYPE      = "Support_Data"
   CATDESC             = "Half averaging interval length"
   UNITS               = "s"
   SI_CONVERSION       = "1.0>s"
   SIZES               = 1
   VALUE_TYPE          = FLOAT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL             = -1.0e28
   FIELDNAM            = "Half width of averaging interval"
   LABLAXIS            = "s"
END_VARIABLE    =  half_interval__C3_CP_EDI_SPIN

START_VARIABLE = status__C3_CP_EDI_SPIN
   PARAMETER_TYPE      = "Support_Data"
```

```
   ENTITY            = "Instrument"
   PROPERTY           = "Status"
   CATDESC           = "EDI Status"
   UNITS             = "unitless"
   SI_CONVERSION      = "1>unitless"
   SIZES             = 7
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 3
   FILLVAL           = 255
   FIELDNAM          = "Status"
   LABLAXIS          = "Status"
   DEPEND_0           = time_tags__C3_CP_EDI_SPIN
   LABEL_1           = "Status[0]","Status[1]","Status[2]","Status[3]","Status[4]","Status[5]","Status[6]"
END_VARIABLE   = status__C3_CP_EDI_SPIN


START_VARIABLE = V_ed_xyz_gse__C3_CP_EDI_SPIN
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
   PROPERTY           = "Velocity"
   FLUCTUATIONS       = "Fluctuation_Level"
   CATDESC           = "Electron Drift Velocity, spin resolution in GSE"
   UNITS             = "km s^-1"
   SI_CONVERSION      = "1.0E3>m s^-1"
   TENSOR_ORDER       = "1"
   COORDINATE_SYSTEM   = "GSE>Geocentric Solar Ecliptic"
   FRAME_VELOCITY      = "Inertial"
   REPRESENTATION_1    = "x", "y", "z"
   SIZES             = 3
   VALUE_TYPE         = FLOAT
   SIGNIFICANT_DIGITS  = 11
   FILLVAL           = -1.0e31
   QUALITY           = 3
   FIELDNAM          = "Electron Drift Velocity, spin resolution in GSE"
   LABLAXIS          = "Velocity"
   DEPEND_0           = time_tags__C3_CP_EDI_SPIN
   LABEL_1           = "Vx", "Vy", "Vz"
END_VARIABLE   = V_ed_xyz_gse__C3_CP_EDI_SPIN

START_VARIABLE = E_xyz_gse__C3_CP_EDI_SPIN
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electric_Field"
   PROPERTY           = "Vector"
   FLUCTUATIONS       = "Fluctuation_Level"
   CATDESC           = "Electric Field, spin resolution in GSE"
   UNITS             = "mV m^-1"
   SI_CONVERSION      = "1.0E-3>V m^-1"
   TENSOR_ORDER       = "1"
   COORDINATE_SYSTEM   = "GSE>Geocentric Solar Ecliptic"
   FRAME_VELOCITY      = "Inertial"
   REPRESENTATION_1    = "x", "y", "z"
   SIZES             = 3
   VALUE_TYPE         = FLOAT
   SIGNIFICANT_DIGITS  = 11
   FILLVAL           = -1.0e31
   QUALITY           = 3
   FIELDNAM          = "Electric Field, spin resolution in GSE"
   LABLAXIS          = "E"
```

```
   DEPEND_0           = time_tags__C3_CP_EDI_SPIN
   LABEL_1           = "Ex", "Ey", "Ez"
END_VARIABLE   = E_xyz_gse__C3_CP_EDI_SPIN
```

5.5 Electron Drift Data: Prime Parameter Plus, spin resolution (PPPlus)

PP-plus files contain spin-averaged drift velocity and electric field data produced by both techniques (“winners” and “losers”), and alll qualities (good/caution/bad). These files are for advanced users that have the software to filter the data.

They have a different number of variables and other skeleton files, than the PP or merged files (MP).

5.5.1 Format

CDF

5.5.2 Standard

As described in Section 4.2

5.5.3 Production Procedure

As described in Section 4.3

5.5.4 Quality Control Procedure

As described in Section 4.4

5.5.5 Delivery Procedure

As described in Section 4.5

5.5.6 Product Specification

C#_PPP_EDI_yyyymmdd_V00.cdf. See 3.3.3.2

5.5.7 Metadata Specification

Metadata are in the skeleton tables: C#_PPP.skt, where # =spacecraft number(1,2,3)

```
!*-Comment   Cluster: EDI Cluster Active Archive skeletons V1.0
!
!*-Comment: Based on CSDS DATABASE (PPDB & SPDB) CDF skeleton file design
!*-Comment:
!*-Comment: Document id  (TBD)
!*-History:  25 August 2003 : P.A. Puhl-Quinn
!*-History:  23 June 2004 : Changed "AR" to "PPP" everywhere
!*-History:  Created from modifying CSDS Skeleton V2.1, C1_PP_EDI.skt
!---------------------------------------------------------------------------
#header
 CDF NAME:  C1_PPP_EDI
 DATA ENCODING : NETWORK
 MAJORITY      : ROW
 FORMAT       : SINGLE
…

#variables
! CSDS does not use rVariables.
#zVariables
!*-Comment: The CDF documentation should be consulted about how variables
```

```
!*-Comment: are declared, but it might be useful to recall that the
!*-Comment: following characteristics are declared (in the following order)
!*-Comment: Name  Type  Number_of_elements  Dimensions
!*-Comment:    Sizes_for_each_dimension  Record_varying?  Dimension_varying?
!*-Comment: The declarations can be difficult to read since some of the
!*-Comment: above are not included in all cases.
!--------------------------------------------------------------------------
! Non-record varying (NRZ) variables common to ALL files
!*-BeginVariable
"L_gse_xyz" CDF_CHAR  7   1    3    F     T
!  Attribute   Type         Value
!-----------   -----        ------
   "FIELDNAM"  CDF_CHAR      { "GSE cartesian components" }
   "VAR_TYPE"  CDF_CHAR      { "metadata" }
   "DICT_KEY"  CDF_CHAR      { "label>frame" }
   "CATDESC"   CDF_CHAR      { "Components in GSE cartesian coordinates" } .
! Explicit values can be assigned as this is non-record varying
   [1] = { "x (GSE)" }
   [2] = { "y (GSE)" }
   [3] = { "z (GSE)" }

!*-BeginVariable
! variable common to all PP and SP database files
"Half_interval__C1_PPP_EDI"  CDF_REAL8  1   0        F
!  Attribute   Type         Value
!-----------   -----        ------

   "FIELDNAM"  CDF_CHAR      { "Half interval" }
   "UNITS"     CDF_CHAR      { "ms" }
   "LABLAXIS"  CDF_CHAR      { "Half sample time interval" }
   "FILLVAL"   CDF_REAL8     { -1.e31 }
   "CATDESC"   CDF_CHAR      { "Half width of measurement interval" }
   "VAR_TYPE"  CDF_CHAR      { "metadata" }
   "Frame"     CDF_CHAR      { "scalar>na" }
   "SI_conversion" CDF_CHAR  { "1.0e-3>s" } .

! Value must be written at the time of populating the CDF file with data
!--------------------------------------------------------------------------
! Instrument specific variables
! -----------------------------
!*-BeginVariables: EDI
!*-BeginVariable: Epoch EDI
"Epoch__C1_PPP_EDI"  CDF_EPOCH   1   0        T
!  Attribute   Type         Value
!-----------   -----        ------

   "FIELDNAM"  CDF_CHAR      { "Time tags" }
   "LABLAXIS"  CDF_CHAR      { "Epoch" }
   "UNITS"     CDF_CHAR      { "ms" }
   "CATDESC"   CDF_CHAR      { "Interval centred time tag " -
                   "rounded to nearest msecond " }
   "VALIDMIN"  CDF_EPOCH     { 01-Jan-1994 00:00:00.000 }
   "VALIDMAX"  CDF_EPOCH     { 01-Jan-2010 00:00:00.000}
   "SCALEMIN"  CDF_EPOCH     { 01-Dec-1994 00:00:00.000}
   "SCALEMAX"  CDF_EPOCH     { 01-Jan-2010 00:00:00.000}
   "FILLVAL"   CDF_REAL8     { -1.e31 }
   "VAR_TYPE"  CDF_CHAR      { "data" }
   "SCALETYP"  CDF_CHAR      { "linear" }
   "MONOTON"   CDF_CHAR      { "INCREASE" }
   "DELTA_PLUS_VAR"  CDF_CHAR     { "Half_interval__C1_PPP_EDI" }
   "DELTA_MINUS_VAR" CDF_CHAR     { "Half_interval__C1_PPP_EDI" }
```

```
  "DICT_KEY"  CDF_CHAR       { "time>Epoch" }
  "Frame"     CDF_CHAR       { "scalar>na" }
  "SI_conversion" CDF_CHAR   { "1.0e-3>s" }
  "Sig_digits" CDF_CHAR      { "14" }
  "Calib_software" CDF_CHAR  { "TO BE OVERWRITTEN" }
  "Calib_input"   CDF_CHAR   { "TO BE OVERWRITTEN" }
  "SC_id"     CDF_CHAR       { "1" } .

!*-EndVariable: Epoch EDI
!*-BeginVariable: Status EDI
"Status__C1_PPP_EDI"  CDF_UINT1   1   1   7     T    T
!  Attribute   Type         Value
!-----------   -----        ------

  "FIELDNAM"  CDF_CHAR       { "EDI status" }
  "LABL_PTR_1"  CDF_CHAR     { "L_Status_EDI" }
  "DEPEND_1"  CDF_CHAR       { "L_Status_EDI" }
  "VALIDMIN"  CDF_UINT1      { 0 }
  "VALIDMAX"  CDF_UINT1      { 255 }
  "UNITS"     CDF_CHAR       { " " }
  "CATDESC"   CDF_CHAR       { "EDI status" }
  "FILLVAL"   CDF_UINT1      { 255 }
  "FORMAT"    CDF_CHAR       { "I3" }
  "AVG_TYPE"  CDF_CHAR       { "none" }
  "VAR_TYPE"  CDF_CHAR       { "data" }
  "DEPEND_0"  CDF_CHAR       { "Epoch__C1_PPP_EDI" }
  "DICT_KEY"  CDF_CHAR       { "flag>status_number" }
  "SC_id"     CDF_CHAR       { "1" } .

!*-EndVariable: Status EDI
!*-BeginVariable V vector EDI
"V_ed_xyz_gse__C1_PPP_EDI"  CDF_REAL4  1   1    3    T     T
!  Attribute   Type         Value
!-----------   -----        ------

  "FIELDNAM"  CDF_CHAR       { "EDI drift velocity" }
  "LABL_PTR_1"  CDF_CHAR     { "L_V_ed_xyz_gse__C1_PPP_EDI" }
  "UNITS"     CDF_CHAR       { "km/s" }
  "CATDESC"   CDF_CHAR       { "EDI drift velocity, GSE frame cartesians" }
  "VALIDMIN"  CDF_REAL4      { -2000., -2000., -2000. }
  "VALIDMAX"  CDF_REAL4      {  2000.,  2000.,  2000. }
  "SCALEMIN"  CDF_REAL4      { -600., -600., -600. }
  "SCALEMAX"  CDF_REAL4      {  600.,  600.,  600. }
  "FORMAT"    CDF_CHAR       { "e10.3" }
  "FILLVAL"   CDF_REAL4      { -1.e31 }
  "VAR_TYPE"  CDF_CHAR       { "data" }
  "SCALETYP"  CDF_CHAR       { "linear" }
  "AVG_TYPE"  CDF_CHAR       { "standard" }
  "DEPEND_0"  CDF_CHAR       { "Epoch__C1_PPP_EDI" }
  "DEPEND_1"  CDF_CHAR       { "L_gse_xyz" }
  "DICT_KEY"     CDF_CHAR    { "velocity>drift_vector_GSE" }
  "Frame"     CDF_CHAR       { "vector>gse_xyz" }
  "SI_conversion" CDF_CHAR   { "1000.>m s^-1" }
  "Sig_digits" CDF_CHAR      { "3" }
  "SC_id"     CDF_CHAR       { "1" } .

!*-EndVariable:V vector EDI
!*-BeginVariable
"E_xyz_gse__C1_PPP_EDI"  CDF_REAL4  1   1    3    T     T
```

```
! Attribute   Type        Value
!-----------  -----       ------

  "FIELDNAM"  CDF_CHAR     { "EDI electric field" }
  "LABL_PTR_1"  CDF_CHAR   {  "L_E_xyz_gse__C1_PPP_EDI" }
  "UNITS"     CDF_CHAR     { "mV/m" }
  "CATDESC"   CDF_CHAR     { "EDI electric field, GSE frame cartesians" }
  "VALIDMIN"  CDF_REAL4    { -200., -200., -200. }
  "VALIDMAX"  CDF_REAL4    {  200.,  200.,  200. }
  "SCALEMIN"  CDF_REAL4    { -30., -30., -30. }
  "SCALEMAX"  CDF_REAL4    {  30.,  30.,  30. }
  "FORMAT"    CDF_CHAR     { "e10.3" }
  "FILLVAL"   CDF_REAL4    { -1.e31 }
  "VAR_TYPE"  CDF_CHAR     { "data" }
  "SCALETYP"  CDF_CHAR     { "linear" }
  "AVG_TYPE"  CDF_CHAR     { "standard" }
  "DEPEND_0"  CDF_CHAR     { "Epoch__C1_PPP_EDI" }
  "DEPEND_1"  CDF_CHAR     { "L_gse_xyz" }
  "DICT_KEY"    CDF_CHAR   { "electric_field>vector_GSE" }
  "Frame"     CDF_CHAR     { "vector>gse_xyz" }
  "SI_conversion" CDF_CHAR { "0.001>V m^-1" }
  "Sig_digits" CDF_CHAR    { "3" }
  "SC_id"     CDF_CHAR     { "1" } .

!*-EndVariable
!*-BeginVariable
"Reduced_chi_sq__C1_PPP_EDI"  CDF_REAL4   1   0        T
! Attribute   Type        Value
!-----------  -----       ------

  "FIELDNAM"  CDF_CHAR     { "EDI Reduced Chi-squared" }
  "LABLAXIS"  CDF_CHAR     { "Reduced Chi Sq" }
  "UNITS"     CDF_CHAR     { " " }
  "CATDESC"   CDF_CHAR     { "EDI Reduced Chi-squared of the BESTARG fit." }
  "VALIDMIN"  CDF_REAL4    { 0.}
  "VALIDMAX"  CDF_REAL4    { 100. }
  "SCALEMIN"  CDF_REAL4    { 0. }
  "SCALEMAX"  CDF_REAL4    { 100. }
  "FORMAT"    CDF_CHAR     { "e10.3" }
  "FILLVAL"   CDF_REAL4    { -1.e31 }
  "VAR_TYPE"  CDF_CHAR     { "data" }
  "SCALETYP"  CDF_CHAR     { "linear" }
  "AVG_TYPE"  CDF_CHAR     { "none" }
  "DEPEND_0"  CDF_CHAR     {  "Epoch__C1_PPP_EDI" }
  "DICT_KEY"    CDF_CHAR   { "fit_parameter>Reduced_chi_sq" }
  "Sig_digits" CDF_CHAR    { "3" }
  "SC_id"     CDF_CHAR     { "1" } .

