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High loaded quality factor superconducting cavities accelerating field parameters regulation during continuous wave operation

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Superconducting niobium cavities are main accelerating components in various research facilities. These installed in the European X-ray Free Electron Laser and other free electron lasers are operated in high gradient range (above 20 MV/m). Electron beam acceleration is realized in short (1-2ms) pulse mode in some devices or in continuous wave in case of others.

EXFEL or FLASH have been designed to be a short pulse machines. Nowadays switching from short pulse to long pulse or CW mode is investigated. Current paper describes extensions of the short pulse mode dedicated Low Level Radio Frequency (LLRF) control systems. Main goal of this accelerator sub-component is to provide accurate regulation of amplitude and phase parameters of accelerating field to achieve best energy transfer to the electron beam. Proposed modifications and adjustments have been introduced to verify system versatility in different cavities operation modes support. LLRF system potential have been successfully verified with single cryomodule that consists of 8 superconducting structures (with 1,3 GHz fundamental frequency). The same system (with slightly adjusted software) is being used for both SP and CW operation.

CW scenario requires better energy management and precise control in case of cavities working with high quality factor conditions (Q). System test results that almost fulfill short pulse linac regulation performance requirements in case of this challenging system configuration are also presented and discussed.

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Description

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