Development of FESA-based Data Acquisition and Control for FAIR

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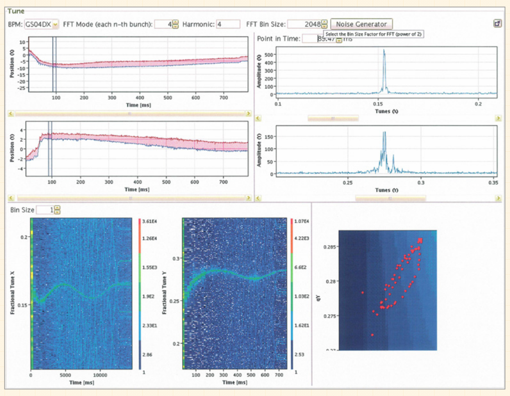
Abstract

GSI has selected the CERN Front-End Software Architecture (FESA) to operate future beam diagnostic devices for the upcoming FAIR facility. The FESA framework is installed and operational at the GSI site, giving equipment specialists the possibility to develop FESA classes for device control and data acquisition. This contribution outlines first developments of FESA-based systems for various applications. Prototype DAQ systems based on FESA are the BPM system of the synchrotron SIS18 with data rates up to 7 GBit/s and a large scaler setup for particle counters called LASSIE. FESA classes that address Gigabit Ethernet cameras are used for video imaging tasks like scintillator screen observation. Control oriented FESA classes access industrial Programmable Logic Controllers (PLCs) for the slow control of beam diagnostic devices. To monitor temperatures and set fan speeds of VME crates, a class communicating via the CAN bus has been developed.

BPM System: TOPOS

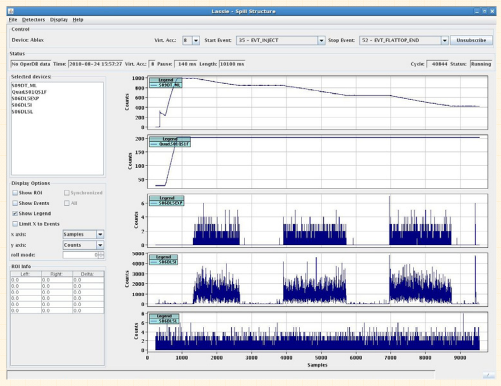
The Tune, Orbit and Position Measurement System (TOPOS) is a FESA installation for **online tune measurements**. Twelve BPMs connected to Libera Hadron devices provide **position data over a whole acceleration cycle** of the GSI synchrotron. Each BPM delivers a data stream between 70 MBit/s and 580 MBit/s, depending on the ion energy. Several FESA classes running on two powerful Linux computers (Dual Intel Xeon QuadCore 2 GHz CPU, 32 GB RAM, 64 bit Scientific Linux) handle and process the data stream and send it to the graphical user interface.

TOPOS in raw data mode: Longitudinal bunch profiles in the synchrotron are recorded over several turns.



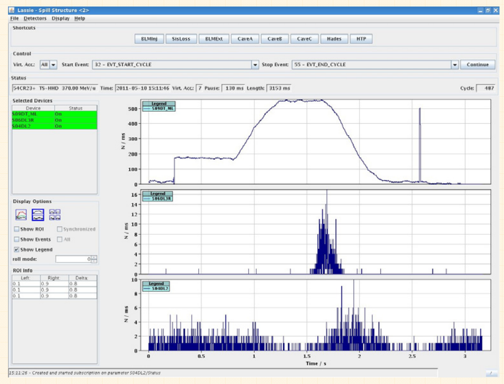
Online tune observation (in x and y planes): the top left chart shows bunch position data, top right is the tune, bottom left is the tune over time. Bottom right are the tune points in the resonance diagram.

Scaler System: LASSIE

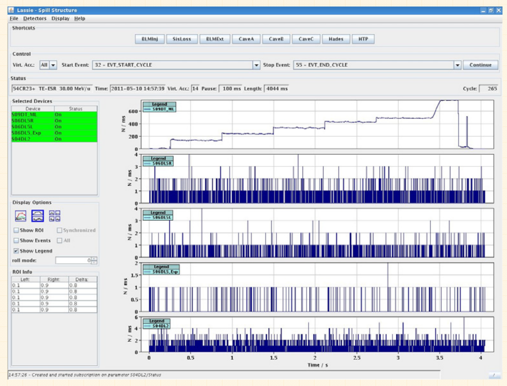


The FESA-based Large Analog Signal and Scaling Information Environment (LASSIE) is a system to **monitor, analyse and distribute analog and digital signals**. Up to 192 channels can be processed using **VME scaler boards** (SIS3820) being read out by FESA. The GUI is freely configurable, allowing the user to decide online, which channels should be observed.