!*-EndVariable
!*-BeginVariable
"Drift_step_mag__C1_PPP_EDI"  CDF_REAL4   1   0        T
! Attribute   Type        Value
!-----------  -----       ------

  "FIELDNAM"  CDF_CHAR     { "EDI Drift Step Magnitude" }
  "LABLAXIS"  CDF_CHAR     { "Drift Step Magnitude" }
  "UNITS"     CDF_CHAR     { "m" }
  "CATDESC"   CDF_CHAR     { "EDI Drift Step of the BESTARG fit." }
  "VALIDMIN"  CDF_REAL4    { 0.}
```

```
   "VALIDMAX"  CDF_REAL4     { 500. }
   "SCALEMIN"  CDF_REAL4     { 0. }
   "SCALEMAX"  CDF_REAL4     { 500. }
   "FORMAT"    CDF_CHAR      { "e10.3" }
   "FILLVAL"   CDF_REAL4     { -1.e31 }
   "VAR_TYPE"  CDF_CHAR      { "data" }
   "SCALETYP"  CDF_CHAR      { "linear" }
   "AVG_TYPE"  CDF_CHAR      { "none" }
   "DEPEND_0"  CDF_CHAR      {  "Epoch__C1_PPP_EDI" }
   "DICT_KEY"  CDF_CHAR      { "length>drift_step" }
   "Frame"     CDF_CHAR      { "scalar>na" }
   "Sig_digits" CDF_CHAR     { "3" }
   "SC_id"     CDF_CHAR      { "1" } .

!*-EndVariable
!*-BeginVariable
"Drift_step_mag_error_inertial__C1_PPP_EDI"  CDF_REAL4   1   0        T
!  Attribute   Type         Value
!-----------   -----        ------

   "FIELDNAM"  CDF_CHAR     { "EDI Drift Step Magnitude Error" }
   "LABLAXIS"  CDF_CHAR    { "Drift Step Magnitude Error" }
   "UNITS"     CDF_CHAR    { "m" }
   "CATDESC"   CDF_CHAR     { "EDI Drift Step Magnitude Error in inertial frame." }
   "VALIDMIN"  CDF_REAL4    { 0.}
   "VALIDMAX"  CDF_REAL4     { 500. }
   "SCALEMIN"  CDF_REAL4     { 0. }
   "SCALEMAX"  CDF_REAL4      { 500. }
   "FORMAT"    CDF_CHAR     { "e10.3" }
   "FILLVAL"   CDF_REAL4    { -1.e31 }
   "VAR_TYPE"  CDF_CHAR      { "data" }
   "SCALETYP"  CDF_CHAR      { "linear" }
   "AVG_TYPE"  CDF_CHAR      { "none" }
   "DEPEND_0"  CDF_CHAR      {  "Epoch__C1_PPP_EDI" }
   "DICT_KEY"  CDF_CHAR     { "length>drift_step_magnitude_error" }
   "Frame"     CDF_CHAR     { "scalar>na" }
   "Sig_digits" CDF_CHAR    { "3" }
   "SC_id"     CDF_CHAR     { "1" } .

!*-EndVariable
!*-BeginVariable
"Drift_step_azi_error_inertial__C1_PPP_EDI"  CDF_REAL4   1   0        T
!  Attribute   Type         Value
!-----------   -----        ------

   "FIELDNAM"  CDF_CHAR      { "EDI Drift Step Azimuthal Error" }
   "LABLAXIS"  CDF_CHAR      { "Drift Step Azimuthal Error" }
   "UNITS"     CDF_CHAR      { "degrees" }
   "CATDESC"   CDF_CHAR      { "EDI Drift Step Azimuthal Error in inertial frame." }
   "VALIDMIN"  CDF_REAL4     { 0.}
   "VALIDMAX"  CDF_REAL4     { 180. }
   "SCALEMIN"  CDF_REAL4     { 0. }
   "SCALEMAX"  CDF_REAL4     { 180. }
   "FORMAT"    CDF_CHAR      { "e10.3" }
   "FILLVAL"   CDF_REAL4     { -1.e31 }
   "VAR_TYPE"  CDF_CHAR      { "data" }
   "SCALETYP"  CDF_CHAR      { "linear" }
   "AVG_TYPE"  CDF_CHAR      { "none" }
   "DEPEND_0"  CDF_CHAR      {  "Epoch__C1_PPP_EDI" }
```

```
  "DICT_KEY"  CDF_CHAR     { "length>drift_step_azimuthal_error" }
  "Frame"     CDF_CHAR     { "scalar>na" }
  "Sig_digits" CDF_CHAR    { "3" }
  "SC_id"     CDF_CHAR     { "1" } .

!*-EndVariable
!*-BeginVariable
"Nbeam__C1_PPP_EDI"  CDF_INT2   1   0        T
! Attribute   Type        Value
!-----------  -----       ------

  "FIELDNAM"  CDF_CHAR     { "EDI Nbeam" }
  "LABLAXIS"  CDF_CHAR     { "Nbeam" }
  "UNITS"     CDF_CHAR     { " " }
  "CATDESC"   CDF_CHAR     { "EDI Number of beams used in calculation." }
  "VALIDMIN"  CDF_INT2     { 0 }
  "VALIDMAX"  CDF_INT2     { 1000 }
  "SCALEMIN"  CDF_INT2     { 0 }
  "SCALEMAX"  CDF_INT2     { 1000 }
  "FORMAT"    CDF_CHAR     { "I4" }
  "FILLVAL"   CDF_INT2     { 32767 }
  "VAR_TYPE"  CDF_CHAR     { "data" }
  "SCALETYP"  CDF_CHAR     { "linear" }
  "AVG_TYPE"  CDF_CHAR     { "none" }
  "DEPEND_0"  CDF_CHAR     { "Epoch__C1_PPP_EDI" }
  "DICT_KEY"  CDF_CHAR     { "fit_parameter>number_of_beams" }
  "Frame"     CDF_CHAR     { "scalar>na" }
  "SC_id"     CDF_CHAR     { "1" } .

!*-EndVariable
!*===================================================================
!* Now for the "Losers"
!* Those results that lost the fight when there was competition
!*===================================================================
!*-BeginVariable: Status EDI
"Status_loser__C1_PPP_EDI"  CDF_UINT1   1   1   7     T    T
! Attribute   Type        Value
!-----------  -----       ------

  "FIELDNAM"  CDF_CHAR     { "EDI status" }
  "LABL_PTR_1"  CDF_CHAR   { "L_Status_EDI" }
  "DEPEND_1"  CDF_CHAR     { "L_Status_EDI" }
  "VALIDMIN"  CDF_UINT1    { 0 }
  "VALIDMAX"  CDF_UINT1    { 255 }
  "UNITS"     CDF_CHAR     { " " }
  "CATDESC"   CDF_CHAR     { "EDI status" }
  "FILLVAL"   CDF_UINT1    { 255 }
  "FORMAT"    CDF_CHAR     { "I3" }
  "AVG_TYPE"  CDF_CHAR     { "none" }
  "VAR_TYPE"  CDF_CHAR     { "data" }
  "DEPEND_0"  CDF_CHAR     { "Epoch__C1_PPP_EDI" }
  "DICT_KEY"  CDF_CHAR     { "flag>status_number" }
  "SC_id"     CDF_CHAR     { "1" }
.
!*-EndVariable: Status EDI
!*-BeginVariable V vector EDI
"V_ed_xyz_gse_loser__C1_PPP_EDI"  CDF_REAL4  1   1    3    T     T
! Attribute   Type        Value
!-----------  -----       ------
```

```
  "FIELDNAM"  CDF_CHAR     { "EDI drift velocity" }
  "LABL_PTR_1"  CDF_CHAR   { "L_V_ed_xyz_gse__C1_PPP_EDI" }
  "UNITS"     CDF_CHAR     { "km/s" }
  "CATDESC"   CDF_CHAR     { "EDI drift velocity, GSE frame cartesians" }
  "VALIDMIN"  CDF_REAL4    { -2000., -2000., -2000. }
  "VALIDMAX"  CDF_REAL4    {  2000.,  2000.,  2000. }
  "SCALEMIN"  CDF_REAL4    { -600., -600., -600. }
  "SCALEMAX"  CDF_REAL4    {  600.,  600.,  600. }
  "FORMAT"    CDF_CHAR     { "e10.3" }
  "FILLVAL"   CDF_REAL4    { -1.e31 }
  "VAR_TYPE"  CDF_CHAR     { "data" }
  "SCALETYP"  CDF_CHAR     { "linear" }
  "AVG_TYPE"  CDF_CHAR     { "standard" }
  "DEPEND_0"  CDF_CHAR     { "Epoch__C1_PPP_EDI" }
  "DEPEND_1"  CDF_CHAR     { "L_gse_xyz" }
  "DICT_KEY"    CDF_CHAR   { "velocity>drift_vector_GSE" }
  "Frame"     CDF_CHAR     { "vector>gse_xyz" }
  "SI_conversion" CDF_CHAR { "1000.>m s^-1" }
  "Sig_digits" CDF_CHAR    { "3" }
  "SC_id"     CDF_CHAR     { "1" } .

!*-EndVariable:V vector EDI
!*-BeginVariable
"E_xyz_gse_loser__C1_PPP_EDI"  CDF_REAL4  1   1   3   T    T
! Attribute   Type        Value
!-----------  -----       ------

  "FIELDNAM"  CDF_CHAR     { "EDI electric field" }
  "LABL_PTR_1"  CDF_CHAR   {  "L_E_xyz_gse__C1_PPP_EDI" }
  "UNITS"     CDF_CHAR     { "mV/m" }
  "CATDESC"   CDF_CHAR     { "EDI electric field, GSE frame cartesians" }
  "VALIDMIN"  CDF_REAL4    { -200., -200., -200. }
  "VALIDMAX"  CDF_REAL4    {  200.,  200.,  200. }
  "SCALEMIN"  CDF_REAL4    { -30., -30., -30. }
  "SCALEMAX"  CDF_REAL4    {  30.,  30.,  30. }
  "FORMAT"    CDF_CHAR     { "e10.3" }
  "FILLVAL"   CDF_REAL4    { -1.e31 }
  "VAR_TYPE"  CDF_CHAR     { "data" }
  "SCALETYP"  CDF_CHAR     { "linear" }
  "AVG_TYPE"  CDF_CHAR     { "standard" }
  "DEPEND_0"  CDF_CHAR     { "Epoch__C1_PPP_EDI" }
  "DEPEND_1"  CDF_CHAR     { "L_gse_xyz" }
  "DICT_KEY"    CDF_CHAR   { "electric_field>vector_GSE" }
  "Frame"     CDF_CHAR     { "vector>gse_xyz" }
  "SI_conversion" CDF_CHAR { "0.001>V m^-1" }
  "Sig_digits" CDF_CHAR    { "3" }
  "SC_id"     CDF_CHAR     { "1" } .

!*-EndVariable
!*-BeginVariable
"Reduced_chi_sq_loser__C1_PPP_EDI"  CDF_REAL4   1   0       T
! Attribute   Type        Value
!-----------  -----       ------

  "FIELDNAM"  CDF_CHAR     { "EDI Reduced Chi-squared" }
  "LABLAXIS"  CDF_CHAR     { "Reduced Chi Sq" }
  "UNITS"     CDF_CHAR     { " " }
  "CATDESC"   CDF_CHAR     { "EDI Reduced Chi-squared of the BESTARG fit." }
  "VALIDMIN"  CDF_REAL4    { 0.}
```

```
  "VALIDMAX"  CDF_REAL4    { 100. }
  "SCALEMIN"  CDF_REAL4    { 0. }
  "SCALEMAX"  CDF_REAL4    { 100. }
  "FORMAT"    CDF_CHAR     { "e10.3" }
  "FILLVAL"   CDF_REAL4    { -1.e31 }
  "VAR_TYPE"  CDF_CHAR     { "data" }
  "SCALETYP"  CDF_CHAR     { "linear" }
  "AVG_TYPE"  CDF_CHAR     { "none" }
  "DEPEND_0"  CDF_CHAR     {  "Epoch__C1_PPP_EDI" }
  "DICT_KEY"    CDF_CHAR   { "fit_parameter>Reduced_chi_sq" }
  "Sig_digits" CDF_CHAR    { "3" }
  "SC_id"    CDF_CHAR      { "1" } .

!*-EndVariable
!*-BeginVariable
"Drift_step_mag_loser__C1_PPP_EDI"  CDF_REAL4   1   0        T
!  Attribute   Type         Value
!-----------   -----        ------

  "FIELDNAM"  CDF_CHAR     { "EDI Drift Step Magnitude" }
  "LABLAXIS"  CDF_CHAR     { "Drift Step Magnitude" }
  "UNITS"     CDF_CHAR     { "m" }
  "CATDESC"   CDF_CHAR     { "EDI Drift Step of the BESTARG fit." }
  "VALIDMIN"  CDF_REAL4    { 0.}
  "VALIDMAX"  CDF_REAL4    { 500. }
  "SCALEMIN"  CDF_REAL4    { 0. }
  "SCALEMAX"  CDF_REAL4    { 500. }
  "FORMAT"    CDF_CHAR     { "e10.3" }
  "FILLVAL"   CDF_REAL4    { -1.e31 }
  "VAR_TYPE"  CDF_CHAR     { "data" }
  "SCALETYP"  CDF_CHAR     { "linear" }
  "AVG_TYPE"  CDF_CHAR     { "none" }
  "DEPEND_0"  CDF_CHAR     {  "Epoch__C1_PPP_EDI" }
  "DICT_KEY"  CDF_CHAR     { "length>drift_step" }
  "Frame"     CDF_CHAR     { "scalar>na" }
  "Sig_digits" CDF_CHAR    { "3" }
  "SC_id"    CDF_CHAR      { "1" } .

