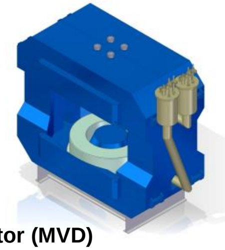
Detector components

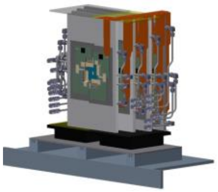
Experimentally, CBM has to identify both hadrons and leptons in a large acceptance. The challenge is to select rare events in nucleus-nucleus collisions with charged particle multiplicities of about 1000 per central event at reaction rates of up to 10 MHz. Such measurements require fast and radiation hard detectors, fast and self-triggered read-out electronics, a high-speed data acquisition system, and online event selection based on full track reconstruction.

The CBM experimental setup comprises the following components:



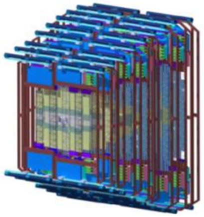
Superconducting Dipole Magnet

Large-acceptance superconducting dipole magnet. The pole gap is 140 cm, the bending power 1 Tm.



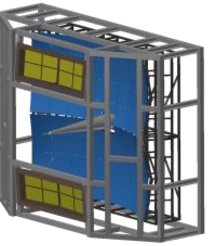
Micro-Vertex Detector (MVD)

The MVD consists of four ultra-thin and highly granulated Silicon pixel detector arrays positioned close to the target. The detector provides the determination of secondary vertices with high precision which is required for the identification of charmed mesons.



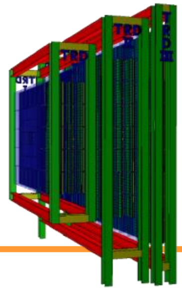
Silicon Tracking System (STS)

The STS consists of 8 thin Silicon micro-strip detector arrays located inside a large-acceptance dipole magnet. The detector provides track reconstruction and momentum determination.



Ring Imaging Cherenkov detector (RICH)

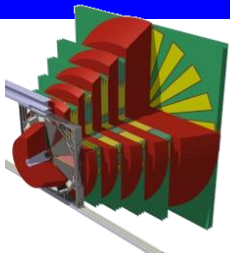
The RICH is used for the identification of electrons with momenta below 8 GeV/c (pion suppression factor of more than 500).



Transition Radiation Detectors (TRD)

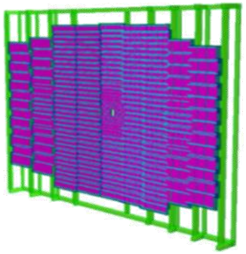
The TRD consists of 12 detectors layers and provides identification of electrons with momenta above 1.5 GeV/c (pion suppression factor of more than 100).

Detector components



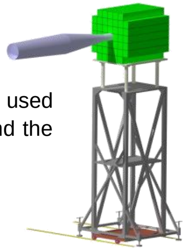
Muon Chamber/absorber system (MUCH)

The MUCH consists of a combination of 15 detector stations and 5 iron absorber layers for hadron suppression. The MUCH provides the identification of muons with momenta above 1.5 GeV/c. MUCH and RICH will be used alternatively.



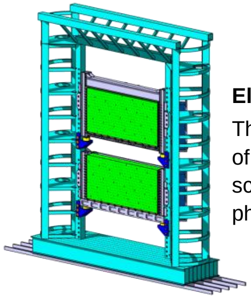
Time-of-Flight Detector (TOF)

The TOF detector composed of timing Resistive Plate Chambers (RPC) provides the time-of-flight measurement needed for hadron identification. Due to the novel low-resistivity glass electrodes, a time resolution of 60 ps can be achieved at a rates up to 25 kHz/cm^2.



Projectile Spectator Detector (PSD)

The PSD is a lead-scintillator calorimeter and is used for the determination of the collision centrality and the orientation of the reaction plane.



Electromagnetic Calorimeter (ECAL)

The ECAL consists of modules composed of 380 alternating layers of lead and plastic scintillator. It provides the measurement of photons and neutral particles.

