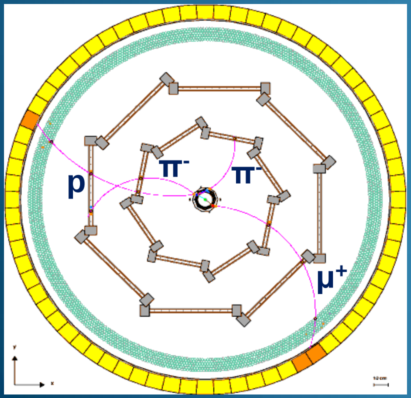
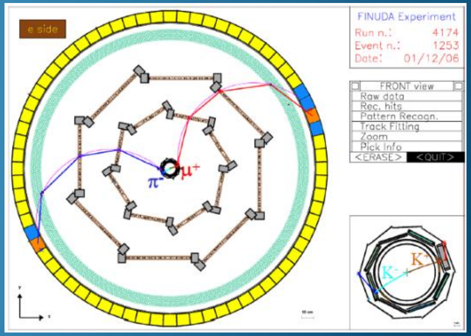
11th International Workshop on Meson Production, Properties and Interaction
KRAKÓW, POLAND
10 - 15 June 2010

FINUDA

experiment at DAΦNE



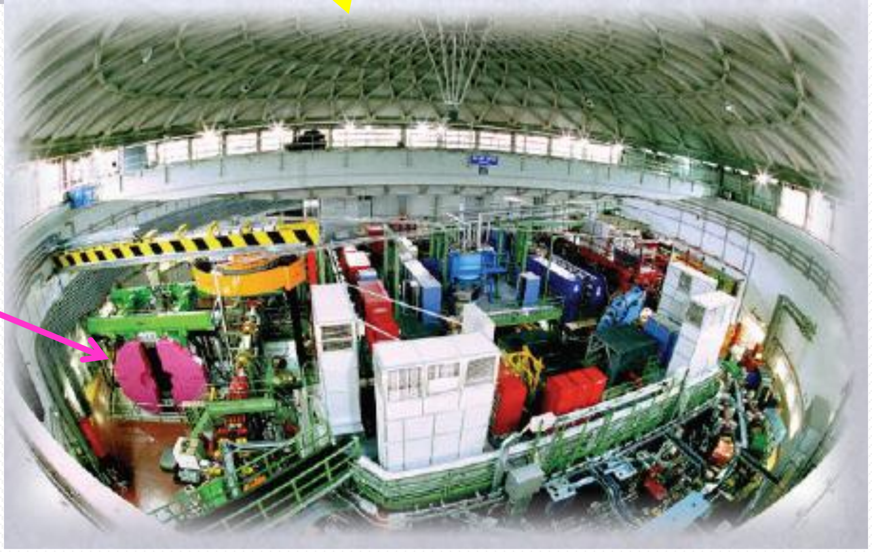


Vincenzo Lucherini - LNF

LNF - INFN Frascati

DAΦNE

FINUDA

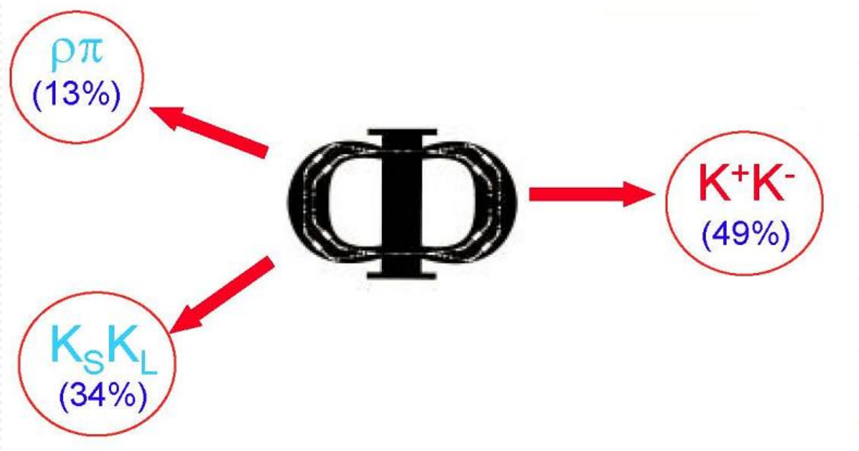


FINDUDA

Hypernuclear Physics (and more) at DAΦNE e^+e^- collider

$e^+e^- \longrightarrow \Phi(1020) \longrightarrow K^+K^-$

~16 MeV



The Φ decay at DAΦNE is a source of:

- **charged (and neutral) kaons**
- **(almost) collinear and tagged**
- **low energy (~16 MeV)**

The K^- can be stopped in thin targets (~ 0.2 ÷ 0.3 g cm^{-2}) to produce Hypernuclei

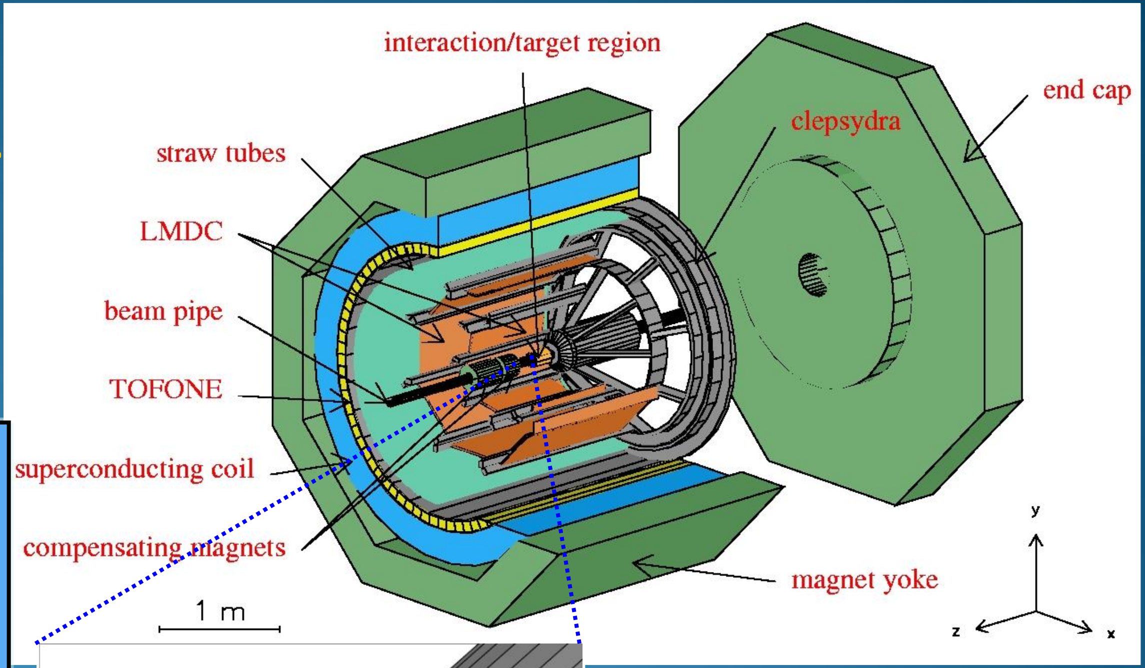
$$K^-_{stop} + {}^{A}Z \longrightarrow {}^{A}_{\Lambda}Z + \pi^-$$

Hypernuclear decay Hypernuclear spectroscopy

In general FINUDA is able to study many facets of K^-_{stop}-Nulceus interactions

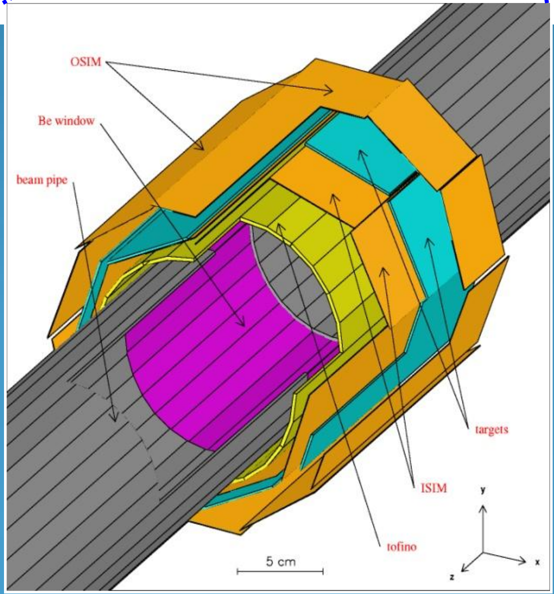
The FINUDA Detector

A Large acceptance Spectromer immersed in a highly uniform 1 T magnetic field generated by a superconducting solenoid



Detector capabilities:

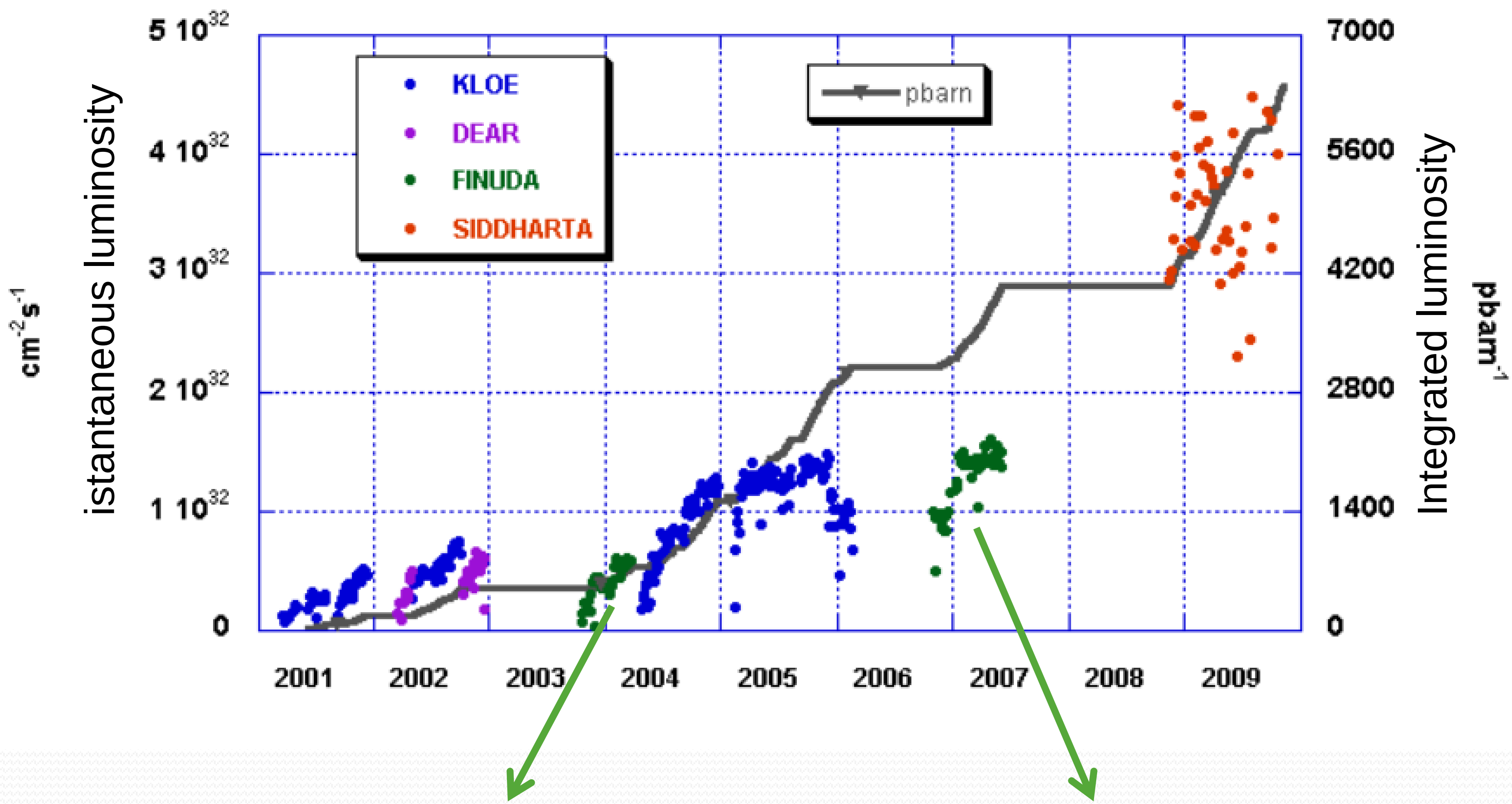
- **Selective trigger** based on fast scintillation detectors (TOFINO, TOFONE)
- **Clean K^- vertex identification** (ISIM P.ID.+ *x,y,z* resolution + K^+ tagging)
- **π, K, p, d, t … P.I.D.** (d*E*/d*x*)
- **High momentum resolution** (6‰ FWHM) tracker resolution+Hebag+thin targets
- **Time-Of-Flight** (TOFONE-TOFINO)
- **Neutron detection** (TOFONE)



K^- from Φ decay at rest: $\sin^2(\Theta)$ respect to beam pipe axis

The volumes between the tracking detectors are filled by He to minimize multiple scattering effects.

Experiments on DAΦNE at a glance



2x ^{6}**Li**, *1x* ^{7}**Li**, *3x* ^{12}**C**, *1x* ^{27}**Al**, *1x* ^{51}**V**

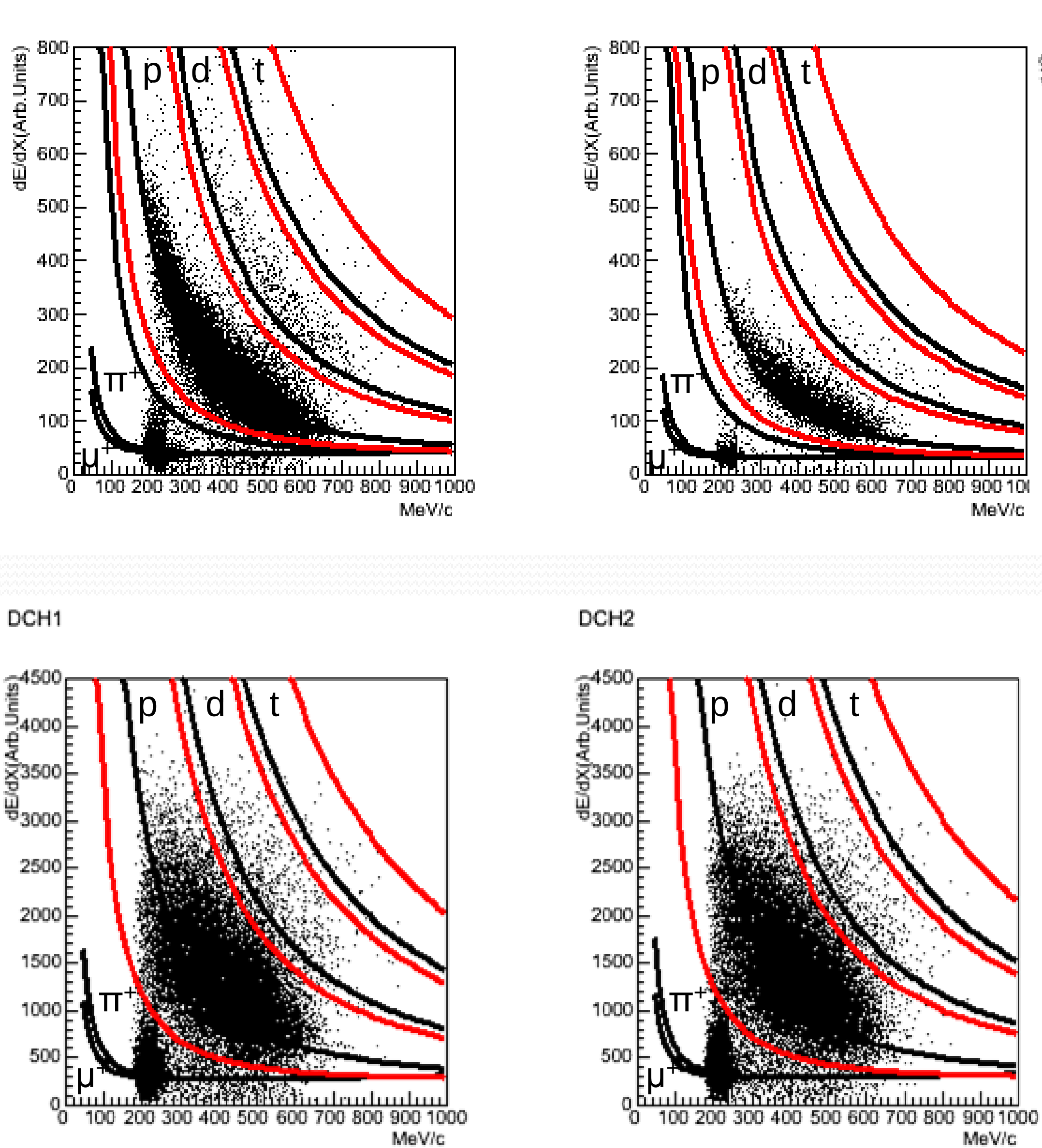
***L*$_I$: 200 pb^{-1}**

2x ^{6}**Li**, *2x* ^{7}**Li**, *2x* ^{9}**Be**, *1x* ^{13}**C**, *1x* ^{16}**O**

