NRF Special session on hadron therapy

Report of Contributions

Contribution ID: **3** Type: **Talk**

Experience in proton therapy with beam energy 1000 MeV

Friday 27 April 2018 17:00 (30 minutes)

Korytova L.I.1, Vinogradova Y.N.1, Korytov O.V.1, Yalynich N.N.1, Gerasimov S.V.1, Kartashov A.V.1, Shalek R.A.1, Maksimov V.I.2, Ivanov E.M.2, Karlin D.L2, Khalikov A.I.2
1. Russian Scientific Center of Radiology and Surgical Technologies n.a. A.M. Granov, St-Petersburg, phone (812) 596-84-62 e-mail: info@rrcrst.ru
2. Petersburg Institute of Nuclear Physics n.a. B.P. Konstantinov, NRC Kurchatov institute, Gatchina, phone (81371) 4-60-25 e-mail: dir@pnpi.nrcki.ru

This lecture will provide the participants with information about current status of proton therapy in RSCRST, which cooperates with PINP over use of proton beam for treating patients. Participants will receive knowledge about "Gatchina method"of treating intracranial targets with proton beam 1 GeV. This method of proton therapy is different from typical irradiation technique, which uses Bragg peak. "Fly through"system is based upon patient rotation at the procedure table with fixed position of proton beam.
Effectiveness and safety of this method was proven by fundamental preclinical research, involving cell cultures, drosophila melanogaster, transplanted tumors and different experimental animals.
Patient treatment had began in 1975, and by present time 1394 patients had underwent proton beam therapy –almost 26% of all patients, which were treated by proton beam therapy in Russian Federation, and 2% of patients worldwide.
As by the date, after modernization proton beam is undergoing certification as medical equipment "stereotactic proton beam therapeutic station". Fundamental, preclinical and scientific research is also underway in an attempt to highlight further ways to further modify element base and software to expand possible applications for "Gatchina method"in treating oncological patients with differently localized tumors of all possible etiology.
The second part of the lecture includes information on the cyclotron C-80 launched with the energy of the extracted proton beam from 40 to 80 MeV and a variable intensity of up to 100 μA and a new project of the onco-ophthalmologic complex of proton beam therapy on its basis. The work is carried out jointly with ITEP, Moscow.

Primary author: KORYTOV, Oleg (RSCRST)

Contribution ID: **4** Type: **Talk**

From Physics to Medical Applications

Friday 27 April 2018 14:45 (30 minutes)

Physics has been and continues to be instrumental in the development of technologies in the biomedical domain especially the use of ionizing radiation for medical imaging and therapy ever since the discovery of X-rays by Roentgen in 1895.

The challenging demand for particle physics has pushed the detector performance to very high limits both in terms of spatial and time resolution and the cross-fertilization between particle physics detectors and imaging tools is bringing real benefits to the medical field especially in diagnosis and treatment of disease. Accelerators are routinely used in hospitals for conventional cancer radiotherapy with X-rays as well as for the production of radioisotopes, which are used for diagnosis and treatment of cancer.
Cancer is a critical societal issue. Worldwide, in 2012 alone, 14.1 million cases were diagnosed, 8.2 million people died and 32.5 million people were living with cancer[1]. The main aim of radiation therapy is to deliver a maximally effective dose of radiation to a designated tumour site while sparing the surrounding healthy tissues as much as possible.
Radiotherapy using charged hadrons (protons and light ions), with their unique physical and radiobiological properties, allows highly conformal treatment of various kinds of tumours, while delivering minimal doses to large volumes of surrounding healthy tissues. Harnessing the full potential of hadrontherapy requires the expertise and ability of physicists, physicians, radiobiologists, engineers, and information technology experts, as well as collaboration between academic, research, and industrial partners.
The necessity to catalyse efforts for collaboration among these disciplines resulted in the establishment of the European Network for Light Ion Hadrontherapy (ENLIGHT[2]). The network was launched in 2002 and was envisaged not only as a common multidisciplinary platform, where participants could share knowledge and best practices, but also as a provider of training and education. In almost 15 years since its creation, ENLIGHT has witnessed a large increase in dedicated centres that use proton and carbon ions to treat cancer. In addition, despite the continuing high cost, innovative medical imaging techniques are starting to make their way into routine diagnostic methods. Adapting and evolving is an intrinsic feature of the ENLIGHT network while maintaining its cornerstones of multidisciplinarity, integration, openness and attention to the future generation.

1 J. Ferlay et al., European Journal of Cancer 49, 1374–1403 (2013). This is most recent global survey available to date.
2 www.cern.ch/enlight

Primary author: DOSANJH, Manjit (CERN)

Contribution ID: **5** Type: **Talk**

Do we need hadron therapy: a medical doctors point of view

Friday 27 April 2018 15:15 (30 minutes)

