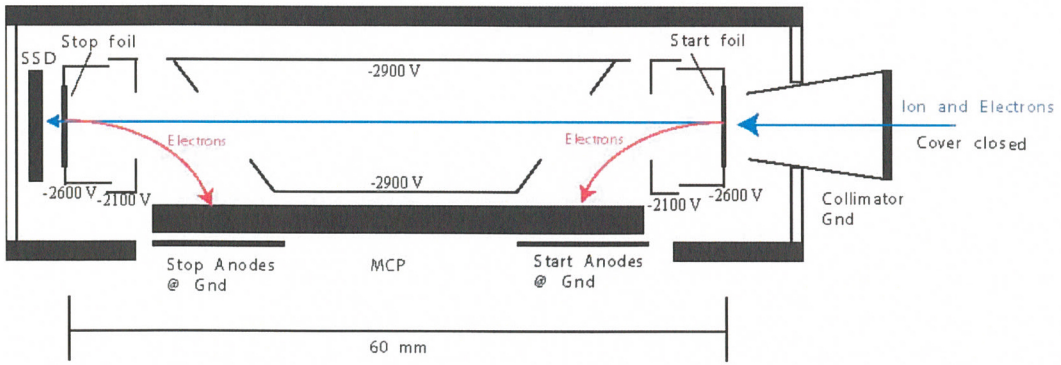
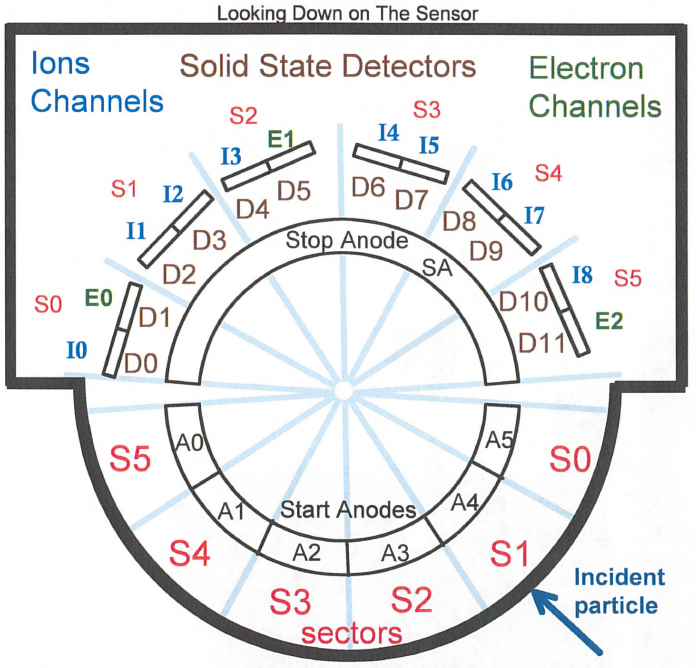
New Horizons Pluto Energetic Particle Spectrometer Science Investigation (PEPSSI)

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 Data Sets:
nh-a-pepssi-2-kem1-v2.0

CALIBRATED Data Sets:
nh-a-pepssi-3-kem1-v2.0

New Horizons PEPSSI Data Set Evaluation Tools

Staging and Evaluation -

Machine: Dell Precision T3400

Operating System: Fedora 27 linux

Data Processing -

Machine: Sun Ultra-350

Operating System: Sun Solaris OS 5.9

Minor Diagnostics -

Machine: IBM lenovo T60p ThinkPad

Operating System: Fedora 25 linux

Documentation Evaluation

nh-a-pepssi-2-kem1-v2.0/catalog
nh-a-pepssi-3-kem1-v2.0/catalog
dataset.cat

```
The leapsecond adjustment (DELTA_ET = ET - UTC) was 65.184s at
NH launch, and the first three additional leapseconds occurred
in at the ends of December, 2009, June, 2012 and June, 2015.
Refer to the NH SPICE data set, NH-J/P/SS-SPICE-6-V1.0, and the
SPICE toolkit documentation, for more details about leapseconds.
```

Update text to include leapsecond at the end on December 2017.
Review all New Horizons trajectory information to determine the Influence and if reprocessing trajectory information is necessary.

nh-a-pepssi-2-kem1-v2.0/catalog
nh-a-pepssi-3-kem1-v2.0/catalog
nh_kem.cat

This Looks Odd

voldesc.cat gives an end date for this mission phase as

```
The nominal start and stop times for the
  KEM1
mission phase are
  2018-08-14T20:08:02.011
and
  2019-01-30T00:08:02.176
```

This end date was just over a year ago.

Short name	Start(1,3)	Stop(2,3)	Full MISSION_PHASE_NAME, plus optional Description
KEM1	2018-08-14	TBD	KEM1 ENCOUNTER, KBO1 ENCOUNTER, KBO1 approach, flyby, post-encounter (4)

```
4 These mission phase dates and/or designations are still under
consideration and will most likely change in future versions of this
mission catalog.
```

Yet this file and note do not yet show an end date.
In addition, the PEPSSI data do not exceed the Date given in voldesc.cat file.

```
OBJECT                = MISSION_INFORMATION
  MISSION_START_DATE  = 2016-10-26
  MISSION_STOP_DATE   = 2021-09-30
```

However, this end date for the mission is given in this file.

nh-a-pepssi-2-kem1-v2.0/catalog
nh-a-pepssi-3-kem1-v2.0/catalog
nhsc.cat

This document needs to be updated. There are references to measurements at Pluto in numerous places. New Horizons is no longer measuring Pluto and is essentially a new mission to the Kuiper Belt. The instrument description gives no confidence that the New Horizons instruments can measure properties of a KBO. The focus of this document is on Pluto and does not discuss the capabilities of the instruments beyond Pluto. I suspect that this is a hold-over document which was never updated for the current extended mission.

nh-a-pepssi-2-kem1-v2.0/catalog
nh-a-pepssi-3-kem1-v2.0/catalog
pepssi.cat 1 of 2

```
Scientific Objectives
=====================

  Summary
  -------

    1.  Determine the escape rate of Pluto's atmosphere.

    2.  Measure the interaction of the solar wind with Pluto's
        ionosphere.

    3.  Determine the source and nature of energetic particles
        found near Pluto.
```

PEPSSI has no science objectives beyond Pluto?

nh-a-pepssi-2-kem1-v2.0/catalog
nh-a-pepssi-3-kem1-v2.0/catalog
pepssi.cat 2 of 2

Molecular ions, expected from Pluto's atmosphere, will break up in the foil prior to their full detection, but will be detected as high-mass events. Internal event classification electronics determine the mass

The New Horizons spacecraft is well beyond Pluto. It should not matter from where molecular ions are received by PEPSSI. Molecular ions will still break up in the PEPSSI foil, even if they are detected at/around a KBO. This sentence needs to be repharsed since PEPSSI is no longer making measurements at Pluto.

actually a BTI, the period between 2007 day 144 and day 178 should be treated with caution as well. The PEPSSI Rate Box tables were changed on day 144 and calibration and analysis of this period is still preliminary.

I would suggest removing this sentence since the probably of accomplishment is low.

nh-a-pepssi-2-kem1-v2.0/calib
nh-a-pepssi-3-kem1-v2.0/calib
rateboxdefinitionplanes.lbl

Through the Jupiter mission phase and into the Pluto Cruise mission phase, PEPSSI has had three sets of Rate Box definitions. There are separate rate box definitions for Normal and Diagnostic mode. The

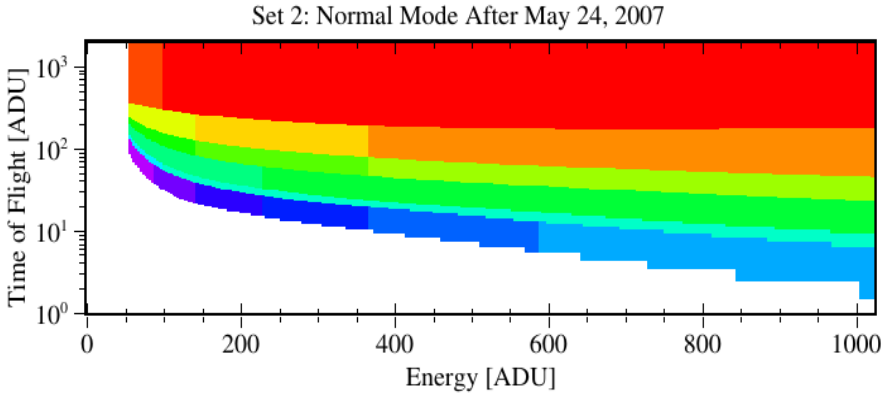
What about this KBO phase? Are these rate box definitions used?

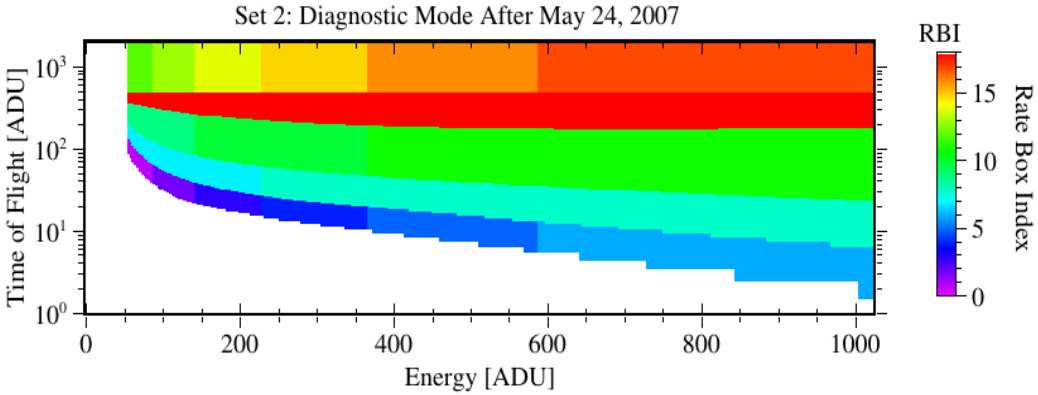
The pepssi.cat file has the following text:

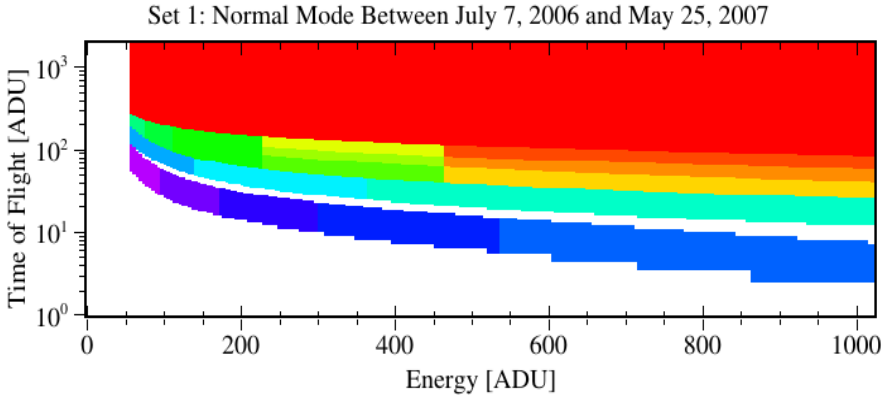
On November 29, 2016, the PEPSSI flight software was updated to allow for better understanding of the data. For now, calibrated data taken after the flight software change will look somewhat different than data taken before the change, with certain problematic channels and sectors removed.

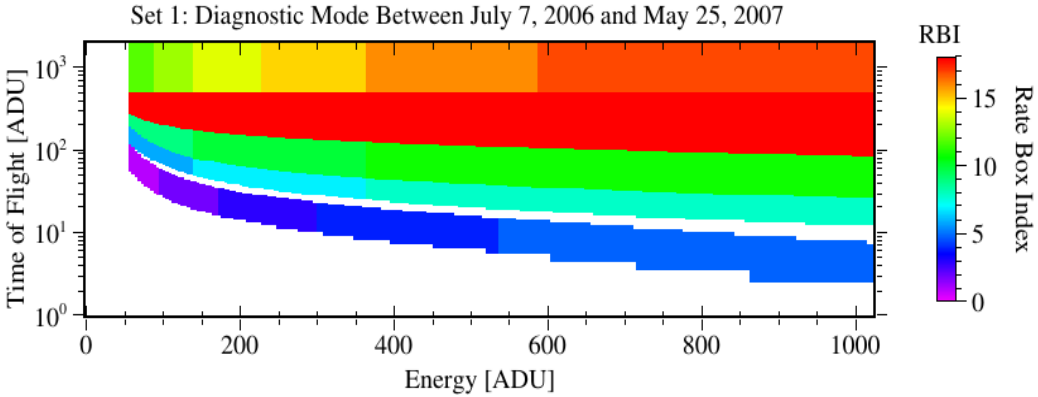
Does this change the rate box definitions? The last update indicated by this lbl file is Set 2, valid after May 24, 2007.

