New Horizons SDC PDS Review

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Student Dust Counter

Detector Assembly

Intra-Harness

Electronics Box

- SDC is an impact dust detector - goal was to measure the spatial distribution and sizeof dust along the trajectory of NH throughout the solar system

- PVDF films generate a depolarization electrical signal when a dust particle impacts the surface.

- 14 "channels", although 1 and 14 are inactive for calibration, channel 11 failed before launch

- Signals are measured as a data number (DN) in the raw data, this is converted to charge and mass via calibration functions that have been improved since the start of the mission by testing on the ground engineering unit.

  - Masses calculated by assuming a velocity of an impacting dust particle to be on a Keplerian orbit at the location of impact.

  - In theory, SDC is capable of detecting particles with masses $m > 10^{-12}$ g, although thresholds for detection vary through mission

  - Smaller particles "detected" by integration of signal over time
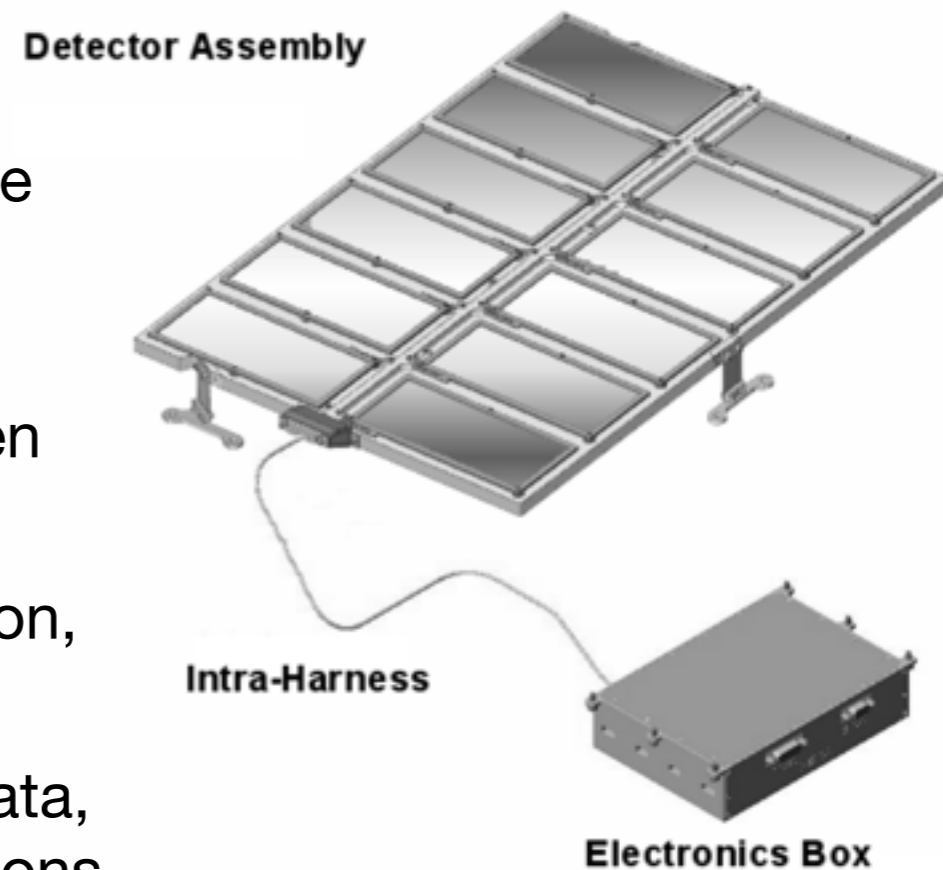
KEM data overview

- The extended mission (KEM) shall go from 2016-10-26 to 2021-09-30
  - KEM Cruise 1 is from 2016-10-26 to 2018-08-14
  - This dataset includes data until 2017-12-17

- Overall, no significant changes to the documentation or the dataset, other than updates for the new mission phase

- Most documentation accurately reflects this (see few typos, issues listed below)

- Interesting note (/catalog/dataset.cat):

  ```
  When considering this data set, note that the SDC channel thresholds were increased to their 'high' settings
  starting on 9/21/2017 (or 39.5 AU) due to unexpected noise following instrument testing for the MU-69
  encounter.
  ```

  - which instrument testing? stimulated calibration (document/sdc_stim_v0002.tab) lists the last stimulated calibration as 2016-07-08.
  - what are the downstream implications for this? is the detector just not sensitive anymore?

