Max-Planck-Institut für Chemie

Rosetta-APXS

To Planetary Science Archive Interface Control Document

RLGS-SPEC-SONC_DPS-SCIE-9240-CNES

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Prepared by: Instrument Archive Responsible

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Approved by: Principal Investigator

Distribution List

Recipient	Organisation	Recipient

Change Log

Date	Sections Changed	Reasons for Change
22/03/2015	SONC	Issue 1.0

TBD ITEMS

Section	Description
2	Science packet definition Backup RAM of CDM error condition
2.3.6	Ancillary data usage
3.3.1	Data quality parameter definition
4.3.3	Calibrated SC data (level 3)
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1 Introduction

1.1 Purpose and Scope

The purpose of this EAICD (Experimenter to (Science) Archive Interface Control Document) is twofold. First it provides users of the APXS instrument with detailed description of the product and a description of how it was generated, including data sources and destinations. Secondly, it is the official interface between your instrument team and your archiving authority.

1.2 Archiving Authorities

The Planetary Data System Standard is used as archiving standard by

- NASA for U.S. planetary missions, implemented by PDS
- ESA for European planetary missions, implemented by the Research and Scientific Support Department (RSSD) of ESA

ESA's Planetary Science Archive (PSA)

ESA implements an online science archive, the PSA,

- to support and ease data ingestion
- to offer additional services to the scientific user community and science operations teams as e.g.
    - search queries that allow searches across instruments, missions and scientific disciplines
    - several data delivery options as
        - direct download of data products, linked files and data sets
        - ftp download of data products, linked files and data sets

The PSA aims for online ingestion of logical archive volumes and will offer the creation of physical archive volumes on request.

1.3 Contents

This document describes the data flow of the APXS instrument on the Rosetta mission from the s/c until the insertion into the PSA for ESA. It includes information on how data were processed, formatted, labeled and uniquely identified. The document discusses general naming schemes for data volumes, data sets, data and label files. Standards used to generate the product are explained. Software that may be used to access the product is explained further on.

The design of the data set structure and the data product is given. Examples of these are given in the appendix.

1.4 Intended Readership

The staff of the archiving authority (Planetary Science Archive, ESA, RSSD, design team) and any potential user of the APXS data.

1.5 Applicable Documents

AD 1. Planetary Data System Data Preparation Workbook, February 17, 1995, Version 3.1, JPL, D-7669, Part1
AD 2. Planetary Data System Standards Reference, August 1, 2003, Version 3.6, JPL, D-7669, Part2
AD 3. Rosetta Time handling RO-EST-TN-3165, issue 1 rev 0, February 9, 2004
AD 4. ROSETTA Archive Generation, Validation and Transfer Plan, December 22, 2003, Issue 2, Rev. 1, RO-EST-PL-5011
AD 5. ROSETTA Archive Conventions RO-EST-TN-3372 Issue 5, Rev. 6, 25 March 2010
AD 6. Rosetta Lander APXS FM ADP Document, RO-LAX-DP-3202-RGd, Version 3, May 5 2001
AD 7. DDID- Data Delivery Interface Document RO-ESC-IF-5003 Issue B6 23/10/2003
AD 8. CDMS Command and Data Management System - Subsystem Specification RO-LCD-SP-3101 29/08/2001, Issue 3, Rev. 5
AD 9. CDMS Command and Data Management System - Operation Manual RO-LCD-SW-3402 12/02/2001, Issue 1, Rev. 2
AD 10. DDID- Data Delivery Interface Document RO-ESC-IF-5003 Issue B6 23/10/2003

1.6 Acronyms and Abbreviations

APXS	Alpha Proton X-ray Spectrometer
CDMS	Command and Data Management System
EQM	Electrical and Qualification Model
FM	Flight Model
FS	Flight Spare
GRM	Ground Reference Model
HK	Housekeeping
LOBT	Lander On Board Time
LSB	Least Significant Byte
MPCh	Max-Planck-Institut für Chemie
OBT	On Board Time
PDS	Planetary Data System
PSA	Planetary Science Archive
QM	Qualification Model
SC	Science
SONC	Science Operations and Navigation Center (CNES-Toulouse)
TBD	To be defined
TBC	To Be Confirmed
UTC	Universal Time Coordinated

1.7 Contact Names and Addresses

Person	***Role***	***Email***	***Tel.***

Göstar Klingelhöfer	PI	klingel@mail.uni-mainz.de	+49 6131 39 23282
Jordi Gironés López	Scientist	jordi.girones.lopez@gmail.com	+49 6131 39 -26883

2 Overview of Instrument Design, Data Handling Process and Product Generation

The APXS instrument consists of an alpha mode for alpha spectroscopy (Rutherford backscattering) and an X-ray mode for alpha-particle and X-ray induced X-ray spectroscopy. The instrument combines these methods in one single instrument while being low in mass (640g) and power consumption (1.5 W in operating mode) [5].

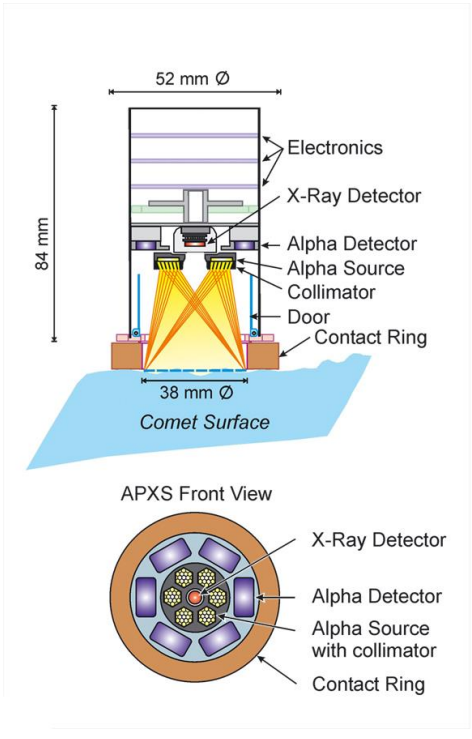
For the elemental characterization, the APXS irradiates the sample with alpha particles and X-rays, emitted by a Cm-244 radioactive source. This irradiation has two different consequences:

- Excitation of characteristic X-rays of most elements in the samples.
- Back-scattering of alpha particles at the target nuclei.

These two processes are detected by two different types of Si based detectors:

- The first one is used for measurements of X-rays to determine the concentration of elements from Na to Fe (increasing atomic number) and maybe beyond.
- The second one is used for the measurement of back-scattered alpha particles to detect C, O, and maybe N and groups of higher Z elements.

The Rosetta APXS design incorporates a silicon drift detector for x-ray detection that delivers a great energy resolution (180 eV at 6.4 keV at temperatures below −40◦C) allowing a good separation of low energy x-rays. The Rosetta x-ray detector is positioned at the center of the sensor head surrounded by the curium sources (Figure 1). This concentric setup is favorable from a geometric point of view. The alpha detectors are arranged as a ring around the sources.



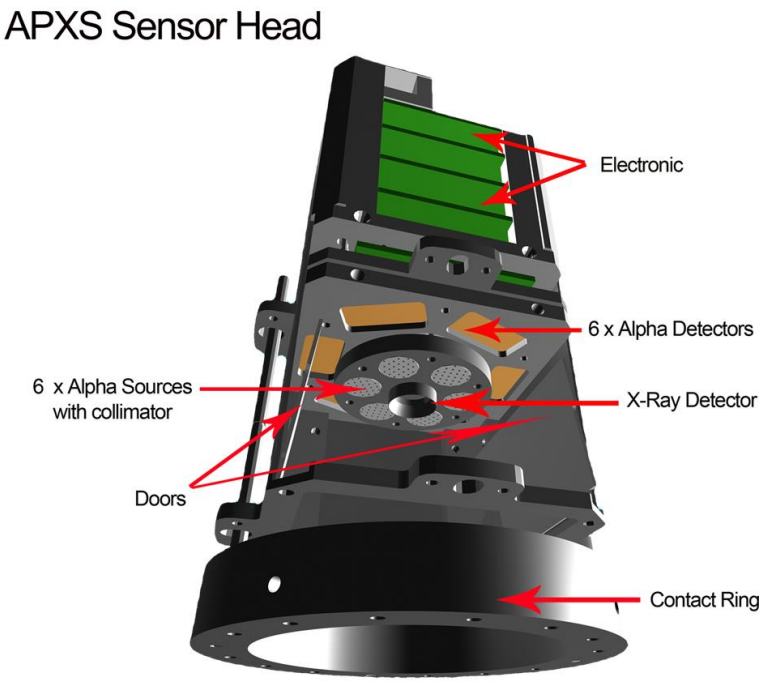


Figure 1 Functional scheme of the APXS sensor head in measurement position. The contact ring is retracted with doors in open position.

Telemetry data

For APXS there are three different types of telemetry data: science data, housekeeping data and Backup RAM contents.

