MESA - Status of the Implementation of the MicroTCA.4-based LLRF Control System

THPO007

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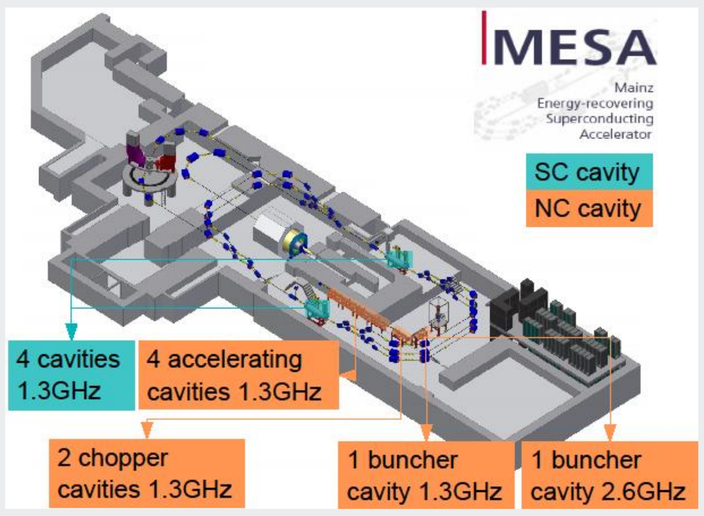
Abstract

MESA is a multi-turn Energy-Recovery-Linac under construction at JGU Mainz, which aims to serve as user facility for particle physics experiments. Its RF-accelerating systems consist of four 9-cell TESLA superconducting cavities and 8 normal conducting cavities working in CW mode. MESA requires RF amplitude and phase stabilities better than 0.01% and 0.01˚. The MicroTCA.4 based digital LLRF control system based on the development at DESY, Hamburg will be adapted for MESA cavities. A Matlab/Simulink model was created to find the proper control parameters and to predict the system performance. We present the simulation results and the progress of the implementation.

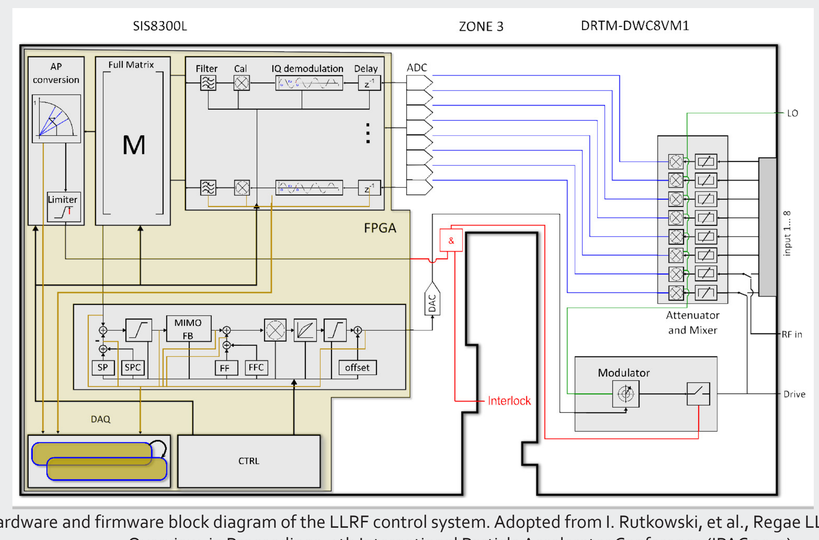
Overview of the MESA RF topology



(1) Overview of MESA RF system topology.

