Mio Science center progress report:
Development of MPPE data (BepiColombo SWT in Fukuoka)

T. Hori, Y. Miyoshi, C.-W. Jun, A. Shinbori, N. Kitamura, K. Yamamoto, S. Chiba

(CHS, ISEE, Nagoya Univ.)

Mio Science Center (Mio-SC) members for MPPE and the dedicated MLs

1) Point of contact (POC) on the Mio-SC side

- MIA: T. Hori
- MEA: T. Hori
- MSA: N. Kitamura
- HEP: T. Hori
- ENA: K. Yamamoto, Y. Miyoshi

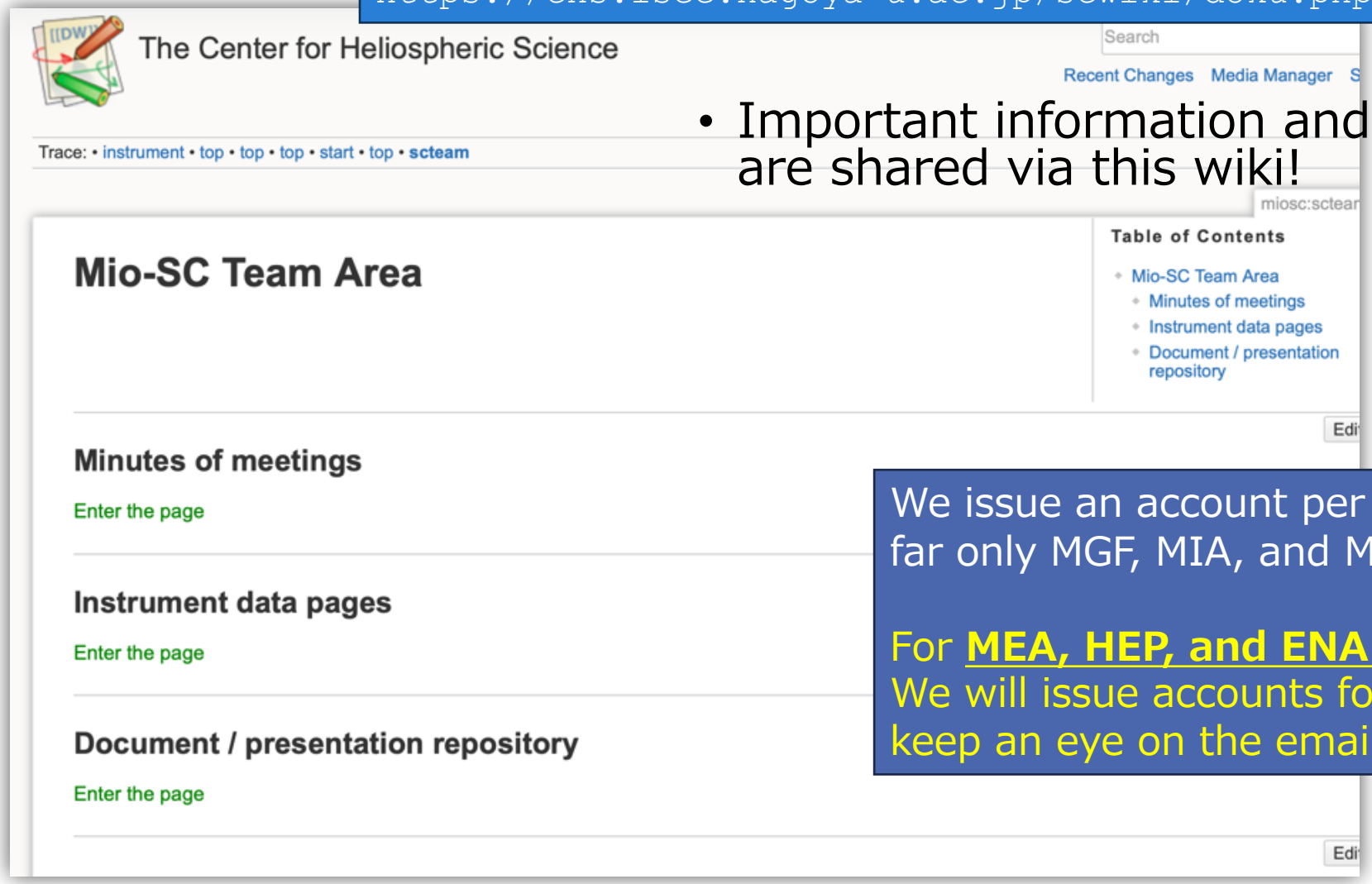
2) The following mailing lists are active, or to be available/refined very soon

- ❖ mio_mia_info@isee.nagoya-u.ac.jp
- ❖ mio_mea_info@isee.nagoya-u.ac.jp
- ❖ mio_msa_info@isee.nagoya-u.ac.jp
- ❖ mio_hep_info@isee.nagoya-u.ac.jp
- ❖ mio_ena_info@isee.nagoya-u.ac.jp

- Any emails to these MLs are distributed to instrument team members, POC of Mio-SC, and G. Murakami.

Mio-SC wiki Team Area

https://chs.isee.nagoya-u.ac.jp/scwiki/doku.php?id=miosc:scteam:start



- Important information and technical specifications are shared via this wiki!

We issue an account per a sub-unit team, and so far only MGF, MIA, and MSA teams have their ones.

For **MEA, HEP, and ENA teams**:
We will issue accounts for you right away: please keep an eye on the email box early next week!

Data Product: Plan for MPPE

Lv.2pre data
= a limited set of sci. data obtained dur. the cruise phase

Before Mercury orbit insertion (MOI):

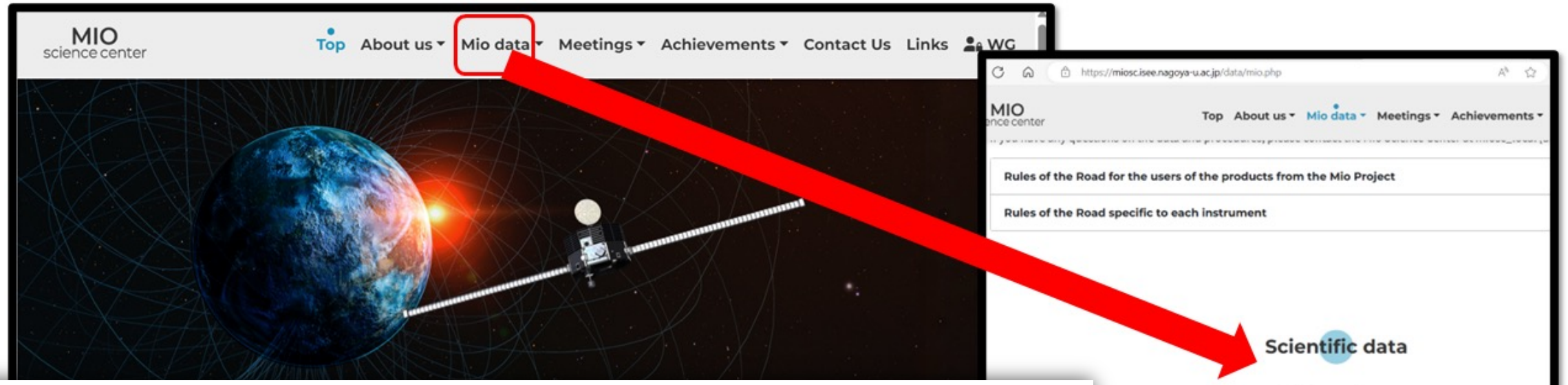
- Science Data: **Lv.2pre data** files
  - Data production target: Some limited datasets for MIA, MEA, (MSA, HEP, and ENA?)
  - The data files are released from the web data repository of the science center.
    - Also delivered to and archived in ESA's PSA??

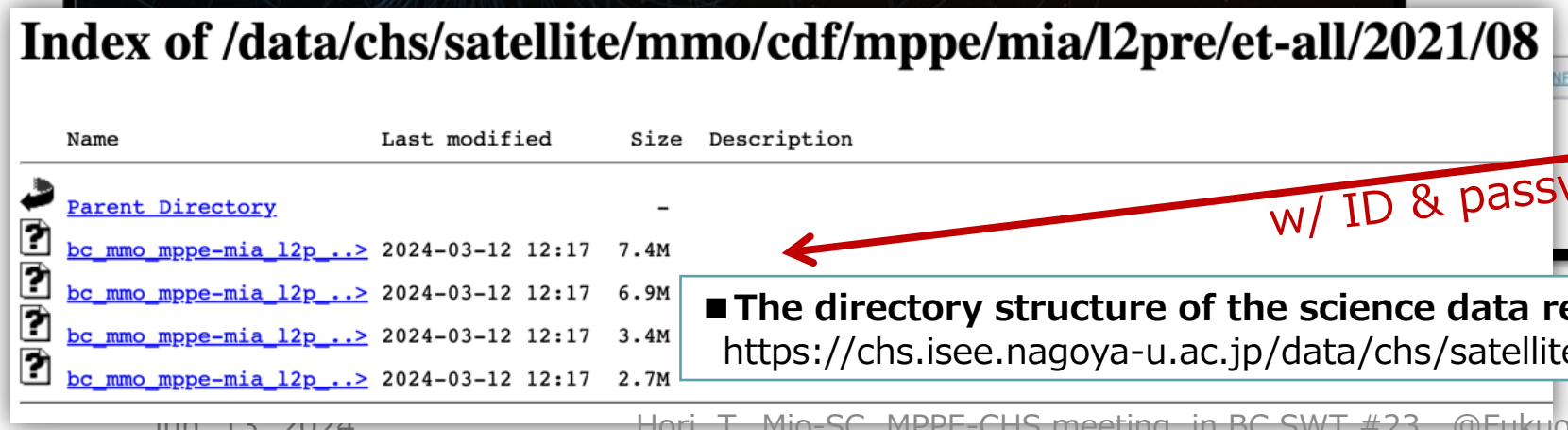
After MOI:

- Science Data: **Lv.2 data** files
  - Data production target: **Partially and fully calibrated datasets of all instruments**
  - The data files are released from the web data repository of the science center.
    - Also delivered in a PDS-compliant package to and archived in ESA's PSA.