There are two kinds of APXS **housekeeping data**. The low byte of the HK data provides analogue information about power consumption and currents of the APXS. These data are autonomously prepared by the APXS-CDMS interface board. The high byte provides digital information about the status of the APXS. The definition of the HK data is made in the document RO-LAX-DP-3500-RG.xls

A **science data packet** from APXS consists of 1500 words (3 KB). It contains:

- 1024 byte X-ray spectra
- 512 byte alpha spectra
- 512 byte proton or 2. Alpha spectra (TBD)
- 512 byte background spectra
- 512 byte temperature record during measurement

This structure holds for the actual spectra and also each backup spectra. The format of each spectrum is: 2 byte counter LSB first. The first channel of each spectrum contains the lifetime [LSB first in 10 sec steps] (lifetime = data acquisition time minus dead time).
The temperature record contains:

- 1. byte = temperature of EBOX and
- 2. byte = temperature Sensorhead (balcony). The unit of the temperature is [1.442 K].

The capability to set a ramp to the spectra, that was included in the EQM model for proper CDMS testing, was left in the FM code. It is highly important to recognize, that this command destroys the actual science data that are contained in the RAM! The command is also still available through GSE RS232 connector. Also the data resulting from the download of the RAM memory containing the **internal parameters** are delivered by the unit with the file definition ".sci".

Backup RAM of CDMS is used to store the position of the APX sensorhead. At position 0x00 of the APXS Backup Ram a hex value is stored with the following meaning. The following 31 words have the same content.

Value	Meaning
0x00	APX is up (in launch lock position)
0x44	APX is moving down
0x77	APX down movement stopped, because of timeout or end switch of threaded rods is reached.
0x99	APX upwards movement stopped, because of timeout
0xBB	APX is moving up
0xFF	APX is down (measuring position)

The values 0x77 and 0x99 indicate an error condition. APX was moving more than TBD minutes (5 minutes in the actual settings), without reaching the desired end position, indicated by switches at the end. In this case the motors are switched off automatically.
In each case of position changing, APX informs CDMS immediately by setting the Service request flag SRF.

There are no intentions to run a position detecting sequence by APXS after each power on of APXS and to update the data in Backup RAM. So it is the responsibility of CDMS to hold the data valid for other Instruments and Subsystems.

2.1 Scientific Objectives

The goal of the Rosetta APXS experiment is the determination of the chemical composition of the landing site and its potential alteration when the comet approaches the Sun. The data obtained will be used to characterize the surface of the comet, to determine the chemical composition of the dust component, and to compare the dust with known meteorite types. These results will be brought into context with other measurements made on the Lander and the Orbiter to fully obtain a more complete picture of the present state of the comet, and to get insight into its evolution and origin.
The APXS provides information on the elemental composition of the material underneath the Lander; many elements are not represented in the volatile fraction with their true abundance and can thus not be analyzed by the Orbiter instruments.

2.2 Data Handling Process

The SONC is responsible for APXS data sets generation and delivery to the PSA.
The APXS telemetry data (packets) are provided by the ESA DDS (Data Distribution Server). The relevant contact information is provided in section 1.7.

Following the operations plan the SONC pulls out archived packets (SC and HK) by direct request to the DDS via FTP and stores them into SONC database.
As soon as they are received, the SC raw packets are passed through the SONC data processing software for decommutation. The decommutated SC (X and alpha spectra) data are stored in the SONC database.
In the same way, the HK raw packets are passed through the SONC data processing software for decommutation and calibration.
The raw and processed APXS data are available online through the W3-SONC server (http://sonc-rosetta.cnes.fr) for the authorized users.

SONC also handles Auxiliary data (Attitude and Orbit files) pushed by the ESA DDS server.

The following data levels are produced:

Data type	CODMAC level	Producer
Edited SC and HK data	2	Initially produced by SONC, reprocessed by APXS team and reinserted into SONC data base. SONC delivers the final level 2 data products to PSA.
Calibrated SC and HK data	3	Produced by APXS team and delivered to SONC. SONC delivers the final levels 3 and 5 data products to PSA.
Derived data	5	

2.3 Overview of Data Products

The main structure of the data products is the same for all mission phases. The data products cover 5 levels (see also section 2.3.4).

The APXS team will deliver for each mission phase the data products of CODMAC level 3 and 5:

- Calibrated SC data (CODMAC level 3): contains calibrated SC data in physical values (energy spectra and temperatures).
  - Plots (image PNG) and
  - ASCII data.
- Calibrated HK data (CODMAC level 3) : contains calibrated HK data in physical values (temperature, energy consumption, position)

  - Excel sheet.

- Calibrated SC data (CODMAC level 5): contains atomic composition.
  - Plots.
- Reduced (or derived) data (CODMAC level 5) : contains atomic composition
  - .txt data.

2.3.1 Pre-Flight Data Products

There are no pre-flight APXS data products delivered to PSA.

2.3.2 Instrument Calibrations

The parameters for the calibration of the HK data are explained in the document: RO-LAX-DP-3500-RG

The data produced during Commissioning is also used for calibration. The raw and processed APXS data are available online through the W3-SONC server (http://sonc-rosetta.cnes.fr) for the authorized users. The final flight calibration for the science data will be done with the results of the measurements done during PC8. The results will be saved as explained in sections 2.4.5.
These results will be put in common with the calibration measurement of the target SKK-1.

2.3.3 Other Files written during Calibration

Cross-calibration measurements done in the lab with Rosetta-like APXS (to be implemented).

2.3.4 In-Flight Data Products

The main structure of the data products is the same for all mission phases. APXS in flight data products cover 4 levels:

- Raw data (CODMAC level 1): HK and SC APXS source telemetry packets as received from DDS. These data are also available at SONC.
  Decomutated SC data (CODMAC level 2): raw (counts/channel) X spectra, alpha spectra and temperatures
- Calibrated SC data (CODMAC level 3): contains calibrated SC data in physical values (energy spectra and temperatures).
- Calibrated HK data (CODMAC level 3): contains calibrated HK data in physical values (temperature, energy consumptions, position).
- Reduced (or derived) data (CODMAC level 5): contains atomic composition.

The APXS archive also contains plots (PNG image files) of level 2, 3 and 5 data. These files are located in the Browse directory of the data set.

The in-flight data are produced during following mission phases:

MISSION_PHASE_NAME	**Abbreviation**	**Start Date** (dd/mm/yyyy)	**End Date** (dd/mm/yyyy)	**APXS data** (1)
Commissioning (part 1)	CVP1	05/03/2004	06/06/2004	**X**
Commissioning (part 2)	CVP2	06/09/2004	16/10/2004	**X**
Cruise 1	CR1	07/06/2004	05/09/2004	
Cruise 2	CR2	05/04/2005	28/07/2006	**X**
Cruise 3	CR3	29/05/2007	12/09/2007	
Cruise 4-1 (including PC#8)	CR4A	28/01/2008	03/08/2008	**X**
Cruise 4-2 (including PC#9)	CR4B	06/10/2008	13/09/2009	**X**

Cruise 5 (including PC#12)	CR5	14/12/2009	16/05/2010	**X**
Cruise 6	CR6	08/06/2011	20/01/2014	
RV Manoeuver 2	RVM2	21/01/2014	07/05/2014	**X**
Near Comet Drift	NCD	07/05/2014	01/07/2014	
Far Approach Trajectory	FAT	02/07/2014	01/08/2014	**X**
Comet Characterisation	CC	03/08/2014	02/09/2014	
Global Mapping, Close Obs	GMP/COP	03/09/2014	24/10/2014	
Landing And FSS	LD/FSS	25/10/2014	20/11/2014	**X**

(1) The last column indicates if APXS data are available

2.3.5 Documentation

The documentation directory contains the following documents:

- EAICD (this document, in PDF format)
- APXS User Manual (in PDF format)
- APXS_CALIBRATION_DESC.TXT
- TIMELINE_ph.TXT, timeline Ascii file for phase ph
- TIMELINE_ph_DESC.TXT, description of the timeline file for phase ph
- TIMELINE_ph_obty.PNG, timeline Image file for phase ph and observation type obty

2.3.6 Ancillary Data Usage

TBD

3 Archive Format and Content

3.1 Format and Conventions

Data processing level number used in APXS naming scheme conforms to CODMAC norm :

1: Raw Data Telemetry data with data embedded.
2: Edited Data Corrected for telemetry errors and split or decommutated into a data set for a given instrument. Sometimes called Experimental Data Record. Data are also tagged with time and location of acquisition. Corresponds to NASA Level 0 data.
3: Calibrated Data Edited data that are still in units produced by instrument, but that have been corrected so that values are expressed in or are proportional to some physical unit such as radiance. No resampling, so edited data can be reconstructed. NASA Level 1A.
5: Derived Data Derived results, as maps, reports, graphics, etc. NASA Levels 2 through 5.

3.1.1 Deliveries and Archive Volume Format

A data set will be delivered for each **simple mission phase.** Each data set will contain **only one level data processing**.

The list of simple mission phases is given in **Erreur ! Source du renvoi introuvable.** §2.1, table 3(a).

Level 1 data set contains SC and HK raw data i.e. source TM packets from DDS.
Level 2 data set contains raw spectra (X and alpha) and temperatures
Level 3 data set contains calibrated

- SC and HK data in physical values
- Browse Images in .png files for SC data

Level 5 data set contains :

- Atomic composition (as example for other people interpretating the data, but without garanties)

In addition a data set will contain :

- Documents (see chapter 2.3.5)

A new dataset version is provided when:

- calibration information refining
- new data processing algorithms are implemented
- producing data of higher levels.