View MESA animation on YouTube: https://youtu.be/RrfiGatx9_4

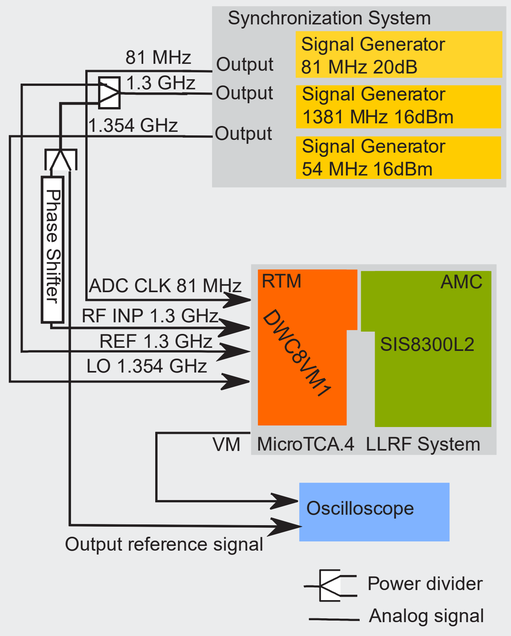
MicroTCA.4 based LLRF system



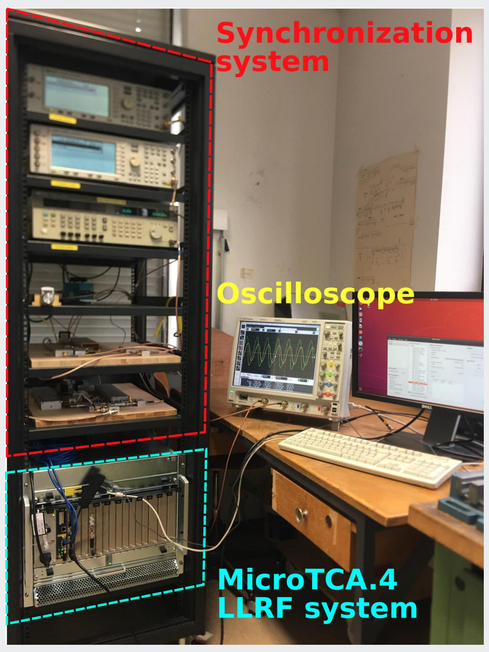
(2) Hardware and firmware block diagram of the LLRF control system. Adopted from I. Rutkowski, et al., Regae LLRF Control System Overview, in Proceedings, 4th International Particle Accelerator Conference (IPAC 2013).

LLRF test setup

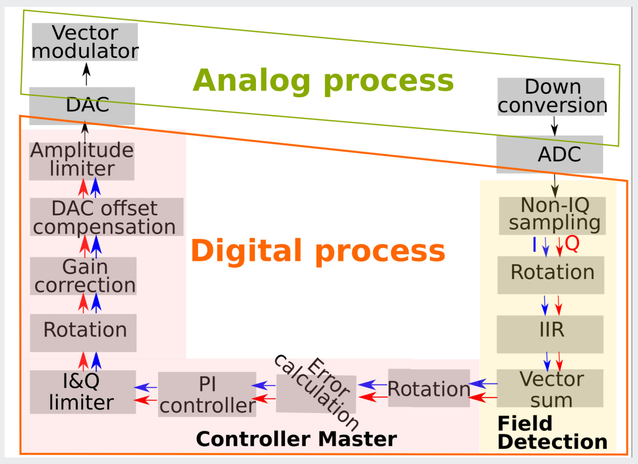
The first test setup is built to check a phase shift of the VM output signal according to the phase shift of the RF input signal in an open-loop.



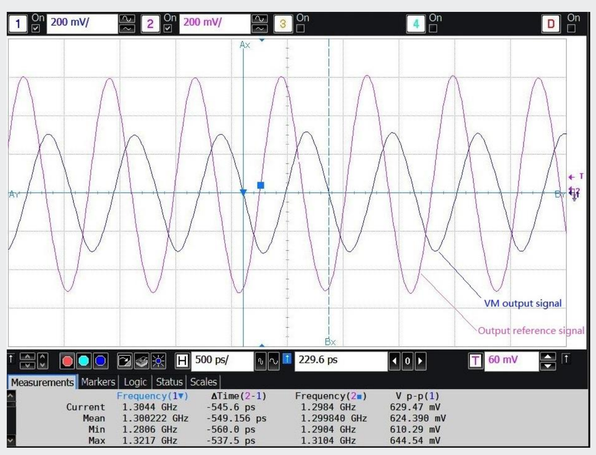
(3) Block diagram of the LLRF test setup.



(4) Front side view of the LLRF test setup.



