Control and Data Acquisition Systems for the FERMI@Elettra Experimental Stations

R. Borghes , V. Chenda, A. Curri, G. Gaio, G. Kourousias, M. Lonza, G. Passos R. Passuello, L. Pivetta, M. Prica, R. Pugliese, G. Strangolino
Sincrotrone Trieste, Trieste, Italy

ICALEPCS 2011

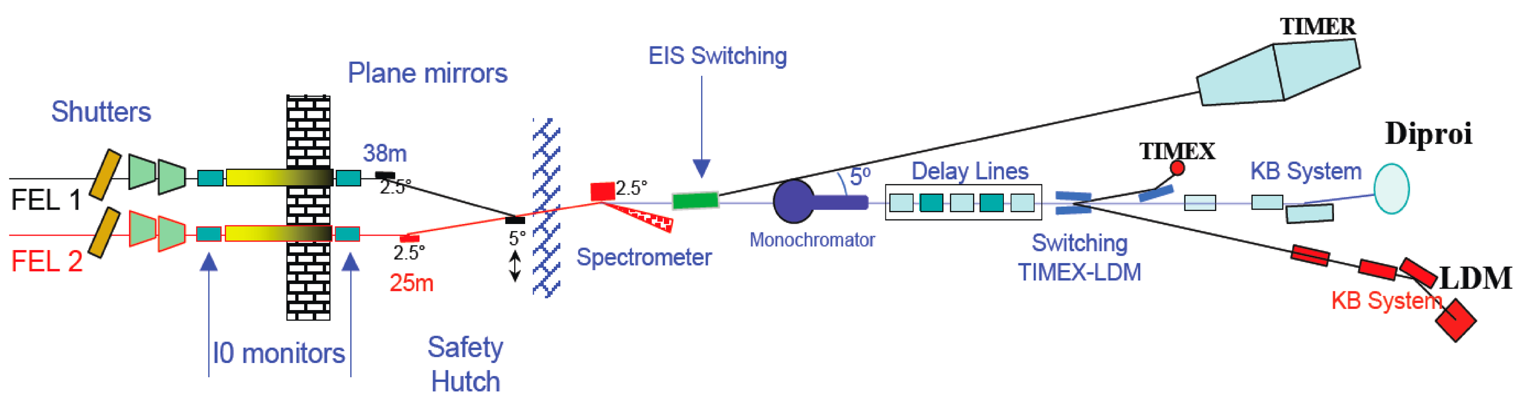
Overview

FERMI@Elettra is a single-pass Free Electron Laser (FEL) user-facility covering the wavelength range from 100 nm to 4 nm. The facility is located in Trieste, Italy, nearby the third-generation synchrotron light source Elettra. Three experimental stations, dedicated to different scientific areas, have been installed in 2011: Low Density Matter (LDM), Elastic and Inelastic Scattering (EIS) and Diffraction and Projection Imaging (DiProI). The experiment control and data acquisition system is the natural extension of the machine control system. It integrates a shot-by-shot data acquisition framework with a centralized data storage and analysis system. Low-level applications for data acquisition and online processing have been developed using the Tango framework on Linux platforms. High-level experimental applications can be developed on both Linux and Windows platforms using C/C++, Python, LabView, IDL or Matlab. The Elettra scientific computing portal allows remote access to the experiment and to the data storage system.

