BROOKHAVEN NATIONAL LABORATORY

Collider Accelerator Department

MOPG025

DESIGN OF A PROTON-ELECTRON BEAM OVERLAP MONITOR FOR THE NEW RHIC ELECTRON LENS, BASED ON DETECTING ENERGETIC BACKSCATTERED ELECTRONS.

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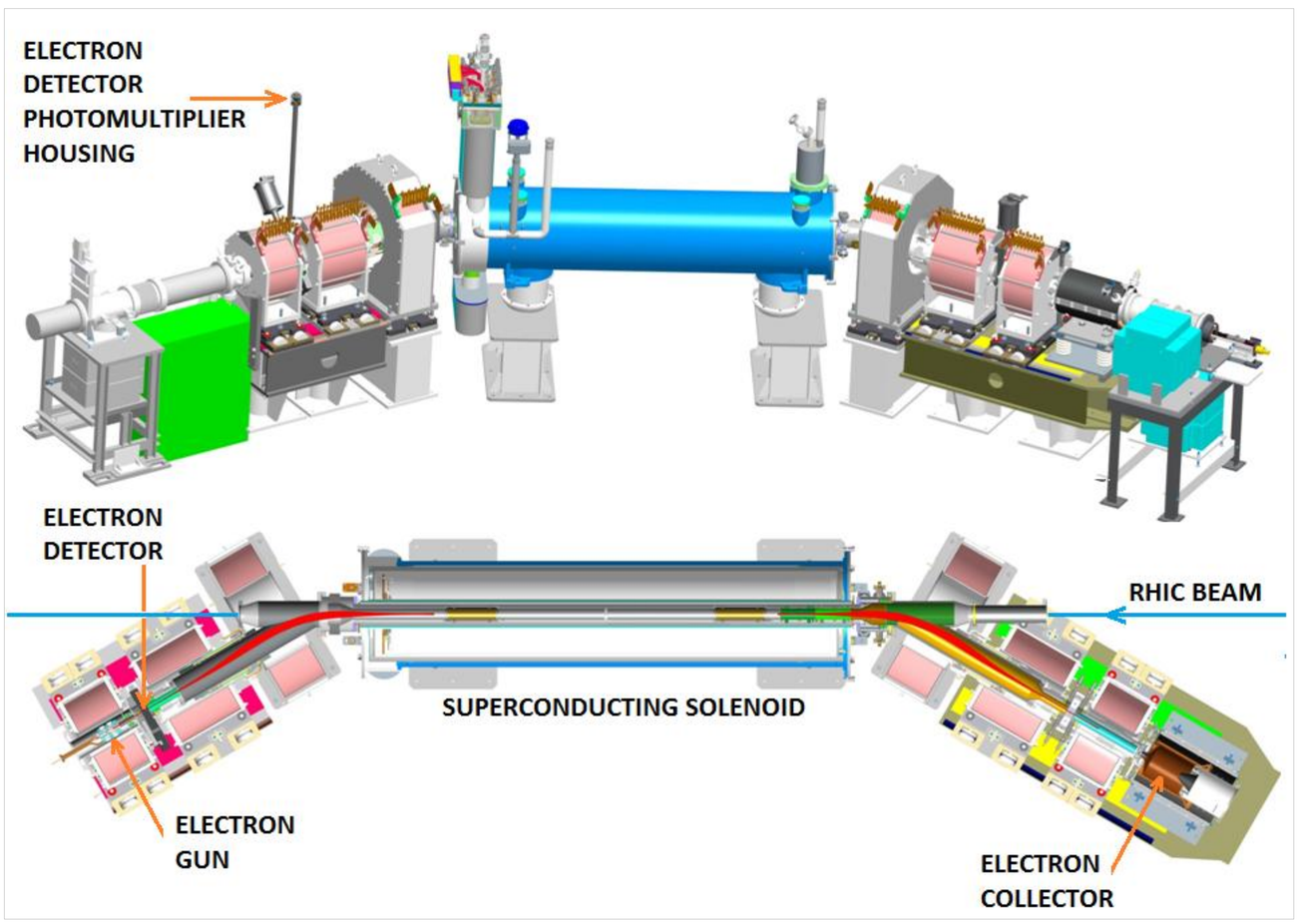
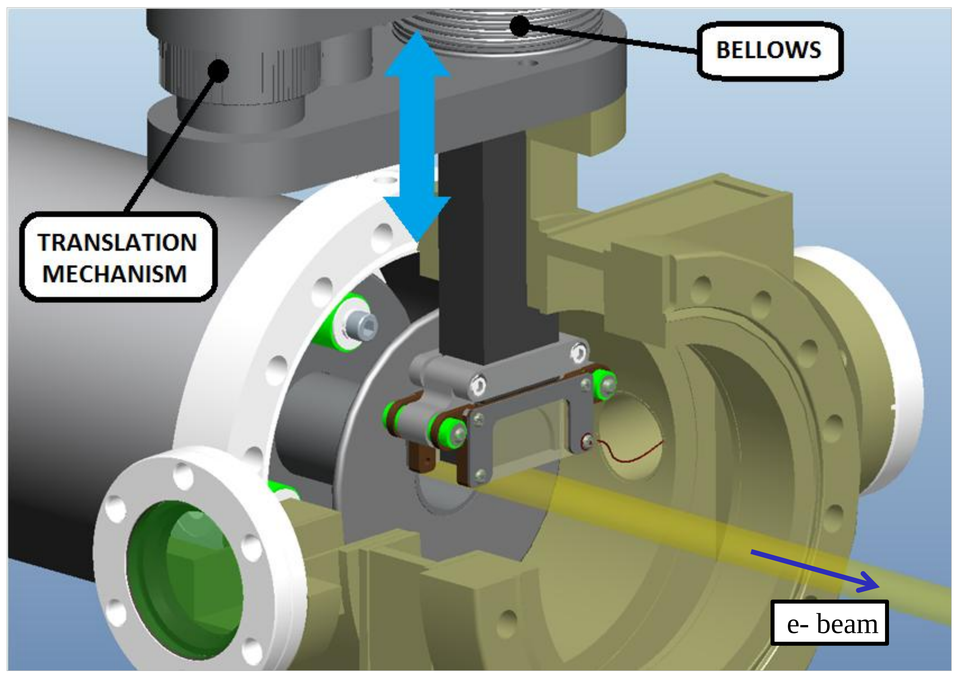
Abstract

