Status report on the backward endcap

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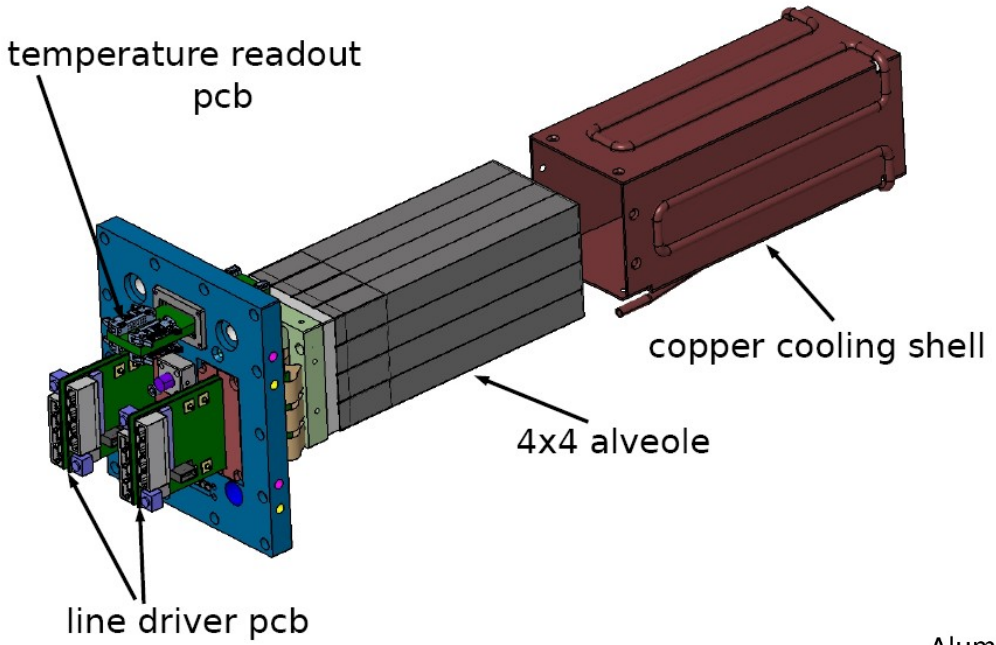
for the Mainz EMC Group

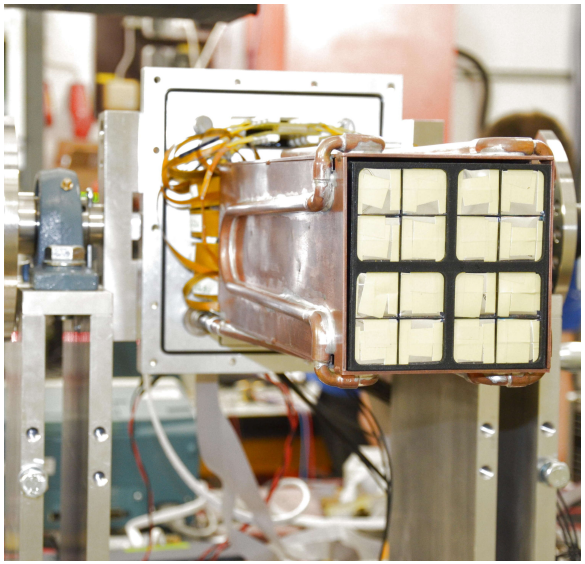
PANDA CM 06/2016 – GSI, 8/6/2016
EMC Session

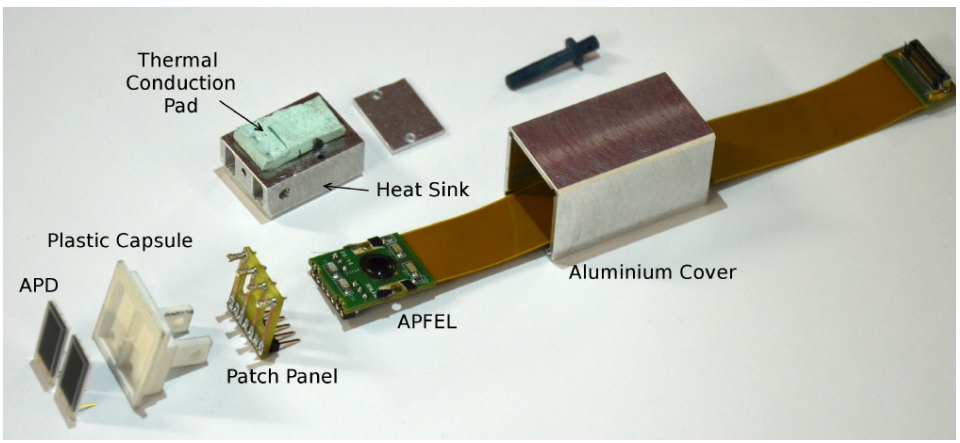
Outline

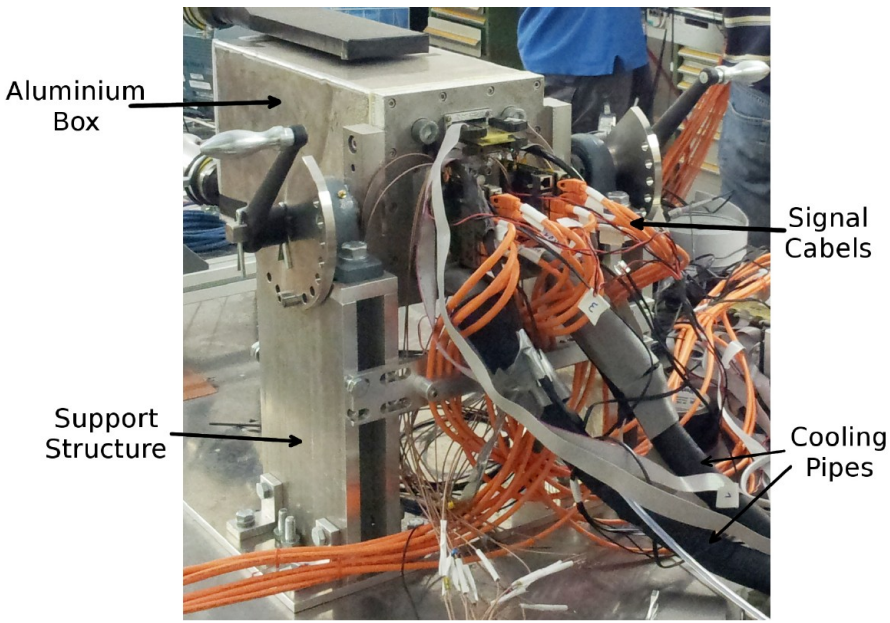
- Update on the prototype Proto16
- First results from the latest beam test
- Experience with the PANDA ADC
- Open tasks for the backward endcap

Prototype “Proto16”

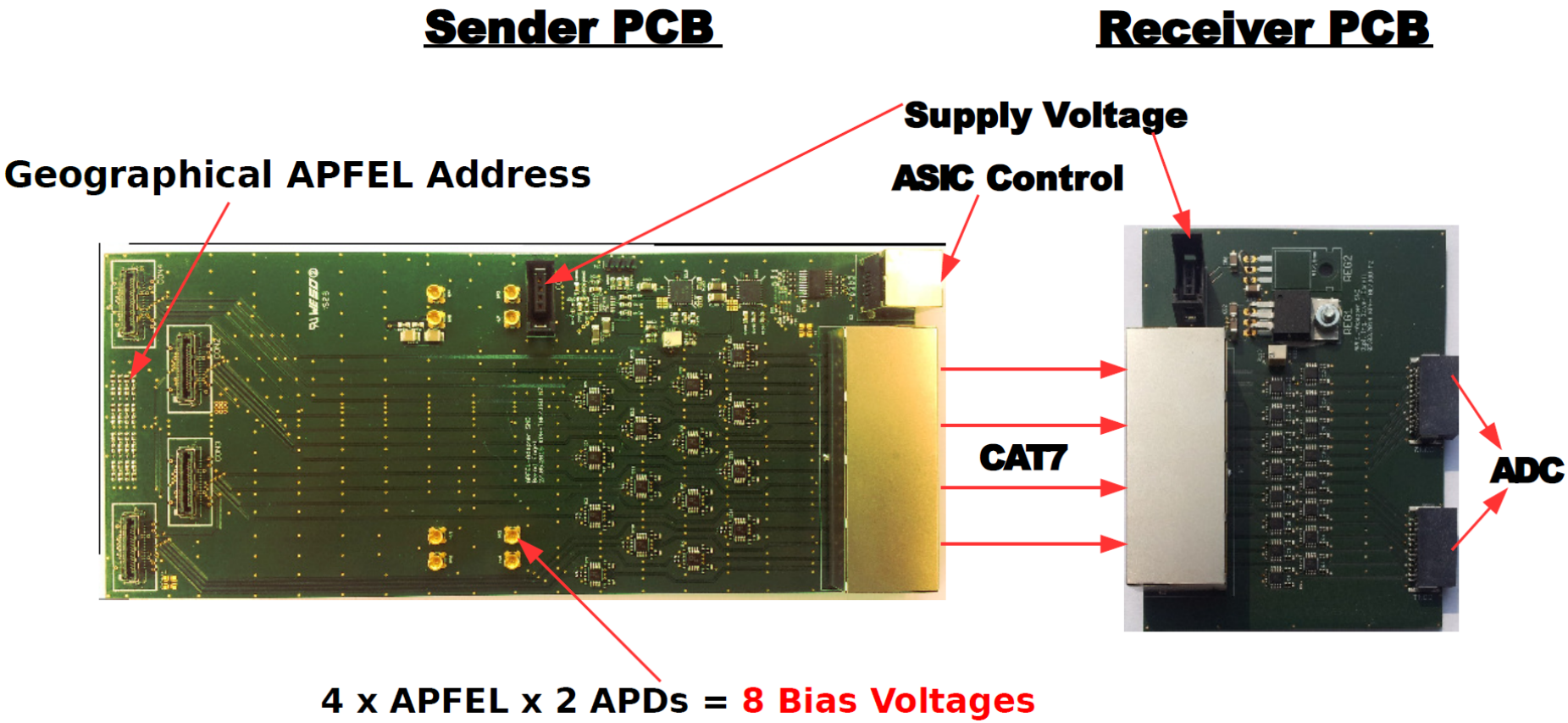








Line Drivers



Upgrades of Proto16

- Used optical grease between APD and crystals
- Shielding for the distribution (sender) boards
- Receiver boards replaced by passive adapters
- Embedding of PANDA (Uppsala) ADC and TRB readout

