Label Design Tool Guide:

Step 0: Preparation

What will the Label Design Tool do for you?

The Label Design Tool helps users create a template label for their archiving needs. This looks and feels exactly like a *real* label that is ready for archiving, but instead we fill it with dummy data. Users can then take the label template and use it in an archiving pipeline to upload their data to the PDS. In this way, we provide the starting point for an archiving process. The tool is designed to allow scientists to make useful XML template labels for their data products with only minimal knowledge of XML and PDS4 standards.

The need for this tool comes from the complexity of both XML language and the PDS4 syntax. Typically, a segment of a PDS4 compliant label will look something like this.

```
<Identification_Area>
        <logical_identifier>urn:nasa:pds:insight_cameras:data:c000m5232t493378259edr_f0000_01
        34m1</logical_identifier>
        <version_id>1.0</version_id>
        <title>INSIGHT CONTEXT CAMERA EDR Observational Product
        c000m5232t493378259edr_f0000_0134m1</title>
        <information_model_version>1.5.0.0</information_model_version>
         <product_class>Product_Observational</product_class>
        <Alias_List>
                    <Alias>
                     <alternate_id>C000M5232T493378259EDR_F0000_0134M1</alternate_id>
                     <comment>VICAR PRODUCT_ID</comment>
                    </Alias>
         </Alias_List>
        <Modification_History>
                <Modification_Detail>
                        <modification_date>2015-11-02</modification_date>
                        <version_id>1.0</version_id>
                        <description>Initial version</description>
                  </Modification_Detail>
         </Modification_History>
 </Identification_Area>
```

Example section of InSight Label

As you can tell, the label is difficult to read and even more difficult to write. It doesn't help that these documents are often 1000 lines long. Before the Label Design Tool (LDT) existed, scientists would have to dedicate dozens of hours to creating these labels for archiving. But no more! We take users through a series of questions and gather all the information needed to create this PDS4 compliant label for you.

How you can be prepared to use the LDT

Using the LDT is simple. You'll be walked through a series of slides that will ask questions about your mission and the associated metadata. Most of these slides will be requesting information about your label. The tool will present you with label items, and you'll have to decide if they apply to your mission. For example, does your mission have more than one name? If so, you need the Alias class in your final label. To make these questions easier, **gather your available metadata into a list**. For example, you may have a specific instance of data and all of the metadata associated with it.

Here is an example of what this list might look like. Let's archive a photo of the original NASA management from 1958.

Nasa Founders 1960

General Identification Information

Mission Title: NASA_Origin
Date: March 1, 1960
Mission Phase: Birth
…

Vehicle Information

Vehicle Info:
VehicleName: Doug_CameraMan
VehicleAge: 33
VehicleMood: Ecstatic
VehiclePosition: Standing
…

Instrument Information

Camera Info:
CameraName: Dougs_Polaroid
CameraTemp: 55 degrees
Camera_Angle: 1 radian
…

