Data analysis on PrimEx-II

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Outline

- Introduction for PrimEx-II Experiment
- Experimental Setup
- The progress of my data analysis work

Introduction for PrimEx-II

- **What is PrimEx-II experiment doing?**

  The PrimEx experiment, which was performed in Hall-B of Jlab, is performing a ~ 1.4% level measurement of the neutral pion lifetime.

- Why does **PrimEx-II want to 1.4% high level precision?**

  The two photon decay of the π^0 is a direct consepuence of the axial anomaly. In the chiral limit, the radiative width $\Gamma(\pi^0 \rightarrow 2\gamma)$ can be calculated exactly in leading order. Recent theoretical calculations in χPT and in the QCD sum rule approach predict a neutral pion radiative width of 8.1 eV (±1.0%) and 7.93 eV (±1.5%), respectively. Thus, a precision measurement of the radiative width would arguably be one of the most fundamental tests of low energy QCD and Chiral Perturbation Theory possible with few GeV photons.

- **Primakoff effect plays an important role for $\Gamma(\pi^0 \rightarrow 2\gamma)$ measurement:**

  Primakoff effect: π0 photo-production from the electric field of a nucleus. The production mechanism ($\gamma\gamma^* \rightarrow \pi^0$) is equivalent to the decay mechanism ($\pi^0 \rightarrow \gamma\gamma$) which implies the Primakoff cross section is proportional to the lifetime (or decay width, $\Gamma_{\gamma\gamma}$).

