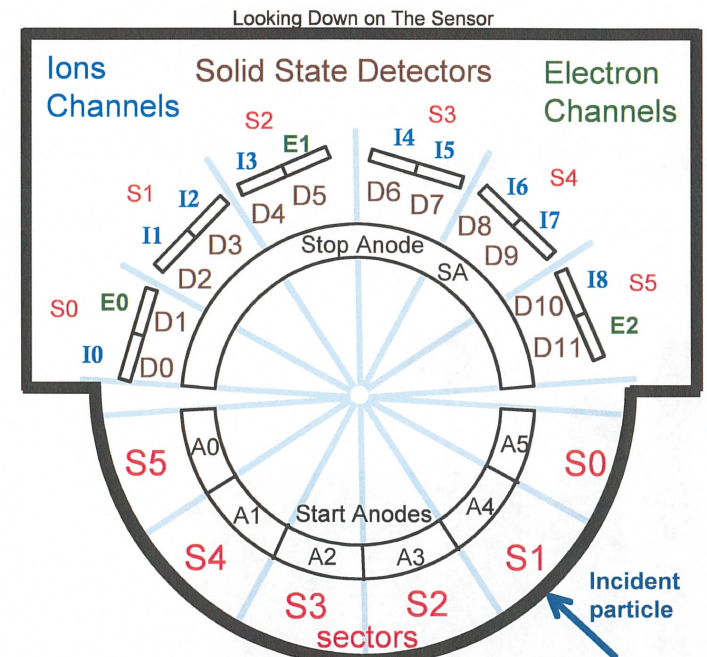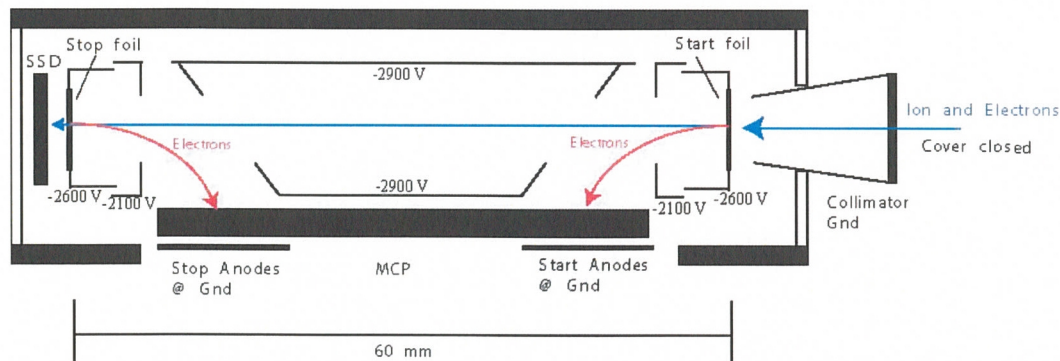# New Horizons
Pluto Energetic Particle Spectrometer Science Investigation (PEPSSI)

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-v2.0
          nh-p-pepssi-2-pluto-v2.0

CALIBRATED ->

        nh-x-pepssi-3-plutocruise-v2.0
          nh-p-pepssi-3-pluto-v2.0

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
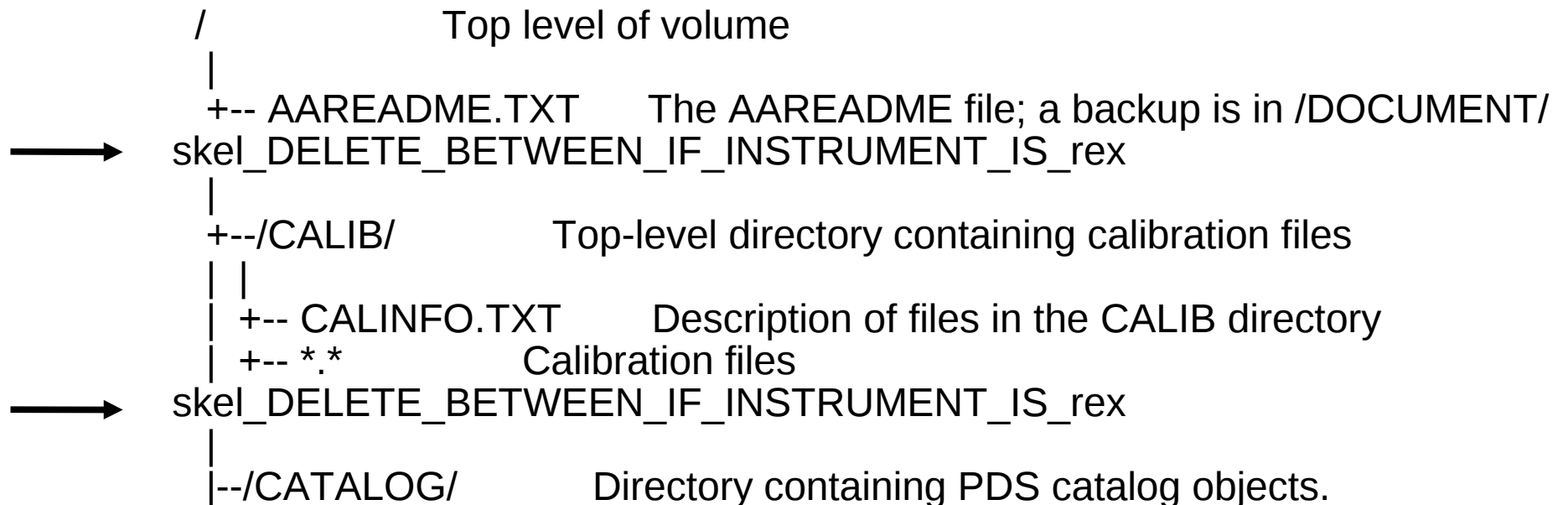
Documentation Evaluation

All Data Sets
Comment on Additional Review Notes

Additional notes submitted to PDS on grammar and spelling are not included within this review document. Additional notes contain errors which show examples found in the text. Since many of the files are duplicated across data sets, please check if the same error exists in the files of all other data sets or similar errors exist in other files.

All Data Sets in the Top Level Directory
aareadme.txt

Left over commands from generic processing ->

```
   /                    Top level of volume
   |
   +-- AAREADME.TXT      The AAREADME file; a backup is in /DOCUMENT/
skel_DELETE_BETWEEN_IF_INSTRUMENT_IS_rex
   |
   +--/CALIB/            Top-level directory containing calibration files
   | |
   | +-- CALINFO.TXT      Description of files in the CALIB directory
   | +-- *.*              Calibration files
skel_DELETE_BETWEEN_IF_INSTRUMENT_IS_rex
   |
   |--/CATALOG/          Directory containing PDS catalog objects.
```

All Data Sets in the catalog Directory dataset.cat – 1 of 2

PEPSSI ApIDs not discussed in ICD.

What is the Difference Between these two sets of ApIDs? There seems to be a missing word in the description.

```
===========  =====================================  ==============
PEPSSI        PEP                                    0X691 - 0X698 *

* Not all values in this range are in this data set
** ApIDs are case insensitive

There are other ApIDs that contain housekeeping values and
other values.  See SOC Instrument ICD (/DOCUMENT/SOC_INST_ICD.*)
for more details.


Here is a summary of the types of files generated by each ApID
(N.B. ApIDs are case-insensitive) along with the instrument
designator that go with each ApID:


ApIDs   Data product description/Prefix(es)
=====   ===================================
0x691 - PEPSSI High Priority Science/PEP
0x692 - PEPSSI Medium Priority Science/PEP
0x693 - PEPSSI Low Priority Science (Up to 500 PHA events)/PEP
0x694 - PEPSSI Low Priority Science (Up to add'l 500 PHA events)/PEP
0x695 - PEPSSI High Priority Science/PEP
0x696 - PEPSSI Medium Priority Science/PEP
0x697 - PEPSSI Low Priority Science (Up to 500 PHA events)/PEP
0x698 - PEPSSI Low Priority Science (Up to add'l 500 PHA events)/PEP
```

All Data Sets in the catalog Directory
dataset.cat – 1 of 2

The PHA event data are 'raw' values and some subset of them are noise
or other instrumental artifacts, so PHA events with parameters outside
the stated instrument sensitivity limits (see SPECIFICATION above)
should be ignored, or, at the very least, used with extreme caution.

There is no SPECIFICATION listed in this document. Unable to locate text which discusses why a PHA event could be outside an instrument limit.

For PEPSSI, the electron count rates have not changed as expected with
distance from the sun. The team is aware of this and is reviewing
the data.

Note that this is of concern. If the electron count rates are found to be caused by some instrumental artifact and not representative of the heliospheric environment, then they should be removed as a science data product from this data set and a note added to the data set documentation to explain the findings. We do not want someone to pick up these electron measurements if they do not represent electrons in the heliosphere

All Data Sets in the catalog Directory ref.cat

The fact that possible ITAR controlled documents are referenced is of concern and this file should be reviewed by the State Department before public release because a review of this file by SwRI finds that some of the listed references violate ITAR.

Reported by the SwRI Library: The references are marked as possibly being under ITAR control are indeed under ITAR control.

Reported by SwRI Legal Department: Revealing the existence of an ITAR controlled document is itself a violation of ITAR.

All Data Sets in the catalog Directory nhsc.cat

circuits is grouped functionally by pairs (to minimize the number of switches required), so that a total of 16 switches control the heater elements, allowing great flexibility to operate the spacecraft safely while drawing the minimum required power. Operational requirements for catalyst bed heater

Missing Text

The pulse duration and total on-time of each thruster are commanded very precisely, providing accurate control of the total impulse generated during a maneuver. The 0.8N thrusters can be turned on for periods as short as 5 ms. The initial propellant load was allocated

```
The calibration parameters are ideally be determined through a
combination of all of the following: ground measurements; analysis of the
in-flight calibration alpha-particle source; modeling; intercalibration
with known measurements.  Currently only the final method has been
employed, which has the obvious drawback of not providing an independent
determination of the absolute flux.  Therefore the fluxes provided in
CODMAC Level 3 data should not be used as is to conduct science that is
relying on absolute fluxes for scientific interpretation unless the user
determines the fluxes independently.
```

Although accurate and it should be in this text, it seems odd that such statement needs to be included at this stage of the mission. Is there a good reason why the PEPSSI instrument was not and has not been absolutely calibrated at this late stage in the mission?

In this initial delivery of the PEPSSI data from the Launch and Jupiter
phases of the New Horizons mission these values are supplied to convert
the instrument specific data (e.g., count rates) into physical
instrument-independent units (e.g., differential intensity), as well as
computing the physical quantities themselves. It must be stressed that
these are preliminary values that should not be used without
significant effort from the user to understand their limitations (see
the SOC Instrument ICD, provided with this archive, and McNutt et
al. (2008) [MCNUTTETAL2008A] for a description of the method used to
calculate differential intensity, also called flux).

This text would seem to indicate that there have been no
adjustments made to the PEPSSI calibration parameters
In a while. Shouldn't the experimenters pay more attention
to these "preliminary" values so that they can be finalized?
This statement and the previous statements raise the question
of whether the PEPSSI data is of high enough quality to be
useful for future scientific investigations.

The Rate_Normalized_Weight quantities have had Priority Group artifacts removed from the PHA data by the procedure described in the SOC Instrument ICD. This column is usually used in making histograms of the High Energy Ion PHA data.