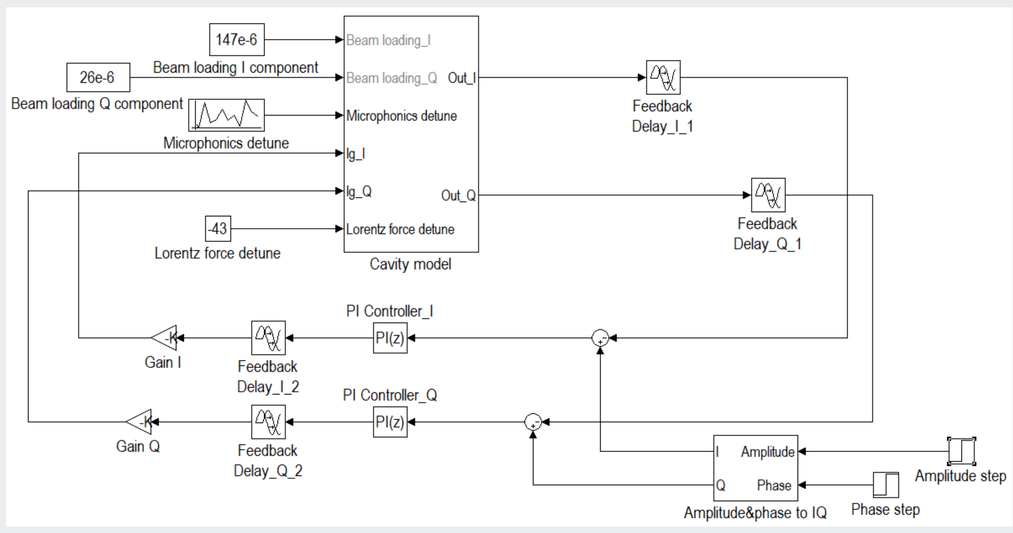
(5) Block diagram of the LLRF firmware.



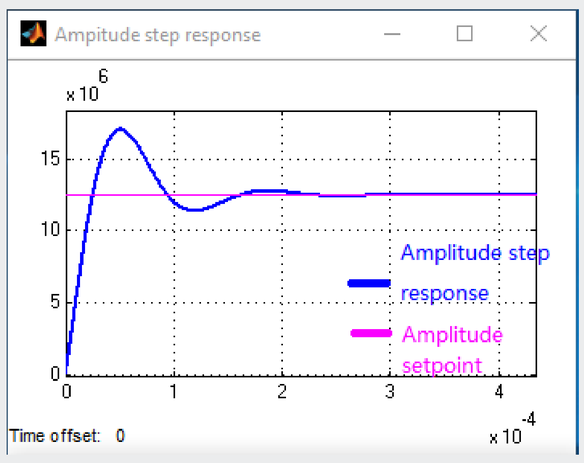
(6) VM output and reference signals and their phase difference observed by an oscilloscope.

Model simulation

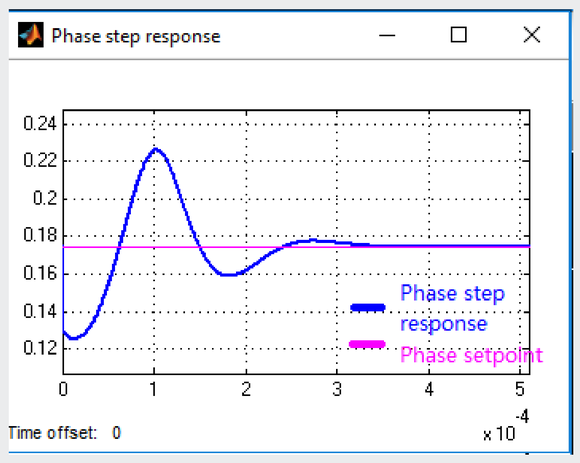
A Matlab/Simulink model is developed to proof the concept, simulate the system response, perform the stability analysis of the control system and optimize control parameters.



(7) Simulink model of the LLRF control system to proof the concept.



(8) Amplitude step response (P gain = 400 and I gain = 25000000).



(9) Phase step response (P gain = 300 and I gain = 11000000).

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