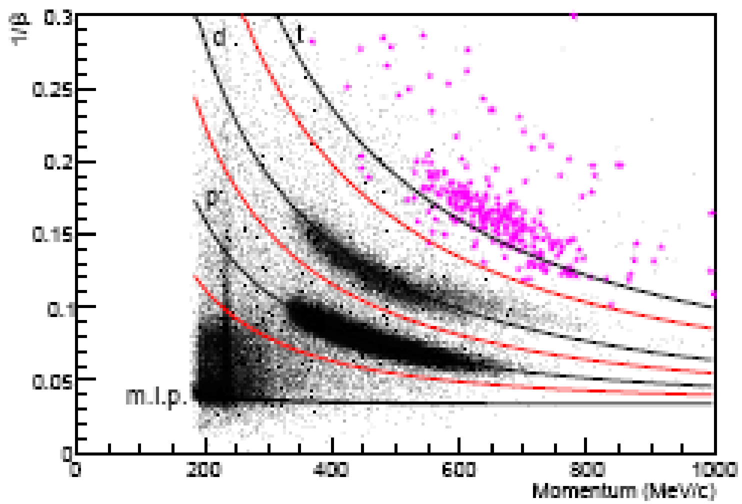
***L*$_I$: 960 pb^{-1}**

A strong feature of FINUDA: excellent PID for Charged Particles

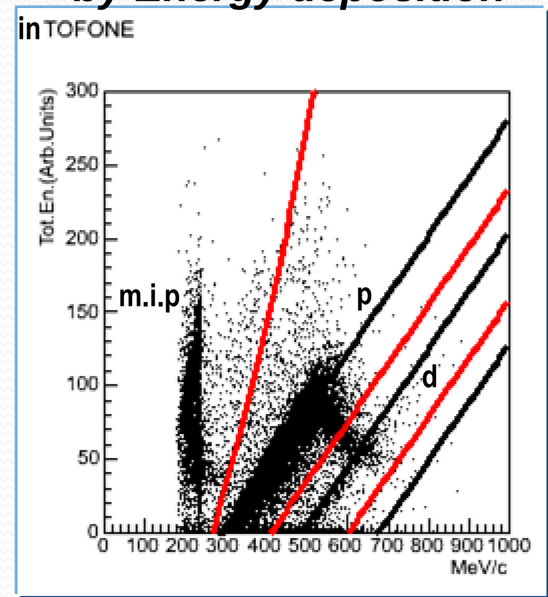
by dE/dx



by t.o.f



by Energy deposition



FINUDA physics program

- Λ HYPERNUCLEAR SPECTROSCOPY
  essential tool for testing :
  - theoretical models of Λ-N potentials
  - single particle nuclear model predictions
  - bound states with strangeness

SIMULTANEOUSLY

- HYPERNUCLEAR DECAYS
  - study of baryon-baryon weak processes in nuclear matter: $\Lambda \rightarrow \pi N$ and $\Lambda N \rightarrow NN$ and more…
  - Neutron-rich hypernuclei and rare decays

and

and, moreover:

ON DIFFERENT NUCLEI

- SEARCH FOR:
  - K- multi-nucleon absorption
  - Deeply bound kaonic nuclei
  - $\Sigma^{+/-}$ production

FINUDA physics program in more detail

$$K^-_{stop} + {}^A Z \rightarrow {}^A_\Lambda Z + \pi^-$$

$$K^- + n \rightarrow \Lambda + \pi^-$$ strangeness exchange reaction

1

HYPERNUCLEI PRODUCTION

HYPERNUCLEI DECAY

Mesonic Weak Decays (MWD)

$${}^A_\Lambda Z \rightarrow {}^A (Z+1) + \pi^-$$

$${}^A_\Lambda Z \rightarrow {}^A Z + \pi^o$$

Λ decay in medium

$$\Lambda_{med} \rightarrow p + \pi^-$$

$$\Lambda_{med} \rightarrow n + \pi^o$$

$$\Lambda_{free} \rightarrow p + \pi^- \ (64.2\%)$$

$$\Lambda_{free} \rightarrow n + \pi^o \ (35.8\%)$$

NON-Mesonic Weak Decays (NMWD)

$${}^A_\Lambda Z \rightarrow {}^{A-2} (Z-1) + p + n$$

$${}^A_\Lambda Z \rightarrow {}^{A-2} Z + n + n$$

Λ decay in medium

$$\Lambda_{med} + p \rightarrow n + p$$

$$\Lambda_{med} + n \rightarrow n + n$$

and on more nucleons

Other NON-Mesonic rare decays (for example ...)

$${}^4_\Lambda He \rightarrow d + d$$

$${}^4_\Lambda He \rightarrow p + t$$

$${}^5_\Lambda He \rightarrow d + t$$

2

K- ABSORPTION ON FEW NUCLEONS

$A\ (K^-, \Lambda p)\ X$ 2 nucleons absorption

$A\ (K^-, \Lambda d)\ X$ 3 nucleons absorption

$A\ (K^-, \Lambda t)\ X$ 4 nucleons absorption

$\Lambda p,\ \Lambda d,\ \Lambda t$

invariant mass study

S. Piano talk

3

… and $\Sigma^{+/-}$ production

Hypernuclear spectroscopy

key features of the spectrometer

very thin targets [0.1 ÷ 0.3 g/cm²]
transparency ➡ high resolution spectroscopy

coincidence measurement with large acceptance
complete event ➡ decay mode study

different targets in the same run
➡ high degree of flexibility

simultaneous tracking of μ⁺ from the K⁺ decay
$K^+ \to \mu^+ \nu_\mu$ ➡ energy and rate calibration

the "strangeness exchange" reaction **it's not** the only mechanism for a production of a **negative pion** in the **K-N interaction**

1 $K^- + n \to \Lambda + \pi^-$

2 $K^- + p \to \Sigma^- + \pi^+$

$\Sigma^- \to n + \pi^-$

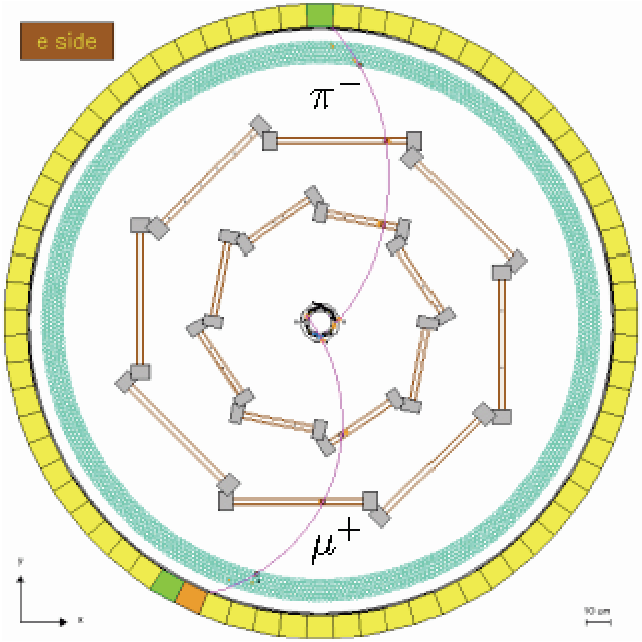
3 $K^- + (np) \to \Sigma^- + p$

4 $K^- \to \mu^- + \overline{\nu}_\mu$

backgrounds

hypernucleus

$$K^-_{stop} + {}^A Z \to {}^A_\Lambda Z + \pi^-$$



Measurement of the (prompt) π^- momentum

How it works

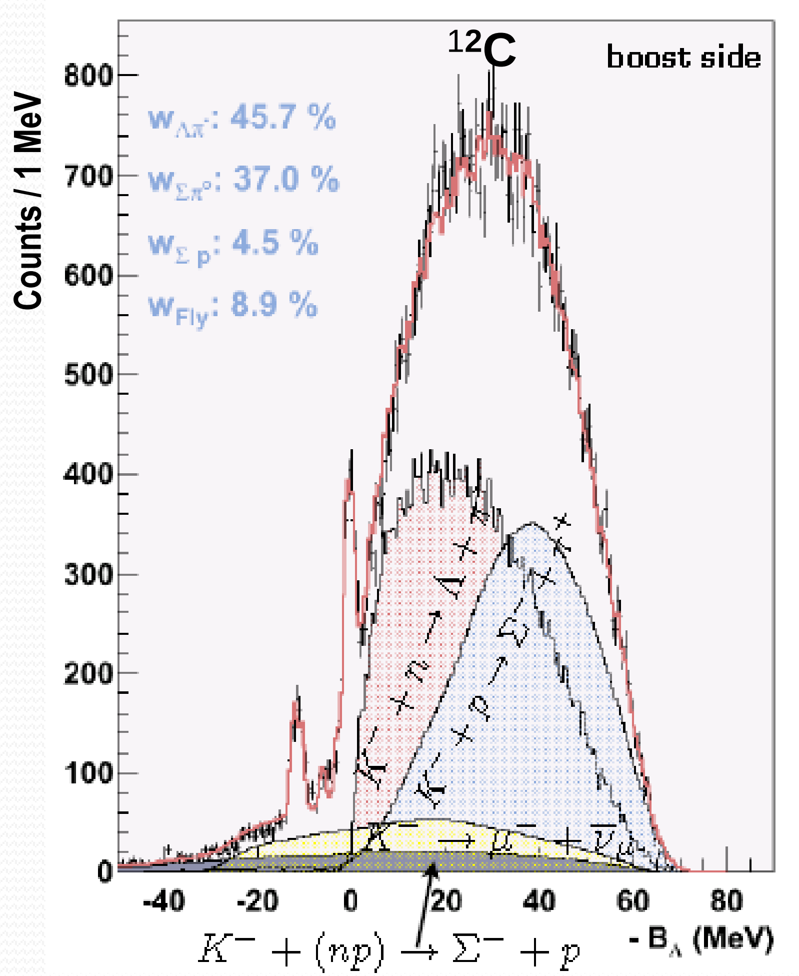
by conserving energy and momentum

$$m_{hyp} = \sqrt{(m_{K^-} + m_{^AZ} - E_{\pi^-})^2 - p_\pi^2}$$

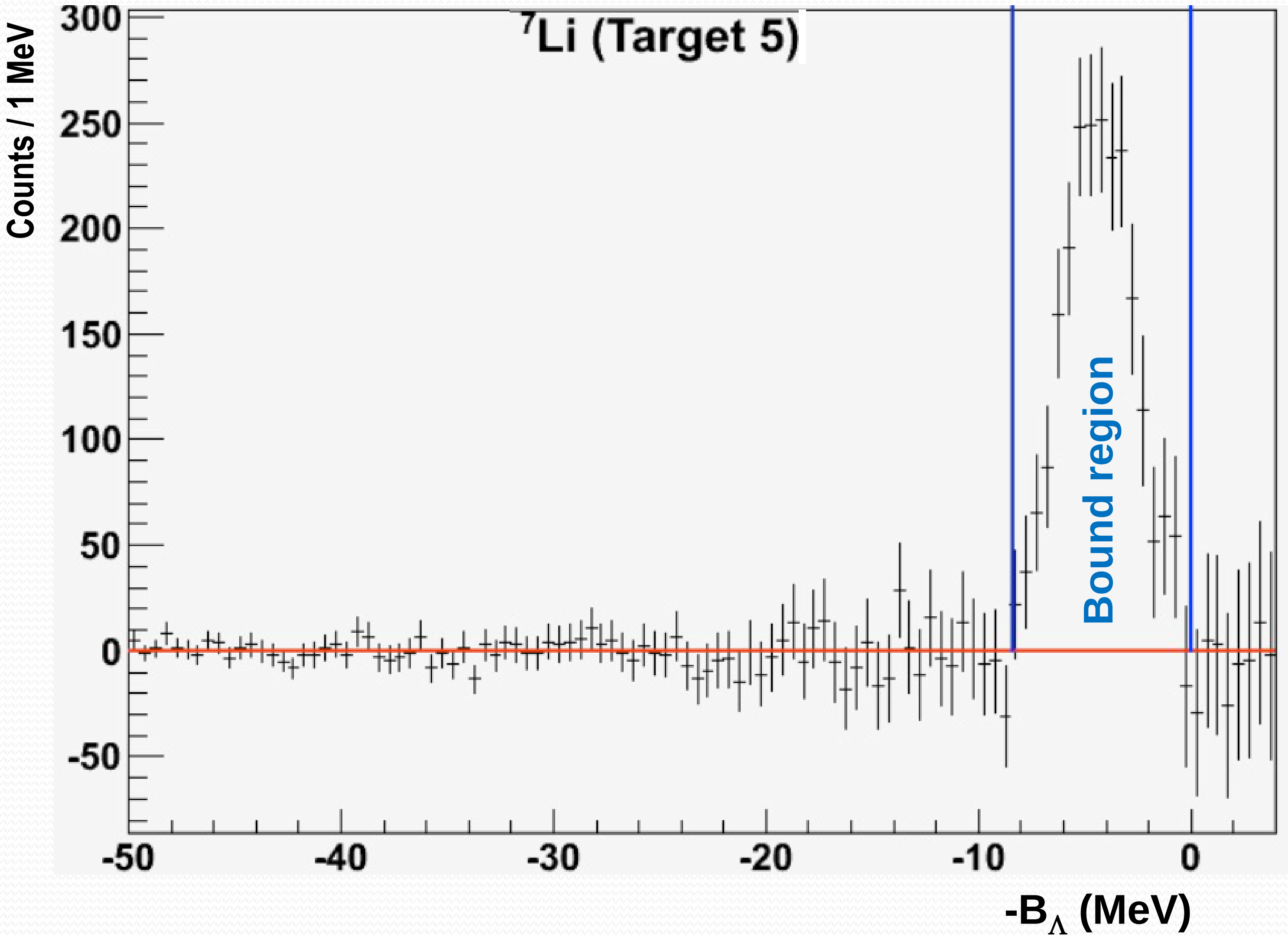
$$-B_\Lambda = m_{hyp} - (m_{^AZ-1n} + m_\Lambda)$$

binding energy

the measured π^- momentum spectrum is transformed in a $-B_\Lambda$ spectrum, and the obtained spetrum is "fitted" by a simulated one, that includes the known processes plus peaks due to hypernuclei formation



Procedure verification:
data - “fit” (only in the background region)



Extraction of the capture Rates

$$n_\Lambda = N_{K^-} \cdot cR \cdot \epsilon_{\pi^-} \cdot \epsilon_D$$

$$cR = \frac{n_\Lambda}{N_{K^-}} \frac{1}{\epsilon_{\pi^-}} \frac{1}{\epsilon_D}$$

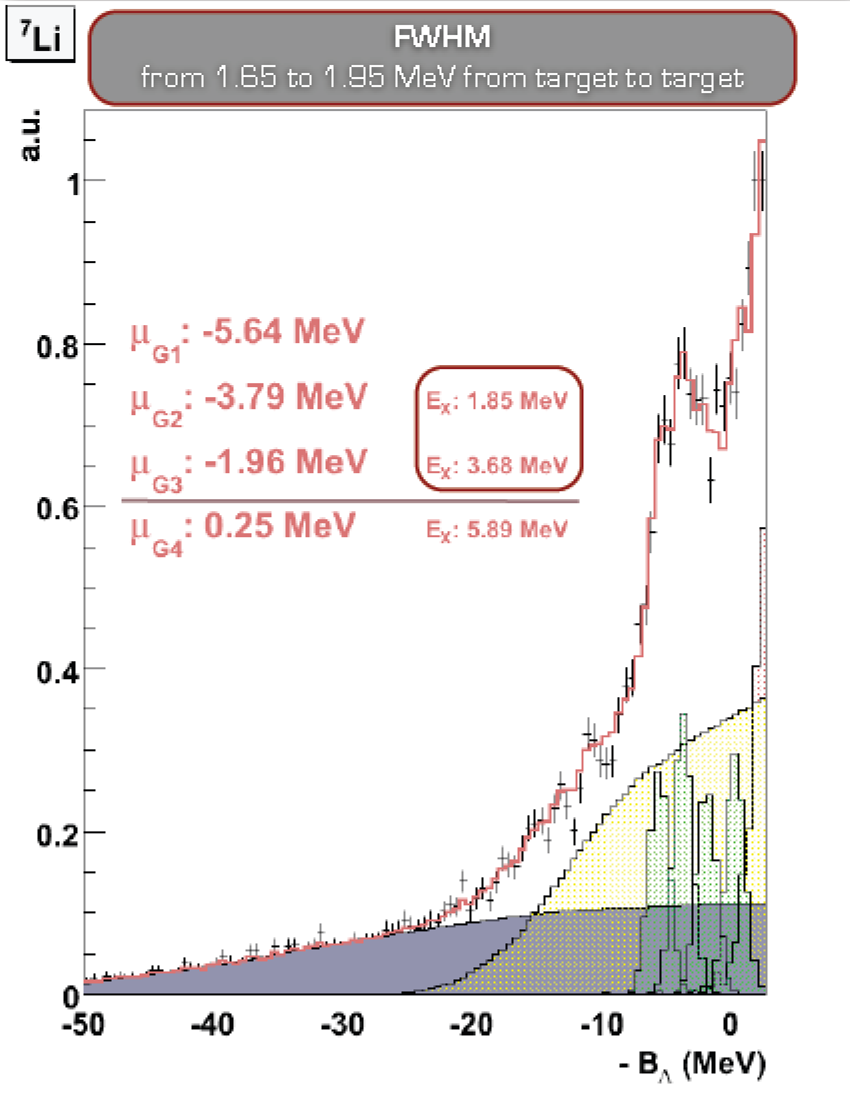
n_Λ =n. of hypernuclei
N_{K^-}=n. of stoppped kaons
cR = capture rate
(formation probability per stopped kaon)
ε_π = all other efficiencies
(trigger, geometrical acceptance, reconstruction, cuts)
ε_D = overall detector efficiency

$$n_\Lambda^{MC} = N_{K^-}^{MC} \cdot cR_{MC} \cdot \epsilon_{\pi^-}$$

$$\epsilon_{\pi^-} = \frac{n_\Lambda^{MC}}{N_{K^-}^{MC} \cdot cR_{MC}}$$

$$\epsilon_D = \frac{n_{\mu^+}^{data} / N_{K^+}^{data}}{n_{\mu^+}^{MC} / N_{K^+}^{MC}}$$

