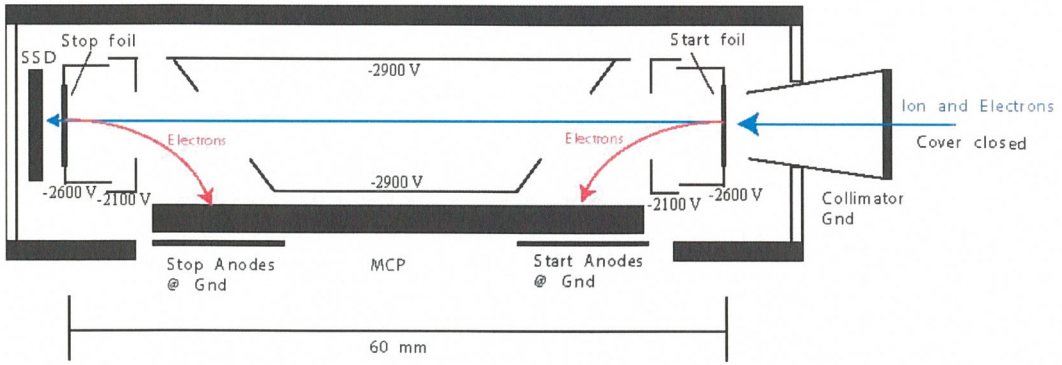
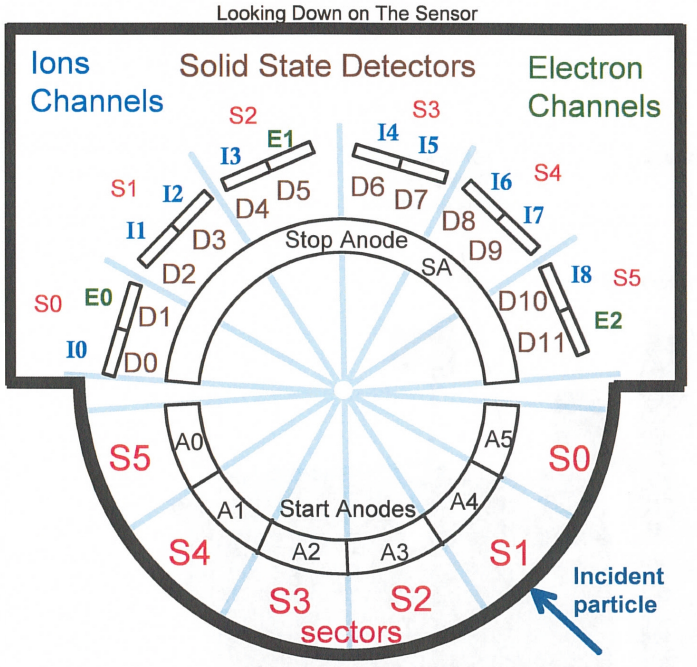
New Horizons Pluto Energetic Particle Spectrometer Science Investigation (PEPSSI)

PRINCIPAL INVESTIGATOR: Ralph McNutt, APL
DESCRIPTION: Medium Energy Particle Spectrometer
ENERGY RANGE: 25-1000 keV (protons)
60-1000 keV (atomic ions)
25-500 keV (electrons)

FIELD OF VIEW: 160 deg x 12 deg
ANGULAR RESOLUTION: 25 deg x 12 deg
ENERGY RESOLUTION: 0.25 keV
SENSOR SIZE: 7.6 cm dia. x 2.5 cm thick
POWER: 1.4 watt
MASS: 1.5 kg





New Horizons PEPSSI Data Sets

RAW ->

nh-x-pepssi-2-plutocruise-v1.0

CALIBRATED ->

nh-x-pepssi-3-plutocruise-v1.0

New Horizons PEPSSI Data Set Evaluation Tools

Staging and Evaluation -

Machine: Dell Precision T3400

Operating System: Fedora 18 linux

Data Processing -

Machine: Sun Ultra-350

Operating System: Sun Solaris OS 5.9

Minor Diagnostics -

Machine: IBM lenovo T60p ThinkPad

Operating System: Fedora 20 linux

Documentation Evaluation

Inconsistent File Name Definition

- Inconsistent definition of file names in aareadme.txt and catalog/dataset.cat

From catalog/dataset.cat (agrees with the ICD):

```
Filename/Product IDs
--------------------

  The filenames and product IDs of observations adhere to a
  common convention e.g.

   ALI_0123456789_0X0AB_ENG_1.FIT
   ^^^ ^^^^^^^^^^ ^^^^^ ^^^ ^\__/
   |         |        |    |  | ^^
   |         |        |    |  |  |
   |         |        |    |  |  +--File type (includes dot)
   |         |        |    |  |     - .FIT for FITS file
   |         |        |    |  |     - .LBL for PDS label
   |         |        |    |  |     - not part of product ID
   |         |        |    |  |
   |         |        |    |  +-- Version number from the SOC
   |         |        |    |      (Science Operations Center)
   |         |        |    |
   |         |        |    +--ENG for CODMAC Level 2 data *
   |         |        |       SCI for CODMAC Level 3 data *
   |         |        |
   |         |        +--Application ID (ApID) of the telemetry data
   |         |           packet from which the data come
   |         |
   |         +--MET (Mission Event Time) i.e. Spacecraft Clock
   |
   +--Instrument designator
```

Inconsistent File Name Definition - 2

From aareadme.txt (agrees with the document aareadme_bu):

```
Data Filenames and Product IDs
==============================

The filenames of data files and the Product IDs of observations adhere
to a common convention e.g.

         ALI_0123456789_0X0AB_ENG_1.FIT
         ^^^ ^^^^^^^^^^ ^^^^^ ^^^ ^\__/
         |         |       |    |  | ^^
         |         |       |    |  |  |
         |         |       |    |  |  +--File type (includes dot)
         |         |       |    |  |     - .FIT for FITS file
         |         |       |    |  |     - .LBL for PDS label
         |         |       |    |  |     - not part of Product ID
         |         |       |    |  |
         |         |       |    |  +-- Version number; SOC-internal
         |         |       |    |      (Science Operations Center)
         |         |       |    |      (see Note FN1)
         |         |       |    |
         |         |       |    +--ENG for Raw data
         |         |       |       SCI for Calibrated data
         |         |       |      (see Note FN1)
         |         |       |
         |         |       +--Application ID (ApID) of the telemetry data
         |         |          packet from which the data come (see Note FN2)
         |         |
         |         +--Spacecraft Receipt Mission Elapsed Time (SCRMET)
         |
         +--Instrument/observation designator
```

Inconsistent File Name Definition - 3

From aareadme.txt:

> Note that, depending on the observation, the SCRMET in the data filename and in the Product ID may be similar to the Mission Elapsed Time (MET) of the actual observation acquisition, but should not be used as an analog for the acquisition time. The SCRMET is the time that the data are transferred from the instrument to spacecraft memory and is therefore not a reliable indicator of the actual observation time. The PDS label

Note that MET is not the same as SCRMET.