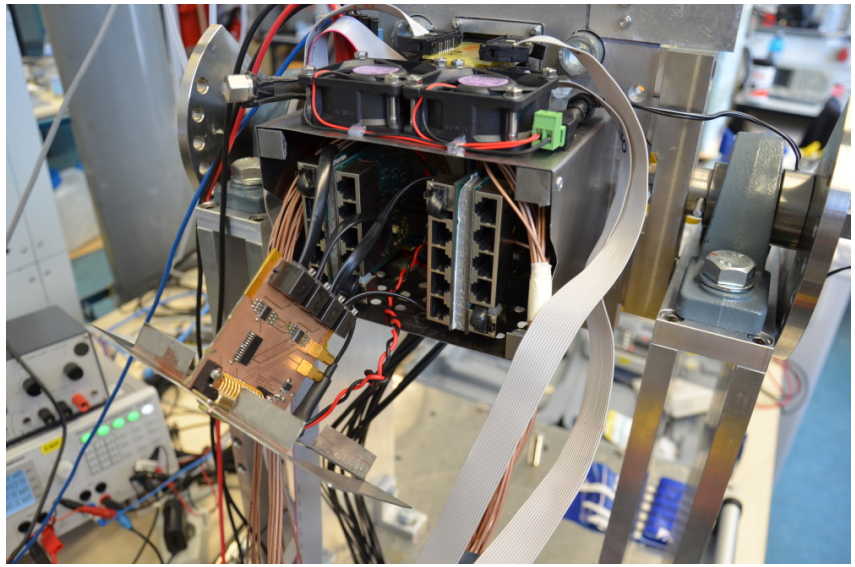
Shielding

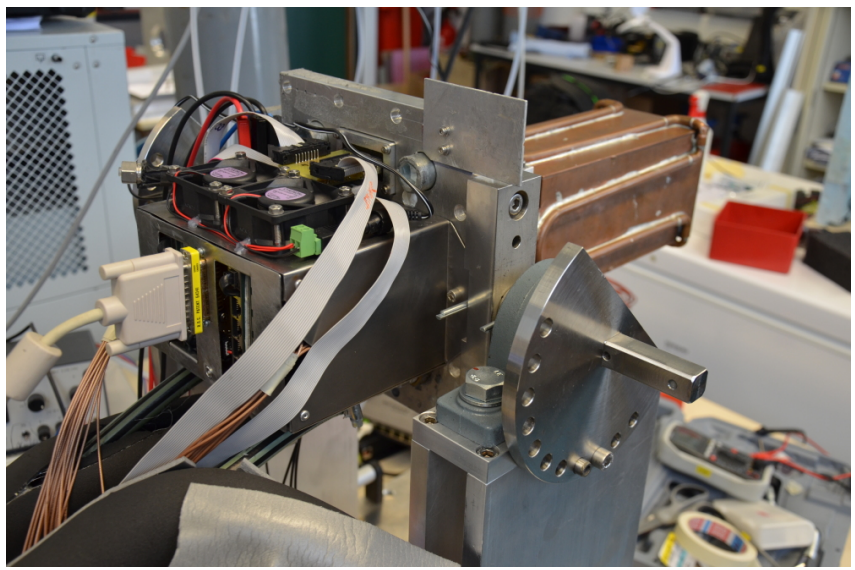
Provides

- Power supply for ASIC and line drivers
- Shielding for ASIC programming cables
- Ventilation

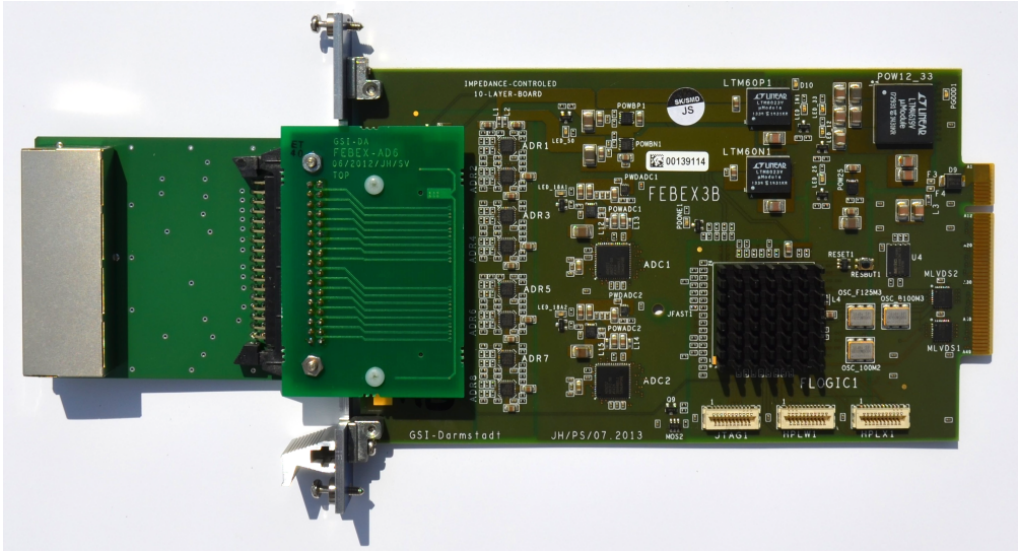
Open issue

- Shielding for Pt100 sensor cables
- Had to be unplugged during beam test





New “receiver” boards



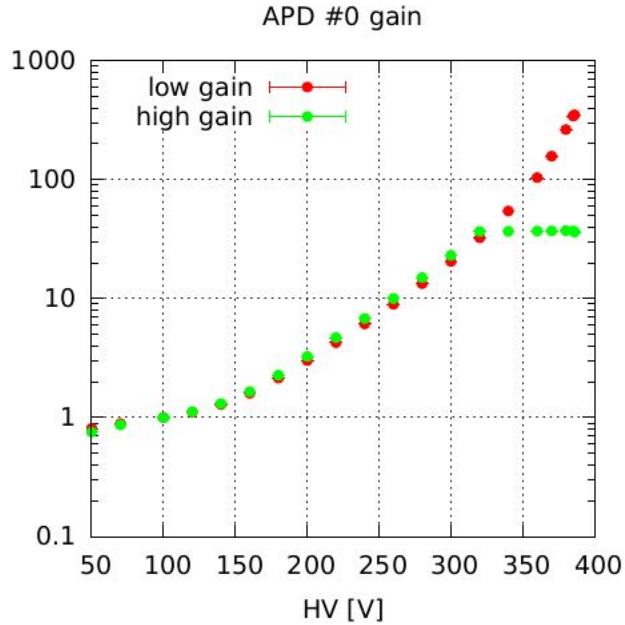
- General passive adapter RJ45 to pin header connector
- Used with the Febex sampling ADC
- Possibility for voltage divider to attenuate signals

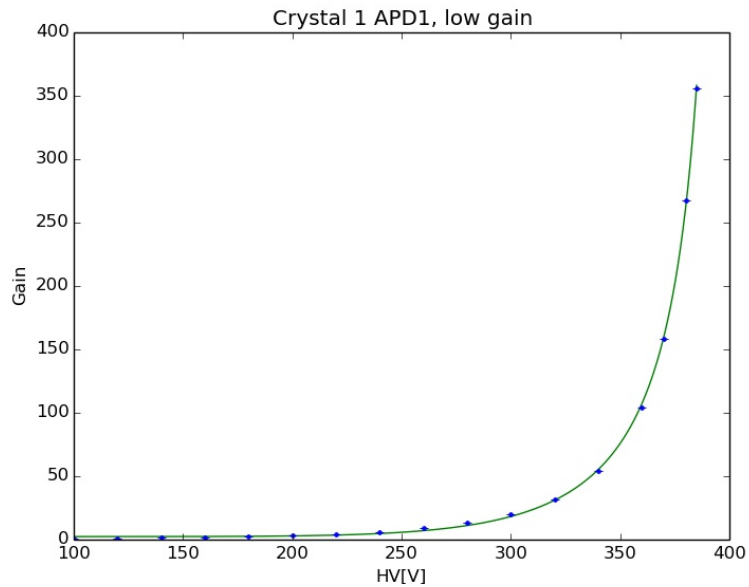
APD characteristics

- Measured with the Proto16:
  LED pulses through optical fibres
- Last time: changing light intensity
  Now: only one intensity for all voltages
- Normalising at $U = 100$ V
- Fit function:

$$M = \frac{A}{1 - (U/U_{\text{br.}})^k} + C$$

- Calculate U for every single APD for given M





Problem

- The fit function is not adequate for pulsed illumination
- At $U = 100$ V the gain is already $M > 1$
  $\Rightarrow$ and it is different for each APD

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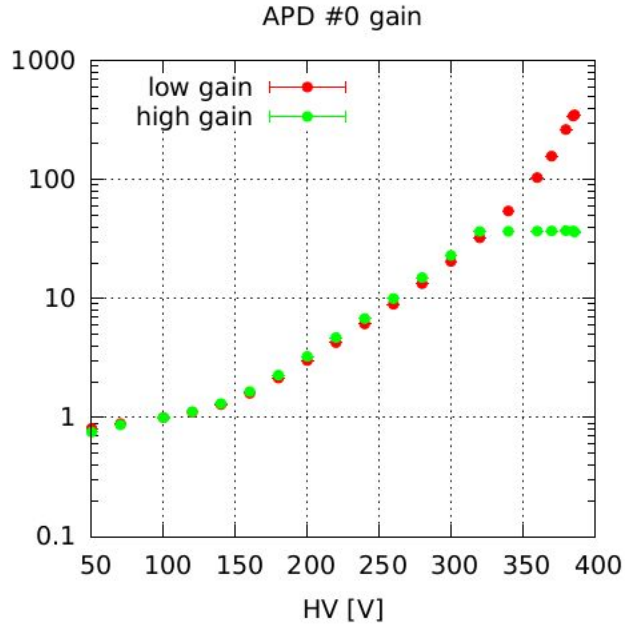

