Interoperable Data Access Data Model

Initial Prototype for Plasmas

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V1.10	*BC*	*25-oct-2010*	*- Added: VERSION HISTORY section* *- Splitting Parameter metadata into PhysicalParameter (modified metadata list) + AxisFrame (modified metadata list) + SupportParameter metadata (modified metadata list)* *- Added: "Req." (required) column for DublinCore metadata table.* *- Added: 'Star' in 'ObservationTarget.TargetType' allowed values list.* *- Added: description for 'Other metadata'*
V1.11	*BC*	*26-oct-2010*	*section 4.1.2:* *- 'DataSet.GranuleFormat' => 'DataSet.Format'* *- Updated: DublinCore Attributes* *- 'DataSet.ReaderResourceID' => 'DataSet.ReaderResourceURL'* *section 4.1.3:* *- Updated: Instrument Attributes comments* *section 4.1.4:* *- Added: 'Star' in TargetType list.* *section 4.1.5:* *- Removed: AxisType entity* *- Modified: AxisFrame Structure* *section 4.1.6:* *- Updated entry list and structure.* *- Added: 'Both' in SensingMode and SensingType entities* *- Added: 'DataType' entry.* *section 5:* *- Updated: IDIS-DataModel entities.*
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V1.17	*BC* *MG*	*25-jan-2011*	*- Added "AssociatedResourceID" item in PhysicalParameter Metadata Group* *- Modified "ObservationTarget" in "Parameter"* *- Added Preliminary InstrumentType list (section 10.1)* *- Added Preliminary TargetType list (section 10.2)* *- Added Preliminary UCDs list section (section 10.3)* *- Added missing items in General Metadata (AccessURL, AssociatedResourceID, ParentRessourceID)* *- Updated Collection description (section 4.3)* *- Updated Granule description (section 4.2): removed "ResourceClass" item* *- Added Cassini/CIRS (Abundance Vertical Profiles at Titan) in Examples (section 9.10)* *- Added "galaxy" item in TargetType list*
V1.17b	*BC* *MG* *EP*	*28-jan-2011*	*- In General Metadata:* • *AssociatedResourceID replaced by ResourceID* • *ParentResourceID replaced by ParentID* *- In AxisFrame Metadata:* • *Units.OtherUnits replaced by Units.Other* • *Units.Expression replaced by Units.Other.Expression* • *Units.ScaleSI replaced by Units.Other.ScaleSI* • *Units.DimEquation replaced by Units.Other.DimEquation* *- In Physical Parameter Metadata:* • *Second occurrence of ParameterName replaced by ParameterDescription* • *Added ParameterKey item* *- In Support Parameter Metadata:* • *Added ParameterKey item* *- In all document:* • *changed ObjectType (-Name, -Key...) into TargetType (-Name, -Key...)* *- Updated section 6.*
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1. SCOPE OF THE DOCUMENT

This document aims at defining an initial prototype of an interoperable Data Model (DM) in the frame of the Plasma Node of IDIS. The DM presented is built for plasma data but having in mind data from other science thematics relevant to IDIS. This DM will be interfaced using the Planetary Data Access Protocol (PDAP), specific discussion on the possible modifications of PDAP are discussed in the "*Interoperable Data Access Data Model - IPDA/PDAP Extension for IDIS*" document. At this stage, the DM goes down to the semantic description DataSet's contents, but does not provide syntactic information required to decode the content of a DataSet.

2. THE PDAP PROTOCOL

The PDAP protocol has been forged by the International Planetary Data Alliance (IPDA). The latest specification of this protocol can be found at:
http://www.planetarydata.org/

As stated in version 1.0 of the PDAP Specification document:
"*[PDAP is] a protocol for the retrieval of distributed planetary data. The interface is meant to be reasonably simple to implement by service providers.*

The basic summarized functionality of the protocol is as follows: a query defining a certain restriction on the available data is used as a first step to query for candidate data. The service returns a list of candidate hits formatted as a VOTable. For each candidate hit an access reference URL may be used to retrieve the real data. Data may be returned in a variety of formats.

This specification describes the "simple" way to access the data through an HTTP protocol. Other types of more complex access, eventually using SQL-like language, and more complex transports as SOAP, will be worked on within the IPDA technical experts group."

The list of compulsory input for a PDAP compliant service is:
- DATA_SET_ID
- PRODUCT_ID
- INSTRUMENT_TYPE
- TARGET_TYPE
- TARGET_NAME
- INSTRUMENT_NAME
- MISSION_NAME
- START_TIME, STOP_TIME
- RETURN_TYPE (VOTABLE, HTML, ASCII)
- RESOURCE_CLASS (DATASET, PRODUCT, IMAGE)

3. WHAT ARE THE MAIN CRITERIA FOR SEARCHING THE DATA ?

This section will be updated with the output of the *IDIS Data Model Science Working Group*, that should conclude before mid-2011. The Data Model will evolve accordingly.

3.1 Searching data for plasmas studies.

The required selection criteria for matching and comparing local plasma measurements is the time (or the time interval) at which a feature occurs. The identification and interpretation of physical processes also depend on the frequency or polarization degree in case of wave observations, as well as energy, mass or composition in case of particle observations.

The observation target which can be defined at various levels of precision (see paragraph "ObservationDescription" of section 4.3.2) is also a criterion that has to be used. The location of the measurement has to be known for multi-point data analysis. The observation objects may be planets, natural satellites, small bodies, the Sun, the Heliosphere, the Galaxy, the local plasma or even the spacecraft itself. The specification of the observation target may also be refined in terms of regions. For instance, for the Sun or any planets, the various layers of the atmosphere's body may be specified.

Another key aspect, which will not be reviewed here, but which is essential in the planetary VO perspective, is the characterization of spatial and temporal propagation of features in order to correctly correlate multi-point datasets. For electromagnetic waves (propagating in regions where free space propagation conditions are verified) and photons, the light travel time between two events has to be taken into account. For particle measurements, or large scale propagating plasma features, the speed of the measured entity has to be taken into account, as well as possible propagation effects between the two regions of observation. This point requires modeling and is a critical task for planetary VO projects.

Finally, it can be useful to be able to distinguish the *sensing type* (ie. 'remote' or 'in-situ' measurements), as well as the *sensing mode* (ie. 'active' or 'passive' measurements). The definition of the sensing type or mode must be defined precisely in each node context.

3.2 Searching data for atmosphere studies

[INPUT NEEDED!!!]
For atmospheric studies the time interval, the altitude and the location on the studied object is required.

time interval

location on surface, observer altitude, local-time, season
incidence angle, emergence, phase, tangent altitude, slant distance
Sub spacecraft coordinates

Specific case: occultations observation

3.3 Searching data for surface studies

[INPUT NEEDED!!!]
Time interval
local time, season
Wavelength of observation.

3.4 Searching for interior studies.

[INPUT NEEDED!!!]
Radar detection, seismic analysis
time interval
location on surface
depth

3.5 Searching data for small bodies studies

[INPUT NEEDED!!!]
time, location, orientation of body.

3.6 Searching data for pluri-disciplinary studies

[INPUT NEEDED!!!]
location: object/region.
time interval (or time tables).
Measurement type ?

Need for an ontology service.
For instance: Auroral science study: «electrons» keyword search should link to UV, Vis, IR auroral images.

4. TENTATIVE IDIS DATA-MODEL

The scope of this data-model is to try to avoid or at least limit extensions.

In previous data models, the required coordinates (used for data ordering and search) make them incompatible and difficult (or even impossible) to extend. For the IVOA, the astronomy heritage implied that the required coordinates are the sky coordinates (Right Ascension and Declination). In the case of planetary and space physics (e.g., PDAP or SPASE), the required coordinate is the time range (Start_Time, Stop_Time). These two requirements are inconsistent and may be incompatible: the sky coordinates have no sense in most of planetary and space sciences, whereas the time range (at year to sub-second scales) is not a primary coordinate in case of astronomical data. Even more, these two models may not be adequate either for modeled or time integrated data such as maps of planetary surfaces, where the adequate coordinate is that of the planet. Laboratory measurements (such as spectroscopy of planetary equivalent materials or ice propagation properties) do not fit either into these two implemented data models. We thus do not propose a specific required coordinate type.

The data model is hierarchically decomposed as follows:
- a DataSet contains a series of Granules.
- a Granule (usually a file) contains a series of Parameters (measured or instrumental).
- a Parameter (usually the data) is a series of physical or instrumental quantities items/values.

Fig. 4.1. Data Model hierarchy.

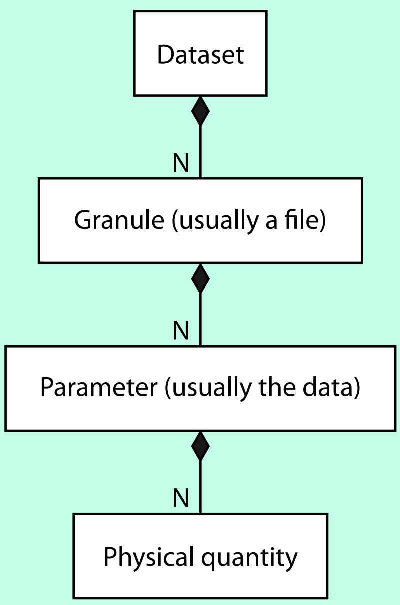
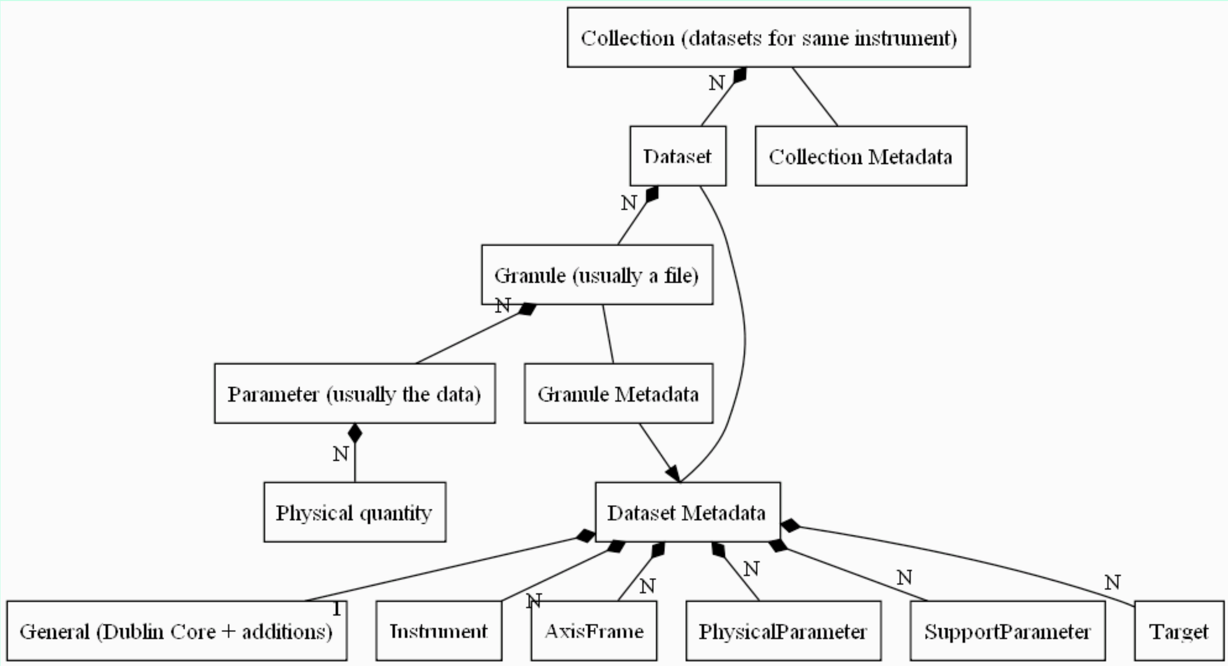


Fig. 4.2. Data Model hierarchy, including metadata.



This Data Model provides semantic description of the content of the DataSets. This means that the Data model does not aim at describing the way to parse the scientific content of the Granules. However, it provides enough information to search into the DataSets in order to identify the Granules of interest for a given request. This data model shall also be easily updated to a higher level of description to provide syntactic access to the Parameters themselves.

Parameters metadata are defined at the DataSet level. Granules inherit these metadata, except for the Parameters dimension ranges that change from one Granule to the other.

A series of DataSets can be associated into a Collection that gathers various DataSets (e.g.: DataSets from the same instrument at different processing levels).

4.1 DataSet

4.1.1 Definition

A DataSet is composed of a series of Granules that contain the same set of Parameters. Most Metadata are thus defined at the DataSet level. Metadata attached to a DataSet can be divided into six main categories: Generic (Dublin Core and some additions), Instrument, AxisFrame, PhysicalParameter, SupportParameter, and Target metadata.