The ICD makes no reference to SCRMET.

nh-x-pepssi-2-plutocruise-v1.0/catalog
nh-x-pepssi-3-plutocruise-v1.0/catalog
nhsc.cat

- Unable to locate Figure 5:

The 16 rocket engine assemblies (REAs) are organized into 8 sets and placed on the spacecraft as shown in Figure 5. Pairs of the 0.8N

- Unable to locate Table II:

rates allowed during this operation mode. Control rates for each of the spacecraft axes are shown below in Table II. One pair of the 4.4N

nh-x-pepssi-2-plutocruise-v1.0/catalog
nh-x-pepssi-3-plutocruise-v1.0/catalog
ref.cat

- Incomplete Journal Specification:

```
OBJECT               = REFERENCE
  REFERENCE_KEY_ID   = "ANDREWSETAL1998"
  REFERENCE_DESC     = "
Andrews, G.B., Robert E. Gold, Edwin P. Keath, Donald G. Mitchell, Richard W.
McEntire, Ralph L. McNutt, Jr., Nicholas P. Paschalidis, Compact particle
detector for space measurements: prototype performance, Proceedings Vol. 3442
Missions to the Sun II, Clarence M. Korendyke, Editors, pp.105-114, 1998.
  "
END_OBJECT           = REFERENCE
```

Should site “Proceedings SPIE” as the journal.

- Incorrect Reference Year:

```
OBJECT               = REFERENCE
  REFERENCE_KEY_ID   = "BELTONETAL2002"
  REFERENCE_DESC     = "
Belton, M. J., et al., New Frontiers in the Solar System. An Integrated
Exploration Strategy, National Research Council, 145 pp, 2002.
  "
END_OBJECT           = REFERENCE
```

Can not find a 2002 reference which has more than 100 pages. There is a 2003 reference which exceeds 145 pages.

nh-x-pepssi-2-plutocruise-v1.0/catalog
nh-x-pepssi-3-plutocruise-v1.0/catalog
ref.cat - 2

- SwRI library unable to locate the following references:

```
OBJECT                = REFERENCE
  REFERENCE_KEY_ID    = "DSN810-5"
  REFERENCE_DESC      = "
Deep Space Network / Flight Project Interface Design Book, JPL-D-810-5, Jet
Propulsion Laboratory, Pasadena, CA 2003.
  "
END_OBJECT            = REFERENCE

OBJECT                = REFERENCE
  REFERENCE_KEY_ID    = "DSN821-104"
  REFERENCE_DESC      = "
Deep Space Mission Systems, Tracking and Navigation Service, Requirements and
Design, DSMS No. 821-104, Rev. B, JPL D-17235, Jet Propulsion Laboratory,
Pasadena, CA, 2003.
  "
END_OBJECT            = REFERENCE

OBJECT                = REFERENCE
  REFERENCE_KEY_ID    = "DSN821-110"
  REFERENCE_DESC      = "
Deep Space Mission Systems, Radio Science Service, Requirements and Design,
DSMS No. 821-110, Rev. A, JPL D-17241, Jet Propulsion Laboratory, Pasadena,
CA, 2001.
  "
END_OBJECT            = REFERENCE
```

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
soc_inst_icd_intro.pdf and soc_inst_icd_acroabbr.pdf

A test was conducted on the ICD intro pdf to determine if an acronym was included within the ICD acroabbr pdf file. The acronym chosen was “CM” and occurs on page 6, section 6.6, line 3 of the ICD intro pdf. This acronym was not found in the acroabbr pdf file.

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
soc_inst_icd.pdf - 1

RATEBOXDEFINITIONPLANES.FIT not found as stated in the ICD

c. For ease of use, we have added a column giving the deduced "Rate Box" of High-Ion PHA and Electron PHA events to the Level 2 PHA data. While this can, in principle, be calculated from the raw Level 2 quantities and the RATEBOXDEFINITIONPLANES.FIT file available in the CALIB/ directiory of the PDS archive, the procedure is complex enough that we have found it convenient to perform this calculation in advance and include the information in the Level 2 files.

11.4.3.5.1 Rate Box Definitions

For Electrons and Low-Ions, the rate box definitions are simple ranges in Energy and TOF in ADUs which can be found in the Level 2 headers. For Hi-Ions, the Rate Boxes are regions in the TOF-Energy plane (see Figure 11-6). The precise specification of the rate boxes is complex and this is why we include rate box classifications in the Level 2 PHA data. However, we also provide the file RATEBOXDEFINITIONPLANES.FIT in the CALIB/ directory of PDS data sets.

