

15th International Workshop on the Physics of Excited Nucleons

Search for a Narrow Λ Resonance Near the $\Lambda\eta$ Threshold at J-PARC E72

2026. 09. 10

Haein Lee

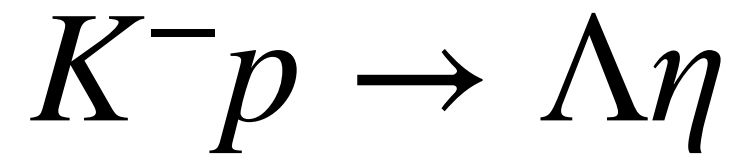
Korea University
for the J-PARC E72 Collaboration



NSTAR 2026

■ Exploring the $\Lambda\eta$ Threshold Region

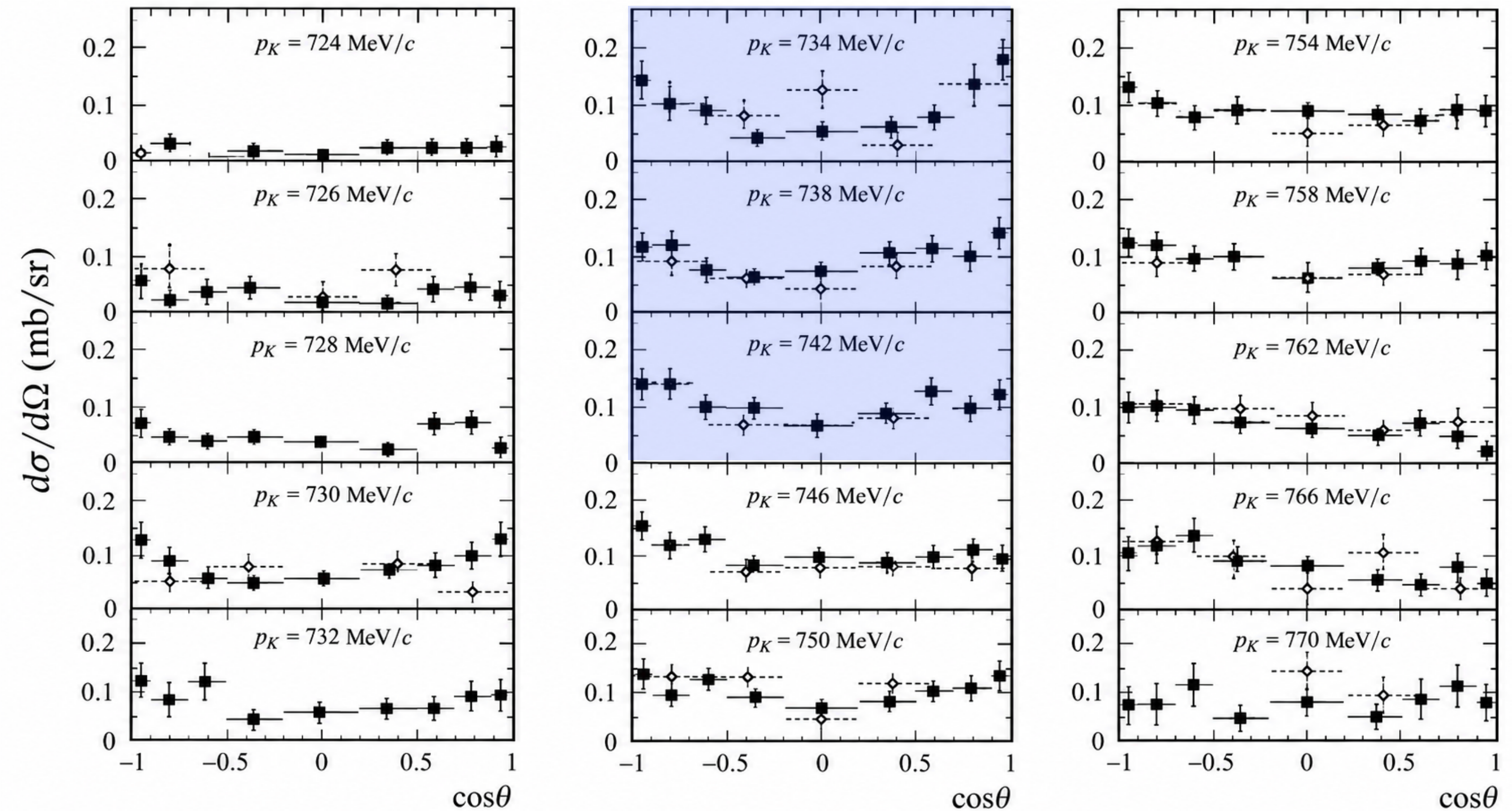
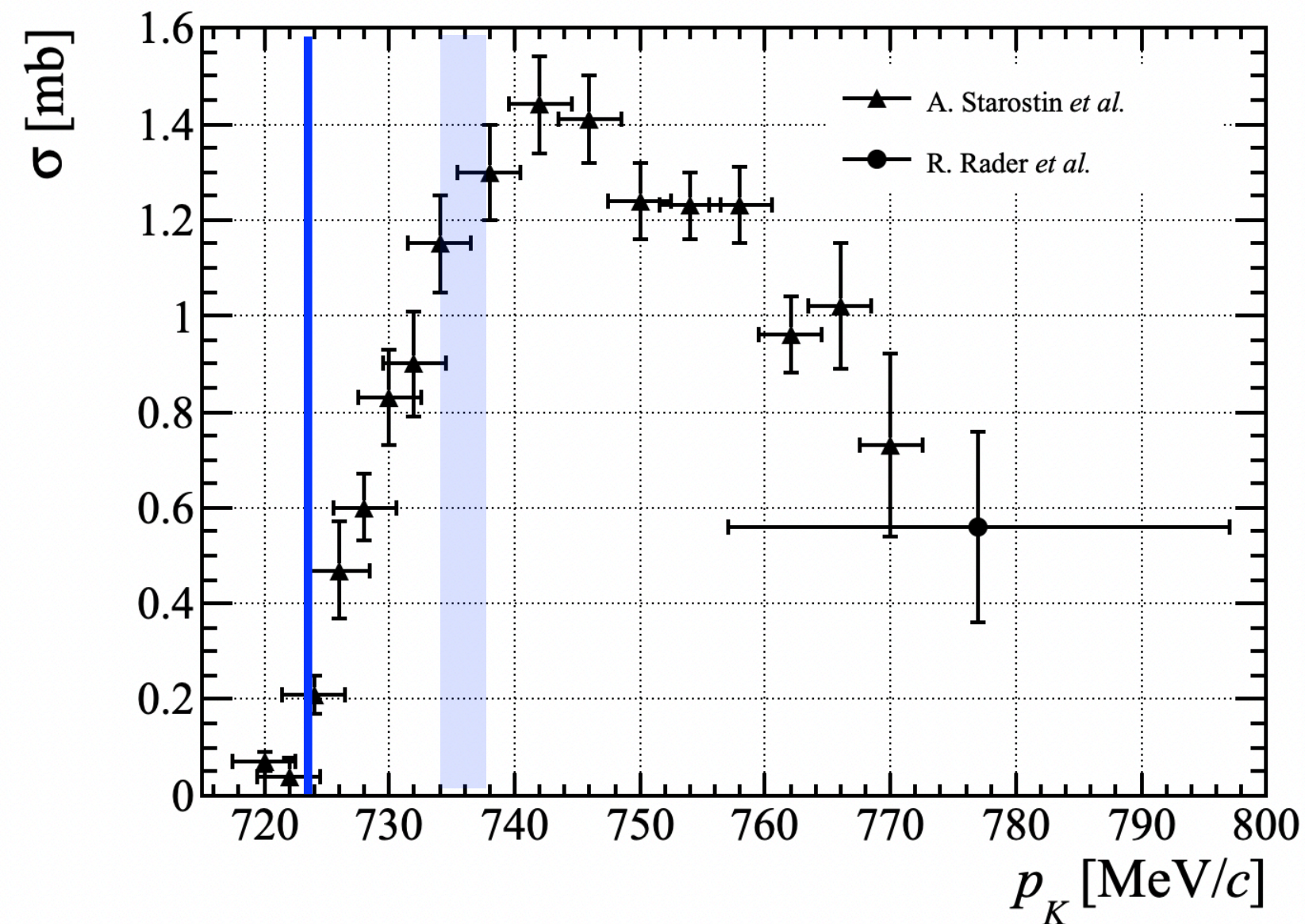
2000