4.1.2 *General Metadata*

Dublin Core metadata[1] is a "interoperable metadata standards that support a broad range of purposes and business models". It is used here to describe generic metadata, which list is given in the following table (DC=DublinCore, Req.=Required):

Entity Name	DC	Req.	Definition	Comments
Title	Y	Y	Name given to the resource	PDS: DATA_SET_NAME
ShortName	Y	N	Short abbreviation for the name given to the resource	
Identifier	Y	Y	URI: unambiguous reference to the resource within a given context	- Recommended best practice is to identify the resource by means of a string conforming to a formal identification system. - For PDS data, it is the DATA_SET_ID
Publisher	Y	Y	Entity responsible for making the resource available	
PublisherID	N	N	URI of the entity responsible for making the resource available	
Creator	Y	N	Entity primary responsible for making the content of the resource	- Examples of a Creator include a person, an organization, or a service. - Typically, the name of a Creator should be used to indicate the entity.
Contributor	Y	N	Entity responsible for making contributions to the content of the resource.	- Examples of a contributor include a person or on organization
Date	Y	Y	Date associated with an event in the life cycle of the resource.	- Typically, Date will be associated with the creation or availability (i.e. most recent relase or version) of the resource
Version	N	N	A label associated with the creation or availability (i.e., most recent release or version) of the resource	
Contact	N	N		
Subject	Y	N	List of Topics, objetc types, or other descriptive keywords about the resource	

1 http://dublincore.org/

Entity Name	DC	Req.	Definition	Comments
Description	Y	N	An account of the content of the resource.	- Description may include but is not limited to: an abstract, table of contents, reference to a graphical representation of context or a free-text account of the content
ReferenceURL	N	N	URL pointing to an additional information about the resource.	- In general, this information should be human-readable
Rights	N	N	Information about right access on the resource. (IVOA definition)	- public, proprietary, mixed.
OriginalResourceID	N	N	ResourceID of the original DataSet in case of a mirrored Resource	
Format	N	Y	Name of the granule format	- The list of possible formats is: CDF, PDS, FITS, NetCDF, CDPP, ASCII, Native. - This list is not restrictive and shall be updated on demand
ReaderResourceURL	N	N	URL of the Granule reader.	- Required in case of GranuleFormat="Native" - Recommended for other cases
AccessURL	N	N	URL used to access to the ressource	
AssociatedID	N	N	ResourceID of associated DataSet	
ParentID	N	N	ResourceID of the DataSet for a Granule, or of the Collection in case of a DataSet	Required in case of a Granule

4.1.3 Instrument Metadata

The Physical Parameters of a DataSet are usually physical measurements, or derived from physical measurements. The Instrument Metadata describe the Instrument(s) linked with the content of the DataSet. There may be several Instrument entities for one DataSet. Each Instrument is described by the following metadata:

Entity Name	Definition	Comments
ObservatoryName	Name of the Mission or of the Observatory	- Recommendation: The MissionName shall be checked with IPDA/PDS MissionName list. - PDS: MISSION_NAME - IAU: OBSERVATORY_CODE
InstrumentHost	Name of the Instrument Set hosting the Instrument	- [optional] if necessary, name of the set of instrument, or experiment (as defined in SPASE 2.2.0) containing the described instrument.

Entity Name	Definition	Comments
InstrumentName	Name of the Instrument	- Recommendation: The InstrumentName shall be checked with IPDA/PDS InstrumentName list. - PDS: INSTRUMENT_NAME - Instrument name for Observatories.
InstrumentType	Type of Instrument	- The InstrumentType list is given in section 10.1
InstrumentKey	Unique Instrument identifier, for cross reference use in Parameters metadata	
ReferenceURL	URL pointing to an additional information about the resource.	- In general, this information should be human-readable

Notes:
- InstrumentType list: taken from SPASE 2.2.0 InstrumentType item.
- In case of ground based measurement, MissionName is ObservatoryCode from IAU list.

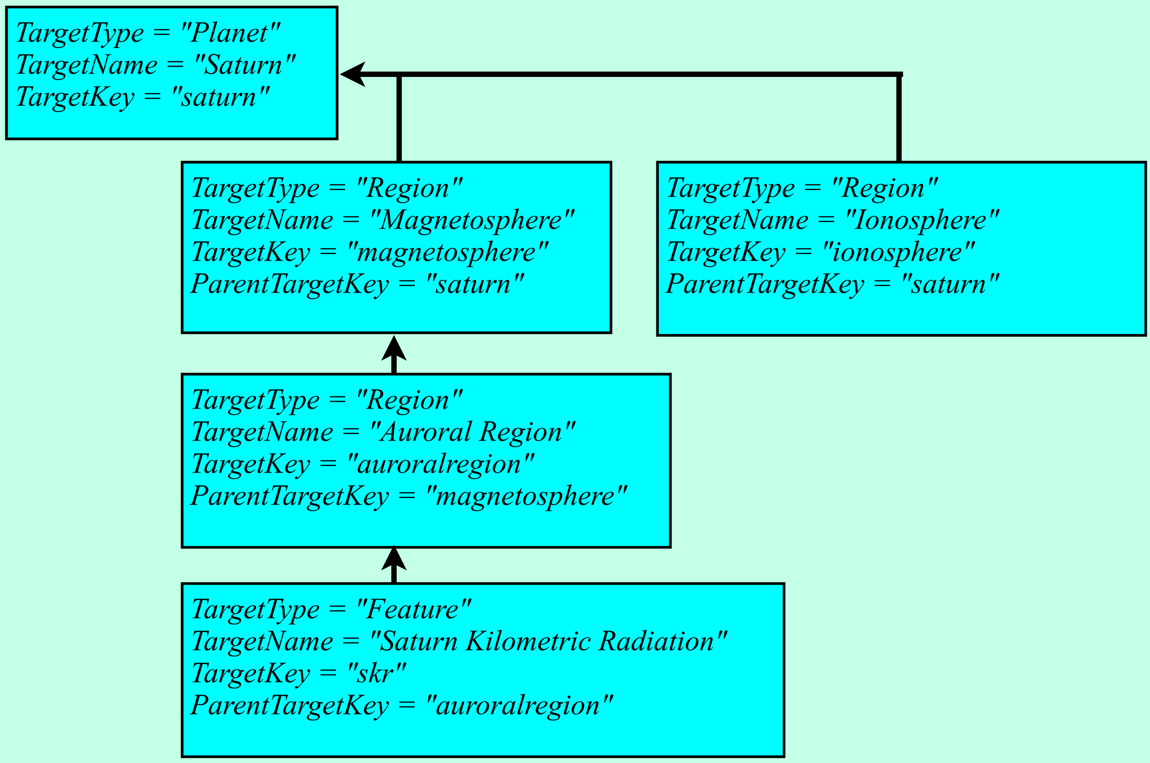
4.1.4 Target Metadata

The Physical Parameters of a DataSet usually aim at one or several Targets. The Target Metadata describe these targets linked with the content of the DataSet. Their may be several Target entities for one DataSet. Each Target is described by the following metadata:

Entity Name	Definition	Comments
TargetType	Type of Observed Target	- Star, Planet, Region, Feature, Exoplanet, Spacecraft... (list in Section 10.2)
TargetName	Name of the Observed Target	- From authoritative list (IAU + lab experiment...)
TargetKey	Unique Target identifier, for cross reference, both in Target Metadata, and in Physical Parameter Metadata	
ParentTargetKey	TargetKey of the parent Target	

The ParentTargetKey allows cross reference with the Target Metadata. This allows to nest Targets with hierarchical description as shown on Figure 4.3.

Fig. 4.3. Cassini/RPWS/HFR data Target included many Objects and Regions throughout the mission. We thus define the following ObservationTarget metadata:



4.1.5 AxisFrame Metadata

We describe here the various axes or frames (i.e., the abscissa) of the physical parameters described in section 4.1.6.

At least one axis is required. For each axis, the Dimension of this Axis shall be defined in terms of Type (time, space, frequency...), Range (MinValue, MaxValue), Resolution (MinResolution, MaxResolution), Accuracy, Units. Figure 2 summarizes the AxisFrame metadata.

The Axis entity is based on the Characterization DataModel[2] developed by IVOA, with some extensions. The *Axis* entity is composed of the following sub-entities:

`AxisKey`	*Unique Object identifier, for cross reference, both in PhysicalParameter Metadata and SupportParameter Metadata*

2 http://www.ivoa.net/Documents/latest/CharacterisationDM.html

`AxisName` *Name of the Axis*

`DimensionType` *Type Dimension for this Axis: 'time', 'space', 'frequency', 'energy', 'mass', 'voltage', 'composition', 'pixel', 'altitude', 'depth', 'distance'... (list to be defined and updated on demand)*

`CoordFrame` *Use TimeFrame (stc:TimeFrameType), SpaceFrame (stc:SpaceFrameType), SpectralFrame (stc:SpectralFrameType) or GenericFrame (stc:GenericCoordFrame). See Space-Time Coordinate (STC) IVOA model[3] and STC-X: Space-Time Coordinate (STC) Metadata XML Implementation[4]*
[NOT IMPLEMENTED YET]

Units: in case of 'time' axis, use 'TimeUnits' instead of 'Units'
`Units` *Unit of the Axis. We used here a description scheme used in the "Single Spectral Lines Data Model"[5] of IVOA (section 2.1.2 of the v1.0 document). It is described with 2 sub-entities:*

`Units.Time` *Unit of a 'time' Axis. Allowed values are: 'ISO-8601'[6], 'JulianSec'... (list to be completed if necessary).*
`Units.Other` *For Units other than time, we use 3 sub-entities: 'Units.expression', 'Units.scaleSI','Units.dimEquation', defined as follows:*

`Units.Other.Expression` *String representation of the unit.*
Examples: "Jansky" or "W.m^-2.Hz^-1"
`Units.Other.ScaleSI` *Scaling factor to convert the unit to its International System (IS) of Units equivalent.*
Examples:
- *1 cm has a scale factor of 1E-2, since 1cm = 0.01 m (its IS equivalent)*
- *1 Jansky has a scale factor of 1E-26, since 1Jy = 1E-26 W.m^-2.Hz^-1*

`Units.Other.DimEquation` *Dimensional equation[7] representation of the unit. The format is a string with the dimensional equation, where M is mass, L is length, T is time, K is temperature and Q is electric charge.*

---

3 http://www.ivoa.net/Documents/latest/STC.html

4 http://www.ivoa.net/Documents/latest/STC-X.html

5 http://www.ivoa.net/Documents/SSLDM/

6 http://en.wikipedia.org/wiki/ISO_8601

7 http://en.wikipedia.org/wiki/Dimensional_analysis

For ease of notation, the caret "^" indicating powers of ten can be removed - as is customary in Dimensional Analysis practices- resulting in expressions like the following, which are equivalent: Example: "ML-1T-3" and "ML^-1T^-3" are equivalent.

`DimensionMode` — *'absolute' or 'relative'*
if 'relative' :

- *OffsetValue* — *Offset from reference point*
- *OffsetUnits* — *Unit of Offset from reference point*
- *ReferenceValue* — *Reference point*
- *ReferenceUnits* — *Unit of reference point*

`IntegratedAxis` — *'yes' or 'no'. Indicates a dimension on which data has been integrated over the given DimensionRange or with only one allowed value for the whole dataset. In that case, DimensionResolution shall not be filled.*
[NOT IMPLEMENTED YET]

`DimensionRange` — *Interval of the Axis specified in two sub-entities:*
- *MinValue*
- *MaxValue*

`DimensionResolution` — *(Optional) Resolution of the Axis. As the Resolution may be variable, 2 sub-entities are available:*

- *MinResolution*
- *MaxResolution*

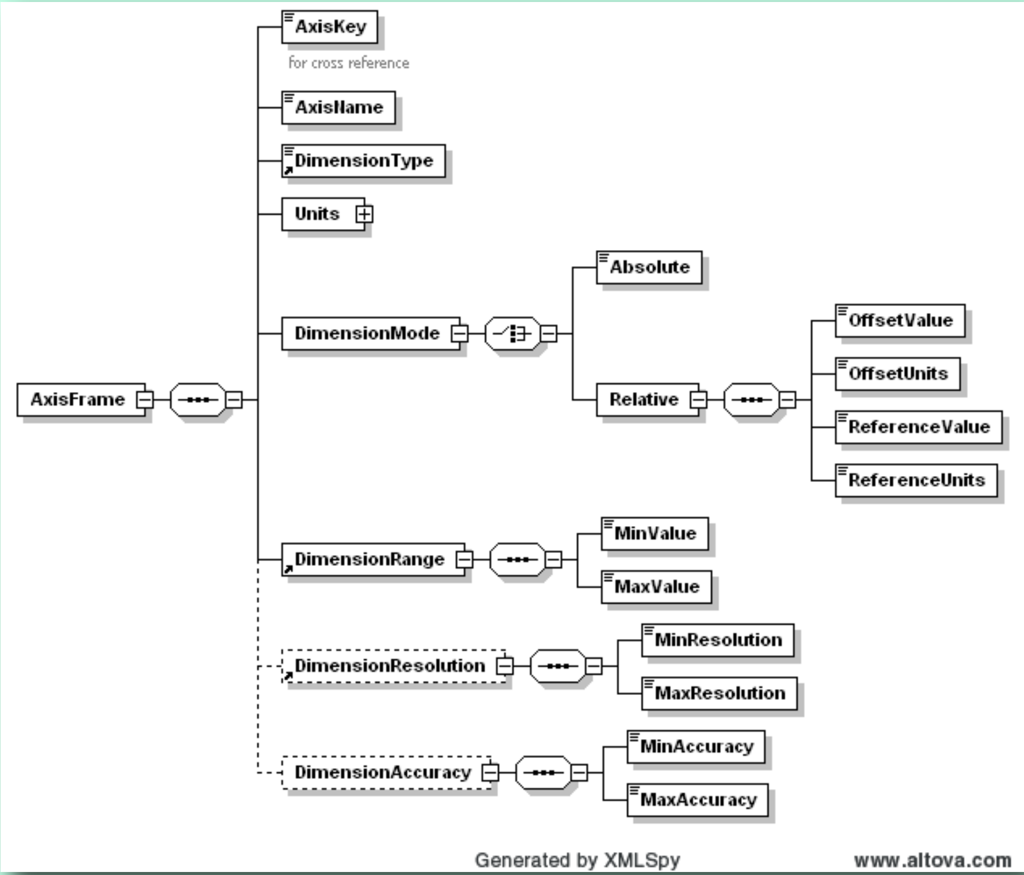
`DimensionAccuracy` — *(Optional) Accuracy of the Axis. As the Accuracy may be variable, 2 sub-entities are available:*

- *MinAccuracy*
- *MaxAccuracy*

`AssociatedID`

(Optional) Associated ResourceID of a table containing the values allowed for this axis.
[NOT IMPLEMENTED YET]

Fig. 4.4. AxisFrame metadata group.



