ASPERA-3 FLIGHT OPERATION MANUAL

	Name and function	Date	Signature
Prepared by:	Stas Barabash, Co-Pi	September, 23, 2002	
Verified by:	Mats Holmström, Operation manager		
Approved by:			

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CHANGE RECORD

Version	Date	Changed Paragraphs	Remarks
Draft Revision 0	1999-03-30	All	New document
Draft Revision 1	1999-04-23	1.9, 3.4 (added), 7.1	DC/DC description added, New paragraph, update of table.
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Issue 1.0	2000-12-15	4,5,6,7,8	Updated and added
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Issue 3	2003-04-16	Added: Appendix 10 MEDOC DB FOP description Appendix 11, 12	
		Appendix 4	Update
		Appendix 5	New issue
		Appendix 6	New issue

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1. Description of the Instrument

1.1. ASPERA-3 Scientific Objectives

The scientific objectives of the Mars Express Orbiter mission are to study the subsurface, the surface, and the atmosphere of Mars, as well as the interaction of the atmosphere with the interplanetary medium. The ASPERA-3 (Analyser of Space Plasma and Energetic Atoms) experiment addressing the last scientific objective will perform:

(1) remote measurements of energetic neutral atoms (ENA) in order to (*a*) investigate the interaction between the solar wind and Martian atmosphere, (*b*) characterise quantitatively the impact of the plasma process on the atmosphere evolution, and (*c*) obtain the global plasma and neutral gas distributions in the near - Mars environment,

(2) in situ measurements of ions and electrons in order to (*a*) complement the ENA images (electrons and multiply-charged ions cannot be so imaged) (*b*) provide undisturbed solar wind parameters necessary for interpretation of ENA images.

The studies of Martian ENAs resulting from the solar wind - atmosphere interaction and near-Mars plasma address the fundamental question: **How strongly does the interplanetary medium affect the Martian atmosphere?** This question is directly related to the problem of Martian dehydration. **What happened to the Martian water** which once flowed in numerous channels? Is it lost or frozen and buried? If it is the former, what could produce such an effective escape mechanism? If the latter, where is this tremendous amount of water stored? As shown by the previous missions and model calculations, the processes associated with the solar-wind interaction could account for the escape of at least 30% of the amount of water once existed on the Martian surface. As we know from our earth's experience, together with an inventory of organic compounds and external energy sources, liquid water is a fundamental requirement for life. Therefore, a clear understanding of the fate of the Martian water is a crucial issue in resolving the problem **whether or not life existed on Mars in the past.**

The general scientific task, to study the solar wind - atmosphere interaction through ENA imaging, can be subdivided into specific scientific objectives, these are listed in the Table 1.3-1.

Table 1.3-1 – The ASPERA-3 scientific objectives

Scientific objectives	Associated measurements
Determine the instantaneous global distributions of plasma and neutral gas near the planet	ENAs originated from the shocked solar wind
Study plasma induced atmospheric escape	ENAs originated inside the magnetosphere
Investigate the modification of the atmosphere through ion bombardment	ENA albedo
Investigate the energy deposition from the solar wind to the ionosphere	Precipitating ENAs, ionospheric electrons and ions
Search for the solar wind - Phobos interactions	ENA originated from Phobos
Define the local characteristics of the main plasma regions	Ions and electron measurements of hot plasma

No instrumentation with similar scientific objectives has or are planned to be flown to Mars.

1.2 Instrument Overview and Functional Diagram

The ASPERA-3 experiment is designed for the analysis of ENAs, electrons, and ions with a complete coverage of the unit sphere. Mechanically, the ASPERA-3 consists of two units, the Main Unit and Ion Mass Analyser (IMA). The Main unit consists of the sensor assembly comprising three sensors, Neutral particle Imager (NPI), Neutral Particle Detector (NPD), and Electron Spectrometer (ELS) and Digital Processing Unit (DPU) placed on the scanner. All electrical interfaces to MU and IMA are made through the scanner. Figure 1.2-1. shows the basic instrument configuration. Table 1.2-1 summarises the experiment mechanical characteristics.

Table 1.2-1. The ASPERA-3 overview characteristics

Parameter	MU	IMA
Mass, kg	6.00	2.20
Dimensions, mm (including rotation)	359 × 393 × 234	255 × 150 × 150 (IMA)
Power	13.5	(included in MU)

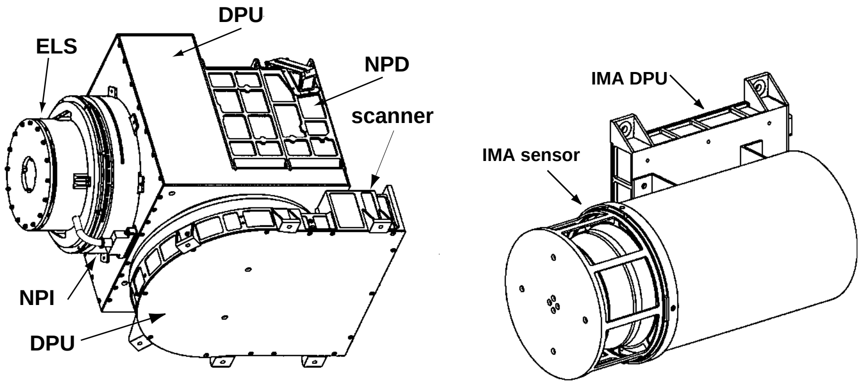


Figure 1.2-1. The ASPERA-3 mechanical configuration

Figure 1.2.-2 shows the functional diagram of the instrument. IMA has its own digital processing unit (IMA DPU) but all IMA TCs and IMA TM are a part of the TC and TM system of MU DPU.

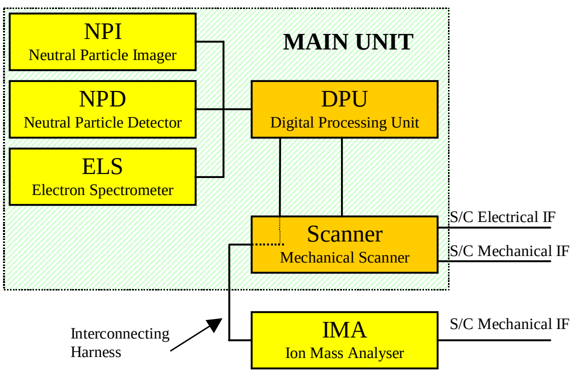


Figure 1.2-2. The ASPERA-3 functional diagram

1.3 Switching Diagram

Figure 1.2-2 in the previous section shows the location of the TM outputs and TC inputs. The electrical circuits powering the instrument described in the Document ME-ASP-DS-007 (EICD).

2. Instrument Redundancy Concept

The PI institute and all other groups with hardware responsibilities have long experience with all critical components which are utilised in the ASPERA-3 experiment. We have followed a basically conservative design philosophy and have chosen whenever possible inherently reliable designs and space proven components. The NPI sensor has been flight proven and the scanner has been flight qualified for the Mars-96 mission. An instrument identical to the ELS sensor, MEDUSA, has be launched on two spacecraft Astrid-2 and Munin in 1998 and 2000. The only unit with no flight experience is the NPD sensor although all components to be used in the sensor are space proven. The two independent ENA sensors using different operational principles provide extra redundancy on the experiment level. In the case either of them fails, the instrument will still be able to fulfil the main scientific objective and perform ENA imaging of the solar wind - atmosphere interaction. We have also been careful to ensure that no single failure of any of the major components in the instrument will disable the more than one sensor. In addition, various backup operational sequences will be stored in the instrument DPU to bypass possible failures.

The critical components of the experiment are the mechanical scanner, high voltage supplies, the MCP detectors, and DPU. In the case of scanner failure, the instrument is able to perform ENA imaging using the relative motion of the spacecraft with respect to the ENA generating region.

In the present design no redundancy of the high voltage supplies is foreseen. However, the HV voltage distribution between sub-systems, e.g., the deflection system plates and MCP assemblies, will be made in such a way as to guarantee ENA sensor operation with only small degradation (fewer azimuth directions or lower cut-off energies of the deflectors) in the case of a single failure. A similar approach is utilised in the ELS and IMA designs as well.

The large number (4 and 6) of MCP detectors used in parallel in the NPD provides inherent redundancy. In the case of a single failure, the sensor will suffer only a small degradation (fewer azimuth directions or lower sensitivity). For the NPI, ELS, and IMA (design option), the routing of the preamplifier inputs will be made to ensure redundancy of the sensors scientific performance.

The DPU will have fully redundant boot sequence from EEPROM and PROM, but will only incorporate one CPU circuit and one set of CPU RAM.

Two redundant high power commands are used to switch on or off the ASPERA-3 DC/DC-converters (to turn on and off the instrument) see the Document ME-ASP-DS-007 (EICD) for details.

3. Instrument Software Design Description

3.1 Software Overview

The DPU unit provides the interface between the spacecraft and the ASPERA-3 sensors for telecommanding and telemetry data. IMA has its own digital processor unit for the data processing but communicates with the spacecraft via the Main Unit DPU. The DPU processes and stores data before it sends them to the spacecraft TM system. The DPU is responsible for the functionality of the packet services. The software serves the interface between the spacecraft and experiment with the highest priority. The software is written in C-language and complies with the ESA software standard ESA PSS-05-0.

At experiment power switch on, the instrument first enters to a safe mode. In the safe mode the software is run in PROM although the software allows command execution, RAM dumping and jumping to the RAM code. The instrument also enters to the safe mode, if the check of the RAM code fails or/and the watch-dog is not reset (a watch-dog detecting lock-ups and endless loops are introduced in the software design).

3.2 The Structure of Software, On-Board Memory Loading and Dumping

The software are so structured, that it is possible to make modifications without affecting any other modules. The memory is divided into functionally distinct areas for (1) software code, (2) fixed constants and (3) variable parameters. These areas are so structured that the TC packets needed for loading these areas are compatible with the maximum size limitation for one packet. The software packets needed to update any memory area are independent of previous packages. Unsuccessfully loaded packets can be loaded separately later. A failure or rejection of a packet is indicated by a TC verification packet. The TC verification packet includes the sequence number and the reason for the failure.

Modifications of any software parameter or constant can be made by a command(s) from the ground.

Any memory area is made accessible for dumping to the ground upon a request from the ground. Only one TC command is required to dump the memory areas, even if several packets are required to convey the dump data to the ground.

3.3 Autonomy Concept and Operability

The instrument will perform full boot-up at power switch on. It will perform full self -check and inform OBDH in the event packet. In the critical failure cases, the failure flags will be used. After boot-up the instrument stays in the housekeeping (HK) mode. The HK mode is a fully operational mode, and the instrument is listening for other commands. The HK mode and all other modes can be switched by one high-level command.

If an error is detected by a watch-dog system, the instrument enters to the safe mode and informs OBDH in the event package. Then it waits for OBDH to perform a predefined procedure for recovery. The can instrument implement any required time lining using its macro commanding system..

3.4 Software architecture

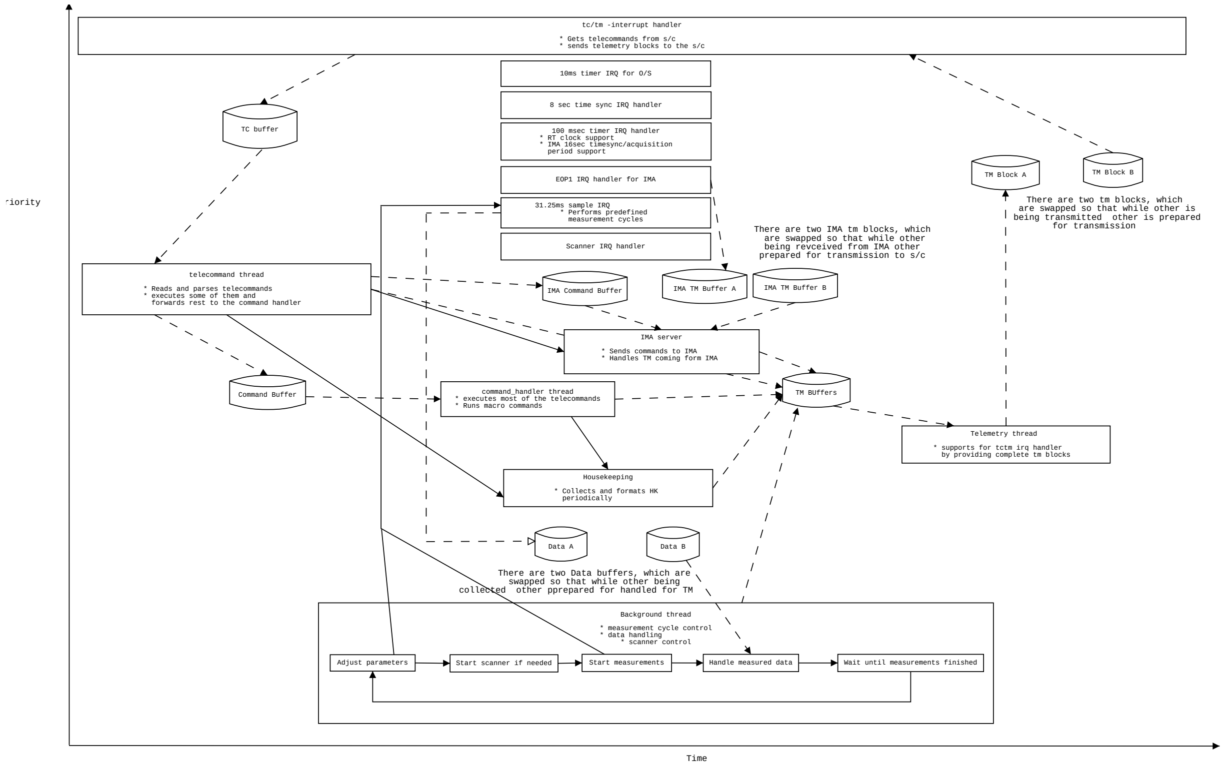


Figure 3.4-1 – The ASPERA-3 software architecture

Software architecture is shown in Figure 3.4-1. Software itself consists of several tasks, for example, TC Handle, Measurements, data handler. TC Handler is running with the highest priority. It listens for TM commands. TM commands have two priority levels. Higher priority commands will be executed immediately and others in the order they are received. TC handler has low-level hardware access when needed.

Measurements task is launched by a TM command. It collects raw data to the data bag A. When data are collected, Data handler are launched. Than Measurements task is launched again, but this time it will collect raw data to the data bag B. When both processes are executed both of them will be launched again (so that Measurements task uses data bag A and Data Handler data bag B). Data handler reduces the resolutions of the actual measurements by and than uses lossless compression algorithm Modified Rice to reduce further the data flow. Data Handler will also performs formatting of the data to TM packages.

4. Instrument Mode Description

4.1 Instrument TM Modes

The ASPERA-3 experiment contains four sensor units and the scanner. Each sensor unit measures different components of the near-Mars plasma and can be operated in different modes. To handle available power and telemetry resource requirements in the most efficient way and to inhibit too large number of individual modes, we introduce seven basic TM modes (macro modes):

- OFF mode
- Safe mode
- Housekeeping mode
- Calibration mode
- Low mode
- Normal mode
- High mode
- Burst mode

OFF mode. The instrument is off although the external heaters are on and controled by the instrument termistors.

Safe mode. At experiment power switch on, the instrument enters to a safe mode. In the safe mode the software is run in PROM although the software allows command execution, housekeeping TM generation, RAM dumping and jumping to the RAM code. The instrument also enters to the safe mode in the following cases:

- the checksum of the RAM code fails
- watch dog is not reset

The safe mode is a fully operational mode, and the instrument is listening for other commands.

Housekeeping mode. In this mode none of the ASPERA-3 sensors is taking scientific data and DPU deliveries housekeeping data to OBDH. This mode is to monitor the instrument status.

Calibration mode. In this mode each of the different sensors is switch on individually for check-out and in-flight calibration purposes.

Low, Normal, High, Burst modes. These modes are foreseen for the scientific data taking. The modes differ from each other in the total amount of data produced and the structure of TM packages although individual settings defining the sensor configurations might be the same for different modes.

The TM requirements for each mode are summarised in Table 4.1-1.

Table 4.1-1 – TM requirements for the ASPERA-3 operational modes

Mode	Acronom	Power, W	Bit rate, bits/s
OFF mode		6 (Heaters)	0
Safe mode	ASPsafe	7	0
Housekeeping mode	ASPHK	7 (TBC)	27
Calibration mode	ASPCal	15	2175
Low mode	ASPLow	15	621
Normal mode	ASPNorm	15	2175
High mode	ASPHigh	15	6214
Burst mode	ASPBurst	15	18204

Note that the operational modes of the individual sensors may vary for the same experiment operation mode (ASPCal, ASPLow, ASPNorm, ASPHigh, ASPBurst) which is defined by the data rate only. The sensor settings for each mode are defined in macro commands stored in on-board software.

The scanning platform has three operational modes: scanning mode, stepping mode, and fixed position mode. In the scanning mode, the platform performs scans with three pre-selected speeds 32, 64, and 128 sec in one 0° - 180° scan. In the stepping mode the platform moves in steps through the angle defined by a command. The time the platform rests in each position is also commanded. In the fixed position mode the platform moves to a commandable position from 0° to 180° and rests there until the scanner mode changes.

4.2 Raw Data and Pre-processing

The raw data in 16 bit words are accumulated from the NPD and NPI sensors during 62.5 ms and from the ELS, IMA during 31.25 ms. The raw bit rates are given in Table 4.2-1.

Table 4.2-1 The ASPERA-3 sensors raw data bit rates

Sensor	Raw data	Bit rate, kbits/s
NPD	$6A \times 16M \times 16E \times 16\text{bits}$ (bin)	384
	$6A \times 512\text{events} \times 32\text{bits}$ (raw)	1536
	$6A \times 16\text{M} \times 16\text{bits}$ (phd)	24
NPI	$32A \times 16\text{bits}$	8
IMA	$16A \times 32M \times 16\text{bits}$	256
ELS	$16A \times 16\text{bits}$	8

A - azimuth directions, *M* - mass, *E* - energy

4.3 ASPERA-3 sensor modes

All four ASPERA-3 sensors, ELS, NPI, NPD1 and NPD2, IMA, can be run independently although the individual sensor bit rates will be set by a macro command defining a macro mode in such way to produce the amount of data specified in Table 4.1.1. The raw data are compressed by integration over time, energy, azimuth, mass as well as using log - compression of 16-bit words to 8-bit words, masking, and look-up tables (NPD). The processed and formatted data are loss-less compressed by the USES algorithm (Universal Source Encoding for Space, CCSDS 111.0-W-2). **The loss-less compression**

factor is not included in the macro mode bit rates while all other compressions are included. For each sensor the loss - less compression factor is evaluated either using previous similar measurements (ELS, NPI) or in-flight callibration. For the estimations of the data rate one can use the loss-less compression factor of 1:4.

