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Design and performance of a prototype gaseous beam monitor with GEM and pixel sensors for the CSR external-target experiment

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A gaseous beam monitor utilizing gas electron multiplier (GEM) and pixel sensors is being developed for the Cooling Storage Ring (CSR) external-target experiment (CEE) at Heavy Ion Research Facility in Lanzhou (HIRFL). The beam monitor is mainly used to track each beam particle, providing an accurate reconstruction of the primary vertex of the collision. Two generations of the pixel sensors (named Topmetal-CEE) were produced, with the second generation having much-improved noise performance over the first one. The readout electronics includes two chip carrier cards, two front-end cards, and a readout and control unit. This talk presents the design and performance of two prototype detectors, featuring two generations of the pixel sensors, respectively. In particular, the results of the tests with heavy-ion beams and laser beams are presented, showing a spatial resolution of better than $50 \mu\text{m}$ and a time resolution of better than 15 ns. The studies demonstrate that the spatial and time resolution of the prototype satisfies the design specifications.

Primary author(s) : WANG, Hulin (Central China Normal University); GAO, Chaosong; LIU, Jun; WANG, Zhen; WEI, Xianglun

Presenter(s) : WANG, Hulin (Central China Normal University)

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