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
soc_inst_icd.pdf - 2

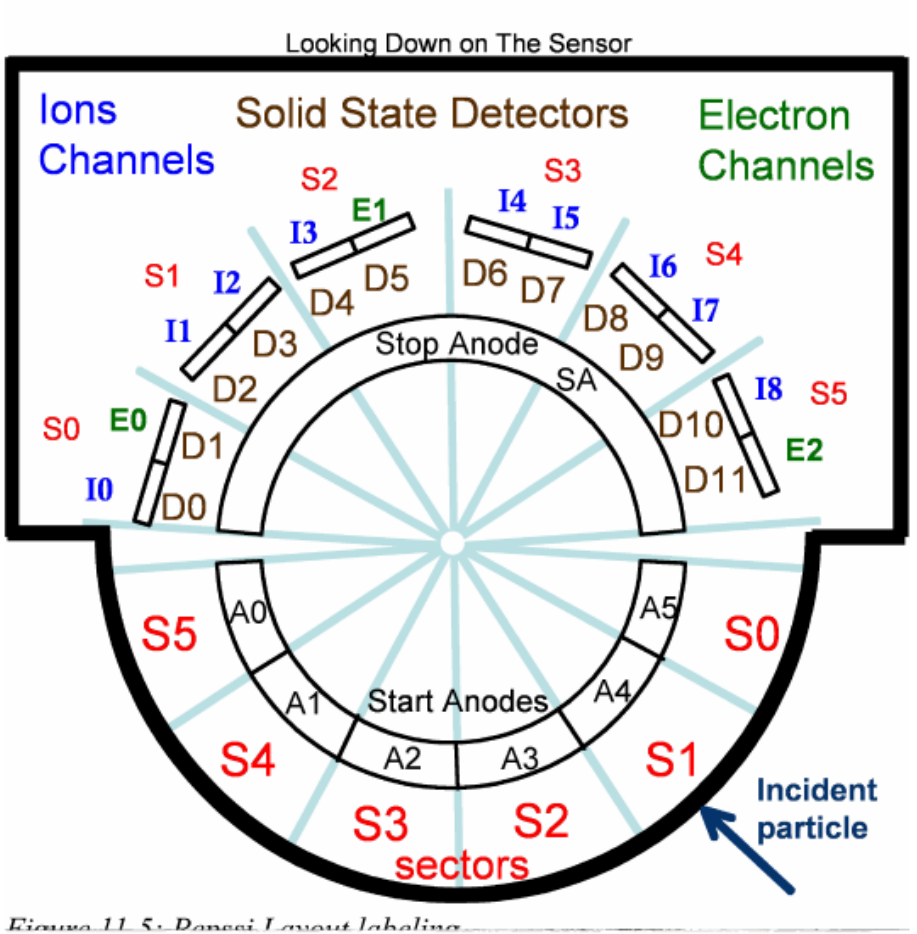


Figure 11-5: Pepssi Layout labeling

Cut Off Figure Caption

