Study of $\Sigma\pi$ invariant mass spectrum in the $d(\gamma, K^+)X$ reaction

Atsushi Tokiyasu

for LEPS collaboration

ELPH, Tohoku University

Outline of my talk

J-PARC E27 experiment studied d(π^+, K^+)X reaction, and observed a 30 MeV shift in Y* region in the inclusive missing mass spectrum.
We studied d(γ, K^+)X reaction, but a significant shift was not observed in the inclusive missing mass spectrum.

To investigate the reason of this discrepancy, we identified the final state of X.

All of this work was performed in LEPS experiment at SPring-8.

Analysis techniques and results will be reported.

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To investigate the reason of this discrepancy, we identified the final state of X. ②

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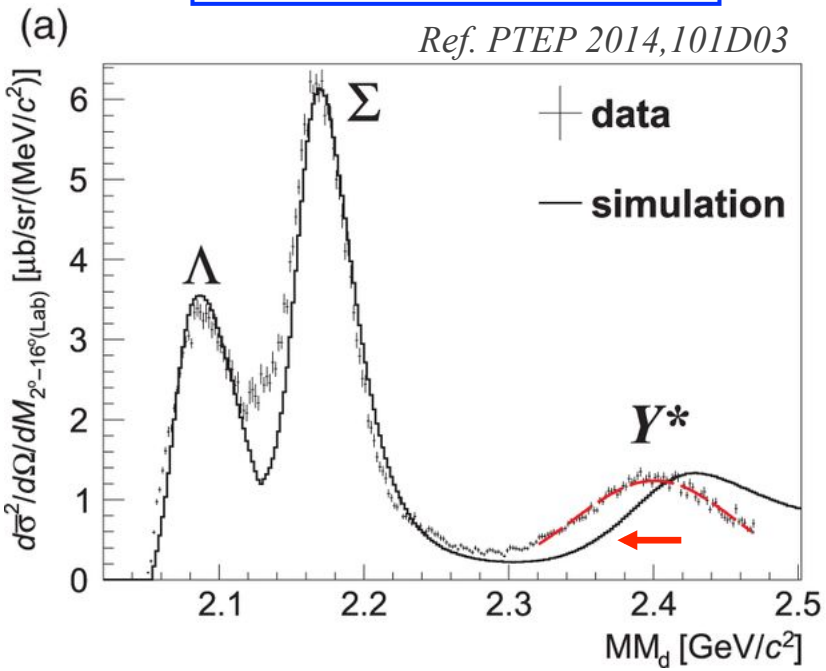
Outline of my talk

$\pi^+ + d \rightarrow K^+ + X$

MM(K^+) *J-PARC E27*

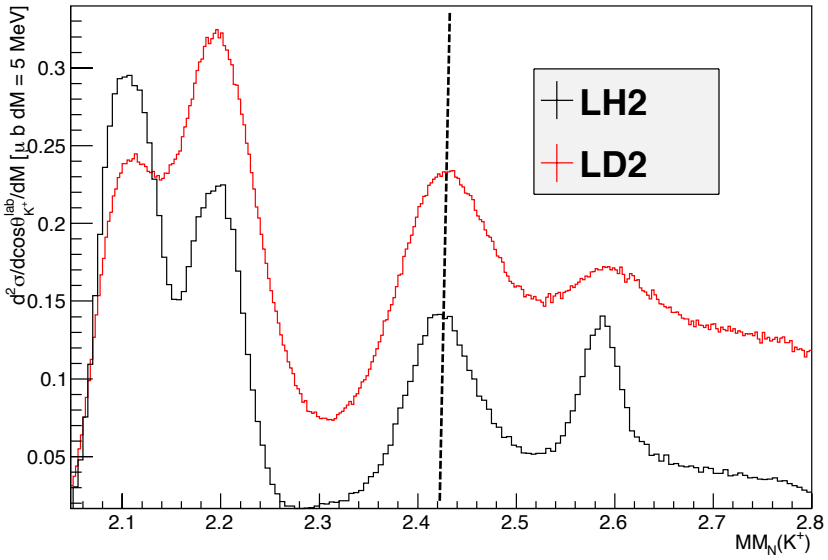


30 MeV shift was observed in Y* region

(caused by Y*N interaction?)

$\gamma + d \rightarrow K^+ + X$

MM(K^+) *LEPS*



no shift was observed in Y* region

Why is the shift not observed in photo-production case?

