Upgrade of HADES data acquisition and event building software for FAIR phase 0

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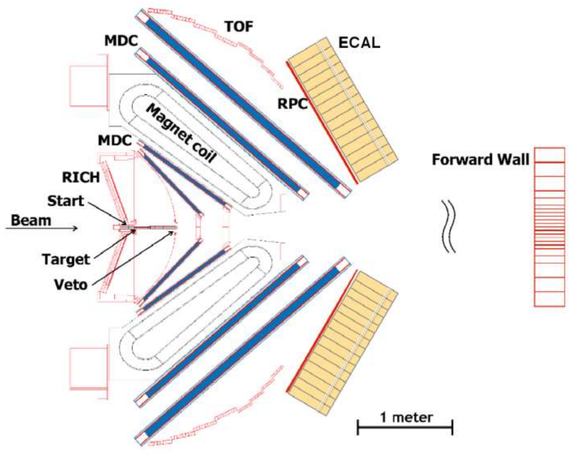
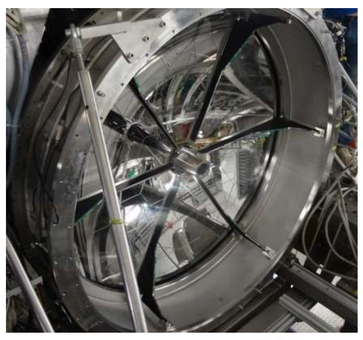
The TRB3 collaboration
http://trb.gsi.de

HADES experiment

The High Acceptance Di-Electron Spectrometer (HADES) is a detector system to investigate proton and heavy ion collisions in the few AGeV energy region [1]. It has been operational in various experiments at the GSI accelerator facility since 2002. HADES consists of several subcomponents, for example a START/VETO detector with time of flight detectors (TOF), a Ring Imaging Cherenkov detector (RICH), 4 planes of Multi-wire Drift Chambers (MDC), and an Electromagnetic Calorimeter (ECAL). The data acquisition (DAQ) of these components is triggered and controlled by the TrbNet DAQ network [2]. Since 2012 this event building software is based on the Data Acquisition Backbone Core (DABC) framework [3].

