R O S E T T A

RPCMAG Userguide

RO–IGEP–TR–0074

Issue: 3 Revision: 1

February 14, 2019

Proper Usage of Magnetic Field Data and potential Pitfalls

Ingo Richter

Institut für Geophysik und extraterrestrische Physik
Technische Universität Braunschweig
Mendelssohnstraße 3, 38106 Braunschweig
Germany

Contents

1 Introduction

This document gives a brief description about the archive structure and dataset content [1] of the magnetic field data observed by the RPCMAG instrument onboard the ROSETTA mission to comet 67P/Churyumov-Gerasimenko.

Special emphasis is laid on the tiny details which are not described in the Experimenter to Archive Interface Control Document (EAICD , RO-IGEP-TR0009) or the calibration procedure (RO-IGEP-TR0028) or the various documents which are delivered within the datasets. This document shall give brief introduction into the usage of RPCMAG data, where they can be found, how they are organized and how the convention for folder and file names lead to the right data.

Additionally the most important "Disturbance" – chapter gives an overview of possible (detected so far) disturbances and interference of S/C–sub-systems and P/L–instruments on magnetic field observations. That chapter should be studied intensively in order to be able to assess specific science data properly. It's a matter of fact that ROSETTA magnetic field data are highly "polluted" by the mentioned sub-systems as ROSETTA was originally not supposed to be a plasma mission, and therefore the limited magnetic cleanliness program, the short stub boom available and the weight limit for the instrument design cause various artefacts to be seen in the data which have to be recognized during the scientific analysis in order to extract the right science out of the data and not to describe putative new physics originated in S/C–disturbance signatures.

The final chapter contains a condensed check list which should be taken to your heart in order to avoid stepping into the described pitfalls and to gain lots of proper new physics which can definitely be found in our treasure of magnetic field data collected during 10 years of the successful ROSETTA mission.

[1] The archive contains all data of all observations ever made by both RPCMAG sensors, the outboard (OB) and the inboard (IB) sensor. All these data are provided for all calibration levels, i.e. RAW, CALIBRATED and RESAMPLED data. However, we do not offer a common "magnetic field data product" as result of an automatic disturbance elimination and using a "dual magnetometer method" as this was not possible due to design an telemetry budget limitations. For details refer i.a. to chapter 5.2.

2 General Overview of the Data Files and Locations

The RPCMAG data are PDS3 compliant and can be downloaded from the Planetary Science Archive (PSA) operated by ESA or the Planetary Data system (PDS) operated by NASA.

The related URLs are:

- ftp://psa.esac.esa.int/pub/mirror/INTERNATIOAL-ROSETTA_MISSION/RPCMAG/
- https://archives.esac.esa.int/psa/#!Table␣View/Rosetta=mission
- https://pdssbn.astro.umd.edu/data_sb/missions/rosetta/index.shtml

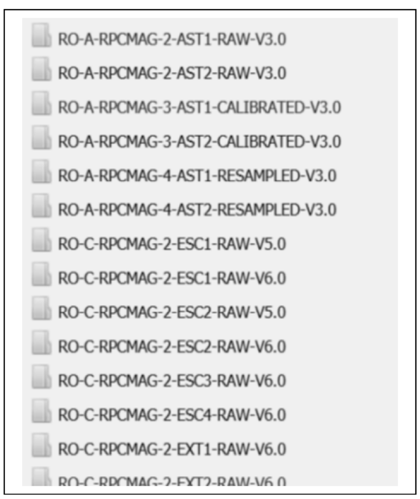


Figure 1: Excerpt of the RPCMAG Dataset List

All data are organized in datasets as shown in Fig.1. Each dataset name contains the mission abbreviation RO for ROSETTA, the target type (A: asteroid, C: comet,E: Earth, M: Mars, SS: Solar System, X: Checkout), the calibration level (2,3,4) and a version number (Vxx)[2]. For each of the missionphases (refer to Table 1) datasets are available in three different levels

[2]For all future data analyses dataset of Version V9.0 should be used.

- Level 2: RAW
- Level 3: CALIBRATED
- Level 4: RESAMPLED

The RAW data contain the raw ADC-counts of the Housekeeping (HK) and science data and are available in the unit reference frame (URF, instrument coordinate system) only. The CALIBRATED data represent fully calibrated data, i.e. the ground calibration results and extended inflight temperature models have been applied, data are in physical units, bad data are flagged [3], offsets and s/c magnetic fields [4] are corrected as much as possible using long term constraints like diamagnetic cavity, separation jump in magnetic field caused by the PHILAE debarking at 12. November 2014, reference field after landing of PHILAE, and the assumption the the longterm averaged solar wind field is zero [5].

The RESAMPLED data are calibrated data averaged down to e.g 1 s or 60 s mean values.

CALIBRATED and RESAMPLED data are present in various coordinate systems like URF, s/c-coordinates, ECLIPJ2000 for the phases until 2011, and CSEQ (Cometo centric Solar EQuatorial coordinates) for the comet phase from 2014 until 2016.

[3] Bad data are NOT removed, but *every* CALIBRATED and RESAMPLED field vector is marked by a quality flag. Refer to chapter 5 for details.

[4] As s/c and instrument are building a joint package it is not possible to separate the instrument offsets from the s/c magnetic field. Therefore, only the sum of it can be adjusted — if feasible at all.

[5] Here not only the solar wind modulus but also the individual component have to be zero in longterm average [B.T. Tsurutani et al., Interplanetary Alfv́en Waves and Auroral (Substorm) Activity: IMP8; JGR, Vol.95, No.A3, 2241-2252, 1990]

Mission Phase	Abbreviation	Duration		
Commissioning Phase	CVP	March 2004	-	October 2004
1. Earth swing-by	EAR1	March 2005	-	March 2005
Cruise Phase	CR2	June 2006	-	July 2006
Mars swing-by	MARS	August 2006	-	May 2007
2. Earth swing-by	EAR2	September 2007	-	January 2008
Cruise Phase	CR4A	July 2008	-	July 2008
Asteroid fly-by at STEINS	AST1	September 2008	-	September 2008
Cruise Phase	CR4B	January 2009	-	February 2009
3. Earth swing-by	EAR3	September 2009	-	November 2009
Cruise Phase	CR5	February 2010	-	May 2010
Asteroid fly-by at LUTETIA	AST2	July 2010	-	July 2010
Rendezvous Manoeuvre 1	RVM1	November 2010	-	December 2012
Prelanding Phase	PRL	March 2014	-	November 2014
Comet Escort Phase 1	ESC1	November 2014	-	March 2015
Comet Escort Phase 2	ESC2	March 2015	-	June 2015
Comet Escort Phase 3	ESC3	July 2015	-	October 2015
Comet Escort Phase 4	ESC4	October 2015	-	January 2016
Extended Mission Phase 1	EXT1	January 2016	-	April 2016
Extended Mission Phase 2	EXT2	April 2016	-	June 2016
Extended Mission Phase 3	EXT3	June 2016	-	September 2016

Table 1: Overview of mission phases.

3 Dataset Content

Figure 2 shows the typical PDS compliant structure of a CALIBRATED RPCMAG dataset as an example. Most important for the user are the entries labeled by green arrows.

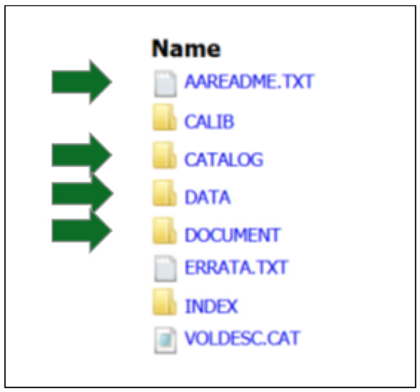


Figure 2: Typical Structure of a Dataset

These items will be described in detail in the following sections.

3.1 The AAREADME.TXT File

The AAREADME.TXT file contains general information about the datasets like used acronyms, details about the mission phase, content of the dataset and contact information.

3.2 The CATALOG Folder

The CATALOG folder (ref to Figure 3) contains various informative catalog files, providing information about the complete mission, the targets of ROSETTA, references for useful literature and more contact information.

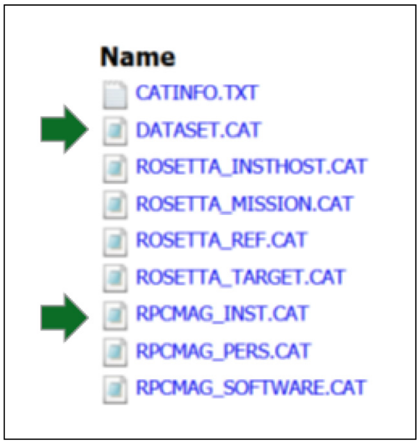


Figure 3: Typical Content of the CATALOG Folder

The most important catalogs are the dataset specific files

- DATASET.CAT
- RPCMAG_INST.CAT

with specific details about the present dataset and detailed facts about the RPCMAG instrument.

3.3 The DOCUMENT Directory

The DOCUMENT directory contains a collection of relevant documentation useful for the understanding of the RPCMAG datasets. Figure 4 gives an overview of documentation available. Again the most important ones are designated by a green arrow.

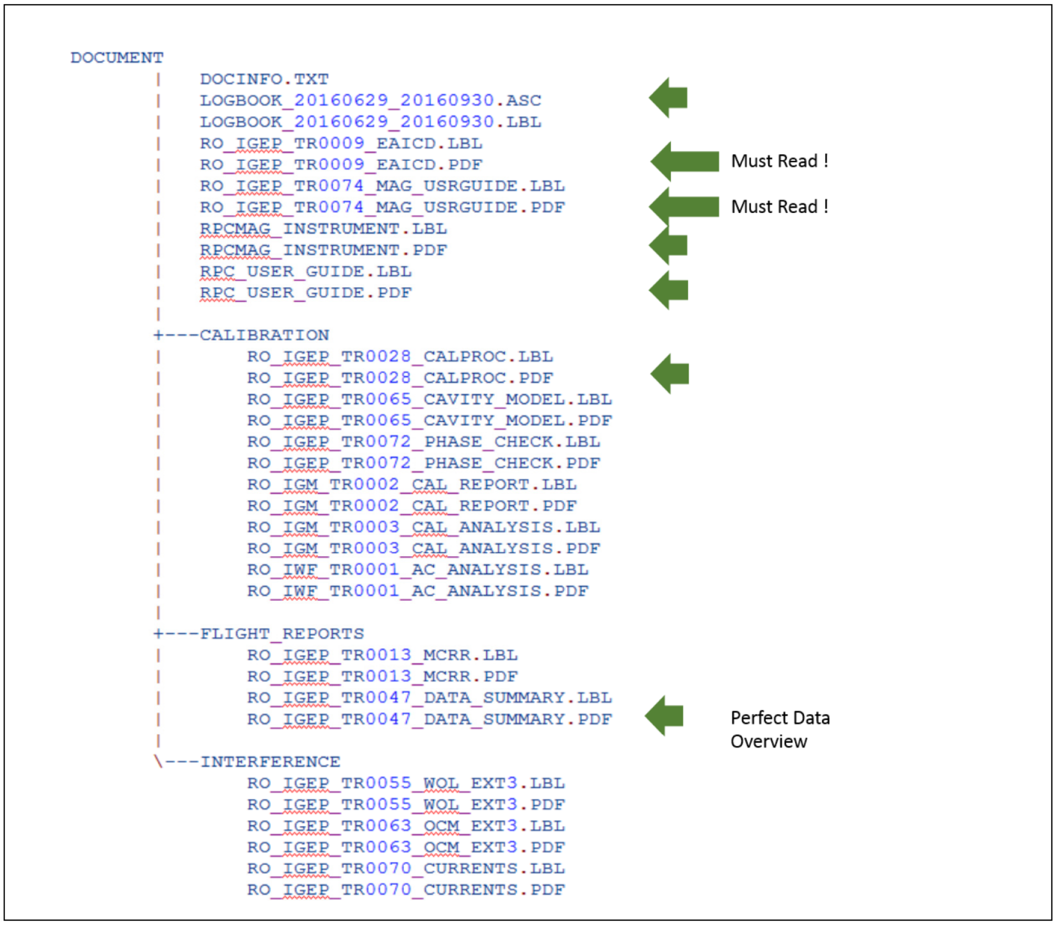


Figure 4: Overview of the DOCUMENT directory

The LOGBOOK and the DATA SUMMARY Reports are described in detail below.

The Experimenter to Archive Interface Control Document (EAICD) describes the complete structure and content of the RPCMAG datasets. That document is a must read for the complete understanding of the archive.

Also the the present RO_IGEP_TR0074_MAG_USRGUIDE should be read as it also reveals lots of details concerning the dataset usage.

The Calibration Procedure (RO_IGEP_TR0028_CALPROC) describes the complete calibration procedure of the magnetic field data in all available levels and coordinate systems. The reading of this additional information is optional and only needed for users who like to gain an in-depth insight into the data.

3.3.1 The Logbook

Figure 5 shows an excerpt of a typical logbook of the RPCMAG operations. The logbook has been automatically generated using the command and event history file for RPC and contains all known relevant events in order to assess specific structures found in the data. E.g. switch on/off times, mode switchings, instrument shut-offs , thruster activities, Wheel-Offloadings, Orbit correction manoeuvres, and similar features are time tagged in the logbooks and can give precious hints in case of unusual magnetic field structures present in the data. The green arrow for example shows the command of a reaction wheel spin down sequence (Wheel Offloading, WOL) which takes 1430 seconds. During this time the S/C attitude is controlled by thrusters which contain movable magnetic latch valves causing a shift in the s/c magnetic field. Such a field shift might be interpreted as external signal and could mislead the untaught physicist to a wrong interpretation of the data.

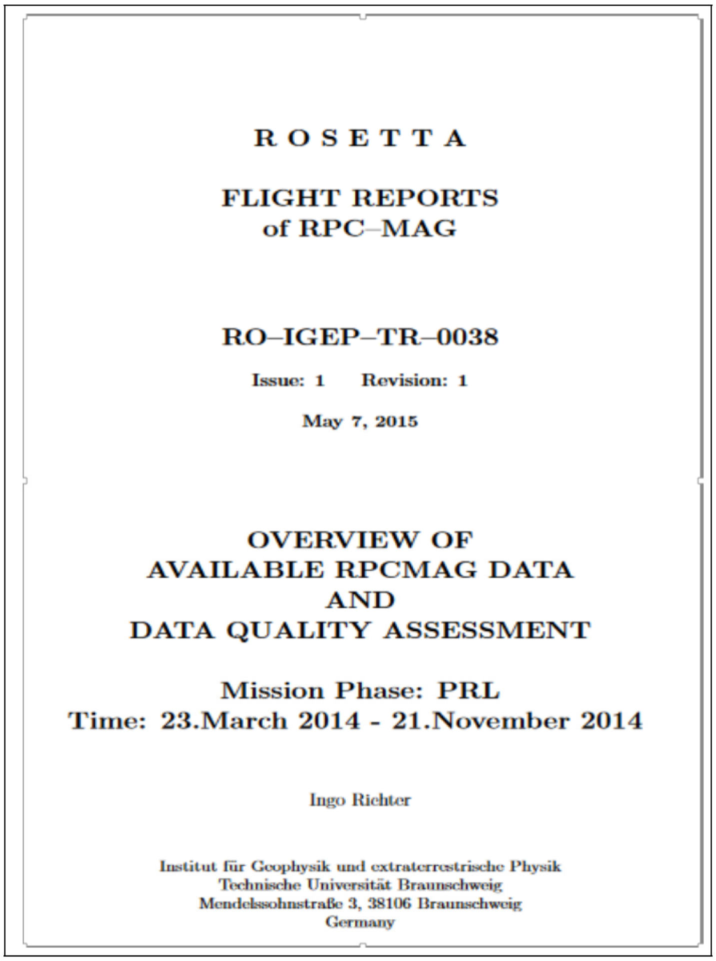
The widespread information provided in the logbook is very detailed but can probably only be fully understood if an in-depth knowledge of the ROSETTA-S/C-system is available, which is beyond the scope of this guide.

```
###############################################################################################
#                                                                                             #
#                                                                                             #
#                                 2014-06-17                                                  #
#                                                                                             #
#                                                                                             #
###############################################################################################
#                                                                                             #
# TIME (UTC)               EVENT          COMMAND    DESCRIPTION                       REMARK #
#                                                                                             #
###############################################################################################
@ 2014-06-17T03:38:46.3    Warning                   EC_MAG_MissedSamples
@ 2014-06-17T03:38:46.3    Warning                   EC_MAG_CounterUnsync
@ 2014-06-17T09:28:59.0                   ZSKA8096   START RPC Mode Control 2 OBCP     ModeMAG:=  Quiet
@ 2014-06-17T09:43:59.0                   ZSKA8092   START RPC Power Off OBCP
###############################################################################################
###############################################################################################
#                                                                                             #
#                                                                                             #
#                                 2014-06-20                                                  #
#                                                                                             #
#                                                                                             #
###############################################################################################
#                                                                                             #
# TIME (UTC)               EVENT          COMMAND    DESCRIPTION                       REMARK #
#                                                                                             #
###############################################################################################
@ 2014-06-20T02:30:02.0                   ZSKA8091   START RPC Power On OBCP
@ 2014-06-20T02:30:46.1    Normal                    EC_PiuAlive
@ 2014-06-20T02:31:49.2    Normal                    EC_SoftReboot
@ 2014-06-20T02:31:58.1    Normal                    EC_PiuAlive
@ 2014-06-20T02:45:05.0                   ZSKA809B   MAG Mode Control                  ModeMAG:=  SID3
@ 2014-06-20T09:39:00.0              ==>  ZAC20188   AOCMS-WOL Swicth ON Wheel Off-Load Man   T_OUT[s]= 1430
###############################################################################################
```

Figure 5: Contents of a typical LOGBOOK

3.3.2 Available Data Overview & Quality Assessment Report

For an easy overview about the data available and a coarse quality check a specific Overview & Quality Assessment Report is provided for each mission phase, as shown in Figure 6.



