Example Namespace

NASA Planetary Data System

Dec 21, 2023

USER GUIDE

Short abstract for the namespace should go here

CHAPTER

ONE

INTRODUCTION

This *User's Guide* provides a brief overview of the New Horizons Mission (NH or "nh:") namespace for those working with data from New Horizons primary or extended missions. The primary New Horizons mission was to the Pluto system. The extended missions to date have been called the "Kuiper Belt Extended Missions 1 and 2", or "KEM1" and "KEM2", in the mission documentation and metadata.

> **Note** *that the New Horizons legacy data migration is in its early stages, with labels being designed for each instrument in turn. This namespace is in active development and will continue to be so for the forseeable future.*

Data from the primary and first extended ("KEM1") missions were archived in PDS3 format and migration is underway to convert the legacy data into PDS4. These migrated products will also serve as templates for the second extended ("KEM2") mission, which will be delivered in PDS4 format.

This guide presents the major features of the namespace.

CHAPTER

TWO

OVERVIEW OF THE NEW HORIZONS (NH) MISSION DICTIONARY

Short abstract for the namespace should go here

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

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

CHAPTER

THREE

ORGANIZATION OF CLASSES AND ATTRIBUTES

The New Horizons dictionary has a single top-level class that must be used to access any of the NH metadata classes. Below that, there are major subclasses for metadata that is common to all (or multiple instruments), as well as classes specific to particular instruments. Processed and calibrated data will generally have additional classes to provide instrument-specific processing details.

The following sections describe the major divisions of the New Horizons Mission namespace, in the order in which they occur in the schema (and thus, labels).

3.1 Top-Level Class: <nh:Mission_Parameters>

The *<nh:Mission_Parameters>* class acts as a wrapper for all other NH classes. It contains one required attribute and (as of this writing) two optional classes for data specific to the Multispectral Visible Imaging Camera (MVIC) part of in the Ralph instrument package.

The class contains a single required attribute, *<nh:mission_phase>*, with the string identifying the mission phase. Mission phase names are unique to the primary or extended mission in which they occur. Specifically, the phases in the extended missions contain the extended mission acronym ("KEM1 Encounter", for example).

The major subclasses of the *<nh:Mission_Parameters>* class are:

- *<nh:Observation_Parameters>*
- *<nh:MVIC_Calibration_Information>*
- *<nh:MVIC_Converstion_Constants>*

You can see a complete outline of the namespace under the *New Horizons Mission Namespace Outline* topic.

3.2 Subclass: <nh:Observation_Parameters>

The *<nh:Observation_Parameters>* class provides details specific to the New Horizons mission and the instrument used to make the observation comprising the data product. It provides three attributes and two classes. As in the PDS common namespace, in the NH dictionary attributes names are all lowercase; class names are in title case.

This class contains:

- <nh:telemetry_appid>
- <nh:sequence_id>
- <nh:observation_description>
- <nh:Mission_Elapsed_Time>

- <nh:Detector>

None of these components is repeatable; all are expected to be present in all raw and processed/calibrated data labels.

<nh:telemetry_appid>, <nh:sequence_id>, and <nh:observation_description> These attributes are provided primarily for provenance and to provide some minimal description of planned activities for the end user. The *nh:telementry_appid* is tied to instrument operating mode and to onboard processing like data compression. The mission documentation for each instrument will provide further detail if desired. The *<nh:sequence_id>* ties into the instrument observing plan, and the codes comprising that ID are roughly translated into something approaching English in the *<nh:observation_description>* string.

<nh:Mission_Elapsed_Time> The *<nh:Mission_Elapsed_Time>* class provides the spacecraft clock partition and count at the start and end of the observation comprising the data product. The translation from spacecraft clock to UTC is dependent on the hardware and is usually described in the mission documentation. Many missions and end-users use the publicly available Navigation and Ancillary Information (NAIF) Toolkit to perform this conversion.

<nh:Detector> The *<nh:Detector>* class identifies the detector used to make the observation, and includes classes to provide detector-specific parameters. "Detector" may mean an instrument, or it may mean literally one of several detectors available within an instrument (as is the case of the MVIC instrument, for example). This class will contain detector-specific subclasses where needed to provide specific observational settings for the detector.

3.3 Subclass: <nh:MVIC_Calibration_Information>

The *<nh:MVIC_Calibration_Information>* class is used in labels for processed data from all seven MVIC detectors. It provides detector-specific quantities used in processing the data, and in the case of the MVIC framing camers, it provides the specific left- and right-side biases used to process each frame.

This class contains:

- <nh:physical_pixel_size>
- <nh:read_noise>
- <nh:gain>
- <nh:tdi_median_bias_level>
- <nh:Framing_Biases>

<nh:physical_pixel_size>, <nh:read_noise> and <nh:gain> The *<nh:physical_pixel_size>* value is constant for all pixels on all MVIC detectors. It is provided explicitly for the convenience of users further analyzing to the data. The *<nh:read_noise>* and *<nh:gain>* are also provided for all MVIC observations.

<nh:tdi_median_bias_level> The *<nh:tdi_median_bias_level>* appears only in processed time delay integration (TDI) observations, from the color channels and the two panchromatic TDI channels. Bias levels for the TDI channels are determined during cruise operations and may be updated through the course of the mission.

<nh:Framing_Biases> The *<nh:Framing_Biases>* class only appears in processing sequences from the MVIC framing array. It contains one *<nh:Frame_Bias_Levels>* class for each frame comprising the observation that identifies the frame by number and lists the left- and right-side bias levels applied in processing that particular frame. For framing observations, bias is measured during each observations using shielded pixels on either edge of the array.

3.4 Subclass: <nh:MVIC_Conversion_Constants>

The *<nh:MVIC_Conversion_Constants>* class is used in labels for processed data from all seven MVIC detectors. The MVIC pipeline does not produce "calibrated" data in the sense that PDS defines "calibrated" - specifically, "Data reduced to physical units". The final reduction step depends on both the spectal characteristics of the target and whether that target is resolved. Instead, the calibration documentation provided with the archive includes formulae for applying the absolute calibration for specific targets, and the constants needed to plug into the formulae are provided in this class.

This class contains:

- <nh:pivot_wavelength>
- <nh:Resolved_Source>
- <nh:Unresolved_Source>

<nh:pivot_wavelength> The *<nh:pivot_wavelength>* attribute contains the pivot wavelength of the filter/dectector combination.

<nh:Resolved_Source> The *<nh:Resolved_Source>* class provides the units of measure (units of radiance, in the case of resolved targets) applicable to the resulting pixel values. Other attributes contain the conversion constants for five targets:

- The Sun
- Jupiter
- (5145) Pholus, a centaur
- Pluto
- Charon

<nh:Unresolved_Source> The *<nh:Unresolved_Source>* class provides the units of measure (units of irradiance, in the case of unresolved targets) applicable to the resulting pixel values. Other attributes contain the conversion constants for five targets:

- The Sun
- Jupiter
- (5145) Pholus, a centaur
- Pluto
- Charon

CHAPTER

FOUR

NEW HORIZONS MISSION NAMESPACE OUTLINE

<nh:Mission_Parameters> is the public entry point to the New Horizons Mission namespace. This class contains all other NH classes and must be included to gain access to them. Below is a summary outline of all classes and attributes currently available in the NH mission dictionary, in the order in which they would appear in a label if every single one was used.

