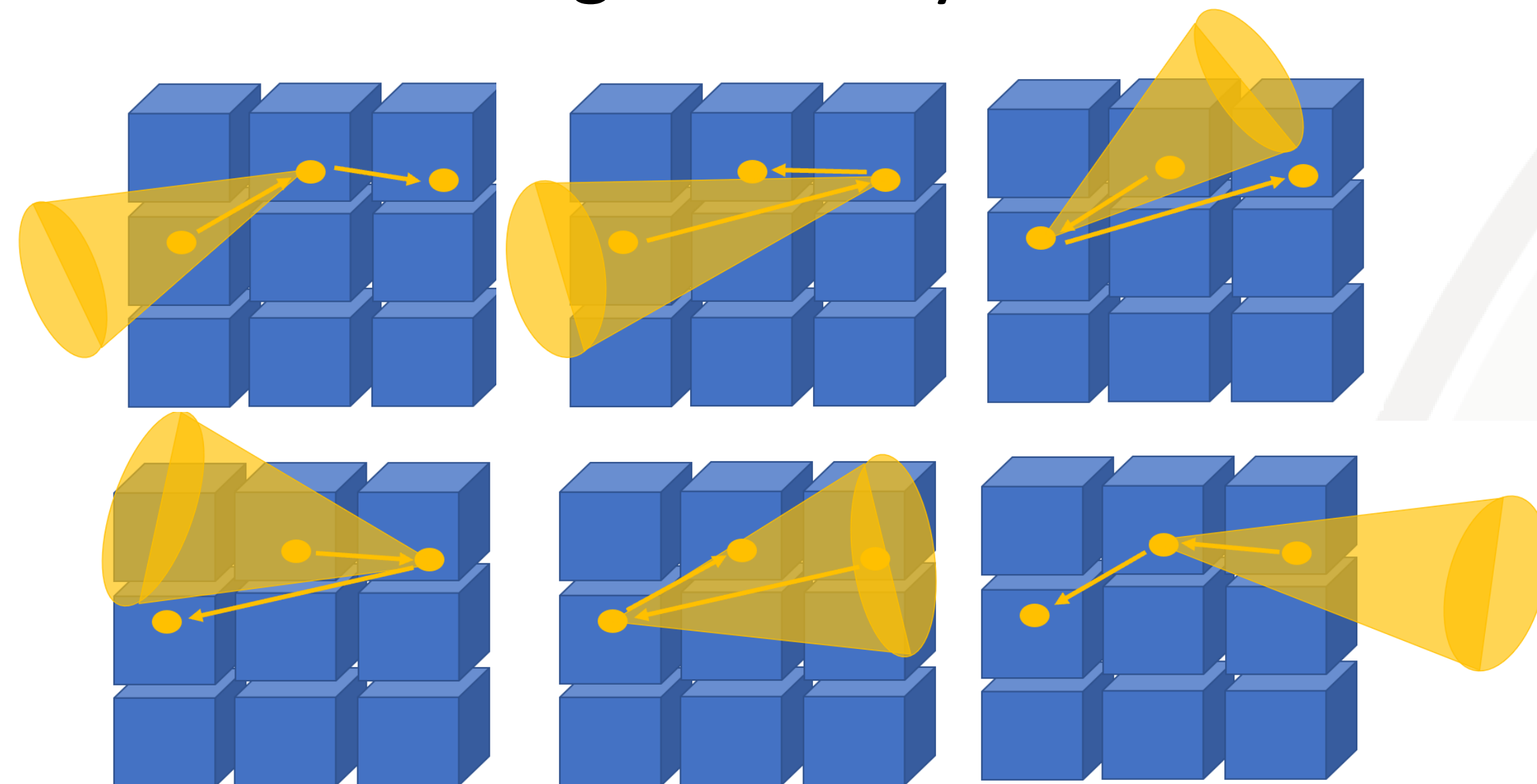


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## Introduction and Motivation

- Compact detectors with low timing resolution require sequencing the order of interactions for multi-interaction gamma-ray events.