ROSETTA

FLIGHT REPORTS
of RPC–MAG

RO–IGEP–TR–0038

Issue: 1 Revision: 1

May 7, 2015

OVERVIEW OF
AVAILABLE RPCMAG DATA
AND
DATA QUALITY ASSESSMENT

Mission Phase: PRL
Time: 23.March 2014 - 21.November 2014

Ingo Richter

Institut für Geophysik und extraterrestrische Physik
Technische Universität Braunschweig
Mendelssohnstraße 3, 38106 Braunschweig
Germany

Figure 6: A typical Data Availability & Quality Assessment Report

For every month a schematic overview of all data in all modes and calibration levels is displayed in graphs like Figure 7. The color coding in the figure represents the instrument mode, thus orange means normal mode (M2, OB: 1 Hz & IB: 1/32 Hz) and red means burst mode (M3, OB: 20 Hz & IB: 1 Hz). Black bars just belong to housekeeping data (HK). The ordinate assignments exhibit the different calibration levels CLx for the different coordinate systems and resampling intervals as defined in section 3.4. The numbers shown for the resampled data products state the time of the average interval in seconds. These are usually 1 s or 60 s.

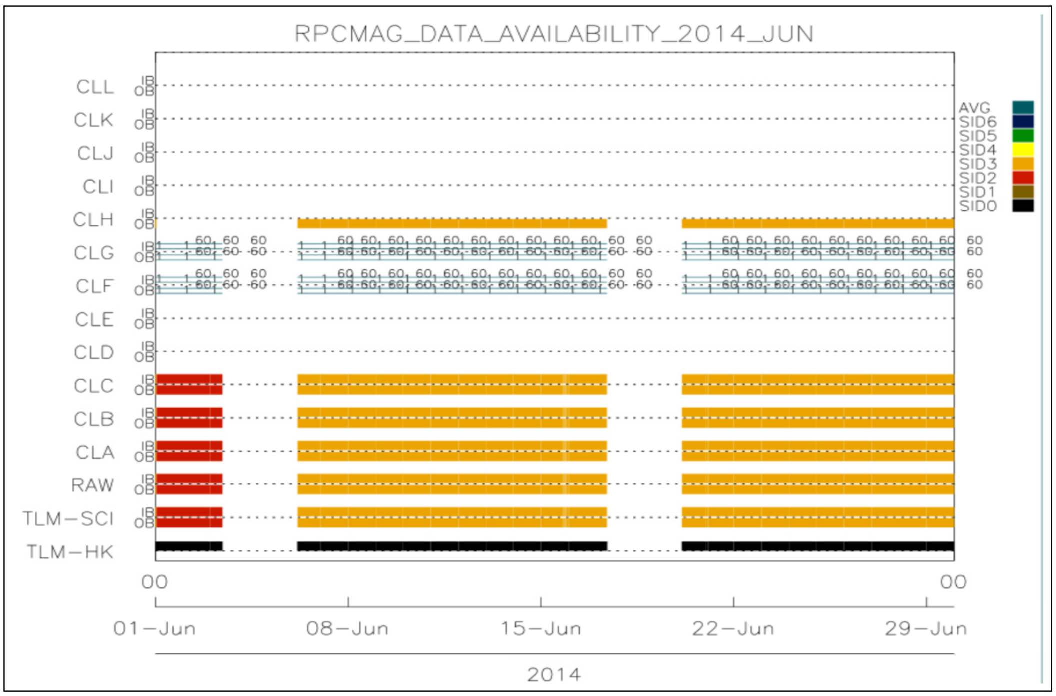


Figure 7: A typical Data Availability Graph

Finally Figure 8 displays lots of information about the actual quality of the data. These plots are generated on daily bases, thus a time interval of 24 h is covered. The averaged data (5 minute mean values) of the OB (red) and IB (black) sensor are plotted in three different panels for the x,y, and z component. The fourth panel exhibits the sensor temperatures of both sensors using identical colors. Besides the pure plot of the time series also the difference of the (OB - IB) data difference and the daily mean value of the (OB-IB) data difference are displayed as colored blocks. Green blocks represent perfect data where this difference is below 1 nT whereas the poorest data with differences greater then 4 nT are shown in orange color. Good and ample colored data are data of average quality as stated in the plot legend.

Areas of violet color represent times where the sensors are not in thermal equilibrium and suffering a temperature change rate of more then 0.1 mK/s. (Not existing in the example shown here).

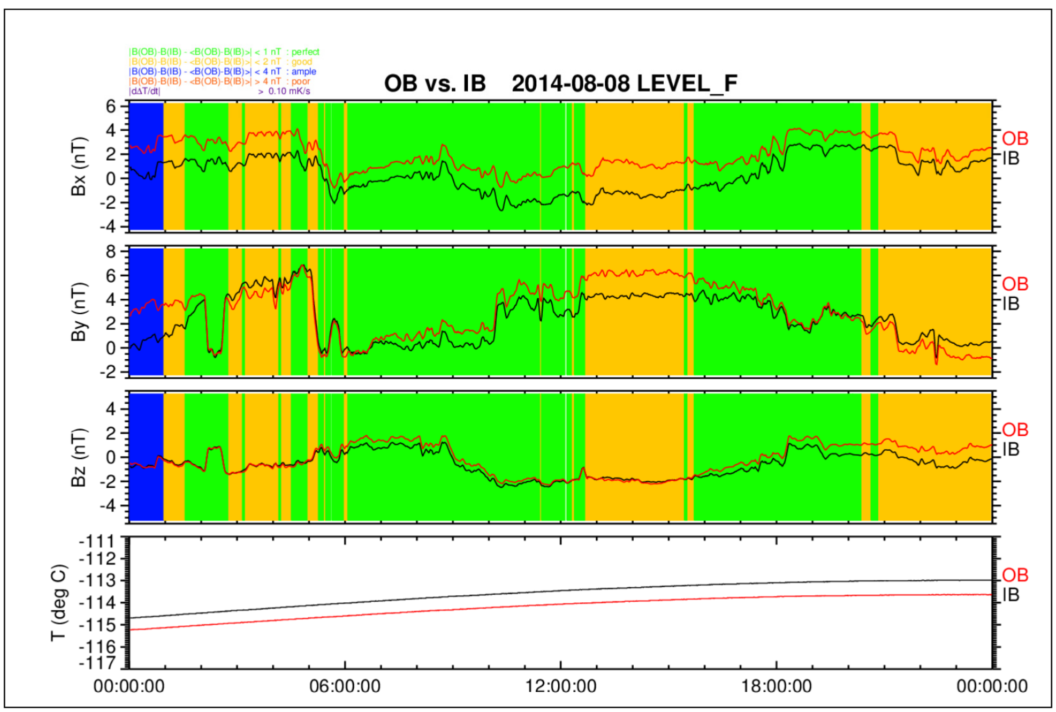


Figure 8: A typical Data Availability & Quality overview plot

This color coding of the differences, the display of both sensor time series, and the related temperatures should help to select time intervals of reasonable data quality for the specific scientific investigation of interest.

As add-on to presented the quality assessment plot in Fig.8 some physical background of the magnetic field observations on spacecrafts shall be given now.

It is good practice to locate magnetic field sensors far outside a spacecraft on a long boom in order to get rid of any magnetic s/c disturbances, which can be caused by different sources like e.g magnetic thrusters, relays, unshielded currents, movable magnetic parts, and reaction wheels et cetera. As ROSETTA, however, was originally not supposed to be a plasma mission, only a short 1.5 m boom was allowed and therefore the magnetic field sensors had to be assembled quite close to the s/c body. Therefore, all the mentioned effects can disturb the magnetic field observations. Due to the short boom length, the spacial sensor separation is 15 cm only. Nevertheless both sensors react unequally to disturbance sources located in the immediate vicinity on the s/c (only the external cometary or solar wind magnetic fields are measured in the same way due to the large distance of those sources). Furthermore, due to weight limitations in the design phase, a proper temperature compensation of the sensor offset had to be dismantled, causing strong and different temperature dependencies of both sensors. This means in essence, that any magnetic/electric state change of the satellite and any illumination variation coming along with temperature variations can cause differences on RPCMAG sensor readings. Therefore, all varying differences exemplarily shown in Fig 8 give whitness of such state changes. As the reasons are manifold, disturbances can hardly be automatically eliminated but only marked using an extended quality flag system.
Due to the tiny spacial sensor separation,the different sampling rates of both sensors, and the tilted boom design it was neither possible to correct one sensor using the other one (which was done by several different missions - ”dual mag method”) nor it was feasible to declare one sensor as ”always the better one”. Therefore, no common magnetic field product was generated but the data-streams of both our sensors were archived for all observation times in all calibration levels. Thus the user has the full flexibility and possibility to choose the best sensor for a given time himself. To assist such an assessment quality plots like the one shown in Fig. 8 are available for every day of observation.

3.4 The DATA Directory

The typical content of the DATA directory is displayed in Figure 9.

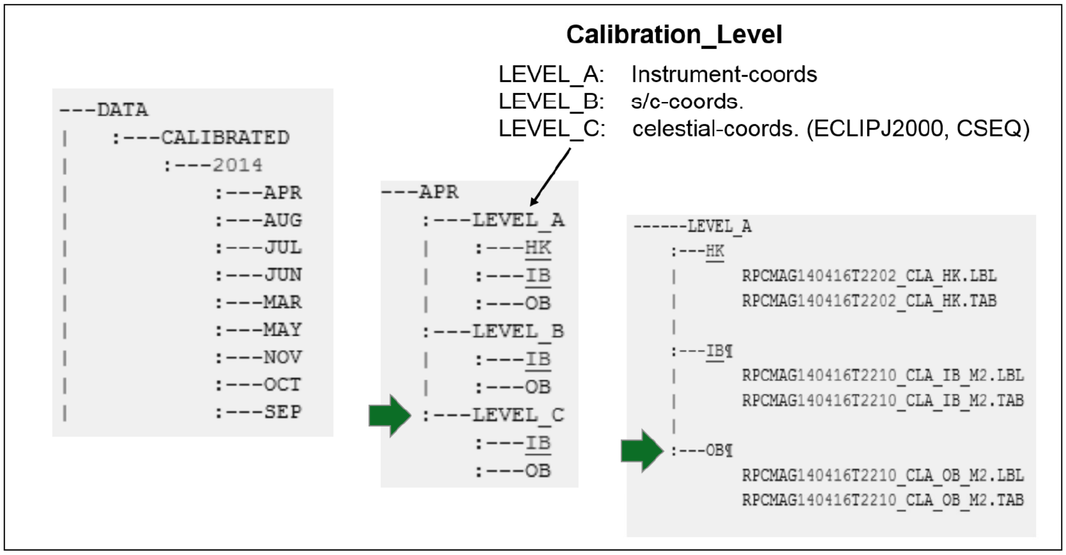


Figure 9: Typical Content of the DATA Folder

The data are sorted by time, thus the top level item is the year of measurement followed by the month, abbreviated by 3 significant characters. Below each month folder the various calibration level directories are located.
The CALIBRATED folder contains the following data products:

- LEVEL_A: (CLA)
  Calibrated data in URF coordinates (instrument frame).
- LEVEL_B: (CLB)
  Calibrated data in s/c-coordinates.
- LEVEL_C: (CLC)
  Calibrated data in celestial coordinates. This is ECLIPJ2000 until hibernation in 2011, and CSEQ for the comet phases in 2014 - 2016.

For each calibration level data of both, IB and OB sensor, are available. These data are corrected for known sensor effects and known s/c DC field effects, where possible. No AC field corrections were applied to these data. However, convenient quality flags indicate the quality state of each measured vector.

In the RESAMPLED folder data of the following calibration levels can be found:

- LEVEL_E: (CLE)
  Resampled data in URF coordinates (instrument frame). 1 s and 60 s averages.
- LEVEL_F: (CLF)
  Resampled data in s/c-coordinates. 1 s and 60 s averages.
- LEVEL_G: (CLG)
  Resampled data in celestial coordinates. This is ECLIPJ2000 until hibernation in 2011, and CSEQ for the comet phases in 2014 - 2016.
  1 s and 60 s averages.
- LEVEL_H: (CLH)
  Resampled data in celestial coordinates as described above, influence of S/C-reaction wheels and disturbance by LAP -instrument eliminated.
  Original sampling rate.

The RESAMPLED data have been directly derived from the related CALIBRATED data by avaraging to the listed temporal resolution.

For each individual level three folders exist for the time series tables (*.TAB) and label files *.LBL):

- HK
  Housekeeping data.
- IB
  Magnetic field data of the Inboard Sensor.
- OB
  Magnetic field data of the Outboard Sensor.

The most relevant data are the OB data, as these data are usually (but not always) the less disturbed ones due to the most distant position of the sensor on the boom. As the spacial separation of OB and IB is only 15 cm, and the sampling rates of both sensors are always different, it is not possible to correct one sensor by the other one. Therefore no common "magnetic field" dataproduct is generated but the datastreams of both sensors are kept at all levels.

For standard purpose the OB data should be used, as these are in general the less disturbed and higher sampled ones.

The following table gives a compact overview about available sampling rates and coordinate systems for each level and sensor:

Level	Coordinate System	Sensor	Mode	Sampling Rate (s^{-1})	Average Interval (s)
RAW	URF	OB IB	NORMAL	1 1/32	
RAW	URF	OB IB	BURST	20 1	
CLA	URF		HK	1/32	
CLA	URF	OB IB	Normal	1 1/32	
CLA	URF	OB IB	Burst	20 1	
CLB	S/C	OB IB	Normal	1 1/32	
CLB	S/C	OB IB	Burst	20 1	
CLC	Celestial Coords.	OB IB	Normal	1 1/32	
CLC	Celestial Coords.	OB IB	Burst	20 1	
CLF	S/C	OB IB	Averaged		1 and 60 1 and 60
CLG	Celestial Coords.	OB IB	Averaged		1 and 60 1 and 60
CLH	Celestial Coords.	OB IB	Burst n/a	20 n/a	

An in depth overview about the filename convention is given in Figure 10.

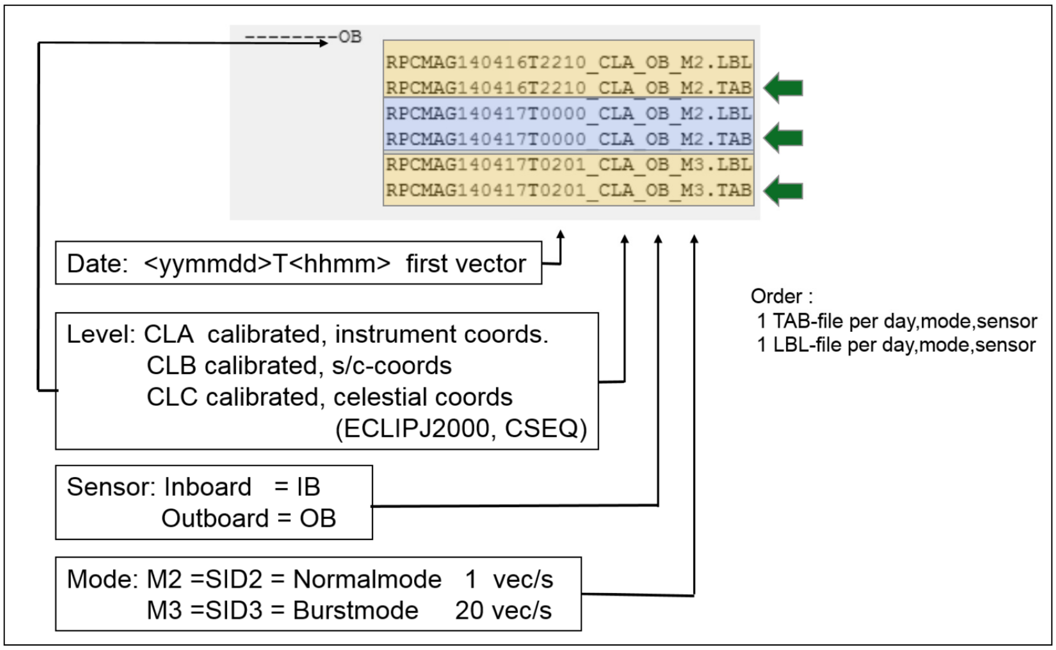


Figure 10: Filename Convention for the Data Files

For each day where measurements are available a pair of files (data: *.TAB, labels: *.LBL) exists for each occurring mode and sensor. The filenames consist of the instrument name RPCMAG, the Date/Time group (yymmddThhmm) of the first vector in the file, the calibration level (CLx), the sensor name (IB/OB) and the measurement mode (M2(Normal mode), OB: 1 Hz & IB: 1/32 Hz; M3(Burst mode), OB: 20 Hz & IB: 1 Hz). If mode changes were present on the actual day, files for every mode were generated. If e.g. RPCMAG was operated in Normal mode (M2) from 03:00 - 05:00 and from 19:00-23:00 all data of this mode can be found in ONE specific file for this day, labeled with M2. There is a data gap from 05:00 - 19:00 in this file. If the instrument was operated also in Burst mode (M3) on this day, e.g. from 05:00 -12:00, all these data were stored in a different file, labeled with M3. Thus, one file only contains data of ONE mode.

