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Development of a gas system for the Transition Radiation Detector of the CBM experiment

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The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany, aims to explore the QCD phase diagram at high baryon densities through high-energy nucleus-nucleus collisions and explore new states of matter. One of the crucial components of the CBM experiment is the Transition Radiation Detector (TRD), which is essential for identifying electrons with a momentum above ⍰>1 GeV/c. A high detection efficiency of better than 90% is required.
The TRD is composed of two parts: the Read-Out Chamber (ROC) and the radiator. Transition Radiation (TR) photons are generated in the radiator by electrons with a certain probability, while heavier pions pass through without producing any TR. The TRD uses a mixture of the noble gas xenon and the quenching gas CO2. Xenon is chosen because of its high absorption cross-section for photons in the TR spectral range.
Since xenon is an expensive gas, a critical part of the TRD is its gas system, which must maintain a stable and optimal mixture in a closed circuit. The design of this gas system also involves considerations of gas purity, flow rates, and pressure stability to ensure efficient charged particle and transition radiation detection, thereby maximizing the detector resolution and efficiency. To accurately identify electrons amidst a high background of other particles. The gas overpressure in the TRD must be precisely controlled and kept in a range of about 0.2 –0.6 mbar.
This report discusses the gas system requirements. The status of a gas system prototype and plans for its development into a full-size system will be presented. This includes the design of the gas distribution and circulation system and the implementation of monitoring systems.

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