

Cyclotron Phase-Lock Loop Control

Technology #15762

Applications

Ultra light and magnetically shielded, high current compact cyclotrons with superconducting magnets have useful applications to a range of medical, scientific, and security applications. For example, radiation beam therapy, nuclear medicine uses, and nuclear materials testing are all areas where this technology could be useful.

Problem Addressed

Synchrocyclotrons require adjustments to the frequency of radio frequency (RF) fields during beam acceleration due to the relativistic effects that change the mass of accelerated particles. Conventional efforts to monitor and control frequency occur after the extraction phase. These efforts lack real-time monitoring and appropriate synchronization of adjustments during the acceleration phase. Addressing the frequency of RF fields in the acceleration phase serves to substantially improve beam quality and promote optimal acceleration. These cyclotron improvements synchronize RF and beam phases to optimize acceleration of particles for efficient beam extraction. Such improvements for high current cyclotron design offer significant advantages for relevant applications, especially when coupled with other improvements such as use of magnetic field coils, magnetic shielding, and superconducting materials.

Technology

To promote optimal beam acceleration, these phase-lock loop synchronization techniques use feedback in the RF field to increase cyclotron current. This phase-controlling technique requires an optimized system of a source to monitor the beam during the acceleration phase. Such control systems require beam sensors and mechanisms located at the dees gap to accordingly adjust RF phase. The RF source phase (ϕ_{source}) that optimizes beam acceleration depends on a function of sensor, beam-gap, beam, RF, and optimal phases. Additionally, use of a pulsed ion source made from appropriate materials (i.e. made of stable compounds that do not breakdown, employ an ablator that does not leave deposits or require maintenance operation) promotes matching of ion source to the acceptance window of the RF in cyclotrons.

Advantages

- Closed loop control enables variation of final beam energy
- Maintains high extraction efficiency

Related Technologies

Cyclotron Phase-Lock Loop Control is connected to [Ironless Cyclotron, Case Number 16121](#).

Categories For This Invention:

[Life Sciences](#)
[Clinical Applications](#)
[Radiology](#)

Intellectual Property:

Phase-Lock Loop Synchronization between Beam Orbit and RF Drive in Synchrocyclotrons
Issued US Patent
9,615,441
Phase-Lock Loop Synchronization between Beam Orbit and RF Drive in Synchrocyclotrons
Issued US Patent
9,603,235

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