ORIGIN

optical fibre dose imaging for adaptive brachytherapy

ORIGIN Newsletter **VOL 2** **SEP 21, 2022**

Welcome to the latest edition of the ORIGIN'newsletter!

Here you can find out more about:

- The project - get the latest news and updates on ORIGIN activities and watch our video!
- The team - meet our researchers in the University of Insubria, Italy and Vrije University, Belgium
- The stats - get a snapshot of current ORIGIN progress
- What's next - check out upcoming ORIGIN events and activities

CHECK OUT THE ORIGIN VIDEO!

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

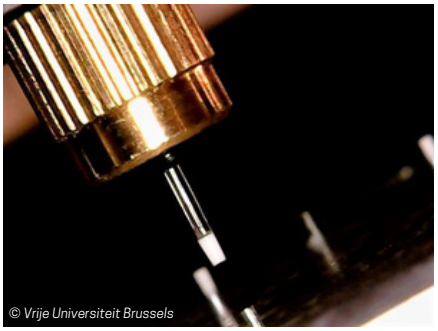
PHOTONICS 21

PHOTONICS PUBLIC PRIVATE PARTNERSHIP

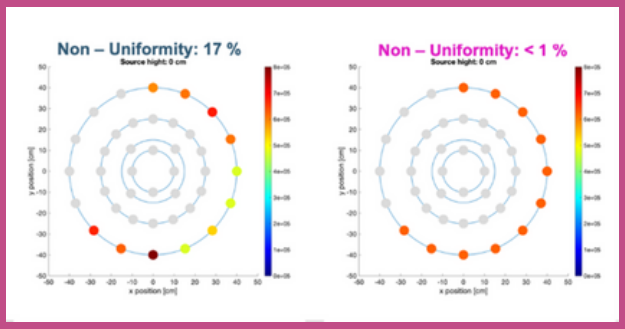
The latest ORIGIN Research

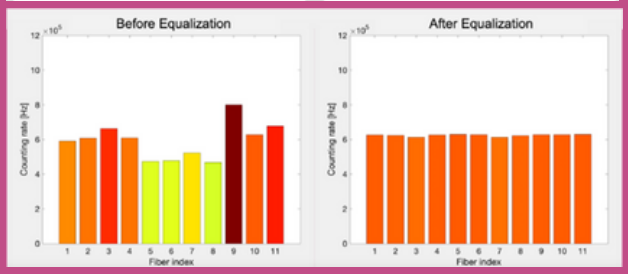
SYSTEM DEVELOPMENT & MANUFACTURABILITY

VUB have demonstrated repeatable fabrication of scintillating brachytherapy sensor probe tips. **160 sensors have been fabricated for characterization in high dose-rate and low dose-rate brachytherapy experiments.** The fabrication method and the assembly process has been gradually improved as more sensors were fabricated, essentially by adapting the tip dimensions in view of getting closer to the design specifications and by improving the alignment and the assembly of the scintillating tip to the optical fiber facet. The figure below shows a white scintillation tip fixed to a 0.5 mm-diameter plastic optical fiber.



The figure shows a white scintillation tip fixed to a 0.5 mm diameter plastic optical fiber.





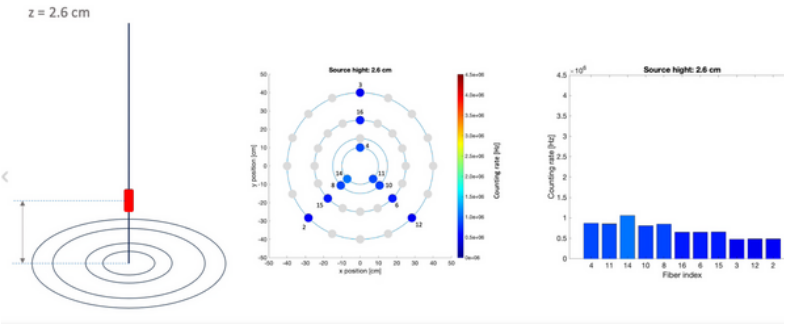
Response of the multi-fibre system before/after equalisation.

