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New LLRF control system at LNL

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The Low-level Radio Frequency (LLRF) control system for linear accelerator at Legnaro National Laboratories (LNL) of INFN is being upgraded by a new digital Radio Frequency (RF) controller. This controller is critical to keep phase, amplitude and frequency stability of the RF field in Quarter Wave Resonator (QWR) cavities of the linear accelerator. These cavities work in superconducting condition. The resonance frequency of low beta cavities is 80 MHz, while medium and high beta cavities resonate at 160 MHz.

Each RF controller can control at the same time eight different cavities. The RF signals picked-up from the cavities are sampled by RF ADCs. The digitized signals are fed into a field programmable gate array (FPGA) which implements the control loop. The signals processed by the FPGA are in-phase/quadrature modulated and sent to power amplifiers and hence to the cavities.

The main feature of the new control system is an all-digital control loop that originates from direct sampling of the antenna RF signal. In-phase and quadrature components are obtained by a suitable choice of the undersampling frequency, while control of the field and phase in the cavity is based on a digital Complex Phase Modulator (CPM).

This paper presents the FPGA firmware, the acquisition techniques and the performances of the new RF controller.

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