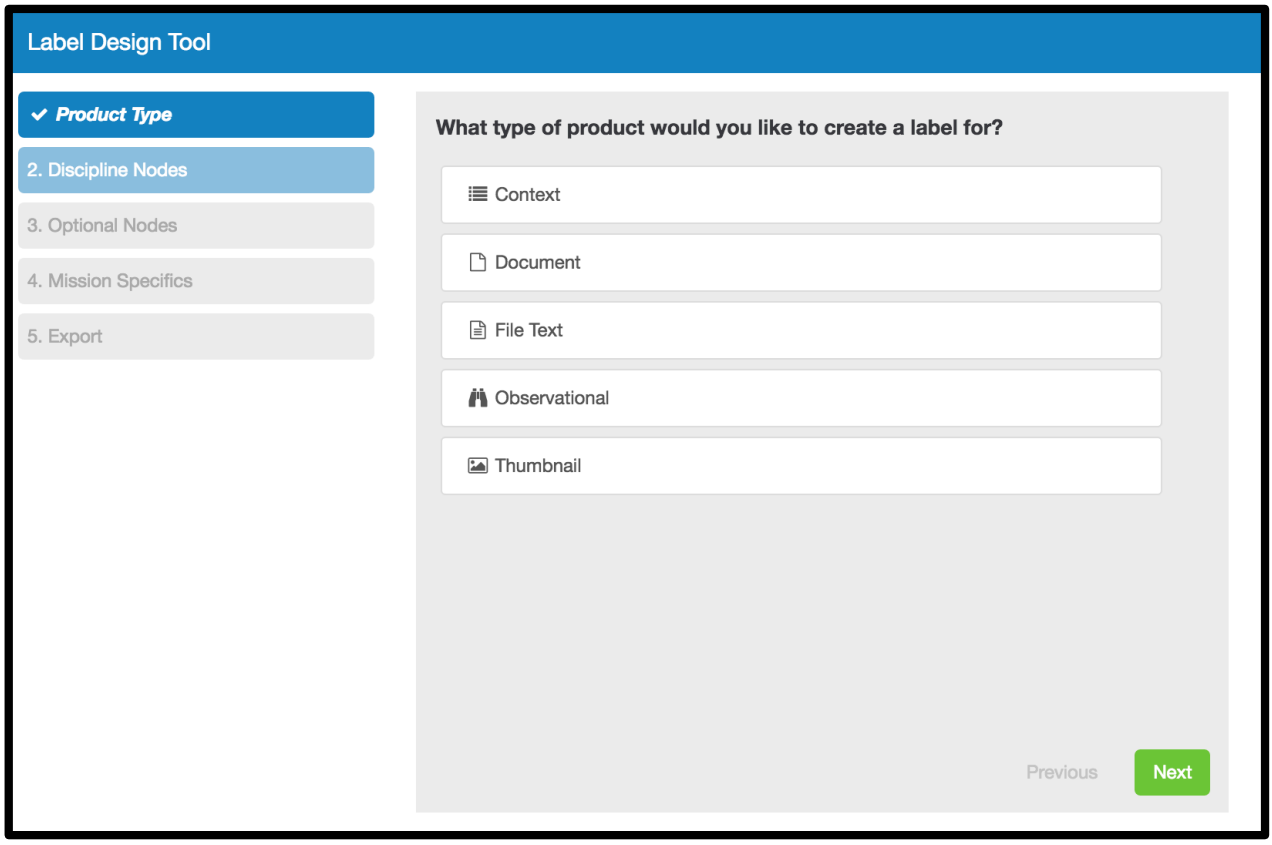
Data Product Information

Image Info:
Size: 500x500 pixels
Filter: None
Color: Black and White
…

Note the way I've divided the metadata into themes. Sketch your metadata similarly, because the LDT will also handle the label in segments divided by subject matter. As you move through the LDT, you'll have a working reference for each question about your label. I cannot overstate the value of this step. If you don't have a sketch, you run a higher risk of making a mistake and having to design a label again or edit the XML yourself.

But If you have a sketched list of metadata on an example product, you'll soar through the Label Design Tool like a pro! And if you're having a hard time deciding what metadata you should have, then check out some sample labels at the NASA PDS4 Example site. https://pds.nasa.gov/pds4/doc/examples/

Step 1: Product Type Selection



It's time to start making labels! The first step in the label design process is picking your archiving product. This decision will shape the general requirements of your label from the PDS. In general, our users need Product Observational. The Product Observational type covers all types of data products that provide science data. Other product types describe the context of data, the structure of the archive, the search interface thumbnail, or custom text. For more information on these labels, please view the Data Providers Handbook.

What is going on?
(Optional—Curious Users Only)

Let me start by saying that you don't need to know the PDS4 structure and the role of product types. That's what the LDT is for! But, if you're intrigued by the field of data management (like we are) then let's dive in!

First, note that product labels are written in XML, a mark-up language with a formal syntax and structure defined by other files called *schemas* and *schematrons.*

Product types are the most general classifications of labels in the Planetary Data System. The product type selection determines the general structure of a label. For example, when a product observational is selected, we know the label will have the form:

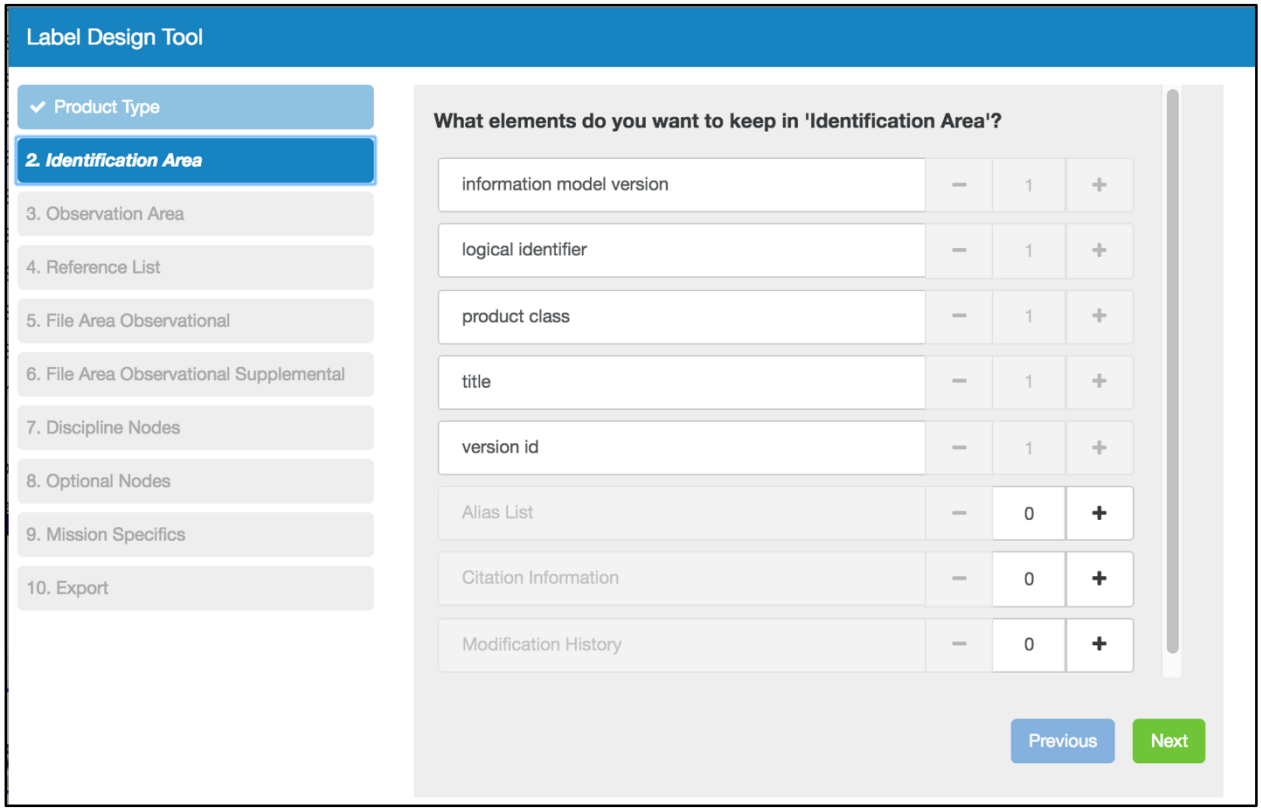
- XML Prolog
  - Provides a declaration that the label is an XML versioned document
  - Identifies the schema and Schematron files against which the label is validated
- Root Tag (Product_Observational)
  - Provides a declaration of the root XML of the label. The Root Tag is based on the product type—for example, Product_Observational
  - Identifies the namespaces used in the label (i.e., the 'pds' namespace and any discipline or mission namespaces) including the associated schemas
- Identification Area
  - Provides identification information specific to the product (the Logical Identifier and the Version Identifier, the information model version, the product class, etc.)
  - Provides citation information specific to the product
  - Provides modification history specific to the product
- Observation Area
  - Provides information about the investigation, instrument, target, times, etc.
  - Includes subsections for relevant classes specific to one or more discipline nodes, and to the mission (or an equivalent namespace)
- Reference List Area
  - Provides identification information for products, journal articles, etc., relecant to understanding the product. References may be made to sources both internal and external to PDS.
- File Area
  - Identifies the file(s) containing the digital object(s), and
  - Provides classes specific to each digital object in a given file (e.g., the description and parameters of each header, table, image).

Structure of Product Observational
See Data Providers Handbook

With the exception of minor changes, this is the format for all Observational Product Labels. When a user selects product observational, we load up a generic label of this form and we start editing it in the coming steps.

Let's move on!

Step 2: Optional Nodes



Now that we've got the general structure of our label, we need to start customizing the label to suit your data products.

The numbers represent the occurrences of an item on your label. Items that are gray (Alias List, Citation Information, Modification History in the above example) have zero occurrences in your final label. Items with the number colored gray (Information Model Version, Logical Identifier, Product Class, Title, Version ID in the above example) have a fixed number of occurrences in your label. At each step between Product Type

Selection and Discipline Node Selection, you will be making these decisions across different sections of your label.

