J-PARC E15 and future perspective

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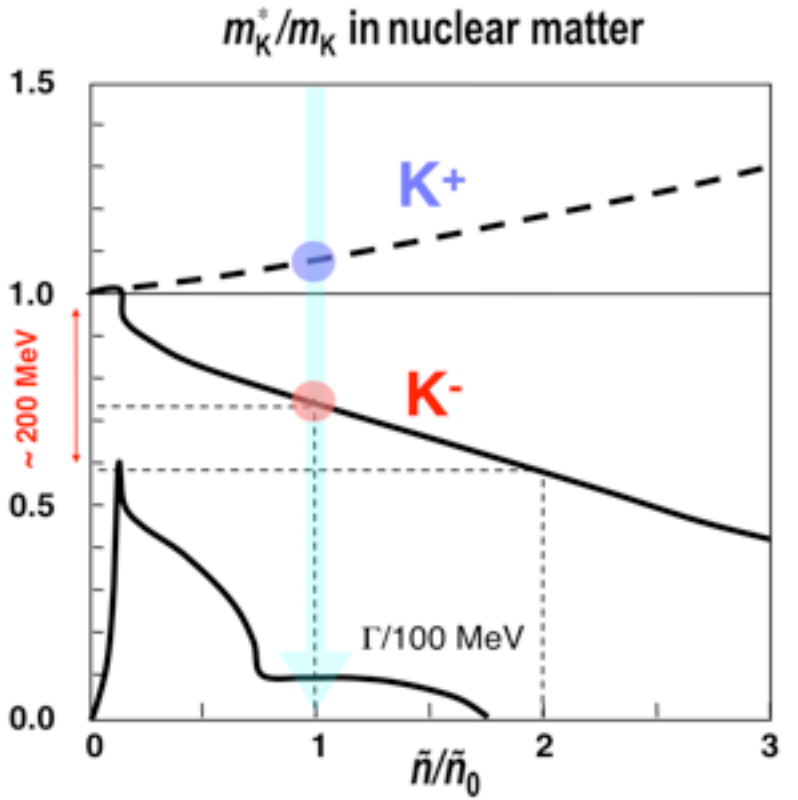
RIKEN / TITech

for J-PARC E15 Collaboration

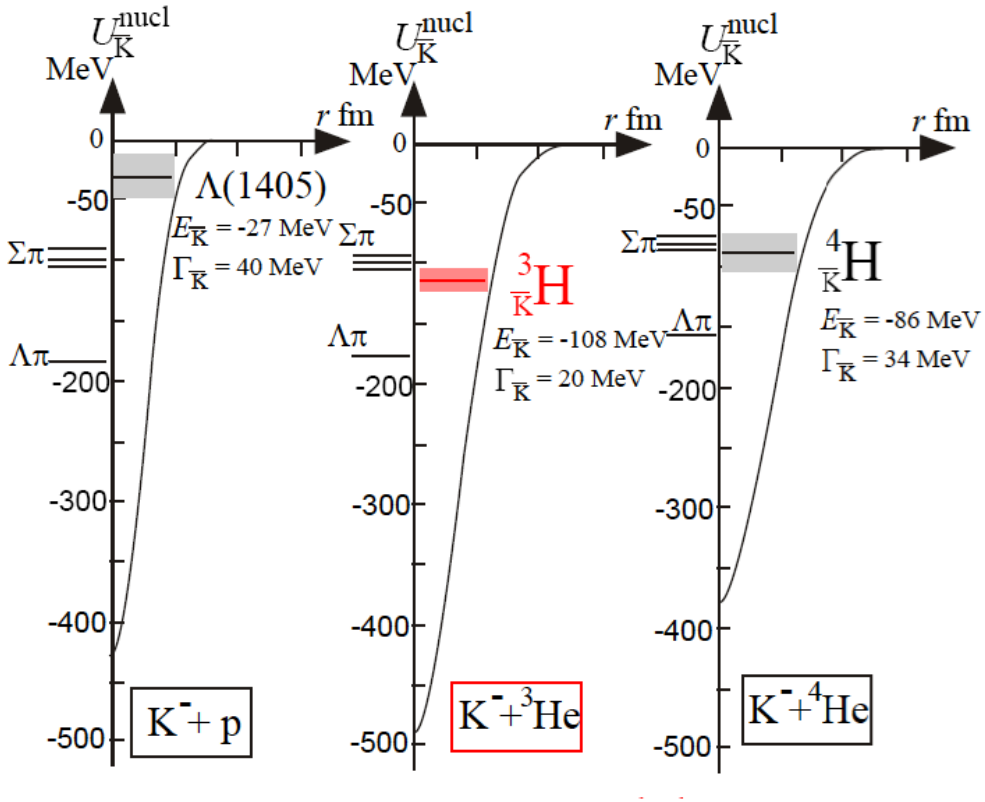
- Introduction
- E15 experiment
- Discussion on E15 ^{1st} engineering run
- Future possibility
- Conclusion

Embedding K^- in nucleus

Motivation of J-PARC E15
~ J-PARC E27



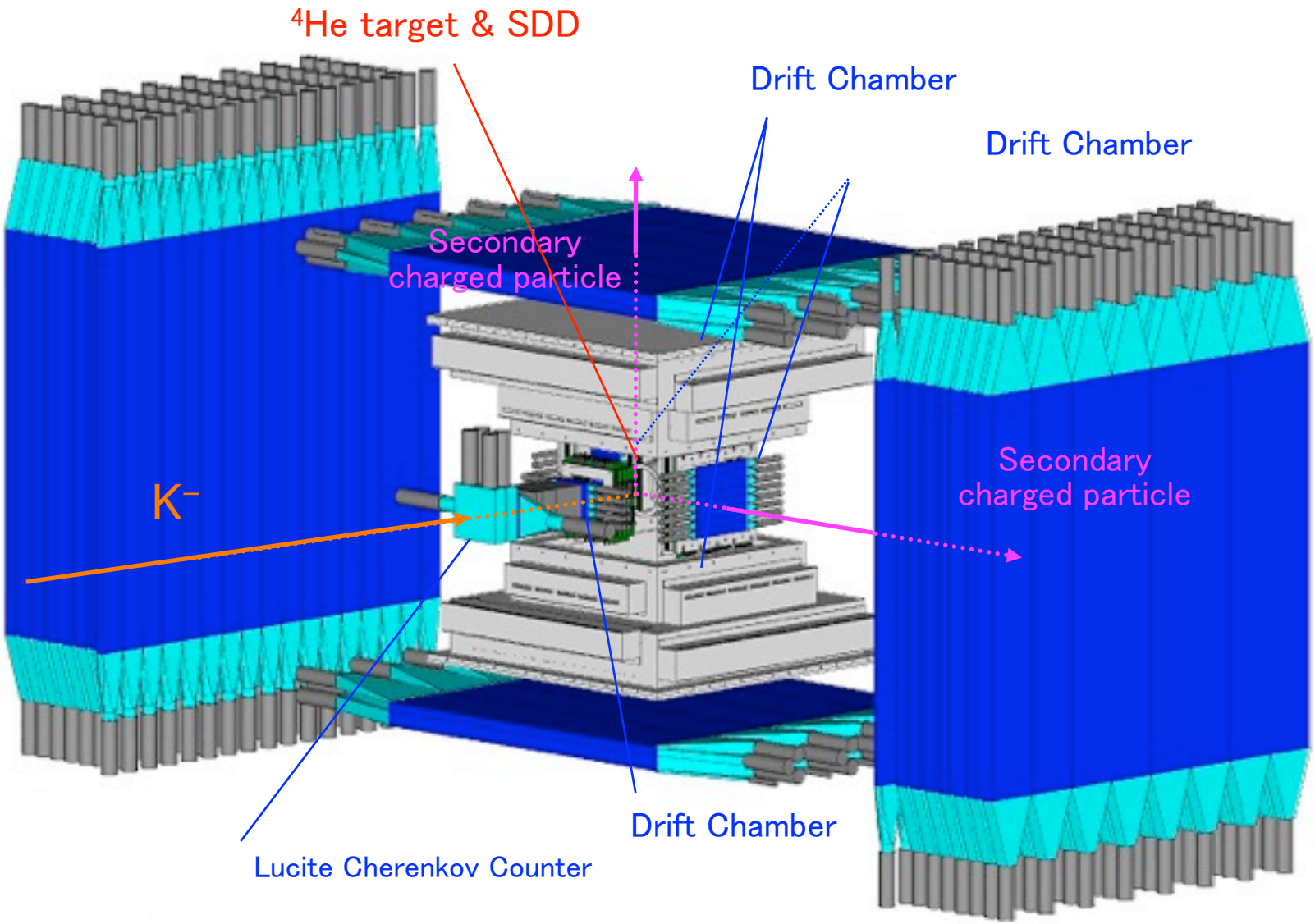
T. Waas, N. Kaiser & W. Weise, Phys. Lett. B379 (1996) 34.



