ECT*
EUROPEAN CENTRE FOR THEORETICAL STUDIES
IN NUCLEAR PHYSICS AND RELATED AREAS
Trento, ITALY

The study of $\Lambda\pi^+$, $\Lambda\pi^-$, $\Lambda\gamma$ and Λp spectra from p+C interactions at momentum of 10 GeV/c

P. Aslanyan, JINR VBLHEP, October 13, 2009, JINR

Contents

P.Zh. Aslanyan, JINR, Octber 13, 2009

P.Z. Aslanyan , Proc. I.Ya.Pomeranchuk and Physics at the Turnof Centuries, Moscow, 24-28 Jan. 2003;PROCEEDINGS. River Edge,World Scientific, 247-251, 2003.ArXiv:hep-ex/0406034,2004.
P.Z.Aslanyan et al.,JINR Comm.,E1-2005-149, 2005.hep-ex/0504026, 2005."Particles and Nuclei, Letters",v.3,N5(134),p.331,2006.
P.Z. Aslanyan et. al., Proc. XVII ISHEPP, Dubna,September 25-30, 2004.
P.Z.Aslanyan et al.,JINR Comm., E1-2005-150, 2005.Arxiv:hep-ex/0403044, 2005. "Particles and Nuclei,Letters",v.4, N1(137),p.99, 2007.
P.Z. Aslanyan et al., Proc. Conf. on LEAP05,May 16-22, Bonn, 2005; AIP,v. 796, p.195, ISBN 0-7354-0284-1;hep-ex/0504026,2005.
P.Zh. Aslanyan, Proc.QGPTH05, Vienna, Austria, 4-9 August,2005; Eur. Phys. J. A v.29,num.1, XI, 2006.ArXiv:hep-ex/0511017.
P.Zh. Aslanyan, Proc. XVIII ISHEPP, Dubna, September 25-30, 2006. Proc. , Spin'06, October 2-7, Kyoto, Japan 2006, ISBN 978-0-7354-0423-6,AIP, v.915.ArXiv:hep-ex/0610086v1.
P.Z. Aslanyan, Proc.International School IUTP'07,Schladming, Austria, 25-3 March, 2007.
P.Z. Aslanyan, Proc. CBM meeting,GSI,Darmstadt, 27-1 March, 2007.
P.Z. Aslanyan, Proc. Annual Winter School of St.Petersburg Nuclear Physics Institute, 18-23 February, St. Peterburg, Russia,2008.
P.Zh. Aslanyan et al.,Phys. of Part. and Nuclei Letters, Vol. 4, No. 1,pp. 99-108, 2007.
P.Z. Aslanyan, Proc. on XII Int. Confereence Hadron Spectroscopy, Frascati, 8-12 October,2007;ArXiv:hep/ex-0710.4322v2. LNF Phys. Series XLVI, p.1283 (2007)
P.Z. Aslanyan et. al., Phys. Part. Nuclei, vol. 39, issue 4, 2008.
P.Z. Aslanyan, Proc. on Int. confereence Hadron Structure, Bratislava, 2-8 Sepember,2007;ArXiv:hep/ex-0710.4322v2. FIZIKA B(Zagreb)17, 1, 2008.
P.Zh. Aslanyan, Proc. Int. Winter School, Schladming, 28 - 6 March, 2009.
P.Zh. Aslanyan, Proc. Int. Conference,"Windows on the Universe", 16-21 June, Blois, 2009.
P.Zh. Aslanyan ,Elementary Part. and Atomic Nuclei , Vol. 40, No. 4, pp. 525–557, 2009

Publications

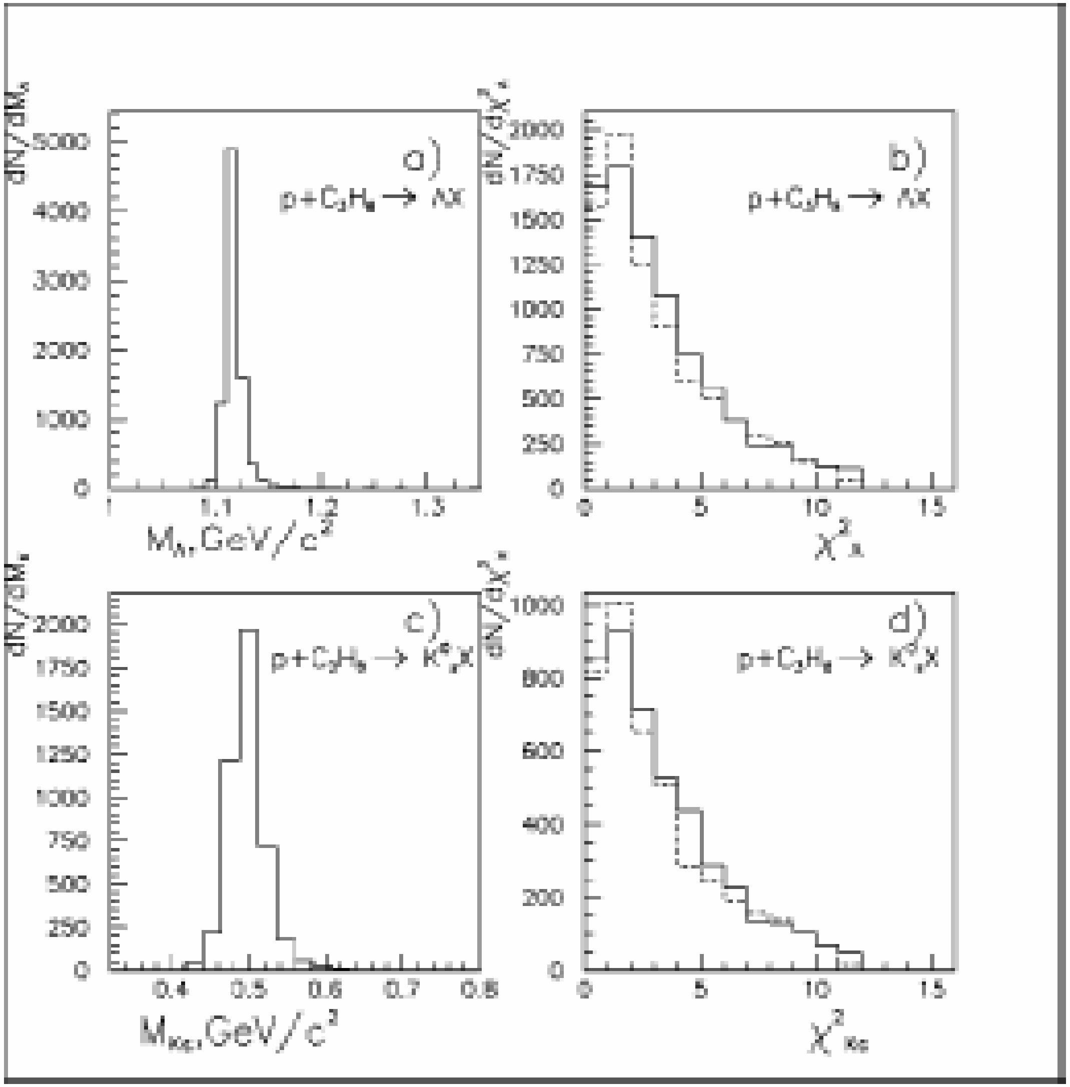
Preview

- There are a few actual problems of nuclear and particle physics which are concerning subject of this study. These are following: in-medium modification of hadrons, the origin of hadron masses, the restoration of chiral symmetry, the confinement of quarks in hadrons, the structure of neutron stars. Strange multi-baryonic clusters are an exiting possibility to explore the properties of cold dense baryonic matter and non-perturbative QCD too. Multi-quark states, glueballs and hybrids have been searched for experimentally for a very long time, but none is established.

- Strange multibaryon states with Λ- hyperon and K_s^0 –meson subsystems has been studied by using data from 700000 stereo photographs or 10^6 inelastic interactions which was obtained from expose proton beams at 10 GeV/c to 2-m propane bubble chamber LHE,JINR. There are not sufficient experimental data concerning for strange-hyperons production in hadron - nucleus and nucleus-nucleus collisions over momentum range of 4-50 GeV/c. A survey for new experiments with much improved statistics compared to those early data would hopefully resolve whether such "exotic“ multi-quark hadron and baryon resonances exist.

Λ- hyperons and K^0_S-mesons production

Figures (a,c) and (b,d) show the effective mass distribution of 8657-events with Λ, 4122-events with K_s^0 particles and their $\chi 2$ from kinematic fits, respectively. The expected functional form for $\chi 2$ is depicted with the dotted histogram. The measured masses of these events have the following Gaussian distribution parameters M_K= 497.7± 3.6, s.d.= 23.9 MeV/c² and M_Λ =1117.0 ± 0.6, s.d.=10.0 MeV/c². The masses of the observed Λ, K_s^0 are consistent with their PDG values. The experimental total cross sections are equal to 13.3 and 4.6 mb for Λ and K_s^0 production in the p+C collisions at 10 GeV/c.



The Λ/π^+ ratio for average multiplicity

Strange particles have been obtained extensively in hadron–nucleus and nucleus–nucleus collisions in 4–15 GeV regions [1–6].
The experimental data from heavy ion collisions show that the K + /π+ Λ /π+ ratio are larger at BNL-AGS energies than at the highest CERN-SPS energies and even at RHIC[9-14]. This behavior is of particular interest as it could signal the appearance of new dynamics for strangeness production in high energy collisions.
The number of Λ-s produced in antiproton +Ta reaction at 4 GeV/c was 11.3 times larger than that expected from the geometrical cross section (KEK, Japan) [9].
Therefore, the analysis of strange hyperon and K^+ total yields [12–14] are of great interest as an indicator of strange quark production. Figure shows the energy dependence of the Λ /π+, Ξ^- / π+ and the Ω^- / π+. As can be seen from the figure there is a very clearly pronounced maximum especially for the Λ / π+ ratio.
The multiplicity of Λ and π+ production in C+C reaction at 10 GeV/c have been used the Glauber approach based on the experimental cross section for p+C → ΛX from this experiment [14].
The Λ/π^+ ratio from this experiment in pC reaction is approximately 1.5-2.0 times larger than ratios at the same energies for pp reaction and for same reaction, which was simulated by FRITIOF model.

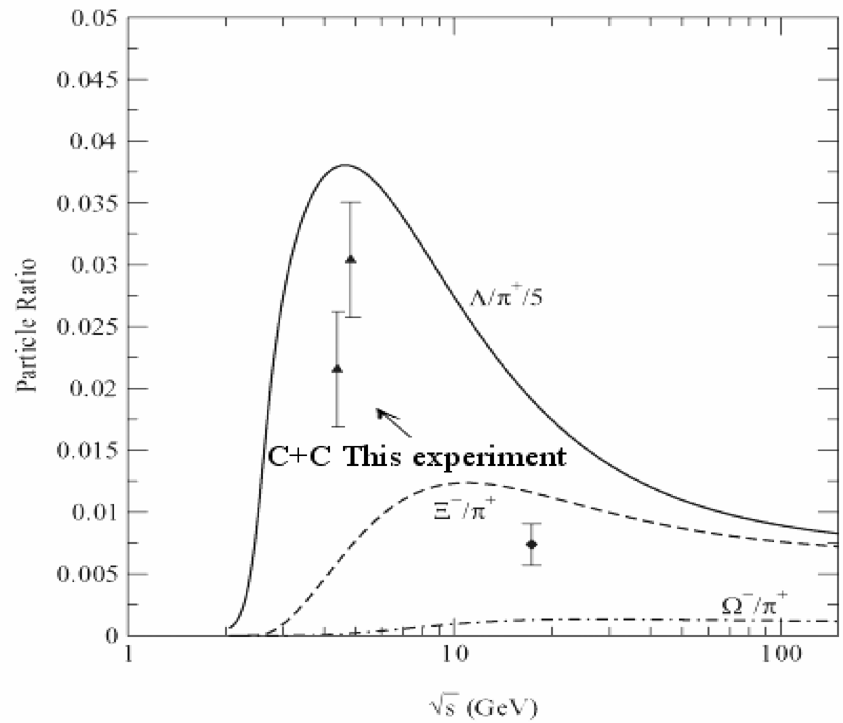
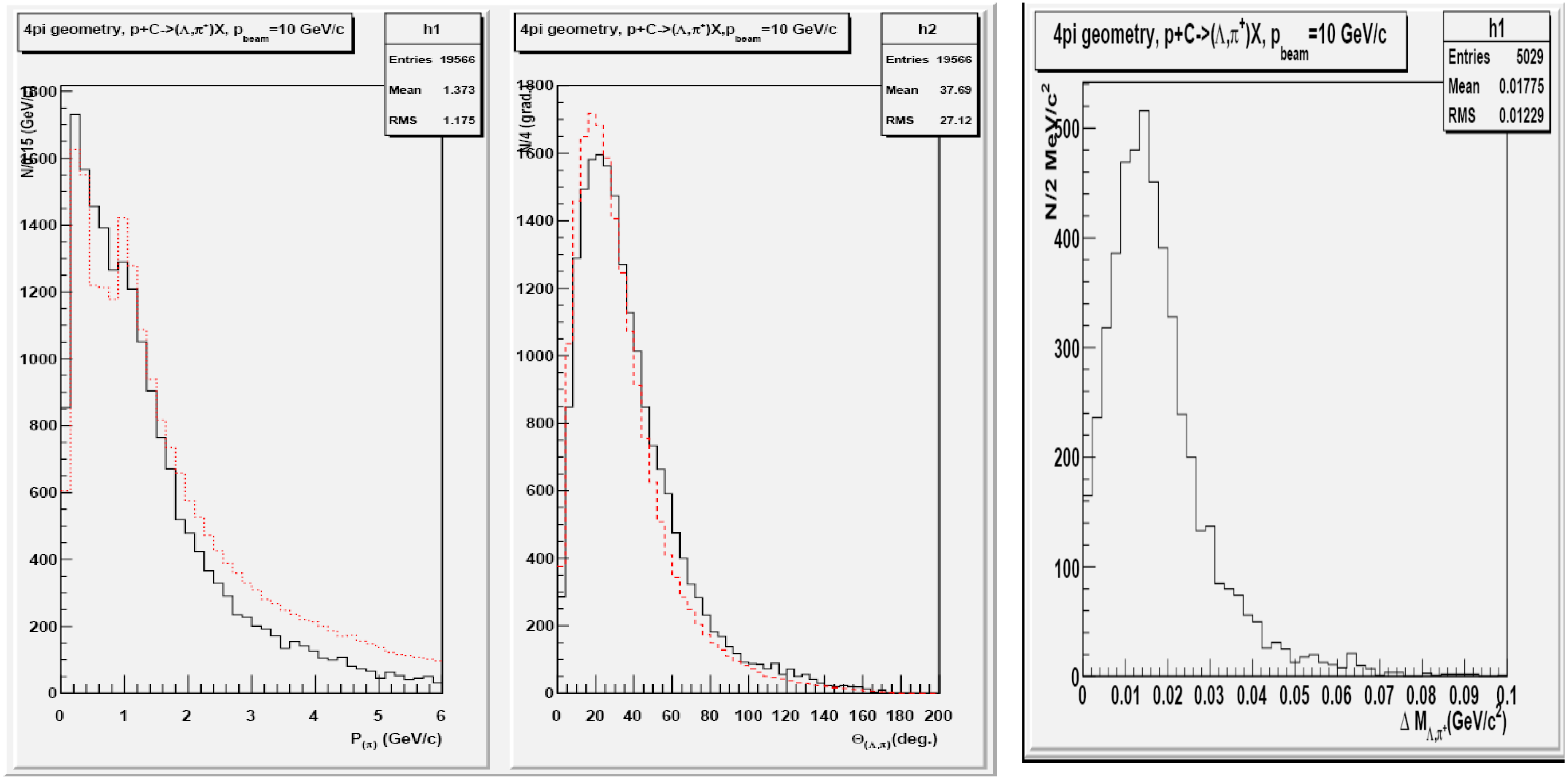


Figure : Prediction of the statistical-thermal model[5,6] for Λ/π^+ note the factor 5, solid line), and Ξ^-/π^+ (dashed line) and Ω^-/π^+ ratios a function of $\sqrt{s}$. For compilation of AGS data see [7]. The Λ / π + ratio in interaction C+C was obtained by using data from this experiment for pC→ Λ X .

