Small Bodies Namespace

NASA Planetary Data System

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USER GUIDE

The Small Bodies dictionary contains classes and attributes specific to the techniques and processes of small bodies research. In some cases the metadata provided in the SB dictionary is specifically identified as supplemental to metadata contained in other namespaces - metadata that should also be present in the product label. The SB namespace also provides some standardization and documentation of data formatting conventions for naming and organizing of PDS data structures that are common across small bodies missions and groundbased sytems.

CHAPTER

ONE

INTRODUCTION

This *User's Guide* provides a brief overview of the Small Bodies (SB or "sb:") namespace for those designing labels for small bodies data, or those developing code to read small bodies data, in the PDS archive. It presents the major features of the namespace and typical usage scenarios.

CHAPTER

TWO

OVERVIEW OF THE SMALL BODIES (SB) DISCIPLINE DICTIONARY

The Small Bodies dictionary contains classes and attributes specific to the techniques and processes of small bodies research. In some cases the metadata provided in the SB dictionary is specifically identified as supplemental to metadata contained in other namespaces - metadata that should also be present in the product label. The SB namespace also provides some standardization and documentation of data formatting conventions for naming and organizing of PDS data structures that are common across small bodies missions and groundbased sytems.

- **Steward:** Anne Raugh, Small Bodies Node, University of Maryland (@acraugh on Github)
- **Dictionary Repo:** https://github.com/pds-data-dictionaries/ldd-sb
- **Namespace Prefix:** sb:

Corrections, changes, and additions should be submitted through the PDS LDD Issue Repo.

CHAPTER

THREE

ORGANIZATION OF CLASSES AND ATTRIBUTES

The Small Bodies dictionary has a single top-level class that must be used to access any of the SB metadata classes. Below that, there are major subclasses for specific types of metadata that might be needed in various cases, depending on the nature and organization of the data. Small bodies research often involved pulling data together from a wide range of sources. Consequently, the Small Bodies dictionary classes are concerned with gathering the specific details and characteristics of the observation into label attributes that support discoverability across observing platforms and instrumentation and documentation of the standard data reduction applied.

The following sections describe the major divisions of the Small Bodies namespace.

3.1 Top-Level Class: <sb:SB_Metadata>

The *SB_Metadata* class acts as a wrapper for all other SB classes. It is required if you plan to use any SB classes in your label. It contains the major subclasses of the dictionary. All subclasses are optional; which classes to use depends on the particular circumstances of the data being described. The Small Bodies Node (SBN) will be happy to assist in selecting classes - contact the namespace steward listed above with questions or requests.

There are three major subclasses in the <sb:SB_Metadata> class:

- *<sb:Observation_Parameters>*
- *<sb:Calibration_Information>*
- *<sb:Additional_Image_Metadata>*

You can see a complete outline of the namespace under the *Small Bodies Dictionary - Outline* topic.

3.2 Main Subclass: <sb:Observation_Parameters>

The *<sb:Observation_Parameters>* class provides additional details to augment information that is expected to be provided elsewhere in the label. It contains three subclasses:

- <sb:Exposure>
- <sb:Filter>
- <sb:Timing>

The <sb:Observation_Parameters> class is not repeatable. The information provided is relevant to the observation as a whole, even when the observation consists of a series of recorded events.

<sb:Exposure> The *<sb:Exposure>* subclass augments the *<img:Exposure>* class from the Imaging dictionary. It is used primarily to provide a description field (*<sb:exposure_description>*) to note any unusual Circumstances with respect to how "exposure" is defined for the data product in hand. An *<sb:exposure_duration>* attribute

is provided, if the user wishes to repeat the duration either in a different unit, or for convenience of reference. Note that the <*img:Exposure*> class provides attributes for describing exposure-related parameters apart from a free-text description that should be used as applicable in all data labels.

The <*sb:Exposure*> class is optional and not repeatable.

<sb:Filter> The <*sb:Filter*> subclass includes specific attributes for describing the various types of filters used in small bodies research. The information here augments both the <*wavelength_range*> information that should be provided in the high-level <*Primary_Result_Summar*>*y* class in the core namespace, as well as the <*img:Filter*> class provided in the Imaging namespace. Small bodies researchers use a variety of filters that are specialized in various ways to extract specific spectral markers or generalized spectral signatures. This class provides attributes to support discoverability based on those characteristics.

For example, this class is where you can specify that a filter is broadband, narrowband, polarizing, etc. The class includes explicit wavelength ranges to cover the cases of filters not well-described by central wavelength and full width at half-maximum. It also provides a flag to indicate when the "central wavelength" reported is a weighted central wavelength, as opposed to the midpoint of the passband. This is also where it is possible to note that a filter has a standard profile (like "Johnson U"), or to link a filter to its documentation (a transmission curve, for example), or include the nickname for well-known filters on space telescopes, remote sensing missions, and used in ground-based observing campaigns.