It is not clear to which column is being referred. Since this information is expected in the data files, both the science and engineering data packets were examined. No column holding the rate weights was found. The ICD is not clear whether or not any data other than that in the Primary HDU is rate corrected.

```
       Events with the multi-hit (cross talk) flag set have been excluded.
Quantities of limited usefulness (such as Heavy Ion Discriminator triggers)
have been excluded.   Because of the difficulty of removing priority scheme
biases from non-N2 PHA data, only N2 (APID == 0x692) PHA data is present in
the calibrated PHA data.
```

Only ApID = 0x691 is found in the calibrated data sets. The ICD agrees with this file and calls out ApID = 0x692 as the L3 data product.

nh-x-pepssi-2-plutocruise-v2.0
nh-p-pepssi-2-pluto-v2.0
calib/calinfo.txt

```
| - [calpars]    Directry containing calibration parameters
|
| - calpinfo.txt  Description of [calpars] directory contents
| - *.*           Calibration parameters files
```

Directory does not exist. It only exists in the L3 structure.

All Data Sets in the calib Directory rateboxdefinitionplanes.lbl

The octal dump was examined. As far as I could tell, the main sections agreed with the byte description in the lbl file. There was no description of what was in the header portion of the fit file, but an octal dump showed that it was ASCII characters, and thus, could be read. Some other minor issues reported to PDS

nh-p-pepssi-3-pluto-v2.0
nh-x-pepssi-3-plutocruise-v2.0
calib/calpars/calpinfo.txt

Shouldn't the file calpar_columns.fmt be listed? Currently it is missing from the calpinfo.txt file.

All Data Sets in the document Directory aareadme_bu.txt

Left over commands from generic processing ->

```
 /                  Top level of volume
 |
 +-- AAREADME.TXT      The AAREADME file; a backup is in /DOCUMENT/
 skel_DELETE_BETWEEN_IF_INSTRUMENT_IS_rex
 |
 +--/CALIB/          Top-level directory containing calibration files
 | |
 | +-- CALINFO.TXT      Description of files in the CALIB directory
 | +-- *.*              Calibration files
 skel_DELETE_BETWEEN_IF_INSTRUMENT_IS_rex
 |
 |--/CATALOG/        Directory containing PDS catalog objects.
```
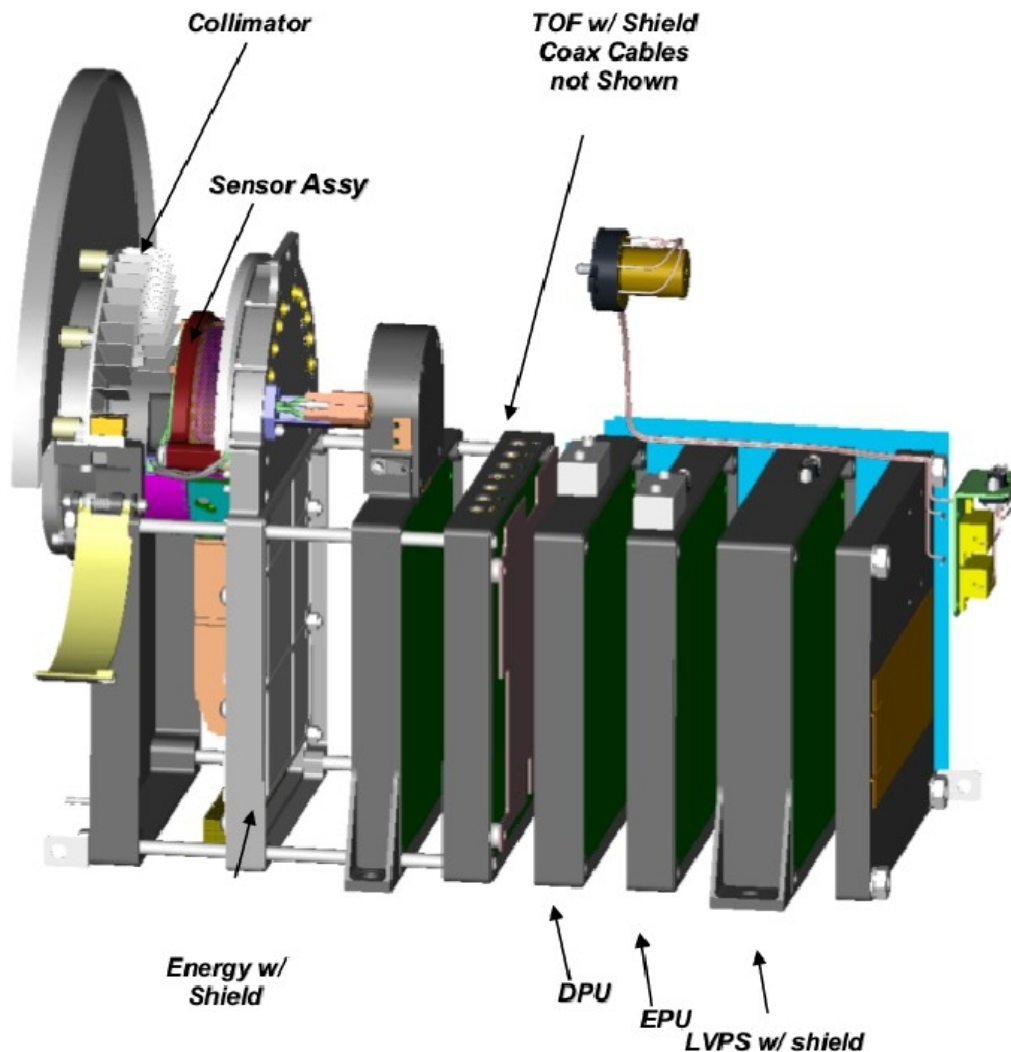
This section lists the boards composing the PEPSSI electronics and refers to Figure 11-4. The text then goes on to describe the function of each board. In each subsection, it would help to include the name of the board being discussed which is shown on Figure 11-4 in the text of Section 11.1.3.

Section 11.1.3

The following electronic boards are cited an then discussed:

1) Energy board;
2) High Voltage Power Supply (HVPS);
3) TOF board;
4) Digital processing board;
5) Common event processor board; and
5) Low Voltage Power Supply (LVPS) board.

Figure 11-4

All Data Sets in the document Directory soc_inst_icd.lbl – 2 of 2

In section 11.3, there should be a reference to Table 11-1.

All Data Sets in the document Directory subdirectory aaa_generic_readme

Why does this subdirectory exist in the PDS archive? The files in this directory appear to be pieces of text that are incorporated in other files within the archive. It appears as though it was used as boiler plate replacement text, so I would suggest to remove this entire directory.

Data Evaluation

Useful Table for PEPSSI

Flight Distance is 6 cm (ICD Section 11.4.5.4)

Time	Velocity	H+ Energy
1 ns	60,000 km/s	18.76 MeV
2 ns	30,000 km/s	4.69 MeV
5 ns	12,000 km/s	750.6 keV
10 ns	6,000 km/s	187.6 keV
20 ns	3,000 km/s	46.9 keV
50 ns	1,200 km/s	7.506 keV
100 ns	600 km/s	1.876 keV
200 ns	300 km/s	469 eV
500 ns	120 km/s	75 eV

nh-x-pepssi-3-plutocruise-v2.0/data
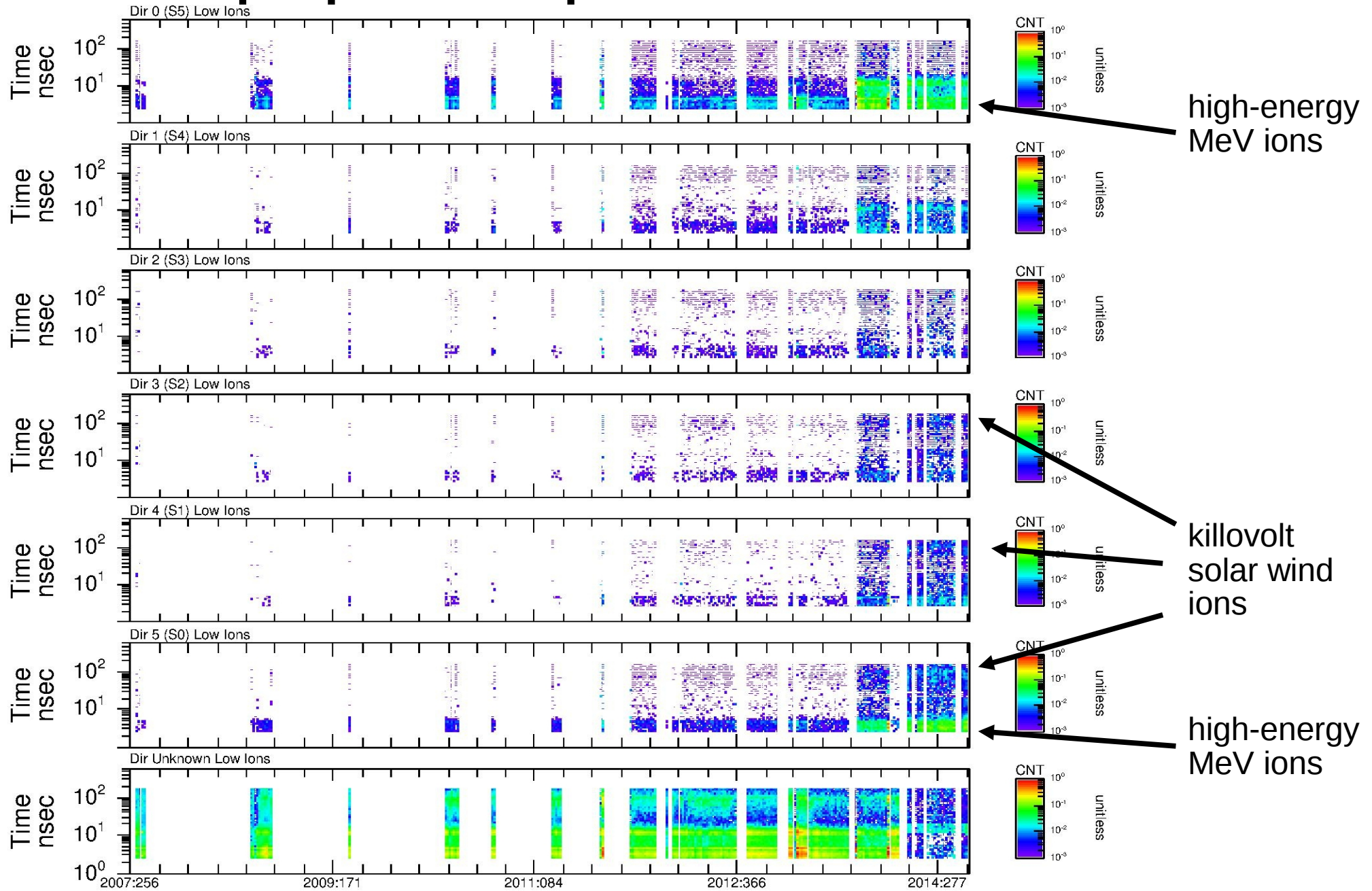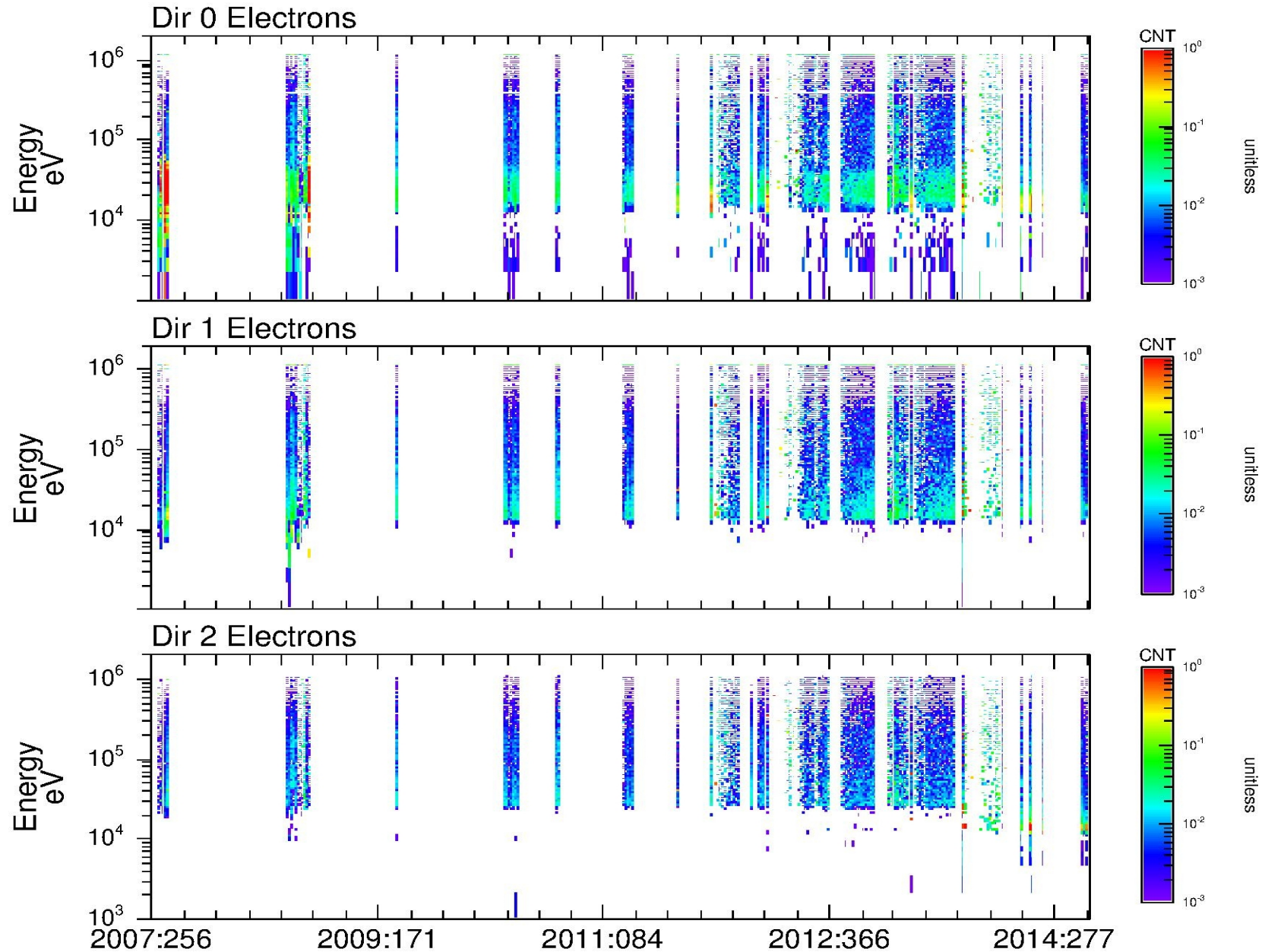
nh-x-pepssi-3-plutocruise-v2.0/data

