A Search for Deeply Bound Kaonic Nuclear State

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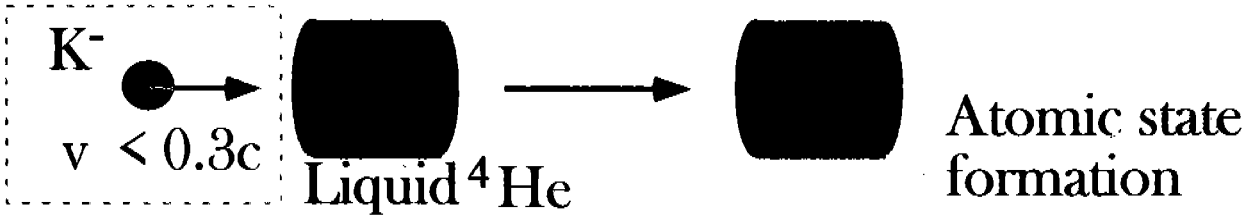
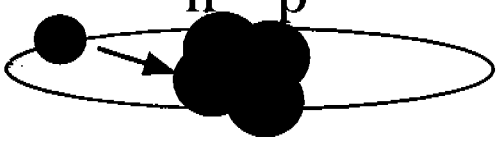
Takatoshi Suzuki and E471 collaboration

*Experimental principle and set up
*Neutron momentum spectra and their interpretation
*Conclusion and future plan

Deeply-bound kaonic nuclear state
--- Formation and decay



Kaonic helium

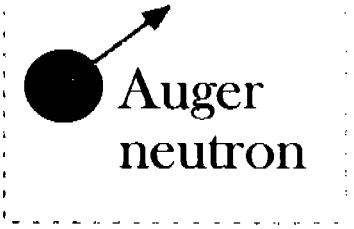


Hyperon Production
$KN \rightarrow Y\pi$

2-Nucleon absorption
$KNN \rightarrow \Sigma N$
$KNN \rightarrow \Lambda N$
etc

Nuclear reaction

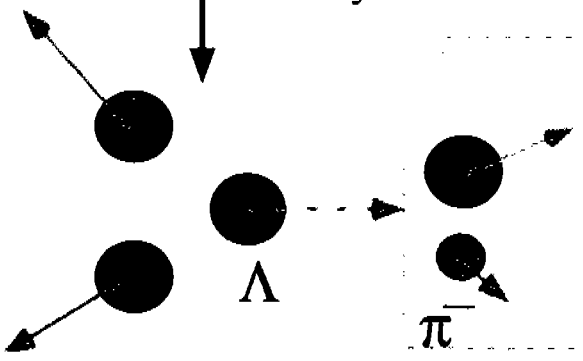
B~2%?
Nuclear Auger effect



β_{rr}~ 0.36? 0.47?
It appears as a monochromatic peak structure, on neutron momentum spectra, if exists

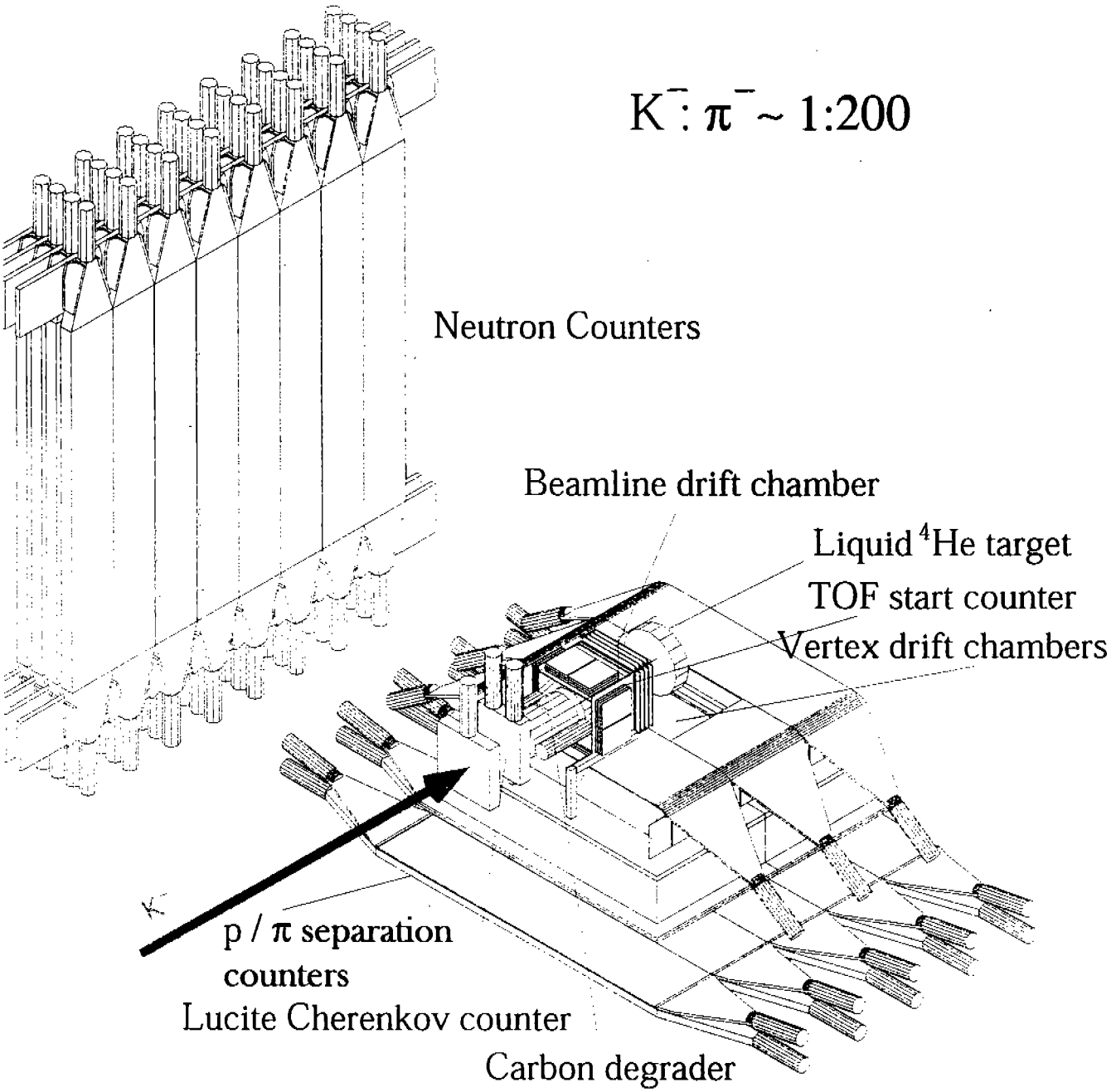
Mesic(Γ~20MeV?)
or
non-mesic(Γ~12MeV?)
decay

