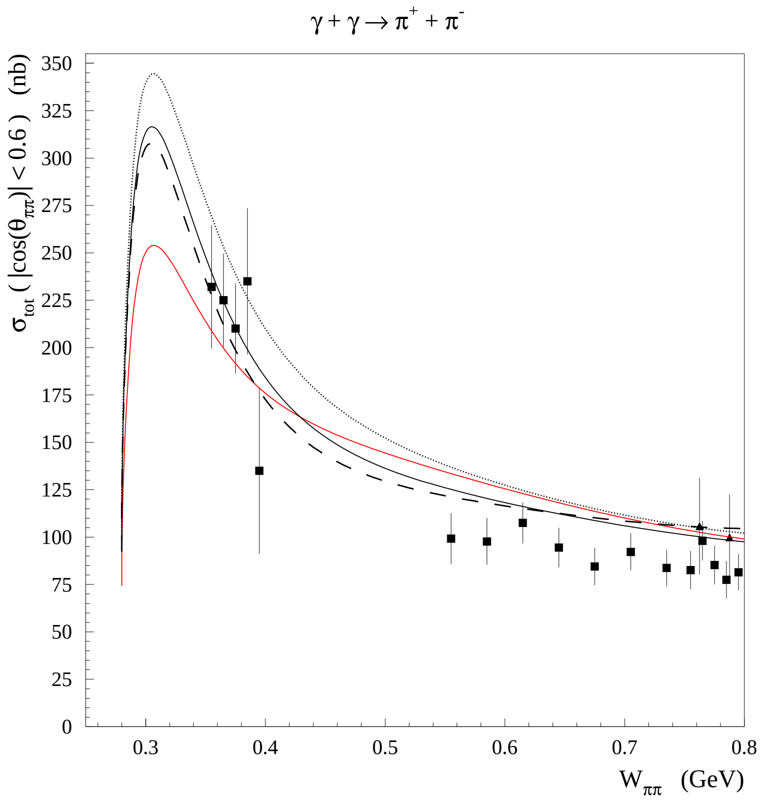
Differential cross section for Primakoff photo-production of $\pi^+\pi^-$

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

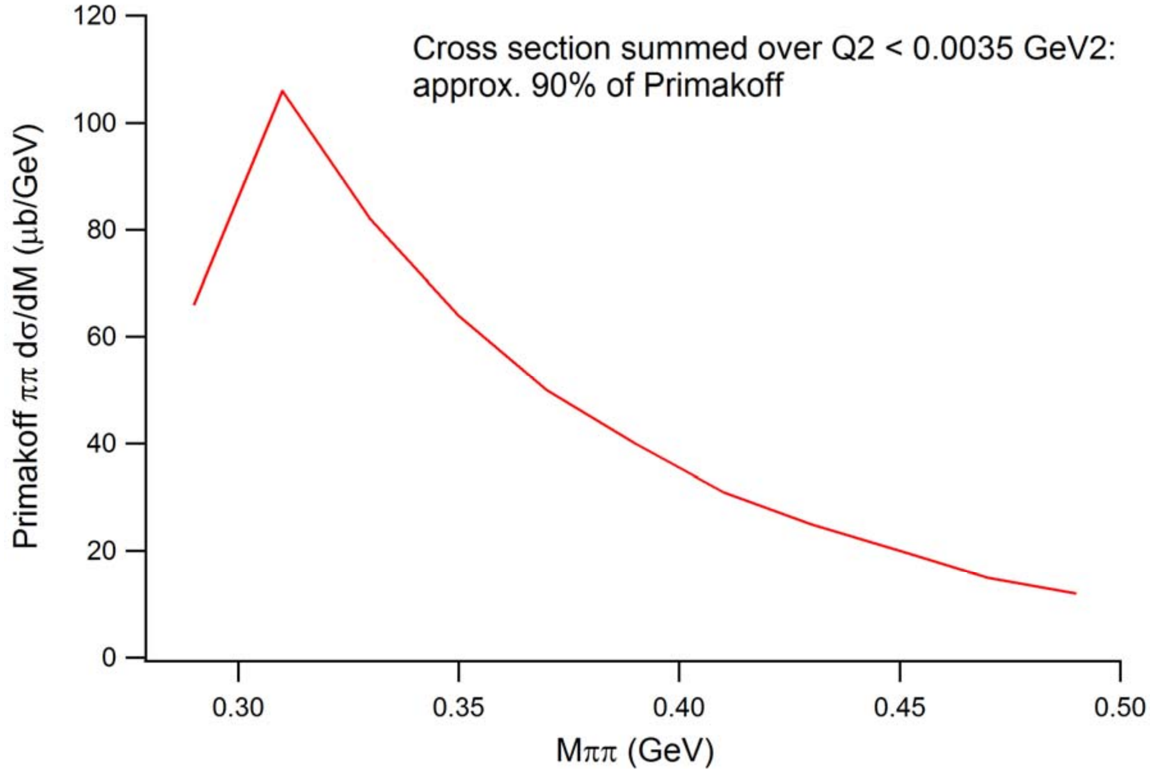
1. A. Halprin, C. Anderson, H. Primakoff, Phys. Rev. 152, 1295 (1966)
2. L. Stodolsky, Phys. Rev. Lett. 26, 404 (1971)
3. V. Budnev, I. Ginzburg, G. Meledin, V. Serbo, Phys. Rep. 15, no. 4, 181 (1975).

