SWEDISH INSTITUTE OF SPACE PHYSICS
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ROSETTA RPC-LAP
to Planetary Science Archive
Interface Control Document

RO-IRFU-LAP-EAICD

Issue 1.9.2

7 July 2015

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Document History

Version	Date	Sections Changed	Notes
1.0	2003-08-19	New document	Initial draft
1.1	2005-08-04	All sections updated.	PDS Software and archive has matured
1.2	2005-11-24	Most sections updated.	Corrections in response to PSA team.
1.3	2006-01-27		Never issued.
1.4	2006-01-31	Minor corrections.	Corrections in response to PSA team.
1.5	2006-10-31	Numerous updates related to PDS review, mostly RID corrections.	PDS archive review.
1.6	2012-07-03	Almost all.	Complete update and revision of all text, taking RIDs from the Lutetia review into account. Geometry info added.
1.7	2012-10-10	Minor corrections.	Corrections in response to comments on previous version. Non-correspondence of file names in EDITED and CALIBRATED described. More details on bias values and their calibration.
1.8	2012-01-30	2.2, 2.3, 2.5, 3.1.4	Editorial and typo correction in response to comments by PSA. All tables renumbered. Improved description of file names in Section 3.1.4.
1.9	2013-08-13		Editorial changes in response to PSA review.
1.9.1	2015-02-23	1.9, 2.5, 4.3.1.5, 4.3.2.2-5	Updated contact names, adresses, a calibration detail (cubic fit), and renamed keywords, other minor edits.

1.9.2	2015-07-07	2.3, Table 2.3-1	Corrected the macro table graphics. Emphasized that the macro table is an example.

CONTENTS

1 Introduction

1.1 Purpose and Scope

This document provides users of PSA/PDS data products from the Langmuir Probe instrument of the Rosetta Plasma Consortium (RPC-LAP) with a description of the data products and how they were generated. It is also the official interface between the LAP team and the archiving authority.

1.2 Archiving Authorities

1.2.1 Planetary Data System (PDS)

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

1.2.2 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 LAP 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 as well as fundamental features of the instrument. Standards used to generate the product are explained. The design of the data set structure and the data product is given, with some examples.

1.4 Intended Readership

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

1.5 Applicable Documents

AD1 Planetary Data System Standards Reference, February 27, 2009, Version 3.8, JPL D-7669, Part 2

AD2 ROSETTA Archive Generation, Validation and Transfer Plan, September 01, 2005,RO-EST-PL-5011

AD3 RO-RPC-UM, Rosetta Plasma Consortium: User´s Manual

AD4 RO-IGEP-TR-0016, RPC Archiving Guidelines

1.6 Reference Documents

RD1 RPC-LAP: The Rosetta Langmuir probe instrument. A. I. Eriksson, R. Boström, R. Gill, L. Åhlén, S.-E. Jansson, J.-E. Wahlslund, M. André, A. Mälkki, J. A. Holtet, B. Lybekk, A. Pedersen, L. G. Blomberg and the LAP team. *Space Science Reviews, 128*, 729-744, 2007. DOI:10.1007/s11214-006-9003-3.

RD2 RPC-LAP: The Langmuir probe instrument of the Rosetta plasma consortium. A. I. Eriksson, R. Gill, J.-E. Wahlund, M. André, A. Mälkki, B. Lybekk, A. Pedersen, J. A. Holtet, L. G. Blomberg and N. J. T. Edberg. In *Rosetta: ESA's Mission to the Origin of the Solar System*, editors R. Schulz, C. Alexander, H. Bönhardt and K.-H. Glassmeier. Springer, 2009.

RD3 RPC: The Rosetta Plasma Consortium. C. Carr, E. Cupido, C. G. Y. Lee, A. Balogh, T. Beek, J. L. Burch, C. N. Dunford, A. I. Eriksson, R. Gill, K. H. Glassmeier, R. Goldstein, D. Lagoutte, R. Lundin, K. Lundin, B. Lybekk, J. L. Michau, G. Musmann, H. Nilsson, C. Pollock, I. Richter and J. G. Trotignon. *Space Science Reviews, 128*, 629-647, 2007. DOI: 10.1007/s11214-006-9136-4.

RD4 RPC: The Rosetta Plasma Consortium. C. Carr, E. Cupido, C. G. Y. Lee, A. Balogh, T. Beek, J. L. Burch, C. N. Dunford, A. I. Eriksson, R. Gill, K. H. Glassmeier, R. Goldstein, D. Lagoutte, R. Lundin, K. Lundin, B. Lybekk, J. L. Michau, G. Musmann, H. Nilsson, C. Pollock, I. Richter and J. G. Trotignon. In *Rosetta: ESA's Mission to the Origin of the Solar System*, editors R. Schulz, C. Alexander, H. Bönhardt and K.-H. Glassmeier. Springer, 2009.

RD5 RPC-MIP: The Mutual Impedance Probe of the Rosetta Plasma Consortium. J.-G. Trotignon, J.-L. Michau, D. Lagoutte, M. Chabassière, G. Chalumeau, F. Colin, P. M. E. Décréau, J. Geiswiller, P. Gille, R. Grard, T. Hachemi, M. Hamelin, A. Eriksson, H. Laakso, J. P. Lebreton, C. Mazelle, O. Randriamboarison, W. Schmidt, A. Smit, U. Telljohann and P. Zamora. *Space Science Reviews, 128*, 713-728, 2007. DOI: 10.1007/s11214-006-9005-1.

1.7 Relationships to Other Interfaces

This document is the top level document for LAP PDS-compliant PSA archiving.

1.8 Acronyms and Abbreviations

ADC	Analog to Digital Converter
AQP	Acquisition Period
bps	Bits per second
BM	Burst rate TM mode
DDS	Data Disposition System
E	Current bias (E-field measurement) mode of a LAP probe
ESA	European Space Agency
ESOC	European Space Operations Centre
GSE	Ground Support Equipment
ICA	Ion Composition Analyzer (other RPC instrument)
HK	Housekeeping
IC	Imperial College, London
IES	Ion and Electron Sensor (other RPC instrument)
IRFU	Swedish Institute of Space Physics ,Uppsala (Institutet for rymdfysik, Uppsala)
LAP	Langmuir Probe instrument
LDL	Long Debye Length mode of the MIP instrument
LM	Low rate TM mode
MAG	Fluxgate magnetometer (other RPC instrument)
MIP	Mutual Impedance Probe (other RPC instrument)
N	Voltage bias (density measurement) mode of a LAP probe
NM	Normal rate TM mode
P1	LAP probe 1
P2	LAP probe 2
PDS	Planetary Data System
PIU	Plasma Interface Unit (RPC central unit)
PSA	Planetary Science Archive

PVV	PSA Volume Verifier
P1	Probe 1
P2	Probe 2
RPC	Rosetta Plasma Consortium
s/c	Spacecraft
SDL	Short Debye Length (normal mode of MIP)
SSP	Surface Science Package (the Philae lander)
TM	Telemetry

1.9 Contact Names and Addresses

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

2.1 RPC and LAP

RPC, the Rosetta Plasma Consortium, is a set of instruments on the Rosetta orbiter for investigation of plasma properties and electromagnetic fields. RPC is described in RD3 and RD4. The Langmuir probe instrument is one of these instruments, and is therefore referred to as RPC-LAP or, as we will do in the rest of this document, just LAP.

2.2 The LAP instrument

This section gives a very brief introduction to the LAP instrument, and is recommended reading for any user of any LAP data product. For more complete information, we refer to the two published instrument descriptions, RD1 and RD2.

LAP uses two spherical sensors of 2.5 cm radius, mounted on 15 cm “stubs,” which, in turn, are attached to the ends of the spacecraft booms by a “foot” (see picture on document cover page). Probe 1 is mounted on the “upper” spacecraft boom, also carrying the RPC-MIP antenna (RD5). This boom, which is 2.24 m in length from hinge to probe, is protruding from the spacecraft at an angle of 45◦ to the nominal comet direction (the *z* axis in Figure 1; see also Table 2.2-1). By pointing to the comet, probe 1 will get access to a plasma flow from the comet as undisturbed as possible by any spacecraft sheath or wakes, without interfering with the field of view of other instruments. Probe 2 is mounted on the “lower” boom, 1.62 m in length, which also carries the RPC-MAG sensors. The distance between the probes is 5.00 m, and the probe separation in the nominal comet direction (z axis) is 4.55 m.

	x (m)	*y* (m)	*z* (m)
Probe 1	−1.19	2.43	3.88
Hinge 1	−1.19	0.85	2.30
Probe 2	−2.48	0.78	−0.65
Hinge 2	−1.19	0.65	0.30

Table 2.2-1. Positions in the spacecraft coordinate system, indicated in Figure 1, for the LAP probes and for the hinges at the boom roots. [After AD3]

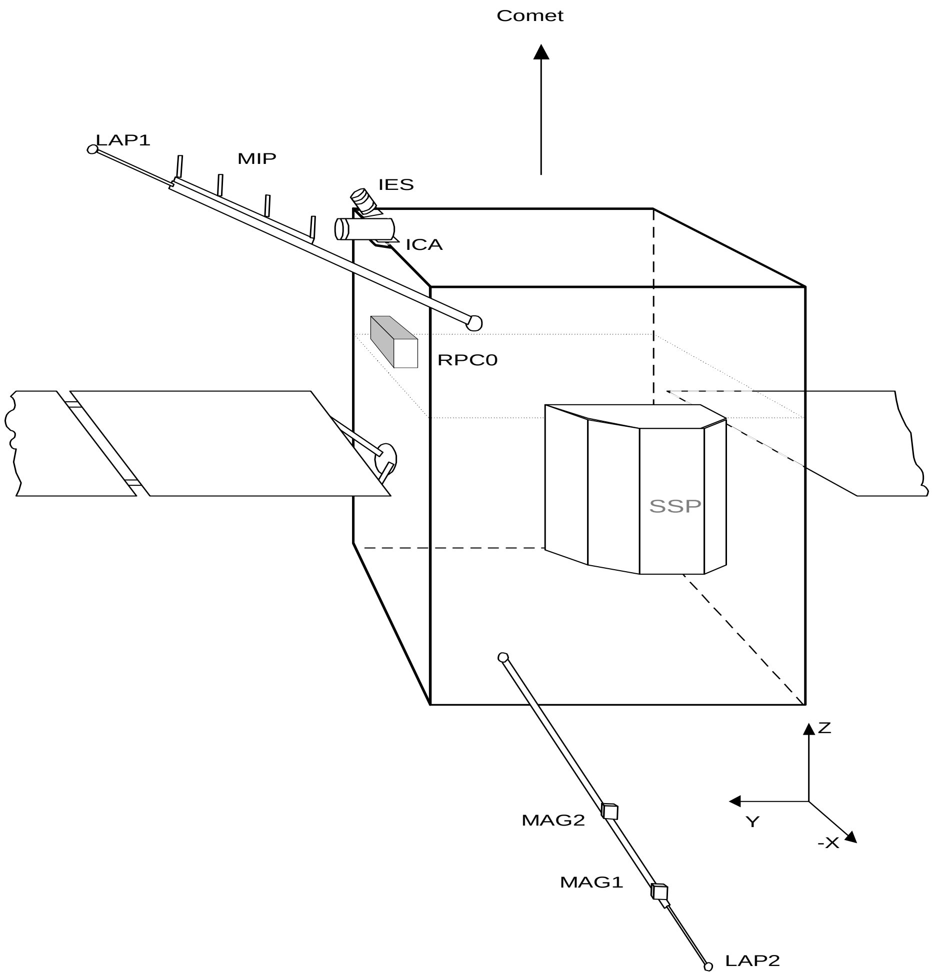

Figure 1. The mounting of the LAP sensors, LAP1 and LAP2, and other RPC units on the Rosetta spacecraft. RPC-0 is the common electronics box, also housing the LAP electronics boards. The direction of the s/c coordinate axes are indicated: the origin of the s/c coordinate system is at the centre of the –Z surface (bottom surface in this sketch). SSP is the Philae lander, not part of RPC. [From RD3]

For the two LAP probes, we will here use the designations P1 and P2, though other schemes can be found in the literature and documentation: LAP1 and LAP2 (as in Figure 1), RPC-3.1 and RPC-3.2, probe 1 and probe 1, S1 and S2, and so forth. The probes can be independently operated in any of two *bias modes*:

- A *bias voltage* can be applied to the probe, in which case the basic measured quantity is the current flowing from the probe to the plasma. In general, we denote this current Ip, with I1 and I2 referring to the specific currents from the two probes. This bias mode is denoted N (for deNsity mode) or (in the archive data file names) D.