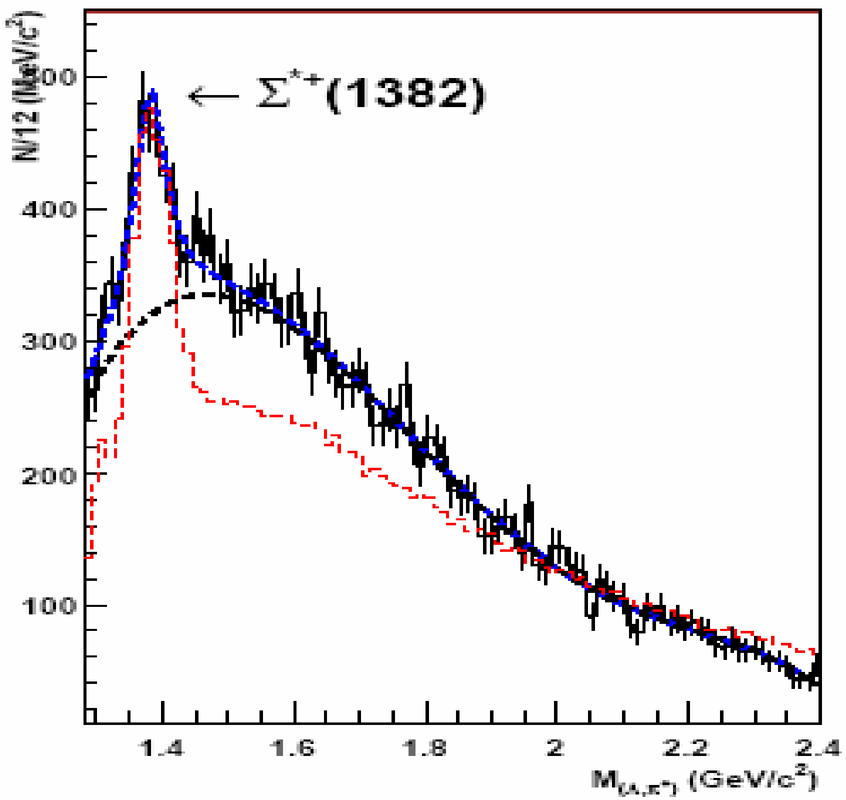
[1]J.Rafaelski et al., PL. 91B,281,1980; PRL 48, 066,1982.
[2] P.Koch et. al., PL 123B,151.1983.
[3] J.Rundrup and C.M.Ko, Nucl.Phys. A343, 519, 1980.
[4] F.Asai, H.Sato and M.Sano, Phys. Lett. 98B, 19, 1981.
[5] J. Cleymans and K.Redlich, Phys.Rev. C60(1999).
[6] P. Braun-Munzinger et al.,NPA697:902-912,2002; hep-ph/0106066,2001.
[7] F. Becattini et al, PR C24,024901,2001.
[8] M. Gazdzicki, hep-ph/0305176v2,2003.
[9] K. Miyano et al., Phys. Rev. C38 (1988).
[10] M. Anikina et al., Phys. Rev. Lett. 50 (1971).
[11] S. Albergo,et. al.,Phys. Rev. Lett. 88,v.6, 2002.
[12] B. Back et al.,E866, E917 Collab., nucl-ex/9910008
[13]J. C. Dunlop and C. A. Ogilvie, Phys. REV. C, VOLUME 61,031901(R),2000;
[14] P.Z. Aslanian et. al., JINR comm., E1-2005-149, 2005. "Particles and Nuclei, Letters“, Vol. 4, No. 1,pp. 99-108,

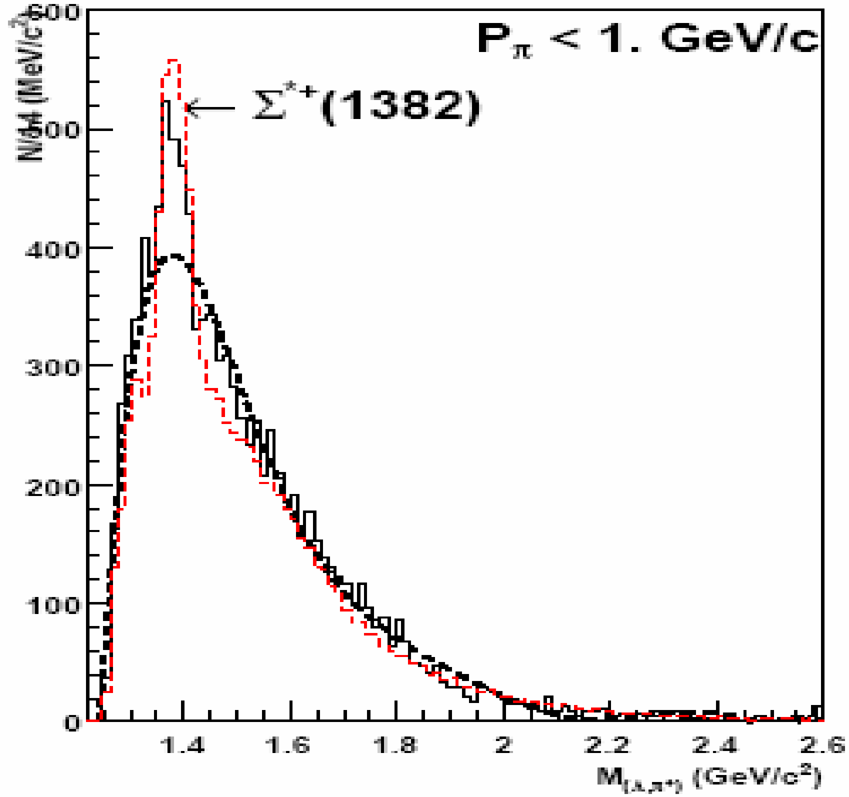
($\Lambda\pi^+$) spectra



Figures has shown distribusions by: π^+ momentum, angle between of $\Lambda\pi^+$ and invariant mass error for $\Lambda\pi^+$ system. The simulated and reconstructed invariant mass ***error is*** $<\sigma(M_{inv})>=12$ MeV/c^2 : $\sigma^2(M_{inv}) = (E_2/E_1{}^*p_1 - p_2 \cos\theta)^2\, \sigma^2(p_1) + (E_1/E_2{}^*\, p_2 - p_1 \cos\theta)^2\, \sigma^2(p_2)$

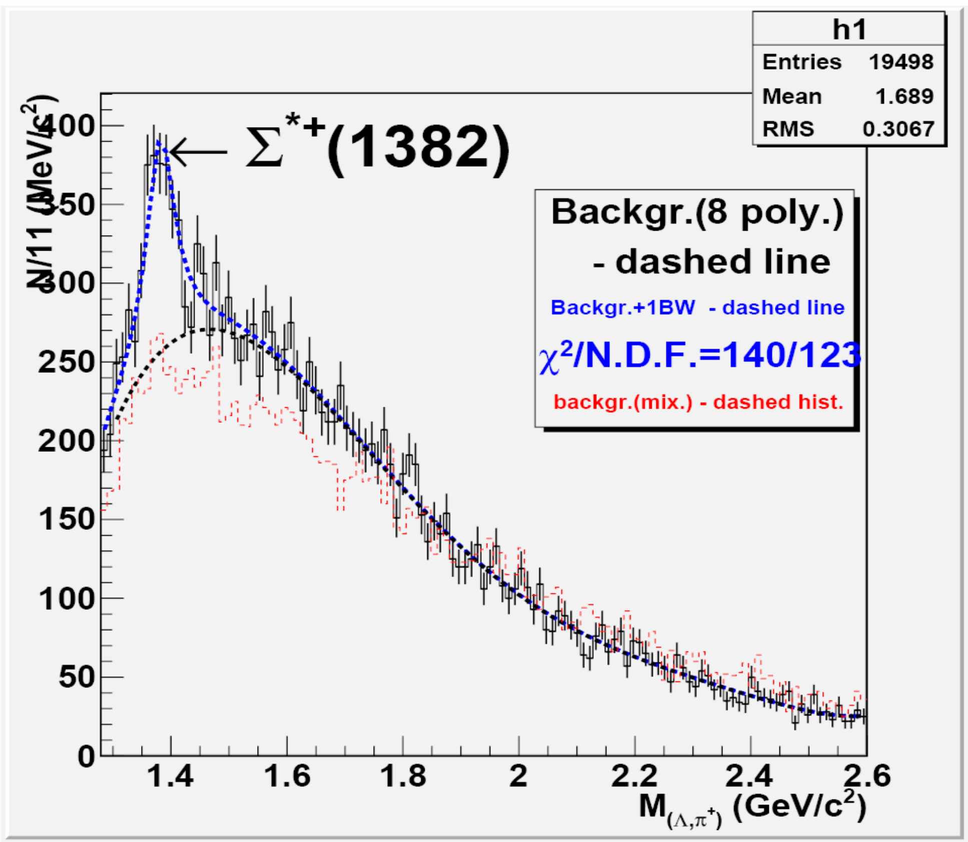
($\Lambda\pi^+$) spectra

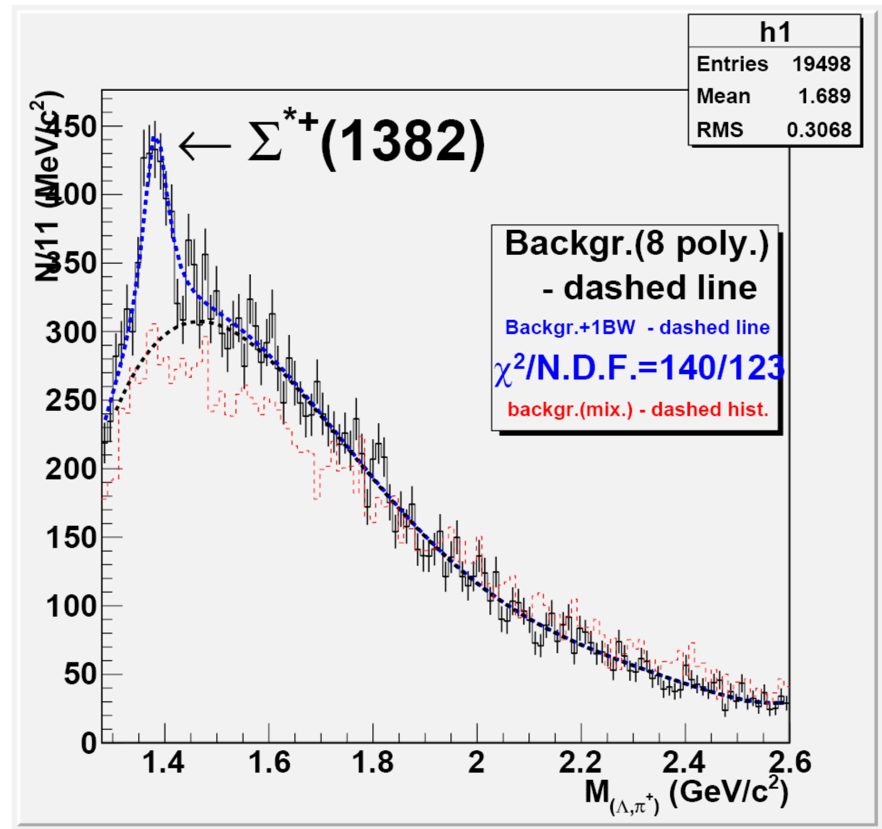




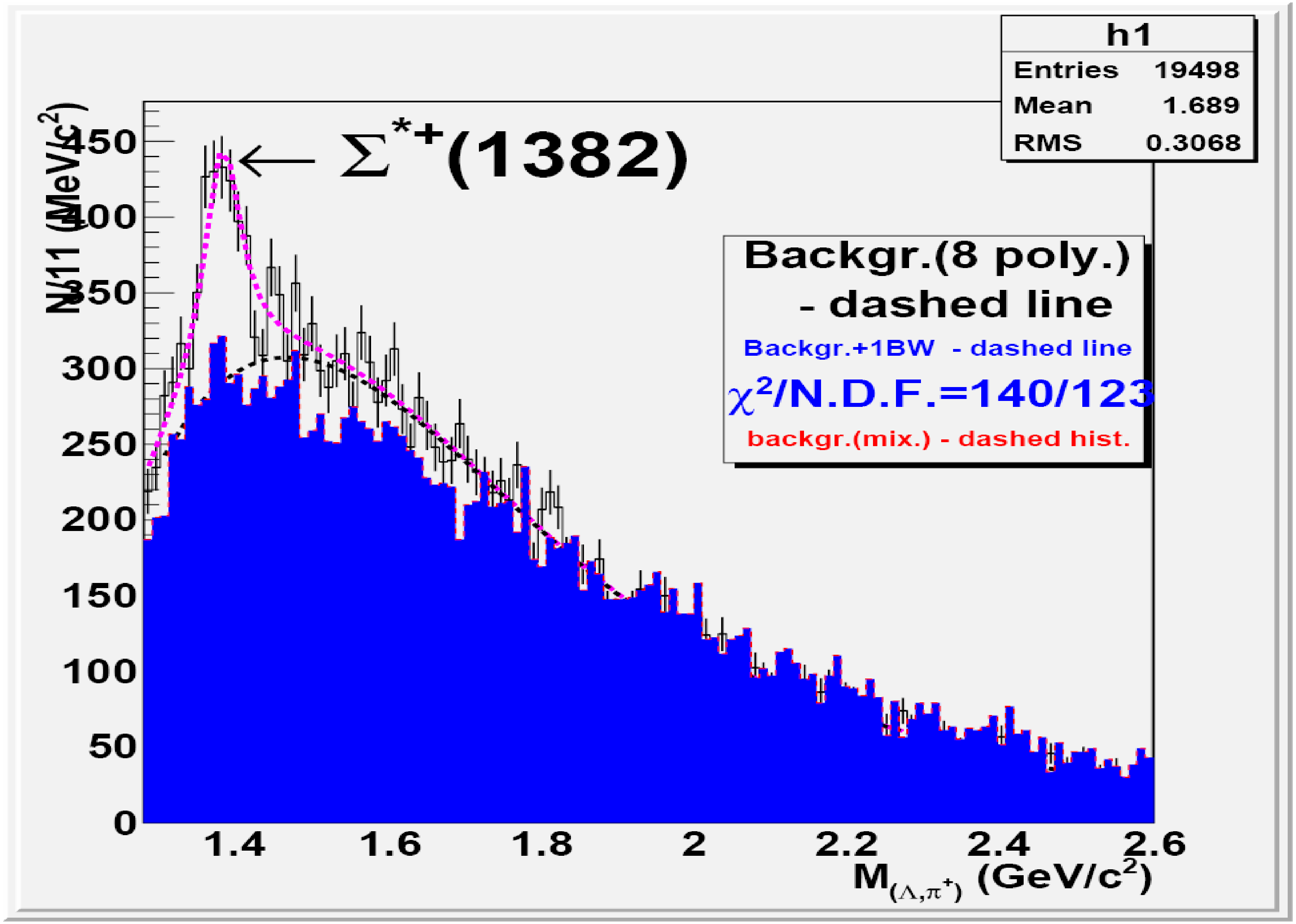
Test method is with known resonance. The resonance (19534 comb.)with similar decay properties as $\Sigma^*(1382)$ is registered with more than 13 S.D.. The decay width is equal to $\Gamma \approx$ 40 MeV/c^2 ($\Delta M/M \approx 0.7$ %). A masses and width are consistent with PDG values for $\Sigma^*(1382)$. After cut of over momentum $P_\pi < 1$ GeV/c there is shift for maximum In mass range of 1370 MeV/c^2(9095 comb.). The cross section of $\Sigma^*(1382)$ production ($\approx$600 exp. events) is equal to 1.1 mb at 10 GeV/c for p+C interaction. The cross section for reaction pp$\rightarrow \Sigma^{*+}(1382)$X is equal to $\approx$ 0.06mb. The cross section for the same reaction pp$\rightarrow \Sigma^*(1382)$X from PDG at momentum 6.6 GeV/c is equal to 0.03