$\Lambda\pi NN$
~~$\Sigma\pi NN$~~
~~$\Lambda\pi d$~~
ΣNN
Λnp
Λd



E471 experimental setup

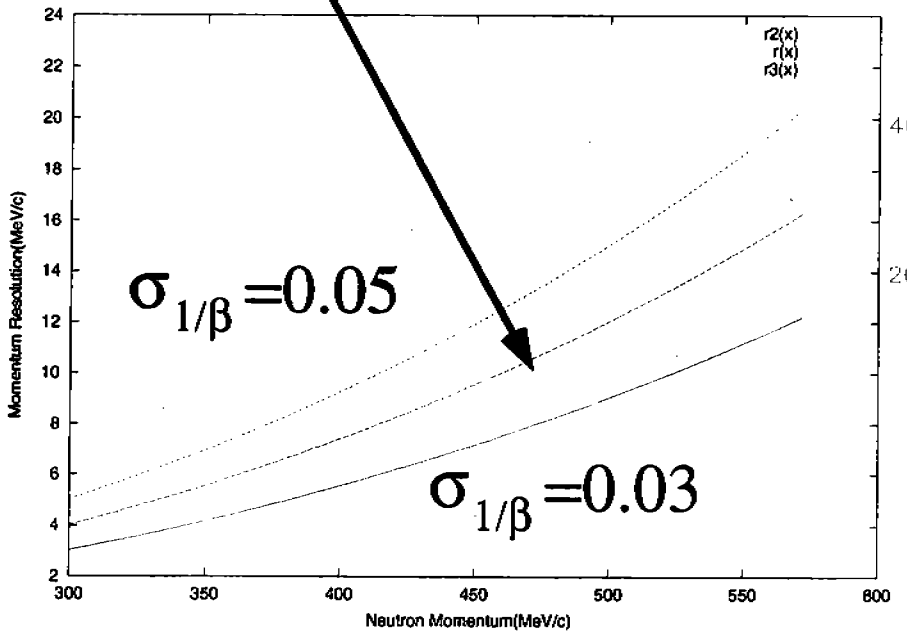
K^- : π^- ~ 1:200

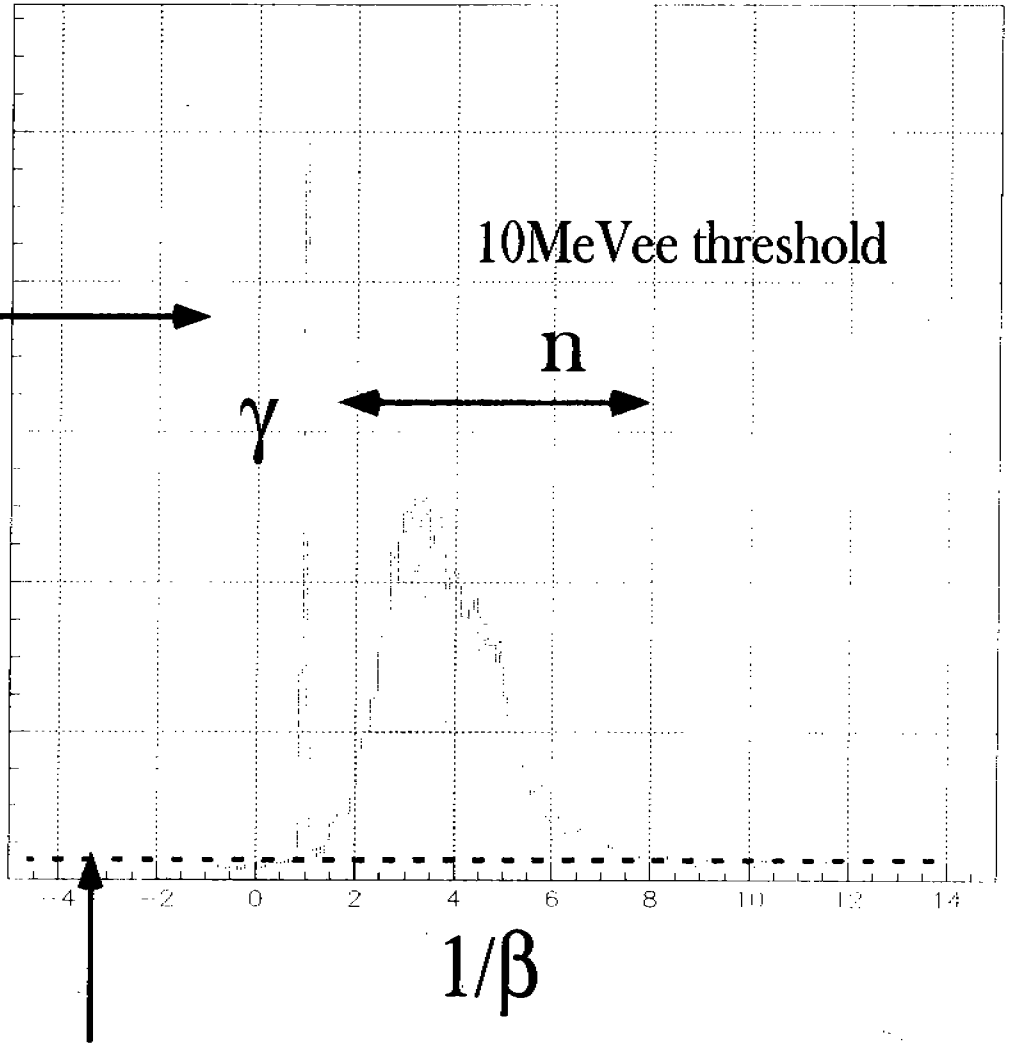


Neutron TOF and momentum resolution

