SPARTA
two data format converters in one

Arnaud Masson

17/10/2019

Outline

1. Scope of the ESA SPace dAta foRmat TrAnslator (SPARTA)
2. Data mapping by SPARTA
3. Metadata mapping by SPARTA
4. Documentation mapping by SPARTA
5. Open access and future of SPARTA

1. Scope of the ESA SPace dAta foRmat TrAnslator (SPARTA)

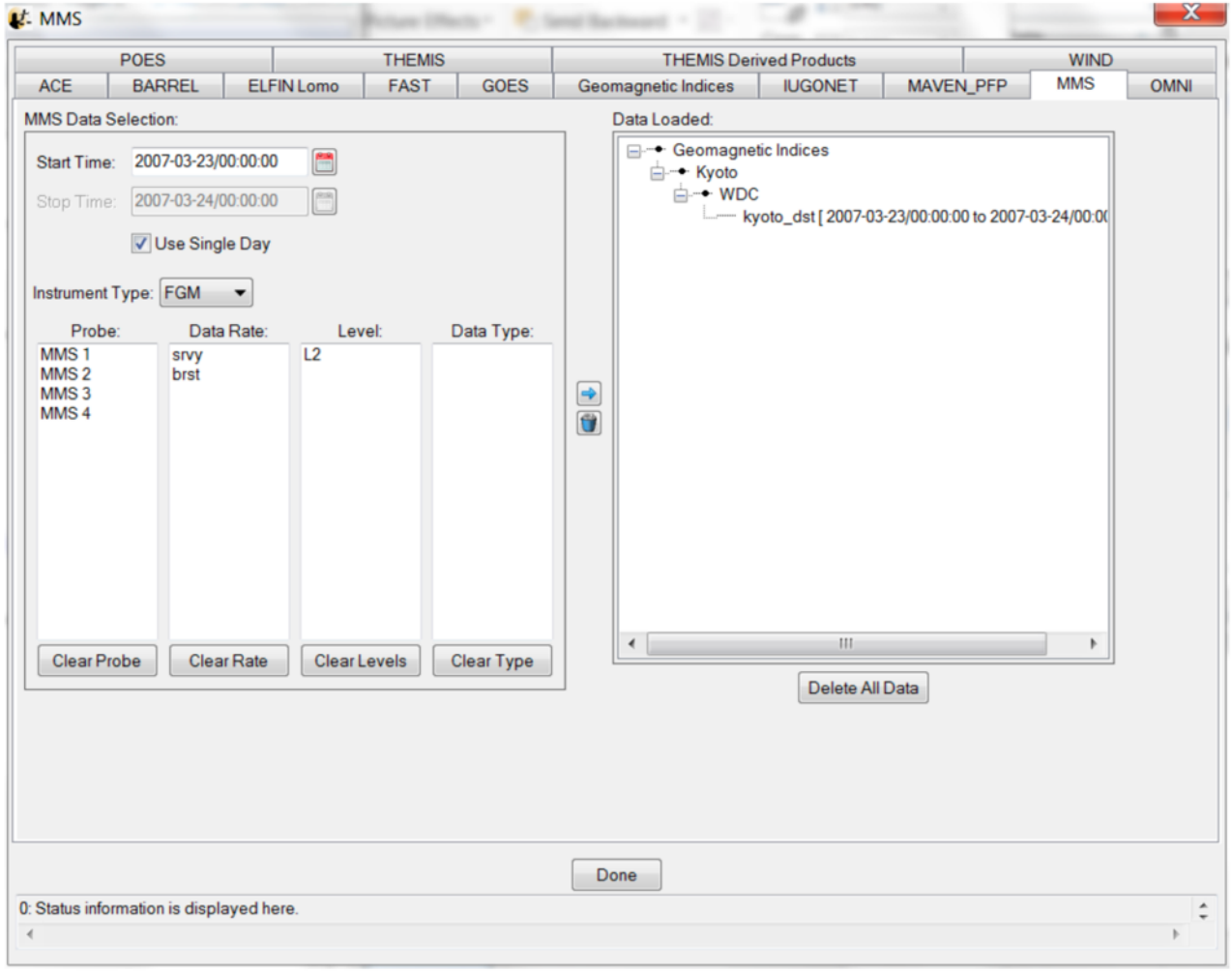
SPARTA converts all science datasets for the Cluster mission, **including 3D** in testing phase

From CEF to CDF ISTP
CEF: (ascii) Cluster Exchange Format

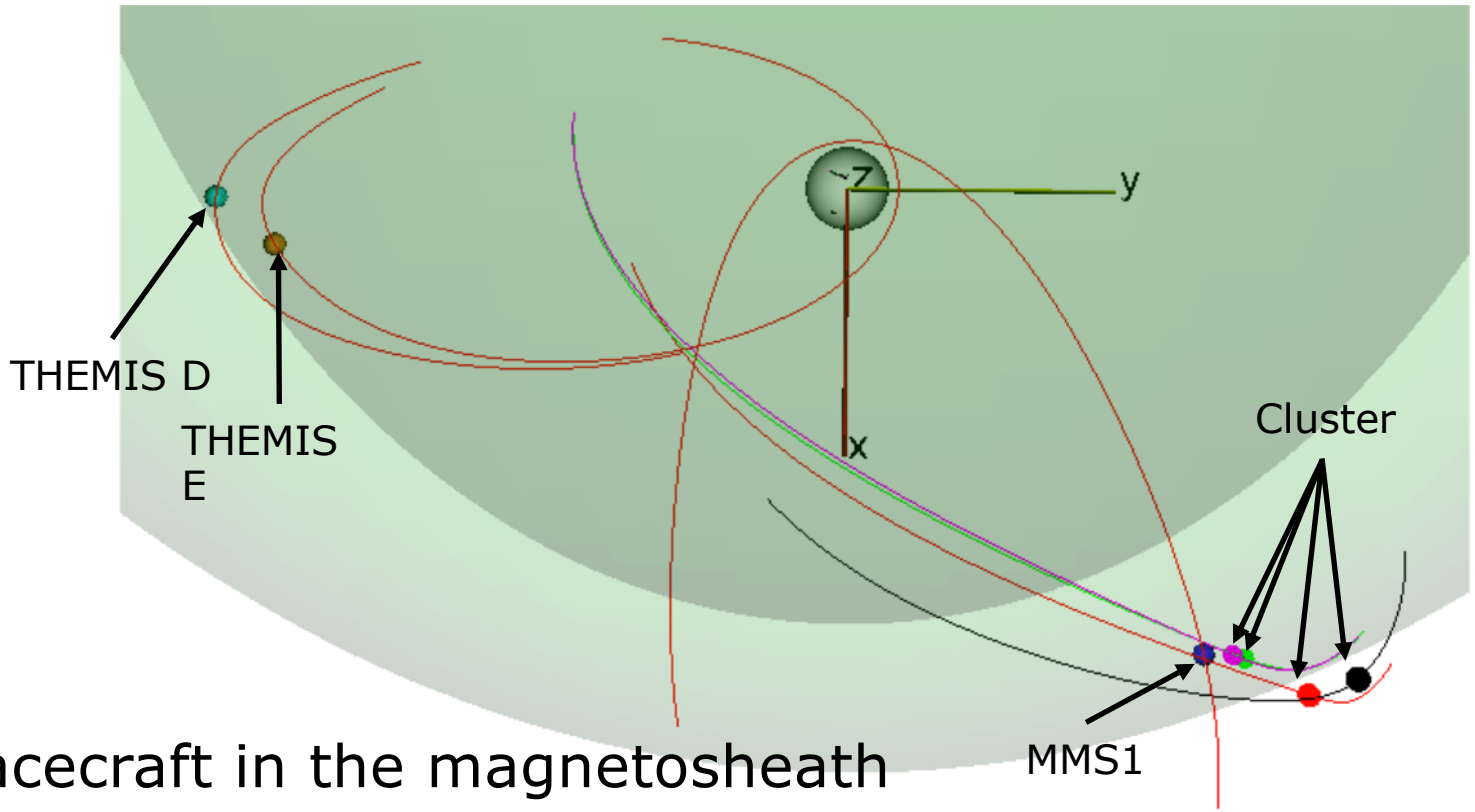
SPARTA converts calibrated datasets from 4 Rosetta RPC plasma instruments (IES, LAP, MAG, MIP)

