Double polarisation observable G at MAMI

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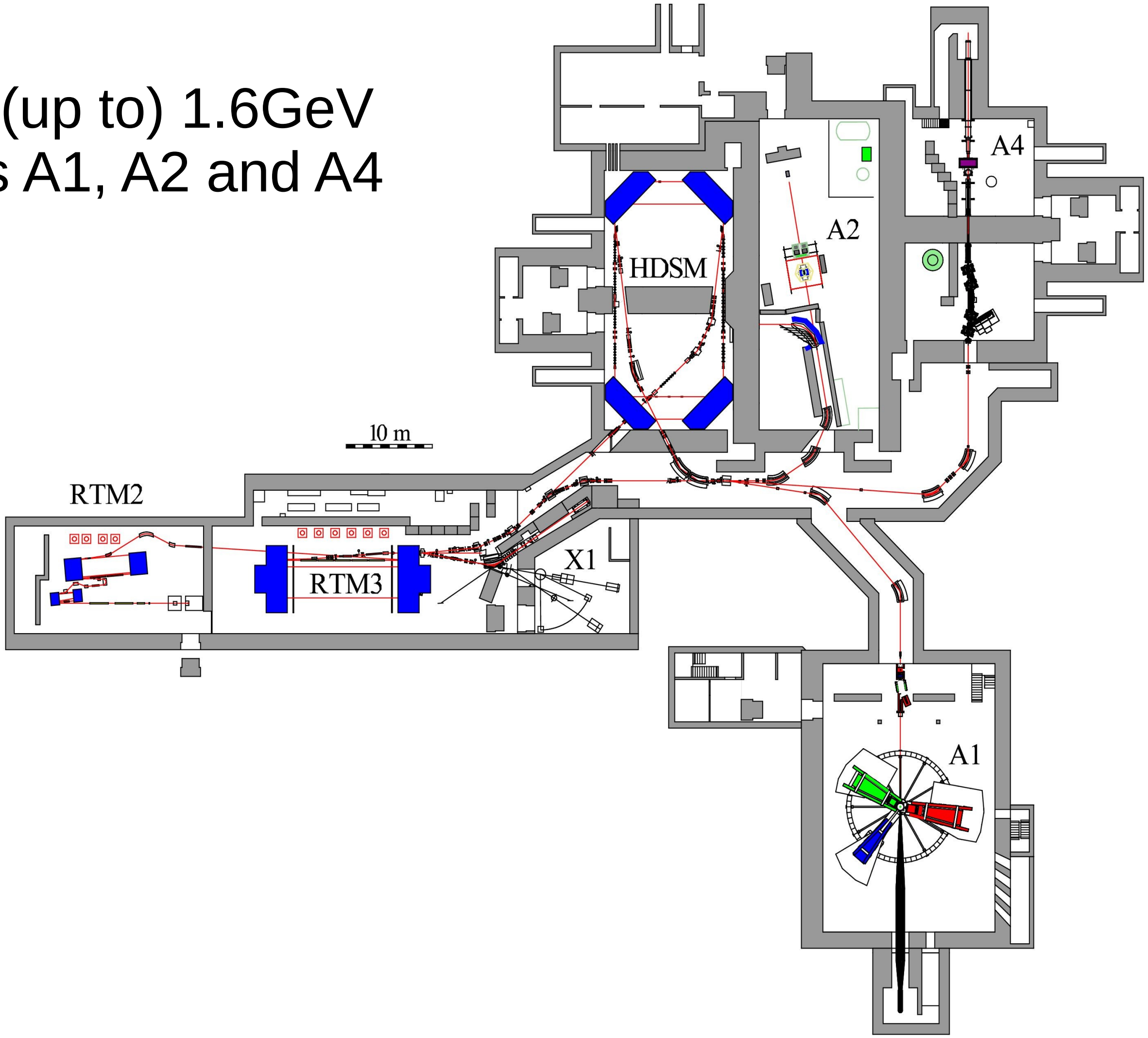
Outline

- General MAMI overview
- Polarisation observables
- Tagging efficiency using photon tagger
- Pair spectrometer comparison