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
soc_inst_icd.pdf - 3

Corrupted Figure

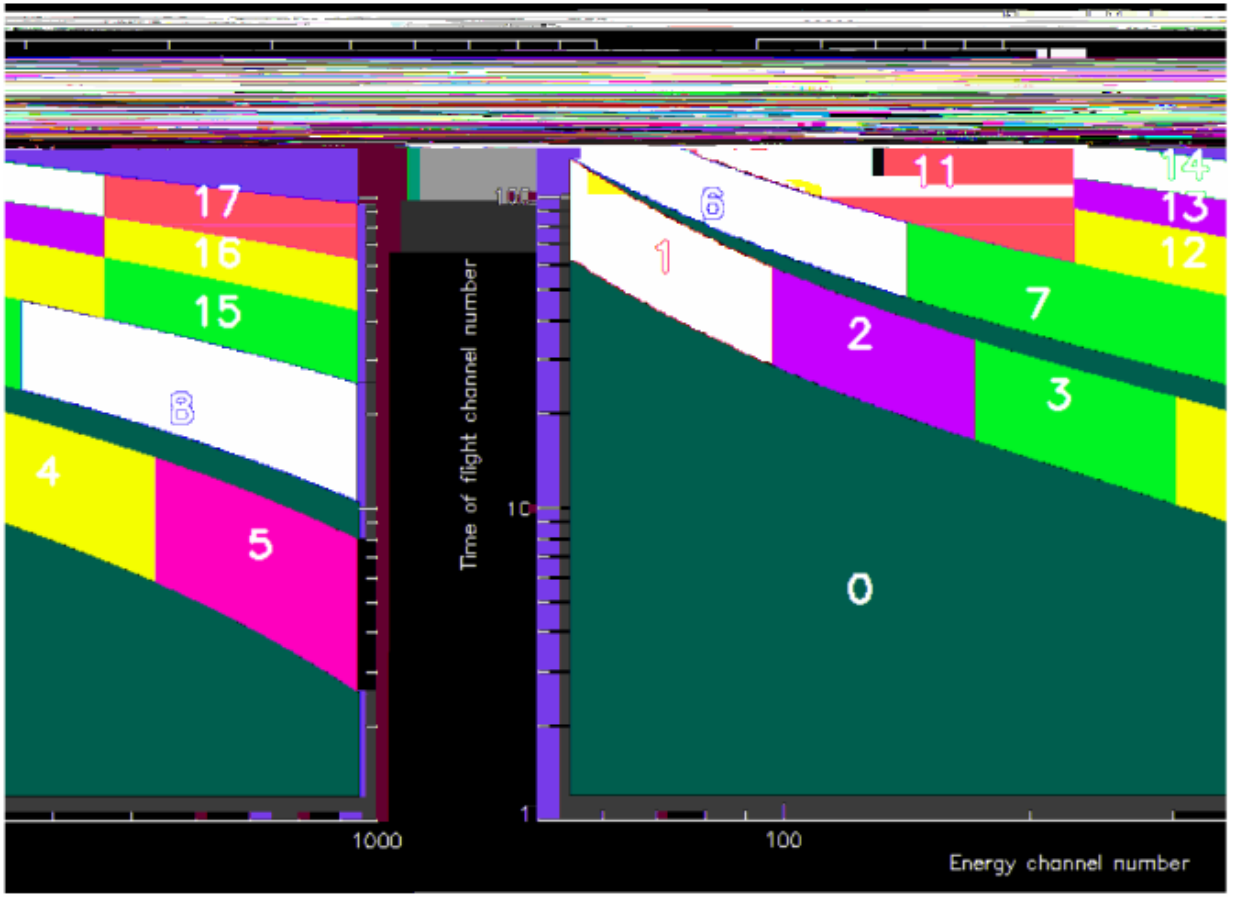
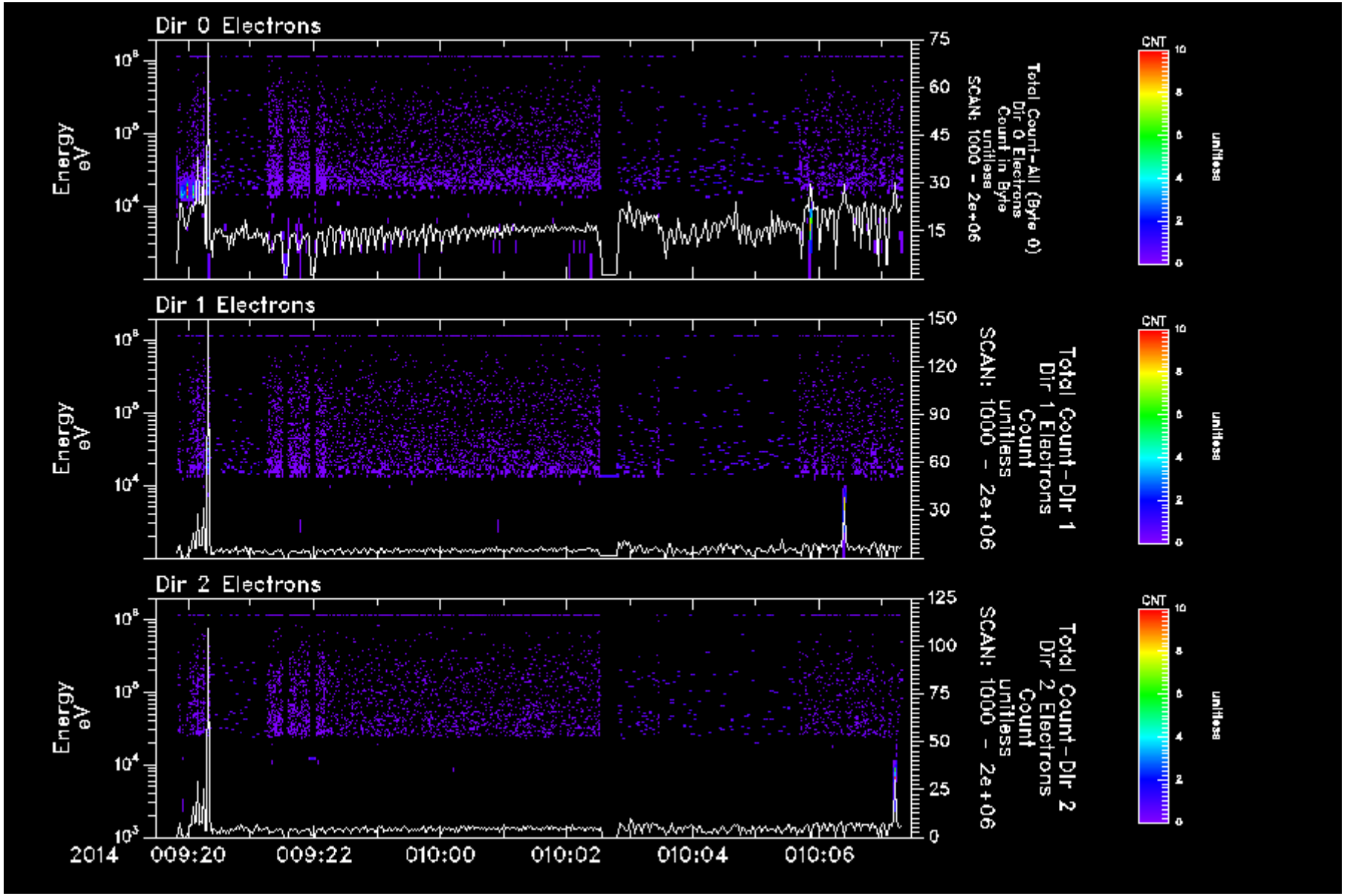


