WWU
MÜNSTER

Electron Detection Efficiency of the CBM-TRD Prototypes in Testbeams at DESY

DPG-Frühjahrstagung 2019, München

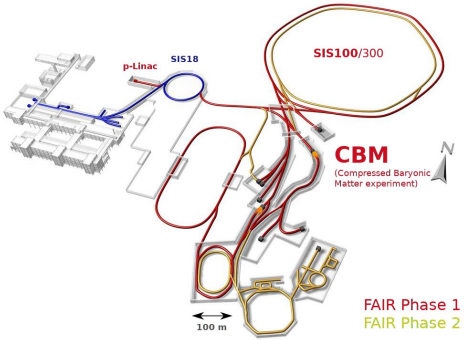
Bundesministerium
für Bildung
und Forschung

FAIR

GSI

CBM
TRD

CBM Experiment at FAIR



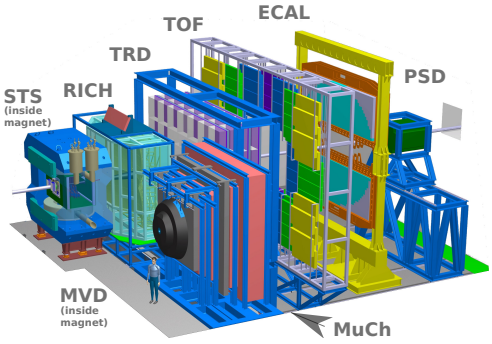
Compressed Baryonic Matter (CBM)

- Fixed target experiment
- Located at FAIR in Darmstadt
- Investigation of QCD matter at high net-baryon densities
- Heavy-ion interaction rates up to 10 MHz

Challenges in QCD matter physics –The scientific programme of the Compressed Baryonic Matter experiment at FAIR,

Eur. Phys. J. A **53** (2017) 60 and arXiv:1607.01487

Transition Radiation Detector for CBM



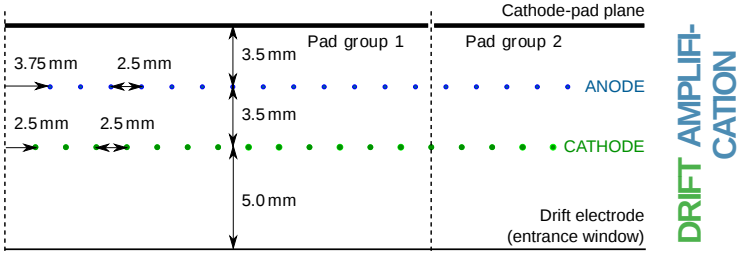
CBM-TRD

- Consists of radiators and MWPCs
- 4 layers with a total active detector area of 114 m^2
- Almost 330k readout channels
- Main tasks:
  - Electron/positron identification at momenta $p > 1\,\mathrm{GeV}/c$
  - Particle tracking
- Detector modules developed in Münster, Frankfurt and Bucharest

Setup at DESY 2017 Testbeam

- Electron beam momenta ranging from 1 to 4 GeV/c

2015-type CBM-TRD Prototypes



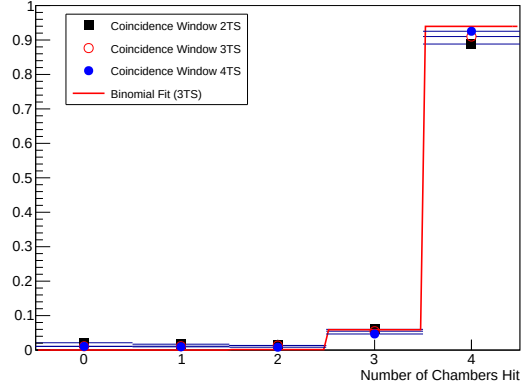
MWPC Properties and Operation at DESY

- Close to final design parameters, final wire geometry
- Readout via induced charge on cathode pads on back panel
- At DESY: Operated with Xe/CO_2 (80:20) at a gas gain of about 4500

