

2023 MENU conference

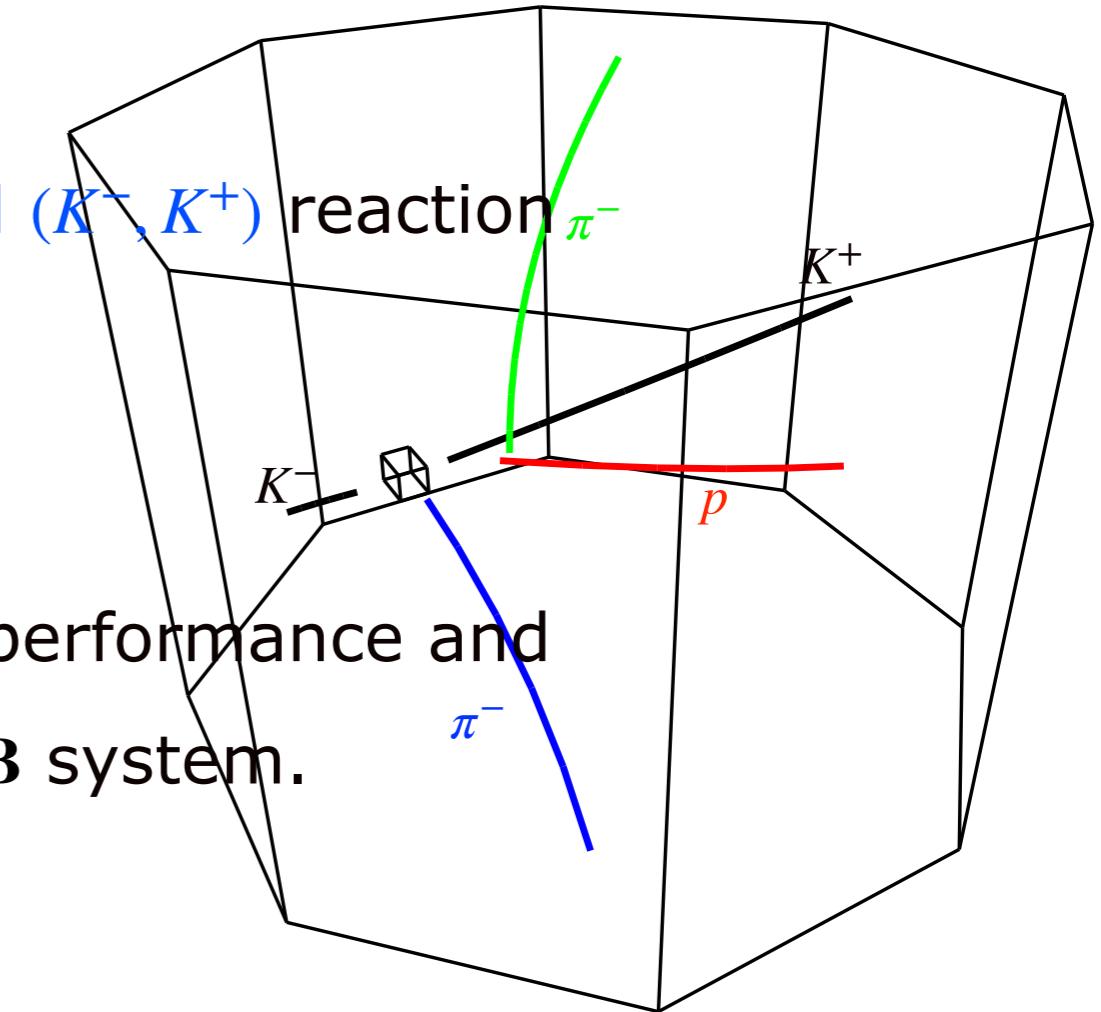


**Production of double-strangeness
systems near the threshold in the
 $^{12}\text{C}(K^-, K^+)X$ reaction at 1.8 GeV/c**

WooSeung Jung(Korea University)
for the J-PARC E42 Collaboration

Outline

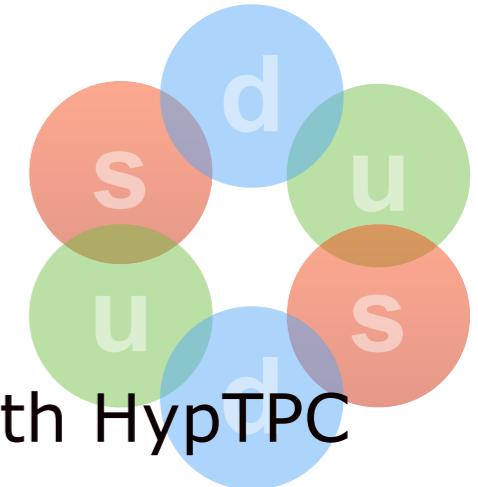
- Production and decay of the double-strangeness systems from $^{12}\text{C}(K^-, K^+)X$ involving double hypernuclei and H-dibaryon
- J-PARC E42 with HypTPC collected 0.3 M (K^-, K^+) reaction events data in 2021
- Preliminary results on the E42 detector performance and binding energy spectra relative to $\Xi^- + ^{11}\text{B}$ system.



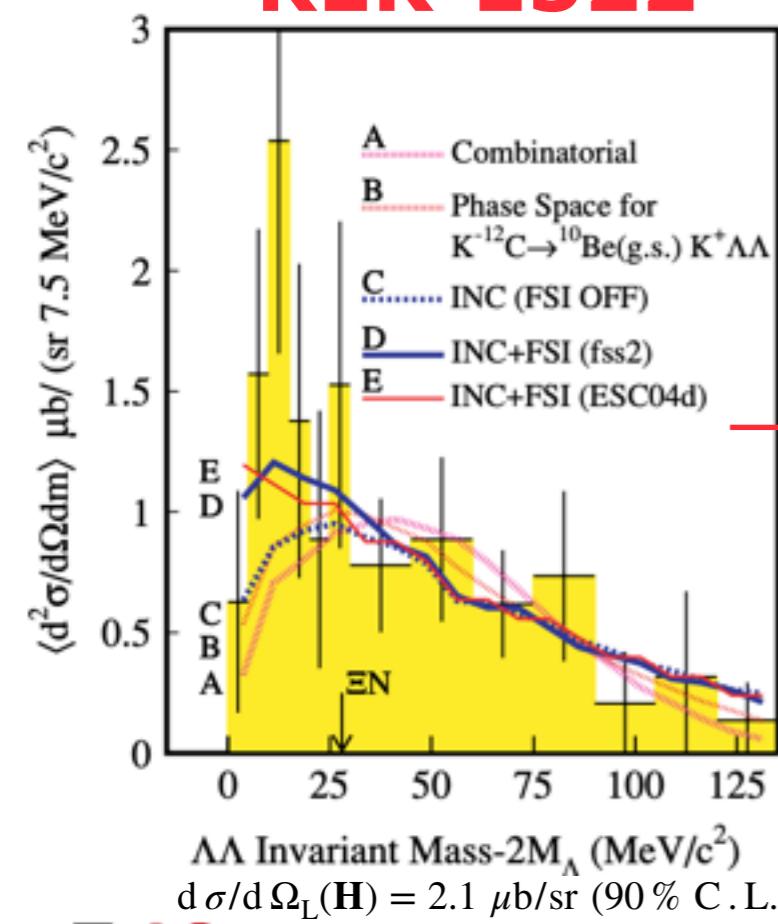
J-PARC E42

H-dibaryon search via $^{12}\text{C}(K^-, K^+)$ reaction

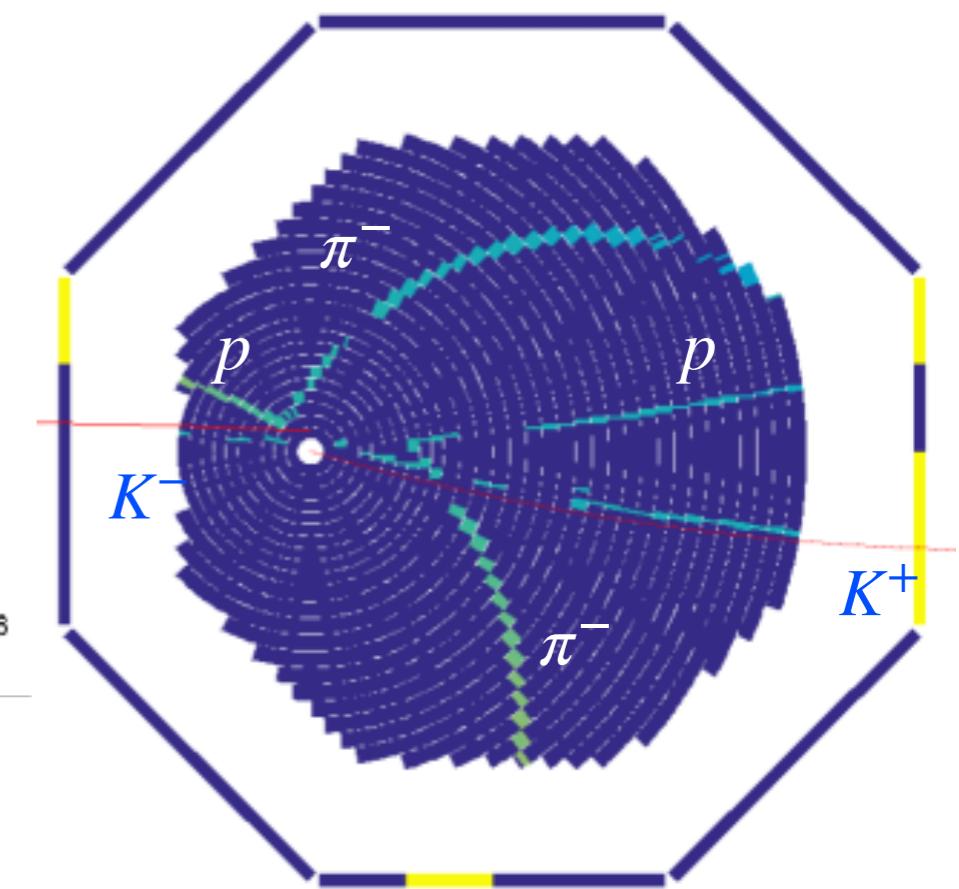
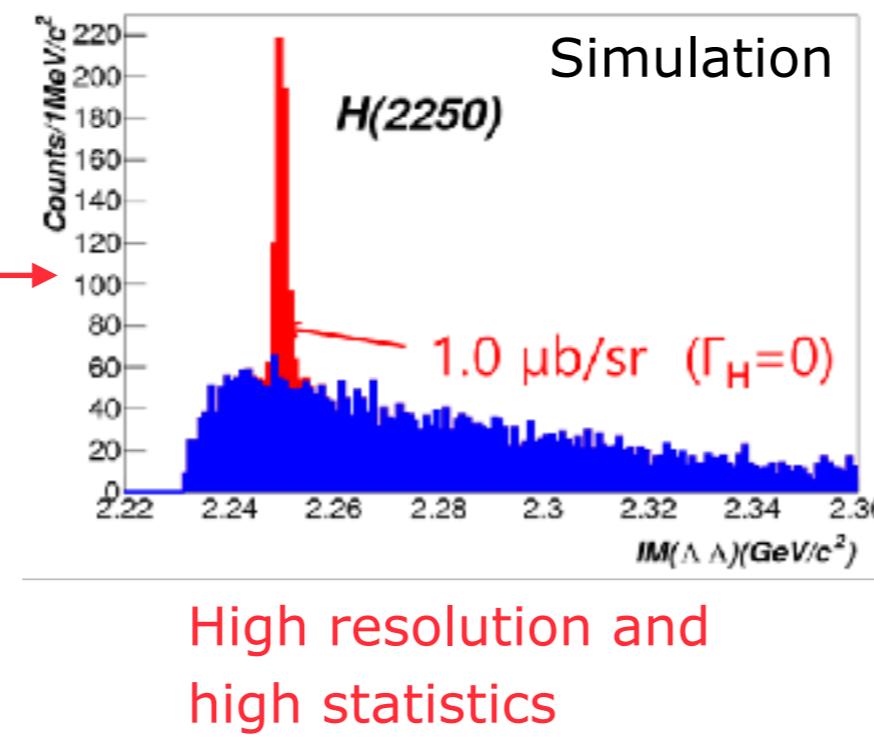
- SU(3) flavor-singlet dibaryon consisting of uuddss
- Collected 0.3 M (K^-, K^+) reaction events data in 2021
- Invariant-mass measurement of $\Lambda\Lambda$ and Ξ^-p systems with HypTPC



