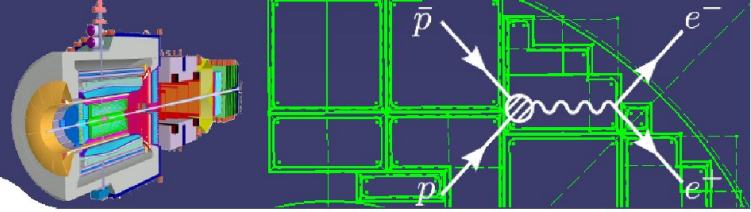
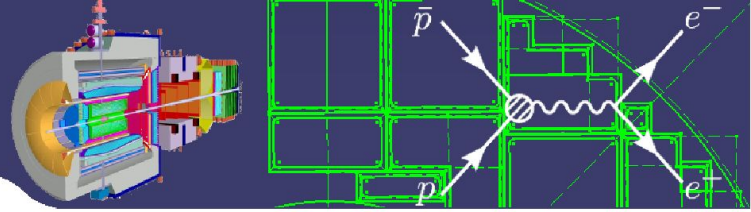


Recent results with the backward EMC prototype

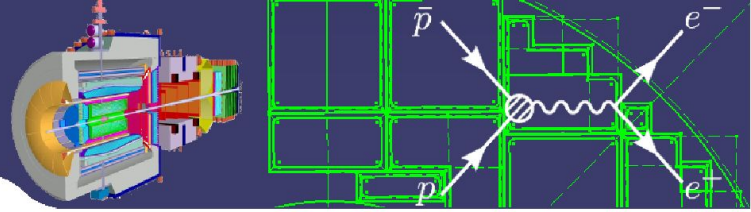
S. Ahmed, L. Capozza, A. Dbeyssi, M. Deiseroth, F. Maas, **O. Noll**, D. Rodríguez, R. Valente

PANDA Meeting September 2015

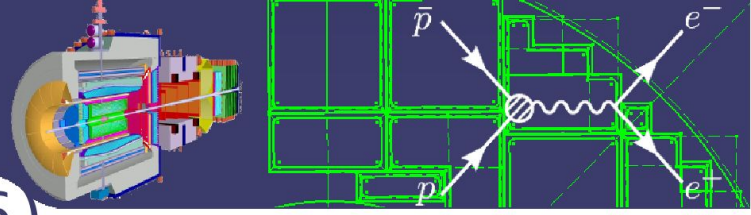
8. September 2015



1. The backward EMC prototype (PROTO16): an update
2. Tests of PROTO16 at the Mainz Microtron Facility
3. Results



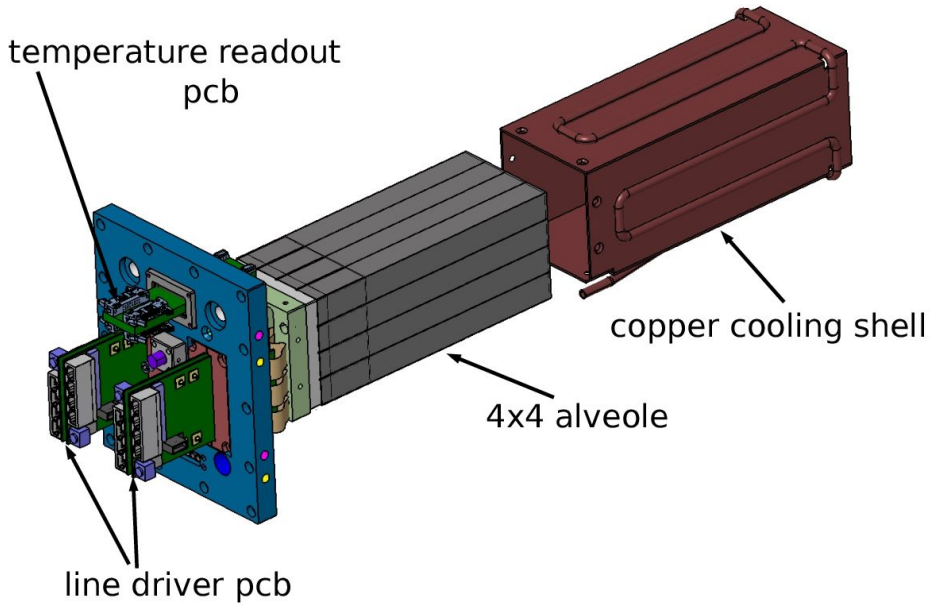
The backward EMC prototype (PROTO16): an update

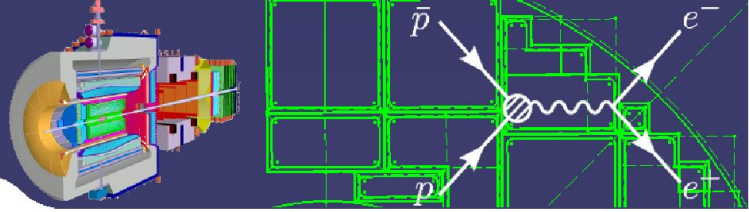


Backward EMC prototype (PROTO16)

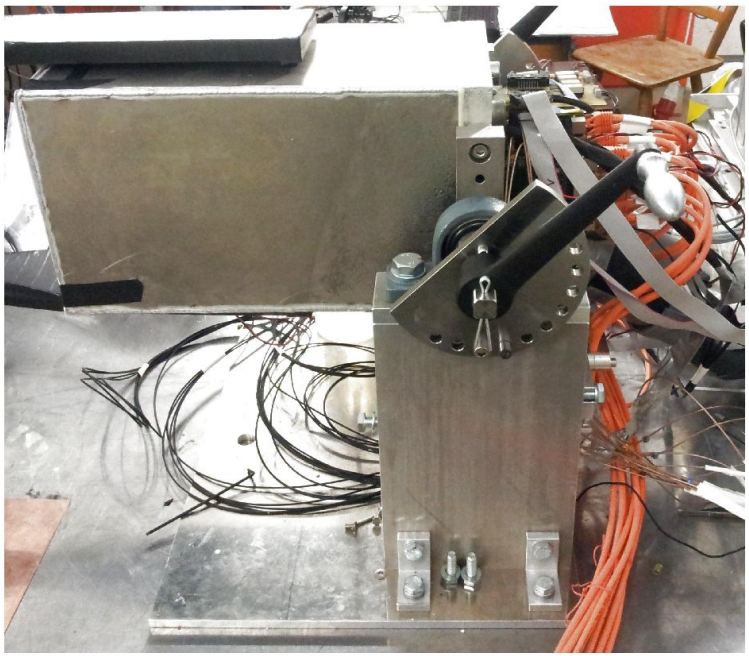
PROTO16

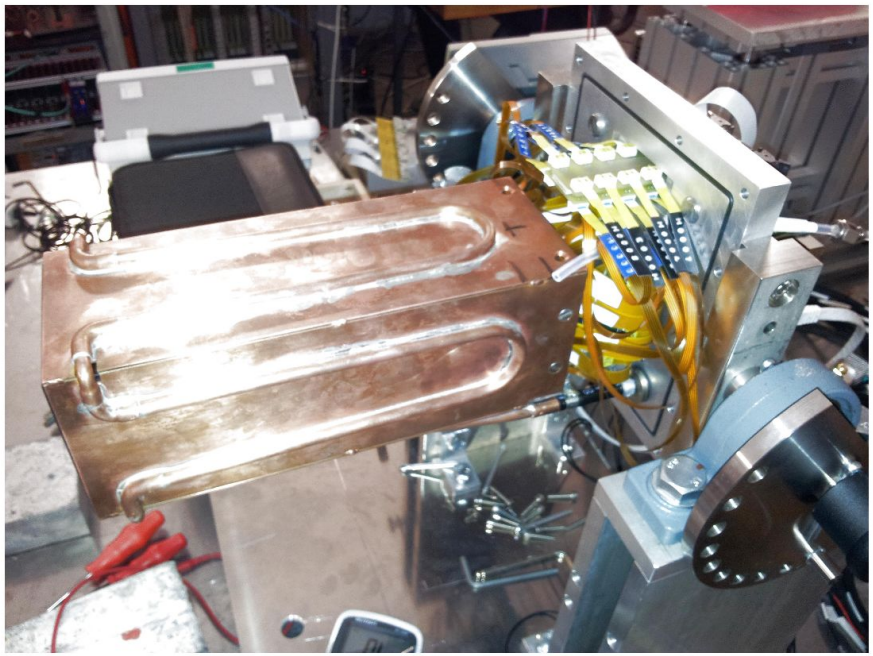
- Mechanics
  - Carbon fibre alveole with 16 $PbWO_4$ crystals
  - Two mounting plates separated with glass fibre feet
  - optical fibre to every crystal
- Cooling
  - Cooling shell
  - Insulated with VIP
  - Nitrogen supply
- Monitoring
  - Flat thermal sensors
  - THMP
- Readout
  - Two APD per crystal
  - APFEL ASIC
  - Line driver

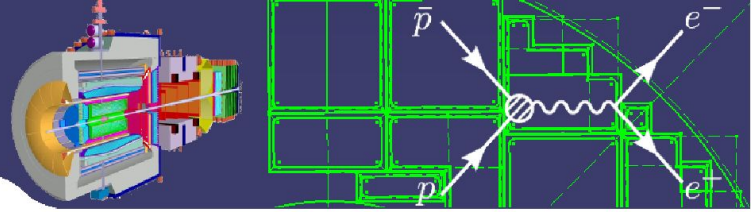




EMC prototype (PROTO16)