nh-x-pepssi-3-plutocruise-v2.0/data

Electrons are showing no variation with distance

This helium channel looks like it is contaminated

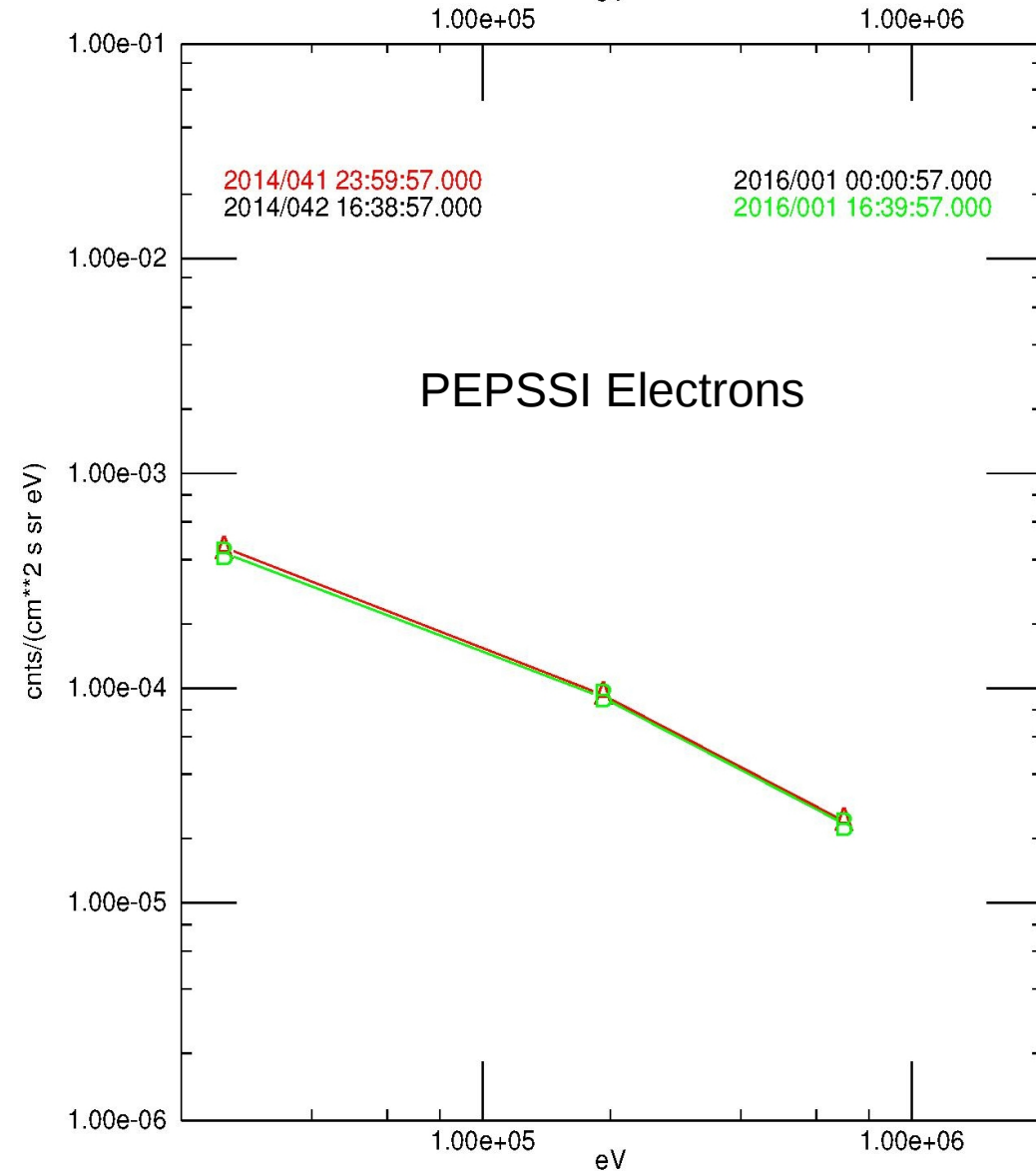Helium energy dependence is masked?
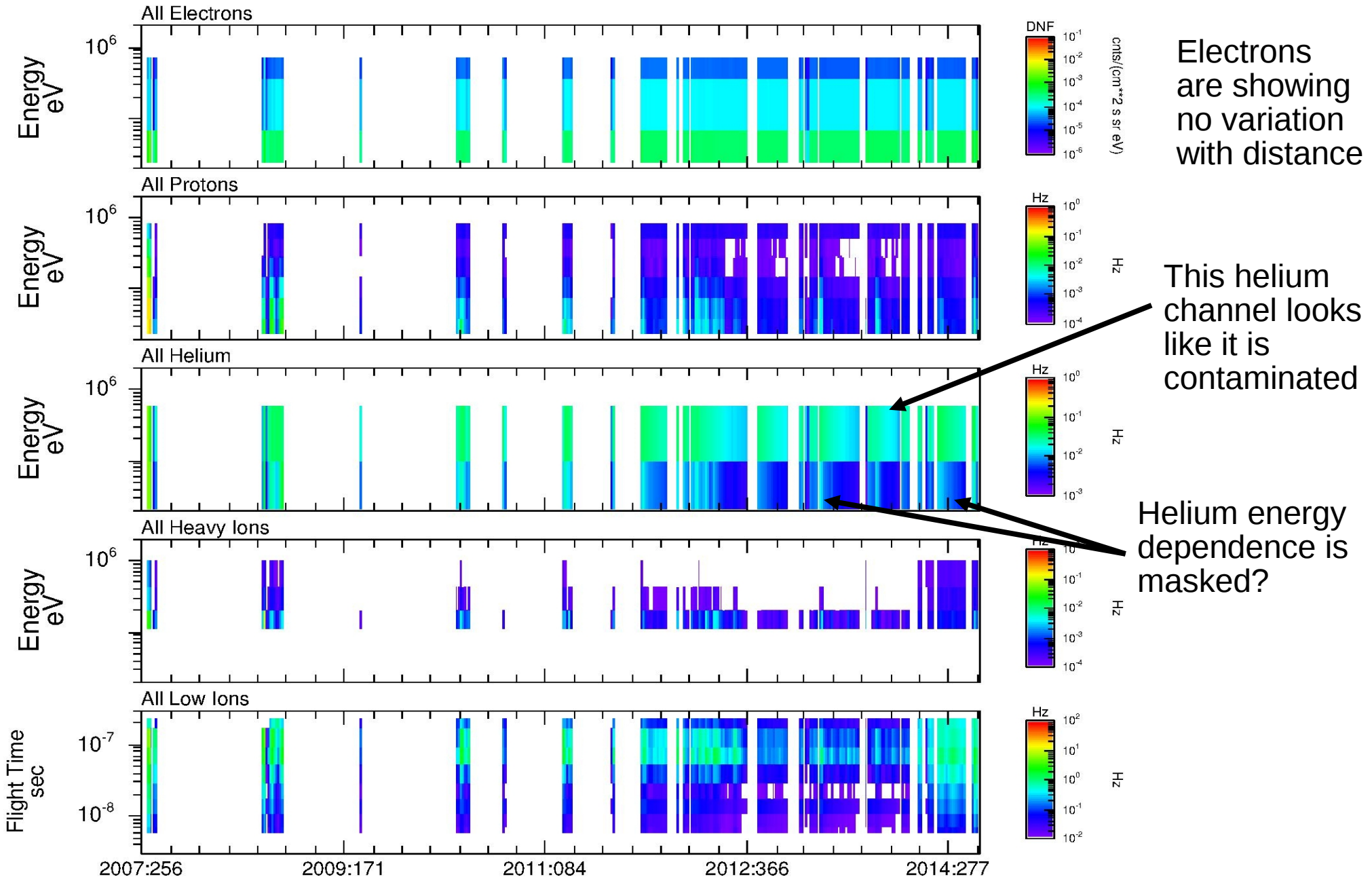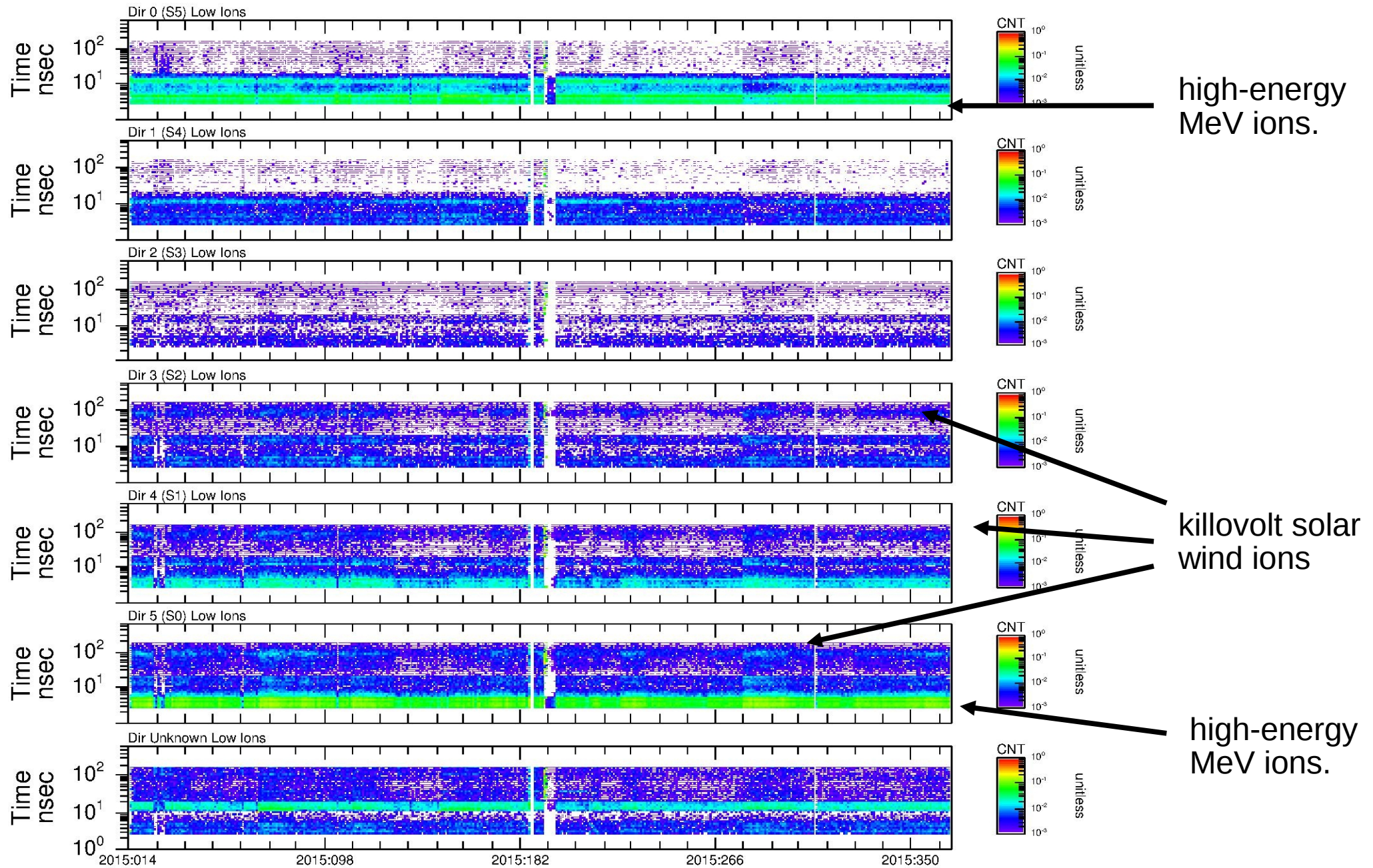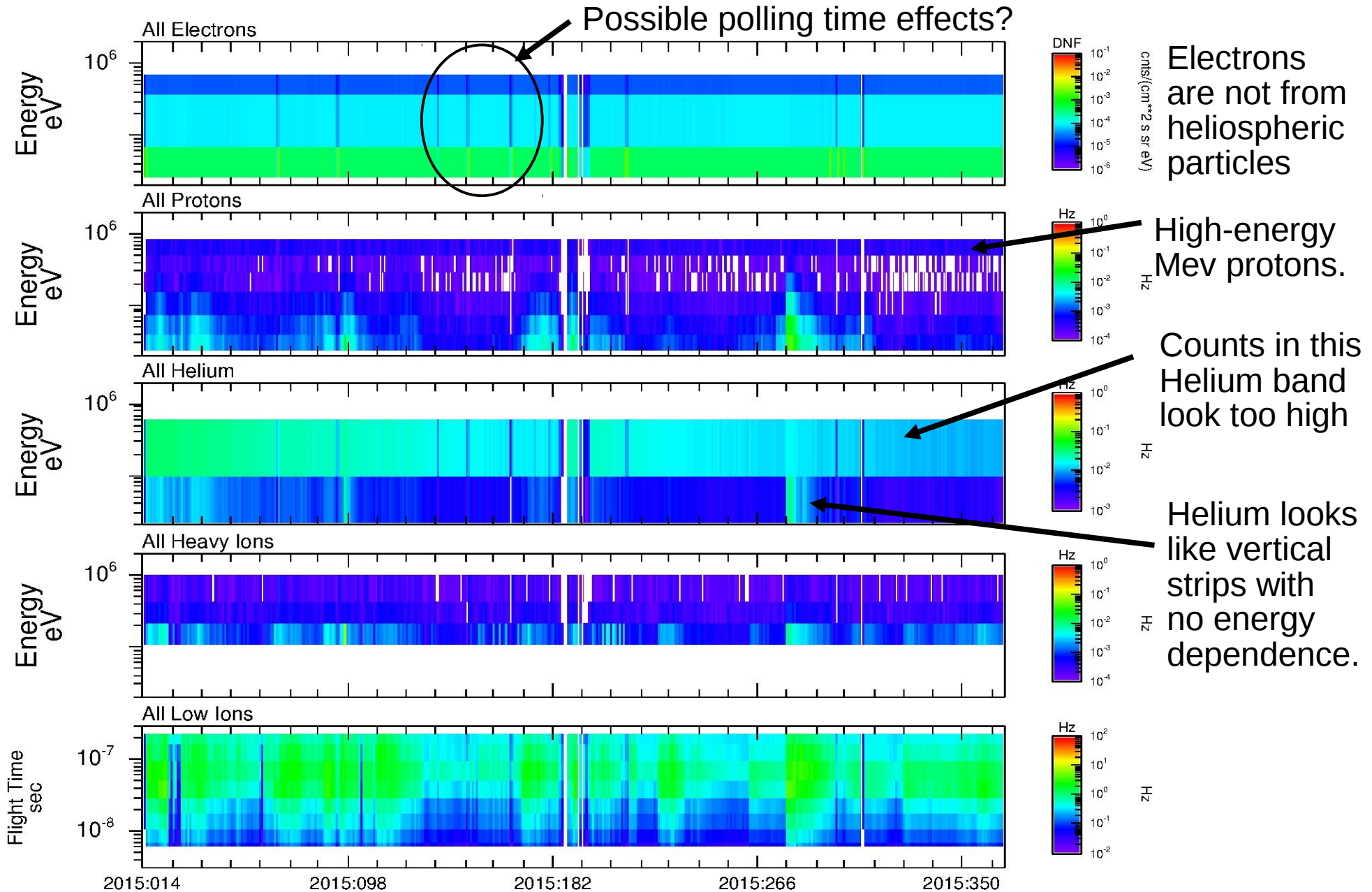
nh-p-pepssi-3-pluto-v2.0/data