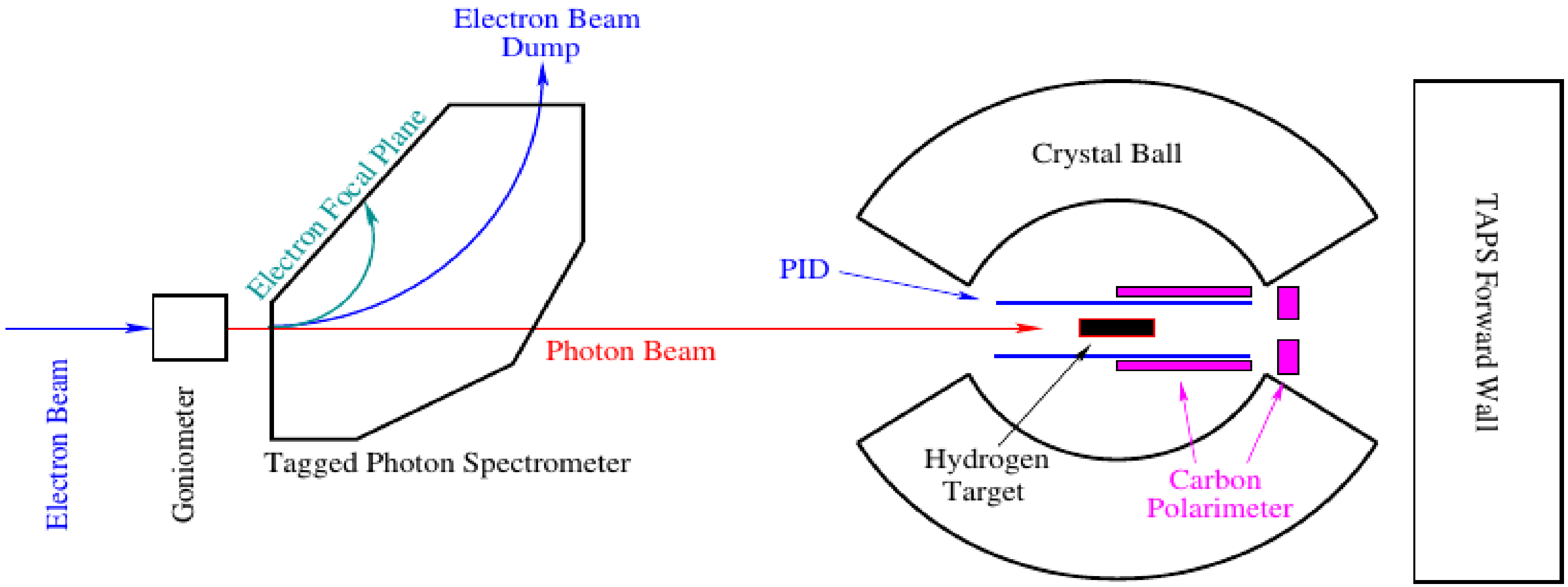
MAMI, Mainz Germany

MAMI

- Electron beam – (up to) 1.6GeV
- Fed to three halls A1, A2 and A4



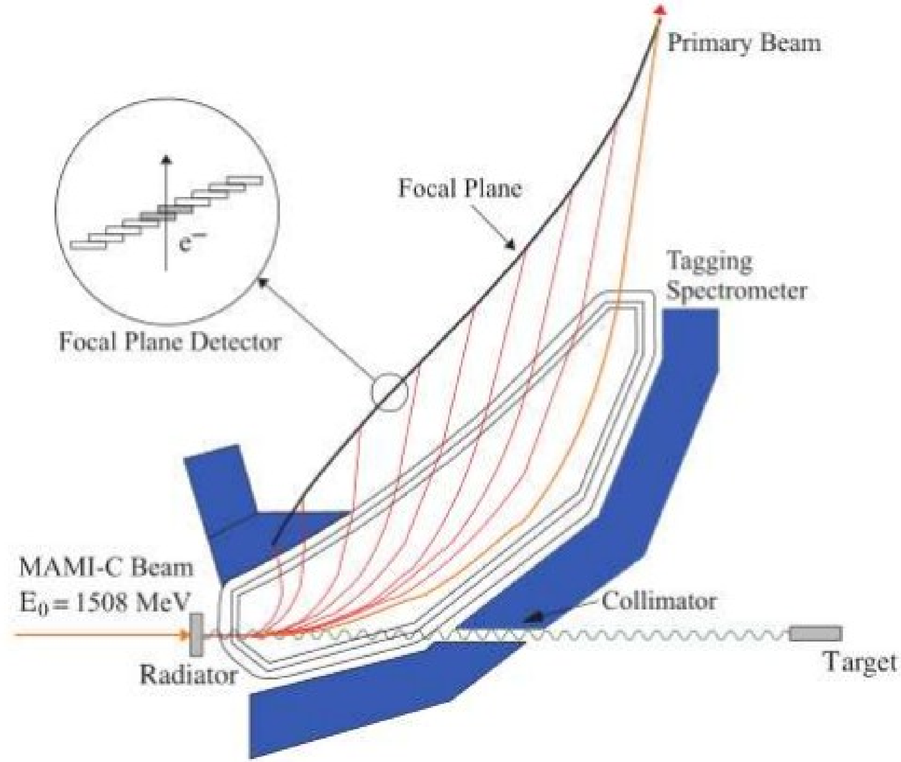
A2 Hall



- Main detectors: Photon tagger, Crystal ball, TAPS and PID

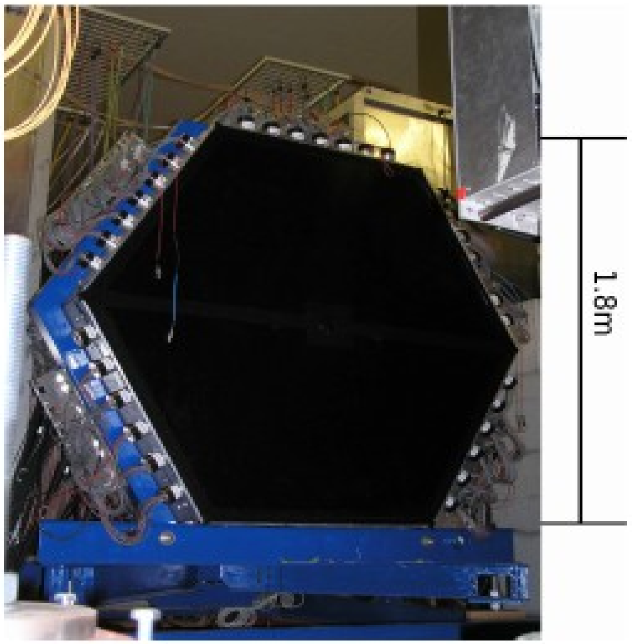
Photon Tagger

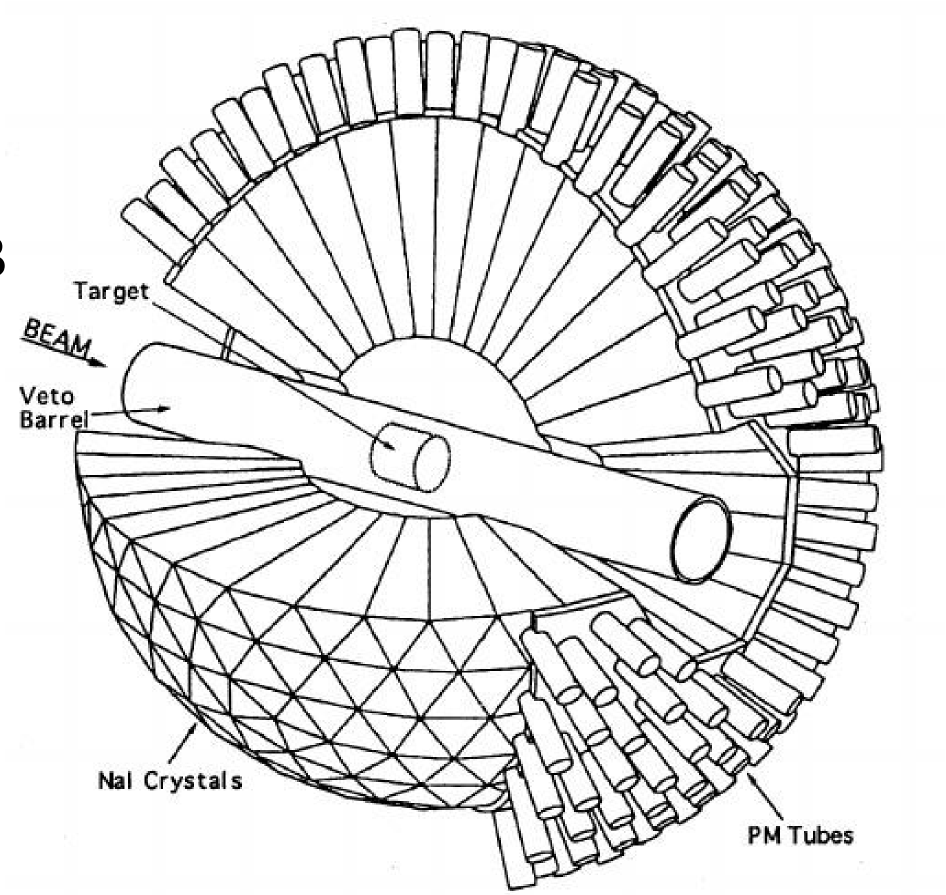
- 352 overlapping plastic scintillators
- ~5-95% beam total energy coverage
- Detects electron hits
- Electrons bent away from main target
- 2mm collimator



