Proposal P02 for J-PARC 50 GeV Proton Synchrotron and for Nuclatron-M at 12 GeV/c Proton Beam

The XX International Baldin Seminar on High Energy Physics Problems "*Relativistic Nuclear Physics and Quantum Chromodynamics*"

The Study of Exotic Multiquark States with Λ-Hyperons and K^0_S -*Mesons Systems*

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Overview

- Abstract
- Experiments at J-PARC
- History
- Physics in LOI P02
- Pre-proposal or Phase -1
- Phase-2 and Phase-3
- Summary

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Abstract

The designed 2m propane bubble chambers(PBC) with modern power technologes for PC and precision digital photographic methods is unique multi-propose and higher-informative 4π *detector for study of exotic multi-strange events with V0* particles, light hyper-nucleus, (V^0, V^0) *interactions and other correlations.* First from all of unbeatable privilege for PBC are registration of multi-vertex or complex decay modes(with 10-50μ*m position) and beam range (near* 0^o *or* 180^o *angles)particles. More than* 70% from Λ hyperons are emitted over beam range with azimuth β or polar angles < *15*^{0} *in* p+C reaction at 10 GeV/c.

Strange multibaryon states with Λ- hyperon and K^0_s *meson subsystems has been* studied by using of data from 700000 stereo photographs or 10^6 inelastic interactions which was obtained from expose 2-m propane bubble chamber LHEP, JINR to proton beams at 10 GeV/c. The observed well-known resonances Σ^0, Σ*(*1385)* and *K*(892) from PDG are good tests of this method. A number of peculiarities* were found in the effective mass spectra with Λ and K^0_s *subsystems which* are crucial important for future particle and nuclear physics.

Strange multi-strange clusters are an exiting possibility to explore the properties of cold dense baryonic matter and non-perturbative QCD. A survey for new experiments with much improved statistics(more than 5 times) compared to those early data would hopefully resolve whether such "exotic multi-quark hadron and baryon resonances exist. High statistics with above necessary conditions there will possible to obtain of new results. Because only with high statistics or from many similarly photographs without new necessary acceptance, resolution and methods analysis there will not possible to obtain of new information about these objects.

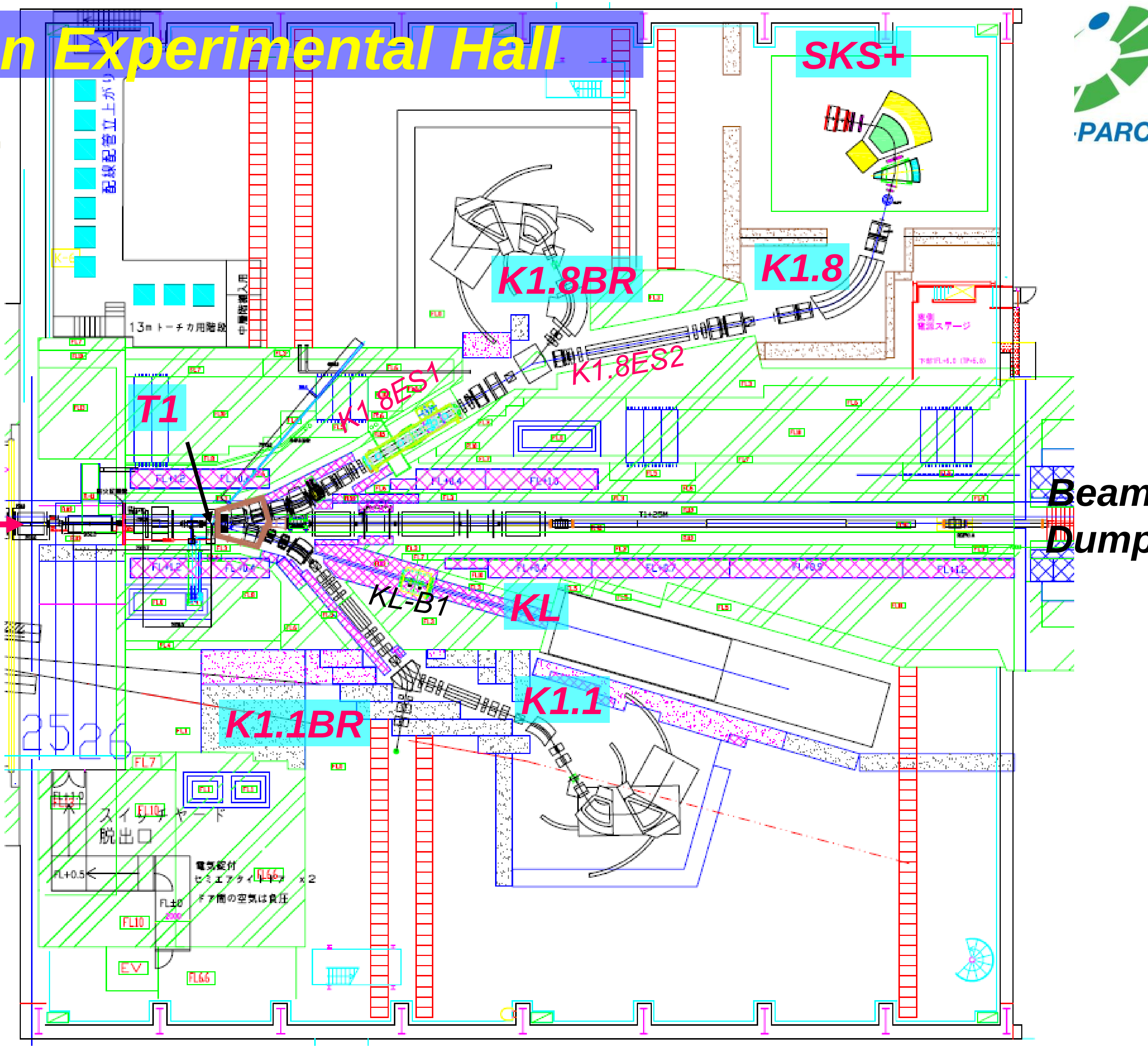
Approved Experiments
— K1.8 beamline —

Stage-2: 5 2 Day-1 experiments
Stage-1: 4

K^- beam: 4
π beam: 5

	Spokesperson	Title	Status	Beam	
→ E19	M.Naruki Sks0	High-resolution search for Θ^+ pentaquark in $\pi^- p \to K^- X$ reactions	Stage-2	π^- (~2.0)	160 hours
→ E10	A.Sakaguchi Sks0	Study on Λ-hypernuclei with the charge-exchange reactions	Stage-2	π^- (1.2)	6 weeks
E13	H.Tamura	Gamma-ray spectroscopy of light hypernuclei SksMinus+HyperBall	Stage-2 Day-1	K^- (1.5)	1000 hours
→ E07	K.Imai, K.Nakazawa, H.Tamura	Systematic study of double strangeness system with an emulsion-counter hybrid method KURAMA+HyperBall	Stage-2	K^- (1.7)	(150+600) hours
E05	T.Nagae	Spectroscopic study of Ξ-hypernucleus, $^{12}_{\Xi}$Be, via the ^{12}C(K^-,K^+) reaction SksPlus	Stage-2 Day-1	K^- (1.8)	(2+4) weeks
E03	K.Tanida	Measurement of X rays from Ξ^- atom KURAMA+HyperBall	Stage-1	K^- (1.8)	(20+100) shifts
E08	A.Krutenkova	Pion double charge exchange on oxygen at J-PARC SksPlus	Stage-1	π^+ (1.1-2.13)	(3+10) days
E18	H.Bhang, H.Outa, H.Park Sks0+ …	Coincidence measurement of the weak decay of 12LC and the three-body weak interaction process	Stage-1	π^+ (1.05)	(28+72) shifts
→ E22	S.Ajimura, A.Sakaguchi Sks0+ …	Exclusive study on the Lambda-N weak interaction in A=4 Lambda-hypernuclei	Stage-1	π^+ (1.1)	4 weeks

Hadron Experimental Hall

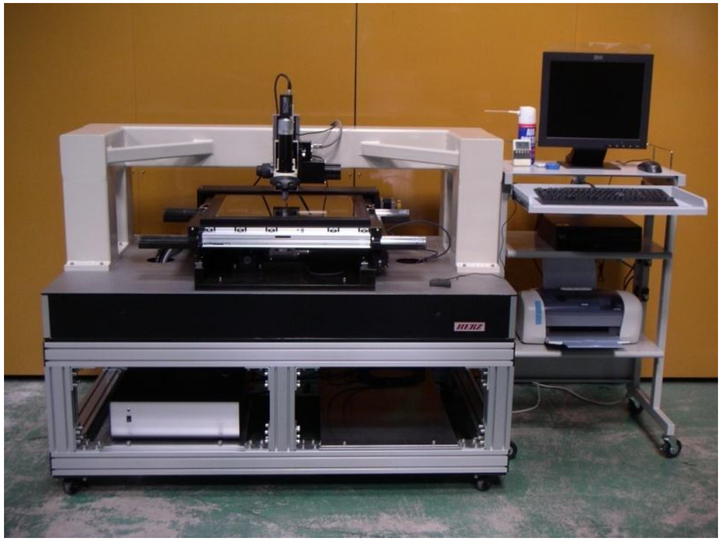


---- Approval summary after the 8th meeting ----

		(Co-) Spokespersons	Affiliation	Title of the experiment	PAC discussion
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	-
P09	LoI	T. Nakano	RCNP, Osaka U	Study of Exotic Hadrons with S=+1 and Rare Decay $K^+ \to \pi^+ \nu$ ν-bar with Low-momentum Kaon Beam at J-PARC	-
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	-
P20	LoI	Y. Kuno	Osaka U	An Experimental Search for μ^- -e^- Conversion at Sensitivity of 10^{-18} with a High Intense Muon Source, PRISM	
P21	LoI	Y. Kuno	Osaka U	An Experimental Search for μ - e Conversion at a Sensitivity of 10-16 with a Slow-Extracted Bunched Beam	2nd meeting
-	LoI	T. Kajita	ICRR, Tokyo	A letter of Intent to extend T2K with a detector 2 km away from the JPARC neutrino source	3rd meeting
-	LoI	K. Itabashi	RIKEN	Spectroscopy of eta mesic nuclei by (pi-,n) reaction at recoilless kinematics	-
-	LoI	M. Iwasaki	RIKEN	A new appoach to study the in-medium phi(1020)-meson mass	-
-	LoI	K. Ozawa	Univ. Tokyo	Combined measurements of nuclear omega bound state and omega mass modification in p(pi-,n)omega reaction	-
-	LoI	K. Miwa	Tohoku U.	A Hyperon-Nucleon Scattering Experiment using a SCIFI-MPPC System	-
-	LoI	H. Tamura	Tohoku U.	Gamma-ray spectroscopy of hypernuclei at K1.1	-
-	LoI	H. Tamura	Tohoku U.	Study of Σ-N interaction using light S-nuclear systems	-
-	LoI	K. Tanida	Tohoku U.	Search for Θ^+ hypernuclei using (K^+, p) reaction	-
-	LoI	N. Saito	KEK	New Measurement of Muon Anomalous Magnetic Moment g-2 and Electric Dipole Moment at J-PARC	-
-	LoI	F. Sakuma	RIKEN	Double Anti-kaon Production in Nuclei by Stopped Anti-proton Annihilation	-

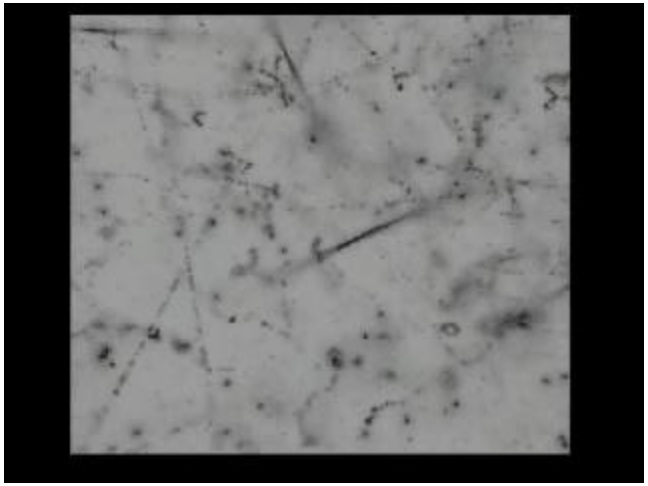
Automatic scanning system for emulsion *at J-PARC*

New Scanning System

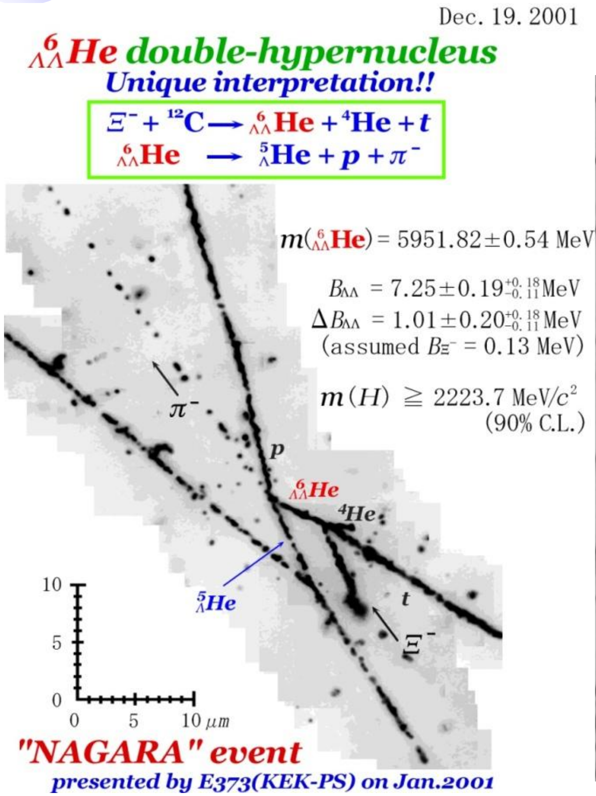


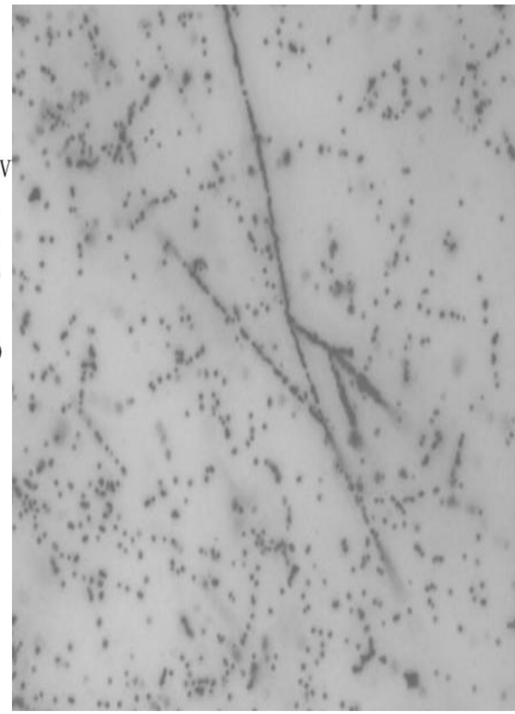
Old system

New system

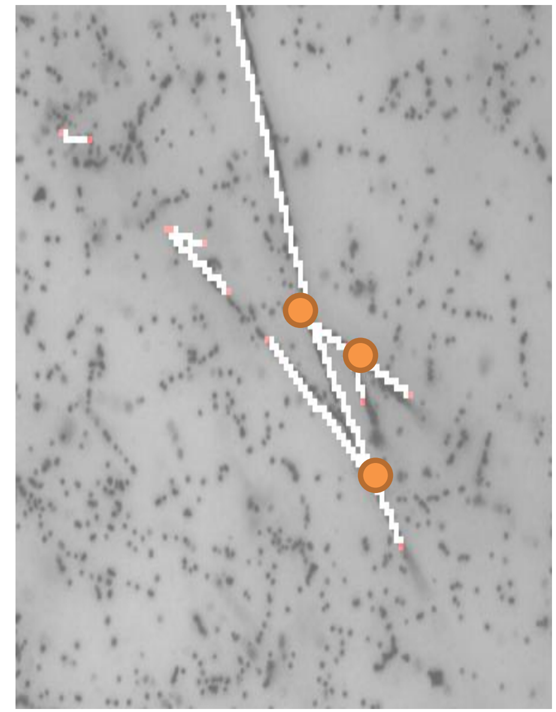


Three vertices are found





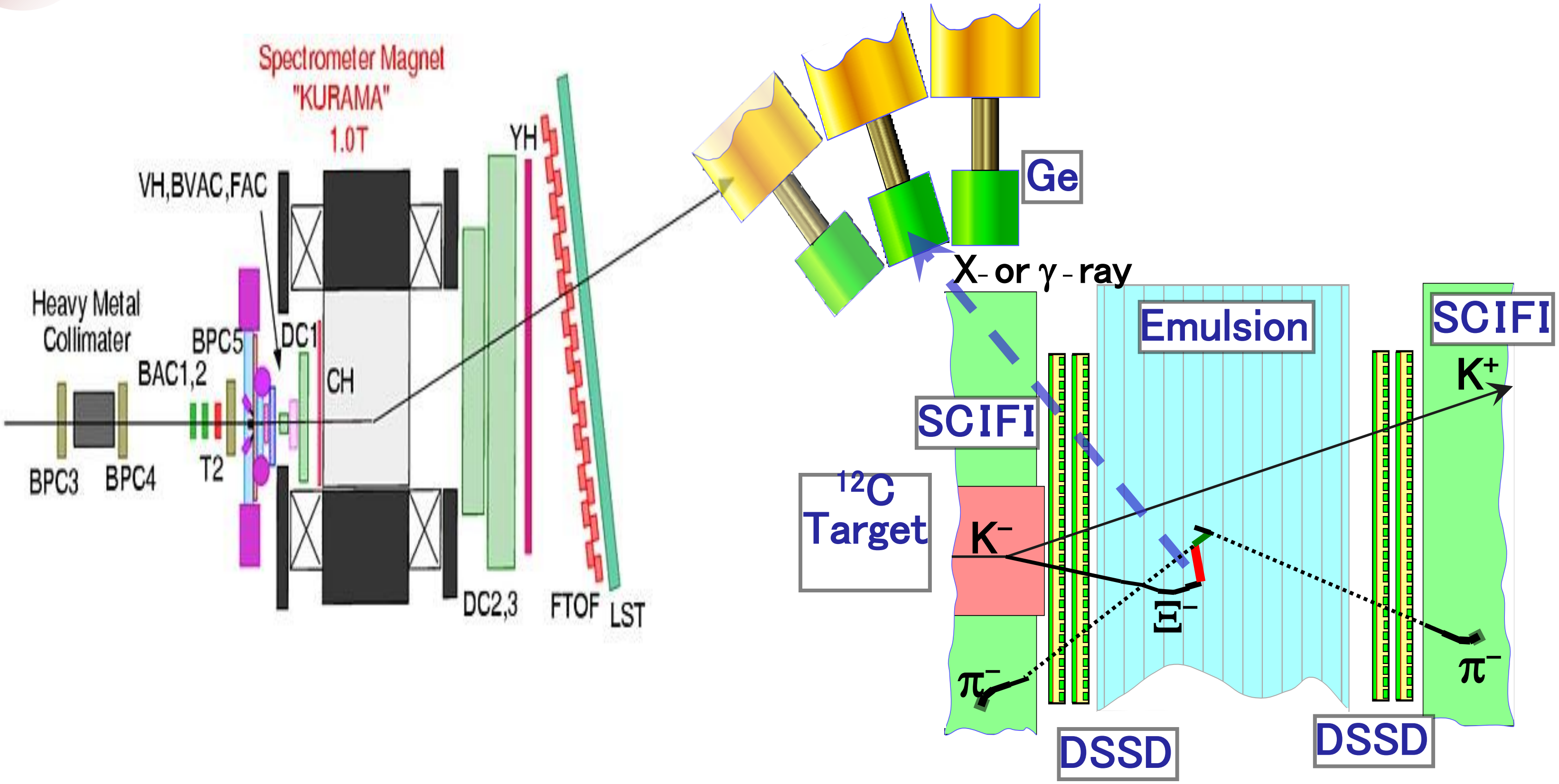
Three vertices



The first algorithm is established.

