

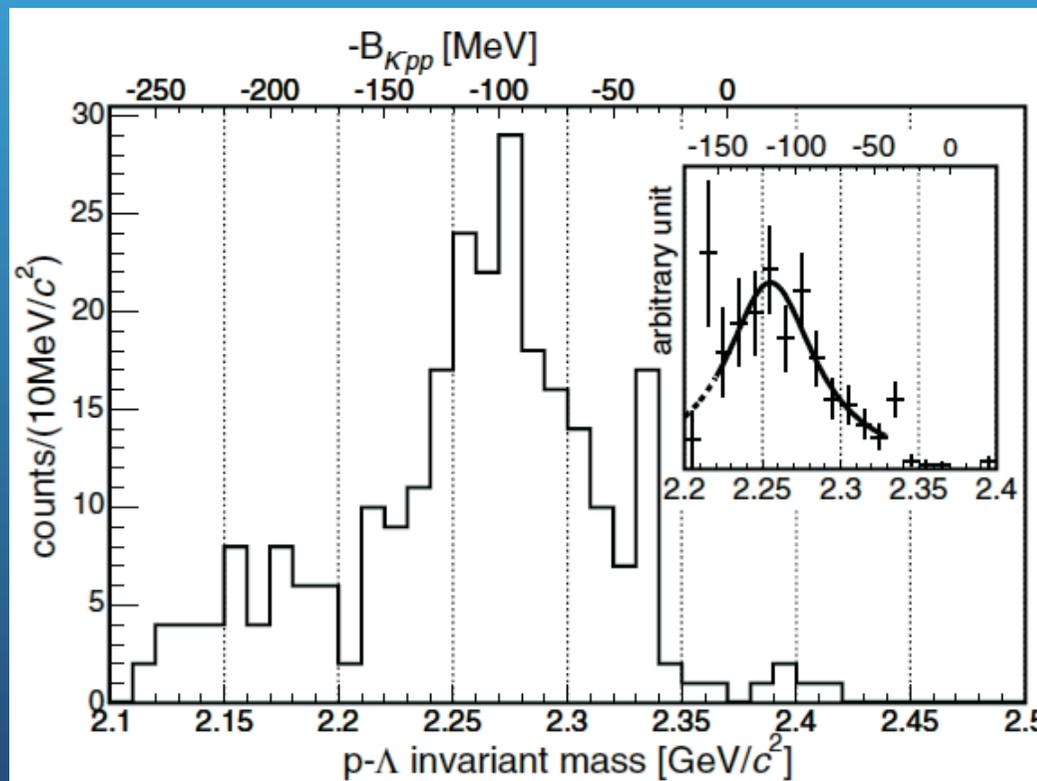
13-July-2012
PAC15

E27 Pilot run in June

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Kyoto University

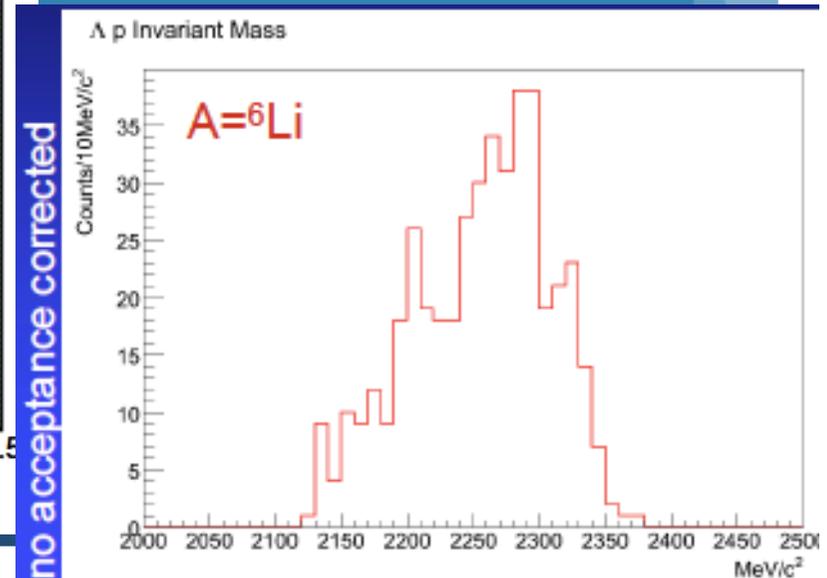
K^-pp : experiments

- FINUDA; First evidence of K^-pp
 - Back-to-back Λ -p pairs in Stopped K^- absorption on ${}^6,7\text{Li}+{}^{12}\text{C}$



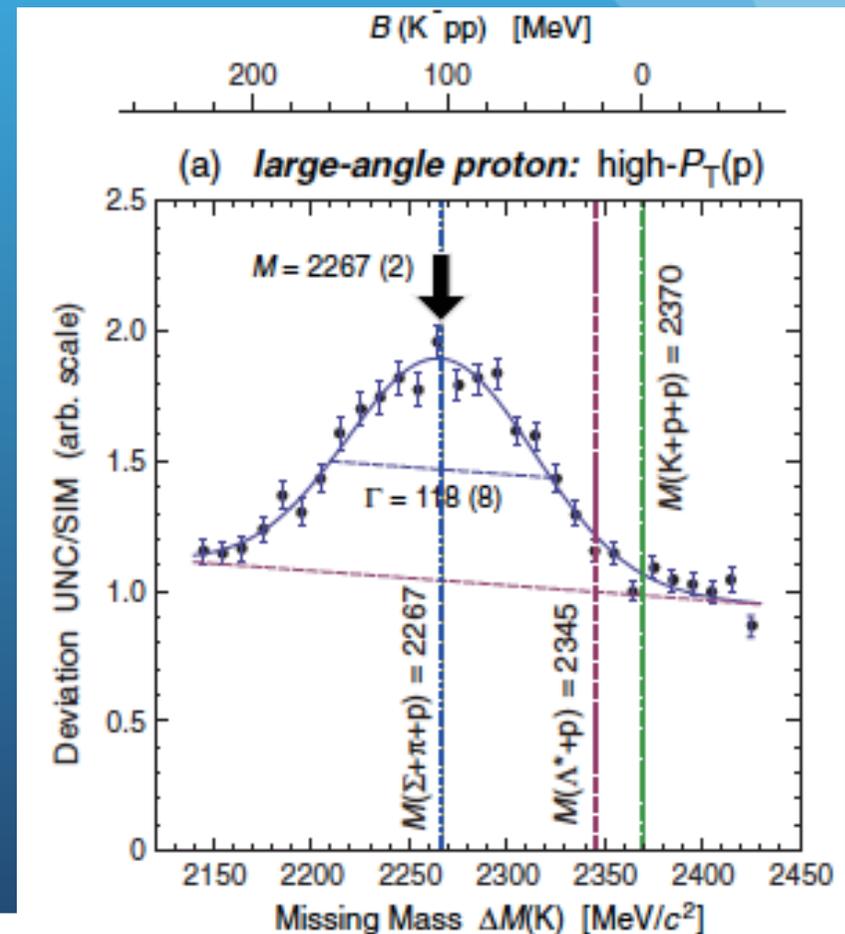
$$B = 115 \pm 6 \text{ MeV}$$
$$\Gamma = 67 \pm 14 \text{ MeV}$$

M. Agnello *et al.*,
PRL 94 (2005) 212303.



- DISTO
 - $pp \rightarrow K^+ + X$ @ $T_p = 2.85$ GeV
 - $X \rightarrow \Lambda p$
 - $M_x = 2267 \pm 3 \pm 5$ MeV
 - $\Gamma_x = 118 \pm 8 \pm 10$ MeV