Think of each label item individually. Hover your mouse over the term for tooltips and descriptions. You can see the information contained in the attribute, including the sub-attributes the element may contain.

You have to ask yourself: Do I have this piece of data? Could this be relevant to my mission? Then select the number of occurrences necessary to have a comprehensive understanding of the data products. **When in doubt, include an item.** It's far easier to trim down a sample label with too much than it is to find the attributes needed for an incomplete label.

In short, there's some customization allowed within the general product label. In these steps you will be customizing the general section of your label. Then next we will move on to the same process for discipline-specific label elements!

What is going on?
(Optional —Only for Curious Users)

Once again, you can skip this section. It's not necessary for navigating the Label Design Tool. But for those interested, I'll describe the optional node selection step of the LDT.

First, we parse through the schema of the PDS node and find the boundaries on occurrences.

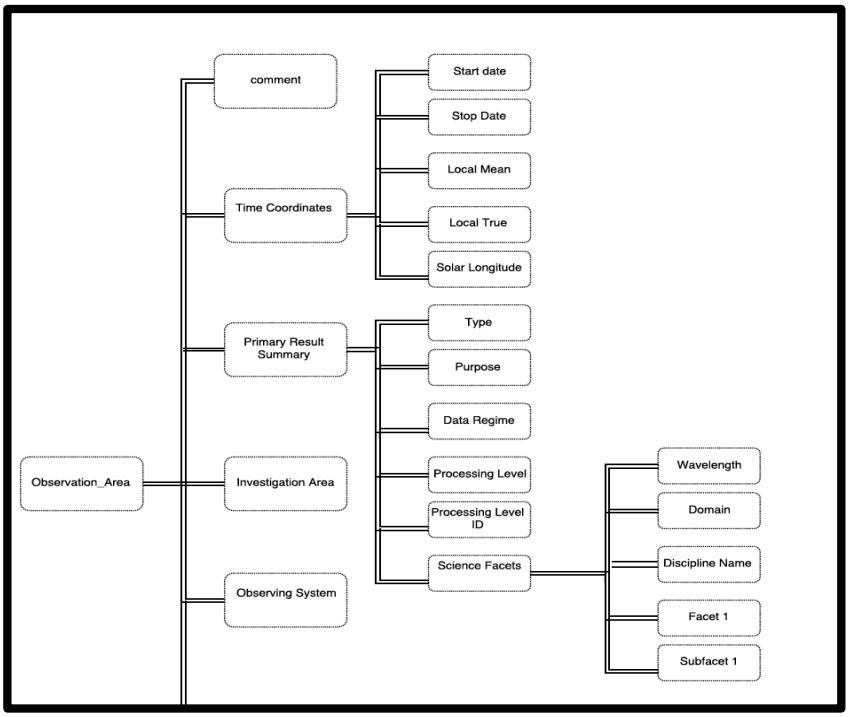
```
<xs:complexType name="Identification_Area">
<xs:annotation>
<xs:documentation>
The identification area consists of attributes that identify and name an object.
</xs:documentation>
</xs:annotation>
<xs:sequence>
        <xs:element name="logical_identifier" type="pds:logical_identifier" minOccurs="1"maxOccurs="1"></xs:elem
ent>
        <xs:element name="version_id" type="pds:version_id" minOccurs="1" maxOccurs="1"></xs:element>
        <xs:element name="title" type="pds:title" minOccurs="1" maxOccurs="1"></xs:element>
        <xs:element name="information_model_version" …minOccurs="1" maxOccurs="1"></xs:element>
        <xs:element name="product_class" type="pds:product_class" minOccurs="1"maxOccurs="1"></xs:element>
        <xs:element name="Alias_List" type="pds:Alias_List" minOccurs="0" maxOccurs="1"></xs:element>
        <xs:element name="Citation_Information" type="pds:Citation_Information"minOccurs="0" maxOccurs="1"><
/xs:element>
        <xs:element name="Modification_History" type="pds:Modification_History"minOccurs="0" maxOccurs="1"><
/xs:element>
</xs:sequence>
</xs:complexType>
```

Section of PDS4 Schema Version 1600
https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1600.xsd

Note the green highlighted sections. These are the variables that define how many of each label item can occur in the label. We use these numbers to control to what extent you can customize the label. We then move through each of the “complex-types” (see the yellow) in the entire PDS standard schema, and we allow you to customize the number of occurrences of each attribute.

