Measurements with CBM-TRD prototypes at the CERN SPS in 2015

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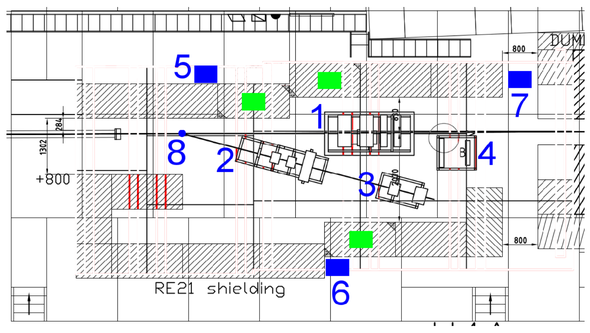
CBM as the heavy-ion experiment at FAIR is designed to investigate the properties of strongly interacting matter at highest net-baryon densities. The main purpose of the Transition Radiation Detector (TRD) will be to discriminate electrons and pions over a large region of particle momenta.

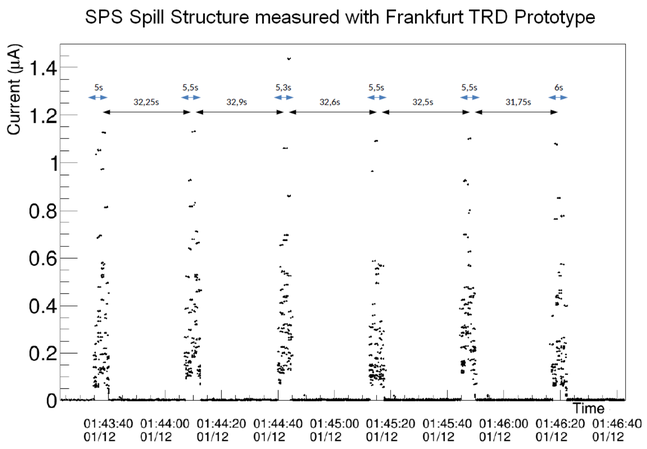
We present two analyzes of data acquired in a test-setup with two TRD prototypes in a Pb-beam at the SPS at CERN in November and December 2015. The first part investigates the capability of the TRD to operate at high hit-rates by analyzing the current measurements at the anode wires, while the second part displays the spatial resolution of the protoypes by analyzing time-correlated events measured in the two chambers.



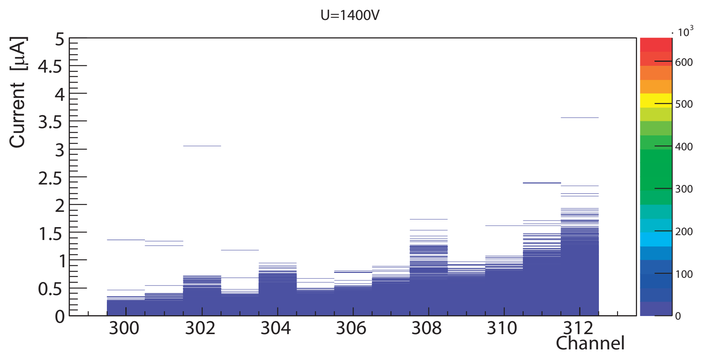
Blueprint[1] of setup in cave
- TRD prototypes from IKF and IKP at pos. 4
- HV supply at pos. 7
- Target at pos. 8

Current measurements

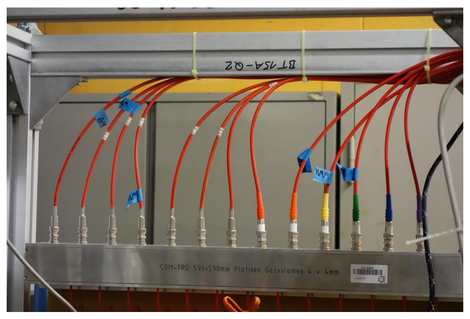
- Full size TRD Prototypes 59x59 cm²
- Anode wire plane subdivided into 13 segments
- Individual high voltage supply for each channel
- Current and high voltage monitored by ISEG HV modules integrated in WIENER MPOD Crate
- Systematic variation of operating voltages between 1350 V and 1600 V in order to optimise gas gain properties and high voltage stability
- Best performance was achieved in the range of 1400 V to 1450 V