Preliminary measurements in HDR clinical conditions were performed installing the phantom in a water tank., positioning the fibres at 1, 1.5, 2.5 and 4 cm axial distance and scanning the 192Ir source over 10 cm lever arm in either 1 cm steps (from z=10 cm to z=3 cm) or 0.2 cm from z=10 cm to z=3 cm).

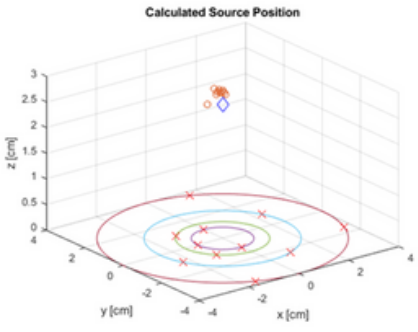
16 channel detector system

The multi-channel detector system, which measures the light emitted by the optical fibres, has been defined and assembled. The system was initially qualified at UNINS using an X-ray cabinet, before repeating the evaluation with HDR sources at Queen's University Belfast, using a custom phantom. The phantom allows the positioning of fibres at equal distance from the central axis, along which an HDR source may be moved.

Calibration phantom



Multi-channel system response for HDR source



HDR source localisation

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. Algorithms developed by UL allow for the localisation of the radiation source in real-time.

Download the ORIGIN factsheet

The latest ORIGIN Research

CLINICAL INTEGRATION

ORIGIN Software user interface

The ability to monitor the treatment in real time allows the treatment to be stopped when critical deviation values are reached. The software 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.

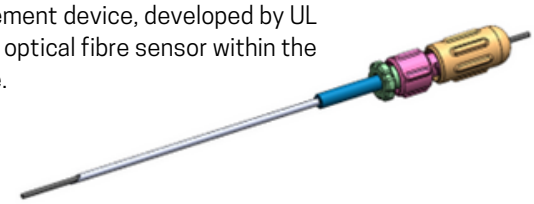
Models know as phantoms, constructed using 3D printing technology are used to reproduce relevant parts of the human body. This enables the examination of dose measurements in anatomically correct models.

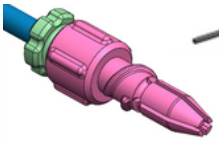
3D printed phantoms

3D printed phantoms

Initial development of a patient phantom for measurements with Origin fibres is underway. As part of the utilisation of 3D printing approaches, representations of the prostate and pelvis were generated and used for an outreach event held at the Northern Ireland Balmoral Show in May.

The fibre securement device, developed by UL for securing the optical fibre sensor within the LDR/HDR needle.





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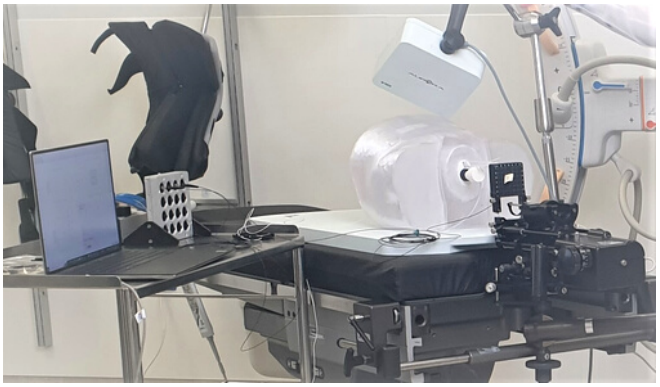
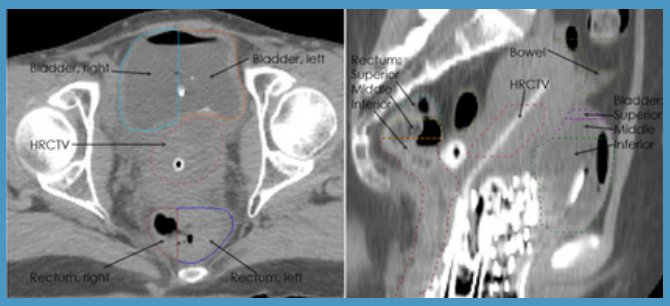
This device was developed to ensure the optical fibre senor remains fixed in place, while mitigating against damage from kinking or crushing of the fibre.