E27 v.s. LEPS result

	J-PARC/E27 $\pi^+ + d \rightarrow K^+ + X$	SPring-8/LEPS $\gamma + d \rightarrow K^+ + X$
momentum transfer	0.8 GeV/c	0.7 – 1.0 GeV/c
mass resolution	2 MeV/c^2	10 MeV/c^2
X (Λ^* / Σ^*)	1 / 3	1 / 10
	Ref. Nucl. Phys. B56, 15(1973)	*Ref. PRC.78,035202 (2008)*

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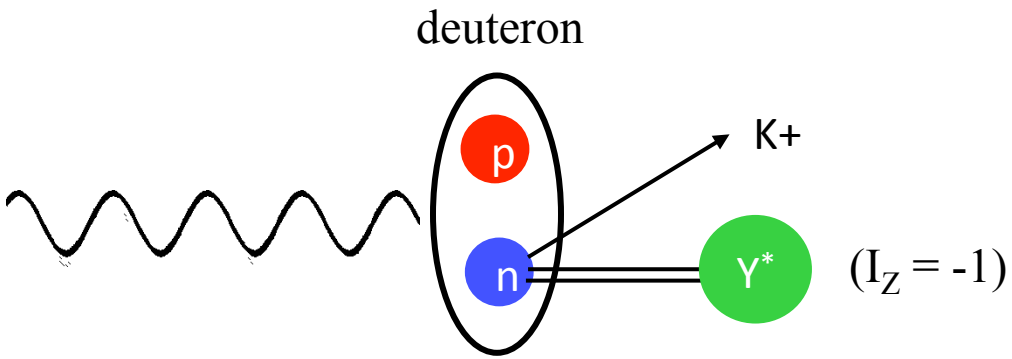
- We need to disentangle Λ*/Σ* contribution.
- Especially Λ*N final state is interesting.

$\gamma + N \rightarrow K^{+} + Y^{*}$



from proton target

$\Lambda(1405)$ $\Sigma\,(1385)^{0}$

from neutron target

$\Sigma\,(1385)^{-}$

$\gamma + N \rightarrow K^+ + Y^*$

from proton target

$\Lambda(1405)$
- $\rightarrow \Sigma^0 \ \pi^0$ (33 %)
- $\rightarrow \Sigma^+ \ \pi^-$ (33 %)
- $\rightarrow \Sigma^- \ \pi^+$ (33 %)

$\Sigma(1385)^0$
- $\rightarrow \Lambda \ \pi^0$ (88 %)
- $\rightarrow \Sigma^- \ \pi^+$ (6 %)
- $\rightarrow \Sigma^+ \ \pi^-$ (6 %)

from neutron target

$\Sigma(1385)^-$
- $\rightarrow \Lambda \ \pi^-$ (88%)
- $\rightarrow \Sigma^0 \ \pi^-$ (6%)
- $\rightarrow \Sigma^- \ \pi^0$ (6%)

1. If we detect π^+ as a decay particle,
   → reactions from proton are selected.
   (directly comparable with LH_2 target data)
2. If we identify $\Sigma^- \pi^+$ final state,
   →Λ^* contribution is enhanced.
   (Λ^*/Σ^* : 1/10 → 2 – 3)