From PDS3 to CDF ISTP
To improve usability of planetary plasma in-situ data

1. SPace dAta foRmat TrAnslator (SPARTA)

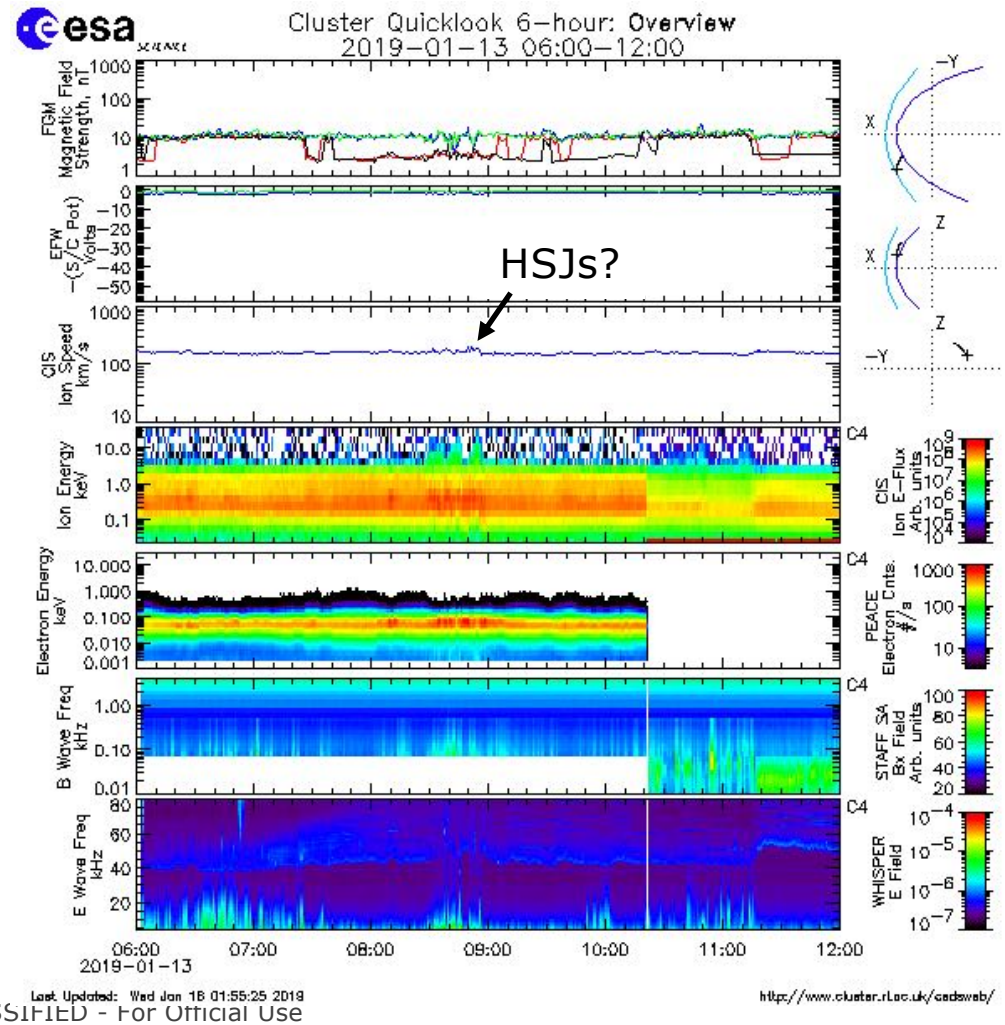


2019/01/13 08:40

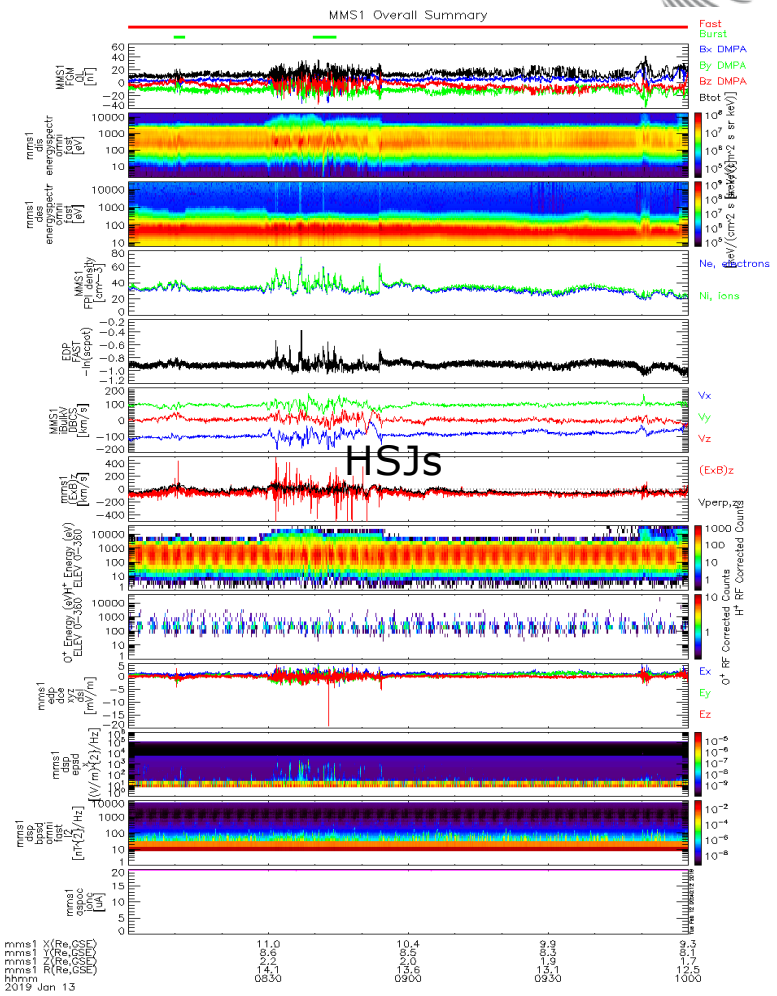


All spacecraft in the magnetosheath
Except C1 and C2 just upstream of shock

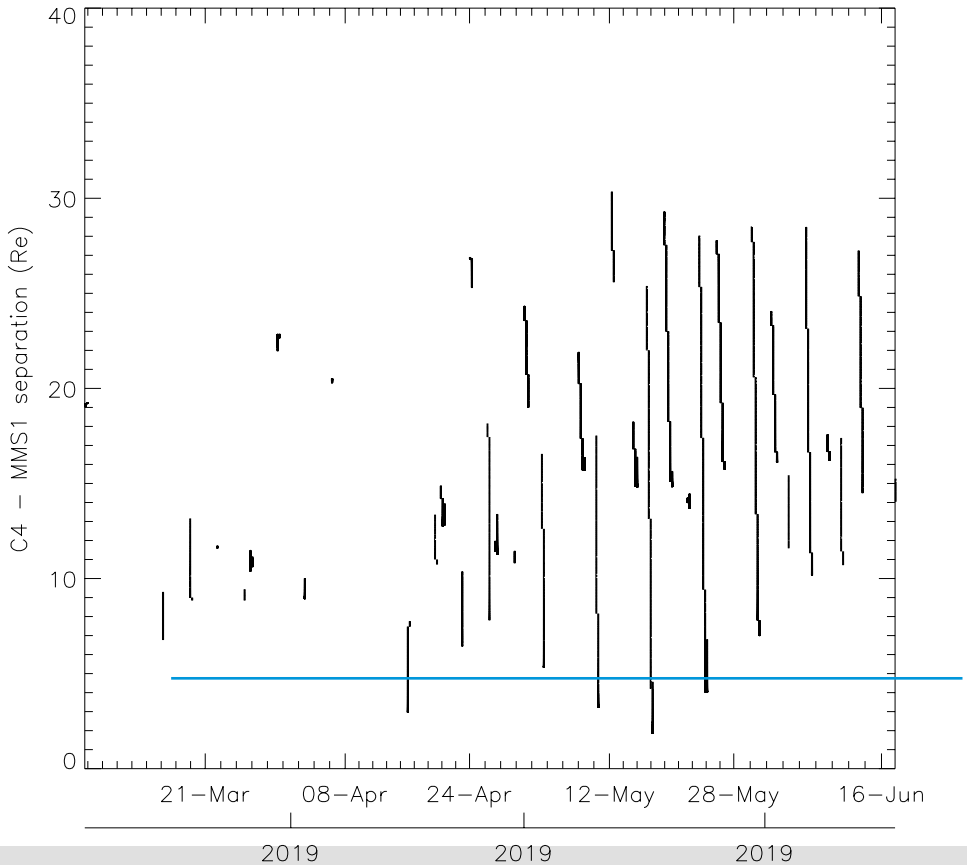
Cluster 4



MMS1



Cluster-MMS-THEMIS conjunctions

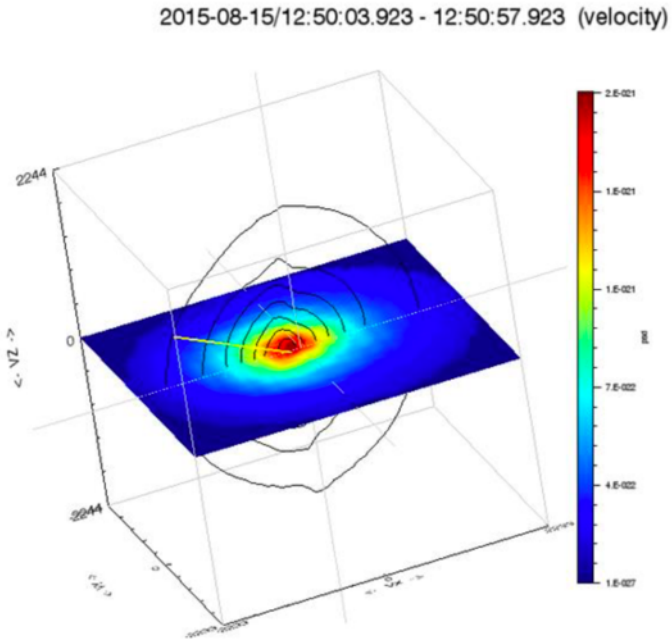


Intervals when separation C4 and MMS1 in magnetosheath (March-June 2019)

