

Phoenix and Cluster II

RAPID

Data Analysis Reference Document
(DARD)

Part 1: EDB Decoding

Issue 2
Revision 7
06.05.2003

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Change Record

Issue	Rev.	Pg.	Date	Changes	Author
1	0	all	8.9.1995	First issue	Di
2	0	all	8.3.1996	New chapter layout. IFFT and histogram modes included.	Di
2	1	all 19 - 21	12.3.1996 12.3.1996 17.4.1996	"Part 1... " on the title page Headerline layout Timing information supplied	Di Di Di
2	2	Title 8 9 (32)	22.1.1997	Project name E-3DD description Hist. data, NM1..3, BM2: Byte count changed. Fig: "Bin boundaries in the E-E/A-Plane" deleted. Belongs to Part II. Reference in I-3DD description also deleted.	Di/Rj
2	3	Title 11 12 14 15 15 16 17 21 20,21 10 9 10 28,29 2,3	17.12.1998	Title changed. Now this is a document for both Phoenix and Cluster II versions of RAPID. STA timing corrected: Timing A -> Timing B. STO timing corrected: Timing A -> Timing B. ENY timing corrected: Timing A -> Timing B. sDIR-3S timing corrected: Timing A -> Timing B. sDIR-Sy timing corrected: Timing A -> Timing B. TAC timing corrected: Timing A -> Timing B. TCR timing corrected: Timing A -> Timing B. I-SPCT table corrected at index 1 and 3: E=5 -> E=4 I-SPCT: 4 References to the no more existing Fig. "Bin boundaries in the E-E/A-Plane" deleted. Clarification: Strip ID=0 equals Strip Number 1. Correction for number of channels and bytes: 168 -> 167. "The channel 167 itself is not available ..." added. Changing of "The remaining channels ..." to "The channels 168 to 255 ...". Clarification: the last channel contains all events from the remaining 8 strips. Defining of CD2, bit 4...0 is now different between the Phoenix and New Cluster II versions of RAPID, therefore new table added. Page numbers in Change Report updated cause of new "page 3".	cd

Issue	Rev.	Pg.	Date	Changes	Author
2	4	28,29	08.02.1999	Now the integration times in the IES are the same for both Phoenix and the new Cluster II versions of RAPID (2 μ s, 5 μ s, 15 μ s and 50 μ s). The definition of CD2, bit 4...0 is the same for both Phoenix and the New Cluster II FMs.	cd
2	5	21	15.02.2000	I-3DD: Accumulation time for new Cluster II versions of RAPID are now different to the Phoenix version of RAPID.	cd
2	6	12 12 19	22.05.2001	m-signs: interpretation corrected IIMS-timing: timing values for updated S/W added DE: description and number of bytes (BM) corrected	cd
2	7	11 11	28.05.2002 06.05.2003	m: table IIMS, m=7, 2 nd Dir corrected from 11 to 0 m. table IIMS, 1 st , 2 nd and 3 rd directions were mixed up and are corrected now	cd cd

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About this Document

This Document was assembled using sources like "Flight Operations Manual", "Instrument User's Guide" or RAPID GSEOS block description files. Special thanks to Rainer Rathje and Andreas Müllers, who answered many questions. It is meant to be a reference to those who want to decode or interpret the RAPID data. It does not explain how the instrument works.

For every data item there is a brief description and the information about how it was gathered, where it can be found in the EDB during the different DPU modes and telemetry modes and how it is to be decoded.

This manual covers "Science Data". "Housekeeping Data" are explained in the "Instrument User's Guide" with all these details.

EDBs in various modes

DPU Modes

The data items within an EDB are grouped so that one part of the EDB is dedicated to the IES, another part to the IIMS, another part to both sensors and yet another part to general system data. In different DPU modes the composition of a part of the EDB will change, usually without affecting the other parts. The mode the DPU is in can be identified by some bits of the "Content descriptors" CD1 and CD2 (x = don't care).

Science Mode: CD1 = 010x 0000 CD2 = 00x0 xxxx

In this mode the EDB contains science data from both sensors. No special tests are performed.

IFFT Mode: CD1 = 010x 0001 CD2 = 00x0 xxxx

In Flight Functional Test. In this mode the EDB part dedicated to the IIMS is used for test results. The other parts of the EDB are not affected.

IES Histogram Mode: CD1 = 010x 0000 CD2 = 10x1 xxxx

In this mode the EDB part dedicated to the IES is used for test results. The other parts of the EDB are not affected.

IIMS Classification Test Mode:

This mode was designed for ground bench tests only. It must not be commanded with the IIMS-SCU installed, in particular not during the mission. Therefore it is not covered in this manual.

RAM Check Mode: CD1 = 010x 0100 CD2 = 00x0 xxxx

In this mode the EDB part dedicated to the IIMS is used to dump data directly from a given RAM range. The other parts of the EDB are not affected.