σ_p : 7MeV/c (400MeV/c)
~11MeV/c(500MeV/c)

$\sigma_{1/\beta} \sim 0.04$

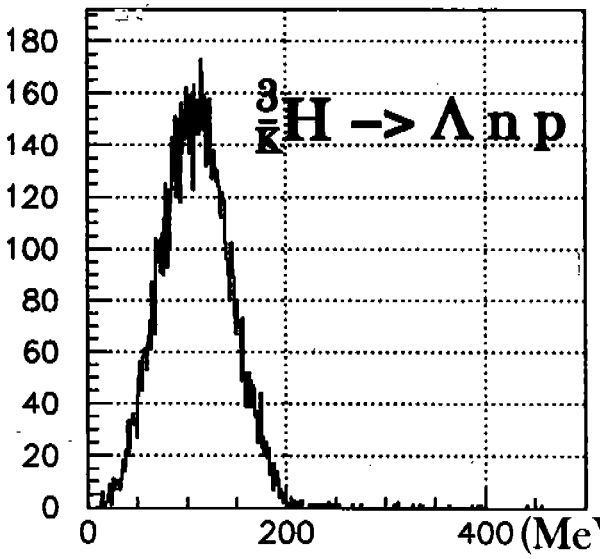


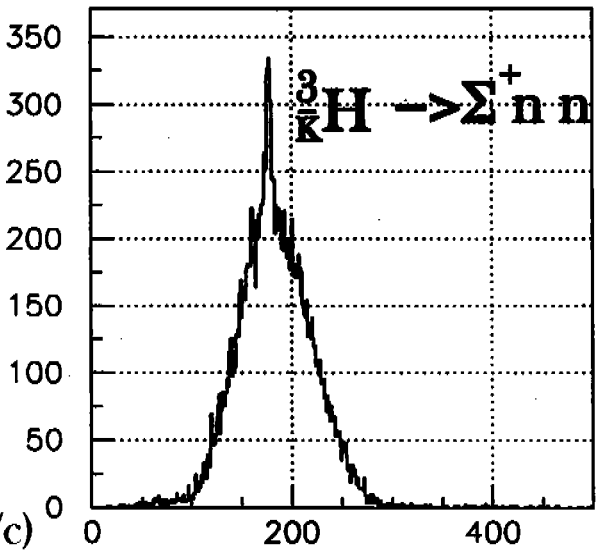


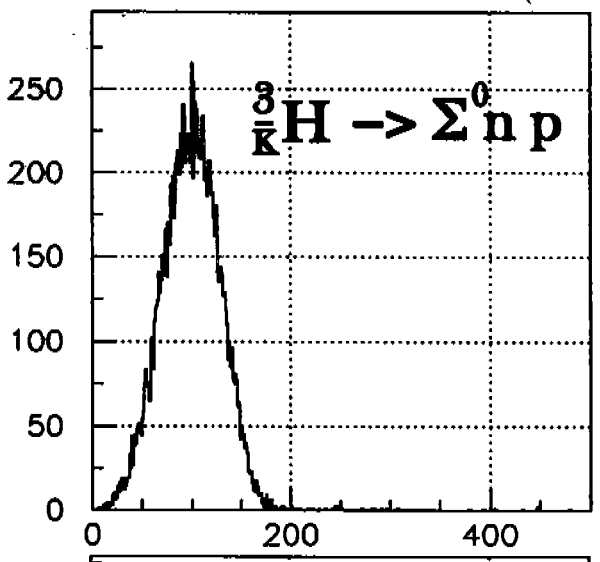
constant background
by accidental coincidence