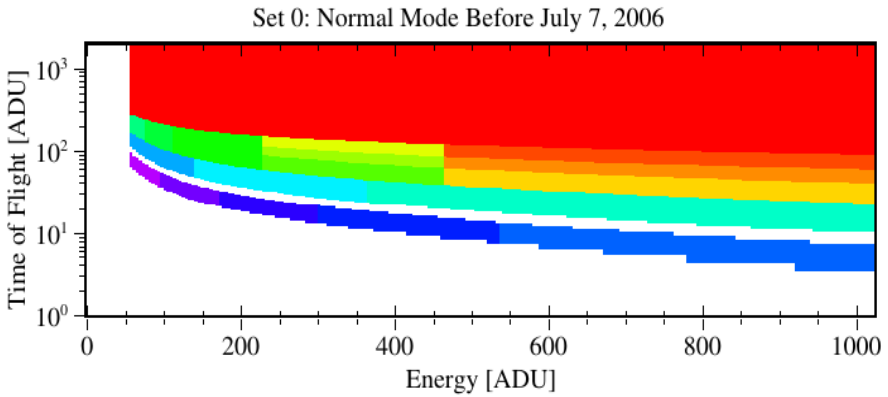
nh-a-pepssi-2-kem1-v2.0/calib
nh-a-pepssi-3-kem1-v2.0/calib
rateboxdefinitionplanes.fit

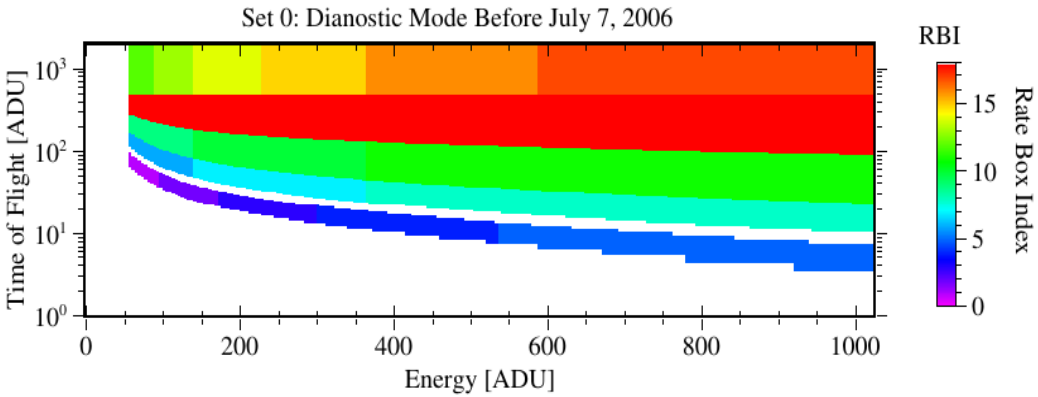












Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Sat Feb 8 20:15:28 2020.

nh-a-pepssi-3-kem1-v2.0/document
soc_inst_icd.pdf – 1 of 2

The science goals of the PEPSSI instrument are:

1. Determine the escape rate of Pluto's atmosphere
1. Measure the interaction of the solar wind with Pluto's ionosphere
2. Determine the source and nature of energetic particles found near Pluto

11.1.2 PEPSSI Sensor Description

So PEPSSI has no KBO science goals beyond Pluto? If the PEPSSI team felt that it was important enough to inform the SOC its science goals when measuring plasma around Pluto, Why is it not important enough to let them know their science Goals for measurements at KBOs?

nh-a-pepssi-3-kem1-v2.0/document
soc_inst_icd.pdf – 2 of 2

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only, but without the SSD signal, providing velocity spectra at these energies as well. Molecular ions, expected from Pluto's atmosphere, will break up in the foil prior to their full detection, but will be detected as high-mass events. Internal event classification electronics determine the mass

The same process will occur no matter from where molecular ions come, even if they are from a KBO.

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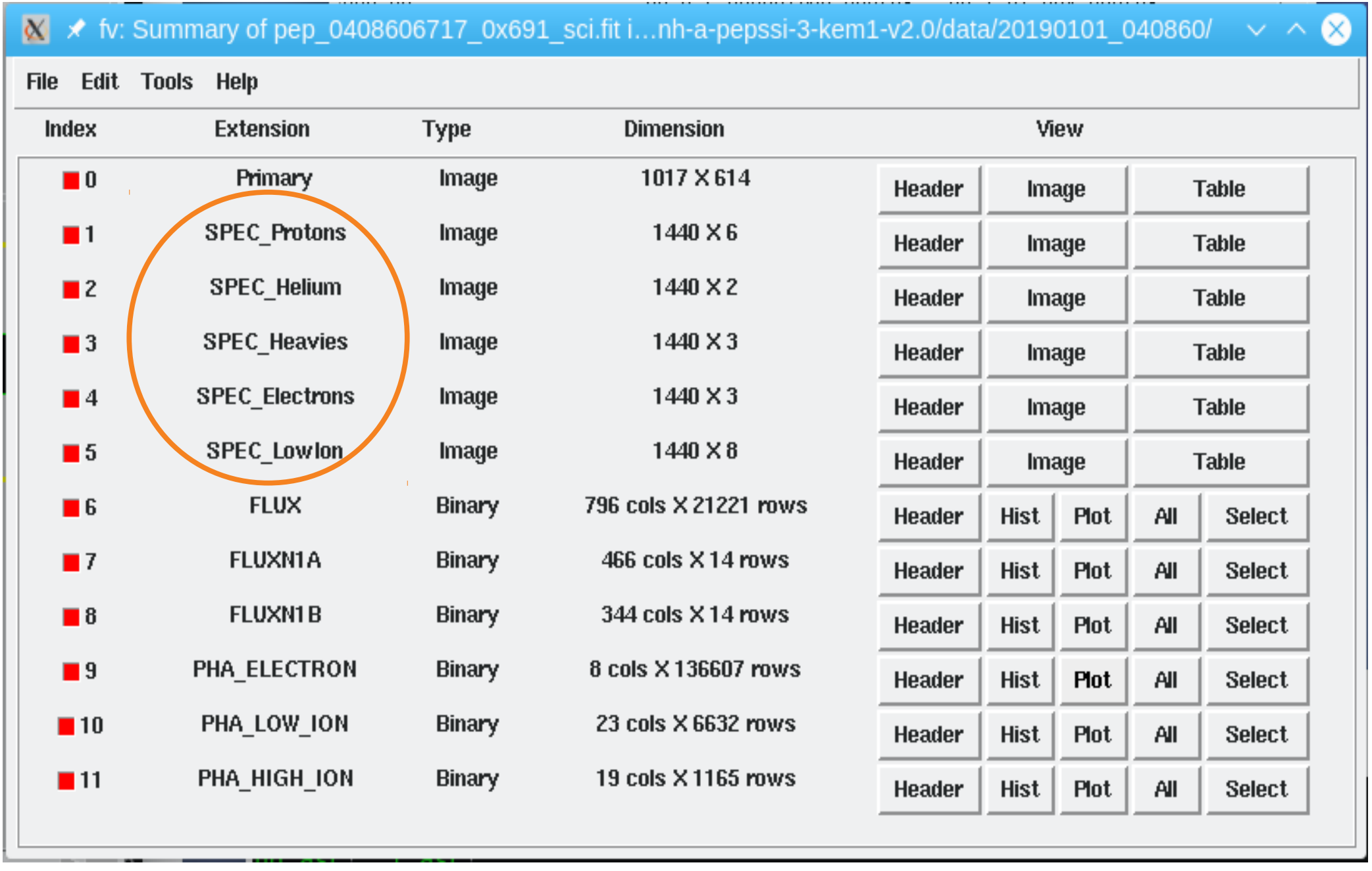
Through the Jupiter mission phase and into the Pluto Cruise mission phase, PEPSSI has had a few sets of Rate Box definitions. There are separate rate box definitions for Normal and Diagnostic mode. The RateBoxDefinitionPlanes.fit file contains an extension for each version of the "B" Look Up Table for each mode (i.e. normal or diagnostic). The Rate Box classification

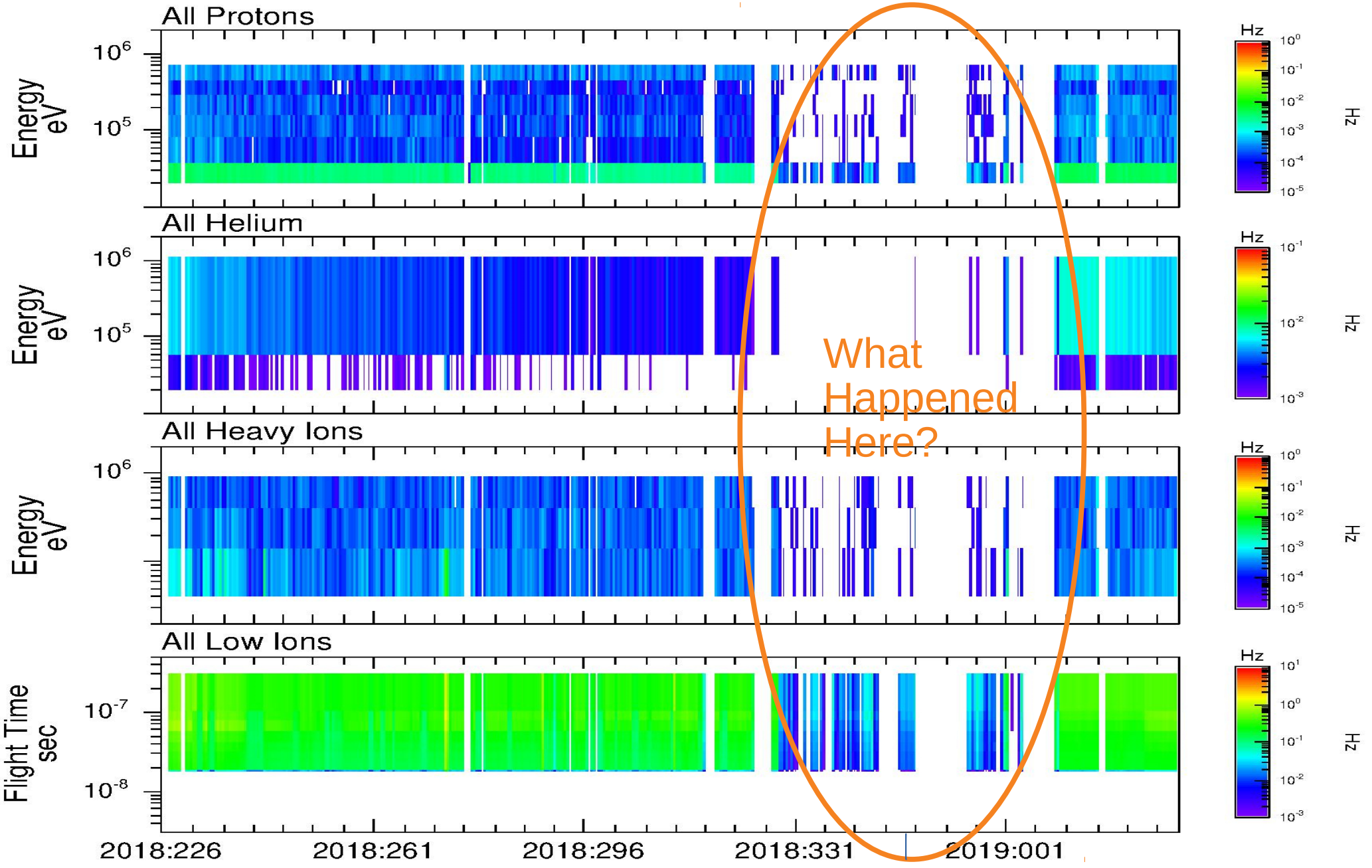
Are the Rate Box Definitions the same for the KBO phase?