!*-EndVariable
!*-BeginVariable
"Drift_step_mag_error_inertial_loser__C1_PPP_EDI"  CDF_REAL4   1   0        T
!  Attribute   Type         Value
!-----------   -----        ------

  "FIELDNAM"  CDF_CHAR     { "EDI Drift Step Magnitude Error" }
  "LABLAXIS"  CDF_CHAR     { "Drift Step Magnitude Error" }
  "UNITS"     CDF_CHAR     { "m" }
  "CATDESC"   CDF_CHAR     { "EDI Drift Step Magnitude Error in inertial frame." }
  "VALIDMIN"  CDF_REAL4    { 0.}
  "VALIDMAX"  CDF_REAL4    { 500. }
  "SCALEMIN"  CDF_REAL4    { 0. }
  "SCALEMAX"  CDF_REAL4    { 500. }
  "FORMAT"    CDF_CHAR     { "e10.3" }
  "FILLVAL"   CDF_REAL4    { -1.e31 }
  "VAR_TYPE"  CDF_CHAR     { "data" }
  "SCALETYP"  CDF_CHAR     { "linear" }
  "AVG_TYPE"  CDF_CHAR     { "none" }
  "DEPEND_0"  CDF_CHAR     {  "Epoch__C1_PPP_EDI" }
  "DICT_KEY"  CDF_CHAR     { "length>drift_step_magnitude_error" }
```

```
  "Frame"     CDF_CHAR         { "scalar>na" }
  "Sig_digits" CDF_CHAR        { "3" }
  "SC_id"     CDF_CHAR         { "1" } .

!*-EndVariable
!*-BeginVariable
"Drift_step_azi_error_inertial_loser__C1_PPP_EDI"  CDF_REAL4   1   0        T
!  Attribute   Type         Value
!-----------   -----        ------

  "FIELDNAM"  CDF_CHAR         { "EDI Drift Step Azimuthal Error" }
  "LABLAXIS"  CDF_CHAR         { "Drift Step Azimuthal Error" }
  "UNITS"     CDF_CHAR         { "degrees" }
  "CATDESC"   CDF_CHAR         { "EDI Drift Step Azimuthal Error in inertial frame." }
  "VALIDMIN"  CDF_REAL4        { 0.}
  "VALIDMAX"  CDF_REAL4        { 180. }
  "SCALEMIN"  CDF_REAL4        { 0. }
  "SCALEMAX"  CDF_REAL4        { 180. }
  "FORMAT"    CDF_CHAR         { "e10.3" }
  "FILLVAL"   CDF_REAL4        { -1.e31 }
  "VAR_TYPE"  CDF_CHAR         { "data" }
  "SCALETYP"  CDF_CHAR         { "linear" }
  "AVG_TYPE"  CDF_CHAR         { "none" }
  "DEPEND_0"  CDF_CHAR         {  "Epoch__C1_PPP_EDI" }
  "DICT_KEY"  CDF_CHAR         { "length>drift_step_azimuthal_error" }
  "Frame"     CDF_CHAR         { "scalar>na" }
  "Sig_digits" CDF_CHAR        { "3" }
  "SC_id"     CDF_CHAR         { "1" } .

!*-EndVariable
!*-BeginVariable
"Nbeam_loser__C1_PPP_EDI"  CDF_INT2   1   0        T
!  Attribute   Type         Value
!-----------   -----        ------

  "FIELDNAM"  CDF_CHAR         { "EDI Nbeam" }
  "LABLAXIS"  CDF_CHAR         { "Nbeam" }
  "UNITS"     CDF_CHAR         { " " }
  "CATDESC"   CDF_CHAR         { "EDI Number of beams used in calculation." }
  "VALIDMIN"  CDF_INT2         { 0 }
  "VALIDMAX"  CDF_INT2         { 1000 }
  "SCALEMIN"  CDF_INT2         { 0 }
  "SCALEMAX"  CDF_INT2         { 1000 }
  "FORMAT"    CDF_CHAR         { "I4" }
  "FILLVAL"   CDF_INT2         { 32767 }
  "VAR_TYPE"  CDF_CHAR         { "data" }
  "SCALETYP"  CDF_CHAR         { "linear" }
  "AVG_TYPE"  CDF_CHAR         { "none" }
  "DEPEND_0"  CDF_CHAR         { "Epoch__C1_PPP_EDI" }
  "DICT_KEY"  CDF_CHAR         { "fit_parameter>number_of_beams" }
  "Frame"     CDF_CHAR         { "scalar>na" }
  "SC_id"     CDF_CHAR         { "1" } .

!*-EndVariable
!*-BeginVariable
"L_Status_EDI" CDF_CHAR  9   1    7    F      T
!  Attribute   Type         Value
!-----------   -----        ------

  "FIELDNAM"  CDF_CHAR         { "Status components" }
```

```
  "VAR_TYPE"  CDF_CHAR     { "metadata" }
  "DICT_KEY"  CDF_CHAR     { "label>status" }
  "CATDESC"   CDF_CHAR     { "Label for Status components" } .

! Explicit values can be assigned as this is non-record varying

  [1] = { "Status[0]" }
  [2] = { "Status[1]" }
  [3] = { "Status[2]" }
  [4] = { "Status[3]" }
  [5] = { "Status[4]" }
  [6] = { "Status[5]" }
  [7] = { "Status[6]" }

!*-EndVariable
!*-BeginVariable
 "L_V_ed_xyz_gse__C1_PPP_EDI"  CDF_CHAR   10   1    3    F     T
!  Attribute   Type        Value
!-----------   -----       ------

  "FIELDNAM"  CDF_CHAR     { "Label for V_xyz_gse" }
  "VAR_TYPE"  CDF_CHAR     { "metadata" }
  "DICT_KEY"  CDF_CHAR     { "label>frame" }
  "CATDESC"   CDF_CHAR     { "Label for V_xyz_gse" } .

  [1] = { "V_ed_x GSE" }
  [2] = { "V_ed_y GSE" }
  [3] = { "V_ed_z GSE" }

!*-EndVariable
!*-BeginVariable
"L_E_xyz_gse__C1_PPP_EDI"  CDF_CHAR   7   1    3    F     T
!  Attribute   Type         Value
!-----------   -----        ------

  "FIELDNAM"  CDF_CHAR     { "Label for E_xyz_gse" }
  "VAR_TYPE"  CDF_CHAR     { "metadata" }
  "DICT_KEY"  CDF_CHAR     { "label>frame" }
  "CATDESC"   CDF_CHAR     { "Label for E_xyz_gse" } .

  [1] = { "E_x GSE" }
  [2] = { "E_y GSE" }
  [3] = { "E_z GSE" }

!*-EndVariable
!*-EndVariables: EDI
#end
```

5.6 Electron Drift Data: Electron Drift Velocity and Electric Field (GSE), best resolution (MP)

Merged Parameter data (MP) are files with improved time resolution, one per day and spacecraft, best available at the time of the ingestion into the Archive. These files are generated by merging separate parameter files with one-spin, half-spin and quarter-spin resolutions; they contain only the “winners” of the technique comparison, with all qualities (good/caution/bad).

MP are produced by the US CoI ‘s and are contingent to NASA support.

5.6.1 Format

CDF

5.6.2 Standard

As described in Section 4.2

5.6.3 Production Procedure

As described in Section 4.3

5.6.4 Quality Control Procedure

As described in Section 4.4

5.6.5 Delivery Procedure

As described in Section 4.5

5.6.6 Product Specification

c#_mp_edi_yyyymmdd_v13.cdf. See 3.3.3.2

5.6.7 Metadata Specification

Higher level metadata valid, as described in Section 4.6

Metadata for the cdf-files are in the skeleton tables: C#_MP.skt, where # =spacecraft number (1, 2, 3)

For the translation to CEF-format the metadata were rewritten and included in the DATASET header files: C#_CH_EDI_MP.ceh. Below, an example for spacecraft 1:

```
START_META    =  DATASET_ID
  ENTRY      =  "C1_CP_EDI_MP"
END_META      =  DATASET_ID

START_META    =  DATA_TYPE
  ENTRY      =  "CP>CAA Parameter"
END_META      =  DATA_TYPE

START_META    =  DATASET_TITLE
  ENTRY      =  "Electron Drift Velocity and Electric Field (GSE), best resolution"
END_META      =  DATASET_TITLE

START_META    =  DATASET_DESCRIPTION
  ENTRY      =  "This dataset contains mixed (i.e. quarter- half- and one spin) resolution measurements of
the"
  ENTRY      =  "electron drift velocity from the EDI experiment on the Cluster C1 spacecraft."
  ENTRY      =  "These data have been converted into Cluster Exchange Format from the original"
  ENTRY      =  "Cluster Science Data System Common Data Format (CDF) Mixed Parameter files"
  ENTRY      =  "The metadata has been updated from the CSDS/CDF standard to the CAA to aid"
  ENTRY      =  "compatibility with tools developed for the Cluster Active Archive."
END_META      =  DATASET_DESCRIPTION
```

```
START_META = CONTACT_COORDINATES
   ENTRY = "MikhailRashev>Archive Scientist>rashev@mps.mpg.de"
END_META = CONTACT_COORDINATES
!
START_META     =   TIME_RESOLUTION
   ENTRY       =   1.
END_META       =   TIME_RESOLUTION
START_META     =   MIN_TIME_RESOLUTION
    ENTRY      =   4.412
END_META       =   MIN_TIME_RESOLUTION
START_META     =   MAX_TIME_RESOLUTION
   ENTRY       =   0.9
END_META       =   MAX_TIME_RESOLUTION
START_META     =   PROCESSING_LEVEL
   ENTRY       =   "Calibrated"
END_META       =   PROCESSING_LEVEL
START_META     =   ACKNOWLEDGEMENT
   ENTRY       =   "Please acknowledge the EDI team and ESA Cluster Active Archive in any publication based
upon use of this data"
END_META       =   ACKNOWLEDGEMENT
!
START_META     =   DATASET_CAVEATS
   ENTRY       =   "Non-regularly spaced time-series! It contains quarter-spin, half-spin and spin resolution
data."
   ENTRY       =   "DATASET VERSION HISTORY"
   ENTRY       =   "VERSION 01: The first version of this dataset was converted by the CAA"
   ENTRY       =   "from source CDF files provided by the EDI team. This conversion involved"
   ENTRY       =   "insertion of a half interval parameter that was not included in the source"
   ENTRY       =   "files and correction of missing or bad metadata. The half interval"
   ENTRY       =   "determination was based on comparison with the spin time-tags provided"
   ENTRY       =   "in the EDI CSDS Prime Parameter data file. In some cases a consistent"
   ENTRY       =   "determination could not be found with the PP data and the half-interval"
   ENTRY       =   "was set to the minimum, quarter spin, 1 second, value."
   ENTRY       =   "CDF to CEF Conversion was done using revision 1.1 (2006/11/06) of edi_mp_convert.pro"
   ENTRY       =   "Metadata correction was done using revision 1.1 (2006/11/06) of edi_fix_fatal.sh"
   ENTRY       =   "FILE VERSION HISTORY"
   ENTRY       =   "For this initial conversion the CAA CEF files have retained the same file"
   ENTRY       =   "version number as the source CDF files. In most cases file versions are"
   ENTRY       =   "V13 or V14."
   ENTRY       =   "*C1_CQ_EDI_CAVF"
END_META       =   DATASET_CAVEATS
!
START_META     =   DATASET_VERSION
   ENTRY       =   "01"
END_META       =   DATASET_VERSION
!
START_META     =   FILE_TYPE
   ENTRY       =   "cef"
END_META       =   FILE_TYPE
!
START_META     =   METADATA_TYPE
   ENTRY       =   "CAA"
END_META       =   METADATA_TYPE
!
START_META     =   METADATA_VERSION
   ENTRY       =   "2.0"
END_META       =   METADATA_VERSION
!
```

```
START_VARIABLE =  time_tags__C1_CP_EDI_MP
   PARAMETER_TYPE      = "Support_Data"
   CATDESC             = "Interval centered time tag"
   UNITS               = "s"
   SI_CONVERSION       = "1.0>s"
   SIZES               = 1
   VALUE_TYPE          = ISO_TIME
   SIGNIFICANT_DIGITS  = 24
   FILLVAL             = 9999-12-31T23:59:59Z
   FIELDNAM            = "Universal Time"
   LABLAXIS            = "UT"
   DELTA_PLUS          = half_interval__C1_CP_EDI_MP
   DELTA_MINUS         = half_interval__C1_CP_EDI_MP
   FRAME = "scalar>na"
END_VARIABLE    =  time_tags__C1_CP_EDI_MP
!
START_VARIABLE = Half_interval__C1_CP_EDI_MP
   PARAMETER_TYPE      = "Support_Data"
   CATDESC             = "Half averaging interval length"
   UNITS               = "s"
   SI_CONVERSION       = "1.0>s"
   SIZES               = 1
   VALUE_TYPE          = DOUBLE
   SIGNIFICANT_DIGITS  = 6
   FILLVAL             = -1.0e31
   FIELDNAM            = "Half width of averaging interval"
   LABLAXIS            = "s"
   FRAME = "scalar>na"
END_VARIABLE = Half_interval__C1_CP_EDI_MP
!
START_VARIABLE = Status__C1_CP_EDI_MP
   PARAMETER_TYPE      = "Data"
   ENTITY              = "Instrument"
   PROPERTY            = "Status"
   CATDESC             = "Cluster C1, EDI Status"
   UNITS               = "unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES               = 7
   VALUE_TYPE          = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL             = 255
   QUALITY             = 2
   FIELDNAM            = "Cluster C1, EDI Status"
   LABLAXIS            = "EDI Status"
   DEPEND_0            = time_tags__C1_CP_EDI_MP
   LABEL_1             = "Status[0]","Status[1]","Status[2]","Status[3]","Status[4]","Status[5]","Status[6]"
   FRAME = "scalar>na"
END_VARIABLE = Status__C1_CP_EDI_MP
!
START_VARIABLE = V_ed_xyz_gse__C1_CP_EDI_MP
   PARAMETER_TYPE      = "Data"
   ENTITY              = "Electron"
   PROPERTY            = "Velocity"
   FLUCTUATIONS        = "Fluctuation_Level"
   CATDESC             = "Cluster C1, Electron Drift Velocity, best resolution in GSE"
   UNITS               = "km s-1"
   SI_CONVERSION       = "1.0E3>m s-1"
   TENSOR_ORDER        = "1"
```

