Contribution ID: **1592** Contribution code: **THPS140** Type: **Poster Presentation**

High precision RF pulse shaping with direct RF sampling for future linear accelerators

Thursday 5 June 2025 15:30 (2 hours)

In various of particle accelerator designs, amplitude and phase modulation methods are commonly applied to shape the RF pulses for implementing pulse compressors or compensating for the fluctuations introduced by the high-power RF components and beam loading effects. The phase modulations are typically implemented with additional phase shifters that requires drive or control electronics. With our recent next generation LLRF (NG-LLRF) platform developed based on the direct RF sampling technology of RF system-on-chip (RFSoC) devices, the RF pulse shaping can be realized without the analogue phase shifters, which can significantly simplify the system architecture. We performed a range of high-power experiments in C-band for evaluating the RF pulse shaping capabilities of the NG-LLRF system at different stages of the RF circuits. In this paper, the high-power characterization results with the Cool Copper Collider structure driven by RF pulses with different modulation schemes will be described. With the pulse modulation and demodulation completely implemented in digital domain, the RF pulse shaping schemes can be rapidly adapted for X-band structures just by adding analogue mixers.

Footnotes

Paper preparation format

LaTeX

Region represented

America

Funding Agency

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Session Classification: Thursday Poster Session

Track Classification: MC6: Beam Instrumentation and Controls,Feedback and Operational Aspects: MC6.T27 Low Level RF