Status of the PrimEx-II Analysis on the π^0 Lifetime Measurement

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(On behalf of PrimEx Collaboration)

Outline

- Physics Motivation
- Experimental Setup
- Data analysis Status
- Summary

Physics Motivation

- $\pi^0 \to \gamma\gamma$ decay width dominated by the QCD chiral anomaly is a fundamental QCD prediction
- The decay width of π^0 predicted by chiral anomaly is exact in chiral limit (when the light quarks are massless) :

$$\Gamma(\pi^0 \to \gamma\gamma) = \frac{\alpha^2 N_c^2 m_\pi^3}{576\pi^3 F_\pi^2} = 7.725\ eV$$

  - Corrections to the chiral anomaly prediction:

    Calculations in NLO ChPT:
    - $\Gamma(\pi^0 \to \gamma\gamma)$ = 8.10eV ± 1.0%

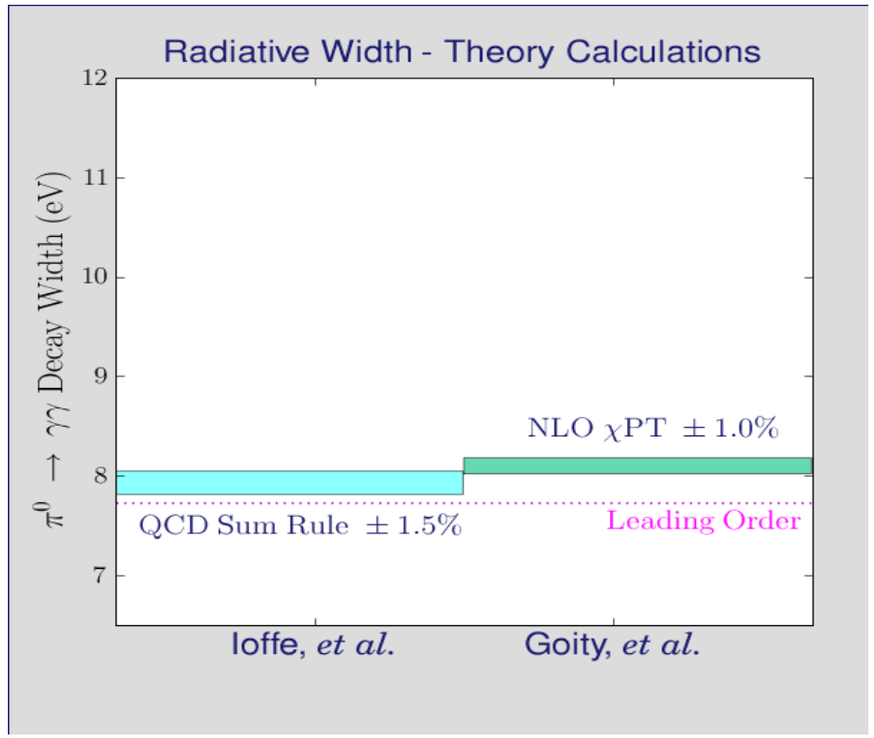
      (J. Goity, et al. Phys. Rev. D66:076014, 2002)
    - $\Gamma(\pi^0 \to \gamma\gamma)$ = 8.06eV ± 1.0%

      (B. Ananthanarayan et al. JHEP 05:052, 2002)

    Calculations in NNLO SU(2) ChPT:
    - $\Gamma(\pi^0 \to \gamma\gamma)$ = 8.09eV ± 1.3%

      (K. Kampf et al. Phys. Rev. D79:076005, 2009)
  - Calculations in QCD sum rule:
    - $\Gamma(\pi 0 \to \gamma\gamma)$ = 7.93eV ± 1.5%

      (B.L. Ioffe, et al. Phys. Lett. B647, p. 389, 2007)



- Precision measurements of $\Gamma(\pi^0 \to \gamma\gamma)$ at the percent level will provide a stringent test of a fundamental prediction of QCD.

