

E471: K-nucleus search

E549: Upgrade of E471 (K-nucleus search)

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E471 → observed **“K-nucl. Bound state”**

E549 → High resolution/statistics w/ detector upgdade

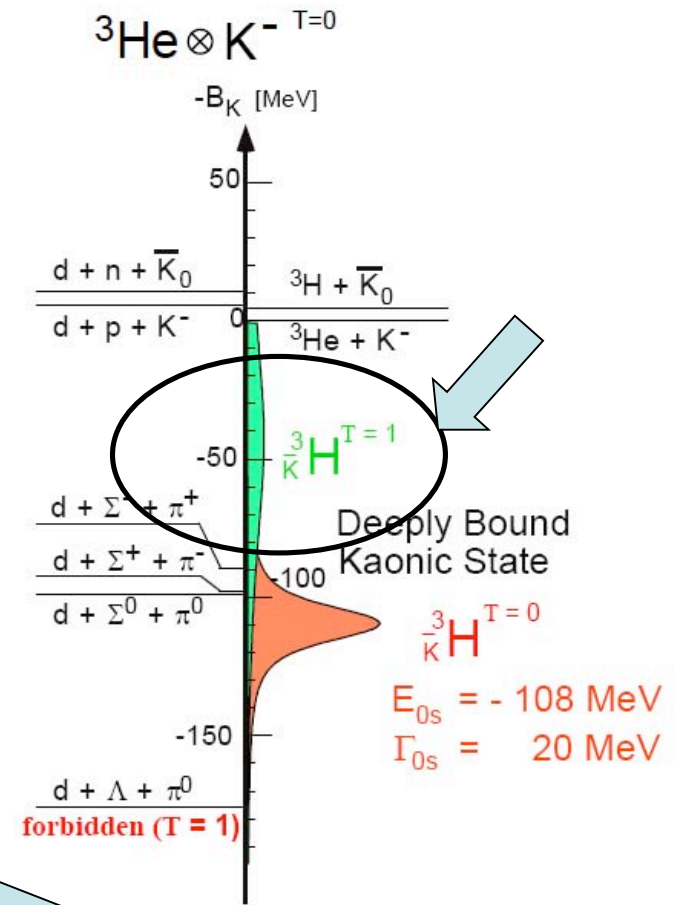
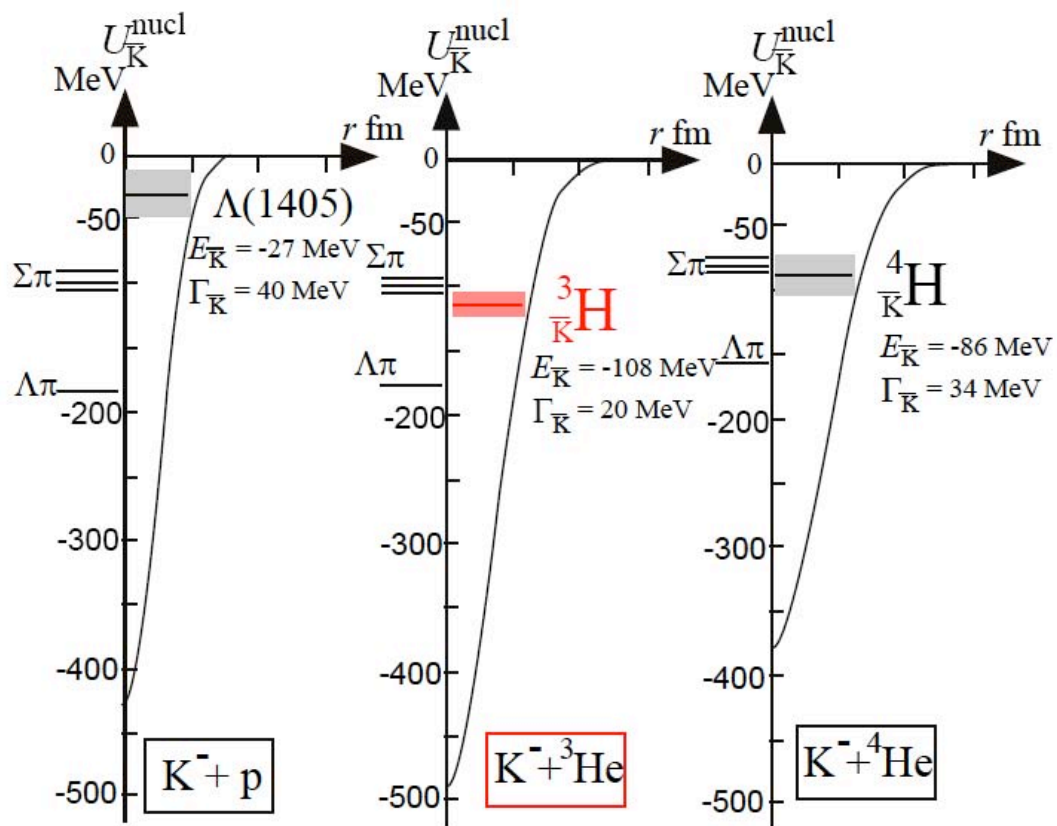
E549 cond. approved : assigned 2005 spring?

