The SWAP raw (level 2) data are arranged in a binary table such that the columns are instrument parameters and measurements, and rows are measurement times. The FITS format has a binary table that allows for columns and rows. Figure 14-5 is a picture of what the Level 2 raw real- time files look like using FITS Viewer (FV). As mentioned earlier the housekeeping data are also in a table extension. The histogram counts and the number of samples in each bin are stored as image extensions. The zeroth extension contains only the primary header, the first extension holds the real-time data, the second extension holds the housekeeping data, and the third extension holds the thruster data.

SWAP data are in CCSDS (Consultative Committee for Space Data Systems) packets packetized by the spacecraft from the low-speed bus. Note that on the New Horizons mission, every instrument also outputs a non-packetized portion of telemetry to the S/C. This portion is also called the "instrument state" and this data is incorporated into the general spacecraft housekeeping data and not into the SWAP packets. All the bits in the SWAP packets were defined for the MOC at APL in EXCEL spreadsheets in the form required by the mission. The New Horizons SOC used the same bit level format description (APL EXCEL spreadsheets) for all the parameters in our packets to decode our raw (level 2) data.

14.4.2 Definition of an "Observation"

A complete histogram observation consists of one histogram type 1 packet and 63 histogram type 2 packets. A complete set of real-time science measurements consists of a full 64-second cycle. This is described in detail in section 14.4.1. One summary packet constitutes a complete measurement. Summary packets are included only in CODMAC Level 2 PDS data sets; CODMAC Level 3 PDS data sets do not contain data from summary packets. Housekeeping data are required for all science measurements since the housekeeping data are key to interpreting the data and determining error flags.

14.4.3 Housekeeping Needed in Level 2 (Raw) Files (for Calibration)

Unlike some of the other instruments all housekeeping data for SWAP are included into the level 2 (raw) files as an extension.

14.4.4 Raw Science Data and/or Housekeeping Requirements

In addition to the complete housekeeping packets, summary, real-time, histogram, and thruster fire packets are included into our raw (level 2) files. The thruster data format for the raw files was reformatted to reduce space. In the calibrated (level 3) data the thruster data has been arranged by thruster name and time. The numbers in the table indicate the duration of the thruster firings.

14.4.5 Evolution of the HISTOGRAM Level 2 Data Product (0x586/7)

The flight software for the histograms has been updated a couple of times to make this data product more useful. Originally, there were only normalized coincidence count rate histograms (2048 array) typically spanning about 1 day. The first flight software update to improve the coincidence count rate histogram data product to store total counts for each of the 64 bins in the coarse scans without normalizing by the location of the peak count rate in the last 64 bins of the 2048 element array. We refer to this histogram product as non-normalized histograms, and these also spanned

about 1 day. The second flight software update eliminated the normalized histograms and reallocated the space to store many non-normalized histograms within the same space to increase the time cadence of the non-normalized histograms to ~30 minutes. The number of changes made to the flight software to implement this was minimized, which has led to a more convoluted format for these new high time resolution non-normalized histograms. Table 1 summaries the evolution of the histogram data products and file formats. Each of these histograms data products are described more fully below. Note all histogram count rates are derived from coincidence measurements. The histogram data products only store data rates summed up when the deflector voltage is zero because the deflector voltage reduces the sensitivity, the majority of the time the deflector voltage is zero, and we do not want to sum data with different levels of sensitivity. For all of the histogram products, the energies for the energy bins for the coarse scans can be found in the 0x584 data taken during the same timeframe as the histograms.

Original Histograms

In the original normalized histogram data product, the 64 step coarse scan count rate arrays were placed into a very large array with 2048 bins (extension 1/histogram) based on the location of the energy bin that had the highest count rate during the fine scan. Note that the fine scans are take right after the coarse scans and consist of another set of 64 measurements closely spaced and centered on the energy step with the highest count rate in the coarse scan. An additional array was used to keep track of the number of times samples (extension 0/primary) that were put into the count rate array. The average count rate could then be calculated by dividing the count rate array (extension 1) by the number of samples array (extension 0) element by element. The normalized histograms turned out not to be useful because while spinning the solar wind beam could go in and out of the FOV. When the solar wind peak was outside the FOV, the coarse scan count rates would be misplaced because the energy bin with the peak count rate did not reflect the count rate at the peak of the solar wind. The time information for this histogram product was stored as MET values in the header for extension 0 in the BEGTIME and ENDTIME parameters.

Addition of Non-normalized Histograms

A prior flight software load addressed the lack of utility of the normalized histograms by storing in the last 64 bins of the 2048 count rate array (extension 1) the total counts for the 64 step coarse scans without making any adjustments based on which bin had the highest count rates. For these non-normalized histograms, the average count rates can be determined by dividing all the count rates in last 64 bins (extension 1) by the value in the SMPLSCNT parameter in the header of extension 0.

Addition of High Time Resolution Non-normalized Histograms

The latest flight software update increases the time resolution of the non-normalized histograms by reallocating all of the original space occupied by the normalized count rate array and the number of samples array. For these new high time resolution non-normalized histograms, the file format is quite different with several 64 element histogram count rate arrays stored in a large array in time