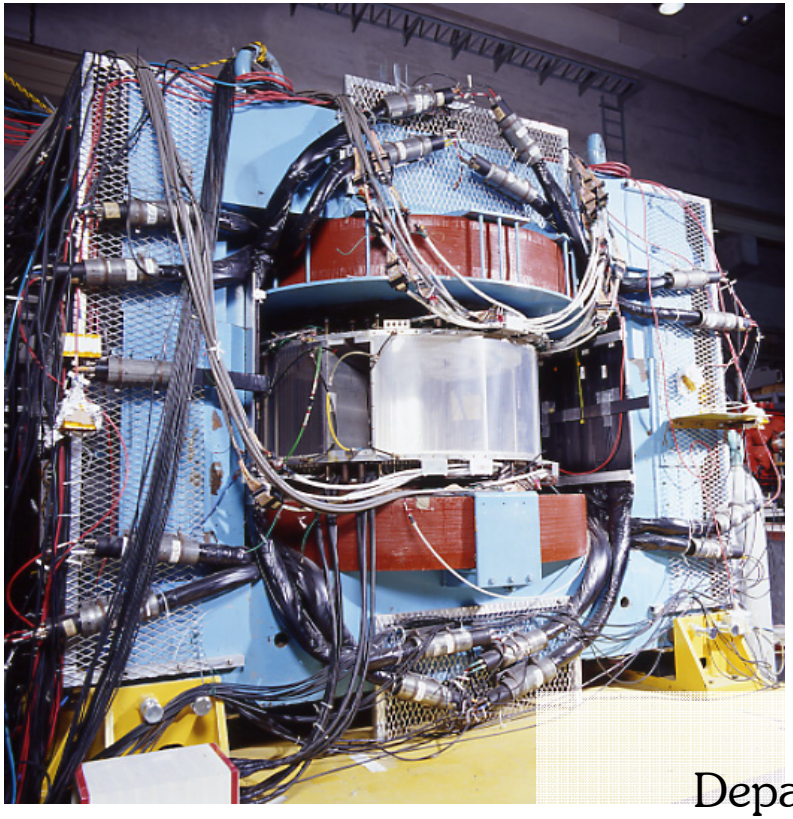
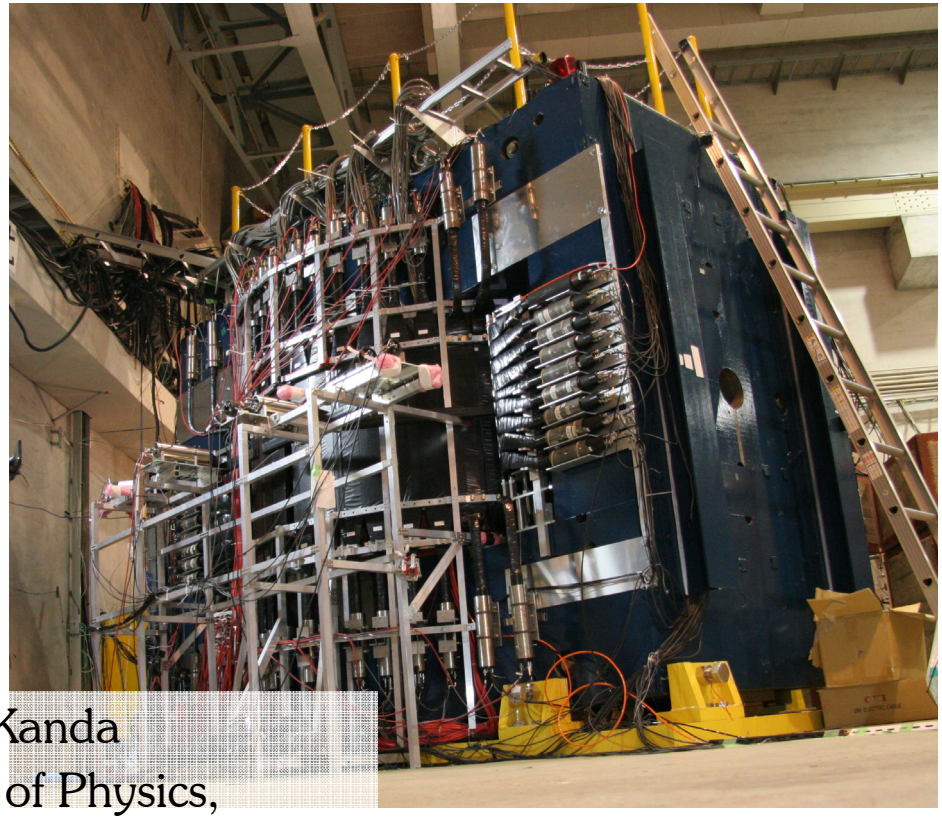
Strangeness photoproduction experiments in Sendai





Hiroki Kanda
Department of Physics,
Tohoku University
for NKS/NKS2 collaborations

Outline

- Motivation
- NKS and its results
- NKS2 and its preliminary results
- Upgrade with a new inner detectors
- Summary

NKS/NKS2 Collaborations

- ***Department of Physics, Tohoku University, Japan***
  - N. Chiga, B. Beckford, A. Chiba, D. Doi, M. Ejima, T. Fujii, Y. Fujii, T.Fujibayashi, T. Gogami, K. Futatsukawa, O. Hashimoto, K.Hirose, R. Honda, K. Hosomi, A. Iguchi, S. Kameoka, H. Kanda, M. Kaneta, F. Kato, M. Kato, D. Kawama, M. Kawai, T. Kawasaki, S. Kinoshita, T. Kon, C. Kimura, S. Kiyokawa, T. Koike, Y. Ma, K. Maeda, N. Maruyama, A. Matsumura, M. Mimori, Y. Miura, Y. Miyagi, H.Miyase, K. Miwa, S. Nagao, S.N. Nakamura, H. Nomura, Y. Okayasu, A. Okuyama, T. Otani, M. Oyamada, M. Sato, A. Shichijo, K. Shirotori, T. Takahashi, H. Tamura, N. Taniya, N. Terada, H. Tsubota, K. Tsukada, D. Uchida, M. Ukai, K. Yagi, F. Yamamoto, T.O. Yamamoto, T. Yamamoto, H. Yamauchi, K.Yawata, K. Yokota, Y. Yonemoto, M. Wakamatsu, T. Watanabe
- ***Department of Electrical and Electronic Engineering, Akita University***
  - A.Sasaki
- ***Laboratory of Nuclear Science, Tohoku University***
  - K. Hirose, T. Ishikawa, T. Kinoshita, F. Miyahara, T. Nakabayashi, H. Shimizu, K. Suzuki, T. Tamae, T. Terasawa, H. Yamazaki
- ***Department of Nuclear Science, Lanzhou University, China***
  - Y.C. Han , T.S. Wang
- ***Department of Electrical Engineering, Ichinoseki National College of Technology***
  - O. Konno
- ***Nuclear Physics Institute, Czech Republic***
  - P. Bydzovsky, M. Sotona

NOTE:
People who belonged only to the NKS collaboration, only to the NKS2 collaboration and to both collaborations are included in this list.

Motivation

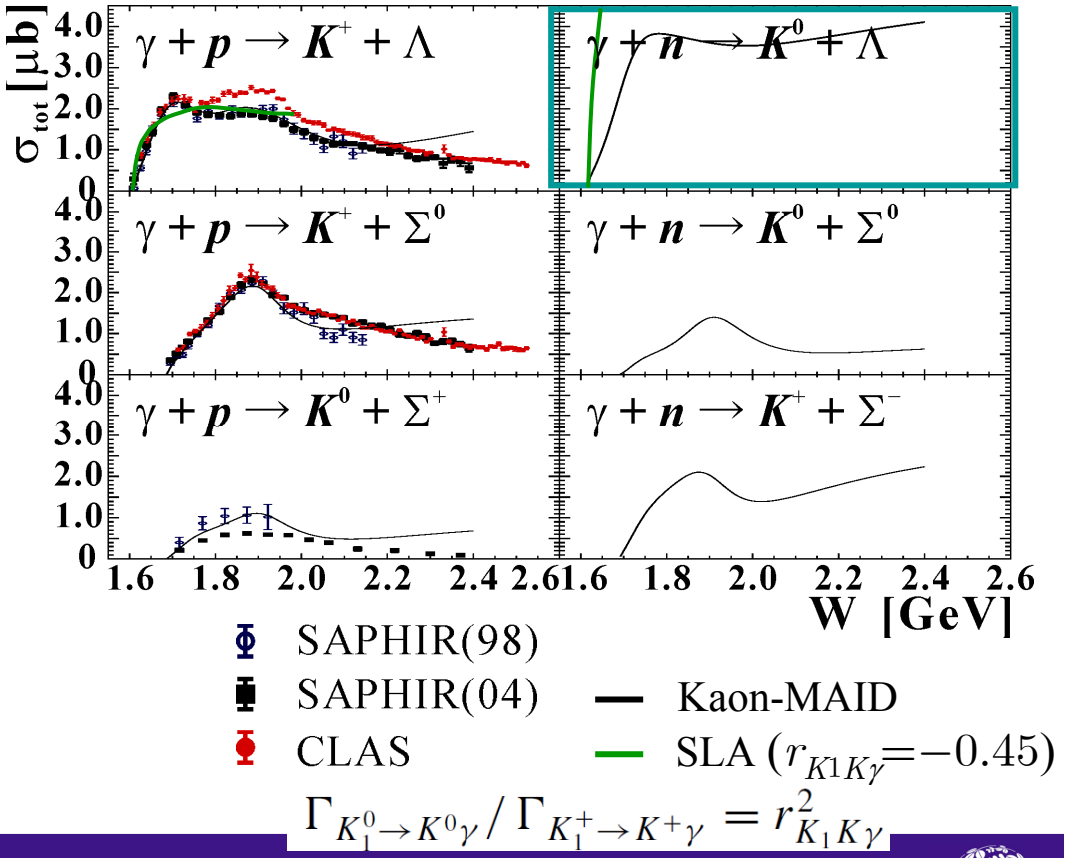
- Tohoku group has been performing the investigation of the hypernuclear physics with electromagnetic production of the strangeness

•Ambiguity of the elementary strangeness production process in theoretical calculations

•Discrepancy between theoretical calculations

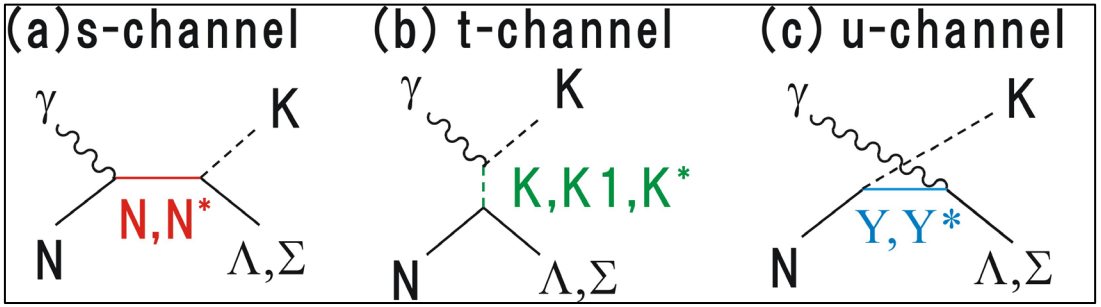
← Not all the isospin channels are covered by the experimental data

•Measurement of the K0 production process on the neutron with REAL PHOTON



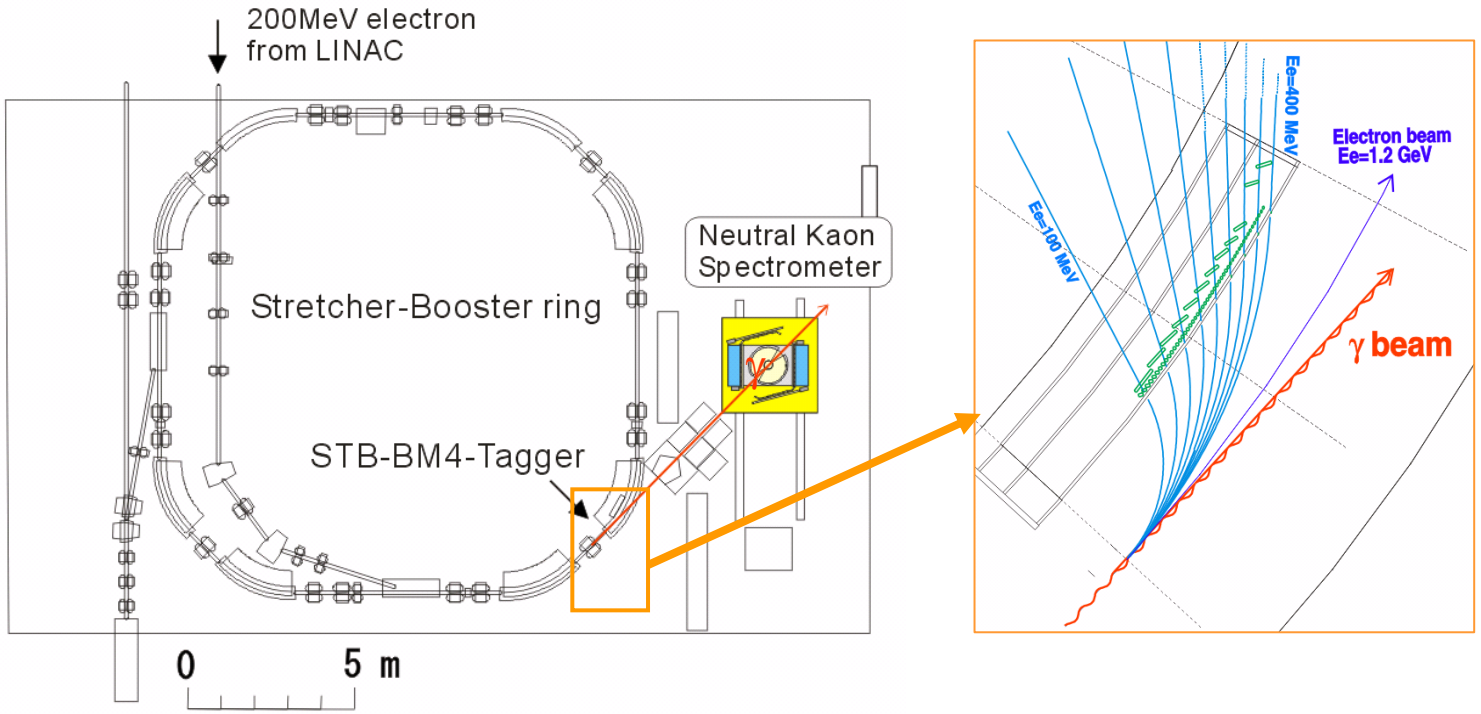
Motivation

- K^0 photoproduction on the neutron: $\gamma + n \rightarrow K^0 + \Lambda^0$
- Suppression of the coupling between the photon and K^0
  → t-channel Born term does not contribute
- $E_\gamma \sim 1$ GeV is just around the threshold
  → contributions from the higher resonances are expected to be small



- Limited number of experimental data (difficulties in an experiment)
  - small cross section
  - neutron target
  - the measurement of K^0 needs a spectrometer which covers all the pions emitted in its decay

Tagged photon beam at LNS-Tohoku



- 1.2 GeV Stretcher-Booster Synchrotron (STB) at LNS-Tohoku and BM4-Tagger provide the tagged photon in the energy region from 0.8 to 1.1 GeV.
- Duty factor (max 90 %)

- Energy bin of the tagging counters: 6 MeV
- Intensity (hit rate of the tagging counters): 1.5 ~ 2.5 MHz

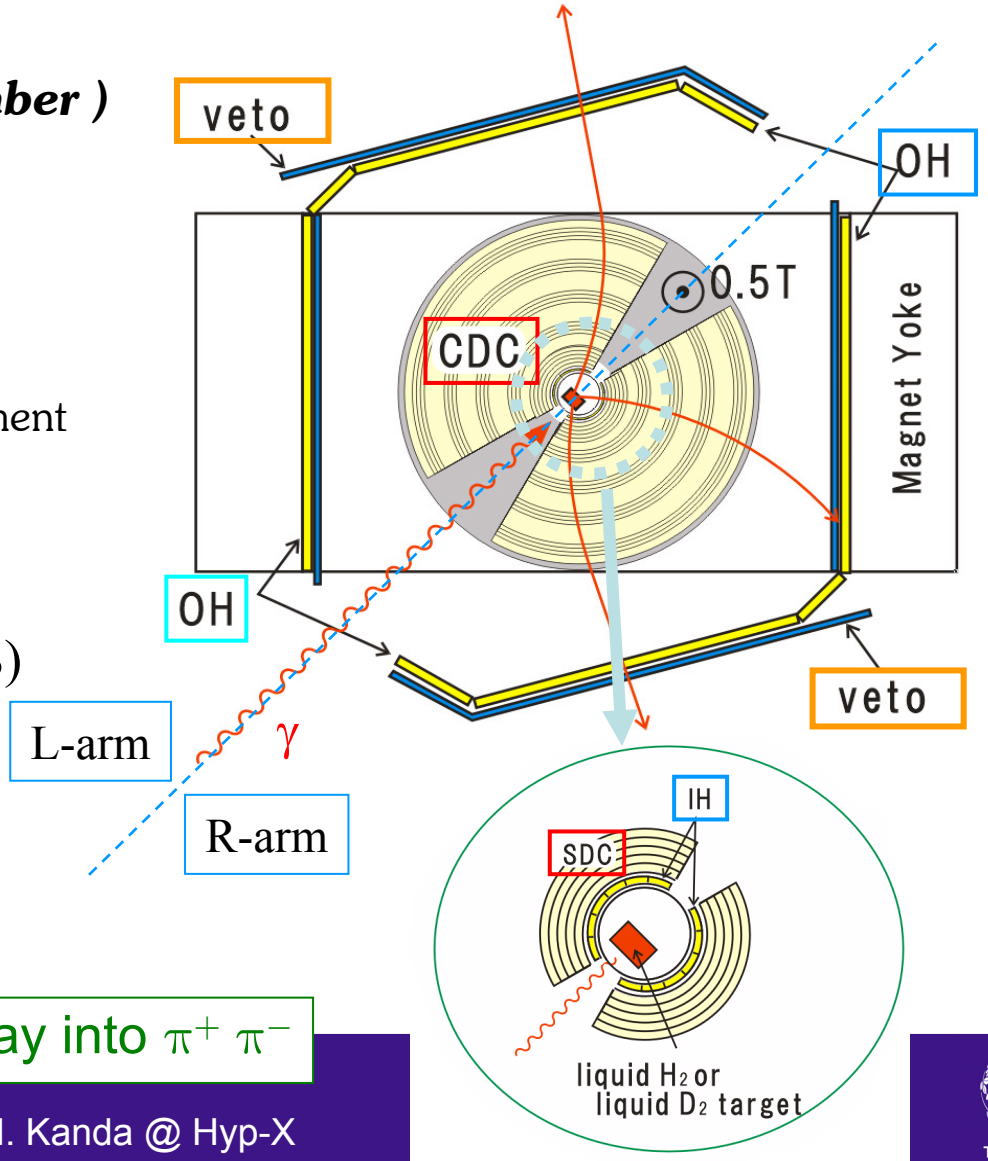
Neutral Kaon Spectrometer (NKS)

- ***Dipole magnet*** 0.5 T
- ***CDC (cylindrical drift chamber)***
  SDC (straw drift chamber)
  - Particle tracking
- ***IH (inner hodoscope)***
- ***OH (outer hodoscope)***
  - Trigger counter
  - Time of flight (TOF) measurement
- ***EV (electron veto counter)***
  - e^+e^- background suppression

Acceptance ~ π sr

TOF resolution ~ 0.5 nsec (RMS)

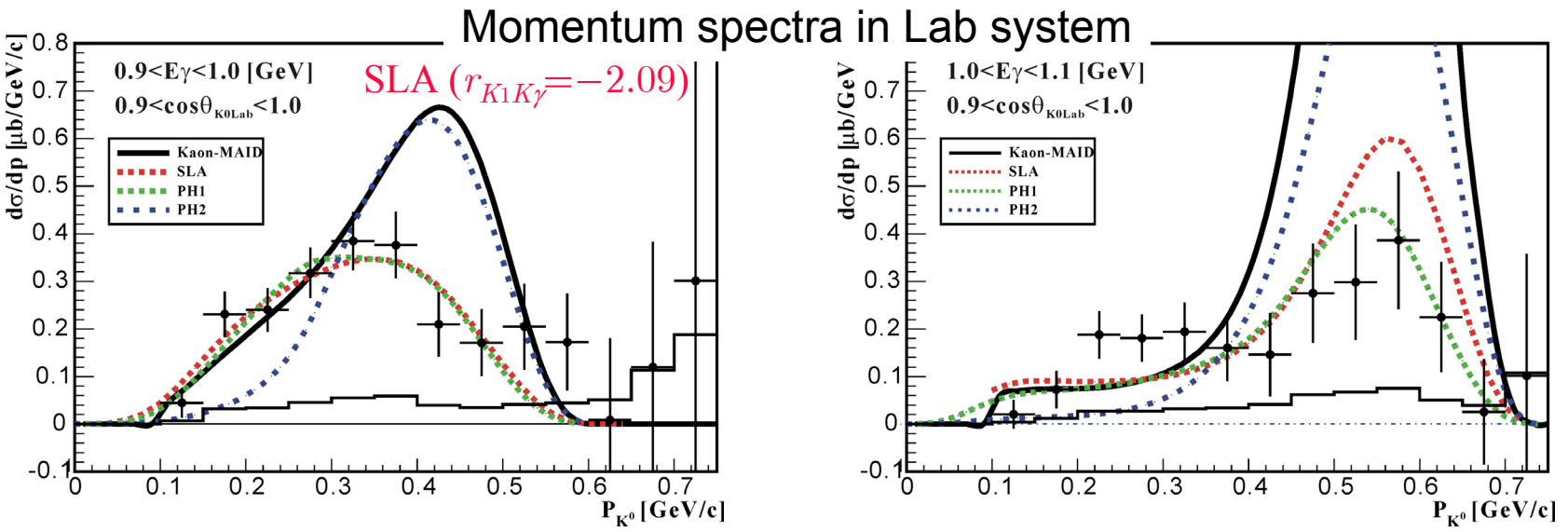
Momentum resolution ~ 9%



- Total *N*photon
  - D_2 target: 2.64 x 10^{12}
  - C target: 1.67 x 10^{12}
  - H_2 target: 6.77 x 10^{11}

- $d(\gamma, K^0)$ → subsequent K_s decay into $\pi^+ \pi^-$

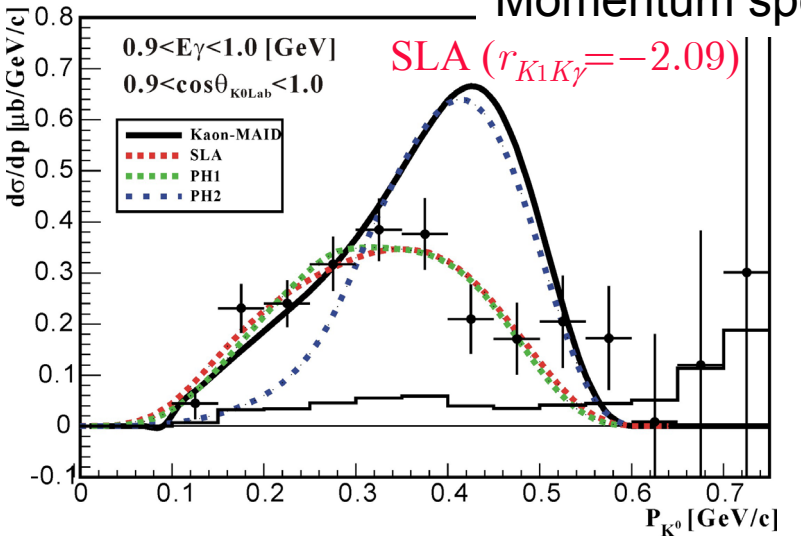
Results from NKS (D_2 target)

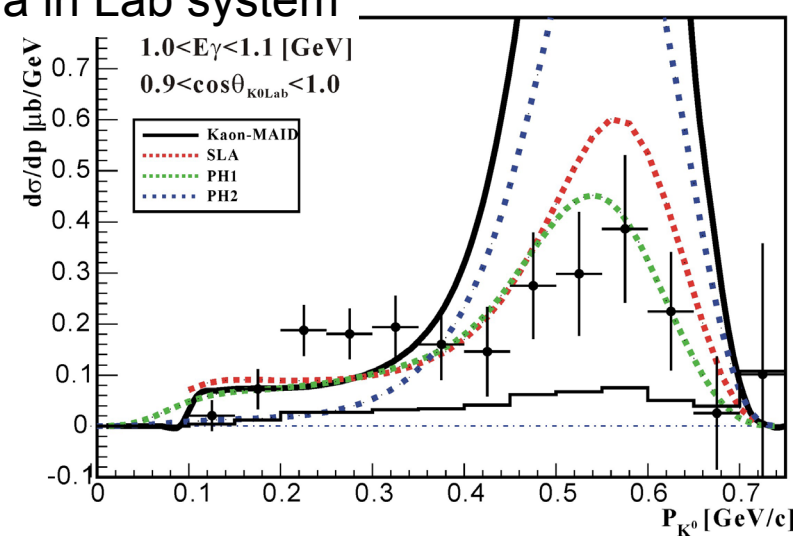


- PH1 and PH2 are calculated by the simple phenomenological formula.
- SLA and PH1 are the results after fitting of the data in 0.9<Eγ<1.0 GeV (left figure).
- PH2 is defined so as to give inversed distribution to PH1 in the center of mass system.
- The differences of the shape and the magnitude are remarkable.

Results from NKS (D_2 target)

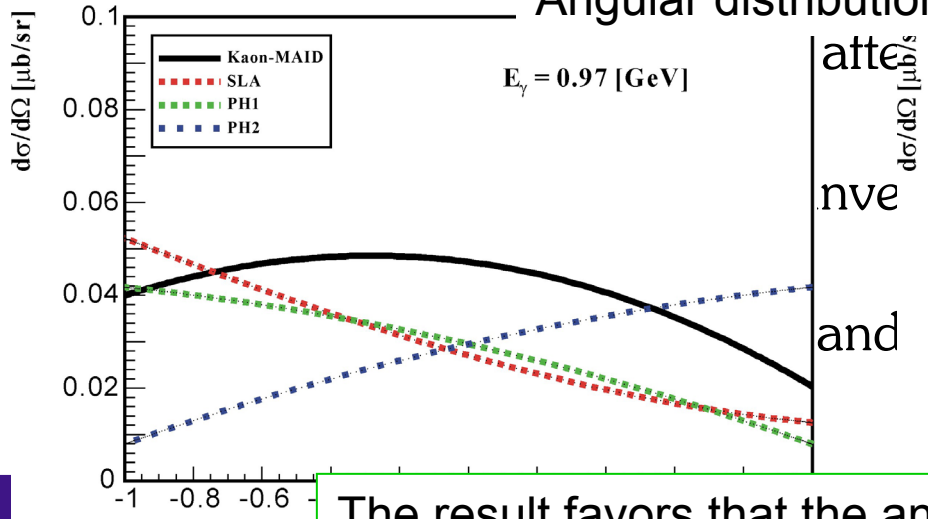
Momentum spectra in Lab system





- PH1 and PH2 a omenological formula.

Angular distribution in CM system



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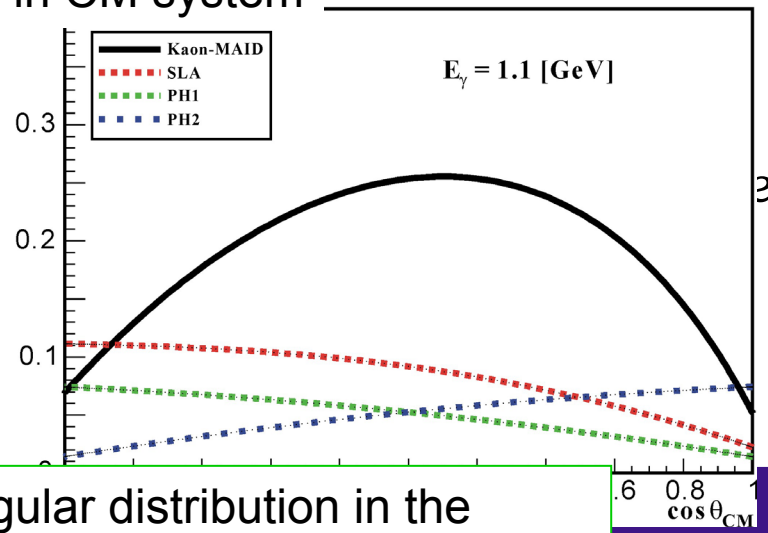

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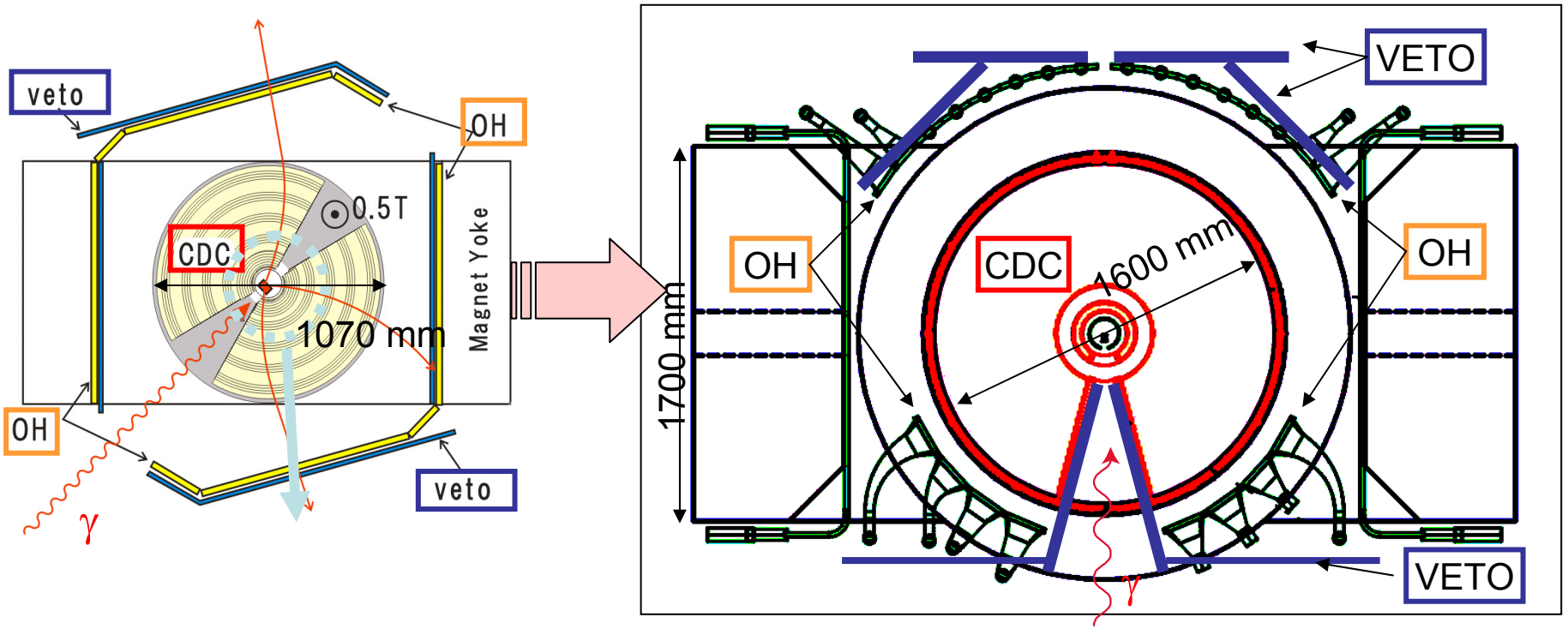
The result favors that the angular distribution in the center of mass system is backward peak.

From NKS to NKS2

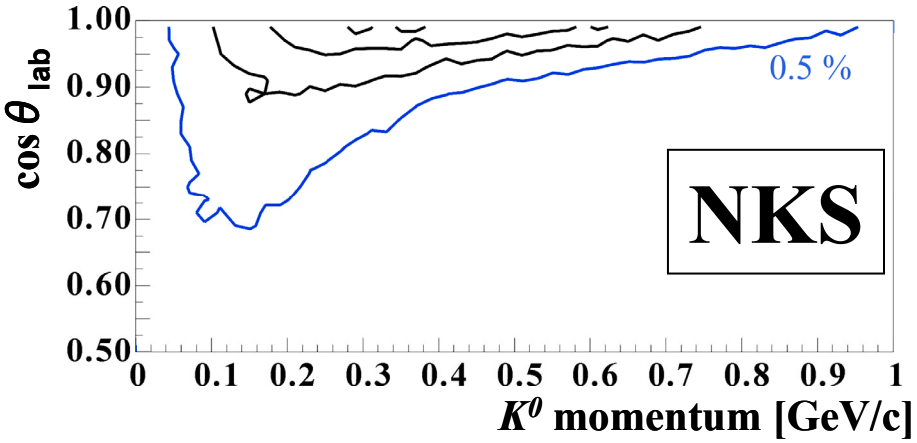
NKS (1998 ~ 2004) NKS2 (2005 ~)

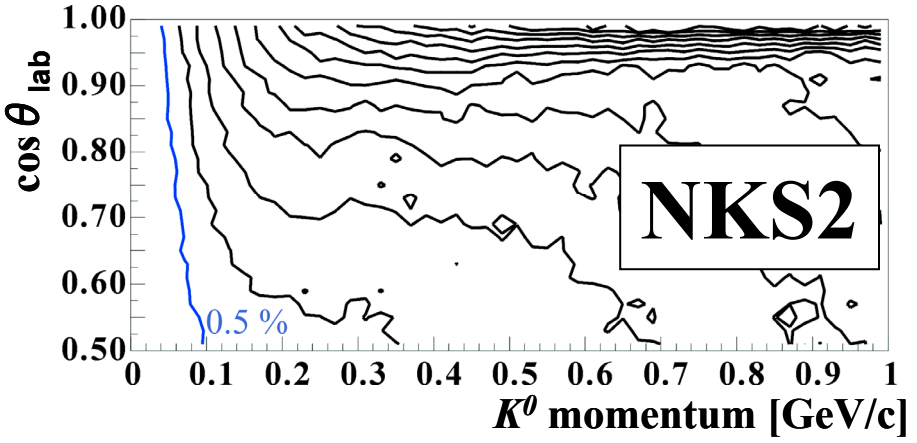


- Larger pole radius → More precise PID and momentum measurement
- Symmetrical design
- Fiducial volume in the forward region
- New trigger system (L-arm and R-arm inclusive trigger)

} Larger acceptances for K_s and Λ

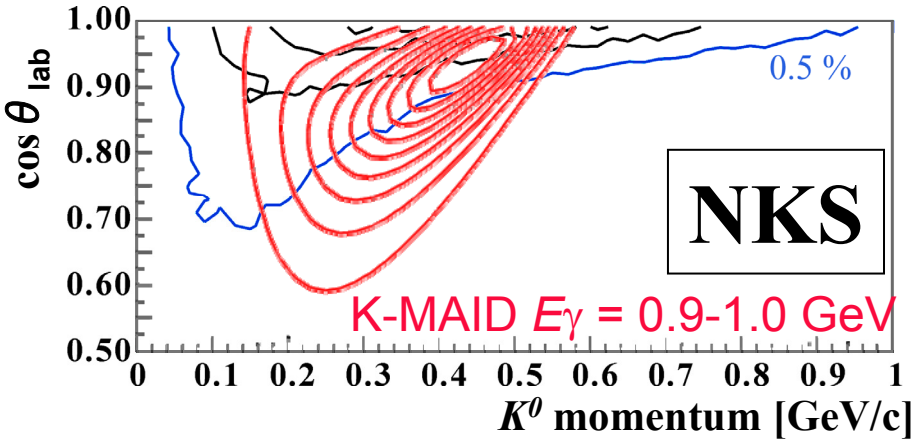
Comparison of the acceptances for K^0

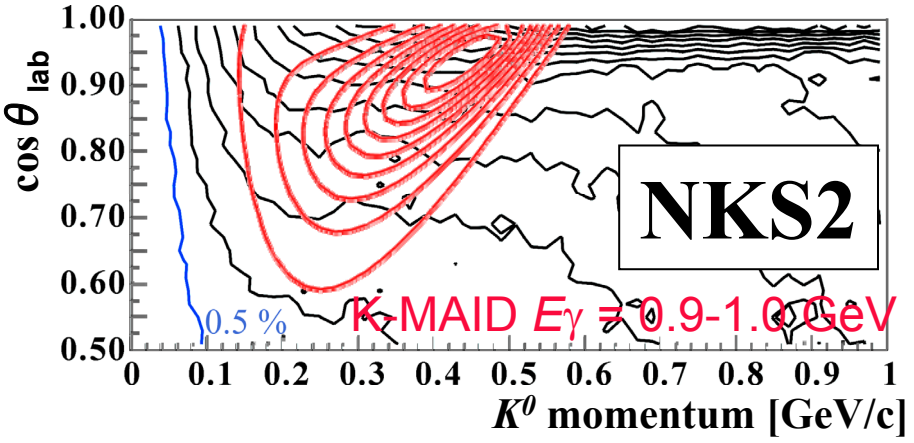


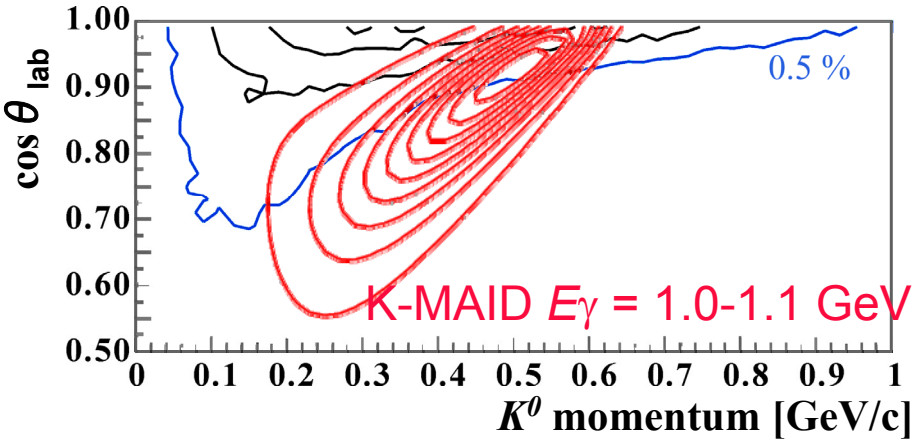


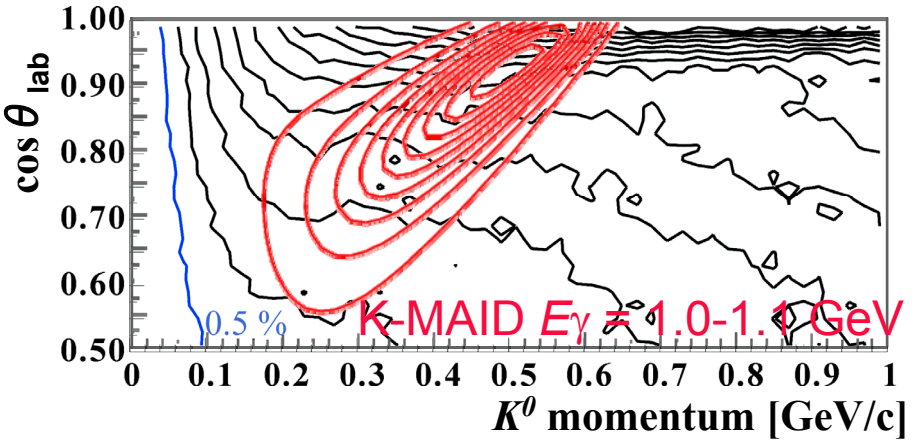
- NKS2 detects K_S by its $\pi^+\pi^-$ decay more than 0.5 % efficiency in all possible kinematic region for n(γ, K^0)Λ
- NKS2 has larger acceptance for both K^0 and Λ than NKS (x 3 for K_S, x 10 for Λ)

Comparison of the acceptances for K^0









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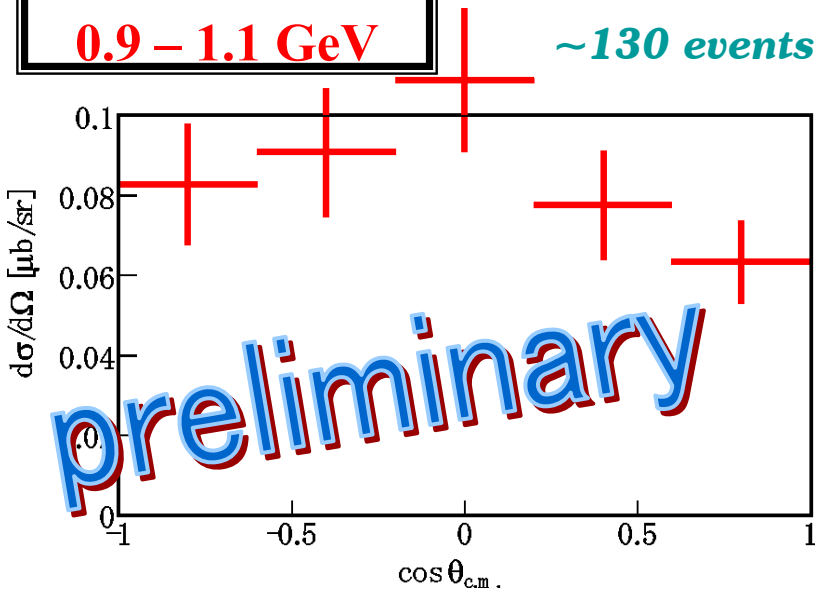
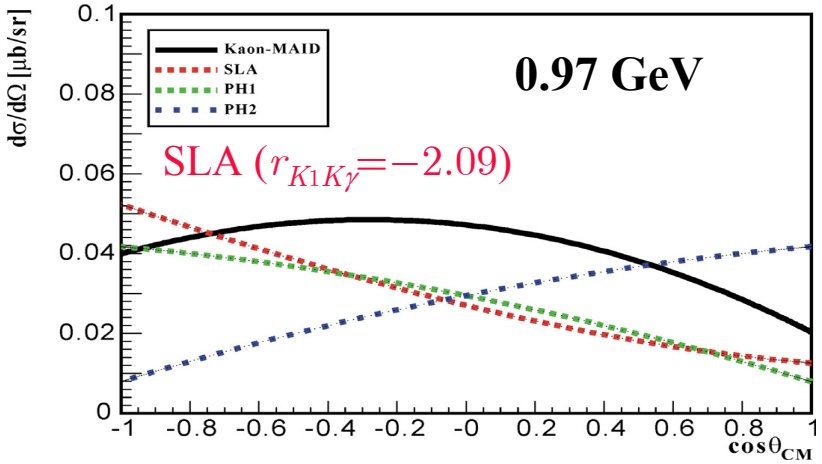
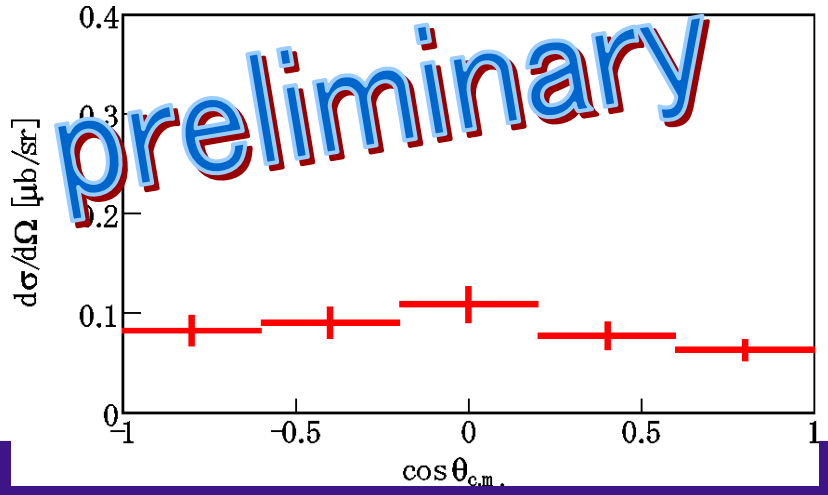
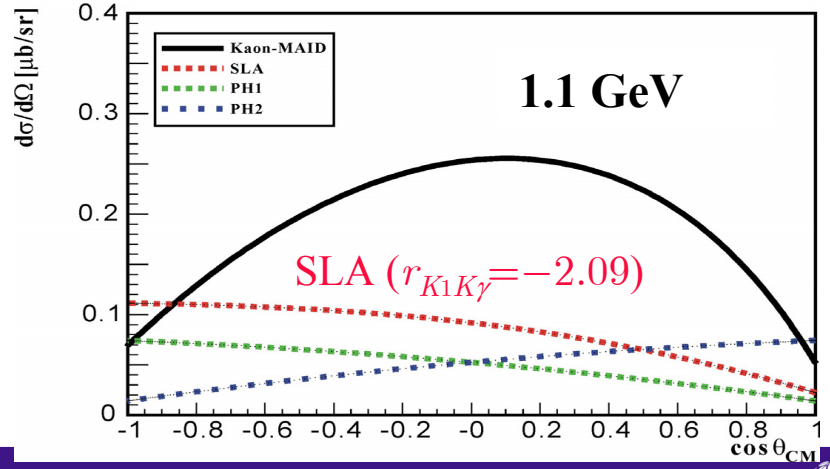
Preliminary result from NKS2 for $K^0\Lambda$ coincident measurement

0.9 – 1.1 GeV ***~130 events***



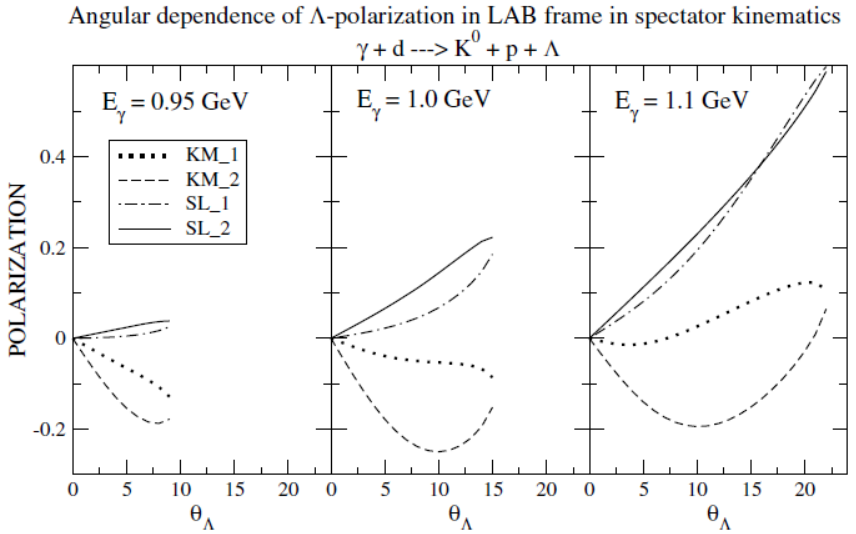


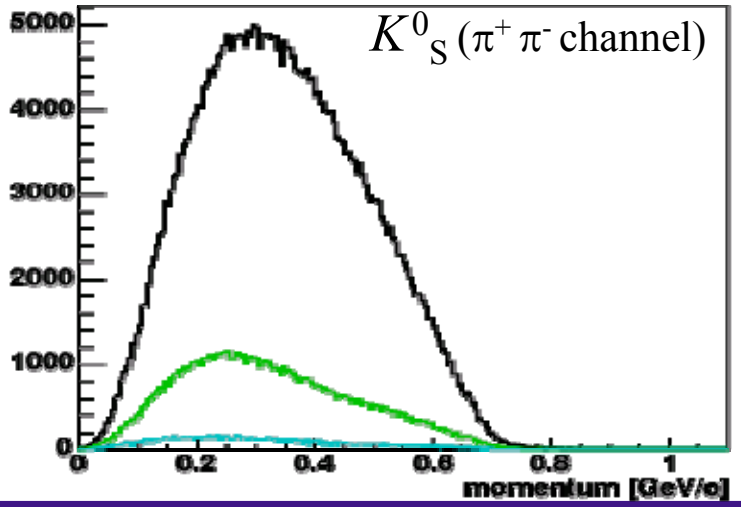


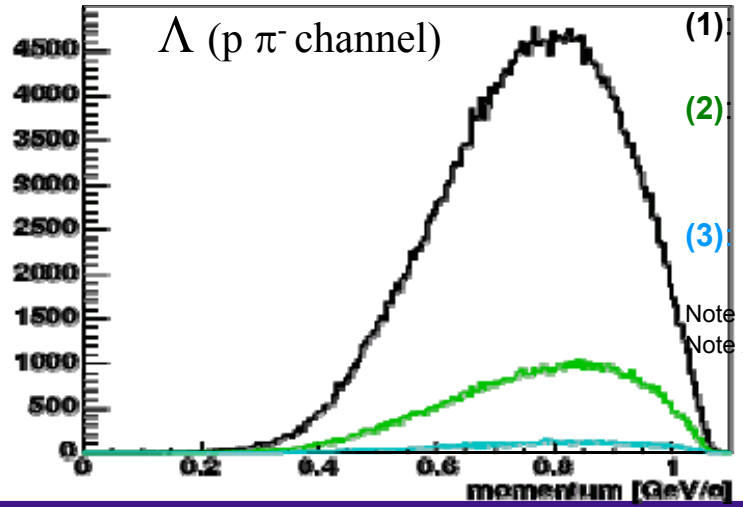


More $K^0\Lambda$ coincident data!

- Measurement of the decay asymmetry of Λ (recoil polarization)
- Detection of Λ with higher acceptance is needed
  ← efficient detection of low energy π^-
  - Re-configuration of the inner TOF counters (IH)
  - New inner tracker: 3D, high resolution vertex drift chamber (VDC)
  - New analysis scheme







all $K^0_S(\pi^+\pi^-)+\Lambda(\pi^-p)$ events

(1)

(2) the four daughters pass through VDC with two OH Hits

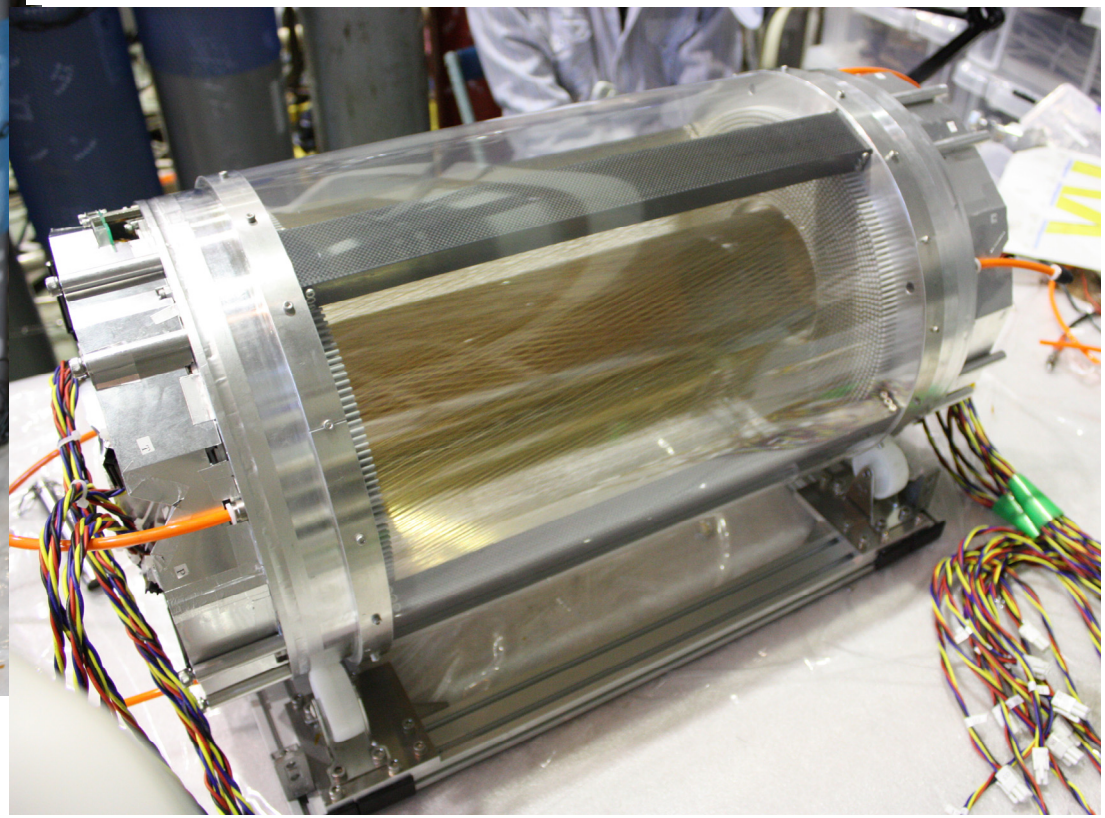
(3) four daughters pass through OH

Note 1: No decay volume cut is applied
Note 2 : Single tracking efficiency is assumed to be 90 %

IH and VDC photos

Upgrading is underway!

- New TOF counter (IH) is in use
- New tracking chamber (VDC) is being commissioned



Summary

- We investigate electromagnetic production of the strangeness with the series of spectrometer systems:
  NKS, NKS2 and upgraded NKS2 at LNS, Tohoku University, Sendai.
- ***The NKS results were new experimental data in n(γ, K^0)***
  (Phys. Lett. B651, 259, 2007; Phys. Rev. C78,014001, 2008)
  → The backward peaking angular distribution of K^0.
- NKS2 has larger acceptance for both K_S and Lambda
  → Larger coverage of K^0 kinematic regions and exclusive measurement.
  The forthcoming results will be important for the understanding of the strangeness photoproduction process.
- The upgraded NKS2 with new IH and VDC is now being commissioned
  → Exclusive measurement in higher statistics. Measurement of recoil polarization is within our scope.
  Coming Soon!