ORIGIN

optical fibre dose imaging for adaptive brachytherapy

ORIGIN Newsletter **VOL.1** **DEC 17, 2021**

Welcome to ORIGIN's newsletter!

Here you can find out more about:

- The project - get the latest news and updates on ORIGIN activities
- The team - meet the ORIGIN team with each issue featuring different researchers
- The stats - get a snapshot of current ORIGIN progress
- What's next - check out upcoming ORIGIN events and activities

ORIGIN AT A GLANCE

- What: ORIGIN is a research project funded by the European Union. ORIGIN aims to deliver more precise and effective brachytherapy for gynaecological and prostate cancer treatment through advanced real-time imaging and mapping of the radiation dose and exact location of the radiation source.
- How: Through the development of a new 16-point optical fibre based sensor system for Low Dose Rate (LDR) and High Dose Rate (HDR) Brachytherapy. The ORIGIN system will lead to a 50% improvement in uncertainty over existing systems. In addition, the technology being developed will provide real-time monitoring of the radiation source location during treatment, which is currently not available.
- Who: ORIGIN is composed of a consortium of 8 members with expertise in medical physics, photonics and medical devices.

PHOTONICS PUBLIC PRIVATE PARTNERSHIP

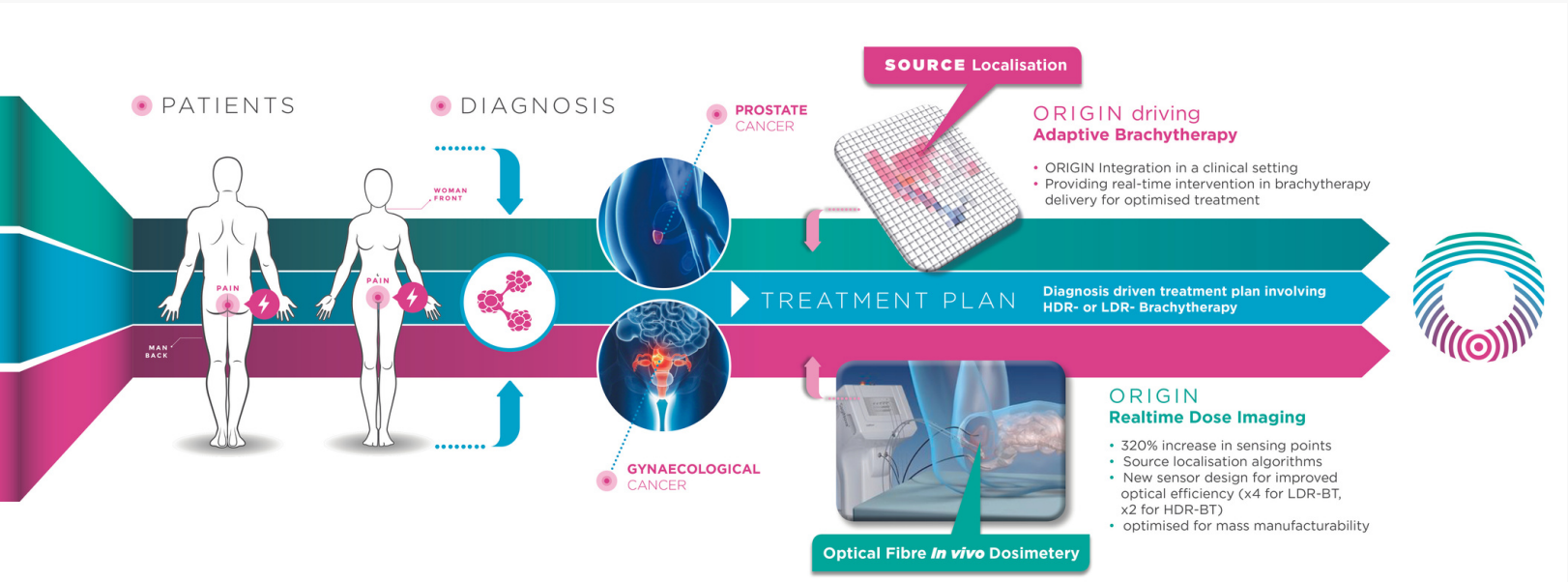
The ORIGIN project is an initiative of the Photonics Public Private Partnership (www.photonics21.org), and has received funding from the European Union's 2020 research and innovation programme under grant agreement No. 871324

