

POLARIZATION SENSITIVITY AS A FUNCTION OF COMPTON SCATTERING ANGLE AND GAMMA ENERGY

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for the ANL1475 Collaboration

April 4-6, 2018

Orsay, France

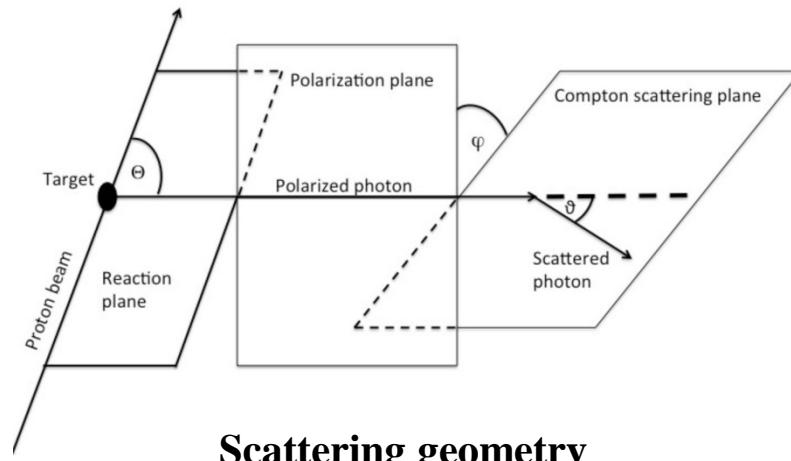
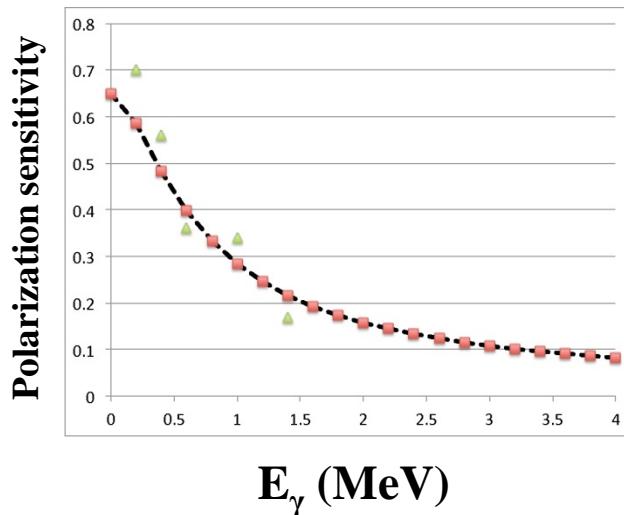


COMPTON SCATTERING & POLARIZATION

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

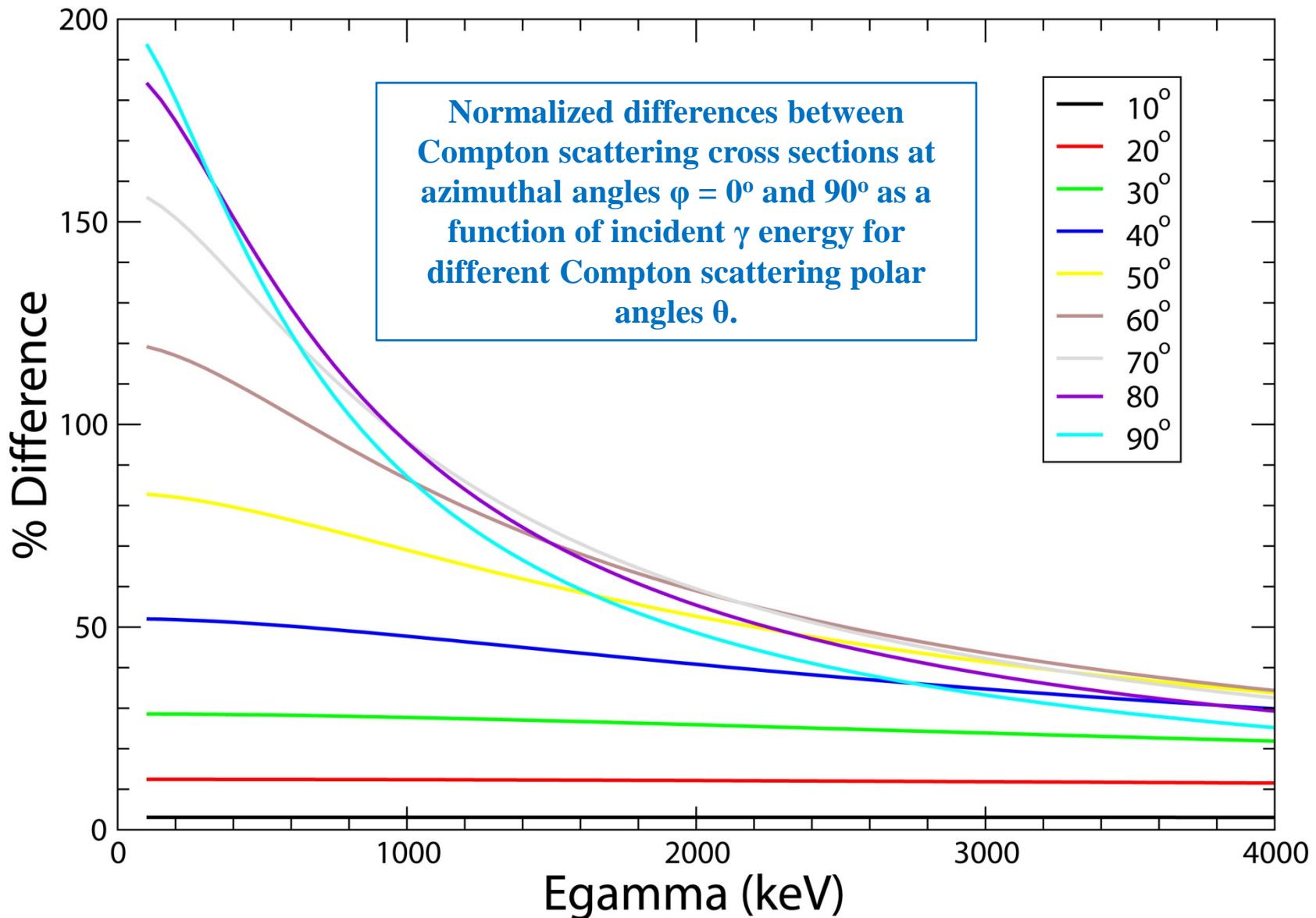
O. Klein & Y. Nishina – Z. Phys. 52, 853 (1929)