Scientific data archive on Mio-SC website

MMO data will be stored in the online data repository on the MIO-SC Web site (https://miosc.isee.nagoya-u.ac.jp) and the data are partially available to users.





w/ ID & password

■ **The directory structure of the science data repository (e.g., for MPPE/MIA)**
https://chs.isee.nagoya-u.ac.jp/data/chs/satellite/mmo/dat/mppe/mia/l2pre/etall/yyyy/mm

Development status of Lv.2pre data and Lv.2 data

(as of Jun. 2024)

sub-unit	Lv.2pre target (period, type)	Dev. status of Lv.2pre	Remarks
MIA	Flyby periods +, omni-dir. count data	Should be ready soon after minor refinement	
MEA	Flyby periods +,	Lv.1prime data are being developed by the inst. team	Will have a dedicated DH meeting on this Fri. @Nagoya
MSA	Flyby periods +?	the inst. team working for generation for Lv. 1 data	Will have a meeting
HEP	Only HEP-e operated, omni-dir. count data during flybys? No HEP-i data	the inst. team working on software for generating Lv.1 data routinely	no definition of the data file structure yet, to be discussed.
ENA	Flyby periods +, count data	Preparing for conversion from ascii (Lv. 1 data) to cdf (Lv. 2pre)	Had a meeting btw. inst. team and SC this week

sub-unit	Lv.2pre target (period, type)	Dev. status of Lv.2pre	Remarks
MIA	Flyby periods +, omni-dir. count data	Should be ready soon after minor refinement	
MEA (updated on Jun 14 @Nagoya)	Flyby periods + **cruise phase**	**Lv.1 data have been developed** by the inst. team **(for first iteration)** **Lv.2 are being developed by the inst. team (starting)**	Will have a dedicated DH meeting on this Fri. @Nagoya **MEA Team would like to deliver to Mio Science Center Lv1.0 and Lv2.0 through the reformatter** **Deadline: 3 months after MFB#6**
MSA (updated on Jun 14 @Nagoya)	Flyby periods +?,	the inst. team working for generation for Lv. 1 data **Lv.2 will be developed by the inst. team**	Will have a meeting **MSA Team would like to deliver to Mio Science Center Lv1.0 and Lv2.0 through the reformatter** **Deadline: TBD**
HEP	Only HEP-e operated, omni-dir. count data during flybys? No HEP-i data	the inst. team working on software for generating Lv.1 data routinely	no definition of the data file structure yet, to be discussed.
ENA	Flyby periods +, count data	Preparing for conversion from ascii (Lv. 1 data) to cdf (Lv. 2pre)	Had a meeting btw. inst. team and SC this week

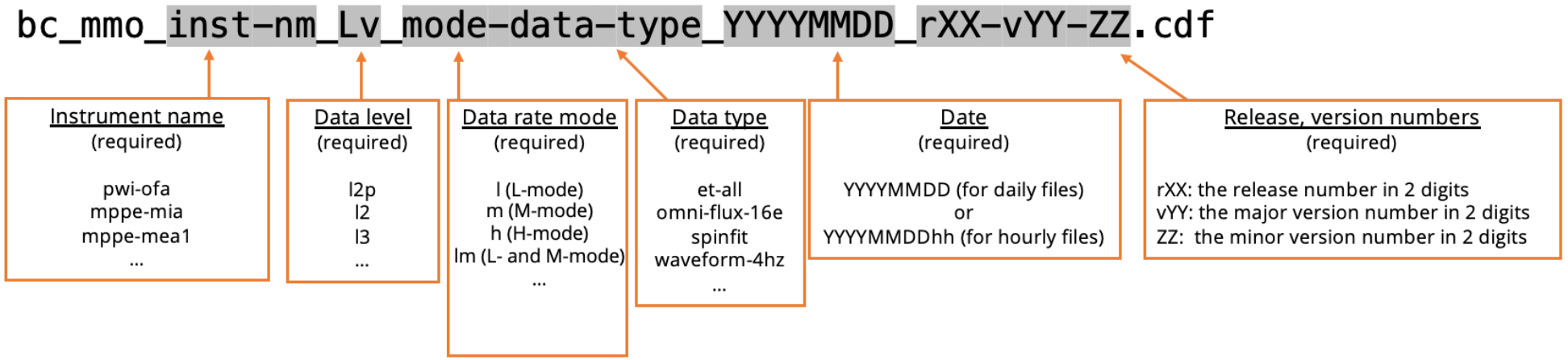
(as of Jun. 2024)

Current Status for sub-instruments

1) File format and metadata

- Common data format (CDF) : ISTP standards
- Metadata is also based on ISTP standards (e.g., g/v-attributes)

2) Common role of the naming convention and versioning for CDF file



3) The science data archive for Lv.2pre datasets:

- Base data repository of Mio-SC:
  https://chs.isee.nagoya-u.ac.jp/data/chs/satellite/mmo/dat/
- For MPPE,
  [Base dir]/mppe/"sub-inst"/l2pre/"data type"/yyyy/mm/"File name"

Data product: Example of MIA Lv.2pre data file

Dump of the data block:

NAME	NUM	IS_ZVAR	DATATYPE	TYPE	NUMATTR	NUMELEM	RECVARY	NUMREC	COMP	GZIP	BLOCK	NDIMEN	D[0]
epoch	0	1	CDF_TIME_TT2000	14	-1	1	1	11558	0	0	0	0	0
strtime	1	1	CDF_CHAR	1	-1	27	1	11558	0	0	0	0	0
time_width	2	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	0	0
mdp_ti	3	1	CDF_UINT4	13	-1	1	1	11558	0	0	0	0	0
count_d1	4	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	1	16
count_d2	5	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	1	16
count_d3	6	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	1	16
count_d4	7	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	1	16
deflux_d1	8	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	1	16
deflux_d2	9	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	1	16
deflux_d3	10	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	1	16
deflux_d4	11	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	1	16
count_energy	12	1	CDF_REAL4	4	-1	1	1	11558	0	0	0	1	16
label_count_energy	13	1	CDF_CHAR	1	-1	11	0	-1	0	0	0	1	16
quality_flag	14	1	CDF_UINT1	1	-1	1	1	11558	0	0	0	1	2

data arrays

variable type

Data product: Example of MIA Lv.2pre data file

Dump of the metadata block:

```
      PROJECT                    = STRING    = 'BC>BepiColombo'
      DISCIPLINE                 = STRING    = 'Space Physics>Magnetospheric Science'
      SOURCE_NAME                = STRING    = 'MMO>Mercury Magnetospheric Orbiter'
      DATA_TYPE                  = STRING    = 'L2P_L-ET-ALL>Level 2-pre Low mode Et All 4 sec resolution M2 M3'
      DESCRIPTOR                 = STRING    = 'MIA>Mercury Ion Analyzer'
      DATA_VERSION               = STRING    = 'r00-v00-00'
      TITLE                      = STRING    = 'BepiColombo Mercury Magnetosphric Orbiter Mercury Ion Analyzer Low-mode
Et All sector 4 sec resolutioin M2 M3 data'
      TEXT                       = STRING    = 'For details please refer to Saito Y., J.A. Sauvaud, M. Hirahara, S. Bara
bash, D. Delcourt, T. Takashima, K. Asamura and BepiColombo MMO/MPPE Team, Scientific objectives and instrumentation of
 Mercury Plasma Particle Experiment (MPPE) onboard MMO, Planetary and Space Science, Volume 58, Issues 1-2, January 201
0, Pages 182-200'
      GENERATED_BY               = STRING    = 'Center for Heliospheric Science, Institute for Space-Earth Environmental
 Research, Nagoya University'
      GENERATION_DATE            = STRING    = '20240312'
      MODS                       = STRING    = 'Drafted 03/2024'
      ADID_REF                   = STRING    = ' '
      LOGICAL_FILE_ID            = STRING    = 'bc_mmo_mppe-mia_l2p_l-et-all_20210810_r00-v00-00'
      LOGICAL_SOURCE             = STRING    = 'BC_MMO_MPPE-MIA_L2P_L-ET-ALL'
      LOGICAL_SOURCE_DESCRIPTION = STRING    = 'BepiColombo Mercury Magnetosphric Orbiter Mercury Ion Analyzer Low-mode
Et All sector 4 sec resolutioin M2 M3 data'
      DOI                        = STRING    = ' '
      PI_NAME                    = STRING    = 'Y. Saito'
      PI_AFFILIATION             = STRING    = 'ISAS/JAXA'
      MISSION_GROUP              = STRING    = 'BepiColombo/MMO'
      INSTRUMENT_TYPE            = STRING    = 'Plasma and Solar Wind'
      TEXT_SUPPLEMENT            = STRING    = ' '
      RULES_OF_USE               = STRING[6] = [ ...]
```

