Development of a mirror supporting frame, mounting scheme and alignment monitoring system for the CBM RICH detector

J. Bendarouach[1], **C. Höhne**[1] and **Y. Riabov**[2,3] for the CBM Collaboration

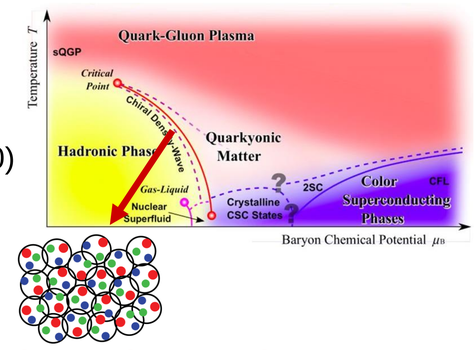
[1] Justus Liebig University, Gießen, Germany, [2] PNPI, Gatchina, Russia, [3] SPbPU, St Petersburg, Russia

CBM at FAIR

Compressed Baryonic Matter experiment

Motivation

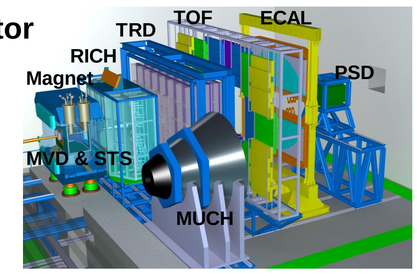
CBM at FAIR: Explore the QCD phase diagram in the region of high net-baryon density with A+A collisions at energies from 2 to 11 AGeV/c (SIS100)



Features of the phase diagram at high μ_B ?
- Quarkyonic phase?
- Phase transition(s)?
- Critical point/ triple point?
- **Need for high precision data including rare probes and among them di-electrons**

Concept of the CBM RICH Detector

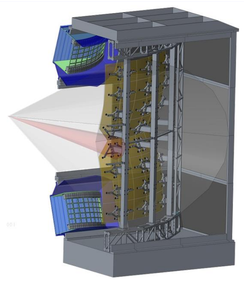
Ring Imaging CHerenkov (RICH) detector
- Gaseous RICH for e- ID (p < 8 GeV/c)
- CO_2 as radiator gas ($p_{\pi,th}$=4.65 GeV/c)



Mirrors and photon sensors
- 2 large spherical mirrors (R=3m) as focusing optics
- Hamamatsu H12700 Multi-Anode PMTs distributed over 2 cylindrical
- surfaces with approx. 64 000 channels
- Dedicated readout chain and electronics developed

RICH Mirrors

Mirrors
- 80 trapezoidal glass mirror tiles of ~ 40x40 cm^2 and 6 mm thick distributed in 2 spheres
- Vertical splitting of RICH geometry due to magnet
- Al+MgF_2 reflective and protective coating

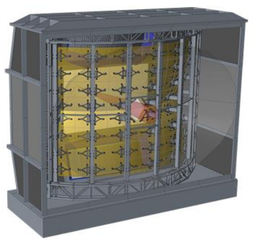


Challenges with respect to detector stability and mirror alignment

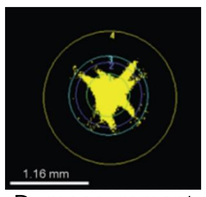
RICH and MUCH detectors will be interchanged approx. once every year
- RICH craned out of the beam line to the MUCH parking position

➢ **Mechanical design and supporting structures** for rigid, low mass and stable detector and mirror system

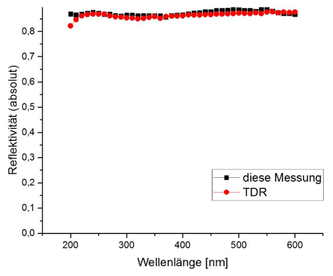
➢ System developed to **monitor mirror alignment**



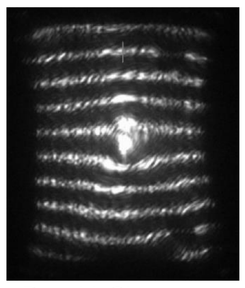
Mirror quality control
- High reflectivity and very good surface homogeneity
- Global control with D0 measurement
  - Averaged on 4 mirrors: 1.19 mm at a radius of 2.22 mm larger than the mirrors radius of curvature
- Local homogeneity measurements
  - Shack Hartmann test: quantitative analysis ongoing
  - Ronchi test



