Solar Wind Around Pluto
SWAP

PRINCIPAL INVESTIGATOR
Dave McComas, Princeton University

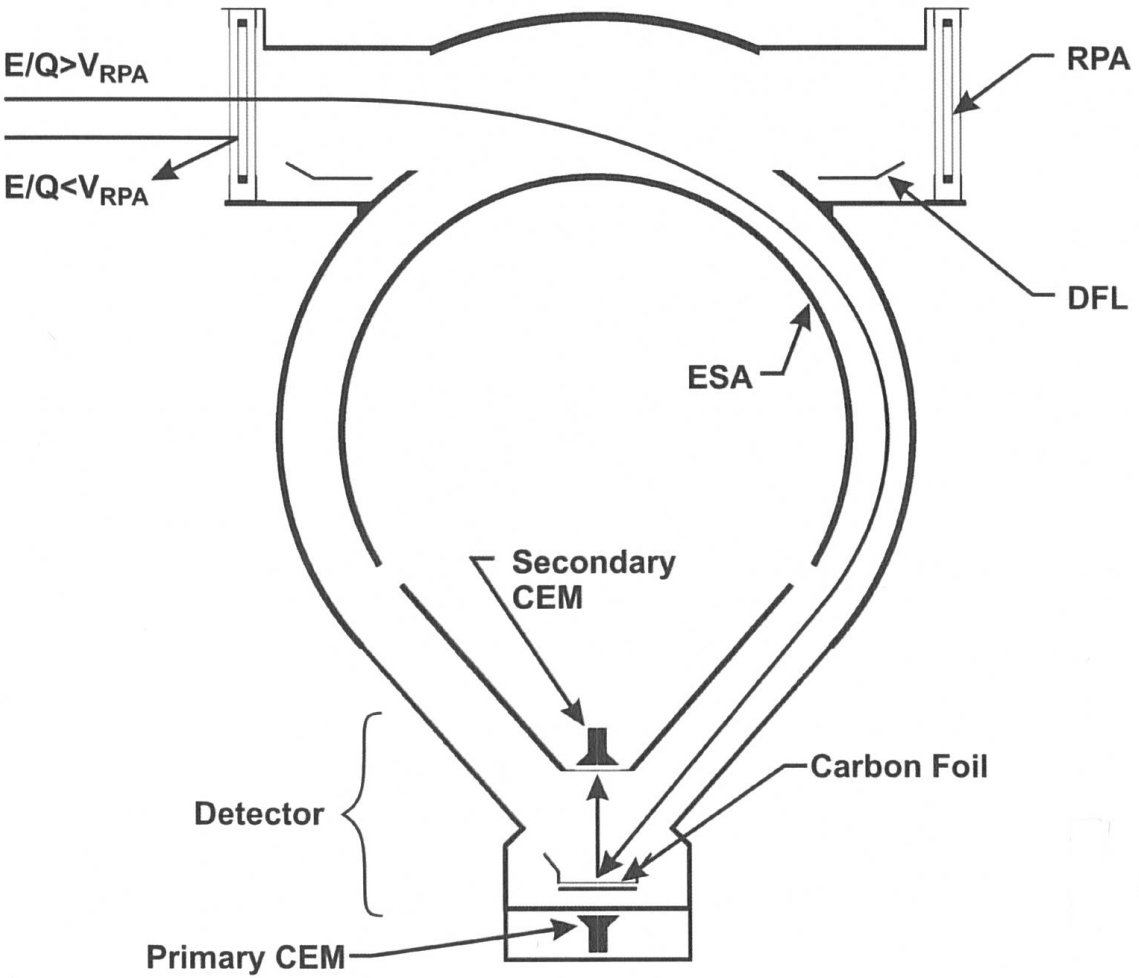
DESCRIPTION
Low Energy Plasma Instrument

ENERGY RANGE
30 eV - 7.7 keV

FIELD OF VIEW
270 deg x 10 deg
(deflection angles up to +15 deg)

ENERGY RESOLUTION
1 eV (< 2 keV); 9% (> 2 keV)

SPECIES
All Ions



New Horizons SWAP Data Sets

RAW Data Sets:
nh-a-swap-2-kem1-v5.0

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

DERIVED Data Sets:
nh-x-swap-5-derived-solarwind-v2.0

RAW and CALIBRATED Data Sets Handled Separately from DERIVED Data Sets

New Horizons SWAP 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

SWAP RAW and CALIBRATED Documentation Evaluation

nh-a-swap-2-kem1-v5.0
nh-a-swap-3-kem1-v5.0
aareadme.txt

GOOD

nh-a-swap-2-kem1-v5.0
nh-a-swap-3-kem1-v5.0
voldesc.cat

GOOD

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

GOOD

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

GOOD

nh-a-swap-2-kem1-v5.0/catalog
nh-a-swap-3-kem1-v5.0/catalog
nh_kem.cat

GOOD

nh-a-swap-2-kem1-v5.0/catalog
nh-a-swap-3-kem1-v5.0/catalog
nhsc.cat

GOOD

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

GOOD

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

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
docinfo.txt

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
codmac_level_definitions.lbl
codmac_level_definitions.pdf

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
lunineetal1995.lbl & lunineetal1995.pdf

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
nh_fov.lbl & nh_fov.png

GOOD

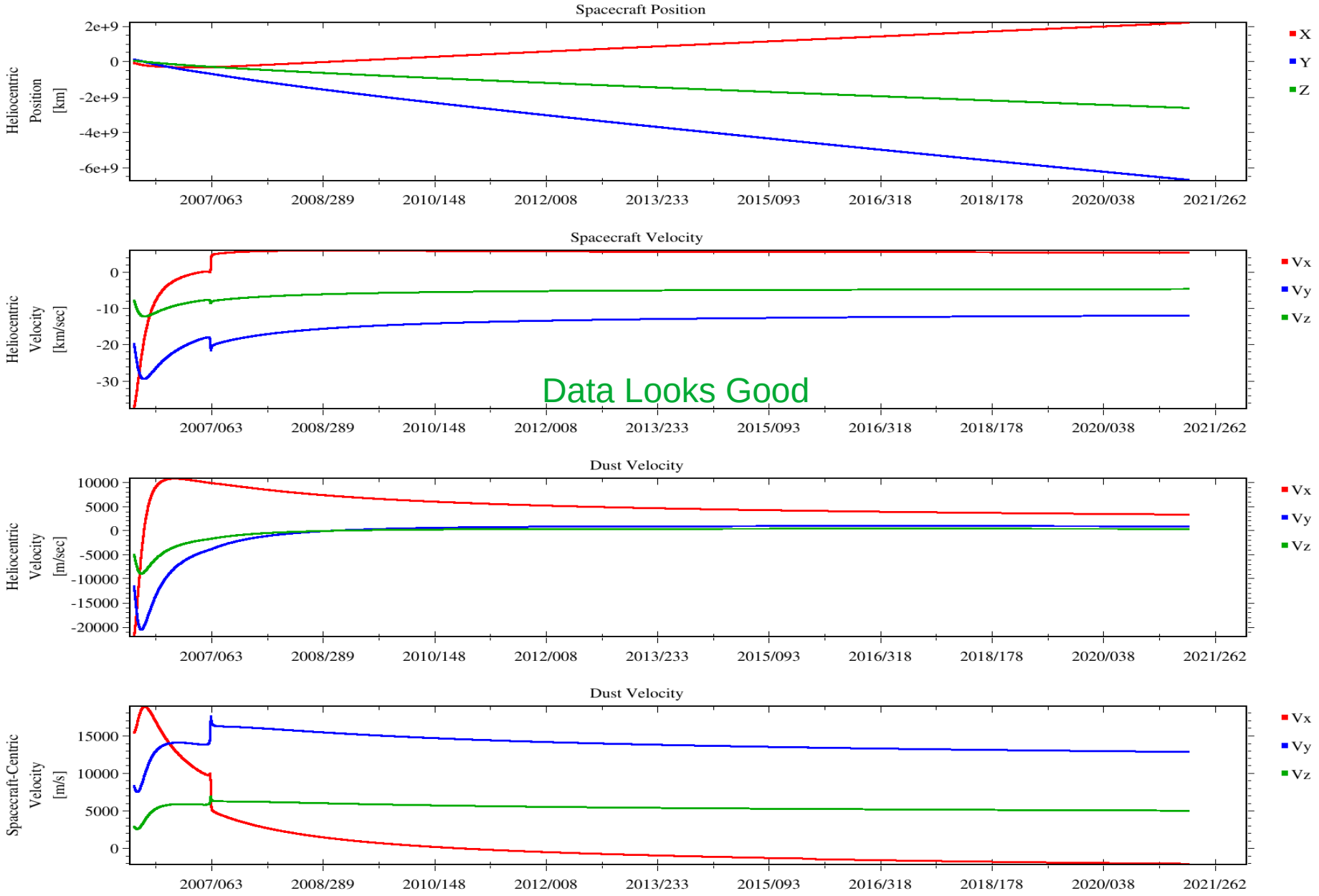
nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
nh_met2utc.lbl & nh_met2utc.tab

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
nh_mission_trajectory.lbl

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
nh_mission_trajectory.tab



Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Sun Jan 16 13:20:13 2022.

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nh-a-swap-3-kem1-v5.0/document
nh_swap_v200_ti.txt

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
payload_ssr.lbl & payload_ssr.pdf

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
quat_axyz_instr_to_j2k.lbl
quat_axyz_instr_to_j2k.asc

GOOD

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nh-a-swap-3-kem1-v5.0/document
seq_swap_kem1.lbl & seq_swap_kem1.tab

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
swap_ssr.lbl & swap_ssr.pdf

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
swap_cal.lbl

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
swap_cal.pdf

Please indicate which curve is which response.

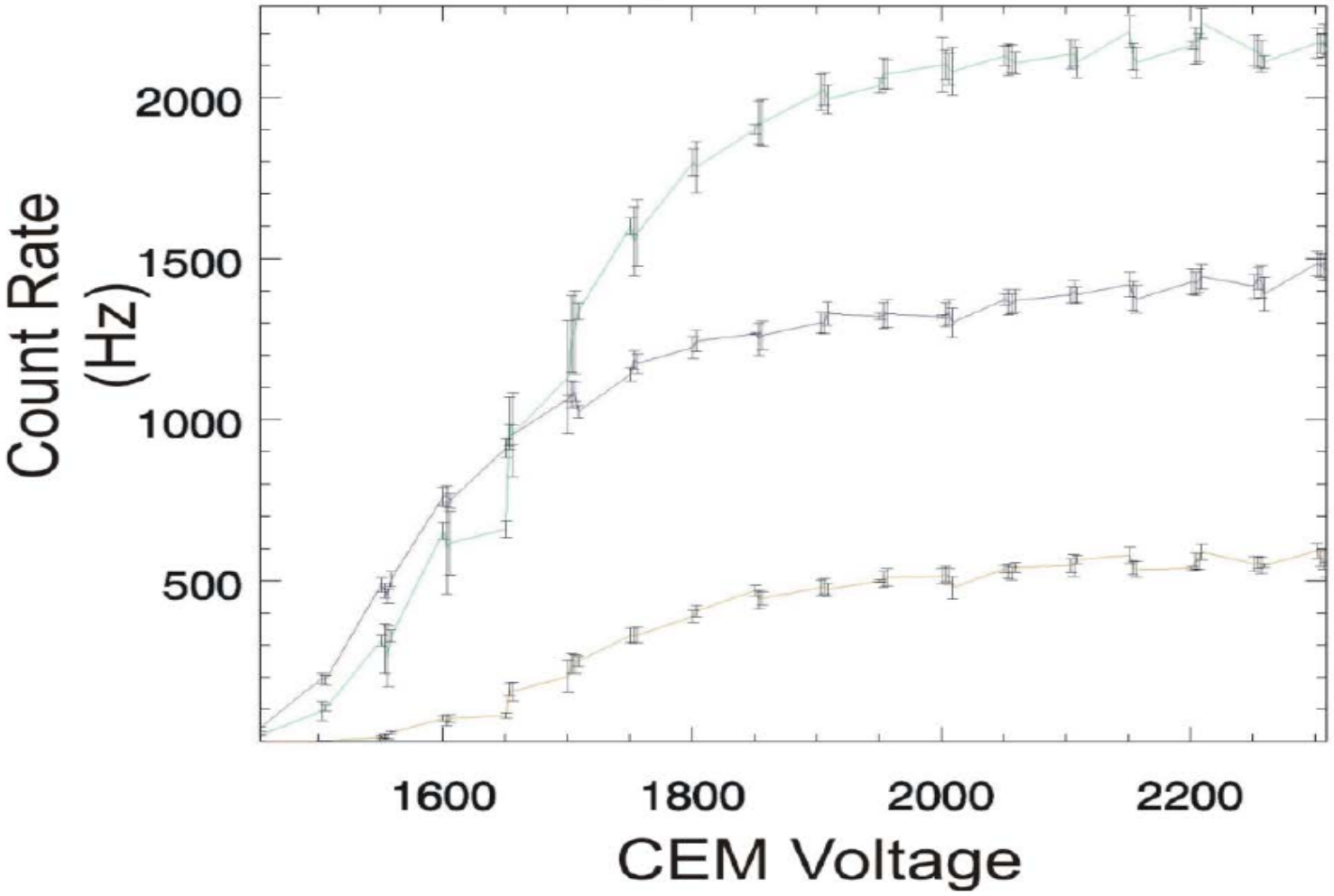

Figure 7. PCEM, SCEM, and coincidence rate response as a function of voltage.

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nh-a-swap-3-kem1-v5.0/document
soc_inst_icd.lbl

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
soc_inst_icd.pdf

$$R_c = \frac{C}{t}$$ (Equation 1)

$$(\Delta R_c)^2 = \left(\frac{\partial R_c}{\partial t}\right)^2 (\Delta t)^2 + \left(\frac{\partial R_c}{\partial C}\right)^2 (\Delta C)^2$$ (Equation 2)

$$(\Delta R_c)^2 = \left(\frac{C^2}{t^4}\right)^2 (\Delta t)^2 + \left(\frac{1}{t}\right)^2 (\Delta C)^2$$ (Equation 3)

Incorrect - $\partial R_c = (-C/t^2) * \partial t$

$$\frac{(\Delta R_c)^2}{R_c^{\,2}} = \frac{(\Delta t)^2}{t^2} + \frac{(\Delta C)^2}{C^2}$$ ← Correct (Equation 4)

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
traj/trajinfo.txt

GOOD

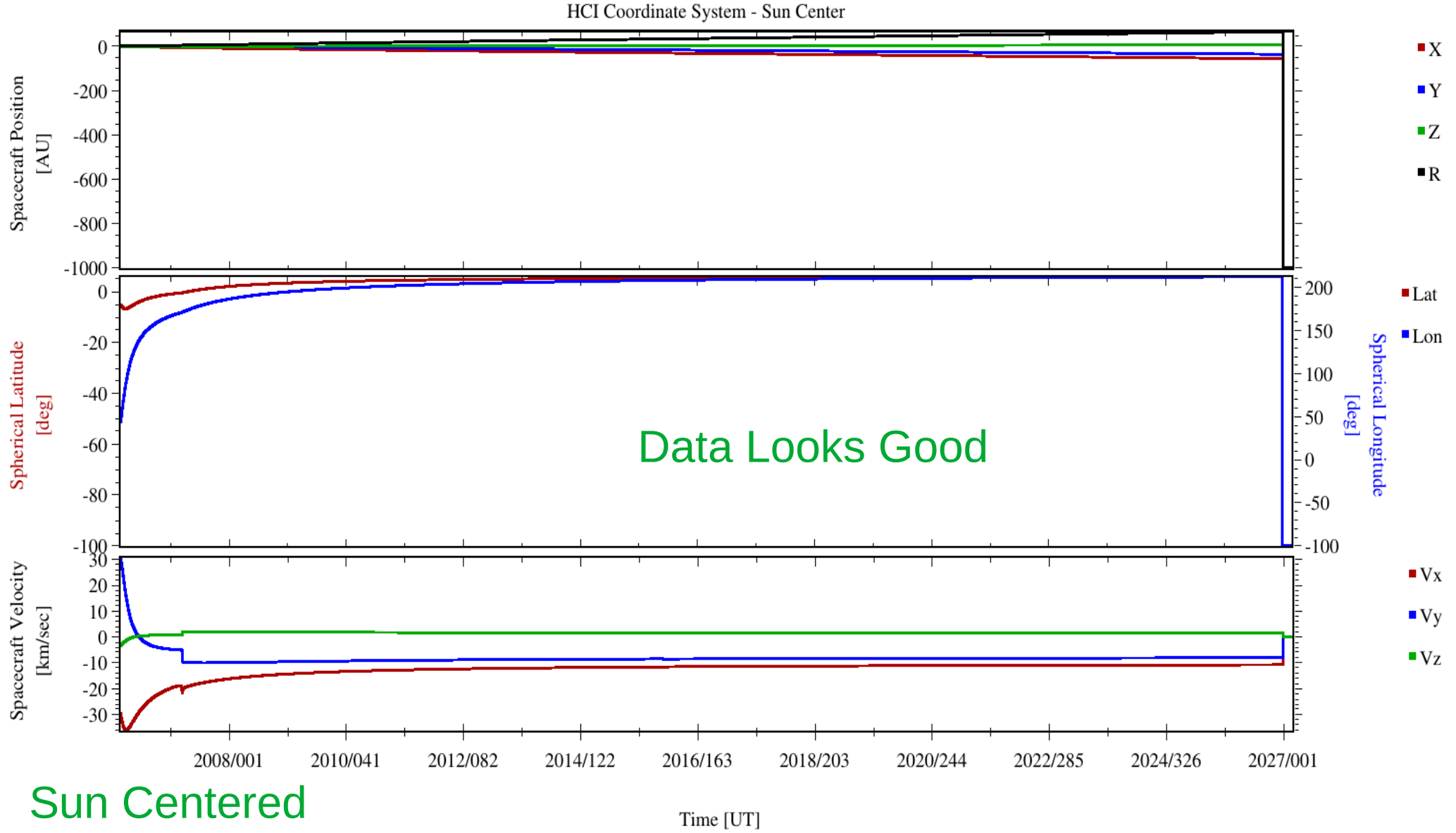
nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
traj/traj.fmt

GOOD

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
traj/traj_2006_2027_1d.lbl

GOOD

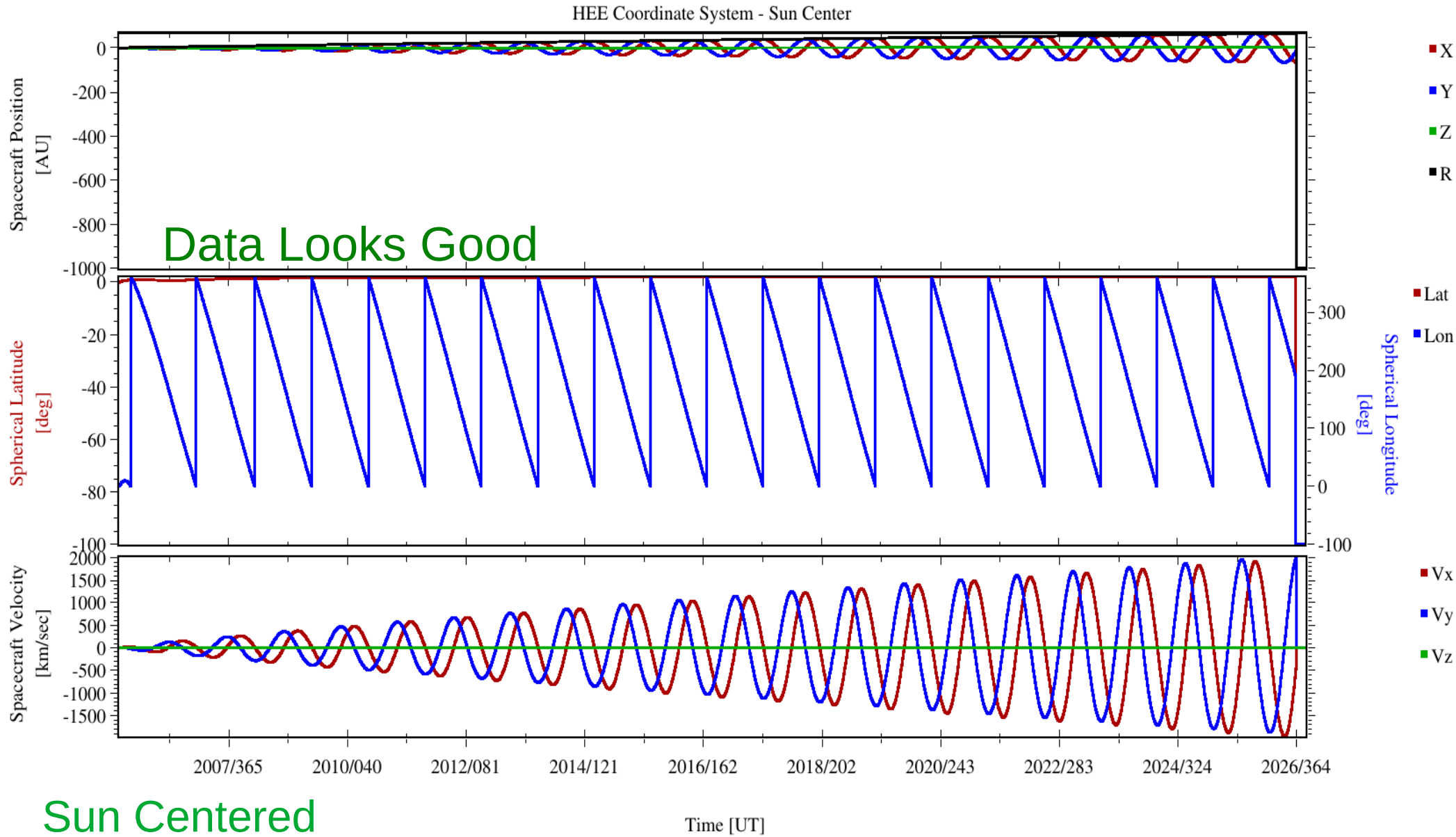
nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
traj/traj_2006_2027_1d.tab - HCI



Sun Centered

Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Wed Jan 12 21:01:14 2022.