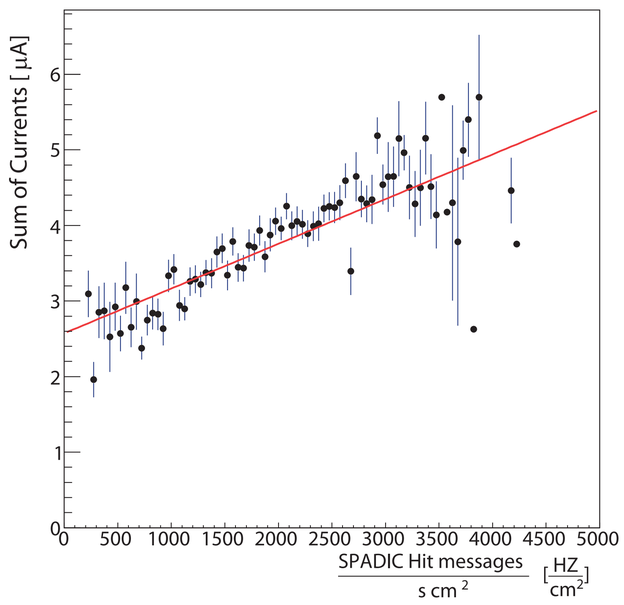
- High precision HV module is sensitive to current changes caused by SPS spill structure



- Channel closest to beam: 312
- Density of ionizing particles decreases with distance to center of beam
- Currents at single field wire are proportional to number of ionizing particles per time unit
- Anode wire groups closer to beam measure higher currents



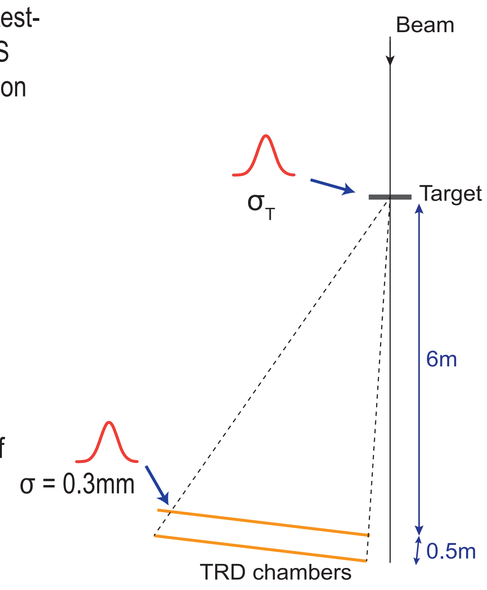
- Connection of HV Supply to 13 segments of TRD



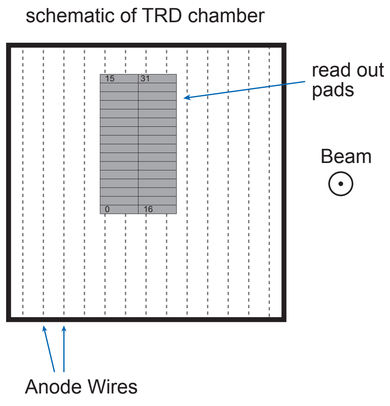
- Correlation of SPADIC Hit Messages per second and cm² to total currents integrated over all 13 channels
- Only moderate increase of currents by roughly a factor of two
- No saturation effects could be observed even at highest hit rates

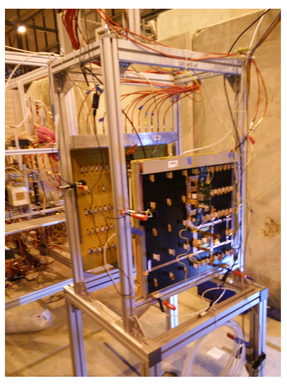
Spatial resolution

- Schematic view of test-setup at CERN-SPS
- 30 AGeV Pb-beam on Pb-target



- Spatial resolution of single chamber[2]
- Readout with Spadic v. 1.0 board with 2x16 channels