T. Yamazaki et al., PRL
104(2010) 132502.



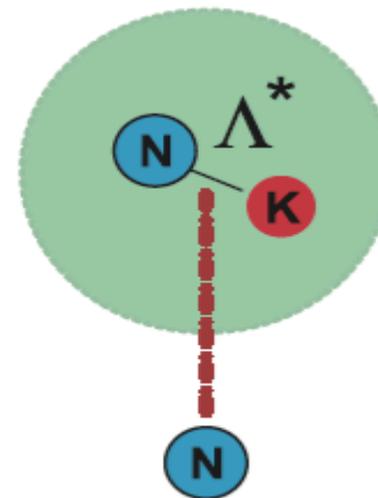
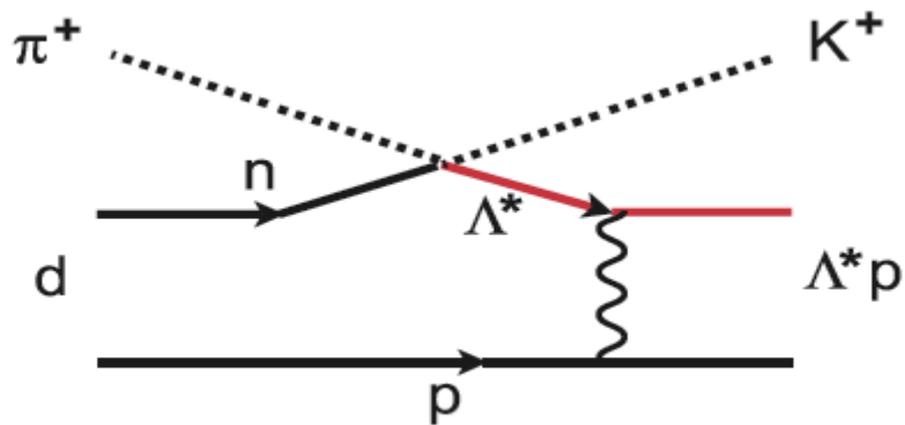
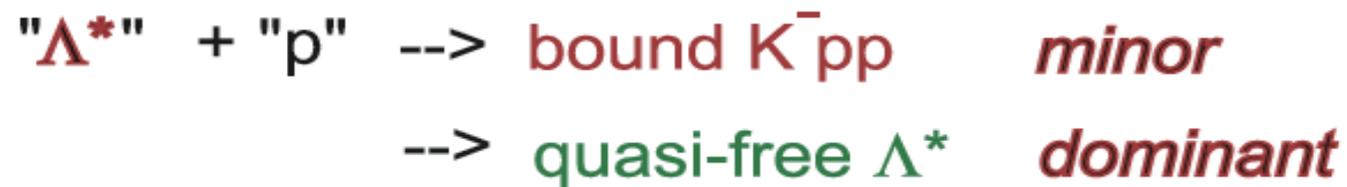
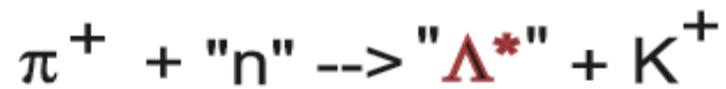
K - pp : theoretical status

Methods	Binding Energy (MeV)	Width (MeV)
Shevchenko, Gal, Mares Faddeev	50 - 70	~100
Ikeda and Sato Faddeev	60 - 95	45 - 80
Yamazaki and Akaishi Variational (ATMS)	48	61
Dote, Hyodo, Weise Variational (AMD)	20 ± 3	40 - 70

- K - pp should exist as a bound state.
 - Deep or Shallow ??
 - Width could be 40 - 100 MeV
- $\Lambda(1405)$ - p bound state ? (Arai, Oka, and Yasui)

$d(\pi^+, K^+)$ reaction

Yamazaki & Akaishi, Phys. Rev. C76 (2007) 045201.

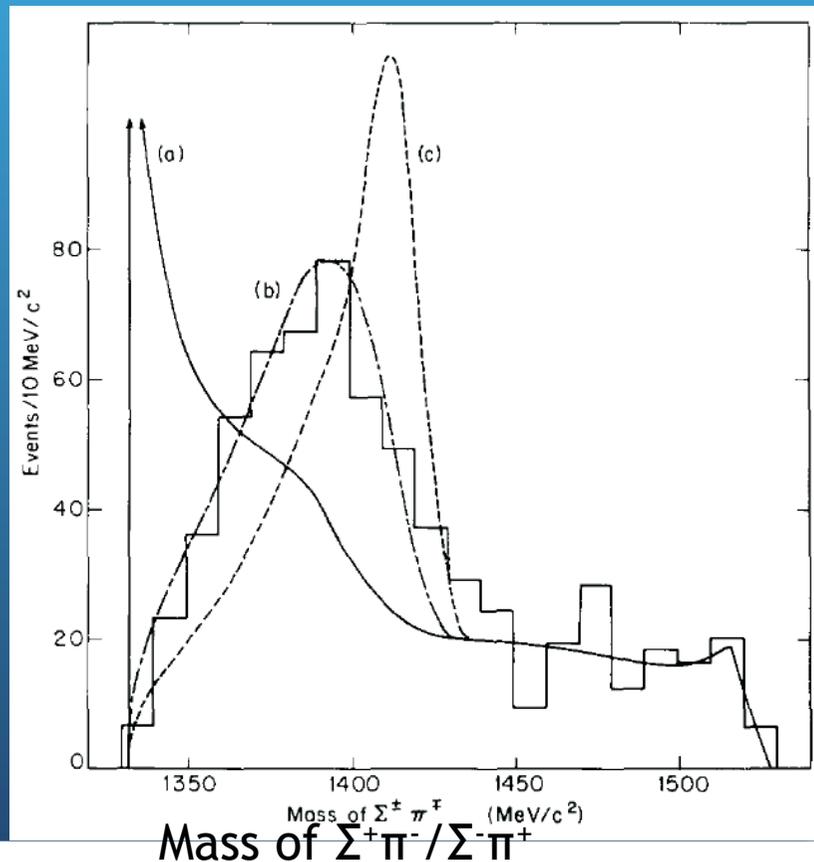


Elementary process:



- Production of $\Lambda(1405)$; about 400 events clearly identified in the $\Sigma\pi$ modes.

D.W. Thomas et al., Nucl. Phys. B 253 (1973)

