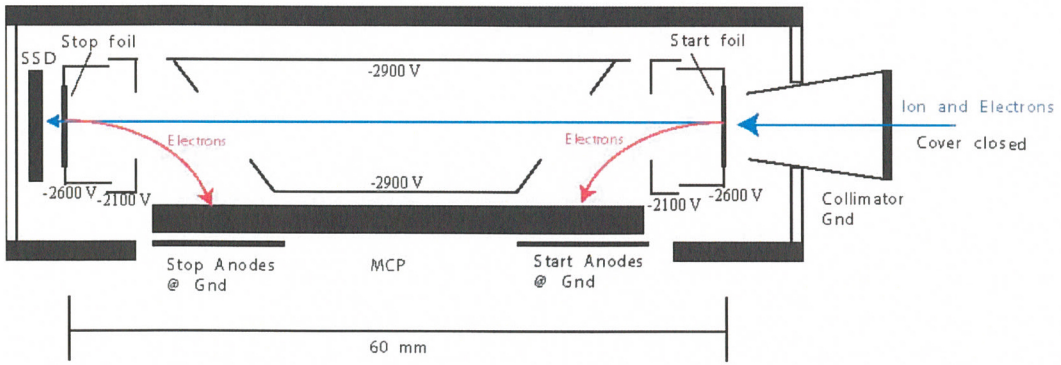
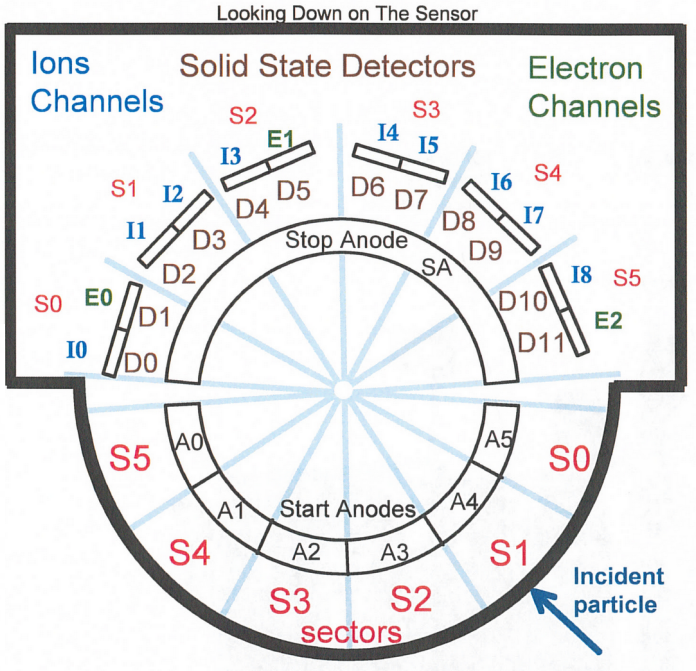
New Horizons Pluto Energetic Particle Spectrometer Science Investigation (PEPSSI)

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-v5.0

CALIBRATED Data Sets:
nh-a-pepssi-3-kem1-v5.0

RESAMPLED Data Sets:
nh-x-pepssi-4-plasma-v1.0

RAW and CALIBRATED Data Sets Handled Separately from RESAMPLED Data Sets

New Horizons PEPSSI Data Set Evaluation Tools

Staging and Evaluation -

- Machine: Dell Precision Tower 5810
- Operating System: Fedora 33 linux

Data Processing -

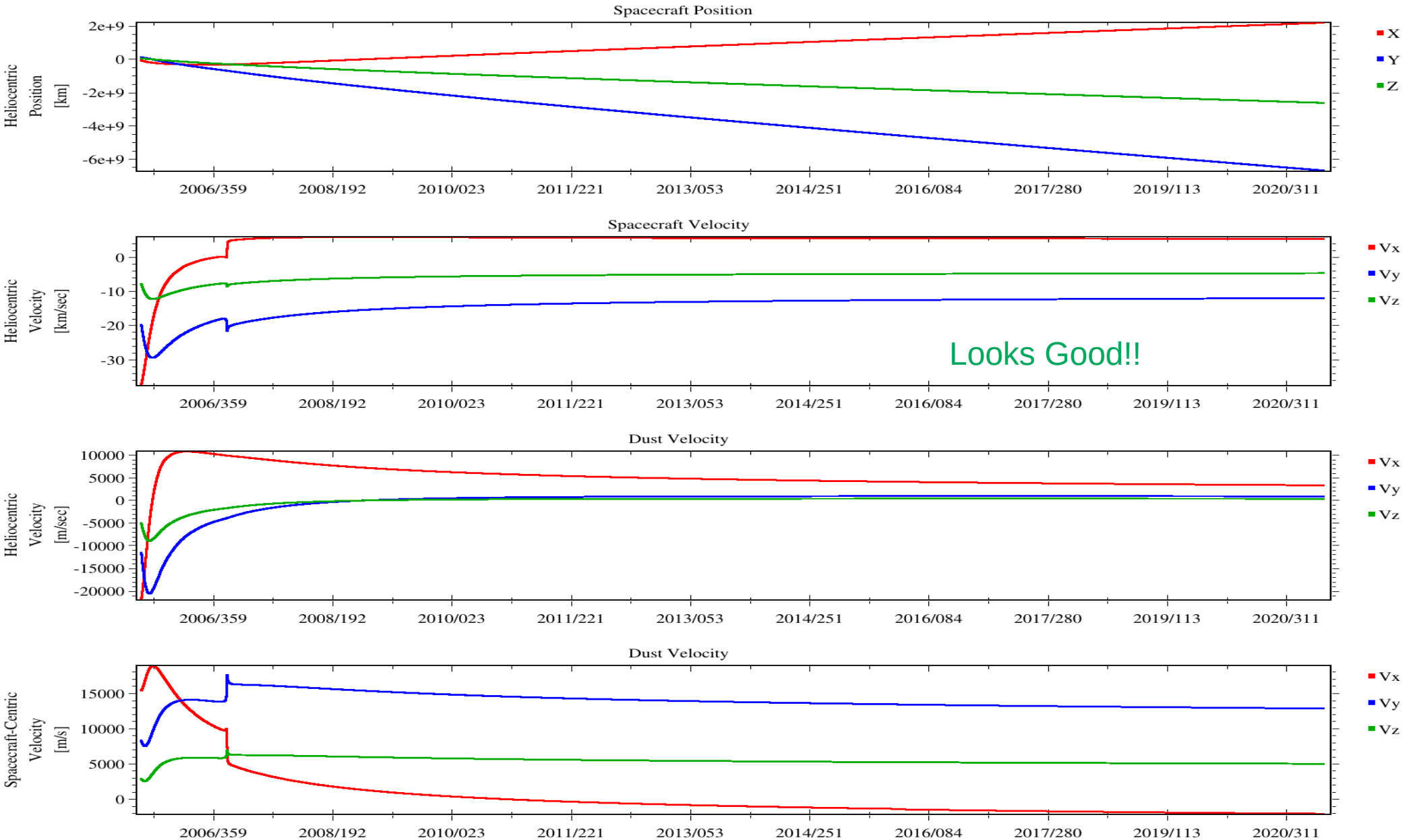
- Machine: Sun Ultra-350
- Operating System: Sun Solaris OS 5.9

Minor Diagnostics -

- Machine: Dell 7520
- Operating System: Fedora 33 linux

PEPSSI RAW and CALIBRATED Documentation Evaluation

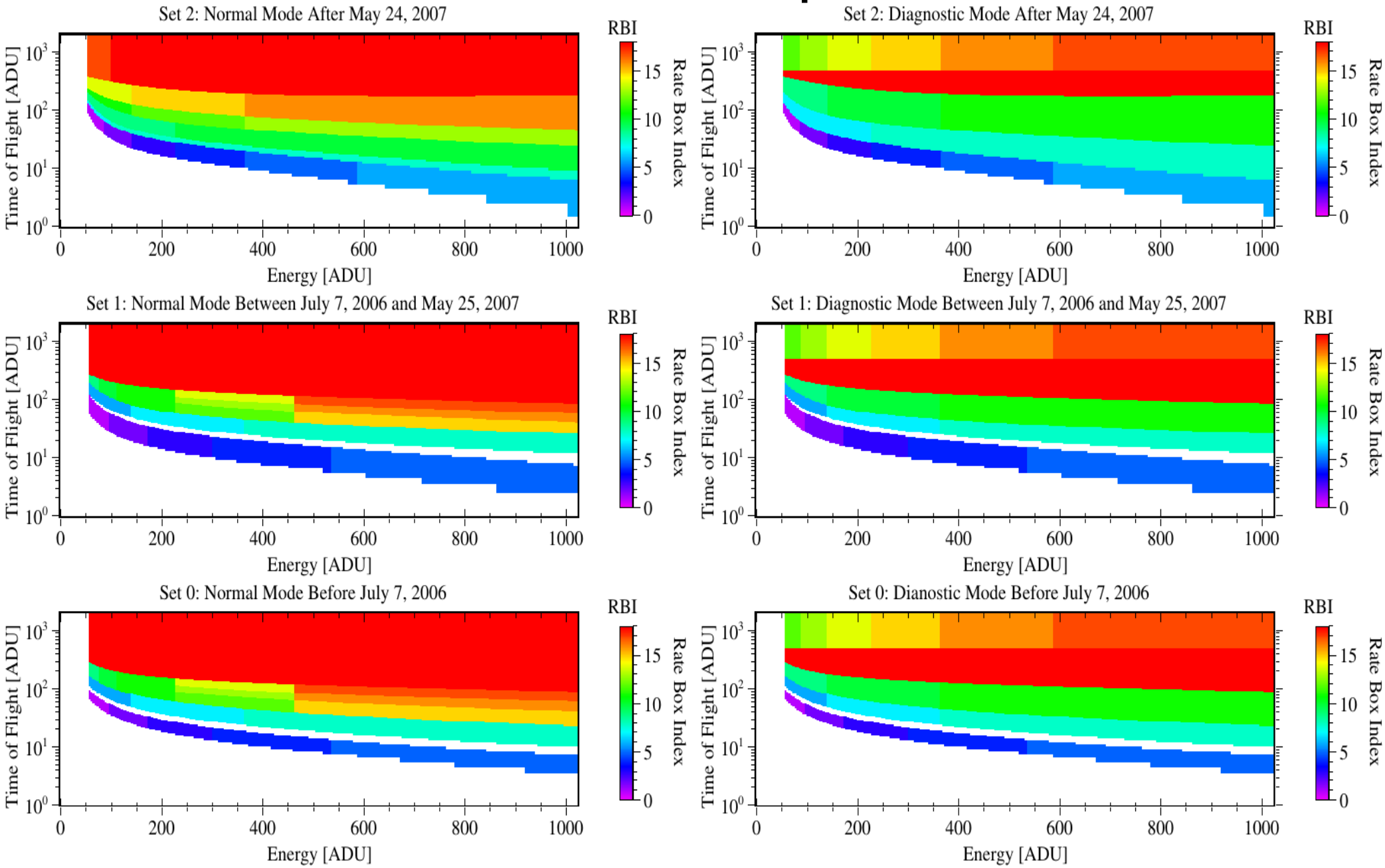
nh-a-pepssi-3-kem1-v5.0/document
nh_mission_trajectory.tab



Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Sun Jan 30 13:08:01 2022.

nh-a-pepssi-3-kem1-v5.0/calib
rateboxdefinitionplanes.fit

Looks Good!!



PEPSSI RAW and CALIBRATED Data Evaluation

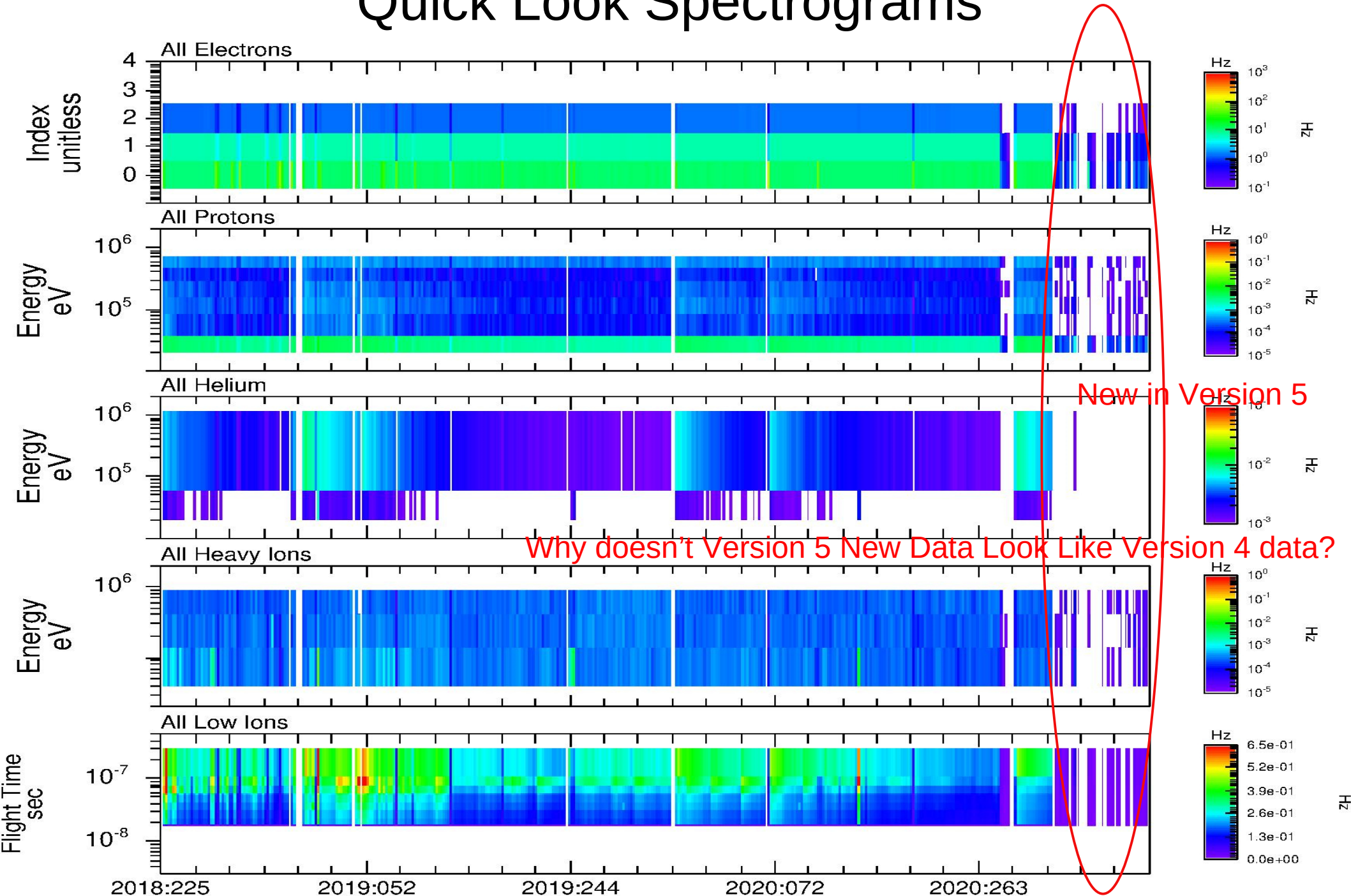
nh-a-pepssi-3-kem1-v5.0/data
PEPSSI FIT File Structure

fv: Summary of pep_0450337917_0x691_sci.fit in /mnt/..._2020c/nh-a-pepssi-3-kem1-v4.0/data/20200429_045033/

File Edit Tools Help

Index	Extension	Type	Dimension	View
0	Primary	Image	1017 X 614	Header Image Table
1	SPEC_Protons	Image	1440 X 6	Header Image Table
2	SPEC_Helium	Image	1440 X 2	Header Image Table
3	SPEC_Heavies	Image	1440 X 3	Header Image Table
4	SPEC_Electrons	Image	1440 X 3	Header Image Table
5	SPEC_LowIon	Image	1440 X 8	Header Image Table
6	FLUX	Binary	796 cols X 37 rows	Header Hist Plot All Select
7	FLUXN1A	Binary	466 cols X 4 rows	Header Hist Plot All Select
8	FLUXN1B	Binary	344 cols X 4 rows	Header Hist Plot All Select
9	PHA_ELECTRON	Binary	8 cols X 654 rows	Header Hist Plot All Select
10	PHA_LOW_ION	Binary	23 cols X 47 rows	Header Hist Plot All Select
11	PHA_HIGH_ION	Binary	19 cols X 79 rows	Header Hist Plot All Select

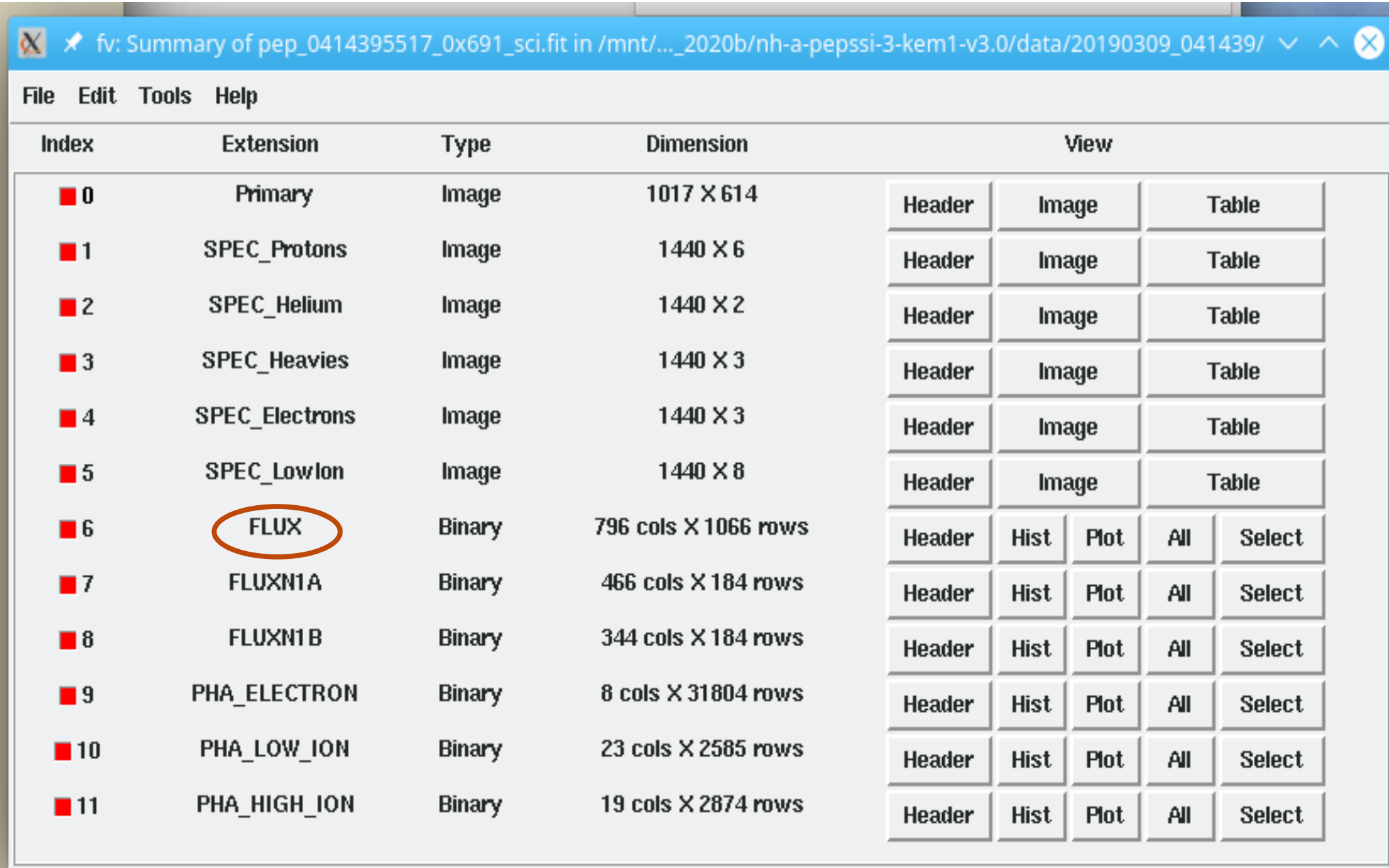
nh-a-pepssi-3-kem1-v5.0/data
Quick Look Spectrograms



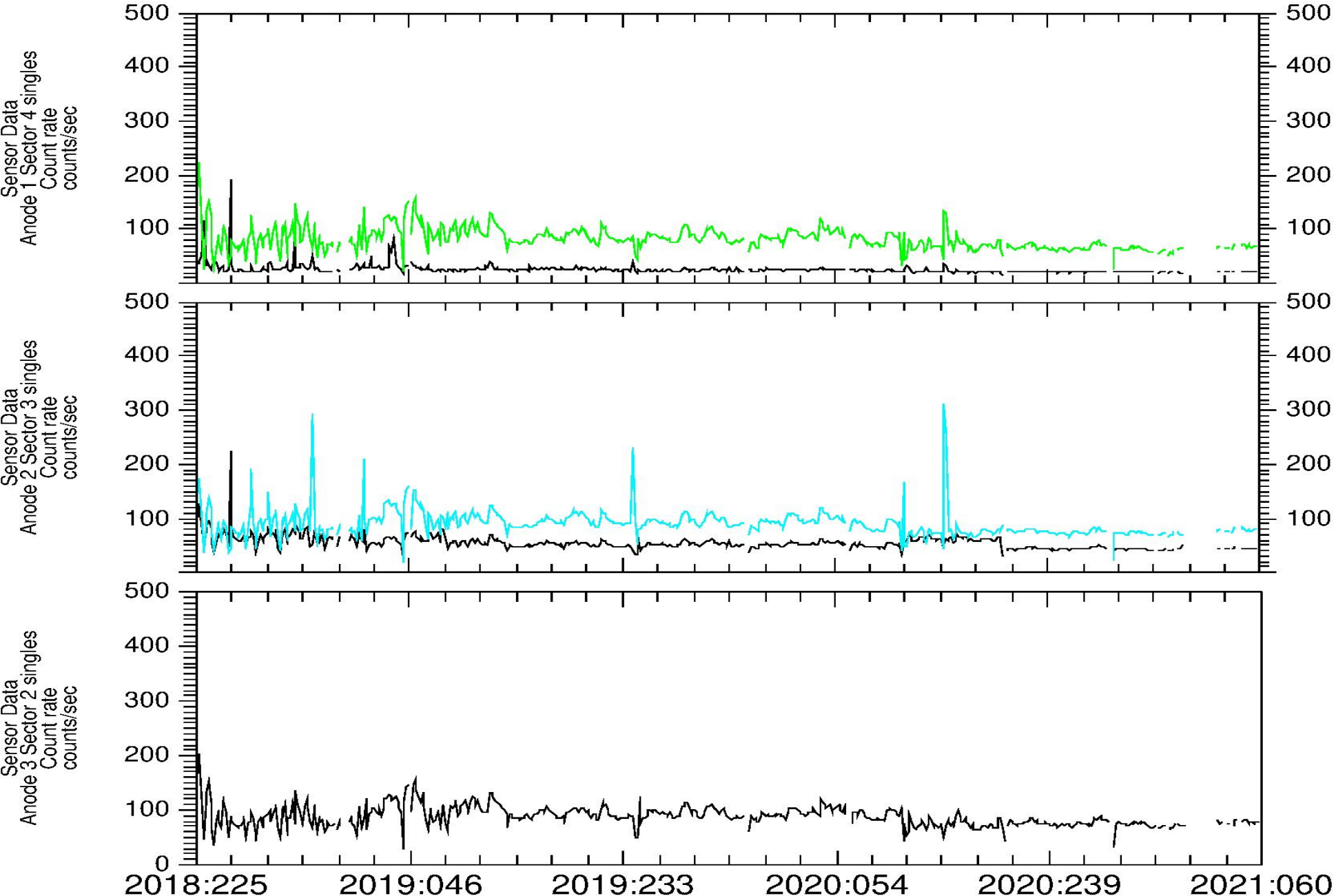
New in Version 5

Why doesn't Version 5 New Data Look Like Version 4 data?

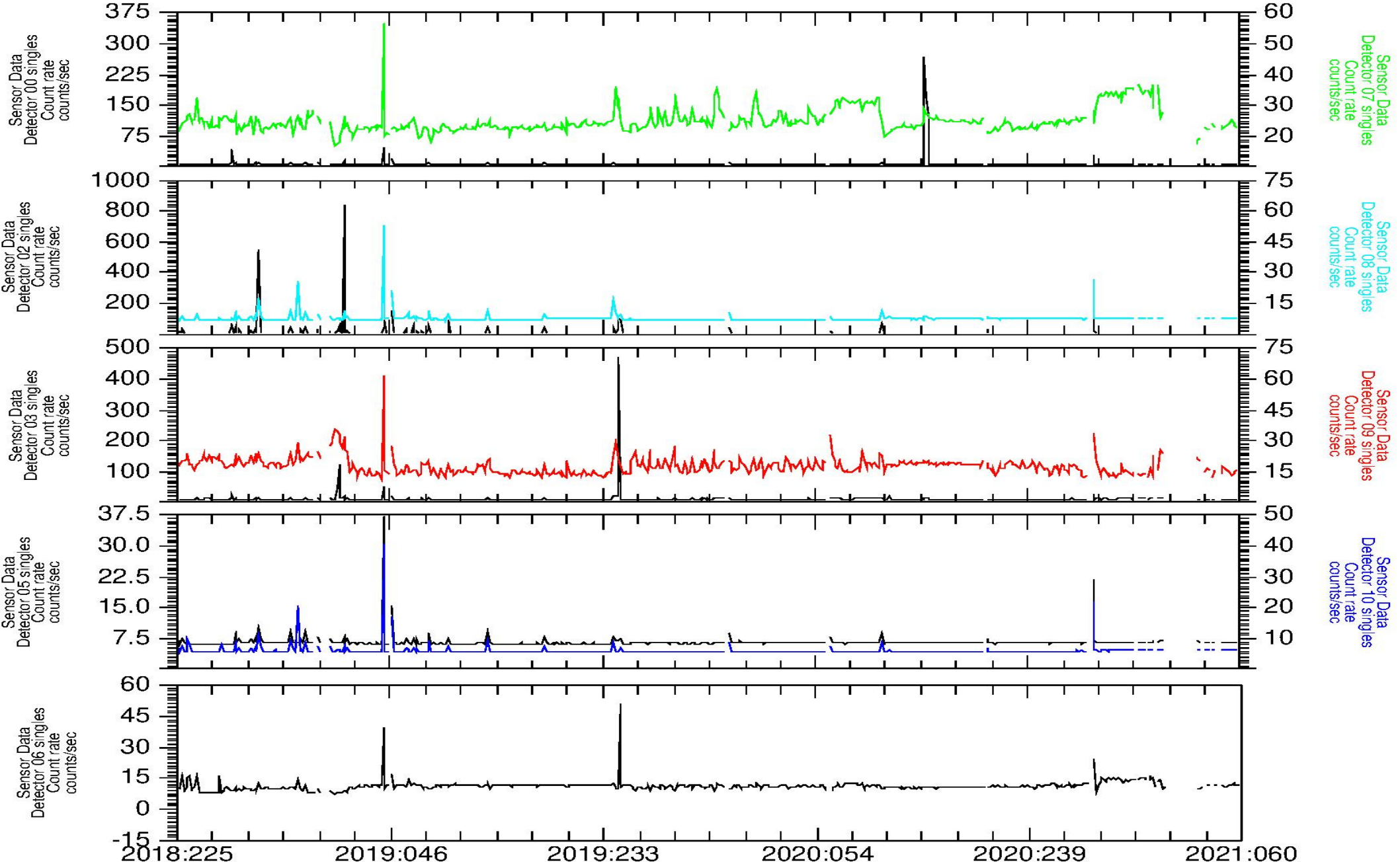
nh-a-pepssi-3-kem1-v4.0/data
PEPSSI FIT File Structure



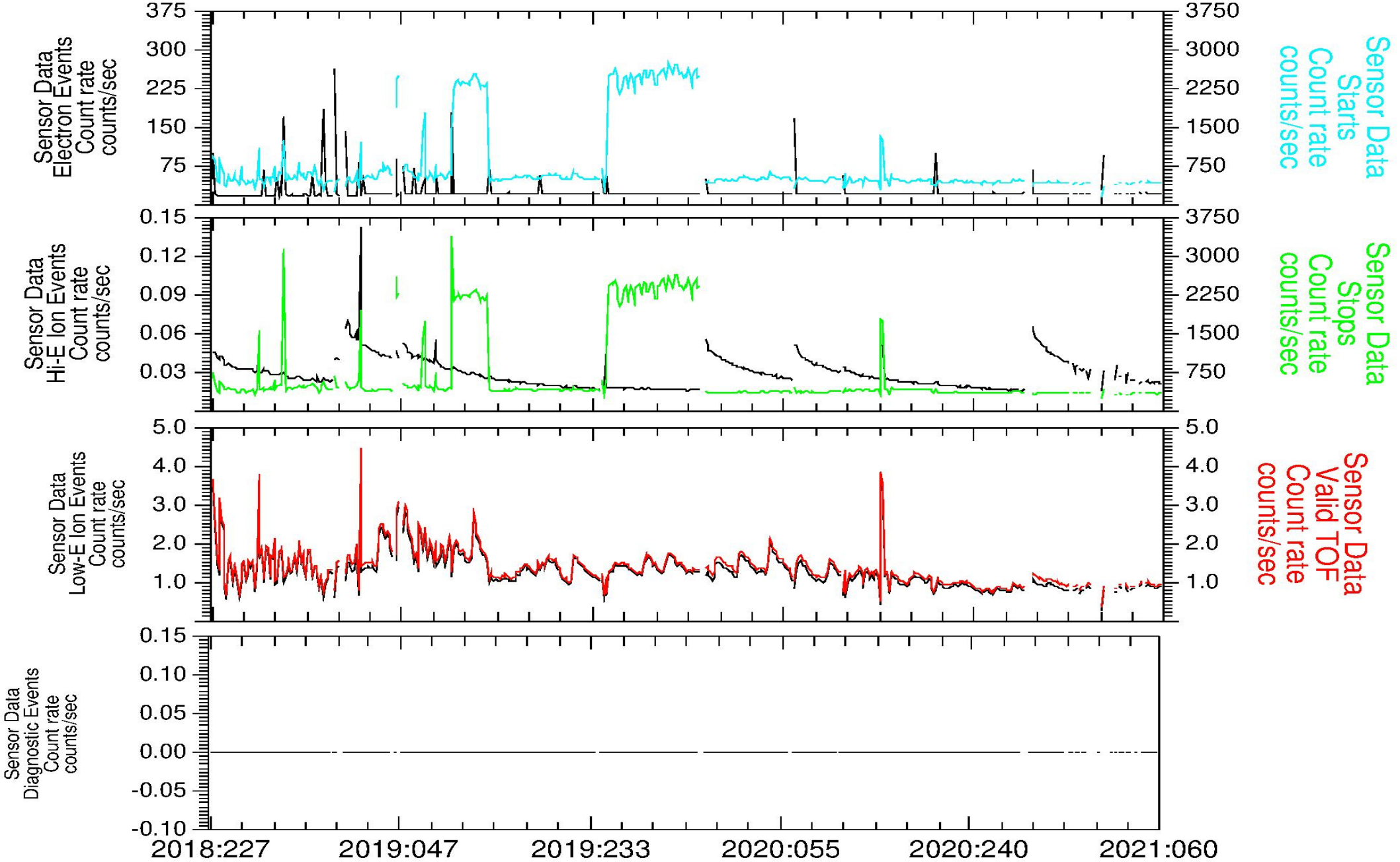
nh-a-pepssi-3-kem1-v5.0/data
FLUX Anode Singles



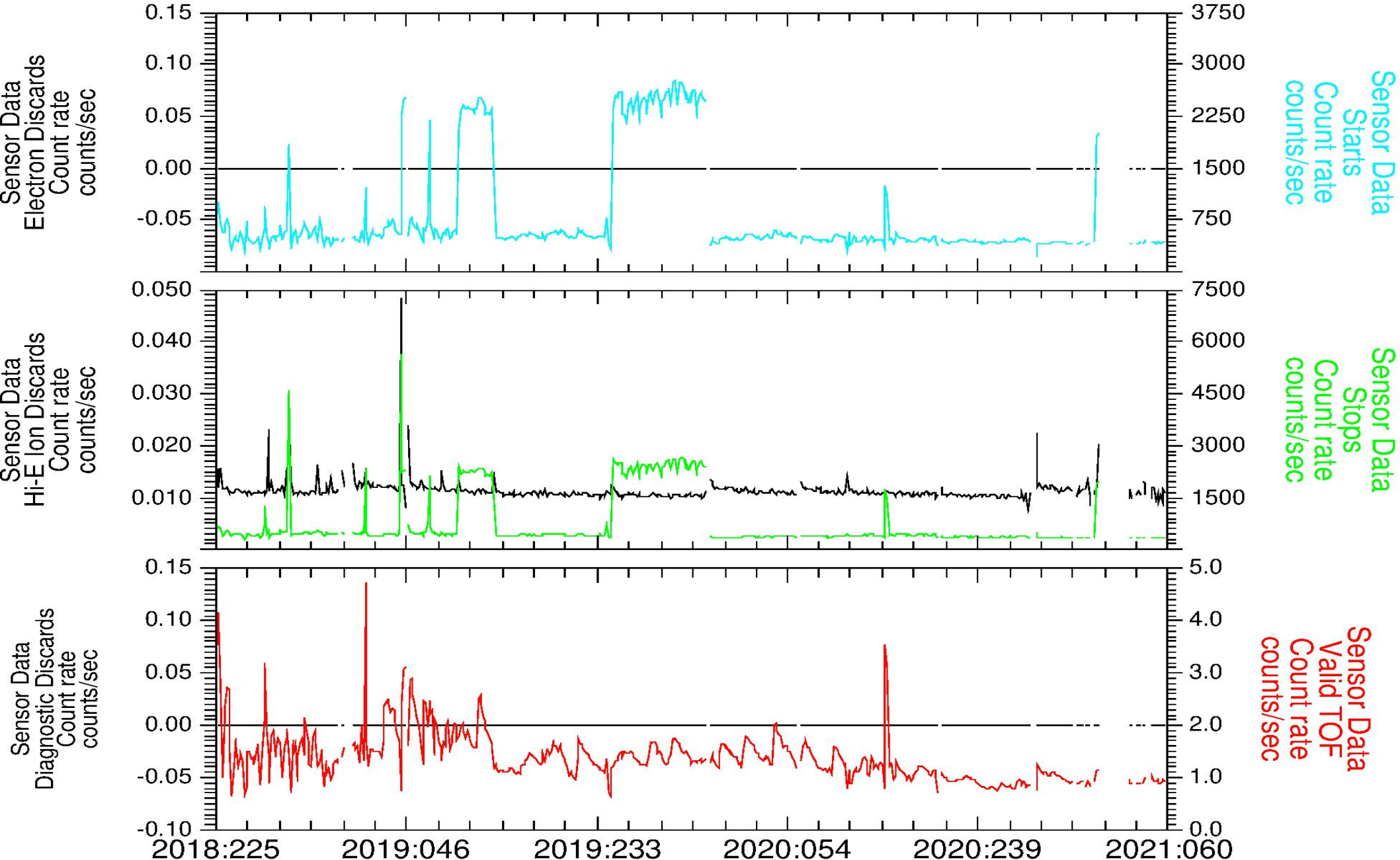
nh-a-pepssi-3-kem1-v5.0/data
FLUX Detector Singles



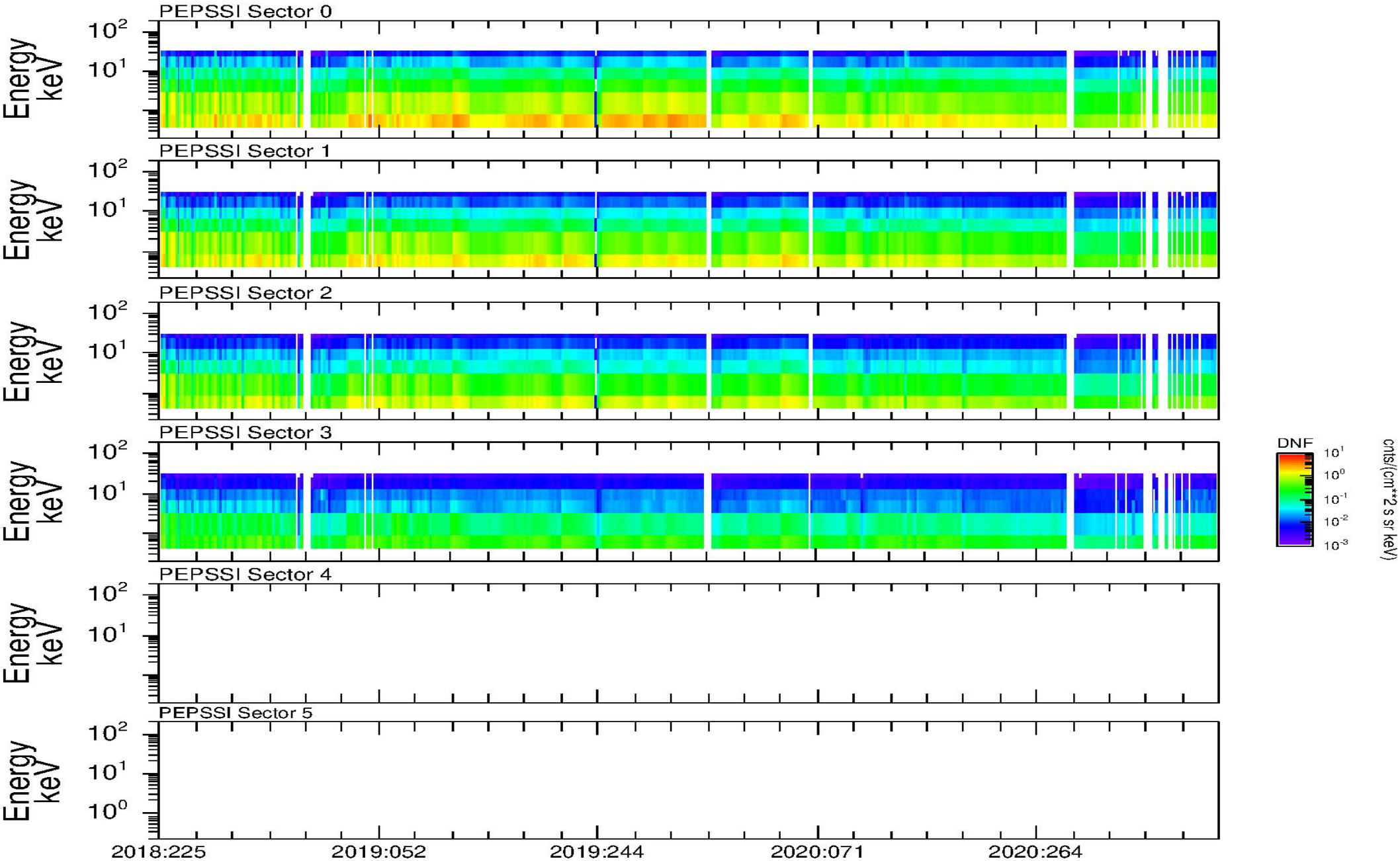
nh-a-pepssi-3-kem1-v5.0/data
FLUX Events “C” Rates



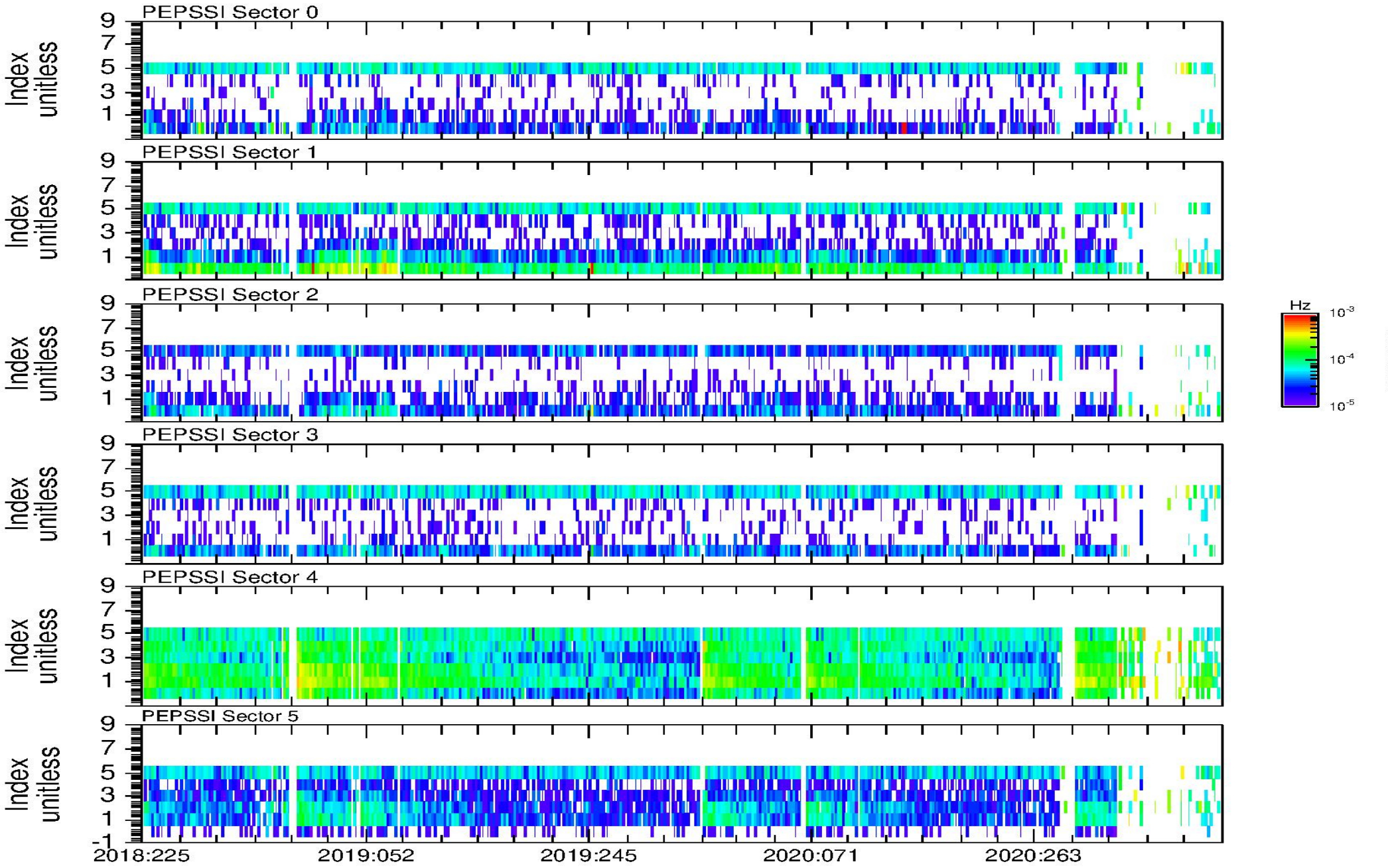
nh-a-pepssi-3-kem1-v5.0/data
FLUX Discards “J” Rates



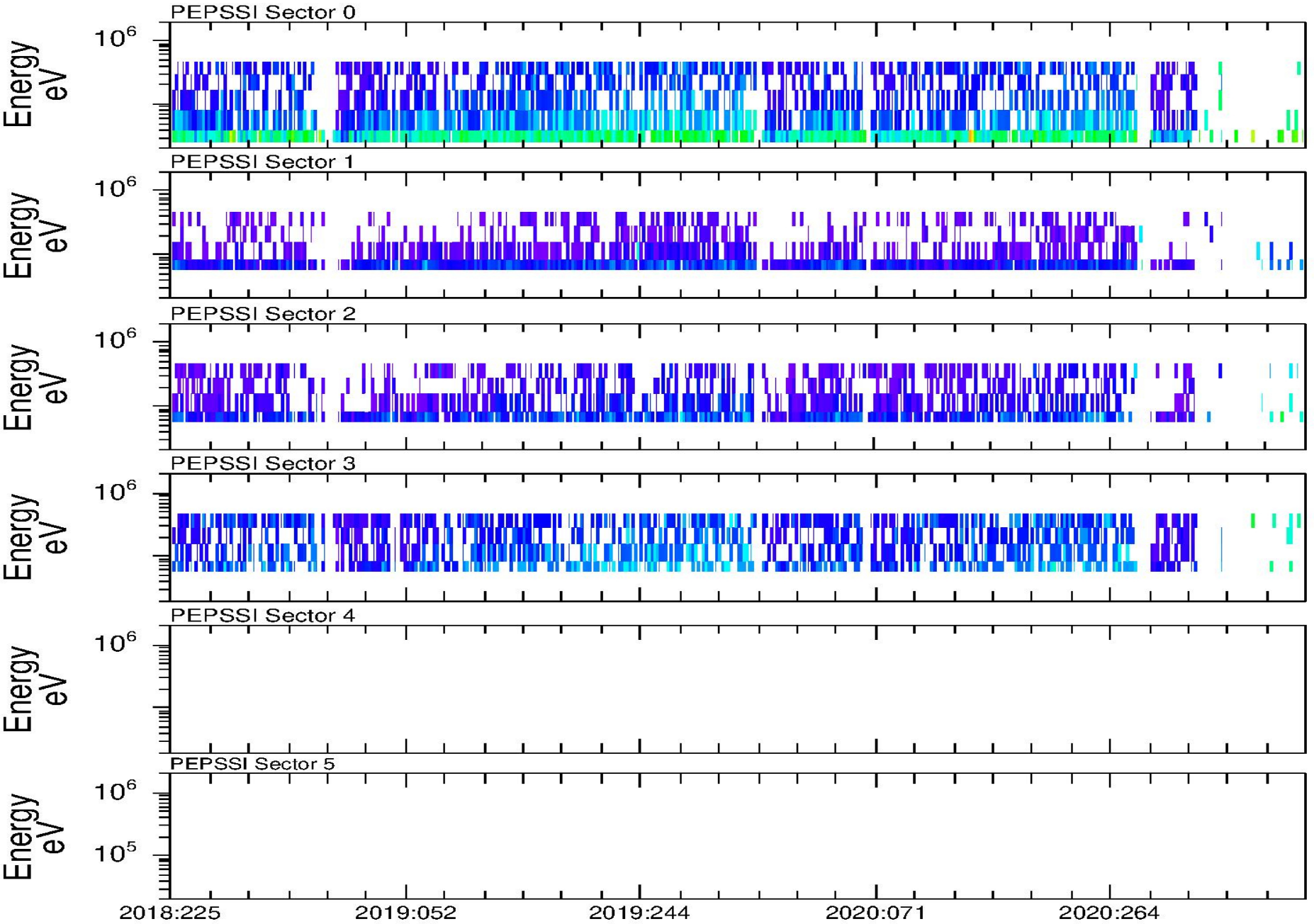
nh-a-pepssi-3-kem1-v5.0/data
FLUX Doubles (“L”) DNF



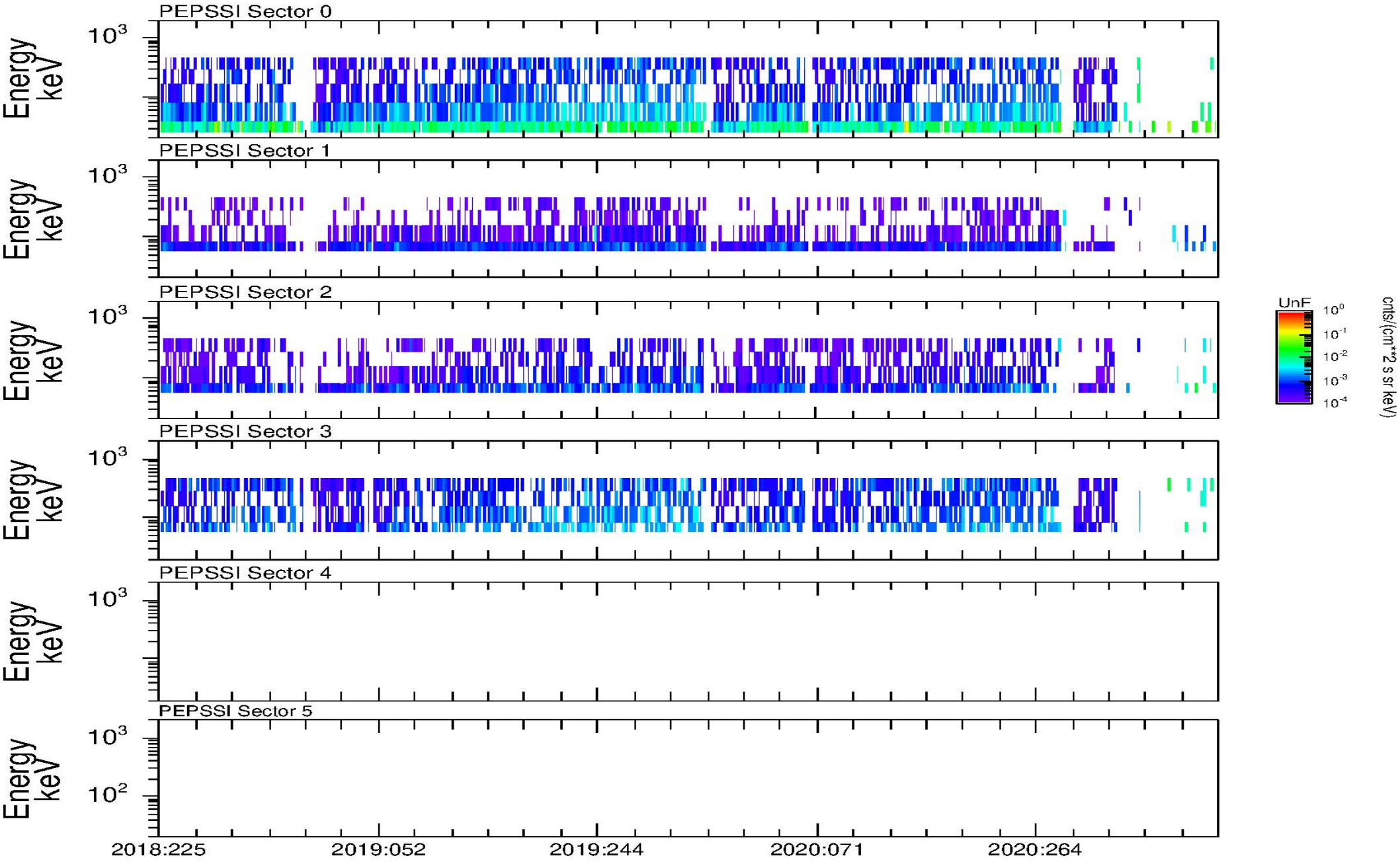
nh-a-pepssi-3-kem1-v5.0/data
FLUX Triples (“D”) CPS Protons



