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A low-level radio frequency (LLRF) control system for multiple superconducting cavities based on MicroTCA.4

Tuesday 23 September 2025 14:30 (3 hours)

In modern particle accelerators, multiple superconducting cavities are often driven simultaneously by one high-power klystron, thereby reducing the cost of the power supplies. The CEPC TDR specifies 96 cryomodules for 650 MHz 2-cell cavities, with each cryomodule originally housing two cavities. During the horizontal testing phase, however, we plan to simultaneously drive six superconducting cavities per klystron to verify the RF system's reliability. This approach significantly reduces the cost of the power supply but introduces several challenges for high-precision control of superconducting cavities, such as gradient differences due to individual cavity variations, frequency offsets caused by Lorentz force detuning, and the calibration of vector sum of amplitudes and phases for multiple cavities. This paper introduces the design of China's first LLRF control system for multi-superconducting cavity control, based on a fully domestic MicroTCA.4 platform with self-developed hardware and software capable of supporting both pulsed and continuous wave operation modes. Based on the vector-sum control principle, the system utilizes IQ sampling, feedforward-feedback control, and other techniques, eventually achieving high-precision amplitude and phase control and frequency tuning of six superconducting cavities through comprehensive domestic innovation in critical components and control algorithms.

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Yes

Footnotes

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