3.4.1 The *.TAB files

An example of CLC data (Calibrated data in celestial coordinates) is presented in Figure 11. The *.TAB files contain the very table of the data. CLC already denotes, that the data are given in a celestial system, but not in which one. That information can only be found in the related label file *.LBL.

RPCMAG140417T0000_CLC_OB_M2.TAB

Time UTC	OBT s.frac frac:0-65535	POSX km	POSY km	POSZ km	BX nT	BY nT	BZ nT	QFLAGS x, 0-9
2014-04-17T00:00:41.077980	356313576.07578	2694384.52	-1758894.4	-538312.14	0.63	-0.33	2.48	xx4x1003
2014-04-17T00:00:42.078929	356313577.07641	2694383.85	-1758894.02	-538312	0.59	-0.34	2.5	xx4x1003
2014-04-17T00:00:43.079879	356313578.07703	2694383.19	-1758893.64	-538311.87	0.56	-0.35	2.52	xx4x1003
2014-04-17T00:00:44.080828	356313579.07765	2694382.52	-1758893.26	-538311.73	0.55	-0.36	2.54	xx4x1003
2014-04-17T00:00:45.081778	356313580.07827	2694381.85	-1758892.88	-538311.59	0.55	-0.36	2.54	xx4x1003
2014-04-17T00:00:46.082727	356313581.07890	2694381.19	-1758892.5	-538311.46	0.59	-0.35	2.52	xx4x1003
2014-04-17T00:00:47.083676	356313582.07952	2694380.52	-1758892.12	-538311.32	0.6	-0.37	2.49	xx4x1003
2014-04-17T00:00:48.084626	356313583.08014	2694379.85	-1758891.74	-538311.18	0.59	-0.34	2.5	xx4x1003
2014-04-17T00:00:49.085575	356313584.08076	2694379.19	-1758891.36	-538311.05	0.56	-0.34	2.49	xx4x1003
2014-04-17T00:00:50.086525	356313585.08139	2694378.52	-1758890.98	-538310.91	0.56	-0.31	2.5	xx4x1003

Figure 11: Example of an ASCII measurement table saved in a *.TAB file.

All *.TAB file follow the same construction rules. The first two columns are always the time in UTC and the Onboard Time (OBT) in relative second. The fractional part of the OBT are NOT decimal fractional seconds but just a counter running from 0 to 65535. The OBT has, in general, not to be considered for standard scientific analyses. The conversion from OBT to UTC is done using the standard ESA conversion procedure as described in detail in the Technical Note *RO-EST-TN-3165_1_1_Rosetta_Time_Handling_2006Feb28.pdf*. Thus, all necessary corrections for spacecraft clock drifts and signal propagation delays are automatically taken into account in the right way.

The next three columns are the components (x,y,z) of the actual position vector of the S/C, in the coordinate system, defined in the related label file. The following three columns represent the magnetic field vector (Bx,By,Bz) in the specific coordinate system stated in the label file as well.

Finally the last column is a string of characters representing the quality flags of the actual magnetic field observation. The format and meaning of these flags are also defined in the related label file (see next section).

3.4.2 The *.LBL files

The label files contain useful information of the actual measurement and the necessary description of the columns of the *.TAB files whereas the *.TAB files contain only the very table of the data.

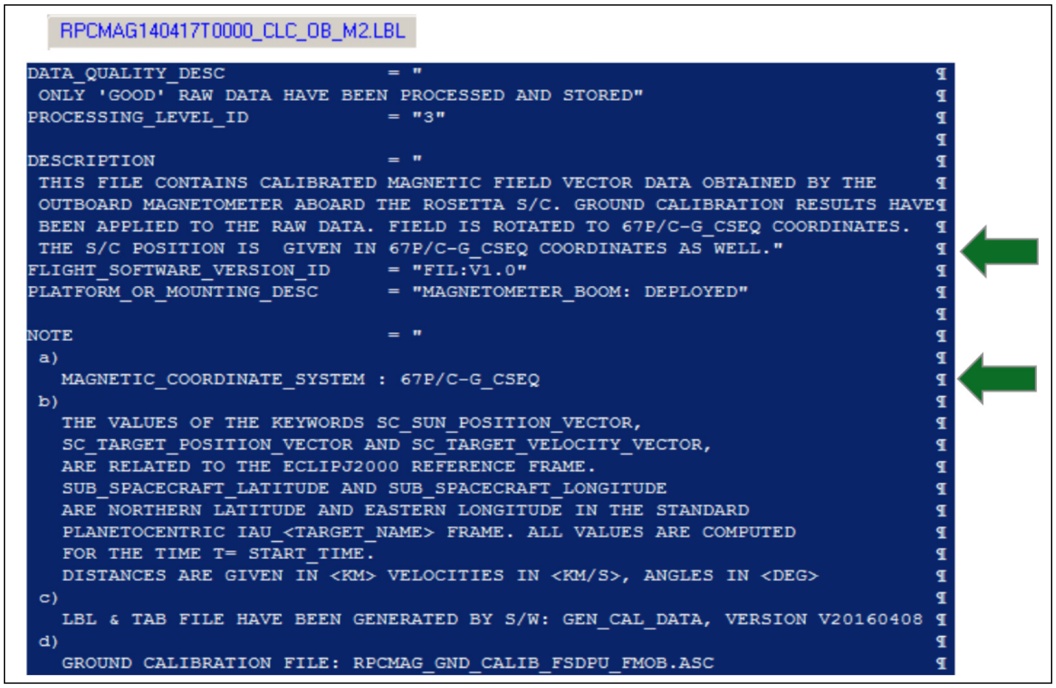
Figure 12 shows an excerpt of a typical PDS3 compliant label file. It contains relevant keywords as right column, describing the actual mission, instrument, observation, measurement interval, used mode, coordinate systems, the column description of the *.TAB files, the quality flags and additional information.

RPCMAG140417T0000_CLC_OB_M2.LBL

```
PDS_VERSION_ID                  = PDS3                                    ¶
LABEL_REVISION_NOTE             = "V1.0"                                  ¶
RECORD_TYPE                     = FIXED_LENGTH                            ¶
RECORD_BYTES                    = 125                                     ¶
FILE_RECORDS                    = 7168                                    ¶
DATA_SET_ID                     = "RO-SS-RPCMAG-3-PRL-CALIBRATED-V6.0"    ¶
DATA_SET_NAME = "ROSETTA-ORBITER SW RPCMAG 3 PRL CALIBRATED V6.0"         ¶
PRODUCT_ID                      = "RPCMAG140417T0000_CLC_OB_M2"           ¶
PRODUCT_CREATION_TIME           = 2016-04-21T11:41:00                     ¶
PRODUCT_TYPE                    = "RDR"                                   ¶
MISSION_ID                      = "ROSETTA"                               ¶
MISSION_NAME                    = "INTERNATIONAL ROSETTA MISSION"         ¶
MISSION_PHASE_NAME              = "PRELANDING"                            ¶
OBSERVATION_TYPE                = "COMMISSIONING"                         ¶
INSTRUMENT_HOST_ID              = "RO"                                    ¶
INSTRUMENT_HOST_NAME            = "ROSETTA-ORBITER"                       ¶
INSTRUMENT_ID                   = "RPCMAG"                                ¶
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - FLUXGATE MAGNETOMETER"      ¶
INSTRUMENT_TYPE                 = "MAGNETOMETER"                          ¶
INSTRUMENT_MODE_ID              = "SID2"                                  ¶
INSTRUMENT_MODE_DESC            = "                                       ¶
 NORMAL MODE: 32 PRIMARY & 1 SECONDARY VECTORS PER 32 SECONDS"            ¶
TARGET_NAME                     = "CHECKOUT"                              ¶
TARGET_TYPE                     = "N/A"                                   ¶
```

Figure 12: Excerpt of an ASCII Label *.LBL file

Figure 13 reveals, where the necessary information about the used coordinate system is provided. There are two coordinate systems which have not necessarily to be identical. One system builds the reference frame for the S/C location w.r.t. to a certain celestial body (SUN, EARTH, 67P,...) and the other one is the base for the magnetic field vector, which is in general the CSEQ-system for cometary observations and e.g. the ECLPJ2000 frame for most of the measurements during the cruise phases.



```
RPCMAG140417T0000_CLC_OB_M2.LBL

DATA_QUALITY_DESC              = "
 ONLY 'GOOD' RAW DATA HAVE BEEN PROCESSED AND STORED"
PROCESSING_LEVEL_ID            = "3"

DESCRIPTION                    = "
 THIS FILE CONTAINS CALIBRATED MAGNETIC FIELD VECTOR DATA OBTAINED BY THE
 OUTBOARD MAGNETOMETER ABOARD THE ROSETTA S/C. GROUND CALIBRATION RESULTS HAVE
 BEEN APPLIED TO THE RAW DATA. FIELD IS ROTATED TO 67P/C-G_CSEQ COORDINATES.
 THE S/C POSITION IS  GIVEN IN 67P/C-G_CSEQ COORDINATES AS WELL."
FLIGHT_SOFTWARE_VERSION_ID     = "FIL:V1.0"
PLATFORM_OR_MOUNTING_DESC      = "MAGNETOMETER_BOOM: DEPLOYED"

NOTE                           = "
 a)
   MAGNETIC_COORDINATE_SYSTEM : 67P/C-G_CSEQ
 b)
   THE VALUES OF THE KEYWORDS SC_SUN_POSITION_VECTOR,
   SC_TARGET_POSITION_VECTOR AND SC_TARGET_VELOCITY_VECTOR,
   ARE RELATED TO THE ECLIPJ2000 REFERENCE FRAME.
   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 T= START_TIME.
   DISTANCES ARE GIVEN IN <KM> VELOCITIES IN <KM/S>, ANGLES IN <DEG>
 c)
   LBL & TAB FILE HAVE BEEN GENERATED BY S/W: GEN_CAL_DATA, VERSION V20160408
 d)
   GROUND CALIBRATION FILE: RPCMAG_GND_CALIB_FSDPU_FMOB.ASC
```

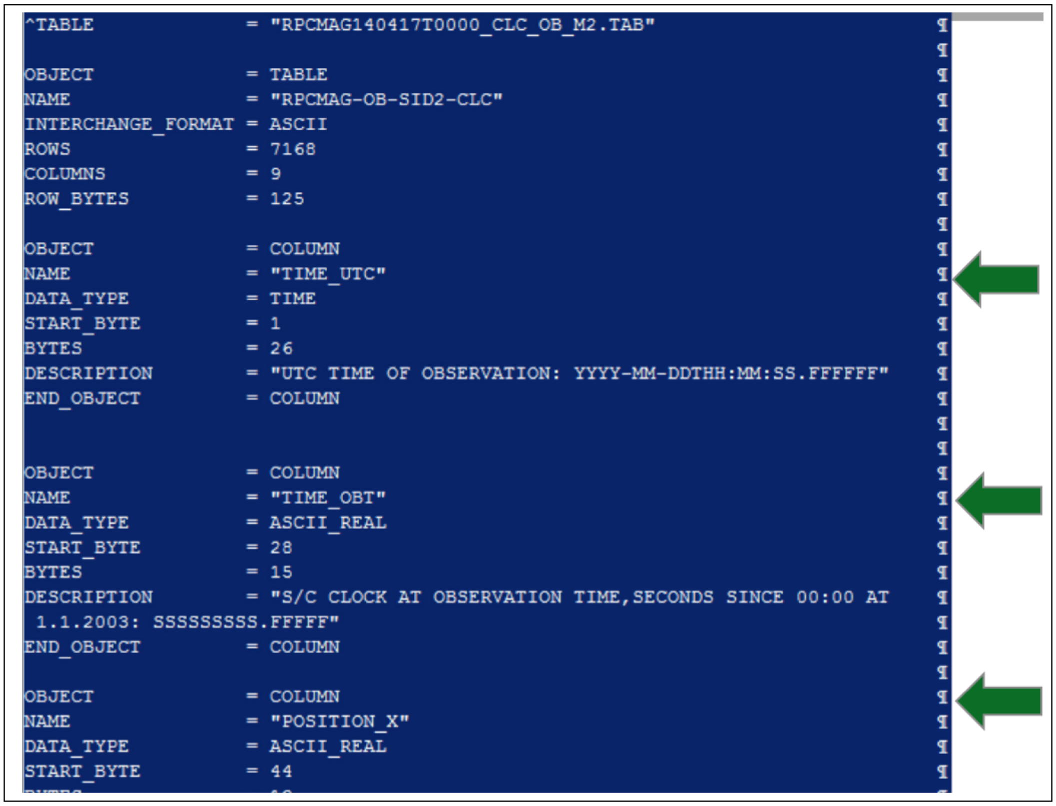
Figure 13: Details of an ASCII Label *.LBL file: Coordinate Systems

The CSEQ frame is defined in the related SPICE frame kernel provided by the SPICE group:

The body-Centered Solar EQuatorial (CSEQ) frames for the Rosetta primary target comet 67P/Churyumov-Gerasimenko and secondary target asteroid 21/LUTETIA are named '67P/C-G_CSEQ' and '21/LUTETIA_CSEQ'. These frames are defined as a two-vector style dynamic frames as follows:

- *+X axis is the position of the Sun relative to the body; it's the primary vector and points from the body to the Sun;*
- *+Z axis is the component of the Sun's north pole of date orthogonal to the +X axis;*
- *+Y axis completes the right-handed reference frame;*
- *The origin of this frame is the body's center of mass.*

Figure 14 displays the relevant lines of a label file defining the content of the table file columns.



```
^TABLE              = "RPCMAG140417T0000_CLC_OB_M2.TAB"

OBJECT              = TABLE
NAME                = "RPCMAG-OB-SID2-CLC"
INTERCHANGE_FORMAT  = ASCII
ROWS                = 7168
COLUMNS             = 9
ROW_BYTES           = 125

OBJECT              = COLUMN
NAME                = "TIME_UTC"
DATA_TYPE           = TIME
START_BYTE          = 1
BYTES               = 26
DESCRIPTION         = "UTC TIME OF OBSERVATION: YYYY-MM-DDTHH:MM:SS.FFFFFF"
END_OBJECT          = COLUMN


OBJECT              = COLUMN
NAME                = "TIME_OBT"
DATA_TYPE           = ASCII_REAL
START_BYTE          = 28
BYTES               = 15
DESCRIPTION         = "S/C CLOCK AT OBSERVATION TIME,SECONDS SINCE 00:00 AT
 1.1.2003: SSSSSSSSS.FFFFF"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
NAME                = "POSITION_X"
DATA_TYPE           = ASCII_REAL
START_BYTE          = 44
```

Figure 14: Details of an ASCII Label *.LBL file: Column Description

For each existing column the name, physical unit, and description is stated here. Thus the table files are unambiguously defined by these entries.

Figure 15 finally displays an excerpt of the quality flag description included in each data label file. The quality string consists of 11 chars of hexadecimal numbers from 0. . .F. Each column describes a specific disturbance diminishing the quality of the magnetic field data. The coding of each column is disturbance dependent and listed in the description field of the actual flag. To be able to compress the needed information in a single hex digit, the specific properties are partly binary and/or—coded, as described in the label file. For a complete quality flag description refer to section 5.]

```
DESCRIPTION        = "
 These flags describe the quality of the magnetic field data.
 The quality is coded in a 11 byte string. Each character can have
 the following values:
  VALUE:     MEANING:
   x         property described by flag is still unknown
   0         no disturbance, good quality
   1..9,A..F specific disturbance/problems, see below
             Value is hexadecimal coded

 Description of the specific flags:

 FLAG-STRING  FLAG  DESCRIPTION
 BA987654321
 ----------:   1    RELATION BETWEEN IB AND OB SENSOR (binary coded)
 ----------:   1    Digit  3 2 1 0 : Value
 ----------:   1                   :  x   no assessment
 ----------:   1               0 0 :  0   Difference < 1nT , PERFECT
 ----------:   1               0 1 : +1   Difference < 2nT , GOOD
 ----------:   1               1 0 : +2   Difference < 4nT , AMPLE
 ----------:   1               1 1 : +3   Difference > 4nT , POOR
 ----------:   1             1     : +4   IB Temperature drifting
 ----------:   1           1       : +8   OB Temperature drifting

 ---------:    2     PERCENTAGE OB / IB  DIFFERENCE
 ---------:    2     x = no assessment
 ---------:    2     0 = deviation < 10 \%, PERFECT CORRELATION
 ---------:    2     1 = deviation < 20 \%, GOOD CORRELATION
 ---------:    2     2 = deviation < 50 \%, AMPLE CORRELATION
 ---------:    2     3 = deviation > 50 \%, POOR CORRELATION

 --------:     3     IMPACT OF REACTION WHEELS AND LAP DISTURBANCE
 --------:     3     x = impact not assessed
 --------:     3     0 = probably no disturbance
 --------:     3     1 = disturbance eliminated during data analysis
 --------:     3     2 = disturbance possible
 --------:     3     3 = disturbance not clear
 --------:     3     4 = data disturbed, cleaned CLH data available
 --------:     3     5 = data disturbed, elimination not possible

 -------:      4     VARIOUS DISTURBANCE EFFECTS
 -------:      4     x = no assessment
 -------:      4     0 = no other problems detected
 -------:      4     1 = severe heater impact at EAR1 eliminated
 -------:      4     2 = severe heater impact at EAR1,about 2nTpp PWM
 -------:      4     3 = S/C 28 V Power failure
 -------:      4     4 = dT/dt > threshold, no thermal equilibrium
 -------:      4     5 = data disturbed by AC-signal, origin at S/C
 -------:      4     6 = data noisy due to power on failure
 -------:      4     7 = ADC latch-up:bit error.Final data corrected!
 -------:      4     8 = sensor saturated due to huge external field
 -------:      4     9 = sensor saturated, instrument power on failed
```

Figure 15: Details of an ASCII Label *.LBL file: Quality Flag Description

4 Disturbance of Magnetic Field Observations

This chapter shall give a broad overview of disturbance sources causing the magnetic field data quality to be diminished. As the RPCMAG sensors are located on a stub boom of only 1.5 m length, the operation in the interference field of the ROSETTA orbiter cannot be avoided.

