DCS for the electromagnetic calorimeter

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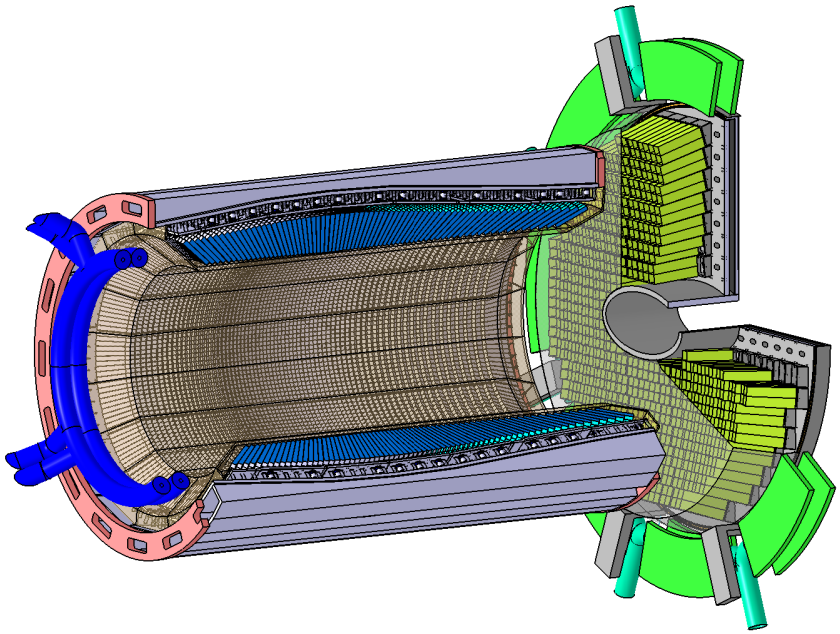
The PANDA electromagnetic calorimeter



- Barrel plus forward and backward endcap
- PWO scintillation crystals cooled down to $-25\,^{\circ}\mathrm{C}$

Controller Area Network

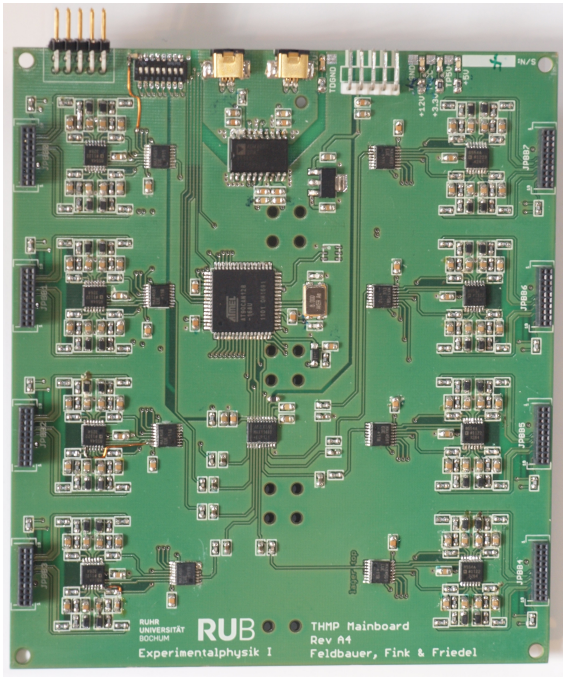
- CAN bus should be used for future devices
- Chosen as default bus system for $\overline{\text{P}}$ANDA
- Two-wire data bus (differential signaling), data rate up to 1 Mbps
- Most devices of the EMC DCS use CAN bus
- Custom hardware for CAN communication based on Raspberry Pi developed by Florian Feldbauer ($\rightarrow$ his talk)

