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Limitations of the EuXFEL 3rd harmonic cryomodule in high duty cycle operation

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Future High Duty Cycle (HDC) operation scenarios of the European X-ray Free Electron Laser (EuXFEL) promise increased bunch repetition rate and photon delivery, at the cost of changing system requirements and moving away from the current mode of Short Pulse (SP) operation. To assess whether the third harmonic cryomodule design is also suitable for Long Pulse (LP) and Continuous Wave (CW) operation, key parameters of the spare module are examined at the Accelerator Module Test Facility (AMTF). For Radio-Frequency (RF) related energy efficiency, the cavity resonance tuning precision and the loaded quality factor tuning range are investigated. As performance indicators, limitations on attainable cavity gradient and RF stability are quantified. The results show that the module in its current design is insufficient for LP at high duty cycles and CW at the required operating points. The installed 3-stub tuners only yield maximum loaded quality factors between 5.3e6 and 1.9e7, and the mechanical cavity tuner prohibits tuning precision within the intended cavity half bandwidth. Also, some higher order mode couplers do not allow CW operation at required gradients. Nevertheless, closed-loop RF stability measured in single cavity control is comparable to that of the third harmonic system of EuXFEL.

Footnotes

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