DART Sample Data Review
Didymos Reconnaissance and Asteroid Camera for OpNav (DRACO)

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Overview

- This is a simulated dataset prepared for the asteroid encounter in 2022.
- The bundle is prepared in PDS4 standard and generally complete as for this stage of mission. Detailed information such as value range in SIS file tables and detector temperature in XML label for each image are very nice to have.
- This review focused on the data structure, label and documents
- Data reviewing tools include Oxygen XML Editor, Diff Files, DS9 and python pds4 tools, "pds4_tools.read" and "pds4_tools.view" .

Fits file

No problem open with python or DS9.

Structure:

- Calibrated data: "error image" is necessary for a lot analyses.

- Not all the cards in fits header has to be copied from raw to calibrated level.

  Do all those track ID relate to scientific applications?

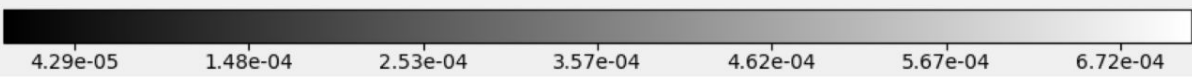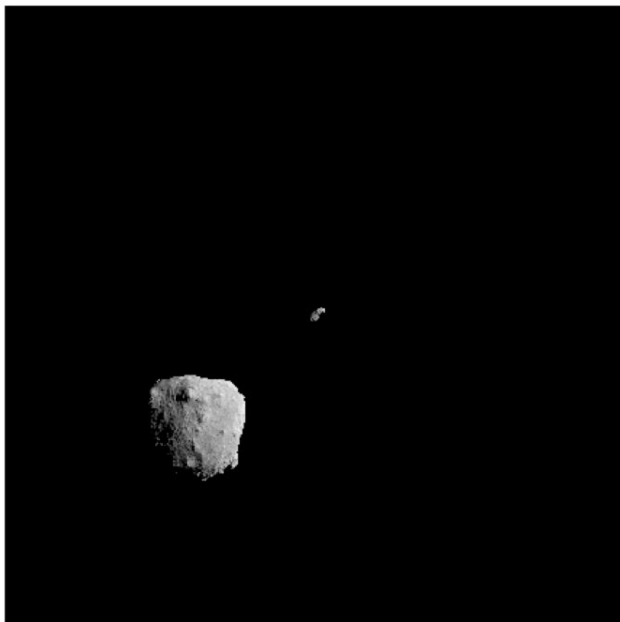- Geometry backplane data: add SPICE kernel information to header or XML label

PDS4 Viewer - Data Structure Summary for '/Users/zouxd/Meeting/PDS-reviews/2021-07-16/dart_spacecraft_bundle/dart/dr...

Index	Name	Type	Dimension	View		
1	dart_0717891977_00957_01_cal	Array_2D_Image	1024 X 1024	Label	Table	Image

PDS4 Viewer - Image 'dart_0717891977_00957_01_cal'

Structure: dart_0717891977_00957_01_cal

Frame: 0

Pixel X: ____ Y: ____ Value: ____

4.29e-05   1.48e-04   2.53e-04   3.57e-04   4.62e-04   5.67e-04   6.72e-04

PDS4 Viewer - Label View

Label

Array_2D_Image
local_identifier: dart_0717891977_00957_01_cal
offset: 23040
axes: 2
axis_index_order: Last Index Fastest

Element_Array
data_type: IEEE754MSBSingle

Axis_Array
axis_name: Line
elements: 1024
sequence_number: 1

Axis_Array
axis_name: Sample
elements: 1024
sequence_number: 2

Special_Constants
missing_constant: 1E32
invalid_constant: -1E30
not_applicable_constant: -1E32
high_instrument_saturation: 1E30

Search   Match Case

My question to PDS about the backplane fits structure

Geometry backplanes all with different units are all cubed in one extension. Is this the standard for this kind of data?

No.	Name	Ver	Type	Cards	Dimensions	Format
0	PRIMARY	1	PrimaryHDU	274	(1024, 1024, 16)	float32

SIS file

- Some critical geometry backplane values should be explained more specifically.
- When the image includes both targets of Didymos and Dimorpho how the geometry values are calculated? Are XYZ lat lon defined in different frame?
- As for all the gravity related values (backplanes 14, 15, 16) are these calculated in two body system or one body?
- For some photometry users, how the incidence and emission angles are derived from the shape model can be very important. Suggest to explain the averaging method for calculating these angles somewhere.

Table 4. Description of image backplanes

Plane Number	Plane Name	Description	Units
1	Pixel value	Pixel values of the calibrated image	I/F
2	X coordinate	X coordinate of the intercept with the surface of the asteroid in body-fixed reference frame	km
3	Y coordinate	Y coordinate of the intercept with the surface of the asteroid in body-fixed reference frame	km
4	Z coordinate	Z coordinate of the intercept with the surface of the asteroid in body-fixed reference frame	km
5	Latitude	Planetocentric latitude	degrees
6	Longitude	Planetocentric longitude	degrees east
7	Radial distance	Radial distance from the asteroid center of figure	km
8	Solar incidence angle	Solar incidence angle	degrees
9	Emission angle	Emission angle	degrees
10	Solar phase angle	Solar phase angle	degrees
11	Horizontal pixel scale	Horizontal pixel scale measured from range to surface and shape	m
12	Vertical pixel scale	Vertical pixel scale measured from range to surface and shape	m
13	Surface slope	Average surface slope relative to gravity	degrees

14	Elevation	Average elevation relative to gravity	m
15	Gravitational acceleration	Average gravitational acceleration	m s^{-2}
16	Gravitational potential	Average gravitational potential	J kg^{-1}

The values used to populate Planes 13–16 were calculated using the method described by Werner and

Table 3. DRACO Data Processing Levels

DRACO Data Product	NASA Product Level	PDS4 Data Processing Level	Unit	Description
Raw Images	Level-0	Raw	DN	Images reassembled from downlinked telemetry with complete image metadata including instrument settings, states, and geometry.
Calibrated Images	Level-2	Calibrated	$W\ m^{-2}\ nm^{-1}\ sr^{-1}$ or I/F	Images calibrated to physical units. The data are represented in radiance when keyword IOVERF = "SKIP" and in reflectance when IOVERF = "PERFORM".
Calibration Files	Level-4	Derived	various	Files needed to process image data.
Image Backplanes	Level-4	Derived	various	Backplanes containing additional per-pixel information.

Red annotations:
- *Not the unit* (pointing to I/F)
- *I/F or RADF* (pointing to reflectance)
- *Mixing Radiance and I/F is often confusing, suggest to generate L2a (RADIANCE) and L2b (RADF or I/F) datasets*
- *Are these files L4? Or should they go with calibrated data bundle as part of the calibration documentation?*
- *Briefly add all the names of layers here.*

XML labels

- In the XML label, Dates and version of SIS file are not consistent
- 2 Error occur in Validation of raw data XML file
  - The value Spacecraft for attribute Observing_System_Component.type is deprecated and should not be used.
  - Failed to read schema document 'https://pds.nasa.gov/pds4/mission/dart/v1/PDS4_DART_1E00_1000.xsd', because 1) could not find the mission dictionary