Data Evaluation

nh-a-pepssi-3-kem1-v2.0/data
PEPSSI FIT File Structure



nh-a-pepssi-3-kem1-v2.0/data
Quick Look Spectrograms



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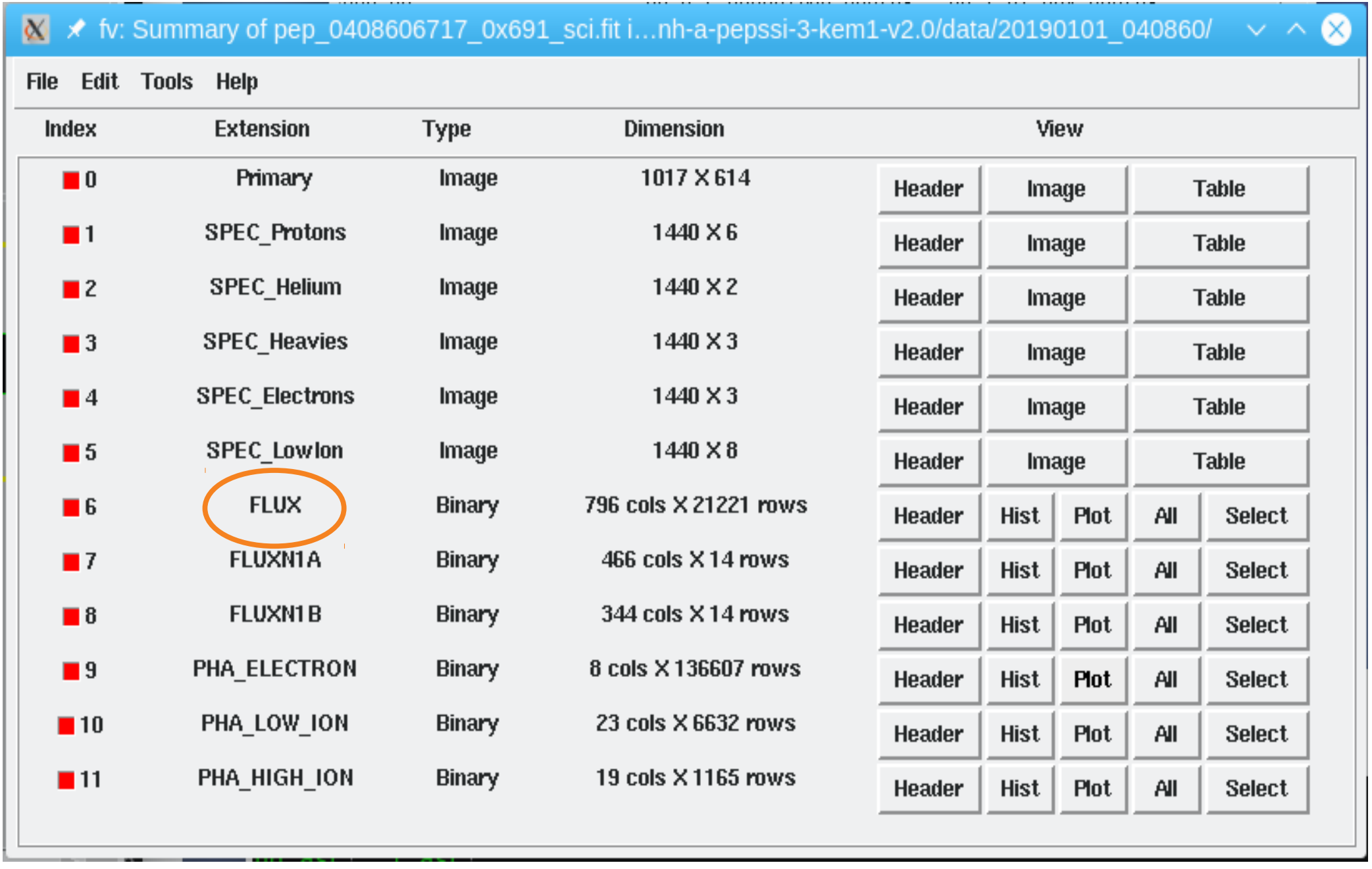
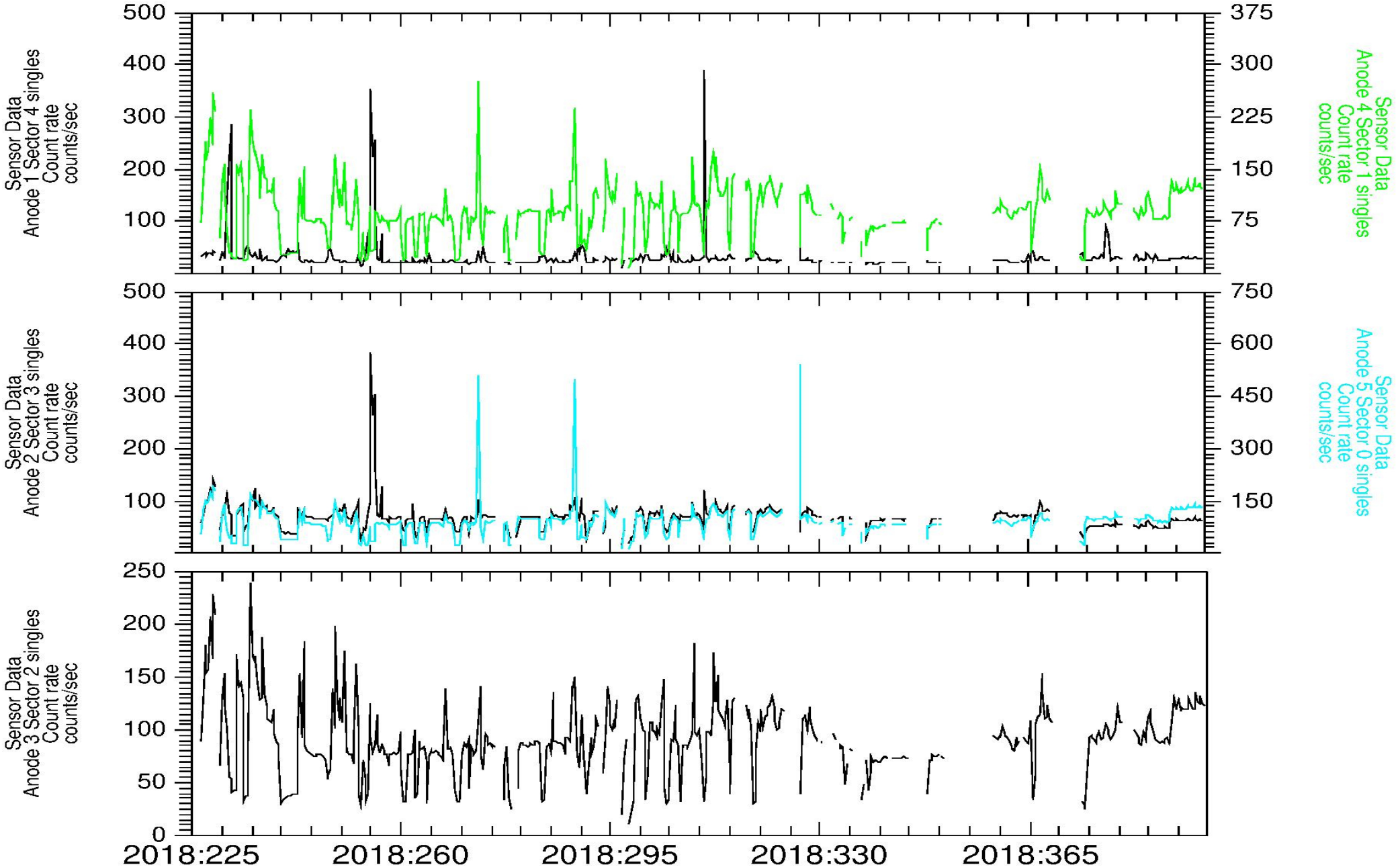
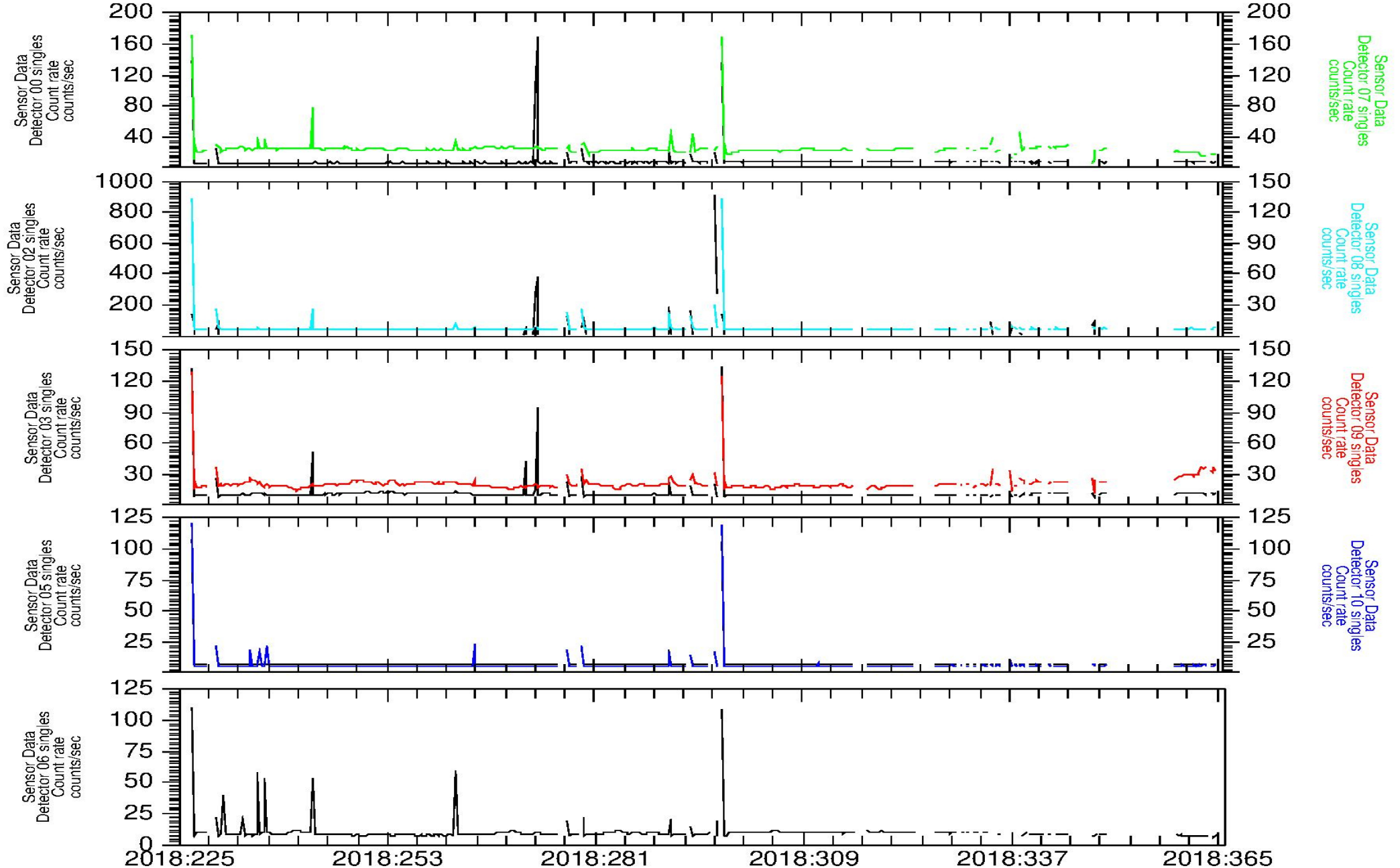
PEPSSI FIT File Structure



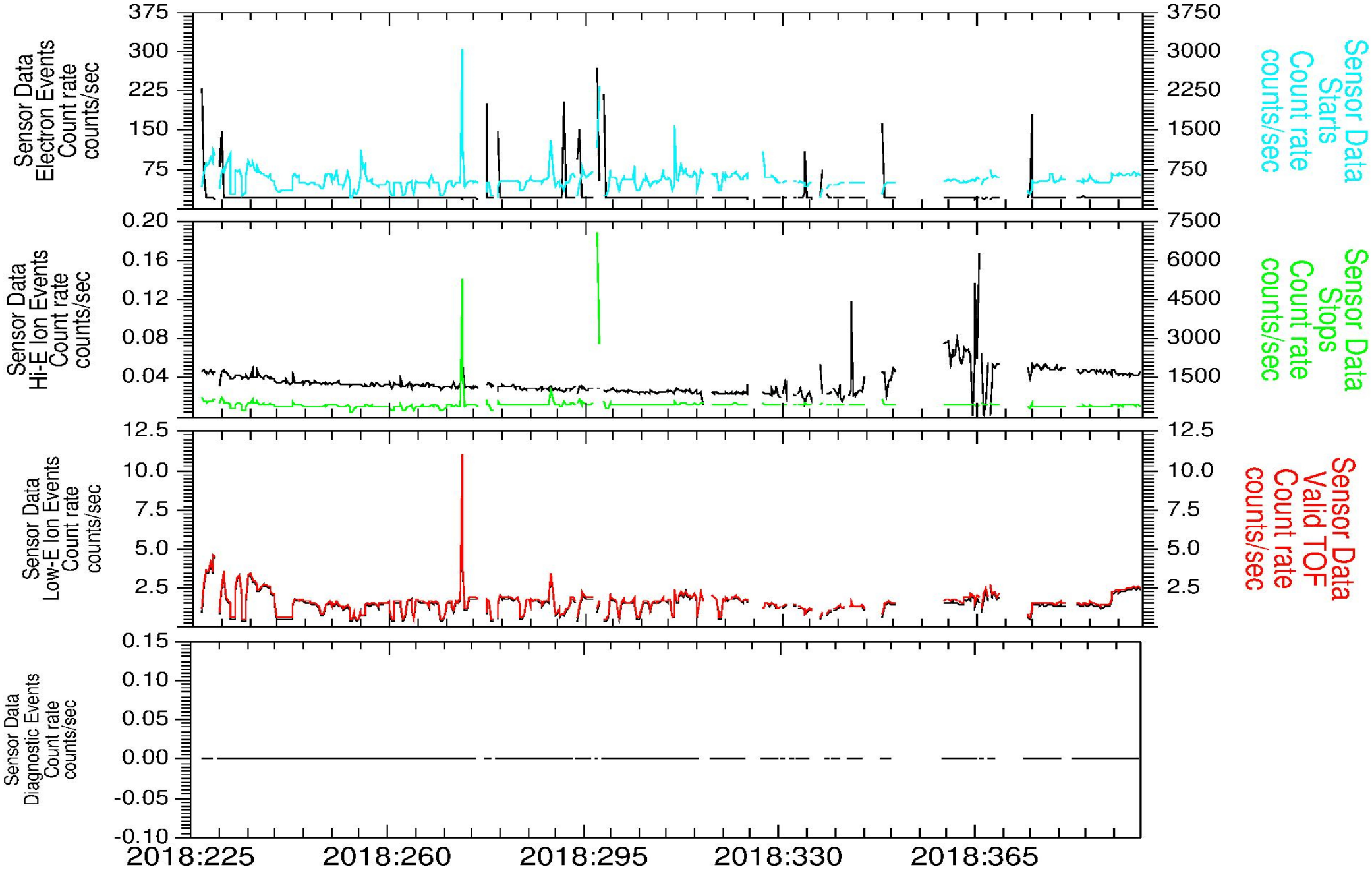
nh-a-pepssi-3-kem1-v2.0/data
FLUX Anode Singles