Crystal Ball & TAPS

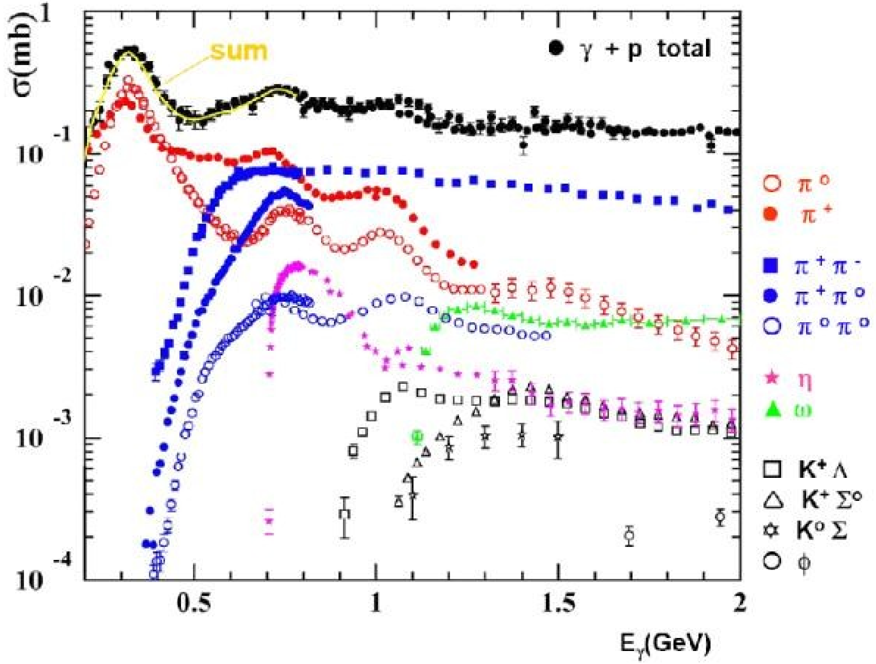
- 672 NaI crystals in CB
- ~ 94% 4π coverage
- TAPS – 384 BaF2 crystals
- PID surrounds target housed in CB





Polarisation observables

- Total p cross section with many resonances
- Greater sensitivity to resonant structure
- 16 different observables



		Target (P^T)			Recoil (P^R)			Target (P^T) + Recoil (P^R)								
					x'	y'	z'	x'	x'	x'	y'	y'	y'	z'	z'	z'
Beam (P^γ)		x	y	z				x	y	z	x	y	z	x	y	z
Unpolarized	$d\sigma_0$		$\hat{T}$			$\hat{P}$		$\hat{T}_{x'}$		$\hat{L}_{x'}$		$\underline{\hat{\Sigma}}$		$\hat{T}_{z'}$		$\hat{L}_{z'}$
$P_L^\gamma \sin(2\phi_\gamma)$		$\hat{H}$		$\hat{G}$	$\hat{O}_{x'}$		$\hat{O}_{z'}$		$\hat{\mathbf{C}}_{\mathbf{z'}}$		$\hat{\mathbf{E}}$		$\hat{\mathbf{F}}$		$-\hat{\mathbf{C}}_{\mathbf{x'}}$	
$P_L^\gamma \cos(2\phi_\gamma)$	$-\hat{\Sigma}$		$\underline{-\hat{P}}$			$\underline{-\hat{T}}$		$-\hat{\mathbf{L}}_{\mathbf{z'}}$		$\hat{\mathbf{T}}_{\mathbf{z'}}$		$-\mathrm{d}\sigma_0$		$\hat{\mathbf{L}}_{\mathbf{x'}}$		$-\hat{\mathbf{T}}_{\mathbf{x'}}$
Circular P_c^γ		$\hat{F}$		$-\hat{E}$	$\hat{C}_{x'}$		$\hat{C}_{z'}$		$-\hat{\mathbf{O}}_{\mathbf{z'}}$		$\hat{\mathbf{G}}$		$-\hat{\mathbf{H}}$		$\hat{\mathbf{O}}_{\mathbf{x'}}$	

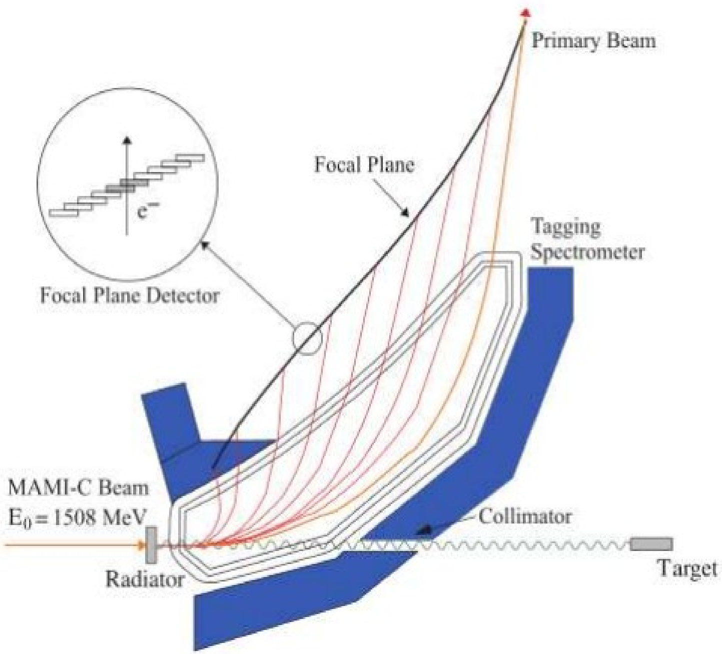
G observable

- Sensitive to several parameters
  - Degree of linear polarisation
  - Dilution factor
  - Target polarisation

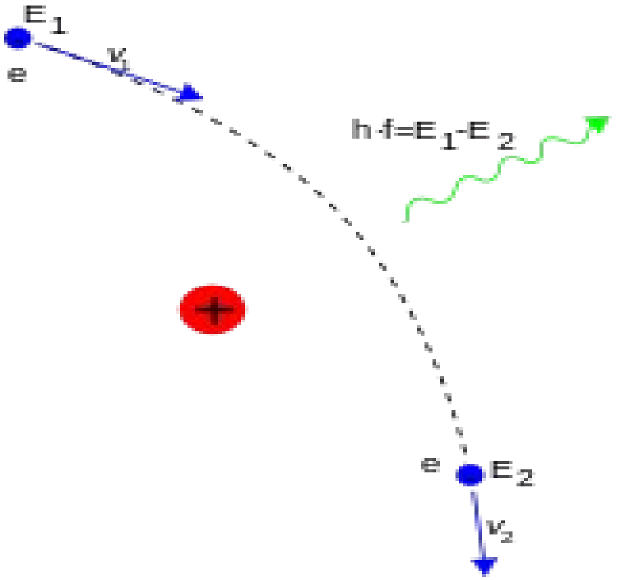
$$\frac{d\sigma}{d\Omega}\Big|_{\alpha}^{\pm t}(\theta,\phi)=\frac{d\sigma}{d\Omega}\Big|_{0}(\theta)\cdot\left(1-\delta_{\pm l}\Sigma p_{\gamma}^{lin}\cos 2(\phi+\alpha)+\delta_{\pm l}\Lambda_{\pm z}p_{\gamma}^{lin}G\sin 2(\phi+\alpha)\right)$$

