

# φ中間子工場における K中間子の深い束縛状態の探索 (7)

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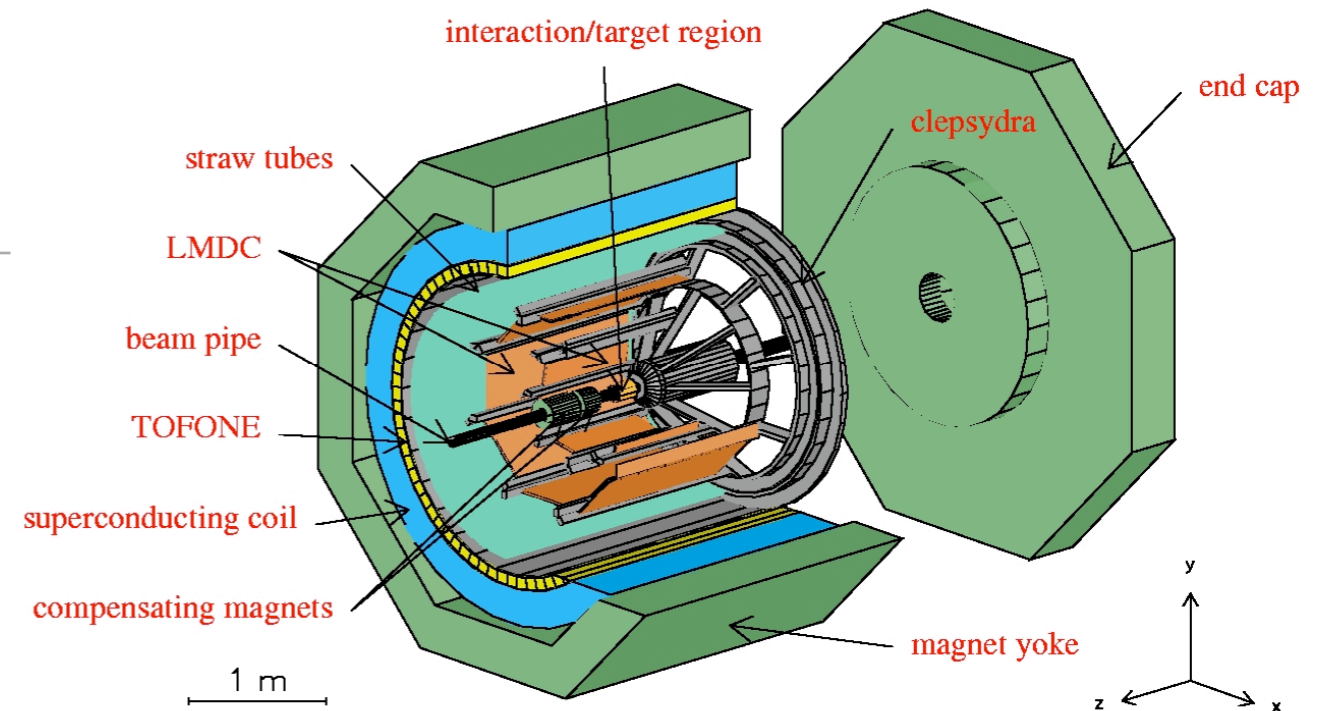
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豊田 晃久, 丸田 朋史, 中嶋 大輔

(on behalf of FINUDA Collaboration)

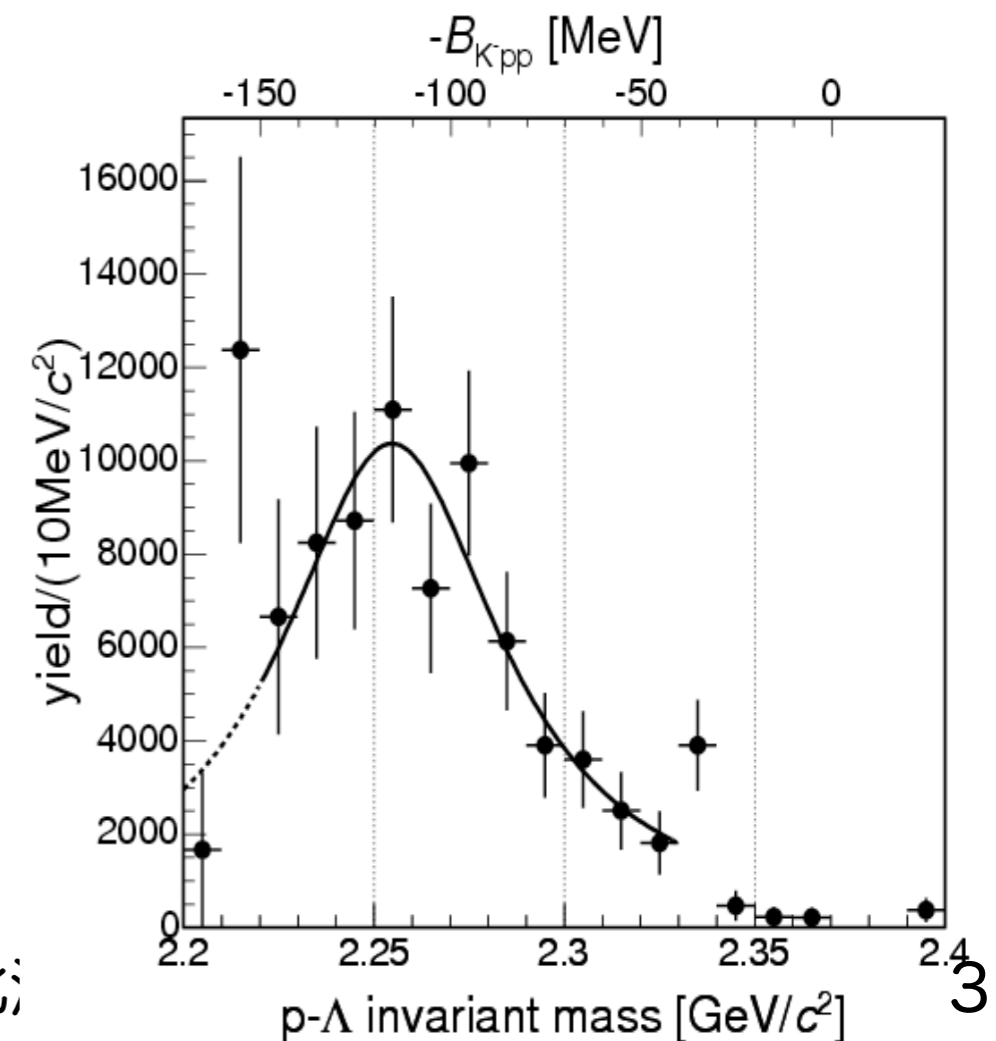
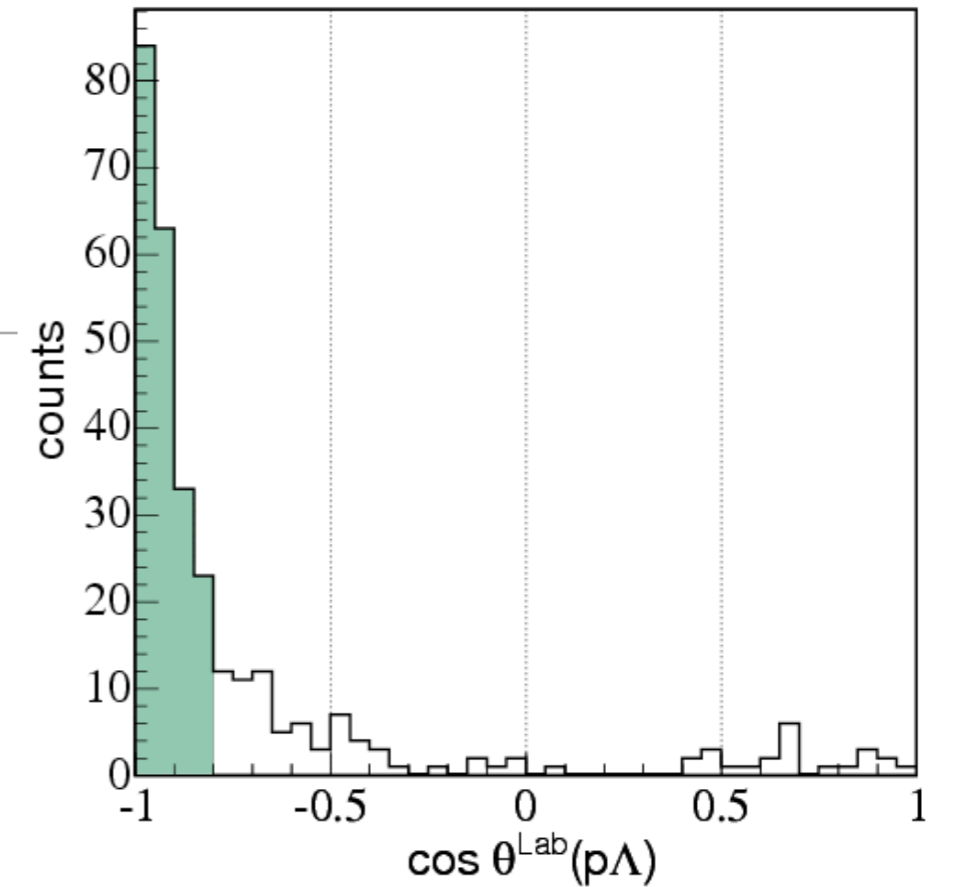
# FINUDA experiment

