The Transition Radiation Detector in the CBM Experiment at FAIR

Philipp Kähler[1], Alexandru Bercuci[2], for the CBM Collaboration

[1] *WWU Münster, Germany,* [2] *IFIN-HH Bucharest, Romania*

CBM

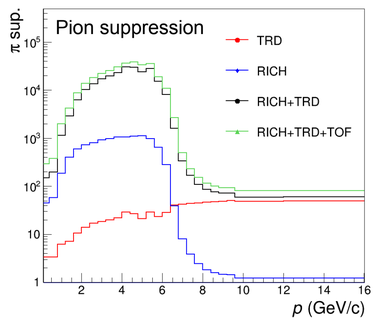
Compressed Baryonic Matter experiment at FAIR

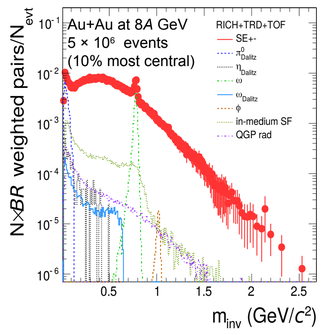
Physics Performance

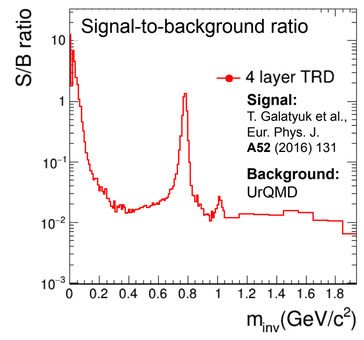
Dielectron Measurements

- Intermediate-mass dielectrons (s. figure)
- Quarkonia in pA (and AA)
- Photons via γ-conversion

- Requires pion suppression at high p_t ⇒ TRD contribution



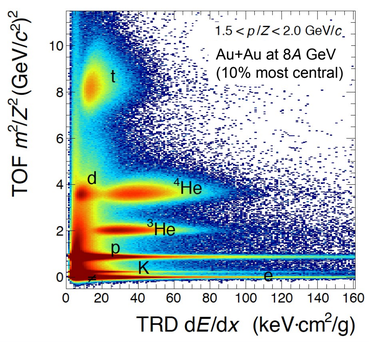


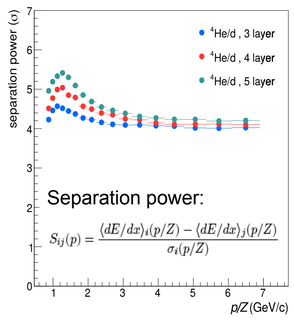


Hadron Identification

- Separation of light nuclei (e.g. d ↔ ^{4}He)
- Important for hypernuclei program (e.g. $^5_\Lambda$He → ^{4}He + p + π$^-$)

- Different charge states cannot be identified with TOF alone
- Additional hadron ID via *dE/dx*-measurement in the TRD