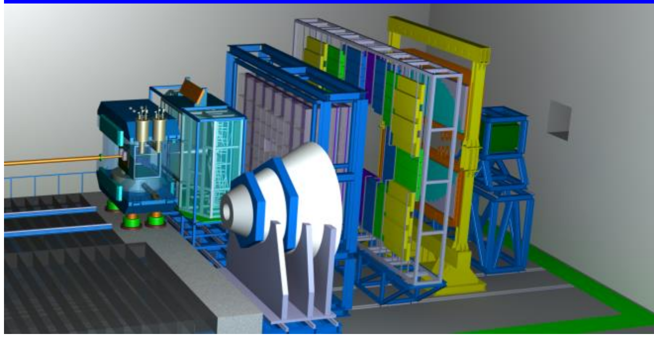
Data Acquisition (DAQ) system and First Level Event Selection (FLES)

The CBM DAQ system combines free-streaming front-end-electronics with a high-speed readout chain.

Data are processed online on the FLES, a high-performance computing cluster located in the GreenIT cube at GSI. The FLES software is highly optimized w.r.t. computational speed such that physical events can be reconstructed, analysed and selected for permanent storage in real-time.

CBM

The Compressed Baryonic Matter experiment



http://www.fair-center.eu/for-users/experiments/cbm.html

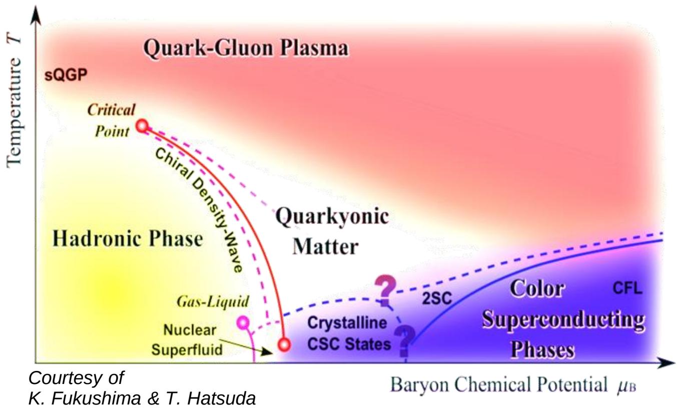
GSI

FAIR

Facility for Antiproton and Ion Research

Physics case

The Compressed Baryonic Matter (CBM) Experiment is designed to investigate high-energy nucleus-nucleus collisions at the future international Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany.



Courtesy of K. Fukushima & T. Hatsuda

The phase diagram of strongly interacting matter

The objective of high-energy heavy-ion collision experiments performed worldwide is to investigate the structure and the properties of strongly interacting matter under extreme conditions, or, in other words, to explore the phase diagram of matter governed by the laws of Quantum-Chromo-Dynamics (QCD). Of particular interest is the phase where the hadrons dissolve into quarks and gluons which then freely move over the reaction volume, forming a so called quark-gluon-plasma. At very high beam energies – as provided by the Relativistic Heavy-Ion Collider in Brookhaven and the Large Hadron Collider at CERN – matter is created at extremely high temperatures similar to the early universe. In heavy-ion collisions at FAIR beam energies (up to 45 AGeV) nuclear matter is compressed to very high net-baryon densities as in core collapse supernovae, or in the interior of neutron stars.

The CBM experiment offers the possibility to discover the most prominent landmarks of the QCD phase diagram expected to exist at high net baryon densities: the first order deconfinement phase transition and the critical endpoint.

Observables

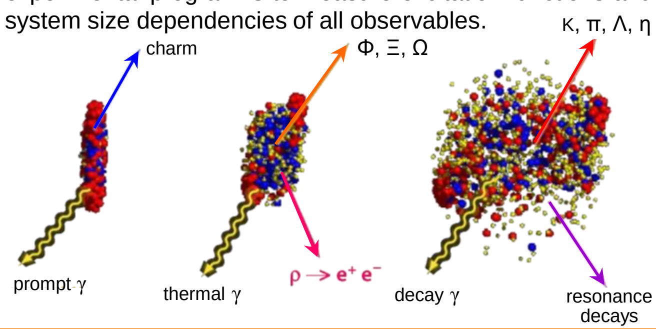
The CBM research program is focused on:

- the study of the equation-of-state of dense baryonic matter
- the search for the phase boundary between hadronic and partonic matter (including the QCD critical endpoint)
- search for the modification of hadron properties in the dense baryonic medium, and for the onset of chiral symmetry restoration.