The μ^+ (from K^+_{stop} decays) are used to calculate the overall detector efficiency ε_D



B_Λ energy measurements

- absolute scale of the energy known at the level of 0.2 MeV
- possible systematic of the fit of 0.2-0.3 MeV

formation probability

capture Rate per stopped K^-

#1: 0.041 ± 0.006 ± 0.005 %

#2: 0.058 ± 0.008 ± 0.006 %

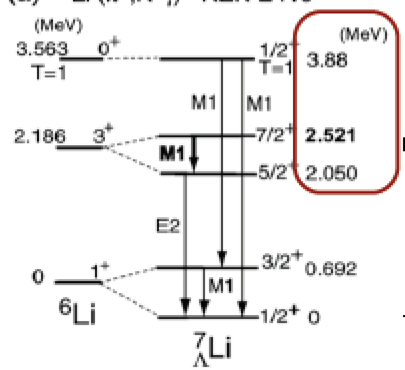
#3: 0.043 ± 0.006 ± 0.005 %

#4: 0.052 ± 0.007 ± 0.006 %

FIRST WORLD MEASUREMENT

Total in the bound region:

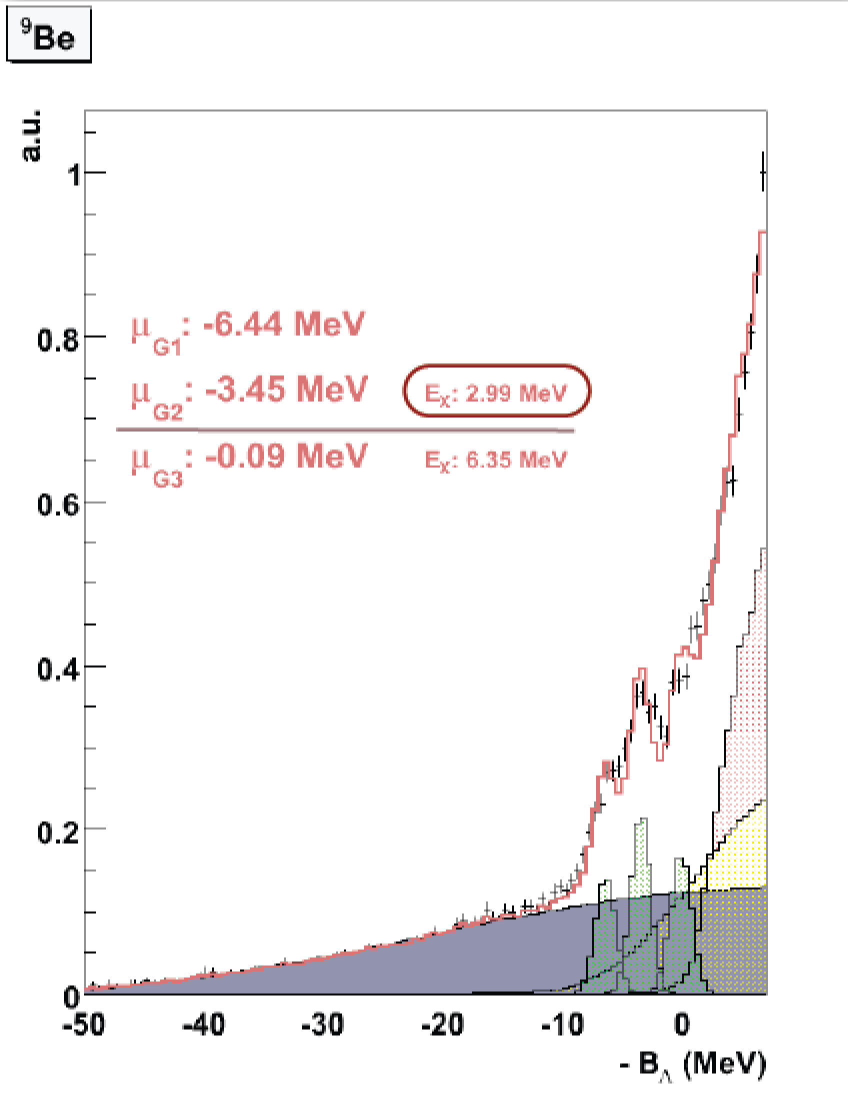
0.14 ± 0.01 ± 0.02 %



H. Tamura et al. Nucl. Phys. A 754 (2005) 58c

excitation energies are referred to the ground state B_Λ = -5.58 ± 0.03 MeV

[M. Juric et al. Nucl. Phys. B 52 (1973) 1]



formation probability

capture Rate per stopped K

#1: 0.022 ± 0.006 ± 0.002 %

#2: 0.036 ± 0.008 ± 0.004 %

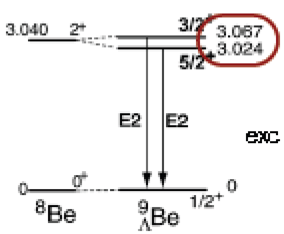
#3: 0.027 ± 0.006 ± 0.003 %

Total in the bound region:

0.058 ± 0.011 ± 0.006

FIRST WORLD MEASUREMENT

(b) ^{9}Be ($K^-,\pi^-\gamma$) BNL E930('98)

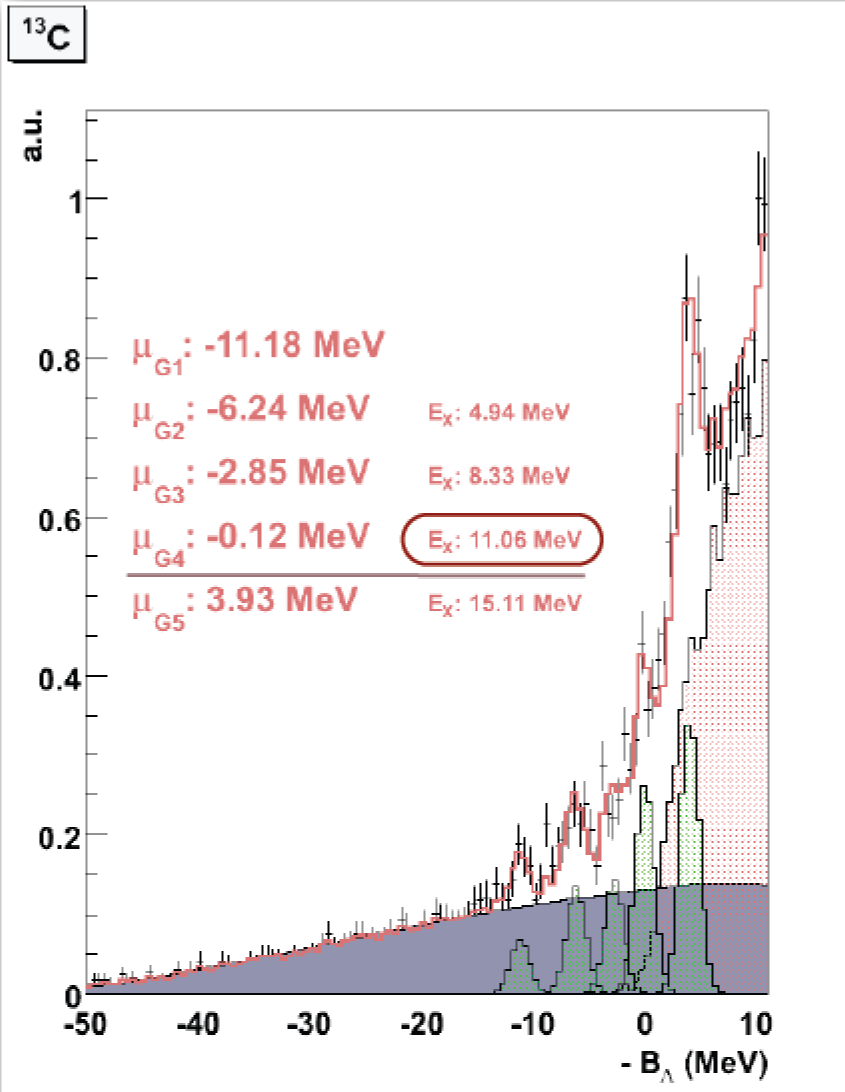


H. Tamura et al. Nucl. Phys. A 754 [2005] 58c

excitation energies are referred to the ground state

B_Λ = -6.61 ± 0.04 MeV

|M. Juric et al. Nucl. Phys. B 52 [1973] 1|



formation probability

capture Rate per stopped K

#1: 0.006 ± 0.001 ± 0.001 %

#2: 0.014 ± 0.002 ± 0.002 %

#3: 0.018 ± 0.002 ± 0.002 %

#4: 0.024 ± 0.003 ± 0.003 %

#5: 0.035 ± 0.005 ± 0.004 %

Total in the bound region:

0.062 ± 0.005 ± 0.008 %

FIRST WORLD MEASUREMENT

PHYSICAL REVIEW C, VOLUME 63, 034607

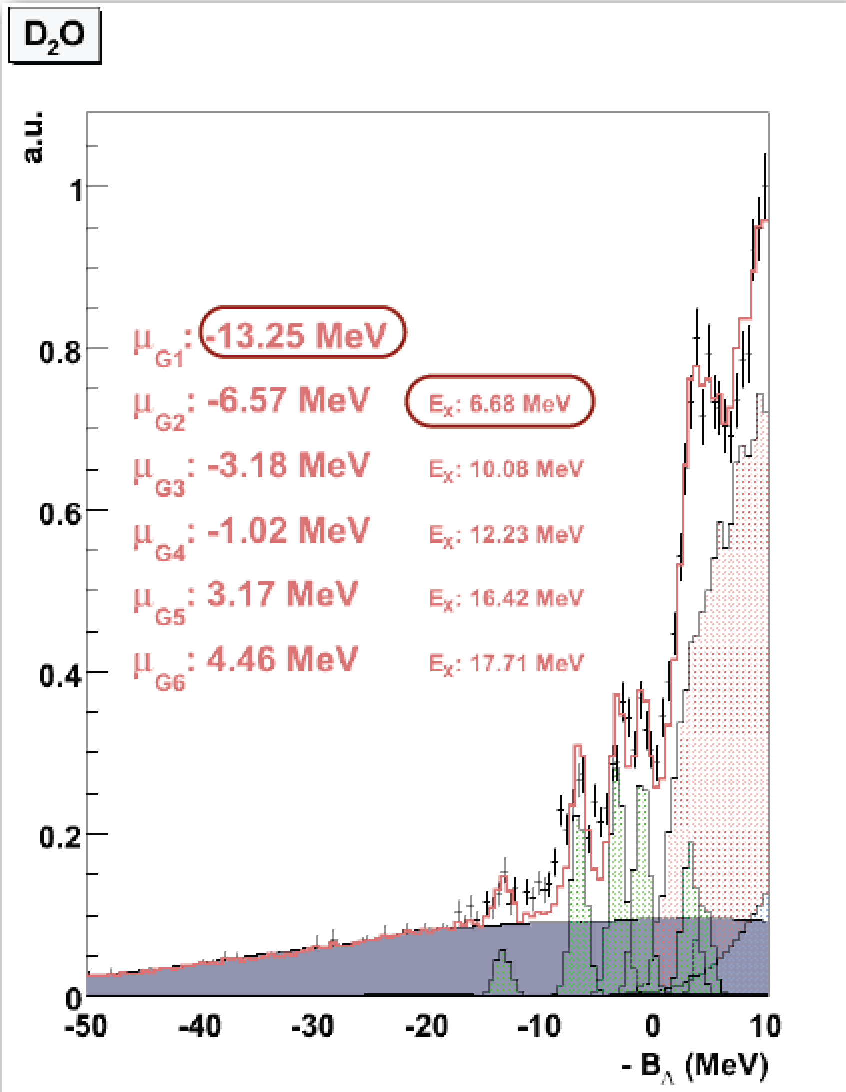
$^{13}_{\Lambda}C$ hypernucleus studied with the $^{13}C(K^-,\pi^-\gamma)$ reaction

gion. The excitation energies of the 1/2$^-$ and 3/2$^-$ states were obtained as 10.982±0.031(stat)±0.056(syst) and 10.830±0.031(stat)±0.056(syst) MeV, respectively. The

excitation energies are referred to the ground state

B_Λ = -11.22 ± 0.08 MeV

[M. Juric et al. Nucl. Phys. B 52 (1973) 1]



O. Hashimoto, H. Tamura / Progress in Particle and Nuclear Physics 57 (2006) 564–653

(π^+, K^+)

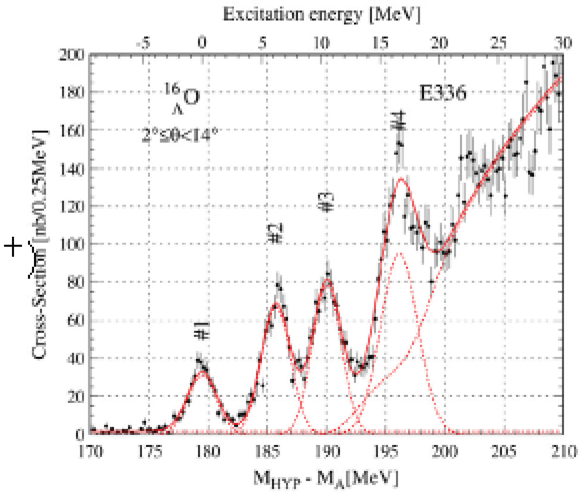


Table 11
Excitation energies and cross sections of $^{16}_{\Lambda}O$ in the (π^+, K^+) reaction

Peaks	B_Λ or E_X (MeV)	FWHM (MeV)	Cross sections $\sigma_{2^\circ-14^\circ}$ (μb)
#1	$B_\Lambda = 12.42 \pm 0.05$	2.75 ± 0.05	0.41 ± 0.02
#2	$E_X = 6.23 \pm 0.06$	2.75 ± 0.05	0.91 ± 0.03
#3	$E_X = 10.57 \pm 0.06$	2.75 ± 0.05	1.06 ± 0.03
#4	$E_X = 16.59 \pm 0.07$	3.13 ± 0.11	1.38 ± 0.06

PHYSICAL REVIEW C 77, 054315 (2008)

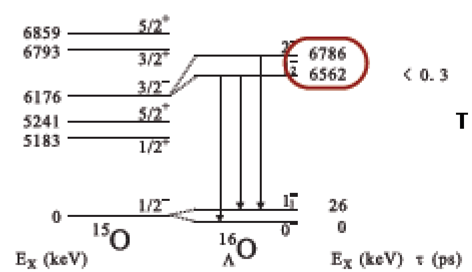
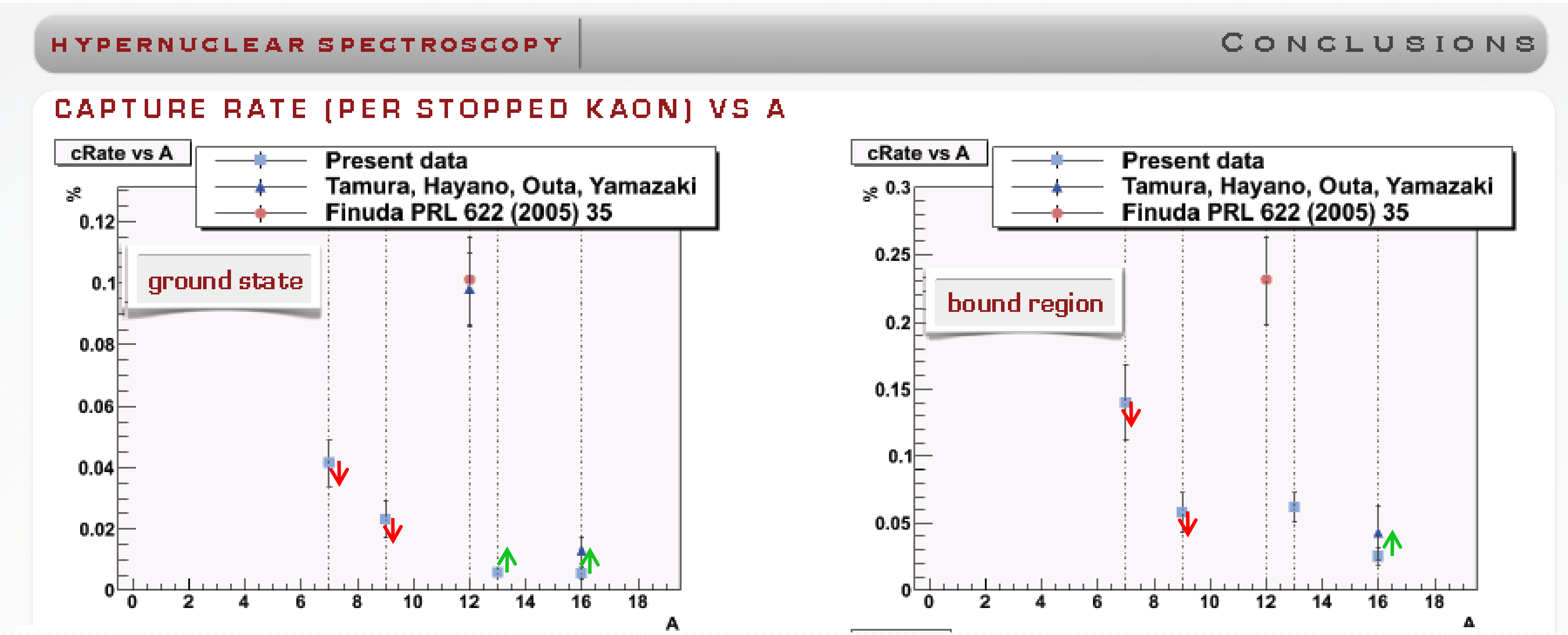


FIG. 16. Experimentally determined level scheme of $^{16}_{\Lambda}O$ and observed γ-ray transitions. The corresponding level scheme of ^{15}O is also shown.