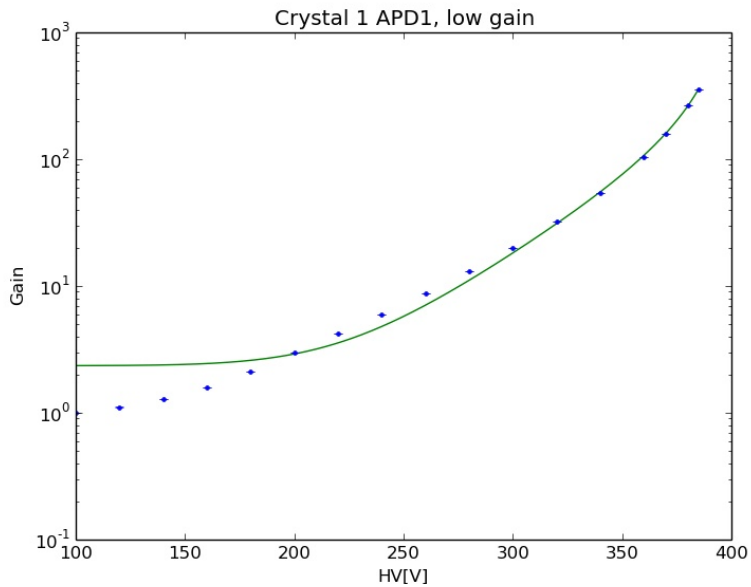

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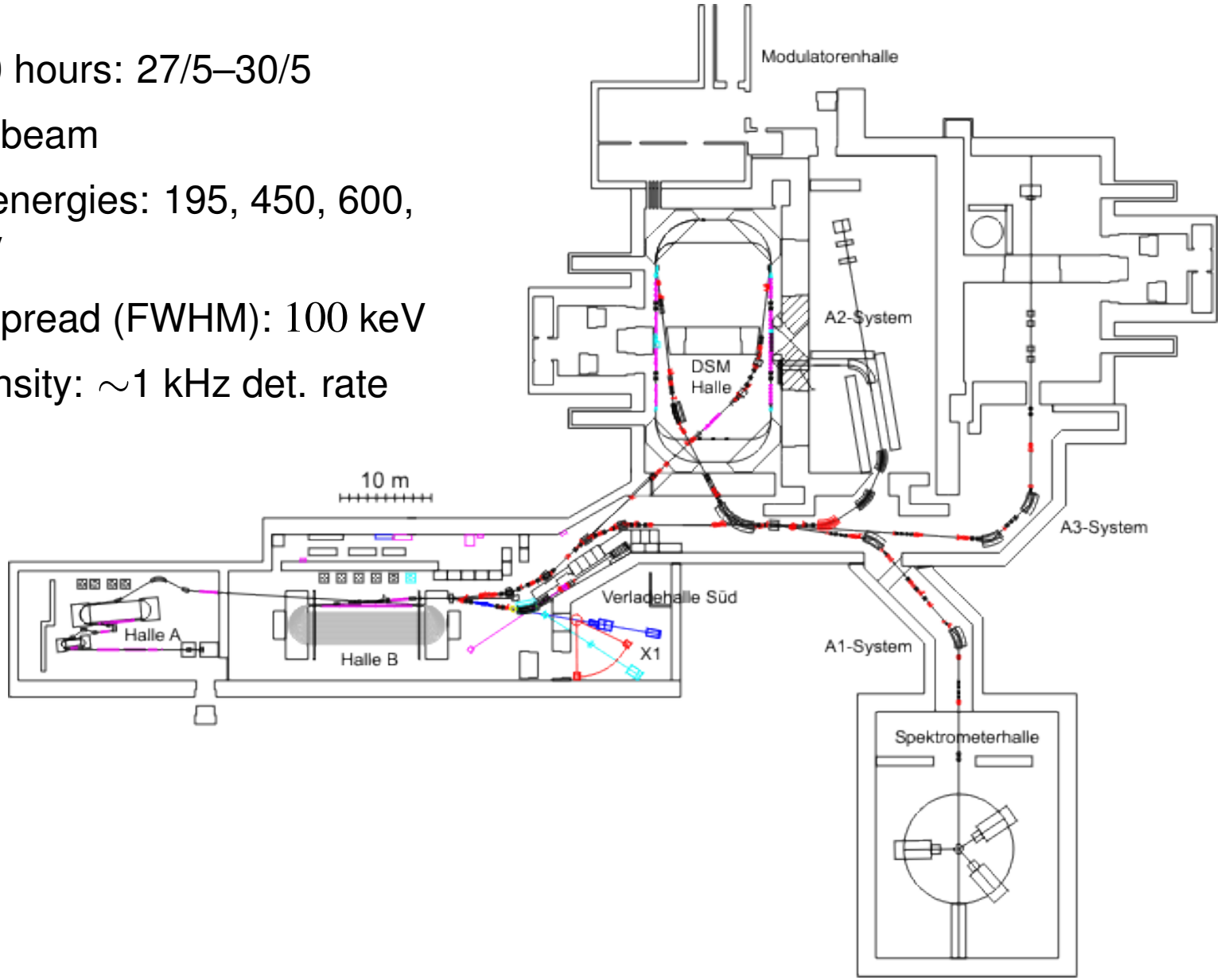
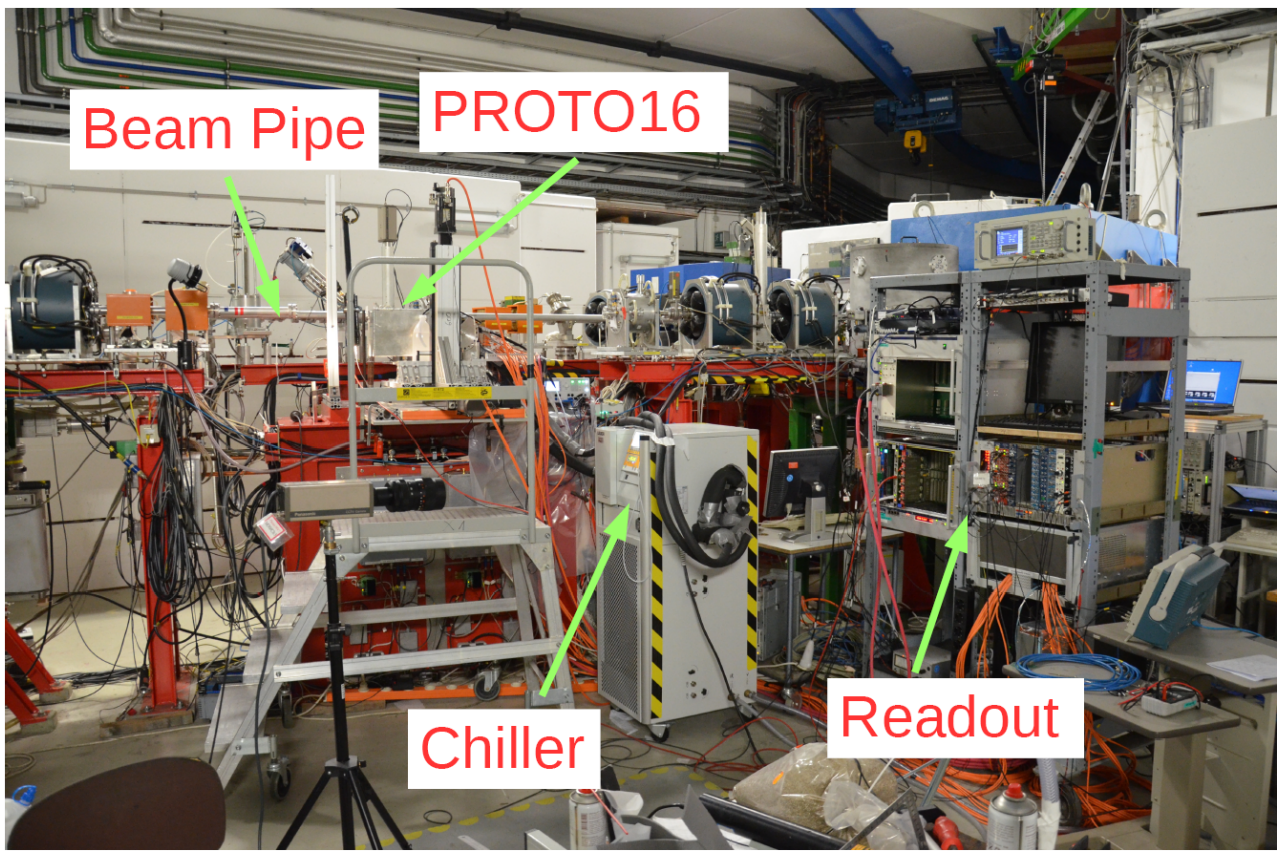
Beam test May 2016 at MAMI

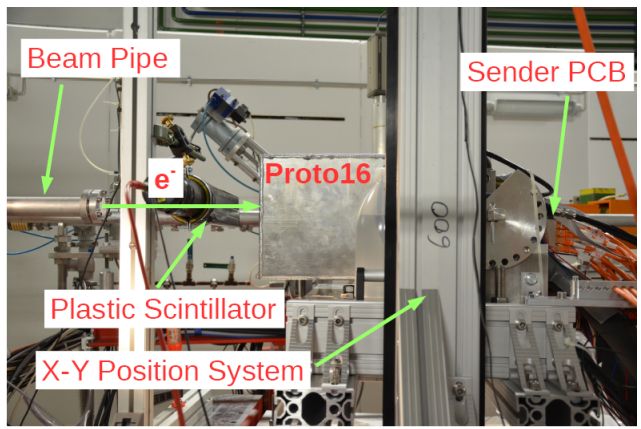
- About 50 hours: 27/5–30/5
- Electron beam
- 4 beam energies: 195, 450, 600, 855 MeV
- Energy spread (FWHM): 100 keV
- Low intensity: $\sim$1 kHz det. rate

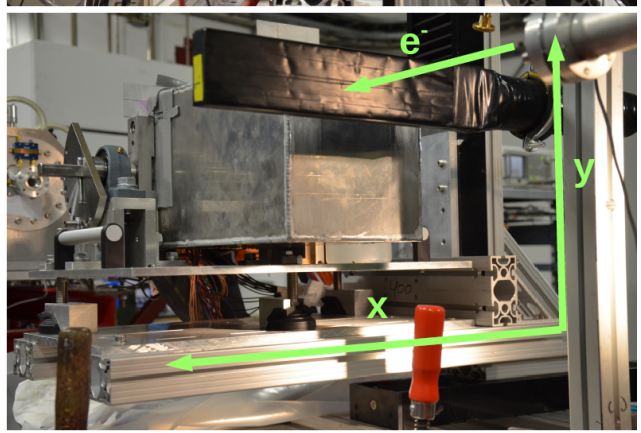


Test setup

- XY-table for centering each crystal on beam
- Rotatable plate for incidence angle scan
- Plastic scintillator for coincidence event triggering







