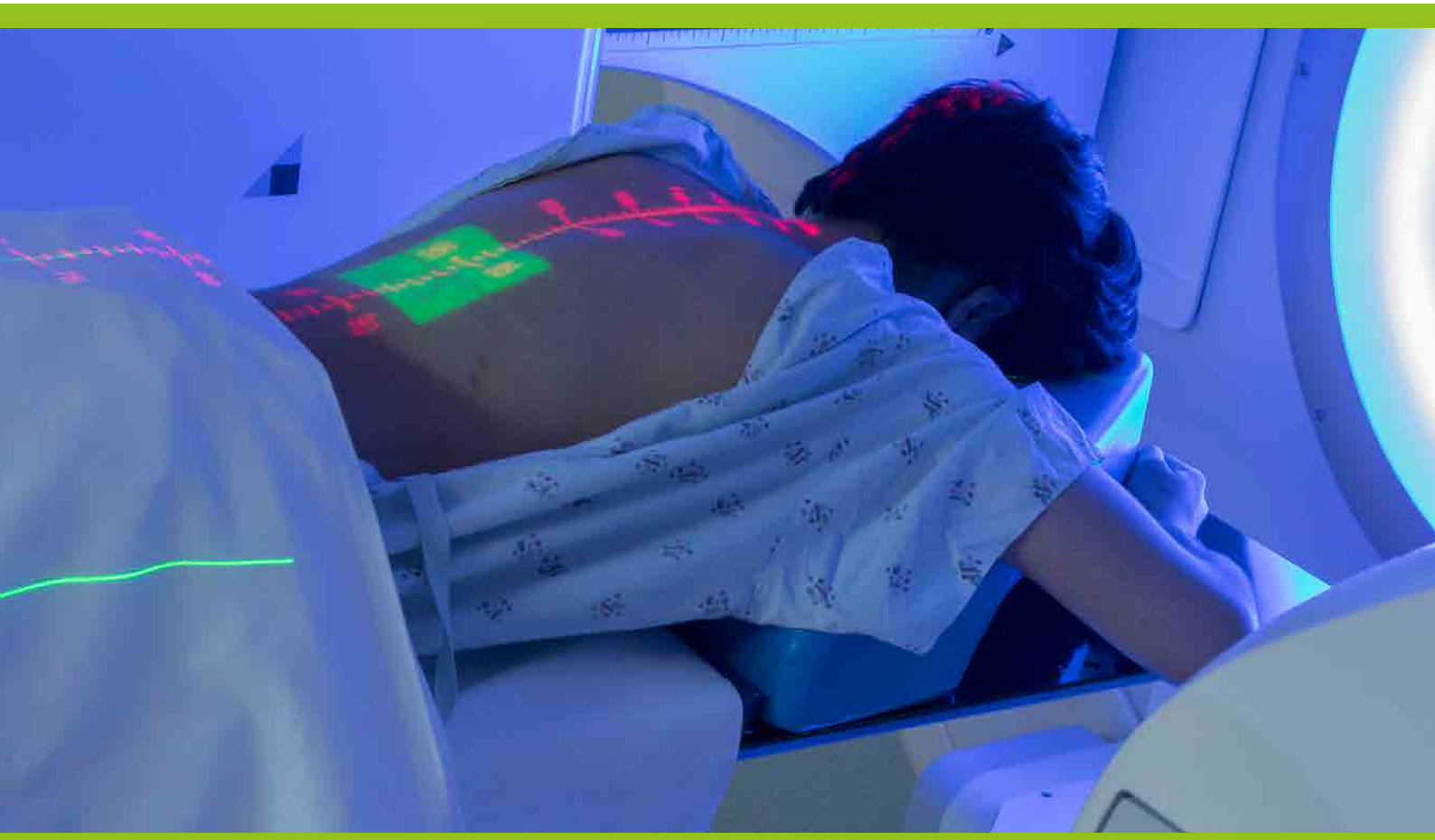
European Metrology Research Programme

Delivering Impact



Targeting tumours accurately

External radiotherapy is aimed at killing cancerous cells, but can be dangerous to healthy ones. Modern radiotherapy machines focus multiple radiotherapy beams on tumours, which minimises harm to surrounding healthy tissue. To ensure that just the right amount of energy is delivered to kill the cancer, clinicians rely on beam strength measurements. As beam areas get smaller, new measurement methods are needed to accurately measure the strength of the highly focused beams used.

Europe's National Measurement Institutes working together

The European Metrology Research Programme (EMRP) brings together National Measurement Institutes in 23 countries to address key measurement challenges at a European level. It supports collaborative research to ensure that measurement science meets the future needs of industry and wider society.

