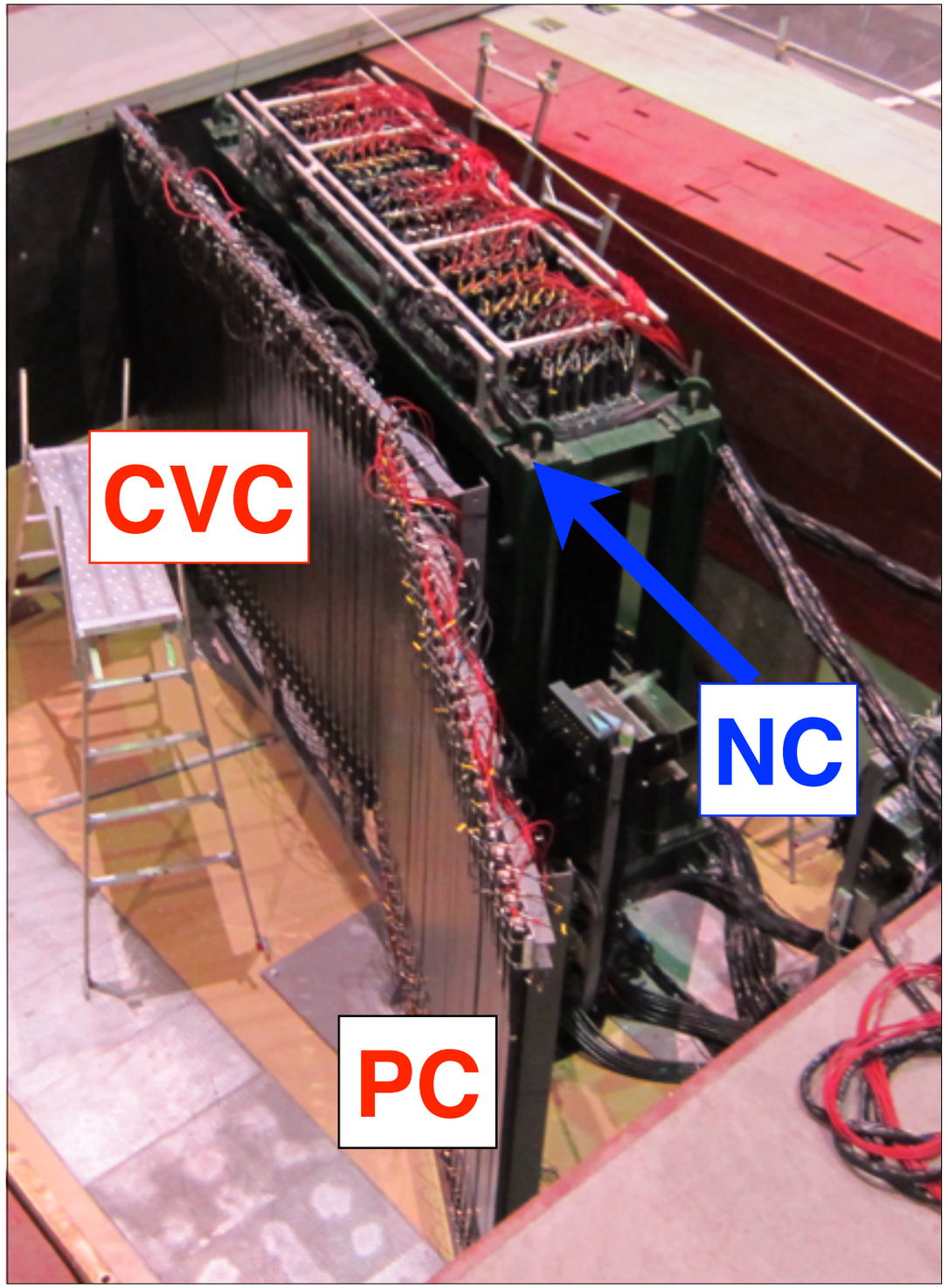
J-PARC E15実験における前方核子を用いた $K^{bar}NN$束縛状態の研究