		Target (P^T)			Recoil (P^R)			Target (P^T) + Recoil (P^R)								
					x'	y'	z'	x'	x'	x'	y'	y'	y'	z'	z'	z'
Beam (P^γ)		x	y	z				x	y	z	x	y	z	x	y	z
Unpolarized	$d\sigma_0$		$\hat{T}$			$\hat{P}$		$\hat{T}_{x'}$		$\hat{L}_{x'}$		$\underline{\hat{\Sigma}}$		$\hat{T}_{z'}$		$\hat{L}_{z'}$
$P_L^\gamma \sin(2\phi_\gamma)$		$\hat{H}$		$\hat{G}$	$\hat{O}_{x'}$		$\hat{O}_{z'}$		$\hat{\mathbf{C}}_{\mathbf{z'}}$		$\hat{\mathbf{E}}$		$\hat{\mathbf{F}}$		$-\hat{\mathbf{C}}_{\mathbf{x'}}$	
$P_L^\gamma \cos(2\phi_\gamma)$	$-\hat{\Sigma}$		$\underline{-\hat{P}}$			$\underline{-\hat{T}}$		$-\hat{\mathbf{L}}_{\mathbf{z'}}$		$\hat{\mathbf{T}}_{\mathbf{z'}}$		$-\mathrm{d}\sigma_0$		$\hat{\mathbf{L}}_{\mathbf{x'}}$		$-\hat{\mathbf{T}}_{\mathbf{x'}}$
Circular P_c^γ		$\hat{F}$		$-\hat{E}$	$\hat{C}_{x'}$		$\hat{C}_{z'}$		$-\hat{\mathbf{O}}_{\mathbf{z'}}$		$\hat{\mathbf{G}}$		$-\hat{\mathbf{H}}$		$\hat{\mathbf{O}}_{\mathbf{x'}}$	

Coherent Bremsstrahlung

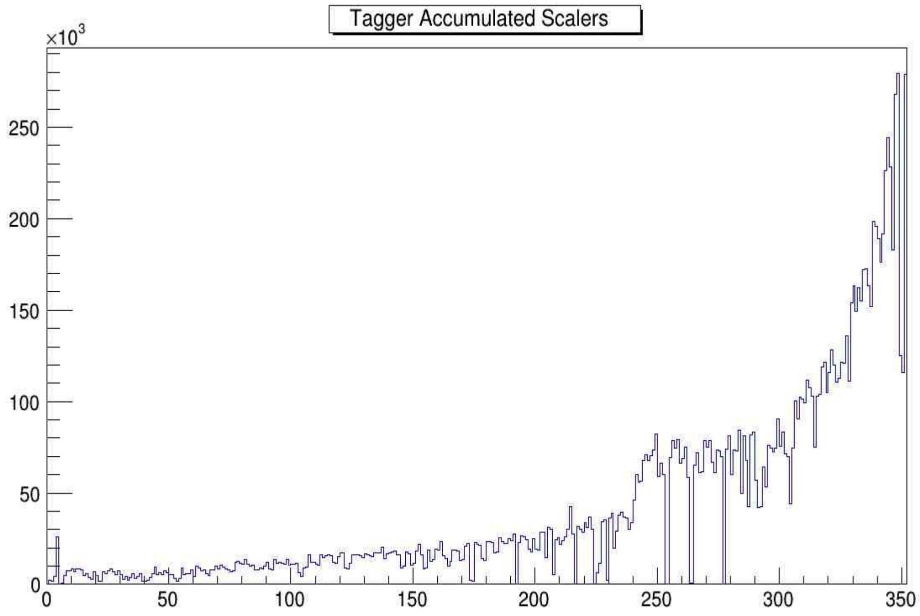


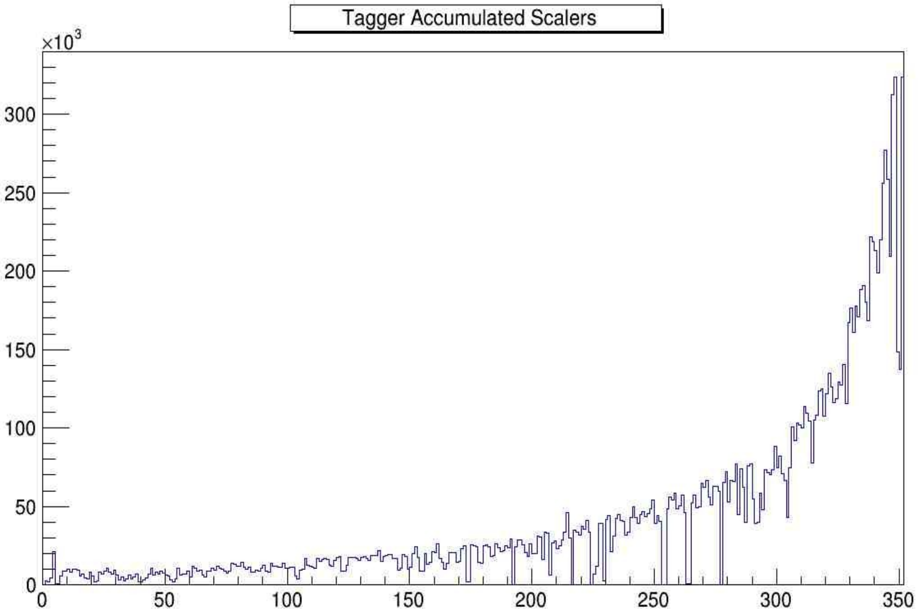
- Copper and Diamond radiators
- Production of linearly polarised photons
- Crystal plane dependent



Tagger Distributions

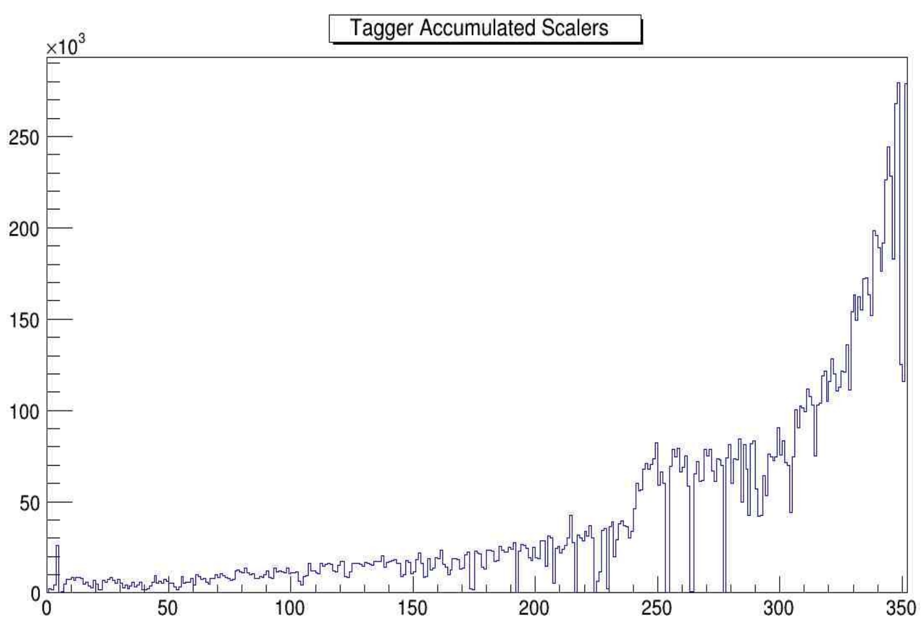
- Scaler plots of photon tagger elements.
- Reference amorphous run with polarised run.





Tagger Distributions

- Enhancement plots needed.
- Reference amorphous run with polarised run.