- A *bias current* (including zero, corresponding to floating probes) can be applied to the probe. In this case, the basic quantity measured is the voltage of the probe with respect to the spacecraft, denoted Vps in general, with V1 and V2 denoting the specific signal from each probe. This bias mode is denoted E (for Electric field mode).

Probe P2 may also be used by the RPC-MIP instrument for use in its LDL (Long Debye-Length) mode [RD5]. In this case, LAP can only take data from P1. To indicate how the probes are operated, it is convenient to group the P1 and P2 bias modes together. NE then indicates that P1 is in voltage bias mode and P2 in current bias mode, while E- indicates that P1 is in current bias mode and P2 is not used by LAP because being handed over to MIP for LDL operations.

In general, voltage bias is most useful in dense plasmas for determining the prime LAP science parameters of plasma density, electron temperature, plasma flow speed, and the density fluctuation spectrum, while the bias current is applied to get measurements of spacecraft potential and electric (wave) fields. In tenuous plasmas, the density is better obtained from the spacecraft potential. The limit between "dense" and "tenuous" is not absolute but set by the currents flowing to an object at zero potential with respect to the surrounding plasma: "dense" means that the random thermal electron current dominates, "tenuous" that the photoemission current dominates. Hence, the dense-tenuous density limit depends on the photoemission current, which is proportional to the solar UV flux. The limit density therefore follows a $1/r^2$ relation with distance from the sun, and also varies with temporal solar UV intensity variations. In general, the limit varies between at a few hundred cm^{-3} at Earth orbit to a few tens cm^{-3} in the outer part of the Rosetta operational range of solar distances.

The bias applied on a probe can either be set to a constant value or, in the case of bias voltage, "sweeped", i.e. varied in steps over some range of voltage. LAP also has the possibility to apply a square-wave voltage of up to a few kHz to either probe and observe the resulting signal on the other probe.

Each probe has its own electronics, and can thus be operated independently of the other probe, regarding biasing as well as sampling. To each probe is attached two analog-to-digital converters: one 20-bit, operating at 57.8 samples/s and denoted L (for low rate sampling), and one 16-bit, operating at 18750 samples/s and denoted H (for high rate sampling). Data are low-pass filtered by one of three different filters before sampling, cutting (3 dB damping point) at 20 Hz for L sampling and at 4 kHz or 8 kHz for H sampling. The filter characteristics (available in the files containing the string FRQ in the CALIB directory, see Section 3.4.3.2) are shown in Figure 2.

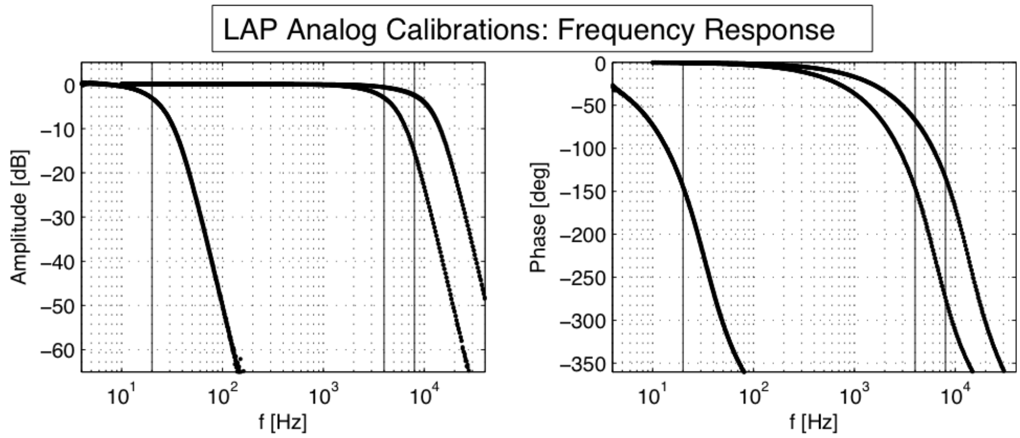

Figure 2. The frequency response of the LAP instrument, showing the rolloff of the anti-aliasing filters, as obtained during laboratory tests of the flight hardware. Data for P1 and P2 are plotted on top of each other: the probes are identical to the limit of this plot resolution.

A variety of different measurements can be produced by this arrangement, producing different data types. The basic data types are listed below: however, it should be noted that the LAP flight s/w is very flexible, and functions can be defined for construction of other data types not listed here.

- *Time series data.* With the probes at constant bias (current or voltage), the time series, at some constant sampling frequency, from both or any of the probes, or derived time series like their sum or their average, can be transmitted.
- *Probe bias sweeps.* The bias voltage can be varied during a brief interval, known as a sweep. While the samples acquired still constitutes a time series, the basic assumption is that the plasma does not vary during the short sweep, and the sweep is treated as a set of instantaneous and simultaneous samples acquired at different bias.

Data can be transmitted to the PIU and further to the spacecraft systems at three different data rates or telemetry modes:

- *Low TM mode (LM):* 1.6 bps. Not used for regular science operations.
- *Normal TM mode (NM):* 62.5 bps. Most common mode for science operations.
- *Burst TM mode (BM):* 2253 bps. Used for shorter intervals when RPC TM allocation so allows.

2.3 LAP Operational Modes

This section describes the LAP operational mode concept. A general knowledge of these is necessary at least for the user of LAP EDITED and CALIBRATED data sets, and could be of interest also to users of the DERIVED data set.

As described above, and in more detail in RD1 and RD2, the LAP probes can be used in different bias and sampling modes. Such settings are combined in instrument macros, which are command sequences stored in the LAP flash memory (RD1, RD2).

The basic time unit for LAP operations is the spacecraft data acquisition period (AQP) of 32 s. A macro specifies the LAP operations over an integer number of AQPs, with indefinite repetition. When the instrument is commanded to run a certain macro, it thus repeats the sequence of operations specified in the macro until commanded to stop or to change macro. A macro can therefore be said to define an operational mode of LAP.

A macro can contain any LAP command. In practice, macro instructions include the following:

- Bias settings for each probe
- Sweep setup
- Number of samples to acquire from each ADC (beginning at the start of the AQP)
- Onboard data reduction: digital filtering, downsampling, and subtraction or addition of two signals.
- Possible idle wait for a number of AQPs (to keep telemetry within bounds)
- Telemetry mode (LM, NM or BM)

Each macro is identified by a macro ID, which is stored in the data so that the instrument setup is always well known. Table 2.3-1 shows a summary of example LAP macros used in science operations. As new macros can be uploaded, the macros actually in use may be different for each phase of the mission. The appropriate macro table for a certain mission phase is stored as a PDF file in the DOCUMENTS directory.

To understand the macro table, we take as an example macro 0x506, which can be run in Normal telemetry rate. From the table, we can see that when this macro is running, both LAP probes are in bias voltage mode (NN), with a constant bias of +10 V when not sweeping. We can also see that the data sampled by the instrument in this mode are:

- Both probe currents I1 and I2 are available continuously at a time resolution of about 2.2 s (0.45 samples/s). These signals are conveniently denoted as I1L and I2L, the L signifying that the low frequency ADCs are used. Had the probes been in current bias mode, the signals had been voltages denoted V1L and V2L. This continuous sampling is not exactly continuous: the sampling is always reset at the beginning of each AQP, and there may also be one or a few samples missing at the end of an AQP. Nevertheless, it covers almost all the AQP, and is available in every AQP, and hence is at least quasi-continuous. These data are produced by the two 20-bit ADCs at 57.8 samples/s, and then downsampled by a factor of 128. This downsampling is always by some power of two, so for a macro where the table says continuous data at 0.9 samples/s, the exact number is 57.8/64 samples/s.

- Every 5th AQP (every 160 s, as one AQP is 32 s), 96 samples are taken simultaneously on both probes at full time resolution by the two 16-bit ADCs (18.750 kHz). These signals are denoted I1H and I2H, with H signifying high frequency, and referred to as HF snapshots. In macros where the probes are in current bias mode, the HF signals are voltage samples denoted by V1H and V2H. In this particular macro, they cover little more than 5 ms, and can thus be used to study wave activity between 0.2 and 8 kHz (where the low pass filter sets in, see Figure 2). In some macros (e.g. 0x700), digitally computed differences rather than individual signals are stored.
- Both probes bias voltages are swept between -12 and +12 V every 5th AQP (every 160 s, not the same AQPs as in which the HF snapshots are taken), in steps of 0.5 V. Sweeps are only available in bias voltage mode. The sweep currents are sometimes denoted I1S and I2S, with S signifying sweep.

In the LAP data archives for EDITED and CALIBRATED data, one file is saved for each record. This means that for this macro, there is for every AQP two data files containing I1L and I2L. For every 5th AQP, there are two additional data files containing I1H and I2H. Also every 5th AQP, there are also two files containing I1S and I2S data. The number of files produced per AQP can thus differ.

Table 2.3-1. LAP science macros uploaded to June 2010. Text color indicates normal mode (NM, black) or burst mode (BM, blue) data rate. Background color indicates operational status: Pale green and orange are useful science macros without or with LDL, yellow calibration macros, and grey older science macros. The table relevant for the current mission phase is available as the LAPMAC document in the DOCUMENT directory of the archive.