The most promising observables from nucleus-nucleus collisions in the FAIR energy range are:

- **Strange baryons** (Λ, Ξ, Ω) and their antiparticles. The yield of particles carrying strange quarks is expected to be sensitive to the fireball evolution.
- **Low-mass vector mesons** decaying into lepton pairs (ρ, ω, φ –mesons). Electron and muon pairs are penetrating probes which carry undisturbed information on hadron properties in the dense and hot fireball.
- **Dynamical fluctuations** of particle multiplicities and momenta. Event-wise fluctuations are expected to occur if the system passes a first order phase transition or the critical endpoint.
- **Collective flow of hadrons**. The flow is driven by the pressure created in the early phase of the collision and carries information on the equation-of-state of dense matter.
- **Particles containing charm quarks** (D, J/ψ, and ψ' mesons). Heavy quarks are created in the early phase of the collision, and, hence, probe highly compressed baryonic matter.

Phase transitions occur above a critical energy density, and can only be observed if the matter extends over a certain volume. Therefore, a key feature of the CBM experimental program is to measure excitation functions and system size dependencies of all observables.



The CBM collaboration

60 institutions, more than 500 members (May 2015)

26th CBM Collaboration Meeting, 14-18 September 2015, Prague

Croatia:
Split Univ.

China:
CCNU Wuhan
Tsinghua Univ.
USTC Hefei
CTGU Yichang

Czech Republic:
CAS, Rez
Techn. Univ.Prague

France:
IPHC Strasbourg

Hungary:
KFKI Budapest
Budapest Univ.

Germany:
Darmstadt TU
FAIR
Frankfurt Univ. IKF
Frankfurt Univ. FIAS
Frankfurt Univ. ICS
GSI Darmstadt
Giessen Univ.
Heidelberg Univ. P.I.
Heidelberg Univ. ZITI
HZ Dresden-Rossendorf
KIT Karlsruhe
Münster Univ.
Tübingen Univ.
Wuppertal Univ.
ZIB Berlin

India:
Aligarh Muslim Univ.
Bose Inst. Kolkata
Panjab Univ.
Rajasthan Univ.
Univ. of Jammu
Univ. of Kashmir
Univ. of Calcutta
B.H. Univ. Varanasi
VECC Kolkata
IOP Bhubaneswar
IIT Kharagpur
IIT Indore
Gauhati Univ.

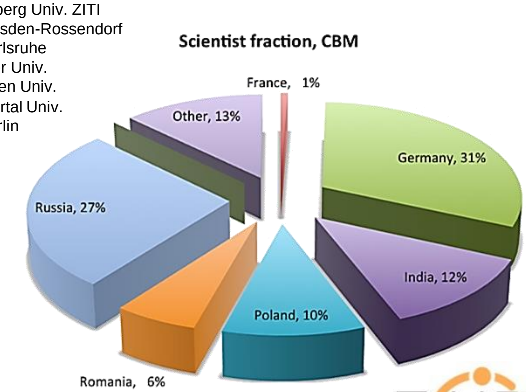
Korea:
Pusan Nat. Univ.

Poland:
AGH Krakow
Jag. Univ. Krakow
Silesia Univ. Katowice
Warsaw Univ.
Warsaw TU

Romania:
NIPNE Bucharest
Univ. Bucharest

Russia:
IHEP Protvino
INR Troitzk
ITEP Moscow
Kurchatov Inst., Moscow
LHEP, JINR Dubna
LIT, JINR Dubna
MEPHI Moscow
PNPI Gatchina
SINP MSU, Moscow
St. Petersburg P. Univ.
Ioffe Phys.-Tech. Inst. St. Pb.

Ukraine:
T. Shevchenko Univ. Kiev
Kiev Inst. Nucl. Research



Facility for Antiproton and Ion Research