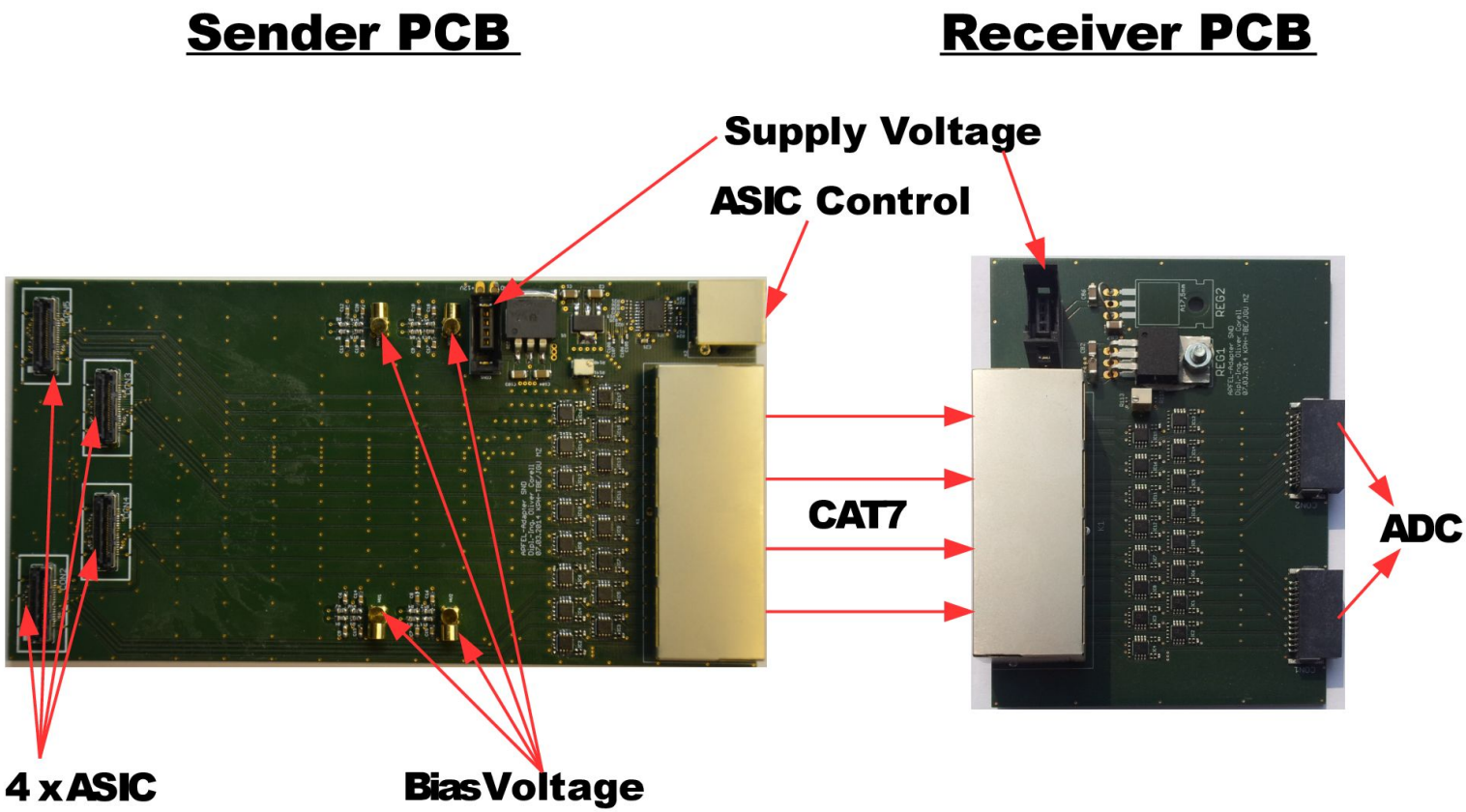
Latest Version of APFEL ASICs

APFEL

- reads out 2 APDs
- charge sensitive preamplifier
- 2 main amplifiers (2 gains)
- 4 differential output channels
- **HV line for each APD**
- **geographical address**

Developer: P. Wieczorek, H. Flemming (GSI)