Physics Goal for PrimEx-II

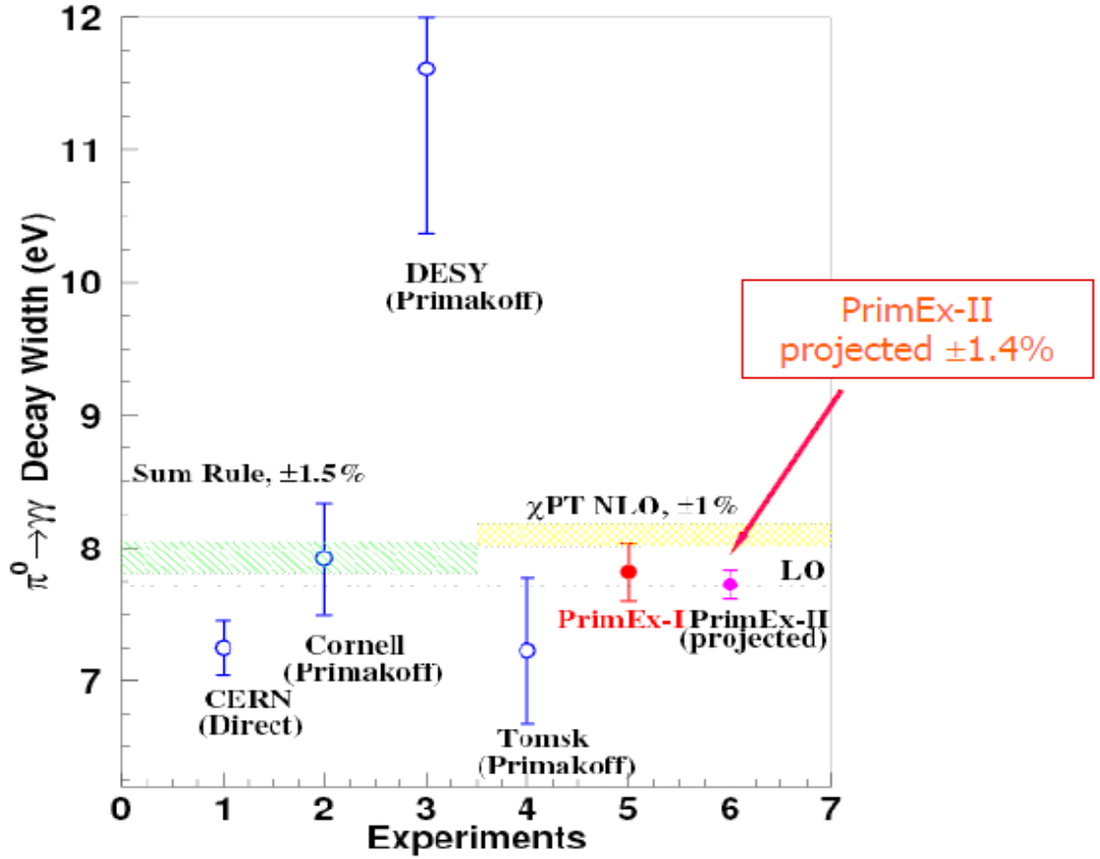
- PrimEx-I:

  $\Gamma(\pi^0 \to \gamma\gamma)$ = 7.82 ± 0.14 ± 0.17 eV (± 2.8% total).

  (I. Larin et al., Phys.Rev.Lett., 106:162303, 2011)

