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Monte Carlo Simulations of Electron Scattering Experiments

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Research Question

- Is it necessary to account for the following details when modeling electron scattering experiments?
  - True Interaction Volume When Using a Moveable Gas Mount
  - Gaussian Laser Distribution
  - Cosine-Squared Gas Distribution
- Experiments typically have a 10% error. Are these approximation errors greater than 10%?

Methodology

- Used a Monte Carlo Simulation: Performed operations on random points that represented electrons
- Written in Python
  - Used SciPy for Graphing
  - Used PyQt for GUI
  - Over 600 Lines of Code

Program Screenshots

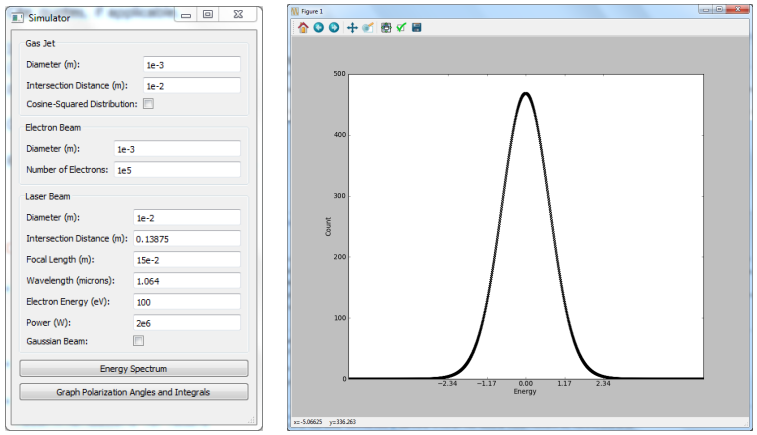

Figure 1. Parameter Window and Energy Spectrum

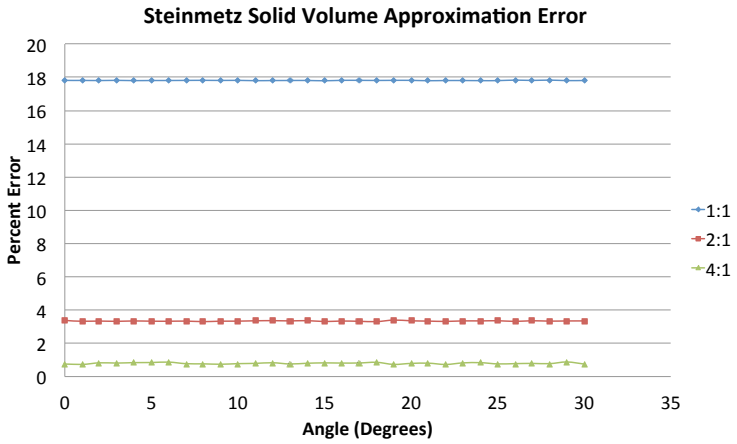

Figure 2. Approximation error of Steinmetz solid volume using a line/cylinder approximation

Results and Data Analysis

- Percent error of two cylinder interaction volumes when using line/cylinder approximation is displayed in *Figure 2*.
- Adding a Gaussian distribution to the laser alone does not make a difference of over 10%.
- Adding a cosine-squared distribution to the gas jet as well as the Gaussian distribution laser makes over a 10% difference when looking at 2 photons and above.

Conclusion

- A line/cylinder approximation for intersection volume cannot be used when the ratio of cylinders is approximately 1:1.
- One needs to take into account the cosine-squared gas distribution and the Gaussian distribution laser when looking at the absorption of two or more photons.