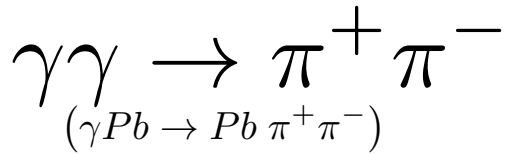


Charged Pion Polarizability Update

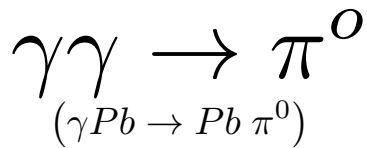
David Lawrence JLab

Mar. 11, 2013

Experimental Setup

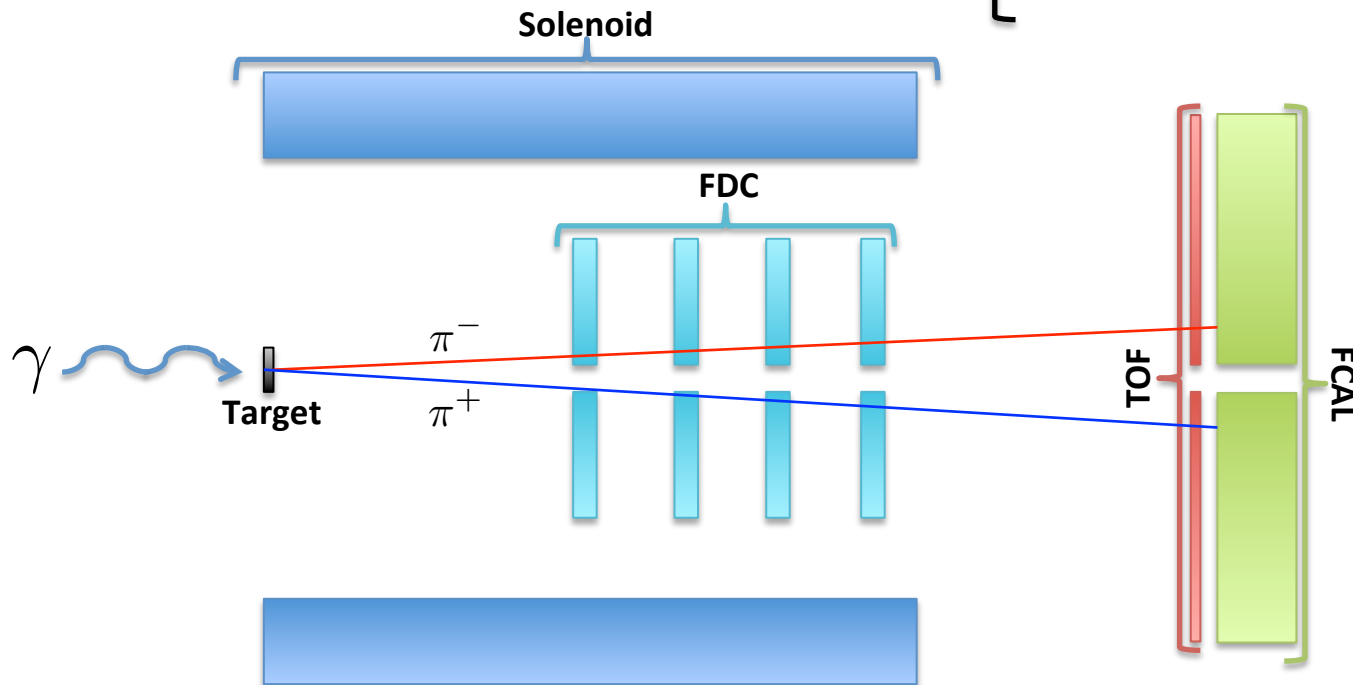


Signal reaction



normalization reaction

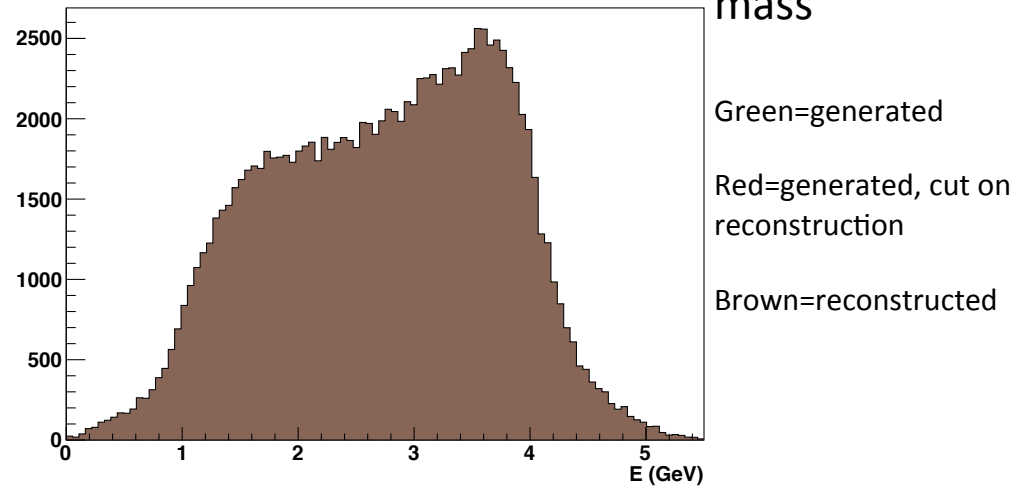
