Contribution ID: **1043** Type: **Parallel Talk**

ORIGIN, an EU project targeting real-time 3D dose imaging and source localization in brachytherapy: commissioning and first results of a 16-sensor prototype.

Thursday, 7 July 2022 17:45 (15 minutes)

The ORIGIN project (Optical Fiber Dose Imaging for Adaptive Brachytherapy), supported by the European Commission within the Horizon 2020 framework program, targets the production and qualification of a real-time radiation dose imaging and source localization system for both Low Dose Rate (LDR) and High Dose Rate (HDR) brachytherapy treatments, namely radiotherapy based on the use of radioactive sources implanted in the patient's body.
Precise positioning of the radiation source is crucial to ensure the target area receives sufficient dose to fulfil the objective of the treatment, whilst minimizing the dose to nearby healthy tissues and organs at risk. The ORIGIN Project aims to address these shortcomings in the current treatment delivery practices, and the urgent need to provide real-time in-vivo dose imaging and source localization methods, by developing a new optical fiber-based sensor system to support diagnostics-driven therapy through enhanced adaptive brachytherapy.

This goal will be achieved through a 16-fiber sensor system, engineered to house in a clear-fiber tip a small volume of the scintillator to allow point-like measurements of the delivered dose. The selected scintillating materials feature a decay time of about 500 μs and the signal associated with the primary γ ray interaction results in the emission of a sequence of single photons distributed in time. Therefore, the operation requires a detector with single-photon sensitivity a system designed to provide dosimetry by photon counting. The instrument being developed is based on Silicon Photomultipliers (SiPMs), with a solution fully qualified on a single fiber prototype and currently scaled-up relying on the CITIROC1A ASIC by WEEROC, to implement an analog chain made of preamplifier, shaper, peak sensing, and discriminator, embedded in the FERS-DT5202 scalable platform designed by CAEN S.p.A.

The fiber response uniformity, system stability, sensitivity, and reproducibility are the key features for a system aiming to perform dose measurements in a clinical environment. The 16-channel dosimeter system commissioning in laboratory conditions with an X-ray cabinet demonstrates that homogeneity within 1% can be achieved following an equalization procedure.
The system performance in terms of sensitivity and measurement range together with the validity of the equalization in clinical conditions was confirmed by the first series of tests at the HDR center of the Belfast Hospital. The data analysis also confirms the system's capability to locate the source and provide a 3D dose map.

A comprehensive overview of the specification together with the qualification procedure and first results achieved in HDR clinical conditions will be presented.

In-person participation

Yes

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Session Classification: Technology and Industrial Applications

Track Classification: Technology Applications and Industrial Applications