nh-p-pepssi-3-pluto-v2.0/data
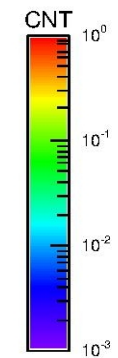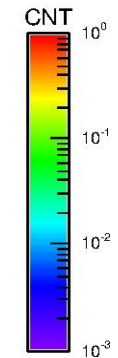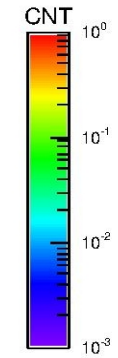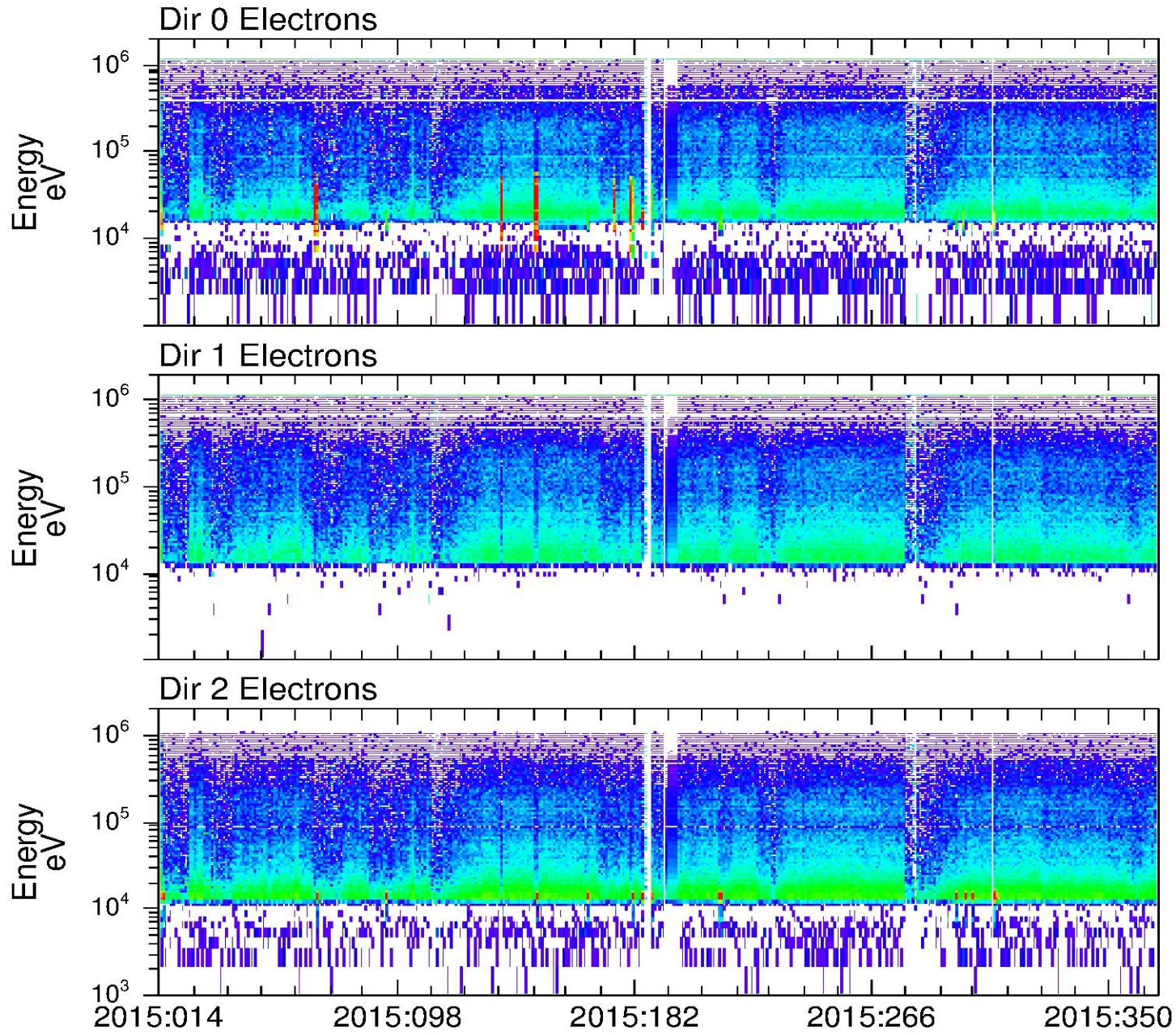
The electron PHA data signifies the spectral shape, but not its Intensity. The electrons here could have the same shape, but the variation could be in the sampling rate.
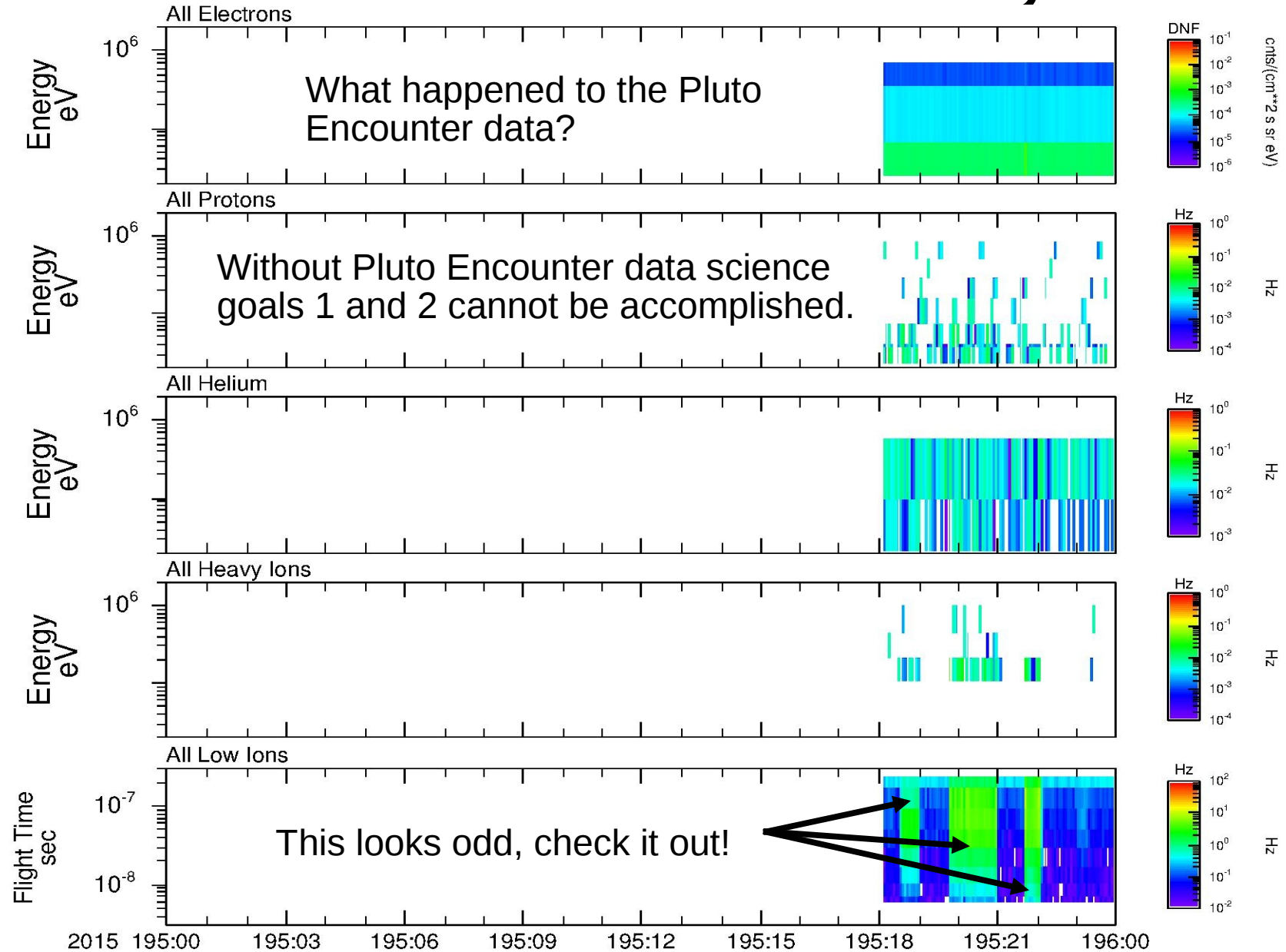
PEPSSI Electrons - Updated
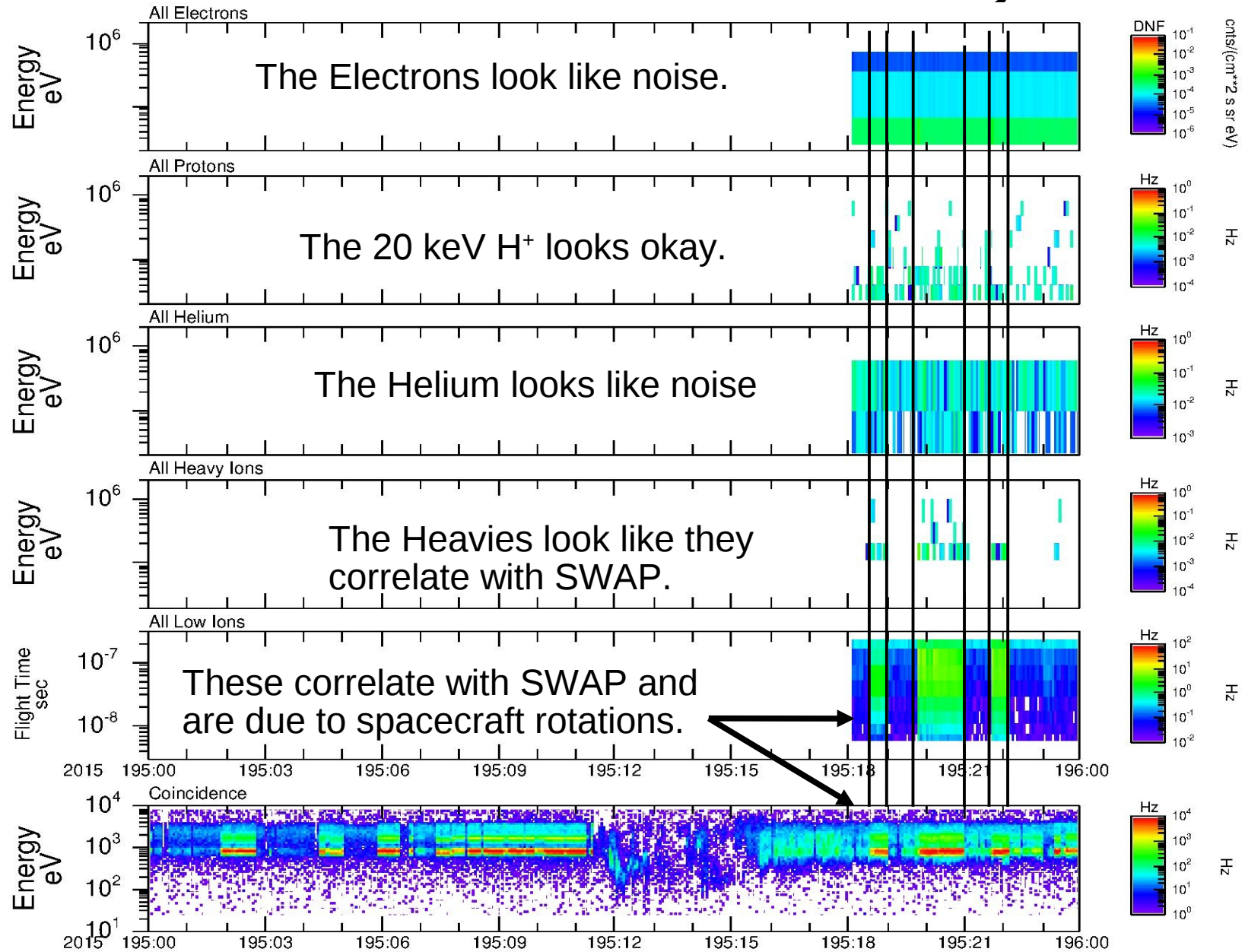
Why are the fluxes from PEPSSI abnormally high?