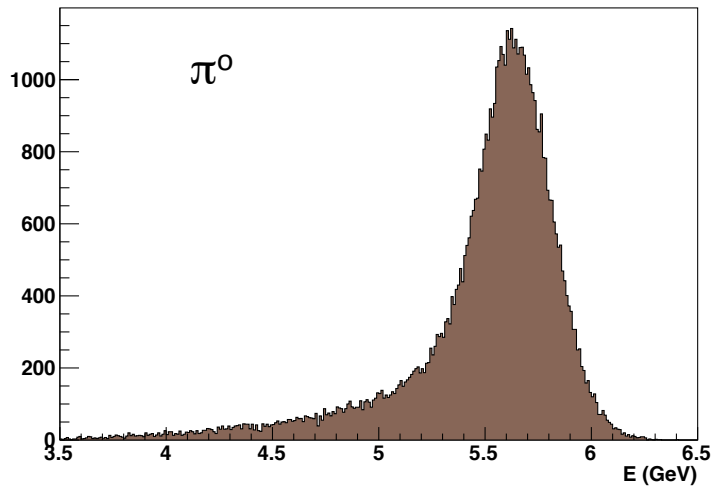
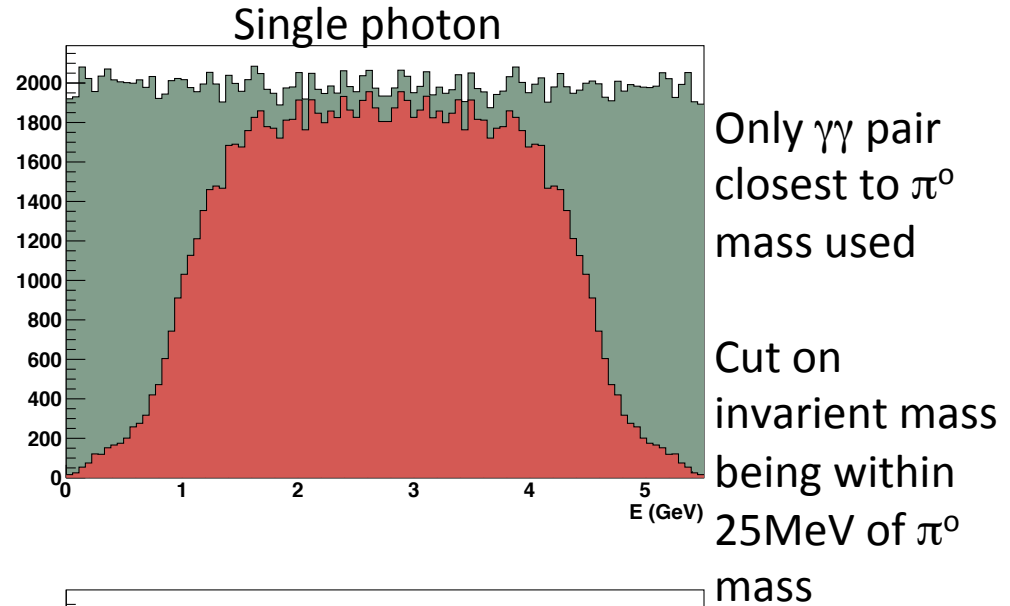
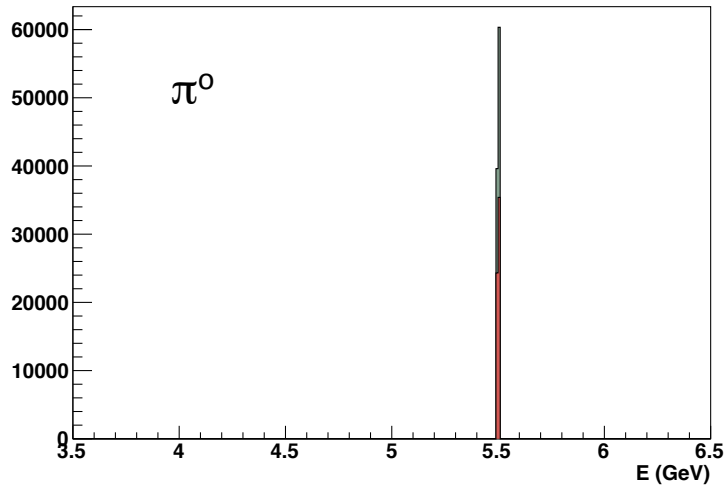
- Both occur via the Primakoff effect (interaction with the Coulomb field of nucleus)
- Both result in very forward going particles
- Low t ($-t < 0.005 \text{ GeV}^2$)