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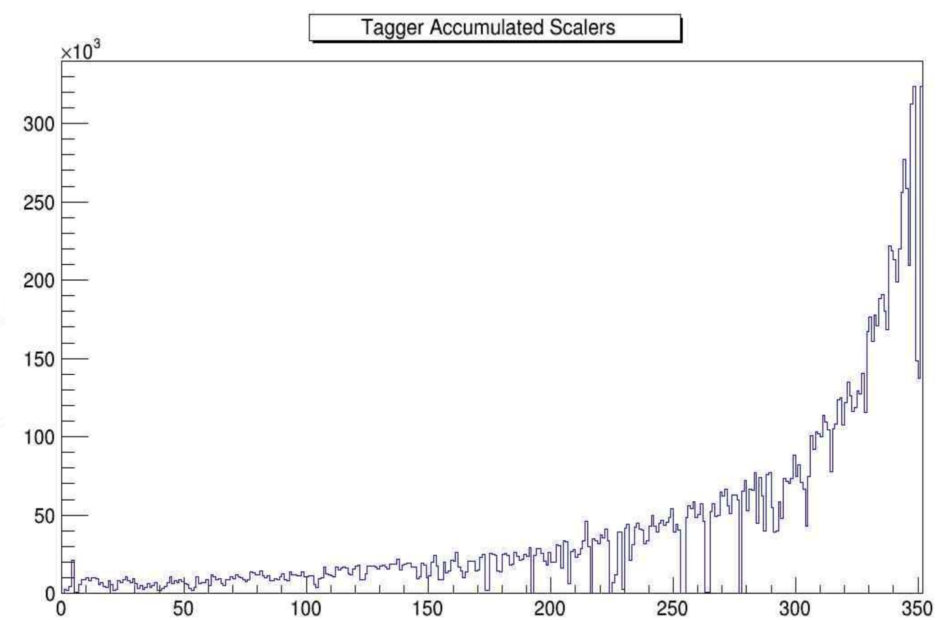
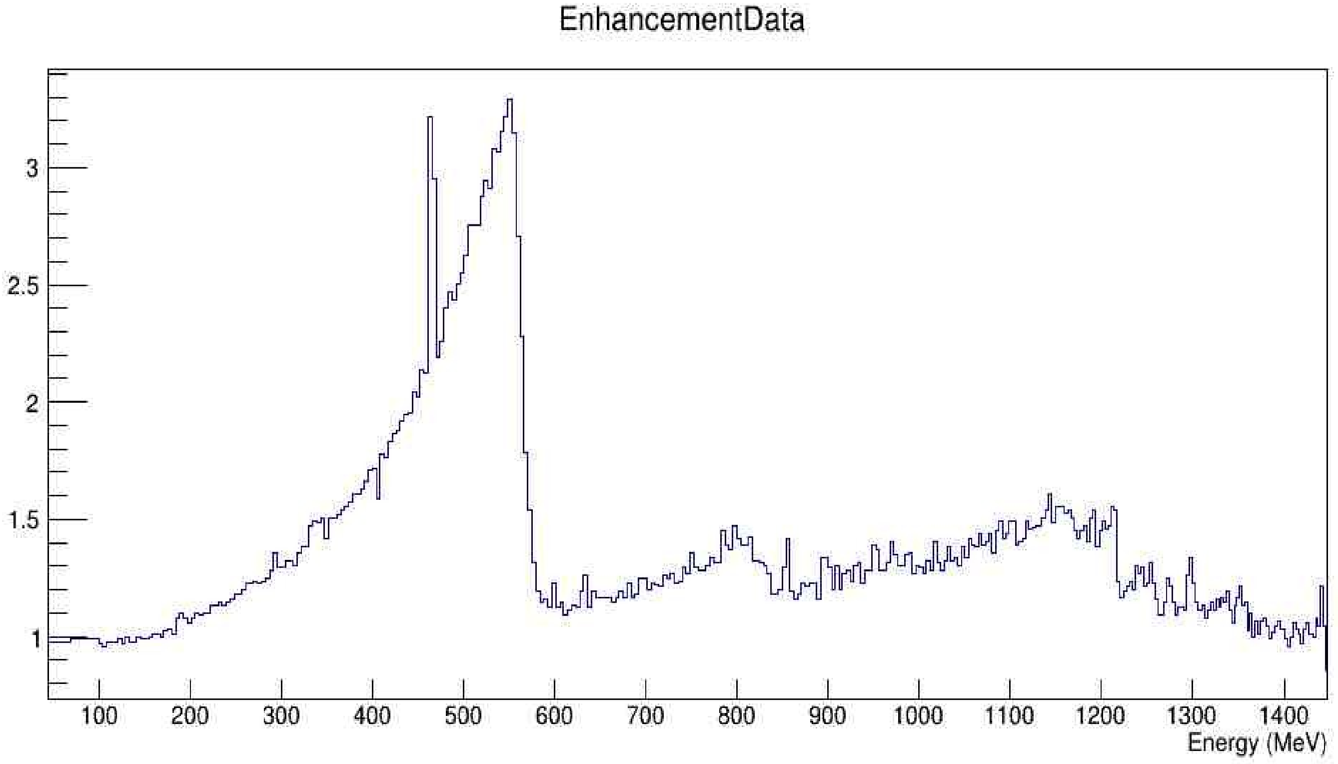


