Abstract
FERMI is the first seeded Free Electron Laser (FEL) user facility. A number of shot-to-shot feedback loops running synchronously at the machine repetition rate (50Hz) stabilize the electron beam trajectory, energy and bunch length, as well as the trajectory of the laser beams used for the seeding and pump-probe experiments. They are based on a flexible real-time distributed framework integrated into the control system. The independence between feedback loops and the need to react coordinately to different operating conditions lead to the development of a real-time supervisor capable of controlling each loop depending on critical machine parameters not directly involved in the feedbacks. The overall system architecture, performance and user interfaces are presented.

Electron Beam Feedbacks

Two pulsed laser systems are currently installed in FERMI: the photo-injector laser and the seed laser. The former is used to extract and shape the electron bunch from the cathode and also used for the Laser Heater. The latter is one of the most sensitive systems of FERMI: a variation of 0.01°C of the seed laser room temperature determines a time shift between the electron bunch and the seed laser pulse of 50 fs with a consequent drop of the FEL output intensity. Two different types of shot-to-shot feedbacks guarantee temporal and trajectory stability of the seed laser. Both of them make use of CCD cameras and mirrors moved by piezoelectric devices.

Laser Beam Feedbacks

The images are acquired by Intel based dual-CPU servers through Gigabit Ethernet links from Basler CCD cameras. The calculation of the beam position using one of the possible algorithms (raw RMS, Gaussian, Asymmetric Gaussian, etc.) is performed by a Tango device server. An optimized code, which makes use of the GNU Scientific Library (GSL) for non-linear fitting and of the OpenMP GCC extension for parallel computing, allows calculating an Asymmetric Gaussian fitting of the laser spot in less than 0.4 ms, a time sufficient to perform a 50 Hz feedback loop.

Trajectory Feedbacks

The main goal of the transverse feedbacks is to stabilize the trajectory in the Elettra in order to control the wake-fields, and inside the undulators, to preserve the overlap with the seed laser. There are presently four feedback loops: two dedicated to FEL-1 and two to FEL-2 operations, controlling a total of 62 Beam Position Monitors (BPM) and 62 correctors.

Energy / BunchLength Feedbacks

At present we operate three separate longitudinal feedback loops. The first controls the energy in the Laser Heater (LI) and energy and bunch length in the first Bunch Compressor (BC01). A second loop controls energy and bunch length in the second Bunch Compressor (BC02). At the end of the linac a third loop stabilizes the final beam energy. Energy and bunch length are measured by BPMs in dispersive regions and pyro detectors respectively. The actuators are amplitudes and phases of the RF plants.

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