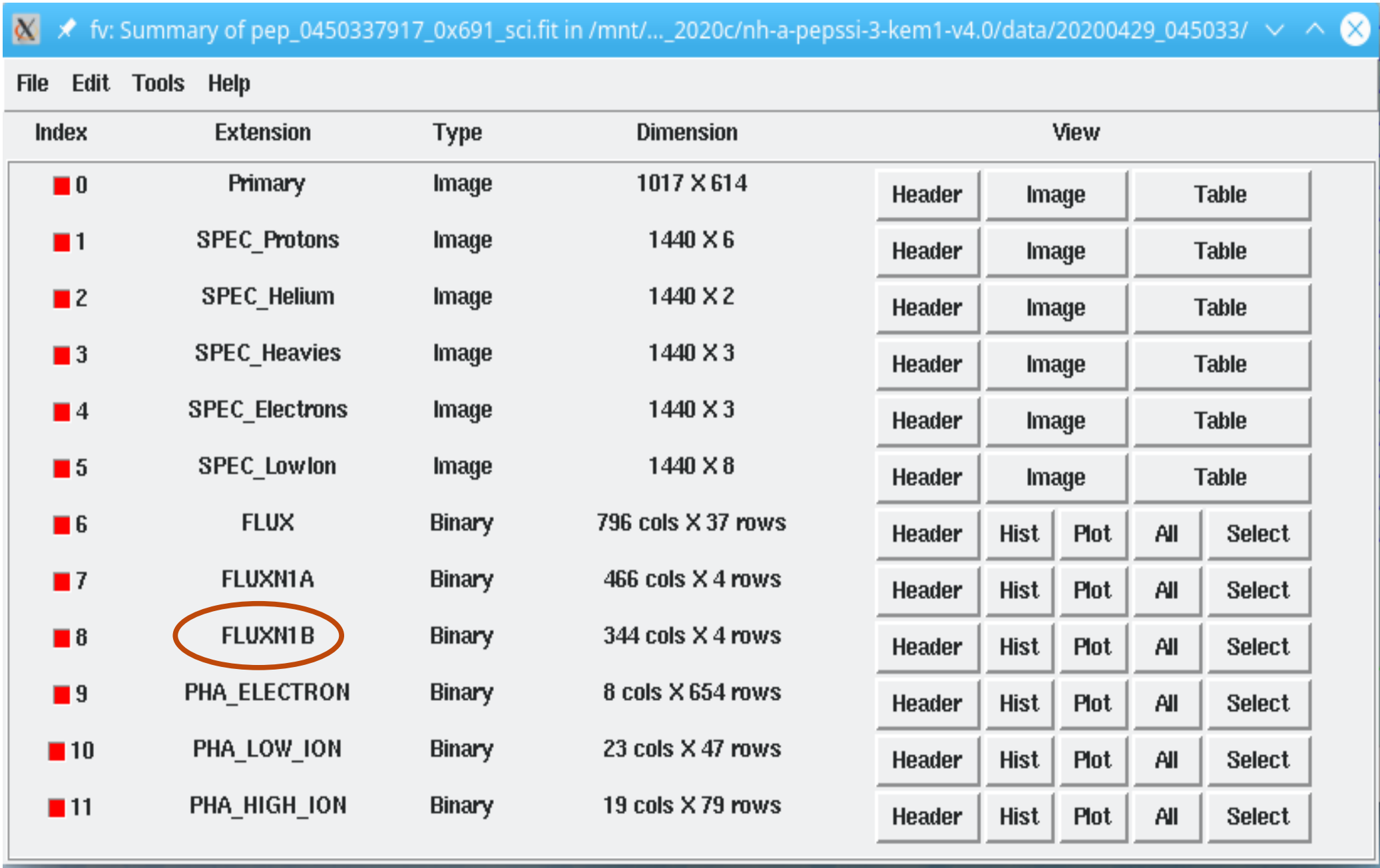
nh-a-pepssi-3-kem1-v4.0/data
FLUX Triples (“D”) DNF Protons



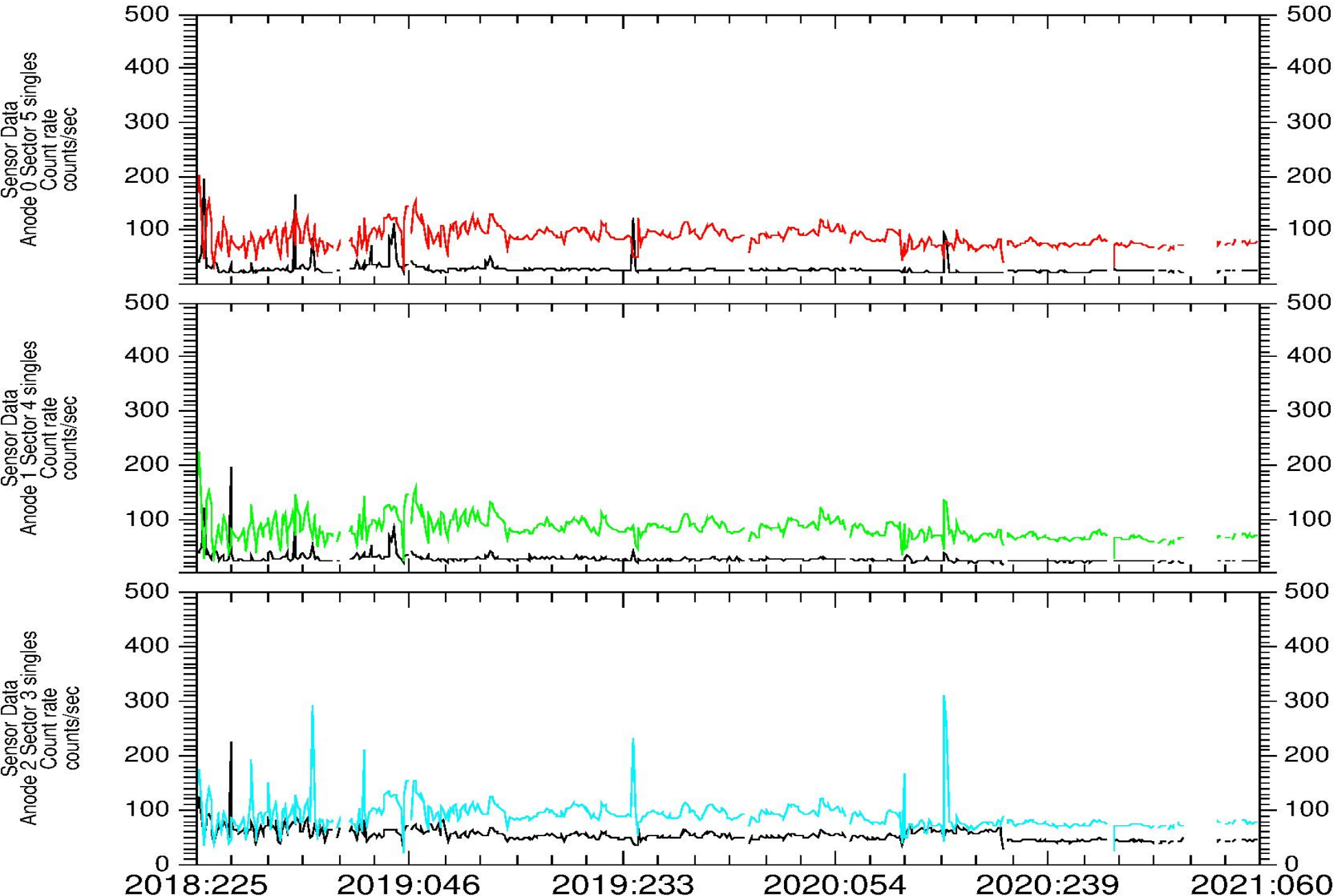
nh-a-pepssi-3-kem1-v4.0/data
FLUX Triples (“D”) UNC Protons



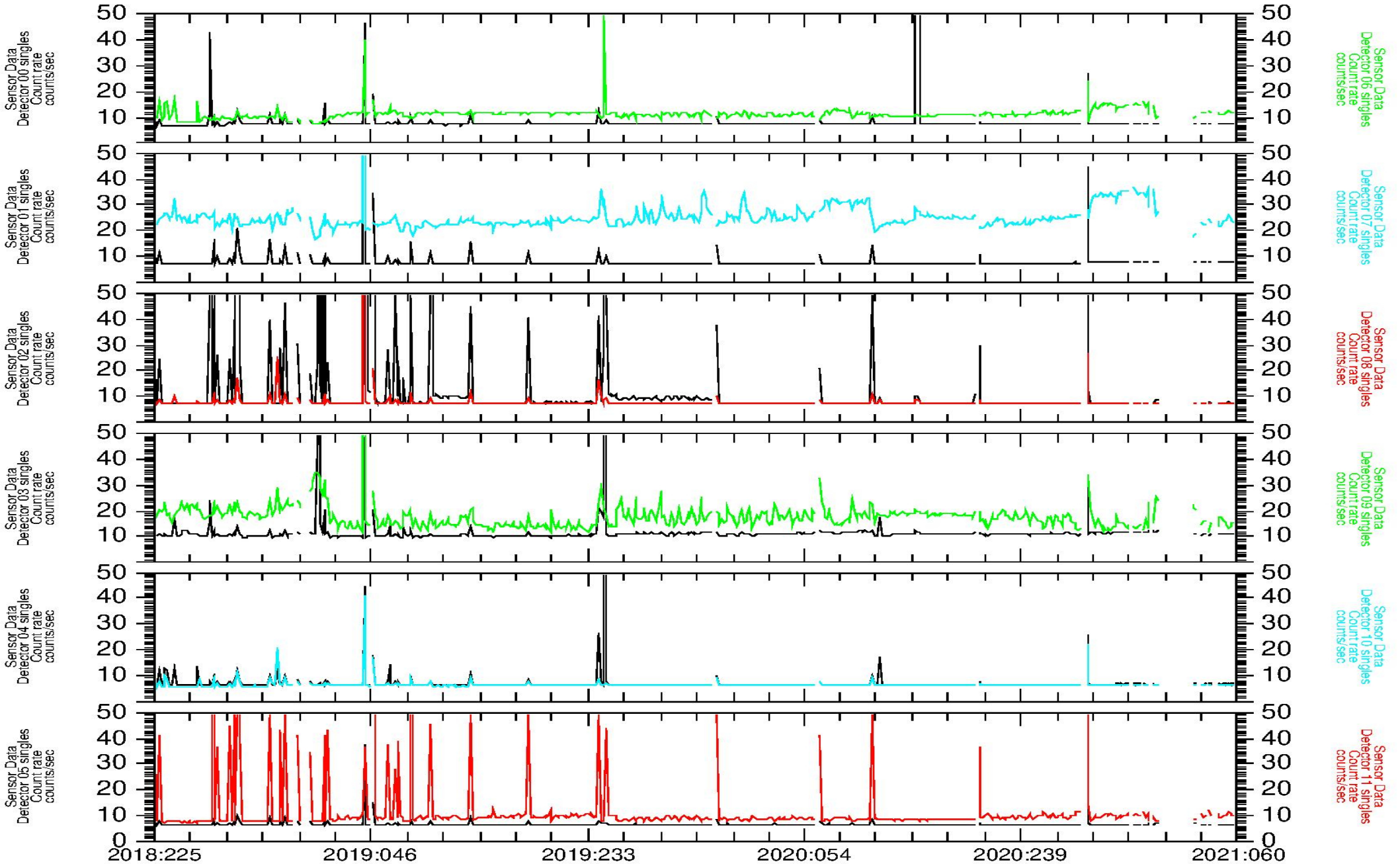
nh-a-pepssi-3-kem1-v5.0/data
PEPSSI FIT File Structure



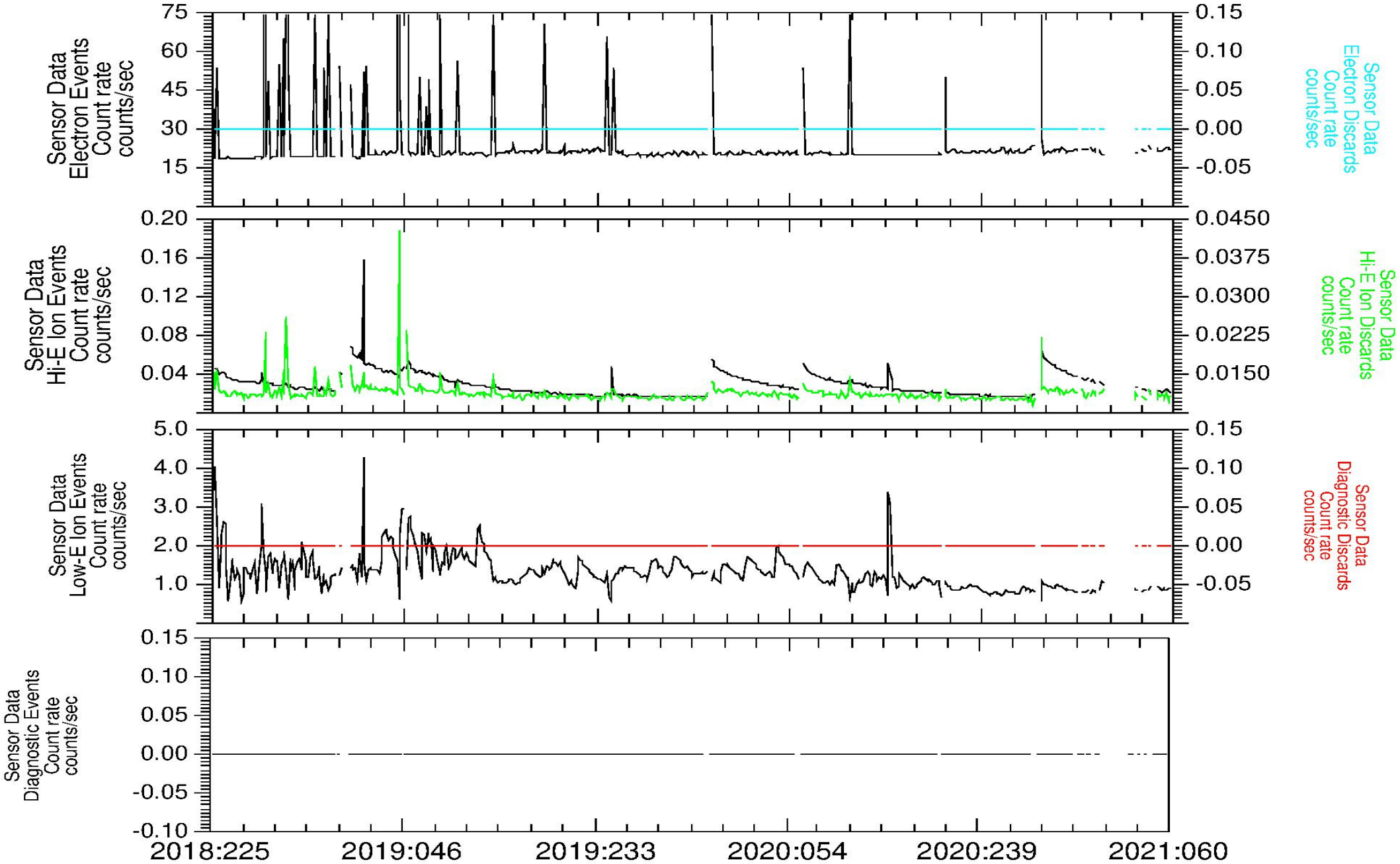
nh-a-pepssi-3-kem1-v5.0/data
FLUXN1B Anode Singles



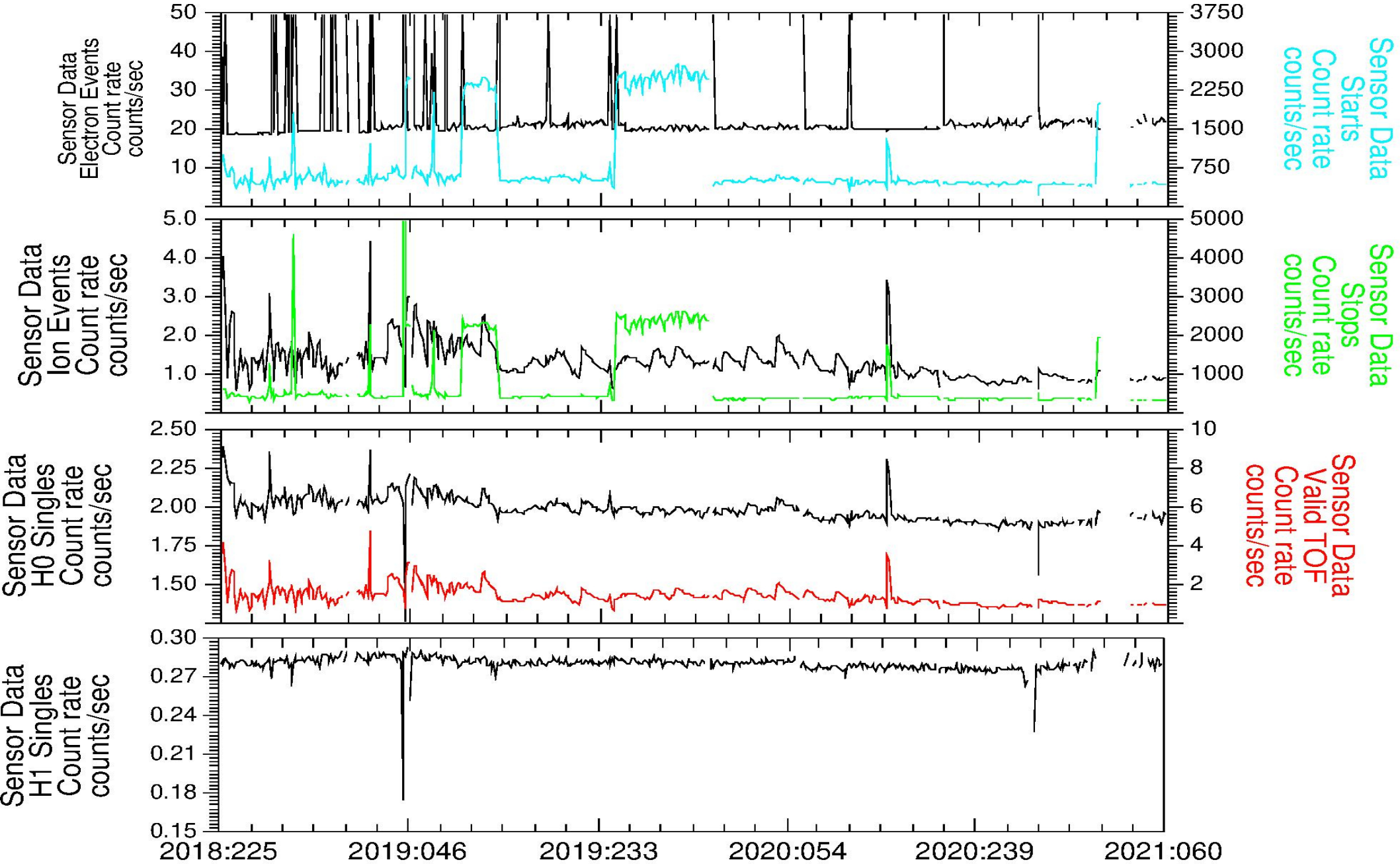
nh-a-pepssi-3-kem1-v5.0/data
FLUXN1B Detector Singles



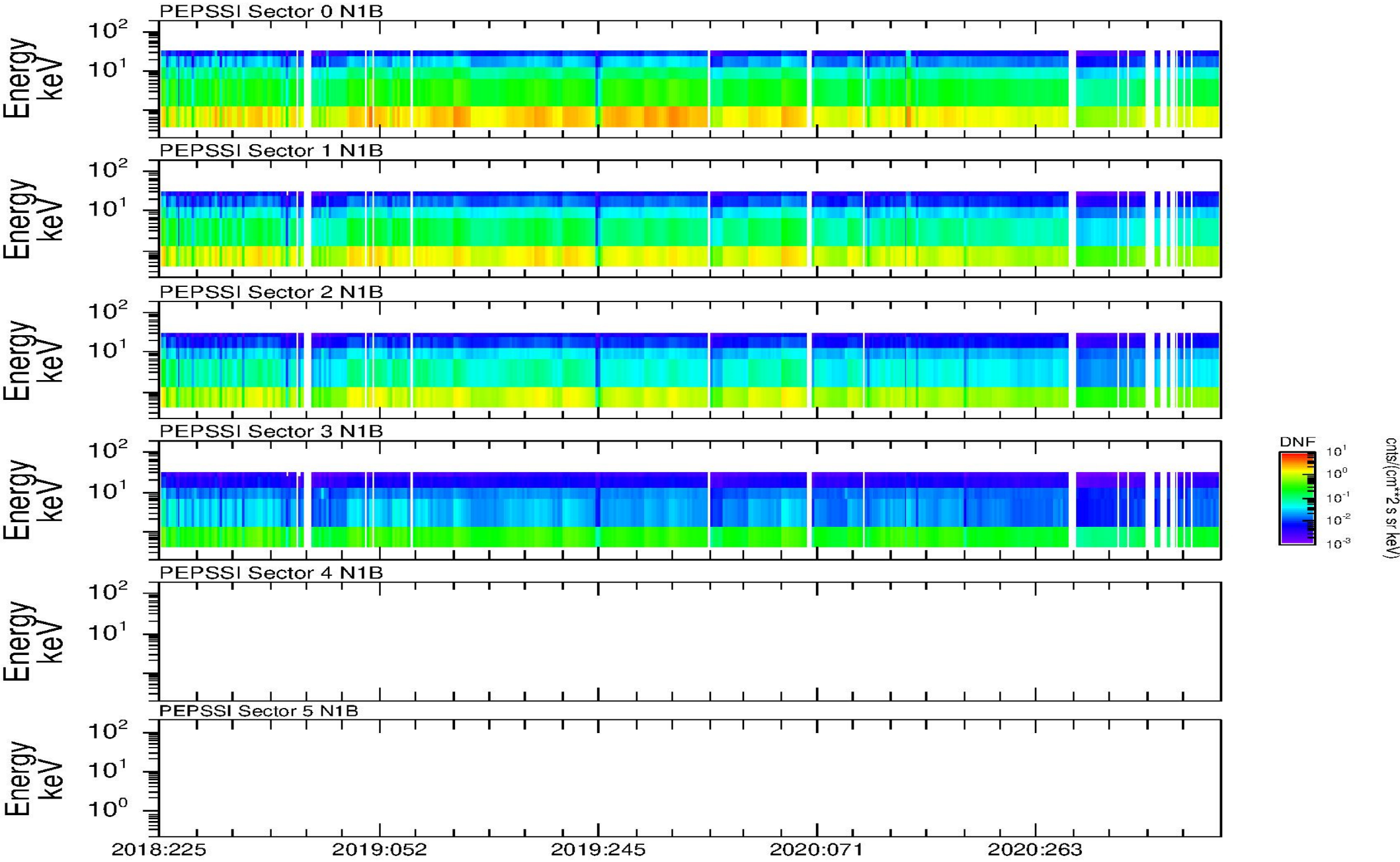
nh-a-pepssi-3-kem1-v5.0/data
FLUXN1B Events & Discards - “J” Rates



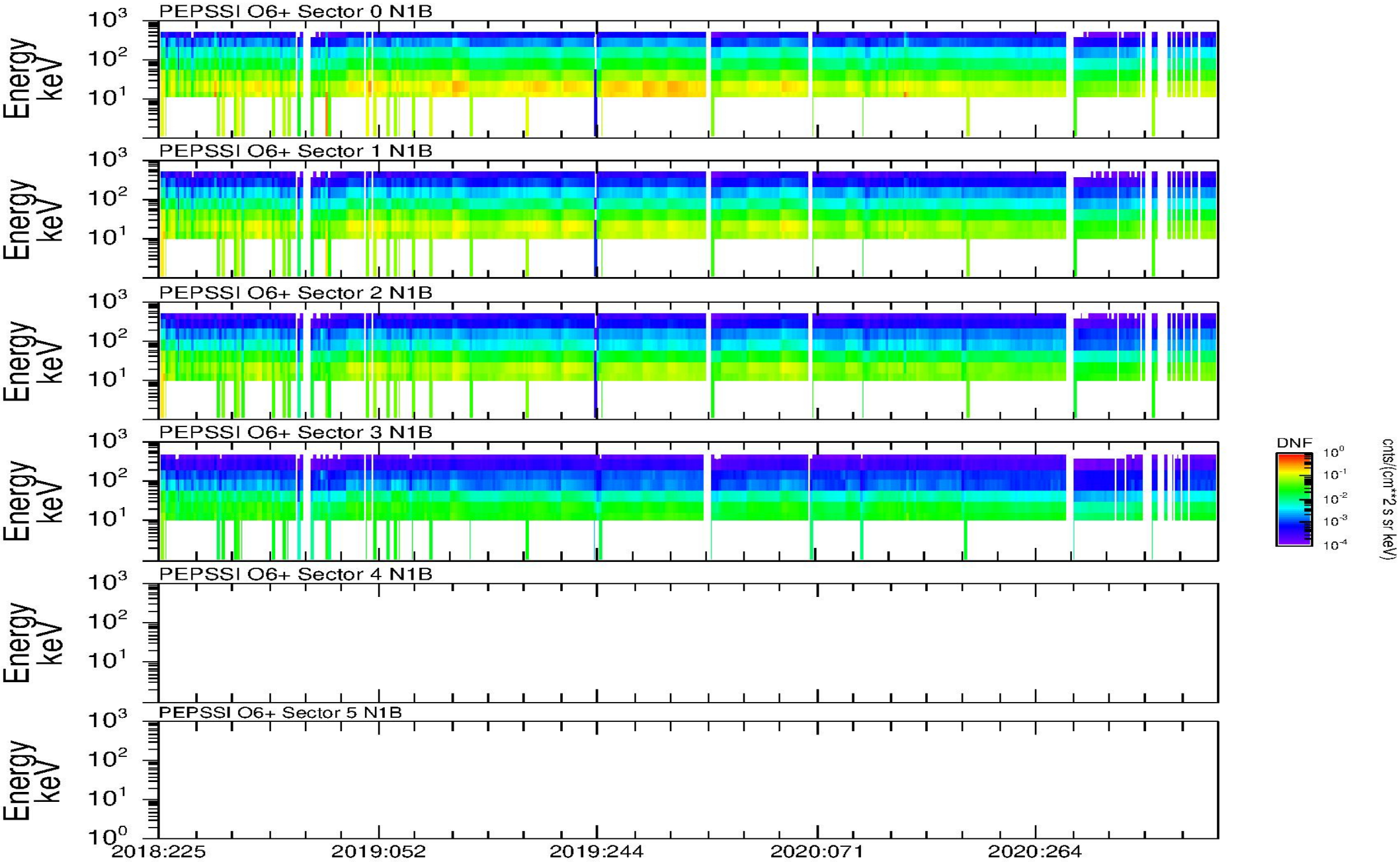
nh-a-pepssi-3-kem1-v5.0/data
FLUXN1B Events - “C” Rates



