

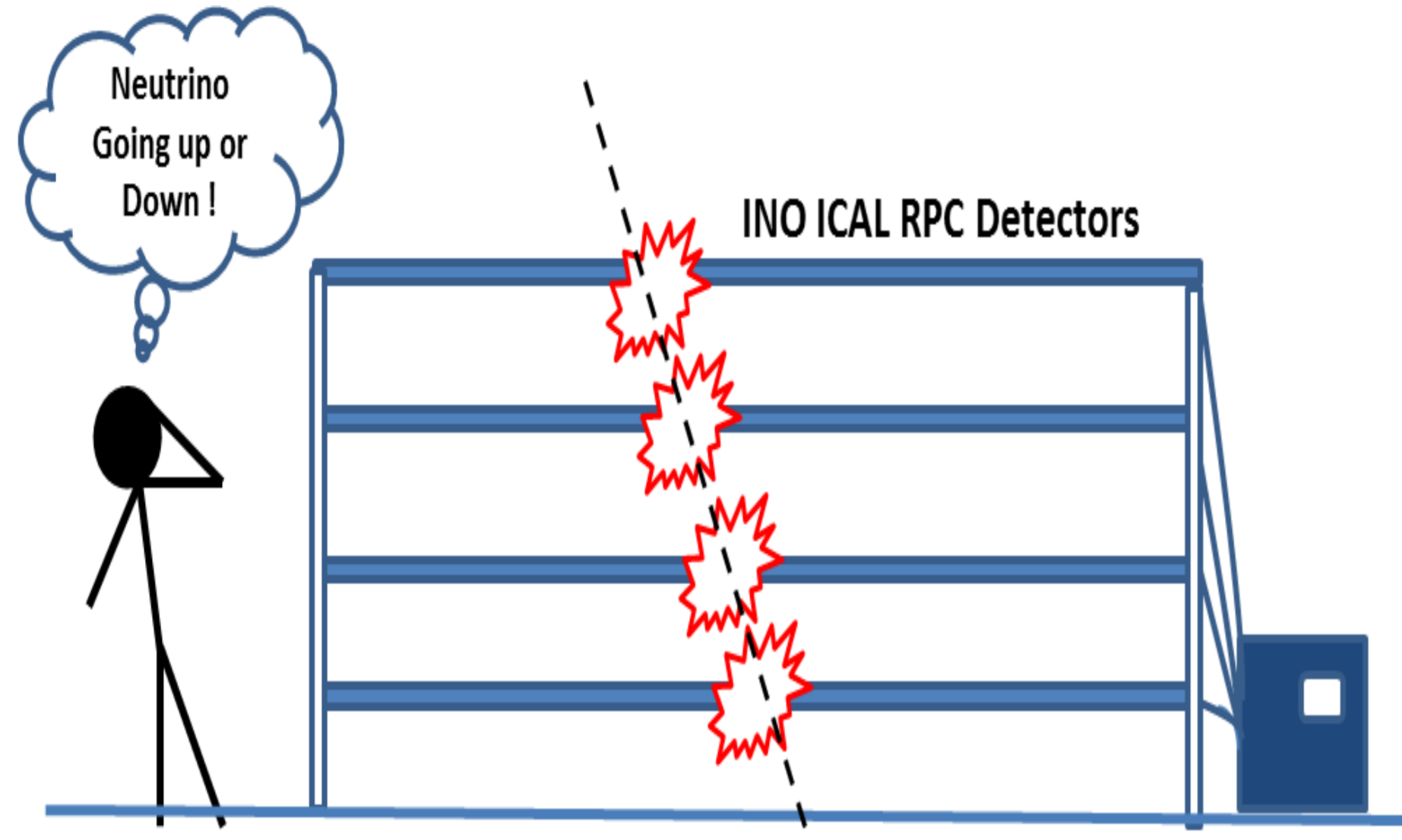
Performance and Integration results of a high resolution Time to Digital Converter designed for INO ICAL Experiment

