The Evolution of the HADES Slow Control System

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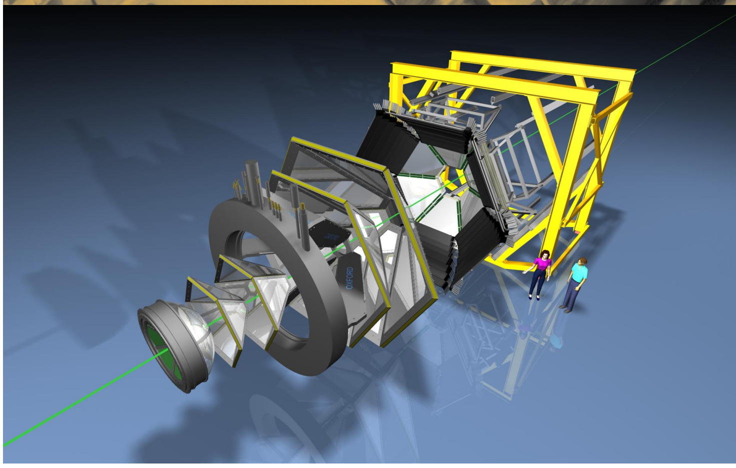
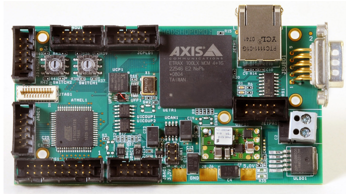
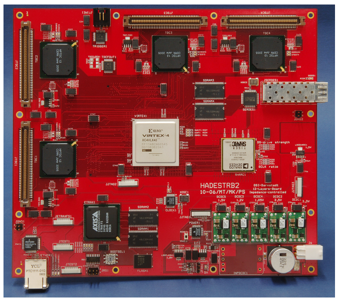




HADCON:
General purpose IO module for SlowControl and small DAQ-systems.
Connectivity to the world is provided by TCP/IP.
8 times 10bit ADC (Atmel)
8 times 8bit DAC (I2C via ATMEL)
CAN bus with optional galvanic isolation for avoiding ground-loop-noise.
I2C, SPI, RS232, CPLD for future extensions, 32 digital I/Os
Hardware Details of HADCON
ETRAX 100LX MCM 4+16
ATMEL AT90CAN128 (CAN bus controller, with optional galvanic isolation)
Xilinx CPLD XCR3064XL-6CS48C
8 channels * 8 bit DAC
Ericsson PME 5218TS switching regulator for up to 6A 3.3V power usable for other boards

HADES is a High Acceptance Di-Lepton Spectrometer. It was designed in the early 90ties and in several phases commissioning and data taking for various collision systems from p-p and N-N took place until recently. During this long time period the technologies for data acquisition and controls have changed significantly.

Old system:
In the beginning most electronic modules were based on the common standards of that time. These standards were NIM, CAMAC, VMEbus, and for the data transport 100baseT Ethernet, ATM, and CAN bus. The readout and control was done mainly by PPC and 68K processors residing in VMEbus crates sending the data via ATM and switches to the event builder PC. At the start of the experiment only the modules necessary for the second level trigger were custom designs in VMEbus form factor modules. The first level trigger coming from multiplicities of TOF scintillation counters and beam detectors was performed with commercial modules in CAMAC and NIM crates.
The slow control system was designed using the EPICS standard. Several Eltec E7 cpus in VME crates controlled via VSB to CAMAC links the modules in CAMAC crates which were used to set the discriminator thresholds of the TOF system. Crates were controlled by CANbus. The CAEN HV system 527 was controlled via a VME module. Several slow ADCs and alarm modules were read by these VME cpus.



