Live Demonstration: ORIGIN – Optical Fibre Sensors for Radiation Dose Mapping and Source Localisation during Brachytherapy

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***Abstract* — ORIGIN is a European H2020 funded research project aimed at improving brachytherapy, a precise type of internal radiotherapy, in the treatment of prostate and gynecological cancer. A novel multichannel optical fibre sensor system has been developed to provide real-time monitoring of the radiation dose delivered to the patient during treatment. Through machine learning algorithms, the radiation source(s) location is determined and a 3D map of the dose delivered to the tumor and nearby organs at risk, e.g. urethra, bladder, rectum, is developed. Real-time *in vivo* dosimetry allows for a dose-led, patient-oriented treatment plan, leading to enhanced treatment safety and improved patient outcomes.**

Keywords—optical fibre sensors, radiation dosimetry, brachytherapy, radiotherapy

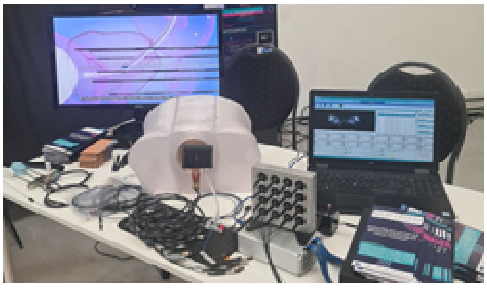
I. DEMONSTRATION SETUP

A specially-adapted setup of the ORIGIN system prototype will clearly demonstrate the ability to provide real-time dosimetry using clinically relevant conditions. The prototype consists of an innovative multipoint optical fibre dosimetry system combined with an electromagnetic tracking system, which provides precise positioning of the optical fibre sensors within the specified field.

The sensor system comprises 16 optical fibres coupled with a small volume of scintillator material, which emits light in the visible spectrum when it interacts with ionizing radiation, such as X or γ ray. Two types of optical fibre sensors have been developed using inorganic scintillators at the tip of a PMMA plastic optical fibre, to respond to the differing energy requirements of low dose rate (LDR) and high dose rate (HDR) brachytherapy (BT) [1,2].

The scintillation signal is detected by a highly sensitive 16-channel detector system, which employs silicon photomultiplier (SiPM) technology [3]. Scintillation occurs in the material of choice with a decay time of approximately 500µs, producing a light signal that consists of a trail of single photons distributed in time. The SiPM was chosen for its single photon sensitivity and high photon detection efficiency and has been optimized for use within the ORIGIN system.

The intensity of the scintillation light is directly proportional to the energy deposited by the radiation, allowing for measurement of the radiation dose. Through machine learning algorithms, employing a Bayesian approach, the dose rate from the 16 sensors allow for localization of the radiation source(s) and a 3D dose map of the radiation dose delivered to the tumor and nearby organs at risk is constructed.



II. VISITOR EXPERIENCE

The ORIGIN demo will firstly provide visitors with an understanding of brachytherapy, the limitations of existing procedures and the explicit need for real-time in vivo dosimetry, which is currently not available. An interactive display with 3D printed semi-anatomical phantoms, brachytherapy applicators and needles and dummy (non-radioactive) seeds will walk the visitor through a typical brachytherapy treatment. UV radiation will be used in place of radioactive sources to demonstrate real-time dose monitoring and source mapping. A video from the clinical team, as well as an animation of the ORIGIN system being used during a prostate brachytherapy treatment will further highlight the impact this technology will have on the treatment and patient outcomes.

III. CONCLUSIONS

ORIGIN addresses the urgent need for *in vivo* dosimetry in brachytherapy. The demonstration will present a prototype of the ORIGIN system, with a 3D printed semi-anatomical phantom to demonstrate the system within the clinical workflow.

REFERENCES

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