Note that there are no real cases in which every single mission class and attribute would appear in a single label. The point of this outline is primarily to catalog what is present and show the required ordering within classes when they are included in a label.

```
<nh:Mission_Parameters>
    <nh:mission_phase_name>

    <nh:Observation_Parameters>
        <nh:telemetry_apid>
        <nh:sequence_id>
        <nh:observation_description>

        <nh:Mission_Elapsed_Time>
            <nh:clock_parition>
            <nh:start_clock_count>
            <nh:stop_clock_count>

        <nh:Detector>
            <nh:detector_name>
            <nh:detector_type>

            <nh:MVIC_Details>
                <nh:scan_type>
                <nh:tdi_rate>

    <nh:MVIC_Calibration_Information>
        <nh:physical_pixel_size>
        <nh:read_noise>
        <nh:gain>
        <nh:tdi_median_bias_level>

        <nh:Framing_Biases>
            <nh:Frame_Bias_Levels>
                <nh:frame_number>
                <nh:left_side_median_bias>
                <nh:right_side_median_bias>
```

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```
<nh:MVIC_Conversion_Constants>
    <nh:pivot_wavelength>

    <nh:Resolved_Source>
        <nh:units_of_conversion_constants>
        <nh:solar_constant>
        <nh:jupiter_constant>
        <nh:pholus_constant>
        <nh:pluto_constant>
        <nh:charon_constant>

    <nh:Unresolved_Source>
        <nh:units_of_conversion_constants>
        <nh:solar_constant>
        <nh:jupiter_constant>
        <nh:pholus_constant>
        <nh:pluto_constant>
        <nh:charon_constant>
```

CHAPTER

FIVE

ALPHABETICAL LIST OF CLASSES

A complete list of all classes in the New Horizons Mission 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 New Horizons Mission class list, look down the list of (alphabetically sorted) dictionary prefixes in the left menu for "Classes in the nh 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 New Horizons Mission 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 New Horizons Mission attribute list, look down the list of (alphabetically sorted) dictionary prefixes in the left menu for "Attributes in the nh 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:

```
<nh:tdi_rate unit="Hz">40.4694</nh:tdi_rate>
```

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

MOCKUP LABEL: MVIC RED CHANNEL, PROCESSED DATA

This label is a mockup created for design purposes during the migration planning for the MVIC data. The test data file contained processed data from a TDI observation through the MVIC Red Channel (identified as "mc0" in file names).

The mockup shows the entire <*Product_Observationsl*> structure including the New Horizons dictionary classes, which are found in the <*Mission_Area*> of the structure.

> **Note** that the versions of both the New Horizons (nh:) and Small Bodies (sb:) shown here are pre-release. Consult the current release documentation for changes to these namespaces-in-development before attempting and real-would applications.

```
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:disp="http://pds.nasa.gov/pds4/disp/v1"
  xmlns:geom="http://pds.nasa.gov/pds4/geom/v1"
  xmlns:img="http://pds.nasa.gov/pds4/img/v1"
  xmlns:sb="http://pds.nasa.gov/pds4/sb/v0"
  xmlns:nh="http://pds.nasa.gov/pds4/mission/nh/v1"
  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/disp/v1 https://pds.nasa.gov/pds4/disp/v1/PDS4_DISP_1J00_1510.
↪xsd
  http://pds.nasa.gov/pds4/geom/v1 https://pds.nasa.gov/pds4/geom/v1/PDS4_GEOM_1J00_1970.
↪xsd
  http://pds.nasa.gov/pds4/img/v1  https://pds.nasa.gov/pds4/img/v1/PDS4_IMG_1J00_1870.
↪xsd
  http://pds.nasa.gov/pds4/sb/v0   https://pds.nasa.gov/pds4/sb/v0/PDS4_SB_1J00_0100.xsd
  http://pds.nasa.gov/pds4/mission/nh/v1 https://pds.nasa.gov/pds4/mission/nh/v1/PDS4_NH_
↪1J00_1000.xsd">

  <Identification_Area>
      <logical_identifier>urn:nasa:pds:nh_mvic:kem1_cal:mc0_0408625487_0x545_sci</
↪logical_identifier>
      <version_id>1.0</version_id>
      <title>New Horizons MVIC Red Channel Observation mc0_0408625487_0x545_sci␣
↪(Processed Data)</title>
      <information_model_version>1.19.0.0</information_model_version>
      <product_class>Product_Observational</product_class>

      <Modification_History>
          <Modification_Detail>
              <modification_date>2022-12-26</modification_date>
```

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```
            <version_id>1.0</version_id>
            <description>
                A.C.Raugh: Migrated from PDS3 product NH-A-MVIC-3-KEM1-V6.0:MC0_
↪0408625487_0X545_SCI
            </description>
        </Modification_Detail>
    </Modification_History>
 </Identification_Area>

 <Observation_Area>
    <Time_Coordinates>
        <start_date_time>2019-01-01T05:12:55.280Z</start_date_time>
        <stop_date_time>2019-01-01T05:14:34.148Z</stop_date_time>
    </Time_Coordinates>

    <Primary_Result_Summary>
        <purpose>Science</purpose>
        <processing_level>Partially Processed</processing_level>
        <Science_Facets>
            <wavelength_range>Visible</wavelength_range>
            <discipline_name>Imaging</discipline_name>
            <facet1>Grayscale</facet1>
        </Science_Facets>
    </Primary_Result_Summary>

    <Investigation_Area>
        <name>New Horizons Kuiper Belt Extended Mission 1</name>
        <type>Mission</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:investigation:mission.new_horizons_kem1
↪</lid_reference>
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>

    <Observing_System>
        <Observing_System_Component>
            <name>New Horizons Spacecraft</name>
            <type>Host</type>
            <Internal_Reference>
                <lid_reference>urn:nasa:pds:context:instrument_host:spacecraft.nh</lid_
↪reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <!-- There is no "Instrument Package" in PDS4 as yet
        <Observing_System_Component>
            <name>RALPH</name>
            <type>Instrument Package</type>
            <description>
                RALPH is an instrument package supporting two independent instrument,
                the Multispectral Visible Imaging Camera (MVIC) and the Linear Etalon
```

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```
                Imaging Spectral Array (LEISA), that share a boresight, a focal plane,
                and electronics. Detectors and pipeline processing are unique to each
                instrument.
            </description>
        </Observing_System_Component>
        -->
        <Observing_System_Component>
            <name>Multispectral Visible Imaging Camera (MVIC)</name>
            <type>Instrument</type>
            <description>
                Note that the MVIC instrument has seven distinct detectors, identified␣
↪by
                the "nh:Detector" class metadata.
            </description>
            <Internal_Reference>
                <lid_reference>urn:nasa:pds:context:instrument:nh.mvic</lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>

    <Target_Identification>
        <name>(486958) Arrokoth</name>
        <alternate_designation>2014 MU69</alternate_designation>
        <type>Trans-Neptunian Object</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:target:trans-neptunian_object.486958_
↪2014_mu69</lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>

