Cluster Active Archive:

Interface Control Document for ASPOC

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1 INTRODUCTION

1.1 Scope

The Interface Control Document (ICD) contains the detailed description and specification of all products to be delivered to the CAA by the team for the instrument ASPOC (Active Spacecraft Potential Control) to the Cluster Active Archive (CAA). The team is lead by the Space Research Institute (IWF) of the Austrian Academy of Sciences located in Graz/Austria. The ICD is intended as a fully self-contained guide.

1.2 Applicable Documents

	Title of Document	Identifier	Issue & Rev.	Date
[CAA-PLAN]	Cluster Active Archive Instrument Archive Plan for ASPOC	CAA-ASP-AP-0001	0.1	22.07.2003

1.3 Reference Documents

	Title of Document	Identifier	Issue & Rev.	Date
[QMW-CDF]	Reference Document for CSDS CDF Implementation	DS-QMW-TN-0003	1.6	09.07.1999
[QMW-CEF]	Cluster Exchange Format	DS-QMW-TN-0010	2	25.05.2004
[CAA-NAME]	Cluster Active Archive: Proposal for the CAA Product and Variable Naming Convention	CAA-EST-TN-0001	Draft 1.0	26.07.2004
[CAA-META]	Cluster Metadata Dictionary	CAA-CDPP-TN-0002	2.0	17.03.2005
[INST-AG]	K. Torkar et al., Active Spacecraft Potential Control for Cluster — Implementation And First Results	Ann. Geophys., 19, pp. 1289–1302		2001
[INST-UM]	CLUSTER/ASPOC Instrument Users Manual	IWF-PD-9326	3.2	07.05.2000

1.4 Acronyms

ASPOC	Active Spacecraft Potential Control
CAA	Cluster Active Archive
CDF	Common Data Format
CEF	Cluster Exchange Format
CIS	Cluster Ion Spectrometry
CSDS	Cluster Science Data System
DDS	Data Disposition System
DPU	Digital Processing Unit
DWP	Digital Wave Processor
EFW	Electric Fields and Waves
IEL	Inter-Experiment Link
IFF	Intermediate Format File
IWF	Institut für Weltraumforschung
OAW	Österreichische Akademie der Wissenschaften
OBDH	On Board Data Handling
PEACE	Plasma Electron And Current Experiment
PP	Prime Parameter
SP	Summary Parameter
WHISPER	Sounder Instrument

1.5 1.5 Purpose

The purpose of the CAA activity for ASPOC is to provide a database with full information on the data produced by the instrument ASPOC and on its technical status throughout the mission. The archiving plan is described in [CAA-PLAN]. ASPOC is an active experiment that modifies the environment of the spacecraft by an energetic ion beam in order to improve measurements by other instruments on board. These include low energy electron data measured by PEACE, low energy ions measured by CIS, and electric fields and spacecraft potential measured by EFW. Detailed knowledge about the operation of ASPOC, its operational status, and of eventual anomalies, is critical for the interpretation of the measurements affected by ASPOC. Short-time variations of the ion beam emitted by ASPOC are not visible in the CSDS data sets (Prime and Summary Parameters), but could be important for a full understanding of plasma, electric field and spacecraft potential data. The operational modes of ASPOC define the method to control the ion beam current. Each method has its own effect on the ion beam.

ASPOC produces a beam of Indium ions. Indium as the charge material is a consumable which is used up during the mission. Occasionally, towards the end of operation for some emitter, some anomalies occurred which need full documentation within the archive, again because of the possible influence on other measurements. Finally, technical information on the performance of the ion emitters is noteworthy in view of possible future missions for this instrument.

2 POINTS OF CONTACT

The entity carrying out the work is:

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3 INSTRUMENT DESCRIPTION

3.1 Science Objectives

The ASPOC ion emitter instrument controls the electric potential of the spacecraft with respect to the ambient plasma by emitting a variable current of positive ions. In steady state, a spacecraft will charge to an equilibrium potential where all currents, namely photo-electron current caused by sunlight, plasma currents due to the environmental electrons and ions, secondary electron currents caused by the impact of primary electrons and ions, and the ion current generated by ASPOC compensate so that there is no net transfer of charge between the spacecraft and the environment. Without active control, spacecraft potentials along the Cluster orbit would range from a few volts positive in the solar wind and magnetosheath up to some 10's of Volts in the plasmasheet and in the magnetospheric lobes. Plasmasheet potentials are expected to lie between the magnetosheath and lobe cases. Small negative potentials are possible in the plasmasphere. High floating potentials may obscure the measurement of the core of the ion-distribution function measured by CIS and contaminate the low-energy portion of the electron spectra measured by PEACE by photo-electrons from the satellite surface, trapped by the positive satellite potential. The reduction of photo-electron fluxes into the PEACE detector, when the spacecraft potential is controlled, also leads to a significant lifetime enhancement of the micro-channel plates. Also electric field measurements by double probes (EFW) may suffer from a high spacecraft potential in certain plasma conditions. The primary objective of ASPOC is the reduction of high positive spacecraft potentials to a constant value which is sufficiently low (a few volts) to reduce the above mentioned disturbances significantly.

Further information on the scientific objectives and about in-orbit results can be found in [INST-AG].

3.2 Hardware Overview

This ICD is intended to provide key information on the instrument ASPOC and its data, Further details about ASPOC can be found in the instrument users manual [INST-UM].

3.2.1 Ion Emitter Design

At the heart of ASPOC are emitters of the liquid metal ion emitter type with indium as charge material. A solid needle, usually made of tungsten (W), with a tip radius of a few µm is mounted in a heated reservoir with the charge material. A potential of 5 to 9.5 kV is applied between the needle and an extractor electrode. If the needle is well wetted by the metal, the electrostatic stress at the needle tip pulls the liquid metal towards the extractor electrode. The liquid metal forms a cone with a very sharp tip, where field evaporation and ionisation of the liquid metal in the strong field generated by the applied high voltage takes place. During emission, ions leaving the surface can be continuously replenished by hydrodynamic flow of liquid metal from the reservoir to the needle apex so that a stable emission can be maintained. Indium has been chosen as ion source charge material because of its low vapour pressure, preventing contamination of the source insulators and ambient spacecraft surfaces. On the other hand, the melting point is high enough (~156 °C) that melting of an unheated source charge cannot occur even at the maximum expected elevated environmental temperature.

Before any ion emission can take place, the indium has to be molten by means of a small electrical heater which is in thermal contact with the reservoir. The melting of the indium from the cold state lasts about 15 minutes in a mode called “start-up”, after which high voltage is applied and successively increased until the field emission process ignites. The emission current is then electronically controlled, while the extraction voltage adjusts itself within the range of the electrical supply.

The emitters are arranged in two “modules” with four emitters each. The emitters are operated one at a time. The individual emitters are of cylindrical geometry. The indium reservoir and the needle sitting on top are kept at high voltage. The emitters are individually and indirectly heated from below by a PT100 resistor embedded into a ceramic insulator tube. This scheme enables the source to be heated from a grounded power supply and the tip itself still being kept at high voltage. The individual emitters are mounted in a slab of porous ceramic with extremely low heat conduction. The thermal isolation of the source has an immediate effect on the heater power consumption which is below 0.6 W. The reservoir contains 500 mg of indium which suffices for about 4000 hours operation per emitter.

The nominal maximum beam current is 50 µA. The emission current of an emitter may be increased to maximum current over a short period (between 30 seconds and a few minutes) as a precaution to remove any contamination from the emitter, thereby ensuring that the operating voltage remains within operational limits.
Fig. 3.1 shows a cross-section of an emitter module.

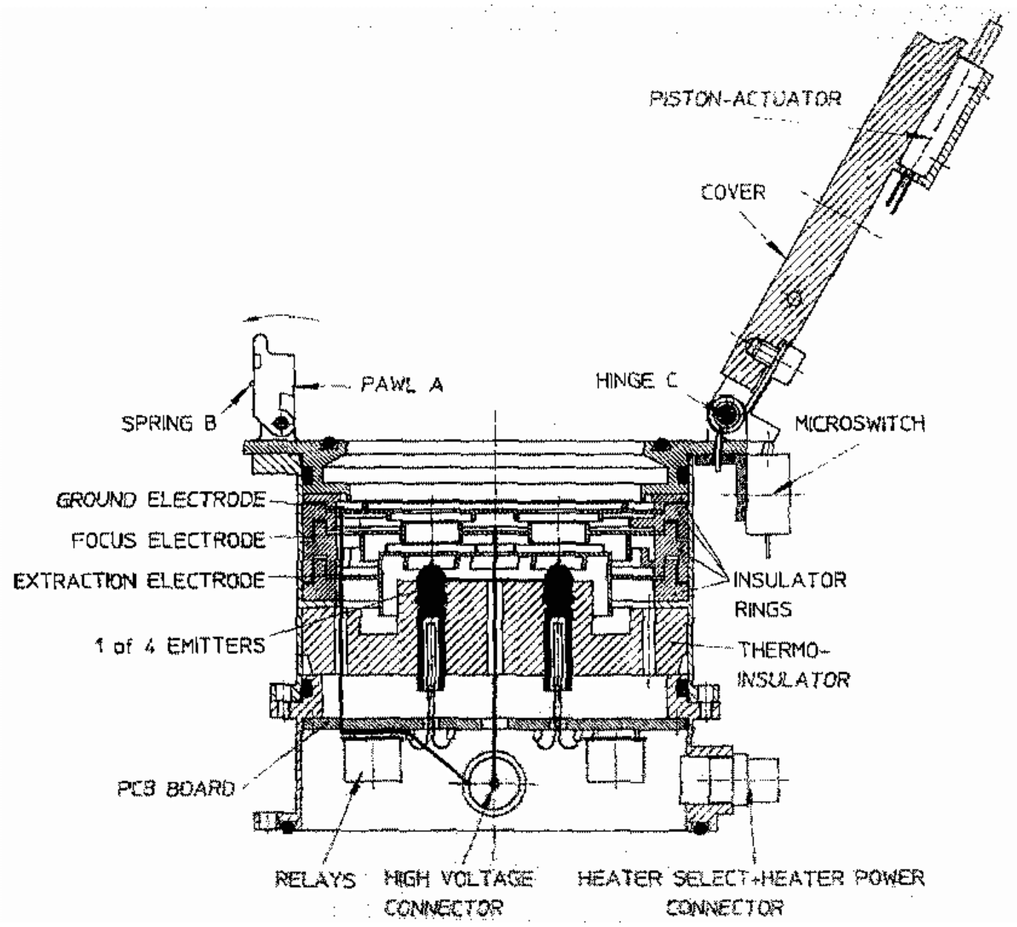

Fig. 3.1. Cross-section of one emitter module containing 4 emitters

3.2.2 Electrical Circuits for Emitters

All emitters have a common extraction- and focusing lens arrangement consisting of a grounded extractor electrode, a focusing electrode at beam potential and a second ground electrode. These three electrodes constitute a unipotential lens with the tip apex located in one focal point. The divergent ion beam (opening angle ca. 30°) emitted from the tip is focused by this lens into a nominally parallel beam. The cold secondary side of the high voltage supply is connected to the extraction and outer electrodes of the focusing lens and to metal tubes around the heater elements. These tubes protect the heaters and their power supply, which is connected to ground, from disastrous high voltage strokes. With this grounding scheme all possible paths for high voltage discharges are confined within the high voltage loop.
The relevant currents flowing in this system are:

1. The current carried by the emitted ion beam. This current loop is closed via the spacecraft surface by the ambient plasma. This current is referred to as ion current or beam current.

