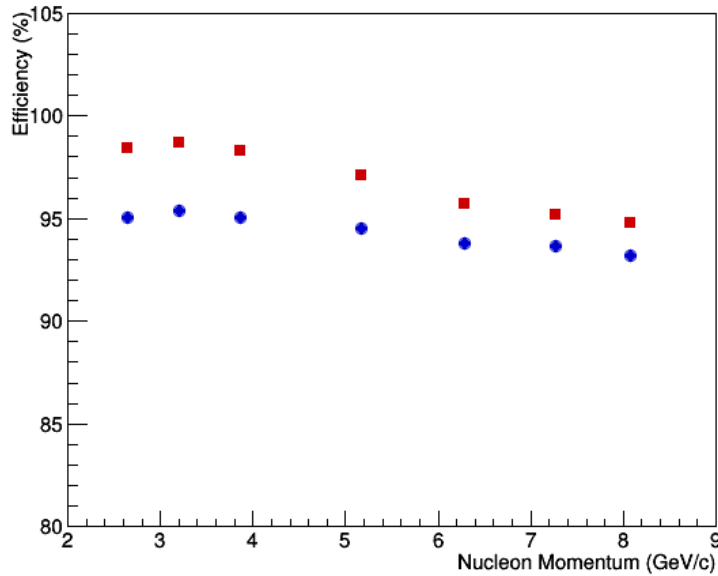
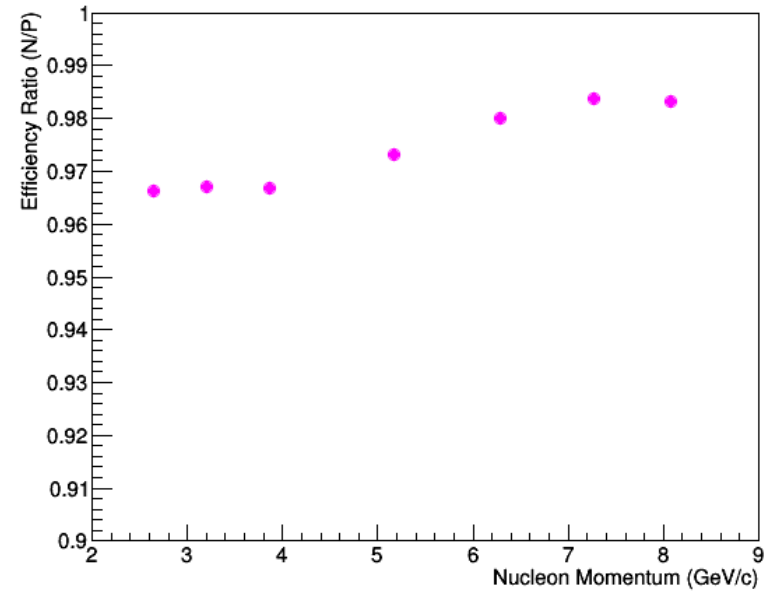


5c) Calibration of HCal n & p efficiency

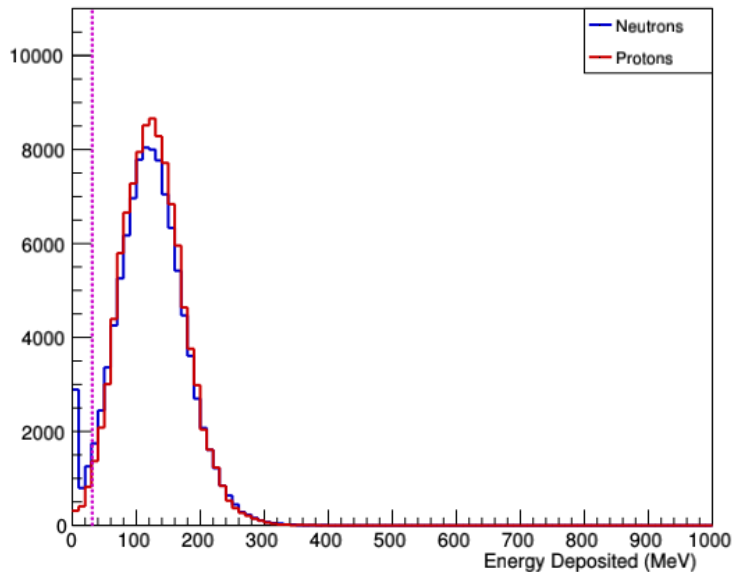
HCAL Efficiency ($E_T=1/4E_{\text{peak}}$) (3x3 cluster)