橋本直 (JAEA) for the J-PARC E15 collaboration

Forward TOF counters at K1.8BR

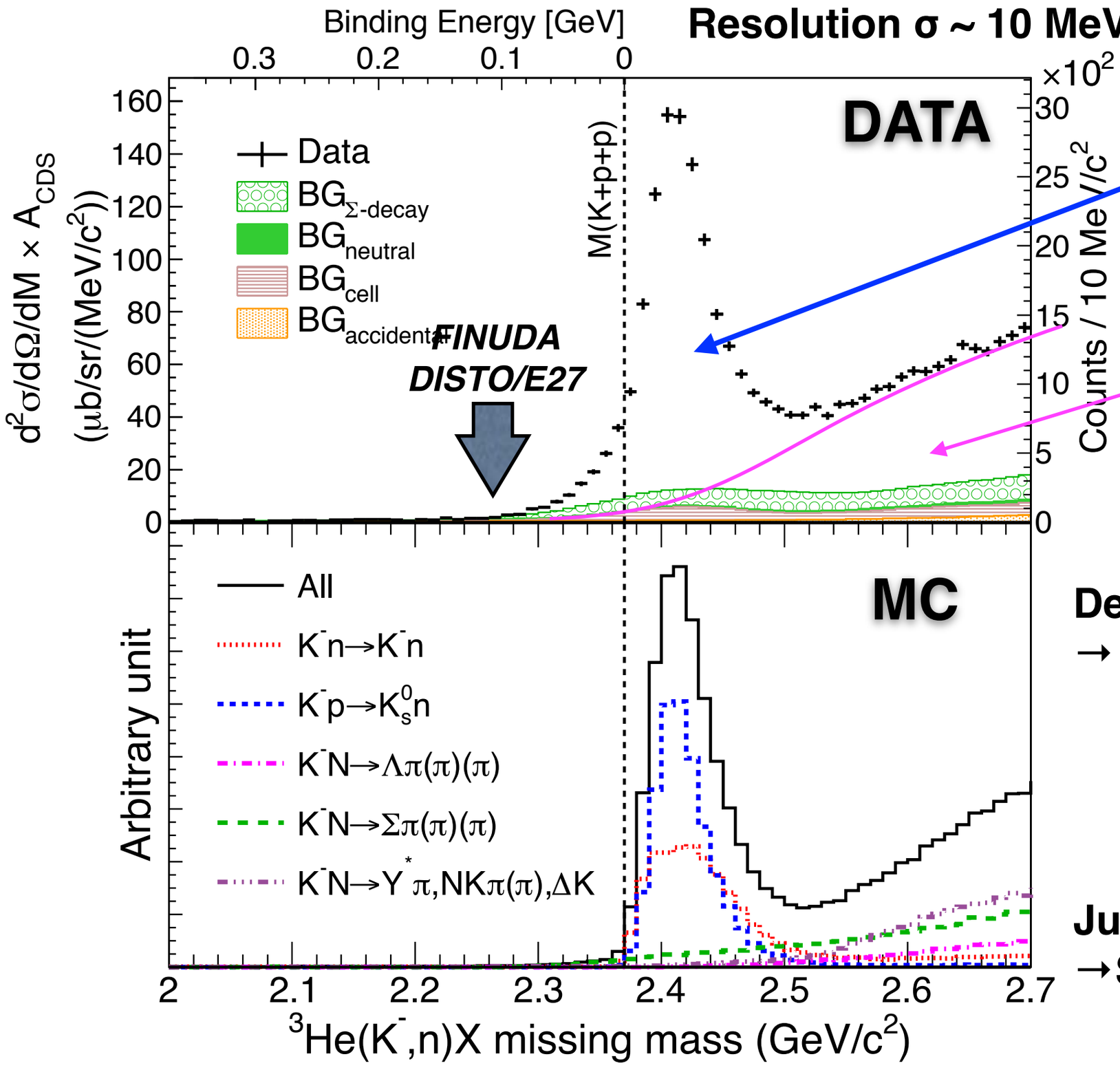
- **Neutron Counter (NC)**
  - flight length ~ 15 m
  - 3.2 m(W) x 1.5m(H) x 0.35 m(T)
  - 16 columns x 7 layers
    = 112 segments
  - ~ 22 msr acceptance
  - eff. ~30% @ 1 GeV/c
- **Charge Veto Counter (CVC)**
  - + Beam sweeping magnet
  - + Beam Veto Counter (BVC)
- **Proton Counter (PC)**