ORIGIN system set up in brachytherapy thaetre



Contouring division of bladder and rectum into subsections

The role for in vivo dosimetry in the reduction of uncertainties in pelvic brachytherapy, the pertinent factors for consideration in clinical practice, and the future potential for in vivo dosimetry in the personalisation of brachytherapy are being evaluated.

Treatment planning studies are also being performed, within the ORIGIN project, to determine the dosimetric uncertainties during Brachytherapy to input into the clinical implementation of the ORIGIN system.

ORIGIN at SPIE Photonics Europe

Invited paper at SPIE photonics Europe

ORIGIN's research was invited to present in the Optical Fibre-based Sensors session. Dr Michael Martyn, ORIGIN researcher at the Galway Clinic presented the recent work on the evaluation of a novel scintillator for use in low dose rate brachytherapy.

Dr Michael Martyn presenting the invited ORIGIN lecture

First in-person conference

SPIE Photonics Europe was a special event for the ORIGIN team as this was the first opportunity for researchers from a number of consortium partners to meet in-person.

L-R: Dr Wern Kam (UL), Dr Agnese Giaz (UNINS), Prof. Francis Berghmans (VUB), Dr Jennifer Hanly (UL), Dr Sineád O'Keeffe (UL), Dr Romualdo Santoro (UNINS), Dr Michael Martyn (GC)

ORIGIN team celebrating a successful event

SPIE Photonics Europe Innovation Village

SPIE Photonics Europe is the premier European optics and photonics research and development event held every two years. ORIGIN was delighted to be selected to exhibit our early system prototype at the event's popular Innovation Village this April. This was a really exciting opportunity for ORIGIN to showcase the technology among innovative researchers and industry leaders.

Exhibit of early ORIGIN prototype at SPIE Photonics Europe 2022

The prototype consisted of optical fibres connected to the 16 channel detector system, with LEDs used to replicate the radiation dose. This demonstrated the sensors ability to monitor the source at different locations. This is the underlying principle of the ORIGIN system allowing us to determine the exact dose and location of the radioactive sources in a clinical scenario.

ORIGIN booth attracting the crowds

The demo generated a lot of interest over the three days and received really positive feedback from the event selection committee, biomedical industries and the photonics community.

ORIGIN Team

UNIVERSITÀ DEGLI STUDI DELL'INSUBRIA

MEET THE TEAM AT UNINS

L-R; (front) Prof. Massimo Caccia, Dr Agnese Giaz (back) Dr Samuela Lomazzi, and Dr Romualdo Santoro, Department of Science and High Technology, Insubria University, Como, Italy

Tell us about the team at UNINS?

This is the core team at UNINS: Massimo Caccia, full professor and team leader, grown up scientifically at CERN, the house of the largest particle accelerators in Geneva, Switzerland; Romualdo Santoro, associate professor, also a CERN kid. Agnese Giaz, senior researcher, nuclear physicist, who joined the team for ORIGIN. Worth mentioning two other people: Samuela Lomazzi, who completed her Ph.D. in ORIGIN and now works as a Science project manager; Simona Cometti, holding a master in physics and a Ph.D. in electronics engineer, post-doc for 2 years in ORIGIN, now at CADENCE. Samuela and Simona are also a good example of "knowledge transfer"from research to industry.

Why did you want to get involved in the ORIGIN project?

Turning the dose delivered inside a patient's body in a stream of photons, the quanta of light; sensing the stream, measuring it, providing a feedback to the medical doctors and improve the quality of radiotherapy and life of the person undertaking it. A great challenge but a clear evidence that Science & Technology is not a wiz kid game in a sterile lab. This is the main reason why, once we were proposed to join ORIGIN, we had no hesitation. We are a team of particle and nuclear physicists, focused on investigating the essence of the sub-atomic world; in order to do so, we develop novel detectors and methods but, apart from looking at the dawn of the Universe, this knowledge can be exploited in applied R&D projects, notably in biomedicine, homeland & cyber security, with a significant fall-out and social impact.