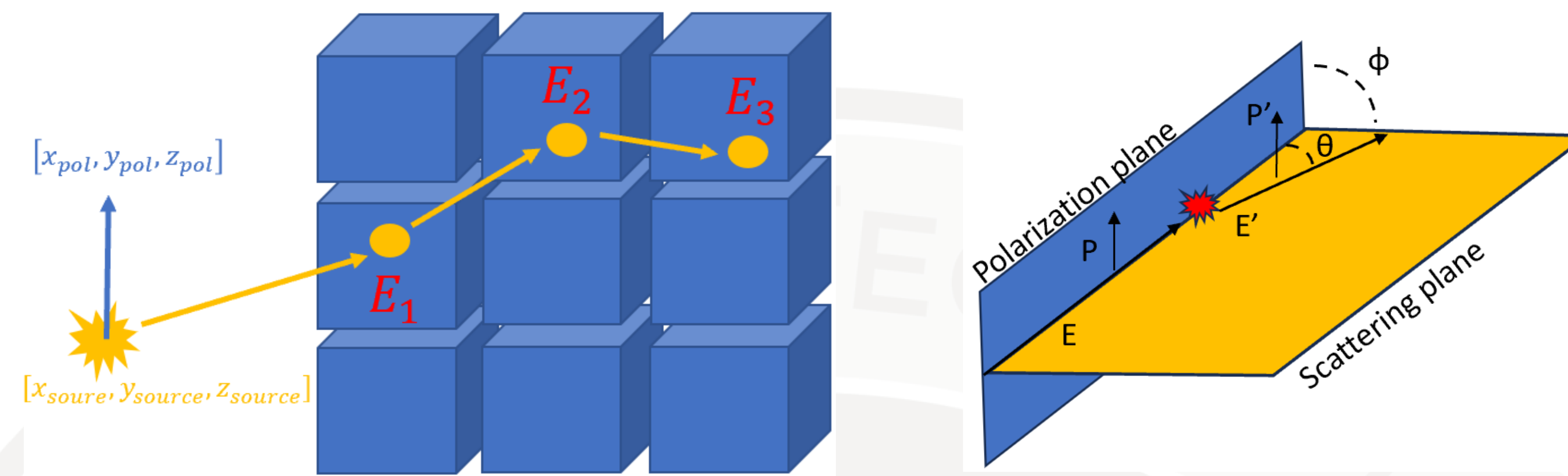
- This work focuses on improving the probabilistic method of sequence reconstruction for Compton imaging by accounting for the photon's polarization.

## Mission Relevance

- Determining the sequence of multiple gamma-ray interaction events is critical to providing the correct source direction, therefore impacting applications such as detecting and locating gamma-emitting materials.

## Technical Approach

- Compare sequencing performance of conventional and proposed method.



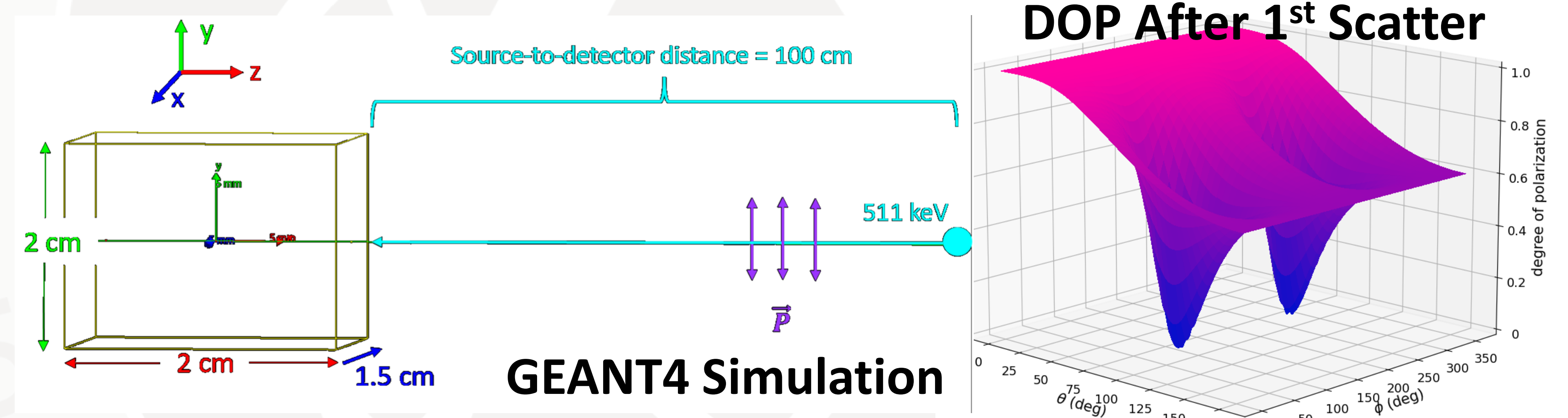
The probability of attenuation, scattering, and absorption are used to calculate the likelihood of each sequence.

The conventional method uses the unpolarized Klein-Nishina (KN) cross-section to calculate the probability of a Compton scatter whereas the proposed method uses the general (KN) cross-section (1).

$$\frac{d\sigma}{d\Omega} = \frac{1}{2} r_0^2 \left(\frac{E'}{E}\right)^2 \left[ \frac{E'}{E} + \frac{E}{E'} - \sin^2 \theta - DOP \sin^2 \theta \cos 2\phi \right] \quad (1)$$

The unpolarized KN was replaced with the general KN in GEANT4.