The following list summarizes the detected and investigated disturbers (so far ...):

- Currents:
  - Heaters
  - P/L , S/C-S/S
  - PHILAE
  - ...
- Movable magnetic parts:
  - Thrusters
  - Reaction Wheels
  - PHILAE
  - ...
- Temperature effects
  - RPCMAG-Sensors
  - ...

Although the sensors are located very close together - the separation distance is only 15 cm - they are measuring disturbing magnetic s/c fields in a different way, as the disturbing sources onboard the spacecraft have different distances and orientations to both sensors. Therefore, every signal which appears with different amplitudes on both sensors can be interpreted as disturbance, whereas signals of the same amplitude are supposed to be of external, plasmaphysical origin. Thus the difference (OB-IB) of the sensor data is a good disturbance indicator.

The temporal occurrence of the disturbances is manifold. All the sources located on the Lander PHILAE (hibernation heaters, experiment heaters of experiments COSAC and PTOLEMY, the known ground loop to the ROSETTA orbiter via PHILAE's umbilical) are only effective until PHILAE was separated at 2014-11-12T08:35.

In contrast, e.g ROSETTA's thruster disturbances occur periodically during every orbit correction manoeuvre (OCM) and every wheel offloading manoeuvre (WOL). Details can be found in the operation LOGBOOKS and the quality flag columns of the data files. The reaction wheels (RW) are causing permanent AC disturbances as these wheels control the s/c attitude all the time.

All these disturbance - but RW signatures - are too complex to be eliminated from the data. Therefore they are only flagged and not reomved (see chapter 5 for details).

In the next sections observed examples of the specific disturbance sources listed above will be presented in depths.

4.1 Heater Signatures

Figure 16 shows a impressive example of magnetic disturbances caused by s/c heaters. On the first view the 3 magnetic field components of the OB sensor, displayed for an 24 h interval on March 3, 2004, look quite normal. However, zooming into the data and stretching the interval to 30 minutes, reveals a periodic rectangular distortion of roughly 1 nT peak to peak amplitude and 32 s period. An analysis of the s/c showed that these oscillations are caused by periodically switched heaters on the Lander PHILAE. The heaters are used to stabilize temperatures of specific spacecraft subsystems. They are operated electrically with relatively high power in order to provide enough heat. As the heater feeders are not twisted or shielded, the heater currents generate uncompensated magnetic fields which are detected by the RPCMAG sensors. The heater signature observed in this example can be seen always once these heaters are operated. Details can be found in the related quality flag. The disturbance could not be removed automatically using the difference of OB-IB data, as both sensors are always operated with different sampling rates.

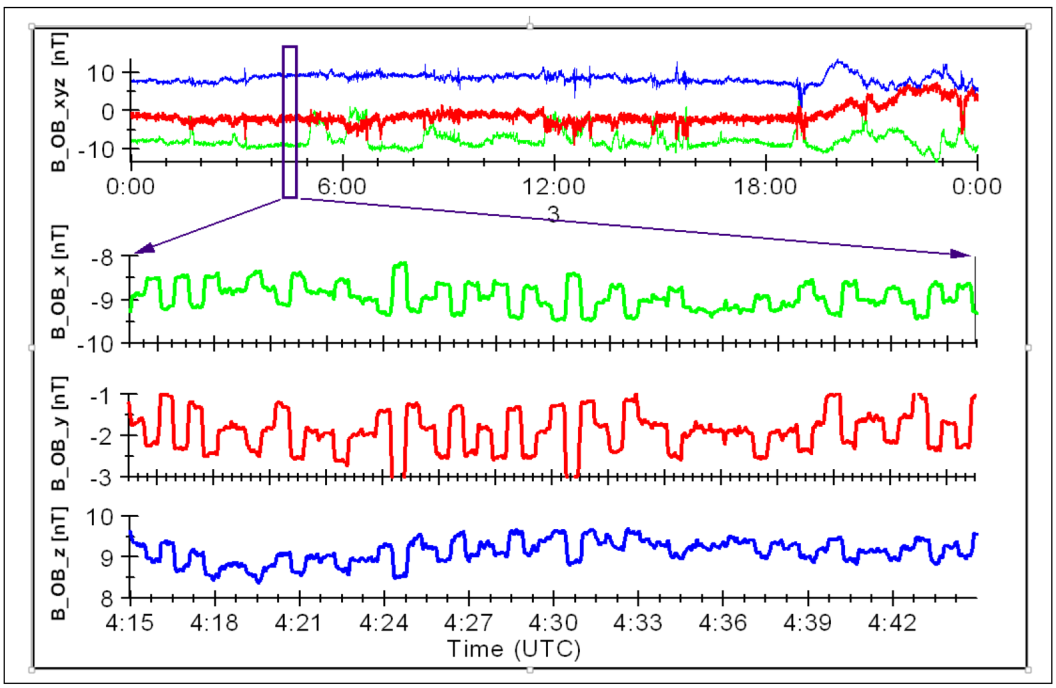


Figure 16: Disturbance: Influence of PHILAE Heater Currents measured at the OB Sensor

Figure 17 shows an example of heater disturbance as well. This observation has been made with the Lander magnetometer ROMAP, and reveals a very noisy signal in the order of 100 nT peak to peak amplitude. Here the waveform consists of a rectangular carrier and additional rectangular pulse-width-modulated signal. The duty cycle varies in a wide range. The peaks vary from short spikes to about 5 s long pulses.

The source of this disturbance are the heaters of the MUPUS instrument onboard the Lander PHILAE. They were tested during the first Earth swing-by in March 2005. The signature was only seen on the Lander magnetometer ROMAP, as RPCMAG was never operated while MUPUS was switched on and PHILAE was still attached to the orbiter.

There are lots of heaters located on ROSETTA which are operated from time to time and can cause disturbances. Some of them are covered by the noise floor, some are visible. Disturbing heaters are indicated by the data quality flagging system as far as they are known and identified. The PHILAE heaters do not harm anymore in the later comet phases after the separation of PHILAE on 2014-11-12T08:35.

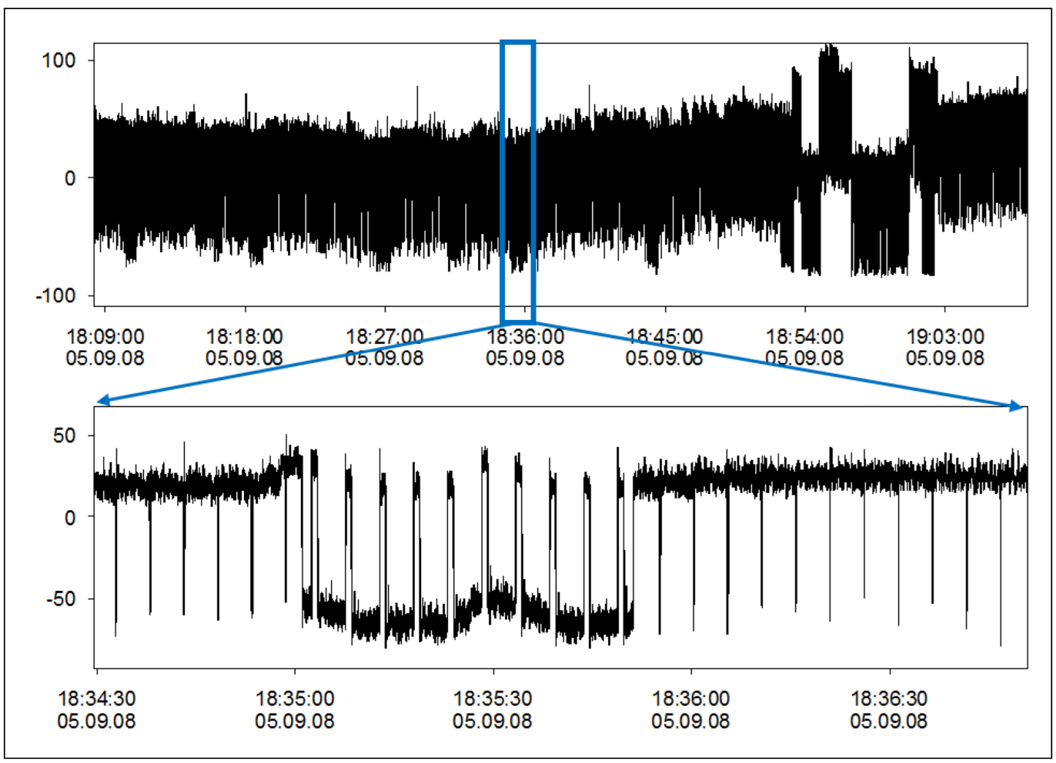


Figure 17: Disturbance: Influence of MUPUS Heaters measured with LANDER magnetometer ROMAP.

4.2 Payload Interference by the Lander Instruments COSAC and PTOLEMY

An excerpt of a magnetic field observation made during the LUTETIA fly-by in July 2010 is displayed in Figure 18. Here the very specific interference of the Lander experiments COSAC (gray) and PTOLEMY (magenta) can be seen and analyzed. The switch on/ switch off sequence of PTOLEMY causes magnetic field jumps in the order of 2 nT, measured at the RPCMAG OB sensor. Furthermore the the operation of this instrument is accompanied by some non specified noise of about 0.5 nT peak to peak amplitude.

The operation of the COSAC instrument can unambiguously be identified in the magnetic field data. A very specific step pattern of constant shape and timing appears on all three components as seen in the graph.

Again, the knowledge of this kind of interference is mandatory in order to avoid any misinterpretation of the data.

PTOLEMY and COSAC were only operated once in the mission in parallel to RPCMAG operations before the separation of PHILAE at 2014-11-12T08:35.

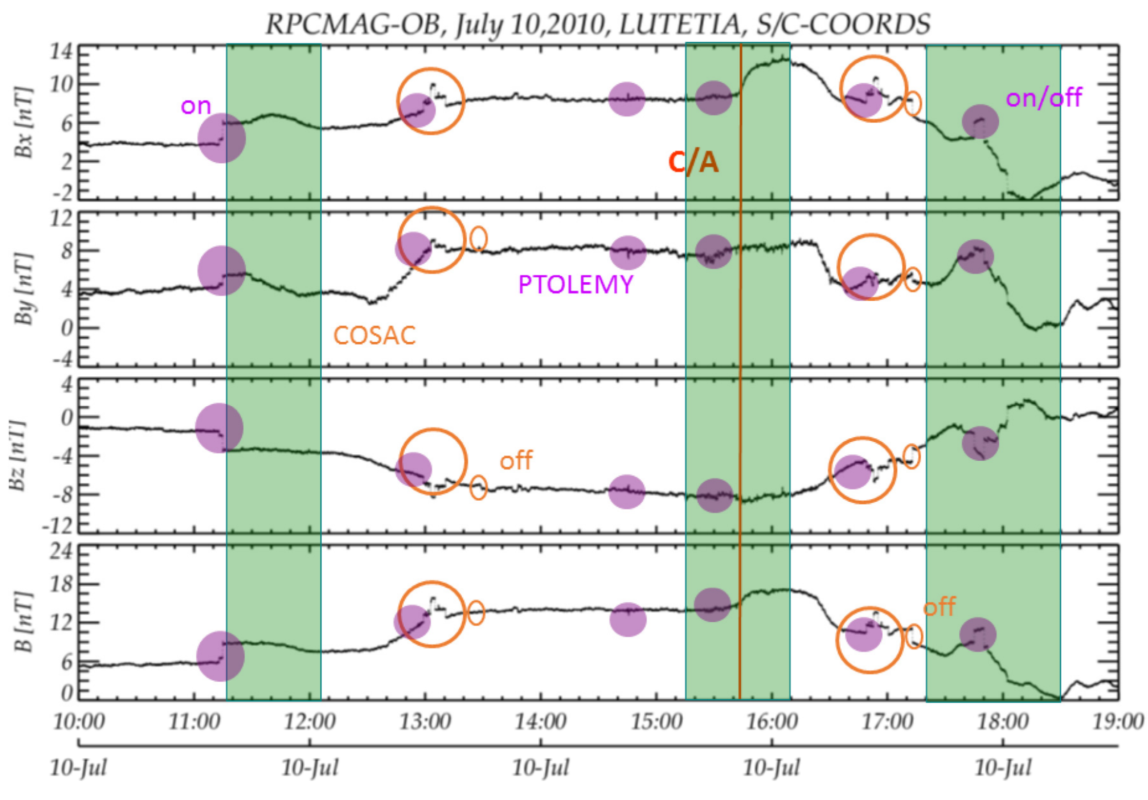


Figure 18: Disturbance: Influence of the PTOLEMY & COSAC Instruments as seen by the RPC-MAG OB Sensor

4.3 Interference of S/C Thrusters during Reaction Wheel Offloading (WOL) and Orbit Correction Manoeuvres (OCM)

In this section examples of s/c thruster disturbances are presented. Figure 19 shows magnetic field data observed during the frequently occurring Wheel Offloading Phases (WOL) and Figure 20 displays the magnetic circumstances during a typical Orbit Correction Manoeuvre (OCM).

A WOL is necessary to spin down the Reaction Wheels of the ROSETTA S/C from time to time in order to stay in the operational limits of the wheel revolutions per time unit. The stability of the S/C attitude during such phases is guaranteed using cold gas thrusters providing thrust in the needed directions. The latch valves of these thrusters contain movable magnetic parts which alter the residual magnetic field of the S/C during activation. Thus every WOL is accompanied by a specific magnetic signature seen at the RPCMAG sensors.
Figure 19 shows the 3 magnetic field components of the OB sensor for an interval of roughly 5 minutes on November 20, 2015. A clear jump of -3 nT is present on the magnetic field By-component (s/c-coordinates) - and only there. A comparison with the s/c command history list reveals that such a jump always occurs 5 s after issuing the specific WOL command ZAC20188. The duration, however, is changing individually. No HK parameter is available indicating the end of such a sequence. But the endurance is in general in the order of 3 minutes. Therefore, the WOL signatures cannot be eliminated but only flagged using a manually determined interval.

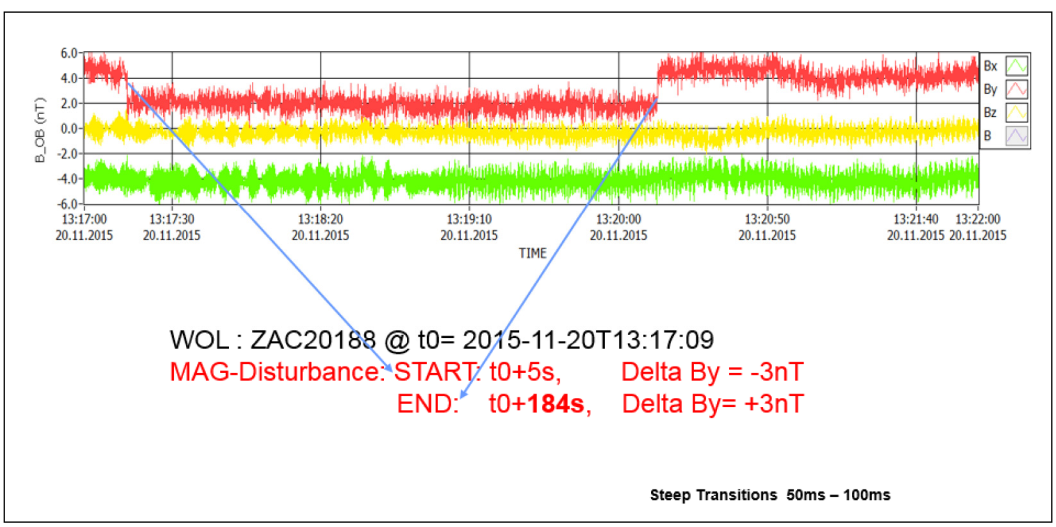


Figure 19: Disturbance: Influence of the Thruster Activity during Wheel Offloadings (WOL) observed at RPCMAG-OB

The next disturbance, occurring during the OCMs, is also caused by the s/c thrusters, but showing a completely different signature. During WOLs the S/C attitude stays constant, whereas OCMs are used in order to change the s/c trajectory and attitude. Therefore, the thruster activation times are usually longer but the manoeuvres need to happen infrequently.

The upper panel of Figure 20 shows the 3 magnetic field components of the OB sensor for an interval of roughly 3 hours. In the time period 09:00 – 09:13 a shift of the field of ~ 2 nT and an increased distortion level of ~ 6 nT peak to peak can be seen. The disturbance always starts 12 s after initiating the OCM by the command ZAC20116.