Result from E15 1st data

Prog. Theor. Exp. Phys. **2015**, 061D01 (11 pages)
DOI: 10.1093/ptep/ptv076

Resolution σ ~ 10 MeV/c² @ threshold



Quasi-elastic

$K^- + {}^3He \rightarrow K^0 + d_s + n$

$K^- + {}^3He \rightarrow K^- + 2p_s + n$

Hyperon decay

$K^- + {}^3He \rightarrow Y + \pi(\pi)(\pi) + 2N_s$

$Y \rightarrow n + \pi$

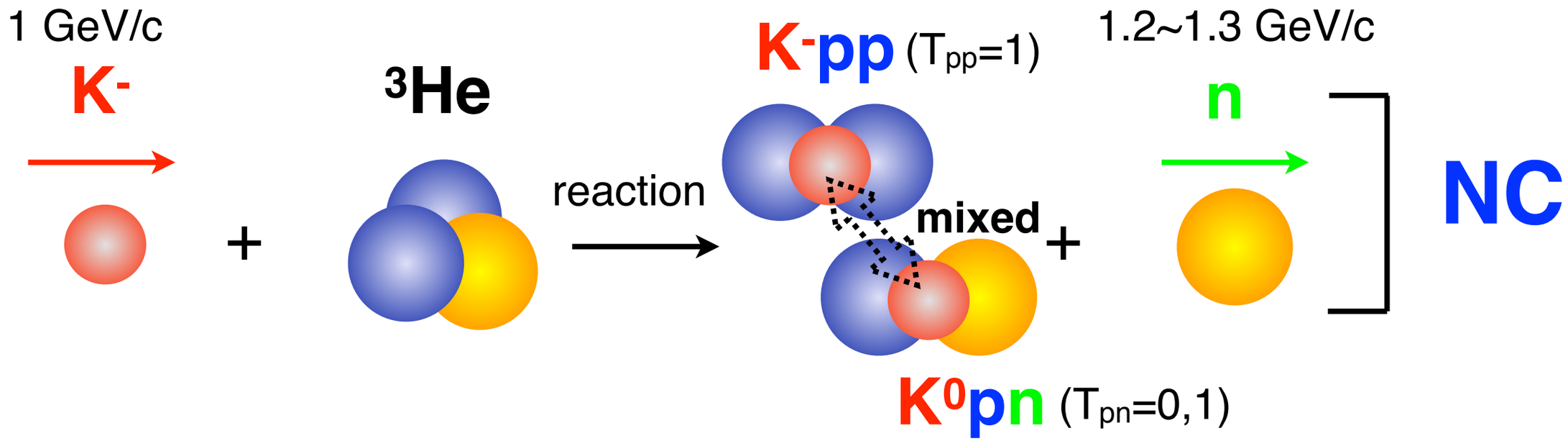
Deep-bound region

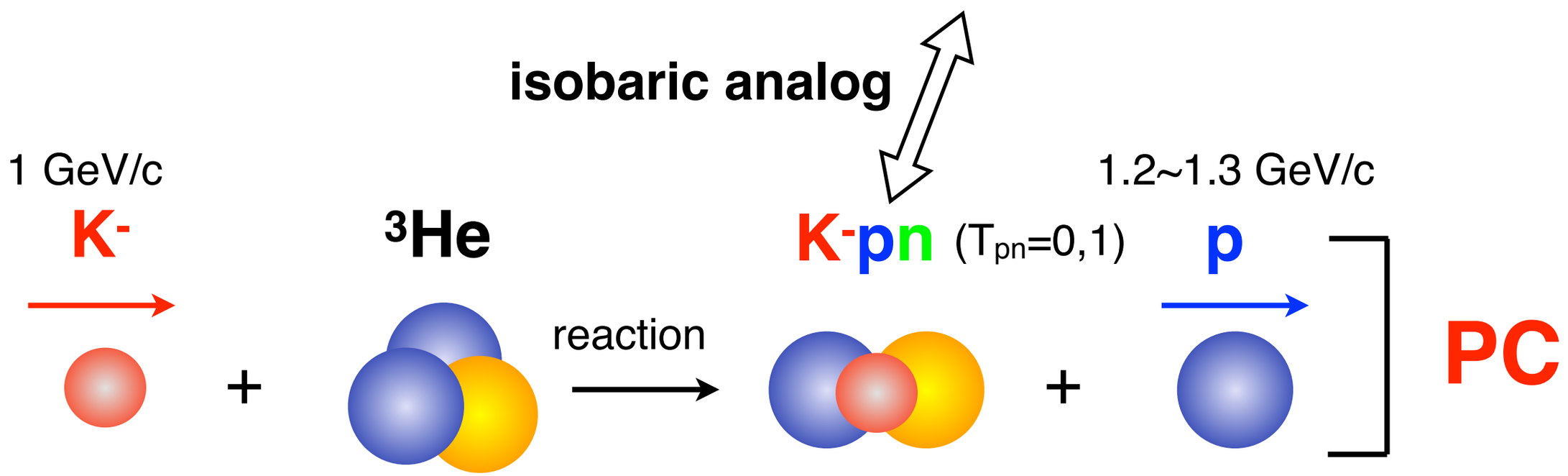
→ No significant peak
set upper limit:
a few hundreds μb/sr
= a few % of quasi-elastic K

Just below the threshold

→Significant yield ~ 1 mb/sr
should include quasi-free Λ(1405)