    <Mission_Area>
        <nh:Mission_Parameters>
            <nh:mission_phase_name>KEM1 Encounter</nh:mission_phase_name>
            <nh:Observation_Parameters>
                <nh:telemetry_apid>0x545</nh:telemetry_apid>
                <nh:sequence_id>KEMV_MU69_CA05_HIRES_MC_2019001</nh:sequence_id>
                <nh:observation_description>MVIC Color CA Scan, LORRI Rider</
↪nh:observation_description>
                <nh:Mission_Elapsed_Time>
                    <nh:clock_partition>3</nh:clock_partition>
                    <nh:start_clock_count>0408625493:06600</nh:start_clock_count>
                    <nh:stop_clock_count>0408625592:00000</nh:stop_clock_count>
                </nh:Mission_Elapsed_Time>
                <nh:Detector>
                    <nh:detector_name>MVIC Red (RED) Channel</nh:detector_name>
                    <nh:detector_type>CCD</nh:detector_type>
                    <nh:MVIC_Details>
                        <nh:scan_type>TDI - Time Delay Integration Mode</nh:scan_type>
                        <nh:tdi_rate unit="Hz">40.4694</nh:tdi_rate>
                    </nh:MVIC_Details>
```

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```
                </nh:Detector>
            </nh:Observation_Parameters>
            <nh:MVIC_Calibration_Information>
                <nh:physical_pixel_size unit="micrometer">13.0000</nh:physical_pixel_
↪size>
                <nh:read_noise>30.000</nh:read_noise>
                <nh:gain unit="electron/DN">58.6000</nh:gain>
                <nh:tdi_median_bias_level unit="DN">25</nh:tdi_median_bias_level>
            </nh:MVIC_Calibration_Information>
            <nh:MVIC_Conversion_Constants>
                <nh:pivot_wavelength unit="micrometer">0.624</nh:pivot_wavelength>
                <nh:Resolved_Source>
                    <nh:units_of_conversion_constants>(DN/s)/(erg/cm^2/s/Angstrom/sr)</
↪nh:units_of_conversion_constants>
                    <nh:solar_constant>30910.883</nh:solar_constant>
                    <nh:jupiter_constant>32852.793</nh:jupiter_constant>
                    <nh:pholus_constant>32509.977</nh:pholus_constant>
                    <nh:pluto_constant>30908.678</nh:pluto_constant>
                    <nh:charon_constant>30856.479</nh:charon_constant>
                </nh:Resolved_Source>
                <nh:Unresolved_Source>
                    <nh:units_of_conversion_constants>(DN/s)/(erg/cm^2/s/Angstrom)</
↪nh:units_of_conversion_constants>
                    <nh:solar_constant>7.880E+13</nh:solar_constant>
                    <nh:jupiter_constant>8.375E+13</nh:jupiter_constant>
                    <nh:pholus_constant>8.287E+13</nh:pholus_constant>
                    <nh:pluto_constant>7.879E+13</nh:pluto_constant>
                    <nh:charon_constant>7.866E+13</nh:charon_constant>
                </nh:Unresolved_Source>
            </nh:MVIC_Conversion_Constants>
        </nh:Mission_Parameters>
    </Mission_Area>

    <Discipline_Area>
        <disp:Display_Settings>
            <Local_Internal_Reference>
                <local_identifier_reference>Image</local_identifier_reference>
                <local_identifier_reference>ErrorEstimate</local_identifier_reference>
                <local_identifier_reference>Quality</local_identifier_reference>
                <local_reference_type>display_settings_to_array</local_reference_type>
            </Local_Internal_Reference>
            <disp:Display_Direction>
                <disp:horizontal_display_axis>Sample</disp:horizontal_display_axis>
                <disp:horizontal_display_direction>Left to Right</disp:horizontal_
↪display_direction>
                <disp:vertical_display_axis>Line</disp:vertical_display_axis>
                <disp:vertical_display_direction>Bottom to Top</disp:vertical_display_
↪direction>
            </disp:Display_Direction>
        </disp:Display_Settings>

        <img:Exposure>
```

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```
            <img:exposure_duration unit="s">0.79072</img:exposure_duration>
        </img:Exposure>
        <img:Onboard_Compression>
            <img:onboard_compression_class>Lossless</img:onboard_compression_class>
        </img:Onboard_Compression>

        <geom:Geometry>

            <geom:comment>
                Note that the geometry parameters in this label were calculated by the
                mission using an unpublished kernel set still in development at the␣
↪time
                of archiving. These parameters are based on "predict geometry", which␣
↪is
                generally not as accurate as metadata available at a later date.
            </geom:comment>

            <geom:Image_Display_Geometry>
                <geom:geometry_reference_time_utc>2019-01-01T05:13:44.714Z</
↪geom:geometry_reference_time_utc>
                <Local_Internal_Reference>
                    <local_identifier_reference>Image</local_identifier_reference>
                    <local_reference_type>display_to_data_object</local_reference_type>
                </Local_Internal_Reference>
                <geom:Geometry_Target_Identification>
                    <geom:body_spice_name>2486958</geom:body_spice_name>
                    <geom:name>(486958) Arrokoth</geom:name>
                </geom:Geometry_Target_Identification>
                <geom:Object_Orientation_RA_Dec>
                    <geom:reference_pixel_location>Center</geom:reference_pixel_
↪location>
                    <geom:right_ascension_angle unit="deg">276.8</geom:right_ascension_
↪angle>
                    <geom:declination_angle unit="deg">-33.8</geom:declination_angle>
                    <geom:celestial_north_clock_angle unit="deg">351.57838</
↪geom:celestial_north_clock_angle>
                    <geom:Reference_Frame_Identification>
                        <geom:name>EME J2000</geom:name>
                    </geom:Reference_Frame_Identification>
                </geom:Object_Orientation_RA_Dec>
                <geom:Object_Orientation_Clock_Angles>
                    <geom:target_positive_pole_clock_angle unit="deg">264.7</
↪geom:target_positive_pole_clock_angle>
                    <geom:sun_direction_clock_angle unit="deg">133.8</geom:sun_
↪direction_clock_angle>
                </geom:Object_Orientation_Clock_Angles>
                <geom:Quaternion_Plus_To_From>
                    <geom:qcos>0.3391999442067836</geom:qcos>
                    <geom:qsin1>0.5793975569923115</geom:qsin1>
                    <geom:qsin2>0.3215769780838686</geom:qsin2>
                    <geom:qsin3>0.6677051115334547</geom:qsin3>
                    <geom:Rotate_From>
```

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```
                        <geom:name>MVIC Instrument Frame</geom:name>
                    </geom:Rotate_From>
                    <geom:Rotate_To>
                        <geom:name>EME J2000</geom:name>
                    </geom:Rotate_To>
                </geom:Quaternion_Plus_To_From>
            </geom:Image_Display_Geometry>

            <geom:Geometry_Orbiter>
                <geom:geometry_reference_time_utc>2019-01-01T05:13:44.714Z</
↪geom:geometry_reference_time_utc>
                <geom:Orbiter_Identification>
                    <geom:Geometry_Target_Identification>
                        <geom:body_spice_name>2486958</geom:body_spice_name>
                        <geom:name>(486958) Arrokoth</geom:name>
                    </geom:Geometry_Target_Identification>
                </geom:Orbiter_Identification>
                <geom:Pixel_Dimensions>
                    <geom:pixel_field_of_view_method>Constant</geom:pixel_field_of_
↪view_method>
                    <geom:horizontal_pixel_field_of_view unit="mrad">.0198065</
↪geom:horizontal_pixel_field_of_view>
                    <geom:vertical_pixel_field_of_view unit="mrad">.0198065</
↪geom:vertical_pixel_field_of_view>
                </geom:Pixel_Dimensions>
                <geom:Distances>
                    <geom:Distances_Specific>
                        <geom:spacecraft_geocentric_distance unit="km">6620524663.
↪557333</geom:spacecraft_geocentric_distance>
                        <geom:spacecraft_heliocentric_distance unit="km">6474349486.
↪445694</geom:spacecraft_heliocentric_distance>
                        <geom:spacecraft_target_center_distance unit="km">17364.
↪42363680587</geom:spacecraft_target_center_distance>
                        <geom:target_geocentric_distance unit="km">6620676566.778128</
↪geom:target_geocentric_distance>
                        <geom:target_heliocentric_distance unit="km">6474366229.430338
↪</geom:target_heliocentric_distance>
                    </geom:Distances_Specific>
                </geom:Distances>
                <geom:Surface_Geometry>
                    <geom:Surface_Geometry_Specific>
                        <geom:subsolar_latitude unit="deg">-61.85812998743076</
↪geom:subsolar_latitude>
                        <geom:subsolar_longitude unit="deg">87.24761404769193</
↪geom:subsolar_longitude>
                        <geom:subspacecraft_latitude unit="deg">-53.47274657874268</
↪geom:subspacecraft_latitude>
                        <geom:subspacecraft_longitude unit="deg">111.6557853166782</
↪geom:subspacecraft_longitude>
                    </geom:Surface_Geometry_Specific>
                </geom:Surface_Geometry>
                <geom:Illumination_Geometry>
```