Telemetry Modes

The size and composition of an EDB changes with telemetry mode. Six telemetry modes are used by the spacecraft. Four modes are identical from the experiment's point of view. These are normal modes 1 to 3 and burst mode 2 while burst modes 1 and 3 are actually different. The telemetry mode can be identified by the 3rd byte of the 1st sync marker.

Schematic overview

Telemetry modes ? ? DPU modes	Normal Mode 1? 3 Burst Mode 2 512 Bytes @ ? 1000 bps	Burst Mode 1 2304 Bytes @ 4620 bps	Burst Mode 3 2340 Bytes @ 1925 bps
Science Mode	NM EDB	BM1 EDB	BM3 EDB
IFFT Mode	IFFT EDB Part 1 IFFT EDB Part 2a IFFT EDB Part 2b <i>(Affect IIMS part only)</i>	n/a	n/a
IES Histogram Mode	NM IES Histogram EDB <i>(Affects IES part only)</i>	BM1 IES Histogram EDB	BM3 IES Histogram EDB
IIMS Classification Test Mode	<i>(not covered in this manual)</i>	n/a	n/a
RAM Check Mode	NM RAM check EDB <i>(Affects IIMS part only)</i>	BM1 RAM check EDB	BM3 RAM check EDB

Data Items

Rate counters are always compressed unless stated otherwise. The decompression algorithm is explained in the “Instrument User’s Guide”, chapter 5.2

IES Data

For the interpretation of the data items E-3DD and E-PAD the actual LUT # must be taken into account. See data item "content descriptor 2".

E-3DD 3D distribution of electrons

DPU Mode: Science Mode, IFFT Mode, RAM Check Mode

Telemetry Mode: NM1...3 and BM2

The abundance of electrons is counted individually for 8 energy channels and 9 directions yielding a matrix of 72 counters. Accumulation period = transmission period = 1 spin.

First byte: 1B0h, number of bytes: 72. Starting with direction 1, energy channel 0. Energy channel varies fastest (0...7), then direction (1...9).

Telemetry Mode: BM1 and BM3

The abundance of electrons is counted for 12 energy channels and 96 spatial bins in a non-uniform resolution. The resolution scheme is given in the table below.

Direction	Sector															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0		3		6		9		12		15		18		21	
2	1		4		7		10		13		16		19		22	
3	2		5		8		11		14		17		20		23	
4	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69
5	25	28	31	34	37	40	43	46	49	52	55	58	61	64	67	70
6	26	29	32	35	38	41	44	47	50	53	56	59	62	65	68	71
7	72		75		78		81		84		87		90		93	
8	73		76		79		82		85		88		91		94	
9	74		77		80		83		86		89		92		95	

Accumulation period = 1/16 to 1/8 spin = 1 to 2 sectors. Transmission period = 1 spin.

First byte: 478h, number of bytes: 1152. Starting with spatial bin 0, energy channel 0. Energy channel (0...11) varies fastest, then Spatial bin according to the above resolution scheme (0...95).

DPU Mode: IES Histogram Mode

Telemetry Mode: all Modes

- n/a -

E-PAD

Pitch angle distribution of electrons

The abundance of electrons is counted individually for three directions and two energy ranges. Range 0 comprises energy channels 0...3, range 1 comprises energy channels 4...7. See "IES and IIMS Data", item "m", to identify the directions.

Such a group of 6 counters exists for each of the 16 sectors, summing up to 96 individual counters.

DPU Mode: Science Mode, IFFT Mode, RAM Check Mode

Telemetry Mode: NM1...3 and BM2

Accumulation period = 1/16 spin = 1 sector. Transmission period = 1 spin.

First byte: 150h, number of bytes: 96. Starting with sector 0 the sequence is: (energy range 0, 1st direction), (energy range 1, 1st direction), (energy range 0, 2nd direction), (energy range 1, 2nd direction), (energy range 0, 3rd direction), (energy range 1, 3rd direction). Then the same for sector 1 etc. until sector 15.

Telemetry Mode: BM1 and BM3

-n/a -

DPU Mode: IES Histogram Mode

Telemetry Mode: all modes

- n/a -

Histogram data

IES Histogram data

The abundance of electrons seen by one detector strip is counted in all 256 energy channels. The number of the actual strip is transmitted in item "Strip ID".

DPU Mode: Science Mode, IFFT Mode, RAM Check Mode

-n/a -

DPU Mode: IES Histogram mode

Telemetry Mode: NM1...3 and BM2

The 3-byte-counters for each energy channel are compressed to one byte as usual before transmission.

Accumulation period = 1 spin. Transmission period = 2 spins.

The first 167 channels are transmitted in even EDBs:

First byte: 151h, number of bytes: 167.

The channels 168 to 255 are transmitted in odd EDBs:

First byte: 151h, number of bytes: 88.

The channel 167 itself is not available in this Telemetry Mode and the last channel contains all events coming from the undesired 8 strips.

Telemetry Mode: BM1 and BM3

The 3-byte-counters of each energy channel are transmitted in full length, i.e. not compressed. Sequence is: Low byte first, then middle byte and finally high byte. All channels are transmitted in a one single EDB.