4.4 ELS modes

The ELS raw bit rate is 8 kbps. The 16 bit samples will first be log - compressed to 8 bit samples. Two options are considered:

ELS formula (Log – compression)
The 8-bit output value is split in a 4-bit exponent (e) and a 4-bit mantissa (m) according to the formula

For e<2, counts=m (for counts <= 32, the output value is the same as the input value)
For e>=2, counts=(m+16)*2^(e-1)

The further reduction will be made through decreasing the time resolution or / and summation of 2 or 4 adjusted energy sweeps. The amount of energy step is thus 128, 64, or 32. The amount and pattern of sectors to be read-out to TM can be also reduced by a command. The amount varies from 1 to 16 resulting to the corresponding bit rate change on a factor from 1 to 16. Table 4.4-1 below gives the ELS data rates.

Table 4.4-1. ELS modes and data rates

Mode	Sweeps summation / time resolution	Sector pattern	Data rate, kbps
ELSB0	No sum. / 4s	[1, 1, 1, 1,.., 1]	4
ELSH0	2 sweeps / 8 s	[1, 1, 1, 1,.., 1]	2
ELSN0	4 sweeps / 16 s	[1, 1, 1, 1,.., 1]	1
ELSL0	8 sweeps / 32 s	[1, 1, 1, 1,.., 1]	0.5
ELSB1	No sum. / 4s	[0, 1, 0, 1,.., 1]	2
ELSH1	2 sweeps / 8 s	[0, 1, 0, 1,.., 1]	1
ELSN1	4 sweeps / 32 s	[0, 1, 0, 1,.., 1]	0.5
ELSL1	8 sweeps / 32 s	[0, 1, 0, 1,.., 1]	0.25
ELSBx	No sum. / 4s	Arbitrary	-
ELSHx	2 sweeps / 8 s	Arbitrary	-
ELSNx	4 sweeps / 32 s	Arbitrary	-
ELSLx	8 sweeps / 32 s	Arbitrary	

4.5 NPI modes

The NPI raw bit rate based on the fundamental sampling time 62.5 ms is 8 kbps. The reduction is made via increasing integration time by a factor of 1, 2, 4, 8,…, 32, 64, 128. Three integration times 500, 1000, and 2000 ms correspond to the three basic scanner periods 32, 64, 128 sec. Change in the scanner period normally results in the change in the NPI mode to keep the largest acceptable pixel size. Similar to ELS, the pattern of sectors to be read-out to TM is commandable and can be arbitrary. Table 4.5-1 below gives the NPI data rates and mode identifications. The 16-bit counters are log-compressed according to the "ELS formula" down to 8-bits. The compression can be turn-on/off by a command.

Table 4.5-1. NPI modes and data rates

Mode	Integration time in the 62.5 ms	Data rate, kbps

NPIH	8	0.5
NPIN	16	0.25
NPIL	32	0.125
NPIx	Any from 1, 2, 4, .., 128, 1024 (=64 sec)	4 bps – 8 kbps

4.6 NPD modes

NPD sensor electronics is run in two fundamental modes - binned matrix mode (B) and raw event mode (R). In both modes each of the NPD sensors (NPD1 or NPD2) can be disable (masked out). In the binned matrix mode (B- mode) the set-ups for both NPD sensors are always identical. In the B - mode the addressing of the data array is as follows (see Appendix 6 DigTOF in ASPERA/NPD, version 0.3, 17.01.02).

Direction	2 bits	4 directions, one not used!
PH STOP	4 bits	16 mass (M) bins
TOF	4 bits	16 velocity (V) bins
Total	10 bits (1024 16-bit counters)	

In the R - mode the bit allocation per each 32-bit event is as follows.

Spare	7 bits[31…25]
Coincidence flags	3 bits[24…22]
Direction	2 bits[21..20]
PH STOP	8 bits[19…12]
TOF	12 bits[11…0]
Total	32 bits

The integration times 500, 1000, 2000 ms (8, 16, 32 sampling periods of 62.5 ms) correspond to the three scanner periods 32, 64, 128 s. These are the basic ones but the integration factor is made commandable, so the integration time can vary as 1, 2, 4, 8,…., 64, 128 times the fundamental sampling period 62.5 ms. If the NPD electronics is run in the raw event mode no further reduction will be made. The R - mode will be used only for calibrations. In the binned data mode 16M x 16V matrix for each direction can be further reduced to a *x*M x *y*V matrix according to the table 4.6-1 below. The default matrix No.=1, corresponding *x*=2, *y*=16. The 16-bit counters are log-compressed to 8 bits.

Table 4.6-1. NPD reduction matrixes for binned data mode

Matrix No.	*x*	*y*
0	16	16
1	2	16
2	1	16

The reduction of 16 masses (PHD) to 2 is done according to the algorithm as below. Figure 4.6-1 shows it graphically. The threshold is commandable and depends on direction (STOP MCP number).

```
if (velocity_index <= 4) {than new_mass_index = 0};
if (velocity_index >= 8), {than new_mass_index = 1};
if ((velocity_index > 4) & (velocity_index < 8))
        if (mass_index <= threshold) {new_mass_index = 0);
        else {new_mass_index = 1};
```

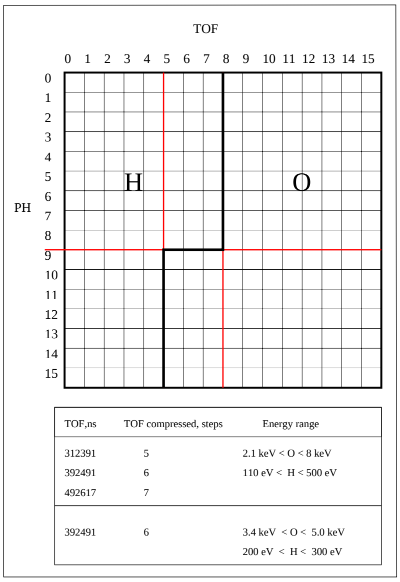


Figure 4.6-1. Reduction of the 16M x 16V bin matrix to 2M x 16V matrix.

Table 4.6-2 gives the thresholds for the flight model NPD1 and NPD2.

Table 4.6-2. Thresholds for the flight model NPD1 and NPD2.

STOP direction	NPD1 threshold index	NPD2 threshold index
Dir0	8	TBD
Dir1	5	TBD
Dir2	7	TBD

Beside two basic hardware modes NPD can be run in two other modes, phd-mode and tof-mode. In tof-mode NPD is run in raw mode and is sampled once per 0.5 sec (8 x 62.5 ms). From 32-bit data places[31…0] of the raw data array TOF[11…0] and Direction[21..20] corresponding to Coincidence[24..22] = 0 are extracted. The 12-bit TOF is converted to a 8-bit TOF by 4-bit right shift. A 16-bit counter of the 3x256 array addressed by the 8-bit TOF and Direction is incremented by 1. After the integration time the 16 - bit counters are log-compressed to 8-bit ones. The data volume 3x256x8=6144 bits/integartion time.

In phd-mode, the array containing 48 bins each with a depth of 65536 (16 - bit) is read-out once per integration time from the register STOPARRAY. The data volume per integration time 48x16 = 768 bits/integration time.

Table 4.6-3. NPD modes and data rates.

NPD mode	Integration time in 62.5 ms	Matrix No.	Data rate / one NPD kbps
NPDHR	8	N/A	32
NPDNR	16	N/A	16
NPDLR	32	N/A	8
NPDxR	Any from 1,2, …64, 128	N/A	-
NPDHB0	8	0(x=16, y=16)	12
NPDNB0	16	0(x=16, y=16)	6

NPDLB0	32	0(x=16, y=16)	3
NPDHB1	8	1(x=2, y=16)	1.5
NPDNB1	16	1(x=2, y=16)	0.75
NPDLB1	32	1(x=2, y=16)	0.375
NPDHB2	8	2(x=1, y=16)	0.75
NPDNB2	16	2(x=1, y=16)	0.375
NPDLB2	32	2(x=1, y=16)	192 bps
NPDxBn	Any from 1,2, …64, 128, 2048 (64 sec)	n = 0,1,2	-
NPDHT	8	N/A	12
NPDNT	16	N/A	6
NPDLT	32	N/A	3
NPDxT	Any from 1,2, …64, 128, 2048 (64 sec)	N/A	-
NPDHP	8	N/A	1.5
NPDNP	16	N/A	0.75
NPDLP	32	N/A	0.375
NPDxP	Any from 1,2, …64, 128, 2048 (64 sec)	N/A	-

4.7 IMA modes

IMA TM mode description is given in Appendix 6 (ICA-IMA TC/TM data formats and related software aspect, Issue 1.2, 2002-04-20). Table 4.7-1 gives summary of the IMA mode bit rates.

Table 4.7-1. ICA - IMA bit rates

Sid	Mnemonic	Exp. Pkt. size in bytes	ICA rate	IMA rate
0	Min (Minimum)	618	5.15 bps	10.3 bps
1	Nrm (Normal)	2478	103.25 bps	206.5 bps
2	Bst (Burst)	4092	1023 bps	2046 bps
3	Cal (Calibration)	1074	268.5 bps	537 bps
4	Spc (Special)	3198	799.5 bps	1599 bps
5	Tst (Test)	600	75 bps	150 bps
6	Ima (Ima)	3996 *	NA	3996 bps
HK	Housekeeping	24	6 bps	12 bps

*) For IMA 2 such packets are sent every acquisition period.

4.8 Mode Transition Diagram

There are no constraints on operation mode transitions.

5. Instrument Telemetry

For the instrument TM description see Appendix 5 (ASPERA-3 Main Unit Software User's Guide. Issue 2.0 2003-01-29). IMA TM is described in Appendix 6 (ICA-IMA TC/TM data formats and related software aspect, Issue 1.4a 2003-06-19).

6. Instrument Telecommands

6.1 Telecommand Description

For the instrument TC description see Appendix 5 (ASPERA-3 Main Unit Software User's Guide. Issue 2.0 2003-01-29). IMA TC are described in Appendix 6 (ICA-IMA TC/TM data formats and related software aspect, Issue 1.2 of 2002-04-20).

6.2 Macrocommand Description

The Macrocommands stored on-board are specified in Appendix 4 (ASPERA-3 Macrocommands).

6.3 List of Critical Commands

Only one command is identified as critical **TC(191,27) aspmSCANStrHeat** (Set string heatrs ON) This command releases the MU scanner. It must not be sent to the instrument before the launch. Yet, this command is not hazardous for the instrument and spacecraft.

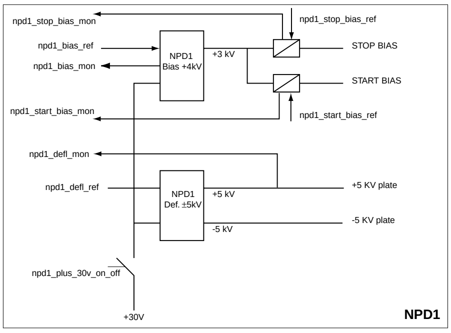
Two commands **TC(191,4) aspmELSHV** (Switch ELS high voltage on/off) and **TC (193,4) aspmWrite** (Write to address) require to be confirmed by the command **TC(191, 255) aspmLaunch** (Confirm command). Note that there is no time-out for confirmation. The conformed command is executed immediately after confirmation.

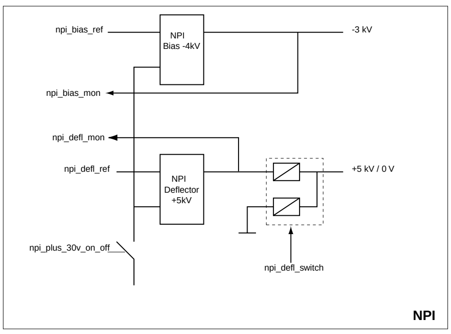
6.4 ASPERA NPI and NPD HV control and operation

The description is based on the convention of 2002-02-21

6.4.1.General schematics

The schematics below shows the software controlled signals and associated mnemonics





6.4.2. HV default values

Mnemonic	HV, kV		Dig. ref	
	Start-up	Nominal	Start-up	Nominal
npi_bias_ref	0	-2.40	0	137
npi_defl_ref	0	5.00	0	245
npi_plus_30v_on_off	off	on		
npi_defl_switch	off	off		
npd1_plus_30v_on_off	off	on		
npd2_plus_30v_on_off	off	on		
npd1_bias_ref	0	2.85	0	163
npd2_bias_ref	0	2.85	0	165
npd1_defl_ref	0	5.00	0	246
npd2_defl_ref	0	5.00	0	242
npd1_start_bias_ref	0	2.70	0	177
npd2_start_bias_ref	0	2.70	0	178
npd1_stop_bias_ref	0	2.70	0	172
npd2_stop_bias_ref	0	2.70	0	178

6.4.3. HV ramping

HV ramping is performed always to rich the nominal HV from the start-up initial values. For the first switch-on, the ramping is done by a special command sequence. During the HV ramping at the first time the instrument is in the parking position.

For the nominal operations the order of switching of HV supplies is given in the table below.

Signal	Duration
NPI-deflector	12 sec
NPI-bias	20 sec
NPD1-deflector	12 sec
NPD1- bias	10 sec
NPD1-START-bias	25 sec
NPD1-STOP-bias	25 sec
NPD2-deflector	12 sec
NPD2 – bias	10 sec
NPD2-START-bias	25 sec
NPD2-STOP-bias	25 sec
Total	2m56sec

<u>NPI-deflector voltage ramping sequence</u>
npi_plus_30v_on_off = ON
The signal npi_defl_ref follows the table.

HV, kV	npi_defl_ref, Digital	Duration, sec
1.0	41	3
2.0	92	3
3.0	143	3
4.0	194	3
5.0	245	

<u>NPI-bias voltage ramping sequence</u>

The signal npi_bias_ref follows the table.

HV, kV	npi_bias_ref, Digital	Duration, sec
-1.00	50	5
-1.50	82	5
-2.00	113	5
-2.20	125	5
-2.40	137	

NPD1-deflector voltage ramping sequence
npd1_plus_30v_on_off = ON
The signal npd1_defl_ref follows the table.

HV, kV	npd1_defl_ref, Digital	Duration, sec
1.0	42	3
2.0	93	3
3.0	144	3
4.0	195	3
5.0	246	

NPD1-bias voltage ramping sequence
The signals npd1_bias_ref, npd1_start_bias_ref, npd1_stop_bias_ref follows the tables.

HV, kV	npd1_bias_ref, Digital	Duration, sec
1.00	51	5
2.00	111	5
2.85	163	

HV, kV	npd1_start_bias_ref, Digital	Duration, sec
1.00	64	5
1.50	97	5
2.00	130	5
2.30	150	5
2.50	164	5
2.70	177	

HV, kV	npd1_stop_bias_ref, Digital	Duration, sec
1.00	58	5
1.50	91	5
2.00	125	5
2.30	145	5
2.50	158	5
2.70	172	

NPD2-deflector voltage ramping sequence
npd2_plus_30v_on_off = ON
The signal npd2_defl_ref follows the table.

HV, kV	npd2_defl_ref, Digital	Duration, sec
1.0	41	3

2.0	91	3
3.0	141	3
4.0	192	3
5.0	242	

NPD2-bias voltage ramping sequence

The signals npd2_bias_ref, npd2_start_bias_ref, npd2_stop_bias_ref follows the tables.

HV, kV	npd2_bias_ref, Digital	Duration, sec
1.00	51	5
2.00	113	5
2.85	165	

HV, kV	npd2_start_bias_ref, Digital	Duration, sec
1.00	64	5
1.50	97	5
2.00	131	5
2.30	151	5
2.50	164	5
2.70	178	

HV, kV	npd2_stop_bias_ref, Digital	Duration, sec
1.00	64	5
1.50	98	5
2.00	131	5
2.30	151	5
2.50	164	5
2.70	178	

6.4.4. NPI deflector switching

In this mode the alternative HV (0 / 5 kV) is applied to the NPI deflector through alternative the signal npi_defl_switch 0/5V. The duration of each period HV=ON or HV=OFF corresponds to the integration periods in the NPIH, NPIN, NPIL modes. Those are 0.25 sec, 0.5 sec, and 1 sec correspondingly.

6.4.5. HV shutter

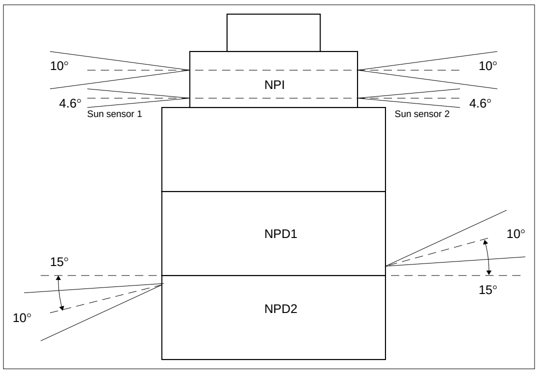
The HV shutter is a short - time decreasing of the MCP bias HV to reduce the MCP gain and avoid MCP aging when the NPI and NPD look directly to the Sun. The table below gives the nominal and reduced voltages for the NPI and NPD biases. Note that npd1_bias_ref and npd2_bias_ref are not affected.

Mnemonic	HV, kV		Dig. ref	
	Reduced	Nominal	Reduced	Nominal
npi_bias_ref	1.900	-2.400	106	137
npd1_bias_ref	2.850	2.850	163	163
npd2_bias_ref	2.850	2.850	165	165
npd1_start_bias_ref	2.000	2.700	130	177
npd2_start_bias_ref	2.000	2.700	131	178
npd1_stop_bias_ref	2.000	2.700	125	172
npd2_stop_bias_ref	2.000	2.700	131	178

The shutter can be enabled and disabled by a command in each of the following shutter modes.

- shutting down is initiated by the solar sensor (SS_shutter)
- shutting down is initiated by increased count rate in NPD (NPD_shutter)
- shutting down is initiated according to the external conditions (Ext_shutter)

Note the different FoV and viewing directions of the Sun sensor, NPI, NPD1, and NPD2. See the diagram below.

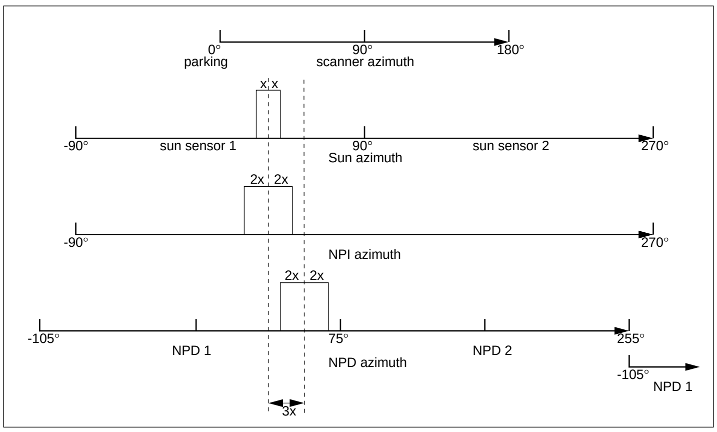


6.4.5.1 SS_shutter

In this mode the position of the Sun is defined by the solar sensors. The first scan after the instrument is switched-on is done with all HV in the Start-up (OFF) position. The duration of the Sun illumination and the Sun position are defined by the fastest (31.25 ms) sampling of the signals sun_sensor_1 and sun_sensor_2 during the first scan. The positions to initiate the shutter and the durations of the reduced bias are calculated for each sensor NPI, NPD1, NPD2. After than the HV ramping begins (no scanning). The SS_shutter affects the controlling signals according to the table (TBC).

	sun_sensor_1	sun_sensor_2
npi_bias_ref	Yes	Yes
npd1_bias_ref	No	No
npd2_bias_ref	No	No
npd1_start_bias_ref	Yes	No
npd2_start_bias_ref	No	Yes
npd1_stop_bias_ref	Yes	No
npd2_stop_bias_ref	No	Yes

The identified positions of the Sun must be re-calculated in the duration and positions for each sensor according to the diagram below.