Efficiency Calculation

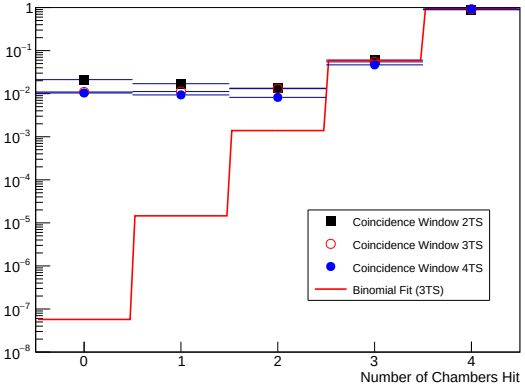
- Electron detection efficiency of a TRD chamber expected to be near to 100 %
  $\Rightarrow$ Calculation from data used as check for the full system
- Event selection: Coincidence in both scintillation detectors
  $\Rightarrow$ Electron passage determined by coincidence in scint. detectors
- Count coinciding TRD signals per electron passage
- Assumption: All four layers have the same efficiency ε
  $\Rightarrow$ Binomial distribution expected

Results



- Electron momentum $p = 4\,\mathrm{GeV}/c$
- Binomial fit for time window of ± 3 TS:
  Efficiency $\varepsilon = \mathbf{(98.45 \pm 0.02)}\,\%$
- Small statistical uncertainties
  $\Rightarrow$ Large $\chi^2_{red} = 1034$

Results



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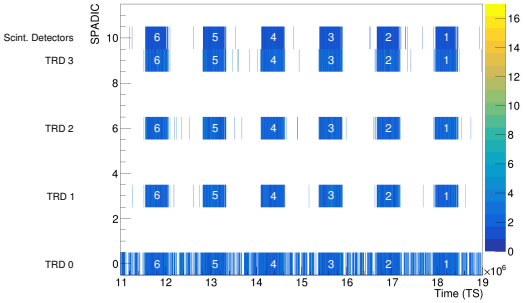
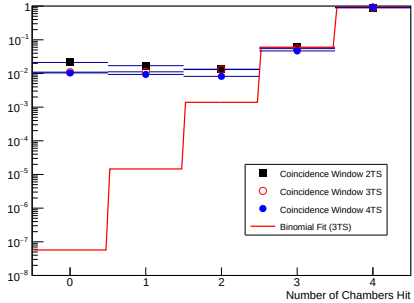
Looking for Random Coincidences



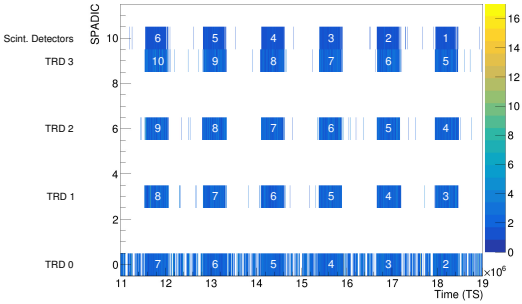
(a) Time Correlation of Data



(b) Counted Coincidences

- Without shift: Binomial “like” distribution
- High electron detection efficiency
- Deviation due to one chamber having a larger coverage

Looking for Random Coincidences



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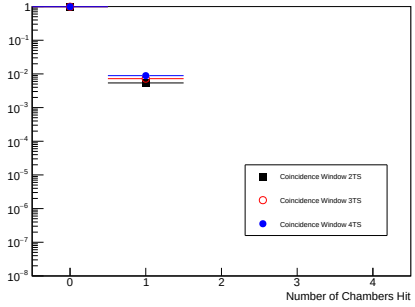
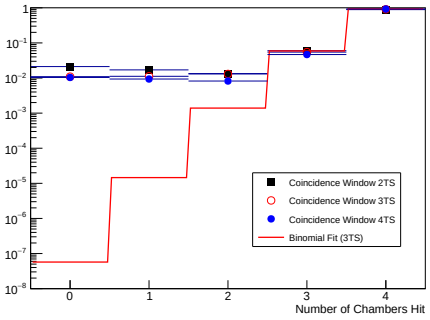


