

# A Low-Latency Distributed Machine-Protection System for the PIP-II Linear Accelerator

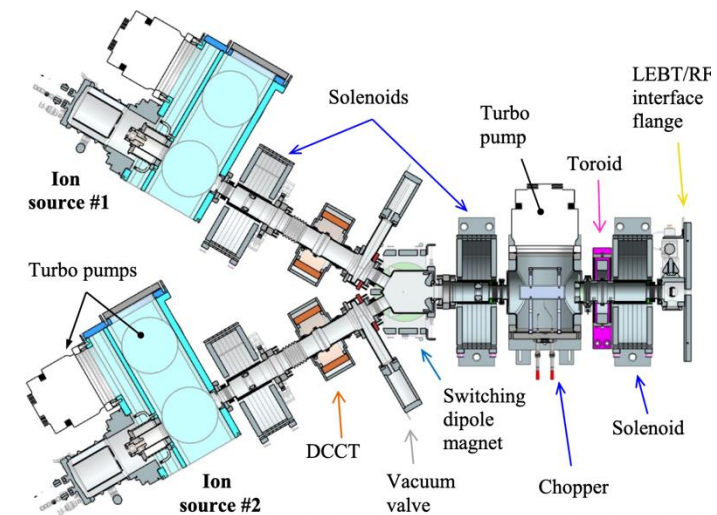
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- PIP-II: A new 800 MeV  $H^-$  superconducting linac at Fermilab, the first stage in delivering neutrinos to DUNE
- Machine Protection System: Protects the accelerator from beam-induced damage.
- Each remote node digitizes 8 channels of analog beam current measurements and streams the data to a central processor for multi-channel fault detection.
- Multiple beam current measurement combined to indirectly detect beam losses, especially in the low-energy sections of the linac.
- System optimized for low latency to inhibit the beam quickly, with high resolution measurement to assist in post-mortem diagnosis and to reject spurious signals.

Poster #96



Front view of the digitization node



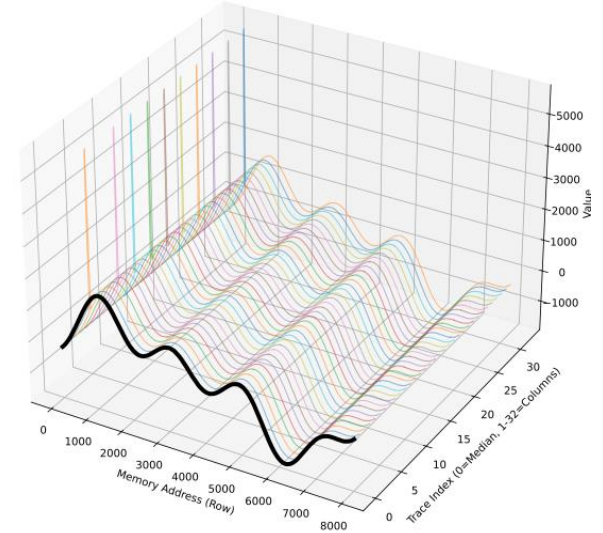
Ion sources and low energy beam transfer section of PIP-II

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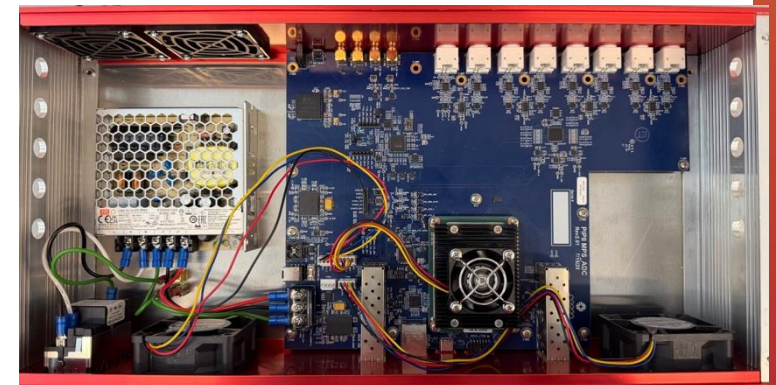
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- TI 16-channel 125 MHz digitizer over JESD206B deterministic latency link (ADS52J65)
- Xilinx Zynq Ultrascale+ based platform (Kria K26)
- Local FPGA performs lowpass filtering, calibration and 60 Hz noise subtraction.
- Continuous data stream to both the central node (2x10gbps fiber) and DMA to local circular buffer in DDR for post-fault analysis and monitoring.
- Local processor system responsible for temperature monitoring, cooling, power and digitizer configuration.

Poster #96



32 simulated 60 Hz cycles, with the 20 Hz beam signal and the median.



Internal view of the digitization node