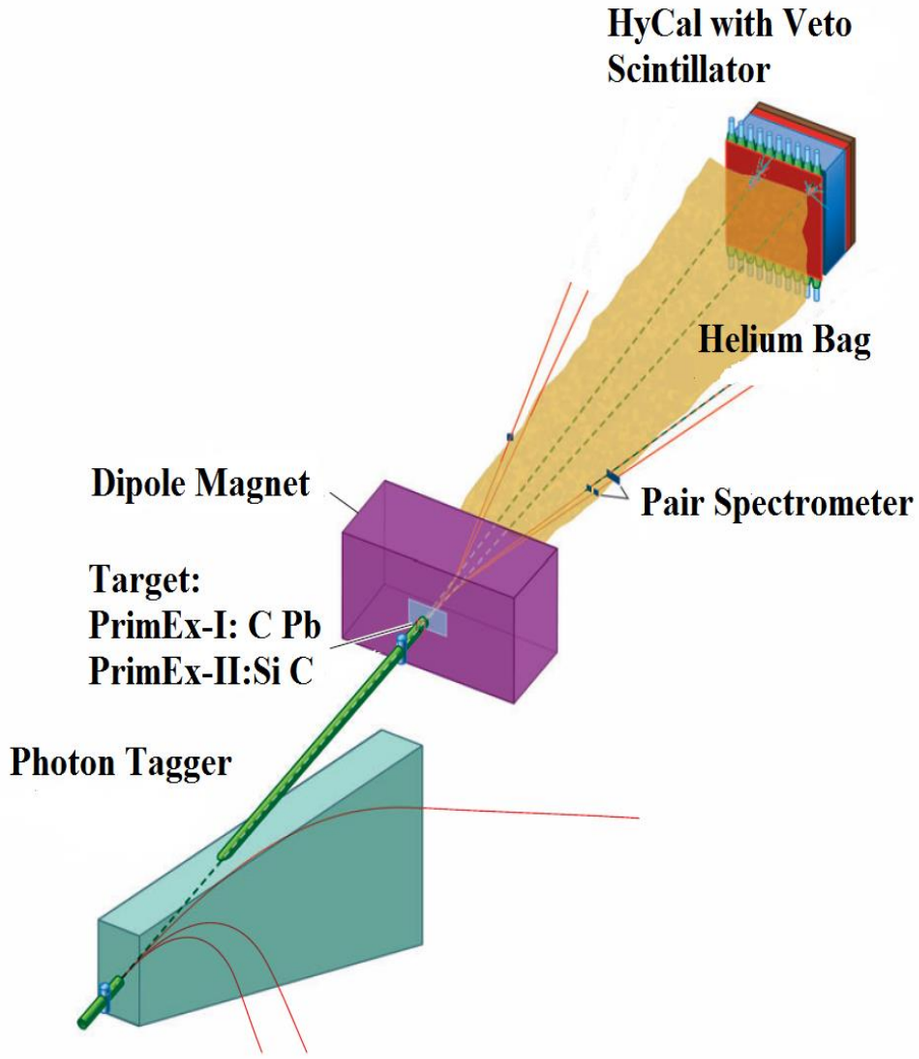
- PrimEx-II:

  projected total uncertainty : ±1.4%



PrimEx-II Experimental Setup

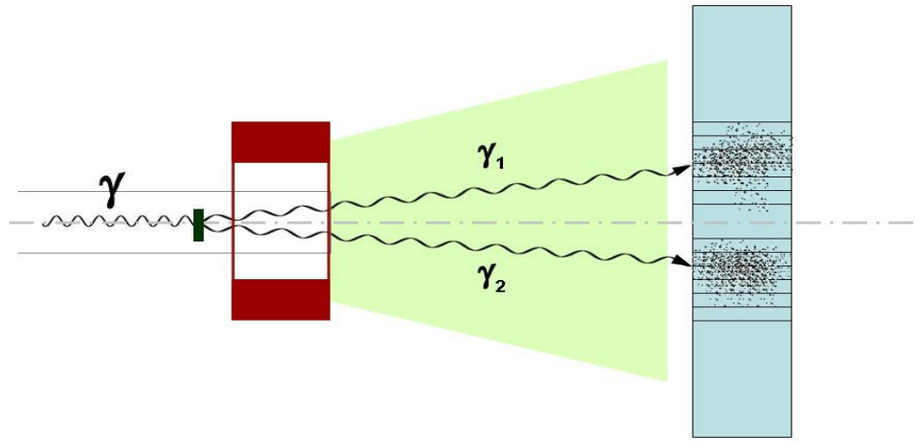
- Used 5.7 GeV continuous e^- beam and Hall B high resolution, high intensity photon tagging facility
- Pair spectrometer for photon flux control at high intensities.
- Two targets: ^{12}C and ^{28}Si (10% R.L.)
- High resolution hybrid multi-channel calorimeter (HYCAL) to detect photons from π^0 decays
- Measured 3 absolute cross sections:
  - ✓ Primary: π^0 production
  - ✓ Secondary: electron Compton and e^+e^- pair production