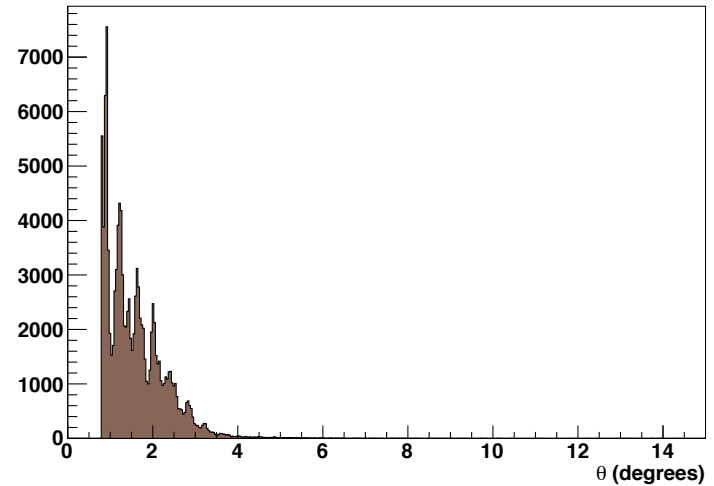
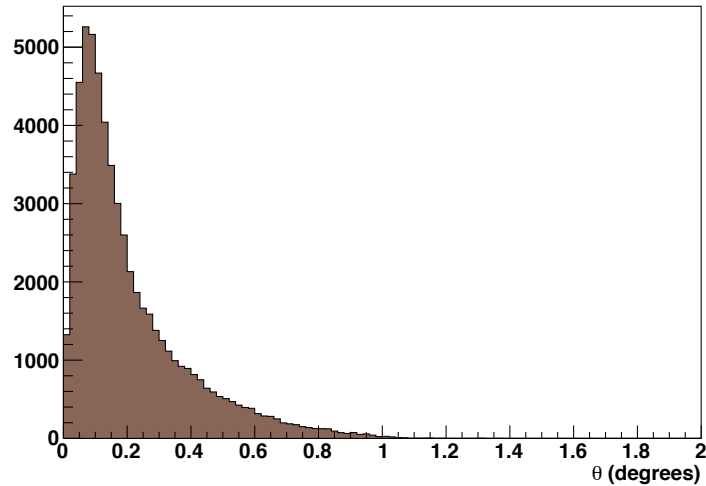
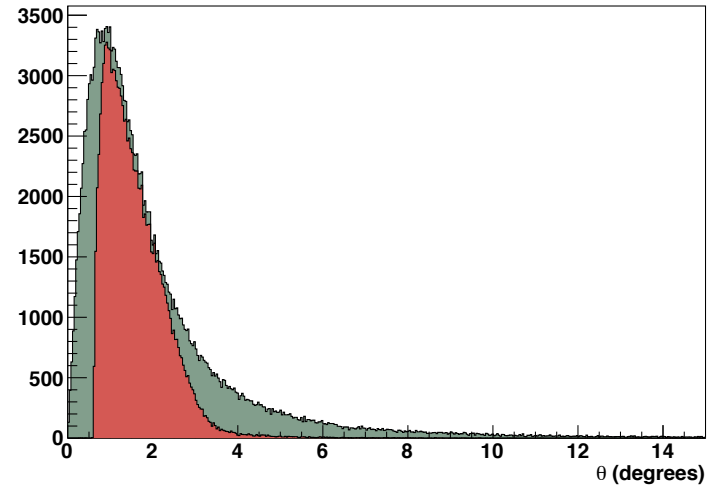
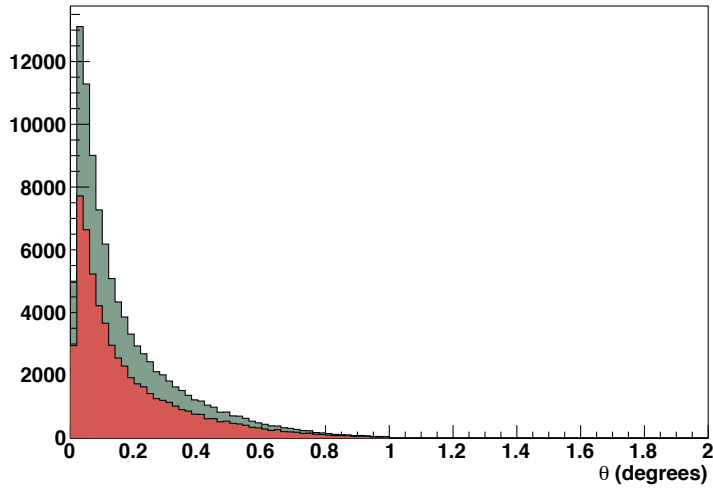
Current Issues