Although, the process of moving through the PDS schema is itself a challenge. Attributes can contain other attributes within them. We use the term “complex” to refer to a label attribute with multiple attributes within it. “Simple” attributes are label items with only a single value represented. This naturally lends itself to a tree structure with branches representing nesting of attributes within one another.

We move through the tree structure by class type first. The user selects attributes from the most general (containing a group of attributes) down to the simplest types. For example, a section of the tree is below.



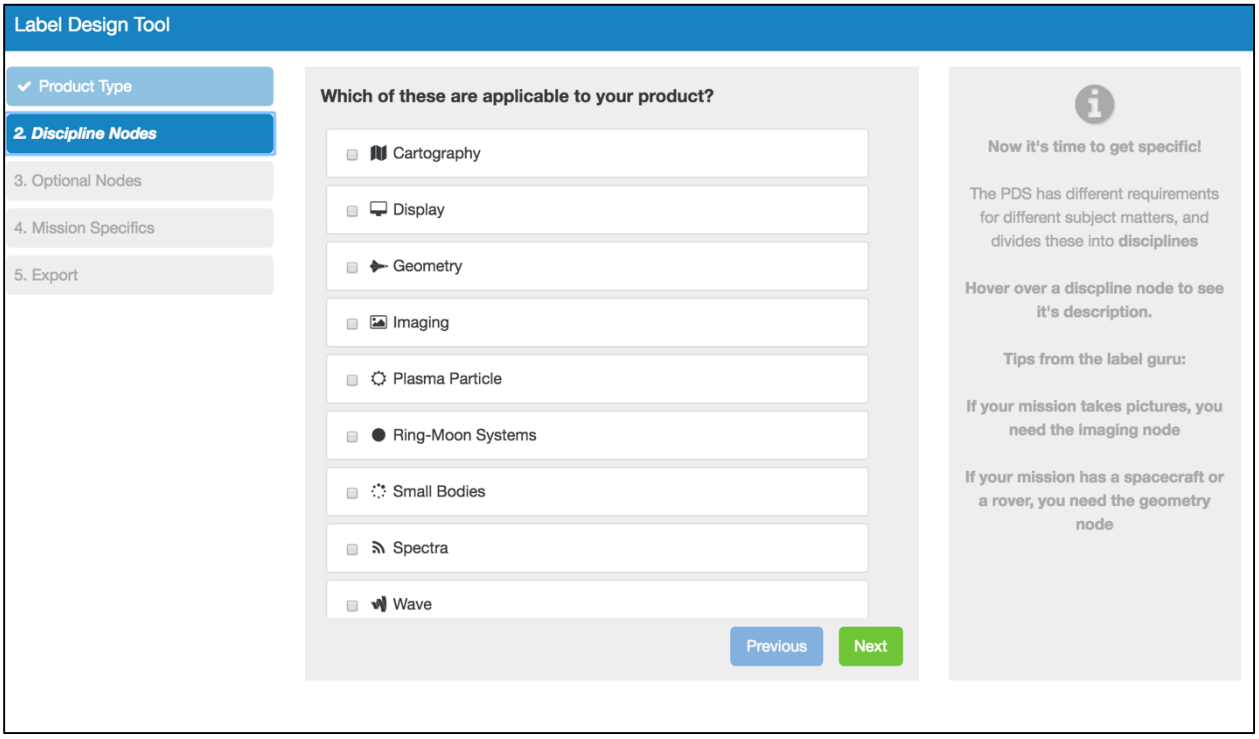
Tree Representation of Observation Area

In this example, our software presents the user with the classes “comment”, “Time Coordinates”, “Primary Result Summary”, “Investigation Area”, and “Observing System”. Comment is optional, and so users will be able to remove it at this page or add as many comments as the user likes. Time Coordinates and Primary Result Summary are required and have a maxOccurs of 1, so the user will be unable to customize the number of these attributes. Investigation Area has minOccurs=1 and maxOccurs= “unbounded” so the user will be able to add more occurrences of Investigation area but will not be able to remove it.

Then after the page displaying options for this level (second level above) the user will advance to customizing within the “Time Coordinates” class. Then the user will move on to customizing within the “Primary Result Summary” class. We call this method “class-first” traversing because the most general classes are visited by the user first. After iterating through the optional classes, it’s time to get more specific to your data products.

