Development of the sPHENIX INTT unpacker

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The sPHENIX experiment is a new collider experiment at RHIC. The tracking subdetectors of sPHENIX include the MVTX (maps-based vertex detector), INTT (intermediate silicon tracker), TPC (time projection chamber), and TPOT (time projection chamber outer tracker). The INTT is a silicon strip detector, which must have software infrastructure in place to read out binary data and transfer this to a common format suitable for track reconstruction. The sPHENIX data reconstruciton workflow utilizes front-end electronics (FEEs) to write data to files in a standardized binary ".prdf" (PHENIX raw data format). The binary files can then be read after and independently of data-taking, *e.g.*, "offline." When this occurs, the raw binary data is parsed using subsystem-specific decoders, and the physical information accessible from the decoded files is used to build software representations of events. Events are distinguished by having distinct triggers, and contain a payload of physical hits with timing and position information-position meaning; for example, the FEE that read the hit, the strip the hit occurred, and the ADC converted value of the hit (see Fig. 1).

The INTT unpacker is a piece of software written in C++ that uses the I/O interface of the decoder class to extract meaningful information from .prdf files and organize it to write `TrkrHitSet` and `TrkrHit` to the Data-Set Tape (DST). These `TrkrHitSet` and `TrkrHit` objects are what is ultimately used in track reconstruction by other sPHENIX subgroups, and are standardized between different subsystems. Subsequently, different subsystems have far more control over how to implement their individual readout encoding.

To obtain physical information associated with the hit, the readout indices must be mapped to the appropriate hardware indices. An idea of the ladder and FEE relationship is shown in Fig. 2. Additionally, the analog-digital converted value must be associated with the energy thresholds (digital-analog conversion). Beyond determining the physical information for hits, the unpacker also filters hits based on timing and hitrate distributions. For example, hits that are far removed from the peak in the time distribution of hits in an event are discarded. Similarly, hits from channels that systematically read too many hits are also discarded.

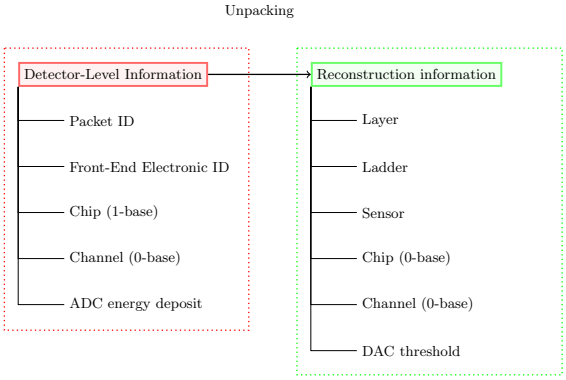

Fig. 1. The unpacking process. Detector-level information, such as indexes describing the readout channels which read out a particular hit, is made available through a decoder class. The unpacker uses the decoder to access detector-level information and map it to indexes which describe the physical hardware that measured the hit.

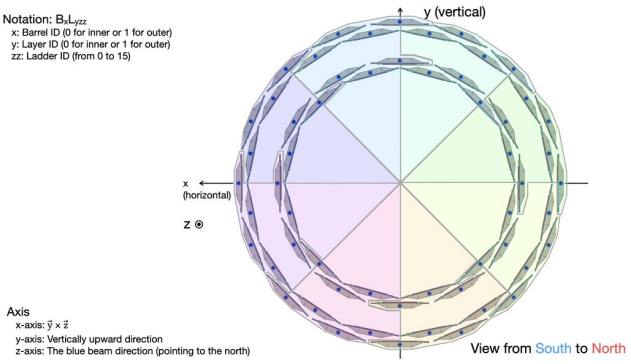

Fig. 2. The arrangement of ladders in the INTT, viewed along the beam axis. The hardware mapping of the ladders to readout modules needs to be maintained and accessible in code. Ladders in the same color region are read out by the same FEE.

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