Where $r_0 = e^2/m_e c^2$, E, E' are the initial and scattered photon energies, and the Compton scattering angles θ and φ are defined in the figure below right: P varies from 0 to 1 depending on the degree of alignment of the parent state.

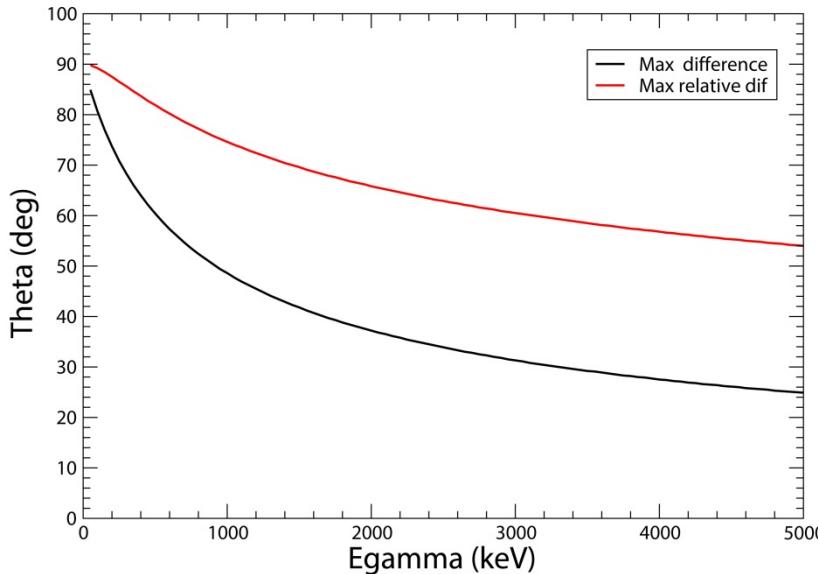
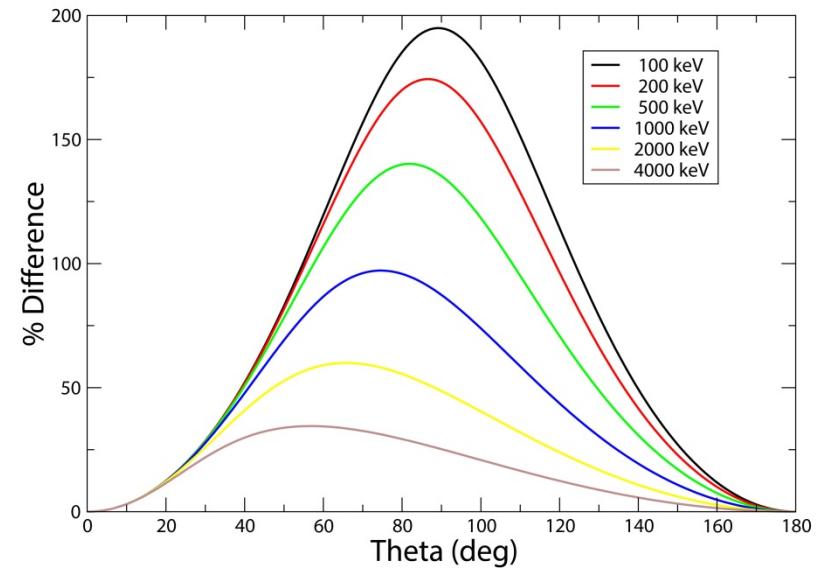
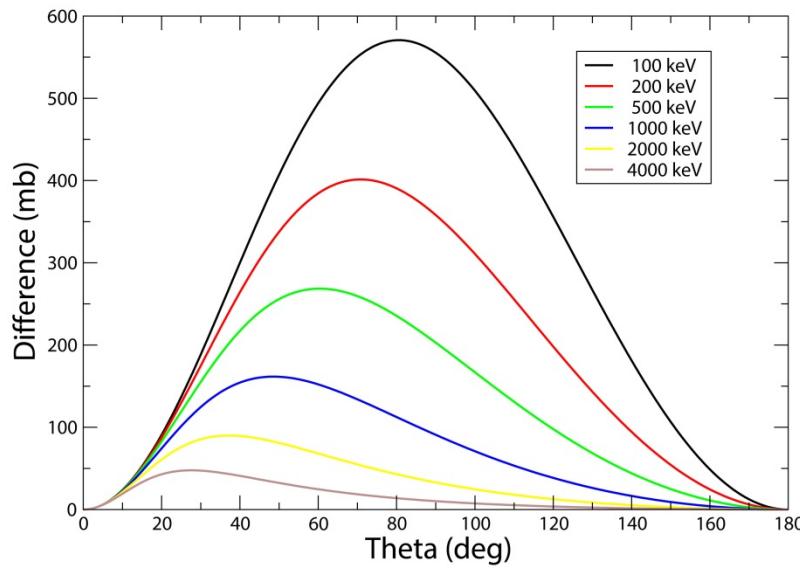


A. Wiens, A. O. Macchiavelli, *et al.*, BAPS 2014 HAW DK2

Simulations of Klein-Nishini Equation



Simulations of Klein-Nishini Equation



Above: Polarization sensitivity as a function of Compton scattering polar angle θ for a range of incident γ energies, both absolute and relative.