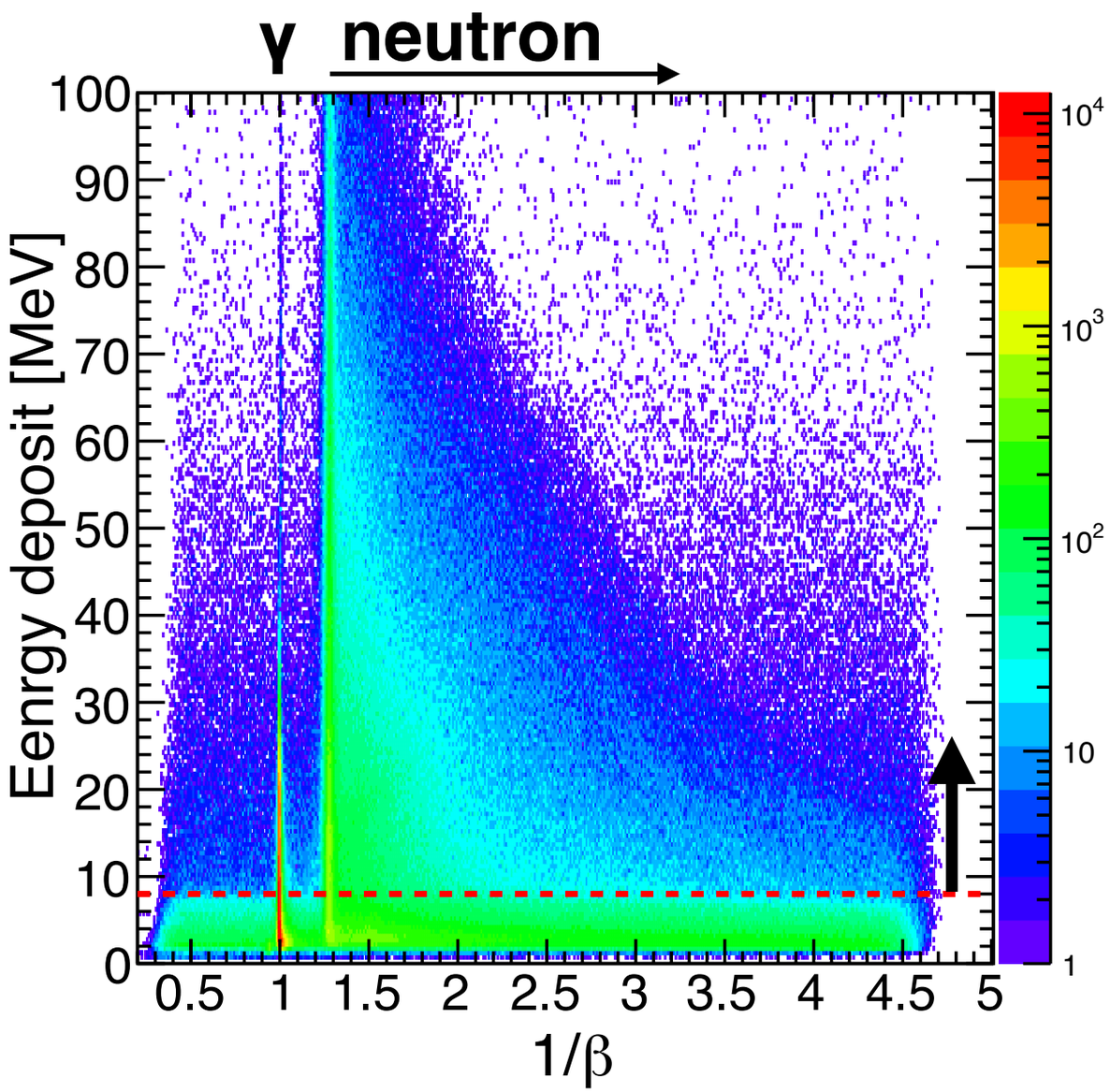
(K-,n) v.s. (K-,p)