3.1.2 Data Set ID Formation

The following naming formation scheme will be used for the data sets :

```
DATA_SET_ID =  <INSTRUMENT_HOST_ID>-<target id>-<INSTRUMENT_ID>-<data processing
level number>-<mission phase abbreviation>-<version>

DATA_SET_NAME =  <INSTRUMENT_HOST_NAME> <target name> <INSTRUMENT_ID> <data
processing level number> <mission phase abbreviation> <version>
```

Examples of DATA_SET_ID and DATA_SET_NAME for APXS level 3 data obtained from the Comet phase:

```
DATA_SET_ID   = "RL-C-APXS-3-COM-V1.0"
DATA_SET_NAME = "ROSETTA-LANDER 67P APXS 3 COM V1.0"
```

3.1.3 Data Directory Naming Convention

The Data directory contains calibrated SC and HK data files. The Browse directory contains plots corresponding to the SC data files in the Data directory for levels 2, 3 and 5.

3.1.4 Filenaming Convention

Each APXS file contains data from one measurement.

The following file naming scheme will be used for SC and HK data files:

APXS_WXYZ_yymmddhhmn.TAB

- W : file type
  - D for Data file
  - P for Plot file (browse)
- **X**: data source
  - G for dround data
  - F for flight data
- **Y**: data type
  - S for science data
  - H for housekeeping data
  - B for files with both science and housekeeping data
- **Z**: CODMAC level
  - 1 for raw data
  - 2 for edited data
  - 3 for calibrated data

- 5 for derived data
- **yymmddhhmn**: start time of data in the file
  - yy = year
  - mm = month
  - dd = day
  - hh = hour
  - mn = minute

Examples :
- Science data: APXS_DFS3_0610122510.TAB
- Housekeeping data: APXS_DFH3_0610122510.TAB

3.2 Standards Used in Data Product Generation

3.2.1 PDS Standards

The APXS archive complies with the version 3.6 of the PDS standard.

3.2.2 Time Standards

3.2.2.1 Generalities

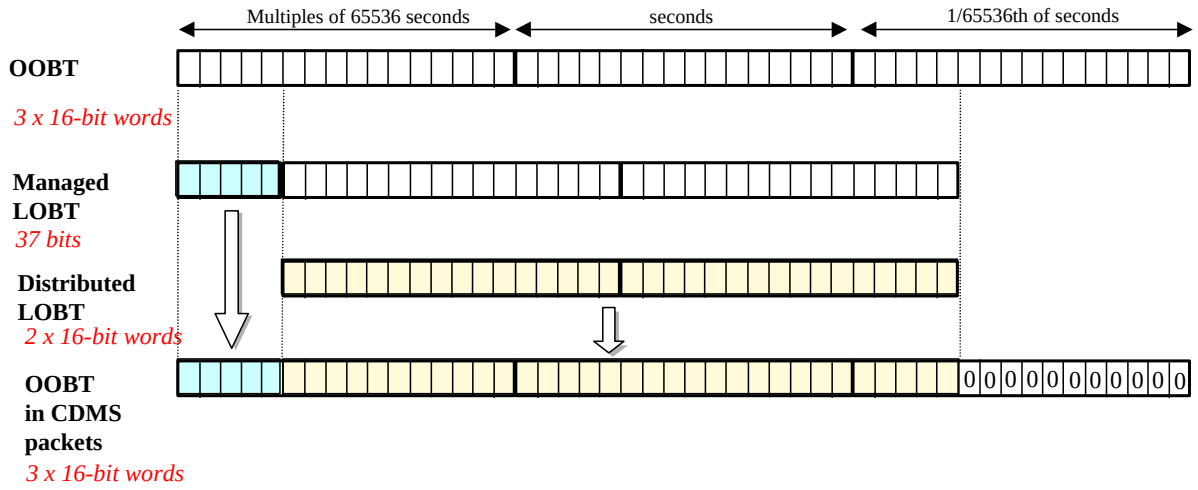
This paragraph gives a summary of the different existing formats in the Rosetta Ground segment, from their generation by the instruments to their availability at SONC:

- The Lander CDMS requires the scientific instruments to transmit the data by bursts of 8 or 64 bytes (4 or 32 16-bit words)

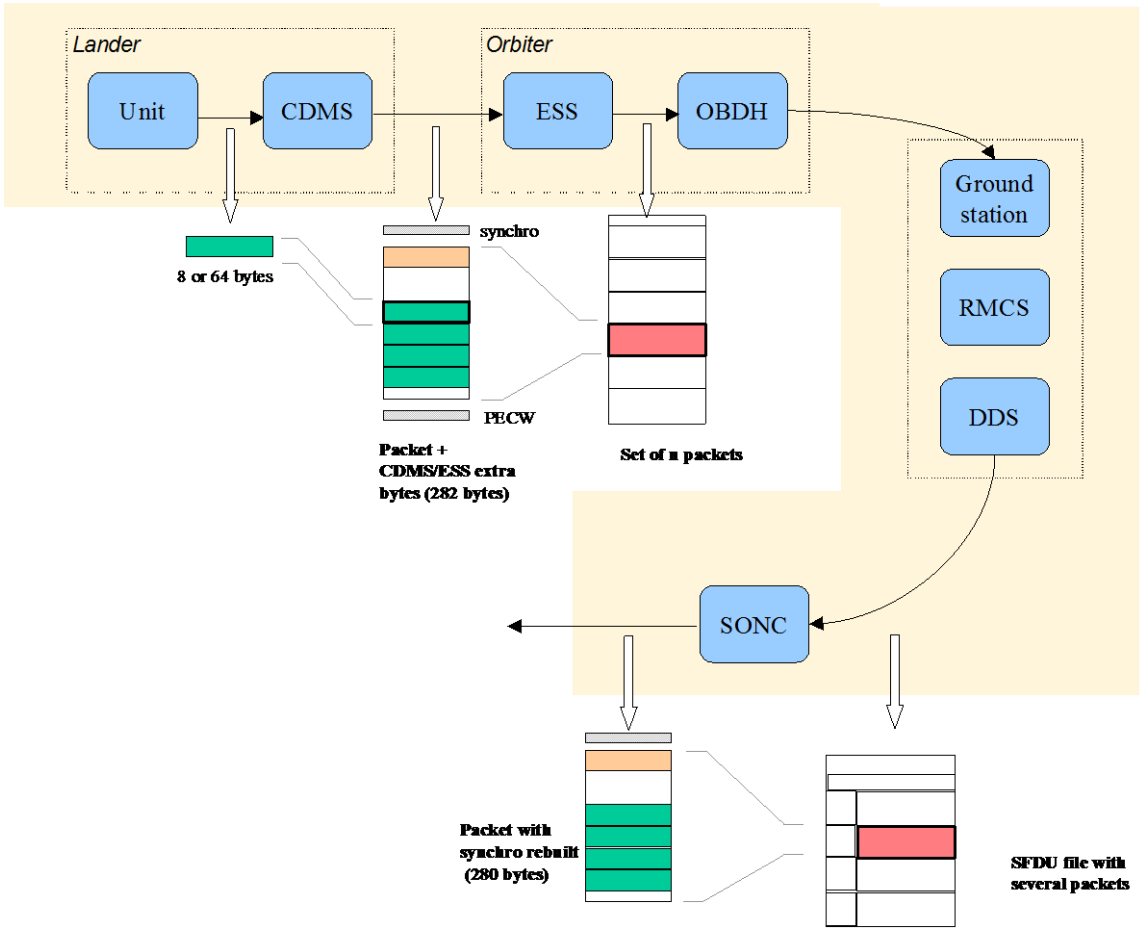
- When sufficient data are received, the CDMS builds packets containing 256 bytes of instrument data. The CDMS adds 18 bytes header (unit PID, sequence count, OOBT : Orbiter OBT, data type) and a 2 bytes checksum (DECW) and creates packets with a fixed length of 276 bytes[1]. For transmission between Lander and Orbiter, a 4 bytes synchro header and a 2 bytes trailing checksum (PECW) are added, increasing the packet size to 282 bytes. The extra bytes are removed by the ESS.

  To comply with ESA requirements, the time registered in the CDMS packets is the **OOBT**. It is reconstituted from the LOBT, as follows:

[1] The Lander CDMS header and the headers of the telemetry source packets from the Orbiter instruments are quite similar. There is a difference in the data field header. The byte containing PUS version, checksum flag and spare fields is set to zero in the CDMS header. Besides the last byte of the OOBT is set to zero in th e CDMS header. The CDMS header has an additional word (2 bytes) after the data field header named "FORMAT ID". This word is mainly used for HK data and it contains the HK scanning period and the SID (structure identification).



- The ESS groups together several packets and passes them to the Orbiter OBDH, which transmits them according to the Space/Ground interface. This part is transparent for the Lander ground segment.
- The data are delivered by the Rosetta Data Distribution System (DDS) to the SONC in SFDU format. A SFDU file is basically a collection of 276-byte packets interspersed with auxiliary information records. An 18 bytes SFDU header is added to the CDMS 276-byte packets. This header contains information added at the ground station (time correlated OBT, ground station id, virtual channel id, service channel, type of data, time quality)
- SONC processes the SFDU files to retrieve the 276-byte packets. This format is available in the SONC database.