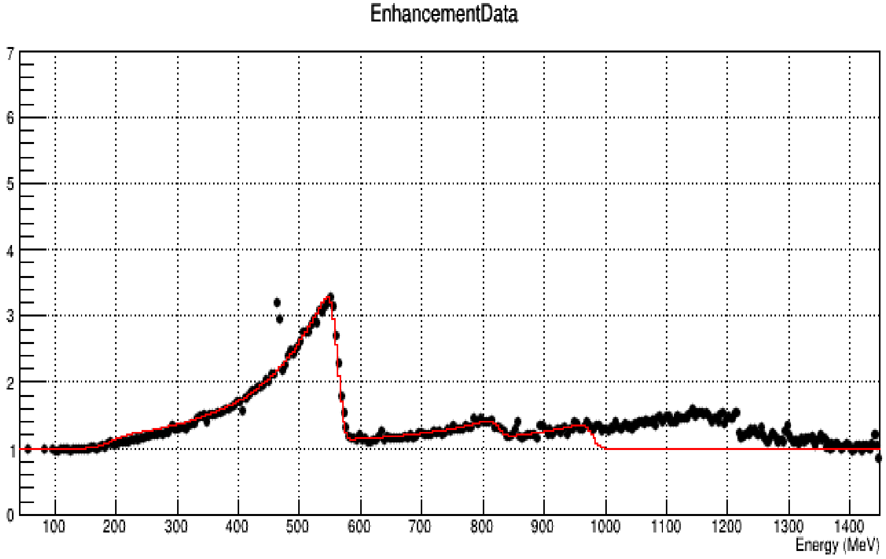
Enhancement

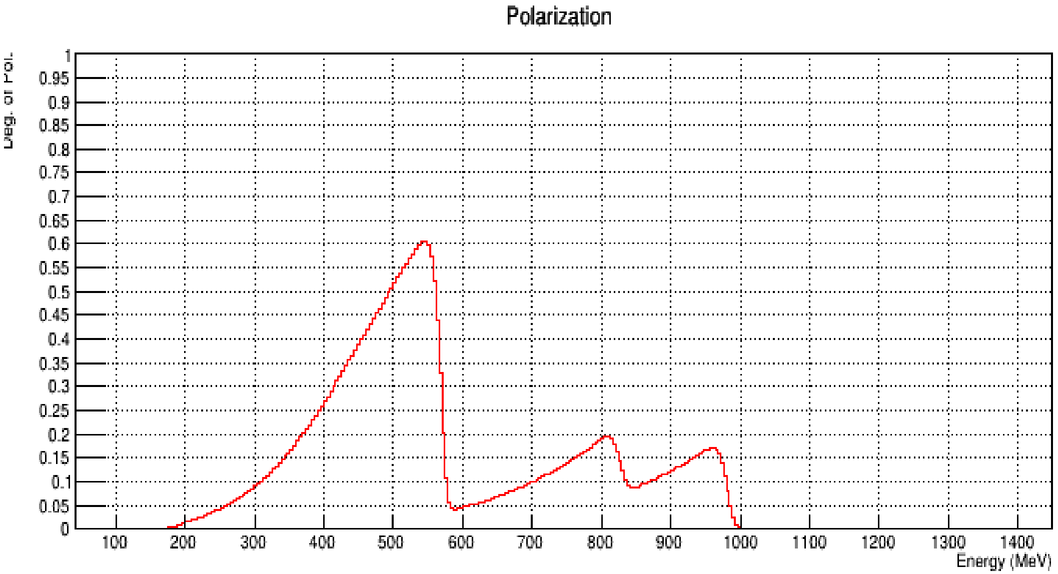


- Enhancement plot binned in terms of energy (MeV).
- Fit applied to enhancement to work out the degree of polarisation.

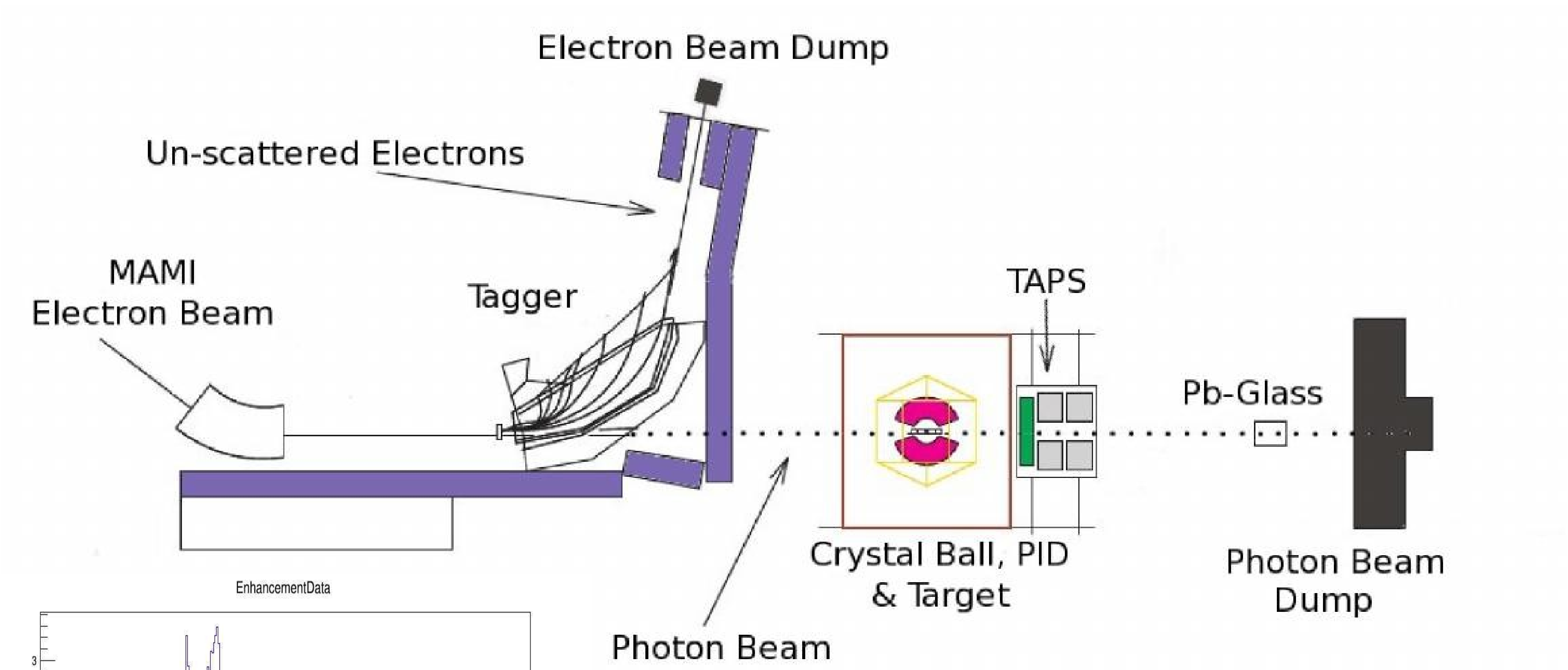
Fitting Function

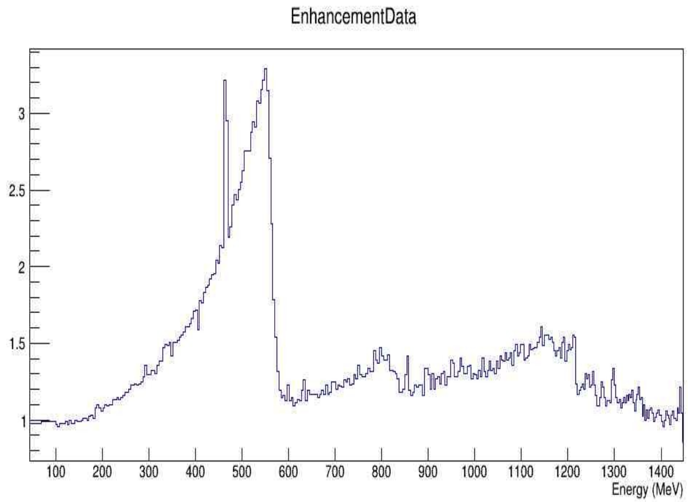
- Coherent edge position
- Range to fit
- Baseline of fit
- Beam energy