KEK-E522



J-PARC E42

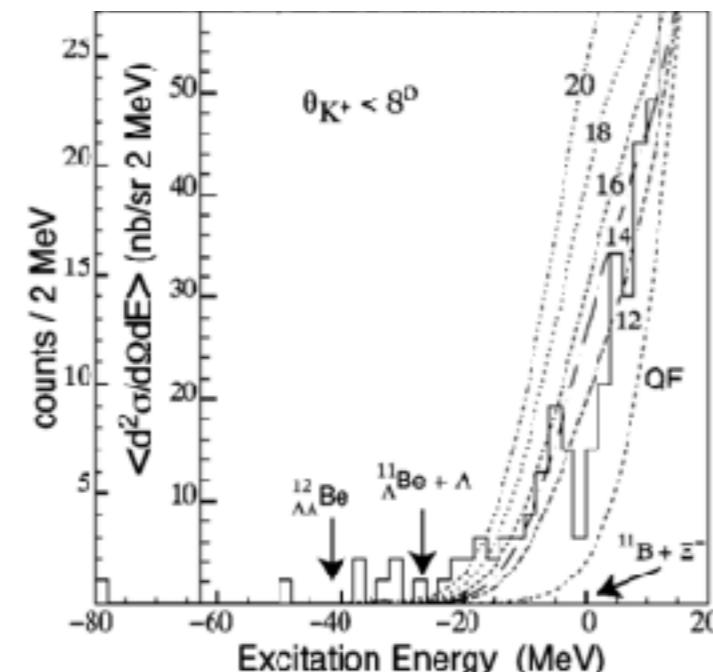


Study of Ξ^- nucleus Potential($V_{0\Xi}$)

- Reinvestigation of the Ξ^- -nucleus potential using the past data

BNL-E885 : $V_{0\Xi} \sim -14$ MeV
by neglecting the $W_{0\Xi}$

BNL-E906 ${}^9\text{Be}(K^-, K^+)$ reaction at
1.8 GeV/c spectrum was studied.

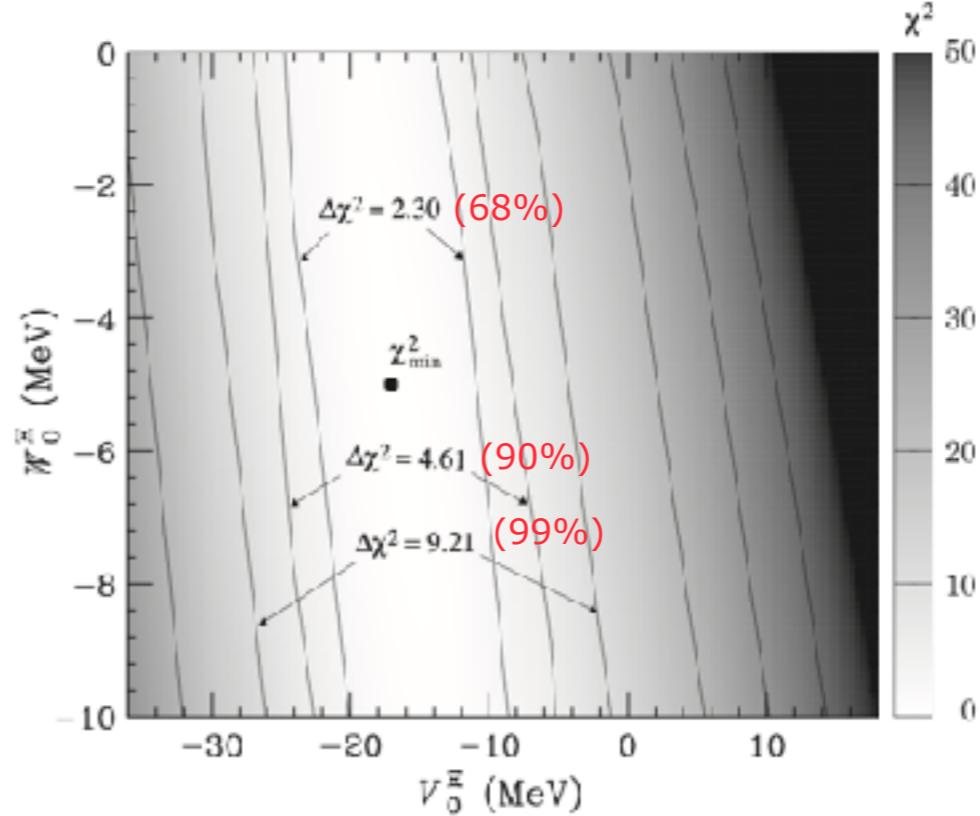


*P. Khaustov et al., PRC 61 (2000) 054603

By SCDW model calculations

- $V_{0\Xi} \sim 0$ with $\Gamma/2=2$ MeV also can reproduce above data.

$$U_\Xi(r) = (V_{0\Xi} + iW_{0\Xi})/[1 + \exp(r - R)/a]$$



- χ^2 is insensitive to $W_{0\Xi}$

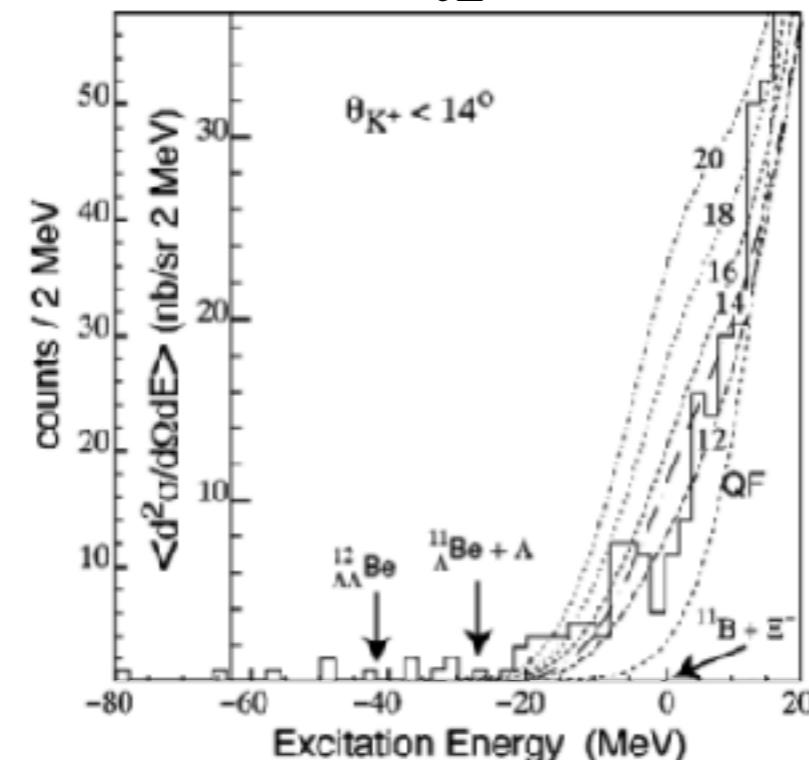
*M. Kohno and S. Hashimoto, Prog. Theor. **123**, (2010).

*T. Harada and Y. Hirabayashi, Phys. Rev. C **103**, 024605 (2001)

Experiments Ξ^- Hypernuclear Spectroscopy

- Search for bound Ξ^- hypernuclei in the excitation-energy spectrum for $^{12}\text{C}(K^-, K^+) \Xi^- X$ reaction

BNL-E885 $V_{0\Xi} \sim -14 \text{ MeV}$

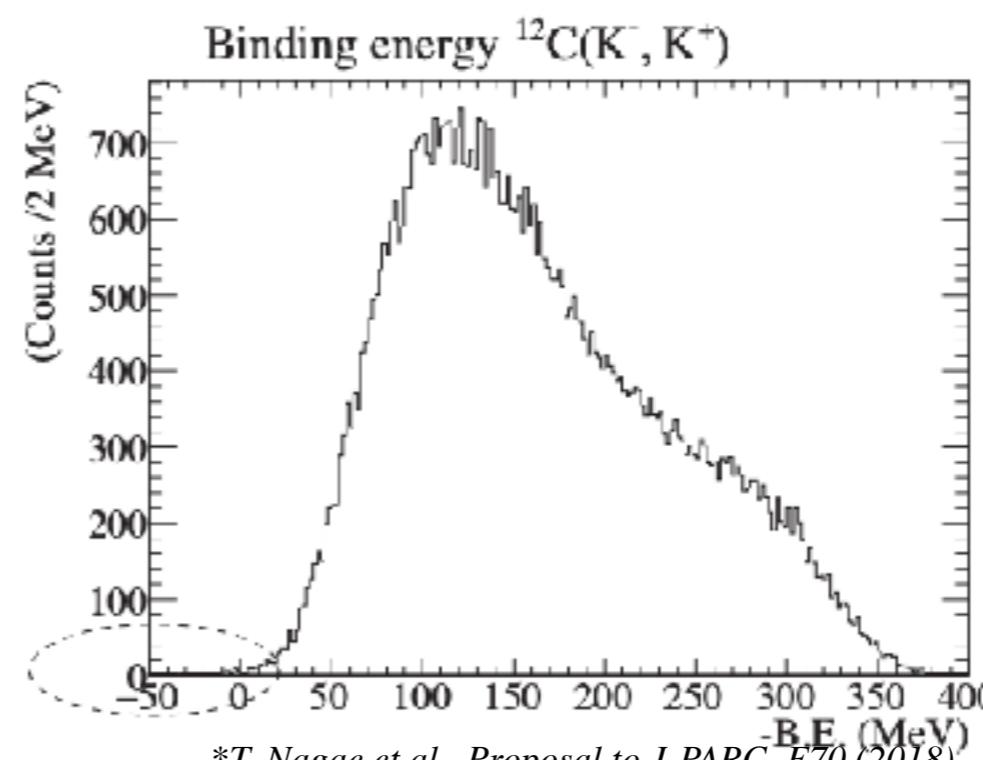


*P. Khaustov et al., PRC 61 (2000) 054603

MM Resolution : FWHM 14 MeV

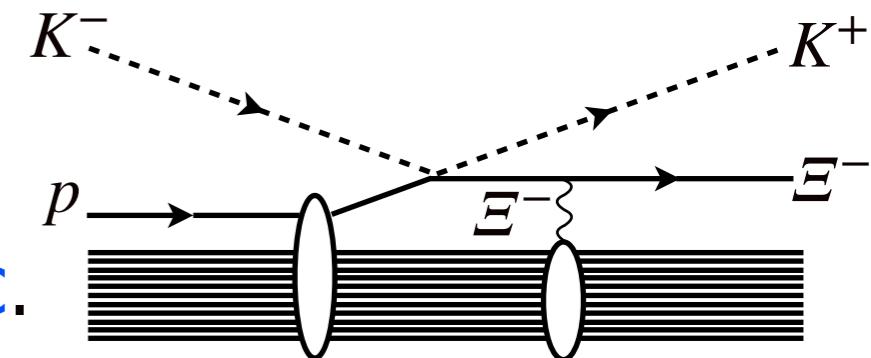
- E42 is sensitive to determine $W_{0\Xi}$ by decomposing the inclusive spectrum into $\Xi^- p \rightarrow \Lambda\Lambda$ conversion and others by HypTPC.