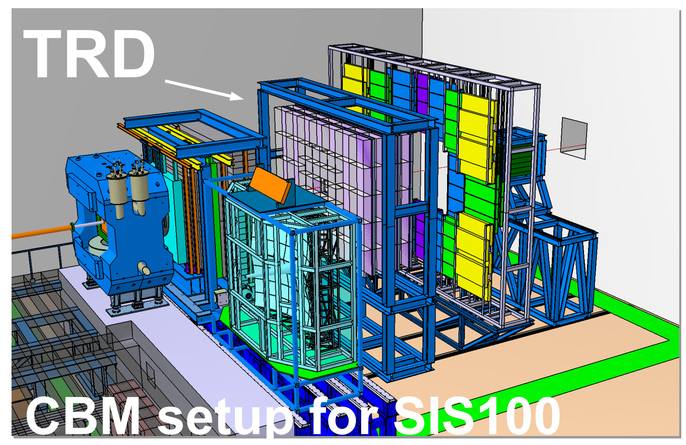


Detector Design

Requirements and Setup

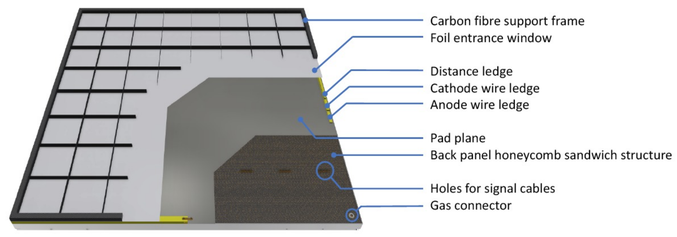
- High-rate capabilities (interaction rates of heavy systems: up to 10 MHz)
- Pion rejection factor ≈ 20
- Charged particle identification
- Tracking capabilities (STS → TOF)
- Muon tracking in MUCH setup
- 4-layer detector setup
- Modular structure

Design Parameters	Value
Pseudo-rapidity coverage	1.15 < η < 3.65
Max. height × width	5.15 m × 6.25 m
Gas volume	1.36 m^3
Active detector area	113.4 m^2
Material budget	< 5 % per layer
Number of modules	216
Number of readout channels	329728
Max. signal collection time	300 ns
Max. hit rate / channel (MB Au+Au at 10 *A*GeV)	≤ 100 kHz
Max. occupancy (cent. Au+Au at 10 *A*GeV)	< 10 %
Space point resolution	~ 300 µm
π-Suppression (90% e-efficiency, p ≥ 1.5 GeV/c)	20
dE/dx-Resolution (p > 1 GeV/c)	≤ 30 %



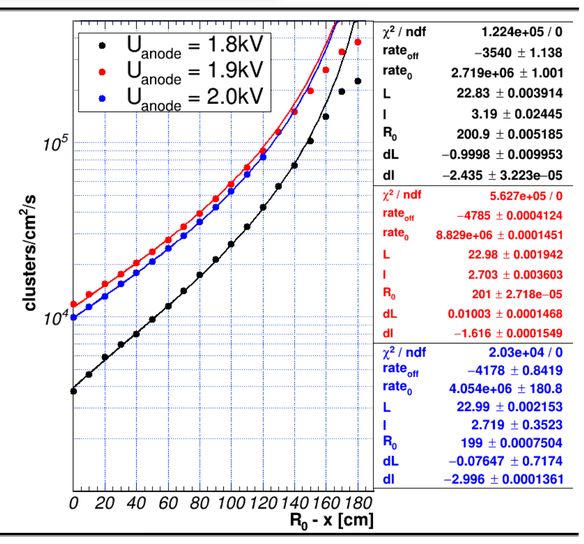
Working Principle

- Radiator: boxes with stacks of PE foam foil
- Readout: Multi-Wire Proportional Chamber (MWPC) with segmented pad plane
- Counting gas: Xe/CO_2 (85/15) ⇒ high γ absorption cross section
- Thin MWPC (3.5+3.5 mm / 5 mm drift) ⇒ fast signal collection



High-Rate Performance Studies with an X-Ray Tube

- Exploring the CBM design values of 100k particle/cm^2/s with X-induced rates (X-ray tube): in-house tests of the inner-zone prototypes
- Control systematic effects on the system (X-ray tube, detector and FEE) by observing the geometrical scaling of the reconstructed yield of hits as function of the distance: source (X-ray tube)–target (TRD)
- *Cluster rate*(x) = I_{off} + I_0 · A(L, I,dL, dI) / (R_0-x)^2
- Preliminary: system is described by the geometrical scaling for rates within CBM specifications and above, especially for low detector gain (lower U_{anode})



High-Rate Tests at the CERN Gamma-Irradiation Facility (GIF^{++})

- In-beam test: MWPC and self-triggered CBM-DAQ chain at the CERN-GIF, ionisation load up to CBM design values
- 14 TBq ^{137}Cs γ source as base load (flexible attenuation system) and µ beam from CERN-SPS
- Observable: µ detection efficiency w.r.t. detector load
- Analysis of data and detector behaviour ongoing, simulation of energy deposition

Load linearity checks