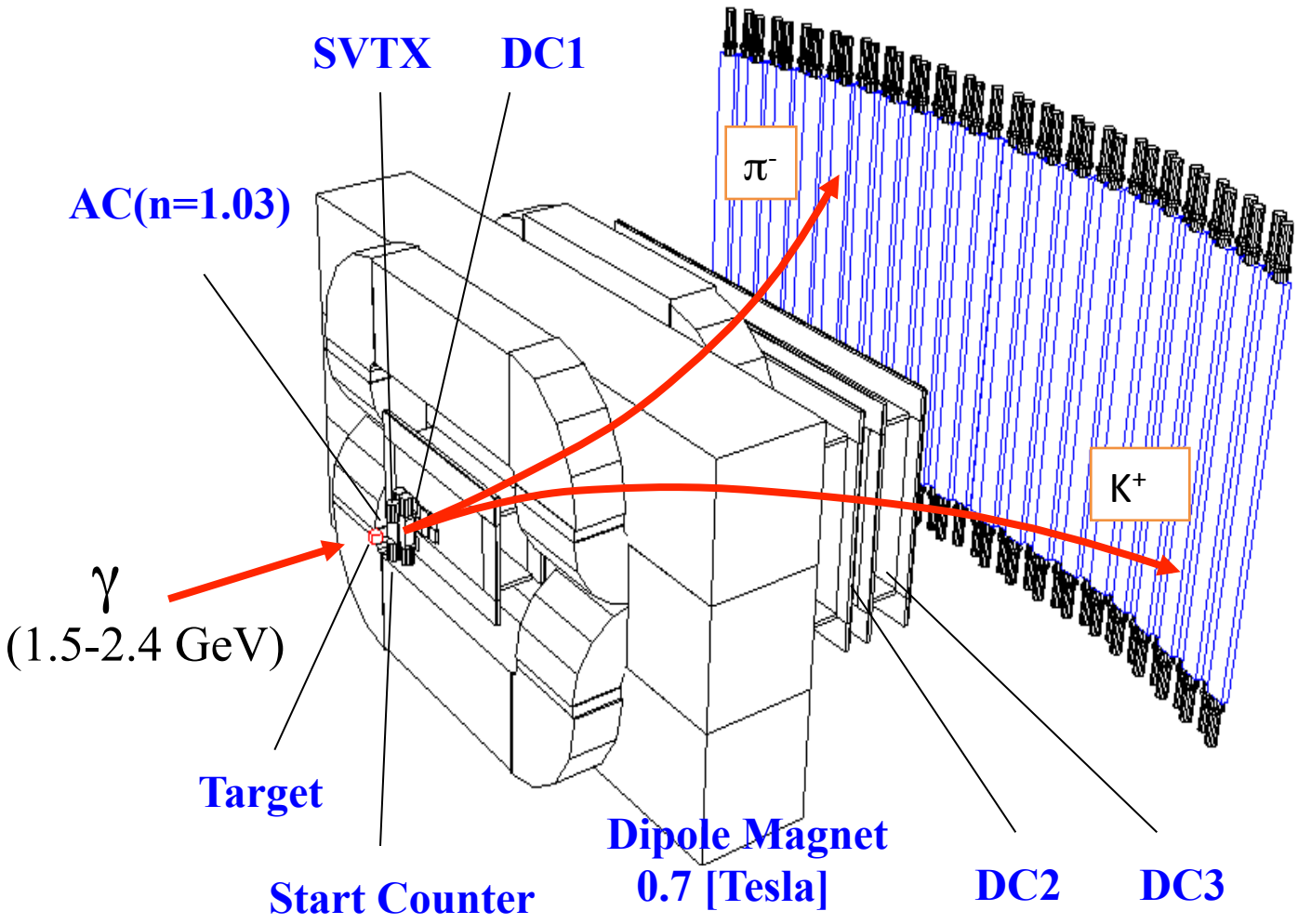
LEPS experiment

Spring-8
(Super Photon ring - 8GeV)
@ Hyogo, Japan

LEPS

(Laser-Electron-Photon facility
at SPring-8)
-Hadron photo-production
by backward compton scattering
-Eγ = 1.5 - 2.4 GeV

LEPS spectrometer



- PID (π, K, p) at forward angle (< 15 degree)