Tagger

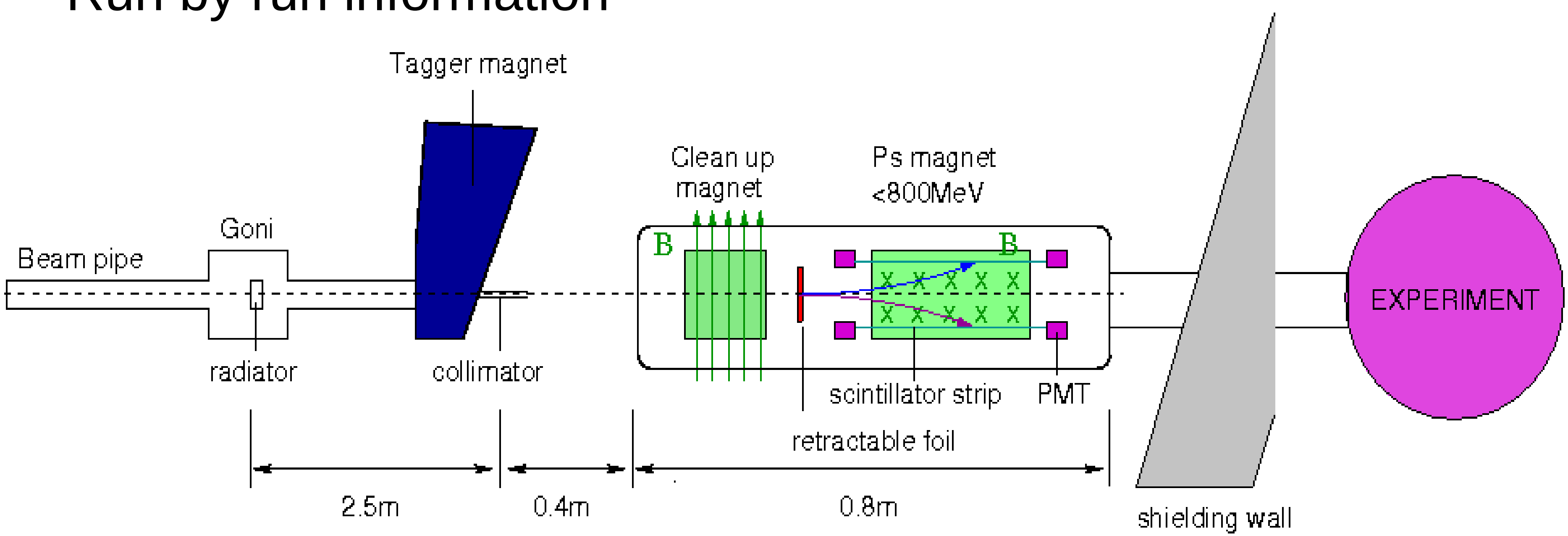




- Only for low intensity tagging efficiency runs.
- May vary over time (during run).

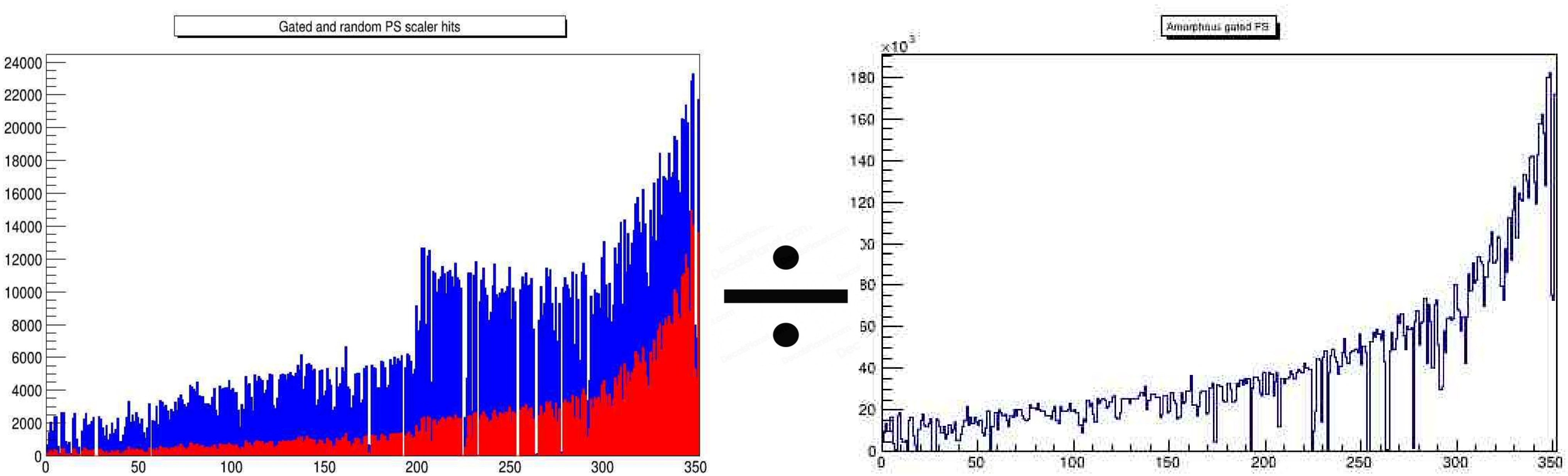
Pair Spectrometer

- Pair production detection
- Useful monitor of coherent peak passed collimator
- Tagging efficiency comparison
- Collimated enhancement
- Run by run information

