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Simulation and analysis of electron guns based on Modelica language and electron beam theory

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Electron guns are widely used in electron accelerator technology. Despite the availability of various simulation tools, limitations remain in modular design, optimization, and computational efficiency. This study uses Modelica and electron beam theory to modularly model and simulate electron guns. The goal is to explore the emission, dispersion, and focusing characteristics of the electron beam under different electrode structures and voltage conditions.

The research modularizes the electron gun system using Modelica and performs simulations based on the dynamic equations of electron beams. Using the parallel-beam Pierce electron gun as an example, the study investigates the electron beam's emission, dispersion, and focusing. The program's accuracy is validated by comparing the results with electron beam theory and related studies, showing minimal error. The study simulates different electron guns by modifying components, revealing how electrode structures and voltage conditions affect electron beam behavior and providing insights for electron gun design and optimization.

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