Cross sections for $\gamma\gamma \to \mu^+\mu^-$

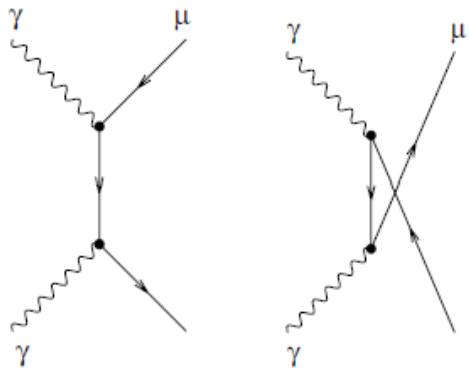


Figure 2.2: *Two-photon subprocess. Shown are the t-channel (right) and the u-channel (left) contribution.*

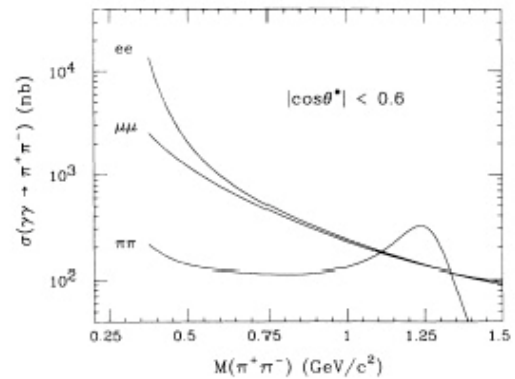


FIG. 1. Predicted two-photon cross sections for pion pairs and lepton pairs. The predictions for lepton pairs are from a Monte Carlo calculation. The prediction for pion pairs is that of Morgan and Pennington (Ref. 15), where the pion-pair cross section consists of a nonresonant continuum and the large $f_2(1270)$ resonance. The observed peak of the $f_2(1270)$ is shifted due to interference with the continuum.

Neglecting the muon mass:
Cross section peaks in forward and backward directions

$$\frac{d\sigma}{dt} = \frac{2\pi\alpha^2}{s}\left(\frac{u}{t} + \frac{t}{u}\right)$$

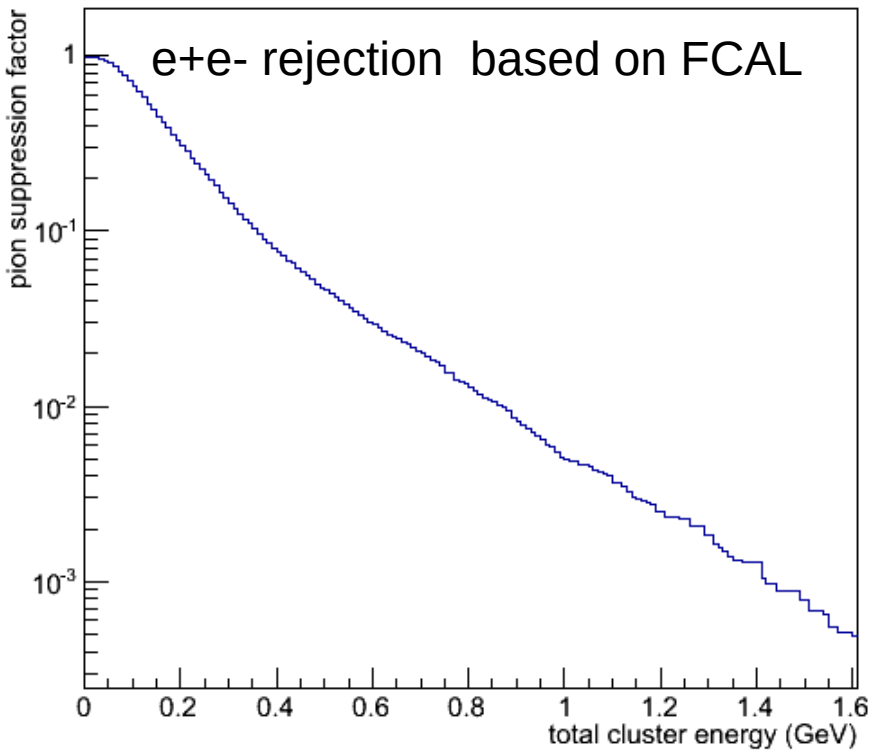
$$\frac{d\sigma\left(\mu^+\mu^- \to \gamma_1\gamma_2\right)}{d\Omega_{LAB-\gamma 1}} = \frac{\alpha^2\left(m + E_+\right)}{8p_+\left(m + E_+ - p_+\cos\theta\right)^2}\left[\frac{E_+ - p_+\cos\theta}{m} + \frac{m}{E_+ - p_+\cos\theta} + 2 - 4\left(\vec{\varepsilon}_1 \cdot \vec{\varepsilon}_2\right)^2\right]$$