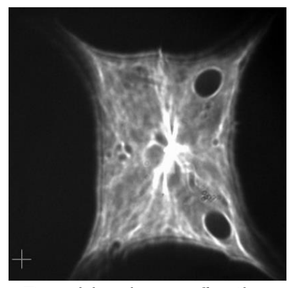
D_0 measurement



Reflectivity



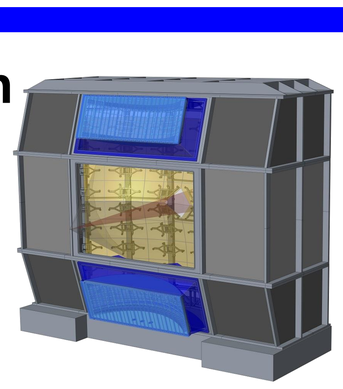
Ronchi: Sharpness



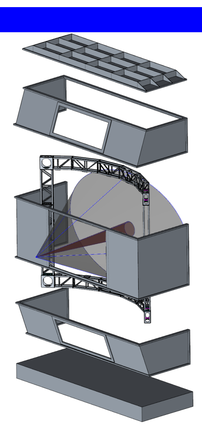
Ronchi: mirror reflection

Mechanical design

Detector supporting structure
- Reduce the material budget
- Mechanically rigid and stable
- frame
- Made of Al for lightweight
- structure

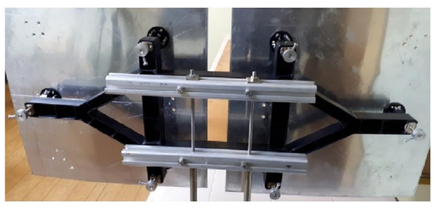


Detector structure

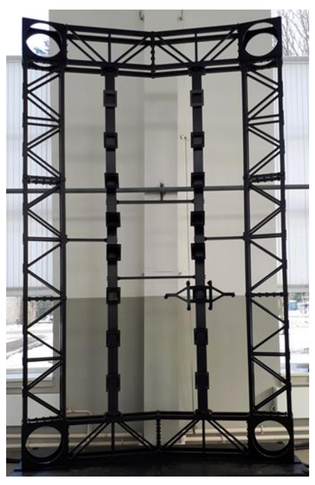


Detector assembly

Mirror supporting frame
- 1 pillar supporting 2 mirror columns
- 1 mirror frame supporting 2 mirrors
  - Prototypes produced
  - Deformation response with load and temperature
- Glue tests for RTV-157 and 24 hour epoxy



Mirror frame

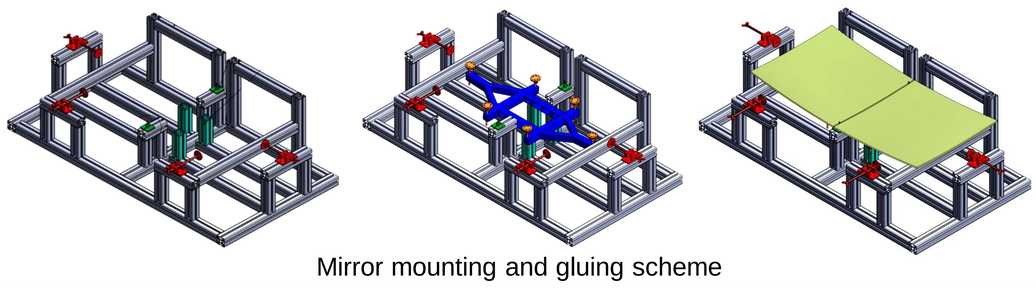


Pillar prototype

Weight test

Mirror frame

Glue stability test: 15 months without problems



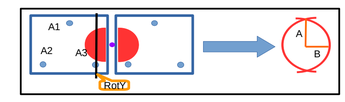
Mirror mounting and gluing scheme

Mirror alignment monitoring system

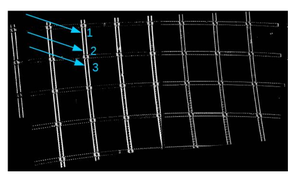
Two methods adapted from COMPASS* and HERA-B# to qualitatively and quantitatively determine mirror rotations