The ORIGIN project

THE BACKGROUND TO ORIGIN

Radiotherapy is the use of radiation for the treatment of cancer and 50 – 60 % of patients require radiotherapy at some point during their treatment. It is delivered in the form of external beam radiotherapy, using X-rays to kill cancer cells, or internally, using radioactive sources, in what is known as brachytherapy.

Brachytherapy is further divided into Low Dose Rate (LDR), where the radioactive sources, known as seeds, remain implanted permanently, releasing radiation slowly over a number of months to destroy the cancer cells and High Dose Rate (HDR), where higher activity radiation sources are temporarily inserted into the target area for a few minutes at a time. Correct placement of the radiation source is vital to ensure adequate radiation to the target area (tumour), while ensuring minimum exposure to nearby critical organs, such as, in the case of prostate and gynaecological cancers, the bladder, urethra and rectal wall. Current positioning techniques rely on pre- and post-treatment CT and ultrasound imaging and the dose is calculated via a computerised treatment planning system. Without direct in person and real time monitoring of the dose being delivered to the patient, there is no independent dose verification, with many errors going undetected at the time of treatment.



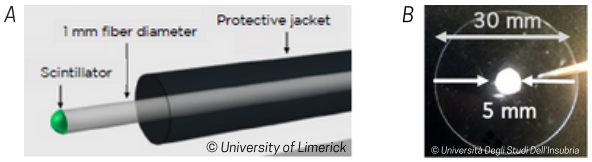
IMPROVED PATIENT OUTCOMES WITH ORIGIN

ORIGIN aims to deliver more precise and effective brachytherapy for gynaecological and prostate cancer treatment through advanced real-time imaging and mapping of the radiation dose and exact location of the radiation source. This will be achieved by the development of a new 16-point optical fibre based sensor system for Low Dose Rate (LDR) and High Dose Rate (HDR) Brachytherapy. The ORIGIN system will lead to a 50% improvement in uncertainty over existing systems. In addition, the technology being developed will provide real-time monitoring of the radiation source location during treatment, which is currently not available. ORIGIN will be integrated into existing clinical brachytherapy treatment planning and delivery systems to confirm that the dose prescribed to the tumour is achieved, whilst ensuring the dose to organs at risk (OARs) is within acceptable limits. The optical fibre sensors that measure the radiation dose are being developed to maximise the accuracy and sensitivity of the readings.

The latest ORIGIN Research

SYSTEM DEVELOPMENT & MANUFACTURABILITY

In order to measure the radiation, optical fibre sensors have been designed with a special radiation-sensitive material, known as a scintillator, which converts the radiation into visible light. The amount of light is then measured by a detector.



A: Schematic of optical fibre dosimeter, B: Light emitted by scintillator

Various mixtures of scintillators have been fabricated and examined in terms of their optical properties (e.g. the degree of light lost, light scatter and the bending of light as it travels through different different materials) and their scintillating properties (the amount of light produced and over what timeframe). The materials demonstrating the best profiles for both HDR and LDR have been determined and examined for their ability to be manufactured at scale.

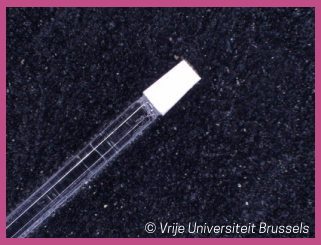
The detector system, which measures the light emitted by the optical fibres, has been defined and assembled. Initial testing was performed using a single channel system in a hospital environment for both LDR and HDR brachytherapy before advancing to a multi-channel system. Excitingly, the results confirm the choice of detector system and demonstrate the system's capability and capacity.