$$\frac{d\sigma\left(\gamma\gamma \to \mu^+\mu^-\right)}{d\Omega_{CM}} = \frac{d\Omega_{LAB-\gamma 1}}{d\Omega_{CM}} \cdot \frac{d\sigma\left(\mu^+\mu^- \to \gamma_1\gamma_2\right)}{d\Omega_{LAB-\gamma 1}}\left(\frac{P_\mu}{P_\gamma}\right)^2_{CM} \times spin - factor$$

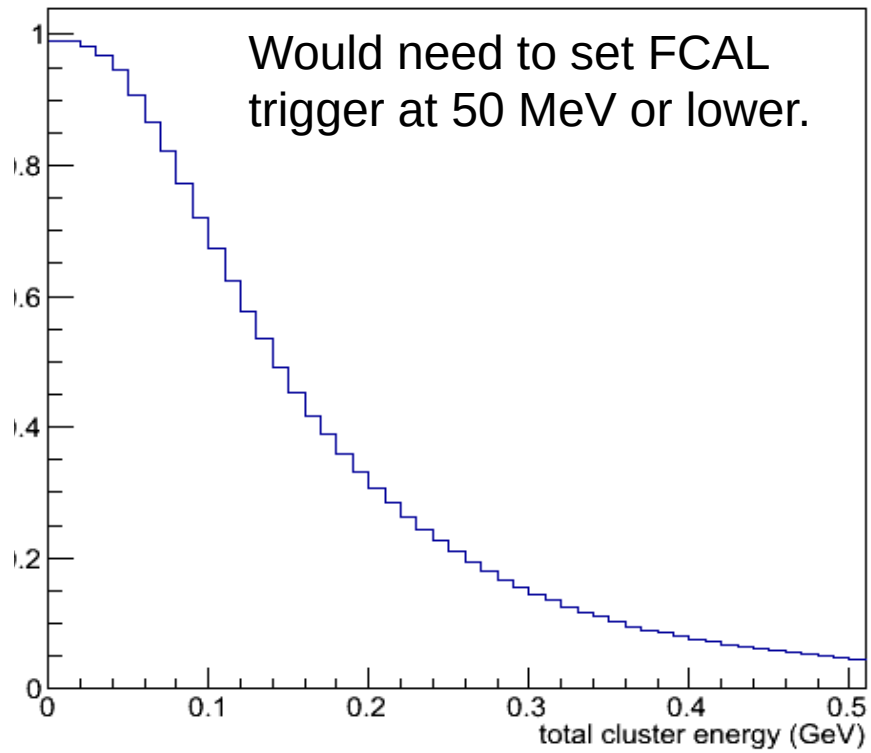
$$\frac{d^2\sigma\left(\gamma A \to \pi\pi A\right)}{d\Omega dM} = \frac{2\alpha Z^2}{\pi^2}\frac{E_\gamma^4\beta^2}{M}\frac{\sin^2\theta}{Q^4}\sigma\left(\gamma\gamma \to \mu\mu\right)$$