nh-p-pepssi-3-pluto-v2.0/data

nh-p-pepssi-3-pluto-v2.0/data Pluto Encounter Day

All Electrons

What happened to the Pluto Encounter data?

All Protons

Without Pluto Encounter data science goals 1 and 2 cannot be accomplished.

All Helium

All Heavy Ions

All Low Ions

This looks odd, check it out!
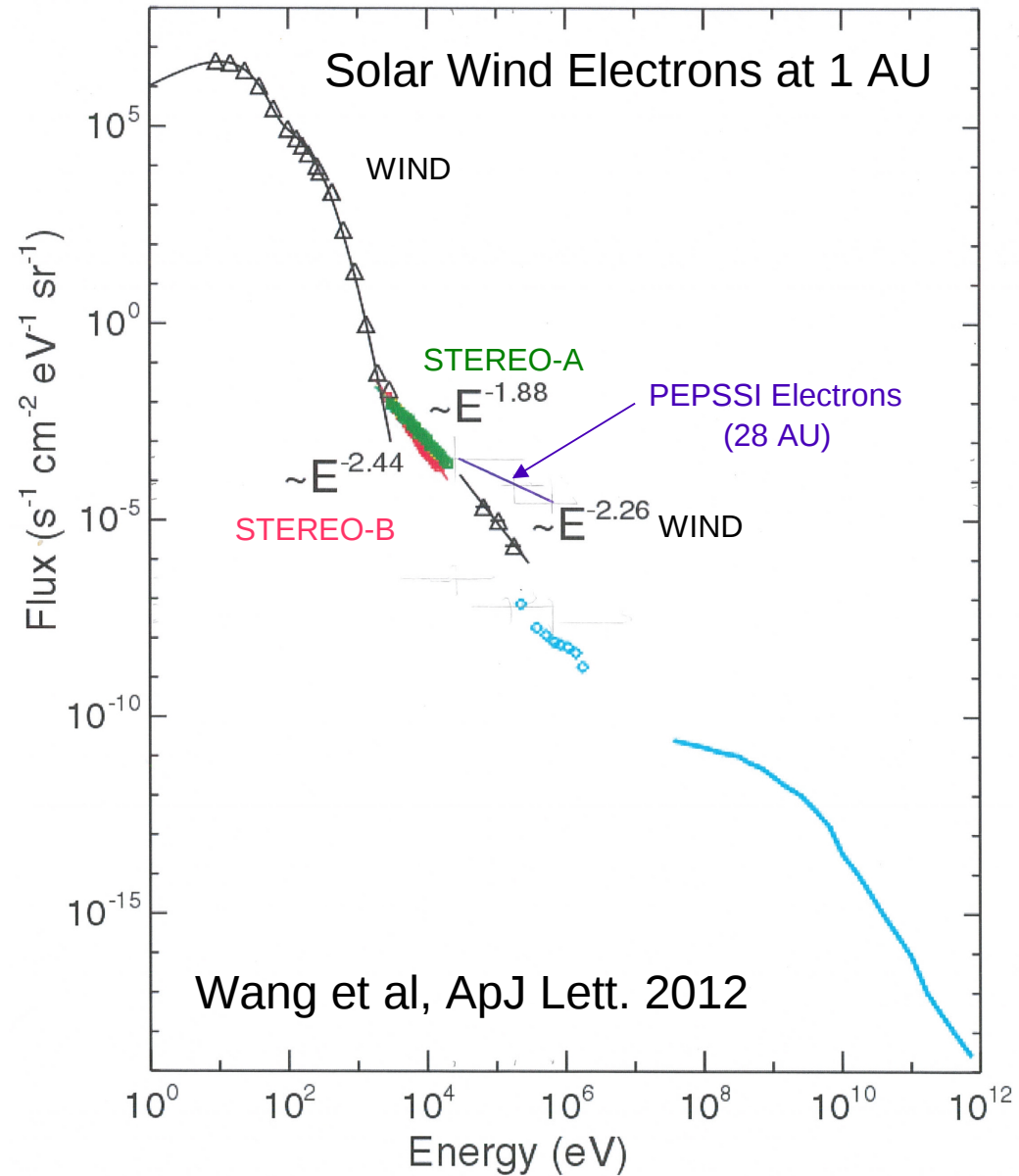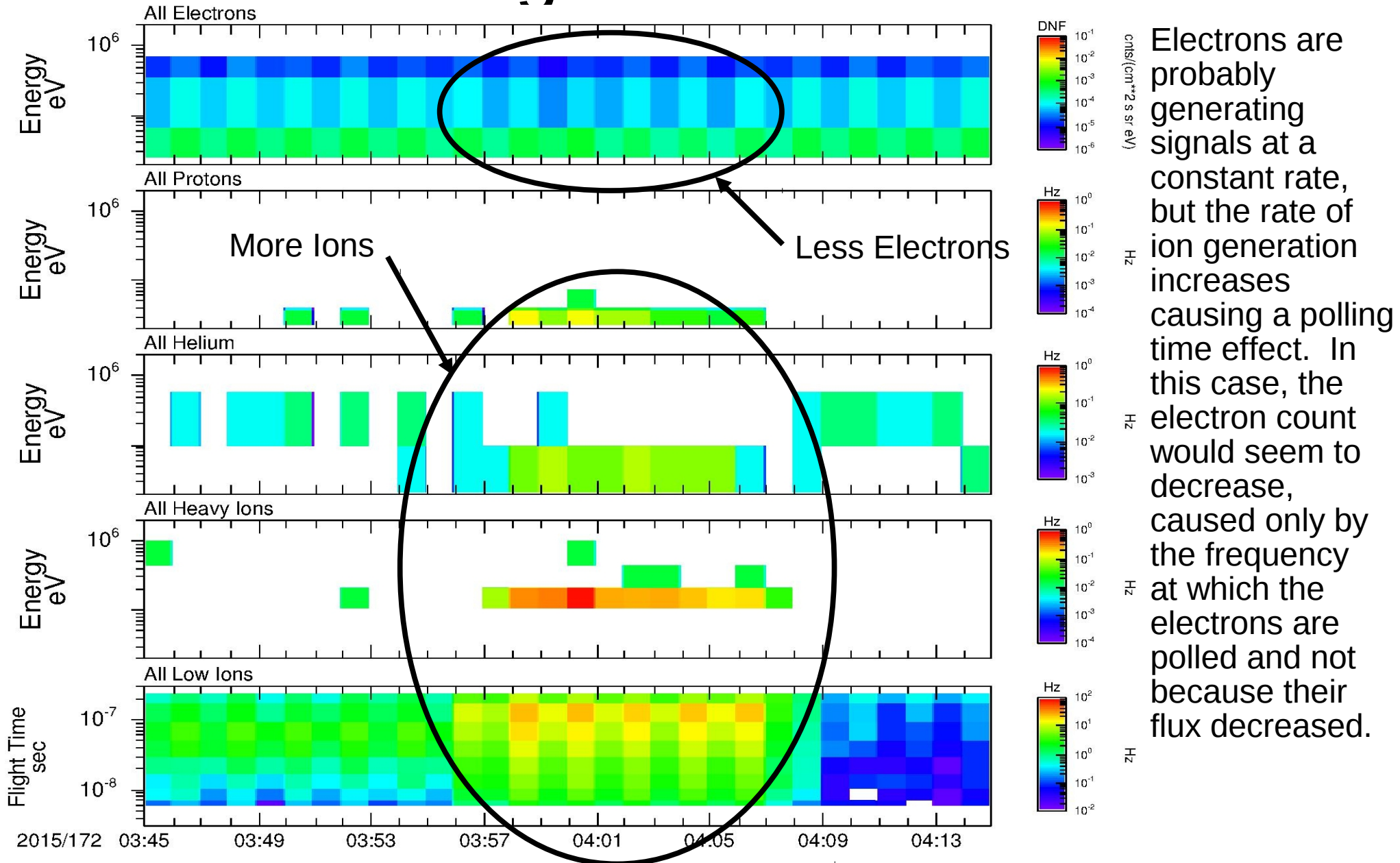
nh-p-pepssi-3-pluto-v2.0/data
Pluto Encounter Day

