

Form B1\_EN - Project Summary

<b>Programme / Sub-programme / Module</b>	5.9/5.9.2/FAIR-RO		
<b>Project type</b>	RD		
<b>Experiment</b>	CBM	<b>Scientific Domain</b>	Nuclear Matter Physics
<b>Project title / Acronym</b>	CBM experiment on the horizon - detectors, electronics, data acquisition and physics/CEHDEP		
<b>Project duration</b>	2024-2026		

**PROJECT SUMMARY**

Systematic studies of the possibility to produce in the laboratory states of the matter supposed to be characteristic for the early Universe, at few microseconds after the Big-Bang, or for the interior of the neutron stars started 40 years ago when the first heavy ion accelerators and associated complex experiments were built. The impressive amount of experimental data collected during this period clearly indicates a transition from normal matter formed by nucleons to deconfined matter formed by its basic constituents, quarks and gluons, as it is predicted by the Quantum Chromo Dynamics (QCD) at high temperature and negligible baryonic chemical potential. Equally interesting is the study of the possibility to produce deconfinement at large baryon densities and moderate temperature, characteristic for the core of massive neutron stars, where the constituent quarks and gluons of the highly packed nucleons become free. The size and lifetime of the pieces of matter, produced in the collisions of hadrons or heavy ions, are excessively small. Therefore, finite size and dynamical effects play an important role and have to be understood in detail in order to extract unbiased experimental information. Multidifferential analyses especially for rare probes, sensitive to the dense phase of the nuclear fireball, require unprecedented statistics. This can be achieved using high intensity or luminosity accelerators and accompanying experimental devices which maintain their performance in high interaction rates. The Compressed Baryonic Matter (CBM) experiment at the Facility for Anti protons and Ion Research (FAIR) in Darmstadt, running at  $10^7$  interaction rate accessible at SIS100 is such a device.

Our group is involved in the CBM Collaboration from its very first days, with essential contributions in developing a new generation of Resistive Plate Counter (RPC) and Transition Radiation Detector (TRD) for high counting rates, Front-End Electronics (FEE) and different versions of trigger-less Data Acquisition (DAQ). The performances of these devices are detailed in the CBM Time-of-Flight (ToF) Technical Design Report (TDR) and in an Addendum to the CBM-TRD TDR for the inner zone of the CBM-TRD subdetector. Further contributions from our group will be dedicated to the assembling and testing of the most challenging regions of these two sub-detectors, i.e. small polar angles. The final solution foreseen as production readiness prototypes still require some R&D activities especially related to high counting rate, high granularity, radiation hardness and FEE. In-beam tests at the mCBM setup at SIS18 – GSI at Darmstadt, where close to real conditions could be accessed, are ideal for the final tests.

Based on the experience and results obtained by our group within the FOPI and ALICE collaborations, theoretical exploratory studies will be conducted focusing on multidifferential studies of observables being accesible at CBM and sensitive to the equation-of-state (EOS) at high baryon densities, for different collision centralities and system sizes, within the  $\sqrt{s_{NN}} = 2-4.9$  GeV energy range, with the aim to understand the fundamental properties of QCD in the corresponding region of the phase diagram. For signal extraction and physics interpretation, the results of different phenomenological models, i.e. UrQMD, SMASH, JAM and AMPT will be systematically analyzed.