- 1. Motivation**
- 2. Present Status**
- 3. Goal for E549**

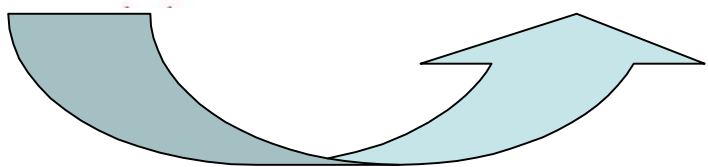
1. Motivation

Akaishi/Yamazaki prediction

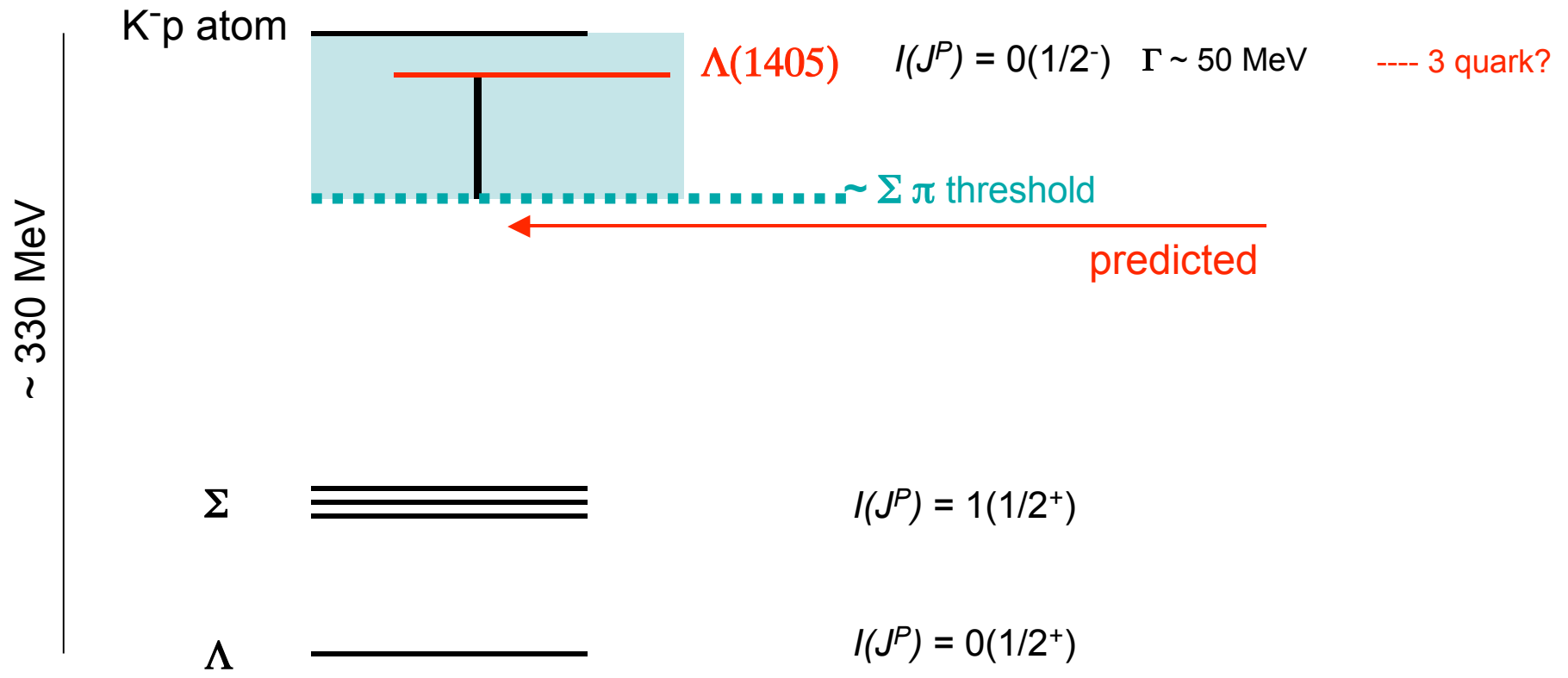
Strong attraction on $l = 0$ channel



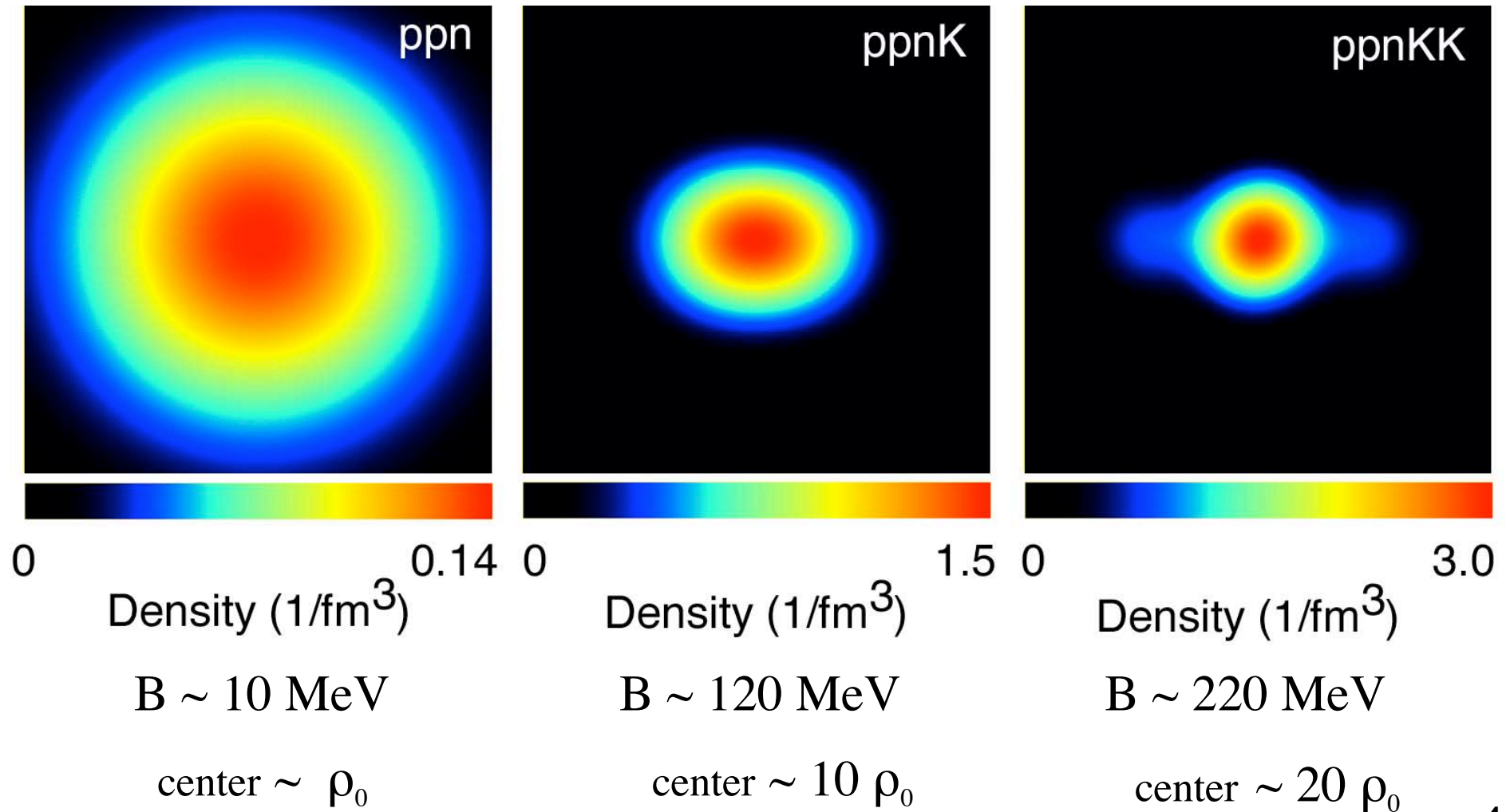
E228 motivated



Deeply bound state of \bar{K}^- meson and nucleus

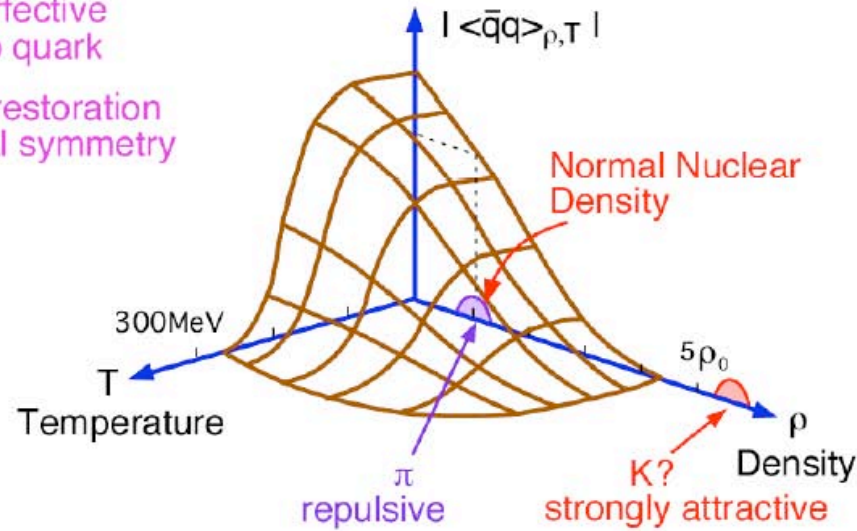


AMD calculation *by Dote et. al.*



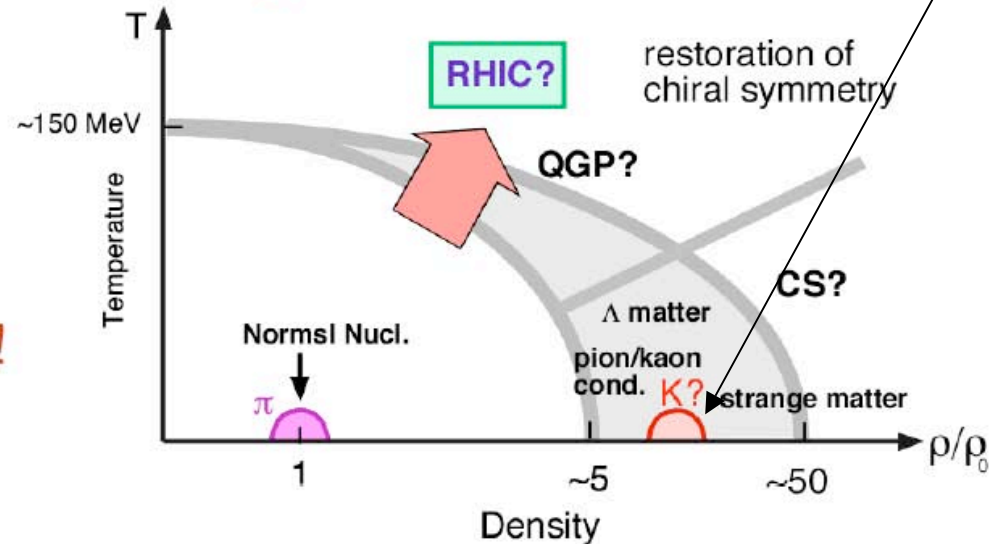
What can be studied by MESON BOUND STATES

$\langle \bar{q}q \rangle$ gives effective mass to quark
partial restoration of chiral symmetry