The optimal performance of the two electron lenses that are being implemented for high intensity polarized proton operation of RHIC requires excellent collinearity of the ~0.3 mm RMS wide electron beams with the proton bunch trajectories over the ~2m interaction lengths. The main beam overlap diagnostic tool will make use of electrons backscattered in close encounters with the relativistic protons. These electrons will spiral along the electron guiding magnetic field and will be detected in a plastic scintillator located close to the electron gun. A fraction of these electrons will have energies high enough to emerge from the vacuum chamber through a thin window thus simplifying the design and operation of the detector. The intensity of the detected electrons provides a measure of the overlap between the e- and the opposing proton beams. Joint electron arrival time and energy discrimination may be used additionally to gain some longitudinal position information with a single detector per lens.



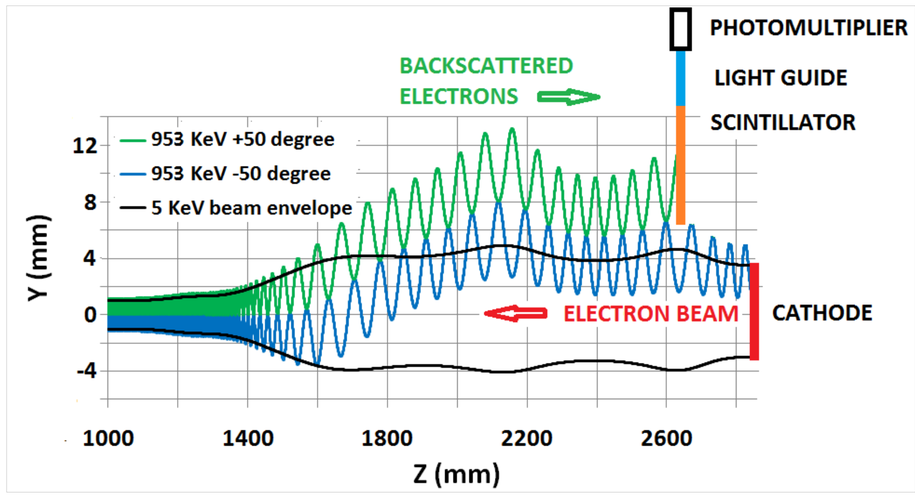
Isometric and cutaway plan view of one of the two electron lenses to be installed in RHIC.