Measurements

For each beam energy

- Each crystal centered on beam
- Two APD gains: 150 and 400

Position scan

- At 195 MeV and 600 MeV

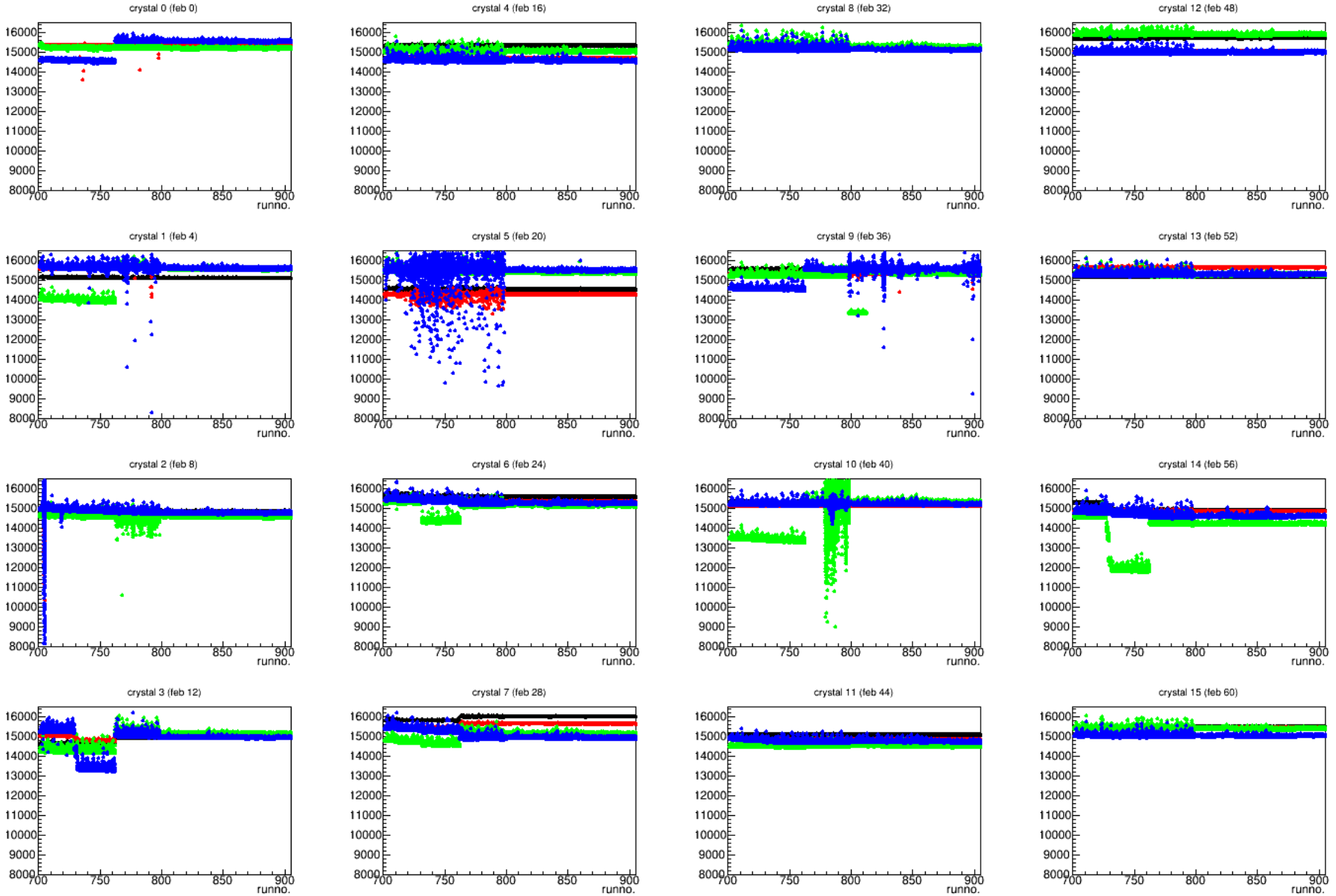
Angle scan

- At 600 MeV

PANDA ADC

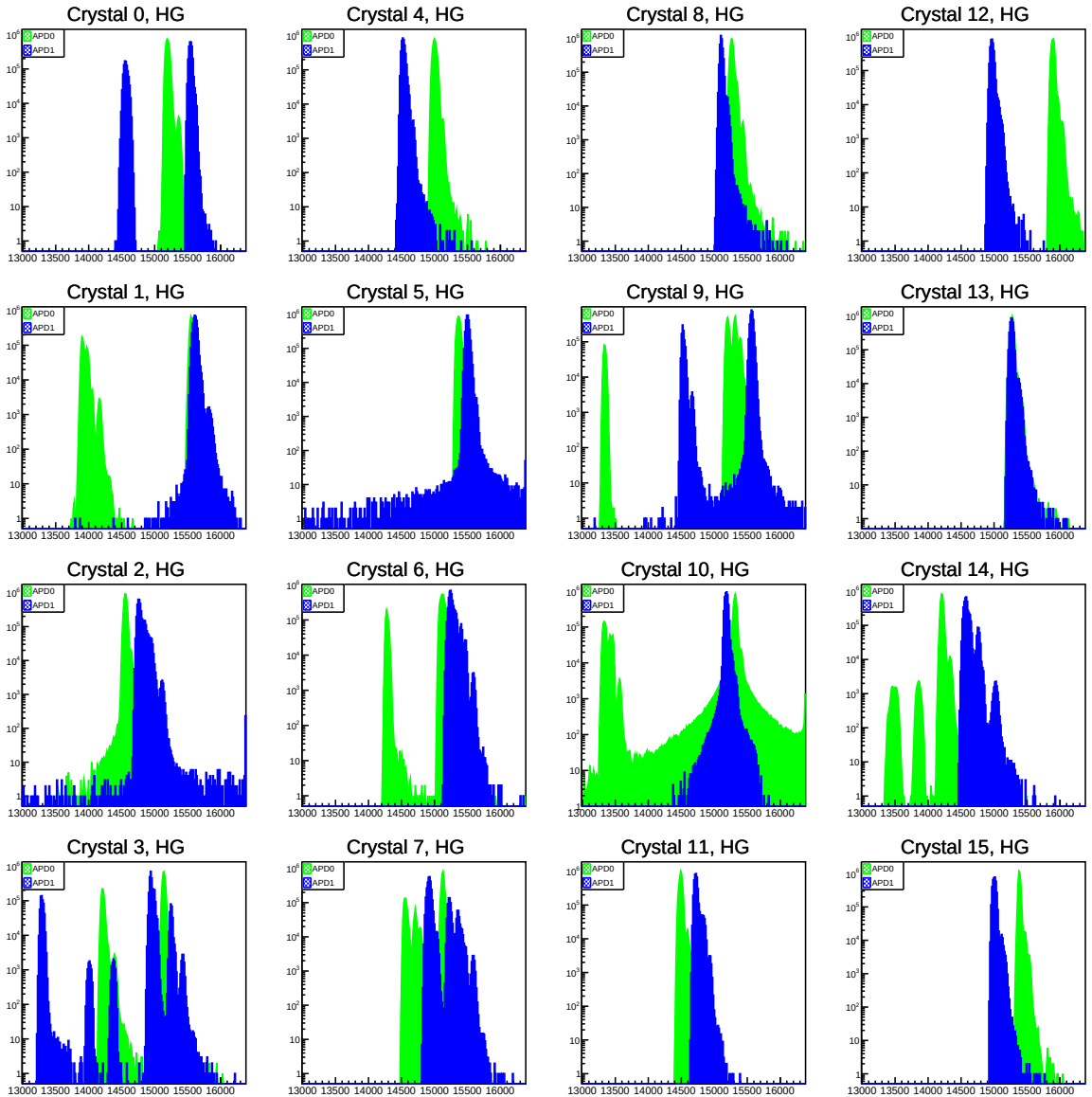
- Energies: 195, 450, 600 MeV

Baseline position



Baseline position (projection)

high gain



Baseline position (projection)

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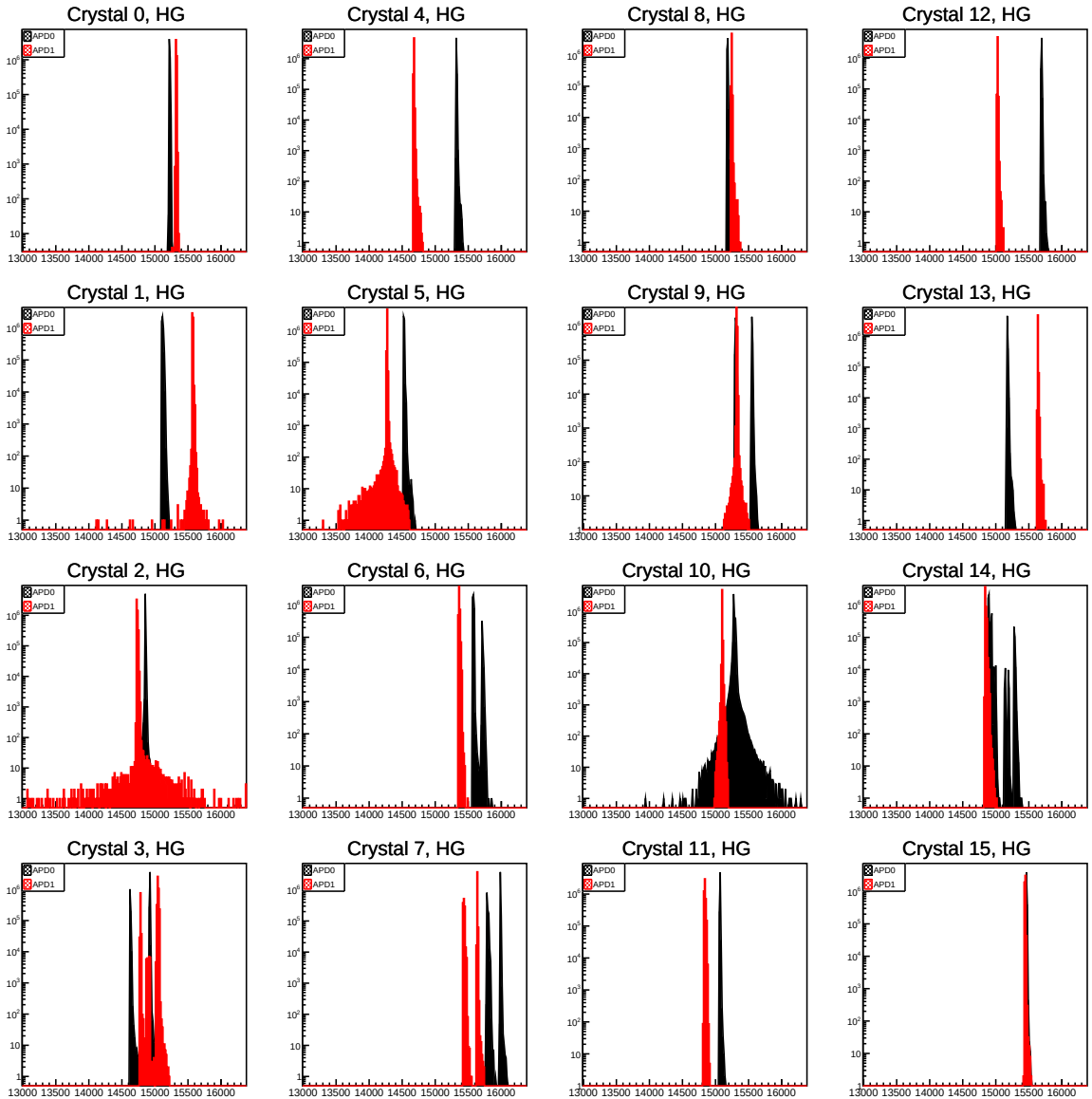
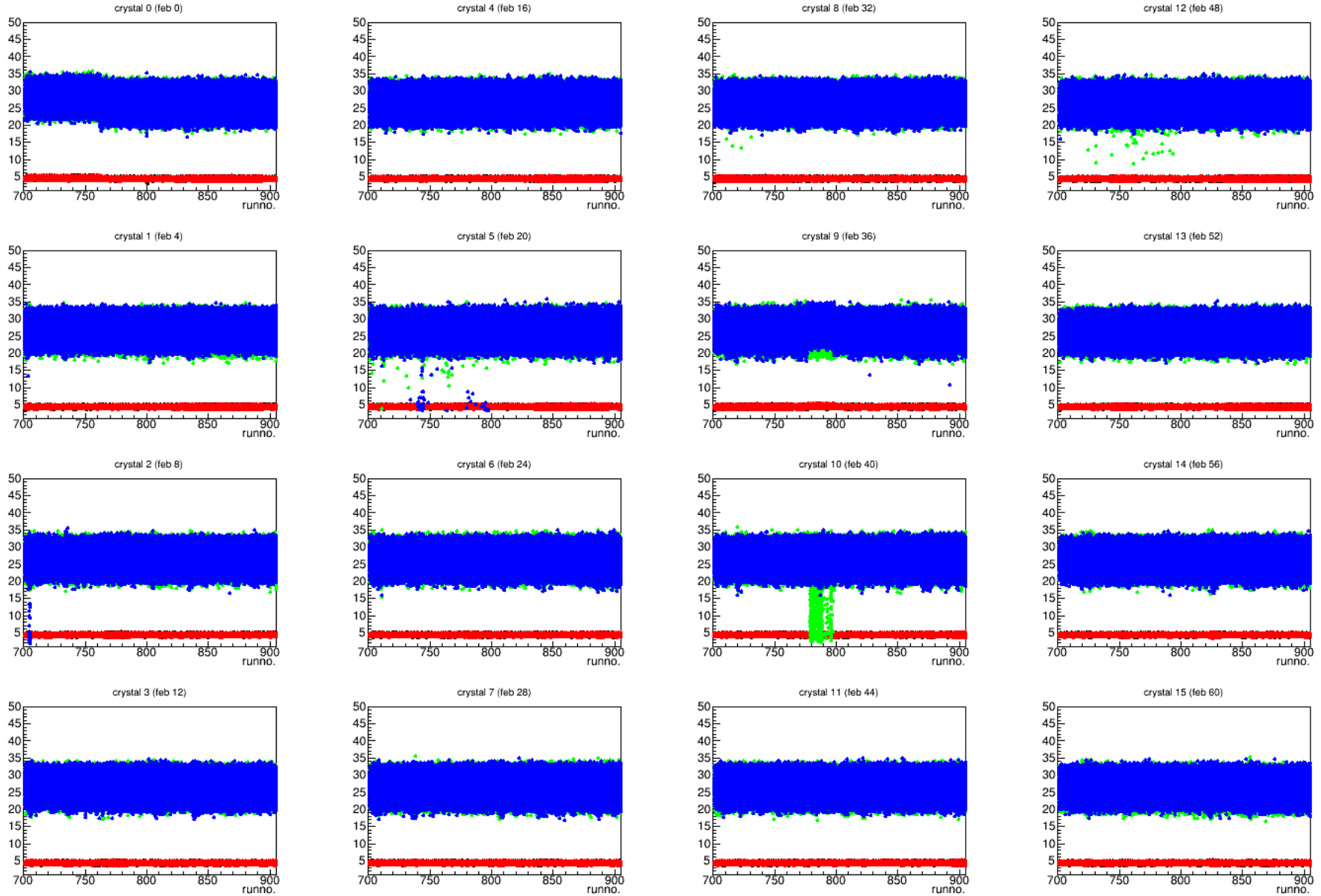
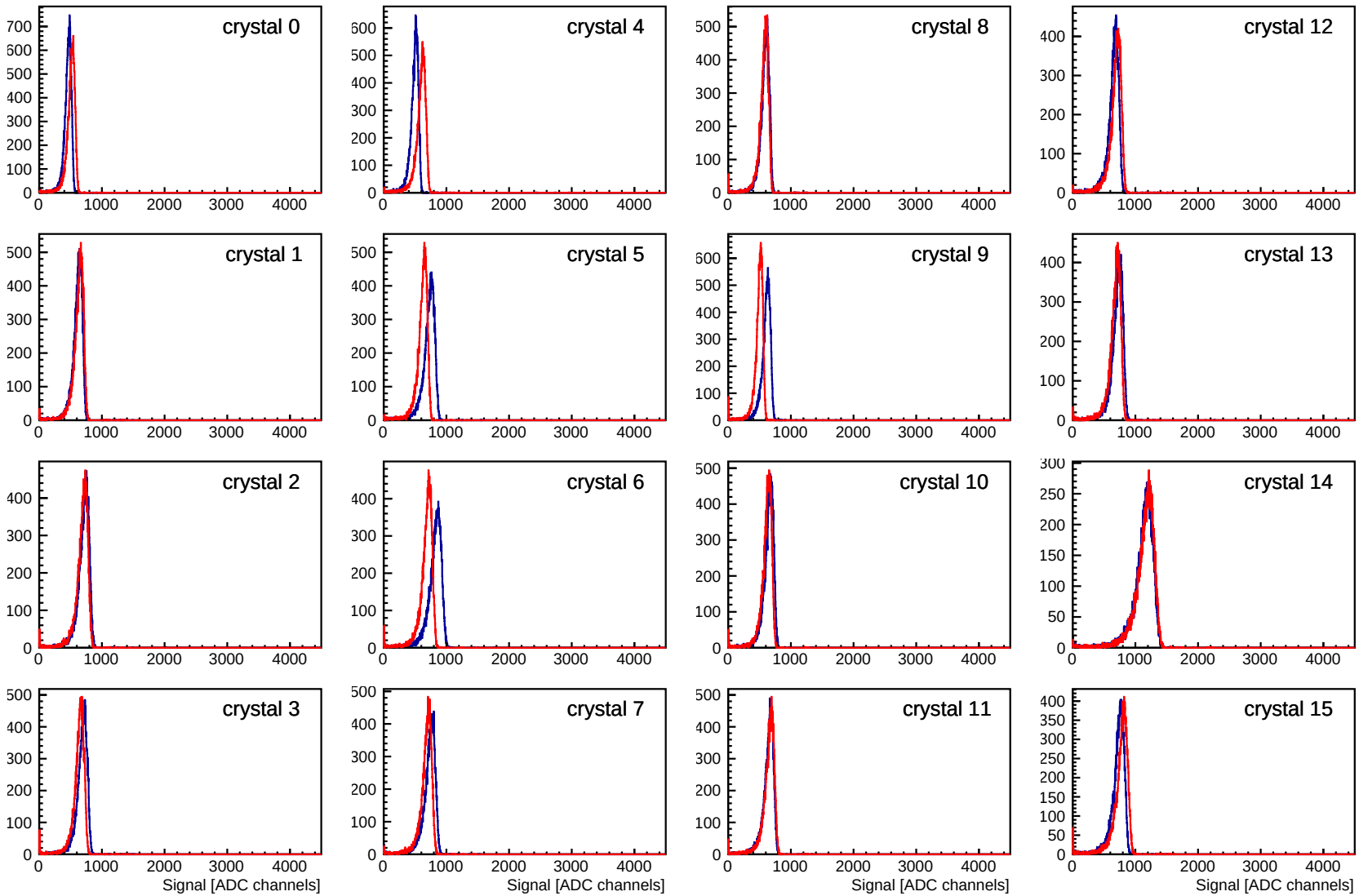