The <*sb:Filter*> class is optional and not repeatable at present.

<sb:Timing> The <*sb:Timing*> class provides attributes to augment the start and stop times noted in the <*Observation_Area*> of the label. It includes an attribute for providing the UTC midobservation time and attributes for the Julian date equivalents of start, stop, and midobservation times. It also provides a comment field, for noting any unusual circumstances related to timing information in the label.

The <*sb:Timing*> class is optional and note repeatable.

3.3 Main Subclass: <sb:Calibration_Information>

The <*sb:Calibration_Information*> class is primarily concerned with providing provenance and reproducibility for the basic data reduction processing applied to the data. It does this in a format that corresponds to the typical, largely source-agnostic, processes used in the small bodies community to reduce observational raw data to a form ready for further analysis.

It is important to note that, in PDS4, *calibrated* means "data converted to physical units". Anything above "raw" but short of "physical units" is *partially processed*. It is common to hear researchers refer to data as "calibrated" that is only *partially processed* in PDS4 parlance, and to refer to the process of data reduction as "calibration" irrespective of whether or not it results in data that is *calibrated* by the PDS4 definition.

Consequently, the word "calibration" is used in the class and attribute names here in the aspirational sense - the particular steps applied are necessary, but possibly not sufficient, to earn the official PDS4 label *calibrated*. This is a case where the dictionary terminology reflects the usage within the discipline, rather than the strict definitions used in the PDS4 archive classifications.

<*sb:Calibration_Information*> has three subclasses:

- <sb:Raw_Data_Product>
- <sb:Calibration_Applied>
- <sb:Calibration_Reference_Files>

The <*sb:Calibration_Information*> class is optional and not repeatable. The processes described are applicable to the observational data as a whole. While optional, it is strongly recommended that this class and all its subclasses be included in all applicable data specifically targeting small bodies, to support interoperability.

Note: A calibration/processing description document should always be part of the archive and a link to that document should be included in the high-level <*Reference_List*> class whenever processed data at any level above "Raw" (and sometimes even then) are archived.

<sb:Raw_Data_Product> The <*sb:Raw_Data_Product*> class provides a link to the original source for the present processed data product, also in the PDS archives. It includes a place for the file name. Although file names should not be considered unique and immutable, they are often referenced in archive documentation and including it can answer a lot of questions very quickly. The raw product should be referenced formally using the (required) <*Internal_Reference*> class (defined in the core *pds:* namespace). This reference should should be to a specific version of that product - in other words, referenced by LIDVID (logical ID and version) rather than just LID.

<sb:Calibration_Applied> The <*sb:Calibration_Applied*> class contains a series of boolean attributes that must be included to indicate that a particular calibration step (like bias subtraction or flat fielding) has been applied, and may also be used to indicate that a specific correction (correction for scattered light, for example) has *not* been applied. There is also a <*sb:comment*> field provided to note unusual circumstances.

<sb:Calibration_Reference_Files> The <*sb:Calibration_Reference_Files*> class is used to create links between the processed data and the specific files used as part of the standard data reduction sequence. Classes are provided for key calibration steps - for example, the flat field file applied is identified in the <*sb:Flat_Field*> subclasses. The file subclasses all have the same form as the <*sb:Raw_Data_Product*> class: an optional <*sb:file_name*> provided largely for convenience; and a formal link to the archival product containing the file via the <*Internal_Reference*> class. As with most classes in the SB dictionary, this one also contains a <*sb:comment*> field that can be used to note unusual circumstances.

3.4 Main Subclass: <sb:Additional_Image_Metadata>

The <*sb:Additional_Image_Metadata*> class provides subclasses that support some common image data organizations for single and multi-frame observations, and to augment the pointing information supplied in the Geometry classes <*geom:Image_Display_Geometry*> and <*geom:Geometry_Orbiter*>. It contains four subclasses and two attributes. In label order these are:

- <pds:Local_Internal_Reference>
- <sb:comment>
- <sb:image_observation_type
- <sb:Ancillary_Data_Objects>
- <sb:Additional_Geometry_Metadata>
- <sb:Per_Frame_Metadata>

The <*sb:Additional_Image_Metadata*> class is optional and not repeatable. It will most often be used with processed image data to link the processed image to the ancillary data objects containing things like signal-to-noise maps and quality assessments when provided in arrays that map pixel-to-pixel with the image.