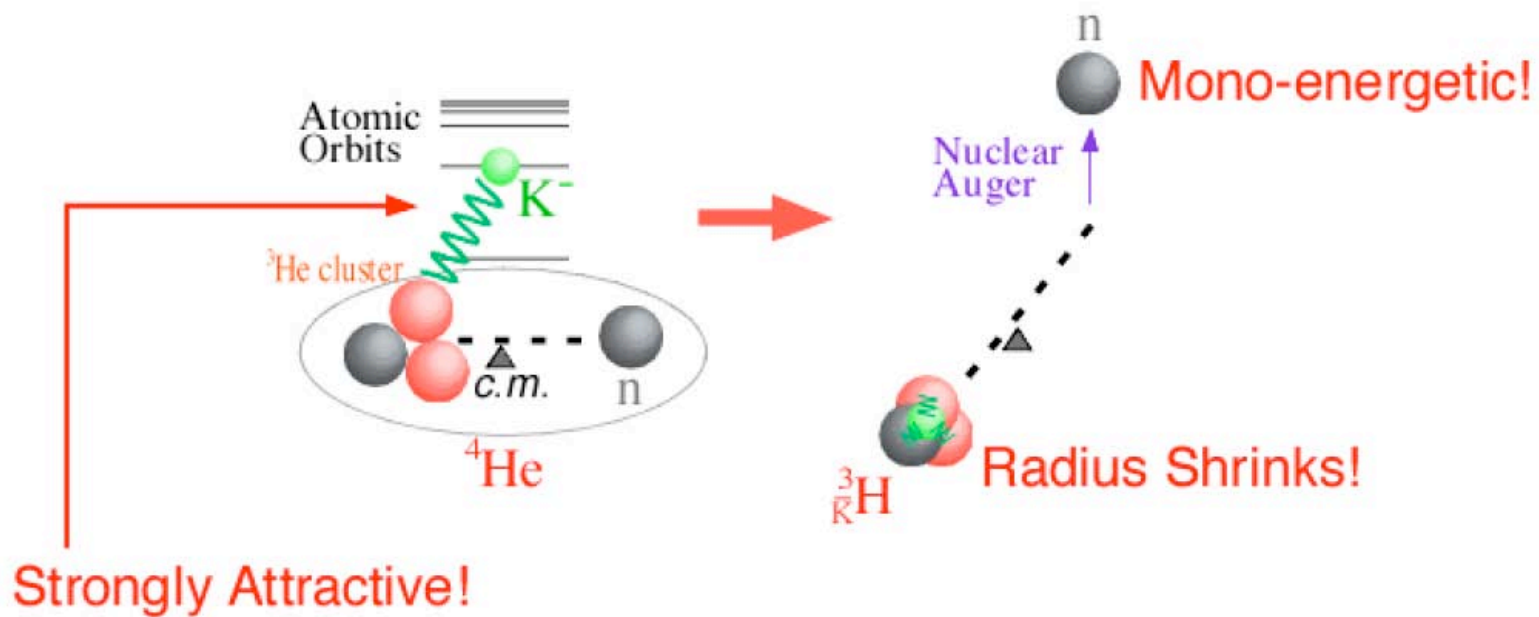


**Low temperature
High density**

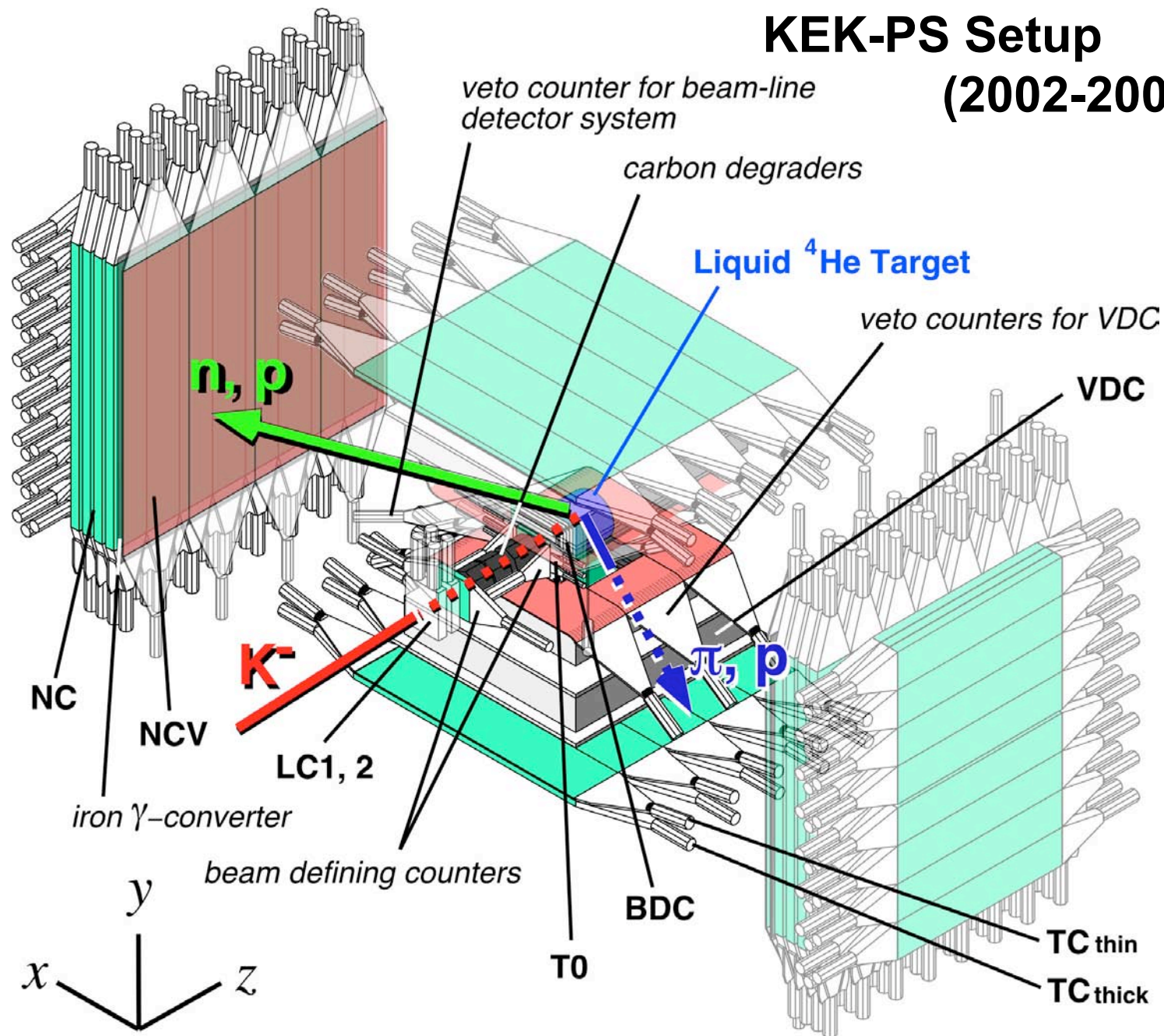
origin of hadron mass!
strange-star?!



2. E471 experiment

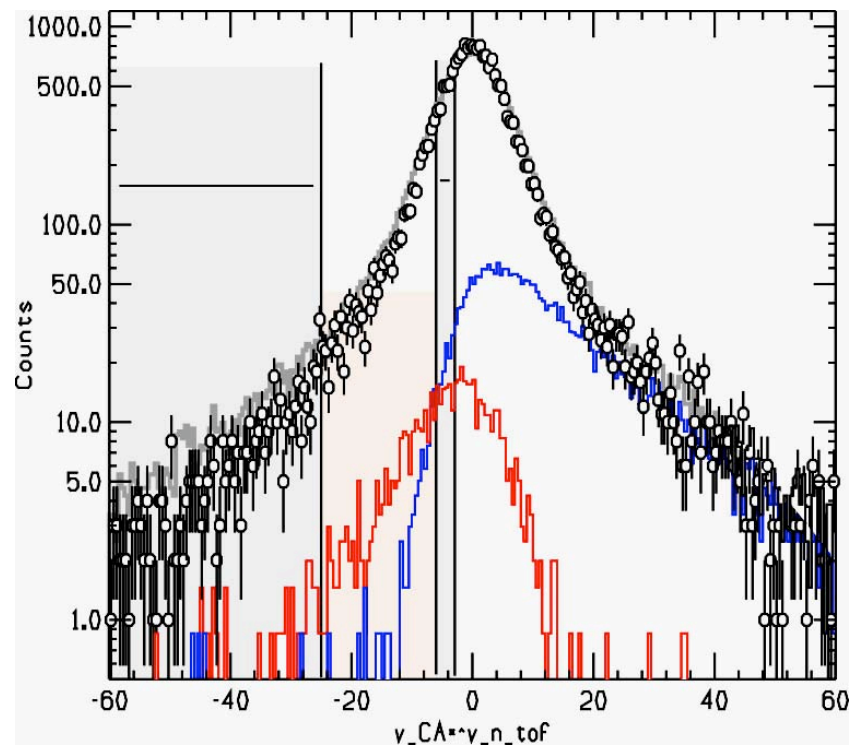
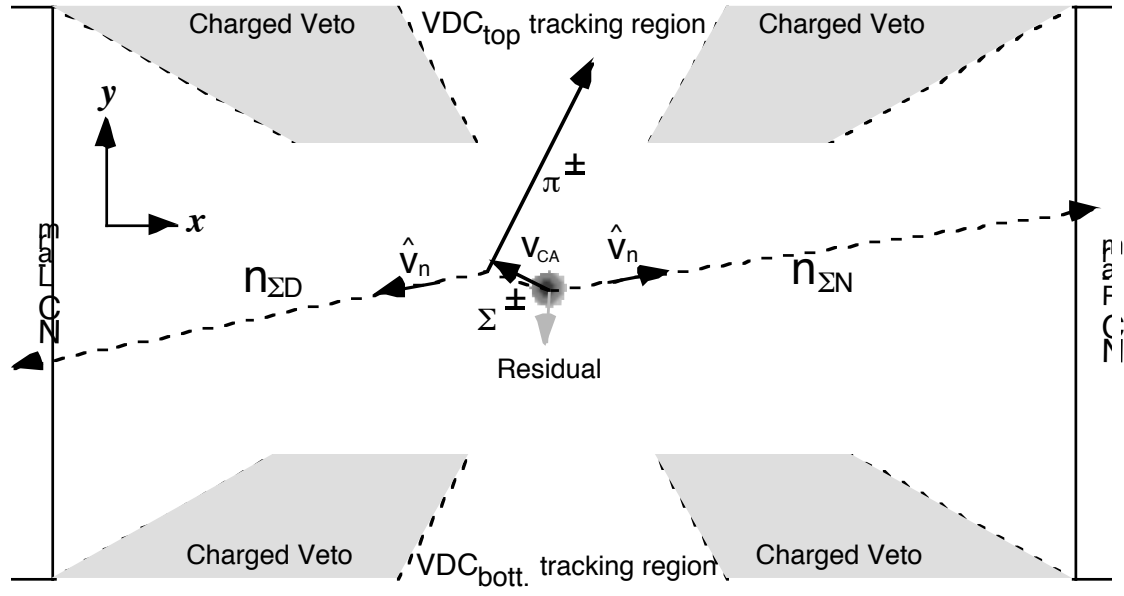


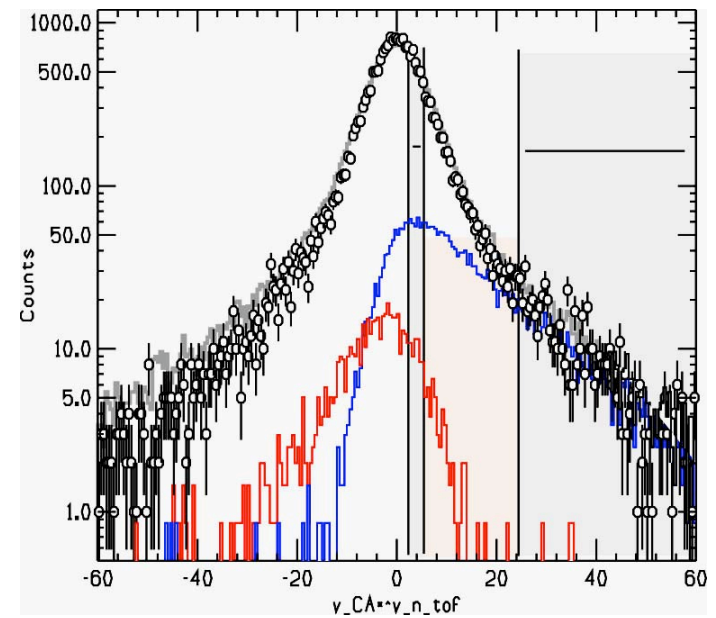
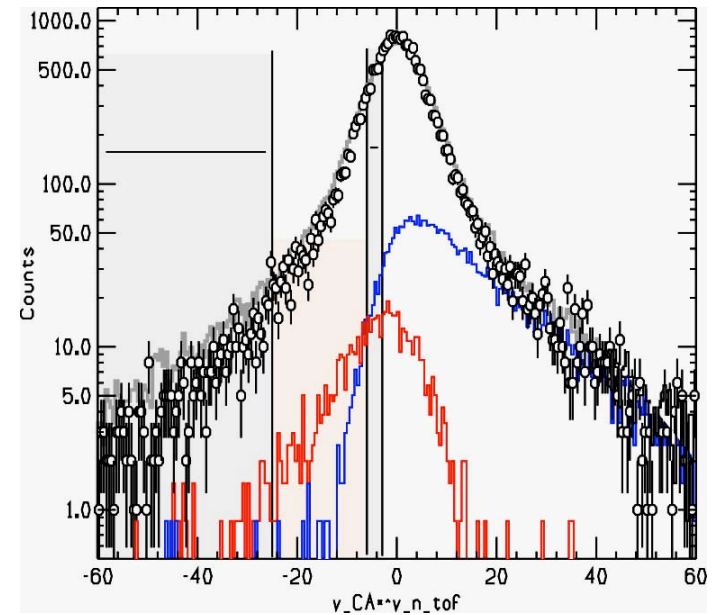
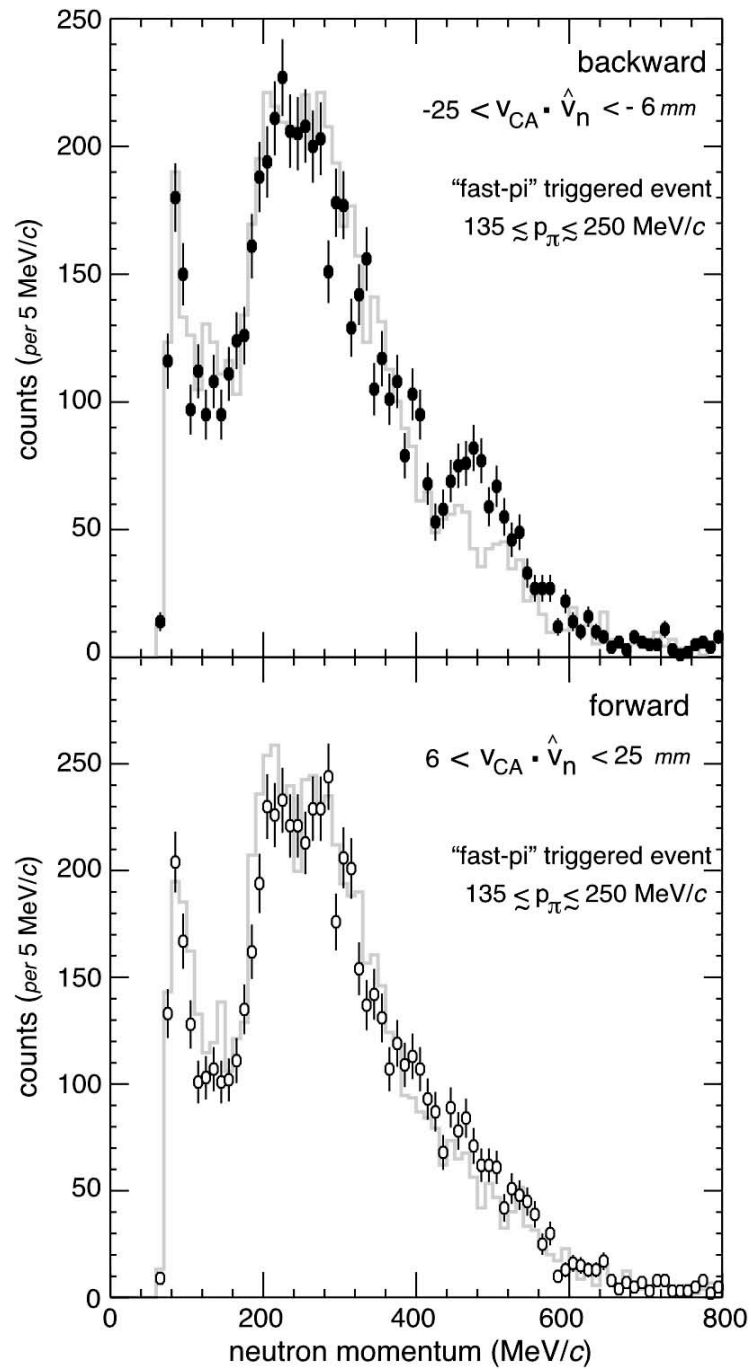
KEK-PS Setup (2002-203)