The picture on the left shows a sequential slow extraction off the synchrotron with signals from a beam transformer, a magnet and three beam loss monitors. It is clearly visible, that beam losses only occur during extraction.

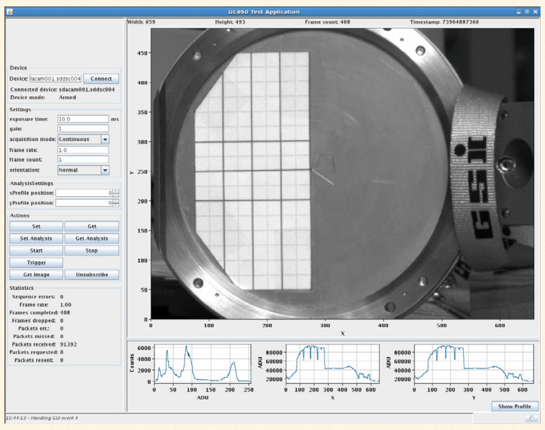


Signals from a transformer and two beam loss monitors during a complete acceleration cycle. Beam losses occur during the extraction of the beam.



During a multiturn injection (top signal shows a beam transformer) and a fast extraction, no visible beam losses are detected. Only noise can be seen on the observed plastic scintillators.

Gigabit Ethernet Cameras



Screenshot of the GUI for GigE camera readout showing a scintillator test installation.

The **readout of Gigabit Ethernet** (GigE) cameras is easily possible **with FESA**. The camera manufacturers provide C++-libraries which have been linked to the FESA class.

Two GigE cameras have been tested at GSI:

- IDS UI-5240SE-M
- Prosilica GC 650

A prototype setup with a simple test GUI reached the performance of 10 frames per second. To save bandwidth, it is possible to solely transmit the histogram and the projections of an image.

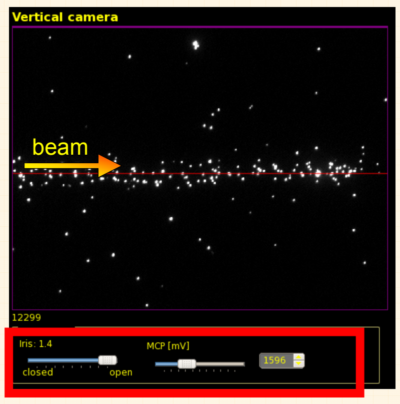
Cameras are installed at scintillator screens and Beam Induced Fluorescence monitors. Currently, FireWire cameras are widely used. Future setups will be realized using GigE cameras to avoid tradeoffs like limited cable length and FireWire driver issues.

UI-5240SE-M © by IDS
ids-imaging.de

Prosilica GC 650 © by AVT
alliedvisiontec.com

PLCs / Slow Control

For several **slow control tasks**, Programmable Logic Controllers (PLCs) by Siemens are used at GSI. 12-bit DAC modules **control several voltages** to adjust remote controllable lenses, calibration LEDs and image intensifier amplifications. Relay modules provide a **remote reset possibility** for various devices.
FESA offers a tool to generate the source code for the PLCs and a matching C++ library which can be used by any FESA class. The communication between FESA and the PLC takes place via standard Ethernet.



Top: Hardware installation of the PLC system containing two sets of: PLC satellite controller, relay module, DAC module (2x).

Left: C++/Qt application to control Beam Induced Fluorescence monitors using FESA for PLC access.

Ethernet Devices

CAEN SY 1527 modular high voltage power supply

Commercial hardware with Ethernet connectivity can easily be controlled by FESA classes. Since FESA is standard C++ code, **UDP and TCP/IP sockets** can be created for communication. Some hardware vendors supply libraries for their Ethernet devices, these can be used for device access as well.

The following Ethernet devices have been integrated into FESA:

- CAEN SY 1527 modular high voltage power supply
- Pfeiffer RVC 300 gas pressure controller (using a RS232-to-Ethernet converter, Lantronix UDS2100)
- remote controllable power plugs (Anel NET-PwrCtrl PRO)
- GigE cameras

Pfeiffer RVC 300 gas pressure controller with Lantronix UDS2100 RS232-to-Ethernet converter

Outlook: Future Form Factors

μTCA crate test installation

To overcome the limitations of the VME architecture, the new 'xTCA for physics' form factor is currently being tested at GSI. The **xTCA** crates offer the following advantages:

- **serial backplane** with high bandwidth of up to **20 GBit/s**
- **multiple protocol support**: GigE, 10 GigE, serial Rapid IO (sRIO), PCI Express
- remote controllable and manageable
- error management, detection of faulty modules
- fast inter-module connections

The first performance test will be carried out using multiple GigE cameras, a 4x Ethernet module (Kontron AM4301) and an Intel Core 2 Duo processor module (Adlink AMC-1000).

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