Cavity Simulator for European Spallation Source

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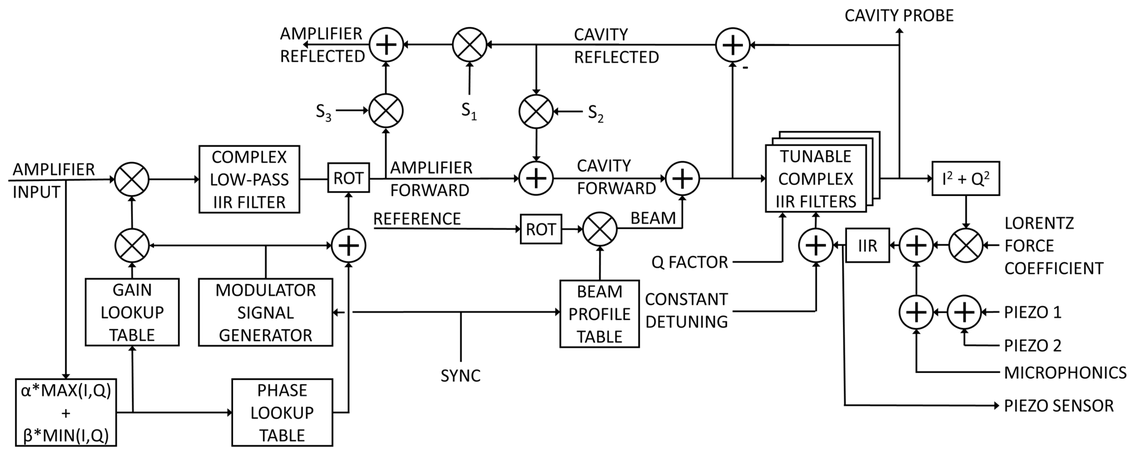
ABSTRACT

European Spallation Source will be the brightest neutron source in the world. It is being built in Lund, Sweden. Over 120 superconducting cavities will be installed in the facility, each regulated by an individual LLRF control system. To reduce the risk of testing the systems on real cavities a Cavity Simulator was designed. It reproduces the behavior of superconducting cavities used in the medium and high beta sections of ESS' Linac. The high power RF amplifier and piezo actuators' parameters are also simulated.

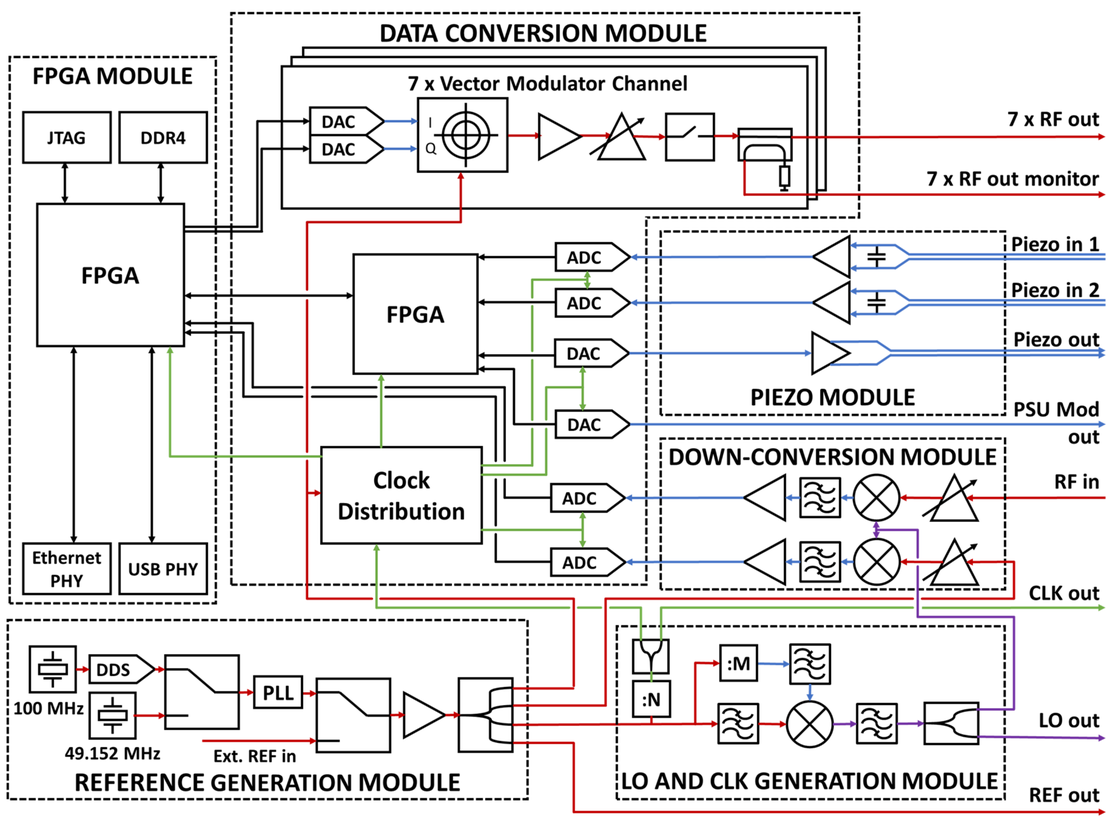
Based on the RF drive and piezo control signals the Cavity Simulator generates the RF signals acquired by the inputs of the LLRF control system. This is used to close the LLRF feedback loop in real time. The RF front end of the Cavity Simulator consists of vector modulators, down-converting circuits, and a set of fast data converters. The cavity response simulation is performed in a high speed FPGA logic by a dedicated firmware, that was optimized to minimize the processing time. The device also generates clock, LO, and the 704.42 MHz reference signals to allow for system tests outside of the accelerator environment.