Left: Compton scattering angle θ of maximum polarization sensitivity in absolute and relative terms as a function of $E\gamma$.

PRESENT POLARIZATION MEASUREMENT

$^{18}\text{O} + ^{18}\text{O}$ at $E_{\text{lab}} = 28.7 \text{ MeV}$

7 modules of GRETINA + Phoswich Wall

First time GRETINA & PW used together!

Average angles of GRETINA modules:

θ : $59^\circ, 90^\circ, 90^\circ, 90^\circ, 121^\circ, 121^\circ, 147^\circ$

ϕ : $288^\circ, 198^\circ, 234^\circ, 306^\circ, 252^\circ, 318^\circ, 290^\circ$

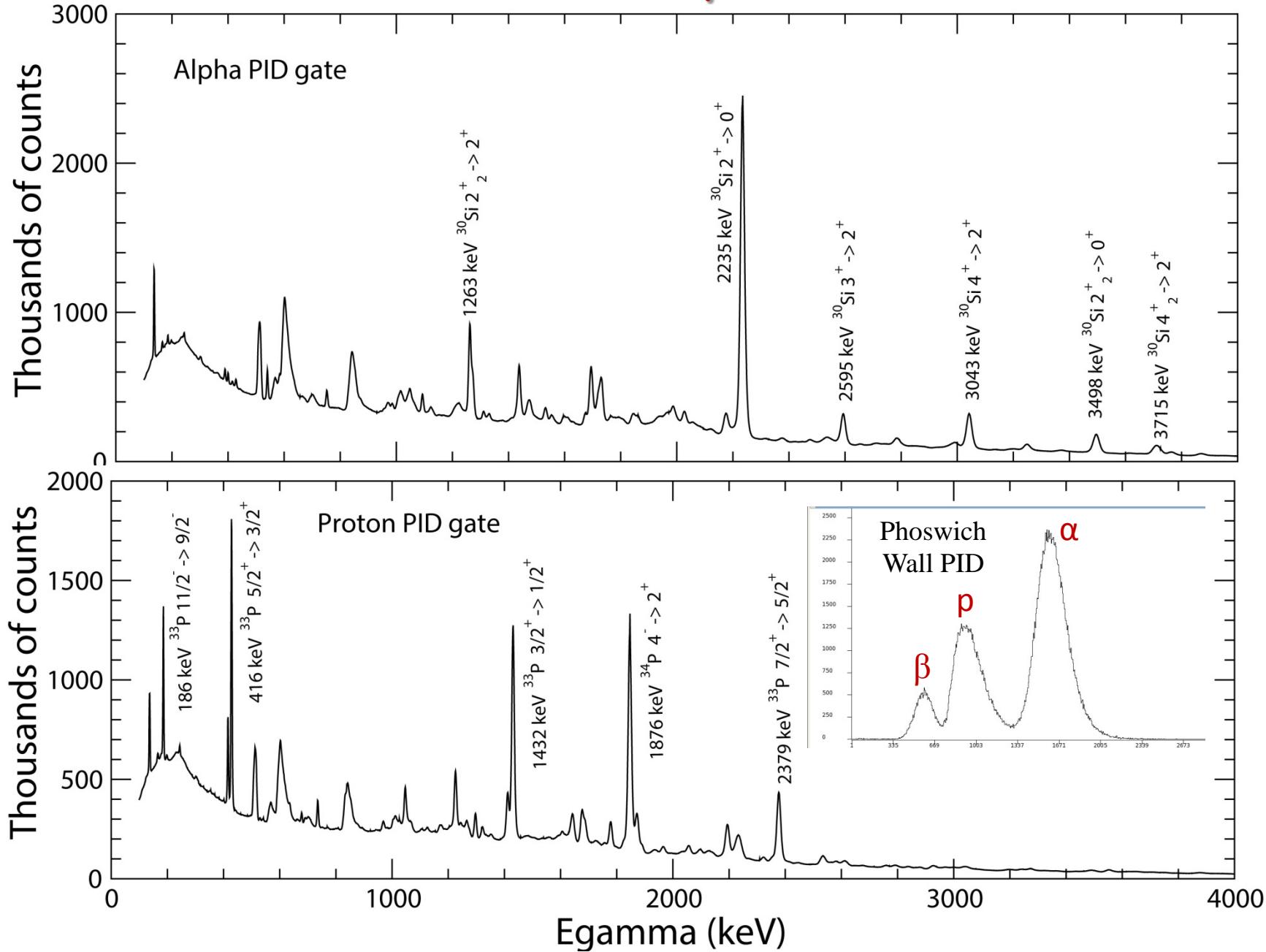
CALIBRATIONS

^{152}Eu 1408 keV and ^{88}Y 1835 keV lines 8 hours each

Sources placed at target position with Phoswich Wall in place

IDENTICAL cuts placed in source spectra as on in-beam data

PARTICLE-GATED γ SPECTRA



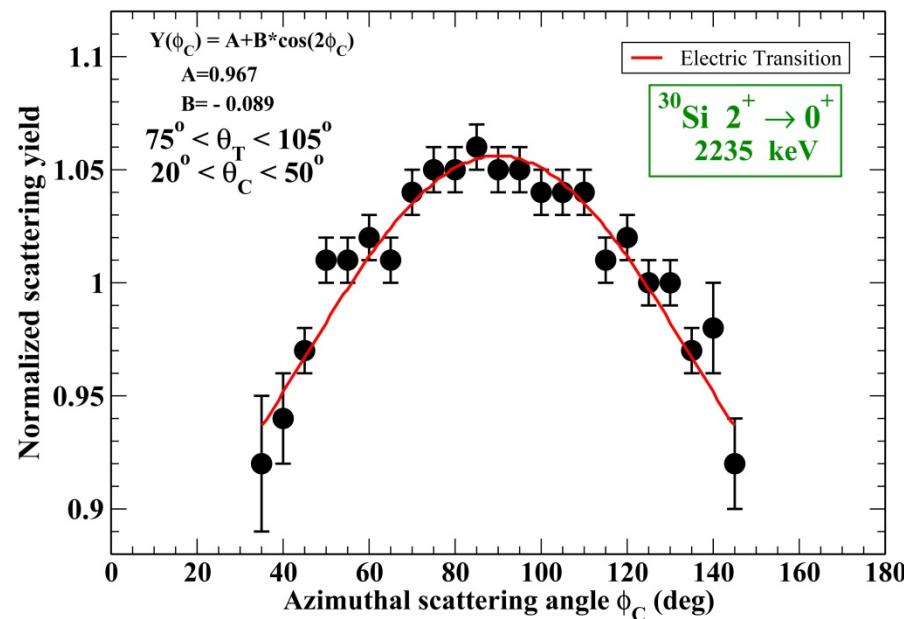
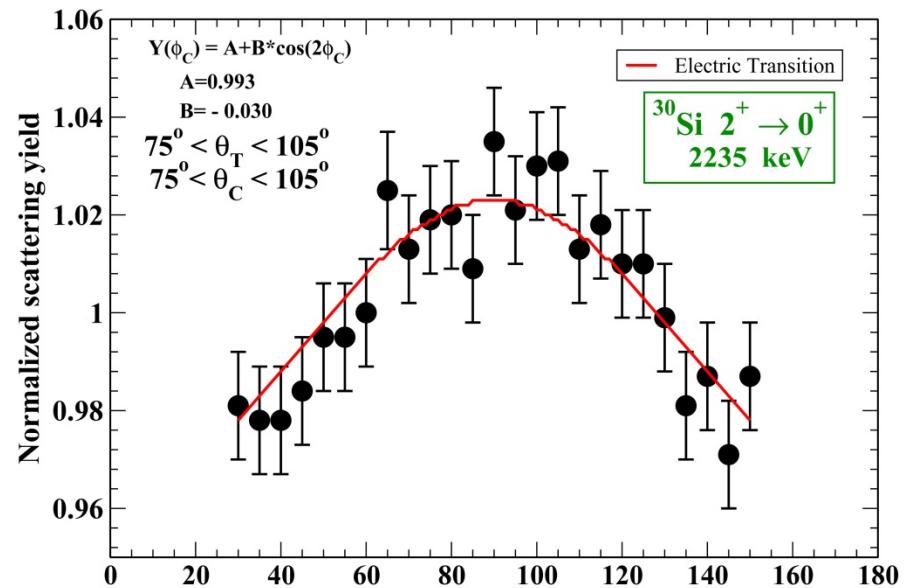
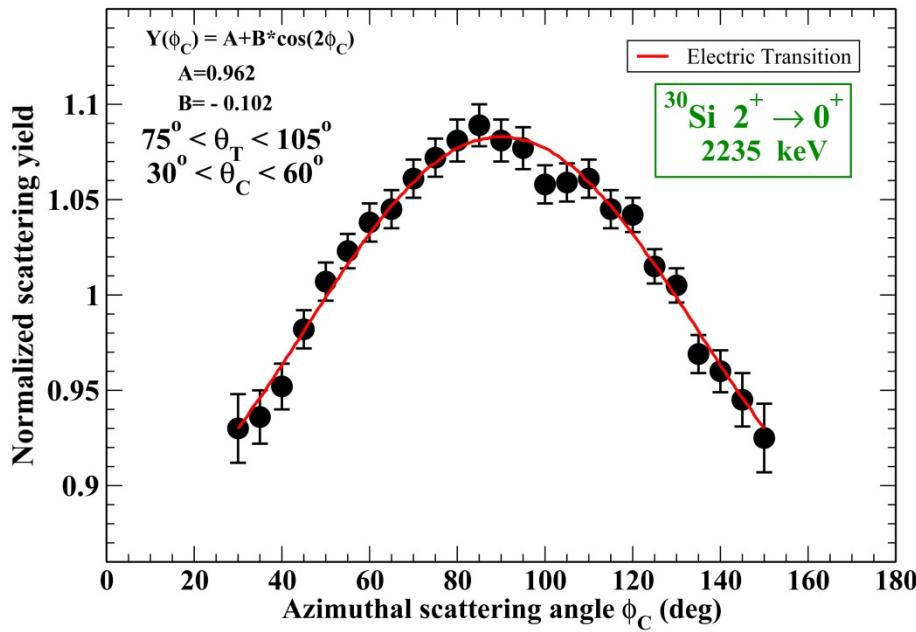
POLARIZATION of 2235 keV $2^+ \rightarrow 0^+$ LINE in ^{30}Si

