

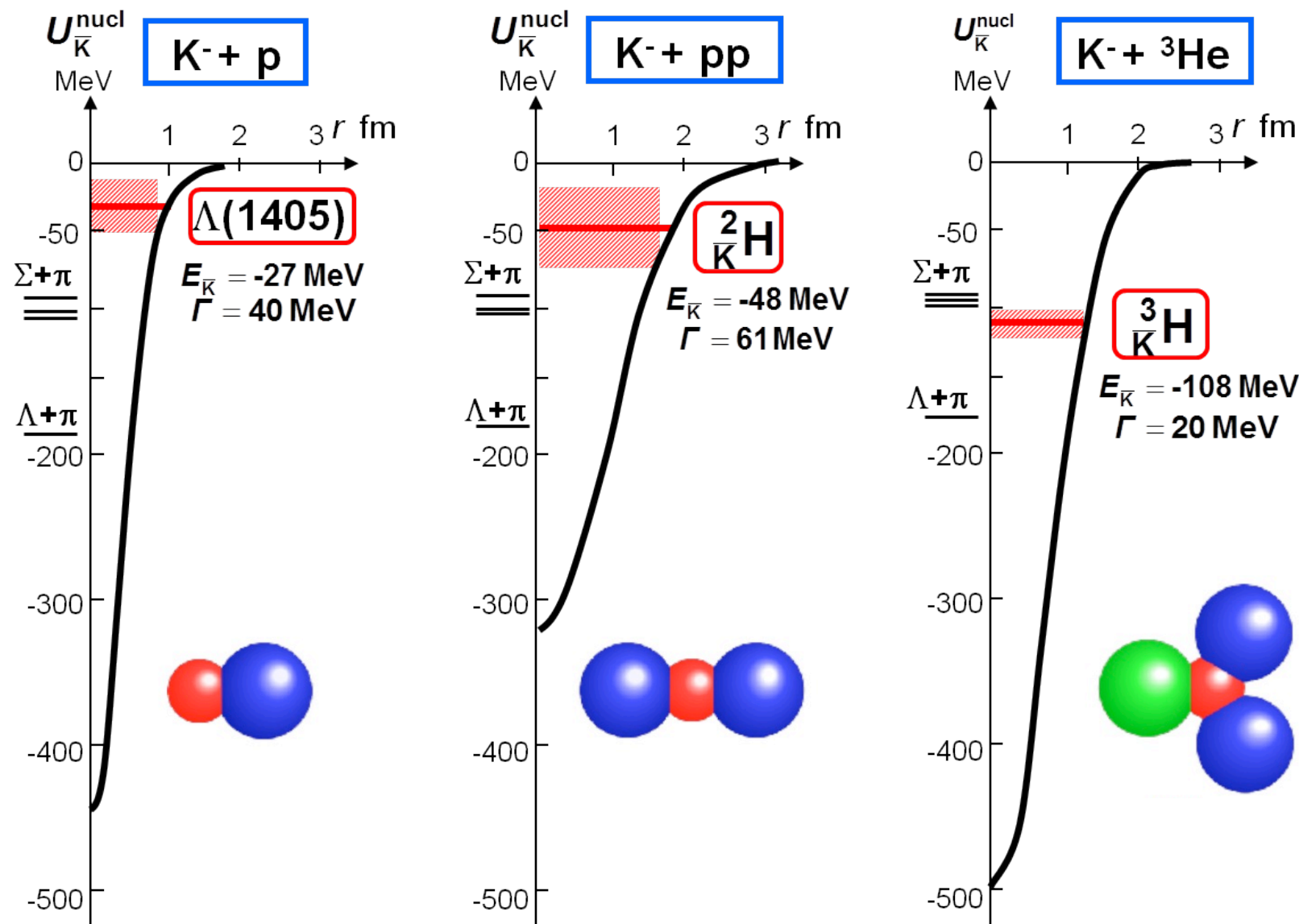
# $^4\text{He}$ 標的へのK-ビーム照射による K-ppn束縛状態探索

橋本 直 (JAEA先端基礎研究センター)  
for the J-PARC E73/T77 collaboration

# Kaonic nuclei

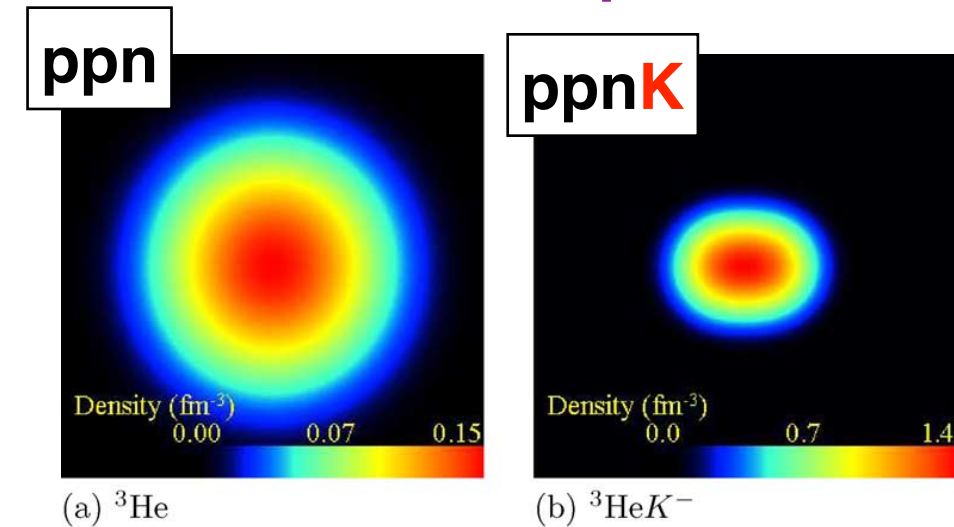
関連セッション: 17pA132 中間子原子・原子核

predicted from  
attractive  $K^{\text{bar}}N$  interaction in  $l=0$



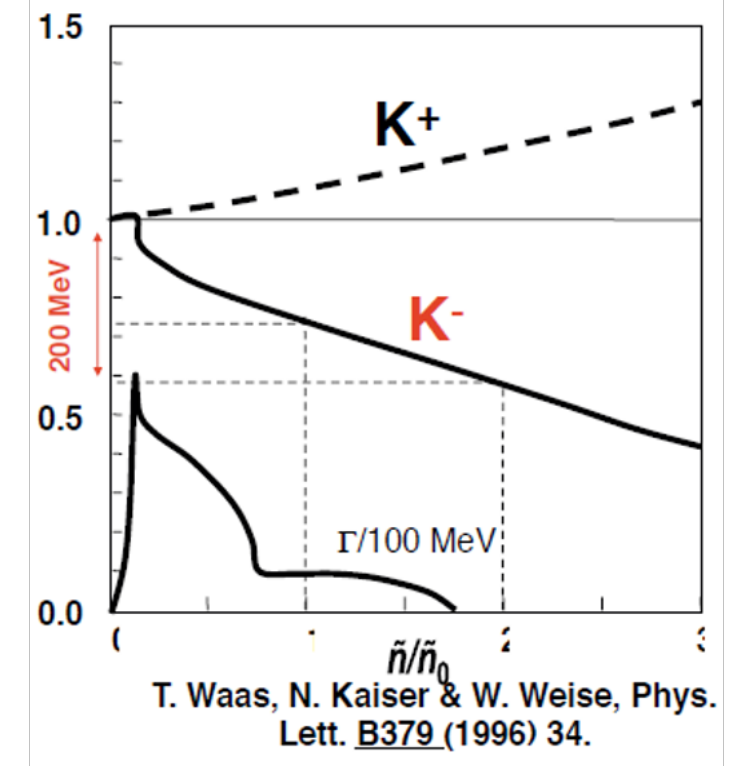
1. Y. Akaishi and T. Yamazaki. *Phys. Rev. C* **65**, 044005 (2002).
2. T. Yamazaki and Y. Akaishi. *Physics Letters B* **535**, 70–76 (2002).