First byte: 479h, number of bytes: 768.

Strip ID

Strip Identification

The number of the detector strip which took the histogram data in this EDB, starting with „0“ for strip number 1.

DPU Mode: Science Mode, IFFT Mode, RAM Check Mode

-n/a -

DPU Mode: IES Histogram mode

Telemetry Mode: NM1...3 and BM2

First byte: 150h, number of bytes: 1.

Telemetry Mode: BM1 and BM3

First byte: 478h, number of bytes: 1.

IES and IIMS Data

m

Directions for I-PAD and E-PAD

m is the direction perpendicular to the magnetic field B on a scale from 0 (up spin axis) to 15 (down the spin axis). Both, IES and IIMS take counts from 3 different directions which are determined from m according to the following tables. IES can use one of two different tables for its 3rd direction. Whether table a or b is actually used is flagged in the "content descriptor 2", bit 5.

IES

m	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1st Dir	1	1	2	2	3	4	4	5	5	6	6	7	7	8	9	9
2nd Dir	6	6	7	7	8	9	9	1	1	1	1	2	2	3	4	4
3rd Dir, Table a	9	9	9	9	1	1	1	9	9	9	9	9	9	1	1	1
3rd Dir, Table b	4	4	5	5	6	7	7	9	9	3	3	4	4	5	6	6

IIMS

m	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1st Dir	0	1	1	2	3	4	4	5	6	7	7	8	9	10	10	11
2nd Dir	6	7	7	8	9	10	10	11	0	1	1	2	3	4	4	5
3rd Dir	11	11	11	11	0	0	0	0	11	11	11	11	11	0	0	0

In case no field vectors are available, m will be 8 for all sectors. This condition will be flagged in "Content descriptor 1", bit 4.

If the B-field should be perpendicular to all look directions in a sector, then m will be 0.

DPU Mode: all modes

Telemetry Mode: NM1...3 and BM2

Accumulation period = 1/16 spin = 1 sector. Transmission period = 1 spin.

First byte: 1F8h, number of bytes: 8.

Each byte contains two 4-bit m-values. Allocation is: high nibble of first byte = sector 0, low nibble of first byte = sector 1, etc. through low nibble of last byte = sector 15.

Telemetry Mode: BM1 and BM3

First byte: 8F8h, number of bytes: 8.

Periods and allocation are identical to NM1.

m-signs

Signs of the B-field

2 bytes. Each bit indicates the polarity of the B-field in a sector. If a bit is "0" then the B-field in the respective sector is parallel to the 1st IIMS direction of this sector. If the bit is "1", the field is antiparallel. To find the respective IES direction the m-values can be compared.

DPU Mode: Science Mode, IES Histogram Mode**Telemetry Mode:** all modes

Accumulation period = 1/16 spin = 1 sector. Transmission period = 1 spin.

First byte: 007h, number of bytes: 2

Bit-to-sector allocation is: first m-signs-byte, bit 7 = sector 0 through second m-signs-byte, bit 0 = sector 15.

DPU Mode: IFFT Mode, RAM Check Mode**Telemetry Mode:** all modes

- n/a -

IIMS Data

Timing

The sector time of nominal 250 ms may vary by 10 %.

At "Timing A" items the default dead time per sector is constant: 10 ms.

At "Timing B" items the measurement time is constant. Serial mode: default time 65 ms for each detector, parallel mode: default time 3 * 65 ms = 195 ms for all detectors.

The updated/patched RAPID S/W requires setting of new timing values:

serial mode: 60ms, parallel mode: 3*60ms = 180ms.

Level 0 Items

STA Start signal rates

DPU Mode: Science Mode, IES Histogram Mode

The sum of the start signal rates of 8 sectors. STA0-7: Sectors 0 through 7, STA8-15: Sectors 8 through 15.

Telemetry Mode: (see SGL0 below)
Timing B.

DPU Mode: IFFT Mode, Part 1

The sum of the start signal rates of 2 sectors.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	020h	040h	060h	080h	0A0h	0C0h	0E0h	100h
Number of bytes:	1	1	1	1	1	1	1	1

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

STO

Stop signal rate

DPU Mode: Science Mode, IES Histogram Mode

The sum of the stop signal rates of 8 sectors. STO0-7: Sectors 0 through 7, STO8-15: Sectors 8 through 15.

Telemetry Mode: (see SGL0 below)

Timing B.

DPU Mode: IFFT Mode, Part 1

The sum of the stop signal rates of 2 sectors.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	021h	041h	061h	081h	0A1h	0C1h	0E1h	101h
Number of bytes:	1	1	1	1	1	1	1	1

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

 EDI_y

 Energy Detector rate _y

_y = detector number 1...3. Events with an energy between the lower and the upper energy detector threshold. The energy detector rates are counted individually for each detector.

DPU mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL2 below)

Timing A.