<Local_Internal_Reference> This class from the core *pds:* namespace is used to identify the data object within the product that contains the primary image data. Most often this is a single 2D image array, but in recent missions there has been a trend to collecting frames taken as part of an observing sequence (but not necessarily as a "movie", i.e., with irregular time steps) into a 3D stack of frames.

<sb:comment> As found frequently in the SB dictionary, this is a free-form text field for noting any unusual circumstances of which the user should be aware.

<sb:image_observation_type> This attribute is used to distinguishe between the more usual **Single Frame** data product, which contains a single 2D image, and a **Frame Sequence** data product, which conains a stack of images resulting from a single observing sequence.

<sb:Ancillary_Data_Objects> The *<sb:Ancillary_Data_Objects>* class is used in *partially processed* and *calibrated* data products to identify and link the primary image data to ancillary data provided in data objects that have identical dimenstions to the primary image data object. So, for example, if error estimates for a 2D image are provided as a 2D array containing error values for each corresponding pixel, the *<sb:Ancillary_Data_Objects>* class will be present with an *<sb:Error_Estimates_Map>* subclass identifying the data object contiaining the errors.

The ancillary data types currently supported are:

- Error estimates, through the *<sb:Error_Estimates_Map>* subclass
- Signal-to-noise ratio, through the *<sb:SNR_Map>* subclass
- Pixel quality assessments, through the *<sb:Quality_Map>* subclass

The *<sb:Quality_Map>* subclass also contains the *<sb:Quality_Map_Definition>* class, which can be used to define the values comprising the quality map pixels.

Ancillary data objects are identified using the *<Local_Internal_Reference>* class from the *pds:* core dictionary.

The *<sb:Ancillary_Data_Objects>* class is optional but not repeatable.

<sb:Additional_Geometry_Metadata> The *<sb:Additional_Geometry_Metadata>* class contains classes for attributes not available from the Geometry dictionary, but often desired by small bodies researchers for use in analysis. In addition to an initial *<sb:comment>* field for the usual notes, this class contains two subclasses:

- <sb:Instrument_Position_Angles>
- <sb:Geometry_Vector_Times>

The *<sb:Instrument_Position_Angles>* class supplements the *<geom:Image_Display_Geometry>* class by adding position angles for the y and z axes of the instrument pointing on the plane of the image, when displayed according to the directions in the *<disp:Display_Settings>* class (which should be present in all image data labels).

The *<sb:Geometry_Vector_Times>* class provides a method for specifying UTC at an observer located at one end point of the geometry vectors included in the *<geom:Geometry_Orbiter>* class. The specific vector is identified, and the UTC at the point of interest (Sun, Earth, spacecraft, or target) can be provided in either YMD format or as a Julian date.

The *<sb:Additional_Geometry_Metadata>* class is optional but not repeatable. In the case of **Frame Sequence** data products, the values for the additional geometry metadata should be referenced to the midpoint of the observing sequence.

<sb:Per_Frame_Metadata> The *<sb:Per_Frame_Metadata>* class is used only in the case of products containing **Frame Sequence** data in order to supply timing and pointing information for each 2D frame comprising the primary data object. The class is repeated once for each frame.

Individual frames are identified by their sequence number, starting at 0 (zero). In addition to providing an exposure duration for the frame, this class contains two subclasses:

- <sb:Midframe_Time>
- <sb:Frame_Pointing>

The *<sb:Midframe_Time>* class provides UTC midobservation time for the single frame in both YMD and Julian date format, and also a place for the delta time from the start of the observing sequence to the midframe time.

The *<sb:Frame_Pointing>* class contains attributes to hold the center of image right ascension and declination, celestial north clock angle, and instrument position angles for each image, as well as the instrument-to-J2000 rotation quaternion specific to the frame.

CHAPTER

FOUR

SMALL BODIES DICTIONARY - OUTLINE

<*sb:SB_Metadata*> is the public entry point to the Small Bodies namespace. This class contains all other SB classes and must be included to use them. Below is a summary outline of *all* classes and attributes in the Small Bodies dictionary, in the order in which they would appear in a label if every single one was used. Most classes are optional at the higher levels, and the majority of attributes are optional as well.

Note that in many cases in which the <*Internal_Reference*> class from the core *pds:* dictionary is used to reference a related file, the referring Small Bodies class **requires** a reference to a specific version of that file - a *lidvid_reference* rather than a *lid_reference*. When either is acceptable, both are listed as alternatives in this outline.