*dense nuclei are predicted*



Phys. Lett. B 590 (2004) 51

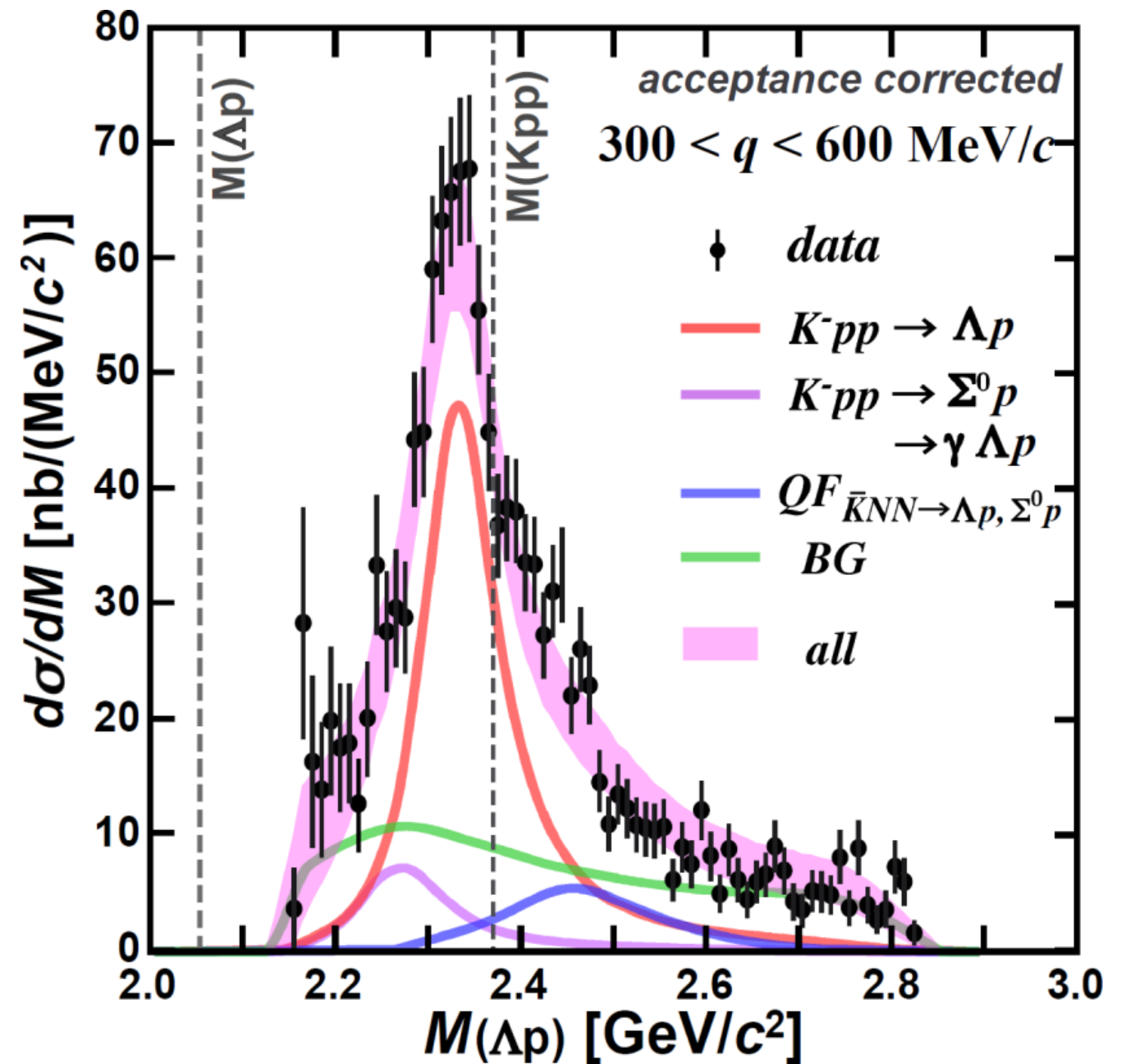
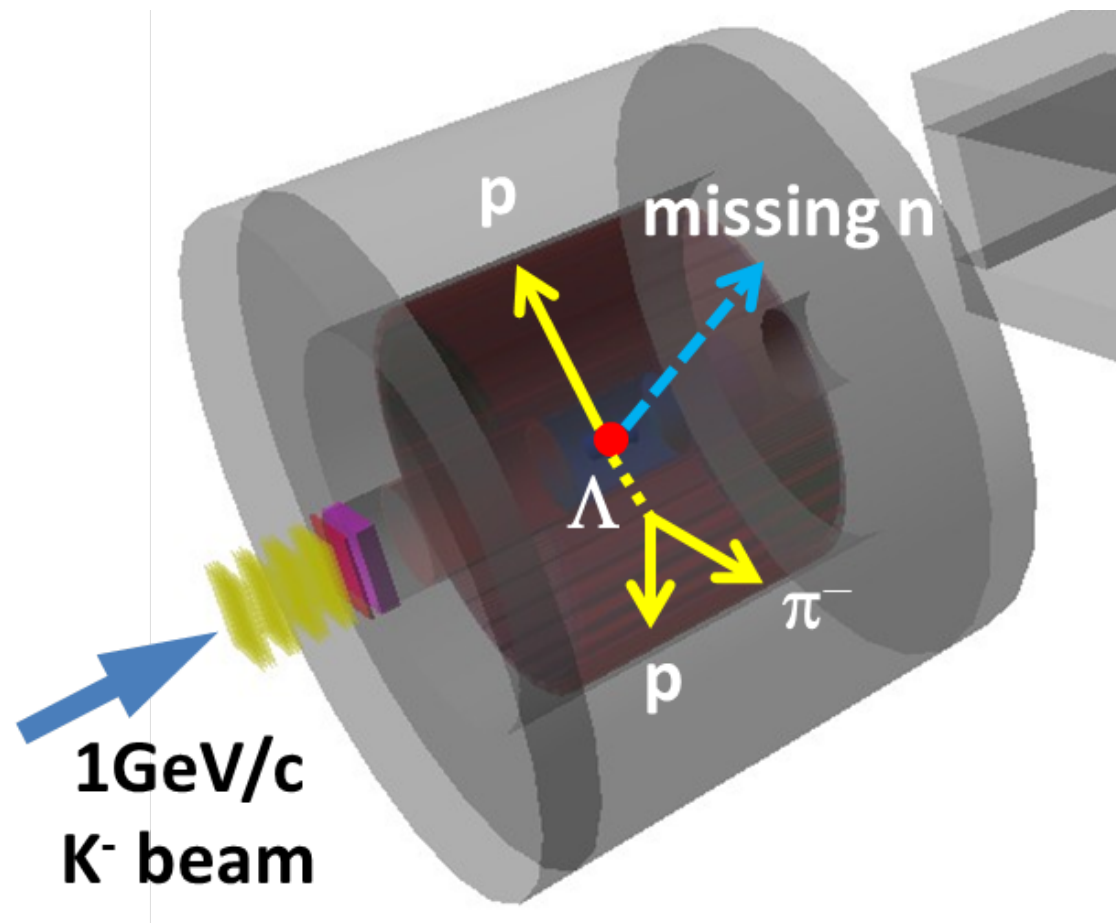
*Kaon mass changes  
in nuclear medium?*



*Anti-Kaon could be a unique probe for hadron/nuclear physics*

# “K-pp” in J-PARC E15

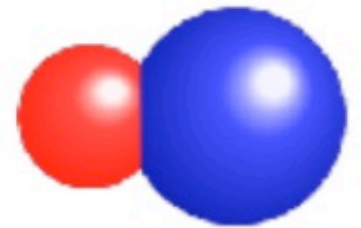
PLB789(2019)620., PRC102(2020)044002.