```
   COORDINATE_SYSTEM   = "GSE>Geocentric Solar Ecliptic"
   FRAME_VELOCITY  = “Inertial”
   REPRESENTATION_1    = "x", "y", "z"
   SIZES             = 3
   VALUE_TYPE         = FLOAT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -1.0e31
   QUALITY            = 2
   FIELDNAM           = "Cluster C1, Electron Drift Velocity, best resolution in GSE"
      LABLAXIS          = "Velocity"
   DEPEND_0           = time_tags__C1_CP_EDI_MP
   LABEL_1            = "Vx", "Vy", "Vz"
END_VARIABLE = V_ed_xyz_gse__C1_CP_EDI_MP
!
START_VARIABLE = E_xyz_gse__C1_CP_EDI_MP
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electric_Field"
   PROPERTY           = "Vector"
   FLUCTUATIONS       = "Fluctuation_Level"
   CATDESC            = "Cluster C1, EDI Electric Field, best resolution in GSE"
   UNITS             = "mV m-1"
     SI_CONVERSION      = "1.0E-3>V m-1"
   TENSOR_ORDER       = "1"
   COORDINATE_SYSTEM   = "GSE>Geocentric Solar Ecliptic"
   FRAME_VELOCITY  = “Inertial”
   REPRESENTATION_1    = "x", "y", "z"
   SIZES             = 3
   VALUE_TYPE         = FLOAT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -1.0e31
   QUALITY            = 2
   FIELDNAM           = "Cluster C1, Electric Field, spin resolution in GSE"
   LABLAXIS           = "E"
   DEPEND_0           = time_tags__C1_CP_EDI_MP
   LABEL_1            = "Ex", "Ey", "Ez"
END_VARIABLE = E_xyz_gse__C1_CP_EDI_MP
!
START_VARIABLE = Reduced_chi_sq__C1_CP_EDI_MP
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electric_Field"
   PROPERTY           = "Magnitude"
   FLUCTUATIONS       = "Fluctuation_Level"
   CATDESC            = "Cluster C1, Reduced Chi-squared, best resolution"
   UNITS             = "unitless"
   SI_CONVERSION      = "1.0>(chi-squared)"
   SIZES             = 1
   VALUE_TYPE         = FLOAT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -1.0e31
   QUALITY            = 2
   FIELDNAM           = "Cluster C1, Reduced Chi-squared, spin resolution"
   LABLAXIS           = "Reduced_chi_sq"
   DEPEND_0           = time_tags__C1_CP_EDI_MP
   FRAME = "scalar>na"
END_VARIABLE = Reduced_chi_sq__C1_CP_EDI_MP
```

5.7 Electron Gyrotime Data (EGD)

EGD files contain: time-tag, time-of-flight, error of time-of-flight, detector unit specification for beams of sufficient quality (one/day/spacecraft) and a flag for electron beam kinetic energy. Such files, in non-standard format, have been generated only on demand until now, mostly to support FGM calibration. The time-of-flight is expressed in microseconds (μs). In order to transform it to magnetic field magnitude in nanoTesla (nT), one should firstly apply Eq 4 to get the gyrotime (T_g) and then, one should use the following transformation: B [nT] =conv_factor / T_g [μs].

The conv_factor = $2\pi m_e / e, \quad m_e = m_{e0} + T_k / c^2$ and has the following values depending on the energy of the electrons:

35793.785 [μs.nT] for $\mathbf{T}_k$ = 1 keV, (Kinetic Energy Flag = 0, default)

35758.831 [μs.nT] for $\mathbf{T}_k$ = 500 eV (Kinetic Energy Flag = 1)

5.7.1 Format

CEF

5.7.2 Standard

As described in Section 4.2

5.7.3 Production Procedure

As described in Section 4.3

5.7.4 Quality Control Procedure

As described in Section 4.4

5.7.5 Delivery Procedure

As described in Section 4.5

5.7.6 Product Specification

C#_CP_EDI_EGD__yyyymmdd_Vii.cef, where # = 1,2,3 (spacecraft id), ii = version number

5.7.7 Metadata Specification

Each EGD file includes metadata for

- MISSION : CL_CH_MISSION.ceh,
- EXPeriment : CL_CH_EDI_EXP.ceh
- OBServatory : C#_CH_OBS.ceh
- INSTrument : C#_EDI_EDI#_INST.ceh
- DATASET : C#_CH_EDI_EGD_DATASET.ceh

= 1,2,3 (spacecraft id), ii = version number.

The hierarchy is : CEF <- DATASET <- INST <- (OBS, (EXP <- MISSION))

CEF-file include the DATASET metadata, which includes INST. INST includes both OBS and EXP and EXP includes MISSION.

DATASET definitions are in the header files: C#_CH_EDI_EGD_DATASET.ceh.

An example for spacecraft 1 is shown below:

```
START_META = DATASET_ID
  ENTRY = "C1_CP_EDI_EGD"
END_META = DATASET_ID
!
START_META = DATA_TYPE
  ENTRY = "CP>CAA Parameter"
END_META = DATA_TYPE
!
START_META = DATASET_TITLE
  ENTRY = "Electron Gyrotime Data"
END_META = DATASET_TITLE
!
START_META = DATASET_DESCRIPTION
  ENTRY = "This dataset contains measurements of the gyro-time of emitted "
  ENTRY = "electrons  from the EDI experiment on the Cluster C1 spacecraft"
  ENTRY = "The kinetic energy of the emitted electrons is: 1. or 0.5 keV (kine_flag=0,1) "
END_META = DATASET_DESCRIPTION
!
START_META = CONTACT_COORDINATES
  ENTRY = "Mikhail Rashev>Archive Scientist>rashev@mps.mpg.de"
END_META = CONTACT_COORDINATES
!
START_META = PROCESSING_LEVEL
  ENTRY ="Auxiliary"
END_META = PROCESSING_LEVEL
!
START_META = MIN_TIME_RESOLUTION
  ENTRY = 0.015625
END_META = MIN_TIME_RESOLUTION
!
START_META = MAX_TIME_RESOLUTION
  ENTRY = 1.e31
END_META = MAX_TIME_RESOLUTION
!
START_META = PROCESSING_LEVEL
  ENTRY = "Calibrated"
END_META = PROCESSING_LEVEL
!
START_META = DATASET_CAVEATS
 ENTRY = "No regularly spaced time series!"
 ENTRY = "MIN_TIME_RESOLUTION is given for burst mode"
 ENTRY = "MAX_TIME_RESOLUTION is set to fill_value"
 ENTRY = "Time_tags are the registered UT at electron detection"
 ENTRY = "To convert gyrotime microseconds to B in nT use for"
 ENTRY = "kine_flag=0: 35793.785"
 ENTRY = "kine_flag=1: 35758.831"
 ENTRY = ""
END_META = DATASET_CAVEATS
!
START_META = ACKNOWLEDGEMENT
 ENTRY="Please acknowledge the EDI team and ESA Cluster Active Archive"
 ENTRY=" when using this data"
END_META = ACKNOWLEDGEMENT
!
```

```
START_META     =   METADATA_TYPE
   ENTRY  =   "CAA"
END_META  =   METADATA_TYPE
!
START_META     =   METADATA_VERSION
   ENTRY  =   "2.0"
END_META  =   METADATA_VERSION
!
START_META     =   FILE_TYPE
   ENTRY  =   "cef"
END_META  =   FILE_TYPE
!
START_META =  DATASET_VERSION
   ENTRY  =   "2.0"
END_META  =  DATASET_VERSION
!
start_variable = time_tags__C1_CP_EDI_EGD
   PARAMETER_TYPE  = "Support_Data"
   CATDESC  = "time tag"
   UNITS = "s"
   SI_CONVERSION  = "1.0>s"
   FIELDNAM = "Universal Time"
   FILLVAL = 9999-12-31T23:59:59.999999Z
   SIGNIFICANT_DIGITS = 6
   LABLAXIS = "UT"
   VALUE_TYPE = ISO_TIME
   DELTA_PLUS = 0.244e-6
   DELTA_MINUS = 0.244e-6
   LABLAXIS = "UT"
 end_variable = time_tags__C1_CP_EDI_EGD
!
start_variable = tof__C1_CP_EDI_EGD
   PARAMETER_TYPE  = "Data"
   ENTITY = "Electron"
   PROPERTY = "Time-of-Flight"
   CATDESC  = "electron gyration time"
   VALUE_TYPE = FLOAT
   FIELDNAM = "Time-of-Flight"
   FILLVAL = 0.000
   SIGNIFICANT_DIGITS = 3
   QUALITY = "3 3"
   LABLAXIS = "tof"
   SI_CONVERSION = "1.0e-6>s"
   UNITS ="microseconds"
   DEPEND_0 = time_tags__C1_CP_EDI_EGD
end_variable =  tof__C1_CP_EDI_EGD
!
start_variable = sigma_tof__C1_CP_EDI_EGD
   PARAMETER_TYPE = "Data"
   ENTITY = "Electron"
   PROPERTY = "Time-of-Flight"
   CATDESC  = "electron gyration time"
   VALUE_TYPE = FLOAT
   FIELDNAM = "Time-of-Flight standard deviation"
   FILLVAL = 0.000
   SIGNIFICANT_DIGITS = 3
   QUALITY = "3 3"
   LABLAXIS = "sigma_tof"
```

```
  SI_CONVERSION = "1.0e-6>s"
  UNITS ="microseconds"
  DEPEND_0 = time_tags__C1_CP_EDI_EGD
end_variable = sigma_tof__C1_CP_EDI_EGD
!
start_variable = gdu_flag__C1_CP_EDI_EGD
  PARAMETER_TYPE = "Support_Data"
  ENTITY = "Electron"
  PROPERTY = "Time-of-Flight"
  CATDESC  = "electron gyration time"
  VALUE_TYPE = INT
  FIELDNAM = "Detector Unit"
  FILLVAL =0
  SIGNIFICANT_DIGITS = 1
  LABLAXIS = "DU"
  UNITS ="Unitless"
  DEPEND_0 = time_tags__C1_CP_EDI_EGD
end_variable = gdu_flag__C1_CP_EDI_EGD
!
start_variable = kine_flag__C1_CP_EDI_EGD
  PARAMETER_TYPE = "Support_Data"
  ENTITY = "Electron"
  PROPERTY = "Time-of-Flight"
  CATDESC  = "electron gyration time"
  VALUE_TYPE = INT
  FIELDNAM = "Kinetic Energy Flag"
  FILLVAL =9
  SIGNIFICANT_DIGITS = 1
  LABLAXIS = "KinEnFlag"
  UNITS ="Unitless"
  DEPEND_0 = time_tags__C1_CP_EDI_EGD
end_variable = kine_flag__C1_CP_EDI_EGD
```

5.8 Ambient Electron Data (AE)

Ambient Electron Data are available from October 2004 onwards. The Ambient Electron Mode and its operation are described in sections 3.2.3 and 3.2.4, respectively. The Ambient Electron Data Product is described in section 3.3.3.3. AE are produced by the US CoI's and are contingent to NASA support.

5.8.1 Format

CEF

5.8.2 Standard

As described in Section 4.2

5.8.3 Production Procedure

As described in Section 4.3

5.8.4 Quality Control Procedure

As described in Section 4.4

5.8.5 Delivery Procedure

As described in Section 4.5

5.8.6 Product Specification

C#_CP_EDI_AE_yyyymmdd_xx.cef. See 3.3.3.3

5.8.7 Metadata Specification

DATASET definitions are in the header files: C#_CH_EDI_EGD_DATASET.ceh.

Original data are in cdf-format. DATASET metadata has been created for the translation to CEF-files, as well as an IDL-routine to translate the cdf-files. As an example the file for spacecraft 1 is included below.

C1_CH_EDI_AE_DATASET.ceh

```
! AE (DATASET) HEADER File for Cluster 1
! TO BE WRITTEN into each AE-file:  *.cef
!
!include INSTRUMENT HEADER file and implicitly MISSION, OBS, EXP headers
INCLUDE = "C1_CH_EDI1_INST.ceh"
!
START_META    =  DATASET_ID
  ENTRY      =  "C1_CP_EDI_AE"
END_META      =  DATASET_ID
!
START_META    =  DATA_TYPE
  ENTRY      =  "CP>CAA Parameter"
END_META      =  DATA_TYPE
!
START_META    =  DATASET_TITLE
  ENTRY      =  "Ambient electron counts"
END_META      =  DATASET_TITLE
!
START_META    =  DATASET_DESCRIPTION
  ENTRY      =  "This dataset contains mixed resolution measurements of the"
  ENTRY      =  "ambient electron counts from the EDI experiment on the Cluster C1 spacecraft."
  ENTRY      =  "The raw data counts are given for 0°/180° and/or 90° pitch angles "
  ENTRY      =  "and electron energies of 0.5 or 1 keV (mostly 0.5 keV)"
  ENTRY      =  "The Status parameter contains the energy and TM info in its two significant bits:"
  ENTRY      =  "If bit 0 is set then the electron energy is 1 keV, else it is 0.5 keV."
  ENTRY      =  "Bit 1 indicates the telemetry mode: 0/1 stays for NM/BM telemetry.
  ENTRY      =  "These data have been converted into Cluster Exchange Format from the original"
  ENTRY      =  "Common Data Format (CDF)"
END_META      =  DATASET_DESCRIPTION
!
START_META = CONTACT_COORDINATES
  ENTRY = "MikhailRashev>Archive Scientist>rashev@mps.mpg.de"
END_META = CONTACT_COORDINATES
!
START_META    =  TIME_RESOLUTION
  ENTRY      =  0.062
END_META      =  TIME_RESOLUTION
!
START_META    =  MIN_TIME_RESOLUTION
   ENTRY     =  0.062
END_META      =  MIN_TIME_RESOLUTION
START_META    =  MAX_TIME_RESOLUTION
  ENTRY      =  0.0078
END_META      =  MAX_TIME_RESOLUTION
START_META    =  PROCESSING_LEVEL
```

