Proton therapy group

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Proton therapy
It can do more!!!

Effectiveness of the proton therapy in targeting and curing tumor.
Supervised by

• Prof. Gennady V. Mytsin
Outline

• Aim of our work
• History and background
• Concept review
• What equipment is used?
• Methodology
• Preparations
• Future work
• Conclusion
• Acknowledgement
• References
Aim of our work

Become familiar with basics of proton therapy and practices taking place at proton therapy unit and its different uses.

Patients preparations, simulations, and Quality assurance of proton beam.

Effectively treat tumors using proton beam at Medical Technical Complex at JINR.
History and Background

• 1919 Rutherford proposed protons existence.
• 1930 E. O. Lawrence built first cyclotron
• 1946 Robert Wilson proposed proton therapy
• 1955 Tobias et al treated patients at LBL
• 1961 Kjellberg et al treated patients at HCL
• 1967 first treatment of patients with proton beam at JINR
• 1972 MGH received first NCI grant for proton studies at HCL
• 1983 Tsukuba Univ. in Japan treated patients
• 1985 PTCOG
• 1991 First hospital-based proton facility at LLUMC
• 2013; over 35 facilities worldwide treating patients
• Over 67,000 patients treated with protons.

Robert R. Wilson
"Father of Proton Therapy"
Concept review

What is protons??

What is a proton therapy?
Cyclotron accelerator

Proton synchrotron

Treatment room with horizontal proton beam
The Bragg peak is a peak on the depth-dose curve which plots the energy loss of charged particles ionizing radiation during its travel through matter/different tissues.

For protons, and other ion beams, the peak occurs immediately before the particles come to rest.

called after William Henry Bragg who discovered it in 1903.
Proton therapy is superior to treat:

• ocular Tumors
• Brain tumors
• Pediatric tumors
• Prostate cancer
• Adult brain tumors
• Spinal tumors

Tumors under research to be treated:
• Lung tumors
• Esophageal tumors
• Liver tumor
What equipment is used?

Cyclotron and synchrotron being the most common, to generate and accelerate protons to speeds up to 60 percent the speed of light and energies of up to 250 million electron volts.

These high-energy protons are delivered by electro-magnets and electro-lenses toward the treatment room, and then to the specific part of the body being treated.
Methodology

- Preparation of individual patient immobilization tools
- The diagnosis and treatment planning
- Simulation of the treatment
- Quality assurance of the proton beam
- The treatment (irradiation)

General concerns:
- Treatment given as few as two times up to as many as 35 times,
- Preparations always include simulation based on CT and MRI as for other radiotherapy
- Immobilizing mask or cast is used
Special preparations:

1. Immobilization (custom mask, tray, moulds, )
2. **computed tomography** (CT) scan,
3. define the boundaries of the tumor and the surrounding normal structures.
4. 3D Treatment planning system
5. Simulation.

Every day before each treatment session the profile, depth dose distribution and dose rate of the proton beam are checked and then are controlled during irradiation of patients with a help of specially designed system
Scanning
Treatment room
Treatment room (Cont.)
Other purposes
Bolus and Collimator manufacturing
Phantoms
Control
Обслужение пациентов 20 Мая 2013 г.

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Всего: 4 услуги, общее время: 4252 минуты, общий объем работы: 4252 минуты.
Home made devices (Proton Therapy center at JINR)

1/ Check Bolus Device
By: shipulinkn (M. Student)

2/ Multi leave Collimator
By: Agapov Alexey (Ph. D. Student)
Future prospects

• Developing novel proton therapy techniques,

Citing a wish list of "five highs": higher quality, higher accuracy, higher flexibility, higher intensity and higher energy.

One low: lower equipment costs – generally achieved via a reduction in the size of the accelerator system.

• 1st Proton therapy center @Egypt.
Conclusion
Proton therapy came to solve a critical drawbacks and side effects of the normal radiation based tumor therapy, to be a superior tool that could be successfully used to treat different tumor lesions especially well located tumors that are close to critical structures.

One of the current obstacles for using proton therapy is the high cost of treatment compared to the other tools. But taking into account that one proton therapy center accommodates several treatment rooms in which about 1000 patients can be treated per year the cost for treatment course is comparable to this one of the Intensity Modulate Photon radio therapy.
Acknowledgments

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At medical technical complex in JINR
Спасибо за внимание
**cyclotron**
A type of particle accelerator in which charged particles are propelled by an alternating electric field between two large electrodes in a constant magnetic field created by two large magnets. The particles are injected at the center of the magnet and spiral outward as their energy increases. Protons produced in a cyclotron can be used to treat cancer, and cyclotron-produced protons can create radioisotopes for nuclear medical procedures.

**synchrotron**
A cyclic particle accelerator in which the magnetic field (to turn the particles so they circulate) and the electric field (to accelerate the particles) are synchronized with the traveling particle beam. While the cyclotron uses a constant magnetic field and a constant frequency electric field, both are varied in the synchrotron. This allows for construction of large rings that can accelerate particles to much higher energies than a cyclotron which has a limited magnet size. The synchrotron uses multiple separate bending magnets and narrow bore tubes to connect them. It can be used to produce high energy protons and other particles such as carbon ions that are used to treat cancer. In addition the energy of the particles can be varied as needed which is very difficult in a cyclotron.