6.4.5.2 NPD_shutter

In this mode the decreasing of the MCP biases for NPI, NPD1, and NPD2 is initiated by the increased count rate in either NPD1 or NPD2. The duration is commandable, the default duration are given in the table below. They are calculated assuming 10° FoV for NPI and NPD

Scanner speed, s	Duration, s
32	1.8
64	3.6
128	7.2

The NPD_shutter is initiated according to the criteria:
Criteria_1: NPD1 Read Register (add(hex)=8) > 50000 / integration time
Or
Criteria_2: NPD2 Read Register (add(hex)=8) > 50000 / integration time

The number in the criteria is commandable.
The NPD_shutter affects the controlling signals according to the table.

	Criteria_1	Criteria_2
npi_bias_ref	Yes	Yes
npd1_bias_ref	No	No
npd2_bias_ref	No	No
npd1_start_bias_ref	Yes	No
npd2_start_bias_ref	No	Yes
npd1_stop_bias_ref	Yes	No
npd2_stop_bias_ref	No	Yes

Note, that the positions where the sensors must be shut down are different in the clock and anti clockwise scans.

6.4.5.3 Ext_shutter

The scanner position where one has to reduce the MCP bias and for how long are given by an external command for each sensors NPI, NPD1, NPD2. Note, that the positions where the sensors must be shut down are different in the clock and anti clockwise scans.

6.4.6 HV digital values

HV digital values are given in Appendix 8 (NPI and NPD HV digital references).

7. Nominal and Contingency Operational Procedures

7.1 General Operational Concept

The general operation concept for the ASPERA-3 instrument through the mission is described in Table 7.1-1. The choice of the instrument operational mode for each phase of the mission is due to available power and telemetry as well as scientific requirements. Appropriate commanding is required. The selection and initiation of the modes are under the control of the ASPERA-3 PI after consulting with the Co-Is responsible for the instrument subunits. The detailed description of the instrument operational modes is given in section 4.

Table 7.1-1. General Operational Concept

Mission Phase Start Time	Instrument activity	Duration
Launch and Early Operations, DFL: 0 - 10		
	ASPERA-3 experiment is OFF. Scanner is in the parking position	
Near-Earth Verification, DFL: 11 - 37		
DFL = 27	First power-on (NEV-AS-001)	30 min
DFL = 28	Realise of the locking mechanism (NEV-AS-002)	30 min
DFL = 29	Sensor check – up (NEV-AS-003)	2 days
DFL = 30	HV ramping (NEV-AS-004)	5 days
DFL = 32	NEV calibrations (NEV – AS – 005)	5 days
Interplanetary Cruise phase, DFL: 39 - 180		
DFL = 175	IC calibrations	5 days
Single events	Software update (IC-AS-002)	8 hours each
Mars Orbit Insertion Phase DFL: 181 - 228		
	ASPERA-3 mode is TBD	
Mars Commissioning, DFL: 230 - 290		
DFL = 230	MC observations	1 orbit, each orbit
Routine / Extended Operation phase, DFL: 291 – 919/ 920 - 1650		
DFL = 291	ASPERA-3 scientific operations (R0-AS-001) *	All orbits through, entire orbit
Monthly	ASPERA-3 is OFF during orbit maintenance corrections	

* To fulfil its scientific objectives the ASPERA-3 experiment must take continues measurements over the entire orbit. ASPERA-3 shall be operational all the time. We accept time sharing during communication sessions, if incompatibilities between simultaneous instrument operations are discovered, provided the experiment still has at least one orbit per day with continues measurement over the entire orbit.

7.2 ASPERA-3 operation activities

In this context the term "activity" is understood as a logically grouped set of actions dedicated to one single goal. During an activity a number of different flight procedures can be run. Table 7.2-2 gives summary of the ASPERA-3 activities. The detailed description of each activity is given in Appendix 9 (Instrument operation activities). It is based on the document MEX-ASP-TN-020830 of 2002-09-02 and follows the MEX EV-IC-MC Request forms (MECC).

Table 7.2-2 Summary of the ASPERA-3 activities.

Activity ID	Activity name
NEV-AS-001	FIRST POWER-ON
NEV-AS-002	REALISE OF THE LOCKING MECHANISM
NEV-AS-003	SENSOR CHECK-UP
NEV-AS-004	ASPERA HV RAMPING
NEV-AS-005	ASPERA NEV CALIBRATIONS
IC-AS-001	ASPERA IC CALIBRATIONS
IC-AS-002	ASPERA SOFWARE UPDATE
MC-AS-001	ASPERA MC OBSERVATIONS
RO – AS - 001	ASPERA ROUTING OBSERVATIONS

Abbreviations:
NEV: Near Earth verification phase
IC: interplanetary cruise
RO: ROUTING OBSERVATIONS

7.2.1 First power-on. NEV-AS-001
See MECC NEV-AS-001.

7.2.2 Release of the locking mechanism. NEV-AS-002
See MECC NEV-AS-002.

7.2.3 Sensor check-up. NEV-AS-003
See MECC NEV-AS-001.

7.2.4 ASPERA-3 HV ramping. NEV-AS-004
See MECC NEV-AS-004.

7.2.5. NEV and IC calibrations. NEV-AS-005 and IC-AS-001
During the near-Earth verification and cruise phase the ASPERA would perform calibrations of its sensor in respect of the well-know sources, the solar wind and interstellar neutral wind. The IMA and ELS sensors are calibrated against the solar wind and NPI and NPD against the neutral wind. The calibrations are performed twice at the beginning of the cruise phase and at the end to evaluate potential aging of the instrument sensors. See MECC NEV-AS-005 and IC-AS-001.

7.2.5.1 IMA in-flight calibrations
IMA will be in-flight calibrated, i.e. the laboratory calibration will be validated, by performing measurements in the solar wind during. The energy sweep will be focused on the solar wind velocity (approx. 450 km/s) and high resolution measurements of the proton and He++ solar wind components will be done. This data will then be compared with data taken during the same time period from other spacecraft in the solar wind. The high-mass mode will be tested (post-acceleration switched off) in order to observe heavier components of the solar wind. The in-flight calibration will also verify that the IMA instrument is not sensitive to UV-light from the Sun. In the baseline spacecraft attitude for the cruise phase (HGA is pointing towards the Sun), the solar wind is within IMA field of view.

7.2.5.2 ELS in-flight calibrations

The ELS in-flight calibrations are performed during cruise phase. Typically, with the frequency once a week with the duration for few hours. The purpose of this operation is to calibrate the instrument in respect of the solar wind electrons. The scanner position / spacecraft attitude are not critical. The purpose of these calibrations is to monitor the health of the sensor and MCP gain stability.

7.2.5.3 NPI in-flight calibrations

The NPI in-flight calibrations are performed during cruise phase. Typically, with the frequency once a week with the duration for few hours. The purpose of this operation is to calibrate the instrument in respect of the interstellar neutral wind. The scanner is in the fixed position which is determined by the direction of the interstellar wind in the galactic co-ordinates (TBD).The purpose for these calibration is to monitor the conversion surface conditions through the cruise phase.

7.2.5.4 NPD in-flight calibrations

The NPD in-flight calibrations are performed during cruise phase. Typically, with the frequency once a week with the duration for few hours. The purpose of this operation is to calibrate the instrument in respect of the interstellar neutral wind. The scanner is in the fixed position which is determined by the direction of the interstellar wind in the galactic co-ordinates (TBD).The purpose for these calibration is to monitor the START surface conditions through the cruise phase.

7.2.6 ASPERA software update. IC-AS-002

See MECC IC-AS-002.

7.2.7 ASPERA MC observations. MC-AS-002

See MECC MC-AS-001.

7.2.8 Routine operations. RO-AS-001

This section provides substantial clarifications and details concerning the ASPERA-3 routine observations in generally described in MECC RO-AS-001. This section is based on the document ME-ASP-TN-020717, Issue 1.0, 2002-07-17.

7.2.8.1 Data taking periods

The instrument is ON and in a data-taking mode through the entire orbit, all orbits per day. Possible events interrupting data taking and corresponding instrument activities are specified in table 7.2.8.1-1.

Table 1.1 Events interrupting data taking

Event	Instrument activity
Orbital maneuvers $T_1 \ldots T_2$	Instrument OFF for $T_1 \ldots T_2$ + 5h
Wheel off-loading $T_1 \ldots T_2$	Instrument ON, scanner OFF, HV reduced down to 1/3 of nominal, science disable, for $T_1 \ldots T_2$ + 1h

$T_1 \ldots T_2$ - the event start and stop

Obviously the instrument is OFF when the spacecraft is in the safe mode.

7.2.8.2 Science and operation strategy

The instrument studies different plasma domains at different parts of an orbit. Table 7.2.8.2-1 summarizes the plasma regions, associated measurements, and scientific tasks.

Table 7.2.8.2-1 Plasma domains through a nominal orbit

Domain	Scientific objective	Measurements
Upper ionosphere	Photochemestry	Electrons, cold ions
Obstacle / inside pile-up boundary	Cold ion escape Solar wind interaction process	Ions
Magnetosheath / inside bow shock	Ion escape Solar wind interaction process	Ions, electrons
Plasmasheet	Ion escape (0.1 - 3 keV) Acceleration mechanisms	Ions
Upstream region	Shock processes	Ions
Global view of the interaction region	Solar wind interaction process Total escape rate	ENAs
ENA albedo /atm. sputtering	Atmospheric modification	ENAs, ions
Phobos environment	Phobos outgassing, Solar wind interaction process	Ions, electrons, ENAs

These regions are shown in Figure 7.2.8.2-1 along a typical orbit. Figure also shows averaged positions of the Martian bow shock and magnetopause (magnetic pile-up boundary). Five orbits shown are separated by 85 days and thus span approximately the first 425 days of operation. The orbits and plasma boundaries are shown in coordinates in which the X-axis is the OX axis of the solar ecliptic coordinates and the Y-axis is the distance to the OX axis. The yellow color marks the time interval ±30 minutes near the pericenter.

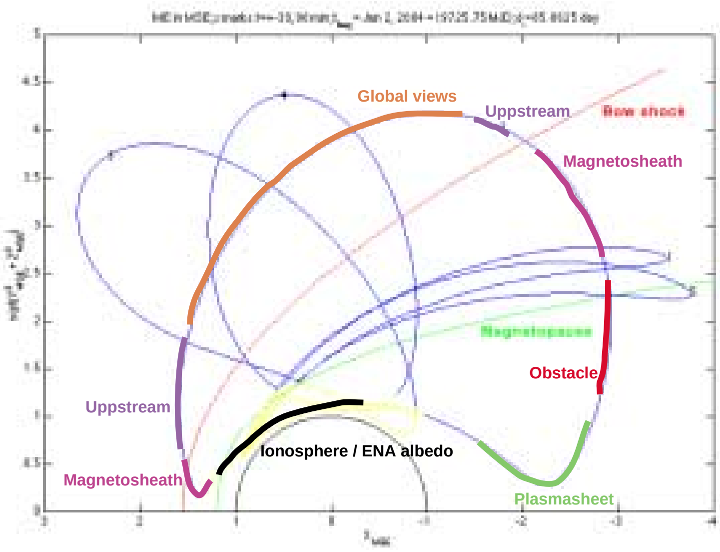


Figure 7.2.8.2-1 Plasma domains along Mars Express orbits.

The instrument operation mode will be adjusted according to the plasma region the instrument is in and synchronized with the pericenter time as follows in Table 7.2.8.2-2

Table 7.2.8.2-2 The instrument operation modes and plasma regions

Operation mode	**Time around T_c**	**Plasma region**
Burst mode phase	T_c± 7 min	Ionosphere ENA albedo / sputtered and backsckattered ENAs Phobos encounters
High mode phase	T_c±25 min	Magnetosheath Plasmasheet

		Obstacle
Global view phase (Normal mode)	Rest of the orbit	ENA imaging Upstream region

Therefore, the instrument will change mode of operation 4 times per orbit and will be running in 3 different modes. Command sequence for this operation will be synchronized with the pericenter time.

7.2.8.3 Instrument configuration before, during and after maneuvers

The instrument is OFF during major orbital maneuvers because of the risk of high voltage discharges that may occur if the gas density suddenly increases around the spacecraft. The instrument is switched off as late as possible before the maneuver and switched on 5 (five) hours later. The switch on and switch off procedures are nominal.

7.2.8.4 Special operations

For the routing operations no specific DPU (digital processing unit) resets are foreseen. Calibrations and testing are performed during commissioning phase(s) only. However, if any not nominal behavior develops, special periods for calibration and testing will be requested.

The instrument does not require any information from another instrument and decoupled from other instruments of the Mars Express payload. That is, there are no constraints between ASPERA-3 operations and the rest of the payload. Special pointings to be used by SPICAM are of big interest for ASPERA because they provide access to new viewing directions.

For debugging purposes memory dumps can be requested to verify contents of EEPROM memory. They are executed by TC, most probable during commissioning phase.

7.2.8.4 Spacecraft pointing during ASPERA nominal operation

The spacecraft pointing is crucial for the ASPERA-3 data quality. During the nominal operation the pointing must fulfil criteria defined in the PID-B, Section 4 (ME-ASP-DS-0001).

7.2.8.5 Commanding issues

In the nominal configuration and during routine operation, that is, after commissioning, there are no critical activities and command sequences which can result in irreversible damage of the instrument. However, switching on HV (high voltage) is preferably conducted through a gradual ramping. This is to avoid potential risk of transient discharges, which may occur in the case of rough arising of high voltage from 0V to a nominal value of few kV.

The command sequence requiring for the routing operation (see 1.2) would be preferably stored on-board and initiated on each orbit automatically with respect to the pericenter time.

7.3 ASPERA flight operation procedures

See Appendix 1 (Flight Operation Procedures) for nominal and contingency operation procedures.

7.4 ASPERA flight operation sequences

See Appendix 2 (Flight Operation Sequences).

8. Operation of the Instrument

8.1 General Management

For the science operation activities we form the ASPERA-3 Science Operation Group (ASOG). ASOG will include PI, EM, Co-PI, Operation Manager, Data archiving and distribution manager. In the close connection with MEX Operation Center (MEXSOC) at ESTEC, ESOC, Payload Operation Support (POS), and the leading Co-Is responsible for the subunits, ASOG performs the instrument operation and commanding scheduling, evaluation of the housekeeping information, and analysis of the raw scientific data. ASOG will also be responsible for the data reduction, archiving, and distribution to the other Co-I groups. During the commissioning phase and the other crucial mission periods, e.g., beginning of the instrument operation at Mars, ASOG can be situated at ESOC or wherever the ASPERA-3 EGSE decommutating the raw telemetry is placed. Normally, ASOG is located at IRF communicating with MEXSOC, ESOC, POS, and Co-I groups via Internet even in real time. The management scheme of the science operation is presented in Figure 8.1-1.

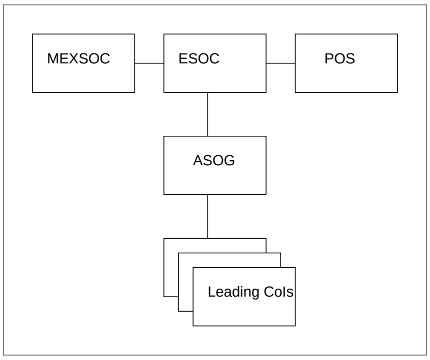


Figure 8.1-1 The management scheme of the science operation

The list of commands to be sent to the instrument during all phases of the mission is prepared by ASOG in close contact with the MEXSOC, ESOC, POS, and leading CoIs and follow the agreed Master Plan. The list is under control of the ASPERA-3 PI. All commands issued to the instrument must be authorised by PI. In the case of emergency and only in this case, the instrument can be shut down by a single command without PI authorisation.

The contact information is given in the table 8.1-1.

Table 8.1-1 ASOG at IRF

Name / Position	**e-mail**	**Phone**	**Fax**
Prof. Rickard Lundin, PI	rickard@irf.se	+46-980-79063	+46-980-79050
Dr. Stas Barabash, Co-PI	stas@irf.se	+46-980-79122	+46-980-79050
Mr. Herman Andersson, EM	herman@irf.se	+46-980-79034	+46-980-79050
Dr. Mats Holmström, Operation manager	matsh@irf.se	+46-980-79186	+46-980-79050
Mr. Leif Kalla, Data archiving manager	Leif@irf.se	+46-980-79016	+46-980-79050

ASOG is located at IRF
Swedish Institute of Space Physics
Box 812 98128
Kiruna Sweden

8.2. Requirements for Ground Support

8.2.1 Auxiliary data

The ASPERA-3 request for the auxiliary data are summirized in the Table 8.2.1

Table 8.2.1 ASPERA-3 request for the auxiliary data.

Data	Timing	Frequency/ Sampling	Accuracy
Reconstituted Attitude	Post-obs,	Weekly/ 1 sample/s	1 deg
Rotation angle of SA	Post-obs.	Weekly / 1 sample /min	1 deg
Orbital data	prediction	weekly	5 km
Quick look orbit estimations	Post-obs.	days	2 km
Times of the attitude thruster faring	Prediction / post-obs	Weekly, every manoeuvre	msec-sec

8.2.2 Pericenter synchronization

The ASPERA-3 performs measurements during the entire orbit studying different plasma domains therefore the instrument must be set in different operational modes depending on the position along the orbit. The commanding is provided by the spacecraft OBDH by time-tagged command referencing the pericenter (alternatively apocenter) time. The accuracy of time - tagging is 1 sec.

8.3 Critical Operational constraints

The HV switch-on must be prohibited during the first 21 days of the mission before the outgassing processes is completed.

The realise of the scanner locking mechanism must be adequately monitored.

The instrument is not accepting any command during the first 60 sec after POWER-ON due to booting procedure.

The instrument is OFF during orbital maneuvers and 5 hours later The instrument HV is reduced to 1/3 of the value during the wheel off-loading and 1 hour later.

