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Design and development of turn-by-turn and bunch-by-bunch high-speed 128-channel data acquisition electronics applied to the HIAF facility

Monday 8 September 2025 16:00 (2 hours)

Real-time precision monitoring of beam profiles and emittance parameters in the High-Intensity Heavy-Ion Accelerator Facility (HIAF) presents critical challenges for analyzing collective beam effects and optimizing operations. During acceleration phases requiring sub-microsecond temporal resolution (0.1-2.048 MHz cyclotron frequency), we developed a heterogeneous computing-based diagnostic system achieving 15 MS/s 128-channel synchronous sampling.The hardware integrates ZYNQ-UltraScale+ MPSoC with eight Kintex-7 FPGAs through a custom nanosecond-synchronized backplane, delivering 26.88 GS/s parallel throughput. A phase-locked adaptive algorithm using multi-channel SUM values enables dynamic frequency matching and real-time turn-by-turn processing. Coupled with multi-wire detectors and residual gas probes (IPM), the system resolves transverse beam profiles (≤500 ns/turn) and longitudinal charge dynamics simultaneously, enabling full 4D phase-space reconstruction for unprecedented accelerator control.

Footnotes

Funding Agency

I have read and accept the Conference Policies

Yes

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