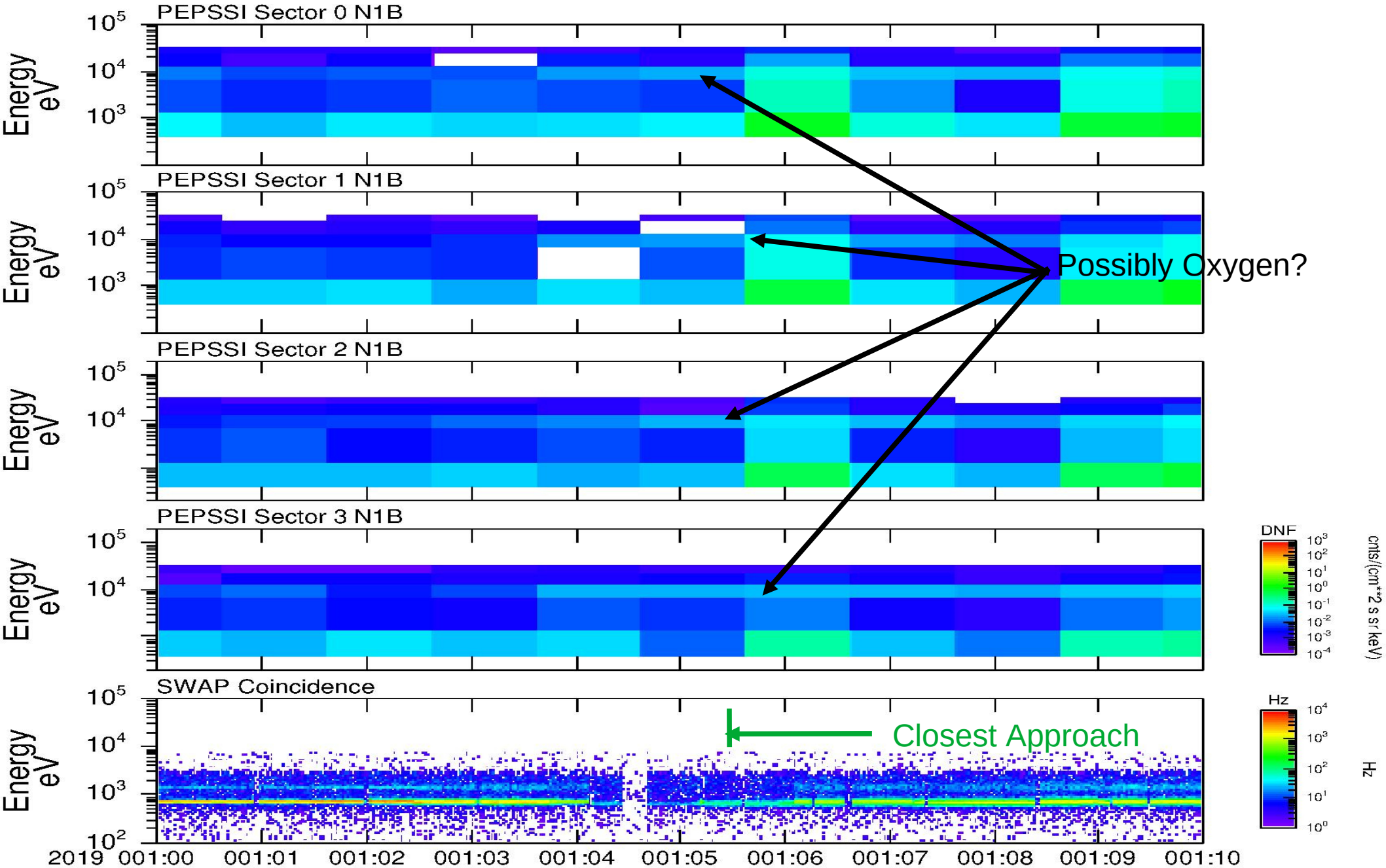
nh-a-pepssi-3-kem1-v5.0/data
FLUXN1B Proton Flux



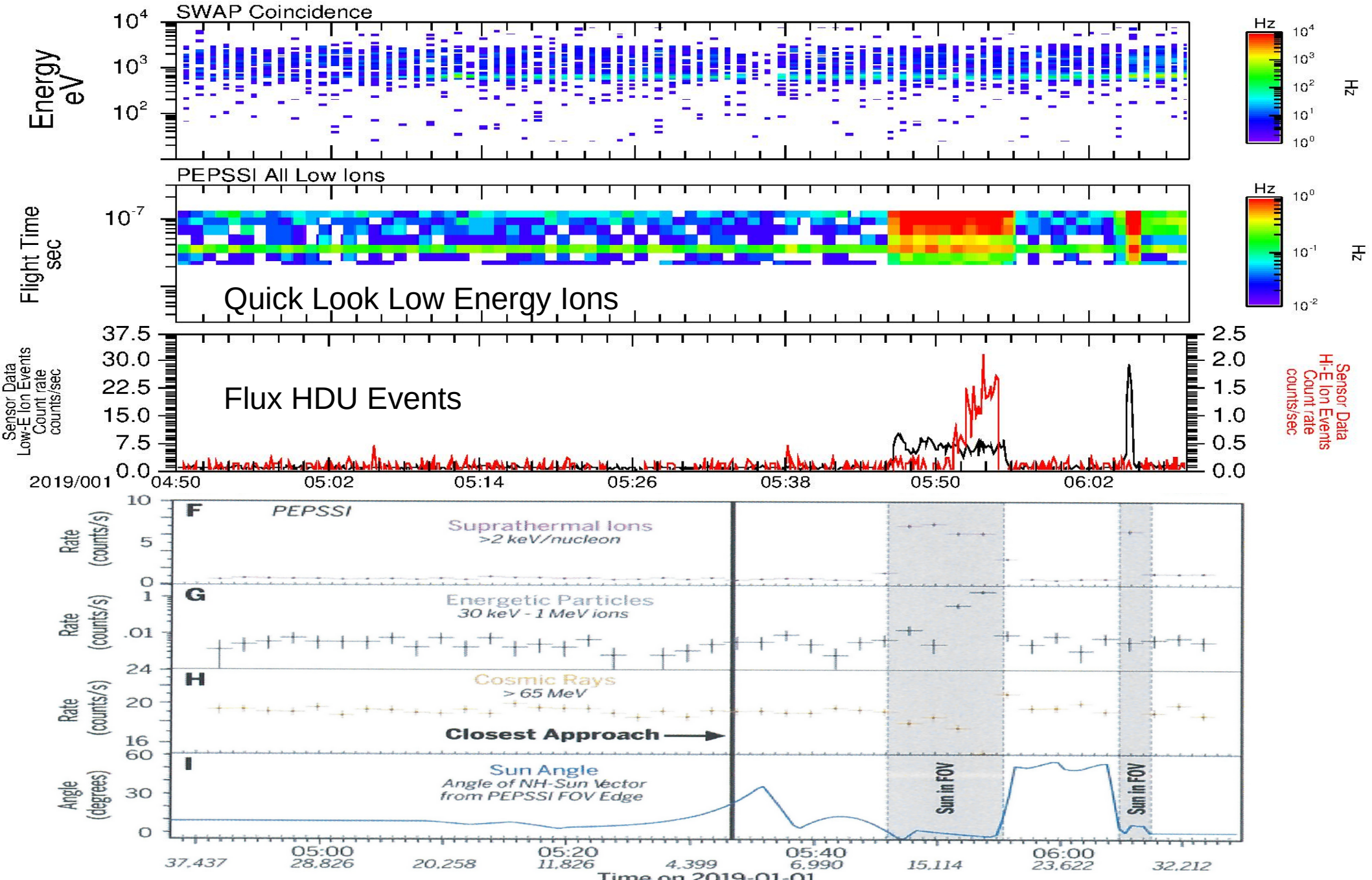
nh-a-pepssi-3-kem1-v5.0/data
FLUXN1B Oxygen Flux



PEPSSI-SWAP
Arrokoth Encounter – 1 of 2



PEPSSI-SWAP Arrokoth Encounter – 2 of 2



Stern et al., Science, 2019, Figure 8

Certification
Raw and Calibrated

This data can be certified.

PEPSSI RESAMPLED Documentation Evaluation

nh-x-pepssi-4-plasma-v1.0/catalog nh_kem.cat

Can this be Updated?

```
OBJECT                = MISSION_INFORMATION
  MISSION_START_DATE  = 2016-10-26
  MISSION_STOP_DATE   = 2021-09-30
  MISSION_ALIAS_NAME  = "NH_KEM"
  MISSION_DESC        = "

This material has been adapted from the New Horizons web site. The mission
stop date is the current stop date of the Kuiper Belt (KB) Extended Mission
(KEM).
The MISSION_STOP_DATE is the current contracted mission stop date. If
approved KEM1's phase may exceed this date and therefore the end is TBD.
```

Has this not Completed?
The Encounter has
Already Occurred.

```
KEM Cruise1
-----------
    Short phase name (in DSID):  KEMCRUISE1
    Formal mission phase name:  CRUISE TO FIRST KBO ENCOUNTER
    Mission Phase Start Time - 2016-10-26
    Mission Phase Stop Time  - 2018-08-14

    Activities during the KEMCRUISE1 mission phase to the first KBO
    encounter are similar to those for Pluto Cruise phase. They also
    include post-Pluto encounter calibrations in mid-2016, along with
    continuing download of data from the Pluto encounter.

    The name and times chosen for this mission phase are still in flux
    and may change in the future.
```

nh-x-pepssi-4-plasma-v1.0/catalog
pepssi.cat


```
Please refer to dataset.cat for additional details on the applicability
and use of the Primary HDU and extensions of data products in this
dataset.
```

Data files in this data set are in CSV format, not FIT format.
The Level 4 dataset.cat file contains no information about the Primary HDU or extensions in FIT files.

nh-x-pepssi-4-plasma-v1.0/catalog dataset.cat

It seems that this file is the only document which describes the resampled data. Thus, extra comments were included as missing in this file.

```
START_TIME                    = 2012-028T00:30:00.000
STOP_TIME                     = 2020-366T23:30:00.000

DATA_SET_DESC                 = "

Data Set Overview
=================

  This dataset contains one-hour averaged energetic particle flux rate
  values and counts-per-second generated by the New Horizons Particles
  and Plasma science team from data taken by the Pluto Energetic Particle
  Spectrometer Science Investigation (PEPSSI) instrument. The data covers
  a time range from early 2012 through January 1, 2020. Flux rates and
  sums are presented for each of the six instrument look directions.
```

Does not agree, stop time does agree with the data files, so this document is incorrect.

nh-x-pepssi-4-plasma-v1.0/catalog dataset.cat

```
The headers and contents for these higher level derived data products
are described below.


Data File Headers
=================
```

Missing Information: these data are organized into separate subdirectories under the data directory:

data: total_counts: pepssi_reduced_j_YYYY (csv and lbl)
double: pepssi_reduced_lZZZ_YYYY_X (csv and lbl)
triple: pepssi_reduced_bZZZ_YYYY_X (csv and lbl)

Where: YYYY is the year the measurements were taken
X is the segment number (a or b)
ZZZ is the units of the data (csv or flux)

nh-x-pepssi-4-plasma-v1.0/catalog dataset.cat

```
Data File Contents
==================

  Three of four detection types are provided in this dataset.

    Triples: B-rates where both the total energy detected and the time
             of flight of the charged particle are known. Thus, the
             mass and energy of the particle can be determined.

    Doubles: L-rates where only the time of flight of the charged
             particle is known. Since the distance of the measurement
             is also known a velocity can be determined. The energy
             per unit mass, more commonly called the 'energy per
             nucleon', E/m, can also be determined through the
             following formulas:

                 E = ( m v^2 ) / 2
                 E/m = ( v^2 ) / 2

    Totals:  Total counts in each of the three detection modes. This
             is useful for determining overall charged particle
             activity at a given time.

  Analysis of the fourth detection type, cosmic ray energy-only events,
  is not yet ready for public release.

  For each measurement, calculated statistical uncertainties are
  provided.

  The L and B fluxes include a complex correction for instrument
  efficiency variations related to turning the instrument off and on.
  See [KOLLMANNETAL2019] Appendix A.

  Data has been removed if it was captured during times (aka 'Bad
  Time Intervals') when spacecraft operations make interpretation
  difficult (power on, power off, unusual telescope pointings, etc).
```

This section is a description of the dataset and the section title is mislabeled (should be Dataset Contents). This section should be placed above the section labeled “Data File Headers”.

The “Data File Contents” section should describe what is in the data files. It should describe the contents of each type of data file and what is inside of each. The section “Data File Types” makes a stab at this.

nh-x-pepssi-4-plasma-v1.0/catalog
dataset.cat

Under “Data File Types”:

BFLUX: 'Triples', counts-per-second.
LFLUX: 'Doubles', counts-per-second.

The data files say the units are:
c/s/ster/cm^2/keV

nh-x-pepssi-4-plasma-v1.0/catalog dataset.cat

The labels are criptic and not explained. These should be included and below is an example (although it could be written in many ways):

LTTSDDI_X where L means Doubles and TT is the channel (0-15), S means the Sensor and DD is the sensor number (0-6), I is the species combined with “Unc” to indicate an Uncertainty, and X is the segment (a or b).

LIonsAllAllS00_B or LIonsAllAllS00Unc_B …
LionsAllAllSAll_B or LionsAllAllSAllUnc_B ...
LIonsAllAllS012_B orLIonsAllAllS012Unc_B …
L01toL13OddAllS00_B or L01toL13OddAllS00Unc_B …
L01toL13OddAllSAll_B or L01toL13OddAllSAllUnc_B ...
L01toL13OddAllS012_B or L01toL13OddAllS012Unc_B ...
L01toL13OddAllS00_B or L01toL13OddAllS00Unc_B …
L01toL13OddAllSAll_B or L01toL13OddAllSAllUnc_B ...
L01toL13OddAllS012_B or L01toL13OddAllS012Unc_B …

The explanation of the J’s in the “Data File Types” section is good, the Doubles and Triples files should be the same. Right now, the general user does not know how to interpret the labels.

nh-x-pepssi-4-plasma-v1.0/catalog dataset.cat


```
ABSTRACT_DESC                    = "
  This dataset contains one-hour averaged energetic particle flux rate
  values and counts-per-second generated by the New Horizons Particles
  and Plasma science team from data taken by the Pluto Energetic Particle
  Spectrometer Science Investigation (PEPSSI) instrument. The data covers
  a time range from early 2012 through January 1, 2020. Flux rates and
  sums are presented for each of the six instrument look directions.
  "
```

Data goes a year beyond this date...

Missing Information: Time tag marks the (beginning, center, End?) of an event, which is a one-hour average window.

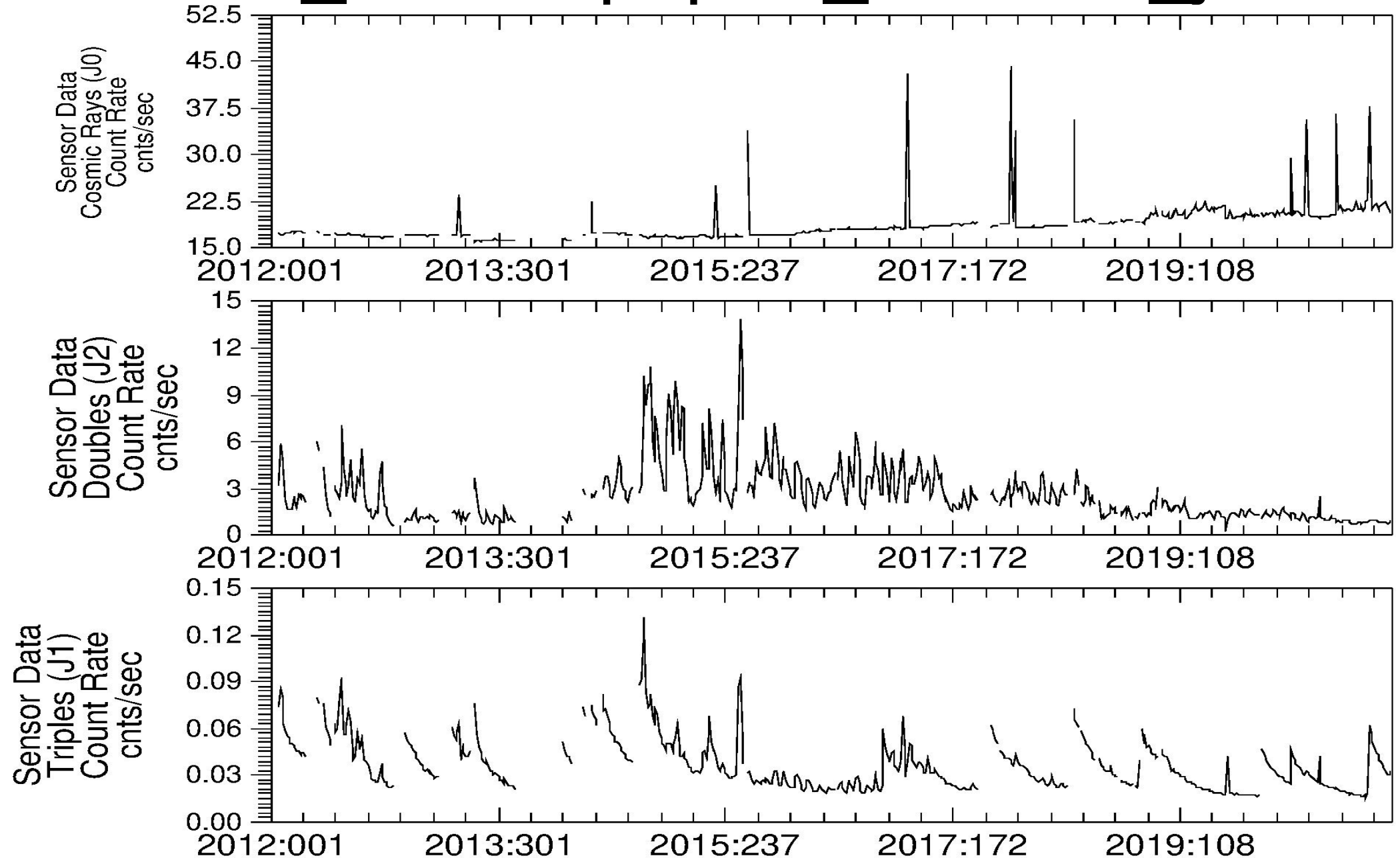
PEPSSI RESAMPLED
Data Evaluation

Assumptions

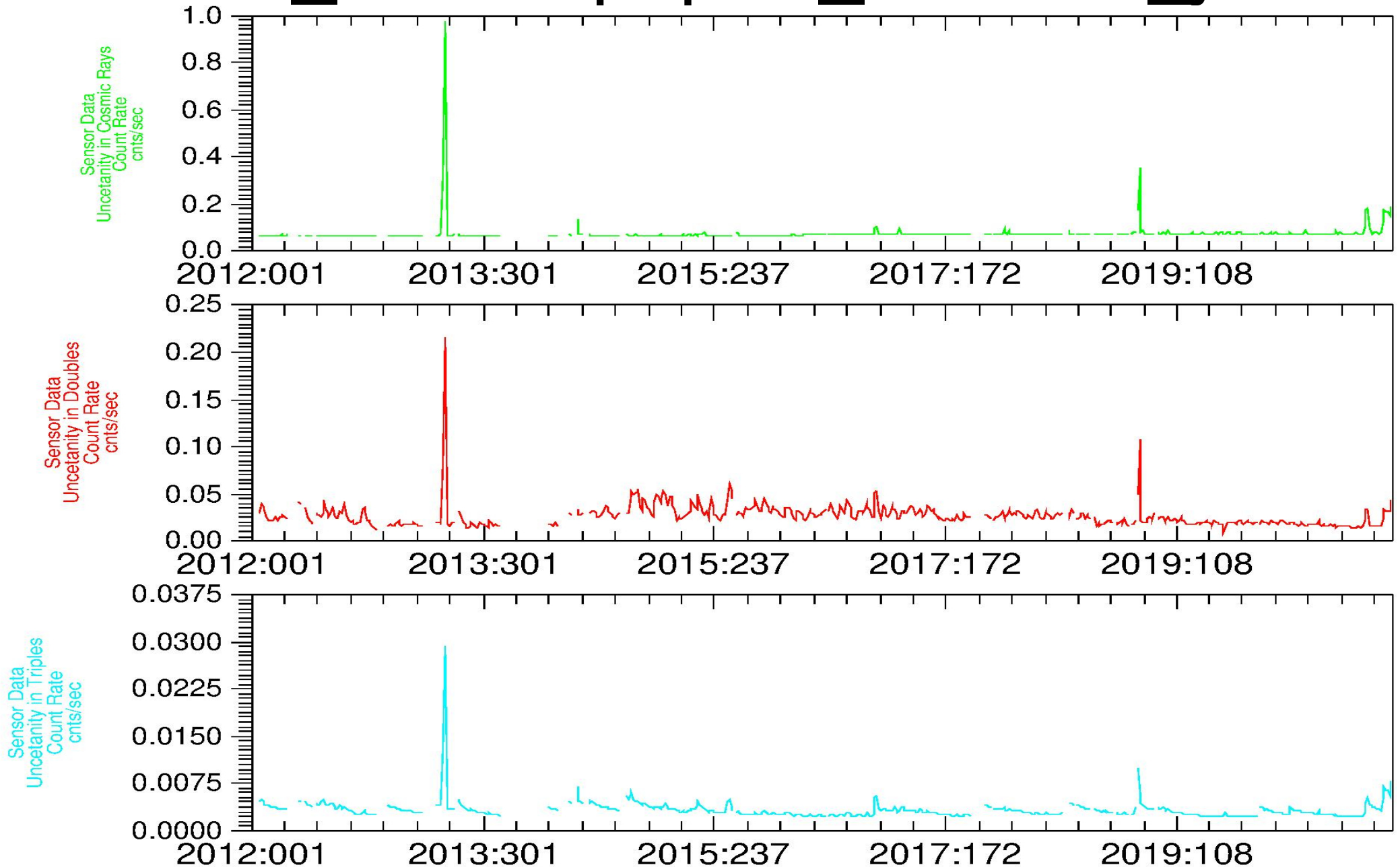
Not enough information in the documentation is given to register the data within the 1 hour accumulation period. The following assumption was made in order to analyze the data:

Time stamp in the data files are at the beginning of the accumulation period.