2. The total current delivered by the high voltage supply to the emitter. This current includes the beam current and internal loss currents (e.g. the current to the extraction and beam focusing electrodes), and may therefore be larger than the beam current. The percentage of loss currents within the total current is small (0 to 20%) for small to medium currents and may increase to 30 to 50% near the maximum total current (about 50 μA).

Within the resolution of the measurements, the full voltage applied to the emitter tips is used to accelerate the ion beam. Therefore the energy of the beam ions corresponds to the applied voltage.

3.2.3 Pyro Actuator for Covers

In order to avoid oxidation of the indium during testing on the ground, the emitters were kept in an almost hermetically closed volume under a protective gas atmosphere. The covers were opened after launch by a pyrotechnic piston actuator, which pushed a hook away from its locking position so that the spring-loaded cover would open. The pyro actuators were powered and commanded through the spacecraft systems. The signal from the micro switch to monitor the cover status was part of the ASPOC telemetry.

3.2.4 Instrument Modes

The instrument modes are defined by the method for the emission current control. There are two stand-alone modes involving the setting a current to a fixed value by time-tagged command.

- The default active mode is a stand-alone mode which fixes the total current of the high voltage unit, including losses inside the lens system (mode ITOT). Experience has shown that the resulting emission of an almost constant ion current fulfils all requirements for spacecraft potential control in the magnetosphere and the solar wind even without on-board feedback from measurements of the spacecraft potential.

- The second stand-alone mode active mode controls the ion emission current to a constant value (mode IION).

- In the two available, so-called feedback modes, a measurement of the spacecraft potential is supplied to ASPOC by either the electric field experiment (EFW) or the electron analyser (PEACE) and this information is then used to adjust the emission current sufficient to reduce the potential to some predetermined value in a closed-loop scheme. This mode is called feedback mode with EFW (mode "FEFW") or feedback mode with PEACE (mode "FPEA"). The measurements of the spacecraft potential are updated once every spin and sent to ASPOC via dedicated serial, digital IEL interfaces. Data from EFW consist of the voltage measured between one pair of spheres and the spacecraft body when operating in voltage mode. The value is sampled every second and sent to the Digital Wave Processor (DWP) instrument, which combines it with operating mode information of the WHISPER instrument and transmits the product to ASPOC. The instrument PEACE attempts to calculate spacecraft potential from the distribution function of electrons in the range below about 25 V and transmits a value if the calculation was successful. If no data are available in feedback mode, ASPOC will return to a commandable "backup" mode, which can be another active mode or standby mode.

- In standby mode (STDB) both the emitters and their heaters are turned off. The standby mode is also the safe mode of the instrument, to which it returns autonomously under certain error conditions. The command into standby mode also clears all error flags, clears the previous emitter and module selection, disables high voltage, and disables the heaters.
- In order to reduce the time before emission starts, a “hot standby” mode (HOTS) keeps the indium in a liquid state. This mode can be used to interrupt the ion emission by command, without change of modes or emitters before and after the break. The re-ignition time is reduced to the time required to sweep the high voltage.
- A “test and commissioning” mode (T&C) describes a method to sweep the total ion current in steps lasting 8 or 16 s, and with 2 or 4 μA current increment. This mode has been used occasionally to establish the current-voltage characteristics of the spacecraft.
- Finally, the instrument features a technical mode (TECH) for low-level commanding.

3.2.4.1 Other Instrument States

Apart from the main operating modes described above there are a few special instrument states (also called "internal modes") which reflect either failure conditions (e.g. an unexpected absence of spacecraft potential data in feed-back mode) or technical constraints (e.g. during start-up of an emitter). The possible failure conditions are described in detail in [INST-UM]. They may be grouped into three categories:

1. Failure of one of the inter-experiment links from the instruments EFW/DWP or PEACE
2. Instrument WHISPER in active mode
3. Failure of the ion emitter, including: no ignition in start-up, no total current, voltage too high, heater failure.

All failure states of the instrument are cleared by the command into standby mode.

3.2.4.2 Precautions for WHISPER active modes.

It is anticipated that the WHISPER instrument in its active sounding modes may have a large effect on the measurements of the spacecraft potential and the potential itself, despite the fact that many instruments including EFW and PEACE have implemented blanking periods during the sounder pulses. If it is found necessary to discard the potential measurements by EFW or PEACE, or to turn off the ion beam altogether, the ASPOC instrument can be commanded to switch into a suitable backup mode set by telecommand whenever WHISPER is operating in a mode which has been found disturbing. This is accomplished by transmitting a three-bit WHISPER operating mode information in every spin period through DWP to ASPOC. ASPOC software reacts according to a decision table which has been set by time-tagged command. Constant ion beam current mode (IION) or standby (STDB) mode are possible backup modes.

If any interruption of the control loop with spacecraft potential data occurs while ASPOC is in feedback mode, the ion emission is kept at the last value for a few spin periods before ASPOC reacts on this timeout condition either by turning off the ion current or by setting it to a constant value, which has been pre-set by time-tagged command. In terms of operating modes this is a transition into standby, hot standby or one of the stand-alone modes.

3.2.4.3 Start-up

The description of modes would be incomplete without the start-up. Before emission can take place, the ion emitter must be heated. Depending on the ambient temperature it takes about 12 to 20 minutes to reach a temperature inside the emitters which is sufficient to ignite the ion beam. The period from the beginning of the heating until a few seconds after the ignition of the beam is defined as start-up period. Whenever ASPOC is commanded into a mode involving ion beam emission, the instrument begins a start-up cycle for an ion emitter. Note that within this period the "instrument mode" reported in telemetry is already according to the commanded target mode, whereas there is no ion emission during start-up yet.

When the indium has reached the necessary temperature for start-up, high voltage is turned on at 5 kV, and ramped upwards at a rate of about 40 V per second, until ignition occurs, or in the absence of ignition to the commanded highest voltage limit. Ignition is defined as an ion beam current exceeding 2.3 µA. After ignition, the high voltage supply is switched over to constant-current mode for the commanded current (either total current or beam current), or to one of the feedback modes.

3.2.4.4 Shutdown.

Turning off the ion beam is accomplished by switching into standby mode, which does not require any special procedures and can be commanded at any time. Shutdown goes into effect immediately.

3.2.4.5 Cleaning.

If the active emitter is contaminated (e.g. by sputter products) the high voltage starts to increase. When a certain threshold is exceeded, an automatic cleaning of the emitter may be initiated by on-board software. The cleaning consists of a short-term (up to 60 seconds) emission of a high current, which very likely removes contamination layers at the emitter. All parameters of the cleaning can be enabled or set by commands: the cleaning option can be enabled or disabled altogether, the threshold value to trigger cleaning can be set, the action after exceeding the threshold can be selected (either triggering of cleaning or switching into standby mode), and the duration and current of the cleaning cycle can be selected between two options. The same cleaning effect can also be achieved by time-tagged commands or procedures for short-time, high-current operation. It can also be carried out as a preventative measure.

3.2.5 Electronics

The instrument utilises a microprocessor for controlling the experiment and for data handling. It basically operates and controls the ion emitting system (high voltage and heater power), performs the start-up procedure of the emitters, and serves the interfaces to the on-board data handling and telecommand units, the double probe electric field instrument (EFW) and the low energy electron spectrometer (PEACE) providing spacecraft potential data in real-time. Special attention is paid to the monitoring and safety of the high voltage unit.

Because of the low data rate (108 bit s^{-1}) all ASPOC data are transmitted through the housekeeping channel. Complete status information is given every ~10.3 s (a part of the status telemetry is subcommutated 1:2).

The DC converter provides three fixed voltages (+5 V, +13.5 V, -5 V) and a variable output for the heater elements in the emitters. The high voltage unit can power one of the two emitter modules at a time in voltage or current controlled modes. Analogue monitors of the high voltage, the total output current at high voltage, and the effective ion beam current are provided. The latter measurement necessitates a special (=floating) grounding concept for the emitter supply unit. The ion beam current is equivalent to the return current across a current monitor between signal ground and the floating ground of the emitter supply unit. The power consumption consists of an almost constant component of ca. 1.5 W for the digital electronics and the heating of one emitter filament and a variable part which is largely proportional to the emitted ion current.

The DPU has a watch-dog timer. If a counter is not reset regularly by the program running in the DPU, it will perform a full reset of the DPU and a re-load of the programme from the PROM into the RAM after 8 seconds. The impact on telemetry is a reset of all parameters to the power-on state, a loss of data for up to 18 seconds, followed by standby operation of the instrument.

3.2.6 Hardware Summary

Table 3.1. Summary specifications for the instrument ASPOC

Mass	1930 g
Size	187 × 157 × 170 mm
Power	
Average	2.4 W
Peak	2.7 W
Telemetry rate	108 bit/s
Design lifetime	32 000 hours at 10 µA
Beam characteristics	
Species	In^+
Atomic mass	113, 115 amu
Energy	5.0 to 9.5 keV
Current	max. 50 µA, design: 10 µA
Opening angle	15° (half maximum)
Direction	along spin axis

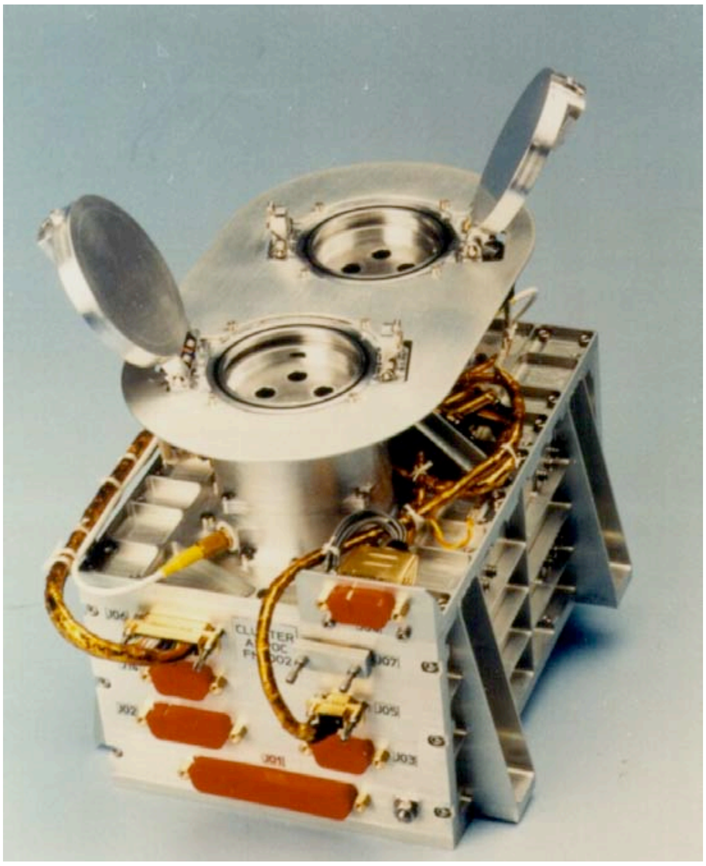

Fig. 3.2. The instrument ASPOC

3.3 Data Processing Chain

3.3.1 Onboard Software Architecture

After power-on or a reset by watchdog action the program is loaded from PROM into RAM. This process takes about 1.5 seconds. Thereafter the software is running in a main loop, performing tasks as required. The main loop cycle is as fast as processor speed permits. Without time-consuming functions being called within the loop, the execution time is about 32 ms. The fast loop tests if one of the following functions has to be called:

- switch mode into standby
- perform update calculation for total current in order to control the beam current in modes IION, FEFW and FPEA
- perform update calculation for ion beam current in order to control the spacecraft potential. This calculation, if executed, may take less than one second. The condition for this calculation is that the experiment is in a feedback mode (FEFW or FPEA) and valid spacecraft potential data are received, which occurs at a rate of one per second from EFW/DWP or one per spin from PEACE.
- Reset the watch-dog timer (a hardware counter). If this counter is not reset within 8 seconds, a full reset will occur and the instrument will be put in power-on status.

