New Research Tools for Light Ions Particle Therapy

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Purpose/Objective

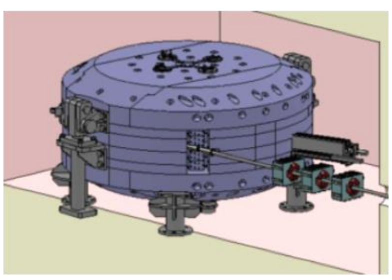
Proton Therapy and Carbon Ion Therapy have shown very good and promising clinical results for a number of indications. There is desire for greater availability of light ions facilities for research and for clinical trials and use with protons and other light ions.

The synchrotrons used to date to accelerate carbon ions for particle therapy are large and expensive to build and operate. We have therefore developed an efficient, compact, effective system for faster light ions research and treatments with less complexity and lower costs, for the benefit of more patients.

Light Ions Range in Water at 300 MeV per nucleon:

- Protons 508 mm
- Helium 510 mm
- Lithium 340 mm
- Boron 210 mm
- Carbon 174 mm

The systems allow for five different light ions species for research and clinical use. There is promising potential in mixing light ions but to date a lack of facilities hinder such research.



Materials and Methods

A new compact superconducting isochronous multiple-light-ion cyclotron has been designed by Sumitomo Heavy Industries Quantum Division. It is for acceleration of Hydrogen Ions (Protons), Helium Ions, Lithium Ions, Boron and Carbon Ions. The peak energy is >300 MeV/u and the maximum Helium range in water is 510 mm.

Pencil Beam Scanning delivery is used for maximum dose conformity to target volumes and minimized exposure to surrounding tissues and organs at risk.

A uniform distribution of biological effect, dose and radiation quality in the tumor volume is desired. It is possible by combining light ions. For instance, with Lithium in combination with Boron or Carbon ions, the Lithium ions are mainly used in the distal tumor region whereas Boron or Carbon ions are used closer to the patient surface. By this method the low LET plateau dose from Lithium is elevated significantly by Bragg peak Boron or Carbon ion dose in the shallow tumor region. (A. Brahme pers. comm. May 2012)

Results

Innovative layout of multiple treatment rooms and the compact new cyclotron accelerator allows a significant cost reduction compared to all previously built carbon ion treatment facilities.

Overall facility costs and cost per light ions research and treatment room is lowered. High dose rates from the cyclotron, fast energy switching and continuous line scanning allow for shorter irradiation times with improved patient comfort and throughput.

Conclusions

The new light ions technology provides a compact and very efficient system for curative treatment of several common malignant tumors with particle therapy. By enhanced throughput in a facility costing equal or less than today's proton-only facilities, the cost per treatment is reduced.

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