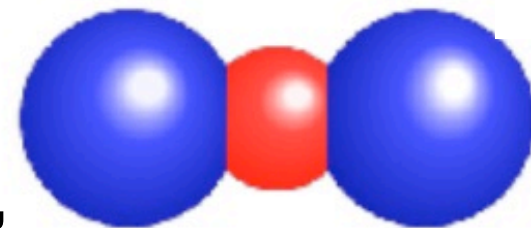
- Exclusive measurement of all the final state particles
- Most convincing data after a history of 20-year search

# What's next?

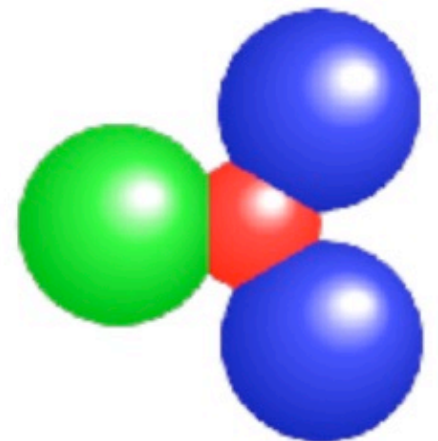
- $\Lambda(1405)$  (E31+)
- Details of the “ $K^{\text{bar}}NN$ ” (P89)
  - spin-parity, isospin partner “ $K^0\text{bar}nn$ ”
- Heavier kaonic nuclei (E80)
- Double kaonic nuclei (LOI)



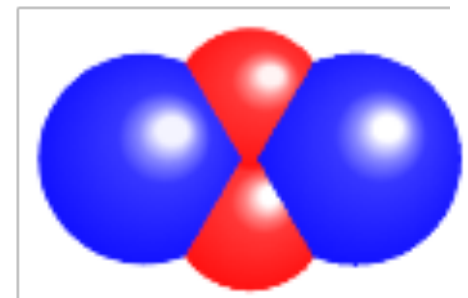
$K^-p$



$K^-pp$



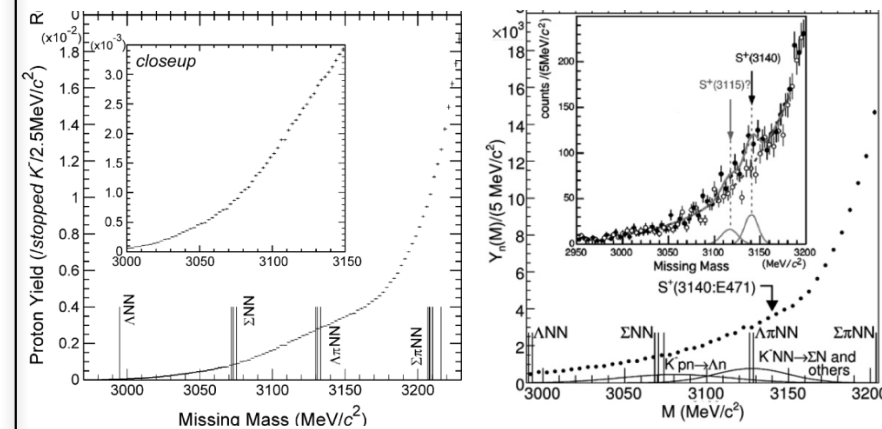
$K^-ppn$



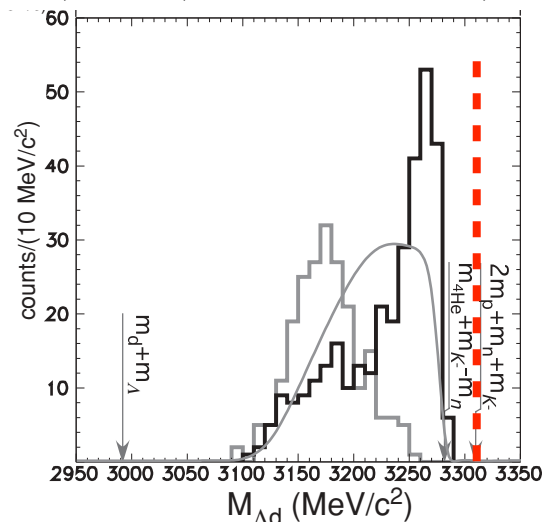
$K\text{-}K^-pp$

# “K-ppn”: Experimental situation

## Stopped K<sup>-</sup> on <sup>4</sup>He E471/E549@KEK



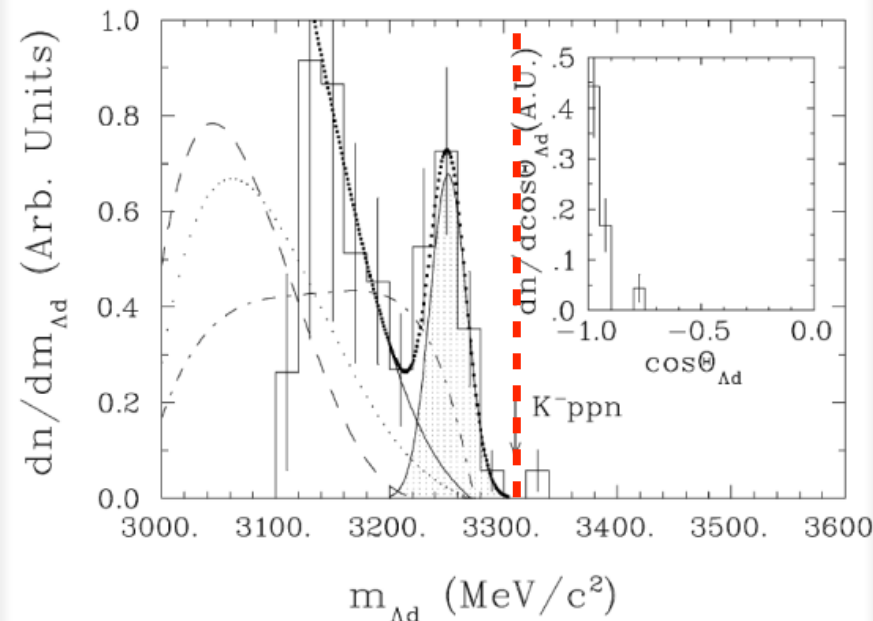
PLB659(2008)107, PLB688(2010)43



PRC76(2007)068202

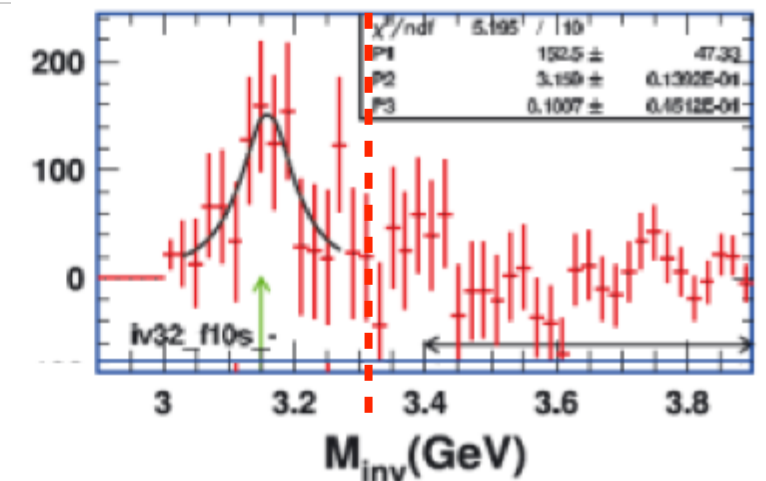
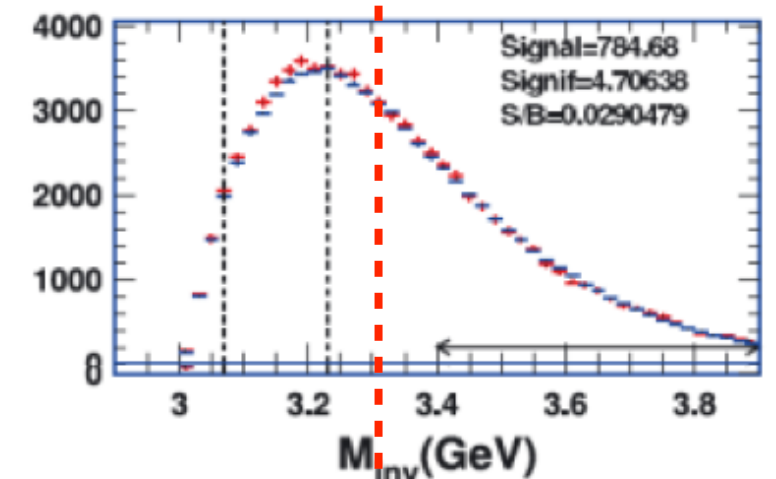
## Stopped K<sup>-</sup> on Li/C back-to-back $\Lambda$ d