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```
                    <geom:Illumination_Specific>
                        <geom:reference_location>Boresight Intercept Point</
↪geom:reference_location>
                        <geom:phase_angle unit="deg">15.4</geom:phase_angle>
                        <geom:solar_elongation unit="deg">164.6</geom:solar_elongation>
                    </geom:Illumination_Specific>
                </geom:Illumination_Geometry>
                <geom:Vectors>
                    <geom:Vectors_Cartesian_Specific>
                        <geom:Vector_Cartesian_Position_Spacecraft_To_Target>
                            <geom:x_position unit="km">1656.2122</geom:x_position>
                            <geom:y_position unit="km">-14549.6368</geom:y_position>
                            <geom:z_position unit="km">-9332.1077</geom:z_position>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Position_Spacecraft_To_Target>
                        <geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target>
                            <geom:x_velocity unit="km/s">1.113444</geom:x_velocity>
                            <geom:y_velocity unit="km/s">-13.442996</geom:y_velocity>
                            <geom:z_velocity unit="km/s">-5.139864</geom:z_velocity>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target>
                        <geom:Vector_Cartesian_Position_Sun_To_Target>
                            <geom:x_position unit="km">1801863012.047373</geom:x_
↪position>
                            <geom:y_position unit="km">-5789632811.265433</geom:y_
↪position>
                            <geom:z_position unit="km">-2269550543.460596</geom:z_
↪position>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Position_Sun_To_Target>
                        <geom:Vector_Cartesian_Velocity_Target_Relative_To_Sun>
                            <geom:x_velocity unit="km/s">4.370272</geom:x_velocity>
                            <geom:y_velocity unit="km/s">1.336516</geom:y_velocity>
                            <geom:z_velocity unit="km/s">0.445148</geom:z_velocity>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Velocity_Target_Relative_To_Sun>
                        <geom:Vector_Cartesian_Position_Earth_To_Target>
                            <geom:x_position unit="km">1828821837.219335</geom:x_
↪position>
                            <geom:y_position unit="km">-5922292146.245399</geom:y_
↪position>
                            <geom:z_position unit="km">-2327063519.570272</geom:z_
↪position>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Position_Earth_To_Target>
                        <geom:Vector_Cartesian_Velocity_Target_Relative_To_Earth>
                            <geom:x_velocity unit="km/s">34.156224</geom:x_velocity>
```

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```
                            <geom:y_velocity unit="km/s">6.405462</geom:y_velocity>
                            <geom:z_velocity unit="km/s">2.642036</geom:z_velocity>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Velocity_Target_Relative_To_Earth>
                        <geom:Vector_Cartesian_Position_Sun_To_Spacecraft>
                            <geom:x_position unit="km">1801956296.599184</geom:x_
↪position>
                            <geom:y_position unit="km">-5789592074.710976</geom:y_
↪position>
                            <geom:z_position unit="km">-2269532636.079516</geom:z_
↪position>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Position_Sun_To_Spacecraft>
                        <geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Sun>
                            <geom:x_velocity unit="km/s">5.483717</geom:x_velocity>
                            <geom:y_velocity unit="km/s">-12.1064806</geom:y_velocity>
                            <geom:z_velocity unit="km/s">-4.694715</geom:z_velocity>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Sun>
                        <geom:Vector_Cartesian_Position_Earth_To_Spacecraft>
                            <geom:x_position unit="km">1827405810.34603</geom:x_
↪position>
                            <geom:y_position unit="km">-5922522508.111715</geom:y_
↪position>
                            <geom:z_position unit="km">-2327157486.28979</geom:z_
↪position>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Position_Earth_To_Spacecraft>
                        <geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Earth>
                            <geom:x_velocity unit="km/s">35.316729</geom:x_velocity>
                            <geom:y_velocity unit="km/s">-7.283111</geom:y_velocity>
                            <geom:z_velocity unit="km/s">-2.604148</geom:z_velocity>
                            <geom:light_time_correction_applied>Received_Light_Time_
↪Stellar_Abb</geom:light_time_correction_applied>
                        </geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Earth>
                    </geom:Vectors_Cartesian_Specific>
                </geom:Vectors>
            </geom:Geometry_Orbiter>
        </geom:Geometry>

        <sb:SB_Metadata>
            <sb:Observation_Parameters>
                <sb:Exposure>
                    <sb:exposure_duration unit="s">0.79072</sb:exposure_duration>
                    <sb:exposure_description>
                        The exposure duration is the amount of time that data was␣
↪collected
                        for each pixel in the array. For details of how the MVIC TDI␣
↪scanning
```

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```
                        observations collected data, see "Ralph: A Visible/Infrared␣
↪Imager for
                        the New Horizons Pluto/Kuiper Belt Mission" (Reuter, et al.␣
↪2008), a
                        preprint copy of which is included in the mission archive and
                        referenced below.
                    </sb:exposure_description>
                </sb:Exposure>
                <sb:Filter>
                    <sb:filter_name>Red</sb:filter_name>
                    <sb:filter_type>Broadband</sb:filter_type>
                    <sb:short_wavelength_limit unit="nm">540</sb:short_wavelength_
↪limit>
                    <sb:long_wavelength_limit unit="nm">700</sb:long_wavelength_limit>
                </sb:Filter>
                <sb:Timing>
                    <sb:midobservation_time_UTC_YMD>2019-01-01T05:13:44.714Z</
↪sb:midobservation_time_UTC_YMD>
                    <sb:midobservation_time_UTC_JD unit="julian day">2458484.7178786</
↪sb:midobservation_time_UTC_JD>
                </sb:Timing>
            </sb:Observation_Parameters>

            <sb:Calibration_Information>
                <sb:Raw_Data_Product>
                    <Internal_Reference>
                        <lidvid_reference>urn:nasa:pds:nh_mvic:kem1_cal:mc0_0408625487_
↪0x545_eng::1.0</lidvid_reference>
                        <reference_type>processed_data_to_raw_data</reference_type>
                    </Internal_Reference>
                </sb:Raw_Data_Product>

                <sb:Calibration_Applied>
                    <sb:comment>
                        The conversion to physical units depends on the spectral␣
↪characteristics of the
                        object and whether it is resolved. Conversion constants are␣
↪provided as part of
                        the mission attributes in this label.
                    </sb:comment>
                    <sb:bias_subtraction>true</sb:bias_subtraction>
                    <sb:flat_field_applied>true</sb:flat_field_applied>
                </sb:Calibration_Applied>

                <sb:Calibration_Reference_Files>
                    <sb:Flat_Field>
                        <sb:file_name>mc0_flat_20160120.fits</sb:file_name>
                        <Internal_Reference>
                            <lidvid_reference>urn:nasa:pds:nh_mvic:calibration_
↪files:mc0_flat::4.0</lidvid_reference>
                            <reference_type>image_to_flat_field_file</reference_type>
                        </Internal_Reference>
```

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```
                    </sb:Flat_Field>
                </sb:Calibration_Reference_Files>
            </sb:Calibration_Information>

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

                <sb:image_observation_type>Single Image</sb:image_observation_type>

                <sb:Ancillary_Data_Objects>
                    <sb:Quality_Map>
                        <Local_Internal_Reference>
                            <local_identifier_reference>Quality</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>
                            <sb:best_quality_value>0</sb:best_quality_value>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>1</sb:flag_value>
                                <sb:flag_meaning>Housekeeping keyword out of yellow␣
↪limits</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>2</sb:flag_value>
                                <sb:flag_meaning>Defect in one of the reference␣
↪calibration files</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>4</sb:flag_value>
                                <sb:flag_meaning>Permanent CCD defect (e.g., dead␣
↪pixel)</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>8</sb:flag_value>
                                <sb:flag_meaning>DN level in non-linear regime of␣
↪detector</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>16</sb:flag_value>
                                <sb:flag_meaning>Zero-value pixel</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>32</sb:flag_value>
                                <sb:flag_meaning>Bad pixel not in any of the above␣
↪categories</sb:flag_meaning>
```

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```
                            </sb:Quality_Flag_Definition>
                        </sb:Quality_Map_Definition>
                    </sb:Quality_Map>
                    <sb:Error_Estimates_Map>
                        <Local_Internal_Reference>
                            <local_identifier_reference>ErrorEstimate</local_
↪identifier_reference>
                            <local_reference_type>image_to_error_map</local_reference_
↪type>
                        </Local_Internal_Reference>
                    </sb:Error_Estimates_Map>
                </sb:Ancillary_Data_Objects>

                <sb:Additional_Geometry_Metadata>
                    <sb:comment>
                        Note that the geometry parameters in this label were␣
↪calculated by the
                        mission using an unpublished kernel set still in development␣
↪at the time
                        of archiving. These parameters are based on "predict geometry",
↪ which is
                        generally not as accurate as metadata available at a later␣
↪date.