(nearly) ISTP-standards-compliant metadata

Data product: Example of Lv.2pre data file

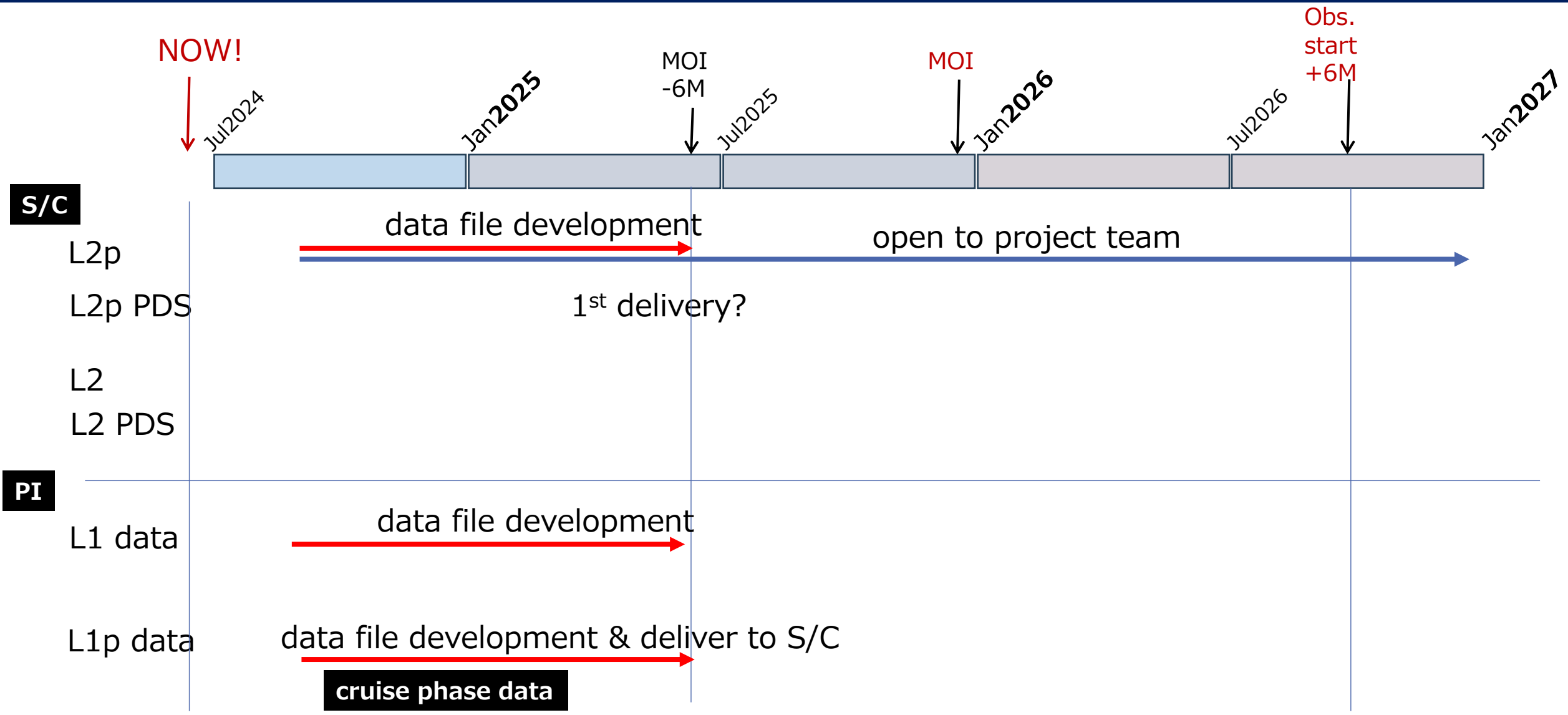
Dump of the metadata block: (Cont'd)

```
      START_TI                    = STRING    = '67371010'
      END_TI                      = STRING    = '104461515'
      DATA_START_TIME             = STRING    = '2021-08-10T03:23:19.000000Z'
      DATA_END_TIME               = STRING    = '2021-08-10T23:30:42.000000Z'
      DATA_AVERAGING_TYPE         = STRING    = '4 s cadence/start'
      SOURCE_FILE                 = STRING    = 'mmo_mppe-mia_l1p_l-et-all_20210810_v00.03.cdf'
      ANCILLARY_FILE              = STRING    = ' '
      GENERATION_CODE             = STRING    = 'makecdf_mmo_mia_l2p_etall.pro(31b9338, 2024-03-12), mial1_etall_to_l2p_etall.pro
(346a3f5, 2024-03-12)'
      CALIBRATION_HISTORY         = STRING    = ' '
      KNOWN_PROBLEMS              = STRING    = ' '
      SPACECRAFT_CLOCK_KERNEL     = STRING    = ' '
      LEAPSECONDS_KERNEL          = STRING    = ' '
      PDS_COLLECCTION_ID          = STRING    = ' '
      PDS_START_TIME              = STRING    = ' '
      PDS_STOP_TIME               = STRING    = ' '
      PDS_SCLK_START_COUNT        = STRING    = ' '
      PDS_SCLK_STOP_COUNT         = STRING    = ' '
```

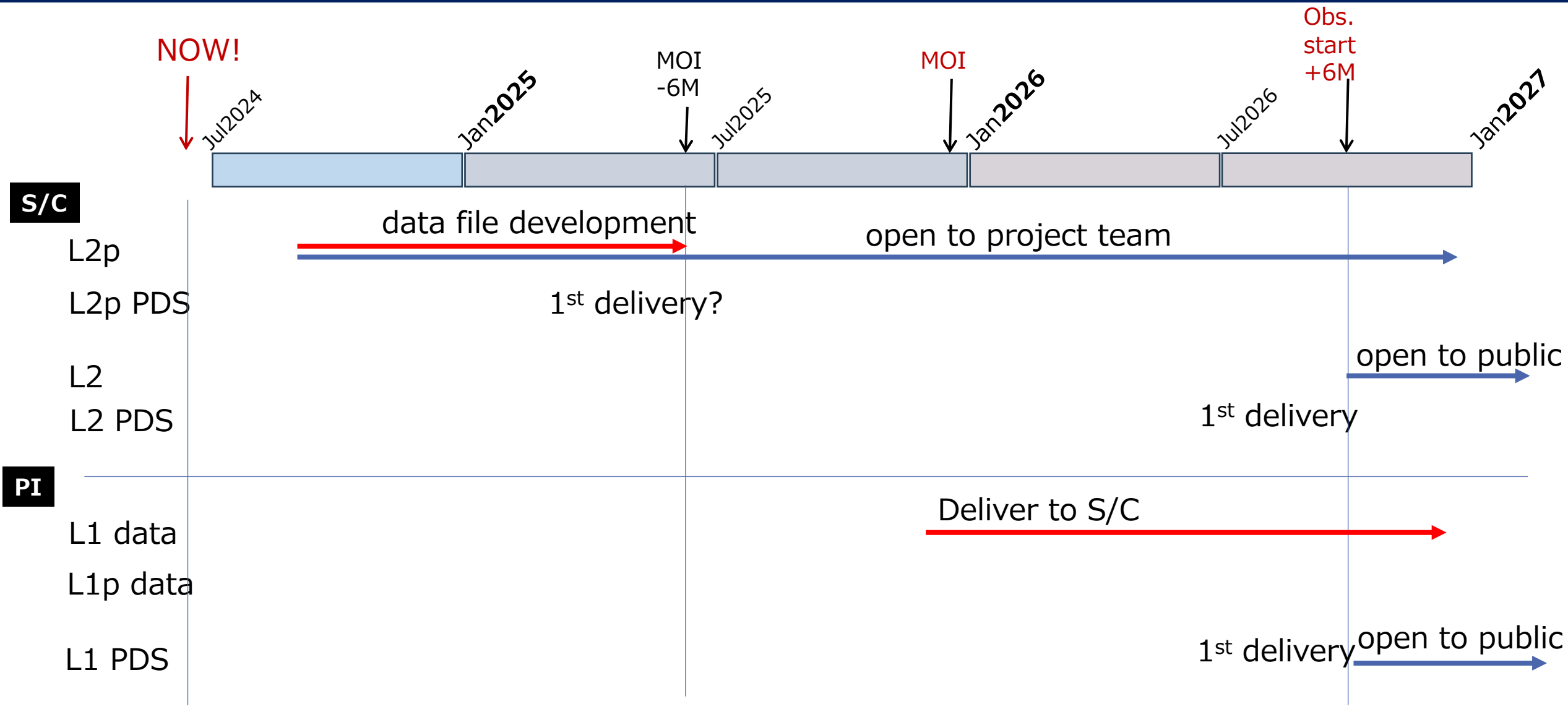
PDS-specific information needed to generate PDS labels (as) automatically (as possible)

These data/metadata specifications have been under discussion with the instrument teams and the data handling archive team of ESA.

Tentative timeline of the MMO data archive development (Cruise Phase data 20240612)

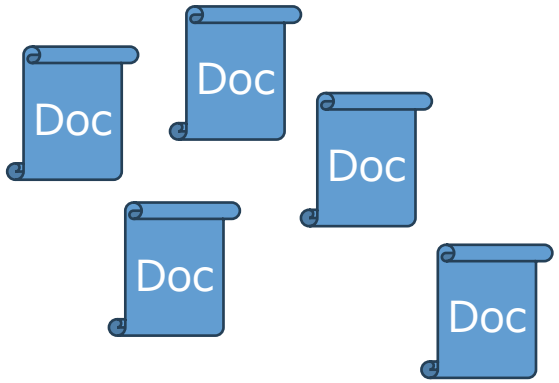


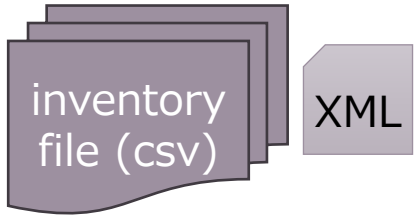
Tentative timeline of the MMO data archive development (after MOI 20240612)



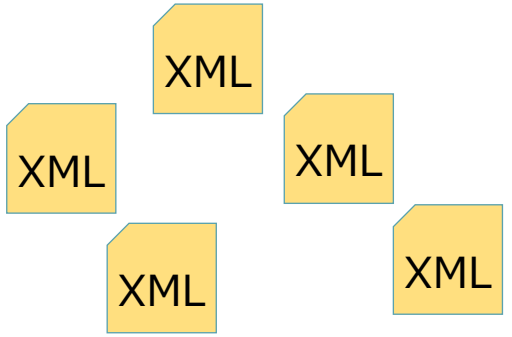
What do we have to deliver to the PDS archive?