- Δp ~ 6 MeV/c @ 1GeV/*c*

- Data-set 2006/2007 10^{12} photon on LD2 target

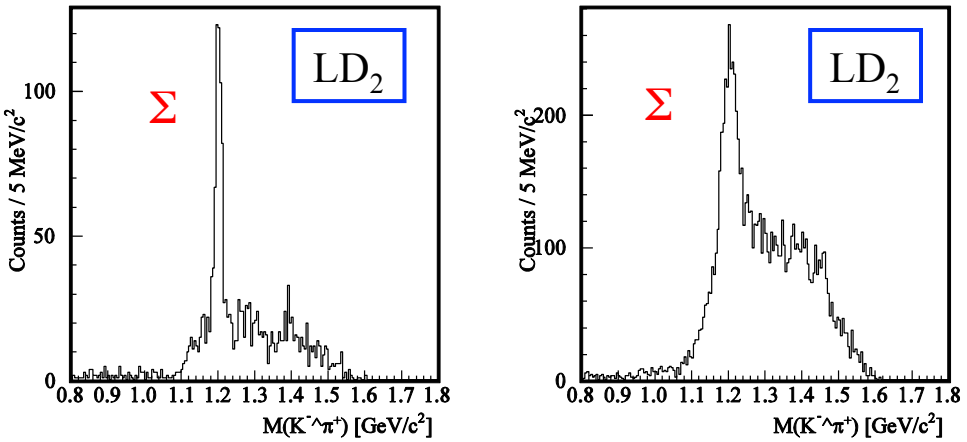
Analysis procedure

☆*Purpose:*

detect detect identify in MM

1. Identify the $\gamma + p \rightarrow K^+ + \pi^+ + \Sigma^-$ reaction.

MM($K^+\pi^+$) spectrum



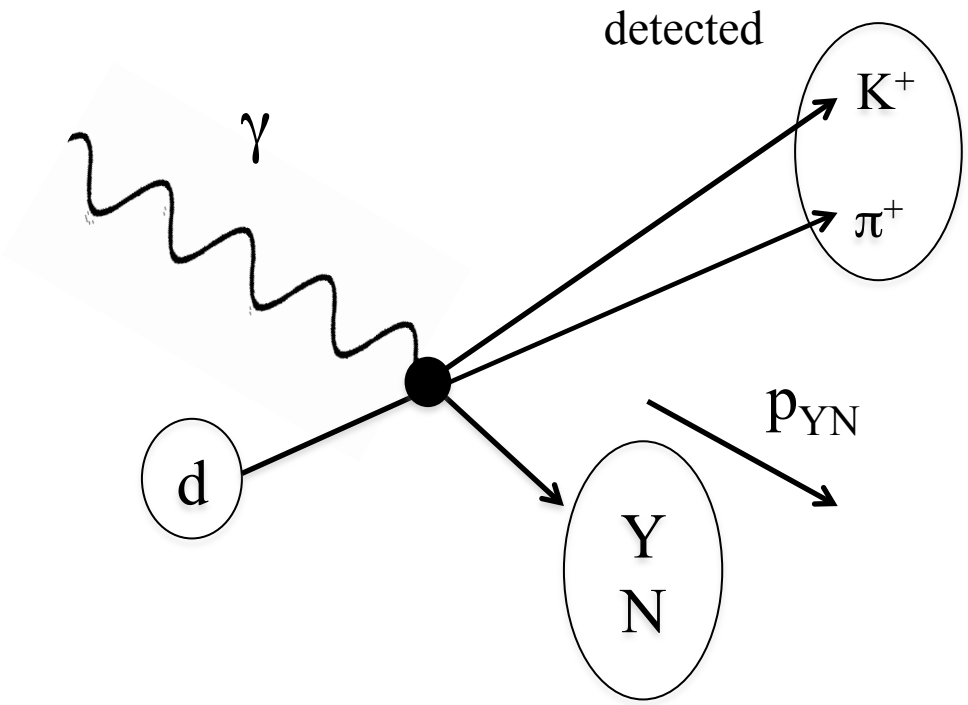
2.Compare the IM($\Sigma^-\pi^+$) btw deuteron and proton target.

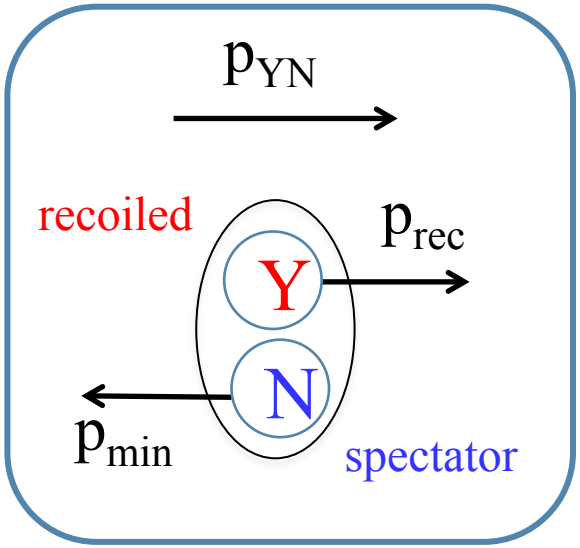
Fermi- motion correction is necessary.