In addition to the above, every second a set of less time-critical functions is performed:

- process timeout counter
- update total current, if the experiment is in constant total current mode (ITOT) or test and commissioning mode (T&C)
- process one command from the command stack at the first full second after a reset pulse.

The impact of a watch-dog reset after malfunction of the DPU on telemetry are:

- about 8 seconds of erroneous or no data
- about 10 seconds without data while the program is loaded from PROM.
- thereafter the instrument will be in standby mode if the failure was temporary.
- reset of all telemetry parameters to the power-on state

3.3.2 Resolution of Onboard Monitors

Onboard electronics follows an 8-bit architecture. With few exceptions, all data are supplied as 8-bit values, and all command parameters have 8 bits. The exceptions are the spacecraft potential via IEL from EFW (12 bit) and some intermediate results of onboard calculations.

3.3.3 Command Execution Timing

ASPOC features a 256 element command stack in order to allow the reception of commands at a high rate. Commands from this stack are executed at a maximum rate of one command per reset pulse interval (~5.15 s). The presence of a command in the stack is interrogated in the 1-second program loop. After a reset pulse, this check is enabled and the command is executed after the first pass of the 1-second program loop following the reset pulse. That is, one command can be executed every ~5.15 s, with a jitter of ~1 s.

3.3.4 Ground Processing

The processing software operates from the ASPOC housekeeping data extracted from the Cluster Raw Data Media as shown in Fig. 3.2.

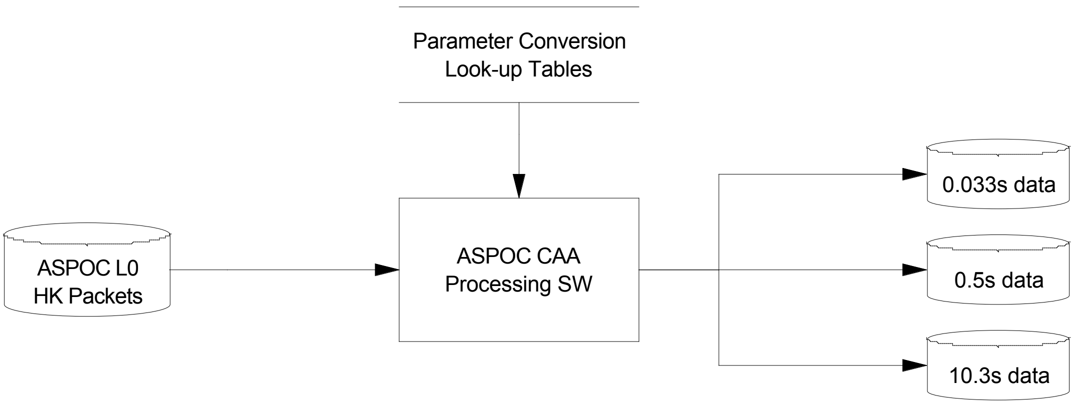

Figure 3.2. ASPOC data processing chain

The data sets are split based on time resolution. Data will be delivered in ASCII. No specific software is required for the end user. There are no plans to provide graphical products or software. Only simple line plots are required to visualise the ASPOC products and the generic plotting capabilities of the CAA should be sufficient for this purpose.

The batch processing for the major data products is performed in a single step. The processing includes the extraction of parameters from the raw data packets, conversion into engineering units using calibration and look-up tables, and calculation of the time stamps.

The caveat information consists of an automatically generated part and a manually generated part. The manual caveats are added to the data set after inspection of the data produced in the batch process using dedicated visualisation software. The automatically generated caveats shall help the user to assess the quality, i.e. stability over time, of the controlled spacecraft potential. The production software derives a quality parameter from the total current consumed by the ion emitter and the emitted ion current.

3.4 Instrument Data Products

3.4.1 Overview

There is a close relation between products measured by ASPOC and products available from the archive. The main data product is the ion beam current. Other data include the total current of the emitter supply, the beam energy, parameters of the emitter heaters and other housekeeping values. The transformation from raw data into archive data is mainly a decommutation, transformation into engineering units, and time stamping of the data.

3.4.2 Timing of Parameters within Housekeeping Packets

For status parameters, housekeeping data sampled at every reset pulse or every second reset pulse: Onboard software updates the values in the buffers at each main program loop cycle of 1 second. At the reception of the reset pulse on board, the telemetry packet is formed containing the latest data from these buffers and transferred to the OBDH still within the interval following this reset pulse. Therefore, the time associated to these parameters is close to the time of the reset pulse which triggers the transmission.

Some parameters are sampled only at every second reset pulse, but the archive data product contains values for every pulse. If no new data has been sampled, the previous value is repeated. This refers to beam energy, heater voltage, heater current, and temperature.

For ion and total current measured at 0.5 s intervals: The first data value in the packet has been measured 0.5 seconds after the reset pulse preceding the triggering pulse. There are 10 values each in a packet, measured every 0.5 s. As the reset pulse interval is longer than 5 s, the time step between the last value of a frame and the first value of the next frame is 0.15222 + 0.5 s.

For ion current snapshot values: High-resolution data are sampled in intervals of nominally 32.768 ms. One block of data contains 250 points, which are read out in telemetry over 25 frames. The beginning of a block is marked by a "high-resolution start" bit. The first data value in the start-frame is measured 0.5 seconds after the reset pulse, that is simultaneously with the first standard-resolution data point in the start-frame.

For IEL data received by EFW/DWP and PEACE: Timing is determined by the data source. ASPOC measures the time of data reception by counters. The first two both valid and "new" data from each source are stored and transmitted in ASPOC telemetry together with their time of reception. The term "new" means that the data value is different from the preceding data.

4 PRODUCT PROVISION - GENERAL CONVENTIONS AND CONSIDERATIONS

4.1 Formats

In general, the data products will be delivered in Cluster Exchange Format (CEF) version 2 as specified in [QMW-CEF].

Naming of the data products follows the proposal given in [CAA-NAME].

4.2 Standards

Metadata follow the convention given in [CAA-META].

CCSDS ASCII time standard will be used

Coordinate systems are not applicable for the ASPOC data sets.

All variables will be given in SI units.

4.3 Production Procedures

The Cluster/ASPOC archiving software is based on the Cluster/ASPOC pipelining software which is used to generate the PP and SP data products. Unlike the pipelining software the Intermediate Format Files (IFF) are not used in the archiving software. The data sets are generated directly from the DDS raw data files. The different data products for a given date range and spacecraft are generated simultaneously:

4.3.1 Usage of Data Archiving Software

```
---------------------------------------------------------------------------
Data Archiving Software - Usage
---------------------------------------------------------------------------

Usage:
    arc_data -s s_date [-e e_date] -i in_list [-o path] [-v version]
              -p product

Parameters:
    -s s_date   Start date [YYYY-MM-DD]
    -e e_date   End date [YYYY-MM-DD], default = start date
    -i in_list  List of DDS ASPOC HK files covering the date range
    -o out_path Output file path, default = local directory
    -v version  File version, default = 1
    -p product  Data product = IONC, IONS, STAT, CMDH or CAVEATS

Purpose:
    The program creates one of the following data products for the Cluster
    Active Archive (x=S/C, yyyymmdd=date, nn=version, CEF=2.0):

    - Cx_CP_ASP_IONC__yyyymmdd_Vnn.cef : ion beam current @ 0.5s
```

```
    - Cx_CP_ASP_IONS__yyyymmdd_Vnn.cef : current snapshot @ 0.033s
    - Cx_CP_ASP_STAT__yyyymmdd_Vnn.cef : extended status information
    - Cx_CP_ASP_CMDH__yyyymmdd_Vnn.cef : command execution history
    - Cx_CQ_ASP_CAVEATS__00000000_Vnn.cef : instrument caveats
```

4.3.2 Usage of Data Processing Script

In order to account for time shifts the provided raw data file list shall cover the given period extended by one day at the beginning and at the end. The file list must be sorted in ascending order. This is accomplished by means of a shell script

```
---------------------------------------------------------------------------
Data Processing Script - Usage
---------------------------------------------------------------------------

Usage:
    make_arc <start_date> [<end_date>] <sc> <product>

Purpose:
    Create Cluster/ASPOC archive data files for the given period.
    If <end_date> is omitted then <end_date> is set to <start_date>.

    The script generates a list of contemplable raw data files
    and calls the program 'arc_data' for each file.

Arguments:
    <start_date> ... YYYYMMDD (e.g. 20030829)
    <end_date>   ... YYYYMMDD (e.g. 20030829), optional
    <sc>         ... 1, 2, 3 or 4
    <product>    ... CAVEATS, CMDH, IONC, IONS or STAT
```

