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PETAT1, a Time-Sorting Readout ASIC for PET

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Modern PET scanners are often based on scintillating crystals read out by photo sensors. The large number of channels is processed by specialized electronic microchips. Data produced by these chips must be received by suitable data acquisition circuits and brought outside of the scanner to a data processing unit where hits must be sorted in time in order to find pairs of hits within a coincidence time window. The components required to transport the data (often FPGAs) must be located close to the sensors in large systems where they consume space and require power and cooling. We propose a novel readout architecture where no auxiliary readout circuits are required and which in addition outputs all hits already sorted by their time-stamps. This is achieved by adding data inputs to each readout chip so that events can be sent from chip to chip. The incoming external hits and the internal hits are buffered and merged by taking into account the hit time information so that the oldest hit is sent out first. The outgoing time-sorted hit data stream can then be merged efficiently with further streams in downstream chips. The architecture has been simulated in full detail with PET-like data. Hit losses are small up to the bandwidth limit of the serial link. The prototype chip PETAT1 including a SiPM readout with amplitude and time measurement has been designed, produced and operated.

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