→Minimum Momentum Spectator Approximation (MMSA)

Minimum Momentum Spectator Approximation

Ref) T.Nakano, PRC79, 025210

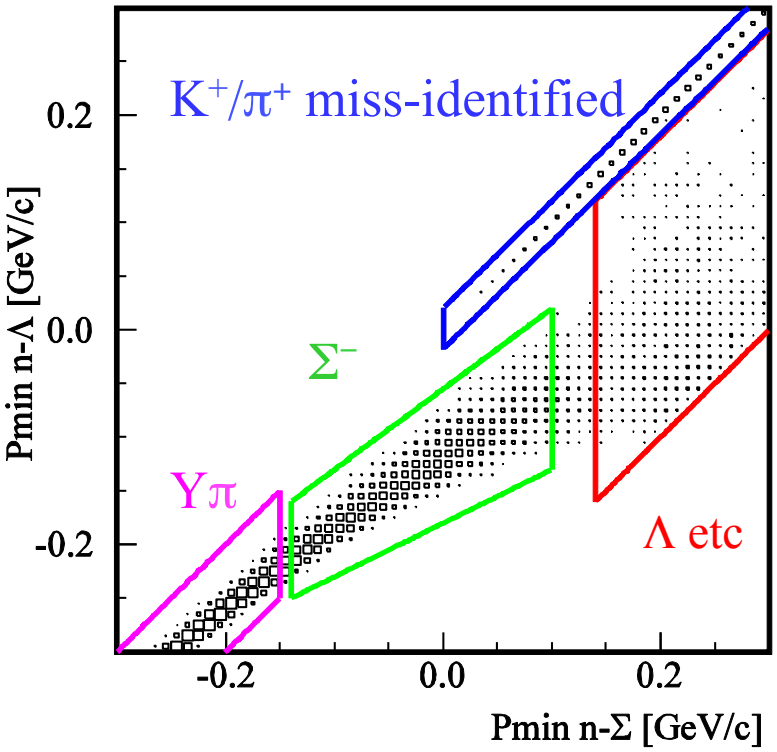


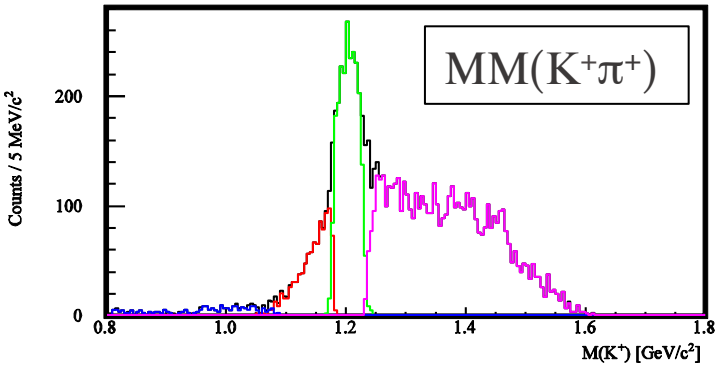


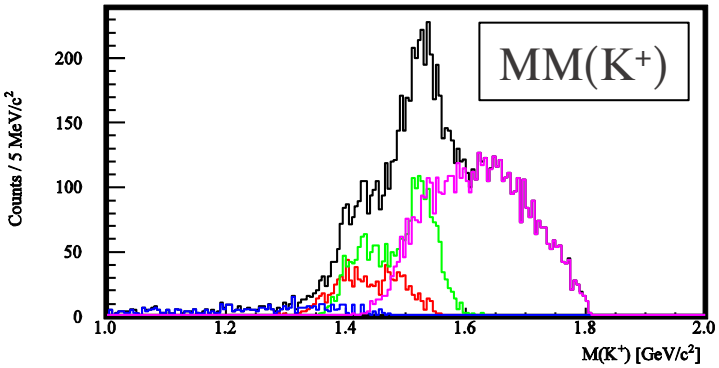
Assume possible minimum momentum (p_{min}) configuration for the spectator.
If the assumption is good, $p_{min} \sim 0$.

$p_{min}(\Sigma N)$ vs $p_{min}(\Lambda N)$ plot → ΣN final state selection.
usage of p_{rec} to calculate IM(Sp) → Fermi motion correction.