Appendix 1. Flight Operation Procedures

1.1 Nominal operation procedures. General description

IDN	Procedure ID	Sequence ID
10N	**Switch On**	
		Switch On
		Time Initialization
20N	**Release Scanner**	Pre-condition: Instrument in HK mode (one packet per 8 sec.)
		Release Scanner
		Scanner Setup
		Scanner Initialization
30N	**Instrument Initialization**	
		Scanner Setup
		Scanner Initialization
		IMA On
		HV Shutter Initialization
		HK Mode
31N	**Instrument Initialization Without scanner**	
		IMA On
		HV Shutter Initialization (NPD shutter)
		HK Mode
40N	**Instrument Preobservation**	
		Scanner Setup
		Scanner Initialization
		ELS HV Ramp Up
		NPD1 HV Ramp Up
		NPD2 HV Ramp Up
		NPI HV Ramp Up
		IMA HV Ramp Up
41N	**Instrument Preobservation without scanner**	
		ELS HV Ramp Up
		NPD1 HV Ramp Up
		NPD2 HV Ramp Up
		NPI HV Ramp Up
		IMA HV Ramp Up
50N	**Instrument Observation**	
		Choose:
		+ Low Mode
		+ High Mode
		+ Normal Mode
		+ Burst Mode

		+ Stepping mode
		+ Fixed position mode
		Routine Observation
		Enable Science
51N	**Instrument Observation Without scanner**	
		Choose:
		+ Low Mode No scanner
		+ High Mode No scanner
		+ Normal Mode No scanner
		+ Burst Mode No scanner
		Routine Observation
		Enable Science
60N	**Run Instrument Observation**	
		Choose:
		+ Disable Science
		+ Enable Science
70N	**Set Instruments Sensor Modes**	
		Choose:
		+ Set Scanner Mode
		+ Set ELS Mode
		+ Set NPD Mode
		+ Set NPI Mode
		+ Set IMA Mode
		Enable Science
80N	**Post Observation**	
		ELS HV Ramp Down
		NPI HV Ramp Down
		NPD1 HV Ramp Down
		NPD2 HV Ramp Down
		IMA HV Ramp Down
		HK Mode (one packet per 16 sec. by defualt)
90N	**Nominal Switch-off**	
		IMA Off
		Disable Science
		Disable HK Generation
		HV Off
		Switch Off
100N	**Instrument Update Parameter Table**	
		Set Instrument In Safe Mode (forces watchdog reset)
		Load Memory
		Patch Memory

110N	**Instrument Request Connection Test**	
		Instrument Request Connection Test
120N	**Instrument Upload Memory**	
		Set Instrument In Safe Mode
		Repeat n-times (N depends on the size of uploading patch)
		+ Upload Mass Memory
		Patch EEPROM
130N	**Instrument Dump Memory**	
		Set Instrument In Safe Mode
		Dump Memory
140N	**NPD Heater ON**	
		Post Observation (procedure)
		HV Off
		NPD Heater On

1.2 Contingency Operations. General description

1.2.1 Actions for specific events

DN - do nothing
CPI - Contact PI

Event number	Event name	Parameter 1	Parameter 2	Description	Action
40001	I'm Alive			Generated after normal bootprocess as an first event	DN
40003	Going to reboot				DN
40004	Watchdog reset	wd_mask	wd_mask cleared		DN
40005	Going to safe mode				DN
40006	Going to normal mode				DN
40007	Telecommand buffer overflow				DN&CPI
40008	Telemetry high priority buffer full				DN&CPI
40009	Telemetry low priority buffer full				DN&CPI
40010	Eeprom programmed				DN&CPI
40011	Eeprom programming - nonsucces	CRC check sum in pactch	CRC checksum in programmed Eeprom area		DN&CPI
40012	CRC error in Eeprom patch	CRC check sum in pactch	CRC chekcum specified in TC		DN&CPI
40013	Module loaded				DN&CPI
40014	Module load failed	Error code definning exact type of error	Optional Extra information		DN&CPI
40015	Default boot module loaded				DN&CPI
40016	Default boot module loading failed	Error code definning exact type of error	Optional Extra information		DN&CPI
40020	Command handler error	1: commamd not confirmed properly 16: other error 0xffff: command not found	Seq count of command raising error		DN&CPI
40021	Invalid confirmation by TC(193,255)	For Command to be confirmed: Bit 8-15: tyåe bit 0-7: Subtype	From the confirmation parameters: Bit 8-15: tyåe bit 0-7: Subtype		DN&CPI
40022	Invalid mode definition	Upmost address for the data storage of invalid mode			DN&CPI
40023	New mode	Mode definition	Extra word	New mode generated by s/w	DN

Event number	Event name	Parameter 1	Parameter 2	Description	Action
				after invalid mode command.	
40074	IMA command buffer full				DN&CPI
40092	Scanner initialized				DN&CPI
40097	Scanner error	2: Communication test failed before initialization 3: Initializtion failed.			DN&CPI

1.2.2 Contingency operation procedures. General description

IDN	Procedure ID	Sequence ID
10C	**Actions described by the Event List**	
20C	**Switch ON failure**	
		Go to red LCL
		+ If failure, contact CPI
30C	**Initialization failure**	
		Switch OFF
		CPI
40C	**HK and Science generation failure**	
		Switch OFF
		CPI
50C	**SSMM Operation gailure**	N/A
60C	**Switch OFF failure**	
		Set instrument in safe mode
		Red Relay
70C	**Heater activation/deactivation failure**	
		Go to HK mode
		CPI
80C	**Observation failure**	
		Set instrument in safe mode
		CPI
90C	**Time update failure**	
		Switch OFF
		CPI

100C	**Parameter update failure**	
		CPI
110C	**Post Observation failure**	
		Set instrument to safe mode
		CPI
120C	**Emergency switch OFF**	
		If time available > 6 min Post observation Procedure, else Switch OFF
		Switch OFF

1.2 Flight Operation procedures. ESOC format

Appendix 2. Flight Operation Sequences

2.1 Summary of the flight operation sequences

IDN system is TBD

IDN	Sequence ID	TC commands description	Remarks
	Switch On	Main 28V On	
	Switch Off	Main 28V Off	
	Time Initialization		Takes 8 sec
	Release Scanner	Scanner string heater (191, 27)	Takes 30 sec
	Scanner Setup	Set scanner setup (191, 25) Set scanner voltages (191, 26)	Takes 1 sec Takes 1 sec
	Scanner Initialization	Scanner init (192, 14): moves to 0° End of sequence	Takes 32 sec After 40 sec
	IMA On		
	HV Shutter Initialization	Shutter mode include. Set value of the threshold for NPD Set value of reduced voltage for NPI, NPD1, NPD2	
	HV Shutter Disable (unused)		
	HV Shutter Mode Off (unused)		
	ELS HV Ramp Up		
	NPD1 HV Ramp Up	macros	
	NPD2 HV Ramp Up	macros	
	NPI HV Ramp Up	macros	
	IMA HV Ramp Up		
	Routine Observation	Scanner mode macro (TBC)	
	Low Mode	ASPLow macro	
	High Mode	ASPHigh macro	
	Normal Mode	ASPNorm macro	
	Burst Mode	ASPBurst macro	
	Stepping Mode	ASPStepping macro	
	Fixed Position Mode	ASPFixed macro	
	Enable Science		
	Disable Science		
	Set Scanner Mode		
	Set ELS Mode		
	Set NPD Mode	NPD mode TC(192,7)	
	Set NPI Mode	NPI mode TC(192,6)	
	Set IMA Mode		
	ELS HV Ramp Down		
	NPI HV Ramp Down	macros	
	NPD1 HV Ramp Down	macros	
	NPD2 HV Ramp Down	macros	
	IMA HV Ramp Down		
	HK Mode	Enable HK generation HK packet genration frequency	
	IMA Off		
	Disable HK Generation		

	HV Off		
	HV On (unused)		
	Set Instrument In Safe Mode	Enable watchdog TC(191, 30) Watchdog reset TC(193,16)	Can be run at any time except in the middle of a macrosequence
	Load Memory		TBC
	Patch Memory		
	Instrument Request Connection Test		
	Upload Mass Memory	TC(6,2) to upload ASPERA mass memory	
	Patch EEPROM	EEPROM TC(193,10)	
	Dump Memory	TC(6,5) dump memory	
	Run Macro Command Sequence (unused)		Any TC beside TC(3,5),TC(3,6),TC(6,2), TC(6,5),TC(6,9),TC(9,1), TC(17,1) will be put in a queue until macro is completed. Can not be run in safe mode.
	NPD Heater On		

2.1 Flight operation sequences (SCOE format)

```
::::::::::::::
switch-on-2.cmd
::::::::::::::
##
## Nominal switch on command sequence
##

##  ==  ISSUES  ==
## Should we have the SW OFF commands in here ?
## Should LCL be swithced on after 28ON (transients ??) ?
## How should the TIME update be done ?
## Should the watchdog be enabled ?
## Are there any commands missing for proper boot ?
## What is the duration of this sequence ?
##

## SWITCH ON INSTRUMENT AND START MEASUREMENTS
_step 1000

# Timeout to 20sec (for verhk, veracka)
_tover 20


tpoll 0
red28off
_step 5000
main28off
_step 100
main28on
```

```
## Request for Acceptance acknowledgements
acka 1
tpoll 1

## Verify that instrument is up and running (event 40001)

_step 1000
verevent 40001

## Command it to safe mode
_step 100
aspmBOOTMODE 1
_step 1000
verevent 40005

## Set time to 0x00000000(sec) 0(subsec)
aspmTime 0x0000 0x0000 0x0000
veracka

## Load default boot module
_step 100
aspmMODULE 0x0002 0x0000 0x0082
#aspmMODULE 0x18000 0x00 0x82
_step 1000

#Wait for event 40013
verevent 40013
verhksid 0


#*******************************************************************
#
# Enable watchdog

aspmwatchdog 0x2704
veracka::::::::::::::
```

release_scanner_proc.cmd

```
::::::::::::::
##
## Release scanner platform

## == ISSUES ==
##
##
## == PRE-CONDITION ==
## MU in HK mode
##

# using string heater 1
aspmSCANSTRHEAT 1

# using string heater 2
aspmSCANSTRHEAT 2



::::::::::::::
```

scanner-setup.cmd

```
::::::::::::::
```

```
## Scanner setup
##

##  ==  ISSUES  ==
## What should the scanner setup be (IRQ, auto switching) ?
## What should the real currents, voltages, thresholds be ?
## What is the duration of this sequence ?
## Should the scanner mode be in this sequence ?

_step 1000

# Autoswitching in scanner (0x4)
# No IRQ used in scanner (0x2) and +30V on (0x1)

aspmSCANSETUP 0x3
#aspmSCANSETUP 0x2 0x1

veracka

# aspmSCANVOLTS vrefmc&coastI rampI&CW_tresh CCW_tresh&Wheel_tresh
aspmSCANVOLTS 0xff90 0x9088 0x6bac
#aspmSCANVOLTS 0xff 0x80 0x85 0x8c 0x8c 0xaf

veracka::::::::::::::
```

scanner-init.cmd

```
::::::::::::::

##
## Initialize scanner
##

##  == ISSUES ==
## What are the prerequisites ?
## What is the duration of the sequence ? "3 min. worst case "
## Scanner error handler -> any duration  ....


_tover 192

aspmScanInit 1
#aspmSCANINIT 0 1

#wait for event 40092
verevent 40092

_tover 20
verhksid 0
::::::::::::::
```

power_on_ima.cmd

```
::::::::::::::
### SWITCH IMA ON


## == Issues ==
##
##
##

## == PRE-CONDITIONS ==
## Instrument in HK mode
```

```
##

_tover 64
aspmIMAPOW 1
verhksid 10
_tover 20


APID 62
acke 1

pkt 194 9 0x0013
veracke
verhksid 10
verhksid 10
verhksid 10


APID 61
acke 0
::::::::::::::
```
hv_shutter_seq.cmd
```
::::::::::::::
### HV Shutter initialization


## == Issues ==
##
##
##

## == PRE-CONDITIONS ==
##
##

aspmhvshutvolts 0x8080 0x8080 0x8080

## Mode: solar sensor/Test
aspmhvshut      0x9000 0x5060 0xa0b0 0 0
::::::::::::::
```
set-hk-freq.cmd
```
::::::::::::::
## Set default HK delay
aspmhkdelay 128
veracka

::::::::::::::
```
set-els-hv.cmd
```
::::::::::::::


#*************************************
#
# Go through ELS commands
_step 100

aspmels30 1
veracka

aspmelsgrid 0xAC
veracka
```

```
aspmelsdefl 0x1038
veracka

aspmelshv 1
veracka
## Launch command for els hv
aspmlaunch 0xbf04
veracka

aspmelsmcp 0x1B
veracka::::::::::::::
```

macros/rampup-npd1-defl.cmd

```
::::::::::::::
mode binary
macro 34

##
## Ramp up the NPD1 deflector voltage.
##

##
## Prerequisites:
## - NPD1 30 on
##

#HV command [npd1defl 1000 V]
ASPMnpd1defl 42
veracka
wait 3
#HV command [npd1defl 2000 V]
ASPMnpd1defl 93
veracka
wait 3
#HV command [npd1defl 3000 V]
ASPMnpd1defl 144
veracka
wait 3
#HV command [npd1defl 4000 V]
ASPMnpd1defl 195
veracka
wait 3
#HV command [npd1defl 5000 V]
ASPMnpd1defl 246
veracka
wait 3
_end
::::::::::::::
```

macros/rampup-npd1-start.cmd

```
::::::::::::::
mode binary
macro 35

##
## Ramp up the NPD1 start bias voltage.
##

##
## Prerequisites:
## - NPD1 30 on
##
```

```
#HV command [npd1start 1000 V]
ASPMnpd1start 64
veracka
wait 5
#HV command [npd1start 1500 V]
ASPMnpd1start 97
veracka
wait 5
#HV command [npd1start 2000 V]
ASPMnpd1start 130
veracka
wait 5
#HV command [npd1start 2300 V]
ASPMnpd1start 150
veracka
wait 5
#HV command [npd1start 2500 V]
ASPMnpd1start 164
veracka
wait 5
#HV command [npd1start 2700 V]
ASPMnpd1start 177
veracka
wait 5
_end
::::::::::::::
```

macros/rampup-npd1-stop.cmd

```
::::::::::::::

##
## Ramp up the NPD1 stop bias voltage.
##

##
## Prerequisites:
## - NPD1 30 on
##

#HV command [npd1stop 1000 V]
ASPMnpd1stop 58
veracka
wait 5
#HV command [npd1stop 1500 V]
ASPMnpd1stop 91
veracka
wait 5
#HV command [npd1stop 2000 V]
ASPMnpd1stop 125
veracka
wait 5
#HV command [npd1stop 2300 V]
ASPMnpd1stop 145
veracka
wait 5
#HV command [npd1stop 2500 V]
ASPMnpd1stop 158
veracka
wait 5
#HV command [npd1stop 2700 V]
ASPMnpd1stop 172
```

```
veracka
wait 5
::::::::::::::
```
macros/rampup-npd2-defl.cmd
```
::::::::::::::
mode binary
macro 37

##
## Ramp up the NPD2 deflector voltage.
##

##
## Prerequisites:
## - NPD2 30 on
##

#HV command [npd2defl 1000 V]
ASPMnpd2defl 41
veracka
wait 3
#HV command [npd2defl 2000 V]
ASPMnpd2defl 91
veracka
wait 3
#HV command [npd2defl 3000 V]
ASPMnpd2defl 141
veracka
wait 3
#HV command [npd2defl 4000 V]
ASPMnpd2defl 192
veracka
wait 3
#HV command [npd2defl 5000 V]
ASPMnpd2defl 242
veracka
wait 3
_end
::::::::::::::
```
macros/rampup-npd2-start.cmd
```
::::::::::::::
mode binary
macro 38
##
## Ramp up the NPD2 start bias voltage.
##

##
## Prerequisites:
## - NPD2 30 on
##

#HV command [npd2start 1000 V]
ASPMnpd2start 64
veracka
wait 5
#HV command [npd2start 1500 V]
ASPMnpd2start 97
veracka
wait 5
#HV command [npd2start 2000 V]
```

```
ASPMnpd2start 131
veracka
wait 5
#HV command [npd2start 2300 V]
ASPMnpd2start 151
veracka
wait 5
#HV command [npd2start 2500 V]
ASPMnpd2start 164
veracka
wait 5
#HV command [npd2start 2700 V]
ASPMnpd2start 178
veracka
wait 5
_end
::::::::::::::
```

macros/rampup-npd2-stop.cmd

```
::::::::::::::
mode binary
macro 39

##
## Ramp up the NPD2 stop bias voltage.
##

##
## Prerequisites:
## - NPD2 30 on
##

#HV command [npd2stop 1000 V]
ASPMnpd2stop 64
veracka
wait 5
#HV command [npd2stop 1500 V]
ASPMnpd2stop 98
veracka
wait 5
#HV command [npd2stop 2000 V]
ASPMnpd2stop 131
veracka
wait 5
#HV command [npd2stop 2300 V]
ASPMnpd2stop 151
veracka
wait 5
#HV command [npd2stop 2500 V]
ASPMnpd2stop 164
veracka
wait 5
#HV command [npd2stop 2700 V]
ASPMnpd2stop 178
veracka
wait 5
_end
::::::::::::::
```

macros/rampup-npi-bias.cmd

```
::::::::::::::
mode binary
macro 33
```

```
##
## Ramp "up" the NPI bias voltage.
##

##
## Prerequisites:
## - NPI 30 on
##

#HV command [npibias -1000 V]
ASPMnpibias 50
veracka
wait 5
#HV command [npibias -1500 V]
ASPMnpibias 82
veracka
wait 5
#HV command [npibias -2000 V]
ASPMnpibias 113
veracka
wait 5
#HV command [npibias -2200 V]
ASPMnpibias 125
veracka
wait 5
#HV command [npibias -2400 V]
ASPMnpibias 137
veracka
wait 5

_end
::::::::::::::
```

macros/rampup-npi-defl.cmd

```
::::::::::::::
mode binary
macro 32

##
## Ramp up the NPI deflector voltage.
##

##
## Prerequisites:
## - NPI 30 on
##

#HV command [npidefl 1000 V]
ASPMnpidefl 41
veracka
wait 3
#HV command [npidefl 2000 V]
ASPMnpidefl 92
veracka
wait 3
#HV command [npidefl 3000 V]
ASPMnpidefl 143
veracka
wait 3
#HV command [npidefl 4000 V]
ASPMnpidefl 194
```

```
veracka
wait 3
#HV command [npidefl 5000 V]
ASPMnpidefl 245
veracka
wait 3

_end
::::::::::::::
```
set-ima-hv-prop.cmd
```
::::::::::::::


#*************************************
#
# Verify IMA 30V command
_step 100


aspmima30 1
veracka

apid 62
ACKE 1

#Main +28 off
pkt 194 3 0x0006
veracke

#Mcp +28 off
pkt 194 1 0x0002
veracke

#Opto +28V off
pkt 194 2 0x0004
veracke

#Pacc off
pkt 194 4 0x0008
veracke

#Grid LV switch off
pkt 194 5 0x000A
veracke

#Entr. HV switch off
pkt 194 6 0x000C
veracke

#Defl. LV switch off
pkt 194 7 0x000E
veracke

#Defl. HV switch off
pkt 194 8 0x0010
veracke

#Alt. Pacc. switch on
pkt 194 15 0x001F
veracke
```

```
#Pacc. level low
pkt 194 16 0x0020
veracke

#Deflection level 32
pkt 195 1 0x0120
veracke

#Entrance level 8
pkt 195 2 0x0208
veracke

#SW start level 8
pkt 195 3 0x0308
veracke

#Opto ref. 0
pkt 195 51 0x1000
veracke

#Mcp ref. 0
pkt 195 52 0x2000
veracke

#Grid ref. 6
pkt 195 53 0x3006
veracke

#Pacc low ref. 1
pkt 195 54 0x4001
veracke

#Pacc. high ref. 5
pkt 195 55 0x5005
veracke

#Deflection LV ref. 128
pkt 195 56 0x6080
veracke

#Deflection HV ref. 128
pkt 195 57 0x7080
veracke

#Entrance ref. 128
pkt 195 58 0x8080
veracke

apid 61
acke 0
```