A. Starostin et al., Phys. Rev. C. 64, 055205 (2001)

Crystal Ball ●.....→

$\Lambda\eta$ Threshold



Total cross section

Differential cross section

Λ Polarization

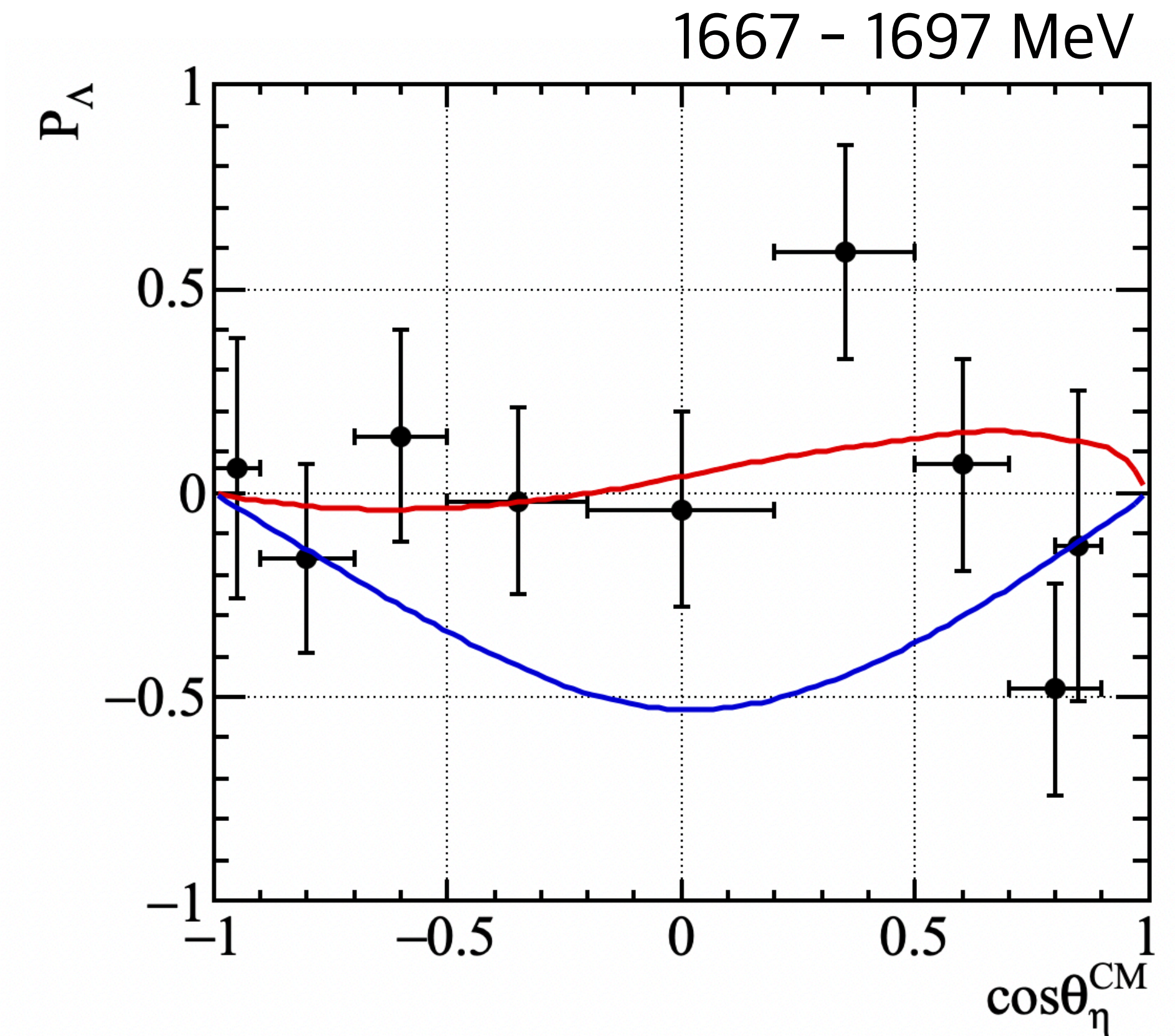
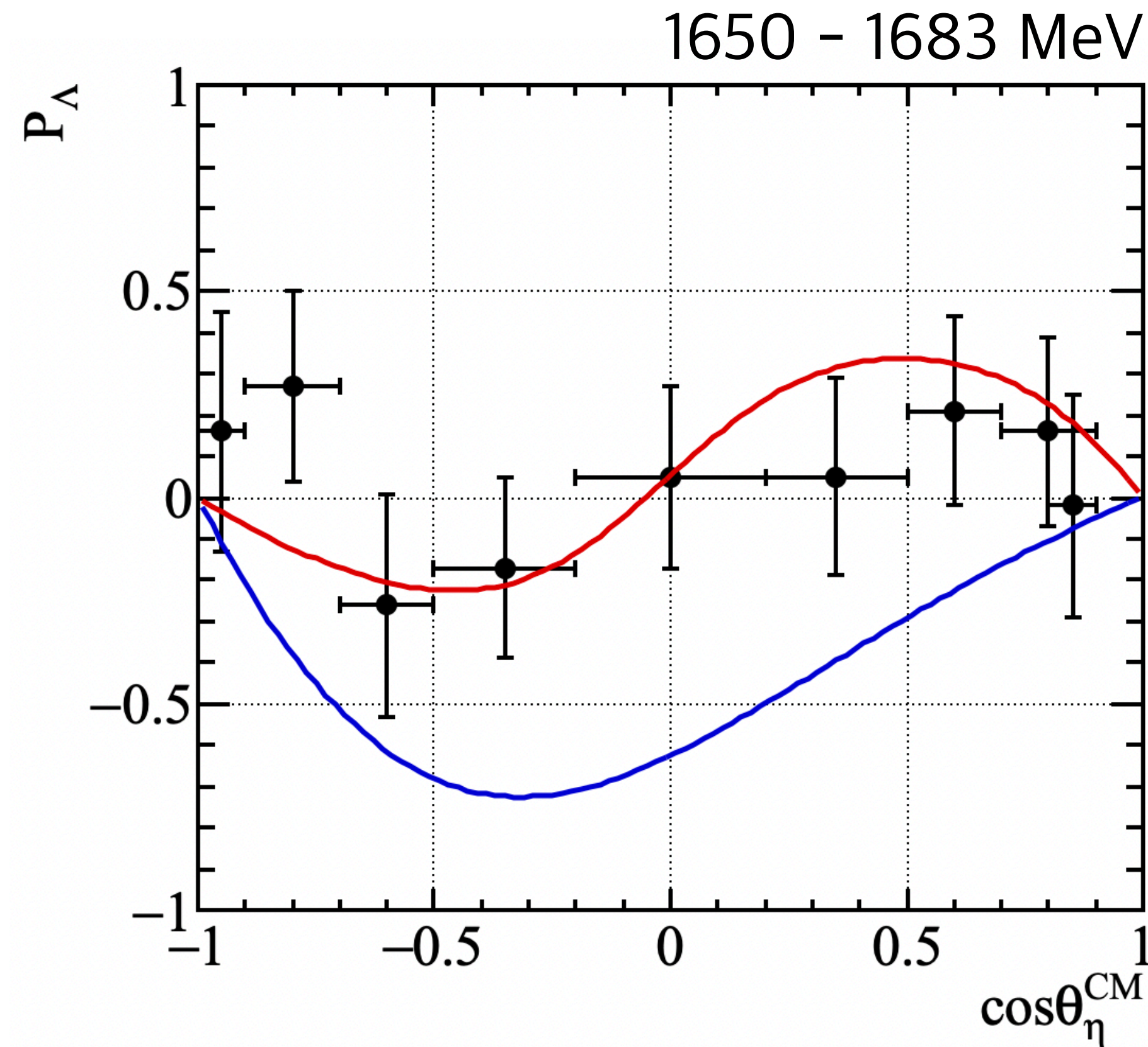
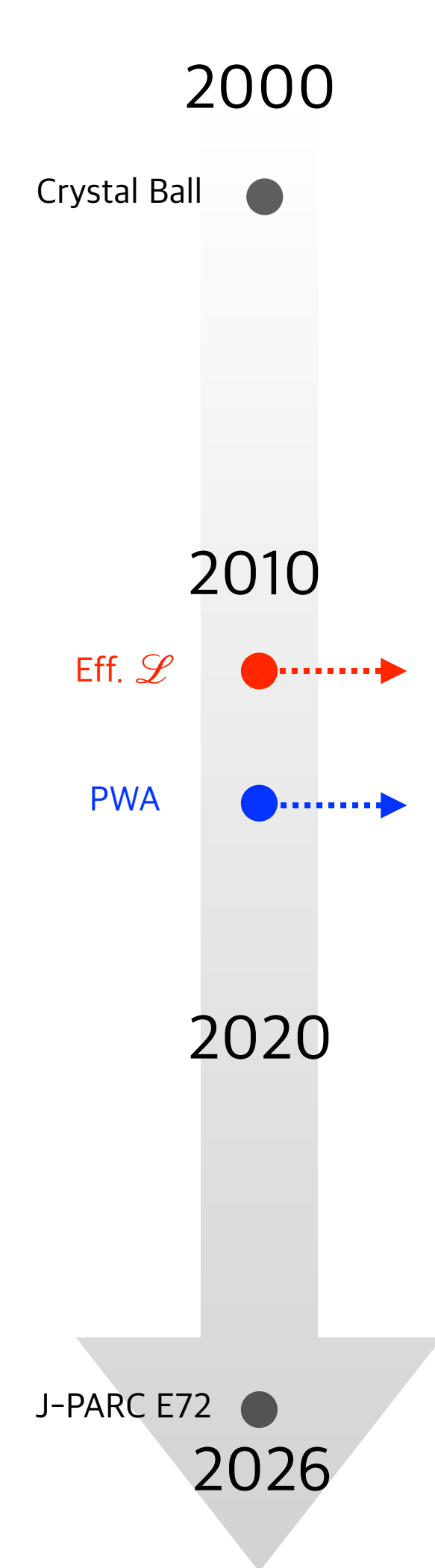
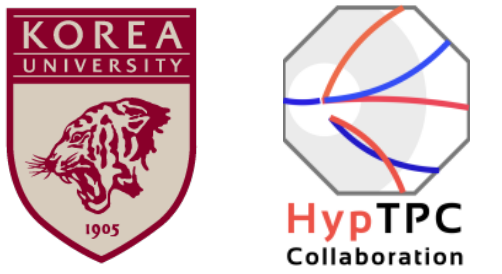
Clean probe of Λ^* resonances due to the isospin constraint

J-PARC E72 ●

2026

■ Λ Polarization as a Probe of Higher Partial Waves

A. Starostin et al., Phys. Rev. C. 64, 055205 (2001)
 Bo-Chao Liu et al., Phys. Rev. C. 86, 055202 (2012)
 H. Kamano et al., Phys. Rev. C. 92, 025205 (2015)



- Pure S-wave $\rightarrow$ only spin-nonflip term, no phase difference $\rightarrow P_\Lambda$ flat
- With higher partial waves, spin-flip term appears $\rightarrow$ interference w/ S-wave produces angular dependence
- P wave interference : $\sin\theta$ shape (no node at 90°)
- D wave interference : $\sin\theta\cos\theta$ shape (node at 90°)

■ Limited Experimental Data near the $\Lambda\eta$ Threshold

D. $K^-p \rightarrow \eta\Lambda$

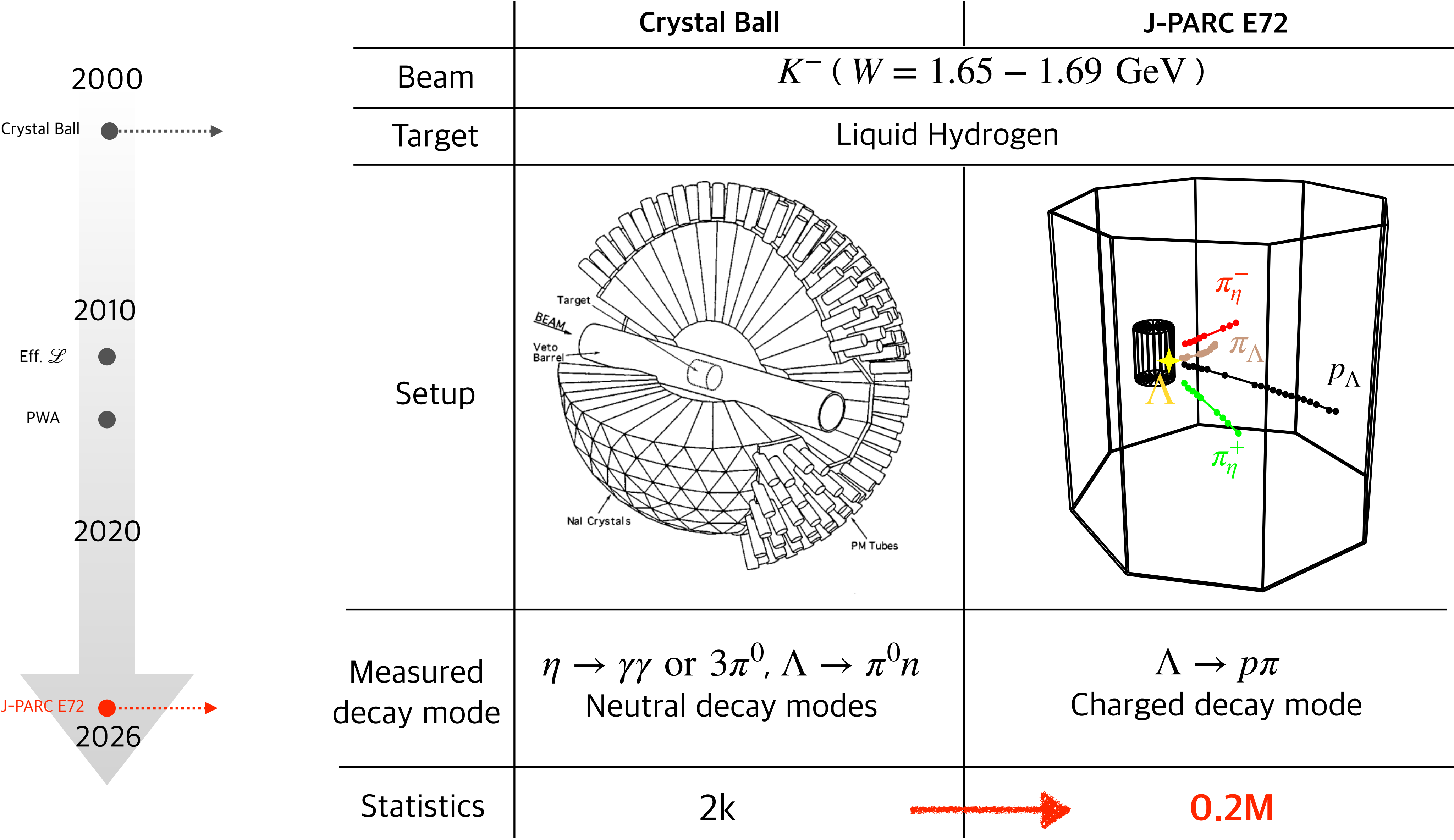
Currently, the data of differential cross sections (Fig. 19) for $K^-p \rightarrow \eta\Lambda$ are limited in the near-threshold region. We observe visible differences between Models A and B in the differential cross sections. Although the Model B shows a better χ^2/data value for this observable, it is not easy to judge the models within the current limited data. There is an inconsistency in the data at $W = 1664$ MeV. The lower set of the data comes from the recent BNL data [81], while the higher set comes from an old bubble chamber experiment at CERN [63]. Our model curves seem to follow the BNL data. Also, we observe that the differential cross section data show a concave-up angular dependence at most W , which suggests a possibility of the sizable contribution from higher partial waves even in the very threshold region. In fact, Model B captures

this angular dependence better than Model A and this is due to the large contribution from P_{03} wave near the threshold, as shown later in Sec. IV A. As for the polarization P (Fig. 20), the data are available only at two W points near the threshold. Model B is found to be a bit off the data.