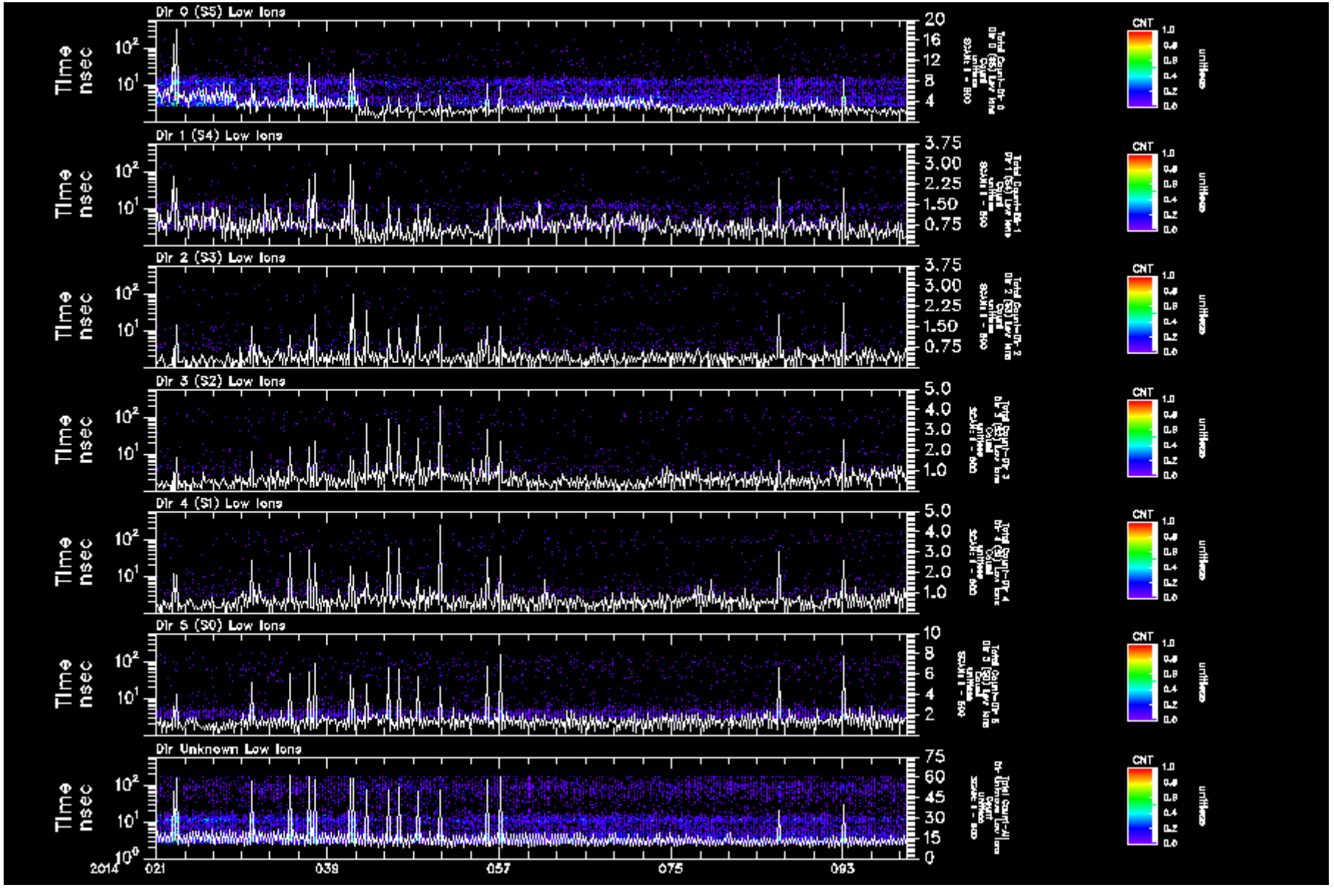
Figure 11-6: PEPSSI Rate Boxes on the TOF vs Energy Plane. Normal Mode.