                        The instrument position angles are calculated at the midpoint␣
↪of the
                        observing sequence.
                    </sb:comment>
                    <sb:Instrument_Position_Angles>
                        <sb:y_axis_position_angle unit="deg">351.5783804696931</sb:y_
↪axis_position_angle>
                        <sb:z_axis_position_angle unit="deg">81.57838046969316</sb:z_
↪axis_position_angle>
                    </sb:Instrument_Position_Angles>
                </sb:Additional_Geometry_Metadata>
            </sb:Additional_Image_Metadata>
        </sb:SB_Metadata>

    </Discipline_Area>
 </Observation_Area>

 <Reference_List>
    <Internal_Reference>
        <lid_reference>urn:nasa:pds:nh_doc:all:ralph_ssr</lid_reference>
        <reference_type>data_to_document</reference_type>
        <comment>
            This document from Space Science Reviews describes technical and␣
↪operational
            details of the RALPH instruments and detectors.
        </comment>
    </Internal_Reference>
 </Reference_List>
```

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```
  <File_Area_Observational>
      <File>
          <file_name>mc0_0408625487_0x545_sci.fit</file_name>
          <comment>
              This file contains a single observation from one of the MVIC color channel␣
↪detectors.
              The image dimensions reflect the full area of the detector, not all of␣
↪which contains
              data in all cases. Pixels for which data was not downloaded are filled␣
↪with the
              "missing_constant" value.
          </comment>
      </File>

      <!-- Primary ("extension 0" in some applications) header and data unit -->

      <Header>
          <offset unit="byte">0</offset>
          <object_length unit="byte">25920</object_length>
          <parsing_standard_id>FITS 3.0</parsing_standard_id>
          <description>
              Primary FITS header unit. The New Horizons pipeline produced data in FITS␣
↪format.
          </description>
      </Header>
      <Array_2D_Image>
          <name>Observational Data (DN)</name>
          <local_identifier>Image</local_identifier>
          <offset unit="byte">25920</offset>
          <axes>2</axes>
          <axis_index_order>Last Index Fastest</axis_index_order>
          <description>
              This array contains data only for pixels within the window(s) defined by␣
↪the
              Subframe(s) listed for this product. Other pixels have been set to -1.0,␣
↪the
              defined "missing_constant".
          </description>
          <Element_Array>
              <data_type>IEEE754MSBSingle</data_type>
              <unit>DN</unit>
          </Element_Array>
          <Axis_Array>
              <axis_name>Line</axis_name>
              <elements>3984</elements>
              <sequence_number>1</sequence_number>
          </Axis_Array>
          <Axis_Array>
              <axis_name>Sample</axis_name>
              <elements>5024</elements>
              <sequence_number>2</sequence_number>
```

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```
        </Axis_Array>
        <Special_Constants>
            <missing_constant>-1.000</missing_constant>
        </Special_Constants>
    </Array_2D_Image>

    <!-- First extension header and data unit -->

    <Header>
        <offset unit="byte">80089920</offset>
        <object_length unit="byte">2880</object_length>
        <parsing_standard_id>FITS 3.0</parsing_standard_id>
        <description>
            FITS IMAGE extension header - a minimal header.
        </description>
    </Header>
    <Array_2D_Image>
        <name>Per-pixel Error Estimate (DN)</name>
        <local_identifier>ErrorEstimate</local_identifier>
        <offset unit="byte">80092800</offset>
        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <description>
            This array provides per-pixel error estimates in DN for each of the␣
↪corresponding
            pixels in the primary data. It contains data only for pixels within the␣
↪window(s)
            defined by the Subframe(s) listed for this product. Other pixels have been␣
↪set to
            -1.0, the defined "missing_constant".
        </description>
        <Element_Array>
            <data_type>IEEE754MSBSingle</data_type>
            <unit>DN</unit>
        </Element_Array>
        <Axis_Array>
            <axis_name>Line</axis_name>
            <elements>3984</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Sample</axis_name>
            <elements>5024</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
        <Special_Constants>
            <missing_constant>-1.00</missing_constant>
        </Special_Constants>
    </Array_2D_Image>

    <!-- Second extension header and data unit -->
```

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```
    <Header>
        <offset unit="byte">160156800</offset>
        <object_length unit="byte">2880</object_length>
        <parsing_standard_id>FITS 3.0</parsing_standard_id>
        <description>
            FITS IMAGE extension header - minimal header. COMMENT cards include terse
            quality code definitions.
        </description>
    </Header>
    <Array_2D_Image>
        <name>Per-pixel Quality Assessment</name>
        <local_identifier>Quality</local_identifier>
        <offset unit="byte">160159680</offset>
        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <Element_Array>
            <data_type>SignedMSB2</data_type>
        </Element_Array>
        <Axis_Array>
            <axis_name>Line</axis_name>
            <elements>3984</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Sample</axis_name>
            <elements>5024</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
        <Special_Constants>
            <missing_constant>-1</missing_constant>
        </Special_Constants>
    </Array_2D_Image>
 </File_Area_Observational>

</Product_Observational>
```

CHAPTER

EIGHT

MOCKUP LABEL: MVIC PANCHROMATIC FRAMING ARRAY, PROCESSED DATA

This label is a mockup created for design purposes during the migration planning for the MVIC data. The test data file contained a single framing camera observation sequence from the MVIC Framing Array (identified as "mpf" in file names). This particular sequence resulted in 11 individual frames.

The mockup shows the entire <*Product_Observationsl*> structure, including the New Horizons dictionary classes, which are found in the <*Mission_Area*> of the structure.

> **Note** that the versions of both the New Horizons (nh:) and Small Bodies (sb:) shown here are pre-release. Consult the current release documentation for changes to these namespaces-in-development before attempting and real-would applications.

```
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:disp="http://pds.nasa.gov/pds4/disp/v1"
  xmlns:geom="http://pds.nasa.gov/pds4/geom/v1"
  xmlns:img="http://pds.nasa.gov/pds4/img/v1"
  xmlns:sb="http://pds.nasa.gov/pds4/sb/v0"
  xmlns:nh="http://pds.nasa.gov/pds4/mission/nh/v1"
  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/disp/v1 https://pds.nasa.gov/pds4/disp/v1/PDS4_DISP_1J00_1510.
↪xsd
  http://pds.nasa.gov/pds4/geom/v1 https://pds.nasa.gov/pds4/geom/v1/PDS4_GEOM_1J00_1970.
↪xsd
  http://pds.nasa.gov/pds4/img/v1  https://pds.nasa.gov/pds4/img/v1/PDS4_IMG_1J00_1870.
↪xsd
  http://pds.nasa.gov/pds4/sb/v0   https://pds.nasa.gov/pds4/sb/v0/PDS4_SB_1J00_0100.xsd
  http://pds.nasa.gov/pds4/mission/nh/v1 https://pds.nasa.gov/pds4/mission/nh/v1/PDS4_NH_
↪1J00_1000.xsd">

  <Identification_Area>
      <logical_identifier>urn:nasa:pds:nh_mvic:kem1_cal:mpf_0408630768_0x539_sci</
↪logical_identifier>
      <version_id>1.0</version_id>
      <title>New Horizons MVIC Panchromatic Framing Observation :mpf_0408630768_0x539_
↪sci (Processed Data)</title>
      <information_model_version>1.19.0.0</information_model_version>
      <product_class>Product_Observational</product_class>

      <Modification_History>
```