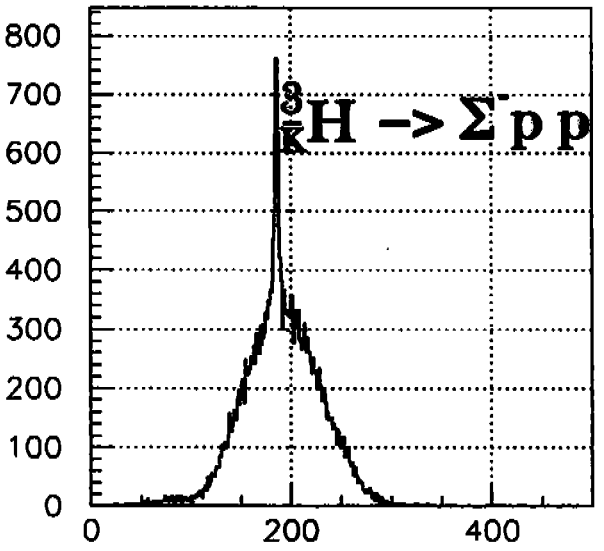
Simulated π – momentum spectra for each non-mesic decay channels

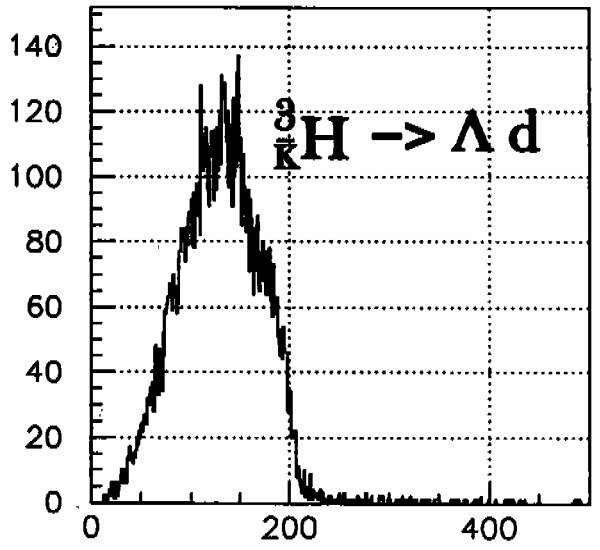
165MeV B.E. is assumed







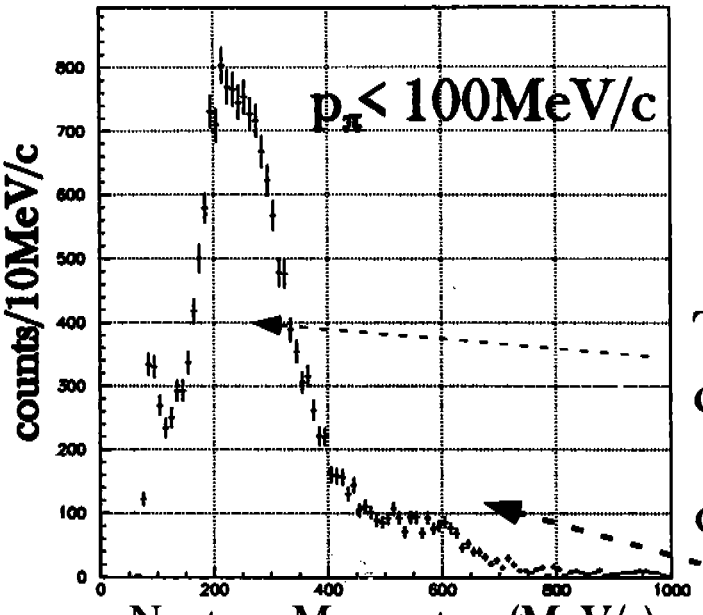




No pions ~~over~~ below 100MeV/c in the final state of the Σ^{+}NN decay branches

Σ N N are main decay branch?