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
traj/traj_2006_2027_1d.tab - HEE



Sun Centered

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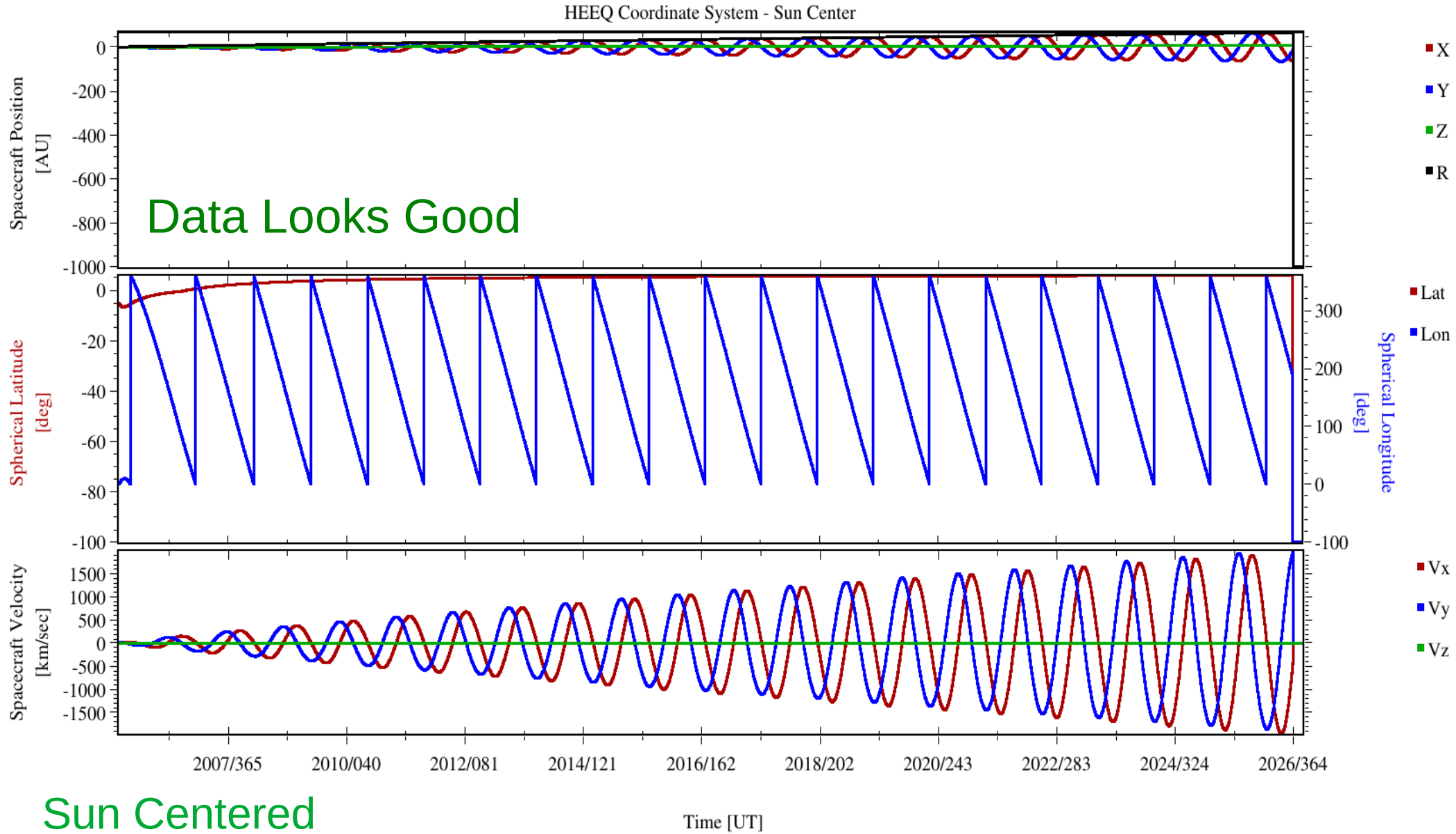
traj/traj_2006_2027_1d.tab - HEEQ



Sun Centered

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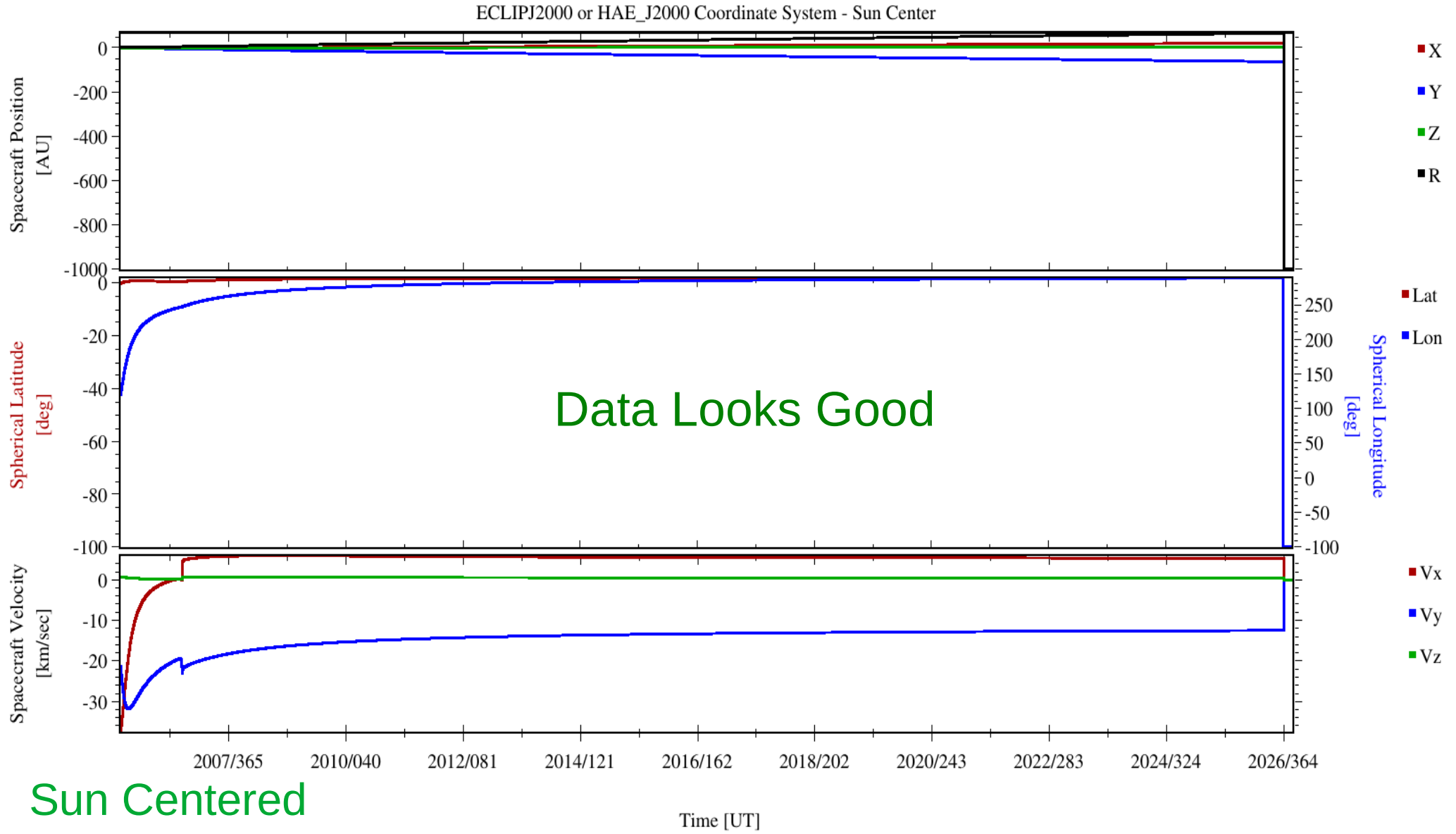
traj/traj_2006_2027_1d.tab - ECLIPJ2000



Sun Centered

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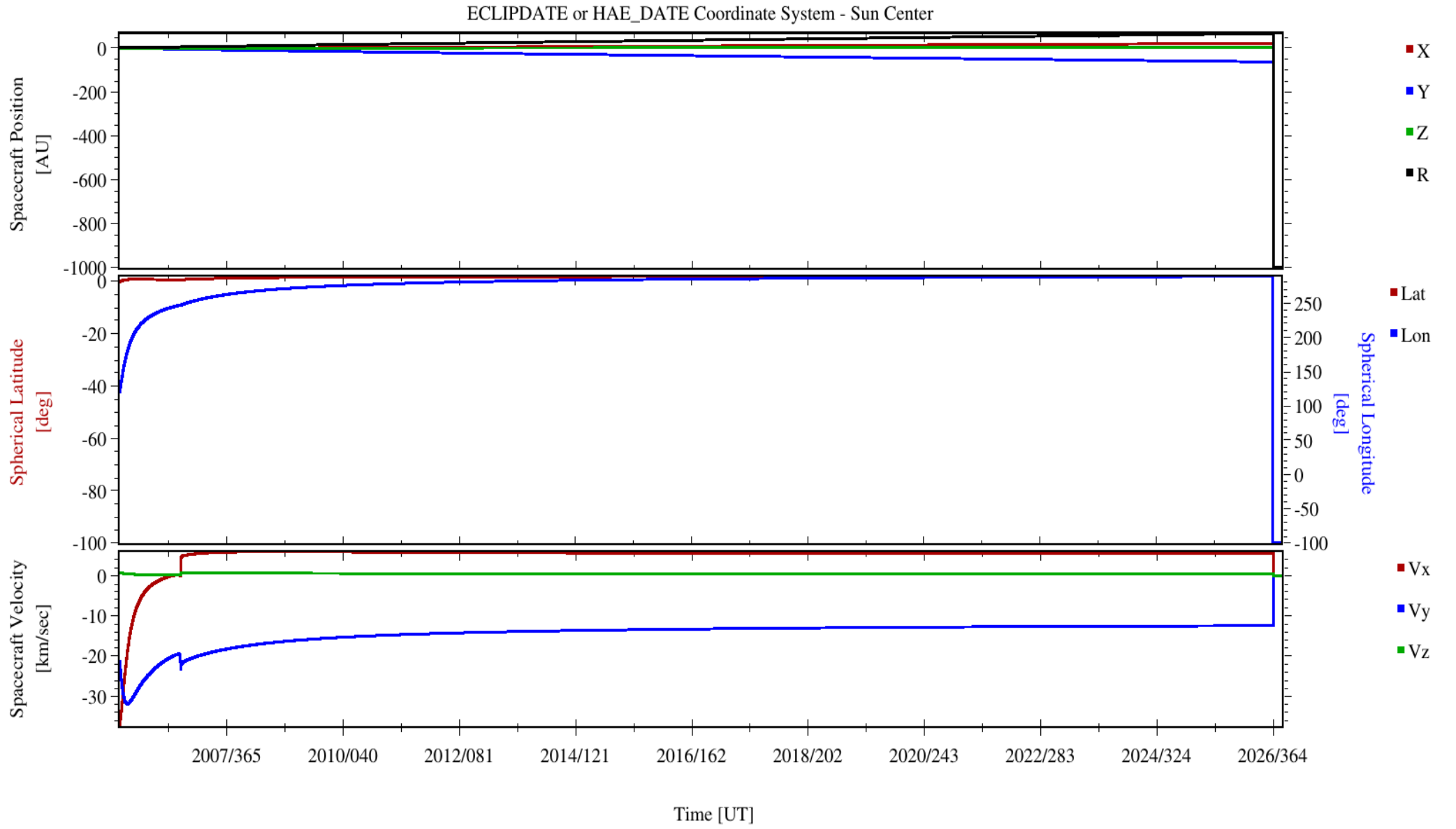
nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
traj/traj_2006_2027_1d.tab - ECLIPDATE



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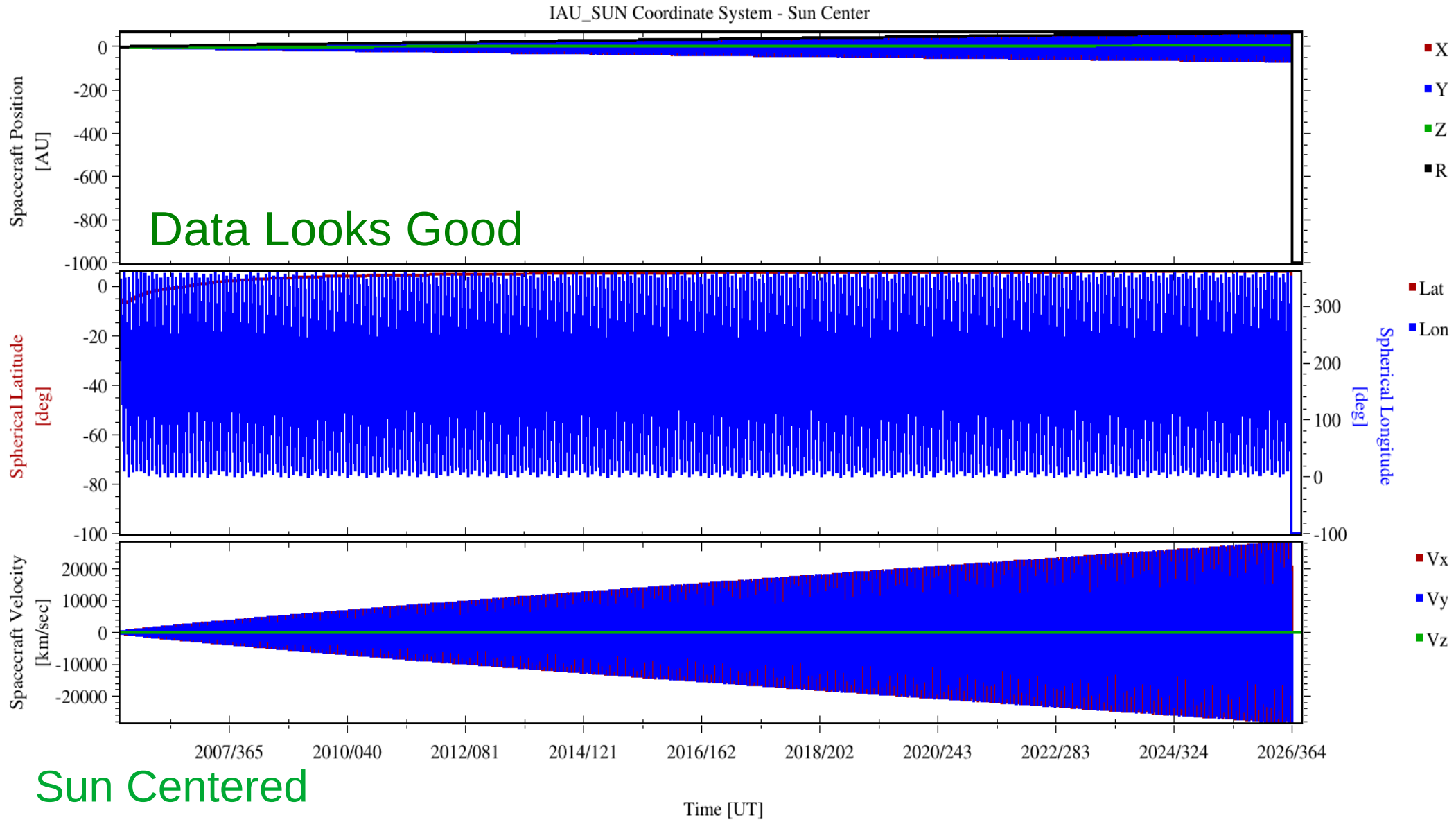
traj/traj_2006_2027_1d.tab - IAU_SUN



Sun Centered

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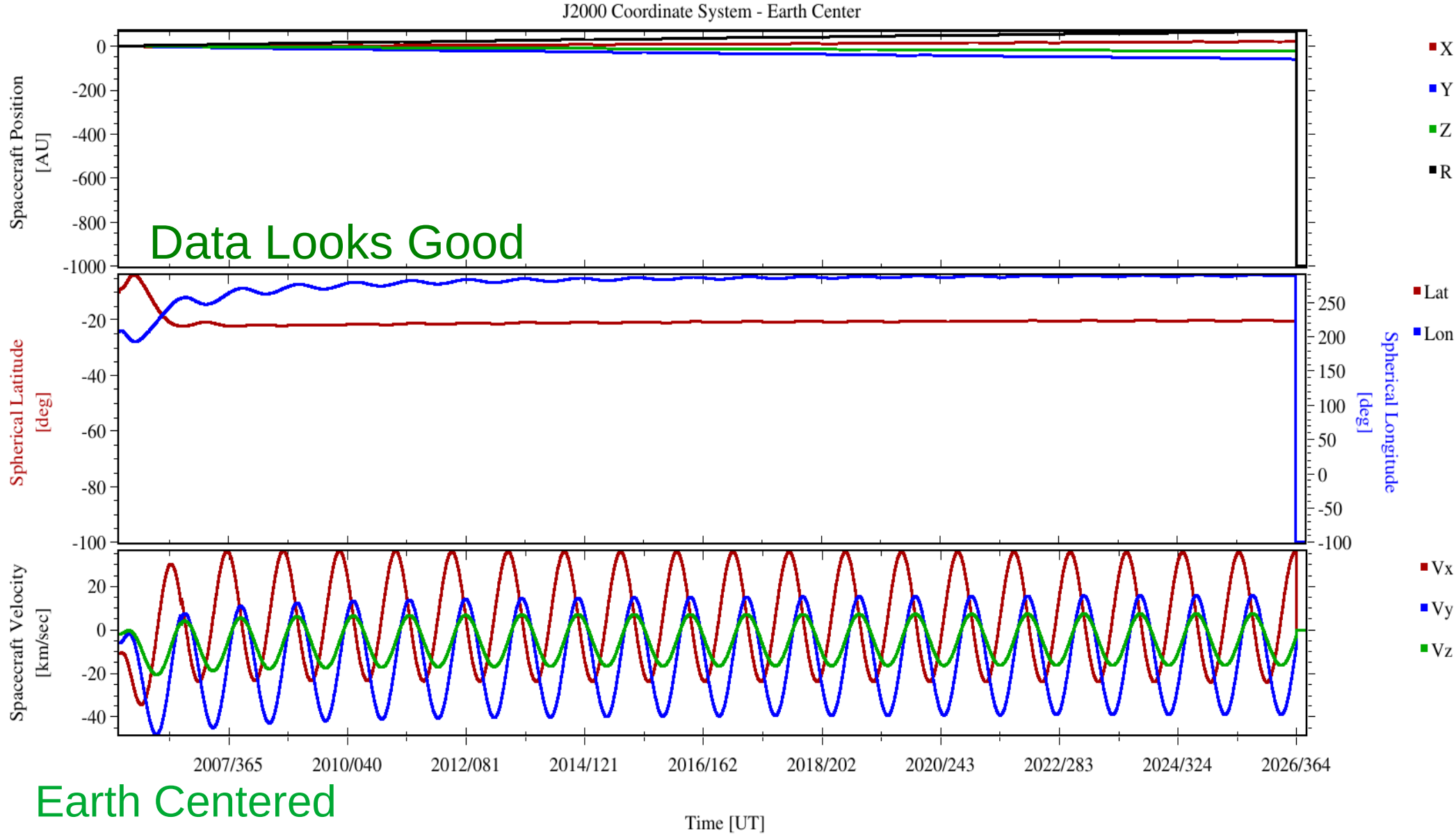
traj/traj_2006_2027_1d.tab - J2000



