Hyperon Production at ANKE

reaction investigated at ANKE: $pp \rightarrow pK^+Y^0$

Y_{max} at **2.83 GeV:** 1540 MeV/c^2

Y^0: $\Lambda(1116)$, $\Lambda(1405)$, $\Lambda(1520)$
$\Sigma^0(1193)$, $\Sigma^0(1385)$
$Y^{*0}(1480)$

excited hyperon decay modes: $\Lambda\pi$, $\Sigma\pi$ (nK^0, pK^-)

Status (PDG 2006)

- reasonable information:
  Y=Λ_{1116}, Σ_{1200}, $\Sigma(1385)$, $\Lambda(1520)$

- question about $\Lambda(1405)$ nature:

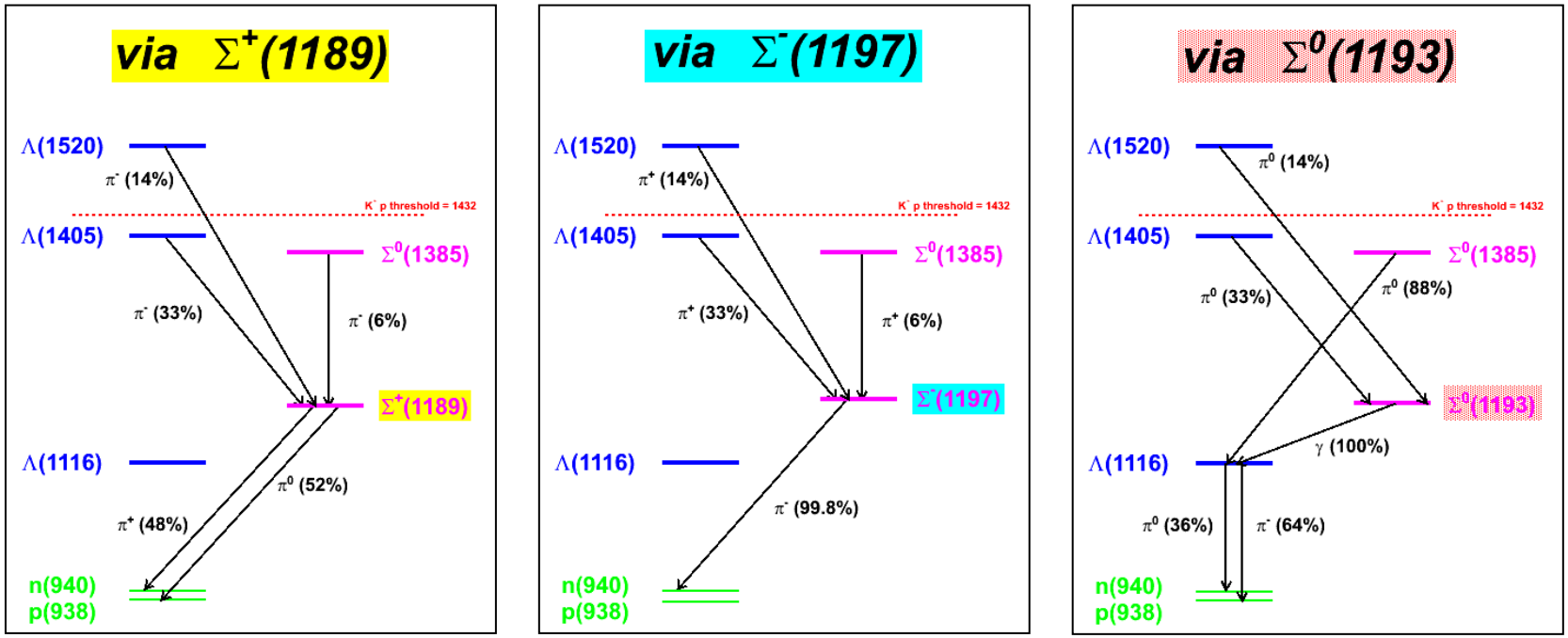
  recent claims for two $\Lambda(1405)$ states

- $Y^0(1480)$ from ANKE in 2005

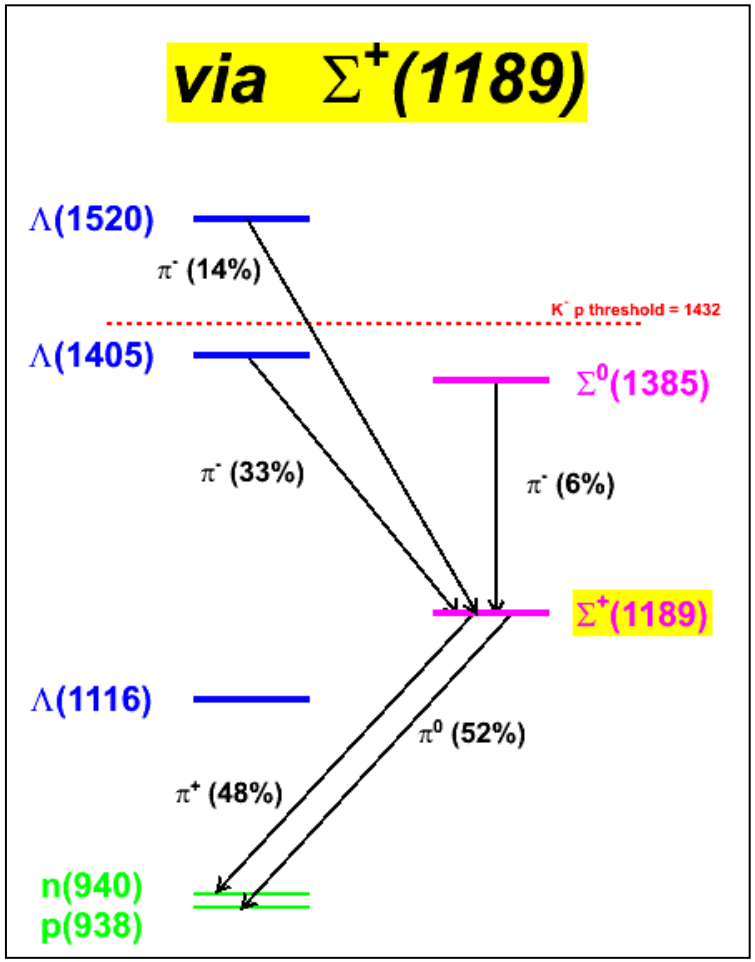
Properties of neutral strange baryons

	mass (MeV/c^2)	FWHM (MeV/c^2)
Λ_{1116}	1115.683±0.006	$(2.50\pm0.02)\cdot10^{-12}$
Σ^0_{1193}	1192.642±0.024	0.0089±0.0009
$\Sigma^0(1385)$	1383.7±1.0	36±5
$\Lambda(1405)$	1406 ±4	50 ±2
$Y^*(1480)$	1480±15	60±15
$\Lambda(1520)$	1519.5 ±1.0	15.6 ±1.0