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Motivation

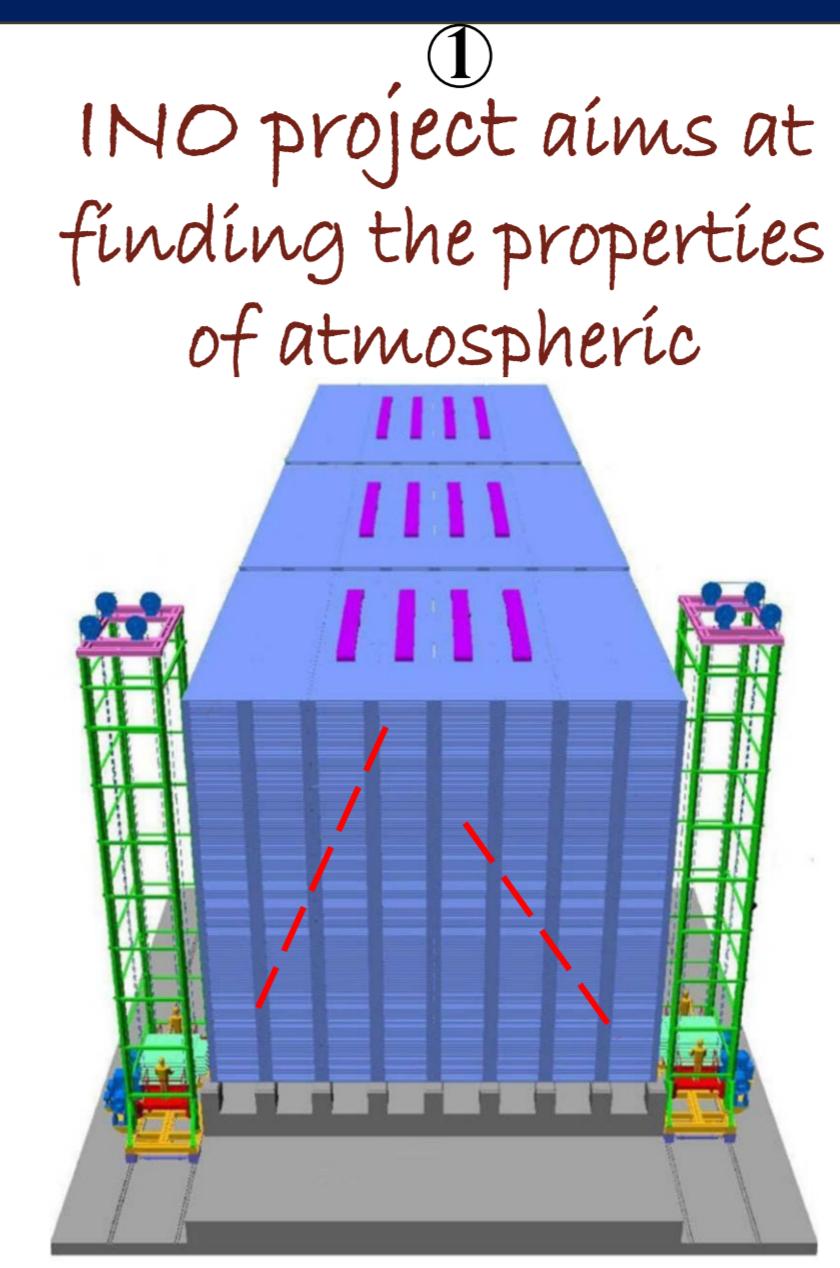


- In INO ICAL Experiment to find the direction of Neutrino generated Muons a sub nanosecond TDC is Required.
- Along with position information tracking of Muons can be done using Time of arrival of Muons

INO ICAL Detector

② A 50 kton Iron Calorimeter and Resistive plate Chamber (RPC) in stacked geometry will be used to track neutrinos.

⑤ To measure this fast pulses we designed a low power, compact multi-channel Delay Chain based time-to-digital converter (TDC) in a 0.13µm ASIC

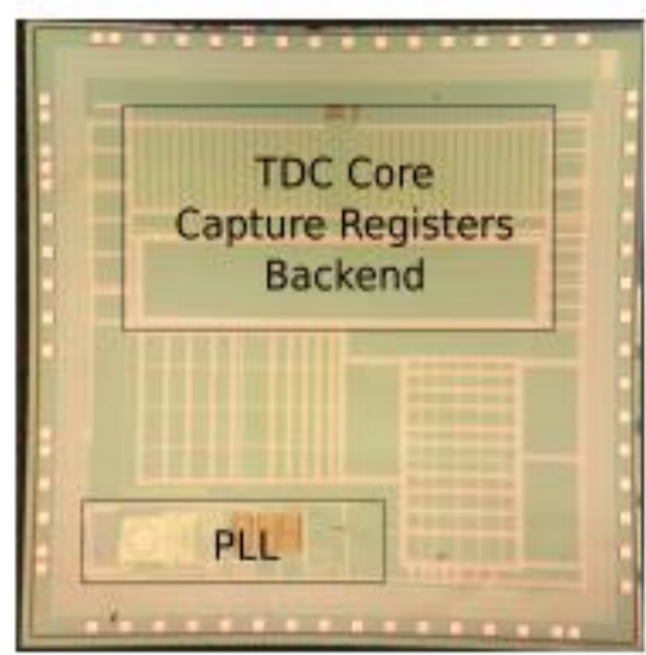


⑥ This TDC is capable of handling multiple hits per channel with resolution of 125ps.

