

J-PARC K1.8BRビームラインにおける 液体 ^3He 標的へのK-ビーム照射実験(2)

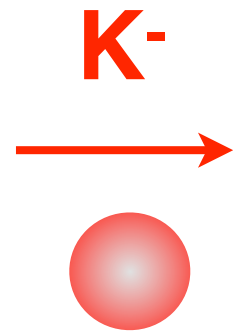
- **Forward neutron in J-PARC E15**
- **NC analysis**
- **$^3\text{He}(\text{K}^-, \text{K}^0_s \text{n})\text{d}$ analysis**
- **neutron semi-inclusive spectrum**

**Tadashi Hashimoto
for J-PARC E15 collaboration**

J-PARC E15 experiment

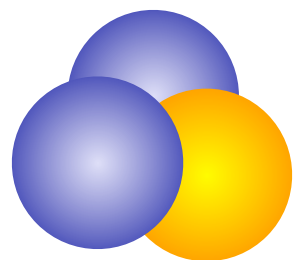
A search for the simplest kaonic nucleus K -pp

1 GeV/c



+

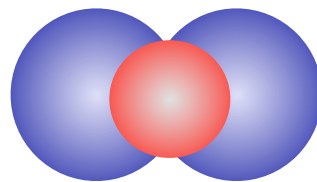
^3He



reaction

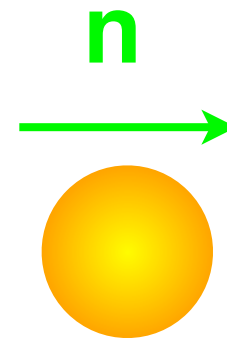


K -pp



+

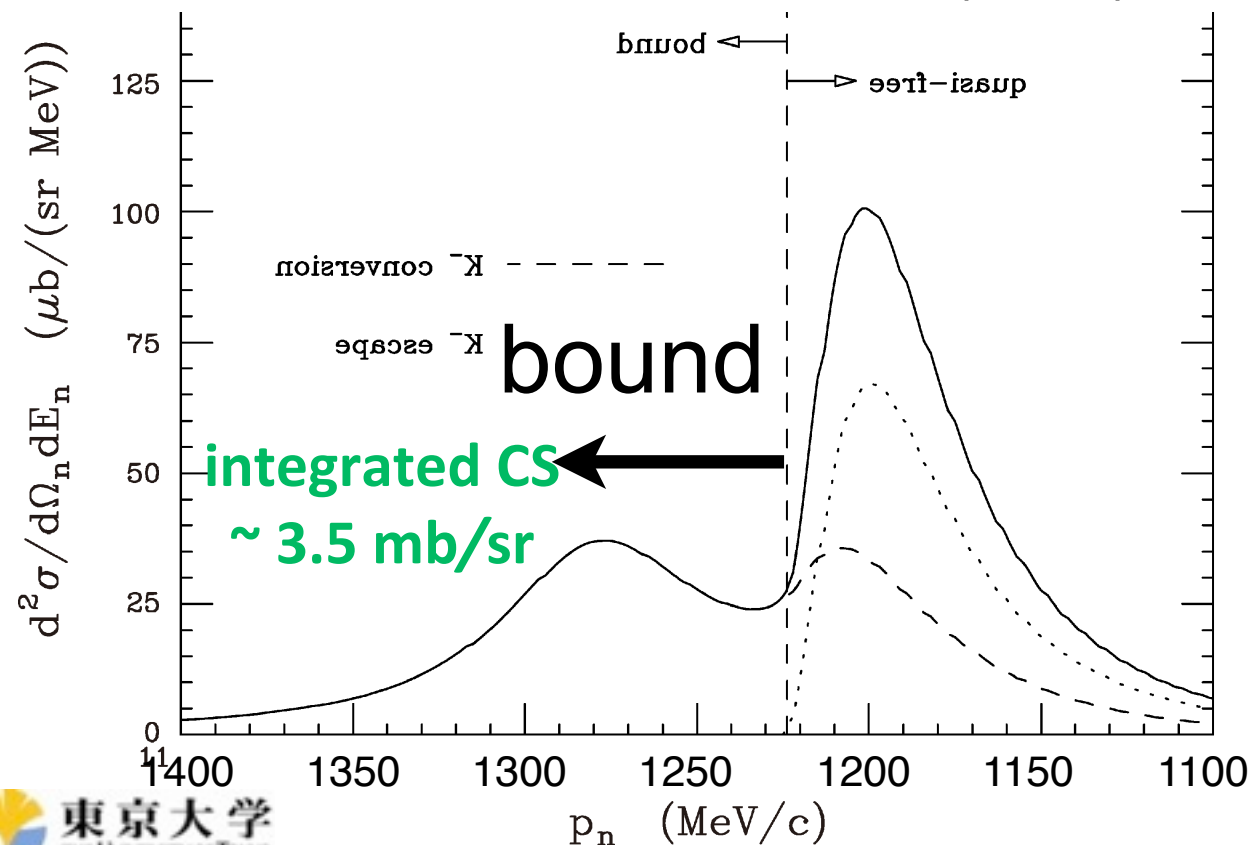
1.2~1.3 GeV/c



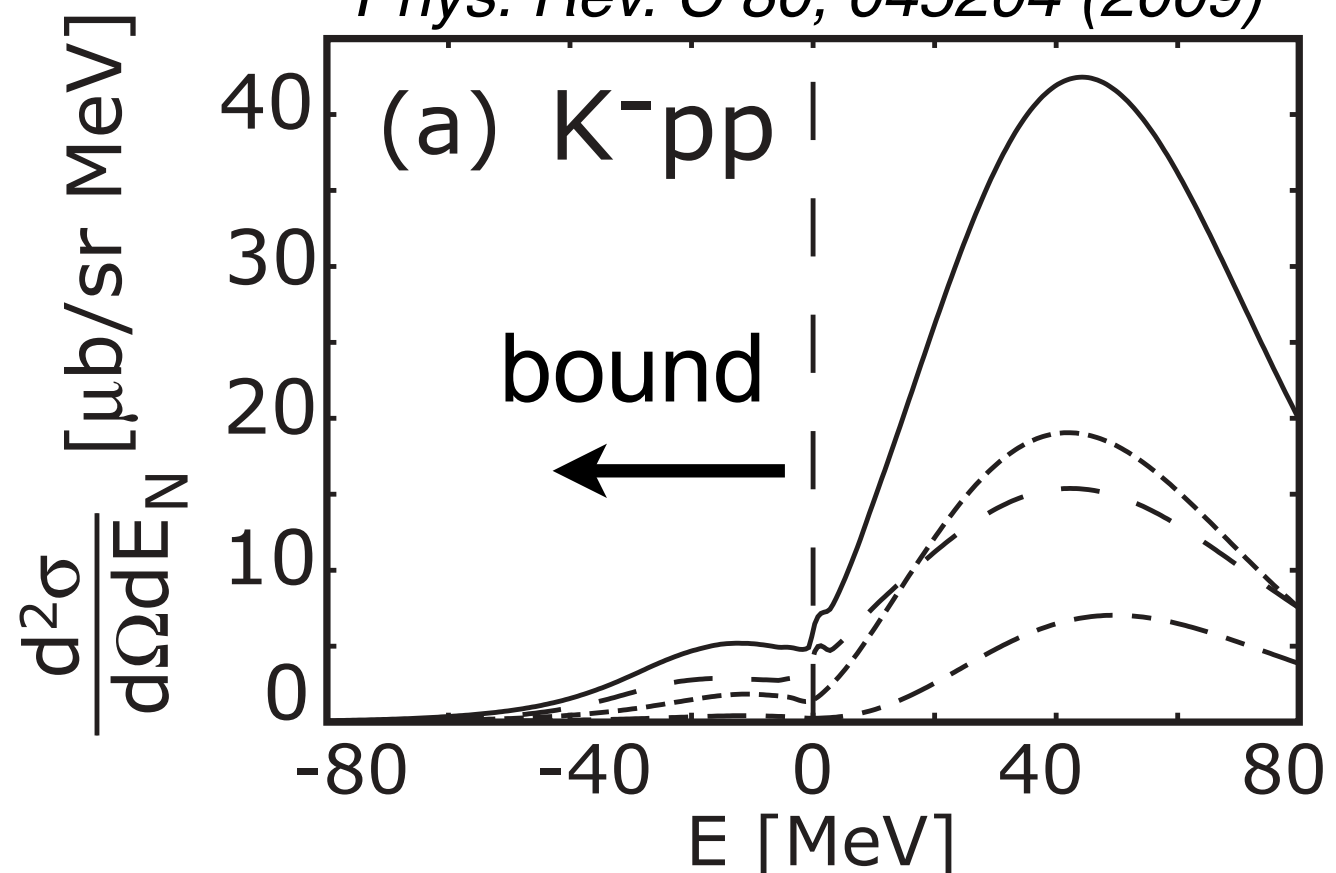
formation
Missing mass spectroscopy
NC

$$K^- + ^3\text{He} \rightarrow "K\text{-}pp" + n \text{ @ } P_K=1\text{GeV}/c, \theta=0^\circ$$