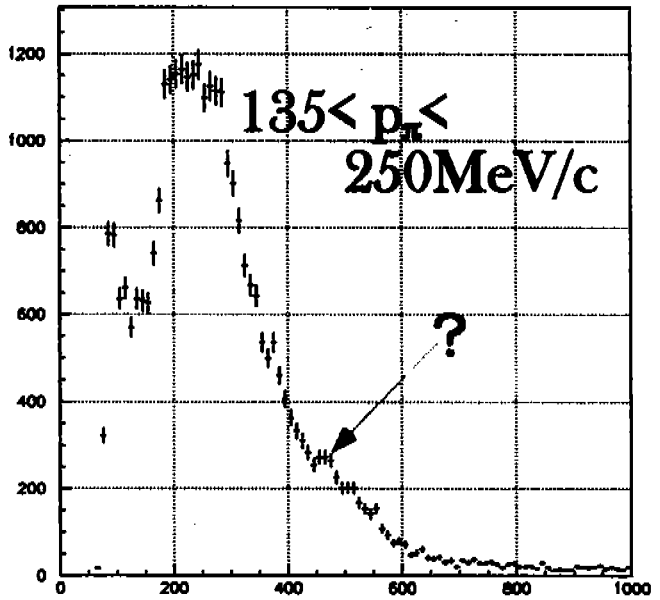
Neutron momentum spectra

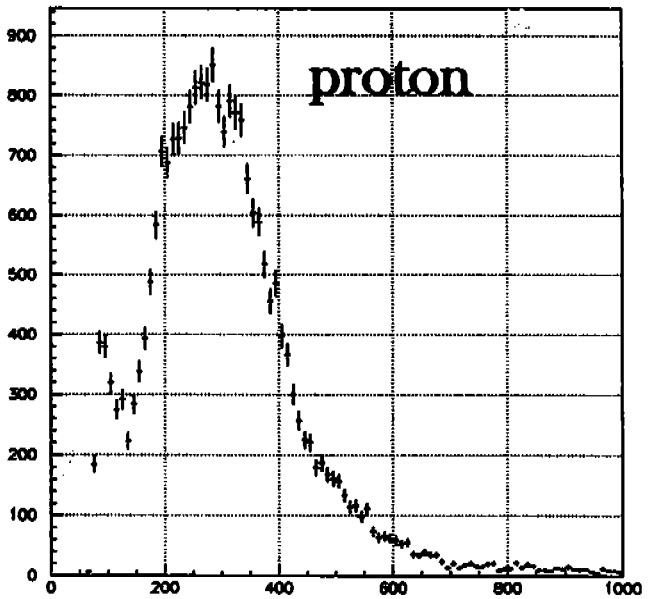


Selection of secondary charged particle changes spectrum shape....

The largest structure consists of
$\bar{\pi}$ "ΝN"->NN
or QF hyperon producion

Second slope consists of
$\bar{K}$ "NN" -> YN



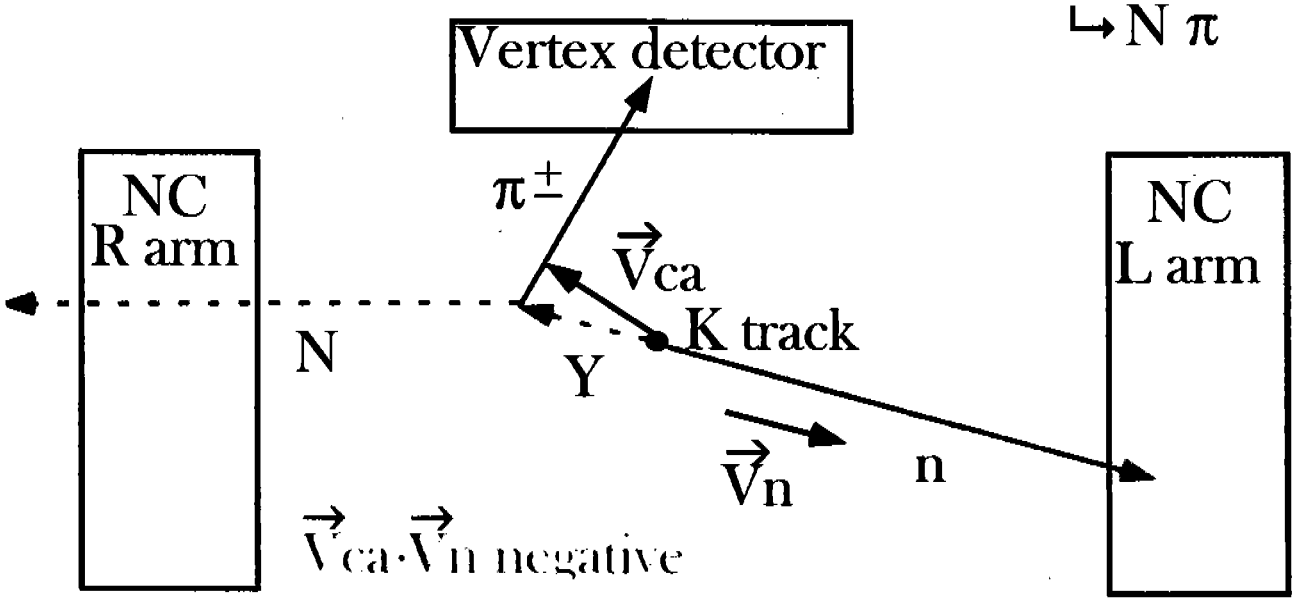


"Signals" are in second spectrum?