Y. Akaishi & T. Yamazaki : PRC 65 (2002) 044005

KEK 12GeV-PS E549 experimental setup

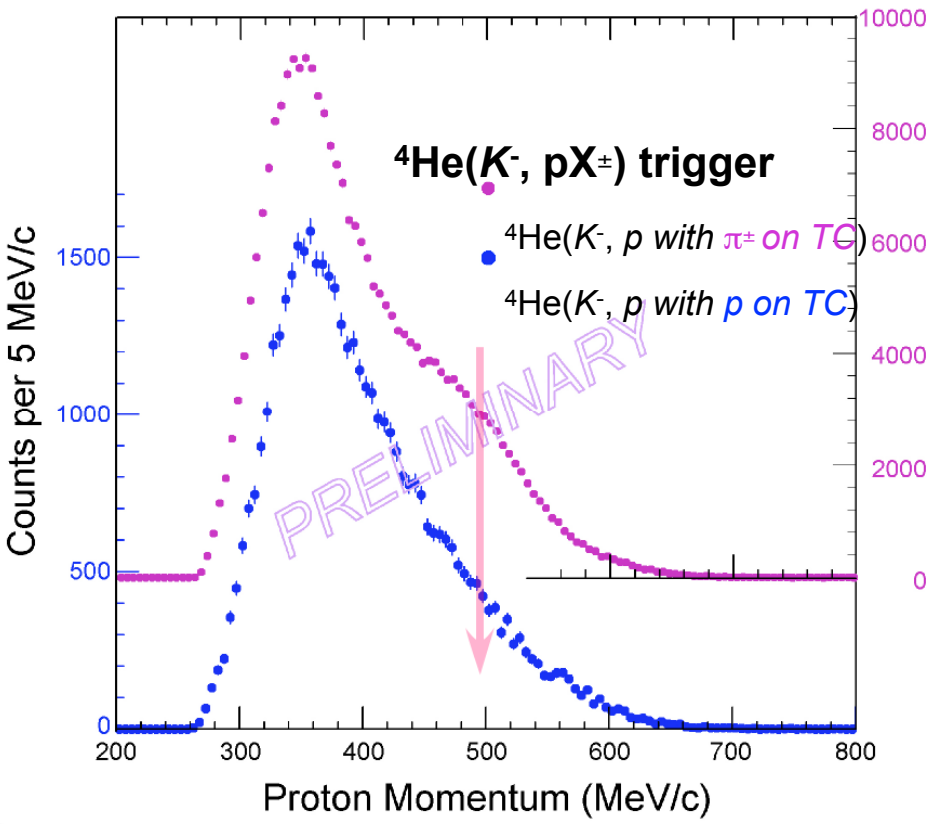
K^- reaction at-rest on ^4He target

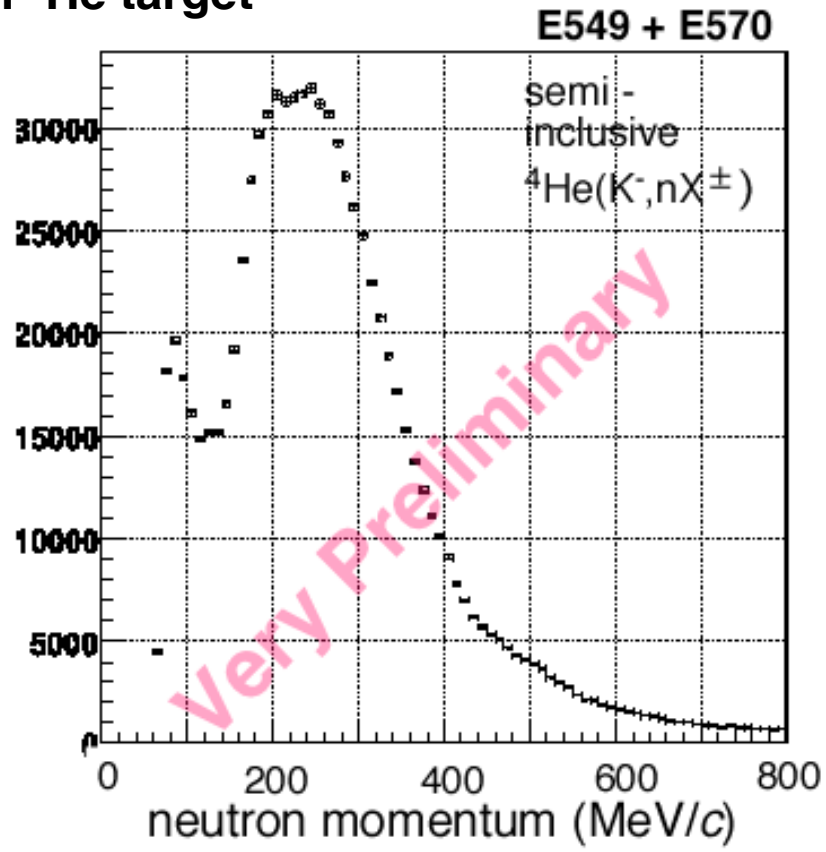


Proton spectra with Charged Particle Trigger

no definitive signal was found in the region of interest

K^- reaction at-rest on ^{4}He target





Severe background from multi-nucleon reaction (2NR) !