- Afterwards, SONC processes science raw packets in order to recompose the science measurement (e.g. an image, a spectrum, ...).

Only the following principles are applied :

- the packet wrapping is removed, and science frames that had to be split into several raw data packets are rebuilt. Basic error detection controls are applied, to recover from possible problems in the transmission chain.

- the Lander On-Board time (LOBT) (synchronised with OOBT) extracted from the packet, and corresponding UTC time coming from the SFDU header, are added.

- in few cases, bit fields are expanded: flags that were stored as bits in the telemetry (to save bandwidth) are stored as integer values instead ; the aim is to ease further processing.

This product is available in the SONC database and used to generate PDS format.

3.2.2.2 APXS Time standards

The time standards used in the APXS data products are:
- the Lander on-board time,
- the DDS header time correlated.
- the UTC.

3.2.2.2.1 The Lander On-Board Time (LOBT)

The instruments on board the spacecraft (Orbiter) generate telemetry source packets with an OOBT (orbiter on board time) time stamp in the header.
The OOBT written into the packet header specifies the time, when CDMS can complete a packet.

In terms of HK packets this is the time of the last HK word. Using the HK scanning rate, which is given in word #9 of the packet, one can calculate the OBT of every individual word in this packet. Note that this is only valid if packets with SID (word #9) 1 or 2 are generated. Packets with SID 4 and 5 are "snapshots", which means you can apply the packet OOBT for every word in this packet. SID 3 packets have to be analysed case by case.

In terms of SC packets this is the receiption of the last 32 word block by CDMS, which also completes the SC packet. How often 32 word blocks are created (and sent) by the unit, and corresponding to this the delta time between each block, might be different for each unit. So, re-calculation of OOBT for SC words depends on this unit feature.

The Orbiter On-Board Time (OOBT) is a linear binary counter having a resolution of 1/65536 sec stored in 3 16-bit words.

The Lander On-Board Time (LOBT) is a linear binary counter having a resolution of 1/32 sec, kept in 37 bits. Only the 32 least significant bits are distributed to the instruments, in 2 16-bit words. The 5 most significant bits are supposed constant during most of the mission, they are available through a specific service.
The LOBT is derived from the Orbiter On-Board Time (OOBT) : the 11 least significant bits of the OOBT are discarded to obtain the LOBT, hence the reduced resolution. A re-synchronization between OOBT and LOBT is performed regularly (see AD 8 Command and Data Management System (CDMS) Subsystem Specification 29/08/2001, Issue 3, Rev. 5 **RO-LCD-SP-3101**).
The Lander will be synchronized prior to Separation and during every RF link after landing. So, during descent and the First Science Sequence this should not be a problem, since LOBT will be kept synchronized as long as the Lander is powered.

Technical details about synchronisation of Lander On-board Time can be found in_ § 2.3.2.6 AD 8 of "Command and Data Management System (CDMS) Subsystem Specification 29/08/2001, Issue 3, Rev. 5, **RO-LCD-SP-3101**" :

On-board time in CDMS (Lander On-board Time, LOBT) is maintained by means of hardware counters (of RTC-1 and RTC-2 boards). Whenever CDMS turns from unpowered state into powered state along with Keep Alive Line (KAL), its hardware timer/counter to be in charge of keeping track of Lander On-board Time (LOBT) starts from zero. Time relation between LOBT and Orbiter On-board Time (OOBT) can be established by the ESS through issuing a specific Time SynchronisationTelecommand Packet (TSTP) towards the Lander.

A TSTP will be composed of an OOBT, at which the TSTP is issued. Assuming some interrupt latency and software administration time of the task scheduler, LOBT update shall be performed within 32 msec with respect to the moment of reception of a full TSTP packet. Since some drift in LOBT can not be excluded, LOBT shall be readjusted frequently enough to maintain its accuracy. It shall be accomplished by ESS through issuing a TSTP at the beginning of each RF visibility periods (and on-Ground initiation too). LOBT will be updated with the received value by loading it into the hardware timer/counter. Payload will be notified of the restored time relation by means of either broadcast or individual RSST messages. The queue of time tagged commands shall be treated in a way that an eventual small jump in the LOBT will result neither in loss nor in repeated issue of time-tagged commands.

An absolute accurate relationship between OOBT and LOBT with the upper resolution (1/65536 sec) can not be established for several reasons (ie.: interrupt latency in ESS, RF link, interrupt latency in CDMS). Therefore LOBT is derived from the OOBT in such a way that the most significant 37 bits of OOBT are

considered to constitute the LOBT and at the same time the least significant 11 bits of the OOBT are discarded. This will result in a resolution of 1/32 sec of the LOBT. Only the 32 least significant bits are distributed to the Lander instruments, in 2 16-bit words. The 5 most significant bits are supposed constant during most of the mission; they are available through a specific service.

For a description of time handling in the Rosetta project see AD 3 (Rosetta Time handling **RO-EST-TN-3165**, issue 1 rev 0, February 9, 2004).
For a description of Lander on board time handling see AD 8 (Command and Data Management System (CDMS) Subsystem Specification 29/08/2001, Issue 3, Rev. 5 **RO-LCD-SP-3101**) :
§ 2.3.2.6 Synchronisation and Adjustment of Lander On-board Time
§ 2.3.2.6.1 Absolute vs. relative time references
§ 2.3.2.6.2 On-board Time Failure Modes and Recovery Procedures
and AD 9 (Command and Data Management System (CDMS) Operation Manual 12/02/2001, Issue 1, Rev. 2 **RO-LCD-SW-3402**) : § 6. About Lander On-board Time.

3.2.2.2.2 The DDS header time correlated

The OOBT is converted to UTC (Coordinated Universal Time) by means of time correlation and included in the additional DDS packet header when the packets are distributed via the DDS server.
The **DDS header time correlated** (SCET field in the DDS header) is the UTC of the start of measurement derived from the OOBT by time correlation.

Its format is the Sun Modified Julian Time (MJT) i.e. two 32 bit integers. The first (MSB) contains the number of seconds since 00:00:00 on 1st January 1970 and the second (LSB) integer the number of micro-seconds from seconds in the first field.

Time correlation is described in AD 10 (Data Delivery Interface Document RO-ESC-IF-5003 Issue B6 23/10/2003 Appendix 18 § 18.1.2.1)

3.2.2.2.3 The UTC

The **UTC** used as time stamp for SC and HK APXS data products (from level 2 to level 5) is the DDS header time correlated.

3.2.3 Reference Systems

The position respect to balcony is included in the HK data.

3.3 Data Validation

The data of levels 2, 3 and 5 are produced and validated by the APXS team and then inserted into the SONC data base. These data are also distributed via the W3-SONC server and used by all Lander experiment teams. The APXS data products are delivered to PSA by SONC.

3.3.1 Data quality parameter

TBD

3.4 Content

3.4.1 Volume Set

One volume corresponds to one data set. The possible values of VOLUME keywords can be found in [AD 5]. The volume keyword values for the Commissioning mission phase are given in the following example.

```
VOLUME_NAME                 = "APXS RAW DATA FOR THE
                               COMMISSIONING PHASE"
VOLUME_SERIES_NAME          = "ROSETTA SCIENCE ARCHIVE"
VOLUME_SET_ID               = "DE_UMZ_IAAC_RLAPX_10XX"
VOLUME_SET_NAME             = "ROSETTA APXS DATA"
VOLUME_ID                   = "RLAPX_1001"
VOLUME_VERSION_ID           = "VERSION 1"
VOLUME_FORMAT               = "ISO-9660"
MEDIUM_TYPE                 = "ONLINE"
VOLUMES                     =  36
PUBLICATION_DATE            = 2006-11-13
DESCRIPTION                 = "This volume contains data
                                and supporting documentation …"
```

3.4.2 Data Set

The APXS data will be archived in as many Data Sets as cumulative mission phases and data processing levels.

Name element	**Data Set ID**	**Data Set Name**
INSTRUMENT_HOST_ID / INSTRUMENT_HOST_NAME	RL (Rosetta Lander)	ROSETTA-LANDER
Target id / target name	See AD 5	
INSTRUMENT_NAME	ALPHA PARTICLE X-RAY SPECTROMETER	
INSTRUMENT_ID	APXS	
Data processing level number	*Level 1 data set contains SC and HK raw data i.e. source TM packets from DDS. * Level 2 is delivered directly after the end of the proprietary period and contains level 2 SC and HK. * Level 3 is delivered after the stabilization of the calibration and contains level 3 SC and HK. * Level 5 is delivered even later and contains the reduced or derived data products.	
mission phase abbreviation	See AD 5	
description	N/A	N/A.
version	The first version of a data set is V1.0	

The archive contains 3 types of data sets.