FUNUDA@DAΦNE



PLB654(2007)80

## $\Lambda$ d in Ni+Ni FOPI@GSI



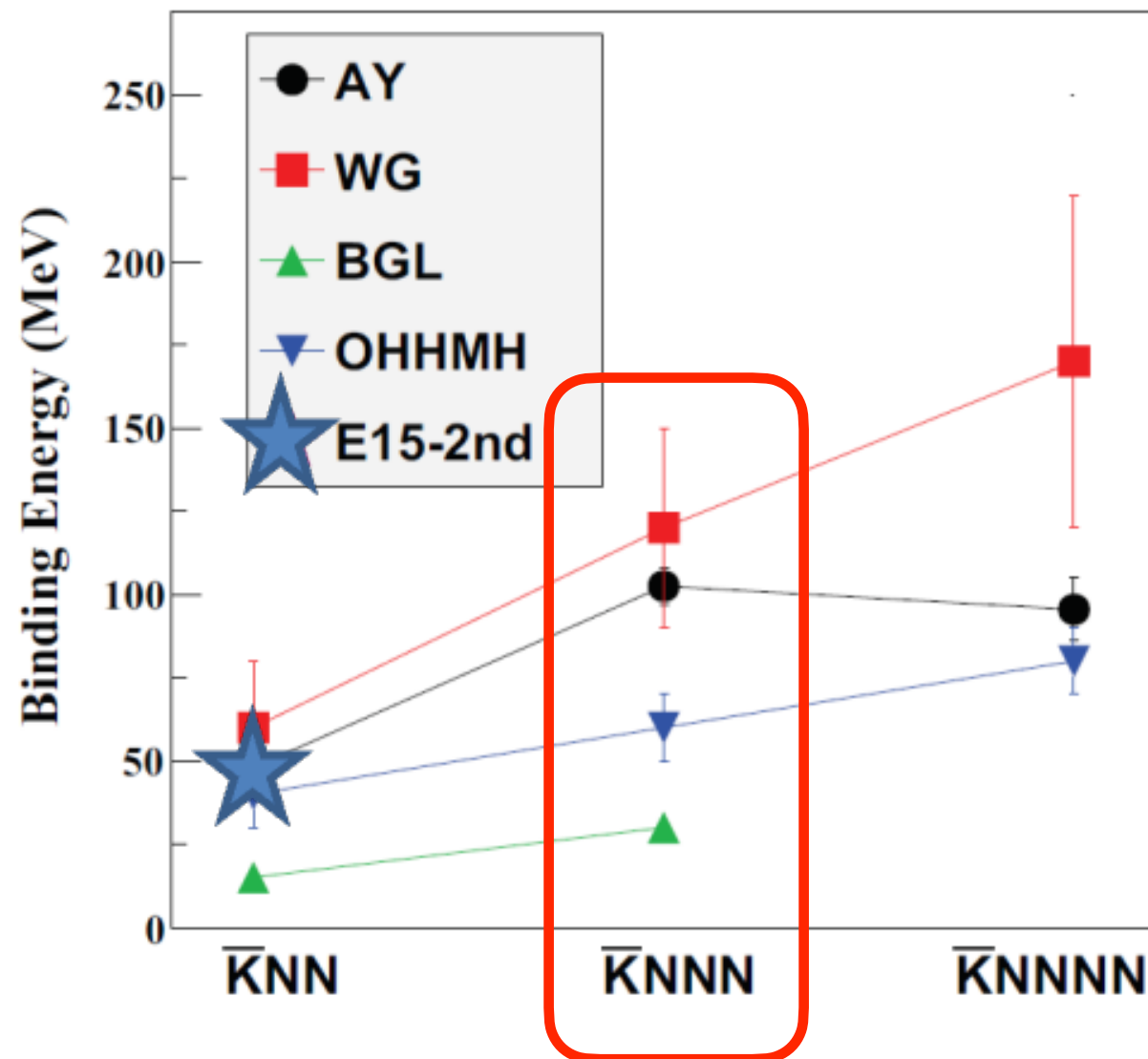
EXA05 Proceedings (2005)

- Some experimental searches in 2000s. No conclusive result.

