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UPDATE ON THE DEVELOPMENT OF THE NEW TIMEPIX2 DETECTOR FOR FUTURE SPACE RADIATION MEASUREMENT APPLICATIONS

Abstract

The CERN-based Medipix2 Collaboration has produced the Timepix2, a successor to the venerable Timepix hybrid pixel detectors that have been operating on the International Space Station (ISS) since 2012 and flew in the Orion module during the EFT-1 mission in 2914. The Timepix has also been deployed on unmanned missions such a Proba-V and will be flown on the upcoming Bio-Sentinel mission, as well as the upcoming EM-1 and EM-2 Orion flights.

The new Timepix2 was first exposed to heavy ions at the Heavy Ion Medical Accelerator Center (HIMAC) in Chiba, Japan in December,2018, with additional characterization runs planned for 2019. The Timepix2 has the same 256 x 256 pixels, each with a 55 μm square pixel size. However, for the Timepix2, each pixel simultaneously incorporates both an Analog-to-Digital Convertor (ADC) using the Time-Over-Threshold (TDC) technique, and a Time-to-Digital Converter to obtain the Time-of-Arrival (TOA). The data are stored in a 28-bit output register with optional allocations for the TOT and TOA values. The chip control logic also provides for suppression of residual charge present in the input from events that occurred prior to the beginning of a data collection frame, and for the continuation of the TOT counting after the frame acquisition time has ended. The analog front end electronics have been substantially redesigned to favor hole-collection and and Adaptive-Gain mode to substantially extend the dynamic range for the measurement of the charge collected by each individual pixel. Another new feature present in the Timepix2 are 6 "Digital Pixels." These are pixels whose discriminators can be directly accessed externally to provide the same signal digitization as within the normal pixel inputs, but can come from external devices. These digital pixels can be used to measure, in the same data output stream, values such as the magnitude of the pulse on the sensor bias voltage, or even the amplified and shaped inputs from external PiN diodes or SiPMs. The full characterization of the chip will continue, and other new features including the stability and longevity of the chip remain to be characterized. The final paper will include the most recent results from this ongoing characterization along with plans for deployment onboard future manned and unmanned missions.