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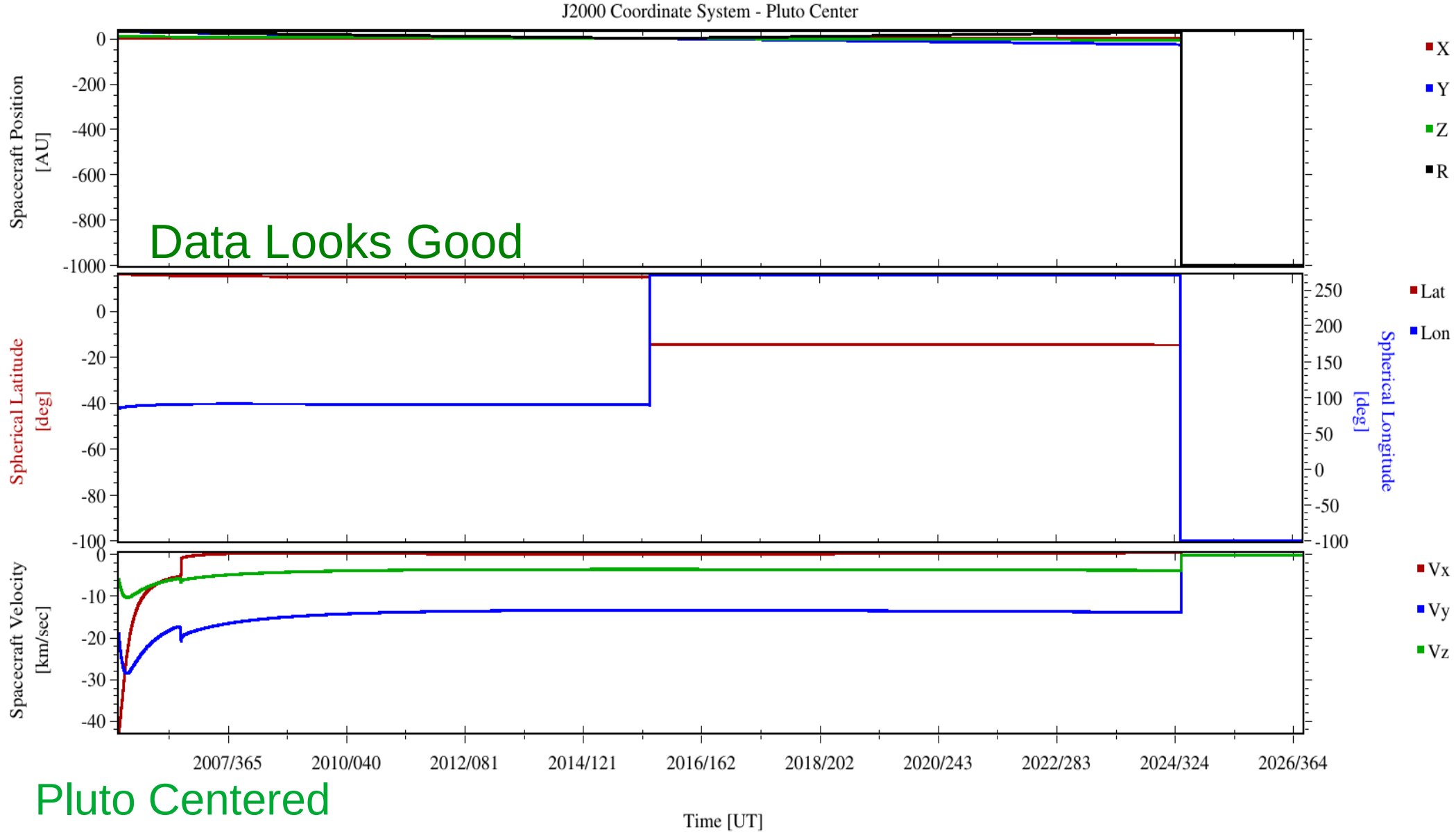
nh-a-swap-3-kem1-v5.0/document
traj/traj_2006_2027_1d.tab - J2000



Pluto Centered

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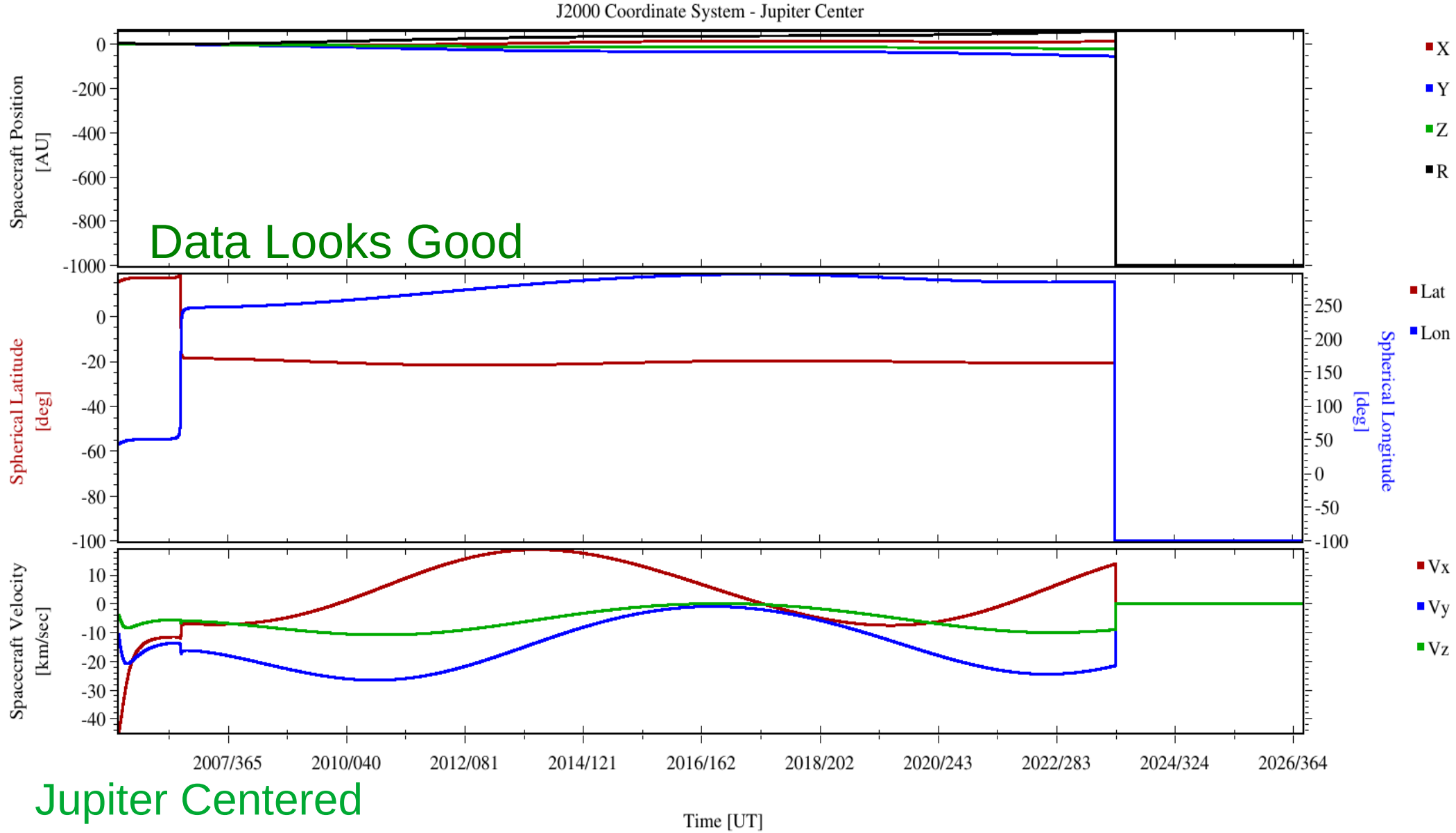
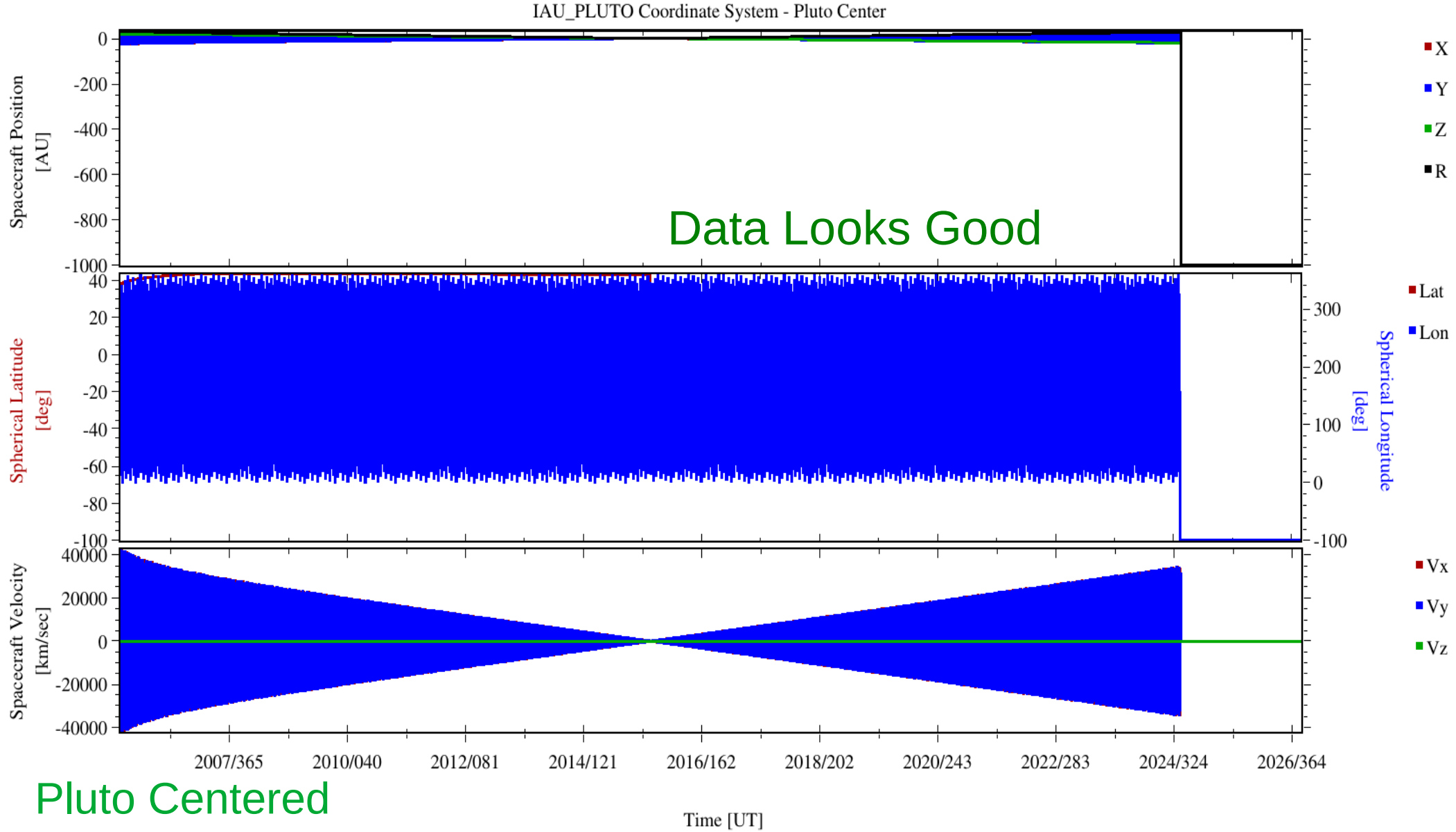
nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
traj/traj_2006_2027_1d.tab - J2000



Jupiter Centered

Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Wed Jan 12 21:03:49 2022.

nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
traj/traj_2006_2027_1d.tab - IAU_PLUTO



Pluto Centered

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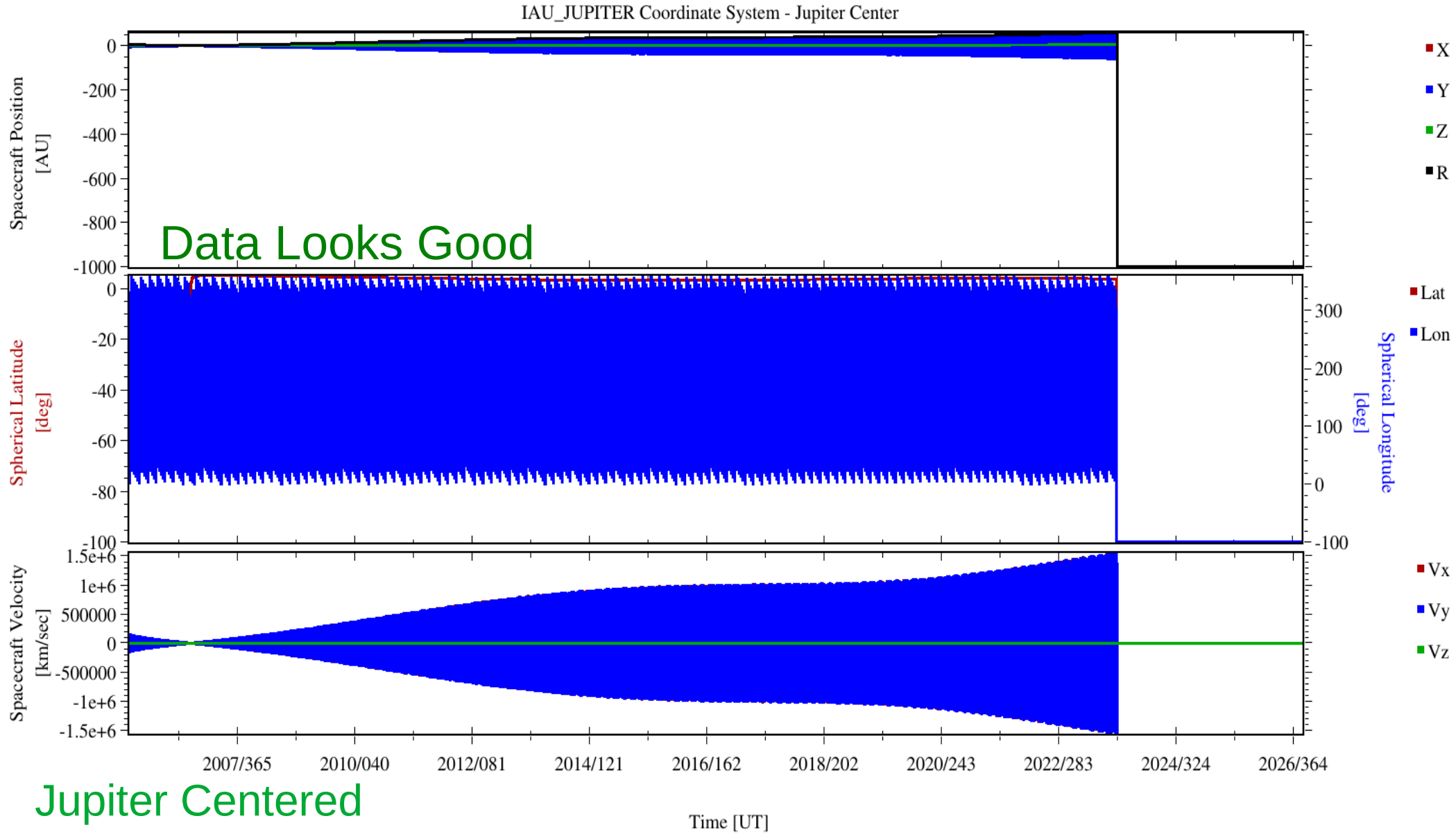
nh-a-swap-2-kem1-v5.0/document
nh-a-swap-3-kem1-v5.0/document
traj/traj_2006_2027_1d.tab - IAU_JUPITER



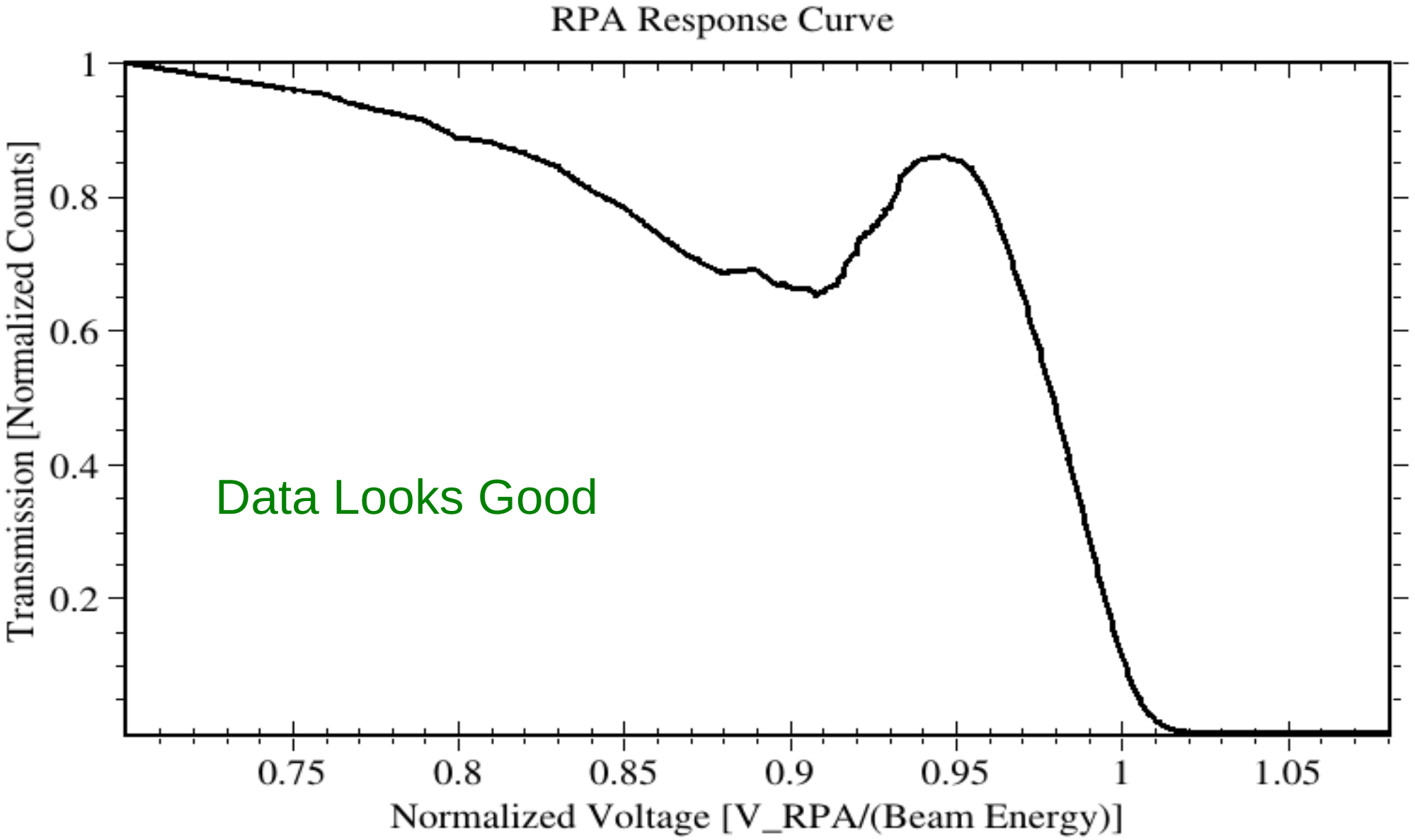
nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
calinfo.txt