- **Photon reconstruction irregularities**
- Kinematic fitting improvement to angular resolution
- Triggering on pions with FCAL
- Muon background

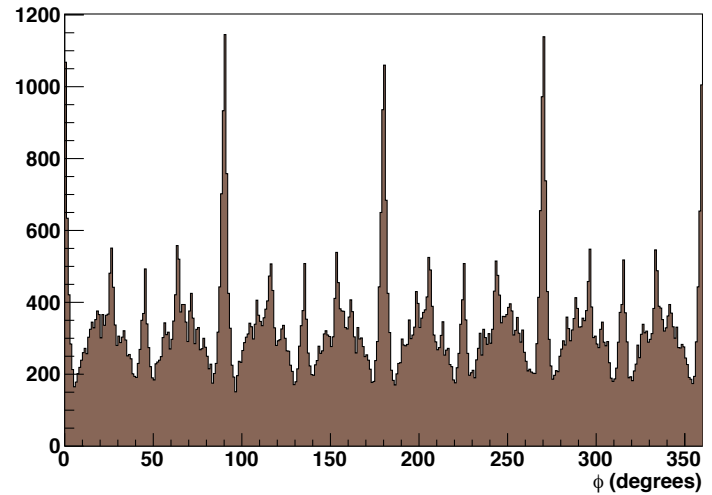
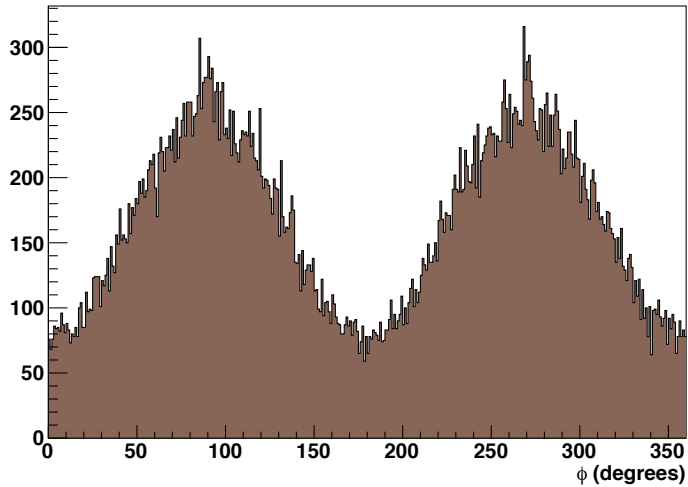
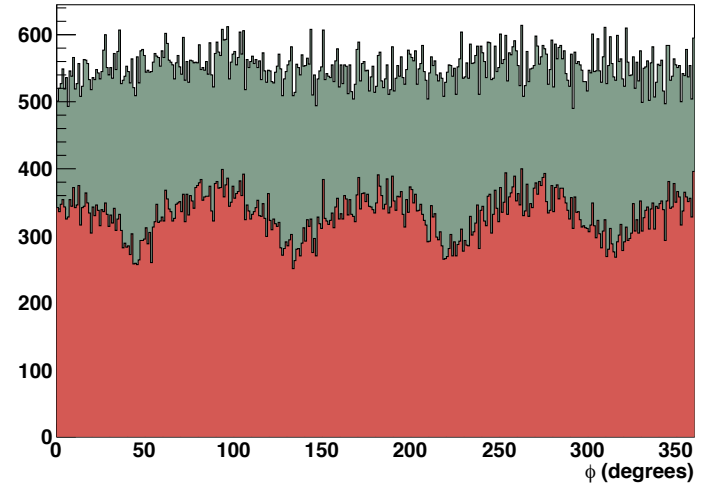
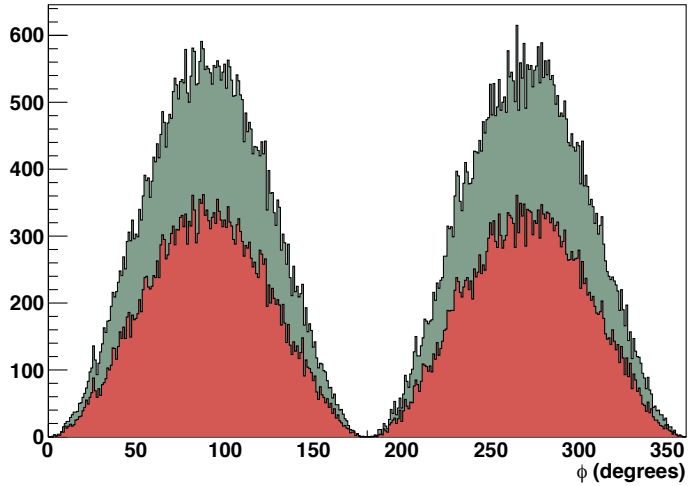
Generated and reconstructed energy of π^0 and γ