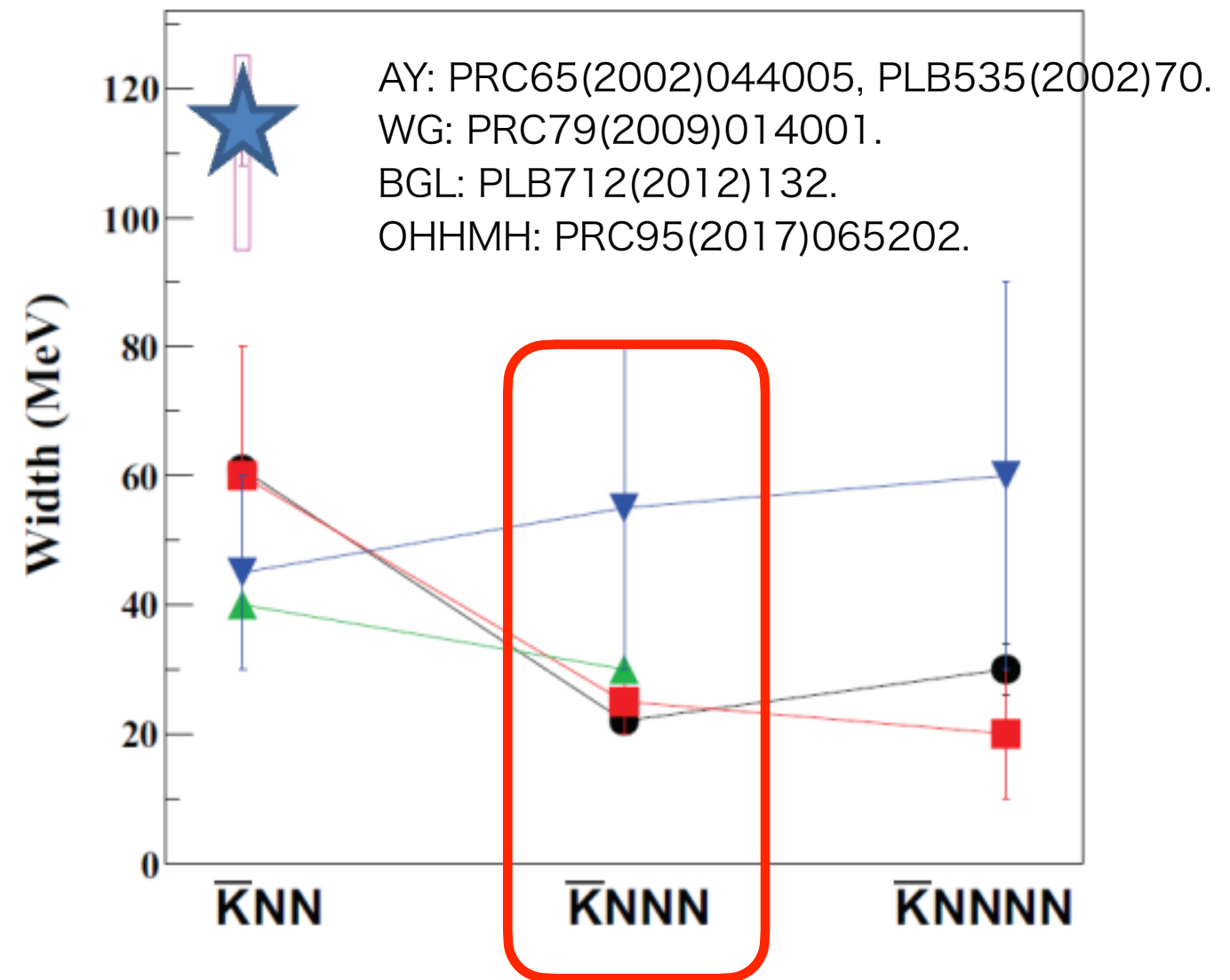


# “K-ppn”: Theoretical situaion

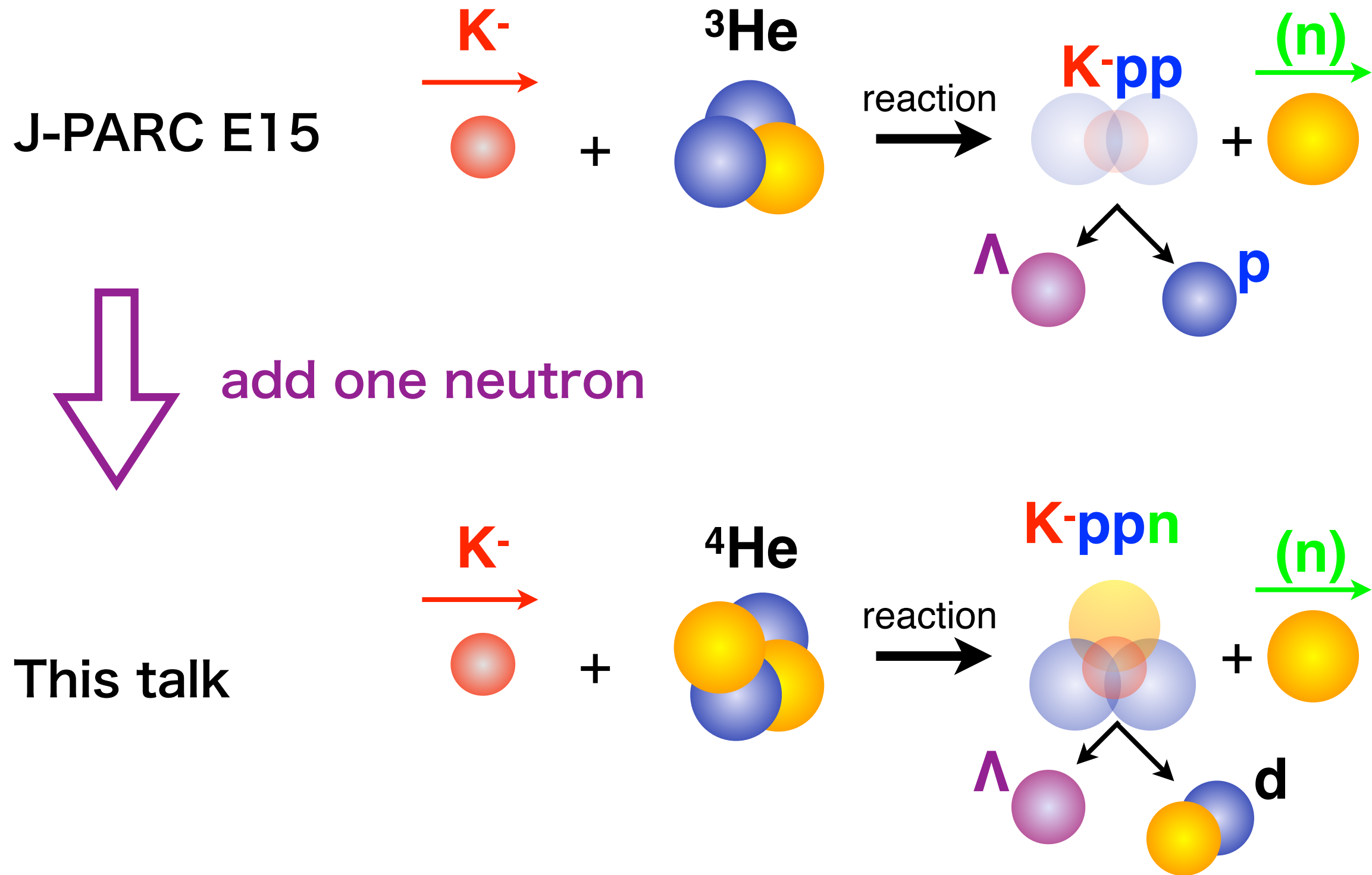
## Binding Energy



## Width (mesonic-only)



Larger binding than “K-pp” and similar width are predicted.

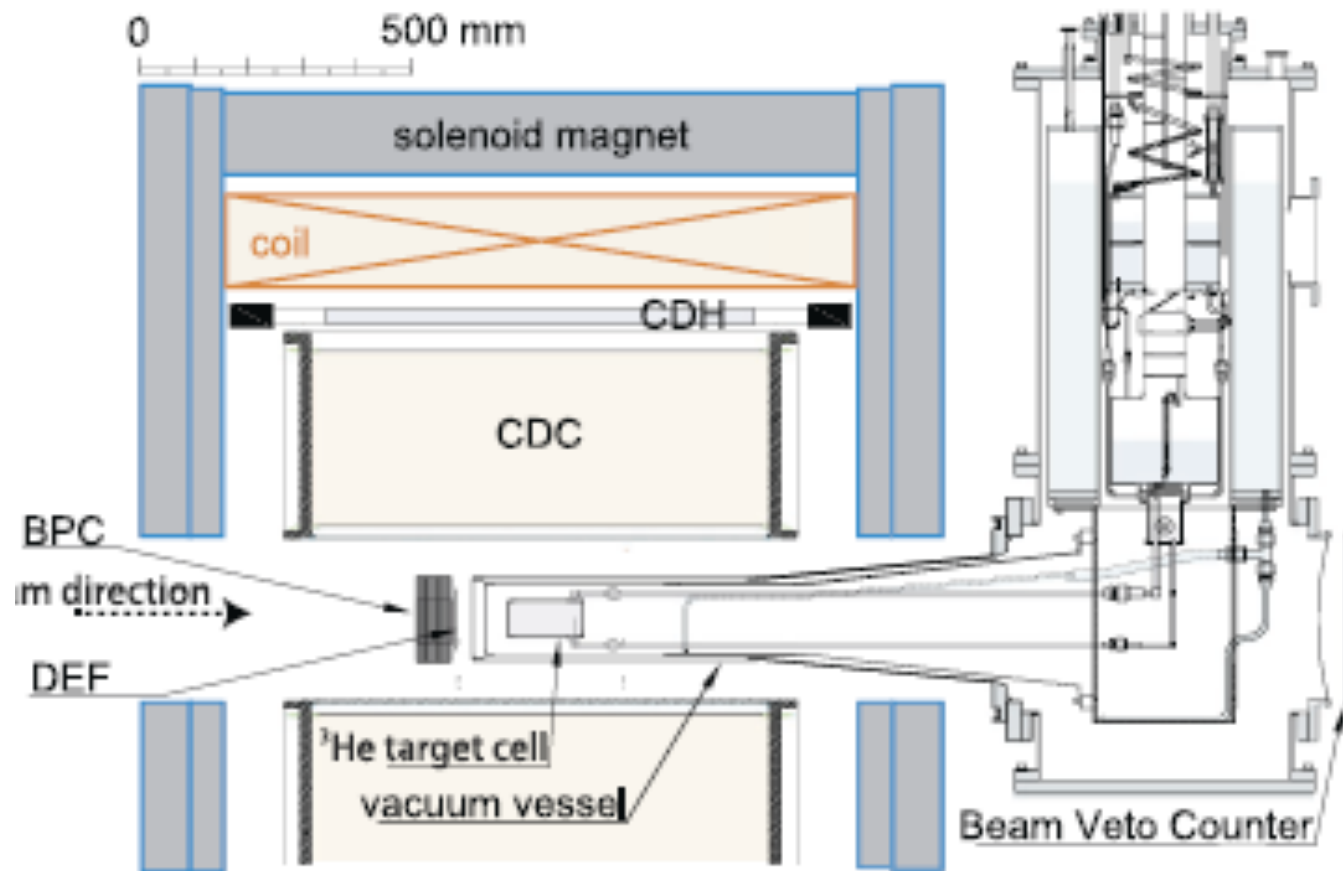


We have small dataset with  ${}^4\text{He}$  target  
for the lifetime measurement of hypernuclei (J-PARC T77/E73)