What is your role within ORIGIN?

Within ORIGIN, this is what we do: the detectors sensing the streams of photons are "silicon pills", actually counting photons one by one; our main involvment is to show thay can do what is expected, qualify the system in the lab and in hospitals, interact with medical physicists and doctors and turn a a dry number into a dose, complementing and adjusting with experimental data what numerical simulations say. We nearly made it; we need "only" to increase sensitivity for the Low Dose Rate Brachytherapy at the largest distance from the radioactive source. But the prototype says we can make it.

Above; Dr Agnese Giaz putting the optical fibre sensors into position

Right; Dr Agnese Giaz and Dr Romualdo Santoro finalising the ORIGIN demo ahead of the SPIE photonics Europe Exhibition

Dr Agnese Giaz giving a demo of the ORIGIN system in UNINS

B-PHOT BRUSSELS PHOTONICS

MEET THE TEAM AT VUB

VUB Photonics Campus B-PHOT Manufacturing Hall

Who are B-PHOT and what do you do?

In ORIGIN, VUB is represented by the Brussels Photonics (B-PHOT) Research Group. B-PHOT teams up a critical mass of 70 highly skilled researchers and technology experts, with a mission to jointly embrace photonics, connect the dots between photonics research, innovation, education and STEM, and establish links to other science and engineering disciplines. Our aim is to contribute with photonics to solving the current and future global challenges in sectors such as Biomedical, Industry 4.0, Agrifood, Information and Communication, Mobility, Durability, and Smart Cities, and to building a brighter and healthier world for all.

VUB B-PHOT's Photonic Innovation Center has a complete pilot line for free form optics. Free form optics for imaging and non-imaging applications, in glass, plastic, semiconductor material can be realized for prototypes, molding or low volume production. To make free form optics in plastic, available options are directly machining a prototype using ultraprecision diamond tooling or making small series via mold manufacturing and subsequent replication through hot embossing or (micro-)injection molding. For the manufacturing of free form optics in glass, glass can be grinded and polished directly, or small series can be made via mold manufacturing, followed by bonnet or fluid jet polishing and subsequent replication through glass press molding.

Tell us about your team within ORIGIN?

Key people from B-PHOT involved in ORIGIN are Agnieszka Gierej, Jürgen Van Erps, Tigran Baghdasaryan and Francis Berghmans. Agnieszka is a post-doctoral researcher. She is in charge of the fabrication, the assembly and the characterization of the sensor tips. Tigran and Jürgen are both associate professors. Tigran has taken care of the optical modelling of the sensor tips in view of optimizing their shape and size such that a maximum amount of scintillation signal is captured by the plastic optical fiber to which the tips are attached. Jürgen supervises the fabrication of the tips and ensures that the fabrication technique is transferable to mass manufacturing. They are supported by a great team of technical experts involving Dries Rosseel, Jef Verbaenen, Kurt Rochlitz and Sergey Verlinski and by Teresa Bouljon, B-PHOT's asset and supply chain manager, who makes sure that all ORIGIN activities are carefully planned in B-PHOT Photonics Innovation Center's busy fabrication calendar. Finally, Francis – full professor of Physics and Photonics at VUB – coordinates VUB's activities within ORIGIN and serves as leader of the Work Package that deals with the fabrication of the brachytherapy optical fiber-based sensors.

Prof. Francis Berghmans

Dr Agnieszka Gierej

Prof. Jürgen Van Erps

Dr Tigran Baghdasaryan

Why is ORIGIN a good fit for B-PHOT?

VUB B-PHOT's mission is to use light to make this world a brighter, healthier, safer and better place for all. According to the World Health Organization, cancer is a leading cause of death worldwide, accounting for 10 million deaths every year. Since ORIGIN targets the safe treatment of cancer and given VUB B-PHOT's mission and capabilities, it felt natural for the team to get involved in ORIGIN and to provide access to its world-unique design and fabrication capabilities for that purpose.