WRONG value:
Tamura private comunication



The ↓↑ arrows indicate the "stabilization" of the results due to the fine tuning of the analysis procedure, now in its final phase.

Hypernuclear weak decay study in FINUDA

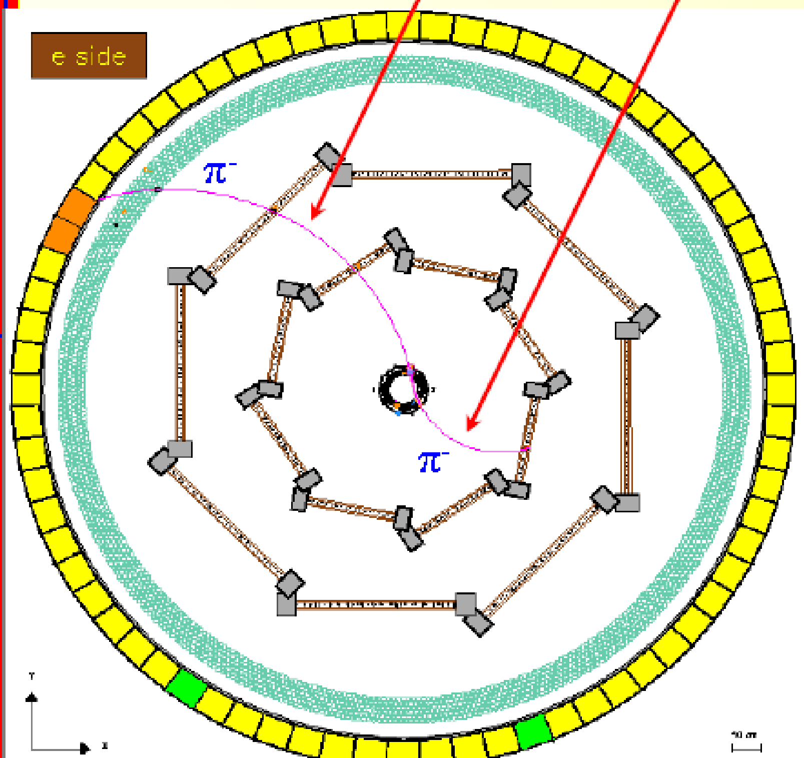
Coincidence measurements

charged Mesonic channel

$K^-_{stop} + {}^{A}Z \rightarrow {}^{A}_{\Lambda}Z + \pi^-$ *prompt*

${}^{A}_{\Lambda}Z \rightarrow {}^{A}(Z+1) + \pi^-$ *decay*

MWD

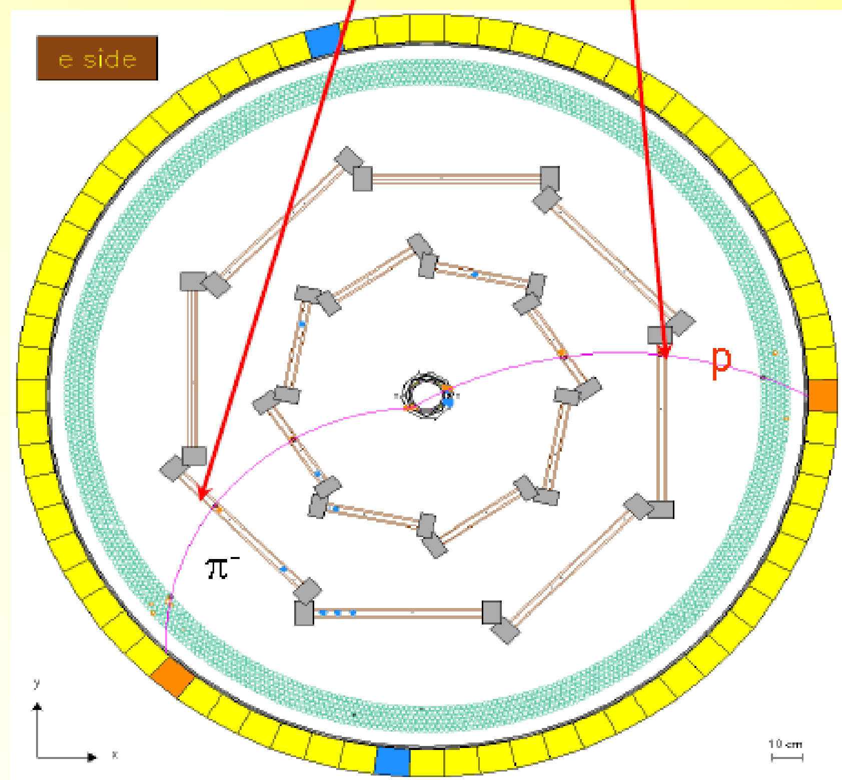


charged Non-Mesonic channel

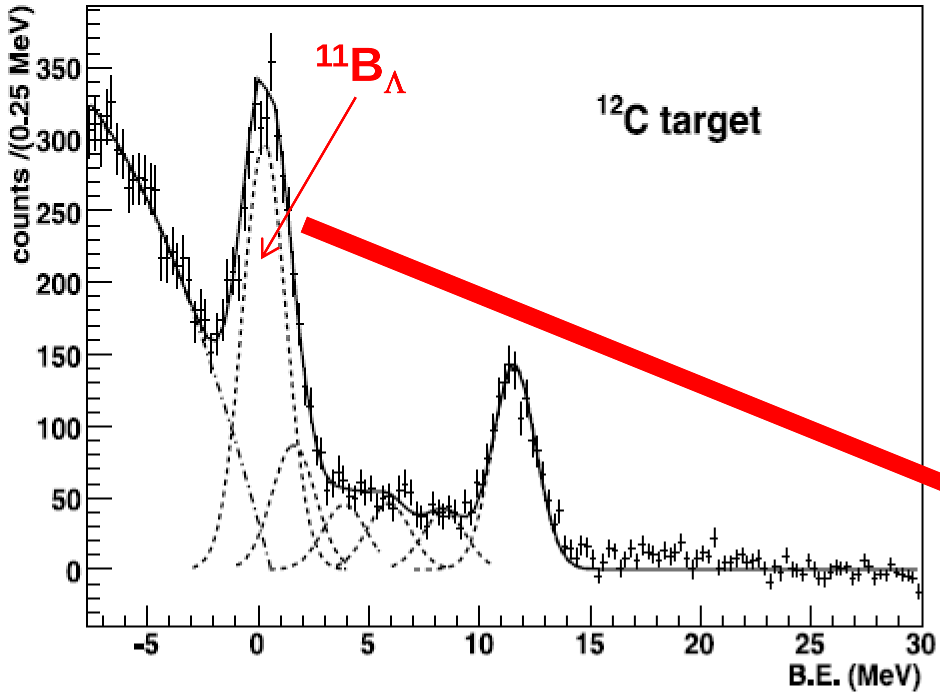
$K^-_{stop} + {}^{A}Z \rightarrow {}^{A}_{\Lambda}Z + \pi^-$ *prompt*

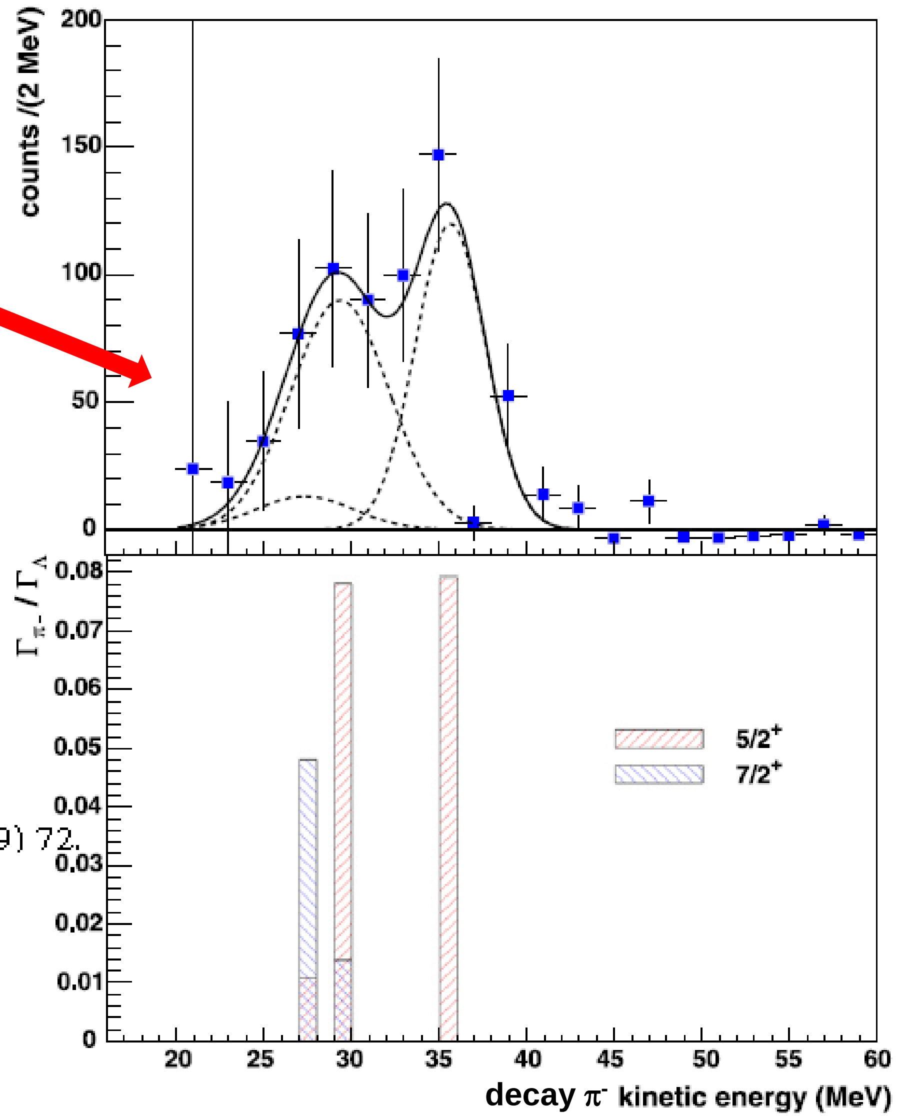
${}^{A}_{\Lambda}Z \rightarrow {}^{A-2}(Z-1) + p + n$ *decay*

NMWD

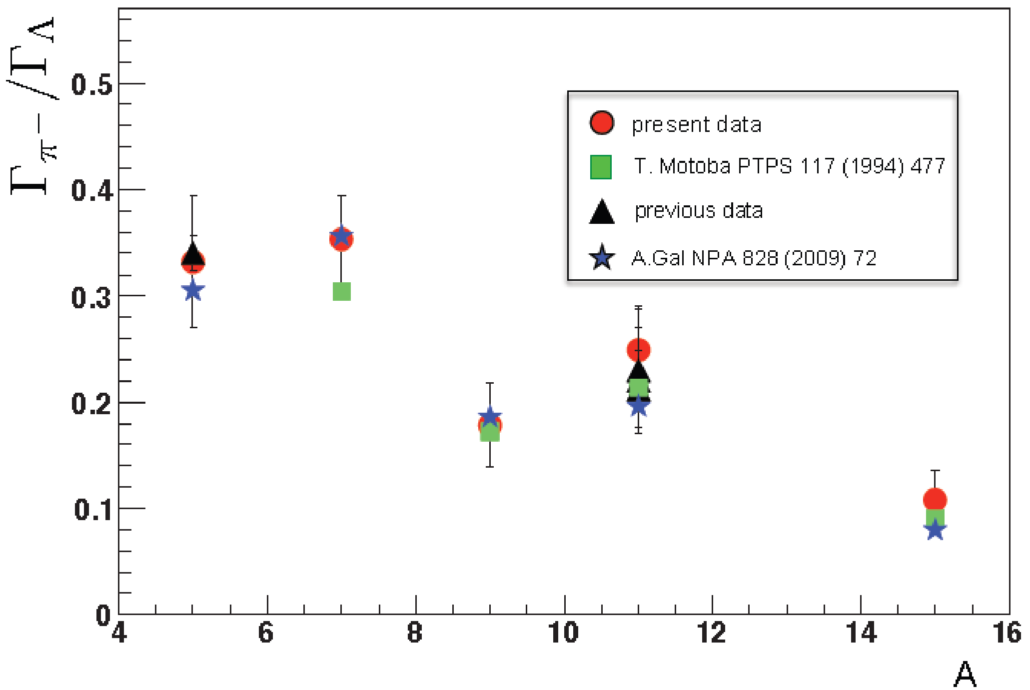


Spin assignment with FINUDA MWD data





A. Gal, Nucl. Phys. A 828 (2009) 72.



FINUDA Coll., PLB 681 (2009) 139

Mesonic decay results

MWD π^- spectra for $^{7}_{\Lambda}$Li, $^{9}_{\Lambda}$Be, $^{11}_{\Lambda}$B and $^{15}_{\Lambda}$N

spin-parity assignment confirmed for $^{7}_{\Lambda}$Li, $^{9}_{\Lambda}$Be, $^{11}_{\Lambda}$B g.s.

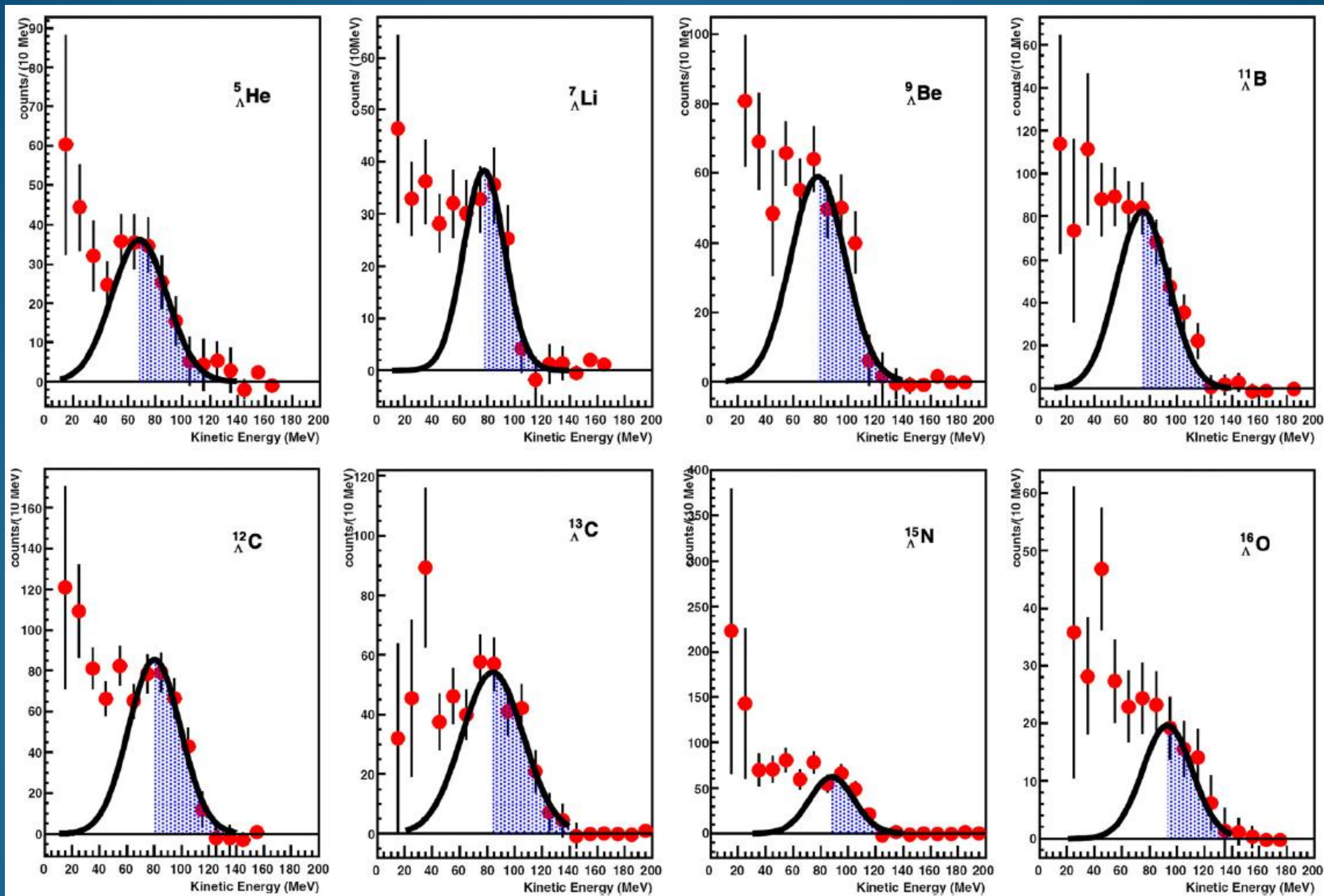
new spin-parity assignment for $^{15}_{\Lambda}$N, based on decay rate [and spectrum shape]