  - related: engineering (level2) dataset on 20170921 has a *large* number of files, some of which are only a couple of data points, showing the fluctuations and then increase in the threshold level

Same problem as seen in previous review: duplicate entries

- two datasets for the same time periods from 20170403-20170912 and 20171022-20171118

- from slimindx.tab:

```
"DUST               ","DATA/20170403_036751/","SDC_0367516328_0X700_SCI  "  ──────────────▶  "DUST               ","DATA/20170403_036784/","SDC_0367844528_0X700_SCI  "
"DUST               ","DATA/20170403_036751/","SDC_0367516329_0X700_SCI  "                    "DUST               ","DATA/20170403_036784/","SDC_0367844529_0X700_SCI  "
"DUST               ","DATA/20170404_036751/","SDC_0367516330_0X700_SCI  "                    "DUST               ","DATA/20170404_036784/","SDC_0367844530_0X700_SCI  "
"DUST               ","DATA/20170405_036751/","SDC_0367516331_0X700_SCI  "                    "DUST               ","DATA/20170405_036784/","SDC_0367844531_0X700_SCI  "
"DUST               ","DATA/20170405_036751/","SDC_0367516332_0X700_SCI  "                    "DUST               ","DATA/20170405_036784/","SDC_0367844532_0X700_SCI  "
"DUST               ","DATA/20170406_036751/","SDC_0367516333_0X700_SCI  "                    "DUST               ","DATA/20170406_036784/","SDC_0367844533_0X700_SCI  "
"DUST               ","DATA/20170406_036751/","SDC_0367516334_0X700_SCI  "                    "DUST               ","DATA/20170406_036784/","SDC_0367844534_0X700_SCI  "
"DUST               ","DATA/20170408_036751/","SDC_0367516335_0X700_SCI  "                    "DUST               ","DATA/20170408_036784/","SDC_0367844535_0X700_SCI  "
"DUST               ","DATA/20170410_036751/","SDC_0367516336_0X700_SCI  "                    "DUST               ","DATA/20170410_036784/","SDC_0367844536_0X700_SCI  "
"DUST               ","DATA/20170411_036751/","SDC_0367516337_0X700_SCI  "                    "DUST               ","DATA/20170411_036784/","SDC_0367844537_0X700_SCI  "
"DUST               ","DATA/20170413_036751/","SDC_0367516338_0X700_SCI  "                    "DUST               ","DATA/20170413_036784/","SDC_0367844538_0X700_SCI  "
"DUST               ","DATA/20170415_036751/","SDC_0367516339_0X700_SCI  "                    "DUST               ","DATA/20170415_036784/","SDC_0367844539_0X700_SCI  "
"DUST               ","DATA/20170416_036751/","SDC_0367516340_0X700_SCI  "                    "DUST               ","DATA/20170416_036784/","SDC_0367844540_0X700_SCI  "
"DUST               ","DATA/20170418_036751/","SDC_0367516341_0X700_SCI  "                    "DUST               ","DATA/20170418_036784/","SDC_0367844541_0X700_SCI  "


"DUST               ","DATA/20170903_036751/","SDC_0367516430_0X700_SCI  "
"DUST               ","DATA/20170910_036751/","SDC_0367516431_0X700_SCI  "
"DUST               ","DATA/20170911_036751/","SDC_0367516432_0X700_SCI  "
"DUST               ","DATA/20170912_036751/","SDC_0367516433_0X700_SCI  "
"DUST               ","DATA/20170403_036784/","SDC_0367844528_0X700_SCI  "
"DUST               ","DATA/20170403_036784/","SDC_0367844529_0X700_SCI  "
"DUST               ","DATA/20170404_036784/","SDC_0367844530_0X700_SCI  "
"DUST               ","DATA/20170405_036784/","SDC_0367844531_0X700_SCI  "
                              ...
                              ...
"DUST               ","DATA/20171116_037335/","SDC_0373355549_0X700_SCI  "
"DUST               ","DATA/20171118_037335/","SDC_0373355550_0X700_SCI  "
"DUST               ","DATA/20171022_037586/","SDC_0375861428_0X700_SCI  "
"DUST               ","DATA/20171023_037586/","SDC_0375861429_0X700_SCI  "
"DUST               ","DATA/20171023_037586/","SDC_0375861430_0X700_SCI  "
```

Example:

MISSION_NAME   = "NEW HORIZONS"
DATA_SET_ID   = "NH-X-SDC-2-KEMCRUISE1-V1.0"
PRODUCT_ID   = "SDC_0367516341_0X700_ENG"
PRODUCER_INSTITUTION_NAME = "SOUTHWEST RESEARCH INSTITUTE"
PRODUCT_TYPE   = "EDR"
MISSION_PHASE_NAME = "CRUISE TO FIRST KBO ENCOUNTER"
NEWHORIZONS:SEQUENCE_ID = "
  16179:TRSD_X_SDC_CHANNELSON_191_01__015"
NEWHORIZONS:OBSERVATION_DESC = "
  POWER ON CHANNELS FOR SCIENCE COLLECTION
"
TARGET_NAME   = "DUST"

PRODUCT_CREATION_TIME = 2018-06-01T00:00:00
START_TIME   = 2017-04-17T20:35:17.525
STOP_TIME   = 2017-04-19T00:59:30.525
SPACECRAFT_CLOCK_CNT_PARTITION = 3
SPACECRAFT_CLOCK_START_COUNT   = "0354767236:00000"
SPACECRAFT_CLOCK_STOP_COUNT   = "0354869488:49940"

MISSION_NAME   = "NEW HORIZONS"
DATA_SET_ID   = "NH-X-SDC-2-KEMCRUISE1-V1.0"
PRODUCT_ID   = "SDC_0367844541_0X700_ENG"
PRODUCER_INSTITUTION_NAME = "SOUTHWEST RESEARCH INSTITUTE"
PRODUCT_TYPE   = "EDR"
MISSION_PHASE_NAME = "CRUISE TO FIRST KBO ENCOUNTER"
NEWHORIZONS:SEQUENCE_ID = "
  16179:TRSD_X_SDC_CHANNELSON_191_01__015"
NEWHORIZONS:OBSERVATION_DESC = "
  POWER ON CHANNELS FOR SCIENCE COLLECTION
"
TARGET_NAME   = "DUST"

PRODUCT_CREATION_TIME = 2018-06-01T00:00:00
START_TIME   = 2017-04-17T20:35:17.525
STOP_TIME   = 2017-04-19T00:59:30.525
SPACECRAFT_CLOCK_CNT_PARTITION = 3
SPACECRAFT_CLOCK_START_COUNT   = "0354767236:00000"
SPACECRAFT_CLOCK_STOP_COUNT   = "0354869488:49940"