NAGARA event can be found

KEK-E373 -> J-PARC E07



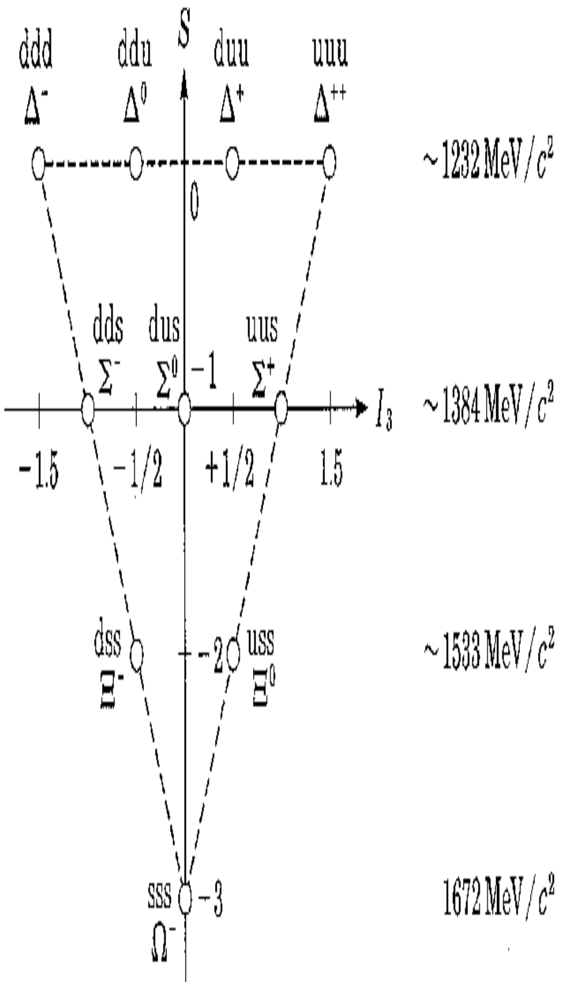
10 times statistics ~100DH ~10 clean DH

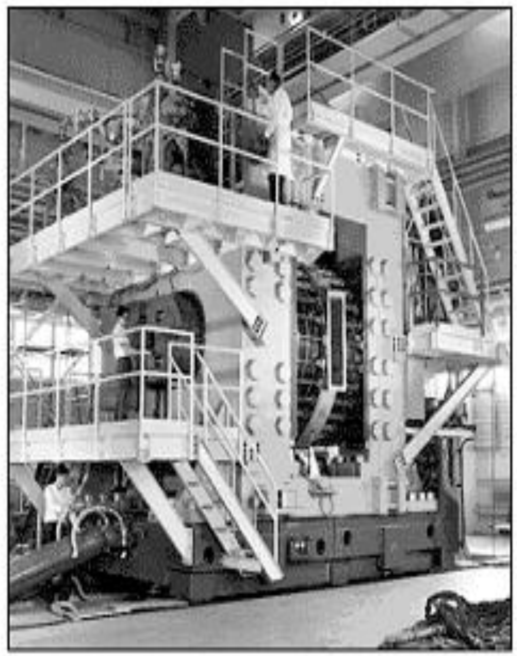
Key: pure K-beam 10times faster automatic scanning

Hystory.Discovery of Ω- success of quark

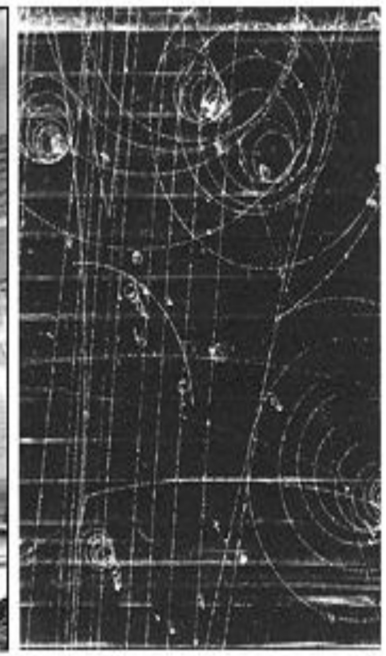
Baryon deculpet 3/2+

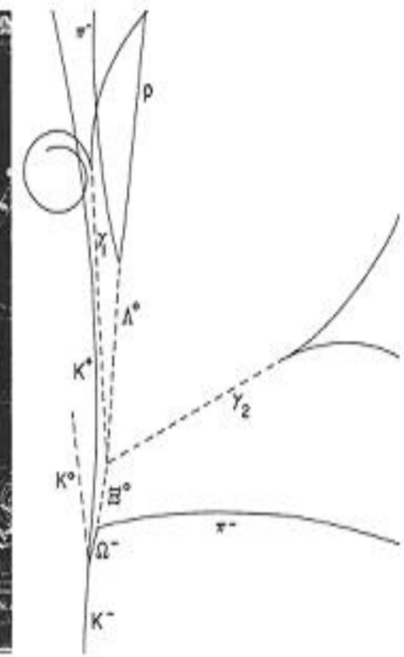
Bubble Chamber





The 80-inch Bubble Chamber





BNL, First Pictures 1963, 0.03s cycle

Discovery of the Ω^- in 1964

Bubble Chambers

The excellent position (5μm) resolution and the fact that target and detecting volume are the same (H chambers) makes the Bubble chamber almost unbeatable for reconstruction of complex decay modes.

The drawback of the bubble chamber is the low rate capability (a few tens/ second). E.g. LHC 10^9 collisions/s.

The fact that it cannot be triggered selectively means that every interaction must be photographed.

Analyzing the millions of images by 'operators' was a quite laborious task.

That's why electronics detectors took over in the 70ties.

•**Why now?** A slow daq and data measurements by using human eyes is removed. New digital photographic technology came up to higher precision which is suitable for a bubble sizes(10-50 μm). Then computers have evolved from large mainframes to desktop and laptops with computing power several orders of magnitude larger than what was available some decades ago(after 2006 y.). The designed BC detector with digital photographic cameras(R~2μm), last power computers and software on base of automatic on line data taking, measurement, reconstruction and automatic analysis of stereo pictures will provide reasonable output (100 times faster or more than 10^7/year events).

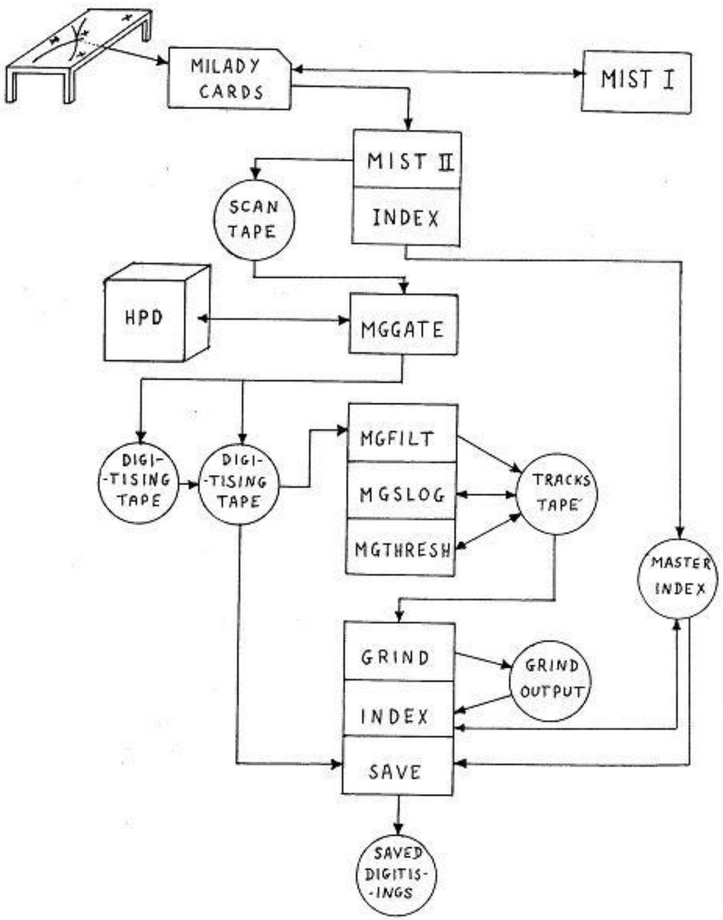
CERN 69-18
Data Handling Division
7 July 1969

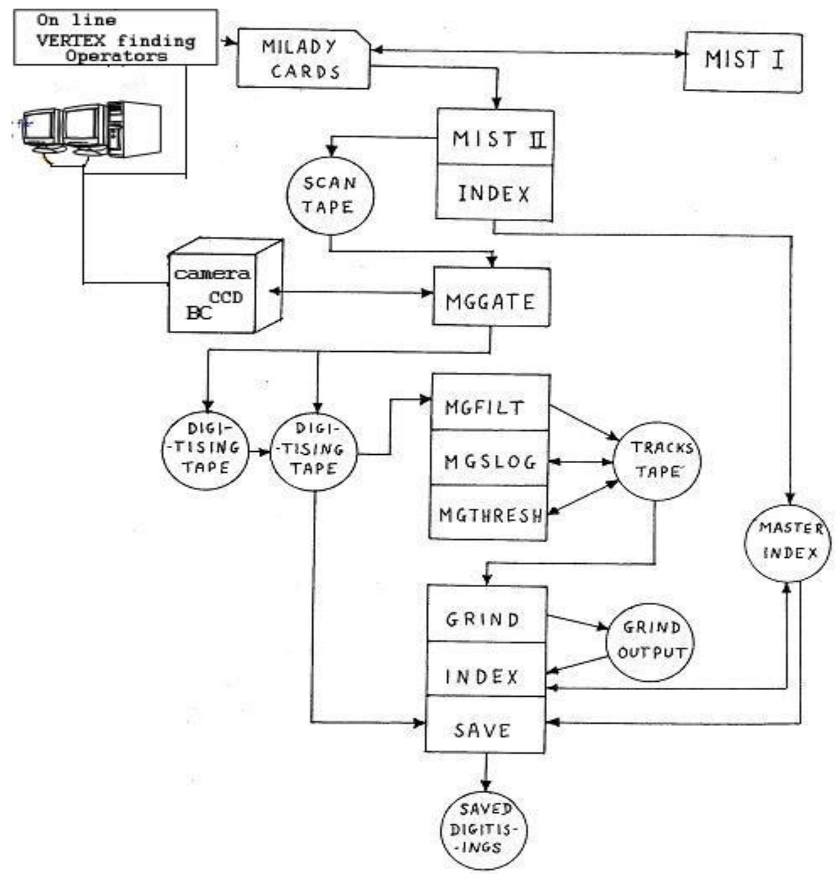
ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE

CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

ON THE QUALITY OF MEASUREMENTS MADE WITH THE HPD MINIMUM GUIDANCE SYSTEM

S.N. Ganguli*) and P. Villemoes





1)Data analysis scheme from CERN HPD for the hydrogen bubble chamber.
2) Automatic data analysis scheme directly from BC detector.

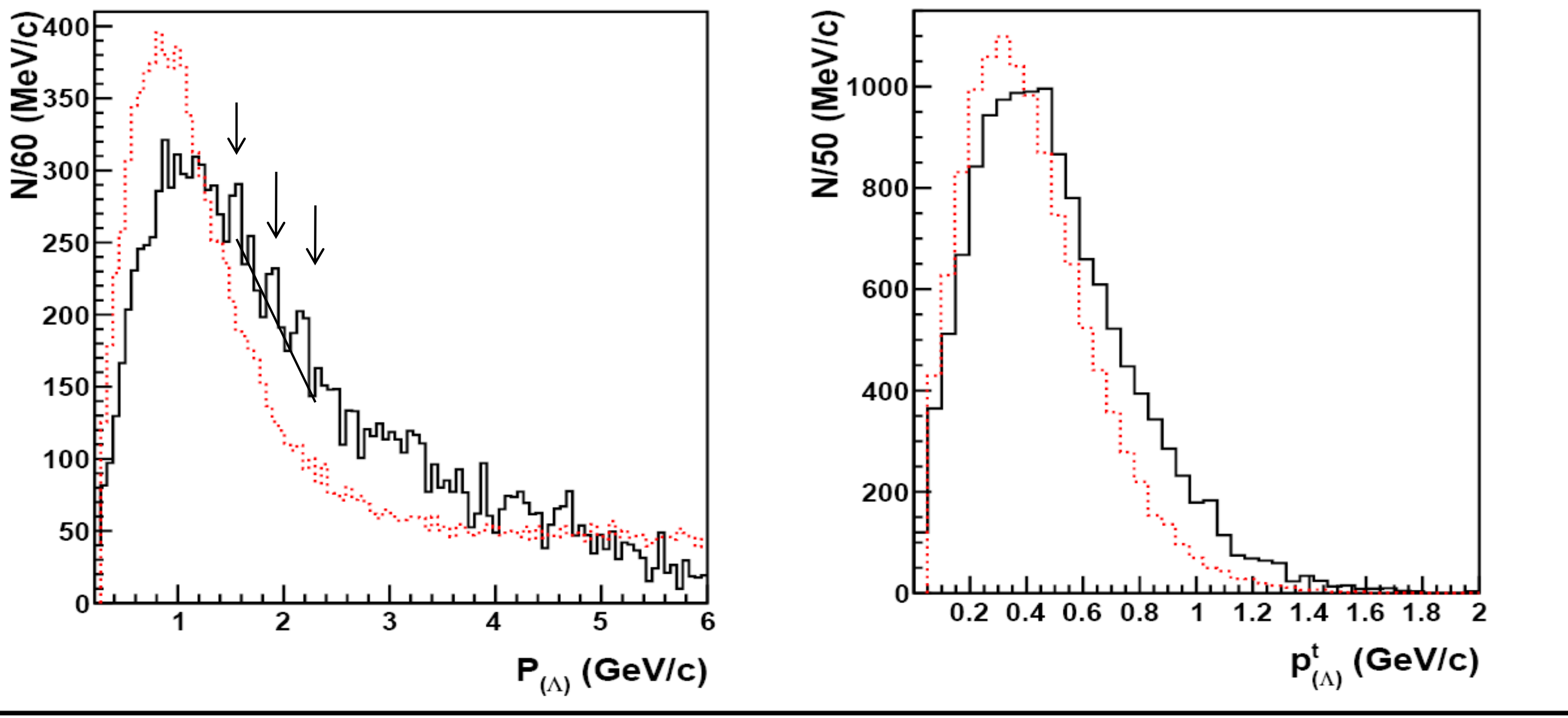
• PBC method is the most suitable, higher-informative and multi-propose 4π detector(included beam range too) for study of exotic multi-vertex states with V^0 particles. The average geometrical weights for Λ, K^0_s *and* γ are to 1.34, 1.22 and 4.1 in p+propane collision at momentum 10 GeV/c, respectively. The average effective mass resolution of (V^0,V^0),(V^0,stoping particles) system is equal to 0.5-1.0 %.

• A low beam intensity (15-20)particles/spill can particularly compensate by using of large chambers (as 2m PBC), large cross sections (*p*+*propane* ¸1450 mb, dead time is to 5 sec, 5 events/spill), fast cyclic chambers, secondary relativistic beams from Ξ^-, Λ hyperons and K+, K^-, K^0_l-mesons.

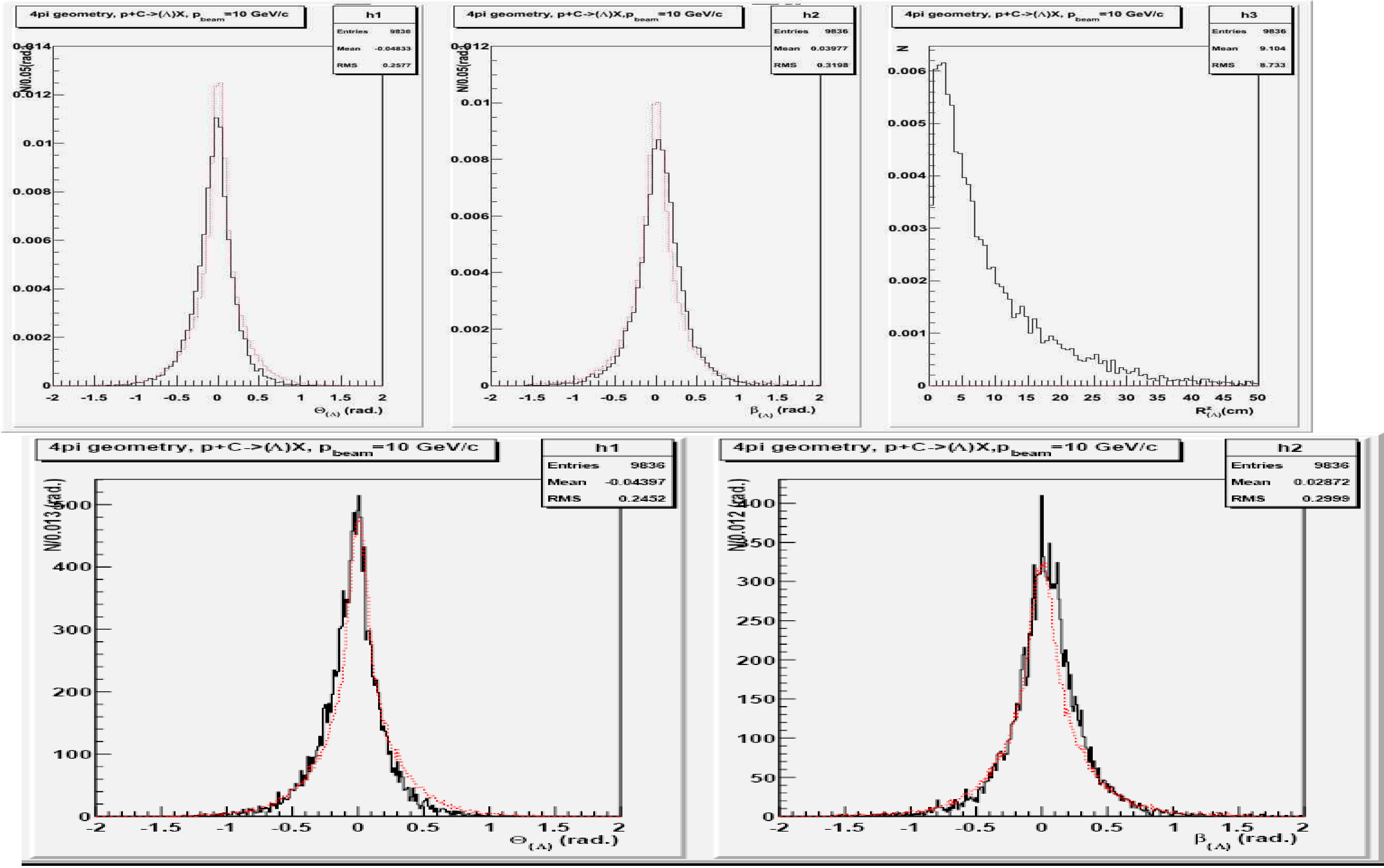
•The GEOFIT based on the Grind-CERN program is used to measure the kinematic parameters of tracks: momenta(P), tgα(α - depth angle) and azimuthal angle(β) from the stereo photographs. The momentum(P) of resolution and the average track length (L) for charged particles are to ΔP/P=2%,< L>=12 cm for stopped particles and ΔP/P=10 %, <L>= 36 cm for nonstopped particles. The momentum resolution of V^0 from (1V-3C) fit is to ΔP/P= 2%. The mean value of error for the depth and azimuthal angles are to Δtgα = 0.0099 (0.6^o) ± 0.0002 and Δβ = 0.0052 (0.3^o)± 0.0001 (rad.).

• The estimation of ionization, the peculiarities of the end track points of the stopped particles, allowed one to identify them. Protons, $K^\pm$ and $\pi^\pm$ can exactly identified by ionization over the following momentum range: $0.13 \leq P_p \leq 0.9$ GeV/c, $0.05 \leq P_K \leq 0.6$ GeV/c and $0.025 \leq P_\pi \leq 0.3$ GeV/c. Protons can separate from other particles in the momentum range of P < 0.900 GeV/c .