SPARTA => integration in SPEDAS

Cluster, MMS, THEMIS combined plots

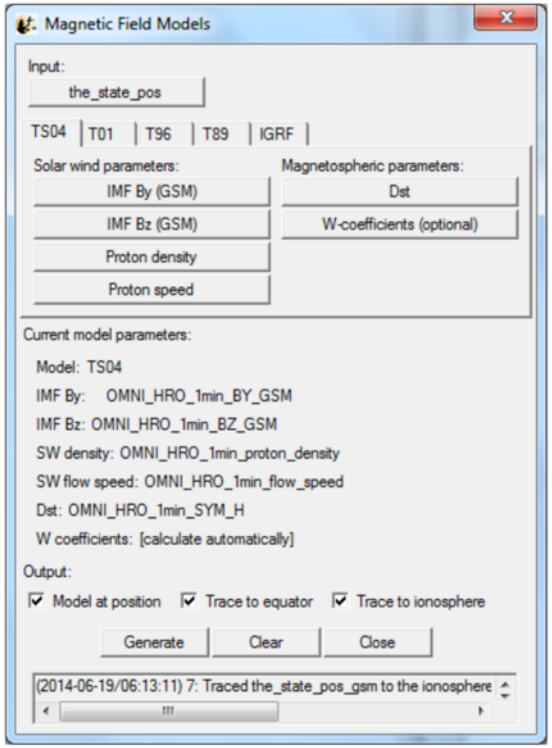
3D Distribution function visualization



SPARTA => integration in SPEDAS

Useful for Cluster data analysis

The GUI is now able to:
- Model the field at the spacecraft position
- Trace field from position to the ionosphere and equator



PDS3 to CDF ISTP conversion by SPARTA

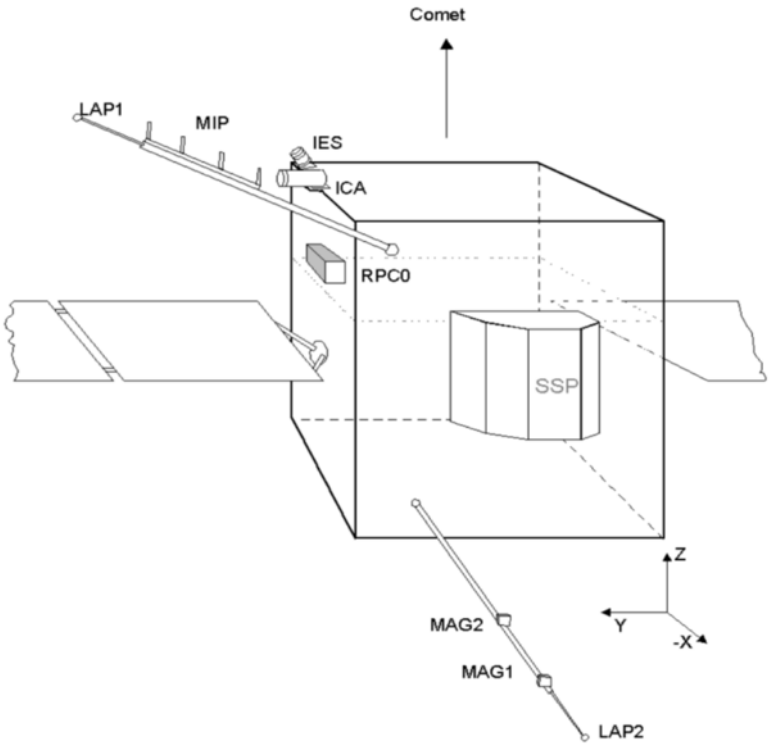
SPARTA converts calibrated datasets from
4 Rosetta RPC instruments
(IES, LAP, MAG, MIP)

Available of the PSA

MAG best calibrated datasets (CLC, CLG, CLH, CLF, CLB)
IES all calibrated L3 datasets (3D) and L5 (moments)

MIP L5 datasets derived products (Ne)
LAP L5 datasets (Ne, Te, Vi, Iph, Vph, Vsc...)