Line Drivers Update

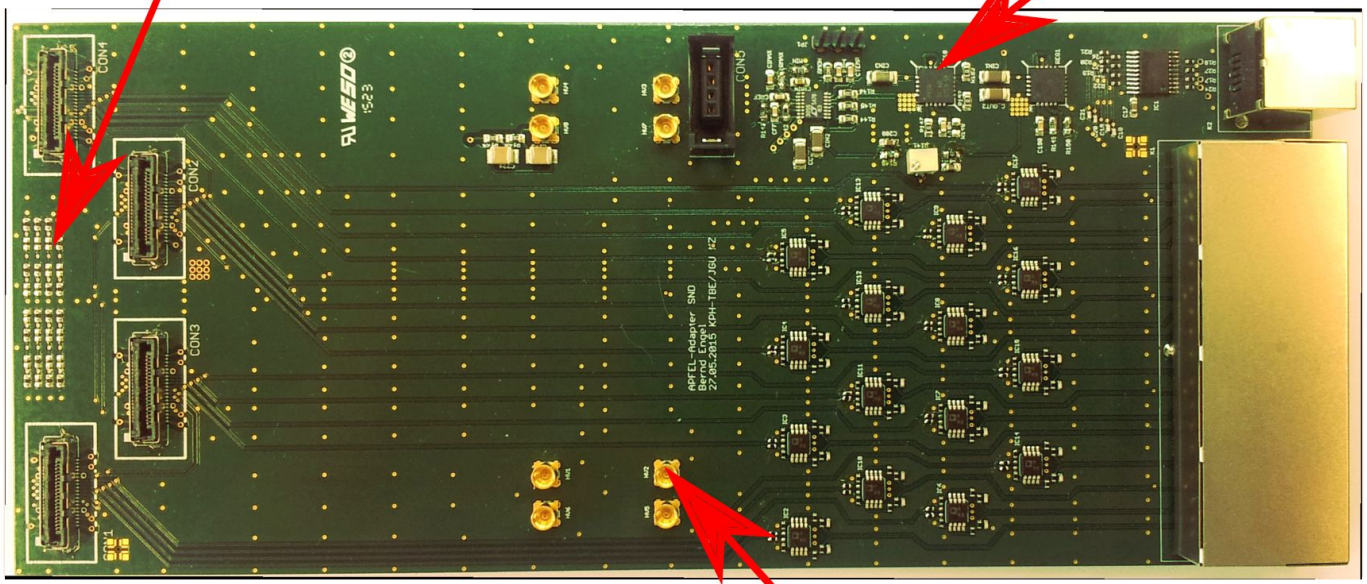


Line Drivers Update

Sender PCB

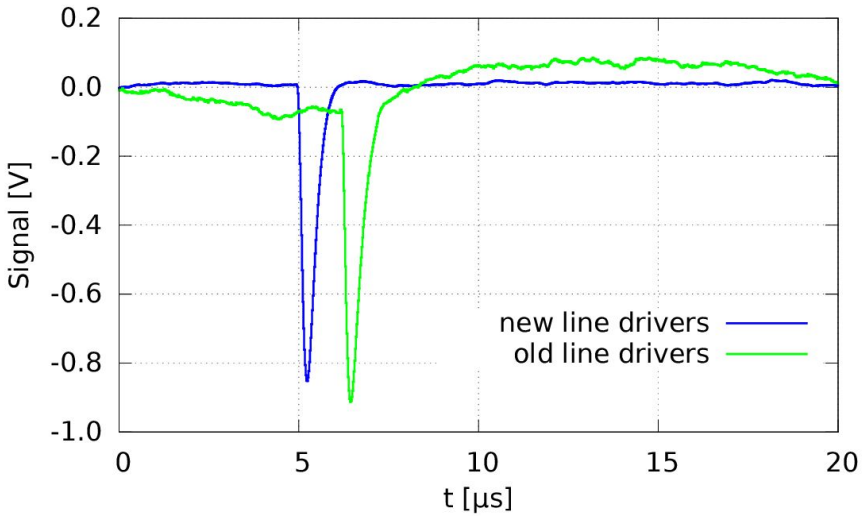
New Voltage Regulator

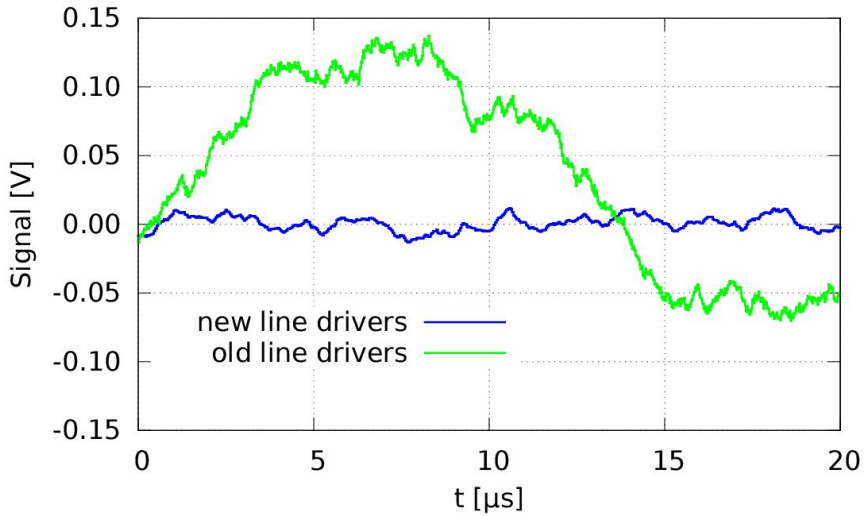
Geographical APFEL Address



4 x APFEL x 2 APDs = 8 Bias Voltages

Line Drivers Update





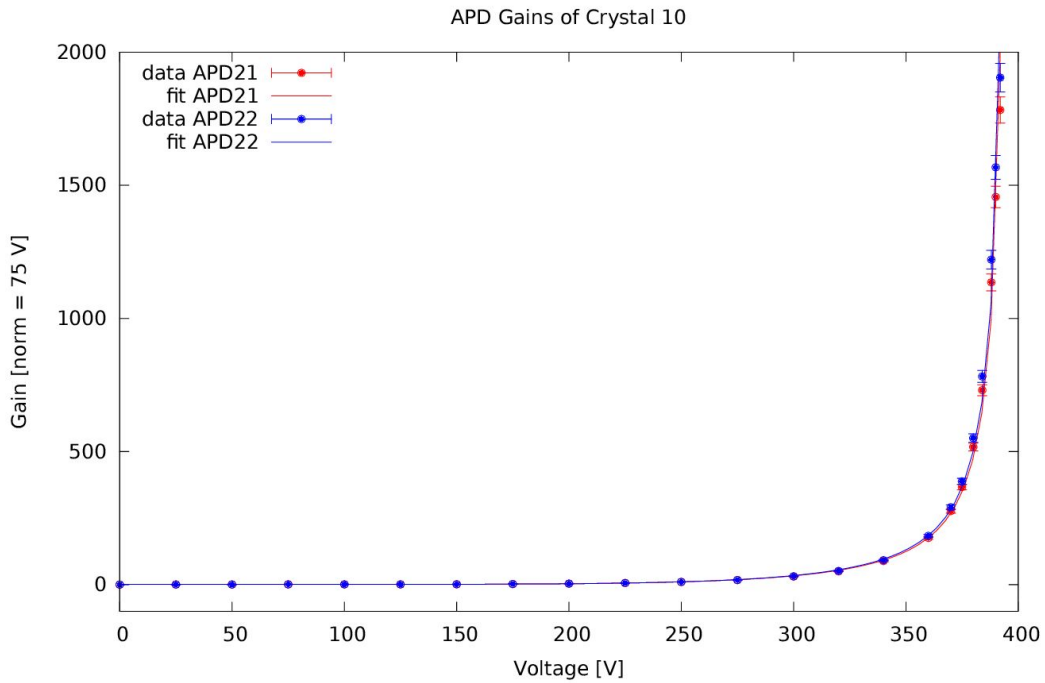
Determination of APD Gain

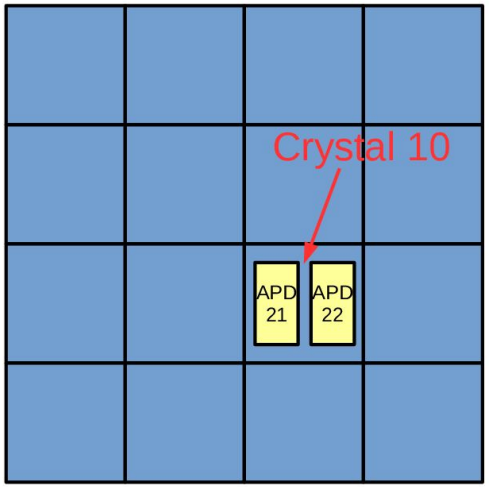
Procedure

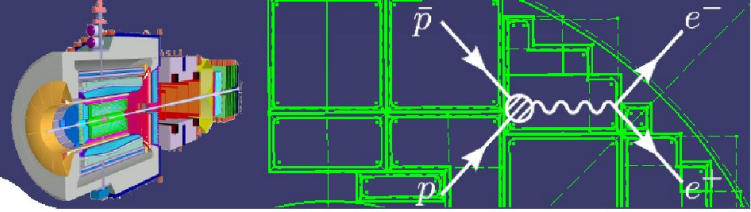
- Constant light pulses
- scan voltages

Fitfunction

- normalized to 75 V
- $G(U) = \frac{A}{1-(U/k)^{k1}} + C$
- k = breakdown voltage
- $k_{APD21} = 396.28 \pm 0.41$ V
- $k_{APD22} = 396.19 \pm 0.43$ V
- $G_{APD21} = 796 \pm 72$
- $G_{APD22} = 845 \pm 81$



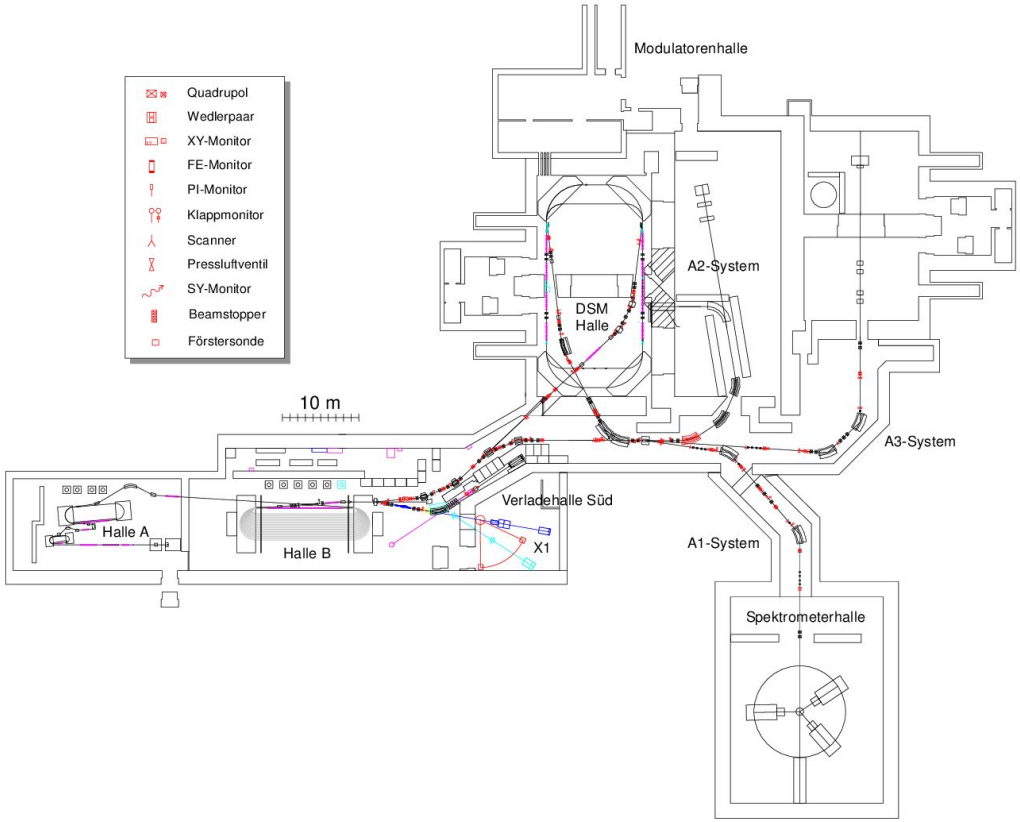


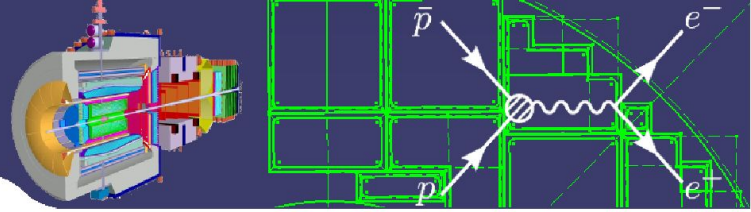


Beam tests of PROTO16 at Mainz (MAMI)

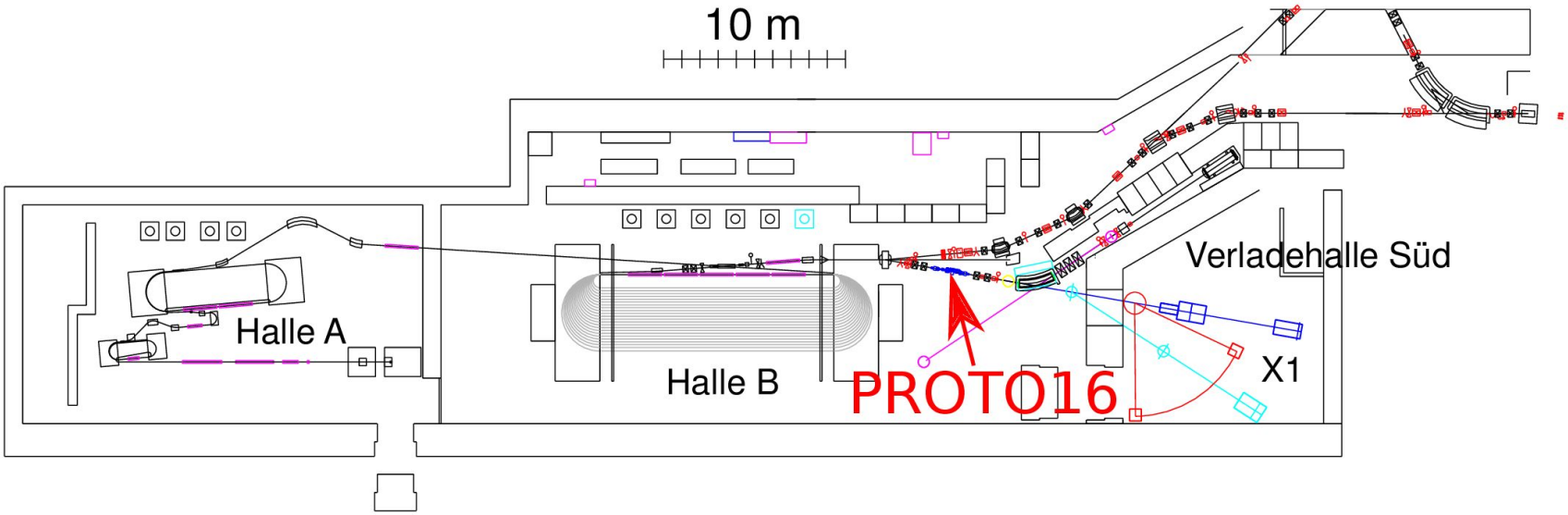
Tests at the Mainz Microtron

- Two tests in June and July 2015 (48 hours each)
- Using electron beam
- Selectable energies from 195 MeV to 855 MeV
- 15 MeV steps (by changing extraction magnet position of MAMI B)
- used energies:
  - 195 MeV
  - 315 MeV
  - 450 MeV
  - 600 MeV
  - 855 MeV