nh-p-pepssi-3-pluto-v2.0/data Polling Time Effect?

A polling time effect could caused when counts for multiple species become disjointed so that the ability to statistical sample is influenced by the count. If you have two input sources with both generating a number at a constant rate, then the probability of polling is constant. However, if the rate of one source increases, then the polling will find that the increased source occurs more frequently due to the increased rate. During this time, the constant source count would look depressed if this is not taken into account.
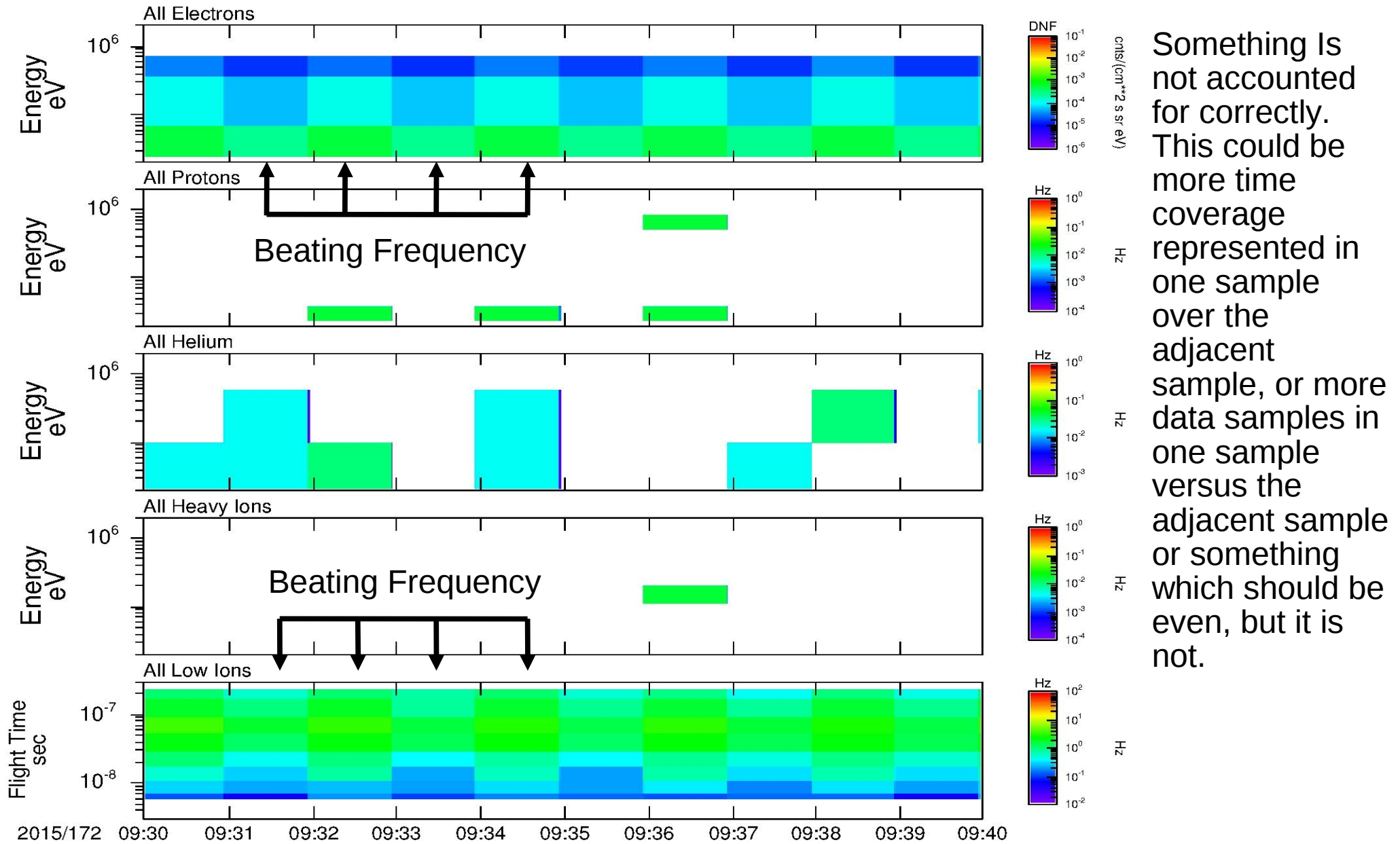
nh-p-pepssi-3-pluto-v2.0/data Polling Time Effect?

Electrons are probably generating signals at a constant rate, but the rate of ion generation increases causing a polling time effect. In this case, the electron count would seem to decrease, caused only by the frequency at which the electrons are polled and not because their flux decreased.

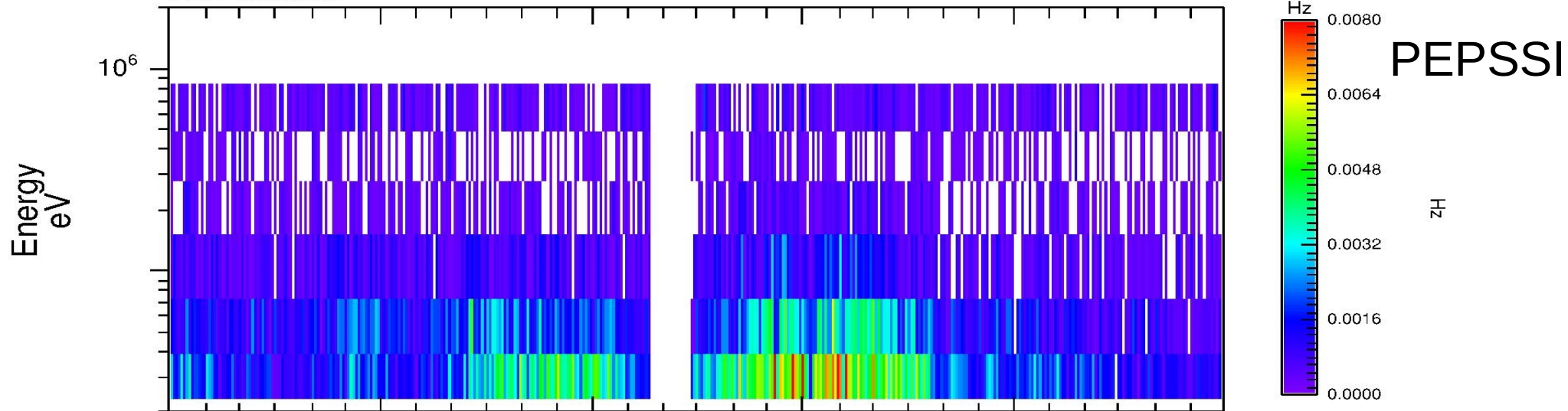# nh-p-pepssi-3-pluto-v2.0/data
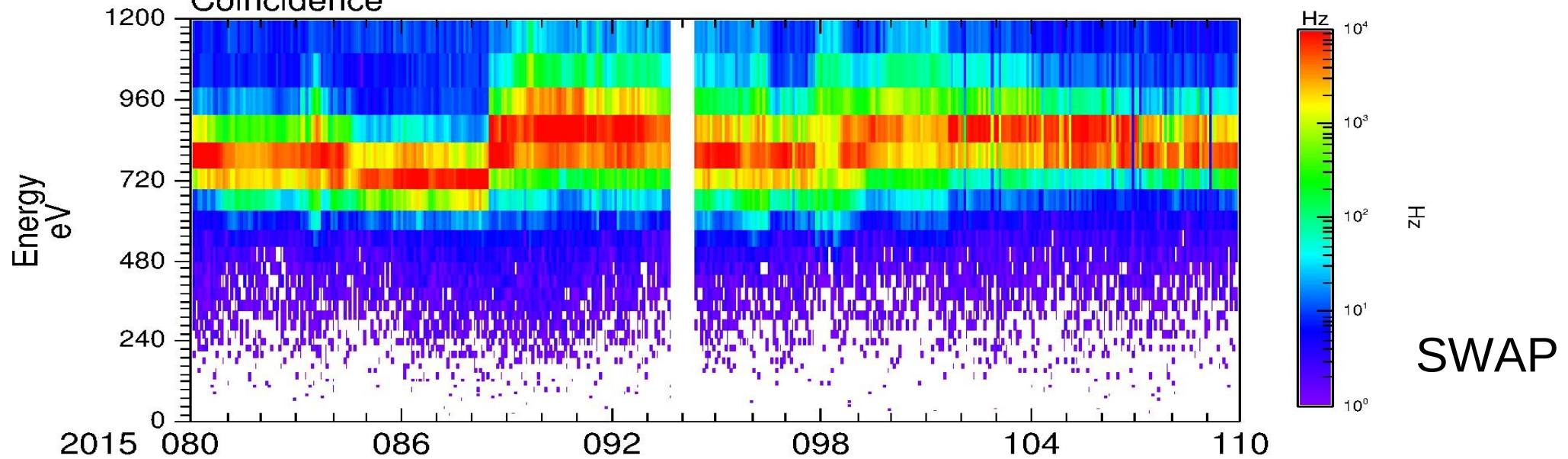# Unequal Sampling Time Effect?