Level 2 data set (edited data) :

DATA_SET_ID = "RL-<*target name*>**-APXS-2-**<*mission phase abbreviation*>**-*V*x.x"**

Level 3 data set (calibrated data) :

DATA_SET_ID = "RL-<*target name*>**-APXS-3-**<*mission phase abbreviation*>**-*V*x.x"**

Level 5 data (derived data) :

DATA_SET_ID = "RL-<*target name*>**-APXS-5>-**<*mission phase abbreviation*>**-*V*x.x"**

3.4.3 Directories

The APXS archive has the following directory structure :

Level 1 data sets:

```
                        |-CATALOG-
                        |-DATA-
|-root directory------ |
                        |-DOCUMENT-
                        |-INDEX-
```

Levels 2 data sets:

```
                        |-CATALOG-
                        |-DATA-
|-root directory------ |
                        |-DOCUMENT-
                        |-INDEX-
                        |-LABEL-
```

Levels 3,5 data sets:

```
                        |-BROWSE-
                        |-CATALOG-
|-root directory------ |
                        |-DATA-
                        |-DOCUMENT-
                        |-INDEX-
                        |-LABEL-
```

3.4.3.1 Root Directory

The root directory of an APXS dataset contains the following files:

File Name	**Contents**
AAREADME.TXT	Volume content and format information
VOLDESC.CAT	A description of the contents of this volume in PDS format readable by both humans and computers

The name of the root directory is the data set ID.

3.4.3.2 Calibration Directory

Calibration information can be found in the file APXS_CALIBRATION_DESC.TXT located in the DOCUMENT directory.

3.4.3.3 Catalog Directory

The catalog directory provides a top level understanding of the mission, spacecraft, instruments and data sets.The catalog directory contains the following files:

File Name	Contents
CATINFO.TXT	A description of the contents of the catalog directory
DATASET.CAT	Data set information
INST.CAT	Instrument information
INSTHOST.CAT	Instrument host (spacecraft) information
MISSION.CAT	Mission information
PERSON.CAT	PDS personnel catalog information about the instrument team responsible for generating the data products. There will be one file for each instrument team providing data to this data set.
REF.CAT	Full citations for references mentioned in any and all of the catalog files, or in any associated label files.
SOFTWARE.CAT	Information about the software included in the SOFTWARE directory

3.4.3.4 Index Directory

Files in the Index Directory are provided to help the user locate products on this archive volume and on previously released volumes in the archive. The following files are contained in the Index Directory.

File Name	Contents
BROWSE_INDEX.LBL	PDS label for the BROWSE index file BROWSE_INDEX.TAB
BROWSE_INDEX.TAB	Index of the BROWSE directory
INDEX.LBL	PDS label for the volume index file, INDEX.TAB
INDEX.TAB	Volume index in tabular format
INDXINFO.TXT	A description of the contents of the Index Directory

3.4.3.5 Browse Directory and Browse Files

The browse directory contains plots (PNG files) that are one to one mapping of the corresponding data of levels 2, 3 and 5 in the DATA directory.
For file naming conventions see 3.1.4.
The browse directory contains also the file BROWSEINFO.TXT which describes the contents of the browse directory.

3.4.3.6 Software directory

There is no software provided in the SOFTWARE directory since the requirements of the PDS standard are too difficult to meet.

3.4.3.7 Label Directory

The label directory contains include files referenced by data files on the data set, e.g. FMT files containing label definitions used in data label files. The following files are contained in the Label directory.

File Name	File Contents
LABINFO.TXT	A description of the contents of this directory (.FMT files)
APXS_SPECTRUM.FMT	Spectrum definition
APXS_TEMP.FMT	Temperatures (e-box and sensor head) definition
APXS_HK.FMT	Housekeeping definition

3.4.3.8 Document Directory

The Document Directory contains documentation to help the user understand and use the archive data. The following files are contained in the Document Directory.

File Name	File Contents
DOCINFO.TXT	A description of the contents of this directory
EAICD_APXS.PDF	The APXS Experiment Archive Interface Control Document (this document) as a PDF file.
EAICD_APXS.LBL	PDS label for file EAICD.PDF
RO-LAX-DP-3202-RGD.PDF	General description of the APXS including a description regarding the generated data [AD 6].
RO-LAX-DP-3202-RGD.LBL	PDS label for RO-LAX-DP-3202-RGD.PDF
APXS_CALIBRATION_DESC.TXT	Description of the HK calibration
APXS_CALIBRATION_DESC.LBL	PDS label for APXS_CALIBRATION_DESC.TXT
TIMELINE_*ph*.TXT	Timeline Ascii file with the PDS label attached for phase *ph*
TIMELINE_*ph*_DESC.TXT	Description of the timeline file for phase *ph*
TIMELINE_*ph_obty*.PNG	Timeline Image file for phase *ph* and observation type *obty*
TIMELINE_*ph_obty*.LBL	PDS label for image TIMELINE_*ph_obty*.PNG

3.4.3.9 Data Directory

The structure and naming scheme of the data directory is described in § 3.1.3 and 3.4.3.

4 Detailed Interface Specifications

4.1 Structure and Organization Overview

The APXS data will be archived in a data set on the basis data processing level and mission phase relative to the production of the data. The DATA directory contains SC and HK data files (file extension TAB). The BROWSE directory contains plots of SC data corresponding to the files in the DATA directory.

4.2 Data Sets, Definition and Content

The data sets are defined according to the accumulative mission phases. The following table gives the definition of the name and id of the foreseen data sets :

Data Set ID	Data Set Name
RL-CAL-APXS-1-GRND-V1.0	ROSETTA-LANDER CAL APXS 1 GRND V1.0
RL-CAL-APXS–1-CVP-V1.0	ROSETTA-LANDER CAL APXS 1 CVP V1.0
RL-CAL-APXS–1-CRU-V1.0	ROSETTA-LANDER CAL APXS 1 CRU V1.0
RL-C-APXS-1-COM-V1.0	ROSETTA-LANDER 67P APXS 1 COM V1.0
RL-CAL-APXS-2-GRND-V1.0	ROSETTA-LANDER CAL APXS 2 GRND V1.0
RL-CAL-APXS-2-CVP-V1.0	ROSETTA-LANDER CAL APXS 2 CVP V1.0
RL-CAL-APXS–2-CRU-V1.0	ROSETTA-LANDER CAL APXS 2 CRU V1.0
RL-C-APXS -2-COM-V1.0	ROSETTA-LANDER 67P APXS 3 COM V1.0
RL-CAL-APXS-3-GRND-V1.0	ROSETTA-LANDER CAL APXS 3 GRND V1.0
RL-CAL-APXS–3-CVP-V1.0	ROSETTA-LANDER CAL APXS 3 CVP V1.0
RL-CAL-APXS–3-CRU-V1.0	ROSETTA-LANDER CAL APXS 3 CRU V1.0

RL-C-APXS-3-COM-V1.0	ROSETTA-LANDER 67P APXS 3 COM V1.0
RL-CAL-APXS-5-GRND-V1.0	ROSETTA-LANDER CAL APXS 5 GRND V1.0
RL-CAL-APXS–5-CVP-V1.0	ROSETTA-LANDER CAL APXS 5 CVP V1.0
RL-CAL-APXS–5-CRU-V1.0	ROSETTA-LANDER CAL APXS 5 CRU V1.0
RL-C-APXS-5-COM-V1.0	ROSETTA-LANDER 67P APXS 5 COM V1.0

The following data sets are foreseen:

RL-CAL-APXS-x-GRND-Vx.x contains data of APXS tests on …
RL-CAL-APXS-x-CVP-Vx.x contains data of CVP phase (2004)
RL-CAL-APXS-x-CRU-Vx.x contains data of cruise phase (2005-2014)
RL-C-APXS-x-COM-Vx.x contains data of comet phase (2014-2015).

4.3 Data Product Design

4.3.1 Raw APXS data product design (Level 1)

Level 1 contains mixed raw housekeeping and science data packets delivered by the Rosetta Lander with detached PDS labels.

4.3.1.1 File Characteristics Data Elements

The raw files (level 1) are described by PDS minimal detached labels. The file characteristic data elements are RECORD_TYPE, PRODUCT_TYPE and FILE_NAME. The PRODUCT_TYPE is UDR. The RECORD_TYPE for raw data is UNDEFINED, i.e. the structure of records is not described in the PDS labels since these data are intended to be processed with the EGSE software available in the EXTRAS directory. The file contains telemetry packets which are described in [**Erreur ! Source du renvoi introuvable.**].

4.3.1.2 Instrument and Detector Descriptive Data Elements

```
INSTRUMENT_HOST_NAME   = "ROSETTA-LANDER"
INSTRUMENT_HOST_ID     = RL
INSTRUMENT_ID          = APXS
INSTRUMENT_NAME        = "ALPHA PARTICLE X-RAY SPECTROMETER"
INSTRUMENT_TYPE        = "SPECTROMETER"
INSTRUMENT_MODE_ID     = "N/A"
INSTRUMENT_MODE_DESC   = "N/A"
```

4.3.2 Edited science data (level 2) product design

An APXS measurement consists of one X ray spectrum, two alpha spectra, one background spectrum as well as the internal (EBOX) and sensor head (balcony) temperatures (measured during the spectra acquisition). The instrument memory can contain up to seven measurements simultaneously.
One level 2 product includes the content of the instrument memory, i.e. seven measurements. The products are organized as ASCII tables (.TAB files) with PDS combined detached labels (.LBL files).

Example:

APXS_FS2_0808011938.LBL
APXS_FS2_0808011938_X.TAB (X spectrum)
APXS_FS2_0808011938_ALPHA1.TAB (first alpha spectrum)
APXS_FS2_0808011938_ALPHA2.TAB (second alpha spectrum)
APXS_FS2_0808011938_BKGND.TAB (background spectrum)
APXS_FS2_0808011938_TEMP.TAB (electronic box and sensor head temperatures)

The table objects corresponding to the distributions are detailed in the following paragraphs.