The main goal of radiotherapy is to maximize the damage to the tumor while minimizing the damage to the surrounding healthy tissue in the attempt to reduce acute and late side effects. Ion beam therapy (i.e. proton and carbon ion radiotherapy) is regarded as a promising therapeutic option because of its physical Bragg-peak characteristics. The fundamental rationale for the use of ion beam therapy is the improved physical selectivity, i.e. better dose conformation properties which enable better sparing of organs at risk and hence the potential of reducing side effects. Protons are typically indicated in tumors which are located next to radiosensitive structures (i.e. central nervous system, skull base or head and neck region). Furthermore, pediatric malignancies are considered as important indication for proton therapy; by limiting the dose to healthy structures using by proton a reduction in severe long time side-effects can be expected.
In addition to the physical Bragg-peak characteristics carbon ions are characterised by an increase in biological effectiveness when compared to protons. Considering different clinical situations, the biological advantages of carbon ions in comparison to protons are expected to be most pronounced for tumors that show low radio sensitivity.
In the early years of ion beam therapy, patients were treated at physics research facilities when beam time was available, whereas during the last decade a clear trend towards hospital-based facilities has been observed with a distinct market for proton facilities developing in the United States. In contrast to that, an interest in both, proton and carbon ion treatments or combined treatments particularly as provided in dual particle beam facilities can be noticed in Asia and especially Europe. Up to now there are five operating facilities worldwide which offer both beam qualities in one center. They are located in Hyogo (Japan), Shanghai (China), Heidelberg (Germany) Marburg (Germany) and Pavia (Italy). The sixth dual beam facility, MedAustron in Austria, is currently treating proton patients and will start with carbon ion treatment in the near future.
With regard to proton therapy, clinical experiences were mainly gained in the United States. By contrast, Japan has the most experience in the clinical application of carbon ion treatment with currently five ongoing centers. By the end of 2016 more than 149000 patients underwent proton- and 21500 patients underwent carbon ion treatment in operating treatment facilities worldwide.
Ion beam therapy has been applied to a variety of tumours like eye melanoma, scull base tumours, paediatric malignancies, prostate carcinoma, etc. and available clinical data appear to be promising. During the presentation, the clinical data will be presented in detail.

Primary author: MAYER, Ramona (Former Medical director of MedAustron , Austria)

Contribution ID: **6** Type: **Talk**

The Radiobiology of Proton Therapy: Challenges and Opportunities to Overcome RBE-related Problems

Friday 27 April 2018 15:45 (30 minutes)

With the current worldwide expansion of proton therapy, there is a great opportunity for clinical radiation oncologists and physicists to develop an interest in the associated scientific base and clinical results. In particular, the continuing controversy regarding the conversion of photon dose to proton dose by the relative biological effectiveness (RBE) must be understood, including its important implications. At the present time, the proton prescribed dose includes an RBE of 1.1 regardless of tissue, tumour and dose fractionation. A body of data has emerged against this pragmatic approach, including a critique of the existing evidence base, due to choice of dose, use of only acute-reacting in vivo assays, analysis methods, and the reference radiations used to determine the RBE. There is also considerable evidence from fast neutron experiments which are relevant some aspects of proton therapy, because neutrons cause most of their ionisation by producing recoil protons.

Relatively simple mathematical modelling systems, based on the best available scientific evidence, and which include the clinically useful Biological Effective Dose (BED) concept have also been developed to estimate proton (or other ion beam) RBEs for different doses and linear energy transfer (LET) values. LET is a measure of radiation ionisation density which progressively increases along each proton track. Late reacting tissues such as the brain, where β = 2 Gy, show a substantially higher RBE than 1.1 at low dose per fraction (1.2-1.8 Gy), for LET values which are used to cover conventional target volumes, but can be much higher, especially at the ends of spread out Bragg peak or scanned beams. RBE changes with tissue depth appear to vary depending on the method of beam delivery used, and may also reflect the beam fluence, which is related to the particle inter-track distance.

To reduce unexpected toxicity, which does occasionally follow proton therapy, a more rational approach to RBE allocation, using a variable RBE which depends on dose per fraction and the tissue and tumour radiobiological characteristics such as β is proposed. Such an approach should make proton therapy safer and more effective.

Primary author: JONES, Bleddyn (University of Oxford)

Contribution ID: **7** Type: **Talk**

Proton therapy in the complex treatment of breast cancer

Friday 27 April 2018 16:30 (30 minutes)

Breast cancer is the most common tumor among women and the second cause of cancer deaths in women. Up to 1 million new cases are registered in the world annually. This disease, diagnosed in the early stages, is characterized by high rates of overall 5-year and 10-year survival, and the late complications of radiation therapy included in the complex treatment of this category of patients become an urgent problem. Proton therapy makes it possible to create a more conformal dose distribution with minimal radiation of healthy tissues. In the lecture, it is planned to discuss indications for proton therapy, selection of patients who can benefit from the use of proton therapy, as well as pitfalls associated with heterogeneity of the dose distribution due to the influence of the value of linear energy transfer (LET) on relative biological efficiency (RBE).

Primary author: MIKHAILOV, Aleksei (Proton therapy center of the Dr. Sergey Berezin Medical Institute)

Contribution ID: **8** Type: **Talk**

Theranostics: new methods for radionuclide therapy and diagnostics

Friday 27 April 2018 17:30 (30 minutes)

The report "Theranostics: new methods for radionuclide therapy and diagnostics" will give knowledge about the important role of novel radionuclides for diagnostics(Positron Emission Tomography and Single Photon Emission Computed Tomography) and therapy (radio-immuno-therapy). Merging imaging and therapy to Theranostics (a neologism from therapy based on diagnostics) for diagnose and treat chronic illnesses such as cancer, will give us the excellent results with minimum side effects. The patient will receive first a cancer-selective diagnostic radionuclide and then therapy with this radionuclide will be adapted accordingly. Thus optimum treatment efficacy can be achieved in this type of personalized medicine.
The report includes: the basics of radionuclide therapy and diagnostics, new methods for radionuclide therapy and diagnostics, our studies of the nuclear reactions for development of novel radionuclides used in these methods.

Primary author: ZHEREBCHEVSKII, Vladimir (St Petersburg State University (RU))