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```
        <Modification_Detail>
            <modification_date>2023-01-02</modification_date>
            <version_id>1.0</version_id>
            <description>
                A.C.Raugh: Migrated from PDS3 product NH-A-MVIC-3-KEM1-V5.0:MPF_
↪0408630768_0X539_SCI
            </description>
        </Modification_Detail>
    </Modification_History>
 </Identification_Area>

 <Observation_Area>
    <Time_Coordinates>
        <start_date_time>2019-01-01T06:40:52.440Z</start_date_time>
        <stop_date_time>2019-01-01T06:43:13.970Z</stop_date_time>
    </Time_Coordinates>

    <Primary_Result_Summary>
        <purpose>Science</purpose>
        <processing_level>Partially Processed</processing_level>
        <Science_Facets>
            <wavelength_range>Visible</wavelength_range>
            <wavelength_range>Near Infrared</wavelength_range>
            <discipline_name>Imaging</discipline_name>
        </Science_Facets>
    </Primary_Result_Summary>

    <Investigation_Area>
        <name>New Horizons Kuiper Belt Extended Mission 1</name>
        <type>Mission</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:investigation:mission.new_horizons_kem1
↪</lid_reference>
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>

    <Observing_System>
        <Observing_System_Component>
            <name>New Horizons Spacecraft</name>
            <type>Host</type>
            <Internal_Reference>
                <lid_reference>urn:nasa:pds:context:instrument_host:spacecraft.nh</lid_
↪reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <!-- There is no Instrument Package in PDS4 as yet.
        <Observing_System_Component>
            <name>RALPH</name>
            <type>Instrument Package</type>
            <description>
```

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```
                RALPH is an instrument package supporting two independent instrument,
                the Multispectral Visible Imaging Camera (MVIC) and the Linear Etalon
                Imaging Spectral Array (LEISA), that share a boresight, a focal plane,
                and electronics. Detectors and pipeline processing are unique to each
                instrument.
            </description>
        </Observing_System_Component>
        -->
        <Observing_System_Component>
            <name>Multispectral Visible Imaging Camera (MVIC)</name>
            <type>Instrument</type>
            <description>
                Note that the MVIC instrument has seven distinct detectors, identified␣
↪by
                the "nh:Detector" class metadata.
            </description>
            <Internal_Reference>
                <lid_reference>urn:nasa:pds:context:instrument:nh.mvic</lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>

    <Target_Identification>
        <name>(486958) Arrokoth</name>
        <alternate_designation>2014 MU69</alternate_designation>
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            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>

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                <nh:sequence_id>KEMV_MU69_DPDEEP_RIDE_MF_2019001A1</nh:sequence_id>
                <nh:observation_description>Departure MVIC Deep Ring Search Rider</
↪nh:observation_description>
                <nh:Mission_Elapsed_Time>
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                    <nh:stop_clock_count>0408630911:41100</nh:stop_clock_count>
                </nh:Mission_Elapsed_Time>
                <nh:Detector>
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↪nh:detector_name>
                    <nh:detector_type>CCD</nh:detector_type>
                    <nh:MVIC_Details>
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                        <nh:scan_type>FRAMING - Framing Mode</nh:scan_type>
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                </nh:Detector>
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            <nh:MVIC_Calibration_Information>
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                <nh:read_noise>30.000</nh:read_noise>
                <nh:gain unit="electron/DN">58.6000</nh:gain>
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↪median_bias>
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                        <nh:right_side_median_bias unit="DN">26.0000</nh:right_side_
↪median_bias>
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                        <nh:right_side_median_bias unit="DN">26.0000</nh:right_side_
↪median_bias>
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↪median_bias>
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                        <nh:right_side_median_bias unit="DN">23.0000</nh:right_side_
↪median_bias>
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↪median_bias>
                    </nh:Frame_Bias_Levels>
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↪median_bias>
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↪median_bias>
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↪median_bias>
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↪median_bias>
                        <nh:right_side_median_bias unit="DN">23.0000</nh:right_side_
↪median_bias>
                    </nh:Frame_Bias_Levels>
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↪median_bias>
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↪median_bias>
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                    <nh:solar_constant>98313.172</nh:solar_constant>
                    <nh:jupiter_constant>84425.375</nh:jupiter_constant>
                    <nh:pholus_constant>97097.703</nh:pholus_constant>
                    <nh:pluto_constant>94817.766</nh:pluto_constant>
                    <nh:charon_constant>97732.594</nh:charon_constant>
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                    <nh:units_of_conversion_constants>(DN/s)/(erg/cm^2/s/Angstrom)</
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                    <nh:jupiter_constant>2.152E+14</nh:jupiter_constant>
                    <nh:pholus_constant>2.475E+14</nh:pholus_constant>
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            </Local_Internal_Reference>
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                <disp:vertical_display_axis>Line</disp:vertical_display_axis>
                <disp:vertical_display_direction>Bottom to Top</disp:vertical_display_
↪direction>
            </disp:Display_Direction>
        </disp:Display_Settings>

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        <geom:Geometry>

            <geom:comment>
                Note that the geometry parameters in this label were calculated by the
                mission using an unpublished kernel set still in development at the␣
↪time
                of archiving. These parameters are based on "predict geometry", which␣
↪is
                generally not as accurate as metadata available at a later date.
            </geom:comment>

            <geom:Image_Display_Geometry>
                <geom:comment>
                    The pointing in this class is calculated at the midpoint of the␣
↪observing sequence and
                    does not necessarily correspond to any single frame. Per-frame␣
↪pointing is contained
                    in the sb:Additional_Geometry_Metadata class.
                </geom:comment>
```

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                <geom:geometry_reference_time_utc>2019-01-01T06:42:03.205Z</
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                </Local_Internal_Reference>
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                    <geom:name>(486958) Arrokoth</geom:name>
                </geom:Geometry_Target_Identification>
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↪location>
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↪angle>
                    <geom:declination_angle unit="deg">-33.8</geom:declination_angle>
                    <geom:celestial_north_clock_angle unit="deg">351.57838</
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                    <geom:Reference_Frame_Identification>
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                    </geom:Reference_Frame_Identification>
                </geom:Object_Orientation_RA_Dec>
                <geom:Object_Orientation_Clock_Angles>
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                    <geom:sun_direction_clock_angle unit="deg">133.8</geom:sun_
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                </geom:Object_Orientation_Clock_Angles>
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                    <geom:qsin1>0.5793975569923115</geom:qsin1>
                    <geom:qsin2>0.3215769780838686</geom:qsin2>
                    <geom:qsin3>0.6677051115334547</geom:qsin3>
                    <geom:Rotate_From>
                        <geom:name>MVIC Instrument Frame</geom:name>
                    </geom:Rotate_From>
                    <geom:Rotate_To>
                        <geom:name>EME J2000</geom:name>
                    </geom:Rotate_To>
                </geom:Quaternion_Plus_To_From>
            </geom:Image_Display_Geometry>