DPU mode: IFFT Mode, Part 1

The sum of the energy detector rates of 2 sectors. Sequence is EDI1, EDI2, EDI3.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	023h	043h	063h	083h	0A3h	0C3h	0E3h	103h
Number of bytes:	3	3	3	3	3	3	3	3

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

EDlyx Energy Detector rate yx
 y = detector number (1...3), x = direction number (1...4).
 The energy detector rates are also counted individually for each detector and each direction within the respective detector.

DPU mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL2 below)
 Timing B.

DPU Mode: IFFT Mode, RAM Check Mode
 - n/a -

OVFy Overflow rate y
 y = detector number(1...3).
 Events with an energy greater than the upper energy detector threshold. The overflow rates are counted individually for each detector.

DPU mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL3 below)
 Timing A.

DPU mode: IFFT Mode, Part 1
 The sum of the overflow rates of 2 sectors. Sequence is OVF1, OVF2, OVF3.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	026h	046h	066h	086h	0A6h	0C6h	0E6h	106h
Number of bytes:	3	3	3	3	3	3	3	3

Telemetry Mode: BM1 and BM3
 - n/a -

DPU Mode: RAM Check Mode
 - n/a -

BDI_y

 Back Detector rate y

y = detector number (1...3). Events with an energy big enough to trigger the back detector of a sensor. Such events are neither counted as EDI nor as OVF. The back detector rates are counted individually for each detector.

DPU mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL2 below)

Timing A.

DPU mode: IFFT Mode, Part 1

The sum of the back detector rates of 2 sectors. Sequence is BDI1, BDI2, BDI3.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	029h	049h	069h	089h	0A9h	0C9h	0E9h	109h
Number of bytes:	3	3	3	3	3	3	3	3

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

Level 1 Items

ENY

Single energy rate

The rate of events where the energy comes from one single detector head.

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL1 below)

Timing B.

DPU Mode: IFFT Mode, Part 1

The sum of the single energy rates of 2 sectors.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	022h	042h	062h	082h	0A2h	0C2h	0E2h	102h
Number of bytes:	1	1	1	1	1	1	1	1

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

sDIR-3S

Single directional signal rate

The rate of events where the direction information is exactly 1 out of 12 directions.

DPU mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL3 below)
Timing B.

DPU Mode: IFFT Mode, Part 1

The sum of the single directional signal rates of 2 sectors.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	02Fh	04Fh	06Fh	08Fh	0AFh	0CFh	0EFh	10Fh
Number of bytes:	1	1	1	1	1	1	1	1

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

sDIR-Sy

Stimulated detector head

The rate of events where the direction information is exactly 1 out of the 4 directions within a detector head. This rate is available for each detector head.

y = Detector head number (1...3).

DPU mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL3 below)
Timing B.

DPU Mode: IFFT Mode, Part 1

The sum of the stimulated detector head rates of 2 sectors. Sequence is sDIR-S1, sDIR-S2, sDIR-S3.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	02Ch	04Ch	06Ch	08Ch	0ACh	0CCh	0ECh	10Ch
Number of bytes:	3	3	3	3	3	3	3	3

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

TAC

valid T analog signal

Rate of events with a valid time of flight (<80 ns).

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL1 below)

Timing B.

DPU Mode: IFFT Mode, Part 1

The sum of the valid T analog signal rates of 2 sectors.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	034h	054h	074h	094h	0B4h	0D4h	0F4h	114h
Number of bytes:	1	1	1	1	1	1	1	1

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

TACy

valid T analog signal y

Same as TAC, but counted individually for each detector head.

y = Detector head number (1...3)

DPU mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL3 below)

Timing B.

DPU Mode: IFFT Mode, Part 1

The sum of the valid T analog signal rates of 2 sectors. Sequence is TAC1, TAC2, TAC3.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	030h	050h	070h	090h	0B0h	0D0h	0F0h	110h
Number of bytes:	3	3	3	3	3	3	3	3

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

TACyx

valid T analog signal yx

Same as TAC, but counted individually for each direction.

y = Detector number (1...3), x = Direction within the detector (1...4).

DPU mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL below)

Timing B.

DPU Mode: IFFT Mode, RAM Check Mode

- n/a -

TCR

Triple Coincidence Rate

Rate of events with valid E and T information, i.e. E and T from the same event.

DPU mode: Science Mode, IES Histogram Mode

Telemetry Mode: (see SGL1 below)
Timing B.

DPU Mode: IFFT Mode, Part 1

The sum of the triple coincidence rates of 2 sectors. Sequence is TCR1, TCR2, TCR3.

Telemetry Mode: NM1...3 and BM2

Sectors:	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	12, 13	14, 15
First byte:	033h	053h	073h	093h	0B3h	0D3h	0F3h	113h
Number of bytes:	1	1	1	1	1	1	1	1

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

Level 2 Items

DE

Direct events (E, T, S/D)

3 consecutive bytes describing a single ion detection. Sequence is: energy, time of flight and a byte with direction information (low nibble) and sector number (high nibble). The direction information is coded as follows:

Direction information	Detector head	Direction within detector head
0	1	1
1	1	2
2	1	3
3	1	4
4	2	1
5	2	2
6	2	3
7	2	4
8	3	1
9	3	2
10	3	3
11	3	4
12	1	n/a
13	2	n/a
14	3	n/a
15	n/a	n/a

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: NM1...3 and BM2

Accumulation period = transmission period = 1 spin. 20 direct events are collected.