Note for future versions: Study the possible use of SPASE (see 2.2.0 document[8]) structure of Ranges:
- *Low* (required): The smallest value within a range of possible values.
- *High* (required): The largest value within a range of possible values.
- *Units* (required): See *Units* as described above.
- *Bin* (Optional, unbounded): A grouping of observations according to a band or window of a common attribute. Each Bin element containing a *Name*, *Low* and *High* attribute.

4.1.6 Physical Parameter Metadata

Parameters are series of numerical or text values with an arbitrary number of dimensions. Each Parameter is described in terms of: Parameter Type, associated Instrument, associated Axis, Processing Level, Parameter Sensing, and Observation Description.

ParameterName

[8] http://www.spase-group.org/data/doc/spase-2_2_0-draft.pdf

Name of the *Physical Parameter*.

ParameterDescription

Description of the *Physical Parameter*.

ParameterType

The ParameterType entry describes the generic type of parameter. The ParameterType concept is close to that of the UCD (Unified Content Descriptors) defined by IVOA[9]. However, we can not use that list right now, as it has not been forged for space physics measurements. The list can be browsed here. In the UCD list, the 'em' entry (`Electromagnetic spectrum`) can be used for electromagnetic waves, but we need two other entries for the measurement type description: 'part' (`Particle`) and 'field' (`DC field`). Neither the parameter 'Model' nor the Location/ Pointing are covered by the UCD model at this time. The Instrumental Status is covered by the 'inst' entry, but shall be extended to fit to space physics observations.

Following the UCD model, we can define the following ParameterTypes:

```
- em                    Electromagnetic Wave (remote source)
- em.elec               Electric component of Electromagnetic Wave
- em.mag                Magnetic component of Electromagnetic Wave
- pw                    Plasma Wave (local wave or plasma oscillation)
- pw.elec               Electric component of Plasma Wave
- pw.mag                Magnetic component of Plasma Wave
- phot                  Photon
- part                  Particle
- part.elec             Electrons
- part.elec.1-20keV     Electrons in energy band 1 to 20 keV
- part.ions             Ions
- part.neut             Neutrals
- dc                    DC Field
- dc.elec               Electric field
- dc.mag                Magnetic field
- model                 Model (suffix to any other measurement type)
```

See Section 10.3 for list of UCDs.

When the Parameter is a measurement, it should refer to the measurement technique rather than to the measured observable, as described in the following examples:

• Sub-surface radar sounding:	***Parameter Type*** = *em . elec*

[9] http://www.ivoa.net/Documents/latest/UCDlist.html

- IR image of Saturn Rings: ***Parameter Type*** = *phot . IR*
- ENA mapping at Saturn: ***Parameter Type*** = *part . neut*
- Plasma density measured by QTN: ***Parameter Type*** = *pw . elec*

NB: At this time it has been chosen to try to keep the Measurement finer description Node-generic. It may prove in the future that we need to have different sets of Measurement description, depending on the Node.

ParameterKey (optional)

Identification Key that can be used to refer to that *Physical Parameter*, if needed for cross-reference.

InstrumentKey

The Instruments associated with the DataSet are listed in the InstrumentDescription entry at the DataSet level. This entry contains the list of the associated Instruments referenced by their *InstrumentKey*.

AxisKey

The Instruments associated with the DataSet are listed in theAxisFrame entry at the DataSet level. This entry contains the list of the associated Instruments referenced by their *AxisKey*.

Units

`Units`	*Unit of the Parameter. We used here a description scheme used in the "Single Spectral Lines Data Model"[10] of IVOA (section 2.1.2 of the v1.0 document). It is described with 3 sub-entities: 'Unit.expression', 'Unit.scaleSI','Unit.dimEquation', defined as follows:*
`Units.expression`	*String representation of the unit.* *Examples: "Jansky" or "W.m^-2.Hz^-1"*
`Units.scaleSI`	*Scaling factor to convert the unit to its International System (IS) of Units equivalent.* *Examples:* *• 1 cm has a scale factor of 1E-2, since 1cm = 0.01 m (its IS equivalent)* *• 1 Jansky has a scale factor of 1E-26, since 1Jy = 1E-26 W.m^-2.Hz^-1*

10 http://www.ivoa.net/Documents/SSLDM/

`Units.dimEquation`	*Dimensional equation representation of the unit. The format is a string with the dimensional equation, where M is mass, L is length, T is time, K is temperature and Q is electric charge.* *For ease of notation, the caret "^" indicating powers of ten can be removed - as is customary in Dimensional Analysis practices- resulting in expressions like the following, which are equivalent:* *Example: "ML-1T-3" and "ML^-1T^-3" are equivalent.*

ProcessingLevel

This entry describes the processing level of the Parameter. It is optional, but highly recommended for *Measurement* Parameter Type.

The allowed values are:

Raw	*(compressed telemetry data)*
Uncalibrated	*(uncompressed telemetry data)*
Partially Calibrated	*(partially calibrated data)*
Calibrated	*(fully calibrated data)*
Derived	

AssociatedID (optional)

The optional *AssociatedID* item is used to link to lower level data in case of a derived physical parameter. Several resource IDs may be provided. This item is optional.

SensingMode

This entry describes the sensing mode:
- *In-Situ*
- *Remote*
- *Both*

The *SensingMode* is defined as follows for plasma-node measurements:
- *In-situ* = measurements of the plasma surrounding the spacecraft.
- *Remote* = measurements of waves or particles coming from a remote location.

NB: This definition has to be updated to fit with the other Science Nodes. For instance:
- *Radar measurement = Remote*
- *IR/UV/Vis camera = Remote*
- *Penetrator = In-Situ*
- *Rover = In-Situ or Remote ?*

This has to be clearly defined depending on instrument;

e.g. for "laser rock composition" (what's the right name?): remote or in-situ ?
- *Radio Science = Remote*
- *Magnetic field measurement = In-Situ (although remote magnetic source)*
- *Gravitational Moments = Remote (although local trajectory)*

SensingType

This entry describes the sensing mode:
- *active*
- *passive*
- *both*

The *SensingType* is defined as follows for plasma-node measurements:
- *active* = the instrument provokes a response of the observed objects/media.
- *passive* = the instrument measures passively the observed objects/media.

NB: This definition has to be updated to fit with the other Science Nodes. For instance:
- *Monostatic radar measurement = Active*
- *Bistatic radar measurement = Active or Passive ?*
  Problem raised here:
  Do we consider the case of artificial stimuli emitted by another spacecraft/station than the observer as Active ?
- *IR/UV/Vis camera = Passive*
- *Penetrator = Active or Passive ?*
- *Rover = Active or Passive ?*
  This has to be clearly defined depending on instrument;
  e.g. for "laser rock composition" (what's the right name?): Active
- *Radio Science = Active or Passive ?*
  Same problem as for bistatic radar.
- *Magnetic field measurement = Passive*
- *Gravitational Moments = Passive*

DataType (Optional)

This entity describes the type of data in terms of source of data. The allowed values are explicit:
- Measurement
- Model
- Mixed

ObservationDescription

This entry describes the primary observation or target. This entry is essential for data search and harvesting. It is composed of two sub-entries: *TargetKey* and *ParameterType*.

The list of observed Objects associated with the DataSet is defined at the DataSet level, in the *Target* metadata. The Object entry refers to these *Targets* by their *TargetKey*.

The *ParameterType* describes the targeted parameter of the observed Region/Object. This entry is filled with one or a series of UCDs describing the measured parameter.

As for now, the ParameterType list is entered directly by the provider (not a drop list).

[Build UCD list !] and look into SPASE dictionary for these lists (for plasma node DataSets and Granules).

4.1.7 SupportParameter Metadata

ParameterName

The name of the *SupportParameter*.

ParameterDescription (Optional)

Description of the *SupportParameter*.

ParameterKey (optional)

Identification Key that can be used to refer to that *Physical Parameter*, if needed for cross-reference.

ParameterType

Similarly to the *ParameterType* entry of the *PhysicalParameter* metadata, we define a list of UCDs describing the Support Parameter Types:

```
- loc                     Location/Pointing
- loc.ephem               Ephemeris (location)
- loc.att                 Attitude (orientation)
- loc.inc                 Incidence angle
- inst                    Instrument Status
- inst.mode               Instrument Mode
- inst.integrationTime    Integration Time
- inst.integrationBand    Integration Bandwidth
- inst.other              To be specified in ParameterDescription
-... (to be completed)
```

InstrumentKey

The Instrument associated with the DataSet are listed in the InstrumentDescription entry at the DataSet level. This entry contains the list of the associated Instruments referenced by their *InstrumentKey*.

AxisKey

The Instrument associated with the DataSet are listed in theAxisFrame entry at the DataSet level. This entry contains the list of the associated Instruments referenced by their *AxisKey*.

Unit (Optional)

`Units`	*Unit of the Parameter. We used here a description scheme used in the "Single Spectral Lines Data Model"[11] of IVOA (section 2.1.2 of the v1.0 document). It is described with 3 sub-entities: 'Unit.expression', 'Unit.scaleSI','Unit.dimEquation', defined as follows:*
`Units.expression`	*String representation of the unit.* *Examples: "Jansky" or "W.m^-2.Hz^-1"*
`Units.scaleSI`	*Scaling factor to convert the unit to its International System (IS) of Units equivalent.* *Examples:* *• 1 cm has a scale factor of 1E-2, since 1cm = 0.01 m (its IS equivalent)* *• 1 Jansky has a scale factor of 1E-26, since 1Jy = 1E-26 W.m^-2.Hz^-1*
`Units.dimEquation`	*Dimensional equation representation of the unit. The format is a string with the dimensional equation, where M is mass, L is length, T is time, K is temperature and Q is electric charge.* *For ease of notation, the caret "^" indicating powers of ten can be removed - as is customary in Dimensional Analysis practices- resulting in expressions like the following, which are equivalent:* *Example: "ML-1T-3" and "ML^-1T^-3" are equivalent.*

4.2 Granule

4.2.1 Definition

Granules are also called Products in PDS/IPDA. They are usually the files containing the data.

[11] http://www.ivoa.net/Documents/SSLDM/

All the Granules of a DataSet are homogeneous in content. This means each Granule contains the same set of Parameters. Solely the range along one or several dimensions changes in each Granules.

Example:
STEREO/Waves Granules (archived at CDPP) are daily files on two separated frequency ranges. For each day, there are two files, spanning respectively on the ranges [2.5 kHz-128kHz] and [125 kHz-15.625 MHz].

The Granules inherit their parent DataSet metadata values, except for Parameters dimension ranges that change from Granules to Granules.

4.2.2 Metadata

RessourceID
ParentID = RessourceID of Parent DataSet

Every other metadata from DataSet level are inherited, except for the *DimensionRanges*, *DimensionResolutions* (if defined) and *DimensionAccuracies* (if defined) that change from one Granule to the other.

4.3 Collection

[Not Fully Implemented Yet]
It may be useful to gather various DataSets into Collections. Collections can be used to link DataSets from the same instrument, but processed at various levels.

The metadata of a Collection includes the *General*, *Instrument*, and *Target* metadata groups, as defined for the DataSet level. The *General* metadata *AssociatedRessourceID* item contains the list of the DataSets *RessourceIDs* contained in the Collection.

4.4 Other linked Metadata

[Not Fully Implemented Yet]
These metadata are based on a very simple structure composed of a Name, a ResourceID, a Description and an URL pointing to the resource.

List of metadata:
AncillaryData [0+]
- Calibration tables
- References Papers

Rules of the road
Caveat
Contacts

Software [0+]
Readers (routine, archive, URL...)
Calibration Routines (routines, archive, URL...)

AssociatedID [0+]
DataSetID/ProductID...

5. METADATA DICTIONARIES

During experimentation that are currently conducted, it may appear that it is necessary to define various metadata dictionaries, depending on the node thematic. This should not change the schema description, but the content of the predefined lists (such as: *InstrumentType*, *DimensionType*, *ParameterType*...)

6. LINKING WITH PDAP

PDAP is an interoperable protocol developed in the frame of the IPDA. It allows extensions for flexibility. We propose here to extend PDAP for various data types. This follows the previous extension approved by IPDA for "Image" data. We propose thus to add a few new types : "time-series", "profile", "spectrum", "dynamic-spectrum", "spectral-cube". The required metadata will depend on the extension definition. This implies that we may ask for a modification of PDAP, because the StartTime and StopTime are required for any type of request, although it is not necessarily required for any type of data.

Correspondence between current PDAP required metadata and the proposed IDIS DataModel:

PDAP	IDIS Data-Model
DATA_SET_ID	DataSet . General . DublinCore . Identifier
PRODUCT_ID	Granule . General . DublinCore . Identifier
INSTRUMENT_TYPE	DataSet . Instrument(i) . InstrumentType
INSTRUMENT_NAME	DataSet . Instrument(i) . InstrumentName
MISSION_NAME	DataSet . Instrument(i) . MissionName
TARGET_TYPE	DataSet . ObservationDescription(j) . TargetType
TARGET_NAME	DataSet . ObservationDescription(j) . TargetName
START_TIME	(DataSet or Granule) . AxisFrame(DimensionType="Time") . DimensionRange . MinValue

PDAP	IDIS Data-Model
STOP_TIME	(DataSet or Granule) . AxisFrame(DimensionType="Time") . DimensionRange . MaxValue
RETURN_TYPE	*From PDAP interface*
RESOURCE_CLASS	*From PDAP interface*

7. RECOMMENDATIONS TO OTHER VO GROUPS

This Data Model is built to organize various types of data in the frame of EPN-IDIS. We will discuss and propose some recommendations to IPDA and IVOA working groups in order to enhance the capabilities of their models and tools in the specific frame of planetary data.