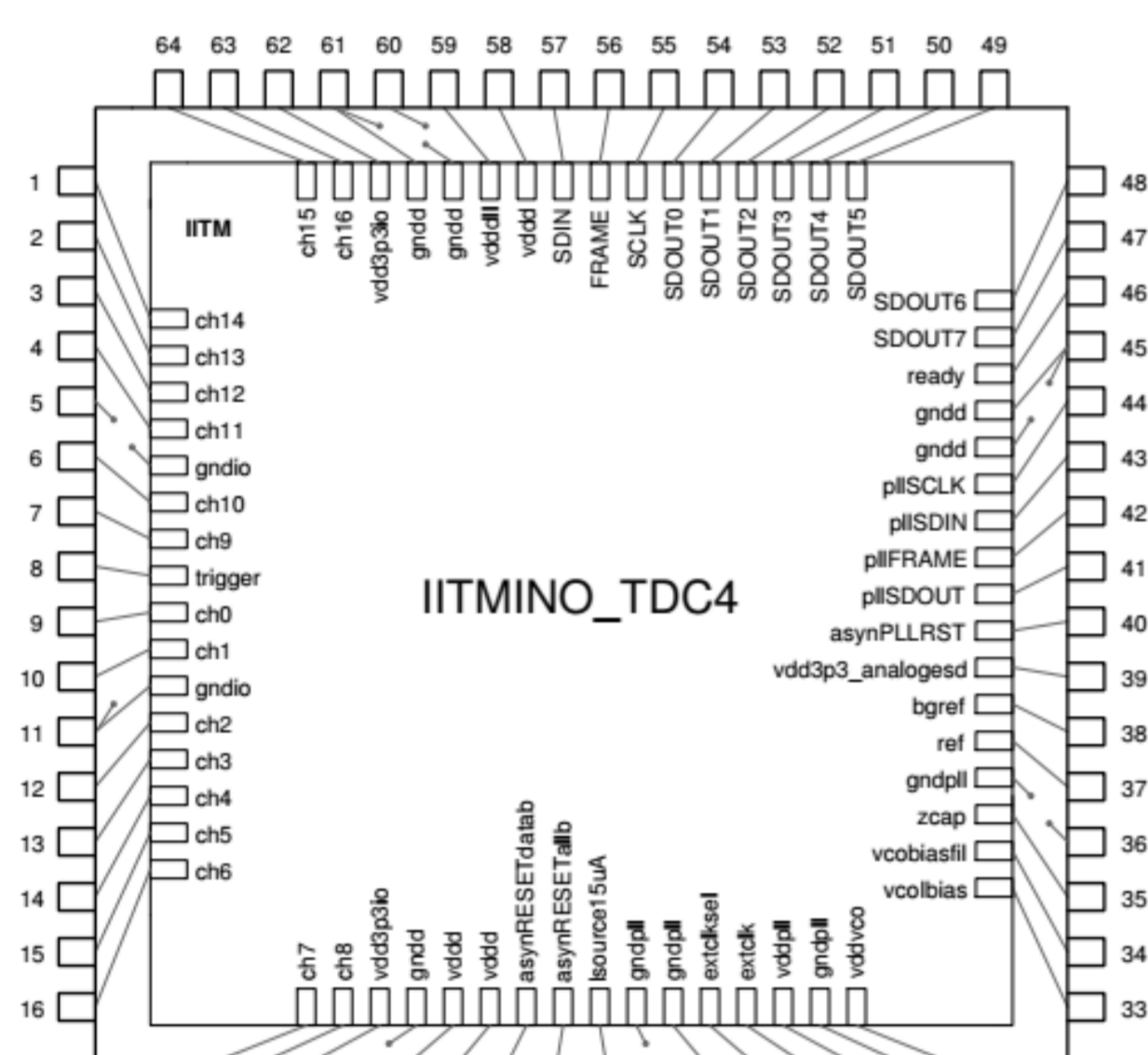
③ Position and directional information are to be used to identify particle energies

④ RPC detector signal of rise time less than 1ns is amplified-discriminated and given to Digital Front End (RPC-DAQ).