::::::::::::::
macros/set-fixed-mode-rice.cmd
::::::::::::::

```
## Macro definition for fixed pos mode (RICE ON)
##
##
mode binary

macro 102
```

```
## ELS
##
## Energy ocmp=4,
## Time comp=8, '
## Sectormask =0xaaaa (odd sectors),
## compression=LOG+RICE
aspmelsmode 0x7303      0xaaaa

## NPI
##
##  Normal mode, sampling time 1s,
##  no sectormasking,
##  compression=log0+rice
aspmnpimode 0x0057      0xffff 0xffff

##  NPDx
##
##  NPD1+NPD2, sampling time 1s,
##  Binmatrxi mode with 2x16 reduction tables (tresholds are 7)
##  compression log-rice

aspmnpdmode 0x0517      0x0777 0x0777

## HK delay to 128 sec
aspmHKDELAY 128

## Scanner
##
## speed 32, fixed position at 90deg (117), 8sec period
aspmSCANMODE    0x0001  0x0275
_end
::::::::::::::
```

macros/set-high-mode-rice.cmd

```
::::::::::::::
## Macro definition for Low mode (RICE ON)
##
##
mode binary

macro 81


## HIGH....
##

## ELS
##
## Energy ocmp=4,
## Time comp=8, '
## No Sectormask ,
## compression=LOG+RICE
aspmelsmode 0x7303      0xffff

## NPI
##
##  Normal mode, sampling time 1s,
##  no sectormasking,
##  compression=log+RICE
aspmnpimode 0x0057      0xffff 0xffff
```

```
##  NPDx
##
##  NPD1+NPD2, sampling time 1s,
##  Binmatrxi mode with 2x16 reduction tables (tresholds are 7)
##  compression log+RICE

aspmnpdmode 0x0517      0x0777 0x0777

## HK delay to 128 sec
aspmHKDELAY 128

## Scanner
##
## 32s Full scanning
aspmSCANMODE      0x0101      0x0000
_end
::::::::::::::
```

macros/set-low-mode-rice.cmd

```
::::::::::::::

## Set measurement mode
##
##

mode binary
macro 65

# LOW....
### RICE ON
aspmelsmode 0x7303      0xaaaa
veracka

## RICE ON
aspmnpimode 0x0060      0xffff 0xffff
veracka

## RICE ON
aspmnpdmode 0x0617      0x0fff 0x0fff
veracka

# HK delay to 128 sec
aspmHKDELAY 128
veracka

# Scanner
aspmSCANMODE      0x0103      0x0000
veracka

_end
::::::::::::::
```

macros/set-normal-mode-rice.cmd

```
::::::::::::::
## Macro definition for Low mode (RICE ON)
##
##
mode binary

macro 73


## LOW....
```

```
##

## ELS
##
## Energy ocmp=4,
## Time comp=8, '
## Sectormask =0xaaaa (odd sectors),
## compression=LOG+RICE
aspmelsmode 0x7303      0xaaaa

## NPI
##
##  Normal mode, sampling time 1s,
##  no sectormasking,
##  compression=log+rice
aspmnpimode 0x0057      0xffff 0xffff

##  NPDx
##
##  NPD1+NPD2, sampling time 1s,
##  Binmatrxi mode with 2x16 reduction tables (tresholds are 7)
##  compression log

aspmnpdmode 0x0517      0x0777 0x0777

## HK delay to 128 sec
aspmHKDELAY 128

## Scanner
##
## 64s Full scanning
aspmSCANMODE      0x0102      0x0000
_end
::::::::::::::
```

macros/set-stepping-mode-rice.cmd

```
::::::::::::::
## Macro definition for stepping mode (RICE ON)
##
##
mode binary

macro 97



## ELS
##
## Energy ocmp=4,
## Time comp=8, '
## Sectormask =0xaaaa (odd sectors),
## compression=LOG
aspmelsmode 0x3300      0xaaaa

## NPI
##
##  Normal mode, sampling time 1s,
##  no sectormasking,
##  compression=log
aspmnpimode 0x0087      0xffff 0xffff

##  NPDx
```

```
##
##  NPD1+NPD2, sampling time 1s,
##  Binmatrxi mode with 2x16 reduction tables (tresholds are 7)
##  compression log

aspmnpdmode 0x081f      0x0000 0x0000

## HK delay to 128 sec
aspmHKDELAY 128

## Scanner
##
## 32s speed, stepping mode with 5deg step (0x7) and 8sec period
aspmSCANMODE      0x0201      0x0207
_end
::::::::::::::
```

macros/run-cal-mode-rice.cmd

```
::::::::::::::
## Macro definition for Low mode (RICE ON)
##
##
mode binary

macro 111

## HK delay to 128 sec
aspmHKDELAY     128

## scanner in fixed position 90deg (pos cmd in dec is 117)
aspmSCANMODE    0x0000  0x0475


## Switch NPI and NPDx OFF
aspmnpimode     0x0050  0xffff 0xffff
aspmnpdmode     0x0420  0x0000 0x0000
aspmscienable

## Set ELS to cal mode
aspmelsmode     0x6203  0xffff
aspmscienable
wait 600


#swithc off ELS and set NPI to cal mode
aspmelsmode     0x6200  0xffff
aspmnpimode     0x0057  0xffff 0xffff
aspmscienable
wait 600

## Switch off npi and set npd1+2 calmode
aspmnpimode     0x0050  0xffff 0xffff
aspmnpdmode     0x050f  0x0000 0x0000
aspmscienable
wait 240


## Switch NPDs off
aspmscienable
aspmnpdmode     0x0500  0x0000 0x0000
```

```
_end
::::::::::::::
```
instrument-observation_burst_rice.cmd
```
::::::::::::::
### Instrument observation sequence



### == ISSUES ==
##
##


## MU Burst mode + RICE
aspmMacroRun 89
vervent 40026


## IMA IMA mode (yes... IMA has mode called IMA)

APID 62
acke 1

pkt 194 54 0x00E6
veracke
pkt 195 10 0x0A13
veracke

APID 61
acke 0
::::::::::::::
```
set-scanner-mode.cmd
```
::::::::::::::
## Set scanner mode
##
##

# full scannning mode: 32sec
aspmSCANMODE 0x0101 0x0000
veracka
::::::::::::::
```
disable_science.cmd
```
::::::::::::::
## Disable science

##
aspmSciDisable
veracka
::::::::::::::
```
enable_science.cmd
```
::::::::::::::
##
## Enable science
##

aspmSciEnable
veracka
::::::::::::::
```
set-els-mode.cmd
```
::::::::::::::
## Set Els mode
```

```
##
## ELS
##
## Energy ocmp=4,
## Time comp=8, '
## Sectormask =0xaaaa (odd sectors),
## compression=LOG
aspmelsmode     0x3303  0xaaaa



::::::::::::::
```
set-ima-mode.cmd
```
::::::::::::::
## Set IMA mode



## IMA Normal mode

APID 62
acke 1

pkt 194 54 0x00E1
veracke
pkt 195 10 0x0A0B

veracke

APID 61
acke 0
::::::::::::::
```
set-npd-mode.cmd
```
::::::::::::::
## Set NPDx mode

##  NPDx
##
##  NPD1+NPD2, sampling time 1s,
##  Binmatrxi mode with 2x16 reduction tables (tresholds are 7)
##  compression log

 aspmnpdmode     0x0515  0x0777 0x0777
::::::::::::::
```
set-npi-mode.cmd
```
::::::::::::::
## Set NPI mode

## NPI
##
##  Normal mode, sampling time 1s,
##  no sectormasking,
##  compression=log
aspmnpimode     0x0055  0xffff 0xffff
::::::::::::::
```
set-scanner-mode.cmd
```
::::::::::::::
## Set scanner mode
##
##
```

```
# full scannning mode: 32sec
aspmSCANMODE 0x0101 0x0000
veracka
::::::::::::::
```

macros/rampdown-npd1-defl.cmd

```
::::::::::::::
mode binary
macro 42

##
## Ramp down the NPD1 deflector voltage.
##

##
## Prerequisites:
## - NPD1 30 on
## - hv ramped up

#HV command [npd1defl 4000 V]
ASPMnpd1defl 195
veracka
wait 3
#HV command [npd1defl 3000 V]
ASPMnpd1defl 144
veracka
wait 3
#HV command [npd1defl 2000 V]
ASPMnpd1defl 93
veracka
wait 3
#HV command [npd1defl 1000 V]
ASPMnpd1defl 42
veracka
wait 3
#HV command [npd1defl 0 V]
ASPMnpd1defl 0
veracka
wait 3

_end
::::::::::::::
```

macros/rampdown-npd1-start.cmd

```
::::::::::::::
mode binary
macro 43
##
## Ramp down the NPD1 start bias voltage.
##

##
## Prerequisites:
## - NPD1 30 on
## - hv ramped up

#HV command [npd1start 2500 V]
ASPMnpd1start 164
veracka
wait 5
#HV command [npd1start 2300 V]
ASPMnpd1start 150
```

```
veracka
wait 5
#HV command [npd1start 2000 V]
ASPMnpd1start 130
veracka
wait 5
#HV command [npd1start 1500 V]
ASPMnpd1start 97
veracka
wait 5
#HV command [npd1start 1000 V]
ASPMnpd1start 64
veracka
wait 5
#HV command [npd1start 0 V]
ASPMnpd1start 0
veracka
wait 5
_end
::::::::::::::
```

macros/rampdown-npd1-stop.cmd

```
::::::::::::::
mode binary
macro 44
##
## Ramp down the NPD1 stop bias voltage.
##

##
## Prerequisites:
## - NPD1 30 on
## - hv ramped up

#HV command [npd1stop 2500 V]
ASPMnpd1stop 158
veracka
wait 5
#HV command [npd1stop 2300 V]
ASPMnpd1stop 145
veracka
wait 5
#HV command [npd1stop 2000 V]
ASPMnpd1stop 125
veracka
wait 5
#HV command [npd1stop 1500 V]
ASPMnpd1stop 91
veracka
wait 5
#HV command [npd1stop 1000 V]
ASPMnpd1stop 58
veracka
wait 5
#HV command [npd1stop 0 V]
ASPMnpd1stop 0
veracka
wait 5
_end
::::::::::::::
```

macros/rampdown-npd2-defl.cmd

```
::::::::::::::
```

```
mode binary
macro 45

##
## Ramp down the NPD2 deflector voltage.
##

##
## Prerequisites:
## - NPD2 30 on
## - hv ramped up

#HV command [npd2defl 4000 V]
ASPMnpd2defl 192
veracka
wait 3
#HV command [npd2defl 3000 V]
ASPMnpd2defl 141
veracka
wait 3
#HV command [npd2defl 2000 V]
ASPMnpd2defl 91
veracka
wait 3
#HV command [npd2defl 1000 V]
ASPMnpd2defl 41
veracka
wait 3
#HV command [npd2defl 0 V]
ASPMnpd2defl 0
veracka
wait 3
_end
::::::::::::::
```

macros/rampdown-npd2-start.cmd

```
::::::::::::::
mode binary
macro 46

##
## Ramp down the NPD2 start bias voltage.
##

##
## Prerequisites:
## - NPD2 30 on
## - hv ramped up

#HV command [npd2start 2500 V]
ASPMnpd2start 164
veracka
wait 5
#HV command [npd2start 2300 V]
ASPMnpd2start 151
veracka
wait 5
#HV command [npd2start 2000 V]
ASPMnpd2start 131
veracka
wait 5
#HV command [npd2start 1500 V]
```

```
ASPMnpd2start 97
veracka
wait 5
#HV command [npd2start 1000 V]
ASPMnpd2start 64
veracka
wait 5
#HV command [npd2start 0 V]
ASPMnpd2start 0
veracka
wait 5
_end
::::::::::::::
```

macros/rampdown-npd2-stop.cmd

```
::::::::::::::
mode binary
macro 47
##
## Ramp down the NPD2 stop bias voltage.
##

##
## Prerequisites:
## - NPD2 30 on
## - hv ramped up

#HV command [npd2stop 2500 V]
ASPMnpd2stop 164
veracka
wait 5
#HV command [npd2stop 2300 V]
ASPMnpd2stop 151
veracka
wait 5
#HV command [npd2stop 2000 V]
ASPMnpd2stop 131
veracka
wait 5
#HV command [npd2stop 1500 V]
ASPMnpd2stop 98
veracka
wait 5
#HV command [npd2stop 1000 V]
ASPMnpd2stop 64
veracka
wait 5
#HV command [npd2stop 0 V]
ASPMnpd2stop 0
veracka
wait 5
_end
::::::::::::::
```

macros/rampdown-npi-bias.cmd

```
::::::::::::::
mode binary
macro 41

##
## Ramp down the NPI bias voltage.
##
```

```
##
## Prerequisites:
## - NPI 30 on
## - bias ramped up

#HV command [npibias -2200 V]
ASPMnpibias 125
veracka
wait 5
#HV command [npibias -2000 V]
ASPMnpibias 113
veracka
wait 5
#HV command [npibias -1500 V]
ASPMnpibias 82
veracka
wait 5
#HV command [npibias -1000 V]
ASPMnpibias 50
veracka
wait 5
#HV command [npibias 0 V]
ASPMnpibias 0
veracka
wait 5
_end
::::::::::::::
```

macros/rampdown-npi-defl.cmd

```
::::::::::::::
mode binary
macro 40

##
## Ramp down the NPI deflector voltage.
##

##
## Prerequisites:
## - NPI 30 on
## - HV ramped up
##

#HV command [npidefl 4000 V]
ASPMnpidefl 194
veracka
wait 3
#HV command [npidefl 3000 V]
ASPMnpidefl 143
veracka
wait 3
#HV command [npidefl 2000 V]
ASPMnpidefl 92
veracka
wait 3
#HV command [npidefl 1000 V]
ASPMnpidefl 41
veracka
wait 3
#HV command [npidefl 0 V]
ASPMnpidefl 0
veracka
```

```
wait 3

_end
::::::::::::::
```

rampdown-ima.cmd

```
::::::::::::::


#**************************************
#
# Verify IMA 30V command
_step 100


apid 62
ACKE 1

#Opto +28V off
pkt 194 2 0x0004
veracke

#Mcp +28 off
pkt 194 1 0x0002
veracke

#Main +28 off
pkt 194 3 0x0006
veracke

apid 61
acke 0

::::::::::::::
```

switch-off.cmd

```
::::::::::::::


## IMA off
aspmIMA30 0
veracka

aspmIMAPOW 0
veracka


##
aspmSCIDISABLE
veracka

## Disable HK
aspmhkdisable 0
veracka

#########################################
#########################################
#
#  High Voltages off


#*************************************
```

```
#
# Go through ELS voltages
_step 100

aspmels30 0
veracka

aspmelsgrid 0
veracka

aspmelsdefl 0
veracka

aspmelshv 0
veracka

aspmlaunch 0xbf04
veracka

aspmelsmcp 0
veracka

#************************************
#
# Go through NPI voltages
_step 100
aspmnpi30 0
veracka

aspmnpibias 0
veracka

aspmnpidefl 0
veracka

aspmnpiswitch 0
veracka

#************************************
#
# Go through NPD1 voltages
_step 100

aspmNpd130 0
veracka

aspmNPd1Bias 0
veracka

aspmNPd1defl 0
veracka

aspmNPd1Start 0
veracka

aspmNpd1Stop 0
veracka

aspmNpd1Switch 0
veracka
```

```
#*************************************
#
# Go through NPD2 voltages
_step 100

aspmNpd230 0
veracka

aspmNpd2Bias 0
veracka

aspmNPd2defl 0
veracka

aspmNPd2Start 0
veracka

aspmNpd2Stop 0
veracka

aspmNpd2Switch 0
veracka


tpoll 0
main28off::::::::::::::
```

instrument-request-connection-test.cmd

```
::::::::::::::
## Requerst connection test

aspmConn
::::::::::::::
```

go-to-safe-mode.cmd

```
::::::::::::::
## Go to safe mode

## Note: After sequence two events (warnings) are produced:
##  1) Watchdog reset
##  2) Gooing to safe mode

##  PRE-CONDITIONS
##  1) Instrument in HK mode



aspmWatchdog 0x2704
veracka
aspmWDReset 0x2704
verevent 40004

::::::::::::::
```

instrument-dump-memory.cmd

```
::::::::::::::
## Instrument DUmp memory


### == ISSUES ==
##
##  How to specify multiple blocks ???
##  Parameters ???
```

```
## Dump 1024 (16bit) words from Massmemory, starting from 0x10000
apsmMemDump 0x8301 0x1 0x0000 1024
::::::::::::::
```

set-npd-heater-on.cmd

```
::::::::::::::
## NPD Heaters on

aspmNPDHeaters 1
veracka
```