GOOD

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
rpa_shape.lbl

GOOD

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
rpa_shape.tab



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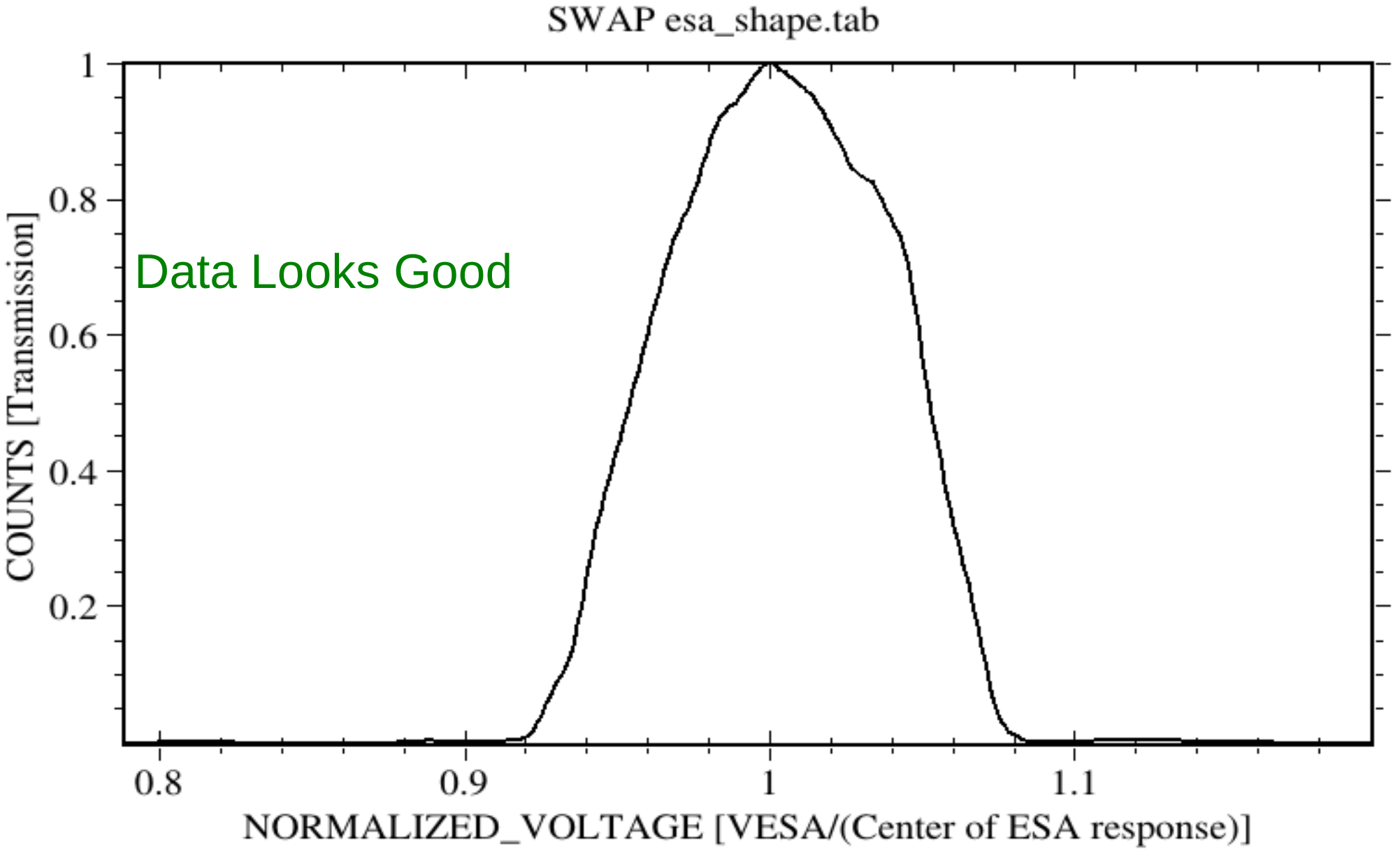
nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_shape.lbl

GOOD

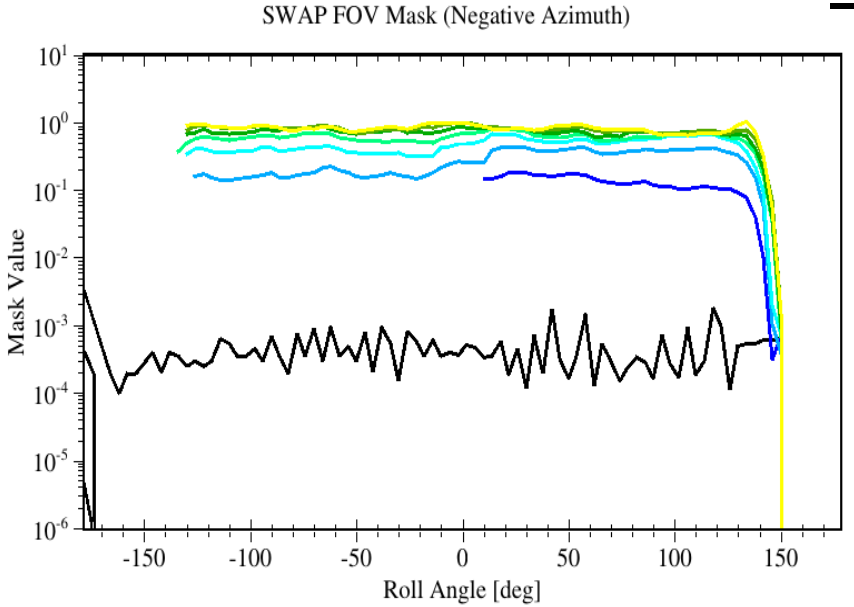
nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_shape.tab

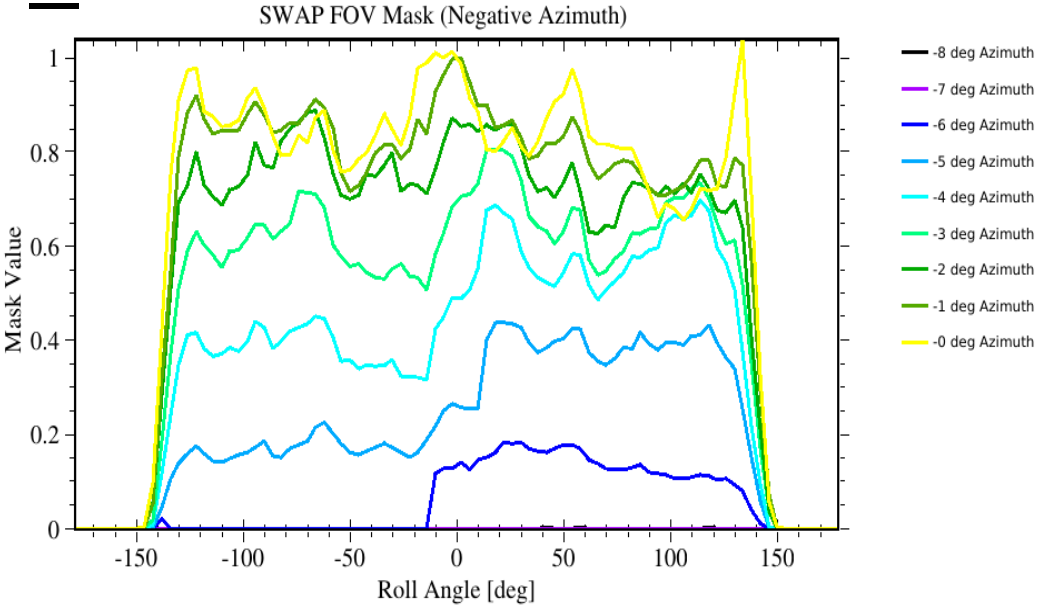


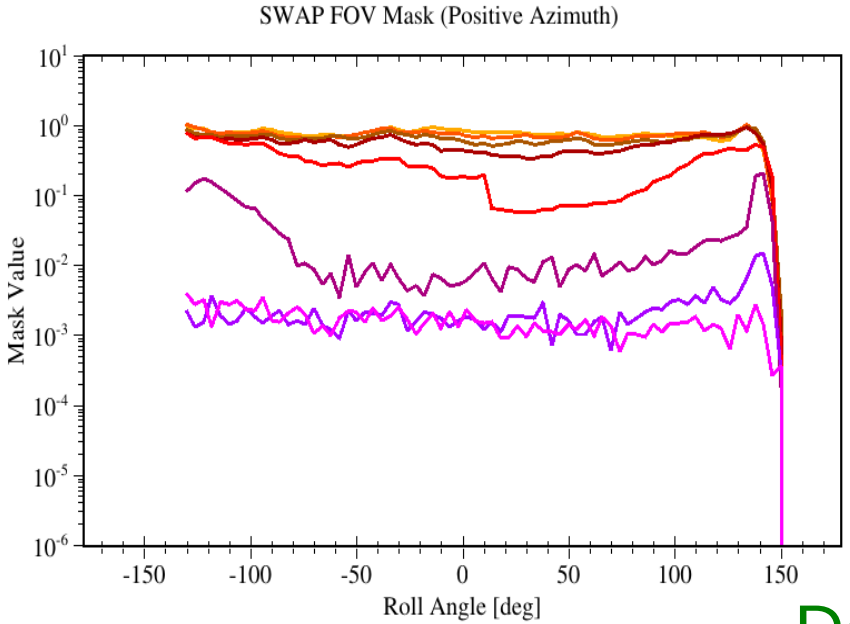
nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
fov_mask_2d.lbl

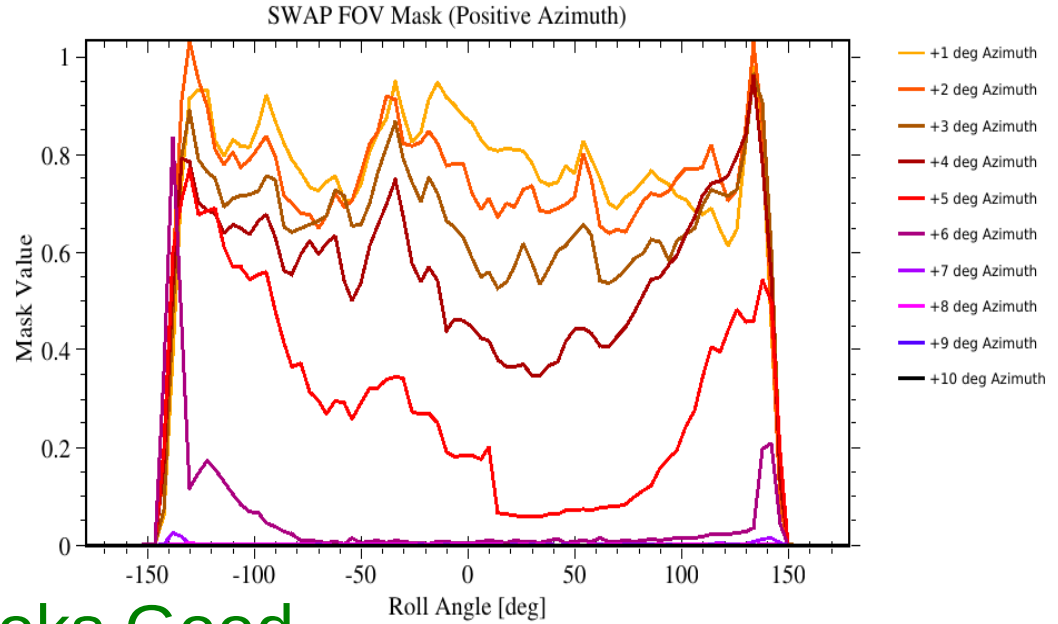
GOOD

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
fov_mask_2d.tab









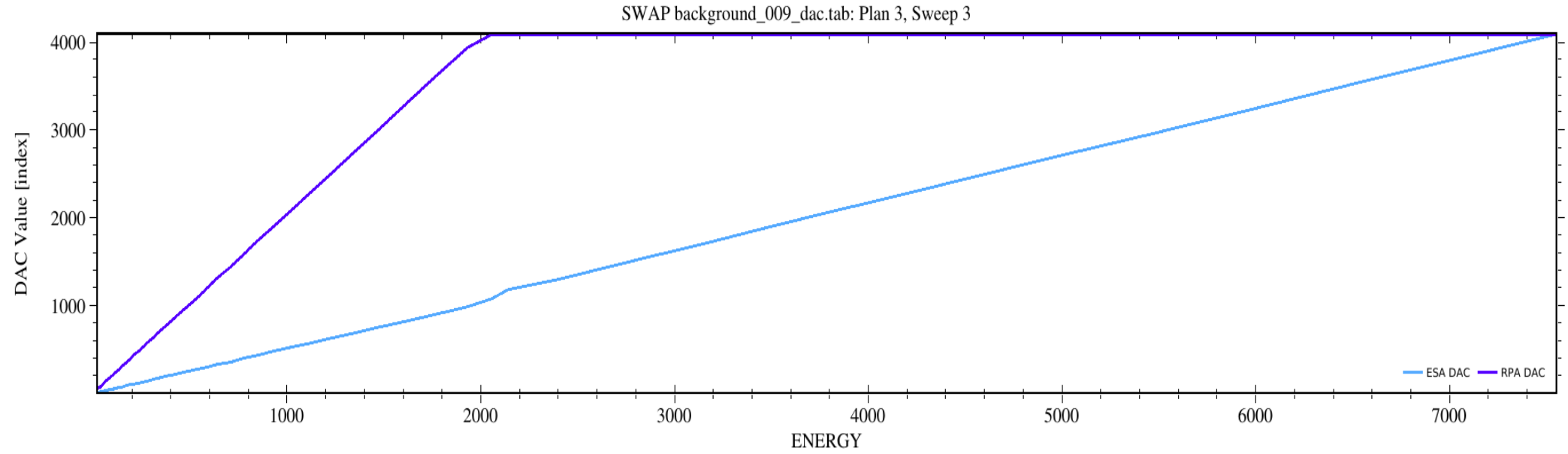
Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Wed Jan 12 17:15:50 2022.

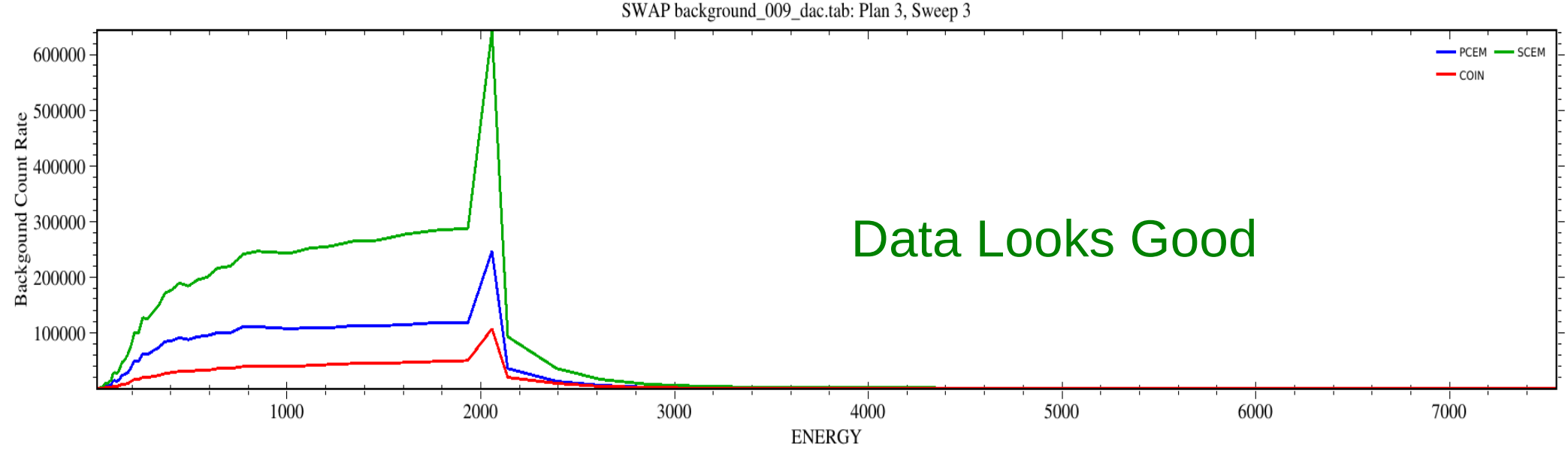
Data Looks Good

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
background_009_dac.lbl

GOOD

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
background_009_dac.tab





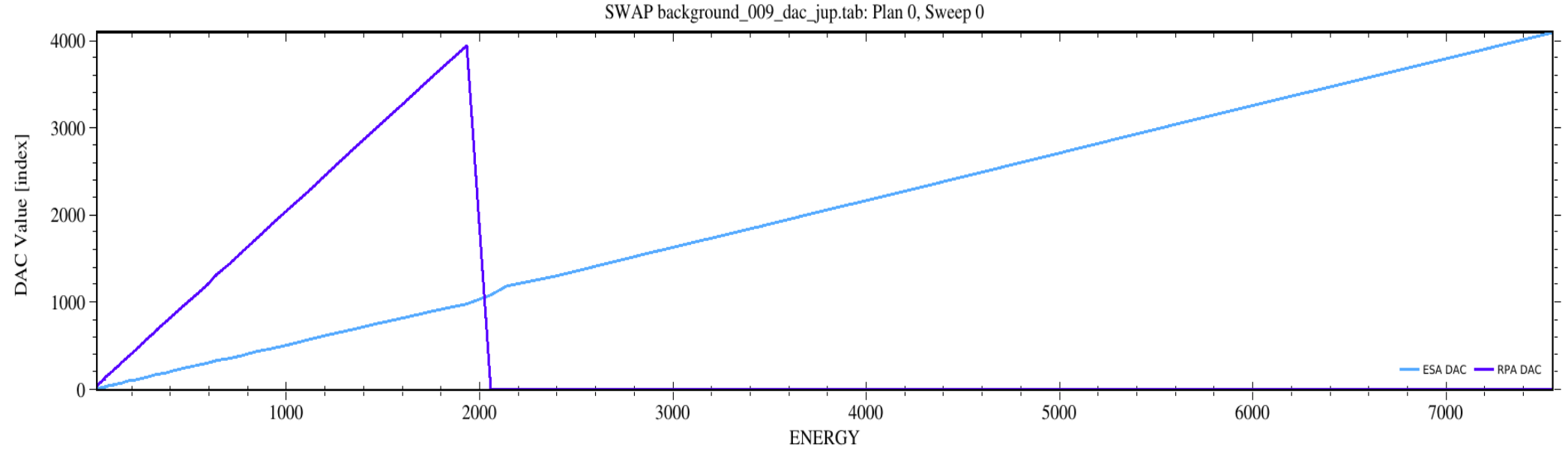
Data Looks Good

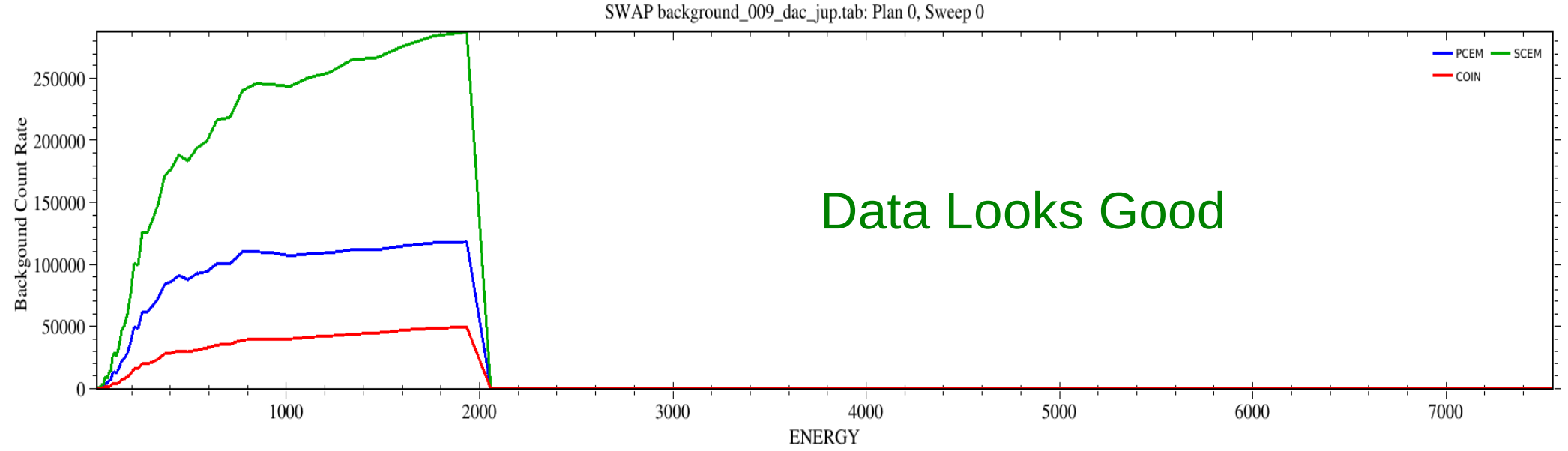
Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Wed Jan 12 16:45:17 2022.

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
background_009_dac_jup.lbl

GOOD

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
background_009_dac_jup.tab





Data Looks Good

Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Wed Jan 12 16:46:37 2022.