Step 3: Discipline Node Selection

Many elements of a mission are captured by the general PDS label requirements. However, the PDS cannot generalize labels to all data products and missions. Some missions study comets and need label elements related to small bodies. Other missions study planets and need label elements related to planets. Pictures and movies need certain metadata, and spectral analyses need other metadata. To handle the differences across missions, the PDS has created *discipline nodes* which contain label elements for different types of data products and missions. For example, rather then each mission with images create a different set of metadata for their images, the PDS prefers if all missions with images implement the same label structure and contains the same metadata. This is the *Imaging Node*. At this step of the process, you will choose which discipline nodes are the most relevant to you.



Discipline Node Selection

Select all of the disciplines that apply. Here are short descriptions on the disciplines and when they may apply.

- Geometry: The Geometry Discipline contains meta-data relating to flight paths of space crafts and the paths of rovers. If your mission involves the movement of any kind of vehicle, you need the geometry discipline. Classes include references to the SPICE kernel for a spacecraft as well as rover navigation.

- Imaging and Cartography: Contains meta-data relating to any images. This includes filters, bands, angles of cameras, temperature of cameras, etc. If your data involves any pictures at all, odds are you need the imaging discipline. Larger classes include metadata such as the temperature of imaging instruments, the angles of joints at the time of capture, and event the software used to generate an imaging product.

- Small Bodies: Contains metadata on objects that qualify as small bodies. Asteroids, comets, dust, or anything that isn't in solar orbit

- Planetary Plasma Interactions: Contains information on the interaction between the solar wind and planetary winds with planetary magnetospheres, ionospheres and surfaces.

- Display: Contains the details about how to display data on a device. For example, if you have movie data, then you need the Display node to explain how to use software to view the movie.

- Spectra: Contains detail about presenting data in any kind of spectrum

- Waves: The Wave dictionary contains classes that describe the composition of multidimensional wave data consisting of Array (and Array subclass) data objects

After selecting your discipline nodes, we will begin iterating through the classes in the same way as in the optional-node step. We will start by asking about the major classes of the discipline nodes and then iterate into the child attributes. Just as in the earlier steps, the best way to be prepared is to have a list of the meta-data you need to include on your label.

What is going on?
(Optional — Only for Curious Users)

This step is very similar to the previous steps both in user action and in back-end functionality. To start, you chose a product type and then customized the general structure in an optional element step. Now you've chosen a new set of requirements in each discipline node. For each applicable node there is a separate XML schema specifying the label's structure and mandated contents.

First we download the Schema and Schematron for every selected discipline node. We then generate a maximal-template label from those Schemas and Schematrons. My maximal-template, I mean we generate the most inclusive label possible.Then, just as in the optional node step before, we iterate through the template labels and present the user with the ability to remove/duplicate label items within the bounds specified in the Schema. Finally, we include the selected disciplines and the associated namespaces in the prologue of the label so that the label can be validated against the newly included schemas.

Step 4: Mission Specific Dictionary

Finally, it's time to finish the label. We've added all the general structure, from identification down to the specific discipline your data falls into. Now you can add the final elements in a *Mission Specific Dictionary*. The PDS knows that disciplines and general identification will certainly miss some key pieces of metadata about your mission. To handle this issue, the PDS allows for the creation of a set of metadata elements called a Mission Specific Dictionary. We then can include the Mission Specific Dictionary in the final label product (and even generate a schema for you to validate future labels against).

Take a look at the Mission-Specific section of this InSight label.

```
<Mission_Area>
        <insight:Observation_Information>
                <insight:release_number>1</insight:release_number>
                <insight:mission_phase_name>TEST</insight:mission_phase_name>
                <insight:product_type>EDR</insight:product_type>
                <insight:spacecraft_clock_start_count>492849479.32814</insight:spacecr
        aft_clock_start_count>
                insight:spacecraft_clock_stop_count>492849481.09591</insight:spacecra
        ft_clock_stop_count>
                <insight:spacecraft_clock_count_partition>1</insight:spacecraft_clock_co
        unt_partition>
                <insight:sol_number>-399</insight:sol_number>
                <insight:local_true_solar_time_sol>-
399</insight:local_true_solar_time_sol>
                <insight:sequence_id>0427</insight:sequence_id>
                        </insight:Observation_Information>
</Mission_Area>
```