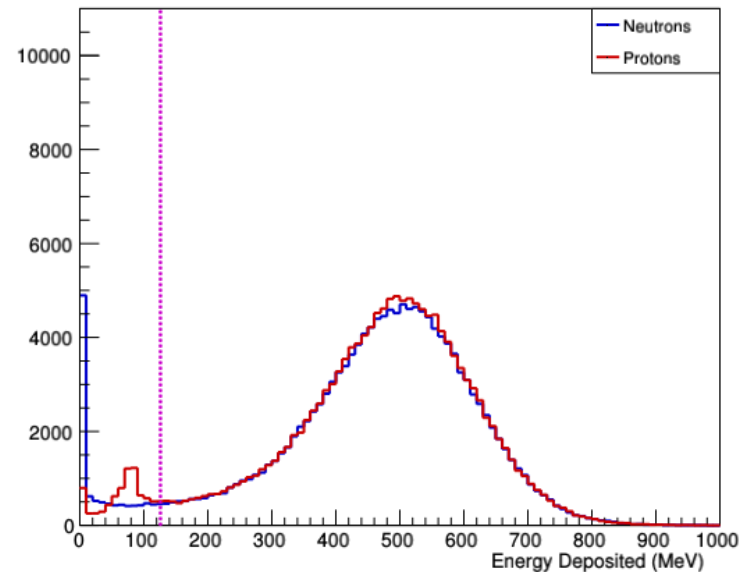
HCAL Efficiency Ratio (N/P) ($E_T=1/4E_{\text{peak}}$) (3x3 cluster)



P=2.64 GeV/c Energy Deposited (3x3 cluster, GMn acceptance)



P=8.08 GeV/c Energy Deposited (3x3 cluster, GMn acceptance)



$p(e,e')p$

Used to cleanly calibrate HCal efficiency with elastic protons
near center of QE distribution at all 7 kinematics

- With 48D48 on, calibrates efficiency as well as position of center of QE proton distribution
- With 48D48 off, calibrates position of center of QE neutron distribution

$p(e,e')p$

configuration	Q^2 (GeV/c) ²	E_{Beam} (GeV)	θ_{BB} (deg.)	$d\sigma/d\Omega$ (fb/sr) ($10^{38}/\text{cm}^2/\text{s}$)	\mathcal{L}	rate time at \mathcal{L}		statistics
						(Hz)	(hours)	
1	3.5	4.4	32.5	1.1E+05	0.7	572	6.3	1.3E+07
2	4.5	4.4	41.9	1.7E+04	1.4	182	7.8	5.1E+06
3	5.7	4.4	58.4	2090	2.8	44	25	4.0E+06
4	8.1	6.6	43.0	794	2.8	16.7	5	3.0E+05
5	10.2	8.8	34.0	459	1.4	4.8	5	8.7E+04
6	12.0	8.8	44.2	83	2.8	1.7	5	3.1E+04
7	13.5	11.0	33.0	103	2.8	2.2	6	4.7E+04

$p(\gamma, \pi^+)n$

Used to cleanly calibrate HCal efficiency with neutrons
near center of QE distribution at 2 kinematics

E	Theta	Q2	$p' \pi^+(n)$	$p' \pi^+ (N\pi)$	$\Delta p'$	$\Delta p'/p'$	
GeV	deg	GeV	GeV	GeV	GeV	%	
4.4	32	3.44	2.57	2.48	0.09	3.55	(Treating π^+ as massless)
4.4	64.3	6.00	1.20	1.16	0.04	3.55	
4.4	32	3.44	2.56	2.48	0.08	3.31	(Including π^+ mass)
4.4	64.3	6.00	1.19	1.15	0.04	3.38	

π has momentum expected for elastic electron scattering, but at positive spectrometer setting. Expect very low background. Shower, gas Cherenkov distinguish from e^+

Top $\sim 3.3\%$ ($\Delta p_\pi/p_\pi$) of bremsstrahlung spectrum cleanly tags (near elastic) neutrons. Easily resolved by HRS.

Cross Section

Based on SLAC measurements

(Anderson et al., PRD 14 (1976) 14)

$$\frac{d\sigma}{dt} \text{ vs. } \cos(\theta^*) \quad \text{at } E_\gamma = 4.0, 5.0, \text{ and } 7.5 \text{ GeV}$$