The zoomed view in the lower panel reveals details of the disturbance. As seen already during the WOL sequence, the By-component(red) jumps initially by ~ -3 nT. Additionally an AC disturbance is present on the Bx- and Bz-components, indicating that the thrusters are operated by short (200 ms width) periodic (626 mHz) pulses. These frequencies are autonomously controlled and vary specifically with every individual OCM. Due to this complex distortion structure only a flagging of the polluted time intervals is possible but no automatic purging of the data. Therefore, all disturbed vectors have been individually flagged.

The WOL abundance during the cruise phase was quite seldom, during the comet phase it happened in general twice a day. OCMs happened more irregularly, very occasionally. Refer to our WOL and OCM disturbance reports, provided with each dataset, for details and timelines.

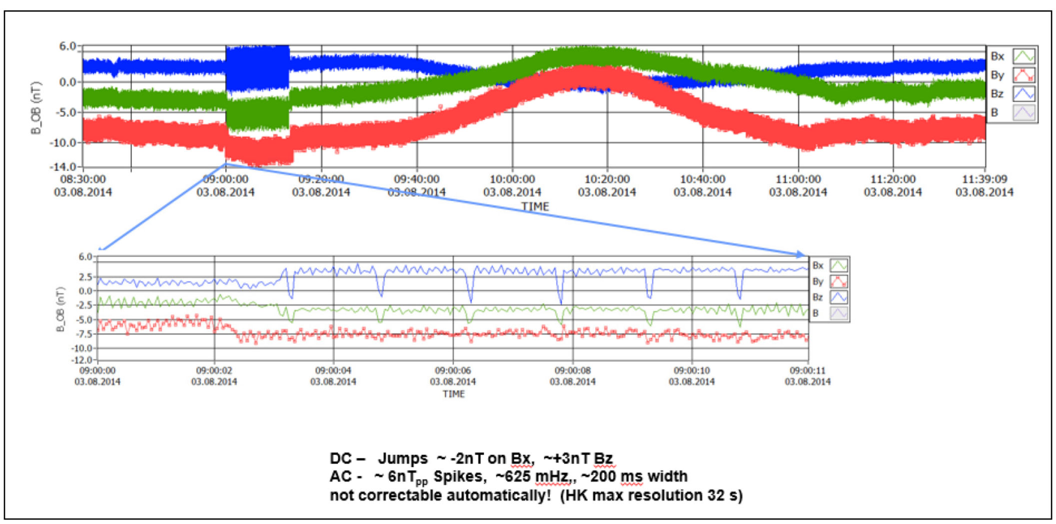


Figure 20: Disturbance: Influence of the Thruster Activity during Orbit Correction Manoeuvres (OCM) observed at RPCMAG-OB

4.4 High Frequency Disturbance caused by Reaction Wheels

A completely different disturbance is caused directly be ROSETTAs reaction wheels (RW). It is not completely clear whether either the wheels are magnetic or the oscillating drive currents are causing magnetic interference. In any case higher frequent, time varying, signals are observed by the magnetometer in the order of 2 nT peak to peak. ROSETTA is equipped with 4 wheels rotating at 4 different speeds. The rotations are accompanied with oscillations whose frequencies are much higher than the sampling frequency of the magnetometer (Burstmode: 20 Hz, Normalmode: 1 Hz). Therefore, the original frequencies are folded down to the sampling range and mirrored at zero and half the sampling frequency according to the Nyquist theorem.

An example of such a distortion is shown in Figure 21. Here the dynamic spectra of the three magnetic field component are displayed for a time interval of about twelve hours at November 9, 2004. The tilted lines appearing in the dynamic spectra of the magnetic field data represent the disturbing frequencies. As the instrument was operated in Burstmode here, the sampling rate was 20 Hz. The curved lines about 16:00 witness a successful commanded roll of the spacecraft.

4.4.1 Elimination Algorithm of Reaction Wheel Signatures

The actual rotation speed of the wheels is known from the related HK data, and the folding of the signal down into the measurement range of 0 - 10 Hz can be described analytically, therefore the actual occurring disturbing frequencies are known exactly. With this knowledge it is possible to eliminate these disturbances from the data: Just cut out the occurring frequencies in the fourier transformed data, set the level of the generated "hole" to the spectral background level of the vicinity of the assigned data point and transform the data back to the time domain. Data which have been treated this way are generated as our standard CLH data product. It has to be mentioned that the elimination only works for the OB Burstmode data (20 Hz sampling frequency). All data of lower sampling rates show the discussed disturbance at lower frequencies where a distinction between wanted and the noise signal becomes impossible, at least for an automatic algorithm. Therefore, CLH data only exist for OB M3 data. In the CLH data the original sampling rate of 20 Hz is kept, no averaging is done here. They are archived as RESAMPLED data, because the data had to be resampled due to Fourier back and forth transformation.

More details can be found in the calibration procedure RO-IGEP-TR0028.

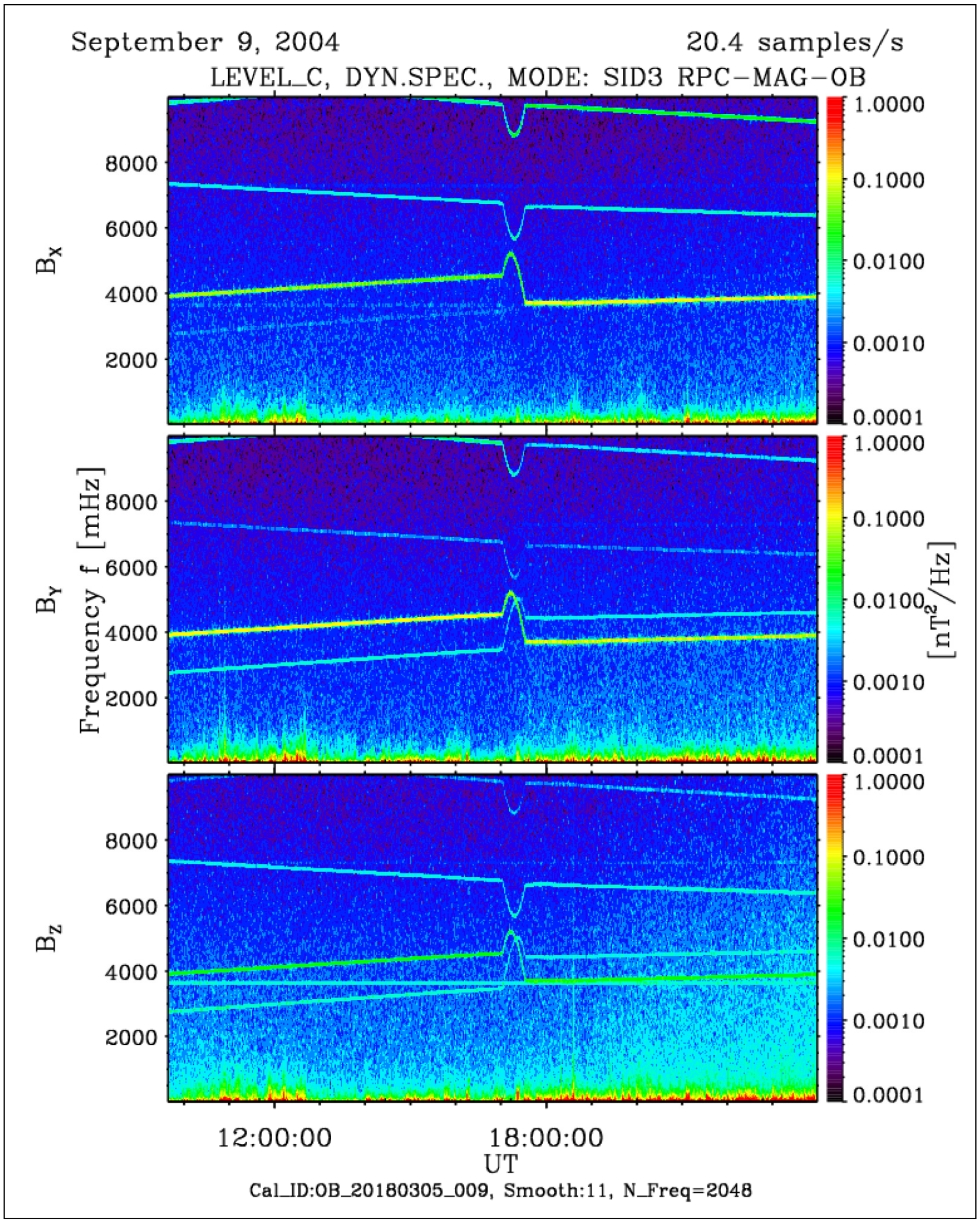


Figure 21: Disturbance: Interference by S/C-Reaction Wheels. Dynamic spectra from RPCMAG-OB Burstmode data at 20Hz (M3 mode).

4.4.2 Pitfall Example of a WOL/Wave-Signature

Figure 22 shows again the example of the WOL discussed in section 4.3 but now under a different aspect. A coarse optical inspection of e.g the Bx-component (green) in the upper panel could entrap a scientist to speculate about present plasma waves here. Without knowledge of any RW signatures this would be a reasonable guess! If one, however, uses the related CLH data (shown in the lower panel), which are purged of any RW disturbance, it is clear that the assumed waves are not present anymore.

Thus be reminded that pitfalls are everywhere!

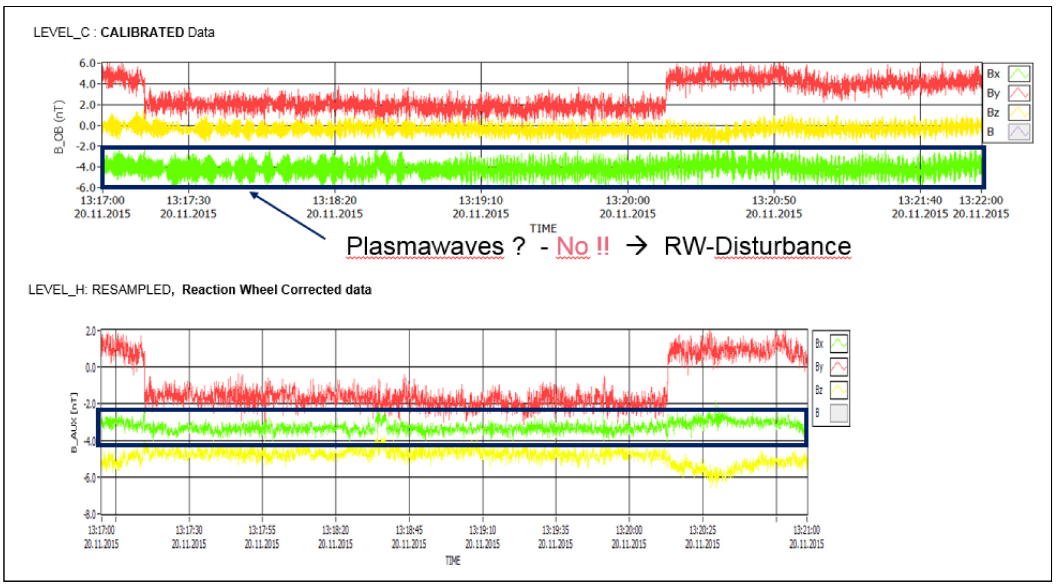


Figure 22: Disturbance: Interference by S/C-Reaction Wheels - Pitfalls! Top Panel: MAG-OB Burstmode Data at 20Hz, Lower Panel: MAG-OB resampled (1Hz) and high Frequency RW Effect removed.

4.5 Additional sources of Disturbance and Data Quality decreasing Issues

Besides the disturbing sources already discussed in the sections above some more shall be listed now in a brief overview. All features are taken into account in our magnetic field data quality flag system described in chapter 5. More details about disturbances can also be found the in the *EAICD, RO_IGEP_TR0009.* and in the *DATA_SUMMARY_REPORTS* coming along with each dataset.

- Magnetic Latch Valves of all Thrusters
- Pyro firing during boom deployment
- Distortion by Lander Activation while still attached to ROSETTA.
- Lander Survival Heater
- Lander Hibernation Heater
- High frequency distortion by LAP instrument at at constant frequencies of 3.2 Hz or 3.6 Hz and an amplitude of about 1 nT.
- Unspecified S/C AC signals
- Transient S/C effects
- Temperature Effects on the RPCMAG sensors

5 Quality flags

As shown in the previous sections magnetic field data measured onboard a s/c can be disturbed and influenced by various entities, leading to a decreased level of data quality. Not only the data itself but some auxiliary information has been collected from various sites in a troublesome process being used to establish the data flagging system described here in detail. In order to get an idea about the data quality a qualitative and – where possible – a quantitative assessment criterion has to be created. For the RPCMAG data this is achieved by a system of data quality flags which are set at the end of the data processing chain. As the data quality is a time dependent entity, each magnetic field vector needs to be flagged individually. Therefore, each magnetic field vector in the CALIBRATED and RESAMPLED data files gets a flag-string (to be found at the end of each row in the *.TAB files). These flag strings have a length of 11 characters. Each character/position of the string represents a specific property of quality diminishment. Each of these 11 variables is enciphered by an alphanumerical (hexadecimal) code with the general meaning:

VALUE:	MEANING:
x	Property described by flag is unknown, no assessment has been / can be made
0	No disturbance, good quality
1..9,A..F	Specific disturbance/problems, specific codes: see section 5.1, In general higher numbers represent more severe quality diminishments.

The specific flag definition as given in section 5.1 is an open and expandable scheme. For the actual situation known problems are covered, however, more details i.e. subitems could be added if necessary.

General data quality flagging strategy:

- **ALL magnetic field vectors get quality flags related to the actual state.**
- **ALL vectors will be kept in the data file, even if flagged as "bad".**
- **Data are NOT changed, only flagged.**

5.1 Quality Flags Description

FLAG-STRING POSITION B A 9 8 7 6 5 4 3 2 1	FLAG	DESCRIPTION
- - - - - - - - - - 1	1	RELATION BETWEEN IB AND OB SENSOR (binary coded)
- - - - - - - - - - 1	1	Digit 3 2 1 0 : Value
- - - - - - - - - - 1	1	: x no assessment
- - - - - - - - - - 1	1	0 0 : 0 Difference < 1nT , PERFECT
- - - - - - - - - - 1	1	0 1 : +1 Difference < 2nT , GOOD
- - - - - - - - - - 1	1	1 0 : +2 Difference < 4nT , AMPLE
- - - - - - - - - - 1	1	1 1 : +3 Difference > 4nT , POOR
- - - - - - - - - - 1	1	1 : +4 IB Temperature drifting
- - - - - - - - - - 1	1	1 : +8 OB Temperature drifting
- - - - - - - - - 2 -	2	PERCENTAGE OB / IB DIFFERENCE
- - - - - - - - - 2 -	2	x = no assessment
- - - - - - - - - 2 -	2	0 = deviation < 10 %, PERFECT CORRELATION
- - - - - - - - - 2 -	2	1 = deviation < 20 %, GOOD CORRELATION
- - - - - - - - - 2 -	2	2 = deviation < 50 %, AMPLE CORRELATION
- - - - - - - - - 2 -	2	3 = deviation > 50 %, POOR CORRELATION
- - - - - - - - 3 - -	3	IMPACT OF REACTION WHEELS AND LAP DISTURBANCE
- - - - - - - - 3 - -	3	x = impact not assessed
- - - - - - - - 3 - -	3	0 = probably no disturbance
- - - - - - - - 3 - -	3	1 = disturbance eliminated during data analysis
- - - - - - - - 3 - -	3	2 = disturbance possible
- - - - - - - - 3 - -	3	3 = disturbance not clear
- - - - - - - - 3 - -	3	4 = data disturbed, cleaned CLH data available
- - - - - - - - 3 - -	3	5 = data disturbed, elimination not possible
- - - - - - - 4 - - -	4	VARIOUS DISTURBANCE EFFECTS
- - - - - - - 4 - - -	4	x = no assessment
- - - - - - - 4 - - -	4	0 = no other problems detected
- - - - - - - 4 - - -	4	1 = severe heater impact at EAR1 eliminated
- - - - - - - 4 - - -	4	2 = severe heater impact at EAR1,about 2nTpp PWM
- - - - - - - 4 - - -	4	3 = S/C 28 V Power failure
- - - - - - - 4 - - -	4	4 = dT/dt > threshold, no thermal equilibrium
- - - - - - - 4 - - -	4	5 = data disturbed by AC-signal, origin at S/C
- - - - - - - 4 - - -	4	6 = data noisy due to power on failure
- - - - - - - 4 - - -	4	7 = ADC latch-up:bit error.Final data corrected!
- - - - - - - 4 - - -	4	8 = sensor saturated due to huge external field
- - - - - - - 4 - - -	4	9 = sensor saturated, instrument power on failed
- - - - - - 5 - - - -	5	LANDER HEATER STATUS (binary coded)
- - - - - - 5 - - - -	5	digit 3 2 1 0 :Value
- - - - - - 5 - - - -	5	: x no assessment
- - - - - - 5 - - - -	5	1 : +1 MSS1 off/on (0/1)
- - - - - - 5 - - - -	5	1 : +2 MSS2 off/on (0/1)
- - - - - - 5 - - - -	5	1 : +4 HIB1 off/on (0/1)
- - - - - - 5 - - - -	5	1 : +8 HIB2 off/on (0/1)
- - - - - 6 - - - - -	6	LANDER P/L STATUS (binary coded)
- - - - - 6 - - - - -	6	digit 3 2 1 0 :Value
- - - - - 6 - - - - -	6	: x no assessment
- - - - - 6 - - - - -	6	1 : +1 COSAC off/on (0/1)
- - - - - 6 - - - - -	6	1 : +2 COSAC active (0/1)
- - - - - 6 - - - - -	6	1 : +4 PTOLEMY off/on (0/1)
- - - - - 6 - - - - -	6	1 : +8 PTOLEMY active (0/1)