1. FERMI@ELETTRA

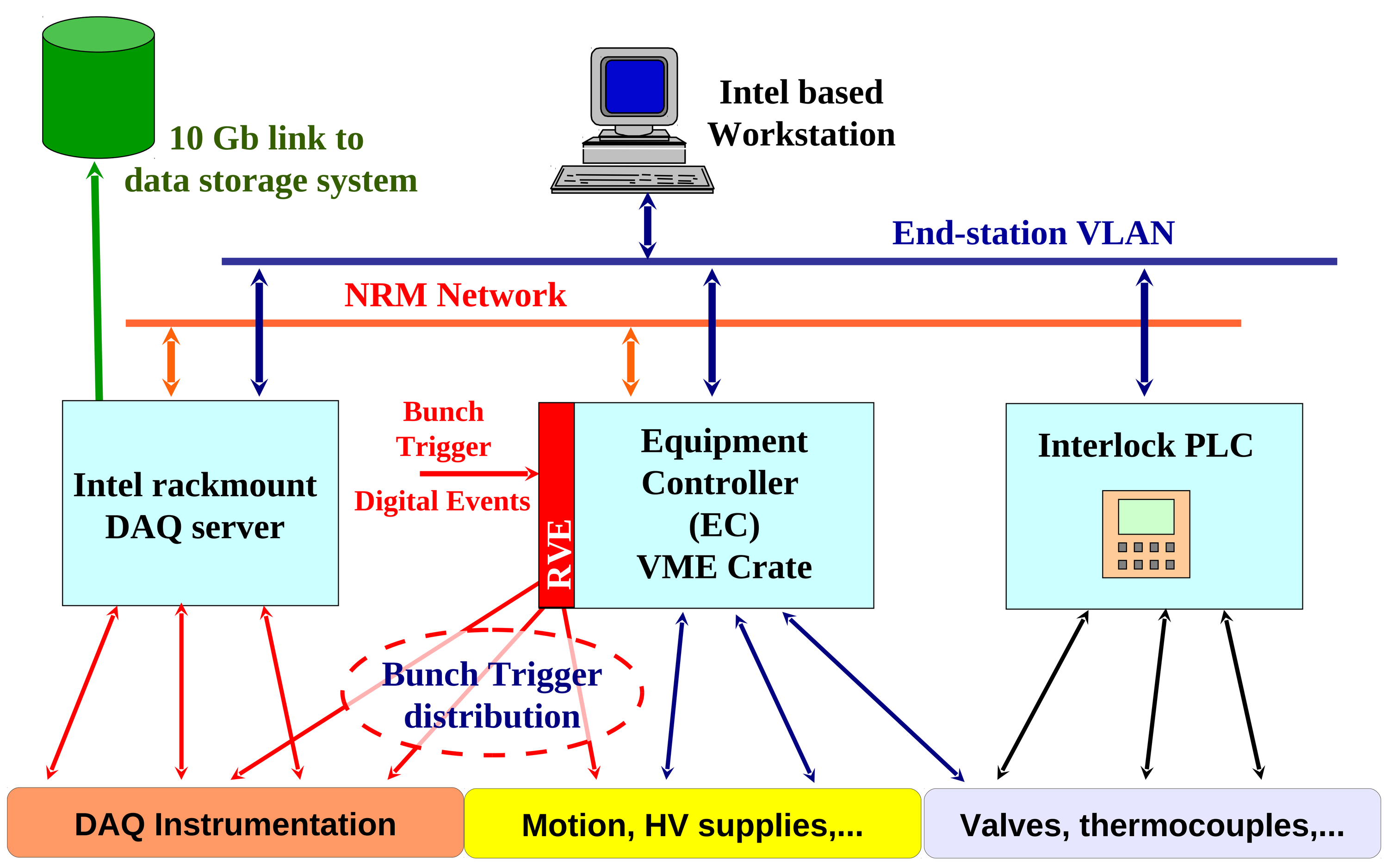
The newly-built free-electron laser FERMI@Elettra generated its first flashes of coherent light in the far ultraviolet in December 2010. The "first-shots" experimental activities, held in March and in July 2011, were mainly devoted to the commissioning and tuning of the three existing end-stations: LDM, EIS and DiProI.

Each laser pulse produced by FERMI@Elettra is unique in terms of spatial position, photon flux and energy spectrum. It is crucial to acquire and store *shot by shot* not only experimental data coming from the beamline detectors but also photon beam diagnostics data. The FERMI@Elettra fast data acquisition (DAQ) system is used to acquire, store and correlate multiple data sources.



2. HARDWARE ARCHITECTURE

Standard instrumentation is controlled by a VME system with an Emerson MVME-7100 PowerPC board (Equipment Controller – EC). The EC also hosts the Event Receiver (EVR) by Micro-Research, that receives the machine bunch trigger via a fiber optics infrastructure. Instruments requiring special hardware interfaces or proprietary software are controlled and acquired by an Intel-based rack-mount server (Pentium XEON Quad Core). Both PowerPc and rack-mount Intel server are based on Linux (Kubuntu 10.04) with the Xenomai real-time extension.