4.3.3 Data Processing Script Source

```
#/bin/csh -f
#++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++
```

```
# Project: Cluster Active Archive (CAA)
# Unit: ASPOC archive data production
# Module: Calling script for archiving software
# Purpose: Creates Cluster/ASPOC archive data files for the given period.
# Mod history: v1.0
#+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++

set sdir = /home/cluster/raw
#set sdir = ./cdrom
set tdir = arc
set logf = arc_data.log
set errmsg = "Script execution error."

if ( -e $logf ) then
    rm -f $logf
endif
touch $logf

# check arguments
if ( $#argv < 3 || $#argv > 4) then
  set errmsg = "Wrong number of arguments."
  goto abort
endif

# check dates and spacecraft

@ idxEnd = $#argv - 2
@ idxSc  = $#argv - 1

set start_date = `date -d $argv[1] +%Y%m%d`
set end_date = `date -d $argv[$idxEnd] +%Y%m%d`
set sc = $argv[$idxSc]
set product = $argv[$#argv]

if ($start_date != $argv[1]) then
  set errmsg = "Start date format error."
  goto abort
endif

if ($end_date != $argv[$idxEnd]) then
  set errmsg = "End date format error."
  goto abort
endif

if ($sc !~ [1-4]) then
  set errmsg = "Invalid spacecraft identifier."
  goto abort
endif

if ($product != CAVEATS && $product != CMDH && $product !~ ION[CS] &&
$product !~ STAT) then
  set errmsg = "Invalid data product."
  goto abort
endif
```

```
# start archive data file generation

set fdir = ${sdir}/cluster${sc}/hkd_${sc}
@ np = `echo $fdir | wc -c` + 10
@ vp = $np + 1
set sstr = "-k 1.${np},1.${np} -k 1.${vp},1.${vp}r"
set ustr = "-w ${np}"
set s_date = `date -d ${start_date} +%Y-%m-%d`
set e_date = `date -d ${end_date} +%Y-%m-%d`
set i_file = ${tdir}/c${sc}_${start_date}_${end_date}.lst
set o_file = ${tdir}/

if ( -e $i_file ) then
    rm -f $i_file
endif
touch $i_file

# extend time range by 1 day to cover time shifting

@ start_date--
set start_date = `date -d ${start_date} +%Y%m%d`
@ end_date++
set end_date = `date -d ${end_date} +%Y%m%d`
@ exec_time = `date +%s`

echo "Creating file list $i_file ..."
set file_date = $start_date
while ($file_date <= $end_date)
  set dstr = `date -d ${file_date} +%y%m%d`

  find ${fdir} -name ${dstr}ah."??"${sc} | sort ${sstr} | uniq ${ustr} >>
${i_file}

  @ file_date++
  set file_date = `date -d ${file_date} +%Y%m%d`
end

echo "Executing archiving software ..."
arc_data -s ${s_date} -e ${e_date} -i ${i_file} -o ${o_file} -p ${product}
#  >> ${logf}

@ exec_time = `date +%s` - $exec_time

goto end

#

abort:
echo ""
echo "% ${errmsg}"
echo ""
echo "Usage:"
echo "    make_arc <start_date> [<end_date>] <sc> <product>"
echo ""
```

```
echo "Purpose:"
echo "    Create Cluster/ASPOC archive data files for the given period."
echo "    If <end_date> is omitted then <end_date> is set to <start_date>."
echo ""
echo "    The script generates a list of contemplable raw data files"
echo "    and calls the program 'arc_data' for each file."
echo ""
echo "Arguments:"
echo "    <start_date> ... YYYYMMDD (e.g. 20030829)"
echo "    <end_date>   ... YYYYMMDD (e.g. 20030829), optional"
echo "    <sc>         ... 1, 2, 3 or 4"
echo "    <product>    ... CAVEATS, CMDH, IONC, IONS or STAT"
echo ""
exit

#

end:
echo FINISHED in $exec_time seconds.
exit
```

For each data product there will be one file per instrument and day, with the exception of the instrument caveats file, which will be one file per instrument covering the entire mission.

4.4 Quality Control Procedures

Quality control includes visual inspection of plots produced from all data products, and spot-checks of the data products proper.

There is software in place to visualize the data products in combined displays, which facilitates the detection of inconsistencies and anomalies.

The consistency between data products will be checked in many aspects including:

- Correlation between ion current and spacecraft potential
- Correlation between ion current and total current flowing into the emitter
- Correlation between currents in the emitter system and the derived quality flag
- Correlation between ion current data products at different time resolutions
- Correlation between instrument status and ion emission. This includes several checks, such as ion emission cannot occur with cold heater, in some instrument modes, without voltage applied to emitter.

Some of these checks can be carried out by the production software and raise warning messages. The other checks will be carried out manually/visually.

The consistency between ASPOC data products, in particular with respect to timing, and the spacecraft potential delivered by EFW has been spot-checked during the software development phase, and will be checked occasionally during the production phase.

If an anomaly is found, which is related to the processing software, the production will be stopped, and new versions of data products will be generated after correction.

If an identified anomaly can be attributed to the instrument performance or status, a new entry into the caveats file will be generated.

The dedicated display software also supports manual entries into the caveats file.

In order to check the quality of the data products, not only the dedicated software will be used, but also the CEF parser and QTRAN will be used to check the syntax of the products.

4.5 Delivery Procedures

Data sets will be produced at IWF Graz and delivered to the CAA using secure FTP to the server caa.estec.esa.int.

Timetable will comply with agreed top-level schedule. It is planned to deliver new products in 6-months intervals.

The four instrument caveat files will cover the entire mission. Any new delivery of this type of file will replace all previous versions for the instrument concerned.

For the other data products there will be one file per instrument and day. A new delivery may contain new versions of previously delivered files.

5 PRODUCT PROVISION - SPECIFIC DESCRIPTIONS

5.1 IONC

This product contains the ASPOC ion beam current at a sampling interval of ~0.5 s.

5.1.1 Formats

No deviation from general conventions.

5.1.2 Standards

No deviation from general conventions.

5.1.3 Production Procedures

No deviation from general conventions.

5.1.4 Quality Control Procedures

The quality control procedures described in section 4.4 will be applied. In particular, the ion beam current will be checked for:

- Correlation between ion current and spacecraft potential
- Correlation between ion current and total current flowing into the emitter
- Correlation with snapshot ion current data at 0.033 s time resolution
- Correlation between instrument status and ion emission. This includes several checks, such as ion emission cannot occur with cold heater, in some instrument modes, without voltage applied to emitter.

5.1.5 Delivery Procedures

No deviation from general conventions.

5.1.6 Product Specification

This product contains time and the ASPOC ion beam current at a sampling interval of ~0.5 s. There is a small irregularity in the time spacing as follows. The first data value in any reset pulse interval (data frame) on board is measured 0.5 seconds after the reset pulse. The 10th value is measured 5.0 seconds after the reset pulse, therefore the time step between the last value of a frame and the first value of the next frame is 0.15222 + 0.5 s.

The resolution is 0.1961 µA/digit

5.1.6.1 Variable Time

```
START_VARIABLE = time_tags__C3_CP_ASP_IONC
    PARAMETER_TYPE = "Support_Data"
    CATDESC = "Interval centered time tag"
```

```
    UNITS = "s"
    SI_CONVERSION = "1.0>s"
    VALUE_TYPE = ISO_TIME
    SIGNIFICANT_DIGITS = 23
    FILLVAL = 9999-12-31T23:59:59Z
    FIELDNAM = "Universal Time"
    LABLAXIS = "UT"
    DELTA_PLUS = 0.25
    DELTA_MINUS = 0
END_VARIABLE = time_tags__C3_CP_ASP_IONC
```

5.1.6.2 Variable Ion_current

```
START_VARIABLE = Ion_current__C3_CP_ASP_IONC
    PARAMETER_TYPE = "Data"
    ENTITY = "Ion"
    PROPERTY = "Current"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Cluster C3 Ion emission current, 0.5s
resolution"
    UNITS = "uA"
    SI_CONVERSION = "1.0E-6>A"
    VALUE_TYPE = FLOAT
    SIGNIFICANT_DIGITS = 6
    FILLVAL = -1E+30
    FIELDNAM = "Ion Emission Current"
    SCALETYP = "Linear"
    LABLAXIS = "Ion Current"
    DEPEND_0 = "time_tags__C3_CP_ASP_IONC"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*C3_CQ_ASP_IONC_"
    QUALITY = "0"
END_VARIABLE = Ion_current__C3_CP_ASP_IONC
```

5.1.7 Metadata Specification

Relevant header files above dataset level (see Section 5.6):

FILENAME	CONTENTS
CL_CH_MISSION.ceh	Mission level metadata
CL_CH_ASP_EXP.ceh	Experiment level metadata
Cn_CH_OBS.ceh	Observatory level metadata (n=1...4)
CL_CH_ASPOCn_INST.ceh	Instrument level metadata (n=1...4)

Dataset-specific header files:

FILENAME (EXAMPLE)	CONTENTS
Cn_CH_ASP_IONC_DATASET.ceh	Metadata for the dataset as a

	whole
Cn_CH_ASP_IONC_PARAMETER.ceh	Metadata for parameters inside the dataset

Metadata for this dataset, contained in file Cn_CH_ASP_IONC_DATASET.ceh:

METADATA	**ENTRY (EXAMPLE)**
DATASET_ID	"C3_CP_ASP_IONC"
DATA_TYPE	"CP>CAA Parameter"
DATASET_TITLE	"Ion emission current, 0.5s resolution"
DATASET_DESCRIPTION	"This dataset contains measurements of the ion emission current from the ASPOC experiment on the Cluster C3 spacecraft."
CONTACT_COORDINATES	"KlausTorkar>PI>Klaus.Torkar@oeaw.ac.at"
TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.500000
MIN_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.500000
MAX_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.500000
PROCESSING_LEVEL	"Calibrated"
DATASET_CAVEATS	"*CL_CQ_ASP_IONC_"
ACKNOWLEDGMEMENT	"Please acknowledge the instrument team and ESA Cluster Active Archive when using this data."

Metadata for this dataset inside the data file:

METADATA	**ENTRY (EXAMPLE)**
FILE_NAME	"C3_CP_ASP_IONC__20030801_V01.cef"
FILE_FORMAT_VERSION	"CEF-2.0"
END_OF_RECORD_MARKER	"$"
LOGICAL_FILE_ID	"C3_CP_ASP_IONC__20030801_V01"
VERSION_NUMBER	"1"
FILE_TYPE	"cef"
METADATA_TYPE	"CAA"
FILE_TIME_SPAN	VALUE_TYPE = ISO_TIME_RANGE
	2003-08-01T00:00:00Z/2003-08-02T00:00:00Z
GENERATION_DATE	VALUE_TYPE = ISO_TIME
	2004-11-26T10:24:52Z
FILE_CAVEATS	"TBW"
DATASET_VERSION	"1_0"

5.2 IONS

This product contains the ASPOC ion beam current at a sampling interval of ~0.033 s.

5.2.1 Formats

Note that this file contains snapshot data, i.e., the time intervals covered by the given sampling rate are separated by gaps.

5.2.2 Standards

No deviation from general conventions.

5.2.3 Production Procedures

No deviation from general conventions.

5.2.4 Quality Control Procedures

The quality control procedures described in section 4.4 will be applied. In particular, the snapshot ion beam current will be checked for correlation with ion beam current data at 0.5 s time resolution.

5.2.5 Delivery Procedures

No deviation from general conventions.

5.2.6 Product Specification

This product contains time and the ASPOC ion beam current at a sampling interval of ~0.033 s.

High-resolution data are sampled in intervals of nominally 32.768 ms. One block of data contains 250 points, which are read out in telemetry over 25 frames. The beginning of a block is marked by a "high-resolution start" bit. The first data value in the start-frame is measured 0.5 seconds after the reset pulse, that is simultaneously with the first standard-resolution data point in the start-frame.