1 GeV/c
K-
+
3He
reaction
K-pp (Tpp=1)
mixed
+
1.2~1.3 GeV/c
n
NC
K0pn (Tpn=0,1)


isobaric analog
1 GeV/c
K-
+
3He
reaction
K-pn (Tpn=0,1)
+
1.2~1.3 GeV/c
p
PC

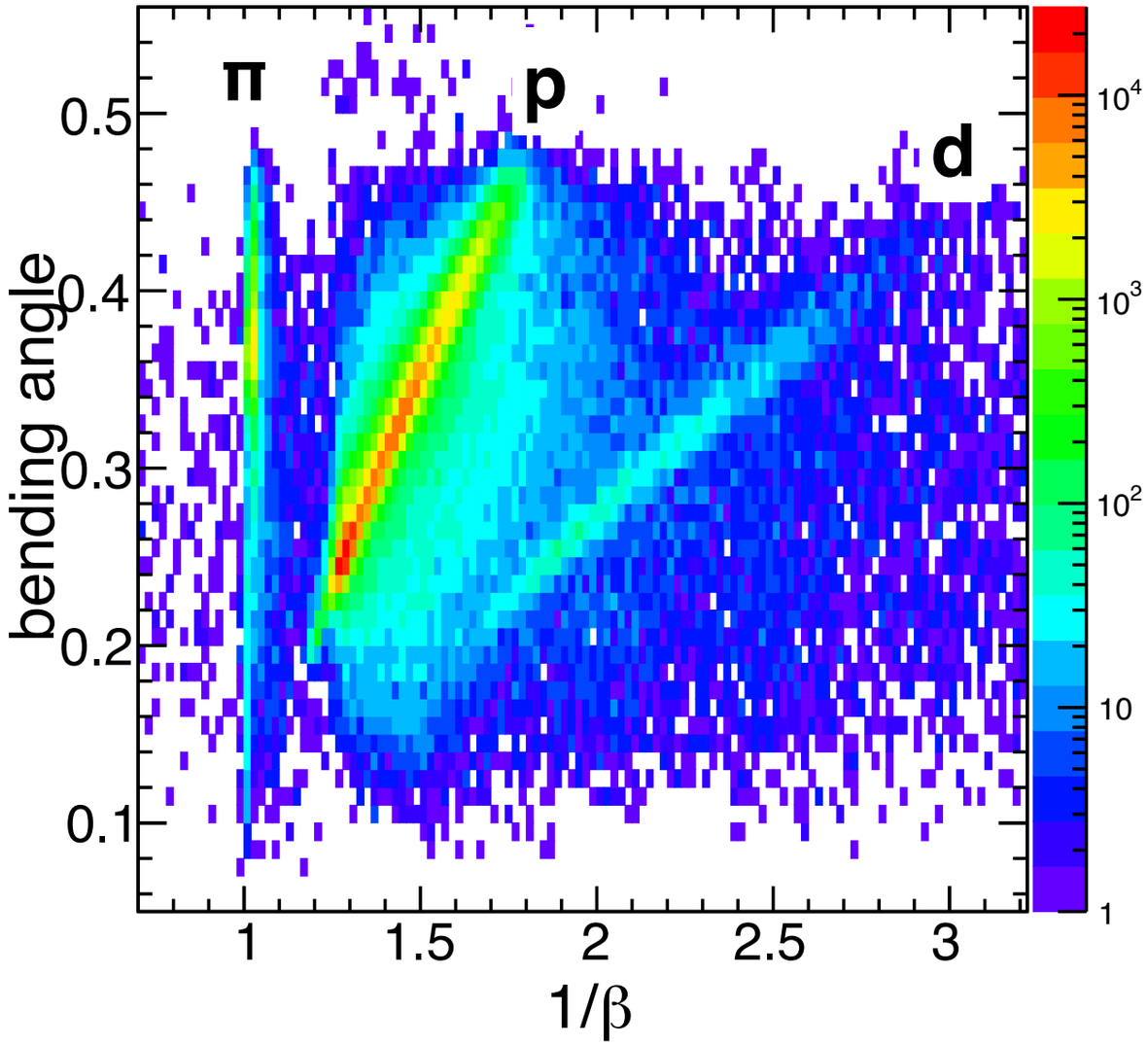
Forward PID/Momentum reconstruction

Neutral (NC)



Calibration by gamma-rays

Charged (CVC/PC)