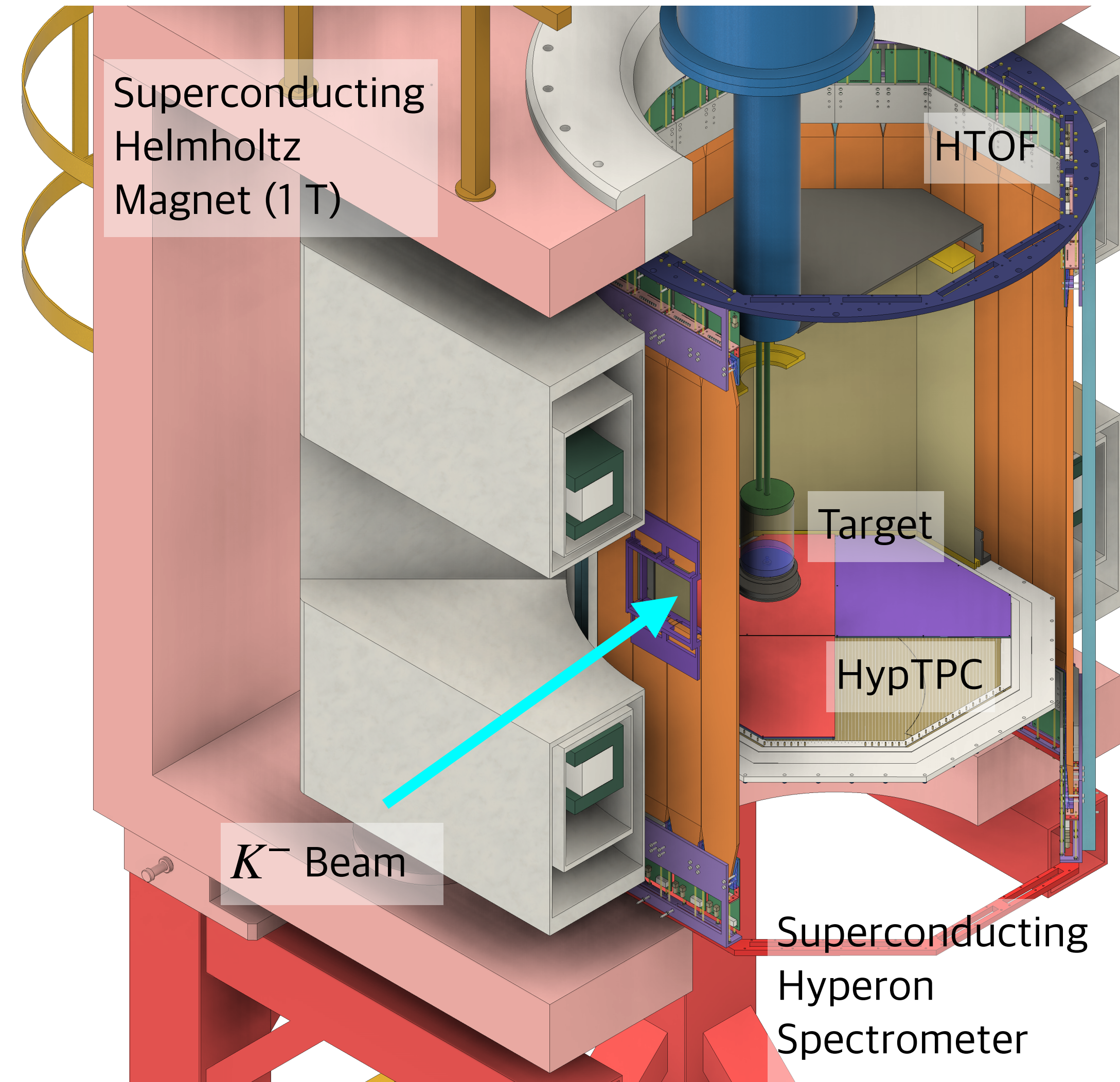
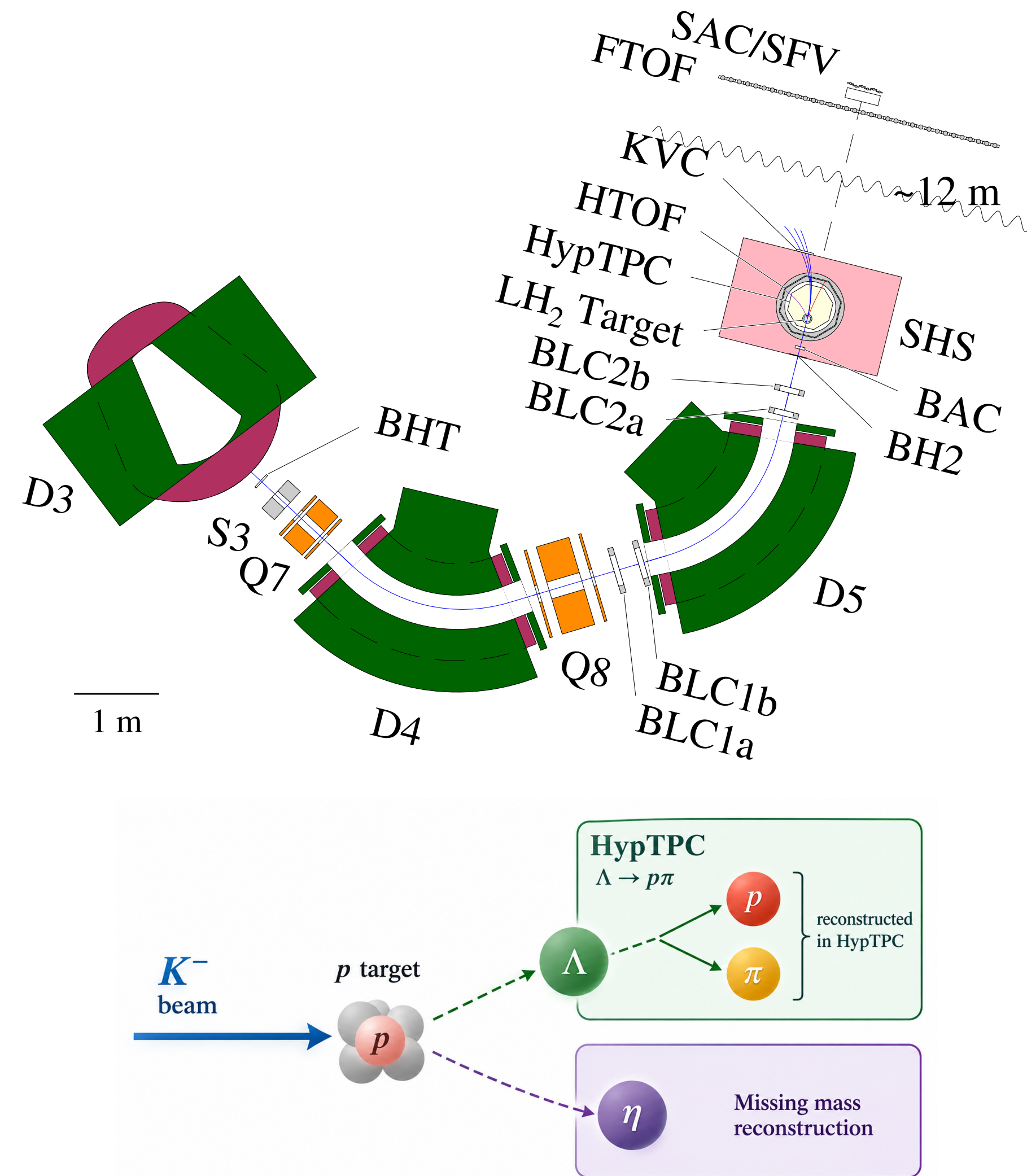
As for the $\eta\Lambda$ channel, the model dependence in the threshold parameters is significant. As for the $K\Xi$ channel, however, the scattering lengths agree reasonably well between Models A and B, while significant model dependences are seen for the effective ranges. The model dependence in the $\eta\Lambda$ and $K\Xi$ threshold parameters are understandable, because they are constrained indirectly by the data of K^-p reactions, in particular by those of $K^-p \rightarrow \eta\Lambda$ and $K^-p \rightarrow K\Xi$, respectively, through coupled-channels effects. Because the quality of the data for $K^-p \rightarrow \eta\Lambda$ and $K^-p \rightarrow K\Xi$ is still poor, it is difficult to strongly constrain the threshold parameters for $\eta\Lambda$ and $K\Xi$.