T.Koike and T.Harada, PLB652 (2007) 262



*J. Yamagata-Sekihara et. al.,
Phys. Rev. C 80, 045204 (2009)*

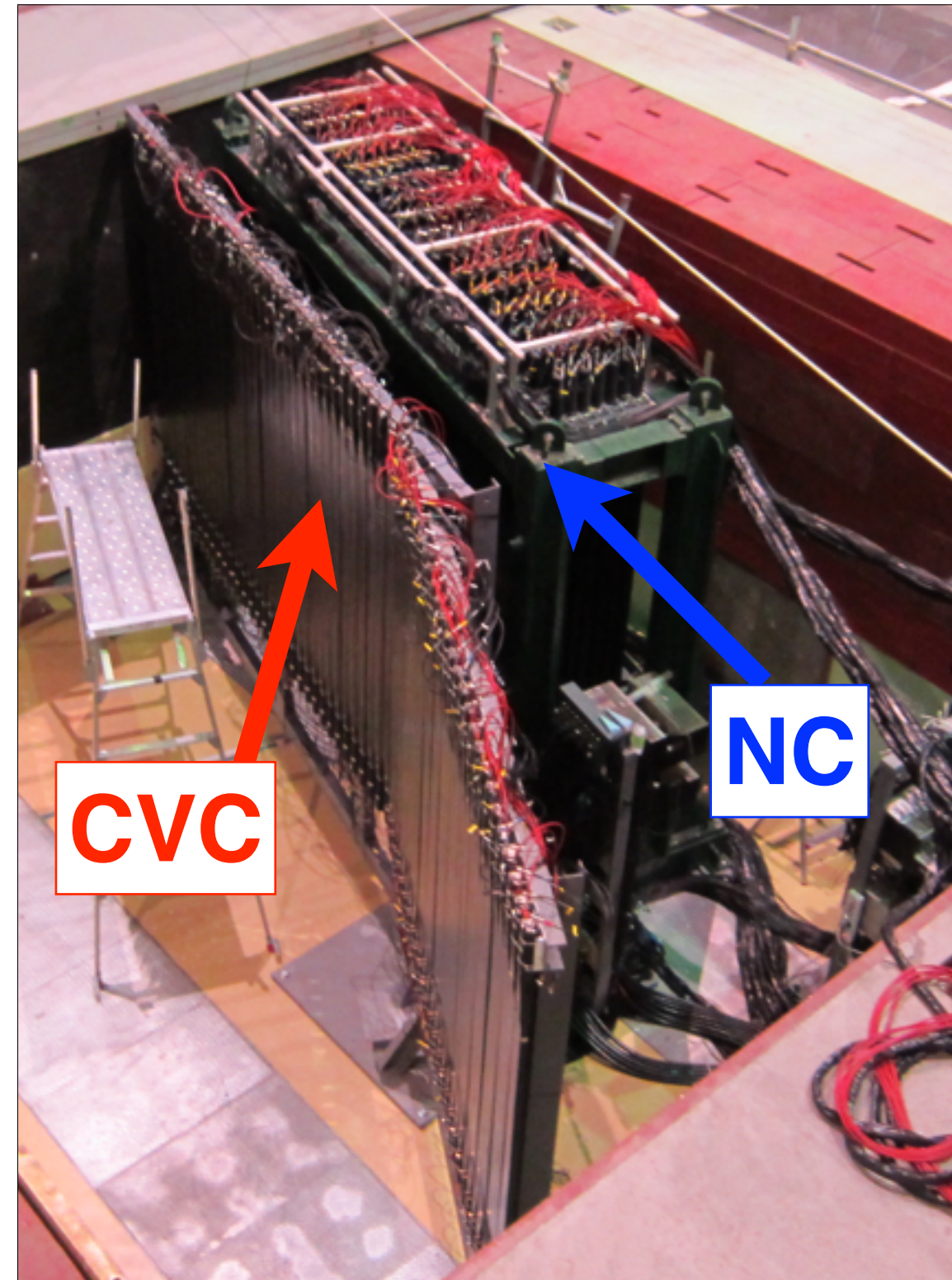


JPS meeting @ Kochi, September. 22nd, 2013

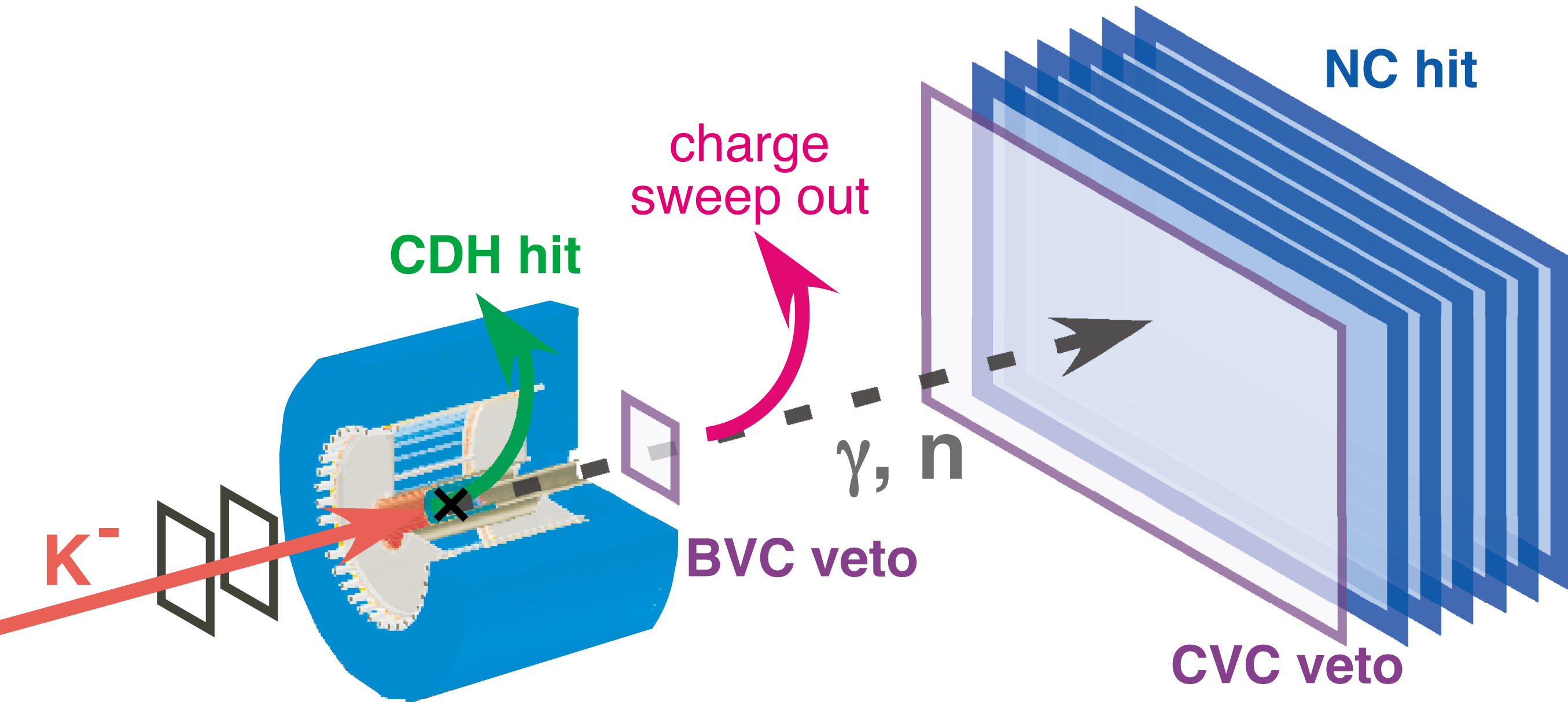
Neutron Counter

▶ Neutron Counter (NC)

- flight length ~ 15 m
 - 3.2 m(W) x 1.5 m(H) x 0.35 m(T)
 - 16 columns x 7 layers
= 112 segments
 - ~ 20 msr acceptance
 - Saint-Gobain BC408&412
 - 2 inch PMT(H6410) on both ends
 - ~ 90 ps σ @ cosmic ray
- ▶ 34-segmented **CVC counter**
- ▶ Beam sweeping magnet
& caved beam dump

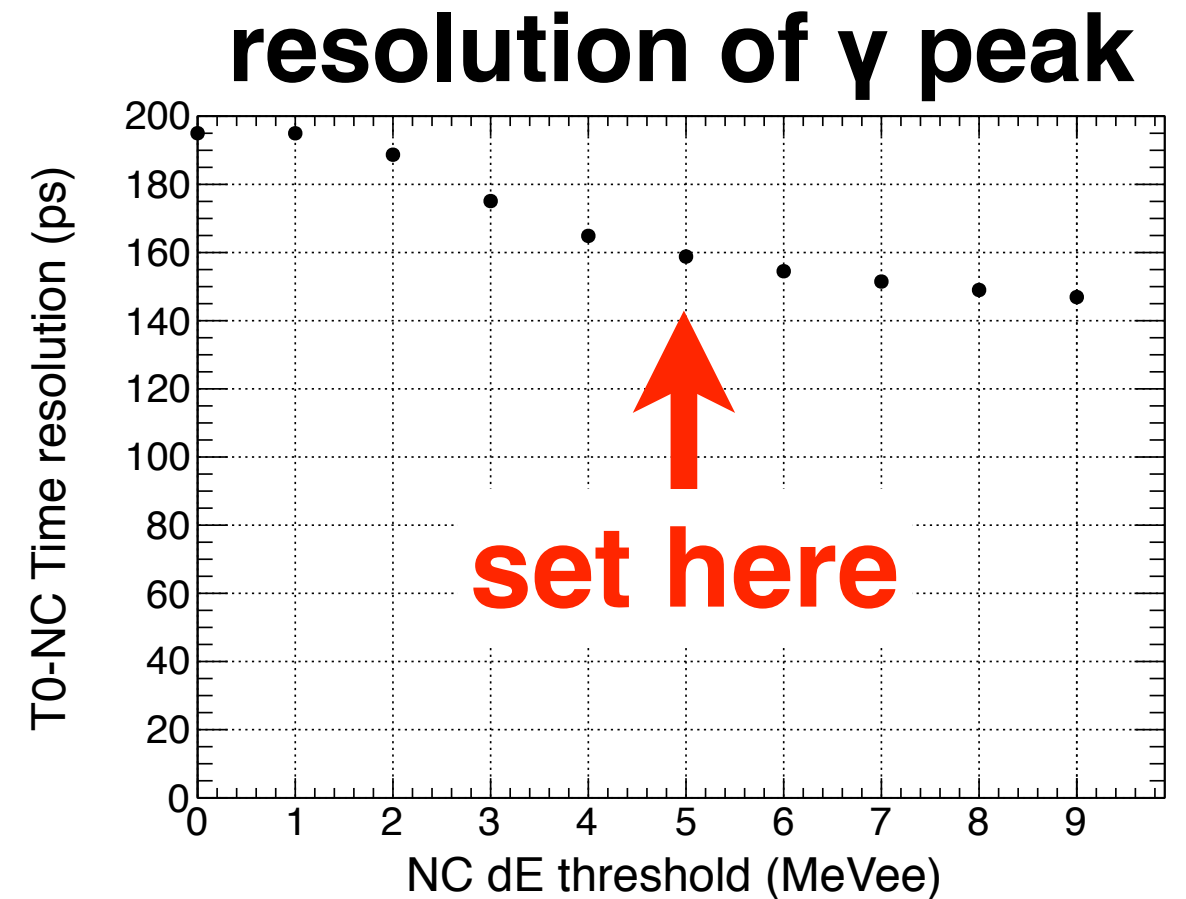
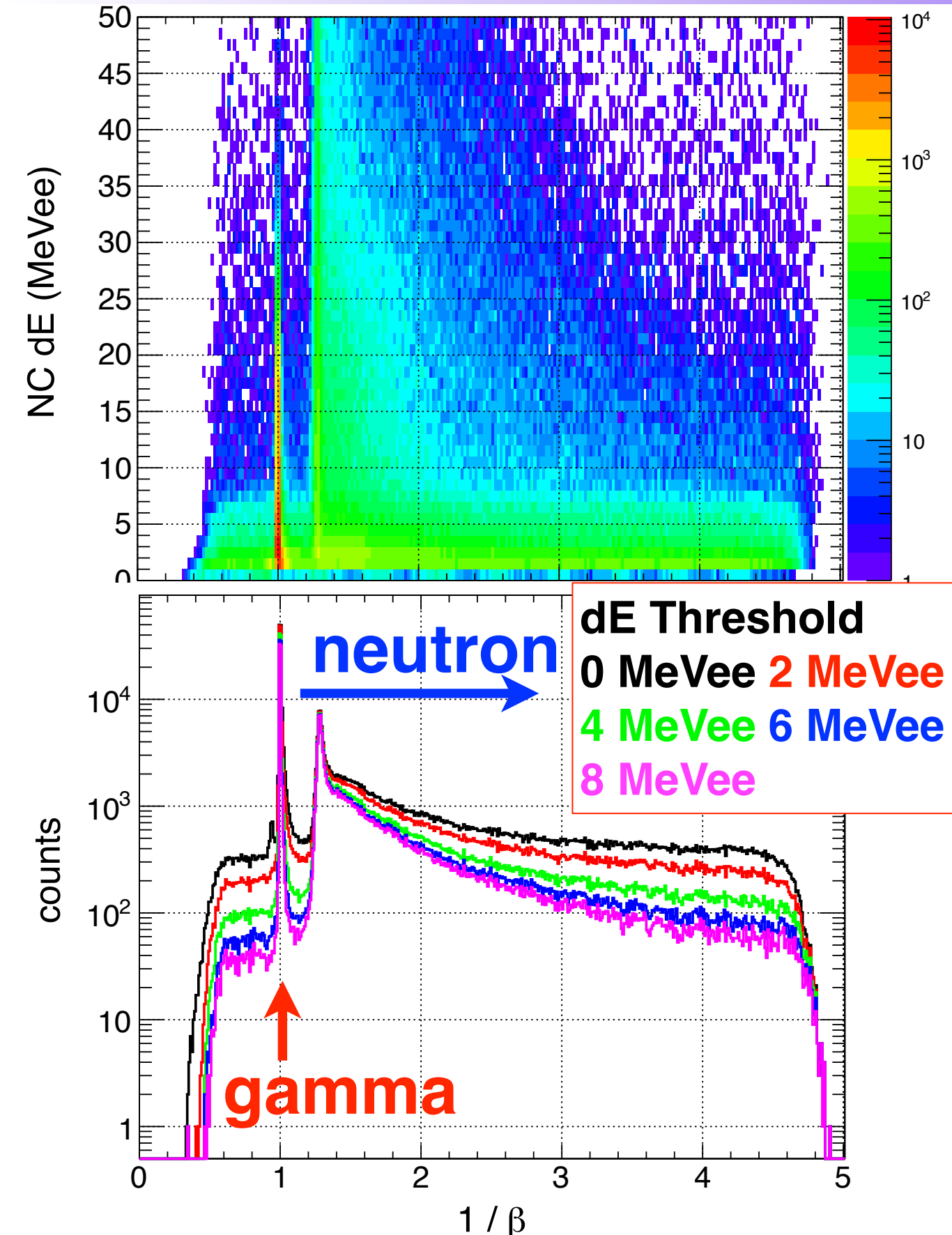