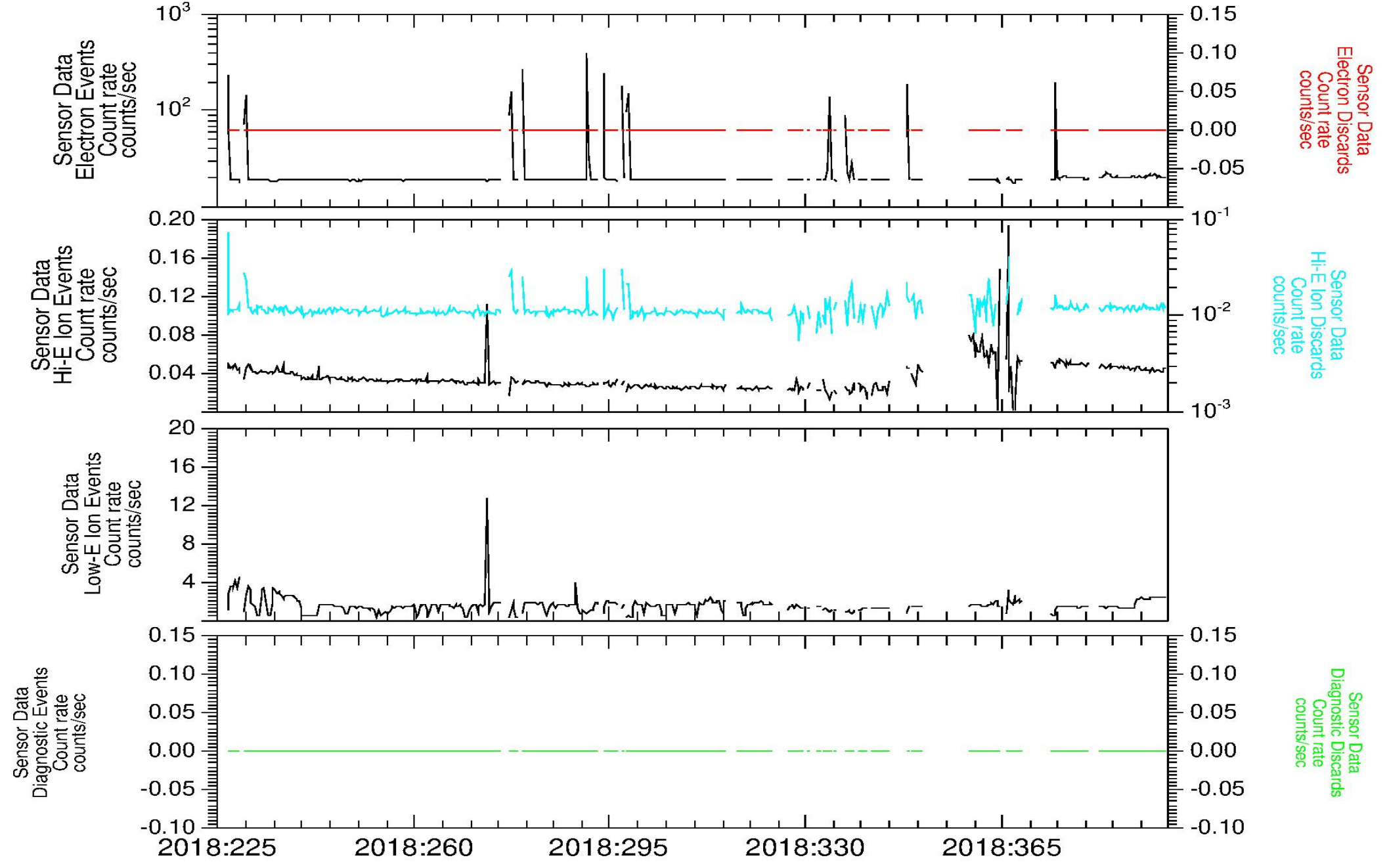
nh-a-pepssi-3-kem1-v2.0/data
FLUX Detector Singles



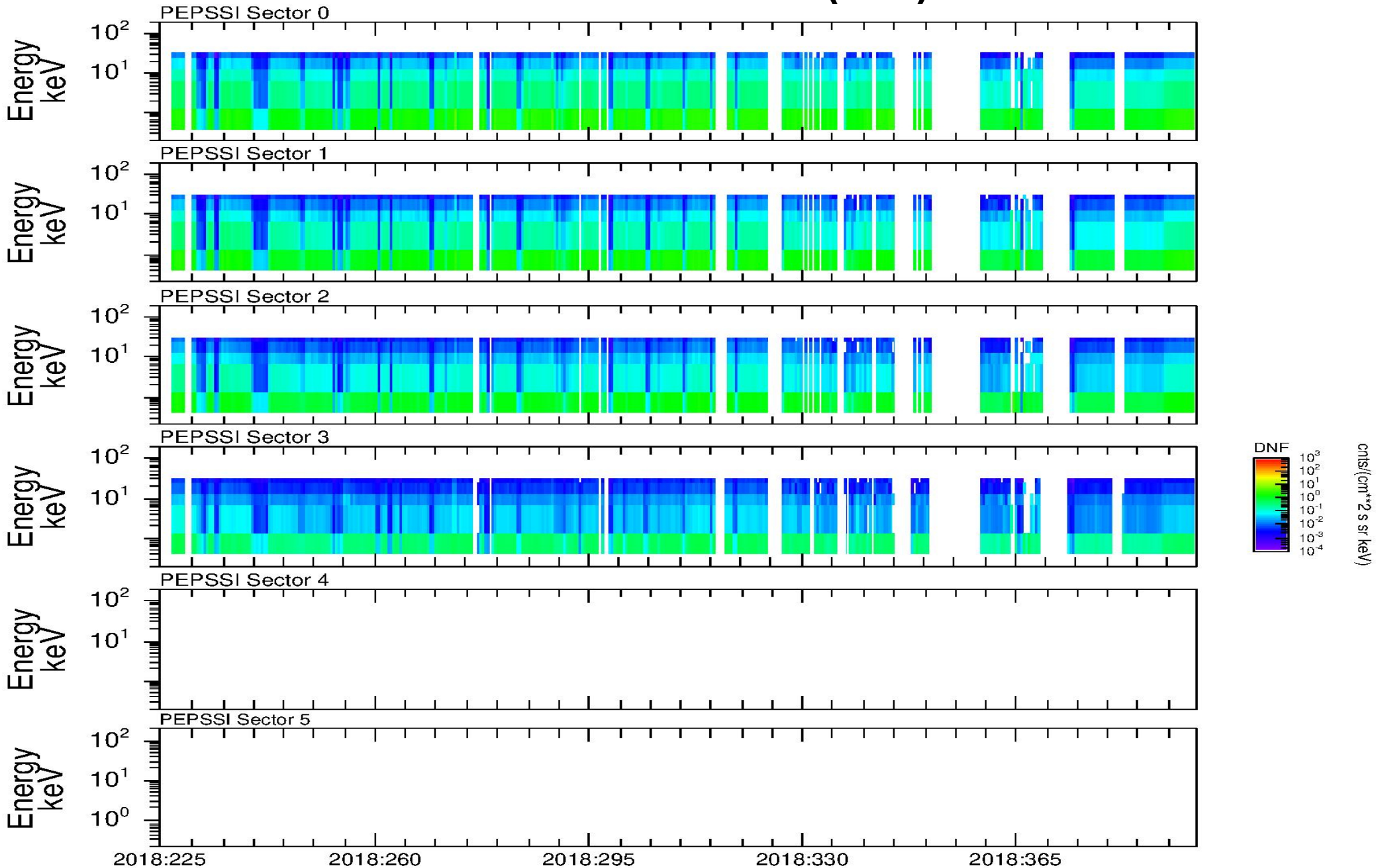
nh-a-pepssi-3-kem1-v2.0/data
FLUX Events “C” Rates



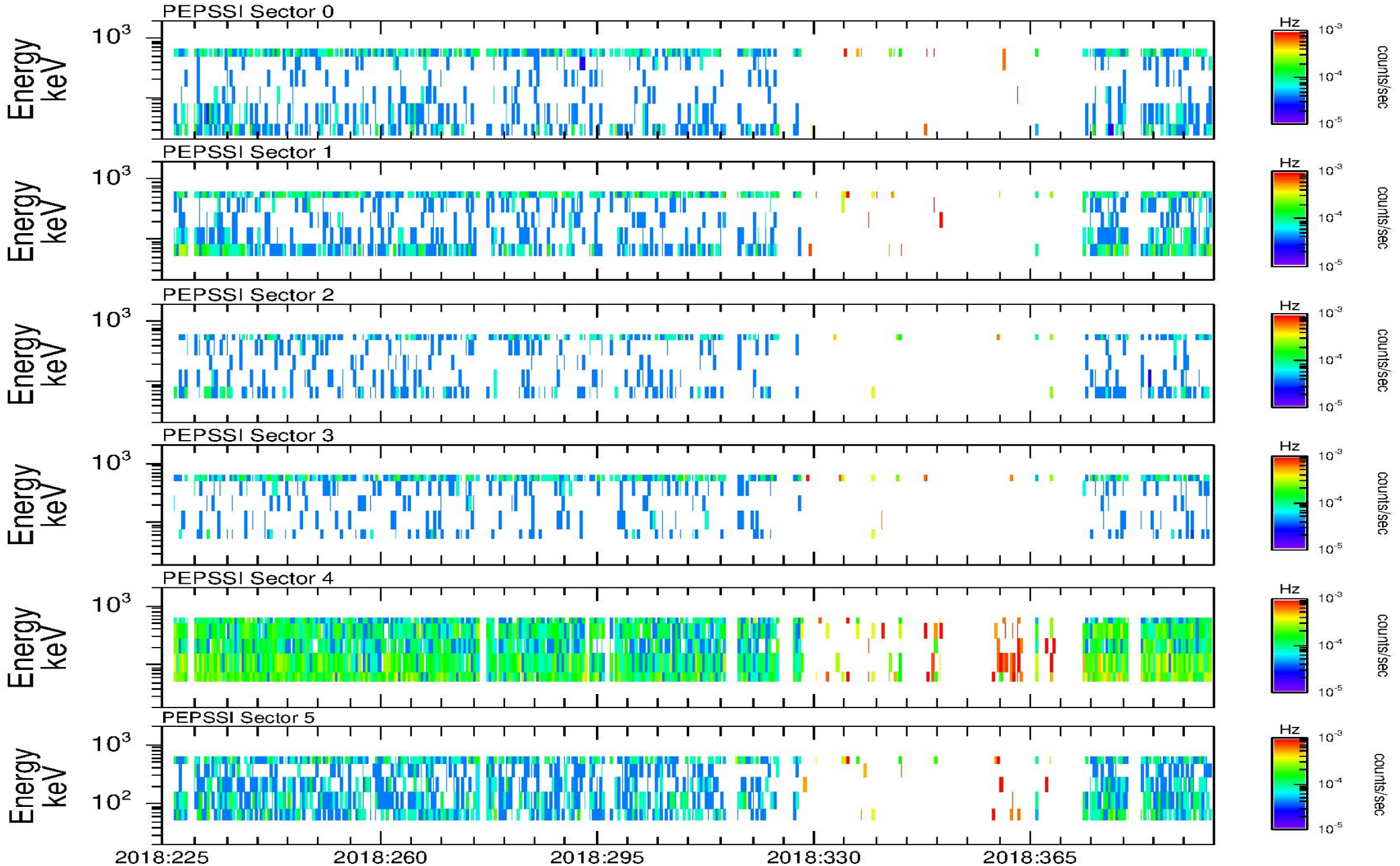
nh-a-pepssi-3-kem1-v2.0/data
FLUX Discards “J” Rates



nh-a-pepssi-3-kem1-v2.0/data
FLUX Doubles (“L”)



nh-a-pepssi-3-kem1-v2.0/data
FLUX Triples (“D”) CPS Protons



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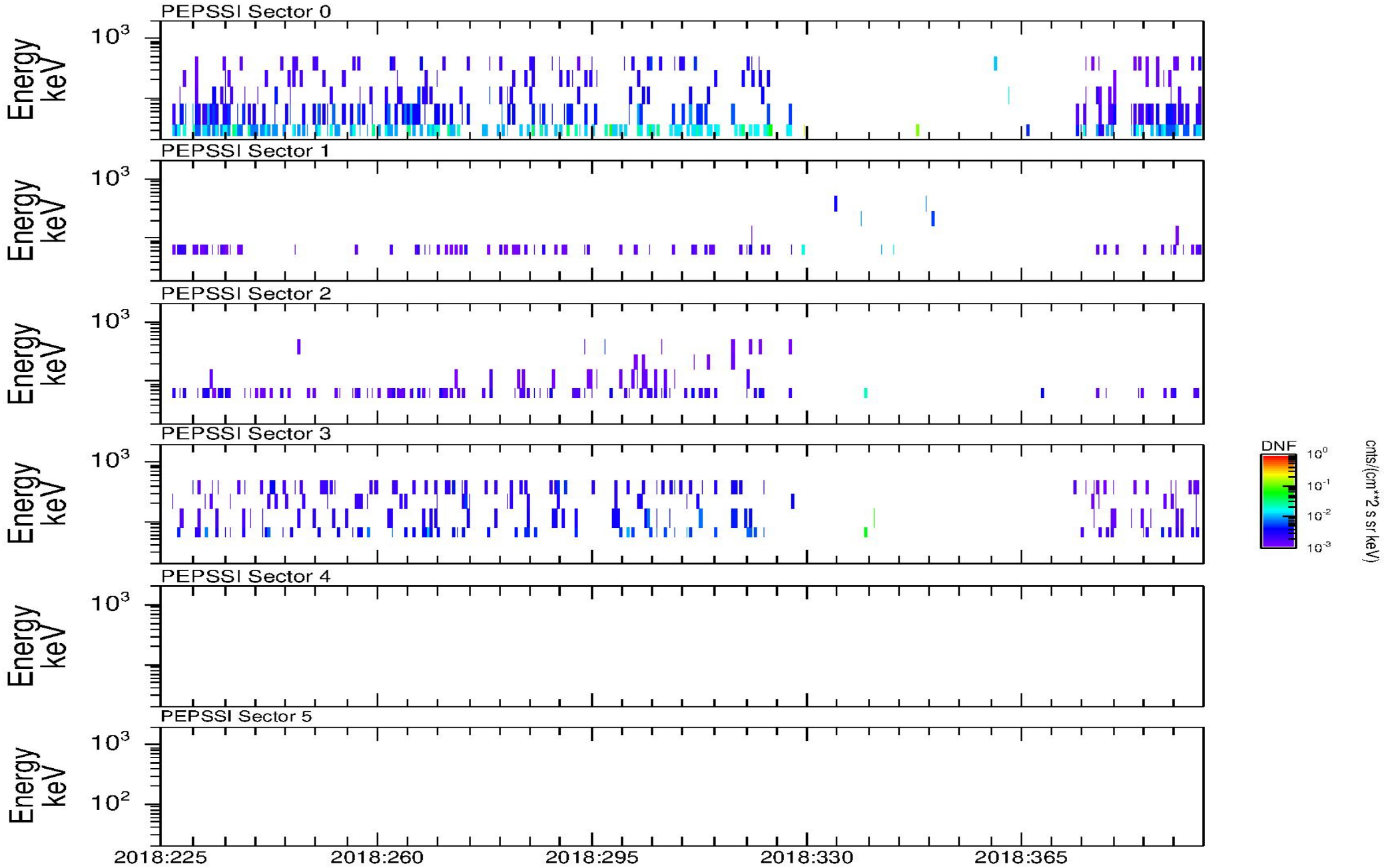

