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A correlation-based timing calibration and diagnostic technique for fast digitizing ASICs

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A general procedure for precision timing calibration of giga-sample/s waveform digitizing ASICs is presented. These devices are increasingly used in a number of high-energy physics experiments to perform waveform sampling of front-end detector signals. Waveform digitizing ASICs have considerable advantages over traditional TDC/ADC systems, such as high channel density and low power consumption, but have irregularly spaced timing intervals between samples due to process variations at the production level. The procedure presented here exploits the known correlation between nearby samples of a sine wave function to obtain the time difference between them. As only the correlations are studied, the procedure can be performed without knowledge of the phase of the input signal, and converges with smaller data samples than other common techniques. It also serves as a valuable diagnostic tool, allowing a fast, visual, qualitative check of ADC linearity, gain mismatches between sampling cells, and other ADC artifacts. Work is continuing to extend the procedure to fit for timing intervals in the face of such non-idealities.

We present both the algorithm and example calibration results from multiple ASICs. In particular, using the PSEC3 ASIC, we show improvement in timing performance for readout of a stripline MCP-PMT, which serves as a prototype for moving toward large (order m^2) photodetectors. Due to the anode geometry, the calibration technique improves both the timing resolution and the spatial resolution of the device.

Authors: Dr ROMERO-WOLF, Andres (Jet Propulsion Laboratory); Dr NISHIMURA, Kurtis (University of Hawaii)

Presenter: Dr NISHIMURA, Kurtis (University of Hawaii)

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