4.3.2.1 File Characteristics Data Elements

PDS data product **labels** contain data element information that describes important attributes of the physical structure of a data product file. The PDS file characteristic data elements for APXS science level 2 data are:

```
RECORD_TYPE = FIXED_LENGTH
FILE_RECORDS
```

The RECORD_TYPE data element identifies the record characteristics of the data product file. Physical records are always fixed-length. The FILE_RECORDS data element identifies the number of physical records in the file.

4.3.2.2 Data Object Pointers Identification Data Elements

The APXS level 2 science data have combined detached labels. A single PDS detached data product label file is used to describe the contents of more than one data product file (the products belong to the same measurement of APXS instrument). The combined detached label contains pointers to individual data products. The labels refer to FILE objects.

4.3.2.3 Instrument and Detector Descriptive Data Elements

The following data identification elements provide additional information about the SESAME data product.

```
INSTRUMENT_HOST_NAME       = "ROSETTA-LANDER"
INSTRUMENT_HOST_ID         = RL
INSTRUMENT_ID              = APXS
INSTRUMENT_NAME            = "ALPHA PARTICLE X-RAY SPECTROMETER"
INSTRUMENT_TYPE            = SPECTROMETER
```

4.3.2.4 Data Object Definition

The APXS data products are organized as ASCII tables.

4.3.2.4.1 Spectrum table definition

The structure of the TABLE object is described in the file APXS_SPECTRUM.FMT as follows:

```
OBJECT                = COLUMN
    NAME              = "CHANNEL"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 1
    BYTES             = 4
    UNIT              = "N/A"
    FORMAT            = "I4"
    DESCRIPTION       = "Channel number"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME                = "UTC_1"
    DATA_TYPE           = TIME
    START_BYTE          = 6
    BYTES               = 23
    DESCRIPTION         = "This column represents the UTC
                           in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME                = "LOBT_1"
    DATA_TYPE           = CHARACTER
```

```
    START_BYTE         = 31
    BYTES              = 14
    DESCRIPTION        = "Lander On Board Time represented as :
                  <Reset number>/<seconds>.<number of 1/32s>
                  Reset number 1 starts at 2003-01-01T00:00:00 UTC.
                  The time resolution is 1/32 s"
END_OBJECT           = COLUMN

OBJECT             = COLUMN
    NAME             = "LIFETIME_1"
    DATA_TYPE        = ASCII_INTEGER
    START_BYTE       = 47
    BYTES            = 5
    UNIT             = "N/A"
    FORMAT           = "I5"
    MISSING_CONSTANT = 99999
   DESCRIPTION       = "Data acquisition time minus dead time.
                        The resolution is 10s"
END_OBJECT         = COLUMN


OBJECT             = COLUMN
    NAME             = "COUNTS_1"
    DATA_TYPE        = ASCII_INTEGER
    START_BYTE       = 53
    BYTES            = 5
    FORMAT           = "I5"
    UNIT             = "N/A"
    MISSING_CONSTANT = 99999
    DESCRIPTION      = " Counts for channel 1 "
END_OBJECT         = COLUMN

OBJECT               = COLUMN
    NAME               = "UTC_2"
    DATA_TYPE          = TIME
    START_BYTE         = 59
    BYTES              = 23
    DESCRIPTION        = "This column represents the UTC
                          in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
    NAME               = "LOBT_2"
    DATA_TYPE          = CHARACTER
    START_BYTE         = 84
    BYTES              = 14
    DESCRIPTION        = "Lander On Board Time represented as :
                  <Reset number>/<seconds>.<number of 1/32s>
                  Reset number 1 starts at 2003-01-01T00:00:00 UTC.
                  The time resolution is 1/32 s"
END_OBJECT           = COLUMN

OBJECT             = COLUMN
    NAME             = "LIFETIME_2"
    DATA_TYPE        = ASCII_INTEGER
    START_BYTE       = 100
    BYTES            = 5
    UNIT             = "N/A"
    FORMAT           = "I5"
    MISSING_CONSTANT = 99999
   DESCRIPTION       = "Data acquisition time minus dead time.
                        The resolution is 10 s"
END_OBJECT         = COLUMN

OBJECT             = COLUMN
    NAME             = "COUNTS_2"
    DATA_TYPE        = ASCII_INTEGER
    START_BYTE       = 106
```

```
    BYTES            = 5
    FORMAT           = "I5"
    UNIT             = "N/A"
    MISSING_CONSTANT = 99999
    DESCRIPTION      = " Counts for channel 2 "
END_OBJECT         = COLUMN

OBJECT               = COLUMN
    NAME               = "UTC_3"
    DATA_TYPE          = TIME
    START_BYTE         = 112
    BYTES              = 23
    DESCRIPTION        = "This column represents the UTC
                          in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
    NAME               = "LOBT_3"
    DATA_TYPE          = CHARACTER
    START_BYTE         = 137
    BYTES              = 14
    DESCRIPTION        = "Lander On Board Time represented as :
                  <Reset number>/<seconds>.<number of 1/32s>
                  Reset number 1 starts at 2003-01-01T00:00:00 UTC.
                  The time resolution is 1/32 s"
END_OBJECT           = COLUMN

OBJECT             = COLUMN
    NAME             = "LIFETIME_3"
    DATA_TYPE        = ASCII_INTEGER
    START_BYTE       = 153
    BYTES            = 5
    UNIT             = "N/A"
    FORMAT           = "I5"
    MISSING_CONSTANT = 99999
   DESCRIPTION       = "Data acquisition time minus dead time.
                         The resolution is 10 s"
END_OBJECT         = COLUMN

OBJECT             = COLUMN
    NAME             = "COUNTS_3"
    DATA_TYPE        = ASCII_INTEGER
    START_BYTE       = 159
    BYTES            = 5
    FORMAT           = "I5"
    UNIT             = "N/A"
    MISSING_CONSTANT = 99999
    DESCRIPTION      = " Counts for channel 3 "
END_OBJECT         = COLUMN

OBJECT               = COLUMN
    NAME               = "UTC_4"
    DATA_TYPE          = TIME
    START_BYTE         = 165
    BYTES              = 23
    DESCRIPTION        = "This column represents the UTC
                          in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
    NAME               = "LOBT_4"
    DATA_TYPE          = CHARACTER
    START_BYTE         = 190
    BYTES              = 14
    DESCRIPTION        = "Lander On Board Time represented as :
                  <Reset number>/<seconds>.<number of 1/32s>
                  Reset number 1 starts at 2003-01-01T00:00:00 UTC.
                  The time resolution is 1/32 s"
```

```
END_OBJECT            = COLUMN

OBJECT              = COLUMN
    NAME              = "LIFETIME_4"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 206
    BYTES             = 5
    UNIT              = "N/A"
    FORMAT            = "I5"
    MISSING_CONSTANT  = 99999
   DESCRIPTION        = "Data acquisition time minus dead time.
                         The resolution is 10 s"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
    NAME              = "COUNTS_4"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 212
    BYTES             = 5
    FORMAT            = "I5"
    UNIT              = "N/A"
    MISSING_CONSTANT  = 99999
    DESCRIPTION       = " Counts for channel 4 "
END_OBJECT          = COLUMN

OBJECT                = COLUMN
    NAME                = "UTC_5"
    DATA_TYPE           = TIME
    START_BYTE          = 218
    BYTES               = 23
    DESCRIPTION         = "This column represents the UTC
                           in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME                = "LOBT_5"
    DATA_TYPE           = CHARACTER
    START_BYTE          = 243
    BYTES               = 14
    DESCRIPTION         = "Lander On Board Time represented as :
                  <Reset number>/<seconds>.<number of 1/32s>
                  Reset number 1 starts at 2003-01-01T00:00:00 UTC.
                  The time resolution is 1/32 s"
END_OBJECT            = COLUMN

OBJECT              = COLUMN
    NAME              = "LIFETIME_5"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 259
    BYTES             = 5
    UNIT              = "N/A"
    FORMAT            = "I5"
    MISSING_CONSTANT  = 99999
   DESCRIPTION        = "Data acquisition time minus dead time.
                         The resolution is 10 s"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
    NAME              = "COUNTS_5"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 265
    BYTES             = 5
    FORMAT            = "I5"
    UNIT              = "N/A"
    MISSING_CONSTANT  = 99999
    DESCRIPTION       = " Counts for channel 5 "
END_OBJECT          = COLUMN
```

```
OBJECT                = COLUMN
    NAME                = "UTC_6"
    DATA_TYPE           = TIME
    START_BYTE          = 271
    BYTES               = 23
    DESCRIPTION         = "This column represents the UTC
                           in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME                = "LOBT_6"
    DATA_TYPE           = CHARACTER
    START_BYTE          = 296
    BYTES               = 14
    DESCRIPTION         = "Lander On Board Time represented as :
                  <Reset number>/<seconds>.<number of 1/32s>
                  Reset number 1 starts at 2003-01-01T00:00:00 UTC.
                  The time resolution is 1/32 s"
END_OBJECT             = COLUMN

OBJECT              = COLUMN
    NAME              = "LIFETIME_6"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 312
    BYTES             = 5
    UNIT              = "N/A"
    FORMAT            = "I5"
    MISSING_CONSTANT = 99999
   DESCRIPTION        = "Data acquisition time minus dead time.
                         The resolution is 10 s"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
    NAME              = "COUNTS_6"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 318
    BYTES             = 5
    FORMAT            = "I5"
    UNIT              = "N/A"
    MISSING_CONSTANT = 99999
    DESCRIPTION       = " Counts for channel 6 "
END_OBJECT          = COLUMN

OBJECT                = COLUMN
    NAME                = "UTC_7"
    DATA_TYPE           = TIME
    START_BYTE          = 324
    BYTES               = 23
    DESCRIPTION         = "This column represents the UTC
                           in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME                = "LOBT_7"
    DATA_TYPE           = CHARACTER
    START_BYTE          = 349
    BYTES               = 14
    DESCRIPTION         = "Lander On Board Time represented as :
                  <Reset number>/<seconds>.<number of 1/32s>
                  Reset number 1 starts at 2003-01-01T00:00:00 UTC.
                  The time resolution is 1/32 s"
END_OBJECT             = COLUMN

OBJECT              = COLUMN
    NAME              = "LIFETIME_7"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 365
    BYTES             = 5
```

```
    UNIT              = "N/A"
    FORMAT            = "I5"
    MISSING_CONSTANT  = 99999
   DESCRIPTION        = "Data acquisition time minus dead time.
                         The resolution is 10 s"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
    NAME               = "COUNTS_7"
    DATA_TYPE          = ASCII_INTEGER
    START_BYTE         = 371
    BYTES              = 5
    FORMAT             = "I5"
    UNIT               = "N/A"
    MISSING_CONSTANT   = 99999
    DESCRIPTION        = " Counts for channel 7 "
END_OBJECT           = COLUMN
```