Λ production in p+C reaction at 10 GeV/c



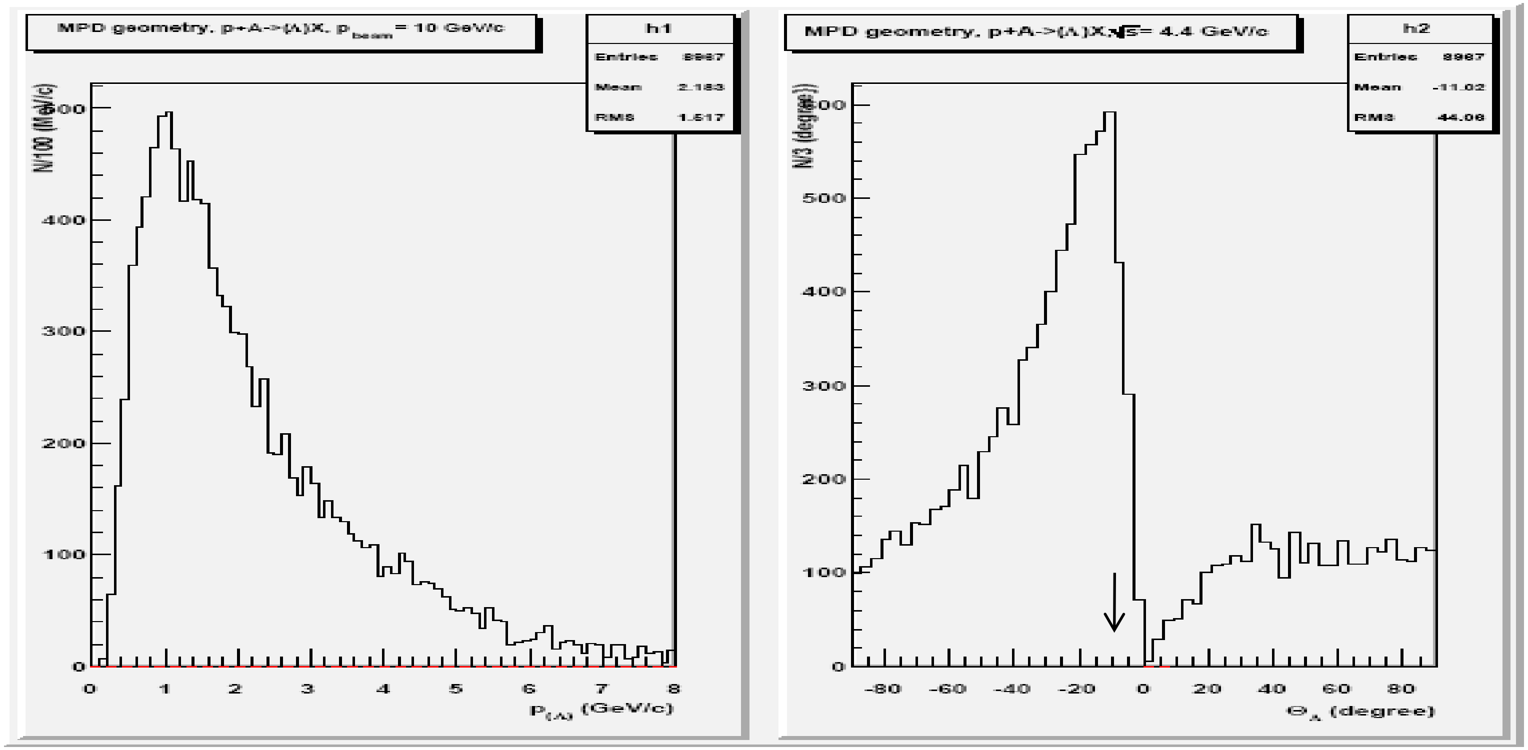
There are fluctuation by momentum in ranges of 1.56(4σ),1.9(3.5σ) and 2.15(3σ) GeV/c. (preliminary)

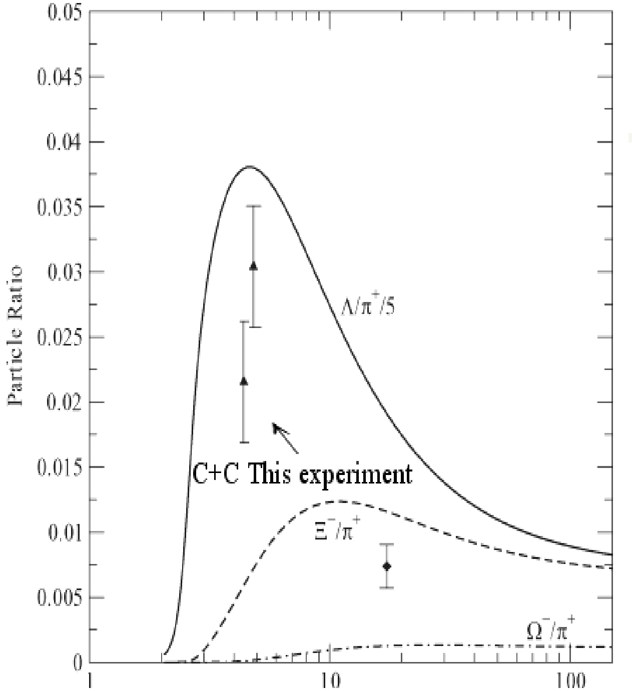


There are fluctuation (≈3σ) by (β) angles in ranges of -0.7⁰ and -6.8ᵒ (preliminary).

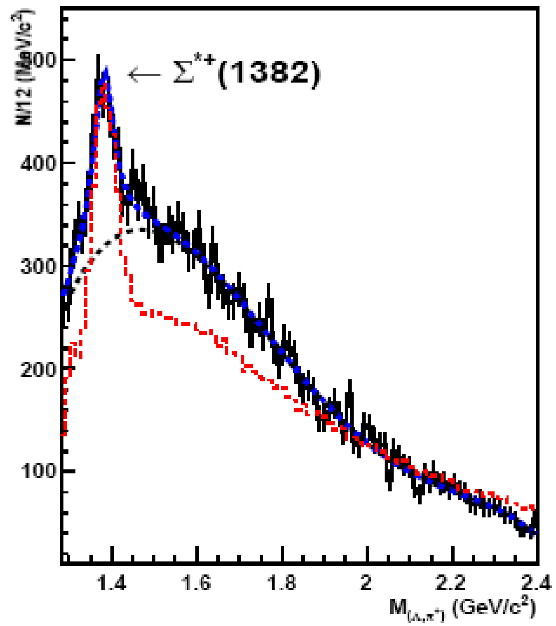
More than 70% from Λ hyperons are emitted over beam range with azimuth β or polar angles < *15⁰ in* p+C reaction at 10 GeV/c.

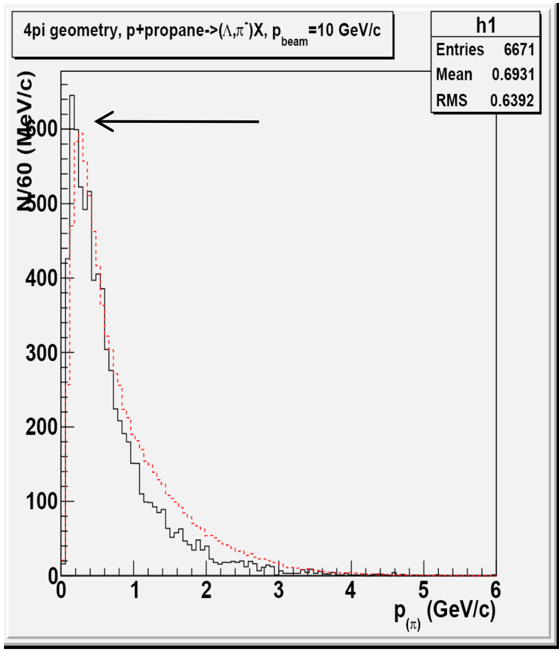
The Λ-hyperons in center of mass (p-p) by polar angle Θ at 10 GeV/c

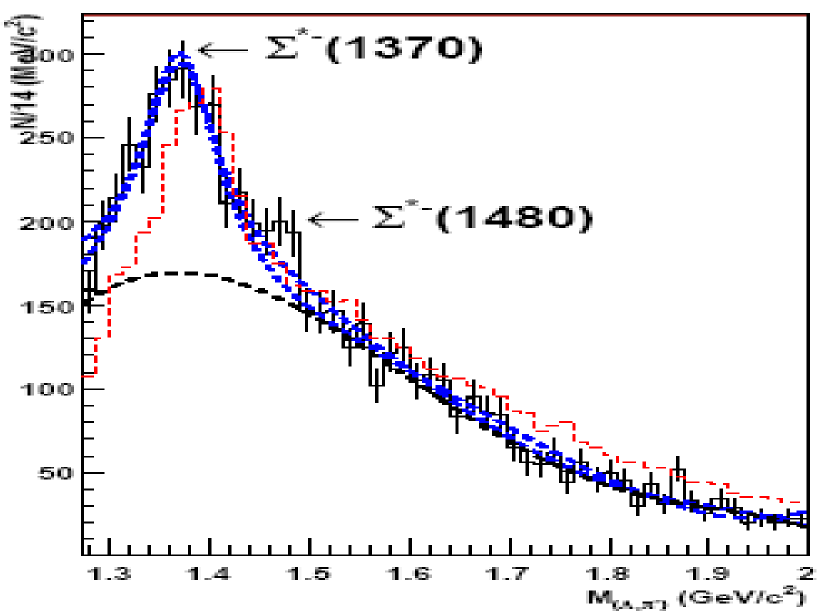


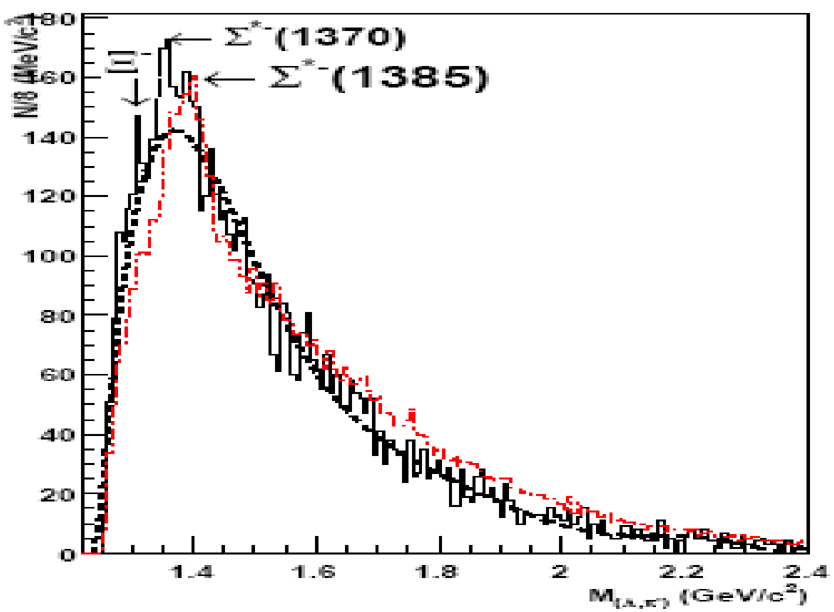

Particle Ratio
Λ/π⁺/5
C+C This experiment
Ξ⁻/π⁺
Ω⁻/π⁺

a)

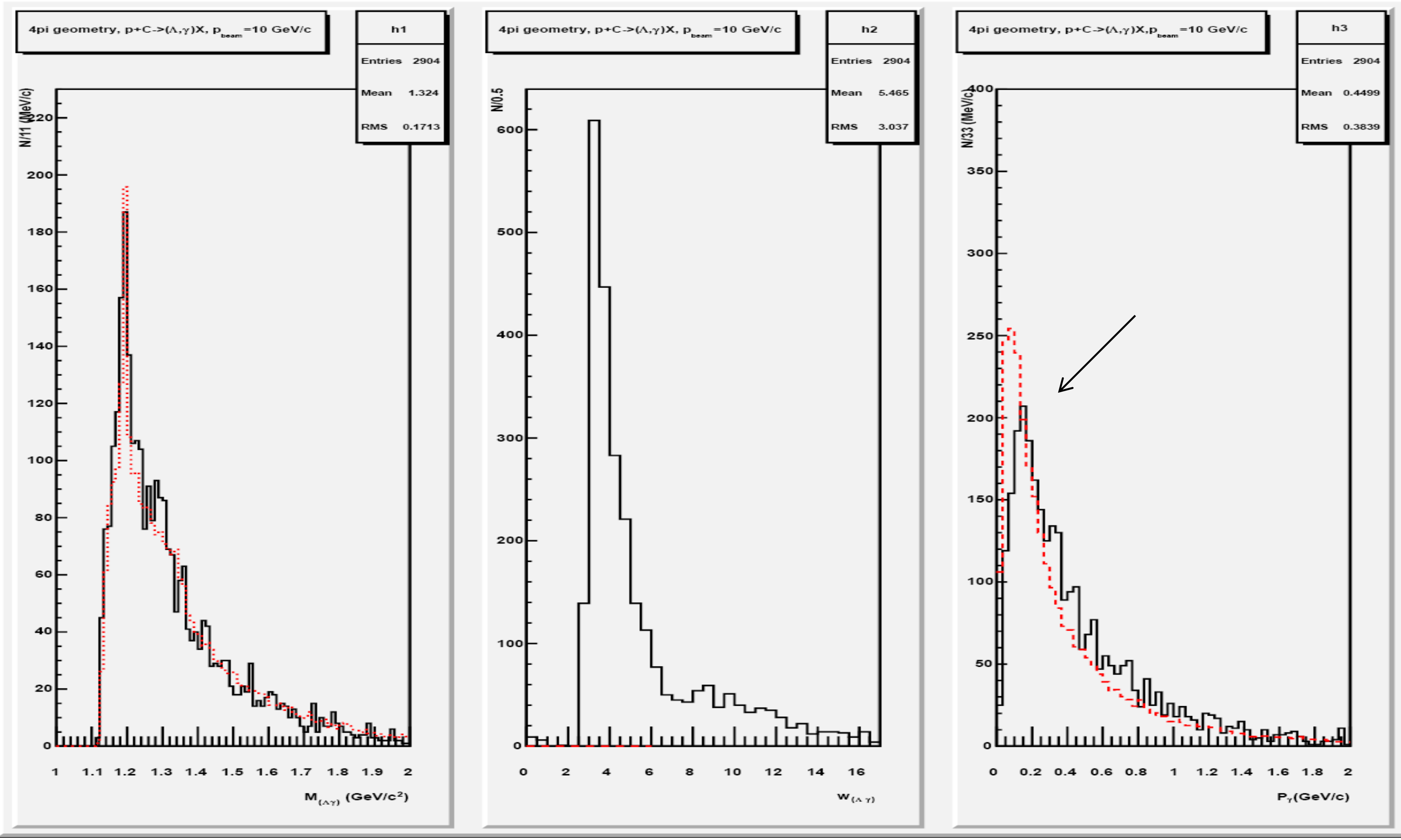

N/12 (MeV/c²)
← Σ*+(1382)
M(Λ,π+) (GeV/c²)


4pi geometry, p+propane->(Λ,π⁻)X, p_beam=10 GeV/c
h1
Entries 6671
Mean 0.6931
RMS 0.6392
N/60 (MeV/c)
p(π) (GeV/c)


N/14 (MeV/c²)
← Σ*-(1370)
← Σ*-(1480)
M(Λ,π⁻) (GeV/c²)


N/8 (MeV/c²)
Ξ⁻
← Σ*-(1370)
← Σ*-(1385)
M(Λ,π⁻) (GeV/c²)

$\Lambda\gamma$ spectrum



$\Lambda\gamma$ spectrum

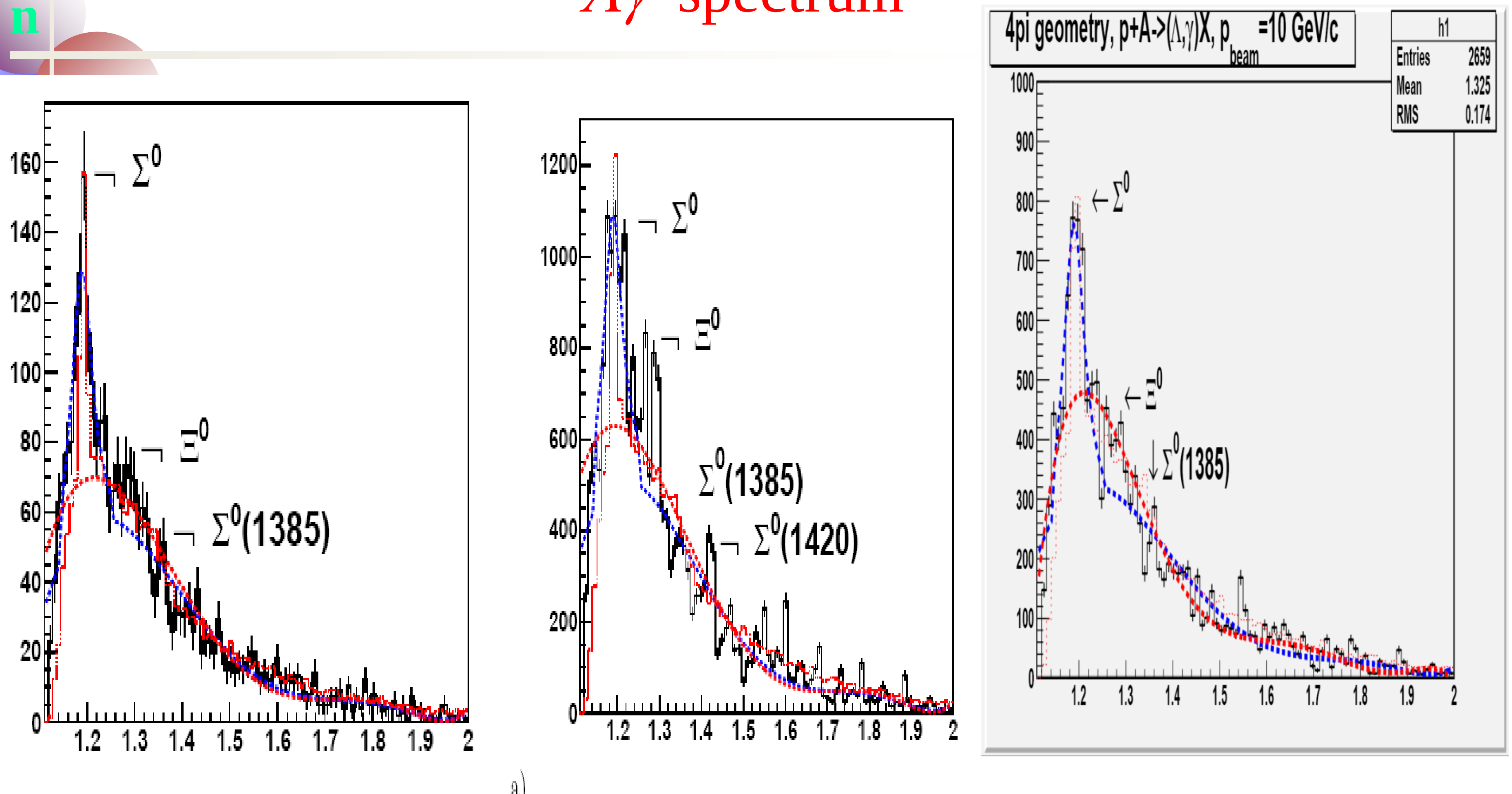
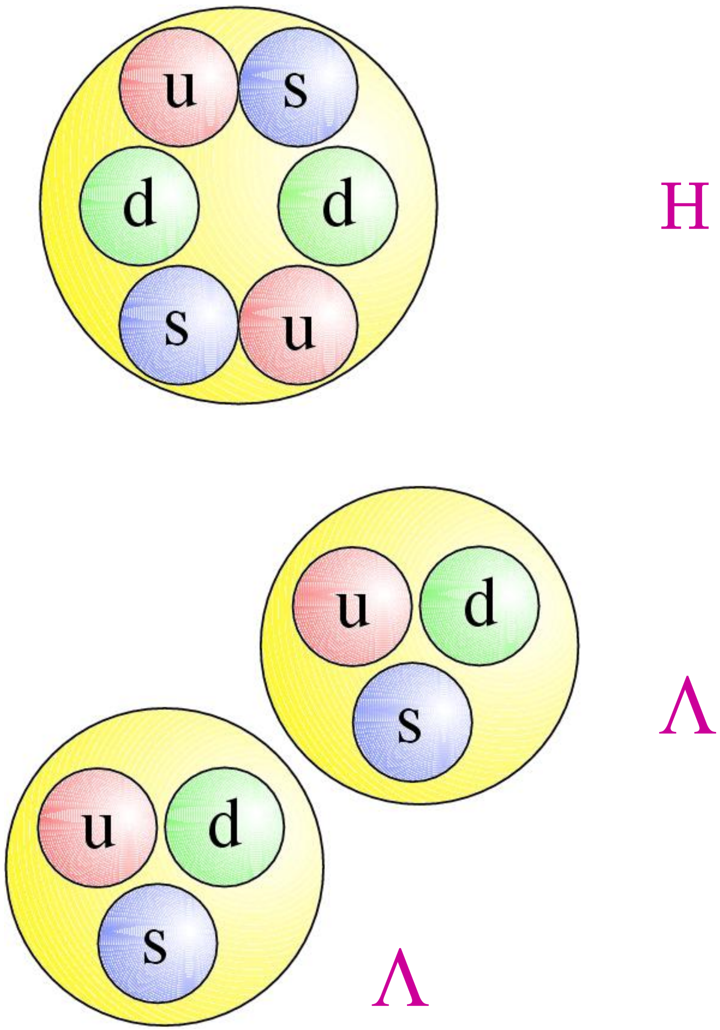