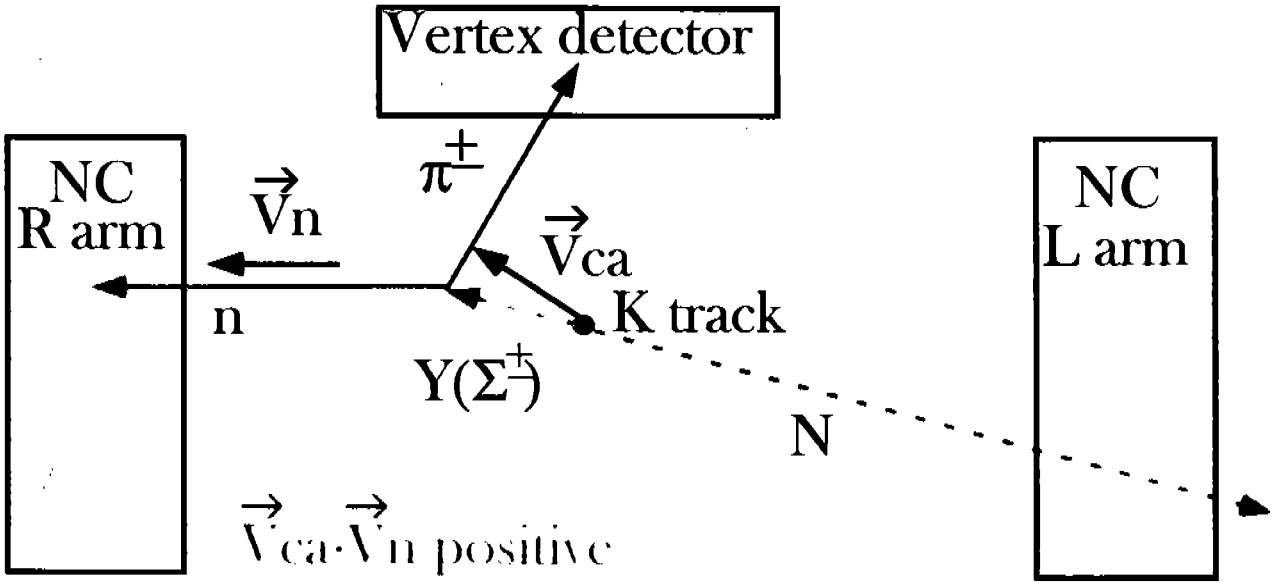
$\vec{V}ca \cdot \vec{V}n$ and reaction topology

Now, we define $\vec{V}n$ as the unit vector along detected neutron motion...