First byte: 00Ah, number of bytes: 60.

Telemetry Mode: BM1 and BM3

Accumulation period = transmission period = 1 spin. 106 direct events are collected.

First byte: 00Ah, number of bytes: 318.

DPU Mode: IFFT Mode Part 2a

Telemetry Mode: NM1...3 and BM2

Accumulation period = transmission period = 1 spin for each sensor.

First byte: 020h, number of bytes: (IFFT events) * 3, max. 81 events.

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

E/T-CAL	<p>E- and T-calibration result of last spin</p> <p>2 consecutive bytes, the first is energy, then time of flight.</p> <p>In every spin a sensor is stimulated by an E/T pulse pair. A full calibration sequence takes 48 EDBs (= 48 spins). For details, especially the nominal values of the calibration see "Beschreibung der SCU im IIMS-Experiment. Werner Weiß, Mai 1991". Though there is actually only one pulse pair generated per spin the data may be regarded as being subcommutated. To facilitate the decoding the remaining 16 EDBs to complete 64 (the next power of 2) are not used.</p> <p>DPU Mode: Science Mode, IES Histogram Mode</p> <p>Telemetry Mode: NM1...3, BM1, BM2 and BM3</p> <p>Transmission period = 1 spin (maximum 64 spins for full calibration sequence).</p> <p>First byte: 005h, number of bytes: 2.</p> <p>DPU Mode: IFFT Mode, RAM Check Mode</p> <p>- n/a -</p>
H-SPCT	<p>Spectrum of protons</p> <p>The abundance of H is counted individually for 8 energy/mass ranges.</p> <p>DPU Mode: Science Mode, IES Histogram Mode</p> <p>Telemetry Mode: NM1...3 and BM2</p> <p>Timing B. Accumulation period = transmission period = 1 spin.</p> <p>First byte: 046h, number of bytes: 8. Sequence is energy/mass range 0 through 7.</p> <p>Telemetry Mode: BM1 and BM3</p> <p>Timing B. Accumulation period = transmission period = 1 spin.</p> <p>First byte: 148h, number of bytes: 8.</p> <p>DPU Mode: IFFT Mode, RAM Check Mode</p> <p>- n/a -</p>

I-3DD

3D distribution of H, He, CNO

The abundance of H, He, and the CNO-group is counted individually for 8 energy/mass ranges, 12 directions and 16 sectors, summing up to 4608 individual counters.

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: NM1...3 and BM2

Timing B.

Accumulation period = 1/16 spin = 1 sector (Phoenix FM).

Accumulation period = 8/16 spin = 8 sectors (New Cluster II FMs).

Transmission period = 32 spins (after a dead time of 31 spins)

First byte: 0B7h, number of bytes: 144

Transmission starts with Sector 0, Hydrogen, Energy/mass range 0, direction 1. Direction varies fastest (1...11), then energy/mass range (0...7), then ion species (H, He, CNO), and finally sector number (0...15).

Telemetry Mode: BM1 and BM3:

Timing B.

Accumulation period = 1/16 spin = 1 sector (Phoenix FM).

Accumulation period = 8/16 spin = 8 sectors (New Cluster II FMs).

Transmission period = 8 spins.

First byte: 478h, number of bytes: 576

Transmission sequence is as with NM1.

DPU Mode: IFFT Mode, RAM Check Mode

- n/a -

I-PAD

Pitch angle distribution of Protons

The abundance of protons is counted individually for three directions and two energy/mass ranges. Such a group of 6 counters exists for each of the 16 sectors, summing up to 96 individual counters. To identify the directions see "IES and IIMS Data", item "m".

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: NM1...3 and BM2

Timing B. Accumulation period = 1/16 spin = 1 sector. Transmission period = 1 spin

First Byte: 057h, number of bytes: 96. Starting with sector 0 the sequence is: (energy/mass range 0, 1st direction), (energy/mass range 1, 1st direction), (energy/mass range 0, 2nd direction), (energy/mass range 1, 2nd direction), (energy/mass range 0, 3rd direction), (energy/mass range 1, 3rd direction), then the same for sector 1 etc. through sector 15.

Telemetry Mode: BM1 and BM3

Timing B. Accumulation period = 1/16 spin = 1 sector. Transmission period = 1 spin

First Byte: 1B2h, number of bytes: 96.

Transmission sequence is as with NM1.

DPU Mode: IFFT Mode, RAM check Mode

- n/a -

I-SPCT

E-spectrum of He, CNO

The abundance of He and the CNO-group is counted individually for 8 energy/mass ranges.

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: NM1...3, BM1, BM2 and BM3

Timing B. Accumulation period = 4 spins. Transmission period = 4 spins

First byte: 04Eh, number of bytes: 4.