Analysis Method



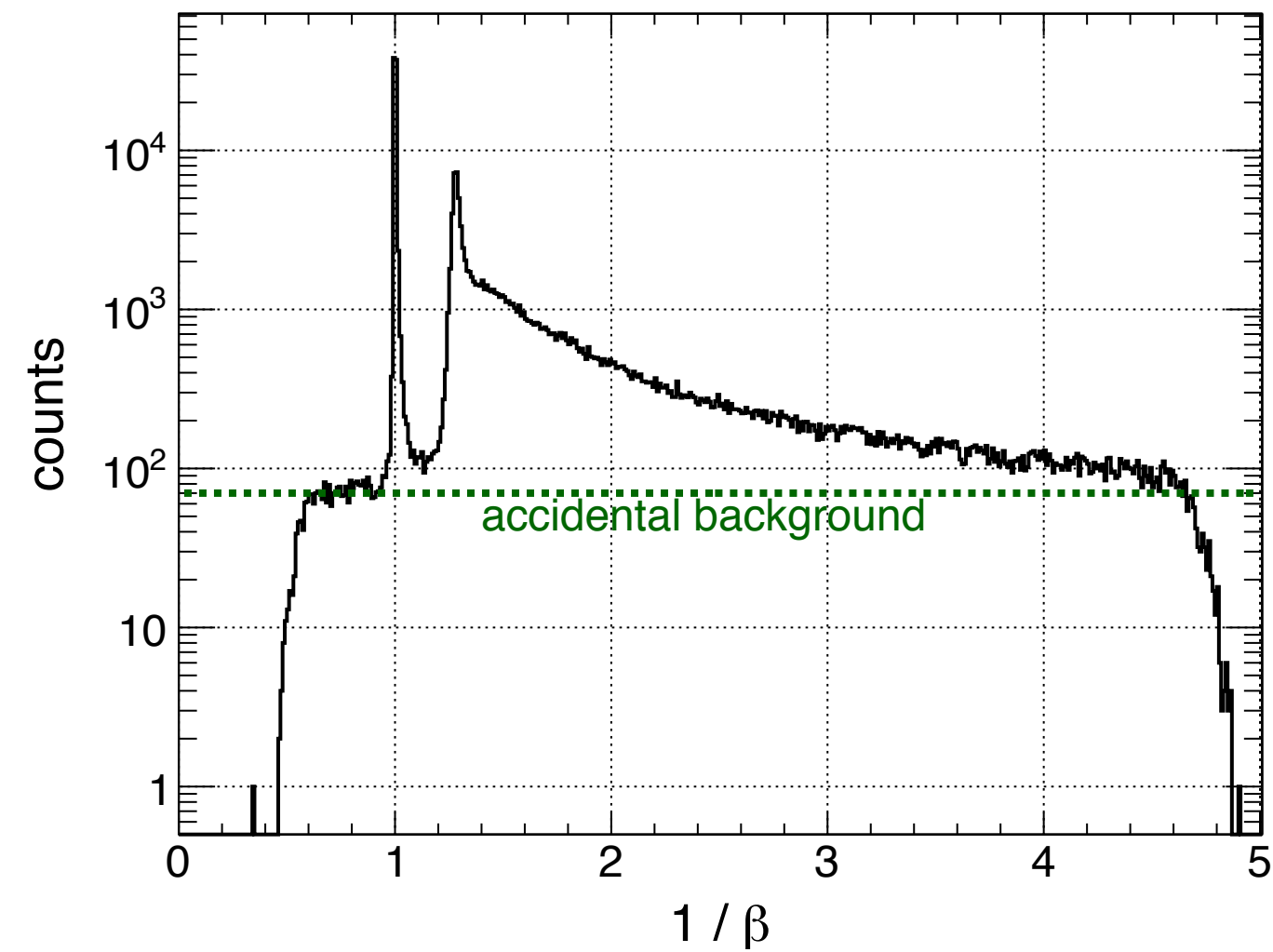
- ▶ Neutron momentum is determined by TOF method
- ▶ **require at least 1 track in CDC** to reconstruct the reaction vertex → Target selection, Flight length

NC dE threshold

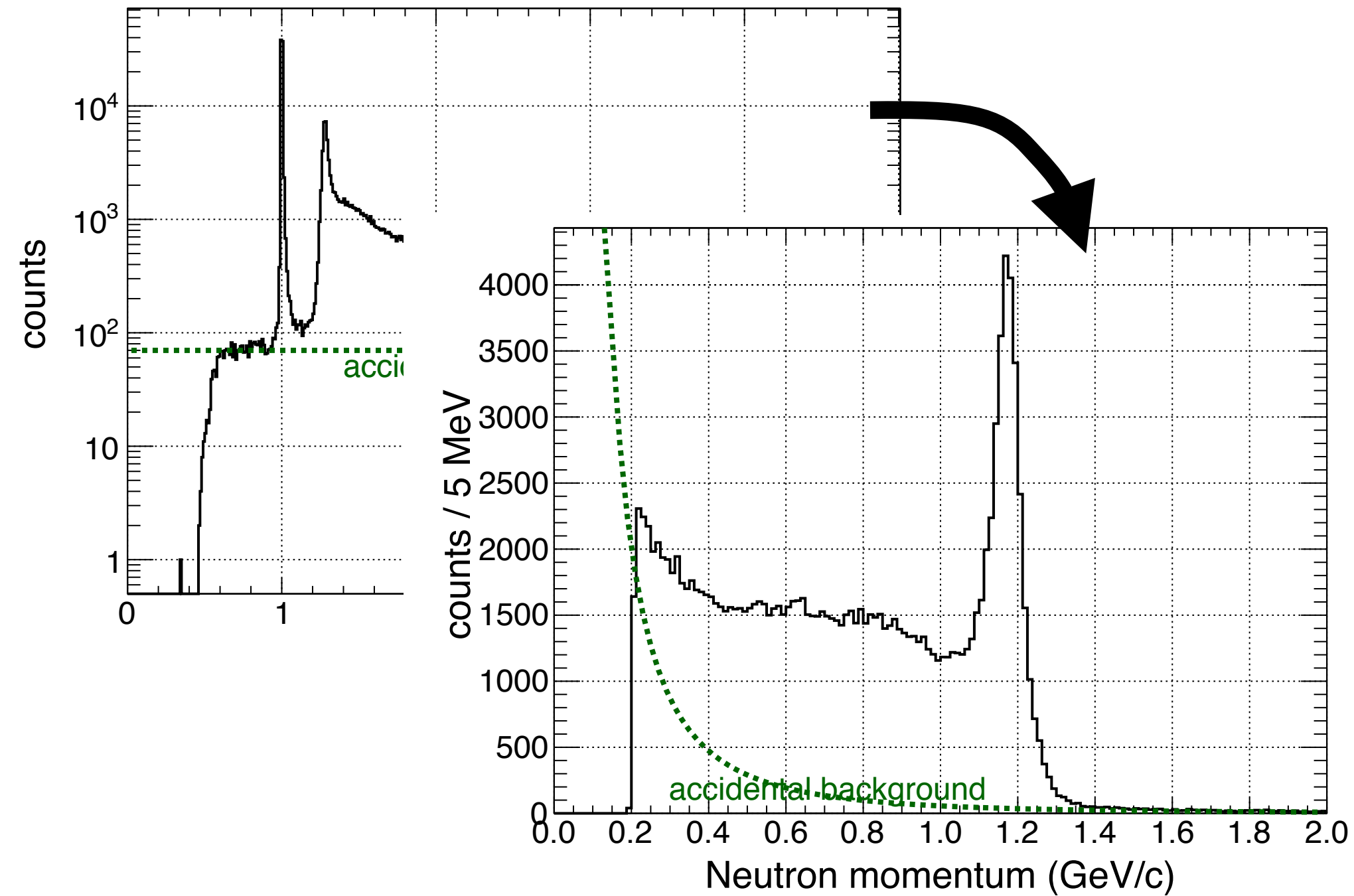


- ▶ **Accidental events can be reduced by an order**
- ▶ **Set threshold 5 MeVee**
 - **~ 160 ps TOF resol.**
 - **~ 9 MeV/c Mom. resol. @ 1 GeV/c neutron**