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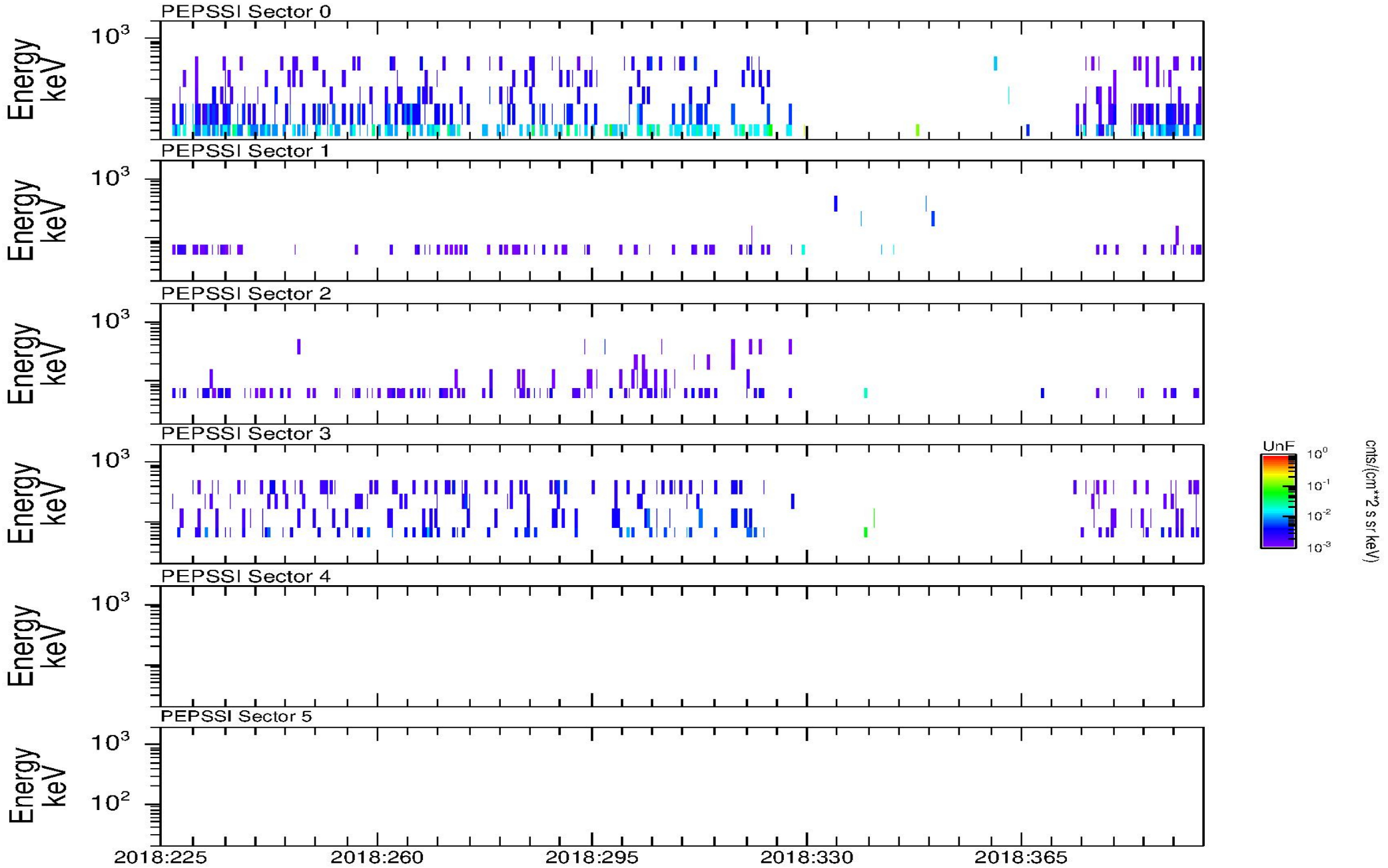
FLUX Triples (“D”) UNC Protons



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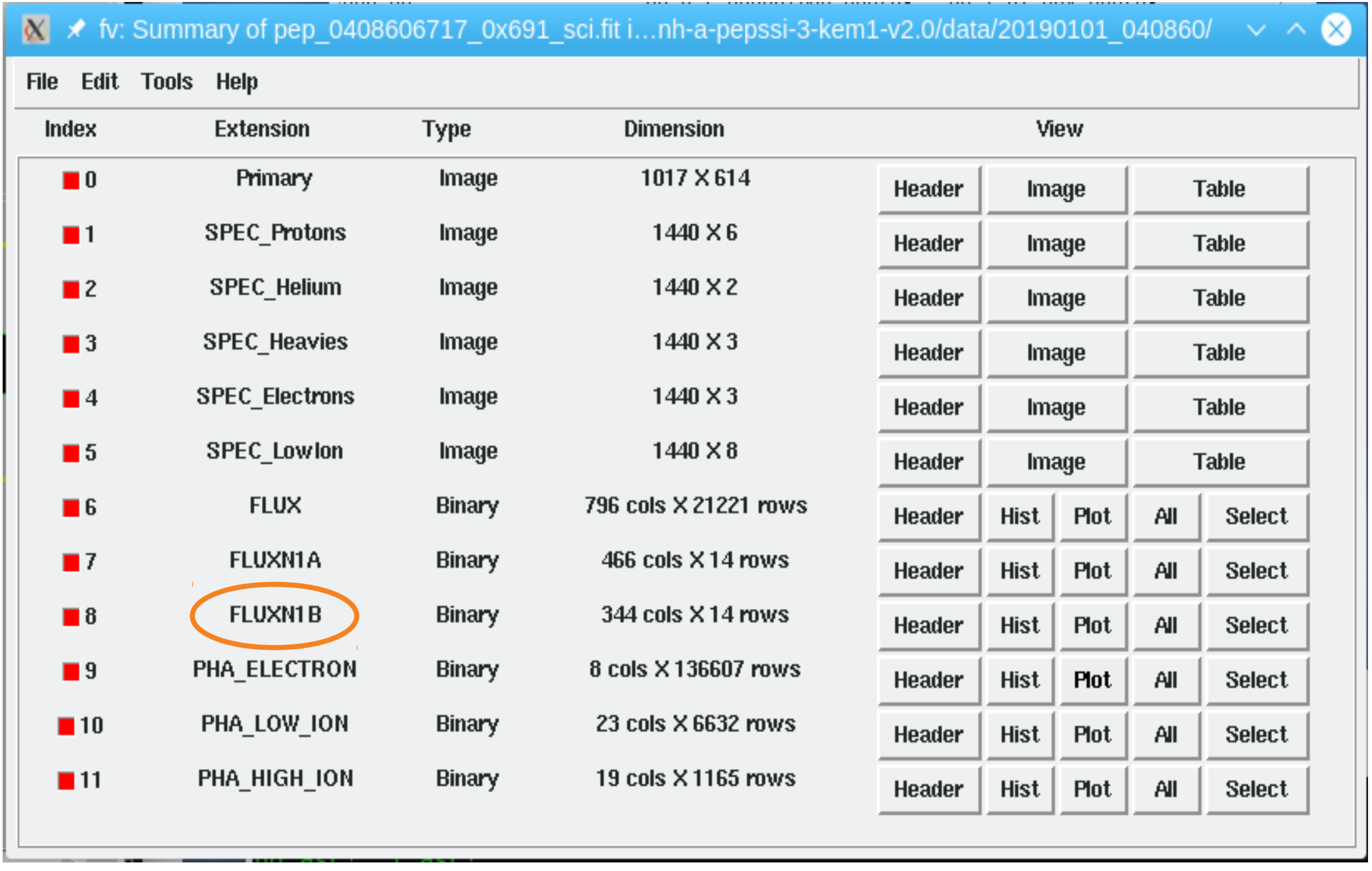
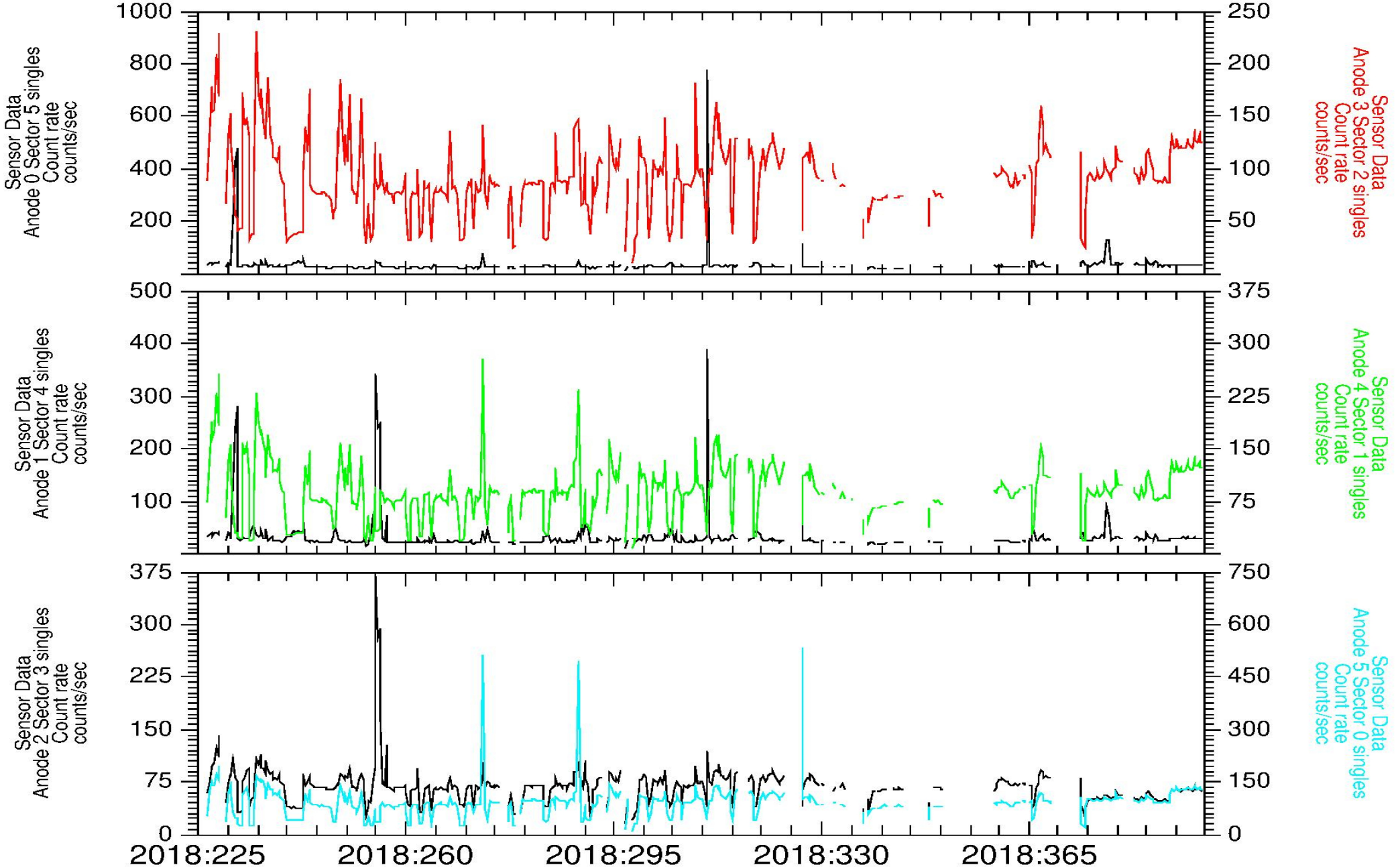
PEPSSI FIT File Structure