in-flight reaction : E15

The J-PARC E15 Collaboration

http://ag.riken.jp/J-PARC/collaboration/

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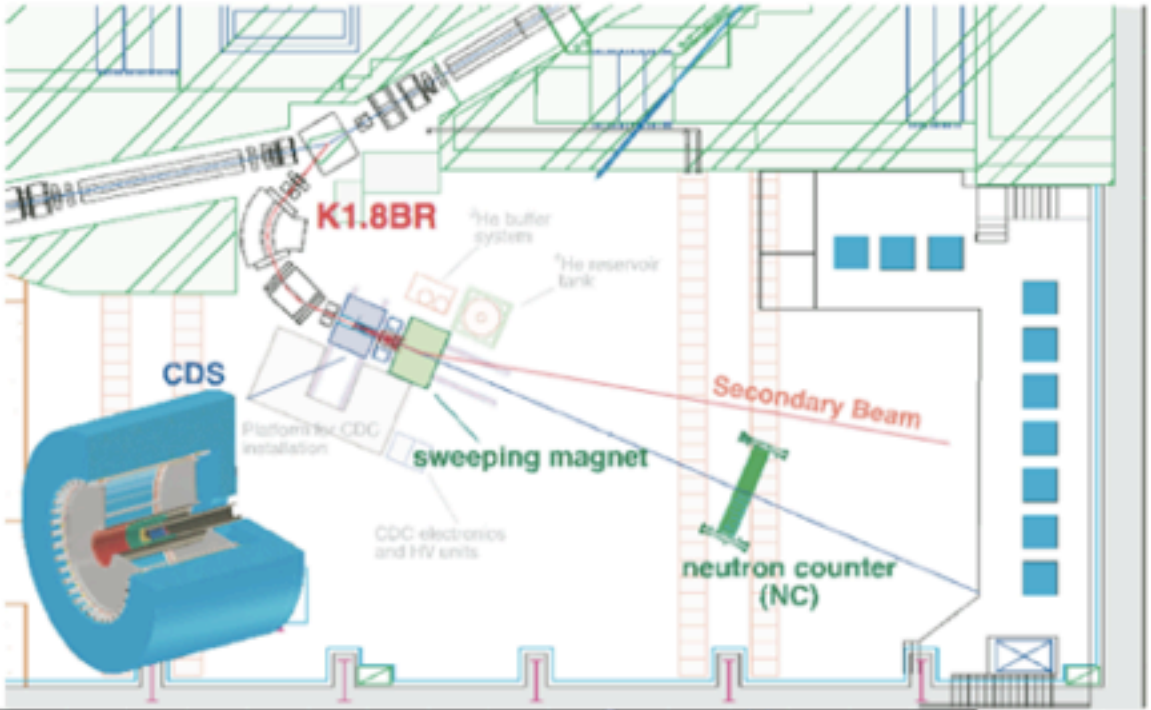
(*) Spokesperson
($) Co-Spokesperson

E15: $\bar{K}N$ interaction study by nuclear bound state



$K^- + {}^3He \rightarrow$ " K^-pp" + n

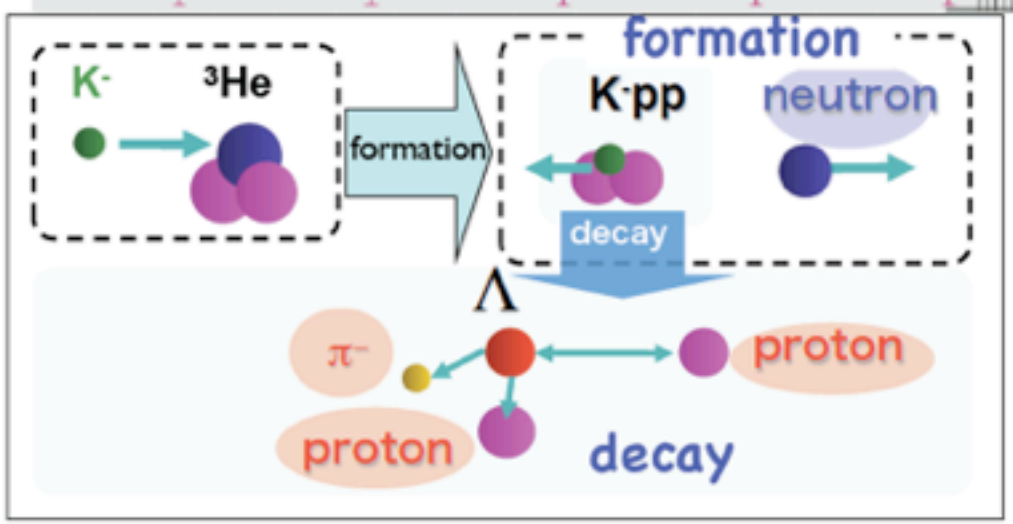
at 1 GeV/c

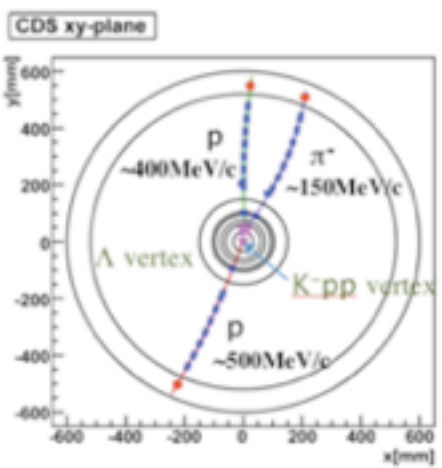
by both

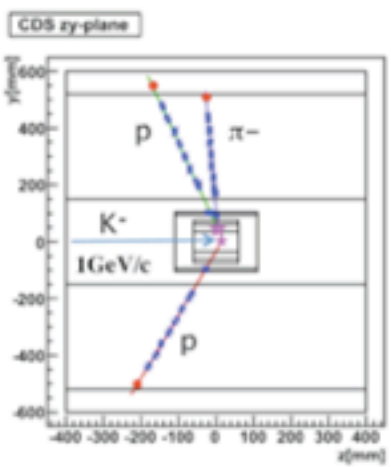
missing & invariant mass

= formation = decay

detect everything!







decay products

detect everything! → event kinematics allows one particle missing

production

$^3He(K^-, n)$ "K^-pp"

by measuring K^- and n (forward)...