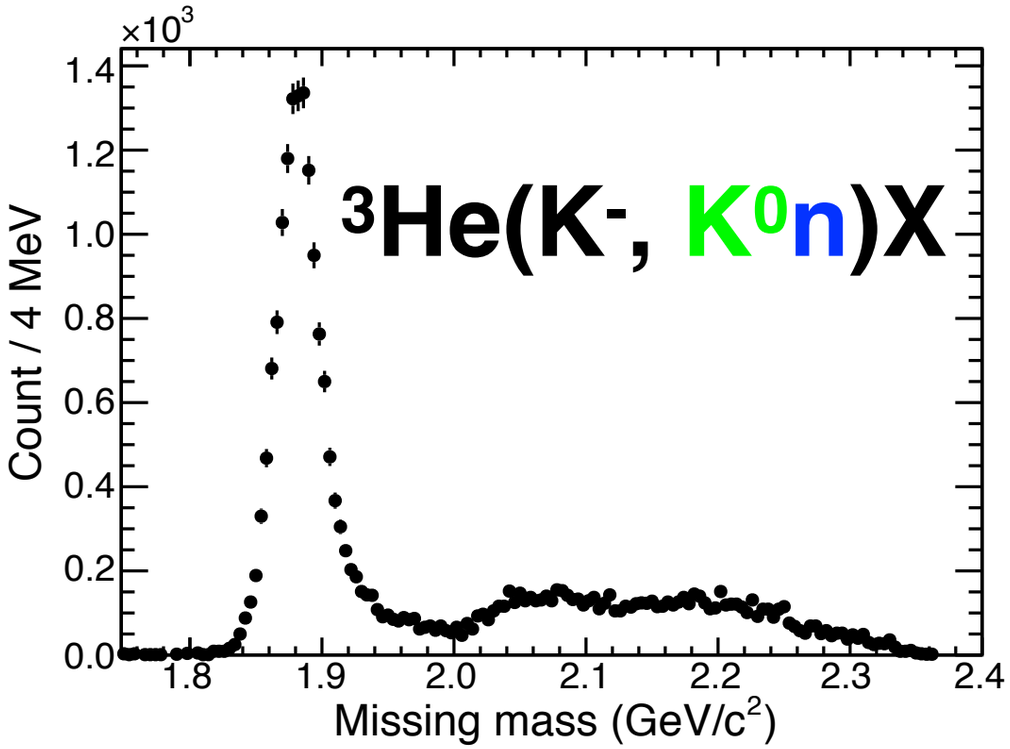


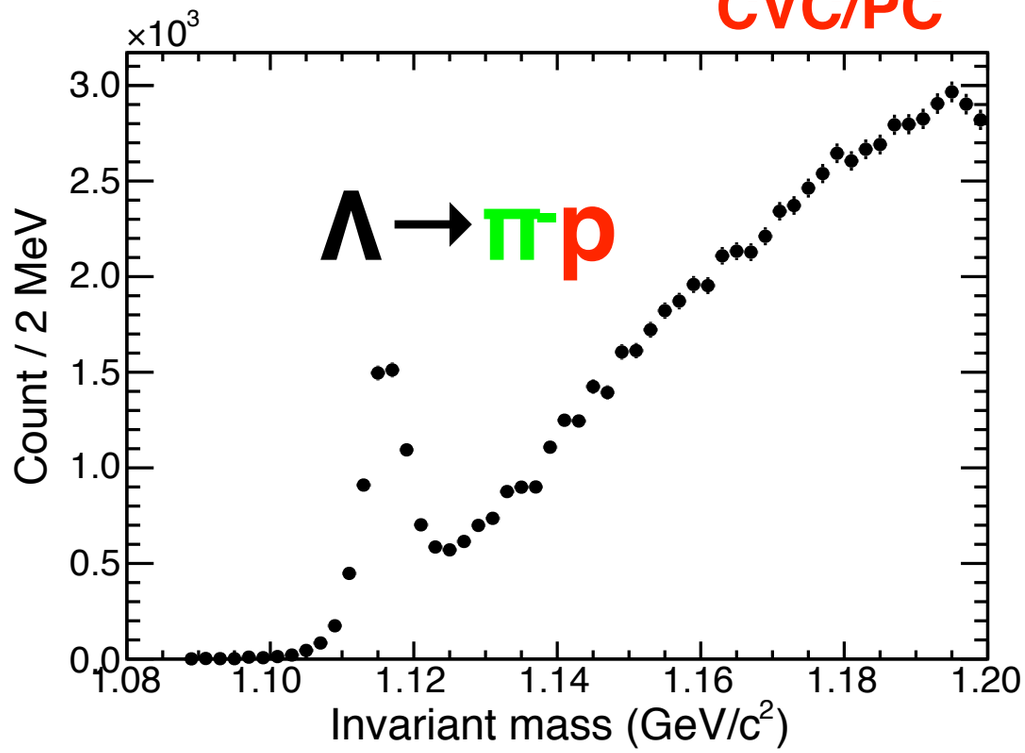
Calibration by beam-thorough data

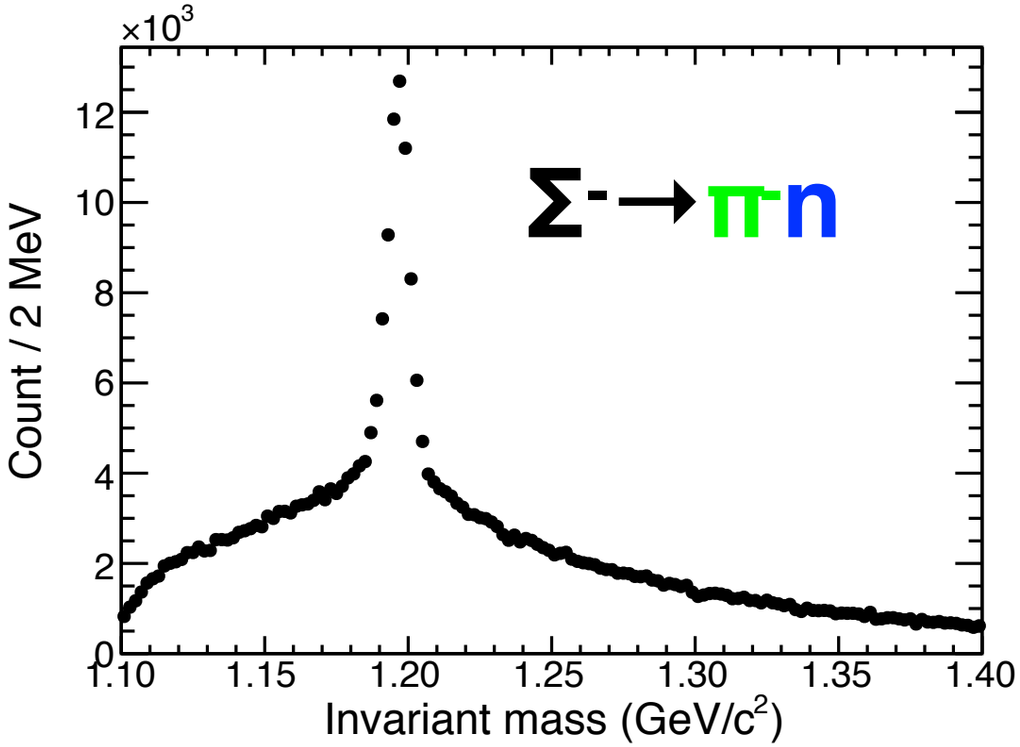
* We need vertex information given by CDS to calculate the flight length