List the recommendations.

Update UCD list. At first: define a branch that will merge in the future. New utype would then be 'epn:...' for the moment.

Define MissionName, InstrumentName, InstrumentType, TargetType, TargetName authoritative list and implement a process to update the list.

8. ON-LINE EDITOR

An online tool that can be used to build XML files providing the metadata of your DataSets or Granules is available online[12].

The XML schema that is used by this interface is available here.

[12] http://oberoi.cesr.fr:8080/jaxfront/JAXFrontServlet?app=jaxfront&action=loadResource&resource=jumpStart/jumpStart.html

9. EXAMPLES OF IMPLEMENTATION

9.1 STEREO/Waves Level 2 data (as currently archived at CDPP)

STEREO/Waves Level 2 data are composed of dynamic spectra of the electric flux density with time and frequency sampling. The following Table 9.1 represents the various parameters included in the DataSet along with the corresponding metadata groups. The Granules are daily files, in a native binary format. The Granules are available from CDPP server (public access after registration). An IDL reader is provided on the CDPP server.
The complete XML file containing the metadata is available here.

Table 9.1: *STEREO/Waves Level 2 data (as currently archived at CDPP)*
The data has been extracted from file "STA_WAV_HFR_20061101.B3E"

Record #	Sweep #	Time (sec. of day)	Freq. (kHz)	Auto_Ch1 (Wm^2/Hz)	Auto_Ch2 (Wm^2/Hz)	ReCross (norm.)	Imcross (norm)	Integ. Time (ms)	Freq. Bandwidth (kHz)	Antenna Mode (code)
0	0	4.151	125.0	4.70252e-17	3.69504e-17	-0.2009	-0.1262	2.5	12.5	31
1	0	4.187	175.0	2.51700e-17	2.67084e-17	-0.1428	-0.1156	2.5	12.5	31
2	0	4.223	225.0	1.68301e-17	4.19077e-17	-0.0838	0.2898	2.5	12.5	31
3	0	4.259	275.0	1.05154e-17	1.40606e-17	-0.1331	0.0050	2.5	12.5	31
4	0	4.295	235.0	1.06270e-17	1.20848e-17	-0.1609	-0.0157	2.5	12.5	31
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
1079986	6776	86400.191	15875.0	6.18147e-16	6.14172e-16	0.0000	0.0000	2.5	12.5	31
1079987	6776	86400.222	15925.0	9.52330e-16	7.25596e-16	0.0000	0.0000	2.5	12.5	31
1079988	6776	86400.262	15975.0	8.31253e-16	7.33993e-16	0.0000	0.0000	2.5	12.5	31
1079989	6776	86400.301	16025.0	6.70138e-16	8.39954e-16	0.0000	0.0000	2.5	12.5	31
Support Parameters		*Axis Frame*		*Physical Parameters*				*Support Parameters*		

General Metadata:

```
<GeneralMetadata>
	<DublinCore>
		<Title>STEREO/Waves Level 2</Title>
		<Identifier>swaves_L2</Identifier>
		<Publisher>CDPP</Publisher>
		<Creator>LESIA</Creator>
		<Date>2011-02-01</Date>
	</DublinCore>
	<Contact>
		<Name>Baptiste Cecconi</Name>
```

```
            <Address>
                  LESIA, Observatoire de Paris,
                  11 av. Marcellin Berthelot,
                  92190, Meudon, France
            </Address>
            <Email>baptiste.cecconi@obspm.fr</Email>
            <Telephone>+33145077759</Telephone>
      </Contact>
      <Rights>public</Rights>
      <Format>Native</Format>
      <ReaderResourceURL>
            http://cdpp2.cnes.fr/cdpp/data/documents/PLAS-LO-STR_SWAVES-00551-LES/
00551.tar
      </ReaderResourceURL>
      <AccessURL>http://cdpp2.cesr.fr/</AccessURL>
</GeneralMetadata>
```


Instrument Metadata:

This metadata group contains here 2 items: the same Waves instrument is placed on STEREO-A and STEREO-B.


```
<Instrument>
      <MissionName>STEREO-A</MissionName>
      <InstrumentName>Waves</InstrumentName>
      <InstrumentType>Spectral Power Receiver</InstrumentType>
      <InstrumentKey>sta_waves</InstrumentKey>
      <ReferenceURL/>
</Instrument>

<Instrument>
      <MissionName>STEREO-B</MissionName>
      <InstrumentName>Waves</InstrumentName>
      <InstrumentType>Spectral Power Receiver</InstrumentType>
      <InstrumentKey>stb_waves</InstrumentKey>
      <ReferenceURL/>
</Instrument>
```


Target Metadata:

This metadata group contains here 4 items: Sun, Heliosphere, Solar Wind and its Radio Emissions.


```
<Target>
      <TargetType>Star</TargetType>
      <TargetName>Sun</TargetName>
      <TargetKey>sun</TargetKey>
      <ParentTargetKey/>
</Target>

<Target>
      <TargetType>Region</TargetType>
      <TargetName>Heliosphere</TargetName>
      <TargetKey>heliosphere</TargetKey>
      <ParentTargetKey>sun</ParentTargetKey>
</Target>

<Target>
      <TargetType>Feature</TargetType>
      <TargetName>Solar Wind</TargetName>
      <TargetKey>sw</TargetKey>
      <ParentTargetKey>heliosphere</ParentTargetKey>
</Target>
```

```
<Target>
       <TargetType>Feature</TargetType>
       <TargetName>Solar Wind Radio emissions</TargetName>
       <TargetKey>sw_radio</TargetKey>
       <ParentTargetKey>sw</ParentTargetKey>
</Target>
```

AxisFrame Metadata:

This metadata group contains here 2 items: Time and Frequency.

```
<AxisFrame>
       <AxisKey>time</AxisKey>
       <AxisName>Time</AxisName>
       <DimensionType>time</DimensionType>
       <Units>
              <Time>JulianSec</Time>
       </Units>
       <DimensionMode>
              <Absolute/>
       </DimensionMode>
       <DimensionRange>
              <MinValue>2006-10-27T00:00:000Z</MinValue>
              <MaxValue>2010-12-26T23:59:999Z</MaxValue>
       </DimensionRange>
</AxisFrame>

<AxisFrame>
       <AxisKey>freq</AxisKey>
       <AxisName>Frequency</AxisName>
       <DimensionType>frequency</DimensionType>
       <Units>
              <Other>
                     <Expression>kHz</Expression>
                     <ScaleSI>1000.</ScaleSI>
                     <DimEquation>T-1</DimEquation>
              </Other>
       </Units>
       <DimensionMode>
              <Absolute/>
       </DimensionMode>
       <DimensionRange>
              <MinValue>2.5</MinValue>
              <MaxValue>16025.</MaxValue>
       </DimensionRange>
</AxisFrame>
```

Parameter Metadata:

This metadata group contains here 4 items described in Table 9.1.

```
<Parameter>
       <ParameterName>Auto_ch1</ParameterName>
       <ParameterDescription>
              Autocorrelation measured on Channel 1
       </ParameterDescription>
       <ParameterType>em.elec</ParameterType>
       <ParameterKey>auto1</ParameterKey>
       <InstrumentKey>sta-waves</InstrumentKey>
       <InstrumentKey>stb-waves</InstrumentKey>
       <AxisKey>time</AxisKey>
       <AxisKey>freq</AxisKey>
       <Units>
              <Expression>W/m^2/Hz</Expression>
              <ScaleSI>1.</ScaleSI>
```

```
            <DimEquation>MT-2</DimEquation>
        </Units>
        <ProcessingLevel>calibrated (fully calibrated data)</ProcessingLevel>
        <SensingMode>remote</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>measurement</DataType>
        <ObservationDescription>
            <TargetKey>heliopshere</TargetKey>
            <TargetKey>sw</TargetKey>
            <TargetKey>sw_radio</TargetKey>
            <ParameterType/>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>Auto_ch2</ParameterName>
        <ParameterDescription>
            Autocorrelation measured on Channel 2
        </ParameterDescription>
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>auto2</ParameterKey>
        <InstrumentKey>sta-waves</InstrumentKey>
        <InstrumentKey>stb-waves</InstrumentKey>
        <AxisKey>time</AxisKey>
        <AxisKey>freq</AxisKey>
        <Units>
            <Expression>W/m^2/Hz</Expression>
            <ScaleSI>1.</ScaleSI>
            <DimEquation>MT-2</DimEquation>
        </Units>
        <ProcessingLevel>calibrated (fully calibrated data)</ProcessingLevel>
        <SensingMode>remote</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>measurement</DataType>
        <ObservationDescription>
            <TargetKey>heliopshere</TargetKey>
            <TargetKey>sw</TargetKey>
            <TargetKey>sw_radio</TargetKey>
            <ParameterType/>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>ReCross</ParameterName>
        <ParameterDescription>
            Real part of Crosscorrelation measured between Channel 1 and 2
        </ParameterDescription>
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>recross</ParameterKey>
        <InstrumentKey>sta-waves</InstrumentKey>
        <InstrumentKey>stb-waves</InstrumentKey>
        <AxisKey>time</AxisKey>
        <AxisKey>freq</AxisKey>
        <Units>
            <Expression>1</Expression>
            <ScaleSI>1.</ScaleSI>
            <DimEquation>1.</DimEquation>
        </Units>
        <ProcessingLevel>calibrated (fully calibrated data)</ProcessingLevel>
        <SensingMode>remote</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>measurement</DataType>
        <ObservationDescription>
            <TargetKey>heliopshere</TargetKey>
            <TargetKey>sw</TargetKey>
```

```
        <TargetKey>sw_radio</TargetKey>
        <ParameterType/>
    </ObservationDescription>
</Parameter>

<Parameter>
    <ParameterName>ImCross</ParameterName>
    <ParameterDescription>
        Imaginary part of Crosscorrelation measured between Channel 1 and 2
    </ParameterDescription>
    <ParameterType>em.elec</ParameterType>
    <ParameterKey>imcross</ParameterKey>
    <InstrumentKey>sta-waves</InstrumentKey>
    <InstrumentKey>stb-waves</InstrumentKey>
    <AxisKey>time</AxisKey>
    <AxisKey>freq</AxisKey>
    <Units>
        <Expression>1</Expression>
        <ScaleSI>1.</ScaleSI>
        <DimEquation>1.</DimEquation>
    </Units>
    <ProcessingLevel>calibrated (fully calibrated data)</ProcessingLevel>
    <SensingMode>remote</SensingMode>
    <SensingType>passive</SensingType>
    <DataType>measurement</DataType>
    <ObservationDescription>
        <TargetKey>heliopshere</TargetKey>
        <TargetKey>sw</TargetKey>
        <TargetKey>sw_radio</TargetKey>
        <ParameterType/>
    </ObservationDescription>
</Parameter>
```


SupportParameter Metadata:

This metadata group contains here 5 items described in Table 9.1.


```
<SupportParameter>
    <ParameterName>IntegTime</ParameterName>
    <ParameterDescription>Integration Time</ParameterDescription>
    <ParameterType>inst.integrationTime</ParameterType>
    <ParameterKey>dt</ParameterKey>
    <InstrumentKey>sta-waves</InstrumentKey>
    <InstrumentKey>stb-waves</InstrumentKey>
    <AxisKey>time</AxisKey>
    <AxisKey>freq</AxisKey>
    <Units>
        <Expression>ms</Expression>
        <ScaleSI>1.e-3</ScaleSI>
        <DimEquation>T</DimEquation>
    </Units>
</SupportParameter>

<SupportParameter>
    <ParameterName>Frequency Band</ParameterName>
    <ParameterDescription>Frequency Bandwidth of integration</ParameterDescription>
    <ParameterType>inst.integrationBand</ParameterType>
    <ParameterKey>df</ParameterKey>
    <InstrumentKey>sta-waves</InstrumentKey>
    <InstrumentKey>stb-waves</InstrumentKey>
    <AxisKey>time</AxisKey>
    <AxisKey>freq</AxisKey>
    <Units>
        <Expression>kHz</Expression>
```

```
            <ScaleSI>1000.</ScaleSI>
            <DimEquation>T-1</DimEquation>
      </Units>
</SupportParameter>

<SupportParameter>
      <ParameterName>Antenna Mode</ParameterName>
      <ParameterDescription>Antenna Mode</ParameterDescription>
      <ParameterType>inst.mode</ParameterType>
      <ParameterKey>ant</ParameterKey>
      <InstrumentKey>sta-waves</InstrumentKey>
      <InstrumentKey>stb-waves</InstrumentKey>
      <AxisKey>time</AxisKey>
      <AxisKey>freq</AxisKey>
</SupportParameter>

<SupportParameter>
      <ParameterName>record number</ParameterName>
      <ParameterDescription>Record Number in file</ParameterDescription>
      <ParameterType>inst.other</ParameterType>
      <ParameterKey>irec</ParameterKey>
      <InstrumentKey>sta-waves</InstrumentKey>
      <InstrumentKey>stb-waves</InstrumentKey>
      <AxisKey>time</AxisKey>
      <AxisKey>freq</AxisKey>
</SupportParameter>

<SupportParameter>
      <ParameterName>sweep number</ParameterName>
      <ParameterDescription>Sweep Number in file</ParameterDescription>
      <ParameterType>inst.other</ParameterType>
      <ParameterKey>isweep</ParameterKey>
      <InstrumentKey>sta-waves</InstrumentKey>
      <InstrumentKey>stb-waves</InstrumentKey>
      <AxisKey>time</AxisKey>
      <AxisKey>freq</AxisKey>
</SupportParameter>
```