- $\Lambda$ -hypernuclear spectroscopy
- stopped  $K^-$  reaction
  - $\varphi(1020) \rightarrow K^+K^-$  ( $E_K=16\text{MeV}$ ) from DAΦNE
- ${}^6\text{Li}$ ,  ${}^7\text{Li}$ ,  ${}^{12}\text{C}$ , ( ${}^{27}\text{Al}$ ,  ${}^{51}\text{V}$ ) targets in 2003-2004
- large acceptance spectrometer
  - charged particle ( $\Delta p/p\text{FWHM}\sim 0.6\%$ )
  - neutral particle (by external TOF counters)



# RUN-I $\Lambda p$ data

- Sum of  $^6\text{Li}$ ,  $^7\text{Li}$ ,  $^{12}\text{C}$  data
- The invariant-mass of back-to-back  $\Lambda$ - $p$  pairs are much smaller than the threshold ( $K^- + 2p$ ) of  $2.37\text{GeV}/c^2$ .
- Evidence for  $K^-pp$  bound states?
- PRL 94 (2005) 212303.  
 $B = 115^{+6+3}_{-5-4} \text{ MeV}$   
 $\Gamma = 67^{+14+2}_{-11-3} \text{ MeV}$



# Criticisms to the PRL paper

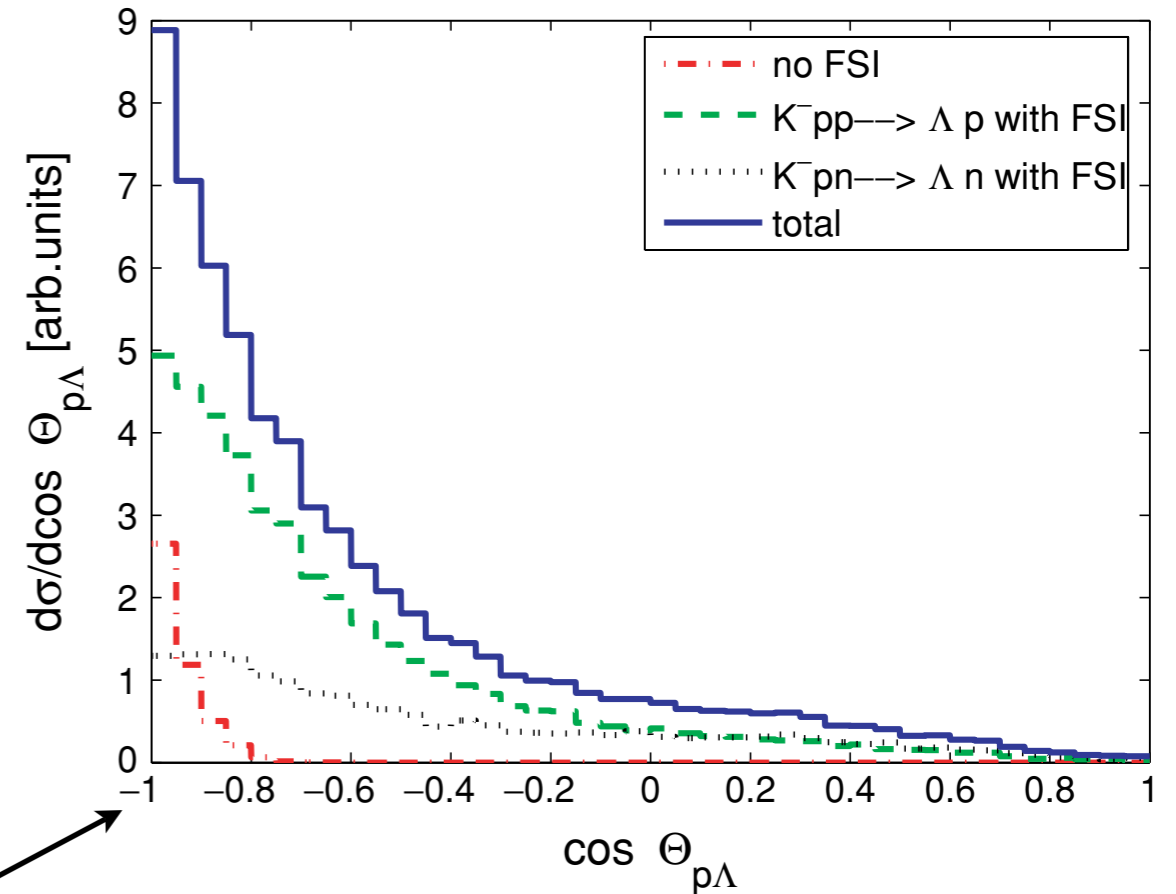
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- Kaon two-nucleon absorption ( $K^- + \text{“pp”} \rightarrow \Lambda + p$  or  $\Sigma^0 + p$ )
  - Contribution of the  $\Sigma^0 + p$  channel
  - Final state interaction affected the spectrum.  
(Magas *et al.*, PRC 74 (2006) 025206)
- Decay of heavier nuclei ( ${}^6\text{Li}K^-$ ,  ${}^{12}\text{C}K^-$ )  
(Mareš *et al.*, NPA 770 (2006) 84)
- Is the spectrum target-dependent or not? If not, the  $K^-pp$  interpretation may be favored.