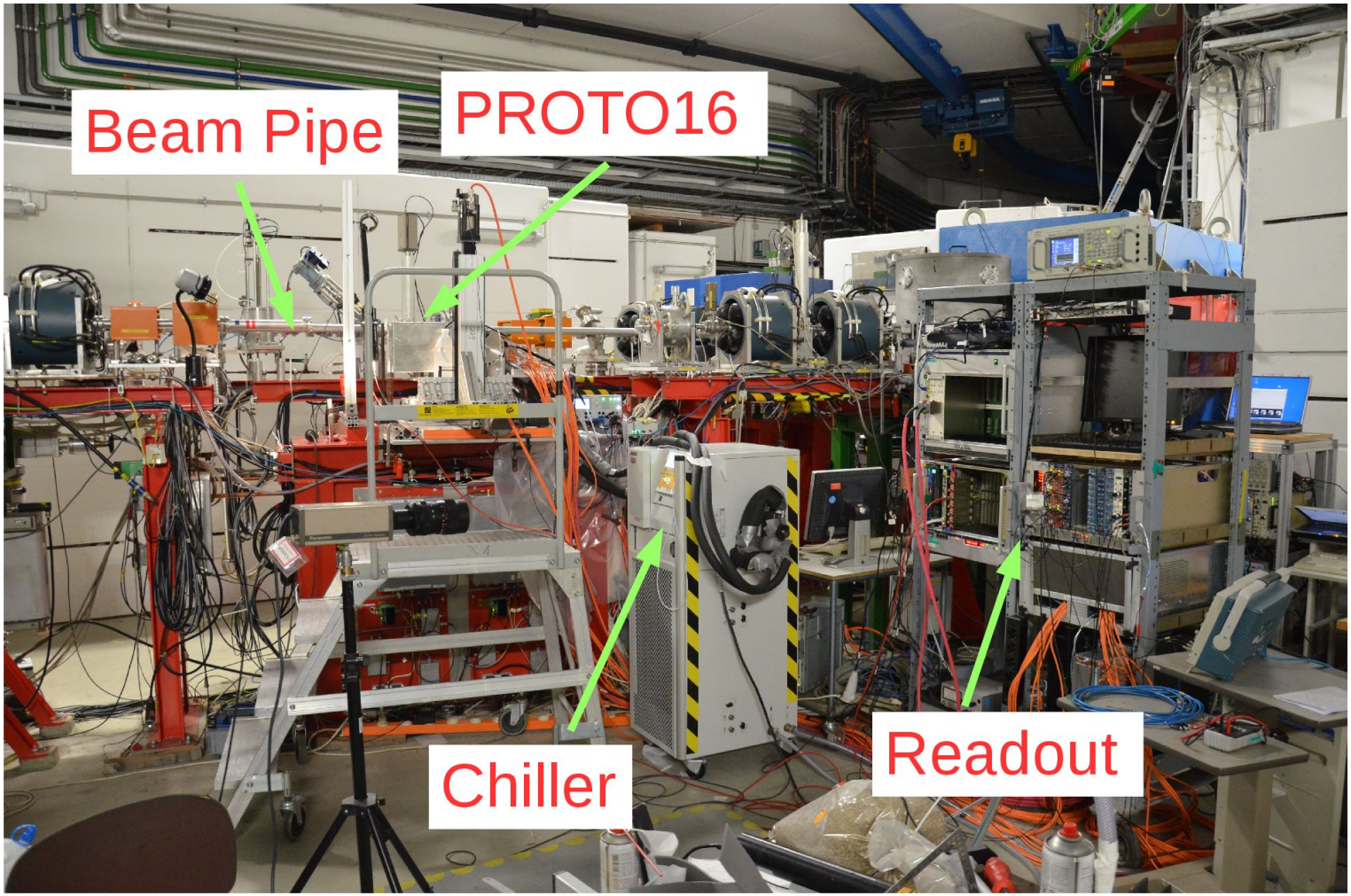




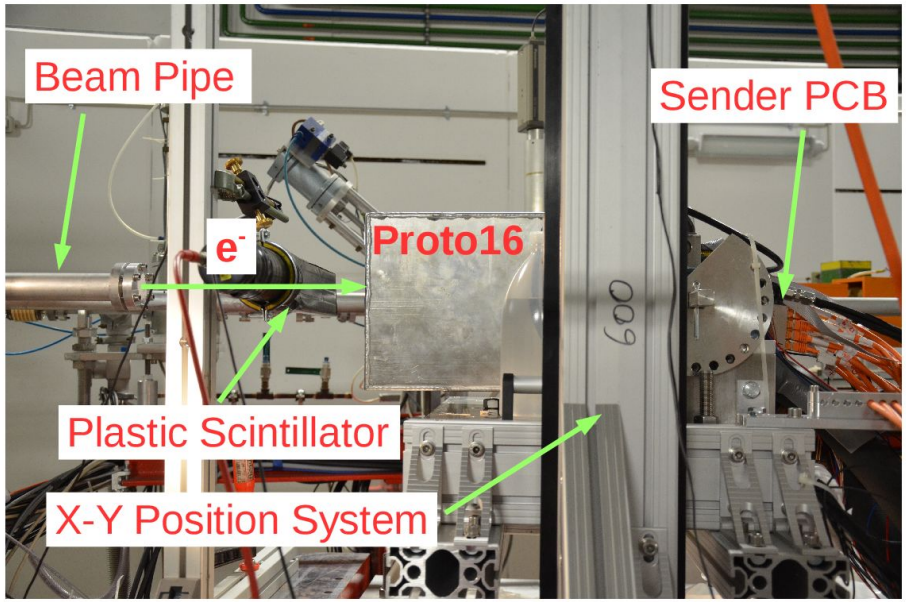
Experiment location at MAMI

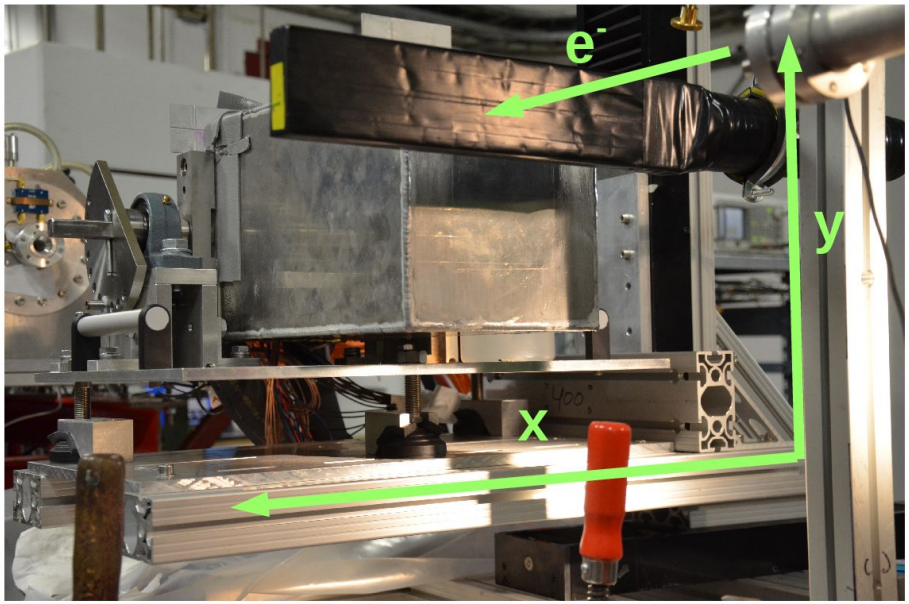


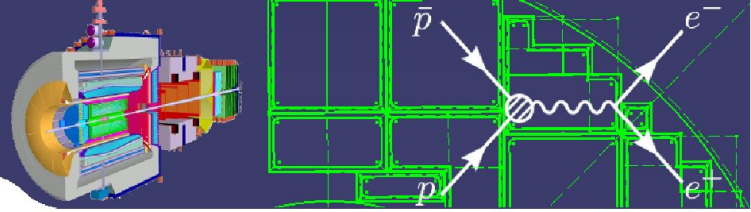
PROTO16 in the MAMI Hall B



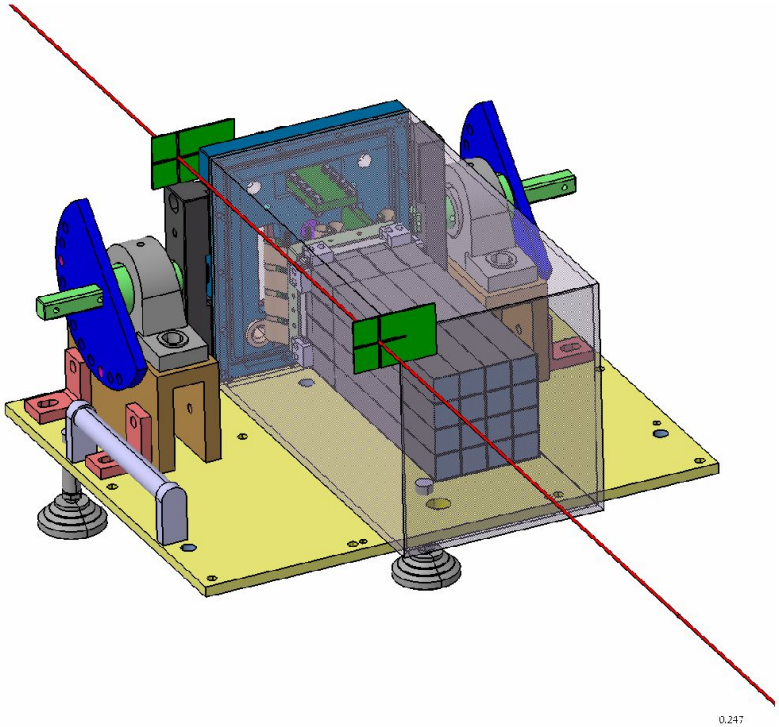
PROTO16 in the MAMI Hall B

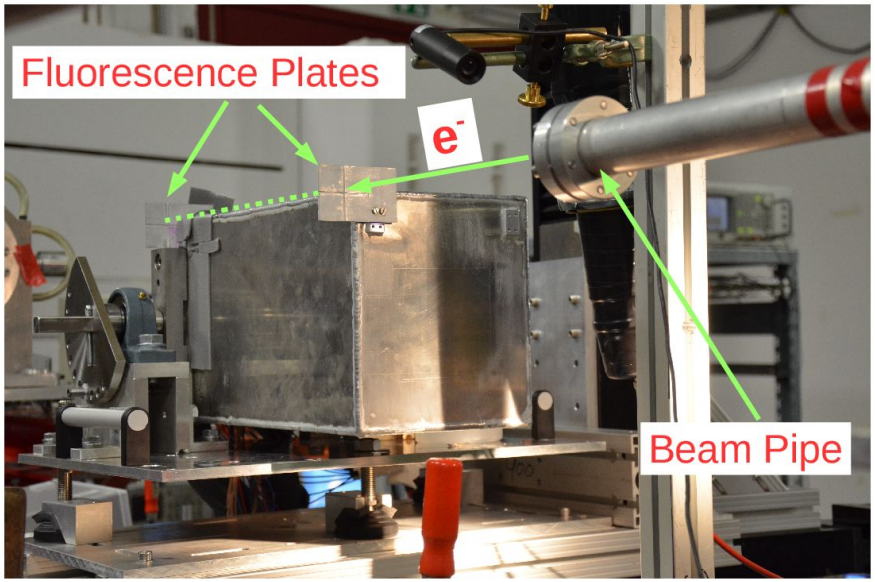




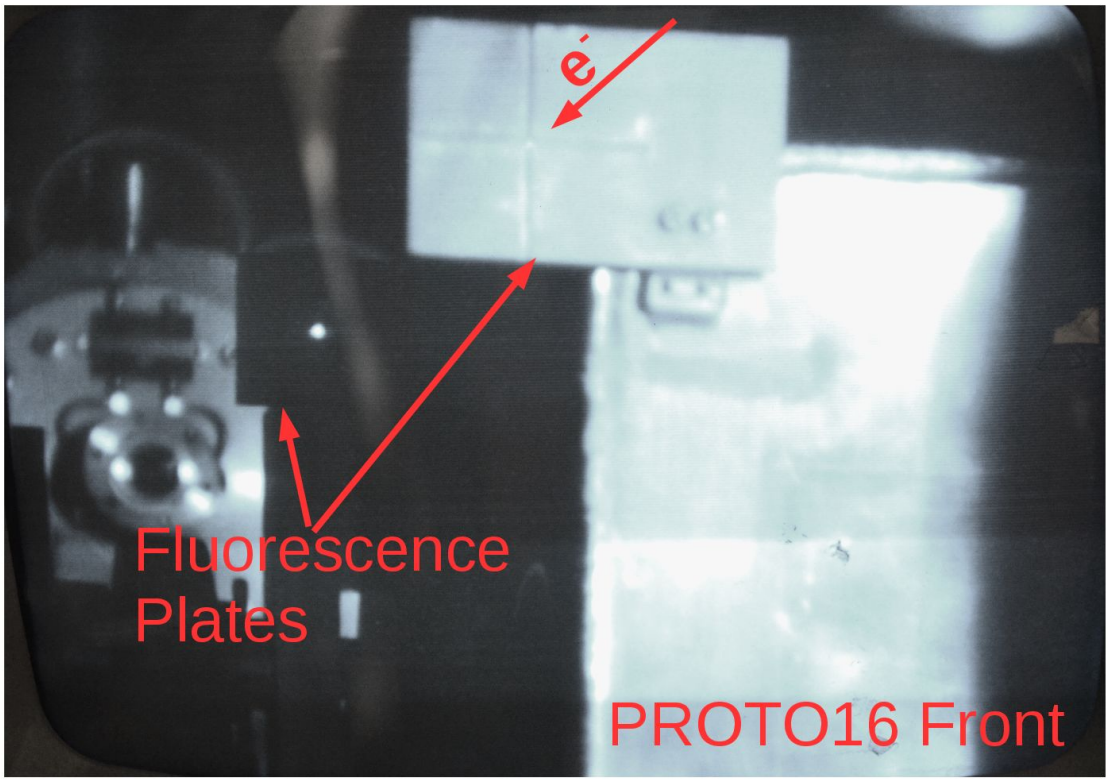


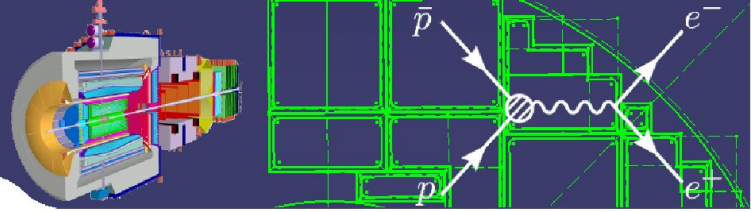
Alignment System



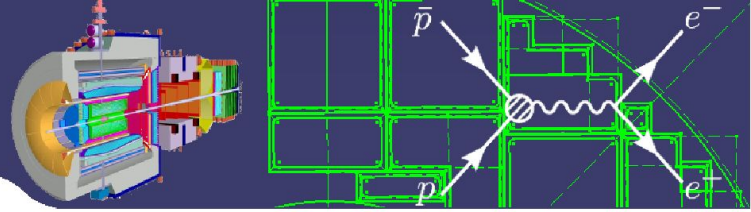


Alignment System





Results



