

A High-Performance Multifunction Scintillator Beam Monitor (SBM)¹

Developed by Integrated Sensors LLC & the University of Michigan

- ❖ A highly versatile beam monitor with *enhanced diagnostics* for *real-time* beamline control/tuning (1 Hz)
- ❖ Beam currents: **single-particles to $>10^{11}$ particles/sec** (pps); precise beam imaging $\sim 10 \mu\text{m}$ spatial resolution
- ❖ Small footprint: entrance-to-exit (front-to-back) $\sim 12 \text{ cm}$ & can be transparent to many beam types.

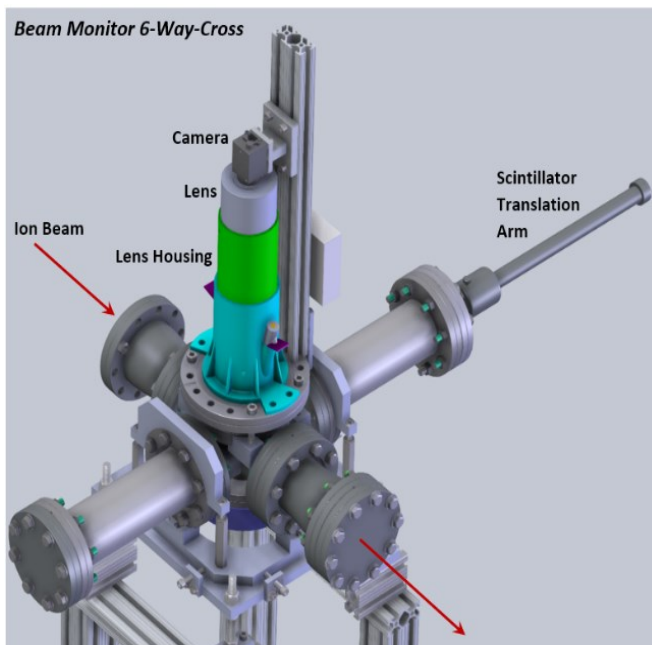


Fig. 1: Six-way-cross (6WC) mounted on support stage.

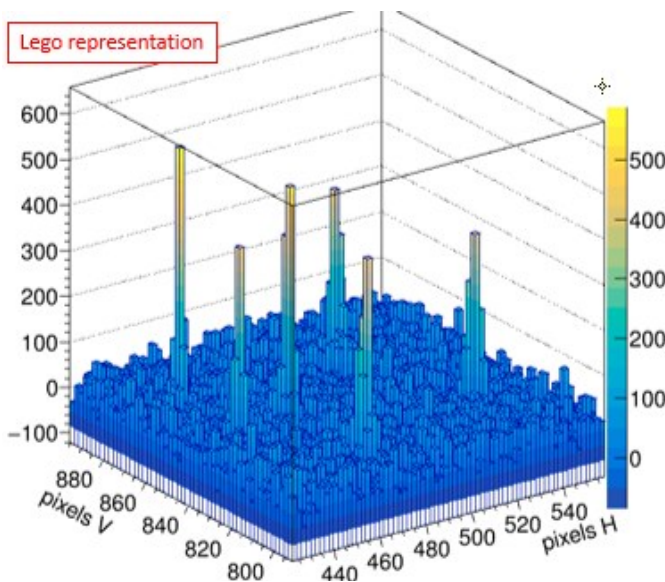


Fig. 2: Single-particle $^{86}\text{Kr}^{+26}$ hits in HM-material in 1 sec.

- ❖ SBM uses six-way-cross configuration (Fig. 1) and multi-sample cassette of thin to ultra-thin scintillator targets movable into/out of the beam (remotely) *without breaking vacuum*.
- ❖ Two **proprietary scintillator** materials (PM & HM) employed that are highly radiation damage resistant, non-hygroscopic, low outgassing, with minimal secondary reflections:
 - (PM) a polymer-film material demonstrated over thickness range from 1-200 μm . Stronger signals than commercial plastic scintillators tested.
 - (HM) a thin sheet of inorganic crystals dispersed in a polymer hybrid matrix, demonstrated over thickness range from 100-400 μm . Produces order-of-magnitude larger sensor signals than single-crystal CsI(Tl) allowing for visualization of **single-ion** signals (Fig. 2).
- ❖ Successful demonstration at the DOE Facility for Rare Isotope Beams (FRIB) on the ReA3 beamline: from **single-particles** up to $\sim 10^6$ pps.
- ❖ Large dynamic range (up to $\sim 10^{11}$ pps): One SBM can measure beam currents now determined at FRIB by four devices: Faraday cup, microchannel plate, silicon detector, calibrated beam attenuator. Also replaces & greatly improves upon standard camera viewers.
- ❖ Response linearity demonstrated over more than 5 orders-of-magnitude.
- ❖ Depending on the particle energy, beam intensity, and choice of scintillator target, the SBM can operate as a nearly **"transparent"** beam monitor and has demonstrated this capability at FRIB.
- ❖ Tested at 4 different particle beam laboratories with the HM scintillator's extraordinary performance verified at DOE/NASA Brookhaven National Laboratory.
- ❖ System capability includes particle beams from electrons to heavy-ions as well as photons, and from low-energy particles/photons to MIPS.
- ❖ Applications are also being developed for:
 - conventional external beam radiation therapy (EBRT)
 - newly emerging FLASH-RT with $\sim 1,000$ - $10,000$ higher dose rates
 - patient-specific quality assurance (PSQA) treatment planning

¹ The SBM is a patented product of Integrated Sensors LLC, of Palm Beach Gardens, Florida. It was developed under an SBIR Phase-II award issued to Integrated Sensors by the US Dept of Energy, Office of Nuclear Physics (Contact: peter@isensors.net).