- - - - 7 - - - - - - -	7	LANDER STATUS (binary coded)
- - - - 7 - - - - - - -	7	digit 3 2 1 0 :Value
- - - - 7 - - - - - - -	7	: x no assessment
- - - - 7 - - - - - - -	7	1 : +1 Lander detached/attached (0/1)
- - - - 7 - - - - - - -	7	2 : +2 ROMAP data available (0/1)
- - - - 7 - - - - - - -	7	4 : +4 LANDER off/on (0/1)
- - - - 7 - - - - - - -	7	8 : +8 Separation ongoing (0/1)
- - - 8 - - - - - - - -	8	BOOM DEPLOYMENT:
- - - 8 - - - - - - - -	8	x = no assessment
- - - 8 - - - - - - - -	8	0 = boom deployed
- - - 8 - - - - - - - -	8	1 = boom stowed
- - - 8 - - - - - - - -	8	2 = boom deployment ongoing. Data only valid
- - - 8 - - - - - - - -	8	in instrument coordinates
- - - 8 - - - - - - - -	8	3 = pyros fired for boom release
- - 9 - - - - - - - - -	9	IMPACT OF WHEEL OFFLOADING MANOEUVRE (WOL)
- - 9 - - - - - - - - -	9	x = no assessment
- - 9 - - - - - - - - -	9	0 = WOL not active
- - 9 - - - - - - - - -	9	1 = WOL active, no disturbance visible
- - 9 - - - - - - - - -	9	2 = Start of WOL not visible
- - 9 - - - - - - - - -	9	3 = End of WOL not visible
- - 9 - - - - - - - - -	9	4 = WOL completely visible
- A - - - - - - - - - -	A	IMPACT OF ORBITAL CORRECTION MANOEUVRE (OCM)
- A - - - - - - - - - -	A	x = no assessment
- A - - - - - - - - - -	A	0 = OCM not active
- A - - - - - - - - - -	A	1 = OCM active, no disturbance visible
- A - - - - - - - - - -	A	2 = Jump visible (in B and/or dB/dt)
- A - - - - - - - - - -	A	3 = Comb-disturbance visible (in B and/or dB/dt)
- A - - - - - - - - - -	A	4 = Jump and comb visible
- A - - - - - - - - - -	A	5 = no data during OCM
B - - - - - - - - - - -	B	PLASMA ENVIRONMENT
B - - - - - - - - - - -	B	x = no assessment
B - - - - - - - - - - -	B	0 = Cavity
B - - - - - - - - - - -	B	1 = pure solar wind
B - - - - - - - - - - -	B	2 = cometary influenced solar wind
B - - - - - - - - - - -	B	3 = pure cometary environment, sw not present
B - - - - - - - - - - -	B	4 = Earth swing-by
B - - - - - - - - - - -	B	5 = Mars swing-by
B - - - - - - - - - - -	B	6 = Steins fly-by
B - - - - - - - - - - -	B	7 = Lutetia fly-by

5.2 Quality decreasing Entities

- Offset/residual-field related Effects – Quality Flag 1 and 2
  It's a known fact that the quality of magnetic field measurements is inter alia strongly dependent on the

  - sensor offset
  - s/c residual-field

  The sensor offset is a temperature dependent entity, which has been calibrated on ground in a limited temperature range. Using inflight data it was possible to create an improved temperature offset-model for an extended temperature range. Thus, the sensor offset can be calibrated if the sensor is in thermal equilibrium. In phases of fast changing temperatures (e.g. a fly-by with a fast varying pointing) the actual offset might not be computed correctly. Therefore data might drift during such phases.

  Additionally the s/c residual field affects the magnetic field measurements strongly. Changes in the s/c residual field (either drifts or jumps) occur quite often due to varying payload or s/c-subsystem activities. Reasons are varying currents, moving magnetic parts or temperature effects acting on spacecraft parts and causing magnetic properties to be changed.
  The magnetic cleanliness requirements for the ROSETTA s/c were far from the requirements applied to e.g. the CLUSTER spacecrafts. Therefore, a very limited magnetic cleanliness program yielded a relatively noisy and "magnetically dirty" ROSETTA satellite which generates the disturbances seen in the magnetic field data during flight.

- Correlation between Inboard (IB) and Outboard (OB) Sensor – Quality Flag 1,2,4
  Under ideal conditions the IB and OB sensor measure the same field. This perfect situation can, however, be declined by different effects:

  - different temperature dynamics (e.g. due to different shadowing and different solar irradiation) cause different offset behavior of both sensors.
  - due to different locations the sensors measure the disturbing sources of the s/c in different ways. Therefore, changing s/c fields produce different impacts at the locations of the sensors and cause the correlation between the sensor data to be decreased.
  - often the real offset of the sensors is not as important as a good common AC-behavior. Thus, the short term "high frequent" behavior can be acceptable where as the long term behavior is poor due to offset or s/c residual-field drifts. This possible characteristics can be reflected by the flagging system.

  The different thermal behavior of the sensors is characterized using the either the combined indicator I_c:

$$I_c = \frac{\partial(T_{\mathrm{OB}} - T_{\mathrm{IB}})}{\partial t}$$

and also the individual temperature change rates

$$I_{\mathrm{OB}} = \frac{\partial T_{\mathrm{OB}}}{\partial t}$$
$$I_{\mathrm{IB}} = \frac{\partial T_{\mathrm{IB}}}{\partial t}.$$

They are used do obtain a quantitative measure of the thermal behavior. If I_c exceeds the threshold level of $\frac{0.1\mathrm{mK}}{\mathrm{s}}$ (empirically chosen) the data in the overview plots will be marked by violet-stripes, indicating that the thermal equilibrium is not reached, and that the time series of both sensors can show different trends. In this case Bit 4 of Quality Flag 4 will be set.
If individual indicators $I_{OB,IB}$ exceed a threshold of $\frac{0.5\mathrm{mK}}{\mathrm{s}}$ the data will be marked by solid-violet boxes and Bit 2 (IB) and /or Bit 3 (OB) of quality flag 1 will be set.

- Reaction Wheels (RW) – Quality Flag 3
  The 4 reaction wheels of the ROSETTA s/c generate varying magnetic fields due to the rotating magnetic material. The changing frequency is known; if burst mode (20Hz sampling for OB) data are present, the disturbance can in general be eliminated by transformation of the data into the frequency domain and damping the affected frequencies down to background noise. The AC disturbance caused by the RWs is in the order of 3 nT. Due to the nature of the occurring frequencies data measured in normal mode (OB: 1 Hz & IB: 1/32 Hz) are in general not disturbed. In case of disturbance, however, elimination is hardly possible due to the amplitude and bandwidth of the disturbance, which covers the full spectral range of the wanted signal.

- LAP disturbance – Quality Flag 3
  The LAP disturbance occurs at constant frequencies of 3.2 Hz or 3.6 Hz. The mechanism of creating this disturbance is unknown to the LAP-team, but as it appears at a constant level (about 1 nT) and constant frequencies, the elimination can be done quite easily during the purging of the reaction wheel impact. Purged data can be found in CLH data.

- Various disturbance effects by other impacts – Quality Flag 4
  Various effects are imaginable causing the magnetic field data quality to be not optimal. Using data collected during the past years of the ROSETTA mission lots of disturbers could be identified. However, often the situation on the s/c was so complex, especially at the "high activity" times during the fly-bys, that neither the disturbers could be identified individually nor the disturbing signals were very clear. In these cases the disturbance is obvious, a flag indicating that the data are not clean is necessary, but the real polluter can not be named. Currently defined

categories for such case are:

– data disturbed by pulses originated in s/c

– data disturbed by AC signals originated in s/c

A second set of problems relates to the RPCMAG instrument itself:

– data noisy due to "power on" failure
– data not computable due to thermistor failure
– sensor saturated due to huge external field
– sensor saturated, instrument power on sequence failed

It happened once in the mission that the "power on" command was received by PIU but not executed by MAG. A reboot of the system solved the problem. Such a behavior can occur very sporadically (it is very unlikely) due to critical link timing issues; in this case, PIU sends TM data, which are just random noise.

It might happen that a sensor thermistor breaks (extremely unlikely). Then temperature data is not available and the temperature offset-model cannot by applied, i.e. calibrated data cannot be produced in the standard way.

The sensor is designed for a field limit of about ±16000 nT. Therefore, the instrument got saturated for some minutes during the Earth flybys due to the high external field. These circumstances can be indicated by the flag system as well.

It might also happen (once in the mission) that the instrument suffers a latch up during the "power on" sequence causing the ADCs to send 0xFFFFF (pretending saturation). This can be indicated by a flag as well. The solution for these cases is also rebooting the MAG instrument.

- Lander: Heater Currents and P/L activation – Quality Flag 5 and 6
  During mission phases where the ROSETTA Lander PHILAE was operated, disturbances caused by various heaters of PHILAE P/L instruments were detected. Those heaters were operated continuously or pulsed (PWM) with periods in the order of a few seconds to minutes. The flowing currents caused magnetic signatures in the order of 2 nT. For certain mission phases these disturbances could semi-manually be eliminated.

- Lander – Quality Flag 7
  The Lander and the wiring concept of the ROSETTA - PHILAE system causes many disturbances as long as PHILAE is connected to ROSETTA. Therefore, all data will be flagged, if PHILAE is present and especially if it is activated. The separation of PHILAE on November 12, 2014 caused a field jump of about 20 nT. The exact jump is taken into account for the final data calibration model of the RPCMAG data.

- Boom Deployment – Quality Flag 8
  During the commissioning phase in March 2004 the magnetometer boom was deployed, changing its orientation from the stowed position to the final deployed orientation. The whole procedure took about 2 hours. During this time interval the residual magnetic field of the s/c measured by the moving RPCMAG sensors changed dramatically (a few hundred nT), as the distance to the disturbing sources located on the s/c changed. In the deployed boom orientation, which is stable since that time, the residual-field and the disturbance/noise level caused by the s/c is much less than in the stowed boom orientation (Therefore the sensors are mounted on the boom ...!).

- Orbit correction (OCM) and Wheel Offloading (WOL) Manoeuvres –
  Quality Flag 9 and A.
  The major attitude changes of ROSETTA are performed using thrusters comprising magnetic valves. Once the thrusters are activated, the movable valve magnets cause also shifts in the magnetic fields recorded with the RPCMAG sensors. Therefore, all these manoeuvre times are flagged in detail in different way, reflecting different disturbances. The disturbance can either be just field shifts or even periodic pulses (626 mHz). The disturbance level is up to 6 nT and can be present up to 20 minutes for the big manoeuvres.

All the effects discussed above can diminish the data quality. If this happens in any way, an appropriate flag (described in the table above) will be set.

Furthermore a final quality Flag (Flag B) has been created to describe the plasma/celestial environment a the actual time. Thus, phases as cavity, solar wind, cometary influenced solar wind or the swing-bys at Earth and Mars can easily be identified.

Remark: There might by users who ask themselves, why the data of the IB and OB sensor are delivered separately and not just a common "magnetic field product". This is unfortunately not possible, as the spacial separation distance of both sensors is – due to boom design constraints – only 15 cm. Furthermore – due to TM budget limitations – the sensors are sampled at different rates; the OB sensor is always sampled at a higher vector rate. Addditionally the disturbance sources onboard the s/c are manifold in temporal and spacial distribution. Therefore, a disturbance elimination using the OB-IB difference correction has little prospect to success and therefore the data of both sensors are archived individually. Most of the time the OB data are the "better" ones, but there are occasional terms where the IB observations shine like diamonds in the darkness of the noisefloor.....

6 Checklist for a proper Usage of RPCMAG Data

- Read documentation!!!!!!!
  - EAICD (RO-IGEP-TR0009)
  - Instrument-Paper (Glassmeier K.-H., Richter I., et al., RPC-MAG — The Fluxgate Magnetometer in the ROSETTA Plasma Consortium, Space Science Reviews (2007) 128: 649–670,DOI: 10.1007/s11214-006-9114-x)
  - INSTRUMENT.CAT
  - DATASET.CAT
  - LOGBOOK.ASC
  - AAREADME.TXT,
  - *.LBL-files
- Check Quality Flags
  - Do not use heavily flagged data
- In case of doubt:
  - Check s/c attitude change
  - Check sensor temperature change
  - Check thruster activation state (WOL, OCM)
  - Compare IB / OB signatures
- For High frequency research ($>$ 1 Hz):
  - Check actual RW frequencies
- Don't trust offset + S/C-residual field dependent quantities @ small fields!
  The magnitude $\mid \underline{B} \mid = \sqrt{\sum_i (B_i + Off_i)^2}$ is calculated by the the root of the sum of squared offset and spacecraft residual afflicted magnetic field components. With uncertain S/C-residual field- and offset-components, the magnitude becomes uncertain in a non-linear way, possibly depicting a strange trend. This is not only a simple additive shift but a variable displacement, possibly leading to misinterpretation.

  Similarly, for magnetic field angles like $\alpha = \arctan\left(\frac{B_i + Off_i}{B_j + Off_j}\right)$ the same care has to be exercised. The division of entities of the same order which are afflicted by errors can produce very uncertain results, especially if the errors are in the order of the actual field components. Thus be careful when calculating and interpreting angles!
- Filtered Data
  An additional point to be mentioned is the filtering of the data. Burstmode OB data are sampled with 20 Hz and pass all the processing chain unchanged from the

instrument via telemetry to the calibration pipeline. The normalmode data, however, show an effective vector rate of 1Hz, which is accomplished by digital filtering inside PIU, using a two stage FIR decimator with -3 dB cutoff at 0.3 Hz and final damping of about -130 dB starting at ~ 1.8 Hz. This very steep filter characteristic was also used for the generation of 1s averaged data for the RESAMPLED datasets, in order to keep the spectral characteristics of the normalmode data also for the averaged burstmode data. Otherwise the noise properties would have changed within one datafile at the transitions from one mode to another. Therefore, RESAMPLED data are good for quicklook purposes, but should not be used for wave investigations as the amplitudes in the 0.1 - 0.5 Hz range are damped much more as if have been filtered by a standard - even higher order - 1Hz Butterworth low-pass.
In essence, spectral analyses should be conducted using the original burstmode data if available.

- For remaining questions & Publications:
  - Contact RPCMAG-Team
    Contact details can be found in the RPCMAG_PERS.CAT provided with each dataset.

7 WARNINGS

7.1 General WARNING for Data User

All effects described above lead to disturbed data which can only partly be improved by sophisticated software. Thus the quality flags of the magnetic field vectors should be observed carefully to avoid misinterpretation of contaminated data.

All data have been processed on best effort base, nevertheless mistakes might slip in always. The data processing is done mostly automatically whereas the quality assessment can only be performed semi-automatically or manually. If a quality flag of a value $\neq 0$ is set, it does not automatically mean that the data are not usable for scientific purposes. One just should be careful and use these data with keen mind.