$(\Lambda\pi^+)$ spectrum



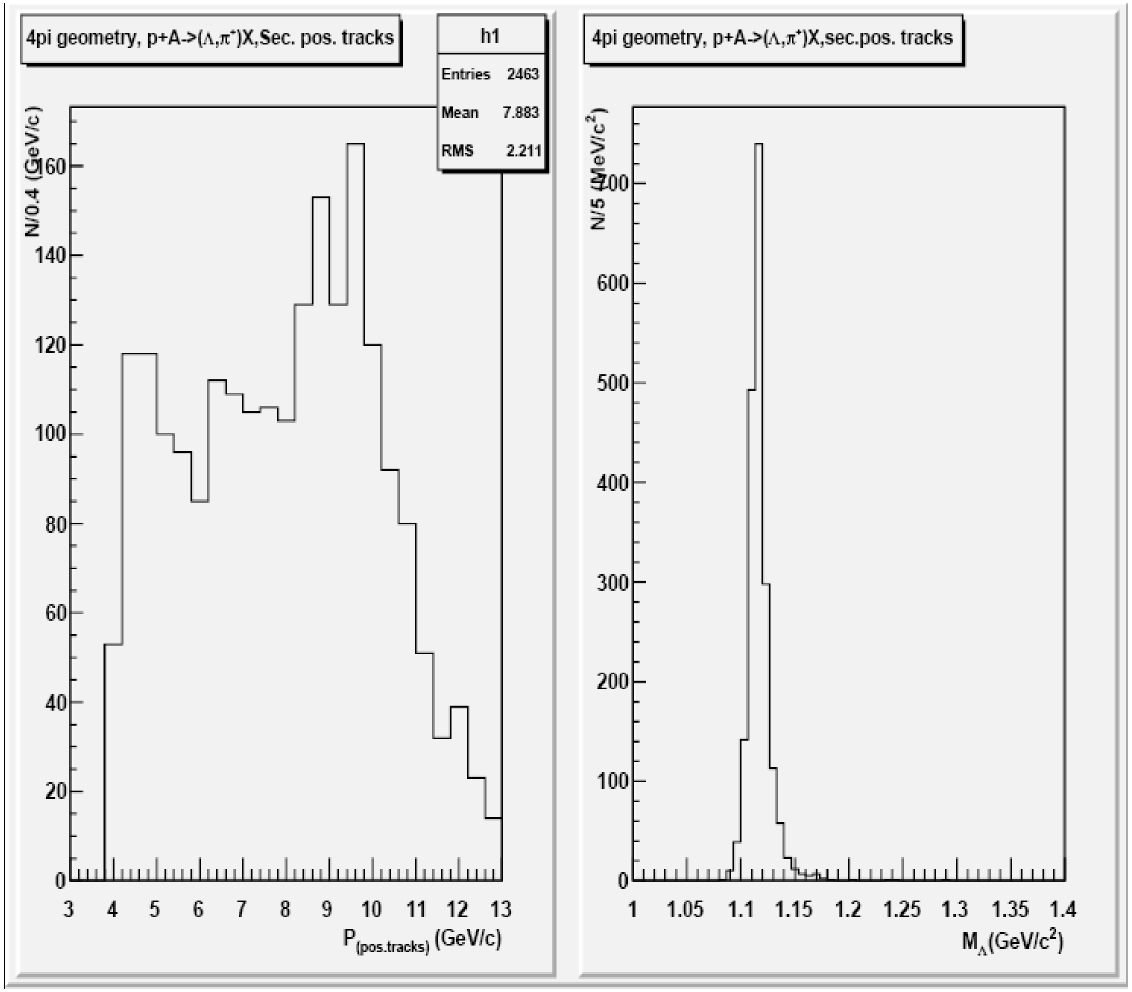


Figures shows $(\Lambda\pi^+)$ spectrum without and with geom. weight for Λ. The background have done by polynomial and mixing momentum methods. Two kind of backgrounds have a similarly behavior.

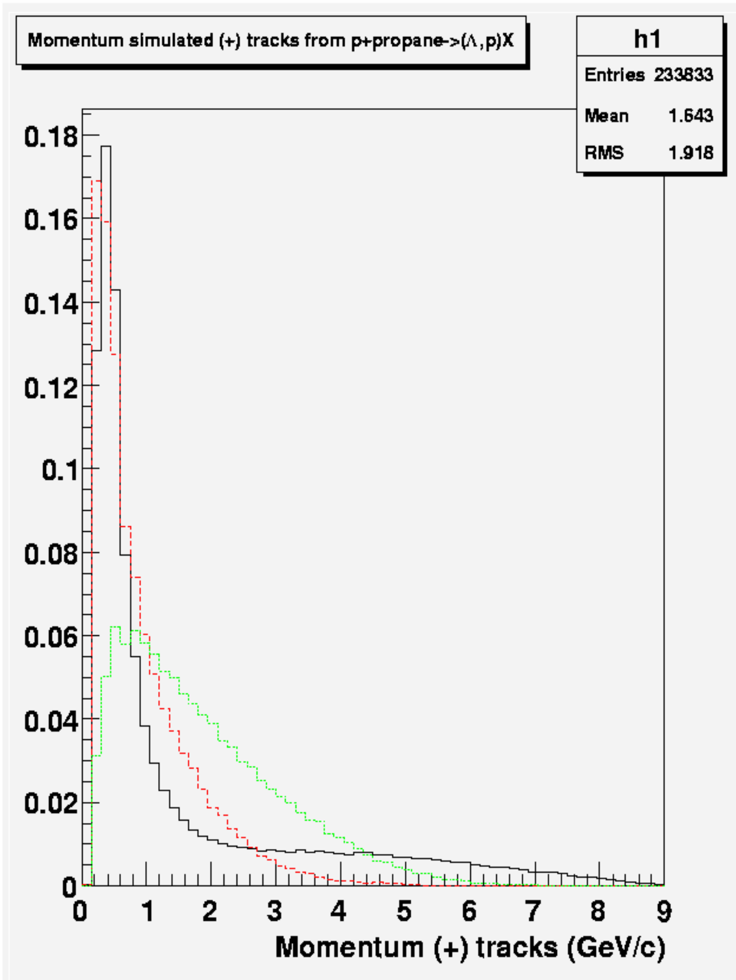

h1
Entries 19498
Mean 1.689
RMS 0.3068
Σ*+(1382)
Backgr.(8 poly.)
- dashed line
Backgr.+1BW - dashed line
χ2/N.D.F.=140/123
backgr.(mix.) - dashed hist.
N/11 (MeV/c2)
M(Λ,π+) (GeV/c2)

Secondary events with Λ hyperons

The secondary events are not satisfied below conditions:
10 cm≤ Y ≤ 80 cm,
20 cм ≤ Z ≤30 cm,
1.6 ≤ <β ≤1.72 rad.
\ tgα\ ≤ 0.02.



2544 secondary events with Λ hyperons from all positive charged secondary tracks(4775) at beam momentum P > 4 GeV/c observed interactions.



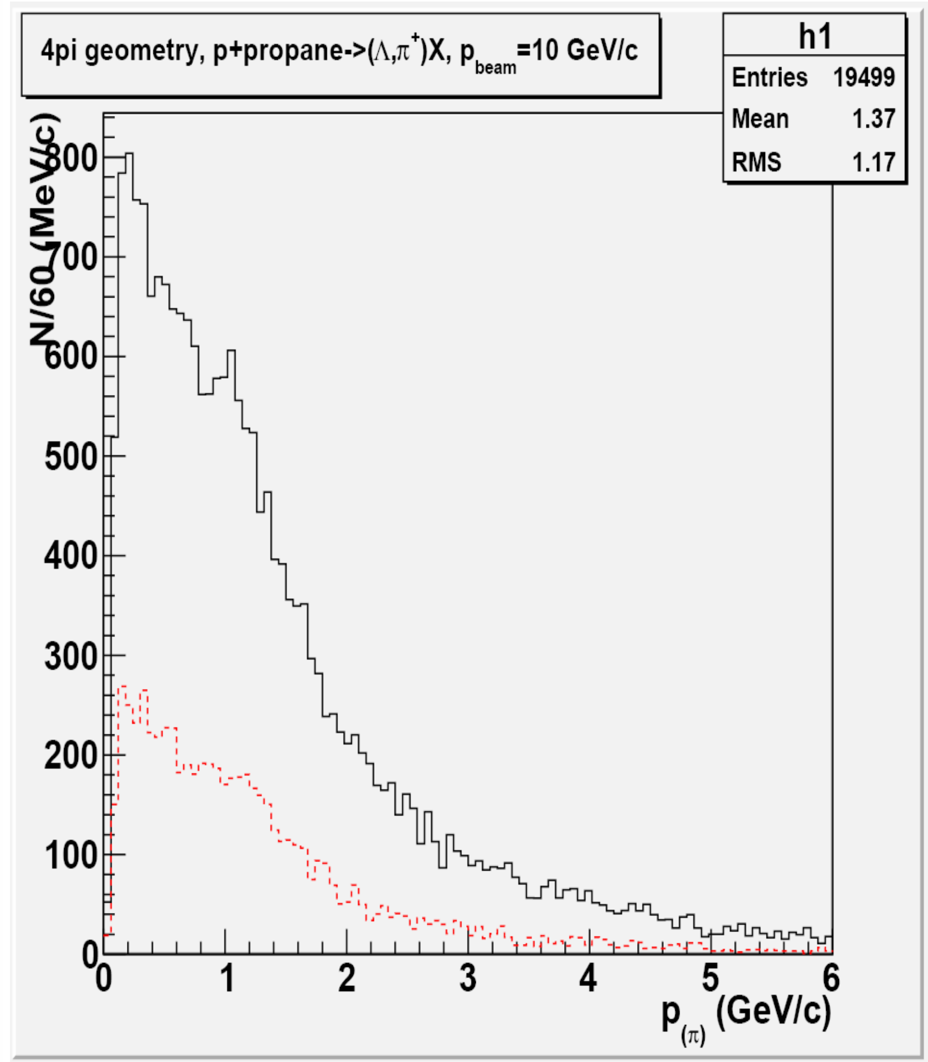
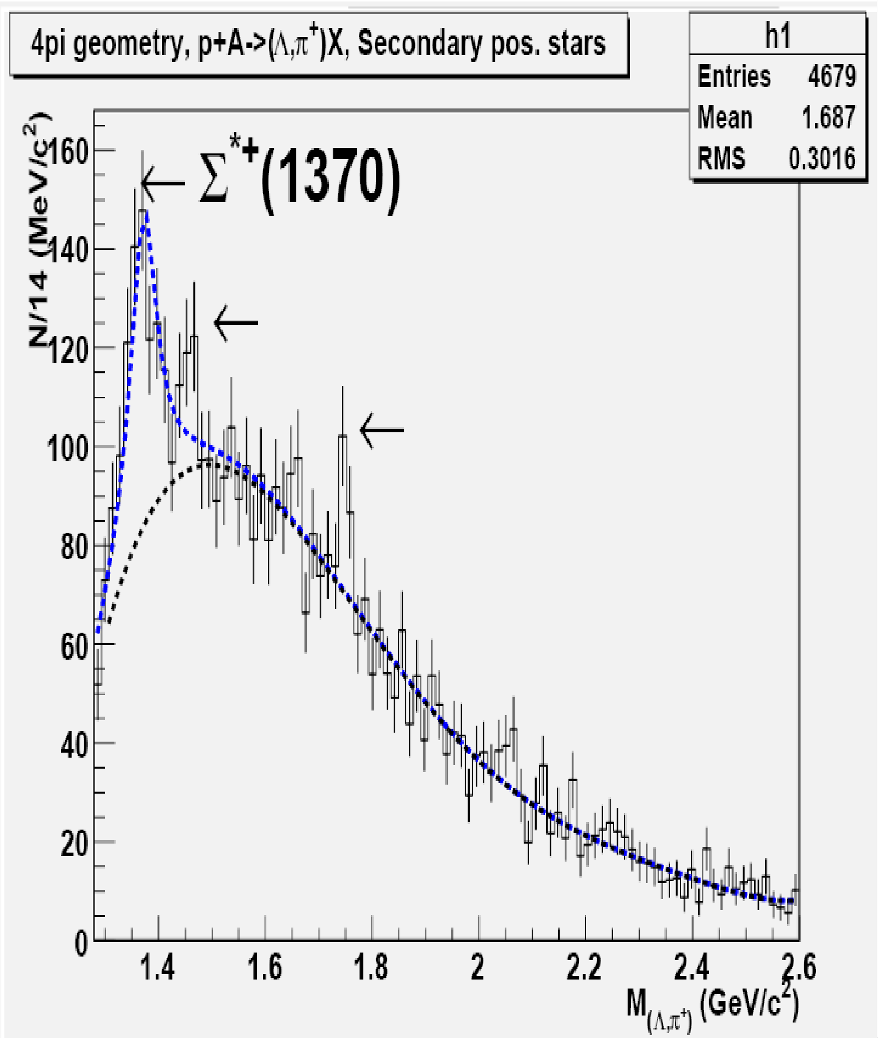
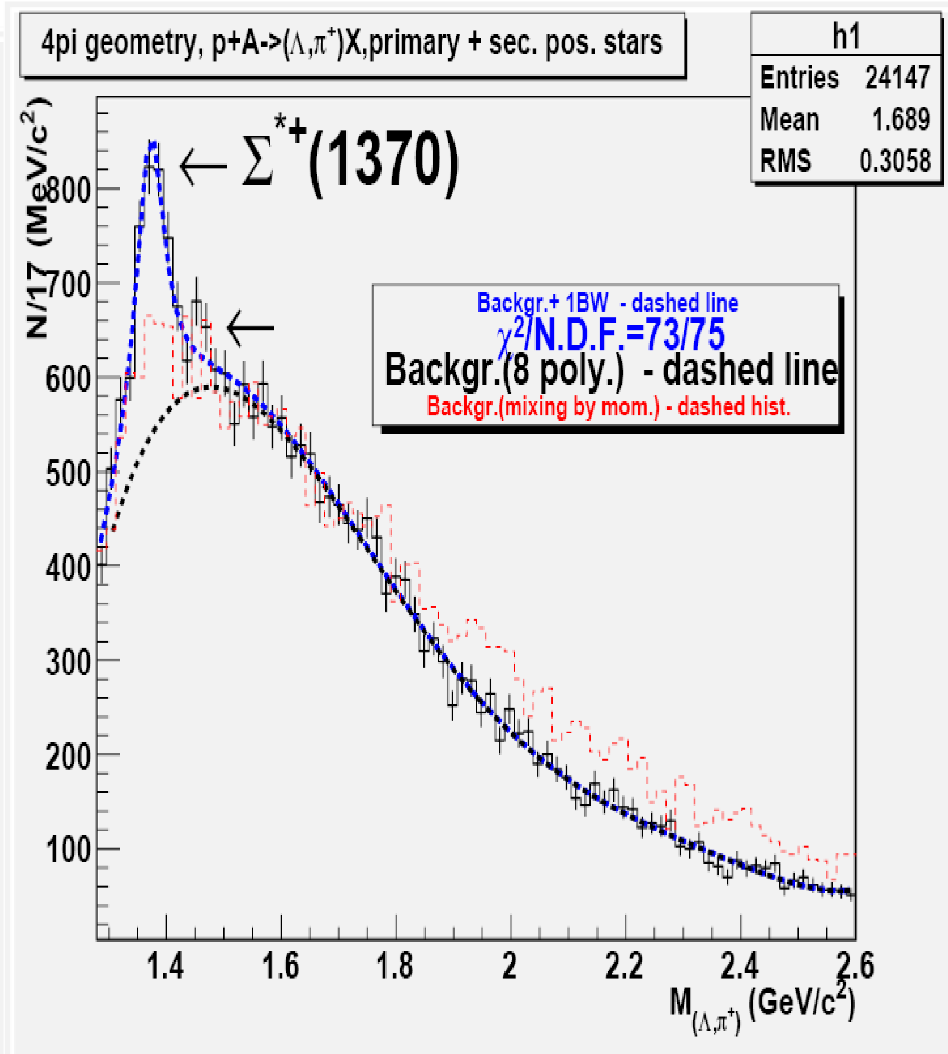