Cuts made on

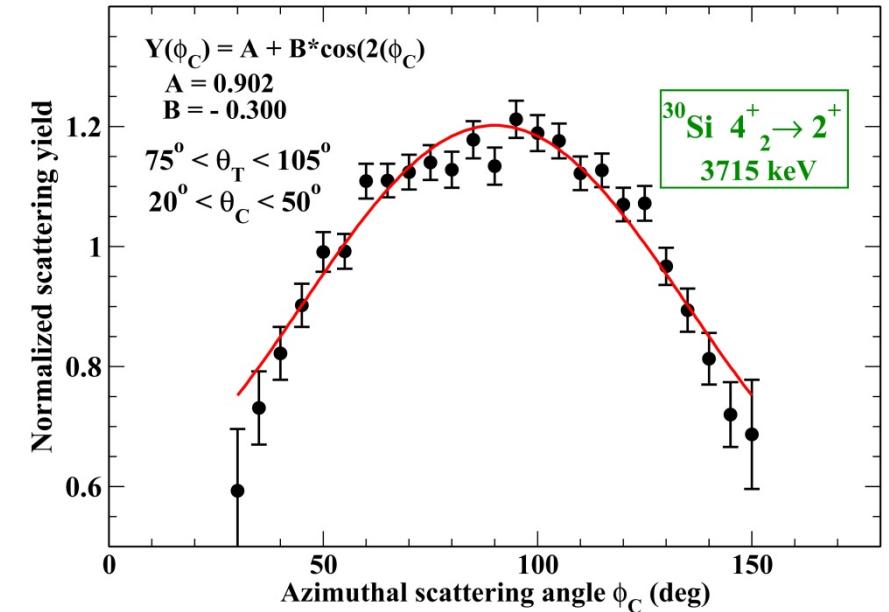
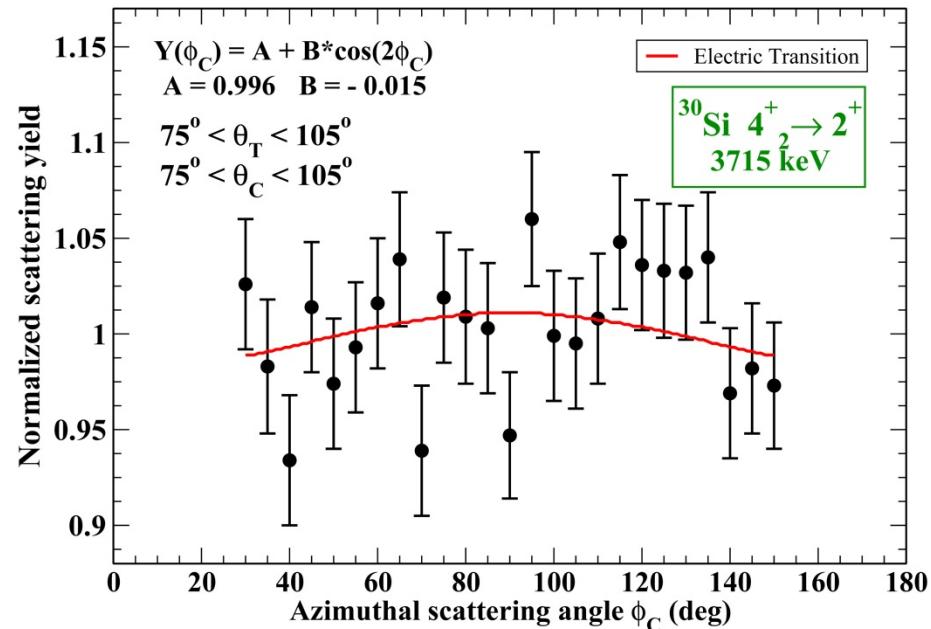
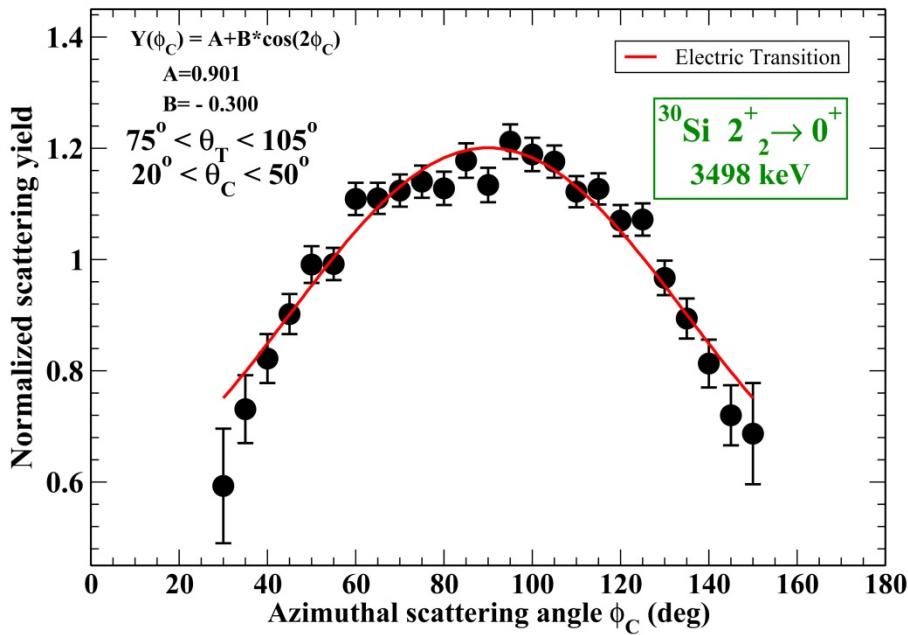
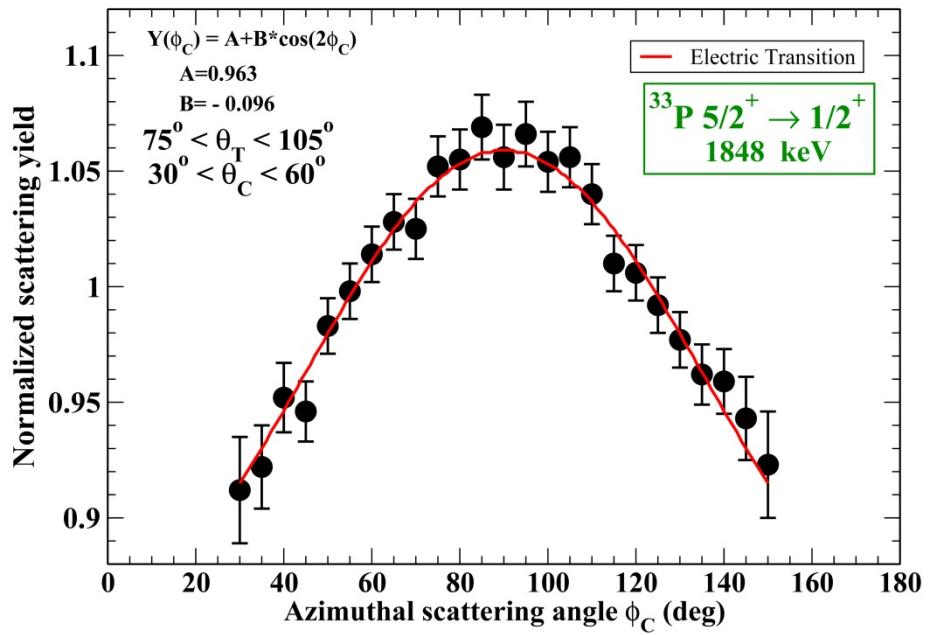
L: length between 1st and 2nd interaction points