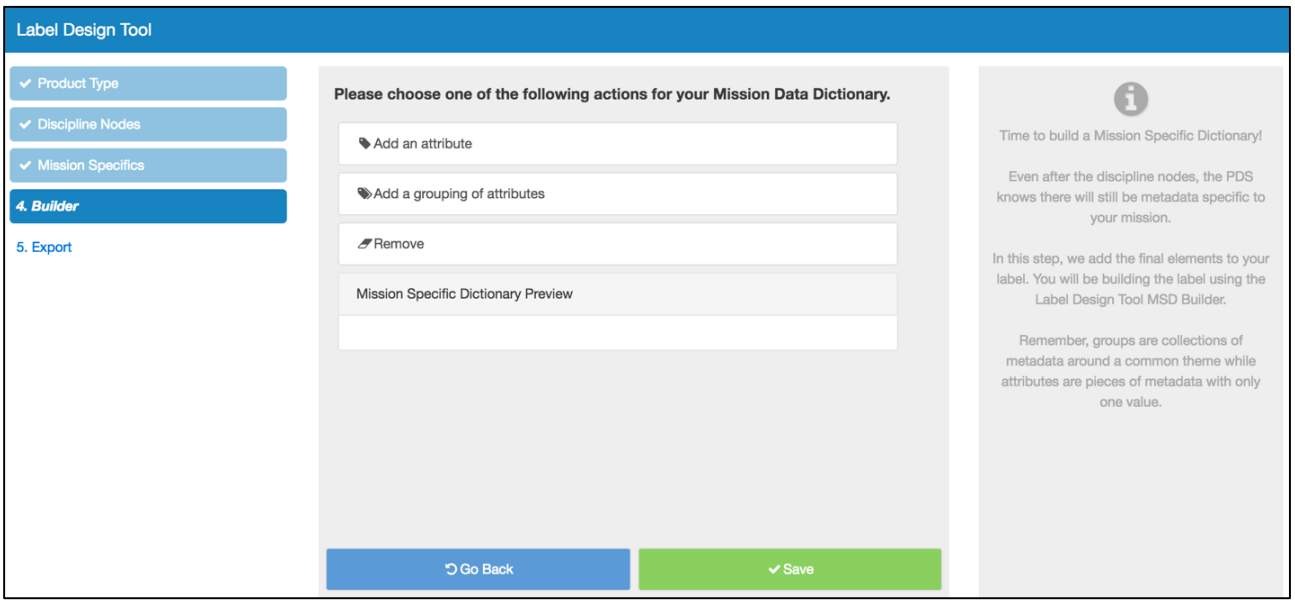
Example of InSight Label-Mission Area

In pink is the namespace for the mission. In the MSD step, you will need to signify an abbreviation that will represent your mission specific components in the label. As you can see, often this is simply the mission name.

In green is the only *class* InSight decided to implement. A class is a grouping of similar elements. In this case, InSight felt all the metadata they had left fit under the group "Observation Information."

In yellow are the attributes themselves. All of these attributes are stored within the Observation Area in this example.

These highlighted areas are the only label elements you'll need to input for your MSD. In order to make this step as easy as possible, sketch out the structure of your MSD. Think about which attributes you need to include. Ask questions: can you group them into classes for a better understanding? Do I have every piece of relevant metadata? After you're ready, it's time to start using the MSD Builder tool to develop your own Mission Specific Dictionary.



Mission Dictionary Builder Interface

First, create any classes you'd like to have, and designate their titles and descriptions. So if your planned MSD label elements looks like

Class: Group_Foo
Foo_Item1
Foo_Item2

Class: Group_Bar
Bar_Item2
Bar_Item2

Then you would first create the classes "Group_Foo" and "Group_Bar" by using the "Add a grouping of attributes" button. After creating these classes and providing descriptions, begin to make the attributes that fill out your classes.

As you click the "Add an attribute" button and provide the names, descriptions, and class-container of you attributes, your classes will be filled with attributes. You can even see the MSD being built in the Mission Specific Dictionary Preview window.

After you've finished the MSD and the preview shows the structure you want, advance to the final step and download your label!

What is going on?
(Optional—Only for Curious Users)

The PDS doesn't have a schema for mission specific dictionaries. Instead, all MSD's are verified by a PDS representative. Therefore, in the MSD step we simply build a template label that can be understood and serve as a starting point for the PDS representative.

We store the attributes and classes in the "##other" area of the PDS label under Mission Area. This is precisely where the PDS calls for the Mission Specific section to be in a label. However, we do not (at this time) generate a schema from the MSD to validate your label against.

Step 6: Download

Download your label and send it over to your PDS representative. Congratulations on your new label!