Baseline standard deviation



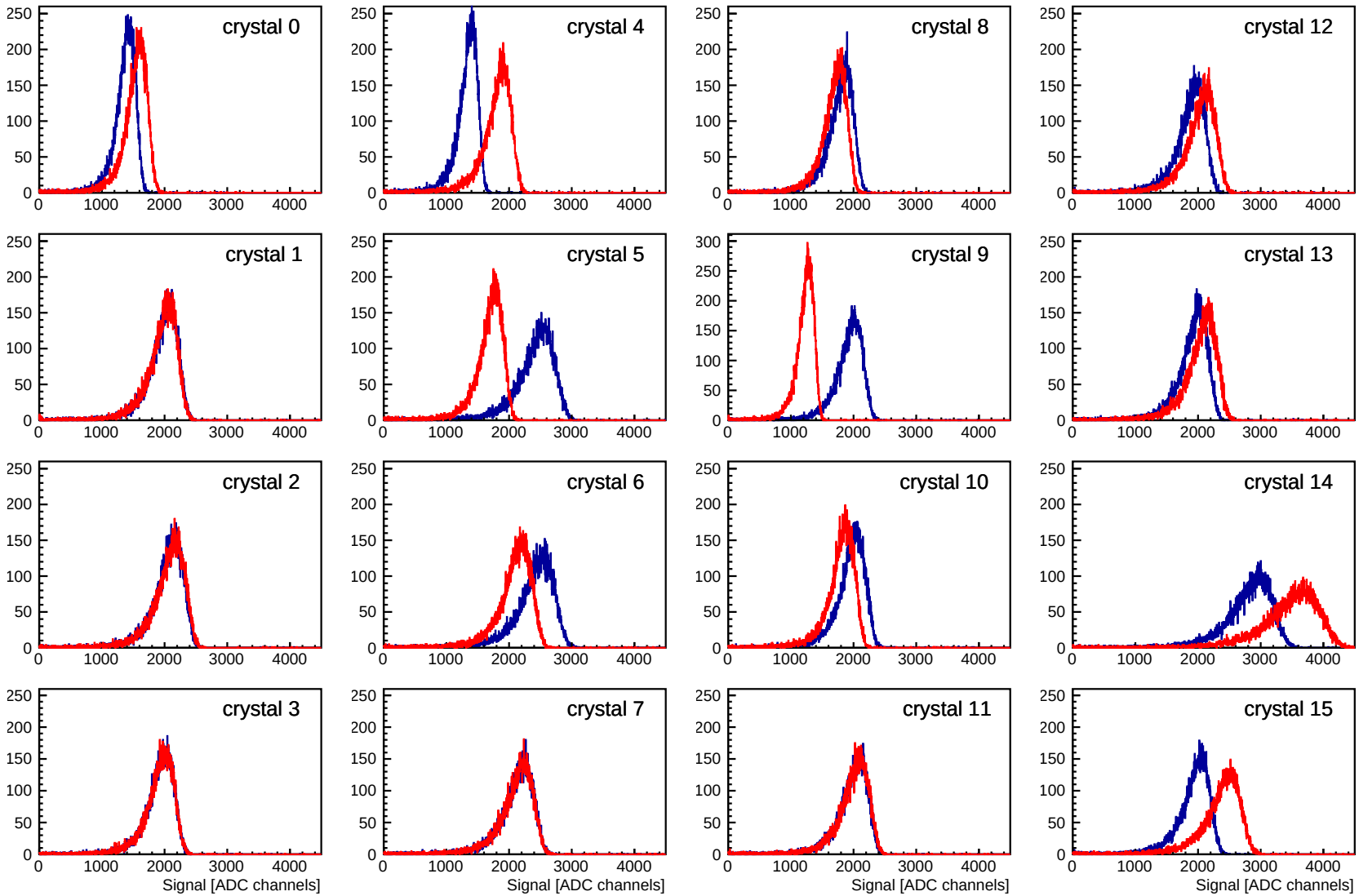
Single APD energy spectra

Beam energy: 600 MeV, APD gain: 150



Single APD energy spectra

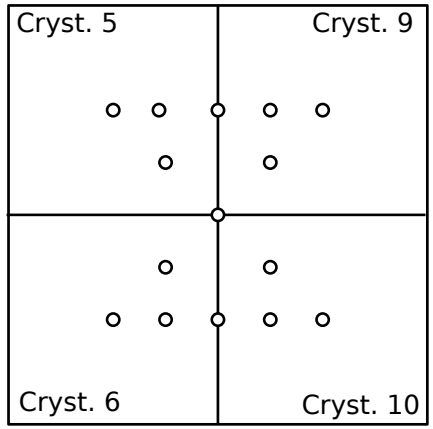
Beam energy: 600 MeV, APD gain: 400



Position and angle scans

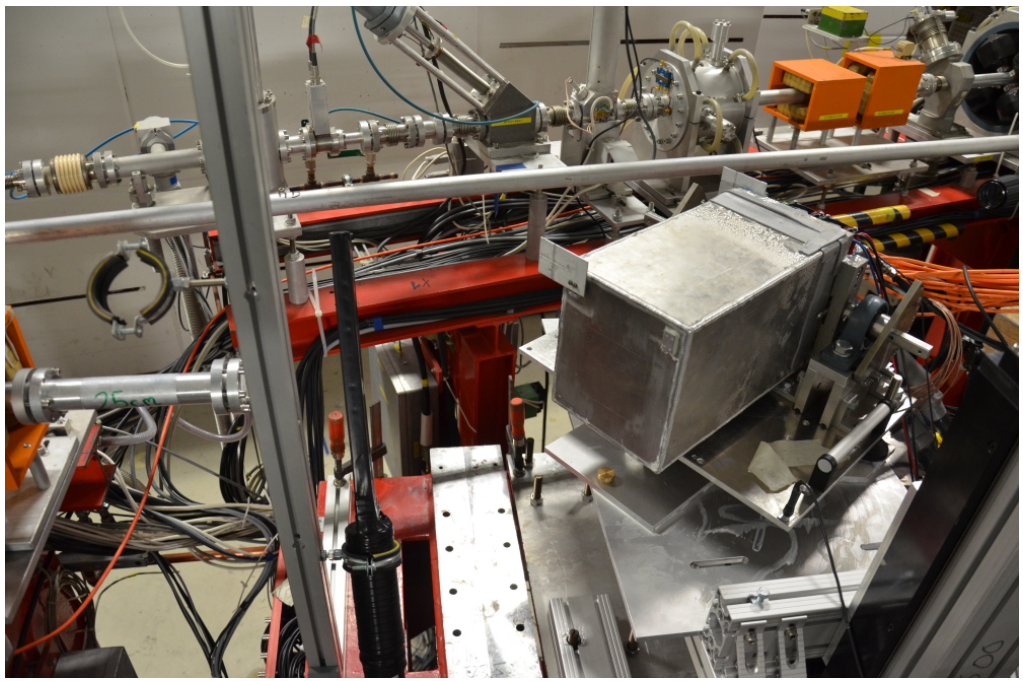
Position scan

- Energies: 195 MeV, 600 MeV
- 12 different impact positions on the central crystals
- Goals: position resolution and influence on energy resolution



