The Control System of the FERMI@Elettra Free Electron Laser

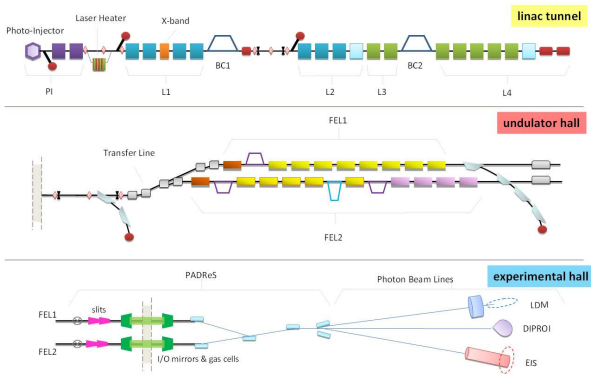
M. Lonza, A. Abrami, F. Asnicar, L. Battistello, R. Borghes, V. Chenda, S. Cleva, G. Del Prete, M. Dos Santos, S. Fontanini, G. Gaio, F. Giacuzzo, R. Marizza, R. Passuello, L. Pivetta, R. Pugliese, C. Scafuri, G. Scalamera, G. Strangolino, D. Vittor, L. Zambon, Sincrotrone Trieste, Trieste, Italy

Abstract

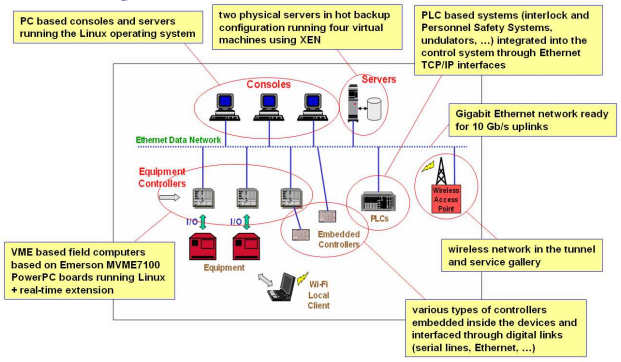
FERMI@Elettra is a new 4th-generation light source currently under construction at the Elettra laboratory. It is based on a single pass free electron laser consisting in a 1.5-GeV normal-conducting linac and two chains of undulators where the photon beams are produced with a seeded laser multistage mechanism. The control system interfaces to and controls all devices and systems of the facility. The hardware architecture has been designed using commercial components and open standards, and a software environment based on GNU/Linux and the Tango control system is deployed on all computers. The safety and protection systems rely on a well established technology based on PLCs. A real time infrastructure based on a dedicated Ethernet network and a real-time implementation of Linux provides centralized shot-by-shot data acquisition at the linac repetition rate, as well as synchronized setting of the controlled variables required to implement feedback loops.

The FERMI@Elettra Free Electron Laser (FEL)

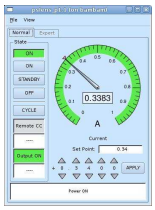
The accelerator complex comprises a high-brightness RF photocathode gun and a 1.5 GeV S band linac made of 18 accelerating sections powered by 15 RF plants. The produced electron beam has a single bunch structure with a repetition rate of 50 Hz. Two FEL cascades with laser seeded harmonic generation provide the beamlines with tunable output over a range from ~100 nm to ~4 nm, pulse duration of ~100 fs and peak power in the GW range. The generated radiation is spatially and temporally coherent, with fully variable output polarization. Four laser systems drive the photocathode gun, the laser heater, the FEL seeding and pump-and probe experiments on the beamlines.



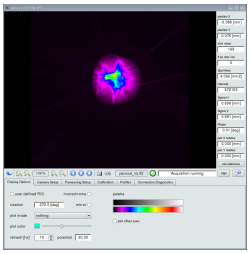
Control System Architecture

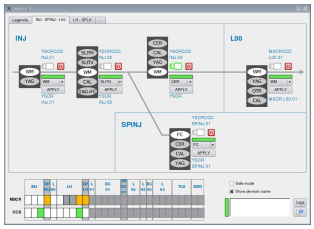


Control Room Software



- generic applications: browser/launcher, alarm system, historical archiving, save/restore, generic tool, etc.
- GUIs using *Qt* (by Trolltech) and *QTango* Libraries (see THP096)
- *QtDesigner* with new functionalities for drawing graphical components, managing layers and importing images (for synoptic panels development)
- online modeling toolkit for easy and quick development of machine physics applications (see TUP037)
- Matlab and its GUIs to develop some machine physics applications for the accelerator commissioning





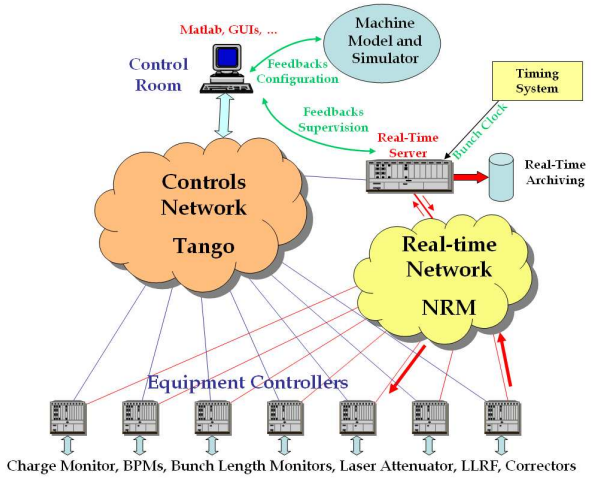
Real-Time framework

Requirements:

- implement built in capabilities to:
  - measure the characteristics of every single laser pulse, electron bunch and radiation pulse, and correlate them to each other
  - run beam-based shot-by-shot (50 Hz) feedback loops to stabilize the laser and electron beams

The implementation:

- control system computers run Linux + Xenomai real time extension
- a dedicated Ethernet network and a software application using the UDP protocol called Network Reflective Memory (NRM) implement a real-time shared memory
- a real-time server is in charge of:
  - bunch number distribution (time stamp)
  - synchronized data acquisition and recording
  - real-time feedback processing
- multiple feedback loops can run in parallel reading sensors and setting actuators through the NRM at the bunch repetition frequency (50 Hz)



for additional information, please contact:
Marco Lonza: marco.lonza@elettra.trieste.it

ICALEPCS 2009, Kobe, October 12-16, 2009