TDC ASIC



TDC ASIC Micrograph



TDC ASIC Pinout

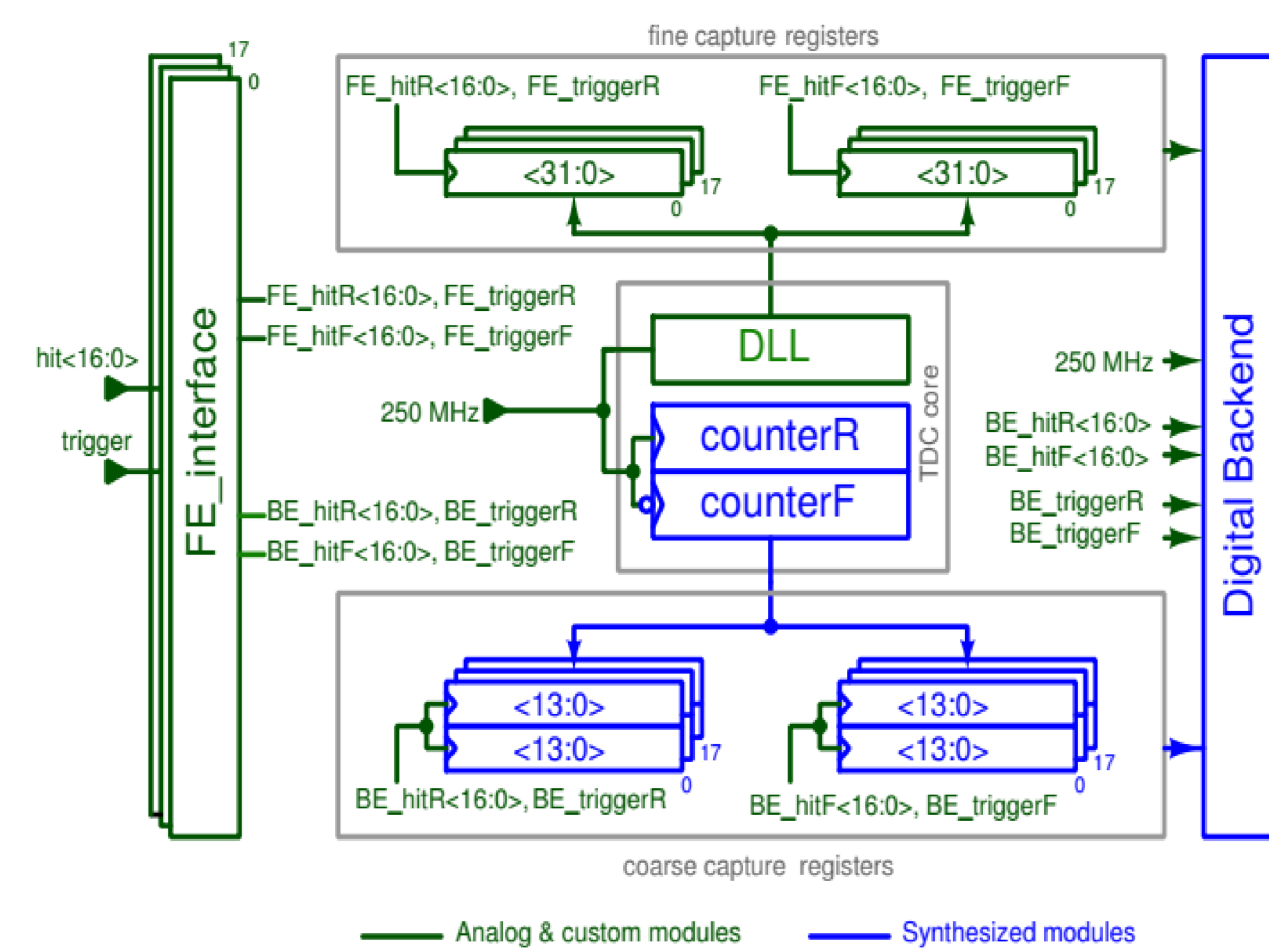


Test Board Developed for Prototyping

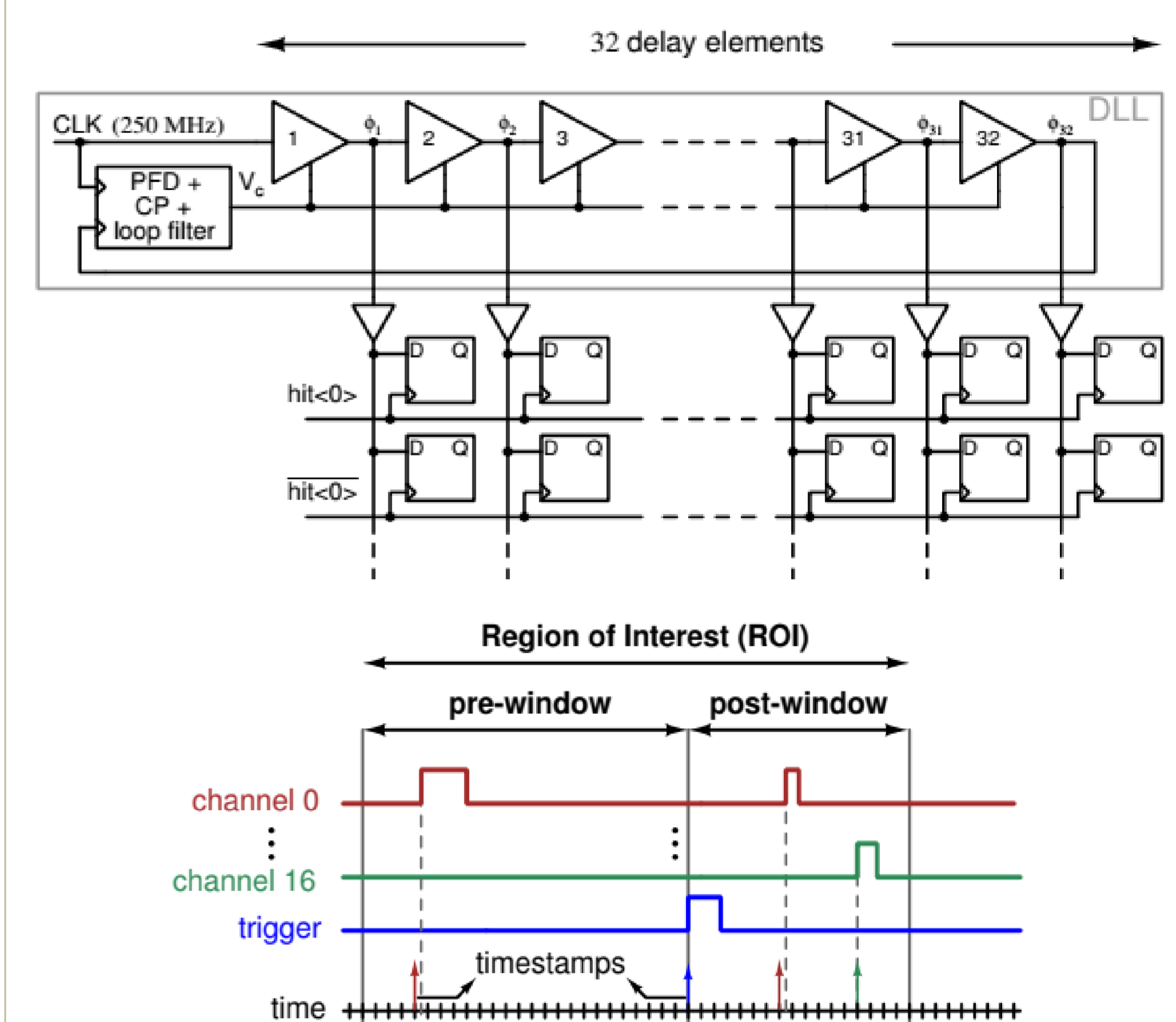
Specifications

- Technology : 0.13µm
- Resolution: 125 pS
- Dynamic Range: 65.5 µS
- Channels: 17 +1
- Multi Hit: 4