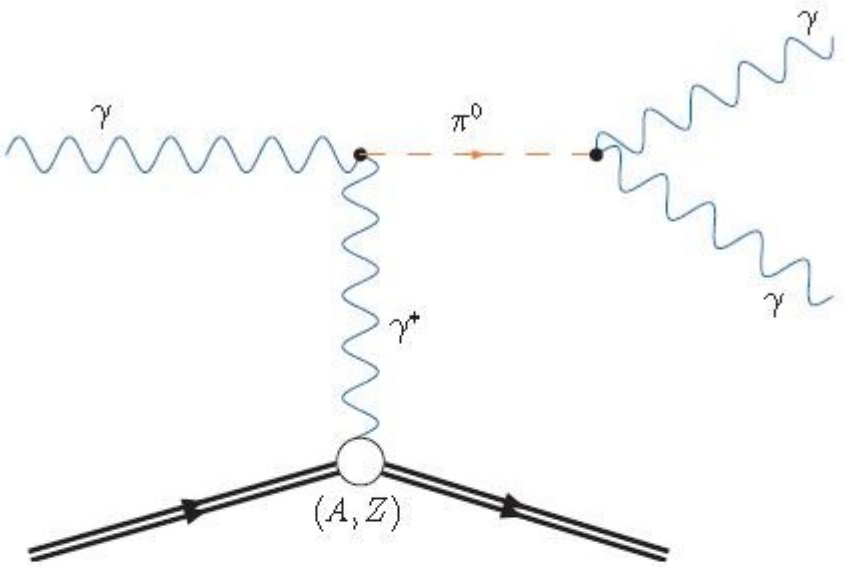


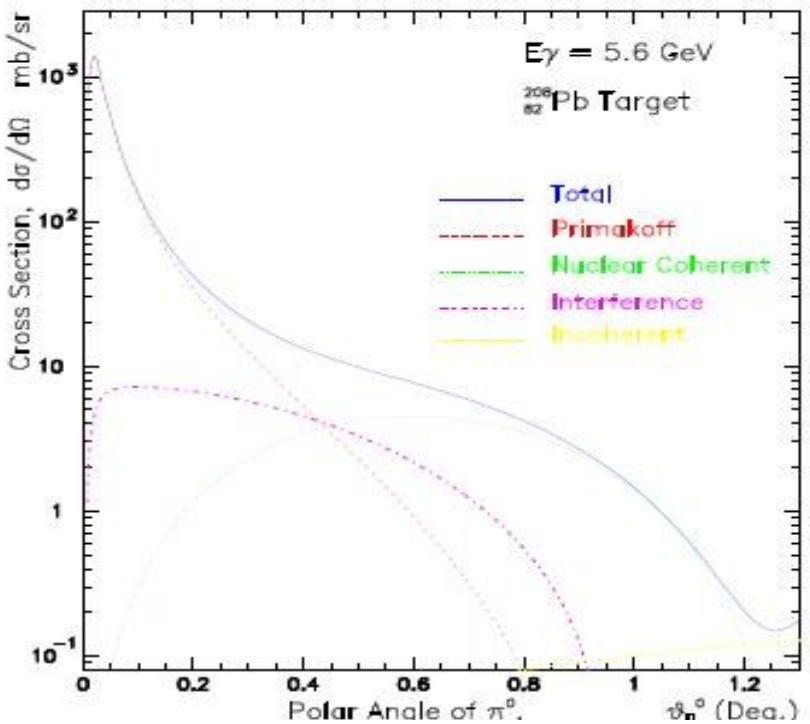
Figure 1: Primakoff effect

The full cross section for pion photoproduction at high energy:

Primakoff Nuclear Coherent Interference Nuclear Incoherent

$$\frac{d\sigma}{d\Omega} = b_p \cdot \frac{d\sigma_P}{d\Omega} + b_{nc} \cdot \frac{d\sigma_{NC}}{d\Omega} + \cos\phi \cdot 2\sqrt{b_p b_{nc} \frac{d\sigma_P}{d\Omega} \frac{d\sigma_{NC}}{d\Omega}} + b_b \cdot \frac{d\sigma_{Inc}}{d\Omega},$$

where bp =$\Gamma_{\gamma\gamma}$ (eV), bnc , φ, and bb are the fit parameters.



Figue 2: Nuclear π^0 photoproduction cross section for ^{208}Pb in the 6.0 GeV energy range

Experimental Setup

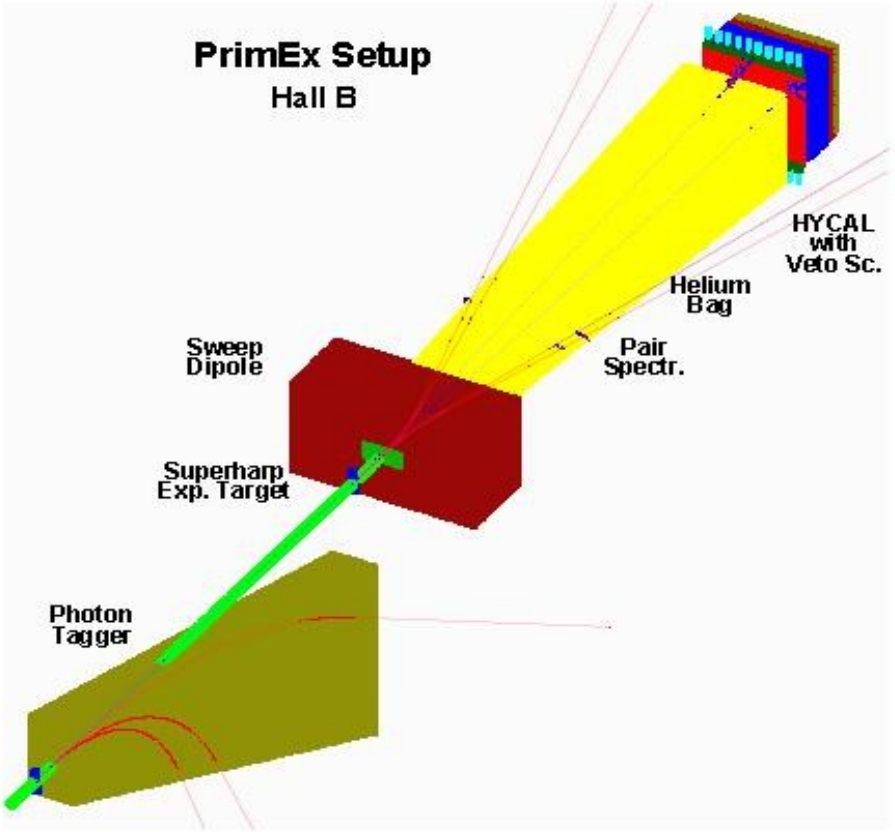
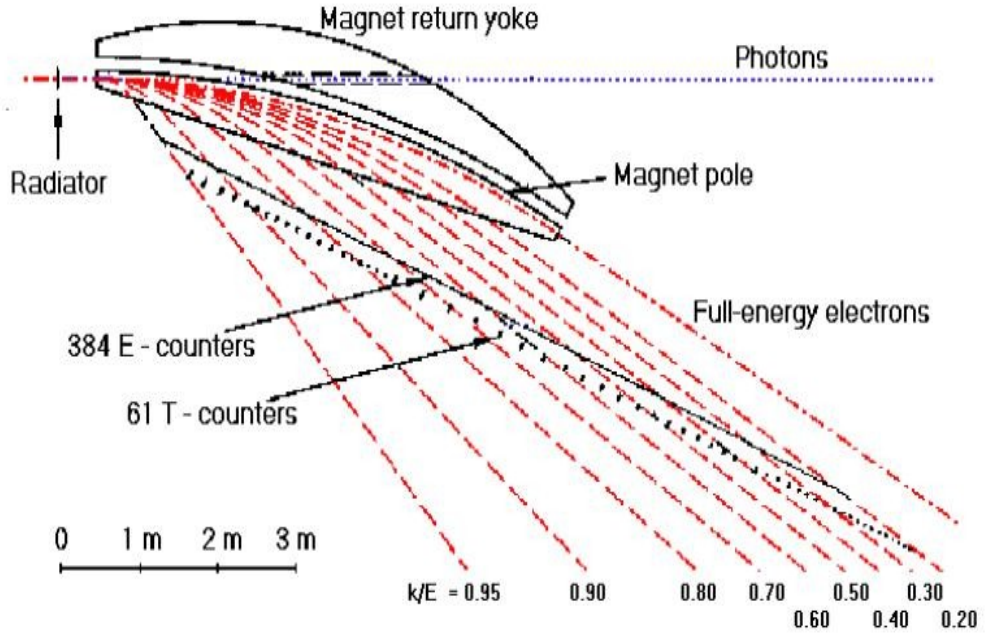


