K^0 photoproduction on ^{12}C in the threshold region

T. Watanabe for NKS collaboration

Tohoku University

- Motivation
- Experiment
- Result
- Summary

Collaboration list

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- *Laboratory of Nuclear Science, Tohoku University*

  T.Ishikawa, T.Kinoshita, H.Shimizu, T.Tamae, T.Terasawa, T.Nakabayashi, H.Yamazaki, N.Miyahara

- *Dept. of Electrical and Electronic Engineering, Akita University*
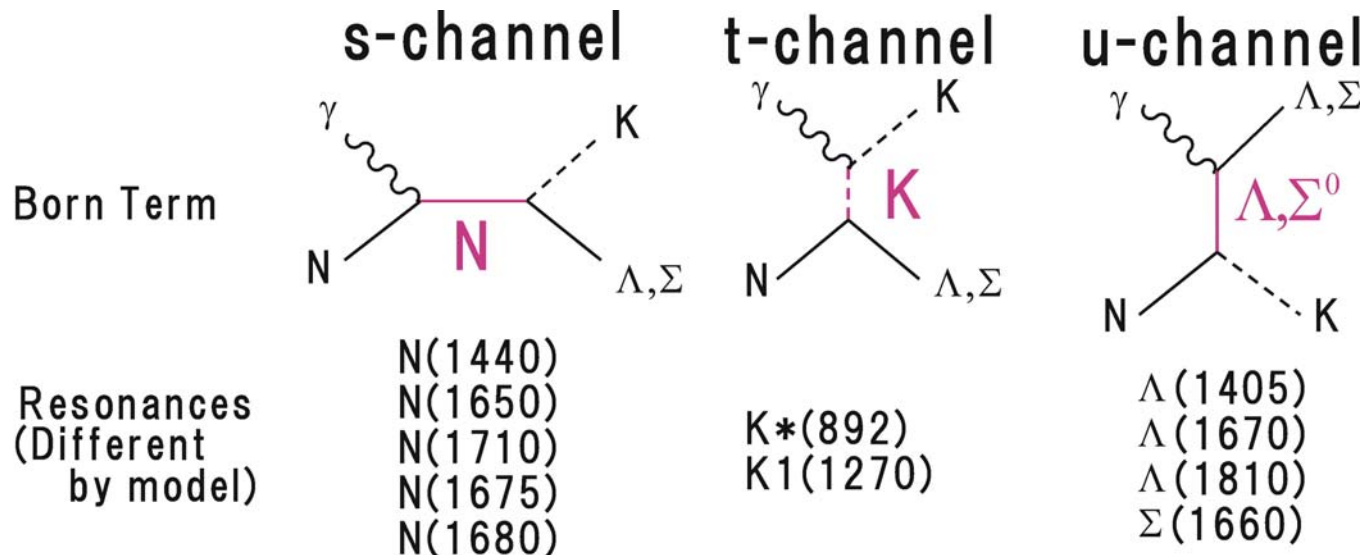
  A.Sasaki, T.Sato, S.Endo

