Integrated Sensors
transforming radiation detection

Ultra-Fast Transmissive (UFT™) Real-Time Beam Monitor for FLASH-RT & Patient QA: Tracking Beam Position, Movement, Intensity Profile, Angular Divergence and Fluence / External Dosimetry in Real-Time, both Upstream & Downstream from Nozzle or Collimator

April 11, 2020 – Integrated Sensors, LLC of Ottawa Hills, Ohio ("I-S") announces the development of its ultra-fast transmissive (**UFT™**) beam monitor technology for ionizing *photon* and *particle* external beam radiotherapy (RT) including FLASH-RT (e.g. protons, photons, carbon & helium ions, neutrons, etc.). UFT™ devices can monitor both spot and raster pencil-beam scanning and can operate either upstream or downstream from the nozzle or collimator providing exceptional performance with self-calibration and high resistance to radiation damage. Results show order-of-magnitude advantages over ionization chambers for beam profile readout with true 2D position resolution, high dose rate operation, and beam hardening. In addition to I-S, the project development team includes scientists from Loma Linda Univ. (Biomedical Engineering) and the Univ. of Michigan (Dept. of Physics), with funding provided to I-S from the NIH/National Cancer Institute and the U.S. Dept. of Energy (Office of Nuclear Physics). Prototypes for radiotherapy are being designed to demonstrate a ***26 cm x 30 cm*** active detection area. Smaller ***5.8 cm x 8.0 cm*** *upstream* prototypes are being developed for vacuum beamline operation with high resolution beam position and intensity shape distributions out to at least three sigma's from the beam center, and with minimal beam energy straggling. High resolution, ***10 μs images for 1-3 mm FWHM proton beams have been demonstrated for FLASH therapy***. Preliminary specifications are:

Real-Time UFT™ Monitor Streaming Readout/Analysis: **≥*0.1 ms***, continuous tracking of downstream ***beam position, intensity profile, movement, fluence/external dosimetry & angular divergence***.

Downstream UFT™ Monitor External Enclosure Depth (in beam direction): ***~ 4-6 inches***

"True" 2D-Position & Ultra-High Beam Profile Resolution: ~***1 μm*** *(depending on readout/update time)*

Proton Beam Energy Loss through UFT™ Monitor:

< ***0.30 MeV*** *(downstream)* at 70 MeV*, and ≤ ***0.03 MeV*** *(upstream, in vacuum)* at 70 MeV
< ***0.18 MeV*** *(downstream)* at 140 MeV*, and ≤ ***0.02 MeV*** *(upstream, in vacuum)* at 140 MeV
< ***0.14 MeV*** *(downstream)* at 210 MeV*, and ≤ ***0.01 MeV*** *(upstream, in vacuum)* at 210 MeV

*Proton Beam Gaussian profile, **σ = 3.500 mm**. Lateral Spread (σ) 70-cm downstream from nozzle due to monitor materials (1st column); due to air (2nd column); and due to monitor + air (3rd column)*:

at 70 MeV*:	≤ ***0.024 mm*** (monitor);	***3.875 mm*** (70-cm air);	***3.899 mm*** (monitor + 70-cm air)
at 140 MeV*:	≤ ***0.006 mm*** (monitor);	***3.612 mm*** (70-cm air);	***3.618 mm*** (monitor + 70-cm air)
at 210 MeV*:	≤ ***0.003 mm*** (monitor);	***3.550 mm*** (70-cm air);	***3.553 mm*** (monitor + 70-cm air)

**Calculated beam energy loss & lateral spread via TOPAS/Geant4 (http://www.topasmc.org/) simulations*.

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