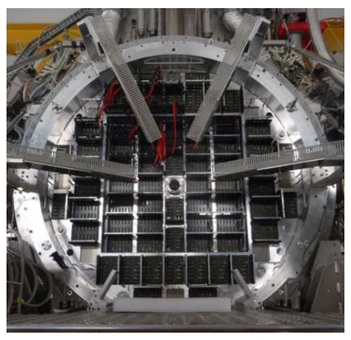


HADES cave



RICH mirror

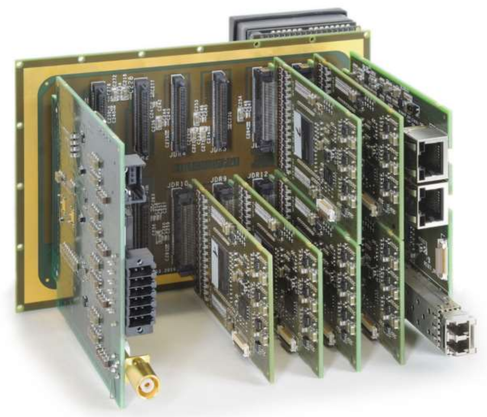
MAPMT array



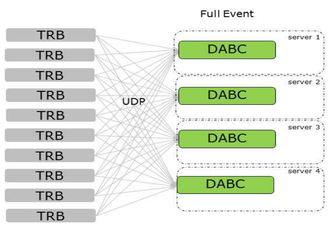
Backplane

Detector upgrade

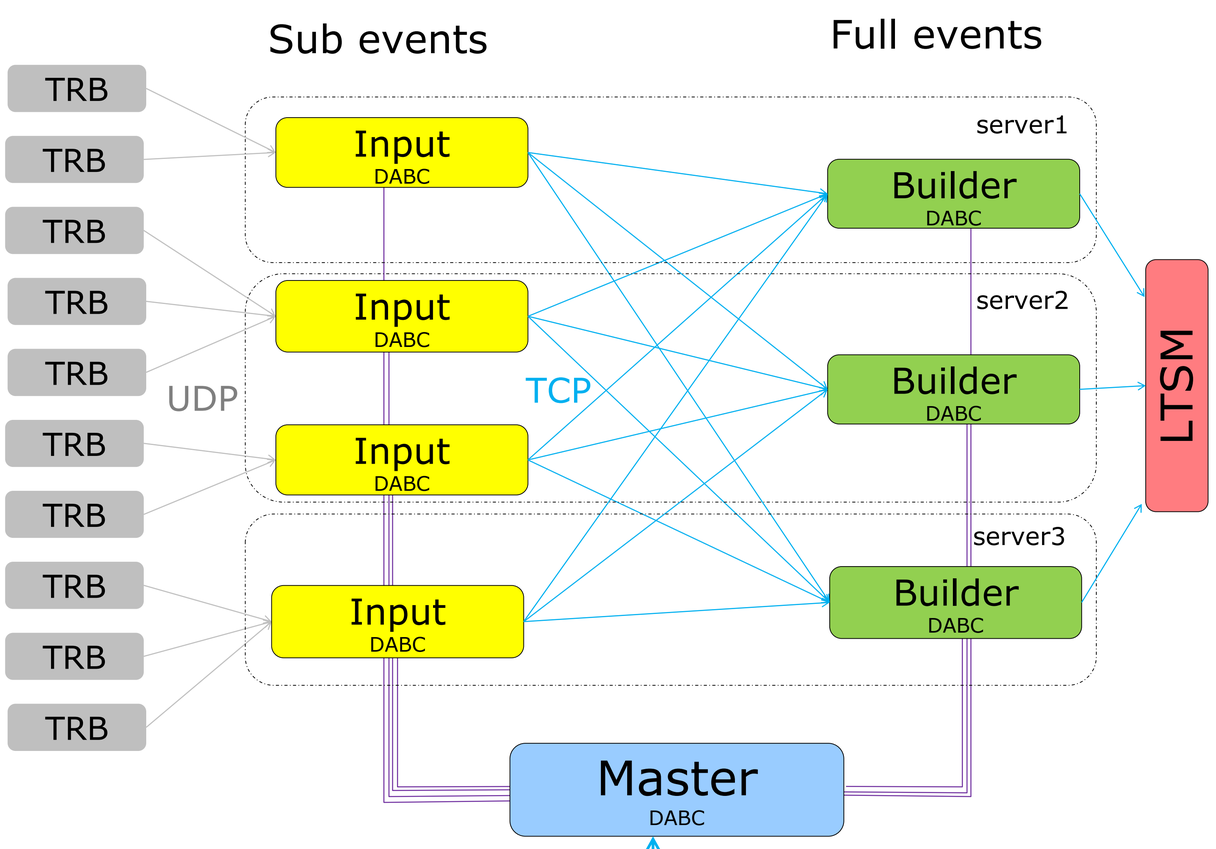
For the “FAIR phase 0” beam time campaign in summer 2018 a number of HADES detector components are being upgraded, such as the RICH and the ECAL. The RICH will be newly equipped with 428 Multi-Anode Photomultipliers (MAPMT) of 64 pixels each, and the ECAL is a new construction with 978 lead glass modules. Both systems will be read out by dedicated front-end boards with FPGA-based TDCs of the TRB3 family [4]. These TRB3 TDCs work by the “tapped delay line” method and provide an excellent timing precision of about 15 ps.



DAQ topology

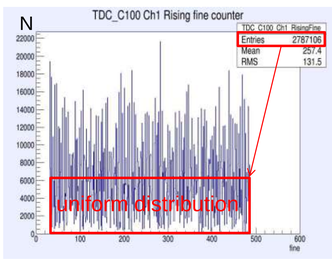


In the previous set up, each front-end hub was sending data via Gb Ethernet UDP connections to all receiving event builder nodes in a barrel shift mode (upper figure). Instead, each front-end will send to a dedicated entry server only and the full event combination is done by a second TCP/IP “builder network” BNET (central figure) [3]. So only such BNET entry servers have to run the TDC calibration software which are receiving the TRB3 data. In general, the load of the event building entities can be tuned better according to the different data rates from individual detector components.

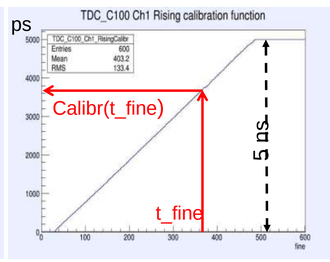


TDC calibrations

The DABC event builder framework offers the possibility to calibrate the TRB3 TDC fine time values “on the fly” before writing the raw data to disk [5]. This has been implemented for different calibration methods (statistical approach, temperature calibration function, simple linear calibration) and was verified in several laboratory test benches. Moreover, advanced analysis and monitoring techniques in such a DABC code have been helpful to further understand functionalities and limitations of the FPGA TDC. Especially the status of the calibration can be inspected by the DABC web interface for any event collecting node [5].