θ_T : polar angle of incoming γ relative to beam

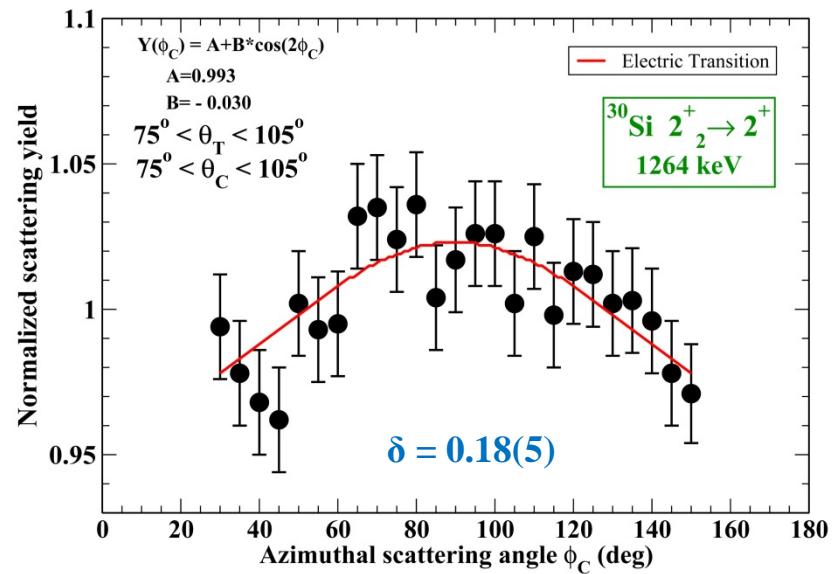
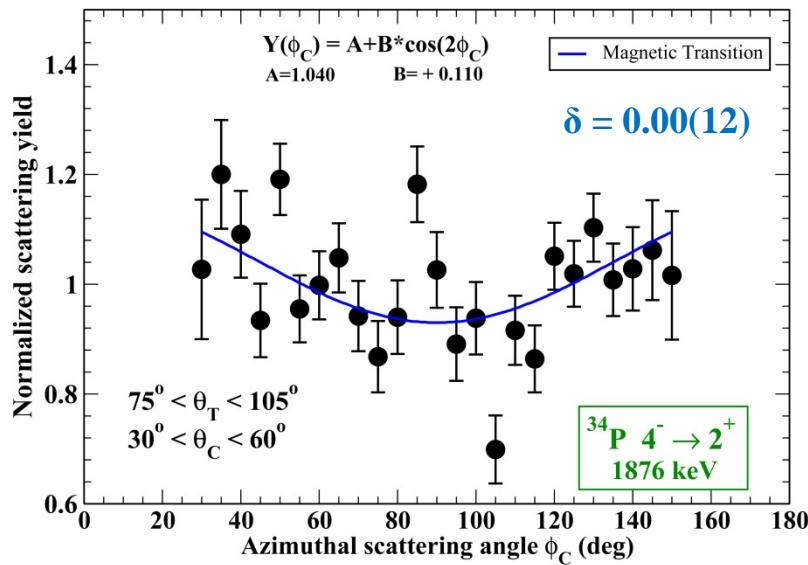
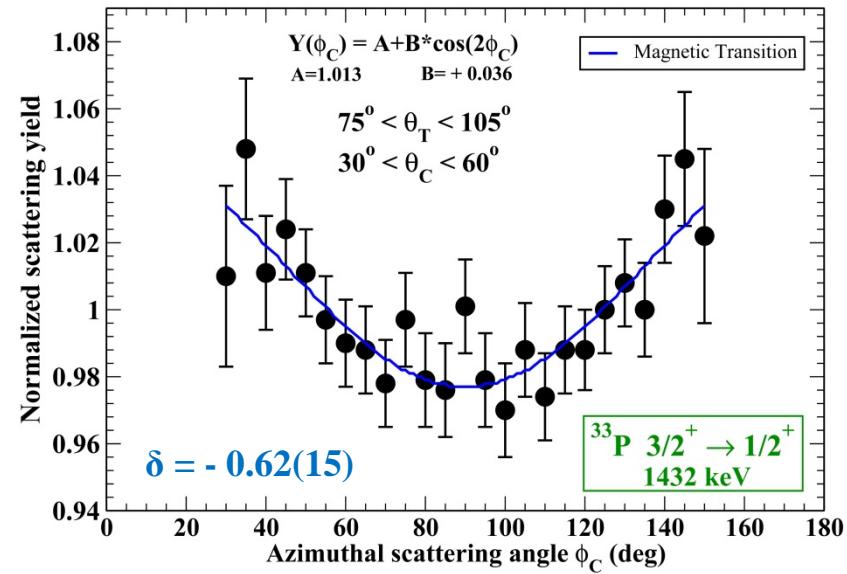
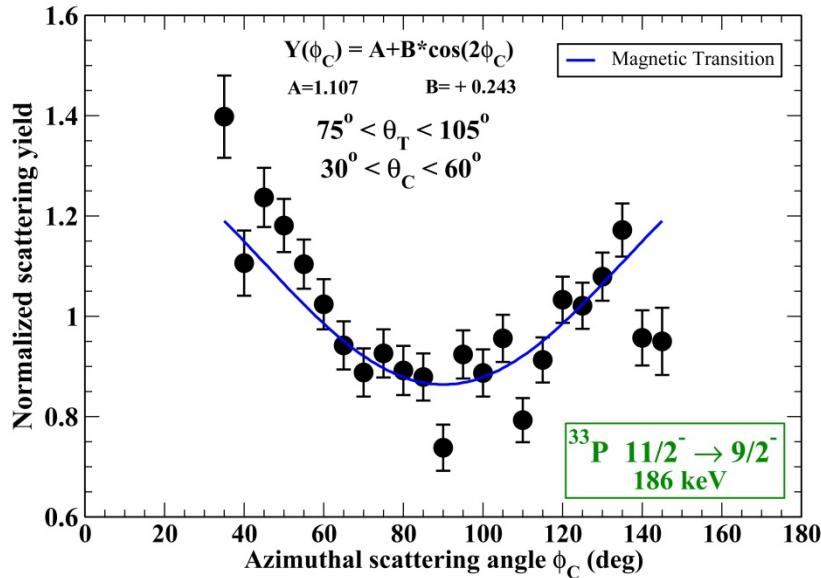
θ_C : polar angle of scattered γ relative to initial one