Figure show secondary momentum distributions simulated by FRITIOF for p (black), π+(red) and K+(green) particles for p+ propane collision at 10 GeV/c. Positive tracks at momentum P > 4 GeV/c are relativistic protons(background from K^+, π^+< 15 %). The mean value of momentum of π+ from secondary interactions(dased red hist.) is lower than π+ momentum from primary interactions

$\Lambda\pi^+$ spectra from secondary events

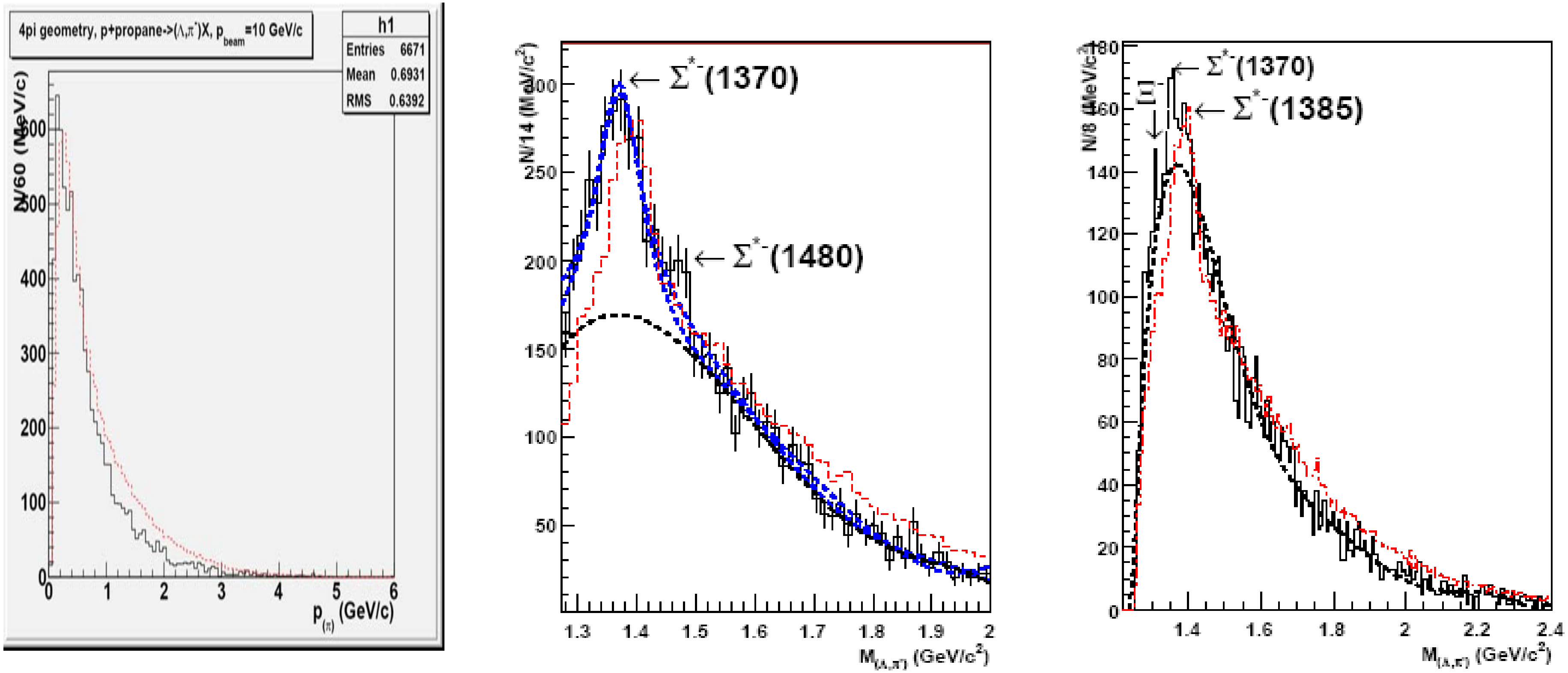




The number of primary(600 events) and secondary events in peak is more than 720 for $\Lambda\pi+$ mass spectrum. The background done by polynomial and mixing momentum methods .There are same enhancements in mass range of 1450(3σ) and 1750($11\ \sigma$) MeV/c^2.

Therefore the mean value of momentum shift for decaying particles from resonance can shift mean value of resonance but not width.

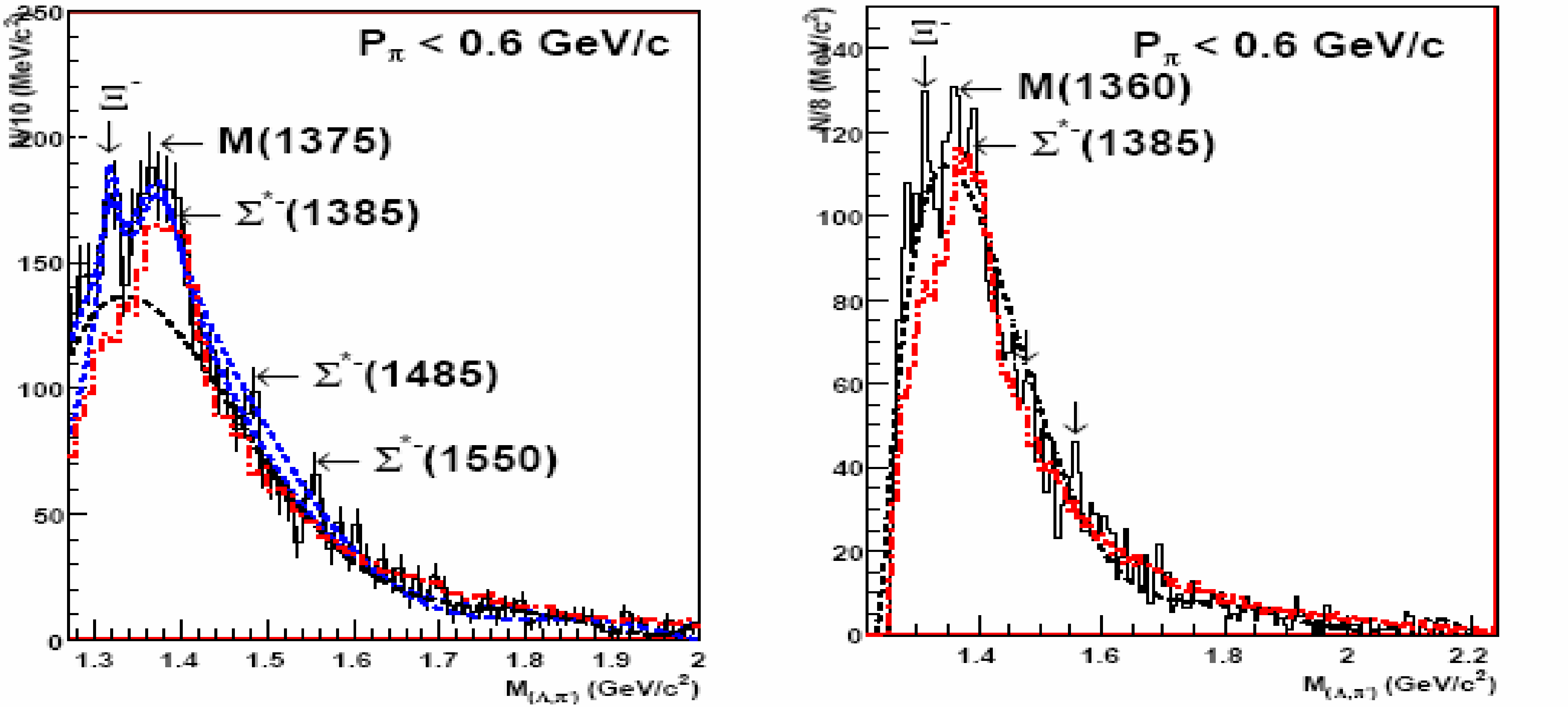
($\Lambda\pi^-$) spectra



The $\Lambda\pi^{-}$ effective mass distribution for all 6465 combinations with bin sizes of 14 and 8 MeV/c^2**.** The solid curve(Fig.a) is the sum of the background (by the first method) and 1 Breit-Wigner resonance. There is significant enhancement In the mass range of 1370 MeV/c^2, with Γ = 103 MeV/c^2. The cross section of Σ^{*-}(1385) production (≈680 events) is equal to ≈ 1.2 mb at 10 GeV/c for p+C interaction.**The width of Σ^-(1385) have observed ≈ 2 times larger than PDG value.** Figure (b) shows effective mass distribution with bin size of 8 MeV/c^2, where there are also significant enhancements in mass regions of 1317(3.0 S.D.) and 1480(3.2 S.D.).

There are negligible enhancements in mass regions of 1410,1520 and 1550 MeV/c^2.

$(\Lambda\pi^-)$ spectra



The cross-section of stopping Ξ^- production ($\geq$65 events from 3829 comb.) in nuclear medium is equal to $\geq$ 120 μb at 10 GeV/c for p+propane interaction. The sum ofl experimental cross section for stopping Ξ^- (65 ev.) and identified by weak decay channel (75 ev.) is more than 4 times larger than the cross section of Ξ^- which is obtained by fritiof model with same experimental conditions. Therefore the large width for Σ^{*-}(1385) can interpreted the sum of enhanced contributions from Ξ^-, Σ^{*-}(1385) and Λ^*(1405)(reflection). There is observed peak in mass range of Σ^{*-}(1480) resonance too which is agreed with SVD2 report on ICHEP06 and COSY. Further studies are required to confirm the existence of the Σ^{*0} (1480) hyperon and to determine its quantum numbers.

29 April 1999

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Physics Letters B 453 (1999) 1–6

Nuclear medium effects on invariant mass spectra of hadrons decaying in nuclei

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Abstract

Effects of nuclear medium on invariant masses of in-medium hadrons as reconstructed from their decay particles alone (here called quasi invariant masses) are examined. Such "inclusive" invariant masses are related to the average potential energies, and thus are not identified as medium-modified hadronic masses. Furthermore, a significant fraction of in-medium hadrons is subject to decay in correlation with surrounding nucleons, producing a broad pseudo peak at a lower mass in a quasi invariant mass spectrum, as calculated for ρ meson decays in high density medium and for proton decays in ^{16}O.

1. Introduction

Since hadrons are composite particles, their sizes, masses, etc., are expected to change in nuclei. How the hadronic masses are modified in nuclei presents extremely interesting questions related to quantum chromodynamics. There are a number of theories in this respect (see, for instance, Ref. [1–3]), whereas there is no clear experimental information yet. The reason is obvious: there is no convincing procedure as to how to deduce medium-modified effective masses from experimental observables. The aim of the present paper is to provide an interface between experimental observables and theoretical quantities.

Some experiments are carried out to determine invariant masses of short-lived hadrons such as ρ meson [4–6] and ϕ meson [7,8] in high energy nuclear reactions. Recent results of the CERES [4] and the HELIOS-3 [5] experiments on dilepton invariant mass spectra have revealed an anomalous excess in the 0.3 − 0.6 GeV range, which is often interpreted in terms of a decreased ρ meson mass in the nuclear medium [9–11]. A dedicated effort will be paid to the dilepton invariant masses in the ρ meson region by the HADES collaboration [6]. Another experiment to investigate the invariant mass of the ϕ meson is in progress at KEK [8].

In such attempts invariant-mass like quantities are reconstructed from measured momenta of daughter particles with masses $(m_1, m_2, ..)$ and momenta (p_1, p_2) as

$$M_{inv}^{*\,2} = E^2 - P^2 = \Big(\sum_i E_i\Big)^2 - \Big(\sum_i p_i\Big)^2. \qquad (1)$$

The above quantity (M_{inv}^*) is equal to the hadron

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Ξ^- events by weak decay channels $\Lambda\pi^-$

These 5 Ξ^- events have identified on 30 % experimental data. The calculated cross section and number of events with Ξ^- by FRITIOF are equal to 41 μb (or 11.3 μb) and 42 events(or 34 ev.) for p+propane (or p+C) collision. Then experimental cross section was estimated by weak decay channel for $\Xi^- \to \Lambda\pi^-$ ($w=1/e_\Lambda$ =5.3) which is equal to ≈80 μb in p+propane collision.

Table 3:Mass and a momentum Ξ hyperon is determined by weak decay channels of $\to \pi^-\Lambda$.

N	Momentum of Ξ^- GeV/c	$M_{\pi^- p}$ invariant mass of Ξ^- (GeV/c^2)	Mass of Ξ^- with fits (GeV/c^2)	C.L. One vertex fit%
1	0.902±0.037	1.312±0.009	1.313±0.008	89.2(1V-2C)
2	0.973±0.038	1.316±0.008	1.315±0.007	96.0(1V-2C)
3	1.320±0.055	1.315±0.006	1.321±0.009	75.3(1V-2C)
4	1.298±0.038	1.313±0.007	1.323±0.008	29.8(1V-2C)
5	2.777±0.335	1.315±0.006	1.398±0.023	6.9(1V-2C)

P.Z. Aslanyan, JINR Commun.,E-2001-265,2002.