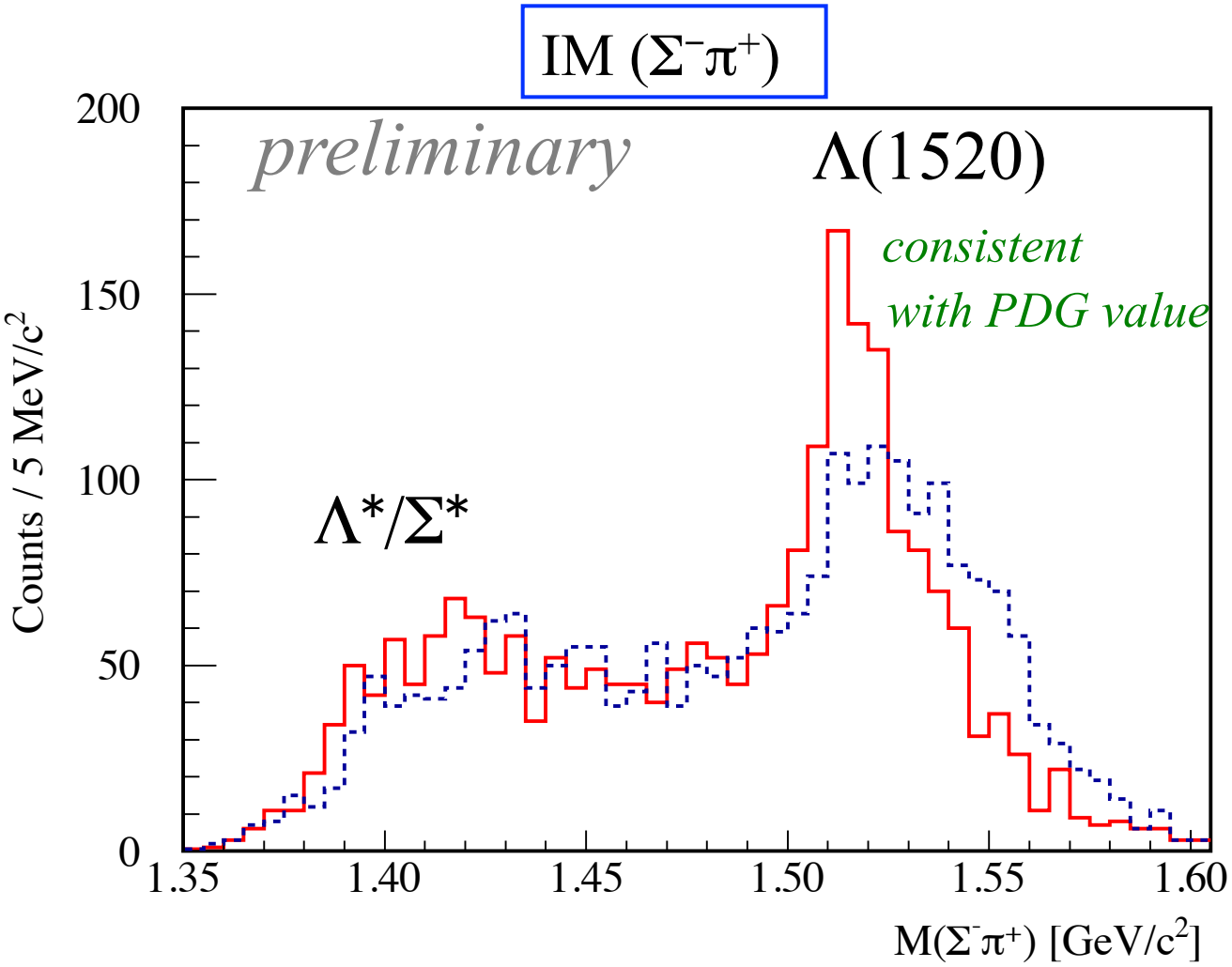
pmin plot


K+/π+ miss-identified
Σ−
Yπ
Λ etc
0.2
0.0
-0.2
-0.2
0.0
0.2
Pmin n-Λ [GeV/c]
Pmin n-Σ [GeV/c]


MM(K+π+)
Counts / 5 MeV/c²
200
100
0
0.8
1.0
1.2
1.4
1.6
1.8
M(K+) [GeV/c²]


MM(K+)
Counts / 5 MeV/c²
200
150
100
50
0
1.0
1.2
1.4
1.6
1.8
2.0
M(K+) [GeV/c²]