- *Dept. of Electrical Engineering, Ichinoseki National College of Technology*

  O.Konno

Strangeness photoproduction

- **Important for Hadron physics**
  - ➤ missing resonance
  - ➤ hadron structure
- **Experiments**
  - ➤ high quality data for K^+
  - ➤ poor data for K^0
- **Various models using an effective Lagrangian**
  - ➤ many parameters to be determined
  - ➤ choice of resonances, coupling constants
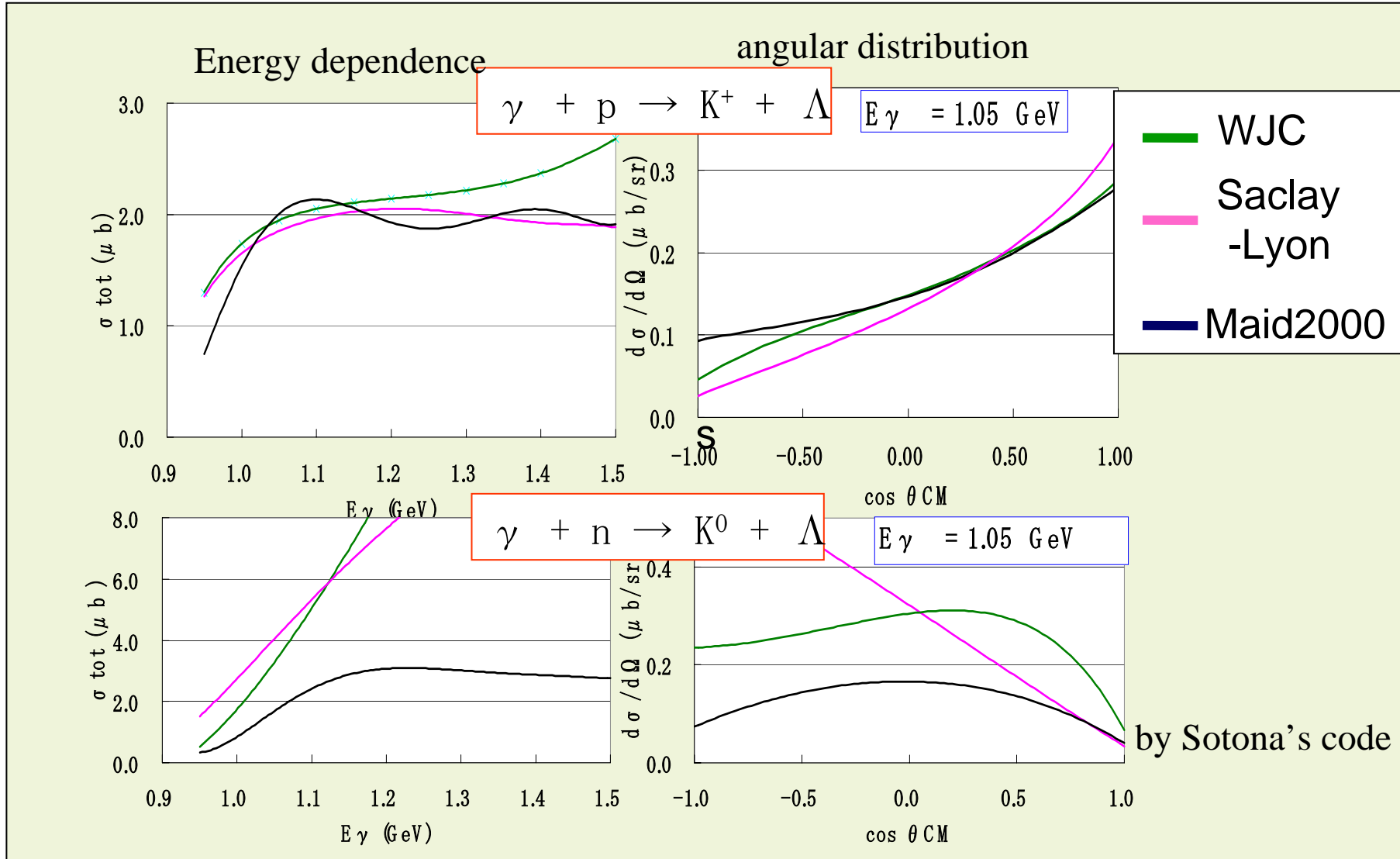- **Basic information for the $(e,e'K^+)$ reaction spectroscopy**

Isobar model of kaon photoproduction

s-channel | **t-channel** | **u-channel**

Born Term

Resonances (Different by model)

s-channel: N(1440), N(1650), N(1710), N(1675), N(1680)

t-channel: K*(892), K1(1270)

u-channel: Λ(1405), Λ(1670), Λ(1810), Σ(1660)

$\gamma n \rightarrow K^0 \Lambda$ *reaction near the threshold*

- No t-channel Born term
- Less contribution of resonances terms
- $g(K^0 \Sigma^0 n) = -g(K^+ \Sigma^0 p)$

Model prediction

Energy dependence

angular distribution

$\gamma + p \rightarrow K^+ + \Lambda$

$E\gamma = 1.05\ GeV$

WJC

Saclay -Lyon

Maid2000

$\gamma + n \rightarrow K^0 + \Lambda$

$E\gamma = 1.05\ GeV$

by Sotona's code

Measurement of K^0 photoproduction

- Beam: Tagged photon at LNS-Tohoku
  - ➤ energy range: 0.8–1.1 GeV
  - ➤ energy resolution: 6 MeV
- Detector: Neutral Kaon Spectrometer (NKS)
  - ➤ $K^0_s \rightarrow \pi^+\pi^-$ decay
- Target: Carbon 2.1 g/cm^2
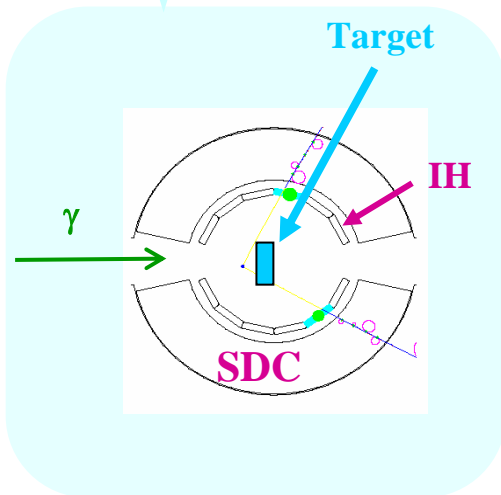 - ➤ quasi-free production: $\gamma n \rightarrow K^0 \Lambda$

Neutral Kaon Spectrometer (NKS)