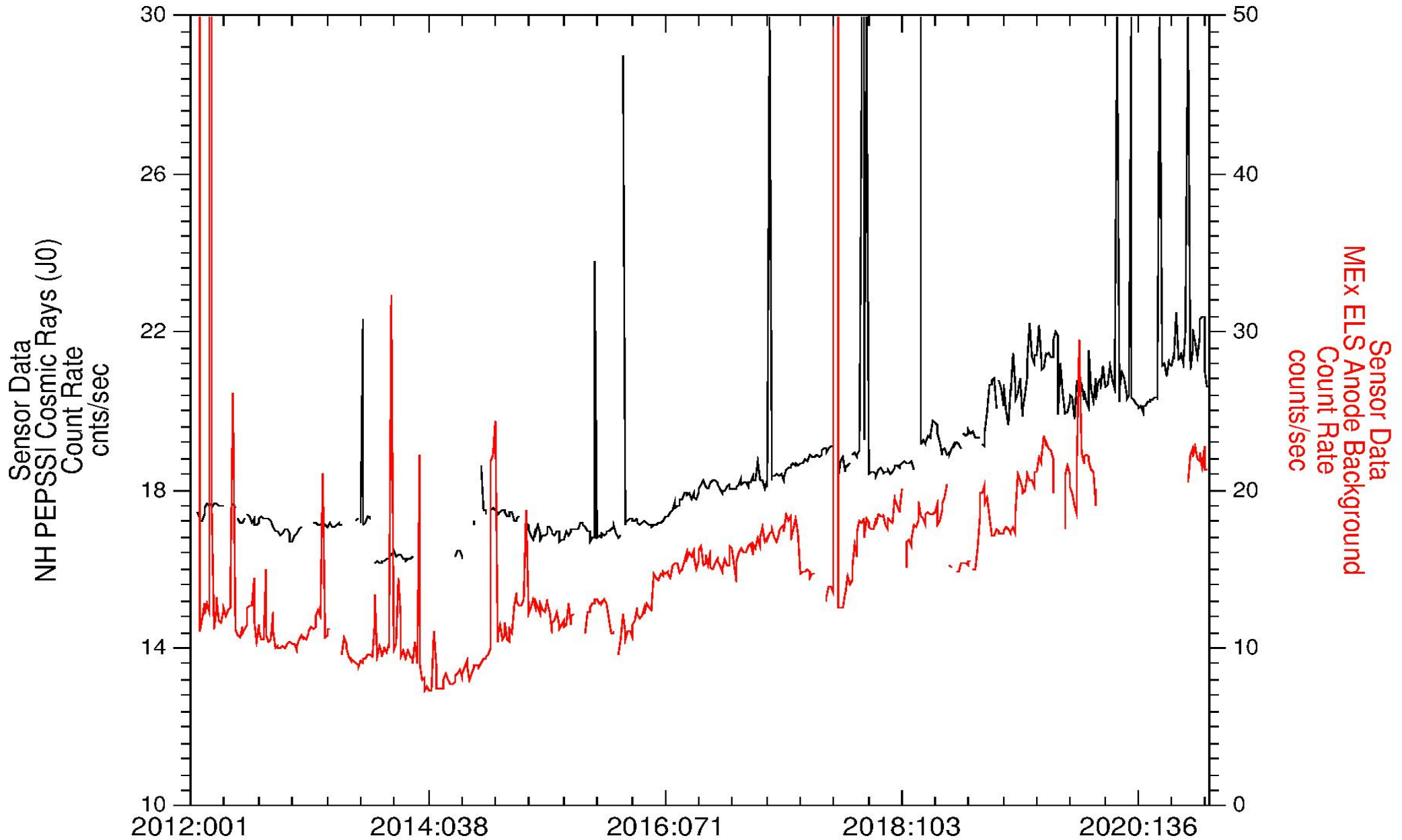
nh-x-pepssi-4-plasma-v1.0/data total_counts/pepssi_reduced_j*



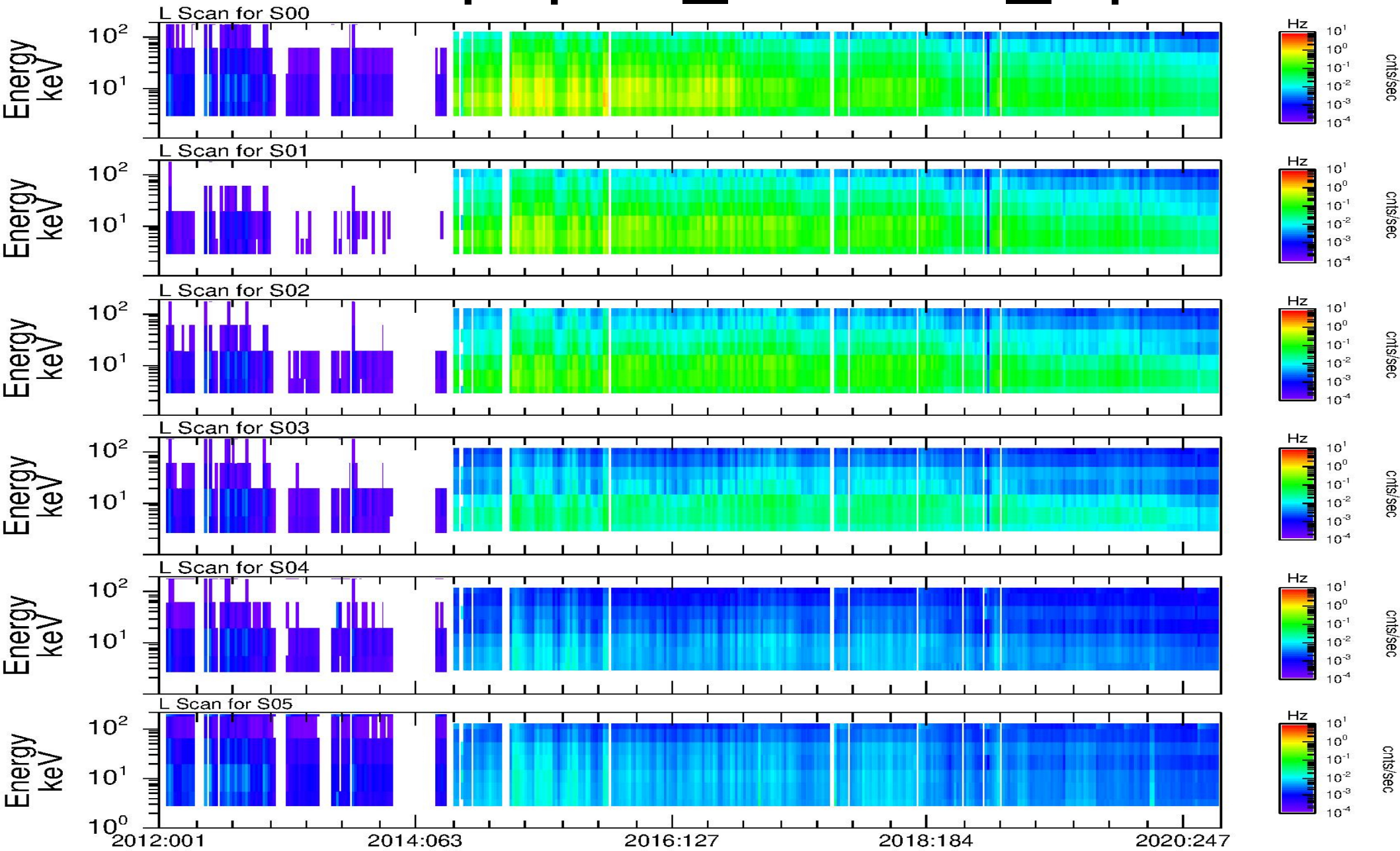
nh-x-pepssi-4-plasma-v1.0/data total_counts/pepssi_reduced_j*



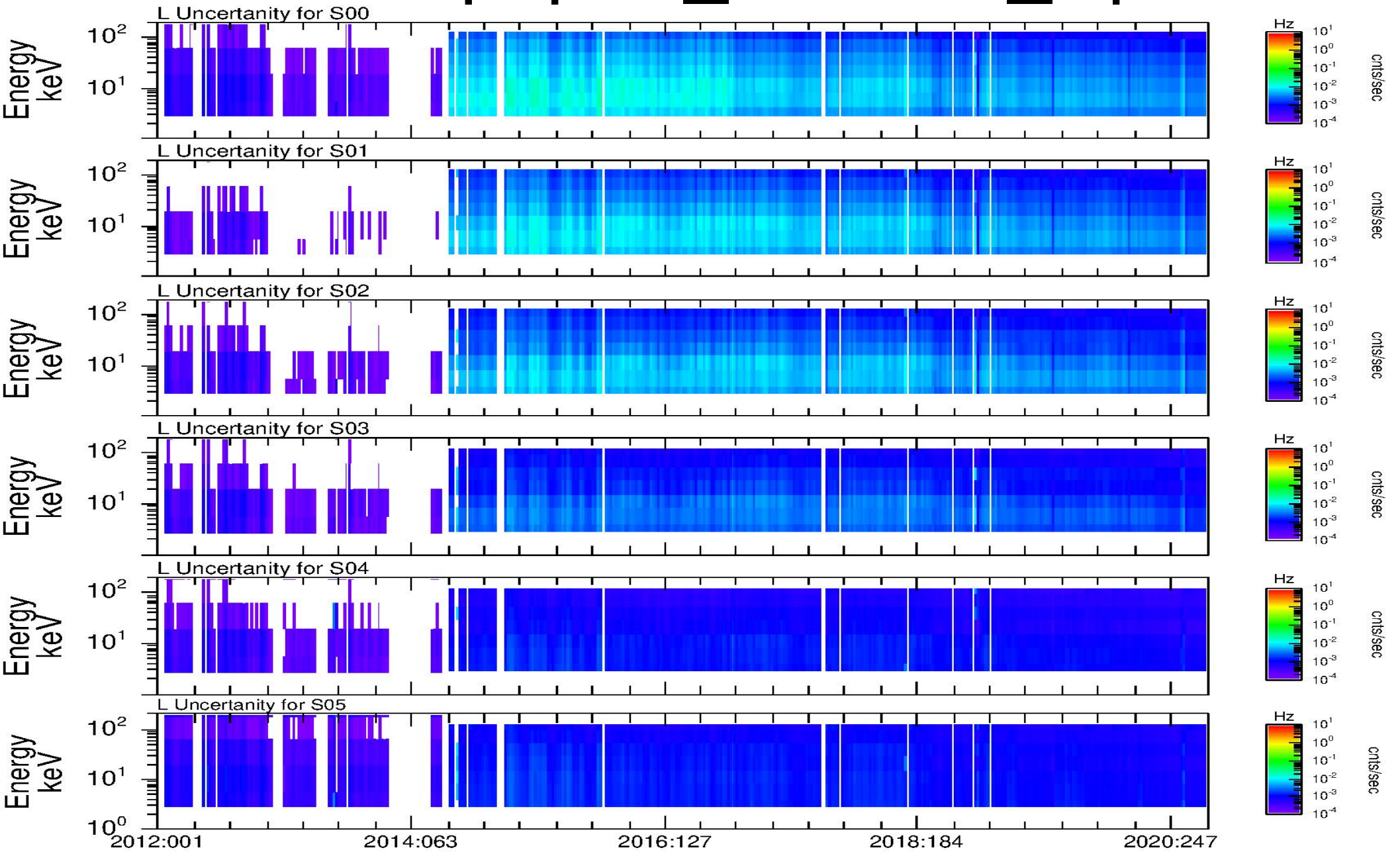
nh-x-pepssi-4-plasma-v1.0/data total_counts/pepssi_reduced_j*



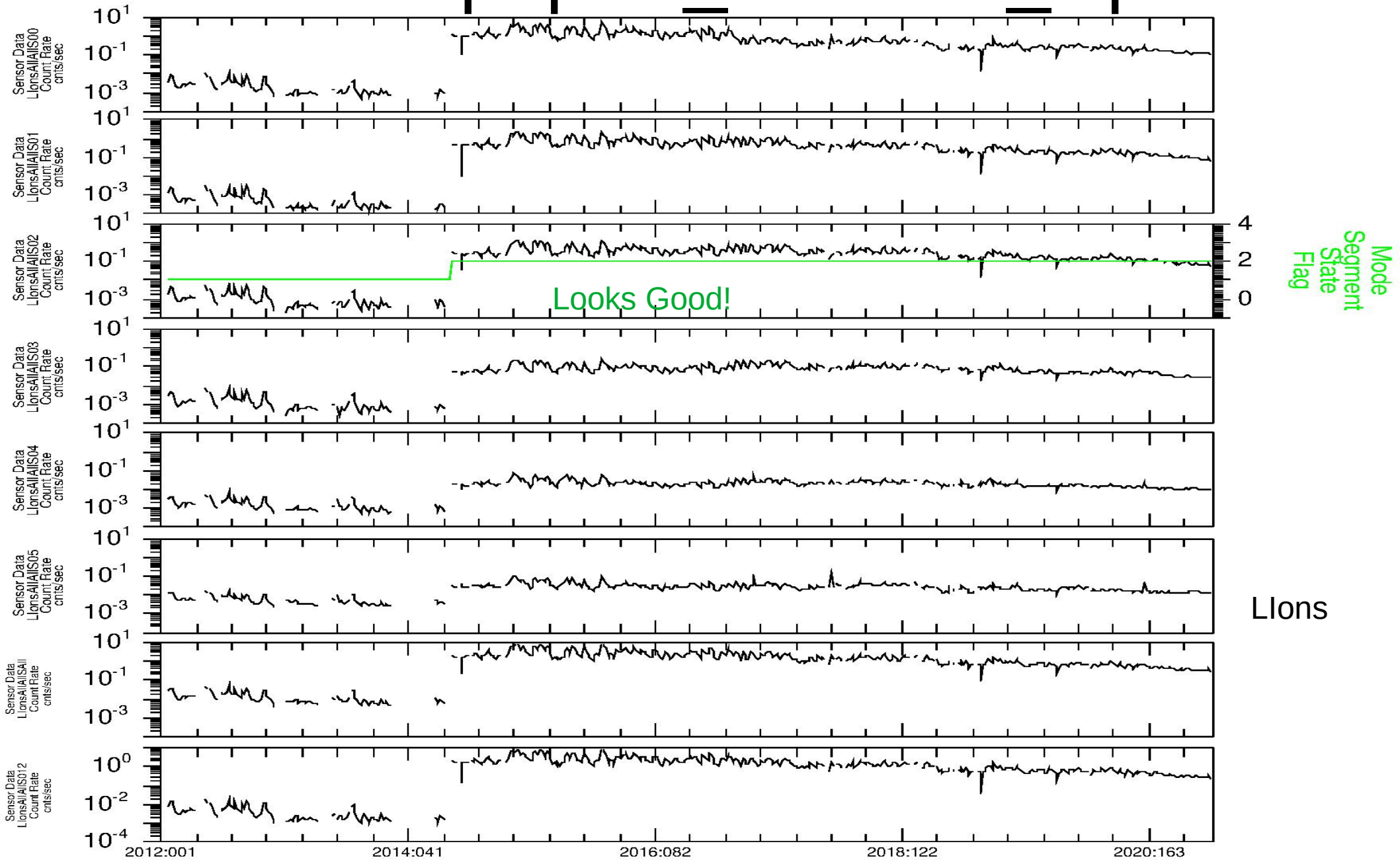
nh-x-pepssi-4-plasma-v1.0/data doubles/pepssi_reduced_lcps*