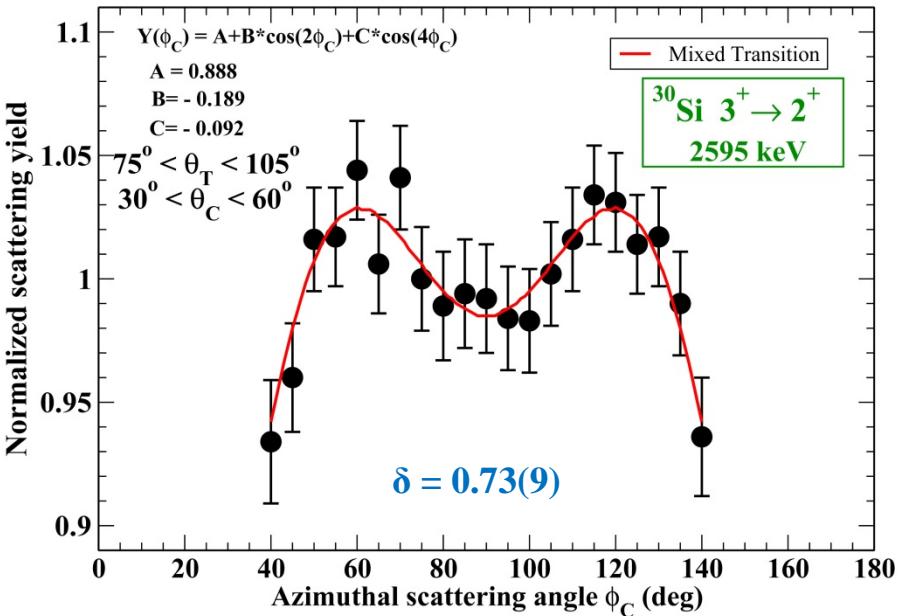
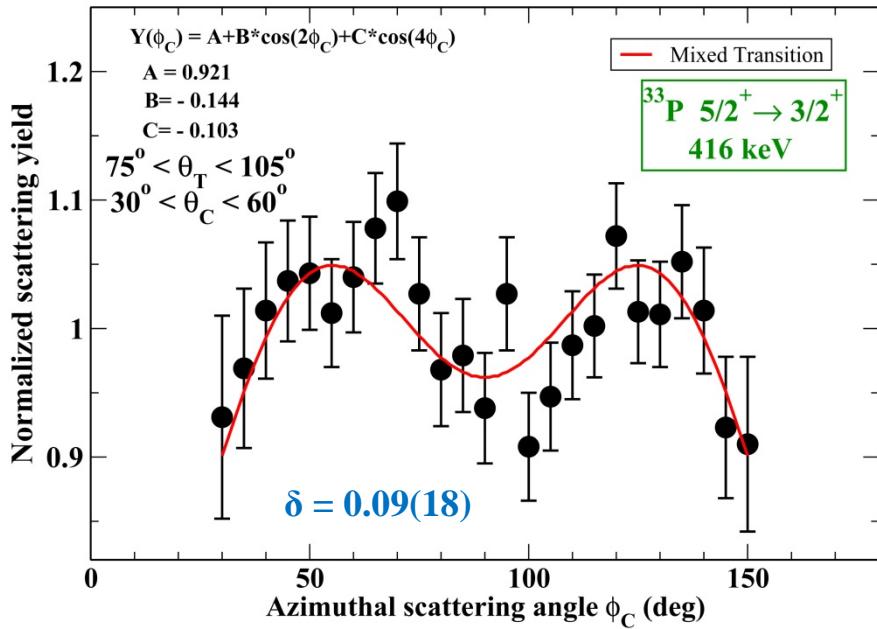
MORE E2 POLARIZATION CURVES