$\gamma\gamma \to \pi^+\pi^-$ data from Mark II.

J. Boyer, et al., Phys. Rev. D 42, 1350 (1990).



Integrate $d^2\sigma/d\Omega dM$ over $Q^2 < .0035\ GeV^2$ (about 90% of Primakoff cross section).



- The integral cross section is about 11 μb.
- Assuming 5% RL target and 10^7 photons/s, the event rate is 380 Primakoff $\pi^+\pi^-$ per hour.
- With acceptance of 50%, can reproduce Mark II statistics every 2 hours

Unfortunately, cross sections for $\gamma\gamma \rightarrow \mu^+\mu^-$ are about ×10 bigger than $\pi^+\pi^-$

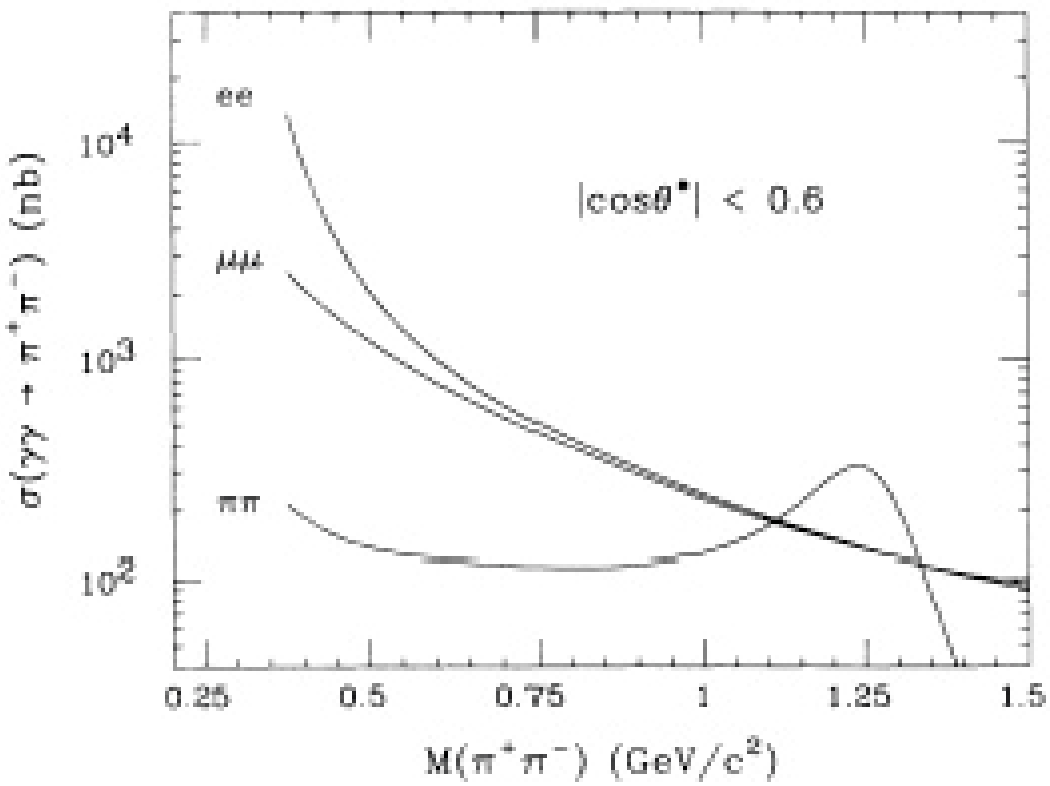


FIG. 1. Predicted two-photon cross sections for pion pairs and lepton pairs. The predictions for lepton pairs are from a Monte Carlo calculation. The prediction for pion pairs is that of Morgan and Pennington (Ref. 15), where the pion-pair cross section consists of a nonresonant continuum and the large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

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

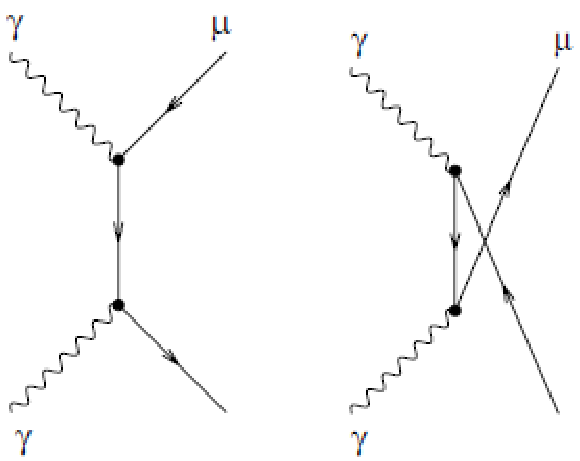


Figure 2.2: *Two-photon subprocess. Shown are the t-channel (right) and the u-channel (left) contribution.*

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

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

Exact expression is given in Bjorken and Drell, *Relativistic Quantum Mechanics,* see "Applications: Pair Annihilation into Gamma Rays"