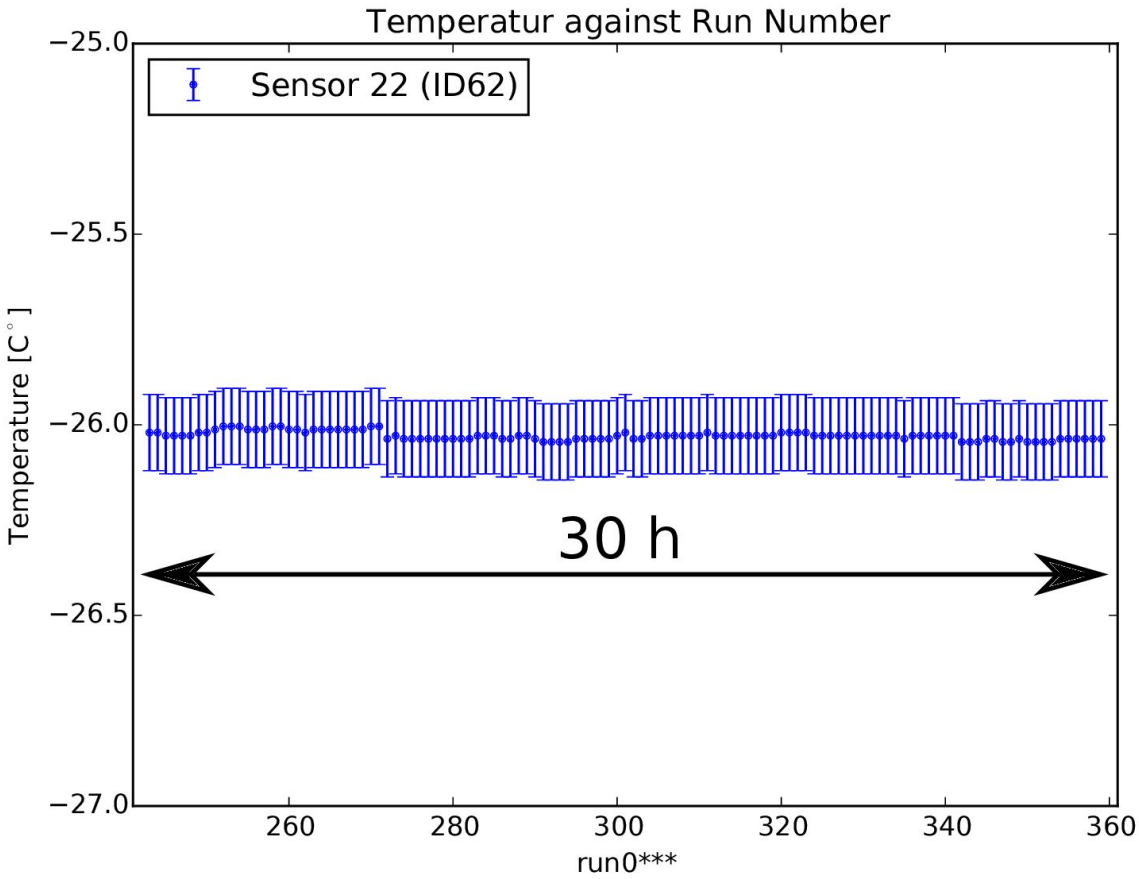
Measurements

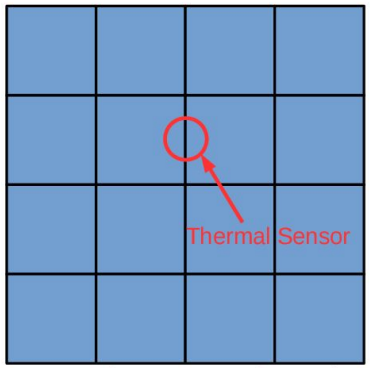
- For each beam event
  - Each crystal centered on beam
  - One run per crystal taken
- For each run
  - All slow control data logged
  - 30000 events
  - Triggered by coincidence between PROTO16 and plastic scintillator
- For each event
  - 64 traces from ASIC saved to disk

Results

- Slow control parameter stability
  - Detector temperature
  - Line driver power consumption
- Signal baseline stability
- Energy spectra
- Energy resolution