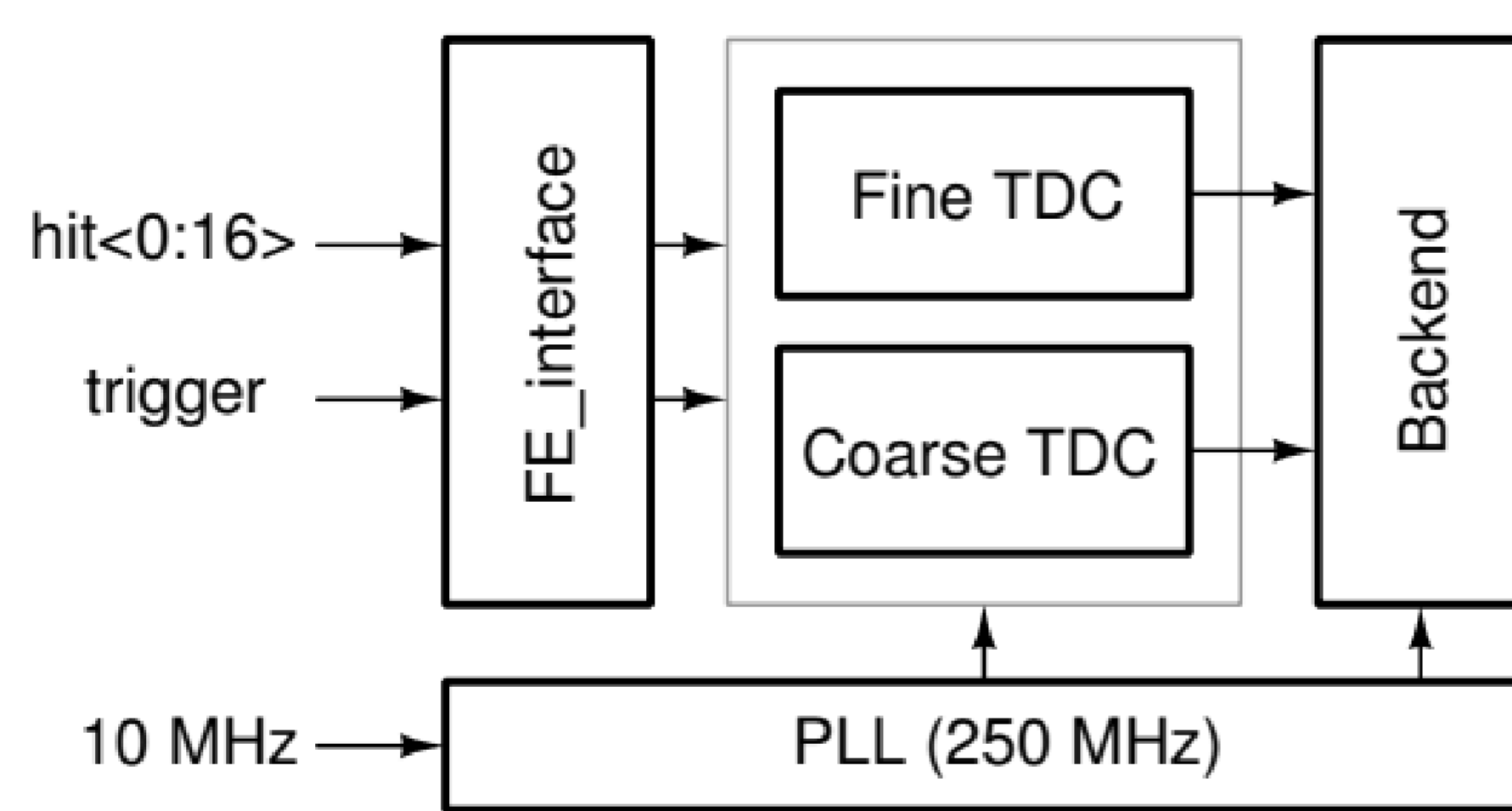
Block Diagram



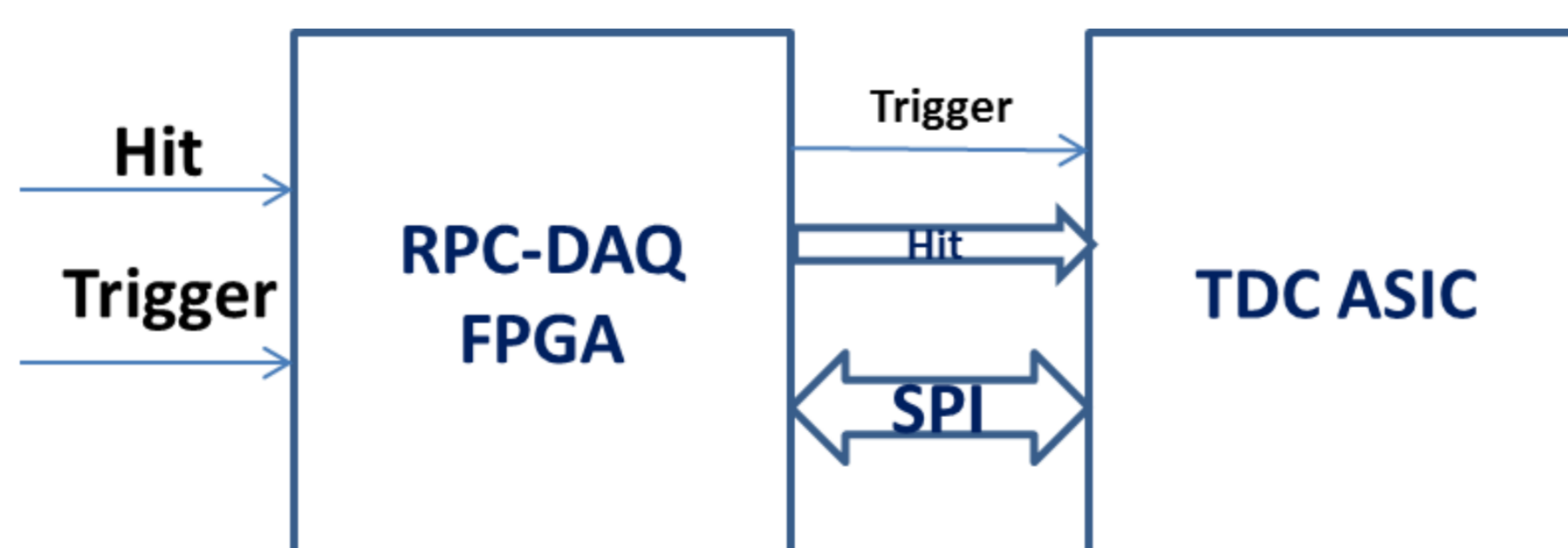
DLL and Timing



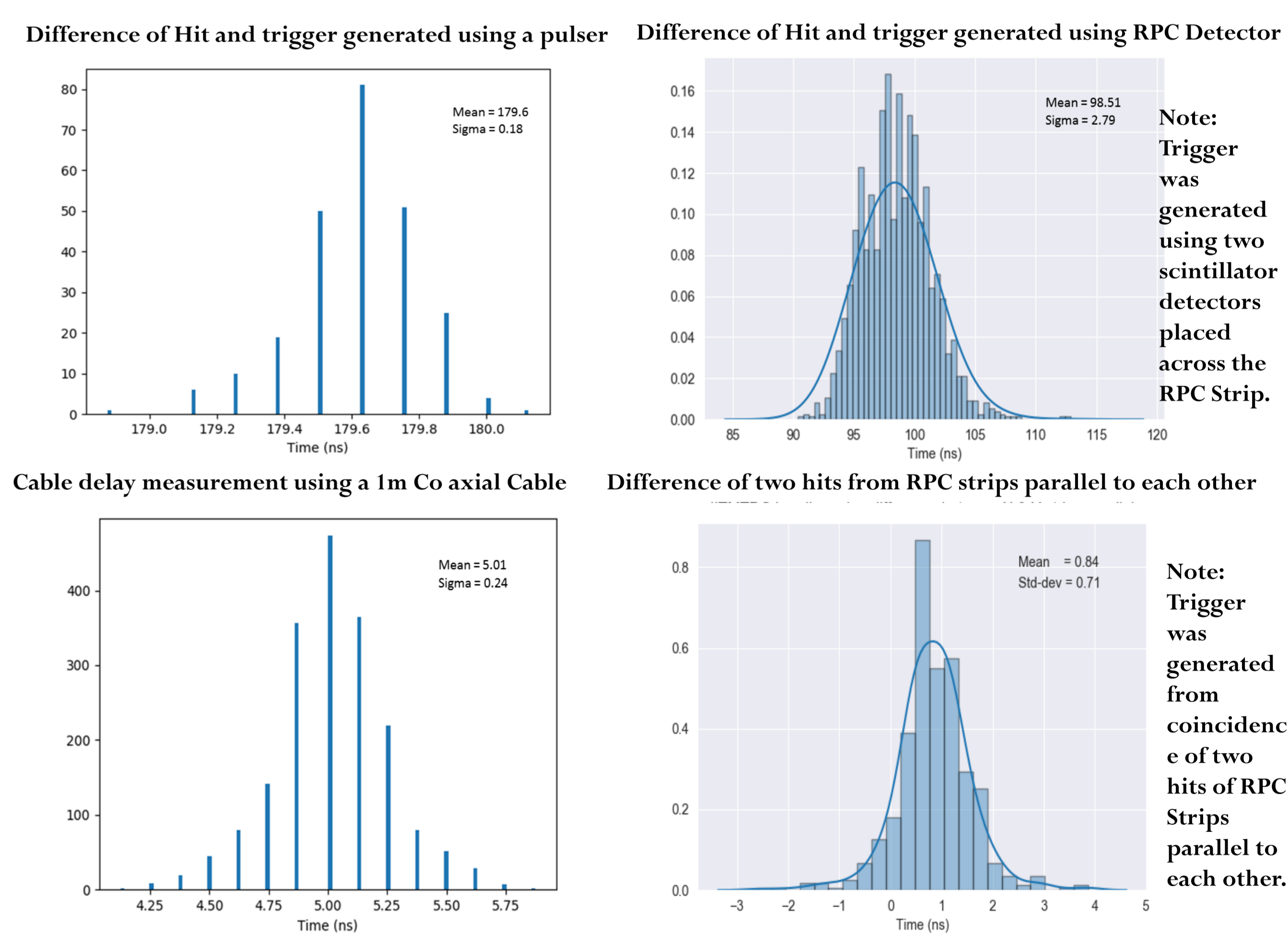
Simplified Block Diagram



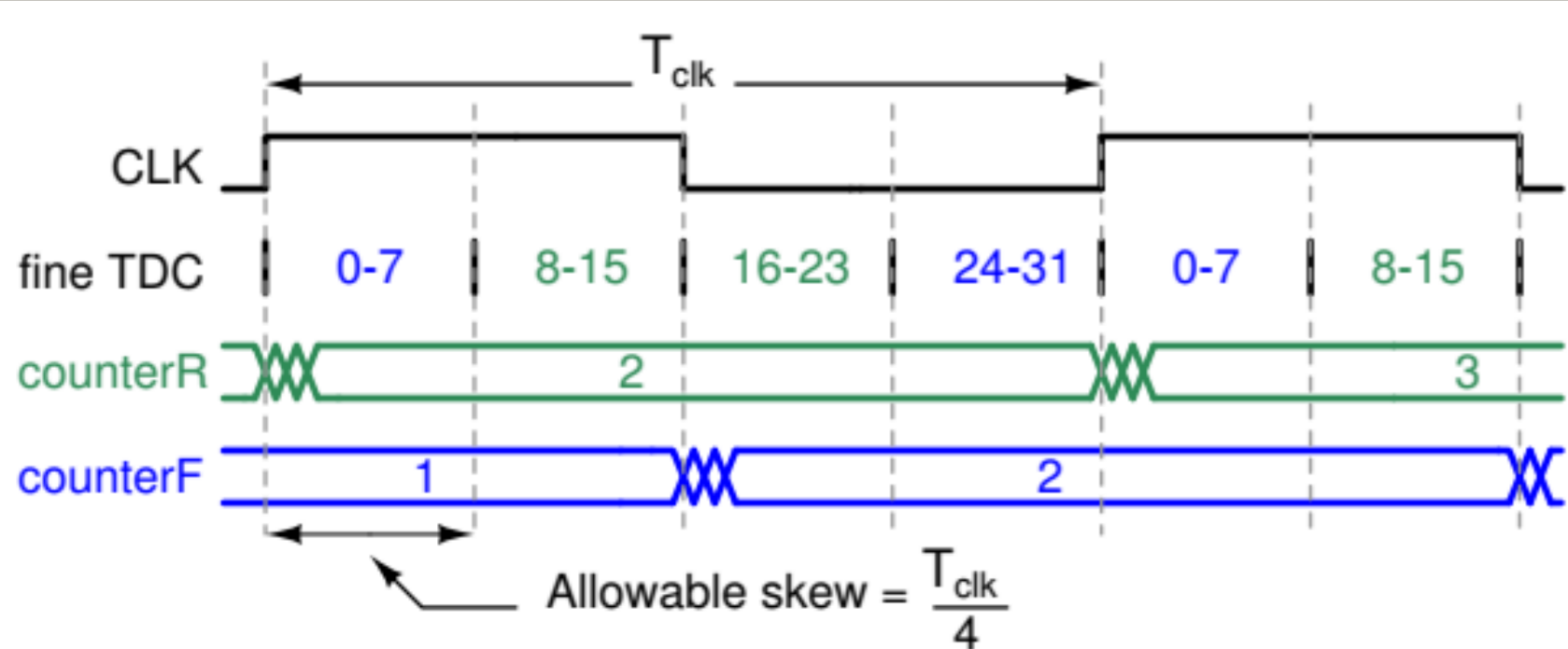
Test Setup



Results