<sb:SB_Metadata>

- <sb:Observation_Parameters>
  - <sb:Exposure>
    - <sb:exposure_duration>
    - <sb:exposure_description>
  - <sb:Filter>
    - <sb:filter_name>
    - <sb:standard_filter_identification>
    - <sb:filter_type>
    - <sb:center_wavelength>
    - <sb:center_wavelength_id_weighted>
    - <sb:short_wavelength_limit>
    - <sb:long_wavelength_limit>
    - <sb:known_short_wavelength_light_leak>
    - <sb:known_long_wavelength_light_leak>
    - <sb:comment>
    - <pds:Internal_Reference>
      - <pds:lid_reference> or <pds:lidvid_reference>
      - <pds:reference_type>
      - <pds:comment>
  - <sb:Timing>
    - <sb:midobservation_time_UTC_YMD>

        - <sb:midobservation_time_UTC_JD>
        - <sb:start_time_UTC_JD>
        - <sb:stop_time_UTC_JD>
        - <sb:comment>
- <sb:Calibration_Information>
  - <sb:Raw_Data_Product>
    - <sb:file_name>
    - <pds:Internal_Reference>
      - <pds:livid_reference>
      - <sb:pds_reference_type>
      - <pds:comment>
  - <sb:Calibration_Applied>
    - <sb:bias_subtraction>
    - <sb:dark_current_removal>
    - <sb:flat_field_applied>
    - <sb:scattered_light_correction>
    - <sb:conversion_to_physical_uni>ts
    - <sb:comment>
  - <sb:Calibration_Reference_Files>
    - <sb:comment>
    - <sb:Flat_Field>
      - <sb:file_name>
      - <pds:Internal_Reference>
        - <pds:lidvid_reference>
        - <pds:reference_type>
        - <pds:comment>
    - <sb:Dark_Field >
      - <sb:file_name>
      - <pds:Internal_Reference>
        - <pds:lidvid_reference>
        - <pds:reference_type>
        - <pds:comment>
    - <sb:Bias_Map>
      - <sb:file_name>
      - <pds:Internal_Reference>
        - <pds:lidvid_reference>

            - <pds:reference_type>
            - <pds:comment>
        - <sb:Bad_Pixel_Map>
            - <sb:file_name>
            - <pds:Internal_Reference>
                - <pds:lidvid_reference>
                - <pds:reference_type>
                - <pds:comment>

- <sb:Additional_Image_Metadata>
  - <pds:Local_Internal_Reference>
    - <pds:local_identifier_reference>
    - <pds:reference_type>
    - <pds:comment>
  - <sb:comment>
  - <sb:image_observation_type>
  - <sb:Ancillary_Data_Objects>
    - <sb:comment>
    - <sb:Quality_Map>
      - <pds:Local_Internal_Referemce>
        - <pds:local_identifier_reference>
        - <pds:local_reference_type>
        - <pds:comment>
      - <sb:Quality_Map_Definition>
        - <sb:flags_are_bit_flags>
        - <sb:best_quality_value>
        - <sb:Quality_Flag_Definition>
          - <sb:flag_value>
          - <sb:flag_meaning>
      - <sb:comment>
    - <sb:Error_Estimates_Map>
      - <pds:Local_Internal_Reference>
        - <pds:local_identifier_reference>
        - <pds:local_reference_type>
        - <pds:comment>
    - <sb:SNR_Map>
      - <pds:Local_Internal_Referemce>

- <pds:local_identifier_reference>
- <pds:local_reference_type>
- <pds:comment>

– <sb:Additional_Geometry_Metadata>

* <sb:comment>
* <sb:Instrument_Position_Angles>
  - <sb:y_axis_position_angle>
  - <sb:z_axis_position_angle>
* <sb:Geometry_Vector_Time>
  - <sb:position_velocity_vectors>
  - <sb:time_at_target_UTC_YMD>
  - <sb:time_at_target_UTC_JD>
* <sb:Per_Frame_Metadata>
  - <sb:frame_number>
  - <sb:frame_exposure_duration>
  - <sb:comment>
  - <sb:Midframe_Time>
    - <sb:midobservation_time_UTC_YMD>
    - <sb:midobservation_time_UTC_JD>
    - <sb:delta_time_from_sequence_start>
  - <sb:Frame_Pointing>
    - <sb:Instrument_to_J2000_Quaternion>
      - <sb:qcos>
      - <sb:qsin1>
      - <sb:qsin2>
      - <sb:qsin3>

CHAPTER

FIVE

ALPHABETICAL LIST OF CLASSES

A complete list of all classes in the Small Bodies Dictionary, in alphabetical order, is available through the PDS4 Data Dictionary page, which is regenerated automatically with each release of the PDS4 Information Model.

To find the Small Bodies class list, look down the list of (alphabetically sorted) dictionary prefixes in the left menu for "Classes in the sb namespace". Select that item and the list of classes will be presented on both the left and the right as clickable links.