H. Kamano et al., Phys. Rev. C. 90, 065204 (2014)

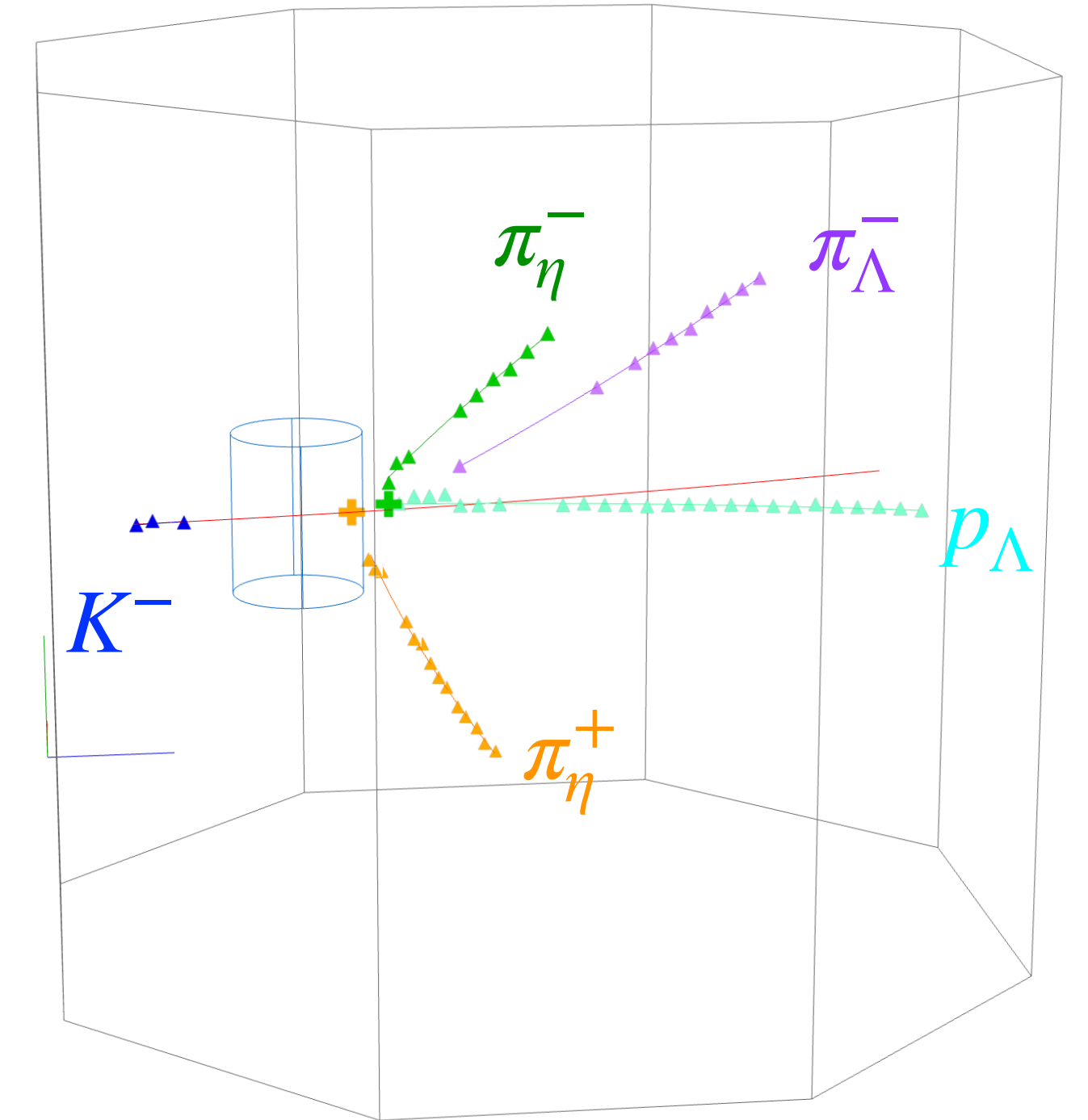
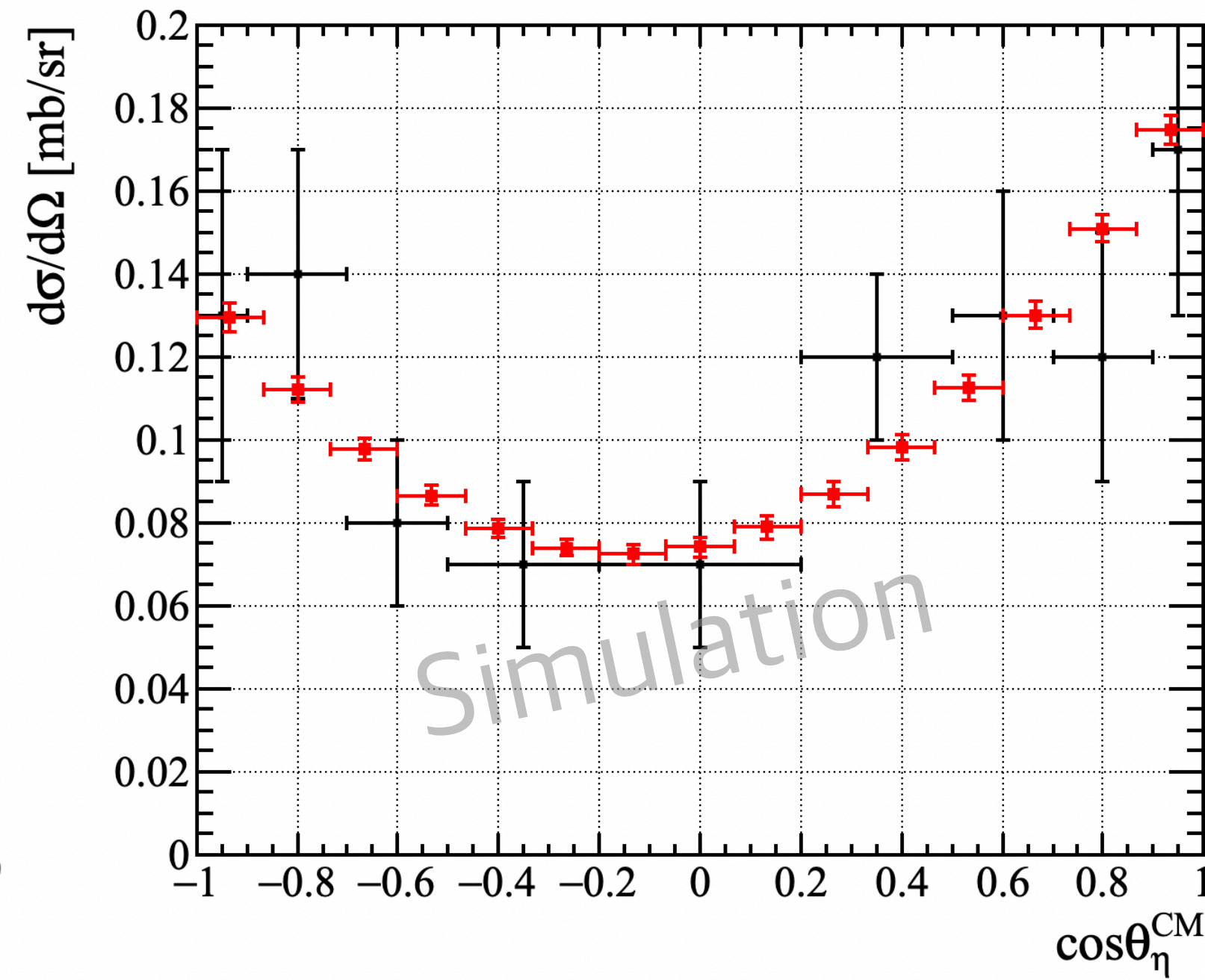
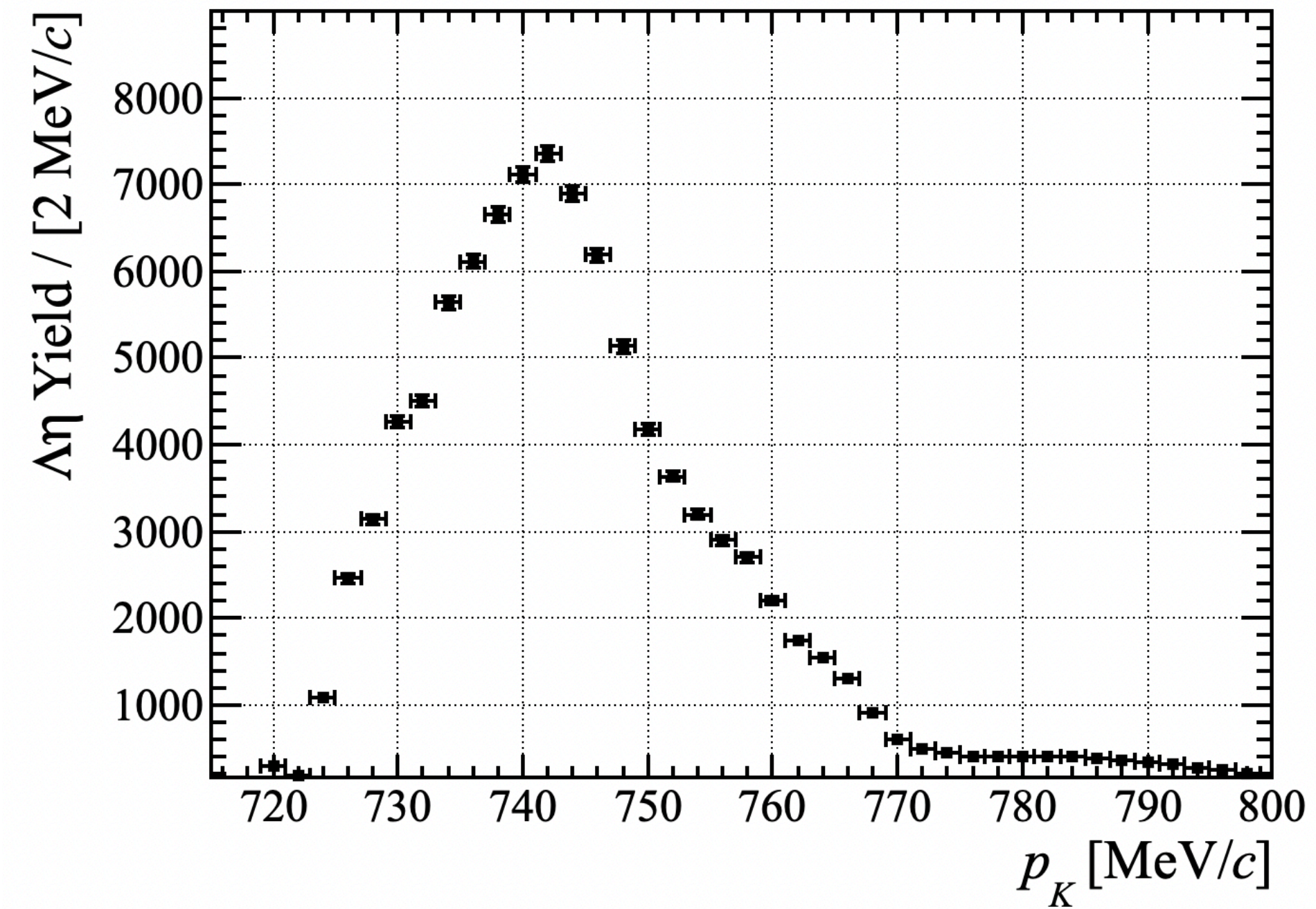
■ High-Statistics Measurement of $K^-p \rightarrow \Lambda\eta$



■ J-PARC E72 Experimental Setup

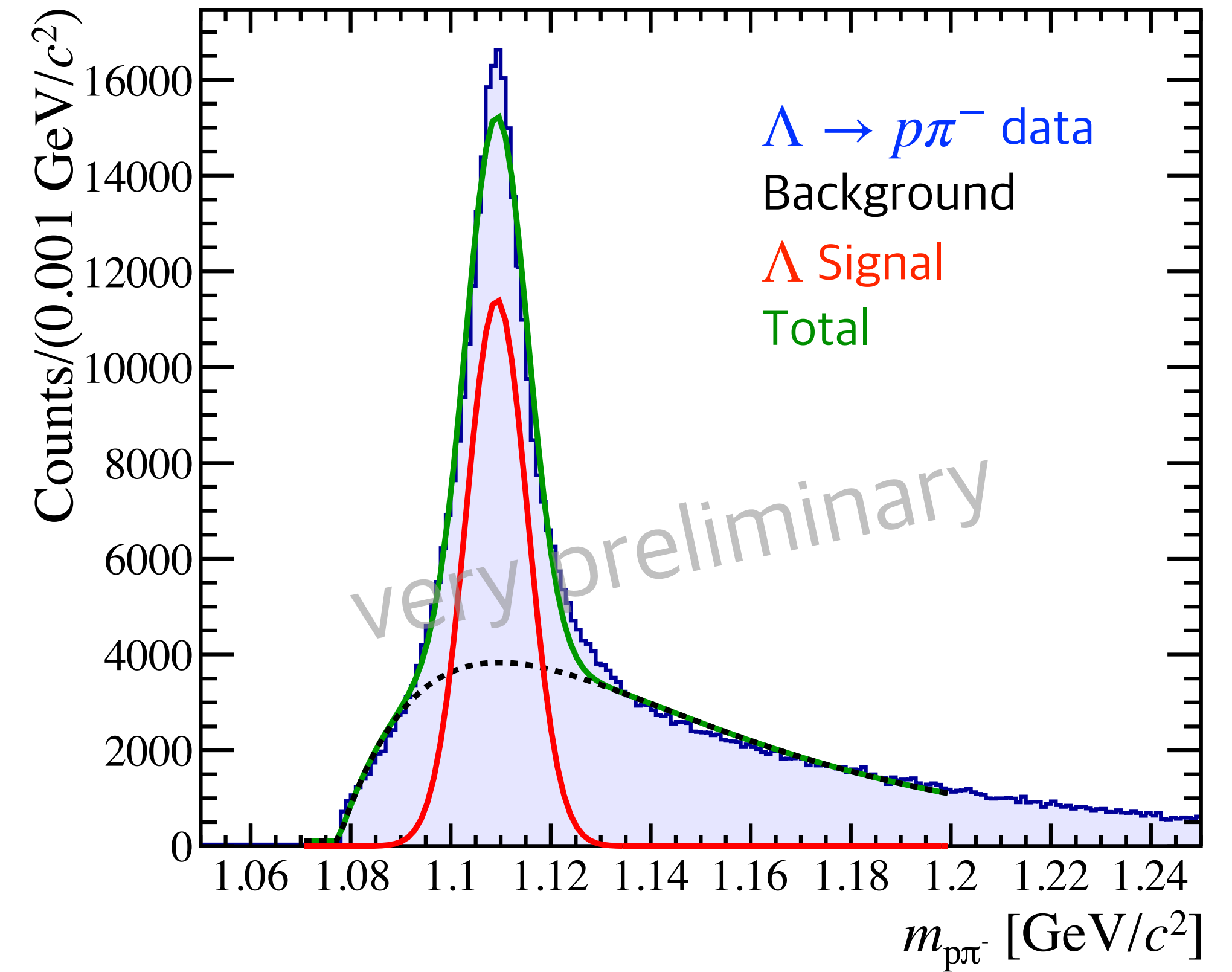
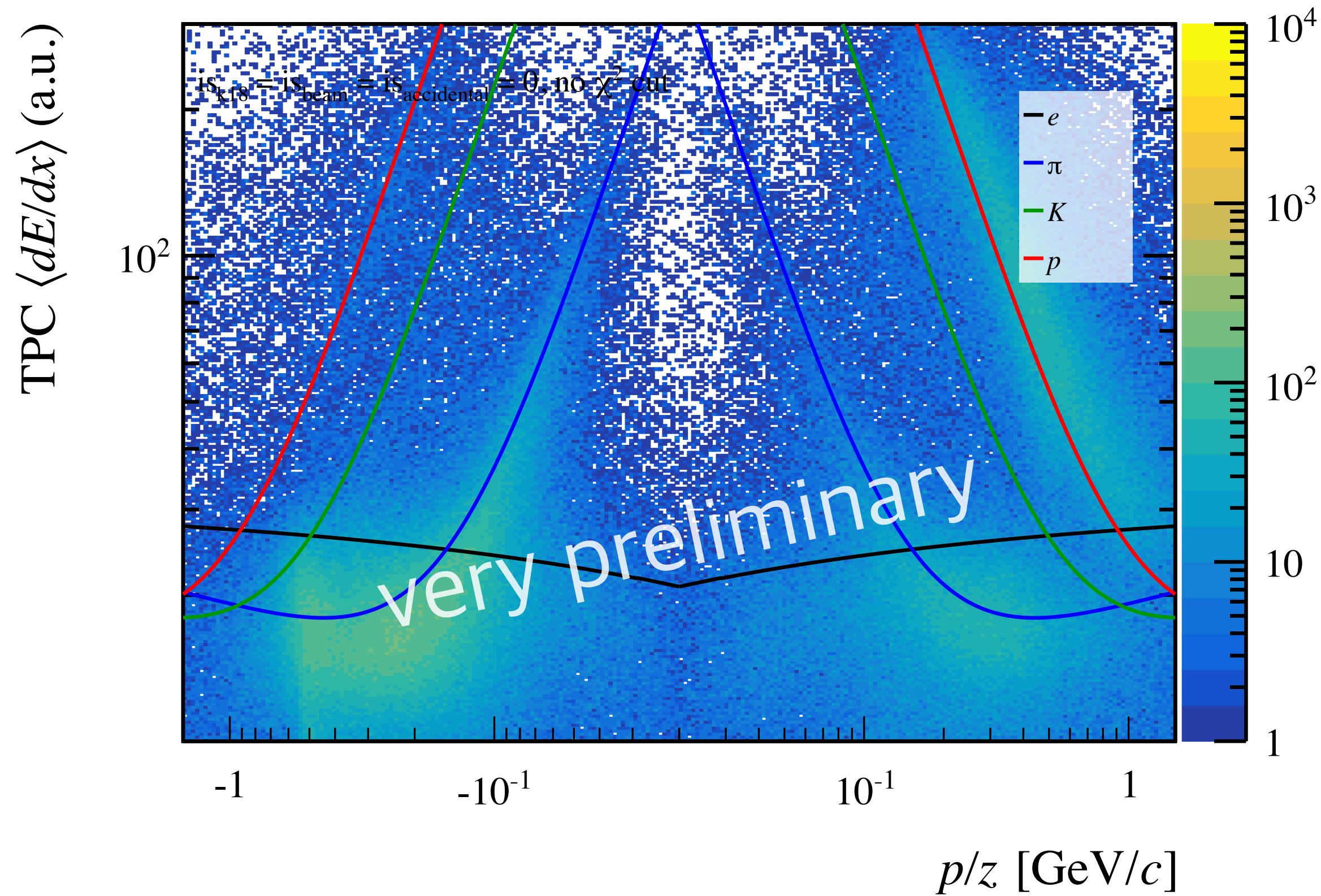