MWD decay rates calculated and compared with theoretical calculations and previous measurements

nuclear structure effects

NMWD: proton kinetic energy in the (5-16) A range

The line is a gaussian fit using only the shadowed zone of the spectra



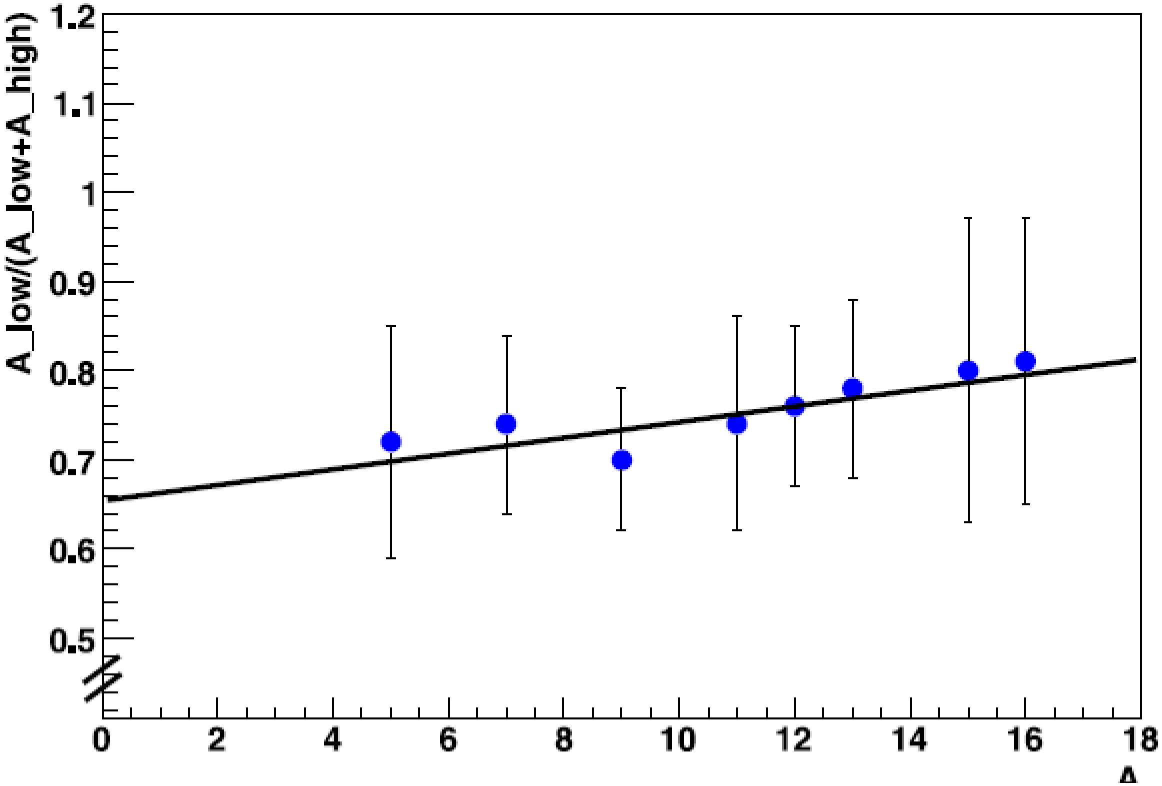
$$A_{\text{low}} = N(\Lambda p \to np)/2 + N(\Lambda np \to nnp) + N_p^{\text{FSI-low}},$$

$$A_{\text{high}} = N(\Lambda p \to np)/2 + N_p^{\text{FSI-high}},$$

$$\frac{N(\Lambda np \to nnp)}{N(\Lambda p \to np)} = \frac{\Gamma_{np}}{\Gamma_p} \simeq \frac{\Gamma_2}{\Gamma_p}.$$

NMWD: FSI & Λnp evaluation

$$R \equiv \frac{A_{\rm low}}{A_{\rm low} + A_{\rm high}} = \frac{0.5N(\Lambda p \to np) + N(\Lambda np \to nnp) + N_p^{\rm FSI\text{-}low}}{N(\Lambda p \to np) + N(\Lambda np \to nnp) + N_p^{\rm FSI\text{-}low} + N_p^{\rm FSI\text{-}high}}.$$



$$\frac{\Gamma_2}{\Gamma_p} = 0.43 \pm 0.25.$$

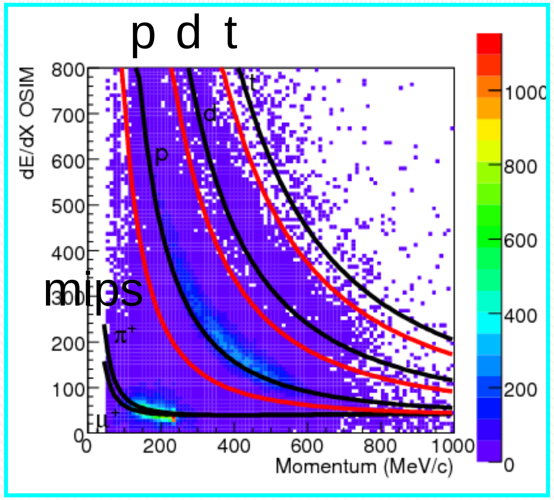
Using reasonable assumptions and known results (from data and calculations), one gets, finally:

$$\frac{\Gamma_2}{\Gamma_{\rm NMWD}} = 0.24 \pm 0.10.$$

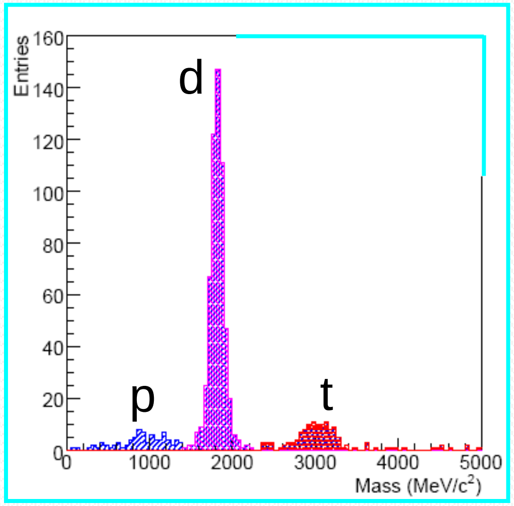
Physics Letters B 685 (2010) 247–252

Rare hypernuclei decays in FINUDA

- large angular coverage (~4π)
- Excellent particle identification for charged hadrons
- Good momentum resolution
- Capability to fully reconstruct the event topologies
  - Set of several targets allowing the production of different hypernuclei and **hypernuclear fragments**



dE/dx p.id.



TOF p.id.

- **$^4_\Lambda$He hyperfragments** production, from all targets
  - $^4_\Lambda$He → dd
    - d momentum: **570 MeV/c**
  - $^4_\Lambda$He → pt
    - p momentum: 508 MeV/c
- **$^5_\Lambda$He hypernucleus formation**
  - From ^{6}Li targets: **$K^-\ ^6Li \rightarrow\ ^5_\Lambda He + p + \pi^-$** (**$\pi^-$** momentum: 275.15 MeV/c)
  - From ^{7}Li targets: **$K^-\ ^7Li \rightarrow\ ^5_\Lambda He + d + \pi^-$**
  - NM two-body decay: $^5_\Lambda$He → dt
    - d momentum: 597 MeV/c

$^4{}_\Lambda$He hyperfragments (from all targets)

$^4{}_\Lambda He \rightarrow dd$ - d momentum: 570 MeV/c

Total probability (yield) per stopped K-
Mean value: (2.82 ± 0.62) $10^{-5}/K^-_{stop}$
For ^{6}Li targets: (5.22 ± 1.90) $10^{-5}/K^-_{stop}$

➡ based on the capture rate per K- at rest measured for $^4{}_\Lambda$He in ^{4}He (Tamura et al.)

$$\Gamma_{dd}\,(^6Li) = (0.3 \pm 0.1)\%\ \Gamma_\Lambda$$

$^4{}_\Lambda He \rightarrow pt$ - p momentum: 508 MeV/c

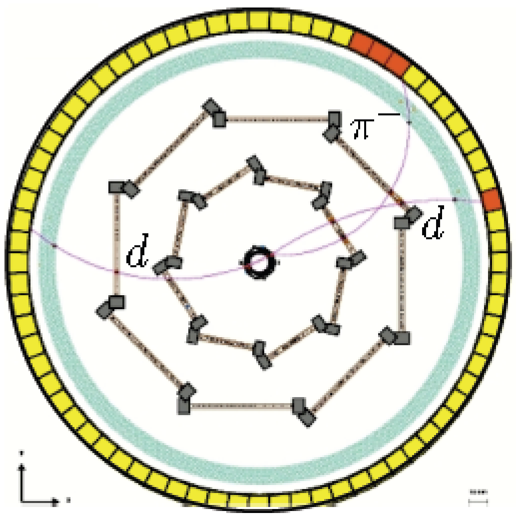
Total probability (yield) per stopped K-
Mean value: (5.42 ± 3.43) $10^{-5}/K^-_{stop}$
For ^{6}Li targets: (18.53 ± 14.80) $10^{-5}/K^-_{stop}$

➡ Under the above assumption

$$\Gamma_{pt}\,(^6Li) = (1.1 \pm 0.9)\%\ \Gamma_\Lambda$$

$^4{}_\Lambda He \rightarrow dd$ 16 complete events + 43 semi-inclusive events with a missing π^-

$^4{}_\Lambda He \rightarrow pt$ 21 events selected with (unfortunately) high S/N ratio



dd/pt ratio: the **pt decay channel is the favoured one**

$^{5}{}_{\Lambda}$He hyperfragments (from ^{6}Li and ^{7}Li targets)

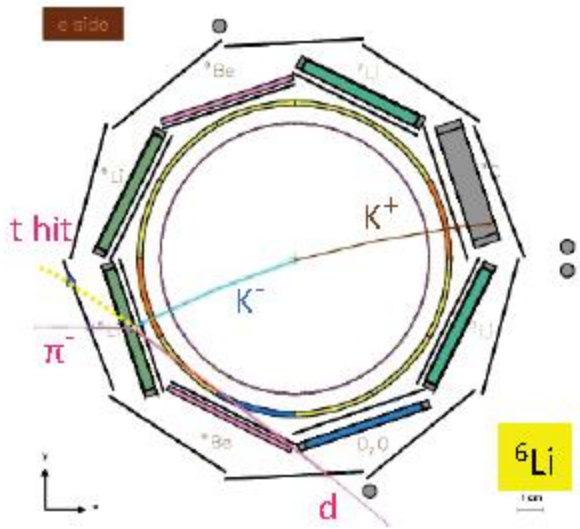
$^{5}{}_{\Lambda}He \rightarrow dt$ - d momentum: 597 MeV/c

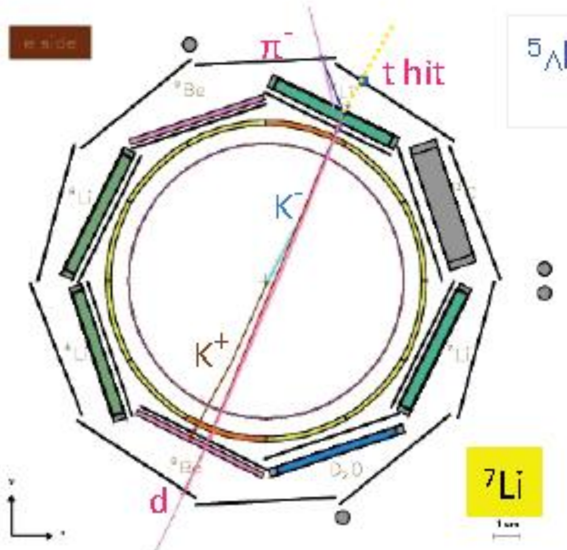
Total probability (yield) per stopped K⁻

Mean value: $(1.23 \pm 0.60)\ 10^{-5}/K^{-}_{stop}$

➥ $\Gamma_{dt} = (0.29 \pm 0.15)\%\ \Gamma_{\Lambda}$

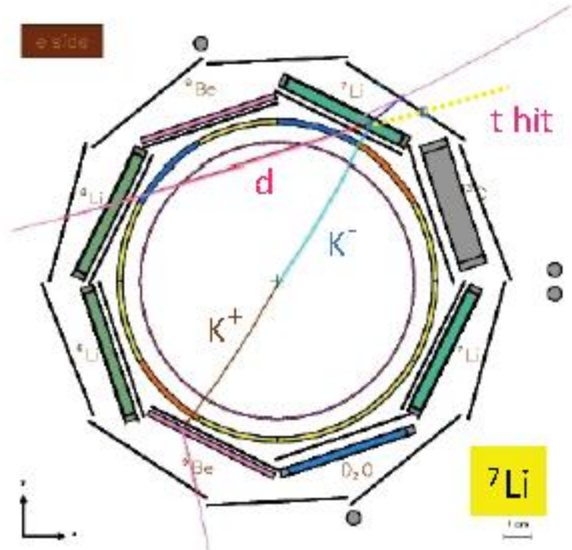
Agreement with theoretical expectations





$^{5}{}_{\Lambda}He \rightarrow dd$ 3 events

1x ^{6}Li, 2x ^{7}Li



Neutron-rich hypernuclei

FINUDA can access to two production mechanisms (inside nuclei):

1) strangeness + double charge exchange

$$K^- + p \rightarrow \Lambda + \pi^0$$

$$\rightarrow \pi^0 + p \rightarrow n + \pi^+$$

2) strangeness exchange with Λ-Σ coupling

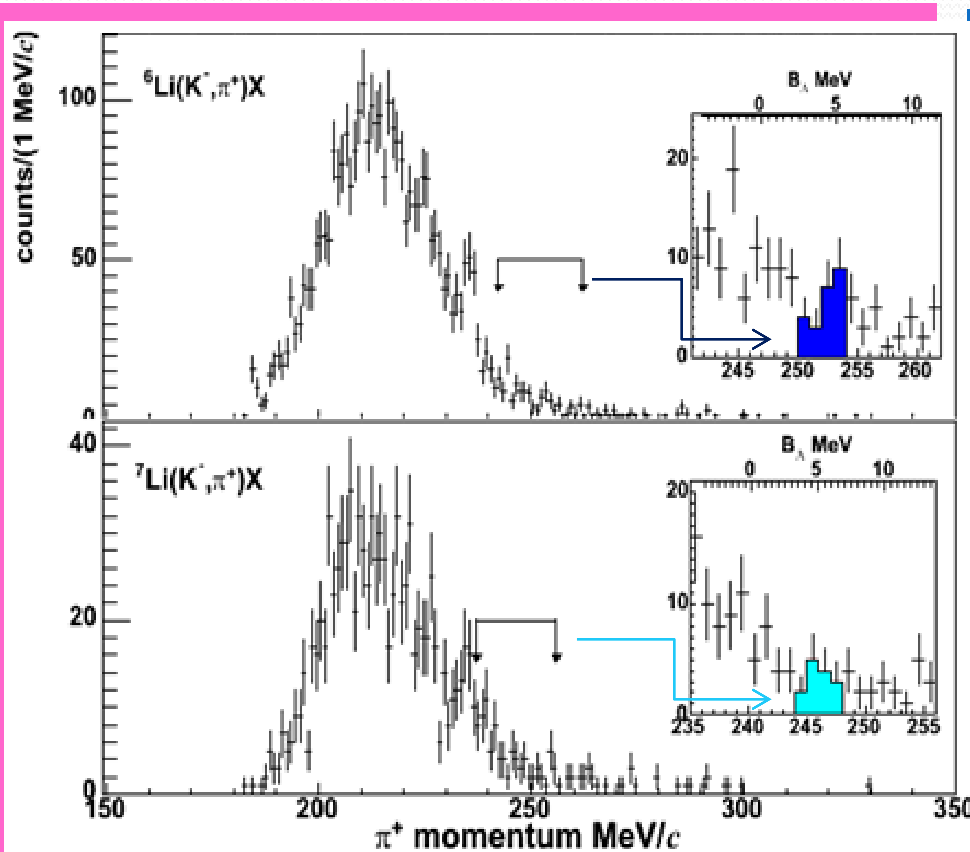
$$K^- + p \rightarrow \Sigma^- + \pi^+$$

$$\rightarrow \Sigma^- + p \rightarrow \Lambda + n$$

Two step reaction → low yield expected
Possible signature in π^+ spectrum following K^- absorption

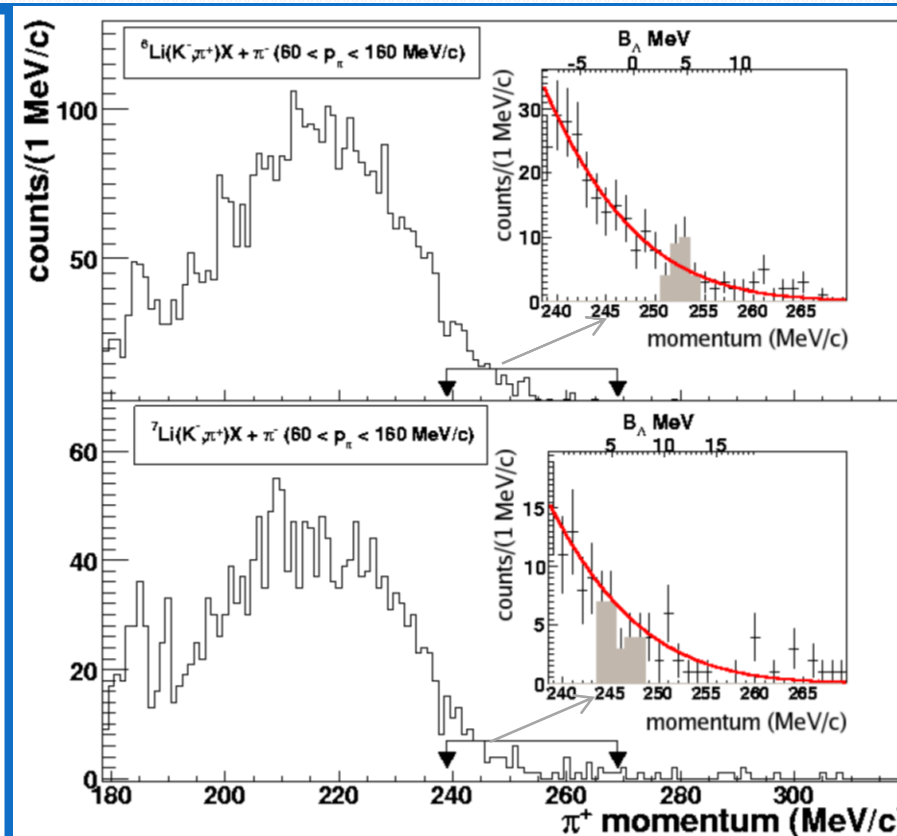
Search for neutron rich hypernuclei
$^{6}_{\Lambda}$H from ^{6}Li and $^{7}_{\Lambda}$H from ^{7}Li targets