In red: not yet public



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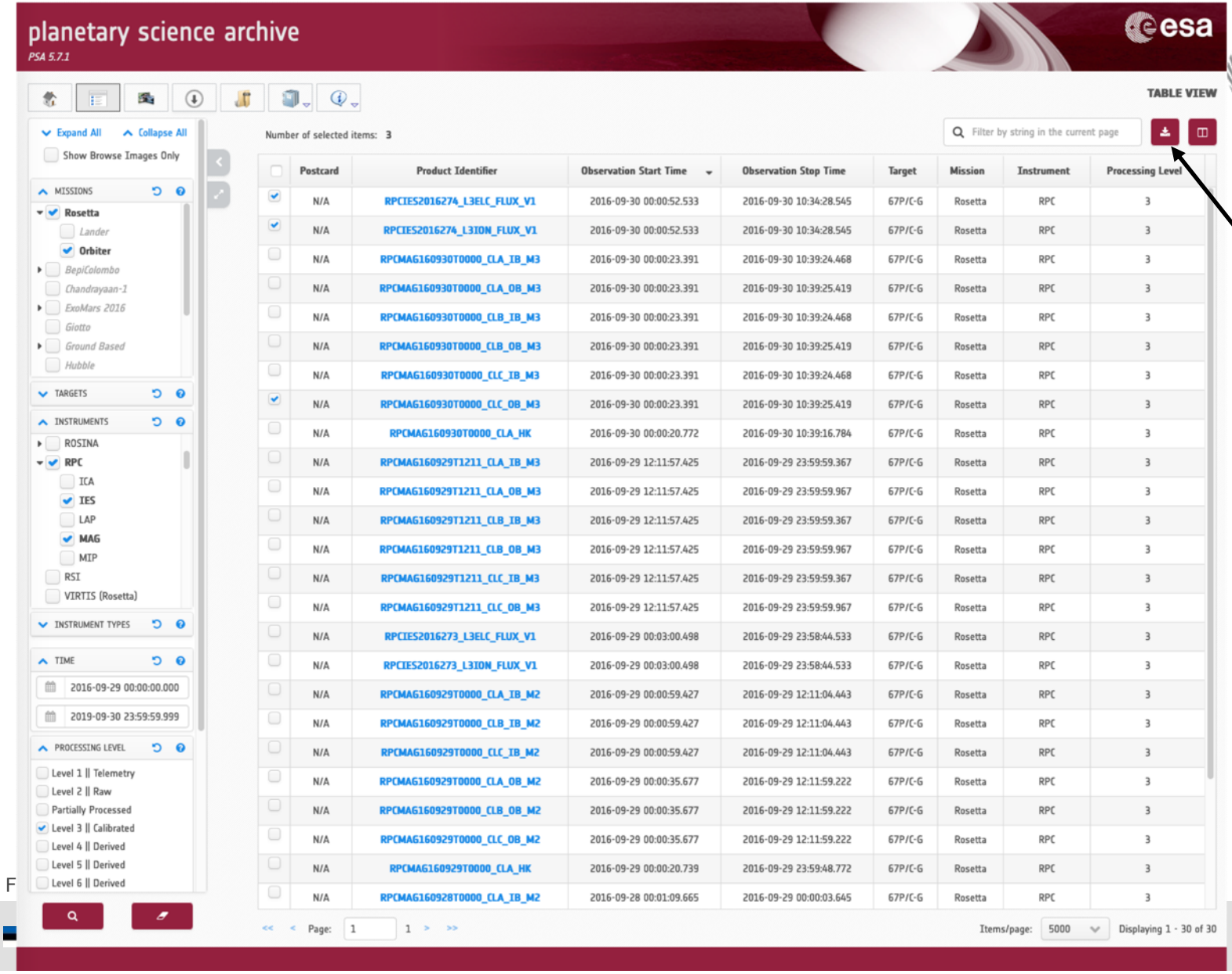
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Collapse All
Show Browse Images Only
MISSIONS
Rosetta
Lander
Orbiter
BepiColombo
Chandrayaan-1
ExoMars 2016
Giotto
Ground Based
Hubble
TARGETS
INSTRUMENTS
ROSINA
RPC
ICA
IES
LAP
MAG
MIP
RSI
VIRTIS (Rosetta)
INSTRUMENT TYPES
TIME
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Level 2 || Raw
Partially Processed
Level 3 || Calibrated
Level 4 || Derived
Level 5 || Derived
Level 6 || Derived
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Filter by string in the current page
Postcard
Product Identifier
Observation Start Time
Observation Stop Time
Target
Mission
Instrument
Processing Level
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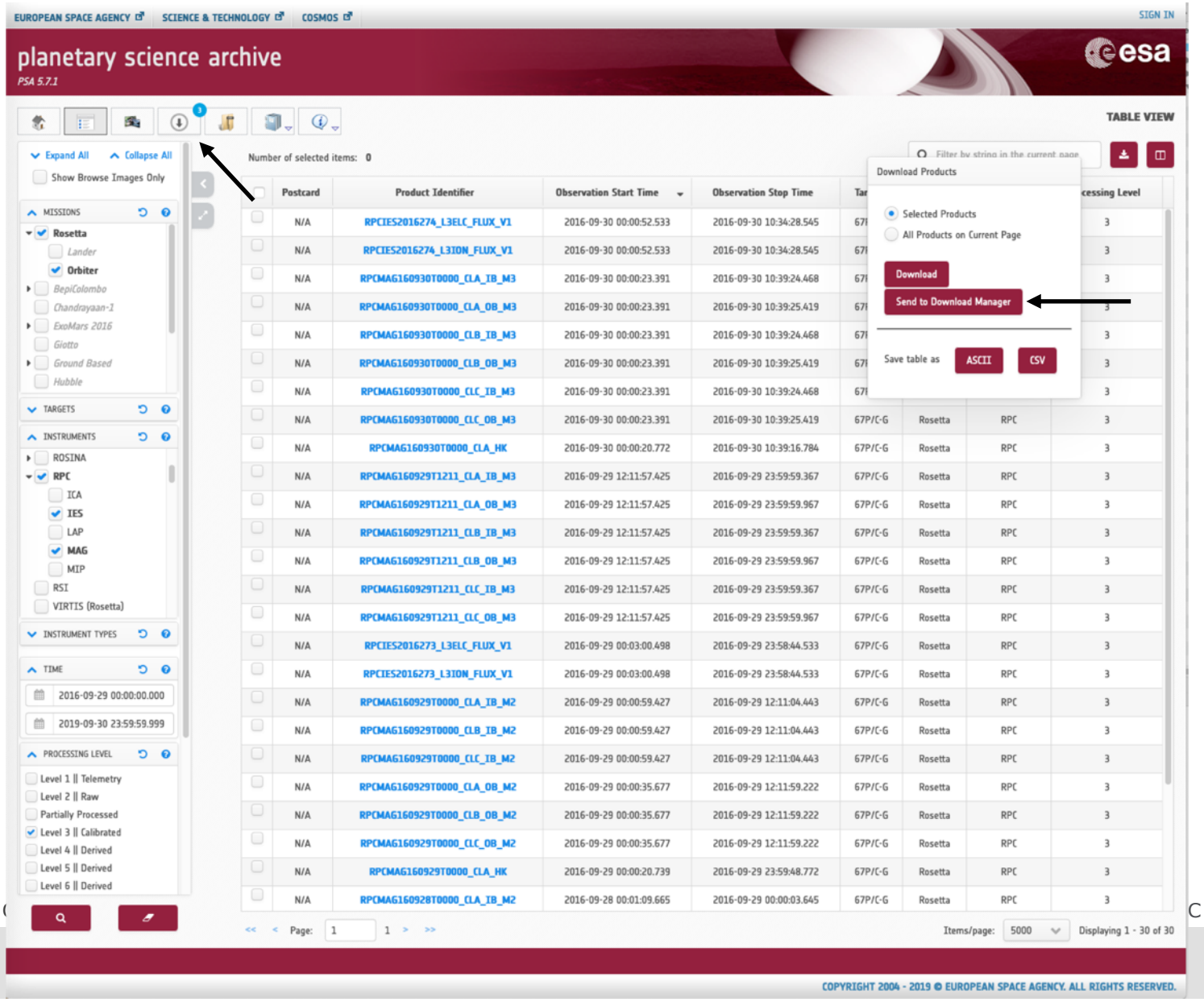
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Chandrayaan-1
ExoMars 2016
Giotto
Ground Based
Hubble
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PROCESSING LEVEL
Level 1 || Telemetry
Level 2 || Raw
Partially Processed
Level 3 || Calibrated
Level 4 || Derived
Level 5 || Derived
Level 6 || Derived
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Selected Products
All Products on Current Page
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Save table as
ASCII
CSV
Postcard
Product Identifier
Observation Start Time
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Items/page: 5000
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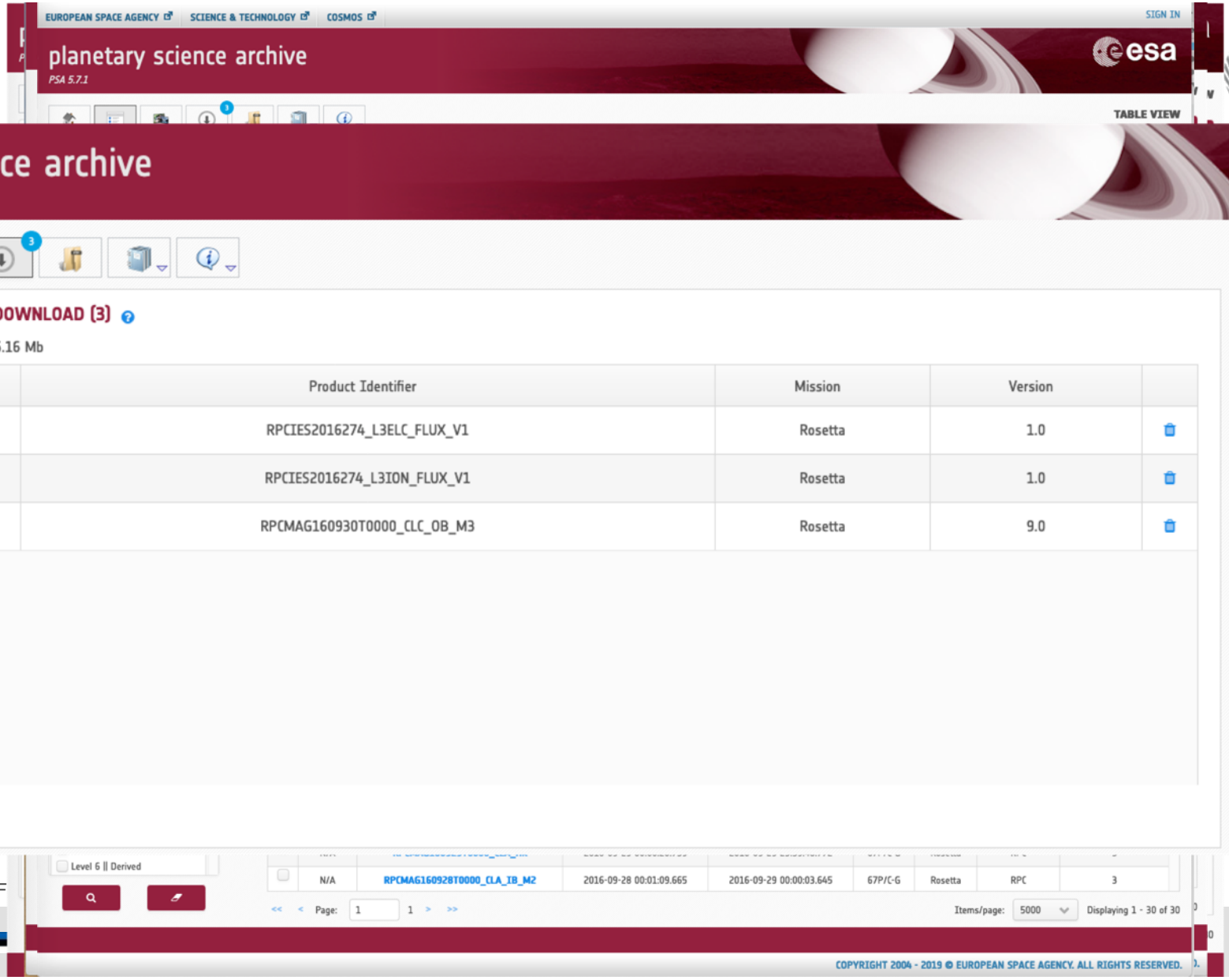
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67P/C-G
Rosetta
RPC
3
Page:
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Items/page:
5000
Displaying 1 - 30 of 30
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SPARTA PDS3 to CDF ISTP compliant conversion