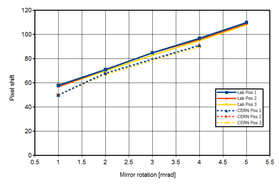
** Nucl. Instr. Meth. Phys. Res. A 595 (2008) 194*
 # Nucl. Instr. Meth. Phys. Res. A 433 (1999) 408

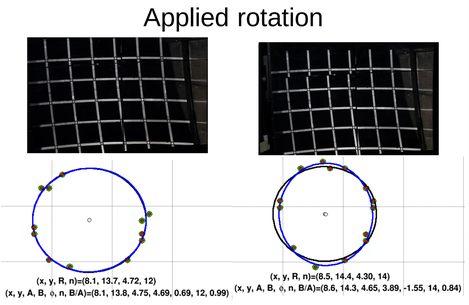
CLAM method
- Qualitative alignment control
- Quantitative mirror rotation determination
- Successfully implemented in CBM-RICH prototype at CERN



Applied rotation

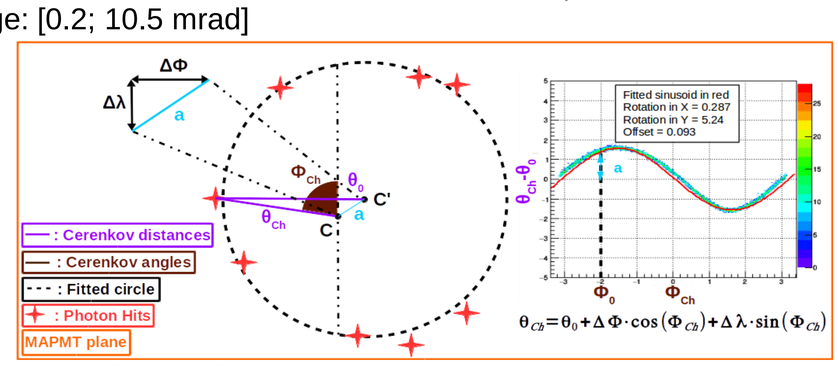




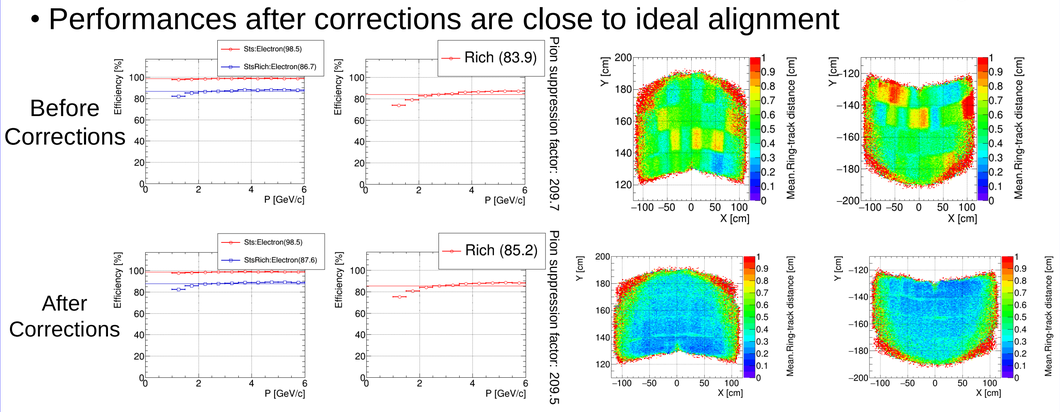


CLAM pictures and reconstructed rings

Software corrections
- Uses data to quantify mirror rotations
- Range: [0.2; 10.5 mrad]



Mirror correction cycle
- Detection and quantification with CLAM and software
- Correct track extrapolation to PMT plane
- Efficiencies (ring-track matching and RICH ID) and ring-track distances compared before and after corrections for a 1 mrad Gaussian misalignment
- Performances after corrections are close to ideal alignment



Supported by the Helmholtz International Center for FAIR, the GSI Helmholtzzentrum für Schwerionenforschung F&E in cooperation with Gießen and Wuppertal, the Helmholtz Graduate School for Hadron and Ion Research and the BMBF grants 05P15RGFCA and 05P15PXFCA