4.3.2.4.2 Temperature table definition

The structure of the TABLE object is described in the file APXS_TEMP.FMT as follows:

```
  OBJECT               = COLUMN
    NAME               = "UTC_1"
    DATA_TYPE          = TIME
    START_BYTE         = 1
    BYTES              = 23
    DESCRIPTION         = "This column represents the UTC
                         in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
  END_OBJECT           = COLUMN

  OBJECT                 = COLUMN
    NAME                 = "LOBT_1"
    DATA_TYPE            = CHARACTER
    START_BYTE           = 26
    BYTES                = 14
    DESCRIPTION            = "Lander On Board Time represented as :
                Reset number (integer starting at 1) / seconds
                The time resolution is 0.03125 s"
  END_OBJECT             = COLUMN

  OBJECT               = COLUMN
      NAME             = "EBOX_TEMP_1"
      DATA_TYPE        = ASCII_INTEGER
      START_BYTE       = 42
      BYTES            = 3
      UNIT             = "N/A"
      FORMAT           = "I3"
      MISSING_CONSTANT = 999
      DESCRIPTION      = "Electronic box temperature. "
  END_OBJECT           = COLUMN

  OBJECT               = COLUMN
      NAME             = "SENSORHEAD_TEMP_1"
      DATA_TYPE        = ASCII_INTEGER
      START_BYTE       = 46
      BYTES            = 3
      FORMAT           = "I3"
      UNIT             = "N/A"
      MISSING_CONSTANT = 999
      DESCRIPTION      = " Sensorhead temperature "
  END_OBJECT           = COLUMN

  OBJECT               = COLUMN
    NAME               = "UTC_2"
    DATA_TYPE          = TIME
    START_BYTE         = 50
```

```
  BYTES              = 23
  DESCRIPTION         = "This column represents the UTC
                       in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT           = COLUMN

OBJECT                 = COLUMN
  NAME                 = "LOBT_2"
  DATA_TYPE            = CHARACTER
  START_BYTE           = 75
  BYTES                = 14
  DESCRIPTION            = "Lander On Board Time represented as :
               Reset number (integer starting at 1) / seconds
               The time resolution is 0.03125 s"
END_OBJECT             = COLUMN

OBJECT               = COLUMN
    NAME             = "EBOX_TEMP_2"
    DATA_TYPE        = ASCII_INTEGER
    START_BYTE       = 91
    BYTES            = 3
    UNIT             = "N/A"
    FORMAT           = "I3"
    MISSING_CONSTANT = 999
    DESCRIPTION      = "Electronic box temperature. "
END_OBJECT           = COLUMN

OBJECT               = COLUMN
    NAME             = "SENSORHEAD_TEMP_2"
    DATA_TYPE        = ASCII_INTEGER
    START_BYTE       = 95
    BYTES            = 3
    FORMAT           = "I3"
    UNIT             = "N/A"
    MISSING_CONSTANT = 999
    DESCRIPTION      = " Sensorhead temperature "
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = "UTC_3"
  DATA_TYPE          = TIME
  START_BYTE         = 99
  BYTES              = 23
  DESCRIPTION         = "This column represents the UTC
                       in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT           = COLUMN

OBJECT                 = COLUMN
  NAME                 = "LOBT_3"
  DATA_TYPE            = CHARACTER
  START_BYTE           = 124
  BYTES                = 14
  DESCRIPTION            = "Lander On Board Time represented as :
               Reset number (integer starting at 1) / seconds
               The time resolution is 0.03125 s"
END_OBJECT             = COLUMN

OBJECT               = COLUMN
    NAME             = "EBOX_TEMP_3"
    DATA_TYPE        = ASCII_INTEGER
    START_BYTE       = 140
    BYTES            = 3
    UNIT             = "N/A"
    FORMAT           = "I3"
    MISSING_CONSTANT = 999
    DESCRIPTION      = "Electronic box temperature. "
END_OBJECT           = COLUMN

OBJECT               = COLUMN
```

```
    NAME              = "SENSORHEAD_TEMP_3"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 144
    BYTES             = 3
    FORMAT            = "I3"
    UNIT              = "N/A"
    MISSING_CONSTANT  = 999
    DESCRIPTION       = " Sensorhead temperature "
END_OBJECT            = COLUMN

OBJECT                = COLUMN
  NAME                = "UTC_4"
  DATA_TYPE           = TIME
  START_BYTE          = 148
  BYTES               = 23
  DESCRIPTION          = "This column represents the UTC
                       in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT            = COLUMN

OBJECT                  = COLUMN
  NAME                  = "LOBT_4"
  DATA_TYPE             = CHARACTER
  START_BYTE            = 173
  BYTES                 = 14
  DESCRIPTION             = "Lander On Board Time represented as :
               Reset number (integer starting at 1) / seconds
               The time resolution is 0.03125 s"
END_OBJECT              = COLUMN

OBJECT                = COLUMN
    NAME              = "EBOX_TEMP_4"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 189
    BYTES             = 3
    UNIT              = "N/A"
    FORMAT            = "I3"
    MISSING_CONSTANT  = 999
    DESCRIPTION       = "Electronic box temperature. "
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME              = "SENSORHEAD_TEMP_5"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 193
    BYTES             = 3
    FORMAT            = "I3"
    UNIT              = "N/A"
    MISSING_CONSTANT  = 999
    DESCRIPTION       = " Sensorhead temperature "
END_OBJECT            = COLUMN

OBJECT                = COLUMN
  NAME                = "UTC_5"
  DATA_TYPE           = TIME
  START_BYTE          = 197
  BYTES               = 23
  DESCRIPTION          = "This column represents the UTC
                       in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT            = COLUMN

OBJECT                  = COLUMN
  NAME                  = "LOBT_5"
  DATA_TYPE             = CHARACTER
  START_BYTE            = 222
  BYTES                 = 14
  DESCRIPTION             = "Lander On Board Time represented as :
               Reset number (integer starting at 1) / seconds
               The time resolution is 0.03125 s"
```

```
END_OBJECT              = COLUMN

OBJECT                = COLUMN
    NAME              = "EBOX_TEMP_5"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 238
    BYTES             = 3
    UNIT              = "N/A"
    FORMAT            = "I3"
    MISSING_CONSTANT  = 999
    DESCRIPTION       = "Electronic box temperature. "
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME              = "SENSORHEAD_TEMP_5"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 242
    BYTES             = 3
    FORMAT            = "I3"
    UNIT              = "N/A"
    MISSING_CONSTANT  = 999
    DESCRIPTION       = " Sensorhead temperature "
END_OBJECT            = COLUMN

OBJECT                = COLUMN
  NAME                = "UTC_6"
  DATA_TYPE           = TIME
  START_BYTE          = 246
  BYTES               = 23
  DESCRIPTION          = "This column represents the UTC
                       in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
END_OBJECT            = COLUMN

OBJECT                  = COLUMN
  NAME                  = "LOBT_6"
  DATA_TYPE             = CHARACTER
  START_BYTE            = 271
  BYTES                 = 14
  DESCRIPTION             = "Lander On Board Time represented as :
                Reset number (integer starting at 1) / seconds
                The time resolution is 0.03125 s"
END_OBJECT              = COLUMN

OBJECT                = COLUMN
    NAME              = "EBOX_TEMP_6"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 287
    BYTES             = 3
    UNIT              = "N/A"
    FORMAT            = "I3"
    MISSING_CONSTANT  = 999
    DESCRIPTION       = "Electronic box temperature. "
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME              = "SENSORHEAD_TEMP_6"
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 291
    BYTES             = 3
    FORMAT            = "I3"
    UNIT              = "N/A"
    MISSING_CONSTANT  = 999
    DESCRIPTION       = " Sensorhead temperature "
END_OBJECT            = COLUMN

OBJECT                = COLUMN
  NAME                = "UTC_7"
  DATA_TYPE           = TIME
```

```
    START_BYTE          = 295
    BYTES               = 23
    DESCRIPTION          = "This column represents the UTC
                          in PDS standard format YYYY-MM-DDThh:mm:ss.sss"
  END_OBJECT            = COLUMN

  OBJECT                  = COLUMN
    NAME                  = "LOBT_7"
    DATA_TYPE             = CHARACTER
    START_BYTE            = 320
    BYTES                 = 14
    DESCRIPTION             = "Lander On Board Time represented as :
                 Reset number (integer starting at 1) / seconds
                 The time resolution is 0.03125 s"
  END_OBJECT              = COLUMN

  OBJECT                = COLUMN
      NAME              = "EBOX_TEMP_7"
      DATA_TYPE         = ASCII_INTEGER
      START_BYTE        = 336
      BYTES             = 3
      UNIT              = "N/A"
      FORMAT            = "I3"
      MISSING_CONSTANT  = 999
      DESCRIPTION       = "Electronic box temperature. "
  END_OBJECT            = COLUMN

  OBJECT                = COLUMN
      NAME              = "SENSORHEAD_TEMP_7"
      DATA_TYPE         = ASCII_INTEGER
      START_BYTE        = 340
      BYTES             = 3
      FORMAT            = "I3"
      UNIT              = "N/A"
      MISSING_CONSTANT  = 999
      DESCRIPTION       = " Sensorhead temperature "
  END_OBJECT              = COLUMN
```