Figure 3: Layout of the *PrimEx* experimental setup.

Figue 3: layout of PrimEx experimental setup



Tagger utilize the well known brems-strahlung photon tagging technique to measure the energy and time information of incident photons in real photon induced reactions

Figue 4: The overall schematic of the Hall B tagging system

Hybrid Calorimeter (HYCAL)

1) Hycal is a two-dimensional matrix of radiators designed to provide precise measurements of position and energy of the detected particles.

2) The HyCal is 119.0 × 119.0 cm^2 in the direction transverse to the beam and it is located about 7.32 meters downstream of the π^0 production target.

3) The inner part of the calorimeter is a 34x34 array of 1152 lead–tungstate (PbWO4) crystals of dimensions 2.075×2.075 × 21.2 cm^3. The matrix of lead–tungstate crystals is surrounded by six layers of lead–glass modules. Each of 576 lead–glass modules is of dimensions 3.815 × 3.815 × 34 cm3 .

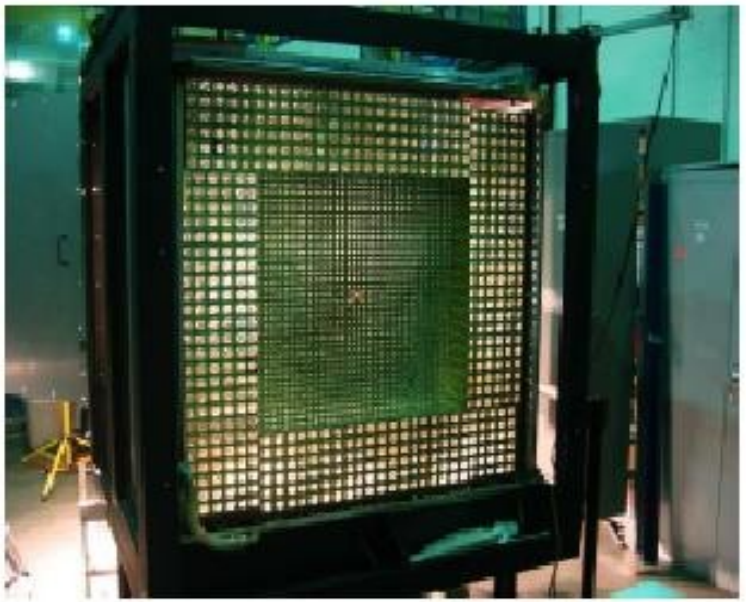
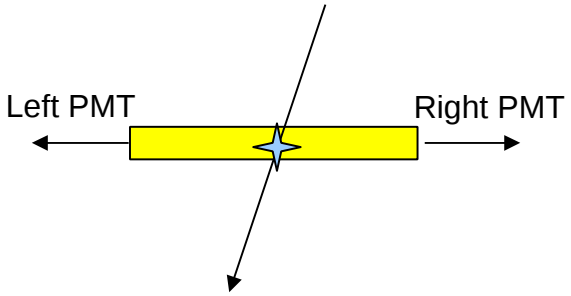


