Increasing cancer treatment efficacy using 3D brachytherapy

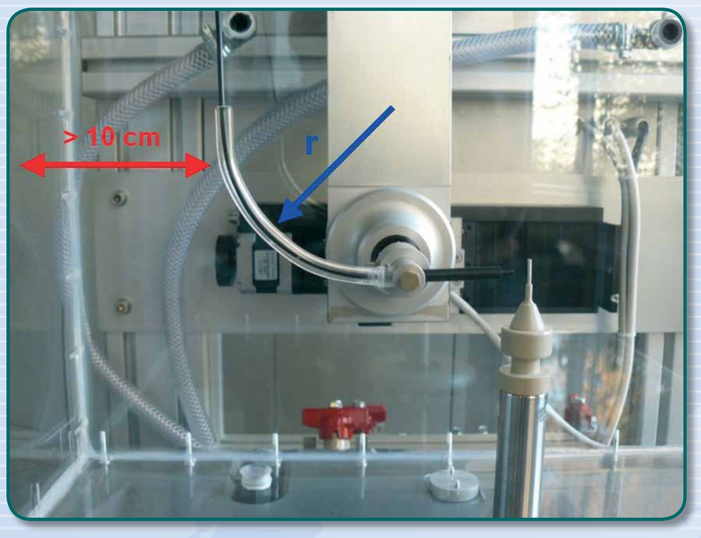
EURAMET
European Association of National Metrology Institutes

The need for the project

Brachytherapy is a cancer radiotherapy approach where small, sealed radioactive sources are placed inside, or in close proximity to, the area requiring treatment. It is commonly used to treat cervical, prostate, breast, and skin cancer and can be used alone or in combination with other therapies.

In Europe, approximately 100,000 patients per year are treated using brachytherapy, but in order to optimise cancer treatment and satisfy the recommendations of the International Atomic Energy Agency (IAEA) TRS-398 2000, an improvement in the accuracy of brachytherapy dosimetry is required.

This project aimed to address this issue by establishing traceable measurements of brachytherapy radiation sources using absorbed dose to water (D_w) primary standards. These new D_w standards should simplify existing measurements and reduce dose uncertainty to below 5%, at the clinical level.



The PTB water phantom for LDR sources for operation with a small scintillation detector.

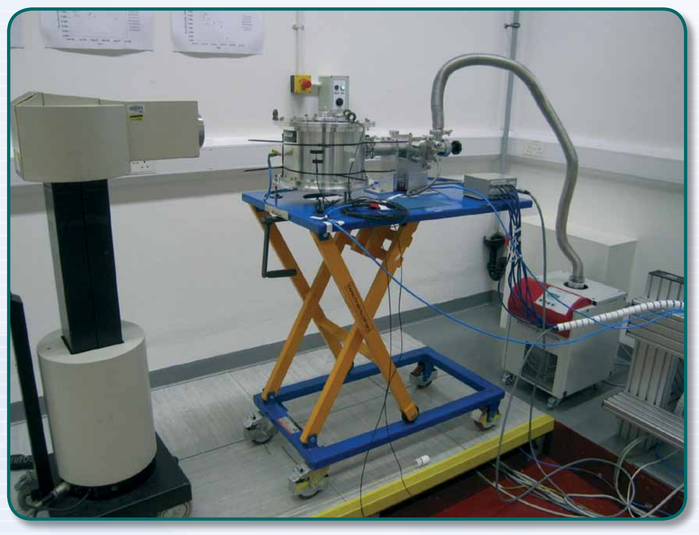
Technical achievements

A number of primary standards have been designed and built for measurements of D_w imparted by brachytherapy sources using low dose-rate (LDR) or high dose-rate (HDR) regimens. For LDR dosimetry, three standards were established by participating National Metrology Institutes, based on ionometric methods. For HDR dosimetry, two primary standards based on water calorimetry were developed along with two other HDR standards based on graphite calorimetry.

The project developed a calibration chain optimised to transfer the new reference quantity D_w to end-users. In particular, a measurement procedure was developed for selected models of well-type chambers. In order to select the models of well-type chambers a questionnaire was distributed to irradiation facilities using brachytherapy dosimetry at secondary standards laboratories and medical centres in Europe - 137 centres responded from 9 different countries.

To support the link between the current metrology (air kerma standards) and the new D_w standards, the dose rate constant (Λ) was re-evaluated for all brachytherapy sources used within the project.