Decay modes of the hyperons

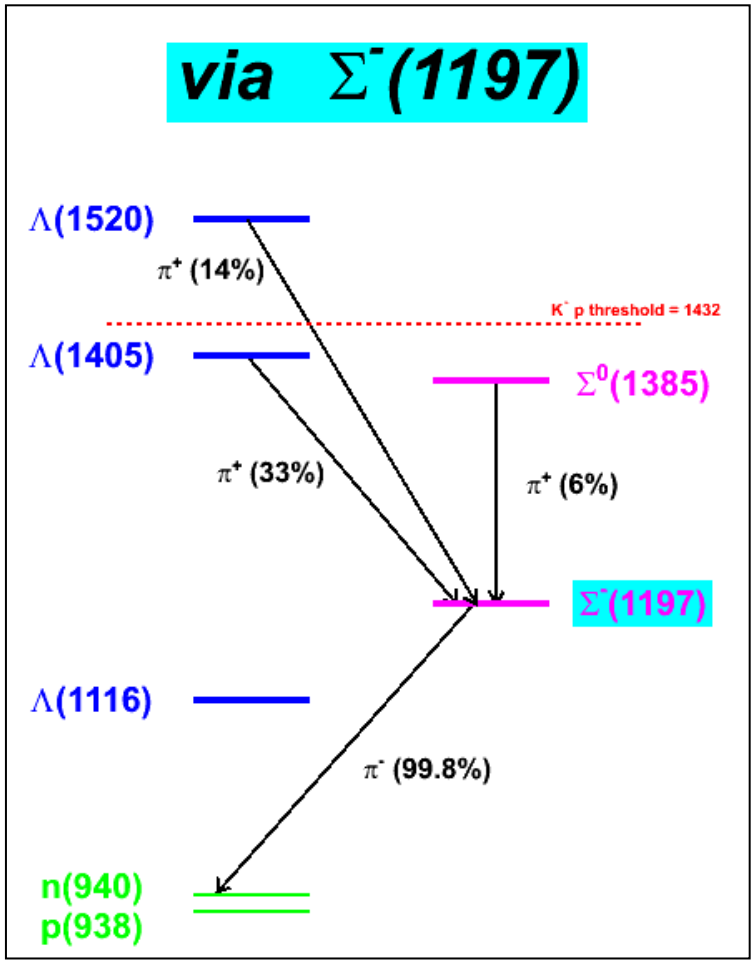


Decay modes of the hyperons



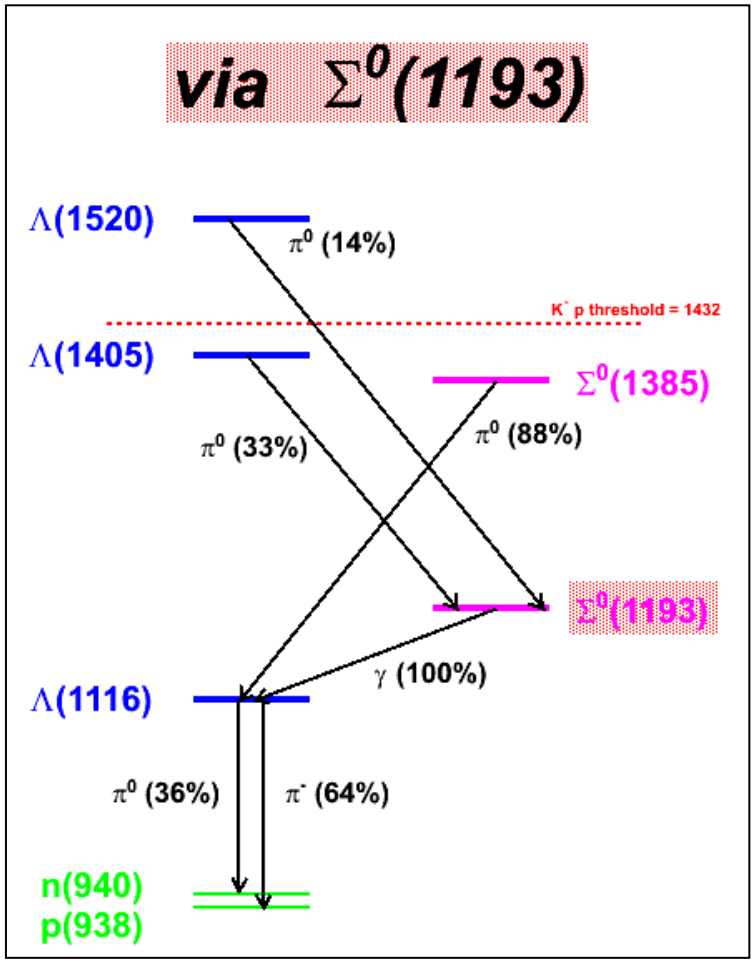
CONCLUSION:
the same final state
$pK^+p\pi^0\ \pi^-$
for $\Sigma^0(1385)$ and $\Lambda(1405)$

Decay modes of the hyperons



CONCLUSION:
the same final state
$pK^+n\pi^-\pi^+$
for $\Sigma^0(1385)$ and $\Lambda(1405)$
without 2nd proton

Decay modes of the hyperons



CONCLUSION:

for $\Sigma^0(1385)$: $pK^+p\pi^-\pi^0$

for $\Lambda(1405)$: $pK^+p\pi^-\pi^0\gamma$

Y^0 decays to $\Lambda\pi^0$ and $\Sigma^0\pi^0$

$$pp \rightarrow pK^+\Sigma^0(1385) \rightarrow pK^+\Lambda\pi^0 \rightarrow pK^+p\pi^-\pi^0$$

- cut on Λ (inv(p, π^-))
- cut on MM_4($pK^+p\pi$) around π^0
- non-resonant background $pp \rightarrow pK^+\Lambda\pi^0 \rightarrow pK^+\pi^-p\ \pi^0$
- background below Λ
- …

CONCLUSION: $\Sigma^0(1385)$ obtained from its decay to $\Lambda\pi^0$

Y^0 decays to $\Lambda\pi^0$ and $\Sigma^0\pi^0$

$$pp \rightarrow pK^+\Lambda(1405) \rightarrow pK^+\Sigma^0\pi^0$$
$$\rightarrow pK^+\Lambda\gamma\pi^0 \rightarrow pK^+p\pi^-\pi^0\gamma$$

- cut on Λ: result sensitive to this cut
- cut on $MM_4(pK^+p\pi) > \pi^0$, left: $\pi^0\gamma$, $2\pi^0$,$3\pi^0$ etc.
  - almost no $\Sigma^0(1385)$
  - $\Lambda(1405)$, $\Lambda(1520)$ and non-resonant contributions
- background below Λ
- …

CONCLUSION: $\Lambda(1405)$ obtained from its decay to $\Sigma^0\pi^0$

Experiment

- 2.83 GeV protons on H_2 cluster-jet target in 2005
- triple coincidences T1=(Te(K^+)+SW(K^+) & Fd & Nd)
- possible event selection with and without delayed veto

- *particle in Te or SW*
- *particle in Nd*
- *particle in Fd*

Precisely:

- *K^+ in positive detector (now: Te(5-15))* — *maybe in SW*
- *p in forward and positive detector (now: Te(5-15))* — *in SW*
- *π^- in negative detector*

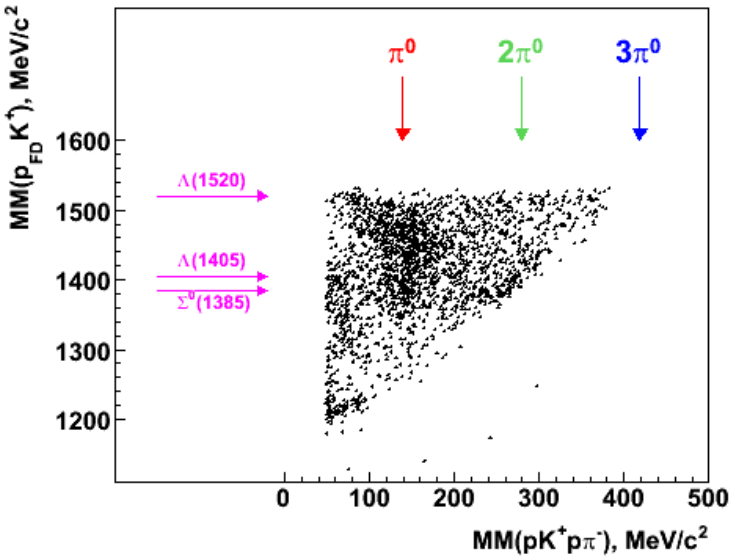
Experiment

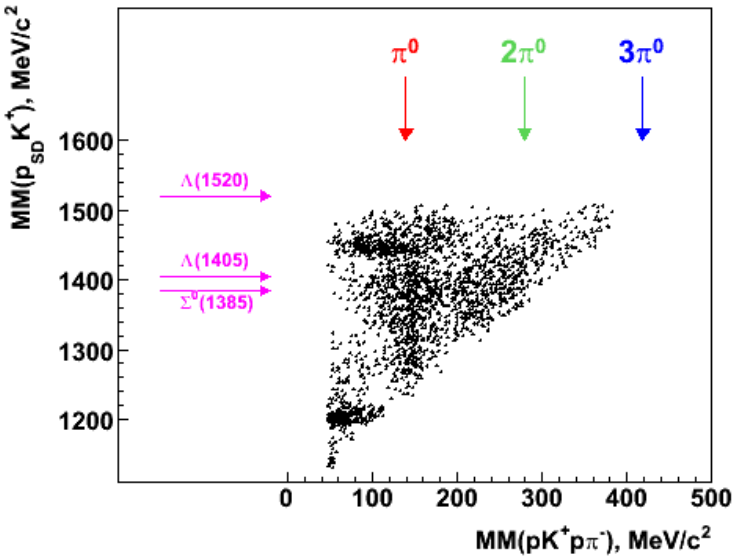
2.83 GeV $pp \rightarrow p_{FD} K^+ p_{SD} \pi^- X^0$

- missing mass of 4 particles: K^+, π^-, p_{FD}, p_{SD}
- invariant mass: $p_{SD/FD}$ and π^-