Appendix 3. ASPERA-3 TC commands list of 2002-08-23 (frozen)

```
Telecommand list:

Parameters are described in the following format:
  Word:      Bits: name and/or possible (discrete) values.

Field Mode shows existence of command in different modes.
  s      safe
  n      normal
  n-     normal, cannot be used in macro
  s+n    both)
  s+(n)  both in current version. Normal mode may disappear (or get some restrictions)
         during s/w finalization.

Class:
  (empty)        normal
   Critical      needs confirmation with TC(191,255)
   Hazardous     Hazardous command on database level


Type    Subtype    Class        Mode    Acronym                 Name  and Description:
----------------------------------------------------------------------------------------------------
----------------------------------------------------------------------------------------------------
3     5                        n       aspmHKEnable            Enable HK generation
                                                                 Parameters:
                                                                 0:            0

3     6                      n       aspmHKDisable             Disable HK generation
                                                                 Parameters:
                                                                 0:            0

----------------------------------------------------------------------------------------------------
6     2                        s+(n)   aspmMEMLoad             Load memory
                                                                 Parameters:
                                                                 0:      8-15:  memory:  0x80: ROM
                                                                                         0x81: RAM
```

```
                                                              0x82: N/A
                                                              0x83: MASSMEMORY

                                                     0-7:   number of blocks

                                             1-2:    32bit address of first block to load
                                             3:      length of block (in 16bit words)

                                             n-(n+3): Parameter words 1-3 repeats once for every
                                                      block in packet

                                             NOTE: Any patch to be loaded to EEPROM must be loaded
                                                   to massmemory. It can be tranferred to EEPROM
                                                   by TC(193,10) which is available only in safe
mode.

6     5                        s      aspmMEMDump              Dump memory
                                             Parameters:
                                             0:      8-15:  memory:  0x80: ROM
                                                                     0x81: RAM
                                                                     0x82: EEPROM
                                                                     0x83: MASSMEMORY

                                                     0-7:   number of blocks

                                             1-2:    32bit address of first dumpable block
                                             3:      length of block (in 16bit words)

                                             n-(n+3): Parameter words 1-3 repeats once for every
                                                      dumpable block

----------------------------------------------------------------------------------------------------
17    1                        s+n   aspmConn            Connection Test
                                             No parameters
```

```
------------------------------------------------------------------------------------------------------
20   1              n      aspmSCIEnable              Enable Science on RTU link
                                                        No parameters

20   2                  n    aspmSCIDisable           Disable Science on RTU link
                                                        No parameters

------------------------------------------------------------------------------------------------------
191  1              n      aspmELS30            Switch ELS +30V On/Off
                                                        Parameters:
                                                        0:      0 = off
                                                                1 = on

191  2              n      aspmELSGrid          Set ELS Screening Grid voltage
                                                        Parameters:
                                                        0:      8-15:  PAD
                                                                0-7:   voltage

191  3                  n    aspmELSDefl              Set ELS Deflection voltage and switch
                                                        Parameters:
                                                        0:      13-15: PAD
                                                                12:    Range 0 = low
                                                                             1 = high
                                                                0-11:  voltage

191  4       Critical   n      aspmELSHV              Switch ELS High Voltage On/Off
                                                        Parameters:
                                                        0:      0 = off
                                                                1 = on

191  5              n      aspmELSMcp           Set ELS mcp bias voltage
                                                        Parameters:
                                                        0:      8-15:   PAD
                                                                0-7:    voltage
------------------------------------------------------------------------------------------------------
```

```
191   7          n    aspmIMA30         Switch IMA +30V on/off
                                                Parameters:
                                                0:      0 = off
                                                        1 = on

191   9          n    aspmIMAPow        Switch IMA +/-5V and +12V on/off (Turn IMA on)
                                                Parameters:
                                                0:      0 = off
                                                        1 = on

--------------------------------------------------------------------------------------------------------
191   10         n    aspmNPDheaters          Switch NPD heaters on/off
                                                Parameters:
                                                0:      0 = off
                                                        1 = on

191   11         n    aspmNPD130        Set NPD1 +30V on/off
                                                Parameters:
                                                0:      0 = off
                                                        1 = on

191   12         n    aspmNPD1bias      Set NPD1 bias
                                                Parameters:
                                                0:      8-15:  PAD
                                                        0-7:   voltage

191   13         n    aspmNPD1defl      Set NPD1 defl bias
                                                Parameters:
                                                0:      8-15:  PAD
                                                        0-7:   voltage

191   14         n    aspmNPD1start           Set NPD1 Start bias
                                                Parameters:
                                                0:      8-15:  PAD
                                                        0-7:   voltage
```

```
191   15            n      aspmNPD1stop        Set NPD1 Stop bias
                                                       Parameters:
                                                       0:       8-15:  PAD
                                                                0-7:   voltage

191   16            n      aspmNPD230          Set NPD2 +30V on/off
                                                       Parameters:

191   17            n      aspmNPD2bias        Set NPD2 bias
                                                       Parameters:
                                                       0:       8-15:  PAD
                                                                0-7:   voltage

191   18            n      aspmNPD2defl        Set NPD2 defl bias
                                                       Parameters:
                                                       0:       8-15:  PAD
                                                                0-7:   voltage

191   19            n      aspmNPD2start             Set NPD2 Start bias
                                                       Parameters:
                                                       0:       8-15:  PAD
                                                                0-7:   voltage

191   20            n      aspmNPD2stop        Set NPD2 Stop bias
                                                       Parameters:
                                                       0:       8-15:  PAD
                                                                0-7:   voltage

----------------------------------------------------------------------------------------------------
191   21            n      aspmNPI30           Set NPI +30V on/off
                                                       Parameters:
                                                       0:       0 = off
                                                                1 = on

191   22            n      aspmNPIBias         Set NPI bias
                                                       Parameters:
```

```
                                                     0:      8-15:  PAD
                                                             0-7:   voltage

191  23          n    aspmNPIDefl        Set NPI deflection voltage
                                                     Parameters:
                                                     0:      8-15:  PAD
                                                             0-7:   voltage

191  24          n    aspmNPISwitch      set NPI switch
                                                     Parameters:
                                                     0:      0 = off
                                                             1 = on

----------------------------------------------------------------------------------------------------
191  25          n    aspmSCANSetup      Set Scanner Setup
                                                     Parameters:
                                                     0:      4-15:   PAD
                                                             3:      Scanner error handling
                                                                     0 = Enabled
                                                                     1 = Disabled

                                                             2:      Auto-Switchoff mode
                                                                     0 = Enabled
                                                                     1 = Disabled

                                                             1:      IRQ     0 = Disabled
                                                                             1 = Enabled

                                                             0:      +30V    0 = off
                                                                             1 = on

191  26          n    aspmSCANVolts      Set scanner voltages
                                                     Parameters:
                                                     0:      8-15:   VREFMC
                                                             0-7:    Coast current
```

```
                                                          1:      8-15:   Ramp current
                                                                  0-7:    Treshold CW

                                                          2:      8-15:   Treshold CCW
                                                                  0-7:    Treshold Wheel

191   27      Hazardous        n      aspmSCANStrHeat      Set stringheaters on/off
                                                          Parameters:
                                                          0:      2-15:   PAD
                                                                  0-1:    String heater number
                                                                          0 = N/A
                                                                          1 = String heater 1
                                                                          2 = String heater 2
                                                                          3 = N/A

-----------------------------------------------------------------------------------------------------
191   30                       n          aspmWatchdog            Enable watchdog
                                                          Parameters:
                                                          0:            0x2704
                                                          NOTE: May contain disable option
-----------------------------------------------------------------------------------------------------
191   32                        n       aspmNPD1switch            Enable NPD1 high voltages
                                                          Parameters:
                                                          0:      0 = off
                                                                  1 = on

191   33                        n       aspmNPD2switch            Enable NPD2 high voltages
                                                          Parameters:
                                                          0:      0 = off
                                                                  1 = on

191     34                      n       aspmNPD1Tresholds     Set NPD1 counter tresholds
                                                          0:      8-15:   start
                                                                  0-7:    stop0
                                                          1:      8-15:   stop1
                                                                  0-7:    stop2
```

```
191     34                    n       aspmNPD2Tresholds       Set NPD2 counter tresholds
                                                              0:      8-15:   start
                                                                      0-7:    stop0
                                                              1:      8-15:   stop1
                                                                      0-7:    stop2
--------------------------------------------------------------------------------------------------------
191   255                   n       aspmLaunch            Confirm hazardous command
                                                              Parameters:
                                                              0:      8-15:   Type of confirmable command
                                                                      0-7:    Subtype of confirmable command

--------------------------------------------------------------------------------------------------------
192   1                     n       aspmELSmode           Set ELS mode
                                                              Parameters:
                                                              0:      7-15:   Compression scheme:
                                                                              15:     spare
                                                                              14:     Rice compression
                                                                                      0 = disabled
                                                                                      1 = enabled
                                                                              13:     Log compression
                                                                                      0 = disabled
                                                                                      1 = enabled
                                                                              11-12:  Energy compression
                                                                              8-10:   Time compression

                                                                      3-7:    Sweep table number
                                                                      2:      PAD
                                                                      1:      Deflection voltage sweep disabled
                                                                      0:      0 = inactive
                                                                              1 = active

                                                              1:    Sector mask


192   6                     n       aspmNPImode           Set NPI mode
```

```
                                                      Parameters:
                                                      0:      8-15:   Stepping mode:
                                                                      0 = Normal mode (no voltage stepping)
                                                                      1-255: Number of samples in one step

                                                              4-7:    Accumulation time (n)
                                                                      so that one period is 31.25ms * (2^n)

                                                              3:      PAD
                                                              2:      Log compression:
                                                                      0 = disabled
                                                                      1 = enabled

                                                              1:      RICE compression:
                                                                      0 = disabled
                                                                      1 = enabled

                                                              0:      0 = inactive
                                                                      1 = active
                                                      1-2:    Sector mask

192   7                 n      aspmNPDmode          Set NPD mode
                                                      Parameters:
                                                      0:      12-15:  Integration factor  (Reserved for TOF
mode)
                                                              8-11:   Accumulation time (n)
                                                                      so that one period is 31.25ms * (2^n)


                                                              7:      PAD
                                                              4-6:    Mode:  0 =  Rawarray mode
                                                                             1 =  Bin matrix mode
                                                                             2 =  TOF mode
                                                                             3 =  PHD mode

                                                              3:      Log compression:
```

```
                                                                0 = disabled
                                                                1 = enabled

                                                        2:      RICE compression:
                                                                0 = disabled
                                                                1 = enabled
                                                        1:      NPD2 active     0 = inactive
                                                                                1 = active
                                                        0:      NPD1 enabled    0 = inactive
                                                                                1 = active

                                                1:      Bin matrix reduction tables for NPD1
                                                        12-15:  PAD
                                                        8-11:   Dir 2
                                                        4-7:    Dir 1
                                                        0-3:    Dir 0

                                                2:      Bin matrix reduction tables for NPD2
                                                        12-15:  PAD
                                                        8-11:   Dir 2
                                                        4-7:    Dir 1
                                                        0-3:    Dir 0

----------------------------------------------------------------------------------------------------
192   12                     n       aspmHKDelay         Set HK generation frequency
                                                  Parameters:
                                                  0:      Delay in seconds

----------------------------------------------------------------------------------------------------
192   13                 n       aspmSCANmode        Set scanner mode
                                                  Parameters:
                                                  0:      11-15: PAD
                                                          8-10:  Mode:     0 = Standing (scanner on)
                                                                           1 = Scanning
                                                                           2 = Stepping
                                                                           3 = Not in use (scanner off)
```

```
                                                               2-7:   PAD
                                                               0-1:   Speed    0 = Shutdown
                                                                               1 = 32 sec per scan
                                                                               2 = 64 sec pre scan
                                                                               3 = 128 sec per scan
                                                       In scanning mode:
                                                          1:      must be sent, but doesn't affect on
anything

                                                       In Standing mode:
                                                          1:      8-15:  Length of measurement cycle (n)
                                                                      so that cycle last for 31.25ms * (2^n)
                                                                  0-7:   Position

                                                       In Stepping mode:
                                                         1:      8-15:  Length of measurement cycle (n)
                                                                      so that cycle last for 31.25ms * (2^n)
                                                                  0-7:   Step angle

192   14                  n       aspmSCANinit         Initialize scanner
                                                       0:      9-15:   PAD
                                                               8:      0: Test communication and initialize
                                                                       1: Test communication only
                                                               0-7:    Communication test value

----------------------------------------------------------------------------------------------------------
192   15                  n       aspmHVShut           Set HV Shutter mode
                                                       Parameters:
                                                       0:      15:     Test mode (with mode 1)
                                                               12-14:  Mode    0 = Off
                                                                               1 = Solsen with init
                                                                               2 = Test scan only
                                                                                  (Do not init HV SHutter)
                                                                               3 = NPD
                                                                               4 = Ext
```

```
In Solsen mode  (1):
   0:   15:      Test mode (with mode 1)
        14:      PAD
        12-13:   Mode    1 = Solsen with init

        4-11:    Re-init-period (number of measurement
cycles)

        2-3:    PAD
        0-1:    Speed of test scan
                         0 = default (32s)
                         1 = 32 sec
                         2 = 64 sec
                         3 = 128 sec

       If test mode is specified:
   1:  8-15:     Solsen1 CW endposition
       0-7:      Solsen1 CCW endposition
   2:  8-15:     Solsen2 CW endposition
       0-7:      Solsen2 CCW endposition
   3-4: Any

In Test scan mode  (1):
   0:   15:      0
        14:      PAD
        12-13:   Mode    2= Test scan only
                             (Do not init HV SHutter)

        4-11:    0

        2-3:     PAD
        0-1:     Speed of test scan
                         0 = default (32s)
                         1 = 32 sec
                         2 = 64 sec
                         3 = 128 sec
```

```
                                                   1-4: Any

                                                In NPD Countrate mode
                                                   0:   14-15:          PAD
                                                        12-13:          Mode    3 = NPD
                                                        0-11:           Duration (n) so that
                                                                reduced voltages are used
                                                                for 31.25ms*(n+1)

                                                   1:   Countrate criteria for NPD1
                                                   2:   Countrate criteria for NPD2
                                                   3-4: Any

                                                In Ext mode:
                                                   0:   14-15:          PAD
                                                        12-13:          Mode    4 = Ext
                                                        0-11:           NPI shutter Duration (n) so
                                                                        that reduced voltages are
used
                                                                        for 31.25ms*(n+1)
                                                   1:   8-15:           CW position for NPI shutter
                                                        0-7:            CCW position for NPI shutter
                                                   2:   12-15:          PAD
                                                        0-11:           NPD1 and NPD2 shutter
Duration
                                                   3:   8-15:           CW position for NPD1 shutter
                                                        0-7:            CCW position for NPD1 shutter
                                                   4:   8-15:           CW position for NPD2 shutter
                                                        0-7:            CCW position for NPD2 shutter

192   16                   n       aspmHVShutVolts       Set HV shutter reduced voltages
                                                      Parameters:
                                                      0:      8-15:   PAD
                                                              0-7:    NPI bias

                                                      1:      8-15:   NPD1 Stop Bias
```

```
                                                                0-7:     NPD1 Start Bias
                                                        2:      8-15:    NPD2 Stop Bias
                                                                0-7:     NPD2 Start Bias

-----------------------------------------------------------------------------------------------------
192   20                       n       aspmMacroRun         Run macro
                                                        Parameters:
                                                        0:      8-15:    PAD
                                                                0-7:     Number of macro (range 0-191)

192   21                       n-      aspmMacroTerminate  Terminate current macro
                                                        No parameters

192   22                       n       aspmMacroRunCmd              Run single macro command
                                                        Parameters
                                                        0:               0x2704
                                                        1:               confirm word (type+subtype as in
aspmLaunch)
                                                        2:      8-15:    type
                                                                0-7:     subtype
                                                        3:               0x0
                                                        4:      8-15:    number of parameters
                                                                0-7:     0x0
                                                        5-:              parameters (as many as specified in
above)

-----------------------------------------------------------------------------------------------------
193   1                        n       aspmPipe             Pipe TC to TM
                                                        Paramters:
                                                        Anything

193   2                        n       aspmRelax            Relax ie. do nothing
                                                        No parameters

193   3                        n       aspmSim              Generate simulated data
                                                        Parameters:
```

```
                                                            0:      0 = simulation disabled
                                                                    1 = simulation enabled

-------------------------------------------------------------------------------------------------------
193   4       Critical        n       aspmWrite               Write to address
Parameters
                                                            0:      Address in RAM
                                                            1:      Word to write

193   5                       n       aspmRead                Read from address
                                                            Parameters
                                                            0:      Address in RAM

-------------------------------------------------------------------------------------------------------
193   10                      s       aspmPatch               Patch eeprom
                                                            Parameters
                                                            0-1:    Start address of patch in massmemory
                                                            2-3:    Start address of patch in eeprom
                                                            4:      15:   0 = Patch without using paging mode
                                                                          1 = Patch using paging mode
                                                                    0-14: Length of the patch (in 16bit words)
                                                            5:      CRC checksum of the patch

193   11                      n       aspmModule              Load module
                                                            Parameters:
                                                            0-1:    32bit address of modules
                                                            2:      10-15:  PAD
                                                                    9:      0 = Load and run module
                                                                            1 = Load but don't run module
                                                                    8:      0 = Verify crc
                                                                            1 = Don't verify crc
                                                                    0-7:    Memory:   0x82 (EEPROM)

-------------------------------------------------------------------------------------------------------
193   12                      s       aspmBootMode            Select boot mode
                                                            Parameters:
```

```
                                                     0:      1 = Safe mode
                                                             2 = Normal mode
                                                     NOTE: no use after boot process

193   16                   n       aspmWDReset           Watchdog reset
                                                     Parameters:
                                                     0:      0x2704

------------------------------------------------------------------------------------------------------
```

Appendix 4. ASPERA-3 Macrocommands

The section is based on the convention of 2002-09-16. New macros 4.9 – 4.14 are added on 2002-10-07 describing macro modes with no scanner.

4.1 Macromode definitions

The tables below define the individual sensors setting which provide the required bit rates for the ASPERA macromodes. Note the following conventions:

ELS

E - energy compression factors
- E= 1 -> 128 energy steps
- E=2 -> 64 energy steps
- E=4 -> 32 energy steps

T - time compression
- T = 1 -> no sweep accumulation
- T = 2 -> 2 sweep accumulation -> one sweep / 8 sec
- T = 8 -> 4 sweep accumulation -> one sweep / 32 sec

S - sector mask
- S = 0 -> 16 sectors
- S = 1 -> 8 sectors

NPI

N - accumulation time in 62.5 msec

NPD

N - accumulation time in 62.5 msec

X - number of PHD bins in the binned matrix mode
- X = 0, no PHD
- X = 2, 2 PHD bins
- X = 16, 16 PHD bins

Y - number of TOF bins in the binned matrix mode
- Y = 16, 16 TOF bins

IMA bit rates are taken from the document "The ICA - IMA TC/TM data formats and related software aspects", Issue 1.2, 2002-04-20.

MU sensor bit rates include the headers and HK information. Log compression is ON everywhere.