Something Is not accounted for correctly. This could be more time coverage represented in one sample over the adjacent sample, or more data samples in one sample versus the adjacent sample or something which should be even, but it is not.

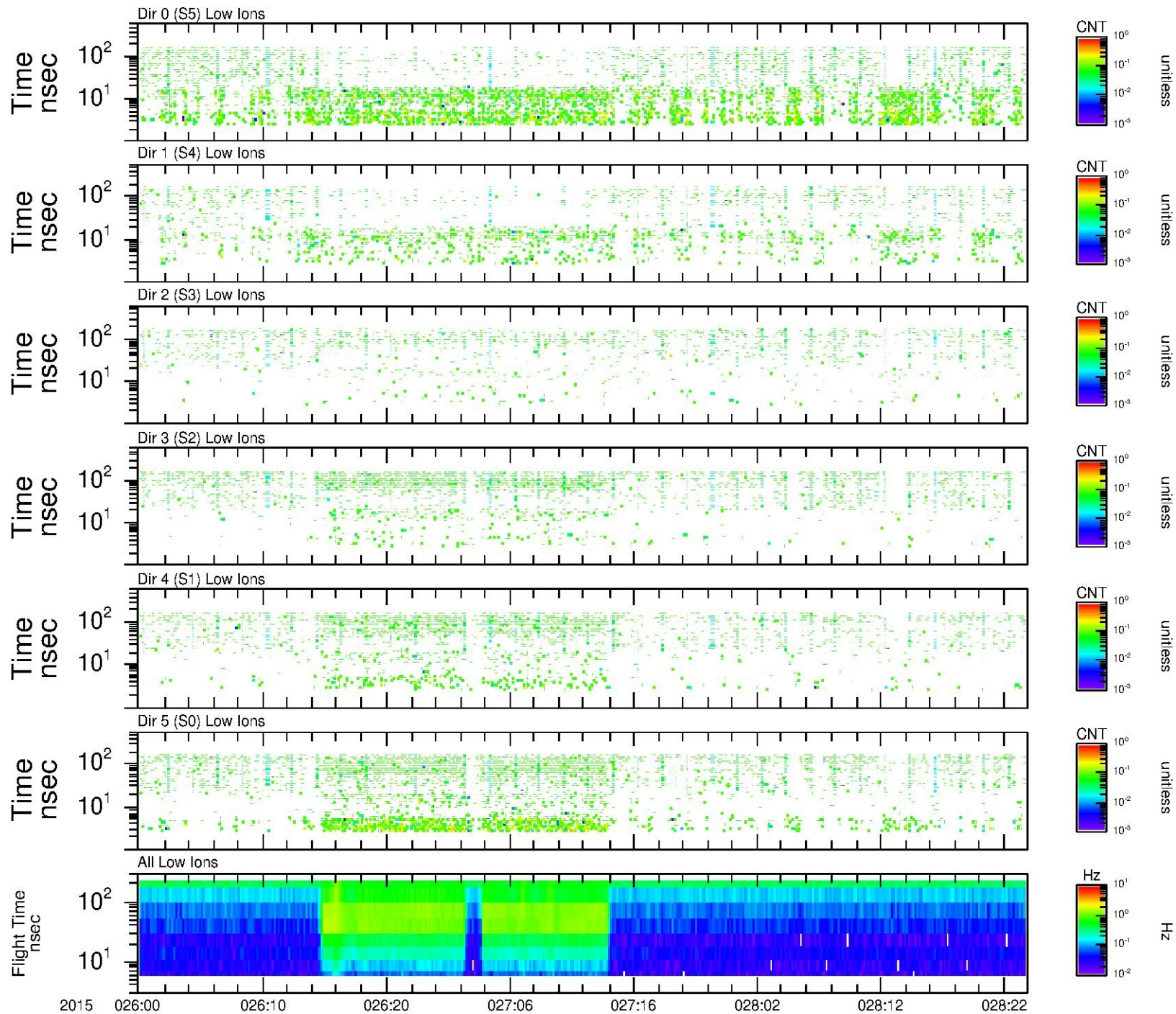# Heliospheric Shock or Heated Region in the Solar Wind - Updated

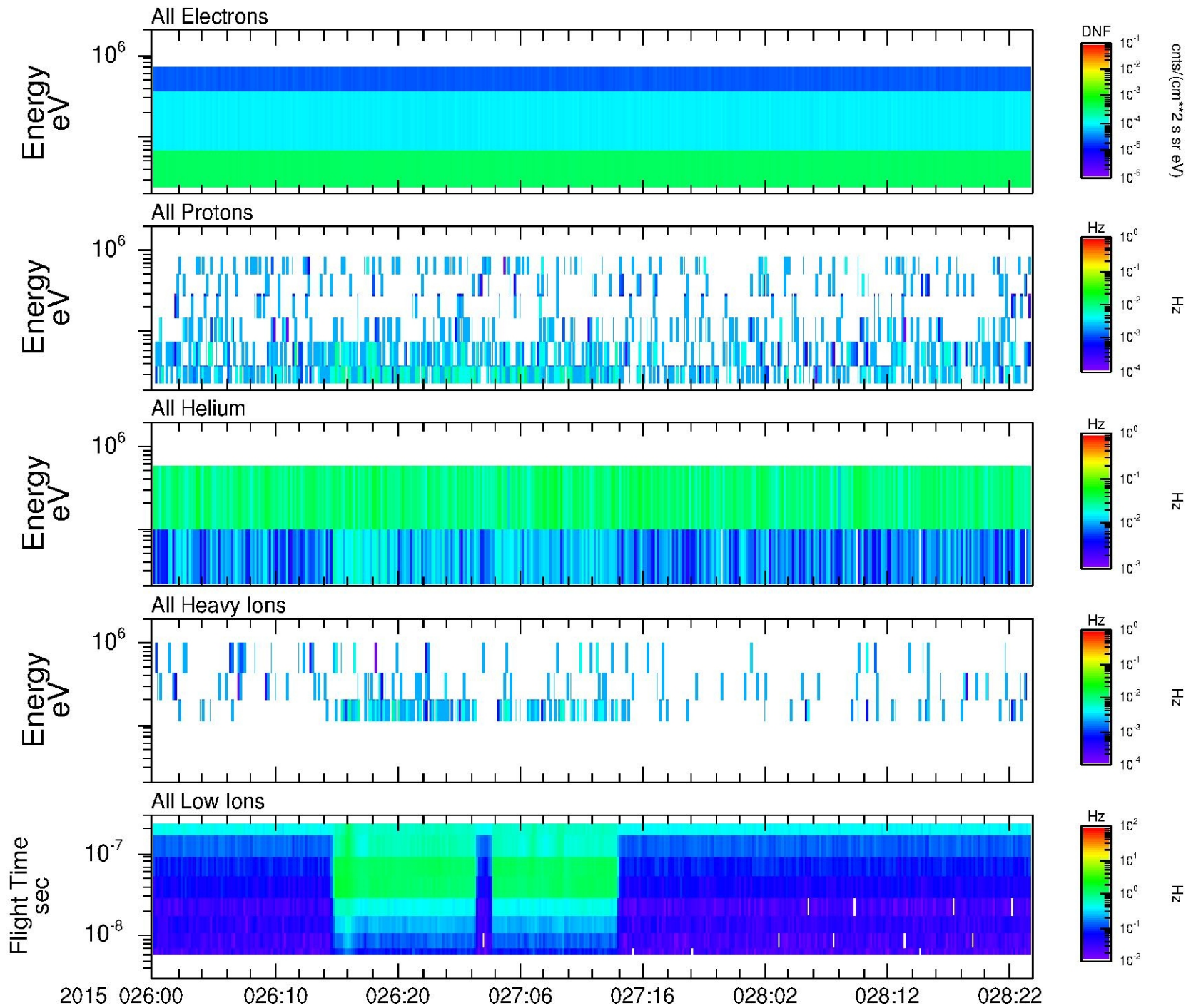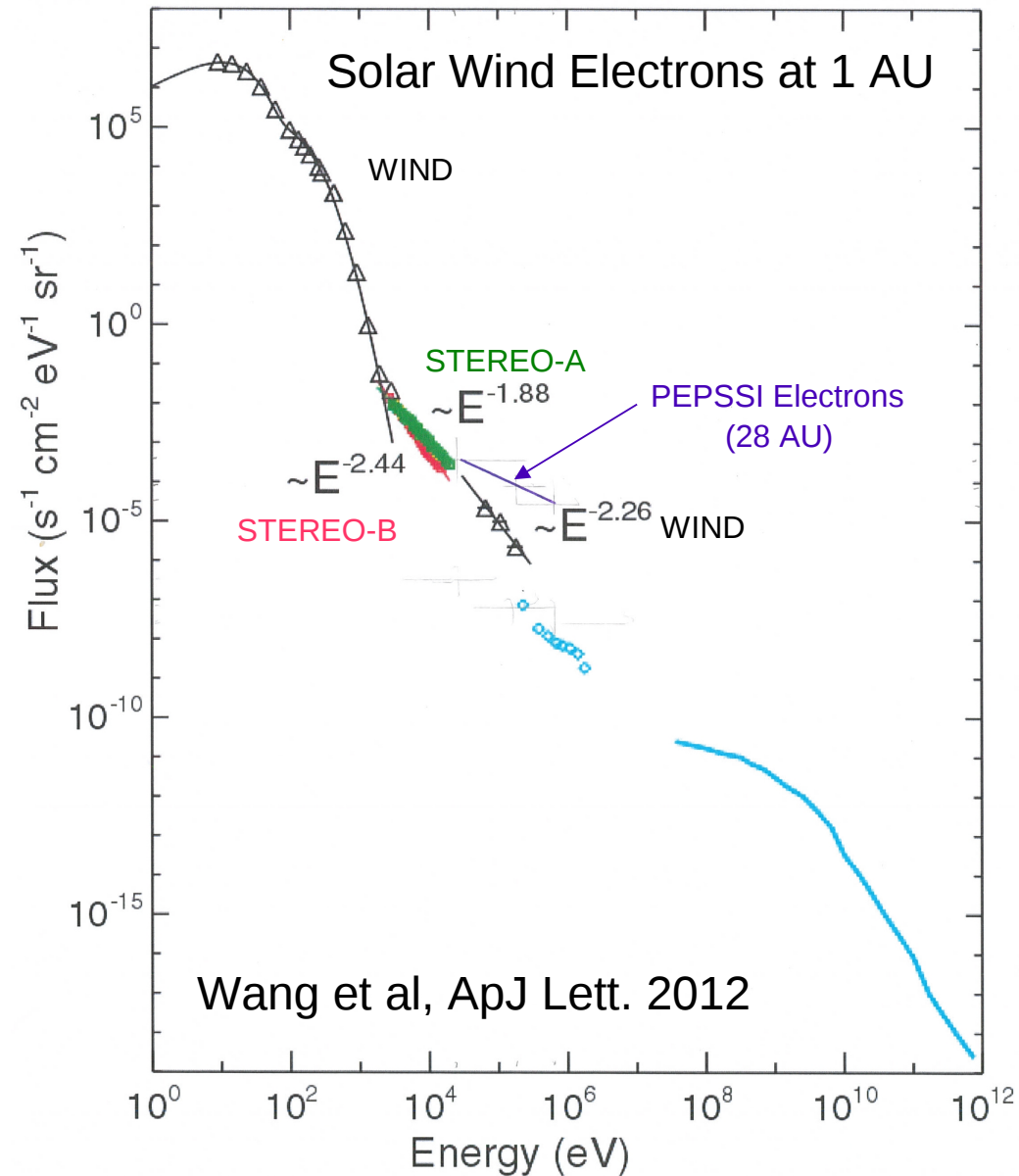# Back-Up Slides

PEPSSI Electrons - 3

Why are the fluxes from PEPSSI abnormally high?