The first 16 channel prototype board for HDR brachytherapy has now been designed and produced, ahead of schedule. This is currently being validated by University of Insubria and will be rolled out at Queens University Belfast in the coming months.

16 channel detector system

The manufacturing process involves designing a specialised mould for use in a hot embossing machine to fabricate the optical fibre sensors. A total of 9 batches of sample types containing scintillating material for HDR-BT and LDR-BT have been fabricated and evaluated for their performance and their ability to be mass produced.

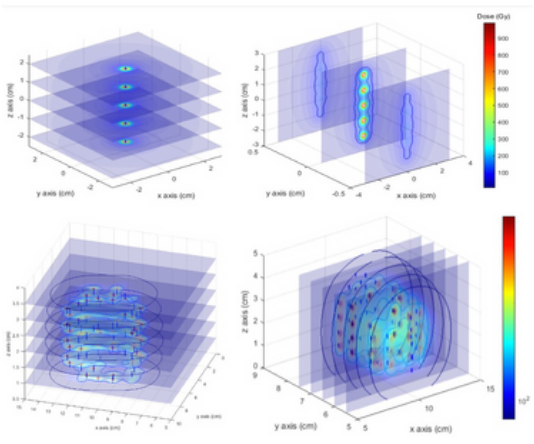
HEX04 hot embosser



HDR optical fibre sensor

The design of the optical fibre sensor tip, which holds the scintillator, has been optimised. The first batch of HDR sensors have been fabricated and delivered to Queens University Belfast for characterisation.

Accurate placement and measurement of the radioactive source during brachytherapy is crucial to guarantee the dose prescribed to the target area, whilst also ensuring minimum exposure to nearby organs. The computer software that underlies the ability to map the dose and the location of the radiation source has been developed for LDR and HDR brachytherapy based on the optical signals from the 16 channel ORIGIN detector system.



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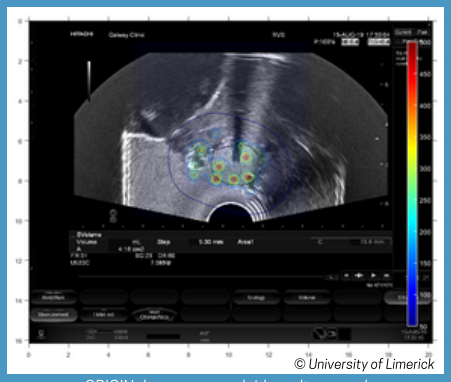
Heat maps illustrating the location and intensity of radiation

The latest ORIGIN Research

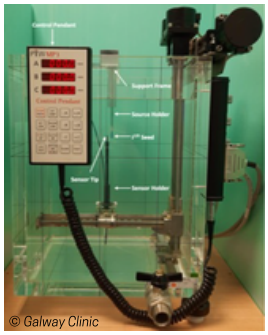
The software generates heat maps which accurately show the position and dose of the radioactive sources. The heat maps can then be overlaid with the patient's CT or ultrasound image to confirm the positioning and dose of the radiation being received.



ORIGIN dose map overlaid on ultrasound

The ability to monitor the treatment in real time allows the treatment to be stopped when critical deviation values are reached. The software that is required to optimise the performance of the system, ensuring that all the necessary data is readily available, displayed appropriately and able to communicate with other external systems has been defined and is currently under development.

Initial protocols that describe how to evaluate and calibrate the project's optical fibre sensors within High Dose Rate (HDR) and Low Dose Rate (LDR) brachytherapy for both prostate and gynaecological cancer treatment have been established.