Generated and reconstructed θ of π^0 and γ



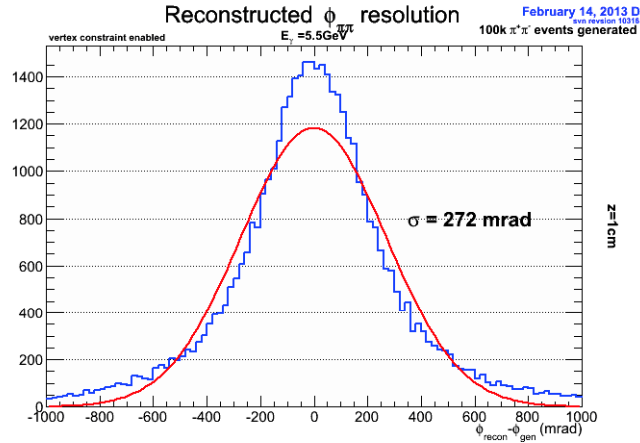
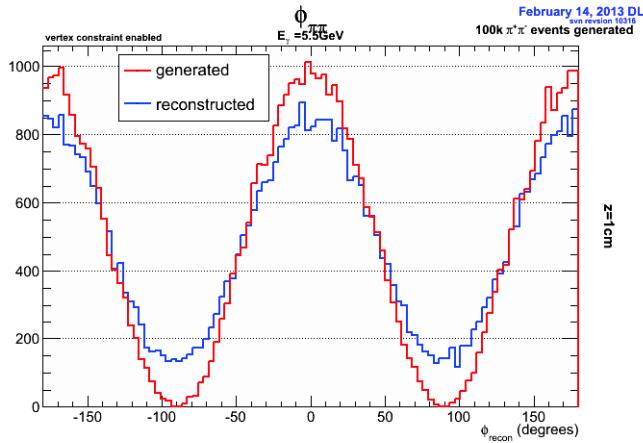
Generated and reconstructed φ of π^0 and γ



Current Issues

- Photon reconstruction irregularities
- **Kinematic fitting improvement to angular resolution**
- Triggering on pions with FCAL
- Muon background

Reconstructed $\phi_{\pi\pi}$ resolution



Approximate contributions from single track uncertainties :