nh-x-pepssi-4-plasma-v1.0/data doubles/pepssi_reduced_lcps*

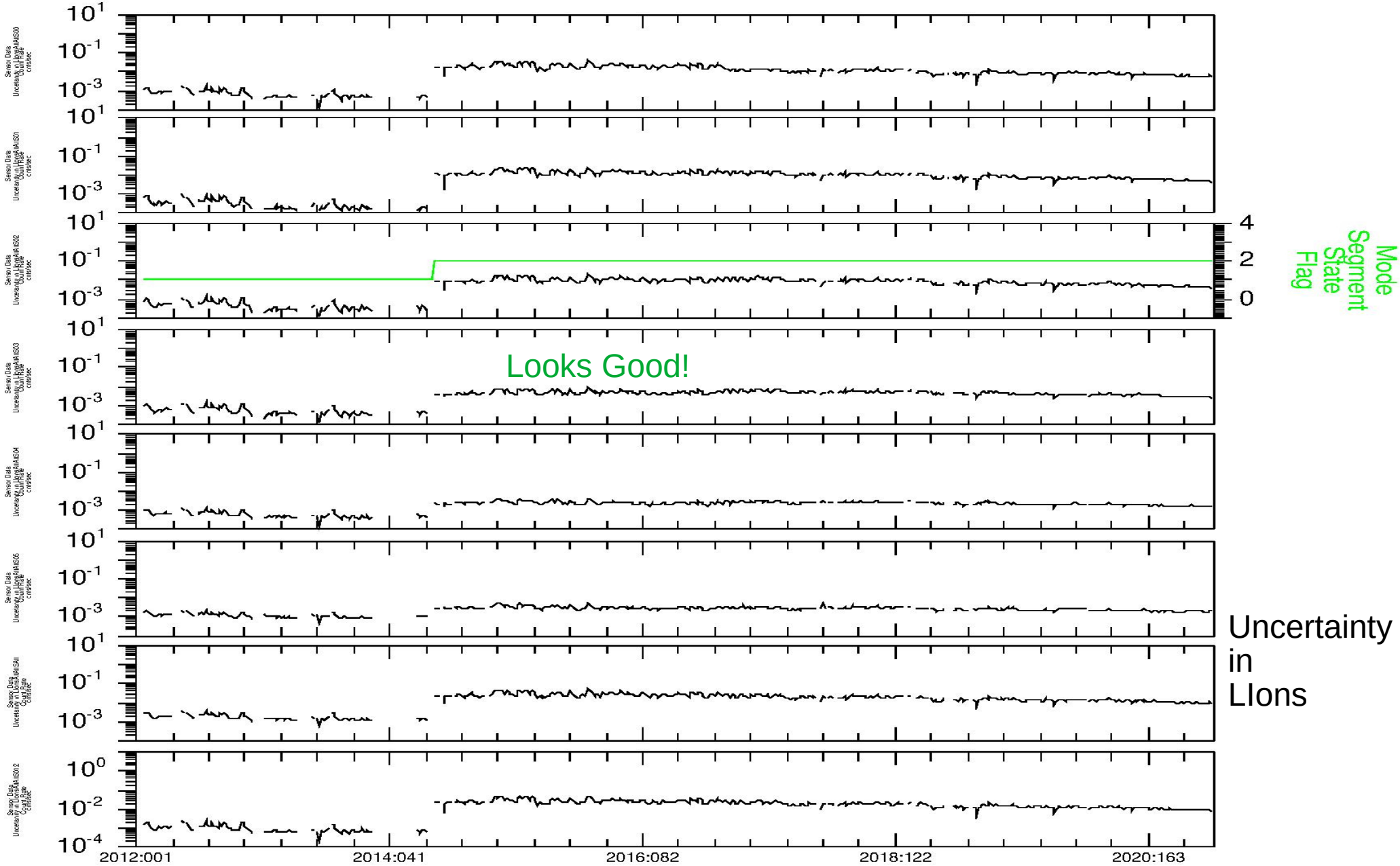


nh-x-pepssi-4-plasma-v1.0/data doubles/pepssi_reduced_lcps*

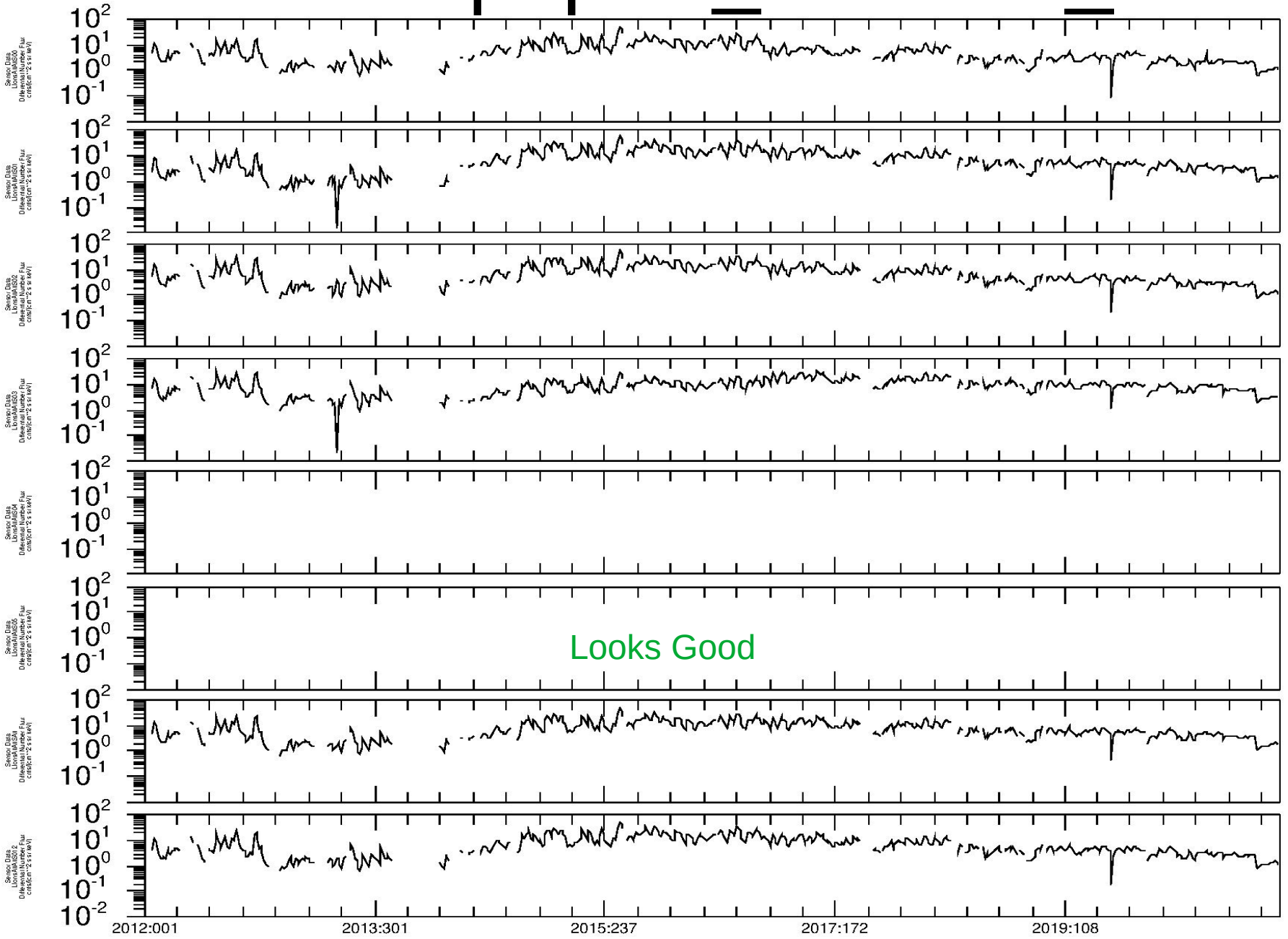


LIons

nh-x-pepssi-4-plasma-v1.0/data doubles/pepssi_reduced_lcps*

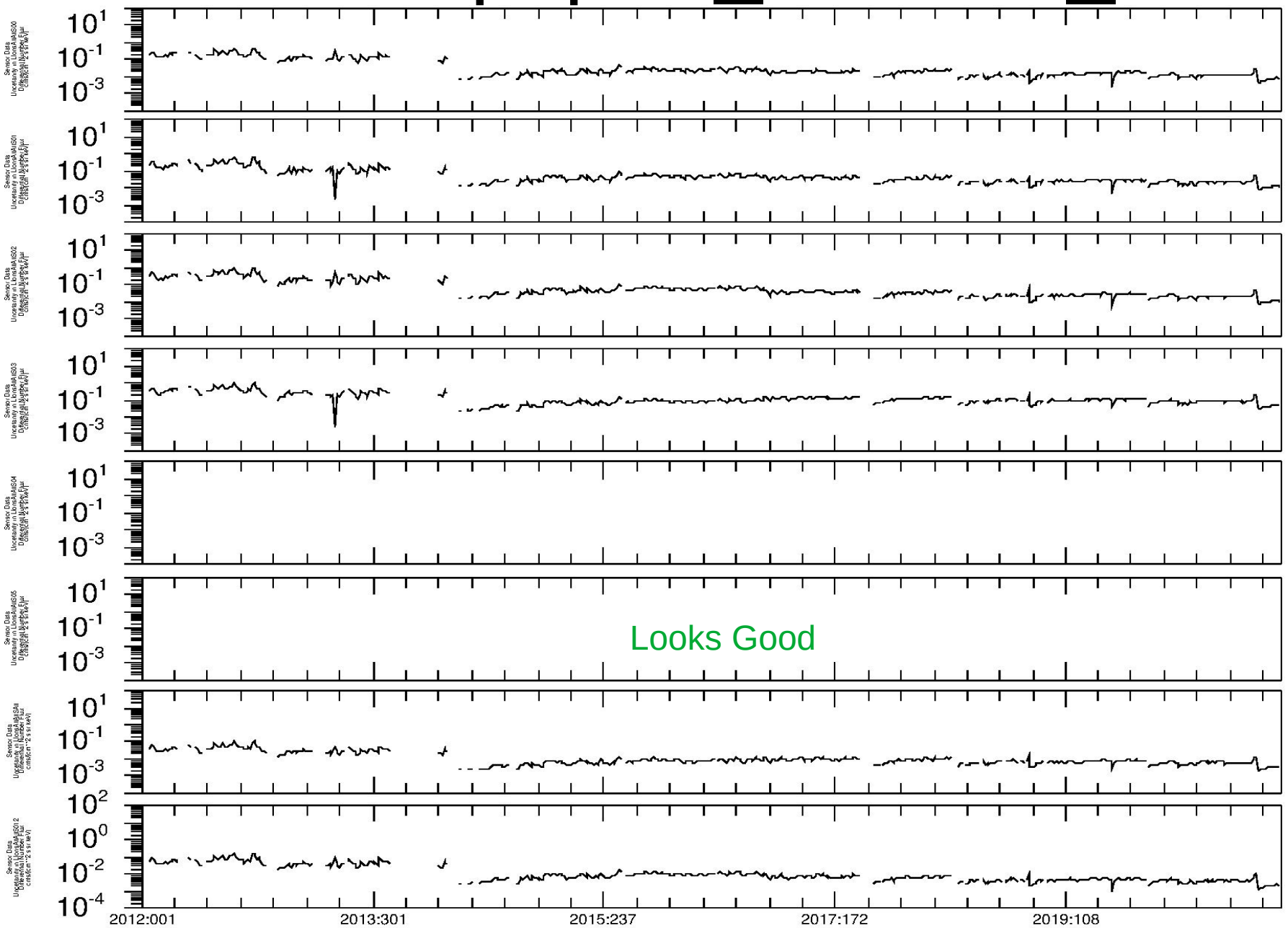


nh-x-pepssi-4-plasma-v1.0/data doubles/pepssi_reduced_lflux*



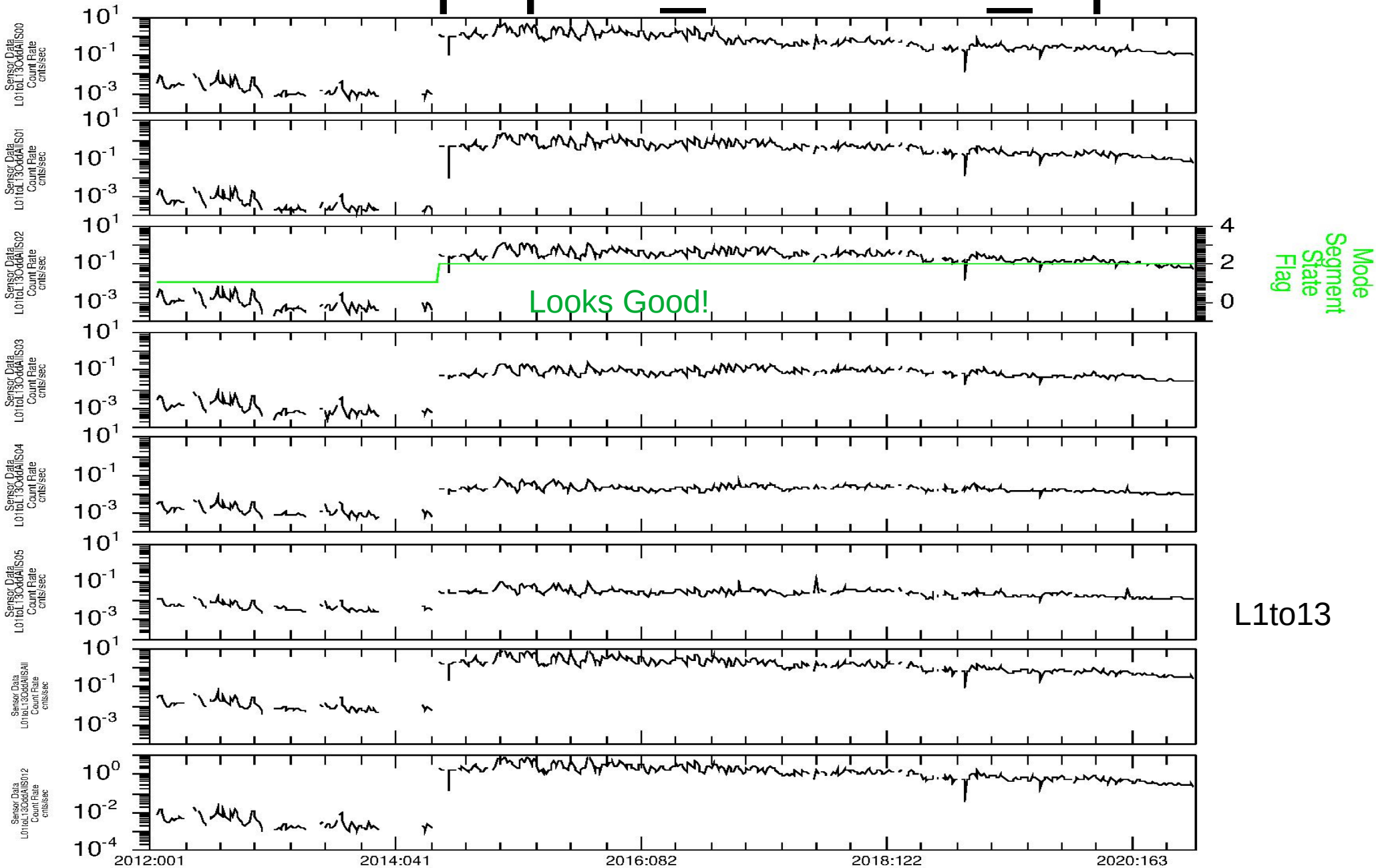
LIons

nh-x-pepssi-4-plasma-v1.0/data doubles/pepssi_reduced_lflux*



Uncertainty in LIons

nh-x-pepssi-4-plasma-v1.0/data doubles/pepssi_reduced_lcps*



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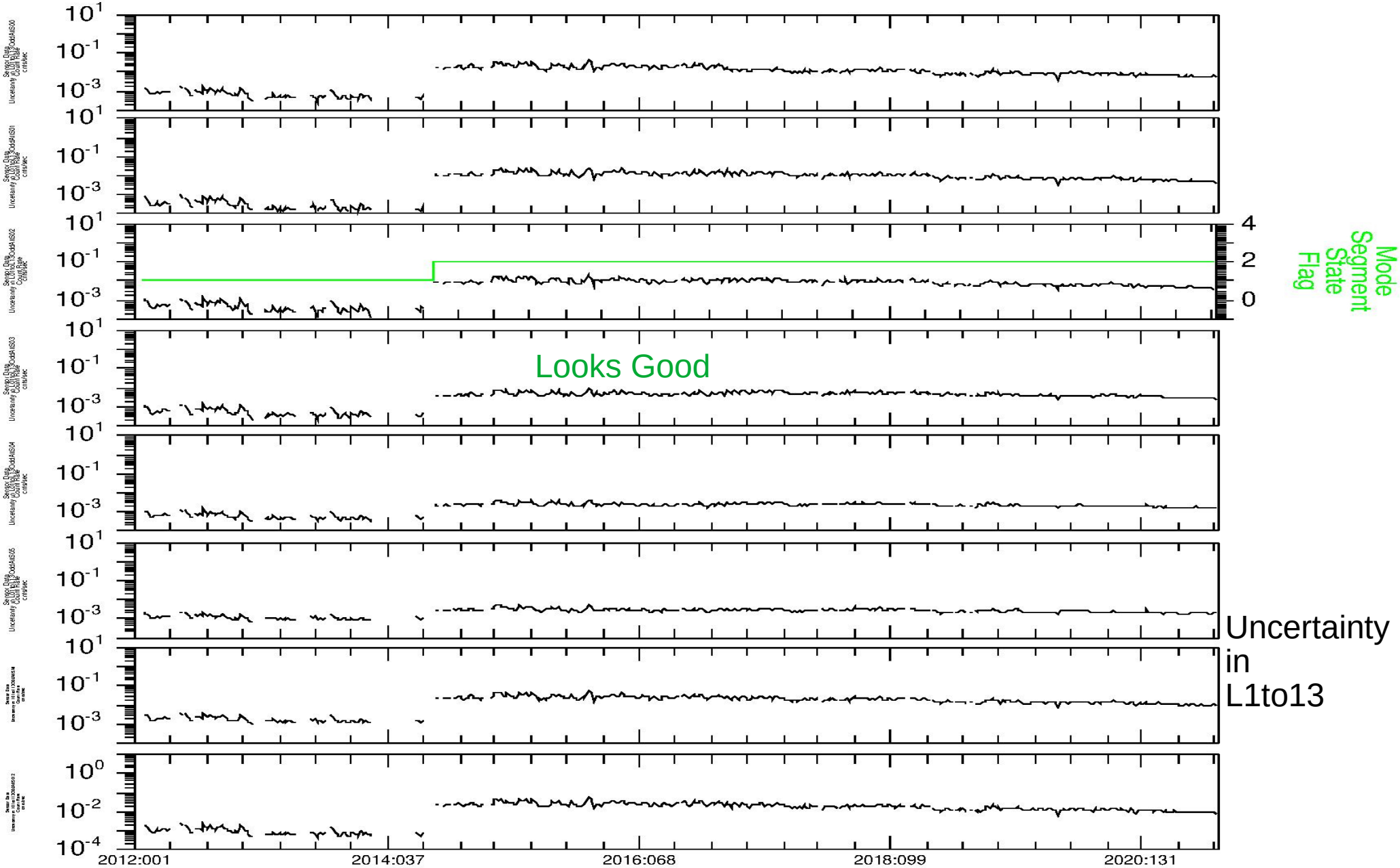
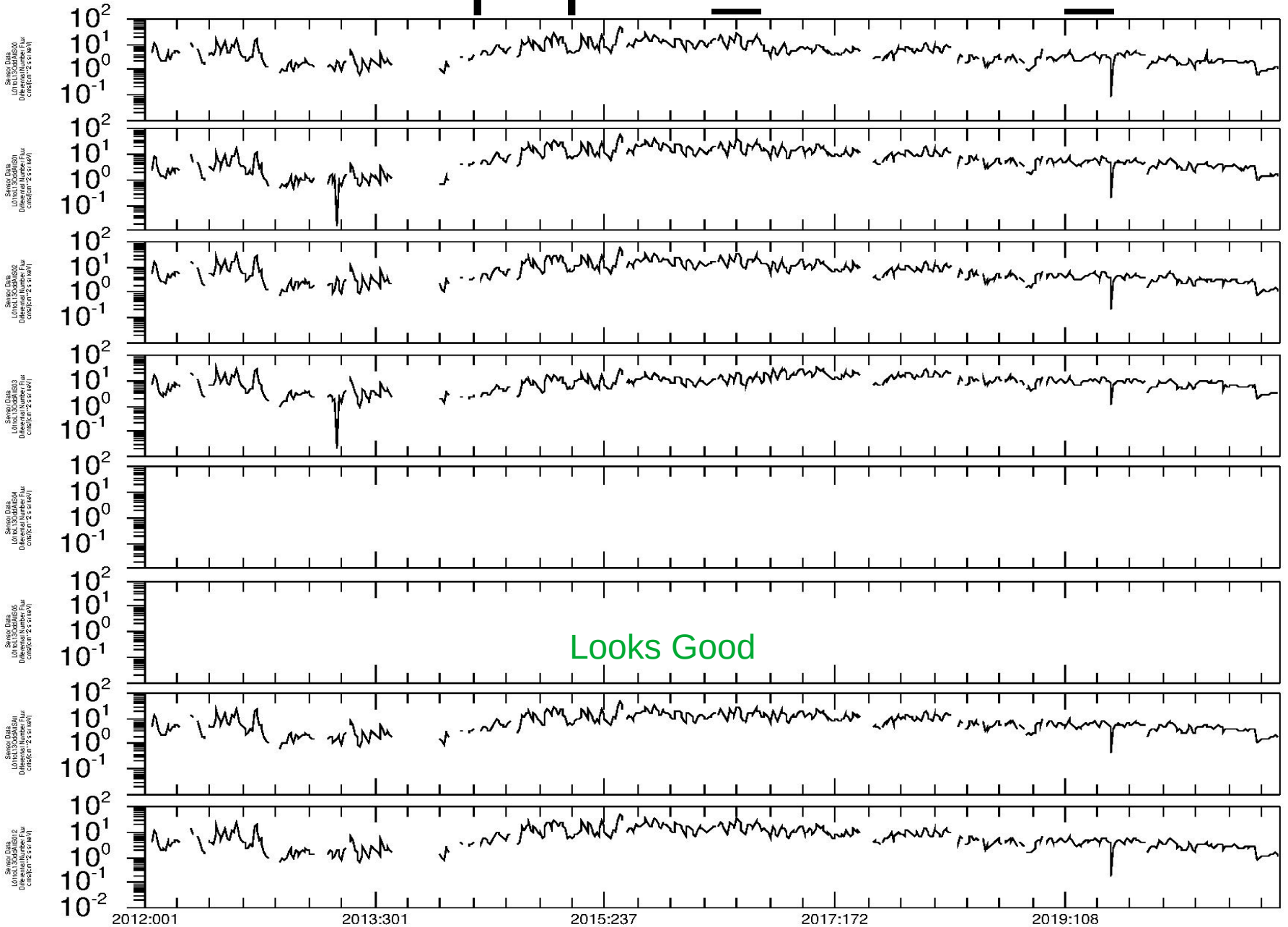
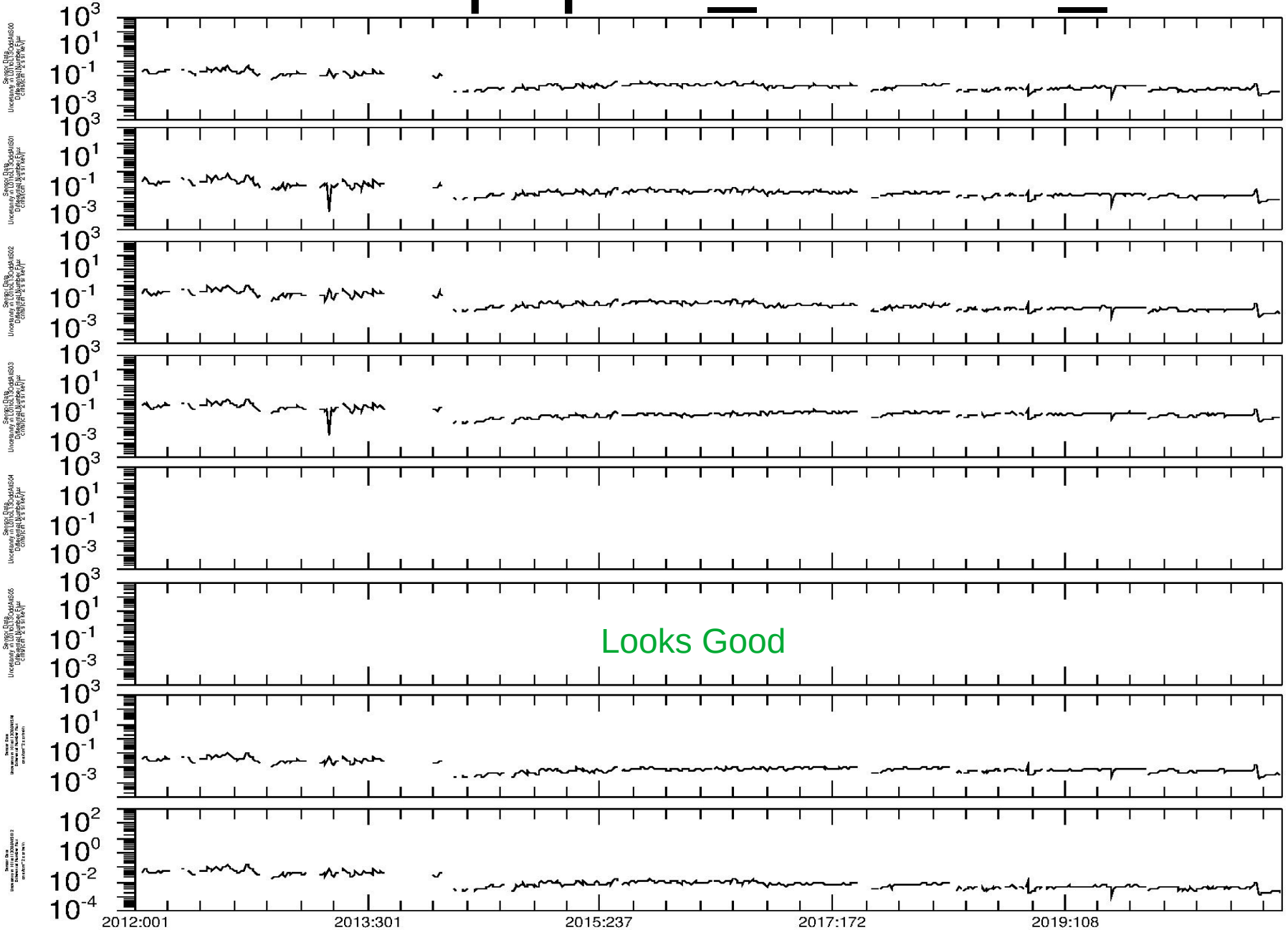


nh-x-pepssi-4-plasma-v1.0/data doubles/pepssi_reduced_lflux*



L1to13

nh-x-pepssi-4-plasma-v1.0/data doubles/pepssi_reduced_lflux*



Uncertainty in LIons

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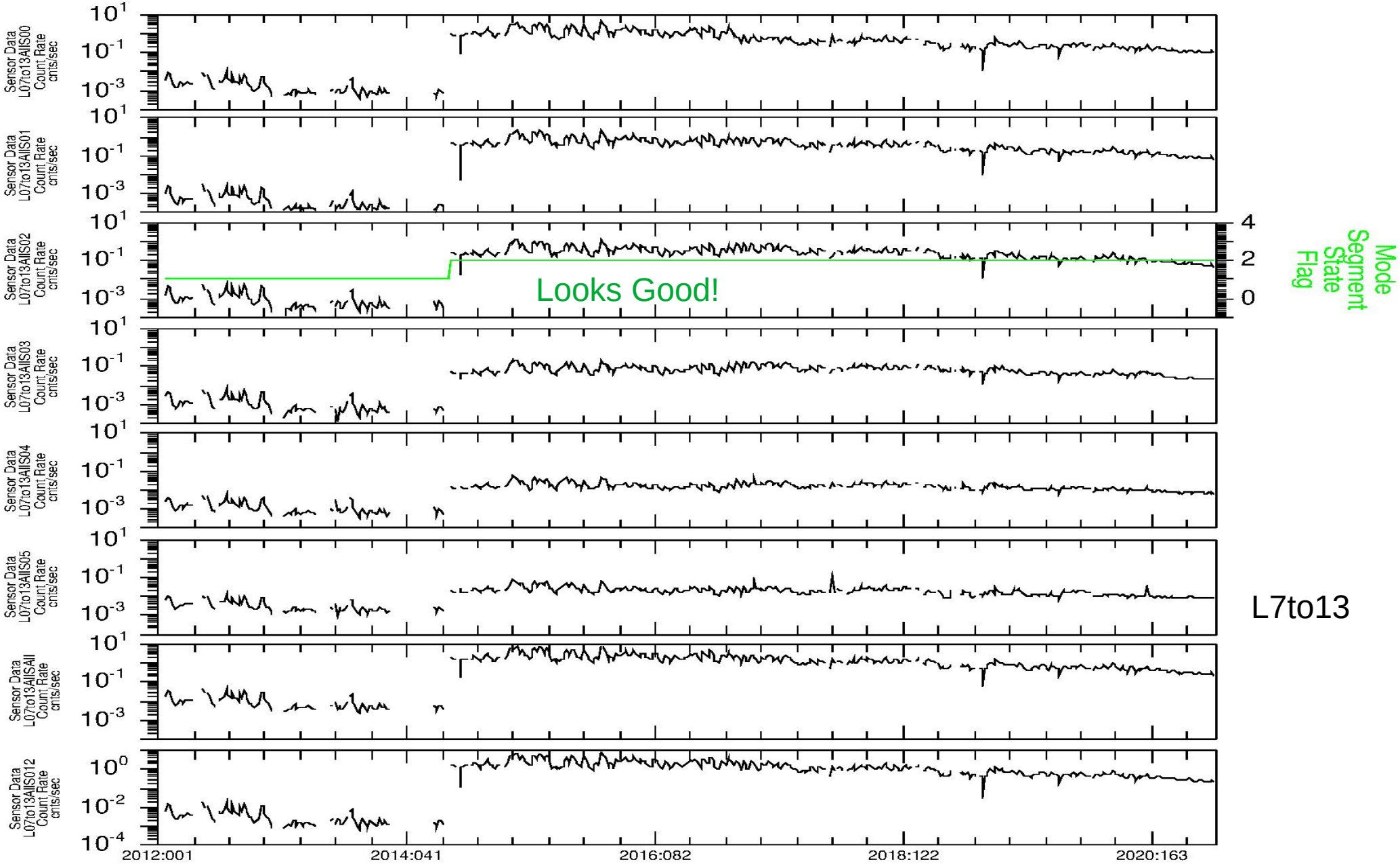

L7to13

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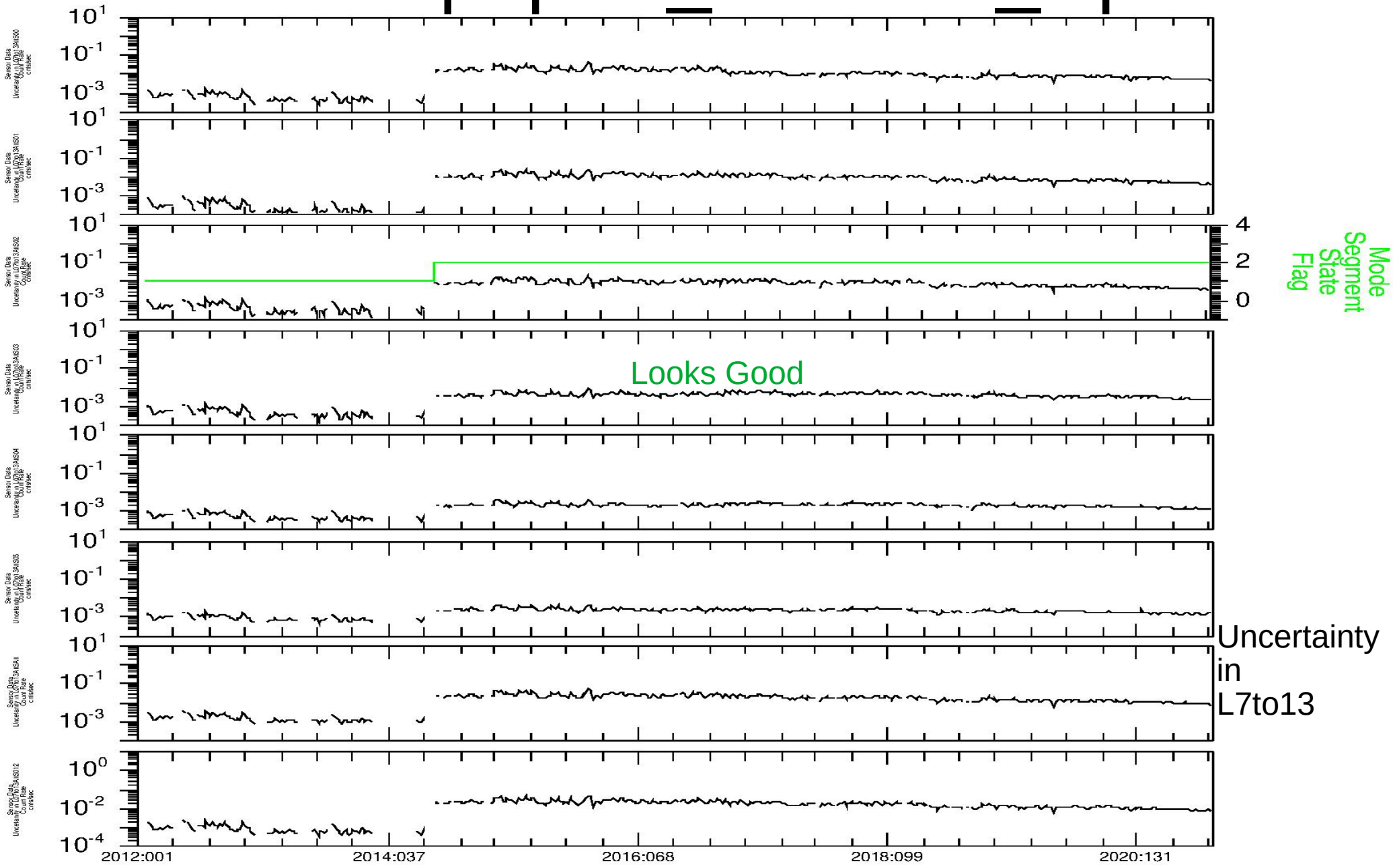

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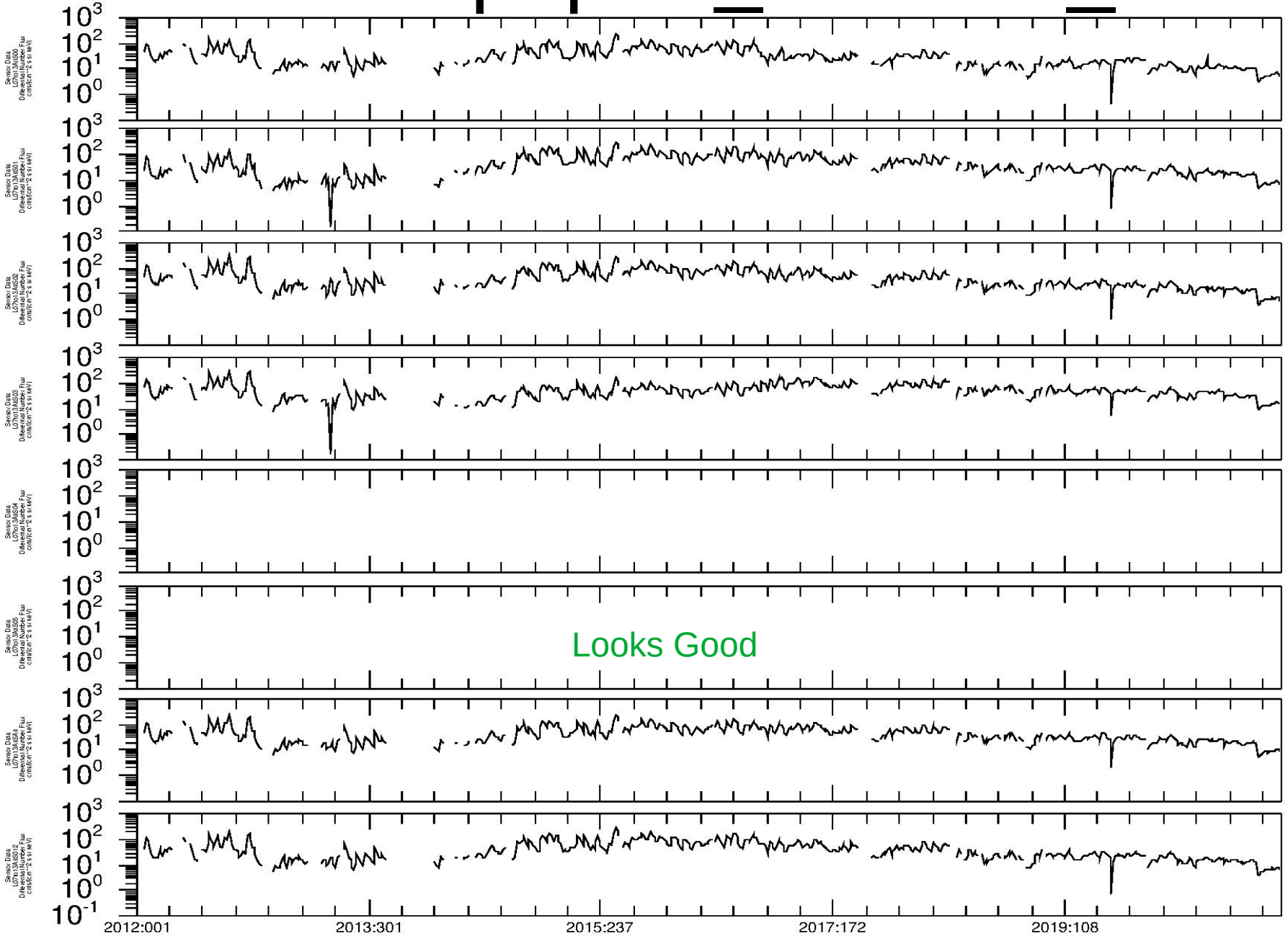