$E = 4.4 \text{ GeV}$

θ	θ^*	$\cos(\theta^*)$
32	85.5	0.079
64.3	127.4	-0.61

$$\frac{d\sigma}{dt} \propto s^{-7} \text{ at fixed } \cos(\theta^*)$$

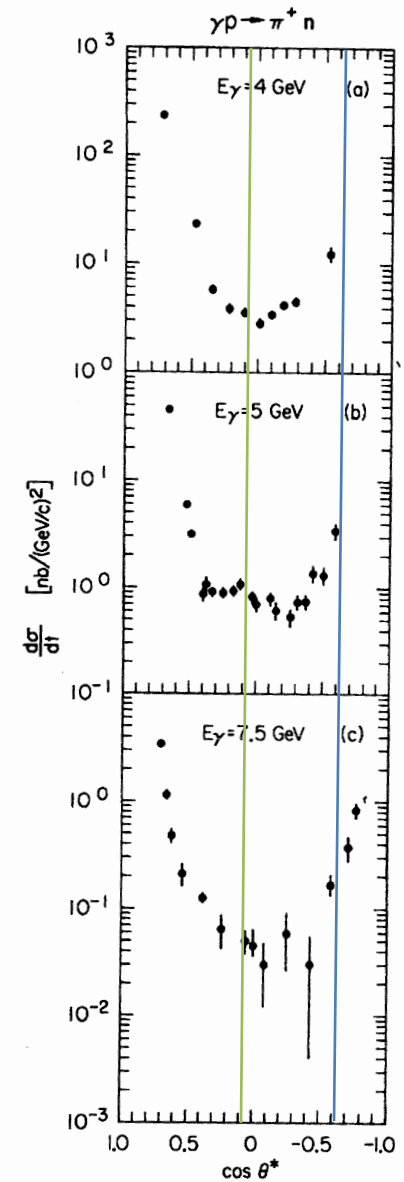
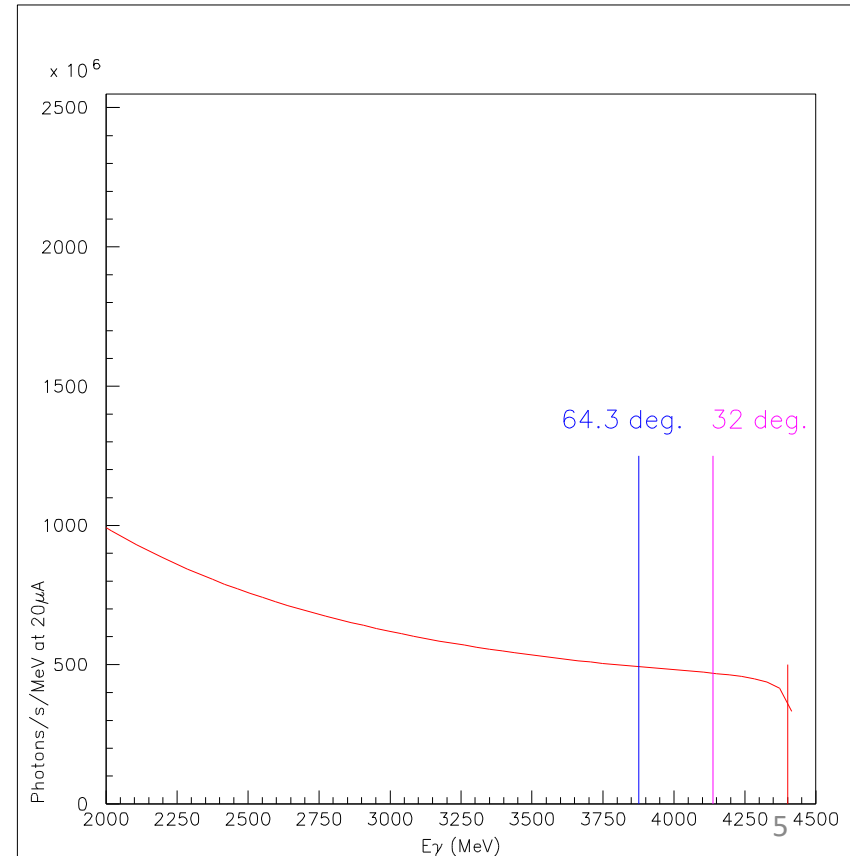


FIG. 5. $d\sigma/dt$ versus $\cos\theta^*$ for the reaction $\gamma p \rightarrow \pi^+ n$ at (a) $E_\gamma = 4.0 \text{ GeV}$, (b) $E_\gamma = 5.0 \text{ GeV}$, and (c) $E_\gamma = 7.5 \text{ GeV}$.

Bremsstrahlung Spectrum

(From Matthews and Owens NIM 111 (11973) 157)

Usable flux from endpoint to $E_{\gamma_{\text{cut}}}$ which gives p_{π} (from $\gamma(p,n)\pi^+$)
below max p_{π} of $\gamma(p,N\pi)\pi^+$ with endpoint photon



Rates and Statistics

	32°	64.3°	
$\frac{d\sigma}{d\Omega^*}$	0.95	3.35	nb/sr
$\frac{d\Omega^*}{d\Omega}$	3.54	0.776	
$\frac{d\sigma}{d\Omega}$	3.36	2.60	nb/sr
Usable Flux	1.31	2.62	$\times 10^{11} / \text{s}$ (@20 uA)
$\rho LN / A$	6.41×10^{23}		$/ \text{cm}^2$
Accept.	5.3×10^{-3}		sr
Rate	1.49	2.32	/s
Hours	24	12	hr
HRS pos.	2	4	
	64.5	25.0	k event per HRS position