The resolution is 0.1961 µA/digit

5.2.6.1 Variable Time

```
START_VARIABLE = time_tags__C3_CP_ASP_IONS
    PARAMETER_TYPE = "Support_Data"
    CATDESC = "Interval centered time tag"
    UNITS = "s"
    SI_CONVERSION = "1.0>s"
    VALUE_TYPE = ISO_TIME
    SIGNIFICANT_DIGITS = 23
    FILLVAL = 9999-12-31T23:59:59Z
    FIELDNAM = "Universal Time"
    LABLAXIS = "UT"
    DELTA_PLUS = 0.25
    DELTA_MINUS = 0
```

```
END_VARIABLE = time_tags__C3_CP_ASP_IONS
```

5.2.6.2 Variable Ion_current

```
START_VARIABLE = Ion_current__C3_CP_ASP_IONS
    PARAMETER_TYPE = "Data"
    ENTITY = "Ion"
    PROPERTY = "Current"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Cluster C3 Ion current snapshot, 0.033s
resolution"
    UNITS = "uA"
    SI_CONVERSION = "1.0E-6>A"
    VALUE_TYPE = FLOAT
    SIGNIFICANT_DIGITS = 6
    FILLVAL = -1E+30
    FIELDNAM = "Ion Emission Current"
    SCALETYP = "Linear"
    LABLAXIS = "Ion Current"
    DEPEND_0 = "time_tags__C3_CP_ASP_IONS"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*C3_CQ_ASP_IONS_"
    QUALITY = "0"
END_VARIABLE = Ion_current__C3_CP_ASP_IONS
```

5.2.7 Metadata Specification

Relevant header files above dataset level (see Section 5.6):

FILENAME	CONTENTS
CL_CH_MISSION.ceh	Mission level metadata
CL_CH_ASP_EXP.ceh	Experiment level metadata
Cn_CH_OBS.ceh	Observatory level metadata (n=1...4)
CL_CH_ASPOCn_INST.ceh	Instrument level metadata (n=1...4)

Dataset-specific header files:

FILENAME (EXAMPLE)	CONTENTS
Cn_CH_ASP_IONS_DATASET.ceh	Metadata for the dataset as a whole
Cn_CH_ASP_IONS_PARAMETER.ceh	Metadata for parameters inside the dataset

Metadata for this dataset, contained in file Cn_CH_ASP_IONS_DATASET.ceh:

METADATA	ENTRY (EXAMPLE)
DATASET_ID	"C3_CP_ASP_IONS"
DATA_TYPE	"CP>CAA Parameter"

DATASET_TITLE	"Ion emission current, 0.5s resolution"
DATASET_DESCRIPTION	"This dataset contains high resolution snapshots of the ion current from the ASPOC experiment on the Cluster C3 spacecraft."
CONTACT_COORDINATES	"KlausTorkar>PI>Klaus.Torkar@oeaw.ac.at"
TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.003300
MIN_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.003300
MAX_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.003300
PROCESSING_LEVEL	"Calibrated"
DATASET_CAVEATS	"*CL_CQ_ASP_IONS_"
ACKNOWLEDGMEMENT	"Please acknowledge the instrument team and ESA Cluster Active Archive when using this data."

Metadata for this dataset inside the data file:

METADATA	**ENTRY (EXAMPLE)**
FILE_NAME	"C3_CP_ASP_IONS__20030801_V01.cef"
FILE_FORMAT_VERSION	"CEF-2.0"
END_OF_RECORD_MARKER	"$"
LOGICAL_FILE_ID	"C3_CP_ASP_IONS__20030801_V01"
VERSION_NUMBER	"1"
FILE_TYPE	"cef"
METADATA_TYPE	"CAA"
FILE_TIME_SPAN	VALUE_TYPE = ISO_TIME_RANGE
	2003-08-01T00:00:00Z/2003-08-02T00:00:00Z
GENERATION_DATE	VALUE_TYPE = ISO_TIME
	2004-11-26T10:24:52Z
FILE_CAVEATS	"TBW"
DATASET_VERSION	"1_0"

5.3 STAT

This product contains status and housekeeping information at a sampling interval of ~5.15 s.

5.3.1 Formats

No deviation from general conventions.

5.3.2 Standards

No deviation from general conventions.

5.3.3 Production Procedures

No deviation from general conventions.

5.3.4 Quality Control Procedures

The quality control procedures described in section 4.4 will be applied. In particular, the status information will be checked for consistency with the ion emission. This includes several checks, such as ion emission cannot occur with cold heater, in some instrument modes, without voltage applied to emitter.

5.3.5 Delivery Procedures

No deviation from general conventions.

5.3.6 Product Specification

5.3.6.1 Variable Time

General caveats on validity: Status data are provided every ~5.15 s, even if the raw value obtained on board has been subcommutated and is only available every ~10.3 s, in which case the previous value is repeated.

```
START_VARIABLE = time_tags__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Support_Data"
    CATDESC = "Interval centered time tag"
    UNITS = "s"
    SI_CONVERSION = "1.0>s"
    VALUE_TYPE = ISO_TIME
    SIGNIFICANT_DIGITS = 23
    FILLVAL = 9999-12-31T23:59:59Z
    FIELDNAM = "Universal Time"
    LABLAXIS = "UT"
    DELTA_PLUS = 0.25
    DELTA_MINUS = 0
END_VARIABLE = time_tags__C3_CP_ASP_STAT
```

5.3.6.2 Variable Operating_mode

General caveats on validity: During the start-up of an emitter, the variable already reflects the operating mode after completion of the start-up.

Possible values:

Bits	Value	Mode
2-0	0 1 2 3 4 5 6 7	STDB, standby ITOT, constant total current IION, constant beam current not used HOTS, hot standby T&C, test and commissioning TECH, technical FPEA, feedback from PEACE
3	0 1	no startup Startup in progress
4	0 1	no cleaning Cleaning is active
7-0	255	Mode undefined

Onboard sampling interval : ~5.15 s

```
START_VARIABLE = Operating_mode__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Translation of the operating mode (0-7) and
startup mode (8)"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    VALUE_TYPE = INT
    SIGNIFICANT_DIGITS = 1
    FILLVAL = -1
    FIELDNAM = "Operating Mode"
    LABLAXIS = "Operating Mode"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*C3_CQ_ASP_STAT_"
    QUALITY = "0"
END_VARIABLE = Operating_mode__C3_CP_ASP_STAT
```

5.3.6.3 Variable Filament_number

General caveats on validity: Filament_number is set by telecommand before the emitter is started. The variable remains set also after the emitter has shut down, until another emitter is selected.

Possible values: 0 ... 3

Onboard sampling interval : ~5.15 s

```
START_VARIABLE = Filament_number__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Translation of the selected filament
(0=Filament 1, ..., 3=Filament 4)"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    VALUE_TYPE = INT
    SIGNIFICANT_DIGITS = 1
    FILLVAL = -1
    FIELDNAM = "Filament Number"
    LABLAXIS = "Filament Number"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_STAT_"
    QUALITY = "0"
END_VARIABLE = Filament_number__C3_CP_ASP_STAT
```

5.3.6.4 *Variable Module_number*

General caveats on validity: Module_number is set by telecommand before the emitter is started. The variable remains set also after the emitter has shut down, until another module is selected.

Possible values: 0 ... 1

Onboard sampling interval : ~5.15 s

```
START_VARIABLE = Module_number__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Translation of the module select monitor
(0=Module A, 1=Module B)"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    VALUE_TYPE = INT
    SIGNIFICANT_DIGITS = 1
    FILLVAL = -1
    FIELDNAM = "Module Number"
    LABLAXIS = "Module Number"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_STAT_"
    QUALITY = "0"
```

```
END_VARIABLE = Module_number__C3_CP_ASP_STAT
```

5.3.6.5 Variable Timeout_flags

General caveats on validity: Timeout_flags are error flags indicating a malfunction, very often a malfunction of an emitter. The name comes from the fact that onboard software typically waits for the recovery from an anomalous situation for a set time. When this wait period expires, onboard software typically switches the instrument into standby mode and sets the appropriate Timeout_flag. This flag remains set until the next standby mode command is received.

Possible values:

Bits	Value	Flag
7-0	0	OK
0	1	No ignition (beam current stays below threshold)
1	1	No beam current (total current drops below limit)
2		*not used*
3	1	PEACE data not valid
4	1	Calculated ion current not valid
5	1	Maximum feedback wait period exceeded
6	1	Cleaning timeout has occurred

Onboard sampling interval : ~5.15 s

```
START_VARIABLE = Timeout_flags__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Translation of the timeout flags (bitmasked, 6
Bits)"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    VALUE_TYPE = INT
    SIGNIFICANT_DIGITS = 2
    FILLVAL = -1
    FIELDNAM = "Timeout Flags"
    LABLAXIS = "Timeout Flags"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_STAT_"
    QUALITY = "0"
END_VARIABLE = Timeout_flags__C3_CP_ASP_STAT
```

5.3.6.6 Variable Beam_energy

General caveats on validity: As the onboard sampling interval is twice the archive data interval, every second value is a copy of the preceding value. The high voltage of the emitter supply is used as a proxy for the beam energy. This is not valid in case of no ignition of the emitter.

Resolution : 0.03921 keV/digit

Onboard sampling interval : ~10.3 s

```
START_VARIABLE = Beam_energy__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Potential"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Energy of the emitted ion beam in keV"
    UNITS = "keV"
    SI_CONVERSION = "1.0E+3>eV"
    VALUE_TYPE = FLOAT
    SIGNIFICANT_DIGITS = 6
    FILLVAL = -1E+30
    FIELDNAM = "Beam Energy"
    SCALETYP = "Linear"
    LABLAXIS = "Beam Energy"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_STAT_"
    QUALITY = "0"
END_VARIABLE = Beam_energy__C3_CP_ASP_STAT
```

5.3.6.7 Variable Total_current

General caveats on validity: Total_current reflects the output current of the high voltage supply to the emitter. There are two main reasons why this current may differ from the ion beam current: a) an internal (ion) current from the emitter tip to the extractor electrode, b) another loss current from high voltage to ground. In constant total current mode of the instrument, which is its nominal mode, the total current is set to a constant value. If the internal losses are small, this mode results in an almost constant ion emission current. The situation becomes less ideal if loss currents are present. The emitted ion current is the difference between the total current and the loss current, and will start to fluctuate in antiphase to the with the variations of the loss currents.

