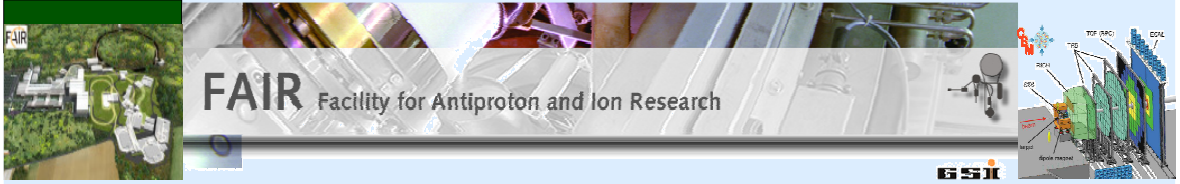

Data acquisition and online monitoring software for CBM test beams

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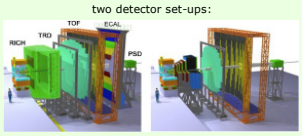
Abstract

The Compressed Baryonic Matter (CBM) experiment is intended to run at the FAIR facility that is currently being built at GSI in Darmstadt, Germany. For testing of future CBM detector and readout electronics prototypes, several test beam campaigns have been performed at different locations, such as GSI, COSY, and CERN PS. The DAQ software has to treat various data inputs, e.g. standard VME modules on the MBS system, and different kinds of the FPGA boards, read via USB, Ethernet or optical links.
The Data Acquisition Backbone Core framework (DABC) is able to combine such different data sources with event builder processes running on regular Linux PCs. DABC can also retrieve the instrumental set up data from EPICS slow control systems and insert it into the event data stream for later analysis. Vice versa, the DIM based DABC control protocol has been integrated to the general CBM EPICS IOC by means of an EPICS-DIM interface. Hence the DAQ can be monitored and steered with an CSS based operator GUI.
The CBM online monitoring analysis is based on the GSI Go4 framework which can directly connect to DABC online data via sockets, or process stored data from list-mode files. A Go4 sub-framework has been implemented to provide possibility of parallel development of analysis code for different sub-detectors groups. This allows to divide the Go4 components up into independent software packages that can run either standalone, or together at the beam-time in a full set up.

CBM experiment

CBM – Compressed Baryonic Matter:
- Fixed target (p-A) and (A-A) at 8-40 AGeV (typ. 25GeV/u Au-Au)
- Scientific goals:
  - in-medium modifications of hadrons in dense matter
  - indications of deconfinement phase transition at high baryon densities
  - the critical point providing direct evidence for a phase boundary
  - exotic states of matter such as condensates of strange particles
- First level event selection will be done in compute farm
- DAQ will sample and transport full datastream with timestamps
- In progress: development of detector and DAQ prototypes

two detector set-ups:



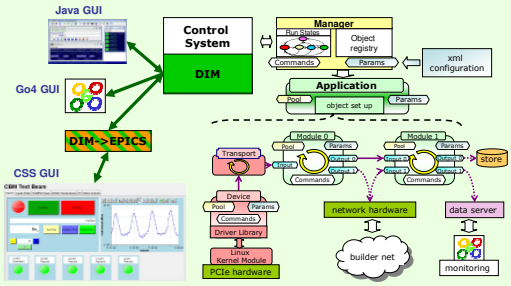
electron-hadron muon

Detector components under development:
- Dipole Magnet
- Micro Vertex Detector (MVD) with silicon pixels
- Silicon Tracking Station (STS) with silicon strips
- Ring Imaging Cherenkov (RICH) detector
- Transition Radiation Detector (TRD)
- Muon Chamber (MUCH) with Gas Electron Multipliers (GEM)
- Resistive Plate Chamber (RPC) for time of flight
- Electromagnetic Calorimeter ECAL

=> Prototype testing with beam is required!

Future DAQ challenge:
- 10 MHz interaction rate
- 1 ns time stamp resolution
- 1 TByte/s primary data rate
- ~1GByte/s maximum archive rate
- First level event selection by online track & vertex reconstruction

DABC Data acquisition software

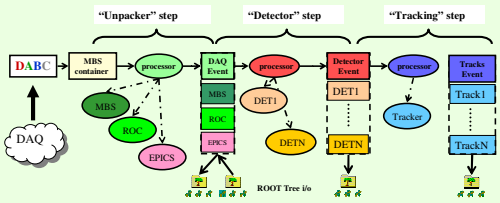


Software objects and connections of a typical DABC node. Run control is done via DIM or EPICS. For various test beams, DABC control was implemented with EPICS Control System Studio (CSS), integrated to a combined slow control GUI of all devices.