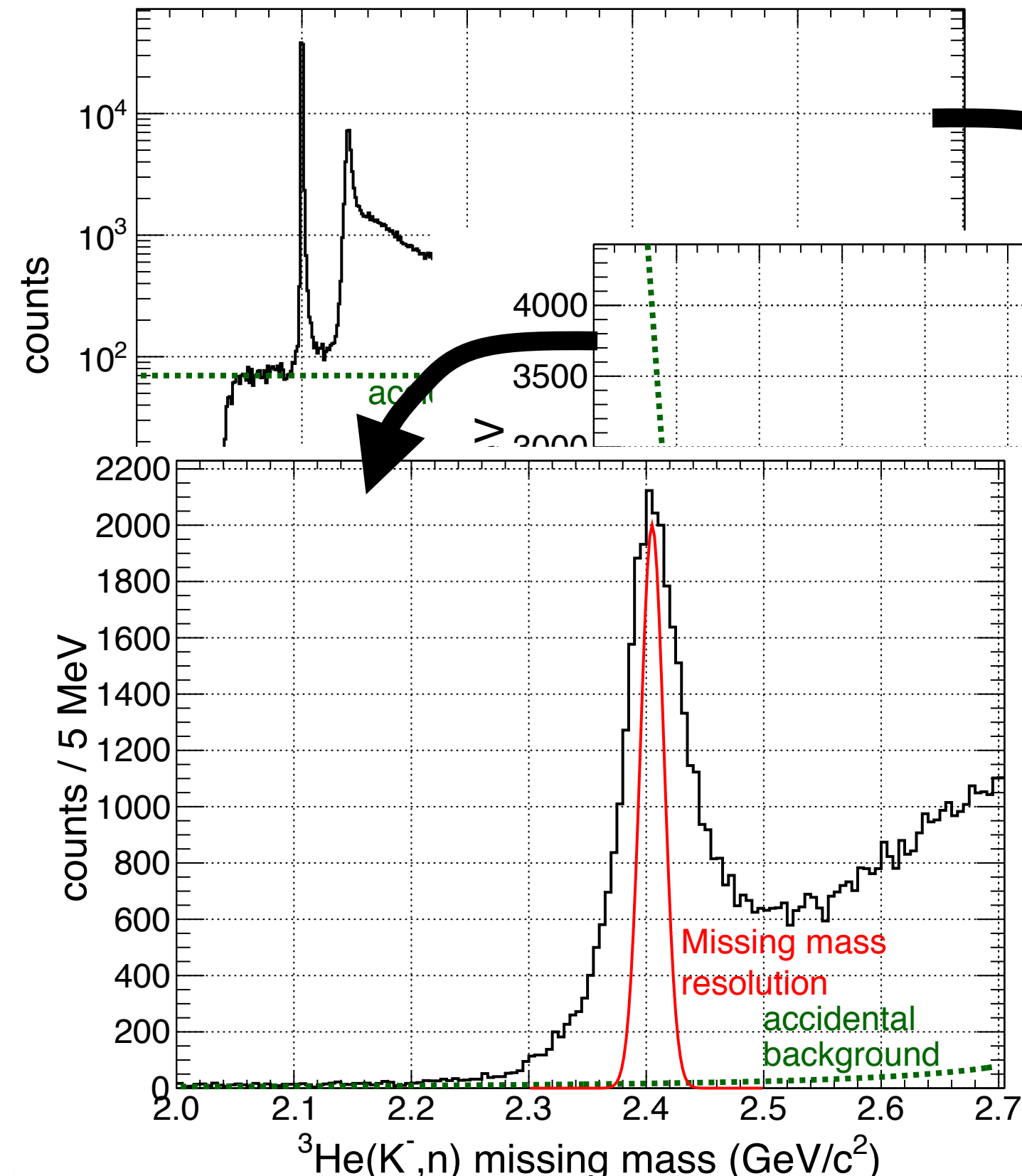
NC spectra



NC spectra

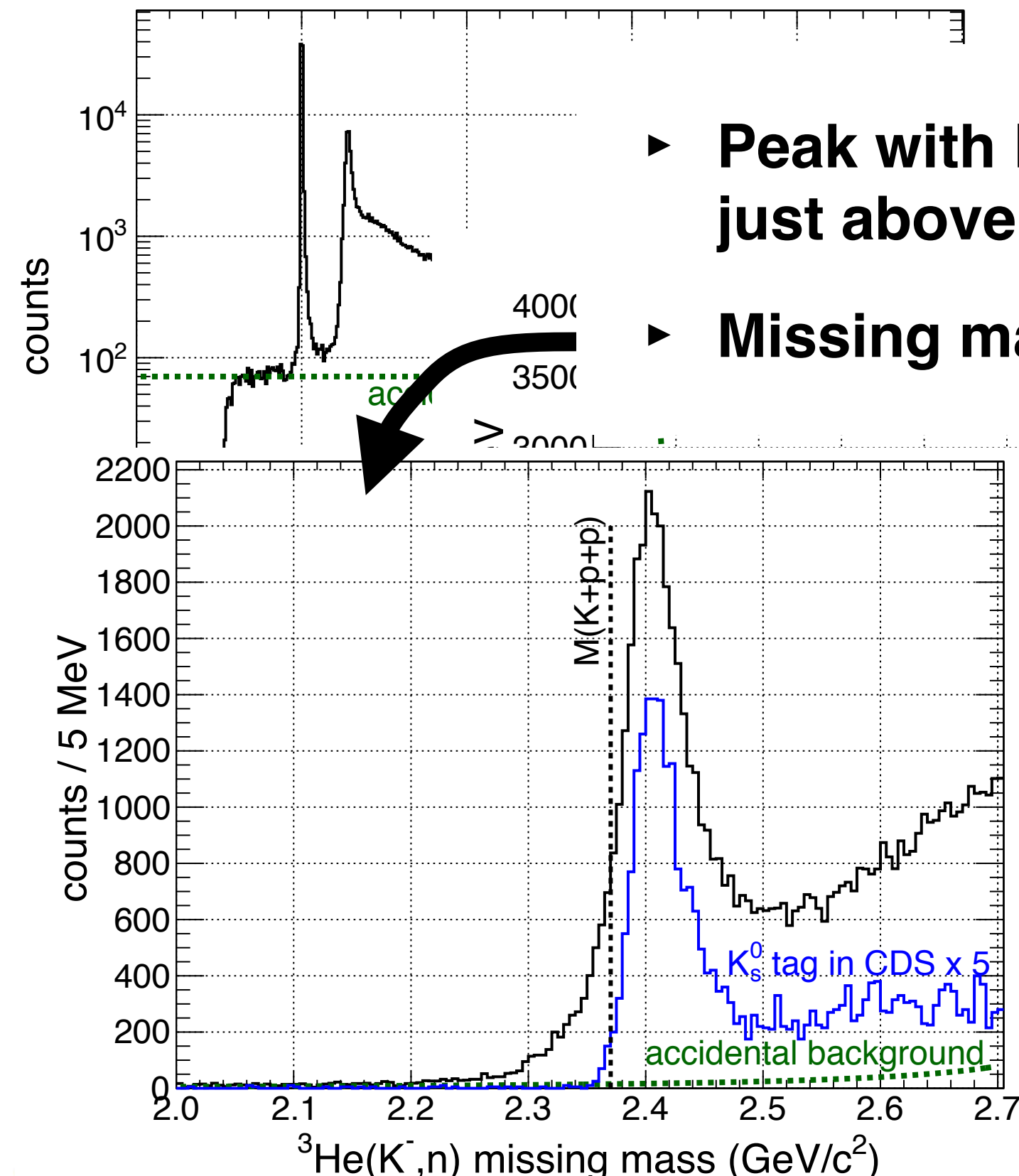


NC spectra

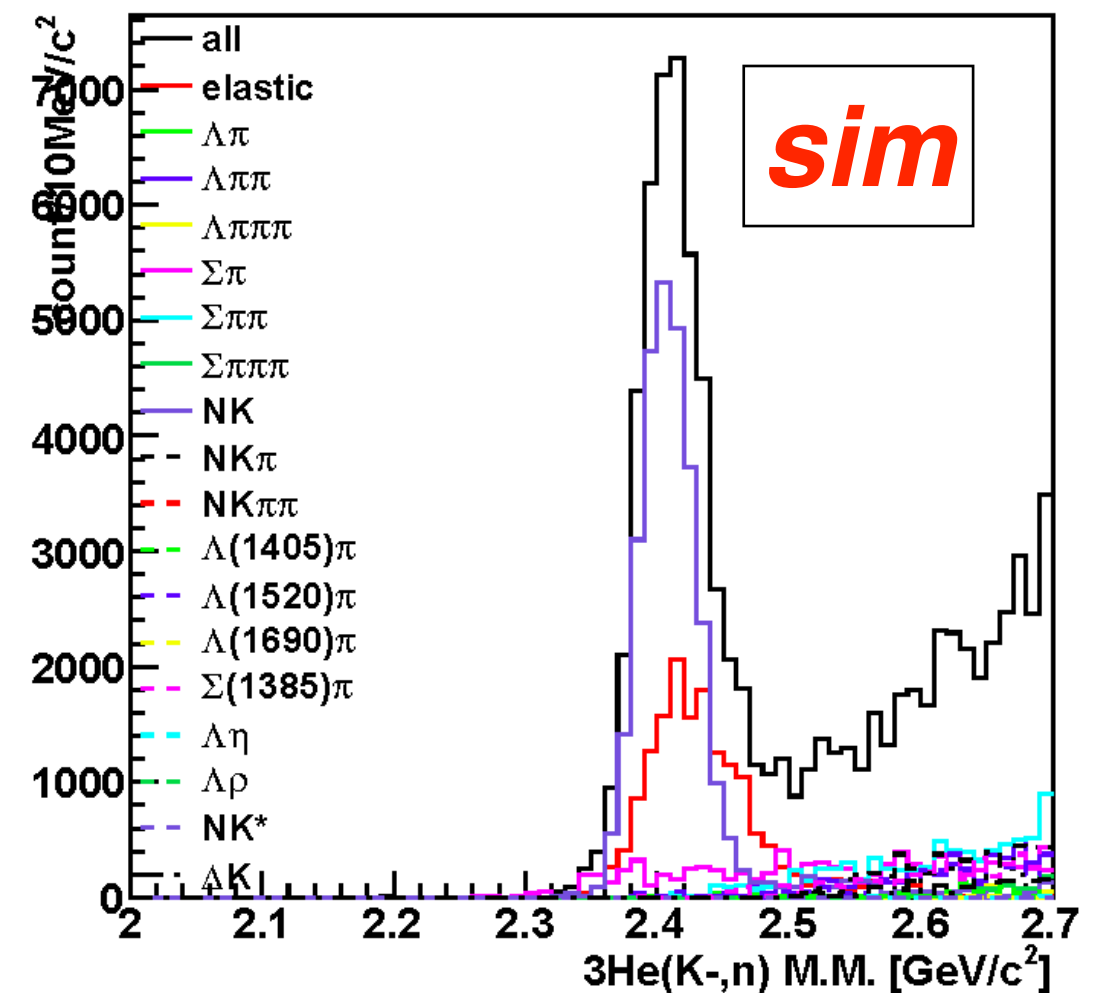


- ▶ beam momentum was calibrated by using pion/proton through data (T0-PC TOF analysis)
- ▶ Beam momentum resol.
~ 2 MeV/c @ 1 GeV/c
- ▶ Missing Mass resolution
@ region of interest
~ 9 MeV/c²