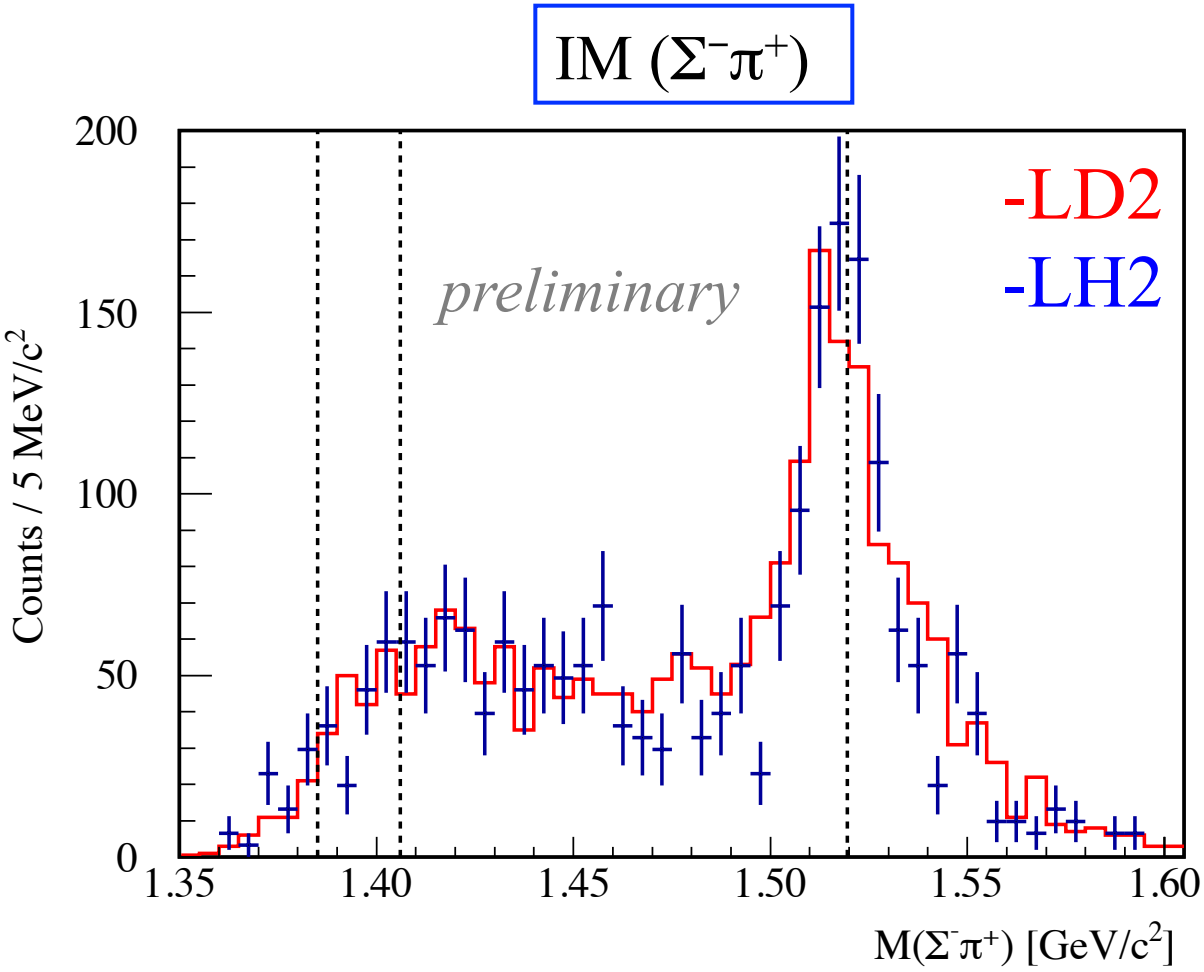
IM($\Sigma^-\pi^+$) spectrum



-w. correction

-w.o. correction

Comparison with LH2 target



Discussion

Result:

Even if we select the $\Sigma^-\pi^+$ final state,
(Λ^* contribution is increased)
a significant mass shift was not observed.

possible interpretation:

1. Λ^*- N interaction has a large isospin dependence?

   d (π^+, K^+) X : X=Λ^* - p

   d (γ , K^+) X : X=Λ^* - n

2. Final state is not $\Sigma\pi$? (YN or $\Lambda\pi$n…)

We need to study d(γ, Ks)X or d(π-, K+)X reactions
to solve the puzzle.

Summary

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