RECENT DEVELOPMENTS

In beam diagnostics and control systems at COSY

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Abstract

Fast and reliable real-time diagnostic of beam parameters is crucial for an accelerator facility like the Cooler Synchrotron (COSY) at Forschungszentrum Jülich. Here presented are the Multi-Wire Proportional Chambers for beam profile acquisition as an example of upgrading and integrating present systems into the Experimental Physics and Industrial Control System (EPICS), enabling online monitoring and data archiving. Additionally the installation of Beam Loss Monitors using the EPICS standard as well is shown.

Multi-Wire Proportional Chambers (MWPC)

Motivation

- 16 MWPCs in extraction beam lines for X and Y profile measurement
- Insufficient reliability and slow response of 25 year old controllers
- Triggered profile acquisition not usable 77 % of the time
- Integration into EPICS as new standard required

Upgrade of control and data processing units

- LAN/GPIB-Gateway as interface to hardware
- Implementation of an EPICS IOC using Python
- Control of subsystems (drives, gas supply) over TCP/IP included
- Development of a new user interface using Control System Studio

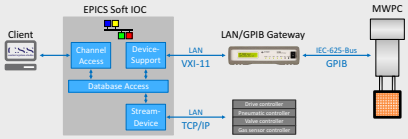

Figure 1: Data flow scheme from device to control room

Benefits

- Improved reliability and use of external trigger (99 % software uptime)
- 5 times faster readout (5 Hz), additional mode for 100 Hz resolution
- Unrestricted parallel usability and monitoring
- Online fitting yields profile characteristics
- Centralised data archiving

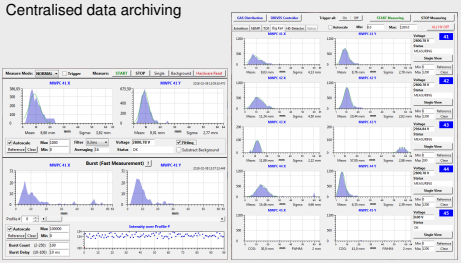

Figure 2: New control panel for a single MWPC (left) and section overview (right)

Informations about the Experimental Physics and Industrial Control System (EPICS)

- Decentralised control system, common for accelerator facilities
- Input-Output-Controllers (IOCs) as interfaces to hardware
- IOCs manage ”Process-Variables” (PVs) with assigned unit, range, state, alarm, etc.
- Channel Access-protocol to read, write and monitor PVs
- Control System Studio (CSS) is a tool to design graphic user interfaces, display and access PVs as well as archived data
- Archiver Appliance for automated archiving of PV data

Beam Loss Monitors (BLM)

Motivation

- Support for operators during beam development
- Need to detect and locate unexpected beam losses

Development of the system

- Use of standard scintillators and photomultipliers as radiation detectors
- Discriminator module for pulse detection outputs digital signal
- IOC on RedPitaya (SBC) with FPGA for fast readout (30 MHz)

Relative calibration

- Determination of optimal voltage for sensitive and proportional range
- Inverse square fit yields offset and sensitivity
- Normalisation using the determined values allows comparability across devices

$$R = R_{bg} + \epsilon \cdot \frac{1}{(d + d_0)^2}$$

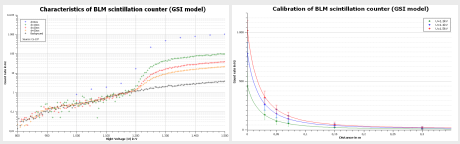

Figure 3: Exemplary HV characteristics and calibration of one detector

Benefits

- Fast localisation of beam losses during operation
- Possibility to compare total loss per cycle
- Visual warning for high losses
- Centralised data archiving

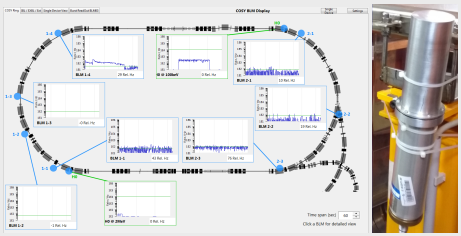

Figure 4: Beam losses over time around COSY. Also shown are H_0-Detector rates for electron cooling (green boxes). Right: Installation of a BLM

References

1. EPICS Home Page `https://epics.anl.gov`
2. COSY Beam Loss Monitor System, IKP Annual Report 2017
3. IOC and GUI repositories `https://gitlab.com/COSY`