nh-a-pepssi-3-kem1-v2.0/data
FLUXN1B Anode Singles



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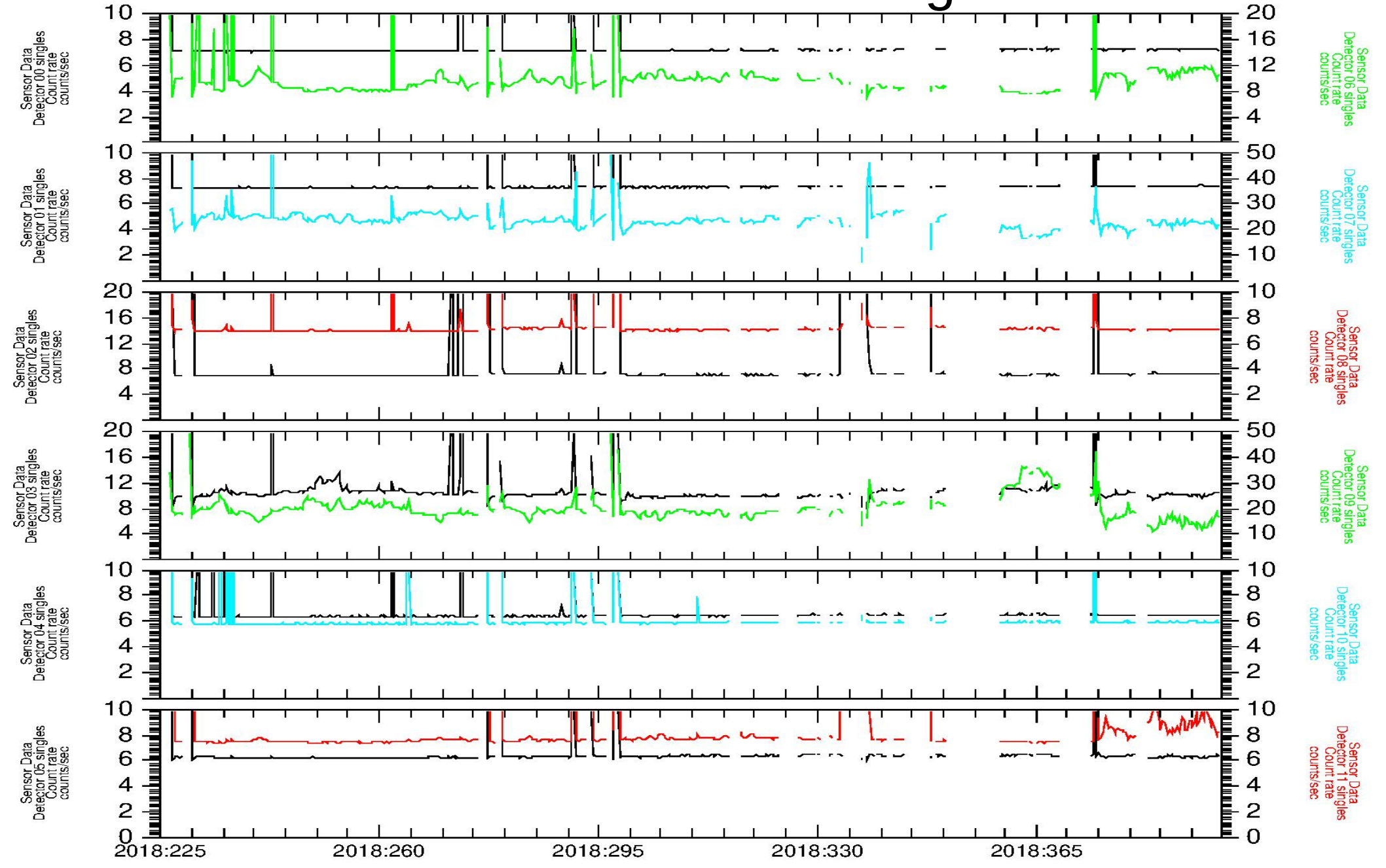
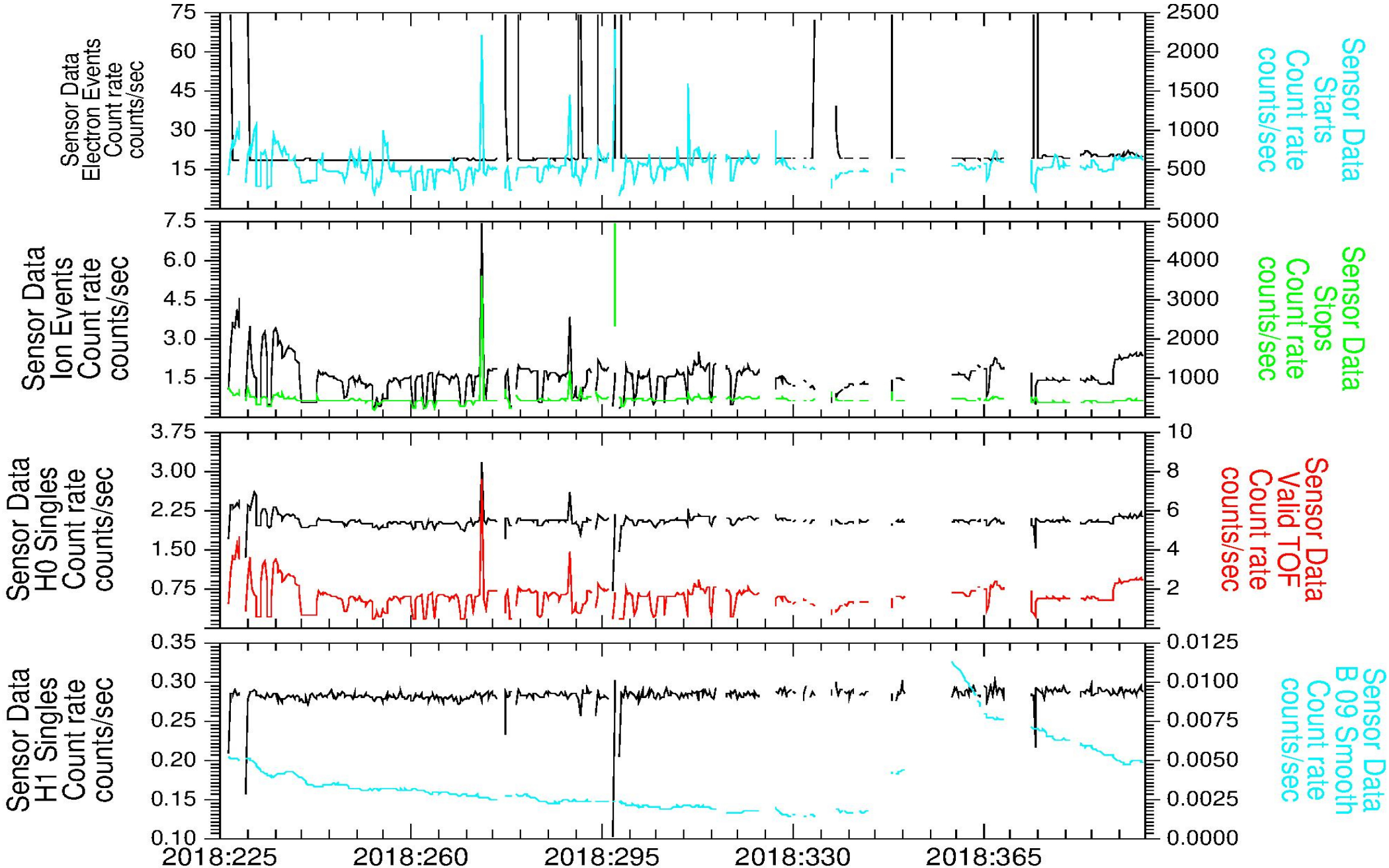
FLUXN1B Detector Singles



nh-a-pepssi-3-kem1-v2.0/data
FLUXN1B Events “C” Rates – 1 of 2

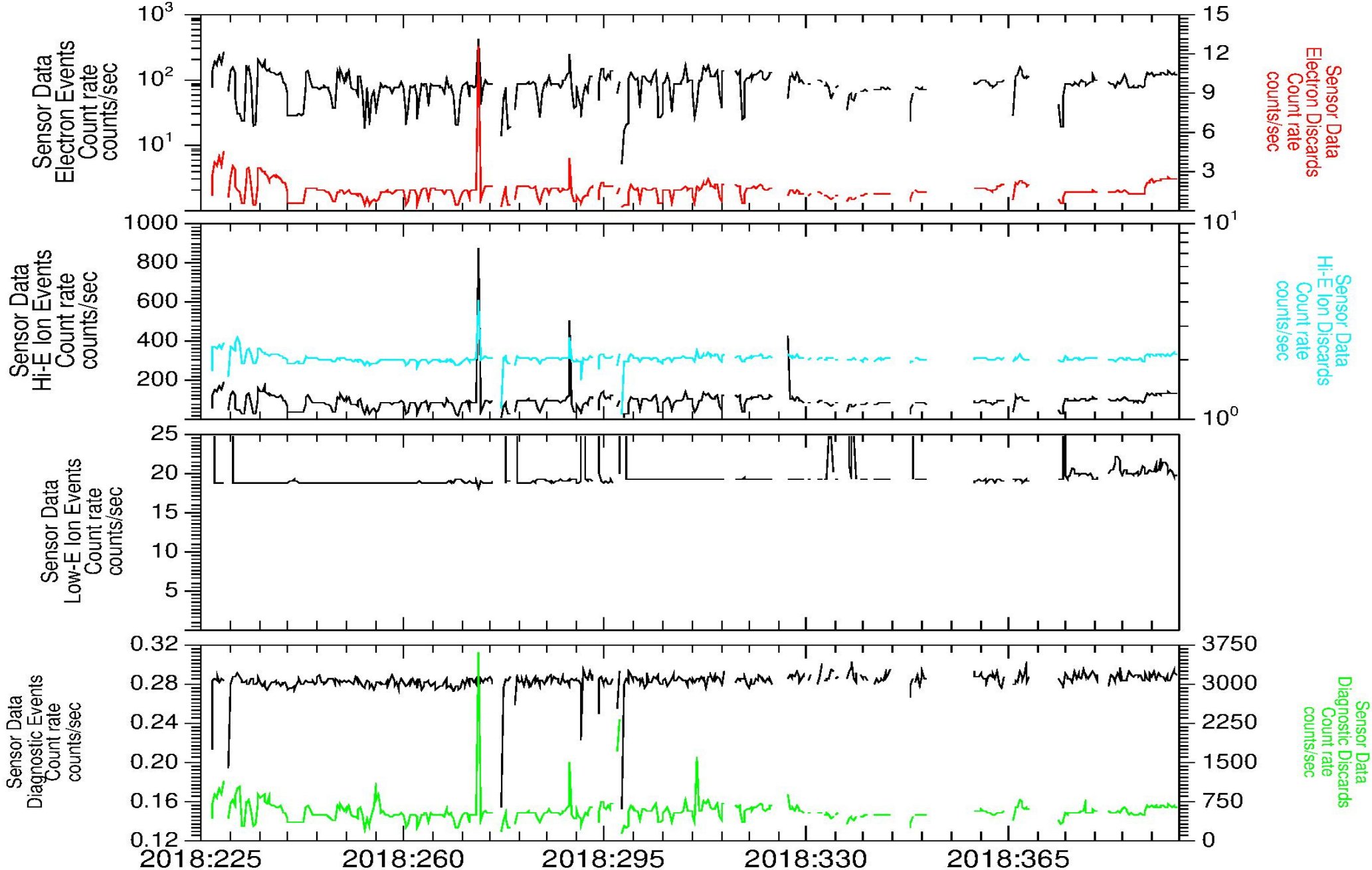


nh-a-pepssi-3-kem1-v2.0/data
FLUXN1B Events “C” Rates – 2 of 2

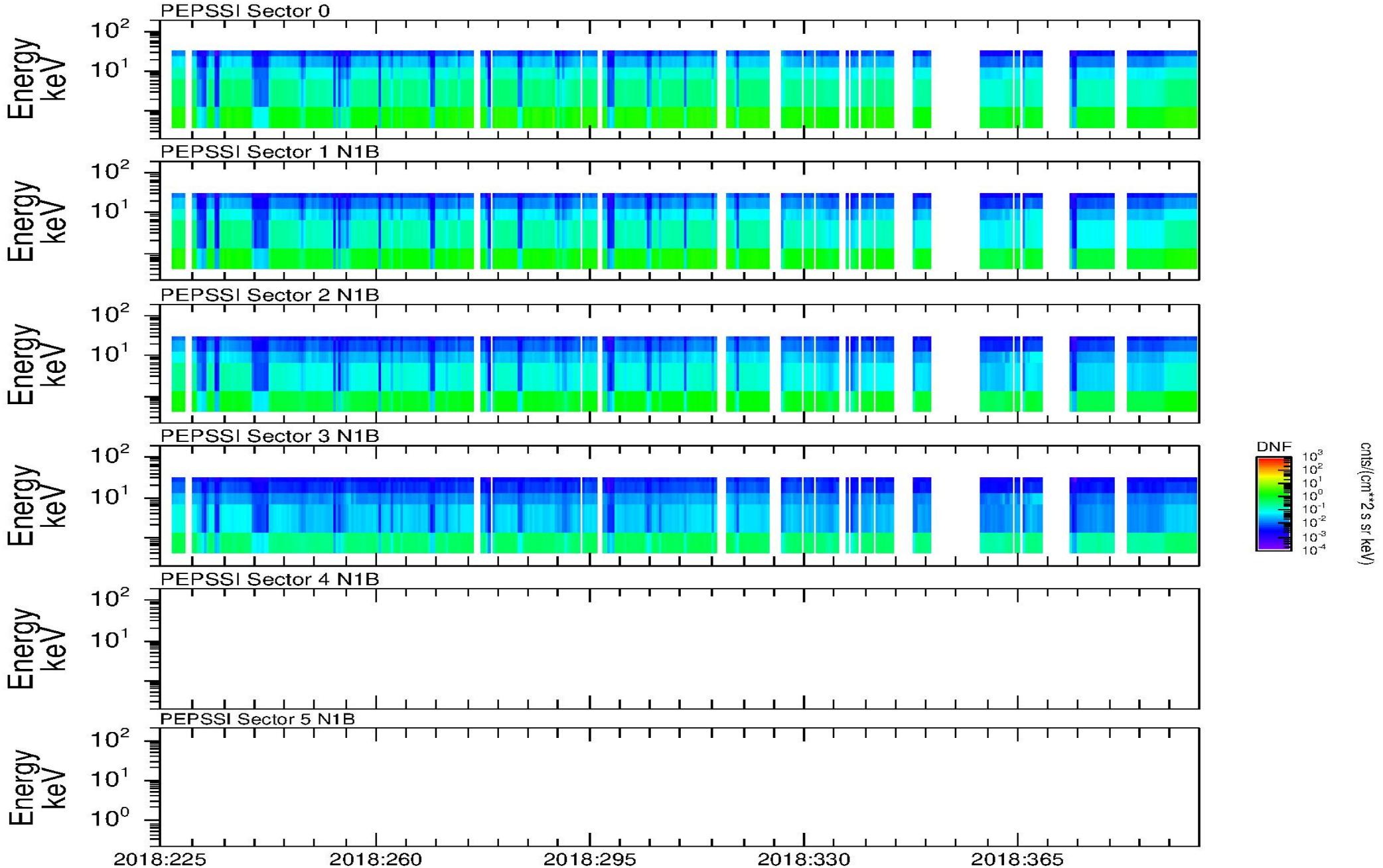
```
TUNIT5  = 'years    '           / Tau Units
TTYPE6  = 'B09SMOOTH'           / Derived B09 Rate
TUNIT6  = 'CPS      '           / B09Smoothed Units
TFORM4  = '1J       '           / column data format
TFORM5  = '1D       '           / column data format
TFORM6  = '1D       '           / column data format
TTYPE7  = 'C000000CPS'          / C000000 Rate: Counts per Second
```

Again, what is B09SMOOTH? Unable to locate any documentation citing this quantity. This was brought up in previous reviews and the PEPSSI Team did not know what this parameter was, but were going to look into its so they could write an explanation.