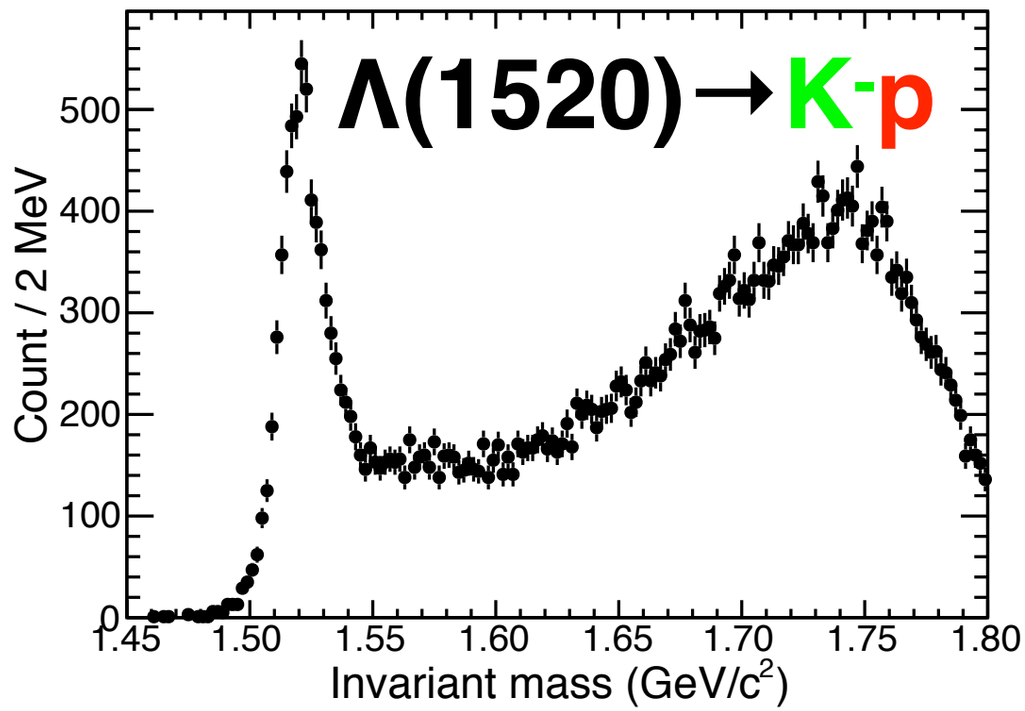
Performances

CDS
NC
CVC/PC





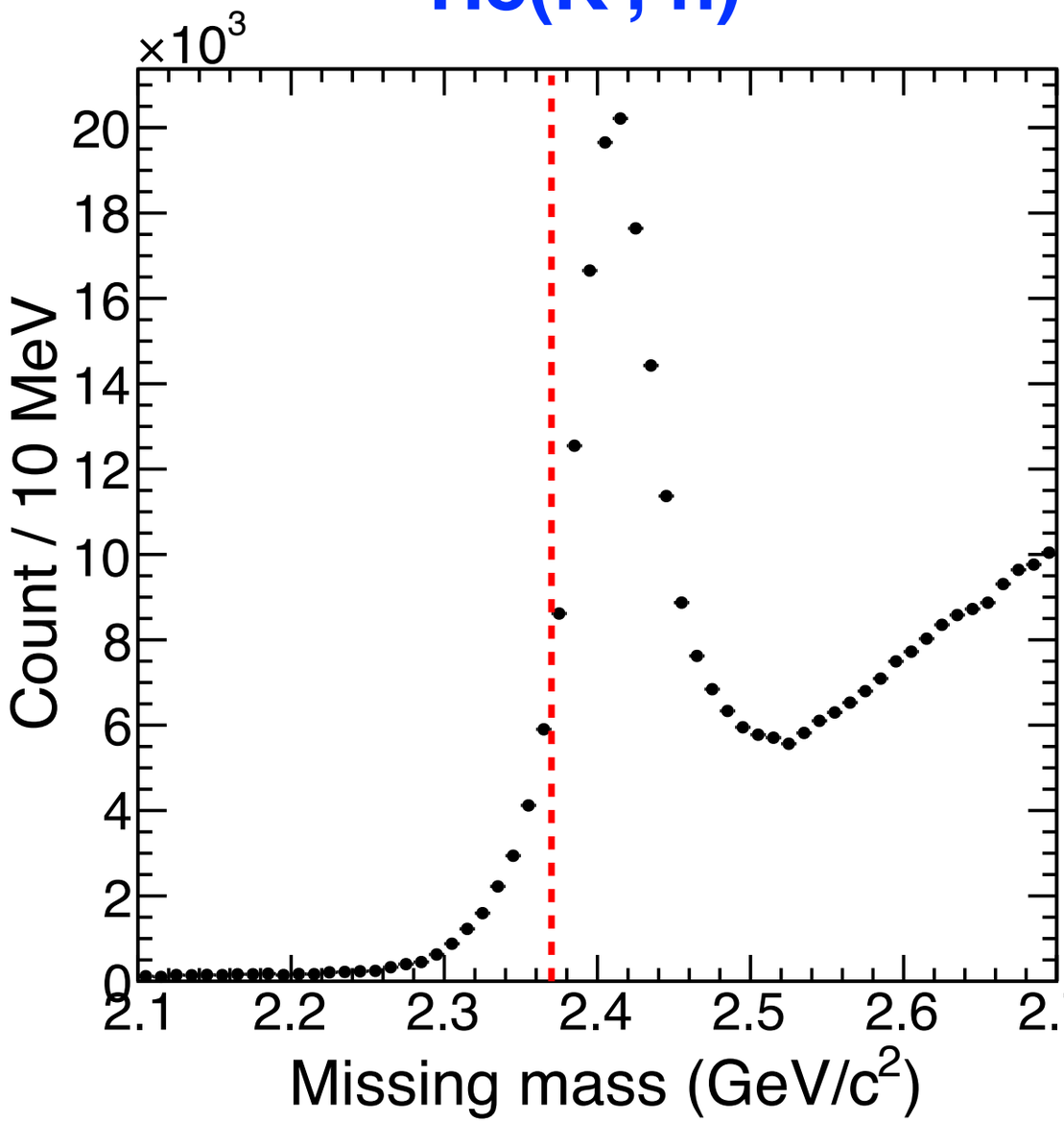