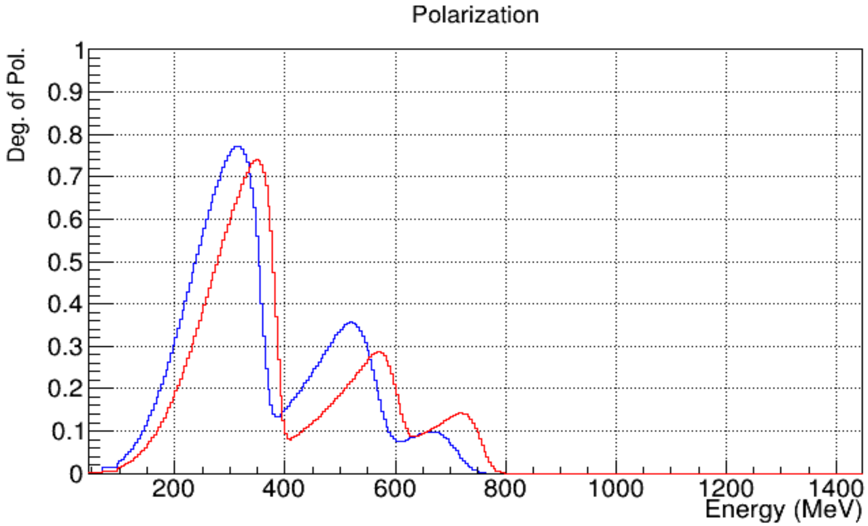


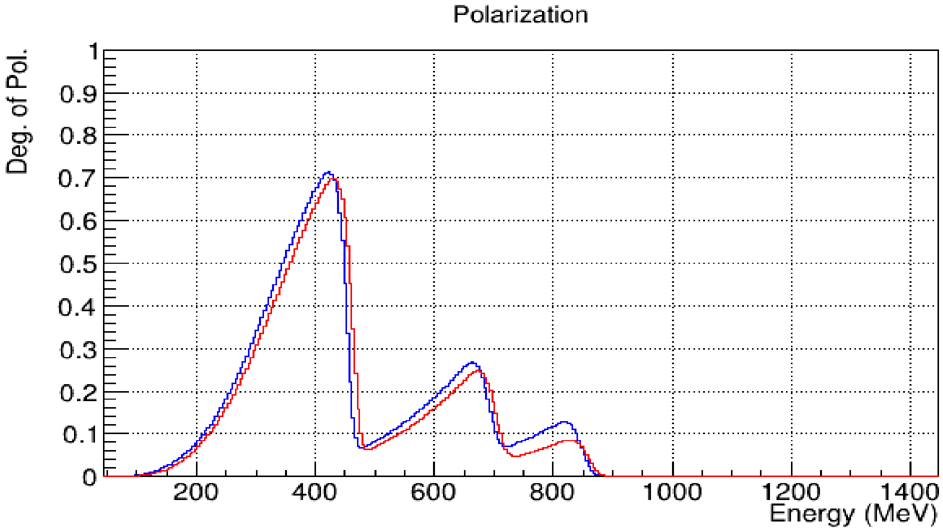
Pair Spectrometer

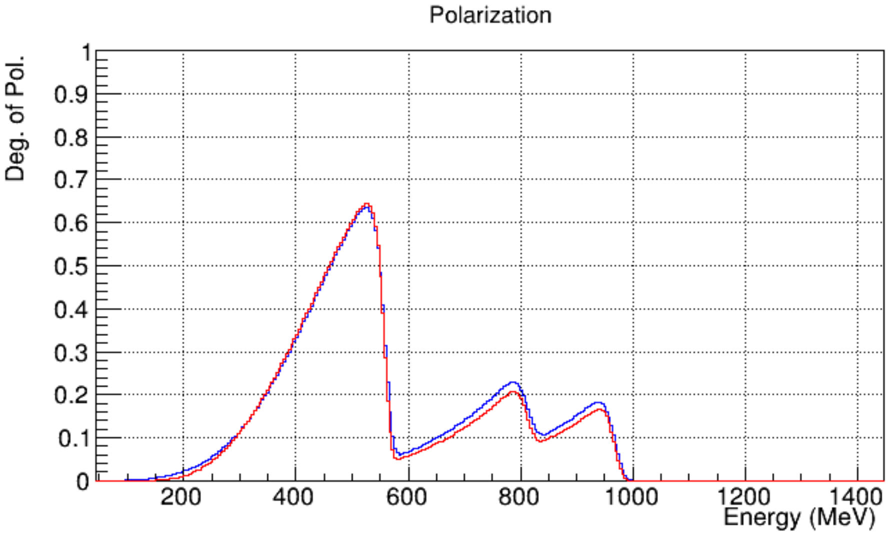
- Pair spectrometer event counts much lower than tagger counts.

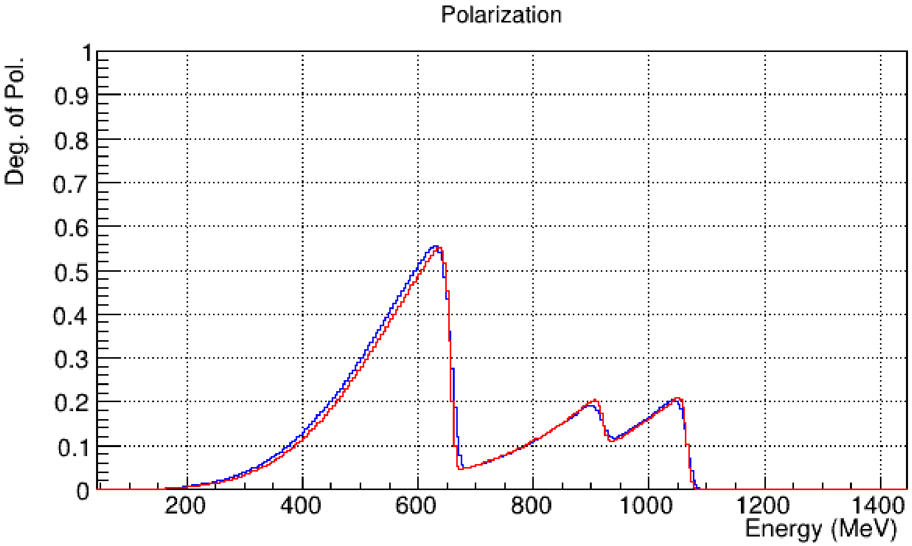


Tagger vs Pair Spectrometer

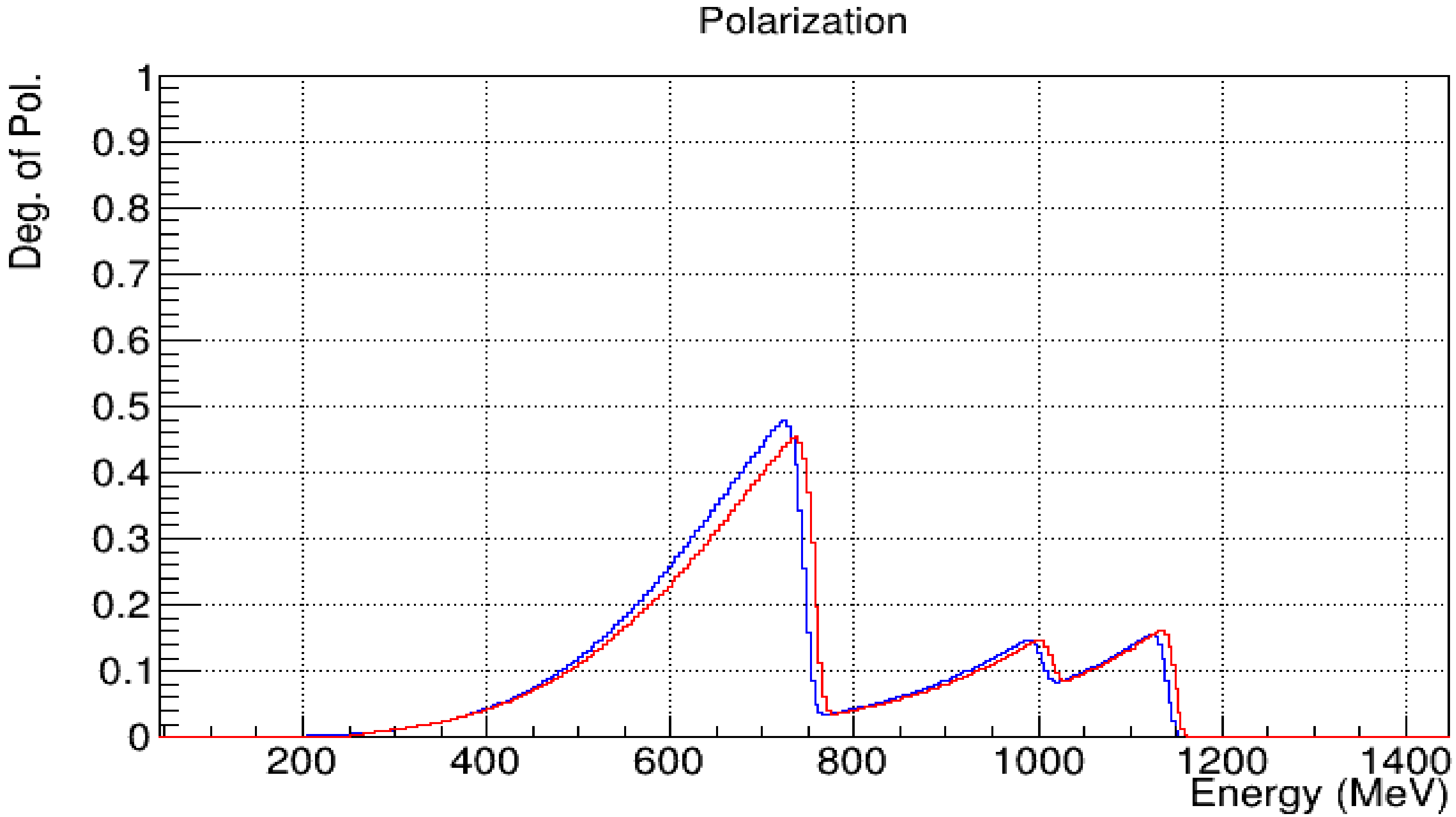








Tagger vs Pair Spectrometer



- Good agreement between Tagger and Pair Spectrometer.
- Comparisons show similar degree of polarisation.
- Pair spectrometer in blue, tagger in red.

Summary

- Polarisation observables offer greater access to excited nucleon spectrum
- G observable sensitive to target and photon polarisation
- Pair spectrometer measurements more accurate and measured for first time