Temperature and Humidity Monitoring

- **T**emperature and **H**umidity **M**onitoring Board for $\overline{\text{P}}$ANDA
- Developed by Florian Feldbauer and Patrick Friedel at RUB during their Master/Diploma studies
- Lightweight solution to monitor environmental conditions:
  - Temperature
  - Humidity
  - Air pressure
  - Flux in cooling tube
- Mountable close to/in the detector
- Generation 1 in use at Proto192 (FEMC) for $>$ 3 years
- Gained lots of experience in these years
- Redesigned device to make it even better $\Rightarrow$ Generation 2
- 10 THM$\overline{\text{P}}$s for FEMC, 1 BEMC, ca. 20 barrel

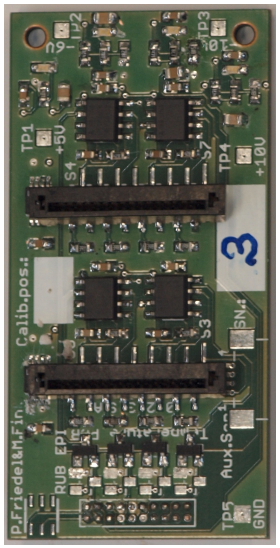
The mainboard

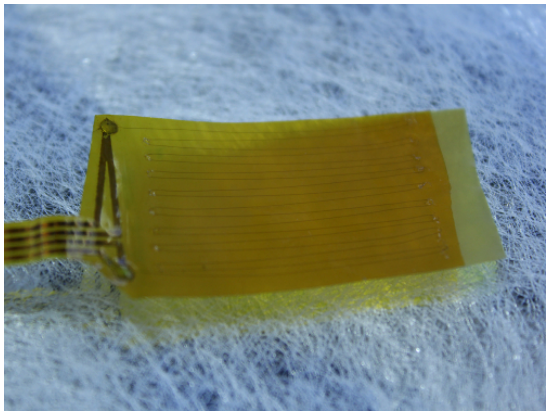
- Powered by AT90CAN128 μC (8 MHz)
- Connected via CAN bus
- Modular design:
  - Connectors for 8 piggyback boards (PBB)
  - Various types of PBBs for different tasks
- 8 channels per PBB $\Rightarrow$ 64 channels per THMP
- 14bit ADC (Maxim MAX1148)
- Channels multiplexed to ADC
- Low power consumption (< 3 W)



Temperature PBB

- Temperature measured by change of resistance of platinum
- Four-wire measurement
- Piggyback board drives a current of 1 mA
- Voltage drop over resistor (Pt100) is measured through separate wires
- Very precise measurement
- Independent of cable length
- Range $-50\,^{\circ}\mathrm{C}$ to $+50\,^{\circ}\mathrm{C}$
- Resolution $< 0.05\,^{\circ}\mathrm{C}$



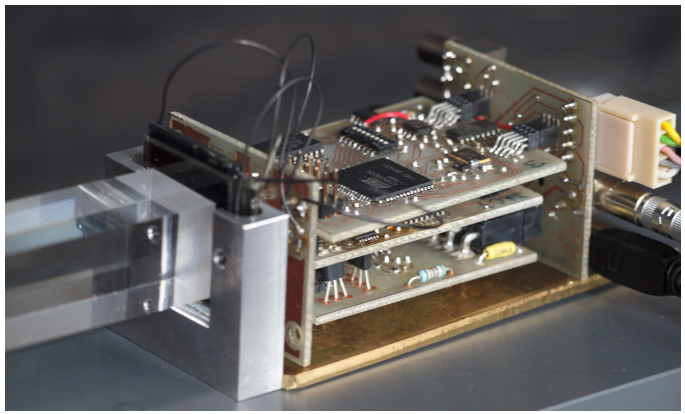


Other PBBs

- Humidity (HIH-4000) and pressure (MPX4115A)
  - Four wires, but no four-wire measurement
  - One wire to power the sensor
  - One wire for readout
  - Two wires common ground
  - Sensor response fed to ADC
- I/O board (planned):
  - Generic communication interface for e.g. relais, end-point switches, safety loops etc.
  - Remote-controllable using the CAN bus of the THMP̄
- Generic interface for new PBB types:
  - New types of PBB without changes to the mainboard
  - PBBs can supply up to 4 V to the ADC
  - Two-wire interface (I^2C) for direct communication to the μC
    $\Rightarrow$ may need firmware extension