Resolution : 0.3921 µA/digit

Onboard sampling interval : ~0.5 s

```
START_VARIABLE = Total_current__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Current"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Total output current of the high voltage supply
in uA"
    UNITS = "uA"
    SI_CONVERSION = "1.0E-6>A"
    VALUE_TYPE = FLOAT
    SIGNIFICANT_DIGITS = 6
    FILLVAL = -1E+30
    FIELDNAM = "Total Current"
    SCALETYP = "Linear"
    LABLAXIS = "Total Current"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_STAT_"
    QUALITY = "0"
END_VARIABLE = Total_current__C3_CP_ASP_STAT
```

5.3.6.8 Variable Filament_current

General caveats on validity: As the onboard sampling interval is twice the archive data interval, every second value is a copy of the preceding value. Filament refers to the heater element of the active emitter. Filament_current and Filament_voltage can be used to determine the status of the heater including power consumption and temperature. The temperature of the heater can be derived from the impedance through the standard Pt100 characteristic according to DIN EN 60751 for the temperature range 0°C ... +399°C given below.

Table 5.1: Impedance of Pt-100 sensors acc. DIN EN 60751 for the temperature range 0°C ... +399°C

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12	103.51	103.90
10	103.90	104.29	104.68	105.07	105.46	105.85	106.24	106.63	107.02	107.40	107.79
20	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90	111.29	111.67
30	111.67	112.06	112.45	112.83	113.22	113.61	114.00	114.38	114.77	115.15	115.54
40	115.54	115.93	116.31	116.70	117.08	117.47	117.86	118.24	118.63	119.01	119.40
50	119.40	119.78	120.17	120.55	120.94	121.32	121.71	122.09	122.47	122.86	123.24
60	123.24	123.63	124.01	124.39	124.78	125.16	125.54	125.93	126.31	126.69	127.08
70	127.08	127.46	127.84	128.22	128.61	128.99	129.37	129.75	130.13	130.52	130.90
80	130.90	131.28	131.66	132.04	132.42	132.80	133.18	133.57	133.95	134.33	134.71
90	134.71	135.09	135.47	135.85	136.23	136.61	136.99	137.37	137.75	138.13	138.51
100	138.51	138.88	139.26	139.64	140.02	140.40	140.78	141.16	141.54	141.91	142.29
110	142.29	142.67	143.05	143.43	143.80	144.18	144.56	144.94	145.31	145.69	146.07
120	146.07	146.44	146.82	147.20	147.57	147.95	148.33	148.70	149.08	149.46	149.83

130	149.83	150.21	150.58	150.96	151.33	151.71	152.08	152.46	152.83	153.21	153.58
140	153.58	153.96	154.33	154.71	155.08	155.46	155.83	156.20	156.58	156.95	157.33
150	157.33	157.70	158.07	158.45	158.82	159.19	159.56	159.94	160.31	160.68	161.05
160	161.05	161.43	161.80	162.17	162.54	162.91	163.29	163.66	164.03	164.40	164.77
170	164.77	165.14	165.51	165.89	166.26	166.63	167.00	167.37	167.74	168.11	168.48
180	168.48	168.85	169.22	169.59	169.96	170.33	170.70	171.07	171.43	171.80	172.17
190	172.17	172.54	172.91	173.28	173.65	174.02	174.38	174.75	175.12	175.49	175.86
200	175.86	176.22	176.59	176.96	177.33	177.69	178.06	178.43	178.79	179.16	179.53
210	179.53	179.89	180.26	180.63	180.99	181.36	181.72	182.09	182.46	182.82	183.19
220	183.19	183.55	183.92	184.28	184.65	185.01	185.38	185.74	186.11	186.47	186.84
230	186.84	187.20	187.56	187.93	188.29	188.66	189.02	189.38	189.75	190.11	190.47
240	190.47	190.84	191.20	191.56	191.92	192.29	192.65	193.01	193.37	193.74	194.10
250	194.10	194.46	194.82	195.18	195.55	195.91	196.27	196.63	196.99	197.35	197.71
260	197.71	198.07	198.43	198.79	199.15	199.51	199.87	200.23	200.59	200.95	201.31
270	201.31	201.67	202.03	202.39	202.75	203.11	203.47	203.83	204.19	204.55	204.90
280	204.90	205.26	205.62	205.98	206.34	206.70	207.05	207.41	207.77	208.13	208.48
290	208.48	208.84	209.20	209.56	209.91	210.27	210.63	210.98	211.34	211.70	212.05
300	212.05	212.41	212.76	213.12	213.48	213.83	214.19	214.54	214.90	215.25	215.61
310	215.61	215.96	216.32	216.67	217.03	217.38	217.74	218.09	218.44	218.80	219.15
320	219.15	219.51	219.86	220.21	220.57	220.92	221.27	221.63	221.98	222.33	222.68
330	222.68	223.04	223.39	223.74	224.09	224.45	224.80	225.15	225.50	225.85	226.21
340	226.21	226.56	226.91	227.26	227.61	227.96	228.31	228.66	229.02	229.37	229.72
350	229.72	230.07	230.42	230.77	231.12	231.47	231.82	232.17	232.52	232.87	233.21
360	233.21	233.56	233.91	234.26	234.61	234.96	235.31	235.66	236.00	236.35	236.70
370	236.70	237.05	237.40	237.74	238.09	238.44	238.79	239.13	239.48	239.83	240.18
380	240.18	240.52	240.87	241.22	241.56	241.91	242.26	242.60	242.95	243.29	243.64
390	243.64	243.99	244.33	244.68	245.02	245.37	245.71	246.06	246.40	246.75	247.09

Resolution : 0.3922 mA/digit

Onboard sampling interval : ~10.3 s

```
START_VARIABLE = Filament_current__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Current"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Value of the filament current monitor in mA"
    UNITS = "mA"
    SI_CONVERSION = "1.0E-3>A"
    VALUE_TYPE = FLOAT
    SIGNIFICANT_DIGITS = 6
    FILLVAL = -1E+30
    FIELDNAM = "Filament Current"
    SCALETYP = "Linear"
    LABLAXIS = "Filament Current"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_STAT_"
    QUALITY = "0"
END_VARIABLE = Filament_current__C3_CP_ASP_STAT
```

5.3.6.9 Variable Filament_voltage

General caveats on validity: As the onboard sampling interval is twice the archive data interval, every second value is a copy of the preceding value. Filament refers to the heater element of the active emitter. Filament_current and Filament_voltage can be used to determine the status of the heater including power consumption and temperature. The temperature of the heater can be derived from the impedance through the standard Pt100 characteristic according to DIN EN 60751 for the temperature range 0°C ... +399°C given above.

Resolution : 0.0588 V/digit

Onboard sampling interval : ~10.3 s

```
START_VARIABLE = Filament_voltage__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Potential"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Value of the filament voltage monitor in V"
    UNITS = "V"
    SI_CONVERSION = "1.0E+0>V"
    VALUE_TYPE = FLOAT
    SIGNIFICANT_DIGITS = 6
    FILLVAL = -1E+30
    FIELDNAM = "Filament Voltage"
    SCALETYP = "Linear"
    LABLAXIS = "Filament Voltage"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_STAT_"
    QUALITY = "0"
END_VARIABLE = Filament_voltage__C3_CP_ASP_STAT
```

5.3.6.10 Variable SC_potential

General caveats on validity:

The variable contains the raw measurement of the potential between the spacecraft body and the average potential of one pair of probes by EFW. It is **not** identical to the potential between the spacecraft and the ambient plasma.

The data received from EFW/DWP through the IEL may have been flagged invalid by these instruments. In this case the variable contains fill values.

The sounder instrument WHISPER may have significant impact on the raw potential data by EFW. This data set does **not** filter out any spikes due to WHISPER.

This data set is intended to document the data sent over the IEL for technical purposes. "Clean" spacecraft potential data for scientific analysis should be taken from the data sets provided by EFW.

Resolution : 0.034 V/digit

Onboard sampling interval : 1 spin period

```
START_VARIABLE = SC_potential__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Potential
    FLUCTUATIONS = "Waveform"
    CATDESC = "Spacecraft potential provided by EFW in V"
    UNITS = "V"
    SI_CONVERSION = "1.0E+0>V"
    VALUE_TYPE = FLOAT
    SIGNIFICANT_DIGITS = 6
    FILLVAL = -1E+30
    FIELDNAM = "EFW Spacecraft Potential"
    SCALETYP = "Linear"
    LABLAXIS = "S/C Potential"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_STAT_"
    QUALITY = "0"
END_VARIABLE = SC_potential__C3_CP_ASP_STAT
```

5.3.6.11 Variable Temperature

General caveats on validity: As the onboard sampling interval is twice the archive data interval, every second value is a copy of the preceding value.

Resolution : 1.942 °C/digit

Onboard sampling interval : ~10.3 s

```
START_VARIABLE = Temperature__C3_CP_ASP_STAT
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Temperature"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Temperature near the covers of the emitter
modules in degC"
    UNITS = "degC"
    SI_CONVERSION = "1.0E+0>degC"
    VALUE_TYPE = FLOAT
```

```
    SIGNIFICANT_DIGITS = 6
    FILLVAL = -1E+30
    FIELDNAM = "Temperature at LMIS cover"
    SCALETYP = "Linear"
    LABLAXIS = "Temperature"
    DEPEND_0 = "time_tags__C3_CP_ASP_STAT"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_STAT_"
    QUALITY = "0"
END_VARIABLE = Temperature__C3_CP_ASP_STAT
```

5.3.7 *Metadata Specification*

Relevant header files above dataset level (see Section 5.6):

FILENAME	CONTENTS
CL_CH_MISSION.ceh	Mission level metadata
CL_CH_ASP_EXP.ceh	Experiment level metadata
Cn_CH_OBS.ceh	Observatory level metadata (n=1...4)
CL_CH_ASPOCn_INST.ceh	Instrument level metadata (n=1...4)

Dataset-specific header files:

FILENAME (EXAMPLE)	CONTENTS
Cn_CH_ASP_STAT_DATASET.ceh	Metadata for the dataset as a whole
Cn_CH_ASP_STAT_PARAMETER.ceh	Metadata for parameters inside the dataset

Metadata for this dataset, contained in file Cn_CH_ASP_STAT_DATASET.ceh:

METADATA	ENTRY (EXAMPLE)
DATASET_ID	"C3_CP_ASP_STAT"
DATA_TYPE	"CP>CAA Parameter"
DATASET_TITLE	"ASPOC extended status, 5.15s resolution"
DATASET_DESCRIPTION	"This dataset contains status information from the ASPOC experiment on the Cluster C3 spacecraft."
CONTACT_COORDINATES	"KlausTorkar>PI>Klaus.Torkar@oeaw.ac.at"
TIME_RESOLUTION	VALUE_TYPE = FLOAT
	5.150000
MIN_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	5.150000
MAX_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	5.150000
PROCESSING_LEVEL	"Calibrated"

DATASET_CAVEATS	"*CL_CQ_ASP_STAT_"
ACKNOWLEDGMEMENT	"Please acknowledge the instrument team and ESA Cluster Active Archive when using this data."