Index	Items			
0	He, E=0	He, E=1	He, E=2	He, E=3
1	He, E=4	He, E=5	He, E=6	He, E=7
2	CNO, E=0	CNO, E=1	CNO, E=2	CNO, E=3
3	CNO, E=4	CNO, E=5	CNO, E=6	CNO, E=7

Item index = EDB counter modulo 4

DPU Mode: IFFT Mode, RAM Check Mode

- n/a -

MTRX

A-E/A matrix

All events are counted in a matrix consisting of 32 mass classes (A) over 64 energy/mass classes (EA) summing up to 2048 individual counters. For details of the matrix definition see figure.

DPU Mode: Science Mode, IES Histogram Mode

All 2048 counters are transmitted.

Telemetry Mode: NM1...3 and BM2

Timing B. Accumulation period = 64 spins. Transmission period = 256 spins.

First byte = 147h, number of bytes = 8. Transmission starts with (A=0, EA=0) with A varying fastest, through (A=31, EA=63).

Telemetry Mode: BM1 and BM3

Timing B. Accumulation period = 64 spins. Transmission period = 64 spins.

First byte: 455h, number of bytes = 32. Transmission sequence is as with NM1.

DPU Mode: IFFT Mode, Part 2b

The matrix elements which were hit by the test events are transmitted in the sequence: coordinates EA (1 byte), A (1 byte) and the uncompressed event count (2 bytes, MSB first). The most significant bit of the event count is an even parity bit.

Up to 81 such 4-byte matrix elements are transmitted one after the other. The actual number is given in item "IFFT Events".

The results of sensor 1 are transmitted in IFFT spin 6, of sensor 2 in spin 8 and of sensor 3 in spin 10.

Telemetry Mode: NM1...3 and BM2

Accumulation period = transmission period = 1 spin for each sensor.

First byte: 020h, number of bytes = (IFFT Events) * 4, maximum 324.

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: RAM Check Mode

- n/a -

Single rates

The single rates are groups of some of the rates described above which are transmitted in a subcommutation cycle. To identify an item in a given EDB the subcommutation index (= EDB counter modulo subcommutation depth) is used.

SGL0

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: NM1...3 and BM2: 1 of 4 items

Index	0	1	2	3
Item	STA0-7	STA8-15	STO0-7	STO8-15

Item index = EDB counter modulo 4.

Accumulation period = transmission period = 4 spins.

First byte: 009h, number of bytes: 1.

Telemetry Mode: BM1 and BM3

- n/a -

DPU Mode: IFFT Mode, RAM Check Mode

- n/a -

SGL1

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: NM1...3 and BM2: 1 of 3 items (+ 1 void item)

Index	0	1	2	3
Item	ENY	TCR	TAC	-void-

Item index = EDB counter modulo 4.
 Accumulation period = transmission period = 4 spins.
 First byte: 052h, number of bytes: 1.

Telemetry Mode: BM1 and BM3: 5 of (16 * 5) = 80 items

Starting with sector 0 the sequence is: ENY, TCR, TAC, STA and STO, then the same for sector 1 etc. through sector 15.
 Accumulation period = 1/16 spin = 1 sector. Transmission period = 1 spin.
 First byte: 156h, number of bytes: 80.

DPU Mode: IFFT Mode, RAM Check Mode

- n/a -

SGL2

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: NM1...3 and BM2: 3 of (15 items + 6 void items)

Index	Items		
0	EDI1	EDI2	EDI3
1	BDI1	BDI2	BDI3
2	EDI11	EDI12	EDI13
3	EDI14	EDI21	EDI22
4	EDI23	EDI24	EDI31
5	EDI32	EDI33	EDI34
6	-void-	-void-	-void-
7	-void-	-void-	-void-

Index of a group of 3 items = EDB counter modulo 8
 Accumulation period = 4 spins. Transmission period = 8 spins.
 First byte: 053h, number of bytes: 3.

Telemetry Mode: BM1 and BM3: 9 of 18 items

Index	Items								
0	EDI1	EDI2	EDI3	BDI1	BDI2	BDI3	EDI11	EDI12	EDI13
1	EDI14	EDI21	EDI22	EDI23	EDI24	EDI31	EDI32	EDI33	EDI34

Index of a group of 9 items = EDB counter modulo 1
 Accumulation period = transmission period = 2 spins.
 First byte: 1A6h, number of bytes: 9.

DPU Mode: IFFT Mode, RAM Check Mode

- n/a -

SGL3

DPU Mode: Science Mode, IES Histogram Mode

Telemetry Mode: NM1...3 and BM2: 1 of 22 items (+ 10 void items)

Index	0	1		
Item	-void-	-void-		
Index	2	3	4	
Item	OVF1	OVF2	OVF3	
Index	5	6	7	8
Item	SDIR-S1	SDIR-S2	SDIR-S3	SDIR-3S
Index	9	10	11	
Item	TAC-S1	TAC-S2	TAC-S3	
Index	12	13	14	15
Item	TAC11	TAC12	TAC13	TAC14
Index	16	17	18	19
Item	TAC21	TAC22	TAC23	TAC24
Index	20	21	22	23
Item	TAC31	TAC32	TAC33	TAC34
Index	24	25	26	27
Item	-void-	-void-	-void-	-void-
Index	28	29	30	31
Item	-void-	-void-	-void-	-void-

Item index = EDB counter modulo 32

Accumulation period = 4 spins. Transmission period = 32 spins.