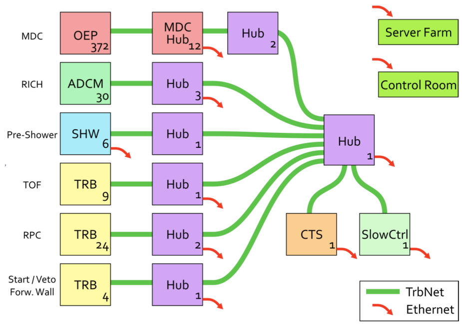
After some years of operation a DAQ upgrade was performed. All VME based readout was removed and replaced with custom built modules. With the removal of the VME and CAMAC crates the slow control functions had to be implemented in a different way:

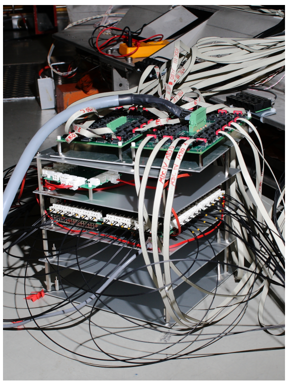
- by implementing the functionality on the readout board (**TRB**)
- by the use of a general purpose board (**HADCON**)
- new functionality on the TRBnet devices

New system:
All CAMAC modules (discriminators, scalers, slow ADCs) are replaced by on board functions of modules in the DAQ-system (TRB-Addons).
Most of the NIM boards (trigger logic, fan-in/fan-out, gate generators, coincidence units) are replaced by a FPGA based CTS board (central trigger system).
Low voltage power supplies are standardized into two types:
- 8 V and 50 V (1500 W) TDK-Lambda rack mounted power supplies plus power distributor boards with DC/DC converters and filters.
  - See: URL: http://hades-wiki.gsi.de/pub/DaqSlowControl/TRBPublicationList/Power_Supply_Experiences_HADES_Upgrade_2010_2.pdf
- High Voltage supplies were replaced with ethernet controlled crates (CAEN SY1527LC).
- Other equipment was replaced with RS232 controllable modules (EPICS stream device support).
- VME-based slow control cpus are replaced either by PCs with Linux EPICS IOCs or with onboard cpus (AXIS) also running Linux interfaced to micro controllers (TRB, HADCON).

TRB V2:
128 ch 100ps TDCs or various Addon boards
Optical data transmission (POF) via TRBnet.
A description of the board can be found in the IEEE 2008 proceedings:

Frohlich, I.; Kajetanowicz, M.; Korcyl, K.; Krzemien, W.; Palka, M.; Salabura, P.; Schrader, C.; Skott, P.; Strobele, H.; Stroth, J.; Tarantola, A.; Traxler, M.; Trebacz, R.; Yurevich, S.; , "A General Purpose Trigger and Readout Board for HADES and FAIR-Experiments," *Nuclear Science, IEEE Transactions on* , vol.55, no.1, pp.59-66, Feb. 2008
doi: 10.1109/TNS.2007.913487
URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4448480&isnumber=4448435





A readout stack in the lab:
Power distribution board
TRBnet hub with plastic optical fibres (POF)

TRBnet DAQ and slow control:
The slow control and monitoring system provides a variety of features:
- the whole network forms a global 32 bit address space with registers on each FPGA
  - each front-end can be monitored and configured individually
- the same network as for data transport has to be used due to space constraints, but:
  - slow control is independent from other channels, can not be blocked by mal-function
- every board is identifiable by on-board id-chip
- DHCP-like assignment of network addresses
  - every board can be addressed individually or in groups (broadcast)
- Further features:
  - allows to upgrade firmware stored in flash memories
  - standard registers provide global status information
- User Interface:
  - a software library provides an easy-to-use basis for any kind of monitoring software
  - User front-end gives access via command line tools and graphical interfaces (EPICS)

Michel, J.; Fröhlich, I.; Böhmer, M.; Korcyl, G.; Maier, L.; Palka, M.; Stroth, J.; Traxler, M.; Yurevich, S.; , "The HADES trigger and readout board network (TrbNet)," *Real Time Conference (RT), 2010 17th IEEE-NPSS* , vol., no., pp.1-5, 24-28 May 2010
doi: 10.1109/RTC.2010.5750405
URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5750405&isnumber=5750311