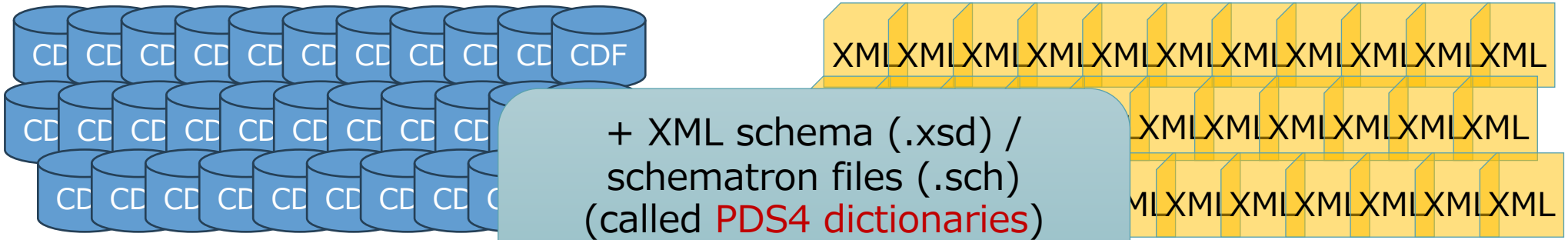
Collections under an instrument bundle



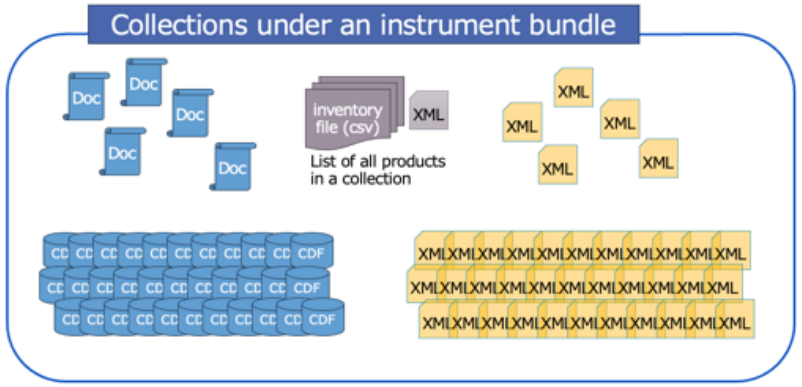


List of all products in a collection

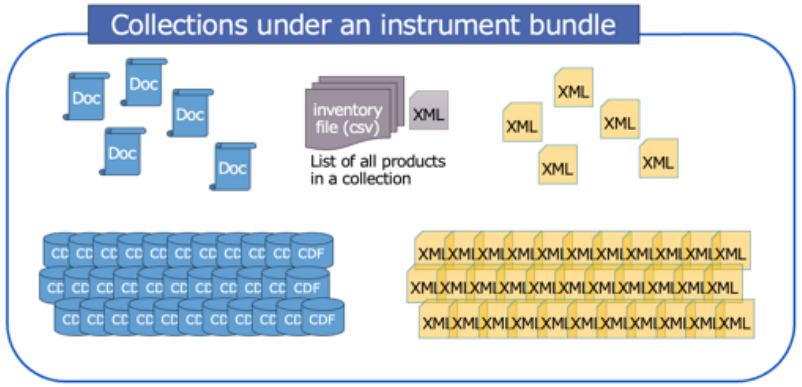




What do we have to deliver to the PDS archive?



for raw datasets (Lv. 1)



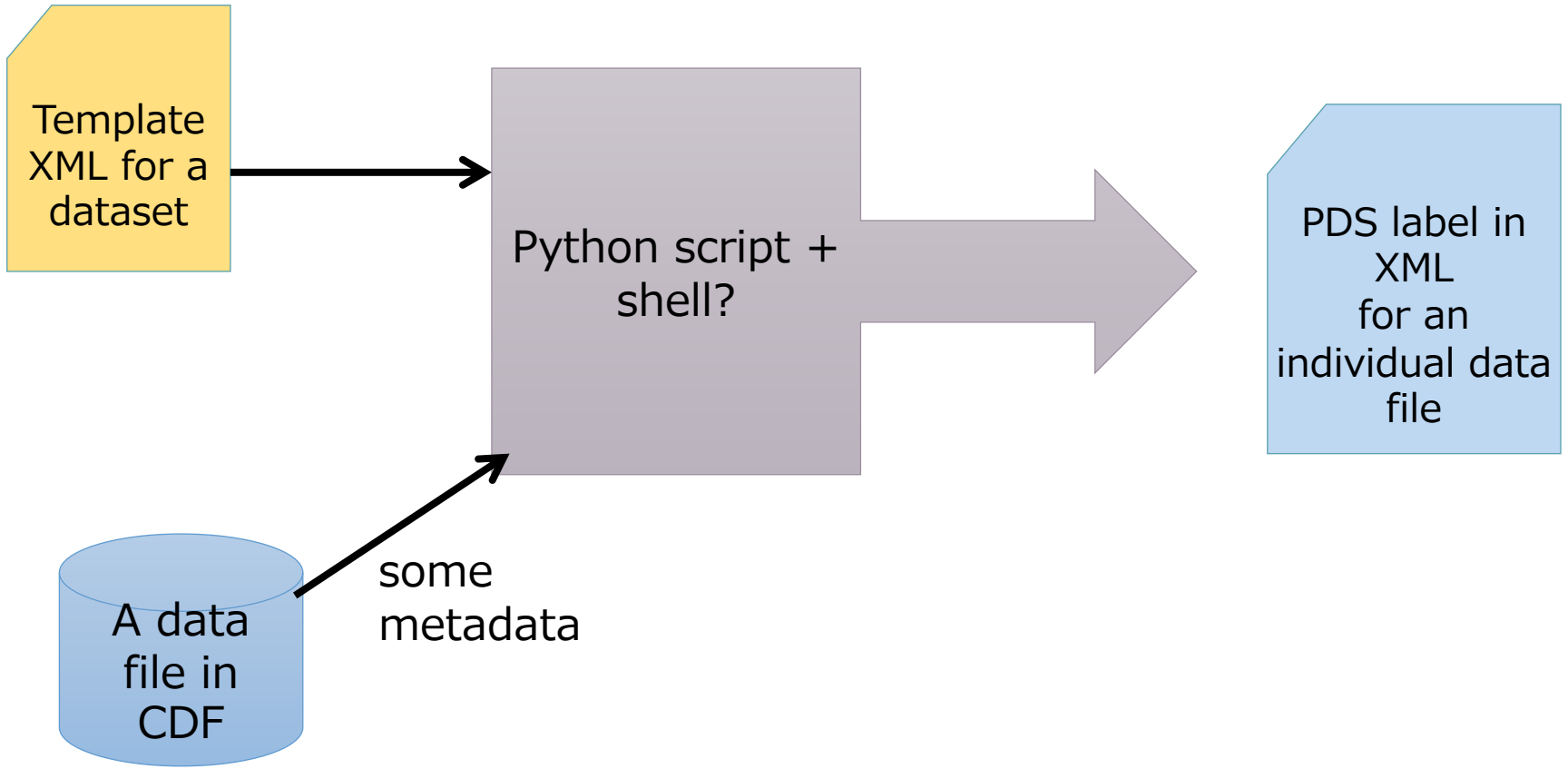
for calibrated datasets (Lv.2)

Our baseline

led by the instrument team

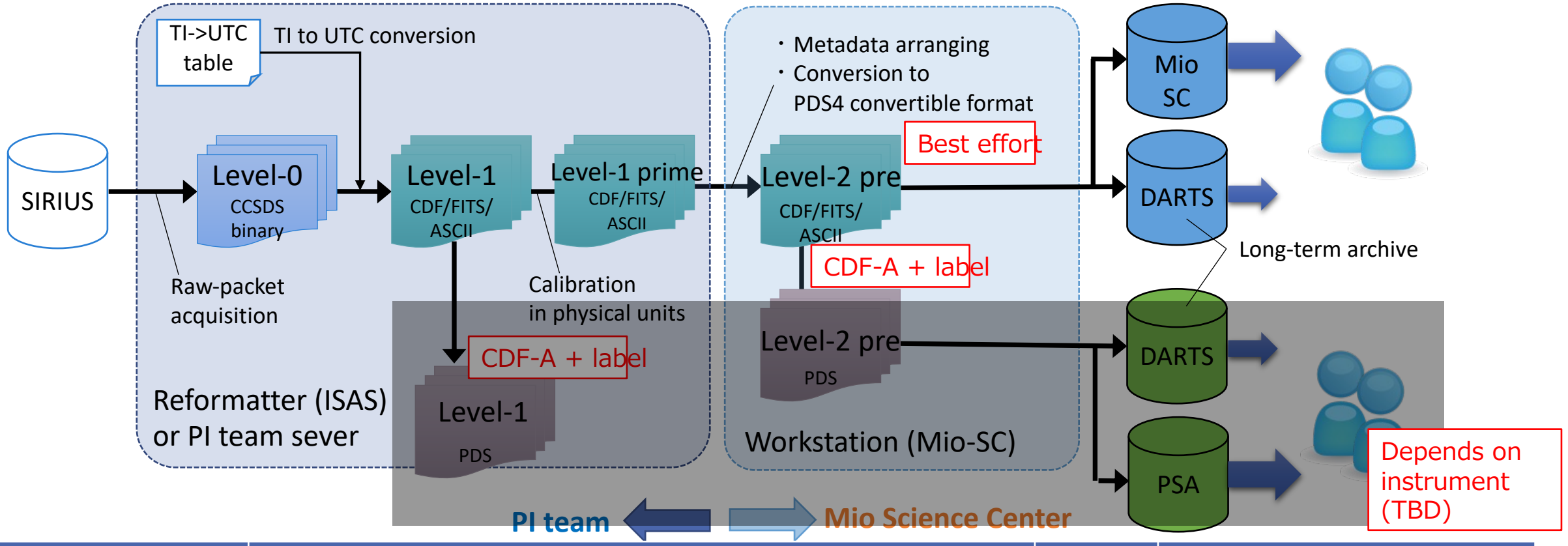
led by Mio-SC

How we can generate a PDS label for a data file?



