

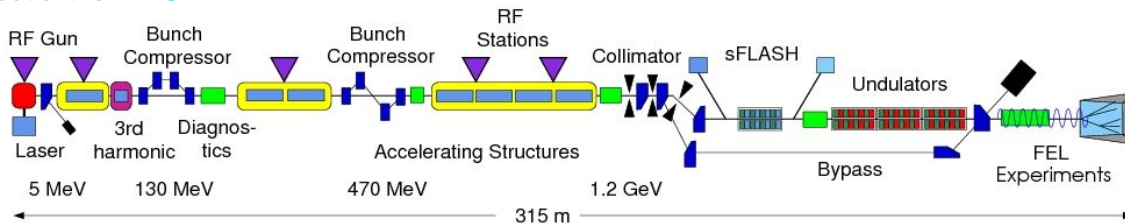
LLRF Control System Upgrade at FLASH

V. Ayvazyan, K. Czuba, Z. Geng, M. Grecki, O. Hensler, M. Hoffmann, M. Hoffmann, T. Jezynski, W. Koprek, F. Ludwig, K. Rehlich, H. Schlarb, C. Schmidt, S. N. Simrock, H.-C. Weddig; DESY, Hamburg, Germany

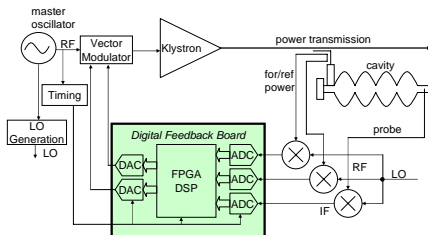
Abstract

The Free Electron Laser in Hamburg (FLASH) is a user facility providing high brilliant laser light for experiments. It is also a unique facility for testing the superconducting accelerator technology for the European XFEL and the International Linear Collider. As a test facility, the accelerator undergoes a constant modification and expansion. The last upgrade was started in autumn 2009 and has finished recently. The beam energy is increased to 1.2 GeV by installing a 7th superconducting accelerating module. The new module is a prototype for the European XFEL. In order to increase the free-electron laser radiation intensity by linearization of the beam phase space the 3rd harmonic superconducting RF cavities are installed in the injector. The old DSP based LLRF control system has been completely upgraded to latest generation controller boards, down-converters for higher intermediate frequency, algorithms like beam loading compensation, feed-forward waveform generation, etc. are improved. In order to improve the reference frequency signals the master oscillator and frequency distribution system has been upgraded as well.

Layout of the FLASH



Architecture of the LLRF System



Digital Feedback Hardware

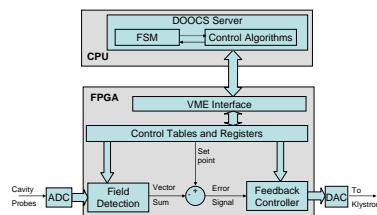
- Upgrade LLRF of all RF stations
- Same type of hardware
- SimconDSP controller
- IF = 250 kHz, IQ-sampling scheme
- Sampling rate 81 MHz
- RF control for 3.9 GHz
- Probe, forward, and reflected signals
- New RF downconverter & LO generation with
- IF = 54 MHz, non IQ-sampling, LO = 3954 MHz
- Sampling rate 81 MHz

SimconDSP Board



- 10 Channel 14 bit ADCs
- 81 MHz clock rate
- 4 DAC, 14 bits
- 2 Gigalinks
- FPGA: XILINX Virtex II pro

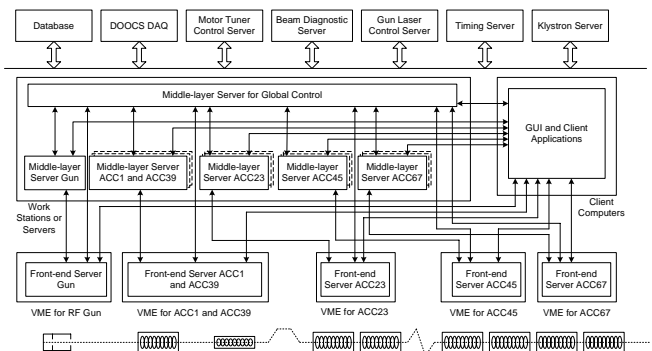
Controller Firmware and Software Architecture



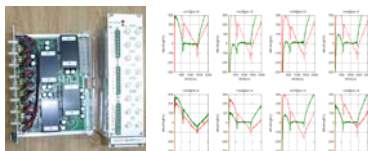
Digital Feedback Software

- Unified and new control software
- New C++ architecture for front-end server
- LLRF library based on SysML approach
- Unified naming convention
- Automatic firmware downloads
- Finite State Machine for automation
- High level software: diagnostics, calibration...
- Integration to data acquisition system
- Model based adaptive feed forward
- Loop phase/gain correction
- Fast piezo control for cavity detuning comp.
- ... and many more

Allocation of the LLRF Applications



Piezo Control Operation at ACC6



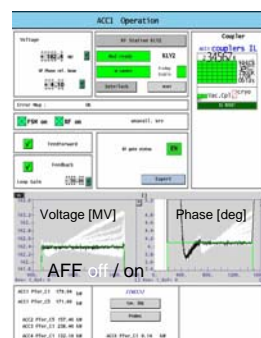
Red – without piezos Green – with piezos

Master Oscillator at FLASH

- New Master installed
- Finishing up with backup Master and refurbished cabling
- New rack & cabling for RF gun and ACC1/ACC39
- Enclosed racks for better temperature stability
- Parallel cabling for development system
- Careful noise investigation and power level adjustment of LO and RF signals



Adaptive Feed-Forward



Performance Results