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nh-a-swap-3-kem1-v5.0/calib
list_energy_files.lbl & list_energy_files.tab

GOOD

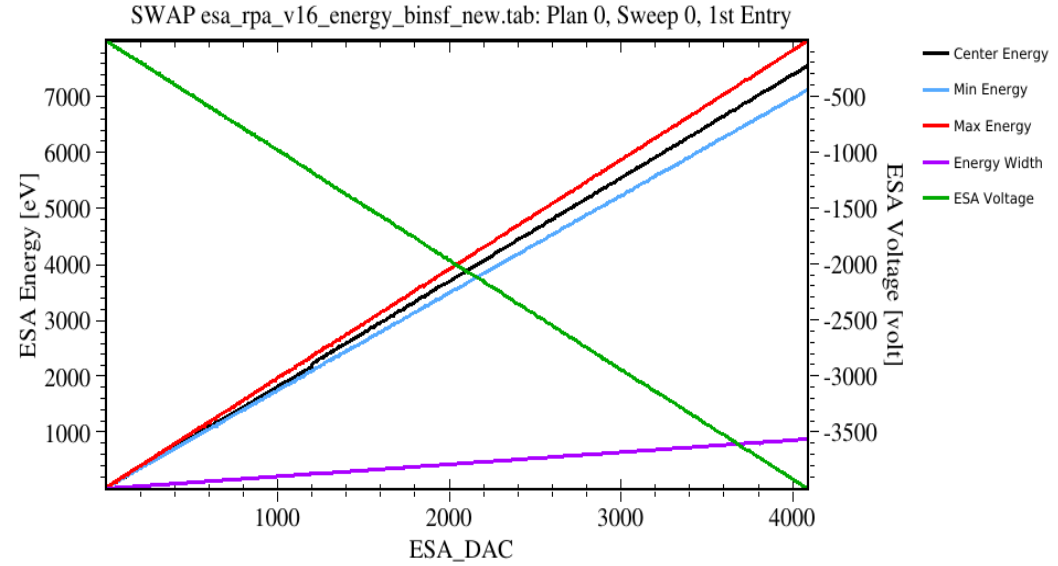
nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_rpa_v16_energy_binsf_new.lbl

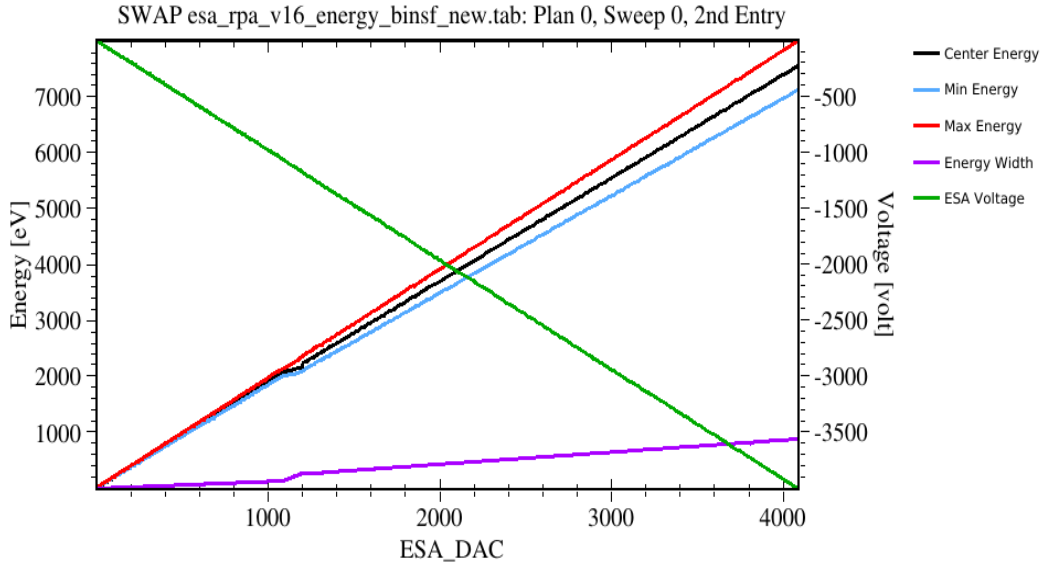
GOOD

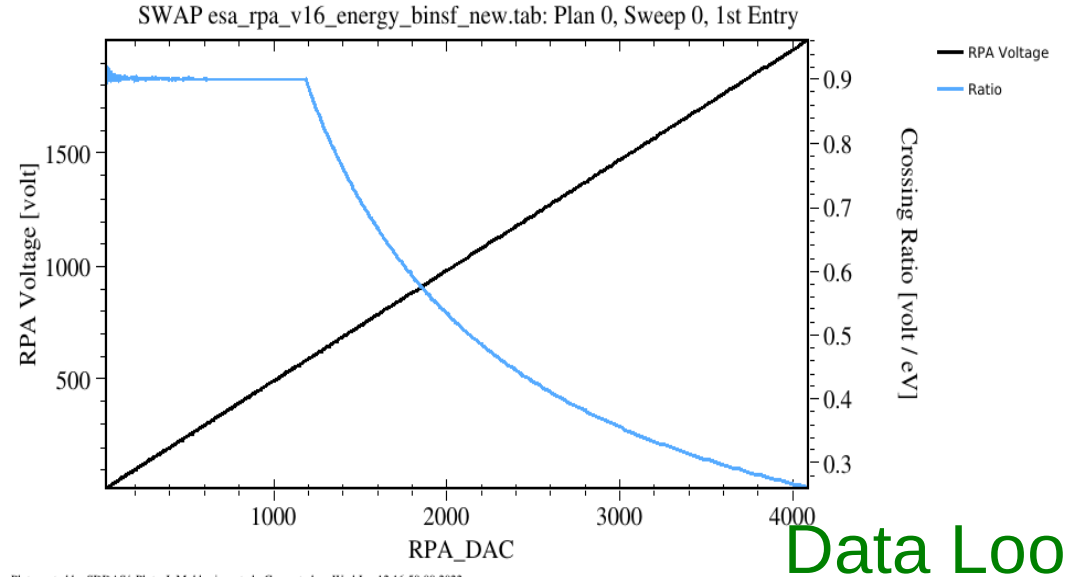
nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_rpa_v16_energy_binsf_new.lbl

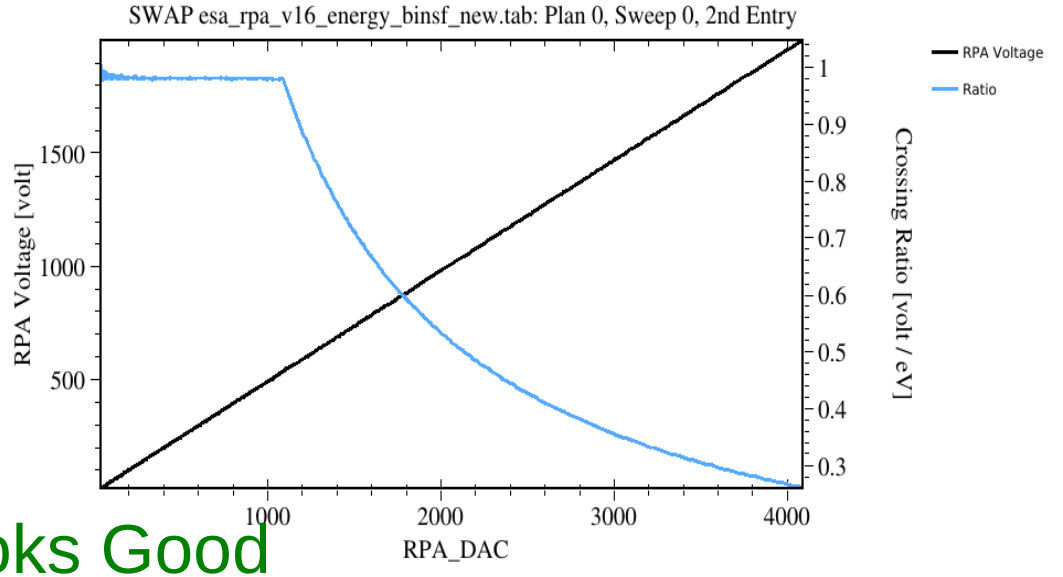
GOOD

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_rpa_v16_energy_binsf_new.tab









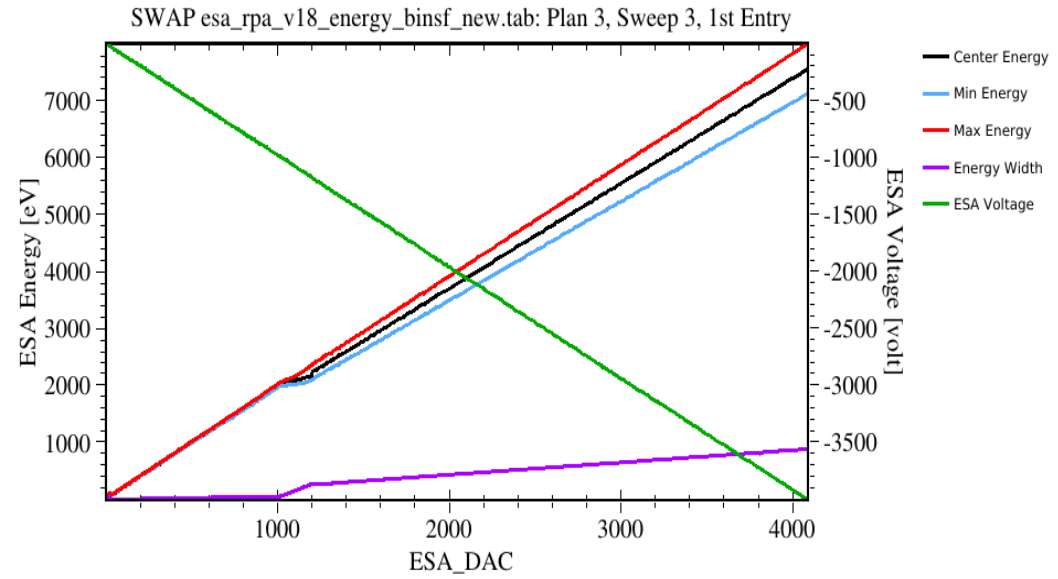
Data Looks Good

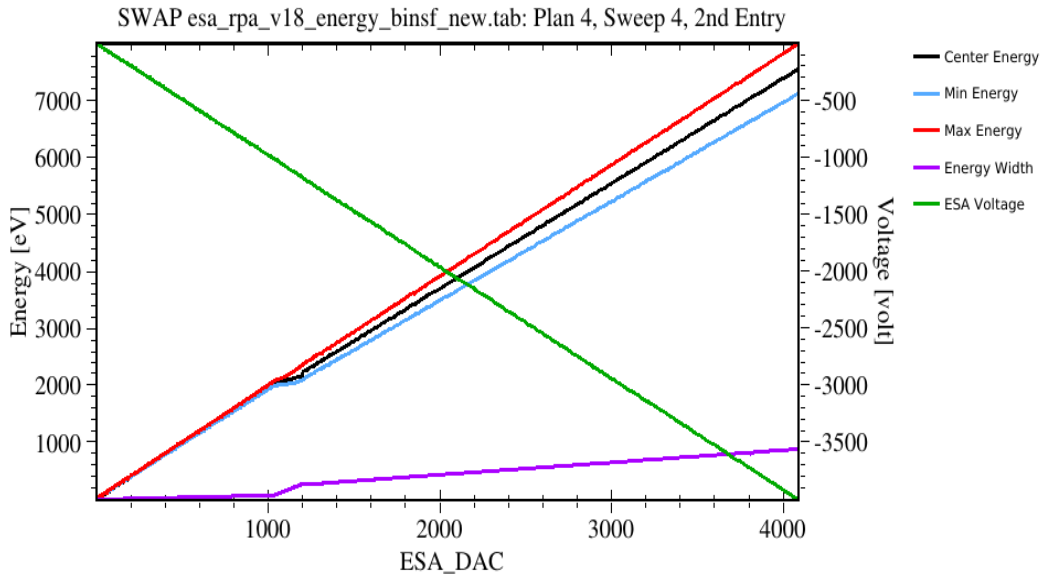
Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Wed Jan 12 16:58:08 2022.

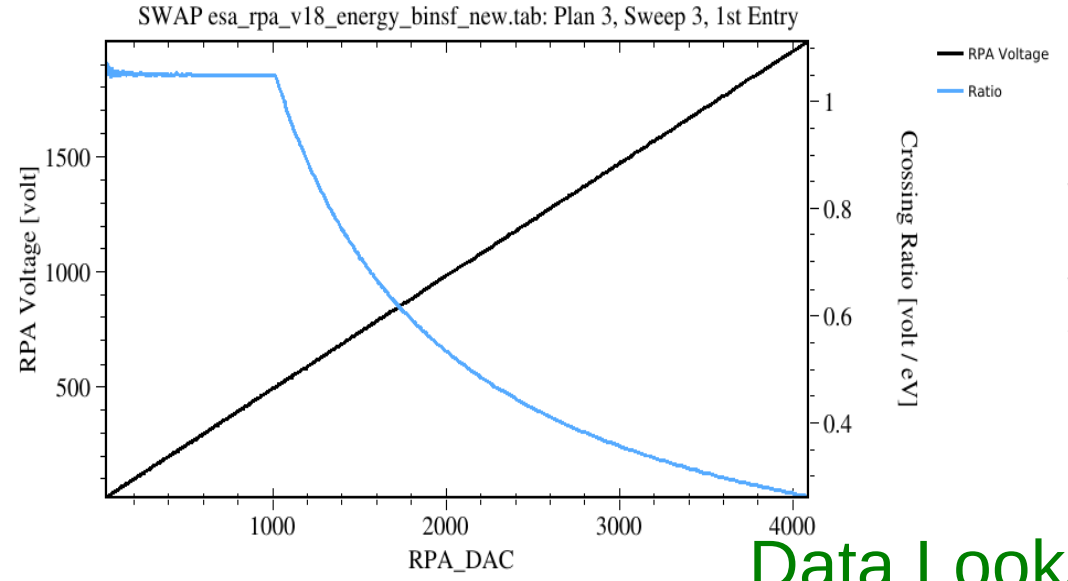
nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_rpa_v18_energy_binsf_new.lbl

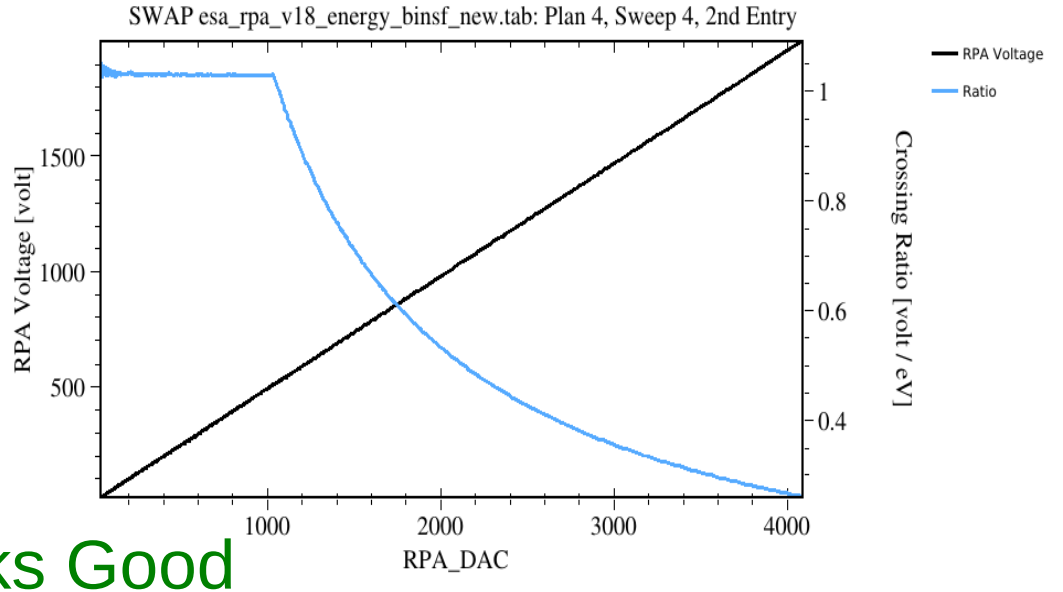
GOOD

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_rpa_v18_energy_binsf_new.tab









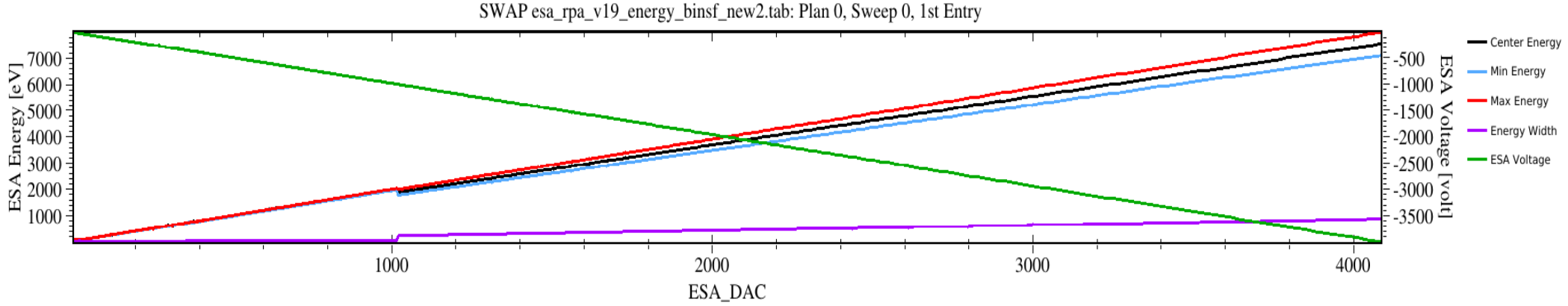
Data Looks Good

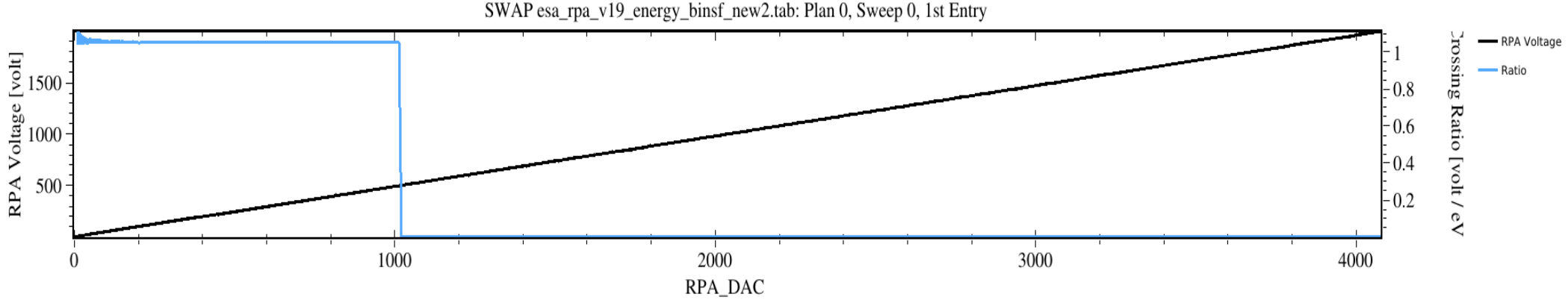
Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Wed Jan 12 16:58:56 2022.