2003-04 data taking:
π^+ ***inclusive*** spectra

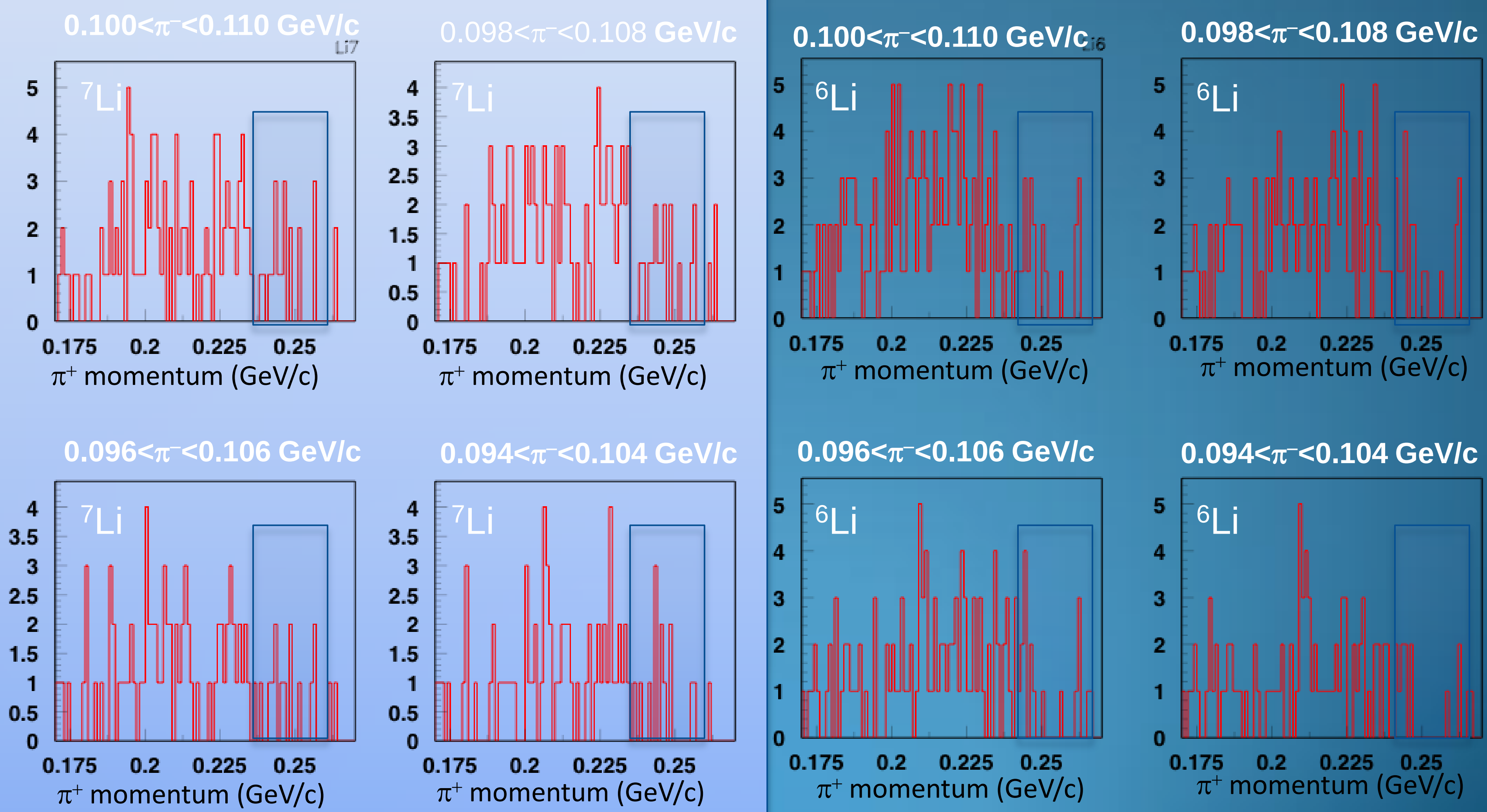


PLB 640 (2006)145

2006-07 data taking:
π^+ spectra ***in coincidence*** with π^- (decay)

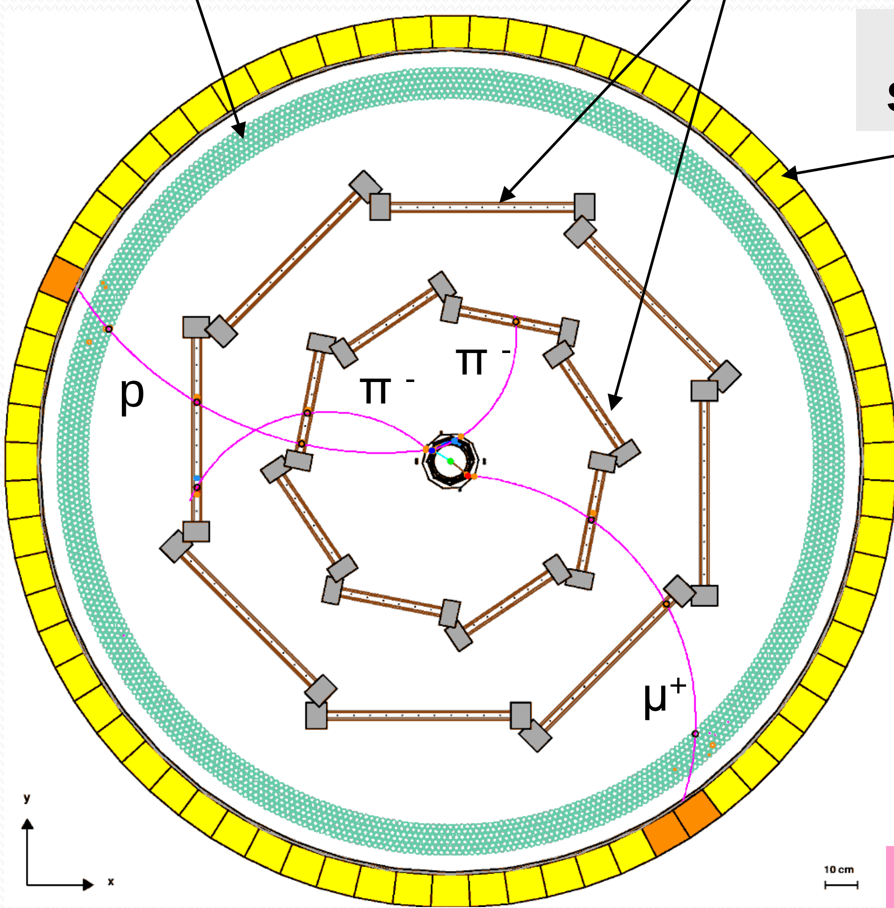


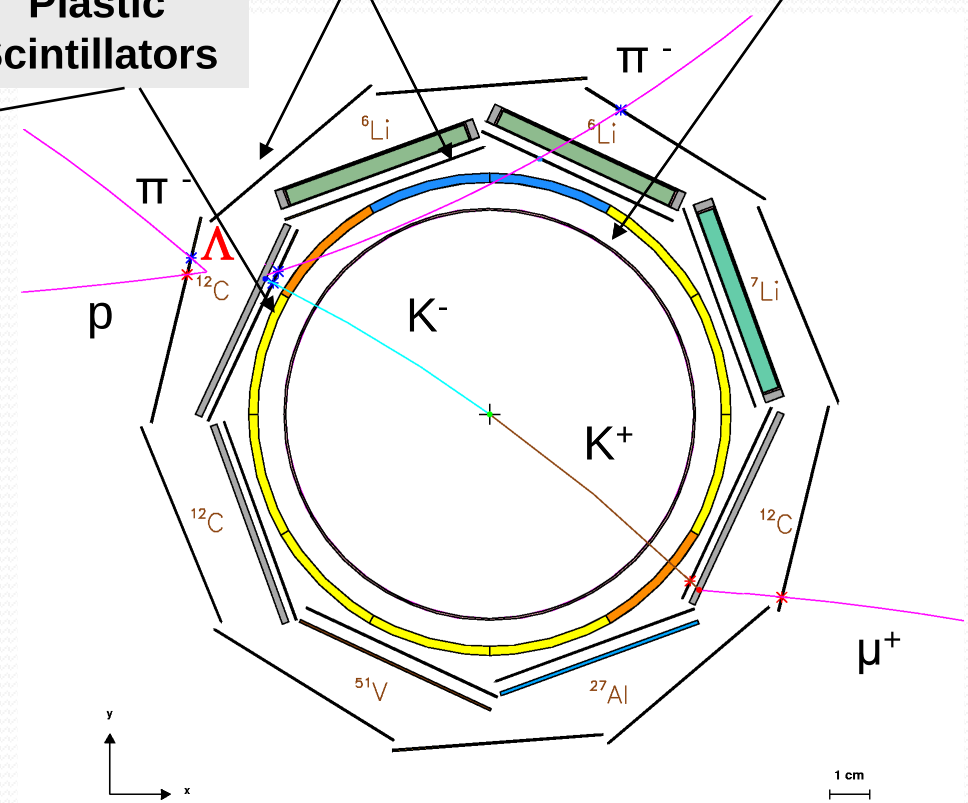
π^+ π^- coincidence, with π^- in selected momentum regions of MWD



K- absorption by few nucleons

For K⁻-Nucleus interactions Λ identification is a crucial item

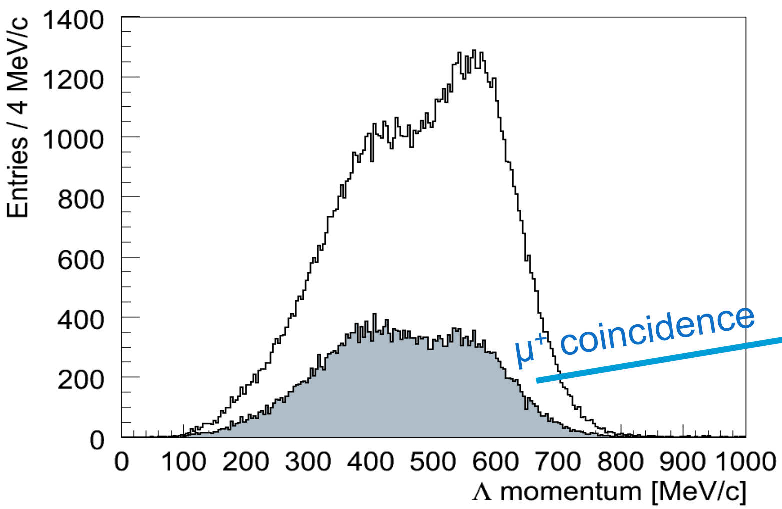


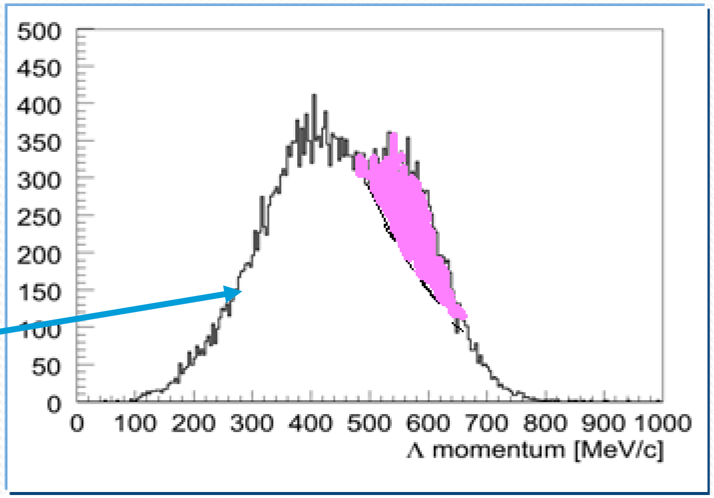


FINUDA is able to reconstruct the Λ vertex also outside the active tracking volumes

Λ Momentum: FINUDA inclusive spectra

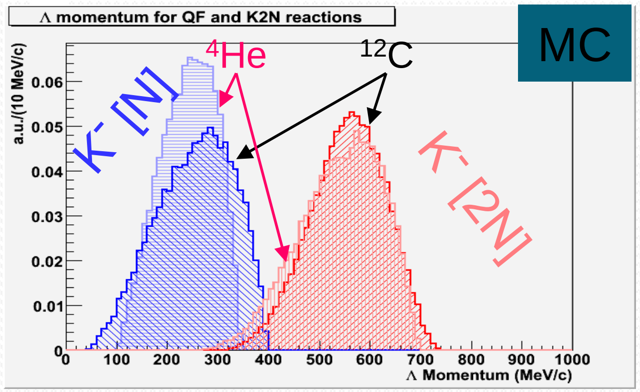
All targets, all tracks (short+long) 2006-07 data



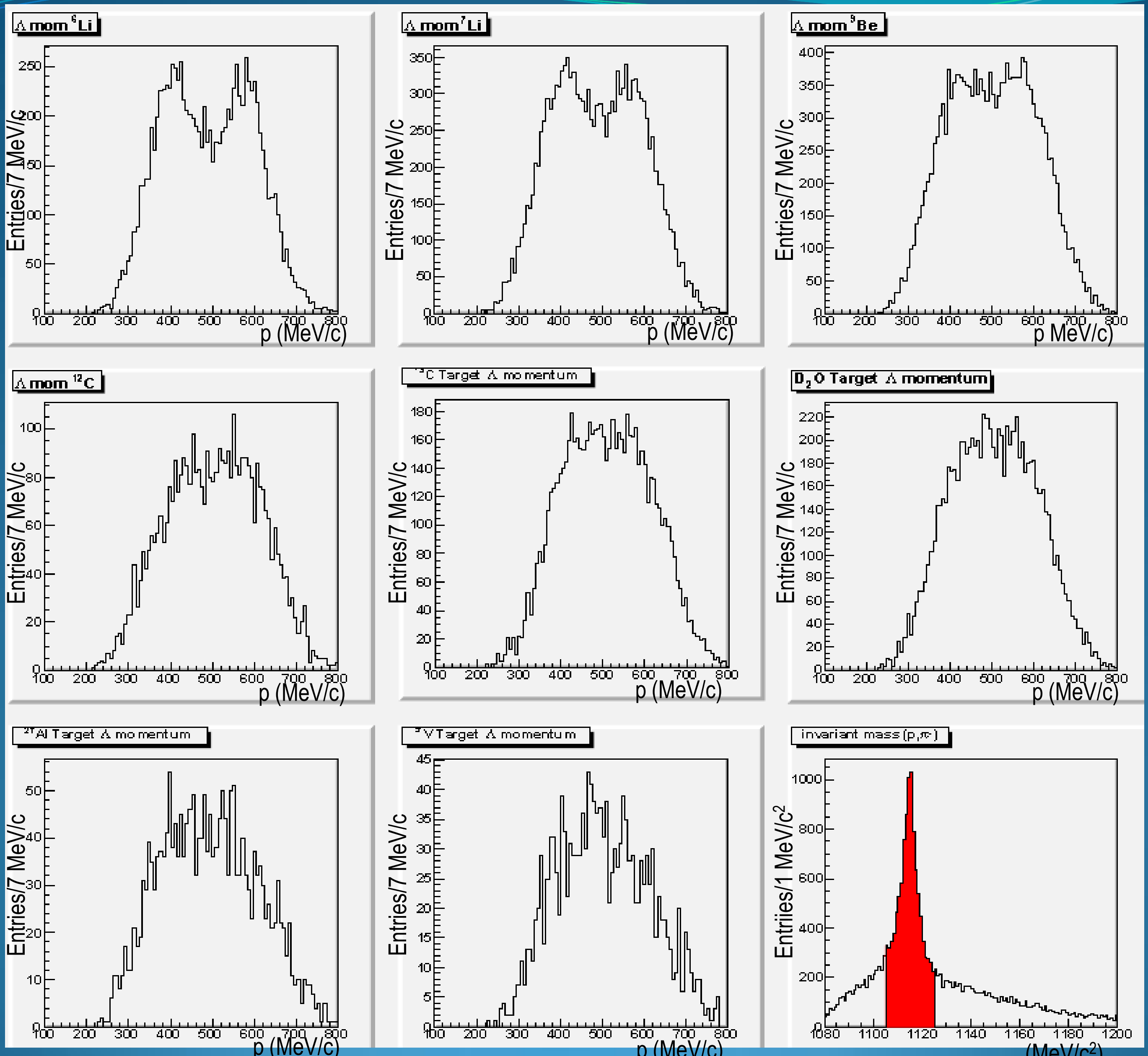


- The requirement of a μ^+ in coincidence eliminates possible distortions due to the applied trigger

The ***two component*** structure remains



Λ Momentum inclusive spectra vs A

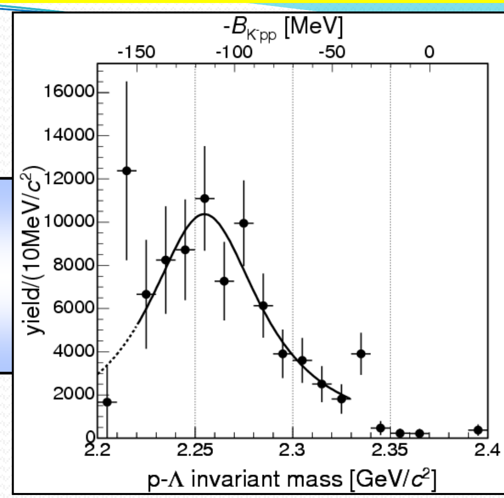


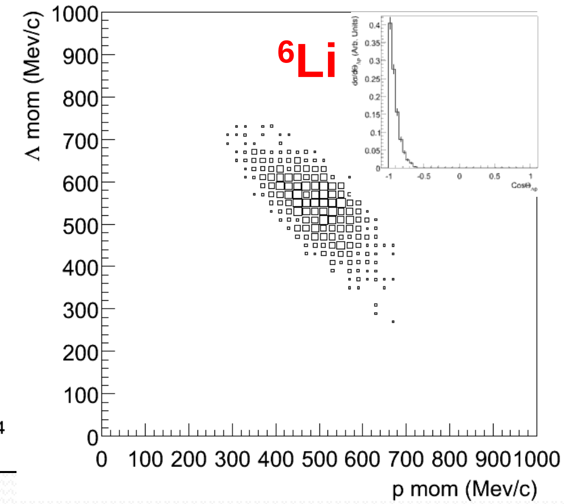
Λ "high momentum" component related to the most interesting findings

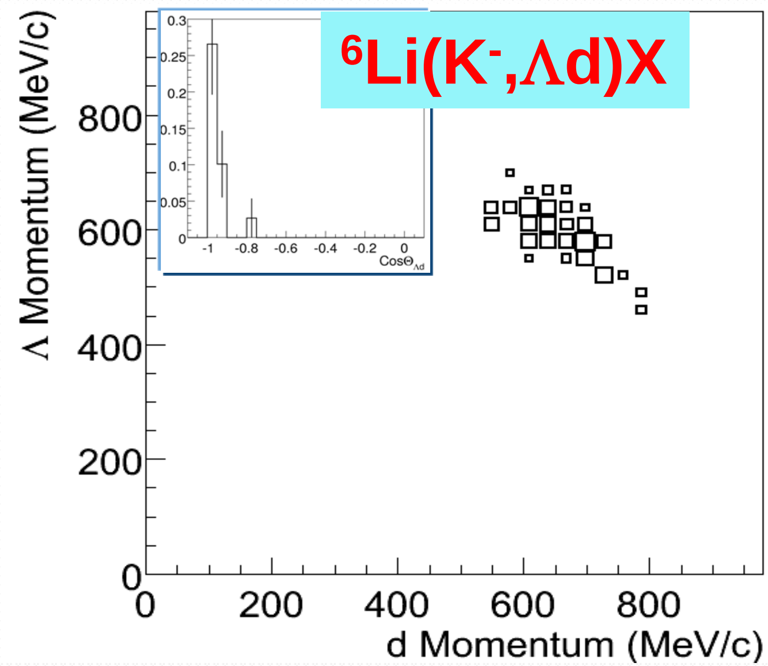
A(K⁻,Λp)X

B = 115$^{+6}_{-5}$ (stat)$^{+3}_{-4}$ (sys) MeV
Γ= 67$^{+14}_{-11}$(stat)$^{+2}_{-3}$ (sys) MeV
Yield ≈ 0.1%/stopped K⁻

FINUDA Coll., PRL 94(2005)212303

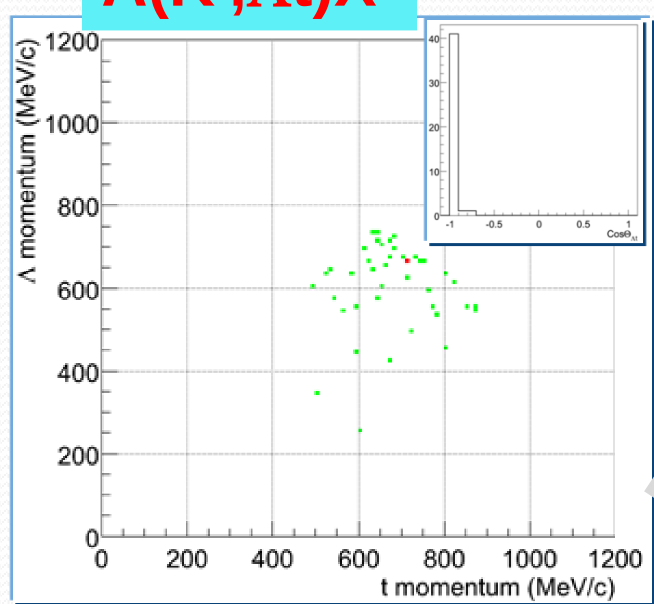






FINUDA Coll., PLB 654(2007)80

A(K⁻,Λt)X



FINUDA Coll., PLB 669(2008)229

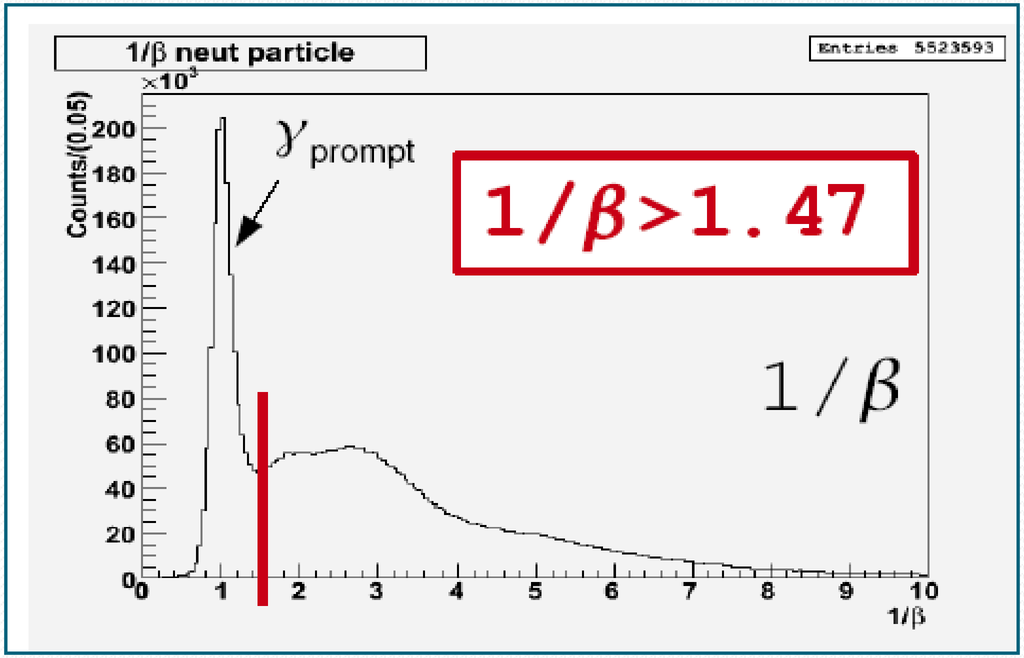
S. Piano talk, this Conference

Neutrons identification in FINUDA

The Tofone thick slabs provide a 8% neutron detection efficiency

TOF allows n/γ signal discrimination with the requirement of

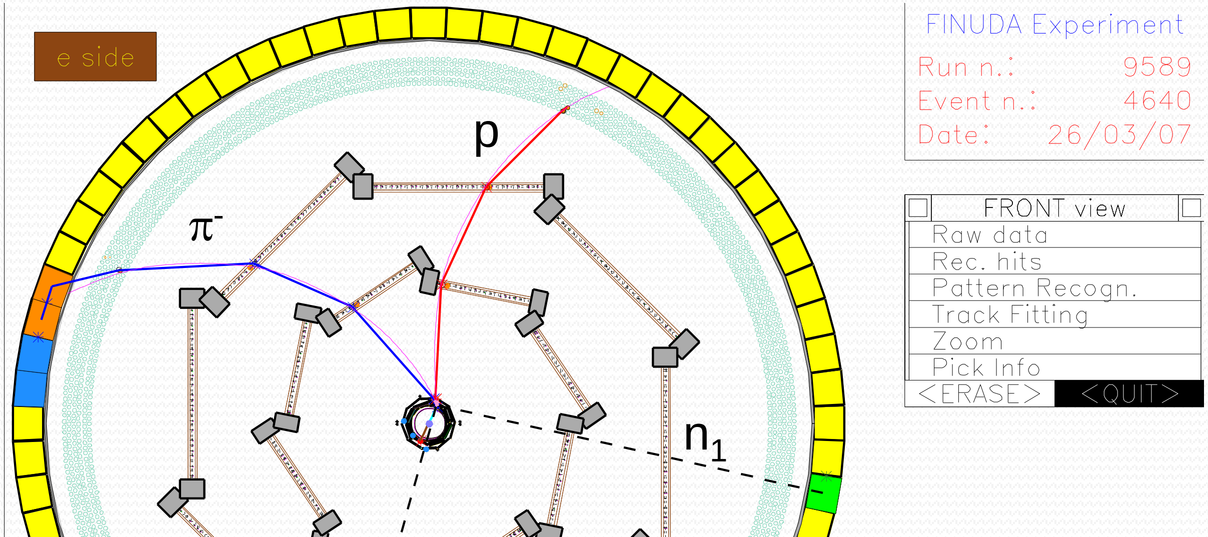
no hits in the tracking detectors facing the fired tofone slab

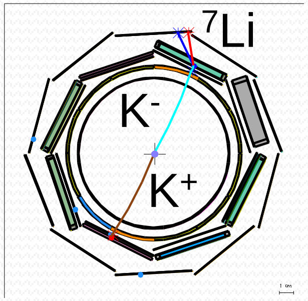


But background prevails, unless physical correlations or selection are imposed

Example of neutrons identification in FINUDA: Λnp NMWD ?

1^{st} event: pnn in coincidence with a prompt π from hypernucleus level formation





$\theta(n_1p) = 102.16°$

$\theta(n_2p) = 164.32°$

$E(n_1) = 16.94$ MeV

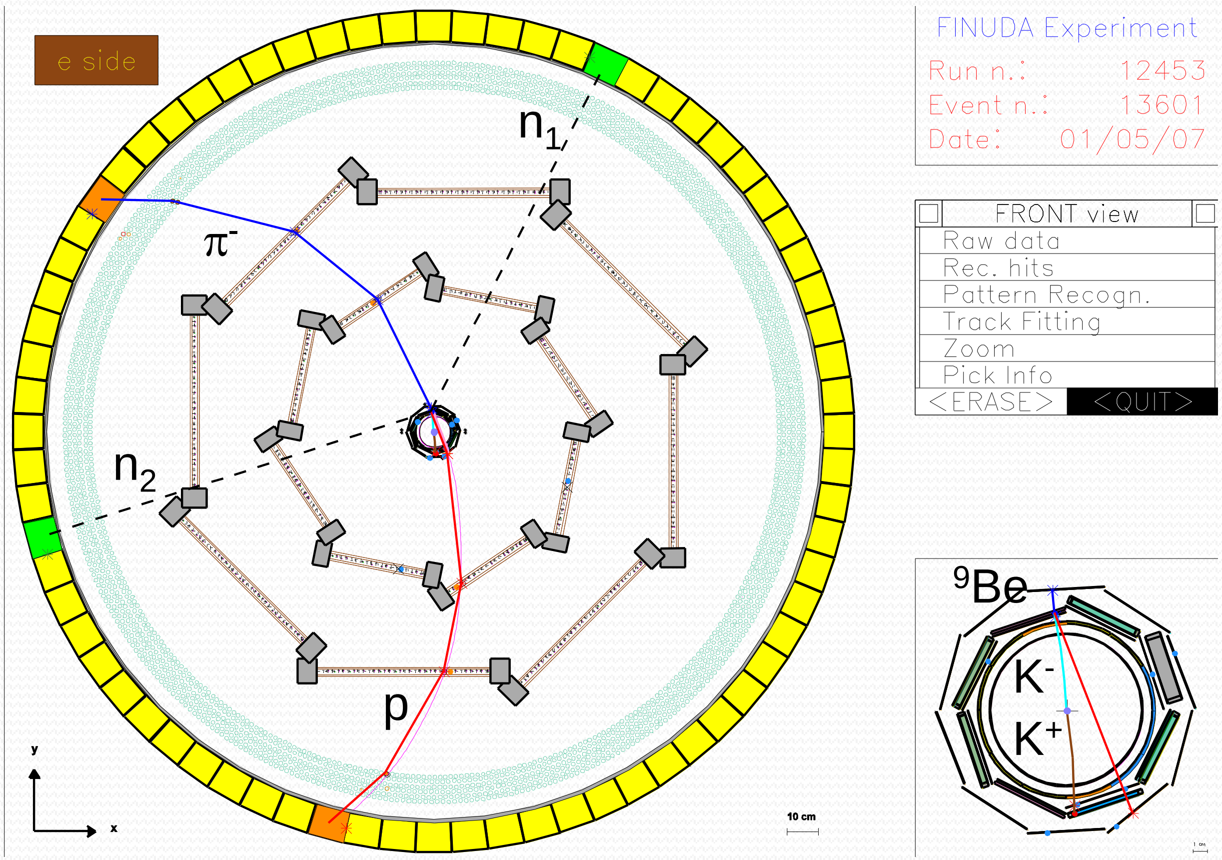
$E(n_2) = 109.70$ MeV

$E(p) = 51.04$ MeV

$E_{tot} = 177.68$ MeV

Missing mom.=216.13MeV/c

2^{nd} event: pnn in coincidence with a prompt π from hypernucleus level formation



