CUPID – New System for Scintillating Screen based Diagnostics

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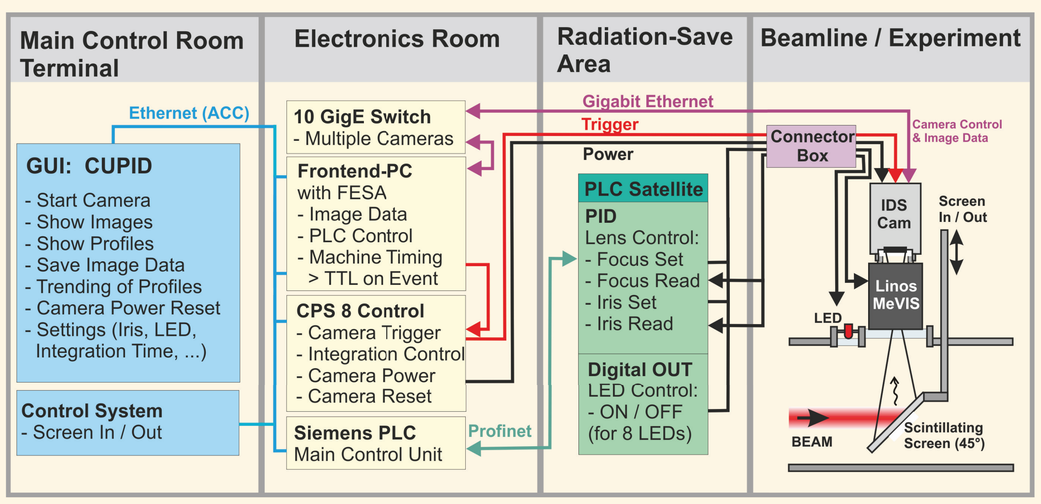
Abstract

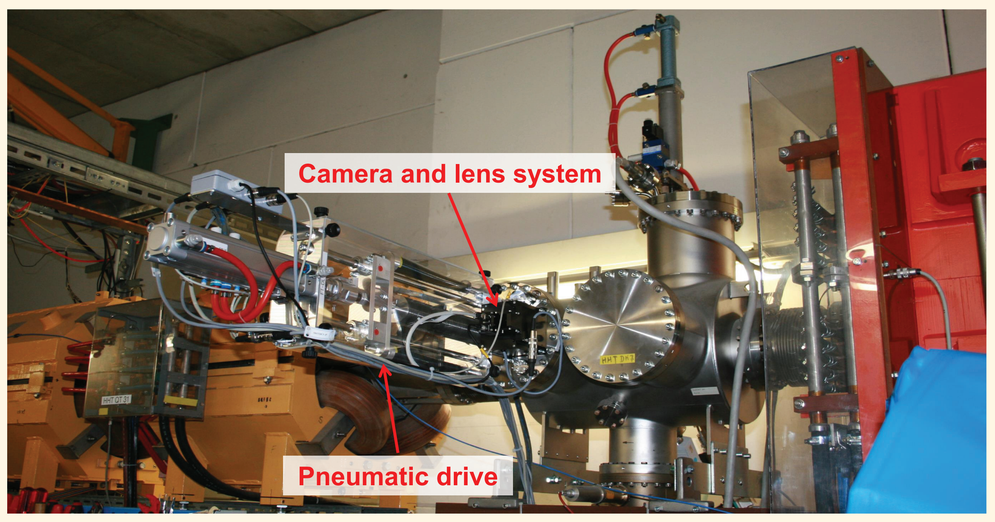
The Facility for Antiproton and Ion Research (FAIR) poses new challenges for standard beam instrumentation like precise beam imaging over a wide range of beam parameters, radiation hardness requirements, etc. A new, fully FAIR-conformal system for standard scintillating screen based beam diagnostics was developed at GSI. To cover a wide range of foreseen applications, a new technical solution was required for the upcoming FAIR High Energy Beam Transport lines and Rings. The newly developed system including digital image acquisition, remote controllable optical system and mechanical design, was set up, commissioned and employed in routine beam operation.