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                    <geom:Geometry_Target_Identification>
                        <geom:body_spice_name>2486958</geom:body_spice_name>
                        <geom:name>(486958) Arrokoth</geom:name>
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                    <geom:vertical_pixel_field_of_view unit="mrad">.0198065</
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↪445694</geom:spacecraft_heliocentric_distance>
                        <geom:spacecraft_target_center_distance unit="km">17364.
↪42363680587</geom:spacecraft_target_center_distance>
                        <geom:target_geocentric_distance unit="km">6620676566.778128</
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↪geom:subspacecraft_longitude>
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                </geom:Surface_Geometry>
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                    <geom:Illumination_Specific>
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                            <geom:y_position unit="km">-14549.6368</geom:y_position>
                            <geom:z_position unit="km">-9332.1077</geom:z_position>
                            <geom:light_time_correction_applied>Received_Light_Time_
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                        </geom:Vector_Cartesian_Position_Spacecraft_To_Target>
                        <geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target>
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                            <geom:z_velocity unit="km/s">-5.139864</geom:z_velocity>
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                        </geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target>
                        <geom:Vector_Cartesian_Position_Sun_To_Target>
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                            <geom:y_position unit="km">-5789632811.265433</geom:y_
↪position>
                            <geom:z_position unit="km">-2269550543.460596</geom:z_
↪position>
                            <geom:light_time_correction_applied>Received_Light_Time_
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                        </geom:Vector_Cartesian_Position_Sun_To_Target>
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                            <geom:z_velocity unit="km/s">0.445148</geom:z_velocity>
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                        </geom:Vector_Cartesian_Velocity_Target_Relative_To_Sun>
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↪position>
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                        </geom:Vector_Cartesian_Position_Earth_To_Target>
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                            <geom:y_position unit="km">-5789592074.710976</geom:y_
↪position>
                            <geom:z_position unit="km">-2269532636.079516</geom:z_
↪position>
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                        </geom:Vector_Cartesian_Position_Sun_To_Spacecraft>
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                            <geom:y_velocity unit="km/s">-12.1064806</geom:y_velocity>
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                            <geom:z_velocity unit="km/s">-4.694715</geom:z_velocity>
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                        <geom:Vector_Cartesian_Position_Earth_To_Spacecraft>
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↪position>
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                        </geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Earth>
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                </geom:Vectors>
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        </geom:Geometry>

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                    <sb:exposure_description>
                        The exposure time is the same for each sequential frame in␣
↪this observation
                    </sb:exposure_description>
                </sb:Exposure>
                <sb:Filter>
                    <sb:filter_name>Clear</sb:filter_name>
                    <sb:filter_type>Neutral</sb:filter_type>
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↪limit>
                    <sb:long_wavelength_limit unit="nm">975</sb:long_wavelength_limit>
                </sb:Filter>
                <sb:Timing>
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↪sb:midobservation_time_UTC_YMD>
                    <sb:midobservation_time_UTC_JD unit="julian day">2458484.7792038</
↪sb:midobservation_time_UTC_JD>
                    <sb:comment>
                        This midobservation time is the midpoint of the observing␣
↪sequence, and corresponds
                        to the time for which the overall observational geometry is␣
↪calculated.
```

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```
                    </sb:comment>
                </sb:Timing>
            </sb:Observation_Parameters>

            <sb:Calibration_Information>
                <sb:Raw_Data_Product>
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↪0x539_enf::1.0</lidvid_reference>
                        <reference_type>processed_data_to_raw_data</reference_type>
                    </Internal_Reference>
                </sb:Raw_Data_Product>
                <sb:Calibration_Applied>
                    <sb:comment>
                        The conversion to physical units depends on the spectral␣
↪characteristics of the
                        object and whether it is resolved. Conversion constants are␣
↪provided as part of
                        the mission attributes in this label.
                    </sb:comment>
                    <sb:bias_subtraction>true</sb:bias_subtraction>
                    <sb:flat_field_applied>true</sb:flat_field_applied>
                    <sb:conversion_to_physical_units>false</sb:conversion_to_physical_
↪units>
                </sb:Calibration_Applied>

                <sb:Calibration_Reference_Files>
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                        <Internal_Reference>
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↪files:mfr_flat::2.0</lidvid_reference>
                            <reference_type>image_to_flat_field_file</reference_type>
                        </Internal_Reference>
                    </sb:Flat_Field>
                </sb:Calibration_Reference_Files>
            </sb:Calibration_Information>

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↪reference_type>
                </Local_Internal_Reference>

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                <sb:Ancillary_Data_Objects>
                    <sb:Quality_Map>
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↪reference>
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                            <sb:Quality_Flag_Definition>
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↪limits</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
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                                <sb:flag_meaning>Defect in one of the reference␣
↪calibration files</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>4</sb:flag_value>
                                <sb:flag_meaning>Permanent CCD defect (e.g., dead␣
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                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
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↪detector</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>16</sb:flag_value>
                                <sb:flag_meaning>Zero-value pixel</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                            <sb:Quality_Flag_Definition>
                                <sb:flag_value>32</sb:flag_value>
                                <sb:flag_meaning>Bad pixel not in any of the above␣
↪categories</sb:flag_meaning>
                            </sb:Quality_Flag_Definition>
                        </sb:Quality_Map_Definition>
                    </sb:Quality_Map>
                    <sb:Error_Estimates_Map>
                        <Local_Internal_Reference>
                            <local_identifier_reference>ErrorEstimate</local_
↪identifier_reference>
                            <local_reference_type>image_to_error_map</local_reference_
↪type>
                        </Local_Internal_Reference>
                    </sb:Error_Estimates_Map>
                </sb:Ancillary_Data_Objects>

                <sb:Additional_Geometry_Metadata>
                    <sb:comment>
                        Note that the geometry parameters in this label were␣
↪calculated by the
                        mission using an unpublished kernel set still in development␣
↪at the time
```

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```
                        of archiving. These parameters are based on "predict geometry",
↪ which is
                        generally not as accurate as metadata available at a later␣
↪date.

                        The instrument position angles are calculated at the midpoint␣
↪of the
                        observing sequence.
                    </sb:comment>
                    <sb:Instrument_Position_Angles>
                        <sb:y_axis_position_angle unit="deg">76.24384745960108</sb:y_
↪axis_position_angle>
                        <sb:z_axis_position_angle unit="deg">166.2438474596011</sb:z_
↪axis_position_angle>
                    </sb:Instrument_Position_Angles>
                </sb:Additional_Geometry_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>0</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:40:57.440Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">5.0</sb:delta_time_
↪from_sequence_start>
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94126963334442</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30486036648045</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24417555028195</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02133200110688761</sb:qcos>
                        <sb:qsin1>-0.7295018068630121</sb:qsin1>
                        <sb:qsin2>0.6549130919762196</sb:qsin2>
                        <sb:qsin3>0.1961145111166537</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>1</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:41:10.593Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">18.15299999713898</
↪sb:delta_time_from_sequence_start>
```

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```
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94152431715064</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30539781972034</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24339609115043</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02132980536561482</sb:qcos>
                        <sb:qsin1>-0.7295032444862805</sb:qsin1>
                        <sb:qsin2>0.6549092258456225</sb:qsin2>
                        <sb:qsin3>0.1961223128288641</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>2</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:41:23.746Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">31.30599999427795</
↪sb:delta_time_from_sequence_start>
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94152308519195</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30455981834362</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24315898248132</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02132330502451953</sb:qcos>
                        <sb:qsin1>-0.7295035357502035</sb:qsin1>
                        <sb:qsin2>0.6549102479876323</sb:qsin2>
                        <sb:qsin3>0.1961185230200374</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>3</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:41:36.899Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">44.45899999141693</
↪sb:delta_time_from_sequence_start>
```

