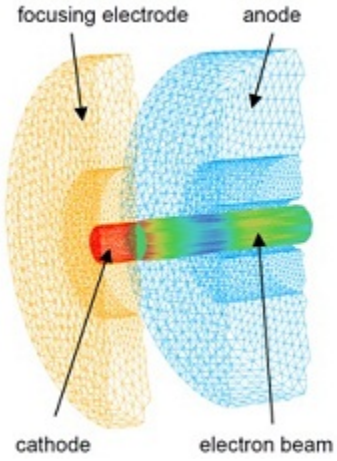
Docket #: S10-094

Optimized Electron Guns for MRI-guided Radiotherapy

This technology is a novel design to improve the performance of electron guns used with MRI for real-time image guidance during linear accelerator (linac)-based radiotherapy. This treatment option will offer fast imaging of tumor and normal tissue for unprecedented accuracy in aligning the radiation beam to the tumor. The low energy electron trajectories for a conventional electron gun are heavily influenced by an external magnetic field such as the fringe field of an MRI magnet, with up to 80% of current lost for inline magnetic fields. Design modifications to overcome this loss include changing the electron gun geometry and changing the cathode material to allow higher current per unit area to accommodate the reduced size of the cathode emitting surface.



Schematic representation of the electron gun model and the space charge solution represented by the electron trajectories.

Stage of Research

Stanford University is participating in a $16M project to create an integrated inline MRI-linear accelerator. The refinement of the electron gun design is continuing. The inventors expect to include these designs in the integrated system and perform experimental reduction to practice to characterize the increased system

performance.

Applications

- **Radiation therapy** - inline MRI-linear accelerators, Robotic Linac Adaptation (RLA) MRI-linacs and other applications that use electron guns in aligned external magnetic fields without magnetic shielding

Advantages

- **Optimized operation** - conventional electron gun designs are not optimal for operation with inline magnetic fields and suffer from current loss up to 80%
- **Operates with high field strength** - this design can be used at higher field values compared to mu-metal shielding approaches (which are saturated at ~0.1 Tesla) and without degradation of the MR magnet field homogeneity
- **Unrestricted linac motion** - due to the absence of the magnetic shield, the linac can be moved with respect to the MRI scanner as proposed in the RLA MRI-linac configuration

Publications

- Constantin DE, Fahrig R, Keall PJ., "A study of the effect of in-line and perpendicular magnetic fields on beam characteristics of electron guns in medical linear accelerators." *Med Phys.* 2011 Jul;38(7):4174-85.

Patents

- Published Application: 20130035905

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