7.2 WARNING for Reaction Wheel Corrected LEVEL_H Data Usage

All LEVEL_H data have been automatically generated, which in general led to good results. Nevertheless it can happen that artificial structures appear in the LEVEL_H data, which are not present in the LEVEL_C source data. This will mainly happen during observations of steep transitions or high level magnetic fields.**Especially between Spring 2015 and Spring 2016 the environmental magnetic conditions are complex leading to potential failures in the described data cleaning. Therefore, in case of using LEVEL_H data, we highly recommend to compare these data to the original LEVEL_C data, and to check the existence of any artificial structures.**

A Acronym List

Acronym	Description
A/D:	Analog/Digital
A/R:	As Required
AAD:	Attitude Anomaly Detector
AC:	Alternate Current
ACID:	Application Configuration Interface Data
ACK:	Acknowledge
ACM:	Active Cruise Mode
ACS:	Avionics Computer System
ACS:	Attitude Control System
ACU:	Attitude Control Unit
AD:	Applicable Document
ADC:	Analog-Digital-Converter
ADD:	Architectural Design Document
ADP:	Acceptance Data Package
AFM:	Asteroid Flyby Mode
AIT:	Assembly Integration Tests
AIU:	AOCMS Interface Unit
AIV:	Assembly, Integration and Verification
ALICE:	ORBITER PAYLOAD INSTRUMENT
ALS:	Alenia Spazio
AM:	Activation Mode
AME:	Absolute Measurement Error
AND:	Alphanumeric Display
ANSI:	American National Standards Institute
AO:	Announcement of Opportunity
AOCMS:	Attitude & Orbit Control Measurement System
AOCS:	Attitude and Orbit Control System
AOS:	Acquisition Of Signal
AOU:	Astronomical Observatory Uppsala
APC:	Active Payload Checkout
APD:	Active Payload Data Dump
APE:	Absolute Pointing Error
APID:	Application Process Identifier
APM:	Antenna Pointing Mechanism
APXS:	LANDER PAYLOAD INSTRUMENT
AQP:	Acquisition Period
AS:	Address State (1750 Processor)
ASA:	Austrian Space Agency
ASAP:	As soon as possible
ASF:	Additional Safety Factors

ASI:	Agenzia Spaziale Italiana
ASIC:	Application Specific Integrated Circuit
ATA:	Alignment Test Adapter
ATP:	Approach Transition Point
AU:	Astronomical Unit
AWG:	American Wire Gauge
BB:	Broad Band
BC:	Bus Controller
BCP1:	Broadcast Command Pulse
BCU:	Battery Charge Unit
BDR:	Battery Discharge Regulator
BDU:	Battery Discharge Unit
BER:	Bit Error Rate
B-FIELD:	Magnetic Field
BFL:	Back Focal Length
BIT:	Build In Test
BL:	Block Length, LAP
BMOS:	Buckling Margin Of Safety
BOB:	Break Out Box
BOL:	Beginning of Life
BPS:	Bits per second
BRU:	Battery Regulator Unit, Battery Recharge Unit
BSM:	Bus Support Module
C/C:	Collectively Controlled
CA:	Contract Authorisation
CADU:	Channel Access Data Unit
CAP:	Comet Acquisition Point
CAPS:	Cassini Plasma Spectrometer
CAV:	Command Acceptance Verification
CC:	Cost Code
CCB:	Configuration Control Board
CCCS:	Common Checkout & Control System
CCD:	Charged Coupled Device
CCDB:	Configuration Control Database
CCE:	Central Checkout Equipment
CCITT:	Consultative Committee International Telegraph & Telephone
CCN:	Change Contract Notice
CCR:	Configuration Control Request
CCS:	Central Check-out System
CCSDS:	Consultative Committee for Space Data Systems
CCU:	Central Computing Unit
CDC:	Clock Drift Correction
CDMS:	Central Data Management System
CDMU:	Central Data Management Unit

CDR:	Critical Design Review
CDV:	Command Dispatch Verification
CE:	Conducted Emission
CESR:	Centre d'Etude Spatiale des Rayonnements
CEV:	Command Execution Verification
CFRP:	Carbon Fibre Reinforced Plastic
CG:	67P/Churyumov-Gerasimenko
CGSE:	Cryocooling Ground Support Equipment
CHF:	Critical History File
CHL:	Command History Log
CHM:	Critical Housekeeping Unit
CI:	Configuration Item
CIA:	Communication Interface Adapter
CIDL:	Configuration Item Data List
CISAS:	Centro Interdipartimentale di Studi e Attivit... Spaziali
CIVA:	Comet nucleus Infrared and Visibility Analyser (Lander Payload)
CLA:	Calibration level A, data in URF coordinates
CLB:	Calibration level B, data in S/C coordinates
CLC:	Calibration level C, data in celestial coordinates
CLCW:	Command Link Control Word
CLE:	Calibration level E, resampled data in URF coordinates
CLF:	Calibration level F, resampled data in S/C coordinates
CLG:	Calibration level G, resampled data in celestial coordinates
CLH:	Calibration level H, RW disturbance eliminated data in celestial coordinates
CLTU:	Command Link Transmission Unit
CM:	Configuration Management
CMD:	Command
CMF:	Configuration Management Facility
CMO:	Configuration Management Officer
CMP:	Configuration Management Plan
CNES:	Centre Nationale d'Etude Spatiale
COB:	Consolidated Obeservation Request
COG:	Centre Of Gravity
Co-I:	Co-Investigator
COM:	Centre Of Mass
CONSERT:	ORBITER & LANDER PAYLOAD INSTRUMENTs
COP:	Command Operations Procedure
COSAC:	LANDER PAYLOAD INSTRUMENT
COSIMA:	ORBITER PAYLOAD INSTRUMENT
COTS:	Commercial Off The Shelf
CPDU:	Command Pulse Distribution Unit
CPU:	Central Processing Unit
CR:	Compression Ratio
CRAF:	Comet Rendezvous and Asteroid Fly-by mission

CRB:	CCD Readout Board
CRC:	cyclic redundancy check
CRF:	Command Request Files
CRID:	Command Request Interface Document
CReMA:	Consolidated Report on Mission Analysis
CRP:	Contingency Recovery Procedure
CRV:	Command Station Reception Verification
CS:	Checksum
CS:	Conducted Susceptibility
CSEQ:	Comet-Centric-Solar-Equatorial Coordinates
CSG:	Centre Spatiale Guyanaise
CSM:	Communication Switching Matrix
CSME:	Communication Switching Matrix Element
CSP:	Charge Sensitive Preamplifier
CSPL:	Consolidated Parameter Scenario List
CSV:	Command Station Radiation Verification
CSY:	Converter Synchronisation
CTC:	Cost to Completion
CUC:	CCSDS Unsegmented Time Code
CuL:	Kupferlackdraht, Enamelled copper wire
CUV:	Command Uplink Verification
CVP:	Commissioning and Verification Phase
D&D:	Design and Development
D/L:	Down Link
D/TOS:	Directorate of Technical and Operational Support
DARA:	Deutsche Agentur fuer Raumfahrtangelegenheiten
DAT:	Digital Analog Tape
DAWG:	Data Archiving Working Group
DB:	Database
DBMS:	Data Base Management System
DC:	Data Centre
DC:	Direct Current
DCA:	Dedicated Control Area
DCL:	Declared Components List
DCR:	Document Change Request
DCR:	Data Change Request
DCR:	Dedicated Control Room
DCS:	Dust Collector Subsystem (COSIMA)
DCT:	Discrete Cosine Transform
DDD:	Detailed Design Document
DDID:	Data Delivery Interface Document
DDS:	Data Distribution System
DDV:	Design Development and Verification
DEF:	Deflector

DFMS:	Double Focusing Mass Spectrometer
DIB:	DPU Interface Board
DISR:	Descent Imager/Spectral Radiometer
DLR:	Deutsche Zentrum fuer Luft und Raumfahrt e.V.
DM:	Dynamic Model
DMA:	Direct Memory Access
DML:	Declared Materials List
DML:	Delayed Memory Load command
DMPL:	Declared Mechanical Parts List
DMS:	Data Management System
DMSS:	Distributed Mission Support System
DoD:	Depth of Discharge
DOF:	Degree Of Freedom
DOP:	Division Operating Procedures
DOR:	Direct Operation Request
DPL:	Declared Process List
DPSS:	Data Packet Switching System
DPU:	Digital Processing Unit
DQE:	Detector Quantum Efficiency
DRAM:	Dynamic Random Access Memory
DRB:	Delivery Review Board
DS:	Digital Serial Aquisition
DS-1:	NASA's Deepspace 1 Mission
DSDB:	Data Sheet Database
DSN:	Deep Space Network
DSP:	Digital Signal Processor
DSS:	Dornier Space Systems
DST:	Deep Space Transponder
DTMM:	Detailed Thermal Mathematical Model
DVAL:	ESA software to check PDS compliant datasets
DVALNG:	DVAL Next Generation
DWG:	Drawing
DWT:	Discrete Wavelet Transform
EAICD:	Experimenter to Archive Interface Control Document
ECDR:	Experiment Critical Design Review
ECF:	Expedited Command File
ECLIPJ2000:	Ecliptic J2000 Reference Frame
ECP:	Executable Control Procedures
ECR:	Expedite Command Request
ECR:	Engineering Change Request
EDAC:	Error Detection And Correction
EDC:	Error Detection Correction
EDF:	Experiment Description File
E-DSF:	Expedite - Detailed Schedule File

EE:	External Entity (SCOE)
EEPROM:	Electrically Erasable Programmable Read Only Memory
EFDR:	Experiment Final Design Review
EFOR:	Experiment Flight Operations Review
EGSE:	Electrical Ground Support Equipment
EID:	Event ID
EID:	Experiment Interface Document
EID:	Event Identification
EID-A:	Experiment Interface Document, Part A
EID-B:	Experiment Interface Document, Part B
EIDR:	Experiment Intermediate Design Review
EIRP:	Equivalent Isotropic Radiated Power
ELC:	Electron
EM:	Engineering Model
EMC:	ElectroMagnetic Compatibility
EMI:	ElectroMagnetic Interference
EOC:	End of Cycle
EOL:	End of Life
EOM:	End of Mission
EOP:	End of Packet
EPC:	Electrical Power Conditioner
EPS:	Electrical Power Subsystem
EPS:	Experiment Planning System
EQM:	Electrical Qualification Model
ERF:	Event Reporting Function
ERT:	Earth Received Time
ESA:	European Space Agency
ESA:	Electrostatic Analyzer
ESAC:	European Space Astronomy Centre
ESANET:	European Space Agency's communications Network
ESARAD:	ESA RADiation
ESATAN:	ESA Thermal Analyser
ESD:	Electrostatic Discharge
ESDS:	Electrostatic Discharge Sensitive
ESM:	Earth Strobing Mode
ESOC:	European Space Operations Centre
ESS:	Electrical Support System
ESTEC:	European Space Research and Technology Centre
ESTRACK:	European Space Tracking Network
ETS:	EMC Test Station
EUT:	Equipment under Test
EUV:	Extreme Ultra Violet
F/D:	Flight Dynamics
FAR:	Flight Acceptance Review

FAT:	Factory Acceptance Test
FAU:	File Assembly Unit
FCL:	Fold-Back Current Limiter
FCP:	Flight Control Procedure
FCS:	Flight Control System
FCT:	Flight Control Team
FCV:	Flow Control Valve
FD:	Flight Dynamics
FD:	Frequency Domain
FDIR:	Failure Detection, Isolation and Recovery
FDR:	Flight Dynamics (Control) Room
FDR:	Functional Design Review
FDR:	Flight Dynamics Request
FDS:	Flight Dynamics System
FE:	Front End
FEC:	Front End Controller
FEE:	Front End Equipment
FE-LAN:	Front-End Local Area Network
FEM:	Finite Element Model
FF:	Full Frame
FGM:	Fluxgate-Magnetometer
FID:	Function Identifier
FIFO:	First In First Out
FITO:	Fabrication and Test Outline
FM:	Flight Model
FM:	File Management
FMECA:	Failure Mode and Effects and Criticality Analysis
FMI:	Finnish Meteorological Institute
FMS:	Failure Management system
FMS:	File Management System
FOD:	Flight Operations Director
FOP:	Flight Operations Plan
FOP:	Flight Operation Procedure
FOV:	Field Of View
FP:	Formal Procedures
FPA:	Focal Plane Assembly
FPGA:	Field Programmable Gate Array
FRAP:	Fine Pointing Accuracy Phase
FRR:	Flight Readiness Review
FS:	Flight Spare
FSS:	First Science Sequence
FT:	File Transfer
FTA:	Fault Tree Analysis
FTP:	File Transfer Protocol

FTS:	File Transfer System
FUSE:	Far Ultraviolet Spectrograph Experiment
FUV:	Far Ultra Violet
FWM:	Filter Wheel Mechanism
G/S:	Ground Station
GFURD:	Ground Facilities User Requirements Document
GH:	Grand Heading
GIADA:	Grain Impact Analyser and Dust Accumulator (Orbiter Payload)
GLEP:	Pointing on Ephemeris Phase Phase with gyroless stellar estimator
GMI:	Global Mapping Insertion
GMT:	Greenwich Mean Time
GPIB:	General Purpose Instrument Bus (IEEE 488-75)
GPR:	Ground Penetrating Radar
GRD:	Graphic Display
GRM:	Ground Reference Model
GS:	Ground Station
GSDR:	Ground Segment Design Review
GSE:	Ground Support Equipment
GSEP:	Pointing on Ephemeris Phase Phase with Gyro-stellar estimator
GSIR:	Ground Segment Implementation Review
GSIS:	Ground Station Interface Specification
GSM:	Ground Segment Manager
GSMP:	Ground Segment Management Plan
GSOC:	German Space Operations Centre
GSP:	Ground commanded Slew Phase
GSRQR:	Ground Segment Requirements Review
GSRR:	Ground Segment Readiness Review
GW:	Gravitational Waves
H/W:	Hardware
HDBK:	Handbook
HDR:	Hardware Design Review
HF:	High Frequency
HFC:	High Frequency Clock
HGA:	High Gain Antenna
HGAPM:	HGA Pointing Mechanism
HIB:	Hibernation
HIPPS:	Highly Integrated Pluto Payload System
HK:	Housekeeping
HL:	High Limit
HM:	Hibernation Mode
HMC:	Halley Multicolour Camera
HOOD:	Hierarchical Object Oriented Design
HPA:	High Power Amplifier
HPC:	High Power Command

HPCM:	HPC Module
HPD:	High Performance Demodulator
HRM:	Holddown & Release Mechanism
HSD:	High Speed Data
HTCB:	Handling Transport Clamp Band
HV:	High Voltage
HVPS:	High Voltage Power Supply
I&T:	Integration & Testing
I/C:	Individually Controlled
I/F:	Interface
I/O:	Input/Output
IAA:	Instituto de Astrofisica de Andalucia
IABG:	Industrieanlagenbetriebsgesellschaft
IAS:	Institute d'Astrophysique Spatiale
IAS-CNR:	Istituto di Astrofisica Spaziale/Consiglio Nazionale delle Richerche
IB:	Inboard
I-BOB:	Intelligent Break Out Box
IC:	Imperial College, London
ICA:	RPC Ion Composition Analyzer
ICD:	Interface Control Document
ID:	Identifier
IDA:	Institut fuer Datenverarbeitungsanlagen
IDL:	Interactive Data Language
IDR:	Instrument Design Review
IEEE:	Institute of Electric and Electronics Engineers
IES:	RPC Ion and Electron Spectrometer
IF:	Intermediate Frequency
IFEM:	Interface Finite Element Model
IFOV:	Intrinsic Field Of View
IGEP:	Institut fuer Geophysik und extraterrestrische Physik, TU-Braunschweig
IMMM:	Interface Mechanical Mathematical Model
IMP:	Imager for Mars Pathfinder
INTA:	Instituto Nacional de Tecnica Aerospacial
IQR:	Internal Quality Report
IR:	Infra Red
IS:	Impact Sensor (GIADA)
ISO:	International Standards Organisation
IST:	Integrated System Test
IT:	Integration Test
IT:	Interruption
ITL:	Instrument Time Line
ITMM:	Interface Thermal Mathematical Model
ITP:	Integration Test Plan
ITR:	Integration Test Report

ITT:	Invitation To Tender
IUE:	Internal Ultraviolet Explorer
IWF:	Institut fuer Weltraumforschung, Graz
JPEG:	Joint Photographics Experts Group
JPL:	Jet Propulsion Laboratory
KAL:	Keep Alive Line
KAU:	Kilo Accounting Units
KBPS:	Kilo-Bits Per Second
KFKI:	Hungarian Research Institute for Particle and Nuclear Physics
KO:	Kick Off
L:	Launch (time)
LABVIEW:	Graphic S/W for Data analysis and H/W control
LAN:	Local Area Network
LAP:	RPC Langmuir Probe Experiment
LAS:	Laboratoire d'Astronomie Spatiale
LCB:	Last Chance Bit
LCDA:	Launcher Coupled Dynamic Analysis
LCL:	Latching Current Limiter
LDL:	Long Debye Length (LAP/MIP Mode)
LEOP:	Launch and Early Orbit Phase
LESS:	Lander Electrical Support System
LET:	Linear Energy Transfer
LEXAN:	Polycarbonate resin thermoplastic
LF:	Low Frequency
LGA:	Low Gain Antenna
LID:	Lander Interface Document
LIFO:	Last In First Out
LIGA:	Lithographie, Galvanoformung und Abformung
LILT:	Low Intensity Low Temperature
LISN:	Line Impedance Stabilization Network
LIT:	Listen-In Test
LL:	Low Limit
LM:	Launch Mode
LMSS:	Lander Mechanical Support and Separation systems
LNA:	Low Noise Amplifier
LO:	Local Oscillator
LOR:	Lander Operational Request
LOS:	Loss Of Signal
LOS:	Line Of Sight
LPCE:	Laboratoire de Physique et Chimie de l'Environnement
LRR:	Launch Readiness Review
LSB:	Least Significant Bit
LSI:	Large Scale Integration
LTP:	Long Term Planning

LU:	Latch Up
LV:	Latch Valve
LVO:	Label Value Object
LVPS:	Low Voltage Power Supply
LW:	Launch Window
LZ:	Lander = SSP
M&C:	Monitoring and Control
MAC:	Model Assurance Criterion
MACOR:	Machinable glas ceramic
MACS:	Modular Attitude Control System
MAG:	Fluxgate Magnetometer (RPC)
MAP:	Multiplexing Access Point
MAS:	Mission Analysis Section
MB:	Measurement Block
MBS:	Micro Balance Sensor (GIADA)
MC:	Measurement Cycle
MCF:	Magnetic Coil Facility
MCM:	Monitoring and Control Module
MCM:	Multi Chip Module
MC-OCF:	Master Channel ? Operational Control Field
MCP:	Micro Channel Plate
MCR:	Main Control Room
MCR:	Memory Checksum Request
MCRR:	Mission Commissioning Results Review
MCS:	Mission Control System
MDR:	Memory Dump Request
MGA:	Medium Gain Antenna
MGM:	Magnetometer
MGSE:	Mechanical Ground Support Equipment
MIB:	Mission Information Base
MICD:	Mechanical Interface Control Document
MID:	Memory Identifier
MIDAS:	ORBITER PAYLOAD INSTRUMENT
MINT:	Monitoring Interval
MIP:	RPC Mutual Impedance Probe
MIP:	Mission Implementation Plan
MIP:	Mandatory Inspection Points
MIRD:	Mission Implementation Requirements Document
MIRO:	Microwave Instrument for the Rosetta Orbiter (Orbiter Payload)
ML:	Memory Load, Medium Level
MLC:	Memory Load Command
MLI:	Multi Layer Insulation
MM:	Mass Memory
MM:	Memory Management