PEPSSI Electrons

Solar Wind Electrons at 1 AU

WIND

STEREO-A

$\sim E^{-1.88}$

PEPSSI Electrons (28 AU)

$\sim E^{-2.44}$

STEREO-B

$\sim E^{-2.26}$ WIND

Wang et al, ApJ Lett. 2012
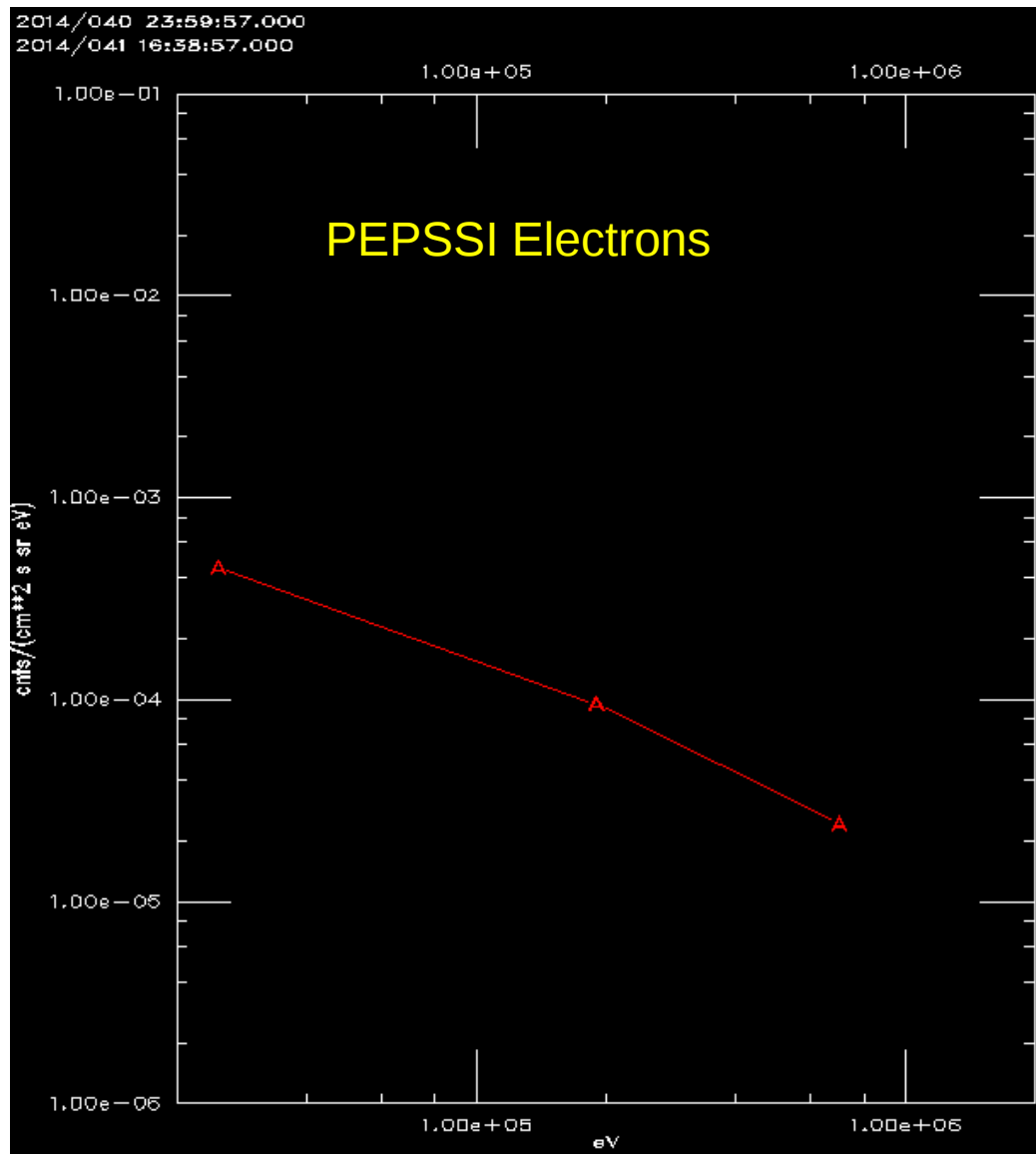
Heliospheric Shock or
Heated Region in the Solar Wind

So is this really a heliospheric shock or just heated plasma from the Sun. Attached is a blow-up on the SWAP H+ region on a linear scale. The PEPSSI data resembles more of an extension of the SWAP H+.
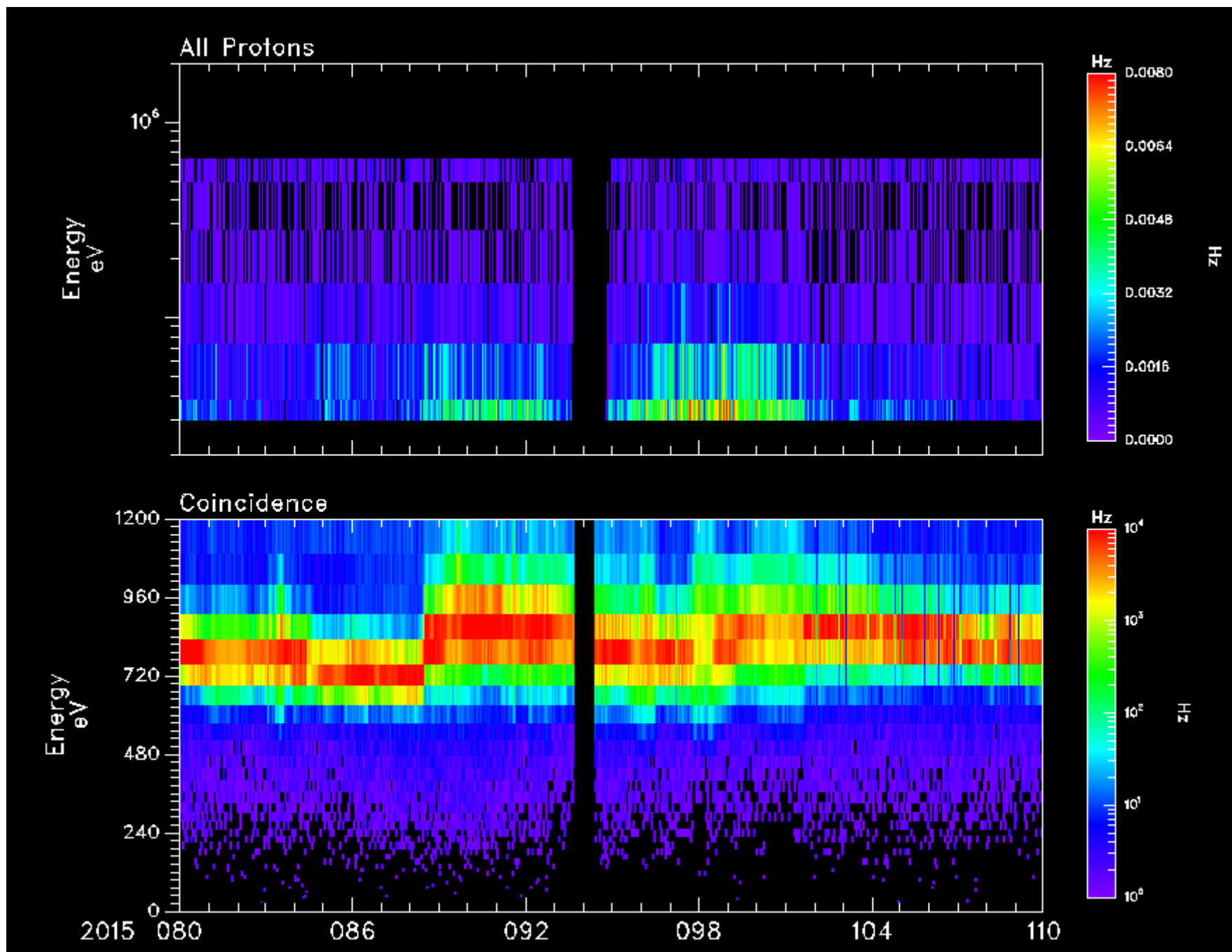
All Data Sets in the Top Level Directory voldesc.cat

GOOD

All Data Sets in the catalog Directory catinfo.txt

GOOD

All Data Sets in the catalog Directory nh.cat

GOOD, some minor issues reported to PDS

All Data Sets in the calib Directory
hk_stat_input_20041016.lbl
hk_stat_input_20041016.tab

GOOD

All Data Sets in the calib Directory
rateboxdefinitionplanes.fit

GOOD

All Data Sets in the calib Directory
hk_n1_input_20050228.lbl
hk_n1_input_20050228.tab

GOOD

nh-p-pepssi-3-pluto-v2.0
nh-x-pepssi-3-plutocruise-v2.0
calib/calpars/calpar_columns.fmt

GOOD

nh-p-pepssi-3-pluto-v2.0/calib/calpars
pep_0294990715_0x691_calpar.tab

GOOD

All Data Sets in the index Directory indxinfo.txt

GOOD

All Data Sets in the index Directory index.lbl

GOOD

All Data Sets in the index Directory checksum.lbl & checksum.tab

GOOD

All Data Sets in the index Directory
slimindx.lbl

GOOD

All Data Sets in the document Directory docinfo.txt

GOOD

All Data Sets in the document Directory soc_inst_icd.lbl

GOOD

All Data Sets in the document Directory
codmac_level_definitions.lbl
codmac_level_definitions.pdf

GOOD

All Data Sets in the document Directory lunineetal1995.lbl & lunineetal1995.pdf

GOOD

All Data Sets in the document Directory
nh_fov.lbl & nh_fov.png

GOOD

All Data Sets in the document Directory nh_met2utc.lbl & nh_met2utc.tab

GOOD

All Data Sets in the document Directory
nh_mission_trajectory.lbl
nh_mission_trajectory.tab

GOOD

All Data Sets in the document Directory nh_trajectory.lbl & nh_trajectory.tab

GOOD

All Data Sets in the document Directory payload_ssr.lbl & paload_ssr.pdf

GOOD

All Data Sets in the document Directory
quat_axyz_instr_to_j2k.lbl
quat_axyz_instr_to_j2k.asc

GOOD

All Data Sets in the document Directory pepssi_ssr.lbl & pepssi_ssr.pdf

GOOD

nh-p-pepssi-2-pluto-v2.0/document
nh-p-pepssi-3-pluto-v2.0/document
seq_pepssi_pluto.lbl & seq_pepssi_pluto.pdf

GOOD

nh-p-pepssi-2-plutocruise-v2.0/document
nh-p-pepssi-3-plutocruise-v2.0/document
seq_pepssi_plutocruise.lbl
seq_pepssi_plutocruise.pdf

GOOD

All Data Sets in the document Directory
nh_pepssi_v110_ti.txt

GOOD

All Data Sets in the document Directory pep_bti.txt & pep_bti.tab

GOOD