Hyperon motion?

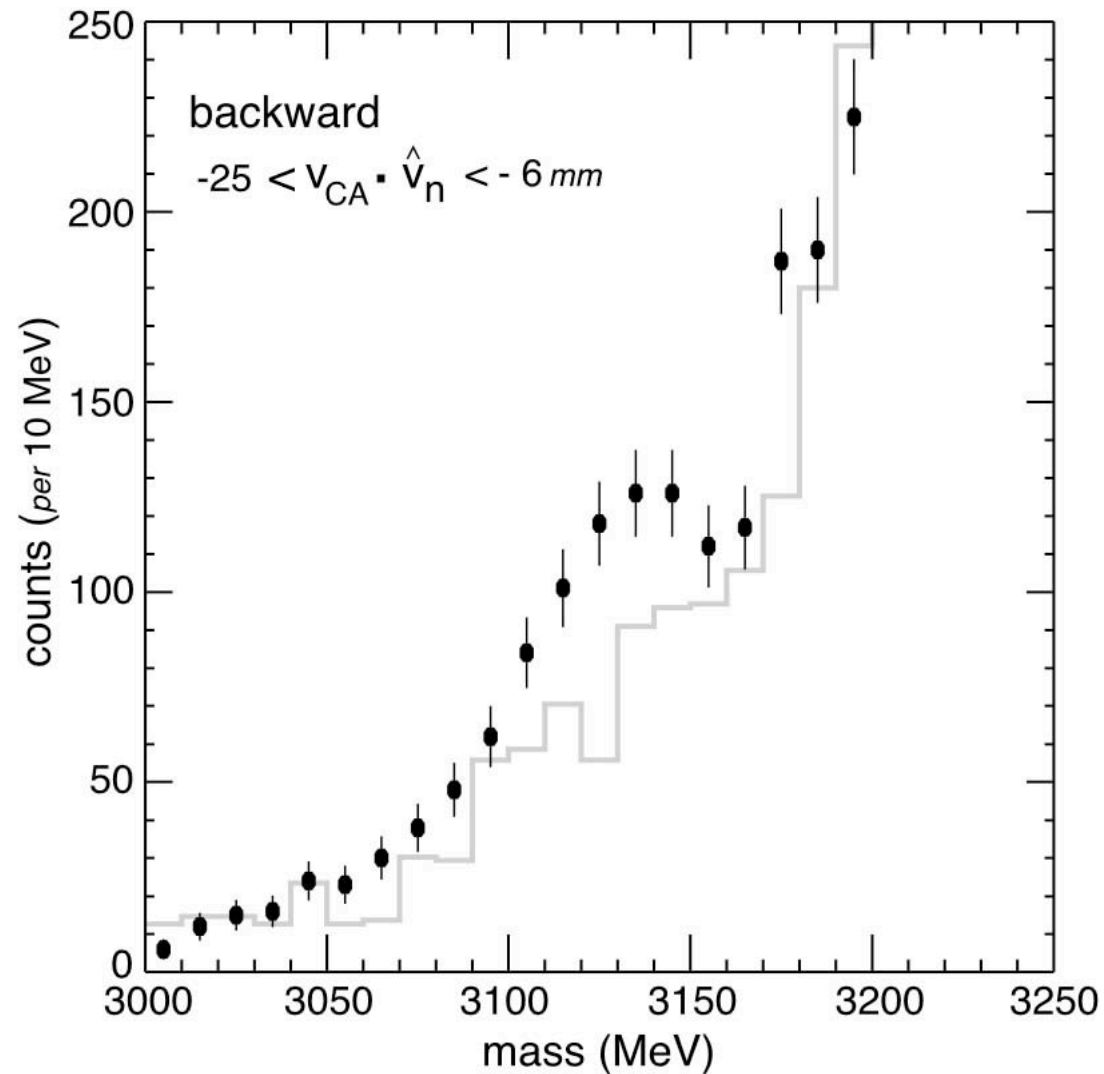
$$v_{CA} \cdot \hat{v}_n$$





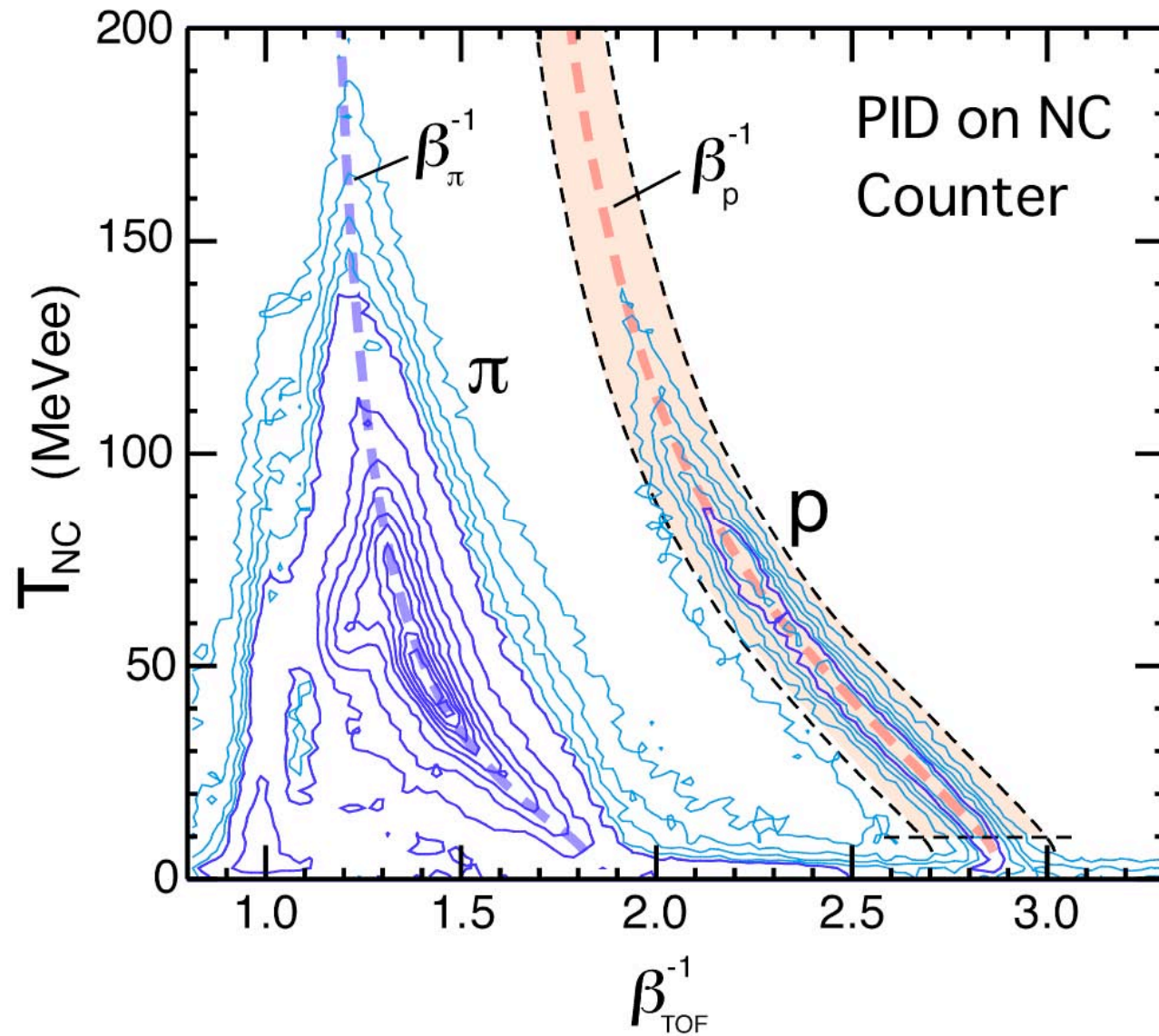
Fast π rigged neutron mass spectrum

backward mass spectrum



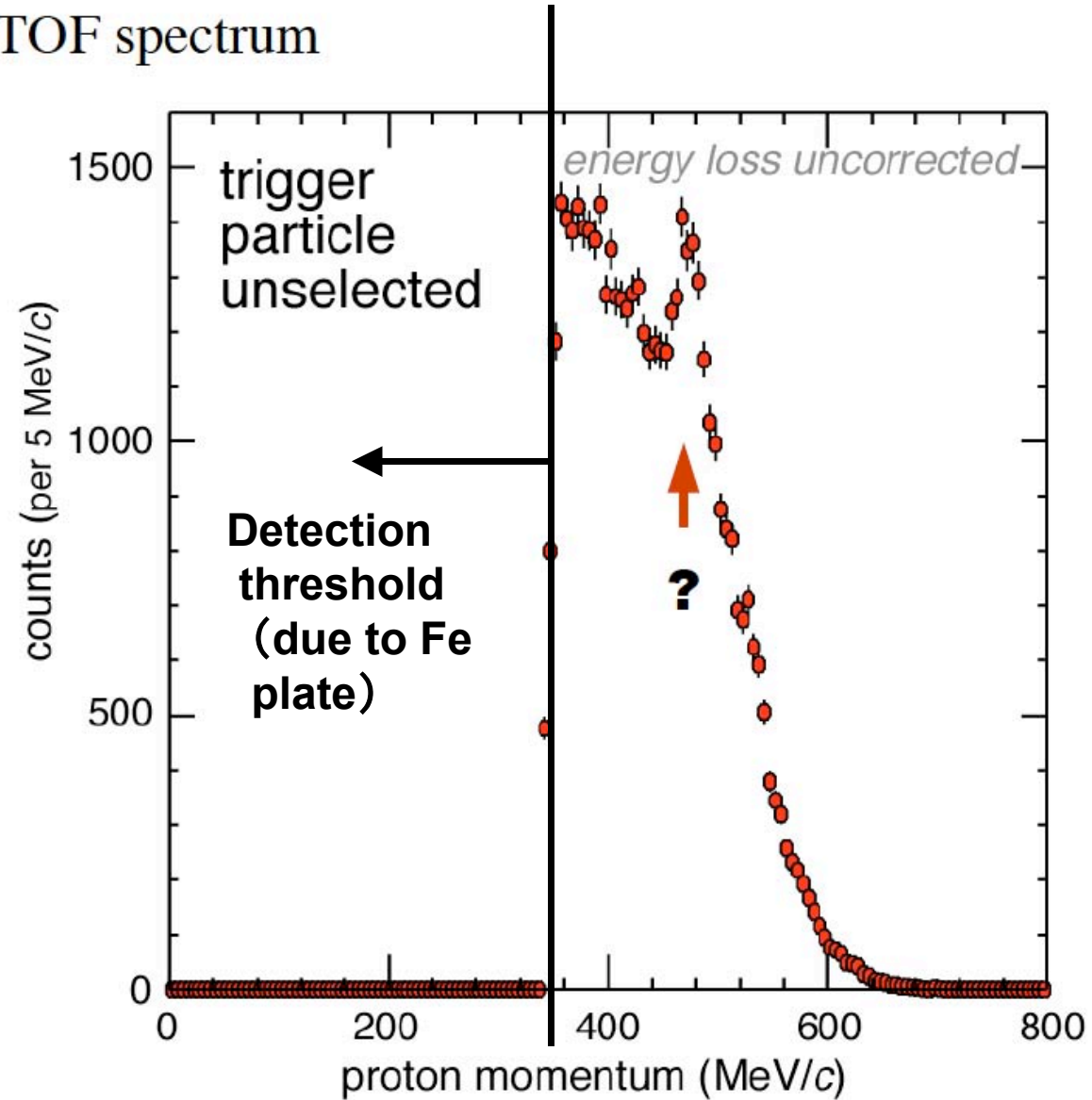
**Need more
data!**

Proton PID on neutron counter system