In this contribution the design of the Cavity Simulator, description of the algorithms used in the firmware, and measurement results of the device are presented.

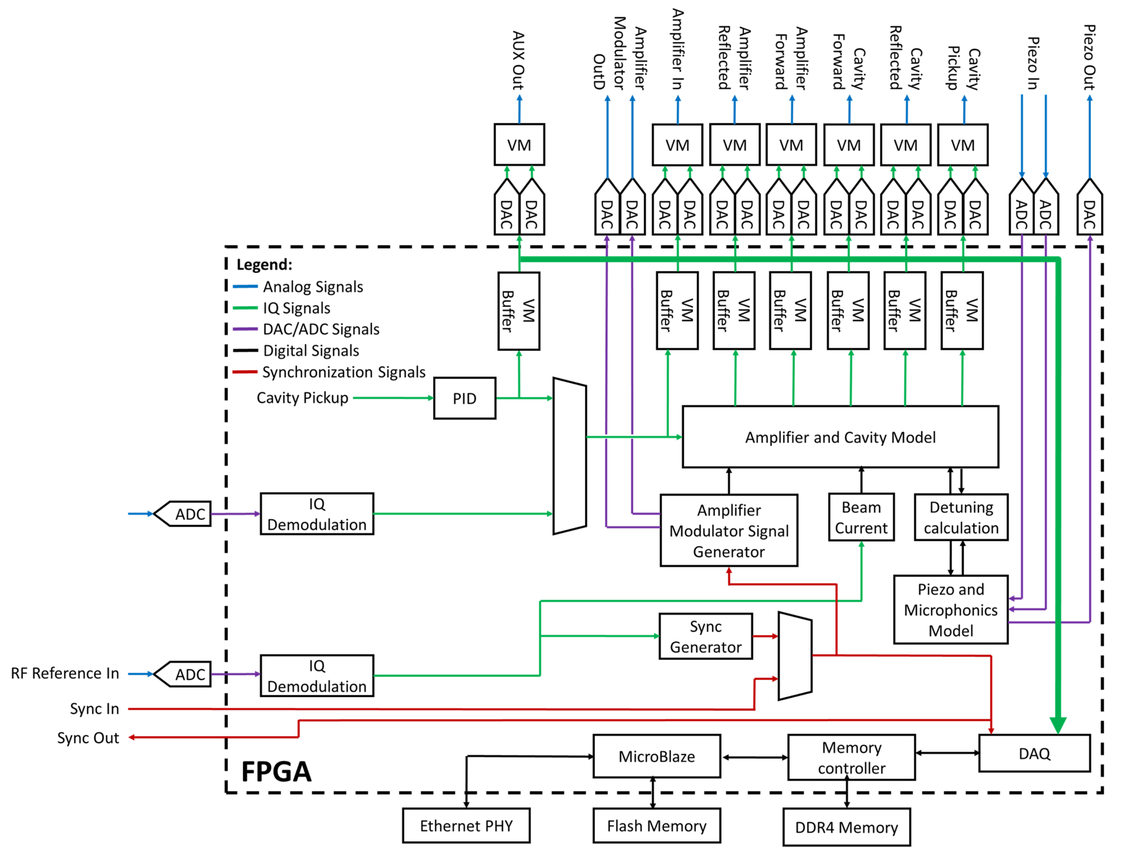
MODEL



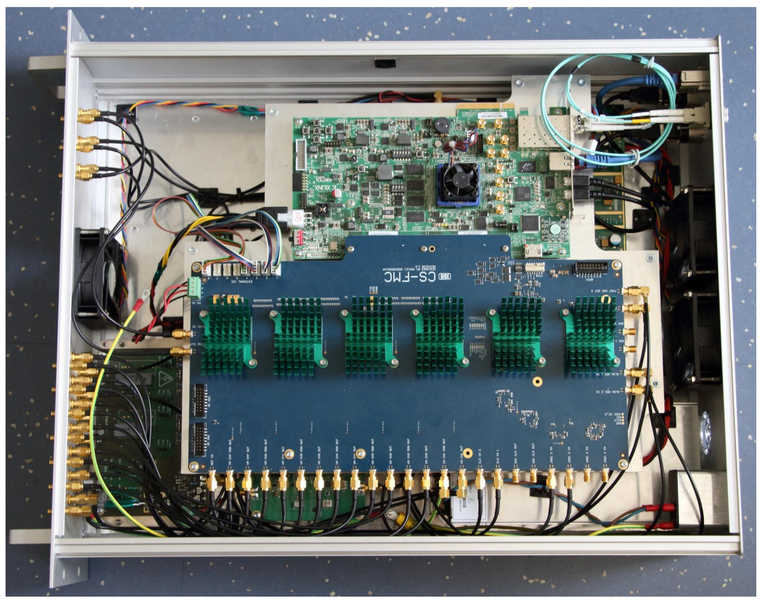
HARDWARE



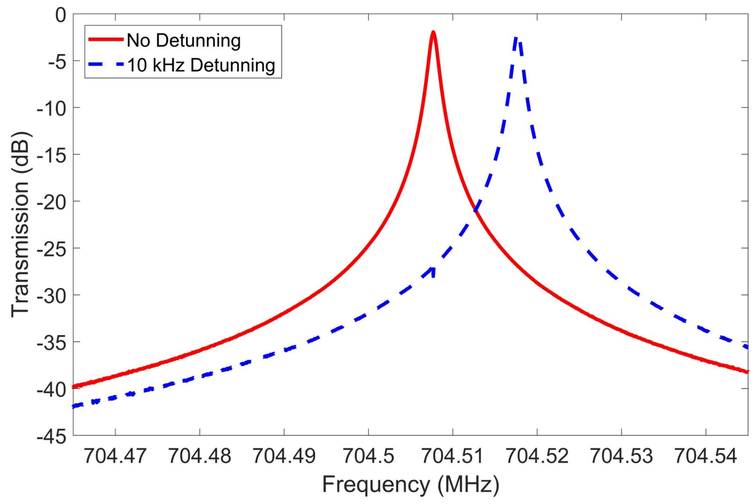