K^-"NN" → Y N or $K + {}^4He \rightarrow {}^3_{\bar{K}}H + n$
↳ N π ↳ YNN
↳ N π

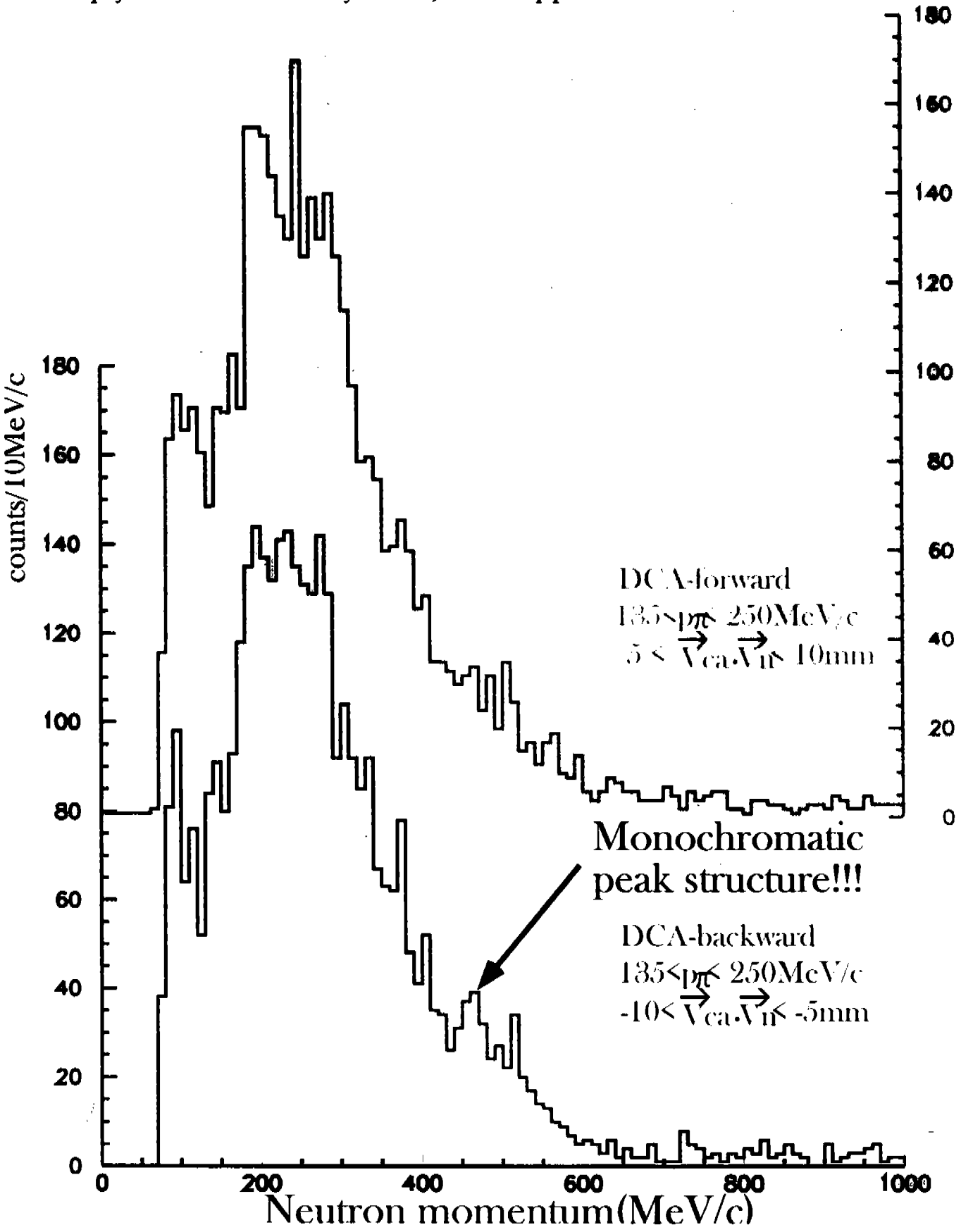


K^-"NN" → Y N
↳ N π



Comparison between "forward" and "backward"

If deeply bound state really exists, it will appear in "backward" event set.....

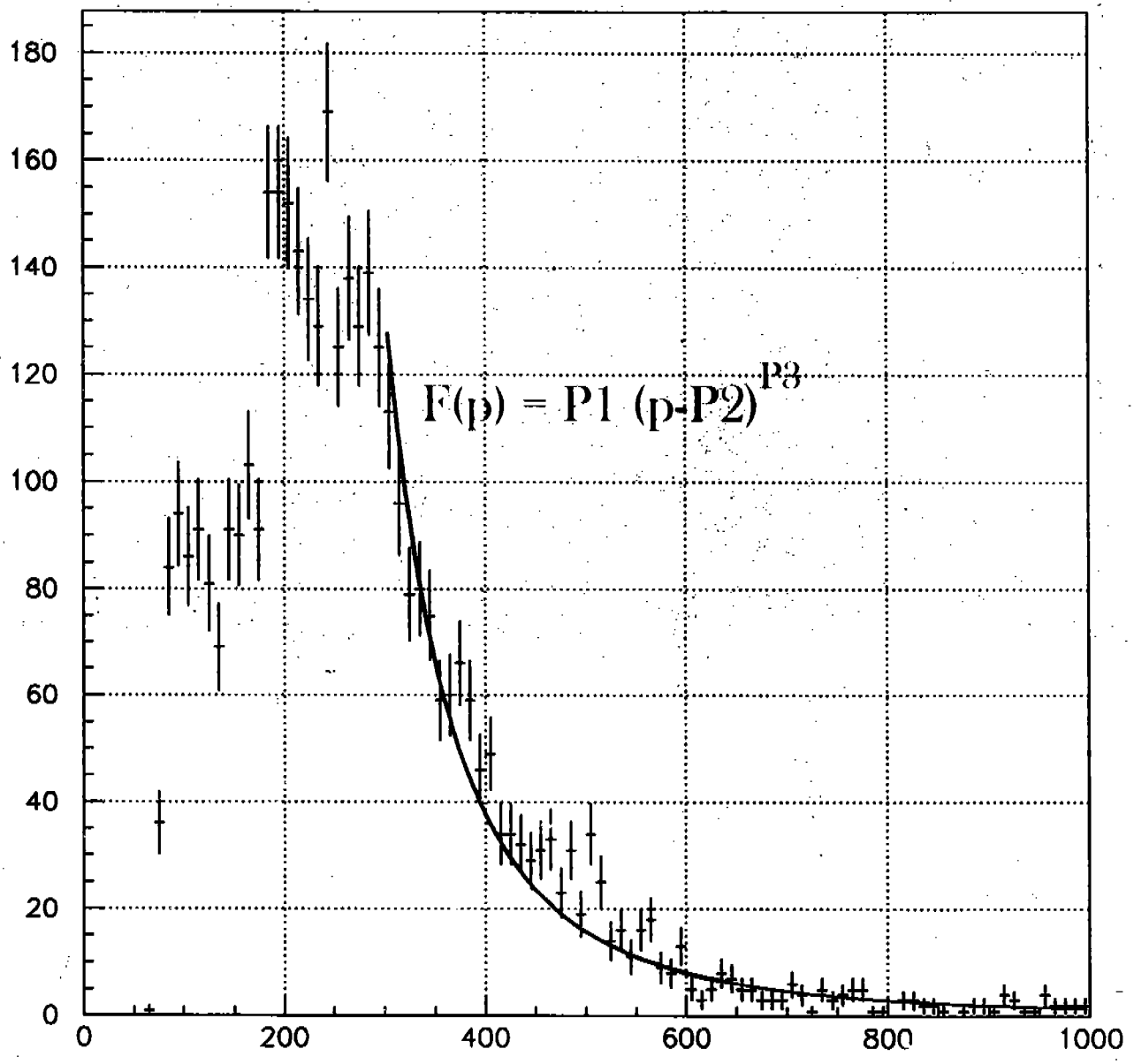


Background estimation

We don't know the background shape correctly.....