- missing mass of 2 particles: K^+ and $p_{FD/SD}$

MM($p_{FD/SD}$ K^+) vs MM($p_{FD/SD}$ K^+ $p_{SD/FD}$ π^-)

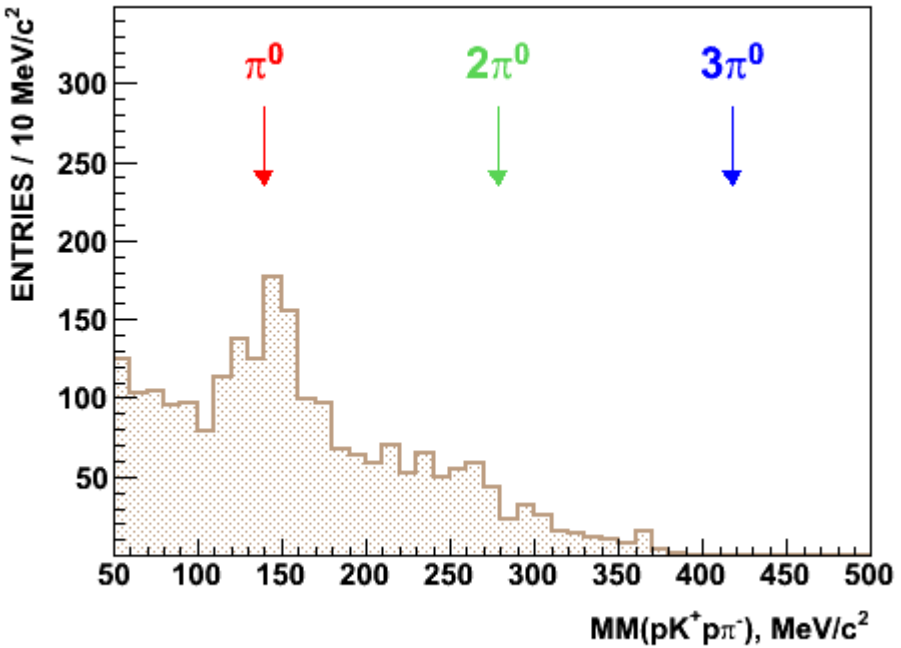




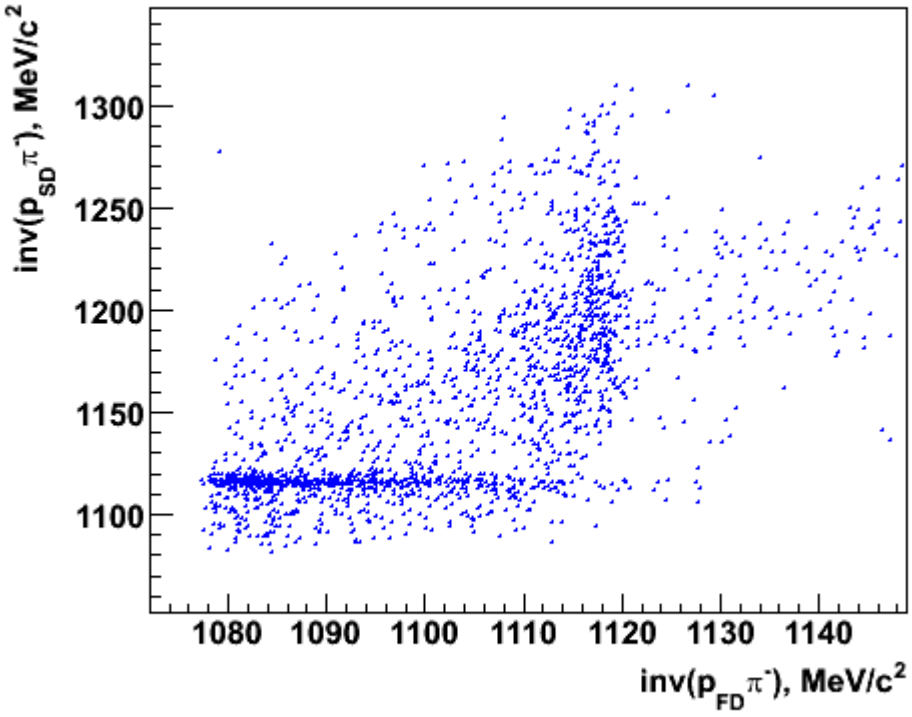
$\Lambda_{SD} \rightarrow p_{SD}\pi^-$

$\Lambda_{FD} \rightarrow p_{FD}\pi^-$

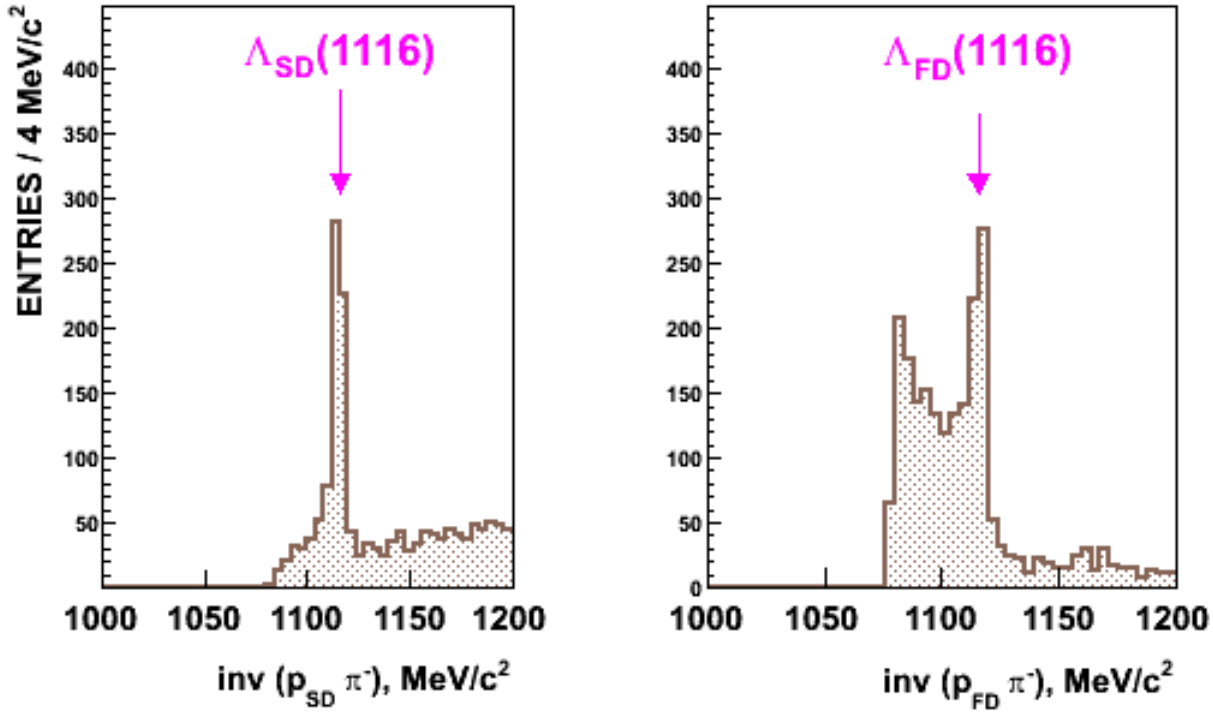
MM($p_{FD/SD}$ K^+ $p_{SD/FD}$ π^-)

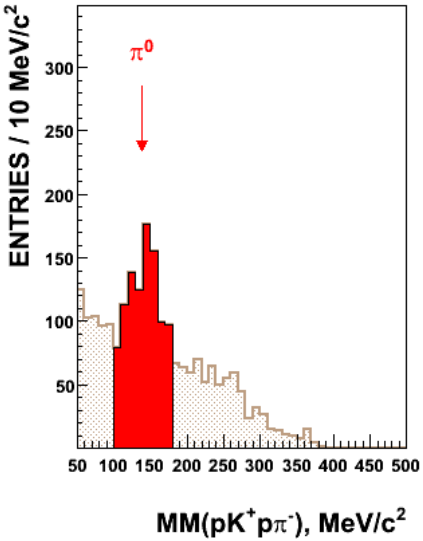


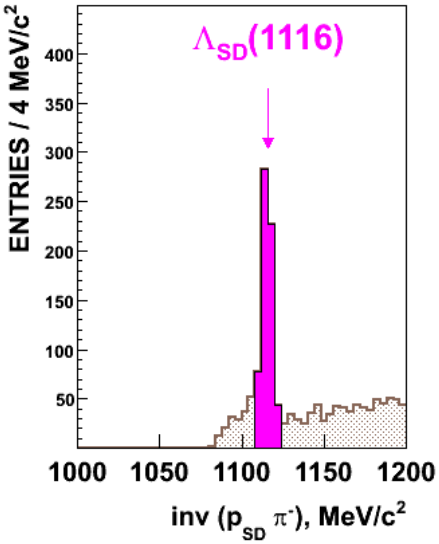
Invariant mass inv($p_{SD/FD}$ π^-)

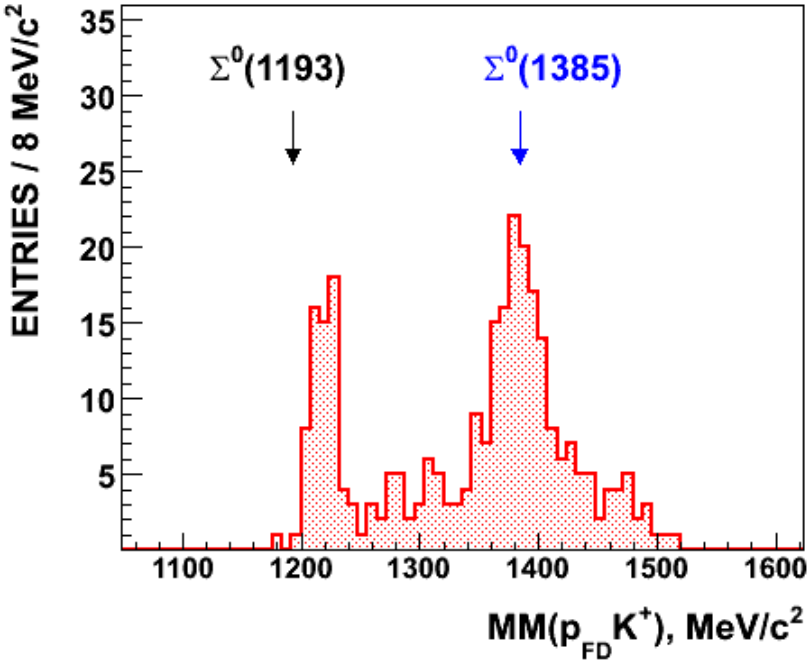


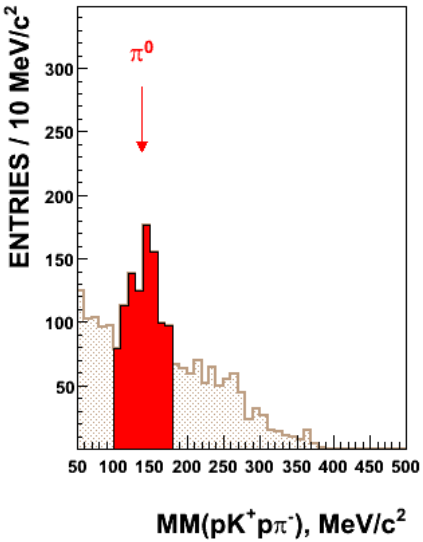
Invariant mass inv($p_{SD/FD}$ π^-)

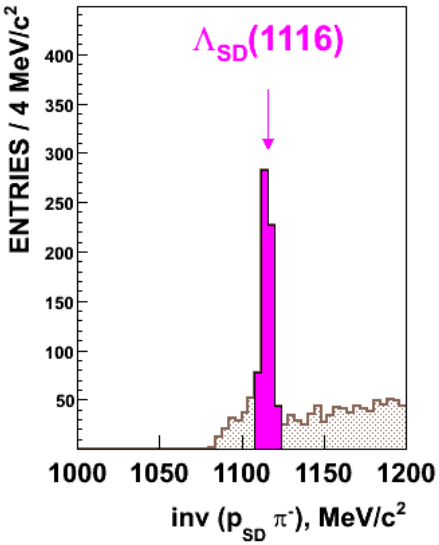


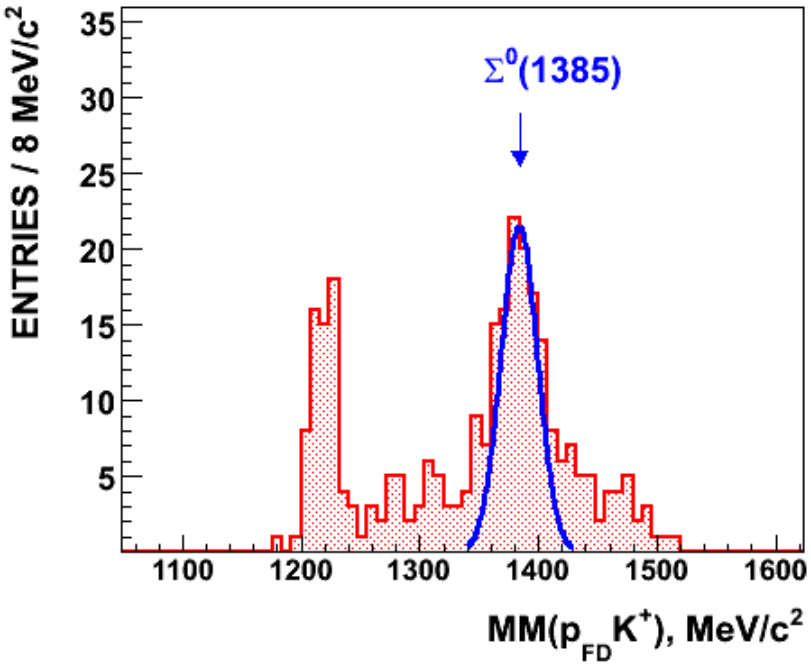


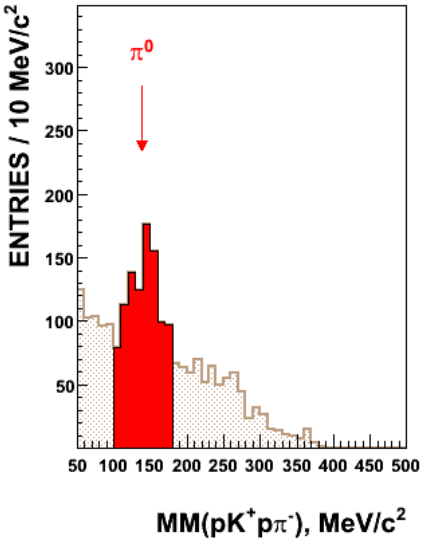


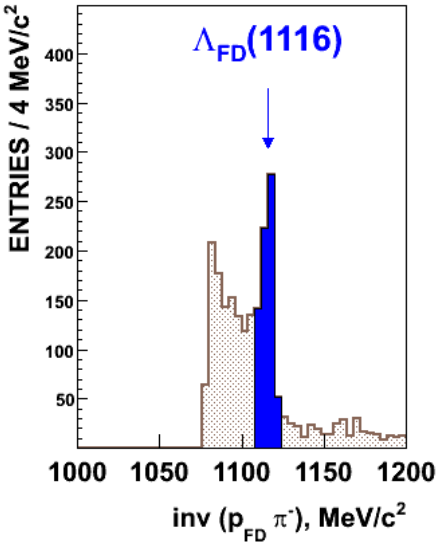


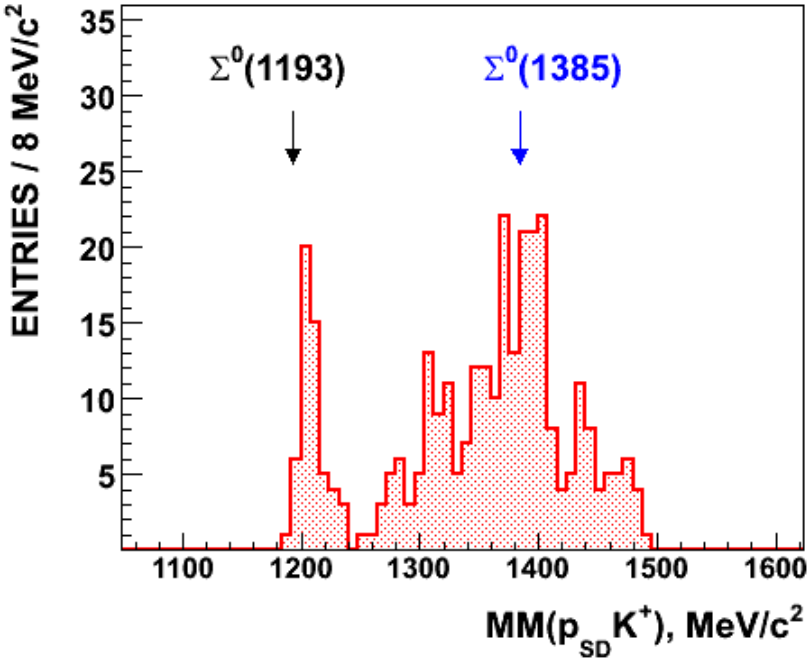


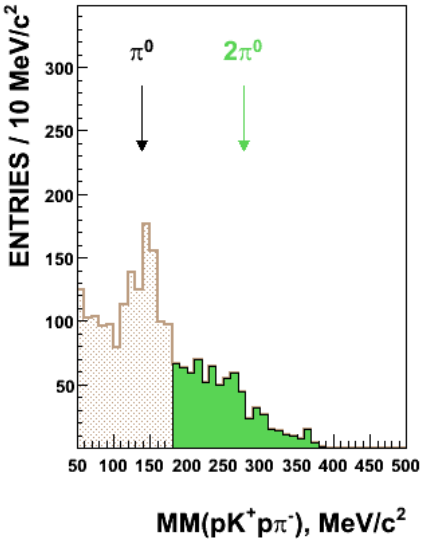


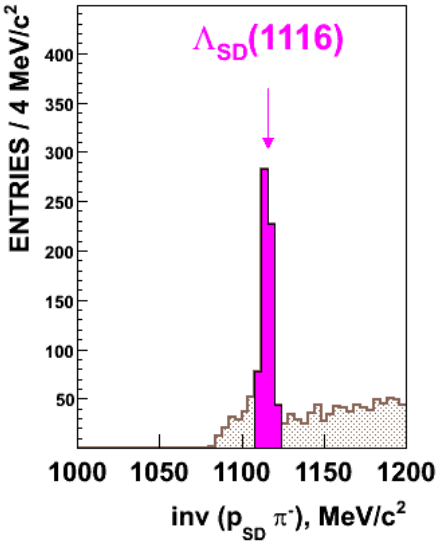


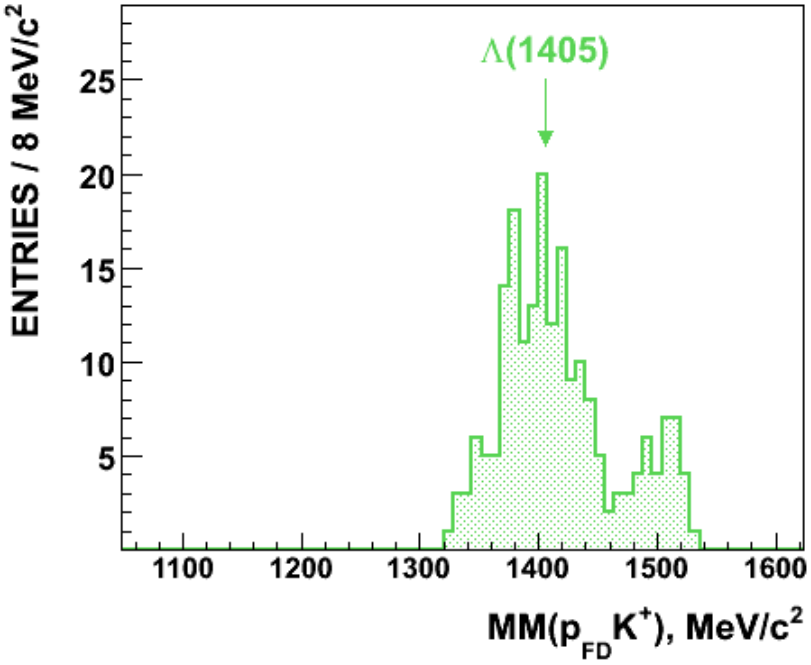


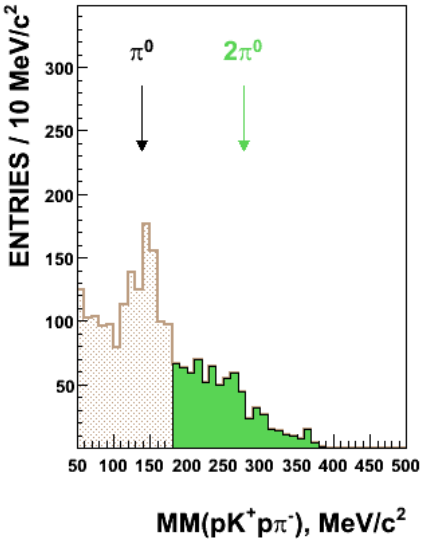


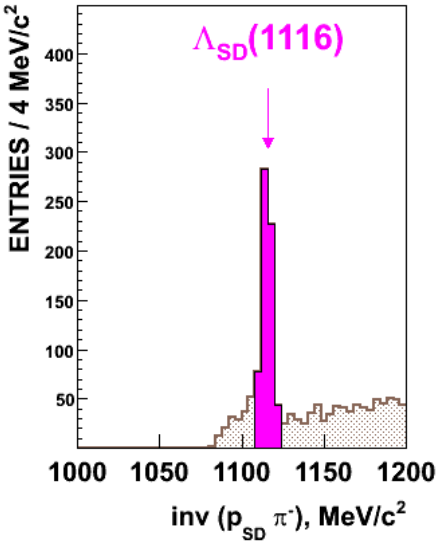


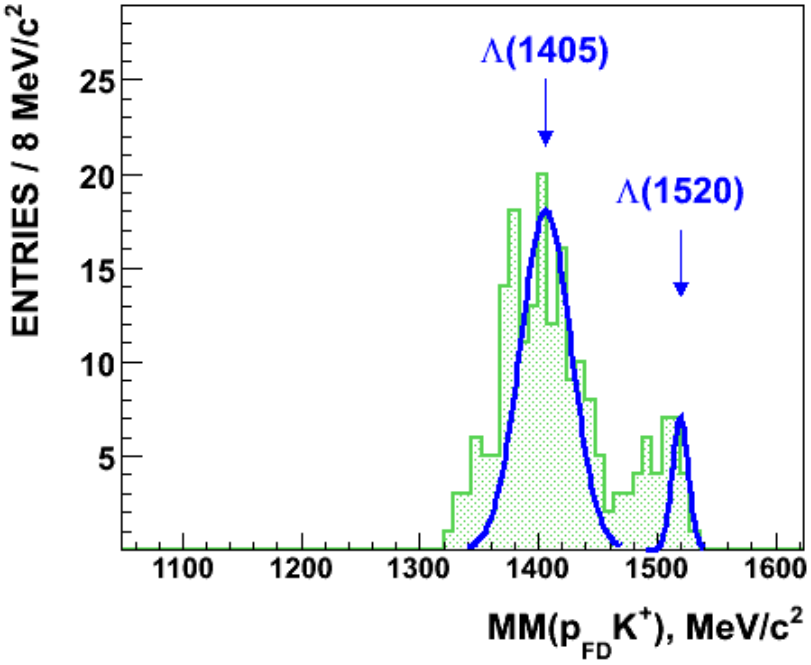


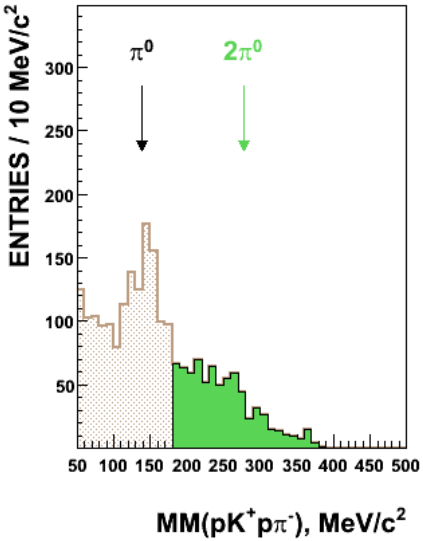


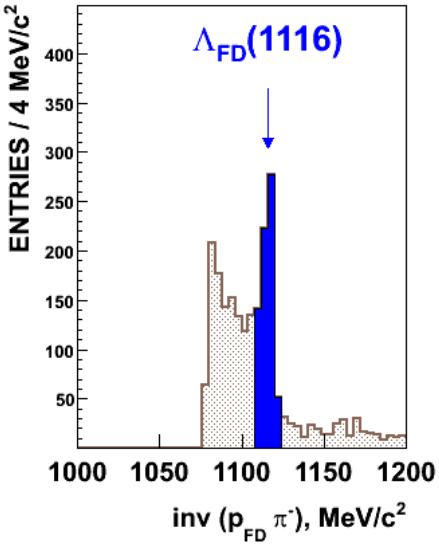


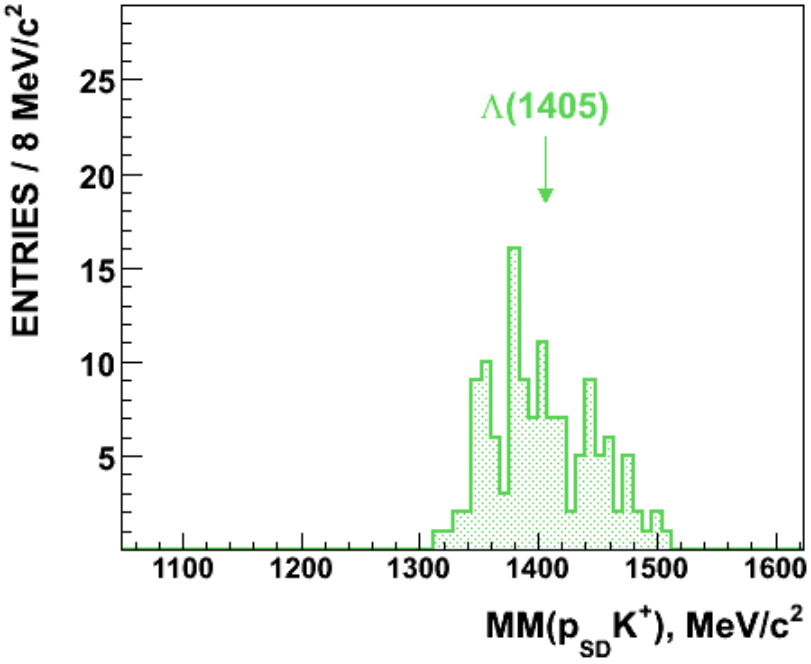




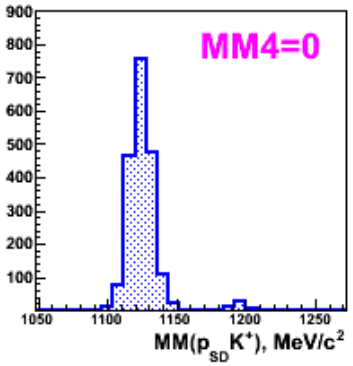


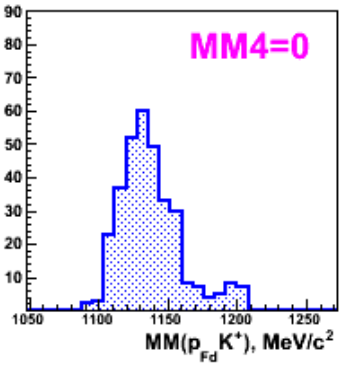


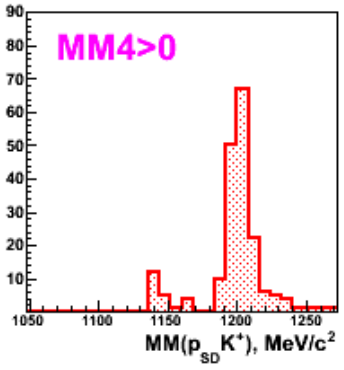


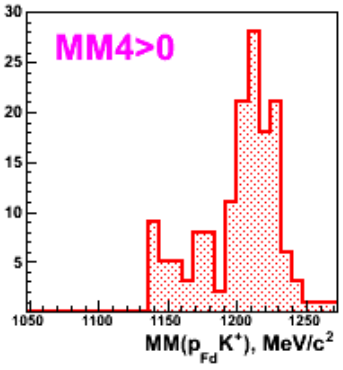


$\Lambda(1116)$ and $\Sigma^0(1193)$

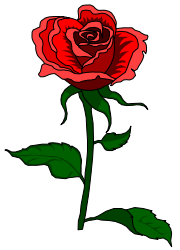




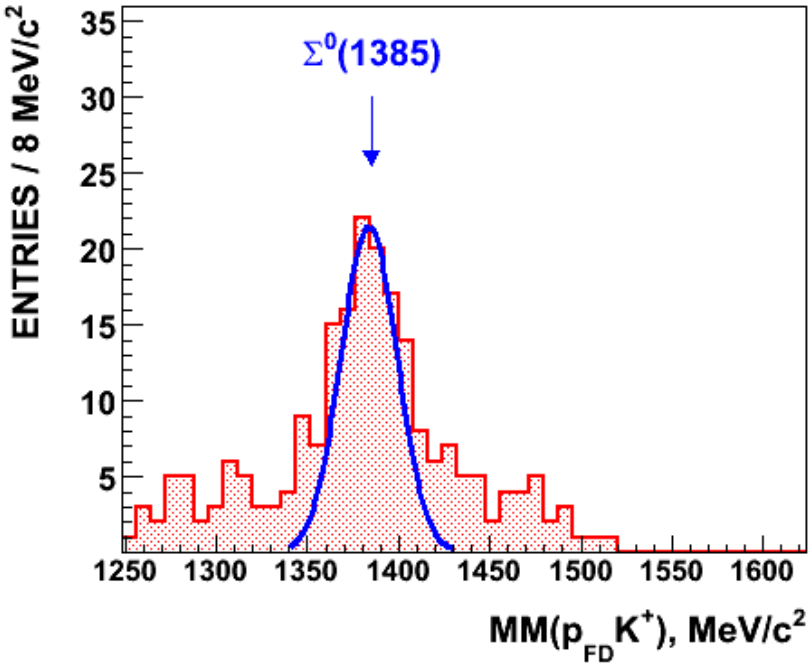


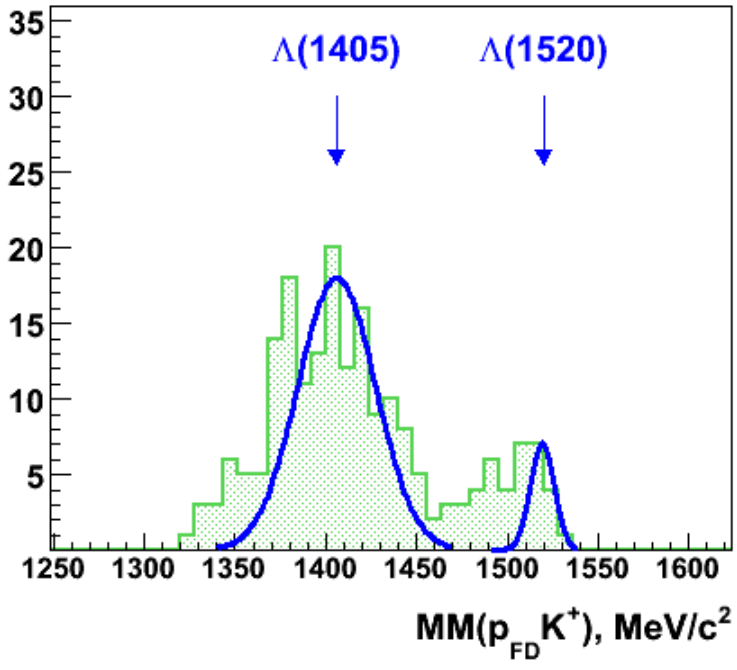


Summary

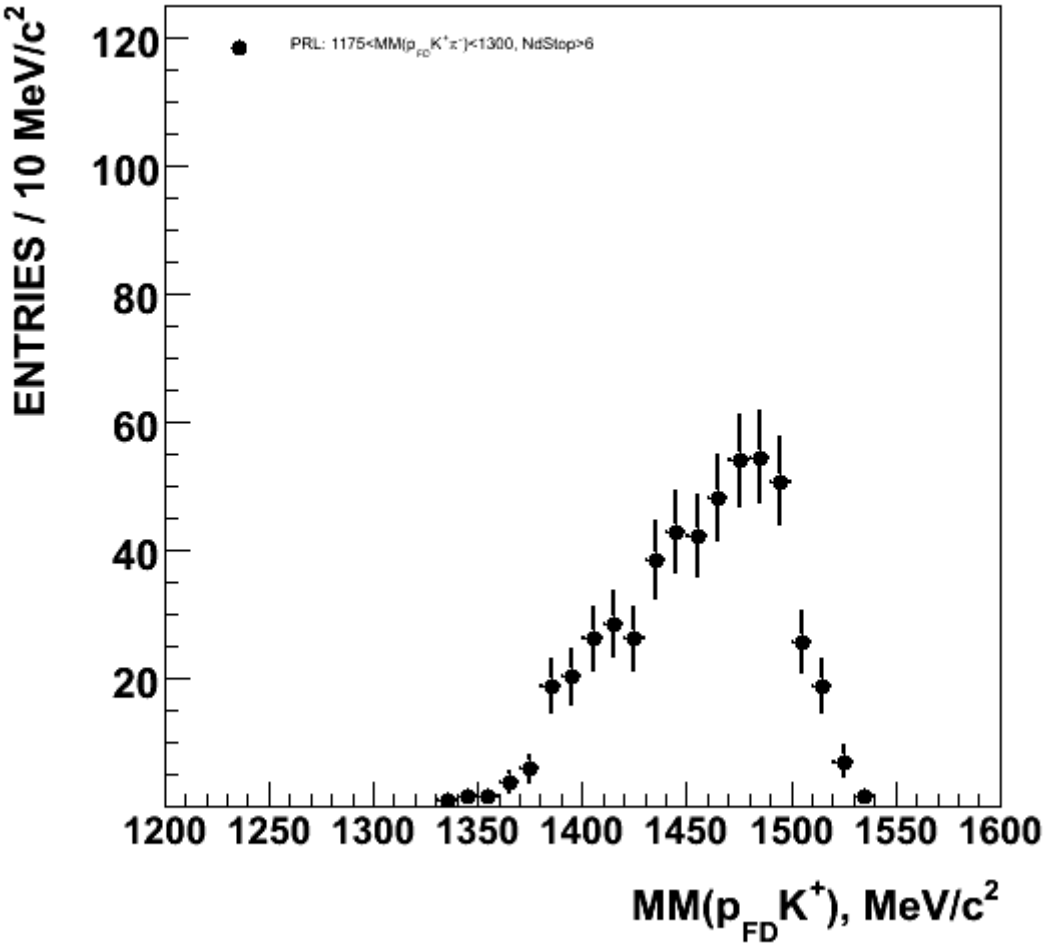


cross section for $\Sigma^0(1385)$ and $\Lambda(1405)$ in 2.83 GeV $pp \rightarrow pK^+Y^0$