Clicking on the specific class name will produce a grid with the full, formal definition of the class.

Clicking on the class name in the "Referenced from:" line at the bottom of the grid will take you to the containing class, where you can see the cardinality of the class (i.e., whether it is required, optional, or repeatable) in the containing class.

You can also click on the attribute names listed to see details of the attribute definitions.

CHAPTER

SIX

ALPHABETICAL LIST OF ATTRIBUTES

A complete list of all attributes in the Small Bodies Dictionary, in alphabetical order, is available through the PDS4 Data Dictionary page, which is regenerated automatically with each release of the PDS4 Information Model.

To find the Small Bodies attribute list, look down the list of (alphabetically sorted) dictionary prefixes in the left menu for "Attributes in the sb namespace". Select that item and the list of attributes will be presented on both the left and the right as clickable links.

Clicking on the specific attribute name will produce a grid with the full, formal definition of the attribute, including data type, restrictions on values, and the list of defined permissible values (if any) and their definitions.

Note that attributes might appear as members of different classes, and that their definitions, or more likely their permissible values, might be context-dependent.

Clicking on the class name in the title bar of the attribute grid will take you to the definition of the class containing that attribute.

If the attribute has an associated unit of measure type, that attribute *must* have an XML attribute called "unit" in its tag when it is used. For example:

```
<sb:exposure_duration unit="s">10.0</sb:exposure_duration>
```

You can see valid values to use for the "unit=" XML attribute by clicking on the value of "Unit of Measure Type" in the grid.

CHAPTER

SEVEN

METADATA TEMPLATE

This metadata template file is a label mock-up designed to demonstrate the order of SB dictionary classes in a label, and the cross-referencing needed to properly identify the various data objects that might be present. It does not necessarily reflect any "real" case, and in general any cutting and pasting done needs to include a fair amount of intelligent interpretation to the real-life circumstances of the data.

It does, however, serve as a "working model", in the sense that it will validate against the SB schemas, and a label designer can thus experiment with it for use in real labels.

Some comments are included regarding cardinality and required/optional status in key places. The definitive source for cardinality information, however, is always the schemas - not the examples.

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1J00.sch" schematypens=
↪"http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/sb/v0/PDS4_SB_1J00_0100.sch" schematypens=
↪"http://purl.oclc.org/dsdl/schematron"?>

<Product_Observational
  xmlns="http://pds.nasa.gov/pds4/pds/v1"
  xmlns:sb="http://pds.nasa.gov/pds4/sb/v0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1 https://pds.nasa.gov/pds4/pds/v1/
↪PDS4_PDS_1J00.xsd
                      http://pds.nasa.gov/pds4/sb/v0  https://pds.nasa.gov/pds4/sb/v0/
↪PDS4_SB_1J00_0100.xsd">

  <Identification_Area>
      <logical_identifier>urn:nasa:pds:bundle:collection:product</logical_identifier>
      <version_id>1.0</version_id>
      <title>Scratch space for designing dictionary classes</title>
      <information_model_version>1.19.0.0</information_model_version>
      <product_class>Product_Observational</product_class>
  </Identification_Area>
  <Observation_Area>
      <Time_Coordinates>
          <start_date_time xsi:nil="true" nilReason="inapplicable"/>
          <stop_date_time xsi:nil="true" nilReason="inapplicable"/>
      </Time_Coordinates>
      <Investigation_Area>
          <name>None</name>
          <type>Mission</type>
```

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```
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:bundle:collection:none</lid_reference>
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
        <Observing_System_Component>
            <name>None</name>
            <type>Host</type>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>None</name>
        <type>Comet</type>
    </Target_Identification>

    <Discipline_Area>
        <!--
            NOTE:

            Flags for missing data and units of measure MUST, MUST, MUST be defined in␣
↪the
            referenced array/image definitions.
        -->

        <sb:SB_Metadata>
            <sb:Observation_Parameters>
                <sb:Exposure>
                    <sb:exposure_duration unit="s">10</sb:exposure_duration>
                    <sb:exposure_description>Something</sb:exposure_description>
                </sb:Exposure>

                <sb:Filter>
                    <sb:filter_name>Red</sb:filter_name> <!-- required -->
                    <!-- All these fields are optional, but as much information should␣
↪be provided as is known and applicable. -->
                    <sb:standard_filter_identification>Kron/Cousins R</sb:standard_
↪filter_identification>
                    <sb:filter_type>Broadband</sb:filter_type>
                    <sb:center_wavelength unit="nm">630</sb:center_wavelength>
                    <sb:center_wavelength_is_weighted>false</sb:center_wavelength_is_
↪weighted>
                    <sb:short_wavelength_limit unit="nm">505</sb:short_wavelength_
↪limit>
                    <sb:long_wavelength_limit unit="nm">735</sb:long_wavelength_limit>
                    <sb:known_short_wavelength_leak>false</sb:known_short_wavelength_
↪leak>
                    <sb:known_long_wavelength_leak>false</sb:known_long_wavelength_
↪leak>
                    <sb:comment>Something</sb:comment>
                    <Internal_Reference>
                        <lid_reference>urn:nasa:pds:bundle:collection:lid</lid_
↪reference>
```