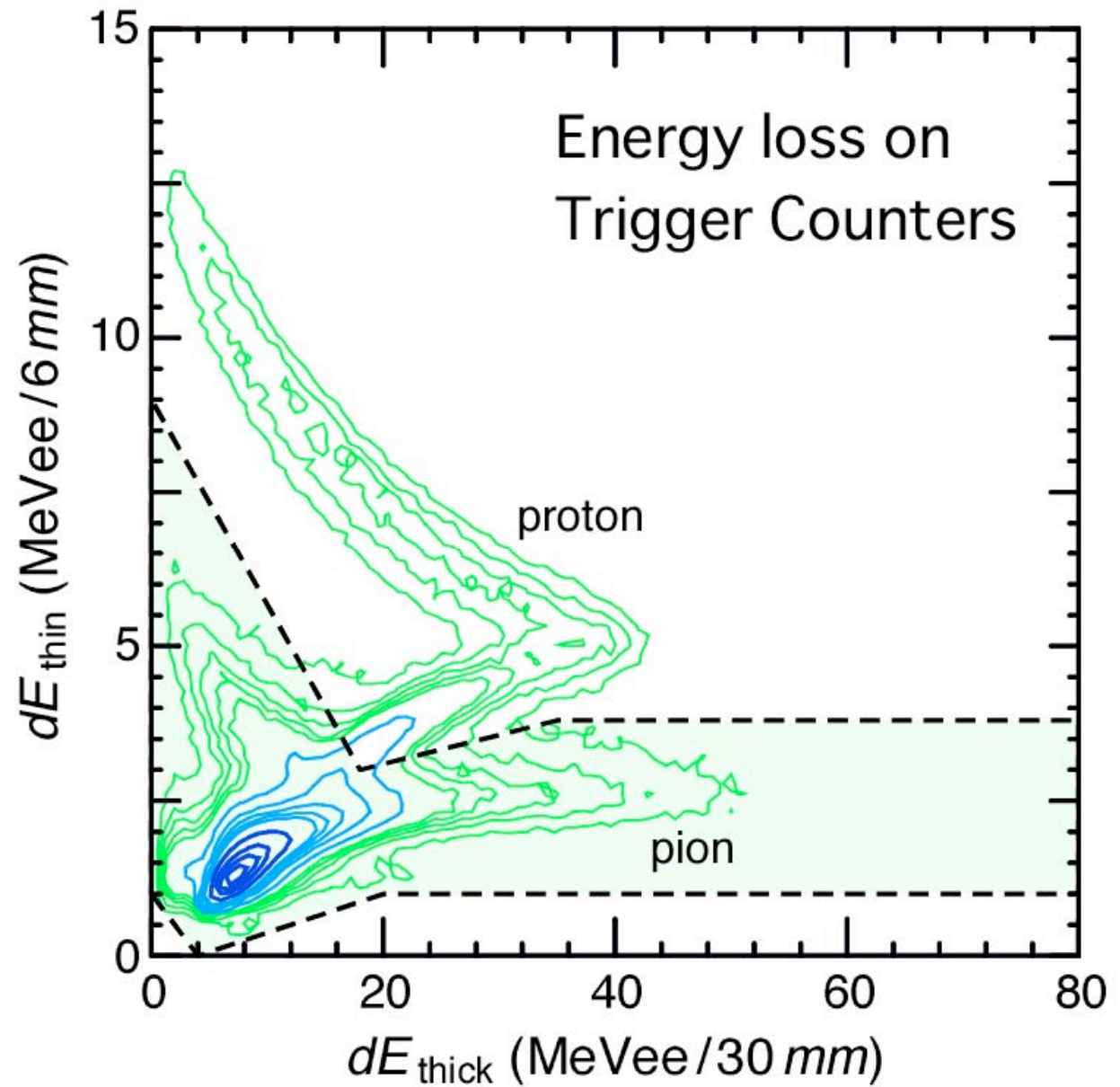


$^4\text{He}(\text{stopped K}^-, \text{p})$ spectrum

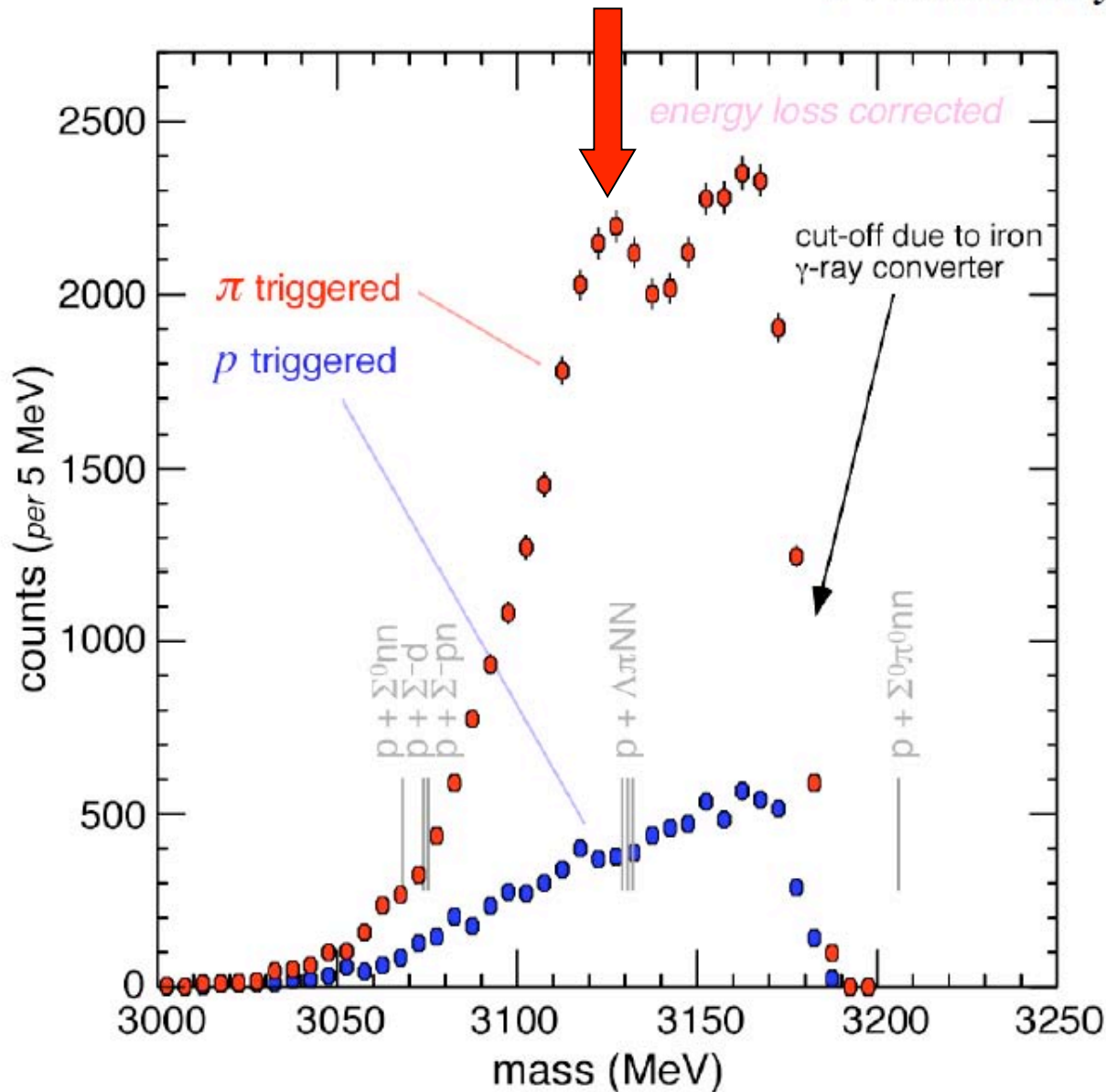
Proton TOF spectrum



PID on TC



Preliminary



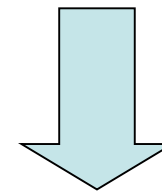
B ~ - 200 MeV
Width < 20MeV
same as resolution