SPARTA is the first PDS3 to CDF ISTP converter

Goal: to offer PDS3 or CDF version of best calibrated products through PSA

Checked with SKTeditor

Validated by PIteam

Only works for 4 Rosetta RPC experiments at the moment (ICA on-going)

Will be expended to all ESA PDS3 datasets (MEX, VEX)

A scientist in the loop is needed to provide ISTP required metadata

In the process of making SPARTA open source (Oct. 2019) for datasets from other planetary missions to be converted to daily CDF ISTP compliant files

SPARTA CEF to CDF ISTP compliant conversion

Compulsory set of global attributes

- Project
- Source_name
- Discipline
- Data_type
- Descriptor
- Data_version
- Logical_file_id
- PI_name
- PI_affiliation
- TEXT
- Instrument_type
- Mission_group
- Logical_source
- Logical_source_description

Compulsory set of variable attributes

- CATDESC
- DEPEND_0
- DEPEND_i (when applicable)
- DISPLAY_TYPE
- FIELDNAM
- FILLVAL
- FORMAT/FORM_PTR
- LABLAXIS/LABL_PTR_i
- UNITS/UNIT_PTR
- VALIDMIN
- VALIDMAX
- VAR_TYPE

SPARTA CEF to CDF ISTP compliant conversion

CDF required variable attribute	CEF variable keyword
CATDESC	CATDESC
DEPEND_0	DEPEND_0
DEPEND_i	DEPEND_i
DISPLAY_TYPE	**Not available but straightfoward to implement**
FIELDNAM	FIELDNAM
FILLVAL	FILLVAL
FORMAT	VALUE_TYPE and SIGNIFICANT_DIGITS
LABLAXIS	LABLAXIS
LABL_PTR_1	LABEL_1 for data of the following form: •1D time_series •2D spectrogram Also needed for 1D and 2D support_data without a LABLAXIS
UNITS	UNITS
VALIDMIN	**Either extracted from the documentation or interacted with the PI team, or calculated on the fly**
VALIDMAX	**Like VALIDMIN**
VAR_TYPE	PARAMETER_TYPE but any entry shall be in lower case (first letter is upper case in VAR_TYPE); see section 5.1

Cluster File naming: ISTP standard

Formats that currently accepted:
Source_datatype_descriptor_yyyymmdd_vxx (xx=01, 02, etc.)
Source_descriptor_datatype_yyyymmdd_vxx

Where the "Source_descriptor_datatype" portion of the file name often has addition underscores and dashes, e.g.
mms1_mec_brst_l2_ephts04d, mms1_scm_brst_l2_schb, rbsp-a_hfr-waveform_emfisis-l2

Then additional variants for the time and version portions of the file name:
yyyydoy_vxx (ISIS)
yyyymmddTss_vxxx.yyy.zzz (RBSP - "X.Y.Z-R")
yyyymmddhhmmss_vxxx.yyy.zzz (MMS followed RBSP's versioning)

Where the vxxx.yyy.zzz = X is the major (interface) number, Y is the minor (quality number), Z is the revision number and R is an optional release number, e.g. "v1.1.1", "v1.2.1", v2.2.1-100"

Cluster File naming: non-compliance with ISTP standard

CDF Regular (CEF converted into CDF files with no ISTP compliance
dataset_ID__startdate_starttime_enddate_endtime_version.cdf

CDF ISTP compliant
dataset_ID__startdateTstarttime_enddateTendtime_version.cdfversion.istp.cdf

where dataset_ID can be decomposed as
Spacecraft_DataType_Instrument_dataset
and cdfversion a two digits number corresponding the to CDF version of the file, for instance

C3_CP_ASP_IONC__20010901T000000_20010906T000000_V051020.37.istp.cdf

Cluster row majority possible?

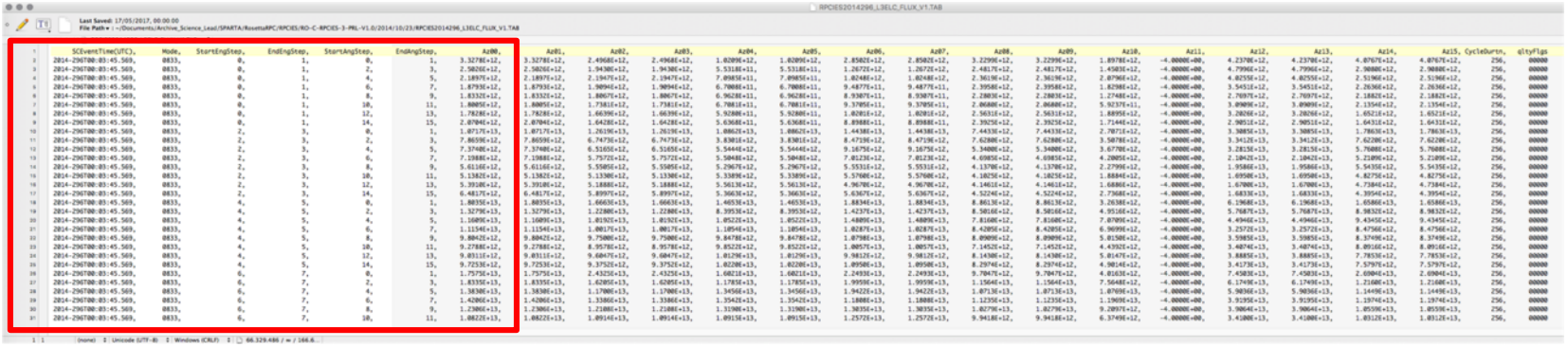
Rational for column majority for CDF ISTP?

Could row majority be accepted as ISTP cpmpliant?

BACKUP SLIDES

1. Why SPARTA?

Rosetta RPCIES
3D electron differential energy flux
daily TAB file within a PDS3 dataset



Can you see anything???

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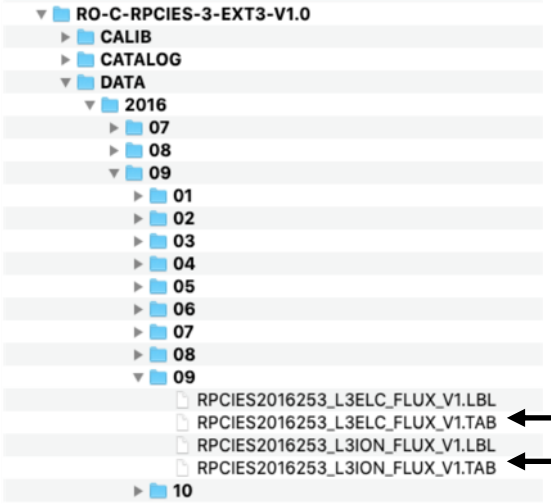
Rosetta RPCIES: 3D electron differential energy flux data content (TAB), on 23-10-2014

2. SPARTA data mapping

Best resolution fixed size matrix to cope with mode changes
16 azimuth x 16 elevation x 128 energies x Nb of time steps
16 azimuth x 16 elevation x 128 energies x Nb of time steps