# 2N absorption+FSI

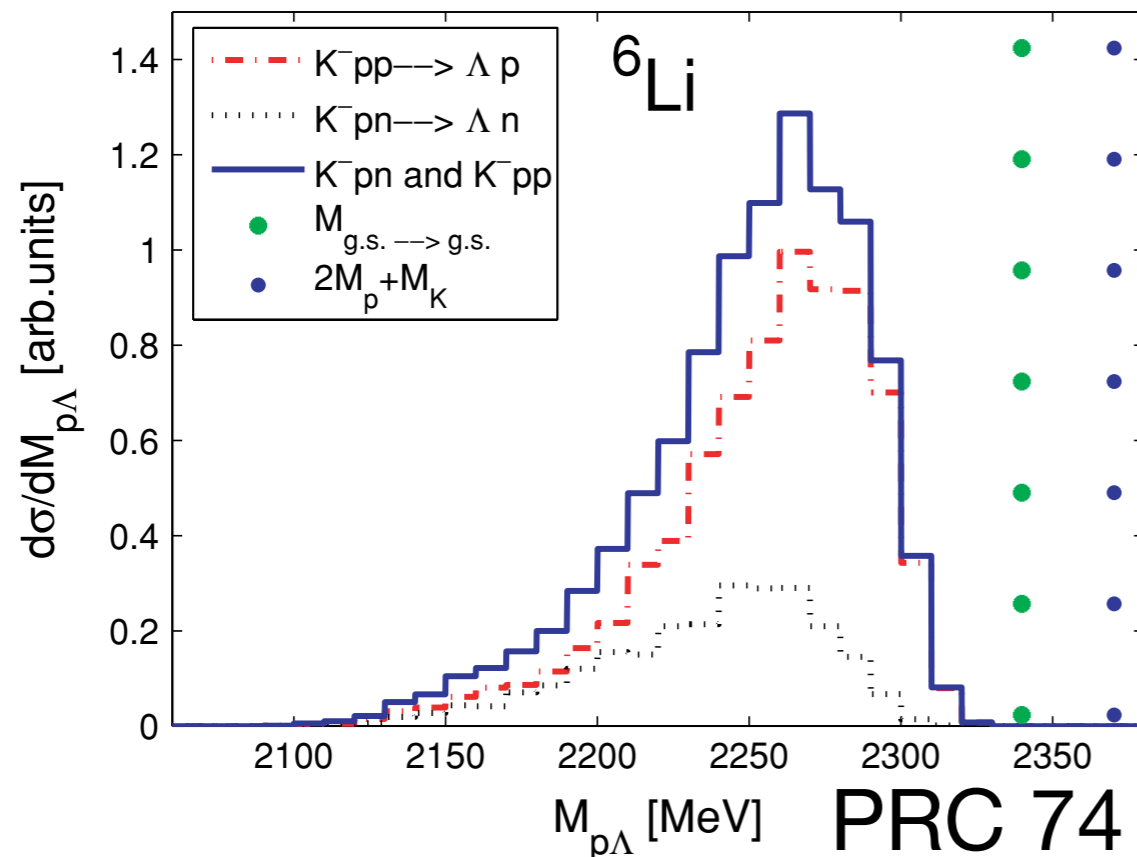
- Back-to-back correlation is loosened after FSI.
- The invariant-mass spectrum has A-dependence.