MMB:	Mass Memory Board
MMD:	Mimic Display
MMH:	Mono Methyl Hydrazine, (MMH-LTO)
MMI:	Man Machine Interface
MMS:	Matra Marconi Space
MMU:	Memory Management Unit
MOC:	Mission Operations Centre
MOD:	Mission Operations Department
MOI:	Moment Of Inertia
MOM:	Minutes of Meeting
MOP:	Mission Operations Phase
MOS:	Margin Of Safety
MOU:	Memorandum Of Understanding
MPA:	Mission Planning Area
MPAE:	Max Planck Institut fuer Aeronomie
MPI:	Max Planck Institut
MPIK:	Max Planck Institut fuer Kernphysik
MPP:	Multiple Phase Pinning
MPPT:	Maximum Power Point Tracking
MPR:	Memory Patch Request
MPS:	Mission Planning System
MPS:	Max Planck Institut fuer Sonnensystemforschung
MPTS:	Multi Purpose Tracking System
MRB:	Material Review Board
MRODE:	Magnetsrode Coil Facility, TUBS
MRT:	Mission Readiness Test
MSB:	Most Significant Bit
MSDR:	Mission System Design Review
MSP :	Master Science Plan
MSS:	Mechanical Support and Separation system
MSSW:	Mission Specific Software
MST:	Mission Simulation Test
MTL:	Mission Timeline
MTP:	Mid Term Planning
MTTR:	Mean Time To Repair
MUPUS:	Multi Purpose Sensor experiment (Lander Payload)
MUSC:	Microgravity User Support Centre
MUX:	Multiplexer
N/A:	Not Applicable
NAC:	Narrow Angle Camera
NACK:	Not Acknowledge
NAIF:	Navigation and Ancillary Information System of NASA
NASA:	National Aeronautics and Space Administration
NASAPSCN:	NASA Private System Communication Network

NASTRAN:	NASA Structural Analysis Tool
NAVCAM:	Navigation Camera
NB:	Narrow Band
NC:	Non Conformity
NCM:	Near Comet Mode
NCR:	Non Conformance Report
NCTRS:	Network Control and Telemetry Receiver System
NDIU:	Network Data Interface Unit
NDM:	Neutral Dynamics Monitor
NF:	Normal Frequency
NI:	Nation Instruments
NM:	Normal Mode
NOCC:	Network Operations Control Centre (JPL)
NRT:	Near Real Time
NRZ-L:	Never Return to Zero-Level
NTO:	Nitrogen Tetroxide
OA:	Operational Archive
OAP:	Off Axis Paraboloid
OB:	Onboard
OB:	Outboard
OBC:	On-Board Computer
OBC:	On-Board Clock
OBCP:	On-Board Control Procedure
OBDH:	On-Board Data Handling
OBEM:	On-Board Event Monitoring
OBR:	Observation Request
OBS:	On-Board Software
OBSM:	On-Board Software Maintenance
OBSW:	On-Board Software
OBT:	On-Board Time
OC:	Output Code
OC:	Open Centre
OCC:	Operations Control Centre
OCM:	Orbit Correction Manoeuvre
OCM:	Orbit Control Mode
OCXO:	Oven Controlled Crystal Oscillator
OD:	Operations Director
OGS:	Operations Ground Segment
OHP:	Observatoire d'Haute Provence
OIOR:	Orbiter Instrument Operational Request
OIP:	Orbit Injection Point
OM:	Operations Manager
OMM:	Operational Macro Mode
OOL:	Out Of Limits

OPAMP:	Operational Amplifier
OPI:	Orbiter Payload Instrument
OPS:	Operations
ORATOS:	Orbit Attitude Operations System
ORS:	Operation Request Structure
OSI:	Open System Interconnection
OSIRIS:	Optical, Spectroscopic and Infrared Remote Imaging System (Orbiter P/L)
OU:	Open University
P/B:	Play Back (data from Solid State Recorder)
P/L:	Payload
PA:	Product Assurance
PAIP:	Product Assurance Implementation Plan
PALASIM:	Parallel Access Large Silicon Memory
PC:	Project Control
PC:	Passive Checkout
PCA:	Pressure Controlled Assembly
PCAT:	Packet Category
PCB:	Printed Circuit Board
PCE:	Power Controller Electronics
PCM:	Pulse Code Modulation
PCM:	Power Converter Module
PCS:	Packet Check Sequence
PCU:	Power Control Unit
PDF:	Product Definition File
PDL:	Pseudo Design Language
PDOR:	Payload Direct Operation Request
PDR:	Preliminary Design Review
PDS :	Planetary Data System
PDU:	Power Distribution Unit
PEM:	Project Element Manager
PEM:	Plasma Environment Monitor
PERMALLOY:	Nickel Iron magnetic alloy
PES:	Performance Evaluation System
PFC:	Parameter Format Code
PFM:	Proto Flight Model
PHD:	Project History Documents
PI:	Principal Investigator
PID:	Process Identifier
PID:	Parameter Identifier
PIR:	Post Integration Review
PISA:	Principal Investigators Support Area
PIU:	Plasma Interface Unit (RPC)
PKT:	Packet
PLM:	Payload Module

PM:	Project Manager
PM:	Processing Module
PMD:	Propellant Management Device
PMIS:	Project Management Information System
PMP:	Part Material and Process
PMU:	Processor Module Unit
POR:	Payload Operation Request
PPWR:	Primary Power
PRNU:	Pixel Response Non Uniformity
PROM:	Programmable Read Only Memory
PRR:	Propellant Refillable Reservoir
PS:	Pass Schedule
PSA:	Planetary Science Archive
PSF:	Point Spread Function
PSK:	Phase Shift Key
PSM:	Payload Support Module
PSR:	Project Support Room
PSR:	Processor Status Registers
PSR:	Project Status Review
PSRI:	Planetary Science Research Institute
PSS:	Portable Satellite Simulator
PSS:	Procedures, Specifications and Standards
PSS:	Programme System Standards
PSU:	Power Supply Unit
PT:	Product Tree
PT1000:	Platinum Thermistor with 1000 Ohm nominal resistance
PTC:	Parameter Type Code
PTR:	Pointing Requirement File
PTT:	Post, Telegraph and Telephone authority
PTV:	Pre-Transmission Validation
PUS:	Packet Utilisation Standard
PVNC:	Pyro Valve Normally Closed
PVNO:	Pyro Valve Normally Opened
QA:	Quality Assurance
QAE:	Quality Assurance Engineer
QAM:	Quality Assurance Management
QAPM:	Quality Assurance Procedures Manual
QC:	Quality Control
QPM:	Quality Policy Manual
QTR:	Qualification Test Review
R&D:	Research & Development
R/T:	Real Time (system)
RAF:	Return All Frames
RAL:	Rutherford Appleton Laboratory

RAM:	Random Access Memory
RAMS:	Reliability, Availability, Maintainability and Safety
RAW:	Data in units of ADC counts in instrument coordinates
RBW:	Resolution Band Width
RC:	Responsibility Code
RC:	Remote Computer
RCCCS:	Rosetta Common Checkout & Control System
RCS:	Reaction Control Subsystem
RD:	Reference Document
RDB:	Rosetta Database
RDDD:	Rosetta Database Definition Document
RDDS:	Rosetta Data Disposition System
RDM:	Raw Data Medium
RDVM:	Rendezvous Manoeuvre
RE:	Radiation Emission
RF:	Radio Frequency
RF S/S:	Radio Frequency Subsystem (TT&C S/S)
RFC:	Request For Change
RFC:	Radio Frequency Self Compatibility
RFD:	Request for Deviation
RFDU:	Radio Frequency Distribution Unit
RFI:	Radio Frequency Interface
RFMU:	Radio Frequency Mock-Up
RFW:	Request For Waiver
RH:	Radiation Hardened
RID:	Review Item Discrepancy
RIS:	Remote Imaging System
RISC:	Reduced Instruction Set Computer
RL:	Register Load
RLA:	Register Load Address
RLG:	Ring Laser Gyro
RLGS:	Rosetta Lander Ground Segment
RM:	Reconfiguration Module
RMCS:	Rosetta Mission Control System
RMOC:	Rosetta Mission Operations Centre
RNCTRS:	Rosetta Network Control & Telemetry Receiver System
ROIRD:	ROSETTA Operations Interface Requirements Document
ROKSY:	ROSETTA Knowledge Management System
ROLIS:	LANDER PAYLOAD INSTRUMENT
ROM:	Read Only Memory
ROMAP:	Rosetta Magnetic Field and Plasma experiment (Lander Payload)
ROSINA:	Rosetta Orbiter Spectrometer for Ion and Neutral Analysis (Orbiter P/L)
ROSIS:	ROSETTA Spacecraft Interface Simulator
RP:	Rundown Phase

RPC:	Rosetta Plasma Consortium (Orbiter Payload)
RPC-0:	RPC Main Electronics Box
RPCMAG:	ROSETTA Orbiter Magnetometer
RPC-MAG:	ROSETTA Orbiter Magnetometer
RPE:	Relative Pointing Error
RPM:	Remote Processing Module
RPRO:	ROSETTA Common Packetized Protocol
RRP:	Rate Reduction Phase
RS:	Radiated Susceptibility
RSDB:	Rosetta System Data Base
RSI:	Radio Science Investigation (Orbiter Payload)
RSOC:	Rosetta Science Operations Centre
RSS:	Root Sum Square
RT:	Real Time
RT:	Remote Terminal
RTC:	Real Time Clock
RTM:	Reduced Thermal Model
RTMM:	Reduced Thermal Mathematical Model
RTOF:	Reflectron Time Of Flight
RTU:	Remote Terminal Unit
RW:	Reaction Wheels
RWA:	Reaction Wheel Assembly
RWL:	Reaction Wheel
RX:	Receiver
S/A:	Solar Array
S/C:	Spacecraft
S/C:	Spacecraft
S/HM:	Safe/Hold Mode
S/S:	Spacecraft Subsystem
S/W:	Software
SA:	Solar Array
SAA:	Solar Aspect Angle
SADM:	Solar Array Drive Mechanism
SAM:	Sun Aquisition Mode
SAP:	Sun Aquisition Phase
SAP:	Science Activity Plan
SAS:	Sun Aquisition Sensor
SASW:	Standard Application Software
SBDL:	Standard Balanced Digital Link
SCET:	Spacecraft Elapsed Time
SCL:	Spacecraft Control Language
SCOE:	Spacecraft Check Out Equipment
SCP:	Sun Capture Phase
SDB:	Satellite (Spacecraft) Data Base

SDD:	System Design Document
SDE:	Software Development Environment
SDID:	Station Data Interchange Document
SDR:	System Design Review
SE:	System Engineer
SEL:	Single Event Latch-up
SEPAC:	Space Experiment with Particle Accelerator
SESAME:	LANDER PAYLOAD INSTRUMENT
SEU:	Single Event Upset
SF:	Safety Factor
SFDU:	Standard Formatted Data Units
SFT:	System Functional Test
SGICD:	Space Ground Interface Control Document
SGM:	Safeguard Memory
SGS:	Science Ground Segment
SI:	Silicon
SID:	Science Mode Identifier
SID:	Structure Identifier
SIM:	Simulator
SIMSAT:	Software Infrastructure for Modelling SATellites
SIR:	Simulation Room
SIS:	Spacecraft Information System
SIS:	Spacecraft Interface Simulator
SIV:	Software Independent Validation
SKM:	Sun Keeping Mode
SLE:	Space Link Extension
SLI:	Space wire Link I/F
SM:	Structural Model
SMCS:	Scalable Multi-Channel Communication Subsystem
SMD:	Surface Mounted Device
SNR:	Signal to Noise Ratio
SOC:	Science Operations Centre
SOHO:	Solar & Heliospheric Observatory
SOM:	Spacecraft Operations Manager
SOR:	Spacecraft Operation Request
SOT:	Science Operations Team
SOW:	Statement of Work
SOWG:	Science operating working group
SPACON:	Spacecraft Controller
SPB:	Superpixel Binning
SPC:	Science Programme Committee
SPD:	Space Division
SPEVAL:	Spacecraft Performance Evaluation System
SPG:	Single Point Ground

SPICE:	Comprehensive S/W system for Celestial Mechanics by NAIF
SPL:	Scenario Parameter List
SpM:	Sin-up Mode
SPP:	Sun Point Phase
SPR:	Software Problem Report
SPT:	Specific Performance Test
SPWR:	Secondary Power
SQA:	Terma Space Division Quality Assurance
SR:	Software Requirements
SRD:	Software Requirements Document
SREM:	Standard Radiation Environment Model
SRR:	Subsystems Requirements Review
SSC:	Source Sequence Counter
SSC:	Status Consistency Checking
SSD:	Space Science Department
SSMM:	Solid State Mass Memory
SSP:	Surface Science Package
SSPA:	Solid State Power Amplifier
SSR:	Solid State Recorder
STC:	Station Computer
STIL:	Irish Space Technology Institute
STM:	Structural Thermal Model
STN:	Standard
STO:	Soyuz Transfer Orbit
STP:	Short Term Planning
STP:	System Temperature Point
STR:	Star Tracker
STSP:	Solar Terrestrial Science Programme
SUM:	Software User Manual
SuM:	Survival Mode
SVF:	Software Validation Facility
SVM:	Service Module
SVT:	System Validation Test
SW:	Software
SWG:	Science Working Group
SWR:	Standing Wave Ratio
SWRI:	South West Research Institute
SWT:	Science Working Team
TBC:	To be confirmed
TBD:	To be Defined
TBI:	To be Inserted
TBP:	Time Broadcast Pulse
TBR:	To be resolved
TBS:	To be supplied

TBW:	To be written
TC:	Telecommand
TC S/S:	Thermal Control Subsystem
TCDL:	Test Configuration Data List
TCDP:	Tele Command Detail Parameter
TCGP:	Tele Command Global Parameter
TCM:	Trajectory Correction Manoeuvre
TCP-IP:	Transport Protocol-Internet Protocol
TCS:	Test Control System
TCS:	Thermal Control Subsystem
TCSL:	Test Configuration Status List
TD:	Time Domain
TER:	Terma Elektronic A.S.
TF:	Transfer Function
TFG:	Transfer Frame Generator
THA:	Transport Handling Adapter
TID:	Task Identifier
TIDE:	Thermal Ion Dynamics Explorer
TLC:	Telecommand
TLM:	Telemetry
TM:	Telemetry
TM:	Technical Manager
TM:	Telemetry
TMM:	Thermal Mathematical Model
TMP:	Telemetry Processing System (within ground station)
TOP:	Transfer Orbit Phase
TR:	Tone Ranging
TRB:	Test Review Board
TRP:	Temperature Reference Point
TRP:	Test Report
TRP:	Temperature Reference Point
TRR:	Test Readiness Review
TRRB:	Test Readiness Review Board
TS:	Time Series
TSE:	Test Support Equipment
TSP:	Test Specification
TSY:	Timer Synchronisation Pulse
TT&C:	Tracking, Telemetry & Commanding
TT&C S/	S: Telemetry, Telecommand and Communication Subsystem (RF S/S)
TUB:	Technical University of Berlin
TUB:	Technical University Braunschweig
TUBS:	Technical University Braunschweig
TUB:	Technical University of Budapest
TV:	Thermal Vacuum

TWTA:	Travellling Wave Tube Assembly
TWTL:	Two Way Travelling Lighttime
TX:	Transmitter
U/L:	Up Link
UARS:	Upper Atmospheric Research satellite
UD:	User Defined
UFT:	Unit Functional Test
UM:	User Manual
UMOS:	Ultimate Margin Of Safety
UPM:	Universidad Politecnica de Madrid
URD:	User Requirements Document
URF:	Unit Reference Frame
us:	microsecond
USO:	Ultra Stable Oscillator
UTC:	Universal Time Coordinated
UTC:	Universal Time Code
UV:	Ultra Violet
UVD:	Under Voltage Detector
UVSC:	Ultra Violet Spectrometer Component
V&V:	Verification & Validation
VC:	Virtual Channel
VCA:	Virtual Channel Assembler
VCM:	Virtual Channel Multiplexer
VDC:	Voltage Direct Current
VDU:	Video Display Unit
VHDL:	VHSIC Hardware Description Language
VHF:	Very High Frequency
VHSIC:	Very High Speed Integrated Circuit
VI:	Virtual Instrument, S/W Routine for NI Labview
VIMS:	Visual Infrared Mapping Spectrometer
VIRTIS:	ORBITER PAYLOAD INSTRUMENT
VIS:	Vertical Integration Stand
VIS:	Visual
VSWR:	Voltage Standing Wave Ratio
VT:	Validation Test
VTP:	Validation Test Plan
VTR:	Validation Test Report
W/S:	Work Station
WAC:	Wide Angle Camera
WAOSS:	Wide Angle Optoelectric Stereo Scanner
WBS:	Work Breakdown Structure
WBS:	Workpackage Breakdown Structure
WCA:	Worst Case Analysis
WD:	Watch Dog

WDE:	Wheel Drive Electronics
WDW:	Window
WIU:	Wave Guide Interface Unit
WOL:	Wheel Offloading of RW
WP:	Work Package
WPD:	Work Package Description
WRT:	With Respect To
WTC:	Wavelet Transform Coding
WVR:	Water Vapor Radiometer
WWW:	World Wide Web
YMOS:	Yield Margin Of Safety
ZOM:	Zero Order Monitor