$\Delta\phi$	127 mrad
$\Delta\theta$	131 mrad
Δp	219 mrad

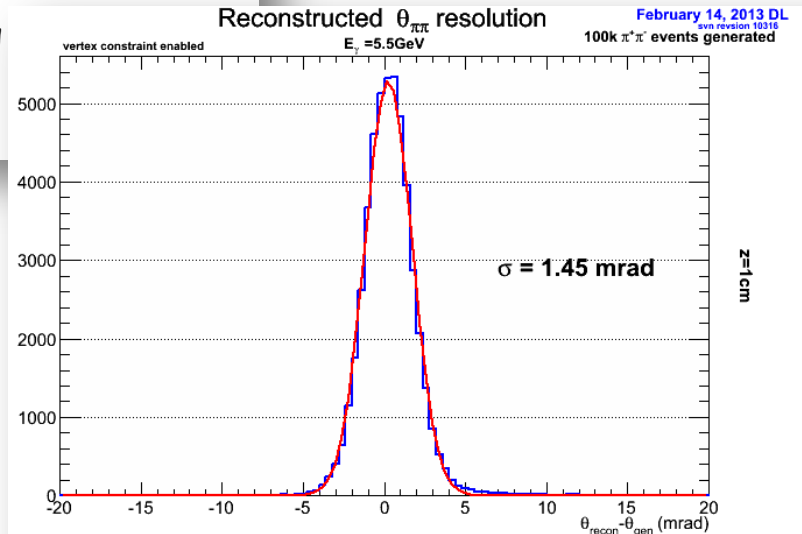
Minimize with kinematic fitting

$$E_\gamma = \sqrt{p_1^2 + m_\pi^2} + \sqrt{p_2^2 + m_\pi^2}$$

Total 285 mrad

- Kinematic fitting may help improve angular resolutions needed to separate Primakoff (signal) from background (primarily coherent rho)

- Plugin using Paul M.'s new ANALYSIS package has been written, but no results to report today



Approximate contributions from single track uncertainties :

$\Delta\phi$.41 mrad
$\Delta\theta$.48 mrad
Δp	.96 mrad

Minimize with kinematic fitting ?

$$E_\gamma = \sqrt{p_1^2 + m_\pi^2} + \sqrt{p_2^2 + m_\pi^2}$$

Total 1.1 mrad

Current Issues

- Photon reconstruction irregularities
- Kinematic fitting improvement to angular resolution
- **Triggering on pions with FCAL**
- Muon background

Triggering

- Currently thinking FCAL may be critical component for triggering $\pi^+\pi^-$ events
- Apparent energy of hadrons may be larger than dE/dx
 - (Lubomir helping with some M.C. calculations)
 - Hoping to get some cosmic data this summer
- Hadronic background rate may be higher than anticipated, but thresholds can be raised (GlueX plans call for 30MeV threshold)

Muons and Hadrons in NOMAD

D. Autiero et al. / Nuclear Instruments and Methods in Physics Research A 387 (1997) 352–364

Calorimeter is 50cm long TF1-000 blocks

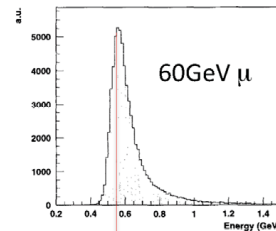


Fig. 23. Muon signal in the calorimeter.