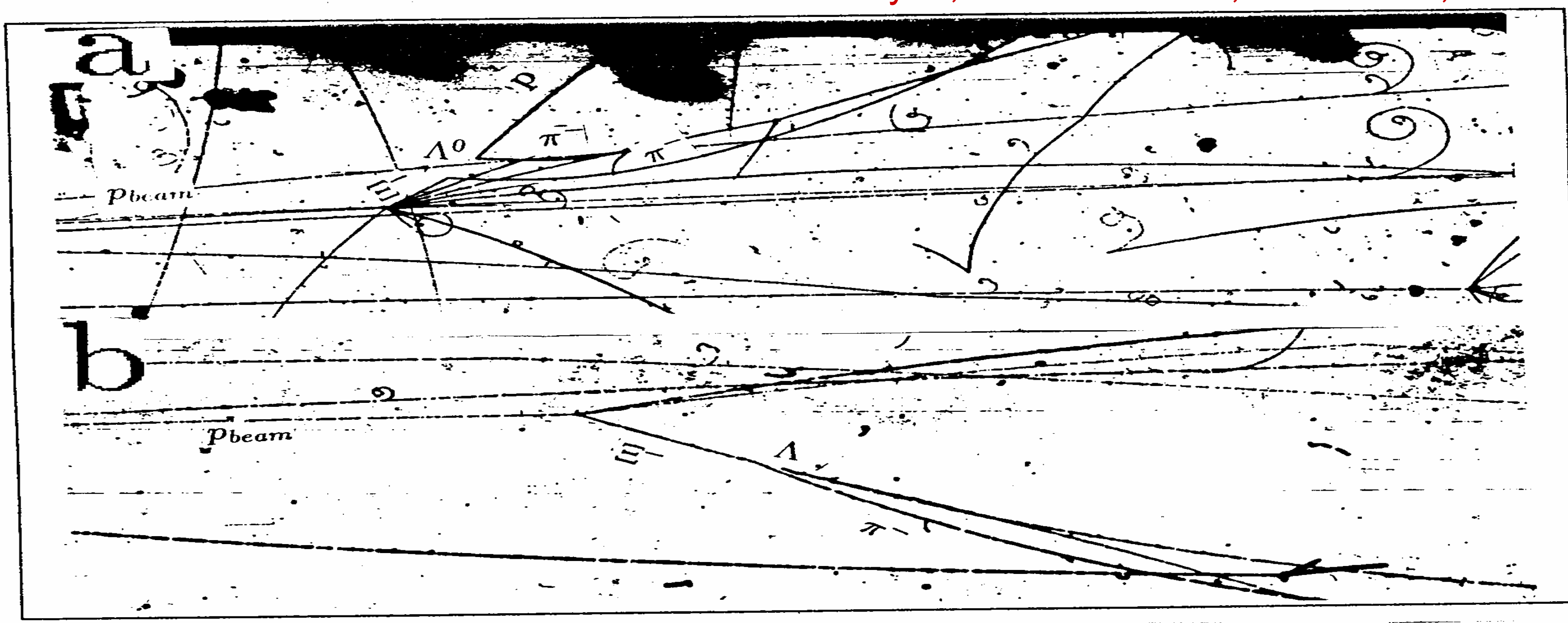
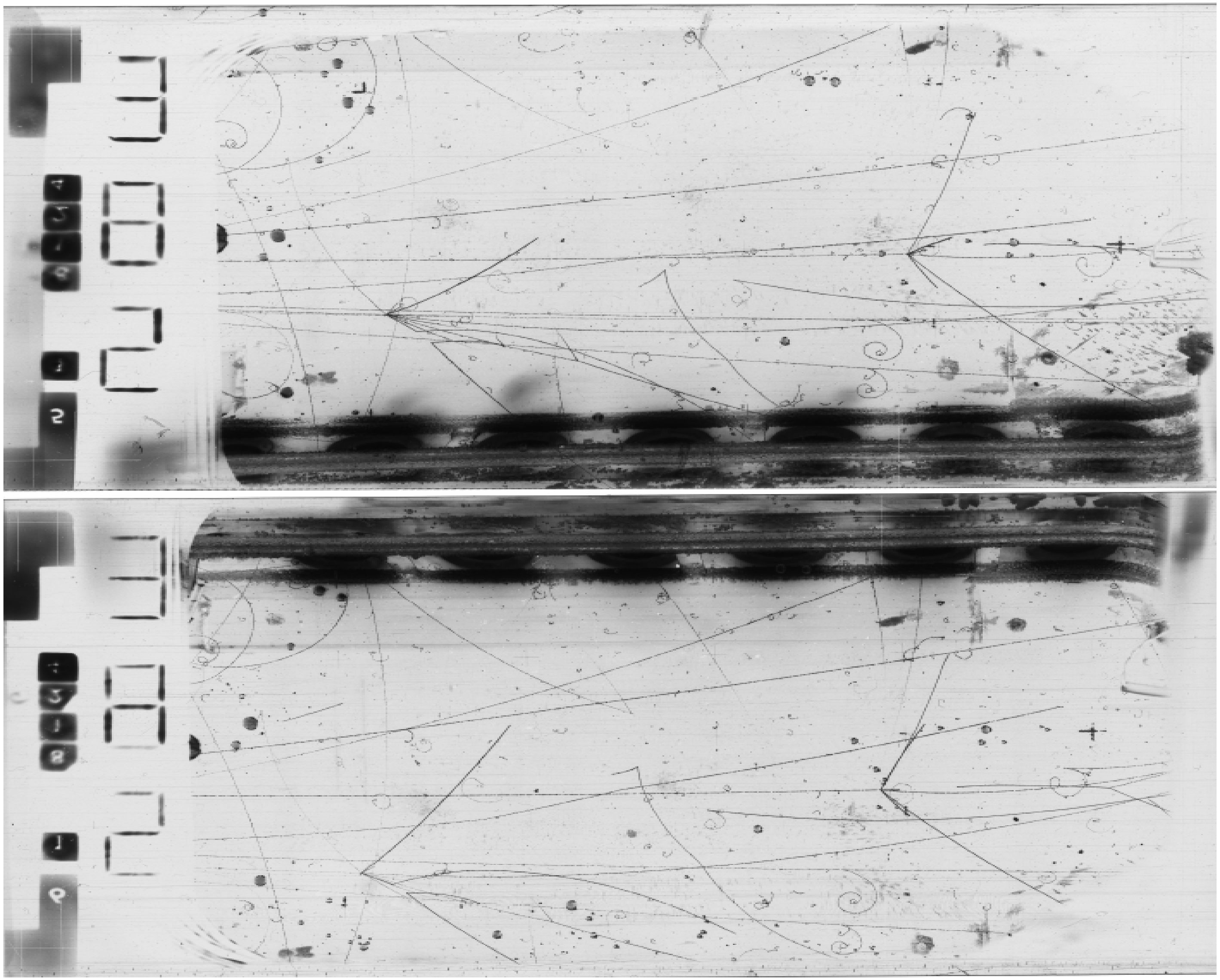
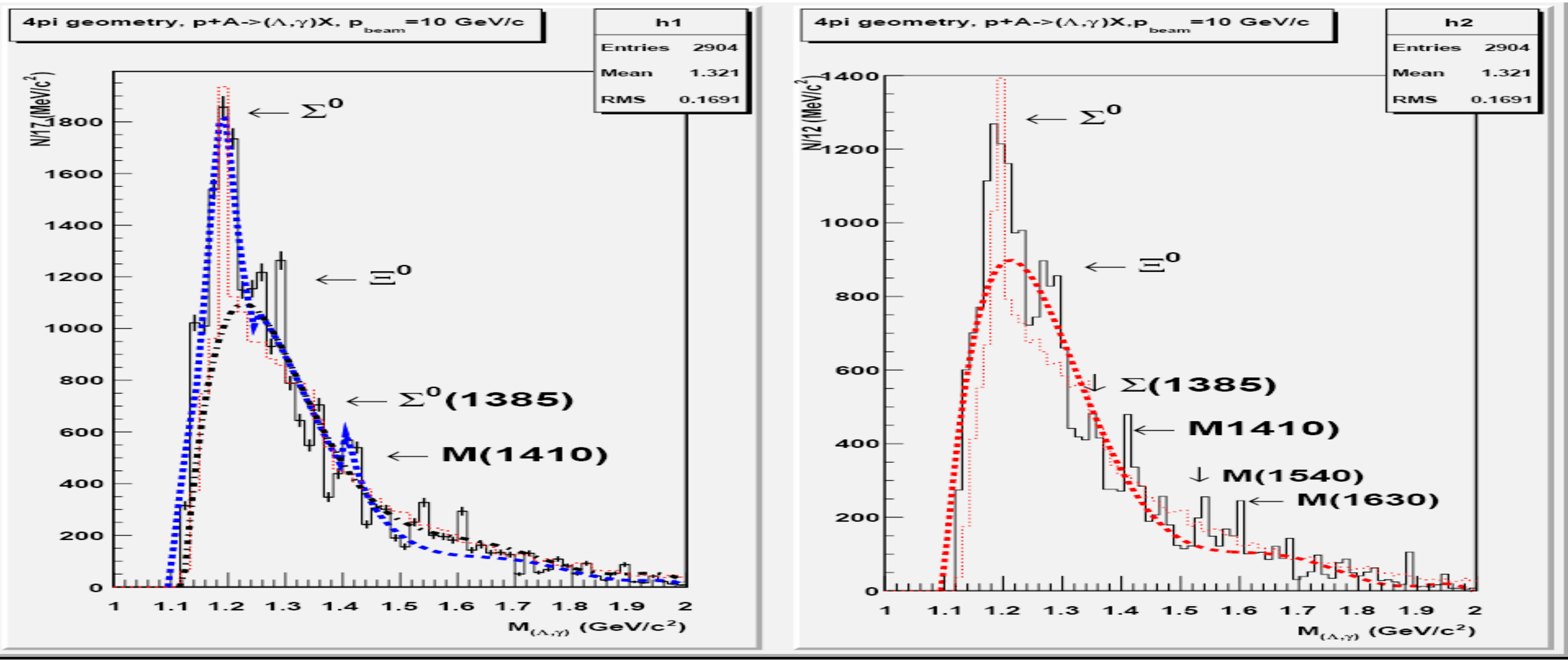


Figure 4: Two body weak decay Ξ^- hyperon $\to \pi^- + \Lambda$: a)first event;b) second event.



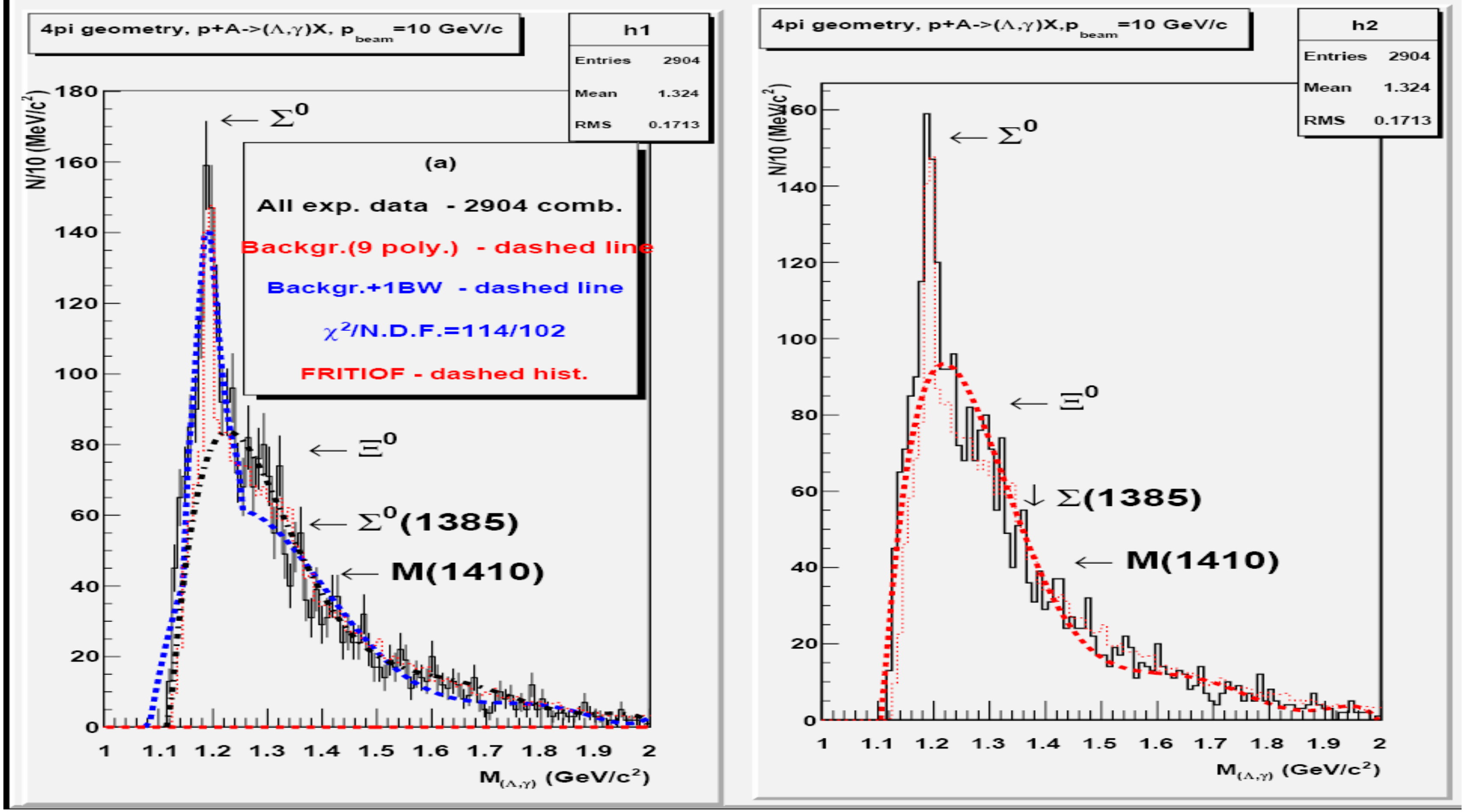
($\Lambda\gamma$) spectrum



The cross section for Σ^0(1189) production (≈1800 events, with total geometrical weights for Λ and γ, where $<w_\gamma>=4.1$) is equal to ≈ 3.3 mb at 10 GeV/c for p+C interaction at 10 GeV/c which is more than 2 **times** larger than simulated cross section by FRITIOF.

The observed width of Σ^0 is ≈2 times larger than value of experimental errors.

There are also enhancements in mass ranges of 1320 ,1360, 1410, 1540 and 1630 at bin sizes 17 and 12 MeV/c^2 which are can be reflection for enhancement productions from well known hyperons in effective mass spectrum from decay channel $\Lambda\gamma\pi^0 \to\to \Lambda\gamma\gamma\gamma$.



(Λ γ) spectrum without geometrical weights. **The observed width of Σ^0 is ≈2 times larger than value of experimental errors, when applied the total geometrical weights for Λ and γ. The number of events in peak is 220(12σ). There are small enhancements for in mass range of 1320, 1360 and 1410 MeV/c². The detail analysis (Λ γ)** and **(p γ) spectra are going on with different method.**

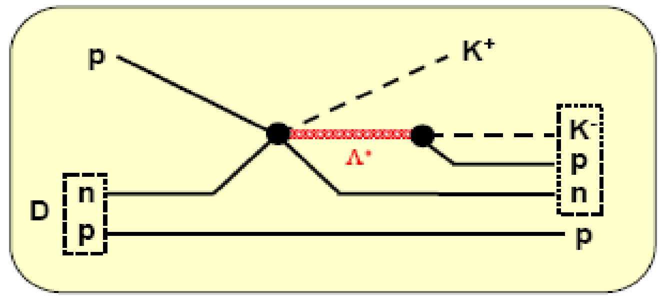
$w_\gamma = \varepsilon_\gamma^{-1}$ = [1-exp(-μ(Eγ)*L/x0)] -1, μ(Eγ)= ($X_0 \rho N_0/A$); X_0=106 cm radiation length in propane bubble chamber, μ(Eγ)- probability conversion from γ -quanta with energy Eγ formation electron-positron on one radiation length. $\sigma_{tote+e-}$ (Eγ) cross section formation of electron-positron on one molecule propane.

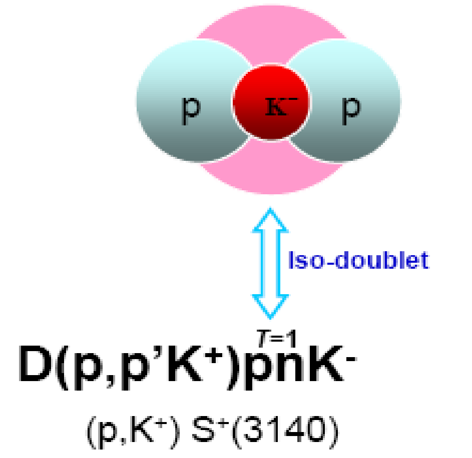
(Λ,p) spectra

•Recently, the existence of discrete nuclear bound states of K^{0bar}p has been predicted with phenomenological Kaonic Nuclear Cluster (KNC) model which is based on the experimental information on the K^{0bar}N scattering lengths, kaonic hydrogen atom and the Λ*(1405) resonance.

Λ(1405)-Doorway Process

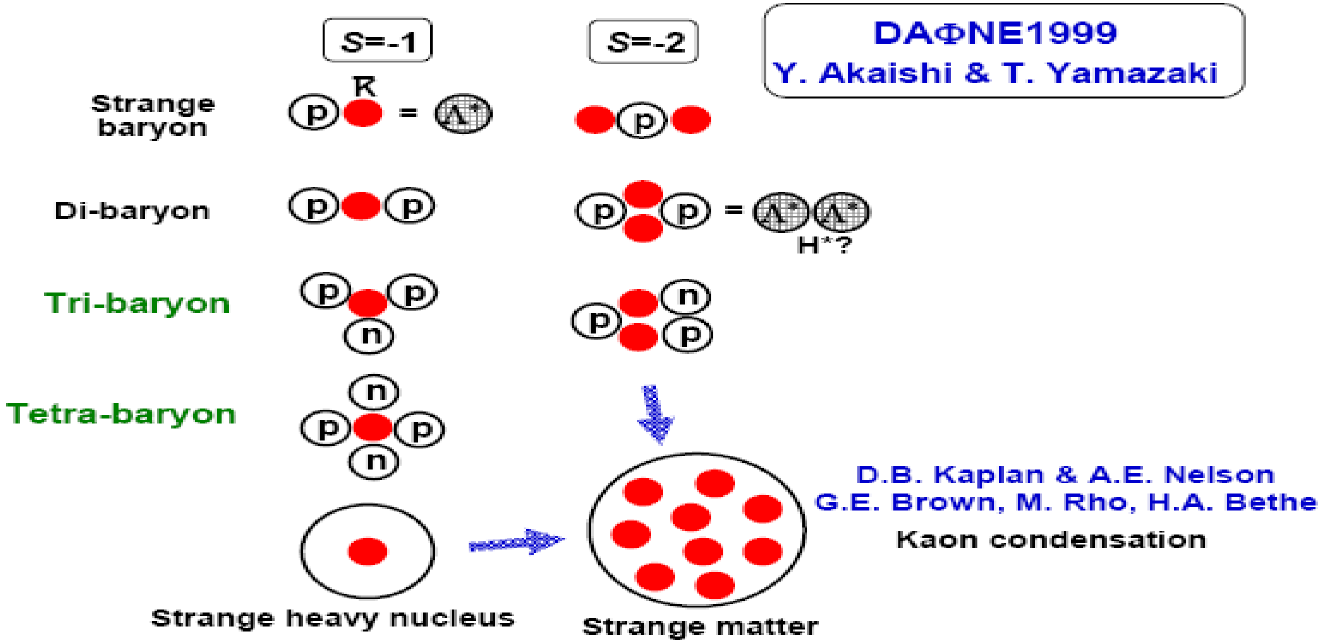
T. Yamazaki & Y. Akaishi, Phys. Lett. B535 (2002) 70.