4.3.2.5 Description of Instrument

The description of the instrument is done in above and as a brief overview in the INST.CAT catalog file.

4.3.2.6 Parameters Index File Definition

4.3.2.7 Mission Specific Keywords

There are no mission specific keywords for APXS

4.3.3 Calibrated SC data (level 3)

TBD

4.3.4 Derived SC data (level 5)

TBD

5 Appendix: Available Software to read PDS files

6 Appendix: Example of PDS combined detached label for APXS level 2 data product

```
PDS_VERSION_ID               = PDS3
LABEL_REVISION_NOTE = "2008-12-19, SONC, version 1.0"

/*  Edited Science data   */

DATA_SET_ID          = "RL-CAL-APXS-2-CR4A-V1.0"
DATA_SET_NAME        = "ROSETTA-LANDER CR4A APXS 2 CR4A V1.0"
PRODUCT_ID           = "APXS_FS2_0808011938"
PRODUCT_CREATION_TIME = 2008-12-19T12:39:25
MISSION_NAME          = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME   = "CRUISE 4-1"
MISSION_ID            = ROSETTA
INSTRUMENT_HOST_NAME = "ROSETTA-LANDER"
INSTRUMENT_HOST_ID   = RL

PRODUCT_TYPE          = RDR
START_TIME            = 2008-08-01T19:38:38.838
STOP_TIME             = 2008-08-01T20:38:38.838
SPACECRAFT_CLOCK_START_COUNT = "2/176240281.27"
SPACECRAFT_CLOCK_STOP_COUNT  = "2/176243881.27"

PRODUCER_ID           = "SONC"
PRODUCER_FULL_NAME    = "SCIENCE OPERATIONS AND NAVIGATION CENTER"
PRODUCER_INSTITUTION_NAME = "CNES"

INSTRUMENT_ID         = APXS
INSTRUMENT_NAME       = "ALPHA PARTICLE X-RAY SPECTROMETER"
INSTRUMENT_TYPE       = SPECTROMETER
INSTRUMENT_MODE_ID    = "N/A"
INSTRUMENT_MODE_DESC = "N/A"
TARGET_NAME           = "CALIBRATION"
TARGET_TYPE           = "CALIBRATION"

PROCESSING_LEVEL_ID  = 2
DATA_QUALITY_ID       = -1
DATA_QUALITY_DESC     = "-1 : NOT QUALIFIED"

/* GEOMETRY PARAMETERS */

/* SPACECRAFT LOCATION: Position <km> */
SC_SUN_POSITION_VECTOR = ( -158127612.1, 158876752.3,  77330498.5)
/* TARGET PARAMETERS: Position <km>, Velocity <km/s> */
SC_TARGET_POSITION_VECTOR = ( -231505054.3,  37330847.1,  24636415.6)
SC_TARGET_VELOCITY_VECTOR = (         11.4,       -25.3,       -10.9)
/* SPACECRAFT POSITION WITH RESPECT TO CENTRAL BODY */
SPACECRAFT_ALTITUDE =   235779828.8 <km>
SUB_SPACECRAFT_LATITUDE =    -5.92 <deg>
SUB_SPACECRAFT_LONGITUDE =   258.92 <deg>
NOTE = "The values of the keywords SC_SUN_POSITION_VECTOR,
       SC_TARGET_POSITION_VECTOR and SC_TARGET_VELOCITY_VECTOR
       are related to the EMEJ2000 reference frame.
       The values of SUB_SPACECRAFT_LATITUDE and SUB_SPACECRAFT_LONGITUDE
       are northern latitude and eastern longitude in the standard
       planetocentric IAU_<TARGET_NAME> frame.
       All values are computed for the time = START_TIME.
       Distances are given in <km> velocities in <km/s>, Angles in <deg>"

/* DATA OBJECT DEFINITION  */

OBJECT                  = FILE
```

```
RECORD_TYPE               = FIXED_LENGTH
RECORD_BYTES              = 377
FILE_RECORDS              = 2
^APXS_X_SPECTRUM_TABLE    = "APXS_FS2_0808011938_X.TAB"
  OBJECT                  = APXS_X_SPECTRUM_TABLE
    NAME                  = APXS_X_SPECTRUM
    INTERCHANGE_FORMAT    = ASCII
    ROWS                  =  2
    ^STRUCTURE            = "APXS_SPECTRUM.FMT"
    COLUMNS               = 29
    ROW_BYTES             = 377
  END_OBJECT              = APXS_X_SPECTRUM_TABLE
END_OBJECT               = FILE

OBJECT                     = FILE
RECORD_TYPE                 = FIXED_LENGTH
RECORD_BYTES                = 377
FILE_RECORDS                =  2
^APXS_ALPHA1_SPECTRUM_TABLE = "APXS_FS2_0808011938_ALPHA1.TAB"
  OBJECT                    = APXS_ALPHA1_SPECTRUM_TABLE
    NAME                    = APXS_ALPHA1_SPECTRUM
    INTERCHANGE_FORMAT      = ASCII
    ROWS                    = 2
    ^STRUCTURE              = "APXS_SPECTRUM.FMT"
    COLUMNS                 = 29
    ROW_BYTES               = 377
  END_OBJECT                = APXS_ALPHA1_SPECTRUM_TABLE
END_OBJECT                 = FILE

OBJECT                     = FILE
RECORD_TYPE                 = FIXED_LENGTH
RECORD_BYTES                = 377
FILE_RECORDS                = 2
^APXS_ALPHA2_SPECTRUM_TABLE = "APXS_FS2_0808011938_ALPHA2.TAB"
  OBJECT                    = APXS_ALPHA2_SPECTRUM_TABLE
    NAME                    = APXS_ALPHA2_SPECTRUM
    INTERCHANGE_FORMAT      = ASCII
    ROWS                    = 2
    ^STRUCTURE              = "APXS_SPECTRUM.FMT"
    COLUMNS                 = 29
    ROW_BYTES               = 377
  END_OBJECT                = APXS_ALPHA2_SPECTRUM_TABLE
END_OBJECT                 = FILE

OBJECT                    = FILE
RECORD_TYPE                = FIXED_LENGTH
RECORD_BYTES               = 377
FILE_RECORDS               = 2
^APXS_BKGND_SPECTRUM_TABLE = "APXS_FS2_0808011938_BKGND.TAB"
  OBJECT                   = APXS_BKGND_SPECTRUM_TABLE
    NAME                   = APXS_BKGND_SPECTRUM
    INTERCHANGE_FORMAT     = ASCII
    ROWS                   = 2
    ^STRUCTURE             = "APXS_SPECTRUM.FMT"
    COLUMNS                = 29
    ROW_BYTES              = 377
  END_OBJECT               = APXS_BKGND_SPECTRUM_TABLE
END_OBJECT                = FILE


OBJECT                   = FILE
RECORD_TYPE               = FIXED_LENGTH
RECORD_BYTES              = 344
FILE_RECORDS = 2
^APXS_TEMP_TABLE = "APXS_FS2_0808011938_TEMP.TAB"
  OBJECT                  = APXS_TEMP_TABLE
    NAME                  = APXS_TEMP
    INTERCHANGE_FORMAT    = ASCII
```

```
    ROWS                    = 2
    ^STRUCTURE              = "APXS_TEMP.FMT"
    COLUMNS                 = 28
    ROW_BYTES               = 344
 END_OBJECT                 = APXS_TEMP_TABLE
END_OBJECT                 = FILE

END
```

7 Appendix: Example of Directory Listing of Data Set X