LAP Macro Table

Date: 120828

Macro ID	0x104	0x212	0x503	0x504	0x505	0x506	0x600	0x604	0x700	0x701	0x702	0x703	0x704	0x705	0x706	0x803	0x804	0x807
Notes	Calibration	Use 0x506			Use 0x506		Use 0x506		Use 0x503	Use 0x503	Use 0x503			Use 0x503	Use 0x504		Use 0x807	
Purpose	Calibration	Swp, HF	Vs, HF	Vs, HF	N, HF, swp	N, HF, swps	Swp, HF	N, HF, swps	Vs, HF	Vs, HF	Vs, HF	LDL, Vs, HF	DL, Vs, wave	Vs, HF	Vs, HF	LDL, N, HF	LDL, N, HF	DL, N, HF, swp
TM rate	NM	NM	NM	BM	NM	NM	NM	BM	NM	NM	NM	NM	BM	NM	BM	NM	BM	BM
Bias mode	NN	NN	EE	EE	NN	NN	NN	NN	EE	EE	EE	E-	E-	EE	EE	N-	N-	N-
Fix bias P1	.	0 V	-8 nA	-8 nA	+10 V	+10 V	+20 V	+20 V	-17 nA	-17 nA	+1 nA	-30 nA	-29 nA	-29 nA	-29 nA	+10 V	+10 V	+10 V
Fix bias P2	.	0 V	+3 nA	+3 nA	+10 V	+10 V	+20 V	+20 V	-17 nA	+1 nA	-17 nA	MIP	MIP	+3 nA	+3 nA	MIP	MIP	MIP
Continuous data (ADC20)																		
Sampled data	.	.	V1, V2	V1, V2	I1, I2	I1, I2	.	I1, I2	V1, V2	V1, V2	V1, V2	V1	V1	V1, V2	V1, V2	I1	I1	I1
fsamp [Hz]	.	.	0.9	57.8	0.45	0.45	.	28.9	0.9	0.9	0.9	1.8	57.8	0.9	57.8	1.8	57.8	57.8
Wave snapshots (ADC16)																		
Sampled data	.	I1, I2	V1	V1, V2	I1, I2	I1, I2	I1, I2	I1, I2	V1-V2	V1-V2	V1-V2	V1	V1	V1-V2	V1-V2	I1	I1	I1
fsamp [Hz]	.	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750
Samples	.	256	272	432	96	96	256	1840	160	160	160	160	2416	272	2624	160	2416	4080
Cadency [AQPs]	.	8	5	1	5	5	8	3	3	3	3	3	1	5	3	3	1	2
Cadency [s]	.	256	160	32	160	160	256	96	96	96	96	96	32	160	96	96	32	64
Sweeps (ADC16)																		
Probes	Open	P1, P2	.	.	P1, P2	P1, P2	P1, P2	P1, P2	.	.	.	.	.	.	.	.	.	P1
Cadency [AQPs]	8	8	.	.	5	5	8	3	.	.	.	.	.	.	.	.	.	2
Cadency [s]	256	256	.	.	160	160	256	96	.	.	.	.	.	.	.	.	.	64
Range [V]	[-30, +30]	[-30,+15]	.	.	[-18, +18]	[-12, +12]	[-30, +20]	[-30, +20]	.	.	.	.	.	.	.	.	.	[-30, +30]
Step [V]	0.25	1	.	.	0.75	0.5	0.25?	0.25	.	.	.	.	.	.	.	.	.	0.25
First upload			PC8	PC8	PC12	PC12			PC4	PC4	PC4	PC6	PC6	PC6	PC6	PC10	PC10	PC12

Field colour indicates use:
Green: prefered non-LDL science macros
Orange: prefered LDL science macros
Yellow: maintenance, diagnostics, etc
Grey: superseded science macros

Text colour indicatess telemetry mode:
Black: Normal Mode
Blue: Burst Mode

2.4 LAP Archive Data

This section describes the general structure of the LAP archive. It should be of interest to any user of this archive.

In conformance to PDS standards, LAP data are archived at three levels: EDITED, CALIBRATED and DERIVED. For LAP, these corresponds to decommutated uncalibrated raw data in TM units, data corrected for instrumental offsets and converted to engineering units (V and A), and final physical output parameters in physical units (V, cm-3, eV etc.), respectively. In more detail:

- EDITED data:
  - Edited science data -- the science data stream converted to human and PDS readable format, but still in telemetry units and with no calibrations or corrections applied. One science packet of data from the s/c is converted to one or more files of data in the edited data set, each packet containing the data from one specific measurement. Data files from onboard calibrations are included. The edited science data files are supplied mainly for long term archiving and reference purposes, and are not intended or suitable for regular scientific use.
  - Edited HK data -- the HK data stream converted to human and PDS readable format, one file for each LAP HK packet. These data are supplied for long term archiving and reference purposes only, and are not intended or suitable for regular scientific use. The edited HK data files are archived together with the edited science data files.
  - Geometry data – one file per day containing position, velocity and attitude information for the start time of each edited science data file. The geometry files are archived with the edited science data files.
- CALIBRATED data:
  - Calibrated science data -- the science data stream converted to engineering units (volts and nanoamperes), calibrated and corrected for known offsets and errors. One science packet of data from the s/c is converted to one or more files of data in the calibrated data set, each packet containing the data from one specific measurement. As they do not contain science data, HK data files or files from onboard calibrations are not included: these are available in the EDITED archive. The CALIBRATED data as such are of high quality, but there is no attempt for correction of e.g. attitude-dependent spacecraft-plasma interaction effects (wakes, photoemission, etc.), and scientific interpretation of the data requires great caution.

    - Geometry data files – one file per day containing position, velocity and attitude information for the start time of each calibrated science data file. The geometry files are archived with the calibrated science data files.
- DERIVED data -- science data converted to the basic measurement units of volts and amperes, and further to Vps, plasma density, temperature, flow speed, electric field, or whatever parameters can be derived. One file for each derived parameter results from each uninterrupted period of operation of a certain macro, though files are split as to not cross day boundaries. No DERIVED data sets are yet present.

2.5 Calibration process

This section is included for reference. It should usually not be of interest to most LAP science data users, who should not need to bother about the EDITED data and the calibration process.

The data in the EDITED data sets are in TM units and hence not subject to calibration. The measured EDITED data (current or voltage) are based on the direct output of the analog-to-digital converters (ADCs), and spans the range -32768 to 32767 (16-bit and 20-bit data truncated to 16 bits) or -524288 to 524287 (20-bit data), with 0 representing zero volt measured by the ADC.

Saturated data only means the signal is outside the range of the ADC and should not be used. Note that saturation on the positive as well as the negative side will give maximum negative value in the data (e.g. -32768 in EDITED 16-bit or truncated 20-bit data, or -40 V in calibrated E-mode data).

The bias values included in the files (EDITED and CALIBRATED) are not measured but reconstructed from the instrument command line and the known characteristics of the instrument modes. When the fix bias value on any of the probes is changed by telecommand, the bias step will be seen in the data files at the time of telecommand execution. The setting actually takes effect 2-3 seconds later, as can be seen in data. In addition, in certain plasmas the time constant for charging a probe when in current bias mode (E mode) can be so long that there is a further delay before the bias has settled. Users should thus take care when interpreting data close to a bias setting. This only applies to measurements at fixed bias: the bias voltage in sweeps has correct timing.

The probe current, be it the bias current in E mode or the measured current in N mode, is by standard convention taken to be positive when flowing from the probe to the plasma. However, to follow the actual settings of the digital-to-analog converters, the bias current values have the opposite sign in the EDITED archive, so that -128 corresponds to a nominal bias current of +44 nA (with conventional sign choice) in the CALIBRATED archive, and +127 to -44 nA. Bias voltages range from -128 to 128 in EDITED, with the same sign as in CALIBRATED. Exact calibration factors are found in the calibration files (see below).

The data in the EDITED data sets have been calibrated using the contents of the CALIB directory (see Section 3.4.3.2). For any sample, the most recent calibration in-flight calibrations, in RPCLAPyymmdd_CALIB_MEAS.LBL and RPCLAPyymmdd_CALIB_MEAS.TAB, is used. Here yymmdd notes the time from which the file is appliccable.

- Measured voltages (E-field mode) are converted to volts from TM units by application of the calibration factors ROSETTA:LAP_VOLTAGE_CAL_16B and ROSETTA:LAP_VOLTAGE_CAL_20B (for data from the 16- and 20-bit ADCs, respectively) based on pre-flight ground tests. These are available in the RPCLAPyymmdd_CALIB_MEAS.LBL file. Note that truncation of M bits from the data results in a change of the calibration factor by a factor of 2^M. Data from the 20-bit ADCs are often truncated to 16 bits (this is clearly shown in the label file), resulting in the calibration factor changing by a factor of 16 (becoming similar to the factor for the 16-bit ADCs).
- Measured currents (bias mode N) are converted to amperes from TM units in a two stage process:
  - This measurement is sensitive to inevitable offsets due to small leakage currents in the instrument. Therefore, a linear function fitted to the bias-dependent offsets regularly recorded onboard and stored in the files RPCLAPyymmdd_CALIB_MEAS.TAB is first subtracted from the data. The offsets are regularly determined by running macro 0x104 (Table 2.3-1), in which the probes are disconnected from the electronics by opening a relay, and the data thus measures all offsets in the instrument electronics. A cubic fit is used rather than tabulated values, to reduce the possible influence of noise during offset determination.
  - After offset removal, we apply the relevant calibration factor of ROSETTA:LAP_CURRENT_CAL_16B_G1, ROSETTA:LAP_CURRENT_CAL_20B_G1, ROSETTA:LAP_CURRENT_CAL_16B_G0_05, or ROSETTA:LAP_CURRENT_CAL_20B_G0_05, all measured on ground and stored in the RPCLAPyymmdd_CALIB_MEAS.LBL file. Which factor is used depends on the ADC (16 or 20 bit) and gain (1 or 0.05) used. The comment on calibration factor change due to truncation of data stated above for voltage data (bias mode E) applies here as well.
- Bias voltage and bias current values are not routinely measured onboard. Their digital values are synthetically generated from knowledge of the commanded bias, whereafter they are converted to physical units (volts and amperes) using the calibration tables contained in the files RPCLAP030101_CALIB_VBIAS.TAB and RPCLAP030101_CALIB_IBIAS.TAB, determined on ground. While there is no routine measurement of the biases onboard, it is possible to measure the current resulting from a given voltage bias applied over a 5.1 Mohm resistor for occasional verification of the instrument integrity and consistency.

The CALIB directory also includes files with the instrument frequency response measured on ground. These are not used at present, but are included for reference as vital instrument information. See also Section 3.4.3.2.

2.6 Data Handling Process

This section is included for archival reference. It should not be of interest for a regular LAP science data user.

To create a LAP PDS archive the LAP PDS software starts from the LAP data packets delivered from ESA/ESOC via the DDS system. The DDS files are transferred from a common RPC DDS archive at IC using rsync software creating a local DDS archive at IRFU. We run the software as new data becomes available for each mission phase. There is a possibility to rerun from scratch building up the PDS archive completely from start or to run it in a appending mode that adds anything new to the archive. In the event that some data is not understood by the PDS software it will be dumped into a separate directory. This data can then be examined by the LAP GSE, together with extensive logs produced by the PDS software. This combination is a powerful diagnostic tool. The LAP PDS software is not completely automatic, some manual work before and after archive generation is required. This includes copying of a template archive before generation and after generation manually edit some info files and catalog files. When the data sets are generated they are verified and tested with the PSA Volume Verifier (PVV) before delivery to ESA.

2.7 Product Generation

This section is included for archival reference. It should typically not be of interest for a regular LAP science data user.

The EDITED dataset is generated first. A separate stand-alone program then analyzes any onboard calibrations done during the time covered by the archive and updates the calibration files accordingly. After this step, a CALIBRATED data set can be generated. Geometry files are added by a separate code using Spice to calculate geometry information at the start time of each data file in the EDITED and CALIBRATED archives.

Production of DERIVED data is TBD.

2.8 Data Quality Flag

The EDITED and CALIBRATED data sets just present the output of the instrument, and are as such of high quality. There is therefore no attempt to assign a detailed quality assessment of these data. The LBL files contain a placeholder quality indicator DATA_QUALITY_ID always set to 1. Further use of this flag is expected only for the DERIVED data set.

2.9 Overview of Data Products

This section describes the organization of the LAP data products. The descriptions of in-flight data products (Section 2.9.3), documentation (Section 2.9.4) and derived data products (Section 2.9.5) should be of interest to any user of the archived LAP data.

2.9.1 Instrument Calibrations

PDS label and table files containing transfer functions from the actually flying hardware unit are used to calibrate the LAP data. Ground calibration data as well as in-flight calibrations are used and included in the archive.