```
  ENTRY      =  "Uncalibrated"
END_META      =  PROCESSING_LEVEL
START_META    =  ACKNOWLEDGEMENT
  ENTRY      =  "Please acknowledge the EDI team and ESA Cluster Active Archive in any publication based
upon use of this data"
END_META      =  ACKNOWLEDGEMENT
!
START_META    =  DATASET_CAVEATS
  ENTRY      =  "The electron counts are raw data and the time resolution is mixed:"
  ENTRY      =  "1/16 s for normal and 1/128 s for burst mode telemetry"
  ENTRY           =  "For science use they must be corrected and calibrated. "
  ENTRY      =  "DATASET VERSION HISTORY"
  ENTRY      =  "VERSION 01: The first version of this dataset was converted by the CAA"
  ENTRY      =  "from source CDF files provided by the EDI team."
  ENTRY      =  "For this initial conversion the CAA CEF files have retained the same file"
  ENTRY      =  "version number as the source CDF files. In most cases file versions are V03"
  ENTRY      =  "VERSION 02: minor changes"
  ENTRY      =  "VERSION 03: Status parameter explained"
END_META      =  DATASET_CAVEATS
!
START_META    =  DATASET_VERSION
  ENTRY      =  "03"
END_META      =  DATASET_VERSION
!
START_META    =  FILE_TYPE
  ENTRY      =  "cef"
END_META      =  FILE_TYPE
!
START_META    =  METADATA_TYPE
  ENTRY      =  "CAA"
END_META      =  METADATA_TYPE
!
START_META    =  METADATA_VERSION
  ENTRY      =  "2.0"
END_META      =  METADATA_VERSION
!
START_VARIABLE =  time_tags__C1_CP_EDI_AE
   PARAMETER_TYPE      = "Support_Data"
   CATDESC            = "Interval centred time tag"
   UNITS              = "s"
   SI_CONVERSION       = "1.0>s"
   SIZES              = 1
   VALUE_TYPE          = ISO_TIME
   SIGNIFICANT_DIGITS  = 24
   FILLVAL            = 9999-12-31T23:59:59.999Z
   FIELDNAM           = "Universal Time"
   LABLAXIS           = "UT"
   DELTA_PLUS          = 0.008
   DELTA_MINUS         = 0.008
   FRAME = "scalar>na"
END_VARIABLE    =  time_tags__C1_CP_EDI_AE
!
START_VARIABLE = Status__C1_CP_EDI_AE
   PARAMETER_TYPE      = "Support_Data"
   ENTITY             = "Instrument"
   PROPERTY            = "Status"
   CATDESC            = "Cluster C1, AE Status"
   UNITS              = "unitless"
```

```
   SI_CONVERSION      = "1>unitless"
   SIZES              = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 1
   FILLVAL            = 9
   FIELDNAM           = "Cluster C1, AE Status"
   LABLAXIS           = "AE Status"
   DEPEND_0           = time_tags__C1_CP_EDI_AE
   FRAME = "scalar>na"
END_VARIABLE = Status__C1_CP_EDI_AE
!
START_VARIABLE = Theta_index__C1_CP_EDI_AE
   PARAMETER_TYPE     = "Support_Data"
   ENTITY             = "Instrument"
   PROPERTY           = "Status"
   CATDESC            = "Cluster C1, theta look direction index"
   UNITS              = "unitless"
   SI_CONVERSION      = "1>unitless"
   SIZES              = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 3
   FILLVAL            = 255
     FIELDNAM           = "Cluster C1, theta look direction index"
   LABLAXIS           = "i_theta"
   DEPEND_0           = time_tags__C1_CP_EDI_AE
   FRAME = "scalar>na"
END_VARIABLE = Theta_index__C1_CP_EDI_AE
!
START_VARIABLE = Phi_index__C1_CP_EDI_AE
   PARAMETER_TYPE     = "Support_Data"
   ENTITY             = "Instrument"
   PROPERTY           = "Status"
   CATDESC            = "Cluster C1, phi look direction index"
   UNITS              = "unitless"
   SI_CONVERSION      = "1>unitless"
   SIZES              = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 3
   FILLVAL            = 255
   FIELDNAM           = "Cluster C1, phi look direction index"
   LABLAXIS           = "i_phi"
   DEPEND_0           = time_tags__C1_CP_EDI_AE
   FRAME = "scalar>na"
END_VARIABLE = Phi_index__C1_CP_EDI_AE
!
START_VARIABLE = counts_GDU1_PA_90__C1_CP_EDI_AE
   PARAMETER_TYPE     = "Data"
   ENTITY             = "Electron"
   PROPERTY           = "Raw_Particle_Counts"
   CATDESC            = "Cluster C1, ambient electron counts GDU1 PA=90 degree"
   UNITS              = "Unitless"
   SI_CONVERSION      = "1>unitless"
   SIZES              = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -32768
   QUALITY            = 2
   FIELDNAM           = "Cluster C1, ambient electron counts GDU1 PA=90 degree"
```

```
   LABLAXIS          = "AE_counts_GDU1_90"
   DEPEND_0          = time_tags__C1_CP_EDI_AE
END_VARIABLE = counts_GDU1_PA_90__C1_CP_EDI_AE
!
START_VARIABLE = counts_GDU2_PA_90__C1_CP_EDI_AE
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
   PROPERTY          = "Raw_Particle_Counts"
   CATDESC           = "Cluster C1, ambient electron counts GDU2 PA=90 degree"
   UNITS             = "Unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES             = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL           = -32768
   QUALITY           = 2
   FIELDNAM          = "Cluster C1, ambient electron counts GDU2 PA=90 degree"
   LABLAXIS          = "AE_counts_GDU2_90"
   DEPEND_0          = time_tags__C1_CP_EDI_AE
END_VARIABLE = counts_GDU2_PA_90__C1_CP_EDI_AE
!
START_VARIABLE = counts_GDU1_PA_180__C1_CP_EDI_AE
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
   PROPERTY          = "Raw_Particle_Counts"
   CATDESC           = "Cluster C1, ambient electron counts GDU1 PA=180 degree"
   UNITS             = "Unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES             = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL           = -32768
   QUALITY           = 2
   FIELDNAM          = "Cluster C1, ambient electron counts GDU1 PA=180 degree"
   LABLAXIS          = "AE_counts_GDU1_180"
   DEPEND_0          = time_tags__C1_CP_EDI_AE
END_VARIABLE = counts_GDU1_PA_180__C1_CP_EDI_AE
!
START_VARIABLE = counts_GDU2_PA_0__C1_CP_EDI_AE
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
   PROPERTY          = "Raw_Particle_Counts"
   CATDESC           = "Cluster C1, ambient electron counts GDU2 PA=0 degree"
   UNITS             = "Unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES             = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL           = -32768
   QUALITY           = 2
   FIELDNAM          = "Cluster C1, ambient electron counts GDU2 PA=0 degree"
   LABLAXIS          = "AE_counts_GDU2_0"
   DEPEND_0          = time_tags__C1_CP_EDI_AE
END_VARIABLE = counts_GDU2_PA_0__C1_CP_EDI_AE
!
START_VARIABLE = counts_GDU1_PA_0__C1_CP_EDI_AE
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
```

```
   PROPERTY          = "Raw_Particle_Counts"
   CATDESC           = "Cluster C1, ambient electron counts GDU1 PA=0 degree"
   UNITS             = "Unitless"
   SI_CONVERSION      = "1>unitless"
   SIZES             = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL           = -32768
   QUALITY           = 2
   FIELDNAM          = "Cluster C1, ambient electron counts GDU1 PA=0 degree"
   LABLAXIS          = "AE_counts_GDU1_0"
   DEPEND_0          = time_tags__C1_CP_EDI_AE
END_VARIABLE = counts_GDU1_PA_0__C1_CP_EDI_AE
!
START_VARIABLE = counts_GDU2_PA_180__C1_CP_EDI_AE
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
   PROPERTY          = "Raw_Particle_Counts"
   CATDESC           = "Cluster C1, ambient electron counts GDU2 PA=180 degree"
   UNITS             = "Unitless"
   SI_CONVERSION      = "1>unitless"
   SIZES             = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL           = -32768
   QUALITY           = 2
   FIELDNAM          = "Cluster C1, ambient electron counts GDU2 PA=180 degree"
   LABLAXIS          = "AE_counts_GDU2_180"
   DEPEND_0          = time_tags__C1_CP_EDI_AE
END_VARIABLE = counts_GDU2_PA_180__C1_CP_EDI_AE
!
START_VARIABLE = D1_xyz_gse__C1_CP_EDI_AE
   PARAMETER_TYPE      = "Support_Data"
   ENTITY            = "Instrument"
   PROPERTY          = "Direction"
   CATDESC           = "Cluster C1, EDI Detector 1 look direction in GSE"
   UNITS             = "m"
   SI_CONVERSION      = "1.0>m"
   TENSOR_ORDER       = "1"
   COORDINATE_SYSTEM   = "GSE>Geocentric Solar Ecliptic"
   REPRESENTATION_1    = "x", "y", "z"
   SIZES             = 3
   VALUE_TYPE    = FLOAT
   SIGNIFICANT_DIGITS  = 12
   FILLVAL           = -1.0e31
   FIELDNAM          = "Cluster C1, EDI Detector 1 look direction in GSE"
   LABLAXIS          = "D1"
   DEPEND_0          = time_tags__C1_CP_EDI_AE
   LABEL_1           = "D1x", "D1y", "D1z"
END_VARIABLE = D1_xyz_gse__C1_CP_EDI_AE
```

5.9 Corrected Ambient Electron Data (AEDC)

Corrected Ambient Electron Data are available from October 2004 onwards; they are obtained at CAA by applying the correction contained in the AEC files on the AE data as described in 3.3.3.3.

5.9.1 Format

CEF

5.9.2 Standard

As described in Section 4.2

5.9.3 Production Procedure

At CAA by using an IDL software delivered by the EDI team.

5.9.4 Quality Control Procedure

None

5.9.5 Delivery Procedure

None

5.9.6 Product Specification

C#_CP_EDI_AEDC_yyyymmdd_xx.cef.

5.9.7 Metadata Specification

DATASET definitions are in the header files: C#_CH_EDI_AEDC_DATASET.ceh.

As an example the file for spacecraft 1 is included below.

C1_CH_EDI_AEDC_DATASET.ceh

```
! AEDC (DATASET) HEADER File for Cluster C1
! TO BE WRITTEN into each AEDC-file:  *.cef
!
!include INSTRUMENT HEADER file and implicitly MISSION, OBS, EXP headers
INCLUDE = "C1_CH_EDI1_INST.ceh"
!
START_META    =  DATASET_ID
  ENTRY      =  "C1_CP_EDI_AEDC"
END_META      =  DATASET_ID
!
START_META    =  DATA_TYPE
  ENTRY      =  "CP>CAA Parameter"
END_META      =  DATA_TYPE
!
START_META    =  DATASET_TITLE
  ENTRY      =  "Corrected ambient electron counts"
END_META      =  DATASET_TITLE
!
START_META    =  DATASET_DESCRIPTION
  ENTRY      =  "This dataset contains mixed resolution measurements of the"
  ENTRY      =  "ambient electron data from the EDI experiment on the Cluster C1 spacecraft."
  ENTRY      =  "These data have been corrected for the angular (theta-phi) dependence of the detection efficieny using the AEC files"
  ENTRY      =  "The data counts are given for 0/180 degree and/or 90 degree pitch angles "
  ENTRY      =  "and electron energies of 0.5 or 1 keV (mostly 0.5 keV)"
  ENTRY      =  "The Status parameter contains the energy and TM info in its two significant bits:"
  ENTRY      =  "If bit 0 is set then the electron energy is 1 keV, else it is 0.5 keV."
  ENTRY      =  "Bit 1 indicates the telemetry mode: 0/1 stays for NM/BM telemetry."
END_META      =  DATASET_DESCRIPTION
!
START_META = CONTACT_COORDINATES
```

```
  ENTRY = "MikhailRashev>Archive Scientist>rashev@mps.mpg.de"
END_META = CONTACT_COORDINATES
!
START_META    =  TIME_RESOLUTION
  ENTRY      =  0.062
END_META      =  TIME_RESOLUTION
!
START_META    =  MIN_TIME_RESOLUTION
   ENTRY     =  0.062
END_META      =  MIN_TIME_RESOLUTION
START_META    =  MAX_TIME_RESOLUTION
  ENTRY      =  0.0078
END_META      =  MAX_TIME_RESOLUTION
START_META    =  PROCESSING_LEVEL
  ENTRY      =  "Uncalibrated"
END_META      =  PROCESSING_LEVEL
START_META    =  ACKNOWLEDGEMENT
  ENTRY      =  "Please acknowledge the EDI team and ESA Cluster Active Archive in any publication based
upon use of this data"
END_META      =  ACKNOWLEDGEMENT
!
START_META    =  DATASET_CAVEATS
  ENTRY      =  "Mixed time resolution: 1/16 s for normal and 1/128 s for burst mode "
  ENTRY      =  "The AEC (*.edi_ae_cor) files were used to correct for angular (theta-phi) dependence of the
efficieny"
  ENTRY      =  "The correction is applied to the original CDF files delivered by the EDI team"
END_META      =  DATASET_CAVEATS
!
START_META    =  DATASET_VERSION
  ENTRY      =  "01"
END_META      =  DATASET_VERSION
!
START_META    =  FILE_TYPE
  ENTRY      =  "cef"
END_META      =  FILE_TYPE
!
START_META    =  METADATA_TYPE
  ENTRY      =  "CAA"
END_META      =  METADATA_TYPE
!
START_META    =  METADATA_VERSION
  ENTRY      =  "2.0"
END_META      =  METADATA_VERSION
!
START_VARIABLE =  time_tags__C1_CP_EDI_AEDC
   PARAMETER_TYPE      = "Support_Data"
   CATDESC            = "Interval centred time tag"
   UNITS              = "s"
   SI_CONVERSION      = "1.0>s"
   SIZES              = 1
   VALUE_TYPE         = ISO_TIME
   SIGNIFICANT_DIGITS  = 24
   FILLVAL            = 9999-12-31T23:59:59.999Z
   FIELDNAM           = "Universal Time"
   LABLAXIS           = "UT"
   DELTA_PLUS         = 0.008
   DELTA_MINUS        = 0.008
   FRAME = "scalar>na"
```