First byte: 056h, number of bytes: 1.

Telemetry Mode: BM1 and BM3: 3 of (22 items + 2 void items)

Index	Items		
0	-void-	-void-	OVF1
1	OVF2	OVF3	SDIR-S1
2	SDIR-S2	SDIR-S3	SDIR-3S
3	TAC-S1	TAC-S2	TAC-S3
4	TAC11	TAC12	TAC13
5	TAC14	TAC21	TAC22
6	TAC23	TAC24	TAC31
7	TAC32	TAC33	TAC34

Index of a group of 3 items = EDB counter modulo 8.

Accumulation period = 2 spins. Transmission period = 8 spins.

First byte: 1AFh, number of bytes: 3.

DPU Mode: IFFT Mode, RAM Check Mode

- n/a -

System Data

Address of lower boundary for RAM check

The address within the processor's RAM of the first byte that is to be dumped.
The three address bytes are transmitted in the order: high, medium, low.

DPU Mode: RAM check Mode

Telemetry Mode: NM1...3, BM1, BM2 and BM3

First byte: 010h, number of bytes: 3.

DPU Mode: Science Mode, IFFT Mode, IES Histogram Mode

- n/a -

Address of upper boundary for RAM check

The address within the processor's RAM of the last byte that is to be dumped.
The three address bytes are transmitted in the order high, medium, low.

DPU Mode: RAM check Mode

Telemetry Mode: NM1...3, BM1 BM2 and BM3

First byte: 014h, number of bytes: 3.

DPU Mode: Science Mode, IFFT Mode, IES Histogram Mode

- n/a -

Content descriptor 1

One byte of flags.

Bit 7 (MSB): IIMS-Sim Active

1: Artificial events are added to the IIMS data. Used only during ground testing.

0: True IIMS data (default).

Bit 6: IES-IF Active

1: Live IES data available (default).

0: No live IES data available.

Bit 5: IES-CAL Active

1: IES spectrum is shifted for calibration.

0: IES spectrum is true (default).

Bit 4: FGM Data

This bit indicates the availability of B-field-vectors from the FGM experiment which are used to compute m and in turn E-PAD and I-PAD.

1: Vectors available, m is computed.

0: Vectors **not** available, m is assigned a fixed number by the DPU.

Bit 3: Class Test

1: Data in IIMS part in "IIMS Classification Test Mode". No live IIMS data. Used only during ground testing.

0: Data in IIMS part **not** in "IIMS Classification Test Mode" (default)

Bit 2: RAM check

1: DPU in RAM Check Mode.

0: DPU **not** in RAM Check Mode (default).

Bit 1: EPP Test

1: IES part of EDB filled with test results. No live IES data. Used only during ground testing.

0: IES part of EDB **not** filled with test results (default).

Bit 0 (LSB): IFFT

1: IIMS part of EDB filled with IFFT test results

0: IIMS part of EDB **not** filled with IFFT test results

DPU Mode: all modes

Telemetry Mode: all modes

First byte: 004h, number of bytes: 1.

Content descriptor 2

One byte of flags.

Bit 7 (MSB): IES DE measurement

1: DPU in "IES histogram mode"

0: DPU **not** in "IES histogram mode"

Bit 6: EPP test procedure on

1: IES part of EDB filled with test results. No live IES data.
Used only during ground testing.

0: IES part of EDB **not** filled with test results (default).

Bit 5: IES table a/b

Tells which direction allocation table was used to collect E-PAD data.

1: Table a (default).

0: Table b

Bit 4...0: EPP LUT

5-Bit number of the EPP look-up table.

LUT #	Description
0h	Uploaded LUT for 2 μs integration time of IES
1h	Uploaded LUT for 5 μs integration time of IES
2h	Uploaded LUT for 15 μs integration time of IES
3h	Uploaded LUT for 50 μs integration time of IES
11h	Histogram mode LUT for IES strip 1
12h	Histogram mode LUT for IES strip 2
13h	Histogram mode LUT for IES strip 3
14h	Histogram mode LUT for IES strip 4
15h	Histogram mode LUT for IES strip 5
16h	Histogram mode LUT for IES strip 6
17h	Histogram mode LUT for IES strip 7
18h	Histogram mode LUT for IES strip 8
19h	Histogram mode LUT for IES strip 9
else	(not during normal operation)

DPU Mode: Science Mode, IES histogram mode, IFFT Mode

Telemetry Mode: NM1...3 and BM2

First byte: 14Fh, number of bytes: 1.

Telemetry Mode: BM1 and BM3

First byte: 154h, number of bytes: 1.

DPU Mode: RAM Check Mode

Telemetry Mode: NM1...3 and BM2

First byte: 14Fh, number of bytes: 1.