Daily PDS3 TAB file content mapped to the variable Data_3D_DEFlux

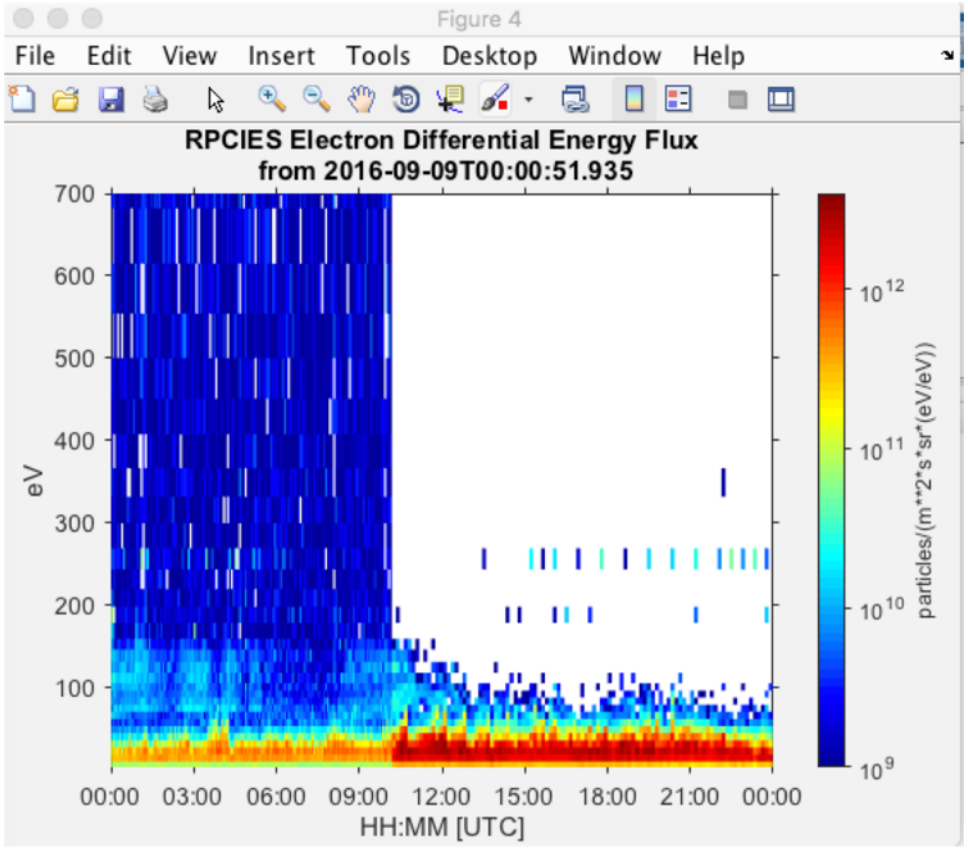


Diff. energy flux
Electrons data

Ions data

For each day, two CDF files are generated

Rosetta_RPCIES_l3elc_flux_20160909_V1.0.cdf
Rosetta_RPCIES_l3ion_flux_20160909_V1.0.cdf



3. SPARTA metadata mapping

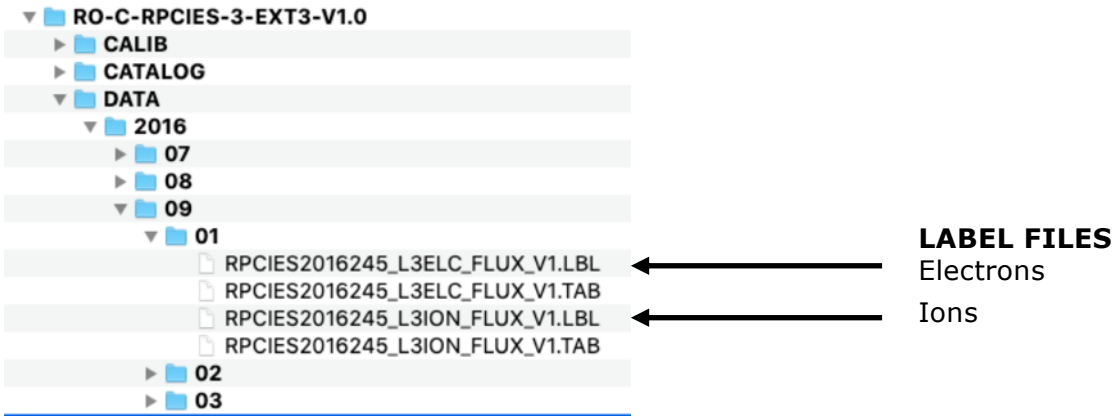
Compulsory ISTP global attributes

Project: {'ROSETTA'}
Discipline: {'Space Physics>Interplanetary Studies'}
Source_name: {'ROSETTA>International Rosetta mission'}
Data_type:{'L3ELC_FLUX>IES calibrated differential electron energy flux'}
Descriptor: {'RPCIES>Rosetta Plasma Consortium - Ion and Electron Sensor'}
Data_version: {'1.0'}
TEXT: see here
Logical_file_id: {'Rosetta_RPCIES_l3elc_flux_20160930_V1.0'}
Logical_source:{'rosetta_rpcies_l3elc_flux'}
Logical_source_description: {4×1 cell}
PI_name: {'Dr. James L. Burch'}
PI_affiliation: {'Southwest Research Institute, San Antonio, Texas, USA'}
Instrument_type: {'Particles (space)'}
Mission_group: {'Rosetta'}
Generated_by: {'BRAD TRANTHAM'}
Generation_date: {'20180710'}
File_naming_convention: {'source_descriptor_datatype_yyyyMMdd'}

These global attributes are listed at the top of the global attributes' list

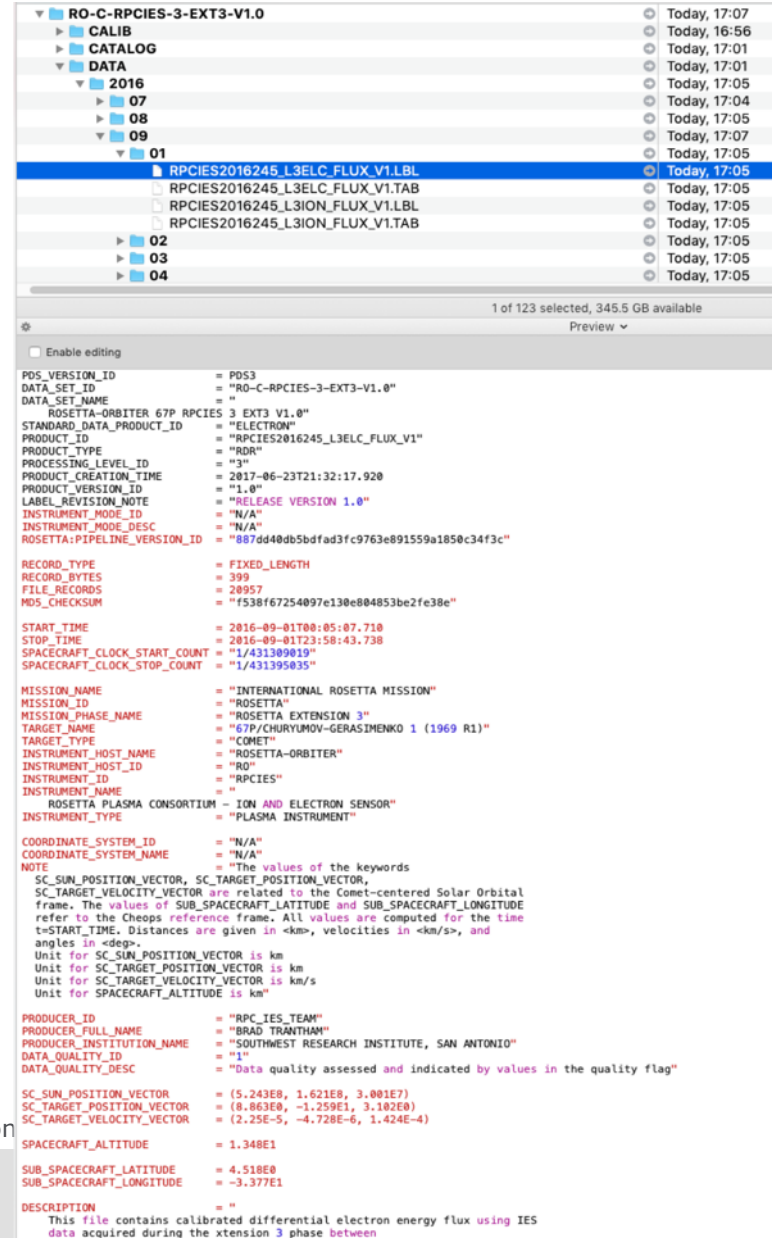
3. SPARTA metadata mapping (2/3)

How PDS3 LBL metadata content is mapped into CDF global attributes?