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```
                        <reference_type>data_to_filter_transmission_curve</reference_
↪type>
                        <comment>something</comment>
                    </Internal_Reference>
                </sb:Filter>

                <sb:Timing>
                    <sb:midobservation_time_UTC_YMD>2023-01-01T00:00:00Z</
↪sb:midobservation_time_UTC_YMD>
                    <sb:midobservation_time_UTC_JD unit="julian day">2459959.1234</
↪sb:midobservation_time_UTC_JD>
                    <sb:start_time_UTC_JD unit="julian day">2459959.1111</sb:start_
↪time_UTC_JD>
                    <sb:stop_time_UTC_JD unit="julian day">2459959.2222</sb:stop_time_
↪UTC_JD>
                    <sb:comment>something</sb:comment>
                </sb:Timing>
            </sb:Observation_Parameters>

            <sb:Calibration_Information>
                <sb:Raw_Data_Product>
                    <sb:file_name>file.dat</sb:file_name>
                    <Internal_Reference>
                        <lidvid_reference>urn:nasa:pds:bundle:collection:product::1.0</
↪lidvid_reference>
                        <reference_type>processed_data_to_raw_data</reference_type>
                    </Internal_Reference>
                </sb:Raw_Data_Product>

                <sb:Calibration_Applied>
                    <sb:comment>something</sb:comment>
                    <sb:bias_subtraction>true</sb:bias_subtraction>
                    <sb:dark_current_removal>true</sb:dark_current_removal>
                    <sb:flat_field_applied>true</sb:flat_field_applied>
                    <sb:scattered_light_correction>false</sb:scattered_light_
↪correction>
                    <sb:conversion_to_physical_units>true</sb:conversion_to_physical_
↪units>
                </sb:Calibration_Applied>

                <sb:Calibration_Reference_Files>
                    <sb:comment>something</sb:comment>
                    <sb:Flat_Field>
                        <sb:file_name>flat.dat</sb:file_name> <!-- optional but␣
↪recommended -->
                        <Internal_Reference>                    <!-- required -->
                            <lidvid_reference>
↪urn:nasa:pds:bundle:collection:product::0.0</lidvid_reference>  <!-- version ID is␣
↪definitely required -->
                            <reference_type>image_to_flat_field_file</reference_type>
                            <comment>something</comment>
                        </Internal_Reference>
```

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```
                    </sb:Flat_Field>
                    <sb:Dark_Field>
                        <sb:file_name>dark.dat</sb:file_name>  <!-- optional but␣
↪recommended -->
                        <Internal_Reference>                   <!-- required -->
                            <lidvid_reference>
↪urn:nasa:pds:bundle:collection:product::0.0</lidvid_reference>  <!-- version ID is␣
↪definitely required -->
                            <reference_type>image_to_dark_field_file</reference_type>
                            <comment>something</comment>
                        </Internal_Reference>
                    </sb:Dark_Field>
                    <sb:Bias_Map>
                        <sb:file_name>bias_frame.dat</sb:file_name>  <!-- optional but␣
↪recommended -->
                        <Internal_Reference>                        <!-- required -->
                            <lidvid_reference>
↪urn:nasa:pds:bundle:collection:product::2.0</lidvid_reference>  <!-- version ID is␣
↪definitely required -->
                            <reference_type>image_to_bias_levels</reference_type>
                        </Internal_Reference>
                    </sb:Bias_Map>
                    <sb:Bad_Pixel_Map>
                        <sb:file_name>badpixel.dat</sb:file_name>  <!-- optional but␣
↪recommended -->
                        <Internal_Reference>                       <!-- required -->
                            <lidvid_reference>
↪urn:nasa:pds:bundle:collection:product::0.0</lidvid_reference>  <!-- version ID is␣
↪definitely required -->
                            <reference_type>image_to_bad_pixel_map</reference_type>
                            <comment>something</comment>
                        </Internal_Reference>
                    </sb:Bad_Pixel_Map>
                </sb:Calibration_Reference_Files>
            </sb:Calibration_Information>

            <sb:Additional_Image_Metadata>
                <Local_Internal_Reference>
                    <comment>something</comment>
                    <local_identifier_reference>Image</local_identifier_reference>
                    <local_reference_type>image_to_additional_metadata</local_
↪reference_type>
                </Local_Internal_Reference>

                <sb:comment>something</sb:comment>

                <sb:image_observation_type>Frame Sequence</sb:image_observation_type>

                <sb:Ancillary_Data_Objects>
                    <!-- Note that the primary data is already identified at the top␣
↪of the class -->
                    <sb:comment>something</sb:comment>
```