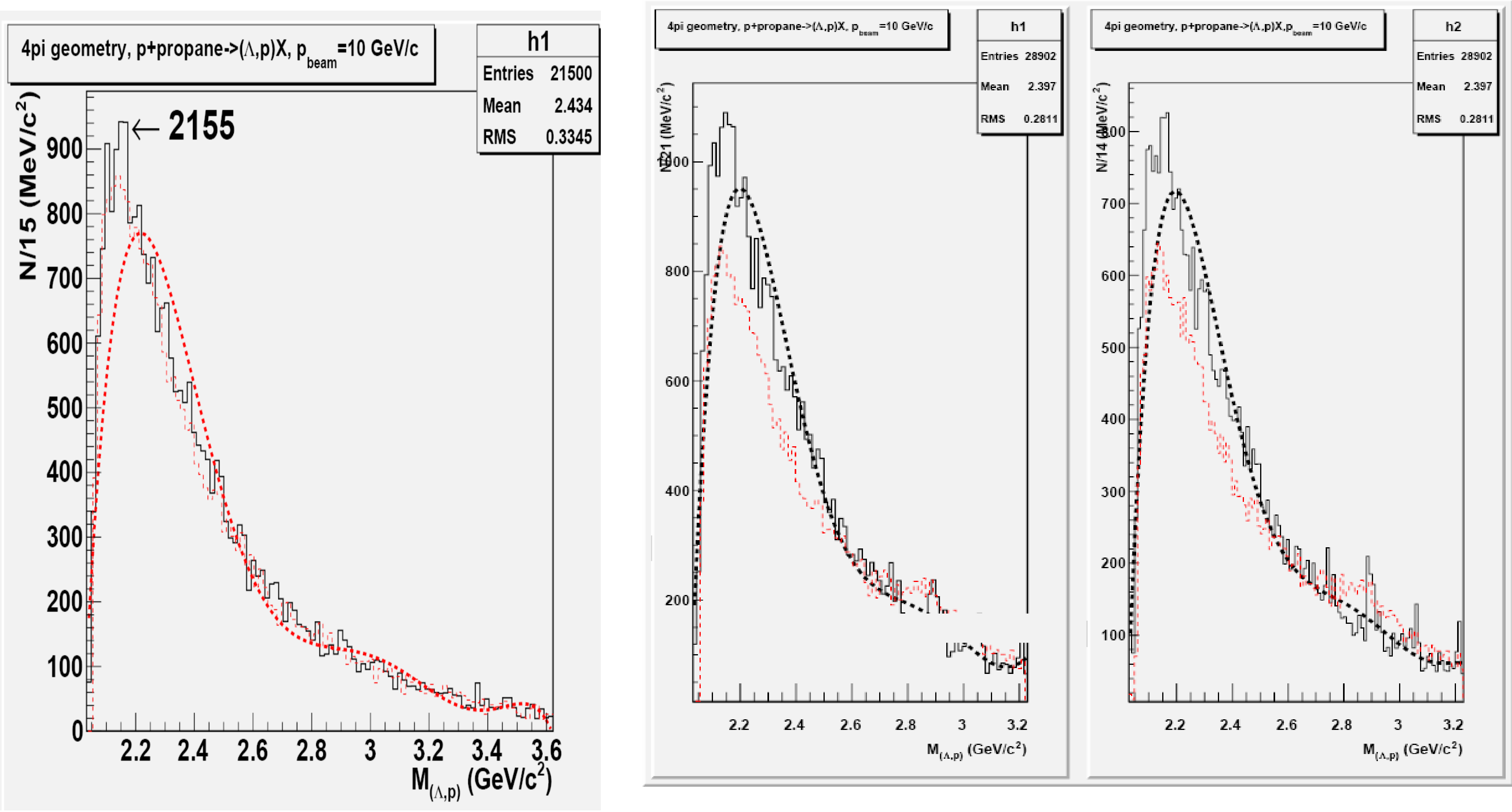




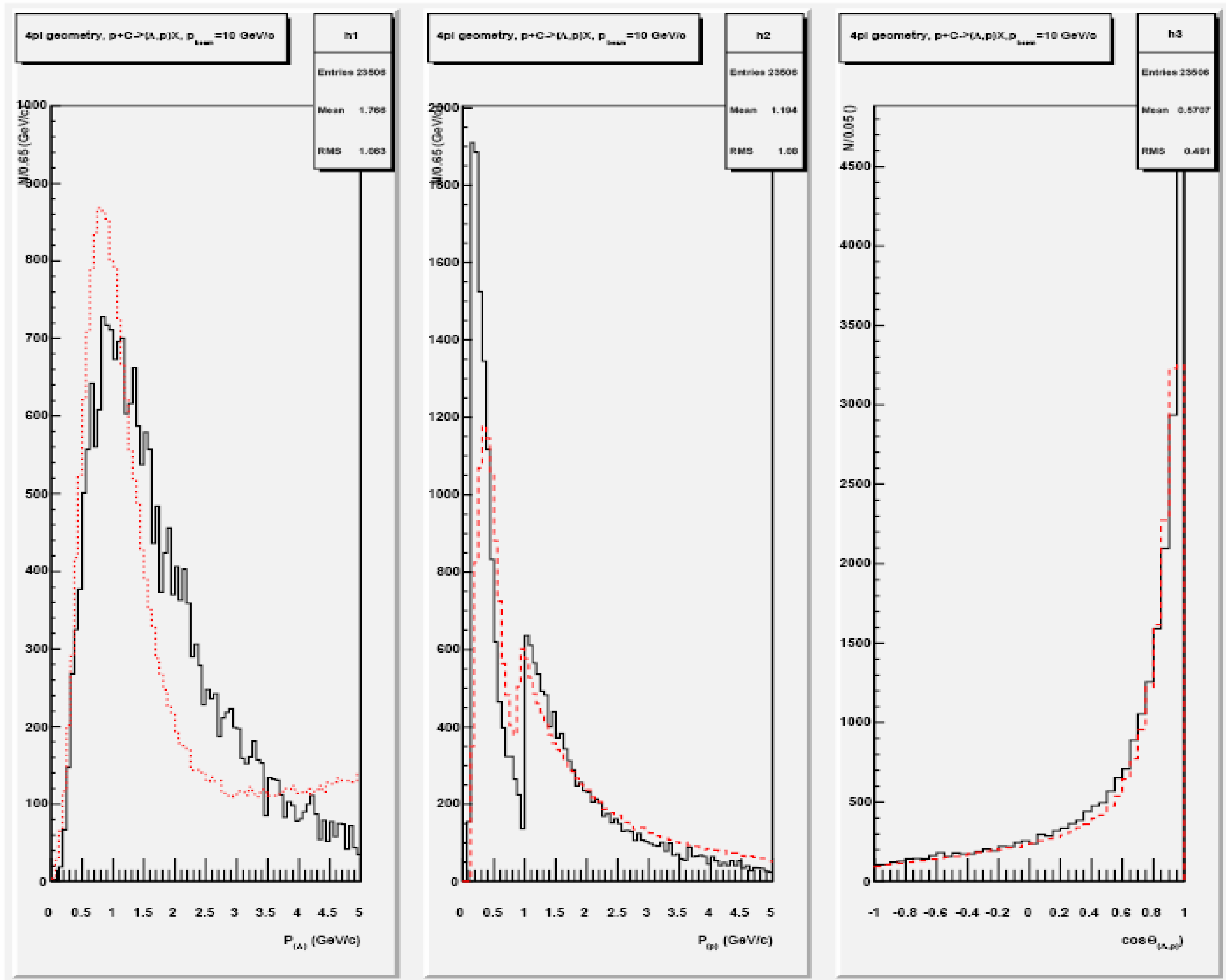
Missing mass spectroscopy

Few-Body K̄N Systems

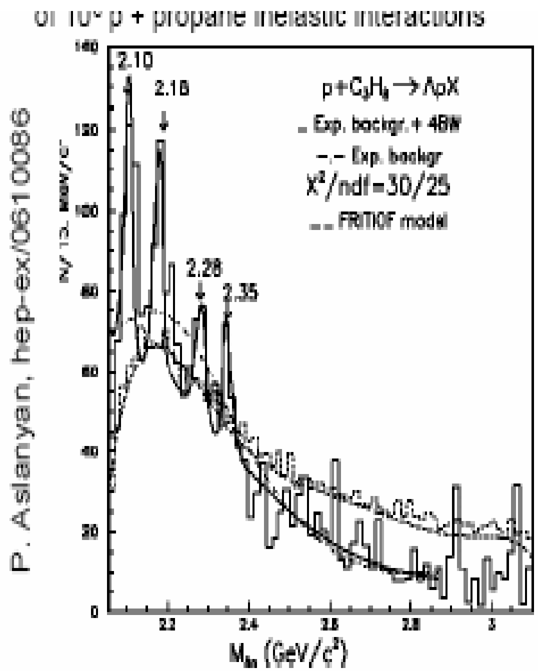




4pi geometry, p+propane->(Λ,p)X, p beam =10 GeV/c
h1
Entries 21500
Mean 2.434
RMS 0.3345
← 2155
N/15 (MeV/c²)
M(Λ,p) (GeV/c²)
4pi geometry, p+propane->(Λ,p)X, p beam =10 GeV/c
h1
Entries 28902
Mean 2.397
RMS 0.2811
N/21 (MeV/c²)
M(Λ,p) (GeV/c²)
4pi geometry, p+propane->(Λ,p)X,p beam =10 GeV/c
h2
Entries 28902
Mean 2.397
RMS 0.2811
N/14 (MeV/c²)
M(Λ,p) (GeV/c²)


4pi geometry, p+C->(Λ,p)X, p_beam=10 GeV/c
h1
Entries 23506
Mean 1.766
RMS 1.063
N/0.05 (GeV/c)
P_(Λ) (GeV/c)
4pi geometry, p+C->(Λ,p)X, p_beam=10 GeV/c
h2
Entries 23506
Mean 1.194
RMS 1.08
N/0.05 (GeV/c)
P_(p) (GeV/c)
4pi geometry, p+C->(Λ,p)X, p_beam=10 GeV/c
h3
Entries 23506
Mean 0.5707
RMS 0.491
N/0.05 ()
cosΘ_(Λ,p)

N. Hermann(FOPI) Talk on BARYON07, Seul.

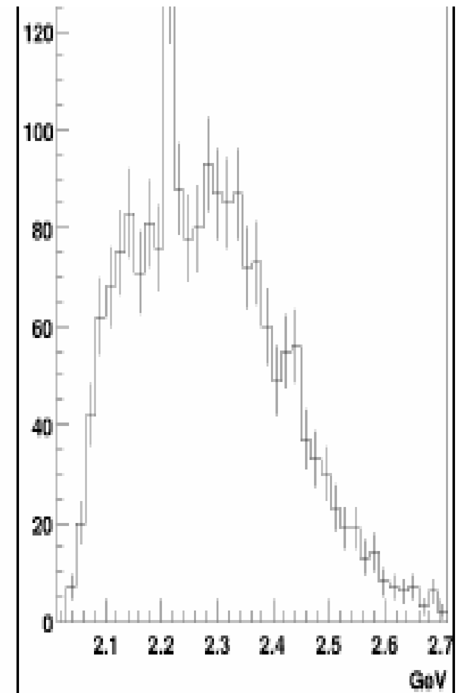


10^4 events

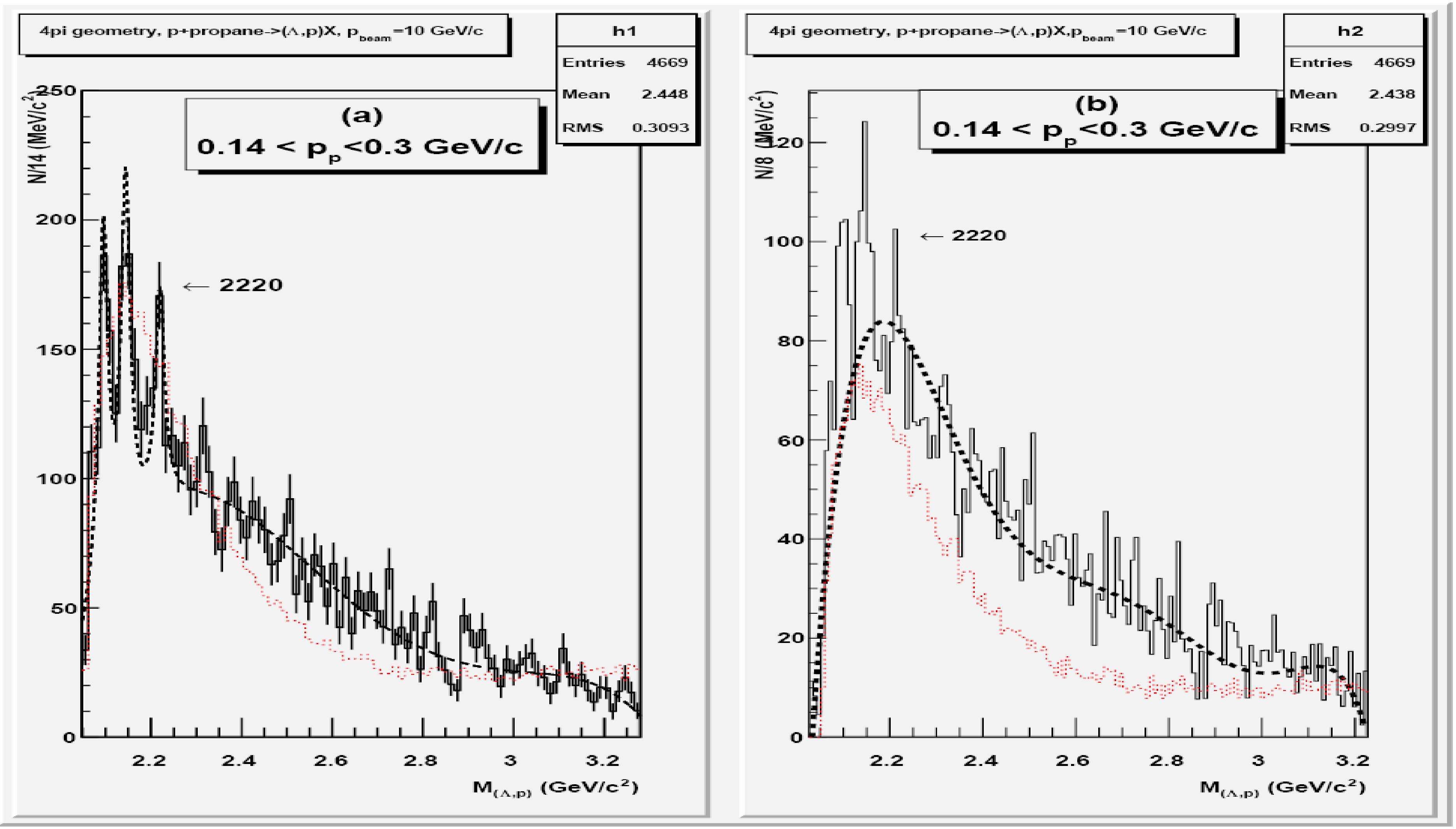
Cuts:
IM(Λ) in [1085 – 1145] MeV
and cosΘ < -0.4

Θ – angle between Λ and K^0_S

→ talk by P. Aslanyan



		M (MeV)	Γ (MeV)	P/Λ	P/(IN)	Sign (σ)
FOPI	HI: Al+Al	2120 ± 10	59 ± 12	$1.7 \cdot 10^{-2}$		5.0
	HI: Ni+Ni	2140 ± 10	59 ± 19	$2.2 \cdot 10^{-2}$		5.4
FINUDA PRL 94(2005)212303	K^- stopped on ^{12}C, $^{6,7}Li$	2255 ± 9	67 ± 14	$3\text{-}4 \cdot 10^{-2}$	$1 \cdot 10^{-3}$	? (10)
Obelix	$\bar{p}$ stopped in ^4He	2209 ± 5	< 24.4		$>1.4 \cdot 10^{-4}$	3.7
Dubna	p + A	2100, 2180, ...	<10		?	?