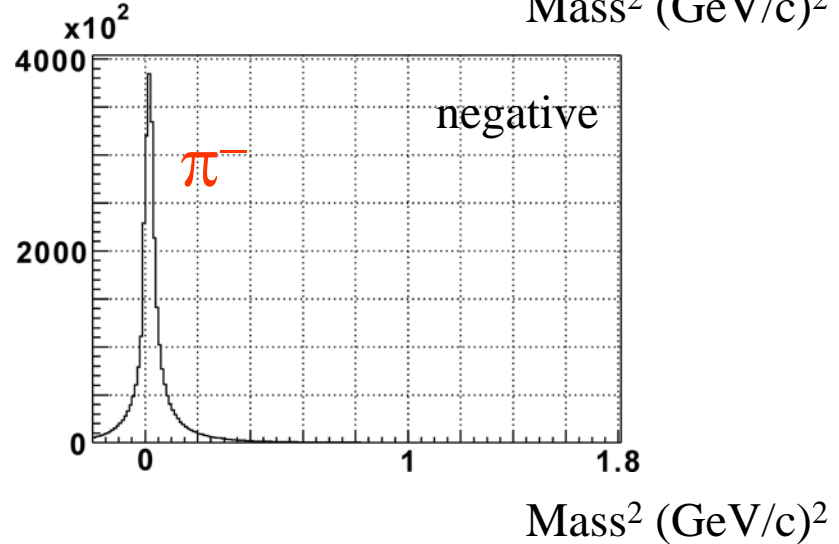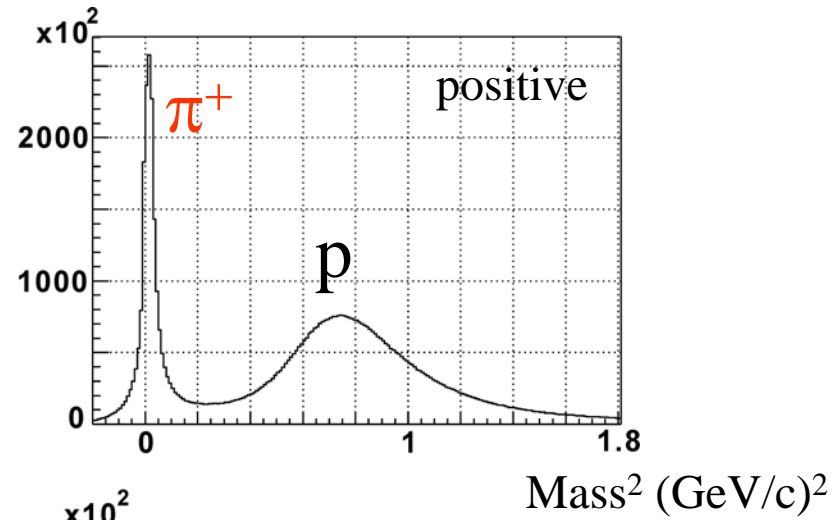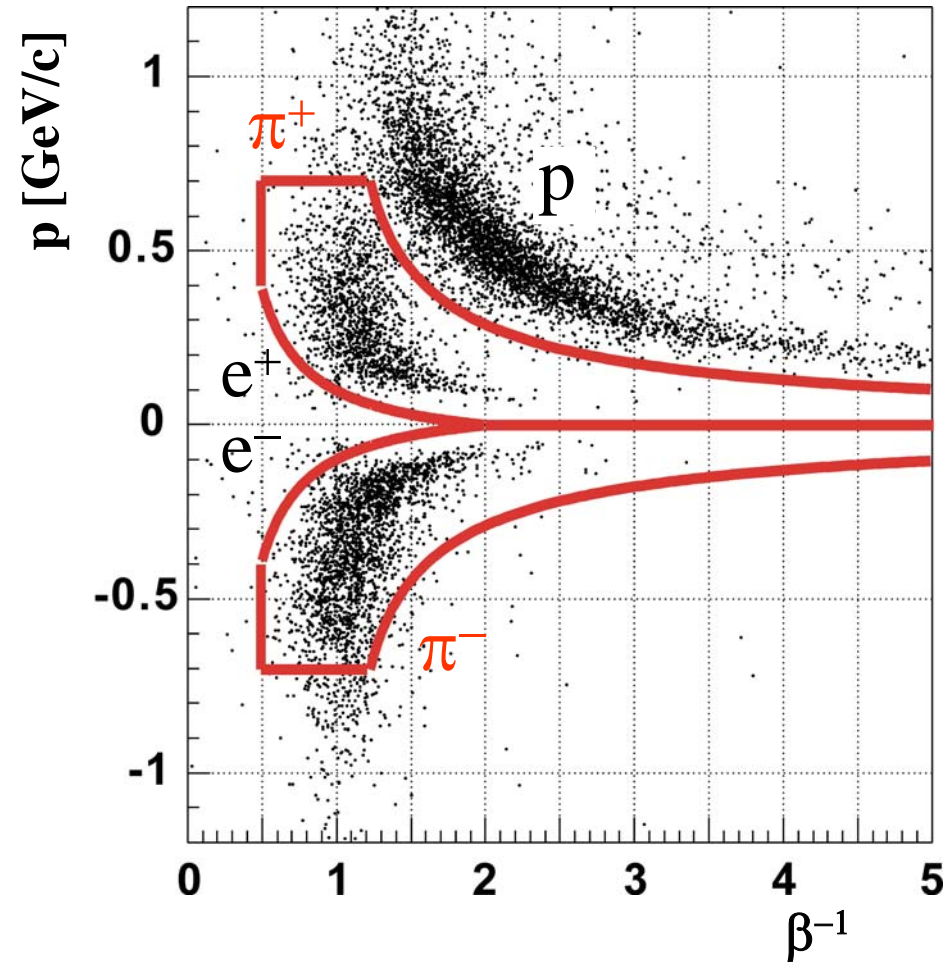$K^0_s \rightarrow \pi^+ \pi^-$ (B.R.:68.6%, $c\tau$:2.68cm)
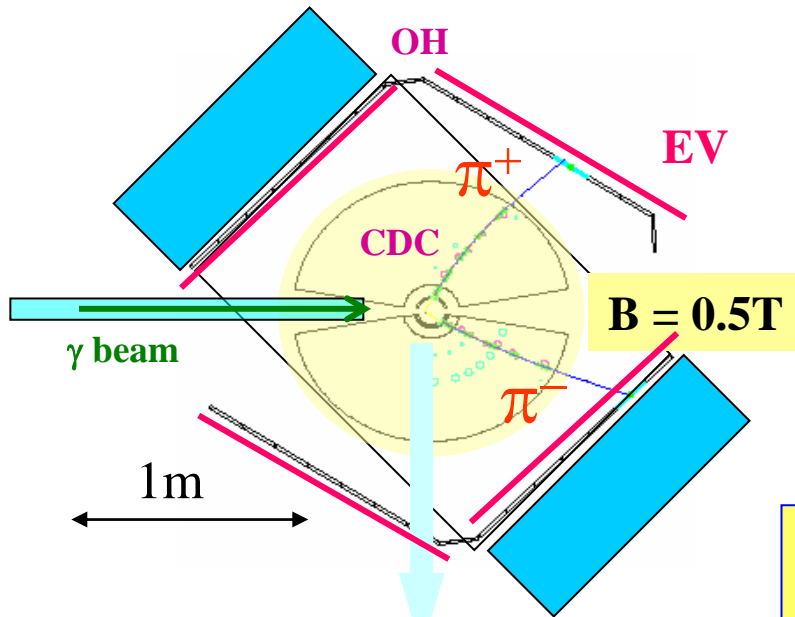
Solid angle: 25% of 4π
Dipole: 0.5 T, gap: 0.5 m