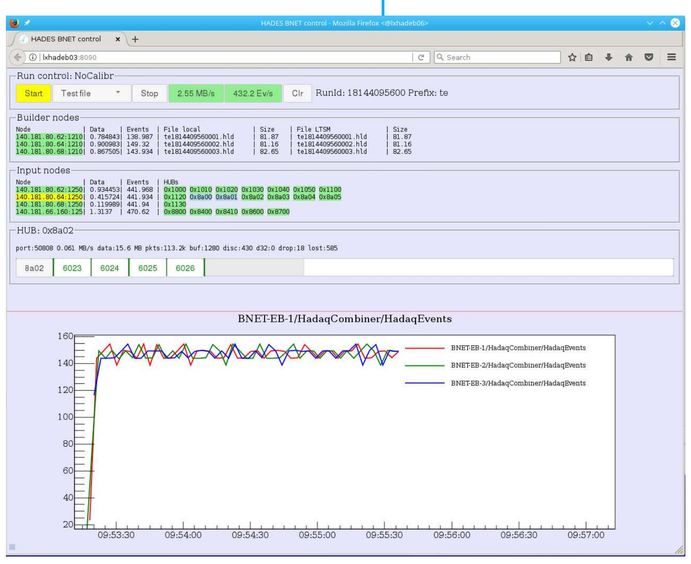
accumulated fine time counter distribution



Resulting calibration function

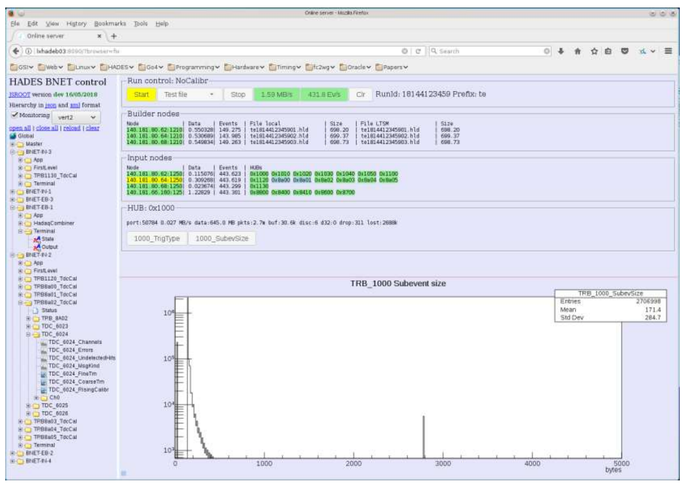
Monitoring and control

A DABC control application runs on a Master node and regularly collects different control records from all BNET components. Gathered information can be provided via http protocol to any client. When required, any control record from every BNET node can be requested through http protocol on master node [3].
The Master also implements several commands to perform synchronous start of the runs (starts of file writing) on all builder nodes. When accumulated file size exceed 2GB limit, the master automatically starts a new run.



Summary

- **The HADES spectrometer has got major upgrades of RICH and ECAL detectors**
- **New TRB3 DAQ hardware is used also for other detectors**
- **Event building topology has changed into BNET with DABC framework**
- **TRB3 TDCs are calibrated on the fly in dedicated BNET input nodes**
- **Run control and monitoring of event builders from DABC master process**
- **DAQ operator UI in web browser with jQuery and JSROOT**
- **The HADES experiment expects to take data from Ag-Ag collisions at 1.65 A GeV with this system in September 2018**



DAQ operator UI

- Runs in any web browser with the HTTP server of the Master application.
- Displays most important monitoring figures of all BNET nodes.
- The operator may inspect various additional quality histograms (data trending, TDC calibration) at any time.
- Allows to start and stop data recording and to define the run type (beam, cosmics, test, ...)
- Implemented with HTML and JavaScript. For different interactive elements jquery-ui was used.
- Histograms and graphs displayed with JSROOT [6] – without involving ROOT code in DABC.

References

1. The HADES collaboration, https://www-hades.gsi.de/
2. J. Michel et al,, “The upgraded HADES trigger and data acquisition system”, *JINST 6 C12056*, Available: http://iopscience.iop.org/1748-0221/6/12/C12056/ , Feb. 2011
3. J. Adamczewski-Musch, N. Kurz, and S. Linev, “Status of data acquisition software DABC” GSI Scientific report 2016, RESEARCH-NQM-HADES-13, Available: http://dx.doi.org/10.15120/GR-2017-1, Mar 2017
4. The trb3 collaboration, http://trb.gsi.de/
5. J. Adamczewski-Musch, S. Linev, C. Ugur “Online calibration of the TRB3 FPGA-TDC with DABC software”, Proceedings of the 20th IEEE RT2016, Padua Available: https://indico.cern.ch/event/390748/contributions/2174357/
6. JavaScript ROOT, https://root.cern/js/

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