4.1 ASPHK mode

Sensor	Settings	Bit rate, bit/s
ELS	No science	0
NPI	No science	0
NPD1	No science	0
NPD2	No science	0
IMA	No science	0
Scanner	Speed = 32 sec	0
IMA HK		21
MU HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		29
Required bit rate		**27**

Measured bit rate (w/o Rice compression)	**28.2**
Measured bit rate (with Rice compression)	**28.2**

4.2 ASPLow mode

Sensor	**Settings**	**Bit rate, bit/s**
ELS	E=4 (32 E-steps), T = 8 (sweep/32 s), S = 1 (8 sectors)	68
NPI	No science	0
NPD1	Bin matrix, N = 32(sample / 64*31.25 ms = 2 sec), X = 0, Y = 16	212
NPD2	Same as NPD1	212
IMA	Normal mode	208
Scanner	Speed = 128 sec	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**729**
Required bit rate		**621**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.3 ASPNormal mode

Sensor	**Settings**	**Bit rate, bit/s**
ELS	E=4 (32 E-steps), T = 2 (sweep/8 s), S = 1 (8 sectors)	260
NPI	N = 16 (sample / 32*31.25 ms = 1 sec)	261
NPD1	Bin matrix, N = 16(sample / 32*31.25 ms = 1 sec), X = 2, Y = 16	788
NPD2	Same as NPD1	788
IMA	Normal mode	208
Scanner	Speed = 64 sec	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**2333**
Required bit rate		**2175**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.4 ASPHigh mode

Sensor	**Settings**	**Bit rate, bit/s**
ELS	E=4 (32 E-steps), T = 1 (sweep/4 s), S = 0 (16 sectors)	1029
NPI	N = 16 (sample / 32*31.25 ms = 1 sec)	265
NPD1	Bin matrix, N = 16(sample / 32*31.25 ms = 1 sec), X = 2, Y = 16	788
NPD2	Same as NPD1	788
IMA	IMA mode	3996

Scanner	Speed = 32 sec	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**6894**
Required bit rate		**6214**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.5 ASPBurst mode

Sensor	Settings	Bit rate, bit/s
ELS	E=1 (128 E-steps), T = 1 (sweep/4 s), S = 0 (16 sectors)	4100
NPI	No science	0
NPD1	TOF matrix, N = 16 (sample / 32*31.25 ms = 1 sec)	6164
NPD2	Same as NPD1	6164
IMA	IMA mode	3996
Scanner	Speed = 32 sec	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**20453**
Required bit rate		**18204**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.6 ASPCal mode

The ASPCal mode consist of consecutive runs of the individual sensors
ELScal: 600 sec,No science from NPI, NPD1, NPD2, IMA
NPICal: 600 sec, No science from ELS, NPD1, NPD2, IMA
NPDCal: 240 sec, No science from ELS, NPI, IMA
IMACal: 600 sec, No science from ELS, NPI, NPD1, NPD2

The table below gives the settings of the individual sensors.

Sensor	Settings	Bit rate, bit/s
ELS	E=1 (128 E-steps), T = 2 (sweep/8 s), S = 0 (16 sectors)	2048
NPI	N = 16 (sample / 32*31.25 ms = 1 sec)	265
NPD1	Raw mode, N = 32(sample / 64*31.25 ms = 2 sec)	8192
NPD2	Same as NPD1	8192
IMA	Calibration mode	537
Scanner	Speed = fixed 90° position	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated AVERAGE bit rate (No rice compression)		**2130**
Required bit rate		**2175**
Measured AVERAGE bit rate (w/o Rice compression)		
Measured AVERAGE bit rate (with Rice compression)		

4.7 ASPStepping mode

Sensor	Settings	Bit rate, bit/s
ELS	No science	0
NPI	N = 128 (1 sample / 8*32*31.25 ms = 8 sec)	69
NPD1	Bin matrix, N = 128(1 sample / 8*32*31.25 ms = 8 sec), X = 16, Y=16	788
NPD2	Same as NPD1	788
IMA	Normal mode	206.5
Scanner	5° / step, Intergation time = 8 sec	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**1880.5**
Required bit rate		**2175**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.8 ASPfixed mode

Same as ASPHigh mode but scanner is in parking position.

Sensor	Settings	Bit rate, bit/s
ELS	E=4 (32 E-steps), T = 1 (sweep/4 s), S = 0 (16 sectors)	1029
NPI	N = 16 (sample / 32*31.25 ms = 1 sec)	265
NPD1	Bin matrix, N = 16(sample / 32*31.25 ms = 1 sec), X = 2, Y = 16	788
NPD2	Same as NPD1	788
IMA	IMA mode	3996
Scanner	Fixed position = 90°	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**6894**
Required bit rate		**6214**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.9 ASPHK_NoScanner mode

Same as ASPHK mode but scanner is not initialized.

Sensor	Settings	Bit rate, bit/s
ELS	No science	0
NPI	No science	0
NPD1	No science	0
NPD2	No science	0
IMA	No science	0
Scanner	Not initialized, preferably in 90° position	0

IMA HK		21
MU HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		29
Required bit rate		**27**
Measured bit rate (w/o Rice compression)		**28.2**
Measured bit rate (with Rice compression)		**28.2**

4.10 ASPLow_NoScanner mode

Same as ASPLow mode but scanner is not initialized.

Sensor	**Settings**	**Bit rate, bit/s**
ELS	E=4 (32 E-steps), T = 8 (sweep/32 s), S = 1 (8 sectors)	68
NPI	No science	0
NPD1	Bin matrix, N = 32(sample / 64*31.25 ms = 2 sec), X = 0, Y = 16	212
NPD2	Same as NPD1	212
IMA	Normal mode	208
Scanner	Not initialized, preferably in 90° position	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**729**
Required bit rate		**621**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.11 ASPNormal_NoScanner mode

Same as ASPNormal mode but scanner is not initialized.

Sensor	**Settings**	**Bit rate, bit/s**
ELS	E=4 (32 E-steps), T = 2 (sweep/8 s), S = 1 (8 sectors)	260
NPI	N = 16 (sample / 32*31.25 ms = 1 sec)	261
NPD1	Bin matrix, N = 16(sample / 32*31.25 ms = 1 sec), X = 2, Y = 16	788
NPD2	Same as NPD1	788
IMA	Normal mode	208
Scanner	Not initialized, preferably in 90° position	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**2333**
Required bit rate		**2175**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.12 ASPHigh_NoScanner mode

Same as ASPHigh mode but scanner is not initialized.

Sensor	Settings	Bit rate, bit/s
ELS	E=4 (32 E-steps), T = 1 (sweep/4 s), S = 0 (16 sectors)	1029
NPI	N = 16 (sample / 32*31.25 ms = 1 sec)	265
NPD1	Bin matrix, N = 16(sample / 32*31.25 ms = 1 sec), X = 2, Y = 16	788
NPD2	Same as NPD1	788
IMA	IMA mode	3996
Scanner	Not initialized, preferably in 90° position	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**6894**
Required bit rate		**6214**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.13 ASPBurst_NoScanner mode

Same as ASPBurst mode but scanner is not initialized.

Sensor	Settings	Bit rate, bit/s
ELS	E=1 (128 E-steps), T = 1 (sweep/4 s), S = 0 (16 sectors)	4100
NPI	No science	0
NPD1	TOF matrix, N = 16 (sample / 32*31.25 ms = 1 sec)	6164
NPD2	Same as NPD1	6164
IMA	IMA mode	3996
Scanner	Not initialized, preferably in 90° position	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated bit rate (No rice compression)		**20453**
Required bit rate		**18204**
Measured bit rate (w/o Rice compression)		
Measured bit rate (with Rice compression)		

4.14 ASPCal_NoScanner mode

Same as ASPCal mode but scanner is not initialized.

The ASPCal mode consist of consecutive runs of the individual sensors
ELScal: 600 sec,No science from NPI, NPD1, NPD2, IMA
NPICal: 600 sec, No science from ELS, NPD1, NPD2, IMA
NPDCal: 240 sec, No science from ELS, NPI, IMA
IMACal: 600 sec, No science from ELS, NPI, NPD1, NPD2

The table below gives the settings of the individual sensors.

Sensor	Settings	Bit rate, bit/s

ELS	E=1 (128 E-steps), T = 2 (sweep/8 s), S = 0 (16 sectors)	2048
NPI	N = 16 (sample / 32*31.25 ms = 1 sec)	265
NPD1	Raw mode, N = 32(sample / 64*31.25 ms = 2 sec)	8192
NPD2	Same as NPD1	8192
IMA	Calibration mode	537
Scanner	Not initialized, preferably in 90° position	0
MU HK		21
IMA HK	1 HK packet / 128 sec	8
Total estimated AVERAGE bit rate (No rice compression)		**2130**
Required bit rate		**2175**
Measured AVERAGE bit rate (w/o Rice compression)		
Measured AVERAGE bit rate (with Rice compression)		

4.15. TM mode verification. No scanner modes

HK byte definiions for different modes for macro No_scanner, No_Rice

Bytes in HK	Field	ASP Low	ASPNormal	ASPHigh	ASPBurst
108-109	ELS sector mask	0x5555	0x 5555	0x FFFF	0x FFFF
110	ELS compression scheme	0x33	0x31(33 svt3)	0x30 (33sv t3)	0x20
112-115	NPI sector mask	0x FFFF	0x FFFF	0x FFFF	0x FFFF
117/bit7	NPI mode (0-normal, 1-stepping)	0	0	0	0
117/bit2-6	NPI accumulation time	0	0x5	0x5	0x5
117/bit1	NPI log compression (0-off,1-on)	0	1	1	1
117/bit0	NPI rice compression(0-off,1-on)	0	0	0	0
118/bit5	NPD Rice compression (0-off,1-on)	0	0	0	0
118/bit4	NPD log compression (0-off,1-on)	0	0 (1sv t3)	0(1 svt3)	0
118/bit0-3	NPD accumulation time	0x6	0x5	0x5	0x5
119/bit4-7	NPD2 TM mode	0x2	0xA	0xA	0xD
119/bit0-3	NPD1 TM mode	0x2	0xA	0xA	0xD
98/bit4	Scanner direction	0	0	0	0
98/bit1	Scanner initialzed	0	0	0	0
99/bit0-1	Scanner speed	0	0	0	0
105	Scanner postion	0	0	0	0

4.16. Macrocommand on-board definitions

Macro name /function	Macro number	TM rate, bits/s (est.)	TM rate, bits/s (measured)
Ramp up NPI deflector	32	N/A	
Ramp up NPI bias	33	N/A	
Ramp up NPD1 deflector	34	N/A	
Ramp up NPD1 START bias	35	N/A	
Ramp up NPD1 STOP bias	36	N/A	
Ramp up NPD2 deflector	37	N/A	
Ramp up NPD2 START bias	38	N/A	
Ramp up NPD2 STOP bias	39	N/A	
Ramp down NPI deflector	40	N/A	
Ramp down NPPI bias	41	N/A	
Ramp down NPD1 deflector	42	N/A	
Ramp down NPD1 START bias	43	N/A	
Ramp down NPD1 STOP bias	44	N/A	
Ramp down NPD2 deflector	45	N/A	
Ramp down NPD2 START bias	46	N/A	
Ramp down NPD2 STOP bias	47	N/A	
Low mode, No RICE	64	729	732
Low mode RICE	65	N/A	544
Low mode, No scanning, No RICE	68	729	881
Low mode, No scaning, RICE	69	N/A	504
Normal mode, No RICE	72	2333	2315
Normal mode, RICE	73	N/A	1320
Normal mode, No scanning, No RICE	76	2333	2570
Normal mode, No scanning, RICE	77	N/A	987
High mode, No RICE	80	6894	2456
High mode, RICE	81	N/A	1402
High mode, No scanning, No RICE	84	6894	2347
High mode, No scanning, RICE	85	N/A	1103
Burst mode, RICE	88	N/A	2373
Burst mode, No RICE	89	20453	14231
Burst mode, No scanning, No RICE	93	20453	16665
Burst mode, No scanning, RICE	94	N/A	3254
Stepping mode, No RICE	96	1880	1184
Stepping mode, RICE	97	N/A	165
Fixed mode, No RICE	102	6894	3665
Fixxed mode, RICE	103	N/A	2095
Cal mode	100		
Cal mode, No RICE	110	2130	
Cal mode, RICE	111	N/A	
Cal mode, No scanning, No RICE	114	2130	

Cal mode, Scanning, RICE	115	N/A	

Appendix 5. ASPERA-3 Main Unit Software User's Guide. Issue 2.0 2003-01-29

Appendix 6. ICA-IMA TC/TM data formats and related software aspect, Issue 1.4a 2003-06-19

Appendix 7. NPD / DigTOF

Appendix 8. NPI and NPD HV digital references

HV command ASPMnpd1bias

HV	Ref.
0	0
100	0
200	2
300	8
400	14
500	20
600	26
700	32
800	38
900	45
1000	51
1100	57
1200	63
1300	69
1400	75
1500	81
1600	87
1700	93
1800	99
1900	105
2000	111
2100	117
2200	124
2300	130
2400	136
2500	142
2600	148
2700	154
2800	160
2900	166
3000	172
3100	178
3200	184
3300	190
3400	196
3500	203
3600	209
3700	215
3800	221
3900	227
4000	233
4100	239
4200	245
4300	251
4400	257
4500	263
4600	269
4700	275
4800	282
4900	288
5000	294

HV command ASPMnpd1start

HV	Ref.
0	0
100	4
200	11
300	17
400	24
500	31
600	37
700	44
800	51
900	57
1000	64
1100	71
1200	77
1300	84
1400	90
1500	97
1600	104
1700	110
1800	117
1900	124
2000	130
2100	137
2200	144
2300	150
2400	157
2500	164
2600	170
2700	177
2800	183
2900	190
3000	197
3100	203
3200	210
3300	217
3400	223
3500	230
3600	237
3700	243
3800	250
3900	257
4000	263
4100	270
4200	276
4300	283
4400	290
4500	296
4600	303

4700	310
4800	316
4900	323
5000	330

HV command ASPMnpd1stop

HV	Ref.
0	0
100	0
200	4
300	11
400	18
500	24
600	31
700	38
800	45
900	51
1000	58
1100	65
1200	71
1300	78
1400	85
1500	91
1600	98
1700	105
1800	112
1900	118
2000	125
2100	132
2200	138
2300	145
2400	152
2500	158
2600	165
2700	172
2800	179
2900	185
3000	192
3100	199
3200	205
3300	212
3400	219
3500	225
3600	232
3700	239
3800	246
3900	252
4000	259
4100	266
4200	272
4300	279
4400	286
4500	292
4600	299
4700	306
4800	313
4900	319
5000	326

HV command ASPMnpd2bias

HV	Ref.
0	0
100	0
200	2
300	8
400	14
500	20
600	26
700	33
800	39
900	45
1000	51
1100	57
1200	63
1300	70
1400	76
1500	82
1600	88
1700	94
1800	100
1900	107
2000	113
2100	119
2200	125
2300	131
2400	137
2500	144
2600	150
2700	156
2800	162
2900	168
3000	174
3100	180
3200	187
3300	193
3400	199
3500	205
3600	211
3700	217
3800	224
3900	230
4000	236

4100	242
4200	248
4300	254
4400	261
4500	267
4600	273
4700	279
4800	285
4900	291
5000	298

HV command ASPMnpd2start

HV	Ref.
0	0
100	4
200	10
300	17
400	24
500	30
600	37
700	44
800	50
900	57
1000	64
1100	70
1200	77
1300	84
1400	91
1500	97
1600	104
1700	111
1800	117
1900	124
2000	131
2100	137
2200	144
2300	151
2400	157
2500	164
2600	171
2700	178
2800	184
2900	191
3000	198
3100	204
3200	211
3300	218
3400	224
3500	231
3600	238
3700	244
3800	251
3900	258
4000	265
4100	271
4200	278
4300	285
4400	291
4500	298
4600	305
4700	311
4800	318
4900	325
5000	331

HV command ASPMnpd2stop

HV	Ref.
0	0
100	4
200	11
300	17
400	24
500	31
600	37
700	44
800	51
900	57
1000	64
1100	71
1200	77
1300	84
1400	91
1500	98
1600	104
1700	111
1800	118
1900	124
2000	131
2100	138
2200	144
2300	151
2400	158
2500	164
2600	171
2700	178
2800	185
2900	191
3000	198
3100	205
3200	211
3300	218
3400	225

3500	231
3600	238
3700	245
3800	251
3900	258
4000	265
4100	271
4200	278
4300	285
4400	292
4500	298
4600	305
4700	312
4800	318
4900	325
5000	332

HV command ASPMnpd1defl

HV	Ref.
0	0
100	0
200	1
300	6
400	11
500	16
600	21
700	26
800	31
900	36
1000	42
1100	47
1200	52
1300	57
1400	62
1500	67
1600	72
1700	77
1800	82
1900	88
2000	93
2100	98
2200	103
2300	108
2400	113
2500	118
2600	123
2700	128
2800	134
2900	139
3000	144
3100	149
3200	154
3300	159
3400	164
3500	169
3600	174
3700	180
3800	185
3900	190
4000	195
4100	200
4200	205
4300	210
4400	215
4500	220
4600	226
4700	231
4800	236
4900	241
5000	246

HV command ASPMnpd2defl

HV	Ref.
0	0
100	0
200	1
300	6
400	11
500	16
600	21
700	26
800	31
900	36
1000	41
1100	46
1200	51
1300	56
1400	61
1500	66
1600	71
1700	76
1800	81
1900	86
2000	91
2100	96
2200	101
2300	106
2400	111
2500	116
2600	121
2700	126
2800	131

2900	136
3000	141
3100	146
3200	151
3300	157
3400	162
3500	167
3600	172
3700	177
3800	182
3900	187
4000	192
4100	197
4200	202
4300	207
4400	212
4500	217
4600	222
4700	227
4800	232
4900	237
5000	242

HV command ASPMnpibias

HV	Ref.
0	0
-100	0
-200	1
-300	7
-400	13
-500	19
-600	26
-700	32
-800	38
-900	44
-1000	50
-1100	57
-1200	63
-1300	69
-1400	75
-1500	82
-1600	88
-1700	94
-1800	100
-1900	106
-2000	113
-2100	119
-2200	125
-2300	131
-2400	137
-2500	144
-2600	150
-2700	156
-2800	162
-2900	169
-3000	175
-3100	181
-3200	187
-3300	193
-3400	200
-3500	206
-3600	212
-3700	218
-3800	224
-3900	231
-4000	237
-4100	243
-4200	249
-4300	256
-4400	262
-4500	268
-4600	274
-4700	280
-4800	287
-4900	293
-5000	299

HV command ASPMnpidefl

HV	Ref.
0	0
100	0
200	0
300	5
400	10
500	15
600	20
700	25
800	31
900	36
1000	41
1100	46
1200	51
1300	56
1400	61
1500	66
1600	71
1700	76
1800	82
1900	87
2000	92
2100	97
2200	102

2300	107
2400	112
2500	117
2600	122
2700	127
2800	132
2900	138
3000	143
3100	148
3200	153
3300	158
3400	163
3500	168
3600	173
3700	178
3800	183
3900	189
4000	194
4100	199
4200	204
4300	209
4400	214
4500	219
4600	224
4700	229
4800	234
4900	240
5000	245

Appendix 9. Instrument operation activities.

The activity descriptions are based on the document MEX-ASP-TN-020830 of 2002-09-02 and follow the MEX EV-IC-MC Request forms (MECC).