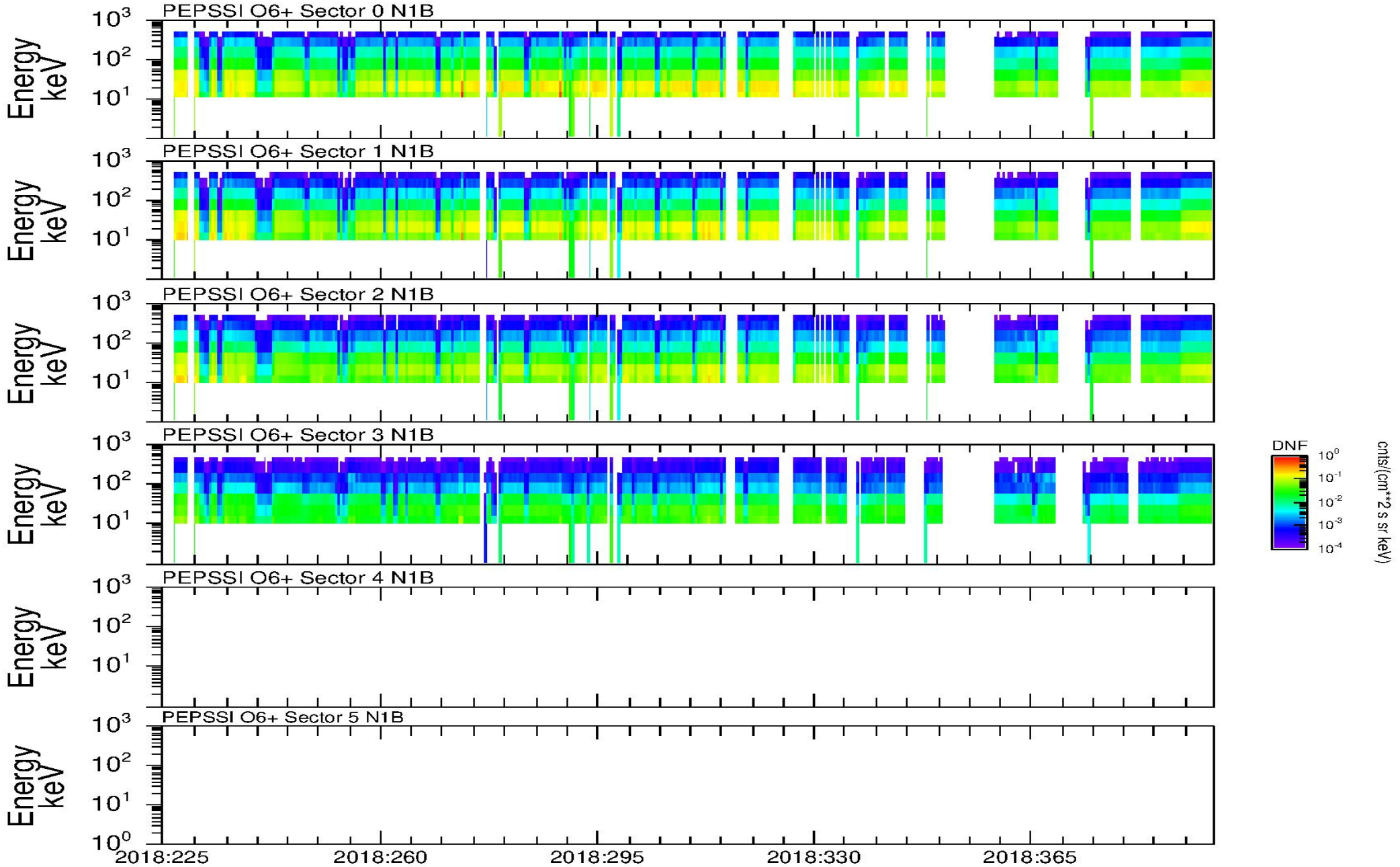
nh-a-pepssi-3-kem1-v2.0/data
FLUXN1B Events “J” Rates



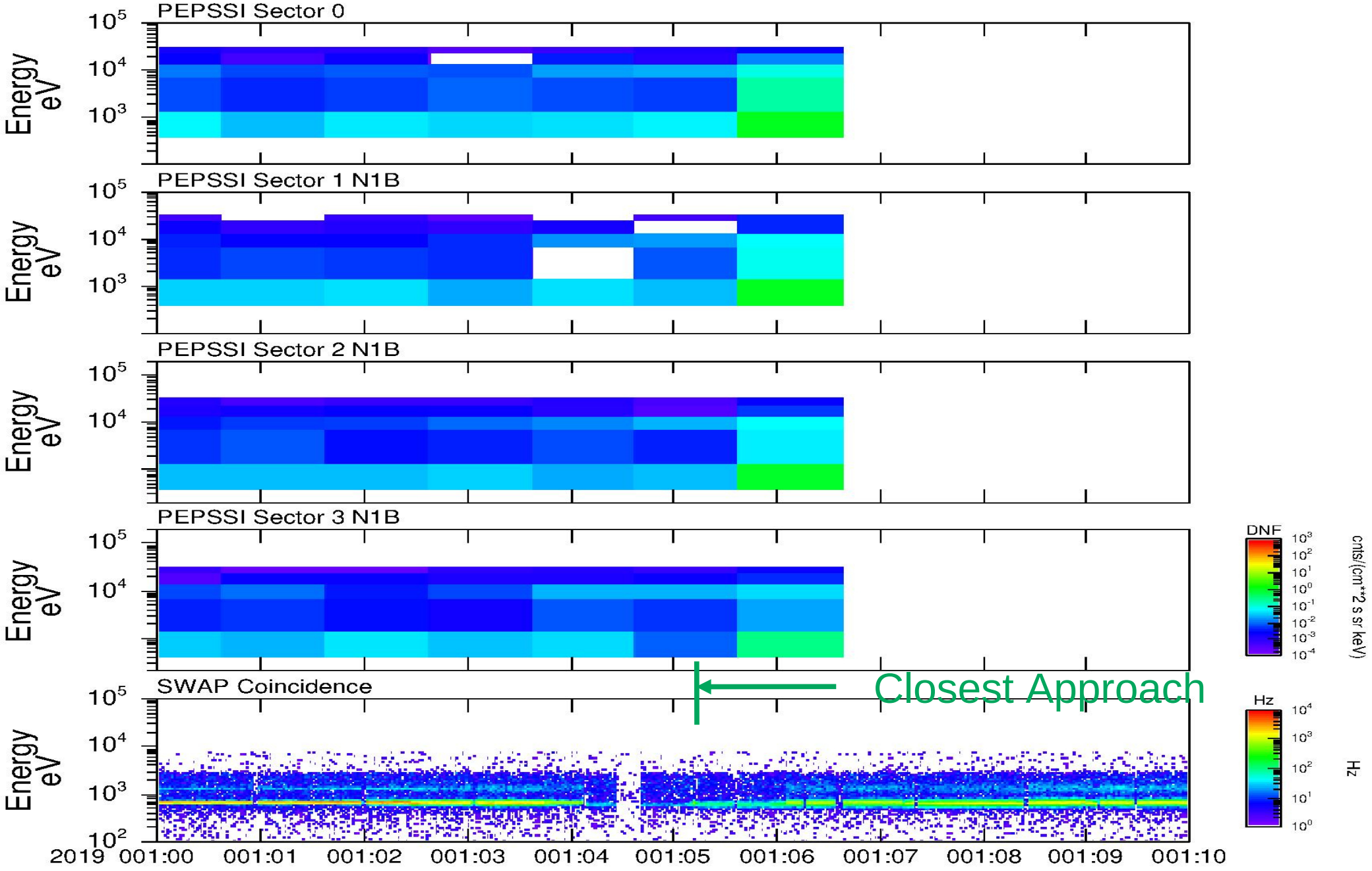
nh-a-pepssi-3-kem1-v2.0/data
FLUXN1B Proton Flux



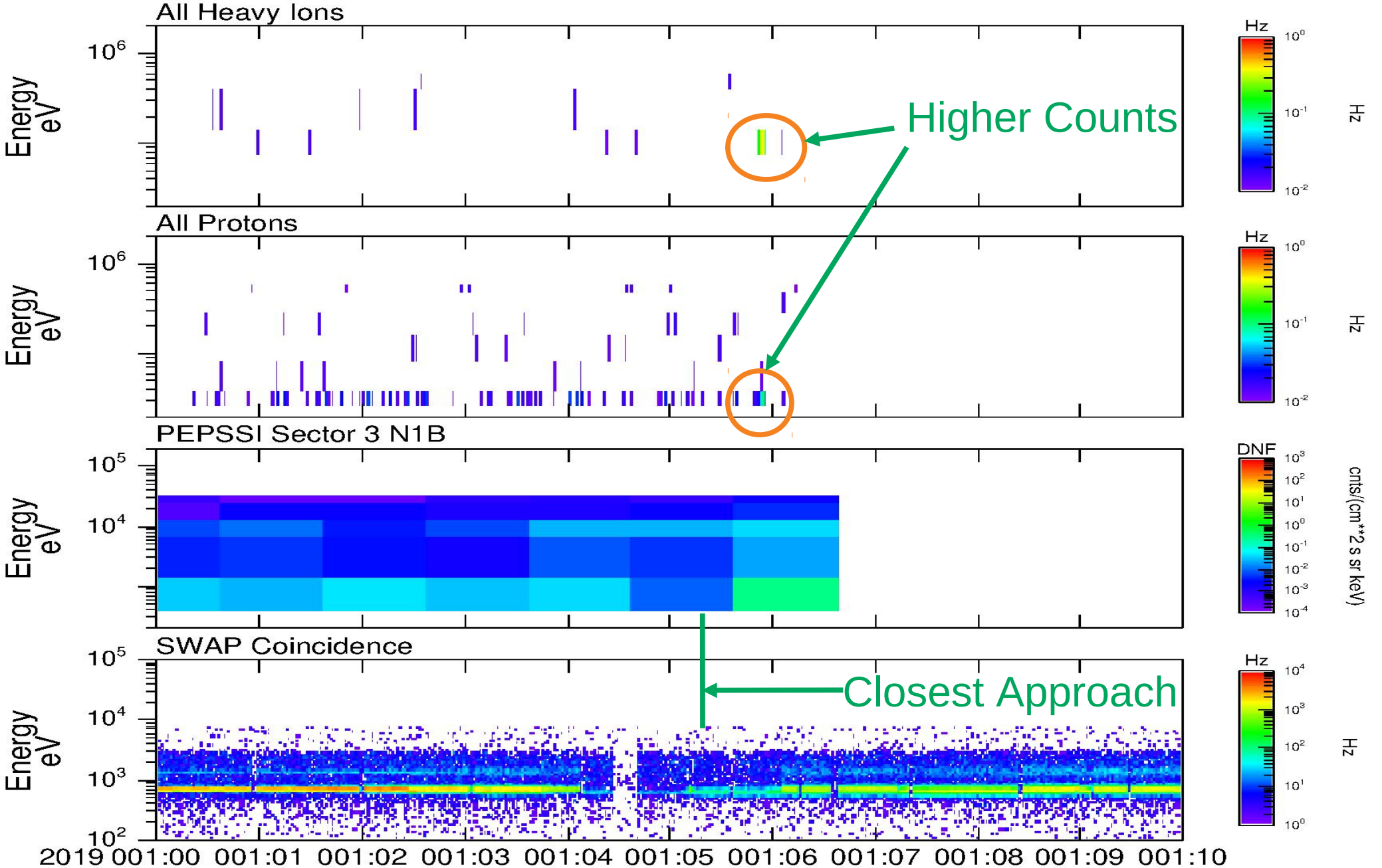
nh-a-pepssi-3-kem1-v2.0/data
FLUXN1B Oxygen Flux