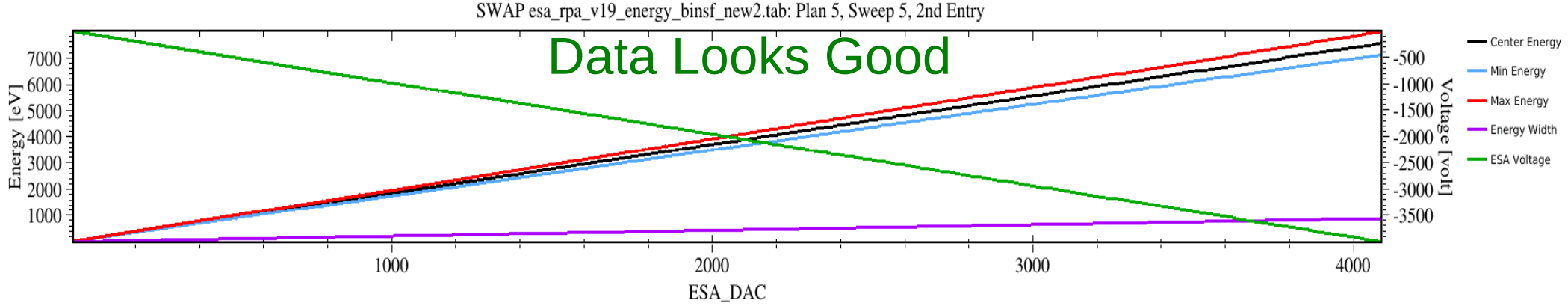
nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_rpa_v19_energy_binsf_new2.lbl

GOOD

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_rpa_v19_energy_binsf_new2.tab



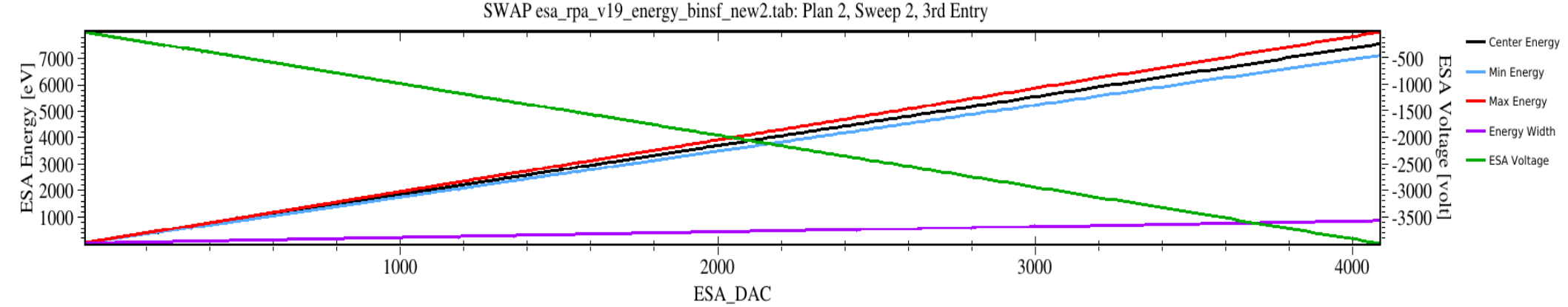


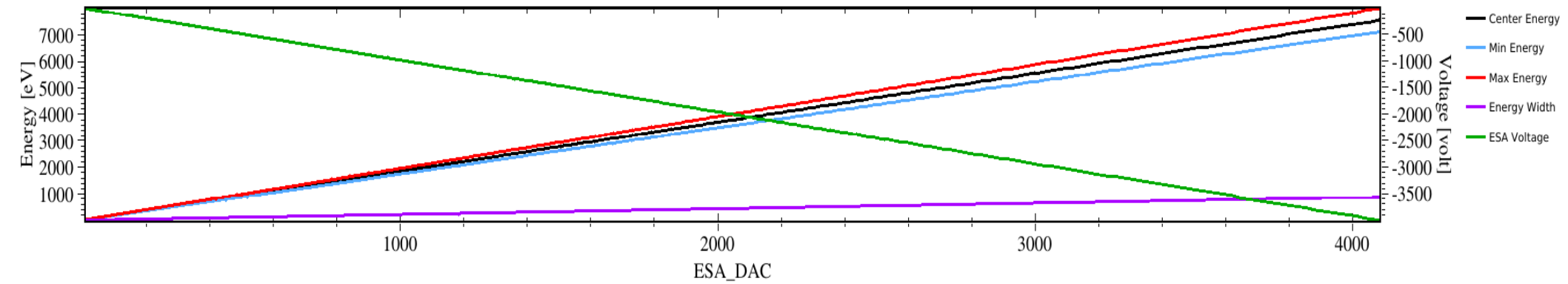


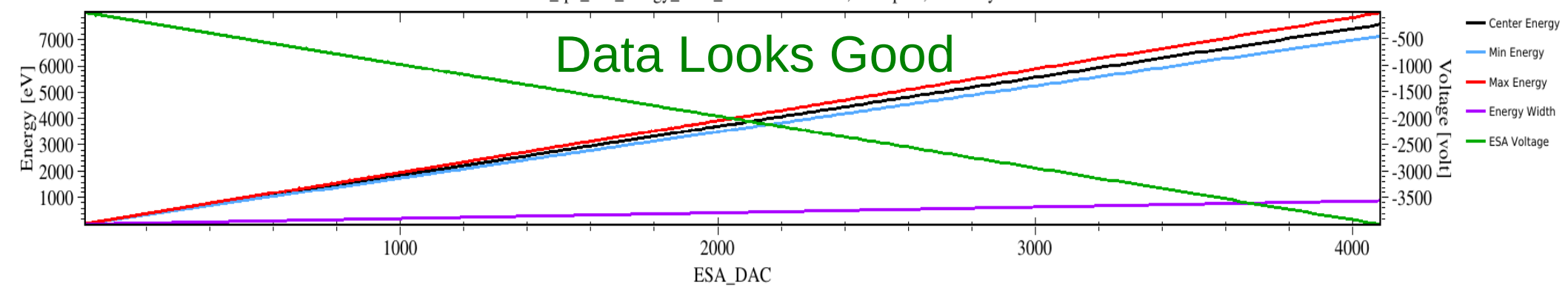
Data Looks Good

Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Wed Jan 12 17:00:00 2022.

nh-a-swap-2-kem1-v5.0/calib
nh-a-swap-3-kem1-v5.0/calib
esa_rpa_v19_energy_binsf_new2.tab







Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Wed Jan 12 17:00:53 2022.

nh-a-swap-2-kem1-v5.0/index
nh-a-swap-3-kem1-v5.0/index
indxinfo.txt

GOOD

nh-a-swap-2-kem1-v5.0/index
nh-a-swap-3-kem1-v5.0/index
index.lbl & index.tab

GOOD

nh-a-swap-2-kem1-v5.0/index
nh-a-swap-3-kem1-v5.0/index
slimindx.lbl & slimindx.tab

GOOD

nh-a-swap-2-kem1-v5.0/index
nh-a-swap-3-kem1-v5.0/index
checksum.lbl & checksum.tab

GOOD

SWAP RAW and CALIBRATED Data Evaluation

nh-a-swap-3-kem1-v5.0/data Histogram Data (0x586)

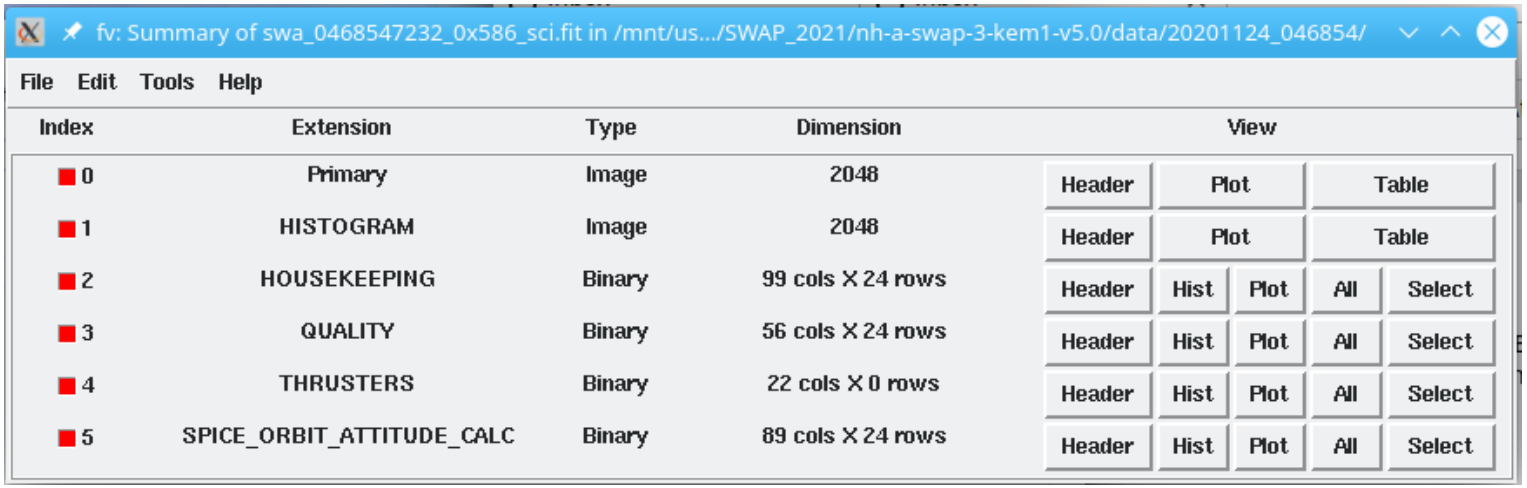
The following files would not process:

swa_0476064032_0x586_sci.fit
swa_0476068192_0x586_sci.fit
swa_0476150432_0x586_sci.fit
swa_0476236832_0x586_sci.fit
swa_0476323232_0x586_sci.fit
swa_0476409632_0x586_sci.fit
swa_0476496032_0x586_sci.fit

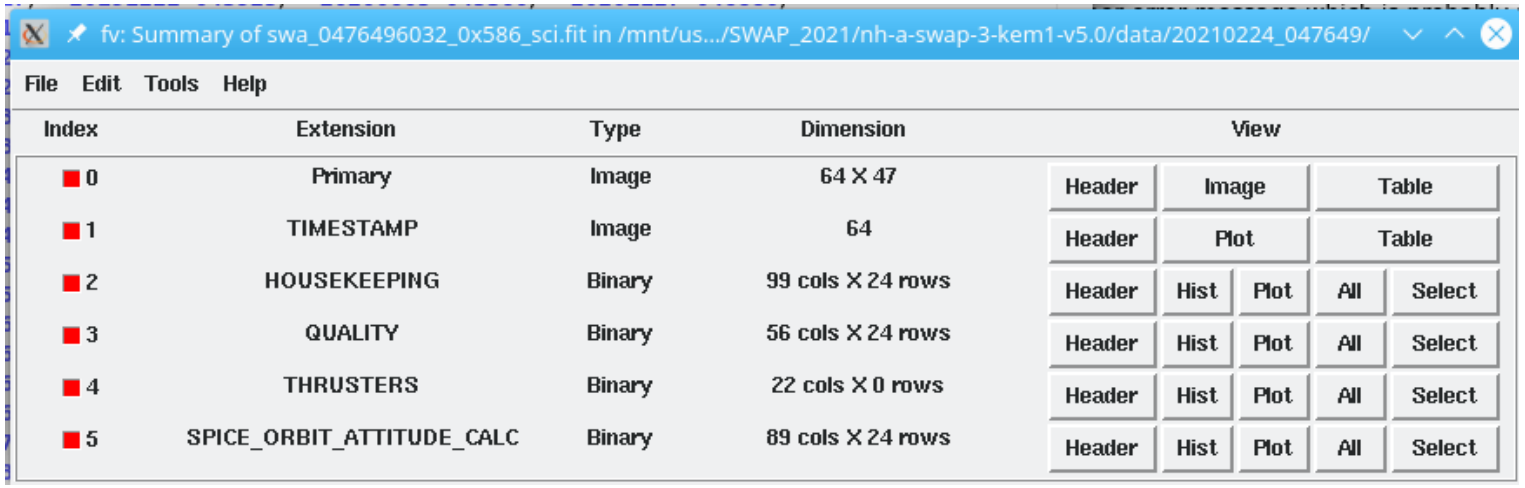
Examination showed that the fits file HDU is different than that described in the ICD. The format of these files are different from the rest of the Histogram fits files and disagree with the ICD. The label files which go along with the above data files appear to describe the format of the above data files. These files are the last 7 which appear within the data set.

nh-a-swap-3-kem1-v5.0/data Histogram Data (0x586)

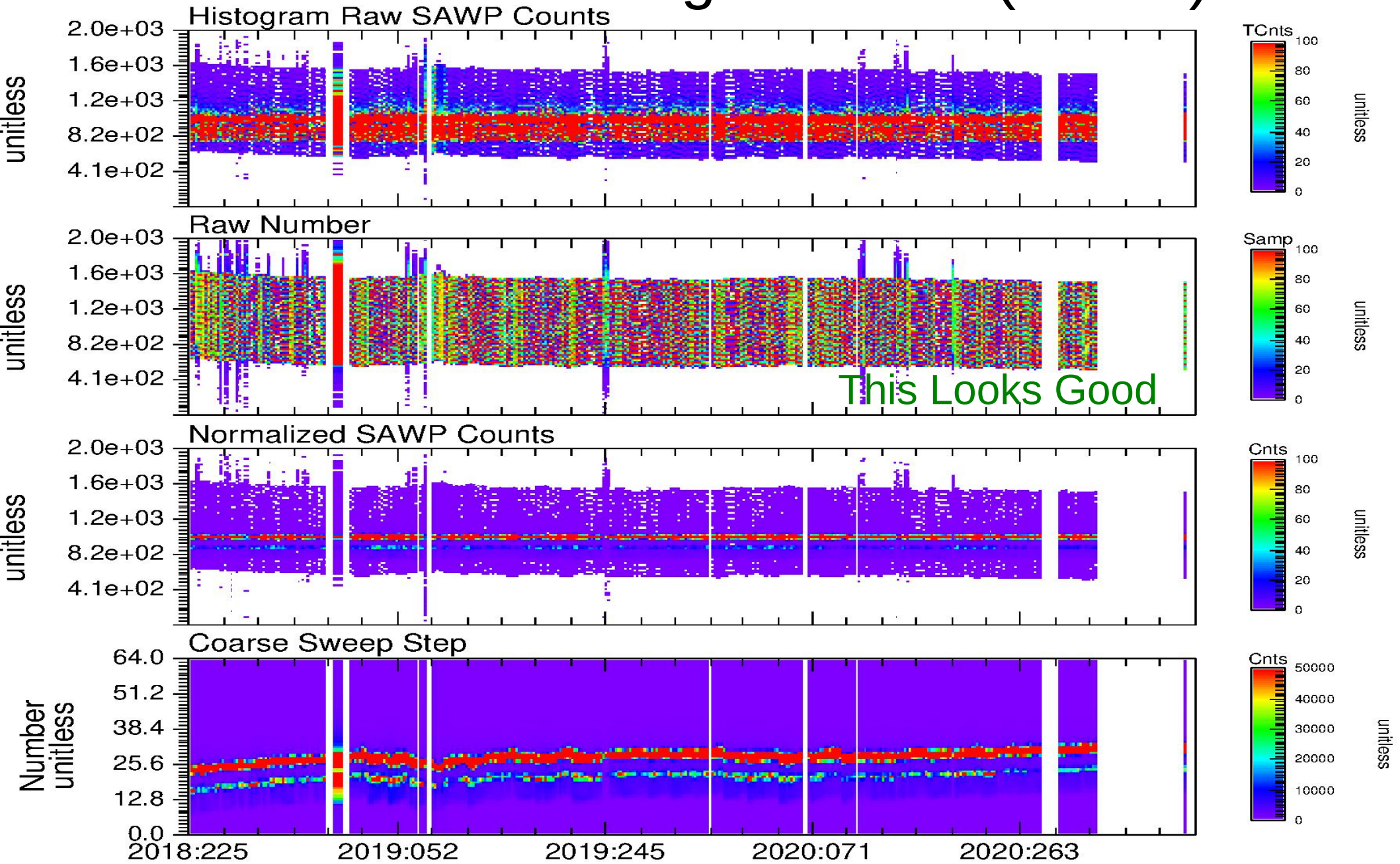
This is the normal fv layout for the Histogram data (0x586) as described in the ICD:



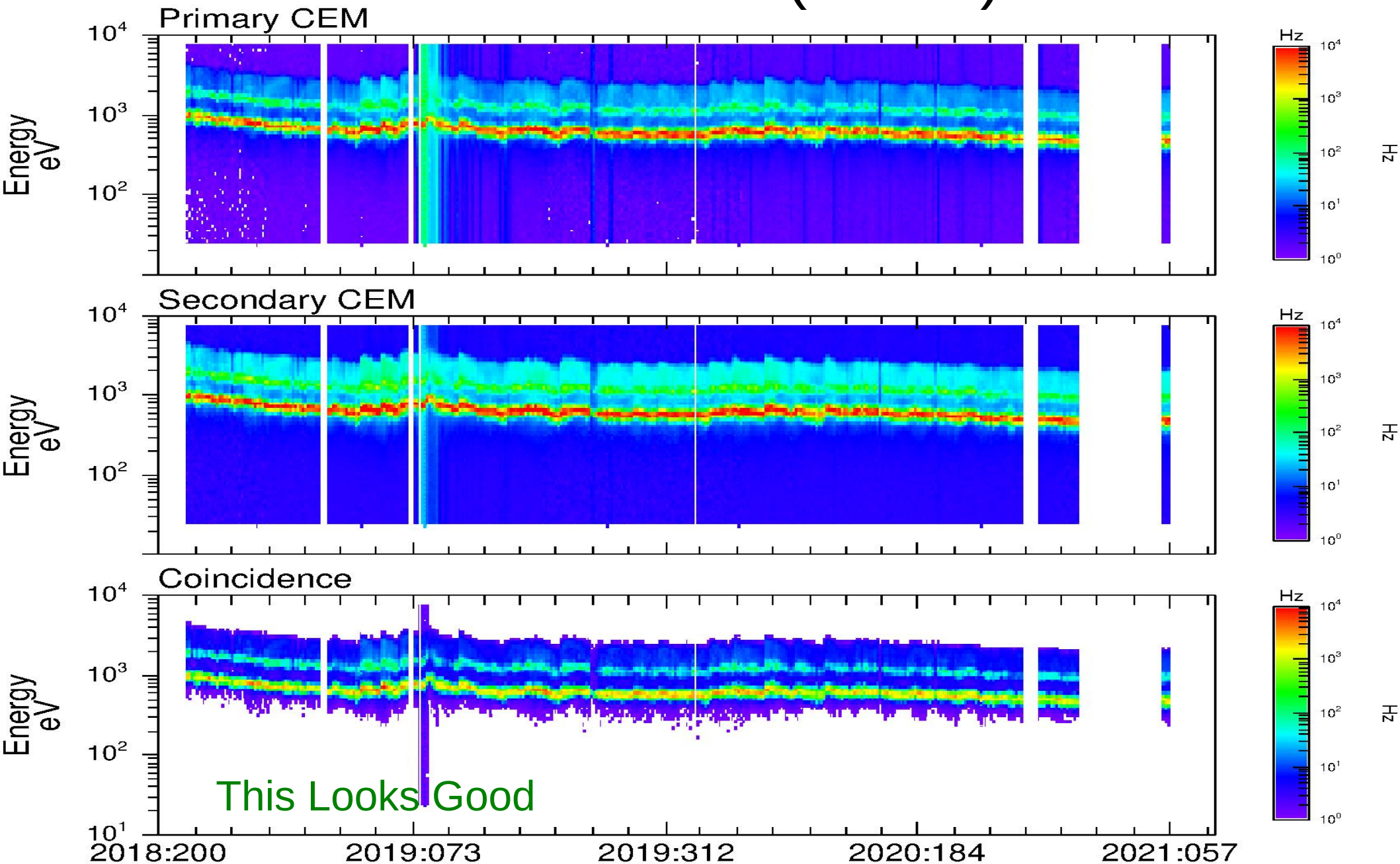
This is the fv layout of the 7 files from the previous page:



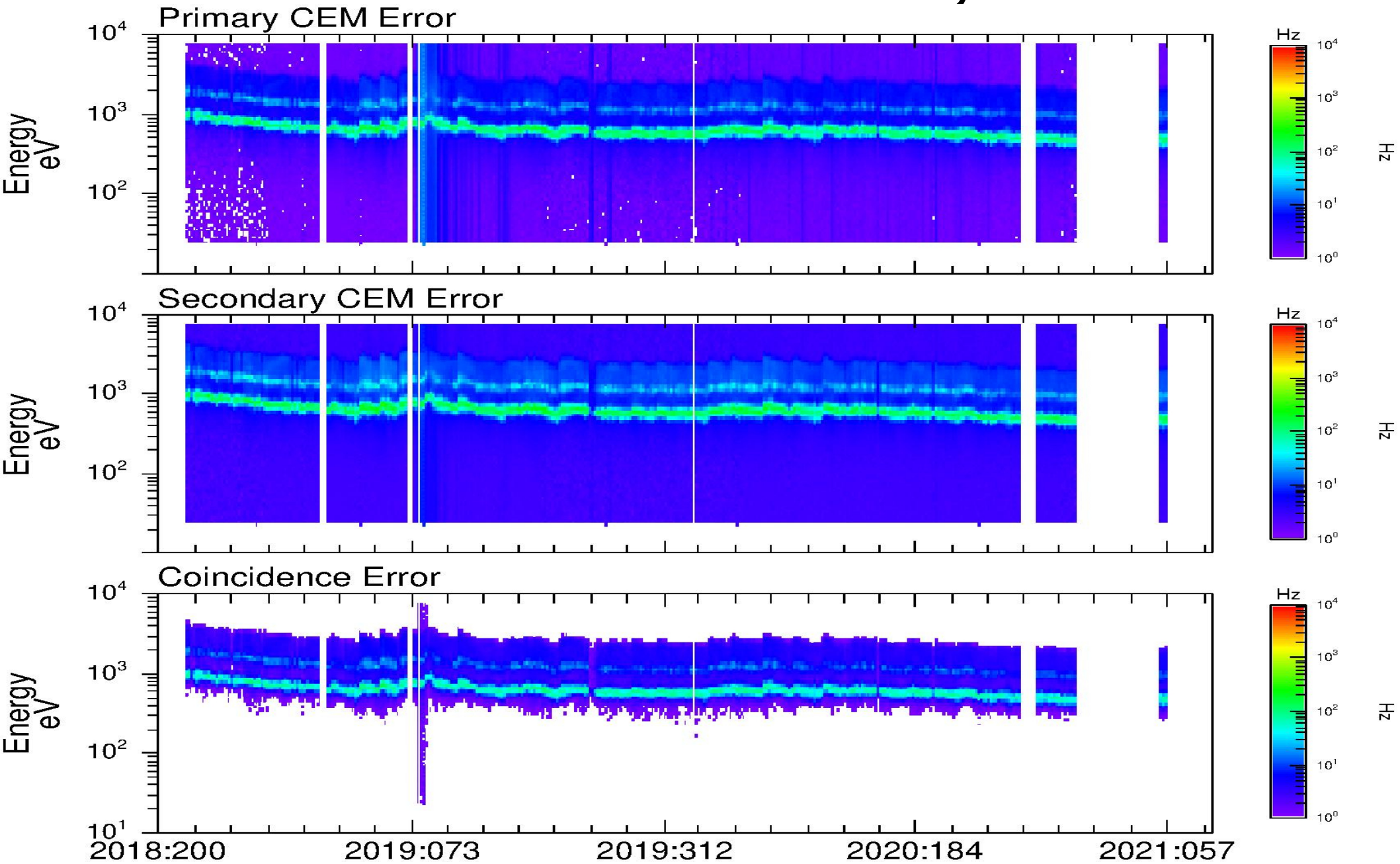
nh-a-swap-3-kem1-v5.0/data
Remainder of Histogram Data (0x586)



nh-a-swap-3-kem1-v5.0/data
Science Data (0x584)

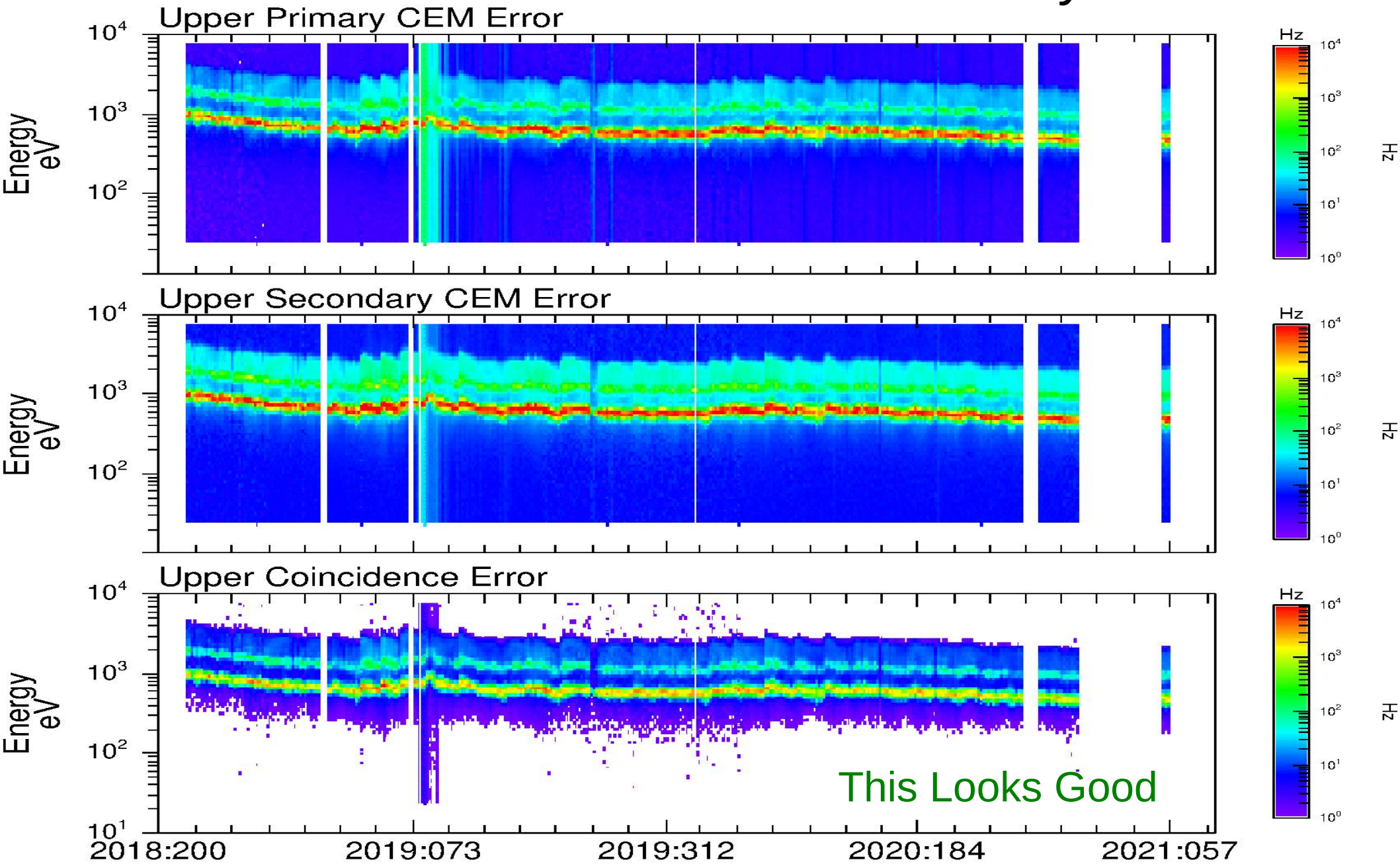


nh-a-swap-3-pluto-v5.0/data
Relative Uncertainty

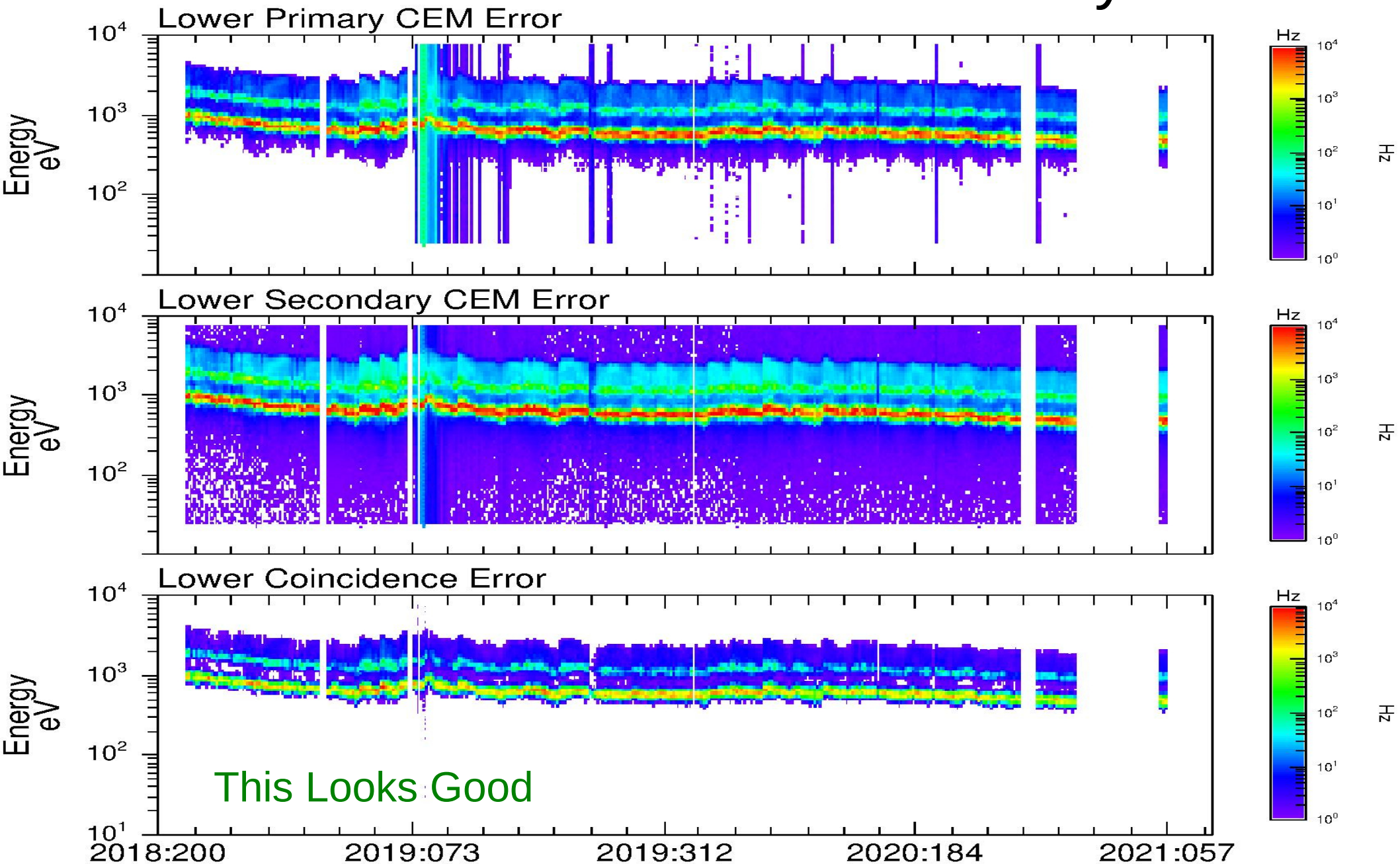


nh-a-swap-3-kem1-v5.0/data

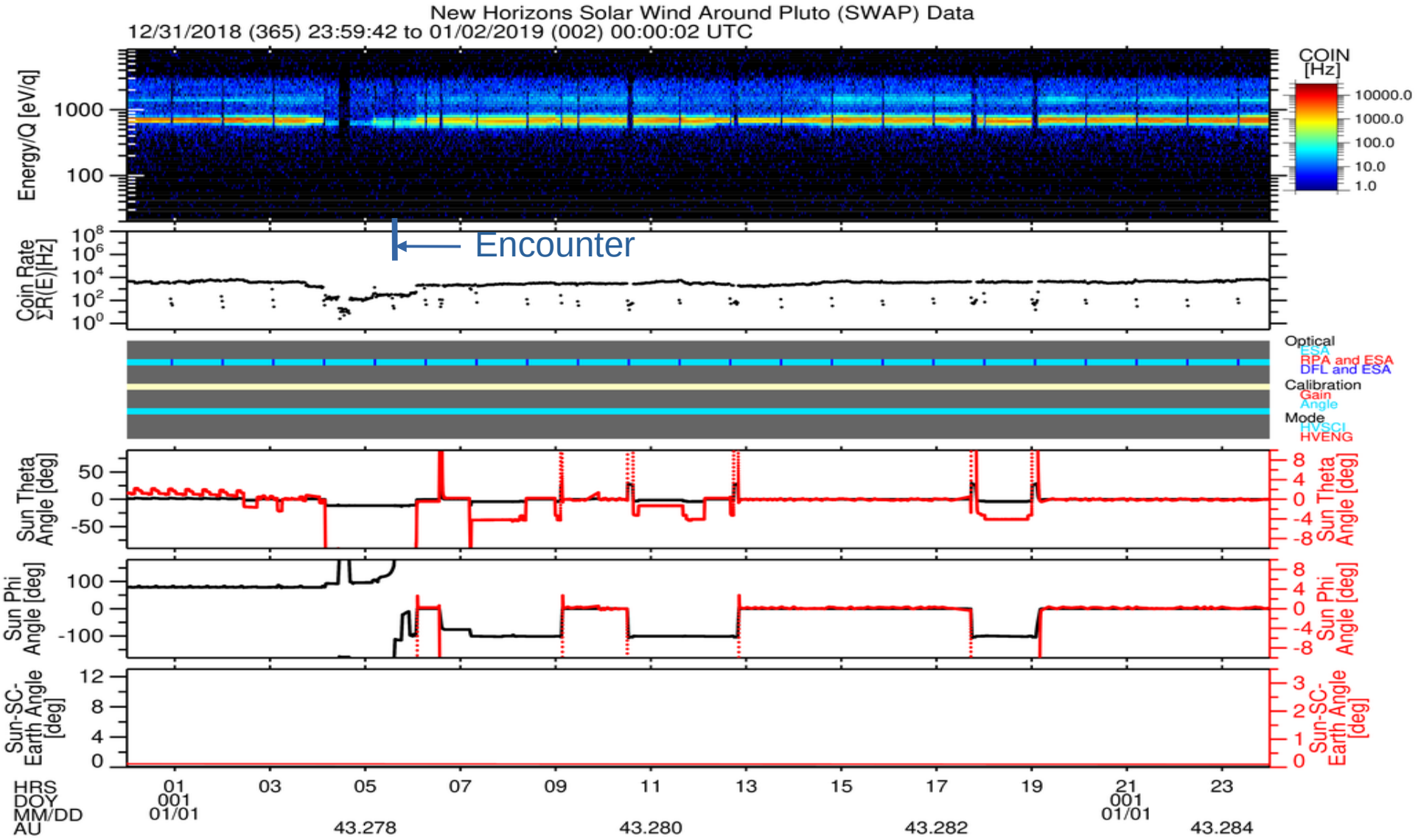
Absolute Maximum Uncertainty



nh-a-swap-3-kem1-v5.0/data
Absolute Minimum Uncertainty



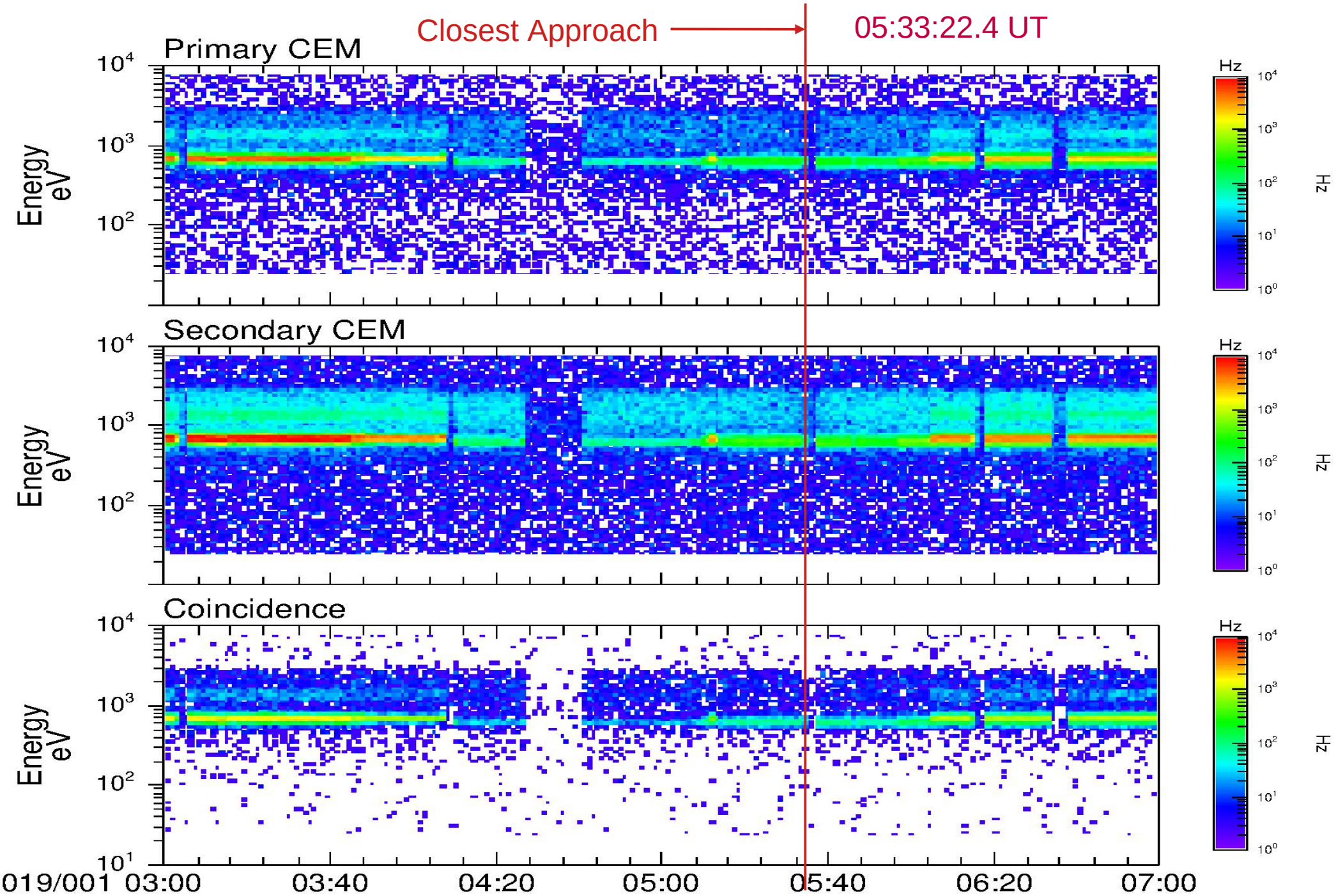
swap_001day_201812312359.png
Arrokoth Encounter



Software Version: ' 3.00000' Processed: 2020-08-08T05:04:05
Plot Created: Tue Aug 25 22:18:40 2020
Files: 0408585600_0x584_sci.fit to 0408758400_0x584_sci.fit

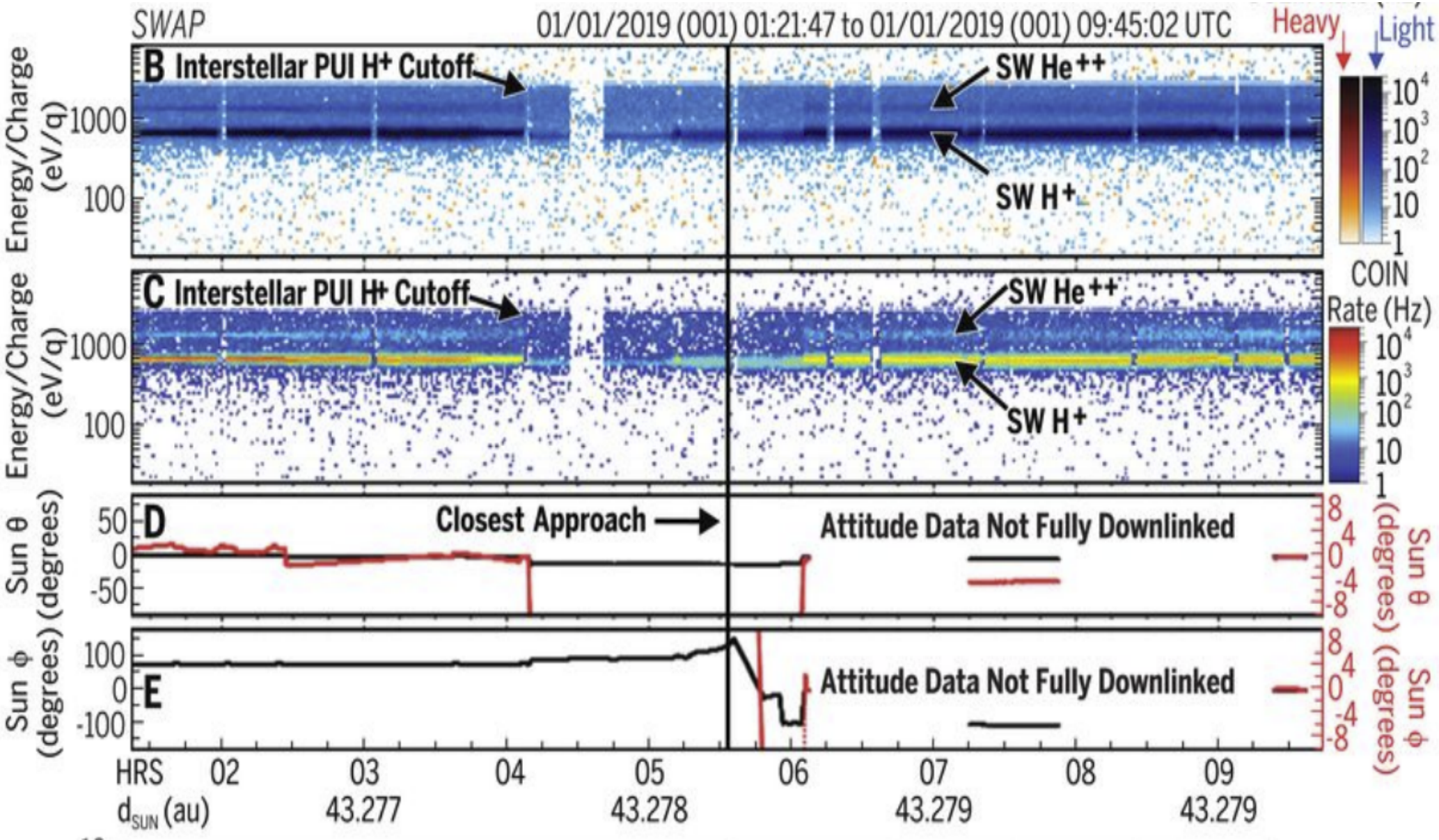
Spectrogram Timing Accurate to Within: 20.00 [sec]
Plot Width:: 0.754545 [norm]
Plot Width: 8.3000 [in]

Close-up of Arrokoth Encounter



Stern, S. A., et al., Initial results from the New Horizons exploration of 2014 MU69, a small Kuiper Belt object, Science 364, 2019. DOI: 10.1126/science.aaw9771

Closest Approach



Certification for nh-a-swap-2-kem1-v5.0 and nh-a-swap-3-kem1-v5.0

There are some minor documentation errors which need to be corrected before certification could be granted; however, the SWAP data for ApID 0x586 pose a more serious issue which require certification be withheld. The documentation describing the format for the last 7 data files is in conflict with the ICD and there is no indication of a format change.

