Gamma-ray Compton imaging uses the three-dimensional position and scattering angle of the first gamma-ray scattering of multiple interaction events to reconstruct the direction of incident photons. However, semiconductor gamma-ray detectors, such as 3-D position sensitive Cadmium Zinc Telluride detectors, do not have a fast enough timing resolution to determine which of the multiple gamma-ray interactions in the first one. Therefore, determining the sequence of multiple gamma-ray interactions is critical to providing the correct source direction and impacts applications such as detecting and locating gamma-emitting materials. This work focuses on improving the probabilistic method of sequence reconstruction for Compton scattering. This method calculates the probability of each sequence per event, where an event consists of all recorded gamma-ray energy depositions that a single photon undergoes in the detector, and then selects the most probable sequence as the correct one. Currently, the unpolarized Klein-Nishina formula is used to calculate the probability of a scatter, and the photoelectric absorption cross section is used to determine the probability of a photoelectric absorption. Yet, studies have shown that for an initially unpolarized photon, even after one scatter, the photon may acquire a degree of polarization significant enough such that the polarized Klein-Nishina formula should better describe the scattering physics process. Unlike the unpolarized Klein-Nishina formula, which is a function of incident energy and polar scattering angle, the polarized Klein-Nishina formula depends also on the azimuthal scattering angle. The azimuthal angle cannot be calculated directly from the recorded gamma-ray interaction positions unless the initial source polarization plane or source location are known. Methods are being investigated to apply the known gamma scattering physics to make assumptions about the azimuthal angle distribution to improve the performance of gamma-ray Compton scattering imaging.