The following calibration products are included in the CALIB directory of the LAP archives:

In flight	***Product ID***
Measured current as function of set bias voltage	RPCLAPYYMMDD_CALIB_MEAS

On ground (pre flight)	***Product ID***
Current biases and measured laboratory values.	RPCLAPYYMMDD_CALIB_IBIAS
Voltage biases and measured laboratory values.	RPCLAPYYMMDD_CALIB_VBIAS
Fine bias voltage settings and measured laboratory values.	RPCLAPYYMMDD_CALIB_FINE
Transfer function probe 1 Density mode	RPCLAPYYMMDD_CALIB_FRQ_D_P1
Transfer function probe 2 Density mode	RPCLAPYYMMDD_CALIB_FRQ_D_P2

Transfer function probe 1 E-field mode	RPCLAPYYMMDD_CALIB_FRQ_E_P1
Transfer function probe 2 E-field mode	RPCLAPYYMMDD_CALIB_FRQ_E_P2

The transfer functions are currently not used in the production of calibrated or edited data sets, but are provided for reference. The other products are used in producing the calibrated data set. Derived data sets will then be produced from the calibrated sets. YYMMDD is the date from which the product is valid.

For RPCLAPYYMMDD_CALIB_MEAS, YYMMDD is again the date from which the product is valid with the addition that it is only valid until the date of another product of the same type with a later date.

2.9.2 In-flight data products

For EDITED and CALIBRATED data the LAP PDS software generates the data products in Tables 3, all of them stored as LBL and TAB files. The geometry data is further described in Table 2.9-2.

Each CALIBRATED data product has a counterpart in EDITED, but the opposite is not true, as HK and onboard calibration data is not included in the CALIBRATED sets. Note that the product IDs (following the file naming convention in Section 3.1.4) are in general not identical at the two archive levels. If one for some reason is interested in comparing the same data in EDITED and CALIBRATED, one thus must search for identical start times (and of course the same probe, ADC etc.). Note that all products above will have a unique product id, and also note that Table 2.9-1 only describes the “format” of the product id. For instance, when the date (YYMMDD) changes, so does the product id.

Data Products (EDITED and CALIBRATED)				
Data type	***Archive level***	***Columns***		***Product ID***
		Num-ber of col-umns	***Column data***	
Housekeeping	E	27	Parameters	RPCLAPYYMMDD_AAA_H
Time series or sweep	EC	1 1 1 1	UTC time OBT time Current bias or measured Voltage bias or measured	RPCLAPYYMMDD_AAAa_bcd1fgS RPCLAPYYMMDD_AAAa_bcd2fgS
Difference measurements E-field	EC	1 1 2 1	UTC time OBT time Current bias Measured voltage difference	RPCLAPYYMMDD_AAAa_bEd3fgS
Difference measurements Density mode	EC	1 1 1 2	UTC time OBT time measured current difference Voltage bias	RPCLAPYYMMDD_AAAa_bDd3fgS
Geometry	EC	23	UTC time 22 geometry parameters (see Table 2.9-2).	RPCLAPYYMMDD_GEOM

Table 2.9-1. LAP data products in the EDITED (E) and CALIBRATED (C) data sets.

Column	Name	Description
1	TIME_UTC	UTC time
2	SC_SUN_POS_X	Heliocentric position coordinates [km] in ecliptic J2000 coordinates.
3	SC_SUN_POS_Y	
4	SC_SUN_POS_Z	
5	SC_TGT_POS_X	Body-centred position coordinates [km] in ecliptic J2000 coordinates. The target body depends on which mission phase the archive covers. It is usually obvious (e.g. Earth for Earth swing-bys) but is also explicitly given in the geometry label file.
6	SC_TGT_POS_Y	
7	SC_TGT_POS_Z	
8	SC_TGT_VEL_X	S/c velocity coordinates wrt target body [km/s] in ecliptic J2000 coordinates.
9	SC_TGT_VEL_Y	
10	SC_TGT_VEL_Z	
11	ALTITUDE	Distance to surface of target body [km]. Set to zero if undefined.
12	LATITUDE	Position coordinates on target body [degrees]. Set to zero if undefined.
13	LONGITUDE	
14	SC_TGT_SPEED	Speed [km/s] relative to target, i.e. the magnitude of the vector of columns 8-10.
15	SC_X_ECLIPJ2000FR_X	Matrix elements for transformation between spacecraft and ecliptic J2000 coordinates. SC_A_ECLIPJ2000FR_B denotes the scalar product of the s/c A (A =X,Y,Z) axis unit vector with the ecliptic J2000 B (B=X,Y,Z) axis unit vector.
16	SC_X_ECLIPJ2000FR_Y	
17	SC_X_ECLIPJ2000FR_Z	
18	SC_Y_ECLIPJ2000FR_X	
19	SC_Y_ECLIPJ2000FR_Y	
20	SC_Y_ECLIPJ2000FR_Z	
21	SC_Z_ECLIPJ2000FR_X	
22	SC_Z_ECLIPJ2000FR_Y	
23	SC_Z_ECLIPJ2000FR_Z	

Table 2.9-2. LAP geometry file contents.

2.9.3 Software

There is no software included with the archive.

2.9.4 Documentation

Relevant documentation is archived in the DOCUMENT directory of each data set (see detailed description in Section 3.4.3.5).

2.9.5 Derived and other Data Products

There is as yet no DERIVED level data included in the archive.

2.9.6 Ancillary Data Usage

We use time correlation packets to convert into UTC as described in RO-ESC-IF-5003 issue B6 page 106, sect 18.1.2.1.

Geometry files are prepared using SPICE, whose kernels are based on information provided by ESOC.

3 Archive Format and Content

This section should be of interest as a reference for any user directly accessing the LAP archive.

3.1 Format and Conventions

3.1.1 Deliveries and Archive Volume Format

We use conventions defined as in the RO-EST-PL-5011_2_Rosetta_Archive_GVT_Plan, and conventions defined by the RPC team. For instance, our data directory naming conventions as in section 3.1.3 are RPC consistent. One Data Set corresponds to one Volume.

3.1.2 Data Set ID Formation

Example:

RO-E-RPCLAP-2-CVP-Description-V1.0

E = TARGET_ID
RO = INSTRUMENT_HOST_ID
RPCLAP = INSTRUMENT_ID
2 = Data processing level numbers
CVP = Mission phase abbreviation

Description can be CALIB, EDITED or DERIVED thus essentially displaying in words the same information as the processing level.

One data set will be produced for each processing level

Edited data = 2, Calibrated data = 3 and Derived data = 5.

Within each data set TARGET_NAME and TARGET_TYPE is used to identify the current target.

3.1.3 Data Directory Naming Convention

Data files are stored in one directory per day, organized as shown in Figure 3.

```
DATA_SET_ROOT
|
_________________________...
|       |           |
DATA    DOCUMENT    ...
|
_________________________
|         |             |
EDITED    CALIBRATED    DERIVED
|
___________________________...
|       |       |       |
2004    2005    2006    ....
|
__________________________...
|     |     |     |     |
JAN   FEB   MAR   APR   ...
|
__________________________...
|     |     |     |     |
D01   D02   D03   D04   ...
```

Figure 3. Data directory structure.

3.1.4 *Filenaming Convention*

This is the LAP filenaming convention for files in the DATA directory.

Each file in the DATA directory starts with RPCLAPYYMMDD_, where YYMMDD is the date. After the underscore follows either (1) the string GEOM, in which case the file contains geometry (position, velocity, pointing) for LAP at the times where measurements were taken, or (2) a string identifying what kind of data the file contains. Two lengths of the file name are possible, the shorter being used for housekeeping data and thus only present in the EDITED archive. The file names are analyzed as follows:

FILENAME: RPCLAPYYMMDD_AAA_H.ext
FILENAME: RPCLAPYYMMDD_AAAa_bcdefghxx.ext

AAA = Alphanumeric counter resetting at zero every new day.
H = non-changing identifier marking housekeeping files (EDITED only)
a = Type, T=20 bit ADC, S=16 bit ADC
b = Format, R=Edited Raw C=Calibrated D=Derived
c = Instrument mode
E = E-Field (Voltage measurements and current bias)

D = Density (Current measurements and voltage bias)
d = Bias mode, S=Sweeping B=Constant Bias
e = Sensor, 1 = Probe 1, 2 = Probe 2, or 3 = Derived from 1 and 2
f = Analog filters applied to the data sampled by the 16-bit ADCs, 8 = 8 kHz 4 = 4 kHz. Note that this number 4 or 8 will be present also in the file name of data sampled with the 20-bit ADCs, which always use the analog filter cutting at 20 Hz. For more on filters, see Section 2.2 above.
g = Telemetry rate, M = Minimum N = Normal B = Burst
h = For science data this character is always an S.
x = For contingency, not present if not needed.

The file extension ext is either LBL or TAB. The alphanumeric counter AAA runs through the numbers 0 to 9 and then the letters A to Z, e.g. from 000 to ZZZ.

Note that the alphanumeric counter is independently generated for the EDITED and CALIBRATED archives. This means that there is no simple correspondence between file names in the two archives containing the same data.

3.2 Standards Used in Data Product Generation

3.2.1 PDS Standards

LAP complies to PDS version 3, and we use version 3.6 of the PDS standard reference.

3.2.2 Time Standards

Time references in the LAP PDS archive are UTC and spacecraft clock. UTC time is displayed in the PDS CCYY-MM-DDThh:mm:ss.sss format. UTC conversion is done using by RSOC issued time calibration packets.

3.2.3 Reference Systems

The geometry files provide positions and velocities related to the ECLIPJ2000 axes directions, centered in the sun or in the target body. The spacecraft pointing is specified by the transformation matrix between ECLIPJ2000 and the s/c coordinate axes, which are briefly described in Figure 1.

3.3 Data Validation

3.3.1 EDITED

Data are automatically scanned for internal consistency when processed into edited format.

3.3.2 CALIBRATED

Data are visually scanned for noting obvious problems. Comparative investigations may be undertaken. Particularly noteworthy features are documented in the DATASET.CAT file in the CATALOG directory of each archive.

3.3.3 DERIVED

There are currently no derived data in the LAP archive.

3.4 Content

3.4.1 Volume Set

According to Section 19.4 in AD1.

3.4.2 Data Set

Our naming convention for the data set will follow the same principles as the DATA_SET_ID.

Example:

DATA_SET_NAME="ROSETTA-ORBITER <TARGET> RPCLAP <LEVELNUM> <MPHASE> <LEVELWORD> V<X>"

The variable fields here are:

<TARGET> = Target name, i.e. LUTETIA.

<LEVELNUM> = Data processing level numbers (e.g. 2 for EDITED).

<MPHASE> = Mission phase abbreviation, example AST1.

<LEVELWORD> = Data processing level in text (e.g. CALIB for calibrated or EDITED for edited data).

<X> = Archive version number, e.g. 2.0.

One data set will be used for each processing level and mission phase. The data set name fits in the full length thus 60 characters.

3.4.3 Directories

3.4.3.1 Root Directory

Contains:

AAREADME.TXT
CALIB
CATALOG
DATA
DOCUMENT
INDEX
VOLDESC.CAT

See section 4.1 for more detail.

3.4.3.2 Calibration Directory

The directory CALIB contains calibration files, described in Section 2.9.1. This includes in-flight calibration files, so this directory grows with time.

Example listing of CALIB directory:

File name	**Comment**
CALINFO.TXT	Information on directory contents
RPCLAP030101_CALIB_FINE.LBL RPCLAP030101_CALIB_FINE.TAB	Ground calibration of fine sweep voltage bias.
RPCLAP030101_CALIB_FRQ_D_P1.LBL RPCLAP030101_CALIB_FRQ_D_P1.TXT	Ground calibration, frequency response for P1 in voltage bias mode.
RPCLAP030101_CALIB_FRQ_D_P2.LBL RPCLAP030101_CALIB_FRQ_D_P2.TXT	Ground calibration, frequency response for P2 in voltage bias mode.