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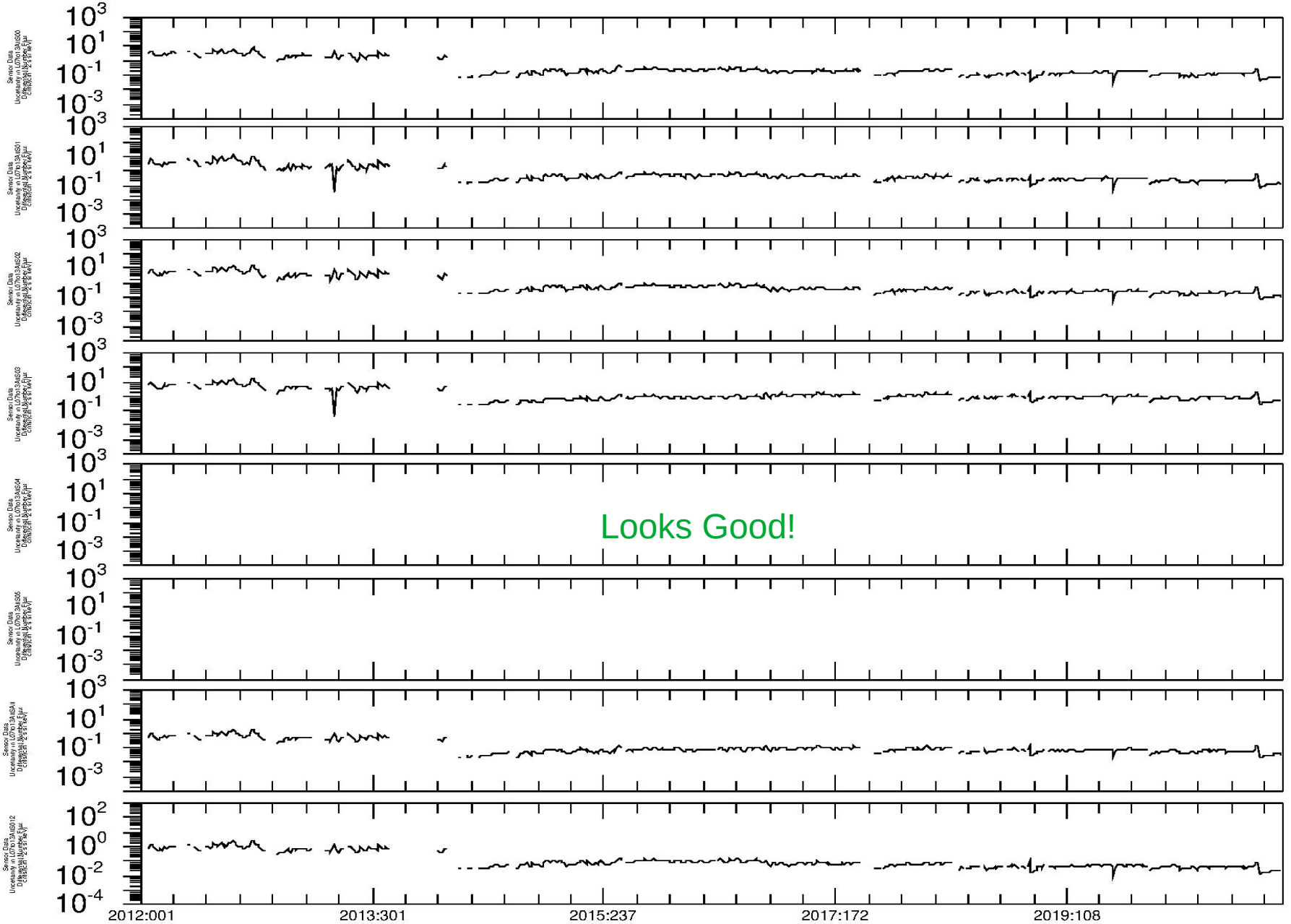
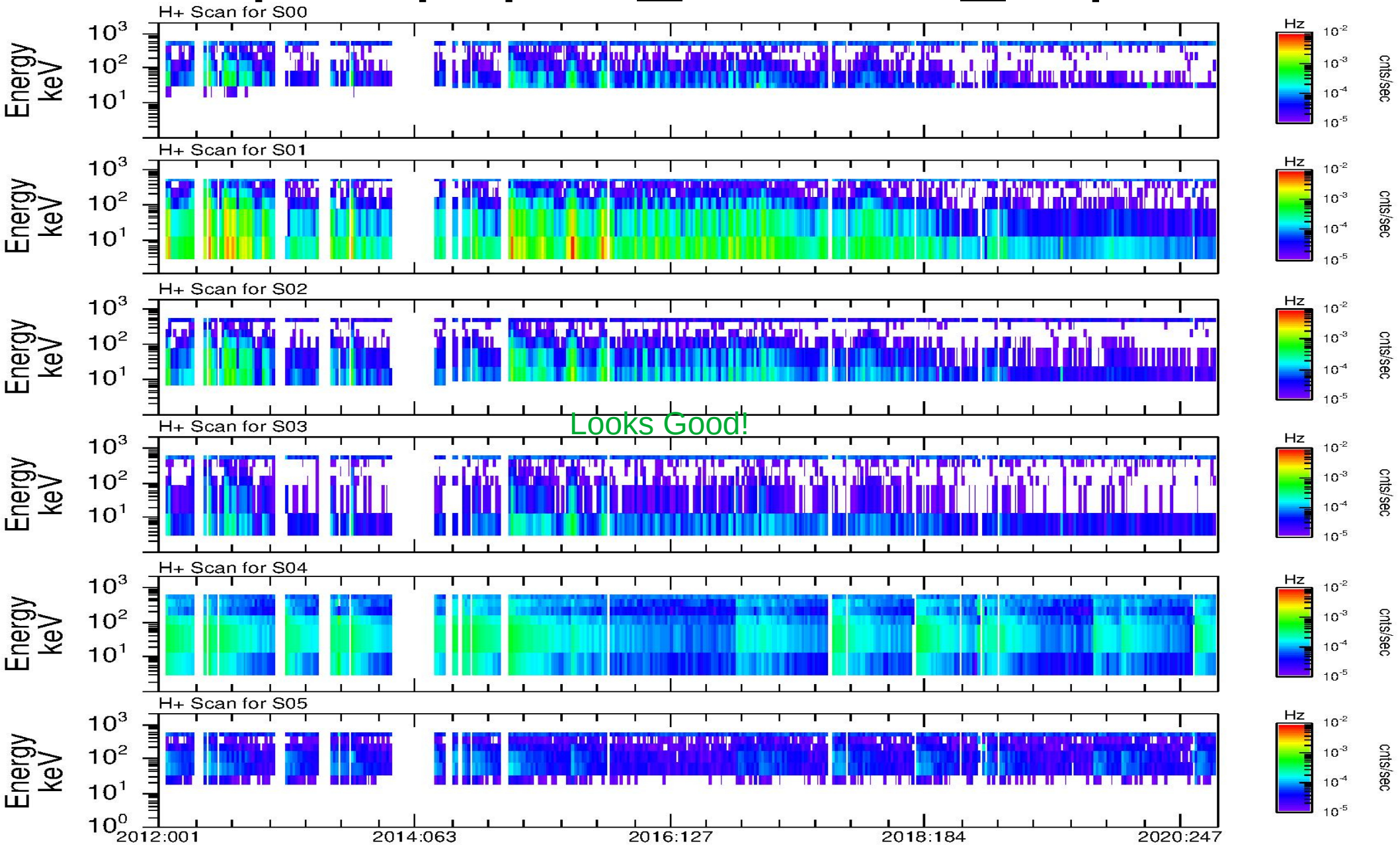


Uncertainty in L7to13

nh-x-pepssi-4-plasma-v1.0/data triples/pepssi_reduced_bcps*

Protons



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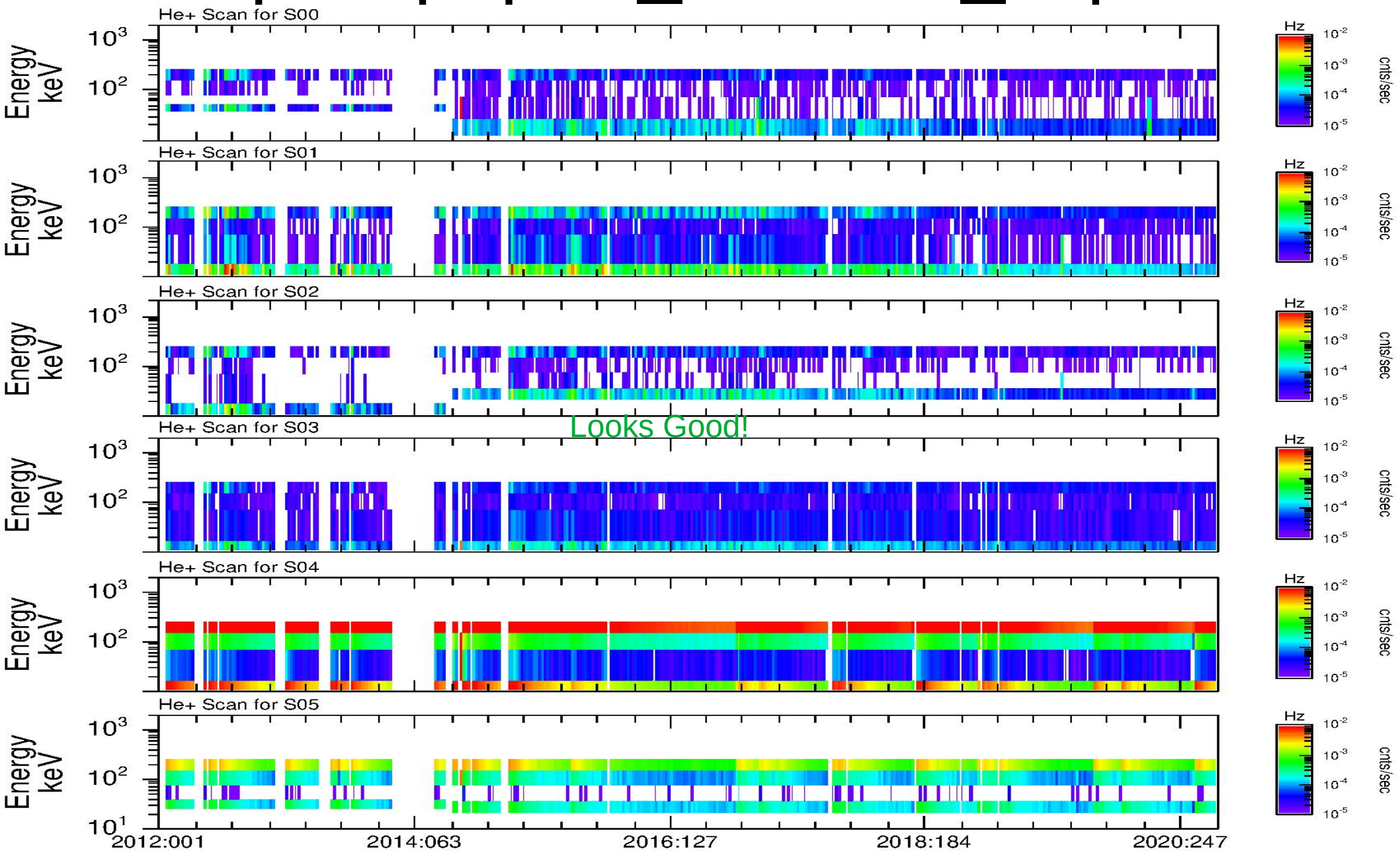
Helium



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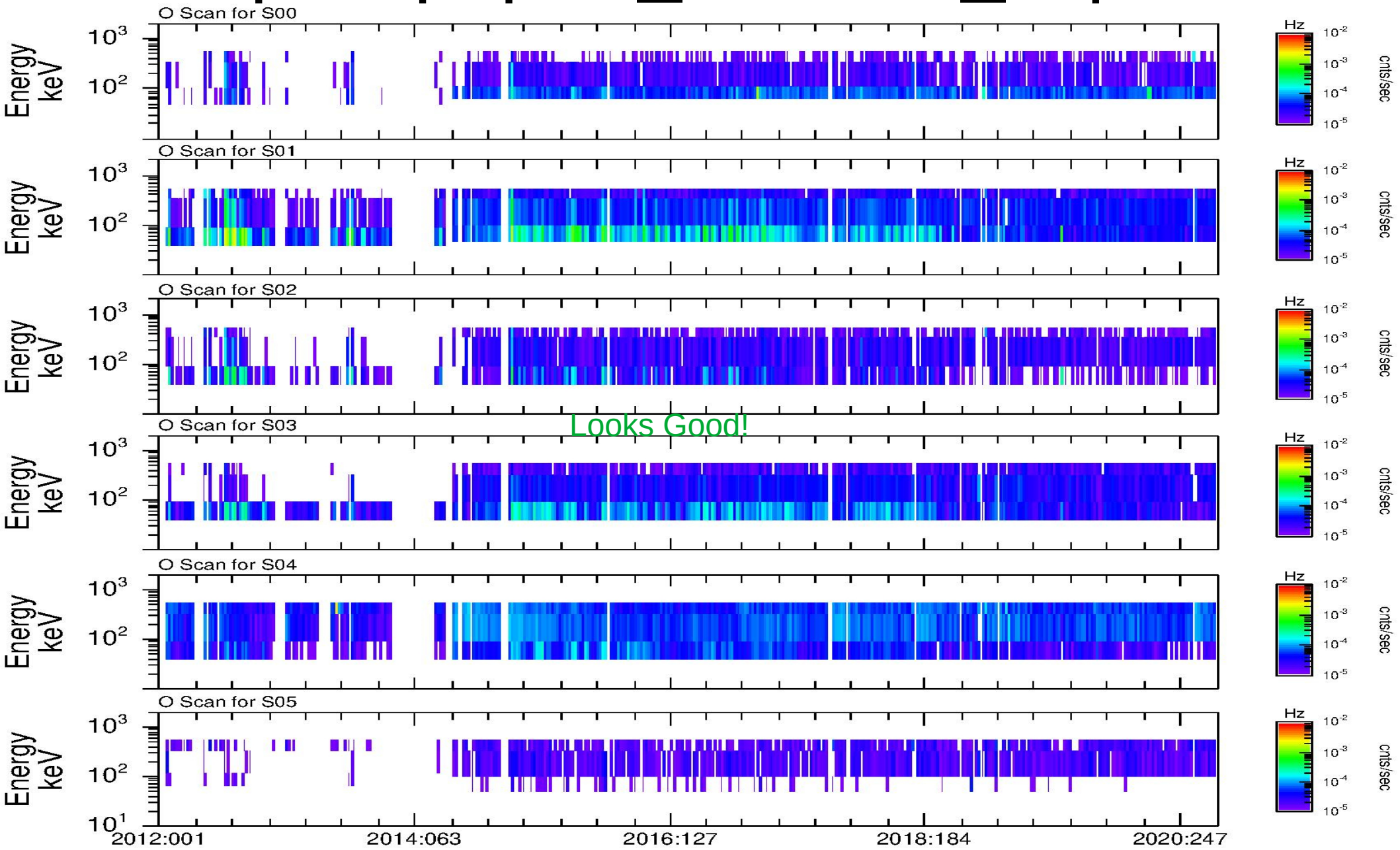
Oxygen



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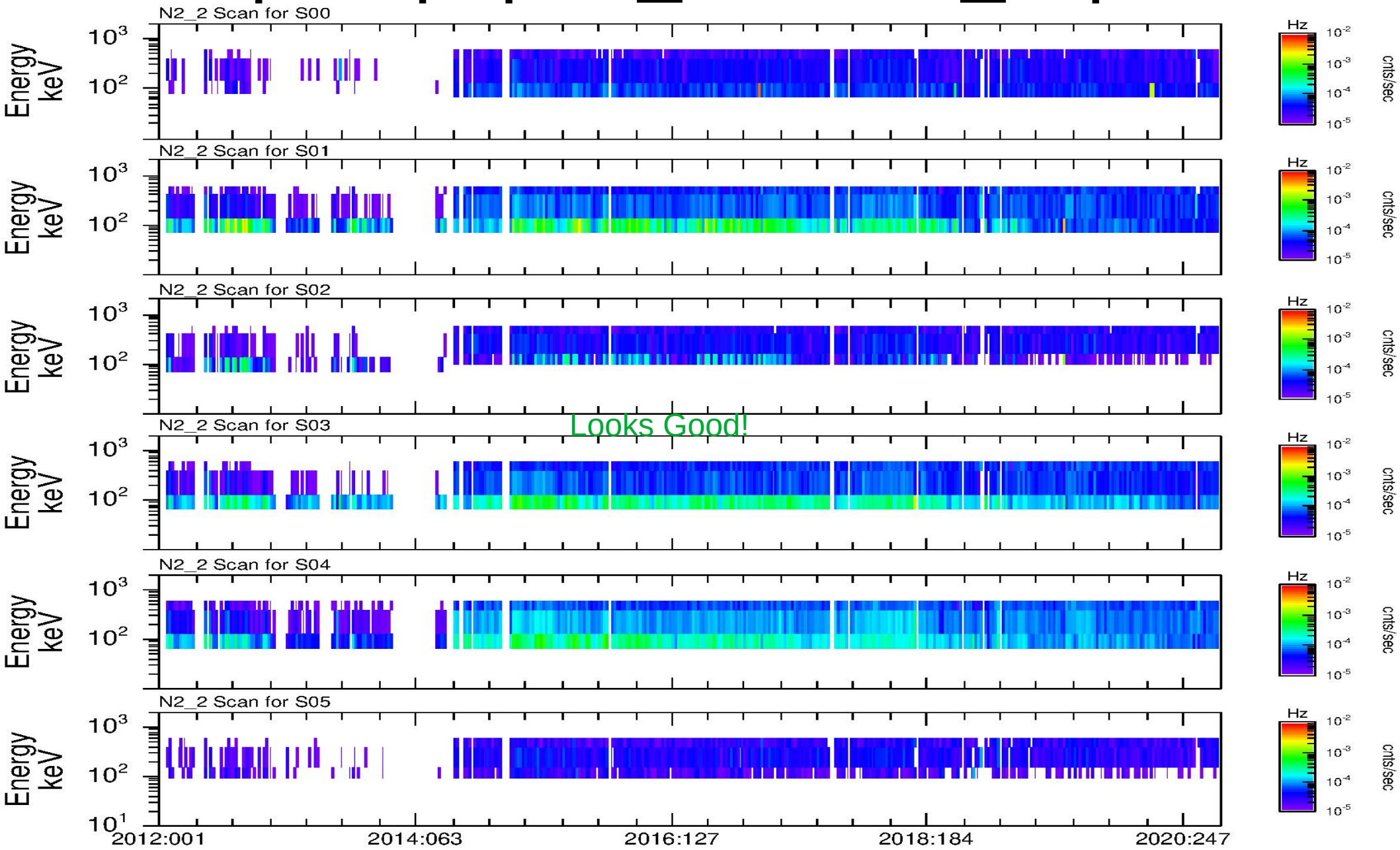
Nitrogen



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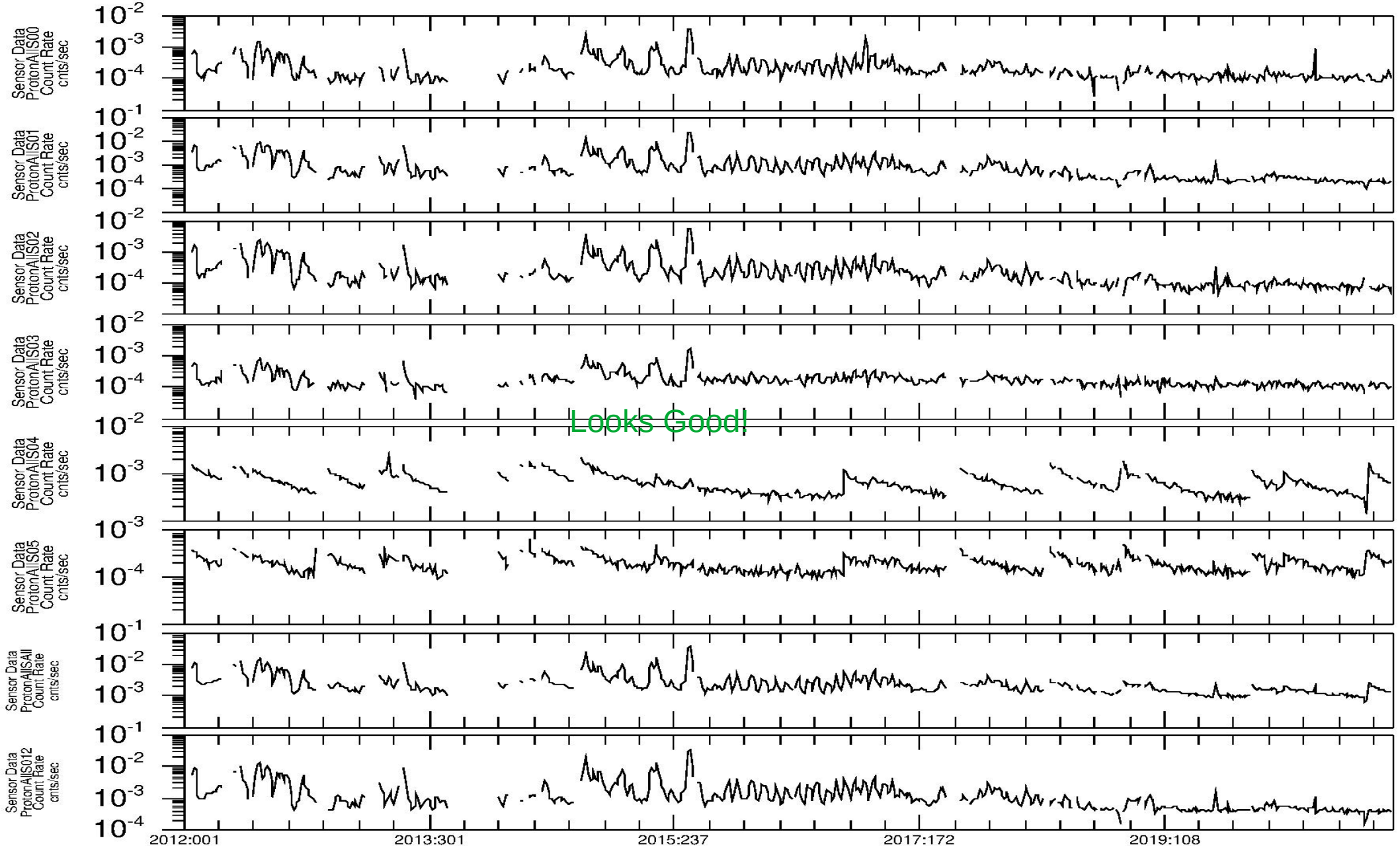
Protons



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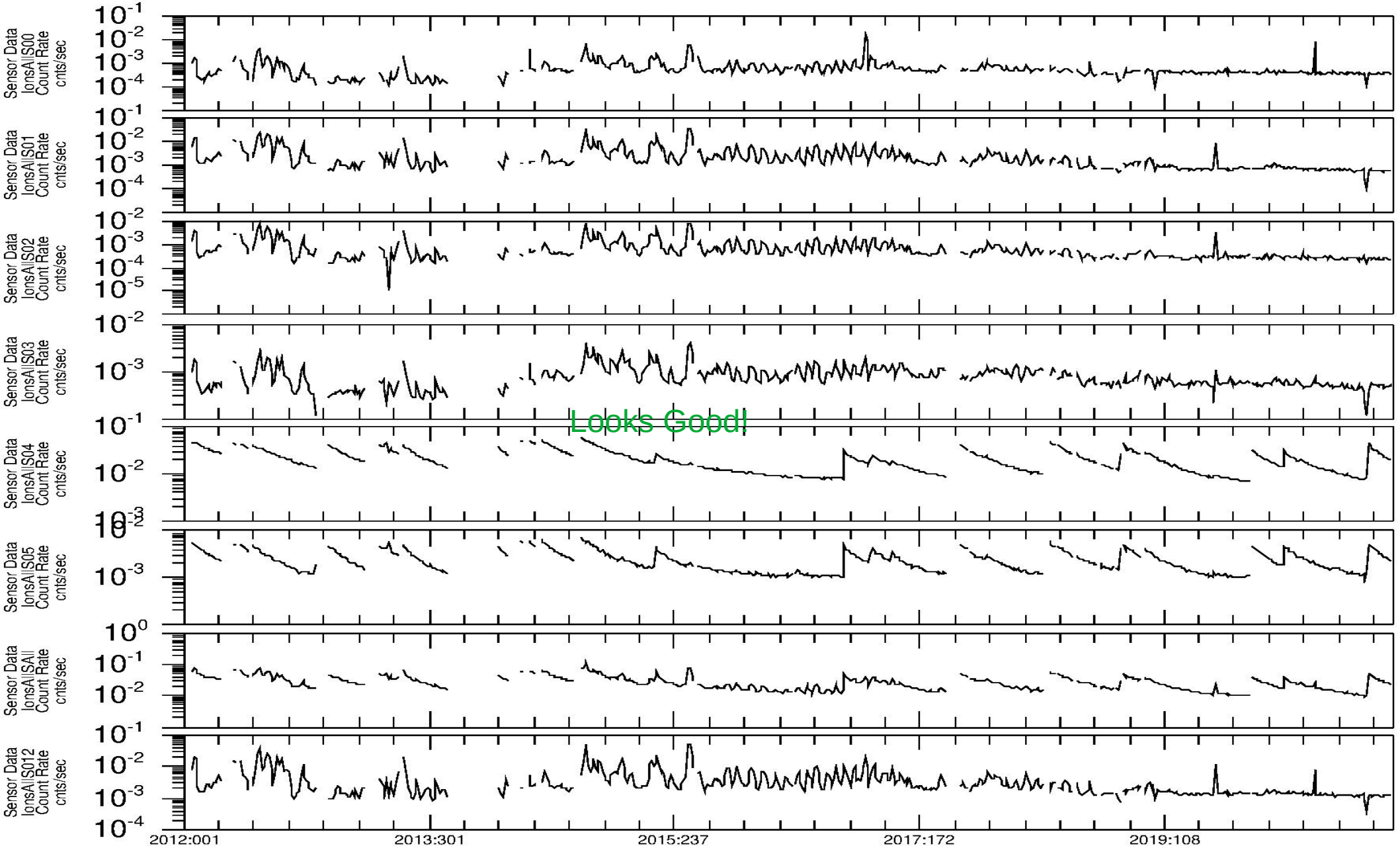
Ions