J-PARC E05 / E70 (near future)



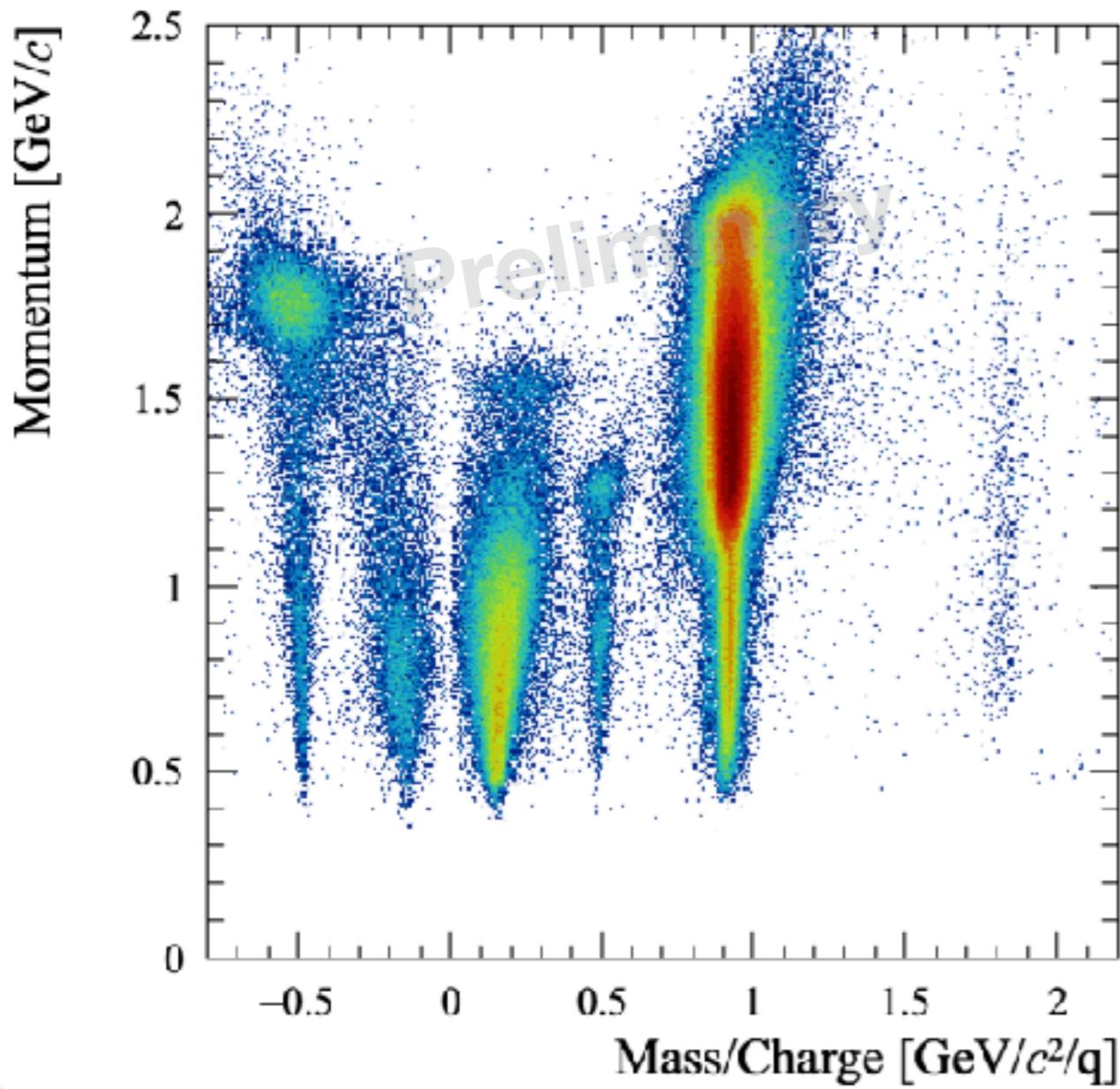
*T. Nagae et al., Proposal to J-PARC, E70 (2018)

MM Resolution : FWHM 2 MeV



J-PARC E42 Detector

Scattered particles at forward angles

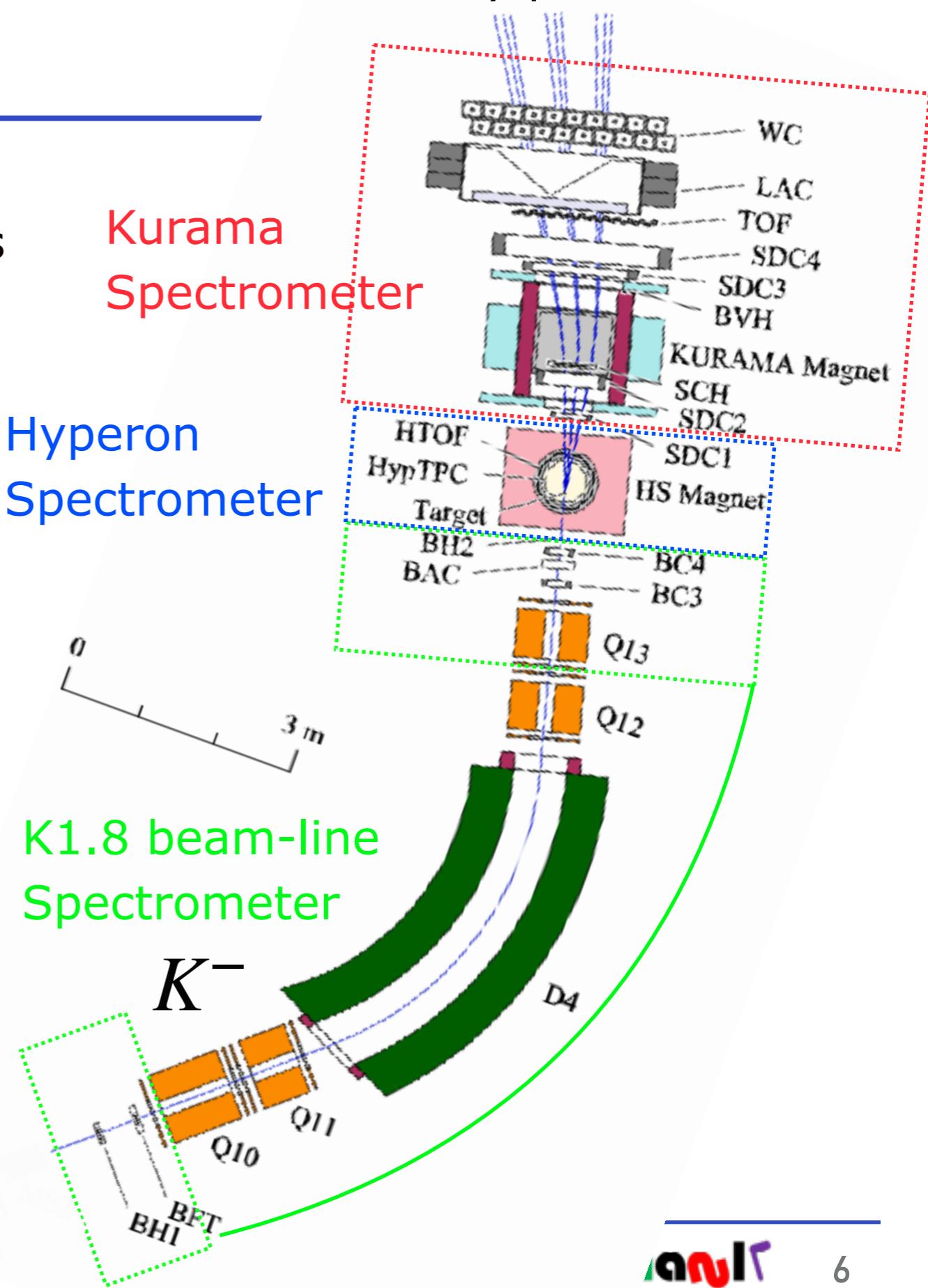


Kurama
Spectrometer

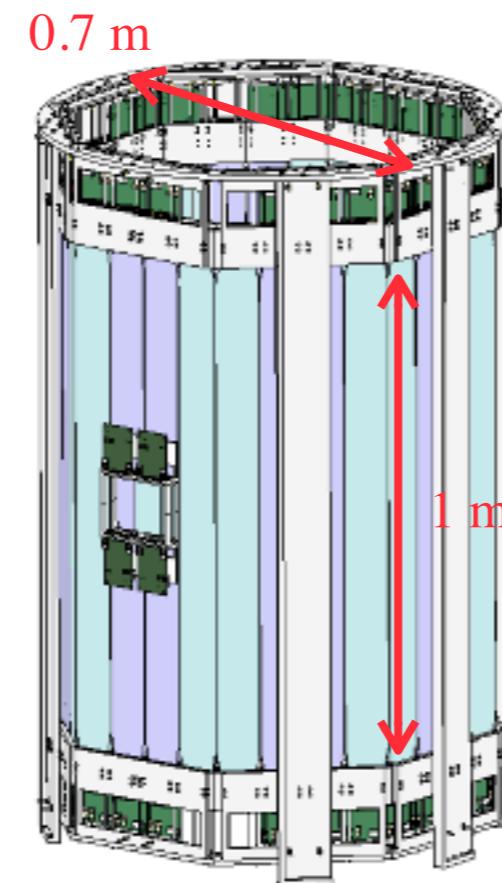
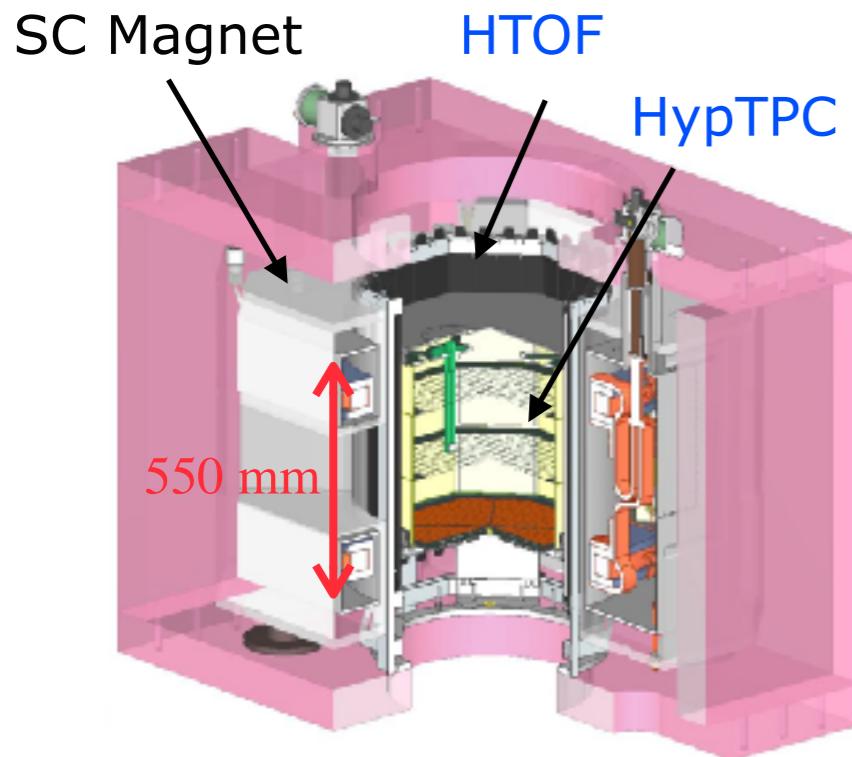
Hyperon
Spectrometer

