

DarkLight non-A' Requirements

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DarkLight Collaboration Meeting

July 12, 2024



Non-A' Physics

Assuming we are only considering the 30 MeV program

- Radiative Møller scattering
- Bethe-Heitler Process
- Radiative Carbon Scattering
- Carbon FF
- Anything else?

With minimal changes to the 30 MeV program

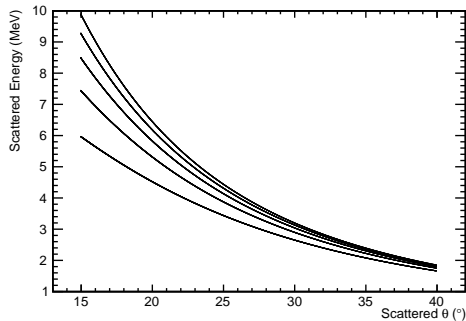
- $C + CH \rightarrow$ proton FF

Non-A' Physics

- Need both spectrometers and *at least* one spectrometer fully instrumented
 - 2 GEMs
 - Trigger scintillators
- Need low beam current, 1-10 μA
- Beam energy scanning capabilities, 10-30 MeV

Radiative Møller Scattering

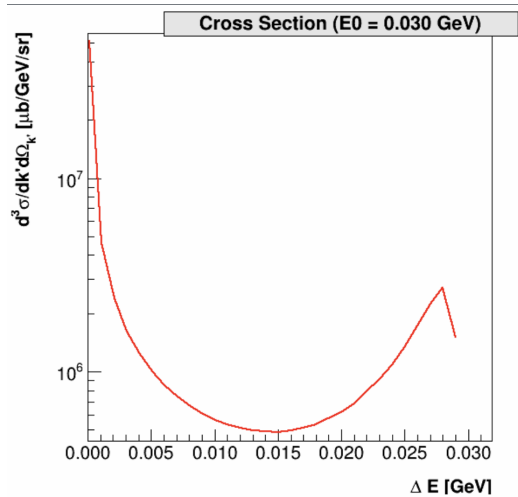
- Requires fully instrumented 20° spectrometer + DAQ
- Energy likely too low for 36° spectrometer
- Discussed in several collaboration meetings already
- Well-understood measurement
- Generators in hand



Møller scattered energy rate versus scattered angle. 30 MeV line on top, 10 MeV line on bottom.

Radiative Carbon Scattering

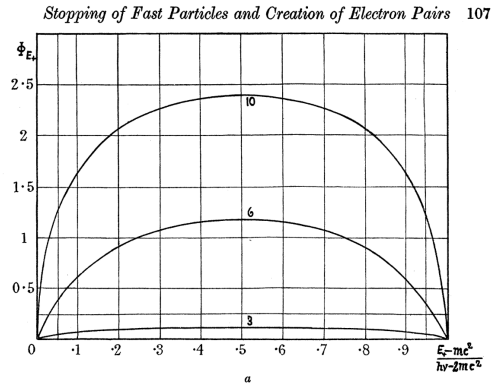
- Can be performed on either/both spectrometers
- Requires full instrumented spectrometer + DAQ
- Use the beam current requirements for commissioning
- Beam energy scanning capabilities, 10-30 MeV
- Measure inelastic Hoyle state



Cross section simulation using A1 eC generator.
Figure from Story.

Bethe-Heitler Pair Production

- e^+e^- pairs produced from eC scattering
- Should be \approx flat spectrum as a function of energy
- Can probe the spectrum with momentum by tuning magnetic fields
- **This is a major experimental background**



H. Bethe, W. Heitler, 1934. Cross section of positron production against fraction of incoming electron kinetic energy

Carbon FF

- Have already discussed calibrating experiment with C elastic line
- Elastic scattering \rightarrow radius
- Desire both spectrometers fully instrumented + DAQ
- Benefit: Completely parasitic to calibration measurements, well studied nucleus, can be used as a benchmark
- Have generator from A1 group courtesy of Miha
- $Q_{\max}^2 \approx 3 \times 10^{-4} (\text{GeV}^2) \rightarrow \text{FF} \approx 1$

Minimal Extension to Planned Experiment

- C+CH Target → proton FF
 - Requires a CH target, would mean replacing either C or Ta on target ladder
 - For a smoother measurement, would want to replace Ta so transition between targets is smooth
 - Obvious difficulty with commissioning
 - Run at several beam energies with measurements on both spectrometers
 - Difficulty in subtracting background to high precision, haven't studied count rates at all

Summary

Measurement	Target	Spectrometer	Beam Current	Beam Energy
Møller Scattering	C	(-)20°	1-5 μ A	10-30 MeV
Rad. C Scat.	C	(-)20° or (-)36°	1-5 μ A	10-30 MeV
Bethe-Heitler	C	(\pm)20° or (\pm)36°	1-5 μ A	10-30 MeV
Carbon FF	C	(-)20° and (-)36°	1-5 μ A	10-30 MeV
Proton FF	C+CH	(-)20° and (-)36°	1-5 μ A	10-30 MeV

Summary of non-A' physics objectives and equipment needed. Note all on carbon, all low current, all energy scanning. Proton FF requires a change to the target ladder to have the CH target.

These non-A' measurements are our commissioning measurements or are parasitic to them!