20170418-20170419 - ENG

20170418-20170419 - SCI
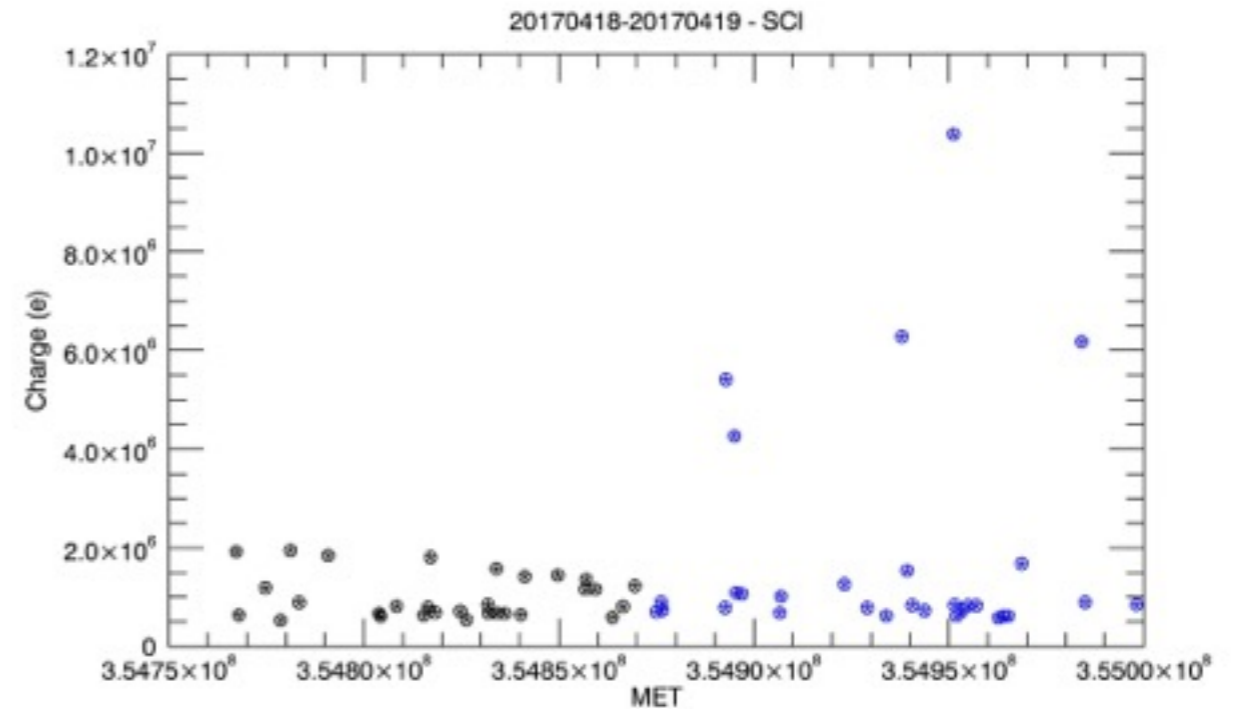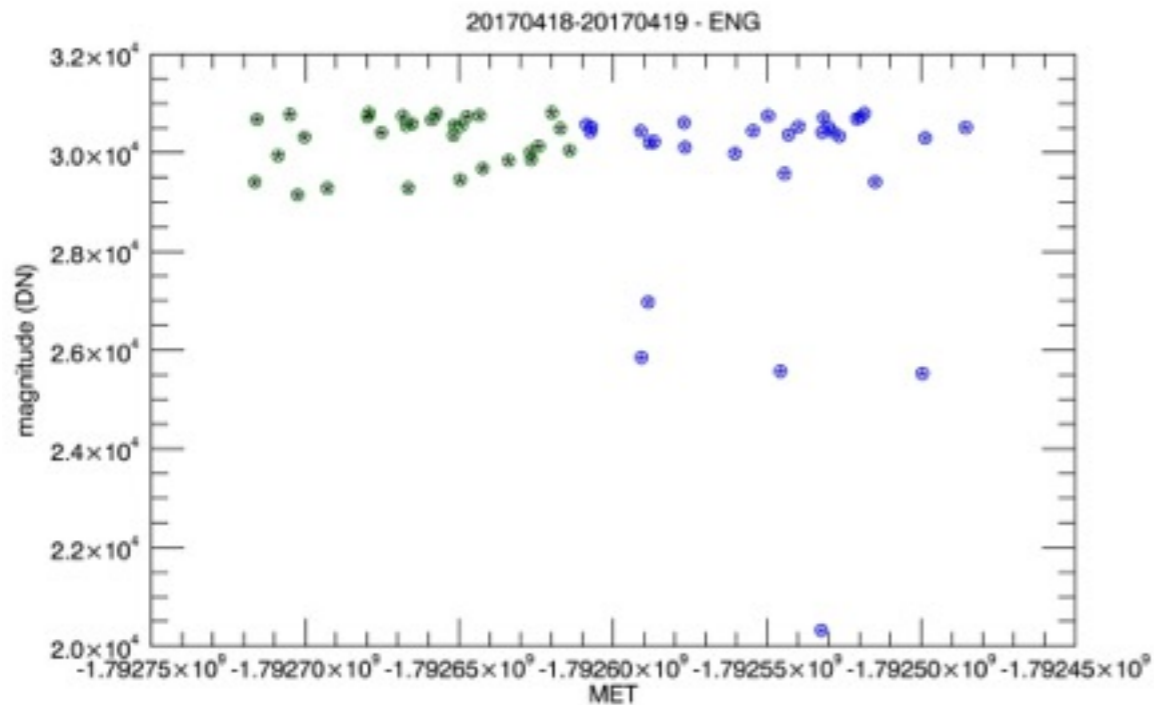
/documents/sdcram.csv

- new file - not in other datasets?

- provides a table of the general pointing direction of the NH s/c at different times, to emphasize when the s/c is pointing in the ram direction, when you would suspect that impact signals would be real

- should be used to verify the validity of dust "detections"?

- no other references to this document in other parts of the dataset, however
  - probably not used for the level 3 product, but should be carefully considered for any analysis

Availability of ancillary data

- Inconsistencies in timing, length of included data within the data files
  - nominal included data goes until 2017-12-17

- In both level 2 & 3

  - documents/sdcram only goes until 2016-12-31

  - documents/sdc_on_off_times_v0830.tab (and _alt.tab) only until 2017-01-24

  - documents/sdc_on_off_cmd_v001.tab (and _alt.tab) only until 2016-10-16

  - documents/sdc_on_3d_v0830.tab only until 2017-01-21

  - documents/sdc_off_3d_v0380.tab only until 2016-10-19

  - mission trajectory listed until 2017-12-31 (good!)