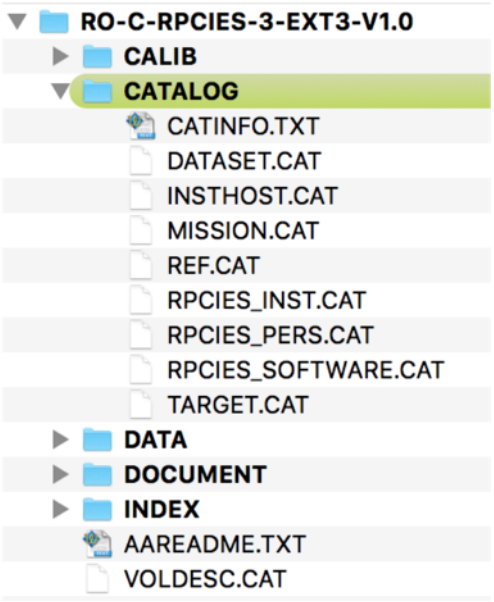


LABEL FILES
Electrons

Ions



3. SPARTA metadata mapping (3/3)



PDS3 Catalog files		CDF/ISTP global attributes
MISSION.CAT	----->	Rosetta_mission_cat
INSTHOST.CAT	----->	Rosetta_insthost_cat
TARGET.CAT	----->	Rosetta_target_cat
REF.CAT	----->	Rosetta_ref_cat
RPCIES_INST.CAT	----->	RPCIES_inst_cat
RPCIES_SOFTWARE.CAT	----->	RPCIES_software_cat
RPCIES_PERS.CAT	----->	RPCIES_pers_cat
DATASET.CAT	----->	Dataset_cat

```
>> info=spdfcdfinfo('Rosetta_RPCIES_l3elc_flux_20160930_V1.0.cdf');
>> info.GlobalAttributes
ans =
  struct with fields:

                        Project: {'ROSETTA'}
                     Discipline: {'Space Physics>Interplanetary Studies'}
                    Source_name: {'ROSETTA>International Rosetta mission'}
                      Data_type: {'L3ELC_FLUX>IES calibrated differential electron energy flux'}
                     Descriptor: {'RPCIES>Rosetta Plasma Consortium - Ion and Electron Sensor'}
                   Data_version: {'1.0'}
                           TEXT: {15×1 cell}
                  Logical_file_id: {'Rosetta_RPCIES_l3elc_flux_20160930_V1.0'}
                 Logical_source: {'rosetta_rpcies_l3elc_flux'}
       Logical_source_description: {4×1 cell}
                        PI_name: {'Dr. James L. Burch'}
                PI_affiliation: {'Southwest Research Institute, San Antonio, Texas, USA'}
               Instrument_type: {'Particles (space)'}
                 Mission_group: {'Rosetta'}
                  Generated_by: {'BRAD TRANTHAM'}
               Generation_date: {'20180612'}
         File_naming_convention: {'source_descriptor_datatype_yyyyMMdd'}
                Pds_version_id: {'PDS3'}
              Pds_data_set_id: {'RO-C-RPCIES-3-EXT3-V1.0'}
            Pds_data_set_name: {'ROSETTA-ORBITER 67P RPCIES 3 EXT3 V1.0'}
  Pds_standard_data_product_id: {'ELECTRON'}
               Pds_product_id: {'RPCIES2016274_L3ELC_FLUX_V1'}
             Pds_product_type: {'RDR'}
       Pds_processing_level_id: {'3'}
    Pds_product_creation_time: {'2017-06-23T21:30:33.908'}
       Pds_product_version_id: {'1.0'}
        Pds_label_revision_note: {'RELEASE VERSION 1.0'}
         Pds_instrument_mode_id: {'N/A'}
       Pds_instrument_mode_desc: {'N/A'}
            Pds_record_type: {'FIXED_LENGTH'}
           Pds_record_bytes: {'399'}
           Pds_file_records: {'73905'}
           Pds_md5_checksum: {'N/A'}
             Pds_start_time: {'2016-09-30T00:00:52.533'}
              Pds_stop_time: {'2016-09-30T10:34:28.545'}
Pds_spacecraft_clock_start_count: {'1/433814363'}
 Pds_spacecraft_clock_stop_count: {'1/433852379'}
           Pds_mission_name: {'INTERNATIONAL ROSETTA MISSION'}
             Pds_mission_id: {'ROSETTA'}
      Pds_mission_phase_name: {'ROSETTA EXTENSION 3'}
           Pds_target_name: {'67P/CHURYUMOV-GERASIMENKO 1 (1969 R1)'}
           Pds_target_type: {'COMET'}
     Pds_instrument_host_id: {'RO'}
   Pds_instrument_host_name: {'ROSETTA-ORBITER'}
        Pds_instrument_id: {'RPCIES'}
      Pds_instrument_name: {'ROSETTA PLASMA CONSORTIUM - ION AND ELECTRON SENSOR'}
   Pds_coordinate_system_id: {'N/A'}
 Pds_coordinate_system_name: {'N/A'}
             Pds_note: {11×1 cell}
          Pds_producer_id: {'RPC_IES_TEAM'}
    Pds_producer_full_name: {'BRAD TRANTHAM'}
Pds_producer_institution_name: {'SOUTHWEST RESEARCH INSTITUTE, SAN ANTONIO'}
       Pds_data_quality_id: {'1'}
     Pds_data_quality_desc: {'Data quality assessed and indicated by values in the quality flag'}
  Pds_sc_sun_position_vector: {3×1 cell}
Pds_sc_target_position_vector: {3×1 cell}
Pds_sc_target_velocity_vector: {3×1 cell}
    Pds_spacecraft_altitude: {'1.695E1'}
  Pds_sub_spacecraft_latitude: {'-4.262E1'}
 Pds_sub_spacecraft_longitude: {'-1.587E2'}
           Pds_description: {4×1 cell}
Rosetta_pipeline_version_id_061: {'887dd40db5bdfad3fc9763e891559a1850c34f3c'}
        Rosetta_mission_cat: {2270×1 cell}
       Rosetta_insthost_cat: {2263×1 cell}
         Rosetta_target_cat: {1522×1 cell}
            Rosetta_ref_cat: {1674×1 cell}
            RPCIES_inst_cat: {426×1 cell}
        RPCIES_software_cat: {2×1 cell}
           RPCIES_pers_cat: {129×1 cell}
               Dataset_cat: {70×1 cell}
  Quality_flags_description: {27×1 cell}
           Software_version: {'SPARTA DEVELOPMENT'}
```

CDF ISTP required and recommended Global attributes

PDS3 keywords mapped to CDF Global attributes

MISSION.CAT
INSTHOST.CAT
TARGET.CAT
REF.CAT
INST.CAT
SOFTWARE.CAT
PERSON.CAT
DATASET.CAT

3. SPARTA metadata mappinp TEXT global attribute

Compulsory ISTP global attributes

Project: {'ROSETTA'}
Discipline: {'Space Physics>Interplanetary Studies'}
Source_name: {'ROSETTA>International Rosetta mission'}
Data_type:{'L3ELC_FLUX>IES calibrated differential electron energy flux'}
Descriptor: {'RPCIES>Rosetta Plasma Consortium - Ion and Electron Sensor'}
Data_version: {'1.0'}
TEXT: see here
Logical_file_id: {'Rosetta_RPCIES_l3elc_flux_20160930_V1.0'}
Logical_source:{'rosetta_rpcies_l3elc_flux'}
Logical_source_description: {4×1 cell}
PI_name: {'Dr. James L. Burch'}
PI_affiliation: {'Southwest Research Institute, San Antonio, Texas, USA'}
Instrument_type: {'Particles (space)'}
Mission_group: {'Rosetta'}
Generated_by: {'BRAD TRANTHAM'}
Generation_date: {'20180710'}
File_naming_convention: {'source_descriptor_datatype_yyyyMMdd'}

These global attributes are listed at the top of the global attributes' list

3. SPARTA metadata mapping

For the example treated here, this global attribute reads (using Matlab)
>> metadata=spdfcdfinfo('Rosetta_RPCIES_l3elc_flux_20160930_V1.0.cdf');
>> metadata.GlobalAttributes.TEXT
ans =
15×1 cell array
'Instrument reference paper: '
'Burch, J. et al., IES - The ROSETTA Ion and Electron Spectrometer, Space Sci. Rev., 128(1-4), 697-712, 2007'
' '
'For more information:'
'* Rosetta mission overview - See Rosetta_mission_cat global attribute'
'* Rosetta spacecraft overview - See Rosetta_instrument_host_cat global attribute'
'* Rosetta targets overview - See Rosetta_target_cat global attribute'
'* Rosetta references listing - See Rosetta_ref_cat global attribute'
'* RPCIES instrument overview - See RPCIES_inst_cat global attribute'
'* RPCIES software overview - See RPCIES_software_cat global attribute'
'* RPCIES personnel contacts - See RPCIES_pers_cat global attribute'
'* RPCIES dataset overview - See RPCIES_dataset_cat global attribute'
' '
'Those attributes are located at the bottom of the global attributes list.'
'The content of these attributes is mapped from the original PDS catalog files'
'Additionally five PDF documents are available'
'ANODES.PDF- IES technical drawing showing orientation of electron and ion anodes'
'FLUX_CALCULATION.PDF- Description of IES level 3 calibration process'
'GROUND_CALIB.PDF - Calibration procedure for the IES Proto-Flight Model'
'10991-IES-EAICD-03.PDF- The RPC-IES to PSA Interface Control Document EAICD'
'IES_MODES.PDF - modes used by IES to return data from the instrument'
' '
'All these files can be dowloaded from:'
_' ftp://psa.esac.esa.int/pub/mirror/INTERNATIONAL-ROSETTA-MISSION/RPCIES/RO-C-RPCIES-3-PRL-V1.0/DOCUMENT/'