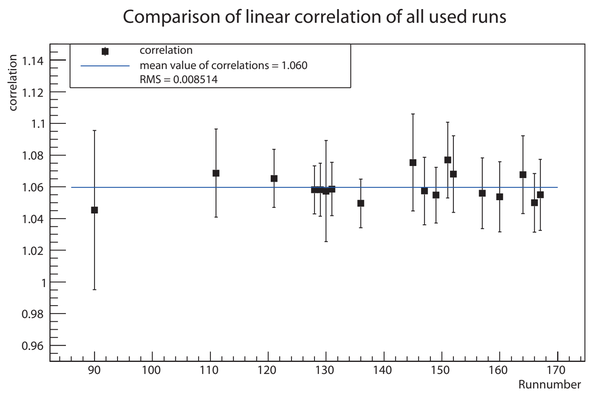


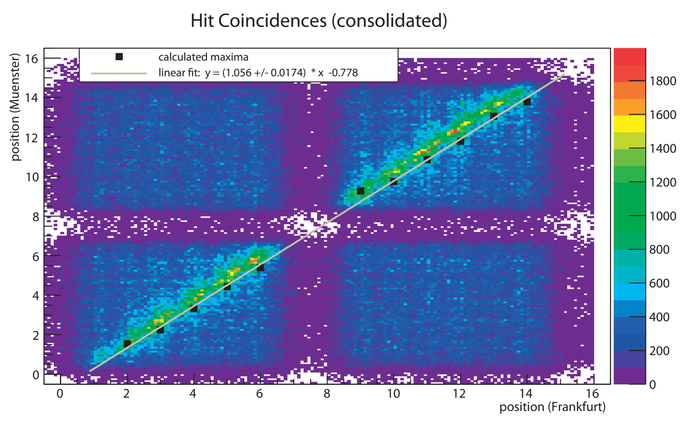


- Setup[3] of the the two TRD-chambers in the cave at CERN.
- Backplanes and readout electronics are visible

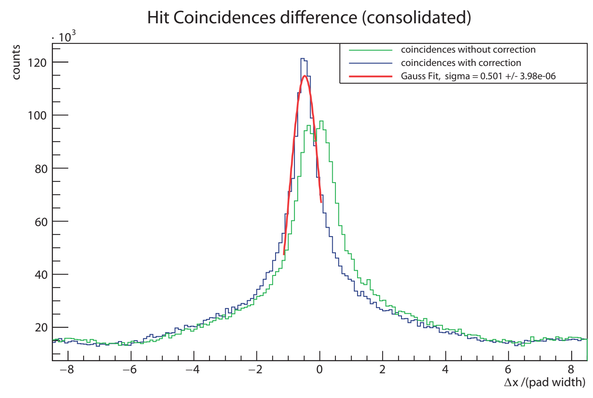
We analyze the **common spatial resolution** of the TRD-prototypes by looking at hits occurring in the same time-slice on both chambers.

Since setup was not changed during beamtime, data from several runs could be consolidated to gain more statistics.





The small tilt in the maxima of hit coincidences is a result of the geometry of the test setup. This needs to be corrected.
In order to do this, we need to find the linear correlation, formed by the maxima in the histogram. Position is given as pad-number.



After correcting and plotting the difference of hit positions, we can calculate the spatial resolution by performing a Gaussian-fit. With a pad width of 7mm, this results in:

$$\text{spatial resolution} \quad r = \frac{0.501 \cdot 7mm}{\sqrt{2}} = 2.48\ mm$$

To verify this result, we programmed a toy-model simulation using a geometry like in the schematic on the far left. According to the simulation, our result corresponds to a target - diameter of ca. 6cm. Since there is no detailed information about the material budget between the target and the TRD chambers, multiple scattering induced by this material was not taken into account.

Sources:

[1] C. Bergmann, P. Kähler u. a. „Combined MWPC prototype test of Münster and Frankfurt using SPADICv1.0 data taking at CERN-SPS/T2-H4 in 2015“. In: CBM Progress Report 2015. Hrsg. von V. Friese, C. Sturm und A. Toia Darmstadt: GSI, 2016, 155 S. : Ill., graf. Darst. isbn: 978-3-9815227-3-0. url: https://repository.gsi.de/record/186952.

[2] Cyrano S.H. Bergmann. „Development, Simulation and Test of Transition Radiation Detector Prototypes for the Compressed Baryonic Matter Experiment at the Facility for Antiproton and Ion Research“. Diss. Westfälische Wilhelms-Universität Münster, 2014. url:http://www.uni-muenster.de/imperia/md/content/physik_kp/agwessels/thesis_db/ag_wessels/bergmann_2014_dissertation.pdf

[3] Picture by Florian Roether, Goethe Universität Frankfurt

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