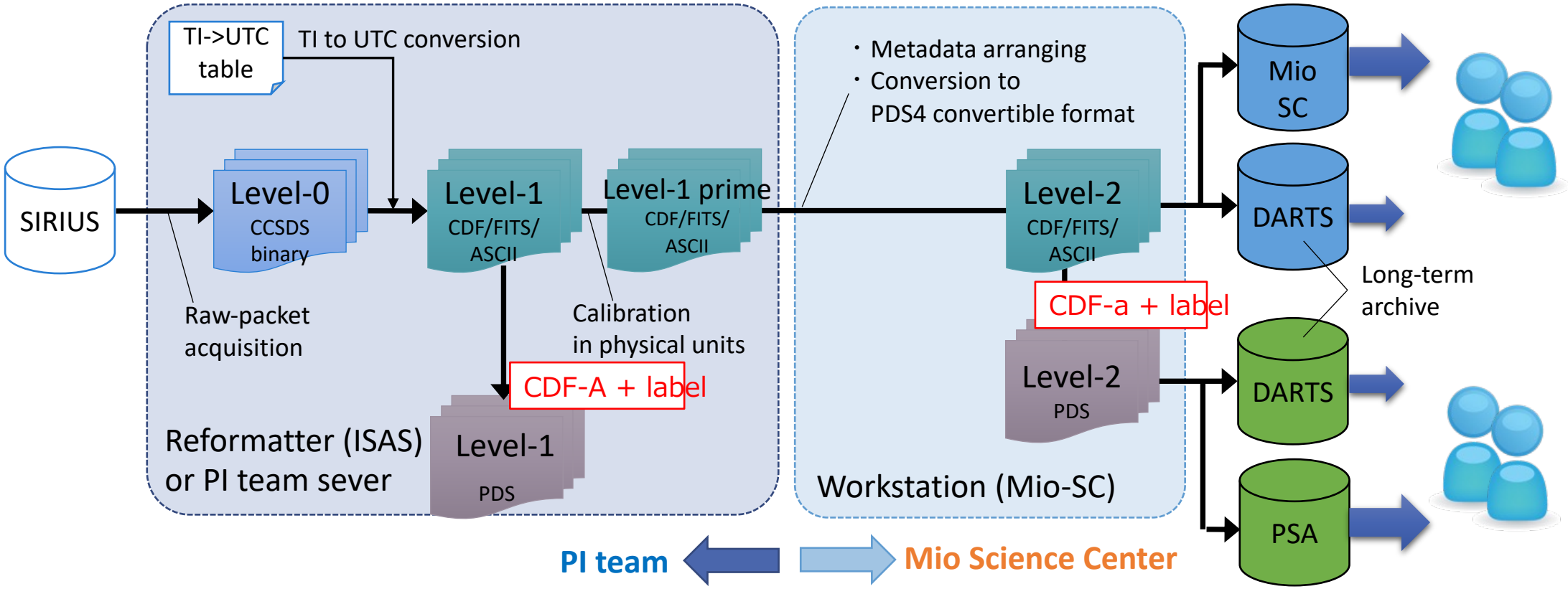
- Mio-SC will develop the python script and the template XMLs for Lv.2 data.
- We are happy to provide instrument teams with them.

Data Pipeline (Cruise Phase Data 20240612)



Level	Contents	Scope	File format
Level-0 (L0)	Raw-telemetry	Internal	CCSDS-Binary
Level-1 (L1)	Uncalibrated data converted from Level-0 raw-telemetry	Internal	CDF, FITS, ASCII
Level-1 prime (L1p)	Calibrated data in physical units	Internal	CDF, FITS, ASCII
Level-2 pre (L2pre)	Cruise-phase data calibrated in physical units with metadata (best efforts)	Internal	CDF, FITS, ASCII
Level-2 (L2)	Calibrated data in physical units with full metadata	Public	CDF, FITS, ASCII
Level-3 (L3)	Processed data by combining data from multiple instruments	Public	CDF, FITS, ASCII

Data Pipeline (after MOI Data 20240612)



Level	Contents	Scope	File format
Level-0 (L0)	Raw-telemetry	Internal	CCSDS-Binary
Level-1 (L1)	Uncalibrated data converted from Level-0 raw-telemetry	Internal	CDF, FITS, ASCII
Level-1 prime (L1p)	Calibrated data in physical units	Internal	CDF, FITS, ASCII
Level-2 pre (L2pre)	Cruise-phase data calibrated in physical units with metadata	Internal	CDF, FITS, ASCII
Level-2 (L2)	Calibrated data in physical units with full metadata	Public	CDF, FITS, ASCII
Level-3 (L3)	Processed data by combining data from multiple instruments	Public	CDF, FITS, ASCII

Messages from Mio-SC

- Please deliver Lv.1(prime) datasets to us as soon as practically possible if an instrument team is willing to provide part of cruise phase data to the project members as Lv.2pre data, hopefully with an EAICD.

- Please deliver them with some help to us also for Mio-SC to develop Lv.2 datasets on schedule.

- Mio-SC will provide any tools, templates, and knowledge that are obtained through the PDS development for Lv.2 data, thereby we will support your development of Lv.1 PDS.

Appendix 1:
PDS archive development

Development of the PDS data archive for MMO data

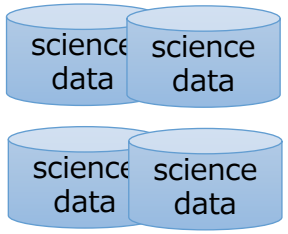
Mio Science Center

Top-level structure of a PDS archive

- **Mission Bundle**
  - the general info. of the BC mission
- **Host Bundle**
  - the general info. of MPO and MMO satellites
- **SPICE Bundle**
  - accommodates SPICE kernel files

Prepared primarily by SGS

- **Instrument Bundle1**
- **Instrument Bundle2**
- … … …



Developed and maintained by the instrument teams and Mio Science Center (Mio-SC)

An instrument bundle is assigned to each instrument

BepiColombo Annex to the PSA PDS4 Archiving Guide:
https://s2e2.cosmos.esa.int/confluence/pages/viewpage.action?spaceKey=IT&title=BepiColombo+Annex+to+the+PSA+PDS4+Archiving+Guide

Bundle name	Logical ID
MPPE data bundle	urn:jaxa:darts:bc_mmo_mppe
PWI data bundle	urn:jaxa:darts:bc_mmo_pwi
MGF data bundle	urn:jaxa:darts:bc_mmo_mgf
MSASI data bundle	urn:jaxa:darts:bc_mmo_msasi
MDM data bundle	urn:jaxa:darts:bc_mmo_mdm
SPM data bundle	urn:jaxa:darts:bc_mmo_spm

Logical ID (LID):

A unique ID assigned to each of any level of data objects (data files, documents, bundle, …)

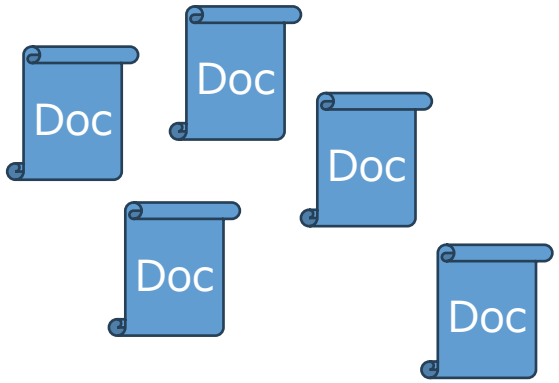
All MMO satellite data have the prefix (urn:jaxa:darts) at the head of their LIDs.

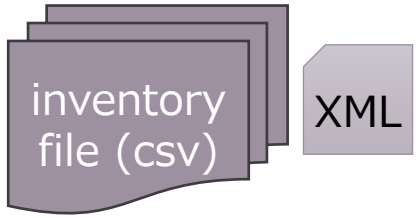
Bundle – Collection – Product

Bundle	Collection	Products archived in the collection
MPPE data bundle bc_mmo_mppe	MEA raw data collection data_raw_mea	Lv.1 data files
	MEA partially calibrated data collection data_par_mea	(Lv.2pre data), (Lv.1prime data)
	MEA calibrated data collection data_cal_mea	Lv.2 data files
	MIA raw data collection data_raw_mia	Lv.1 data files
	… … … … … … …	… … … … … … …
	Document collection document	All related document files
	Calibration collection calibration	Calibration data, tables, parameters, and documents specific to calibration

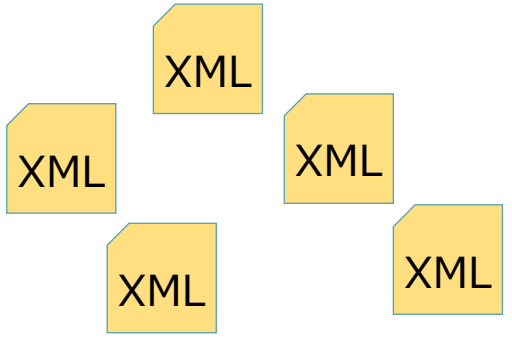
All products are accompanied by their own PDS labels

