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# The Digital Data Processing System of the ASTRO-E Hard X-Ray Detector

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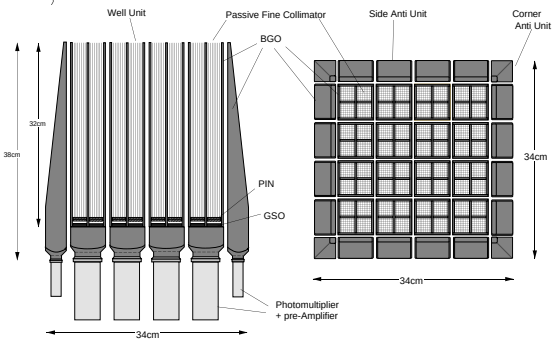
## 1. Introduction

The Hard X-Ray Detector (HXD) is one of three instruments on board ASTRO-E, scheduled for launch in January 2000. The HXD covers the energy range from 10 keV to 600 keV with an effective area of 330 $cm^2$ at 50 keV. It features a very low background level at $1 \times 10^{-5}$ c $s^{-1}$ $cm^{-2}$ $keV^{-1}$ at 200 keV at sea level. The X-ray detection part of the HXD consists of 4×4 GSO/BGO well-type phoswitch scintillators (Well-counters), of which the low-energy efficiency is increased by incorporating 64 silicon PIN diodes of 2 mm thickness each. The 16 Well-counters are surrounded by 20 Anti coincidence counters (Anti-counters) acting as active shields, each made of 4 cm thick BGO crystals. These Anti-counters have a very large geometrical area of 1200 $cm^2$ per one side, which amounts to 600 $cm^2$ even at 1 MeV.




Utilizing the Earth Occulitation technique, the shielding Anti-counters act as a monitor for high-energy transient sources and $\gamma$-ray bursts in an energy range of 100 keV to 2 MeV.

## 2. The HXD Data Processing

The total number of signal channels extracted from the HXD detector amounting to 100. The raw background rate is estimated to be $\sim$ 4 kHz in total. Due to the high count rate and the multi-channel access, the HXD requires a very fast real-time performance for the on board data processing. To minimize the processing time, the analog electronics (HXD–AE) utilizes 9 parallel modules, and the digital data produced by AE are sent to the digital electronics (HXD–DE) by the direct-memory-access mode. The hardware and software implemented for HXD–DE have been designed to realize a fast real-time data processing system with the limited resources available for the satellite [1].

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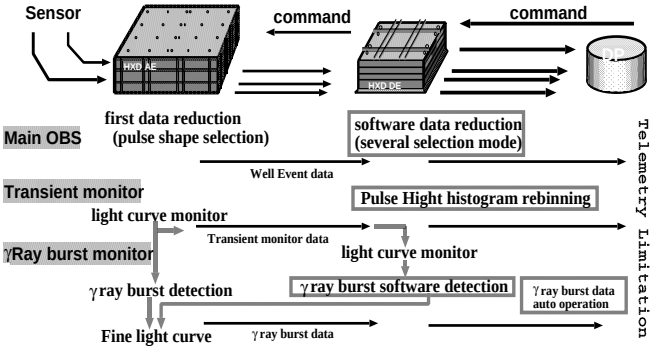
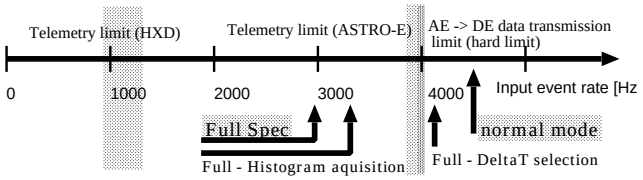
## 3. Outline of the HXD–DE Software




For the main event data from Well-counters, 8 event selection algorithms and six diagnostic histogram acquisition functions can be selected by commands [2]. For example, by the pulse shape information of events supplied from AE, the event-selection process rejects background events, if it is activated. DE also monitors coincident events detected by the surrounding of Well or Anti counters for the software event selection procedure to reduce Comptonized or particle interaction events.

For monitoring transient objects, DE has a function to reduce the data size to save on the limited spacecraft telemetry bandwidth when observing bright sources. In addition to the automated $\gamma$-ray burst detection in AE, DE also has burst detection algorithms referring to both Well- and Anti-counter count rates.

## 4. The Performance of HXD–DE




During the preflight end-to-end test in 1998, it was confirmed that the flight-model DE can process events with a speed exceeding 4 kHz, which is the maximum data transmission rate from AE to DE. The speed gradually decreases as various functions are activated, as shown in the above diagram. Nevertheless, the full load speed exceeds the telemetry limitation (1 kHz).

## References

[1] T. Takahashi 1998, SPIE, 3445, 155
[2] Y. Terada 1999, Master Thesis ,The University of Tokyo