π^0 event selection

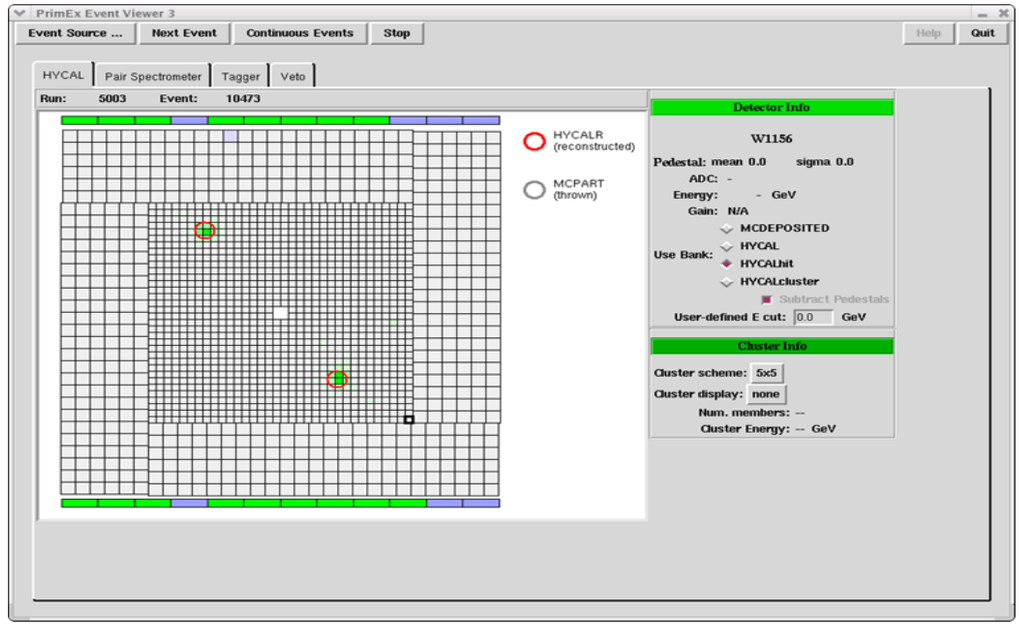
- Measured quantities:

  - ✓ initial photon energy and time
  - ✓ energy and time of decayed photons
  - ✓ X,Y positions of decayed photons



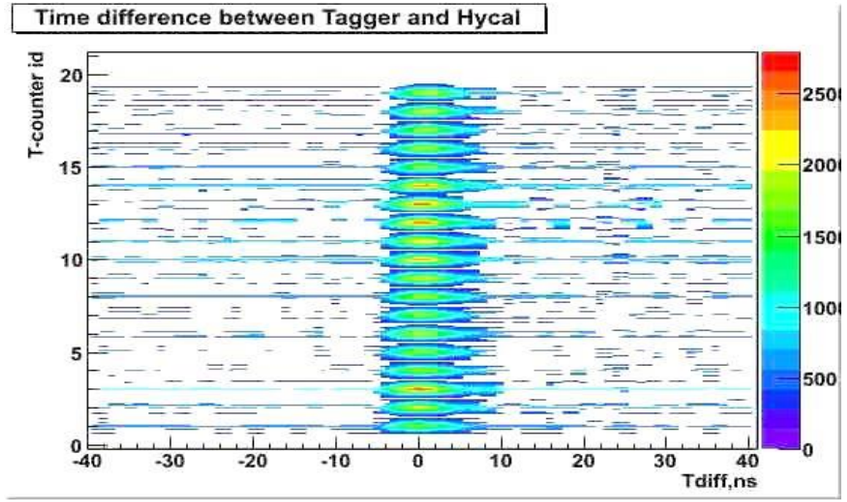
- Kinematical constrains:

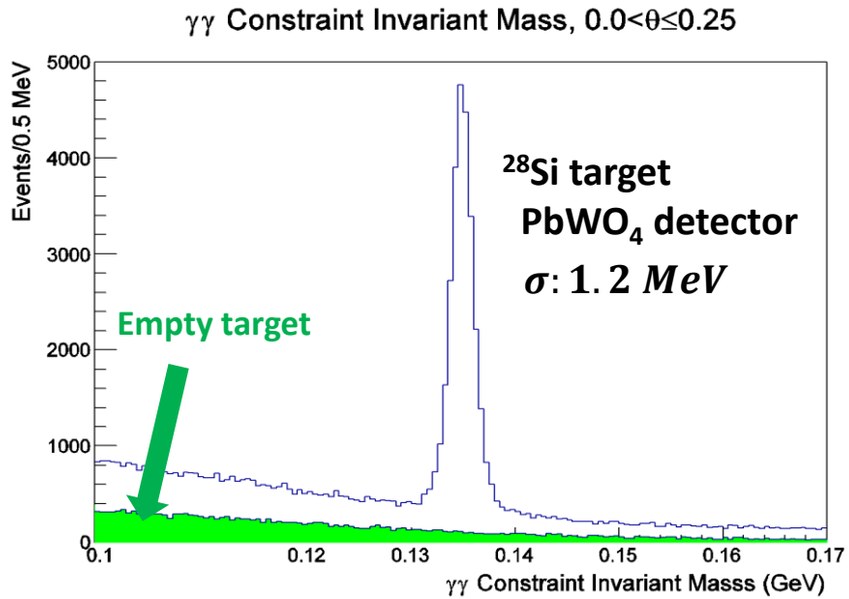
  - ✓ Conservation of energy;
  - ✓ Conservation of momentum;
  - ✓ $m_{\gamma\gamma}$ invariant mass

