CUPID: new system for scintillating screens based diagnostics

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The Facility for Antiproton and Ion Research (FAIR) with its wide range of beam parameters poses new challenges for standard beam instrumentation like precise beam imaging. To cover a wide range of foreseen applications, a new technical solution was required for diagnostics upgrades for the PRIOR Experiment, CRYRING and between the Experimental Storage Ring (ESR) and Cave A as a precursor to the FAIR High Energy Beam Transport lines.

The new system (see Figure 1), including digital image acquisition, remote controllable optical system and mechanical design, was set up and commissioned during 2014 beam time. CUPID (Control Unit for Profile and Image Data) is based on the Front-End Software Architecture (FESA) to control beam diagnostic devices.

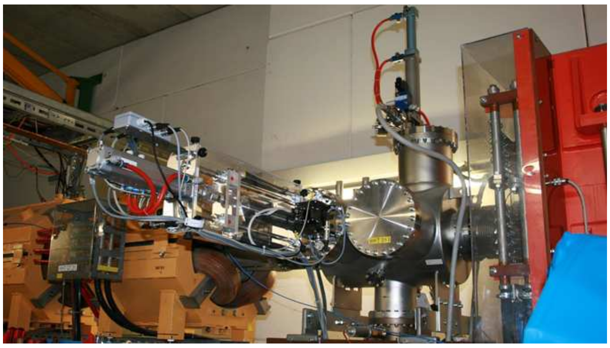

Figure 1: Scintillating Screen installation at High Energy Beam Transport Lines.

The FESA class for the digital GigE camera (IDS uEye UI-5240SE-M, CMOS type) acquires the images and preprocesses the optical data as required by the geometry of the setup (rotation, stretching). It calculates the projections and the intensity histogram and converts pixel number into a position in millimeters, which results in absolute beam position and width. The performance of the system reached more than 15 frames per second with one connected client.

Additionally, dedicated FESA classes access industrial Programmable Logic Controllers (PLCs) for a reliable slow control solution. A Siemens PLC (main unit and satellites) handles control of lens focus and iris motors (LINOS MeVis-Cm 16), read and set by a PID controller (FM355C). PLC digital outputs (SM322) switch the LED to illuminate the target for calibration issues. Camera control and timing, as well as, power supply and reset options for up to eight digital cameras are realized by the in-house developed Camera Power Supply controller CPS8 with network access.

For basic operation the camera controls are reduced to changing the opening of the iris and switching on or off the LED. An expert mode provides more detailed control like changing the exposure time or the binning of the image for low beam intensities. The CUPID system provides three acquisition modes. In the 'free run' mode suitable for slow beam extraction, the camera continuously acquires images with the specified exposure time and frame rate. The acquired images are displayed in the GUI as they arrive in real time. In the 'triggered' mode for fast extraction, the image acquisition is triggered by a machine event of the accelerator. At the time of the trigger, a single image is acquired by the FESA class and displayed by the GUI (see Figure 2). An extension of the 'triggered' mode is the 'sequence' mode, which acquires a predefined number of images with the specified frame rate after a trigger is received.

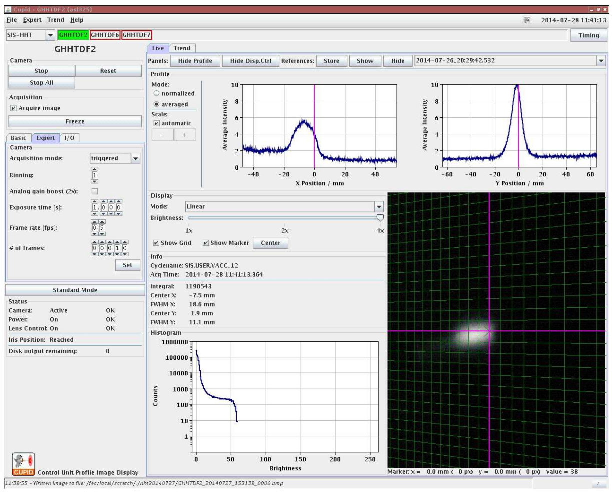

Figure 2: CUPID GUI with an image of 7×10^9 protons at 4 GeV on Chromox screen.

The CUPID system is currently running successfully at 16 different points in the GSI high energy beam transport lines. In daily operation it was used to image several beams from protons up to uranium with various beam energies and intensities. The generally positive feedback by the operating team highlights the simple usage of the GUI and the advanced features of the new system. The work experience gathered so far, confirms CUPID as a standard for scintillating screen based beam instrumentation at GSI and FAIR.

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