

Exploring baryon-rich QCD matter with CBM at FAIR: from detector construction to physics

The Compressed Baryonic Matter (CBM) experiment at FAIR is designed to explore the phase structure and microscopic properties of strongly interacting matter at high net- baryon densities and moderate temperatures. Using heavy- ion collisions at center- of- mass energies of $\sqrt{s_{\rm NN}} = 2.7\text{--}4.9$ GeV, CBM will access a region of the QCD phase diagram where the highest net- baryon densities in the laboratory are expected. Its physics program addresses the equation of state and collective dynamics of dense matter, the search for critical phenomena, in- medium properties and the temperature of the fireball, as well as strangeness and hypernuclear physics.

CBM combines fast, radiation- hard detector systems with a free- streaming, self- triggered readout and online event reconstruction and selection. Designed for interaction rates of up to 10 MHz, this concept enables high- statistics measurements of rare probes that have so far remained inaccessible in this energy regime. Recent realistic performance studies demonstrate experimental sensitivity to multi- strange hyperons and hypernuclei, thermal dileptons in both the electron and muon channels, collective flow and femtoscopic observables, and higher- order fluctuations. The physics program is complemented by precision measurements with proton and deuteron beams, providing access to elementary hadron production and hadron spectroscopy.

At the same time, CBM has entered an advanced construction and integration phase. Detector production is progressing across the experiment, while installation of the experimental infrastructure at FAIR is underway. The coming period will see the transition from subsystem production and testing to installation and global commissioning, in preparation for first SIS 100 beams and the start of the CBM experimental program.

This contribution will present the latest status of the CBM experiment, recent detector and integration progress, and selected results from the new comprehensive CBM physics- performance studies, illustrating the measurement capabilities of CBM and its prospects for precision exploration of baryon- rich QCD matter.