Monte-Carlo Simulations of a miniRICH detector with aerogel radiator in miniCBM

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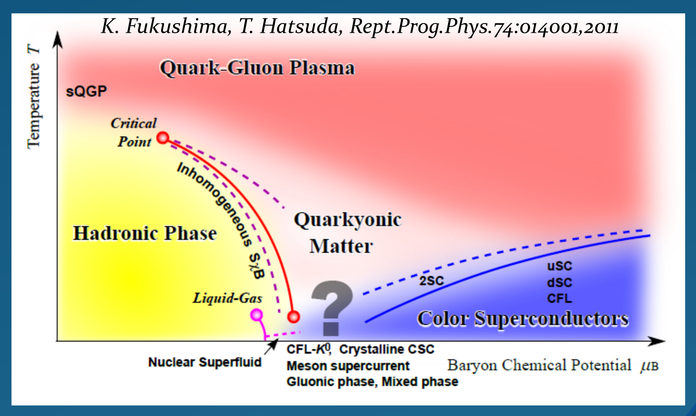
Compressed Baryonic Matter @ FAIR – high μ_B, moderate T

QCD phase diagram at high μ_B ?

- quarkyonic phase ?
- phase transitions ?
- critical (triple) point ?

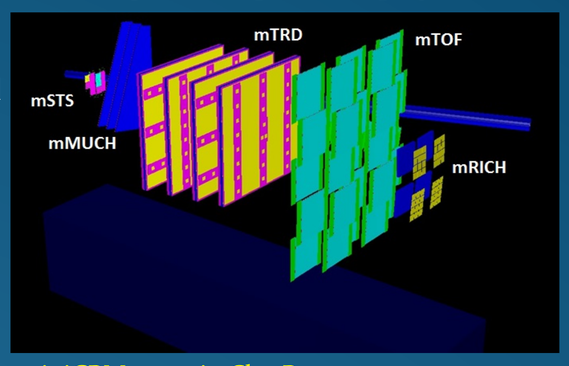
Need for high precision data including rare probes!
Specifically promising: electromagnetic probes

CBM@SIS100: Au+Au interactions from 2/4 – 11 AGeV beam energy



miniCBM with CBM subdetector prototypes @SIS18

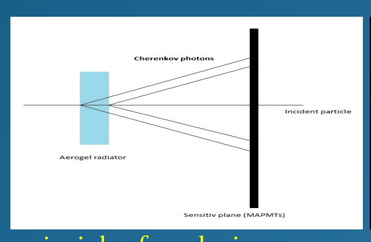
- miniCBM is set up for studying and testing the complex interplay of the subsystems with respect to the free streaming data acquisition, online event reconstruction and selection
- up to top CBM interaction rates of 10 MHZ
- test read out electronics before going into the final production series
- Start summer 2018: 1.24GeV Au+Au collisions



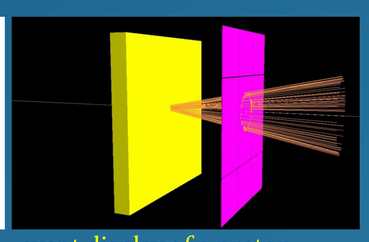
miniCBM setup in CbmRoot event display

miniRICH prototype with aerogel radiator

- CBM: RICH detector with gaseous radiator (CO_2) for electron identification in order to access electromagnetic probes
- miniCBM: due to space constraints and focus on hadrons, a setup with aerogel radiator is proposed
  → pion/proton separation for low momenta, reduced complexity as no gas system is required
  → combine two 2x3 MAPMT modules as developed for the HADES/CBM RICH with aerogel, similar to COSY test beam setup
  → test TRB based RICH read out connection to CBM DAQ, (online) event reconstruction in combination with other CBM prototypes



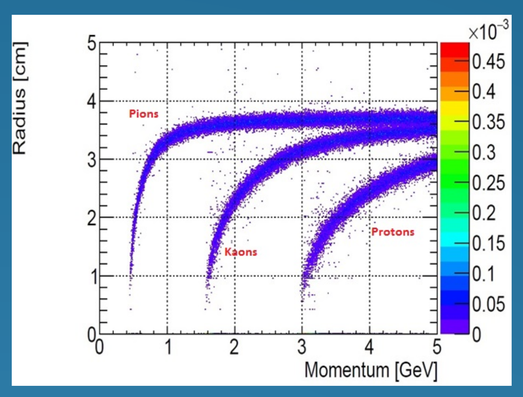
principle of producing a RICH ring with aerogel radiator in a proximity focussing setup



event display of a proton (from left) producing a RICH ring in the prototype (Aerogel (yellow), PMT plane (magenta))

Setup adopted from COSY test beam setup:

- (20 x 20 x 2)cm³ aerogel radiator (n=1.05)
- 10cm distance between radiator and two 2x3 MAPMT modules
- MAPMT: H12700

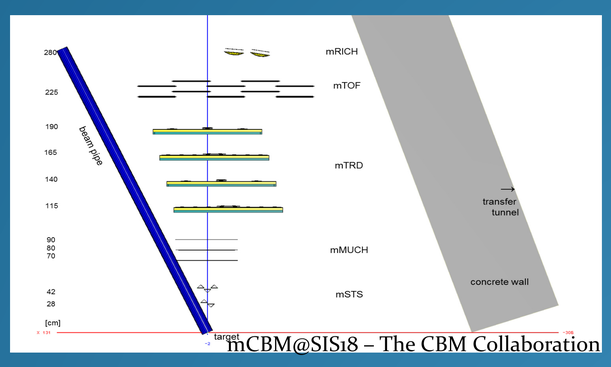


radius momentum distribution

- $\cos(\theta_C) = 1/(\beta n)$
- calculated thresholds:
  p: 3.077 GeV
  K: 1.617 GeV
  π: 455.87 MeV

