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

PEPSSI is a compact particle telescope with a time-of-flight (TOF) section and a solid-state detector (SSD) array (see Figure 11-2). A mechanical collimator defines the acceptance angles for the incoming ions and electrons. A cutaway view of the assembly is shown in Figure 11-3. The TOF section is axially symmetric; entrance and exit apertures are 6 mm wide with an azimuthal opening angle of 160°. The entry and exit apertures are covered by thin (~7 μg/cm^2) polyimide/aluminum and (~10 μg/cm^2) palladium/carbon foil mounted on high-transmittance stainless-steel grids, respectively. The foil thickness and composition is a compromise to minimize the energy threshold, secondary electron production, and scattering of particles in the foil while blocking UV from the direct Sun and Lyman-α background. PEPSSI measures the ion TOF using secondary electrons generated as the ion passes through the entrance and exit foils in the spectrometer. Total energy is measured by the SSD array. Each of the six SSDs has two pixels, three of the SSDs are dedicated for ion measurement. The other three have one pixel covered with ~1 μm Al absorber, to block low energy ions and permit measurements of electrons. The fan-like collimator together with the internal geometry defines the acceptance angles. The FOV is 160° by 12° with six angular sectors of 25° each; the total geometric factor is ~0.15 cm^{2}sr. As an ion passes through the sensor, it is first accelerated by the potential of ~3 kV on the front foil prior to contact with that foil. The ion generates secondary electrons at the foils, which are then electrostatically steered to well-defined separate regions on a single micro channel plate (MCP), providing "start" and "stop" signals for the TOF measurements (from 1 ns to 320 ns). The segmented MCP anode, with one start segment for each of the six angular entrance segments, allows determination of the direction of travel even for lower-energy ions that do not give an SSD signal above threshold.

The combination of measured energy and TOF provides unique particle identification by mass and particle energy depending on the range: for protons from ~30 keV to ~1 MeV; for heavy (CNO) ions from ~80 keV to ~1 MeV. Lower-energy (>3 keV) ion fluxes are measured by TOF 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 and produce an eight-point energy spectrum for each of four species for six arrival directions. Energetic electrons are measured simultaneously in the dedicated electron pixels in the range from ~30keV to 700 keV. Only protons with energies > 300 keV (expected to be very rare at Pluto) can penetrate the absorbers on these pixels, and even those would be eliminated by on-board MCP coincidence requirements and ground comparisons with the simultaneously measured ion flux.

times of data coverage from successive days both will drift with respect to UTC with the clock on the spacecraft, and will jump by about one second on days that have leap-seconds. ~~Through 2010;~~ the typical clock drift rate through 2010 is of order 1ms/d, and the TOD of the start and stop times for each file are within a few seconds of midnight on each day.

The exceptions to the 86,400 spacecraft seconds rule are days when new Rate Box definitions are loaded to the spacecraft, in which case there will be a "before" file and an "after file" (such load-days are very rare).

The DataConverter program essentially "flattens out" the Pre-L2 structure. In the L2 files, each row is a separate sampling period or PHA event (i.e. the blockcnt, hi_cnt, lo_cnt, etc. axis is now the row structure of the FITS binary table). Each "Rate Box" or hardware count is a separate column in the N1 or N2 FITS table. So, for example, each row of the N1 rates extension represents a separate sampling period (usually 600 seconds) and each column is a different rate, listed in alphabetical order by rate name, so the columns would be:

ET, MET, B00S00, B00S01, …, B18S05, C00D00, C01D01, …, C23, C24, HK00, HK01, …,HK34, J00, J01, …, J06, L00S01, L00S02, …, L15S05, L15SUnknown, R00S00, …, R02S05

The meaning of the individual Rate Labels will be discussed below, or see the comments in the corresponding FITS header. As another example, the PHA_ELECTRON extension is another simple 2D table of values; each row represents a separate PHA event, the columns are:

ET, MET, ApID (packet Application Process IDentifier; also Application ID), Cross_Talk_Indicator, Electron_Channel, Raw_Energy

IMPORTANT NOTE: Calibration work on the PEPSSI instrument is ongoing. Uncertainties in some quantities (particularly efficiency) are still very large.

11.4.5.3.1 FLUX Calibration Procedure

We calculate the differential intensity j (1/cm^{2}sr-s-keV) in terms of the counts C, time coverage T (s), geometric factor G (cm^{2}sr), upper and lower energy bounds E_{hi} and E_{lo} (keV), and detection efficiency η:

$$j = \frac{C/T}{G\Delta E\eta},$$

Character does not print correctly, shouldn't this be "δ" as well?

where $\Delta E = E_{hi} - E_{lo}$. We assume Poisson statistics for C, no error in T, absolute errors in G, E_{hi}, E_{lo} and relative error in η. So, formally we quote the counts as $C = C \pm \sqrt{C}$, the energies as $E = E \pm \delta E$, and the geometry factor is $G = G \pm \delta G$. We could also write $\eta' = \eta' \pm ! \ \eta'$ but choose instead to define the relative error $\varepsilon \equiv \frac{\delta\eta}{\eta}$. Starting with the minimum and maximum efficiencies that describe a two sigma confidence band, η_{lo} and η_{hi}, we determine our best efficiency using the geometric mean $\eta = \sqrt{h_{hi}h_{lo}}$ and subsequently determine the relative error $\varepsilon = \sqrt{\frac{\eta_{hi}}{\eta_{lo}}}$. So, we can quote the efficiency and relative error as $\eta = \eta \times\div \frac{\delta\eta}{\eta}$ or $\eta = \eta \times\div \varepsilon$, meaning that the actual efficiency is between η/ε and $\eta\varepsilon$, to one sigma confidence.

With these given errors the formal error in j is given by:

$$\delta j = j\sqrt{\frac{1}{C} + \left(\frac{\delta G}{G}\right)^2 + \frac{(\delta E_{hi})^2 + (\delta E_{lo})^2}{\Delta E^2} + \left(\frac{\delta\eta}{\eta}\right)^2} = j\sqrt{\frac{1}{C} + \left(\frac{\delta G}{G}\right)^2 + \frac{(\delta E_{hi})^2 + (\delta E_{lo})^2}{\Delta E^2} + \varepsilon^2}$$

Here we have assumed that all errors $\delta x_1,\ldots,\delta x_N$, are uncorrelated and have used the general expression for the error in a function $f = f(x_1,\ldots,x_N)$:

$$(\delta f)^2 = \sum_{i=1}^{N}\left(\frac{\delta f}{\delta x_i}\delta x_i\right)^2$$

A "pseudo-code" version of the actual calculation code used is given in **COMMENT** keywords in the FITS header.