Typos

nh-x-sdc-2-kemcruise1-v1.0/catalog/nh_kem.cat

```
Mission Overview
================
   The New Horizons Kuiper Belt Extended Mission is a mission to a
   recently discovered, unexplored region of the solar system, the
   Kuiper Belt (KB). The centerpiece of the mission is a close flyby of
   Kuiper Belt Object (KBO) 2014 MU69. The mission will also aggressively
   survey the KB using NH as an observatory, examining many other
   Kuiper Belt Objects and Centaurs while studying the Kuiper Belt
   dust, gas, plasma, and energetic particle environments. Doing so
   will place both 2014 MU69 and the Pluto system in better context
   among KBOs, increasing scientific understanding of both.



Characterize regolith scattering properties of MU69 and any satellites
   and rings.
```

Typos

document/sdcram.lbl
Issues seen in both sdc-2 and sdc-3

```
3) Two counter fields indicating the power state of the SDC instrument:
4) Two fields comprising max and min  the angle between the SDC detector
   normal vector and the ram direction vector, over the sixty samples.
4) Two fields comprising the range (minimum and maximum values) of the
   angles between the SDC detector normal vector and the ram direction
   vector, as calculated over the sixty samples.

Awkward sentence:
Subtleties, such as how much the ram direction is from pointing directly
away from the Sun, are ignored.
```

should read MAXIMUM

```
OBJECT                  = FIELD
   NAME                 = "MINIMUM SDC BORE-RAM ANGLE"
   FIELD_NUMBER         = 9
   BYTES                = 7
   DATA_TYPE            = "ASCII_REAL"
   FORMAT               = "F7.2"
   UNIT                 = "DEGREES"
   INVALID_CONSTANT     = -999.00
   DESCRIPTION          = "This field provides the minimum value of the
                           angle between the SDC boresight and the ram
                           direction.  As long as one or more samples
                           were successfully calculated, this value will
                           range from 0.00 to 180.00.  For rows occurring
                           during large gaps in the time coverage of the
                           available SPICE C-Kernels, there may be no
                           successful results, the COOUNTER FOR
                           UNKNOWN ANGULAR VELOCITY field (FIELD_NUMBER
                           6) will be 60, and this field will have the
                           INVALID_CONSTANT value of -999.00.

                           The calculation of the boresight-ram angle
                           using SPICE C-Kernels; refer to the NH SPICE
                           data set [NH-J/P/SS-SPICE-6-V1.0] for more
                           details.
                           "
END_OBJECT              = FIELD
```

```
OBJECT                  = FIELD
   NAME                 = "MINIMUM SDC BORE-RAM ANGLE"
   FIELD_NUMBER         = 10
   BYTES                = 7
   DATA_TYPE            = "ASCII_REAL"
   FORMAT               = "F7.2"
   UNIT                 = "DEGREES"
   INVALID_CONSTANT     = -999.00
   DESCRIPTION          = "This field provides the maximum value of the
                           angle between the SDC boresight and the ram
                           direction.  As long as one or more samples
                           were successfully calculated, this value will
                           range from 0.00 to 180.00.  For rows occurring
                           during large gaps in the time coverage of the
                           available SPICE C-Kernels, there may be no
                           successful results, the COOUNTER FOR
                           UNKNOWN ANGULAR VELOCITY field (FIELD_NUMBER
                           6) will be 60, and this field will have the
                           INVALID_CONSTANT value of -999.00.

                           The calculation of the boresight-ram angle
                           using SPICE C-Kernels; refer to the NH SPICE
                           data set [NH-J/P/SS-SPICE-6-V1.0] for more
                           details.
                           "
END_OBJECT              = FIELD
```

Typos

```
nh-x-sdc-2-kemcruise1-v1.0/document/sdc_off_3d_v0830.lbl
nh-x-sdc-2-kemcruise1-v1.0/document/sdc_on_3d_v0830.lbl


      This table includes only only those time periods with a
      duration of at least three days.  This was requested by the
      reviewers during the peer review of this data set.


_____


nh-x-sdc-2-kemcruise1-v1.0/document/sdc_on_off_cmd_v0001.lbl
nh-x-sdc-2-kemcruise1-v1.0/document/sdc_on_off_cmd_v0001_alt.lbl

Repeated phrasing:

   The ordering of events in this file is by time, then channel number.

    This INCLUDES ONLY those events initiated by spacecraft commanding.

    This EXCLUDES those events initiated by SDC autonomy.

    The ordering of events in this file is by time, then channel number.


_____
```

typos in (all) _eng.lbl files:

…
…
Extension_HK_0x00D_TABLE

…
Spacecraft housekeeping data table from ApID 0X00D
- Miscellaneouse RALPH and SDC temperatures