

Hi'Beam-SEE: a silicon pixel sensor-based beam monitor for heavy-ion experimental terminals

Noninterceptive and high-accuracy beam monitors are critical for the experimental terminals at the high-intensity heavy-ion accelerator facility (HIAF) complex. The Hi'Beam-SEE, a silicon pixel sensor-based beam monitor, has been designed to measure the track of every single particle. The Hi'Beam-SEE consists of the detectors and the readout system. When the charged particle passes through the detector field, it will ionize the gas along its track. In the presence of the electric field, the ionized electrons drift to the position-sensitive anode (PSA), on which the silicon pixel sensor is placed. The projection of the track can then be reconstructed with the charge collected by the silicon pixel sensor.

The Topmetal-M silicon pixel sensors are used in the HiBeam-SEE. The Topmetal-M is a large area pixel sensor (18 mm × 23 mm) prototype fabricated in a new 130 nm high-resistivity CMOS process, and it contains 400 rows × 512 columns square pixels with a pitch of 40μm. Part of each pixel's top metal layer is exposed to sense the drifting charge; thus, it can directly collect the charge in the gas. The in-pixel circuit mainly consists of a low-noise charge-sensitive amplifier to establish the signal for the energy reconstruction and a discriminator with a Time-to-Amplitude Converter (TAC) for the Time of Arrival (TOA) measurement.

A beam test of the Hi'Beam-SEE has been carried out with $^{209}\text{Bi}^{36+}$ with the energy of $\sim 10.32\text{MeV/u}$, and an excellent spatial resolution of $\sim 12.77\mu\text{m}$ has been achieved.

Submission declaration

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Track Classification: New ideas and future applications