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decay examples

"K^-pp" → $\Sigma^\pm \pi^\mp p$

$\Sigma^\pm \to n\, \pi^\pm$

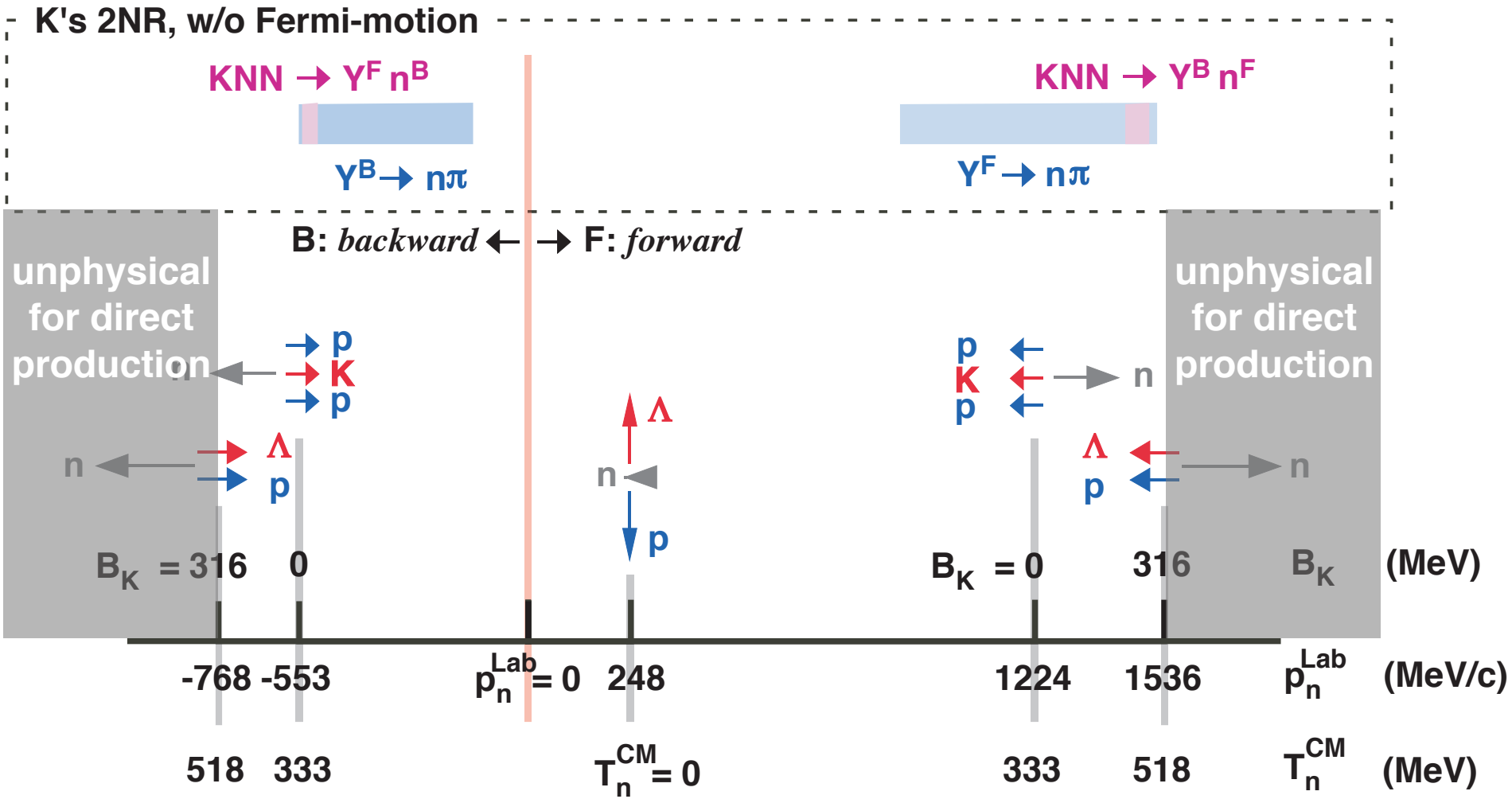
missing neutron can be identified by missing mass analysis