# J-PARC E15 vs T77

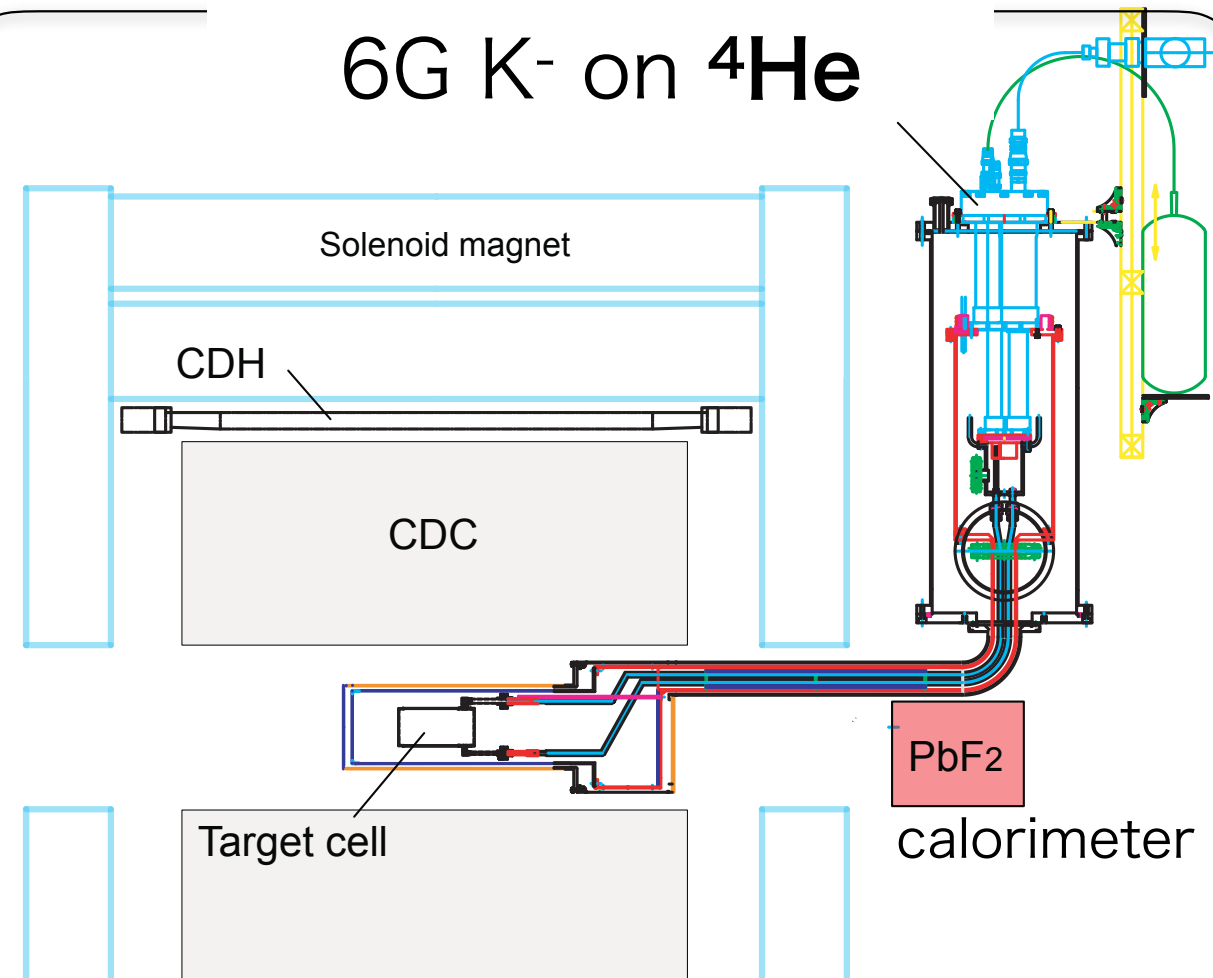
J-PARC E15@2015

42G K<sup>-</sup> on <sup>3</sup>He



J-PARC T77@2020

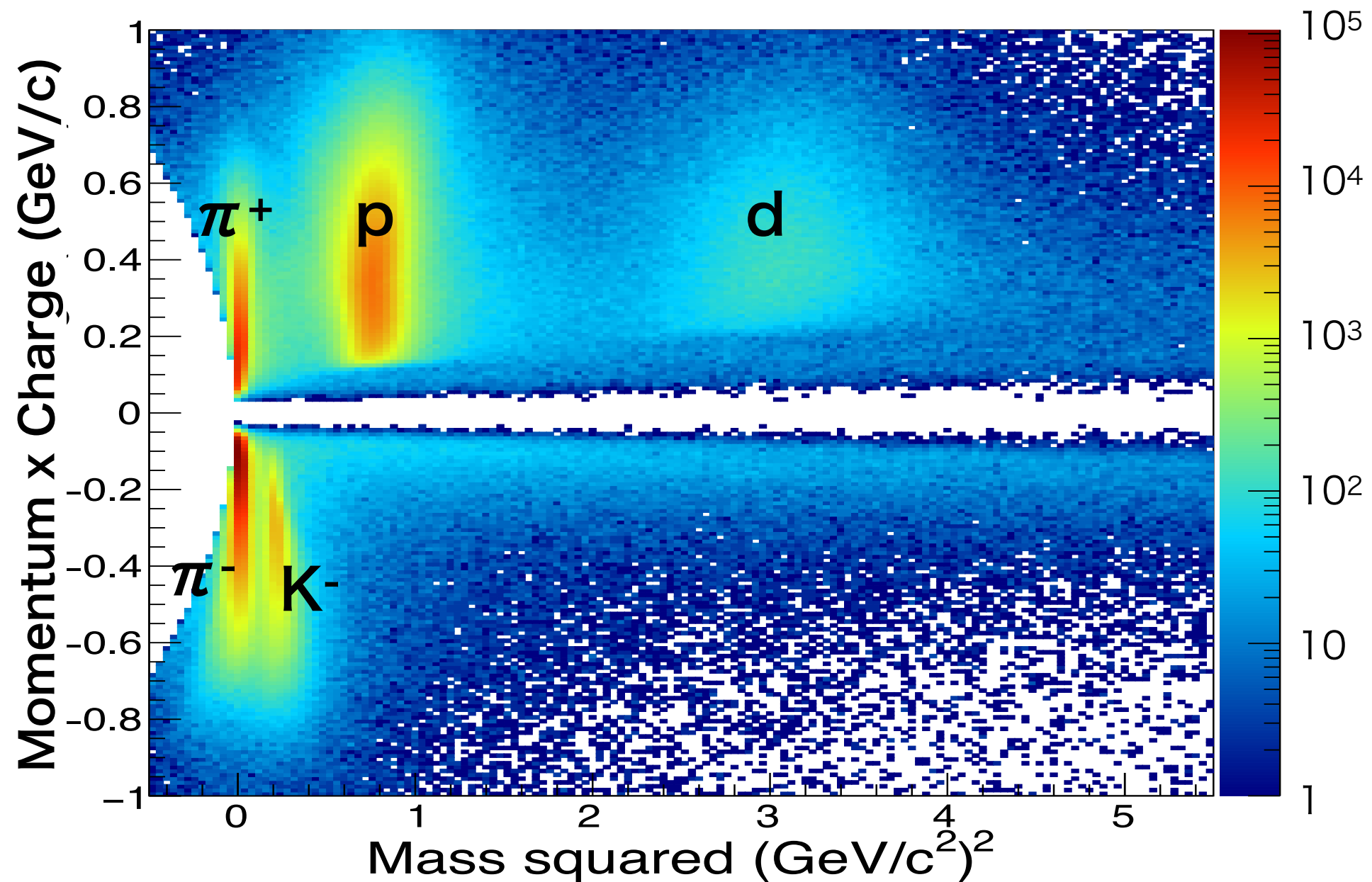
6G K<sup>-</sup> on <sup>4</sup>He



- The same cylindrical detector system + forward calorimeter for lifetime measurements of hypernuclei
- New cryogenic target system. <sup>3</sup>He → <sup>4</sup>He
- Improved DAQ efficiency. 80%@1k/spill → >90%@10k/spill



