INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Development of dedicated systems based on accelerators and detectors of ionizing radiation for medical therapy and in detection of hazardous materials and toxic wastes

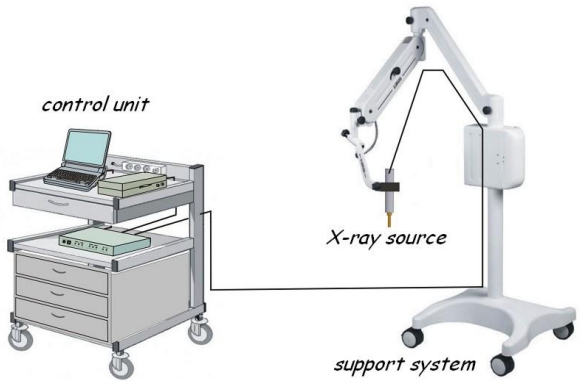
Main information about project

The aim of the project is to increase innovation and competitiveness of Polish science and industry in the fields of diagnostics and treatment of cancer and screening of large cargos. Developing these systems requires mastery and using of new techniques and technologies in the field of electron accelerators, control systems and steering of electron beams as well as in detectors of photons, neutrons and electrons, deep acquaintance with methods of computer simulation of radiation transport through matter, systems for collecting and processing information, and reconstruction algorithms and image recognition.

The target group of recipients of the project outcome:

- health care facilities performing oncological treatment in Poland, in both developed and developing countries,
- bulk cargo control points in Poland, in EU and outside EU

NARL – low-energy accelerator with X-ray tube



The system dedicated for intra-operative radiation therapy for breast cancer in the conservative method is developed within the Accelerators and Detectors (A&D) project. This system is based on the special design of the X-ray tube with needle-like anode. X-ray tube operates at anode voltage up to 50 kV and anode current of 50 μA. This source is characterized by isotropic dose distribution. Dose rate is sufficient to destroy any cancerous lesions remaining after tumor resection, radiotherapy in one session lasting up to 40 minutes. The proposed system is mobile and requires no preparation of radiological operating room.

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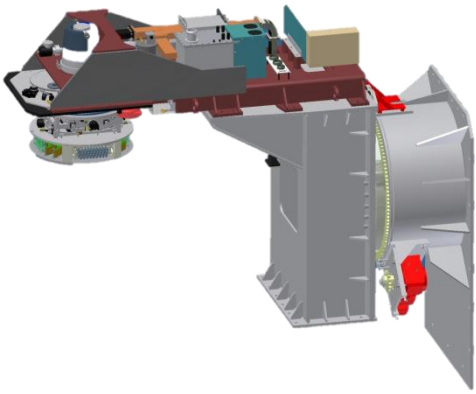
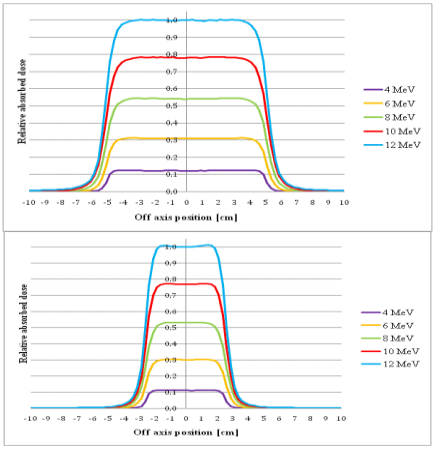
Highly-specialized accelerator

The A&D project is being developed and built the highly specialized system for radiotherapy. It consists in the fact that the tumor is subjected to therapy Imaging, planned and irradiated in the art three-dimensional. 4D adaptive radiotherapy also takes into account the fourth dimension - the change of position and size of the tumor and critical organs during the entire treatment process. The accelerator will produce a photon beam with energies of 6 and 18 MV, and from four to six electron beams with energies from 4 to 22 MeV. The radiation dose rate for both photon energy is a minimum of 600 monitor units per minute with the possibility of changes during the irradiation. Developed device is characterized by high stability of the energy and dose rate with the possibility of precise control (gating breath and the continuous change in the intensity of thin beams of radiation) and rigid mechanical design providing stable mechanical isocentre in the whole range of the arm and the collimator rotating. The device will be able to precisely shape the irradiation field using a multi collimator leaf width at isocentre level no greater than 5 mm in the central part (min. 120 leafs).



Accelerator for intraoperative radiation therapy



Dose profiles at dmax for an IORT metal model with applicator diameters of (top) 10 cm and (bottom) 5 cm for energies ranging from 4 to 12 MeV

Within the A&D project there is drafted mobile electron linac for Intraoperative Electron Radiation Therapy (IORT). This will be the machine delivering electron beams of energies 5 to 12 MeV (in several chosen steps) and single radiation dose 10-20 Gy. The accelerating head will consists of 18 cell, 3 GHz, graded β accelerating structure and soft or hard docked treatment head delivering electron radiation to patient placed on treatment table. The whole system including the RF high power supply, RF waveguides, vacuum and cooling system is to be mounted on movable base (trolley) in the way that accelerating head can be set to any necessary position above the operating table. The mechanical design of linac was preceded by RF calculations optimizing the shapes of cavities at fixed frequency and thermal calculation establishing the necessary outer dimensions of cavities. Extensive study of electron beam dynamics allowed to fix such basic parameters as the injection energy, the length of initial 4 cavities and the beam aperture in whole linac structure. The simulation codes SUPERFISH, CST/MWS, ANSYS, ELIN and GPT were used for study and design of linac structure.

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