"K^-pp" → Λp

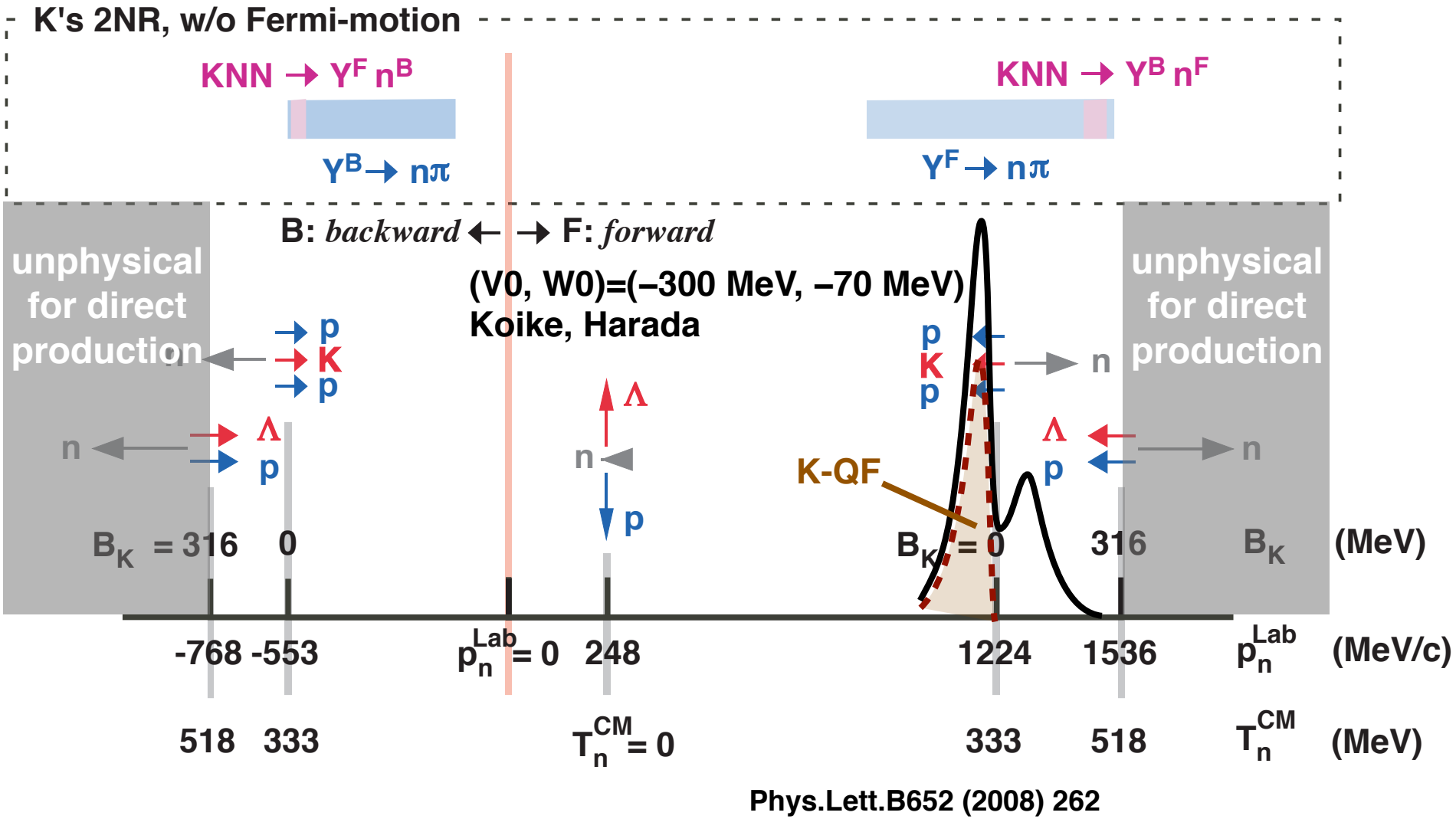
$\Lambda \to p\, \pi^-$

increase sensitive area allowing one particle missing

formation neutron



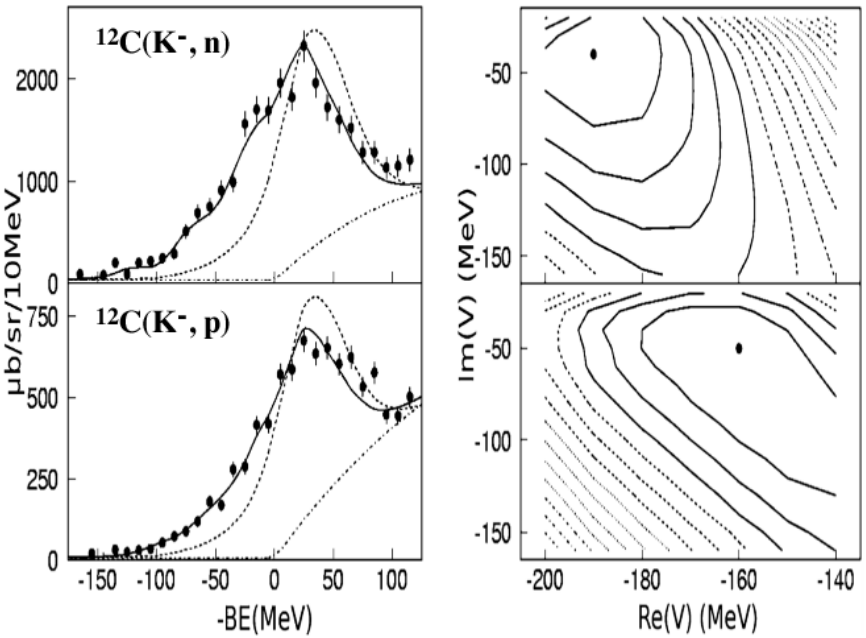
formation neutron



Phys.Lett.B652 (2008) 262

New data

in-flight (K^-, n) reaction @ 1 GeV/c



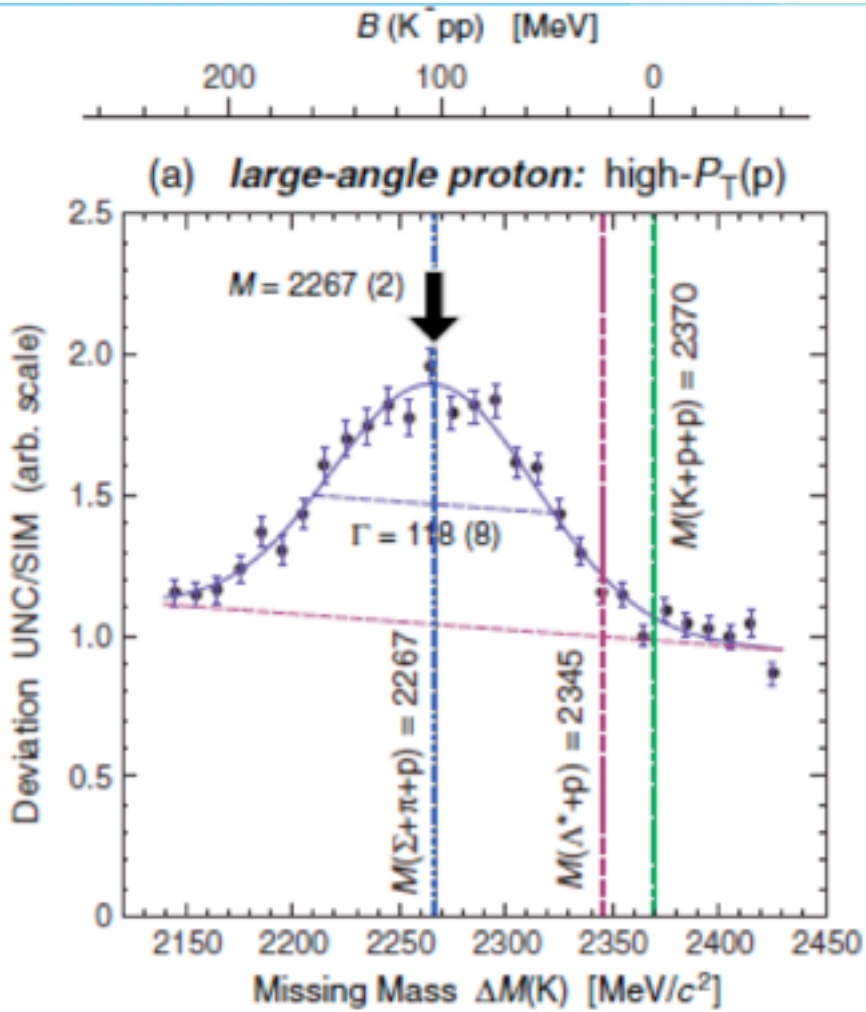
fit = Green's function

T. Kishimoto et al., Prog. Theor. Phys. 118 (2007) 18

indicating very deep potential

- deep & wide KN pot.
  - Re(V) ~ 180 MeV
  - Im(V) ~ 50 MeV
- lower background
  - in-flight ensures ...
  - 2N process suppressed

p (p, K^+) X @ T = 2.85 GeV



T.Yamazaki et al., PRL104(2010)132502

Kpp state? at

M_x=2267±3±5 MeV !