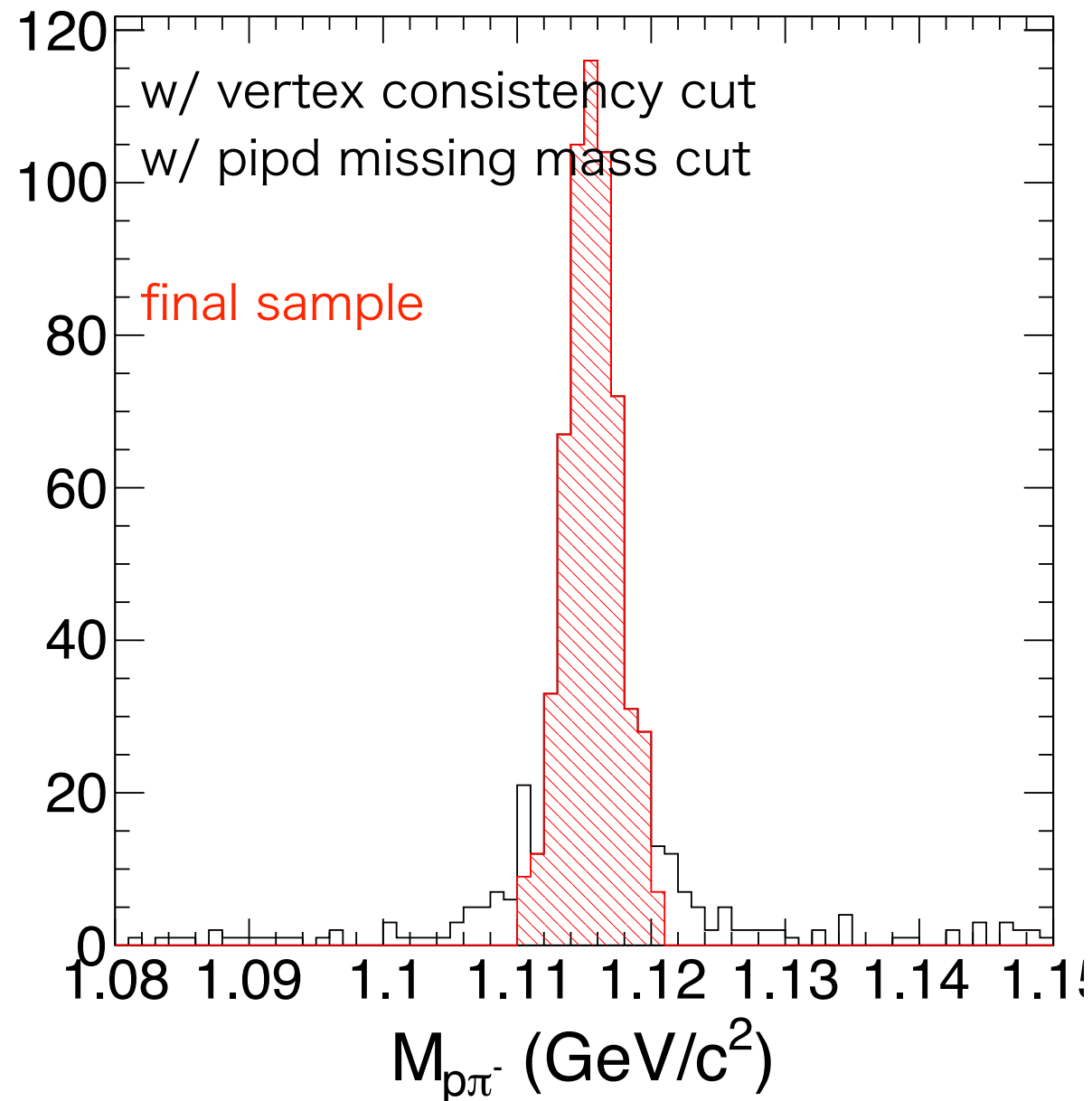
# Deuteron identification in CDS



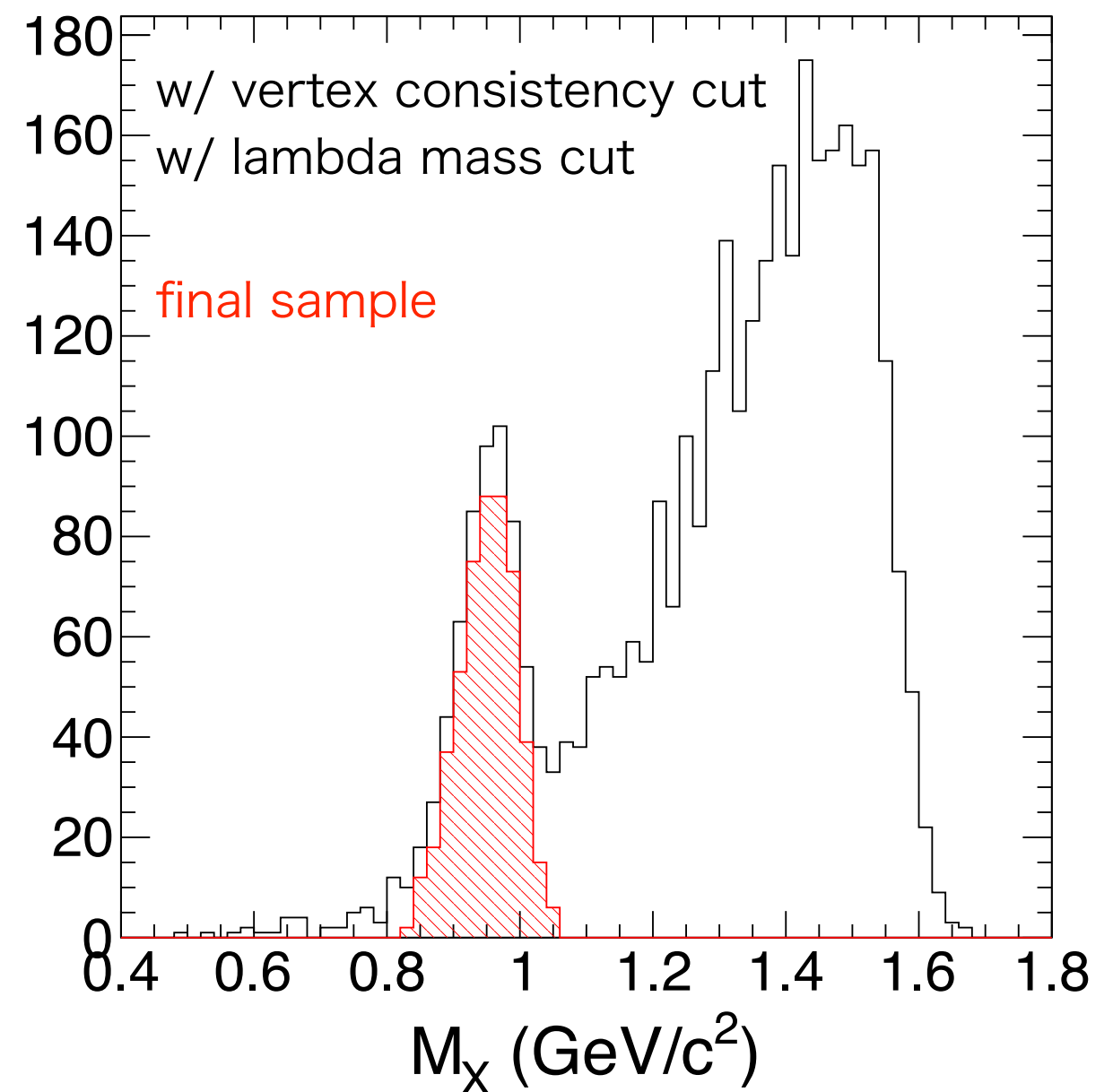
Deuterons are identified using the track curvature and TOF

# $\Lambda$ dn event selection

## $\Lambda$ reconstruction



## Missing neutron ID

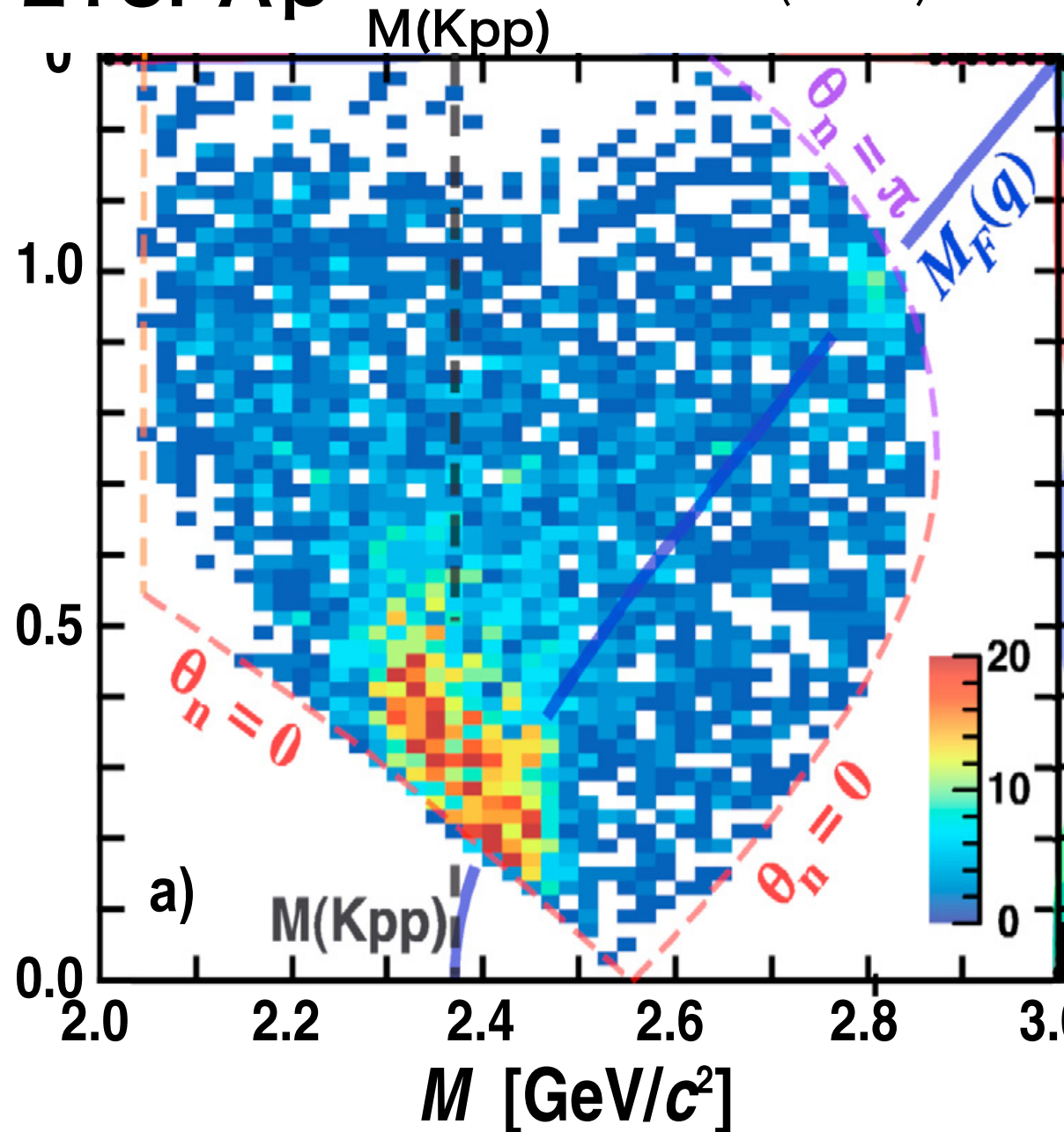


- $\Lambda$ dn final states are identified with a good purity
- ~20% contamination from  $\Sigma^0$ dn/ $\Sigma^-$ dp

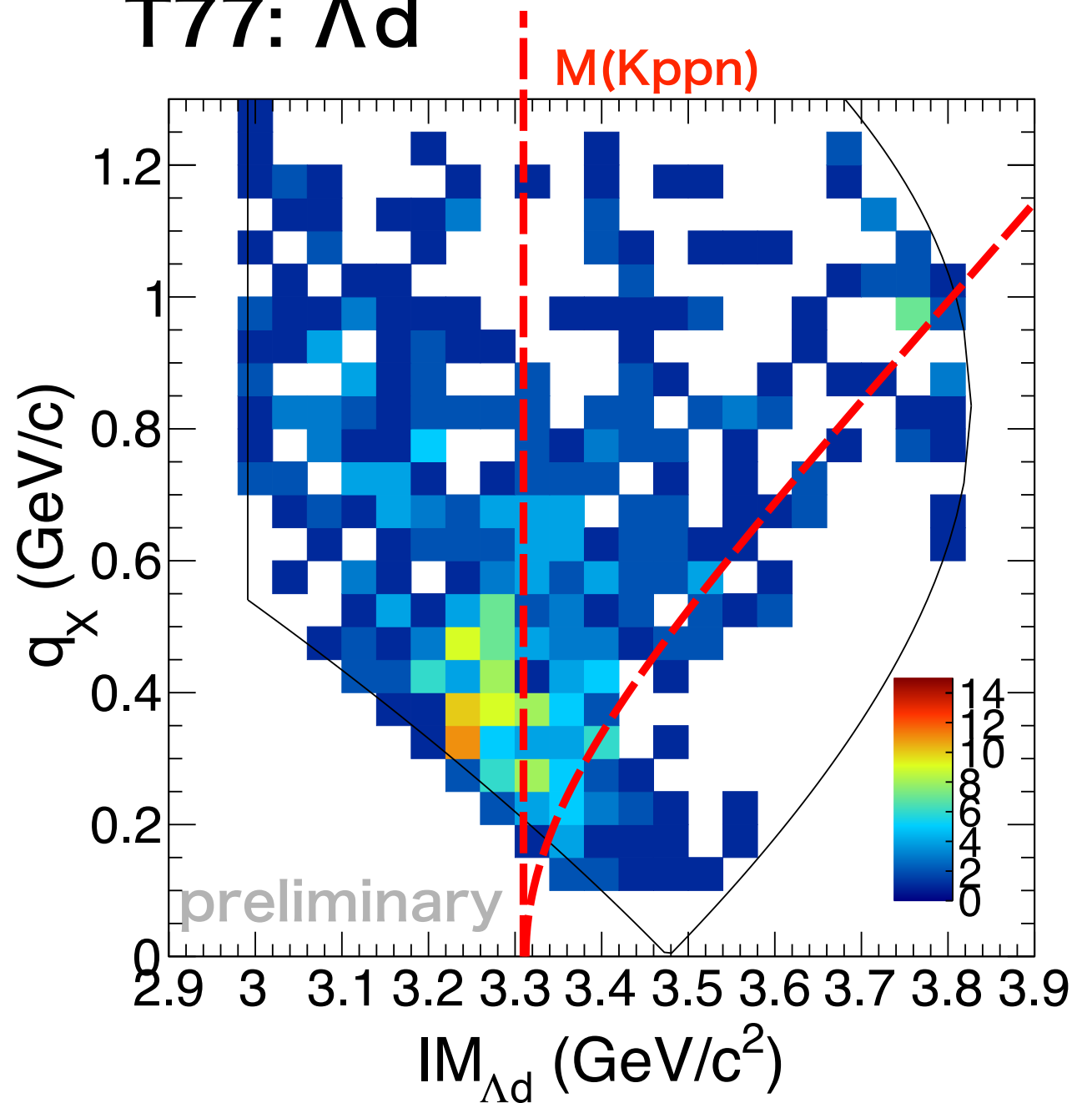
# Preliminary result

before acceptance correction

E15:  $\Lambda p$  PLB789(2019)620



T77:  $\Lambda d$



- Two distributions are quite similar
- CS x B.R.  $\sim 10 \mu b$  for “K-pp”, a few  $\mu b$  for “K-ppn”

# Summary & Outlook

- We observed  ${}^4\text{He}(\text{K}^-, \Lambda)\text{d}n$  events as a by-product of J-PARC T77: Lifetime measurement of hypernuclei.
- The observed distribution is similar to that of  $\Lambda p$  in E15, and would be a signal of “**K-ppn**”.  
→ **First A-dependence data of Kaonic nuclei.**
- We are proposing to take **x10 data** with the present CDS to compare with “K-pp” in detail. (**~ 2 week** beam time as P92)
- More comprehensive study with a **neutron detection** capability and  **$\sim 4\pi$  acceptance** can be done with a next-generation larger CDS in the not-so-distant future.

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**Thank you for your attention!**