$P_{\Lambda} > 300 \text{ MeV}$

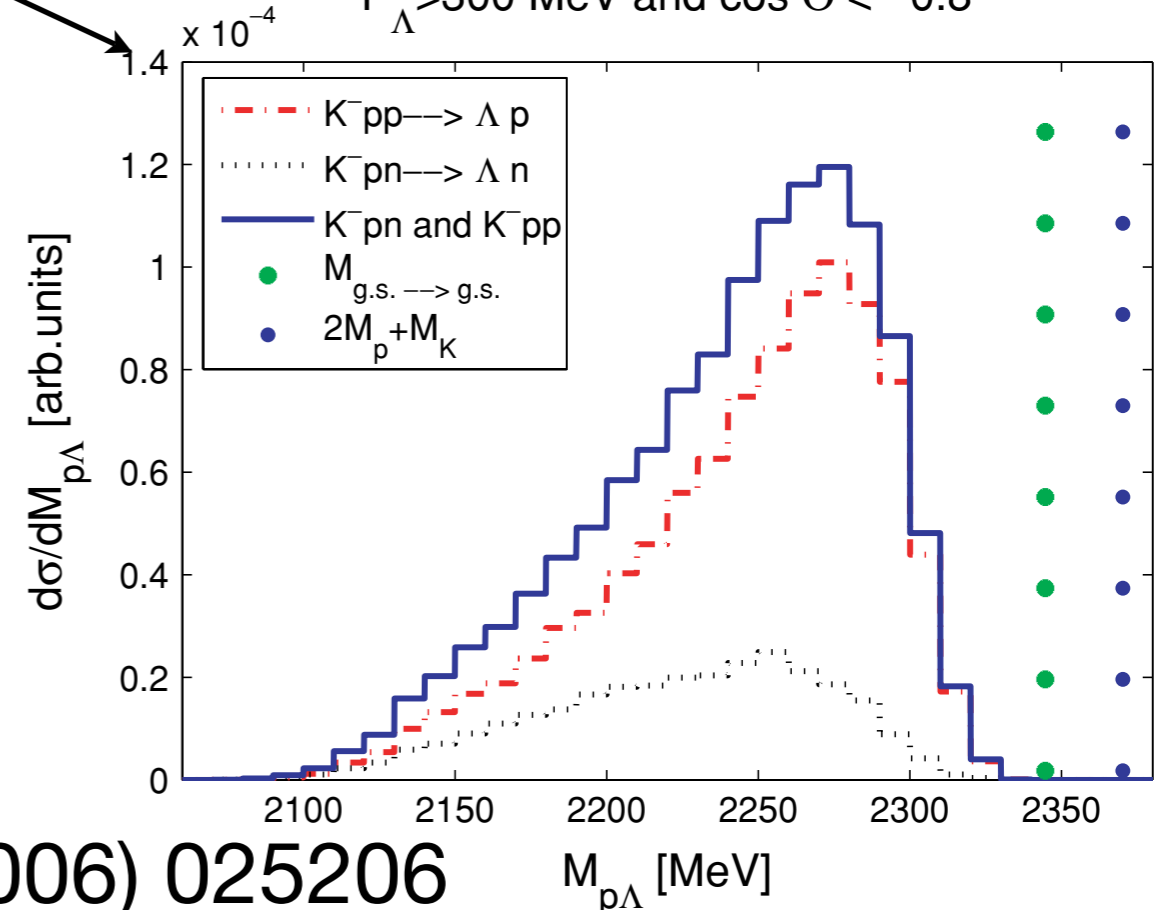


$^{12}\text{C}$

$P_{\Lambda} > 300 \text{ MeV}$  and  $\cos \Theta < -0.8$



$P_{\Lambda} > 300 \text{ MeV}$  and  $\cos \Theta < -0.8$



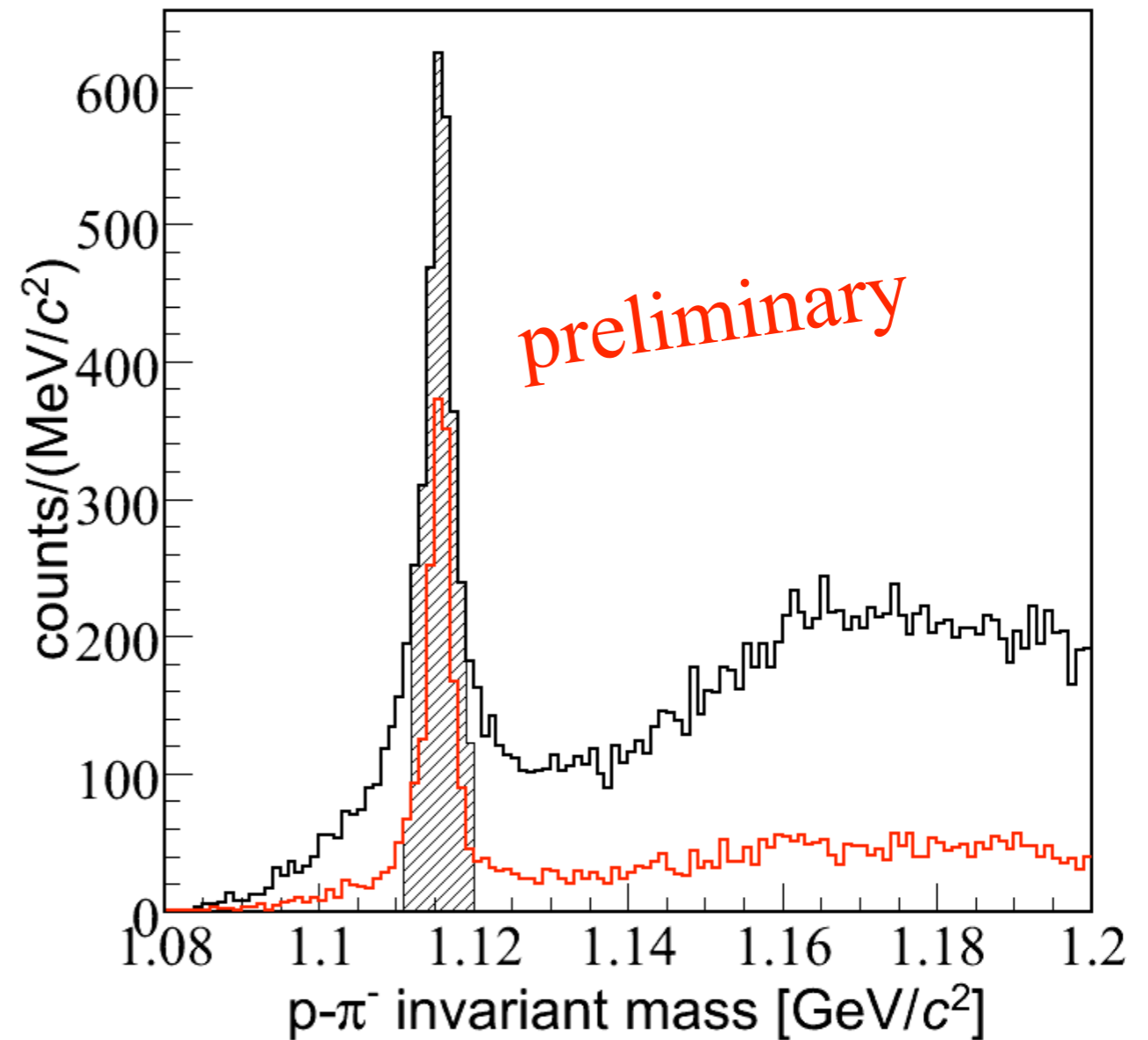
# From Run-I to Run-II

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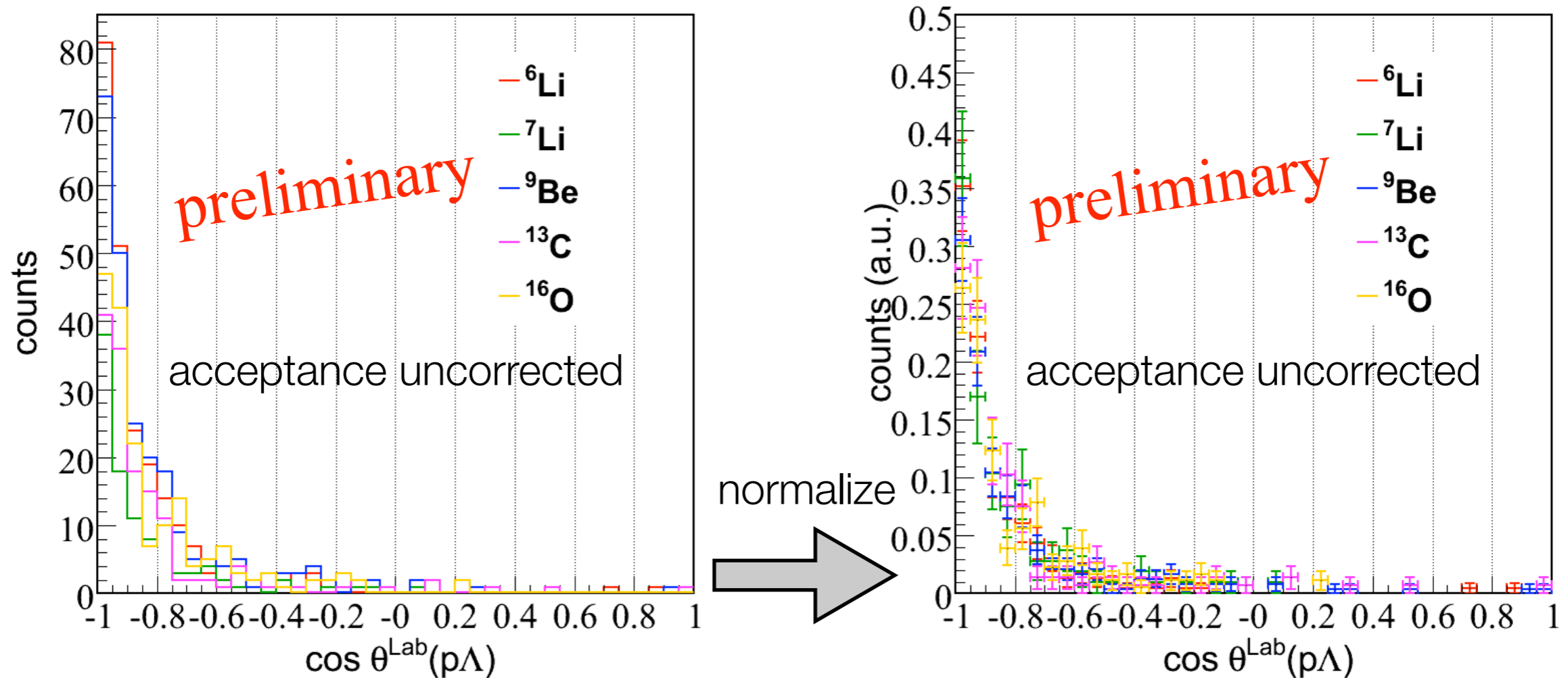
- RUN-I ( $\sim 220\text{pb}^{-1}$ ) [Oct/2003 - Mar/2004]
  - ${}^6\text{Li}$  x2,  ${}^7\text{Li}$  x2,  ${}^{12}\text{C}$  x3,  ${}^{27}\text{Al}$ ,  ${}^{51}\text{V}$
- RUN-II ( $\sim 960\text{pb}^{-1}$ ) [Oct/2006 - Jun/2007]
  - ${}^6\text{Li}$  x2,  ${}^7\text{Li}$  x2,  ${}^9\text{Be}$  x2,  ${}^{13}\text{C}$ ,  $\text{D}_2\text{O}$
- $\sim 10$  times more data from light nuclei are expected.
- Separated spectra will be obtained with enough events.