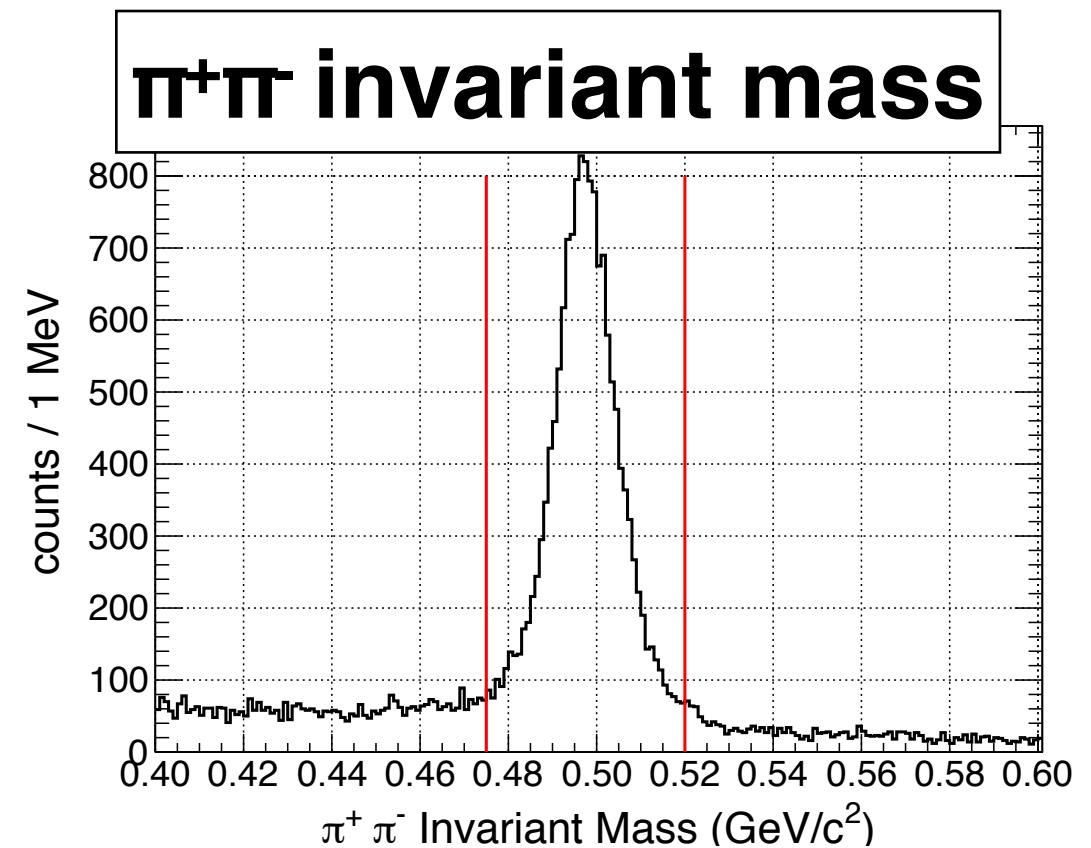
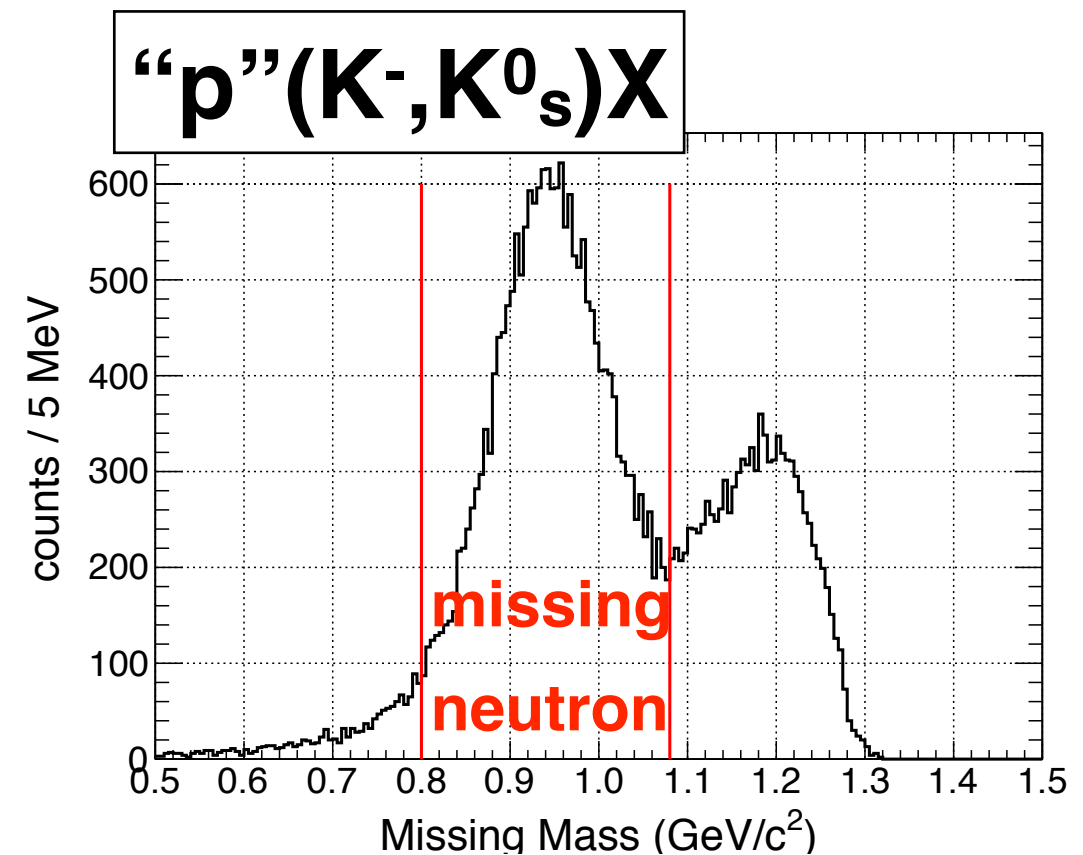
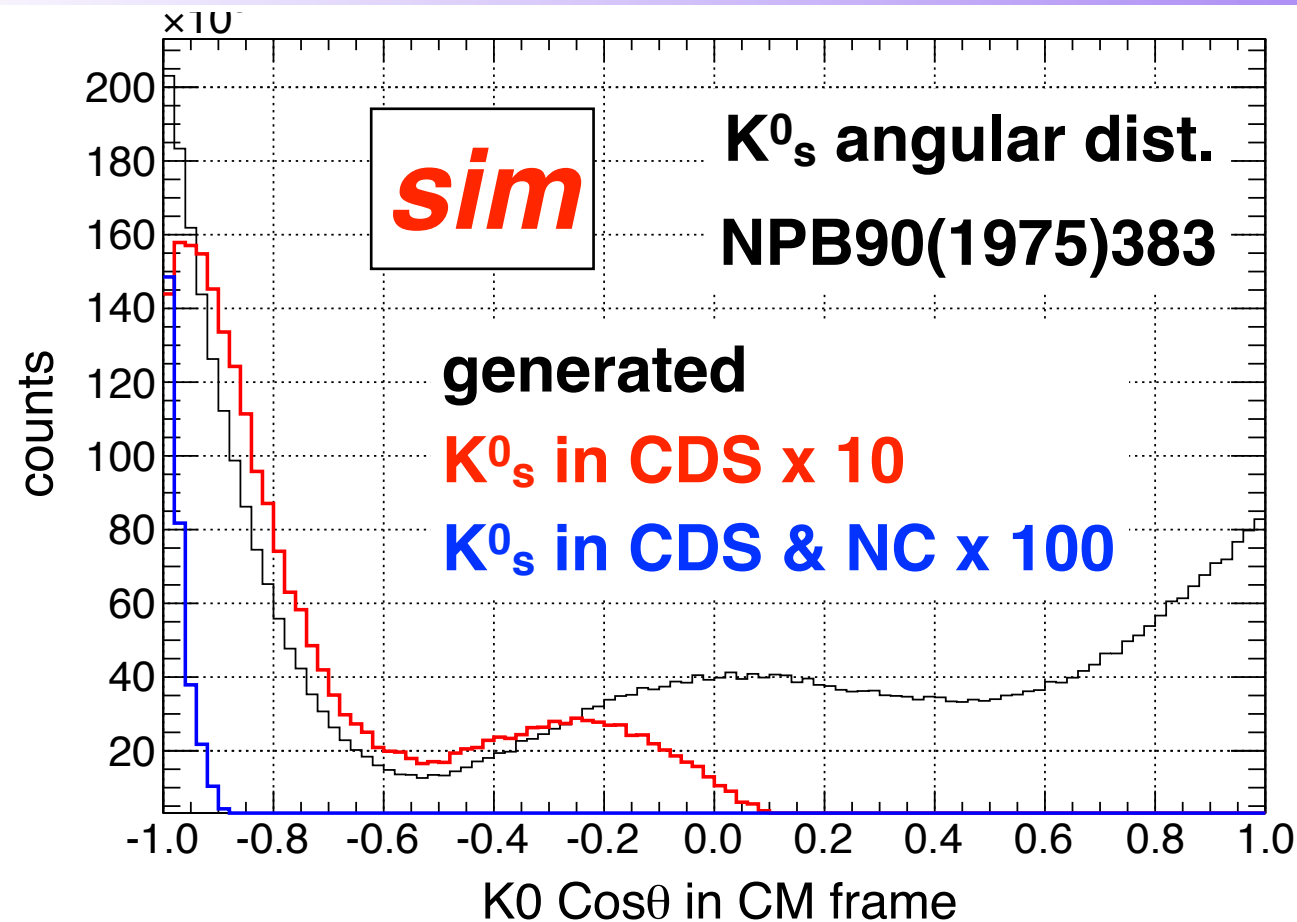
NC spectrum



- ▶ Peak with K^0_s tag in CDS correctly stands just above the K-pp binning threshold.
- ▶ Missing mass scale is OK !

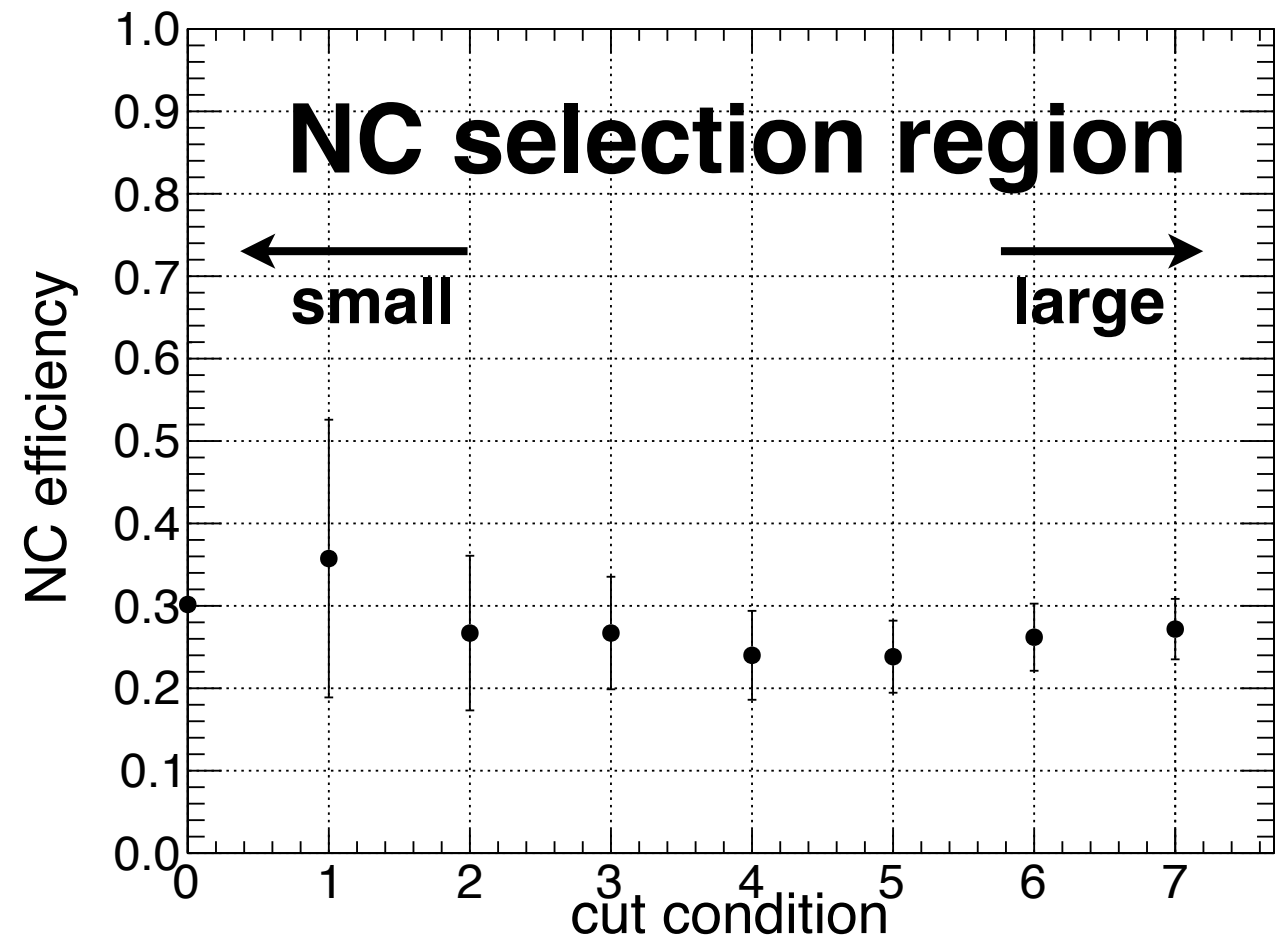
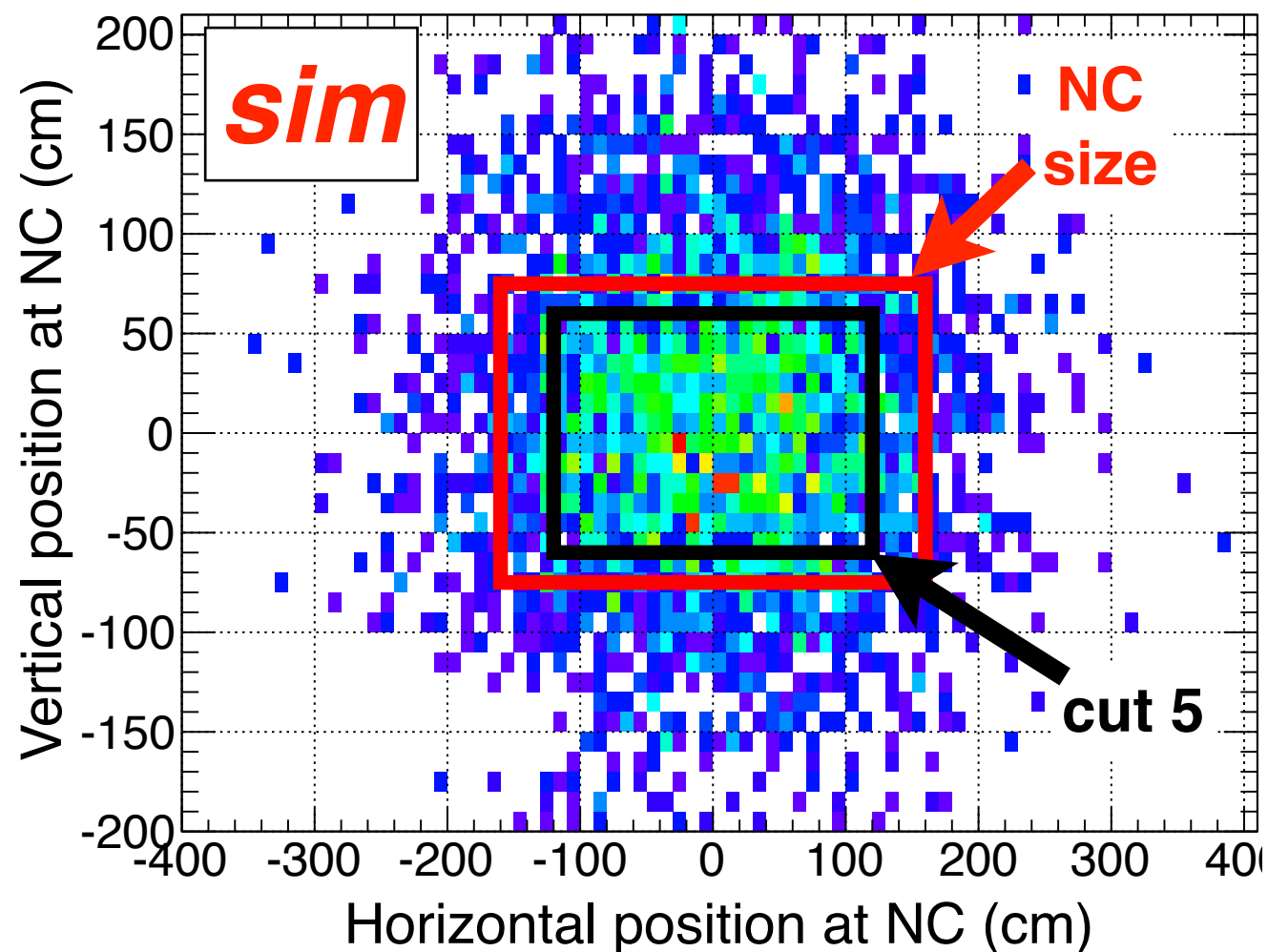