K1.8 beam-line
Spectrometer

Decay particles K^+



Hyperon Spectrometer

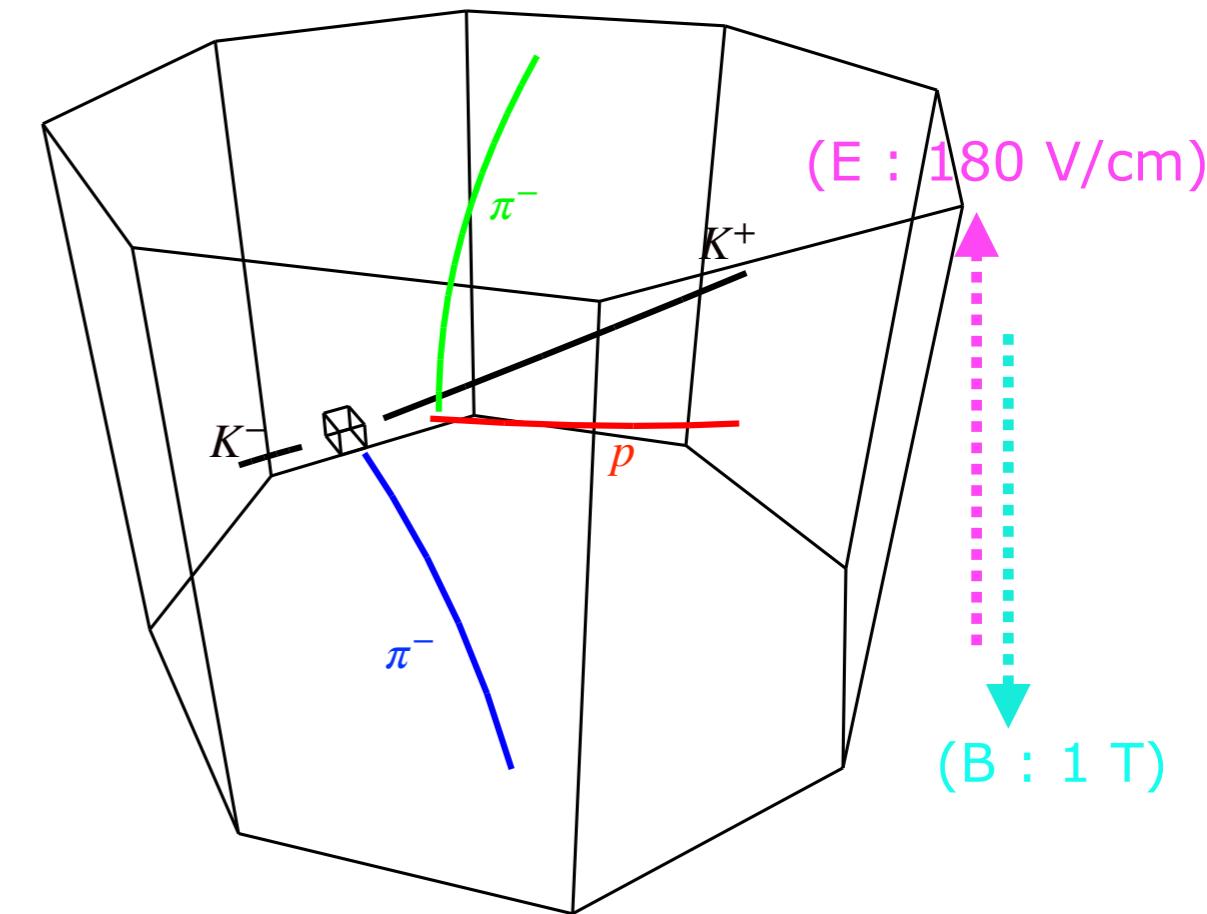


HypTPC

- Main tracker for charged decays.
- E42 target is located inside the TPC off-axis with the beam.

HTOF

- 1m long TOF counter surrounding TPC



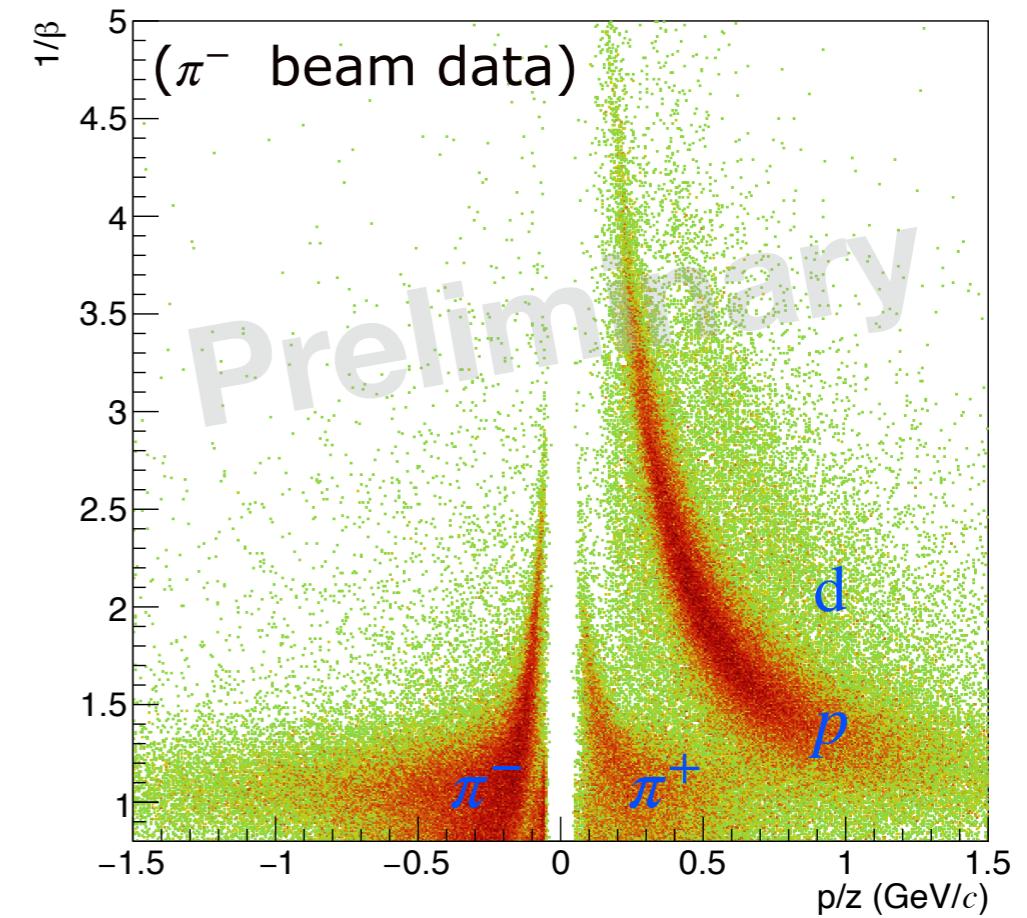
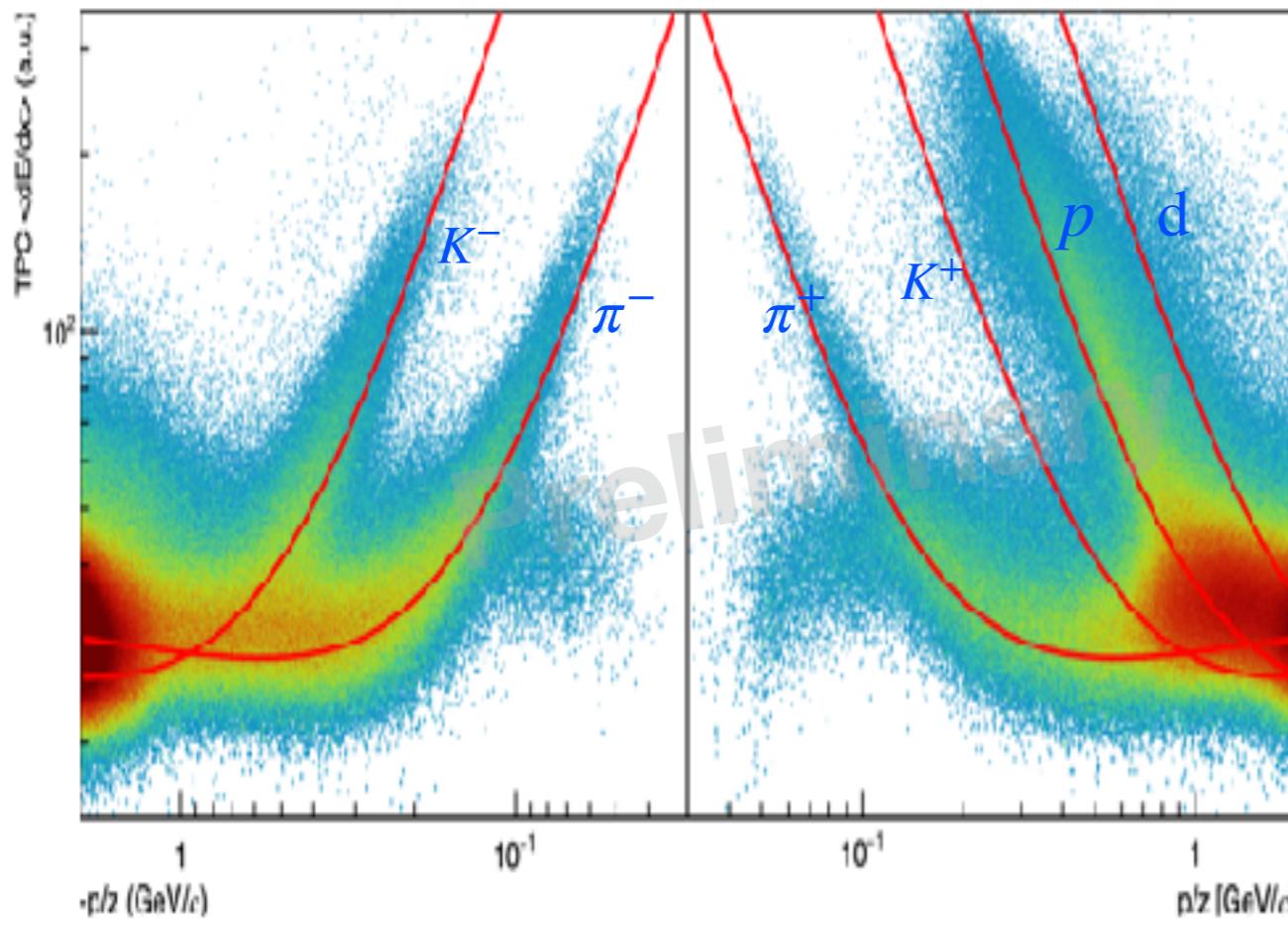
Particle Identification by Hyperon Spectrometer

HypTPC dE/dx

- $\langle dE/dx \rangle_{20\% \text{ truncated}} \text{ vs } p/z$ for reconstructed tracks of $^{12}\text{C}(K^-, K^+)$ reactions
- $\sigma_{\langle dE/dx \rangle} / \langle dE/dx \rangle \sim 20\%$ for the range $0.40 < p_t < 0.45 \text{ GeV}/c$