Detector Stability - Temperature

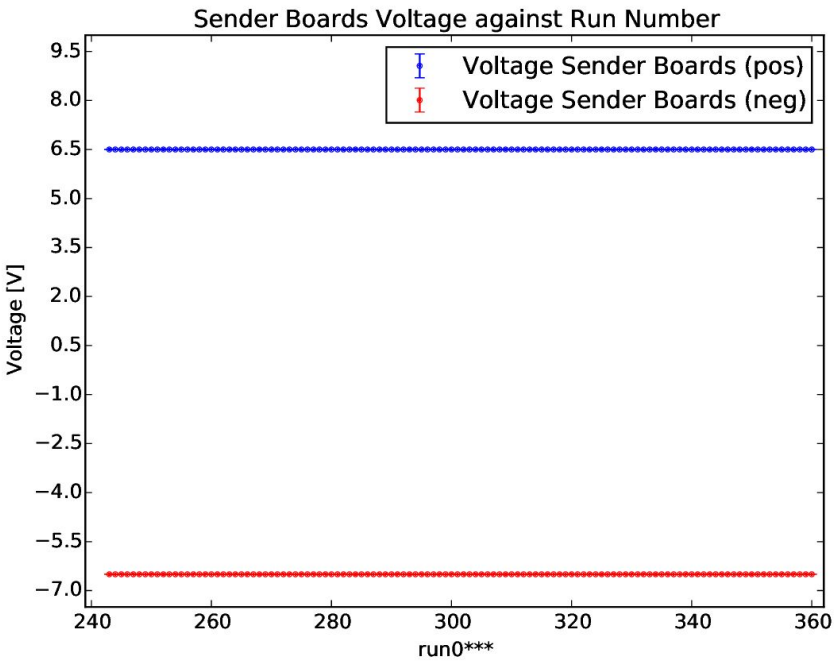


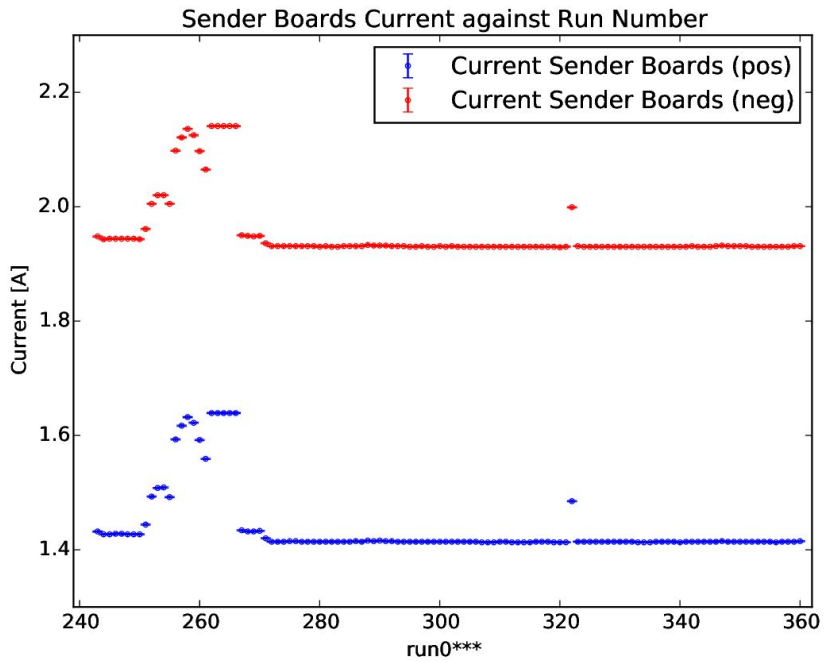


Front of 4x4 crystal matrix

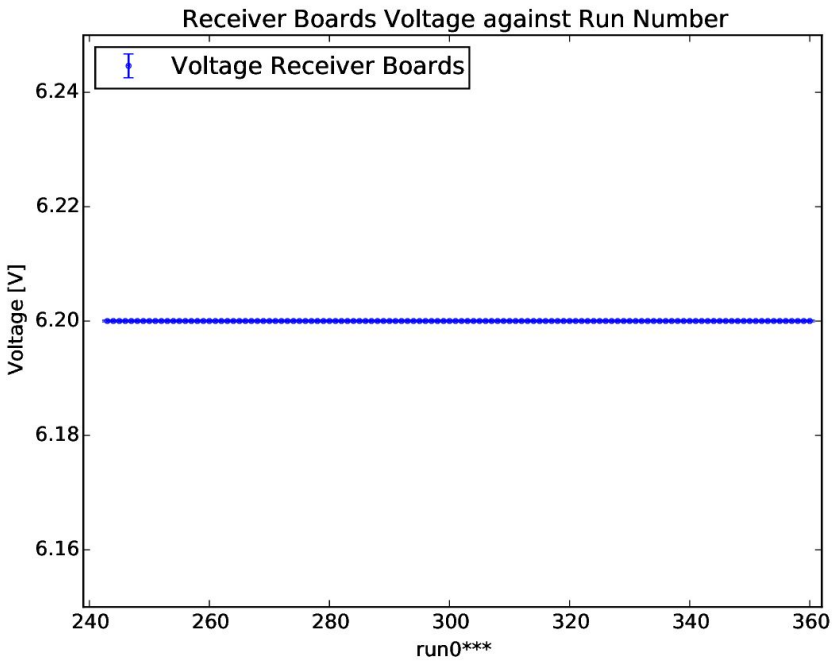
z-position: half crystal length

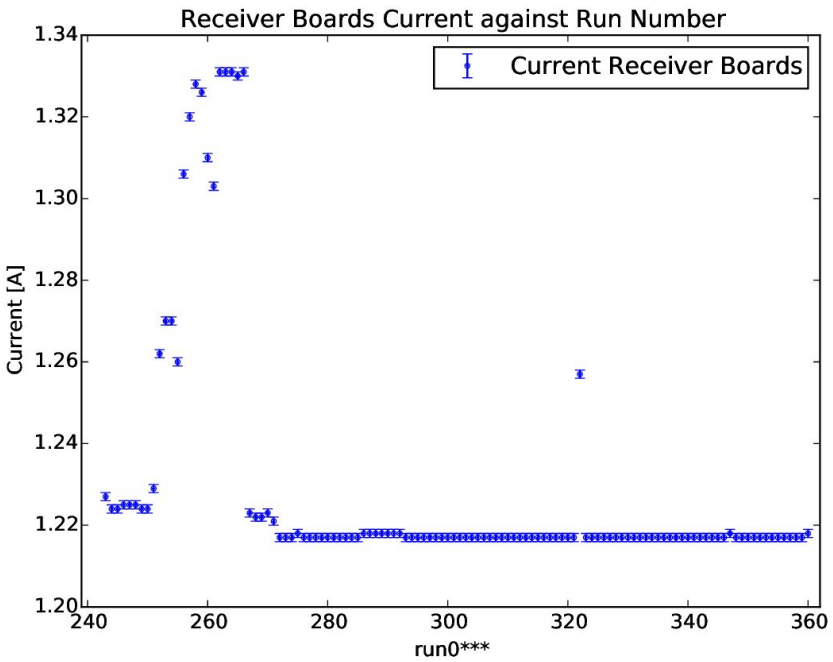
Detector Stability - Sender PCB

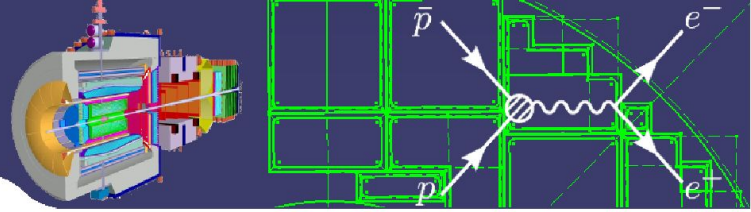




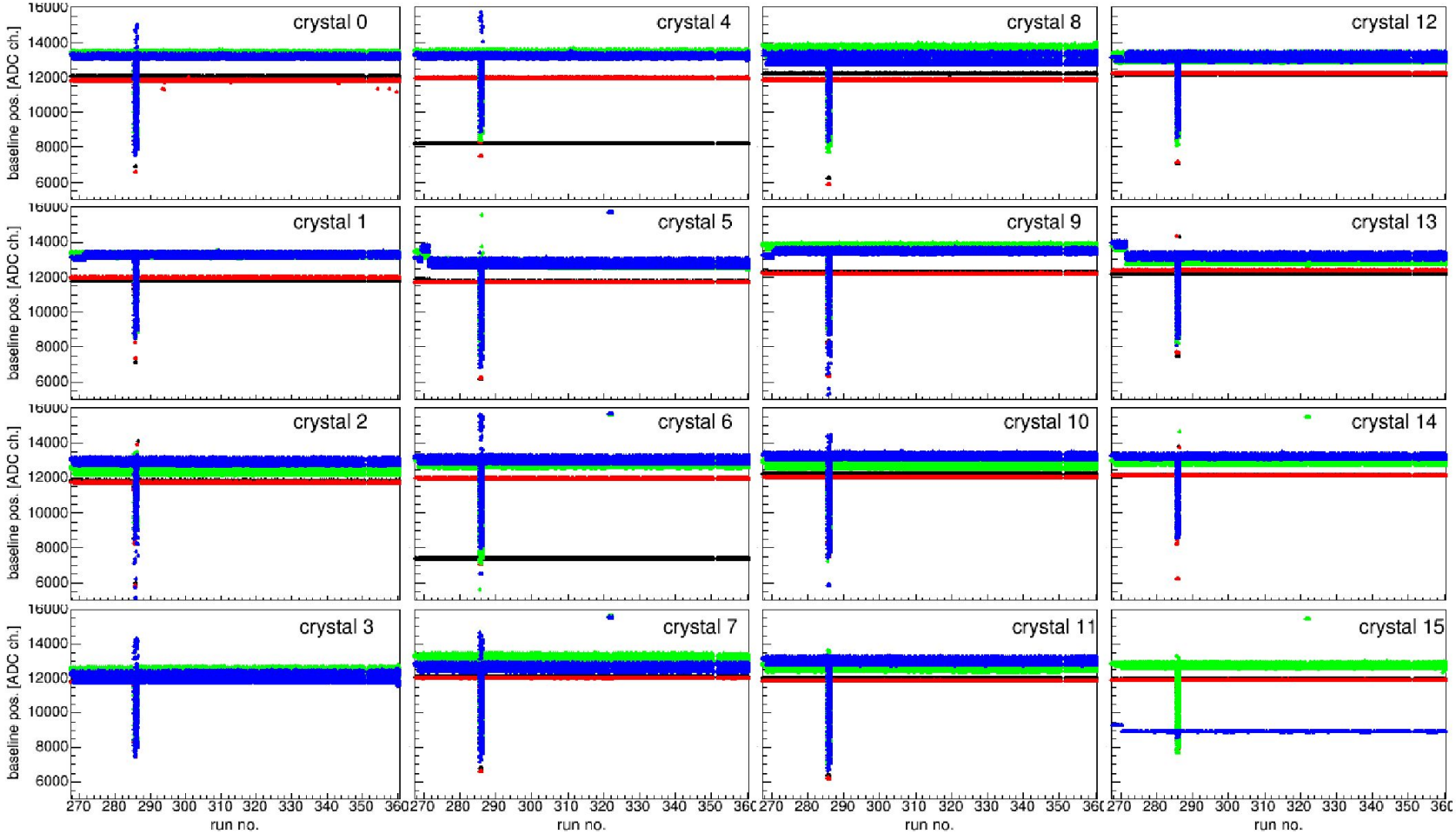
Detector Stability - Receiver PCB





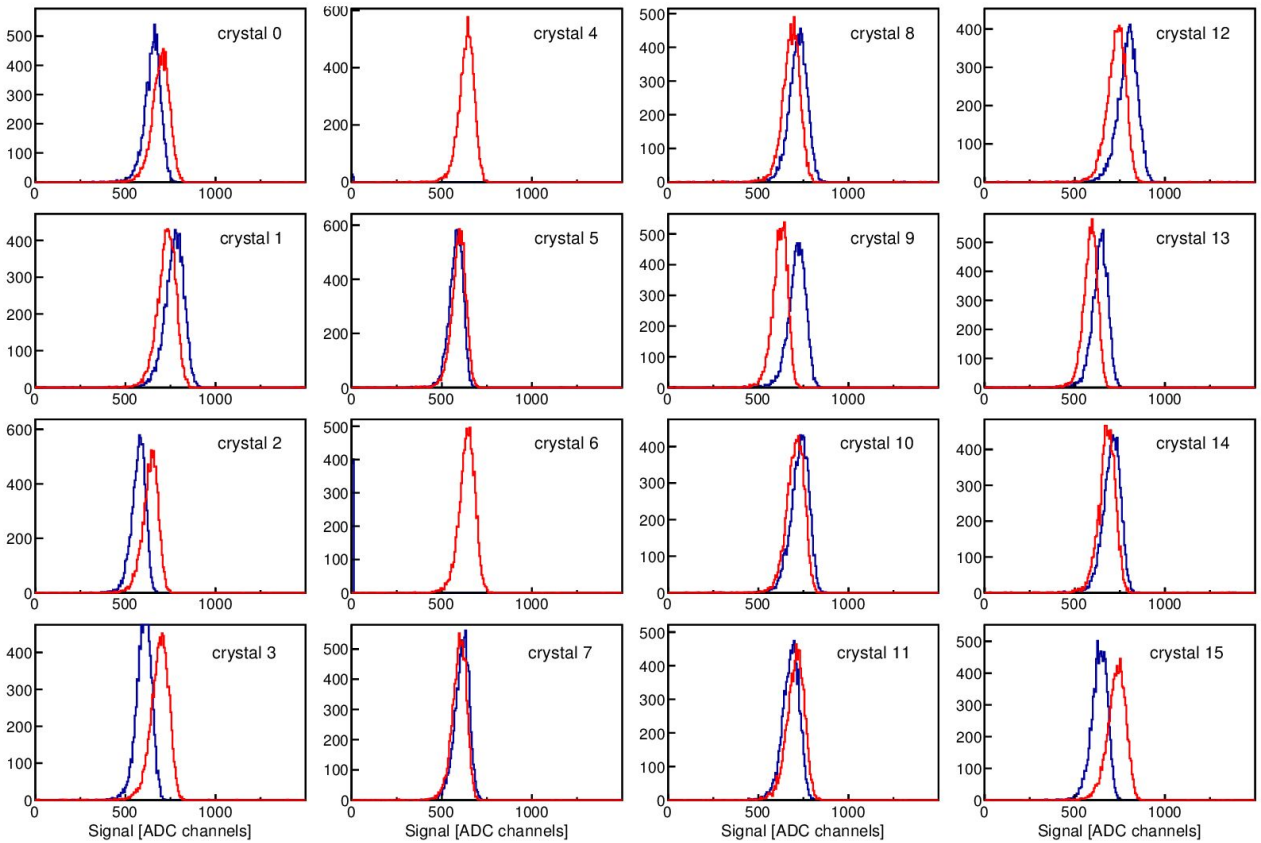


Detector Stability - Baselines

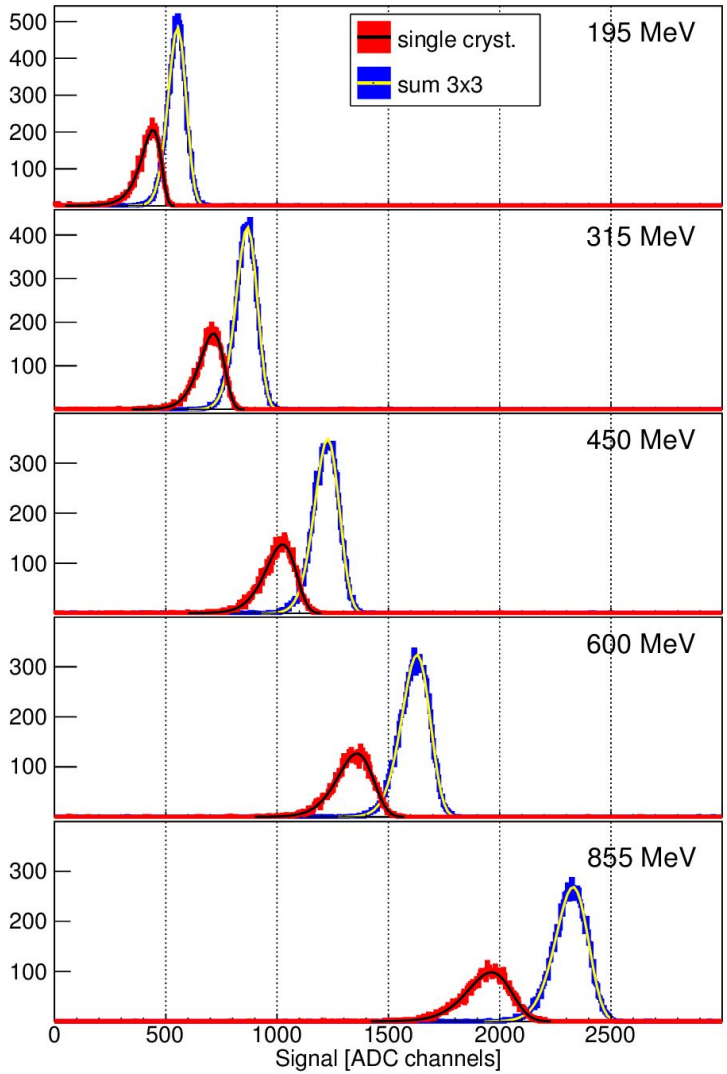


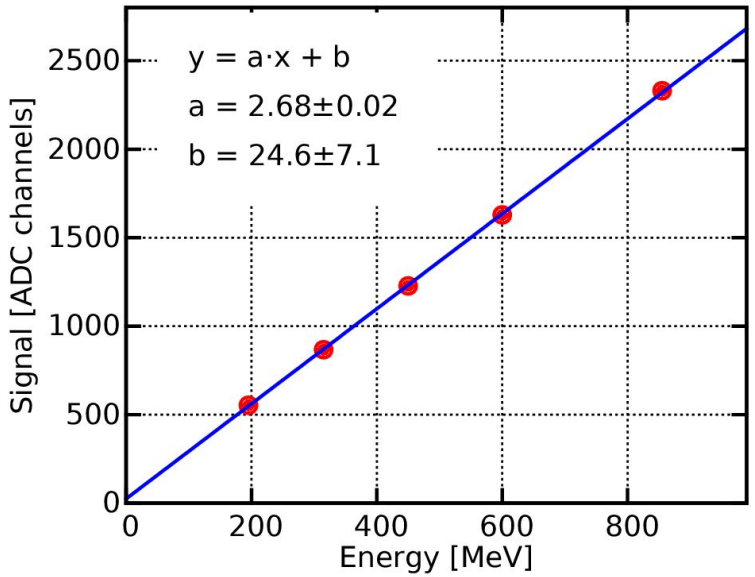
Single APD Spectra

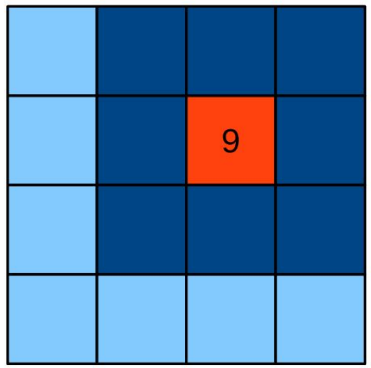
- $E_{e^-} = 600$ MeV
- beam centered on each crystal
- low gain ASIC output signal only



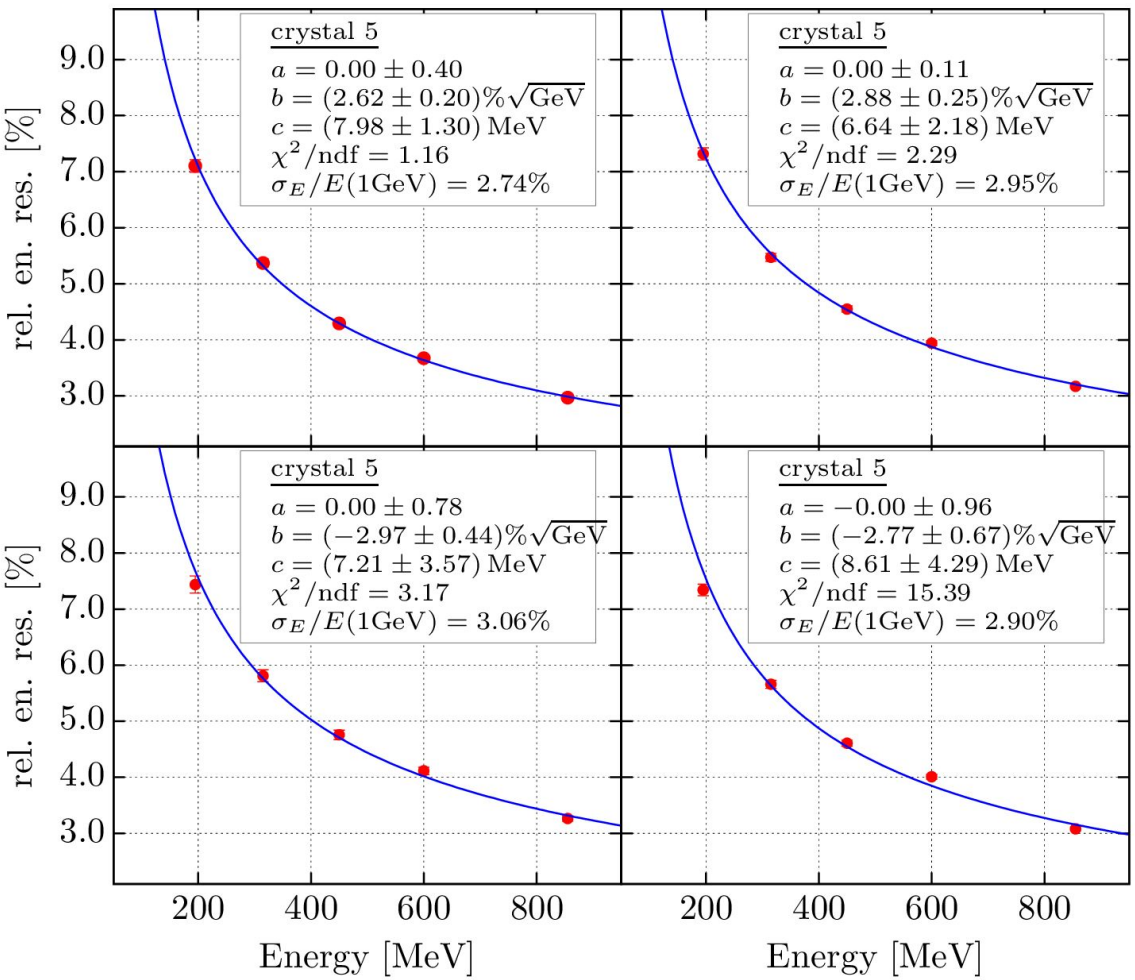
Single Crystal vs. Sum Spectra