Certification Remedies for nh-a-swap-2-kem1-v5.0 and nh-a-swap-3-kem1-v5.0

1) Update the ICD (and possibly swap.cat file) to describe the data format and relative information for ApID 0x586. Resubmit the archive and conduct a new data review, OR

2) Withdraw ApID 0x586 data, correct the documentation, and certify the data which remains. Then correct the documentation describing 0x586 data and conduct a new data review on ApID 0x586 data, OR

3) Remove the offending data files, fix the documentation issues, and the this generates a certifiable data set. The offending ApID 0x586 data files can be submitted with a new data set at a later date when the ICD and/or other documentation is updated.

SWAP DERIVED Documentation Evaluation

nh-x-swap-5-derived-solarwind-v2.0
aareadme.txt

Minor Correction Sent to PDS

nh-x-swap-5-derived-solarwind-v2.0
voldesc.cat

GOOD

nh-x-swap-5-derived-solarwind-v2.0
index/indxinfo.txt

GOOD

nh-x-swap-5-derived-solarwind-v2.0
index/index.lbl

GOOD

nh-x-swap-5-derived-solarwind-v2.0
index/index.tab

GOOD

nh-x-swap-5-derived-solarwind-v2.0
index/checksum.lbl

GOOD

nh-x-swap-5-derived-solarwind-v2.0
index/checksum.tab

GOOD

nh-x-swap-5-derived-solarwind-v2.0
document/docinfo.txt

GOOD

nh-x-swap-5-derived-solarwind-v2.0
document/error_notes.txt

GOOD

nh-x-swap-5-derived-solarwind-v2.0
catalog/catinfo.txt

GOOD

nh-x-swap-5-derived-solarwind-v2.0
catalog/dataset.cat

Minor Corrections Send to PDS

nh-x-swap-5-derived-solarwind-v2.0
catalog/nh.cat

Minor Correction Send to PDS

nh-x-swap-5-derived-solarwind-v2.0
catalog/nhkem.cat

Can this be Updated?

```
OBJECT                   = MISSION
  MISSION_NAME           = "NEW HORIZONS KUIPER BELT EXTENDED MISSION"

  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-swap-5-derived-solarwind-v2.0
catalog/nhsc.cat

GOOD

nh-x-swap-5-derived-solarwind-v2.0
catalog/ref.cat

GOOD

nh-x-swap-5-derived-solarwind-v2.0 catalog/swap.cat – 1 of 2

In the Level 3 Directory Tree (not in Level 5 data)

```
Calibration
========

See

  /DOCUMENT/SWAP_CAL.*

and Section 4 of  McComas et al. (2008) [MCCOMASETAL2008], also available as a
preprint at this URL:

  http://www.boulder.swri.edu/pkb/ssr/ssr-swap.pdf

as of 20.April, 2007.
```

Update? It works in 2022!!

nh-x-swap-5-derived-solarwind-v2.0
catalog/swap.cat – 2 of 2

This Section Describes Data in the
Level 3 Directory Tree
(not in Level 5 data)

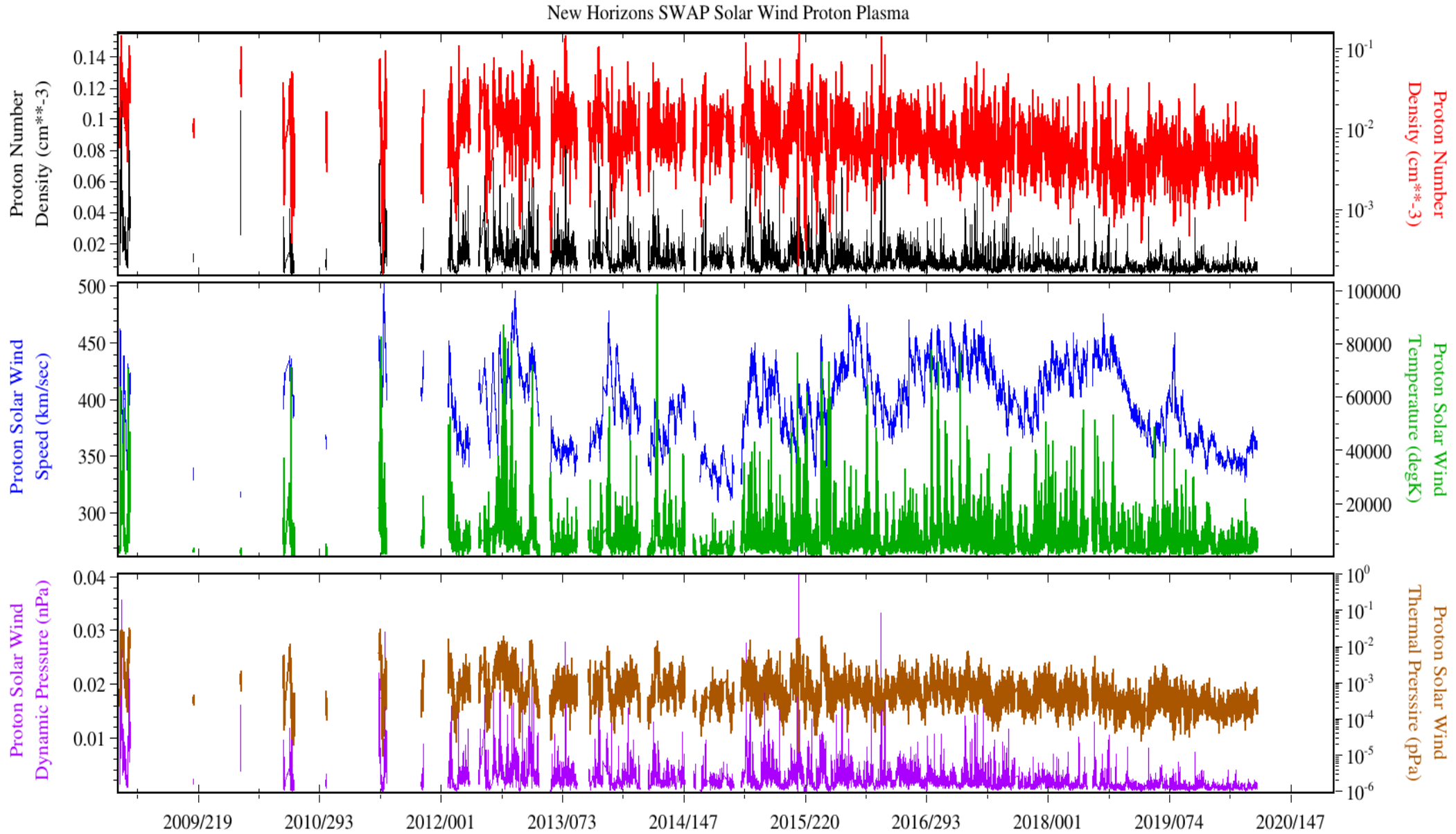
```
Note on Reading the Data and Extensions
=======
Summary plots cover ranges from 1 day to 1 year of data. Some of the summary
plots do not contain any data, or such a limited amount that it is hard to
see. The main purpose of the summary plots is to get a quick look at the data
available, so it is normal when some of these plots appear to be blank.

For the histogram data (0x586) extension zero is an array of 2048 values
containing the number of samples in the normalized histograms. Extension 1
holds the total count rates in bins normalized according to the peak location
found in the fine scans. Starting in 2008, the histogram data files were
changed such that the last 64 bins of extension 1 contain the total count
rates for each of the coarse scan energy steps. In extension 0 the number of
samples for these last 64 elements is zero. The other bins remain as they were
prior to this change. To obtain the number of samples in the totals for the
last 64 bins you need to use the parameter SMPLCNT in the primary header
(header for extension 0).
```

SWAP DERIVED
Data Evaluation

nh-x-swap-5-derived-solarwind-v2.0
data/nh_sw_20081010_20200127.lbl

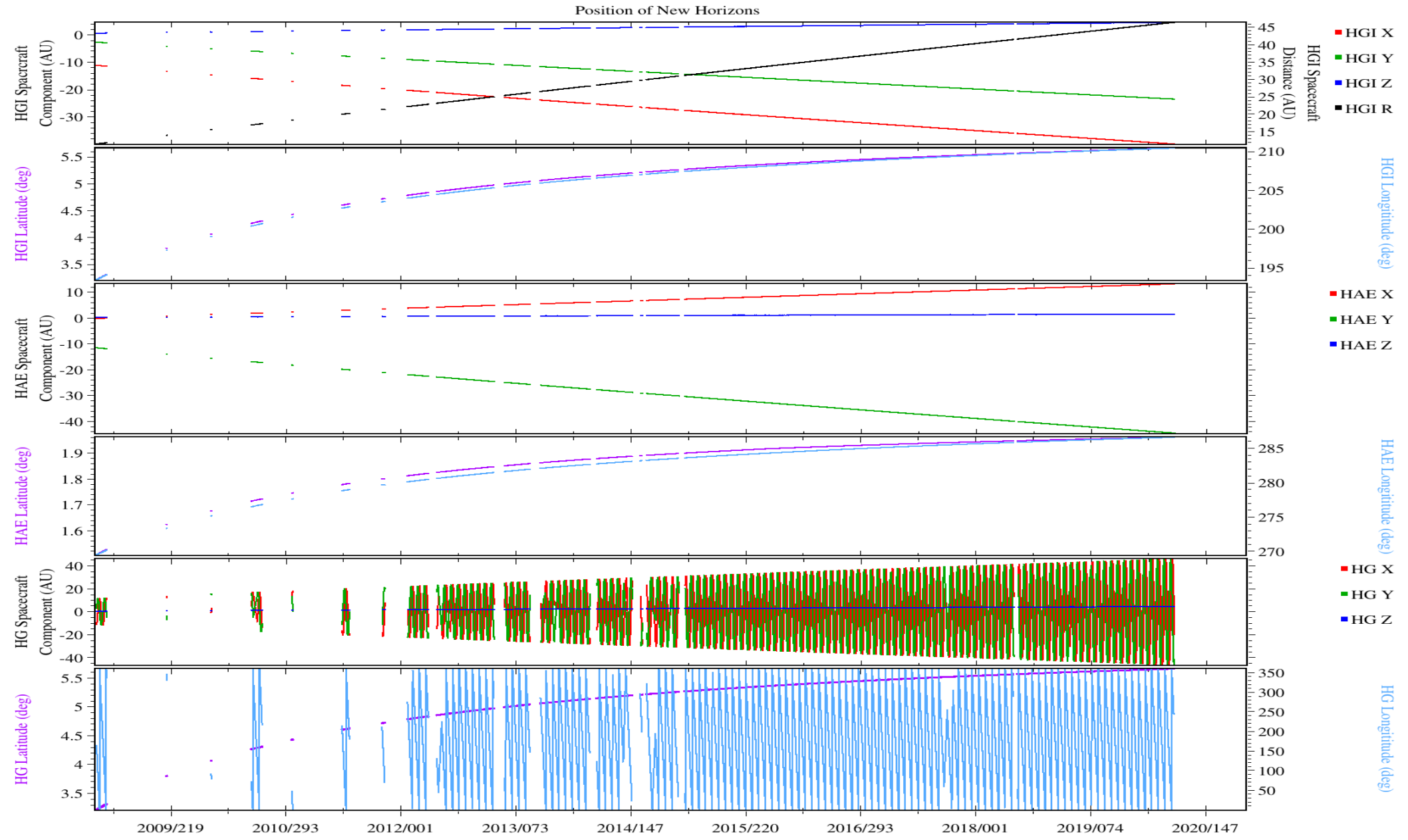
GOOD

nh-x-swap-5-derived-solarwind-v2.0
data/nh_sw_20081010_20200127.csv



Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Fri Dec 10 15:03:04 2021.

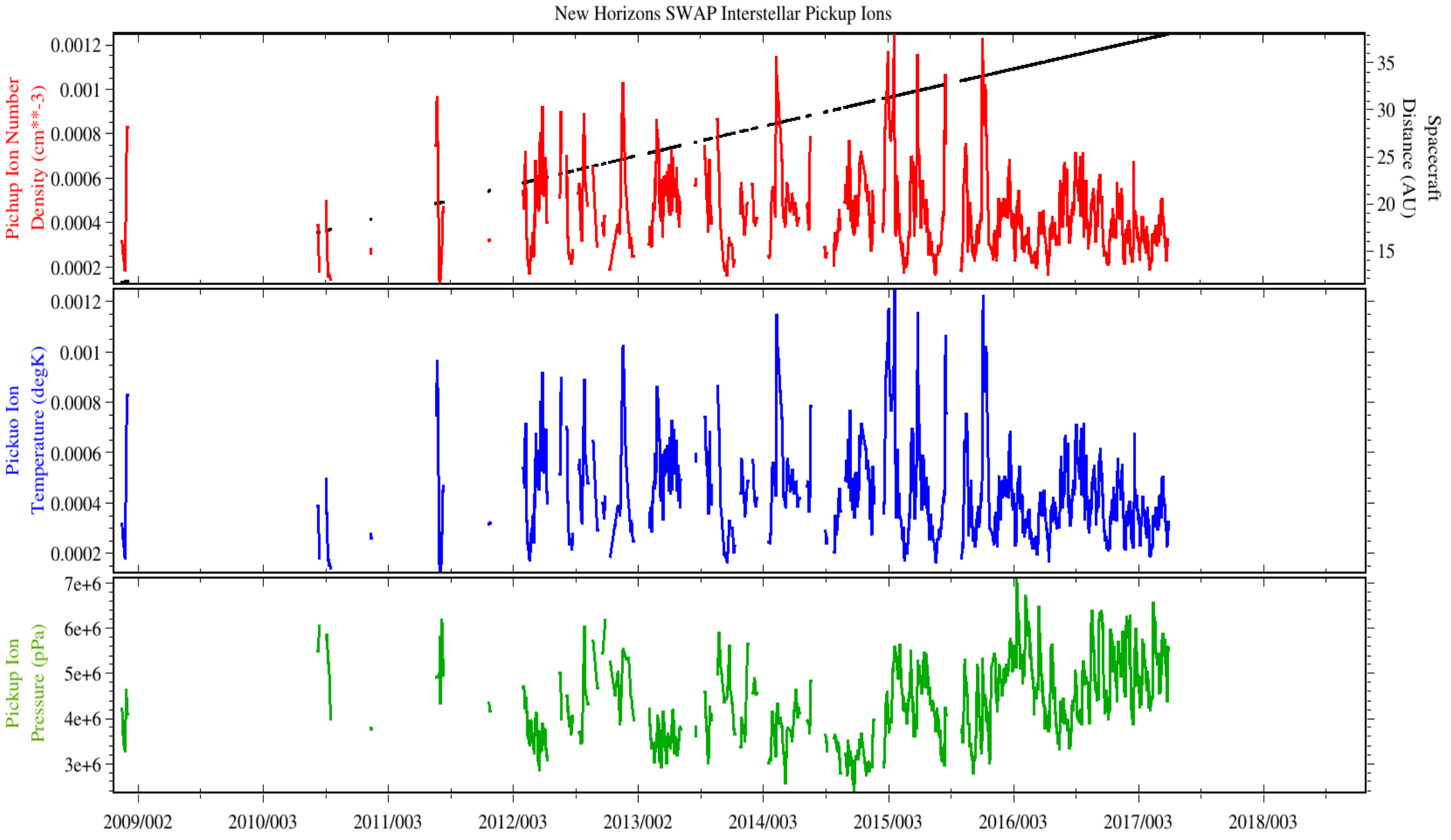
nh-x-swap-5-derived-solarwind-v2.0 data/nh_sw_20081010_20200127.csv



nh-x-swap-5-derived-solarwind-v2.0
data/nh_pickupions_2008_11_16.lbl

GOOD

nh-x-swap-5-derived-solarwind-v2.0
data/nh_pickupions_2008_11_16.csv



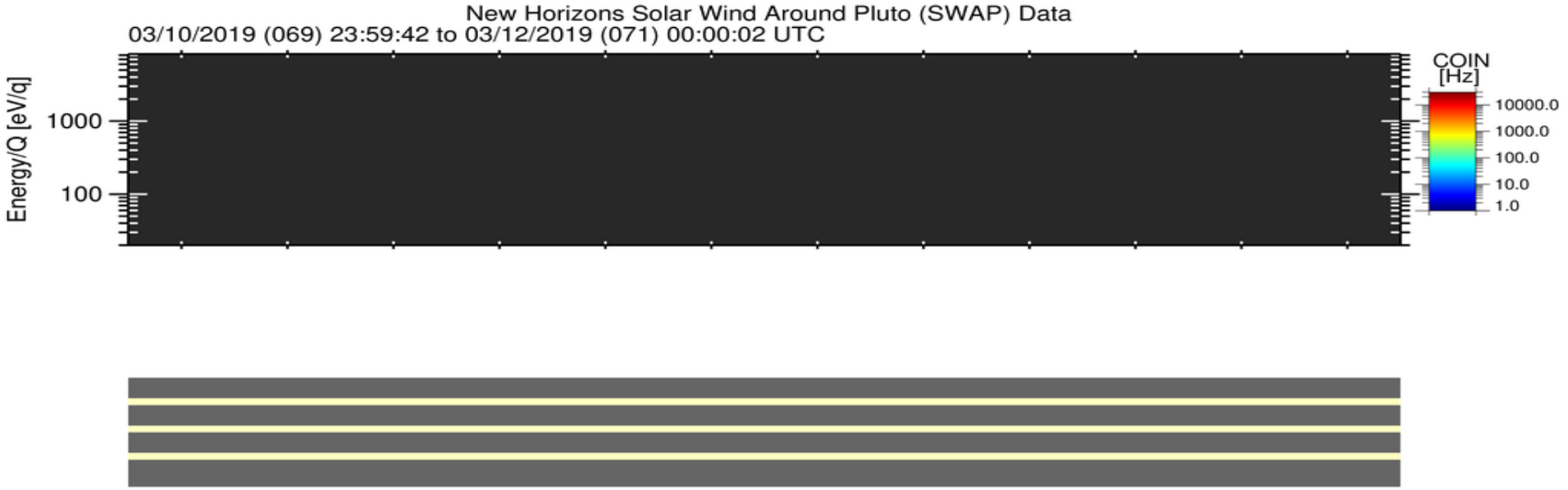
Plot created by SDDAS/gPlot - J. Mukherjee, et al. Generated on Fri Dec 10 16:32:37 2021.

Certification for nh-x-swap-5-derived-solarwind-v2.0

These SWAP Level 5 data from nh-x-swap-5-derived-solarwind-v2.0 are certifiable once documentation corrections have been made.

BACK-UP SLIDES

nh-a-swap-2-kem1-v3.0/document
nh-a-swap-3-kem1-v3.0/document
data_summary_plots/swap_001day_201903102359.png



I still do not like having plots like this in the archive. This looks like the plotting package software failed where you really want to convey that there is no data for the time frame covered by the plot. Empty plot frames with the words “no data” are much better because you see right away that the reason for the empty frame is that there was no data to plot and it was not due to a failure in the plotting software.