HTOF Time-of-flight

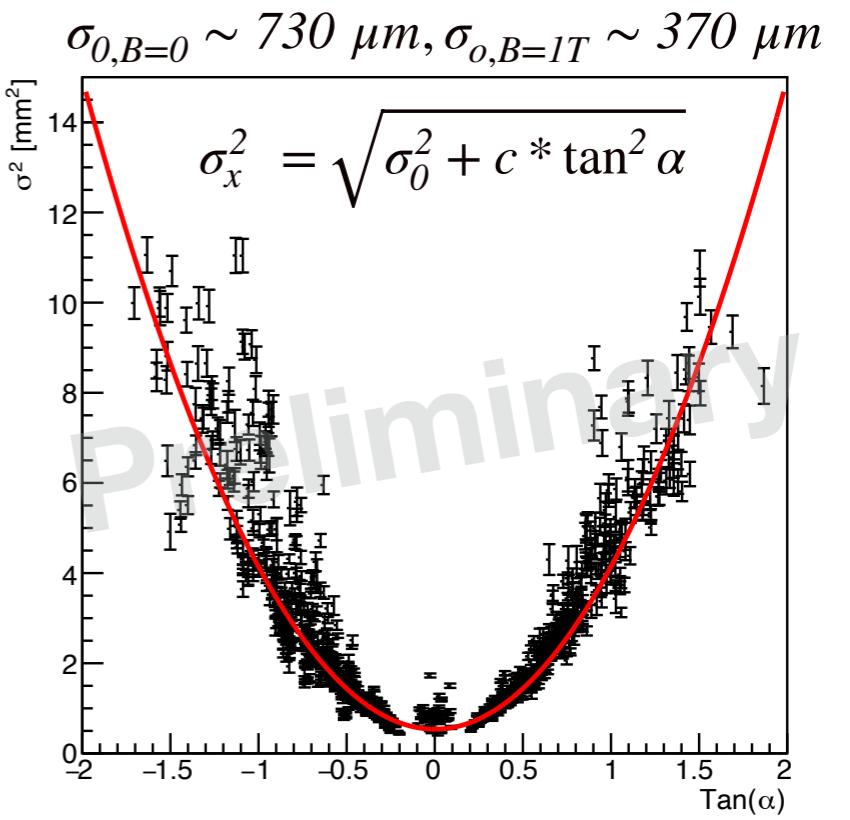
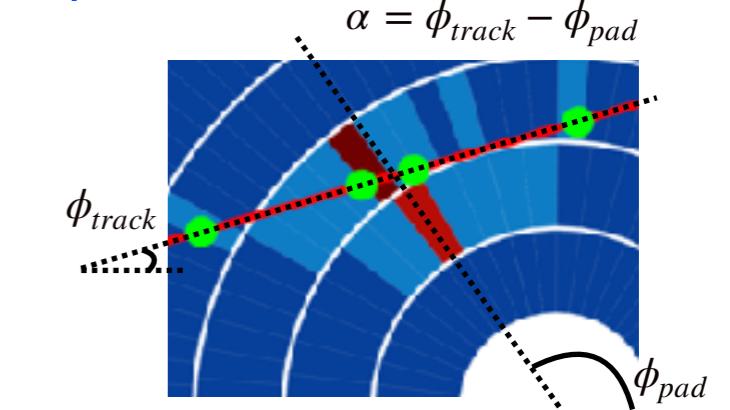
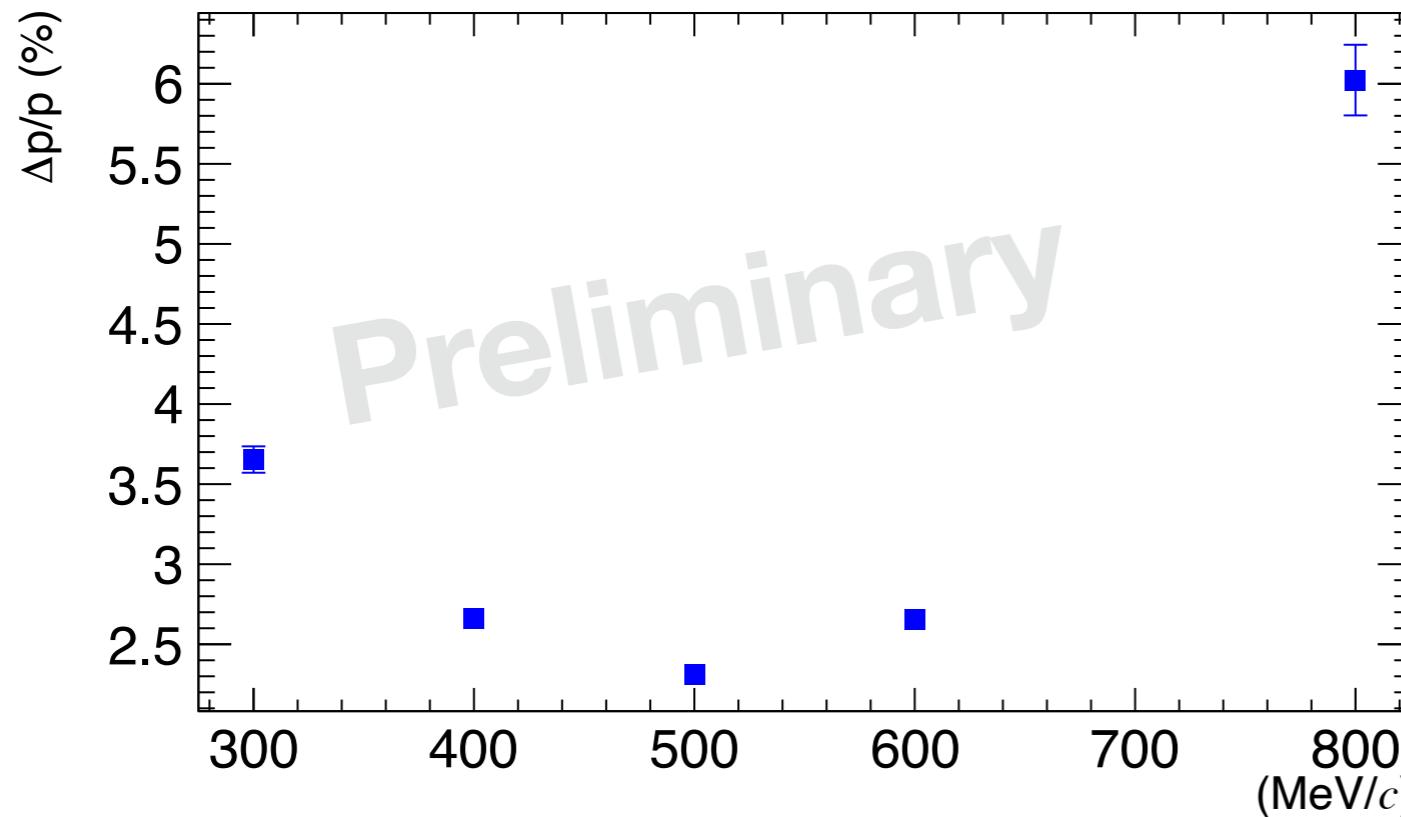
- Flight length about $200 \sim 500 \text{ mm}$, $\sigma_t \sim 120 \text{ ps}$ for π^-



Spatial and Momentum Resolutions of HypTPC

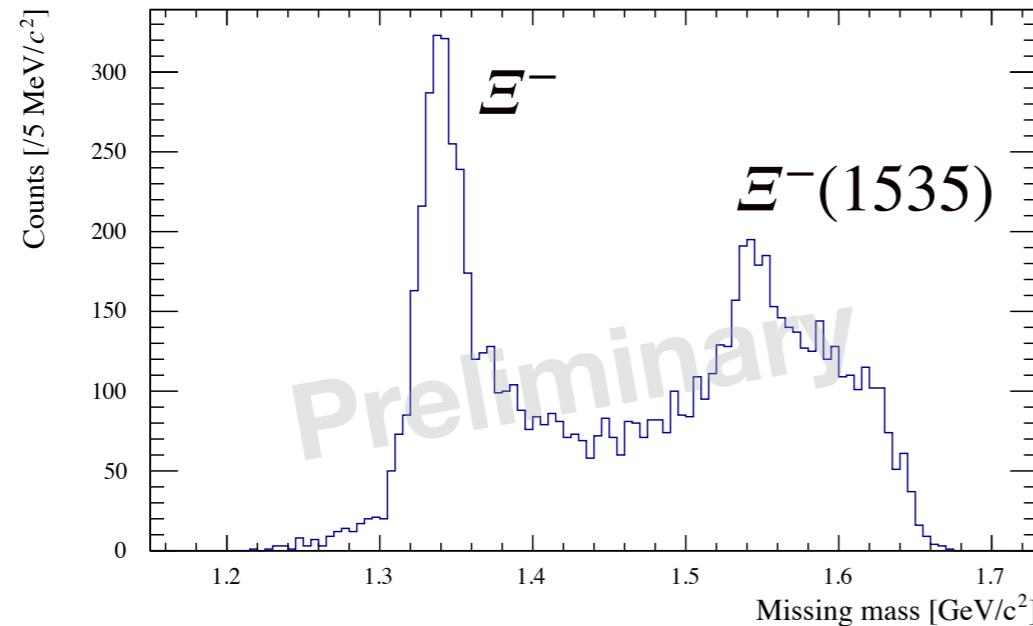
- Momentum resolution was measured with π^- beam-through data of various momentums.
- Spatial resolution is parameterized with **intrinsic** and **angular dependent** terms.

Momentum resolution for π^-



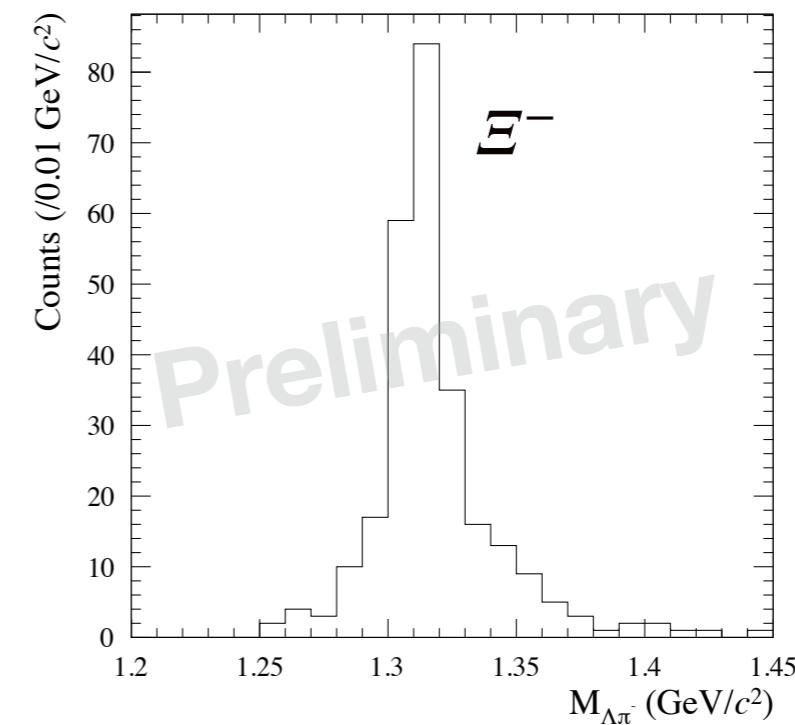
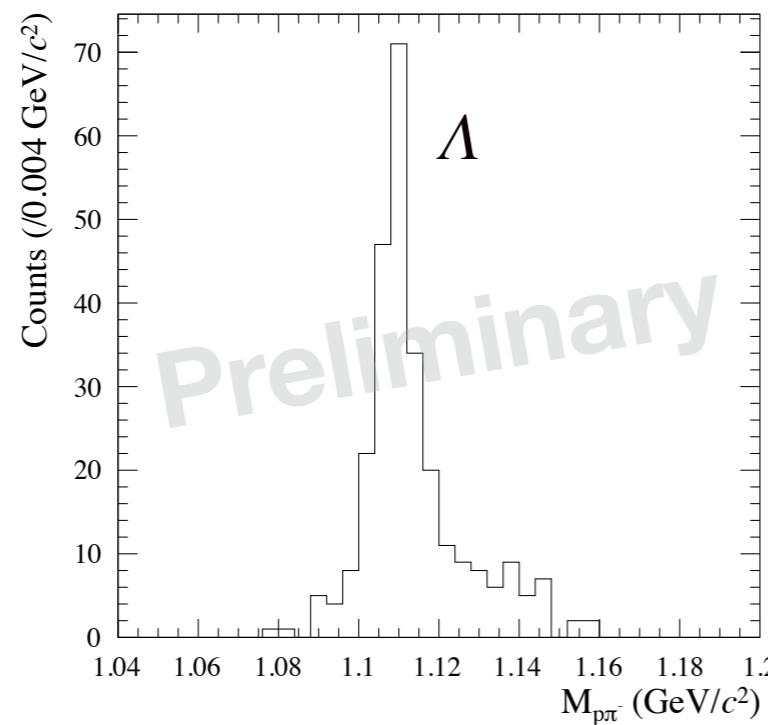
Preliminary Λ / Ξ^- reconstruction via the $\text{CH}_2(K^-, K^+)X$ reaction