■ Data Statistics



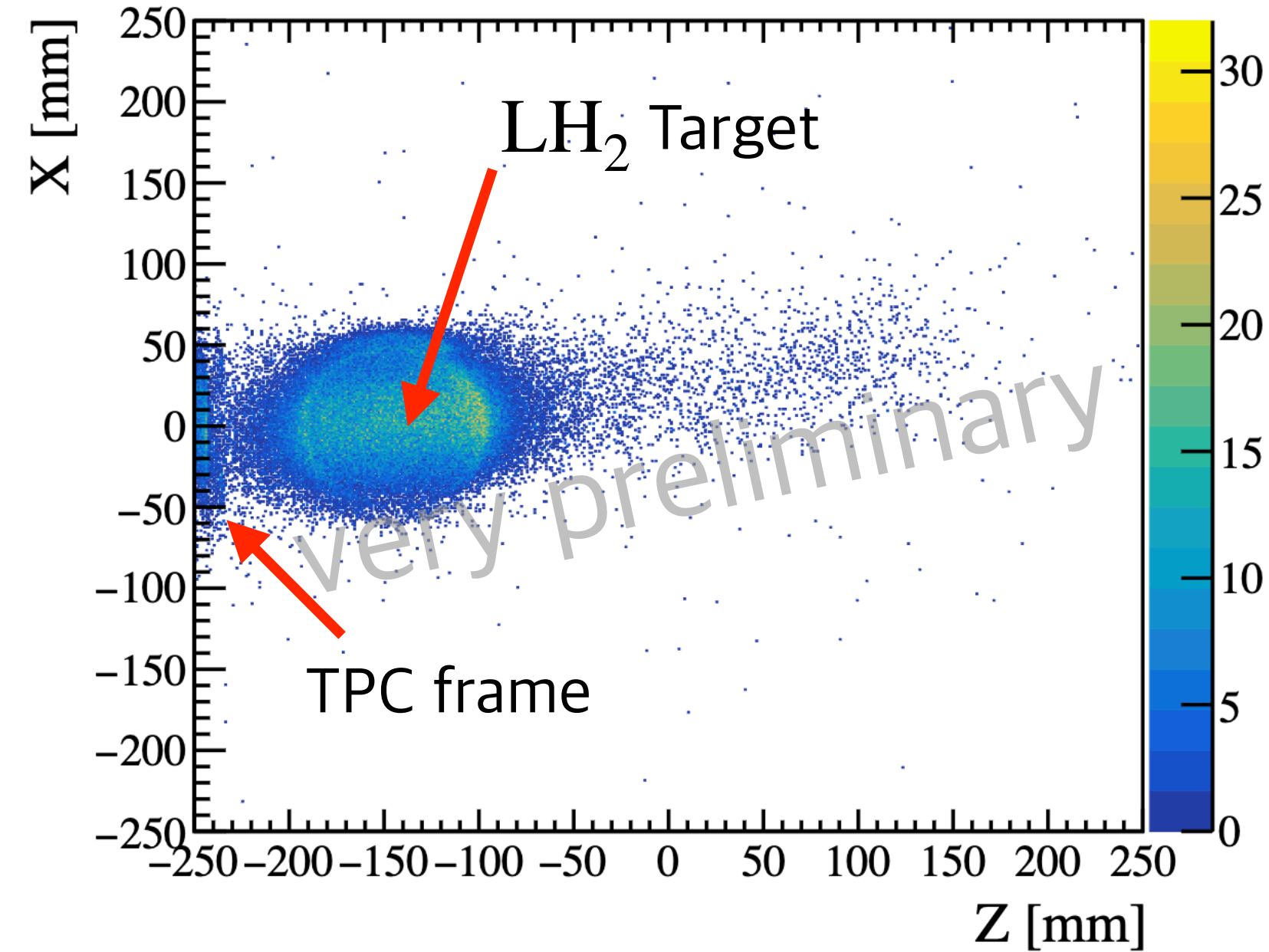
The target statistics of $\sim 0.2\text{M}$ $\Lambda\eta$ events have been achieved.