$^3\text{He}(K^-, K_s^0 n)d$ study for calibration



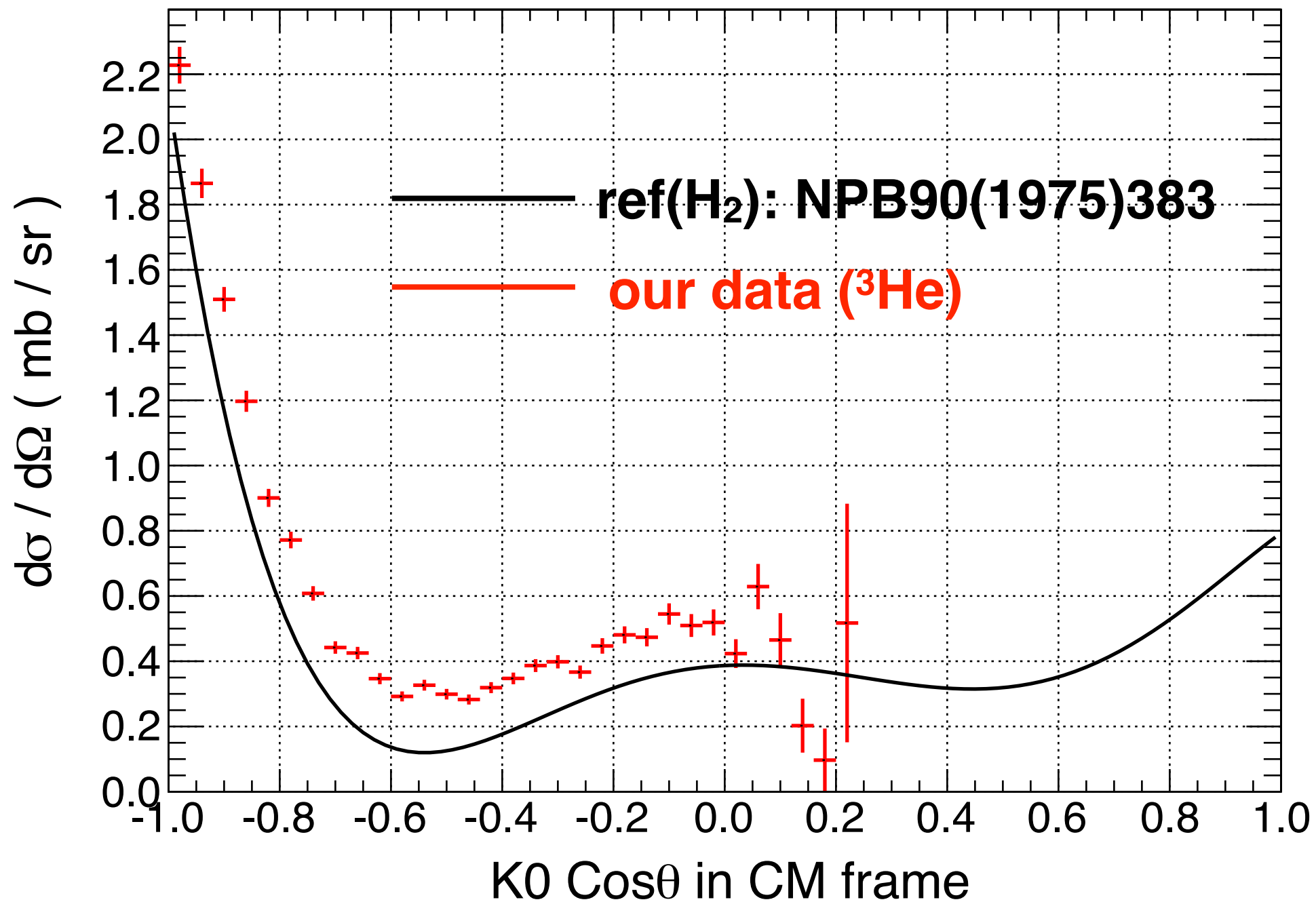
- ▶ **NC efficiency measurement**
 - detection efficiency for 1 GeV/c neutron is not well established
- ▶ **Cross section check**
- ▶ $^3\text{He}(K^-, K_s^0 n)d$ events were selected by requiring missing mass of K_s^0 to be neutron.

Neutron Counter Efficiency



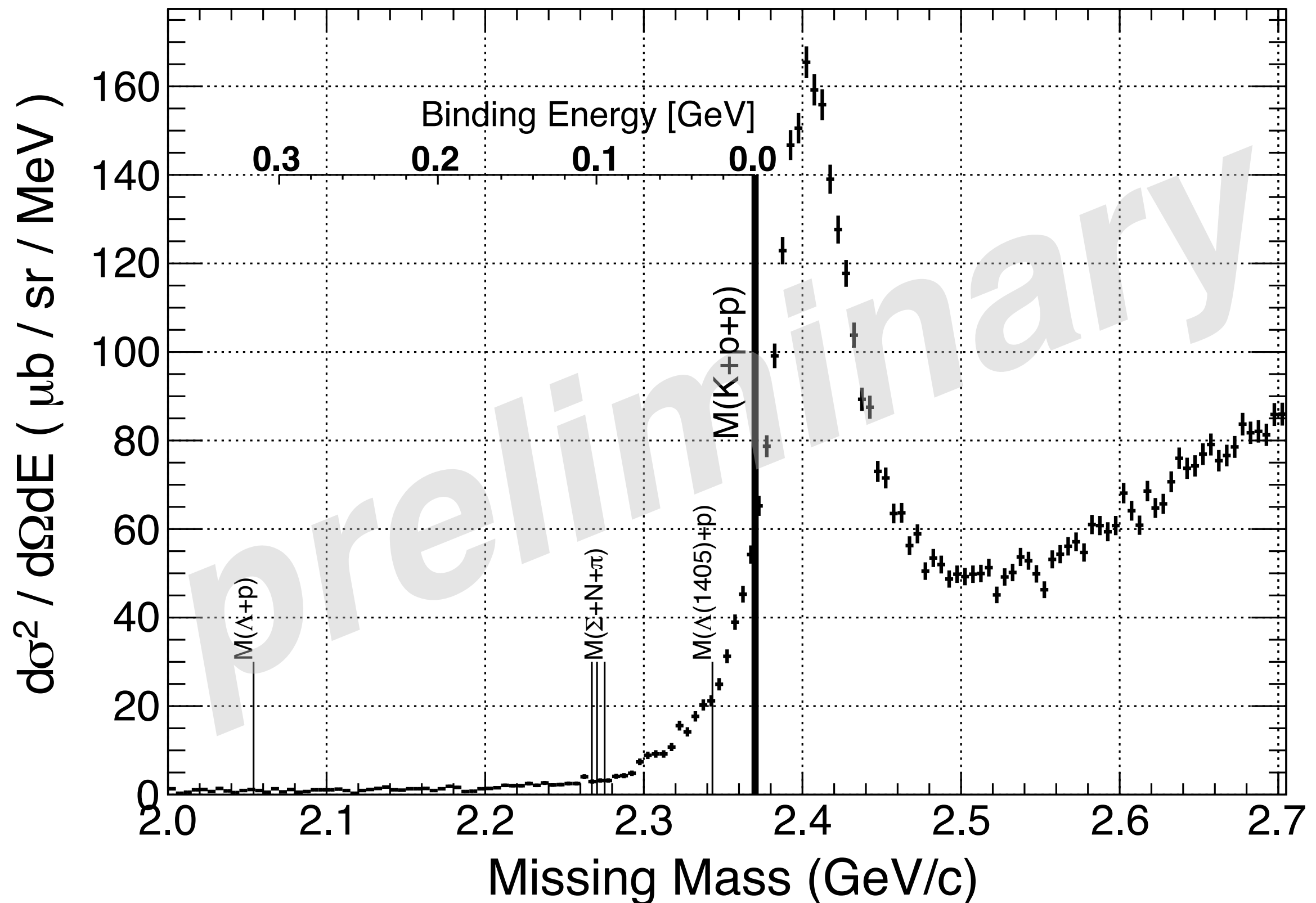
- ▶ **Estimate the neutron position by missing momentum vector**
-> check NC fire or not
 - real hit / estimated hit number is evaluated by using Geant4
- ▶ **measured NC efficiency ~ 25 %.**
 - Consistent with the simulation. (QGSP_BIC_HP in Geant4)

