

Motivation

- Use Cyclotron Radiation Emission Spectroscopy (CRES) to reconstruct the beta decay spectrum of 6 He.
- •Check the validity of this experiment in a Penning trap.
- Fit the spectrum and measure the Fierz parameter.

Fierz Parameter

- In Standard Model Physics the Fierz term, b = 0.
- A deviation in b may lead to possible contributions of scalar or tensor couplings.



Fig.1 Ratio of energy spectrum with maximum allowed Fierz value with respect to the Stand ard Model.

 $F(\pm Z, E_{\rho})$ $W(E_e)dE_e = \frac{F(\pm Z, E_e)}{2\pi^3} p_e E_e (E_0 - E_e)^2 dE_e \xi \left(1 + b\frac{m_e}{E_e}\right)$

Cyclotron Radiation Emission Spectroscopy

- Measure the emitted cyclotron radiation from a beta particle as it travels through a constant magnetic field.
- Reconstructs the starting kinetic energy from the
- cyclotron frequency.

Cyclotron Radiation Emission Spectroscopy

Simulations with Kassiopeia

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Kassiopeia

 $f = \frac{1}{2\pi \left(m + \frac{E}{C^2}\right)}$

- Particle tracking simulation for navigating though complex electromagnetic fields [2].
- Allows us to track physical quantities through user defined spaces.
- •Spaces, fields and particle generators are defined in an XML file used to run the simulation.



Fig.2 Simulated Penning trap, modeled after SHIPTRAP[3], with a single electron track showing the loss of energy due to cyclotron radiation

Optimization of Kassiopeia

- Kassiopeia had extremely_ long computation times which had to be lowered. •Compared to Project8
- experiment to ensure the simulation remained physical





Fig.3 Spectrogram of a CRES event shown by Project8 [1]



observed from a Kassiopeia simulation.

Conclusions and Future Work

- per event.
- within the Penning trap.

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- ISOLTRAP" In: (Feb. 2005).

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Fig.4 Beta decay spectrum created from initial cyclotron frequency

 Successfully implemented a Penning trap into Kassiopeia and drastically reduced computation time

• Was able to use the CRES technique to reconstruct the top third of the beta decay spectrum of ⁶He •Will be constructing a waveguide in HFSS to test the ability to read the initial radiated frequency from

References

[1]Ali Ashtari Esfahani et al. "Determining the neutrino mass with cyclotron radiation emission spectroscopy—Project 8". In: J. Phys. G44.5

[2] Daniel Furse et al. "Kassiopeia: a modern, extensible C++ particle tracking package". In: New Journal of Physics 19.5 (May 2017), p.

[3] M. Saidur Rahaman. "First on-line mass measurements at SHIPTRAP and mass determinations of neutron-rich Fr and Ra isotopes at