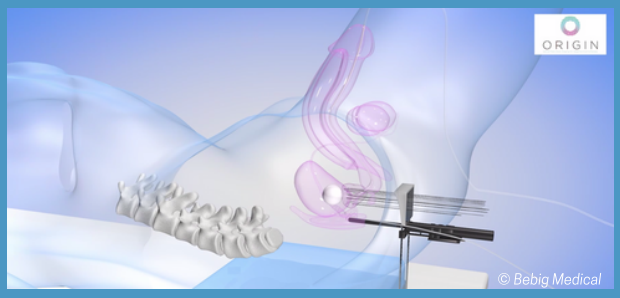


Models know as phantoms, constructed using 3D printing technology are used to reproduce relevant parts of the human body. This enables the examination of dose measurements in anatomically correct models.

CLINICAL INTEGRATION

The ORIGIN system will be integrated into existing clinical Brachytherapy treatment planning systems. This will enable ORIGIN to be easily adopted by hospitals and treatment clinics. The details of the hardware and software requirements for the seamless integration of the ORIGIN system with existing clinical treatment planning systems and dose delivery systems for HDR and LDR brachytherapy have been identified.

Hospital clinicians who use brachytherapy systems were consulted in relation to the requirements and specifications of the ORIGIN system and how it will be integrated into current clinical workflows. A protocol that describes, step-by-step, how the ORIGIN system is used in the clinic to deliver real time, accurate dosing and the precise location of the radiation has been developed.



Animation of the ORIGIN system

In order for the ORIGIN system to commercialised, it requires regulatory approval as a medical device from the relevant licensing authority. An initial regulatory assessment of the ORIGIN system was carried out to determine its medical device classification and the list of standards the device must meet before it can enter the market. A comprehensive business plan and commercialisation strategy has been developed for the ORIGIN system in order to pave the way for its long-term success.

ORIGIN Team News

MEET THE COORDINATOR

Dr Sinéad O'Keeffe, Royal Society - Science Foundation Ireland (SFI) University Research Fellow, leads a research team at the Optical Fibre Sensors Research Centre and Health Research Institute, University of Limerick.

What was the inception or "origin" of ORIGIN?

My lab had been working on developing radiation dosimeters for radiotherapy for a number of years and during discussions with a number of ORIGIN partners we identified the real clinical need for providing radiation dose information over the entire target area and nearby organs at risk (e.g. urethra and rectum). Additionally the need to monitor the precise location of the radiation source(s) was also highlighted to provide an additional level of assurance during the treatment process.

How will ORIGIN improve cancer treatment?

ORIGIN aims to deliver more effective brachytherapy for cancer treatment through advanced real-time radiation dose imaging and source localisation, providing a dose-led, patient oriented, personalised radiation treatment. In addressing the need for more effective medical interventions and treatments for cancer, ORIGIN's impact is three-fold: 1) improving health related quality of life outcomes 2) allowing for improved dose-led treatment plans and 3) avoiding treatment errors that result in patient misdosing.

Who do you hope will benefit from ORIGIN?

Obviously the patients stand to benefit the most, with the potential for improved outcomes for cancer patients. However, there are are a range of other benefits for oncologists, radiation physicists and for the hospitals themselves through the availability of real-time monitoring of dose and source locations.

What excites you about ORIGIN?

Working with the clinical partners we can really see how the ORIGIN system can make a big difference to the way brachytherapy is delivered. Providing real-time feedback on the radiation dose and the ability to identify potential radiation hotspots, combined with the potential to provide for adaptive brachytherapy will allow for more precise treatment for cancer patients.

What do you enjoy most about coordinating ORIGIN?

I am extremely privileged to have such a talented consortium working on ORIGIN. It is a highly multidisciplinary group, bringing together technical and clinical expertise. Everyone is very passionate about their area of expertise and particularly so for the ORIGIN project. Even in the face of covid-19, partners adapted and worked together virtually to ensure the project progressed. It is so rewarding to work with a team that give it everything to ensure the project is successful!