Stopped K- origin

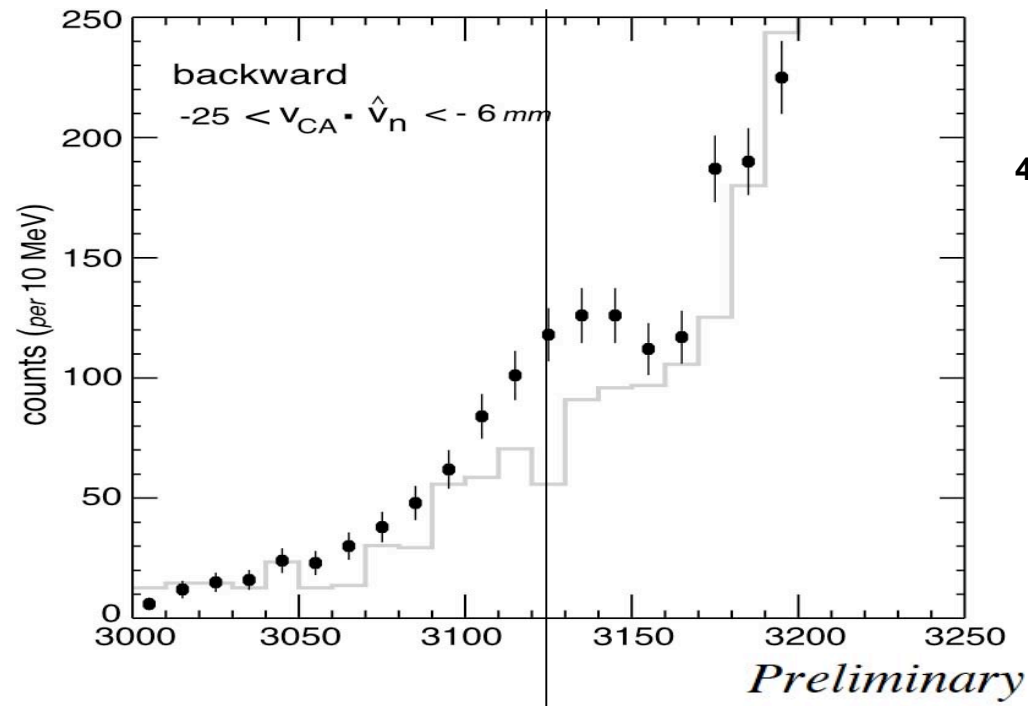
No peak in proton-tagged
→ **Σ NN decay dominant**

Exists in all counters

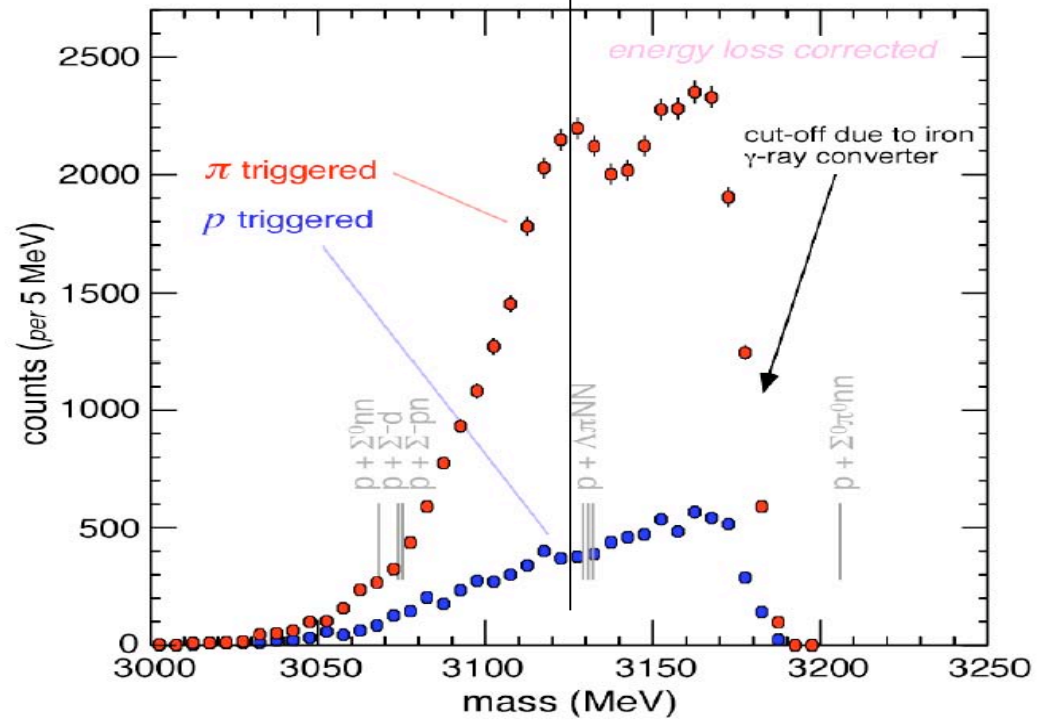
Completely independent
analysis gives the same
result



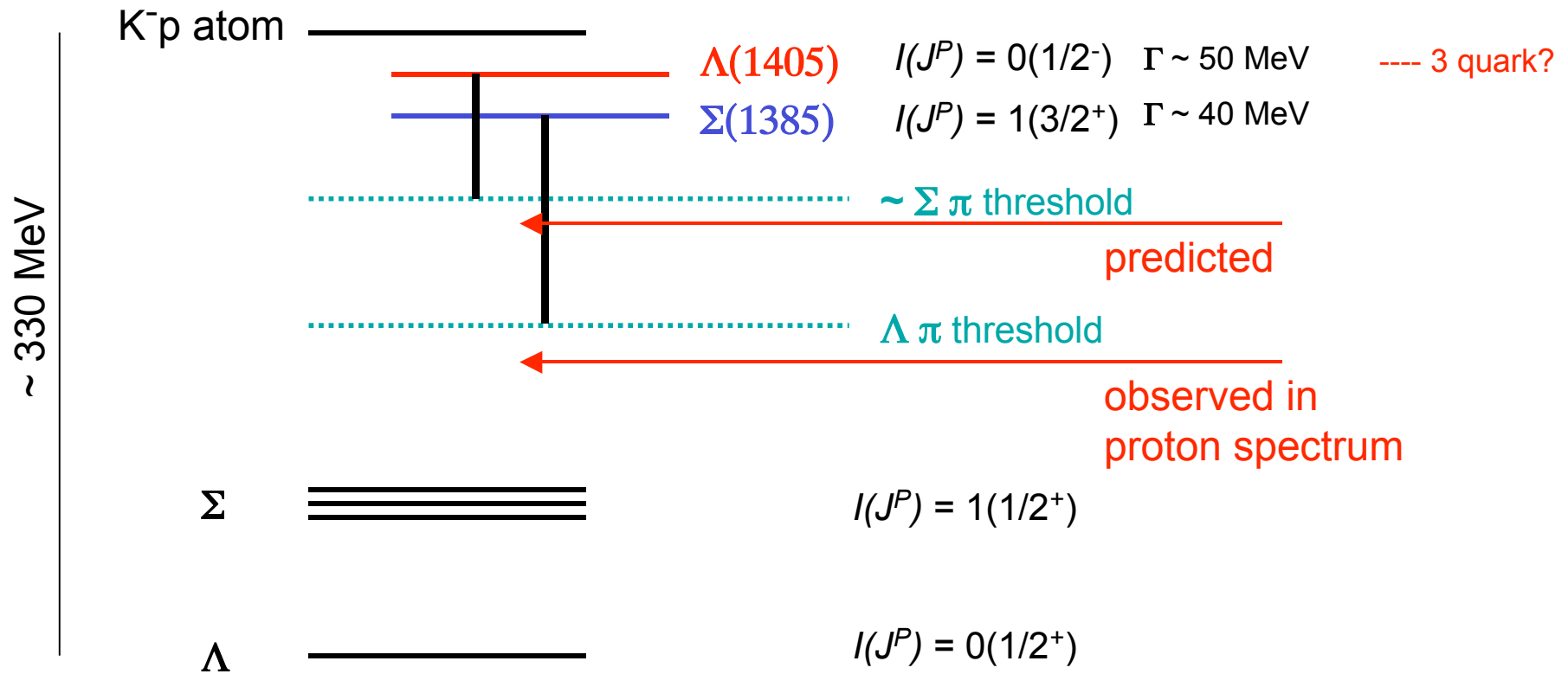
Peak is real !!