Fig. 9.2: http://www.lesia.obspm.fr/kronos/docs/skr_readme.txt

```
================================================================================
          Daily ASCII files of SKR flux densities and integrated powers
               in Left-Hand and Right-Hand Circular polarizations
================================================================================

Time resolution = 3 minutes

--------------------------------------------------------------------------------

48 Frequency bands:
24 log-spaced bands from 3.5 to 320 kHz, with bandwidth = 20% of central
frequency
24 linearly-spaced from 350 to 1500 kHz, with bandwidth = 50 kHz

List of central frequencies (kHz) [48g9.6] :
  3.95480  4.77290  5.76010  6.95160  8.38950  10.1248  12.2191  14.7465
  17.7968  21.4779  25.9205  31.2821  37.7526  45.5616  54.9858  66.3593
  80.0854  96.6507  116.642  140.769  169.887  205.027  247.436  298.617
  350.000  400.000  450.000  500.000  550.000  600.000  650.000  700.000
  750.000  800.000  850.000  900.000  950.000  1000.00  1050.00  1100.00
  1150.00  1200.00  1250.00  1300.00  1350.00  1400.00  1450.00  1500.00

--------------------------------------------------------------------------------

File format:

Column  Items      Unit      Format
1        YEAR   I4
2        DAY    1X,I3
3        HH:MM:SS      3(1X,I2)
4        Received RH integrated power in 100-400 kHz           W/m^2     E10.2
5        Emitted  RH integrated power in 100-400 kHz           W/sr      E10.2
6        Received LH integrated power in 100-400 kHz           W/m^2     E10.2
7        Emitted  LH integrated power in 100-400 kHz           W/sr      E10.2
8        Received RH integrated power in 10-1000 kHz           W/m^2     E10.2
9        Emitted  RH integrated power in 10-1000 kHz           W/sr      E10.2
10      Received LH integrated power in 10-1000 kHz    W/m^2     E10.2
11      Emitted  LH integrated power in 10-1000 kHz    W/sr      E10.2
12-59    RH SKR flux density measured in 48 frequency bands   W/m^2/Hz  48E10.2
60-107  circular polarization degree of RH SKR-1.1<<-0.2 48F6.2
108-155 LH SKR flux density measured in 48 frequency bands   W/m^2/Hz  48E10.2
156-203 circular polarization degree of LH SKR 0.2<<1.1  48F6.2

--------------------------------------------------------------------------------

Circular polarization degree V varies from -1 (RH) to 1 (LH).

Selection criteria for flux and power data:>0.2, SNR(X)>10dB and SNR(Z)>10dB
Tabulated flux and power data =  0.00e+00 correspond to absence of detected
     flux under the above selection criteria.
Tabulated flux and power data = -1.00e+00 correspond to data gaps.

For more details, see Appendix of paper:
L. Lamy et al., J. Geophys. Res.,113, A07201, 2008. (doi:10.1029/2007JA012900)
Preprint version: http://www.lesia.obspm.fr/kronos/docs/lamy_JGR_07.pdf

--------------------------------------------------------------------------------

SKR data are available from http://www.lesia.obspm.fr/kronos/

Data have been produced by L. Lamy, B. Cecconi & P. Zarka, from the Observatoire
de Paris/LESIA Cassini-RPWS team. Use of these data should comply with
Cassini-MAPS 'rules of the road'. Using these data for publications should imply
co-authorship of L. Lamy and/or B. Cecconi and/or P. Zarka in that order of
priority. Preferred collaboration is participation to analysis well ahead of
publication.

Any other question or request (e.g. integrated powers over frequency bands
other than 100-400 and 10-1000 kHz) should be addressed to
laurent.lamy@obspm.fr, baptiste.cecconi@obspm.fr, or philippe.zarka@obspm.fr

--------------------------------------------------------------------------------
[27-feb-2009] REV1
--------------------------------------------------------------------------------
```

9.2 Cassini/RPWS/HFR/SKR Dynamic Spectra (as distributed by LESIA)

Cassini/RPWS/HFR/SKR Dynamic Spectra are Level 3 data computed from Cassini/RPWS/HFR radio data. It provides the intensity and the polarization of the Saturn Kilometric Radiation (auroral radio emission from Saturn). The DataSet is composed of 12 different parameters:

- *a time series of emitted RH-polarized SKR power, in W/sr, integrated on 100kHz-400kHz;*
- *a time series of emitted LH-polarized SKR power, in W/sr, integrated on 100kHz-400kHz;*
- *a time series of received RH-polarized SKR power, in W/m^2, integrated on 100kHz-400kHz;*
- *a time series of received LH-polarized SKR power, in W/m^2, integrated on 100kHz-400kHz;*
- *a time series of emitted RH-polarized SKR power, in W/sr, integrated on 10kHz-1000kHz;*
- *a time series of emitted LH-polarized SKR power, in W/sr, integrated on 10kHz-1000kHz;*
- *a time series of received RH-polarized SKR power, in W/m^2, integrated on 10kHz-1000kHz;*
- *a time series of received LH-polarized SKR power, in W/m^2, integrated on 10kHz-1000kHz;*
- *a dynamic spectrum of the received RH-polarized SKR spectral flux density, in W/m^2/Hz;*
- *a dynamic spectrum of the received LH-polarized SKR spectral flux density, in W/m^2/Hz;*
- *a dynamic spectrum of the received RH-polarized SKR polarization degree;*
- *a dynamic spectrum of the received LH-polarized SKR polarization degree.*

Each of the dynamic spectra contains 48 (fixed) frequencies.

The time resolution is fixed to 3 minutes and the frequencies (for the dynamic spectra) are given in a separated document available here: http://www.lesia.obspm.fr/kronos/docs/skr_readme.txt (the document is reproduced on next page). The structure, caveats and references are given in that document. The DataSet is organised in daily Granules stored in plain text format.

The complete XML file containing the metadata is available here.

General Metadata:

```
&lt;GeneralMetadata&gt;
	&lt;DublinCore&gt;
		&lt;Title&gt;Cassini/RPWS/HFR SKR Data&lt;/Title&gt;
		&lt;Identifier&gt;Cassini_RPWS_HFR_SKR&lt;/Identifier&gt;
		&lt;Publisher&gt;AMDA/CDPP&lt;/Publisher&gt;
		&lt;Creator&gt;LESIA&lt;/Creator&gt;
		&lt;Date&gt;2010-26-10&lt;/Date&gt;
		&lt;ShortName&gt;skr&lt;/ShortName&gt;
	&lt;/DublinCore&gt;
	&lt;Rights&gt;proprietary&lt;/Rights&gt;
	&lt;PublisherID&gt;CDPP&lt;/PublisherID&gt;
	&lt;Contact&gt;
		&lt;Name&gt;Laurent Lamy&lt;/Name&gt;
		&lt;Address&gt;LESIA, 11 av. Marcellin Berthelot, 92190 Meudon, France&lt;/Address&gt;
		&lt;Email&gt;laurent.lamy@obspm.fr&lt;/Email&gt;
		&lt;Telephone&gt;+33145077759&lt;/Telephone&gt;
	&lt;/Contact&gt;
	&lt;ReferenceURL&gt;
		http://www.lesia.obspm.fr/kronos/docs/skr_readme.txt
	&lt;/ReferenceURL&gt;
	&lt;Format&gt;ASCII&lt;/Format&gt;
	&lt;AccessURL&gt;http://amda-cdpp.cesr.fr&lt;/AccessURL&gt;
```

```
</GeneralMetadata>
```

Instrument Metadata:

```
<Instrument>
        <InstrumentType>Spectral Power Receiver</InstrumentType>
        <InstrumentKey>cassini_hfr</InstrumentKey>
        <InstrumentName>RPWS/HFR</InstrumentName>
        <MissionName>Cassini-Huygens</MissionName>
        <ReferenceURL/>
</Instrument>
```

Target Metadata:

This metadata group contains here 4 items: Saturn, its Magnetosphere, its region region and the SKR.

```
<Target>
        <TargetType>Planet</TargetType>
        <TargetName>Saturn</TargetName>
        <TargetKey>saturn</TargetKey>
        <ParentTargetKey/>
</Target>

<Target>
        <TargetType>Region</TargetType>
        <TargetName>magnetosphere</TargetName>
        <TargetKey>ms-saturn</TargetKey>
        <ParentTargetKey>saturn</ParentTargetKey>
</Target>

<Target>
        <TargetType>Region</TargetType>
        <TargetName>auroral region</TargetName>
        <TargetKey>auroral</TargetKey>
        <ParentTargetKey>ms-saturn</ParentTargetKey>
</Target>

<Target>
        <TargetType>Feature</TargetType>
        <TargetName>Saturn Kilometric Radiation</TargetName>
        <TargetKey>skr</TargetKey>
        <ParentTargetKey>auroral</ParentTargetKey>
</Target>
```

AxisFrame Metadata:

This metadata group contains here 2 items: Time and Frequency.

```
<AxisFrame>
        <AxisKey>time</AxisKey>
        <AxisName>Time</AxisName>
        <DimensionType>time</DimensionType>
        <Units>
                <Time>ISO-8601</Time>
        </Units>
        <DimensionMode>
                <Absolute/>
        </DimensionMode>
        <DimensionRange>
                <MinValue>2004-001T00:00:00Z</MinValue>
                <MaxValue>2010-287T00:00:00Z</MaxValue>
        </DimensionRange>
        <DimensionResolution>
                <MinResolution>0000-000T00:03:00Z</MinResolution>
```

```
            <MaxResolution>0000-000T00:03:00Z</MaxResolution>
      </DimensionResolution>
</AxisFrame>

<AxisFrame>
      <AxisKey>freq</AxisKey>
      <AxisName>Frequency</AxisName>
      <DimensionType>frequency</DimensionType>
      <Units>
            <Other>
                  <Expression>kHz</Expression>
                  <ScaleSI>1000.</ScaleSI>
                  <DimEquation>T-1</DimEquation>
            </Other>
      </Units>
      <DimensionMode>
            <Absolute/>
      </DimensionMode>
      <DimensionRange>
            <MinValue>3.95</MinValue>
            <MaxValue>1500.</MaxValue>
      </DimensionRange>
      <DimensionResolution>
            <MinResolution>0.82</MinResolution>
            <MaxResolution>50.</MaxResolution>
      </DimensionResolution>
</AxisFrame>
```

Parameter Metadata:

This metadata group contains here 12 items, as described above. We show here 2 of them.

```
<Parameter>
      <ParameterName>Received_RH_Power_100_400</ParameterName>
      <ParameterDescription>
            Received RH integrated power in 100-400 kHz
      </ParameterDescription>
      <ParameterType>em.elec</ParameterType>
      <ParameterKey>receivedRH100400</ParameterKey>
      <InstrumentKey>cassini_hfr</InstrumentKey>
      <AxisKey>time</AxisKey>
      <Units>
            <Expression>W/m^2</Expression>
            <ScaleSI>1</ScaleSI>
            <DimEquation>MT-3</DimEquation>
      </Units>
      <ProcessingLevel>derived</ProcessingLevel>
      <Sensing>
            <SensingMode>remote</SensingMode>
            <SensingType>passive</SensingType>
      </Sensing>
      <DataType>measurement</DataType>
      <ObservationDescription>
            <TargetKey>skr</TargetKey>
            <ParameterType>Electro-Magnetic Wave</ParameterType>
            <ParameterType>Intensity</ParameterType>
      </ObservationDescription>
</Parameter>

<Parameter>
      <ParameterName>Circ_polar_SKR_RH</ParameterName>
      <ParameterDescription>
            Circular polarization degree of RH SKR
      </ParameterDescription>
```

```
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>V_SKR_RH</ParameterKey>
        <InstrumentKey>cassini_hfr</InstrumentKey>
        <AxisKey>time</AxisKey>
        <AxisKey>freq</AxisKey>
        <Units>
                <Expression/>
                <ScaleSI>1</ScaleSI>
                <DimEquation>1</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <Sensing>
                <SensingMode>remote</SensingMode>
                <SensingType>passive</SensingType>
        </Sensing>
        <DataType>measurement</DataType>
        <ObservationDescription>
                <TargetKey>skr</TargetKey>
                <ParameterType>Electro-Magnetic Wave</ParameterType>
                <ParameterType>Polarization</ParameterType>
        </ObservationDescription>
</Parameter>
```

9.3 Ulysses/URAP Thermal Noise Time Series (as proposed by CDPP)

This is a processed DataSet archived and distributed by the CDPP. This DataSet comprises daily files of ULYSSES/URAP radio data. These files contain plasma parameters (mainly the electron density and temperature) computed by the plasma quasi-thermal noise method from 128 s radio spectra measured on the 1.25-48.50 kHz receiver connected to the thin wire 2x35m electric dipole. The DataSet contains the following physical parameters:
- Plasma Frequency (and associated standard deviation)
- Cold Electron Temperature (and associated standard deviation)
- Hot to Cold Electron Densities Ratio (and associated standard deviation)
- Hot to Cold Electron Temperature Ratio (and associated standard deviation)
- Solar Wind Velocity (and associated standard deviation)
- Proton Temperature (and associated standard deviation)

There are also SupportParameters indicating the location of the spacecraft along time:
- Distance to the Sun (in AU)
- Heliographic Latitude and Longitude.

The complete XML file containing the metadata is available here.