## Results



Proposed Method's Performance for  $DOP_0 = 1$  and  $DOP_0 = 0$  Source

$E_0$ (keV)	No. interactions	$DOP_1 \approx 1$	$DOP_1 \approx 0$	$DOP_1 \approx 0.6$
511	3	- 0.34 %	+ 4.83 %	- 0.52 %
511	4	- 3.04 %	+ 2.23 %	- 1.26 %

$E_0$ (keV)	No. interactions	$DOP_1 < 0.1$	$DOP_1 \approx max$	$DOP_1 < 0.1$
511	3	- 1.62 %	+ 2.05 %	- 0.03 %
350	3	-	+ 3.06 %	-

$DOP_0$  &  $DOP_1$  are the degree of polarization before and after 1<sup>st</sup> scatter

## Expected Impact

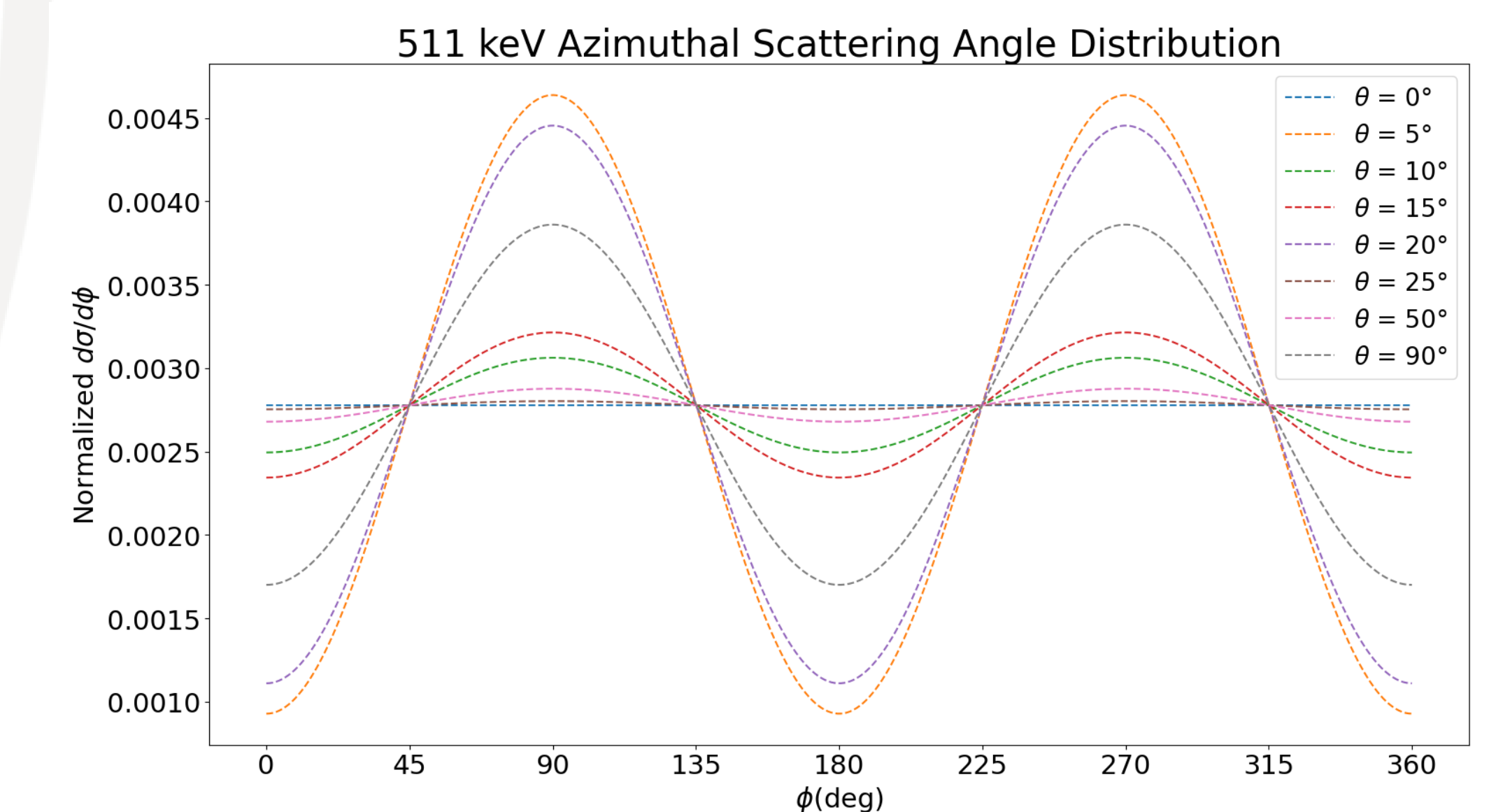
- This work can improve the Compton imaging of unpolarized and polarized sources.
- Polarized sources are imaged in PET scans and in astrophysics.

## MTV Impact

MTV has provided me with the opportunity to attend workshops and conferences where I can present my work and learn from others.

## Conclusion

Replacing the unpolarized KN cross-section with the general KN cross-section improves overall sequencing performance.



Improvement when  $\phi$  distribution varies most from uniform distribution

## Next Steps

- Explain why there was less improvement for 4-interaction full-dep events
- > 1 MeV photons check sequencing performance for all 3+ interaction events
- Confirm the results experimentally