CDC, SDC (drift chambers):
  Momentum reconstruction
  Vertex reconstruction
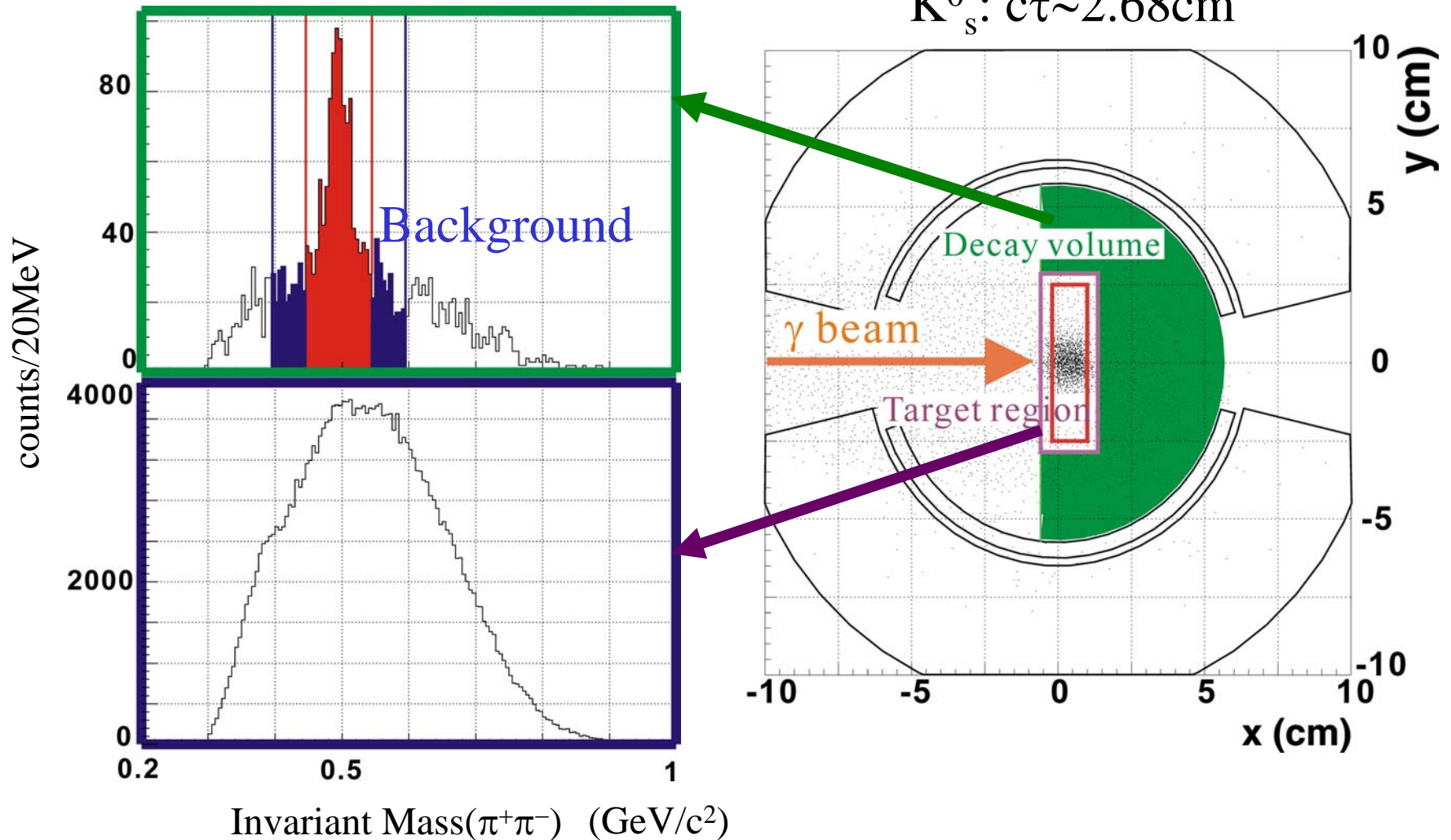Inner Hodoscope, Outer Hodoscope:
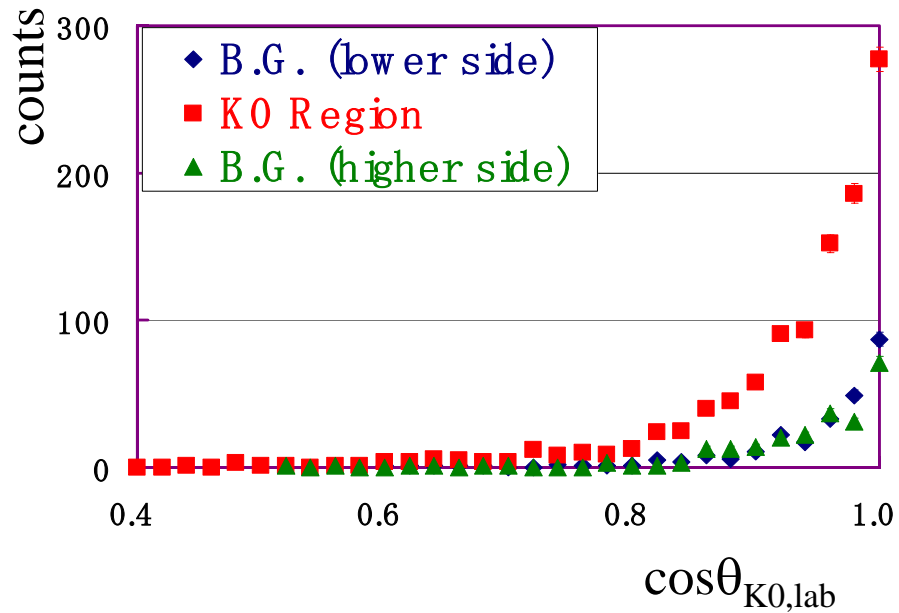 Time of Flight