General Metadata:

```
<GeneralMetadata>
	<DublinCore>
		<Title>Ulysses/URAP Plasma Parameters</Title>
		<Identifier>URAP_RAR_BQT</Identifier>
		<Publisher>CDPP</Publisher>
		<Creator>LESIA</Creator>
		<Date>2011-02-01</Date>
	</DublinCore>
	<PublisherID>DA_TC_ULS_URAP_RAR_BQT</PublisherID>
	<Contact>
		<Name>Karine Issautier</Name>
		<Address>
			LESIA, Observatoire de Paris,
			11 Av. Marcellin Berthelot,
			92190 Meudon, France
		</Address>
		<Email>karine.issautier@obspm.fr</Email>
	</Contact>
	<Rights>public</Rights>
	<Format>Native</Format>
	<ReaderResourceURL>
		http://cdpp2.cnes.fr/cdpp/data/documents/PLAS-LO-ULYSS_URAP-557-LES/00557.tar
	</ReaderResourceURL>
	<AccessURL>http://cdpp2.cnes.fr</AccessURL>
</GeneralMetadata>
```

Instrument Metadata:

```
<Instrument>
	<InstrumentType>Spectral Power Receiver</InstrumentType>
	<InstrumentKey>urap</InstrumentKey>
	<InstrumentName>URAP/RAR</InstrumentName>
	<MissionName>Ulysses</MissionName>
	<ReferenceURL/>
</Instrument>
```

Target Metadata:

This metadata group contains here 3 items: the Sun, the Heliosphere and the Solar Wind.

```
<Target>
      <TargetType>Star</TargetType>
      <TargetName>Sun</TargetName>
      <TargetKey>sun</TargetKey>
      <ParentTargetKey/>
</Target>

<Target>
      <TargetType>Region</TargetType>
      <TargetName>Heliosphere</TargetName>
      <TargetKey>heliosphere</TargetKey>
      <ParentTargetKey>sun</ParentTargetKey>
</Target>

<Target>
      <TargetType>Feature</TargetType>
      <TargetName>Solar Wind</TargetName>
      <TargetKey>sw</TargetKey>
      <ParentTargetKey>heliosphere</ParentTargetKey>
</Target>
```

AxisFrame Metadata:

This metadata group contains here 1 items: the Sun, the Heliosphere and the Solar Wind.

```
<AxisFrame>
      <AxisKey>time</AxisKey>
      <AxisName>time</AxisName>
      <DimensionType>time</DimensionType>
      <Units>
            <Time>ISO-8601</Time>
      </Units>
      <DimensionMode>
            <Absolute/>
      </DimensionMode>
      <DimensionRange>
            <MinValue>1990-11-06T00:03:04.000Z</MinValue>
            <MaxValue>2001-12-31T23:57:39.000Z</MaxValue>
      </DimensionRange>
</AxisFrame>
```

Parameter Metadata:

This metadata group contains here 12 items, as described above.

```
<Parameter>
      <ParameterName>Plasma Frequency</ParameterName>
      <ParameterDescription>Plasma Frequency</ParameterDescription>
      <ParameterType>em.elec</ParameterType>
      <ParameterKey>fp</ParameterKey>
      <InstrumentKey>urap</InstrumentKey>
      <AxisKey>time</AxisKey>
      <Units>
            <Expression>kHz</Expression>
            <ScaleSI>1000.</ScaleSI>
            <DimEquation>T-1</DimEquation>
      </Units>
      <ProcessingLevel>derived</ProcessingLevel>
      <SensingMode>in situ</SensingMode>
```

```
        <SensingType>passive</SensingType>
        <DataType>mixed</DataType>
        <ObservationDescription>
                <TargetKey>sw</TargetKey>
                <ParameterType>part.elec</ParameterType>
                <ParameterType>phys.density</ParameterType>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>Standard Deviation of Plasma Frequency</ParameterName>
        <ParameterDescription>
                Standard Deviation of Plasma Frequency (relative units in %)
        </ParameterDescription>
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>fp_sig</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
                <Expression>%</Expression>
                <ScaleSI>1.</ScaleSI>
                <DimEquation>1.</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>mixed</DataType>
        <ObservationDescription>
                <TargetKey>sw</TargetKey>
                <ParameterType>part.elec</ParameterType>
                <ParameterType>phys.density</ParameterType>
                <ParameterType>stat.stdev</ParameterType>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>Cold Electron Temperature</ParameterName>
        <ParameterDescription>
                Cold Electron Temperature
        </ParameterDescription>
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>tc</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
                <Expression>K</Expression>
                <ScaleSI>1.</ScaleSI>
                <DimEquation>Q</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>mixed</DataType>
        <ObservationDescription>
                <TargetKey>sw</TargetKey>
                <ParameterType>part.elec</ParameterType>
                <ParameterType>phys.temperature</ParameterType>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>Standard Deviation of Cold Electron Temperature</ParameterName>
        <ParameterDescription>
                Standard Deviation of Cold Electron Temperature (relative units in %)
        </ParameterDescription>
```

```
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>tc_sig</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
              <Expression>%</Expression>
              <ScaleSI>1.</ScaleSI>
              <DimEquation>1.</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>mixed</DataType>
        <ObservationDescription>
              <TargetKey>sw</TargetKey>
              <ParameterType>part.elec</ParameterType>
              <ParameterType>phys.temperature</ParameterType>
              <ParameterType>stat.stdev</ParameterType>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>Hot to Cold Electron Densities Ratio</ParameterName>
        <ParameterDescription>
              Ratio of Hot electrons / Cold electrons Densities
        </ParameterDescription>
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>R_NHNC</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
              <Expression>1.</Expression>
              <ScaleSI>1.</ScaleSI>
              <DimEquation>1.</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>mixed</DataType>
        <ObservationDescription>
              <TargetKey>sw</TargetKey>
              <ParameterType>part.elec</ParameterType>
              <ParameterType>phys.density</ParameterType>
              <ParameterType>arith.ratio</ParameterType>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>Standard Deviation of Hot to Cold Electron Density Ratio</
ParameterName>
        <ParameterDescription>
              Standard Deviation of Ratio of Hot electrons / Cold electrons Densities (in
%)
        </ParameterDescription>
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>R_NHNC_sig</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
              <Expression>%</Expression>
              <ScaleSI>1.</ScaleSI>
              <DimEquation>1.</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
```

```
        <SensingType>passive</SensingType>
        <DataType>mixed</DataType>
        <ObservationDescription>
              <TargetKey>sw</TargetKey>
              <ParameterType>part.elec</ParameterType>
              <ParameterType>phys.density</ParameterType>
              <ParameterType>arith.ratio</ParameterType>
              <ParameterType>stat.stdev</ParameterType>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>Hot to Cold Electron Temperature Ratio</ParameterName>
        <ParameterDescription>
              Hot to Cold Electron Temperature Ratio (in %)
        </ParameterDescription>
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>R_THTC</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
              <Expression>1.</Expression>
              <ScaleSI>1.</ScaleSI>
              <DimEquation>1.</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>mixed</DataType>
        <ObservationDescription>
              <TargetKey>sw</TargetKey>
              <ParameterType>part.elec</ParameterType>
              <ParameterType>phys.temperature</ParameterType>
              <ParameterType>arith.ratio</ParameterType>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>
              Standard Deviation of Hot to Cold Electron Temperature Ratio
        </ParameterName>
        <ParameterDescription>
              Standard Deviation of Hot to Cold Electron Temperature Ratio (in %)
        </ParameterDescription>
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>R_THTC_sig</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
              <Expression>%</Expression>
              <ScaleSI>1.</ScaleSI>
              <DimEquation>1.</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>mixed</DataType>
        <ObservationDescription>
              <TargetKey>sw</TargetKey>
              <ParameterType>part.elec</ParameterType>
              <ParameterType>phys.temperature</ParameterType>
              <ParameterType>arith.ratio</ParameterType>
              <ParameterType>stat.stdev</ParameterType>
        </ObservationDescription>
</Parameter>
```

```xml
<Parameter>
	<ParameterName>Solar Wind Velocity</ParameterName>
	<ParameterDescription>Solar Wind Velocity</ParameterDescription>
	<ParameterType>em.elec</ParameterType>
	<ParameterKey>Vsw</ParameterKey>
	<InstrumentKey>urap</InstrumentKey>
	<AxisKey>time</AxisKey>
	<Units>
		<Expression>km/s</Expression>
		<ScaleSI>1000.</ScaleSI>
		<DimEquation>LT-1</DimEquation>
	</Units>
	<ProcessingLevel>derived</ProcessingLevel>
	<SensingMode>in situ</SensingMode>
	<SensingType>passive</SensingType>
	<DataType>mixed</DataType>
	<ObservationDescription>
		<TargetKey>sw</TargetKey>
		<ParameterType>part.elec</ParameterType>
		<ParameterType>phys.velocity</ParameterType>
	</ObservationDescription>
</Parameter>

<Parameter>
	<ParameterName>Standard Deviation of Solar Wind Velocity</ParameterName>
	<ParameterDescription>
		Standard Deviation of Solar Wind Velocity (in %)
	</ParameterDescription>
	<ParameterType>em.elec</ParameterType>
	<ParameterKey>Vsw_sig</ParameterKey>
	<InstrumentKey>urap</InstrumentKey>
	<AxisKey>time</AxisKey>
	<Units>
		<Expression>%</Expression>
		<ScaleSI>1.</ScaleSI>
		<DimEquation>1.</DimEquation>
	</Units>
	<ProcessingLevel>derived</ProcessingLevel>
	<SensingMode>in situ</SensingMode>
	<SensingType>passive</SensingType>
	<DataType>mixed</DataType>
	<ObservationDescription>
		<TargetKey>sw</TargetKey>
		<ParameterType>part.elec</ParameterType>
		<ParameterType>phys.velocity</ParameterType>
		<ParameterType>stat.stdev</ParameterType>
	</ObservationDescription>
</Parameter>

<Parameter>
	<ParameterName>Proton Temperature</ParameterName>
	<ParameterDescription>Proton Temperature</ParameterDescription>
	<ParameterType>em.elec</ParameterType>
	<ParameterKey>Tp</ParameterKey>
	<InstrumentKey>urap</InstrumentKey>
	<AxisKey>time</AxisKey>
	<Units>
		<Expression>K</Expression>
		<ScaleSI>1.</ScaleSI>
		<DimEquation>Q</DimEquation>
	</Units>
	<ProcessingLevel>derived</ProcessingLevel>
	<SensingMode>in situ</SensingMode>
	<SensingType>passive</SensingType>
```

```
        <DataType>mixed</DataType>
        <ObservationDescription>
              <TargetKey>sw</TargetKey>
              <ParameterType>part.proton</ParameterType>
              <ParameterType>phys.temperature</ParameterType>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>Standard Deviation of Proton Temperature</ParameterName>
        <ParameterDescription>
              Standard Deviation of Proton Temperature
        </ParameterDescription>
        <ParameterType>em.elec</ParameterType>
        <ParameterKey>Tp_sig</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
              <Expression>%</Expression>
              <ScaleSI>1.</ScaleSI>
              <DimEquation>1.</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>mixed</DataType>
        <ObservationDescription>
              <TargetKey>sw</TargetKey>
              <ParameterType>part.proton</ParameterType>
              <ParameterType>phys.temperature</ParameterType>
              <ParameterType>stat.stdev</ParameterType>
        </ObservationDescription>
</Parameter>
```


SupportParameter Metadata:

This metadata group contains here 3 items.


```
<SupportParameter>
        <ParameterName>HelioLat</ParameterName>
        <ParameterDescription>Heliographic Latitude of Spacecraft</ParameterDescription>
        <ParameterType>loc.ephem</ParameterType>
        <ParameterKey>hlat</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
              <Expression>deg</Expression>
              <ScaleSI>1.</ScaleSI>
              <DimEquation>1.</DimEquation>
        </Units>
</SupportParameter>

<SupportParameter>
        <ParameterName>HelioLong</ParameterName>
        <ParameterDescription>Heliographic Longitude of Spacecraft</ParameterDescription>
        <ParameterType>loc.ephem</ParameterType>
        <ParameterKey>hlong</ParameterKey>
        <InstrumentKey>urap</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
              <Expression>deg</Expression>
              <ScaleSI>1.</ScaleSI>
              <DimEquation>1.</DimEquation>
        </Units>
</SupportParameter>
```

```
<SupportParameter>
	<ParameterName>Rsun (UA)</ParameterName>
	<ParameterDescription>Distance to the Sun (UA)</ParameterDescription>
	<ParameterType>loc.ephem</ParameterType>
	<ParameterKey>r_ua</ParameterKey>
	<InstrumentKey>urap</InstrumentKey>
	<AxisKey>time</AxisKey>
	<Units>
		<Expression>UA</Expression>
		<ScaleSI>150e8</ScaleSI>
		<DimEquation>L</DimEquation>
	</Units>
</SupportParameter>
```

9.4 Cassini/RPWS/HFR-QTN Time Series

This is a processed DataSet proposed by LESIA, and soon distributed by AMDA/CDPP.
[TO BE UPDATED SOON.]

9.5 Cassini/RPWS/LP Plasma Density and Spacecraft Potential Time Series

This is a processed DataSet proposed by IRFU (Sweden), and soon distributed by CDPP/AMDA.
[TO BE UPDATED SOON.]

9.6 Cassini/CAPS/ELS Data from PDS

This is a DataSet archived in PDS (mirrored and redistributed by AMDA/CDPP).

[TO BE UPDATED SOON.]

9.7 Cassini/MAPSKP Data

This is a collection of Cassini DataSets including all Saturn magnetosphere science instrumentation. **[TO BE UPDATED SOON.]**

9.8 Cassini/UVIS

[TO BE UPDATED SOON.]

9.9 Nançay Decameter Array Jovian Radio Survey

This is a processed DataSet proposed by the *Nançay Decameter Array*, at the *Nançay Radio Astronomy Facility*. It is composed of daily 8h surveys of jovian radio emissions between 10 MHz and 40 MHz.

[TO BE UPDATED SOON.]