Data Evaluation

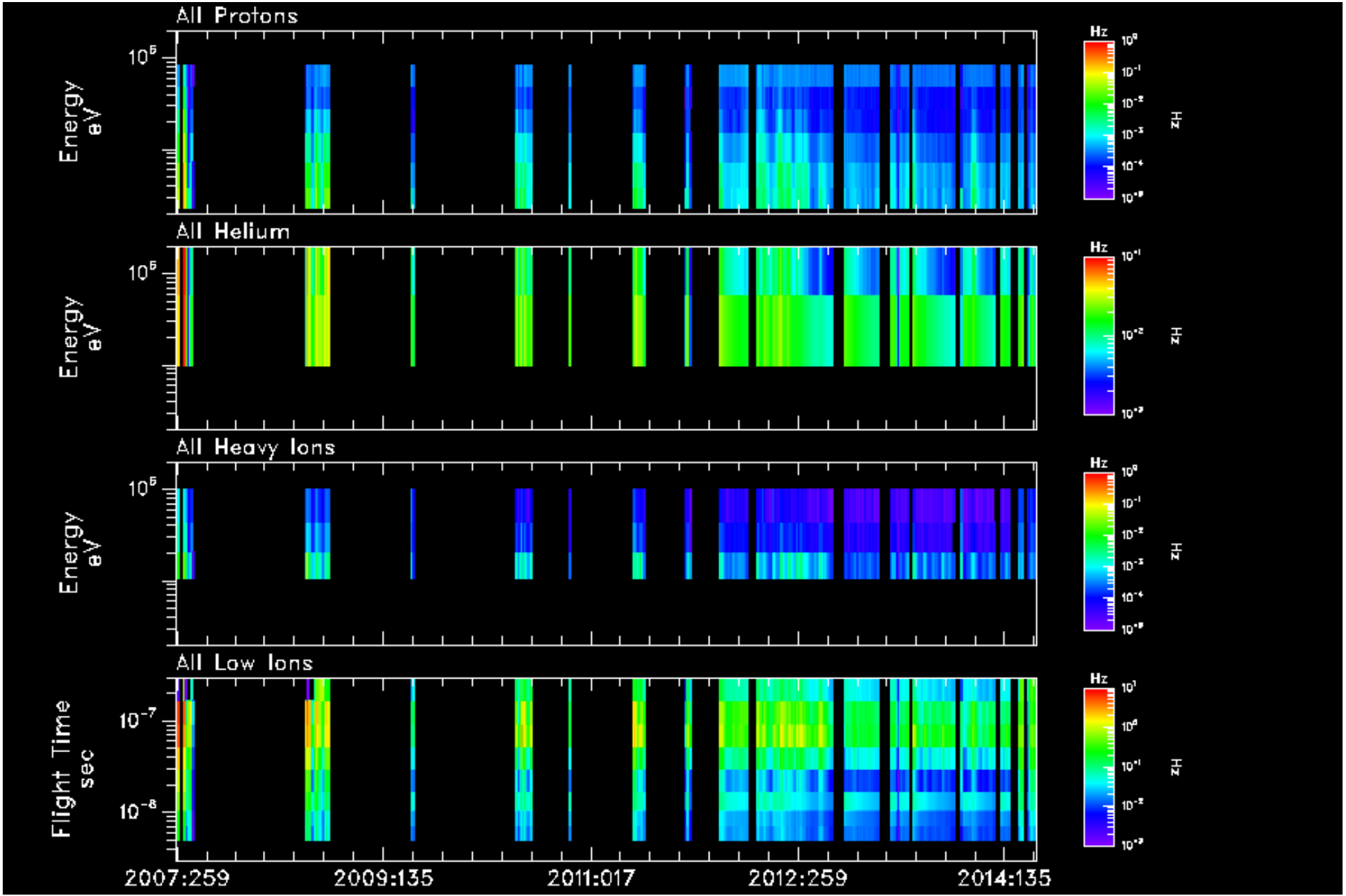
PHA for Electrons



TOF for Low Energy Ions



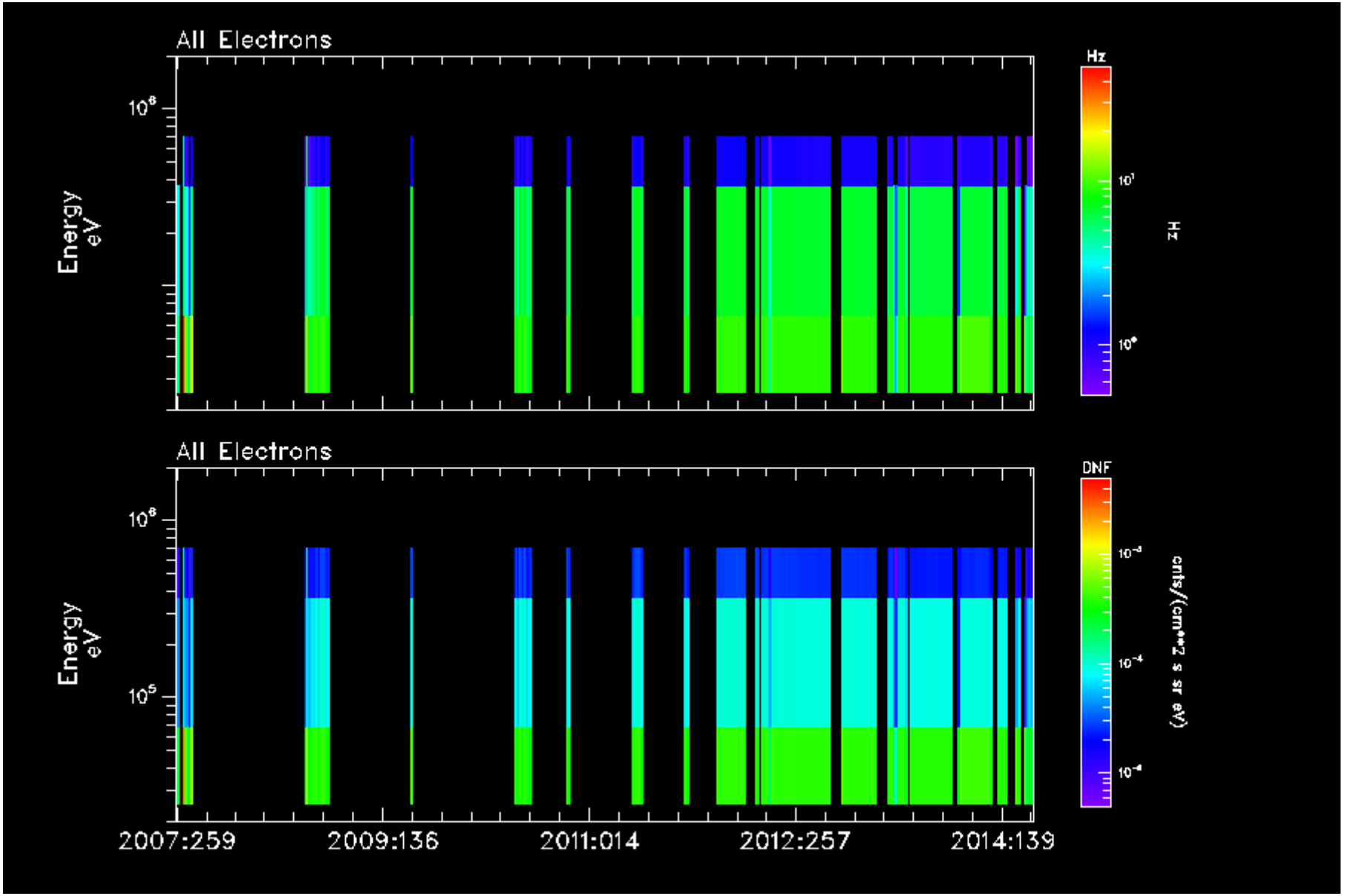
PEPSSI Ions - 1



PEPSSI Ions - 2

- Time axis represents radial distance, about 5 AU in 2007 to about 28 AU in 2014.
- Density decreases by about r^{-2} with radial distance.
- Velocity is approximately constant with radius.
- So number flux decreases with radial distance.
- Since count rate is proportional to flux, we expect the count rate to decrease with radial distance.
- We see the ion count rates decreasing with radial distance as expected.

