
Contribution ID: **27** Type: **Contributed Talk**

# Optimization of FEL performance using modern LLRF systems

*Monday 14 July 2025 15:45 (15 minutes)*

The performance of Free Electron Lasers (FELs) strongly depends on the stability, synchronization, and control of the electron beam that drives the lasing process. While Low-Level RF (LLRF) systems are a critical component regulating the amplitude, phase, and frequency of the RF accelerating fields within linac structures, they form part of a broader control system required to ensure overall beam quality and stability.
As FELs increasingly demand higher peak currents, shorter bunches, and sub-femtosecond timing precision, LLRF systems face increasingly stringent performance requirements. Modern digital LLRF systems must incorporate fast feedback, precise timing control, and real-time processing to meet these challenges particularly in high frequency regimes such as X-band, which require tight field stability and fast system response.
Advances in digital LLRF architectures, high-speed data converters, machine learning based control, and real-time FPGA processing are enabling new possibilities for enhancing FEL beam quality and operational flexibility. In particular, X-band accelerator structures present unique challenges and opportunities for LLRF integration, including improved temporal resolution and a reduced footprint.
This talk presents an overview of state-of-the-art LLRF system architectures, highlighting their role in enhancing beam stability, synchronization, and lasing performance, with a focus on next-generation FELs such as EuPRAXIA.

**Author:** MERUGA, Phani Deep

**Presenter:** MERUGA, Phani Deep

**Session Classification:** Session 2: FEL driven by LWFA