9.10 HST Saturn Aurora data

This is a processed DataSet proposed by LESIA, derived from HST data distributed by MAST. **[TO BE UPDATED SOON.]**

9.11 Abundance Vertical Profile at Titan with Cassini/CIRS

Cassini/CIRS Abundance Vertical Profile at Titan are computed from Cassini/CIRS occultation data, using a model (*explanations by Sandrine needed...*). It is composed of ASCII files containing abundance vertical profiles of various species at Titan.

The complete XML file containing the metadata is available here.

General Metadata:


```
<General>
	<DublinCore>
		<Title>Abundance Vertical Profile at Titan with Cassini/CIRS</Title>
		<Identifier>Cassini/CIRS/AbundanceProfileTitan</Identifier>
		<Publisher>LESIA</Publisher>
		<Creator>Sandrine Vinatier</Creator>
		<Date>13/01/2011</Date>
	</DublinCore>
	<Rights>public</Rights>
	<Format>ASCII</Format>
	<AccessURL/>
</General>
```


Instrument Metadata:

This metadata group contains here 1 item: Cassini InfraRed Spectrometer (CIRS)


```
<Instrument>
	<InstrumentType>Spectrometer</InstrumentType>
	<InstrumentKey>cassini_cirs</InstrumentKey>
	<InstrumentName>CIRS</InstrumentName>
	<MissionName>Cassini</MissionName>
	<ReferenceURL/>
</Instrument>
```


Target Metadata:

This metadata group contains here 2 items: Titan and its atmosphere.


```
<Target>
	<TargetType>Satellite</TargetType>
	<TargetName>Titan</TargetName>
	<TargetKey>titan</TargetKey>
	<ParentTargetKey>saturn</ParentTargetKey>
</Target>

<Target>
	<TargetType>Region</TargetType>
	<TargetName>Atmosphere of Titan</TargetName>
	<TargetKey>titan_atm</TargetKey>
	<ParentTargetKey>titan</ParentTargetKey>
</Target>
```


AxisFrame Metadata:

This metadata group contains here 6 items: Date, Latitude, Longitude, Season, Pressure and Altitude. We provide here 2 examples: Date and Latitude.


```
<AxisFrame>
	<AxisKey>date</AxisKey>
	<AxisName>Date</AxisName>
```

```
        <DimensionType>time</DimensionType>
        <Units>
                <Time>ISO-8601</Time>
        </Units>
        <DimensionMode>
                <Absolute/>
        </DimensionMode>
        <DimensionRange>
                <MinValue>2006-01-01T00:00:00</MinValue>
                <MaxValue>2008-01-01T00:00:00</MaxValue>
        </DimensionRange>
</AxisFrame>

<AxisFrame>
        <AxisKey>latitude</AxisKey>
        <AxisName>Latitude</AxisName>
        <DimensionType>time</DimensionType>
        <Units>
                <Other>
                        <Expression>deg</Expression>
                        <ScaleSI>1</ScaleSI>
                        <DimEquation>1</DimEquation>
                </Other>
        </Units>
        <DimensionMode>
                <Absolute/>
        </DimensionMode>
        <DimensionRange>
                <MinValue>-56.</MinValue>
                <MaxValue>80.</MaxValue>
        </DimensionRange>
</AxisFrame>
```

Parameter Metadata:

This metadata group contains here 10 items: The inferred mixing ratio for the 10 modelled species. We show here only 1 item as an example: the C_4H_2 mixing ratio.

```
<Parameter>
        <ParameterName>q_C4H2</ParameterName>
        <ParameterDescription>C4H2 Mixing Ratio</ParameterDescription>
        <ParameterType>part.neut</ParameterType>
        <ParameterKey/>
        <InstrumentKey>cassini_cirs</InstrumentKey>
        <AxisKey>pressure</AxisKey>
        <AxisKey>altitude</AxisKey>
        <Units>
                <Expression>1</Expression>
                <ScaleSI>1</ScaleSI>
                <DimEquation>1</DimEquation>
        </Units>
        <ProcessingLevel>derived</ProcessingLevel>
        <Sensing>
                <SensingMode>remote</SensingMode>
                <SensingType>passive</SensingType>
        </Sensing>
        <DataType>mixed</DataType>
        <ObservationDescription>
                <TargetKey>titan_atm</TargetKey>
                <ParameterType>Neutral</ParameterType>
                <ParameterType>Ratio</ParameterType>
        </ObservationDescription>
</Parameter>
```

9.12 Venus Express Magnetic Field Data

Venus Express (VEx) magnetometer (MAG) is measuring the magnetic field vector around Venus. This DataSet is hosted by the IWF (Institut für Weltraumforschung/Space Research Institute) of the Austrian Academy of Sciences, in Graz, Austria. The data are freely available through FTP, as text files. The data resolution is 4 minutes. This data is already shared with an interoperable link with AMDA (Automated Multi Dataset Analysis) tool at CDPP, using SPASE (data model) and SOAP (protocol).

The complete XML file containing the metadata is available here.

General Metadata:

```
<General>
	<DublinCore>
		<Title>Venus Express Magnetic Field in VSO Coordinates</Title>
		<Identifier>VEX_MAG_VSO</Identifier>
		<Publisher>IWF-OeAW</Publisher>
		<Creator>IWF-OeAW</Creator>
		<Date>2011-02-04</Date>
	</DublinCore>
	<Contact>
		<Name>Florian Topf</Name>
		<Address>
			IWF-OeAW,
			Schmiedlstrasse 6,
			A-8042 Graz, Austria
		</Address>
		<Email>florian.topf@oeaw.ac.at</Email>
	</Contact>
	<Rights>public</Rights>
	<Format>ASCII</Format>
	<AccessURL>ftp://amda-idis.oeaw.ac.at/MAG/VSO/</AccessURL>
</GeneralMetadata>
```

Instrument Metadata:

This metadata group contains here 1 item: VEx-MAG

```
<Instrument>
	<MissionName>Venus Express</MissionName>
	<InstrumentName>MAG</InstrumentName>
	<InstrumentType>Magnetometer</InstrumentType>
	<InstrumentKey>VEX_MAG</InstrumentKey>
	<ReferenceURL/>
</Instrument>
```

Target Metadata:

This metadata group contains here 2 items: Titan and its atmosphere.

```
<Target>
	<TargetType>Planet</TargetType>
	<TargetName>Venus</TargetName>
	<TargetKey>venus</TargetKey>
	<ParentTargetKey/>
</Target>
<Target>
	<TargetType>Region</TargetType>
	<TargetName>Magnetosphere</TargetName>
```

```
        <TargetKey>magnetosphere</TargetKey>
        <ParentTargetKey>venus</ParentTargetKey>
</Target>
```

AxisFrame Metadata:

This metadata group contains here 1 items: Time.

We provide here 2 examples: Date and Latitude.

```
<AxisFrame>
        <AxisKey>time</AxisKey>
        <AxisName>time</AxisName>
        <DimensionType>time</DimensionType>
        <Units>
                <Time>ISO-8601</Time>
        </Units>
        <DimensionMode>
                <Absolute/>
        </DimensionMode>
        <DimensionRange>
                <MinValue>2006-04-24T00:00:00</MinValue>
                <MaxValue>2009-12-27T23:59:56</MaxValue>
        </DimensionRange>
</AxisFrame>
```

Parameter Metadata:

This metadata group contains here 2 items: The magnetic field vector components in two different coordinate systems. These coordinate systems are: VSO (Venus Solar Orbital) and RTN (Radial Tangential Normal).

```
<Parameter>
        <ParameterName>B_SC</ParameterName>
        <ParameterDescription>
                Magnetic Field Vector in SC Coordinates
        </ParameterDescription>
        <ParameterType>dc.mag</ParameterType>
        <ParameterKey/>
        <InstrumentKey>VEX_MAG</InstrumentKey>
        <AxisKey>time</AxisKey>
        <Units>
                <Expression>nT</Expression>
                <ScaleSI>1e-9</ScaleSI>
                <DimEquation>TM-1Q-1</DimEquation>
        </Units>
        <ProcessingLevel>calibrated</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>measurement</DataType>
        <ObservationDescription>
                <TargetKey>magnetosphere</TargetKey>
                <ParameterType/>
        </ObservationDescription>
</Parameter>

<Parameter>
        <ParameterName>B_VSO</ParameterName>
        <ParameterDescription>
                Magnetic Field Vector in VSO Coordinates
        </ParameterDescription>
        <ParameterType>dc.mag</ParameterType>
        <ParameterKey/>
        <InstrumentKey>VEX_MAG</InstrumentKey>
```

```
        <AxisKey>time</AxisKey>
        <Units>
              <Expression>nT</Expression>
              <ScaleSI>1e-9</ScaleSI>
              <DimEquation>TM-1Q-1</DimEquation>
        </Units>
        <ProcessingLevel>calibrated</ProcessingLevel>
        <SensingMode>in situ</SensingMode>
        <SensingType>passive</SensingType>
        <DataType>measurement</DataType>
        <ObservationDescription>
              <TargetKey>magnetosphere</TargetKey>
              <ParameterType/>
        </ObservationDescription>
</Parameter>
```

10. APPENDICES

10.1 List of InstrumentTypes

The list of *InstrumentTypes* must be defined possibly using existing standards or published or commonly used lists. The compiled list should then be taken as the reference list for IDIS use. We give here two lists that appeared to be relevant: the PDS InstrumentType list and the SPASE InstrumentList. Because these two lists are not perfect (being either incomplete, or not consistently defined, or too specific), we propose to compile a new one taken parts of each. The PDS list is the following:

PDS InstrumentType list:
3-COLOR PUSHBROOM IMAGER, ABRADER, ACCELEROMETER, ACOUSTIC SENSOR, ANEMOMETER, ANTENNAE, ATMOSPHERIC PROFILER, ATTITUDE CONTROL SYSTEM, BAROMETER, BETA DETECTOR, BOLOMETER, CALORIMETER/SPECTROMETER, CAMERA, CCD, CCD CAMERA, CCD/SPECTROGRAPH, CHARGED PARTICLE ANALYZER, CHARGED PARTICLE TELESCOPE, COMPUTATION, COSMIC DUST ANALYZER, COSMIC RAY DETECTOR, DETECTOR ARRAY, DOSIMETER, DRILL, DUST DETECTOR, DUST IMPACT DETECTOR, DUST SAMPLE COLLECTOR, ELECTRODE, COLLECTOR, ELECTRON REFLECTOMETER, ELECTRON SPECTROMETER, ELECTRONICS, ELECTROSTATIC ANALYZER, ENERGETIC PARTICLE DETECTOR, ENERGETIC PARTICLES DETECTOR, EYE, FARADAY CUP, FLUXGATE MAGNETOMETER, FLUXGATE SENSOR, FRAMING CAMERA, GAMMA RAY SPECTROMETER, GAMMA-RAY BURST DETECTOR, GAS DETECTOR, HIGH ENERGY PARTICLE DETECTOR, HOUSEKEEPING, HYGROMETER, IMAGER, IMAGING CAMERA, IMAGING SCIENCE SUBSYSTEM, IMAGING SPECTROMETER, IN SITU METEOROLOGY, INERTIAL MEASUREMENT UNIT, INFRARED IMAGER, INFRARED IMAGING DEVICE, INFRARED IMAGING SPECTROMETER, INFRARED INTERFEROMETER, INFRARED PHOTOMETER, INFRARED POLARIMETER, INFRARED SPECTROMETER, ION MASS SPECTROMETER, LASER ALTIMETER, LASER RANGEFINDER, LIDAR, LINEAR ARRAY CAMERA, LOW-FREQUENCY RADIO ARRAY, MAGNETOMETER, MAGNETOMETER ELECTRON REFLECTOR, MAGNETOSPHERIC IMAGING, MASS SPECTROMETER, MATERIAL PROPERTY SENSOR, METEOROLOGY, MICROSCOPE, N/A, NEPHELOMETER, NEUTRAL PARTICLE DETECTOR, NEUTRON SPECTROMETER, OPTICAL SPECTROGRAPH, OPTICAL TELESCOPE, PARTICLE COUNTER, PARTICLE DETECTOR, PARTICLE TELESCOPE, PHOTOELECTRIC PHOTOMETER, PHOTOMETER, PHOTOMULTIPLIER, PHOTOPOLARIMETER, PHOTOPOLARIMETER RADIOMETER, PLASMA EXPERIMENT, PLASMA INSTRUMENT, PLASMA WAVE, PLASMA WAVE SPECTROMETER, POLARIMETER, PROBE, QUADRUPOLE MASS SPECTROMETER, QUADRUPOLE MASS SPECTROMETER, RADAR, RADAR ANTENNA, RADAR MAPPER, RADAR TRANSMITTER/RECEIVER, RADIO AND PLASMA WAVE SCIENCE, RADIO SCIENCE, RADIO SPECTROMETER, RADIO TELESCOPE, RADIOMETER, REFERENCE DATA, REFLECTANCE SPECTROMETER, RETARDING POTENTIAL ANALYZER, ROBOTIC ARM,

SCANNING PROBE MICROSCOPE, SPECTRAL IMAGER, SPECTROGRAPH, SPECTROMETER, SPECTROMETRIC CORONAGRAPH, SPECTROREFLECTOMETER, STAR SCANNER, SYNTHESIZED ARRAY, TELESCOPE, THERMAL INFRARED SPECTROMETER, THERMISTOR, THERMOMETER, TOTAL POWER DETECTOR, ULTRAVIOLET SPECTROMETER, UNK, UNKNOWN, UV/VISIBLE SPECTROMETER, VIDICON CAMERA, VISIBLE SPECTROMETER, VISUAL COUNT, WIDE FIELD CAMERA, WIDE FIELD PLANETARY CAMERA 2, XRAY SPECTROMETER

SPASE InstrumentType list (click on item for definition): *Antenna, Channeltron, Coronograph, Double Sphere, Dust Detector, Electron Drift Instrument, Electrostatic Analyser, Energetic Particle Instrument, Faraday Cup, Flux Feedback, Fourier Transform Spectrograph, Geiger-Mueller Tube, Imager, Imaging Spectrometer, Interferometer, Ion Chamber, Ion Drift, Langmuir Probe, Long Wire, Magnetometer, Mass Spectrometer, Microchannel Plate, Multispectral Imager, Neutral Atom Imager, Neutral Particle Detector, Particle Correlator, Particle Detector, Photometer, Photopolarimeter, Platform, Proportional Counter, Quadrispherical Analyser, Radar, Radiometer, Resonance Sounder, Retarding Potential Analyser, Riometer, Scintillation Detector, Search Coil, Sounder, Spacecraft Potential Control, Spectral Power Receiver, Spectrometer, Time Of Flight, Unspecified, Waveform Receiver*

One way to select items in these two lists is to restrict to a measurement device list (the model permits to provide several Instruments for a Measurement if needed). Hence, in the PDS list, we shall not select items like "Plasma Waves" or "Radio and Plasma Waves", but rather "Waveform Receiver" or "Spectral Power Receiver" (that are proposed in the SPASE list, and are more specific)

The final list will be compiled from these 2 lists and may include additional items. A definition has to be added for each selected PDS term.

