A real-time, large-area transparent FLASH beam monitor and dosimeter

Presenter: Peter S. Friedman (United States of America)

- P. Friedman1,
- V. Bashkirov2,
- C. Ferretti3,
- D. Levin3,
- D. Litzenberg4
- N. Ristow3,
- R. Schulte2
- M. Tecchio3

1 Integrated Sensors, LLC, Research and Development, Palm Beach Gardens, Florida, United States of America
2 Loma Linda University, Basic Sciences - Biomedical Sciences, Loma Linda, California, United States of America
3 University of Michigan, Physics Department, Ann Arbor, Michigan, United States of America
4 University of Michigan Hospital, Radiation Oncology, Ann Arbor, Michigan, United States of America

Abstract

A novel large-area system for real-time beam monitoring and dosimetry for all FLASH-radiotherapy modalities is being developed. It is based on a recently patented 2D beam imaging detector, with a prototype already tested. The system utilizes a machine-vision camera, folded optics, and novel, proprietary low-mass (<1 mm water-equivalent) 30x30 cm^2 scintillators providing excellent radiation hardness. The ultrafast camera acquires data at up to 20,000 frames/s and continuously streams and analyzes each image in ≤50 μs for beam position, profile, and dosimetry during treatment. The system provides a linear response to particle flux over the FLASH dose-rate range and can achieve <50 μm spatial resolution for beam position and profiles. It features a thin profile and a rapid internal calibration system. A prototype system has been tested at the University of Michigan Hospital and the University of Notre Dame, the latter with an 8 MeV electron beam delivering 1.9 Gy per 2 ns pulse (i.e., an instantaneous dose rate of >900 MGy/s). The system can also analyze sporadic dose-rate spikes of <50 μs from synchrotron accelerators for proton and carbon-ion therapy and can be adapted for mini-beams and BNCT. This FLASH-enabling beam monitor provides a large-area, high accuracy, ultrafast beam position and profile analysis, and dosimetry with real-time verification during delivery to ensure patient safety with an application-specific response time of 0.1 to 2.5 ms (i.e., tailored to beam pulse structure).