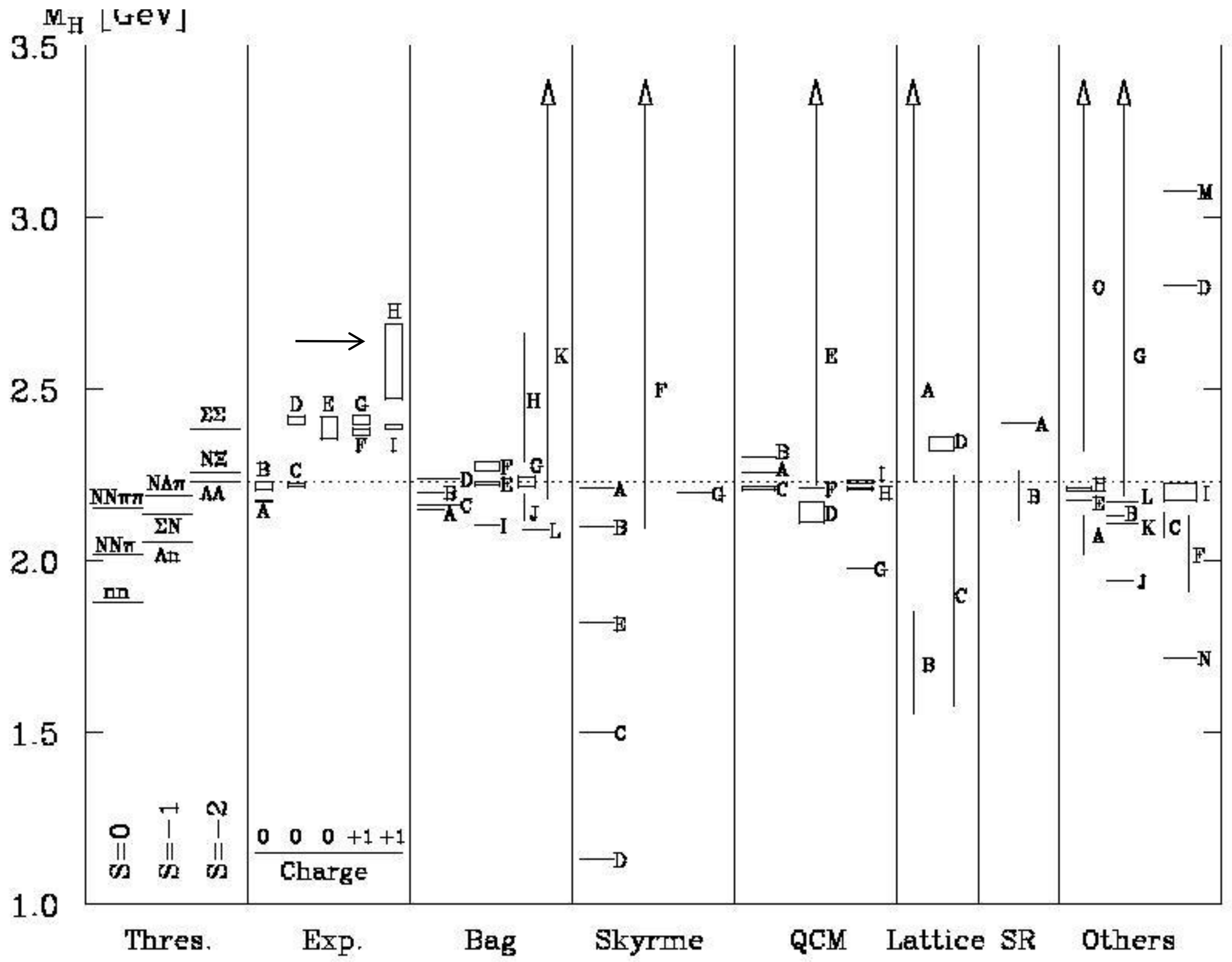
Figure: *a)The $\Lambda\gamma$ spectrum for 2902 combination with bin size of 12 MeV/c²; b) the $\Lambda\gamma$ spectrum with total weight of Λ and γ*.The cross section of production for Σ^0(1189) (≈700 events, with geometrical weights of $<w_\gamma>$=4.1) is equal to ≈ 1.3 mb at 10 GeV/c for p+C interaction at 10 GeV/c which is 2 **times** larger than simulated cross section by FRITIOF. **The observed width of Σ^0 is more than 2 times larger by total weight than value of experimental errors.** There are also enhancements in mass ranges of 1290-1320 ,1360, 1420 and 1560 MeV/c² which are can be reflection for enhancement productions from well known hyperons in effective mass spectrum from decay channel $\Lambda\pi^0$. After cut of total w< 16 Fig has shown small enhancements in mass ranges of 1300,1385 and 1560 MeV/c² .

H is bound state or not ?

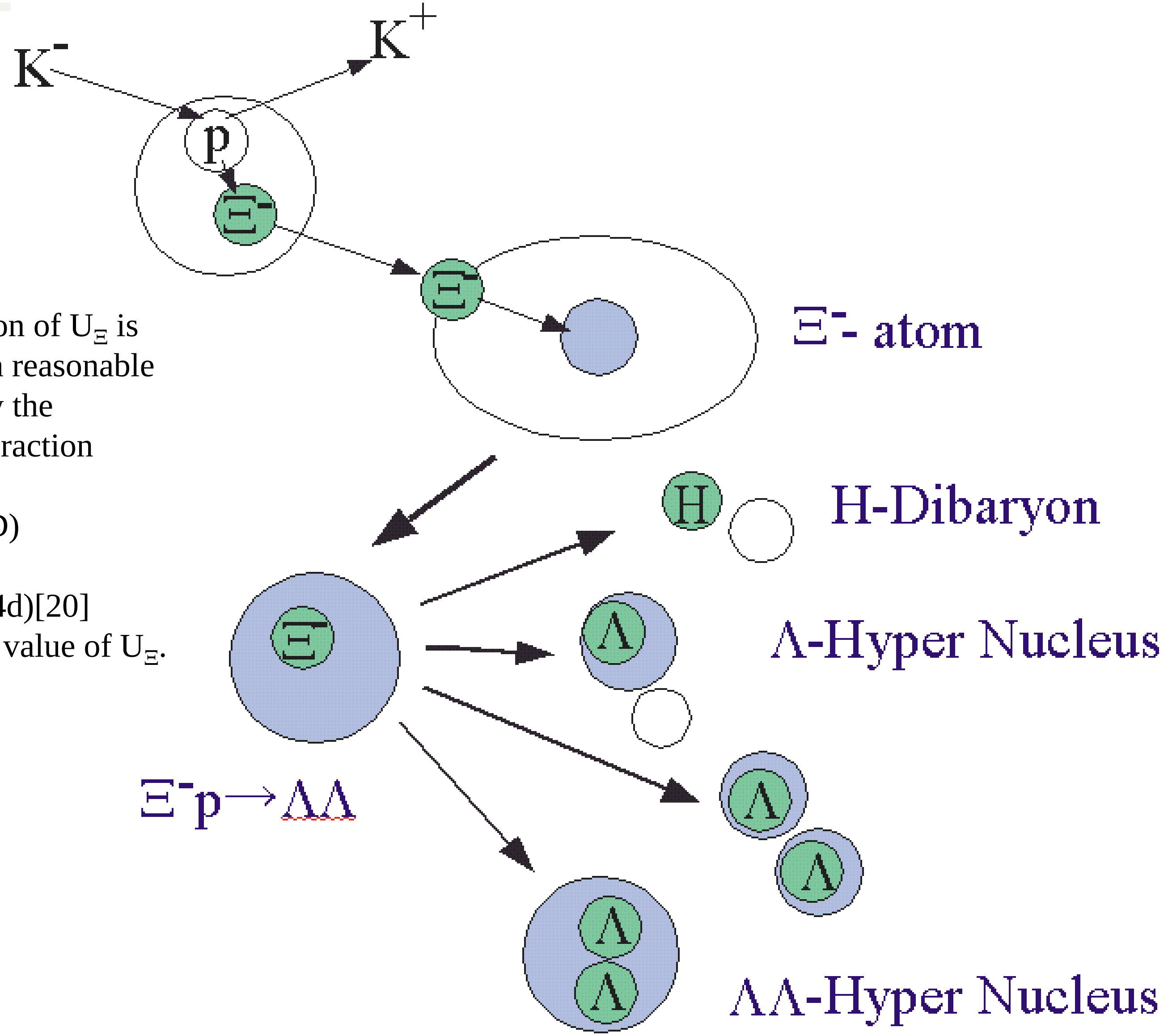


Which is stable?

S=-2 H-Dihyperon mass (Predictions)



Production of S=–2 Systems



Therefore the experimental determination of U_{Ξ} is decisively important in order to obtain a reasonable inter action model. Here, we briey show the calculation results in three different interaction models;

Nijmegen Hard-Core model D (NHC-D)

Ehime model

Extended Soft-Core model 04d (ESC04d)[20]

These models give attractive (negative) value of U_{Ξ}.

K^-pp: theoretical status

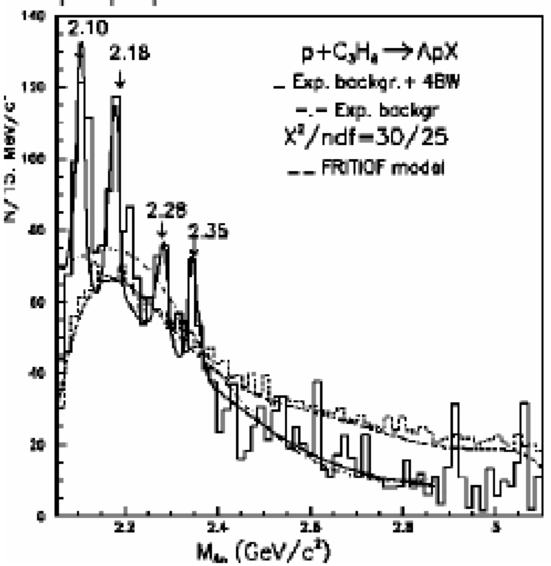
Methods	Binding Energy (MeV)	Width (MeV)
Shevchenko, Gal, Mares Faddeev	50 - 70	~100
Ikeda and Sato Faddeev	60 - 95	45 - 80
Yamazaki and Akaishi Variational (ATMS)	48	61
Dote, Hyodo, Weise Variational (AMD)	20±3	40 - 70

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

Further observations of Λp – correlations

pA collisions @ 10 GeV/c
JINR 2m – propane bubble chamber
700.000 stereo photographs
of 10^6 p + propane inelastic interactions

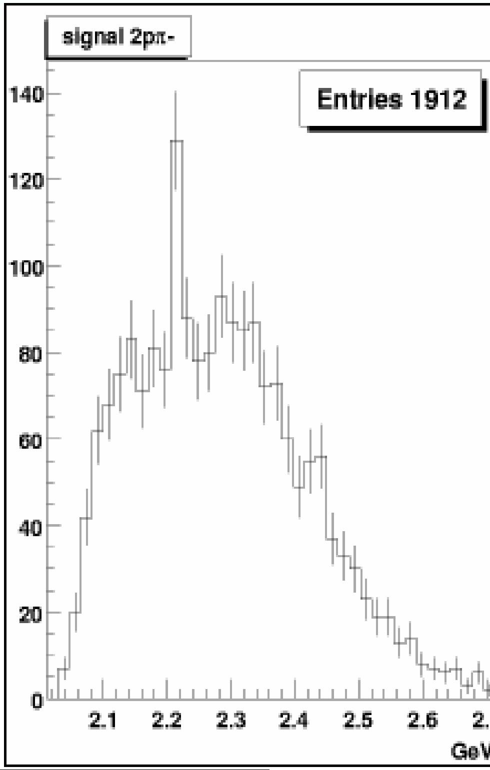
P. Aslanyan, hep-ex/0610086



Obelix:
200 MeV/c antiprotons stopped in helium (NTP)
10^4 events

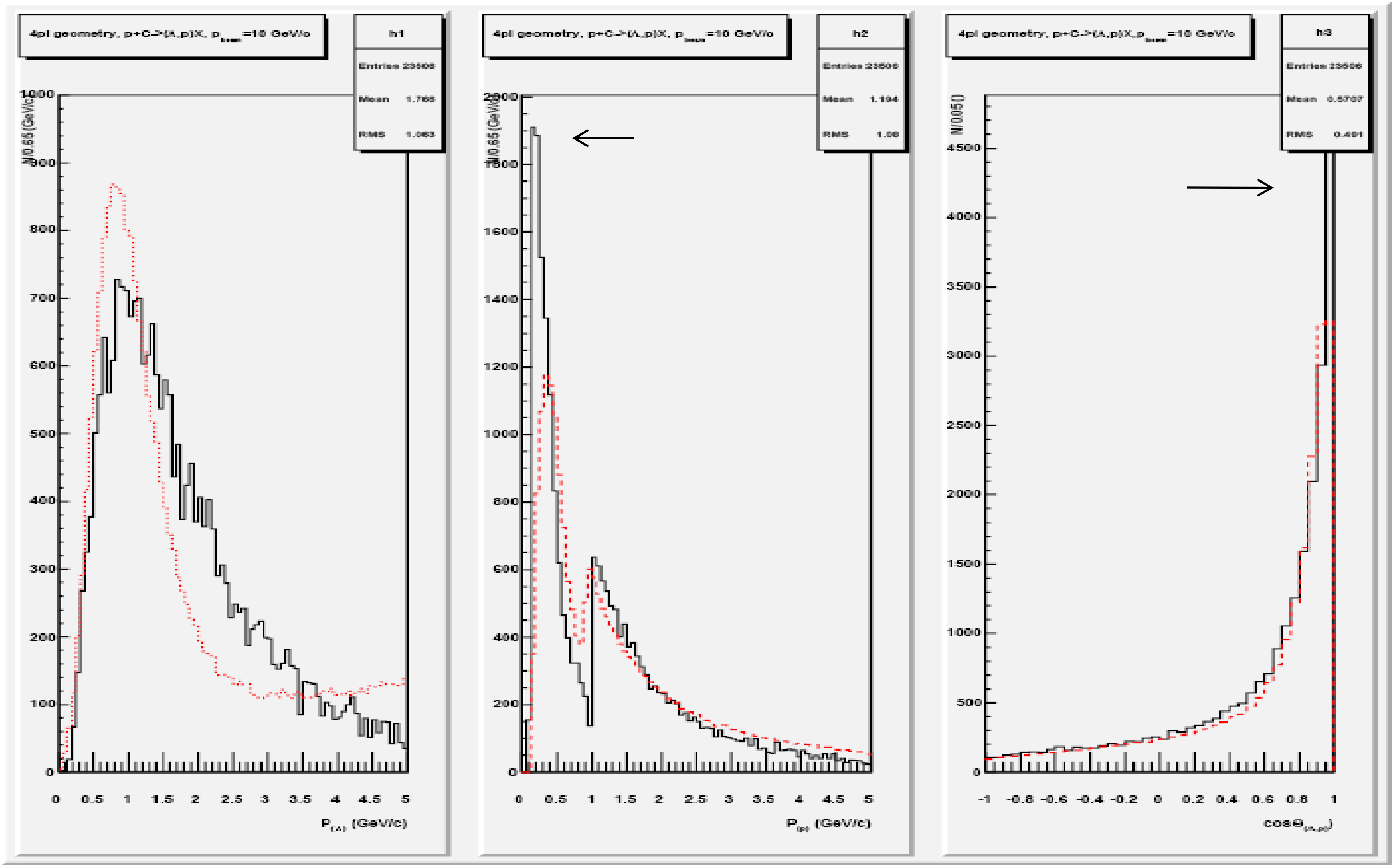
Cuts:
IM(Λ) in [1085 – 1145] MeV
and cosΘ < -0.4

Θ – angle between Λ and K^0_S

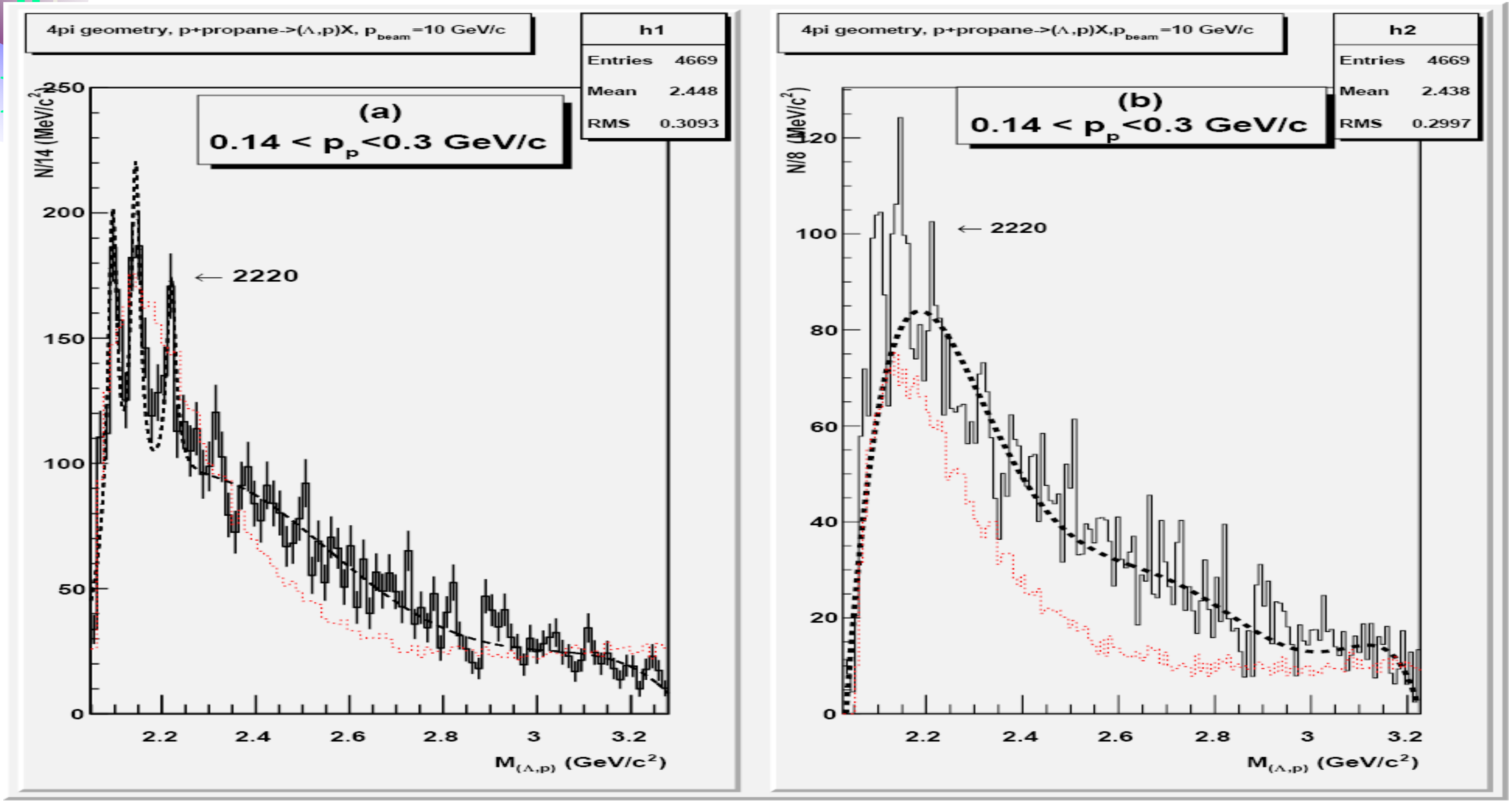


		M (MeV)	Γ (MeV)	P/Λ	P/(IN)	Sign (σ)
FOPI	HI: Al+Al	2120 ± 10	59 ± 12	$1.7 \cdot 10^{-2}$		5.0
	HI: Ni+Ni	2140 ± 10	59 ± 19	$2.2 \cdot 10^{-2}$		5.4
FINUDA PRL 94(2005)212303	K^- stopped on ^{12}C, $^{6,7}Li$	2255 ± 9	67 ± 14	$3\text{-}4 \cdot 10^{-2}$	$1 \cdot 10^{-3}$	? (10)
Obelix	$\bar{p}$ stopped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