RPCLAP030101_CALIB_FRQ_E_P1.LBL RPCLAP030101_CALIB_FRQ_E_P1.TXT	Ground calibration, frequency response for P1 in current bias mode.
RPCLAP030101_CALIB_FRQ_E_P2.LBL RPCLAP030101_CALIB_FRQ_E_P2.TXT	Ground calibration, frequency response for P2 in current bias mode.
RPCLAP030101_CALIB_IBIAS.LBL RPCLAP030101_CALIB_IBIAS.TAB	Ground calibration of current bias.
RPCLAP030101_CALIB_MEAS.LBL RPCLAP030101_CALIB_MEAS.TAB	Ground calibration of voltage bias mode data, identical in format to subsequent in-flight calibrations.
RPCLAP030101_CALIB_VBIAS.LBL RPCLAP030101_CALIB_VBIAS.TAB	Ground calibration of voltage bias.
RPCLAP060704_CALIB_MEAS.LBL RPCLAP060704_CALIB_MEAS.TAB RPCLAP070223_CALIB_MEAS.LBL RPCLAP070223_CALIB_MEAS.TAB RPCLAP080713_CALIB_MEAS.LBL RPCLAP080713_CALIB_MEAS.TAB RPCLAP080719_CALIB_MEAS.LBL RPCLAP080719_CALIB_MEAS.TAB RPCLAP080726_CALIB_MEAS.LBL RPCLAP080726_CALIB_MEAS.TAB RPCLAP080901_CALIB_MEAS.LBL RPCLAP080901_CALIB_MEAS.TAB RPCLAP100707_CALIB_MEAS.LBL RPCLAP100707_CALIB_MEAS.TAB RPCLAP100712_CALIB_MEAS.LBL RPCLAP100712_CALIB_MEAS.TAB	In-flight calibration of voltage bias mode data. The TAB file contains measured offsets for P1 and P2 (voltage bias mode). Static calibration factors derived from ground calibrations are placed in the LBL as special keywords.

3.4.3.3 Catalog Directory

Contents:

File name	**Description**
CATINFO.TXT	This file contains a list of all catalog files located in the CATALOG directory, with brief descriptions (as this table).
DATASET.CAT	Description of the data in the present Data Set, including caveats.
ROSETTA_INSTHOST.CAT	ROSETTA spacecraft information. File provided by ESA.
ROSETTA_MSN.CAT	ROSETTA Mission information. File provided by ESA.

RPCLAP_INST.CAT	LAP instrument description.
RPCLAP_PERS.CAT	LAP key people with contact details.
RPCLAP_REF.CAT	Catalog of relevant publications. File provided by ESA.
RPCLAP_SOFTWARE.CAT	Software catalog file (only containing the information that there is no s/w).

3.4.3.4 Index Directory

Contents:

INDXINFO.TXT
INDEX.LBL
INDEX.TAB

This directory contains the index files generated by the ESA S/W PVV.

3.4.3.5 Document Directory

This directory contains relevant LAP documentation as described below.

The FLIGHT REPORTS subdirectory contains LAP operations reports from the relevant mission phase (and may contain reports for other mission phases as well). These reports summarize the commanding, data taking, anomalies and outcomes of each operation. Note that one mission phase may include several operations, documented in separate reports (for example, EAR2 includes not only the operations around the 2nd Earth swing-by, but also a payload checkout activity).

LAP PDS Document Directory Contents	
Document	**Description**
DOCINFO.TXT	Describes directory contents
ERIKSSON2007A.LBL ERIKSSON2007A.PDF	Instrument description, label file and document as PDF: A. I. Eriksson, R. Boström, R. Gill, L. Åhlén, S.-E. Jansson, J.-E. Wahlund, M. André, A. Mälkki, J. A. Holtet, B. Lybekk, A. Pedersen, L. G. Blomberg and the LAP team, RPC-LAP: The Rosetta Langmuir probe instrument, *Space Sci. Rev.*, 128, 729-744, 2007, doi:10.1007/s11214-006-9003-3
ERIKSSON2008A.LBL	Instrument description, label file and

ERIKSSON2008A.PDF	document as PDF: A. I. Eriksson, R. Gill, J.-E. Wahlund, M. André, A. Mälkki, B. Lybekk, A. Pedersen, J. A. Holtet, L. G. Blomberg and N. J. T. Edberg, RPC-LAP: The Langmuir probe instrument of the Rosetta Plasma Consortium, in *Rosetta: ESA's mission to the origin of the solar system*, eds. R. Schulz, C. Alexander, H. Boehnhardt and K.-H. Glassmeier, pp. 435-447, Springer, 2009, ISBN: 978-0-387-77517-3.
RO-IRFU-LAP-EAICD-ver.LBL RO-IRFU-LAP-EAICD-ver.DOC RO-IRFU-LAP-EAICD-ver.PDF	EAICD (this document) as Word document and PDF, with label file (ver = version number)
RO-IRFU-LAPMAC.LBL RO-IRFU-LAPMAC-yymmdd.PDF	Description of the LAP macros refered to by INSTRUMENT_MODE_ID, in PDF format, with label file. This replaces the outdated LAPMPF document present in previous releases. The date yymmdd is a version identifier.

3.4.3.6 Data Directory

See Section 3.1.3 for overall structure, Section 2.7 for data products in the data directory and Section 4.3.2 for detailed examples of data product design.

4 Detailed Interface Specifications

4.1 Structure and Organization Overview

The contents of the directories in an EDITED or CALIBRATED Data Set are discussed in Section 3. The general organization of the archive can be seen from the following example for the dataset of CALIBRATED data from the Lutetia flyby:

```
DATASET_ROOT
  |-CALIB
  |-CATALOG
  |-DATA
  |---CALIBRATED
  |-----2010
  |-------JUL
  |---------D07
  |---------D08
  |---------D09
  |---------D10
  |---------D11
  |---------D12
  |---------D13
  |-DOCUMENT
  |---FLIGHT_REPORTS
  |-INDEX
```

For the contents of these directories, please see Section 3.4.

4.2 Data Sets, Definition and Content

Please see Section 2.4.

4.3 Data Product Design

4.3.1 General Issues

4.3.1.1 File Characteristics Data Elements

Data are stored in ASCII files with the .TAB extension. The associated label file, describing the data file in detail, has the same name but with extension .LBL.

4.3.1.2 Data Object Pointers Identification Data Elements

The only pointer which is used is the pointer from the *.LBL file to the *.TAB file.

4.3.1.3 Instrument and Detector Descriptive Data Elements

Please see Sections 2.2 and 2.3.

4.3.1.4 Data Object Definition

All data are stored in *.TAB files. Their structure is defined in the OBJECT Table definition within the *.LBL Files. Each data definition block has a DESCRIPTION which explains the meaning of the assigned data column exactly.

4.3.1.5 Mission Specific Keywords

We use some specific keywords for the LAP instrument in the label files, as illustrated by the following examples:

ROSETTA:LAP_TM_RATE = “BURST”
ROSETTA:LAP_P1_SWEEP_START_BIAS = "0x00c0"
ROSETTA:LAP_CURRENT_CAL_16B_G0_05 = "6.10360876E-9"

The instrument specific keywords used are tabulated in Table 4.3-1 below. Most of them regard instrument internal settings and are mostly present for completeness: see the instrument descriptions in the DOCUMENTS archive for understanding of their meaning. Note that Hex word means values from 0x0000 to 0xffff, though they are stored as character strings. **Note that all values in** Table 4.3-1 **are DATA_TYPE = CHARACTER and are enclosed in quotes in the label file.** The valid string values are separated by a : in Table 4.3-1, thus the : is not part of the values themselves. Also note that the maximum character string length do not include counting quotes, null terminators, line feeds or carriage returns.

Rosetta LAP specific label keywords	***Valid values separated by :***	***Maximum character string length***	***Description***
LAP_TM_RATE	NONE:MINIMUM:NORMAL:BURST	7	Telemetry rate
LAP_FEEDBACK_P1	DENSITY:E-FIELD	7	E-Field or Density feedback relay probe 1
LAP_FEEDBACK_P2	DENSITY:E-FIELD	7	E-Field or Density feedback relay probe 2

LAP_P1_ADC20	DENSITY:E-FIELD	7	20 Bit ADC probe 1 E-Field or Density mode
LAP_P2_ADC20	DENSITY:E-FIELD	7	20 Bit ADC probe 2 E-Field or Density mode
LAP_P1_ADC16	DENSITY:E-FIELD	7	16 Bit ADC probe 1 E-Field or Density mode
LAP_P2_ADC16	DENSITY:E-FIELD	7	16 Bit ADC probe 2 E-Field or Density mode
LAP_P1_RANGE_DENS _BIAS	+5:+32	3	Density bias range probe 1
LAP_P2_RANGE_DENS _BIAS	+5:+32	3	Density bias range probe 2
LAP_P1_STRATEGY_O R_RANGE	BIAS:FLOAT:GAIN 0.05:GAIN 1	9	E-Field strategy or density gain probe 1
LAP_P1_BIAS_MODE	E-FIELD:DENSITY	7	Probe 1 bias mode
LAP_P1_RX_OR_TX	ANALOG INPUT:TRANSMITTER	12	Connected to transmitter or not
LAP_P2_STRATEGY_O R_RANGE	BIAS:FLOAT:GAIN 0.05:GAIN 1	9	E-Field strategy or density gain probe 2
LAP_P2_BIAS_MODE	E-FIELD:DENSITY	7	Probe 1 bias mode
LAP_P2_RX_OR_TX	ANALOG INPUT:TRANSMITTER	12	Connected to transmitter or not
LAP_BOOTSTRAP	ON:OFF	3	Bootstrapping on or off
LAP_P1_ADC16_FILTE R	4 KHz:8 KHz	5	Analog filter used
LAP_P2_ADC16_FILTE R	4 KHz:8 KHz	5	Analog filter used
LAP_P1_ADC16_UNI_B I_POLAR	UNIPOLAR:BIPOLAR	8	16 Bit ADC output data type probe 1
LAP_P2_ADC16_UNI_B I_POLAR	UNIPOLAR:BIPOLAR	8	16 Bit ADC output data type probe 2
LAP_P1_SWEEP_FOR MAT, LAP_P2_SWEEP_FOR MAT	UP:DOWN:DOWN UP:UP DOWN	7	Sweeping direction on probe 1 and 2 respectively
LAP_P1_SWEEP_RES OLUTION, LAP_P2_SWEEP_RES OLUTION	COARSE:FINE	6	Sweeping resolution on probe 1 and 2 respectively
LAP_SWEEPING_P1	NO:YES	3	A sweep or time series