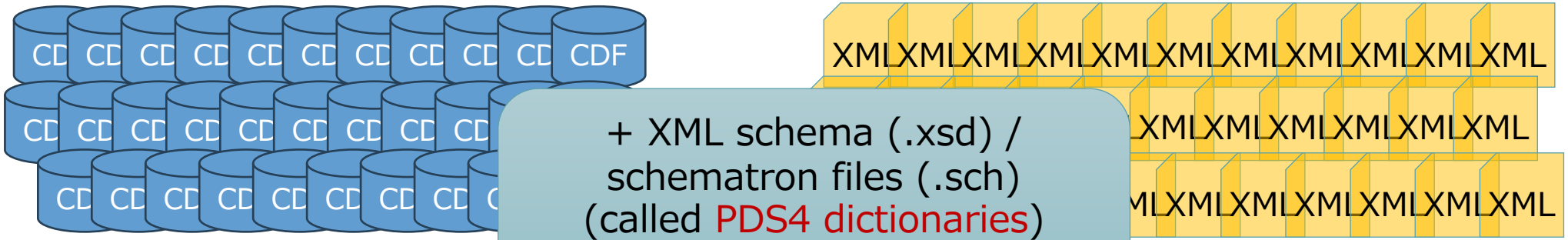
Collections under an instrument bundle



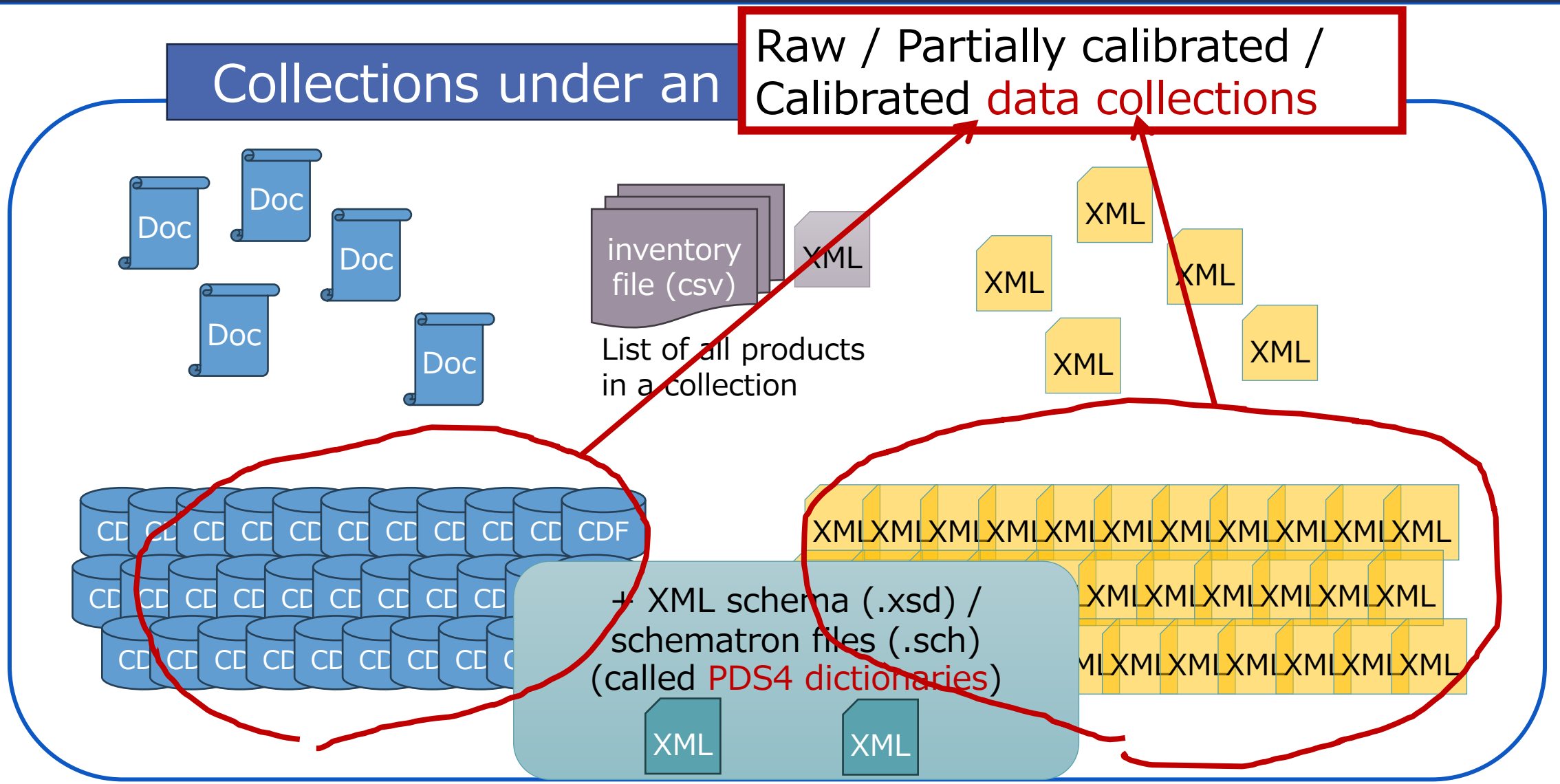


List of all products
in a collection

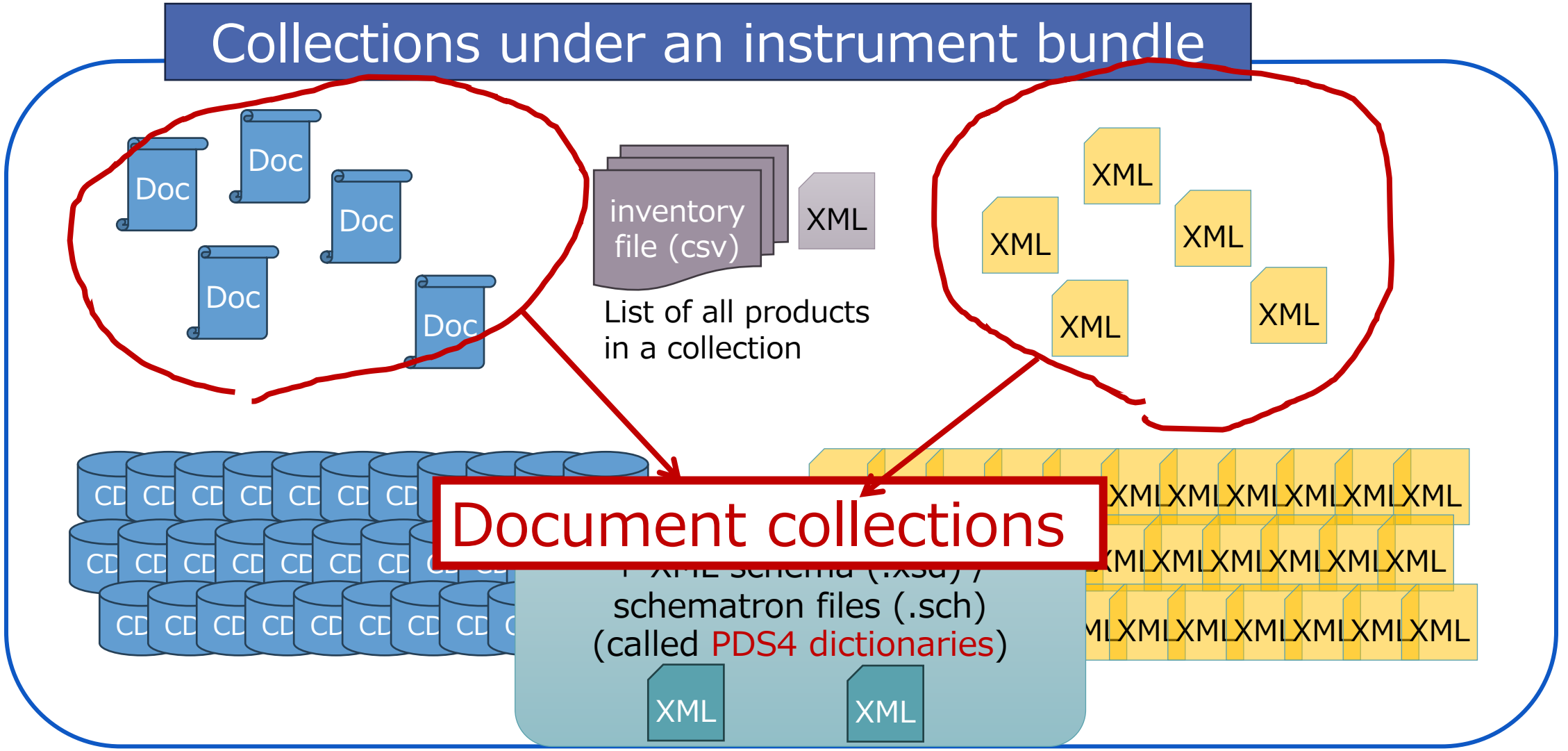




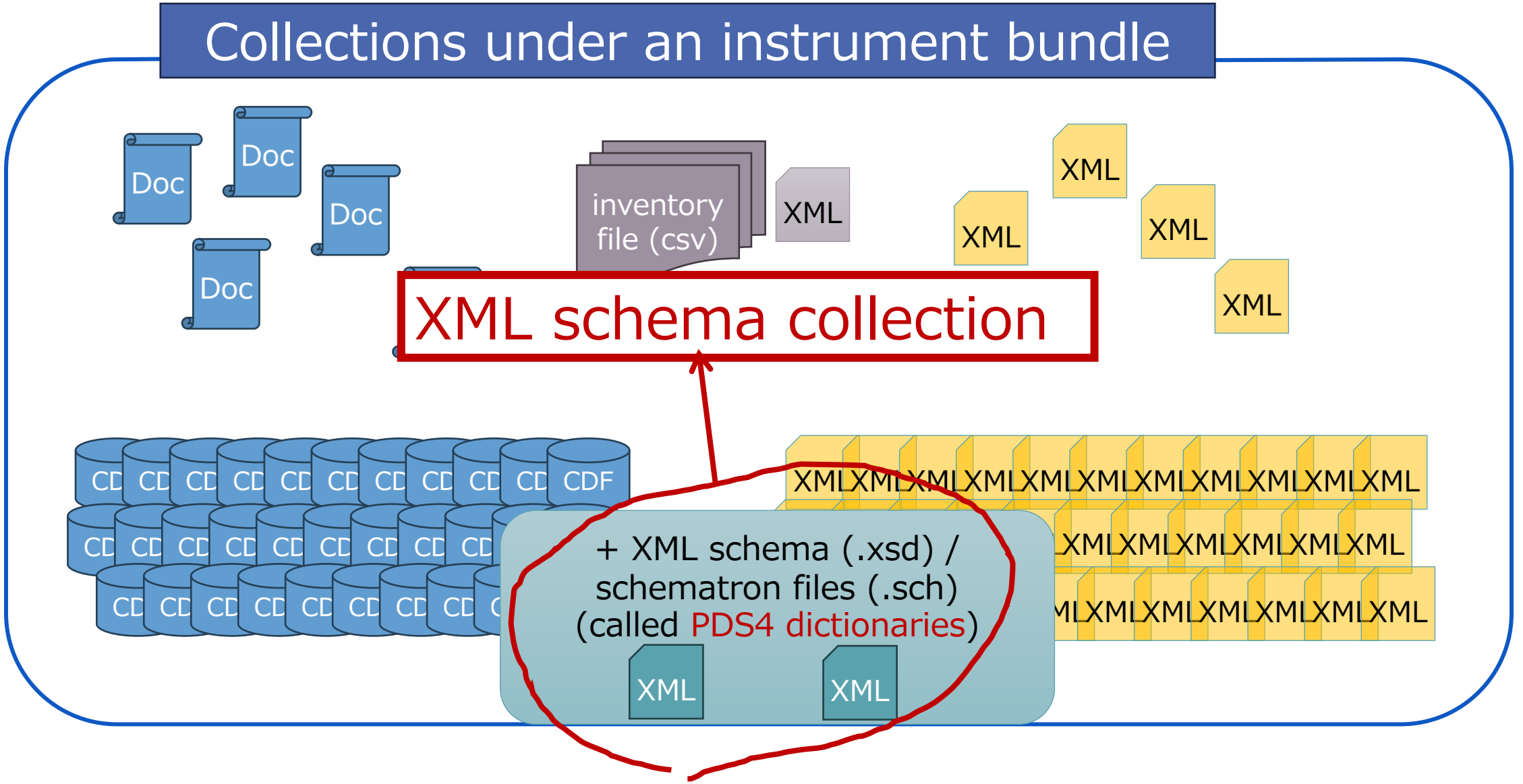
All products are accompanied by their own PDS labels



