5.7 Summary of Significant Changes for the HEXTE in RXTE NRA2

Since the first NASA Research Announcement, information in the HEXTE chapters of this Technical Appendix has been updated with the knowledge obtained during the in-orbit checkout phase shortly after launch. For convenience we list here some of the more significant changes to the HEXTE's operations and performance.

5.7.1 Loss of Spectral Information from Phoswich Detector PWB2

On 1996 March 6 at 11:27:12 UT, detector 2 in cluster B lost its ability to provide spectral information; all accepted photon events between the lower and upper energy discriminators produce counts in PHA channels 1 and 2 only, regardless of their incident energy in this range.

However, data from this detector may still be used to provide a broad-band flux as a function of time. The only drawback is that without a gain calibration spectrum, automatic gain control is no longer possible for this detector, resulting in a drift of the high voltage as the spacecraft passes through the changing magnetic field in its orbit. This translates into gain variations (or variations in the effective upper and lower energy bounds) of around 2% per orbit, with a a secular gain decrease of the same order over a month. Bright, soft-spectrum sources will therefore produce count rate variations in this detector due to the changing effective lower energy bound. However, for most faint source observations this effect should be negligible and this detector operates effectively as a 12-250 keV photometer.

Since the PHA channels 1 and 2 lie outside the pre-defined PHA channel ranges of Archive Temporal Bin mode (q.v.), counts from this detector will not appear in this mode's telemetry. The same is true for the common Temporal (Multiscalar) Bin Science Modes, whose PHA channel ranges were defined and used before this detector's loss of spectral information. Therefore, users are now recommended to contact the HEXTE team in advance for assistance with this mode. Otherwise, users may use Event List mode where possible for fast timing observations of bright sources; high telemetry rates can be avoided in this mode by increasing the Lower Energy Bound above its default value of 12 keV.

5.7.2 Dead-time Performance and Estimation

During RXTE's Cycle 1 it was determined that the dead-time counter value alone underestimates the time for which the event selection logic is unavailable for event processing, due to the long periods of dead-time following impacts by high energy particles (known as XULD events). These events combine to incur a substantial dead-time fraction which averages 25% around an orbit, which is equivalent to a reduction in the HEXTE's effective area by the same amount.

While the dead-time counter does not account adequately for such events, it is believed that accurate dead-time estimates can be recovered in the data analysis by a simple combination of dead-time counter values and HEXTE Housekeeping monitor rates (specifically, the XULD rate).

The HEXTE proposal preparation materials, including the PIMMS and *HEXTEmporize* software, as well as the HEXTE response matrices and background spectra, have been updated to reflect the current dead-time fraction. Therefore users do not need to make explicit corrections for dead-time to their calculated HEXTE exposure times.

5.7.3 Background Spectrum

Original estimates of the HEXTE internal background spectrum did not include a large spectral feature at 30 keV (**Figure 5.8**). This feature is a blend of x-ray lines from de-excitation of spallation-created daughters of Iodine in the detector (which decay promptly by K-capture). The total background in the 15-250 keV range is 90-100 count/s per HEXTE cluster, and not 40 count/s as predicted in XTE NRA1, partly as a result of this feature. A typical in-orbit HEXTE cluster background spectrum (*hexte_nra2.bak*) has been provided for NRA2 spectral simulations.

5.7.4 Sensitivity Performance

The effect on the HEXTE's sensitivity due to the additional background count rate is small, partly due to the larger unobstructed open detector area (~890 cm^2) than originally advertised. However, this is offset by the larger-than-anticipated dead-time fraction in orbit. Sensitivity estimates and source flux/HEXTE count rate conversions are provided in the HEXTE Feasibility Chapter, which has been updated to include all these effects.

5.7.5 HEXTE Response Matrix

Characterization of the HEXTE detectors' response as a function of energy is ongoing. However, Monte-Carlo simulations of the x-ray interaction with the NaI and CsI have already reproduced the response sufficiently accurately that spectral fitting to the Crab nebula reveals residuals of order a few percent. A new HEXTE cluster response matrix (*hexte_nra2.rsp*) which combines the Monte-Carlo models with the in-orbit effective area and dead-time effects, has been provided for NRA2 spectral simulations. A graphical representation of this matrix is shown in **Figure 5.6.**

5.7.6 HEXTE-related Proposal Software

PIMMS and *HEXTEmporize* have been updated for RXTE NRA2 to incorporate the measured in-orbit effective area, dead-time and background information. A number of improvements have also been made to these tools and the RPS proposal software, as itemized below:

1. PIMMS now allows users to experiment with non-default Lower Energy Bounds (or LLDs for Lower Level Discriminators). These are implemented in PIMMS as "filters" which have 100% transmission above the specified energy threshold. PIMMS reports count rates in 4 energy bands as before, but the lowest band now covers PHA channels 0-29 (as opposed to 15-29 in NRA1). The default lower energy bound (currently 12 keV) is implemented as filter "DEFAULT", or "D" for short. Users converting fluxes or count rates to HEXTE count rates should therefore specify:

   ```
   PIMMS> TO XTE HEXTE D
   ```

2. *HEXTEmporize* now reads in a HEXTE background spectrum and effective area curve (similar to those used by PIMMS) to provide more accurate count rate and telemetry estimates. Therefore, installers must now edit a file (HEXTEmporize.h) to specify their directory location before compiling and linking this software.

   Furthermore, users must now specify an approximate power-law spectral index for their source spectrum. Unlike the PCA/EDS *recommd* tool, *HEXTEmporize* no longer recommends specific science modes, but allows users to verify and customize their HEXTE configurations with the guidance provided by the HEXTE Feasibility Chapter.

3. The RPS proposal software now checks the entered HEXTE configurations for validity, and calculates the HEXTE telemetry rates automatically.