summary: spectral integrals

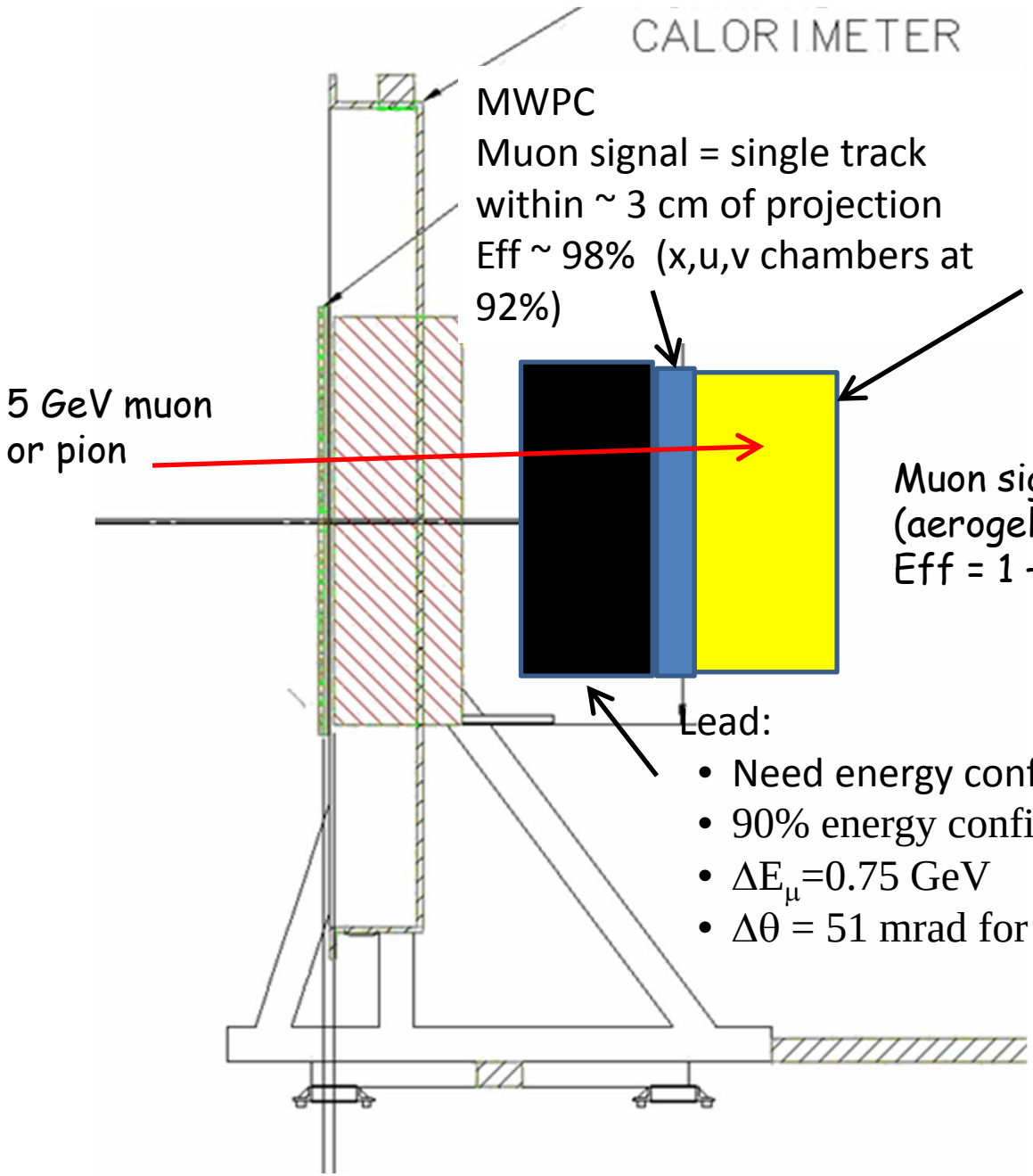
e/π separation lookup*



trigger efficiency lookup*



* These results were derived from the unbiased spectra, level 1 trigger only.


CALORIMETER
MWPC
Muon signal = single track within ~ 3 cm of projection
Eff ~ 98% (x,u,v chambers at 92%)
Silica aerogel cherenkov, n=1.03
Pion threshold 0.58 GeV
Muon threshold 0.44 GeV
N_{pe} = 4
Eff= 98%
5 GeV muon or pion
Muon signal = (good track in MWPC) OR (aerogel hit)
Eff = 1 – (.02)² = 99.96%
Lead:
• Need energy confinement > (5-.58)/5 = 90%
• 90% energy confinement for 5 GeV pion ~ 25 cm Pb
• ΔE_μ=0.75 GeV
• $\Delta\theta$ = 51 mrad for 2.5 GeV incident muon