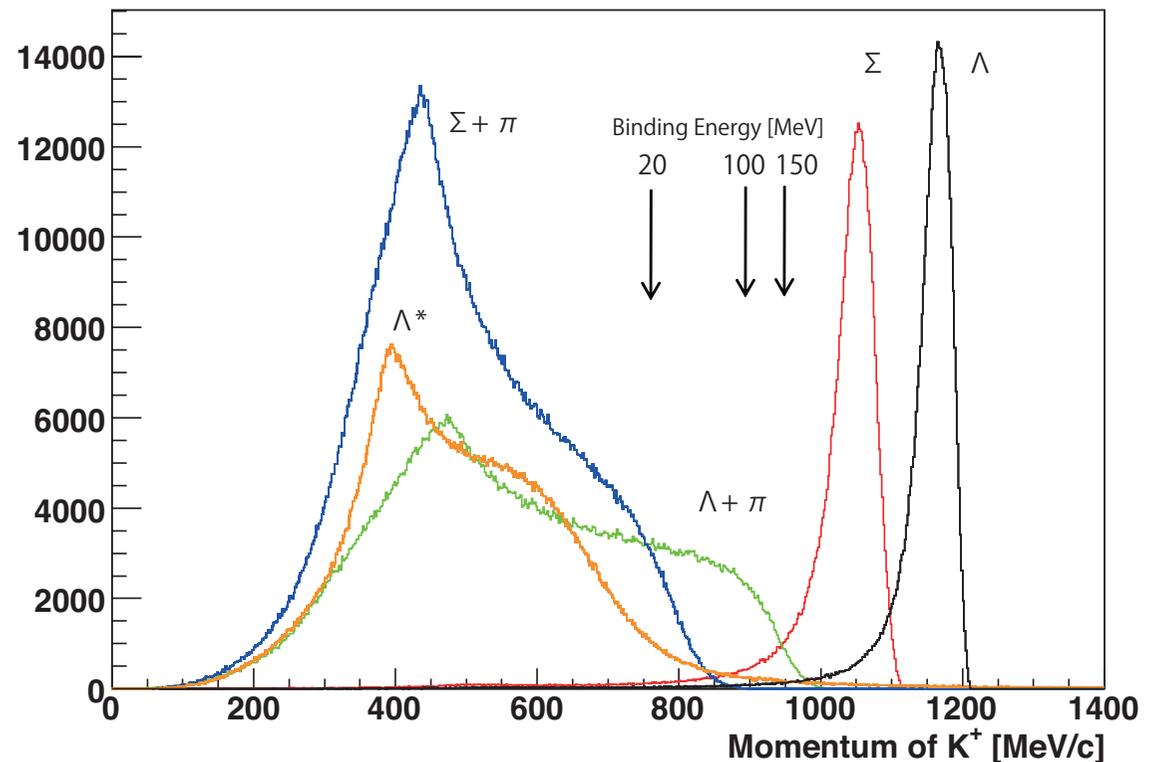


46% $\Lambda(1405)$
43% $K\pi\Sigma$
11% $\Sigma(1385), \Lambda(1520)$

Backgrounds

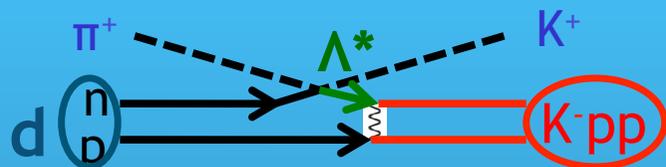
- Quasi-free Processes:
 - $\pi^+d \rightarrow \Lambda + K^+ + p_s$
 - $\rightarrow \Sigma^0 + K^+ + p_s$
 - $\rightarrow \Sigma^+ + K^+ + n_s$
 - $\pi^+d \rightarrow \Lambda + \pi + K^+ + N_s$
 - $\rightarrow \Sigma + \pi + K^+ + N_s$

Momentum of Kaon



E27: Search for “K⁻pp” bound state in the d(π⁺,K⁺)X reaction

- “K⁻pp” is produced through Λ^* doorway in the d(π⁺,K⁺) reaction



- Semi-exclusive measurement by Range Counter Array (RCA) in order to suppress quasi-free B.G.

- $K^-pp \rightarrow \Lambda p_1, \Lambda \rightarrow p_2 \pi^-$
- $K^-pp \rightarrow \Sigma^0 p_1, \Sigma^0 \rightarrow (\Lambda \gamma) \rightarrow p_2 \pi^- \gamma$
- $\pi^+d \rightarrow \Lambda^* K^+ p_{1s}, \Lambda^* \rightarrow \Sigma \pi, \Sigma^+ \rightarrow p_2 \pi^0$

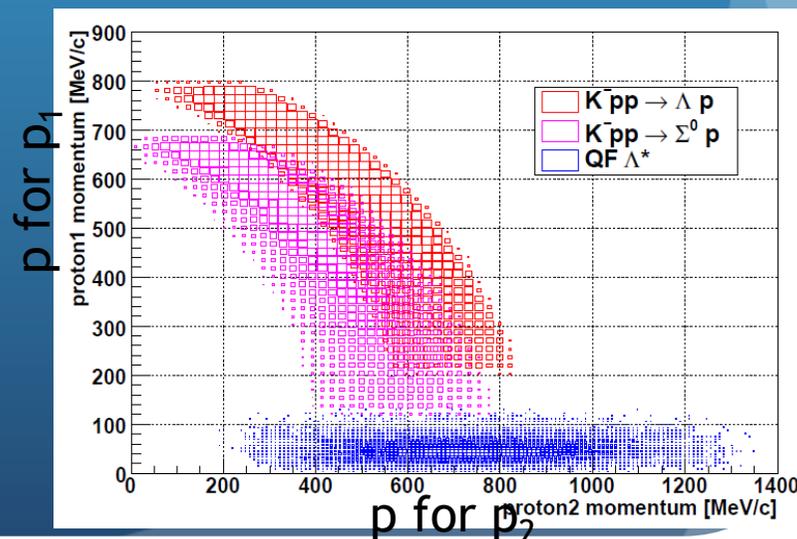
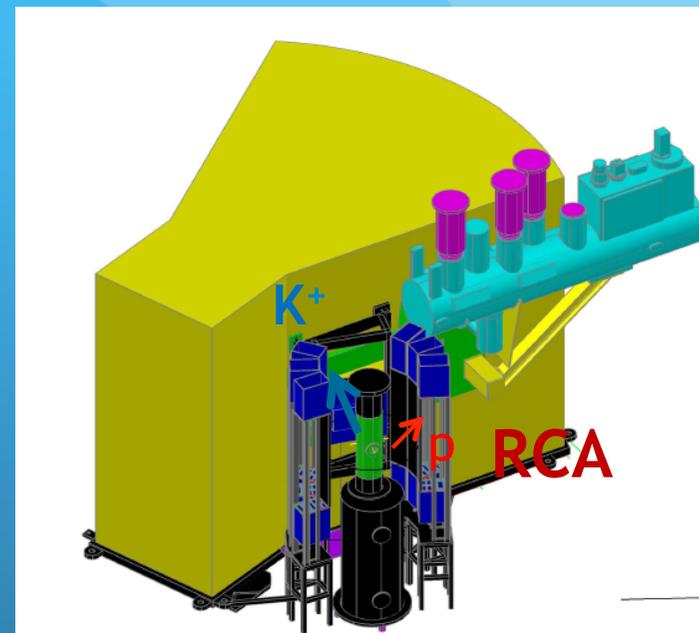
- Original Proposal: 5M/spill beam