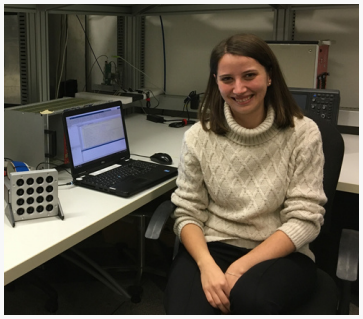
ORIGIN GRADUANTS

Congratulations to ORIGIN researchers Agnieszka Gierej and Samula Lomazzi, who recently completed their PhDs.

Dr Agnieszka Gierej with PhD supervisor Prof. Francis Berghmans

Dr Agnieszka Gierej was awarded her doctorate from Vrije Universiteit Brussel for her work on "Biodegradable and biocompatible Polymer Optical Fibres - BioPOFs: from fabrication to early proof-of-principle applications".

Dr Samuela Lomazzi, whose thesis was titled "Development of novel multi-SiPM systems for biomedical applications" was awarded the prestigious degree from the University of Insubria.



Dr Samuela Lomazzi

Well done Dr Gierej and Dr Lomazzi on the fantastic achievement!!

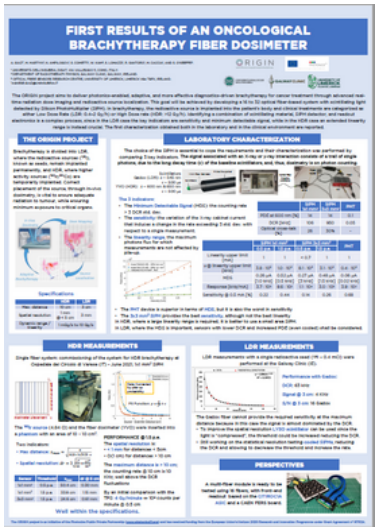
Conferences and Events

RECENT CONFERENCES

The latest ORIGIN research was recently presented at a number of scientific conferences.

12th International Conference on POSITION SENSITIVE DETECTORS — Hosted by UNIVERSITY OF BIRMINGHAM

Giaz A., Martyn M., Ampilogov N., Cometti S., Kam W., Lomazzi S., Santoro R., Caccia M., and O'Keeffe S. "**First results of an oncological brachytherapy fiber dosimeter**". Poster presented at: 12th International Conference on Position Sensitive Detectors; 2021 12-17th Sep, Birmigham



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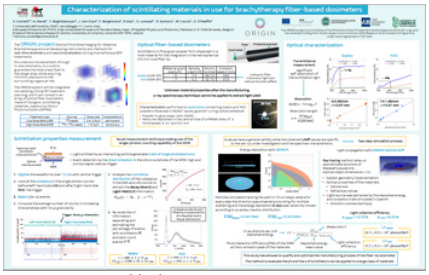
IEEE NPSS NUCLEAR & PLASMA SCIENCES SOCIETY — 2021 IEEE NSS MIC

Cometti S., Gierej A., Baghdasaryan T., Van Erps J., Berghmans F., Giaz A. Lomazzi S., Santoro R., Caccia M., O'Keeffe S. "**Characterisation of scintillating materials in use for brachytherapy fiber-based dosimeters**" Oral and poster presentation at: 2021 Virtual IEEE Nuclear Science Symposium and Medical Imaging Conference; 2021 16-23 Oct.



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Giaz A., Martyn M., Ampilogov N., Bianchi C., Cometti S., Kam W., Lomazzi S., Novario R., Santoro R., Caccia M., and O'Keeffe S. "**First results of an oncological brachytherapy fiber dosimeter**". Oral presentation at: 2021 Virtual IEEE Nuclear Science Symposium and Medical Imaging Conference; 2021 16-23 Oct.

ORIGIN STATS

08 Partners

32 Researchers

23 Months

23 Deliverables

11 Milestones

Vhi Women's Mini Marathon

ORIGIN is very excited to be taking part in the Women's Mini Marathon in Dublin next June, raising awareness of gynaecological cancers and Women in Cancer Research.

Follow our training progress on twitter **@ORIGIN_2020**

Visit www.origin2020.eu