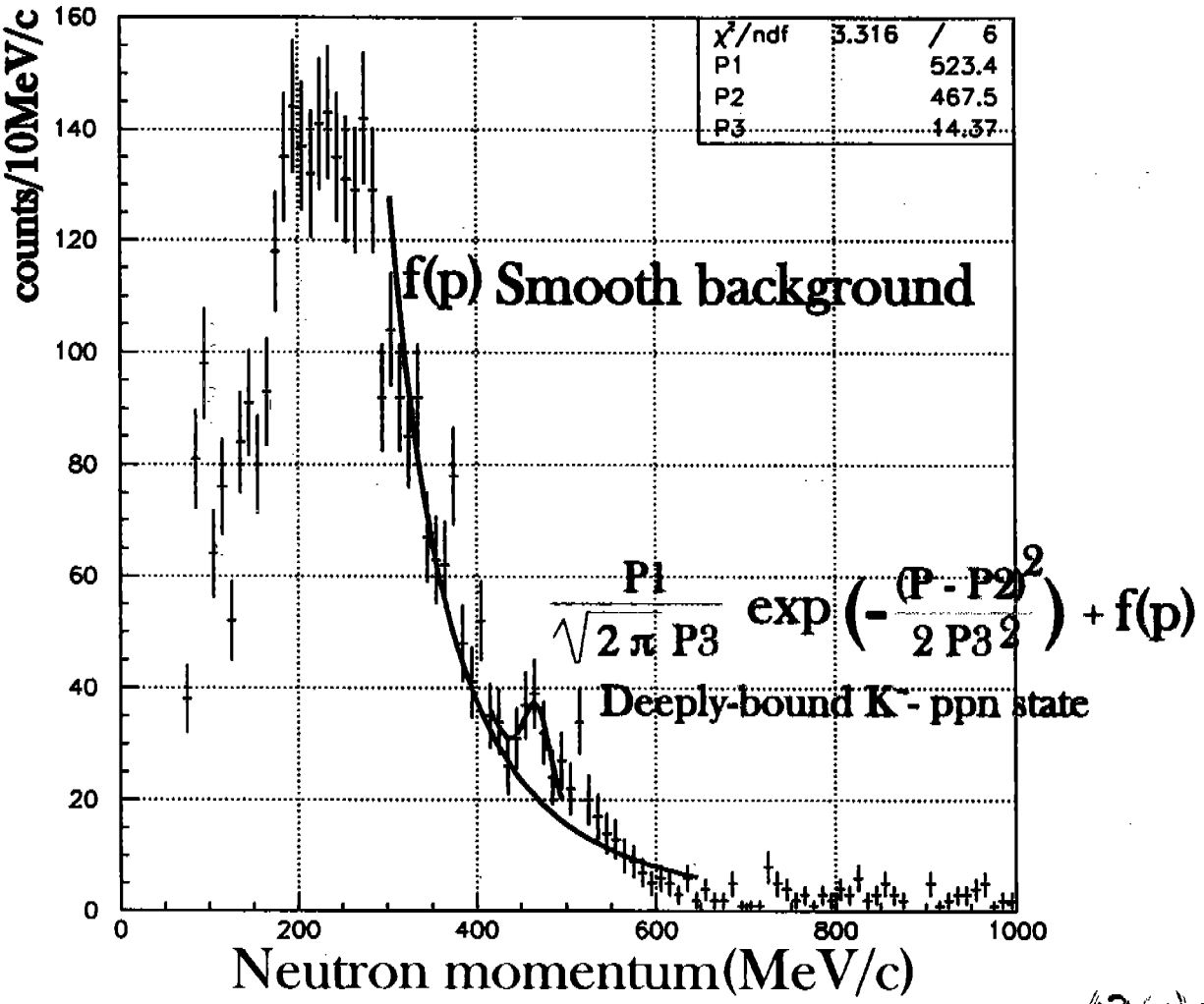
We use "forward" spectra as the background of "backward" spectra.

A global fit(300~800MeV/c) is performed, assuming a simple smooth function.



Final momentum spectra and peak fitting

We adopt background function obtained by a global fit of the " forward" spectra with a smooth function, without any modification.....



Central momentum : 467.5±3.5 MeV/c

Observed momentum width : 14.1±3.7 MeV/c (σ)

Event number in the peak : 52.3±14.7 events(3.6σ)

Δp (σ) = 10.7 MeV/c

Conclusion

We have performed an experiment to search for deeply-bound K^- – ppn states via stop K^- method, and almost finished the data analysis

As the result, we have found a peak structure around 470MeV/c on the neutron momentum spectra

The peak structure is interpreted as the evidence of the formation of deeply-bound K^-– ppn state!

Binding energy and natural width are:

	B.E(MeV)	Γ(MeV)
value	165.1 M(K⁻-ppn) = 3133 MeV	14.1
Statistical error	3.6	(<25.1)

There is no quantitative estimation of the formation branching ratio so far, but ΣNN is main decay channel