FIRMWARE



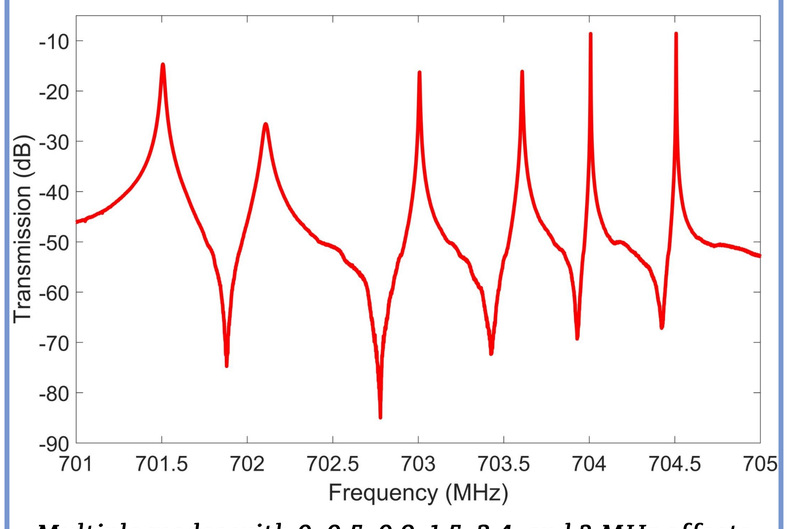
PHOTO



TRANSMISSION

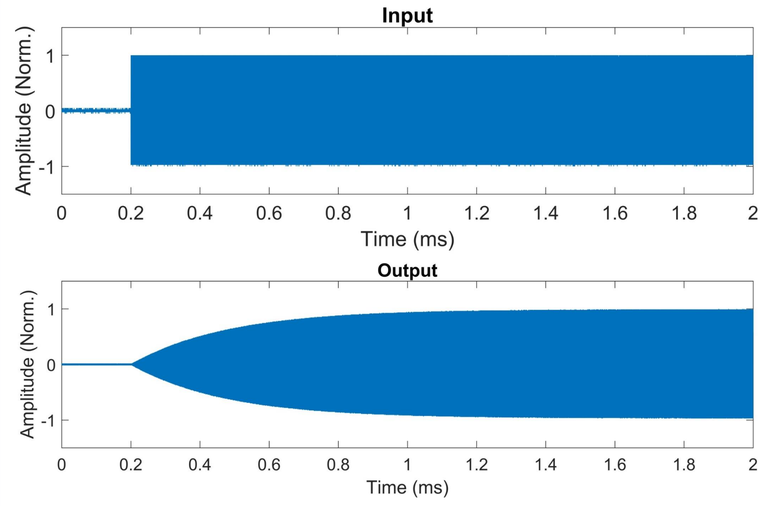


Single mode (Q ≈ 700 000) with 0 and 10 kHz detunning

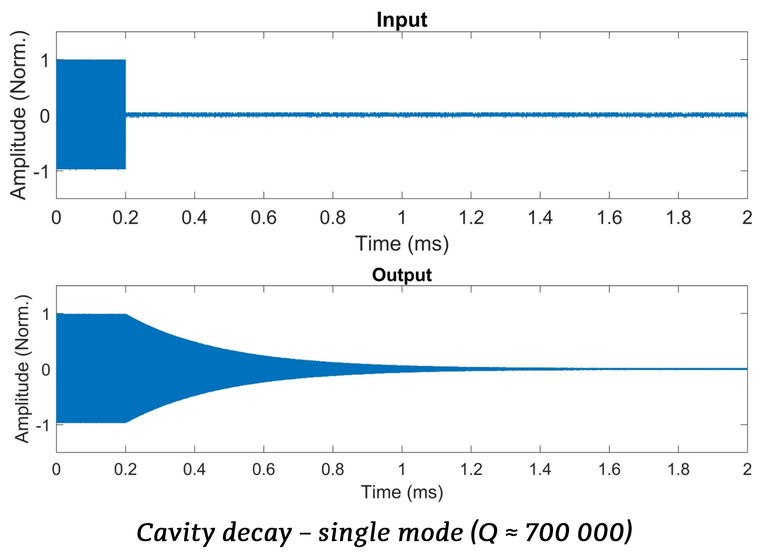


Multiple modes with 0, 0.5, 0.9, 1.5, 2.4, and 3 MHz offsets