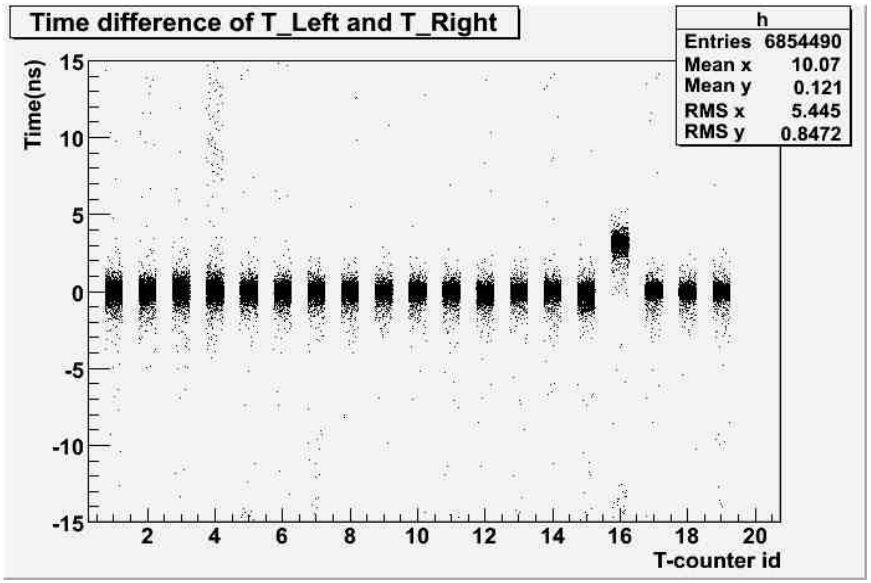
Figure 5:The Hybrid Calorimeter(*HYCAL)*

The progress of my data analysis work

•TDC alignment between T_Left and T_Right

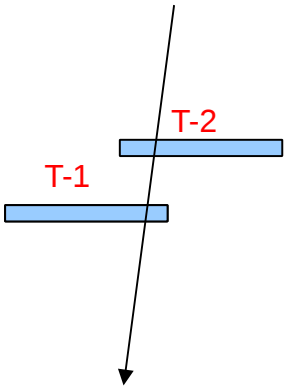


Tcounter has two PMT at the left and right side

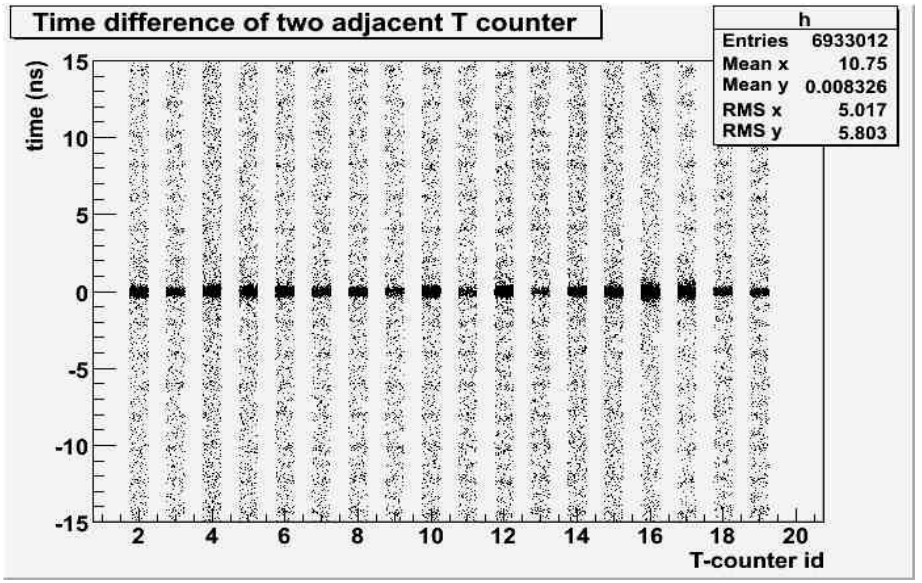


TDC alignment between T_Left and T_Right

- TDC alignment between two adjacent Tcounters



One photon passing through the overlapping area of two adjacent Tcounters



TDC alignment between two adjacent Tcounters