Λp spectrum

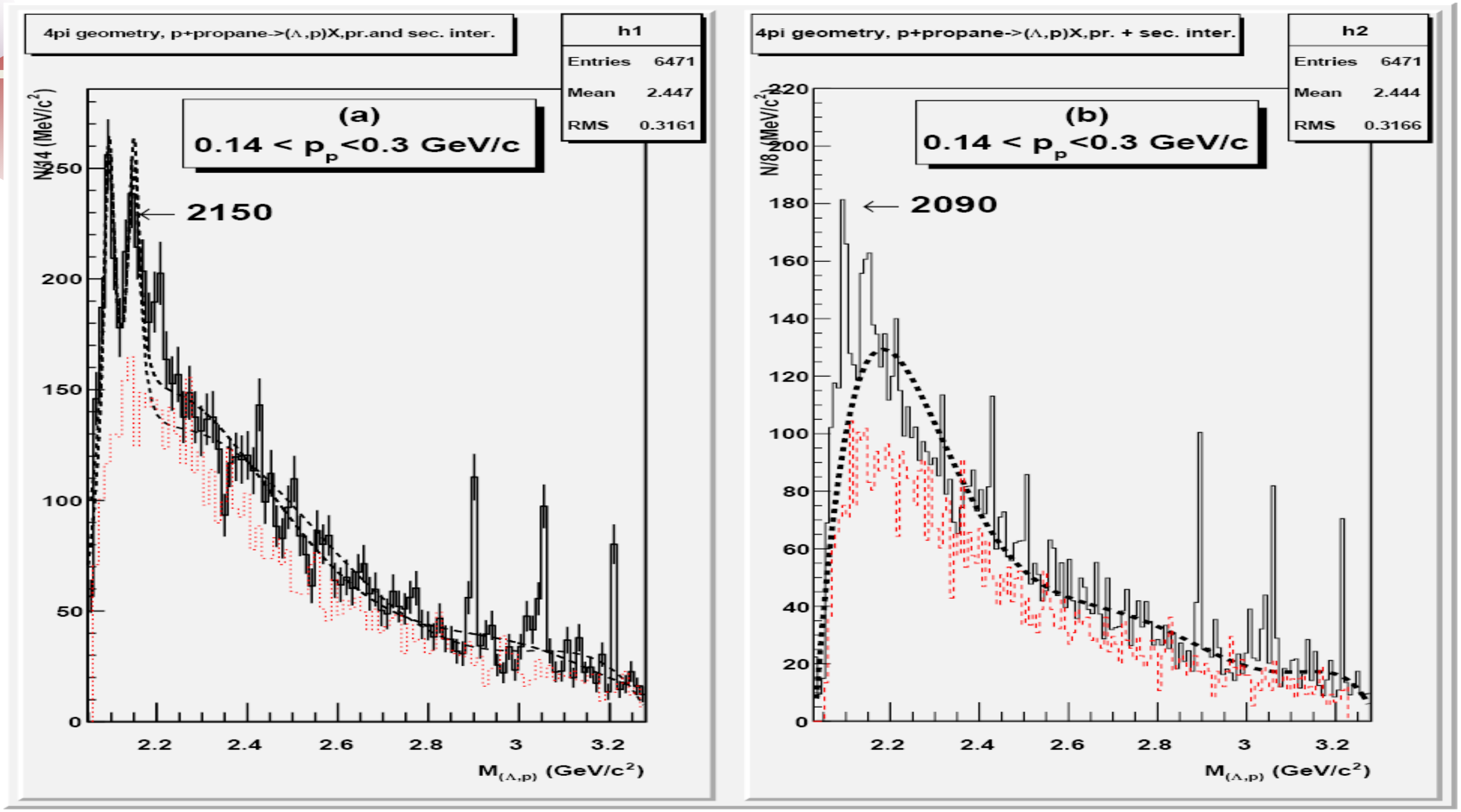

4pi geometry, p+C->(Λ,p)X, p_beam=10 GeV/c
h1
Entries 23506
Mean 1.766
RMS 1.063
N/0.65 (GeV/c)
P_(Λ) (GeV/c)
h2
Mean 1.104
RMS 1.08
P_(p) (GeV/c)
h3
Mean 0.5707
RMS 0.491
N/0.05 ()
cosΘ_(Λ,p)

Λp spectrum with identified potons



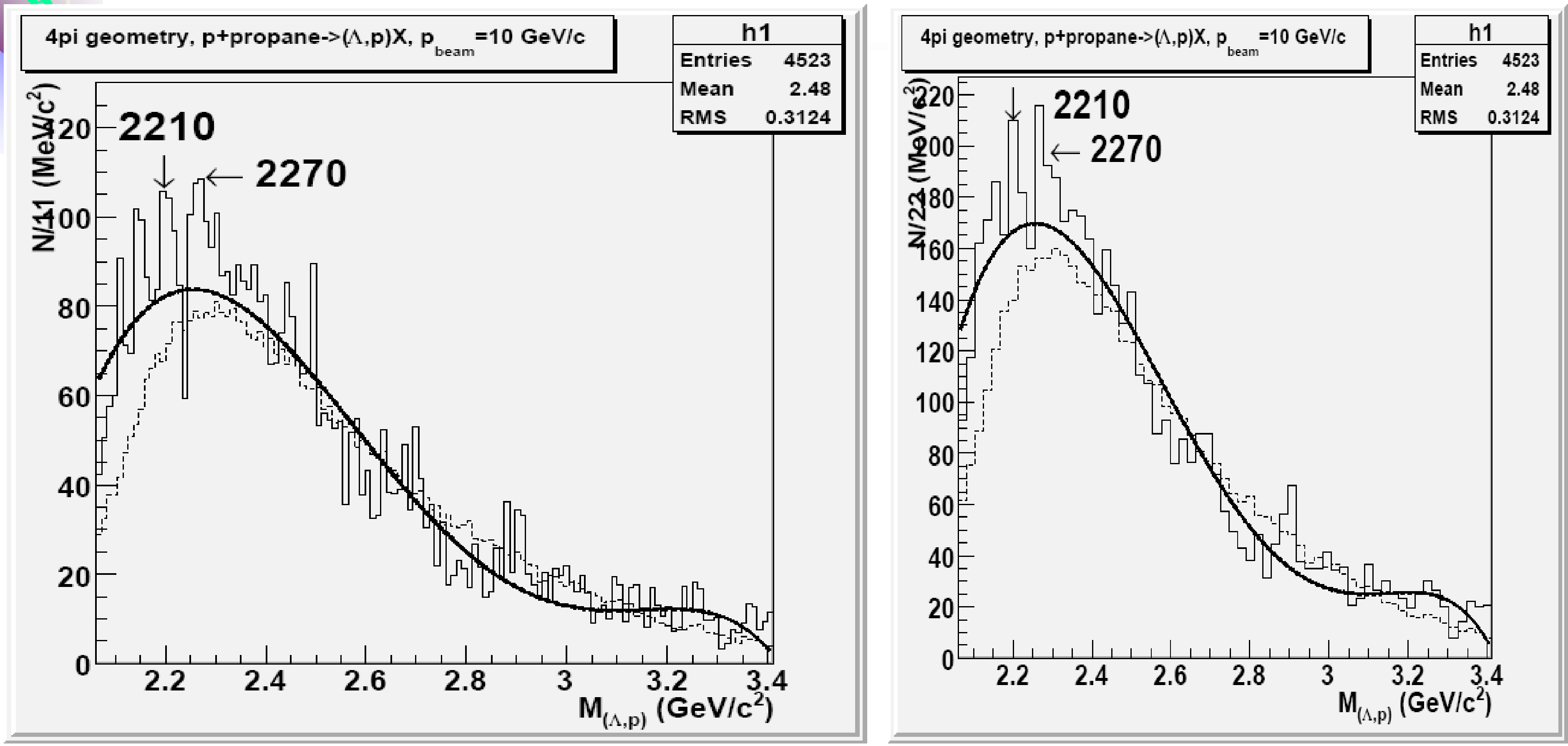
2100	24	5.7
2150	19	5.7
2220	28	6.1

The background have done by polynomial and FRITIOF methods.



The (Λ,p) spectrum with stopped protons 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. This case also shows that there are the enhancement signals in mass range of **2900(10 s.d.) , 3050(9 s.d) 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 same enhancements in mass ranges of 2145(4.4 S.D.),2210(4.7 S.D.), 2270(4.0 S.D.),2700 and 2900MeV/c^2

(Λ,p) spectrum with stopped protons

Decay mode	Effective mass(Mev/c^2)	Experimenta lwidth(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

1. 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).

A significant peak at invariant mass $M \sim 2220$ MeV/c^2 , $B_K \sim 120$ 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 .

DISTO
Saturne

p+p ->
p+Λ+K+

@2.85 GeV

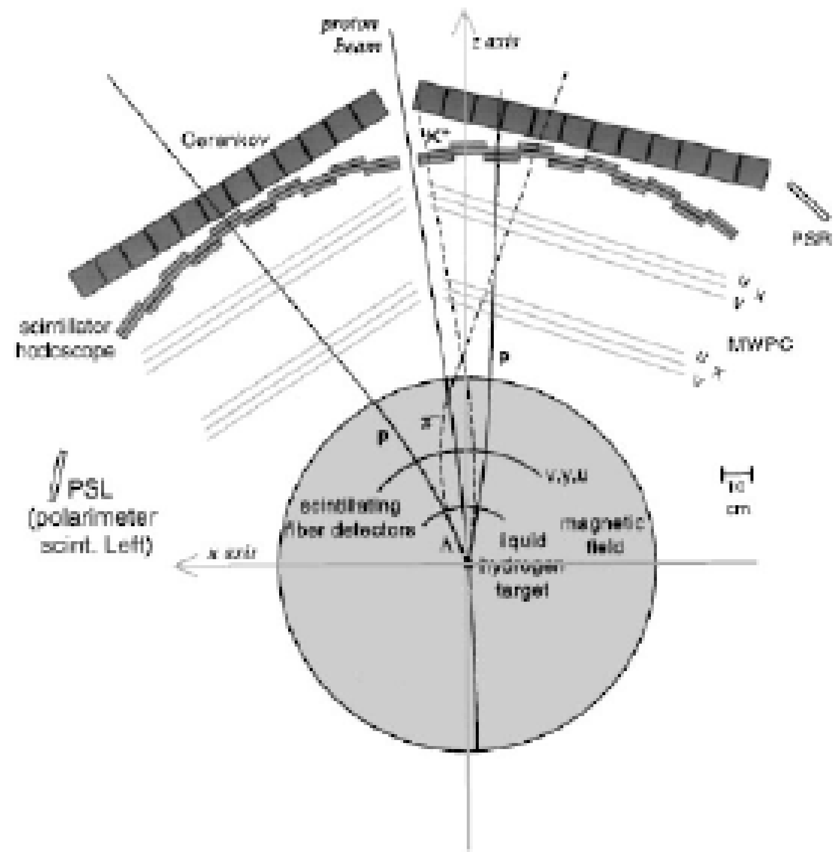
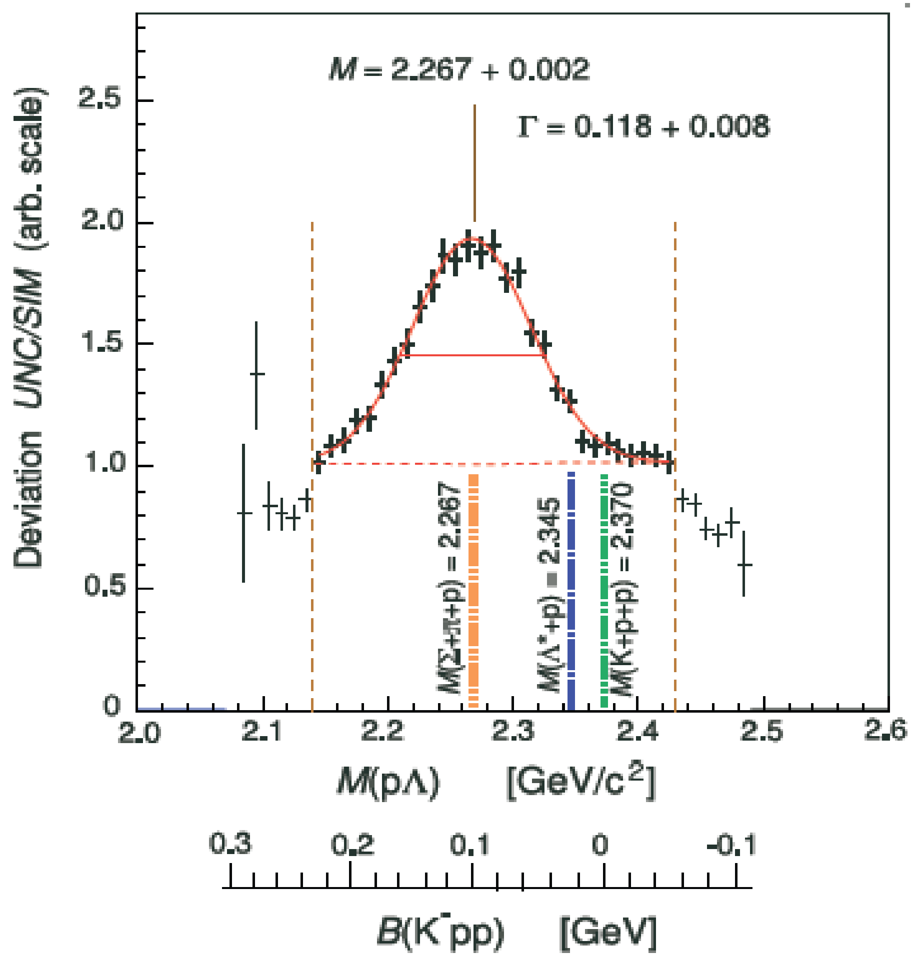


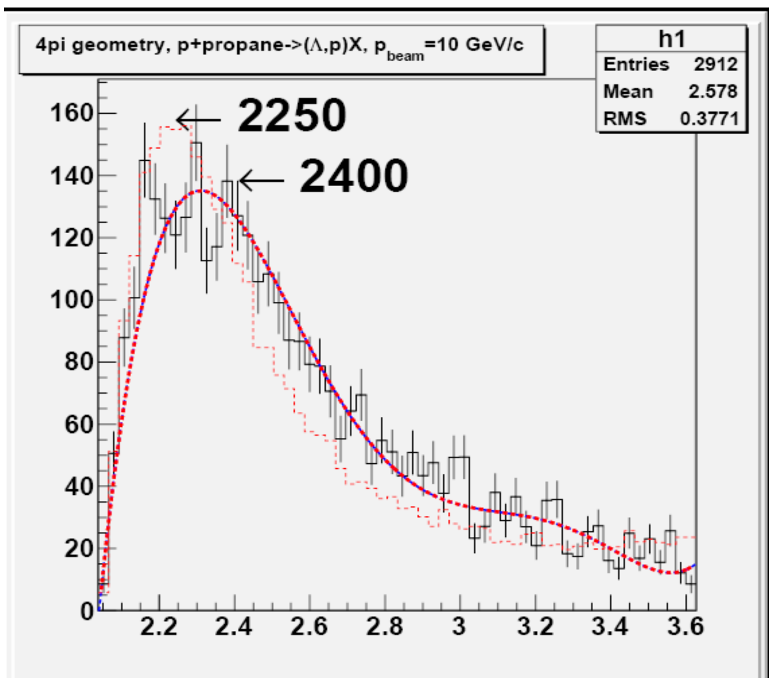
Fig. 1. Schematic layout of the DISTO experimental apparatus, viewed from above, including simulated trajectories from a $pp \rightarrow pK^+\Lambda$ event. The large shaded circle represents the effective field region. PSR and PSL are the two slabs to detect backward scattered protons in the polarimeter.