■ Analysis : PID and Λ Reconstruction

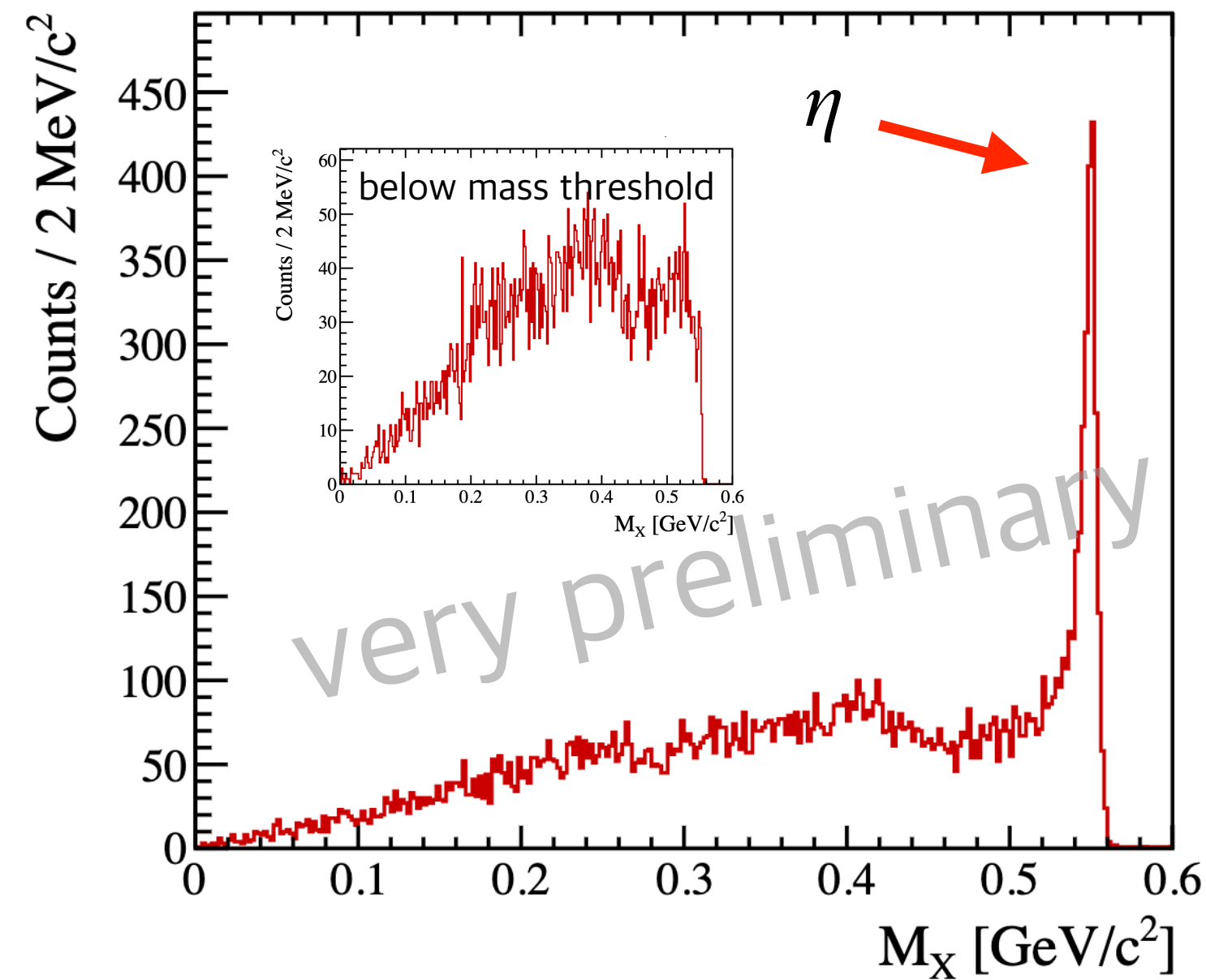


■ Analysis : $\Lambda\eta$ Reconstruction

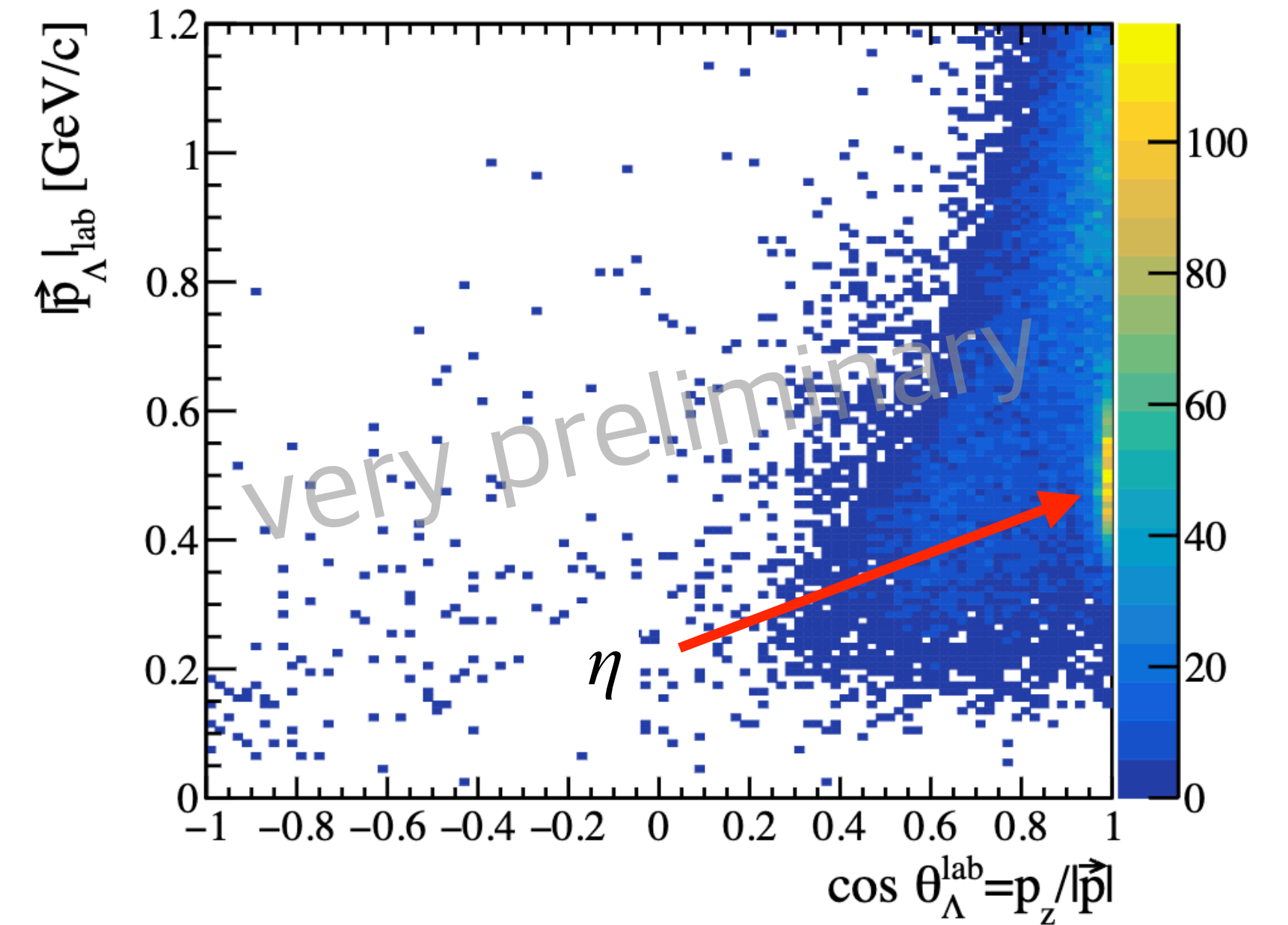
Λ Production Vertex distribution



$p(K^-, \Lambda)X$ Missing Mass distribution

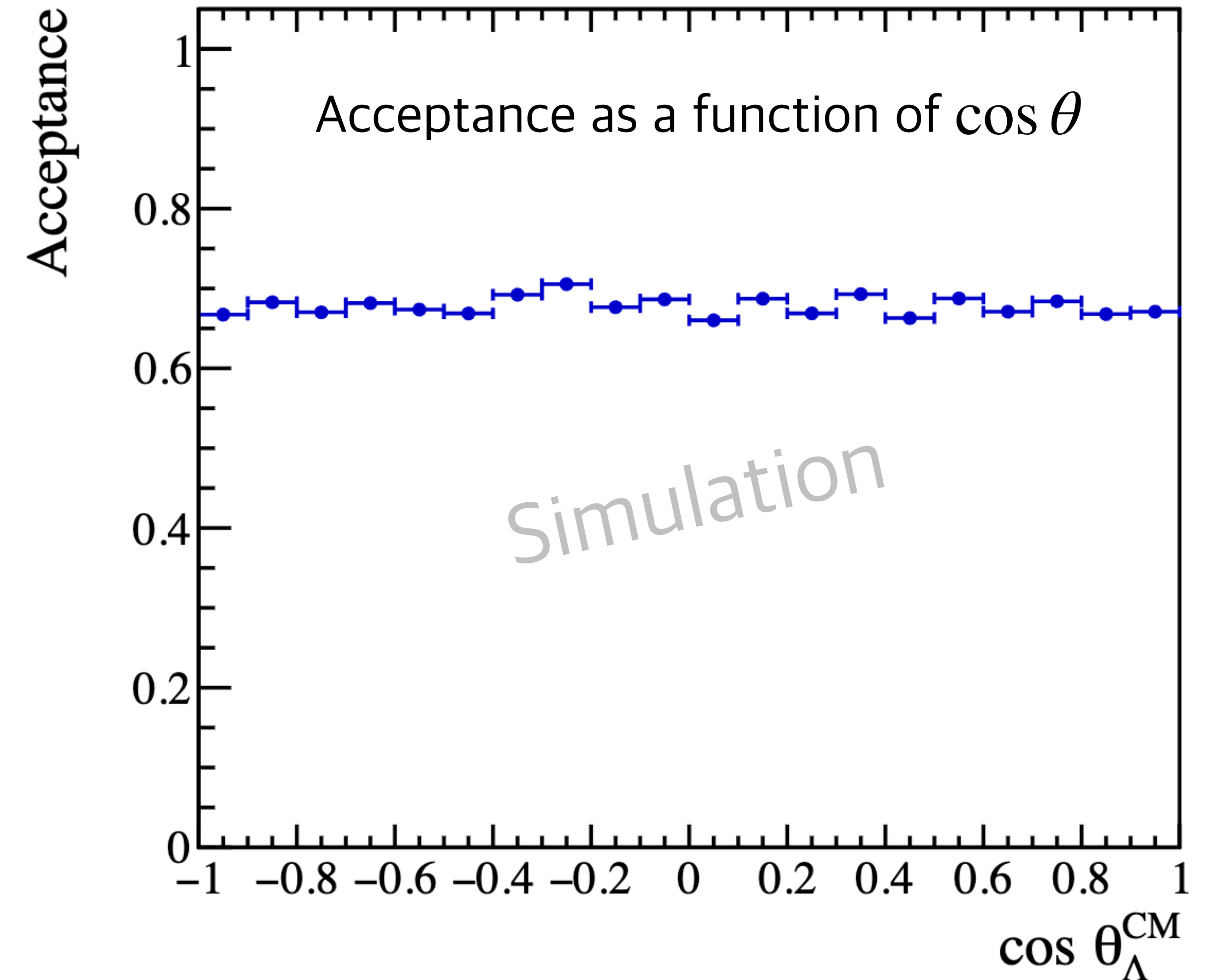
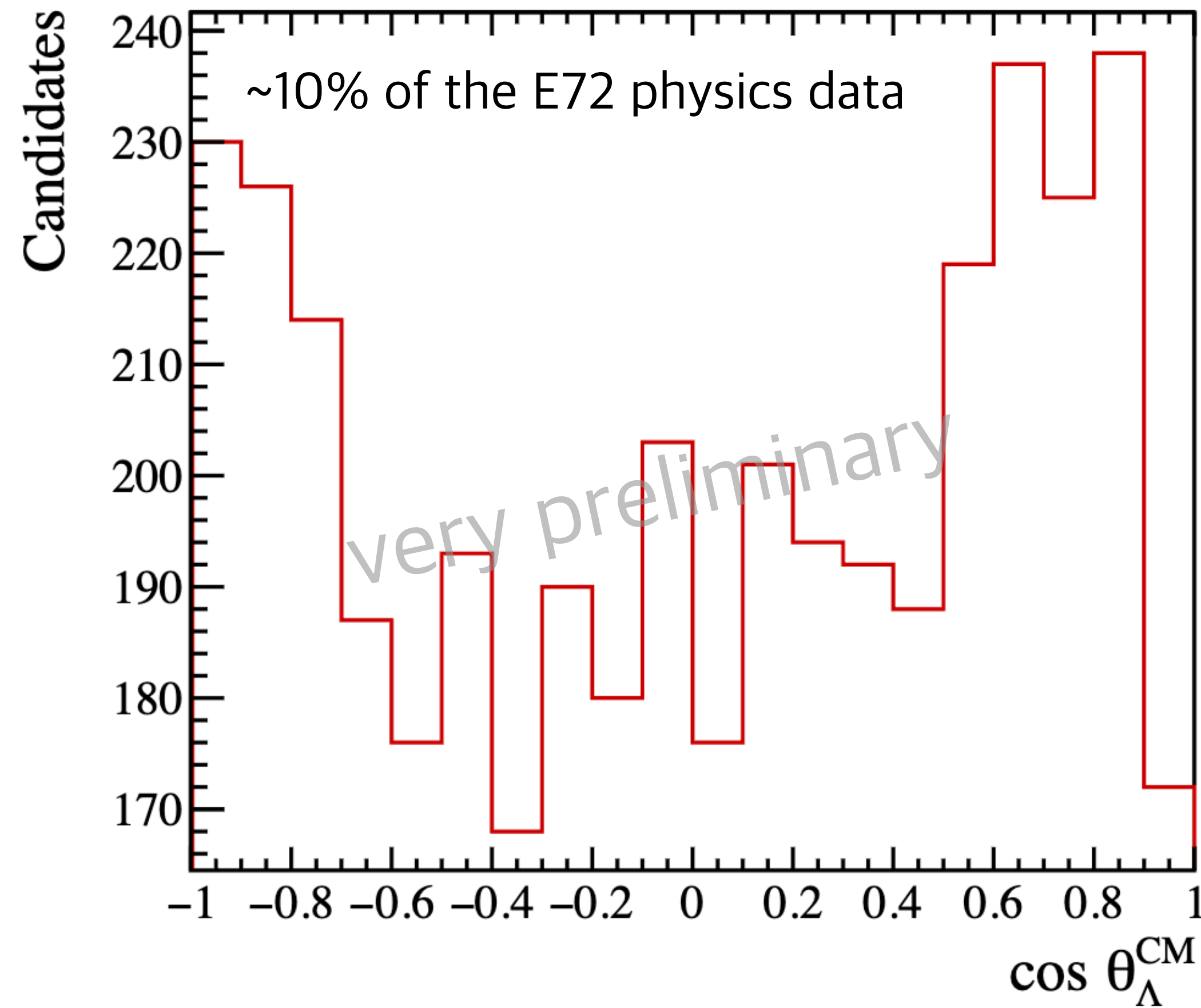


Λ Kinematics in the Lab Frame



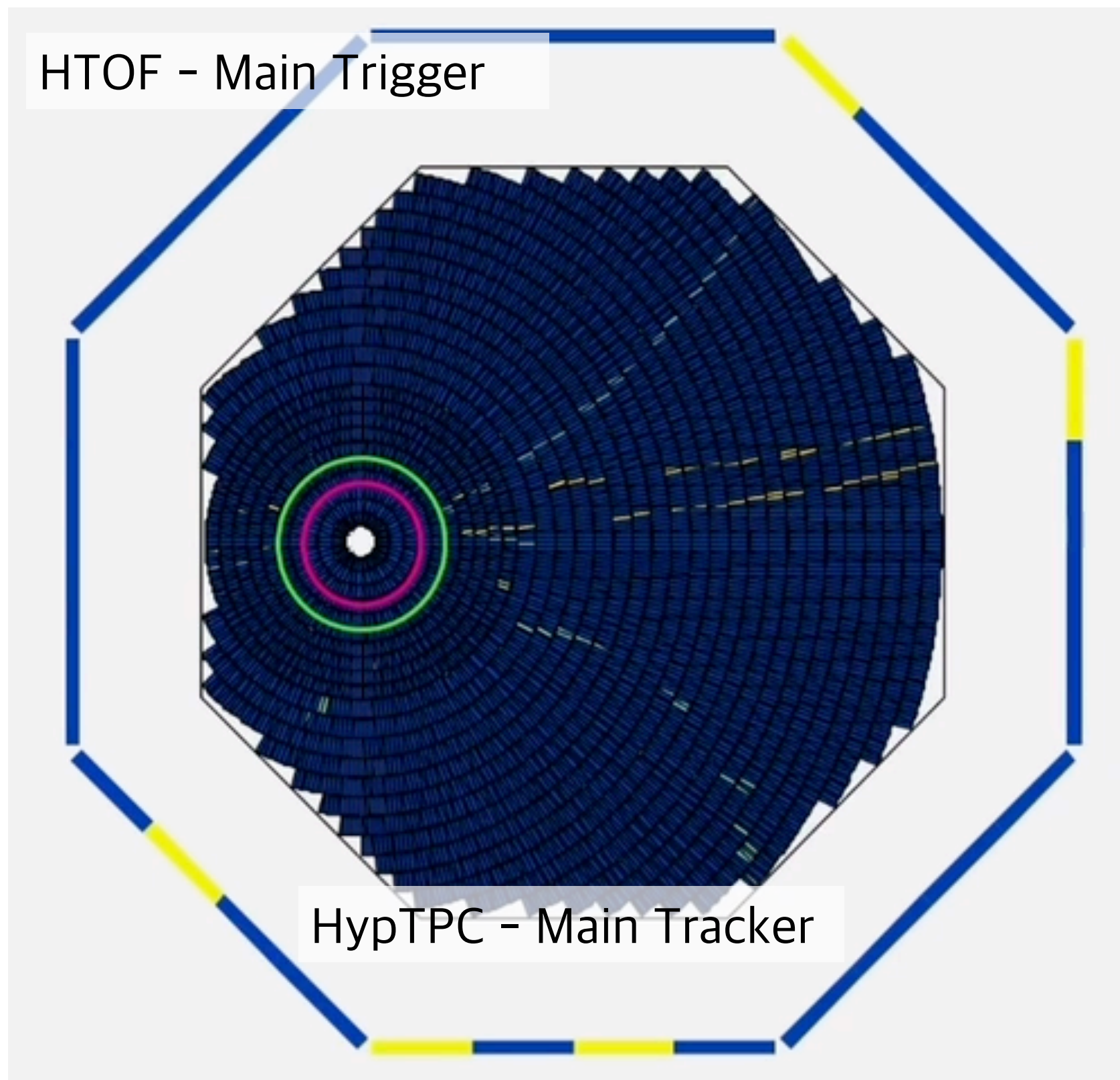
- Λ Production from the LH_2 target is clearly visible
- Clear η peak observed in the $p(K^-, \Lambda)X$ missing-mass spectrum
- Reconstructed Λ kinematics are consistent with the expected $K^-p \rightarrow \Lambda\eta$ two-body kinematics