PEPSSI Electrons - 1

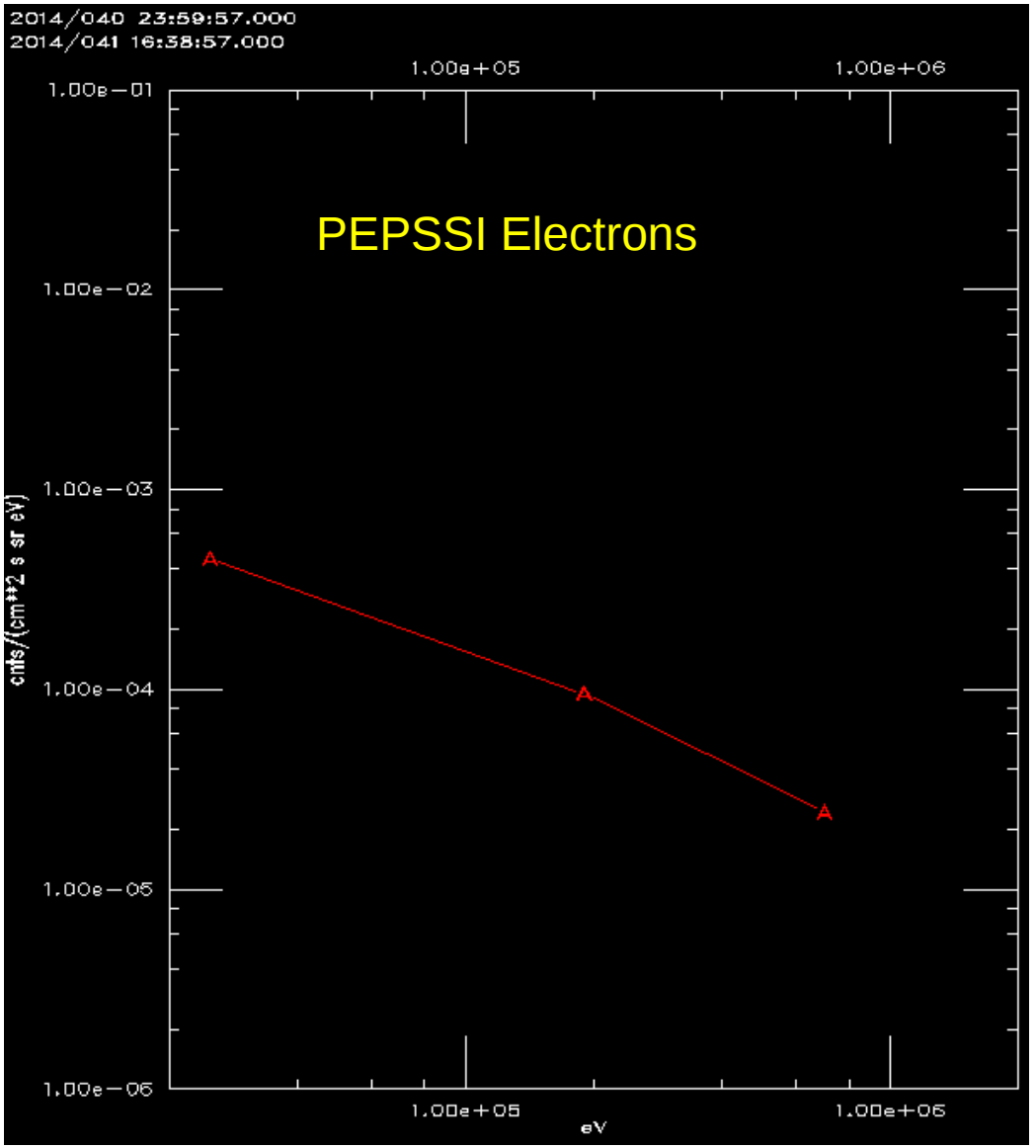


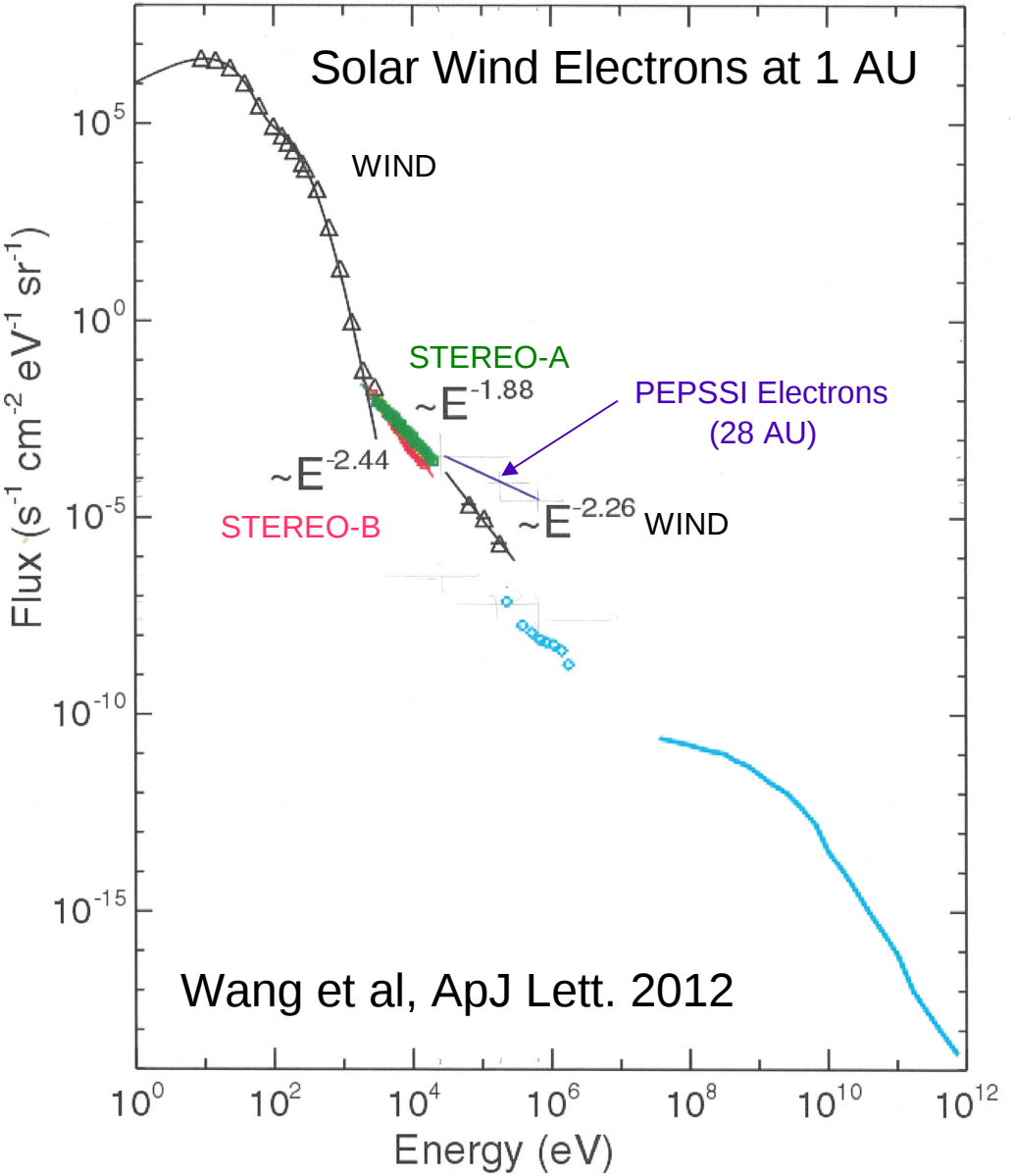
PEPSSI Electrons - 2

- Electrons should also show a flux decrease with distance.
- Count rates for electrons and electron flux spectrograms do not indicate a decrease with distance...Why?
- Electron count rates seem higher than expected. Investigating this further, let's compare the 28 AU fluxes to 1 AU fluxes, they should be lower by about 28^{-2}.

PEPSSI Electrons - 3

Why are the fluxes from PEPSSI abnormally high?





Calculation of Flux

$$\text{Flux}(i) = \text{Count Rate}(i) / [G * \Delta E(i) * 1000 \text{ eV/keV}]$$