4. Variable attributes

To be ISTP compliant, the following variable attributes are compulsary (in bold) or recommended
FIELDNAM for all variables
CATDESC for all variables
VAR_TYPE for all variables (CDF specific)
UNITS for data and support data
FORMAT for all variables not using FORM_PTR
FILLVAL for data, Record Varying (RV) support_data, and RV metadata
VALIDMIN for data and RV support_data
VALIDMAX for data and RV support_data **DEPEND_0** for data, RV support_data, and RV metadata
DISPLAY_TYPE for data
LABLAXIS for data of type image, scalar time series and 1D spectrogram
LABL_PTR_1 for vectors
Additional variable attributes are recommended
TIME_BASE (recommended for time variables) or optional like SI_CONVERSION
All these variable attributes are explained in more detailed in section 6. The values of these variable attributes have been mapped from the PDS3 LBL files. The variable attributes' values are detailed below

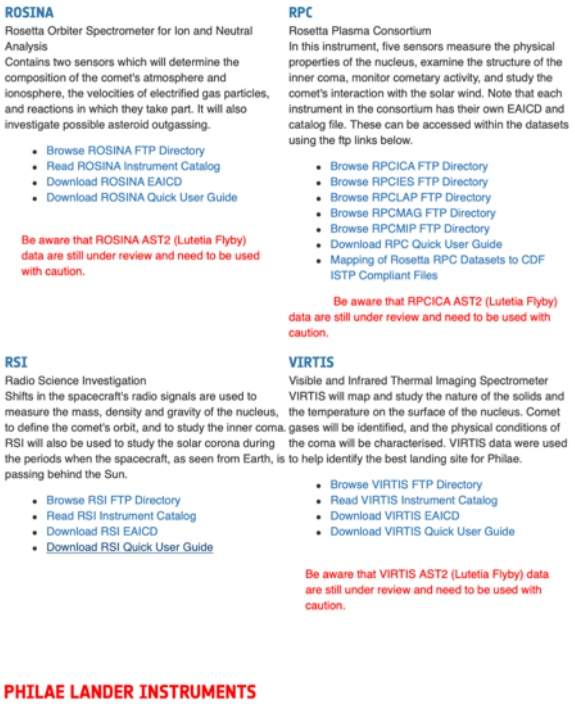
4. Variable attributes

CDF variable name	LABLAXIS	VAR_TYPE	UNITS
Time_UTC	UTC time	support_data	ms
Data_3D_DEFlux	Diff. energy flux	data	particles/(m**2*s*sr*(eV/eV))
Uncertainty_3D_DEFlux	Diff. energy flux uncertainty	data	particles/(m**2*s*sr*(eV/eV))
Azimuth_angles	Azimuth range	support_data	deg
Azimuth_anode	Anode reference number	support_data	
Elevation_angles	Elevation range	support_data	deg
Elevation_step_number	Elevation step number	support_data	
Energy	Energy values	support_data	eV
Energy_step_number	Energy step number	support_data	
Background_counts	Bgd counts	data	counts/s
Instrument_mode	IES mode	metadata	
Cycle_duration	Cycle duration	data	s
Quality_flags	Quality flags	metadata	
Azimuth	Central azimuth	support_data	deg
Elevation	Central elevation	support_data	deg

4. Variable attributes

CDF variable name	VALIDMIN	VALIDMAX	DISPLAY_TYPE	DEPEND_0	DEPEND_1
Time_UTC	On the fly	On the fly			
Data_3D_DEFlux	-100	1.0E20	spectrogram	TIME_UTC	Azimuth
Uncertainty_3D_DEFlux	-100	1.0E20	spectrogram	TIME_UTC	Azimuth
Azimuth_angles	0	360	no_plot	TIME_UTC	
Azimuth_anode	0	15	no_plot	TIME_UTC	
Elevation_angles	0	360	no_plot	TIME_UTC	
Elevation_step_number	0	15	no_plot		

5. Technical note and interaction with the PI team



ROSINA

Rosetta Orbiter Spectrometer for Ion and Neutral Analysis

Contains two sensors which will determine the composition of the comet's atmosphere and ionosphere, the velocities of electrified gas particles, and reactions in which they take part. It will also investigate possible asteroid outgassing.

- Browse ROSINA FTP Directory
- Read ROSINA Instrument Catalog
- Download ROSINA EAICD
- Download ROSINA Quick User Guide

Be aware that ROSINA AST2 (Lutetia Flyby) data are still under review and need to be used with caution.

RPC

Rosetta Plasma Consortium

In this instrument, five sensors measure the physical properties of the nucleus, examine the structure of the inner coma, monitor cometary activity, and study the comet's interaction with the solar wind. Note that each instrument in the consortium has their own EAICD and catalog file. These can be accessed within the datasets using the ftp links below.

- Browse RPCICA FTP Directory
- Browse RPCIES FTP Directory
- Browse RPCLAP FTP Directory
- Browse RPCMAG FTP Directory
- Browse RPCMIP FTP Directory
- Download RPC Quick User Guide
- Mapping of Rosetta RPC Datasets to CDF ISTP Compliant Files

Be aware that RPCICA AST2 (Lutetia Flyby) data are still under review and need to be used with caution.

RSI

Radio Science Investigation

Shifts in the spacecraft's radio signals are used to measure the mass, density and gravity of the nucleus, to define the comet's orbit, and to study the inner coma. RSI will also be used to study the solar corona during the periods when the spacecraft, as seen from Earth, is passing behind the Sun.

- Browse RSI FTP Directory
- Read RSI Instrument Catalog
- Download RSI EAICD
- Download RSI Quick User Guide

VIRTIS

Visible and Infrared Thermal Imaging Spectrometer

VIRTIS will map and study the nature of the solids and the temperature on the surface of the nucleus. Comet gases will be identified, and the physical conditions of the coma will be characterised. VIRTIS data were used to help identify the best landing site for Philae.

- Browse VIRTIS FTP Directory
- Read VIRTIS Instrument Catalog
- Download VIRTIS EAICD
- Download VIRTIS Quick User Guide

Be aware that VIRTIS AST2 (Lutetia Flyby) data are still under review and need to be used with caution.

PHILAE LANDER INSTRUMENTS

https://www.cosmos.esa.int/web/psa/rosetta

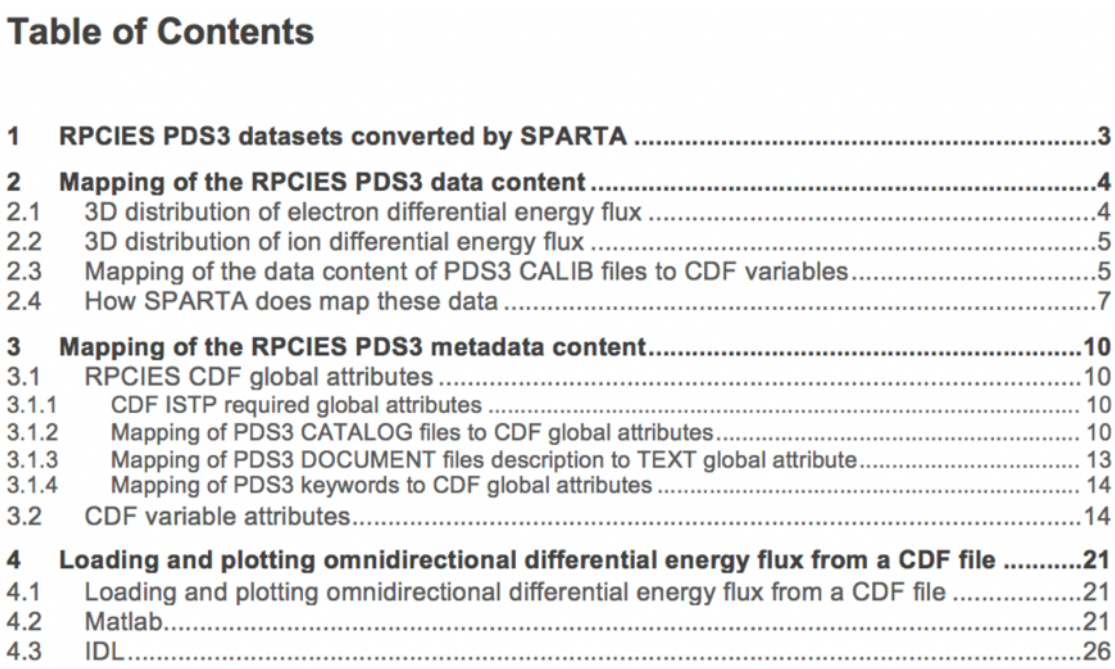


Table of Contents

Soon will be delivered with the CDF files

5. Technical note and interaction with the PI team

```
function [DEFomni,DEF]=plotRPCIESomniDEF(filename)
data=spdfcdfread(filename);
metadata=spdfcdfinfo(filename);

time=data{1};
energy=data{8};
DEF=data{2};

DEF(DEF<1)=NaN;
nts=length(time);
DEFomni=reshape(sum(reshape(DEF,256,128,nts),'omitnan'),128,nts);
DEFomni(DEFomni<1)=NaN;

figure
pcolor(time,energy,log(DEFomni));
```