FILLING AND DECAY

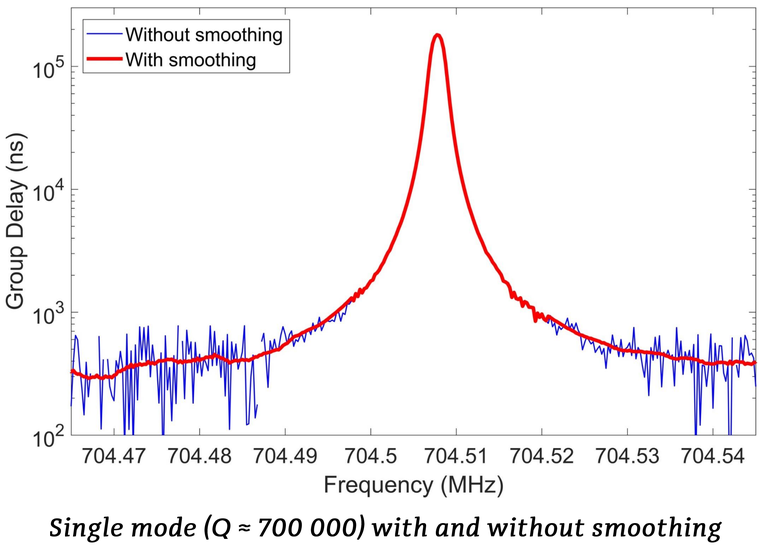


Cavity filling – single mode (Q ≈ 700 000).



Cavity decay – single mode (Q ≈ 700 000)

GROUP DELAY



Single mode (Q ≈ 700 000) with and without smoothing

CONTACT

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