Monitoring the CBM-TRD performance with a ^{55}Fe - Source

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Testbeam Setup at DESY

The Compressed Baryonic Matter (CBM) experiment at FAIR is designed to investigate the properties of strongly interacting matter at highest net-baryon densities. The Transition Radiation Detectors (TRD) main purpose is the identification of electrons with momenta above 1 GeV/c, to enable dielectron measurements in the low and intermediate mass region. The second important contribution of the TRD to the CBM experiment is the measurement of the specific energy loss, in order to differentiate between nuclear fragments with the same *m/Z* -ratio but different *Z*. The TRD detector will consist of four layers of Multi-Wire-Proportional-Chambers (MWPC). To generate transition radiation, each layer will be equipped with a foam-foil radiator.

Testbeam at DESY

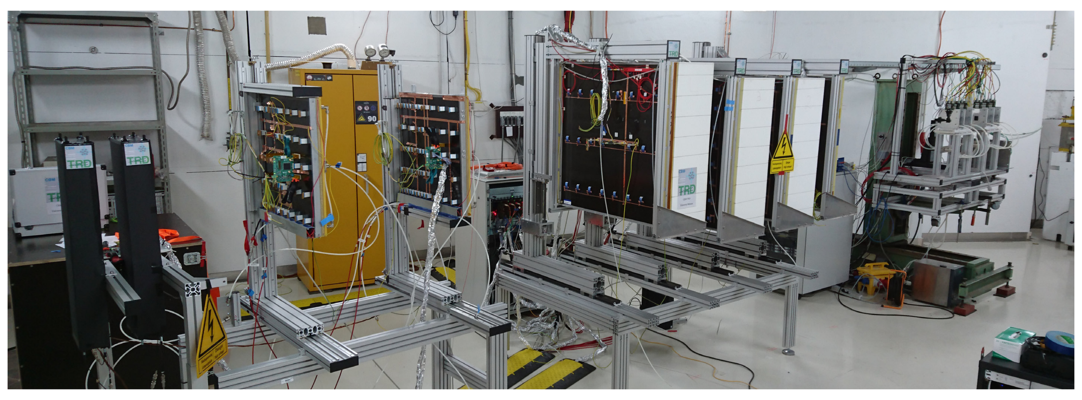

Fig. 1: Setup at DESY T22 in September 2017. From left to right: Two PMT's, two small TRD chambers, one big TRD chamber rotated by 90° with radiator, three big TRD chambers with radiator. Beam from the right.

Beam:
- Pure electron beam
- Measurements with momenta of 1, 2, 3 and 4 GeV/c

The main goals of this test campaign were a performance test of the radiators and the readout electronics, a measurement of the spatial resolution and a calibration of the gas-gain for the new Xe/CO_2 mixture. For the latter, a ^{55}Fe source (100 MBq) was placed in front of one detector.

Detectors:
- Four TRD chambers 95x95 cm^2, gas volume 3.5+3.5+5 mm, equipped with full radiator, operated with XeCO_2 80:20
- Radiators: 95x95x30 cm^3, 146 sheets of 2 mm PE foam foil with 8 mm Rohacell housing
- Two smaller MWPC as position reference, without radiator
- Two Scintillators/PMT to confirm electron event selection

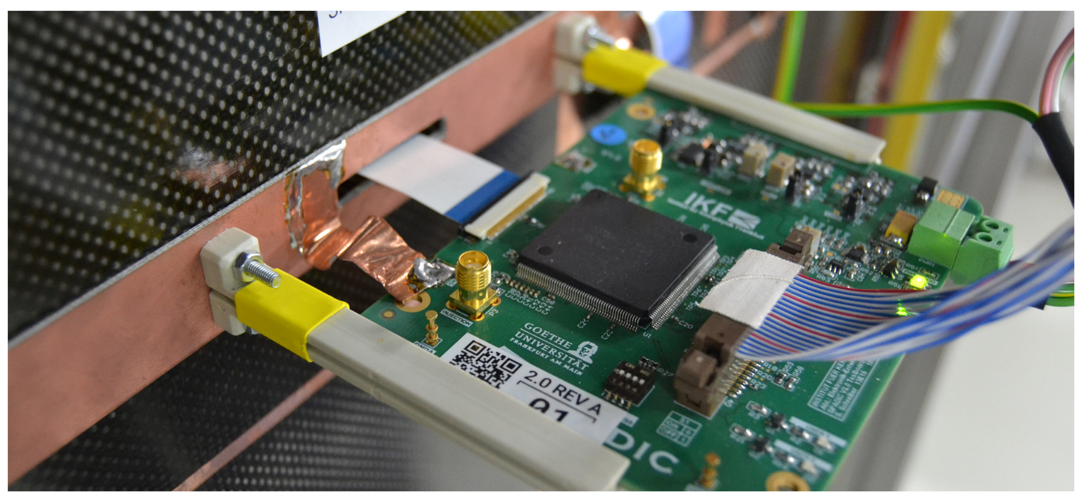

Fig. 2: Front-End-Board with SPADIC-chip, mounted to the backplane of the detector. KEL40-cable on the right side connecting the spadic with the AFCK board.