Abbreviations:
NEV: Near Earth verification phase
IC: interplanetary cruise
RO: routing observations

MEX EV-IC-MC REQUEST FORM (MECC)			
Instrument ASPERA-3		Originator Name S. Barabash (Co-PI)	**Date** 2002-09-23
Mission Phase **NEV**	Activity ID **nev-as-001**	Activity Name First power-on	
Description of Activity: THE ACTIVITY IS TO SWITCH-ON POWER FOR THE INSTRUMENT FOR THE FIRST TIME AND MAKE INITIAL CHECK OF ITS HEALTH. Activity Duration: **30 min** Time constrains: **not earlier than 21 days after launch** Time Criticality (if any, can this activity be done in any other portion of the mission): **Must be conducted at the beginning of the cruise phase** Instrument Mode: **HK mode** Telemetry rate: **29 bit/s** Power Profile (approximate): **app. 15 W constant** Monitoring Required (1): **Yes** Interaction Required (2): **Yes** Instrument Thermal requirement: **Before initiating the activity it must be verified that the instrument temperatures given by the spacecraft termistors (3 termistors) are within operation limits:** **Thermistor 1 (scanner): -35°…+50°** **Thermistor 2 (DPU): -40°…+50°** **thermistor 3 (IMA, DPU): -50°…+60°** Geometry Requirements: **No** s/c Pointing Requirements: **No**			
Comments/other constrains: **During this activity all HV are off. IMA is OFF. The instrument is powered-on and goes to HK mode by default.**			
Accepted:	PI	MEX Project	ESOC

[1] This requirement should be stated if monitoring of the housekeeping TM is required during the activity. The monitoring will be provided by the MEX Mission Control System either from the MEX Dedicated Control Room and from the S2K workstation provided in the PISA.

[2] This requirement should be stated if command interaction is required during the activity, i.e. the activity cannot be performed from the Master Timeline using time-tagged commands (normal mode of operation).

<table>
<tr><td colspan="5">MEX EV-IC-MC REQUEST FORM (MECC)</td></tr>
<tr><td colspan="2">Instrument
ASPERA-3</td><td>Originator Name
S. Barabash (Co-PI)</td><td colspan="2">Date
2002-09-23</td></tr>
<tr><td>Mission Phase

NEV</td><td>Activity ID

nev-as-002</td><td colspan="3">Activity Name

Realise of the locking mechanism</td></tr>
<tr><td colspan="5">Description of Activity:
THE ACTIVITY IS TO REALISE THE ASPERA-3 LOCKING MECHANISM AND VERIFIED SCANNER FUNCTIONALITY.
Activity Duration: 30 min
Time constrains: not more than 2 day after the first power-on activity
Time Criticality (if any, can this activity be done in any other portion of the mission): Must be conducted at the beginning of the cruise phase
Instrument Mode: HK mode
Telemetry rate: 29 bit/s
Power Profile (approximate): app. 15 W constant
Monitoring Required (1): Yes (TBC)
Interaction Required (2): Yes (TBC)
Instrument Thermal requirement: Before initiating the activity it must be verified that the instrument temperatures given by the spacecraft termistors (3 termistors) are within operation limits:
Thermistor 1 (scanner): -35°…+50°
Thermistor 2 (DPU): -40°…+50°
thermistor 3 (IMA, DPU): -50°…+60°

Geometry Requirements: No
s/c Pointing Requirements: No</td></tr>
<tr><td colspan="5">Comments/other constrains:
The release is performed by a single command. After the release the scanner is ready for operation and check-out. The verification of the command execution is made via starting rotation of the scanner with the speed 128 sec with the default values of the current and sensor thresholds. The scanner will be verified in different modes (stepping, scanning) and spin periods (32, 64, 128 sec). Monitoring is made via HK TM.</td></tr>
<tr><td>Accepted:</td><td colspan="2">PI</td><td>MEX Project</td><td>ESOC</td></tr>
</table>

[1] This requirement should be stated if monitoring of the housekeeping TM is required during the activity. The monitoring will be provided by the MEX Mission Control System either from the MEX Dedicated Control Room and from the S2K workstation provided in the PISA.

[2] This requirement should be stated if command interaction is required during the activity, i.e. the activity cannot be performed from the Master Timeline using time-tagged commands (normal mode of operation).

MEX EV-IC-MC REQUEST FORM (MECC)			
Instrument ASPERA-3		Originator Name S. Barabash (Co-PI)	**Date** 2002-09-23
Mission Phase **NEV**	Activity ID **nev-as-003**	Activity Name Sensor check-up	

Description of Activity:
THE ACTIVITY IS TO VERIFY FUNCTIONALITY AND HEALTH OF ALL ASPERA-3 SENSORS (ELS, NPI, NPD1, NPD2, IMA, SOLAR SENSOR) WITHOUT HV.
Activity Duration: **app. 8 hours / sensor, in total 2 days**
Time constrains: **not more than 1 day after the realise of the locking mechanism**
Time Criticality (if any, can this activity be done in any other portion of the mission): **Must be conducted at the beginning of the cruise phase**
Instrument Mode: sensor dependent
Telemetry rate: **variable, max 18.2 kbits**
Power Profile (approximate): **app. 15 W constant**
Monitoring Required (1): **No**
Interaction Required (2): **No**
Instrument Thermal requirement: **Before initiating the activity it must be verified that the instrument temperatures given by the spacecraft termistors (3 termistors) are within operation limits:**
Thermistor 1 (scanner): -35°…+50°
Thermistor 2 (DPU): -40°…+50°
Thermistor 3 (IMA, DPU): -50°…+60°

Geometry Requirements: **No**
s/c Pointing Requirements: **No**

Comments/other constrains:
This activity can be run several times depending on the evaluation of the results after the first run. Check – up is made individually for each sensor. Note, that the duration of this low voltage mode is depending on the temperature of the instrument, if the temperature is low then this mode will be used to warm up the instrument and thus increase the outgassing. Inthis case the duration may exceed 2 days.

Accepted:	PI	MEX Project	ESOC

[1] This requirement should be stated if monitoring of the housekeeping TM is required during the activity. The monitoring will be provided by the MEX Mission Control System either from the MEX Dedicated Control Room and from the S2K workstation provided in the PISA.

[2] This requirement should be stated if command interaction is required during the activity, i.e. the activity cannot be performed from the Master Timeline using time-tagged commands (normal mode of operation).

<table>
<tr><td colspan="4">MEX EV-IC-MC REQUEST FORM (MECC)</td></tr>
<tr><td colspan="2">Instrument
ASPERA-3</td><td>Originator Name
S. Barabash (Co-PI)</td><td>Date
2002-09-23</td></tr>
<tr><td>Mission Phase

NEV</td><td>Activity ID

nev-as-004</td><td colspan="2">Activity Name

ASPERA-3 HV ramping</td></tr>
<tr><td colspan="4">Description of Activity:
THE ACTIVITY IS TO ARISE HV FOR ALL INSTRUMENT SENSORS (ELS, NPI, NPD1, NPD2, IMA). THE RAMPING IS DONE FOR A SINGLE HV AT ONCE. THE MU CONTAINS 8 SEPARATE HV'S AND IMA 4.
Activity Duration: app. 3 hours / HV, in total 36 hours + 2 days for middle voltage outgassing (max), different voltages are to be done in different sessions
Time constrains: not earlier than 28 days after launch
Time Criticality (if any, can this activity be done in any other portion of the mission): Must be conducted at the beginning of the cruise phase
Instrument Mode: sensor dependent
Telemetry rate: variable, max 6.2 kbits
Power Profile (approximate): app. 15 W constant
Monitoring Required (1): Yes
Interaction Required (2): Yes
Instrument Thermal requirement: Before initiating the activity it must be verified that the instrument temperatures given by the spacecraft termistors (3 termistors) are within operation limits:
Thermistor 1 (scanner): -35°…+50°
Thermistor 2 (DPU): -40°…+50°
thermistor 3 (IMA, DPU): -50°…+60°
Geometry Requirements: No
s/c Pointing Requirements: No</td></tr>
<tr><td colspan="4">Comments/other constrains:
The instrument MCP bias voltage (MU and IMA) will be slowly increased to 1.0 kV to allow further outgassing. After 24 hours at 1.0 kV the voltage are ramped further with the steps 300V/30 min. to the nominal value. After successful MCP voltage activation in MU and IMA other HV will be switched on and ramped up. The HV ramping is performed individually for all HV supplies in MU and IMA. The ramping is the gradual increase of HV with the steps 300V / 30 min (the deflector HV only) with monitoring of the sensor health. The instrument is in the HK mode. The purpose of this operation is to verify stability of HV supplies. After this the instrument is in its nominal working mode, however fine tuning of high voltage reference settings and other software parameters are most likely to be needed.</td></tr>
<tr><td>Accepted:</td><td>PI</td><td>MEX Project</td><td>ESOC</td></tr>
</table>

[1] This requirement should be stated if monitoring of the housekeeping TM is required during the activity. The monitoring will be provided by the MEX Mission Control System either from the MEX Dedicated Control Room and from the S2K workstation provided in the PISA.

[2] This requirement should be stated if command interaction is required during the activity, i.e. the activity cannot be performed from the Master Timeline using time-tagged commands (normal mode of operation).

<table>
<tr><td colspan="4">MEX EV-IC-MC REQUEST FORM (MECC)</td></tr>
<tr><td colspan="2">Instrument
ASPERA-3</td><td>Originator Name
S. Barabash (Co-PI)</td><td>Date
2002-08-30</td></tr>
<tr><td>Mission Phase

NEV</td><td>Activity ID

nev-as-005</td><td colspan="2">Activity Name

ASPERA-3 NEV calibrations</td></tr>
<tr><td colspan="4">Description of Activity:
THE ACTIVITY IS TO CALIBRATE ASPERA-3 SENSORS AGAINST SOLAR WIND AND INTEPLANETARY NEUTRAL WIND.
Activity Duration: 5 days continued, <u>only 8h sessions can be available</u>
Time constrains: right after completion of the hv ramping
Time Criticality (if any, can this activity be done in any other portion of the mission): conducted at the beginning of the cruise phase
Instrument Mode: sensor dependent
Telemetry rate: variable, max 6.2 kbits
Power Profile (approximate): app. 15 W constant
Monitoring Required (1): No
Interaction Required (2): No
Instrument Thermal requirement: Before initiating the activity it must be verified that the instrument temperatures given by the spacecraft termistors (3 termistors) are within operation limits:
Thermistor 1 (scanner): -35°…+50°
Thermistor 2 (DPU): -40°…+50°
thermistor 3 (IMA, DPU): -50°…+60°

Geometry Requirements: TBD
s/c Pointing Requirements: TBD</td></tr>
<tr><td colspan="4">Comments/other constrains:</td></tr>
<tr><td>Accepted:</td><td>PI</td><td>MEX Project</td><td>ESOC</td></tr>
</table>

[1] This requirement should be stated if monitoring of the housekeeping TM is required during the activity. The monitoring will be provided by the MEX Mission Control System either from the MEX Dedicated Control Room and from the S2K workstation provided in the PISA.

[2] This requirement should be stated if command interaction is required during the activity, i.e. the activity cannot be performed from the Master Timeline using time-tagged commands (normal mode of operation).

<table>
<tr><td colspan="4">MEX EV-IC-MC REQUEST FORM (MECC)</td></tr>
<tr><td colspan="2">Instrument
ASPERA-3</td><td>Originator Name
S. Barabash (Co-PI)</td><td>Date
2002-08-30</td></tr>
<tr><td>Mission Phase

IC</td><td>Activity ID

IC-as-001</td><td colspan="2">Activity Name

ASPERA-3 IC calibrations</td></tr>
<tr><td colspan="4">Description of Activity:
THE ACTIVITY IS TO CALIBRATE ASPERA-3 SENSORS AGAINST SOLAR WIND AND INTEPLANETARY NEUTRAL WIND. THE IDEA IS TO VERIFY THE HEALTH OF MCPS AND ABSENT OF DEGRADATION BY COMPARING THE RESULTS WITH THE CALIBRATIONS MADE DURING NEV PHASE.
Activity Duration: 5 days requested by ASPERA, <u>8h possible from ESOC</u>
Time constrains: as later as possible before MOI (2 month before MIO)
Time Criticality (if any, can this activity be done in any other portion of the mission): conducted at the end of the cruise phase
Instrument Mode: sensor dependent
Telemetry rate: variable, max 6.2 kbits
Power Profile (approximate): app. 15 W constant
Monitoring Required (1): No
Interaction Required (2): No
Instrument Thermal requirement: Before initiating the activity it must be verified that the instrument temperatures given by the spacecraft termistors (3 termistors) are within operation limits:
Thermistor 1 (scanner): -35°…+50°
Thermistor 2 (DPU): -40°…+50°
thermistor 3 (IMA, DPU): -50°…+60°
Geometry Requirements: TBD
s/c Pointing Requirements: TBD</td></tr>
<tr><td colspan="4">Comments/other constrains:
<u>Repetition one of the 8-h session of nev-as-005</u></td></tr>
<tr><td>Accepted:</td><td>PI</td><td>MEX Project</td><td>ESOC</td></tr>
</table>

[1] This requirement should be stated if monitoring of the housekeeping TM is required during the activity. The monitoring will be provided by the MEX Mission Control System either from the MEX Dedicated Control Room and from the S2K workstation provided in the PISA.

[2] This requirement should be stated if command interaction is required during the activity, i.e. the activity cannot be performed from the Master Timeline using time-tagged commands (normal mode of operation).

<table>
<tr><td colspan="4" align="center">MEX EV-IC-MC REQUEST FORM (MECC)</td></tr>
<tr><td colspan="2">Instrument
ASPERA-3</td><td>Originator Name
S. Barabash (Co-PI)</td><td>Date
2002-08-30</td></tr>
<tr><td>Mission Phase

IC</td><td>Activity ID

IC-as-002</td><td colspan="2">Activity Name

ASPERA-3 software update</td></tr>
<tr><td colspan="4">Description of Activity:
THE ACTIVITY IS TO UPDATE THE ASPERA-3 SOFTWARE. THE ACTIVITY MAY OR MAY NOT BE REQUIRED DEPENDING ON THE RESULTS OF THE ASPERA – 3 SENSOR CHECK – UP ACTIVITY.
Activity Duration: 8 hour
Time constrains: no
Time Criticality (if any, can this activity be done in any other portion of the mission): conducted as soon as possible when the need is identified
Instrument Mode: hk
Telemetry rate: 29 bits/s
Power Profile (approximate): app. 15 W constant
Monitoring Required (1): No
Interaction Required (2): No
Instrument Thermal requirement: Before initiating the activity it must be verified that the instrument temperatures given by the spacecraft termistors (3 termistors) are within operation limits:
Thermistor 1 (scanner): -35°…+50°
Thermistor 2 (DPU): -40°…+50°
thermistor 3 (IMA, DPU): -50°…+60°

Geometry Requirements: No
s/c Pointing Requirements: No</td></tr>
<tr><td colspan="4">Comments/other constrains:
<u>Can be prepared before the launch and executed before the end of NEV.</u></td></tr>
<tr><td>Accepted:</td><td>PI</td><td>MEX Project</td><td>ESOC</td></tr>
</table>

[1] This requirement should be stated if monitoring of the housekeeping TM is required during the activity. The monitoring will be provided by the MEX Mission Control System either from the MEX Dedicated Control Room and from the S2K workstation provided in the PISA.

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<tr><td colspan="2">Instrument
ASPERA-3</td><td>Originator Name
S. Barabash (Co-PI)</td><td>Date
2002-08-30</td></tr>
<tr><td>Mission Phase

MC</td><td>Activity ID

mc-as-001</td><td colspan="2">Activity Name

ASPERA-3 MC observations</td></tr>
<tr><td colspan="4">Description of Activity:
THE ACTIVITY IS TO PERFORM OBSERVATIONS WHEN IN ORBIT AROUND MARS AND ADJUST TIMING OF THE MODE SWITCHING AND THE INDIVIDUAL SENSOR. THE INSTRUMENT IS OPERATIONAL THROUGH THE ENTIRE ORBIT. AFTER COMPLETION THE INSTRUMENT IS OFF.
Activity Duration: 1 orbit
Time constrains: no
Time Criticality (if any, can this activity be done in any other portion of the mission): as early as possible after start of mc
Instrument Mode: the standard operation scenario is verified
Telemetry rate: variable, max 18.2 kbits
Power Profile (approximate): app. 15 W constant
Monitoring Required (1): No
Interaction Required (2): No
Instrument Thermal requirement: Before initiating the activity it must be verified that the instrument temperatures given by the spacecraft termistors (3 termistors) are within operation limits:
Thermistor 1 (scanner): -35°…+50°
Thermistor 2 (DPU): -40°…+50°
thermistor 3 (IMA, DPU): -50°…+60°
Geometry Requirements: No
s/c Pointing Requirements: according to the science master plan</td></tr>
<tr><td colspan="4">Comments/other constrains:
other payloads can be operating during this activity.</td></tr>
<tr><td>Accepted:</td><td>PI</td><td>MEX Project</td><td>ESOC</td></tr>
</table>

[1] This requirement should be stated if monitoring of the housekeeping TM is required during the activity. The monitoring will be provided by the MEX Mission Control System either from the MEX Dedicated Control Room and from the S2K workstation provided in the PISA.

[2] This requirement should be stated if command interaction is required during the activity, i.e. the activity cannot be performed from the Master Timeline using time-tagged commands (normal mode of operation).

<table>
<tr><td colspan="5" align="center">MEX EV-IC-MC REQUEST FORM (MECC)</td></tr>
<tr><td colspan="2">Instrument
ASPERA-3</td><td>Originator Name
S. Barabash (Co-PI)</td><td colspan="2">Date
2002-08-30</td></tr>
<tr><td>Mission Phase

RO</td><td>Activity ID

RO-as-001</td><td colspan="3">Activity Name

ASPERA-3 routine observations</td></tr>
<tr><td colspan="5">Description of Activity:
THE ACTIVITY IS TO PERFORM ROUTINE OBSERVATIONS.
Activity Duration: 1 orbit
Time constrains: after completing mc
Time Criticality (if any, can this activity be done in any other portion of the mission): after start mc

Instrument Mode: the standard operation scenario
Telemetry rate: variable, max 18.2 kbits
Power Profile (approximate): app. 15 W constant
Monitoring Required (1): No
Interaction Required (2): No
Instrument Thermal requirement: instrument is on all the time

Geometry Requirements: No
s/c Pointing Requirements: according to the science master plan</td></tr>
<tr><td colspan="5">Comments/other constrains:
other payloads can be operating during this activity.</td></tr>
<tr><td>Accepted:</td><td colspan="2" align="center">PI</td><td align="center">MEX Project</td><td align="center">ESOC</td></tr>
</table>

[1] This requirement should be stated if monitoring of the housekeeping TM is required during the activity. The monitoring will be provided by the MEX Mission Control System either from the MEX Dedicated Control Room and from the S2K workstation provided in the PISA.

[2] This requirement should be stated if command interaction is required during the activity, i.e. the activity cannot be performed from the Master Timeline using time-tagged commands (normal mode of operation).

Appendix 10. ASPERA-3 Main Unit Software Description

Issue 1.0 2003-04-14

Appendix 11. ASPERA-3 Sensor Numbering

Appendix 12. MEDOC data base definitions