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```
                    <sb:Quality_Map>
                        <Local_Internal_Reference>
                            <local_identifier_reference>QualityMap</local_identifier_
↪reference>
                            <local_reference_type>image_to_quality_map</local_
↪reference_type>
                        </Local_Internal_Reference>

                        <sb:Quality_Map_Definition>
                            <sb:flags_are_bit_flags>true</sb:flags_are_bit_flags> <!--␣
↪required -->
                            <sb:best_quality_value>0</sb:best_quality_value>      <!--␣
↪required -->
                            <sb:Quality_Flag_Definition>   <!-- Repeat as needed -->
                                <sb:flag_value>2</sb:flag_value>
                                <sb:flag_meaning>Bad attitude</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>4</sb:flag_value>
                                <sb:flag_meaning>escaped during processing</sb:flag_
↪meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>8</sb:flag_value>
                                <sb:flag_meaning>Looked at me funny.</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                        </sb:Quality_Map_Definition>
                        <sb:comment>something</sb:comment>
                    </sb:Quality_Map>

                    <sb:Error_Estimates_Map>
                        <Local_Internal_Reference>
                            <local_identifier_reference>ErrorMap</local_identifier_
↪reference>
                            <local_reference_type>image_to_error_map</local_reference_
↪type>
                        </Local_Internal_Reference>
                        <sb:comment>something</sb:comment>
                    </sb:Error_Estimates_Map>

                    <sb:SNR_Map>
                        <Local_Internal_Reference>
                            <local_identifier_reference>SNRMap</local_identifier_
↪reference>
                            <local_reference_type>image_to_snr_map</local_reference_
↪type>
                        </Local_Internal_Reference>
                        <sb:comment>something</sb:comment>
                    </sb:SNR_Map>

                </sb:Ancillary_Data_Objects>
```

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```
                <sb:Additional_Geometry_Metadata>
                    <sb:comment>something</sb:comment>
                    <sb:Instrument_Position_Angles>
                        <sb:y_axis_position_angle unit="deg">20</sb:y_axis_position_
↪angle>
                        <sb:z_axis_position_angle unit="deg">110</sb:z_axis_position_
↪angle>
                    </sb:Instrument_Position_Angles>
                    <sb:Geometry_Vector_Time> <!-- This class is still in development.␣
↪Use with the expectation it will change. -->
                        <sb:position_velocity_vectors>Spacecraft_to_Target</
↪sb:position_velocity_vectors>
                        <sb:time_at_target_UTC_YMD>2022-12-25T12:34:56.789Z</sb:time_
↪at_target_UTC_YMD>
                        <sb:time_at_target_UTC_JD unit="julian day">2459925.987</
↪sb:time_at_target_UTC_JD>
                    </sb:Geometry_Vector_Time>
                    <sb:Geometry_Vector_Time> <!-- This class is still in development.␣
↪Use with the expectation it will change. -->
                        <sb:position_velocity_vectors>Earth_to_Target</sb:position_
↪velocity_vectors>
                        <sb:time_at_Earth_UTC_YMD>2022-12-25T12:34:56.789Z</sb:time_at_
↪Earth_UTC_YMD>
                        <sb:time_at_Earth_UTC_JD unit="julian day">2459925.987</
↪sb:time_at_Earth_UTC_JD>
                    </sb:Geometry_Vector_Time>
                    <sb:Geometry_Vector_Time> <!-- This class is still in development.␣
↪Use with the expectation it will change. -->
                        <sb:position_velocity_vectors>Sun_to_Spacecraft</sb:position_
↪velocity_vectors>
                        <sb:time_at_Sun_UTC_YMD>2022-12-25T12:34:56.789Z</sb:time_at_
↪Sun_UTC_YMD>
                        <sb:time_at_Sun_UTC_JD unit="julian day">2459925.987</sb:time_
↪at_Sun_UTC_JD>
                    </sb:Geometry_Vector_Time>
                    <sb:Geometry_Vector_Time> <!-- This class is still in development.␣
↪Use with the expectation it will change. -->
                        <sb:position_velocity_vectors>Earth_to_Spacecraft</sb:position_
↪velocity_vectors>
                        <sb:time_at_Earth_UTC_YMD>2022-12-25T12:34:56.789Z</sb:time_at_
↪Earth_UTC_YMD>
                        <sb:time_at_Earth_UTC_JD unit="julian day">2459925.987</
↪sb:time_at_Earth_UTC_JD>
                    </sb:Geometry_Vector_Time>
                </sb:Additional_Geometry_Metadata>

                <!-- "Per_Frame_Metadata" is only valid for "Frame Sequence" data.␣
↪Repeated for each frame. -->

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>0</sb:frame_number>
```