Metadata for this dataset inside the data file:

METADATA	ENTRY (EXAMPLE)
FILE_NAME	"C3_CP_ASP_STAT__20030801_V01.cef"
FILE_FORMAT_VERSION	"CEF-2.0"
END_OF_RECORD_MARKER	"$"
LOGICAL_FILE_ID	"C3_CP_ASP_STAT__20030801_V01"
VERSION_NUMBER	"1"
FILE_TYPE	"cef"
METADATA_TYPE	"CAA"
FILE_TIME_SPAN	VALUE_TYPE = ISO_TIME_RANGE
	2003-08-01T00:00:00Z/2003-08-02T00:00:00Z
GENERATION_DATE	VALUE_TYPE = ISO_TIME
	2004-11-26T10:24:52Z
FILE_CAVEATS	"TBW"
DATASET_VERSION	"1_0"

5.4 CMDH

This product contains the Telecommand History of ASPOC with the time stamps of the onboard execution. The added value to the global command history data of the mission is related to the fact that the instrument internally delays the execution of telecommands after the reception of the command at the interface to the spacecraft. A command is executed by the instrument at the time when the first reset pulse after command reception is distributed on the spacecraft. Only one command is executed at each reset pulse. Up to 254 commands can be buffered in the instrument before execution.

In addition to this exact timing information this product provides all information about the commands including textual description and parameter values in engineering units.

5.4.1 Formats

No deviation from general conventions.

5.4.2 Standards

No deviation from general conventions.

5.4.3 Production Procedures

No deviation from general conventions.

5.4.4 Quality Control Procedures

The quality control procedures described in section 4.4 will be applied. In particular, the command history will be checked for consistency with the instrument status.

5.4.5 Delivery Procedures

No deviation from general conventions.

5.4.6 Product Specification

5.4.6.1 Variable Time

```
START_VARIABLE = time_tags__C3_CP_ASP_CMDH
    PARAMETER_TYPE = "Support_Data"
    CATDESC = "Interval centered time tag"
    UNITS = "s"
    SI_CONVERSION = "1.0>s"
    VALUE_TYPE = ISO_TIME
    SIGNIFICANT_DIGITS = 23
    FILLVAL = 9999-12-31T23:59:59Z
    FIELDNAM = "Universal Time"
    LABLAXIS = "UT"
    DELTA_PLUS = 0.25
    DELTA_MINUS = 0
END_VARIABLE = time_tags__C3_CP_ASP_CMDH
```

5.4.6.2 Variable Cmd_counter

The variable contains a counter of the executed telecommands since the instrument was powered. Note that in the case that more than one commands have been received during one reset pulse interval (~5.15 s), this counter will increase only by 1 at the reset pulse, as the instrument only executes one command per reset pulse invterval.

```
START_VARIABLE = Cmd_counter__C3_CP_ASP_CMDH
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Incremental counter of the commands received by
ASPOC"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    VALUE_TYPE = INT
    SIGNIFICANT_DIGITS = 3
    FILLVAL = -1
    FIELDNAM = "Command Counter"
    LABLAXIS = "CmdCounter"
    DEPEND_0 = "time_tags__C3_CP_ASP_CMDH"
    LABEL_1 = ""
```

```
    PARAMETER_CAVEATS = "*CL_CQ_ASP_CMDH_"
    QUALITY = "0"
END_VARIABLE = Cmd_counter__C3_CP_ASP_CMDH
```

5.4.6.3 Variable Cmd_code

The variable contains the hexadecimal command code. For a full description of all telecommand codes refer to the instrument users manual [INST-UM].

```
START_VARIABLE = Cmd_code__C3_CP_ASP_CMDH
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Hexadecimal code of the received command"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    SIGNIFICANT_DIGITS = 0
    FILLVAL = "?"
    VALUE_TYPE = CHAR
    FIELDNAM = "Command Code"
    LABLAXIS = "CmdCode"
    DEPEND_0 = "time_tags__C3_CP_ASP_CMDH"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_CMDH_"
    QUALITY = "0"
END_VARIABLE = Cmd_code__C3_CP_ASP_CMDH
```

5.4.6.4 Variable Cmd_mnemonic

The variable contains the 8-character command mnemonic. For a full description of all telecommand mnemonics refer to the instrument users manual [INST-UM].

```
START_VARIABLE = Cmd_mnemonic__C3_CP_ASP_CMDH
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Short label for the received command"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    SIGNIFICANT_DIGITS = 0
    FILLVAL = "?"
    VALUE_TYPE = CHAR
    FIELDNAM = "Command Mnemonic"
    LABLAXIS = "CmdMnemonic"
    DEPEND_0 = "time_tags__C3_CP_ASP_CMDH"
    LABEL_1 = ""
```

```
    PARAMETER_CAVEATS = "*CL_CQ_ASP_CMDH_"
    QUALITY = "0"
END_VARIABLE = Cmd_mnemonic__C3_CP_ASP_CMDH
```

5.4.6.5 *Variable Cmd_description*

The variable contains the textual command description. For a full description of all telecommands refer to the instrument users manual [INST-UM].

```
START_VARIABLE = Cmd_description__C3_CP_ASP_CMDH
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Textual description of the received command"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    SIGNIFICANT_DIGITS = 0
    FILLVAL = "?"
    VALUE_TYPE = CHAR
    FIELDNAM = "Command Description"
    LABLAXIS = "CmdDescription"
    DEPEND_0 = "time_tags__C3_CP_ASP_CMDH"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_CMDH_"
    QUALITY = "0"
END_VARIABLE = Cmd_description__C3_CP_ASP_CMDH
```

5.4.6.6 *Variable Cmd_parameter*

The variable contains the value of the command parameter, if present, in engineering units. For a full description of all telecommand parameters and calibrations refer to the instrument users manual [INST-UM].

```
START_VARIABLE = Cmd_parameter__C3_CP_ASP_CMDH
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Description of the parameter value of the
received command"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    SIGNIFICANT_DIGITS = 0
    FILLVAL = "?"
    VALUE_TYPE = CHAR
    FIELDNAM = "Command Parameter Value"
    LABLAXIS = "CmdParVal"
```

```
    DEPEND_0 = "time_tags__C3_CP_ASP_CMDH"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_CMDH_"
    QUALITY = "0"
END_VARIABLE = Cmd_parameter__C3_CP_ASP_CMDH
```

5.4.7 Metadata Specification

Relevant header files above dataset level (see Section 5.6):

FILENAME	CONTENTS
CL_CH_MISSION.ceh	Mission level metadata
CL_CH_ASP_EXP.ceh	Experiment level metadata
Cn_CH_OBS.ceh	Observatory level metadata (n=1...4)
CL_CH_ASPOCn_INST.ceh	Instrument level metadata (n=1...4)

Dataset-specific header files:

FILENAME (EXAMPLE)	CONTENTS
Cn_CH_ASP_CMDH_DATASET.ceh	Metadata for the dataset as a whole
Cn_CH_ASP_CMDH_PARAMETER.ceh	Metadata for parameters inside the dataset

Metadata for this dataset, contained in file Cn_CH_ASP_CMDH_DATASET.ceh:

METADATA	ENTRY (EXAMPLE)
DATASET_ID	"C3_CP_ASP_CMDH"
DATA_TYPE	"CP>CAA Parameter"
DATASET_TITLE	"ASPOC command history"
DATASET_DESCRIPTION	"This dataset contains the telecommand execution history from the ASPOC experiment on the Cluster C3 spacecraft."
CONTACT_COORDINATES	"KlausTorkar>PI>Klaus.Torkar@oeaw.ac.at"
TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.000000
MIN_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.000000
MAX_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.000000
PROCESSING_LEVEL	"Calibrated"
DATASET_CAVEATS	"*CL_CQ_ASP_CMDH_"
ACKNOWLEDGMEMENT	"Please acknowledge the instrument team and ESA Cluster Active Archive when using this data."

Metadata for this dataset inside the data file:

METADATA	ENTRY (EXAMPLE)
FILE_NAME	"C3_CP_ASP_CMDH__20030801_V01.cef"
FILE_FORMAT_VERSION	"CEF-2.0"
END_OF_RECORD_MARKER	"$"
LOGICAL_FILE_ID	"C3_CP_ASP_CMDH__20030801_V01"
VERSION_NUMBER	"1"
FILE_TYPE	"cef"
METADATA_TYPE	"CAA"
FILE_TIME_SPAN	VALUE_TYPE = ISO_TIME_RANGE
	2003-08-01T00:00:00Z/2003-08-02T00:00:00Z
GENERATION_DATE	VALUE_TYPE = ISO_TIME
	2004-11-26T10:24:52Z
FILE_CAVEATS	"TBW"
DATASET_VERSION	"1_0"

5.5 CAVEATS

In contrast to the more global information provided in the INSTRUMENT_CAVEATS parameter of the instrument level metadata (filename: CL_CH_ASPOCn_INST.ceh with n=1...4), this product contains more detailed information on the status and quality of the ion emission. Knowledge about this may be interesting for the scientific user as it affects the value and stability of the resulting spacecraft potential. Also, the parameters in this product highlight cases when the ion current is set to non-standard values for technical reasons.

The quality of spacecraft potential control can be described by the absolute value of the potential and its stability in time. In the nominal mode of operation, the instrument is set to output a constant current into the ion emitters (so-called "total current"). If internal loss currents can be neglected, the emitted ion current is also constant and the resulting spacecraft potential has maximum stability with the intended value. If loss currents are present, the emitted ion current is the difference between the total current and the loss current, and will start to fluctuate in antiphase to the with the variations of the loss currents. There are two main reasons why the total current may differ from the ion beam current: a) an internal (ion) current from the emitter tip to the extractor electrode, b) another loss current from high voltage to ground.

The quality of the emission, provided in this product, is derived from the total current and the emitted ion current. There are new entries whenever the instrument mode changes, or when the commanded emission current changes.

Table 5.2. Derivation of Quality Flagss

Quality Flag	Current Conditions	Ion Emission Quality
1	$I_{beam}/I_{total} > 0.97$	Excellent
2	$0.92 < I_{beam}/I_{total} \leq 0.97$	Good, almost completely stable
3	$0.75 < I_{beam}/I_{total} \leq 0.92$	Moderate fluctuations
4	$0.30 < I_{beam}/I_{total} \leq 0.75$	Substantial fluctuations
5	$0.00 < I_{beam}/I_{total} \leq 0.30$	Severe variations
8	$I_{total} \geq 20$ μA AND $I_{beam}/I_{total} \geq 0.50$	Cleaning
9	$I_{beam} = 0.0$	No emission

5.5.1 Formats

No deviation from general conventions.

5.5.2 Standards

No deviation from general conventions.

5.5.3 Production Procedures

This data product is generated by the production software together with the other products. As the four instrument caveat files cover the entire mission, these files will be manually edited to include the newly generated time intervals. Any new delivery of this type of file will replace all previous versions for the instrument concerned.

5.5.4 Quality Control Procedures

The quality control procedures described in section 4.4 will be applied. In particular, the quality flags will be checked for consistency with the currents in the emitter system (total current and ion beam current) and with the spacecraft potential.

5.5.5 Delivery Procedures

No deviation from general conventions.