# $\Lambda$ detection

- $\sigma \sim 2.0 \text{ MeV}/c^2$  (preliminary)  
 $|M(p\pi) - M_\Lambda| < 4 \text{ MeV}/c^2$
- Secondary Vertex Cut  
(z-tolerance  $< 1 \text{ mm}$ )  
S/N  $2.3 \rightarrow 5.9$



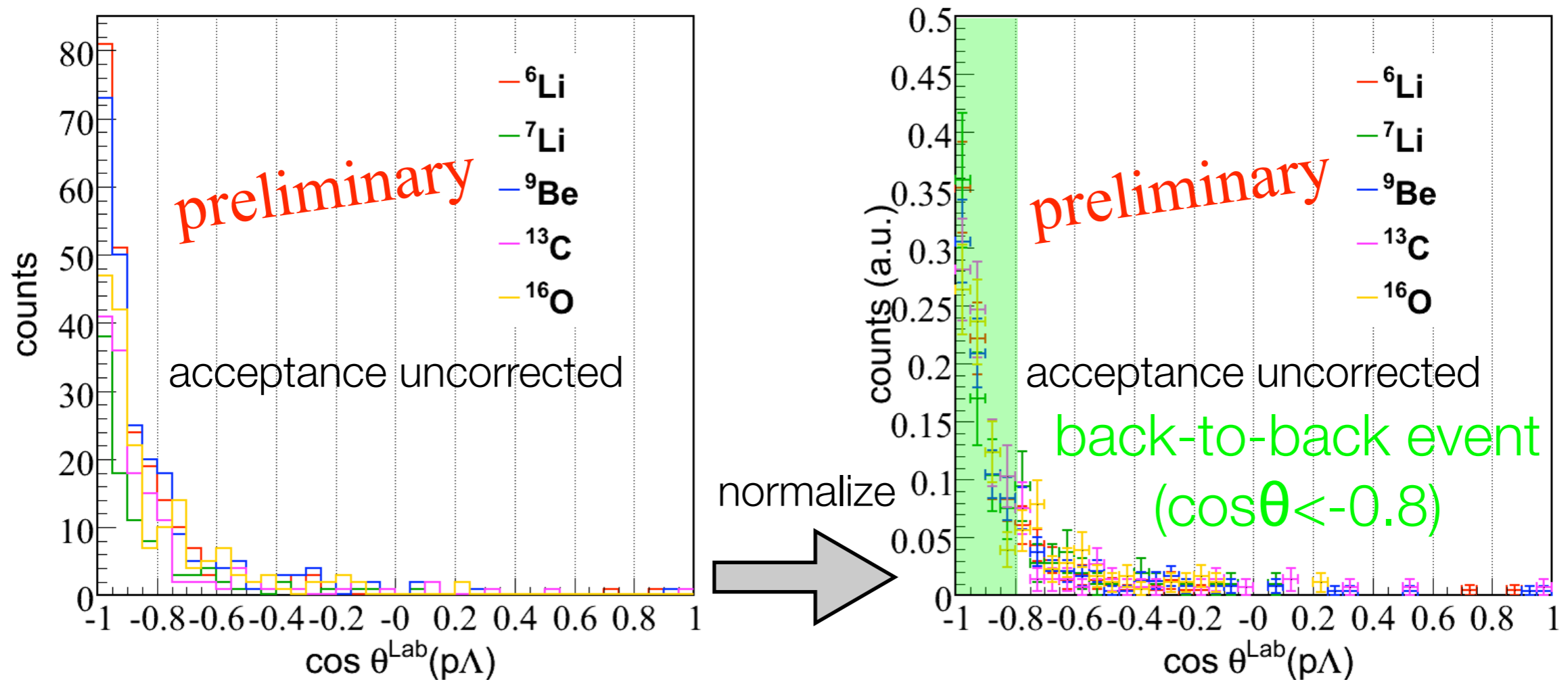
# Angular correlation between $\Lambda$ and proton



- The angular distribution for each p-shell nuclear target looks similar to each other within statistical errors.