Telemetry Mode: BM1 and BM3

- n/a -

CRC

Check sums

The first part of the EDB (Bytes 000h ... 8FFh) is divided into 10 ranges and a cyclic redundancy checksum is appended for each range. Note that the 3 * 3 bytes are left out where in Science Mode the constant sync markers are located.

DPU Mode: Science Mode, IES Histogram Mode, RAM Check Mode

Telemetry Mode: NM1...3, BM1 and BM2

- n/a -

Mode: BM3

Byte	Range	
	from	to
900h	003h	009h
901h	00Ah	147h
902h	148h	153h
903h	154h	1A5h
904h	1A6h	1B1h
905h	1B2h	211h
906h	215h	454h
907h	455h	474h
908h	478h	8F7h
909h	8f8h	8FFh

DPU Mode: IFFT Mode

- n/a -

EDB counter

EDB counter

An 8 bit number which is incremented by one for each new EDB. After reaching FFh it wraps around. A varying number of LSBs is used as subcommutation index.

DPU Mode: all Modes

Telemetry Mode: all Modes

First byte: 003h, number of bytes: 1.

IFFT Events

The number of transmitted matrix elements.

DPU Mode: Science Mode, IES Histogram Mode, RAM Check Mode

- n/a -

DPU Mode: IFFT Mode, Parts 2a + 2b

Telemetry Mode: NM1...3 and BM2

First byte: 006h, number of bytes = 1.

Telemetry Mode: BM1 and BM3

- n/a -

IFFT spin counter

A one-byte counter which counts the spins of the IFFT (1 through 10). The three different IFFT EDBs can be identified by this value.

IFFT spin counter	EDB
1 ... 4	IFFT Part 1
5, 7, 9	IFFT Part 2a
6, 8, 10	IFFT Part 2b

DPU Mode: Science Mode, IES Histogram Mode, RAM Check Mode

- n/a -

DPU Mode: IFFT Mode

Telemetry Mode: NM1...3 and BM2

First byte: 005h, number of bytes: 1

Telemetry Mode: BM1 and BM3

- n/a -

Long EDB counter Long EDB counter

A 32 bit number which is incremented by one for each new EDB. After reaching FF FF FF FFh it wraps around. The value of the least significant byte is identical to the EDB counter.

DPU Mode: Science Mode, IES Histogram Mode, RAM Check Mode

Telemetry Mode: NM1..3, BM1 and BM2

- n/a -

Telemetry Mode: BM3

First byte: 90Ah, number of bytes: 4

DPU Mode: IFFT Mode

- n/a -

RAM check data block

A certain number of bytes copied from the processor's RAM. In general, each EDB contains a different portion of the RAM. The data item "Start address of RAM check data in this EDB" uniquely identifies it.

DPU Mode: RAM check Mode

Telemetry Mode: NM1...3 and BM2

First byte: 020h, number of bytes: 256.

Telemetry Mode: BM1 and BM3

First byte: 020h, number of bytes: 2048.

DPU Mode: Science Mode, IES Histogram Mode, IFFT Mode

- n/a -

Start address of RAM check data in this EDB

The address within the processor's RAM of the first byte of the "RAM check data block" contained in the present EDB. The three address bytes are transmitted in the order high, medium, low.

DPU Mode: RAM check Mode

Telemetry Mode: NM1...3, BM1, BM2 and BM3

First byte: 018h, number of bytes: 3.

DPU Mode: Science Mode, IES Histogram Mode, IFFT Mode

- n/a -

Subcom. INDEX see: EDB counter

sync. marker, 1st First Synchronization Marker

A 3-byte constant used to identify the start of an EDB. The first two bytes are the same in all modes while the third byte varies with telemetry modes.

DPU Mode: all Modes

Telemetry Mode: NM1...3 and BM2

Constant = 14 6f 2e

First byte: 000h, number of bytes: 3

Telemetry Mode: BM1

Constant = 14 6f 3d

First byte: 000h, number of bytes: 3

Telemetry Mode: BM3

Constant = 14 6f 8b

First byte: 000h, number of bytes: 3

sync. marker, 2nd Second Synchronization Marker

A 2-byte constant located about one third into the EDB which can be used to verify the synchronism.

DPU Mode: Science Mode

Telemetry Mode: NM1...3 and BM2

- n/a -

Telemetry Mode: BM1 and BM3

Constant = 4c 43 e2

First byte: 212h, number of bytes: 3

DPU Mode: IFFT Mode, RAM Check Mode, IES Histogram Mode

- n/a -

sync. marker, 3rd Third Synchronization Marker

A 2-byte constant located about two thirds into the EDB which can be used to verify the synchronism.

DPU Mode: Science Mode

Telemetry Mode: NM1...3 and BM2

- n/a -

Telemetry Mode: BM1 and BM3

Constant = 54 e1 e1

First byte: 475h, number of bytes: 3

DPU Mode: IFFT Mode, RAM Check Mode, IES Histogram Mode

- n/a -

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