Ironless Cyclotron
Technology #16121

Applications

Cyclotrons are used for high energy particle production for particle physics experimentation and hadron radiotherapy (e.g., pCyclotrons are used for high energy particle production for particle physics experimentation and hadron radiotherapy (e.g. protons, carbon ions).rotons, carbon ions).

Problem Addressed

Superconducting cyclotrons are increasingly employed for proton beam radiotherapy treatment. The use of superconductivity in a cyclotron design reduces its mass an order of magnitude over conventional resistive magnet technology, yielding significant reduction in overall cost of the device, the accelerator vault, and its infrastructure, as well as reduced operating costs. The present approach for making cyclotrons includes the use of magnetic iron poles and iron return yokes. These iron components comprise a large fraction of the weight of a superconducting cyclotron. Furthermore, due to the nonlinearity of the magnetic properties of iron, existing cyclotrons can produce only a single fixed energy beam, which calls for using a degrader for the in-depth beam scanning.

Technology

The invention uses magnetic field coils to produce the field shaping needed to generate the field profile required in a cyclotron, avoiding or minimizing the ferromagnetic pole pieces typically used in these machines. Coils are adjusted to produce the required field for either synchrocyclotrons or isochronous machines. In addition, magnetic field coils are used to magnetically shield the device, similarly eliminating the need for a ferromagnetic return yoke serving as a ferromagnetic shield. Elimination of all magnetic iron in the flux circuit yields a linear relationship between the operating current and the magnetic field intensity in the beam space. In a synchrocyclotrons this permits continuous beam energy variation without the use of an energy degrader, thus eliminating secondary radiation during the in-depth beam scanning.

Advantages

- Reduces weight and cost
- Reduced stray magnetic field
- Reduced secondary radiation
- Permits variable beam energy

Related Technologies

Ironless Cyclotron is connected to Cyclotron Phase-lock Loop Control, Case Number 15762.
Categories For This Invention:
Life Sciences
Clinical Applications
Radiology

Intellectual Property:
Ultra-light, magnetically shielded, high-current, compact cyclotron
Issued US Patent
8,975,836

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Publications:
Making Cancer Treatment More Accessible
MIT News
June 4, 2015
Superconducting Magnets for Ultra Light and Magnetically Shielded, Compact Cyclotrons for Medical, Scientific, and Security Appl
IEEE Transactions on Applied Superconductivity
Volume: 24, Issue: 3, June 2014
Variable Energy Acceleration in a Single Iron-Free Synchrocyclotron
PSFC MIT Report, PSFC/RR-13-9
September 5, 2013

External Links:
Plasma Science and Fusion Center
https://www.psfc.mit.edu/

Image Gallery: