The Nature of the $\Lambda(1405)$ from Photoproduction at LEPS/SPring-8

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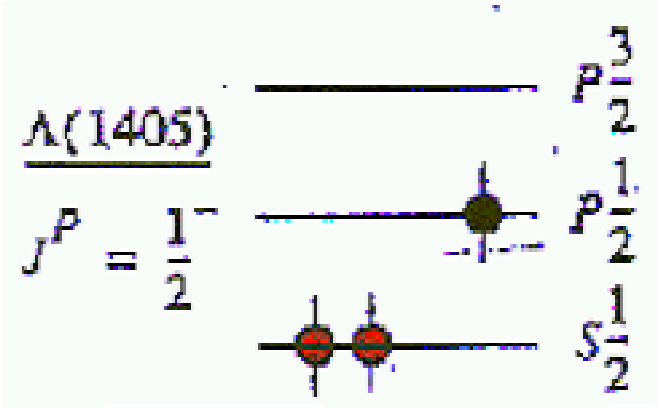
for the LEPS Collaboration

Λ(1405) S_{01}



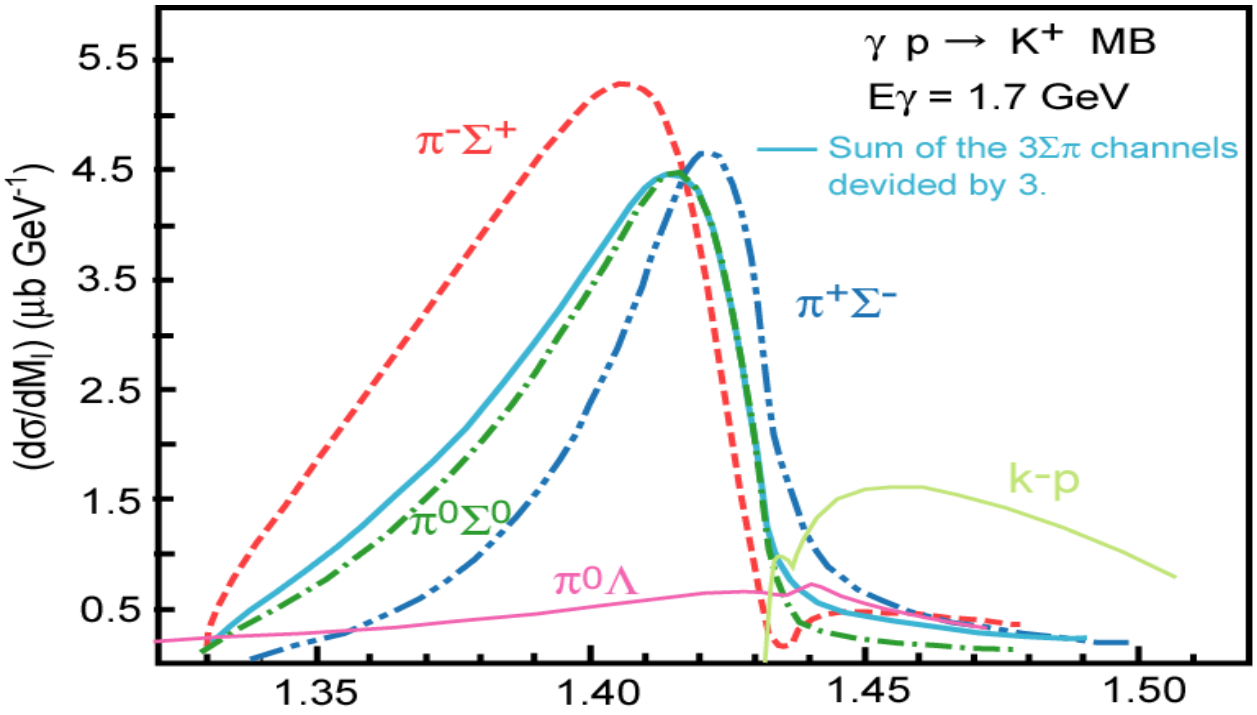
- **Quark Model State with Orbital Excitation**
  - **Mass-degenerate J^p=3/2- Λ(1520) 115 MeV away**
- **KN Molecule, Dynamically Generated**
  - **Another J^p=1/2- Λ(1520) undetected as yet**
- **New forms of hadronic matter such as meson-baryon molecules, pentaquarks, and/or hybrids.**

$$\frac{1}{2}|T^{(1)}|^2 + \frac{1}{3}|T^{(0)}|^2 + \frac{2}{\sqrt{6}} Re(T^{(0)} T^{(1)*}); \quad \pi^+\Sigma^-$$

$$\frac{1}{2}|T^{(1)}|^2 + \frac{1}{3}|T^{(0)}|^2 - \frac{2}{\sqrt{6}} Re(T^{(0)} T^{(1)*}); \quad \pi^-\Sigma^+$$

$$\frac{1}{3}|T^{(0)}|^2; \quad \pi^0\Sigma^0$$

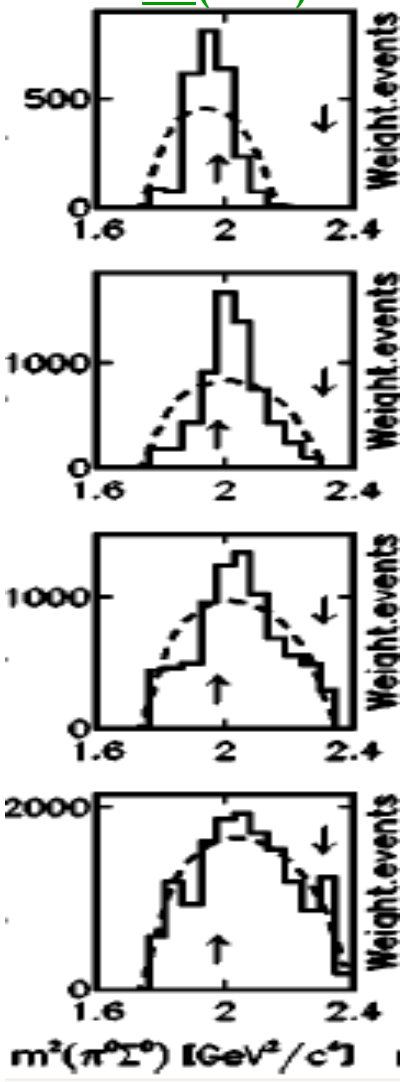
E. Oset et al., PLB455 55(1999)

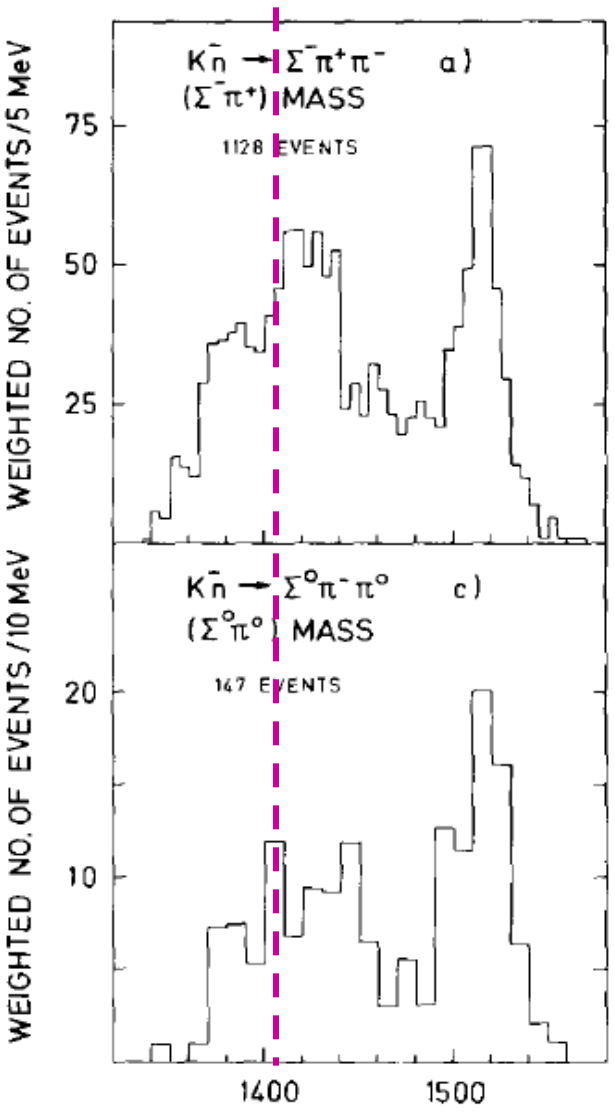


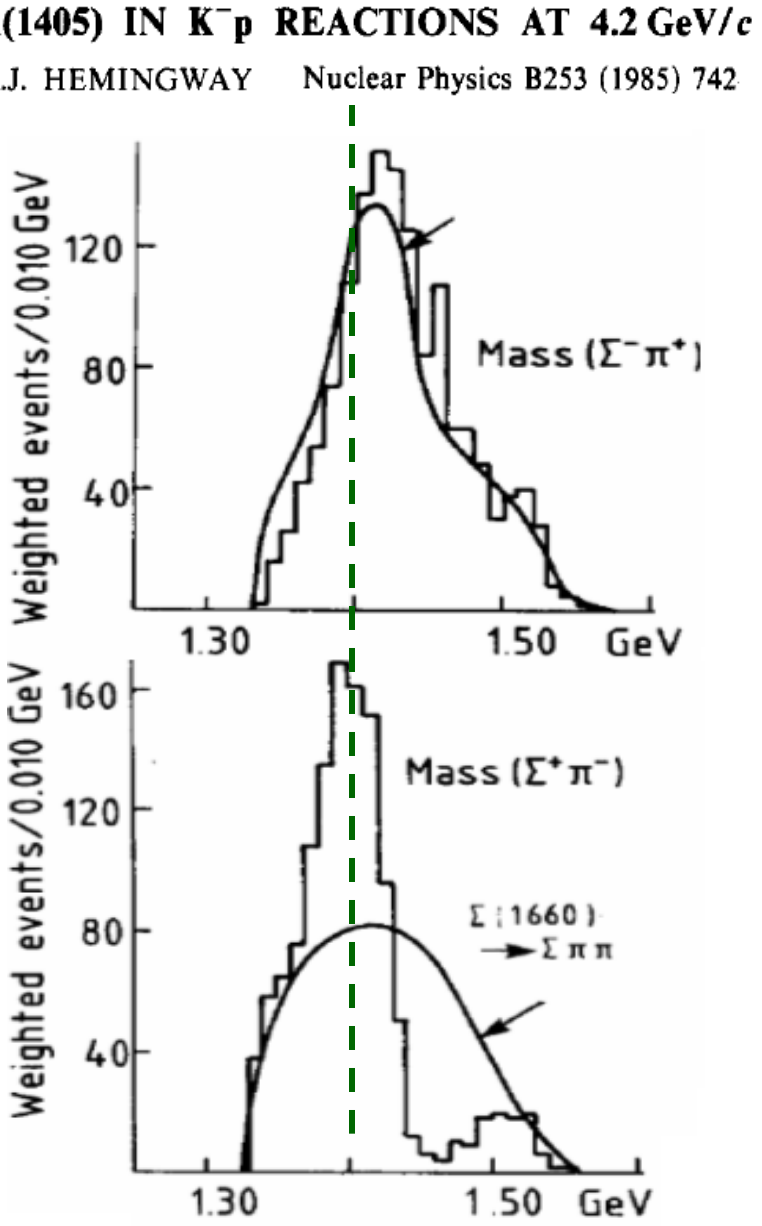
$\pi^0\Lambda$ $\pi^0\Sigma^0$ $\pi^-\Sigma^+$ $\pi^+\Sigma^-$ K^-p $\bar{K}^0p$ $\eta\Lambda$ $\pi^0\Sigma^0$ $K^0\Xi^0$ $K^-\Xi^+$

S. Prakhov et al.,

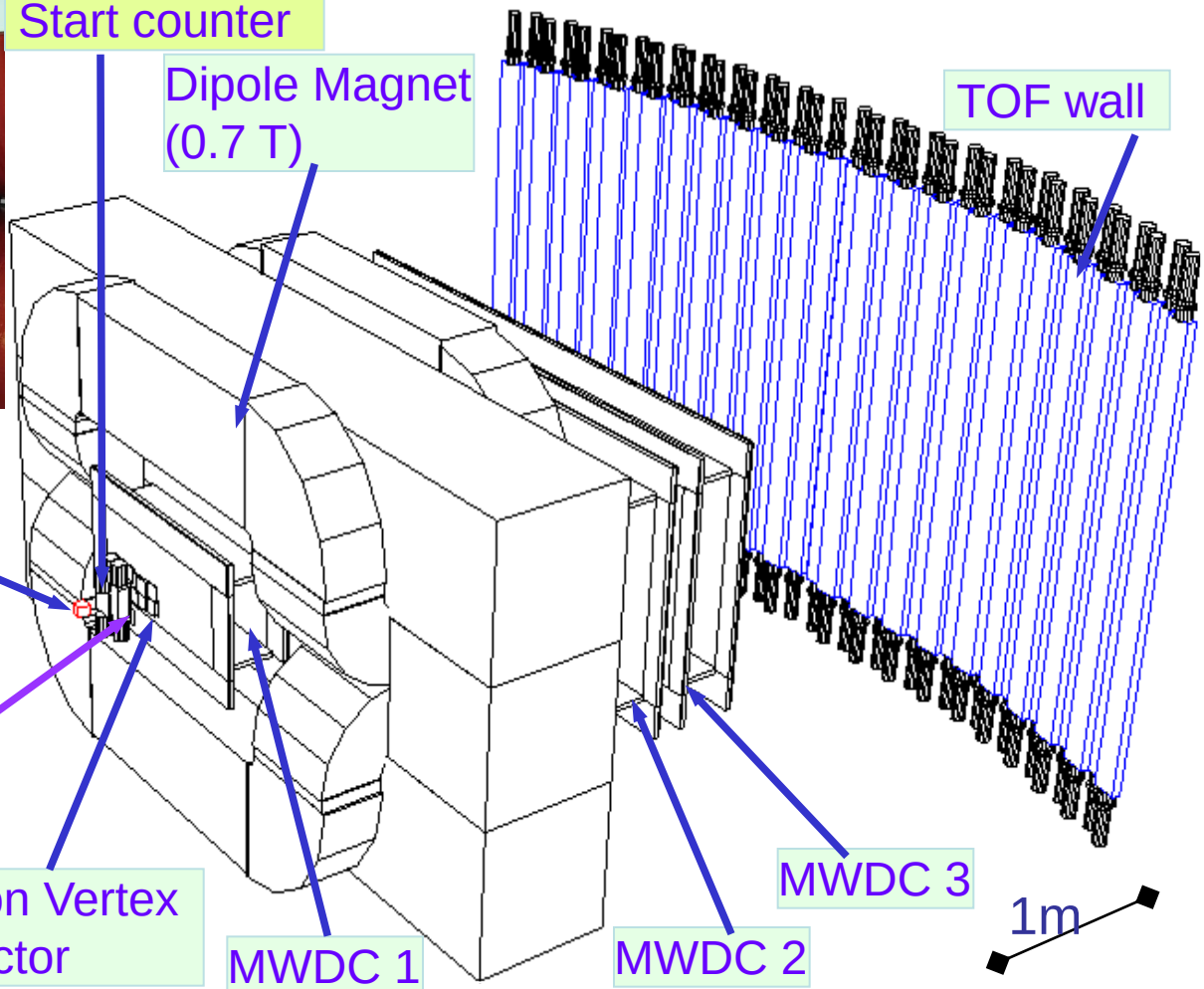
PRC 70(2004) 034605



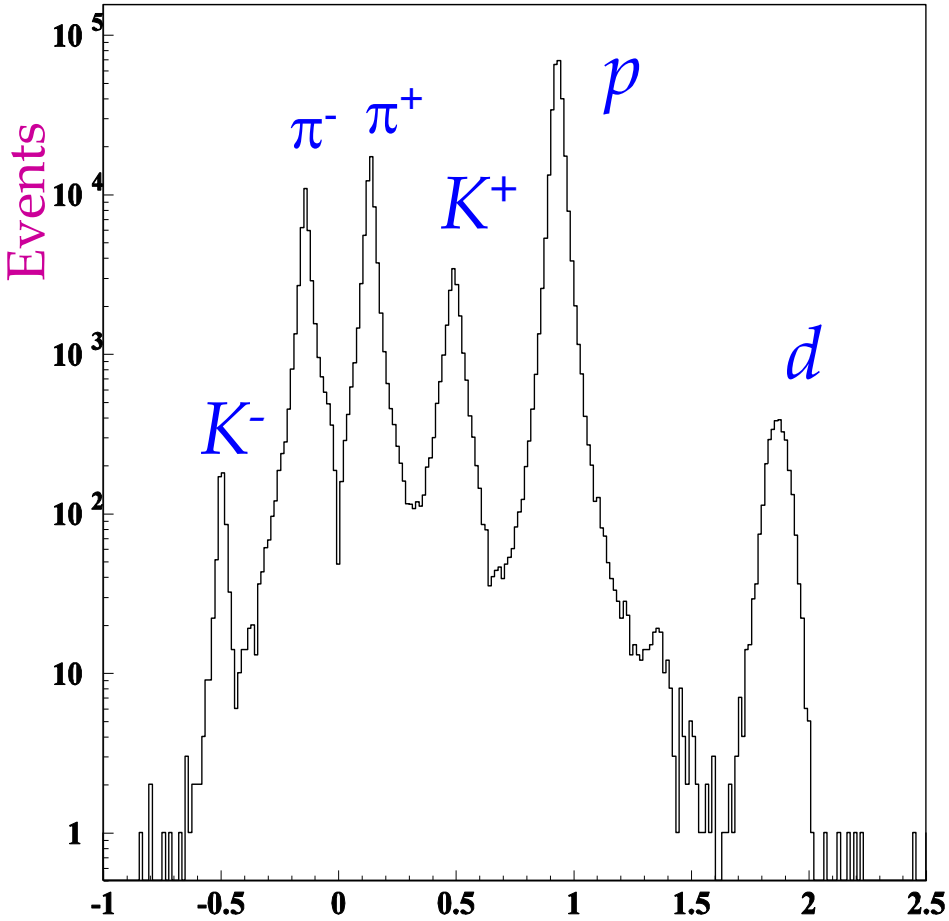




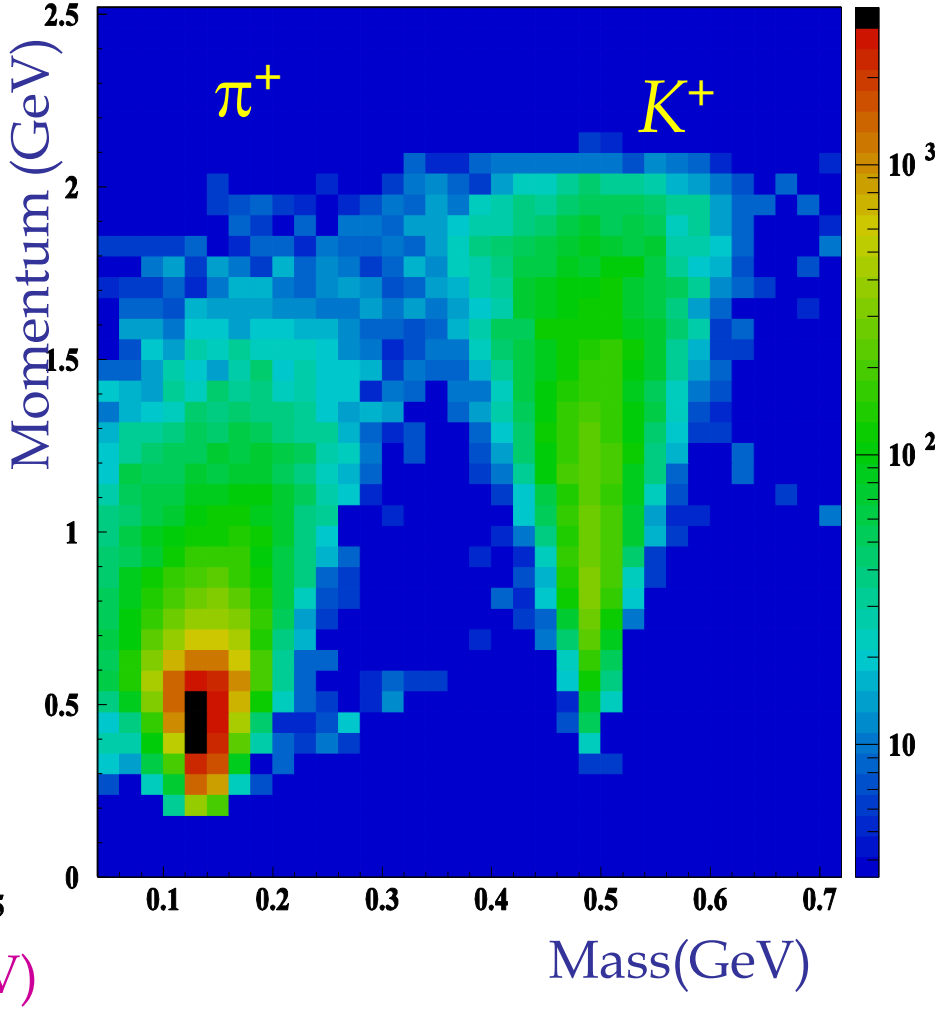
2.4-GeV LEP with Ar laser [351 nm, 6.5 W, CW]
3.0-GeV LEP with Deep-UV laser [257 nm, 1-1.5 W, CW]



Reconstructed mass



K/π separation (+ve charge)



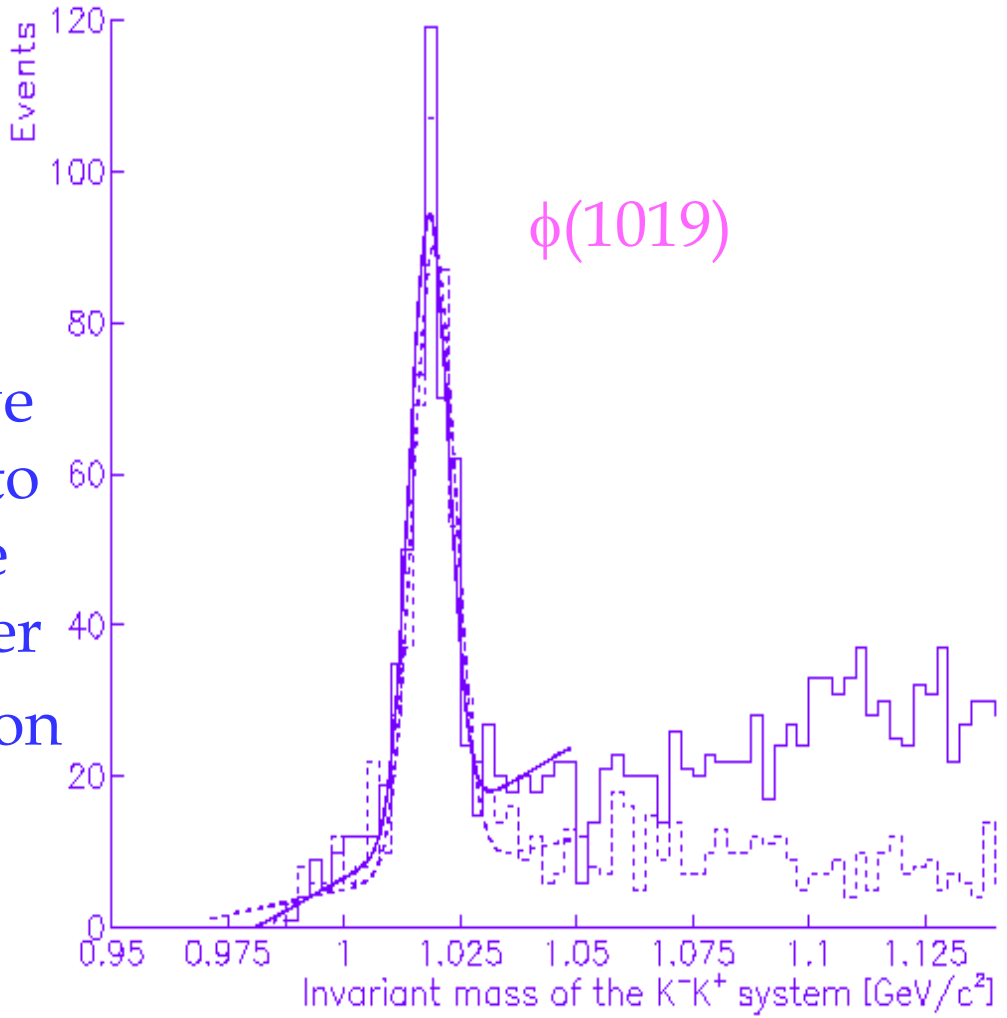
σ(mass) = 30 MeV(typ.) for 1 GeV/c Kaon

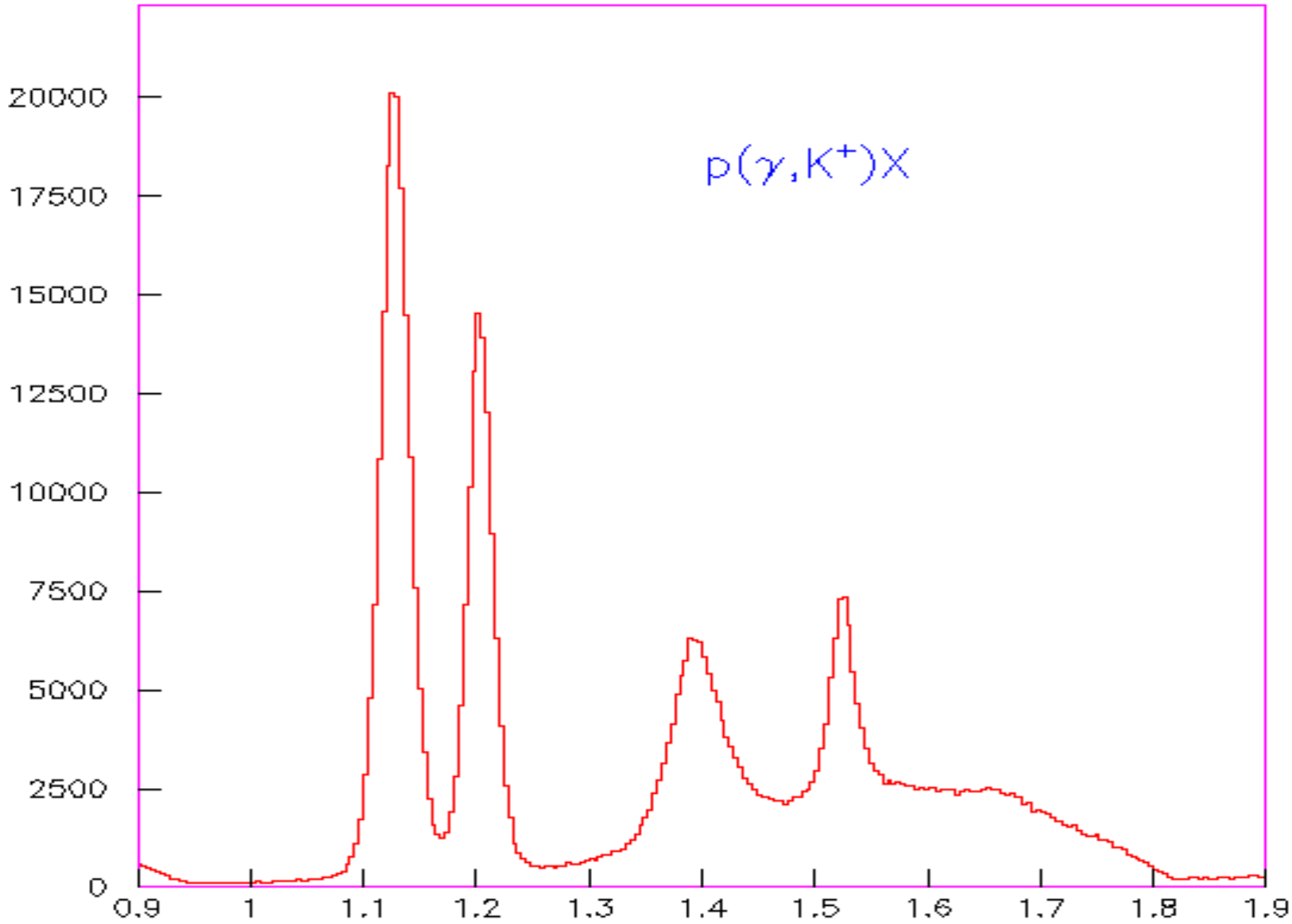
Acceptance for +/− Particles

$$\gamma p \rightarrow K^+ \Sigma^+ \pi^-$$

$$\gamma p \rightarrow K^+ \Sigma^- \pi^+$$

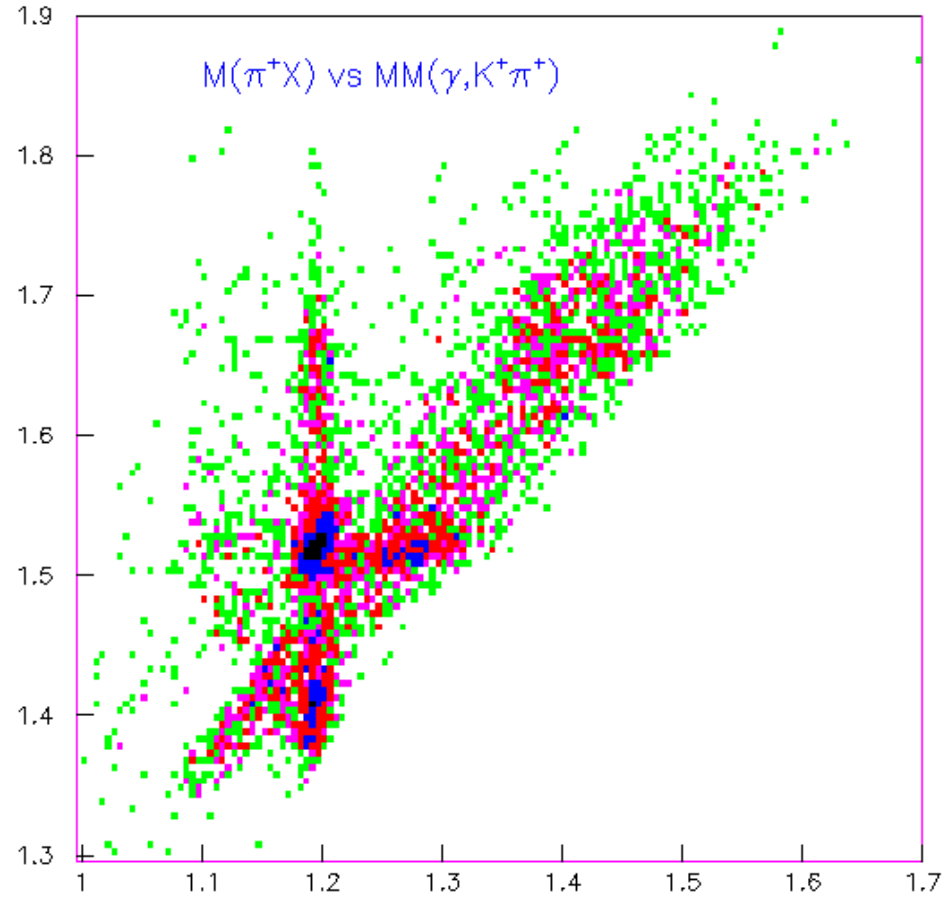
- Equal Acceptance for +ve and –ve particles thank to good performance of the LEPS dipole spectrometer
- The φ(1019) reconstruction from $p(\gamma,K^-p)K^+$ and $p(\gamma,K^+p)K^-$

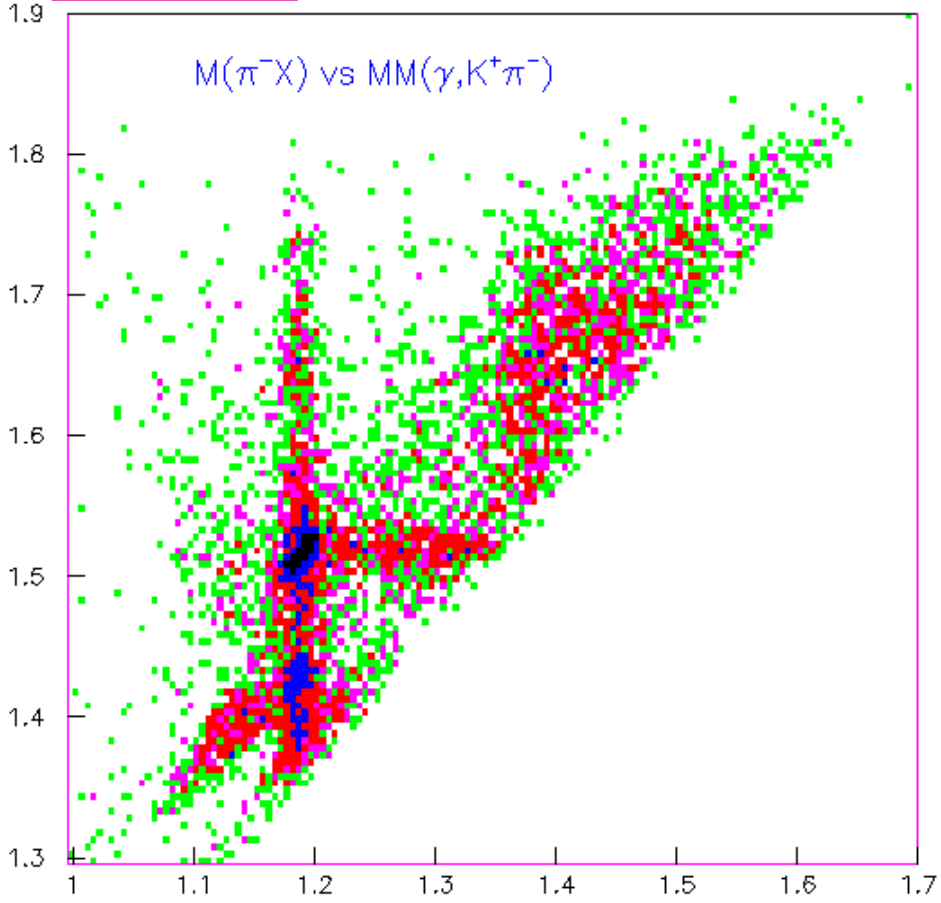


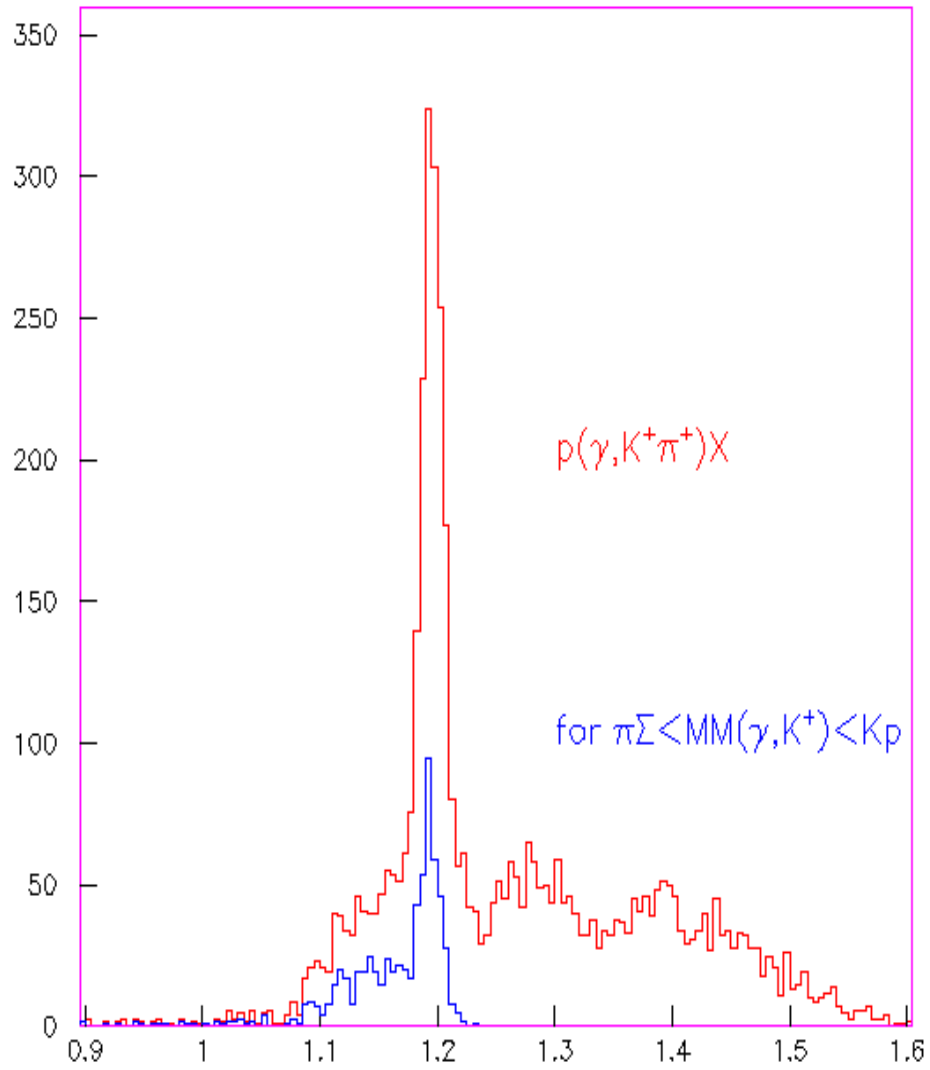

p(γ,K+)X
20000
17500
15000
12500
10000
7500
5000
2500
0
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9

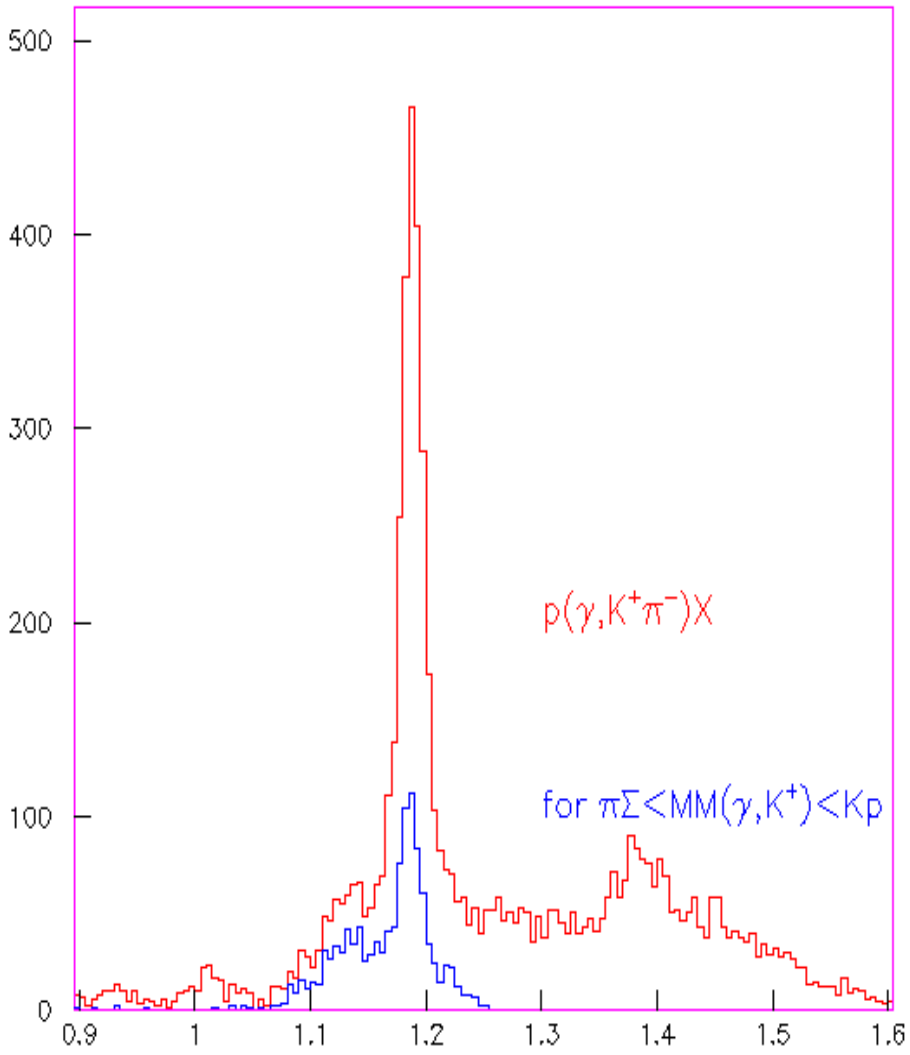
$\gamma p \rightarrow K^+ \pi^- \Sigma^+$

$\gamma p \rightarrow K^+ \pi^+ \Sigma^-$



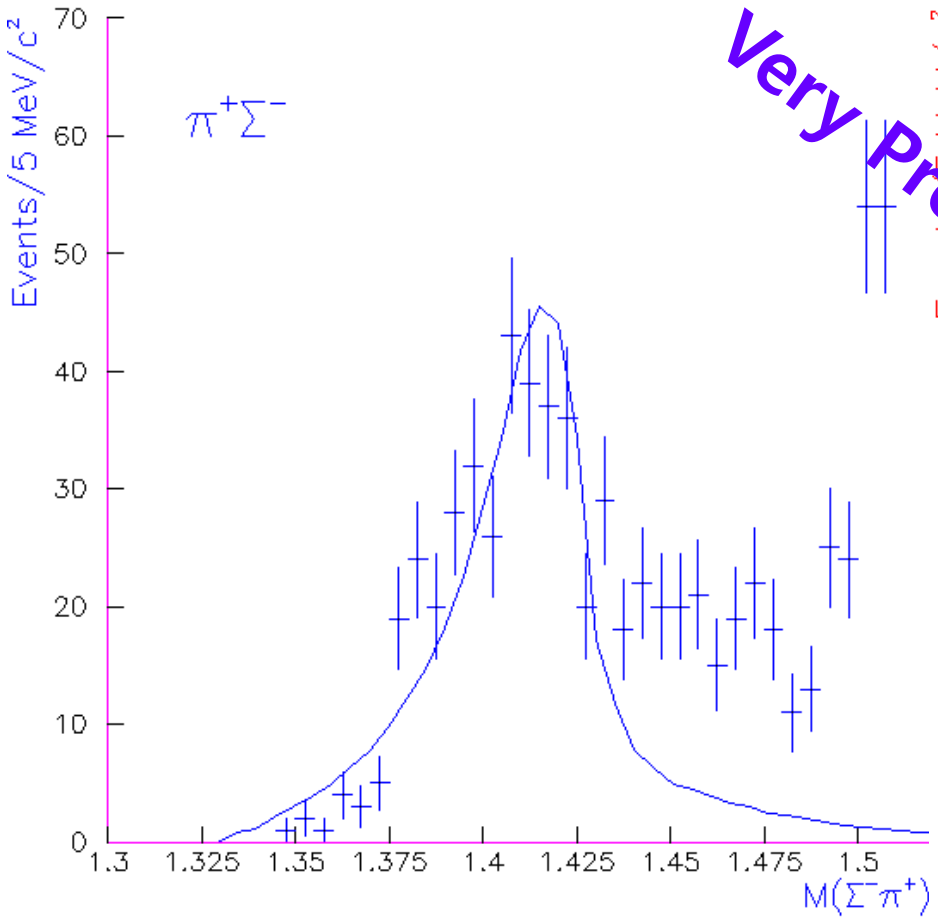


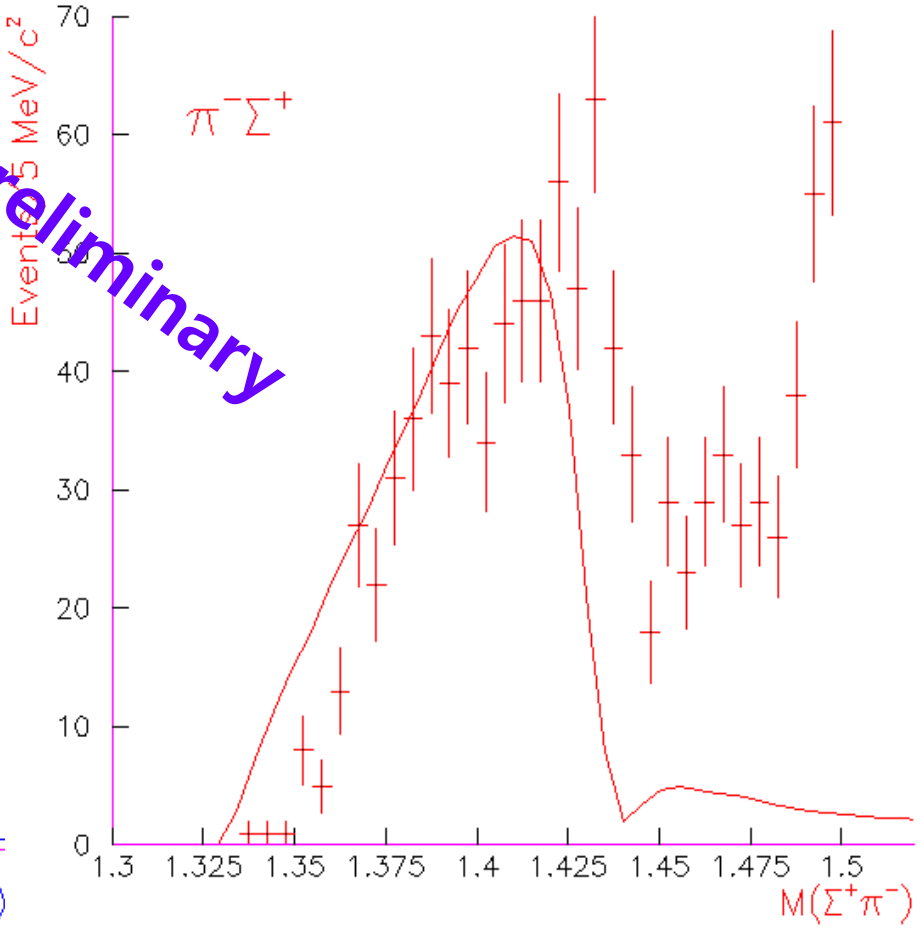

p(γ,K+π+)X
for πΣ<MM(γ,K+)<Kp


p(γ,K+π−)X
for πΣ<MM(γ,K+)<Kp

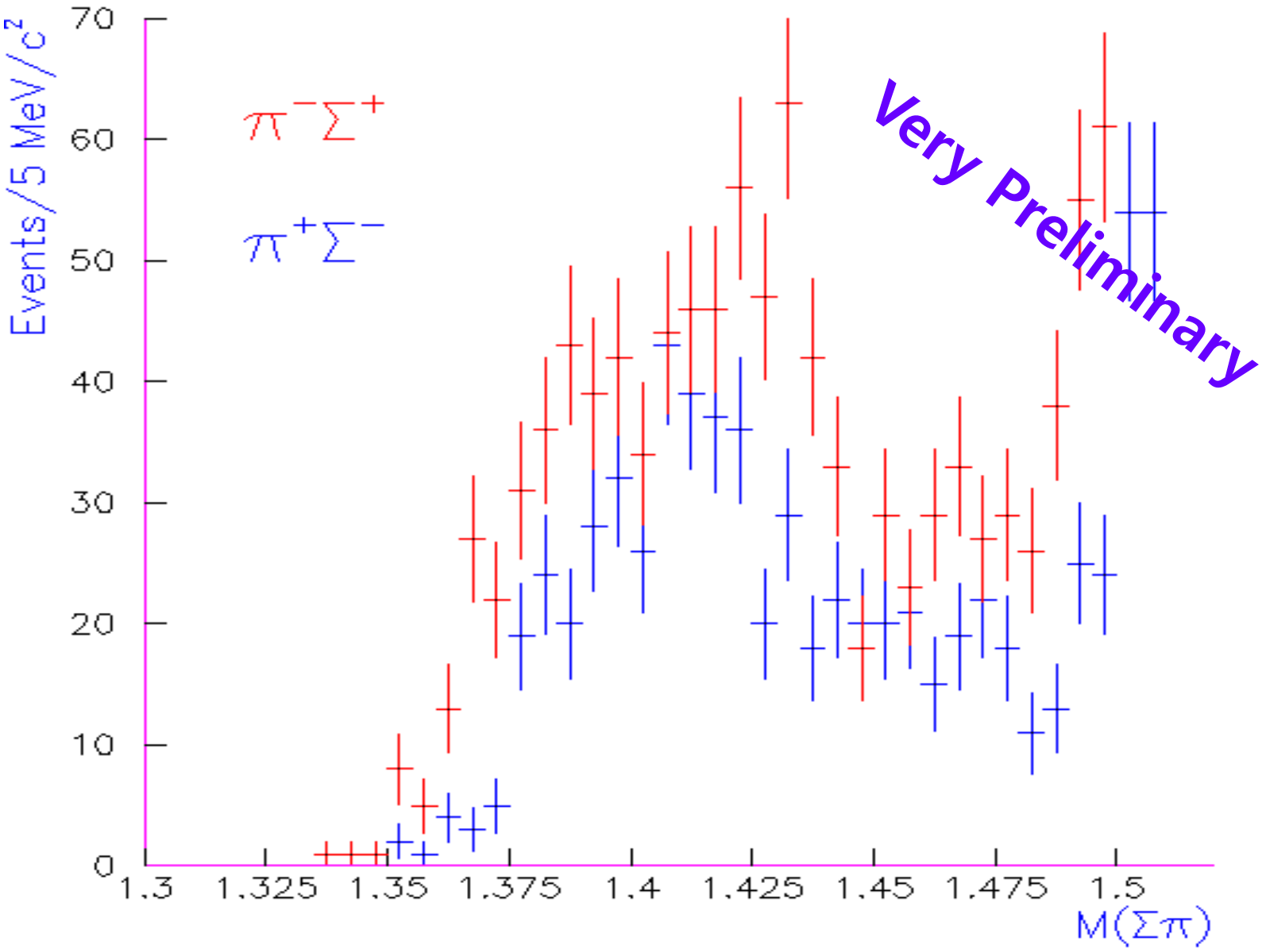
Lineshapes of the Λ(1405) in $\pi^+\Sigma^-$ and $\pi^-\Sigma^+$ Modes

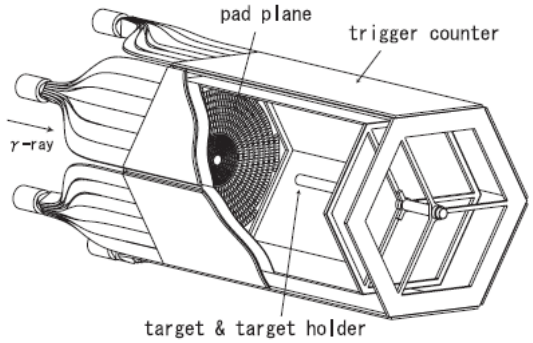
$$\frac{d\sigma(\pi^{\pm}\Sigma^{\mp})}{dM_I} \propto \frac{1}{3}|T^{(0)}|^2 + \frac{1}{2}|T^{(1)}|^2 \pm \frac{2}{\sqrt{6}} Re(T^{(0)}T^{(1)*})$$

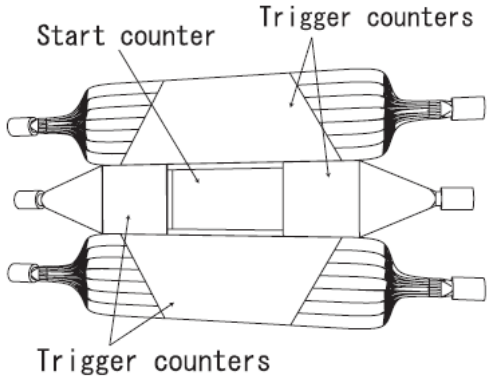


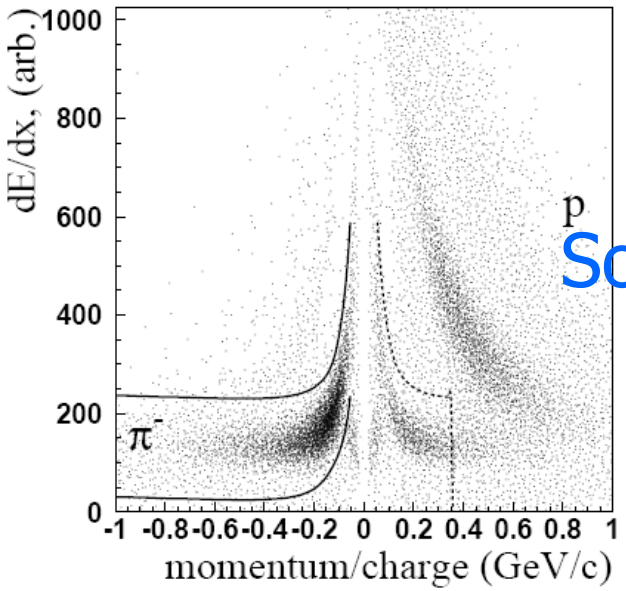


Very Preliminary


Events/5 MeV/c²
70
60
50
40
30
20
10
0
1.3
1.325
1.35
1.375
1.4
1.425
1.45
1.475
1.5
M(Σπ)
π⁻Σ⁺
π⁺Σ⁻
Very Preliminary


pad plane
trigger counter
γ-ray
target & target holder


Start counter
Trigger counters
Trigger counters

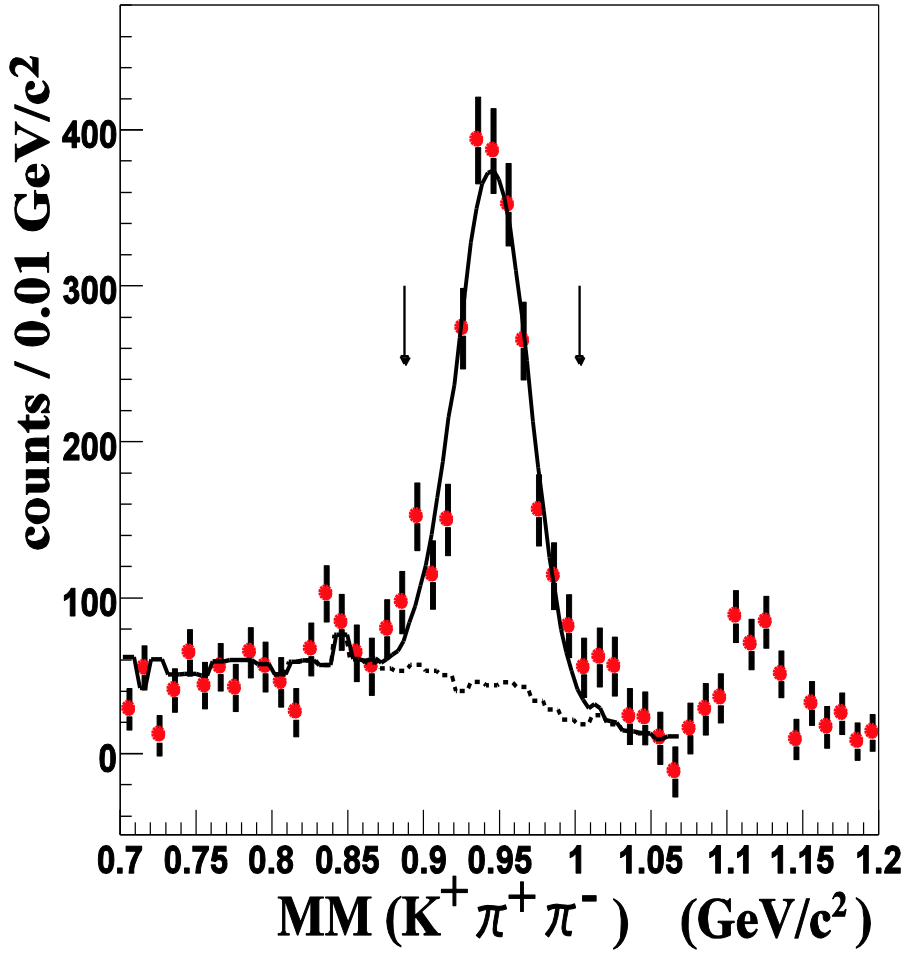

dE/dx, (arb.)
1000
800
600
400
200
0
p
π-
-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1
momentum/charge (GeV/c)

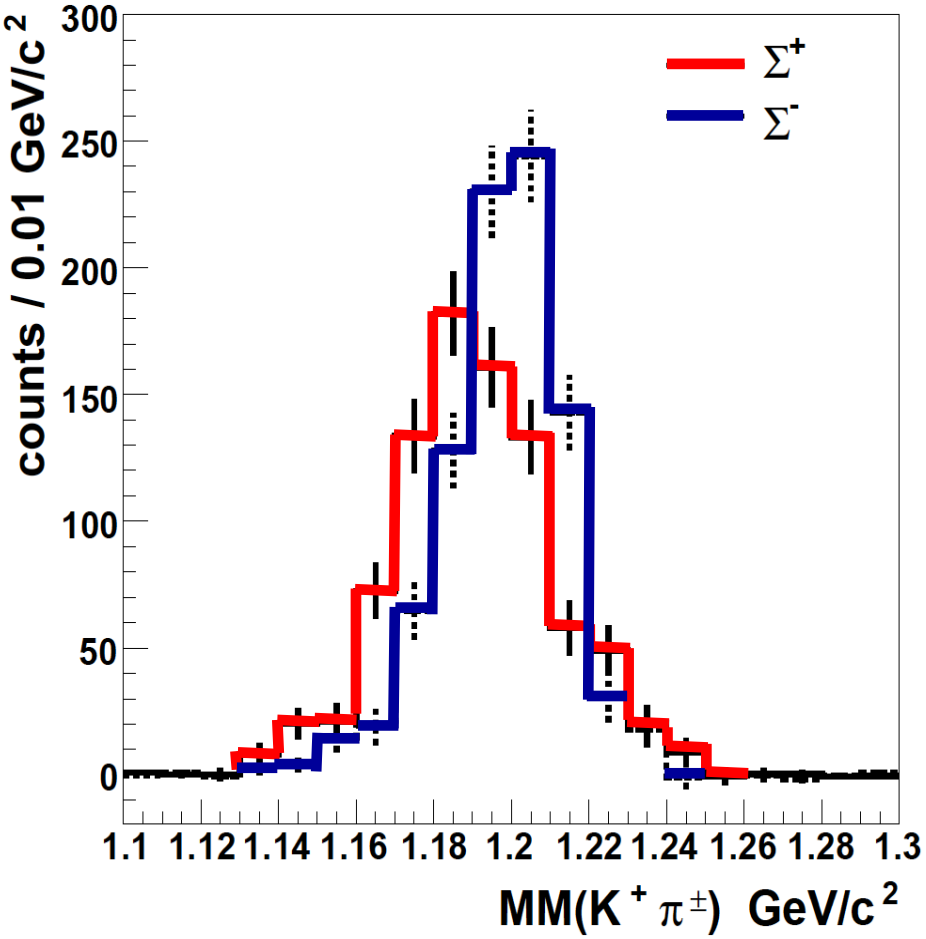
Solenoid
Dipole Spectrometer
Time Projection Chamber
γ

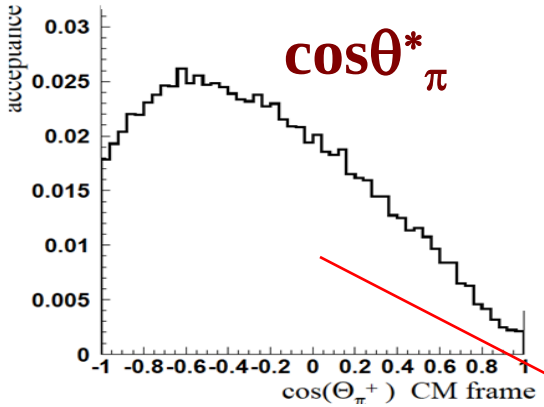
$$\gamma\, p \rightarrow K^+\, \Lambda(1405) \rightarrow K^+ \Sigma^{\pm}\, \pi^{\mp} \rightarrow K^+\, \pi^+\, \pi^-\, n$$

Spectrometer TPC

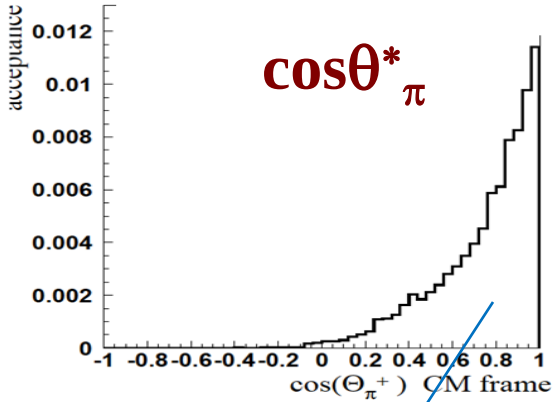
M. Niiyama et al. (LEPS Collaboration), PRC 78, 035202 (2008)

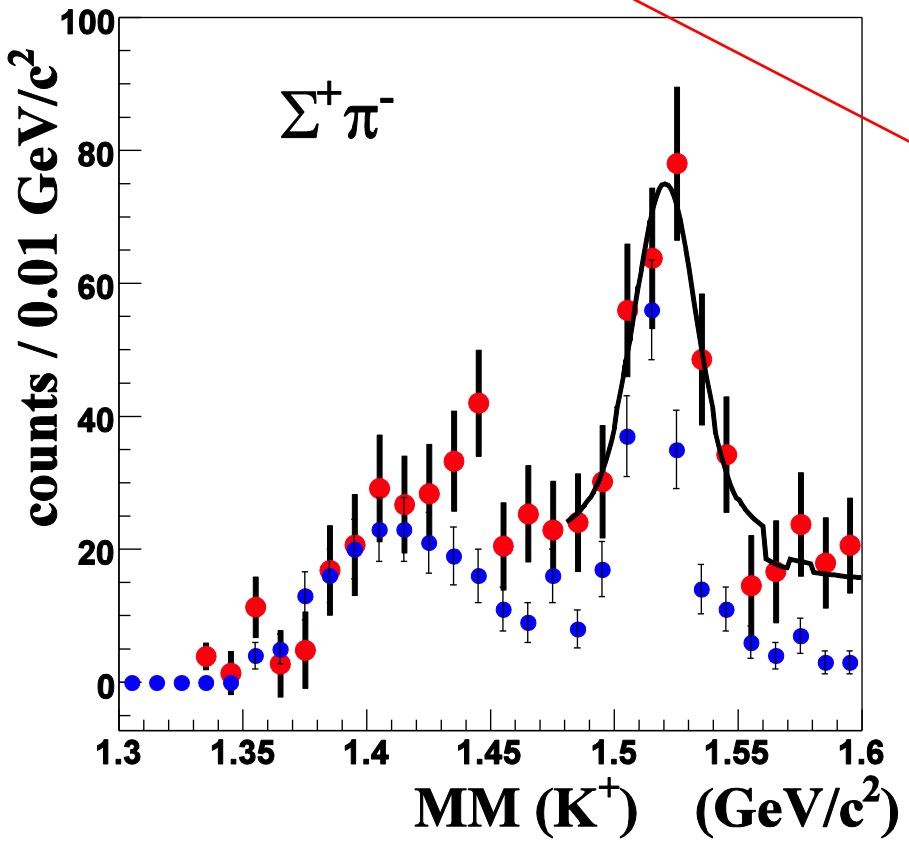


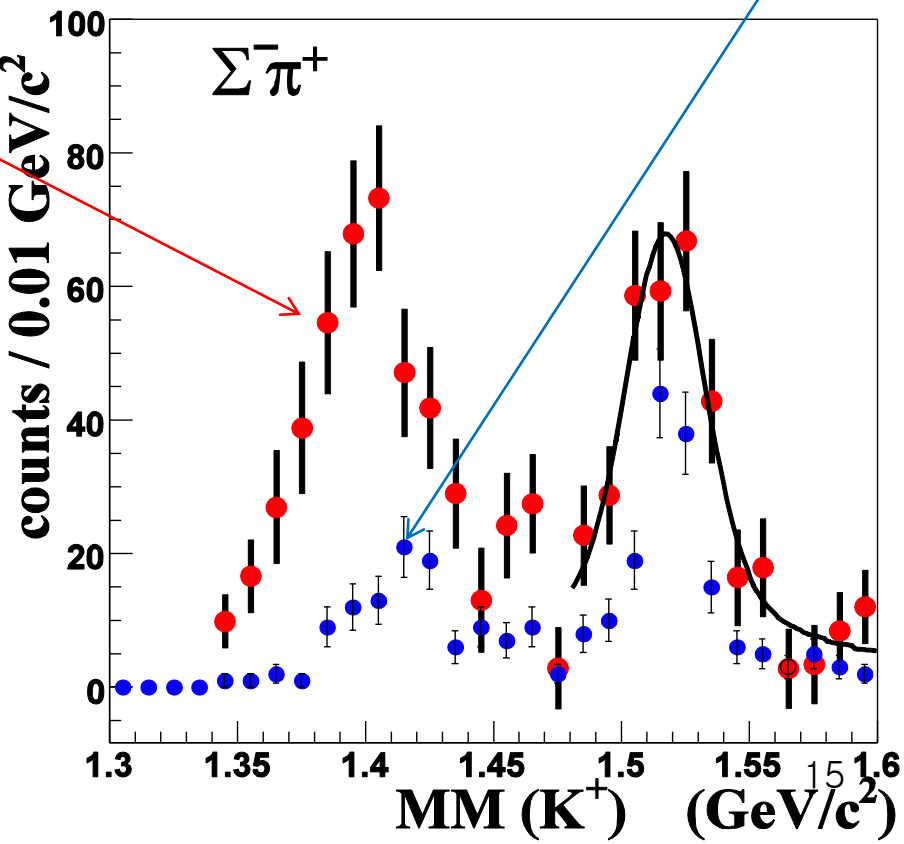




The Λ(1405) Lineshape depends on the decay angles at its rest frame?

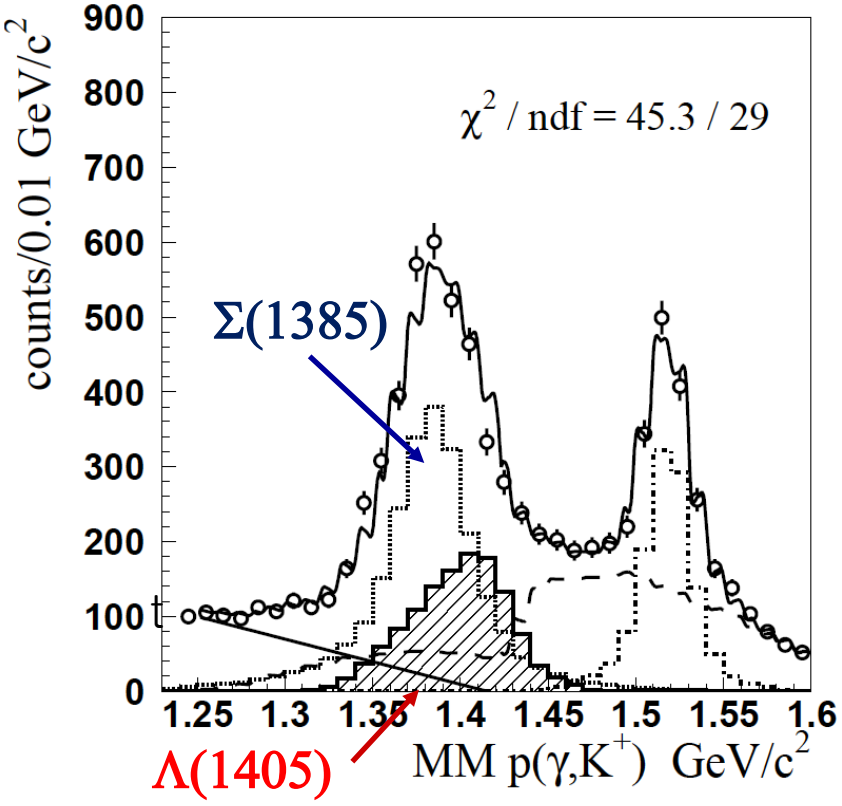


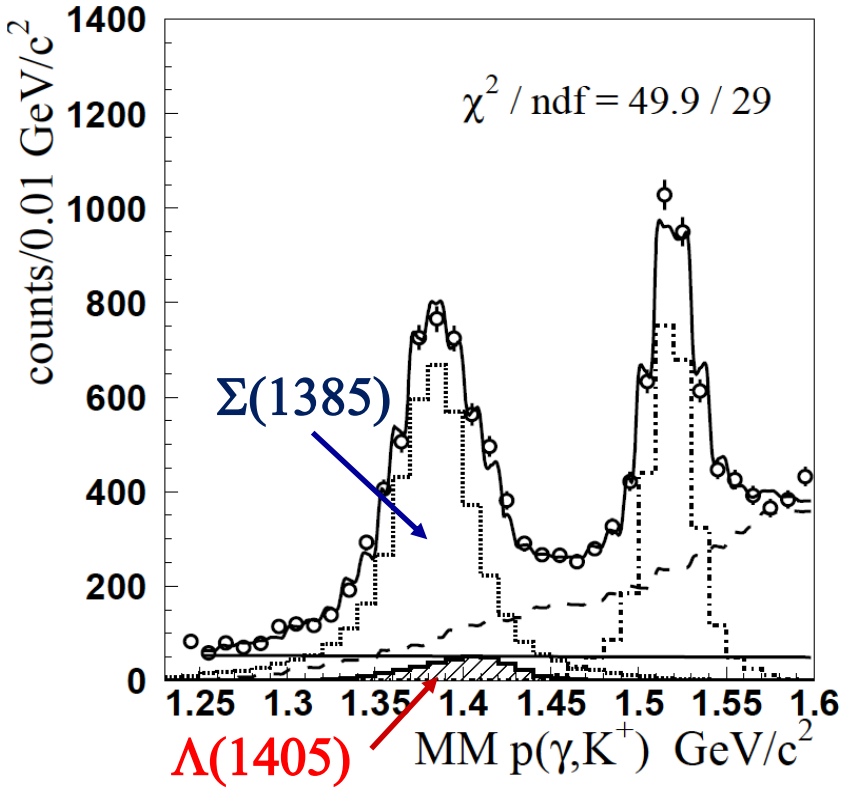


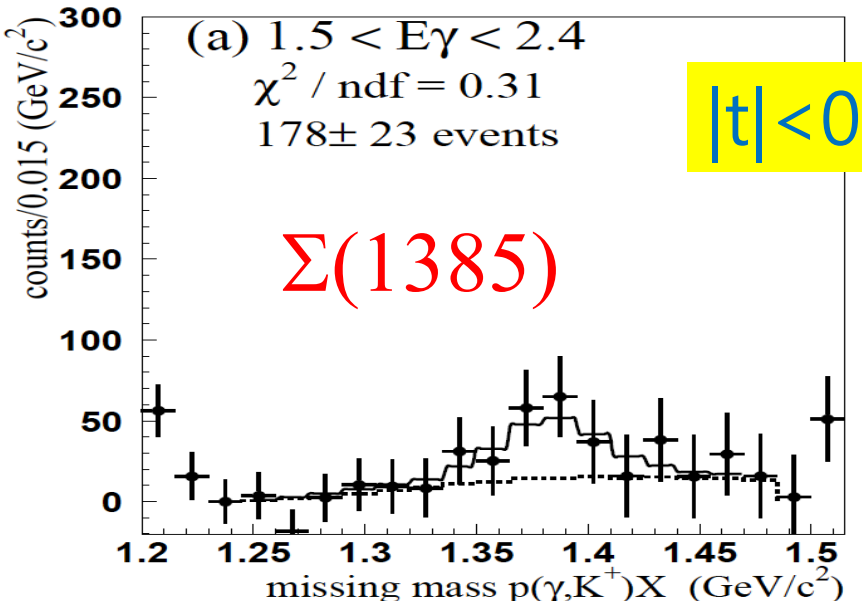


$0.8 < \cos\theta^*_{K^+} < 1.0$

	$1.5 < E_\gamma < 2.0$ GeV	$2.0 < E_\gamma < 2.4$ GeV
	$d\sigma/d(\cos\theta)$ [μb]	$d\sigma/d(\cos\theta)$ [μb]
$\Lambda^*(1405)$	$0.43 \pm 0.088^{+0.034}_{-0.14}$	$0.072 \pm 0.061^{+0.011}_{-0.0056}$
$\Sigma^{*0}(1385)$	$0.80 \pm 0.092^{+0.062}_{-0.27}$	$0.87 \pm 0.064^{+0.13}_{-0.067}$

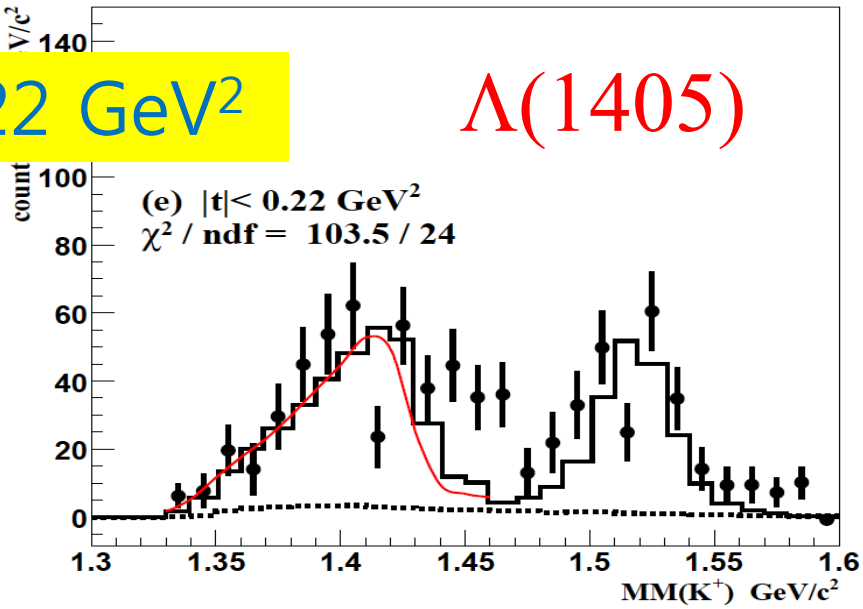


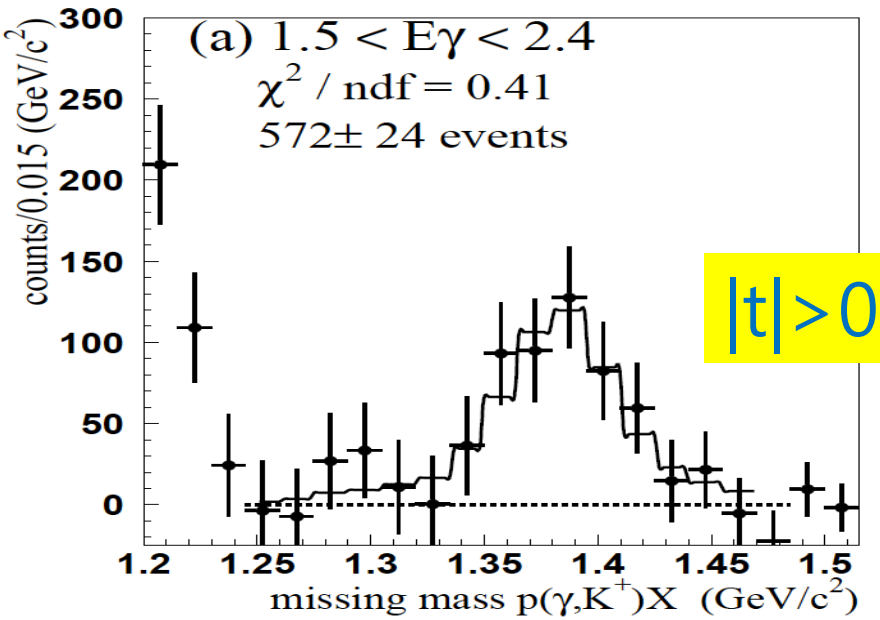




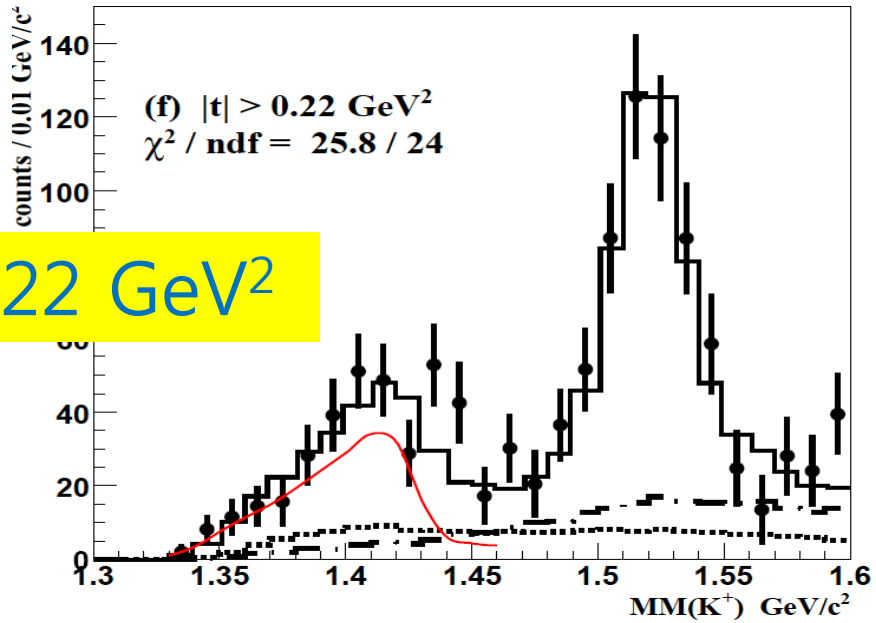
|t|<0.22 GeV²

Λ(1405)





|t|>0.22 GeV²



- We have observed an isospin interference with charged πΣ systems.

- Data from the TPC experiment show different line-shapes of the Λ(1405), which could be due to a possible angular dependence of the isospin interference with charged πΣ systems.

- The Λ(1405) production cross section decreases rap idly as photon energy increases (0.43μb for 1.5-2.0 G eV and 0.072 μb for 2.0-2.4 GeV). New data for 1.5-3. 0 GeV are soon available.

Photoproduction of Λ(1405) and Σ^0(1385) on the proton at E γ =1.5-3.0GeV at SPring-8/LEPS

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