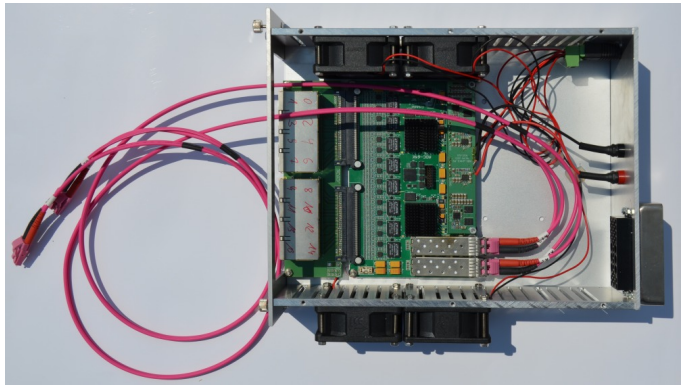
Angle scan

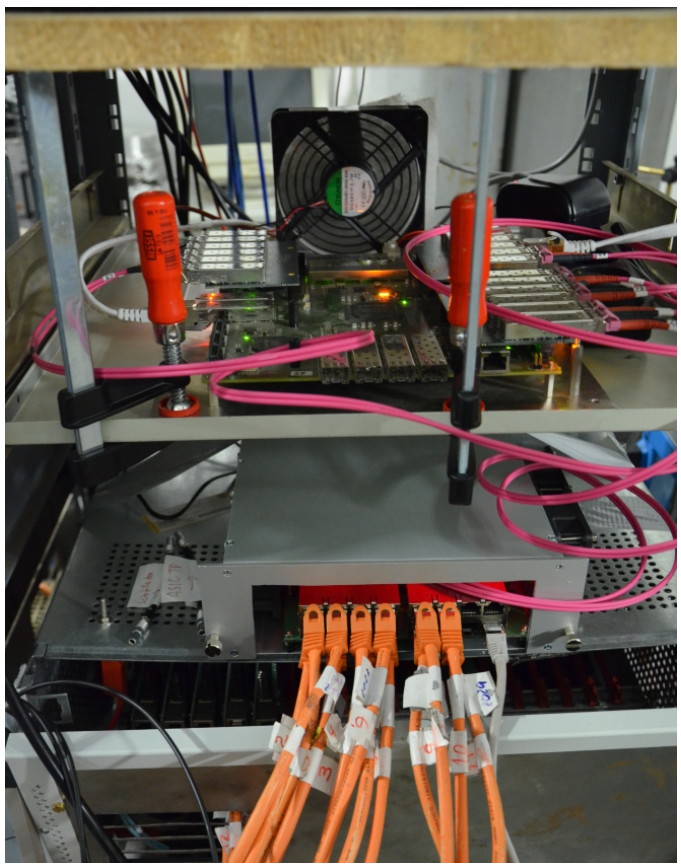
- Beam energy: 600 MeV
- 4 different angles from 5° to 35°
- 5 different impact positions for each angle
- Data to be analysed



Tests with PANDA ADC

- Sampling ADC from Uppsala
- RJ45-Samtec adapter from Gießen (Thanks!)
- Box for:
  - cooling
  - shielding
  - power supply
  - fixing connectors
- TRB3 board for SODA source, DC and UDP encoder (DIRC Group)
- Linux PC as `trbnet` server and UDP listener
- Software and scripts from Groningen



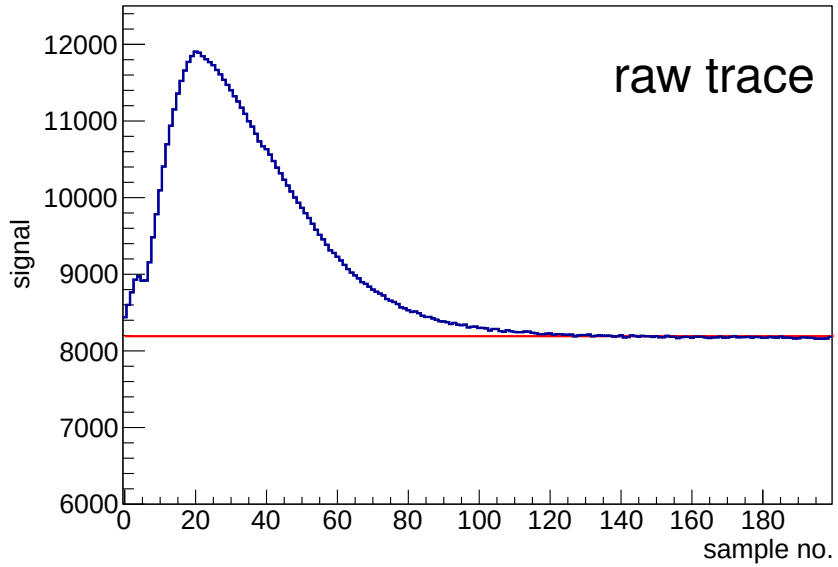


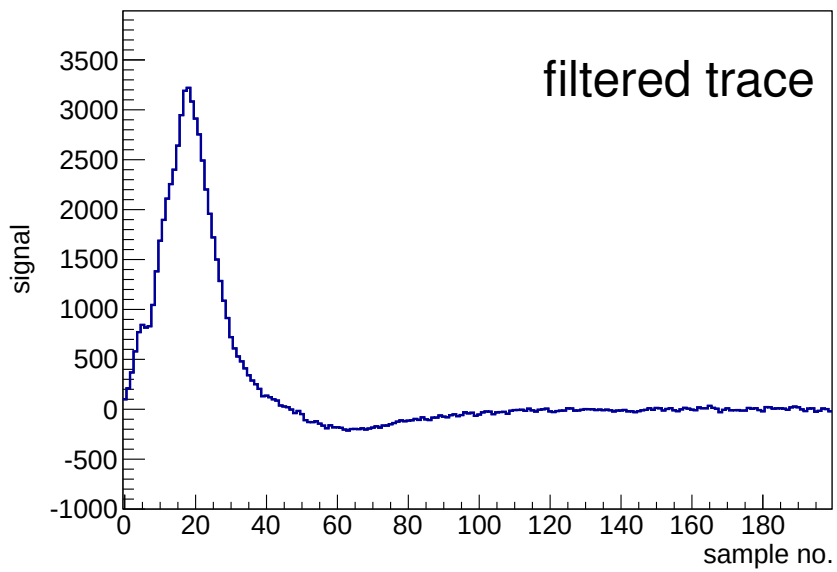
Waveforms

- Baseline does not move: ADC input AC coupled?
- Filter parameters:

```
cf_delay=6
mwd_width=10
mwd_tau=2047
```

- Wish: seeing sample waveforms during measurement



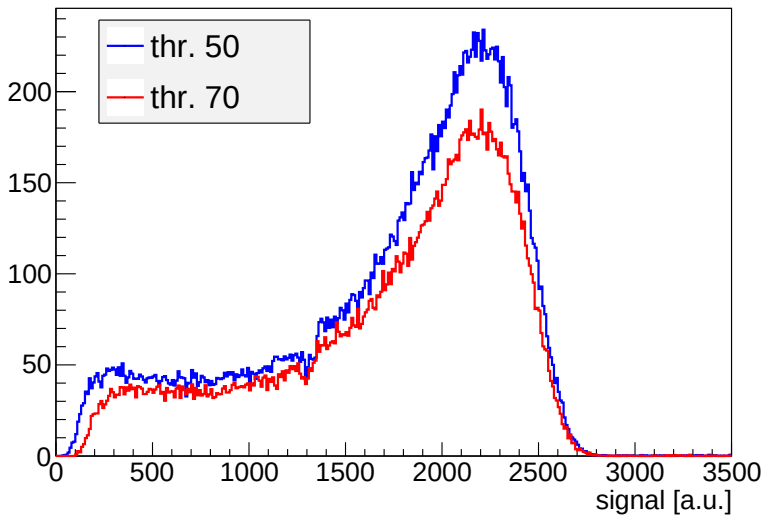


Thresholds

Parameters used:

```
thr_low_gain=50
thr_high_gain=255
mode=1
IA_min=6
IA_max=63
Raw_ADC_data=0
wf_length_min=5
wf_length_pileup=255
wf_length_max=100
wf_max_size_hg=0
wf_max_size_lg=0
```

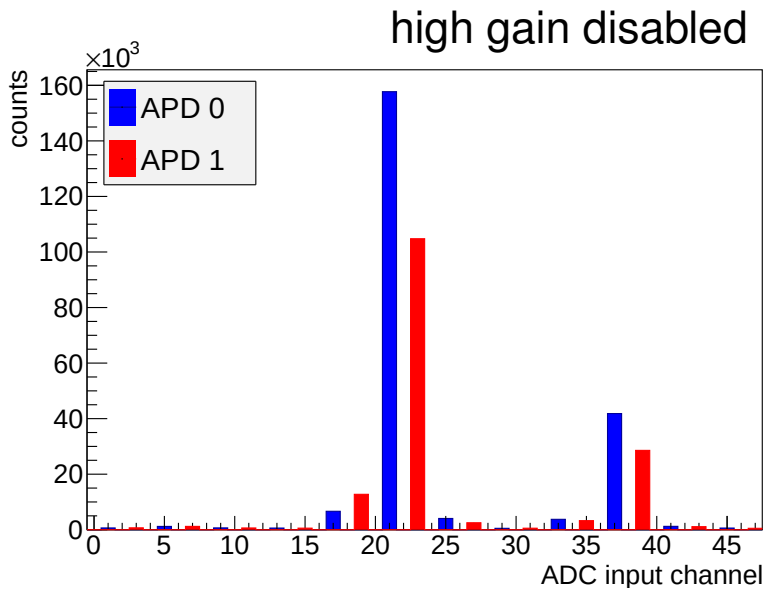
- Energy: 195 MeV
- Run duration: 1 min.
- Counting rate: ≈3 kHz (measured by scintillator)

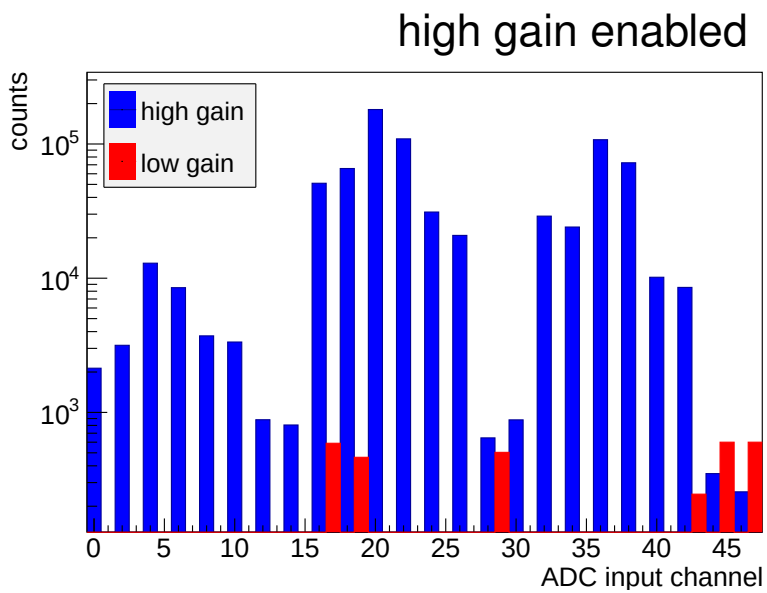


- looked at hit rate ⇒ stopped at thr=50
- threshold change affects whole spectrum
- actual effect of the threshold?

