Contribution ID: **18** Type: **Oral**

Design of a 40 GS/sec 10 mw/Channel Waveform Sampling ASIC in 65 nm CMOS

Thursday, 9 November 2023 11:00 (20 minutes)

The development of large-area MCP-based particle detectors with time resolutions of 5 ps or less [1] would allow substantive advances in particle identification at particle colliders such as the LHC and EIC, high precision mass reconstruction in searches for rare K and η decays, and a reduction by orders-of-magnitude of the radiation dose in positron-emission tomography [2, 3]. We describe a preliminary design for a 16-channel 40 GS/sec waveform sampling ASIC in the TSMC 65 nm process with the goal of achieving 1 ps resolution at 10 mW power per
channel. The buffer depth of each channel is 256 samples, corresponding to a recording window of 6.4 ns, long compared to a pulse from an MCP-based photomultiplier. In parallel for each channel, a 5 GS/sec 1024-deep sampling records a longer window of 204.8 ns for identifying pile-up and the temporal context for unusual signals. Recording of the data for each channel is triggered by a 10 ps resolution fast constant fraction discriminator [4] capable of multiple triggering during the window of the slow buffer. The sampling switches are implemented as 2.5V nMOSFETs controlled by 1.2V shift registers in order to achieve a large dynamic range, low leakage, and high bandwidth. Stored data is exported to be digitized by an external ADC at 10 bits or better. Specifications on operational parameters include a 4 GHz analog bandwidth and a deadtime of 20 microseconds, corresponding to a 50 kHz readout rate, determined by the choice of the external ADC. The current status will be presented.

[1] K. Inami, N. Kishimoto, Y. Enari, M. Nagamine, and T.
Ohshima; A 5-ps Tof-counter with an MCP-PMT; Nucl. Instr. Meth. A560, p.303, 2006

[2] P.~Lecoq, C.~Morel and J.~Prior, Case for setting up a 10ps challenge: A step toward reconstruction-less TOF-PET, Nuovo Cim. C (2020) no.1, 2 doi:10.1393/ncc/i2020-20002-y

[3] K. Domurat-Sousa, C. Poe, H. J. Frisch, B. W. Adams, C. Ertley, N. Sullivan; Low-Dose TOF-PET Based on Surface Electron Production in Dielectric Laminar MCPs; To be published in Nucl. Instr. and Meth. A, arXiv:2307.02708.

[4] Si Xie, Artur Apresyan, Ryan Heller, Christopher Madrid, Irene Dutta, Aram Hayrapetyan, Sergey Los, Cristián Peña, Tom Zimmerman,
Design and performance of the Fermilab Constant Fraction Discriminator ASIC, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume 1056, 2023, 168655, ISSN 0168-9002

Early Career

Yes

Primary authors: Prof. OBERLA, Eric (University of Chicago); Dr ANGELICO, Evan (Stanford University); Dr RICO-ANILES, Hector (North Central College); FRISCH, Henry (University of Chicago); PARK, Jinseo (University of Chicago); PASTIKA, Nathaniel (Fermi National Accelerator Laboratory); RUBINOV, Paul (Fermilab); Mr YEUNG, Richmond (University of Chicago); Dr ENGLAND, Troy (Fermi National Accelerator Laboratory)

Presenter: PARK, Jinseo (University of Chicago)

Session Classification: RDC11

Track Classification: RDC Parallel Sessions: RDC11: Fast Timing