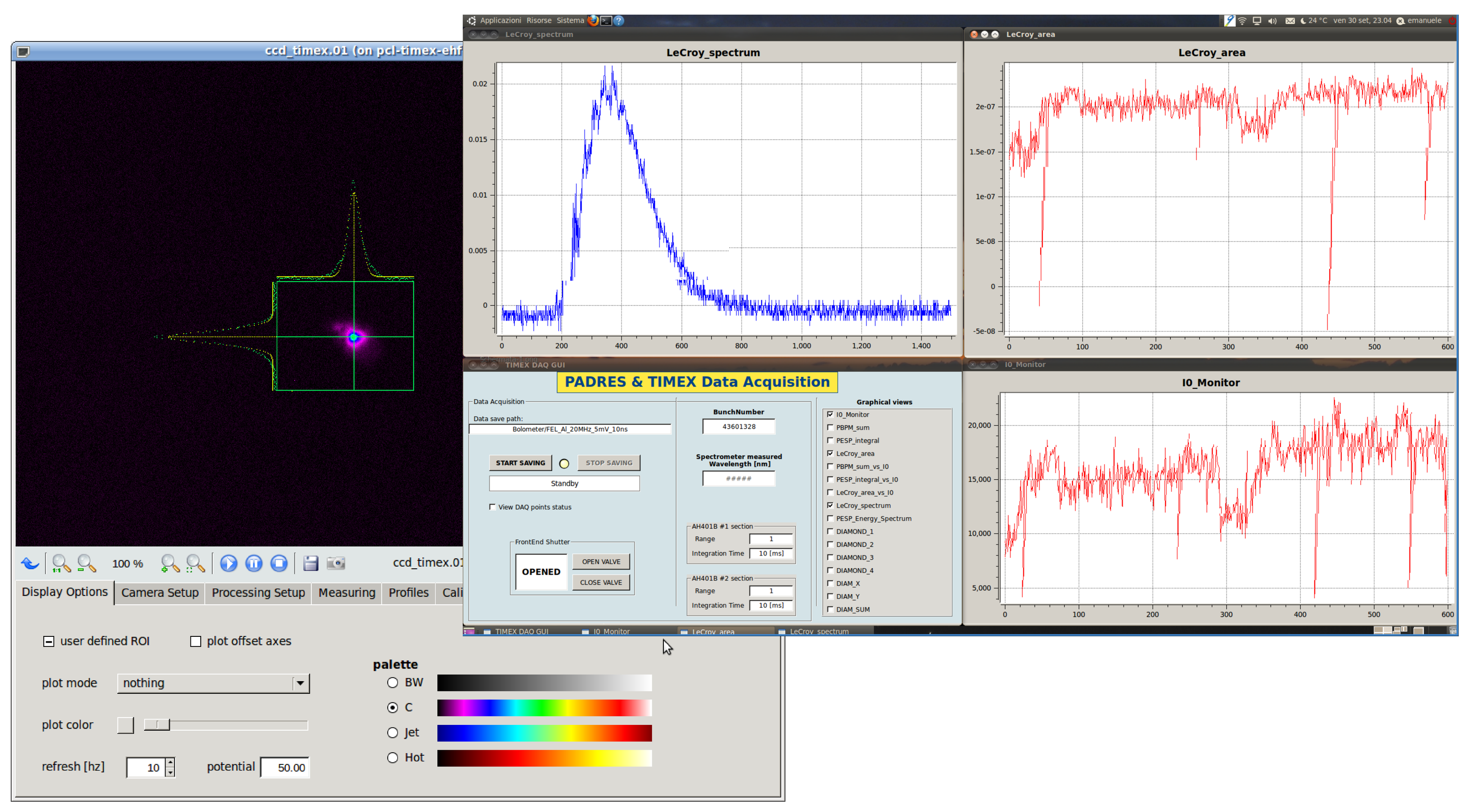


Real-time machine diagnostics data are transparently shared among DAQ computers using a network software application called Network Reflective Memory (NRM). It works on a fully dedicated, private network that covers the whole machine from the electron gun to the experimental hall.

Finally, a Siemens S7 series 300 PLC is used for the interlock system in order to protect equipment and devices from damage.

3. SOFTWARE ARCHITECTURE

The DAQ system of the experimental stations is based on the Tango framework. Instrumentation control, scan operations, data acquisition and analysis is done through Tango device servers (C++ and Python). Graphical interfaces can be developed by beamline staff on Linux and Windows platforms using common frameworks like Labview, IDL, Python or Matlab. Applications developed by controls specialists have been written using QTango, a Qt based framework developed in house.