K^0_s differential cross section

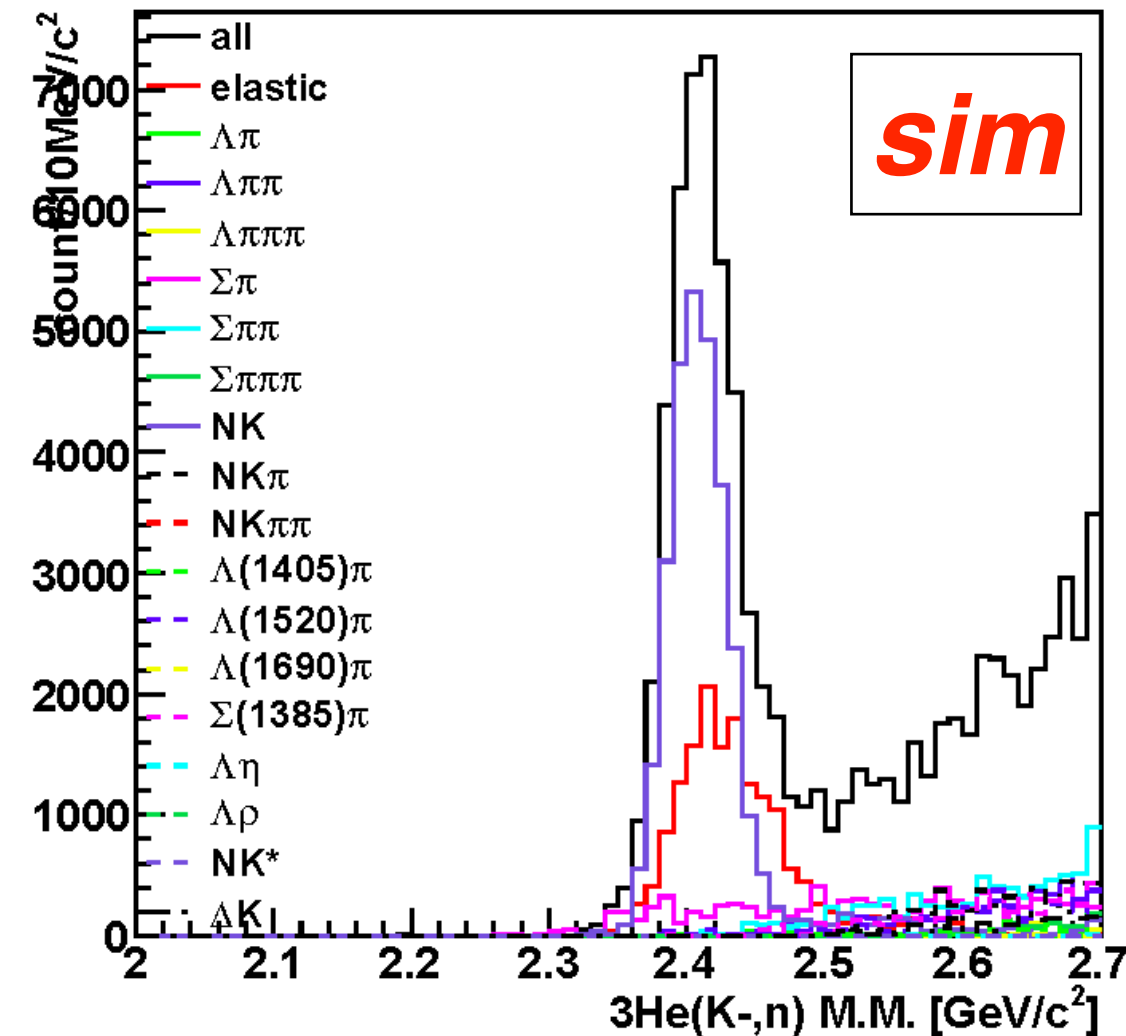
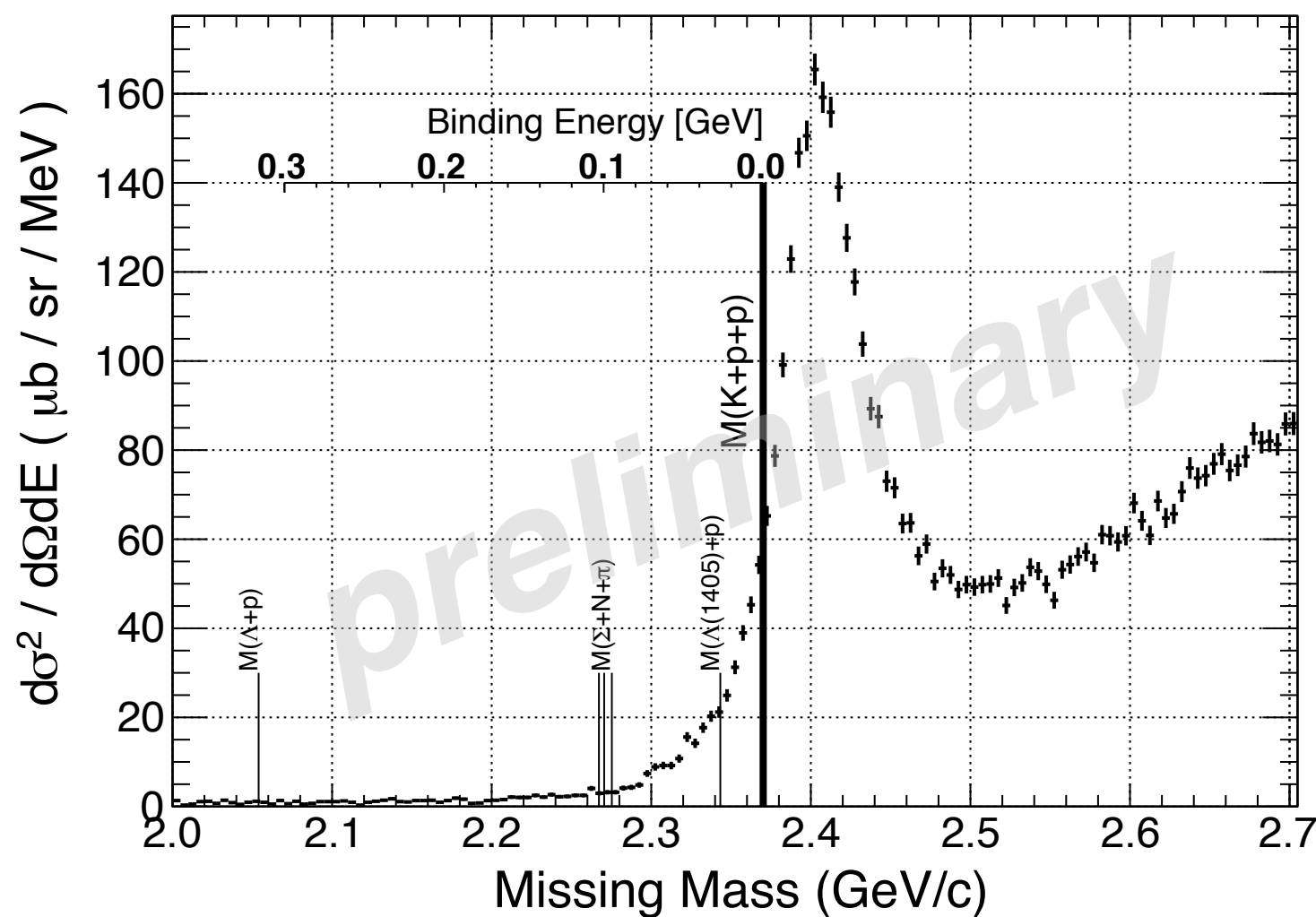


- ▶ Total cross section ~ 7.5 mb (H_2 : $5.6 \sim 7.8$ mb @ 1 GeV/c)
- ▶ The effective proton number is between 1 and 2 as expected

$3\text{He}(\text{K}^-, \text{n})\text{X}$ “**semi**-inclusive” spectrum



$3\text{He}(\text{K}^-, \text{n})\text{X}$ “**semi**-inclusive” spectrum



- ▶ Global shape is roughly understood by known processes.
 - ▶ We require at least 1 charged track in CDS.
- Direct comparison with theoretical spectra is not possible.

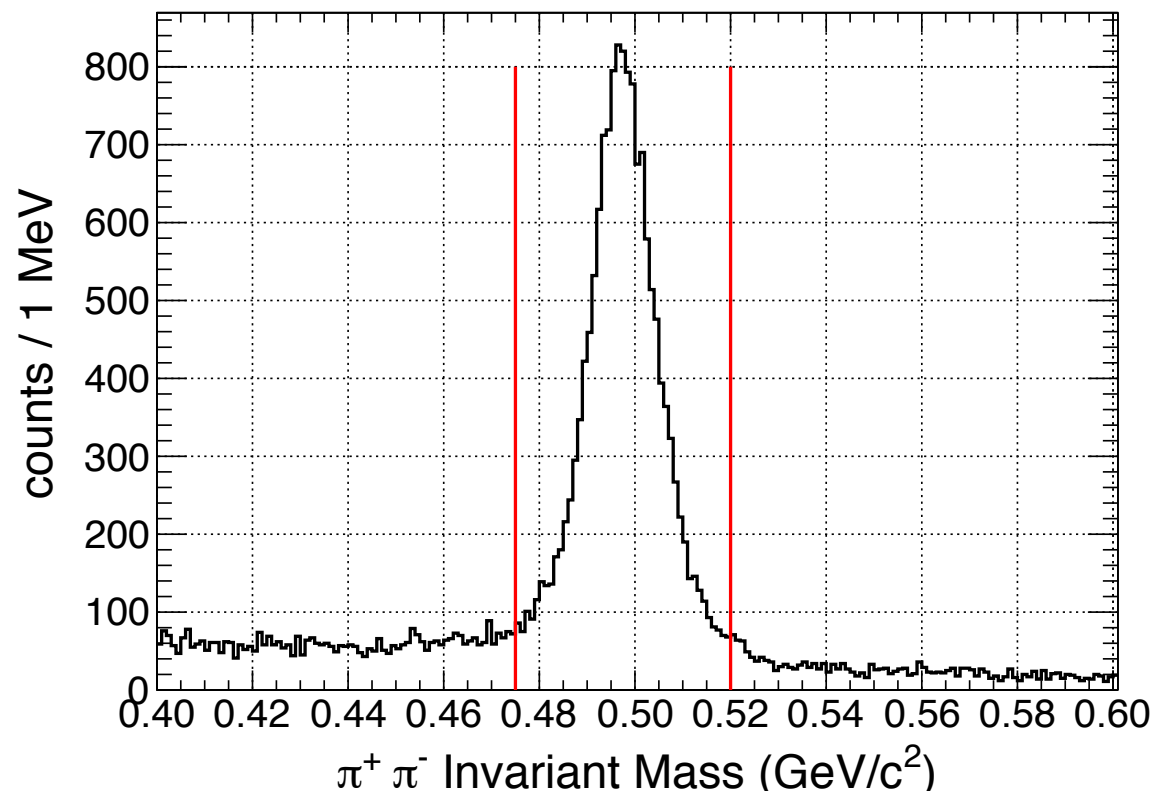
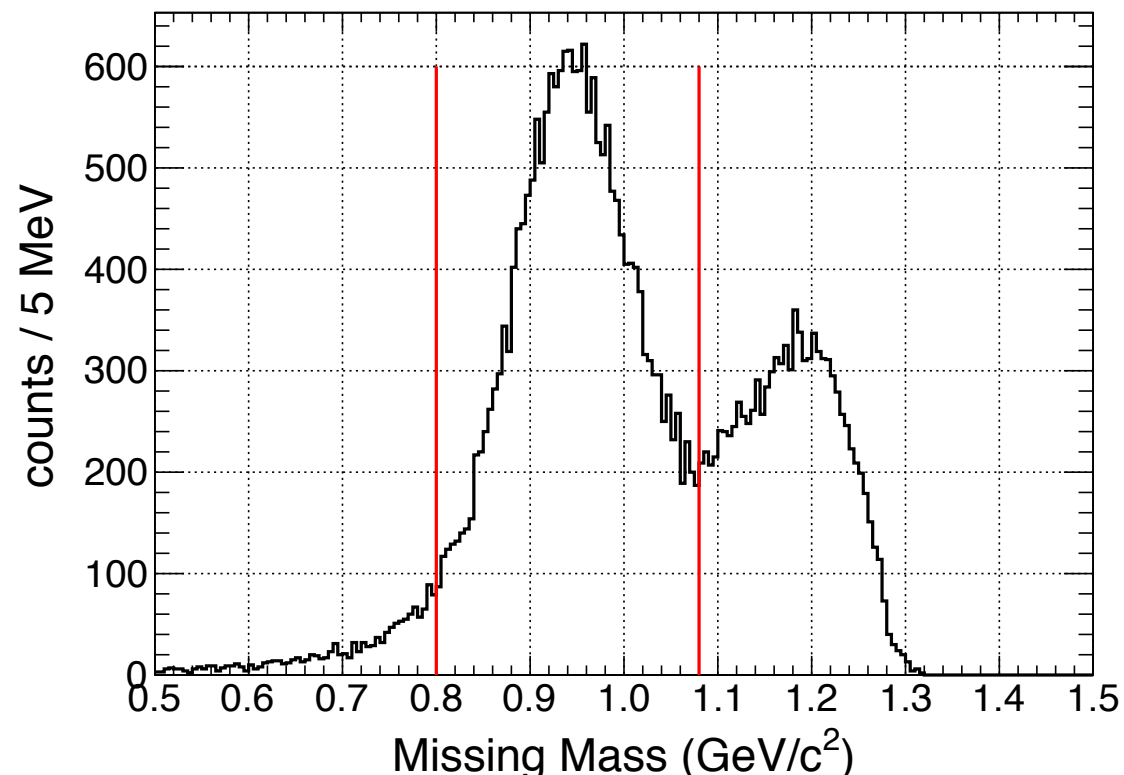
Summary