Challenge

Treating cancerous tumours with radiotherapy requires precisely targeted treatments to be delivered directly to the cancerous cells without harming surrounding healthy tissue. For example with facilities like gamma knife, up to 200 low power beams, which individually do little harm can be focused to a single area of just a few millimetres on the cancerous cells. The combined deposited energy of all these beams destroys the tumour. It is therefore vital that each of these beams is performing as expected, small errors across multiple beams can quickly add up and over or under delivery of planned treatments can occur.

Clinics are required to check their radiotherapy instruments monthly and perform further daily checks to confirm beam performance and ensure delivery matches prescription. Silicon diodes, widely used for these calibrations, are damaged by the radiation they are measuring and their response changes over time. Radiation resistant measurement instruments are needed to ensure accurate delivery of therapeutic doses during radiotherapy and to enable confirmation that delivered treatment matches the patient's individual treatment plan.

Solution

The EMRP project *Metrology for radiotherapy using complex radiation fields* tested and demonstrated the validity of a breakthrough new diamond detector which could in the future be used to accurately calibrate all types of small radiotherapy beams.

The diamond detector developed and validated for electron and photon beams an earlier Euramet project, has had its performance evaluated in this EMRP project for proton and carbon-ion beams. This has shown that this innovative detector is suitable for use with all current forms of radiotherapy beams.

The EMRP project also used simulations and performance testing with photon beams to generate highly accurate correction factors that in the future will enable the diamond detector's use for clinical beam calibrations with direct traceability to the SI.

Impact

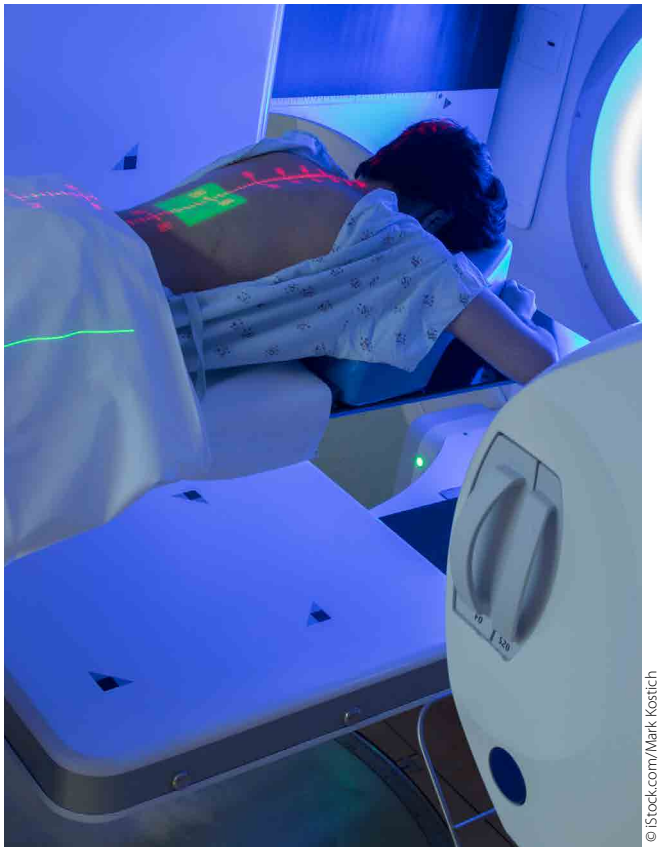
PTW, a market leader in dosimetry equipment for radiation therapy, now markets the microDiamond dosimeter based on a detector prototype developed in a pre-cursor Euramet project, to radiotherapy centres for measuring the strengths of their multi-therapy beam machines. MicroDiamond has significant advantages over silicon diodes in that it is small and easy to use, gives a response which is easy to relate to the response of body tissue, and does not suffer from radiation damage. The detectors ease of use and stability over time is making it popular with users and encourages more frequent beam performance checks.

PTW anticipates that the project derived small correction factor will soon enable the microDiamond detector to provide the ultimate calibration for radiotherapy machines.

Greater accuracy in measuring multi-beam radiotherapy delivery will give clinicians increased confidence in being able to match planned dose to that delivered, opening up further the potential for individually designed patient therapies.

Metrology for complex radiotherapy fields

The EMRP project *Metrology for radiotherapy using complex radiation fields* developed an improved calibration chain linking absorbed dose to water standards to clinical instruments and patient treatment for the small radiation fields used during cancer surgery and therapy. Modern cancer treatments use complex radiation fields generated by a range of high energy radiotherapy beams delivering intense radioactive doses to areas of only a few millimetres across. As a result of this project, it is now easier for therapies to meet the requirements set out by the International Commission on Radiation Units and Measurements (ICRU) and clinicians are able to more accurately link delivered therapeutic dose to treatment plans across all therapy types.



EMRP
European Metrology Research Programme
Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

www.euramet.org/project-HLT09

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