CUPID System

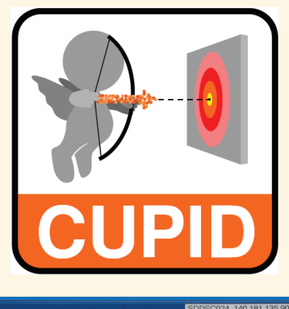
CUPID (**C**ontrol **U**nit for **P**rofile and **I**mage **D**ata) is based on the CERN **F**ront-**E**nd **S**oftware **A**rchitecture (**FESA**).
The FESA class for the digital GigE camera (IDS uEye UI-5240SE-M):

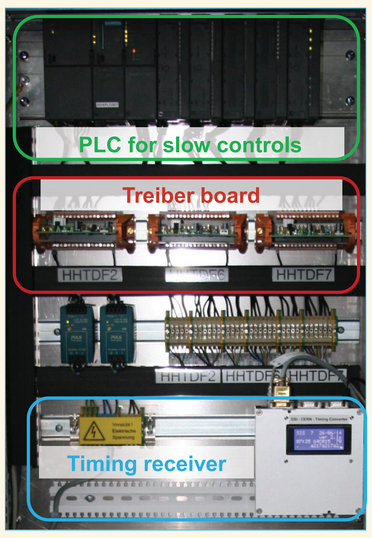
- acquires the images and manipulates them as required by the geometry of the setup
- calculates the projections, intensity histogram and converts pixel numbers into mm.





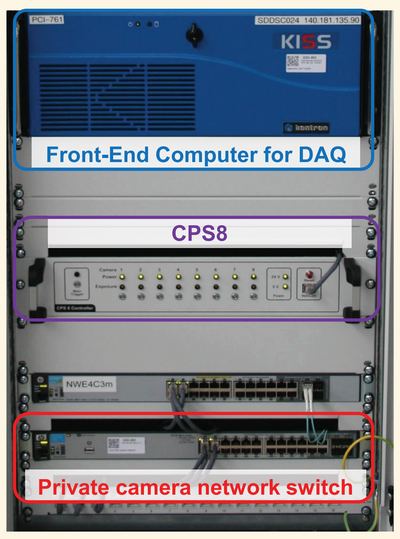
Camera control and timing, power supply and reset options for up to eight digital cameras are realized by the in-house developed **C**amera **P**ower **S**upply controller **CPS8** with network access.





FESA classes access industrial Siemens Programmable Logic Controllers (PLCs) for slow control which:

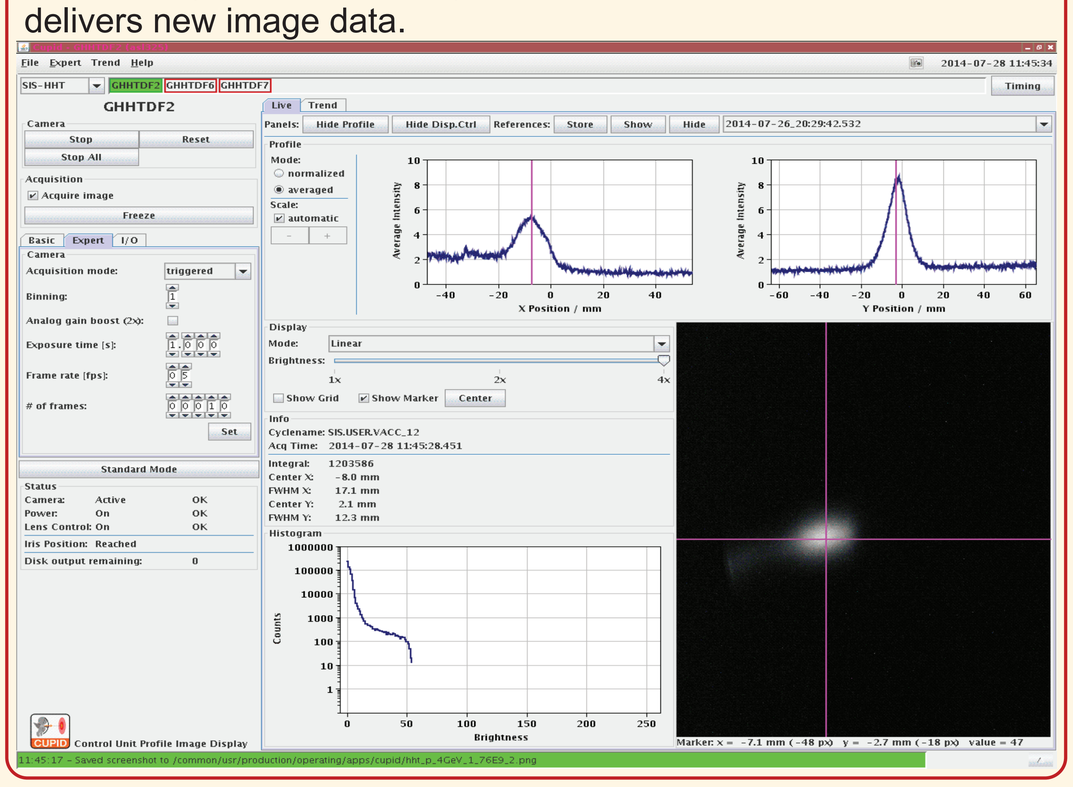
- handle control of lens focus and iris motors (LINOS MeVis-Cm 16), read and set by a PID controller (FM355C)
- control the LED to illuminate the targets for calibration issues via the digital outputs (SM322)