$\theta\ (n_1p)$= 128.46 °

$\theta\ (n_2p)$= 95.39°

$E(n_1)$= 20.17 MeV

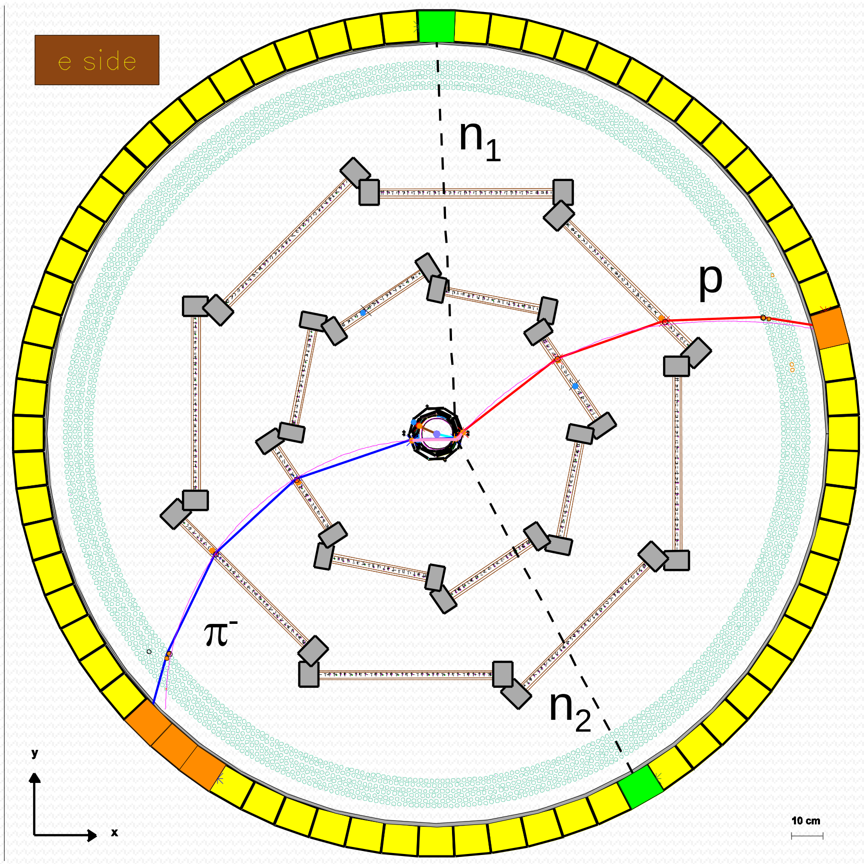
$E(n_2)$=31.52 MeV

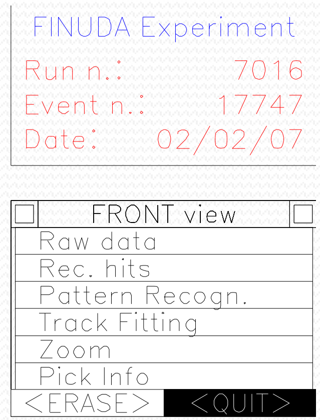
E(p)=71.77 MeV

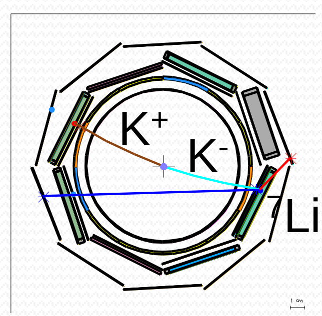
Etot= 123.46 MeV

Missing mom.=252.47 MeV/c

3rd event: pnn in coincidence with a prompt π from hypernucleus level formation







$\theta\ (n_1p) = 128.46\ °$

$\theta\ (n_2p) = 95.39°$

$E(n_1) = 20.17$ MeV

$E(n_2) = 31.52$ MeV

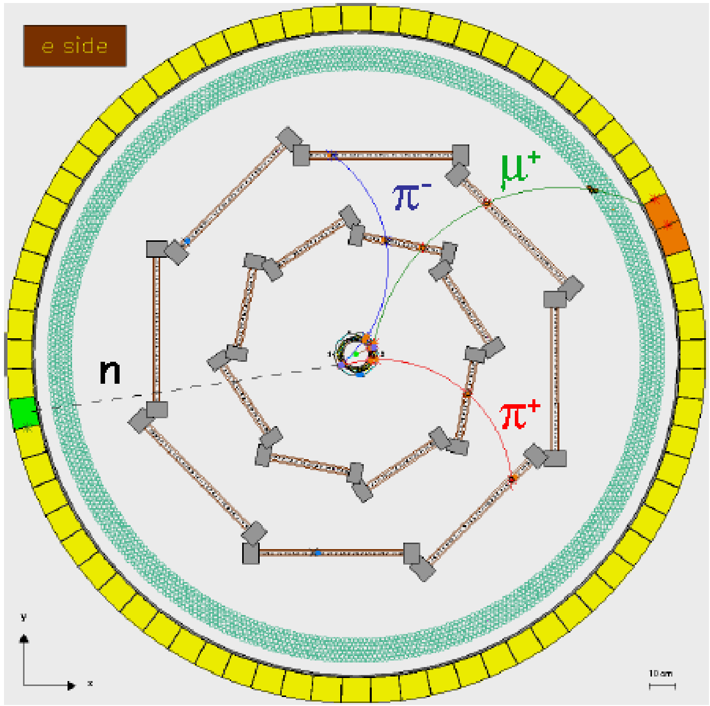
$E(p) = 71.77$ MeV

Etot= 123.46 MeV

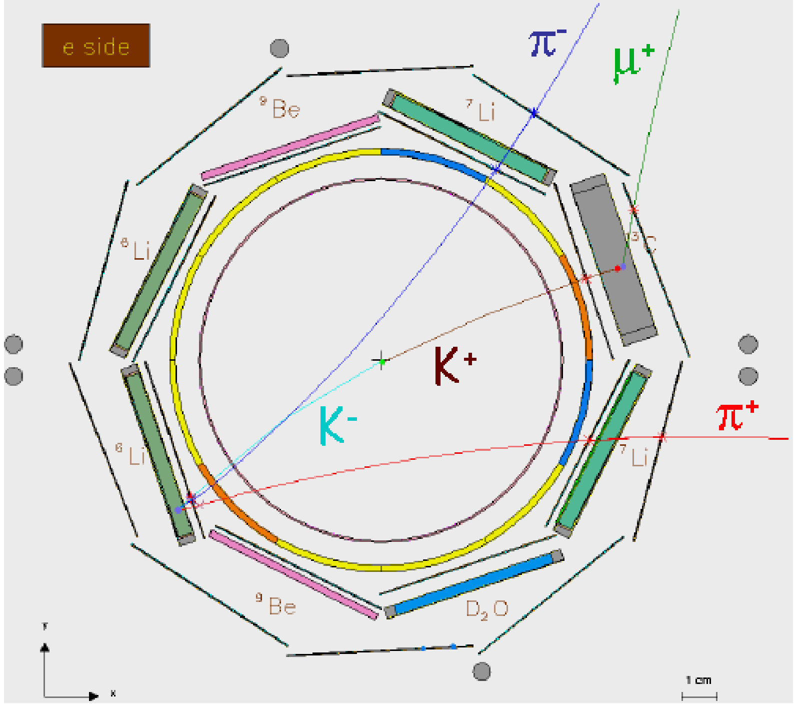
Missing mom.=252.47 MeV/c

Topology of a $n\pi^+\pi^-$ event

FINUDA spectrometer



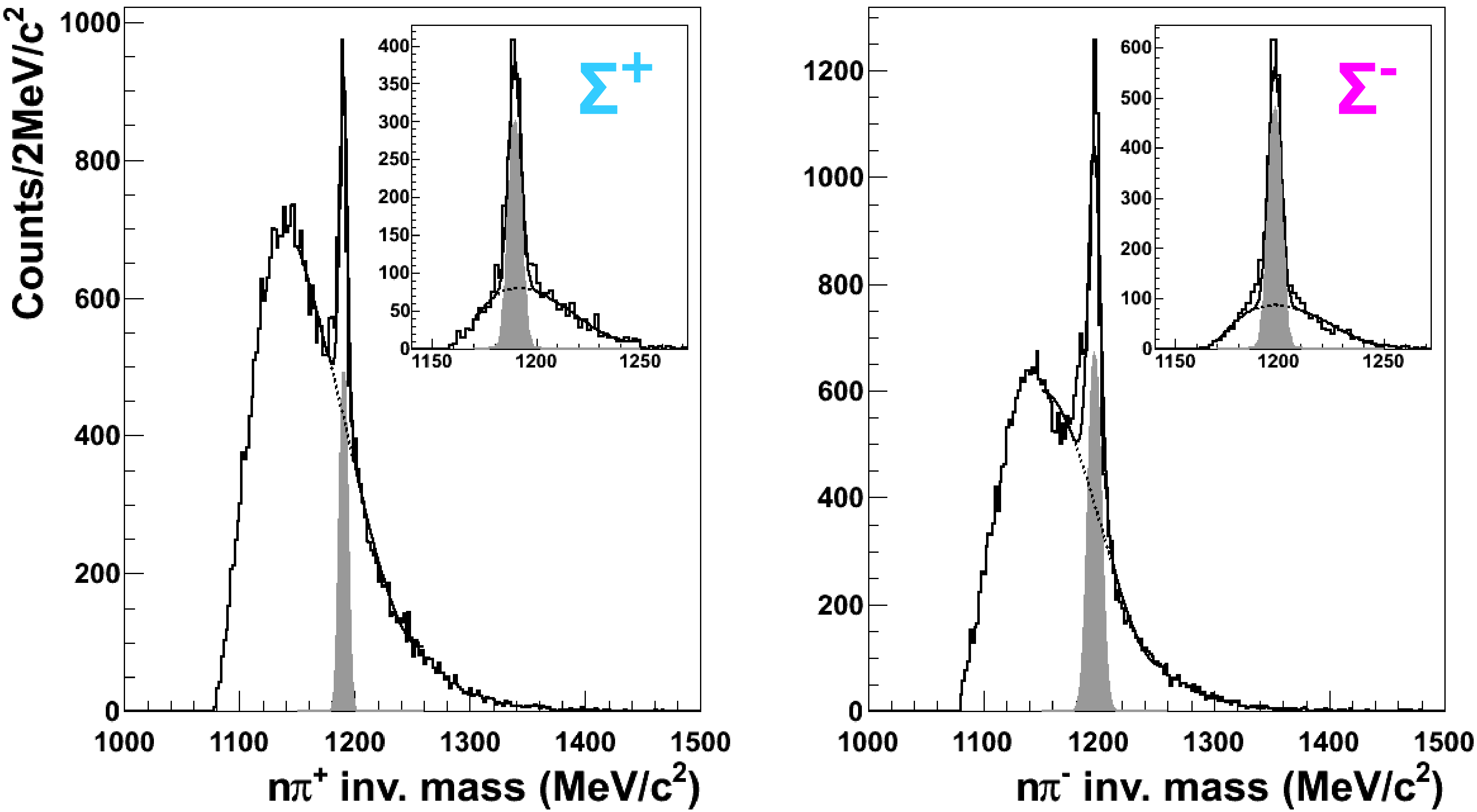
Central region



$$\mu^+ \nu \leftarrow K^+ \longleftarrow \Phi \rightarrow K^- A \rightarrow \pi^- \ \pi^+ n \ A'$$

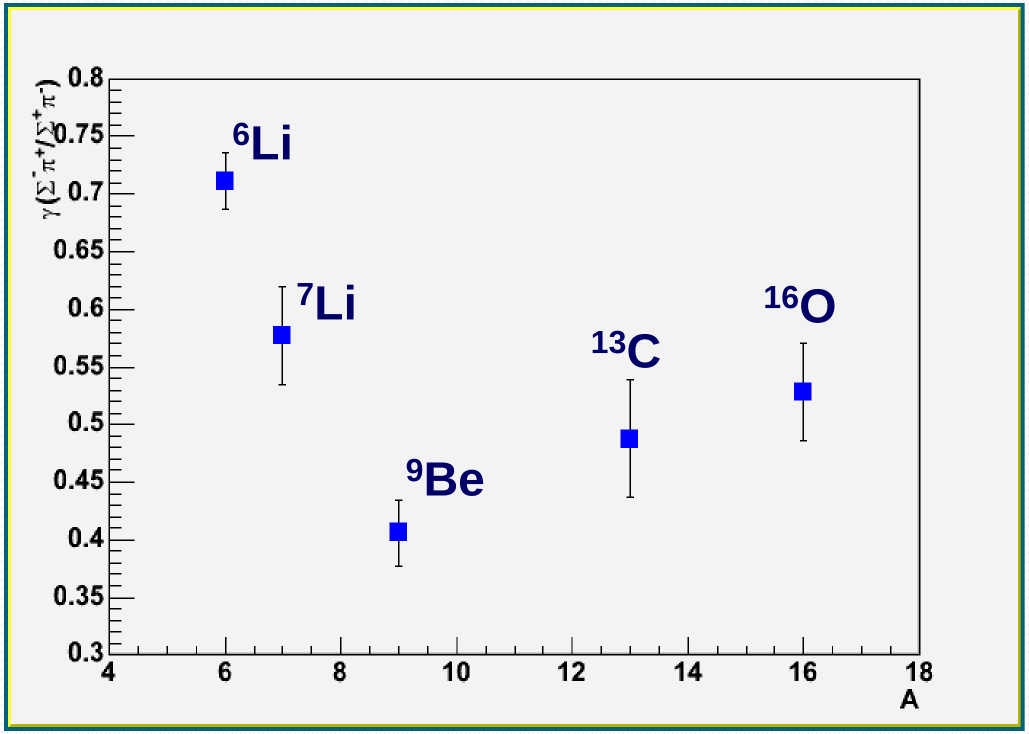
$$\Sigma^- \qquad \Sigma^+$$

Σ^- and Σ^+ identification in $K^-\,^6Li \Rightarrow (n\pi^+\pi^-)X$ events



The insets are after applying selection cuts (angular and momentum correlations, track quality, missing mass …)

$(\Sigma^-\pi^+)$ vs $(\Sigma^+\pi^-)$ QF production strength

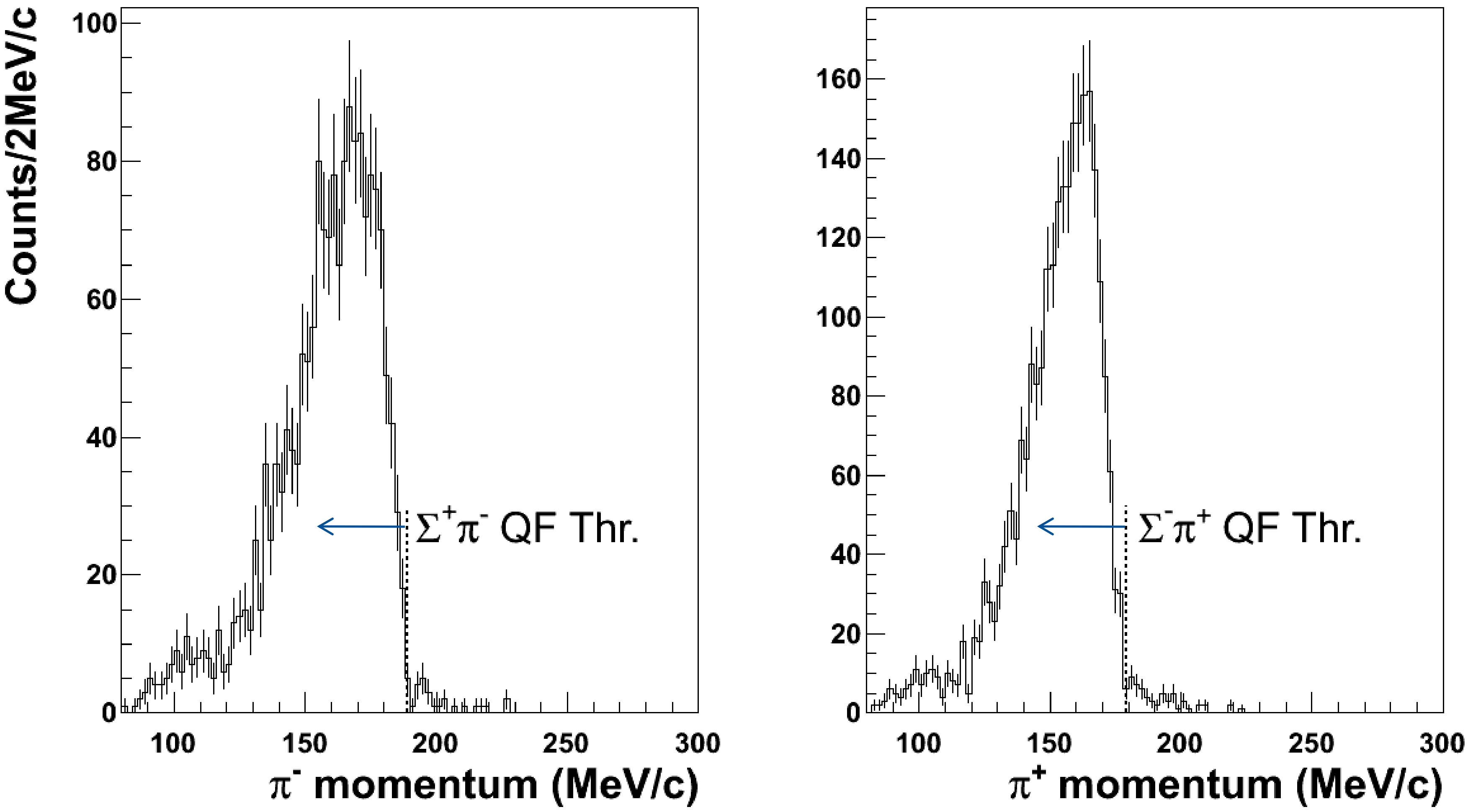


$$\gamma = \frac{\Gamma(K^- p \to \Sigma^- \pi^+)}{\Gamma(K^- p \to \Sigma^+ \pi^-)}$$

- Acceptances of the two channels factorize away (same $n\pi^+\pi^-$ sample)
- Dominance of $\Sigma^+\pi^-$ QF production channel over $\Sigma^-\pi^+$ on all targets
  - Expected value for K^-p at threshold (integrated on all decay channels):

    $\gamma = (2.36 \pm 0.04)$
  - Sizeable in-medium interactions: $\Sigma^-p \to \Lambda n$
  - The Σ^+ "feels" less the nuclear medium (decay at rest)
  - Larger in-medium interaction (conversion reactions) of Σ^- in heavier nuclei

Charged pion momentum from K^- $^6Li \Rightarrow (n\pi^+\pi^-)X$ events after $\Sigma^{+/-}$ selection



FINUDA the time evolution

1993 FINUDA experiment proposal (preprint LNF-93/021, 11 May 1993)

……………………………………………………………………………………

2003-04 FINUDA 1st data taking (200 pb^{-1} integrated luminosity)

2006-07 FINUDA 2nd data taking (968 pb^{-1} integrated luminosity)

2008 FINUDA 3rd data taking proposed in 2009 (for 1 fb^{-1} integr. lum.)

The proposed 3rd data taking could not find room in the LNF planning:

"… The FINUDA collaboration was placed in stand-by, until the uncertainties on the roll-in of KLOE (entailing the switch of the IR) could be removed. It now appears clear that the roll-in of KLOE in late 2009 will take place, which suppresses the time window that FINUDA could have used. …" ***37th MEETING OF THE LNF SCIENTIFIC COMMITTEE*** *(December 1 - 2, 2008)*

As a consequence, at beginning of 2009, decision was taken to de-commission the experiment

CONCLUSIONS

The FINUDA original proposal was put forward in1993 –Prepr. LNF-93/(021), 11 May 1993-, but it could have its first data taking starting only in fall 2003. The second, and last one, started in fall 2006. FINUDA had a total integrated luminosity of just 1.2 fb^{-1}, the lowest allocated to any of the different lines of reasearch on DAΦNE.
In spite of this unfavourable conditions, it can now be said that:

The FINUDA main task (the simultaneus study of spectroscopy and decay of hypernuclei in a broad range of A) can be considered achieved, with the ability of the apparatus to measure also MWD and rare decays into d-d and p-t of light hypernuclei, not foreseen in the proposal. Some other items, as the search of neutron rich hypenuclei, and the decay of hypernuclei into channels with two neutrons, have instead been strongly hampered by the low statistics that FINUDA could collect.

FINUDA turned out able, however, also to reconstruct secondary verteces and short tracks of light ions . This opened the possibility to study the interactions of stopped K^- on multi-nucleons aggregates inside nuclei, that, in its turn, allowed to discover the emission of correlated (in momentum and angle) high momentum Λp, Λd and Λt pairs. Such findings have generated worldwide interest since a possible explanation could be the formations of the controversial so called “deeply bound kaonic nuclear states”. Moreover, also $\Sigma^{+/-}$ production could be studied.

Regrettably, FINUDA had not another chance to deepen its original, fashinating findinds. Anyway, it can be said that, in many respects, it “**showed the path**”, as a shining comet crossing the deep blue sky of kaon-nucleus interactions.