```
END_VARIABLE   =  time_tags__C1_CP_EDI_AEDC
!
START_VARIABLE = counts_GDU1_PA_90__C1_CP_EDI_AEDC
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
   PROPERTY           = "Raw_Particle_Counts"
   CATDESC           = "Cluster C1, corrected ambient electron counts GDU1 PA=90 degree"
   UNITS             = "Unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES             = 1
   VALUE_TYPE          = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -32768
   QUALITY             = 2
   FIELDNAM           = "Cluster C1, corrected ambient electron counts GDU1 PA=90 degree"
   LABLAXIS           = "AE_counts_GDU1_90"
   DEPEND_0           = time_tags__C1_CP_EDI_AEDC
END_VARIABLE = counts_GDU1_PA_90__C1_CP_EDI_AEDC
!
START_VARIABLE = counts_GDU2_PA_90__C1_CP_EDI_AEDC
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
   PROPERTY           = "Raw_Particle_Counts"
   CATDESC           = "Cluster C1, corrected ambient electron counts GDU2 PA=90 degree"
   UNITS             = "Unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES             = 1
   VALUE_TYPE          = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -32768
   QUALITY             = 2
   FIELDNAM           = "Cluster C1, corrected ambient electron counts GDU2 PA=90 degree"
   LABLAXIS           = "AE_counts_GDU2_90"
   DEPEND_0           = time_tags__C1_CP_EDI_AEDC
END_VARIABLE = counts_GDU2_PA_90__C1_CP_EDI_AEDC
!
START_VARIABLE = counts_GDU1_PA_180__C1_CP_EDI_AEDC
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
   PROPERTY           = "Raw_Particle_Counts"
   CATDESC           = "Cluster C1, corrected ambient electron counts GDU1 PA=180 degree"
   UNITS             = "Unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES             = 1
   VALUE_TYPE          = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -32768
   QUALITY             = 2
   FIELDNAM           = "Cluster C1, corrected ambient electron counts GDU1 PA=180 degree"
   LABLAXIS           = "AE_counts_GDU1_180"
   DEPEND_0           = time_tags__C1_CP_EDI_AEDC
END_VARIABLE = counts_GDU1_PA_180__C1_CP_EDI_AEDC
!
START_VARIABLE = counts_GDU2_PA_0__C1_CP_EDI_AEDC
   PARAMETER_TYPE      = "Data"
   ENTITY            = "Electron"
   PROPERTY           = "Raw_Particle_Counts"
   CATDESC           = "Cluster C1, corrected ambient electron counts GDU2 PA=0 degree"
```

```
   UNITS             = "Unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES             = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -32768
   QUALITY            = 2
   FIELDNAM           = "Cluster C1, corrected ambient electron counts GDU2 PA=0 degree"
   LABLAXIS           = "AE_counts_GDU2_0"
   DEPEND_0            = time_tags__C1_CP_EDI_AEDC
END_VARIABLE = counts_GDU2_PA_0__C1_CP_EDI_AEDC
!
START_VARIABLE = counts_GDU1_PA_0__C1_CP_EDI_AEDC
   PARAMETER_TYPE      = "Data"
   ENTITY             = "Electron"
   PROPERTY           = "Raw_Particle_Counts"
   CATDESC            = "Cluster C1, corrected ambient electron counts GDU1 PA=0 degree"
   UNITS             = "Unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES             = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -32768
   QUALITY            = 2
   FIELDNAM           = "Cluster C1, corrected ambient electron counts GDU1 PA=0 degree"
   LABLAXIS           = "AE_counts_GDU1_0"
   DEPEND_0            = time_tags__C1_CP_EDI_AEDC
END_VARIABLE = counts_GDU1_PA_0__C1_CP_EDI_AEDC
!
START_VARIABLE = counts_GDU2_PA_180__C1_CP_EDI_AEDC
   PARAMETER_TYPE      = "Data"
   ENTITY             = "Electron"
   PROPERTY           = "Raw_Particle_Counts"
   CATDESC            = "Cluster C1, corrected ambient electron counts GDU2 PA=180 degree"
   UNITS             = "Unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES             = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS  = 6
   FILLVAL            = -32768
   QUALITY            = 2
   FIELDNAM           = "Cluster C1, corrected ambient electron counts GDU2 PA=180 degree"
   LABLAXIS           = "AE_counts_GDU2_180"
   DEPEND_0            = time_tags__C1_CP_EDI_AEDC
END_VARIABLE = counts_GDU2_PA_180__C1_CP_EDI_AEDC
!
START_VARIABLE = D1_xyz_gse__C1_CP_EDI_AEDC
   PARAMETER_TYPE      = "Data"
   ENTITY             = "Instrument"
   PROPERTY           = "Direction"
   CATDESC            = "Cluster C1, EDI Detector 1 look direction in GSE"
   UNITS             = "m"
   SI_CONVERSION       = "1.0>m"
   TENSOR_ORDER       = "1"
   COORDINATE_SYSTEM   = "GSE>Geocentric Solar Ecliptic"
   REPRESENTATION_1    = "x", "y", "z"
   SIZES             = 3
   VALUE_TYPE    = FLOAT
```

```
   SIGNIFICANT_DIGITS  = 12
   FILLVAL            = -1.0e31
   QUALITY             = 2
   FIELDNAM            = "Cluster C1, EDI Detector 1 look direction in GSE"
   LABLAXIS            = "D1"
   DEPEND_0            = time_tags__C1_CP_EDI_AEDC
   LABEL_1             = "D1x", "D1y", "D1z"
END_VARIABLE = D1_xyz_gse__C1_CP_EDI_AEDC
!
START_VARIABLE = Status__C1_CP_EDI_AEDC
   PARAMETER_TYPE      = "Support_Data"
   ENTITY             = "Instrument"
   PROPERTY            = "Status"
   CATDESC             = "Cluster C1, AE Status"
   UNITS              = "unitless"
   SI_CONVERSION       = "1>unitless"
   SIZES              = 1
   VALUE_TYPE          = INT
   SIGNIFICANT_DIGITS  = 1
   FILLVAL            = 9
   FIELDNAM            = "Cluster C1, AE Status"
   LABLAXIS            = "AE Status"
   DEPEND_0            = time_tags__C1_CP_EDI_AEDC
   FRAME = "scalar>na"
END_VARIABLE = Status__C1_CP_EDI_AEDC
```

5.10 Ambient Electron Correction Files (AEC)

The correction files called in previous documents calibration files are used to correct raw particle counts; they are to remove look-direction variations in the raw counts that are associated with the detector’s effective geometric factor. AEC are produced by the US CoI ‘s and are contingent on NASA support..

5.10.1 Format

ASCII

The content of the AEC files called previously AECAL_TEXT in the CAA (two factors for the relative difference in the efficiency of detector 2 compared to detector 1 set both to 1, 138 theta correction and 128 phi correction factors for both detectors) is changed in the new AEC_TEXT files (10.a in Table 3.4.1) which are going to replace the old ones. The inter-detector correction factors cannot be included in the AEC daily-files since the efficiency ratio is not constant during a day as thought in the beginning. A separate file could be created to contain the inter-detector efficiency correction factors as a time interval series.

An ambient electron correction file will contain (ASCII data in this order):

theta correction for detector 1 (139 values)

theta correction for detector 2 (139 values)

phi correction for detector 1 (128 values)

phi correction for detector 2 (128 values)

5.10.2 Standard

N/A

5.10.3 Production Procedure

As described in Section 4.3

5.10.4 Quality Control Procedure

As described in Section 4.4

5.10.5 Delivery Procedure

As described in Section 4.5

5.10.6 Product Specification

C#_YYYYMMDD_Vxx.edi_ae_cal (See 3.3.3.4)

5.10.7 Metadata Specification

TBD (calfile generation date, s/w program name & version, spacecraft number)

5.11 Graphical Data (3-h Survey Plots)

The graphical data consist of three hourly survey plots for one spacecraft, usually C3, in PNG format. Selected parameters from MP, AE and CLIST files are plotted. A self-describing sample plot is given in *Figure 5.1*. The 3-h survey plots are produced by the US CoI 's and are contingent to NASA support.

They are called **EDI_SUMMPLOT** in the CAA.

5.11.1 Format

PNG

5.11.2 Standard

As described in Section 4.2

5.11.3 Production Procedure

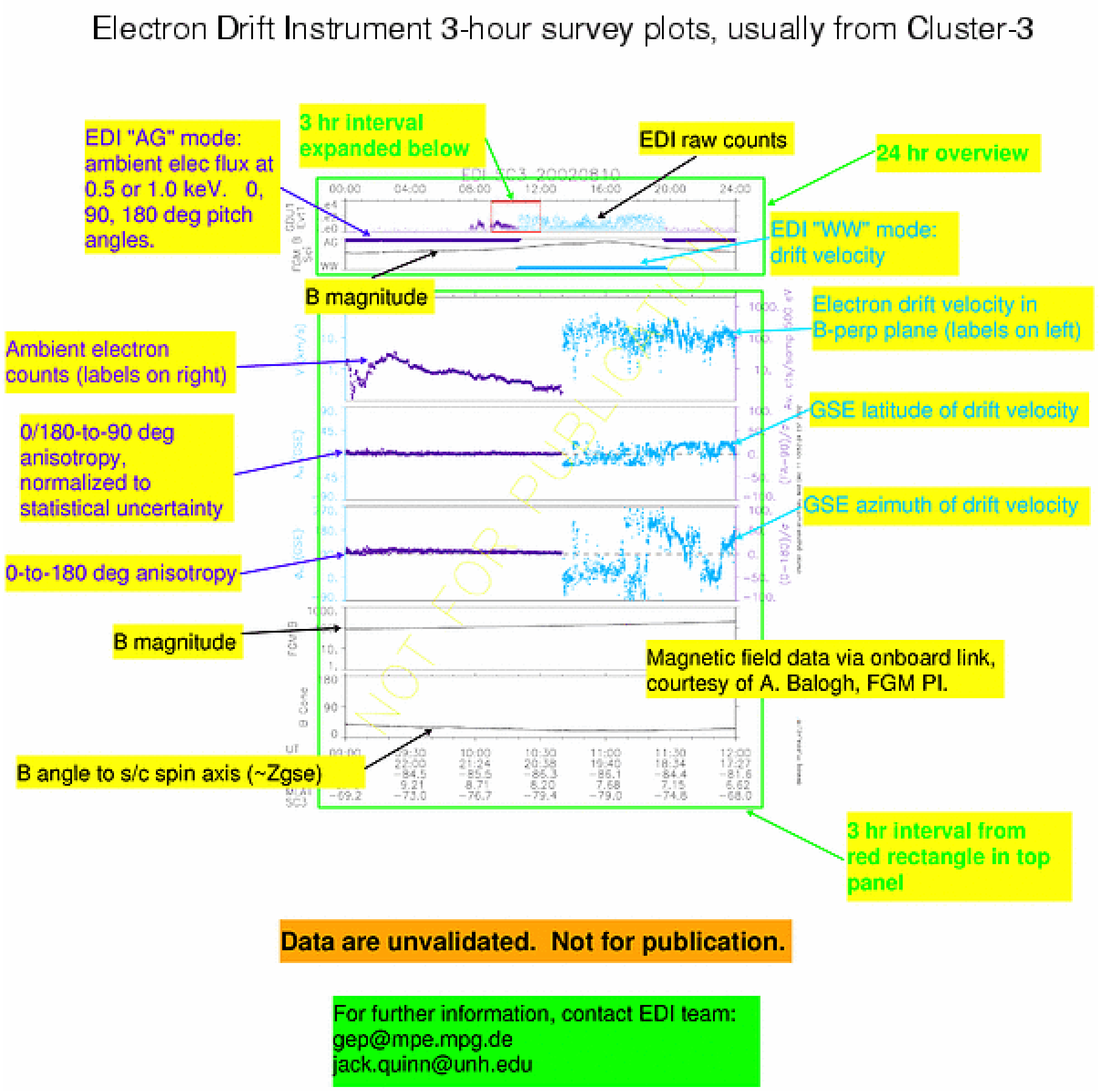
As described in Section 4.3

5.11.4 Quality Control Procedure

As described in Section 4.4

5.11.5 Delivery Procedure

As described in Section 4.5



Data are unvalidated. Not for publication.

For further information, contact EDI team:
gep@mpe.mpg.de
jack.quinn@unh.edu

Figure 5.1 Sample 3-hourly Survey Plot (called EDI_SUMMPLOT in the CAA). “AG” is the same as “AE”

5.11.6 Product Specification

EDI_bb_ee_yyyymmdd_Caution.png, where yyyymmdd = date, bb = begin_time (hour) and ee = end_time (hour).

5.11.7 Metadata Specification

No DATASET metadata defined. Higher level metadata valid, as described in Section 4.6

Following dataset metadata entries could be defined:

File_time_span = ”24 hr”

Plot_resolution = ”3 hr”

Data_type = ”preplotted graphics”

Display_type/plot_type = ”time_series”

Plot_parameters = from parent datasets: MP + AE + CLIST

5.12 Instrument modes (CLIST)

The CLIST product contains information about data availability and significant instrument modes. There is one file per month for each spacecraft. Dataset parameters are described in the dataset header-file. The dataset contains time intervals of the 2 instrument operation modes labelled “AE” and “WW” for “ambient electron” and “windshield wiper” respectively. Minimum time span is one data frame, i.e. one reset time = 5.1225 s. Time intervals may contain gaps of missing data frames, but not more than 2.

5.12.1 Format

CEF

5.12.2 Standard

As described in Section 4.2

5.12.3 Production Procedure

As described in Section 4.3

5.12.4 Quality Control Procedure

As described in Section 4.4

5.12.5 Delivery Procedure

As described in Section 4.5

5.12.6 Product Specification

C#_CQ_EDI_CLIST__yyyymm00_Vii.cef, where # = 1,2, 3 is spacecraft number und ii, version number.

5.12.7 Metadata Specification

Each CLIST file includes metadata for

MISSION :	CL_CH_MISSION.ceh,
EXPeriment :	CL_CH_EDI_EXP.ceh
OBServatory :	C#_CH_OBS.ceh
INSTrument :	C#_EDI_EDI#_INST.ceh
DATASET :	C#_CQ_EDI_CLIST.ceh

= 1,2,3,4 (spacecraft id), ii = version number.

The hierarchy is: CEF <- DATASET <- INST <- (OBS, (EXP <- MISSION))

CEF-file includes DATASET header-file, which includes INST. INST includes both OBS and EXP and EXP includes MISSION.

DATASET definitions are in the header files: C#_CQ_EDI_CLIST.ceh, where # = 1,2,3,4 is the spacecraft number. See below an example for spacecraft 1:

```
! Caveat List (DATASET) HEADER File for Cluster 1
!include INSTRUMENT HEADER file and implicitly MISSION, OBS, EXP headers
include="C1_CH_EDI1_INST.ceh"
```