DABC features
- Based on C++ on Linux
- Multi-threaded data-flow core
- Software objects for processing, connectivity, buffering, commands
- Plug-in architecture for user applications and extensions
- Runtime configuration with XML files
- Implemented data transports: TCP/IP, UDP/IP, InfiniBand, …
- Supports set-up of event-building network
- Interface to GSI Multi Branch System framework MBS (VME-bus,…)
- Implements DIM (optional DIM/EPICS) for control system access

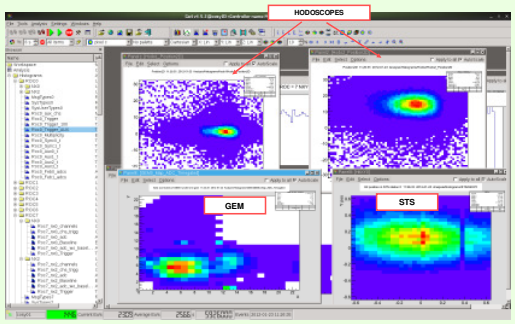
http://dabc.gsi.de

Online analysis with GO4 framework



Go4 analysis software organization for typical CBM test beams. Subsequent data generations are separated by "analysis steps", each producing a resulting data structure. Each analysis step may run together code for independent frontend or detector components. The final step may show correlations, or trajectory fits of different components. The event structure of the legacy Multi Branch System (MBS) framework is used as generic data container interface for all DABC generated inputs.

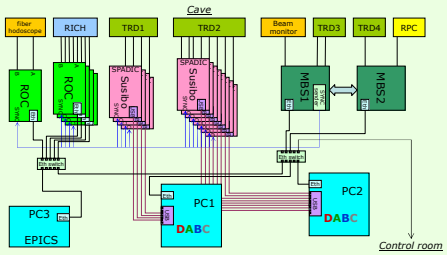
GO4 (GSI Online Offline Object Oriented) features
- C++ and ROOT based analysis framework
- Native support of Multi Branch System (MBS) data sources
- Online monitoring with interactive live display at DABC data sockets
- Offline analysis from file possible with same code (GUI or batch mode)
- Analysis performs subsequent data generations ("analysis steps")
- Composite structure with independent modules for different detectors
- Common CBM DAQ code components reusable for different test set-ups
- Modular code development by participating subdetector experts



http://go4.gsi.de

TRD/RICH test DAQ

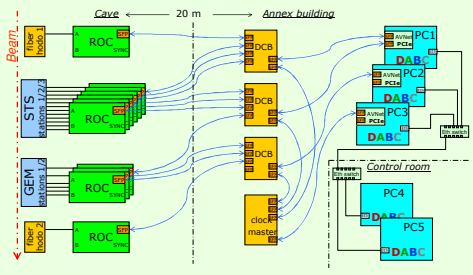
(CERN PS October 2011, 1-10 GeV/c e^- and π^-)



- merge three different kinds of readout
- combine trigger-based and free-running systems
- connection to DABC nodes via USB and Ethernet
- include EPICS slow control data of detector set up

STS/MUCH test DAQ

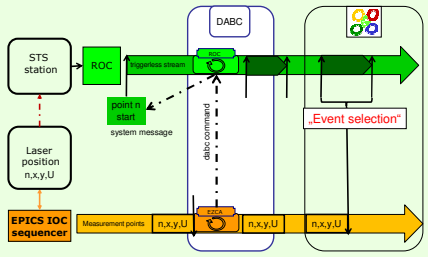
(COSY January 2012, 2 GeV/c p^+)



- pure "triggerless" acquisition with time-stamped data stream
- homogeneous readout via optical fibre connection to PCIe receiver boards
- time synchronisation of branches with deterministic latency messages
- reference time to beam "trigger" message used in Go4 analysis for event selection
- include EPICS slow control data of detector set up

Include EPICS data in DAQ

- DABC reads out EPICS Process Variables (PV) via Easy Channel Access (EZCA)
- Configuration by DABC xml file (generated from IOC dbl listing)
- DABC inserts EPICS PVs to DAQ data stream when triggered by special PV
- Go4/CBM epicsmonitor library provides generic PV trending and histograming
- Go4 online analysis may combine the slow control setup with detector data



Application for the readout of silicon strip station prototypes (STS) irradiated by a movable laser. The laser position is controlled by an EPICS sequencer. The strip responses are sampled by NXYTEr/SysCore2 Readout Controllers (ROC) as trigger-less stream of time-stamped messages. Each laser scan point is combined with corresponding messages in Go4 analysis. For synchronization with EPICS, DABC inserts time markers into ROC data stream at begin and end of each scan point.

CHEP 2012, 21-25 May, New York