LAP_SWEEPING_P2	NO:YES	3	A sweep or time series
LAP_P2_FINE_SWEEP_OFFSET	*Hex word string*	*6*	Probe 2 fine sweep bias offset
LAP_P1_FINE_SWEEP_OFFSET	*Hex word string*	*6*	Probe 1 fine sweep bias offset
LAP_P1_SWEEP_PLATEAU_DURATION, LAP_P2_SWEEP_PLATEAU_DURATION	*Hex word string*	*6*	Samples on a plateau on probe 1 and 2 respectively
LAP_P1_SWEEP_STEPS, LAP_P2_SWEEP_STEPS	*Hex word string*	*6*	Number of bias steps in sweep on probe 1 and 2 respectively
LAP_P1_SWEEP_STEP_HEIGHT, LAP_P2_SWEEP_STEP_HEIGHT	*Hex word string*	*6*	Height of a bias step on probe 1 and 2 respectively
LAP_P1_INITIAL_SWEEP_SMPLS, LAP_P2_INITIAL_SWEEP_SMPLS	*Hex word string*	*6*	Initial samples before a sweep starts on probe 1 and 2 respectively
LAP_P1_SWEEP_START_BIAS, LAP_P2_SWEEP_START_BIAS	*Hex word string*	*6*	Sweep start bias on probe 1 and 2 respectively
LAP_VBIAS2	*Hex word string*	*6*	Fix voltage bias sensor 2
LAP_VBIAS1	*Hex word string*	*6*	Fix voltage bias sensor 1
LAP_P1_DENSITY_FIX_DURATION	*Hex word string*	*6*	Duration in samples of fix density bias data sensor 1
LAP_P2_DENSITY_FIX_DURATION	*Hex word string*	*6*	Duration in samples of fix density bias data sensor 2
LAP_IBIAS2	*Hex word string*	*6*	Fix current bias sensor 1
LAP_IBIAS1	*Hex word string*	*6*	Fix current bias sensor 2
LAP_P1_E-FIELD_FIX_DURATION	*Hex word string*	*6*	Duration in samples of fix E-field bias data sensor 1
LAP_P2_E-FIELD_FIX_DURATION	*Hex word string*	*6*	Duration in samples of fix E-field bias data

			sensor 2
LAP_LDL_ACTIVE	ACTIVE SYNC 0:ACTIVE SYNC 1	13	Determines the sync period that is considered to be the active one.
LAP_LDL_MODE	OFF:MIXED START SYNC 0:NORMAL:MIXED START SYNC 1	16	LDL mode mostly OFF or NORMAL LDL ignore mixed
LAP_P2_ADC16_DOWNSAMPLE	*Hex word string*	*6*	Data sensor 2 downsampled n times
LAP_P1_ADC16_DOWNSAMPLE	*Hex word string*	*6*	Data sensor 1 downsampled n times
LAP_P2_ADC16_DIG_FILT_CUTOFF	4688 Hz:2344 Hz:1172 Hz:586 Hz	7	Digital filter used
LAP_P1_ADC16_DIG_FILT_CUTOFF	4688 Hz:2344 Hz:1172 Hz:586 Hz	7	Digital filter used
LAP_P2_ADC16_DIG_FILT_STATUS	DISABLED:ENABLED	8	Digital filter on or off
LAP_P1_ADC16_DIG_FILT_STATUS	DISABLED:ENABLED	8	Digital filter on or off
LAP_P1P2_ADC20_DOWNSAMPLE	*Hex word string*	*6*	Downsampling n times on 20 Bit ADC data sensor 1 and 2
LAP_P1P2_ADC20_RECORD_LENGTH	*Hex word string*	*6*	Length of 20bit data record
LAP_P1P2_ADC20_MA_LENGTH	*Hex word string*	*6*	Length of moving average used
LAP_P1P2_ADC20_STATUS	EMPTY:P2T:P1T:P1T & P2T:P2F:P1T P2F:P1F:P1F P2T:P1F & P2F	9	Status: P1 = Sensor 1 P2 = Sensor 2 T = Truncated to16 bit F = Full 20 bit
LAP_TRANSMITTER_FREQUENCY	*Hex word string*	*6*	Frequency of transmitter square wave in Hz. Not used up to now.
LAP_TRANSMITTER_AMPLITUDE	LTRO1:MTRO2:HTRO3:LTR1:MTR2:HTR3	5	Amplitude of transmitter signal full description. Not used up to now.
LAP_TRANSMITTER_STATUS	DISABLED:ENABLED	8	Transmitter on or off
LAP_VOLTAGE_CAL_1	*Ascii real string*	14	Convert TM to [V]

6B			16 bit ADCs
LAP_VOLTAGE_CAL_20B	*Ascii real string*	14	Convert TM to [V] 20 Bit ADCs
LAP_CURRENT_CAL_16B_G1	*Ascii real string*	14	Convert TM to [A] 16 Bit ADCs gain 1
LAP_CURRENT_CAL_20B_G1	*Ascii real string*	14	Convert TM to [A] 20 Bit ADCs gain 1
LAP_CURRENT_CAL_16B_G0_05	*Ascii real string*	14	Convert TM to [A] 16 Bit ADCs gain 0.05
LAP_CURRENT_CAL_20B_G0_05	*Ascii real string*	14	Convert TM to [A] 20 Bit ADCs gain 0.05

Table 4.3-1. LAP instrument specific keywords.

We have also defined a set of instrument modes using the already existing keyword INSTRUMENT_MODE_ID and INSTRUMENT_MODE_DESC. Instrument modes are identified by the onboard macro producing the data (Section 2.3). The macro ID (MCID) is a hexadecimal number 0x0100 to 0x0A07 where the last digit cannot be higher than 7. The middle digit represents the version number of the macro, starting from 0.

4.3.2 Data Product Design

LAP data products are described in Section 2.9. The file naming convention, identifying the data product, is given in Section 3.1.4

All science data products in the EDITED and CALIBRATED data sets have the same structure: ASCII tables giving time (in UT), spacecraft time, probe current value (bias or measured), and probe voltage (measured or bias) for one of the probes. The sole exception is the differential measurements sometimes taken between the probes: in these files, the bias of both probes are given, adding an extra column.

We here provide the detailed design of the science data products (in the order of Table -2.91, Section 2.9) by displaying example label files for each of them. The products for the EDITED and CALIBRATED data sets are very similar: just the units differ, and we take some products from each data set.

4.3.2.1 Housekeeping Data Product Design

```
PDS_VERSION_ID = PDS3
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 208
FILE_RECORDS = 16
```

FILE_NAME = "RPCLAP100707_01J_H.LBL"
^TABLE = "RPCLAP100707_01J_H.TAB"
DATA_SET_ID = "RO-A-RPCLAP-2-AST2-EDITED-V1.0"
DATA_SET_NAME = "ROSETTA-ORBITER LUTETIA RPCLAP 2 AST2 EDITED V1.0"
DATA_QUALITY_ID = 1
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME = "LUTETIA FLY-BY"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE PHYSICS, UPPSALA"
PRODUCER_ID = RG
PRODUCER_FULL_NAME = "REINE GILL"
LABEL_REVISION_NOTE = "2012-01-25T13:36:39, Liza Dackborn IRFU, first release"
PRODUCT_ID = RPCLAP100707_01J_H
PRODUCT_TYPE = "EDR"
PRODUCT_CREATION_TIME = 2012-01-25T13:36:39
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0503
INSTRUMENT_MODE_DESC = "N/A"
TARGET_NAME = "21 LUTETIA"
TARGET_TYPE = "ASTEROID"
PROCESSING_LEVEL_ID = N
START_TIME = 2010-07-07T23:51:29.490
STOP_TIME = 2010-07-07T23:59:29.490
SPACECRAFT_CLOCK_START_COUNT = "1/0237167442.42944"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0237167922.42944"
DESCRIPTION = "LAP HK Data, Each line is a separate HK packet sent every 32s"
OBJECT = TABLE
INTERCHANGE_FORMAT = ASCII
ROWS = 16
COLUMNS = 29
ROW_BYTES = 208
DESCRIPTION = "LAP HK Data table."
OBJECT = COLUMN
NAME = UTC_TIME
DATA_TYPE = TIME
START_BYTE = 1
BYTES = 26
DESCRIPTION = "UTC TIME"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = OBT_TIME
START_BYTE = 28
BYTES = 16
DATA_TYPE = ASCII_REAL
UNIT = SECONDS
FORMAT = "F16.6"
DESCRIPTION = "SPACE CRAFT ONBOARD TIME SSSSSSSSS.FFFFFF (TRUE DECIMALPOINT)"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = PMAC

DATA_TYPE = ASCII_INTEGER
START_BYTE = 45
BYTES = 1
DESCRIPTION = "CURRENTLY PROGRAMMING MACRO"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = EMAC
DATA_TYPE = ASCII_INTEGER
START_BYTE = 47
BYTES = 1
DESCRIPTION = "CURRENTLY EXECUTING MACRO"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = WATCHD
DATA_TYPE = CHARACTER
START_BYTE = 49
BYTES = 8
DESCRIPTION = "WATCHDOG STATUS"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = PROMEN
DATA_TYPE = CHARACTER
START_BYTE = 58
BYTES = 8
DESCRIPTION = "PROM AND FLASH MEMORY STATUS"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = OSC
DATA_TYPE = ASCII_INTEGER
START_BYTE = 67
BYTES = 1
DESCRIPTION = "USING OSCILLATOR 0 or 1"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = LDLMODE
DATA_TYPE = CHARACTER
START_BYTE = 69
BYTES = 7
DESCRIPTION = "LDL MODE AND PHASE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = TEMP
DATA_TYPE = CHARACTER
START_BYTE = 77
BYTES = 8
DESCRIPTION = "TEMPERATURE SENS STATUS, VALID TEMPERATURE IF IN E-FIELD MODE"

END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CDRIV2
DATA_TYPE = CHARACTER
START_BYTE = 86
BYTES = 4
DESCRIPTION = "RANGE PROBE 2 BIAS "
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CDRIV1

```
DATA_TYPE = CHARACTER
START_BYTE = 91
BYTES = 4
DESCRIPTION = "RANGE PROBE 1 BIAS "
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = E2D216
DATA_TYPE = CHARACTER
START_BYTE = 96
BYTES = 7
DESCRIPTION = "ADC 16 PROBE 2 MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = E1D116
DATA_TYPE = CHARACTER
START_BYTE = 104
BYTES = 7
DESCRIPTION = "ADC 16 PROBE 1 MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = E2D120
DATA_TYPE = CHARACTER
START_BYTE = 112
BYTES = 7
DESCRIPTION = "ADC 20 PROBE 2 MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = E1D120
DATA_TYPE = CHARACTER
START_BYTE = 120
BYTES = 7
DESCRIPTION = "ADC 20 PROBE 1 MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CNTRE2
DATA_TYPE = CHARACTER
START_BYTE = 128
BYTES = 7
DESCRIPTION = "P2 FEEDBACK"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CNTRE1
DATA_TYPE = CHARACTER
START_BYTE = 136
BYTES = 7
DESCRIPTION = "P1 FEEDBACK"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = MIPLAP
DATA_TYPE = CHARACTER
START_BYTE = 144
BYTES = 3
DESCRIPTION = "INSTRUMENT USING PROBE 2"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = BTSTRP
DATA_TYPE = CHARACTER
START_BYTE = 148
```

```
BYTES = 8
DESCRIPTION = "INTERNAL BOOTSTRAP STATUS"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F2122
DATA_TYPE = CHARACTER
START_BYTE = 157
BYTES = 2
DESCRIPTION = "P2 CONNECTED TO, RX=ANALOG INPUT TX=TRANSMITTER"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F22ED
DATA_TYPE = CHARACTER
START_BYTE = 160
BYTES = 7
DESCRIPTION = "P2 BIAS MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F22EDDEDC
DATA_TYPE = CHARACTER
START_BYTE = 168
BYTES = 5
DESCRIPTION = "P2 DENSITY RANGE OR E-FIELD STRATEGY"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F1121
DATA_TYPE = CHARACTER
START_BYTE = 174
BYTES = 2
DESCRIPTION = "P1 CONNECTED TO, RX=ANALOG INPUT TX=TRANSMITTER"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F11ED
DATA_TYPE = CHARACTER
START_BYTE = 177
BYTES = 7
DESCRIPTION = "P1 BIAS MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F11EDDEDC
DATA_TYPE = CHARACTER
START_BYTE = 185
BYTES = 5
DESCRIPTION = "P1 DENSITY RANGE OR E-FIELD STRATEGY"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CALIBRATIONA
DATA_TYPE = ASCII_INTEGER
START_BYTE = 191
BYTES = 3
DESCRIPTION = "FLASH CHECKSUM AT START, THEN FREE FOR OTHER USES"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CALIBRATIONB
DATA_TYPE = ASCII_INTEGER
START_BYTE = 195
BYTES = 3
DESCRIPTION = "FLASH CHECKSUM AT START, THEN FREE FOR OTHER USES"
```

```
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = TMP12
DATA_TYPE = ASCII_INTEGER
START_BYTE = 199
BYTES = 4
DESCRIPTION = "UNCALIBRATED TEMP, VALID IF TEMP IS ENABLED AND E-
FIELD MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = SWVERSION
DATA_TYPE = ASCII_INTEGER
START_BYTE = 205
BYTES = 2
DESCRIPTION = "SOFTWARE VERSION"
END_OBJECT = COLUMN
END_OBJECT = TABLE
END
```