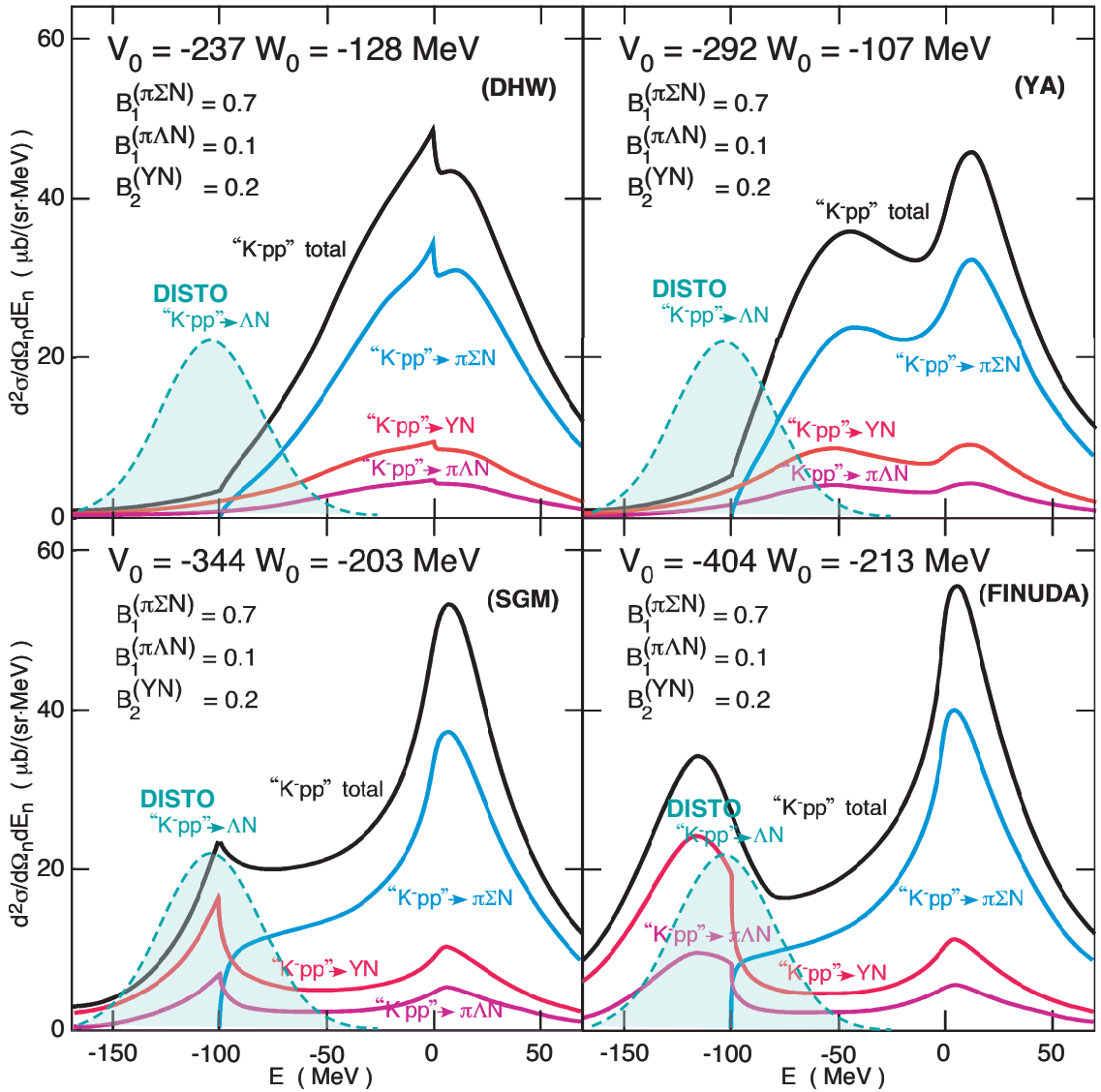
Γ_x=118±8±10 MeV !

Koike-Harada & DISTO

DISTO

B_K~100MeV and Γ_K~100MeV

spectroscopic function



DHW: A. Dote, T. Hyodo, and W. Weise,
Nucl. Phys. A804, 197 (2008);
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YA: T. Yamazaki and Y. Akaishi,
Phys. Lett. B535, 70 (2002);
Proc. Jpn. Academy, Series B 83, 144 (2007)

SGM: N.V. Shevchenko, A. Gal, and J. Mares,
Phys. Rev. Lett. 98, 082301 (2007);
N.V. Shevchenko, A. Gal, J. Mares, and J. Revai,
Phys. Rev. C76, 044004 (2007).

FINUDA: M. Agnello et al.,
Phys. Rev. Lett. 94, 212303 (2005).

DISTO

B_K~100MeV and Γ_K~100MeV

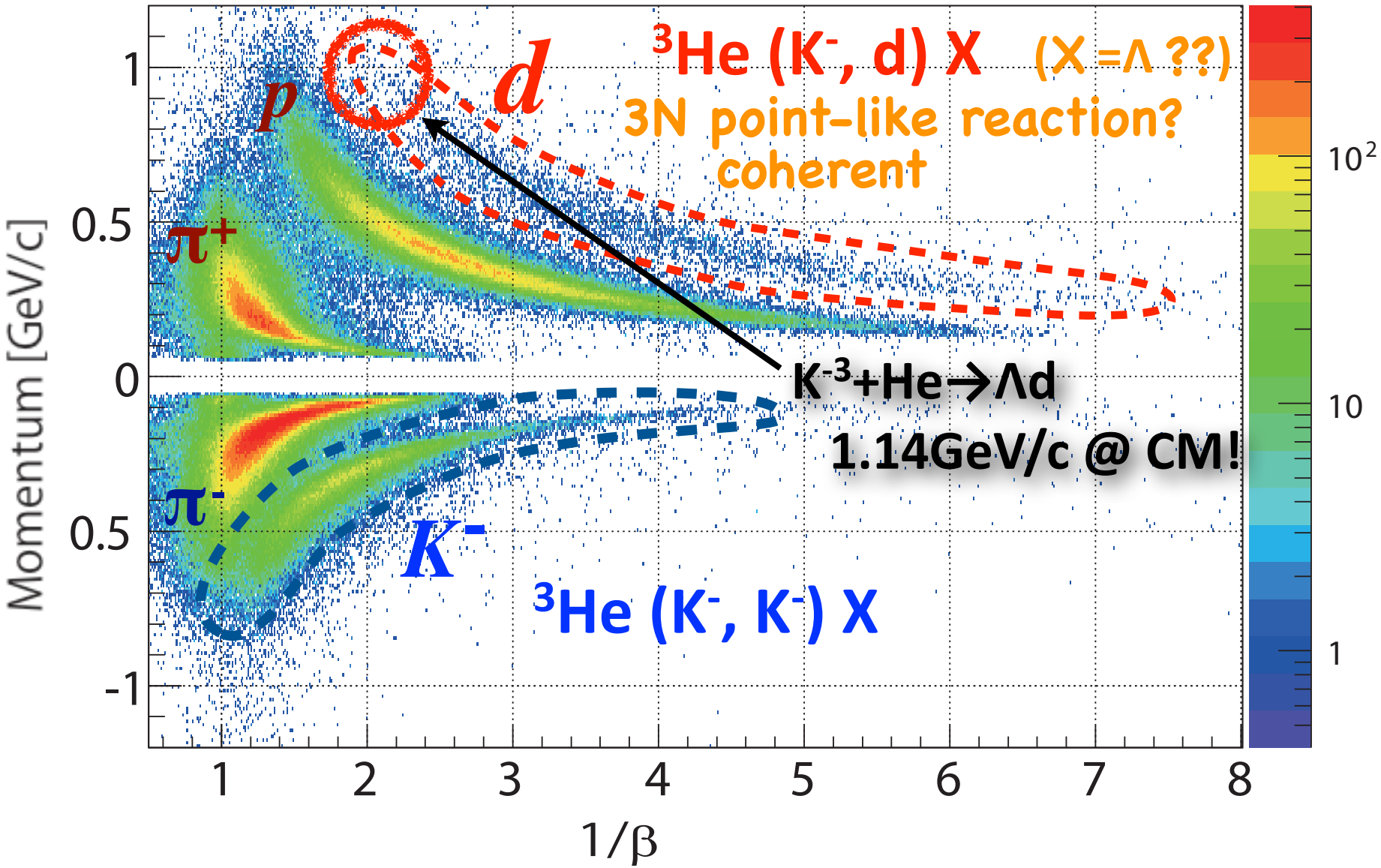
- only for Λp decay ch.