■ Analysis : Toward the Differential Cross Section

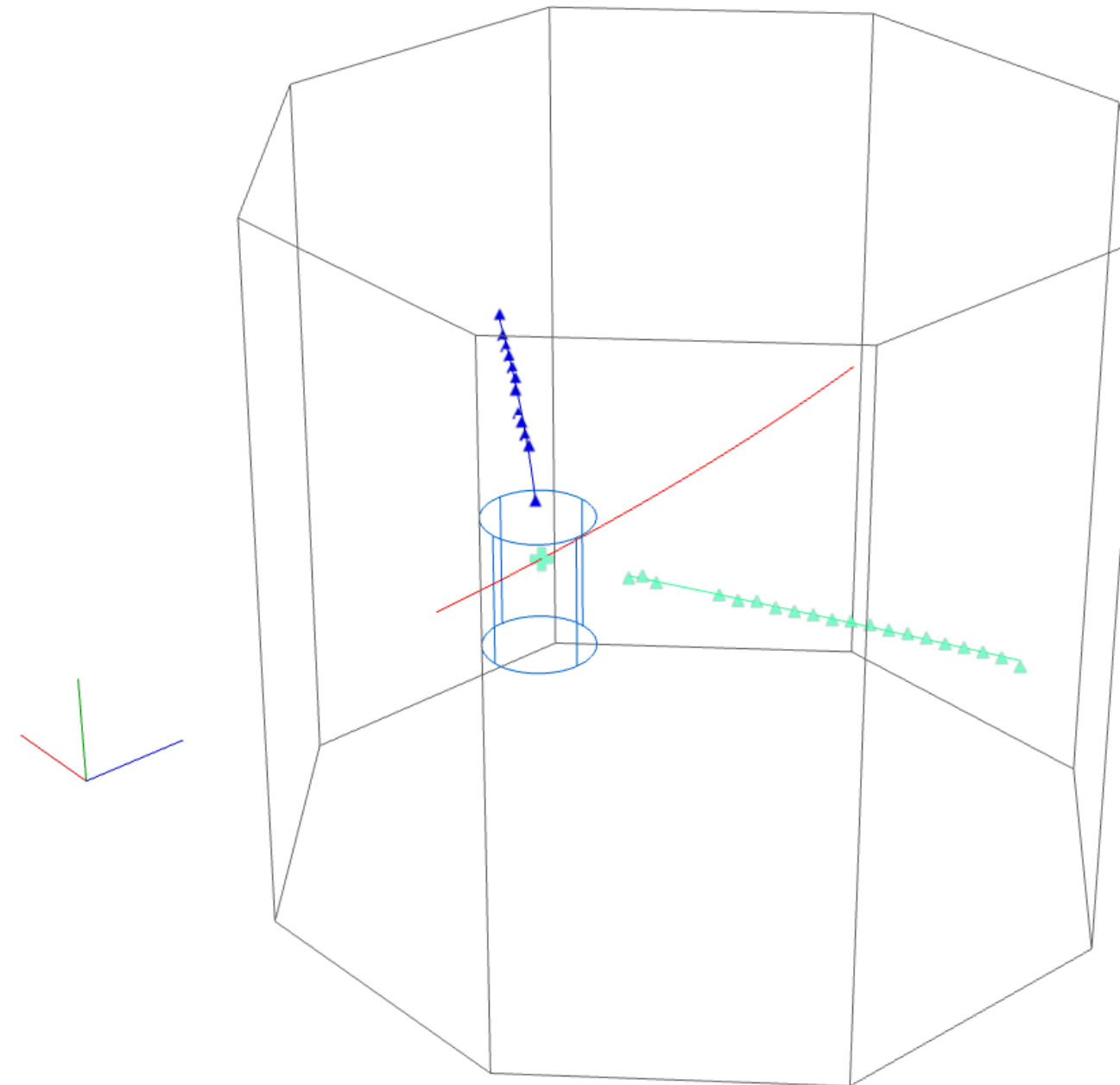


- Acceptance correction for the $\Lambda\eta$ candidates is under study
- An empty-target run for background subtraction is planned for this winter
- Final differential cross sections are expected soon

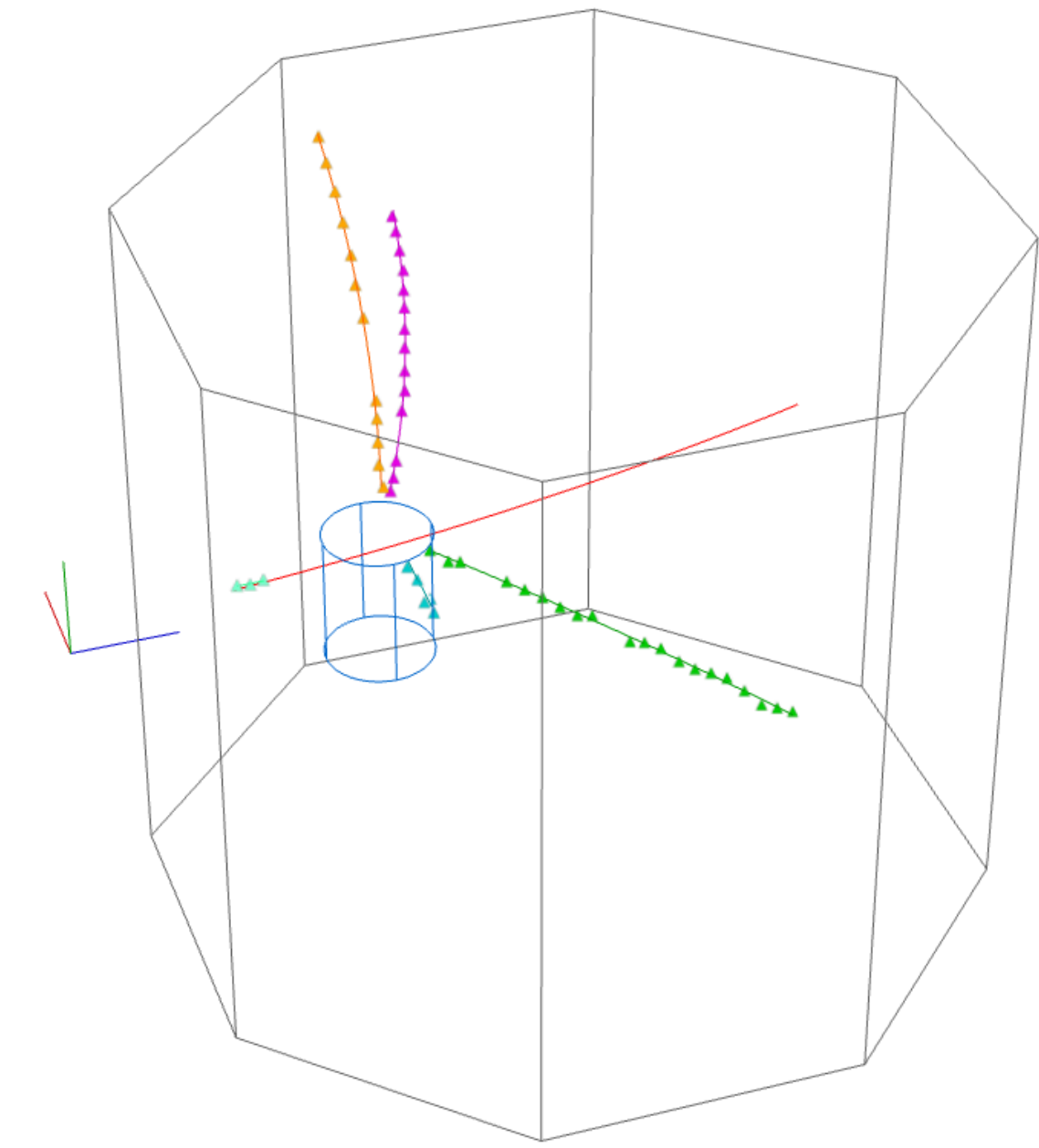
■ Additional Physics Opportunities with E72