4.3.2.2 Time Series Data Product Design

```
PDS_VERSION_ID = PDS3
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 75
FILE_RECORDS = 28
FILE_NAME = "RPCLAP100707_0AYT_CEB18NS.LBL"
^TABLE = "RPCLAP100707_0AYT_CEB18NS.TAB"
DATA_SET_ID = "RO-A-RPCLAP-3-AST2-CALIB-V1.0"
DATA_SET_NAME = "ROSETTA-ORBITER LUTETIA RPCLAP 3 AST2 CALIB V1.0"
DATA_QUALITY_ID = 1
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME = "LUTETIA FLY-BY"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE PHYSICS,
UPPSALA"
PRODUCER_ID = RG
PRODUCER_FULL_NAME = "REINE GILL"
LABEL_REVISION_NOTE = "2012-01-13T12:34:54, Liza Dackborn IRFU,
first release"
PRODUCT_ID = "RPCLAP100707_0AYT_CEB18NS"
PRODUCT_TYPE = "RDR"
PRODUCT_CREATION_TIME = 2012-01-13T12:34:54
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0503
INSTRUMENT_MODE_DESC = "EE Cont. 20 bit down 64, Every 160s 16 Bit
P1"
TARGET_NAME = "21 LUTETIA"
TARGET_TYPE = "ASTEROID"
PROCESSING_LEVEL_ID = 3
START_TIME = 2010-07-07T23:59:29.490
STOP_TIME = 2010-07-07T23:59:58.290
SPACECRAFT_CLOCK_START_COUNT = "1/0237167922.42944"
```

```
SPACECRAFT_CLOCK_STOP_COUNT = "1/0237167951.29837"
DESCRIPTION = "E_P1P2INTRL_TRNC_20BIT_RAW_BIP"
ROSETTA:LAP_TM_RATE = "NORMAL"
ROSETTA:LAP_BOOTSTRAP = "ON"
ROSETTA:LAP_FEEDBACK_P2 = "E-FIELD"
ROSETTA:LAP_P2_ADC20 = "E-FIELD"
ROSETTA:LAP_P2_ADC16 = "E-FIELD"
ROSETTA:LAP_P2_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P2_STRATEGY_OR_RANGE = "BIAS"
ROSETTA:LAP_P2_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P2_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_IBIAS2 = "0x007d"
ROSETTA:LAP_P2_BIAS_MODE = "E-FIELD"
ROSETTA:LAP_FEEDBACK_P1 = "E-FIELD"
ROSETTA:LAP_P1_ADC20 = "E-FIELD"
ROSETTA:LAP_P1_ADC16 = "E-FIELD"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "BIAS"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_IBIAS1 = "0x008e"
ROSETTA:LAP_P1_BIAS_MODE = "E-FIELD"
ROSETTA:LAP_P1P2_ADC20_STATUS = "P1T & P2T"
ROSETTA:LAP_P1P2_ADC20_MA_LENGTH = "0x0040"
ROSETTA:LAP_P1P2_ADC20_DOWNSAMPLE = "0x0040"
OBJECT     = TABLE
INTERCHANGE_FORMAT = ASCII
ROWS               = 28
COLUMNS            = 4
ROW_BYTES          = 75
DESCRIPTION        = "E_P1P2INTRL_TRNC_20BIT_RAW_BIP"
OBJECT     = COLUMN
NAME        = UTC_TIME
DATA_TYPE   = TIME
START_BYTE  = 1
BYTES       = 26
DESCRIPTION = "UTC TIME"
END_OBJECT = COLUMN
OBJECT     = COLUMN
NAME        = OBT_TIME
START_BYTE  = 28
BYTES       = 16
DATA_TYPE   = ASCII_REAL
UNIT        = SECONDS
FORMAT      = "F16.6"
DESCRIPTION = "SPACE CRAFT ONBOARD TIME SSSSSSSSS.FFFFFF (TRUE
DECIMALPOINT)"
END_OBJECT = COLUMN
OBJECT     = COLUMN
NAME        = P1_CURRENT
DATA_TYPE   = ASCII_REAL
START_BYTE  = 45
BYTES       = 14
UNIT        = AMPERE
FORMAT      = "E14.7"
DESCRIPTION = "CALIBRATED CURRENT BIAS"
END_OBJECT = COLUMN
OBJECT     = COLUMN
```

```
NAME        = P1_VOLTAGE
DATA_TYPE   = ASCII_REAL
START_BYTE  = 60
BYTES       = 14
UNIT        = VOLT
FORMAT      = "E14.7"
DESCRIPTION = "MEASURED CALIBRATED VOLTAGE"
END_OBJECT = COLUMN
END_OBJECT = TABLE
END
```

4.3.2.3 Sweep Data Product Design

```
PDS_VERSION_ID = PDS3
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 59
FILE_RECORDS = 200
FILE_NAME = "RPCLAP100707_05HS_RDS18NS.LBL"
^TABLE = "RPCLAP100707_05HS_RDS18NS.TAB"
DATA_SET_ID = "RO-A-RPCLAP-2-AST2-EDITED-V1.0"
DATA_SET_NAME = "ROSETTA-ORBITER LUTETIA RPCLAP 2 AST2 EDITED V1.0"
DATA_QUALITY_ID = 1
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME = "LUTETIA FLY-BY"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE PHYSICS,
UPPSALA"
PRODUCER_ID = RG
PRODUCER_FULL_NAME = "REINE GILL"
LABEL_REVISION_NOTE = "2012-01-25T13:36:39, Liza Dackborn IRFU,
first release"
PRODUCT_ID = "RPCLAP100707_05HS_RDS18NS"
PRODUCT_TYPE = "EDR"
PRODUCT_CREATION_TIME = 2012-01-25T13:36:39
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0600
INSTRUMENT_MODE_DESC = "As MCID0x212 but with 20 V bias and 8KHz
filters"
TARGET_NAME = "21 LUTETIA"
TARGET_TYPE = "ASTEROID"
PROCESSING_LEVEL_ID = 2
START_TIME = 2010-07-07T20:20:49.488
STOP_TIME = 2010-07-07T20:20:50.873
SPACECRAFT_CLOCK_START_COUNT = "1/0237154802.42944"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0237154804.2684"
DESCRIPTION = "D_SWEEP_P1_RAW_16BIT_BIP"
ROSETTA:LAP_P1_INITIAL_SWEEP_SMPLS = "0x0005"
ROSETTA:LAP_P1_ADC16_DOWNSAMPLE = "0x0080"
ROSETTA:LAP_TM_RATE = "NORMAL"
ROSETTA:LAP_BOOTSTRAP = "ON"
ROSETTA:LAP_FEEDBACK_P1 = "DENSITY"
ROSETTA:LAP_P1_ADC20 = "DENSITY"
```

```
ROSETTA:LAP_P1_ADC16 = "DENSITY"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "GAIN 1"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_SWEEPING_P1 = "YES"
ROSETTA:LAP_P1_FINE_SWEEP_OFFSET = "0x0000"
ROSETTA:LAP_P1_SWEEP_FORMAT = "DOWN"
ROSETTA:LAP_P1_SWEEP_RESOLUTION = "COARSE"
ROSETTA:LAP_P1_SWEEP_PLATEAU_DURATION = "0x0200"
ROSETTA:LAP_P1_SWEEP_STEPS = "0x0030"
ROSETTA:LAP_P1_SWEEP_STEP_HEIGHT = "0x0004"
ROSETTA:LAP_P1_SWEEP_START_BIAS = "0x00c0"
OBJECT     = TABLE
INTERCHANGE_FORMAT = ASCII
ROWS               = 200
COLUMNS            = 4
ROW_BYTES          = 59
DESCRIPTION        = "D_SWEEP_P1_RAW_16BIT_BIP"
OBJECT     = COLUMN
NAME        = UTC_TIME
DATA_TYPE   = TIME
START_BYTE  = 1
BYTES       = 26
DESCRIPTION = "UTC TIME"
END_OBJECT = COLUMN
OBJECT     = COLUMN
NAME        = OBT_TIME
START_BYTE  = 28
BYTES       = 16
DATA_TYPE   = ASCII_REAL
UNIT        = SECONDS
FORMAT      = "F16.6"
DESCRIPTION = "SPACE CRAFT ONBOARD TIME SSSSSSSSS.FFFFFF (TRUE
DECIMALPOINT)"
END_OBJECT = COLUMN
OBJECT     = COLUMN
NAME        = P1_CURRENT
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 45
BYTES       = 6
DESCRIPTION = "MEASURED CURRENT"
END_OBJECT = COLUMN
OBJECT     = COLUMN
NAME        = P1_VOLTAGE
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 52
BYTES       = 6
DESCRIPTION = "VOLTAGE BIAS"
END_OBJECT = COLUMN
END_OBJECT = TABLE
END
```