private communication

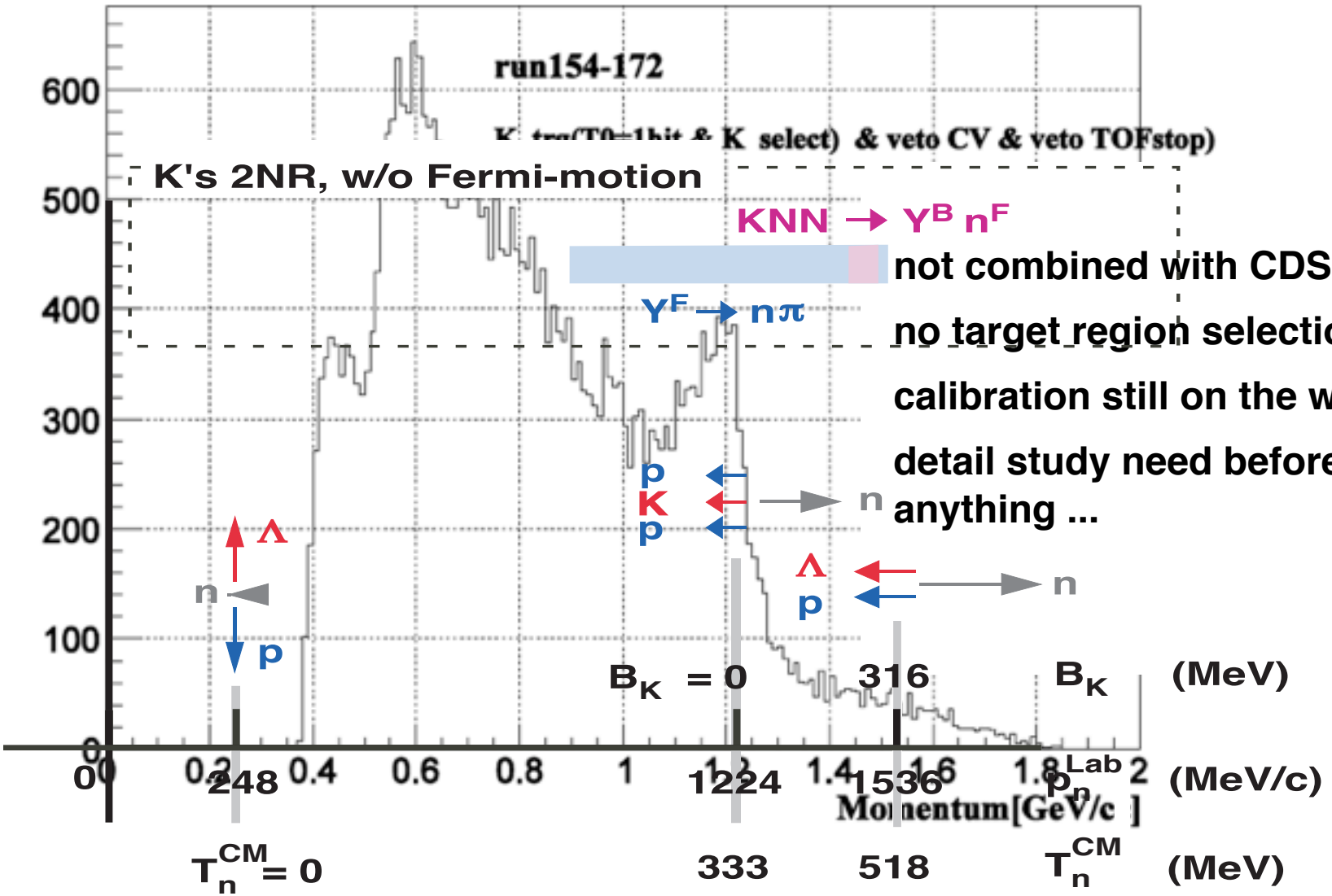
- does not fit in KH scheme

easy to observe,
if dσ/dΩ ≳1mb/sr

PID for CDS: Reaction vertex is in target volume



Very Preliminary Results on ^{3}He(K$^-$,n)



not combined with CDS data yet

no target region selection

calibration still on the way

detail study need before compare anything ...

summary for present E15

E15^{1st} ~ 30kW*week before long shutdown in 2013

1. to know the background processes
2. to evaluate the realistic beam time for E15^{full}
3. to present an information of the K^{bar}N interaction
   → ^{3}He(K^{-},n) spectrum below K^{bar}N threshold
4. to hunt for a hint of signal in Λ+p+n final states

We are ready!

Data seems to be very enthusiastic!

50 ~ 100 times more data only with E15^{1st}!

Beyond E15^{1st}

near future experiments

E17: KN interaction by atom

E31: study of Λ(1405)

beyond E15^{1st} depends largely on result

hint/ambiguous → E15^{full}

¿clear signal? → series of K-nucleus?

can it be feasible only with few % beam of E15^{full}?

another idea at J-PARC?

charmonium in nucleus?

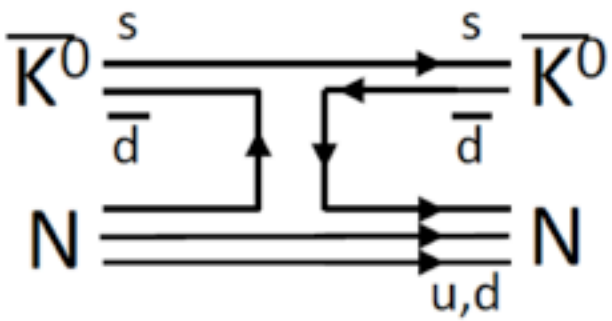
X(1835) : glue-ball? / p-p^{bar} bound state?

doorway to p^{bar} nucleus?

σ in nucleus? (QCD-higgs)

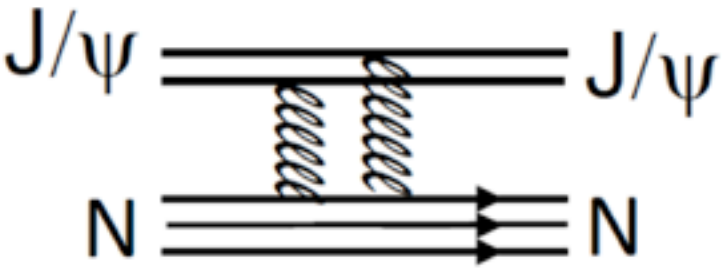
Charmonium in nucleus

- Why charmonium?



