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Compact and Scalable Electronics for Sub-10 ps Timing in Particle Physics and Medical Imaging

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High-precision time measurements are crucial for both high-energy physics experiments and advanced medical imaging applications, such as Positron Emission Tomography (PET). Future detector systems require readout electronics that combine sub-10 ps timing resolution with scalability, compactness, and efficient multichannel integration.

The CAEN A5203 module, part of the FERS 5200 system, integrates the high-performance picoTDC ASIC from CERN, enabling precise Time of Arrival (ToA) and Time over Threshold (ToT) measurements. The unit features 3.125 ps LSB precision over 64 channels and can be coupled with a leading-edge discriminator stage. In this configuration, it achieves ~7 ps RMS timing resolution for constant-amplitude signals and ~20 ps RMS for variable-amplitude signals. The walk effect is corrected via ToT, which also enables signal amplitude reconstruction and background noise suppression.

Successfully deployed in a high-resolution PET imaging system, the A5203 has demonstrated its capability for large-scale applications, supporting continuous, dead-time-free acquisition from thousands of channels. In high-energy physics, the FERS architecture, combined with the picoTDC's performance, is well-suited for integration with advanced front-end electronics, such as Weeroc's Radioroc and Psiroc ASICs, enabling precise energy and time measurements with Silicon-based detectors. These features make the FERS system a powerful and flexible solution for next-generation applications in both fundamental research and applied physics.

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