- DISTO
  - pp→K^++X @ Tp=2.85 GeV
  - X→ Λ p
    - M_x=2265±2 MeV
      Γ_x=118±8 MeV

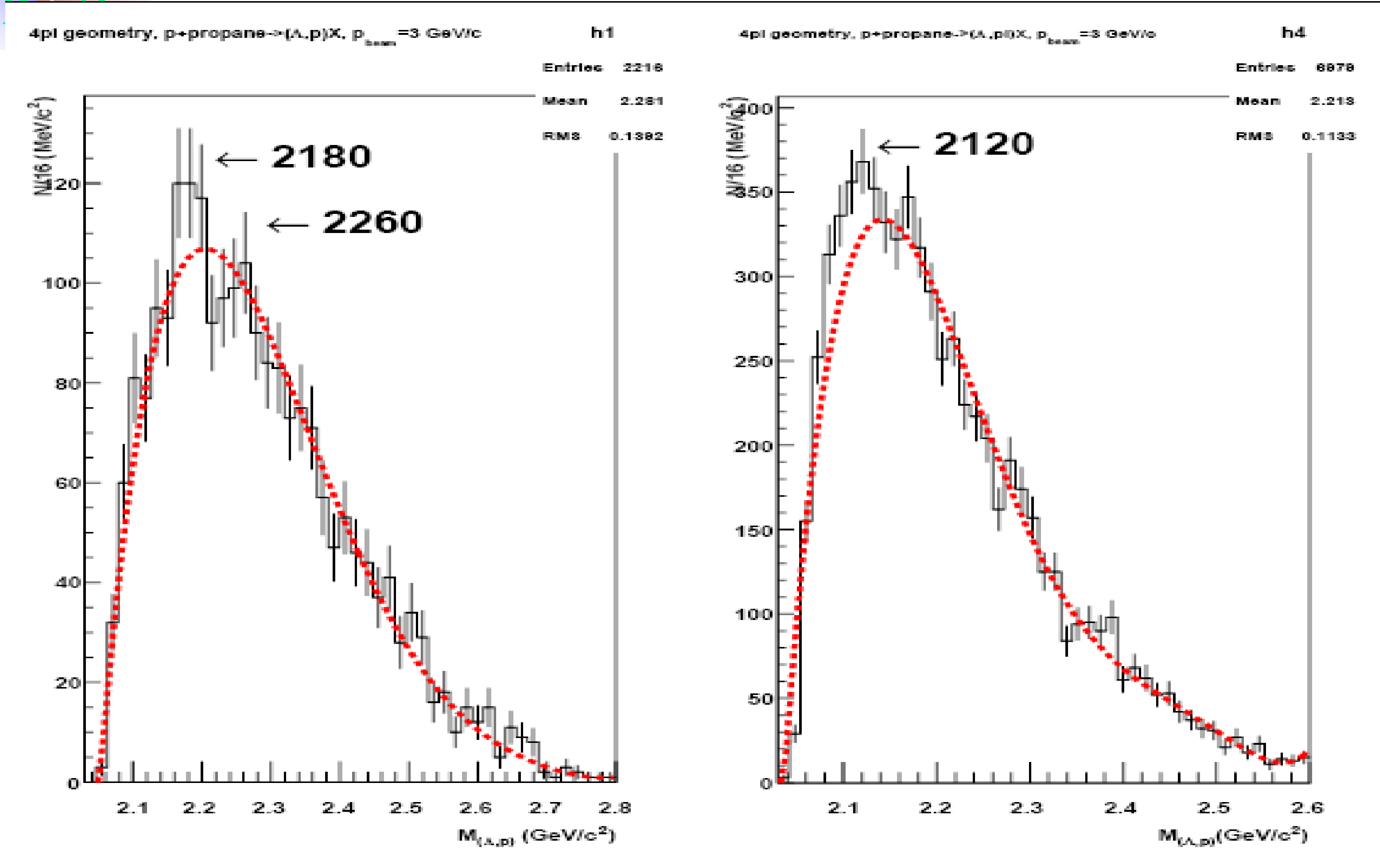
T.Yamazaki, EXA08

Very preliminary

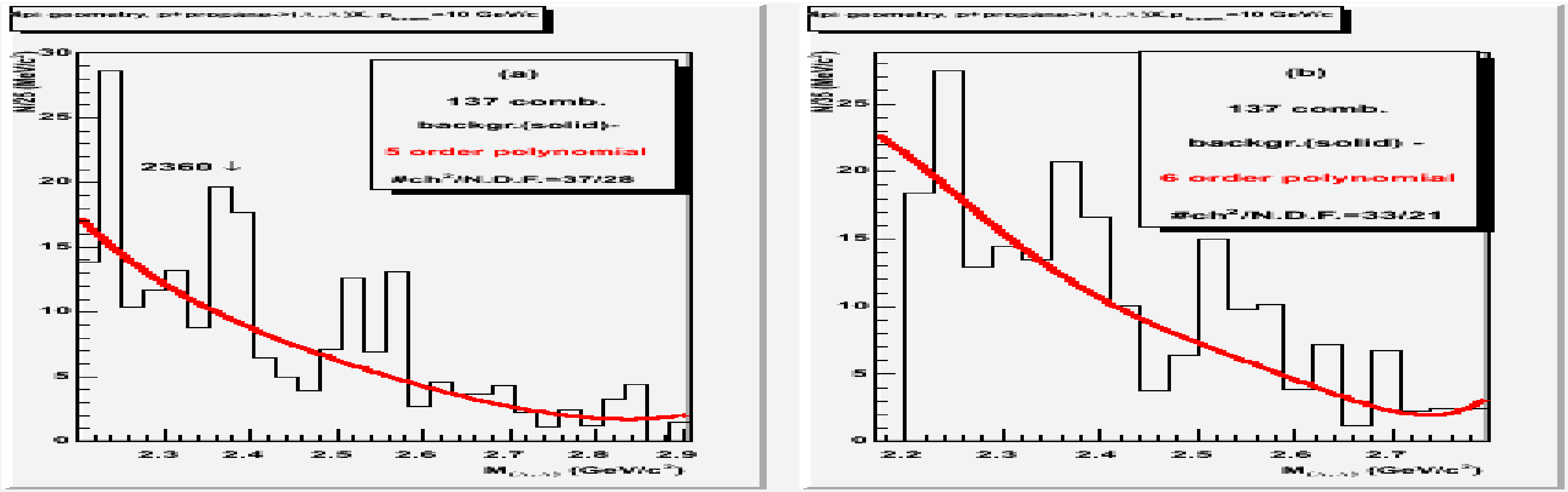




FRITIOF Model simulation for p+C->(Λp)X reaction at 3 GeV/c with backward and forward protons

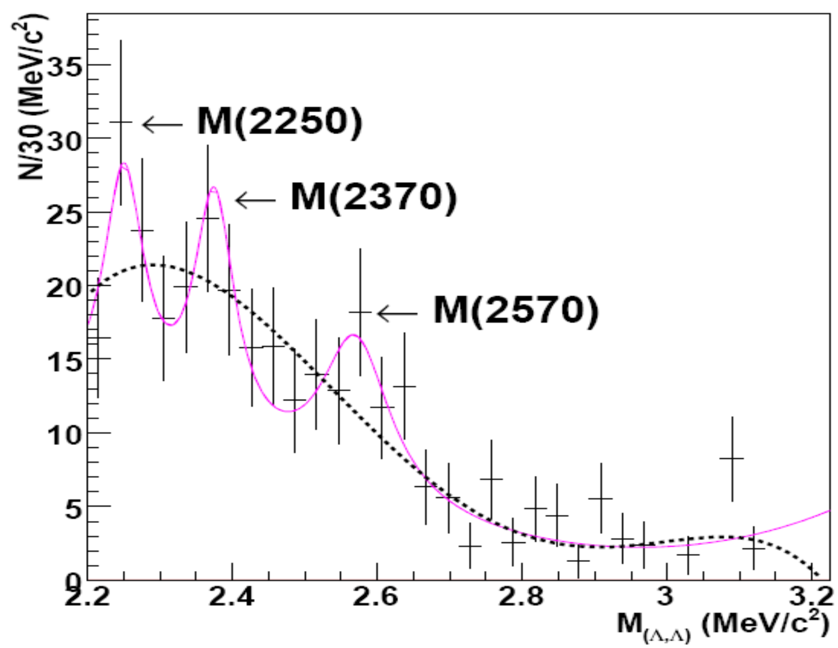


ΛΛ spectrum from 2m PBC

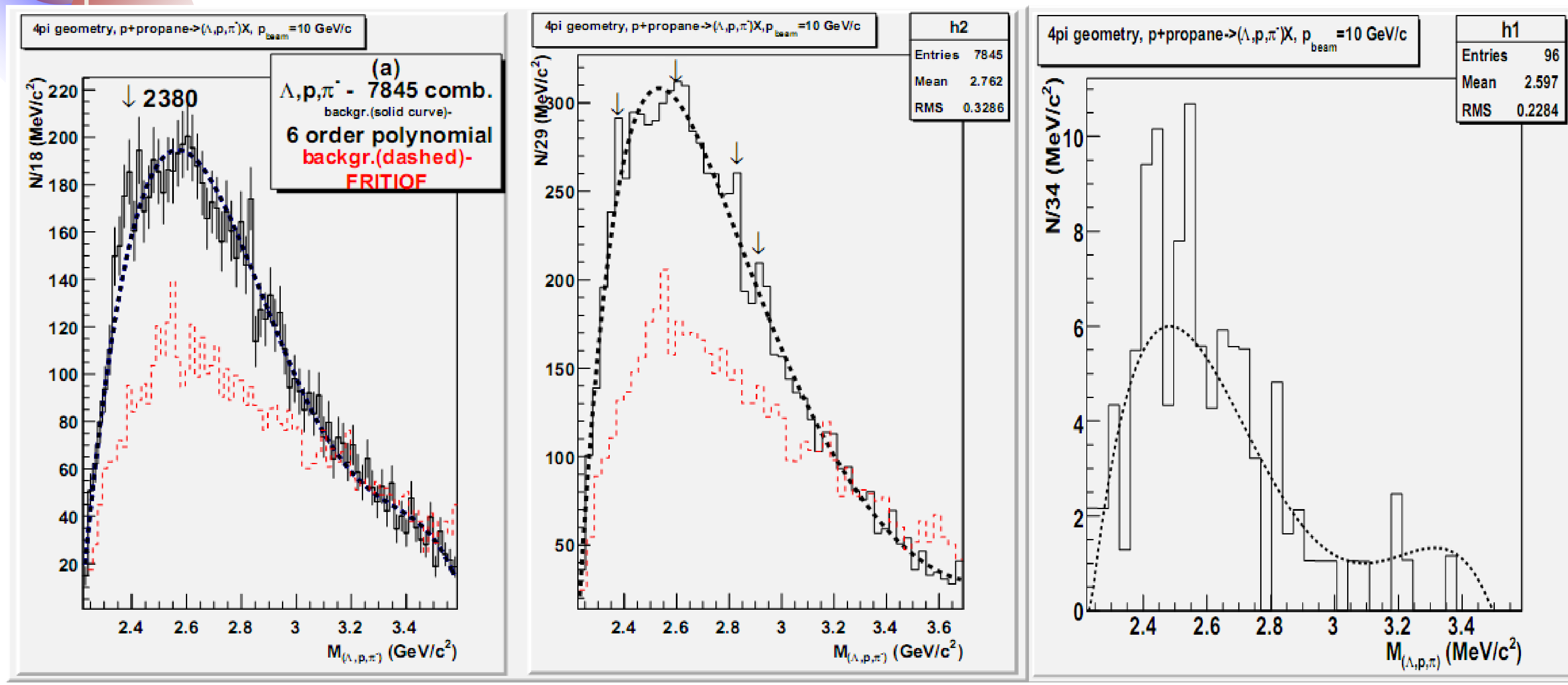


There is observed statistical enhancement in mass region of 2360(4.5 S.D.) Mev/c^2 (137 comb.).

Fig. has shown that there is significant enhancement in mass range of 2370(4.5S.D.) Mev/c^2 for ΛΛ spectrum (201 combination). There are negligble enhancement in mass range of 2250,2570 and 3100 Mev/c^2 too.

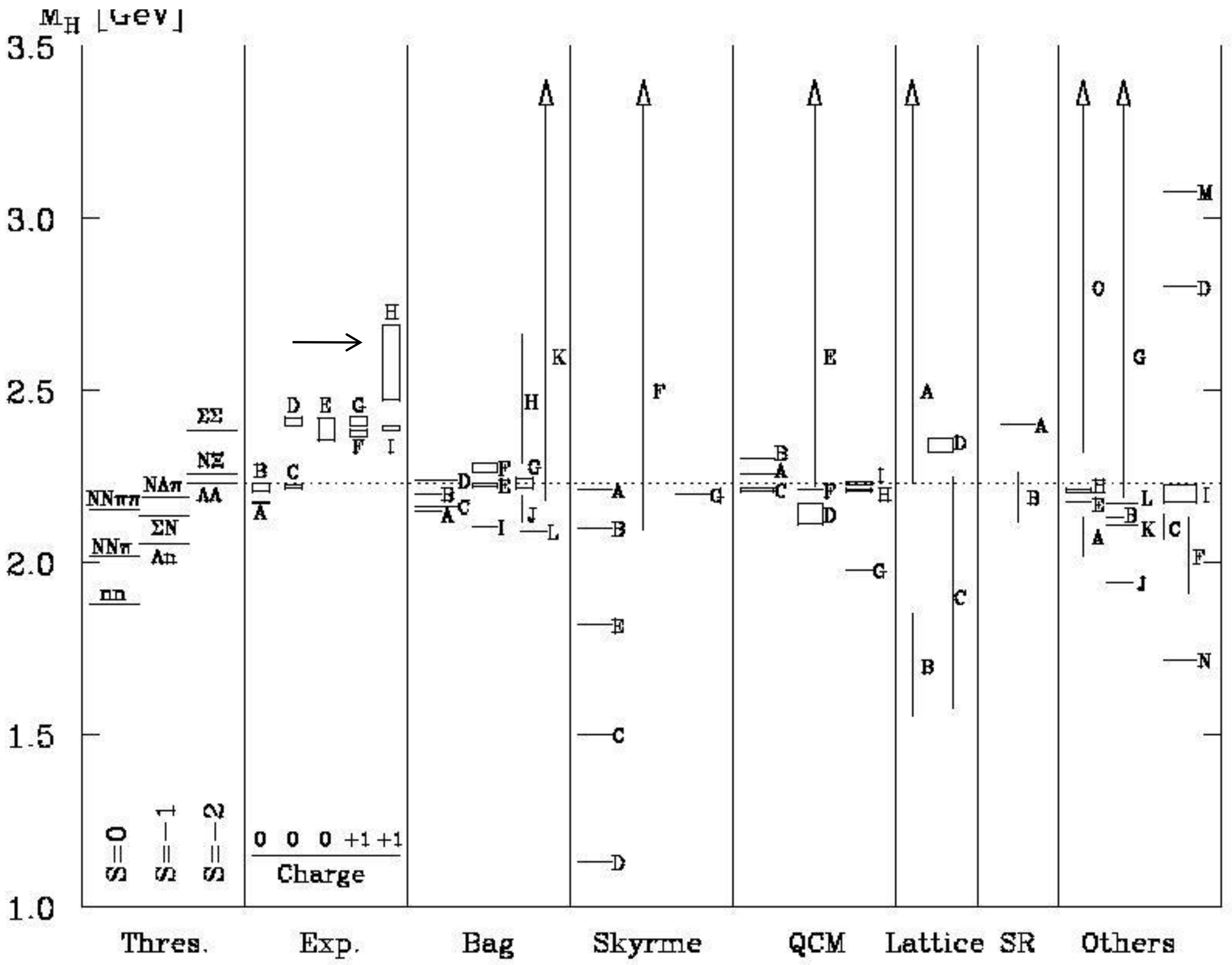


$\Lambda\pi^{-}p$ spectrum from 2m PBC



$\Lambda\pi^{-}p$ spectrum is not describe by FRITIOF model. There are observed small enhancements($\leq 3\ \sigma$) in mass range of 2380, 2600, 2850 and 2950 MeV/c2 range, which are same mass ranges of enhancements as in $\Lambda\Lambda$ spectrum. After cut of by co planarity criteria from 7845 go to 96 comb. in $\Lambda\pi^{-}p$ spectrum and we have a same mass ranges of enhancements .

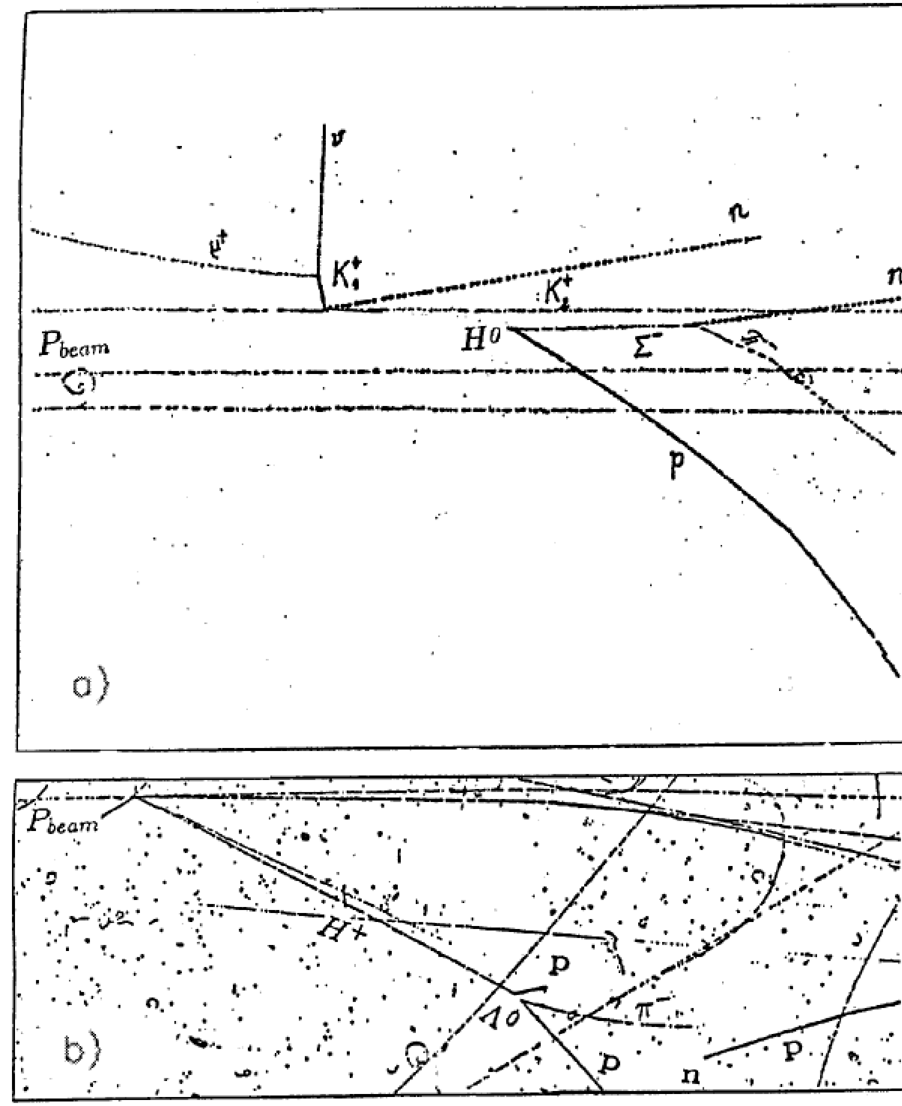
S=-2 H-Dihyperon mass (Predictions)



S=-2 H^0 and H^+ dihyperons by weak decay channel s searches

Table 3: Mass and weak decay channels for the registrated dibaryons.

Channel of decay	Mass H (MeV/c^2) Dibaryon	C.L. of fit %	References
$H^0 \to \Sigma^- p$	2172 ± 15	99	Z.Phys.C 39, 151(1988).
$H^0 \to \Sigma^- p, \Sigma^- \to n\pi^-$ $H_1^0 \to H^0(2146)\gamma$	2146 ± 1 2203 ± 6	30 51	JINR RC, N 1(69)-95-61,1995.
$H^0 \to \Sigma^- p, \Sigma^- \to n\pi^-$	2218 ± 12	69	Phys.Lett B235(1990),208.
$H^0 \to \Sigma^- p, \Sigma^- \to n\pi^-$	2385 ± 31	34	Phys.Lett B316(1993),593.
$H^+ \to p\pi^0\Lambda^0, \Lambda^0 \to p\pi^-$	2376 ± 10	87	Phys.Lett B316(1993),593
$H^+ \to p\pi^0\Lambda^0, \Lambda^0 \to p\pi^-$ $H^+ n \to \Sigma^+\Lambda^0 n, \Lambda^0 \to p\pi^-$	2580 ± 108 2410 ± 90	86 6	Nucl.Phys.75B(1999),63.
$H^+ \to p\gamma\Lambda^0, \Lambda^0 \to p\pi^-$ $H^+ \to p\pi^0\Lambda^0, \Lambda^0 \to p\pi^-$	2448 ± 47 2488 ± 48	73 72	JINR Com.(2002) E1-2001-265



Examples for Ξ^- and H^0 heavy hyperons are identified by weak decay channels.

Higher ionized negative projectile track is induce decay by channel of π^- (or K^-)Λ, which by kinfit is identified by hypothesis Ξ^- and Ω^-. After identification of negative track as π^- by ionization is remain only Ξ^- hypothesis. The momenta of P_Ξ, P_{π}- and P_Λ are equal to 0.900, 0.215 and 0.734 GeV/c. Ten events are identified by this topology.

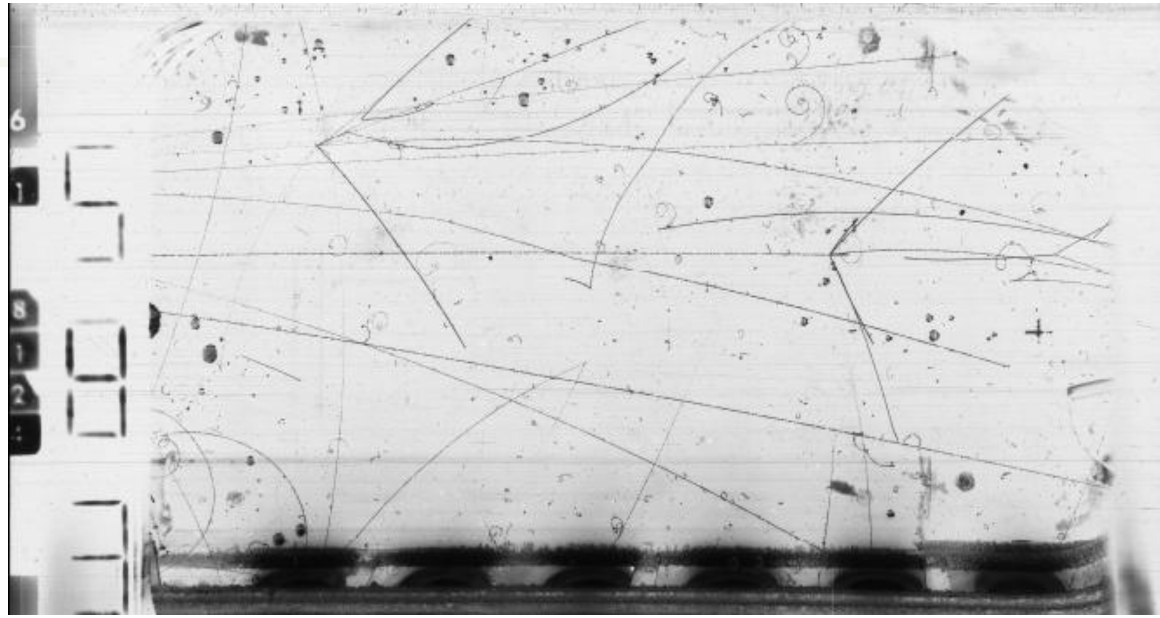
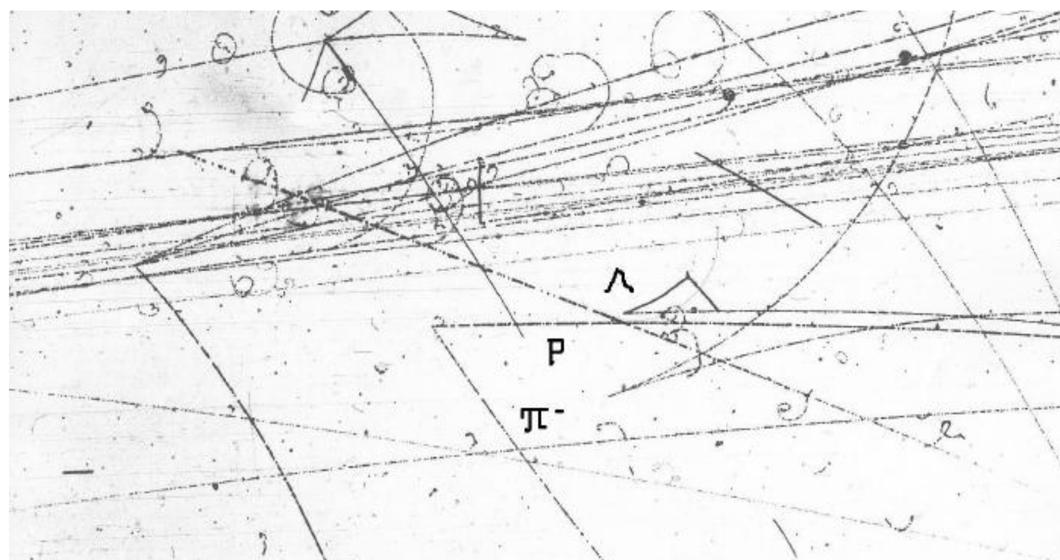
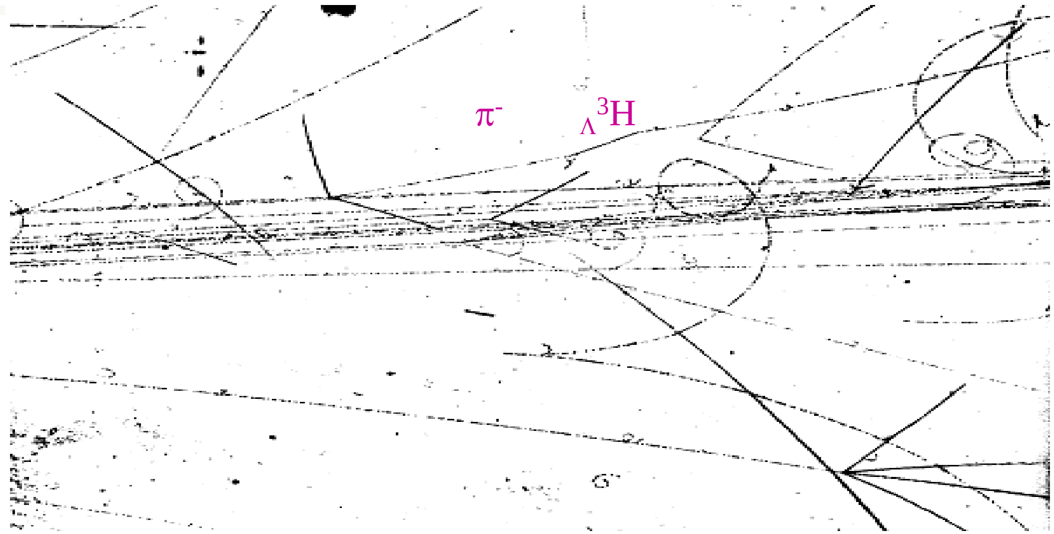


Fig. has shown the event as candidates for heavy neutral $H^0 \rightarrow \Lambda\pi^- p$ dihyperon in the decay length 21 cm from mother star and with mass of M_H=2625(Meff.= 2626) MeV/c^2(C.L.=96%) from kinematical fits.

The reaction $\Lambda n \rightarrow \Lambda\pi$-p has a kinematical fit (C.L.-22%) . Thus, the second V0 identified only by weak decay of the Λ hyperon at momentum P_Λ = 794 MeV/cwhich is directed to neutral two-prong star with effective mass $M_{\pi p}$ =1836.25 MeV/c^2which is also directed to primary mother interaction(four-prong-star) at beam momentum 10 GeV/c. Three events identified by this topology



Fig~a)has shown π- C$\rightarrow{}_{\Lambda}{}^{3}$H+(or Σ^{-}) + K^{0}_{s}, $K^{0}\rightarrow\pi$-π+,${}_{\Lambda}{}^{3}$H(or Σ) $\rightarrow{}^{3}$He(n) + π^{-} multi-vertex reaction as candidate for hypernuclear ${}_{\Lambda}{}^{3}$H where we can clear see all stages of multivertex event. The projectile secondary negative relativistic track at momentum of P_{π}-=1.1 GeV/c, 8.2 cm long, is formed by the beam proton, what is emitted from four prong star. After break of the second part of track is identified as thick solid track, which can registered by relative ionization as ${}_{\Lambda}{}^{3}$H in length 2.73 cm and a momentum of 0.870 GeV/c. This track induce second vertex . The emitted negative track from the second vertex is identified as π- at momentum of 0.353 MeV/c The V^{0} is identified as a weak decay of a K^{0}_{s} meson at momentum 0.471 GeV/c , with 6.3 cm length.



The projectile negative relativistic track at momentum of P_{K}-=1.2 GeV/c, 19.9 cm long, in Fig. is formedfrom the secondary neutral and six prong star. In this event(Fig.b), Λ - hyperon by 2.54 cm long and momentum 0.371 GeV/c is directed to three-prong stars. Two solid thick positive tracks are identified as K^{+}, with 23.6 cm length, at momentum 0.423 GeV/c (by decay channel of $K^{+}\rightarrow\pi^{+}$) and stopped proton at momentum 0.331 GeV/c(13.43 cm). The negative track is identified as π- at momentum Pπ =0.076 GeV/c(3.85cm). This event is a candidate for decay topology of H^{0} dihyperon by channels of $\pi^{-}p\Lambda$. and Σ-p.

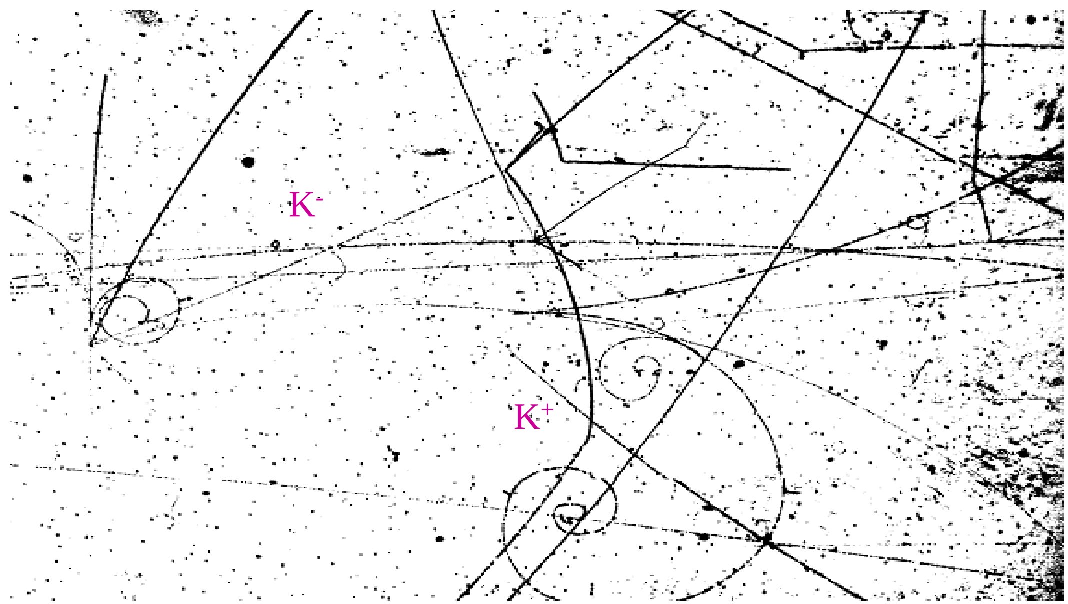
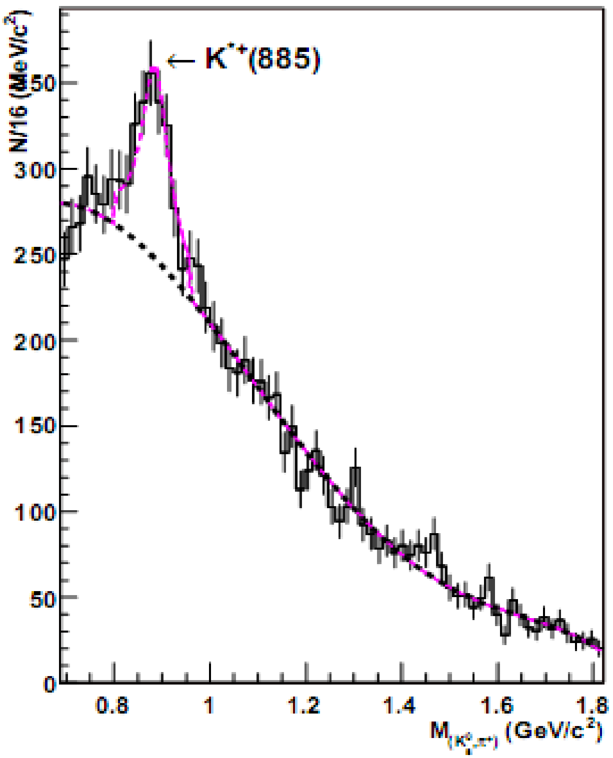
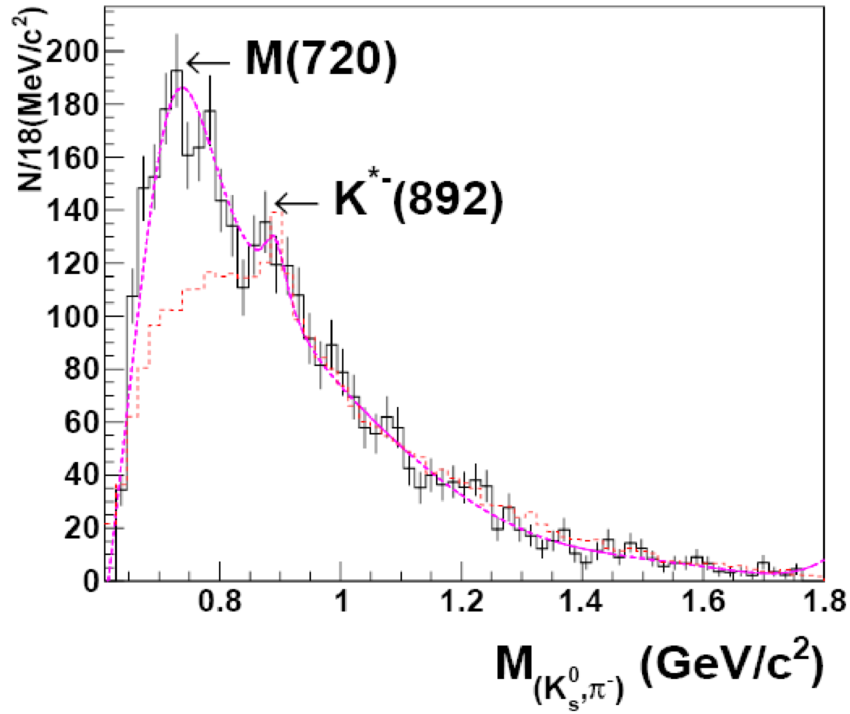


Table . The observed signals from mass spectra with Λ subsystems

Decay mode	M (MeV/c^2)	Γ(MeV/c^2)	S.D.
Λγ	Σ^0	55(PDG)	12.0
Λπ$^+$	Σ^{*+}(1382)	40(PDG)	12.9
Λπ$^-$	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
	2700 2900	- -	- -
ΛΛ	2250 2370 2570	- -	- 4.5
Λpπ	2380 2600	-	-
Λpp	3140	40	6.1
	3320	-	4.8

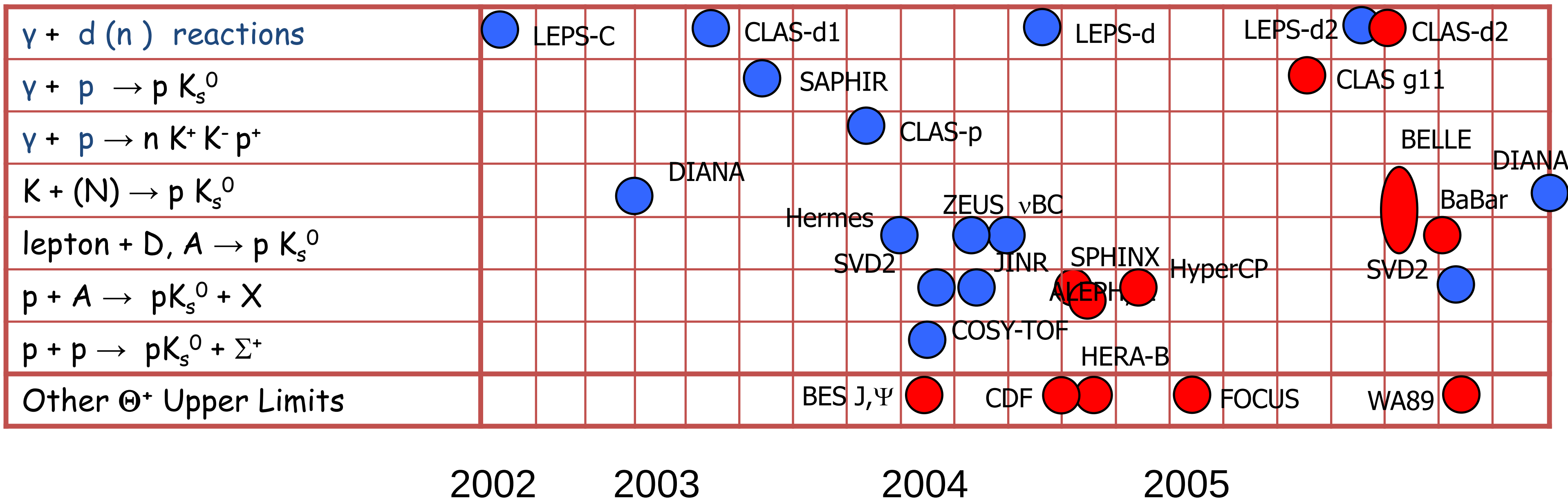
The observed signals from mass spectra with K^0_s subsystems





$K^0_s\pi^\pm$	885	48	6.0-8.2
	780-800	10	2.5-4.2
	720-730	$\geq$30-135	4.1-15.2
	1060	-	4.1

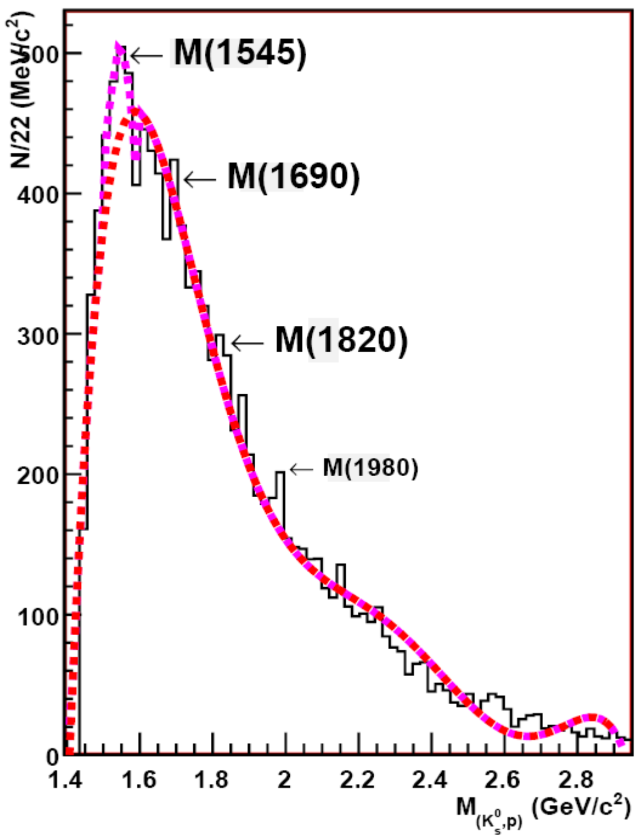
Time dependent experimental status of Θ^+