The background have done by polynomial and FRITIOF methods.

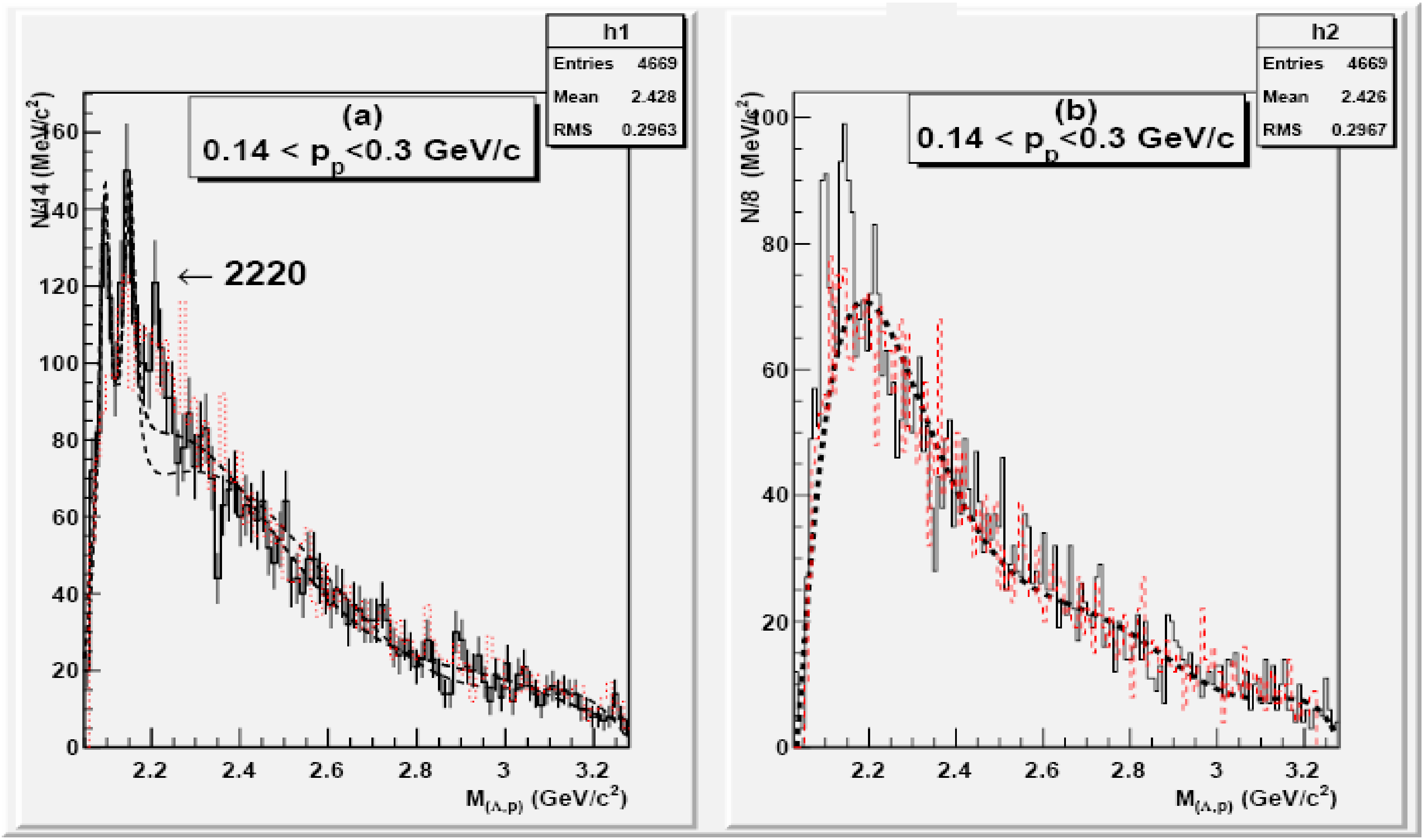
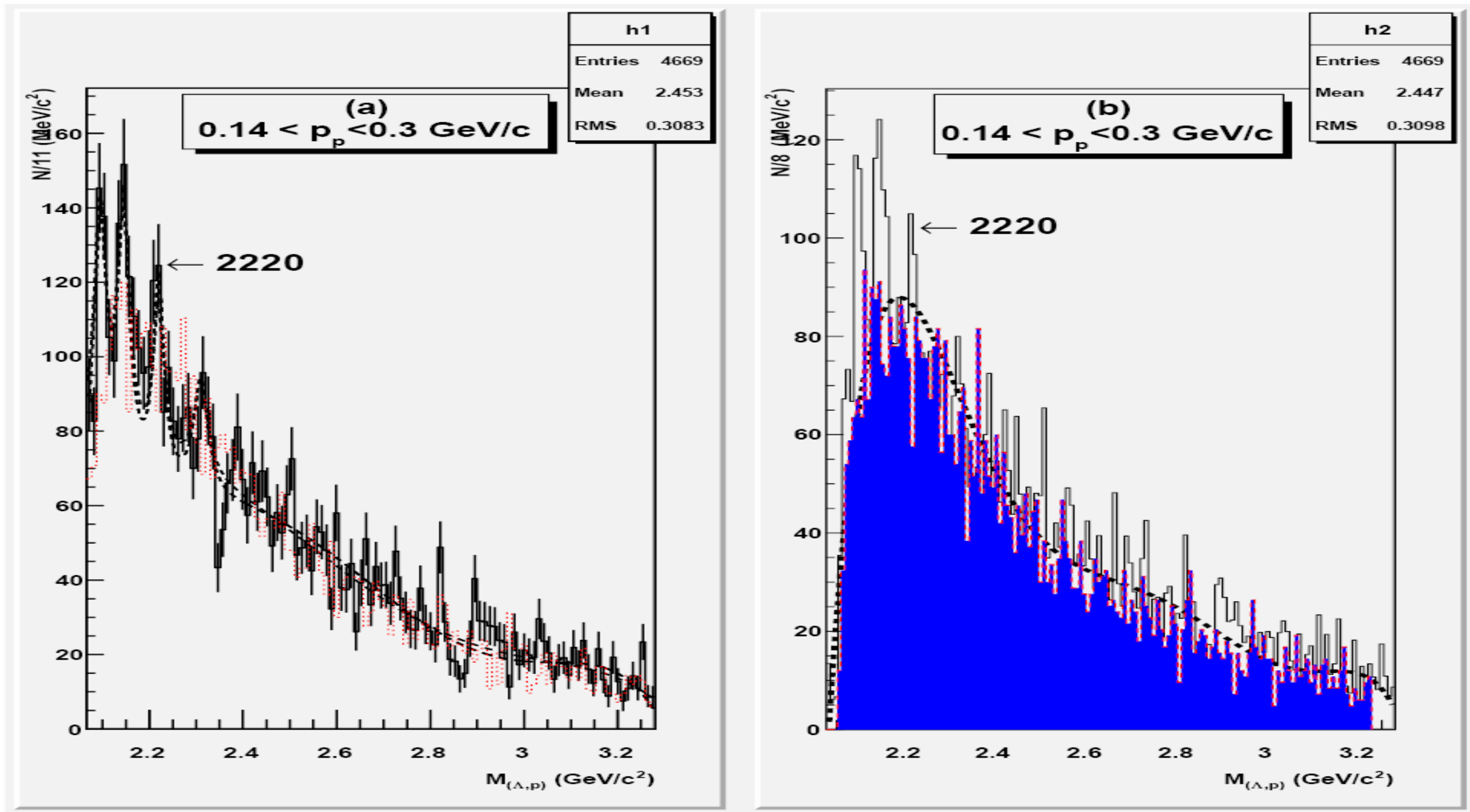
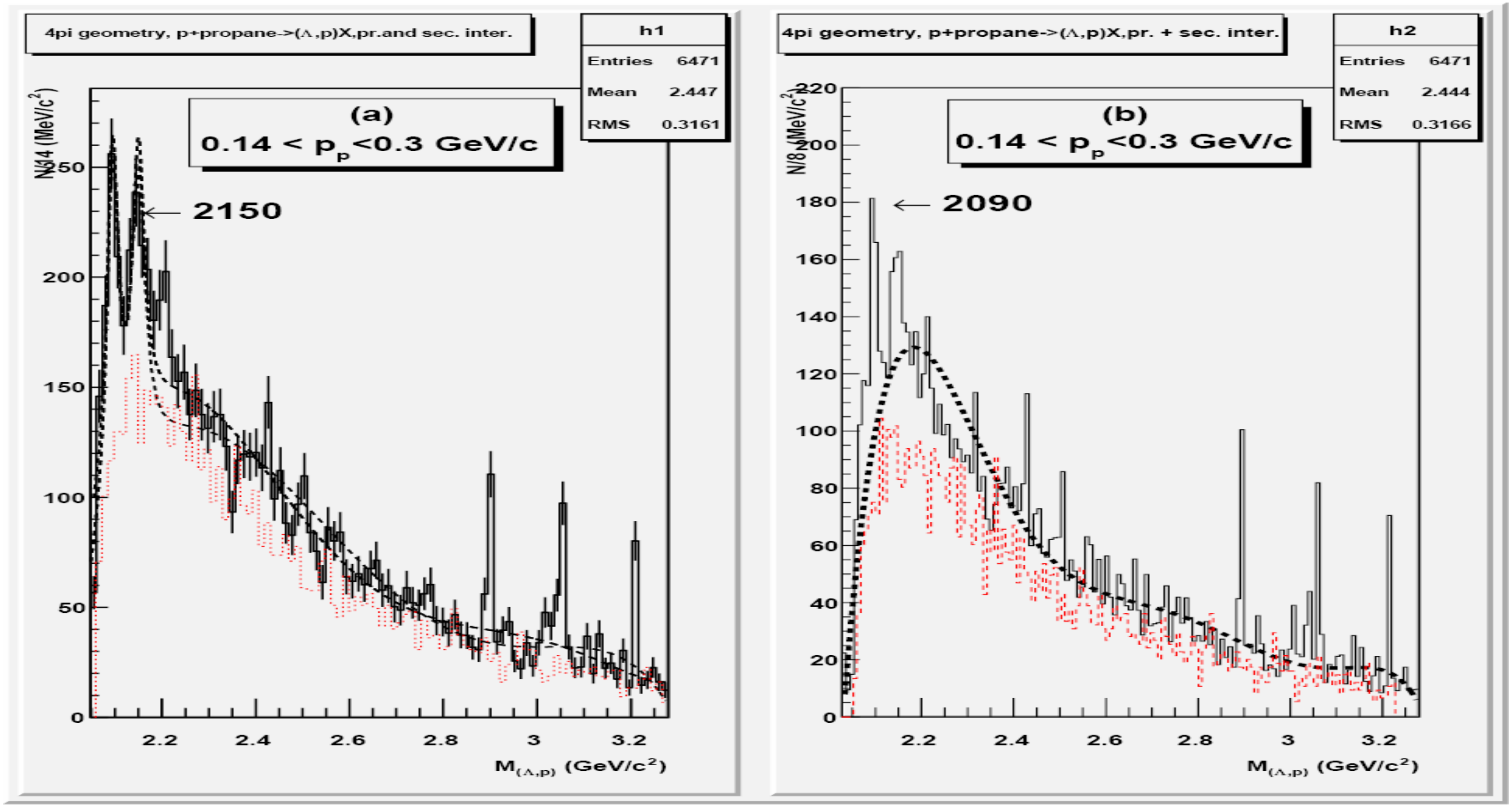


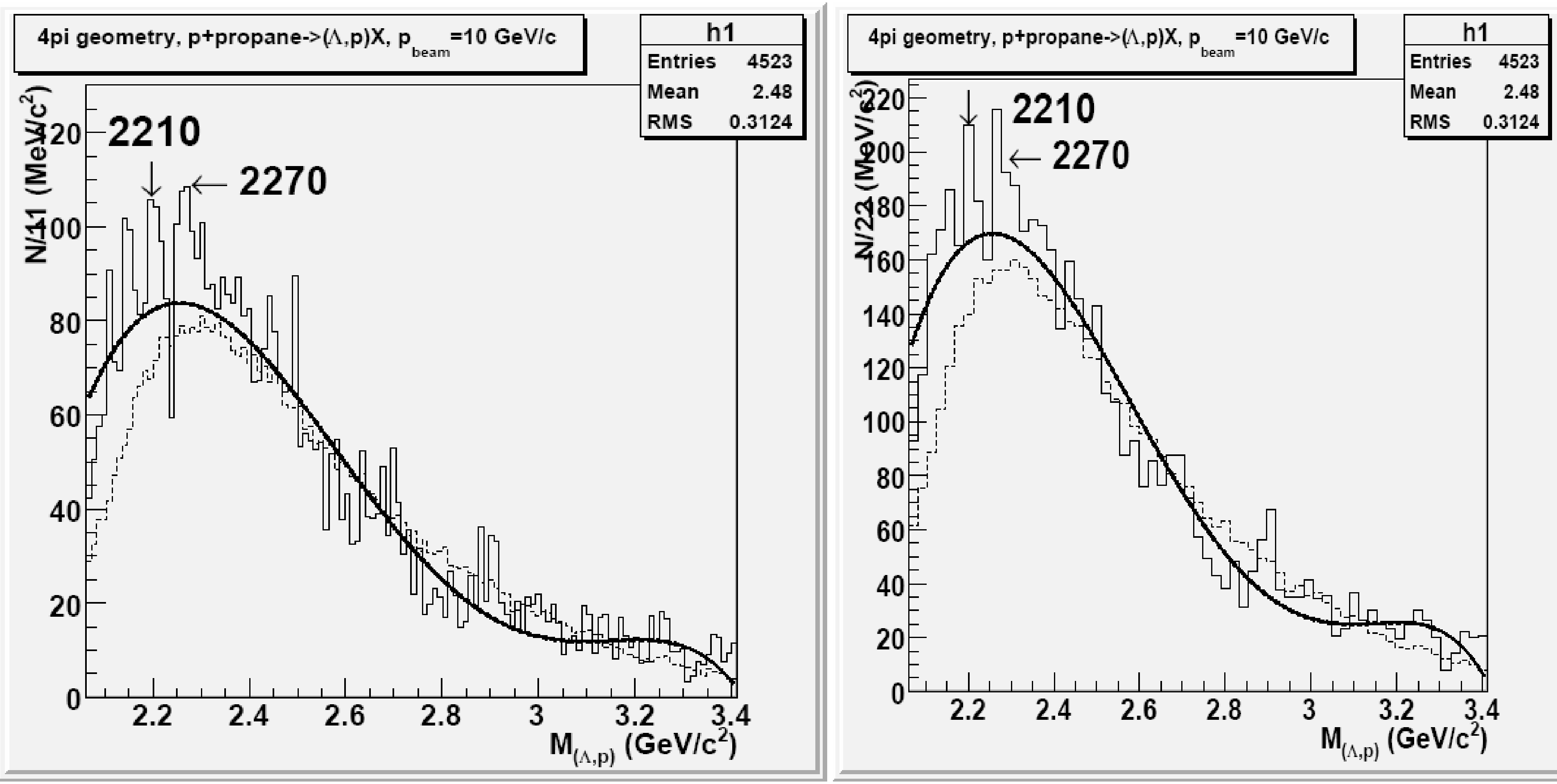
Figure shows Λp spectrum without geometrical weights for Λ. The background have done by polynomial and mixing momentum. The background have done by polynomial and mixing momentum methods. The backgrounds have a similarly behavior.


h1
Entries 4669
Mean 2.453
RMS 0.3083
(a)
0.14 < p_p<0.3 GeV/c
2220
N/11 (MeV/c^2)
$M_{(\Lambda,p)}$ (GeV/c^2)
h2
Entries 4669
Mean 2.447
RMS 0.3098
(b)
0.14 < p_p<0.3 GeV/c
2220
N/8 (MeV/c^2)
$M_{(\Lambda,p)}$ (GeV/c^2)



(Λ,p) spectrum with stopped protons (6478 comb.) induced from primary and sec. projectile protons for p+A→ (Λ,p)X inclusive reactions. There are same signals in mass range of 2100,2150 and 2220 MeV/c ^{2}. Figure shows enhancement signals in mass range of 2450, 2900 , 3050 and 3210 MeV/c ^{2}.