$\text{CH}_2(K^-, K^+)X$ Missing-mass spectra



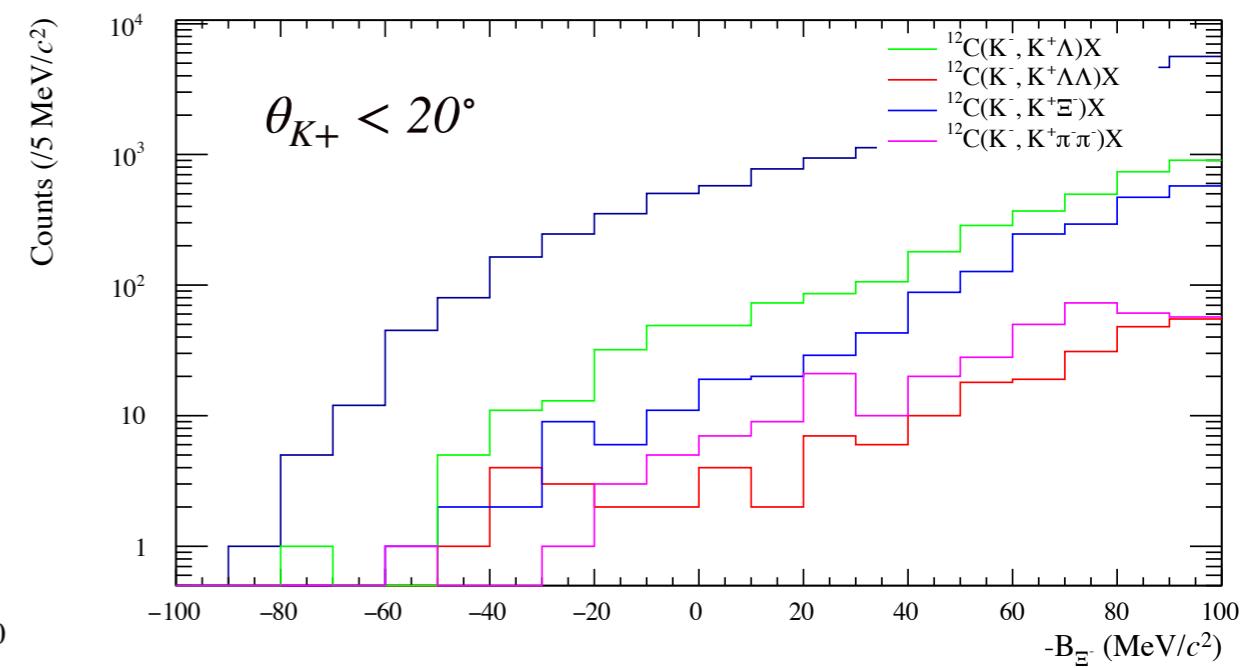
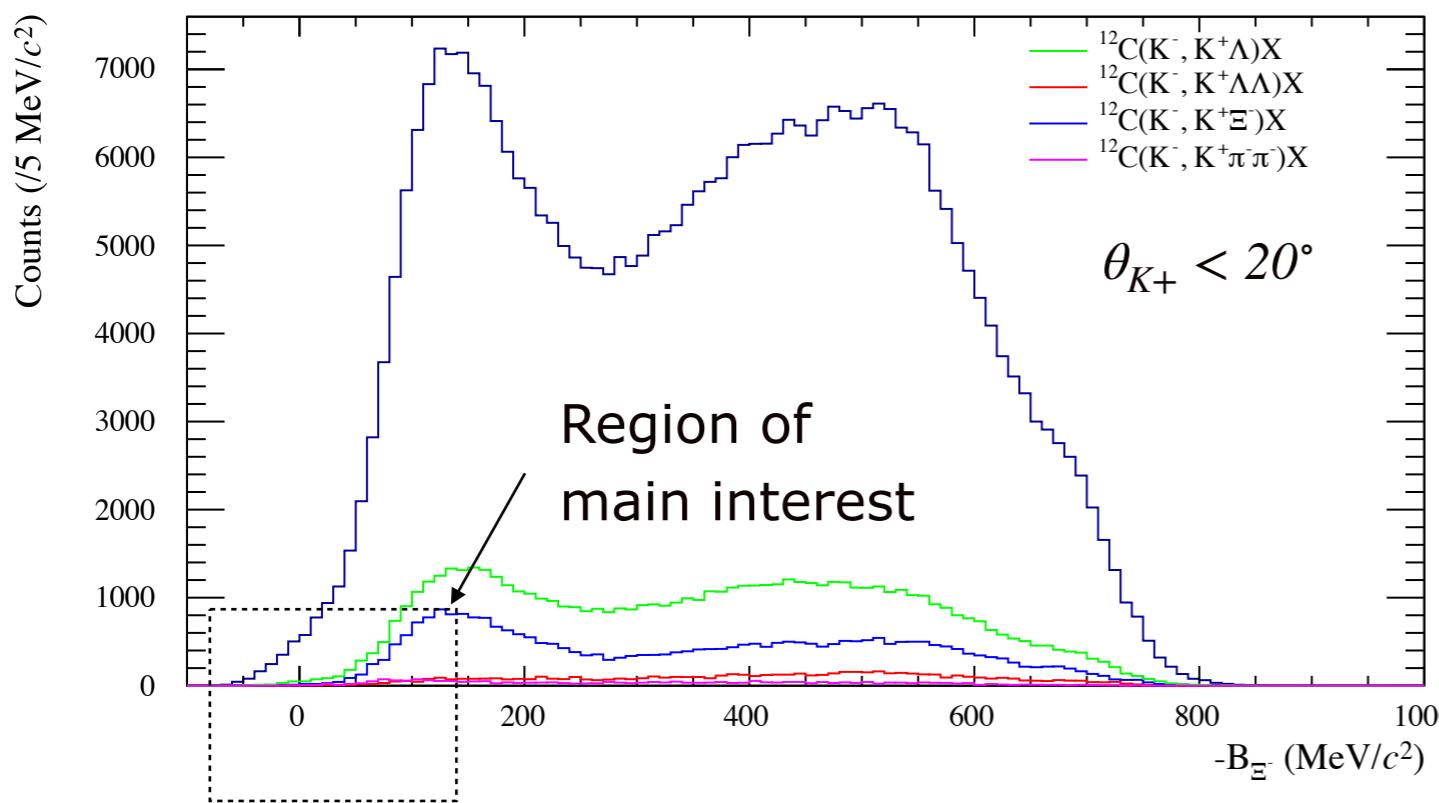
- $\Xi^- \rightarrow \Lambda \pi^-$ decays are reconstructed by the HypTPC by requiring $|m_{\Xi} - M_X| < 0.2 \text{ GeV}/c^2$

Reconstructed invariant-mass

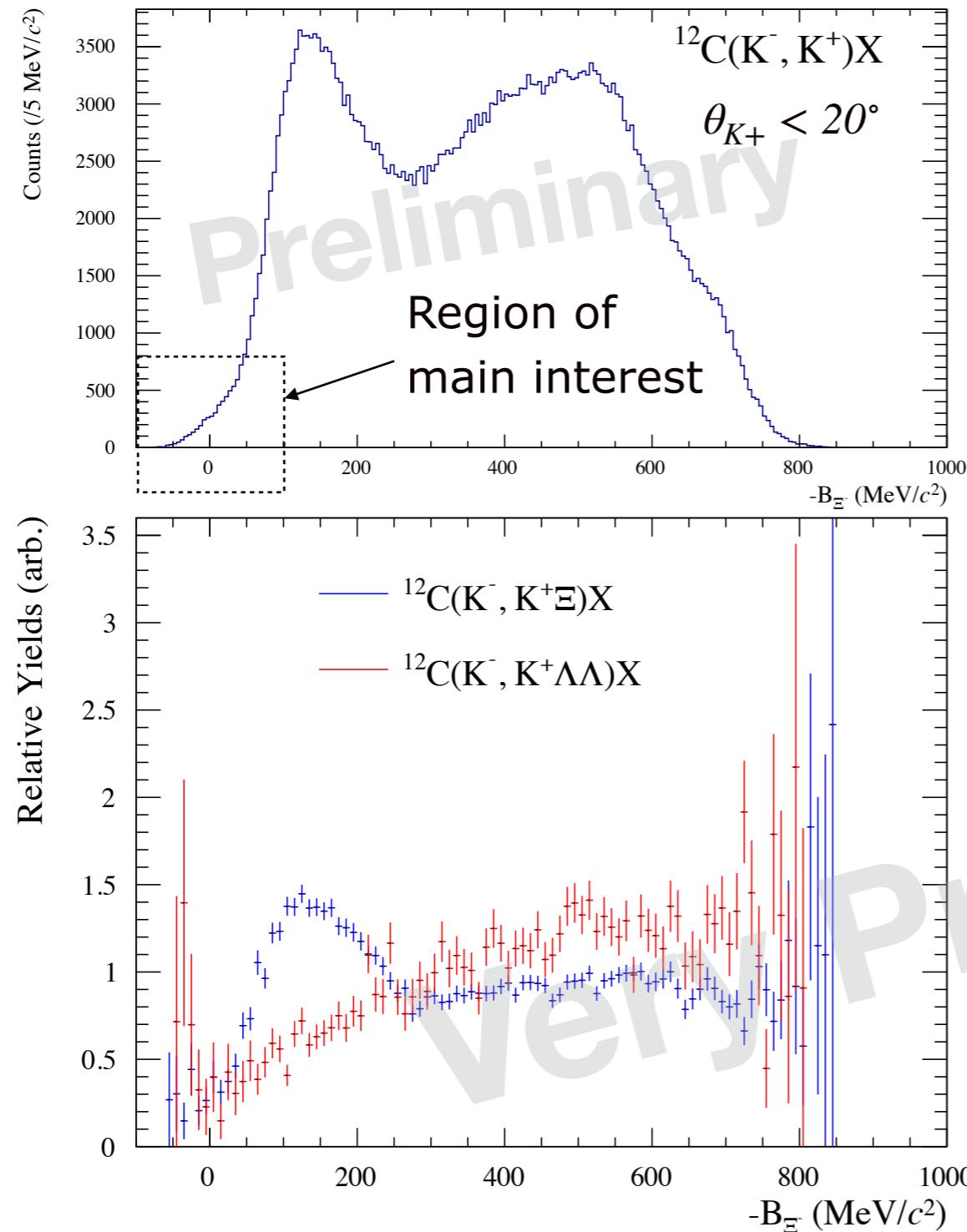


Preliminary Binding-energy Spectra Relative to $\Xi^- + {}^{11}\text{B}$ system

- $B_{\Xi^-} = \mathbf{M}_X - \mathbf{M}(\Xi^-) - \mathbf{M}({}^{11}\text{B})$ where $\mathbf{M}_X : {}^{12}\text{C}(K^-, K^+)X$
- Inclusive spectrum decomposed into each reaction.