60GeV μ gives 550MeV of apparent energy

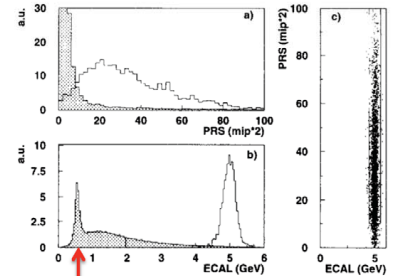


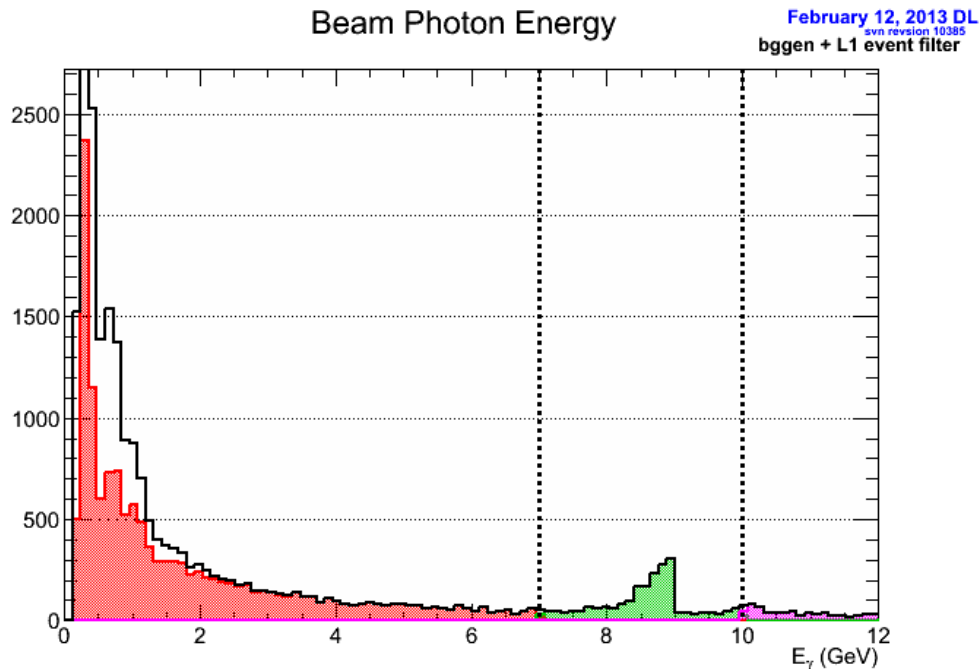
Fig. 20. 5 GeV π (shaded) and electron signals on the PRS (a) and on ECAL (b). PRS vs. ECAL signals for 5 GeV electrons (c), the limits shown in this figure define the 90% efficiency region for electrons detection.

5GeV π gives ~550MeV of apparent energy

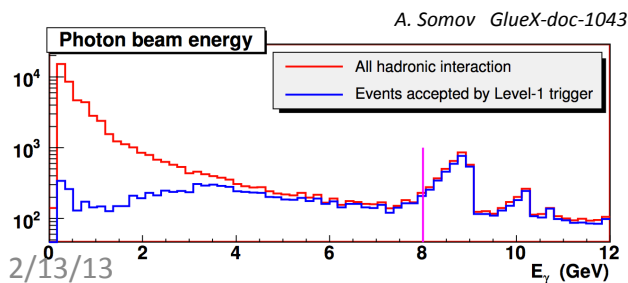
NOMAD blocks are 19Xo while PHENIX blocks are only 14.4Xo
NOMAD had PMTs angled at 45° wrt to block axis

Software Level-1 Event filter

```
// BCAL and FCAL
bool sum_cut = (Ebc al + 4.0*Efc al)>=2.0;
trig->L1a_fired = sum_cut && Ebc al>0.200 && Efc al>0.030;
trig->L1b_fired = sum_cut && Ebc al>0.030 && Efc al>0.030 && Nschits>0;
```



- Event is kept if either L1a_fired or L1b_fired is true
- 38% of events discarded by software L1 trigger
(original L1 study rejected ~53%)
- 0.1% of events in coherent peak region discarded by L1 trigger
- 13.3% of L1 accept events in coherent peak region
- Trigger implemented in TRIGGER library (DMCTrigger objects)
— *hd_eventfilter*



Nominal goal for L3 is to discard 90% of L1-accepted events

Hadrons in PHENIX Calorimeter

L. Aphecetche et al. / Nuclear Instruments and Methods in Physics Research A 499 (2003) 521–536

	pions	protons
0.15 GeV/c	25MeV	-
1 GeV/c	460MeV	80MeV
4 GeV/c	540MeV	540MeV

Cerenkov threshold: $\beta_t = \frac{1}{n}$

$$p_t = m\beta_t\gamma_t = \frac{m\beta_t}{\sqrt{1-\beta_t^2}}$$

$$p_t = \frac{m}{\sqrt{1/\beta_t^2 - 1}} = \frac{m}{\sqrt{n^2 - 1}}$$

TF1 PbGlass: n=1.648

proton $p_t = 716\text{MeV}/c$

pion $p_t = 107\text{MeV}/c$

“At 500 MeV/c no significant signal is observed for protons ...”