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```
                    <sb:frame_exposure_duration unit="s">10.5</sb:frame_exposure_
↪duration>
                    <sb:comment>something</sb:comment>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2023-01-05T11:22:33.44Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:midobservation_time_UTC_JD unit="julian day">2459955.5678</
↪sb:midobservation_time_UTC_JD>
                        <sb:delta_time_from_sequence_start unit="s">5</sb:delta_time_
↪from_sequence_start>
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">112.0</sb:frame_center_ra>
                        <sb:frame_center_dec unit="deg">-45.0</sb:frame_center_dec>
                        <sb:celestial_north_clock_angle unit="deg">75.123</
↪sb:celestial_north_clock_angle>
                        <sb:Instrument_Position_Angles>
                            <sb:y_axis_position_angle unit="deg">57.123</sb:y_axis_
↪position_angle>
                            <sb:z_axis_position_angle unit="deg">123.04</sb:z_axis_
↪position_angle>
                        </sb:Instrument_Position_Angles>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.12345</sb:qcos>
                        <sb:qsin1>0.12345</sb:qsin1>
                        <sb:qsin2>0.12345</sb:qsin2>
                        <sb:qsin3>0.12345</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

            </sb:Additional_Image_Metadata>
        </sb:SB_Metadata>
    </Discipline_Area>

</Observation_Area>

<File_Area_Observational>
    <File>
        <file_name>No.Data</file_name>
        <comment>
            The scenario here is a file which contains three cubes - one for data,
            one for error, and one for quality - in which the planes correspond.
            There is also a single bad pixel map image that applies to all image
            frames. There are five planes defined for each cube. (offsets and
            sizes have been ignored.)
        </comment>
    </File>

    <Array_3D_Image>
        <name>Image Data</name>
        <local_identifier>Image</local_identifier>
```

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```
        <offset unit="byte">0</offset>
        <axes>3</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <Element_Array>
            <data_type>SignedByte</data_type>
            <unit>DN</unit>
        </Element_Array>
        <Axis_Array>
            <axis_name>Line</axis_name>
            <elements>1</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Sample</axis_name>
            <elements>1</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Frame</axis_name>
            <elements>5</elements>
            <sequence_number>3</sequence_number>
        </Axis_Array>
    </Array_3D_Image>

    <Array_3D>
        <name>Error map</name>
        <local_identifier>ErrorMap</local_identifier>
        <offset unit="byte">10</offset>
        <axes>3</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <Element_Array>
            <data_type>IEEE754MSBSingle</data_type>
            <unit>Percent</unit>
        </Element_Array>
        <Axis_Array>
            <axis_name>Line</axis_name>
            <elements>1</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Sample</axis_name>
            <elements>1</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Error Estimate</axis_name>
            <elements>5</elements>
            <sequence_number>3</sequence_number>
        </Axis_Array>
    </Array_3D>

    <Array_3D>
```

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```
        <local_identifier>QualityMap</local_identifier>
        <offset unit="byte">20</offset>
        <axes>3</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <description>
            The elements in this array are quality bit-flag fields.
        </description>
        <Element_Array>
            <data_type>UnsignedByte</data_type>
        </Element_Array>
        <Axis_Array>
            <axis_name>Line</axis_name>
            <elements>1</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Sample</axis_name>
            <elements>1</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Quality Flags</axis_name>
            <elements>5</elements>
            <sequence_number>3</sequence_number>
        </Axis_Array>
    </Array_3D>

    <Array_2D>
        <local_identifier>SNRMap</local_identifier>
        <offset unit="byte">30</offset>
        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <description>
            Another array to test the SNR option.
        </description>
        <Element_Array>
            <data_type>UnsignedByte</data_type>
        </Element_Array>
        <Axis_Array>
            <axis_name>Line</axis_name>
            <elements>1</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Sample</axis_name>
            <elements>1</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
        <Special_Constants>
            <error_constant>1</error_constant>
        </Special_Constants>
    </Array_2D>
```

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```
  </File_Area_Observational>

</Product_Observational>
```