Fig. 3: Positioning of the ^{55}Fe-source in front of the detector. The golden entrance-window-foil of the MWPC is visible, because radiators were removed in front of the source.

Front-End Readout:
- With SPADIC v.2.0 ASICs
- One chip per detector in beam position
- One chip for gain monitoring with ^{55}Fe-source at first detector
- One chip for PMT integration
- For further information, see HK 12.4 and HK 12.5

Readout chain:
- Readout was running free-streaming selftriggered
- No external trigger needed
- Data transmission from FEBs to AFCK boards via e-link
- Optical link to FLES board in the DAQ-PC
- Very stable transmission, recording up to 170 MB/s

Iron Spectrum

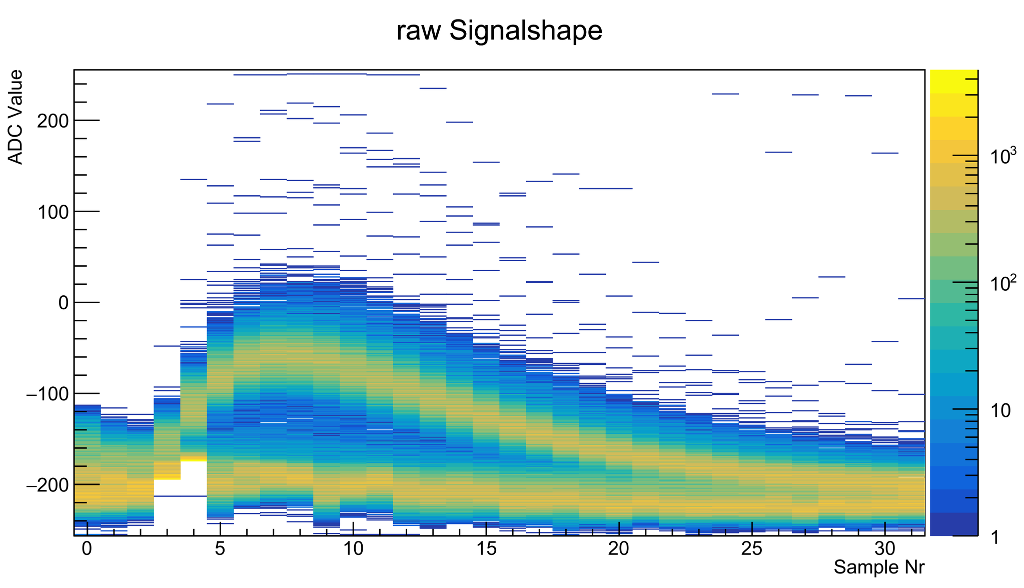

Fig. 4: Signal shape of the pad in front of the iron source without correction.

- Baseline at approx. -220 ADC
- Signal of iron source clearly visible with maximum at -50 ADC

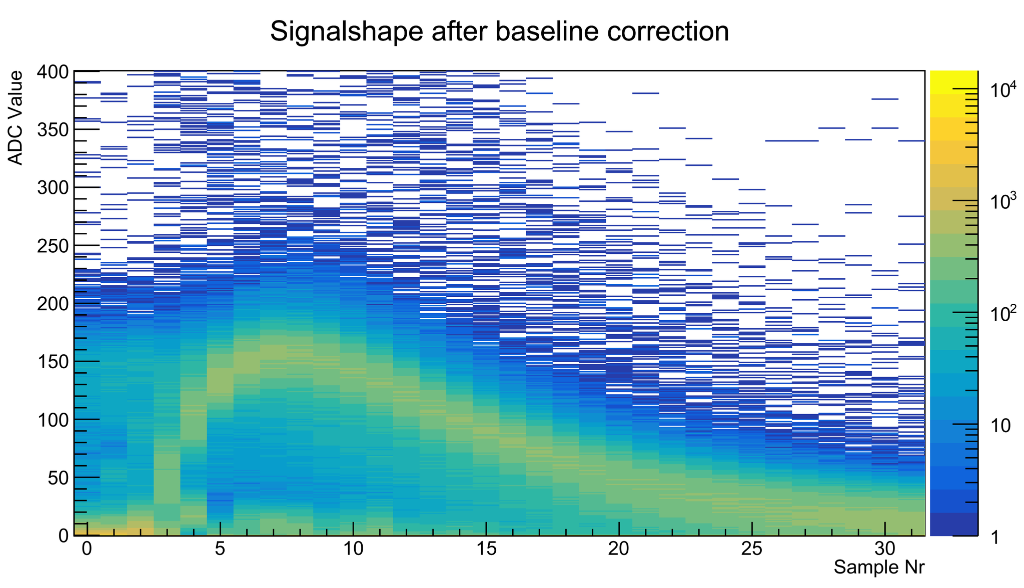

Fig. 5: Signal shape of the pad in front of the iron source after correction.