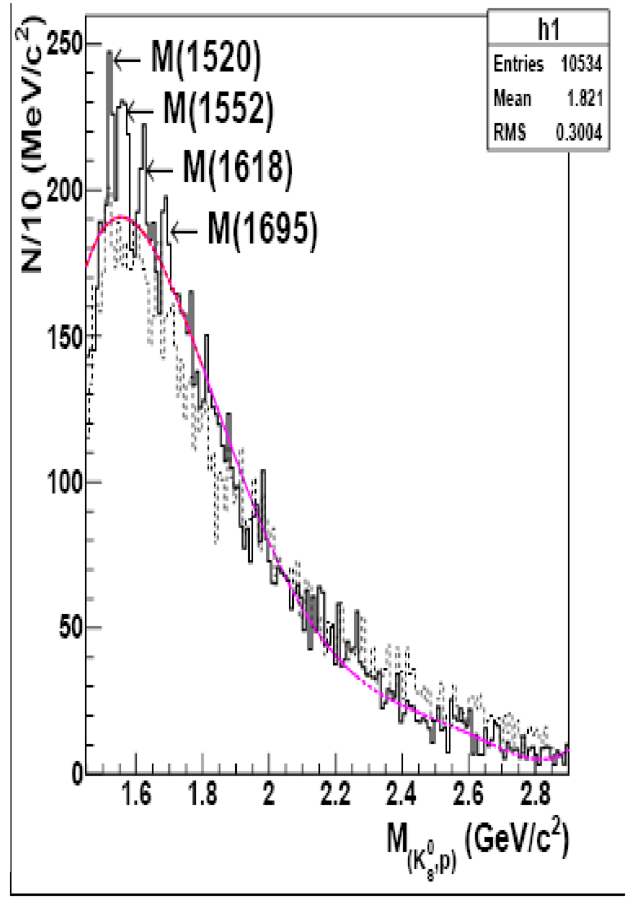


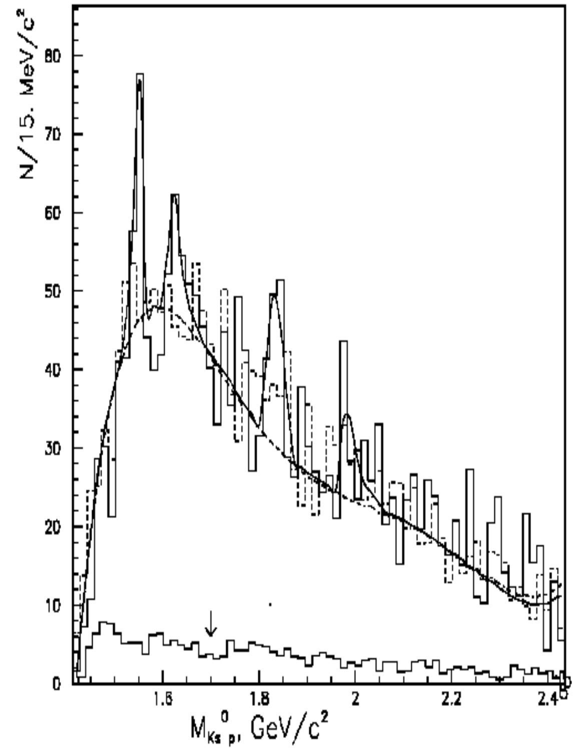
: Positive result

: Negative result

T.Nakano's slide

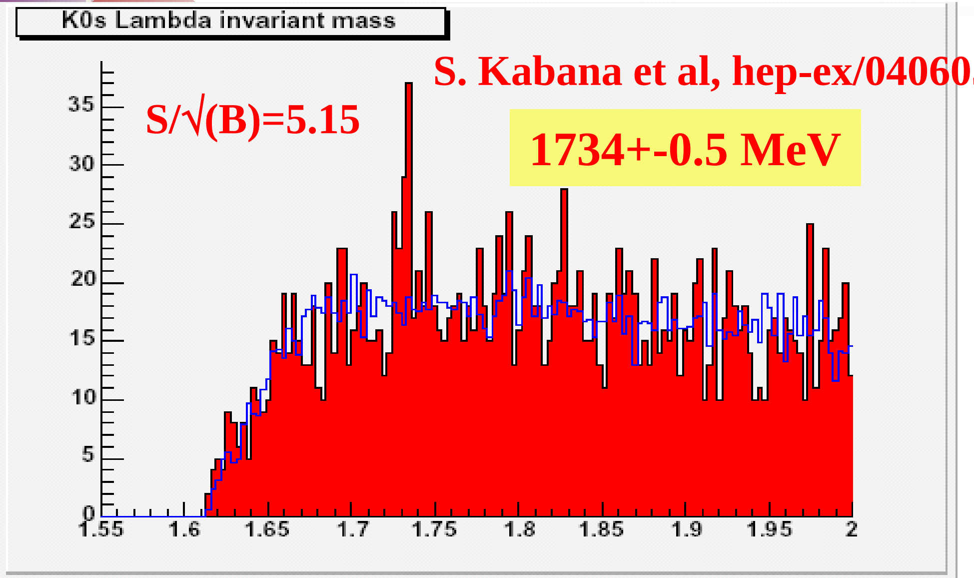




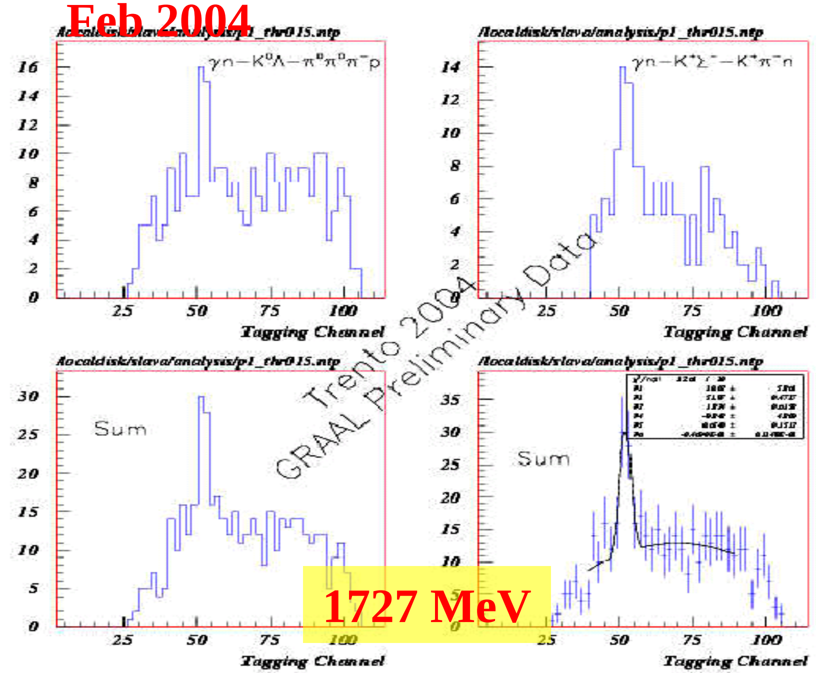


Resonance system	M MeV/c^2	Γ_e MeV/c^2 Experiment	Γ MeV/c^2	The statistical significance N_{sd}
$K_s^0 p$	1540±8	18.2±2.1	9.2±1.8	5.5±0.5
$K_s^0 p$	1613±10	23.6±6.0	16.1±4.1	4.8±0.5
$K_s^0 p$	1821±11	35.9±12.0	28.0±9.4	5.0±0.6

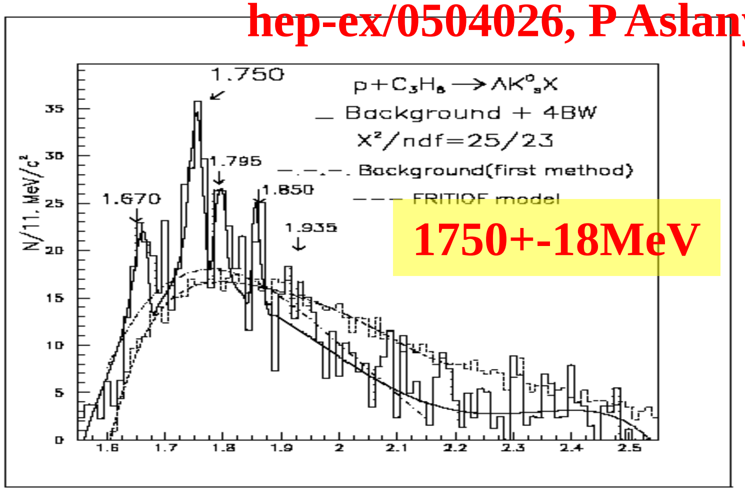
STAR Au+Au coll. 200 GeV preliminary



S Kouznetsov et al, Graal, Trento, Feb 2004



hep-ex/0504026, P Aslanyan et al



(ΛK^0_s)spectrum at 10 GeV beam, JINR

- Seen in 2 decay channels. The Sigma-K+channel tags the strangeness content as ssbar --> N0 candidate (Graal)
- Consistent with a partial wave analysis of old data suggesting two narrow N states at 1680 and/or 1730 MeV width < 30 MeV (nucl-th/0312126, R Arndt et al)

The Study of Exotic Multiquark States with Λ-Hyperons and K^0_S -*Mesons Systems*

LOI –P02

Beam: 10 (or 12) GeV/c protons

Intensity: 15 protons/circle

(5 sec/circle and 5 inelastic interaction per circle)

p+C_3H_8 (inelastic interactions)/day: ≥72000 (inelastic interactions from secondary particles/day: ≥ 65000).

Beam time: 100 day for setup.

Total number inelastic interaction of protons from beam: ≥ $7.2*10^6$(2100TB)

Target: C_3H_8 propane , 200cm length ,0.43 g/cm^2 density

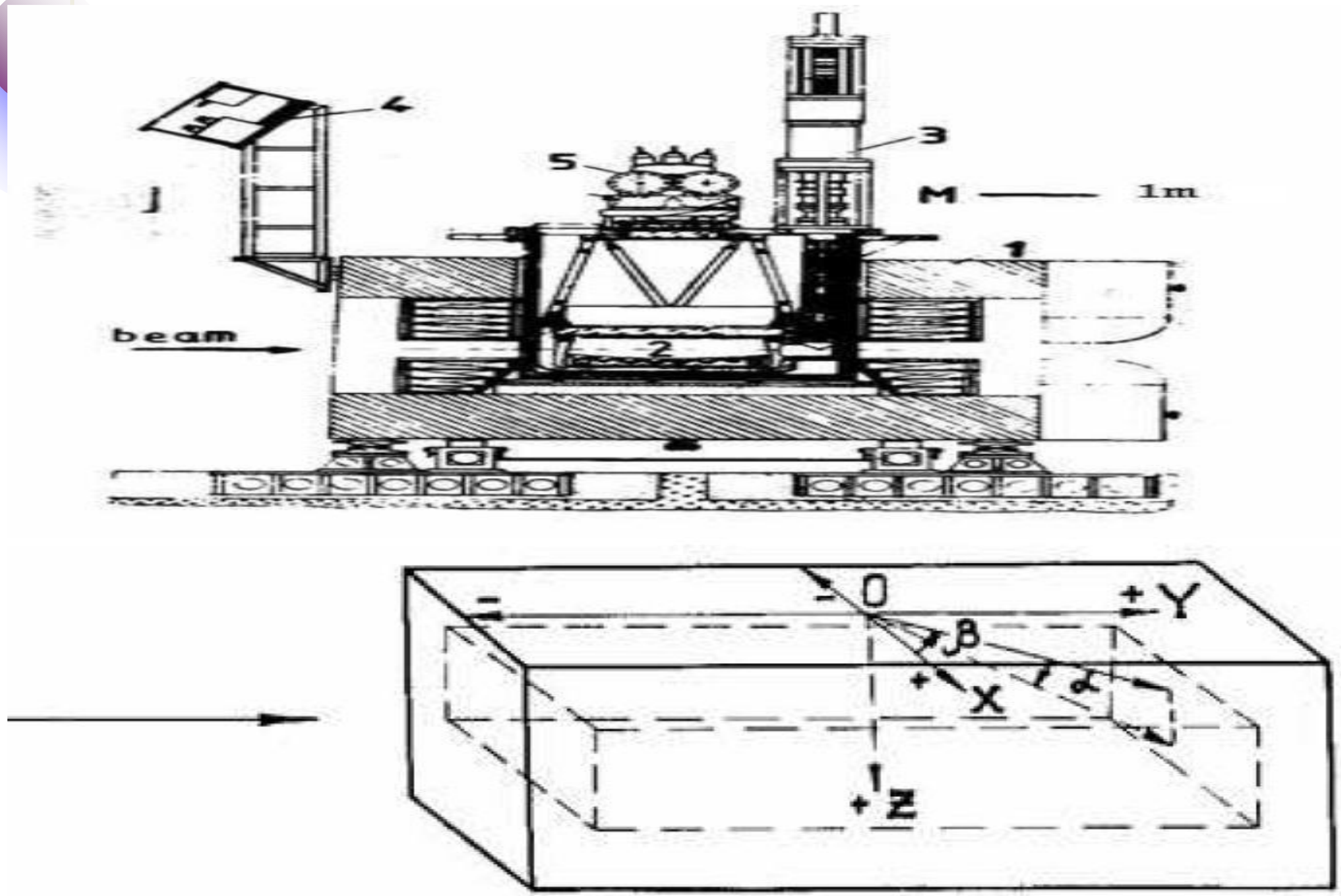
Estimated Yield: the number of identified Λ(→π-p) hyperons ≥ 63000 and Σ(→Λγ)>2000. Film data is to 40TB..

Number of $K^0_s(\rightarrow\pi^+\pi^-)$ mesons ≥ 30000(20 TB).

Data analysis: 1 year

Statistical significance of reviewed peaks in proposal p02 will increase more than 4(or 6) times.


2СП-41Г
Magnet
PBC



a)The frontal view of BC(movable) where 1 is a universal superconductive solenoidal magnet (as a barrel); 2 is chamber; 3 is mechanism of the expansion; 4 is a information desk; 5 is a system of the illumination and photography b)The scheme of PBC with sizes 40*60*200 cm^3.

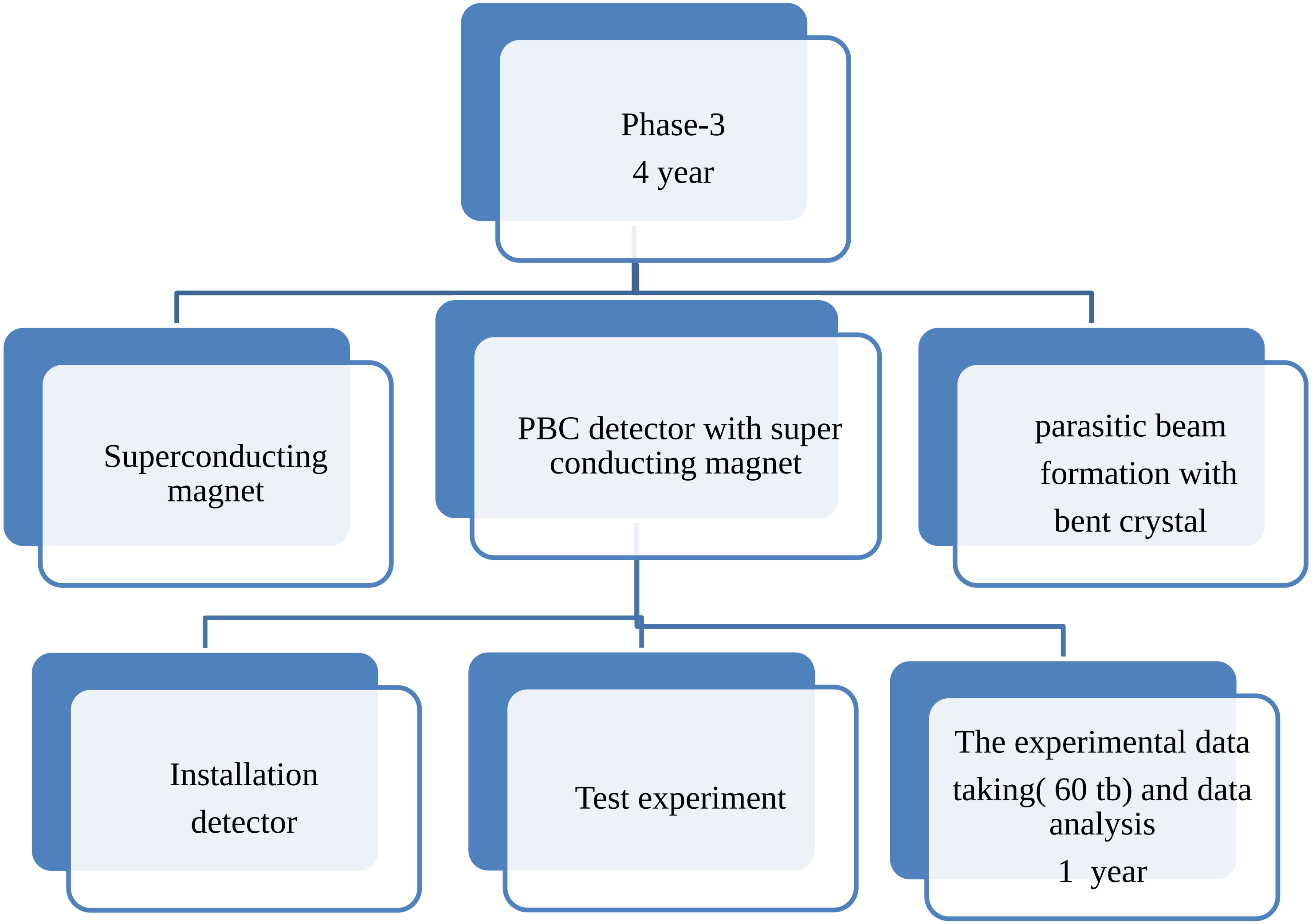
The Study of Exotic Multiquark States with Λ-Hyperons and K^0_S -*Mesons Systems*

PRE-PROPOSAL or Phase-1 (1- year)
Primary total budget 37 kUSD

- International collaboration will organize on base of necessary tasks
  - We will organize workshop, meeting and discussion with experienced specialists.
    Budget is 12 kUSD
- Special tasks and main topologies on base of old data at 12 GeV/c beam
  - The impact of experimental conditions by using of different methods(P05.P07,P27) , geometry and generators for identification of exotica will study .
- The old bubble chamber inspect and determine of basic works and budget for reanimation
  - The list of necessary materials for new upgraded PBC with on line data taking.
    5 kUSD
- Software for automatic on line and off line data taking and measurement (3-year)
  - Software for “minimum” guide and “0”guide programs will debug (1.5 year).
    Budget 20 kUSD

Phase-2
Approximately budget is to 350 kUSD,
from JINR-JPARC(50-50%)
minimum manpower 12
3 year

- A proposed location and design
  - We will discuss and develop to possibility versions for new beam lines construction in HADRON hall
- CDR for parasitic beam formation with bent crystal method
- CDR for PBC with universal solenoid super-conductive magnet
  - We will organize of meeting and discussion for construction of universal super-conductive magnet with PBC and TPC for J-PARC
- Software for GIANT4-ROOT
  - Simulation reactions for basic topologies
- PBC without magnet
  - Installation digital stereo photographic system
  - Installation all systems
  - test for on line data taking


Phase-3
4 year
Superconducting magnet
PBC detector with super conducting magnet
parasitic beam formation with bent crystal
Installation detector
Test experiment
The experimental data taking(60 tb) and data analysis
1 year

Three ways for the proposal are scheduled from time for J-PARC and NUCLATRON-M

I-way
Total time
Step by step
7-year

Phase-1
1-year

Phase-2
2-year

Phase-3
4 year

II-way
5 –year
Good way

Phase-1
1-year

Phase-2 and Phase-3
4- year

III-way
With old Magnet
on NUCLATRON-M
Most reasonable way 4 year

Phase-1
1-year

Phase-2 and Phase-3
3- year

Summary

Experimental Challenges in multi- strangeness nuclear physics

- We have new opportunities! J-PARC, BNL, Jlab, DAϕNE, LEPS, FAIR(GSI), IHEP (Protvino), JINR(NuclatronM), ..
- YN scattering experiments
- Expand the world of light hyper nuclei
- Dihyperon
- K bound states
- Exotic hadrons
- Establishment of truly exotic strange hadrons

Summary

Experimental Challenges in multi -strangeness nuclear physics

- But there is need for new high energy particle and nuclear physics with strangeness to build of new detectors with:
- 4π acceptance included beam ranges too;
- multi-vertex resolutions for secondary and et al. vertexes are to <50μm;
- development of methods and triggers for detecting particles in beam area;
- good separation of protons from charged π-s and K-s is necessary;
- momentum resolution is to <2%;
- low momentum charged π-s and K-s are to < 50 MeV/c;
- mass resolution is to $<0.5^{o}$;
- mass resolution is to <0.5 %;
- high statistics .
- High statistics with above necessary conditions there will possible to obtain of new results in physics. Because from many similarly photographs without new necessary resolution and method analysis there will not possible to obtain of new information about object.

October 5, 2010 (@LHEP.JINR.) Thank You!

7 years stages for proposal with new magnet

- Phase1. organize collaboration; select main physics tasks and reaction topology , inspect of old detector; discuss and develop of type, size and cost for universal super conducting magnet; minimum guide program debug on base of ROOT; estimate of budget.(1 year -37k$, manpower -7)

Phase 2. A proposed location design, CDR for PBC without magnet , CDR for parasitic beam formation with bent crystal; simulation and reconstruction software develop and debug on base of ROOT-GEANT4, install of minimum guide and "0" guide programs, construct of PBC, construct and install of gas and other necessary systems, construct and install of PBC with digital stereo photographic system;; (3 year , 370k$ PBC without magnet, manpower 13? CDR for universal super conducting magnet ; main CDR for PBC with magnet;

Phase 3. construct and install parasitic beam extraction, construct of magnet, construct and install of PBC with magnet, construct and install trigger, install data taking, Test experiment for installation of detector(3 year).

$$w_\gamma=\varepsilon_\gamma^{-1} = 1/[1-\exp(-\mu(E_\gamma)*L/x_0)] \,,\ \mu(E_\gamma)= (X_0\rho N_0/A)$$

X_0=106 cm radiation length in propane bubble chamber, $\mu(E\gamma)$- probability conversion from γ -quanta with energy E_γ formation electron-positron on one radiation length. $\sigma_{tot}^{e+e-}(E_\gamma)$ cross section formation of electron-positron on one molecule propane.