Visit www.b-phot.org to learn more about VUB B-PHOT!

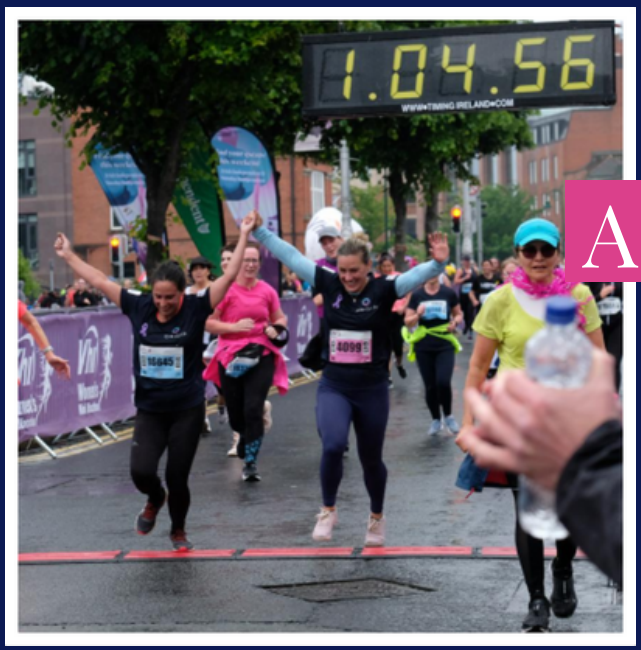
ORIGIN'S WONDER WOMEN

Cancer Research

ORIGIN is a European funded research project that aims to deliver more precise and effective brachytherapy for the treatment of gynaecological and prostate cancer.

Fundraising

ORIGIN recently took part in this year's VHI Women's Mini Marathon in Dublin to raise awareness of gynaecological cancer, promote women in STEMM and raise vital funds for the Irish Cancer Society.



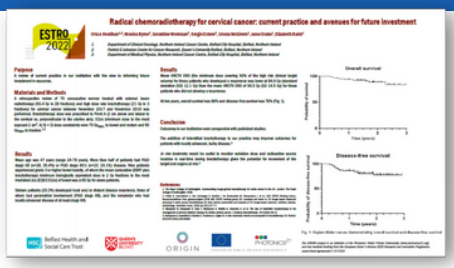
Across the line!!

A fantastic day was had, despite the Irish weather! Over €1,000 was raised for the Irish Cancer Society.

ORIGIN

Conferences and Events

Houlihan O., Byrne M., Workman G., McGivern U., Drake A., and Baird E. **"Radical chemoradiotherapy for cervical cancer: current practice and avenues for future investment"** Poster presented at: ESTRO 2022 May 6-10, Copenhagen



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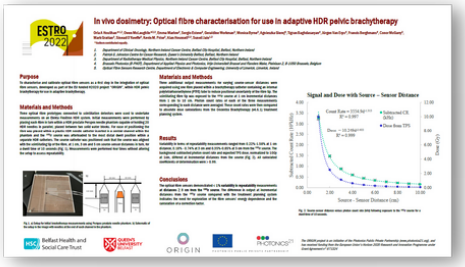

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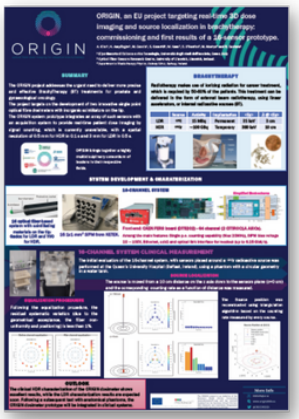
Houlihan O., McLaughlin O., Marlow E., Esteve S., Workman G., Byrne M., Gierej A., Baghdasaryan T., Van Erps J., Berghmans F., McGarry C., Grattan M., O'Keeffe S., Prise K, Hounsell A., and Jain S. **"In vivo dosimetry: Optical fibre characterisation for use in adaptive HDR pelvic brachytherapy"** Poster presented at: ESTRO 2022 May 6-10, Copenhagen

Giaz A., Ampilogov N., Caccia M., Cometti S., Kam W.,, O'Keeffe S., Martyn M., and Santoro R.. "**ORIGIN, an EU project targeting real-time 3D dose imaging and source localization in brachytherapy: commissioning and first results of a 16-sensor prototype"**. Poster presentation at: 15th Pisa meeting on advanced detectors 22 16-23 Oct, Elba.