(Λ,p) spectrum with relativistic protons



Recent Λp effective mass distribution for 4523 comb. **with relativistic protons at momentum of P >1.5 GeV/c** is shown in Figure. The solid curve is the 6-order polynomial function (χ^2/n.d.f=270/126). Backgrounds for analysis of the experimental data are based on FRITIOF and the polynomial methods. There are significant enhancements in mass ranges of 2145(4.4 S.D.), 2210(4.7 S.D.), 2270(4.0 S.D.) and 2900(5.1 S.D.) MeV/c^2.

(Λ,p) spectrum with stopped protons

Decay mode	Effective mass(Mev/c^2)	Experimental width(Mev/c^2)	Width(Mev/c^2) ≈	Statistical significance
Λp	2100	36	24	5.7
Λp	2145	32	19	5.7
Λp	2220	36	23	6.1
Λp	2310	44	30	3.7
Λp	2380	46	32	3.5

A significant peak at invariant mass M ~ 2220 MeV/c^2 , B_K ~ 120 MeV was specially stressed by Professor T. Yamazaki on μCF2007, Dubna, June-19-2007 that is conform with KNC model prediction by channel of K^-pp --> Λ + p .

Summary

- The observation of Σ^{*+}(1385), K*(890) and Σ^0 strange particles from PDG are the good tests for this method.
- The experimental $\Lambda/\pi+$ ratio in the pC reaction is approximately 2 times larger than ratio from pp reactions or from simulated pC reaction by FRITIOF model at momentum 10 GeV/c
- A number of important peculiarities were observed in pA $\rightarrow \Lambda(K^0_S)$ X reactions in the effective mass spectrum for exotic states with decay modes (TABLE 1) : 1) (Λ, π), (Λ,γ), (Λ,p), (Λ, p, p), (Λ,Λ), (K^0_S,Λ).
- The enhancement production for all registered hyperons have observed than calculated geometrical cross sections.
- There are enhancement signals for total spectrum of (Λ,p) in mass range of 2450, 2900, 3050 and 3210 MeV/c^2 , when applied geometrical weights for Λ.
- The mass of exited Σ^{*-}(1385) is shifted to M(1370) which interpreted as contribution from low momentum π-.
- The width of Σ^*-(1385) two time larger in medium of carbon than data from PDG. Such of behavior for width can explain as the sum of contributions in Σ^{*-}(1385), the enhancement production from stopped Ξ^- and reflection from Λ^*(1410).
- The observed width of Σ^0 is $\approx$2 times larger than value of experimental error, when applied the total geometrical weights from Λ and γ . It is also evidence for reflection of the enhancement productions from secondary clusters with hyperons in medium of carbon nucleus, which is induced decay by γ channel.
- There are small signals in mass range of $\Sigma^{*\pm}$(1480), Σ^{*0}(1480) by channels of (Λ, π) , which are conformed from the **collaboration** reports of SVD2 and COSY. The reflection from Λ^*(1410) by channel of (Λ γ) have observed.

The sum of primary and secondary event s allow to obtain larger statistical significances for

- Prof. T.Bressani report on conference EXA08(OBELIX coll.), Vienna.No assumptions (purely experimental) Believing in the statistics, we observe a 3σ (4.5 σ new analysis ???) signal for a S=-1 dibaryon with M=2212.1±4.9 MeV, Γ=24.4±8.0 MeV, yield of 1.5×10-4 and a 2.6 σ signal for a S=-1 trybarion with M=3190±15 MeV, Γ≤60 MeV, yield of 0.39×10-4 Resemblance with similar signals claimed in other processes (see e.g. P. Zh. Aslanyan, Proc. HADRON07, LNF Phys. Series XLVI (2007), p.1283).

- P. Salvini et al., at LEAP08, Vienna

Further experimental fact: compare strangeness production in p annihilation on nuclei with that on hydrogen related to the possible quark-gluon plasma formation [*]
or to the existence of DBKS in dense hadronic matter[**]

- Following the conjectures of J. Rafelski (Phys. Lett. B 91(1980),281, Phys. Lett. B 207(1988),371)

We assume that the above exp. fact (I) is due to the formation of a “blob” of QGP

- A recent paper over viewing the status of the problem, from A. Gal (Nucl. Phys. A 790, 143 (2007)) and et. al. : “It is clear that the issue of $\overline{K}^0$ nuclear states is far yet from being experimentally resolved and more dedicated, systematic searches are necessary”.

- The search for and study of the decay channels of exotic strange multiquark states with Λ and K_s^0 systems at FAIR, FLAIR(GSI), JPARC(KEK), Frascati, (INFN) and MPD(NICA,JINR) can get a valuable information about their nature, properties and it will be a test for observed data on PBC. Higher statistics , 4π geometry for experiments and mass resolution $\approx$1% are needed.

Experiments at GSI: upgrade of FOPI and HADES

Experiments at DAFNE-upgrade: AMADEUS and future plans;

SIDDHARTA; FINUDA upgrade

E15and E17at J-PARC

Facility for low-energy antiproton and ion research: FLAIR at GSI

The MultiPurpose Detector { MPD
to study Heavy Ion Collisions at NICA
(Conceptual Design Report)
Project leaders: A.N. Sissakian, A.S. Sorin, V.D. Kekelidze

NICA / MPD project has started
to study of hot & dense strongly interacting QCD matter
& search for possible manifestation of the mixed phase formation & critical endpoint in heavy ion collisions.

It will allow to study in-medium properties of hadrons and nuclear matter equation of state including a search for possible manifestation of deconfiment and/or chiral symmetry restoration phase transition & QCD critical end-point in the energy region of $\sqrt{S_{NN}}$ ***= 3-9 GeV***

Multi-strange hyperon production: yield & spectra

NICA / MPD is a leading **LHE** project in both – ***research progra***
of ***basic facility*** *in* ***2008-2015***

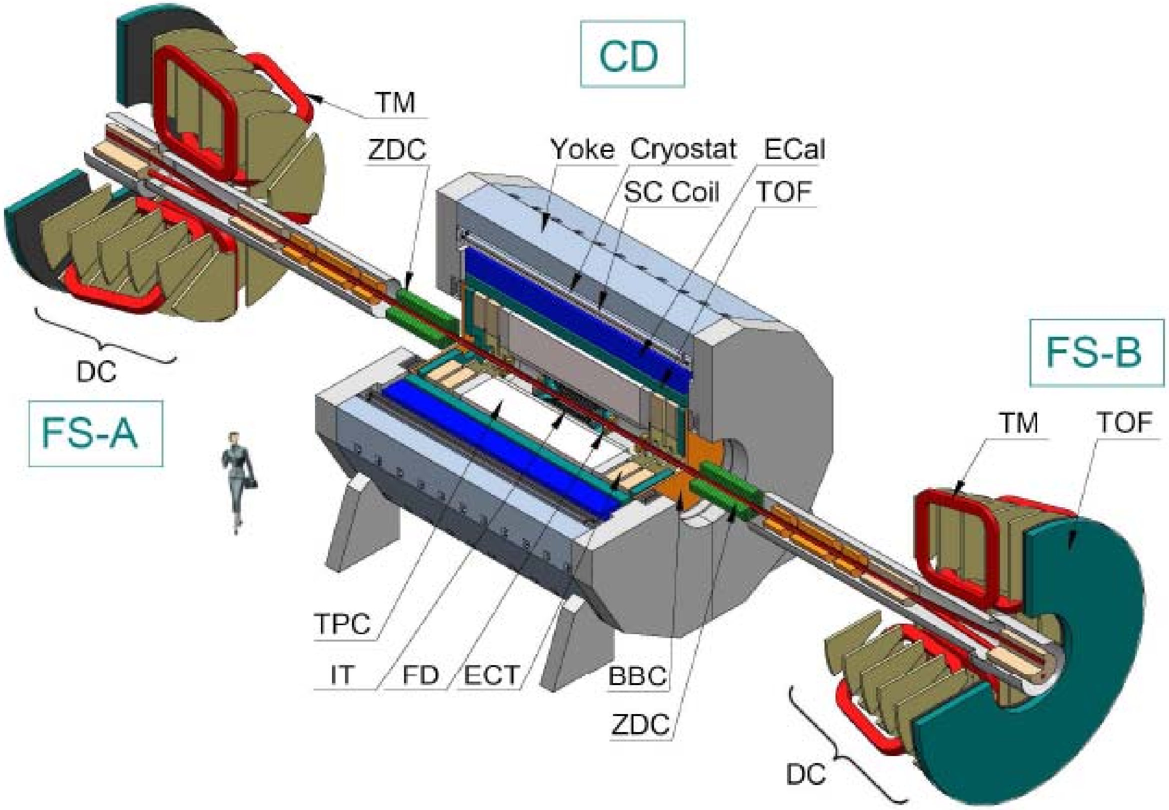


Fig. 2.1: General view of the MPD detector with end doors retracted for access to the inner detector components. The detector is represented by three major parts: CD-central parts, and (FS-A, FS-B) - two forward spectrometers (optional). The subsystems are indicated: superconductor solenoid (SC Coil) and magnet yoke, inner detector (IT), straw-tube tracker (ECT), time-projection chamber (TPC), time-of-flight stop counters (TOF), electromagnetic calorimeter (EMC), fast forward detectors (FFD), beam-beam counter (BBC), and zero degree calorimeter (ZDC).

---- J-PARC PAC Approval summary after the 2nd meeting ----

		(Co-)Spokespersons	Affiliation(*)	Title of the experiment	Approval status	Slow line priority		2nd PAC Recommendation
						Day1?	Day1 Priority	
P01		V. Sumachev	Petersburg Nuclear Physics Institute	Proposal on measurements of the spin rotation parameters A and R at the J-PARC in the resonance region of π-N elastic scattering	Rejected			
P02	LoI	P. Aslanyan	Laboratory for High Energy, JINR	Study of Exotic Multiquark States with Λ-Hyperons and K^0_s Meson Systems at JPARC	-			-
P03		K. Tanida	Kyoto U	Measurement of X rays from Ξ^- Atom	Stage 1			-
P04		J.C.Peng; S.Sawada	U.of Illinois at Urbana-Champaign; KEK	Measurement of High-Mass Dimuon Production at the 50-GeV Proton Synchrotron	Deferred			-
P05		T. Nagae	KEK	Spectroscopic Study of Ξ-Hypernucleus, $^{12}_{\Xi}Be$, via the $^{12}C(K^-, K^+)$ Reaction	Stage 2	Day1	1	-
P06		J. Imazato	KEK	Measurement of T-violating Transverse Muon Polarization in $K^+ \rightarrow \pi^0 \mu^+ \nu$ Decays	Stage 1			-
P07		K. Imai, K. Nakazawa, H. Tamura	Kyoto U., Gifu U., Tohoku U.	Systematic Study of Double Strangeness System with an Emulsion-counter Hybrid Method	Stage 1			Stage 2
P08		A. Krutenkova	ITEP	Pion double charge exchange on oxygen at J-PARC	-			Stage 1
P09	LoI	T. Nakano	RCNP, Osaka U	Study of Exotic Hadrons with S=-1 and Rare Decay $K^+ \rightarrow \pi^+ \nu$ ν-bar with Low-momentum Kaon Beam at J-PARC	-			-
P10		A. Sakaguchi, T. Fukuda	Osaka U	Production of Neutron-Rich Lambda-Hypernuclei with the Double Charge-Exchange Reaction (Revised from Initial P10)	Deferred			Stage 1
P11		K. Nishikawa	KEK	Tokai-to-Kamioka (T2K) Long Baseline Neutrino Oscillation Experimental Proposal	Stage 2			-
P12	LoI	S. Choi	Seoul National University	Study of Parton Distribution Function of Mesons via Drell-Yan Process at J-PARC at High-p beamline	-			-
P13		T. Tamura	Tohoku U.	Gamma-ray spectroscopy of light hypernuclei	Stage 2	Day1	2	-
P14		T. Yamanaka	Osaka University	Proposal for $K_L \rightarrow \pi^0 \nu$ ν-bar Experiment at J-PARC	Stage 1			-
P15		M. Iwasaki, T. Nagae	RIKEN, KEK	A Search for deeply-bound kaonic nuclear states by in-flight 3He(K-, n) reaction	Stage 1	Day1		Stage 2
P16		S. Yokkaichi	RIKEN	Electron pair spectrometer at the J-PARC 50-GeV PS to explore the chiral symmetry in QCD	Deferred			Stage 1
P17		R. Hayano, H. Outa	U. Tokyo, RIKEN	Precision spectroscopy of Kaonic ^3He 3d->2p X-rays	Stage 1	Day1		Stage 2
P18		H. Bhang, H. Outa, H. Park	SNU, RIKEN, KRISS	Coincidence Measurement of the Weak Decay of $^{12}_{\Lambda}C$ and the three-body weak interaction process	Deferred			Stage 1
P19		M. Naruki	RIKEN	High-resolution Search for Θ^+ Pentaquark in $\pi^- p \rightarrow K^- X$ Reactions	Stage1	Day1		Stage 2
P20	LoI	Y. Kuno	Osaka U	An Experimental Search for $\mu^- - e^-$ Conversion at Sensitivity of 10^{-18} with a High Intense Muon Source, PRISM	-			-
P21	LoI	Y. Kuno	Osaka U	An Experimental Search for $\mu^- - e$ Conversion at a Sensitivity of 10^{-16} with a Slow-Extracted Bunched Beam	-			-
P22		S. Ajimura, A. Sakaguchi	Osaka U	Exclusive Study on the Lambda-N Weak Interaction in A=4 Lambda-Hypernuclei (Revised from Initial P10)				Stage 1

Table 1. The observed signals from mass spectra with Λ subsystems

Decay mode	M (MeV/c^2)	Γ(MeV/c^2)	S.D.
$\Lambda\gamma$	Σ^0	55(PDG)	12.0
$\Lambda\pi^+$	Σ^{*+}(1382)	40(PDG)	12.9
$\Lambda\pi^+\pi^-$	Λ^*(1600)	55(PDG)	5.5
	Λ^*(1750)	54(PDG)	4.2
	Λ^*(1830)	51(PDG)	5.6
$\Lambda\pi^-$	Σ^{*-}(1370)	93 (PDG)	11.3
	Ξ^- (1320)	-	3.0
	Σ^{*-} (1480)	-	3.2
Λp	2100	24	5.7
	2150	19	5.7
	2220	28	6.1
	2310(2270)	30	3.7
	2380	32	3.5
ΛΛ	2370	-	4.5
Λpp	3140	40	6.1
	3320	-	4.8
ΛK^0_s	1750	14	5.6
	1795	26	3.3