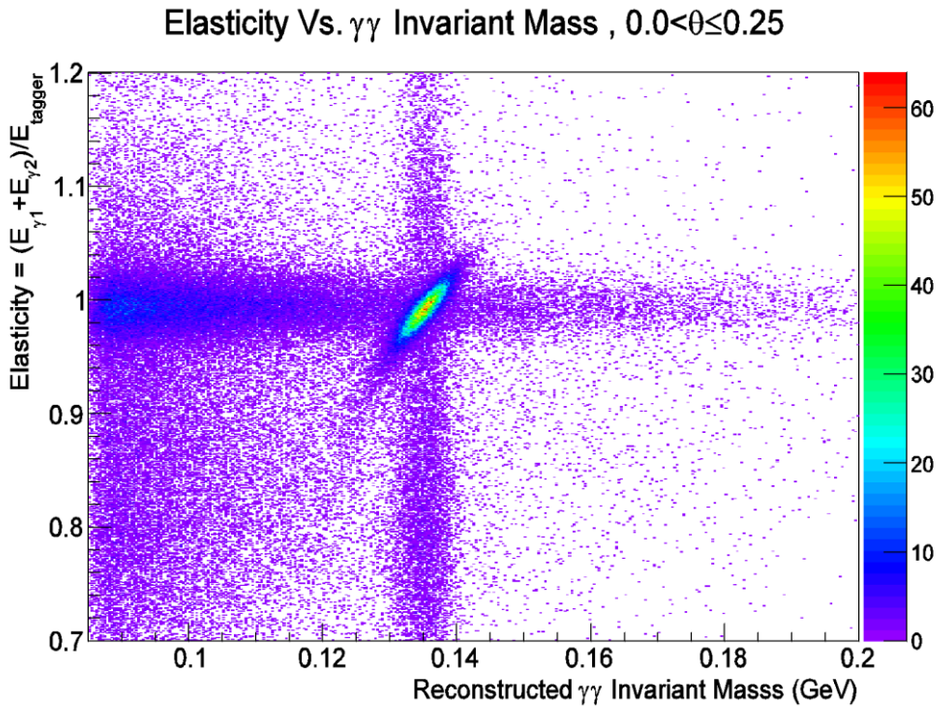


Data Analysis Status

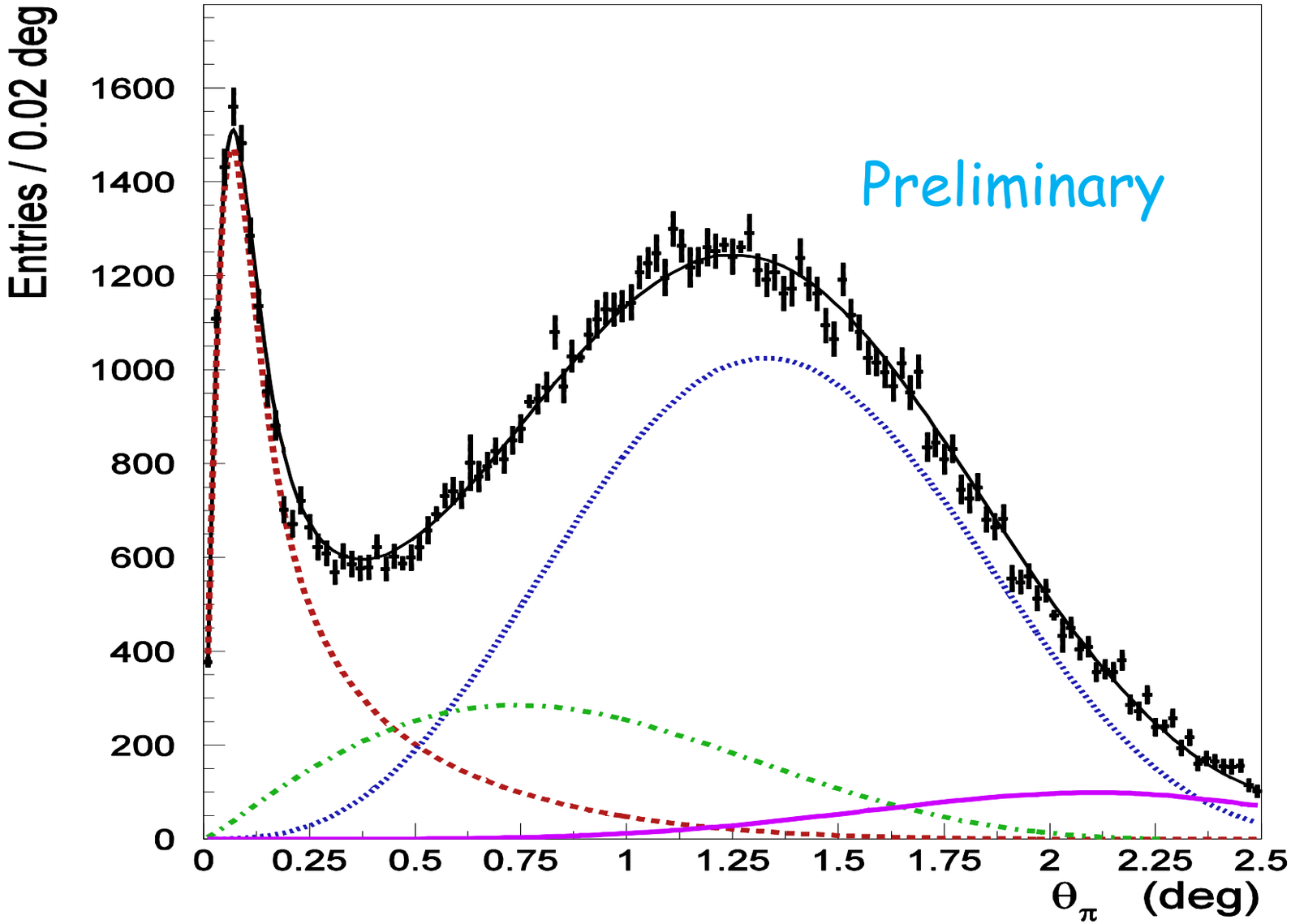
Tagger timing calibration







Extracted π^0 Yields on ^{28}Si target (Preliminary Results)



Summary

- PrimEx-II experiment was performed in Hall B to extract $\Gamma(\pi^0 \to \gamma\gamma)$ with high precision to provide a stringent test of a fundamental QCD prediction
- Two targets: ^{12}C and ^{28}Si
- Data analysis is in progress:
  - ✓ calibrations are done
  - ✓ Photon flux analysis is completed
  - ✓ Preliminary results on π^0 yield and primakoff amplitude extraction on ^{28}Si target are obtained
- Future plans:
  - ➢ Extract final π^0 differential cross sections for both ^{12}C and ^{28}Si targets
  - ➢ Fit cross sections and extract $\Gamma(\pi^0 \to \gamma\gamma)$
  - ➢ Finalize experimental systematic uncertainties with analyzing the electron Compton and e^+e^- pair production data

This project is supported by NSF and Jefferson Lab

Thank you!