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Tuning-Free High-Gradient RF Structures: From SwissFEL to FCC-ee –A Scalable Technology for Future Accelerators

Tuesday 12 August 2025 14:50 (20 minutes)

At the Paul Scherrer Institute (PSI), a novel, industrially scalable, and tuning-free manufacturing process for normal-conducting high-gradient C-band accelerating structures has been developed and successfully implemented for the Swiss Free-Electron Laser (SwissFEL). This approach, which eliminates RF post-production tuning, achieves excellent field flatness and phase accuracy through ultra-precision machining and brazing techniques. Over 100 accelerating structures were produced and installed without tuning, operating reliably with breakdown rates below 1e-9 bpp/m. Following SwissFEL's commissioning and successful operation, PSI extended this process to other frequency bands, including S-band and X-band, for applications in collaborations with CERN, ELETTRA, and DESY. These efforts include the construction of X-band accelerating structures for CLIC, high-gradient S-band structures for the FERMI FEL upgrade, and the development of ultra-precise transverse deflecting structures (TDS) with variable polarization for advanced beam diagnostics. Building on this expertise, PSI is now leading a multi-institutional effort to develop the lepton injector for the FCC-ee, with plans for mass production of over 400 tuning-free RF structures. This contribution presents the evolution, deployment, and future prospects of tuning-free RF structure technology, underscoring its pivotal role in the next generation of accelerator infrastructures.

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No

Footnotes

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Yes

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