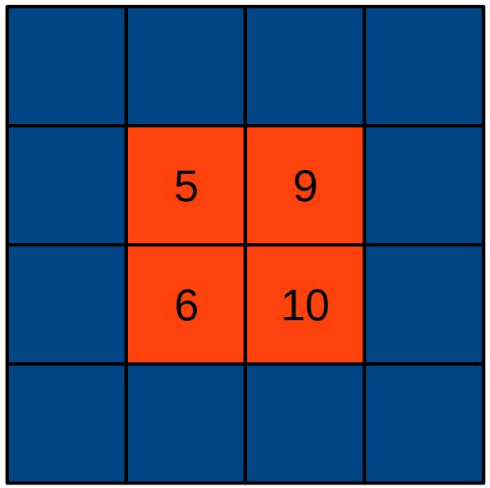


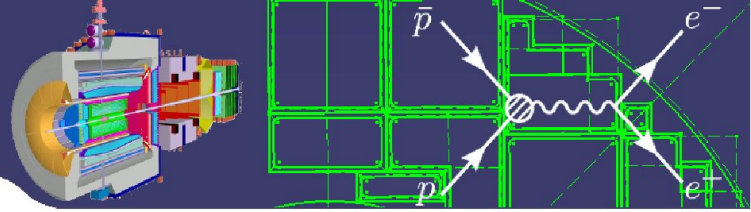
Energy Resolution



Energy Resolution

- $\frac{\sigma_E}{E} = a \oplus \frac{b}{\sqrt{E}} \oplus \frac{c}{E}$

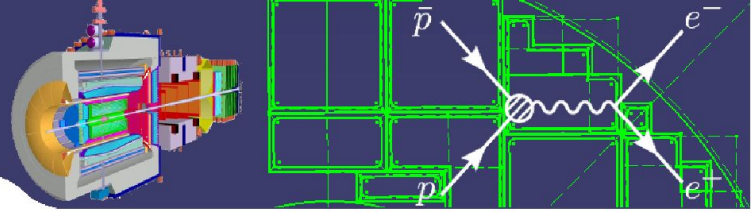




Summary and Outlook

Summary

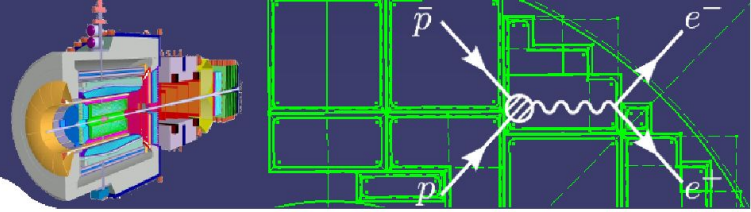
- Update PROTO16
  - New ASIC
  - New line drivers
  - New align system
- Improvements
  - Individual APD biasing
  - Geographical addressing of ASIC
  - Elimination of slow frequency noise from line drivers
  - Convenient alignment of prototype EMC
- New beam test at MAMI
  - With electrons
  - Data taken with five energies between 195 MeV and 855 MeV
- Results
  - Stable system during beamtime
  - Good signal vs. energy linearity
  - energy resolution within the TDR specifications