EMC light pulser system

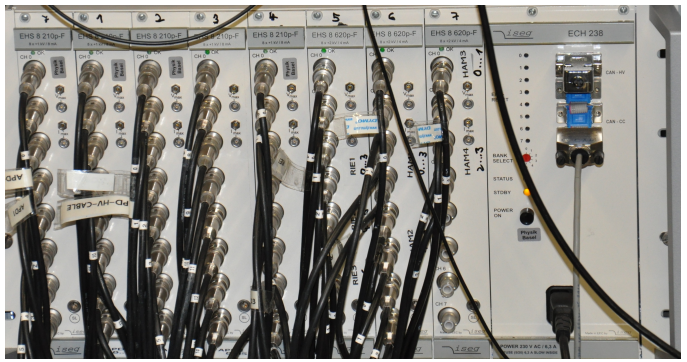
- Red, green and blue light pulser
- Blue pulse resembles scintillation light from PWO
- Developed by Christof Motzko at Ruhr-Universität Bochum
- Controlled via CAN bus
- Amplitude and frequency configurable
- One pulser for 400 crystals ($\Rightarrow$ 10 for FEMC, 1 BEMC, $\sim$28 barrel)



iseg high voltage power supply

- Crate ECH238 houses up to eight HV modules
- Uniform CAN protocol for all module types

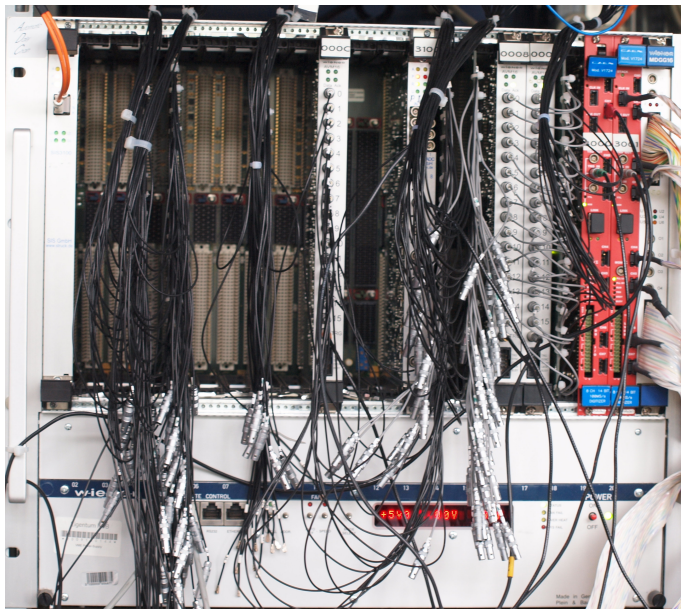
- Different modules of EHS and EDS series available:
  - Polarity, maximum output voltage and current up to ± 10 kV and 15 mA
  - For FEMC we use EHS F240p-F ($+2$ kV/4 mA), F8210p-F ($+1$ kV/8 mA), and F8620p-F ($+2$ kV/4 mA)



- $\Delta U = 0.01\% \cdot U_{\text{mom}} \oplus 0.02\% \cdot U_{\text{max}}$ (not for F8620p-F)
- $\Delta I = 0.01\% \cdot I_{\text{mom}} \oplus 0.02\% \cdot I_{\text{max}}$ (not for F8620p-F)

Wiener VME crate and cooling

- Crate temperature, power supply and fan speed monitorable via CAN bus
- Detailed voltage and current overview
- Remote control of crate
- Chillers for Proto192 controlled by RS232 bus
- Integrated into EPICS and CSS
- Number of cooling/LV devices yet to be determined



The End

Thank you for your attention!