All products are accompanied by their own PDS labels



All products are accompanied by their own PDS labels



A sample of the PDS label in XML

A drafted PDS label for an SPM Lv.2pre data file

https://www.dropbox.com/scl/fi/1x3851le1x48cl3boms7g/bc-mmo-spm_par_sc_cnt_20210810.xml?rlkey=yj1p33hvieg2ury0qpgdjlrsu&dl=0

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model
href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1L00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://pds.nasa.gov/pds4/multi/v2/PDS4_MULTI_1L00_2000.
sch" schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1L00
_2010.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://pds.nasa.gov/pds4/msn/v1/PDS4_MSN_1L00_1303.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://psa.esa.int/psa/v1/PDS4_PSA_1200.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://psa.esa.int/psa/bc/v1/PDS4_PSA_BC_1005.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>

<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:multi="http://pds.nasa.gov/pds4/multi/v2"
xmlns:particle="http://pds.nasa.gov/pds4/particle/v2"
xmlns:msn="http://pds.nasa.gov/pds4/msn/v1"
xmlns:psa="http://psa.esa.int/psa/v1"
xmlns:bc="http://psa.esa.int/psa/bc/v1" xsi:schemaLocation="
http://pds.nasa.gov/pds4/pds/v1
https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1L00.xsd

http://pds.nasa.gov/pds4/multi/v2
https://pds.nasa.gov/pds4/multi/v2/PDS4_MULTI_1L00_2000.xsd

http://pds.nasa.gov/pds4/particle/v2
https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1L00_2010.
xsd

http://pds.nasa.gov/pds4/msn/v1
https://pds.nasa.gov/pds4/msn/v1/PDS4_MSN_1L00_1303.xsd
http://psa.esa.int/psa/v1
https://psa.esa.int/psa/v1/PDS4_PSA_1200.xsd

http://psa.esa.int/psa/bc/v1
https://psa.esa.int/psa/bc/v1/PDS4_PSA/BC_1005.xsd">
```

A sample of the PDS label in XML (cont'd)

A drafted PDS label for an SPM Lv.2pre data file

https://www.dropbox.com/scl/fi/1x3851le1x48cl3boms7g/bc-mmo-spm_par_sc_cnt_20210810.xml?rlkey=yj1p33hvieg2ury0qpgdjlrsu&dl=0

```
<Identification_Area>
<logical_identifier>urn:jaxa:darts:bc_mmo_spm:data_partially_processed:l2p_cn
t_20210810</logical_identifier>
<version_id>0.0</version_id>
<title>BepiColombo/MMO SPM Level-2pre count data for 2021-08-10</title>
<information_model_version>1.21.0.0</information_model_version>
<product_class>Product_Observational</product_class>
<Citation_Information>
<author_list>Murakami, G.</author_list>
<publication_year>2024</publication_year>
<description>
BepiColombo MMO SPM Level-2pre count in units of raw count (counts / s) for
2021-08-10
</description>
</Citation_Information>
<Modification_History>
<Modification_Detail>
<modification_date>2024-06-01</modification_date>
<version_id>0.0</version_id>
<description>
Intial Draft Version
</description>
</Modification_Detail>
</Modification_History>
</Identification_Area>
<Observation_Area>
<Time_Coordinates>
<start_date_time>2021-08-10T00:00:00.000Z</start_date_time>
<stop_date_time>2021-08-10T23:59:59.999Z</stop_date_time>
</Time_Coordinates>
<Primary_Result_Summary>
<purpose>Science</purpose>
<processing_level>Partially Processed</processing_level>
<Science_Facets>
<domain>Magnetosphere</domain>
<discipline_name>Particles</discipline_name>
<facet1>Electrons</facet1>
<facet2>Solar Energetic</facet2>
</Science_Facets>
</Primary_Result_Summary>
<Investigation_Area>
<name>BepiColombo Mission</name>
<type>Mission</type>
<Internal_Reference>
<lid_reference>urn:esa:psa:context:investigation:mission.bc</lid_reference>
<reference_type>data_to_investigation</reference_type>
</Internal_Reference>
</Investigation_Area>
<Observing_System>
<Observing_System_Component>
<name>MMO</name>
<type>Host</type>
<Internal_Reference>
<lid_reference>urn:jaxa:darts:context:instrument_host:spacecraft.mmo</lid_ref
erence>
<reference_type>is_instrument_host</reference_type>
</Internal_Reference>
</Observing_System_Component>
<Observing_System_Component>
<name>Mercury Plasma Particle Experiment</name>
<type>Instrument</type>
<Internal_Reference>
<lid_reference>urn:jaxa:darts:context:instrument:mmo.spm</lid_reference>
<reference_type>is_instrument</reference_type>
</Internal_Reference>
</Observing_System_Component>
</Observing_System>
<Target_Identification>
<name>Mercury</name>
<type>Planet</type>
<Internal_Reference>
<lid_reference>urn:nasa:pds:context:target:planet.mercury</lid_reference>
<reference_type>data_to_target</reference_type>
</Internal_Reference>
</Target_Identification>
```

A sample of the PDS label in XML (cont'd)

A drafted PDS label for an SPM Lv.2pre data file

https://www.dropbox.com/scl/fi/1x3851le1x48cl3boms7g/bc-mmo-spm_par_sc_cnt_20210810.xml?rlkey=yj1p33hvieg2ury0qpgdjlrsu&dl=0

```
<Mission_Area>

<!-- The mission area is to be drafted later -->
<!-- Almost the same element is repeated as
<msn:Mission_Information>. Are both needed?? -->
<psa:Mission_Information>
<psa:spacecraft_clock_start_count>26/0000000:00</psa:spacecraf
t_clock_start_count>
<psa:spacecraft_clock_stop_count>26/7852224:00</psa:spacecraft
_clock_stop_count>
<psa:mission_phase_name>Cruise</psa:mission_phase_name>
<psa:mission_phase_identifier>cruise</psa:mission_phase_identi
fier>
</psa:Mission_Information>

<!-- Data quality info, Observation context info, and
Processiong context info are to be added here. -->

</Mission_Area>

<Discipline_Area>
<msn:Mission_Information>
<msn:mission_phase_name>Cruise</msn:mission_phase_name>
<msn:spacecraft_clock_start>26/0000000.00</msn:spacecraft_cloc
k_start>
<msn:spacecraft_clock_stop>26/7852224.00</msn:spacecraft_clock
_stop>
</msn:Mission_Information>
<particle:Particle_Observation>
<particle:energy_range_minimum
unit="MeV">3</particle:energy_range_minimum>
<particle:energy_range_maximum
unit="MeV">10</particle:energy_range_maximum>
<particle:Particle_Parameter>
<particle:particle_type>Electrons</particle:particle_type>
<particle:particle_measurement_type>Count
Rate</particle:particle_measurement_type>
</particle:Particle_Parameter>
</particle:Particle_Observation>
<particle:Particle_Observation>
<particle:energy_range_minimum
unit="MeV">40</particle:energy_range_minimum>
<particle:energy_range_maximum
unit="MeV">200</particle:energy_range_maximum>
<particle:Particle_Parameter>
<particle:particle_type>Ions</particle:particle_type>
<particle:particle_measurement_type>Count
Rate</particle:particle_measurement_type>
</particle:Particle_Parameter>
</particle:Particle_Observation>

</Discipline_Area>
</Observation_Area>
```

A sample of the PDS label in XML (cont'd)

A drafted PDS label for an SPM Lv.2pre data file

https://www.dropbox.com/scl/fi/1x3851le1x48cl3boms7g/bc-mmo-spm_par_sc_cnt_20210810.xml?rlkey=yj1p33hvieg2ury0qpgdjlrsu&dl=0

```
<File_Area_Observational>
<File>
<file_name>bc_mmo_spm_l2p_cnt_20210810_r00-v00-00.cdf</file_name>
<creation_date_time>2024-06-01T00:00:00</creation_date_time>
<file_size unit="byte">167197</file_size>
<md5_checksum>????????????????????????????????????</md5_checksum> <!-
- Currently a dummy value is inserted here -->
</File>
<Header>
<name>CDF Header</name>
<offset unit="byte">0</offset>
<object_length unit="byte">404</object_length>
<parsing_standard_id>CDF 3.4 ISTP/IACG</parsing_standard_id>
</Header>

<Array>
<name>epoch</name>
<local_identifier>epoch</local_identifier>
<offset unit="byte">26407</offset>
<axes>1</axes>
<axis_index_order>Last Index Fastest</axis_index_order>
<description>Time, center of sample, in TT2000 time base. TT2000 is
UTC time in nanoseconds from 2000-Jan-01 12:00:00.000 including leap
seconds.</description>
<Element_Array>
<data_type>SignedMSB8</data_type>
<unit>ns</unit>
</Element_Array>
<Axis_Array>
<axis_name>time</axis_name>
<elements>1346</elements>
<sequence_number>1</sequence_number>
</Axis_Array>
</Array>

<Table_Character>
<name>strtime</name>
<local_identifier>strtime</local_identifier>
<offset unit="byte">38885</offset>
<records>1346</records>
<description>UTC time labels in a string form of YYYY-MM-
DDThh:mm:ss.fff each of which corresponds to that of
epoch.</description>
<record_delimiter>none</record_delimiter>
</Table_Character>