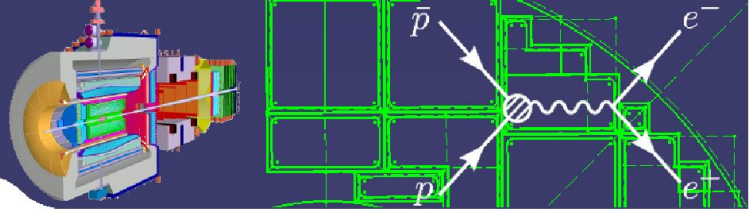
Summary and Outlook

To do

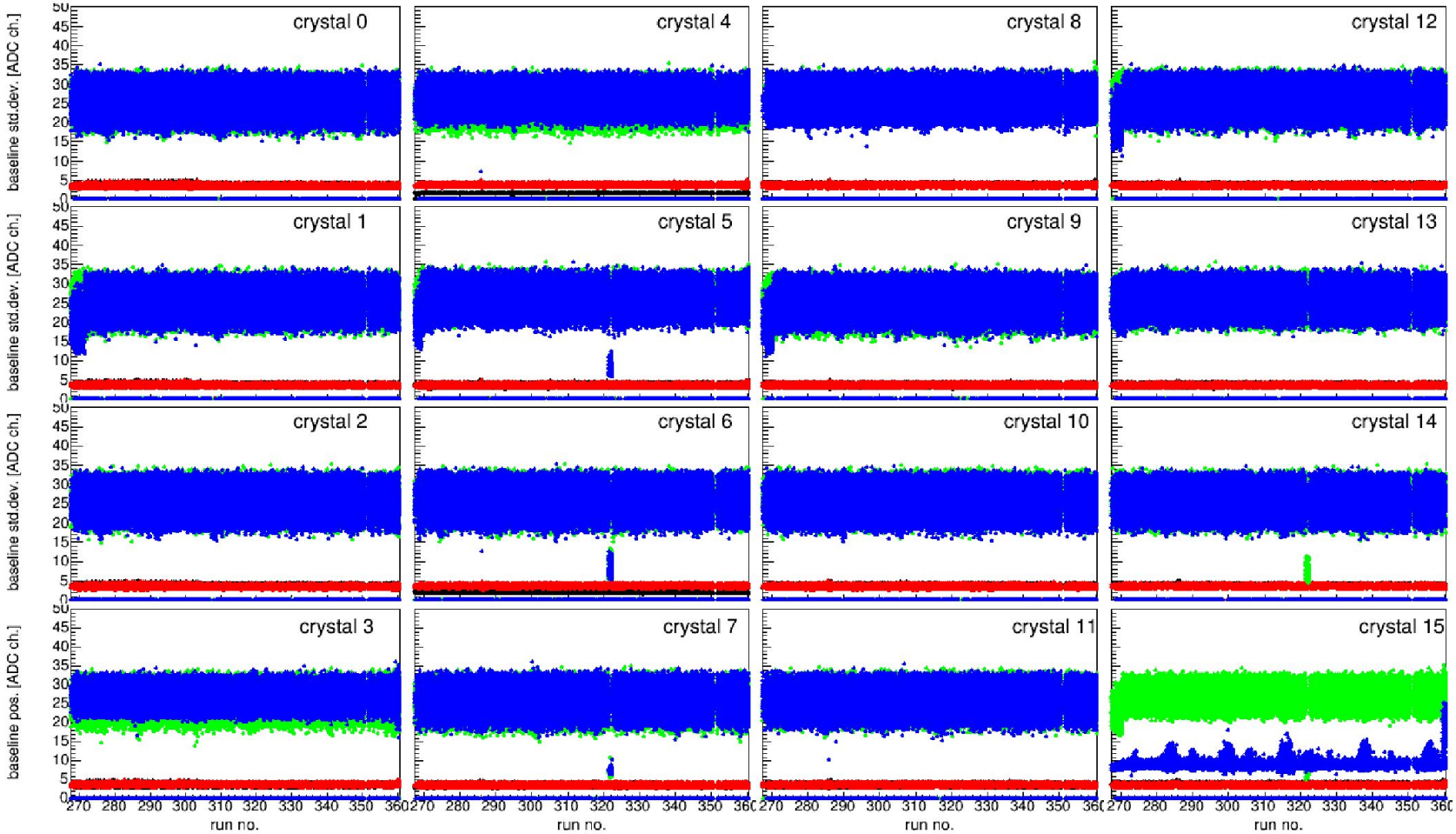
- Data analysis
  - Alternative extraction of noise term c
  - Extraction of lowest possible single crystal threshold
  - Optimization of pulse hight extraction
- Bochum light pulser system
- Uppsala sampling ADC
- PANDA readout system

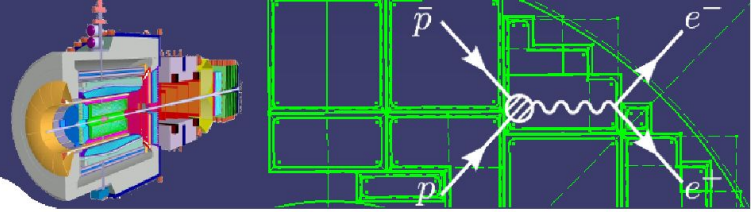


Thank you!

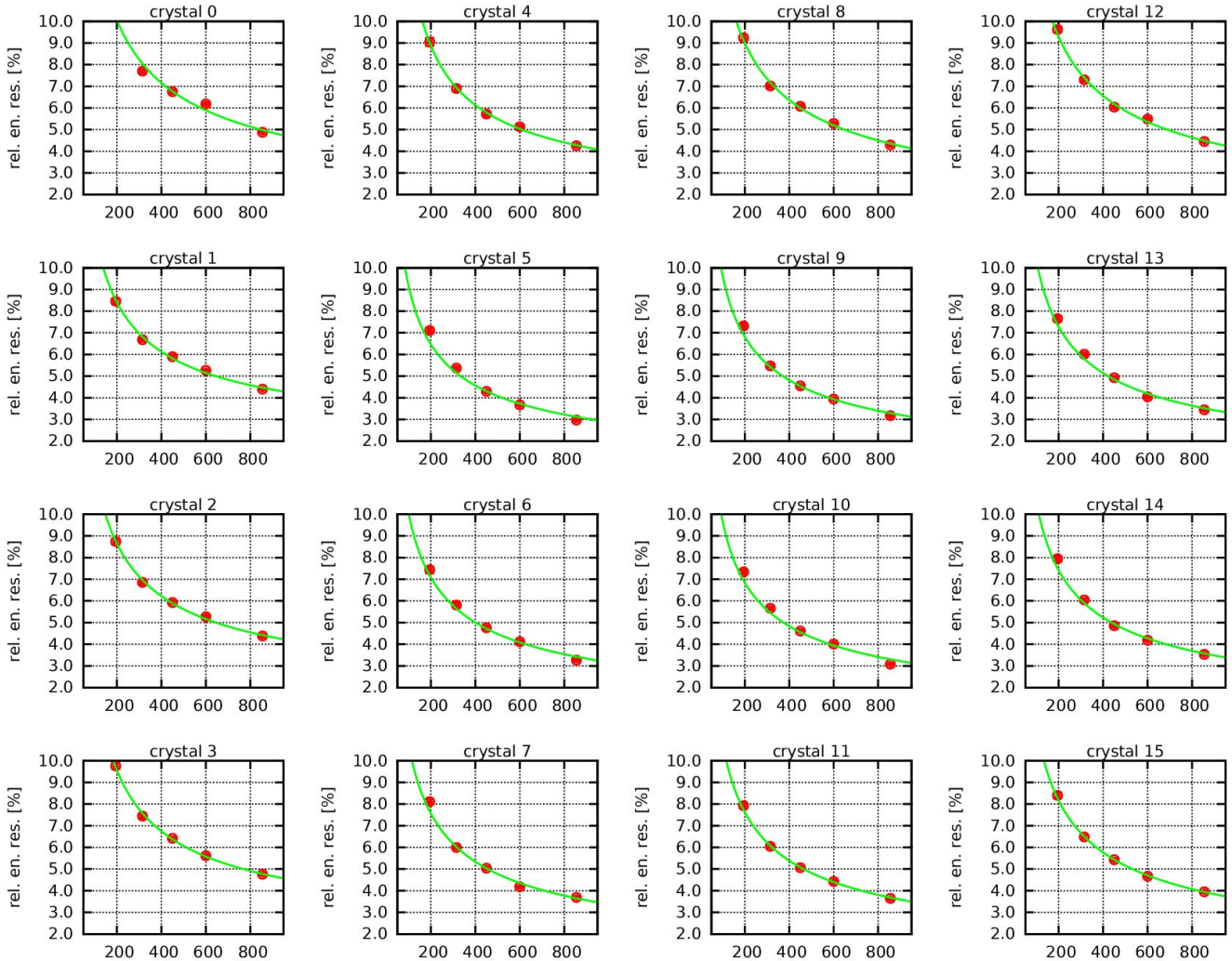


Appendix - Baselines (stand. dev.)





Appendix - 3x3 energy resolution



Appendix - 3x3 liniarity