- $6 \times 10^4 \Lambda^*$ /day

Assuming 1% trapping probability

- 600 bound states/day (inclusive)
- ~300 events/40 days (exclusive)

with $\epsilon_{RCA} \sim 14\%$ for two protons



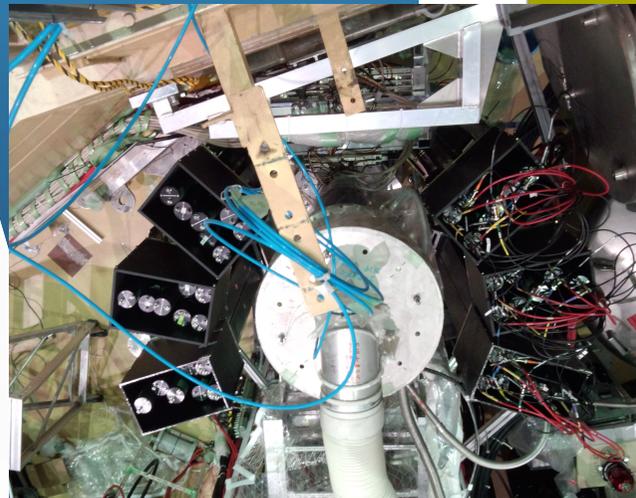
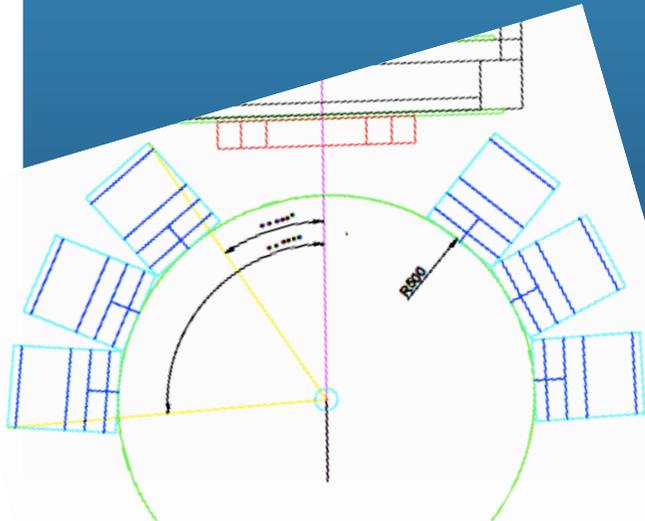
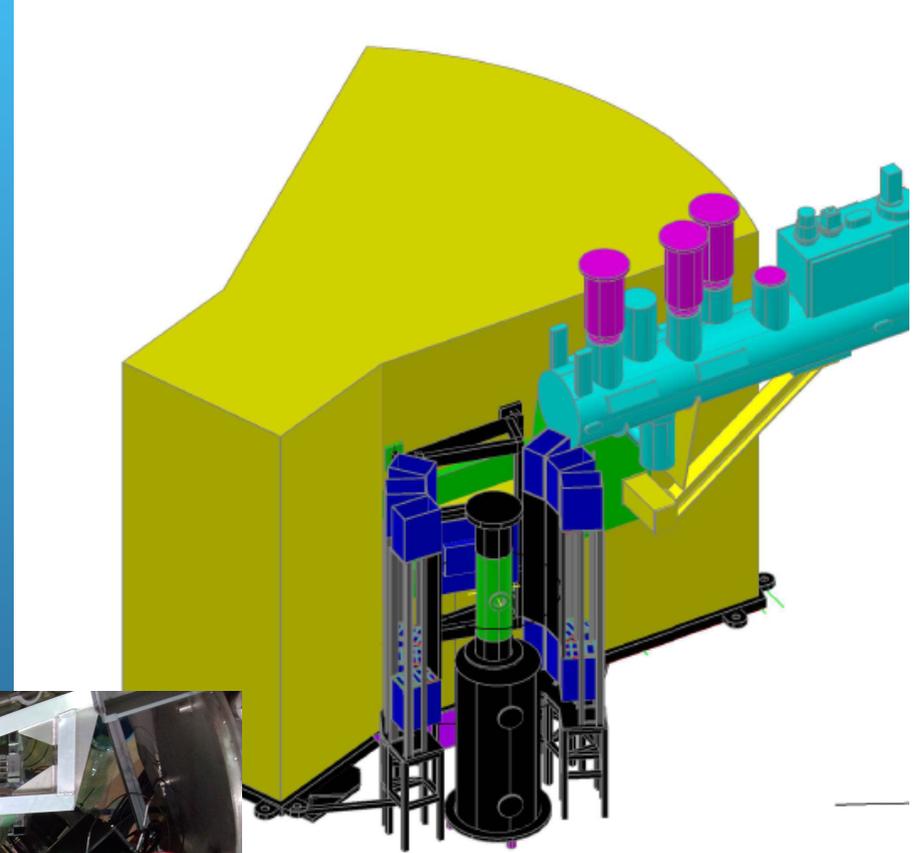
E27: The first step Goal

3M π^+ /spill

- Inclusive $d(\pi^+, K^+)X$ spectrum @ $2.2 < M_X < 2.5 \text{ GeV}/c^2$.
 - The first measurement of this reaction and this missing mass region.
→ To evaluate the maximum value of the cross section, and to understand the background shapes.
 - $p(\pi^+, K^+)X$ for 1 day
→ contribution of “p” in “d”
- Check the feasibility of coincidence measurement
 - One proton tag/Two proton tag

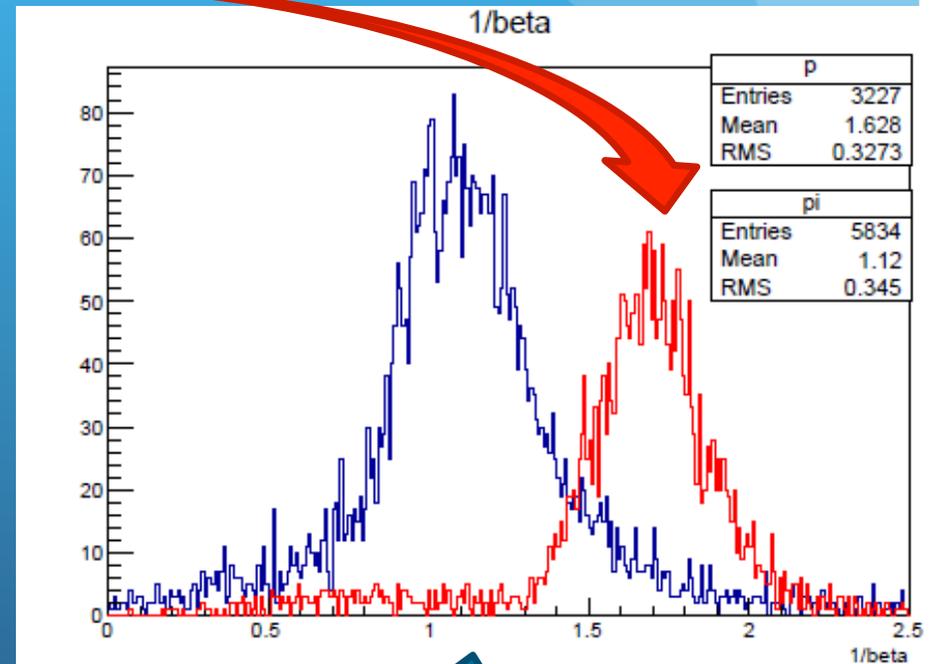
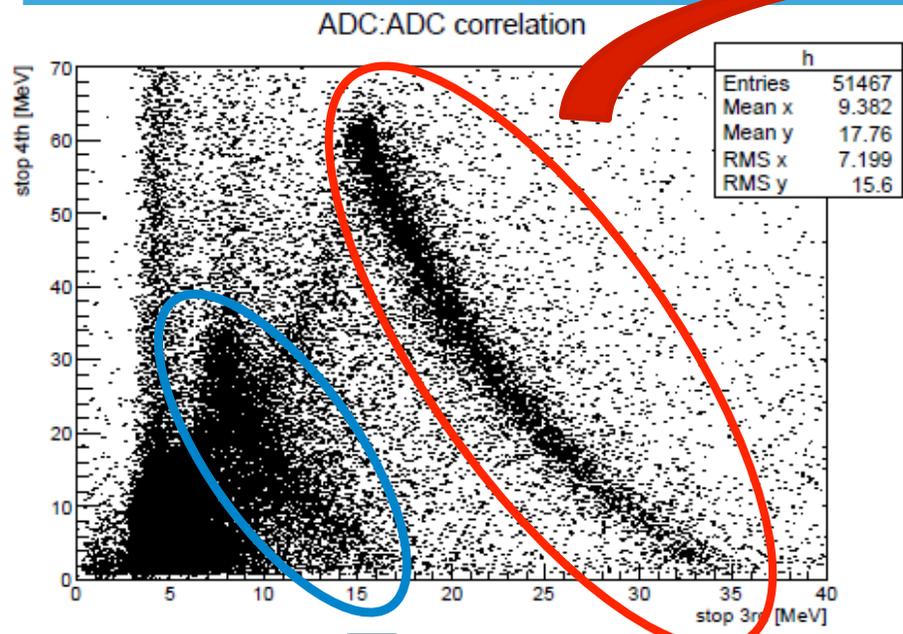
Range Counter System for E27

- 5 layers (1+2+2+5+2cm) of plastic scinti.
- 39 - 122 degrees (L+R)
- 50 cm TOF



Preliminary result of Range Counter

ADC correlation for the events stopped at 4th layer



π

PID performance is good !