- ^{55}Fe-source recorded throughout the beamtime
- Slow control data like anode wire voltage, beam energy, gas flow, air temperature and athmospheric pressure also recorded
- Dependency of the iron spectrum on these variables can be tested
- Estimate on energy resolution of the TRD chamber can be done

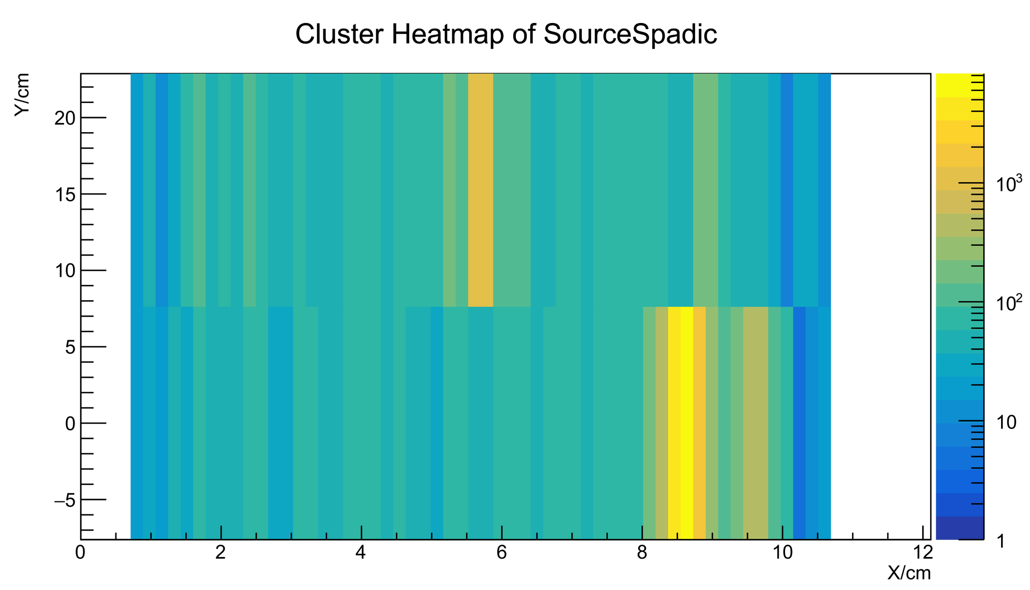

Fig. 6: Heatmap of the padplane around the position of the iron source showing number of clusters measured at the given position.

- Iron source is located in the lower pad-row at $x \approx 8.5$ cm
- Other pads with many entries contain only noise
- Cut on the position of the source was added to the spectrum to filter out noisy pads.
- Charge of a cluster is estimated by taking the maximum ADC-value of the signalshape

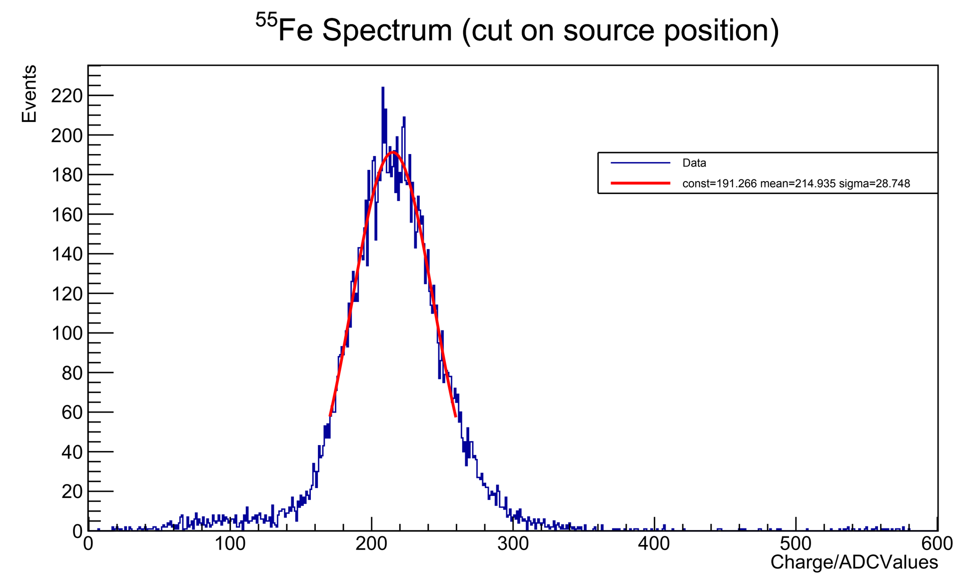

Fig. 7: Spectrum of the ^{55}Fe-source.

- Energy resolution of the TRD chamber can be estimated with this spectrum
- For this purpose: Gauß-fit is performed on the peak

$$\Delta E_{rel} = \frac{\sigma}{mean}$$

$$\sigma = 28.748 \pm 0.041$$
$$mean = 214.935 \pm 0.032$$
$$\Rightarrow \Delta E_{rel} = 0.13374 \pm (1.91 \cdot 10^{-4})$$

- Relative energy resolution is approximately 13.4%
- Energy of the ^{55}Fe-K_α spectral line is 5.9 keV, wich should correspond to the peak position.

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