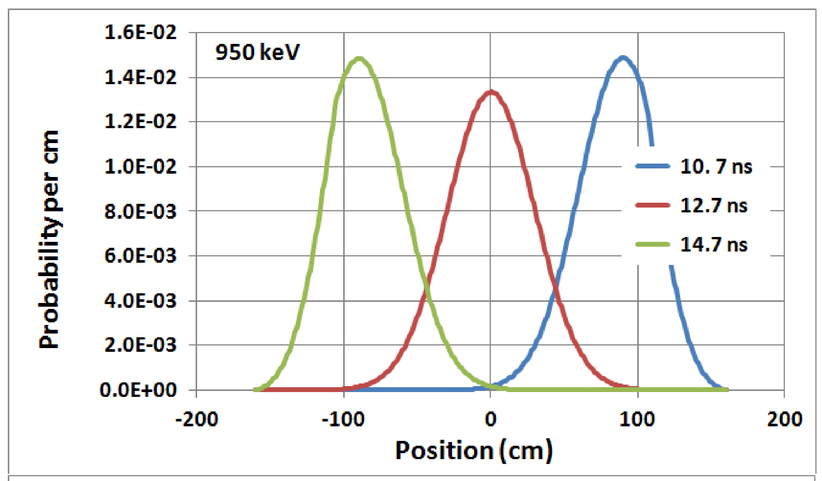
Positioning mechanism and vacuum-side view of the detector well with the attached thin tungsten foil used for detecting low energy electrons returning from the collector. The backscattered high energy electrons will emerge from the vacuum through a thin window and will be detected by a plastic scintillation detector.

CONCLUSIONS

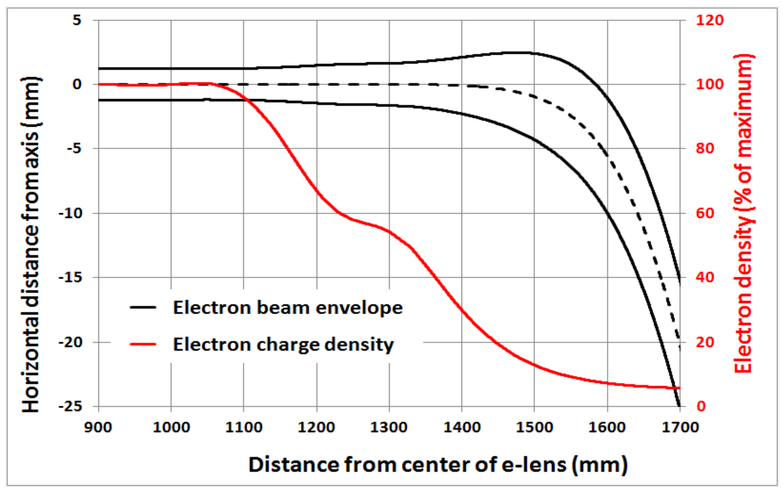
- **This system should provide a good "luminosity" signal to optimize the overlap of the electron and proton beams.**
- **Achieving good position sensitivity along the interaction length will be much more difficult but would also be very useful for tuning.**



Schematic representation of the backscattered electron detector. Trajectories of two spiraling electrons were generated with an Opera simulation.



Examples for two energies of ideal position resolutions that would be obtained for error-free electron energy and time measurements.



Electron beam envelope (black) and electron charge density (red) at one end of the interaction region showing that the correction due to the off-axis portions of the electron beam will be small.