K^-p



$\Lambda\pi\pi$



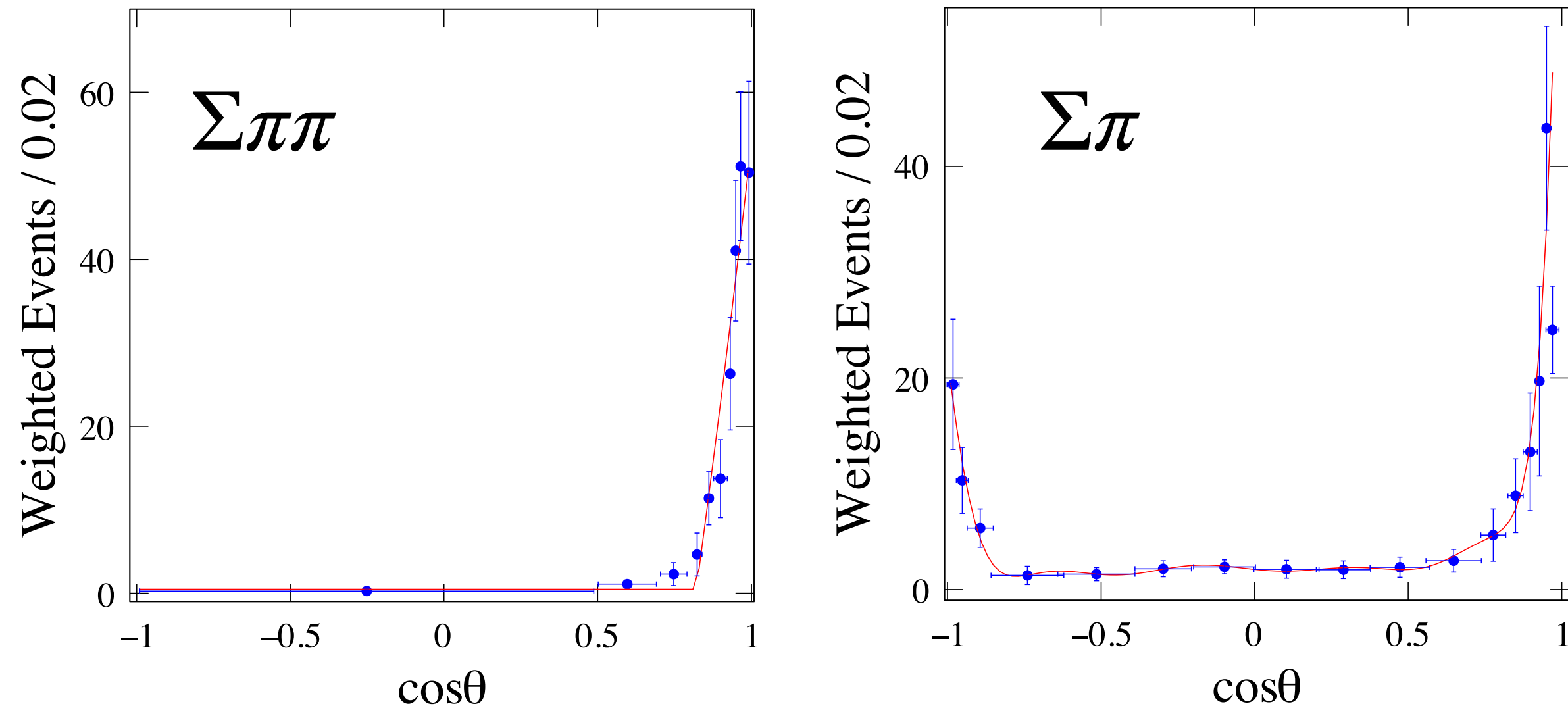
Inclusive trigger condition

- ≥ 2 charged particles in HTOF, or
- a forward-going proton

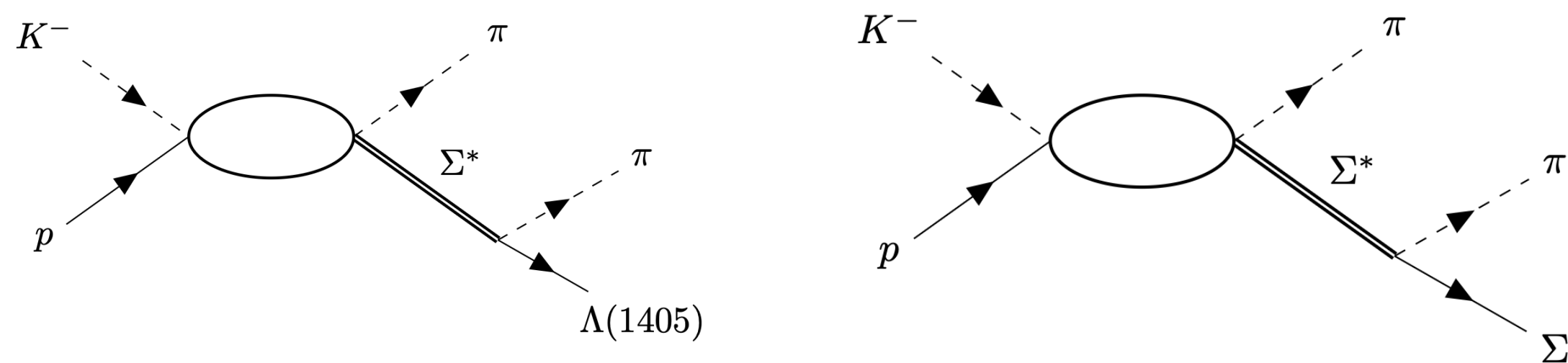
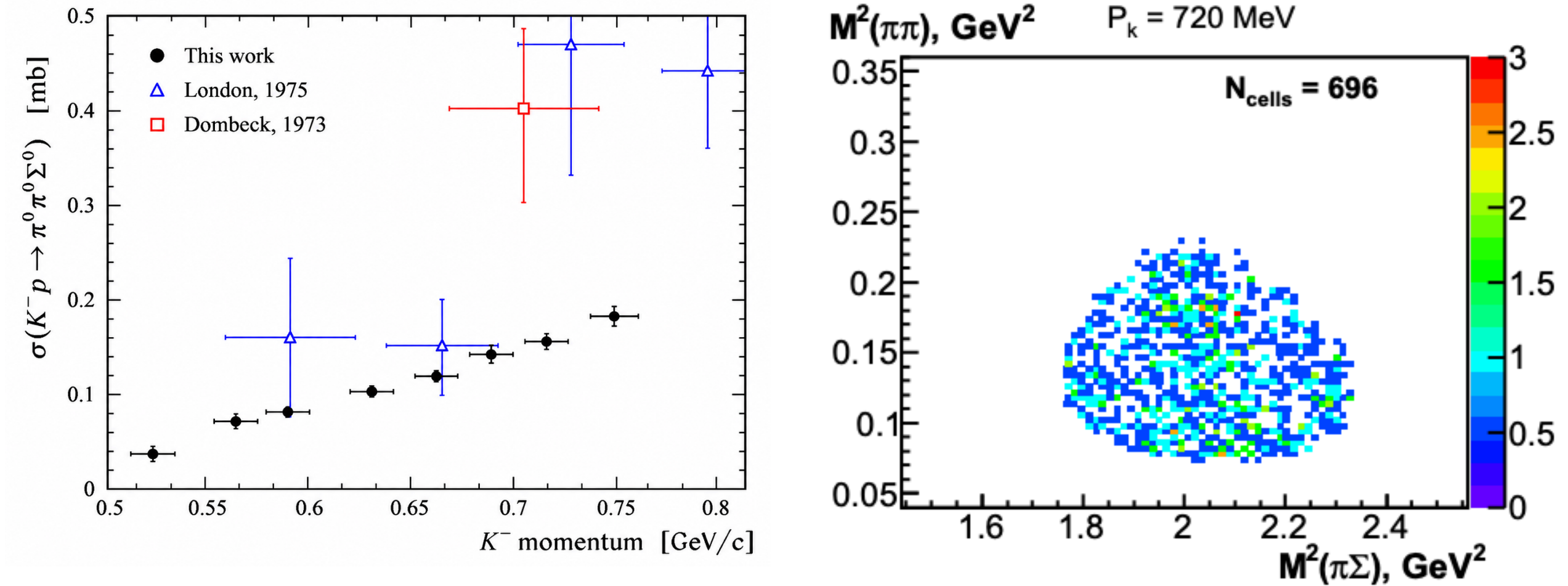
→ Various decay channels satisfying the trigger condition were recorded simultaneously.

■ Revisiting the $\Sigma(1670)$ Puzzle

J.J.M. Timmermans et al., Nucl. Phys. B112, 77 (1976)



A. V. Sarantsev et al., Eur. Phys. J. A 55, 180 (2019)



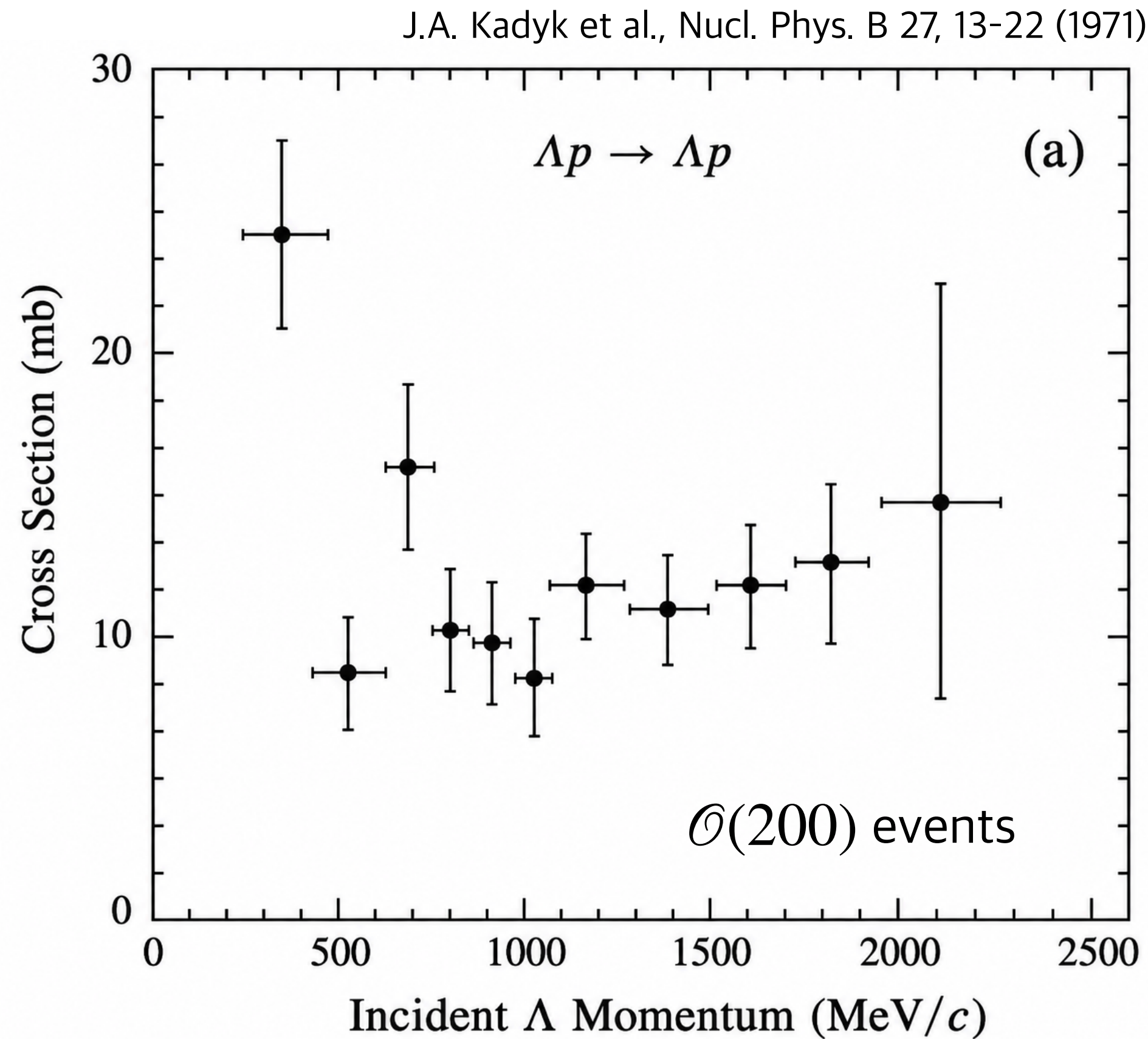
Decay-mode dependent angular distribution
→ Two nearly mass-degenerate Σ states?

Crystal Ball, $K^-p \rightarrow \Sigma^0\pi^0\pi^0$: $\Lambda(1405)\pi$ allowed

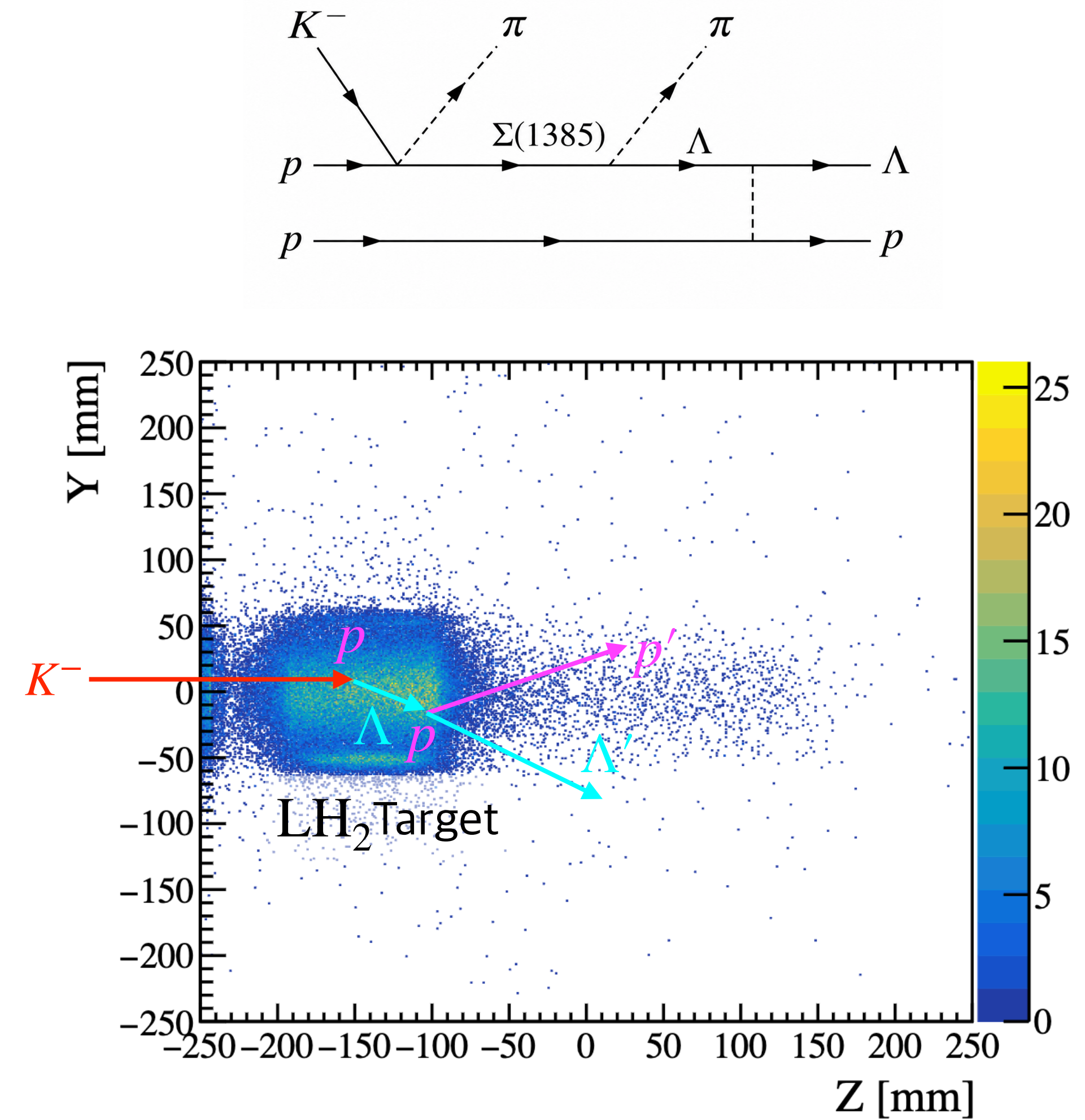
J-PARC E72, $K^-p \rightarrow \Sigma\pi$, $K^-p \rightarrow \Sigma^0\pi^+\pi^-$

→ Direct test of the $\Lambda(1405)\pi$ contribution
in the $\Sigma(1670)$ region

■ Λp Elastic Scattering



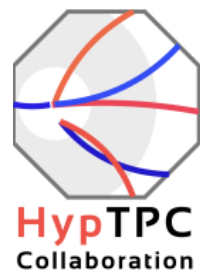
Improved YN constraints are relevant to hypernuclear structure and the hyperon puzzle in neutron stars.



Potential $\mathcal{O}(10^3)$ Λp sample with the E72 dataset

■ Summary

- J-PARC E72 aims to investigate the $K^-p \rightarrow \Lambda\eta$ reaction near $\Lambda\eta$ threshold with unprecedented statistics.
- The first physics run in Nov. 2025 successfully collected ~ 0.2 M events about two orders of magnitude more than the previous measurement.
- $\Lambda \rightarrow p\pi^-$ reconstruction and a clear η signal in the missing-mass spectrum have been established.
- Acceptance studies are ongoing toward the extraction of differential cross section; additional data taking is scheduled for Nov. 2026.
- The inclusive E72 dataset also opens opportunities for broader hyperon physics.



Thank you