Channel efficiencies

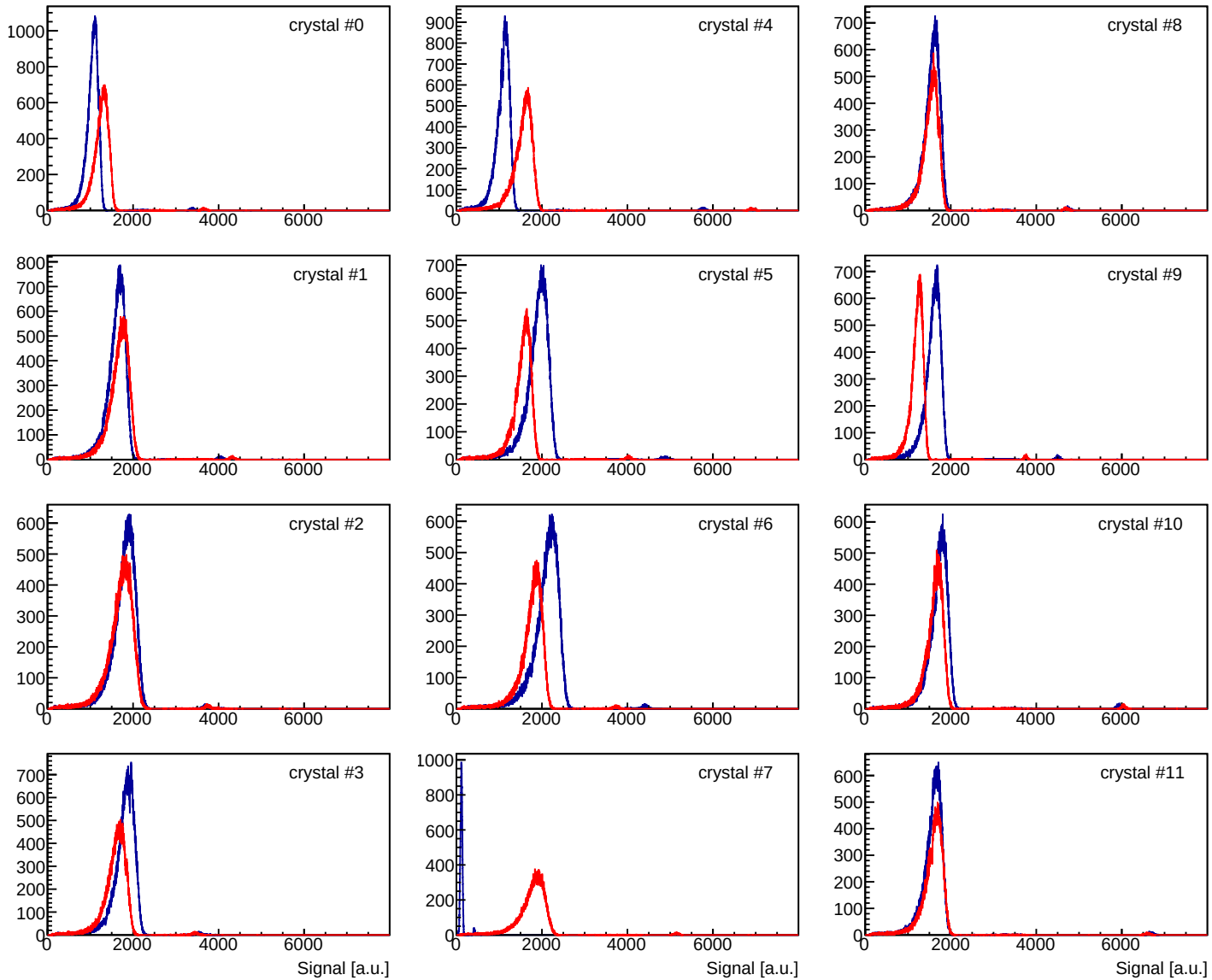
- Number of hits in each channel
- If high gain channels enabled: low gain disappears
- High gain might saturate at high energy $\Rightarrow$ low gain kept for the beam test
- APD channels from same crystal have different efficiency





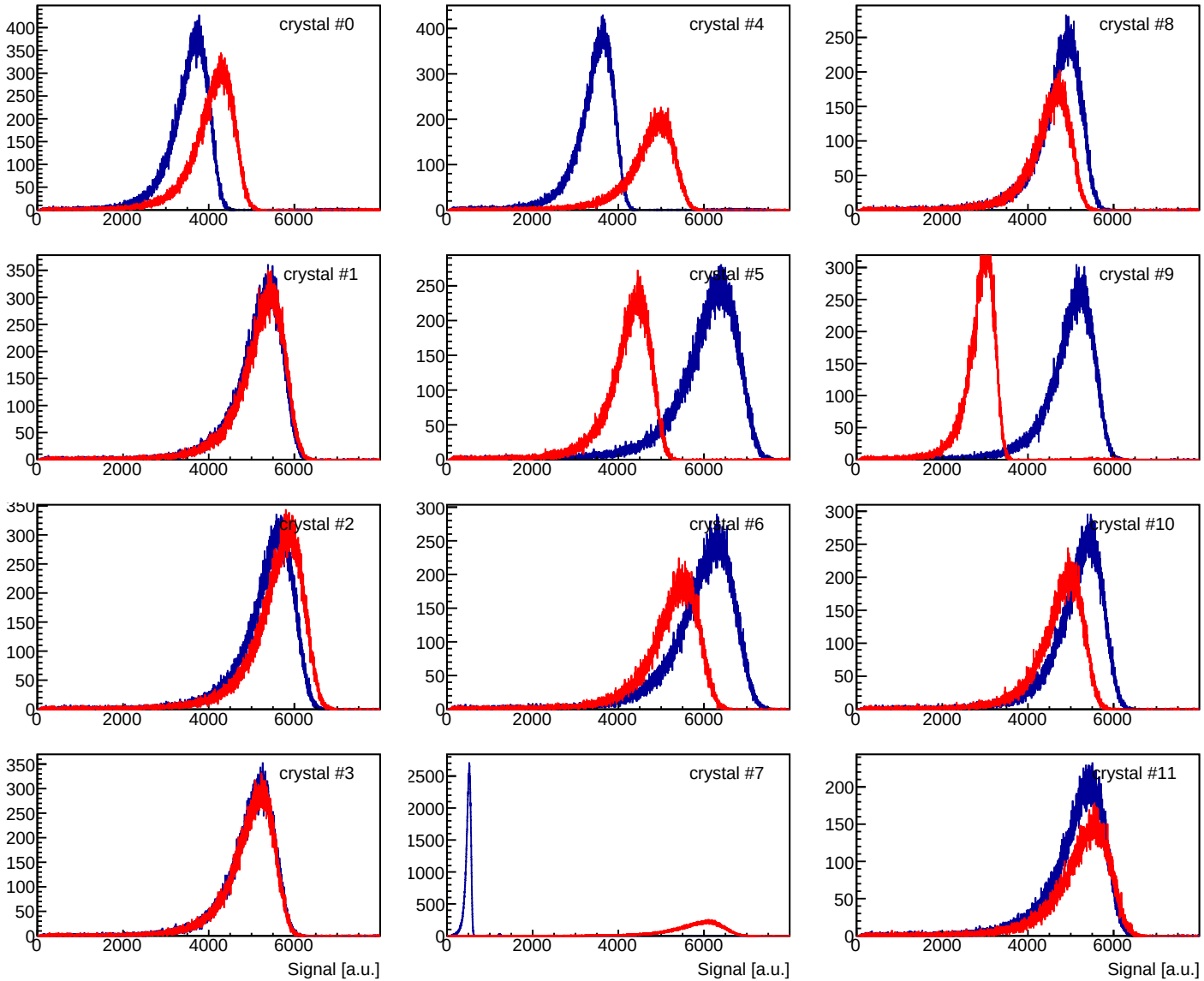
Single APD energy spectra

Beam energy: 600 MeV, APD gain: 150, PANDA ADC



Single APD energy spectra

Beam energy: 600 MeV, APD gain: 400, PANDA ADC



BWEC further development

- APD coupling to the crystals
  - Glue or no glue?
  - Tests needed?
- Final version of the preamplifier Al capsules
  - modification of APFEL board with lines for SMD LED
  - arrangement of the LED on the crystal surface
- Final version of the distribution boards
  - reduce dimensions
  - add HV splitter, synergy with the barrel group?
  - decide how to go through the mounting plate
  - maximum length for the APFEL board flex cable?
- PANDA ADC integration and control
  - optimise dynamic range: low or high ASIC gain? Attenuation?
  - ADC input lines AC coupled?
  - possibility to see sample traces during measurement?
  - best filter settings/threshold values?
  - problem with the HG channels?
- Geometrical dimensions and number of crystals ($\rightarrow$MEC)...