<Array>
<name>time_width</name>
<local_identifier>time_width</local_identifier>
<offset unit="byte">71577</offset>
<axes>1</axes>
<axis_index_order>Last Index Fastest</axis_index_order>
<description>The time widths in second of data accumulation periods
whose centers correspond to ecpoh. </description>
<Element_Array>
<data_type>SignedMSB8</data_type>
<unit>s</unit>
</Element_Array>
<Axis_Array>
<axis_name>time</axis_name>
<elements>1346</elements>
<sequence_number>1</sequence_number>
</Axis_Array>
</Array>
```

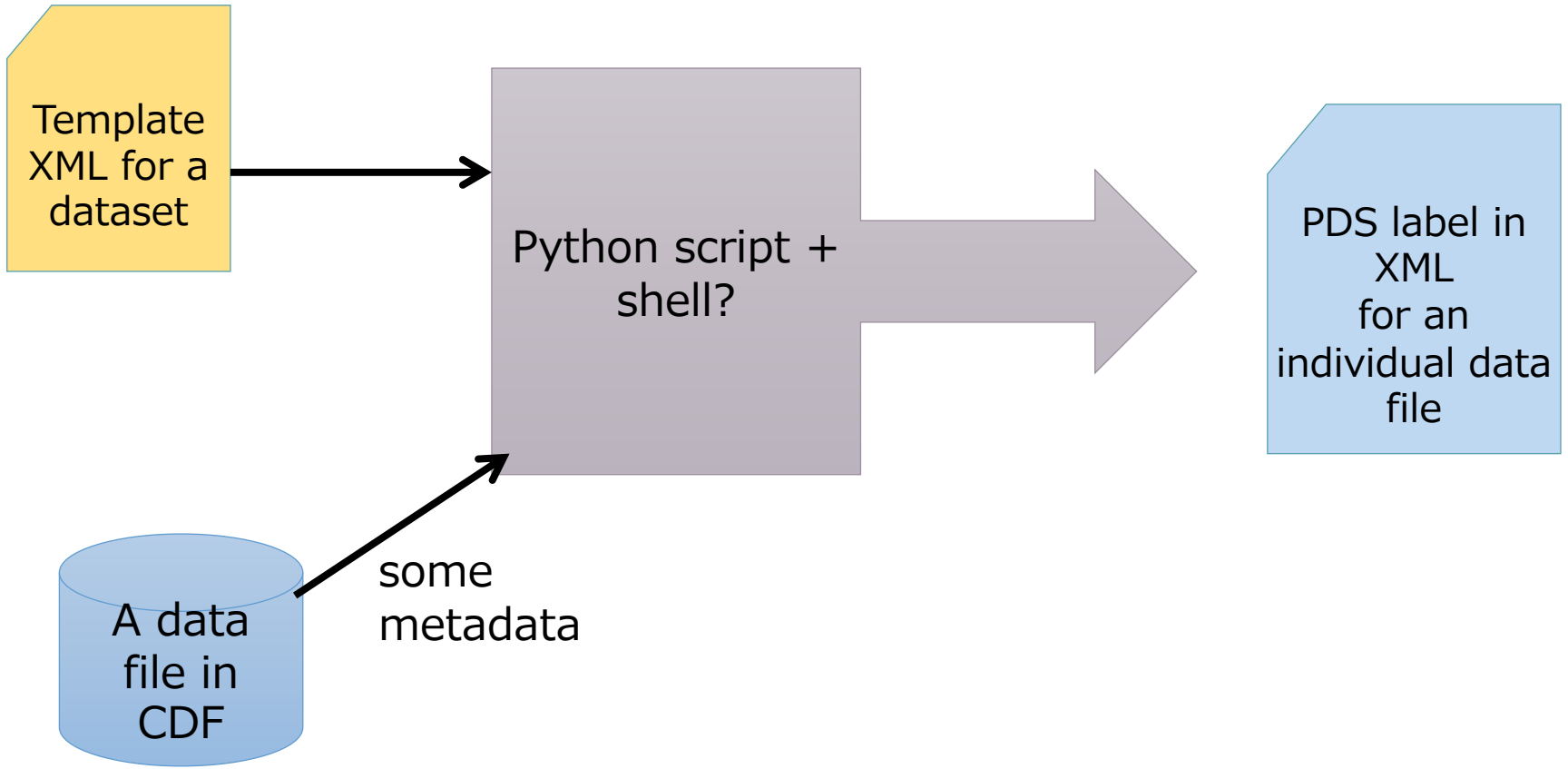
A sample of the PDS label in XML (cont'd)

A drafted PDS label for an SPM Lv.2pre data file

https://www.dropbox.com/scl/fi/1x3851le1x48cl3boms7g/bc-mmo-spm_par_sc_cnt_20210810.xml?rlkey=yj1p33hvieg2ury0qpgdjlrsu&dl=0

```
    <Array>
    <name>mdp_ti</name>
    <local_identifier>mdp_ti</local_identifier>
    <offset unit="byte">81403</offset>
    <axes>1</axes>
    <axis_index_order>Last Index Fastest</axis_index_order>
    <description>Time indicator (TI) values given by MDP to individual time periods of
    measurement.</description>
    <Element_Array>
    <data_type>SignedMSB4</data_type>
    </Element_Array>
    <Axis_Array>
    <axis_name>time</axis_name>
    <elements>1346</elements>
    <sequence_number>1</sequence_number>
    </Axis_Array>
    </Array>

    <!-- Deposite energy ranges: Lv.1: 0.0732-0.3435 MeV, Lv.2: 0.3435-0.7962, Lv.3: 0.7962-1.1481,
    Lv.4: >1.1481 -->
    <Array>
    <name>spm1_lv1_cnt</name>
    <local_identifier>spm1_lv1_cnt</local_identifier>
    <offset unit="byte">91098</offset>
    <axes>1</axes>
    <description>Raw instrument counts for the level-1 energy range measured by SPM1</description>
    <Element_Array>
    <data_type>IEEE754MSBSingle</data_type>
    <unit>counts/sample</unit>
    </Element_Array>
    <Axis_Array>
    <axis_name>time</axis_name>
    <elements>1346</elements>
    <sequence_number>1</sequence_number>
    </Axis_Array>
    <Special_Constants>
    <invalid_constant>-1.0E31</invalid_constant>
    <valid_maximum>99999.9</valid_maximum>
    <valid_minimum>0.0</valid_minimum>
    </Special_Constants>
    </Array>

    <Array>
    <name>spm1_lv2_cnt</name>
    <local_identifier>spm1_lv2_cnt</local_identifier>
    <offset unit="byte">100799</offset>
    <axes>1</axes>
    <description>Raw instrument counts for the level-2 energy range measured by SPM1</description>
    <Element_Array>
    <data_type>IEEE754MSBSingle</data_type>
    <unit>counts/sample</unit>
    </Element_Array>
    <Axis_Array>
    <axis_name>time</axis_name>
    <elements>1346</elements>
    <sequence_number>1</sequence_number>
    </Axis_Array>
    <Special_Constants>
    <invalid_constant>-1.0E31</invalid_constant>
    <valid_maximum>99999.9</valid_maximum>
    <valid_minimum>0.0</valid_minimum>
    </Special_Constants>
    </Array>

    <Array>
    <name>spm1_lv3_cnt</name>
    <local_identifier>spm1_lv3_cnt</local_identifier>
    <offset unit="byte">110500</offset>
    <axes>1</axes>
    <description>Raw instrument counts for the level-3 energy range measured by SPM1</description>
    <Element_Array>
    <data_type>IEEE754MSBSingle</data_type>
    <unit>counts/sample</unit>
    </Element_Array>
    <Axis_Array>
    <axis_name>time</axis_name>
    <elements>1346</elements>
    <sequence_number>1</sequence_number>
    </Axis_Array>
    <Special_Constants>
    <invalid_constant>-1.0E31</invalid_constant>
    <valid_maximum>99999.9</valid_maximum>
    <valid_minimum>0.0</valid_minimum>
    </Special_Constants>
    </Array>

    <Array>
    <name>spm1_lv4_cnt</name>
    <local_identifier>spm1_lv4_cnt</local_identifier>
    <offset unit="byte">120201</offset>
    <axes>1</axes>
    <description>Raw instrument counts for the level-4 energy range measured by SPM1</description>
    <Element_Array>
    <data_type>IEEE754MSBSingle</data_type>
    <unit>counts/sample</unit>
    </Element_Array>
    <Axis_Array>
    <axis_name>time</axis_name>
    <elements>1346</elements>
    <sequence_number>1</sequence_number>
    </Axis_Array>
    <Special_Constants>
    <invalid_constant>-1.0E31</invalid_constant>
    <valid_maximum>99999.9</valid_maximum>
    <valid_minimum>0.0</valid_minimum>
    </Special_Constants>
    </Array>


    </File_Area_Observational>
    </Product_Observational>
```

How we can generate a PDS label for a data file?



- Mio-SC will develop the python script and the template XMLs for Lv.2 data.
- We are happy to provide instrument teams with them.

Recommended documentation for PDS archives

[adopted from how-to-create-a-pds4-archive-v4.pptx distributed by the PDS/PPI node]

- Typical archive documents include:
  - Software interface specifications (SIS) or Experiment-archive interchange documents (EAICD)
  - Mission and instrument papers
  - Calibration description (→ calibration collection)
  - User guides
  - Relevant scientific articles
  - Relevant flight project documents

Must be archived as flat UTF-8 with no markup or PDF/A files

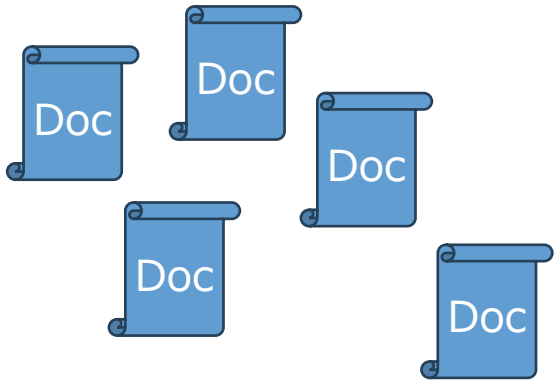
Document inclusion criteria:

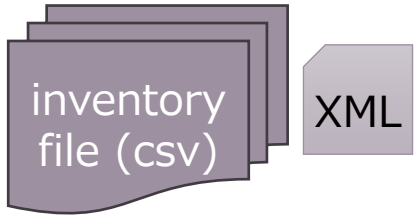
- Document that are necessary or useful for evaluating, understanding, or using the data should be included.
- Document distribution must not be restricted.

Backup slides

All products are accompanied by their own PDS labels

Collections under an instrument bundle





List of all products
in a collection