```
!
START_META = DATASET_ID
  ENTRY = "C1_CQ_EDI_CLIST"
END_META = DATASET_ID
!
START_META = DATA_TYPE
  ENTRY = "CQ>CAA Quality/Caveats"
END_META = DATA_TYPE
!
START_META = DATASET_TITLE
  ENTRY = "Instrument Modes"
END_META = DATASET_TITLE
!
START_META = DATASET_DESCRIPTION
  ENTRY = "This dataset contains time intervals of EDI operation modes "
  ENTRY = "2 values are possible: 'WW' and 'AE'"
  ENTRY = " 'WW' stands for Windshield-Wiper or 'Electric Field' mode"
  ENTRY = " 'AE' for AmbientElectron or 'Ambient Geos' mode"
END_META = DATASET_DESCRIPTION
!
START_META = CONTACT_COORDINATES
  ENTRY = "MikhailRashev>Archive Scientist>rashev@mps.mpg.de"
END_META = CONTACT_COORDINATES
!
START_META = PROCESSING_LEVEL
  ENTRY ="Auxiliary"
END_META = PROCESSING_LEVEL
!
START_META = DATASET_CAVEATS
 ENTRY = "Time spans include gaps of maximum 15.5s (= 3 resets)"
 ENTRY = "minimum time interval between 2 time-spans is greater than 20s"
END_META = DATASET_CAVEATS
!
START_META = ACKNOWLEDGEMENT
 ENTRY="Please acknowledge the EDI team and ESA Cluster Active Archive"
 ENTRY=" when using this data"
END_META = ACKNOWLEDGEMENT
!
START_META     =   METADATA_TYPE
  ENTRY  =   "CAA"
END_META  =   METADATA_TYPE
!
START_META     =   METADATA_VERSION
  ENTRY  =   "2.0"
END_META  =   METADATA_VERSION
!
START_META     =   FILE_TYPE
  ENTRY  =   "cef"
END_META  =   FILE_TYPE
!
START_META     = DATASET_VERSION
   ENTRY  =   "1.0"
END_META  =  DATASET_VERSION
!
start_variable = time_tags__C1_CQ_EDI_CLIST
  PARAMETER_TYPE = Support_Data
  VALUE_TYPE = ISO_TIME_RANGE
  CATDESC = "Interval centered time tag"
```

```
  UNITS = "s"
  SI_CONVERSION  = "1.0>s"
  SIGNIFICANT_DIGITS = 3
  DELTA_PLUS = 1.00E-3
  DELTA_MINUS = 1.00E-3
  LABLAXIS = "UT"
  FILLVAL = 9999-12-31T23:59:59.999Z/9999-12-31T23:59:59.999Z
  FIELDNAM = "Universal Time"
end_variable = time_tags__C1_CQ_EDI_CLIST
!
start_variable = mode__C1_CQ_EDI_CLIST
  PARAMETER_TYPE = "Support_Data"
  VALUE_TYPE = CHAR
  CATDESC = "EDI Operation Mode"
  UNITS  = "Unitless"
  FIELDNAM = "Instrument_Mode"
  FILLVAL = "NA"
  DEPEND_0 = time_tags__C1_CQ_EDI_CLIST
end_variable = mode__C1_CQ_EDI_CLIST
!
```

5.13 Code repetition Frequency (CRF)

The **C**ode **R**epetition **F**requency files contain the instrument housekeeping data. This information helps to understand the interference generated effects in the data of the wave instruments (WHISPER, WBD). The EDI CRF (code repetition frequency) product is in CEF-format and contains 5 columns: time, code repetition frequency, code flag and beam current indices for the two guns.

Example:

```
2003-01-20T00:00:20, 4.369, 0, 19, 19
2003-01-20T00:00:25, 4.369, 0, 19, 19
2003-01-20T00:00:30, 4.369, 0, 19, 19
```

The beam current, in nA, can be determined using a table, but for WHISPER or WBD the index should be enough. The index is the position (starting with 0) of the value in the following array(31):

[0.0625, 0.0884, 0.125, 0.177, 0.25, 0.354, 0.5, 0.707, 1.0, 1.41, 2.0, 2.83,4.0, 5.66, 8.0, 11.0, 15.0, 21.2, 30.0, 42.4, 60.0, 86.6, 125.0, 177.0, 250.0, 354.0,500.0, 707.0, 1000.0, 1410.0, 2000.0].

The code flag defines the code length. It has the value 0 for “short”(15) and 1 for “long”(127) code.

One should keep in mind that the beam current determination is uncertain for Cluster and especially for Cluater 2.

5.13.1 Format

CEF

5.13.2 Standard

As described in Section 4.2

5.13.3 Production Procedure

As described in Section 4.3

5.13.4 Quality Control Procedure

As described in Section 4.4

5.13.5 Delivery Procedure Procedure

As described in Section 4.5

5.13.6 Product Specification

C#_CP_EDI_CRF__yyyymm00_Vii.cef, where # = 1,2,3 is spacecraft number und ii, version number.

5.13.7 Metadata Specification

Each CRF file includes metadata for

- MISSION : CL_CH_MISSION.ceh,
- EXPeriment : CL_CH_EDI_EXP.ceh
- OBServatory : C#_CH_OBS.ceh
- INSTrument : C#_EDI_EDI#_INST.ceh
- DATASET : C#_CH_EDI_CRF_DATASET .ceh

Where, # = 1,2,3,4 (spacecraft id), ii = version number.

The hierarchy is : CEF <- DATASET <- INST <- (OBS, (EXP <- MISSION))

CEF-file includes DATASET header-file, which includes INST. INST includes both OBS and EXP and EXP includes MISSION. The DATASET definitions are in the header files: C#_CH_EDI_CRF_DATASET .ceh, where # = 1,2,3,4 is the spacecraft number. See below an example for spacecraft 1:

```
START_META = DATASET_ID
  ENTRY = "C1_CP_EDI_CRF"
END_META = DATASET_ID
!
START_META = DATA_TYPE
  ENTRY = "CP>CAA Parameter"
END_META = DATA_TYPE
!
START_META = DATASET_TITLE
  ENTRY = "Code Repetition Frequency"
END_META = DATASET_TITLE
!
START_META = DATASET_DESCRIPTION
  ENTRY = "This dataset is extracted from the EDI housekeeping data"
  ENTRY = "It contains the code repetition frequency, the code type and "
  ENTRY = "the beam current indices for the two electron guns on Cluster 1"
  ENTRY = "The code type describes its length and is 0 for short(15) and 1 for long(127)"
  ENTRY = "The beam current index is the zero-based position of the beam current value in the following array: "
  ENTRY = "[ 0.0625, 0.0884, 0.125, 0.177, 0.25, 0.354, 0.5, 0.707, 1.0, 1.41, "
  ENTRY = "2.0, 2.83, 4.0, 5.66, 8.0, 11.0, 15.0, 21.2, 30.0, 42.4, 60.0, "
  ENTRY = "86.6, 125.0, 177.0, 250.0, 354.0, 500.0, 707.0, 1000.0, 1410.0, 2000.0"
  ENTRY = "The values are expressed in nA"
END_META = DATASET_DESCRIPTION
!
START_META = CONTACT_COORDINATES
  ENTRY = "MikhailRashev>Archive Scientist>rashev@mps.mpg.de"
END_META = CONTACT_COORDINATES
```

```
!
START_META = PROCESSING_LEVEL
   ENTRY ="Auxiliary"
END_META = PROCESSING_LEVEL
!
START_META = TIME_RESOLUTION
   ENTRY = 5.
END_META = TIME_RESOLUTION
!
START_META = MAX_TIME_RESOLUTION
   ENTRY = 5.
END_META = MAX_TIME_RESOLUTION
!
START_META = MIN_TIME_RESOLUTION
   ENTRY = 1.e31
END_META = MIN_TIME_RESOLUTION
!
START_META = DATASET_CAVEATS
  ENTRY = "MIN_TIME_RESOLUTION is set to fill_value"
  ENTRY = ""
END_META = DATASET_CAVEATS
!
START_META = ACKNOWLEDGEMENT
  ENTRY="Please acknowledge the EDI team and ESA Cluster Active Archive"
  ENTRY=" when using this data"
END_META = ACKNOWLEDGEMENT
!
START_META     =   METADATA_TYPE
   ENTRY  =   "CAA"
END_META  =   METADATA_TYPE
!
START_META     =   METADATA_VERSION
   ENTRY  =   "2.0"
END_META  =   METADATA_VERSION
!
START_META     =   FILE_TYPE
   ENTRY  =   "cef"
END_META  =   FILE_TYPE
!
START_META =  DATASET_VERSION
   ENTRY  =   "5.0"
END_META  =  DATASET_VERSION
!
start_variable = time_tags__C1_CP_EDI_CRF
   PARAMETER_TYPE  = "Support_Data"
   CATDESC  = "Time Tag"
   UNITS = "s"
   SI_CONVERSION  = "1.0>s"
   FIELDNAM = "Universal Time"
   FILLVAL = 9999-12-31T23:59:59
   SIGNIFICANT_DIGITS =19
   LABLAXIS = "UT"
   VALUE_TYPE = ISO_TIME
   DELTA_PLUS = 1.
   DELTA_MINUS = 1.
 end_variable = time_tags__C1_CP_EDI_CRF
!
start_variable = crf__C1_CP_EDI_CRF
```

```
  PARAMETER_TYPE  = "Support_Data"
  ENTITY = "Instrument"
  PROPERTY = "Status"
  CATDESC  = "Code repetition frequency"
  VALUE_TYPE = FLOAT
  FIELDNAM = "Code repetition frequency"
  FILLVAL = 0.000
  SIGNIFICANT_DIGITS = 6
  QUALITY = "0"
  LABLAXIS = "CRF"
  SI_CONVERSION = "1.0e+3>s-1"
  UNITS ="kHz"
  DEPEND_0 = time_tags__C1_CP_EDI_CRF
end_variable =  crf__C1_CP_EDI_CRF
!
start_variable = code_flag__C1_CP_EDI_CRF
  PARAMETER_TYPE = "Support_Data"
  ENTITY = "Instrument"
  PROPERTY = "Status"
  CATDESC  = "Code Flag"
  VALUE_TYPE = INT
  FIELDNAM = "Code flag"
  FILLVAL = 9
  SIGNIFICANT_DIGITS = 1
  LABLAXIS = "code_flag"
  UNITS ="unitless"
  DEPEND_0 = time_tags__C1_CP_EDI_CRF
end_variable = code_flag__C1_CP_EDI_CRF
!
start_variable = bcrt_indx_gdu1__C1_CP_EDI_CRF
  PARAMETER_TYPE = "Support_Data"
  ENTITY = "Electron"
  PROPERTY = "Current"
  CATDESC  = "Beam current index GDU1"
  VALUE_TYPE = INT
  FIELDNAM = "Beam current index GDU1"
  FILLVAL = 255
  SIGNIFICANT_DIGITS = 3
  LABLAXIS = "bcrti_1"
  UNITS ="Unitless"
  DEPEND_0 = time_tags__C1_CP_EDI_CRF
end_variable = bcrt_indx_gdu1__C1_CP_EDI_CRF
!
start_variable = bcrt_indx_gdu2__C1_CP_EDI_CRF
  PARAMETER_TYPE = "Support_Data"
  ENTITY = "Electron"
  PROPERTY = "Current"
  CATDESC  = "Beam current index GDU2 "
  VALUE_TYPE = INT
  FIELDNAM = "Beam current index GDU2"
  FILLVAL = 255
  SIGNIFICANT_DIGITS = 3
  LABLAXIS = "bcrti_2"
  UNITS ="Unitless"
  DEPEND_0 = time_tags__C1_CP_EDI_CRF
end_variable = bcrt_indx_gdu2__C1_CP_EDI_CRF
```

5.14 Background electron counts in WW-mode (QZC)

The **Q**ZC files are a by-product of the "WW"-mode. They contain time series of the ambient electron counts at 90° pitch angle and fixed energy 1 keV, rarely 0.5.keV. The status byte has only 2 significant bits: bit0 shows the sampling mode and bit1 is the energy info flag. If bit0 is set then the acquisition scheme was 4 times 1 ms samples, otherwise 2 times 2 ms samples in an operation cycle of 4ms. Bit1 cleared means that the electron energy is 1 keV otherwise 0.5 keV. In order to get the electrons/second one has to multiply the electron counts with 1024 if bit0 is set, otherwise with 512. The detector look direction in degrees for every count is given in spherical coordinates in inertial GSE. **These raw electron counts may be contaminated by artificial beam electrons and should be used only for boundary recognition purpose.**

5.14.1 Format

CEF

5.14.2 Standard

As described in Section 4.2

5.14.3 Production Procedure

As described in Section 4.3

5.14.4 Quality Control Procedure

As described in Section 4.4

5.14.5 Delivery Procedure Procedure

As described in Section 4.5

5.14.6 Product Specification

C#_CP_EDI_QZC__yyyymm00_Vii.cef, where # = 1,2,3 is spacecraft number und ii, version number.

5.14.7 Metadata Specification

Each QZC file includes metadata for

- MISSION : CL_CH_MISSION.ceh,
- EXPeriment : CL_CH_EDI_EXP.ceh
- OBServatory : C#_CH_OBS.ceh
- INSTrument : C#_EDI_EDI#_INST.ceh
- DATASET : C#_CH_EDI_QZC _DATASET.ceh

Where, # = 1,2,3,4 (spacecraft id), ii = version number.

The hierarchy is : CEF <- DATASET <- INST <- (OBS, (EXP <- MISSION))

CEF-file includes DATASET header-file, which includes INST. INST includes both OBS and EXP and EXP includes MISSION. DATASET definitions are in the header files: C#_CH_EDI_QZC _DATASET .ceh, where # = 1,2,3,4 is the spacecraft number. See below an example for spacecraft 1:

```
! AE (DATASET) HEADER File for Cluster 1
! TO BE WRITTEN into each QZC-file:  *.cef
!
!include INSTRUMENT HEADER file and implicitly MISSION, OBS, EXP headers
```

```
INCLUDE = "C1_CH_EDI1_INST.ceh"
!
START_META    =  DATASET_ID
  ENTRY      =  "C1_CP_EDI_QZC"
END_META      =  DATASET_ID
!
START_META    =  DATA_TYPE
  ENTRY      =  "CP>CAA Parameter"
END_META      =  DATA_TYPE
!
START_META    =  DATASET_TITLE
  ENTRY      =  "Background electron counts (in WW-mode)"
END_META      =  DATASET_TITLE
!
START_META    =  DATASET_DESCRIPTION
  ENTRY      =  "This dataset contains mixed resolution measurements of the"
  ENTRY      =  "quality zero electron beam counts from the EDI experiment"
  ENTRY      =  "These data have been collected in its active electron  drift operation mode"
  ENTRY      =  "The electrons counted are background electrons contaminated with beam electrons"
END_META      =  DATASET_DESCRIPTION
!
START_META = CONTACT_COORDINATES
  ENTRY = "MikhailRashev>Archive Scientist>rashev@mps.mpg.de"
END_META = CONTACT_COORDINATES
!
START_META    =  TIME_RESOLUTION
  ENTRY      =  0.01562
END_META      =  TIME_RESOLUTION
!
START_META    =  MIN_TIME_RESOLUTION
   ENTRY     =  0.125
END_META      =  MIN_TIME_RESOLUTION
START_META    =  MAX_TIME_RESOLUTION
  ENTRY      =  0.01562
END_META      =  MAX_TIME_RESOLUTION
START_META    =  PROCESSING_LEVEL
  ENTRY      =  "Uncalibrated"
END_META      =  PROCESSING_LEVEL
START_META    =  ACKNOWLEDGEMENT
  ENTRY      =  "Please acknowledge the EDI team and ESA Cluster Active Archive in any publication based
upon use of this data"
END_META      =  ACKNOWLEDGEMENT
!
START_META    =  DATASET_CAVEATS
  ENTRY      =  "Mixed time resolution: 1/8 s for normal and 1/64 s for burst mode "
  ENTRY      =  "MIN_TIME_RESOLUTION is set to fill_value"
  ENTRY      =  "MAX_TIME_RESOLUTION is given for BM"
  ENTRY      =  "Not regularly spaced timeline "
  ENTRY      =  "The background electron counts at fixed energy and pitch angle may be contaminated with
beam electrons "
  ENTRY      =  "Status parameter has two bits for electron energy and acquisition time for the electron
counts"
  ENTRY      =  "bit0=0: acquisition time=1/512 s; bit0=1: acq_time=1/1024 s "
  ENTRY      =  "bit1 is the energy flag=0/1 for 1/0.5 keV electron energy"
END_META      =  DATASET_CAVEATS
!
START_META    =  DATASET_VERSION
  ENTRY      =  "01"
```