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Giaz A., Ampilogov N., Cometti S., Kam W., Martyn M., Santoro R., Caccia M., and O'Keeffe S. "**Real-time 3D dose imaging and source localization in brachytherapy"**. Oral presentation at: ICHEP 2022 6-13 Jul, Bologna.

BRITISH GYNAECOLOGICAL CANCER SOCIETY

Houlihan O., Byrne M., Workman G., Esteve S., McGivern U., Drake A., and Baird E. **"The Role for Personalised Brachytherapy Treatment in Cervical Cancer"** Poster presented at: BGCS 2022 Jul 7-8, London

Click to view poster

ecmp 4th Dublin 2022

Houlihan O., McLaughlin O., Byrne M., Workman G., Esteve S., Gierej A., Baghdasaryan T., Van Erps J., Berghmans F., McGarry C., Grattan M., Prise KM., Hounsell A., and Jain S. **"Pre-clinical characterisation of optical fibre sensors in HDR brachytherapy"** Oral presentation at: ECMP 2022 Aug 17-20, Dublin

ORIGIN STATS

- 07 Partners
- 39 Researchers
- 33 Months
- 33 Deliverables
- 15 Milestones
- 01 Prototype

ORIGIN news

ORIGIN PUBLICATIONS

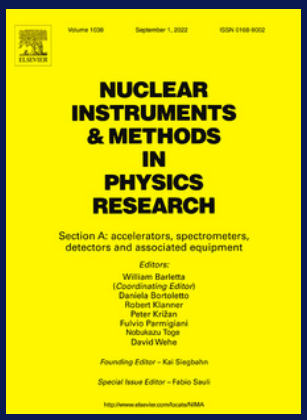
ORIGIN recently published two peer-reviewed articles in prominent scientific journals. This is a great milestone within the project and we look forward to publishing many more papers. Congratulations to all the authors!


REVIEW ARTICLE

In vivo dosimetry in pelvic brachytherapy

Houlihan O., Workman G., Hounsell A., Prise KM, and Jain S. (2022) ***In vivo* dosimetry in pelvic brachytherapy.** *The British Journal of Radiology* Vol 95 (1137).

In this comprehensive review article, the role for *in vivo* dosimetry in the reduction of uncertainties in pelvic brachytherapy is presented. The paper also describes how the ORIGIN project is developing technology that addresses the current clinical need and will lead to more precise and effective brachytherapy.




Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment

Characterization of scintillating materials in use for brachytherapy fiber based dosimeters

Abstract

Cometti, S., Gierej, A., Giaz, A., Lomazzi, S., Baghdasaryan, T., Van Erps., Berghmans, F., Santoro, R., Caccia, M., O'Keeffe, S. **Characterization of scintillating materials in use for brachytherapy fiber based dosimeters** (2022) *Nuclear Instruments and Methods in Physics Research Section A* Vol 1042

This paper describes the characterisation of the two scintillating materials in powder form, Gadox and YVO embedded in a light-activated resin, used in the ORIGIN sensor probes developed for brachytherapy in-vivo dosimetry.

TECHNICAL VIDEO SHOOT

Behind the scenes of ORIGIN's video

Filming is currently underway for our technical video. This involves a coordinated effort from the consortium across multiple countries! The video will provide a technical overview of the innovative technology being developed within ORIGIN and how the ORIGIN system will deliver real-time *in vivo* dose imaging and source localisation, leading to improved cancer care for patients.