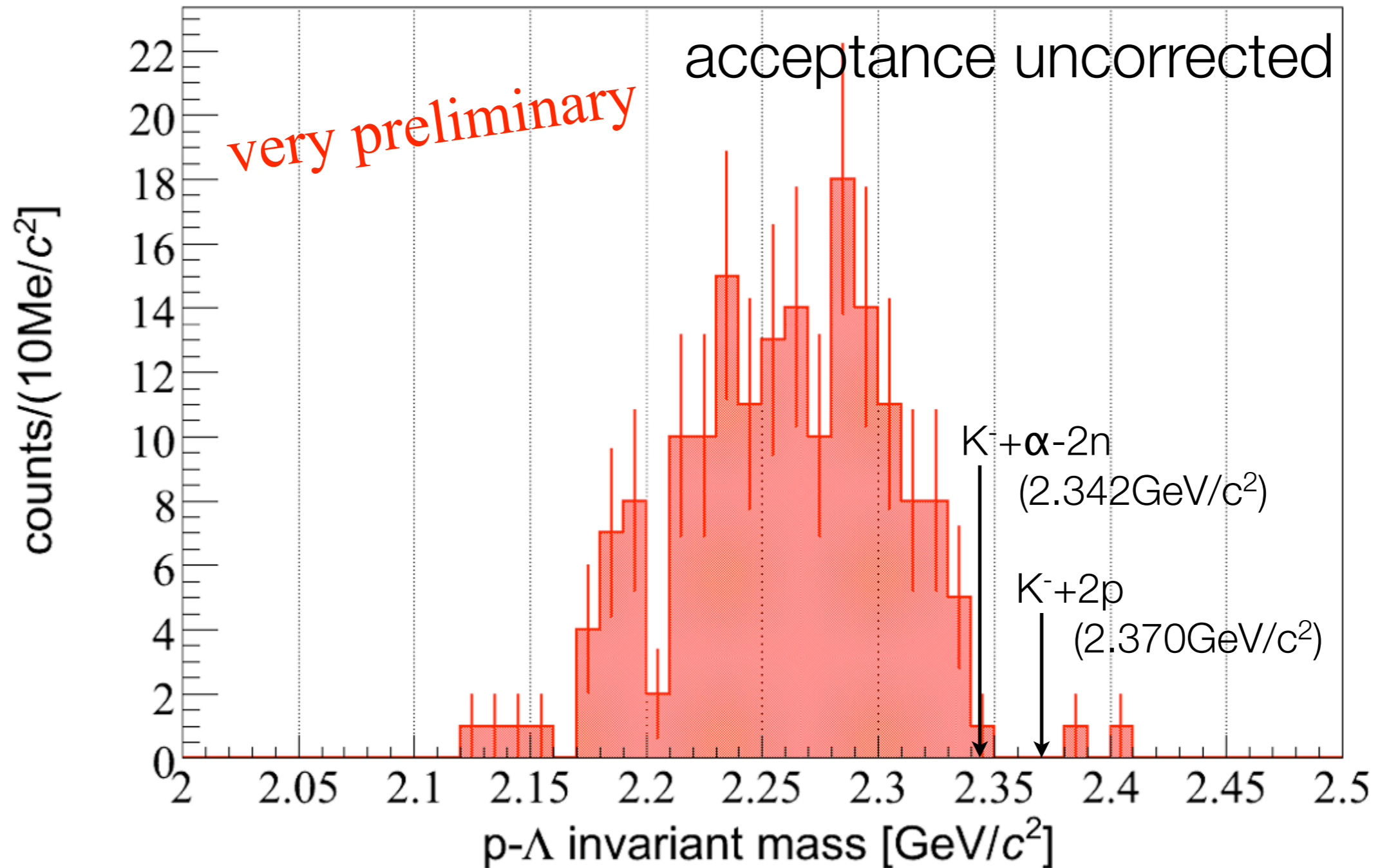


# Angular correlation between $\Lambda$ and proton

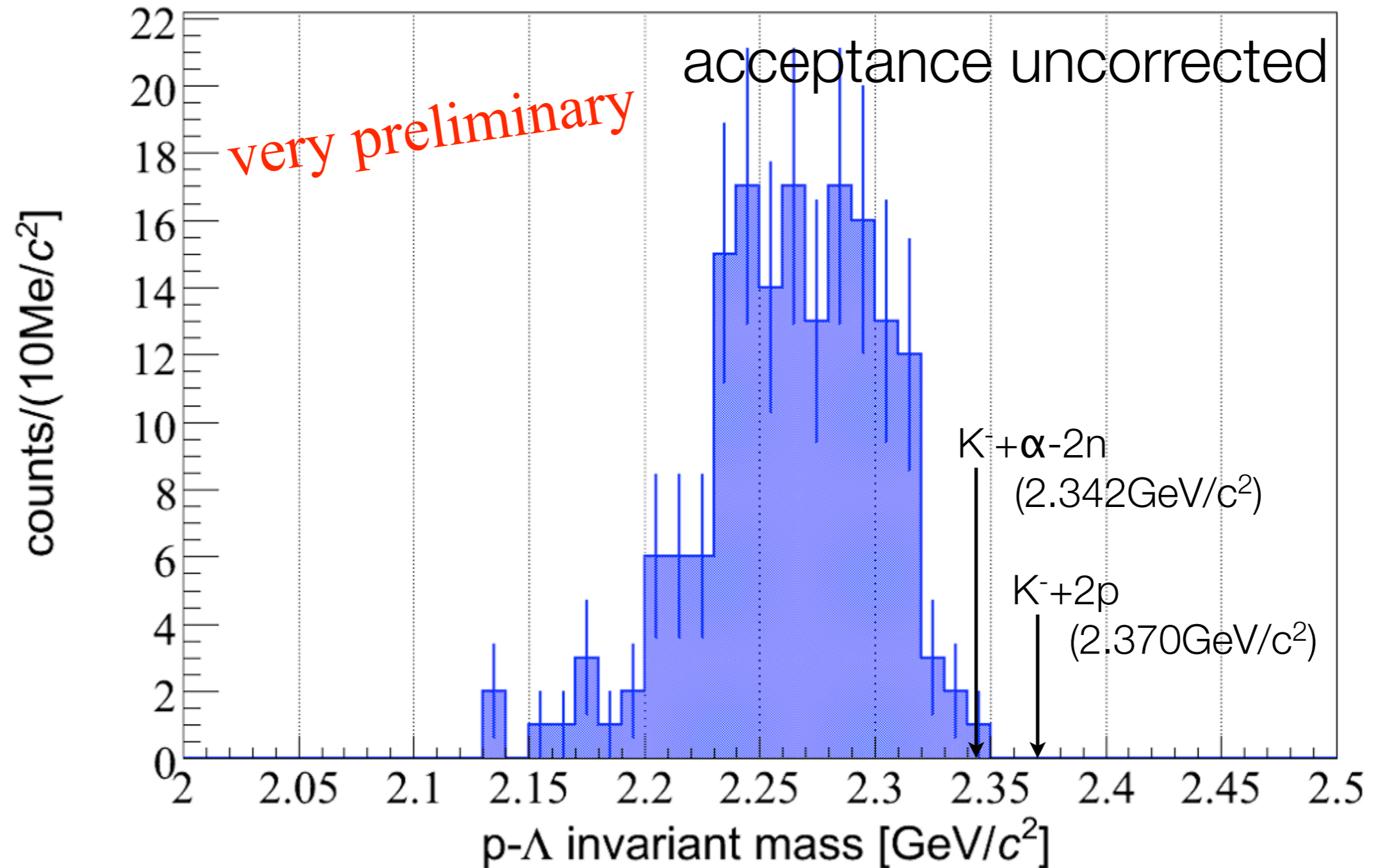


- The angular distribution for each p-shell nuclear target looks similar to each other within statistical errors.

