Integrated Sensors
transforming radiation detection

A Real-Time, Large-Area FLASH-RT Beam Monitor and Dosimeter

May 20, 2023 – Integrated Sensors, LLC of Palm Beach Gardens, Florida (USA), announces the successful development and demonstration of its ultrafast and transmissive FLASH Beam Scintillator Monitor (FBSM) technology. We are testing first-generation prototypes of the patented breakthrough FBSM for all FLASH-RT modalities based on our recently patented imaging system that provides: 1) large area coverage (30x30-cm^2); 2) low mass profile; 3) linear response over a broad dynamic range; 4) enhanced radiation hardness; 5) real-time analysis IEC-compliant fast beam-interrupt signal; 6) true two-dimension beam imaging with excellent spatial resolution. For large scale FLASH-RT clinical trials to be conducted safely and effectively, real-time precise beam monitoring and dosimetry that can interrupt/terminate an out-of-tolerance beam is required.

The FBSM uses two types of proprietary low mass (<1 mm water-equivalent), non-hygroscopic, radiation tolerant scintillator materials viewed by high frame-rate machine-vision cameras. Folded optics enable a thin monitor profile. An FPGA-based data acquisition system generates real-time analysis and a beam interrupt signal on a time scale appropriate to the RT beam modality: 100-1000 Hz for pulsed electrons and 10-20 kHz for quasi-continuous proton beams.

Prototype devices were fabricated and tested in various radiation beams, including protons at nA currents, FLASH level electron beams, and in a hospital radiotherapy clinic. Results include response linearity, radiation hardness, spatial resolution, and real-time data processing of beam position, beam profile and dosimetry. The linear response of the FBSM was demonstrated under highly accelerated test conditions at a FLASH dose rate of 234 Gy/s for 15 minutes resulting in a cumulative dose of 212 kGy, indicating that it will take a year or more for the scintillator signal to decline by ~1%. Comparison with Gafchromic film showed that the FBSM produces a nearly identical 2D beam profile, while proving superior in all other respects, especially since it provides essentially instantaneous readout and eliminates time consuming film calibration. Real-time computation and analysis of beam position, beam shape and dose takes <1 µs, independent of frame rate.

In summary, the FBSM provides real-time IEC-compliant beam monitoring and dosimetry without significantly degrading beam quality. Prototype devices have been tested at FLASH dose rates. Radiation hardness is excellent and spatial resolution is comparable to radiochromic films.

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