```
END_META      =  DATASET_VERSION
!
START_META    =  FILE_TYPE
  ENTRY     =  "cef"
END_META      =  FILE_TYPE
!
START_META    =  METADATA_TYPE
  ENTRY     =  "CAA"
END_META      =  METADATA_TYPE
!
START_META    =  METADATA_VERSION
  ENTRY     =  "2.0"
END_META      =  METADATA_VERSION
!
START_VARIABLE =  time_tags__C1_CP_EDI_QZC
   PARAMETER_TYPE = "Support_Data"
   CATDESC              = "Time Tag"
   UNITS                = "s"
   SI_CONVERSION        = "1.0>s"
   SIZES                = 1
   VALUE_TYPE         = ISO_TIME
   SIGNIFICANT_DIGITS  = 27
   FILLVAL              = 9999-12-31T23:59:59.999999Z
   FIELDNAM             = "Universal Time"
   LABLAXIS             = "UT"
   DELTA_PLUS           = 0.008
   DELTA_MINUS          = 0.008
   FRAME                = "scalar>na"
END_VARIABLE    =  time_tags__C1_CP_EDI_QZC
!
START_VARIABLE = Status__C1_CP_EDI_QZC
   PARAMETER_TYPE = "Support_Data"
   ENTITY               = "Instrument"
   PROPERTY             = "Status"
   CATDESC              = "QZC Status"
   UNITS                = "unitless"
   SI_CONVERSION        = "1>unitless"
   SIZES                = 1
   VALUE_TYPE           = INT
   SIGNIFICANT_DIGITS= 1
   FILLVAL              = 9
   FIELDNAM             = "QZC Status"
   LABLAXIS             = "QZC Status"
   DEPEND_0             = time_tags__C1_CP_EDI_QZC
   FRAME                = "scalar>na"
END_VARIABLE = Status__C1_CP_EDI_QZC
!
START_VARIABLE = counts_GDU1_PA_90__C1_CP_EDI_QZC
   PARAMETER_TYPE = "Data"
   ENTITY               = "Electron"
   PROPERTY             = "Raw_Particle_Counts"
   CATDESC              = "QZC electron counts GDU1 PA=90 degree"
   UNITS                = "Unitless"
   SI_CONVERSION        = "1>unitless"
   SIZES                = 1
   VALUE_TYPE           = INT
   SIGNIFICANT_DIGITS= 6
   FILLVAL              = -1
```

```
   QUALITY                = 1
   FIELDNAM               = "QZC electron counts GDU1 PA=90 degrees"
   LABLAXIS               = "QZC_counts_GDU1_90"
   DEPEND_0               = time_tags__C1_CP_EDI_QZC
END_VARIABLE              = counts_GDU1_PA_90__C1_CP_EDI_QZC
!
START_VARIABLE = D1_rlp_gse__C1_CP_EDI_QZC
   PARAMETER_TYPE = "Support_Data"
   ENTITY                 = "Instrument"
   PROPERTY               = "Direction"
   CATDESC                = "GDU1 look direction in spherical polar GSE coordinates"
   UNITS                  = "degree","degree"
   SI_CONVERSION          = "1>pi/180 rad","1>pi/180 rad"
   TENSOR_ORDER           = "1"
   COORDINATE_SYSTEM   = "GSE>Geocentric Solar Ecliptic"
   FRAME_VELOCITY  = "Inertial"
   REPRESENTATION_1= "l", "p"
   SIZES                  = 2
   VALUE_TYPE             = FLOAT
   SIGNIFICANT_DIGITS= 7
   FILLVAL                = 999.99, 999.99
   FIELDNAM               = "GDU1 look direction in GSE"
   DEPEND_0               = time_tags__C1_CP_EDI_QZC
   LABEL_1                = "D1_lat_gse", "D1_lon_gse"
END_VARIABLE = D1_rlp_gse__C1_CP_EDI_QZC
!
START_VARIABLE = D1_phi_index__C1_CP_EDI_QZC
   PARAMETER_TYP   = "Support_Data"
   ENTITY            = "Instrument"
   PROPERTY               = "Status"
   CATDESC                = "Cluster C1, phi look direction index for D1"
   UNITS                  = "unitless"
   SI_CONVERSION         = "1>unitless"
   SIZES                  = 1
   VALUE_TYPE             = INT
   SIGNIFICANT_DIGITS= 3
   FILLVAL                = 999
   FIELDNAM               = "Cluster C1, phi look direction index for D1"
   LABLAXIS               = "i_phi_D1"
   DEPEND_0               = time_tags__C1_CP_EDI_QZC
   FRAME                  = "scalar>na"
END_VARIABLE = D1_phi_index__C1_CP_EDI_QZC
!
START_VARIABLE = D1_theta_index__C1_CP_EDI_QZC
   PARAMETER_TYPE = "Support_Data"
   ENTITY                 = "Instrument"
   PROPERTY               = "Status"
   CATDESC                = "Cluster C1, theta look direction index for D1"
   UNITS                  = "unitless"
   SI_CONVERSION          = "1>unitless"
   SIZES                  = 1
   VALUE_TYPE             = INT
   SIGNIFICANT_DIGITS= 3
   FILLVAL                = 999
   FIELDNAM               = "Cluster C1, theta look direction index for D1"
   LABLAXIS               = "i_theta_D1"
   DEPEND_0               = time_tags__C1_CP_EDI_QZC
   FRAME = "scalar>na"
```

```
END_VARIABLE = D1_theta_index__C1_CP_EDI_QZC
!
START_VARIABLE = counts_GDU2_PA_90__C1_CP_EDI_QZC
   PARAMETER_TYPE = "Data"
   ENTITY             = "Electron"
   PROPERTY           = "Raw_Particle_Counts"
   CATDESC            = "QZC electron counts GDU2 PA=90 degree"
   UNITS              = "Unitless"
   SI_CONVERSION      = "1>unitless"
   SIZES              = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS= 6
   FILLVAL            = -1
   QUALITY            = 1
   FIELDNAM           = "QZC electron counts GDU2 PA=90 degrees"
   LABLAXIS           = "QZC_counts_GDU2_90"
   DEPEND_0           = time_tags__C1_CP_EDI_QZC
END_VARIABLE = counts_GDU2_PA_90__C1_CP_EDI_QZC
!
START_VARIABLE = D2_rlp_gse__C1_CP_EDI_QZC
   PARAMETER_TYPE = "Support_Data"
   ENTITY             = "Instrument"
   PROPERTY           = "Direction"
   CATDESC            = "GDU1 look direction in spherical polar GSE coordinates"
   UNITS              = "degree","degree"
   SI_CONVERSION      = "1>pi/180 rad","1>pi/180 rad"
   TENSOR_ORDER       = "1"
   COORDINATE_SYSTEM   = "GSE>Geocentric Solar Ecliptic"
   FRAME_VELOCITY  = "Inertial"
   REPRESENTATION_1 = "l", "p"
   SIZES              = 2
   VALUE_TYPE         = FLOAT
   SIGNIFICANT_DIGITS  = 7
   FILLVAL            = 999.99, 999.99
   FIELDNAM           = "GDU1 look direction in GSE"
   DEPEND_0           = time_tags__C1_CP_EDI_QZC
   LABEL_1            = "D2_lat_gse", "D2_lon_gse"
END_VARIABLE = D2_rlp_gse__C1_CP_EDI_QZC
!
START_VARIABLE = D2_phi_index__C1_CP_EDI_QZC
   PARAMETER_TYPE = "Support_Data"
   ENTITY             = "Instrument"
   PROPERTY           = "Status"
   CATDESC            = "Cluster C1, phi look direction index for D2"
   UNITS              = "unitless"
   SI_CONVERSION      = "1>unitless"
   SIZES              = 1
   VALUE_TYPE         = INT
   SIGNIFICANT_DIGITS= 3
   FILLVAL            = 999
   FIELDNAM           = "Cluster C1, phi look direction index for D2"
   LABLAXIS           = "i_phi_D2"
   DEPEND_0           = time_tags__C1_CP_EDI_QZC
   FRAME = "scalar>na"
END_VARIABLE = D2_phi_index__C1_CP_EDI_QZC
!
START_VARIABLE = D2_theta_index__C1_CP_EDI_QZC
   PARAMETER_TYPE      = "Support_Data"
```

```
  ENTITY              = "Instrument"
  PROPERTY            = "Status"
  CATDESC             = "Cluster C1, theta look direction index for D2"
  UNITS               = "unitless"
  SI_CONVERSION       = "1>unitless"
  SIZES               = 1
  VALUE_TYPE          = INT
  SIGNIFICANT_DIGITS= 3
  FILLVAL             = 999
  FIELDNAM            = "Cluster C1, theta look direction index for D2"
  LABLAXIS            = "i_theta_D2"
  DEPEND_0            = time_tags__C1_CP_EDI_QZC
  FRAME = "scalar>na"
END_VARIABLE = D2_theta_index__C1_CP_EDI_QZC
```

6 DOCUMENTS – REFERENCES

This chapter contains a list of delivered documents and references. Table 6.1 contains EDI specific references and Table 6.2 general references. Table 6.3 lists the source codes delivered to the archive.

Table 6.1. EDI Reference Documents

	Reference / Doc_ID	File Name, as ingested into CAA	Comments
A1	CL_CD_EDI_CAAICD http://caa.estec.esa.int/documents/ICD/CAA_EST_ICD_EDI_v26.pdf	CAA_EST_ICD_EDI_v26.pdf	Present document Latest version available at http://caa.estec.esa.int/caa/ug_cr_icd.xml
A2	CL_CD_EDI_USERMAN http://caa.estec.esa.int/documents/teams/EDI/EDIum_i3r5.pdf	EDIum_i3r5.pdf	Detailed technical description of the instrument
A3	CL_CD_EDI_USERMAN_APP http://caa.estec.esa.int/documents/teams/EDI/EDIumApp_i3r5.pdf	EDIumApp_i3r5.pdf	Detailed description of the formats
A4	CL_CD_EDI_INSTR_PAPER1 http://caa.estec.esa.int/caa/edi_docs.xml	AnnGeo_FirstResults.pdf	Published in Annales Geophys.
A5	CL_CD_EDI_INSTR_PAPER2 http://caa.estec.esa.int/caa/edi_docs.xml	AnnGeo_JQuinn1669.pdf	Published in Annales Geophys.
A6	CL_CD_EDI_PISO_SW_DOC1 http://caa.estec.esa.int/documents/teams/EDI/edi_piso.tgz	EDI_PISO_README.doc	Part of EDI_PISO s/w packet
A7	CL_CD_EDI_PISO_SW_DOC2 http://caa.estec.esa.int/documents/teams/EDI/edi_piso.tgz	EDI_PISO_OUTPUT_DEFS.txt	Part of EDI_PISO s/w packet

A8	CAA_EST_UG_EDI http://caa.estec.esa.int/documents/UG/CAA_EST_UG_EDI_v35.pdf	CAA_EST_UG_EDI_v35.pdf	Latest version available at http://caa.estec.esa.int/caa/ug_cr_icd.xml
A9	CAA_EST_CR_EDI http://caa.estec.esa.int/documents/CR/CAA_EST_CR_EDI_v16.pdf	CAA_EST_CR_EDI_v16.pdf	Latest version available at http://caa.estec.esa.int/caa/ug_cr_icd.xml
A10	CDDID3-0.pdf http://caa.estec.esa.int/documents/CDDID3-0.pdf	CL-ESC_ID_2001	http://caa.estec.esa.int/documents/CDDID3-0.pdf

Items 6 and 7(table 6.1) are in the software packets.

Table 6.2. Other Reference Documents

	Reference / Doc_ID	File Name	Comments
B1	QMW-CEF	DS-QMW-TN-0010	Version 2.0.01, 25-05-2004
B2	QMW-CDF	DS-QMW-TN-0003	NASA Common Data Format (CSDS Implementation)
B3	MPAE-MSF	DS-MPA-TN-0017	technical note, 2000-07-28

Table 6.3. Software source codes for documentation

Nr	Directory Name	Name in flowchart	Current version/date	Code	Product
C1	PICK_LIB	PICK LIBRARY	2004_01_05	IDL	used internally
C2	EDI_PISO	EDI_PISO	V2_50	IDL	PP, PPPlus, MP
C3	AED	AE	V1.01/2007_11_27	IDL	AE
C4	SPLOT	SurveyPlot	HR_V1.18/2006-10-20	IDL	SPLOT
C5	QSTAT	qstat	V1.2_2001_07_25	C	QSTAT
C6	EGD	caa_editof/wwconv	V1.02/2006-03-01	IDL/C	EGD
C7	CLIST	caa_editm	V1.03/2006-11-30	IDL/C	CLIST
C8	MP	V11	V11	IDL	MP
C9	CRF	caa_edi_crf	V1.02/2007-04-02	IDL/C	CRF

The software archive contains 8 gzipped-directories (tgz-file) with C and IDL software modules, named mainly after their output. The table shows the correspondence between the directory names, the module names in the flowchart shown in Fig 3.2, the date/version of the current software, the programming language and the output. CLIST is the Instrument modes data containing the time intervals when EDI was in active (WW) mode and CRF contains EDI housekeeping (code repetition frequency, code flag and beam current index) relevant for the functioning for other instruments on board.

7 FIGURE CAPTION