Response of lead-glass cerenkov counters to charged pions

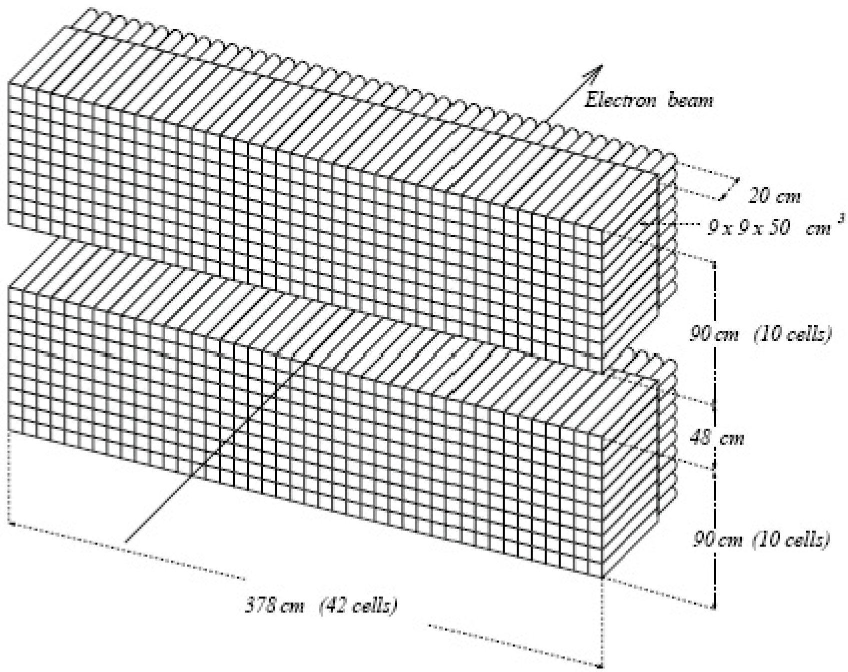


Figure 1: Isometric view of