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```
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94243716042934</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30502429546362</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24268121481965</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02132146650564566</sb:qcos>
                        <sb:qsin1>-0.7295087078440583</sb:qsin1>
                        <sb:qsin2>0.6549028240421432</sb:qsin2>
                        <sb:qsin3>0.1961242751608453</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>4</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:41:50.052Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">57.61199998855591</
↪sb:delta_time_from_sequence_start>
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94208586411156</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30495773447827</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.2430073134865</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02132374716131024</sb:qcos>
                        <sb:qsin1>-0.72950665965348</sb:qsin1>
                        <sb:qsin2>0.6549057313638785</sb:qsin2>
                        <sb:qsin3>0.1961219374648477</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>5</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:42:03.205Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">70.76499998569489</
↪sb:delta_time_from_sequence_start>
```

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```
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94167228018676</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30448076866241</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24384745960108</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02132696162203221</sb:qcos>
                        <sb:qsin1>-0.7295042842775433</sb:qsin1>
                        <sb:qsin2>0.6549106104371681</sb:qsin2>
                        <sb:qsin3>0.1961141307134634</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>6</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:42:16.358Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">83.91799998283386</
↪sb:delta_time_from_sequence_start>
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94158501398022</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30389771482717</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24302589436928</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02131840683028375</sb:qcos>
                        <sb:qsin1>-0.7295041152370967</sb:qsin1>
                        <sb:qsin2>0.6549107479726801</sb:qsin2>
                        <sb:qsin3>0.1961152303423269</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>7</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:42:29.511Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">97.07099997997284</
↪sb:delta_time_from_sequence_start>
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```
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94172246247751</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30435500338081</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24229269410498</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02131622856547525</sb:qcos>
                        <sb:qsin1>-0.7295048985077288</sb:qsin1>
                        <sb:qsin2>0.6549078431842543</sb:qsin2>
                        <sb:qsin3>0.1961222536805067</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>8</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:42:42.664Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">110.2239999771118</
↪sb:delta_time_from_sequence_start>
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94210398189352</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30548919180629</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24313501860101</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02132769566012568</sb:qcos>
                        <sb:qsin1>-0.7295065782288451</sb:qsin1>
                        <sb:qsin2>0.6549049339540055</sb:qsin2>
                        <sb:qsin3>0.1961244737440251</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>9</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:42:55.817Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">123.3769999742508</
↪sb:delta_time_from_sequence_start>
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```
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94136130460349</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.30471203536422</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24287531597059</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02132268299486258</sb:qcos>
                        <sb:qsin1>-0.7295026177663414</sb:qsin1>
                        <sb:qsin2>0.6549105344638835</sb:qsin2>
                        <sb:qsin3>0.1961210486158648</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>

                <sb:Per_Frame_Metadata>
                    <sb:frame_number>10</sb:frame_number>
                    <sb:frame_exposure_duration unit="s">10.0</sb:frame_exposure_
↪duration>
                    <sb:Midframe_Time>
                        <sb:midobservation_time_UTC_YMD>2019-01-01T06:43:08.970Z</
↪sb:midobservation_time_UTC_YMD>
                        <sb:delta_time_from_sequence_start unit="s">136.5299999713898</
↪sb:delta_time_from_sequence_start>
                    </sb:Midframe_Time>
                    <sb:Frame_Pointing>
                        <sb:frame_center_ra unit="deg">93.94499370129392</sb:frame_
↪center_ra>
                        <sb:frame_center_dec unit="deg">18.29649568239491</sb:frame_
↪center_dec>
                        <sb:celestial_north_clock_angle unit="deg">76.24156606546185</
↪sb:celestial_north_clock_angle>
                    </sb:Frame_Pointing>
                    <sb:Instrument_to_J2000_Quaternion>
                        <sb:qcos>0.02125917781985866</sb:qcos>
                        <sb:qsin1>-0.729526110493996</sb:qsin1>
                        <sb:qsin2>0.6548990916725287</sb:qsin2>
                        <sb:qsin3>0.1960787627266722</sb:qsin3>
                    </sb:Instrument_to_J2000_Quaternion>
                </sb:Per_Frame_Metadata>
            </sb:Additional_Image_Metadata>
        </sb:SB_Metadata>

    </Discipline_Area>
</Observation_Area>

<Reference_List>
    <Internal_Reference>
        <lid_reference>urn:nasa:pds:nh_doc:all:ralph_ssr</lid_reference>
        <reference_type>data_to_document</reference_type>
```

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```
        <comment>
            This document from Space Science Reviews describes technical and␣
↪operational
            details of the RALPH instruments and detectors.
        </comment>
    </Internal_Reference>
 </Reference_List>

 <File_Area_Observational>
    <File>
        <file_name>mpf_0408630768_0x539_eng.fit</file_name>
        <comment>
            This file contains a single Panchromatic Framing observation from the MVIC␣
↪Pan Frame detector.
            The image dimensions reflect the full area of the detector, not all of␣
↪which contains data in
            all cases. Pixels not downloaded are filled with a "missing data" value of␣
↪-1.00.
        </comment>
    </File>

    <!-- Primary ("extension 0" in some applications) header and data unit -->

    <Header>
        <offset unit="byte">0</offset>
        <object_length unit="byte">40320</object_length>
        <parsing_standard_id>FITS 3.0</parsing_standard_id>
        <description>
            Primary FITS header unit. The New Horizons pipeline produced data in FITS␣
↪format.
        </description>
    </Header>
    <Array_3D_Image>
        <name>Observational Data (DN)</name>
        <local_identifier>Image</local_identifier>
        <offset unit="byte">40320</offset>
        <axes>3</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <description>
            This array contains data only for pixels within the window(s) defined by␣
↪the
            Subframe(s) listed for this product. Other pixels have been set to -1.0,␣
↪the
            defined "missing_constant".
        </description>
        <Element_Array>
            <data_type>IEEE754MSBSingle</data_type>
            <unit>DN</unit>
        </Element_Array>
        <Axis_Array>
            <axis_name>Frame</axis_name>
            <elements>11</elements>
```

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```
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Line</axis_name>
            <elements>128</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Sample</axis_name>
            <elements>5024</elements>
            <sequence_number>3</sequence_number>
        </Axis_Array>
        <Special_Constants>
            <missing_constant>-1.000</missing_constant>
        </Special_Constants>
    </Array_3D_Image>

    <!-- First extension header and data unit -->

    <Header>
        <offset unit="byte">28336320</offset>
        <object_length unit="byte">2880</object_length>
        <parsing_standard_id>FITS 3.0</parsing_standard_id>
        <description>
            FITS IMAGE extension header - a minimal header.
        </description>
    </Header>
    <Array_3D>
        <name>Per-pixel Error Estimate (DN)</name>
        <local_identifier>ErrorEstimate</local_identifier>
        <offset unit="byte">28339200</offset>
        <axes>3</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <description>
            This array provides per-pixel error estimates in DN for each of the␣
↪corresponding
            pixels in the primary data. It contains data only for pixels within the␣
↪window(s)
            defined by the Subframe(s) listed for this product. Other pixels have been␣
↪set to
            -1.0, the defined "missing_constant".
        </description>
        <Element_Array>
            <data_type>IEEE754MSBSingle</data_type>
            <unit>DN</unit>
        </Element_Array>
        <Axis_Array>
            <axis_name>Frame</axis_name>
            <elements>11</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Axis_Array>
```

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```
            <axis_name>Line</axis_name>
            <elements>128</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Sample</axis_name>
            <elements>5024</elements>
            <sequence_number>3</sequence_number>
        </Axis_Array>
        <Special_Constants>
            <missing_constant>-1.00</missing_constant>
        </Special_Constants>
    </Array_3D>

    <!-- Second extension header and data unit -->

    <Header>
        <offset unit="byte">56635200</offset>
        <object_length unit="byte">2880</object_length>
        <parsing_standard_id>FITS 3.0</parsing_standard_id>
        <description>
            FITS IMAGE extension header - minimal header. COMMENT cards include terse
            quality code definitions.
        </description>
    </Header>
    <Array_3D>
        <name>Per-pixel Quality Assessment</name>
        <local_identifier>Quality</local_identifier>
        <offset unit="byte">56638080</offset>
        <axes>3</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <Element_Array>
            <data_type>SignedMSB2</data_type>
        </Element_Array>
        <Axis_Array>
            <axis_name>Frame</axis_name>
            <elements>11</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Line</axis_name>
            <elements>128</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
        <Axis_Array>
            <axis_name>Sample</axis_name>
            <elements>5024</elements>
            <sequence_number>3</sequence_number>
        </Axis_Array>
        <Special_Constants>
            <missing_constant>-1</missing_constant>
        </Special_Constants>
```

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```
      </Array_3D>
  </File_Area_Observational>

</Product_Observational>
```