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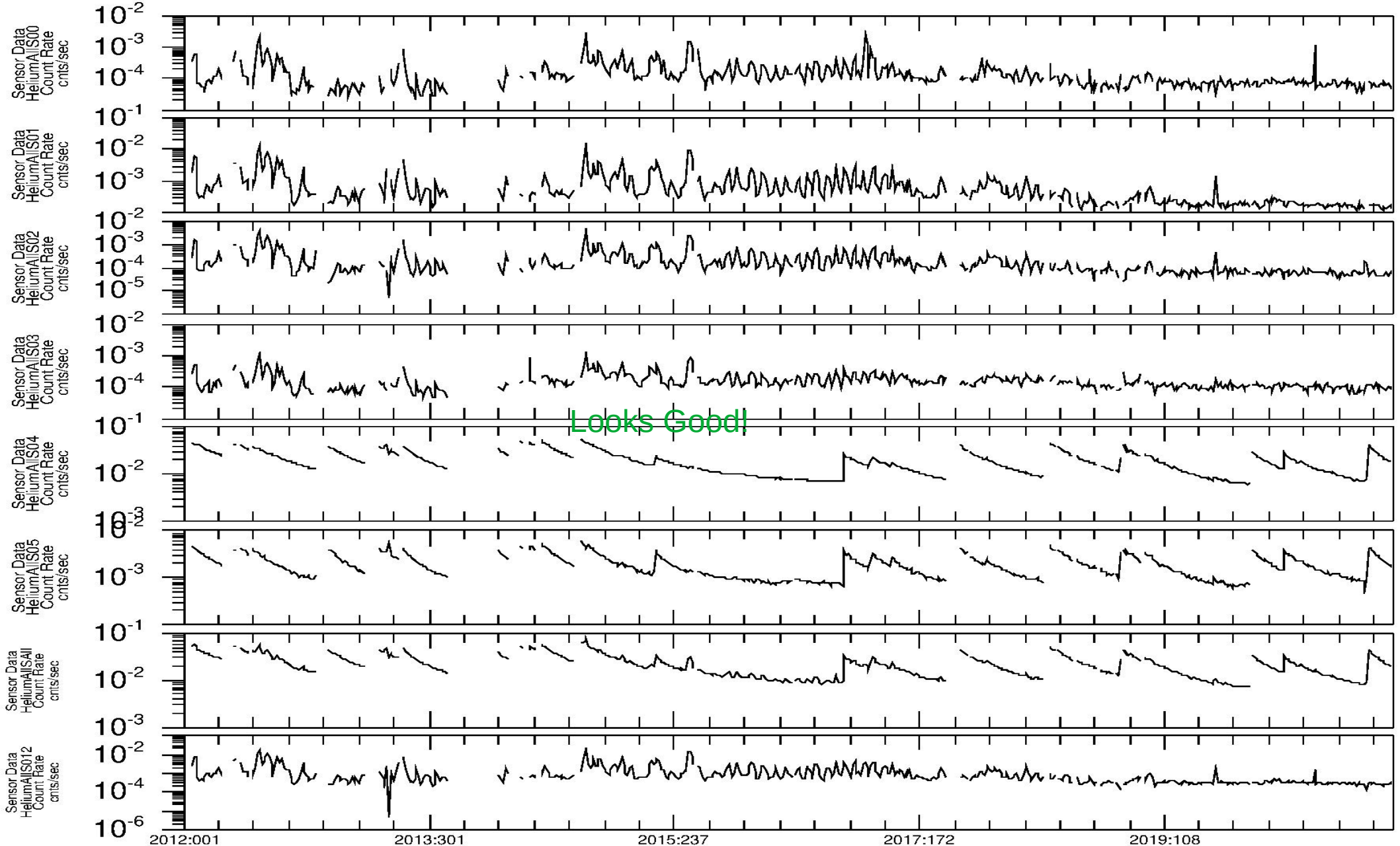
Helium



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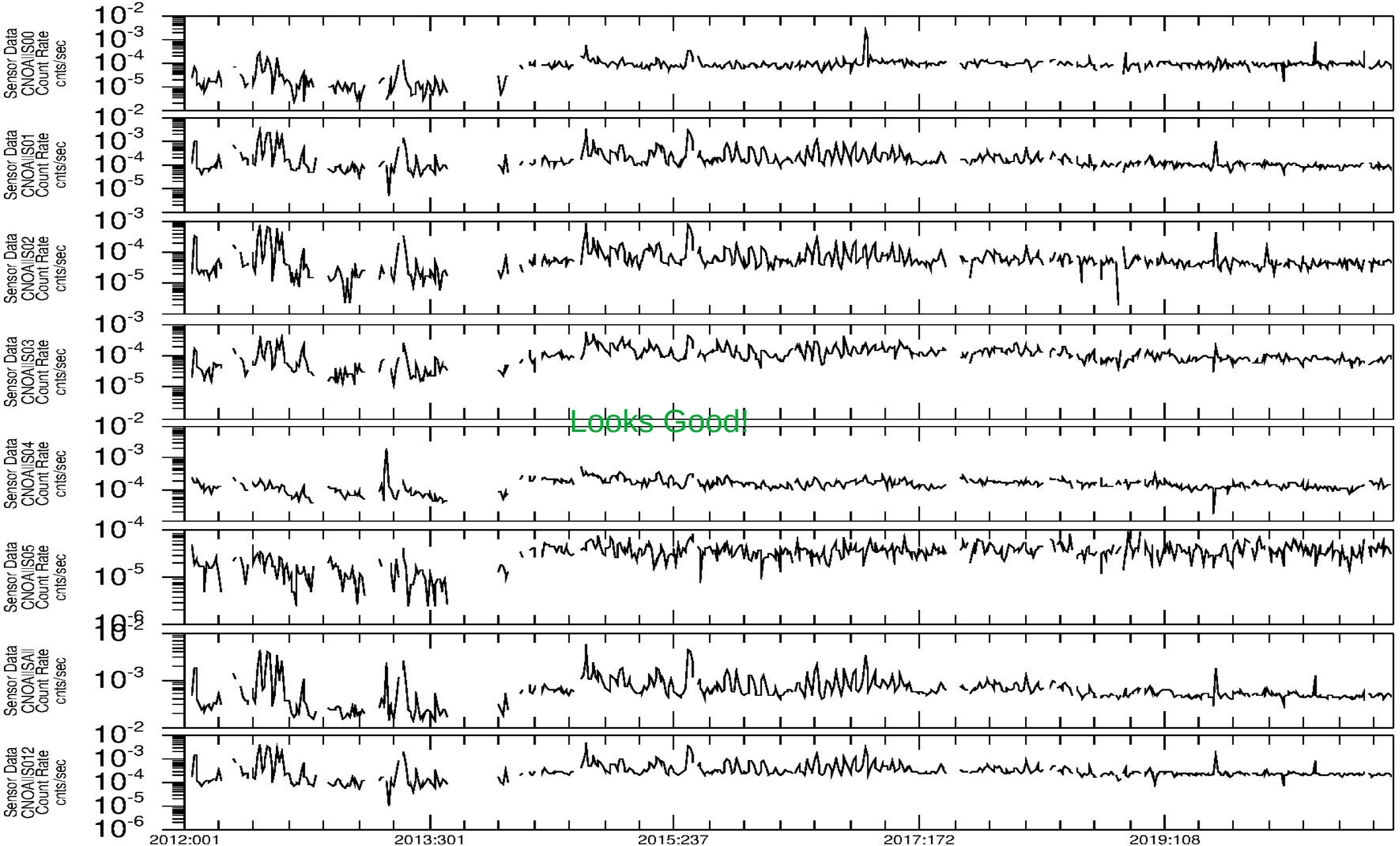
CNO



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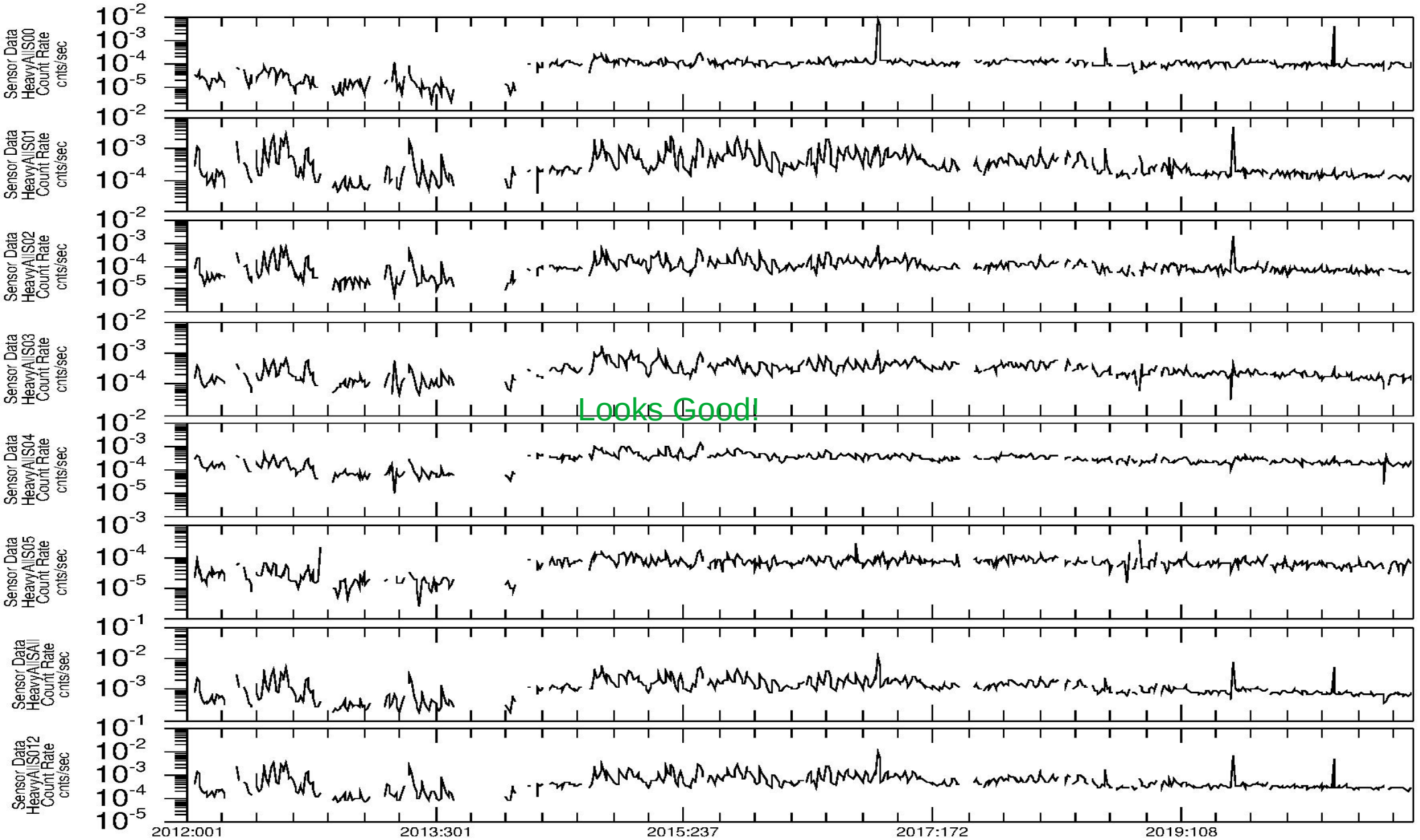
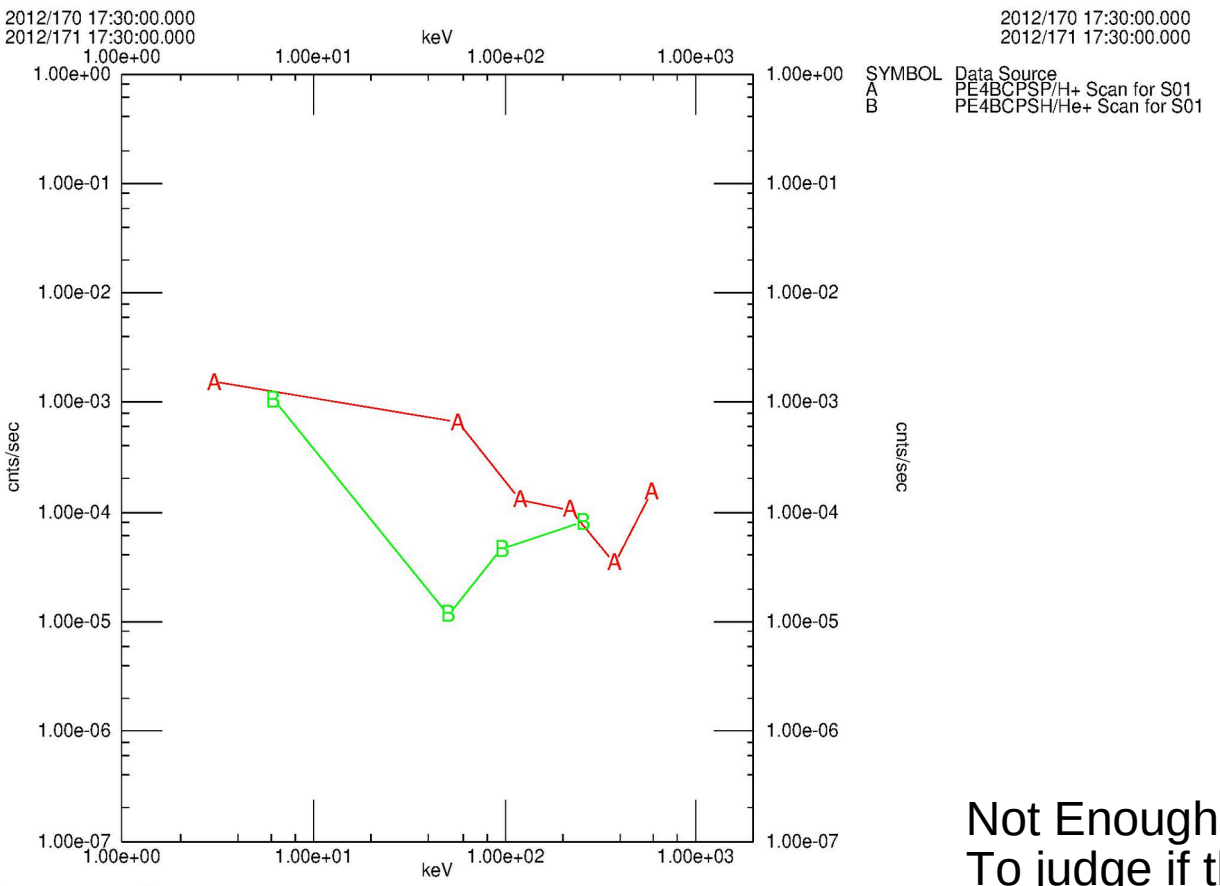
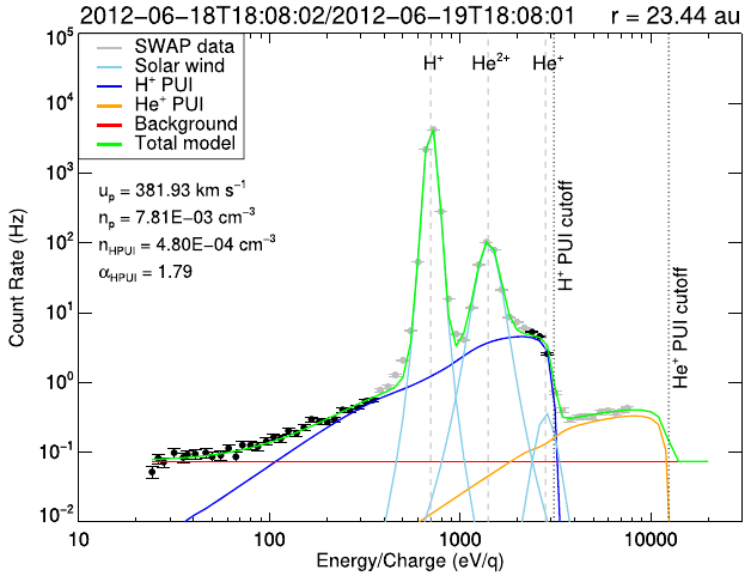
Heavy







Not Enough Information
To judge if the data are
Reasonable.

Swaczyna et al., Astrophysical Journal, 2020.

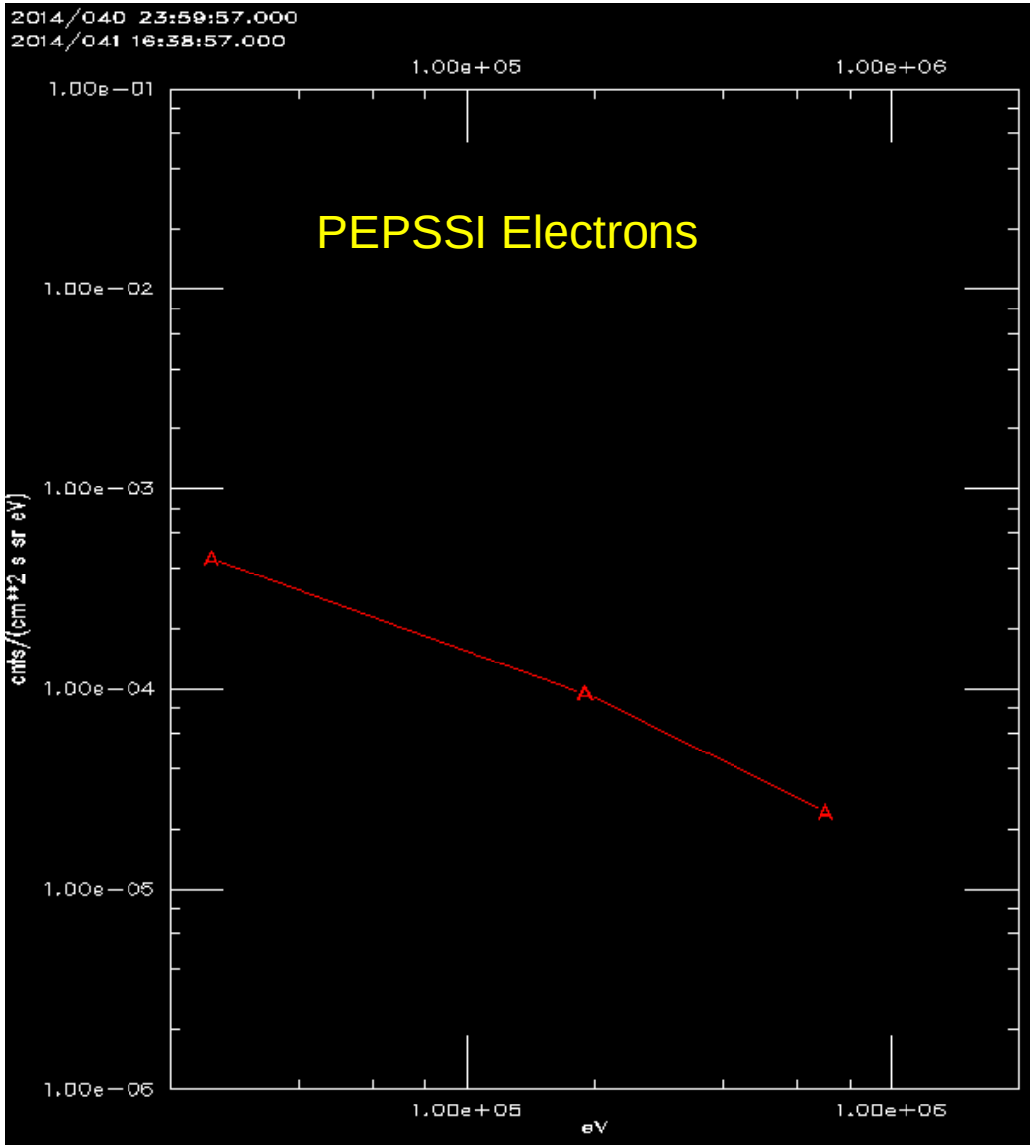
Certification Resampled

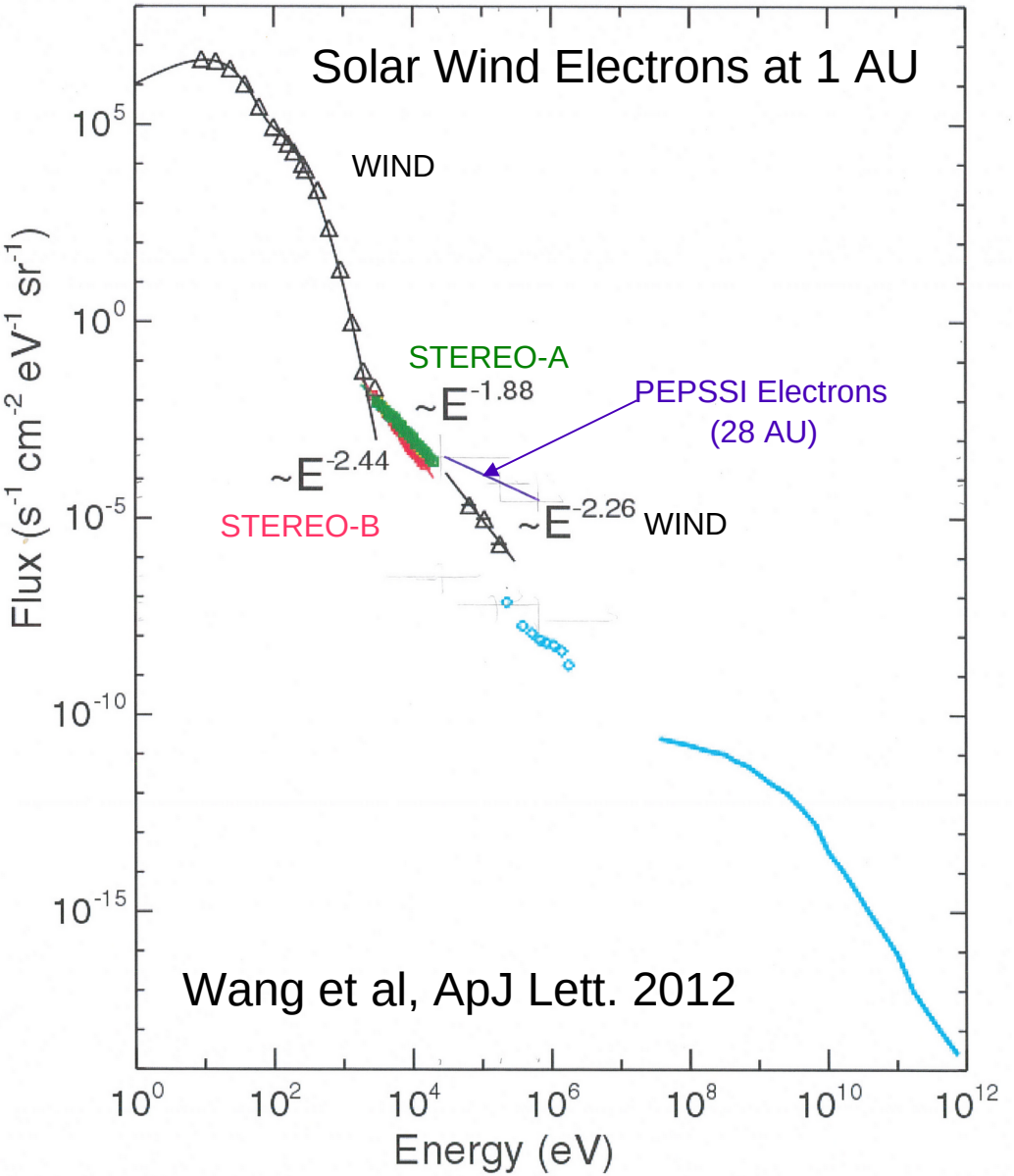
?

BACK-UP Slides

PEPSSI Electrons - 3

Why are the fluxes from PEPSSI abnormally high?





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nh-a-pepssi-3-kem1-v5.0
aareadme.txt

GOOD

nh-a-pepssi-2-kem1-v5.0
nh-a-pepssi-3-kem1-v5.0
voldesc.txt

GOOD

nh-a-pepssi-2-kem1-v5.0/catalog
nh-a-pepssi-3-kem1-v5.0/catalog
catinfo.txt

GOOD

nh-a-pepssi-2-kem1-v5.0/catalog
nh-a-pepssi-3-kem1-v5.0/catalog
dataset.cat

GOOD

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nh-a-pepssi-3-kem1-v5.0/catalog
nhsc.cat

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nh-a-pepssi-3-kem1-v5.0/catalog
nh_kem.cat

GOOD

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nh-a-pepssi-3-kem1-v5.0/catalog
pepssi.cat

GOOD

nh-a-pepssi-2-kem1-v5.0/catalog
nh-a-pepssi-3-kem1-v5.0/catalog
ref.cat

GOOD

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codmac_level_definitions.lbl
codmac_level_definitions.pdf

GOOD

nh-a-pepssi-3-kem1-v5.0/document
lunineetal1995.lbl & lunineetal1995.pdf

GOOD

nh-a-pepssi-3-kem1-v5.0/document
nh_met2utc.lbl & nh_met2utc.tab

GOOD

nh-a-pepssi-3-kem1-v5.0/document
nh_fov.lbl & nh_fov.pdf

GOOD

nh-a-pepssi-3-kem1-v5.0/document
nh_mission_trajectory.lbl

GOOD

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payload_ssr.lbl & payload_ssr.pdf

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GOOD

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GOOD

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nh-a-pepssi-3-kem1-v5.0/index
checksum.lbl & checksum.tab

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slimindx.lbl & slimindx.tab

GOOD

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index.lbl & index.tab

GOOD

nh-x-pepssi-4-plasma-v1.0
aareadme.txt

GOOD

nh-x-pepssi-4-plasma-v1.0
voldesc.txt

GOOD

nh-x-pepssi-4-plasma-v1.0/catalog
catinfo.txt

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nh-x-pepssi-4-plasma-v1.0/catalog
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