the HERMES calorimeter

Simulated response

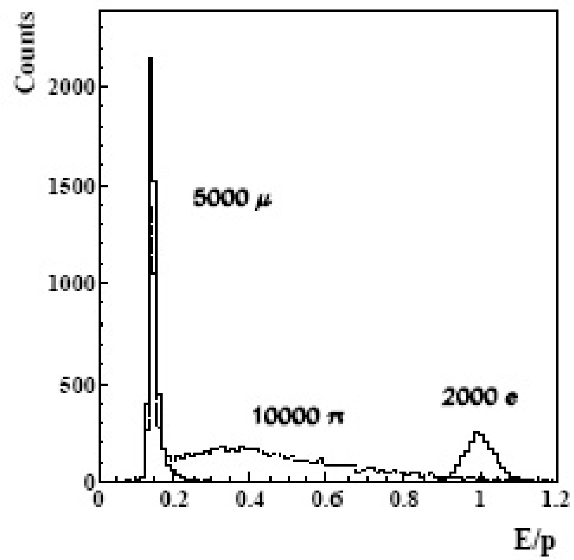
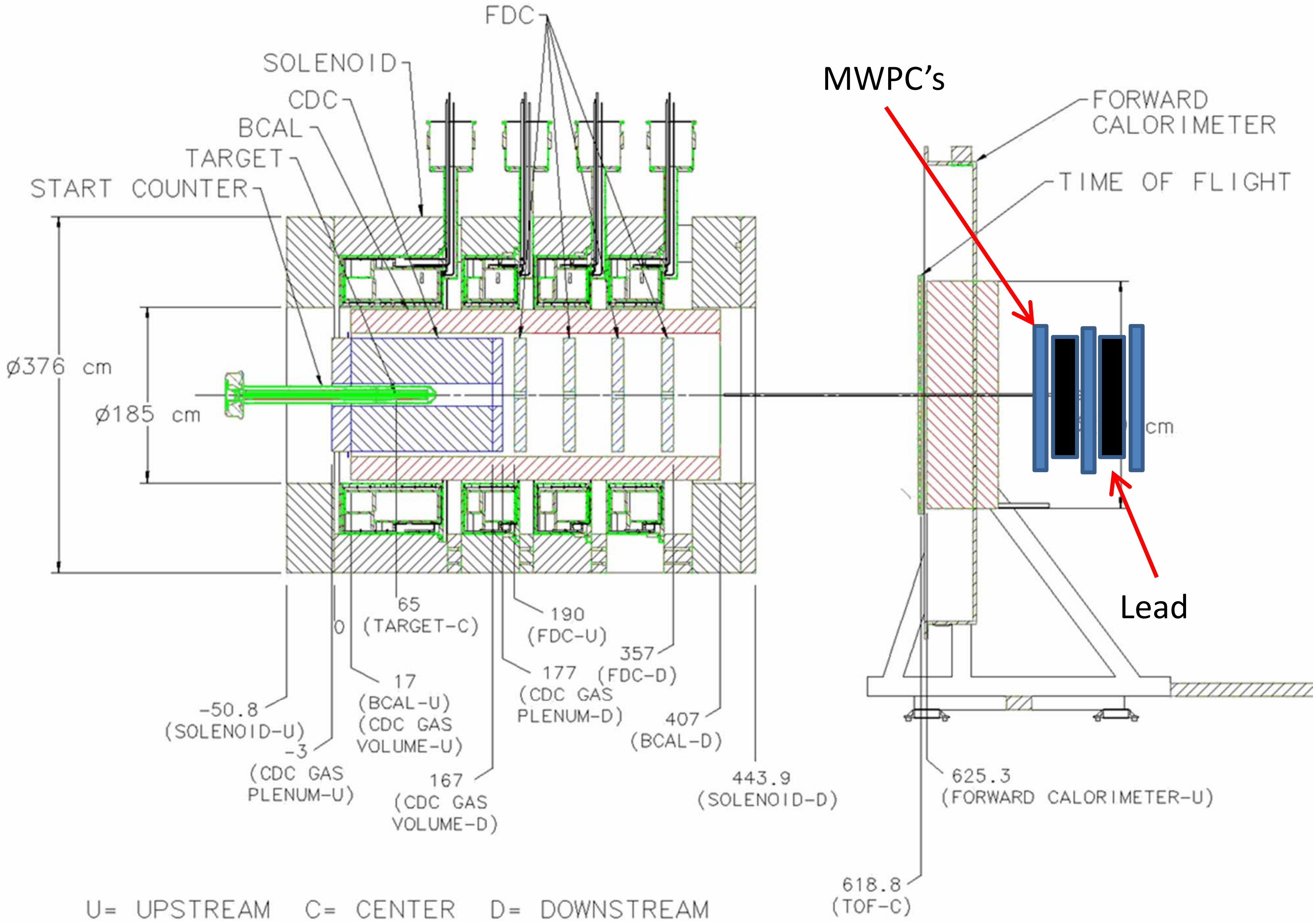