5.5.6 Product Specification

5.5.6.1 Variable Time

```
START_VARIABLE = time_tags__C3_CQ_ASP_CAVEATS
    PARAMETER_TYPE = "Support_Data"
    CATDESC = "Interval centered time tag"
    UNITS = "s"
    SI_CONVERSION = "1.0>s"
    VALUE_TYPE = ISO_TIME
    SIGNIFICANT_DIGITS = 23
    FILLVAL = 9999-12-31T23:59:59Z/9999-12-31T23:59:59Z
    FIELDNAM = "Universal Time"
```

```
    LABLAXIS = "UT"
    DELTA_PLUS = 0.25
    DELTA_MINUS = 0
END_VARIABLE = time_tags__C3_CQ_ASP_CAVEATS
```

5.5.6.2 Variable Quality_avg

The variable contains the quality flag calculated from the average ion beam current and total current over the time range.

```
START_VARIABLE = Quality_avg__C3_CQ_ASP_CAVEATS
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Average quality level of the S/C potential
control (1-5,8=cleaning,9=no emiss.)"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    VALUE_TYPE = INT
    SIGNIFICANT_DIGITS = 1
    FILLVAL = -1
    FIELDNAM = "Average Data Quality"
    LABLAXIS = "QualityAvg"
    DEPEND_0 = "time_tags__C3_CQ_ASP_CAVEATS"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_CAVEATS_"
    QUALITY = "0"
END_VARIABLE = Quality_avg__C3_CQ_ASP_CAVEATS
```

5.5.6.3 Variable Quality_min

The variable contains the lowest quality flag within the time range calculated from individual values of ion beam current and total current.

```
START_VARIABLE = Quality_min__C3_CQ_ASP_CAVEATS
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Best quality level of the S/C potential control
(1-5,8=cleaning,9=no emiss.)"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    VALUE_TYPE = INT
    SIGNIFICANT_DIGITS = 1
    FILLVAL = -1
    FIELDNAM = "Minimum Data Quality"
```

```
    LABLAXIS = "QualityMin"
    DEPEND_0 = "time_tags__C3_CQ_ASP_CAVEATS"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_CAVEATS_"
    QUALITY = "0"
END_VARIABLE = Quality_min__C3_CQ_ASP_CAVEATS
```

5.5.6.4 Variable Quality_max

The variable contains the highest quality flag within the time range calculated from individual values of ion beam current and total current.

```
START_VARIABLE = Quality_max__C3_CQ_ASP_CAVEATS
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Worst quality level of the S/C potential
control (1-5,8=cleaning,9=no emiss.)"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    VALUE_TYPE = INT
    SIGNIFICANT_DIGITS = 1
    FILLVAL = -1
    FIELDNAM = "Maximum Data Quality"
    LABLAXIS = "QualityMax"
    DEPEND_0 = "time_tags__C3_CQ_ASP_CAVEATS"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_CAVEATS_"
    QUALITY = "0"
END_VARIABLE = Quality_max__C3_CQ_ASP_CAVEATS
```

5.5.6.5 Variable Comment

The variable contains the textual description associated with the average quality flag over the time range.

```
START_VARIABLE = Comment__C3_CQ_ASP_CAVEATS
    PARAMETER_TYPE = "Data"
    ENTITY = "Instrument"
    PROPERTY = "Status"
    FLUCTUATIONS = "Waveform"
    CATDESC = "Textual description of the quality level of the
S/C potential control"
    UNITS = "unitless"
    SI_CONVERSION = "1>unitless"
    VALUE_TYPE = CHAR
    SIGNIFICANT_DIGITS = 0
```

```
    FILLVAL = "?"
    FIELDNAM = "Data Quality Comment"
    LABLAXIS = "Comment"
    DEPEND_0 = "time_tags__C3_CQ_ASP_CAVEATS"
    LABEL_1 = ""
    PARAMETER_CAVEATS = "*CL_CQ_ASP_CAVEATS_"
    QUALITY = "0"
END_VARIABLE = Comment__C3_CQ_ASP_CAVEATS
```

5.5.7 Metadata Specification

Relevant header files above dataset level (see Section 5.6):

FILENAME	CONTENTS
CL_CH_MISSION.ceh	Mission level metadata
CL_CH_ASP_EXP.ceh	Experiment level metadata
Cn_CH_OBS.ceh	Observatory level metadata (n=1...4)
CL_CH_ASPOCn_INST.ceh	Instrument level metadata (n=1...4)
CL_CQ_ASPOCn.txt	Textual caveats at instrument level (n=1...4)

Dataset-specific header files:

FILENAME (EXAMPLE)	CONTENTS
Cn_CH_ASP_CAVEATS_DATASET.ceh	Metadata for the dataset as a whole
Cn_CH_ASP_CAVEATS_PARAMETER.ceh	Metadata for parameters inside the dataset

Metadata for this dataset, contained in file Cn_CH_ASP_CAVEATS_DATASET.ceh:

METADATA	ENTRY (EXAMPLE)
DATASET_ID	"C3_CQ_ASP_CAVEATS"
DATA_TYPE	"CP>CAA Parameter"
DATASET_TITLE	"ASPOC instrument caveats"
DATASET_DESCRIPTION	"This dataset contains the instrument caveats from the ASPOC experiment on the Cluster C3 spacecraft."
CONTACT_COORDINATES	"KlausTorkar>PI>Klaus.Torkar@oeaw.ac.at"
TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.000000
MIN_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.000000
MAX_TIME_RESOLUTION	VALUE_TYPE = FLOAT
	0.000000
PROCESSING_LEVEL	"Calibrated"
DATASET_CAVEATS	"*CL_CQ_ASP_CAVEATS_"

ACKNOWLEDGMEMENT	"Please acknowledge the instrument team and ESA Cluster Active Archive when using this data."

Metadata for this dataset inside the data file:

METADATA	**ENTRY (EXAMPLE)**
FILE_NAME	"C3_CQ_ASP_CAVEATS__20030801_V01.cef"
FILE_FORMAT_VERSION	"CEF-2.0"
END_OF_RECORD_MARKER	"$"
LOGICAL_FILE_ID	"C3_CQ_ASP_CAVEATS__20030801_V01"
VERSION_NUMBER	"1"
FILE_TYPE	"cef"
METADATA_TYPE	"CAA"
FILE_TIME_SPAN	VALUE_TYPE = ISO_TIME_RANGE
	2003-08-01T00:00:00Z/2003-08-02T00:00:00Z
GENERATION_DATE	VALUE_TYPE = ISO_TIME
	2004-11-26T10:24:52Z
FILE_CAVEATS	"TBW"
DATASET_VERSION	"1_0"

5.6 Header Files above Dataset Level

5.6.1 Mission Level Metadata

FIlename: CL_CH_MISSION.ceh

METADATA	**ENTRY (EXAMPLE)**
MISSION	"Cluster"
MISSION_TIME_SPAN	VALUE_TYPE = ISO_TIME_RANGE
	"2000-08-16T12:39:00Z/2005-12-31T23:59:59Z"
MISSION_AGENCY	"ESA>European Space Agency"
MISSION_DESCRIPTION	"The aim of the Cluster mission is to study small-scale structures of the magnetosphere and its environment in three dimensions. To achieve this, Cluster is constituted of four identical spacecraft that will flight in a tetrahedral configuration. The separation distances between the spacecraft will be varied between 600 km and 20 000 km, according to the key scientific regions."
MISSION_KEY_PERSONNEL	"Philippe Escoubet>Philippe.Escoubet@esa.int

	>Cluster Project Scientist"
MISSION_REFERENCES	"The Cluster and Phoenix Missions>Cluster project and instrument teams>Space Sci. Rev. 79, Nos. 1-2, 1997"
MISSION_REGION	"Solar_Wind"
	"Bow_Shock"
	"Magnetosheath"
	"Magnetopause"
	"Magnetosphere"
	"Magnetotail"
	"Polar_Cap"
	"Auroral_Region"
	"Cusp"
	"Radiation_Belt"
	"Plasmasphere"
MISSION_CAVEATS	"*CL"

5.6.2 Experiment Level Metadata

FIlename: CL_CH_ASP_EXP.ceh

METADATA	**ENTRY (EXAMPLE)**
EXPERIMENT	"ASPOC"
EXPERIMENT_DESCRIPTION	"Active Spacecraft Potential Control"
INVESTIGATOR_COORDINATES	"KlausTorkar>PI>Klaus.Torkar@oeaw.ac.at"
EXPERIMENT_REFERENCES	"*CL_CD_ASP_CAAICD__"
EXPERIMENT_KEY_PERSONNEL	"KlausTorkar>Klaus.Torkar@oeaw.ac.at"
EXPERIMENT_CAVEATS	"*CL_CQ_ASP_CAVEATS_"

5.6.3 Observatory Level Metadata

Filename: Cn_CH_OBS.ceh (n=1...4)

METADATA	**ENTRY (EXAMPLE)**
OBSERVATORY	"Cluster-3"
OBSERVATORY_CAVEATS	"*C4_CQ"
OBSERATORY_DESCRIPTION	"Missing, needs to be filled in."
OBSERVATORY_TIME_SPAN	VALUE_TYPE = ISO_TIME_RANGE
	"2000-07-16T12:39:00Z/2005-12-31T23:59:59Z"
OBSERVATORY_REGION	"Solar Wind"

	"Bow_Shock"
	"Magnetosheath"
	"Magnetopause"
	"Magnetosphere"
	"Magnetotail"
	"Polar_Cap"
	"Auroral_Region"
	"Cusp"
	"Radiation_Belt"
	"Plasmasphere"

5.6.4 Instrument Level Metadata

Filename: CL_CH_ASPOCn_INST.ceh (n=1...4)

METADATA	**ENTRY (EXAMPLE)**
INSTRUMENT_NAME	"ASPOC3"
INSTRUMENT_DESCRIPTION	"ASPOC Experiment on Cluster C3"
INSTRUMENT_TYPE	"Spacecraft Potential Control"
MEASUREMENT_TYPE	"Instrument_Status"
	NOTE: MEASUREMENT_TYPE shall be changed to "Emitted_Current" as soon as the metadata dictionary has been updated.
INSTRUMENT_CAVEATS	"*CL_CQ_ASPOC3.txt"

Filename: CL_CQ_ASPOCn.txt (n=1...4)

This file is referenced by the file described above, and contains a textual description of caveats referring to the instrument, organised as a chronological table.

ENTRY (EXAMPLE)	
2001-01-17	Total currents 12.5, 15 and 20 uA were used to establish the characteristics of the emitter; variable operating voltage.
2001-01-31	Less than 100% efficiency before 02:16 UT; thereafter, 100% efficiency at stable 6.75 kV.

5.6.4.1 Production Procedures

While the files CL_CH_ASPOCn_INST.ceh are generated automatically, the textual caveats referenced by these files are generated manually and cover the entire mission. This data product (CL_CQ_ASPOCn.txt) will be updated for each delivery of data products. It contains comments and caveats pertaining to the general performance of the ion emitters, and other background information about the instrument status and operations. Each entry is typically valid for time spans between one day and a few months, and characterizes particular issues of the instrument performance or status in this period.