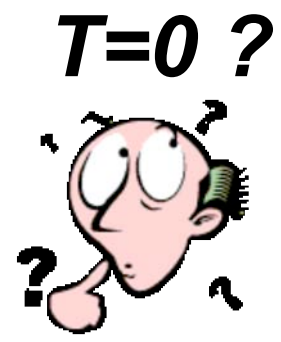
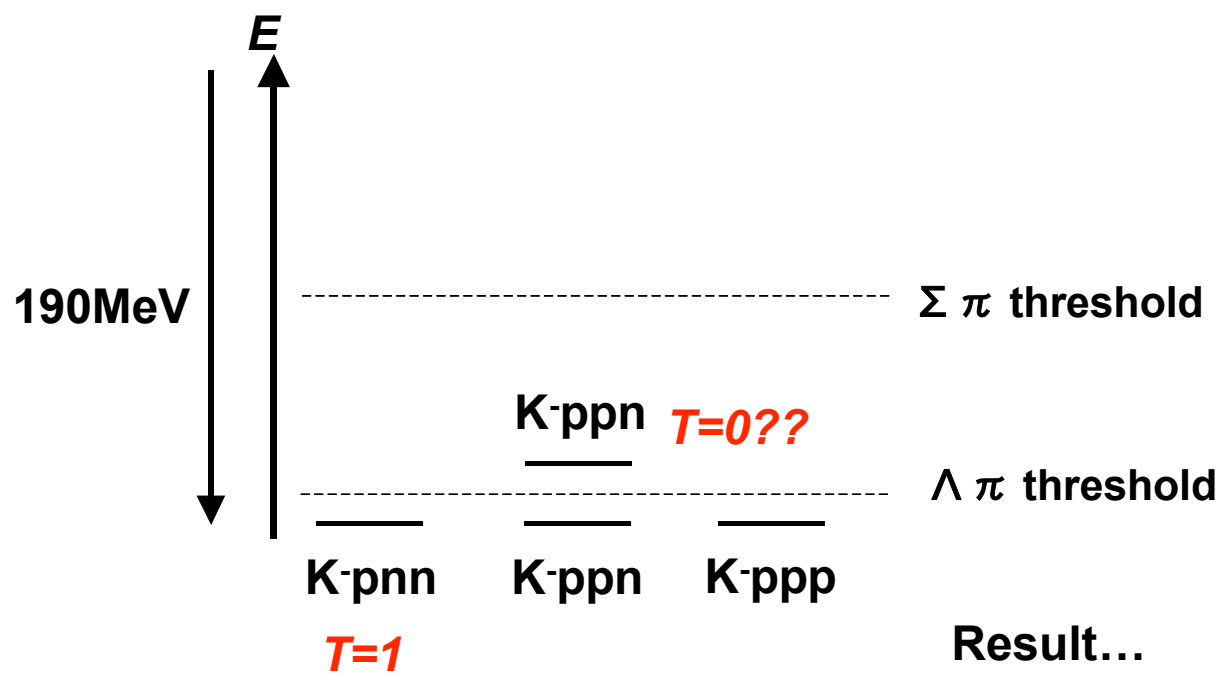
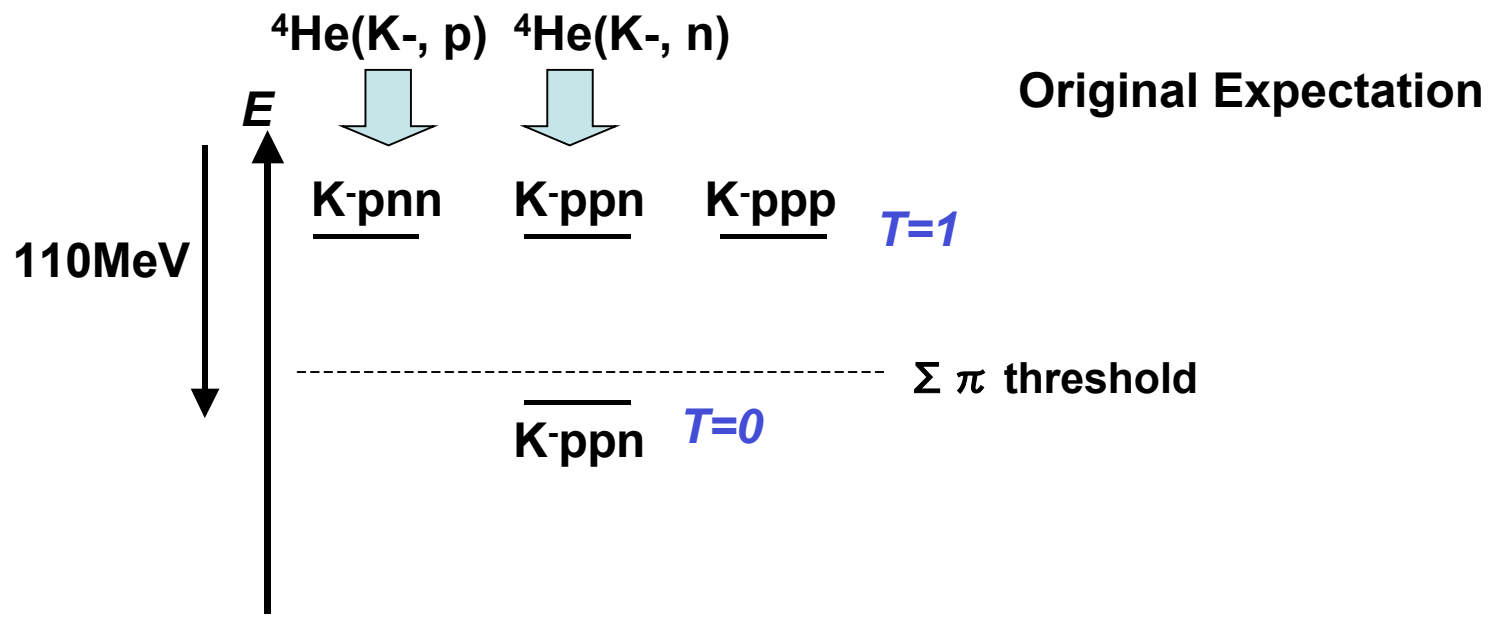


${}^4\text{He}(K^-, n)$



${}^4\text{He}(K^-, p)$





3. Goal of E549

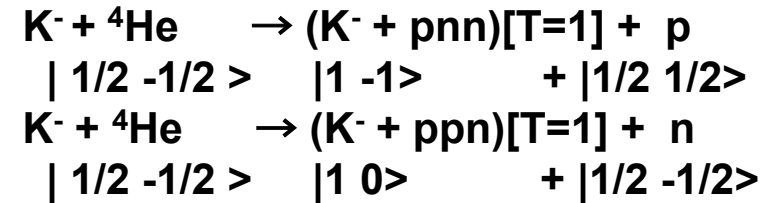
① ${}^4\text{He}(\text{K}^-, \text{p})$ peak/width determination

Energy error $\sim 5\text{MeV}$? $\rightarrow \sim 1\text{ MeV}$

Width upper limit \rightarrow OK if $< 10\text{ MeV}$

Proton statistics $\times 100$ (inclusive)

Energy resolution 2-3 times improve



Formation rate 2:1

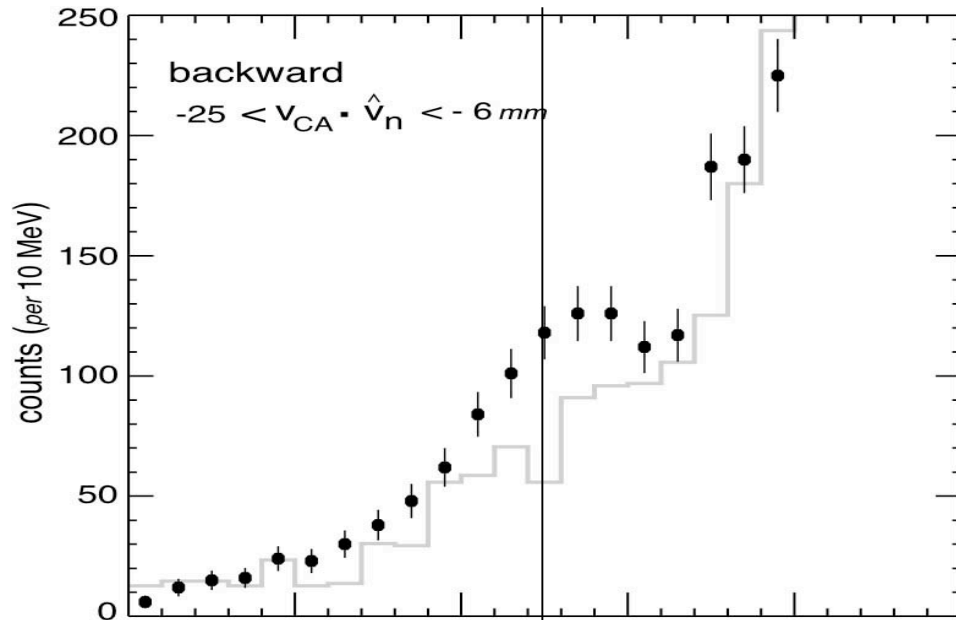
② High statistics ${}^4\text{He}(\text{stoppedK}^-, \text{n})$ spectrum

Confirm peak! (As present proton statistics)

T=0 contribution study

Neutron statistics $\times 10$ times more

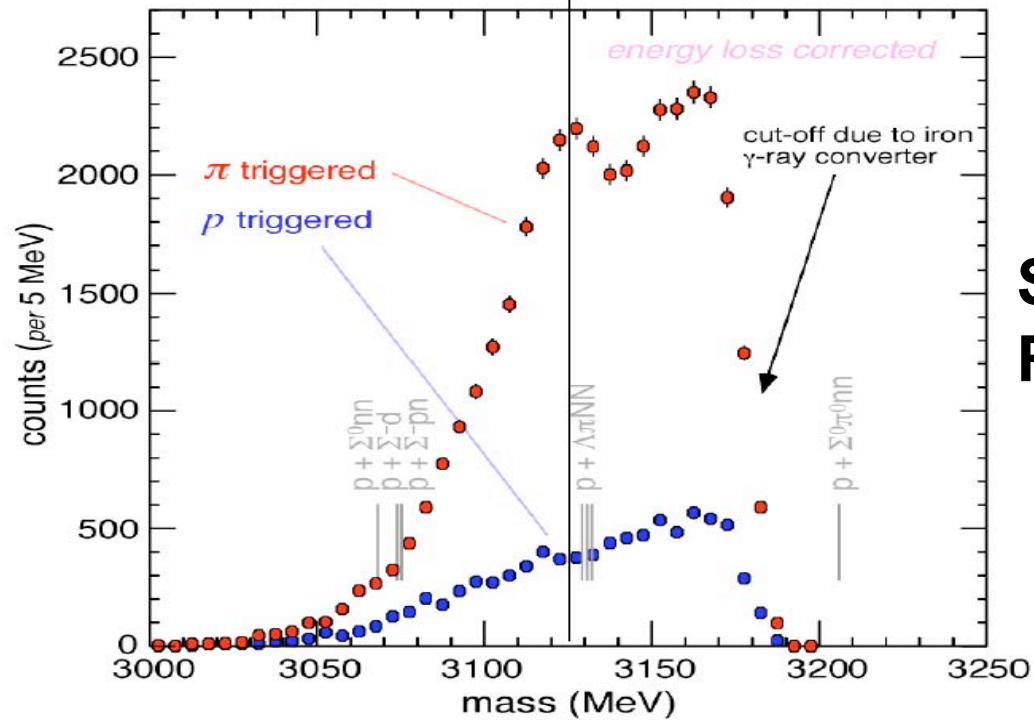
Energy resolution 1.5 times



${}^4\text{He}(K^-, n)$

**Statistics $\times 10$
Resolution $\times 1.5$**

Preliminary



${}^4\text{He}(K^-, p)$

**Statistics $\times 100$
Resolution $\times 3$**

Lower background

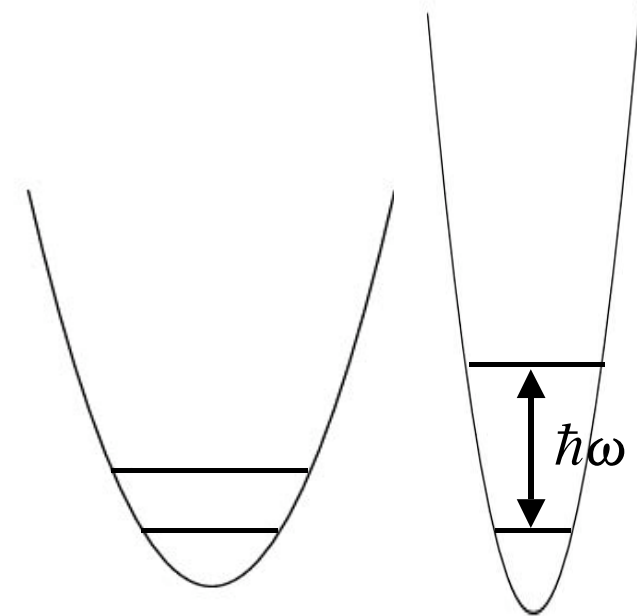
③ Momentum slit re-install

Direct evidence of high density state?