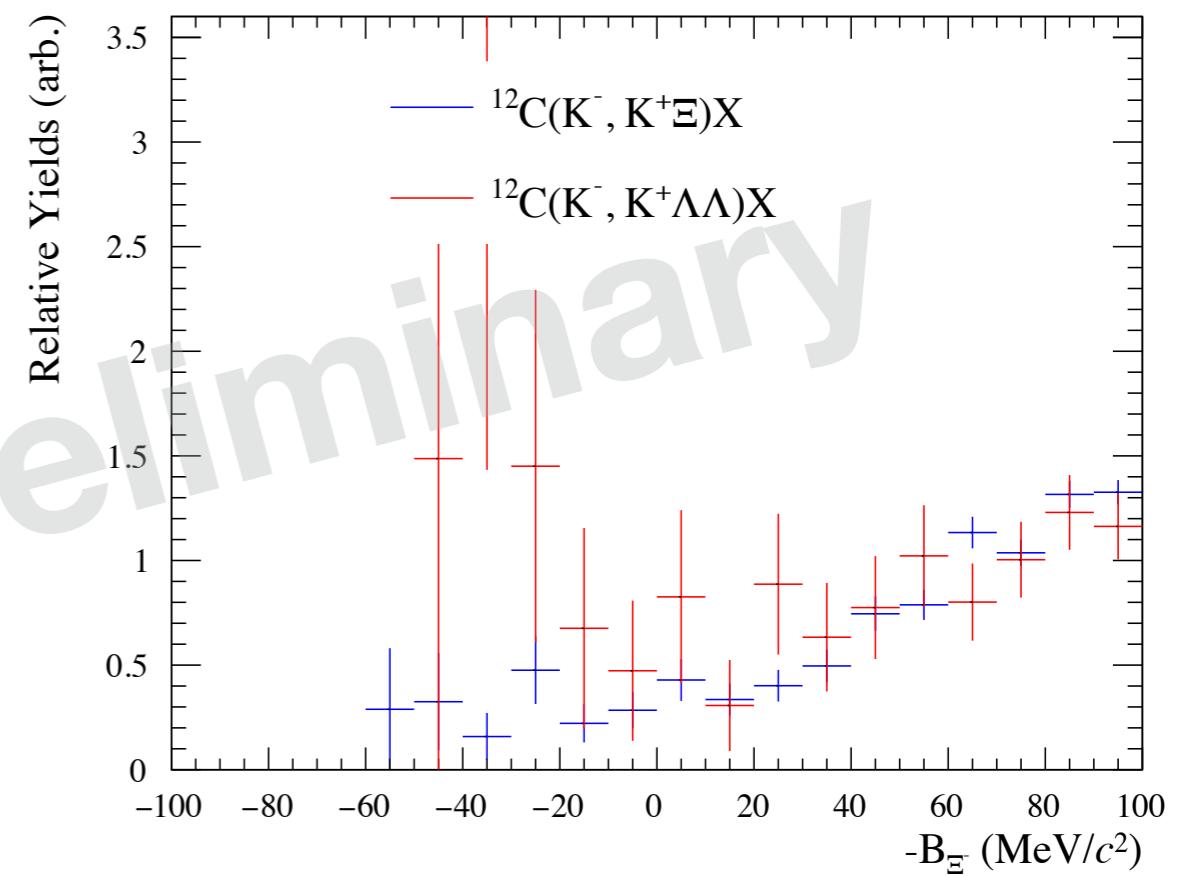


Preliminary Relative Yield Spectrums of $^{12}\text{C}(K^-, K^+)X$ reactions

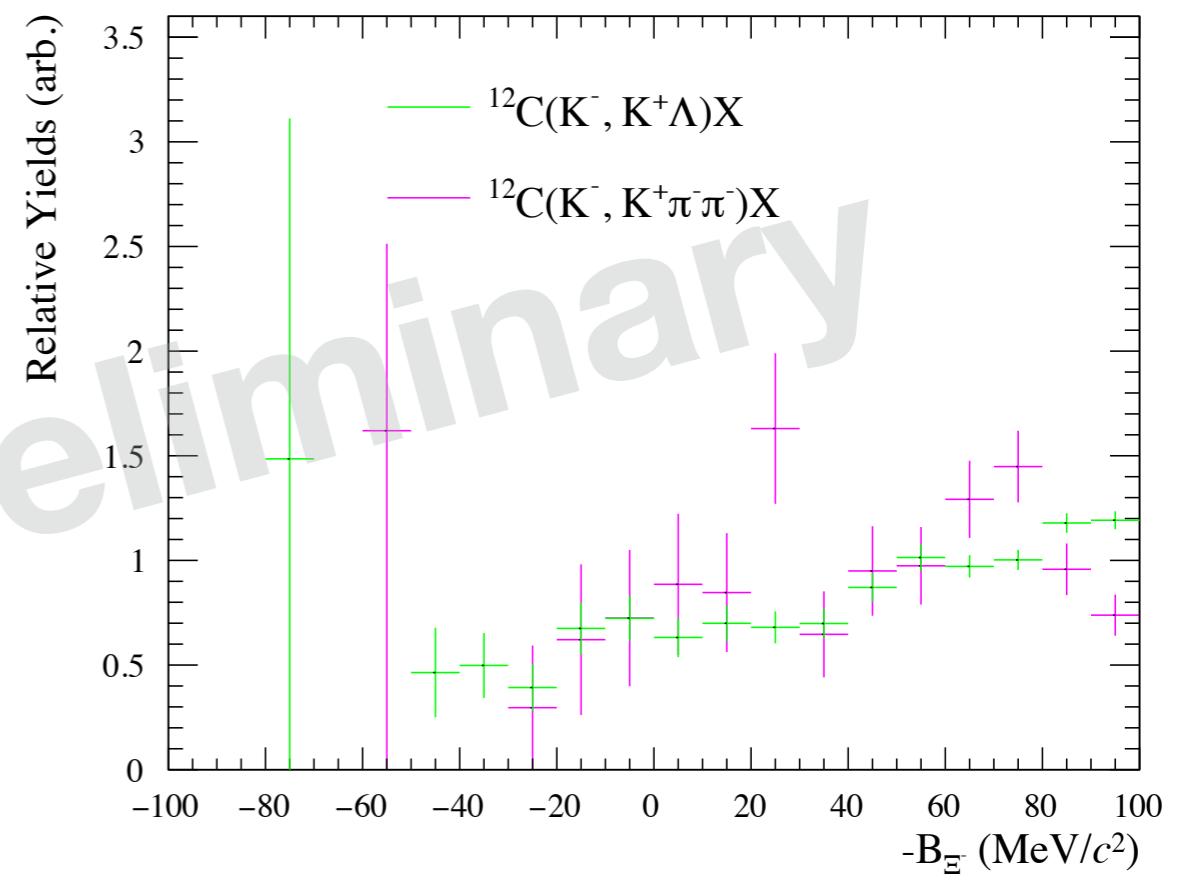
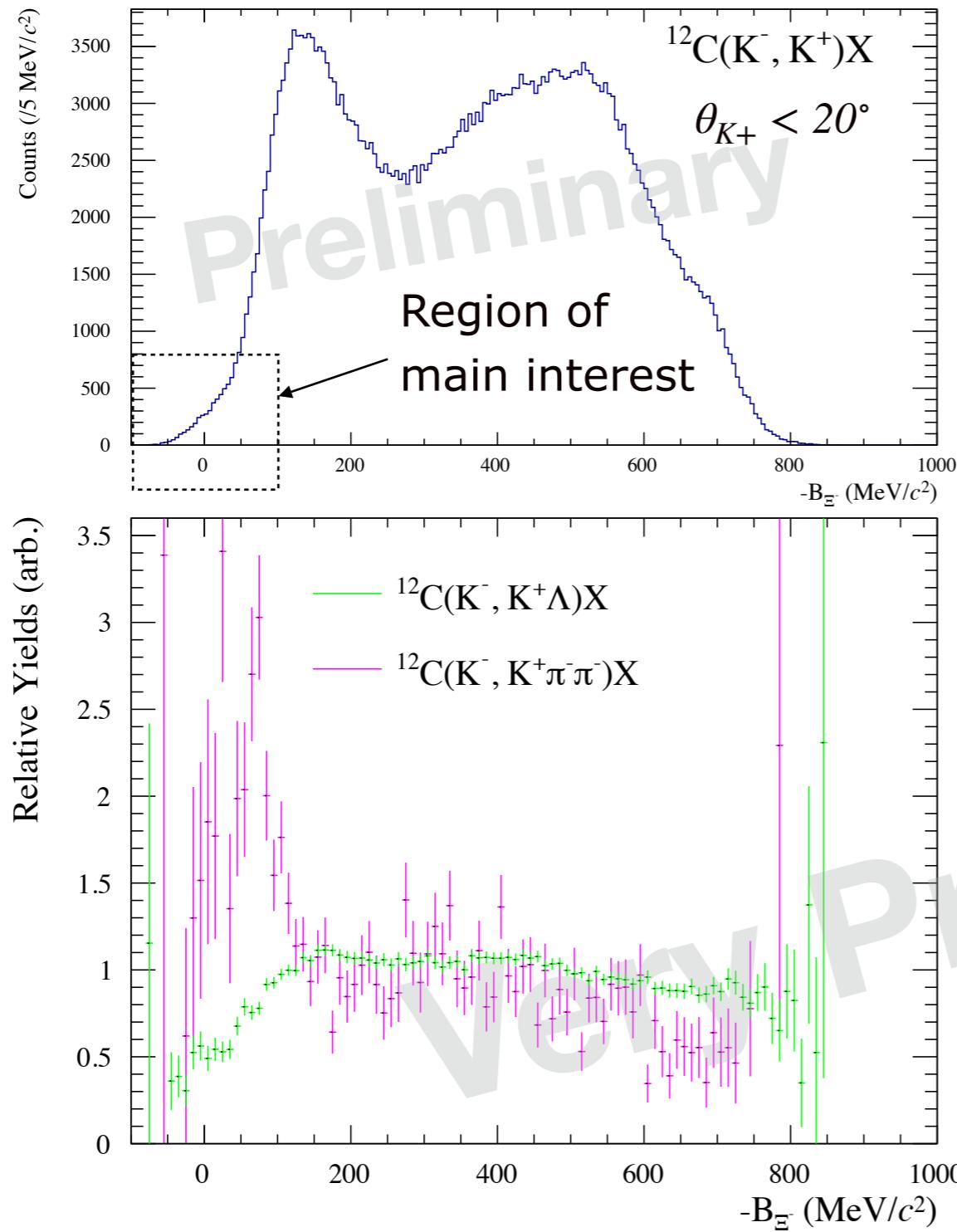


Relative yields of

- Escaping Ξ^-
- $\Xi^- p \rightarrow \Lambda\Lambda$ conversion process



Preliminary Relative Yield Spectrums of $^{12}\text{C}(K^-, K^+)X$ reactions

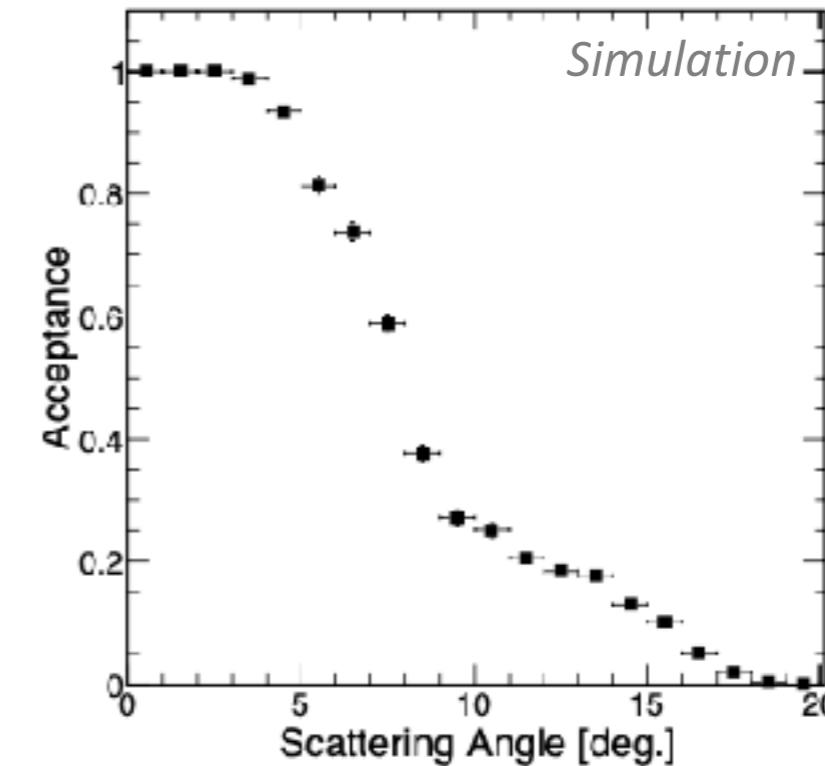
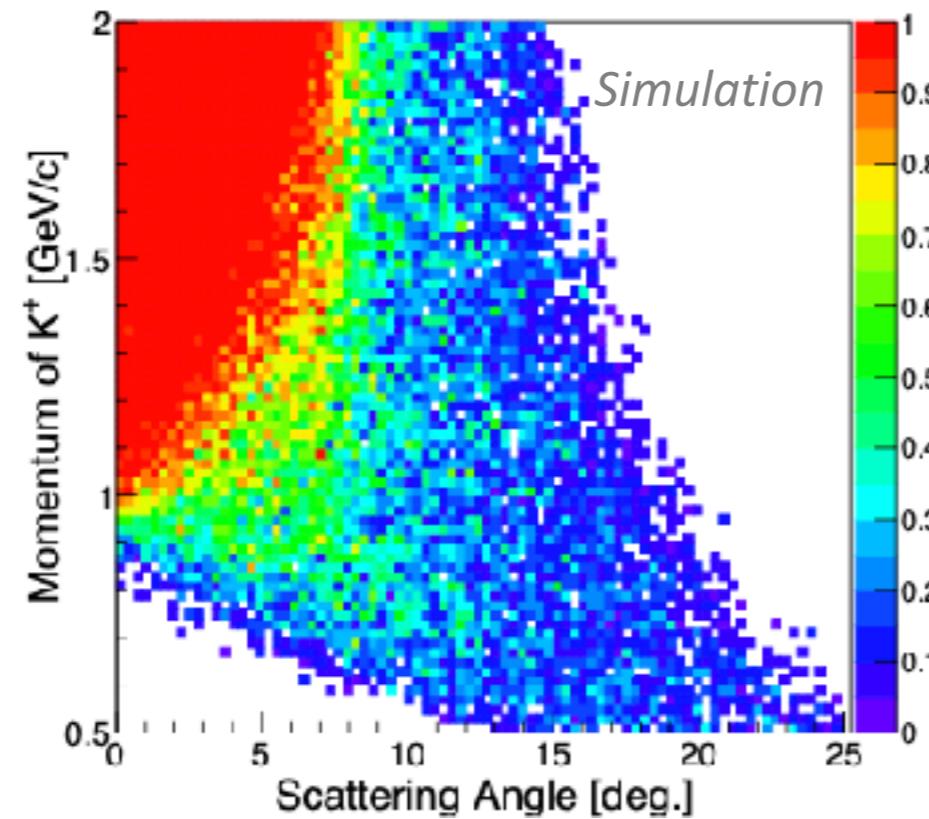