Beam Requested for June Run

- Beam Commissioning (28h)
- Range Counter Calib.(4h,p)、 Trigger study (4h)
- Σ^+ Calib. (8h,p)、 Empty run (4h)



2 days

2 days

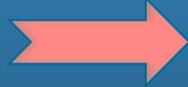
- $p(\pi^+, K^+)$



0.5 days

0.6 days

- $d(\pi^+, K^+)$

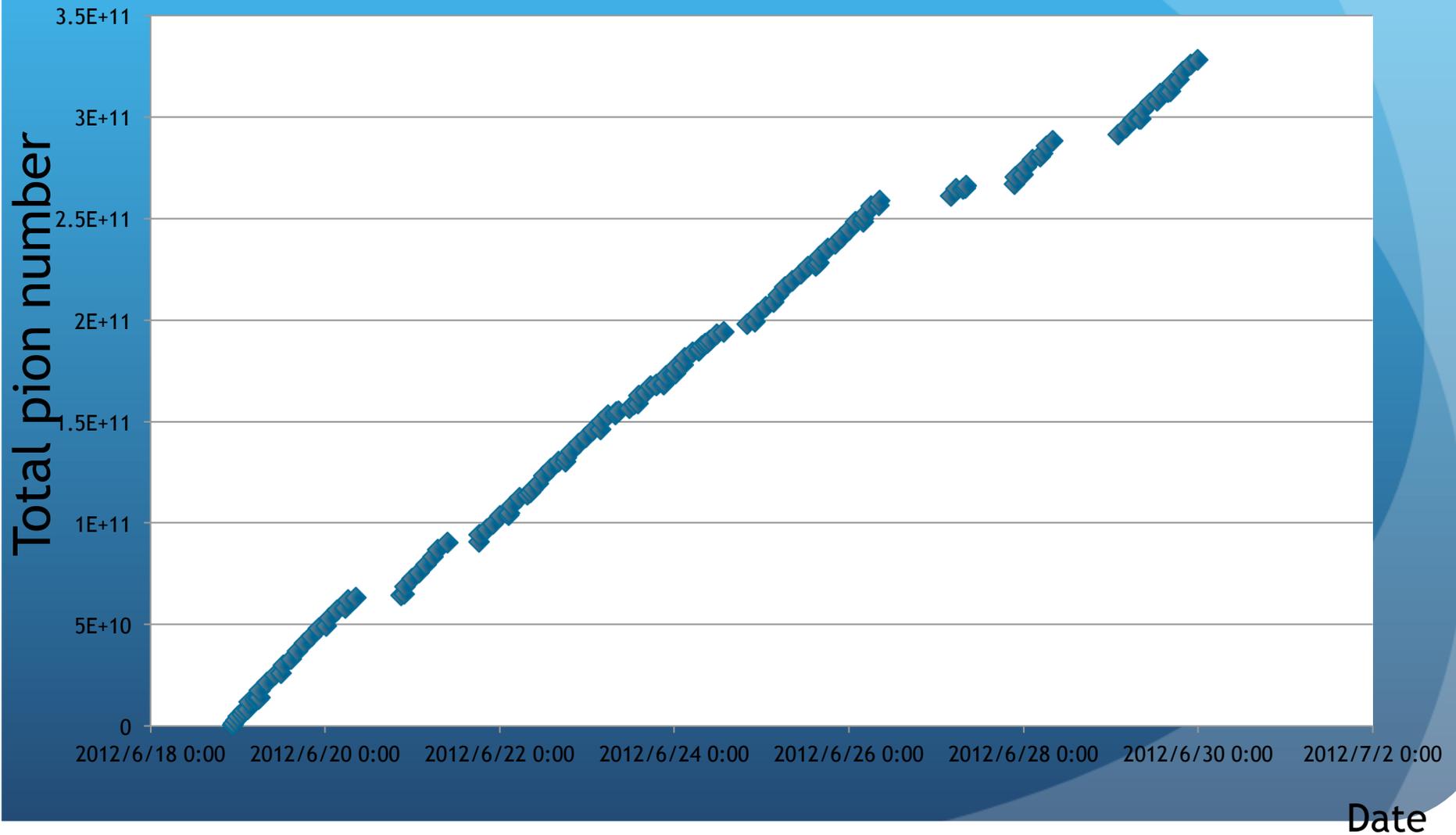


10 days

7.6 days

Preliminary Analysis on Inclusive Spectra

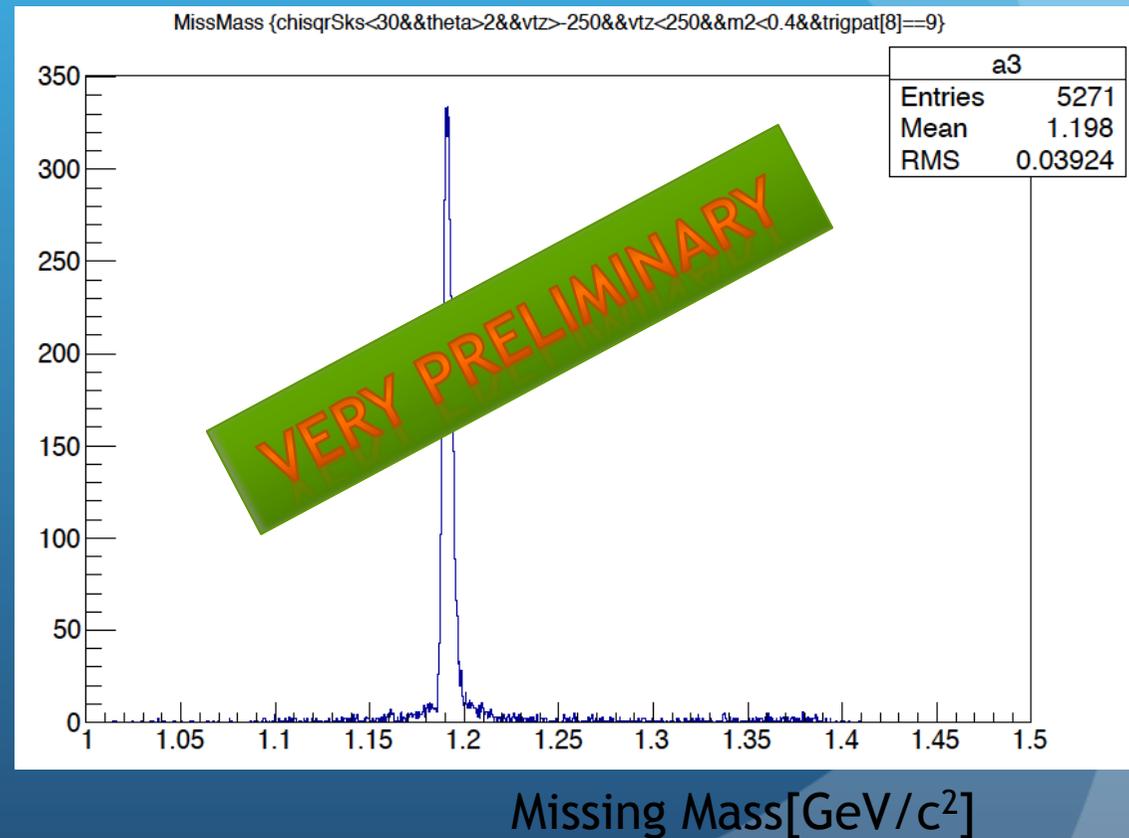
Total pion number for physics run



$p(\pi^+, K^+)\Sigma^+$ @1.58 GeV/c