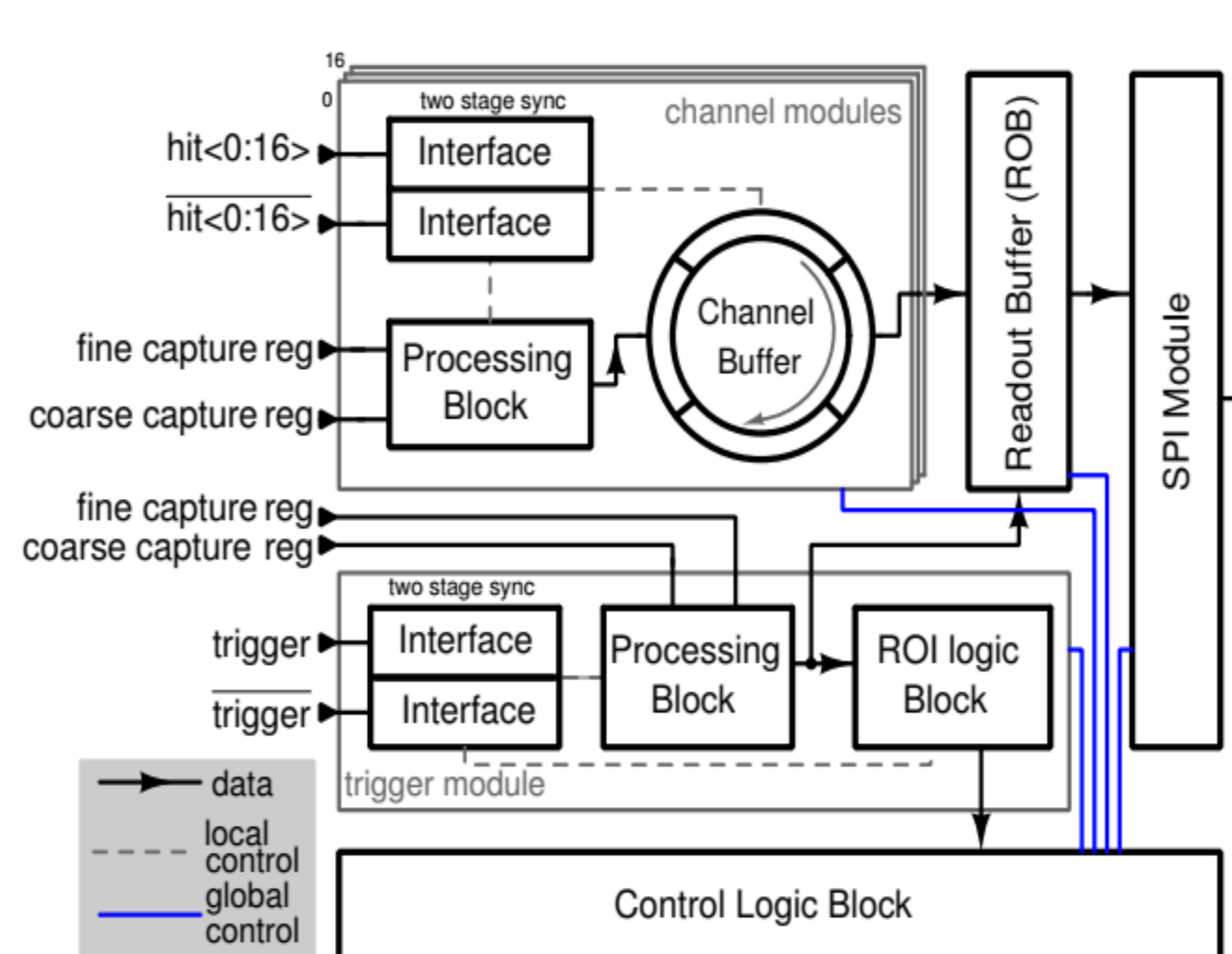


Coarse Counter Jitter handling



- Two coarse counters are implemented one running at rising edge of clock and other running at falling edge of the clock.
- Coarse counter jitter was handled by the Encoder by choosing one of these counter using the Fine counter value.
- Depending on the phase of the coarse clock where the Fine counter value indicates which counter to use.

Back End



Conclusion and Future Scope

- At Present INO TDC is interfaced with RPC-DAQ FPGA via test boards and adapter and performance was studied.
- Present results shows INO TDC suiting ICAL timing Requirements.
- Wafer production for more quantities will begin shortly
- Design of Next version of RPC DAQ with INO TDC is started.