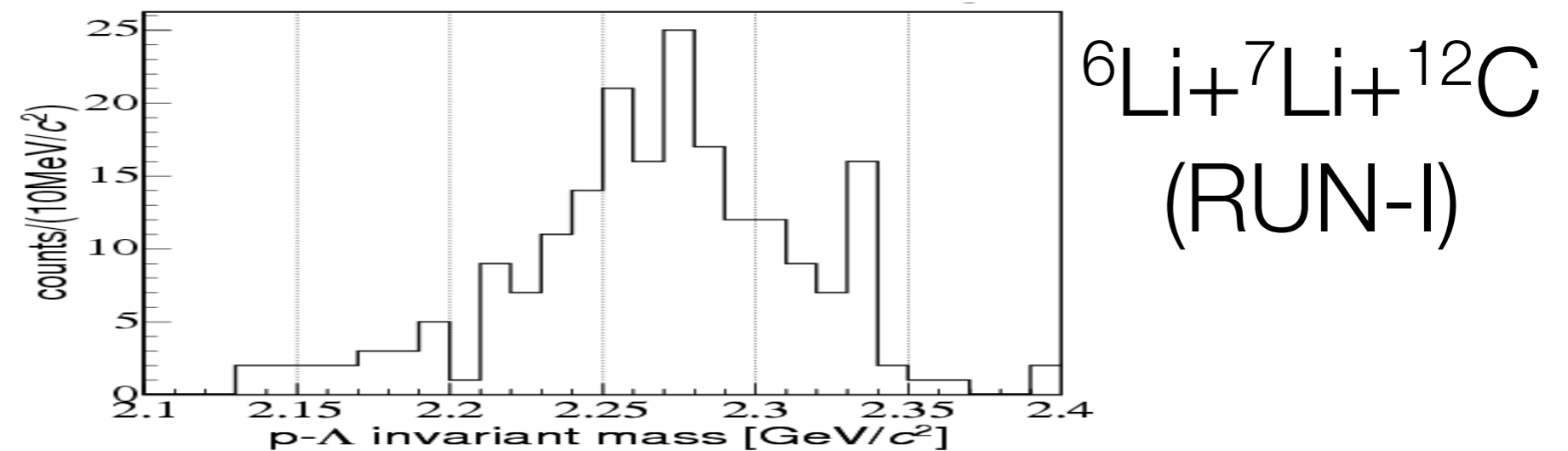
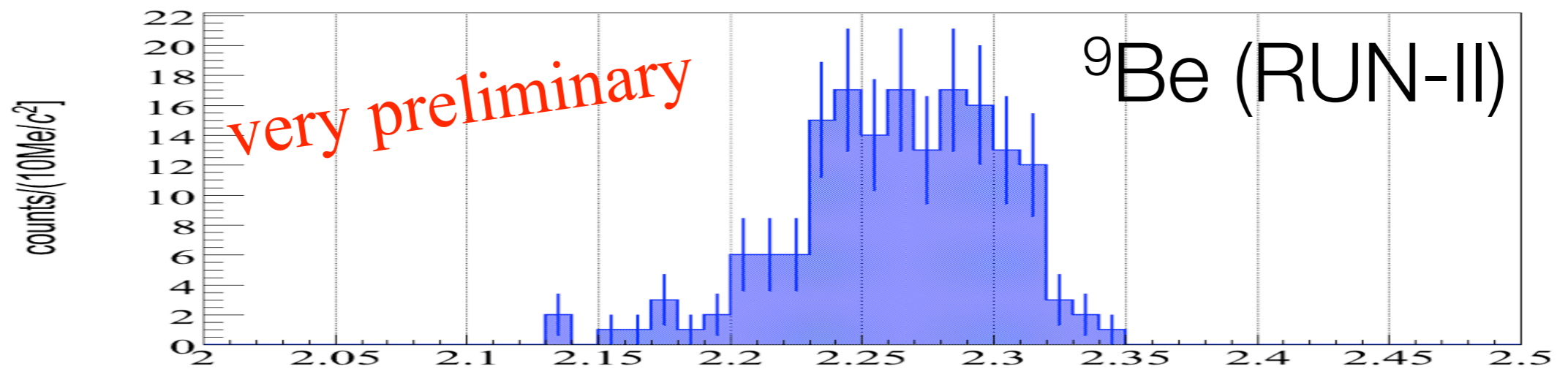
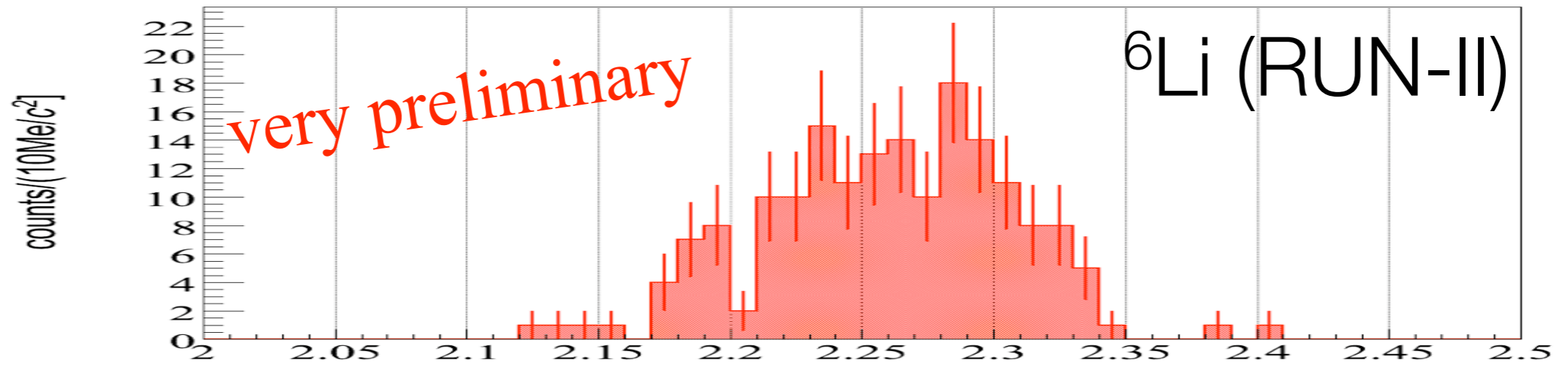
# Invariant-mass spectrum for the ${}^6\text{Li}$ target