Figure 3: Distribution of the ratio of the energy deposited E and momentum p for e, π and μ of 5 GeV/c momentum.

Performance of F101 Radiation Resistant Lead Glass Shower Counters, Avakian et al., NIM

Consider using a muon veto counter and a Cerenkov counter for the experiment.

- For 2.5 GeV muons in lead, dE/dX ~ 15 MeV/cm, stopping distance ~ 1.5 m
- Hadronic interaction length in lead $\lambda_H \sim 17$ cm
- FCAL has about 1.5 hadronic interaction lengths
- To contain hadron showers probably want total length of at least $5\lambda_H$
- The transverse size of a hadron shower is of order λ_H , whereas a muon is a single track.
- → ***Install 60 cm of lead behind FCAL with MWPC readout***


FDC
SOLENOID
CDC
BCAL
TARGET
START COUNTER
MWPC's
FORWARD CALORIMETER
TIME OF FLIGHT
ø376 cm
ø185 cm
cm
Lead
65 (TARGET-C)
0
190 (FDC-U)
357 (FDC-D)
177 (CDC GAS PLENUM-D)
17 (BCAL-U) (CDC GAS VOLUME-U)
-50.8 (SOLENOID-U)
-3 (CDC GAS PLENUM-U)
407 (BCAL-D)
167 (CDC GAS VOLUME-D)
443.9 (SOLENOID-D)
625.3 (FORWARD CALORIMETER-U)
618.8 (TOF-C)
U= UPSTREAM C= CENTER D= DOWNSTREAM

Overview:

- Complete study of kinematic fitting. Finalize resolution studies for $\phi_{\pi\pi}$, and $\theta_{\pi\pi}$, and the experimental bin size in $M_{\pi\pi}$
- Write event generators for $\gamma\gamma\rightarrow\mu\mu$ and $\gamma\gamma\rightarrow$ee, evaluate QED backgrounds.
- Study muon veto counter concept and geometry. GEANT simulation.
- Evaluate need for Cerenkov counter to reject e^+e^- pairs