Kaon-nucleon interaction

Pion (meson) exchange



J/ψ-nucleon interaction

gluon exchange

J/ψ embedded in nucleus will be best choice
to understand nucleon interaction via gluons
(no meson exchange channel exist in J/ψ-N interaction)

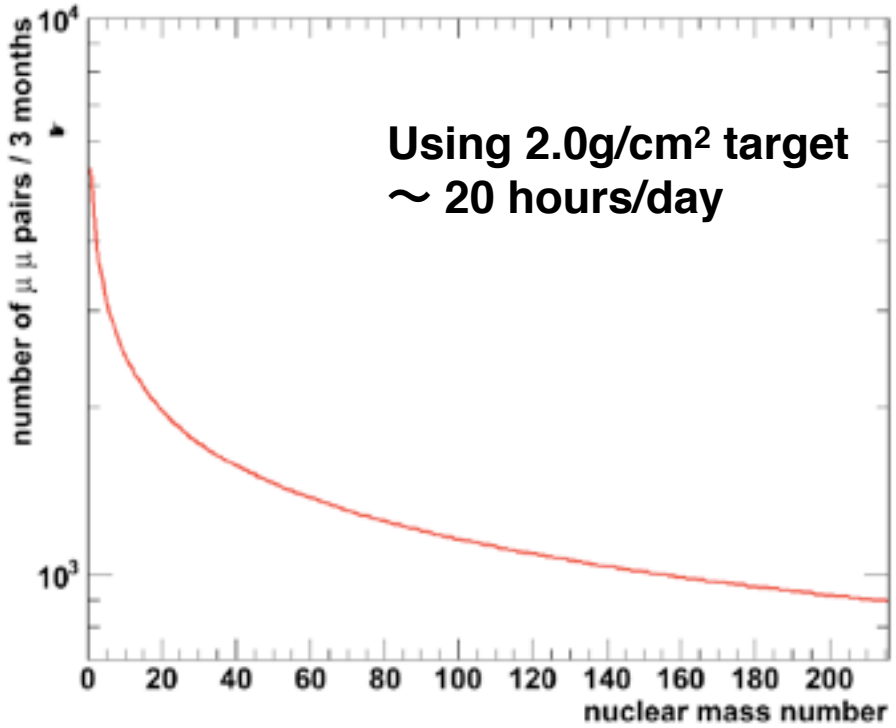
One possibility : using anti-proton?

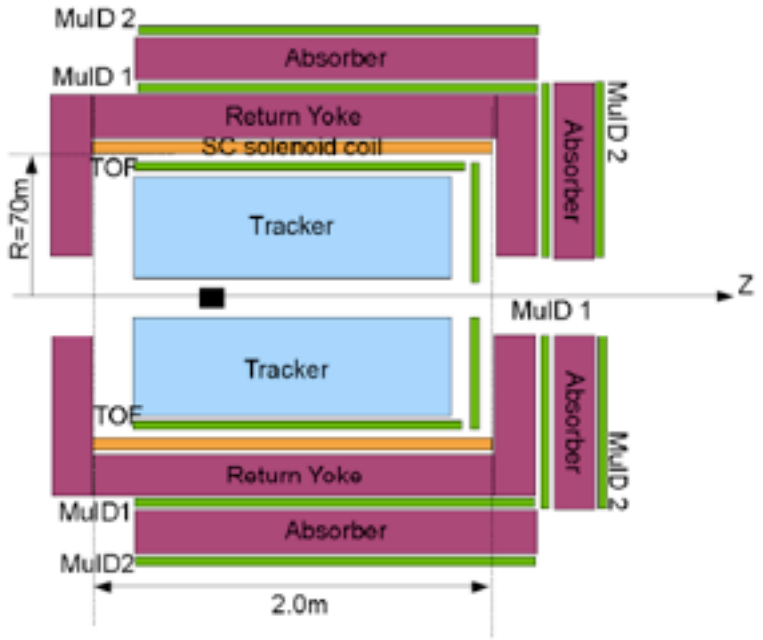
Well known production cross section

(~ 311 nb for p^{bar}-p →J/ψ →μμ on pole energy : p^{bar} @ 4.07 GeV/c)

A-dependence of J/ψ production cross section

about three months of study





Muon spectrometer

Slow J/ψ production

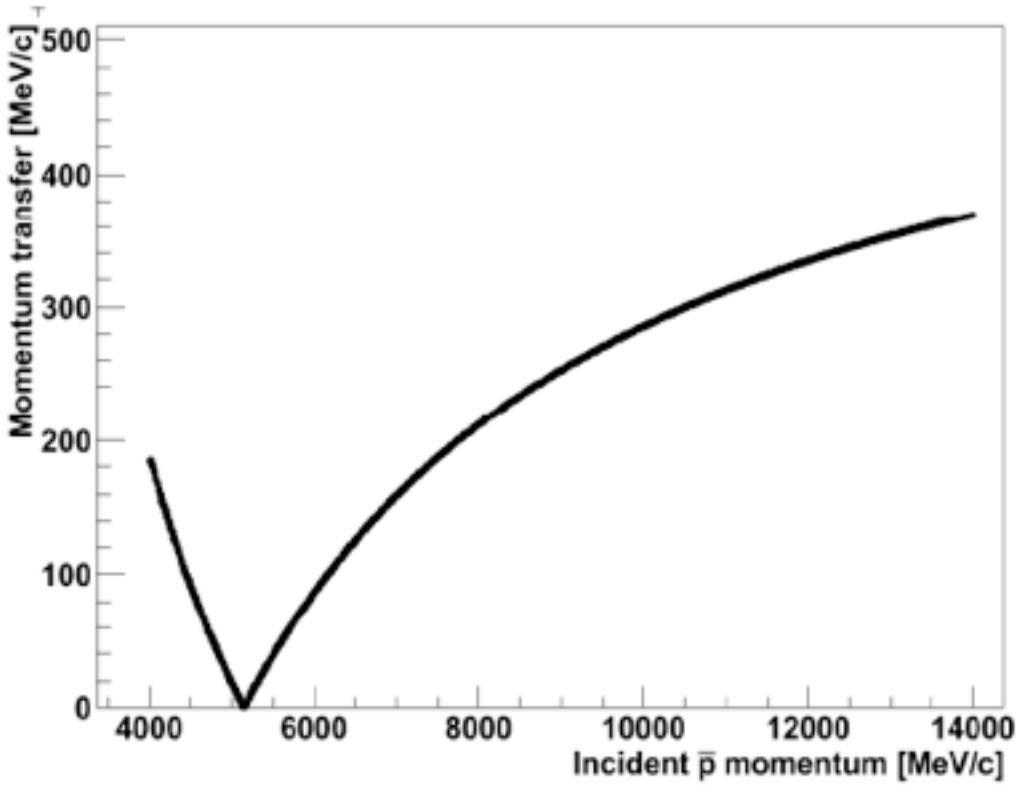
reaction: $p^{bar} + {}^4He \rightarrow J/\psi + {}^3He$

"^{3}He" forward emission :
motivated by E15 d emission, α-cluster in nuclei

magic momentum @ 5GeV/c!

small elementary cross section at magic, unfortunately

momentum transfer is as small as < 200MeV/c near threshold (~300nb), though



We wish to open a new era of nuclear physics using J-PARC