Pbglass A2 Test Results
Electron/Pion Discrimination 1 GeV

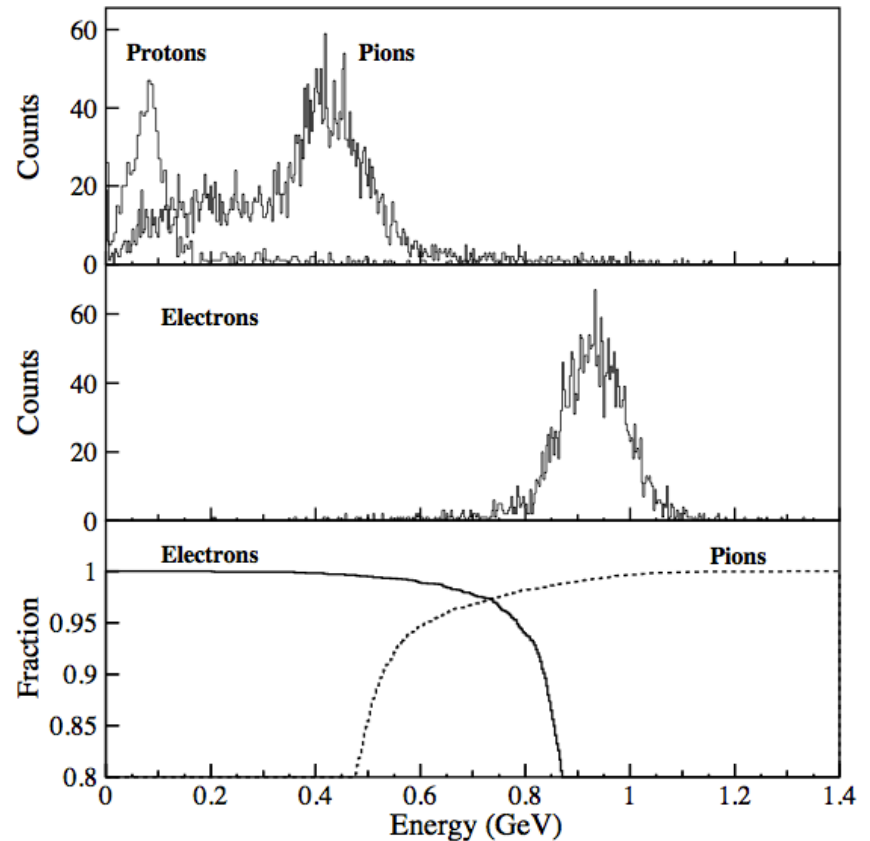
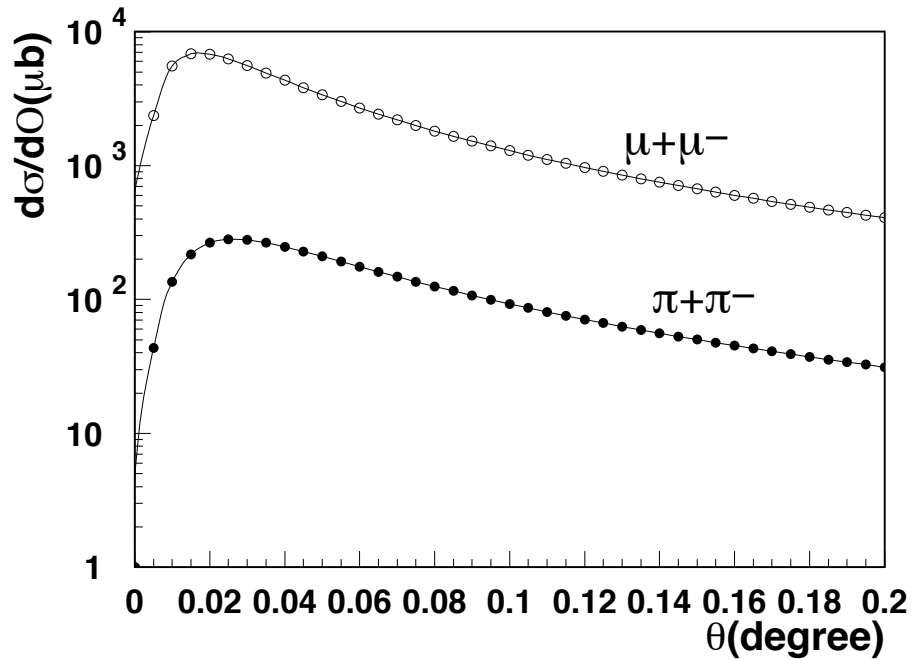


Fig. 12. Measured energy signal for protons, π^+ and e^+ of 1 GeV/c incident momentum. The lower panel shows the fraction of e^+ accepted or π^+ rejected for a varying threshold on the measured energy.

Current Issues

- Photon reconstruction irregularities
- Kinematic fitting improvement to angular resolution
- Triggering on pions with FCAL
- **Muon background**

$\mu+\mu^-$ background



- Sergey G. has calculated cross-sections
- Currently comparing to what is in hdgeant