- ▶ **The neutron counter worked fine.**
 - **momentum resolution 9 MeV/c @ 1.2 GeV/c neutron**
 - **measured efficiency ~ 25 %**
- ▶ **cross section of quasi-free K^0_s charge exchange production on ^3He was evaluated.**
 - **total cross section : ~ 7.5 mb**
 - **effective proton number : 1 ~ 1.5**
- ▶ **(semi-)inclusive $^3\text{He}(K^-,n)X$ spectrum was obtained.**
 - **global shape is roughly understood by known processes.**

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(J-PARC E15 Collaboration)

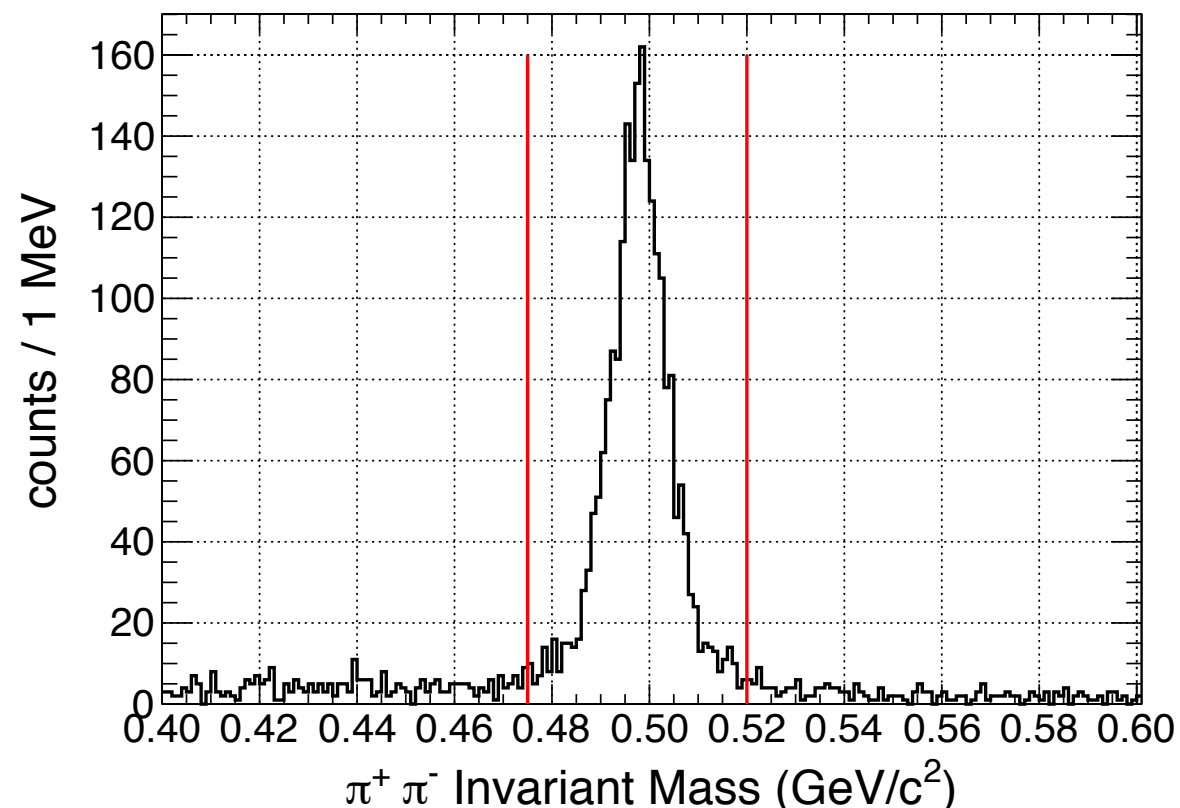
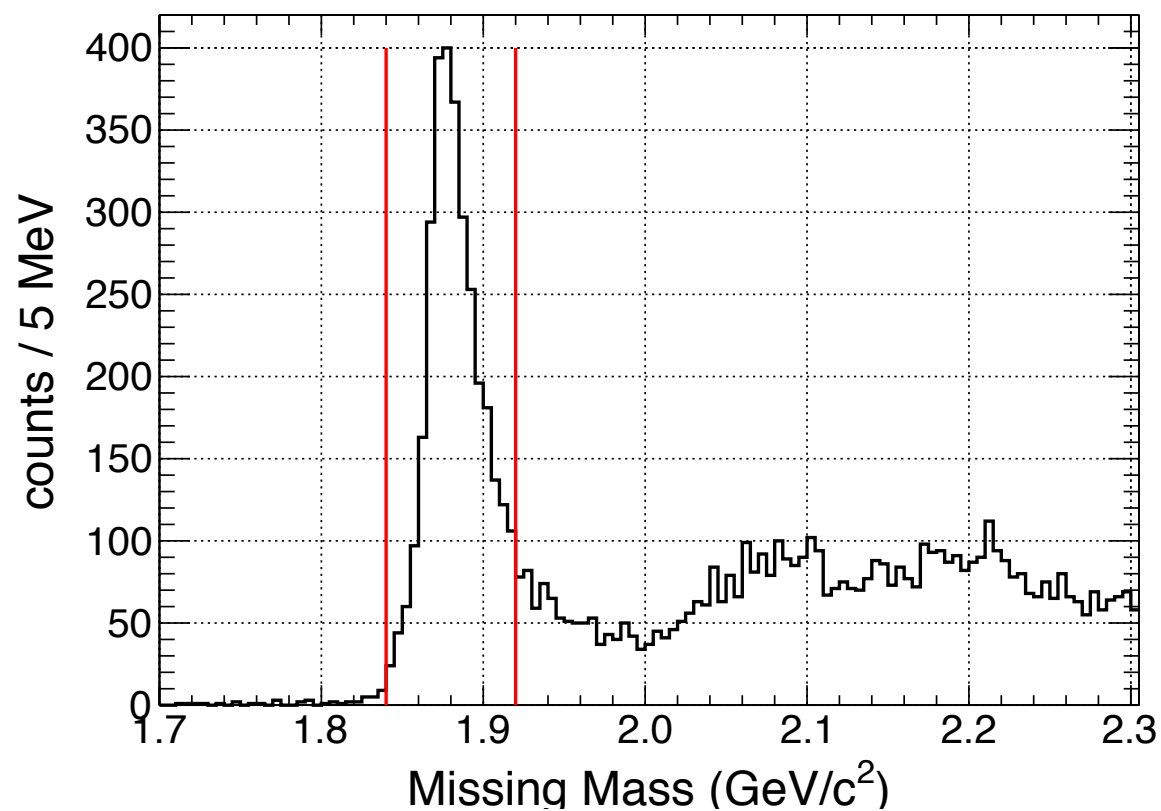
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K^0_s cross section **without** n detection



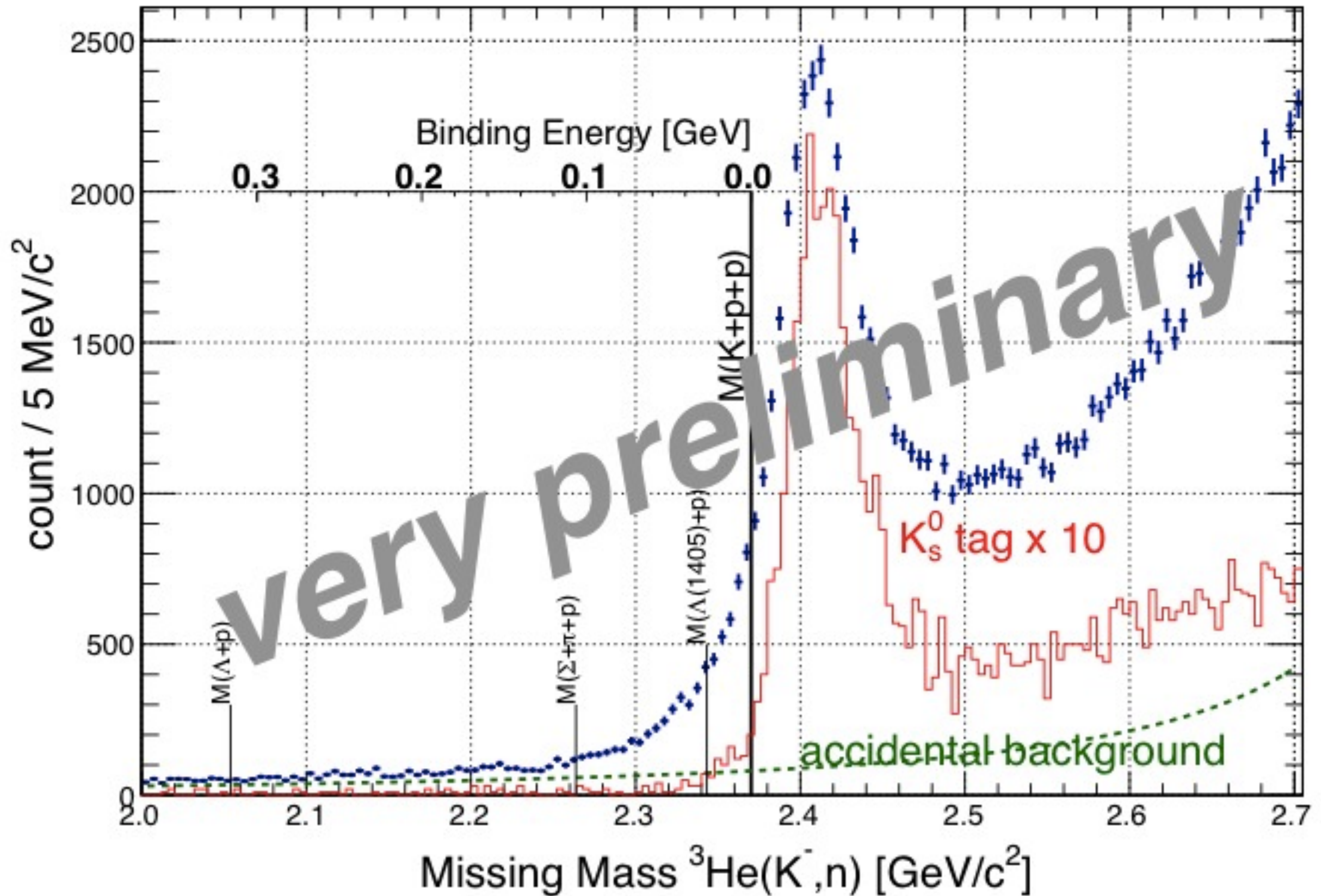
		error(%)
f_good vertex	0.85	5
f_2 charged	0.69	5
f_kinema	0.95	1
e_cdh	1	5
e_cdctrack	0.92	5
e_PID	1	1
e_DAQ	0.116	1
total eff	0.0546	10
acceptance	0.053	5
N_target(10^{23})	1.6	1
N_beam(10^9)	4.1	1
N_event	14,000	10
cross section(mb)	7.35	20

K^0_s cross section **with** n detection



		error(%)
f_missn	0.95	1
e_cdctrack	0.92	5
e_PID	1	1
e_DAQ	0.81	1
f_missVETO	1	1
f_overVETO	1	3
total eff	0.6513	5
acceptance	0.00069	20
N_target(10^{23})	1.6	1
N_beam(10^9)	4.1	1
N_event	2,200	10
cross section(mb)	7.47	30

Inclusive neutron spectrum at forward angle



- ▶ **production 60 - 156**
- ▶ **should be checked**
 - **69,86,143(PC),156**
- ▶ **junk**
 - **78,150**
- ▶ **USWK**
 - **141,142**
- ▶ **60~65~70~76~83~89~94~100~106~112~119
~125~130~135~143~148~153**