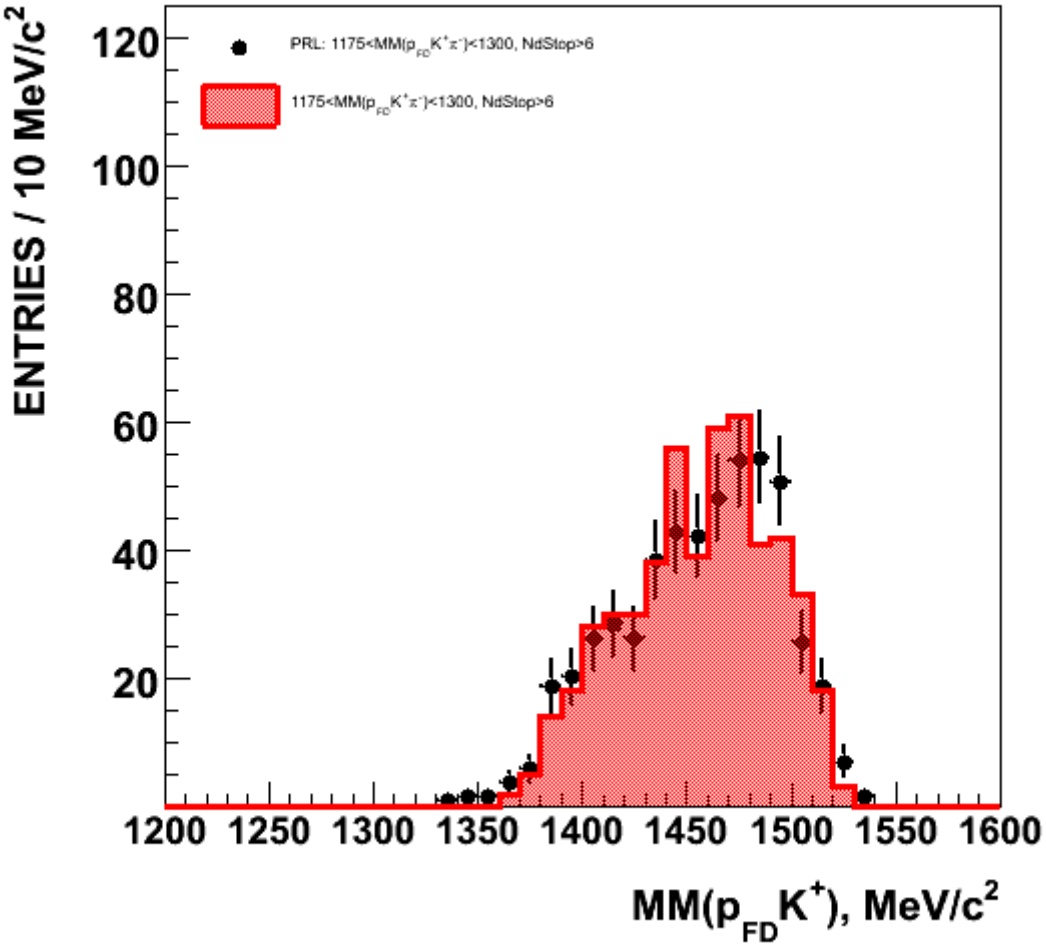




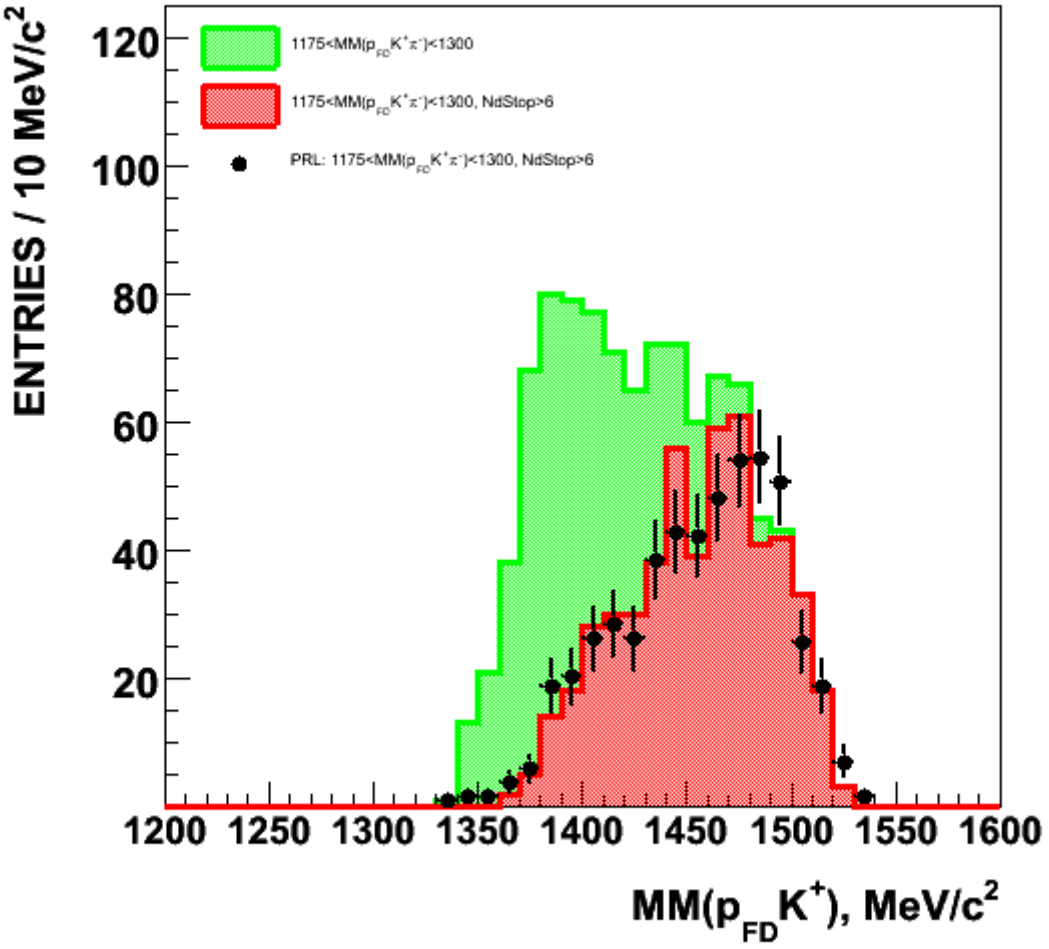
COMPARISON WITH 2002 DATA



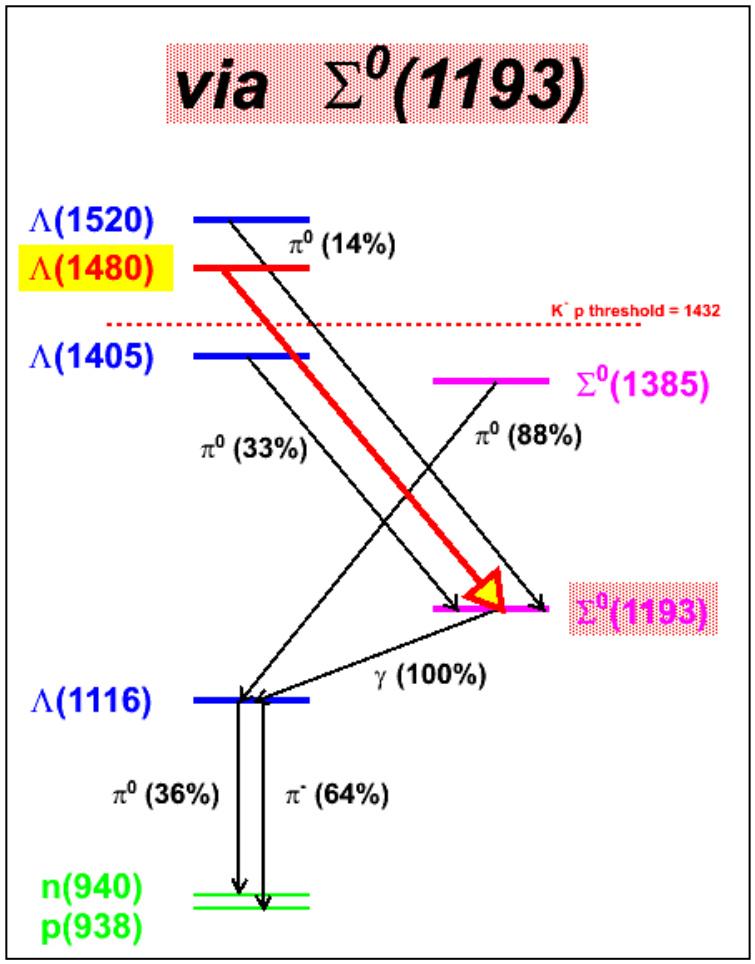
COMPARISON WITH 2002 DATA

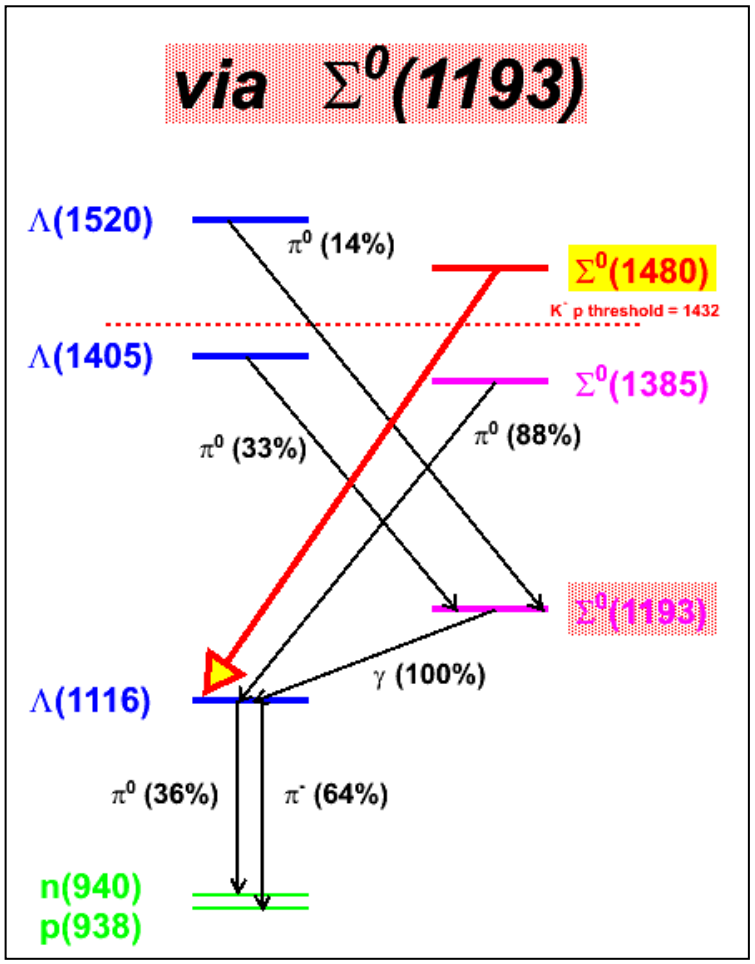


COMPARISON WITH 2002 DATA

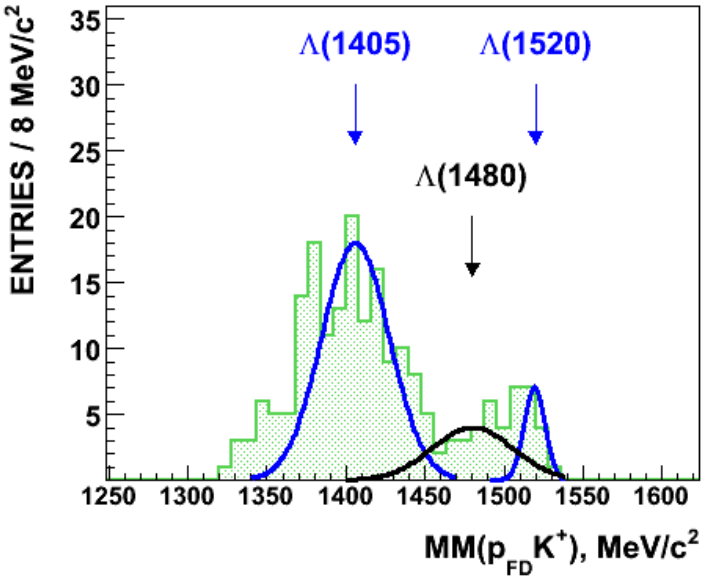


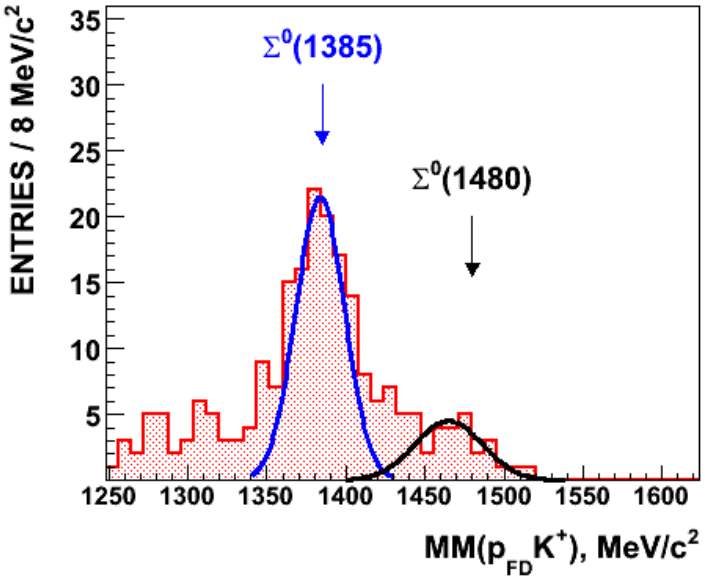
$Y^{*0}(1480)$


via $\Sigma^0(1193)$
$\Lambda(1520)$
$\Lambda(1480)$
π^0 (14%)
K^- p threshold = 1432
$\Lambda(1405)$
$\Sigma^0(1385)$
π^0 (33%)
π^0 (88%)
$\Sigma^0(1193)$
γ (100%)
$\Lambda(1116)$
π^0 (36%)
π^- (64%)
n(940)
p(938)


via $\Sigma^0(1193)$
$\Lambda(1520)$
π^0 (14%)
$\Sigma^0(1480)$
K^- p threshold = 1432
$\Lambda(1405)$
$\Sigma^0(1385)$
π^0 (33%)
π^0 (88%)
$\Sigma^0(1193)$
γ (100%)
$\Lambda(1116)$
π^0 (36%)
π^- (64%)
n(940)
p(938)

$Y^{*0}(1480)$


ENTRIES / 8 MeV/c²
Λ(1405)
Λ(1520)
Λ(1480)
MM(p_FD K⁺), MeV/c²


ENTRIES / 8 MeV/c²
Σ⁰(1385)
Σ⁰(1480)
MM(p_FD K⁺), MeV/c²