COSY test beam setup (uncovered) with two 2x3 MAPMT modules and quartz radiator
Successfully tested autumn 2017

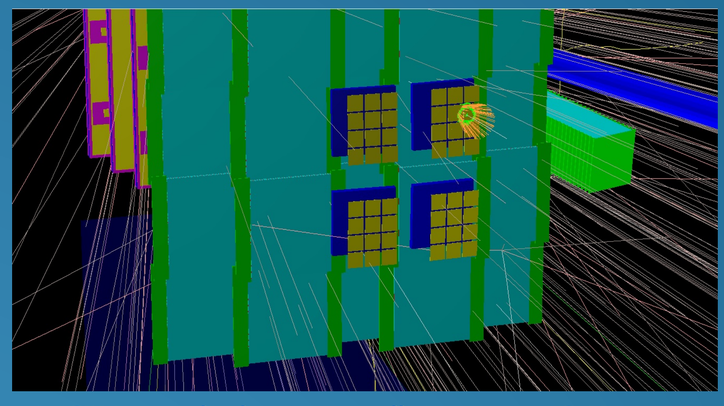
miniCBM and miniRICH setup



Schematic miniCBM setup 20° relative to the beam axis

miniRICH as last detector

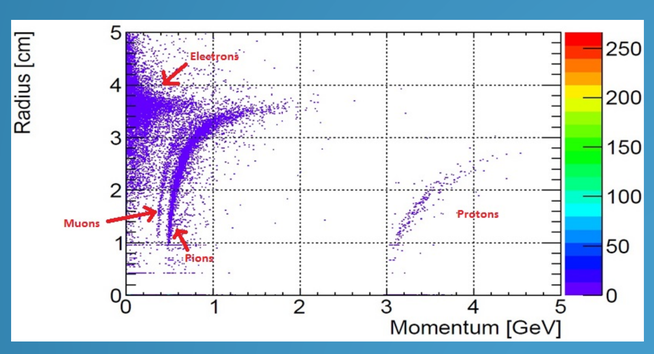
- miniRICH last detector in miniCBM behind miniTOF
- Simulations: four single mRICH prototypes implemented for enhanced acceptance
- Every particle leaving a ring in miniRICH should have a corresponding miniTOF hit
- miniCBM has *NO magnetic field* and thus no momentum information
- Simulations performed for Au+Au collisions at 1.24 AGeV (SIS18, GSI)



miniCBM event display, Au+Au collision at 1.24 AGeV
miniRICH placed behind miniTOF
RICH ring produced by a pion

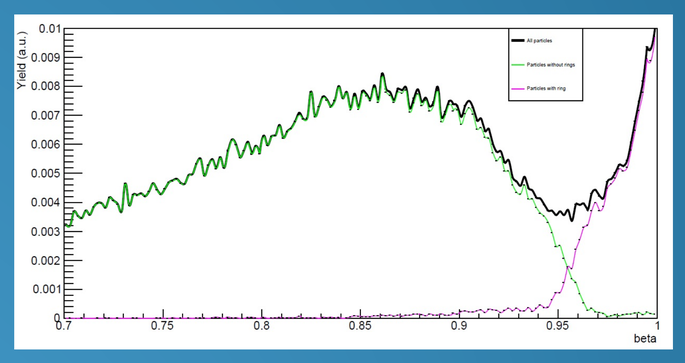
miniCBM simulations including miniRICH

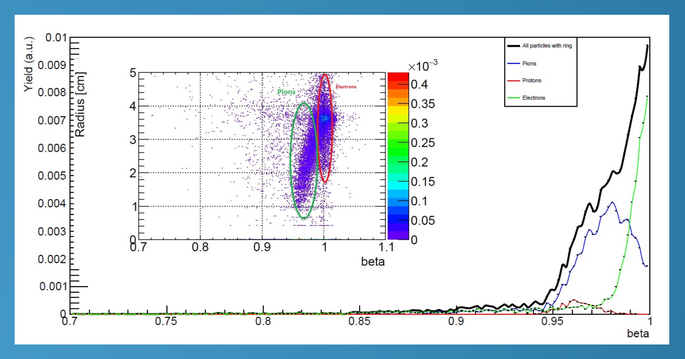
- Au+Au collisions at 1.24 AGeV beam energy
- miniRICH implemented in CbmRoot, ring reconstruction algorithms from CBM RICH applicable
- No momentum information from experimental setup due to missing magnetic field
  → combine reconstructed ring radii with MC momentum information: large contribution from secondary electrons, muons, pions, protons clearly distinguishable



RICH ring radius momentum correlation plot simulated for miniCBM for 100000 events

- Combine miniRICH (ring radius R) and miniTOF (velocity β) information, both experimentally accessible: improved particle identification?
- particles crossing miniToF and miniRICH without producing a ring are mostly protons (β < 0.95)
- particles producing a ring with β ~ 1 are mostly electrons
- particles producing a ring with 0.95 < β < 0.98 are mostly pions





Top: β distribution of all particles in miniTOF and mRICH acceptance (100000 Au+Au collisions); particles producing a ring (purple) and producing no ring (green)
Bottom: β distribution of particles producing a ring, separated by type (electrons (green), pions (blue), protons (red)) and radius β distribution

Outlook

- miniCBM is under construction, first data summer 2018, miniRICH will join in 2019
- miniRICH setup with aerogel radiator proposed due to space constraints and for less complexity (no gas system required) → pion / proton separation possible
- Monte Carlo simulations show good performance, improved pion identification in combination with TOF possible