Particle identification
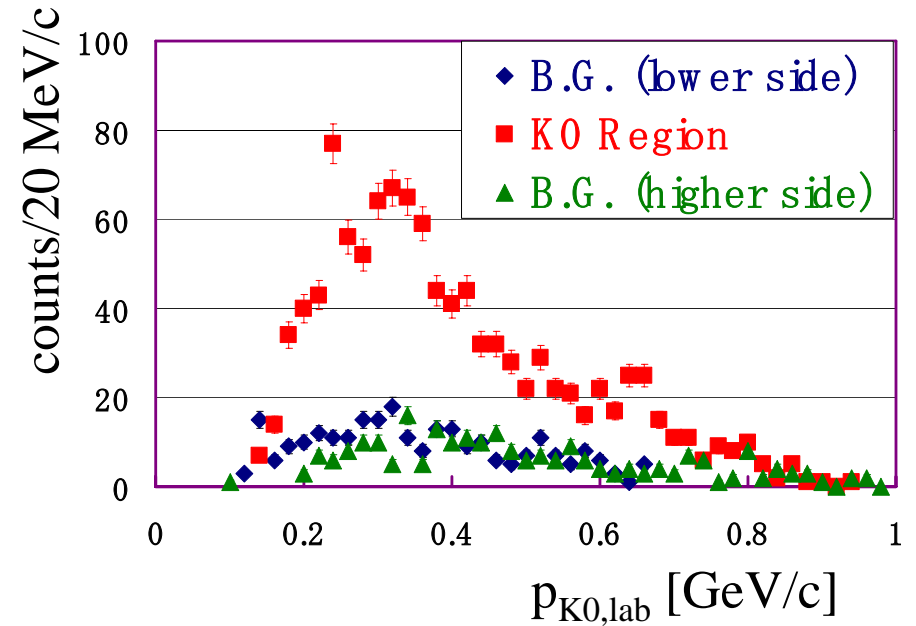
$\pi^+\pi^-$ invariant mass spectra

$K^0 \sim 450$

$K^0_s: c\tau \sim 2.68\text{cm}$

Background

counts/20MeV

Invariant Mass($\pi^+\pi^-$) (GeV/c²)

Decay volume

γ beam

Target region

y (cm)
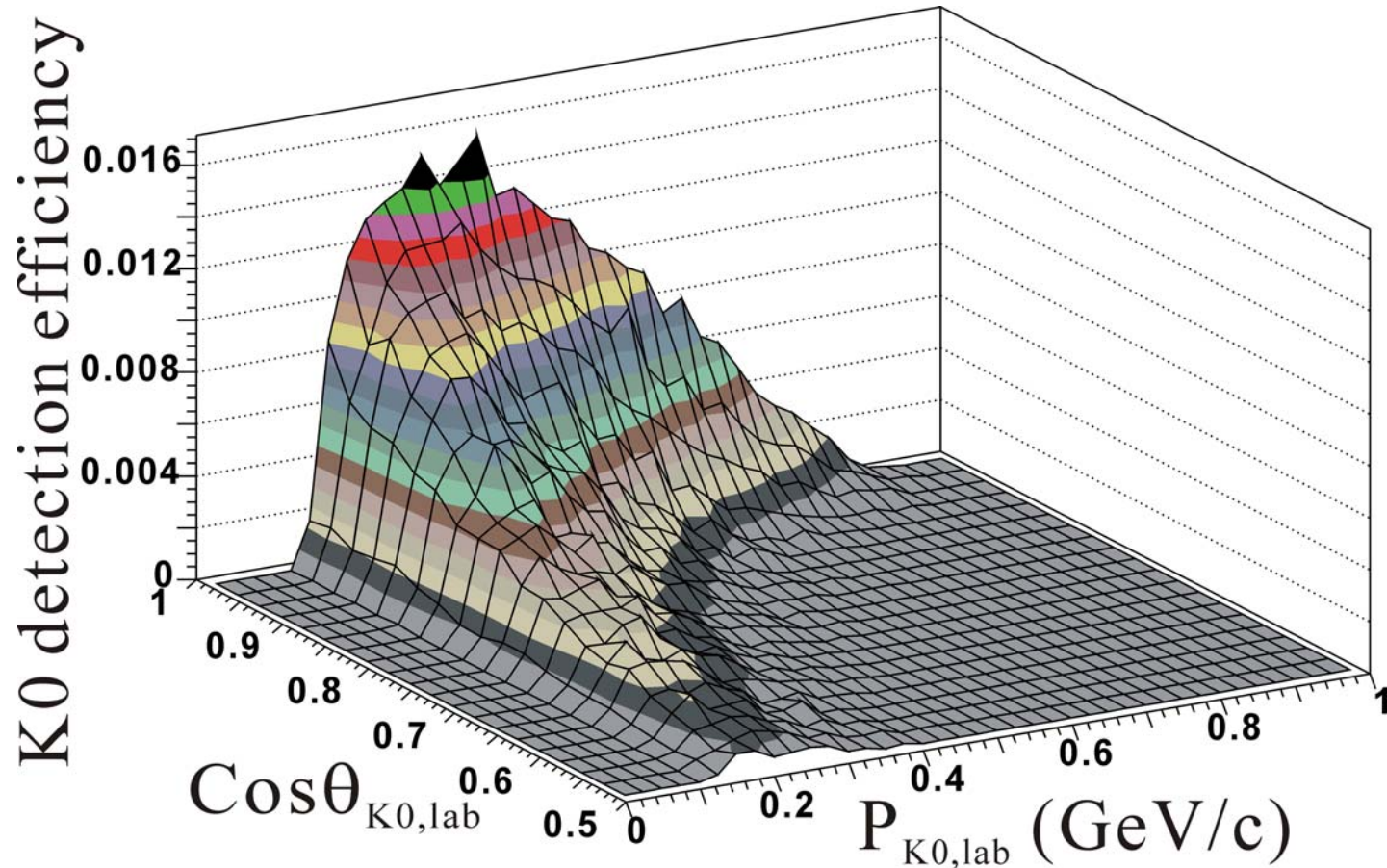
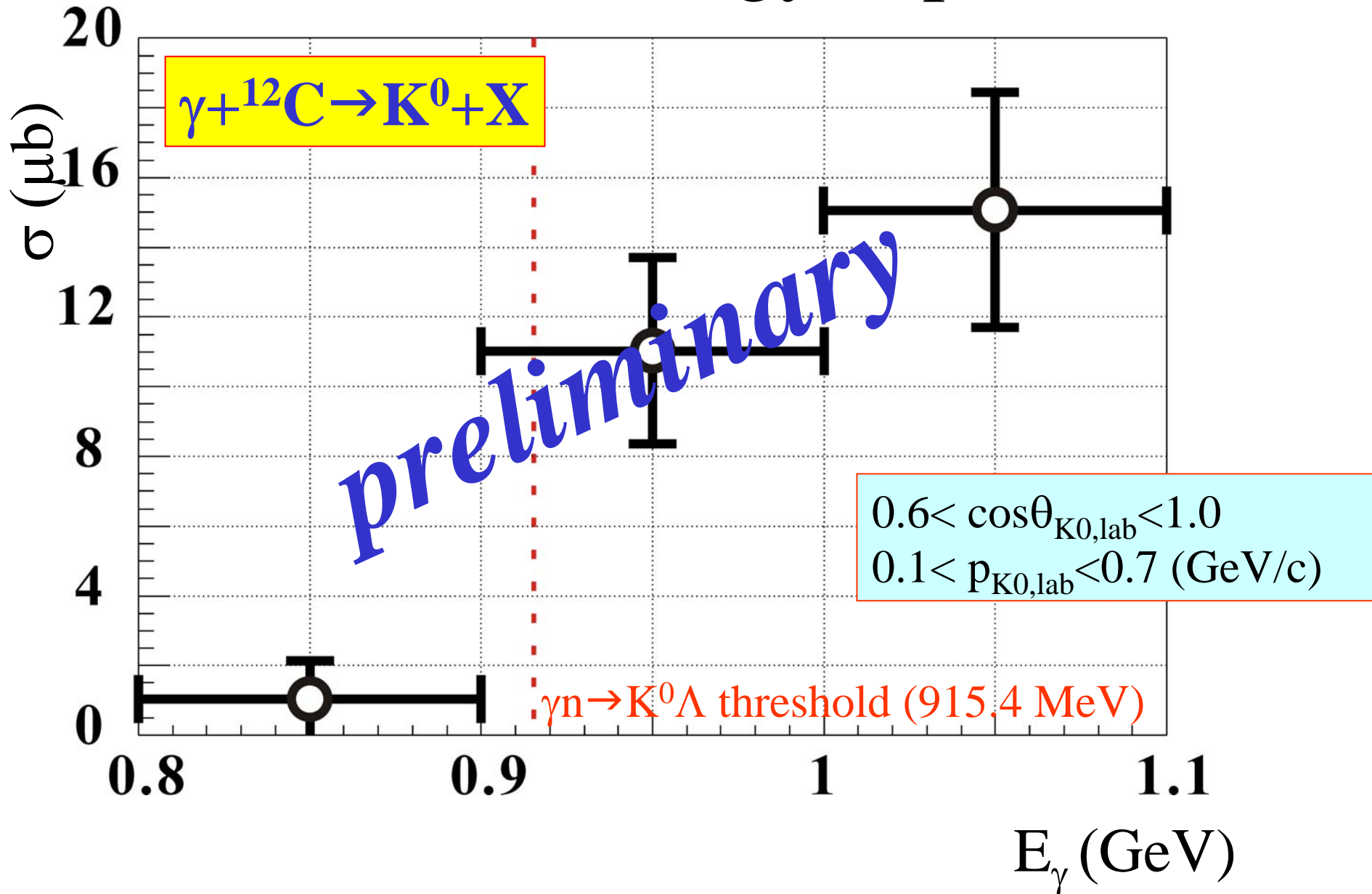x (cm)

Event distribution

angular distribution

momentum distribution

Acceptance of NKS

- Geometry

- Algorithm

- Analysis cut

Simulated by Geant4

Photon beam energy dependence

$\gamma + {}^{12}C \rightarrow K^0 + X$

preliminary

$0.6 < \cos\theta_{K0,lab} < 1.0$
$0.1 < p_{K0,lab} < 0.7 \ (GeV/c)$

$\gamma n \rightarrow K^0\Lambda$ threshold (915.4 MeV)

$\sigma \ (\mu b)$

$E_\gamma \ (GeV)$

Angular distribution

$\gamma + {}^{12}C \rightarrow K^0 + X$

$0.1 < p_{K0,lab} < 0.7$ GeV/c

$E\gamma$: 0.8–0.9
$E\gamma$: 0.9–1.0
$E\gamma$: 1.0–1.1

preliminary

$d\sigma/d\Omega$ (μb/sr)

$\cos\theta_{K0,lab}$
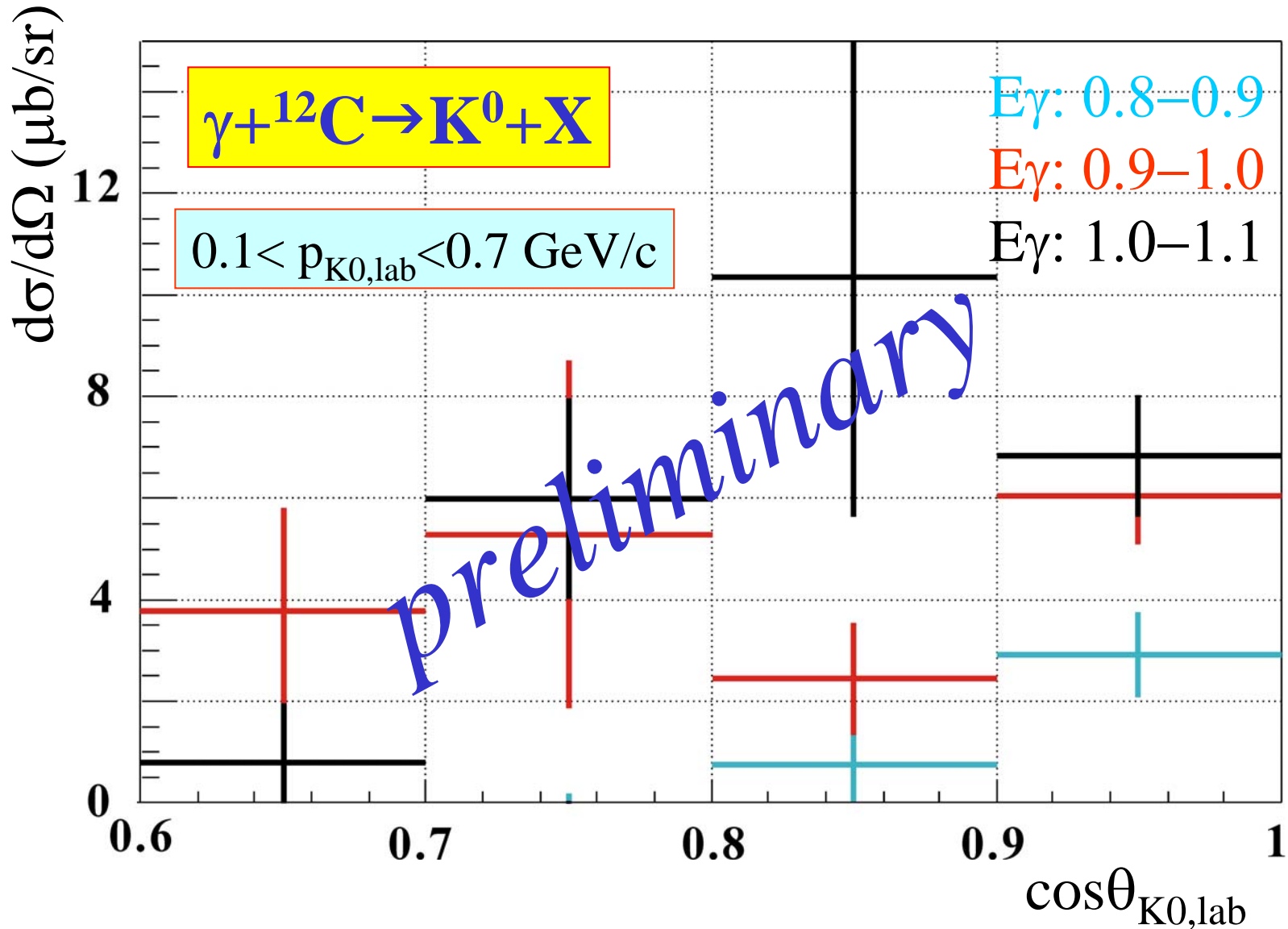
Summary

- The $\gamma n \rightarrow K^0 \Lambda$ process plays a unique role in the investigation of strangeness photoproduction.

- We measured K^0 quasi-free photoproduction on ^{12}C near the threshold for the first time by detecting $\pi^+ \pi^-$ in coincidence.

- Results of preliminary analysis are presented,
  - photon energy dependence
  - angular distribution

- Further analysis is underway.