Where Count Rate are from data file in s^{-1}

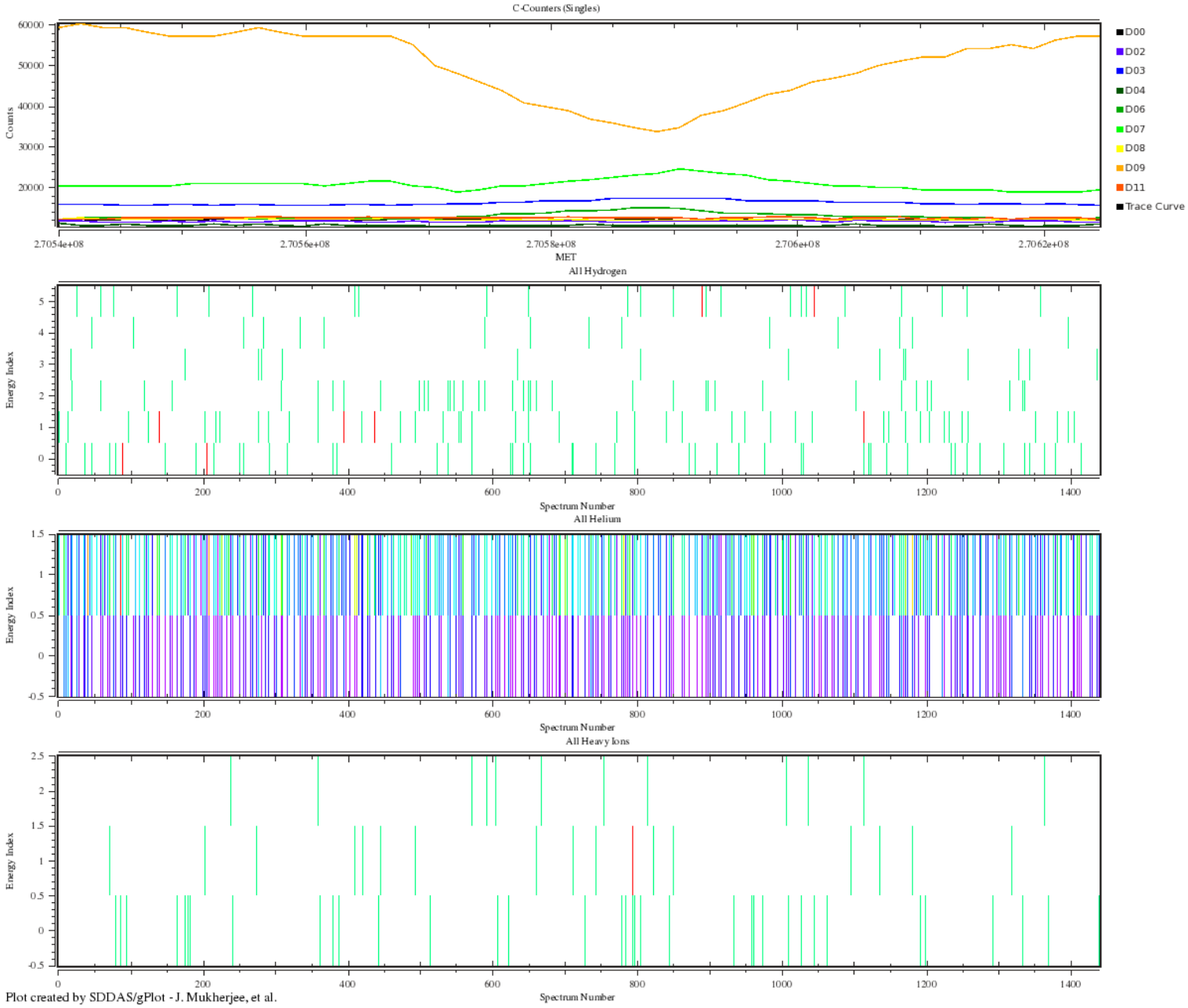
$$G = 0.14 \text{ cm}^2 \text{ sr}$$

$$\Delta E(i) = E_{high}(i) - E_{low}(i)$$

$E_{high}(i)$ and $E_{low}(i)$ are from data file in keV

and Flux(i) is in units of particles/[cm^2 s sr eV]

Data/20140817_027053/
pep_0270539515_0x691_eng_1.fit
pep_0270539515_0x691_sci_1.fit



Ion SSD Singles

Hydrogen

Helium

Heavy

Data/20140817_027053/
pep_0270539515_0x691_eng_1.fit
pep_0270539515_0x691_sci_1.fit - 2

- Results of all ion sensors are averaged to produce spectrograms.
- Ion sensor D09 dominates over every-other sensor (solar wind in sector D09?).
- No documentation indicates an abnormality with any sector and all SSDs have the same efficiency.
- Counts in D09 show a dip by a factor of 2 during the day
- Ion spectrgrams do not show a decrease in count rates during the day.
- Why do the ion spectrograms not show a decrease during the day?

Data/20140817_027053/
pep_0270539515_0x691_eng_1.fit
pep_0270539515_0x691_sci_1.fit - 3

- So how do the experimenters convert their raw engineering data into their spectral data?
- Unable to locate a document which tells how this is done.
- I would suggest that there experimenters generate and include a small document which describes the procedure for converting the raw data into the science data. Starting from the raw data, how is the science data generated. Include notations where assumptions are made (like in SSD efficiency of 100%).

Back-Up Slides

nh-x-pepssi-2-plutocruise-v1.0
nh-x-pepssi-3-plutocruise-v1.0
errata.txt

GOOD

nh-x-pepssi-2-plutocruise-v1.0
nh-x-pepssi-3-plutocruise-v1.0
voldesc.cat

GOOD

nh-x-pepssi-2-plutocruise-v1.0/calib
nh-x-pepssi-3-plutocruise-v1.0/calib
calinfo.txt

GOOD

nh-x-pepssi-2-plutocruise-v1.0/calib
nh-x-pepssi-3-plutocruise-v1.0/calib
hk_n1_input_20050228.lbl

GOOD

nh-x-pepssi-2-plutocruise-v1.0/calib
nh-x-pepssi-3-plutocruise-v1.0/calib
hk_n1_input_20050228.tab

GOOD

nh-x-pepssi-2-plutocruise-v1.0/calib
nh-x-pepssi-3-plutocruise-v1.0/calib
hk_stat_input_20041016.lbl

GOOD

nh-x-pepssi-2-plutocruise-v1.0/calib
nh-x-pepssi-3-plutocruise-v1.0/calib
hk_stat_input_20041016.tab

GOOD

nh-x-pepssi-2-plutocruise-v1.0/catalog
nh-x-pepssi-3-plutocruise-v1.0/catalog
catinfo.txt

GOOD

nh-x-pepssi-2-plutocruise-v1.0/catalog
nh-x-pepssi-3-plutocruise-v1.0/catalog
dataset.cat

- See note on Inconsistent File Name Definition
- Minor Corrections Sent to PDS/SBN

nh-x-pepssi-2-plutocruise-v1.0/catalog
nh-x-pepssi-3-plutocruise-v1.0/catalog
pepssi.cat

- Minor Corrections Sent to PDS/SBN

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
aareadme_bu.txt

- See note on Inconsistent File Name Definition
- Minor Corrections Sent to PDS/SBN

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
docinfo.txt

- See note on Inconsistent File Name Definition
- Minor Corrections Sent to PDS/SBN

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
lunineetal1995.lbl and lunineetal1995.pdf

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
nh_fov.lbl and nh_fov.png

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
nh_met2utc.lbl and nh_met2utc.tab

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
nh_mission_trajectory.lbl and nh_mission_trajectory.tab

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
nh_pepssi_v110_ti.txt

- Minor Corrections Sent to PDS/SBN

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
nh_trajectory.lbl and nh_trajectory.tab

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
payload_ssr.lbl and payload_ssr.pdf

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
pdsdd_insert_newhorizons.txt

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
pep_bti.lbl and pep_bti.tab

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
pepssi_ssr.lbl and pepssi_ssr.pdf

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
quat_axyz_instr_to_j2k.lbl and
quat_axyz_instr_to_j2k.asc

GOOD

nh-x-pepssi-2-plutocruise-v1.0/document
nh-x-pepssi-3-plutocruise-v1.0/document
seq_pepssi_plutocruise.lbl and
seq_pepssi_plutocruise.tab

GOOD