2.5 M π /spill
8.2 hours

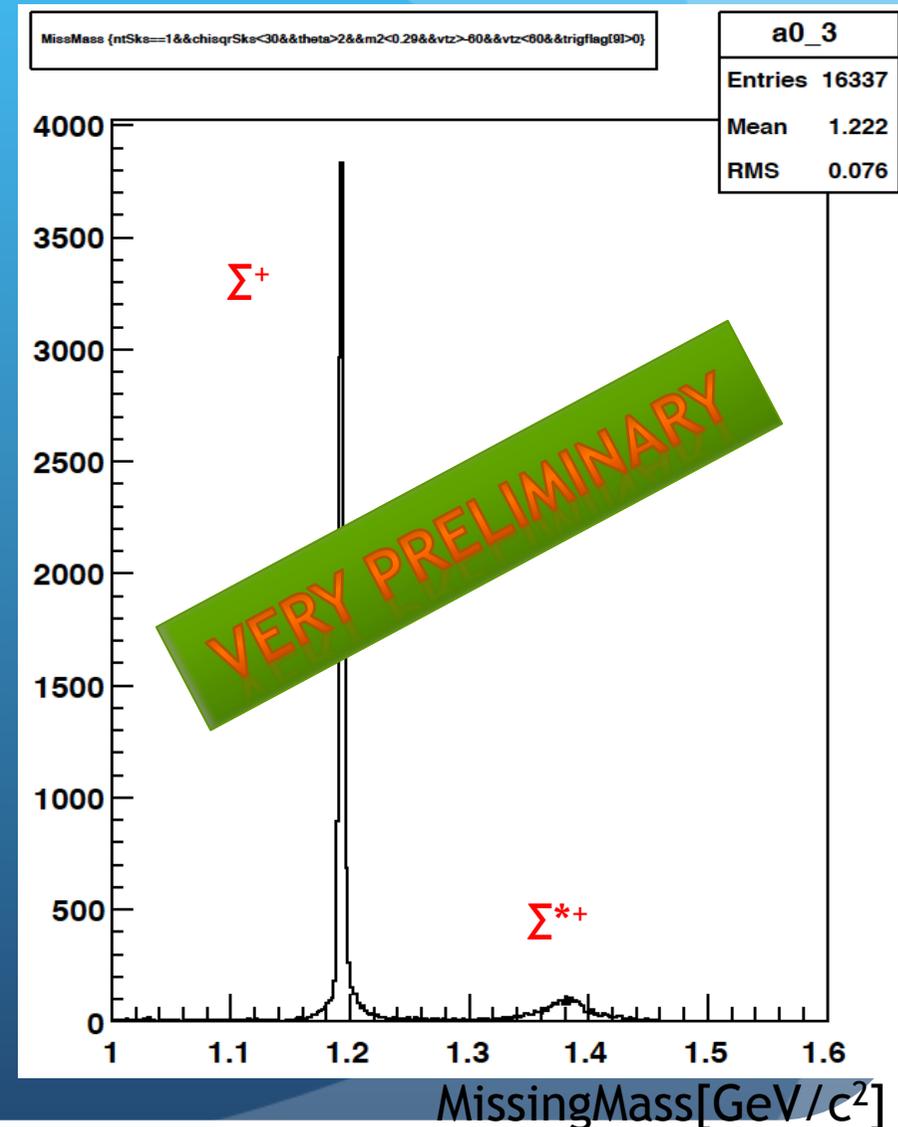
- Energy Calibration & Cross Section Normalization Check
- Σ^+ Production
 - 7083 ; expected
 - 6442 ; observed
 - < 10%
- $\Delta M \sim 2.3$ MeV(FWHM)



$p(\pi^+, K^+)X @ 1.7 \text{ GeV}/c$

2.5 M π /spill
15 hours

- “p” contribution in “d”
- Σ^+ production
 - 1.10×10^4 ; expected
 - 1.08×10^4 ; observed
 - In good agreement
- $\Sigma^+(1385)$
 - 4700 ; expected
 - 3100 ; observed
 - $\sim 2/3$