10.2 List of TargetTypes

The list of *TargetTypes* must be defined possibly using existing standards or published or commonly used lists. The compiled list should then be taken as the reference list for IDIS use. We give here two lists that appeared to be relevant: the PDS TargetType list and part of the SPASE metadata. Because these two lists are not perfect (being either incomplete, or not consistently defined), we propose to compile a new one taken parts of each. The PDS list is the following:

PDS TargetType list:
ASTEROID, *CALIBRATION*, COMET, DUST, METEORITE, METEOROID, *STREAM*, *N/A*, NEBULA, PLANET, *PLANETARY*, *SYSTEM*, *PLASMA CLOUD*, RING, SATELLITE, STAR, *SUN*.

Items in italic in that list are items that are not identified as relevant for the list of *TargetTypes*. There is no specific *TargetType* list in SPASE, but an item called "Observed Region", which is a mix of *TargetTypes*, *TargetNames* and regions as defined in this document (see section). The "Observed Regions" list is the following:

SPASE TargetType (called "Observed Region") list (click on item for definition):
Asteroid, Comet, *Earth, Earth.Magnetosheath, Earth.Magnetosphere, Earth.Magnetosphere.Magnetotail, Earth.Magnetosphere.Main, Earth.Magnetosphere.Polar, Earth.Magnetosphere.Radiation Belt, Earth.Near Surface, Earth.Near Surface.Atmosphere, Earth.Near Surface.Auroral Region, Earth.Near Surface.Equatorial Region, Earth.Near Surface.Ionosphere, Earth.Near Surface.Ionosphere.D-Region, Earth.Near Surface.Ionosphere.E-Region, Earth.Near Surface.Ionosphere.F-Region, Earth.Near Surface.Ionosphere.Topside, Earth.Near Surface.Mesosphere, Earth.Near Surface.Plasmasphere, Earth.Near Surface.Polar Cap, Earth.Near Surface.South Atlantic Anomaly Region, Earth.Near Surface.Stratosphere, Earth.Near Surface.Thermosphere, Earth.Near Surface.Troposphere, Earth.Surface, Heliosphere, Heliosphere.Inner, Heliosphere.Near Earth, Heliosphere.Outer, Heliosphere.Remote 1AU, Interstellar, Jupiter, Mars, Mercury, Neptune, Pluto, Saturn, Sun, Sun.Chromosphere, Sun.Corona, Sun.Interior, Sun.Photosphere, Sun.Transition Region, Uranus, Venus*

Again, items in italic may not be relevant for the *TargetType* list, the complete list is interesting for showing how to construct nested targets as we propose in the IDIS DataModel.

The final list will be compiled from these 2 lists and may include additional items (such as "Galaxy"). A preliminary list is the following:

IDIS-DM TargetType list: Asteriod, Comet, Dust, Meteorite, Meteoroid, Nebula, Planet, Dwarf Planet, Small Body, Ring, Satellite, Star, Galaxy, Spacecraft, Region (or Layer), Feature.

The Region (or Layer) Type is used to define a named part of the parent Target, such as a layer of an atmosphere, a region of a surface (polar, equatorial...), a part of a magnetosphere (magnetosheath, magnetotail...). The Feature Type is used to define a named feature or phenomenon, such as a named radio emission, a type of atmospheric cloud...

Using this list, we can describe a few examples from the SPASE "Observed Region" list:

SPASE "Observed region"	IDIS TargetType	IDIS TargetKey	IDIS ParentTargetKey
Earth	Planet	earth	
Earth.Magnetosheath	Region	earth_msheath	earth
Earth.Magnetosphere	Region	earth_msphere	earth
Earth.Magnetosphere.Magnetotail	Region	earth_mtail	earth_msphere
Sun	Star	sun	

SPASE "Observed region"	IDIS TargetType	IDIS TargetKey	IDIS ParentTargetKey
Heliosphere	Region	heliosphere	sun
Heliosphere.Inner	Region	inner_heliosphere	heliosphere
	Galaxy	galaxy	
Interstellar	Region	interstellar	galaxy

10.3 List of UCDs

Unified Content Descriptors will be compiled from the list provided by CDS, enriched with SPASE and PSDD inspired items.

Preliminary list of UCDs (proposed additions):

```
- em                               Electromagnetic Wave (remote source)
- em.elec                          Electric component of Electromagnetic Wave
- em.mag                           Magnetic component of Electromagnetic Wave
- pw                               Plasma Wave (local wave or plasma oscillation)
- pw.elec                          Electric component of Plasma Wave
- pw.mag                           Magnetic component of Plasma Wave
- phot                             Photon
- part                             Particle
- part.elec                        Electrons
- part.elec.1-20keV                Electrons in energy band 1 to 20 keV
- part.ions                        Ions
- part.neut                        Neutrals
- dc                               DC Field
- dc.elec                          Electric field
- dc.mag                           Magnetic field
- model                            Model (suffix to any other measurement type)
```

Preliminary list of UCDs (taken from CDS list):

```
- arith                            Arithmetic quantities
- arith.diff                       Difference between two quantities described by
                                     the same UCD
- arith.factor                     Numerical factor
- arith.grad                       Gradient
- arith.rate                       Rate (per time unit)
- arith.ratio                      Ratio between two quantities described by the
                                     same UCD
- arith.zp                         Zero point
- phys                             Physical quantities
- phys.SFR                         Star formation rate
- phys.absorption                  Extinction or absorption along the line of sight
- phys.absorption.coeff            Absorption coefficient (e.g. in a spectral line)
- phys.absorption.gal              Galactic extinction
- phys.absorption.opticalDepth     Optical depth
- phys.abund                       Abundance
- phys.abund.Fe                    Fe/H abundance
- phys.abund.X                     Hydrogen abundance
- phys.abund.Y                     Helium abundance
- phys.abund.Z                     Metallicity abundance
```

```
- phys.acceleration              Acceleration
- phys.albedo                    Albedo or reflectance
- phys.angArea                   Angular area
- phys.angMomentum               Angular momentum
- phys.angSize                   Angular size width diameter dimension extension
                                   major minor axis extraction radius
- phys.angSize.smajAxis          angular size extent or extension of semi-major
                                   axis
- phys.angSize.sminAxis          angular size extent or extension of semi-minor
                                   axis
- phys.area                      Area (in linear units)
- phys.atmol                     Atomic and molecular physics (shared properties)
- phys.atmol.branchingRatio      Branching ratio
- phys.atmol.collisional         Related to collisions
- phys.atmol.collStrength        Collisional strength
- phys.atmol.configuration       Configuration
- phys.atmol.crossSection        Atomic / molecular cross-section
- phys.atmol.element             Element
- phys.atmol.excitation          Atomic molecular excitation parameter
- phys.atmol.final               Quantity refers to atomic/molecular final/ground
                                   state, level, etc.
- phys.atmol.initial             Quantity refers to atomic/molecular initial
                                   state, level, etc.
- phys.atmol.ionStage            Ion, ionization stage
- phys.atmol.ionization          Related to ionization
- phys.atmol.lande               Lande factor
- phys.atmol.level               Atomic level
- phys.atmol.lifetime            Lifetime of a level
- phys.atmol.lineShift           Line shifting coefficient
- phys.atmol.number              Atomic number Z
- phys.atmol.oscStrength         Oscillator strength
- phys.atmol.parity              Parity
- phys.atmol.qn                  Quantum number
- phys.atmol.radiationType       Type of radiation characterizing atomic lines
                                   (electric dipole/quadrupole, magnetic dipole)
- phys.atmol.symmetry            Type of nuclear spin symmetry
- phys.atmol.sWeight             Statistical weight
- phys.atmol.sWeight.nuclear     Statistical weight for nuclear spin states
- phys.atmol.term                Atomic term
- phys.atmol.transition          Transition between states
- phys.atmol.transProb           Transition probability, Einstein A coefficient
- phys.atmol.wOscStrength        Weighted oscillator strength
- phys.atmol.weight              Atomic weight
- phys.columnDensity             Column density
- phys.composition               Quantities related to composition of objects
- phys.composition.massLightRatioMass to light ratio
- phys.composition.yield         Mass yield
- phys.cosmology                 Related to cosmology
- phys.damping                   Generic damping quantities
- phys.density                   Density (of mass, electron, ...)
- phys.dielectric                Complex dielectric function
- phys.dispMeasure               Dispersion measure
- phys.electField                Electric field
- phys.electron                  Electron
- phys.electron.degen            Electron degeneracy parameter
- phys.emissMeasure              Emission measure
- phys.emissivity                Emissivity
- phys.energy                    Energy
- phys.energy.density            Energy-density
```

- phys.entropy	Entropy
- phys.eos	Equation of state
- phys.excitParam	Excitation parameter U
- phys.gauntFactor	Gaunt factor/correction
- phys.gravity	Gravity
- phys.ionizParam	Ionization parameter
- phys.ionizParam.coll	Collisional ionization
- phys.ionizParam.rad	Radiative ionization
- phys.luminosity	Luminosity
- phys.luminosity.fun	Luminosity function
- phys.magAbs	Absolute magnitude
- phys.magAbs.bol	Bolometric absolute magnitude
- phys.magField	Magnetic field
- phys.mass	Mass
- phys.mass.loss	Mass loss
- phys.mol	Molecular data
- phys.mol.dipole	Molecular dipole
- phys.mol.dipole.electric	Molecular electric dipole moment
- phys.mol.dipole.magnetic	Molecular magnetic dipole moment
- phys.mol.dissociation	Molecular dissociation
- phys.mol.formationHeat	Formation heat for molecules
- phys.mol.quadrupole	Molecular quadrupole
- phys.mol.quadrupole.electric	Molecular electric quadrupole moment
- phys.mol.rotation	Molecular rotation
- phys.mol.vibration	Molecular vibration
- phys.particle.neutrino	Related to neutrino
- phys.polarization	Polarization degree (or percentage)
- phys.polarization.circular	Circular polarization
- phys.polarization.linear	Linear polarization
- phys.polarization.rotMeasure	Rotation measure polarization
- phys.polarization.stokes	Stokes polarization
- phys.pressure	Pressure
- phys.recombination.coeff	Recombination coefficient
- phys.refractIndex	Refraction index
- phys.size	Linear size, length (not angular)
- phys.size.axisRatio	Axis ratio (a/b) or (b/a)
- phys.size.diameter	Diameter
- phys.size.radius	Radius
- phys.size.smajAxis	Linear semi major axis
- phys.size.sminAxis	Linear semi minor axis
- phys.temperature	Temperature
- phys.temperature.effective	Effective temperature
- phys.temperature.electron	Electron temperature
- phys.transmission	Transmission (of filter, instrument, ...)
- phys.veloc	Space velocity
- phys.veloc.ang	Angular velocity
- phys.veloc.dispersion	Velocity dispersion
- phys.veloc.escape	Escape velocity
- phys.veloc.expansion	Expansion velocity
- phys.veloc.microTurb	Microturbulence velocity
- phys.veloc.orbital	Orbital velocity
- phys.veloc.pulsat	Pulsational velocity
- phys.veloc.rotat	Rotational velocity
- phys.veloc.transverse	Transverse / tangential velocity
- phys.virial	Model (suffix to any other measurement type)
- stat	Statistical parameters
- stat.Fourier	Fourier coefficient
- stat.Fourier.amplitude	Amplitude Fourier coefficient
- stat.correlation	Correlation between two parameters

- stat.covariance	Covariance between two parameters
- stat.error	Statistical error
- stat.error.sys	Systematic error
- stat.filling	Filling factor (volume, time, ..)
- stat.fit	Fit
- stat.fit.chi2	Chi2
- stat.fit.dof	Degrees of freedom
- stat.fit.goodness	Goodness or significance of fit
- stat.fit.omc	Observed minus computed
- stat.fit.param	Parameter of fit
- stat.fit.residual	Residual fit
- stat.likelihood	Likelihood
- stat.max	Maximum or upper limit
- stat.mean	Mean, average value
- stat.median	Median value
- stat.min	Minimum or lowest limit
- stat.param	Parameter
- stat.probability	Probability
- stat.snr	Signal to noise ratio
- stat.stdev	Standard deviation
- stat.uncalib	Qualifier of a generic incalibrated quantity
- stat.value	Miscellaneous value
- stat.variance	Variance
- stat.weight	Statistical weight