④ Search for excited states in ${}^4\text{He}(\text{K}^-, \text{p})$

$$\Delta E = \hbar\omega \approx 45\text{MeV}$$

cf. Search for $(\text{K}^- \text{ppp})_{T=1}$ by
 ${}^3\text{He}(\text{K}^-, \pi^-)$ or ${}^3\text{He}(\pi^+, \text{K}^+)$



Spin (parity) and decay

$$I(J^P) = 1(3/2^+)$$

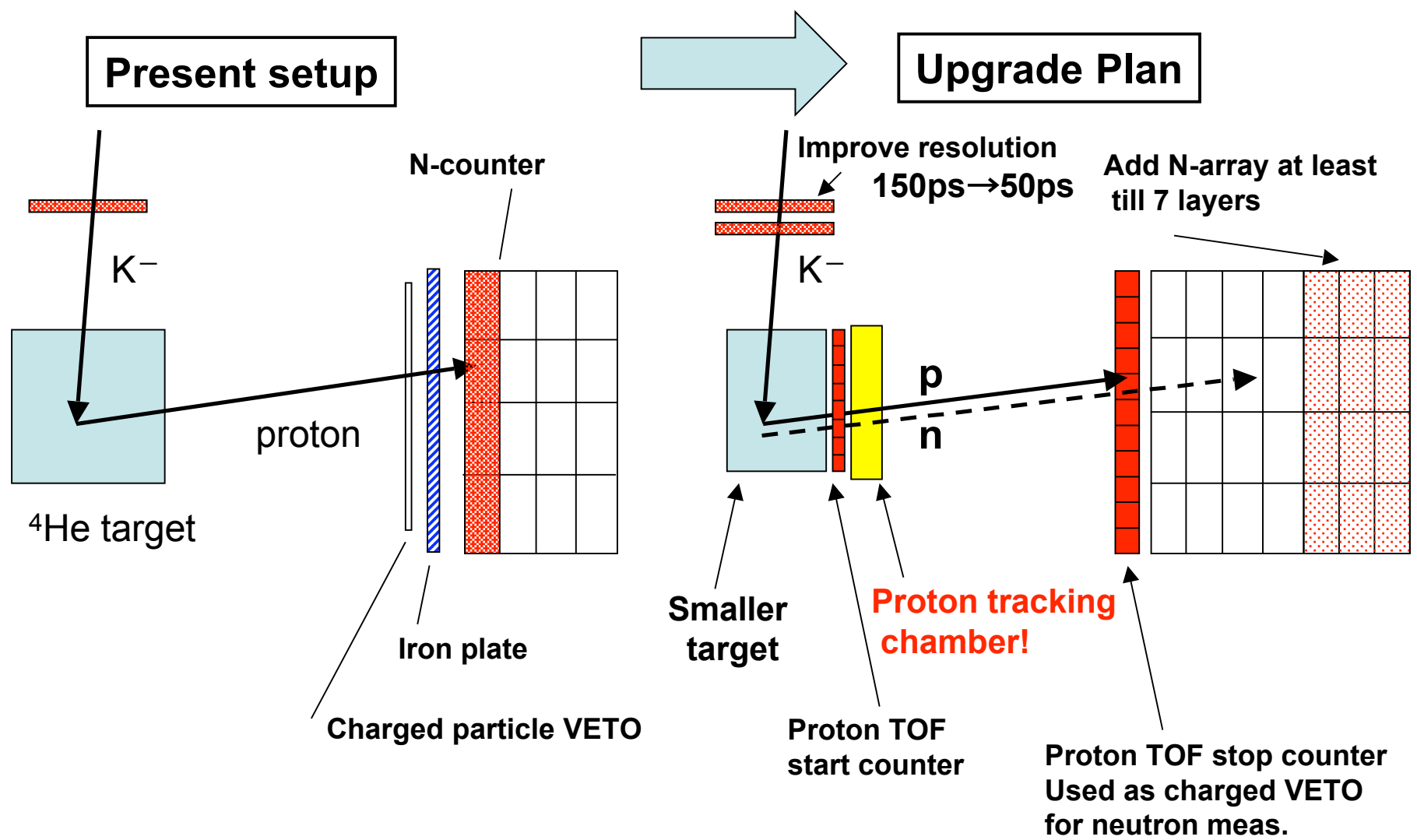
... Nemura / Akaishi

--- LS importance

⑤ Decay asymmetry

Tracking Chamber Installation

- (1) $^4\text{He}(\text{stopped } K^-, p)$ inclusive spectrum
w/o trigger counters
 K^- stop position --- must
→ **Statistics $\times 20$**
(Width/Position error $\downarrow \downarrow$)
→ Formation Branch
- (2) Study of the decay
 $\Sigma NN?$ $\text{Spin}^P = 3/2^+$
- (3) $^4\text{He}(K^-, n)$ spectrum
— T=1 component → T=0 component
- (4) TOF prompt calibration



Both n/p
 $\sigma \sim 300\text{ps}$

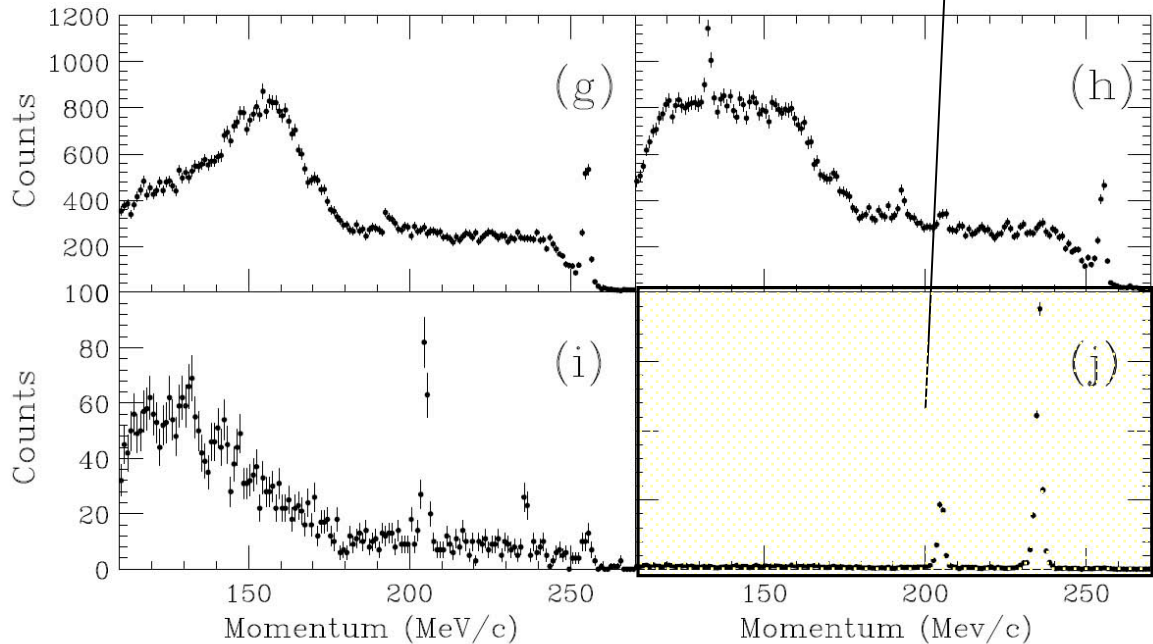
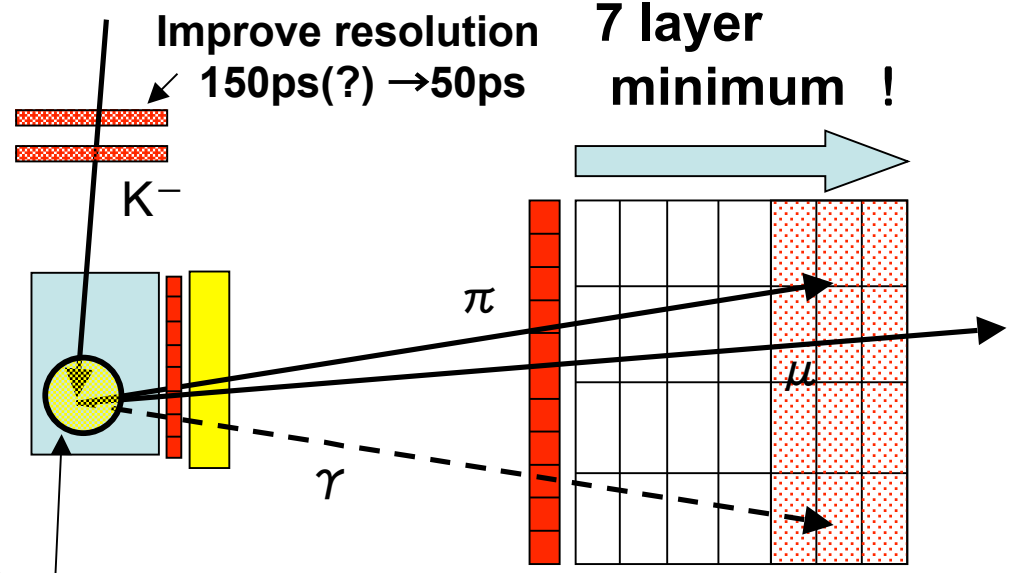


Proton $\sigma = 100 \sim 150\text{ps}$
Neutron $\sigma = 200\text{ps}$

Prompt Calibration

Metastable state for calibration

From K- injection,
charged π/μ emission
occurs $>3\text{ns}$ later



235MeV/c μ^-
Range 60.1cm
Formation $\sim 1.6\%$
 $1/\beta = 1.0953$

205MeV/c π^- $\Delta(1/\beta) < 0.02$
Range 33.4cm
Formation $\sim 0.5\%$
 $1/\beta = 1.2109$

30days $>10^6$ identified
 \rightarrow In-beam TOF calibration

Towards J-PARC

Really Deep-K?

check with other nuclei - DAFNE/FINUDA -Nagae?
K2 by Kishimoto?

LS?

K^- ^3He / K^- ^4He atom - DAFNE/DEAR

kaonic atom = highly excited deep-K?

Preparation of CDC / Spectrometer

@ J-PARC

If Deep-K = yes ... wide research area open!

spin / parity / isospin / LS / A dep. (baryon #) ...

Double-K nucleus!