# Invariant-mass spectrum for the ${}^9\text{Be}$ target



# Comparison with RUN-I and RUN-II



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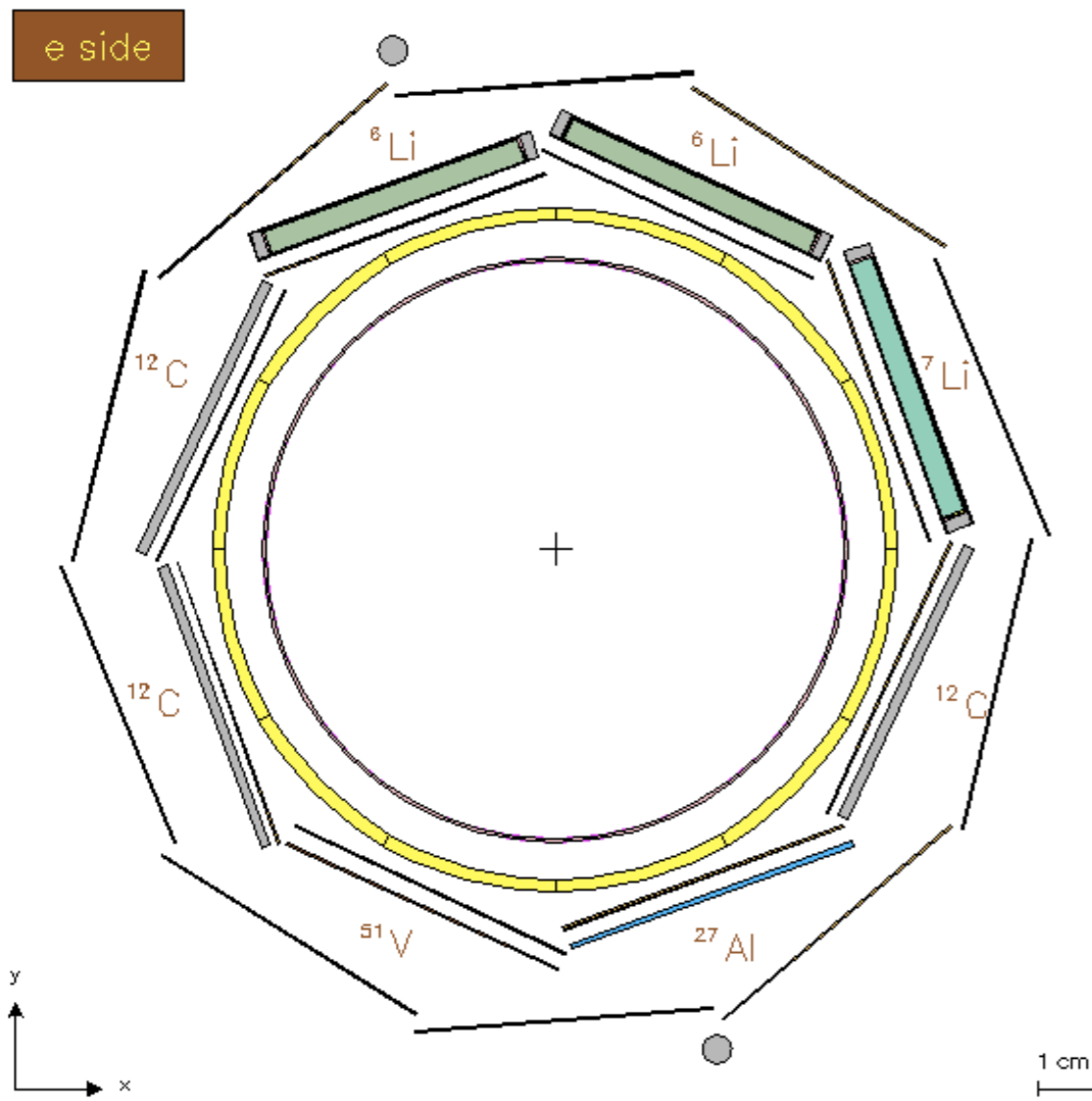
# Summary and Perspective

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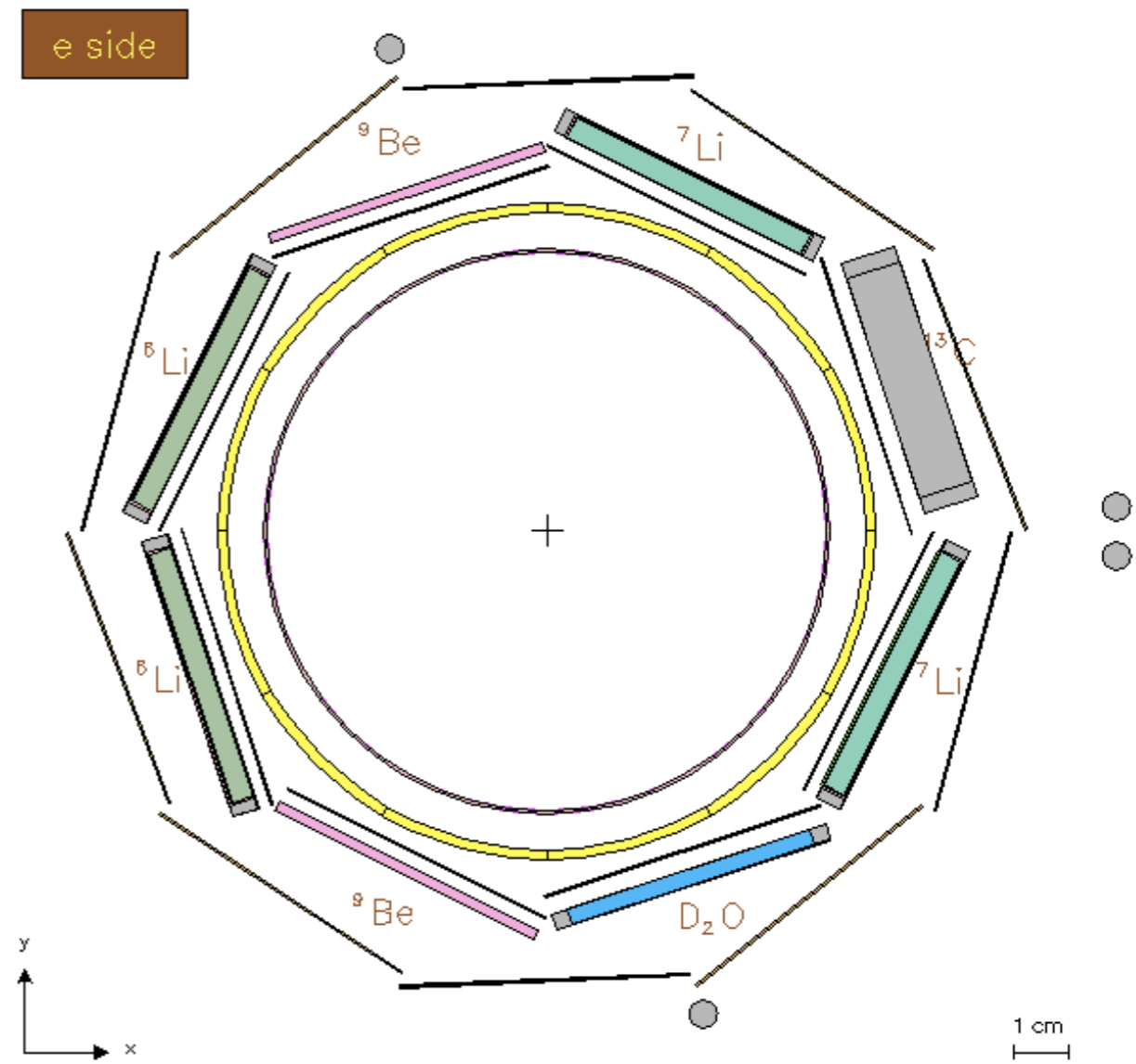
- We observed strong back-to-back correlation of  $\Lambda$ -p pairs from p-shell nuclei ( ${}^6\text{Li}$ ,  ${}^7\text{Li}$ ,  ${}^9\text{Be}$ ,  ${}^{13}\text{C}$ ,  ${}^{16}\text{O}$ ). They are similar to each other.
- The invariant mass spectrum for back-to-back events from  ${}^6\text{Li}$ ,  ${}^9\text{Be}$  shows a large mass shift ( $\sim 100\text{MeV}$ ) as seen in RUN-I.
- The study on acceptance correction is on-going.
- $K^- + \text{“pn”} \rightarrow \Lambda + n / \Sigma^- + p$  will also be studied.

# Target configuration

## RUN-I



## RUN-II



# Discussion

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- While the spectra are not corrected for the detector acceptance, the deformation due to the acceptance is similar for each target.
  - The detector system including the targets are axially symmetric.
- The spectra are similar to the one obtained in RUN-I ( ${}^6\text{Li} + {}^7\text{Li} + {}^{12}\text{C}$ ).
- Broad structure centered at around  $B_K \sim 100\text{MeV}$  (preliminary).