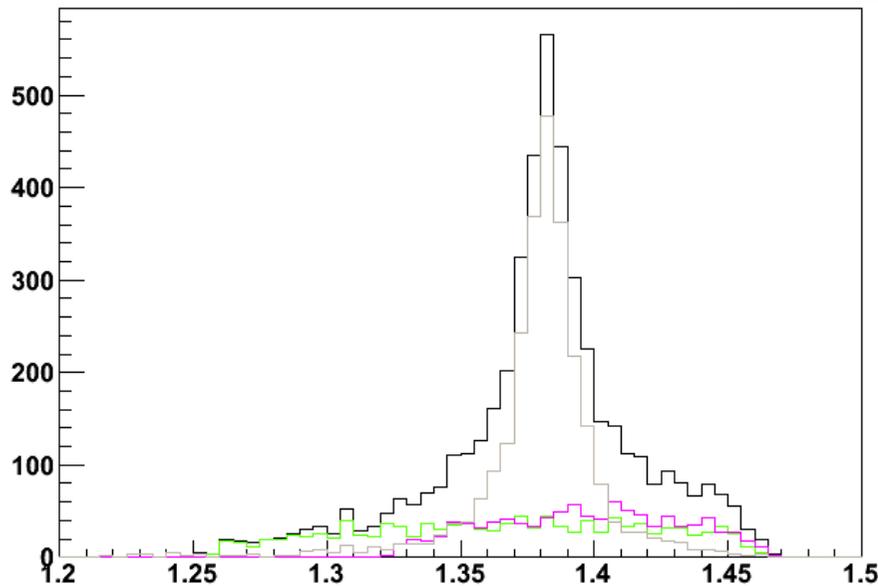


$\Sigma(1385)$ Production

- $\Sigma(1385)$ resonance / $\pi\Sigma$ (non resonant) ; smaller than expected

P-Target simulation

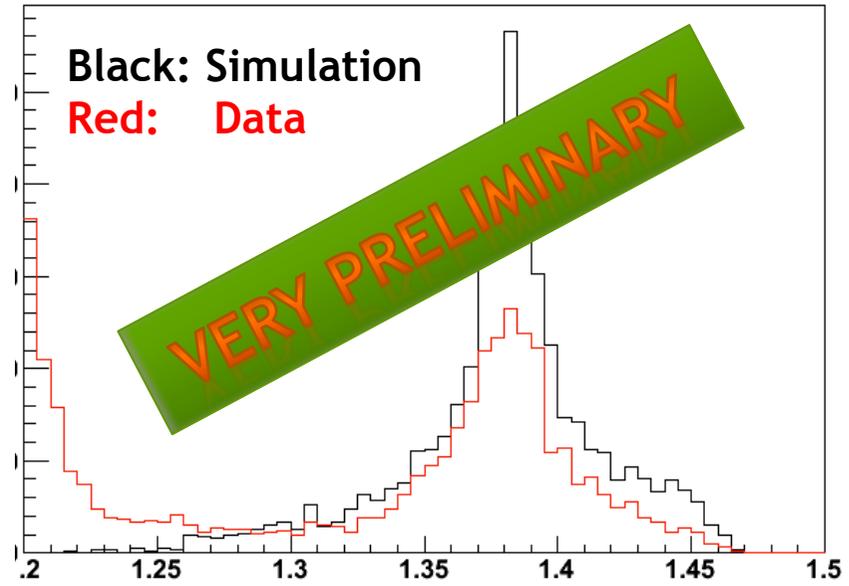
in_mm	
Entries	15826



MissingMass

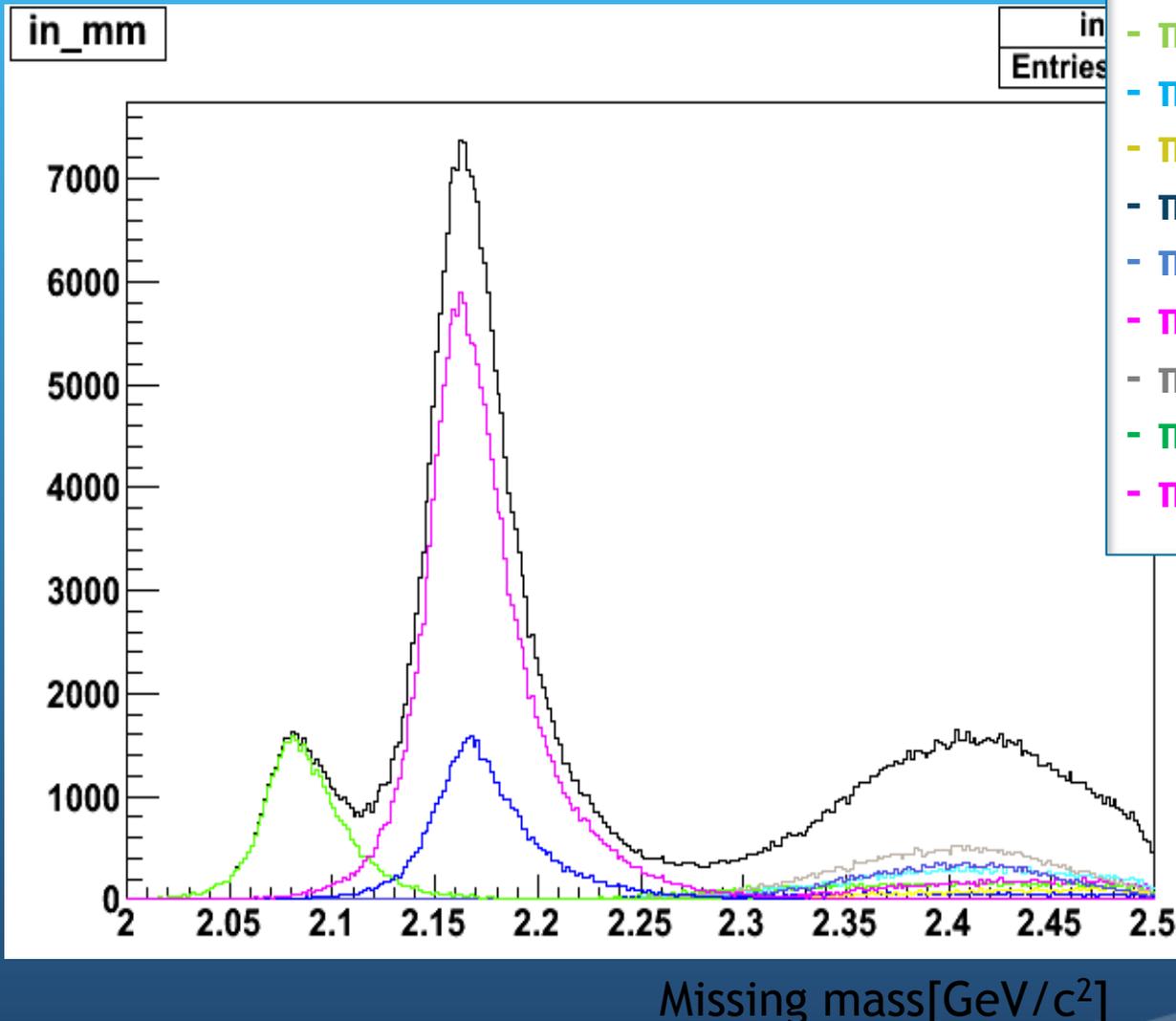
P-Target data

in_mm_data	
Entries	17214



MissingMass

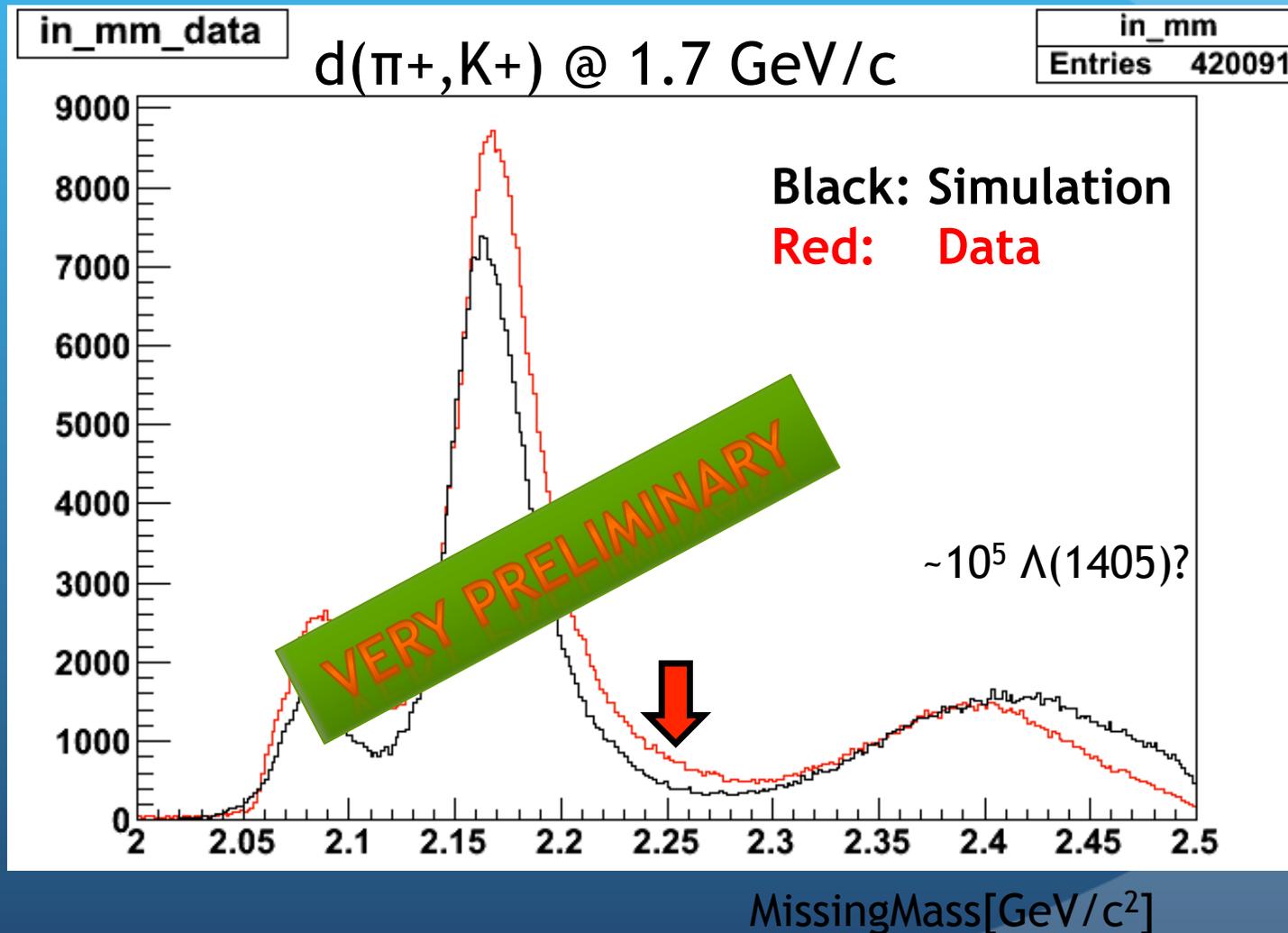
$d(\pi^+, K^+)X @ 1.7 \text{ GeV}/c$ Expected Inclusive Spectrum