Summary

- Some developments of the Proto16
  - optical grease used
  - shielding
  - PANDA ADC integrated
- First results from the last beam test
  - Stable operation
  - Data from energy, position and angle scan
  - First data with the PANDA ADC and SODA on TRB
- To do:
  - Analyse beam test data
  - Solve question of APD gain
  - Take last decisions for the BWEC design

Backup

PANDA requirements

Relative energy resolution

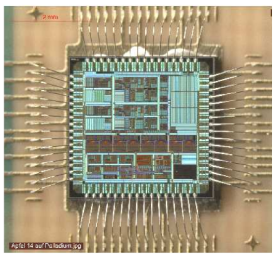
$$\frac{\sigma_E}{E} = a \oplus \frac{b}{\sqrt{E/\mathrm{GeV}}} \oplus \frac{c}{E}$$

- In this talk: electronic noise contribution c/E
- TDR requirement: $c = 1\ \mathrm{MeV}$

Single crystal energy threshold (E_{xtl})

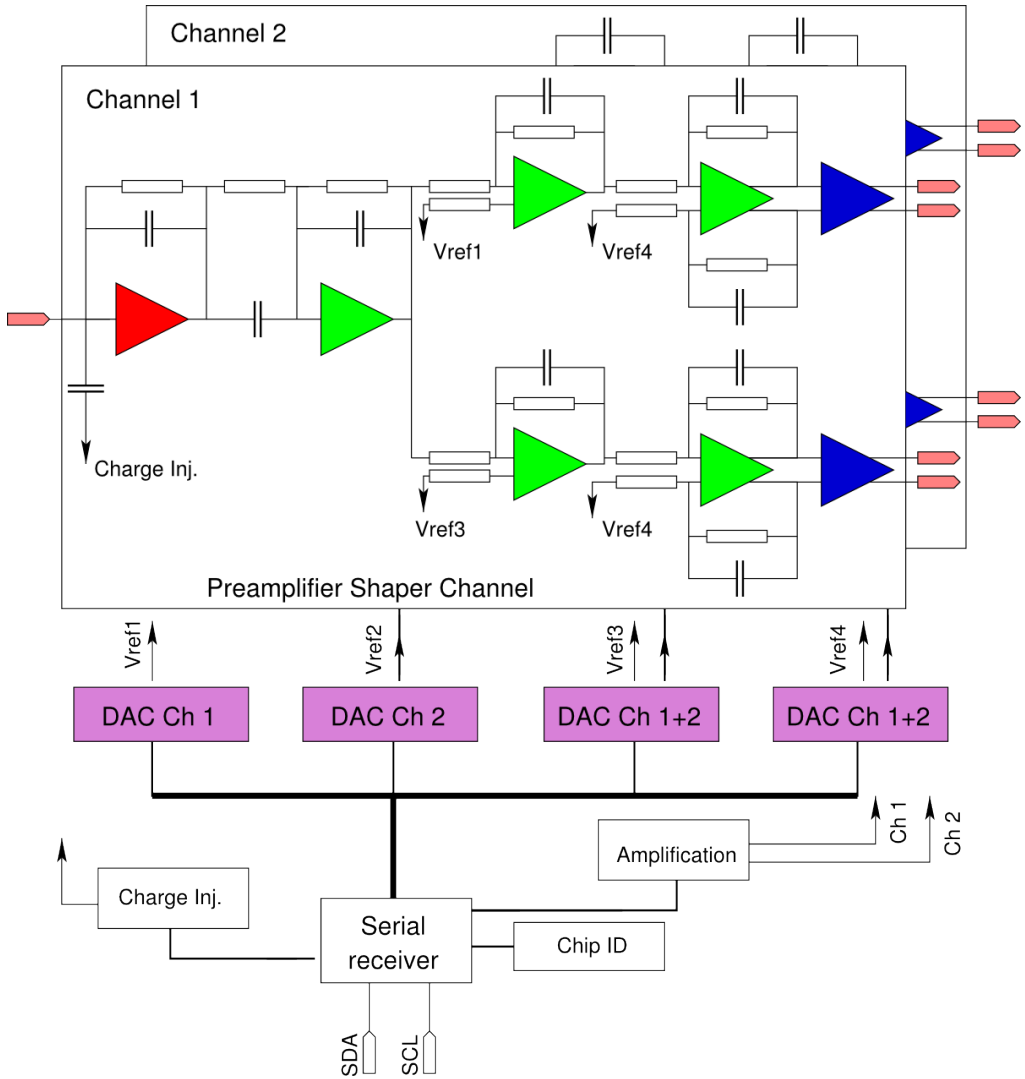
- Lowest energy distinguishable from noise
- Below E_{xtl}: contribution shower leakages
- TDR requirement: $E_{\mathrm{xtl}} = 3\ \mathrm{MeV}$

APFEL ASICs



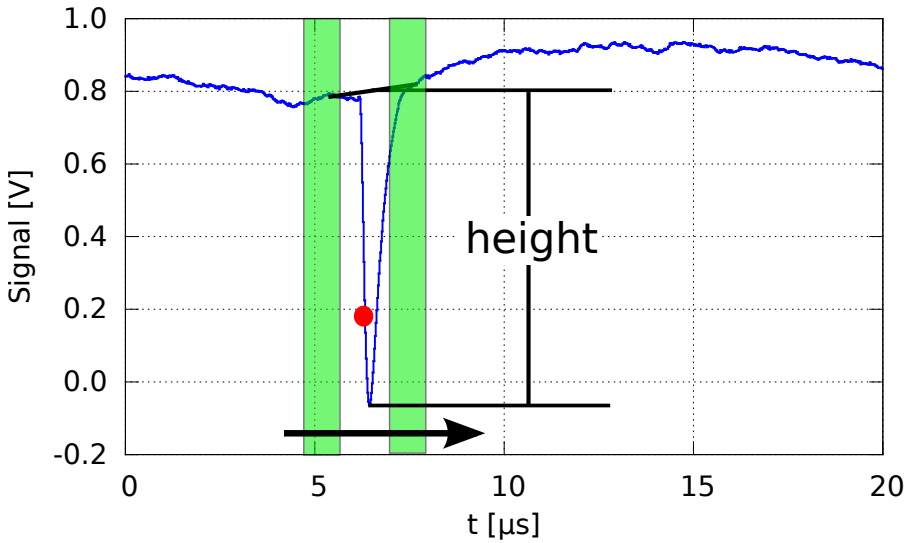
- reads out 2 APDs
- charge sensitive preamplifier
- shaper (pulse width $\sim \mu$s)
- 2 main amplifiers (2 gains)
- 4 differential output channels

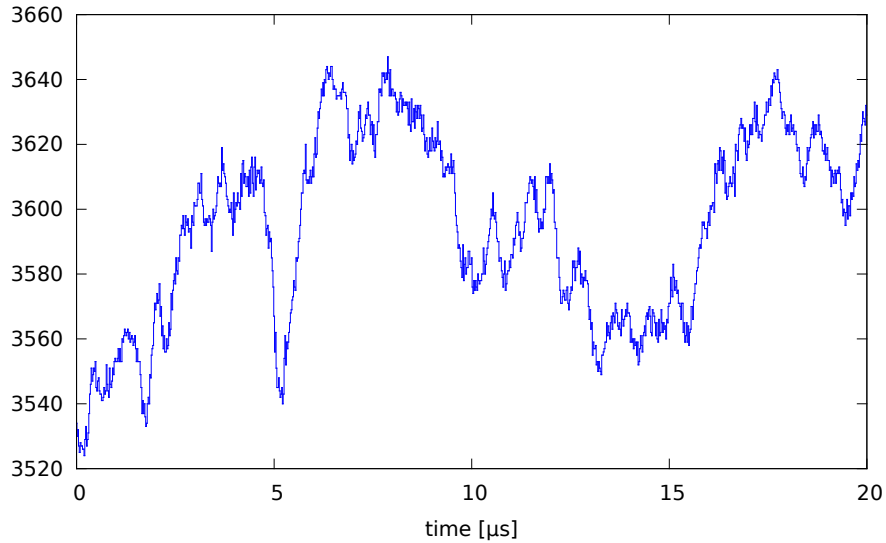
- bonded on a FFC-board
- power and programming lines
- HV lines for the APDs
- output signal lines

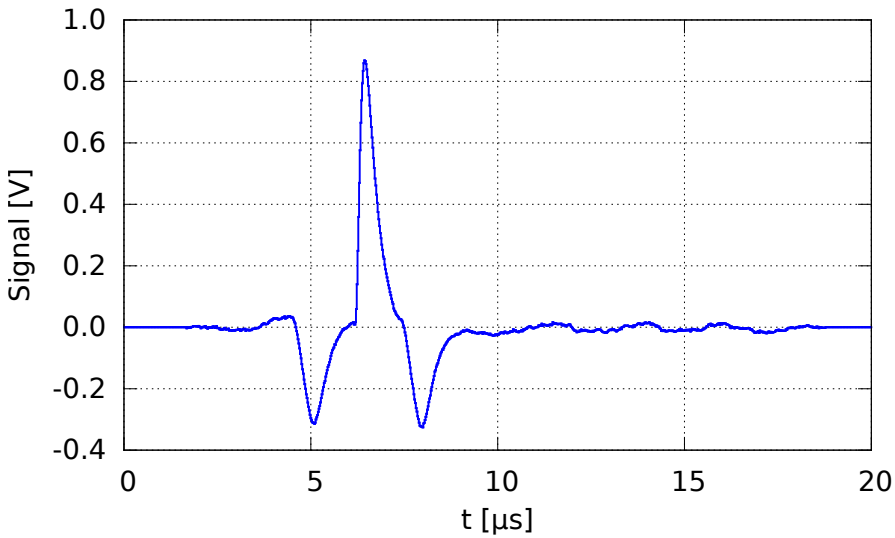


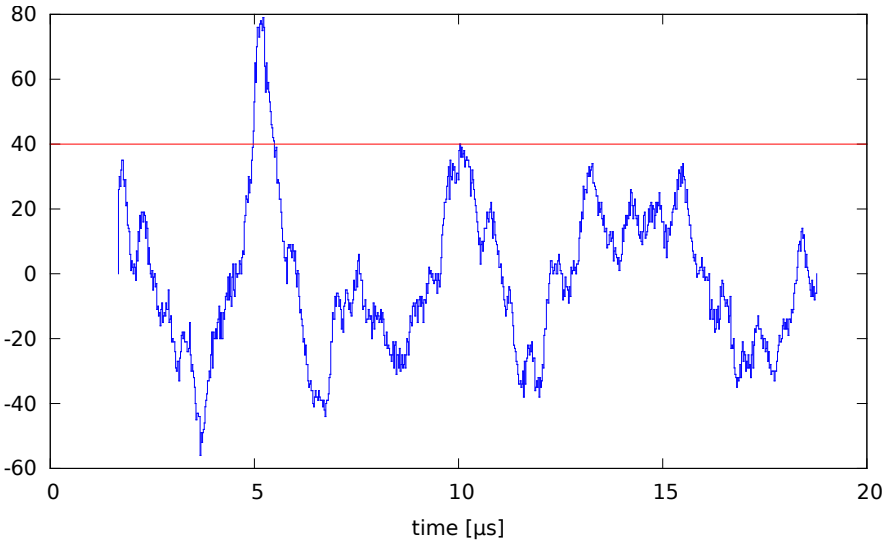
P. Wieczorek, H. Flemming, IEEE Nucl.Sci.Symp.Conf.Rec. 2010, 1319-1322

Two-windows filter









Readout and DAQ

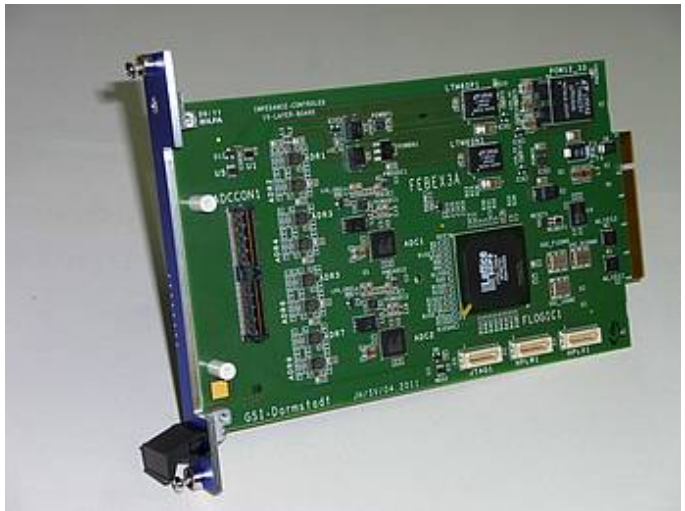
Sampling ADC

- Febex3a module from the GSI
- Sampling rate: 50 MSample/s
- Resolution: 12 bit
- Input range: -1 V ... $+1$ V

Data acquisition

- MBS system from the GSI
- PCI optical receiver (PEXOR) for ADC interface
- PCI trigger/dead time unit (TRIXOR/EXPLODER)
- Extensible with VME branch

FEBEX



PEXOR