The project also developed suitable portable methods to improve the verification of the 3D dose distributions of brachytherapy sources in water or in water equivalent phantoms.



Graphite calorimeter developed by NPL with Nucletron microSelection Classic afterloader. The treatment unit is connected to the calorimeter via a transfer tube.

New D_w reference standards

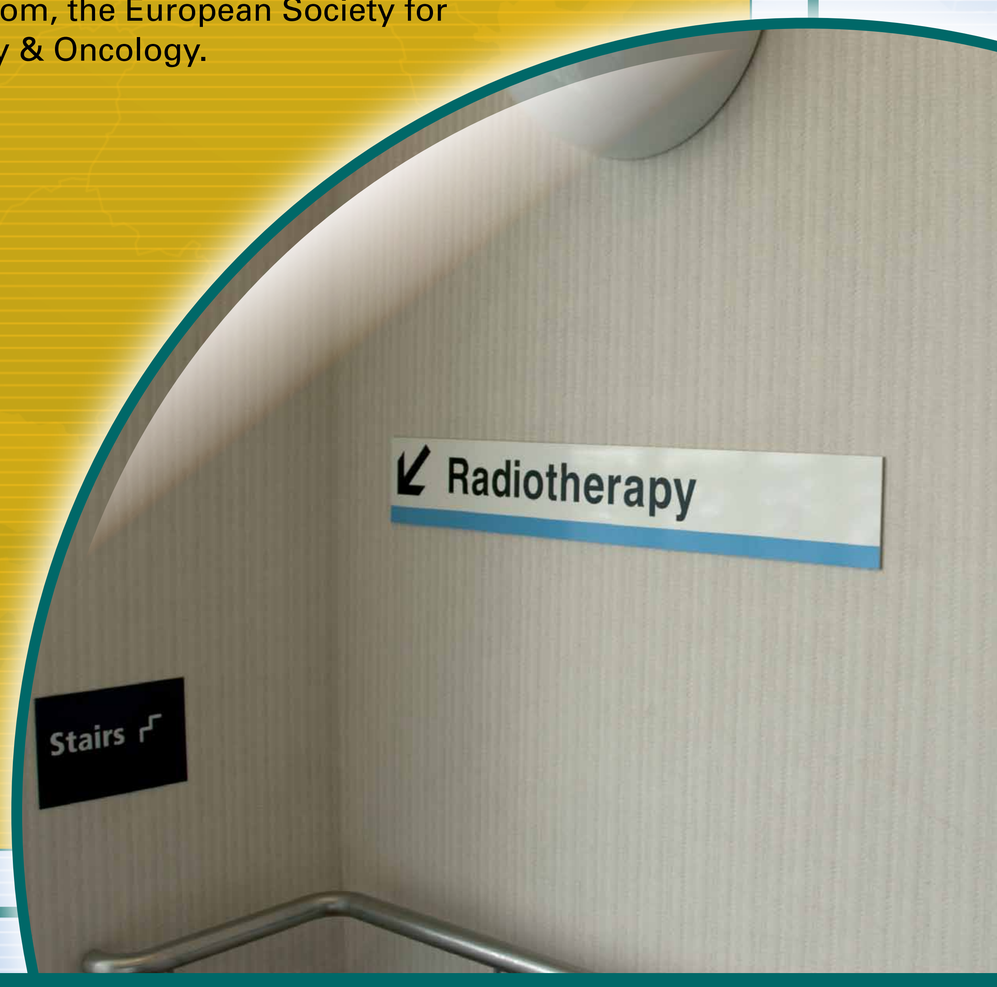
Developed seven new D_w primary standards for measurements of brachytherapy sources at low and high dose-rate regimens. These were then linked to existing air kerma standards by validating the use of the dose rate constant (Λ). The project also developed methods to verify the dose distribution of brachytherapy sources in water or water equivalent phantoms.

Input to standardisation

The project results have input into an AFNOR working group, which is a mirror of ISO TC 85/SC2 WG22 *'Dosimetry and related protocols in medical applications of ionizing radiation'* and have fed into the revision of DIN standard 6809-2 *'Clinical dosimetry; Brachytherapy with sealed gamma sources'*.

The results of the project have been presented to the IAEA, where the move from air kerma to D_w standards for dosimetry for brachytherapy was discussed with the support of the medical community.

The project also has the support of, and has benefited from input from, the European Society for Radiotherapy & Oncology.



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