4.3.2.4 Difference Measurements Data Product Design

```
PDS_VERSION_ID = PDS3
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 90
FILE_RECORDS = 272
FILE_NAME = "RPCLAP071107_293S_CEB38NS.LBL"
^TABLE = "RPCLAP071107_293S_CEB38NS.TAB"
DATA_SET_ID = "RO-E-RPCLAP-3-EAR2-CALIB-V1.0"
DATA_SET_NAME = "ROSETTA-ORBITER EARTH RPCLAP 3 EAR2 CALIB V1.0"
DATA_QUALITY_ID = 1
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME = "EARTH SWING-BY 2"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE PHYSICS,
UPPSALA"
PRODUCER_ID = RG
PRODUCER_FULL_NAME = "REINE GILL"
LABEL_REVISION_NOTE = "2009-09-21T10:35:46, Reine Gill (IRFU), first
release"
PRODUCT_ID = "RPCLAP071107_293S_CEB38NS"
PRODUCT_TYPE = EDR
PRODUCT_CREATION_TIME = 2009-09-21T10:35:46
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0705
INSTRUMENT_MODE_DESC = "E-Field,Cont. 20 Bit down 64, Every 160s 16
bit diff"
TARGET_NAME = "EARTH"
TARGET_TYPE = "PLANET"
PROCESSING_LEVEL_ID = 3
START_TIME = 2007-11-07T23:58:02.875
STOP_TIME = 2007-11-07T23:58:02.890
SPACECRAFT_CLOCK_START_COUNT = "1/0153100650.1600"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0153100650.2547"
DESCRIPTION = "E_DIFF_P1P2"
ROSETTA:LAP_P2_ADC16_DOWNSAMPLE = "0x0001"
ROSETTA:LAP_P1_ADC16_DOWNSAMPLE = "0x0001"
ROSETTA:LAP_TM_RATE = "NORMAL"
ROSETTA:LAP_BOOTSTRAP = "ON"
ROSETTA:LAP_FEEDBACK_P2 = "E-FIELD"
ROSETTA:LAP_P2_ADC20 = "E-FIELD"
ROSETTA:LAP_P2_ADC16 = "E-FIELD"
ROSETTA:LAP_P2_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P2_STRATEGY_OR_RANGE = "BIAS"
ROSETTA:LAP_P2_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P2_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_P2_EFIELD_FIX_DURATION = "0x0002"
ROSETTA:LAP_IBIAS2 = "0x00d6"
ROSETTA:LAP_P2_BIAS_MODE = "E-FIELD"
ROSETTA:LAP_FEEDBACK_P1 = "E-FIELD"
ROSETTA:LAP_P1_ADC20 = "E-FIELD"
ROSETTA:LAP_P1_ADC16 = "E-FIELD"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
```

```
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "BIAS"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_P1_EFIELD_FIX_DURATION = "0x0002"
ROSETTA:LAP_IBIAS1 = "0x0077"
ROSETTA:LAP_P1_BIAS_MODE = "E-FIELD"
OBJECT     = TABLE
INTERCHANGE_FORMAT = ASCII
ROWS               = 272
COLUMNS            = 5
ROW_BYTES          = 90
DESCRIPTION        = "E_DIFF_P1P2"
OBJECT     = COLUMN
NAME        = UTC_TIME
DATA_TYPE   = TIME
START_BYTE  = 1
BYTES       = 26
DESCRIPTION = "UTC TIME"
END_OBJECT = COLUMN
OBJECT     = COLUMN
NAME        = OBT_TIME
START_BYTE  = 28
BYTES       = 16
DATA_TYPE   = ASCII_REAL
UNIT        = SECONDS
FORMAT      = "F16.6"
DESCRIPTION = "SPACE CRAFT ONBOARD TIME SSSSSSSSS.FFFFFF (TRUE
DECIMALPOINT)"
END_OBJECT = COLUMN
OBJECT     = COLUMN
NAME        = P1_CURRENT
DATA_TYPE   = ASCII_REAL
START_BYTE  = 45
BYTES       = 14
UNIT        = AMPERE
FORMAT      = "E14.7"
DESCRIPTION = "MEASURED CALIBRATED CURRENT OR CALIBRATED CURRENT
BIAS"
END_OBJECT = COLUMN
OBJECT     = COLUMN
NAME        = P2_CURRENT
DATA_TYPE   = ASCII_REAL
START_BYTE  = 60
BYTES       = 14
UNIT        = AMPERE
FORMAT      = "E14.7"
DESCRIPTION = "MEASURED CALIBRATED CURRENT OR CALIBRATED CURRENT
BIAS"
END_OBJECT = COLUMN
OBJECT     = COLUMN
NAME        = P1-P2_VOLTAGE
DATA_TYPE   = ASCII_REAL
START_BYTE  = 75
BYTES       = 14
UNIT        = VOLT
FORMAT      = "E14.7"
DESCRIPTION = "MEASURED CALIBRATED VOLTAGE OR CALIBRATED VOLTAGE
BIAS"
```

```
END_OBJECT = COLUMN
END_OBJECT = TABLE
END
```

4.3.2.5 Geometry Data Product Design

```
PDS_VERSION_ID = PDS3
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 421
FILE_RECORDS = 1528
FILE_NAME = "RPCLAP100713_2_GEOM.LBL"
^TABLE = "RPCLAP100713_2_GEOM.TAB"
DATA_SET_ID = "RO-A-RPCLAP-2-AST2-EDITED-V2.0"
DATA_SET_NAME = "ROSETTA-ORBITER LUTETIA RPCLAP 2 AST2 EDITED V2.0"
DATA_QUALITY_ID = 1
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME = "LUTETIA FLY-BY"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE PHYSICS,
UPPSALA"
PRODUCER_ID = RG
PRODUCER_FULL_NAME = "REINE GILL"
LABEL_REVISION_NOTE = "2012-04-25T12:00:00, AIE, 3rd draft after
review by Maud"
PRODUCT_ID = "RPCLAP100713_2_GEOM"
PRODUCT_TYPE = "EDR"
PRODUCT_CREATION_TIME = 2012-06-20T13:33:08.215
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = "N/A"
TARGET_NAME = "21 LUTETIA"
TARGET_TYPE = "ASTEROID"
PROCESSING_LEVEL_ID = 2
START_TIME = 2010-07-13T00:00:01.567
STOP_TIME = 2010-07-13T13:34:25.575
SPACECRAFT_CLOCK_START_COUNT = "1/0237578386.42944"
SPACECRAFT_CLOCK_STOP_COUNT =  "1/0237624530.42944"

OBJECT = TABLE
NAME = "RPCLAP-2-AST2-GEOM"
INTERCHANGE_FORMAT = ASCII
ROWS = 1528
COLUMNS = 23
ROW_BYTES = 424
DESCRIPTION = "GEOMETRY DATA. TIME AND 22 GEOMETRY PARAMETERS."

OBJECT = COLUMN
NAME = TIME_UTC
DATA_TYPE = TIME
START_BYTE = 1
BYTES = 23
```

```
UNIT = SECONDS
DESCRIPTION = "TIME OF GEOMETRY DATA YYYY-MM-DDTHH:MM:SS.ssssss"
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_SUN_POS_X
DATA_TYPE = ASCII_REAL
START_BYTE = 26
BYTES = 16
UNIT = "km"
DESCRIPTION = "HELIOCENTRIC ECLIPJ2000 POSITION X"
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_SUN_POS_Y
DATA_TYPE = ASCII_REAL
START_BYTE = 44
BYTES = 16
UNIT = "km"
DESCRIPTION = "HELIOCENTRIC ECLIPJ2000 POSITION Y"
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_SUN_POS_Z
DATA_TYPE = ASCII_REAL
START_BYTE = 62
BYTES = 16
UNIT = "km"

DESCRIPTION = "HELIOCENTRIC ECLIPJ2000 POSITION Z"
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_TGT_POS_X
DATA_TYPE = ASCII_REAL
START_BYTE = 80
BYTES = 16
UNIT = "km"
DESCRIPTION = "TARGET CENTRED ECLIPJ2000 POSITION X. ZERO WHEN NO
TARGET."

END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_TGT_POS_Y
DATA_TYPE = ASCII_REAL
START_BYTE = 98
BYTES = 16
UNIT = "km"
DESCRIPTION = "TARGET CENTRED ECLIPJ2000 POSITION Y. ZERO WHEN NO
TARGET."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_TGT_POS_Z
DATA_TYPE = ASCII_REAL
START_BYTE = 116
BYTES = 16
```

```
UNIT = "km"
DESCRIPTION = "TARGET CENTRED ECLIPJ2000 POSITION Z. ZERO WHEN NO
TARGET."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_TGT_VEL_X
DATA_TYPE = ASCII_REAL
START_BYTE = 134
BYTES = 16
UNIT = "km/s"
DESCRIPTION = "ECLIPJ2000 VELOCITY X RELATIVE TO TARGET. ZERO WHEN
NO TARGET."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_TGT_VEL_Y
DATA_TYPE = ASCII_REAL
START_BYTE = 152
BYTES = 16
UNIT = "km/s"
DESCRIPTION = "ECLIPJ2000 VELOCITY Y RELATIVE TO TARGET. ZERO WHEN
NO TARGET."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_TGT_VEL_Z
DATA_TYPE = ASCII_REAL
START_BYTE = 170
BYTES = 16
UNIT = "km/s"
DESCRIPTION = "ECLIPJ2000 VELOCITY Z RELATIVE TO TARGET. ZERO WHEN
NO TARGET."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = ALTITUDE
DATA_TYPE = ASCII_REAL
START_BYTE = 188
BYTES = 16
UNIT = "km"
DESCRIPTION = "DISTANCE TO SURFACE OF CURRENT TARGET. ZERO WHEN NO
TARGET."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = LATITUDE
DATA_TYPE = ASCII_REAL
START_BYTE = 206
BYTES = 16
UNIT = "degrees"
DESCRIPTION = "LATITUDE ON SURFACE OF CURRENT TARGET. ZERO WHEN NO
TARGET."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = LONGITUDE
DATA_TYPE = ASCII_REAL
```

START_BYTE = 224
BYTES = 16
UNIT = "degrees"
DESCRIPTION = "LONGITUDE ON SURFACE OF CURRENT TARGET. ZERO WHEN NO TARGET."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SC_TGT_SPEED
DATA_TYPE = ASCII_REAL
START_BYTE = 242
BYTES = 16
UNIT = "km/s"
DESCRIPTION = "SPEED RELATIVE TO CURRENT TARGET. ZERO WHEN NO TARGET."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SC_X_ECLIPJ2000FR_X
DATA_TYPE = ASCII_REAL
START_BYTE = 260
BYTES = 16
UNIT = "N/A"
DESCRIPTION = "SPACECRAFT FRAME X EXPRESSED IN ECLIPTIC J2000 FRAME X."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SC_X_ECLIPJ2000FR_Y
DATA_TYPE = ASCII_REAL
START_BYTE = 278
BYTES = 16
UNIT = "N/A"
DESCRIPTION = "SPACECRAFT FRAME X EXPRESSED IN ECLIPTIC J2000 FRAME Y."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SC_X_ECLIPJ2000FR_Z
DATA_TYPE = ASCII_REAL
START_BYTE = 296
BYTES = 16
UNIT = "N/A"
DESCRIPTION = "SPACECRAFT FRAME X EXPRESSED IN ECLIPTIC J2000 FRAME Z."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SC_Y_ECLIPJ2000FR_X
DATA_TYPE = ASCII_REAL
START_BYTE = 314
BYTES = 16
UNIT = "N/A"
DESCRIPTION = "SPACECRAFT FRAME Y EXPRESSED IN ECLIPTIC J2000 FRAME X."
END_OBJECT = COLUMN

OBJECT = COLUMN

```
NAME = SC_Y_ECLIPJ2000FR_Y
DATA_TYPE = ASCII_REAL
START_BYTE = 332
BYTES = 16
UNIT = "N/A"
DESCRIPTION = "SPACECRAFT FRAME Y EXPRESSED IN ECLIPTIC J2000 FRAME
Y."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_Y_ECLIPJ2000FR_Z
DATA_TYPE = ASCII_REAL
START_BYTE = 350
BYTES = 16
UNIT = "N/A"
DESCRIPTION = "SPACECRAFT FRAME Y EXPRESSED IN ECLIPTIC J2000 FRAME
Z."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_Z_ECLIPJ2000FR_X
DATA_TYPE = ASCII_REAL
START_BYTE = 368
BYTES = 16
UNIT = "N/A"
DESCRIPTION = "SPACECRAFT FRAME Z EXPRESSED IN ECLIPTIC J2000 FRAME
X."
END_OBJECT  = COLUMN

OBJECT = COLUMN
NAME = SC_Z_ECLIPJ2000FR_Y
DATA_TYPE = ASCII_REAL
START_BYTE = 386
BYTES = 16
UNIT = "N/A"
DESCRIPTION = "SPACECRAFT FRAME Z EXPRESSED IN ECLIPTIC J2000 FRAME
Y."
END_OBJECT  = COLUMN

OBJECT = COLUMN

NAME = SC_Z_ECLIPJ2000FR_Z
DATA_TYPE = ASCII_REAL
START_BYTE = 404
BYTES = 16
UNIT = "N/A"
DESCRIPTION = "SPACECRAFT FRAME Z EXPRESSED IN ECLIPTIC J2000 FRAME
Z."
END_OBJECT  = COLUMN

END_OBJECT = TABLE

END
```