

Novel Thin-Scintillator Ion Beam Imagers

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The thin-scintillator ion beam imager (SIBI) is a novel charged particle imaging detector developed by our group for various applications. It uses proprietary high light-yield, very thin ($<500\text{ }\mu\text{m}$) hybrid inorganic scintillator sheets or ultra-thin ($3\text{--}200\text{ }\mu\text{m}$) organic scintillator films. The scintillation elements are coupled by low f-number optics to high sensitivity, low-noise or ultra-low noise machine vision cameras. The initial application is for beam imaging and profile analysis at the U.S. DOE Facility for Rare Isotope Beams (FRIB) and other ion beam laboratories. For FRIB, we are developing the SIBI towards maximizing sensitivity to low rate and low energy ion beams with real-time feedback while limiting beam degradation for moderate energy FRIB beams over a large dynamic range from single particles up to $\sim 10^{10}$ pps. The SIBI has demonstrated detection sensitivity to single 5 MeV alpha particles with a position resolution of $5\text{ }\mu\text{m}$, while for heavier ions, the position resolution is $\sim 2\text{ }\mu\text{m}$. Other SIBI applications are being developed for conventional proton/ion beam therapy and for the newly emerging cancer treatment modality known as FLASH radiotherapy (RT), which delivers approximately four (4) orders-of-magnitude higher dose rates than conventional RT. The SIBI is intended to provide dosimetric and imaging capabilities necessary for FLASH-RT clinical trials to proceed. We will describe system designs and report preliminary performance results.

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