GUI

- chooses and starts the camera in free-run or triggered mode
- adjusts the camera and iris settings
- displays the processed image, the horizontal and vertical intensity profiles
- displays the intensity histogram

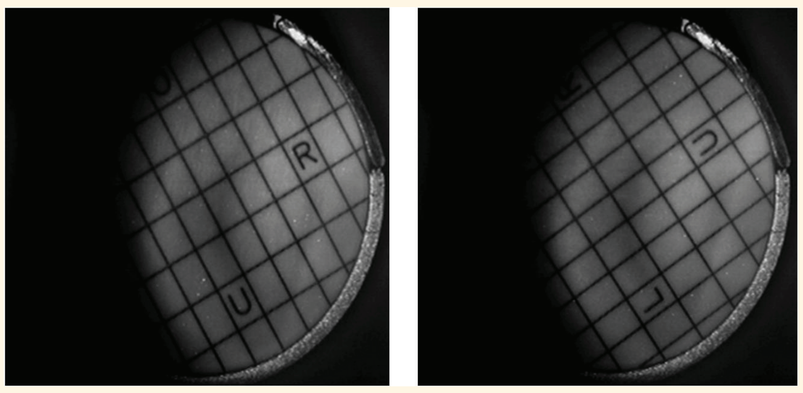
The display is automatically updated whenever the FESA class delivers new image data.



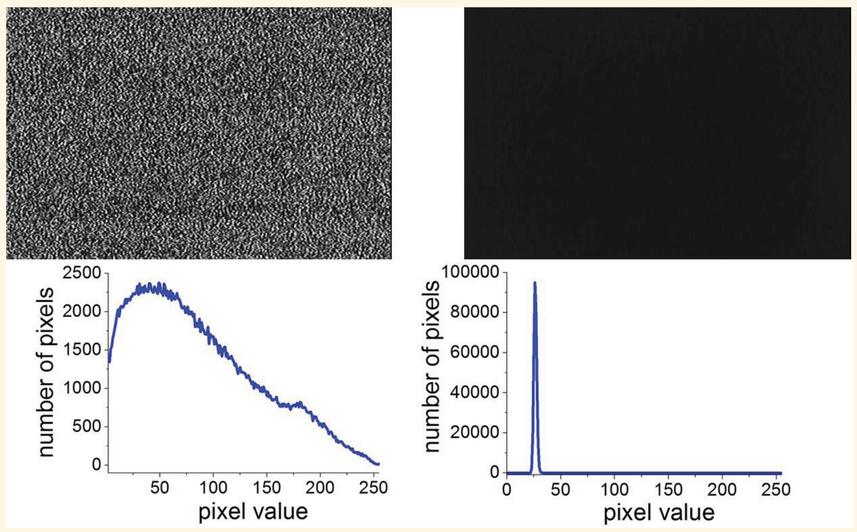
Rad-Hardened Camera Test

In the SIS18 extraction point, where a high radiation level is observed, the CCIR MegaRad3 (8726DX7) radiation-hardened solid-state CID (Charge Injection Device)-based camera was installed in 2013.

- significant improvement for operation in a radiation rich environment
- tests show that the camera is not sensitive to radiation on the level observed at GSI.
- image quality to be the same after eight months of exposure to neutron (accumulated dose: 55 Sv) and gamma (accumulated dose: 33 Sv) radiation.
- no significant change in camera performance like loss of contrast and resolution



Original pictures of scintillating screen target with progressive level of accumulated dose. Left: before test, right: after 8 months of beam operation.



Dark image and its histograms of the standard CCD camera Sony XC-ES30 (left) and CID camera MegaRad3 (right) after irradiation.

Conclusions

CUPID, a new, fully FAIR conformal system for standard scintillating screen based diagnostics was developed, commissioned and employed in routine beam operation at GSI with beams from proton to uranium. It includes digital imaging, a remote controllable optical system, mechanical design and easy to use GUI. Based on FESA it is expected to seamlessly integrate into the future control system of FAIR.

Our first experiences with this radiation-hardened solid-state CID-based camera look very promising. MegaRad3 is suitable for use in precise and reliable profile monitors of high energy heavy ion beams in the vicinity of beam extraction points, targets or beam dumps as well as other higher radiation environments expected at FAIR.

CUPID and the radiation hardened camera are the first beam instrumentation devices for FAIR used in routine operation.

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