M1/E2 TRANSITIONS – A MIXED BAG



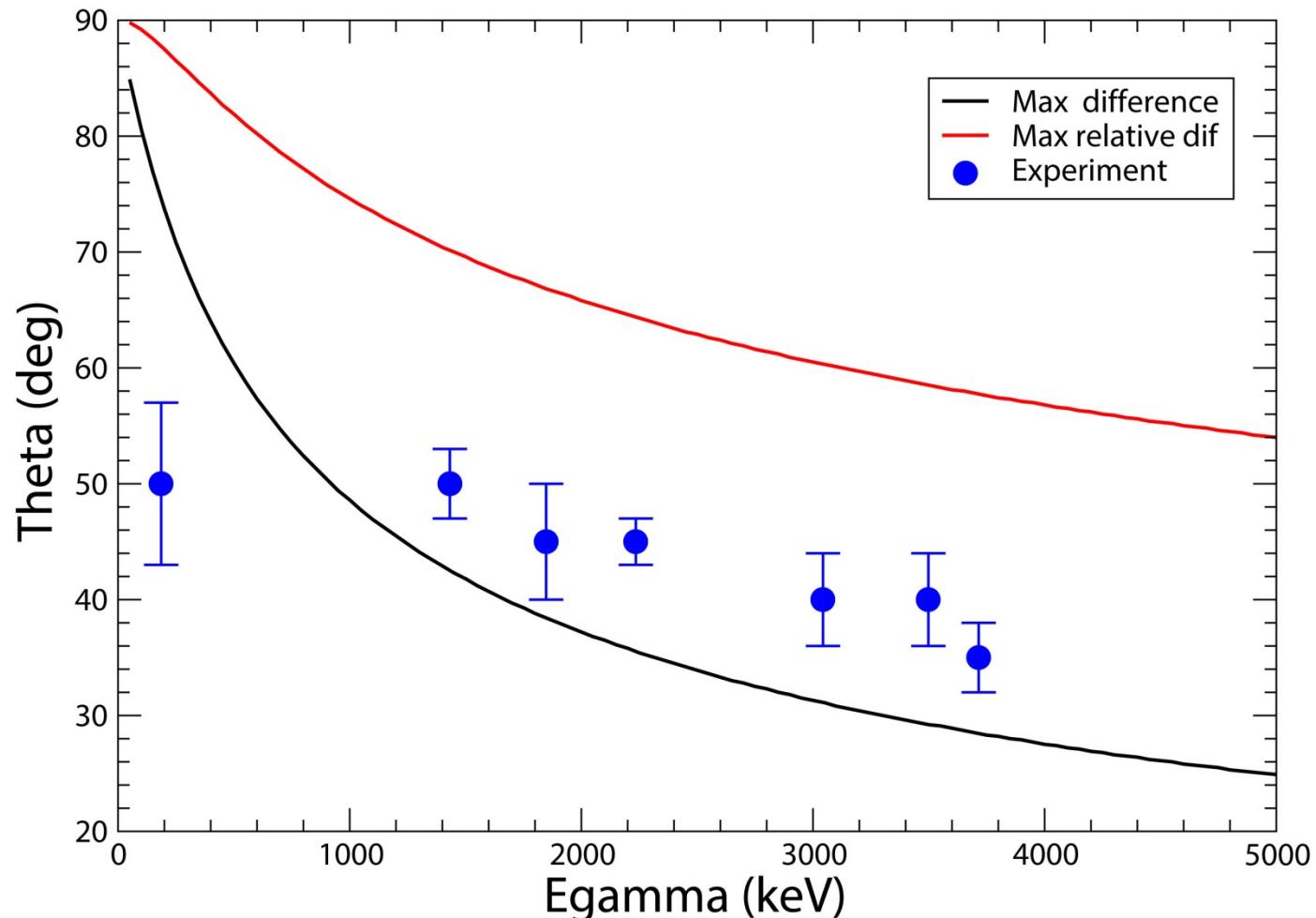
M1/E2 TRANSITIONS – A MIXED BAG



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- Fitted with: $Y(\phi) = A + B \cos(2\phi) + C \cos(4\phi)$
- Note: $2 \sin(\phi)\cos(\phi) = \sin(2\phi)$
- M1 – E2 interference???
- Some artifact ???

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SUMMARY

- * **GRETINA is the best Compton polarimeter in the U.S. because of its ability to allow variable angle cuts and to directly view the ϕ dependence.**
- * **Identical cuts must be made on the normalization data so high statistics are needed to not limit accuracy**
- * **Simulations suggest that the optimum Compton scattering polar angle θ for maximum polarization sensitivity decreases with increasing γ energy.**
- * **Measurements confirm that more forward Compton scattering polar angles θ enhance the polarization sensitivity for higher γ energies.**

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