4. SCIENTIFIC DATA STORAGE

Acquisition device servers export "*bunch number*" tagged data to higher level storage device servers that organize experimental data in HDF5 (Hierarchical Data Format). Data archives are directly saved on a high speed centralized storage via a 10Gb ethernet connection.

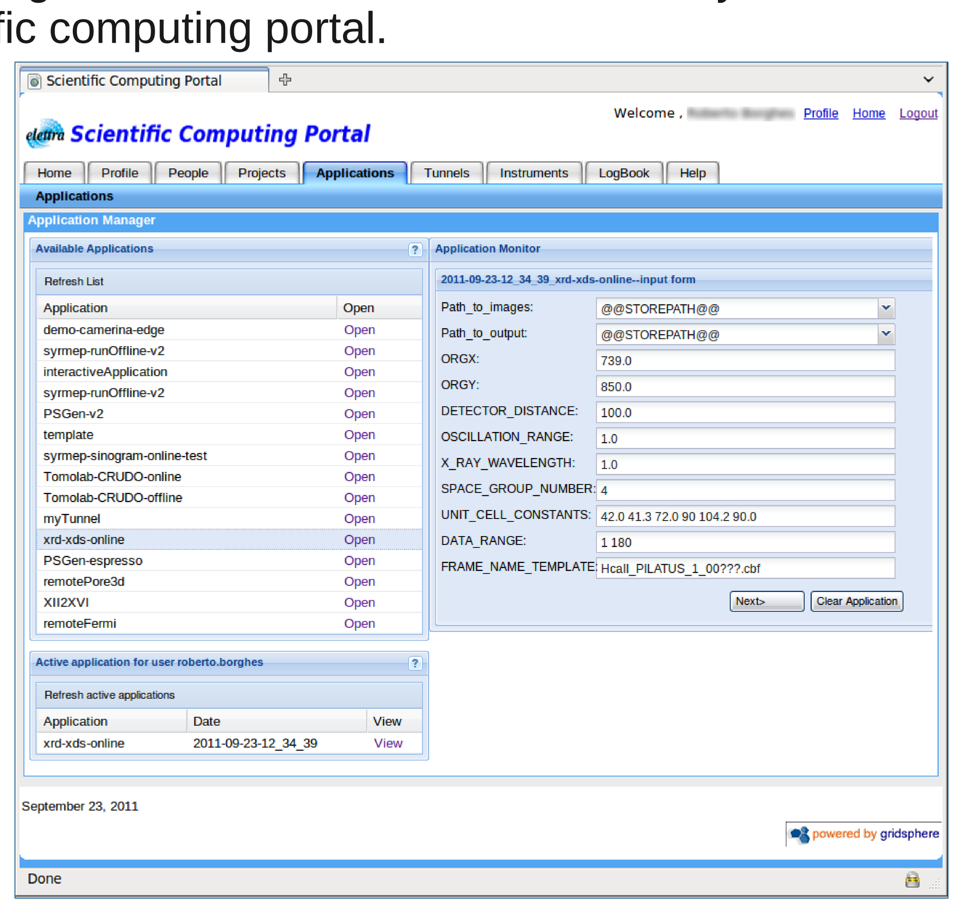
The current storage system is based on a 70 TB EMC Storage Area Network, its next planned upgrade will provide FERMI users with a 1 PB distributed filesystem.

Estimated experimental data throughput

Endstation	FEL @ 10Hz	FEL @ 50Hz
DIPROI	140 Gbyte/hour	700 Gbyte/hour
LDM	280 Gbyte/hour	1400 Gbyte/hour
EIS	66 Gbyte/hour	330 Gbyte/hour

5. ELETTRA COMPUTING INFRASTRUCTURE

Experimental data are available for offline data processing using the Elettra high performance computing clusters. Besides this, experimental data and local computing infrastructures can be remotely accessed through the Elettra scientific computing portal.



Work supported by the Italian Ministry of University and Research under grants FIRB-RBAP045JF2 and FIRB-RBAP06AWK3

For additional information, please contact:
Roberto Borghes - Sincrotrone Trieste, Trieste, Italy
roberto.borghes@elettra.trieste.it