PEPSSI-SWAP
Ultima Thule Encounter – 1 of 2



PEPSSI-SWAP
Ultima Thule Encounter – 2 of 2



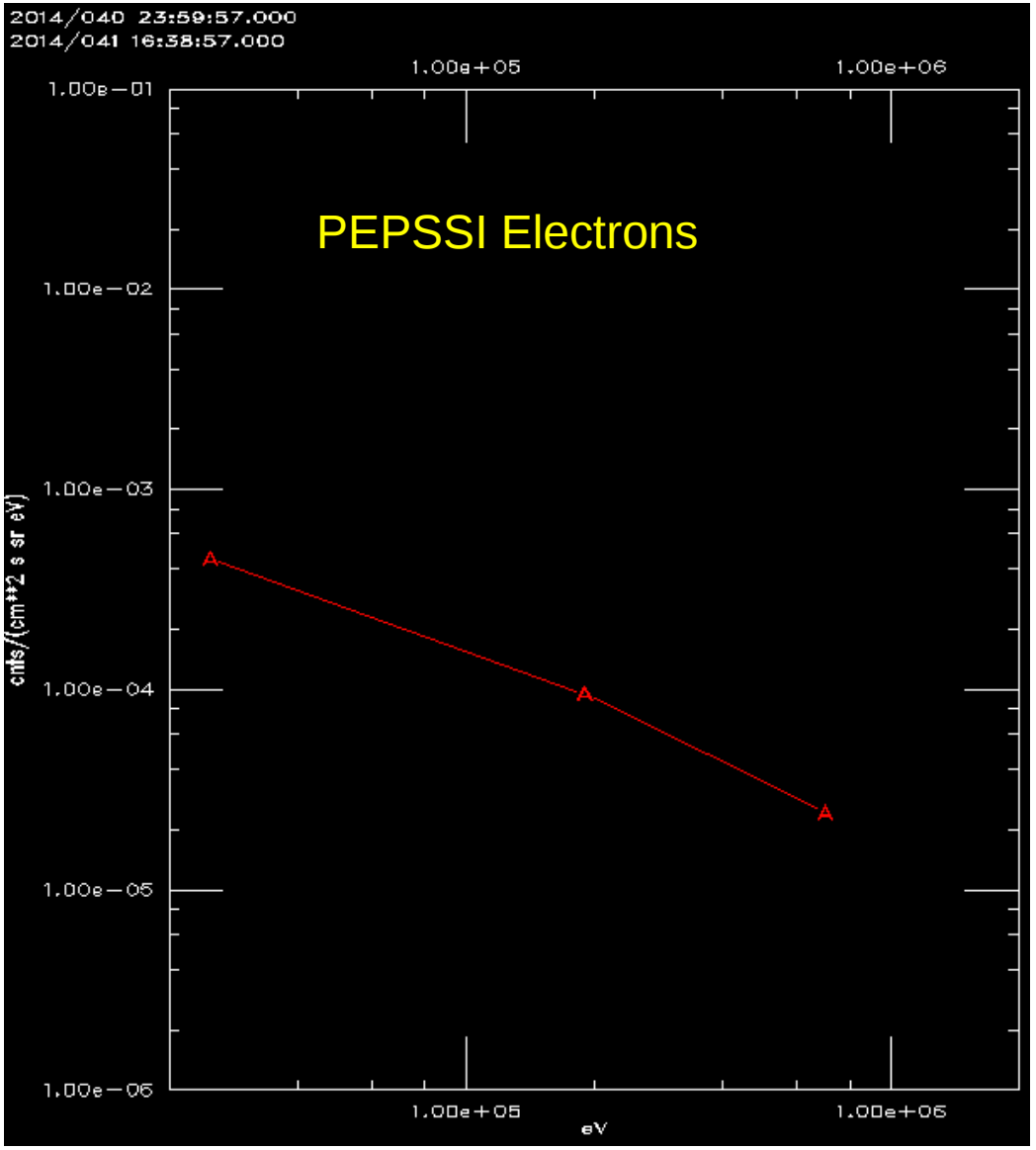
Certification

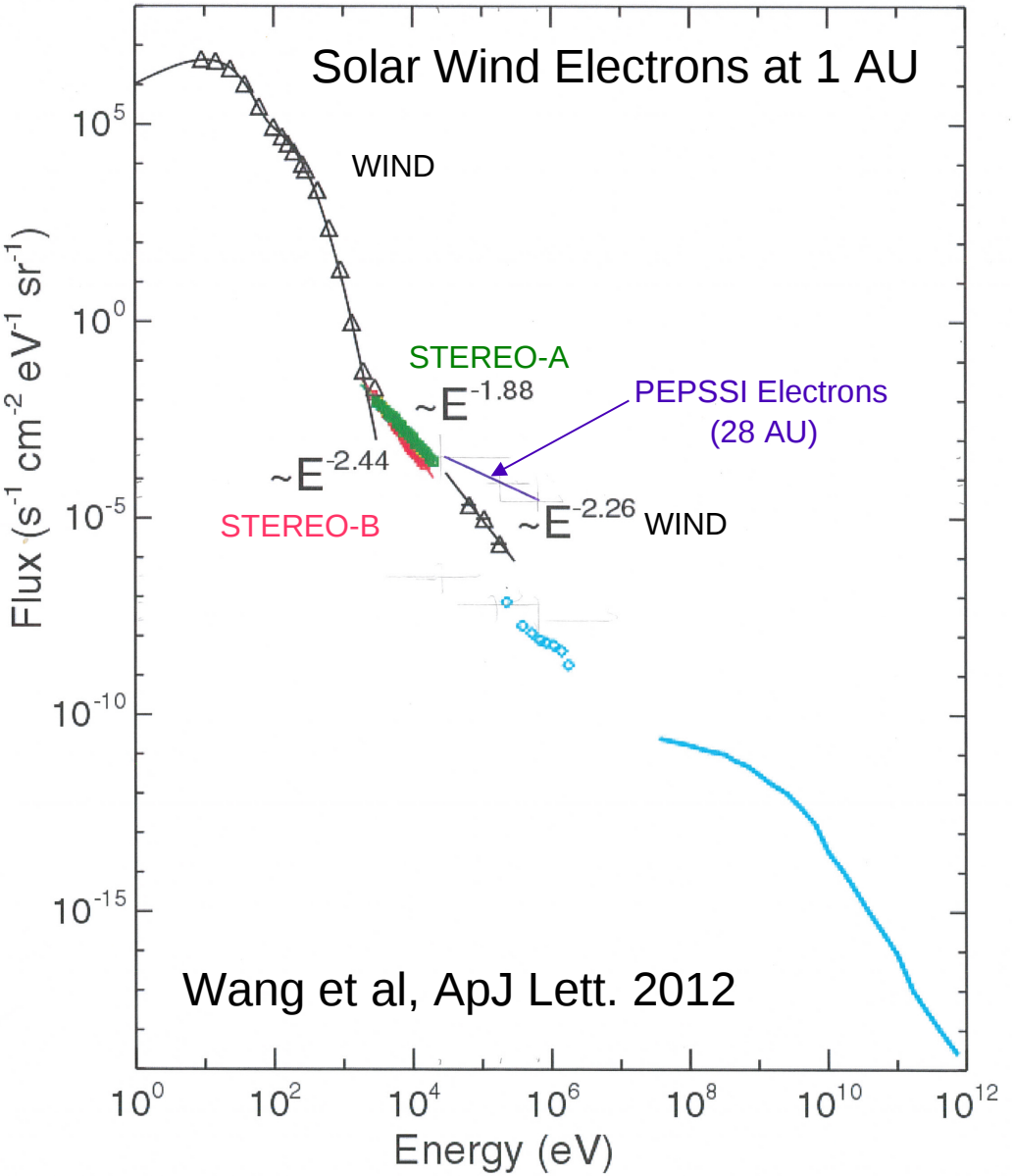
These PEPSSI data are certifiable and look good to be released to the public; however, there are some issues with the documentation submitted with this data set. In particular, the PEPSSI catalog file science goals, the New Horizons spacecraft catalog file, and the instrument ICD. There are some other minor issues which need to be cleaned up. In addition, the project should look into whether or not the proper leap second SPICE kernel was included in the trajectory information. Although this probably would not affect PEPSSI, being 1 second off may effect other New Horizons spacecraft instruments.

BACK-UP Slides

PEPSSI Electrons - 3

Why are the fluxes from PEPSSI abnormally high?





nh-a-pepssi-2-kem1-v2.0
nh-a-pepssi-3-kem1-v2.0
aareadme.txt

GOOD

nh-a-pepssi-2-kem1-v2.0
nh-a-pepssi-3-kem1-v2.0
voldesc.txt

GOOD

nh-a-pepssi-2-kem1-v2.0/index
nh-a-pepssi-3-kem1-v2.0/index
indxinfo.txt

GOOD

nh-a-pepssi-2-kem1-v2.0/index
nh-a-pepssi-3-kem1-v2.0/index
checksum.lbl & checksum.tab

GOOD

nh-a-pepssi-2-kem1-v2.0/index
nh-a-pepssi-3-kem1-v2.0/index
slimindx.lbl & slimindx.tab

GOOD

nh-a-pepssi-2-kem1-v2.0/index
nh-a-pepssi-3-kem1-v2.0/index
index.lbl & index.tab

GOOD

nh-a-pepssi-2-kem1-v2.0/catalog
nh-a-pepssi-3-kem1-v2.0/catalog
catinfo.txt

GOOD

nh-a-pepssi-2-kem1-v2.0/catalog
nh-a-pepssi-3-kem1-v2.0/catalog
ref.cat

GOOD

nh-a-pepssi-2-kem1-v2.0/calib
nh-a-pepssi-3-kem1-v2.0/calib
hk_n1_input_20050228.lbl
hk_n1_input_20050228.tab

GOOD

nh-a-pepssi-2-kem1-v2.0/calib
nh-a-pepssi-3-kem1-v2.0/calib
hk_stat_input_20041016.lbl
hk_stat_input_20041016.tab

GOOD

nh-a-pepssi-3-kem1-v2.0/calib/calpars
calpinfo.txt

GOOD

nh-a-pepssi-3-kem1-v2.0/calib/calpars
calpar_columns.fmt

GOOD

nh-a-pepssi-3-kem1-v2.0/document
docinfo.txt

GOOD

nh-a-pepssi-3-kem1-v2.0/document
codmac_level_definitions.lbl
codmac_level_definitions.pdf

GOOD

nh-a-pepssi-3-kem1-v2.0/document
lunineetal1995.lbl & lunineetal1995.pdf

GOOD

nh-a-pepssi-3-kem1-v2.0/document
nh_fov.lbl & nh_fov.pdf

GOOD

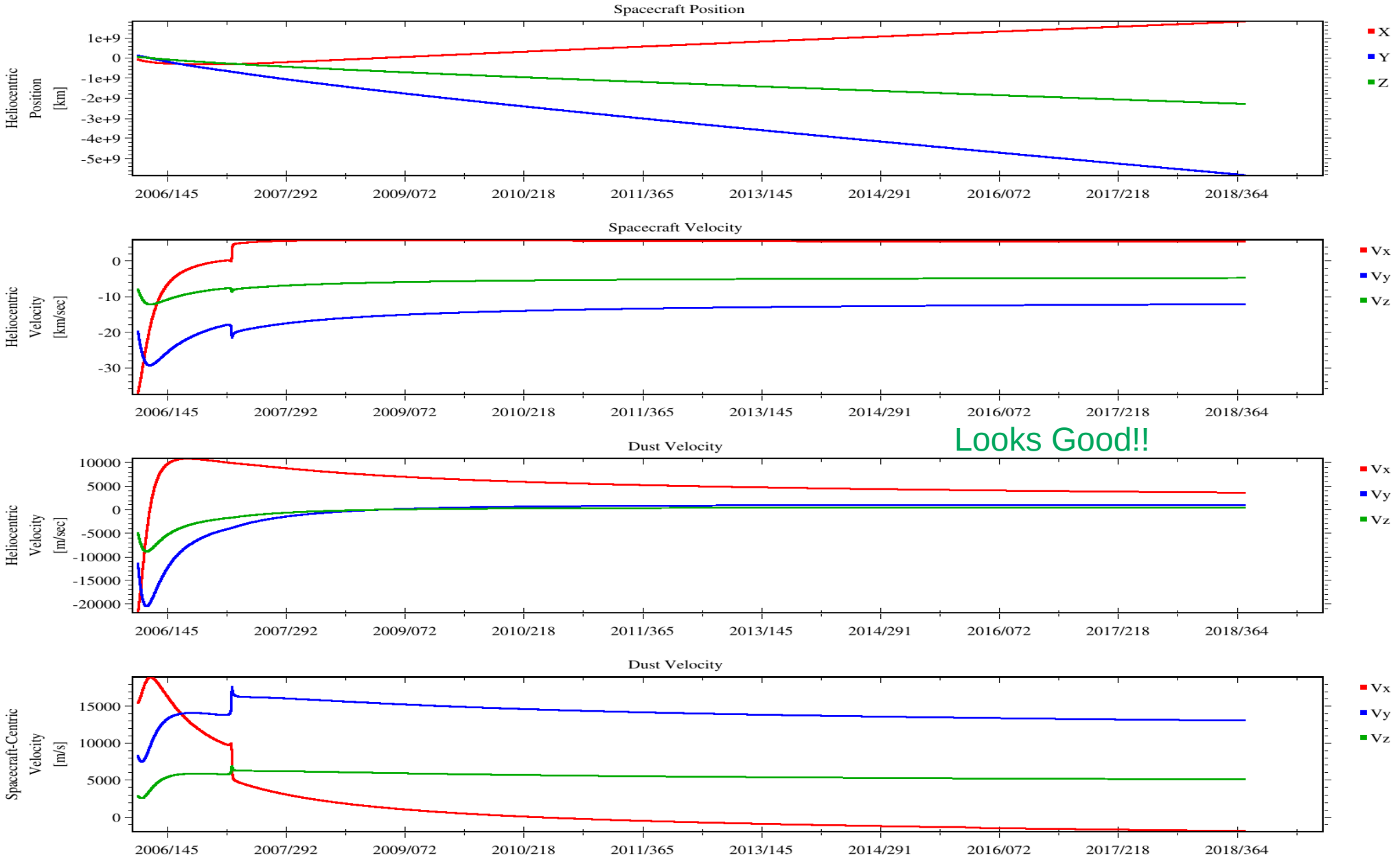
nh-a-pepssi-3-kem1-v2.0/document
nh_met2utc.lbl & nh_met2utc.tab

GOOD

nh-a-pepssi-3-kem1-v2.0/document
nh_mission_trajectory.lbl

GOOD

nh-a-pepssi-3-kem1-v2.0/document
nh_mission_trajectory.tab



Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Sun Feb 9 17:49:23 2020.

nh-a-pepssi-3-kem1-v2.0/document
nh_pepssi_v110_ti.txt

GOOD

nh-a-pepssi-3-kem1-v2.0/document
payload_ssr.lbl & payload_ssr.pdf

GOOD

nh-a-pepssi-3-kem1-v2.0/document
pepssi_ssr.lbl & pepssi_ssr.pdf

GOOD

nh-a-pepssi-3-kem1-v2.0/document
quat_axyz_instr_to_j2k.lbl
quat_axyz_instr_to_j2k.asc

GOOD

nh-a-pepssi-3-kem1-v2.0/document
seq_pepssi_kem1.lbl
seq_pepssi_kem1.tab

GOOD

nh-a-pepssi-3-kem1-v2.0/document
soc_inst_icd.lbl

GOOD