Summary

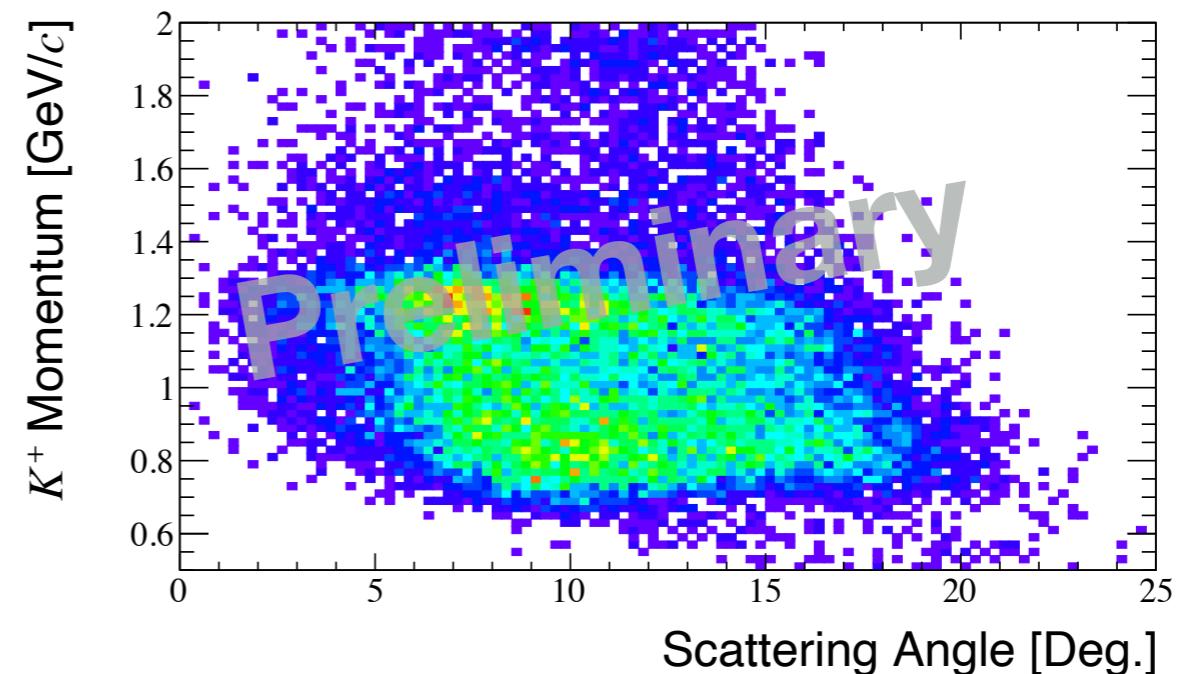
- J-PARC E42 is searching the H-dibaryon via $^{12}\text{C}(K^-, K^+)$ reaction.
We collected approximately **0.3M (K^-, K^+) reaction events**.
- Recent theoretical study to determine **Ξ^- nucleus potential** indicates that $W_{0\Xi}$ is not sensitive to inclusive $^{12}\text{C}(K^-, K^+)X$ missing-mass spectrum.
- E42 can decompose **$\Xi^- p \rightarrow \Lambda\Lambda$ conversion** spectrum from the $^{12}\text{C}(K^-, K^+)X$ inclusive missing-mass spectrum. So E42 has high sensitivity for **$W_{0\Xi}$ determination**.
- E42 data analysis is on-going. We hope to finalize and show preliminary analysis result soon.

Backup

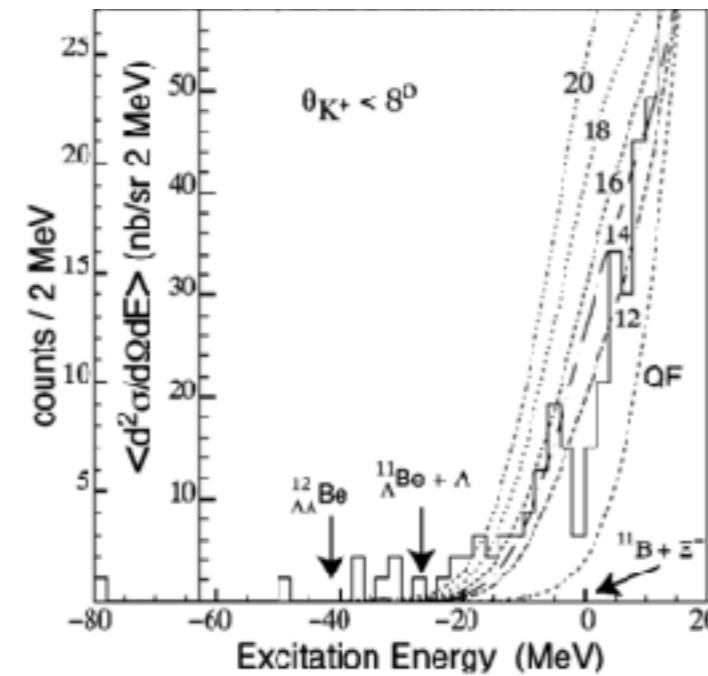
E42 Spectrometer Acceptance



- $\Delta\Omega(K^+) = 0.09 \text{ sr}$
- $0.5 \text{ GeV}/c < p_{K^+}$

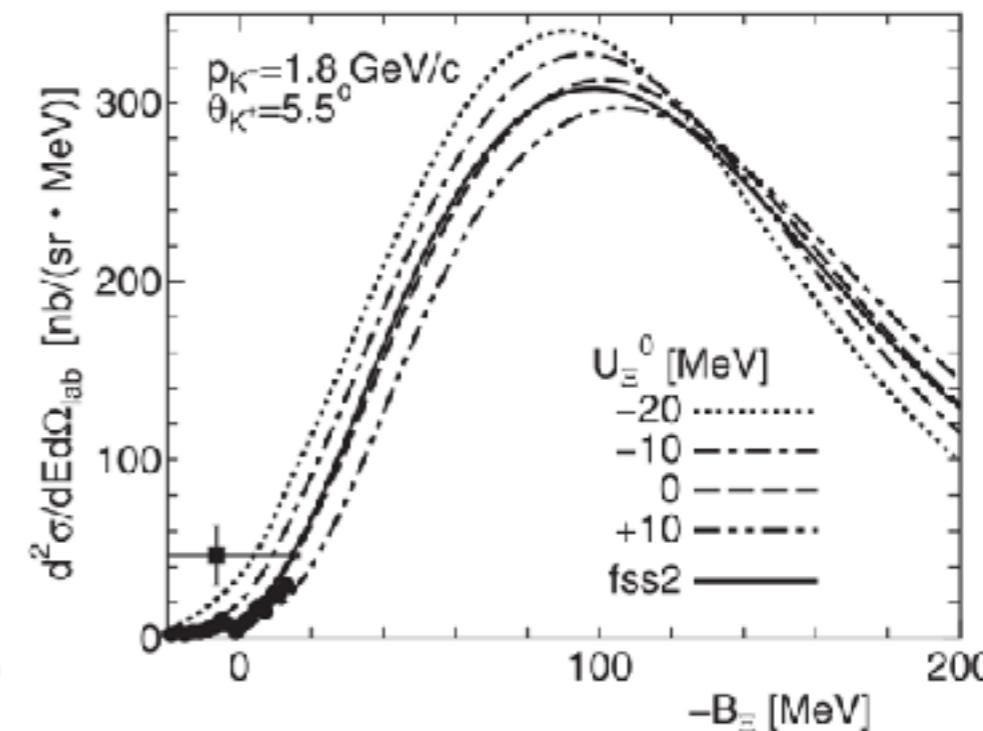
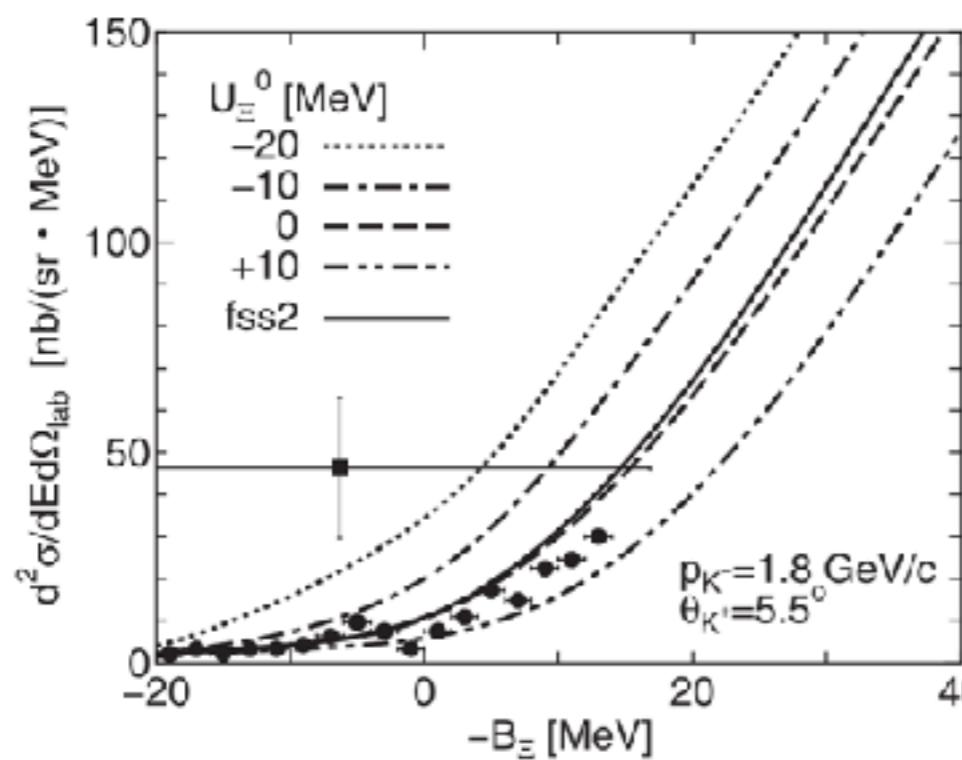


Reinvestigation of the Ξ^- -nucleus potential using the past data



M.Kohno-san's study

SCDW model calculations
 $V_{0\Xi} \sim 0$ with $\Gamma/2=2$ MeV



*M. Kohno and S. Hashimoto, Prog. Theor. **123**, (2010).