(b) Counted Coincidences

- With shift: Only random coincidences
  $\Rightarrow$ Efficiency value dropping, random coincidences excluded
- Randoms tracked down to TRD 0

Single Coincidences



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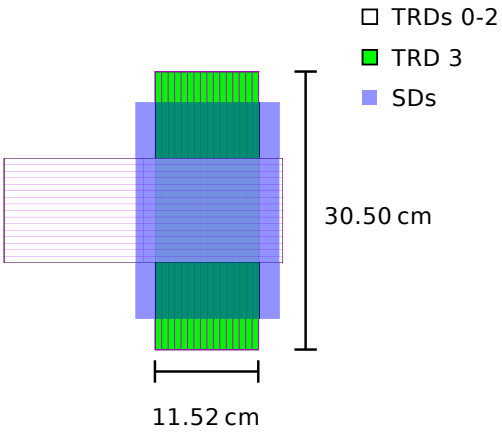
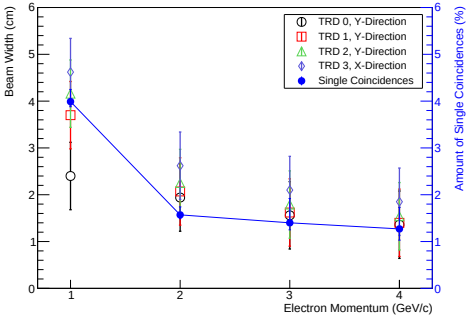
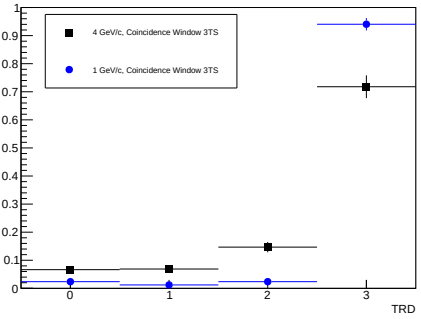


(b) Active detector areas

Single Coincidences



(a) Beam width (open symbols) and amount of single coincidences (filled symbols)



(b) Amount of single coincidences per TRD

- Correlation between beam width and single coincidences
- Most single coincidences on TRD 3
  $\Rightarrow$ Caused by detector orientation

Conclusion & Outlook

Conclusion

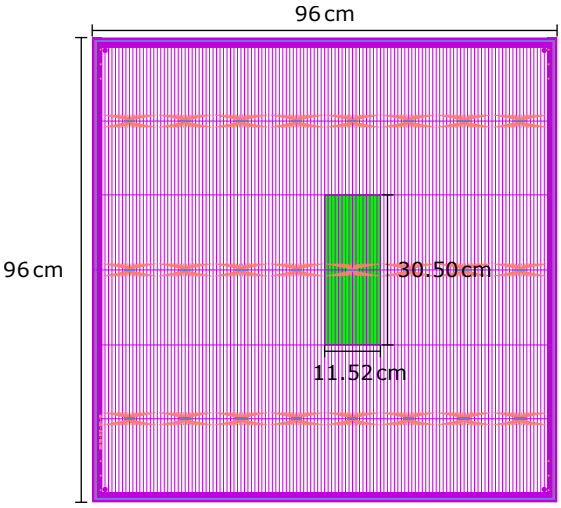
- Overall detector efficiency confirmed
- Including systematic uncertainties: $\varepsilon = \mathbf{(98.45 \pm 2.00)}\,\%$
- System efficiency compatible with known loss effects in readout electronics

Outlook

- Comparison with data from planned 2019 DESY testbeam
  $\Rightarrow$ Larger active detector areas
  $\Rightarrow$ Fixed loss effects in readout electronics

Thank you for your attention!

Active Detector Areas



- 768 equally sized cathode pads ($0.72\,\text{cm} \times 15.25\,\text{cm}$)
- At DESY: 32 pads readout
- High position resolution only in one direction per layer