- π^+ "n" -> $\Sigma^0 K^+$	120.6 μb
- π^+ "n" -> ΛK^+	174.7 μb
- π^+ "n" -> $\Lambda(1405) K^+$	20.6 μb
- π^+ "n" -> $\Sigma\pi K^+$	40 μb
- π^+ "n" -> $\Sigma^0(1385)K^+$	76.7 μb
- π^+ "n" -> $\Lambda\pi K^+$	13.7 μb
- π^+ "p" -> $\Sigma^+ K^+$	470 μb
- π^+ "p" -> $\Sigma^+(1385)K^+$	124 μb
- π^+ "p" -> $\Lambda\pi K^+$	40 μb
- π^+ "p" -> $\Sigma\pi K^+$	28.9 μb

Preliminary Inclusive spectrum

3 M π /spill
7.6 days



E27: Expected B.G. spectrum with one proton tag

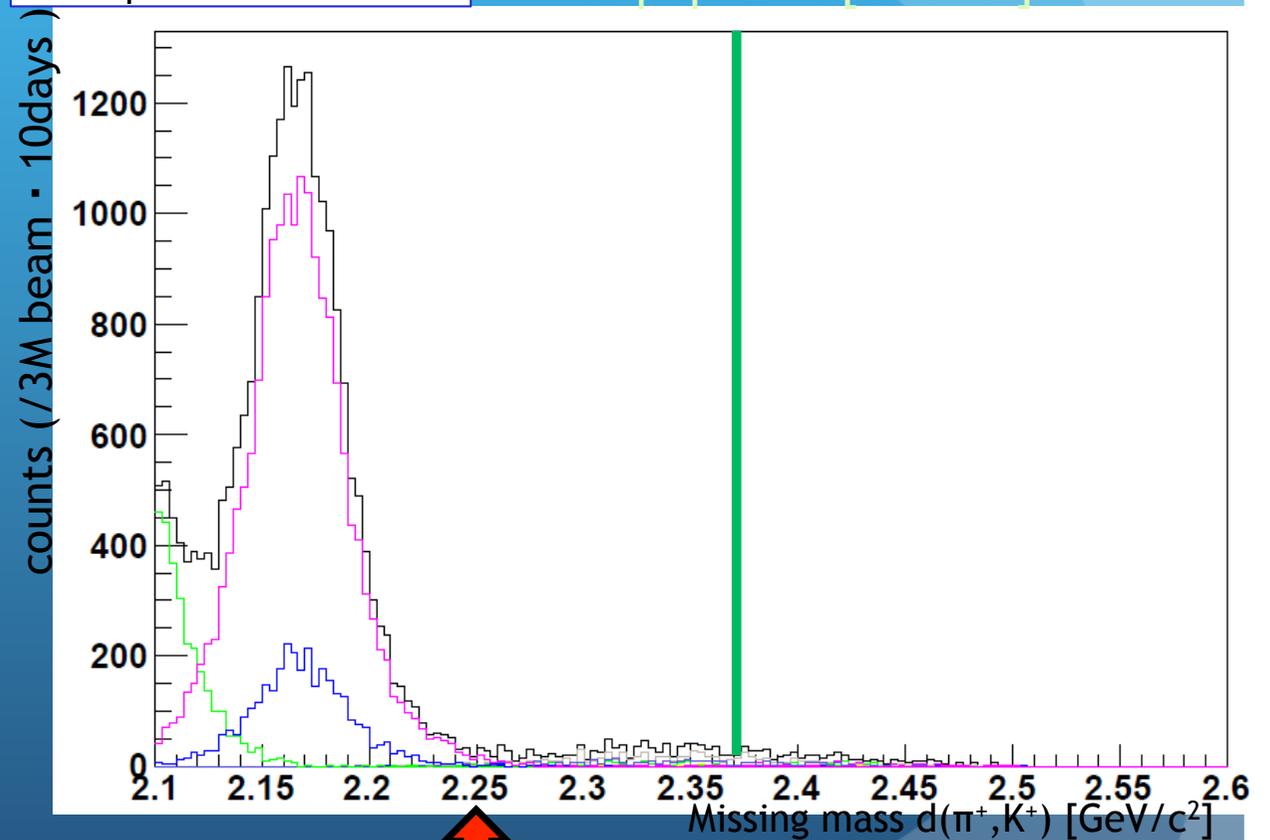
$P_\pi = 1.7 \text{ GeV}/c$, SKS=350A

10 days with 3M/spill beam

- π^+ "n" $\rightarrow \Sigma^0 K^+$
- π^+ "n" $\rightarrow \Lambda K^+$
- π^+ "n" $\rightarrow \Lambda(1405) K^+$
- π^+ "n" $\rightarrow \Sigma \pi K^+$
- π^+ "n" $\rightarrow \Sigma^0(1385) K^+$
- π^+ "n" $\rightarrow \Lambda \pi K^+$
- π^+ "p" $\rightarrow \Sigma^+ K^+$
- π^+ "p" $\rightarrow \Sigma^+(1385) K^+$
- π^+ "p" $\rightarrow \Lambda \pi K^+$
- π^+ "p" $\rightarrow \Sigma \pi K^+$

Mom_{proton} > 350 MeV/c

$K+p+p \sim 2.37 [\text{GeV}/c^2]$



FINUDA, DISTO

Conference Presentations on E27

- The 20th Few-Body Conference in Fukuoka, Japan:
20-25 August
 - An invited talk, one oral presentation
- The 11th HYP Conference in Barcelona, Spain;
1-5 October
 - An invited talk, two posters



Summary

- E27 Pilot run in June has been successfully completed, as scheduled.
- We've obtained
 - $d(\pi^+, K^+) @ 1.7 \text{ GeV}/c$
 - $p(\pi^+, K^+) @ 1.7 \text{ GeV}/c$
 - $p(\pi^+, K^+)\Sigma^+ @ 1.58 \text{ GeV}/c$ for calibration
- Inclusive spectra are roughly understandable.
 - Need detail study.
- Coincidence analysis is underway.