BeamView – A Data Acquisition System for Optical Beam Instrumentation

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Abstract

At the GSI accelerator facility, several optical beam instrumentation devices for transversal profile measurement are installed. Their readout is done with FireWire CCD cameras attached to a small embedded device, specialized for image processing tasks (National Instruments Compact Vision System 1456). Here a LabView application preprocesses the images based on user requests.
The resulting data (e.g. projections, histograms, compressed or original images) is sent over Ethernet to a Windows or Linux PC, reaching frame rates above 30fps at VGA resolution. Using C++ with Qt libraries for networking and GUI purposes, platform independence without source code modification is achieved. Here the system components and software design to control CCD cameras and various other devices with an easy-to-use graphical user interface for machine operators are presented as well as first experiences of the system with beam.

Outdated Previous System

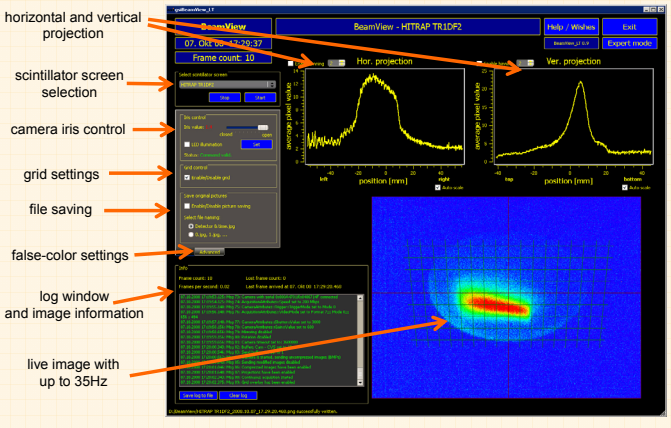
Disadvantages

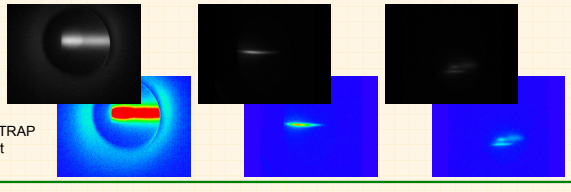
- analog cameras (Monacor TVCCD-240) with video multiplexers and TV screens
- no frame grabbers, no exact triggering or exposition control
- difficult to observe beam properties or compare different accelerator settings

Advantages

- simple, cheap and reliable

New System: "BeamView"



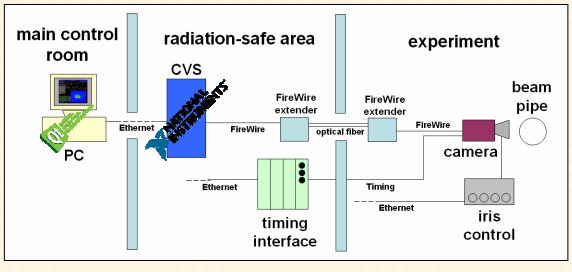


images from HITRAP experiment

New System: Distributed Digital Hardware

- CCD camera: AVT Marlin F033B, VGA, monochrome, FireWire 1394a
- lens: Pentax B2514ER, remote controllable
- DAQ system: NI 1456 Compact Vision System (CVS), 733 MHz Intel Celeron CPU, 128MB RAM, 256MB flash drive, FireWire 1394a, Ethernet, integrated FPGA with digital I/Os, programmable with NI LabView Realtime, Vision, FPGA

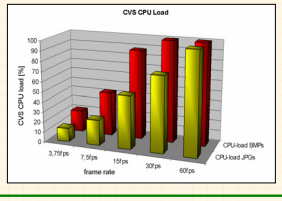
Hardware Setup



- hardware in radiation-safe area wherever possible
- remote-controllable via XML commands over Ethernet: camera iris, camera trigger (timing interface)
- remote-resetable through IP-controlled power plugs
- standard industry interfaces: FireWire, Ethernet, RS232
- optical FireWire extenders so exceed limited FireWire cable length

Performance

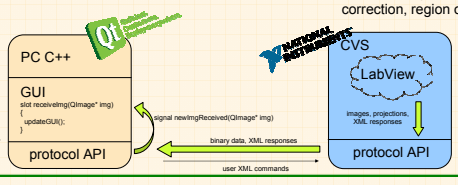
- CVS CPU load and network traffic measured at different frame rates transmitting compressed or uncompressed images
- max. achievable frame rates:
  - uncompressed: 16fps @ 42 MBit
  - compressed: 35fps @ 11 MBit



New System: Distributed Software

PC Software

- written in C++ with Qt libraries and therefore platform independent
- observe scintillator screens and Beam Induced Fluorescence monitors (BIF)
- receive images and binary data from the CVS
- present images, histograms, projections in an easy-to-use GUI
- control camera, CVS, trigger and camera iris remotely
- usage of Qt signal/slot mechanism to receive and update data
- communicate with CVS over simple application layer protocol

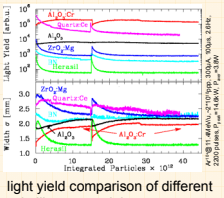


CVS Software

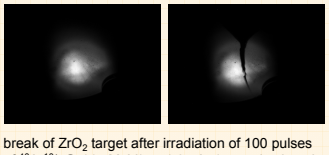
- written in NI LabView Realtime, FPGA, Vision
- control up to four cameras simultaneously, preprocess image data and send results via Ethernet
- optional image calculations: histogram/projection calculation, image compression, dead-pixel correction, region of interest, perspective correction, mirroring, rotation
- access to all camera parameters like gain, integration time, resolution, trigger mode
- store data in buffers in case of heavy network traffic or unavailability of the PC/client
- disable camera trigger when camera is still busy
- XML interface for CVS and camera control

BeamView at Scintillator Screen Experiments

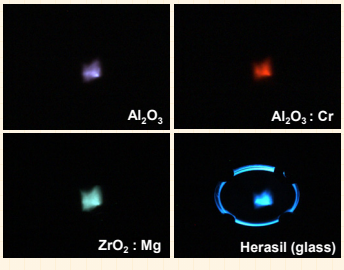
E.Gutlich, P.Forck, R.Haseitl, "Scintillation Screen Investigations for High Current Ion Beams at GSI Linac", BIW'08, Lake Tahoe, (2008)



light yield comparison of different scintillator materials



break of ZrO_2 target after irradiation of 100 pulses of $^{40}Ar^{10+}$ @ 11.4MeV/u, ~1.3mA, 1ms pulse length, $1.6*10^{11}$ppp



experiment by E.Gütlich: wavelength examination with color camera (AVT Marlin F033C) in 10/2008

all samples irradiated by $^{64}Ni^{9+}$ @ 11.4MeV/u, ~12µA, 200µs pulse length, $2*10^9$ppp