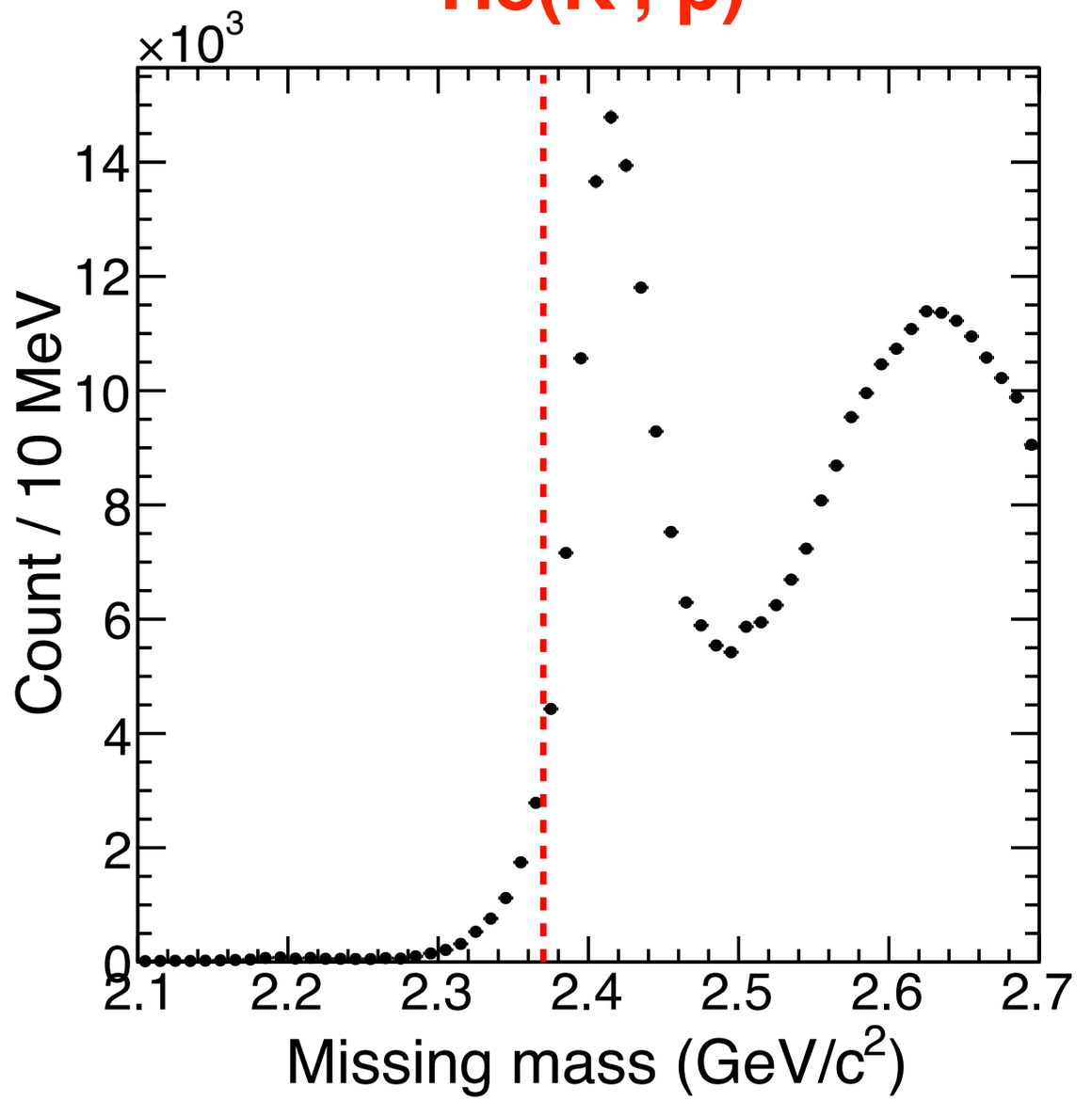
Resolution σ ~ 10 MeV @ 1 GeV/c, Energy scale ~ 10 MeV accuracy

E15^{2nd}: Semi-inclusive spectra

^{3}He(K^-, n)

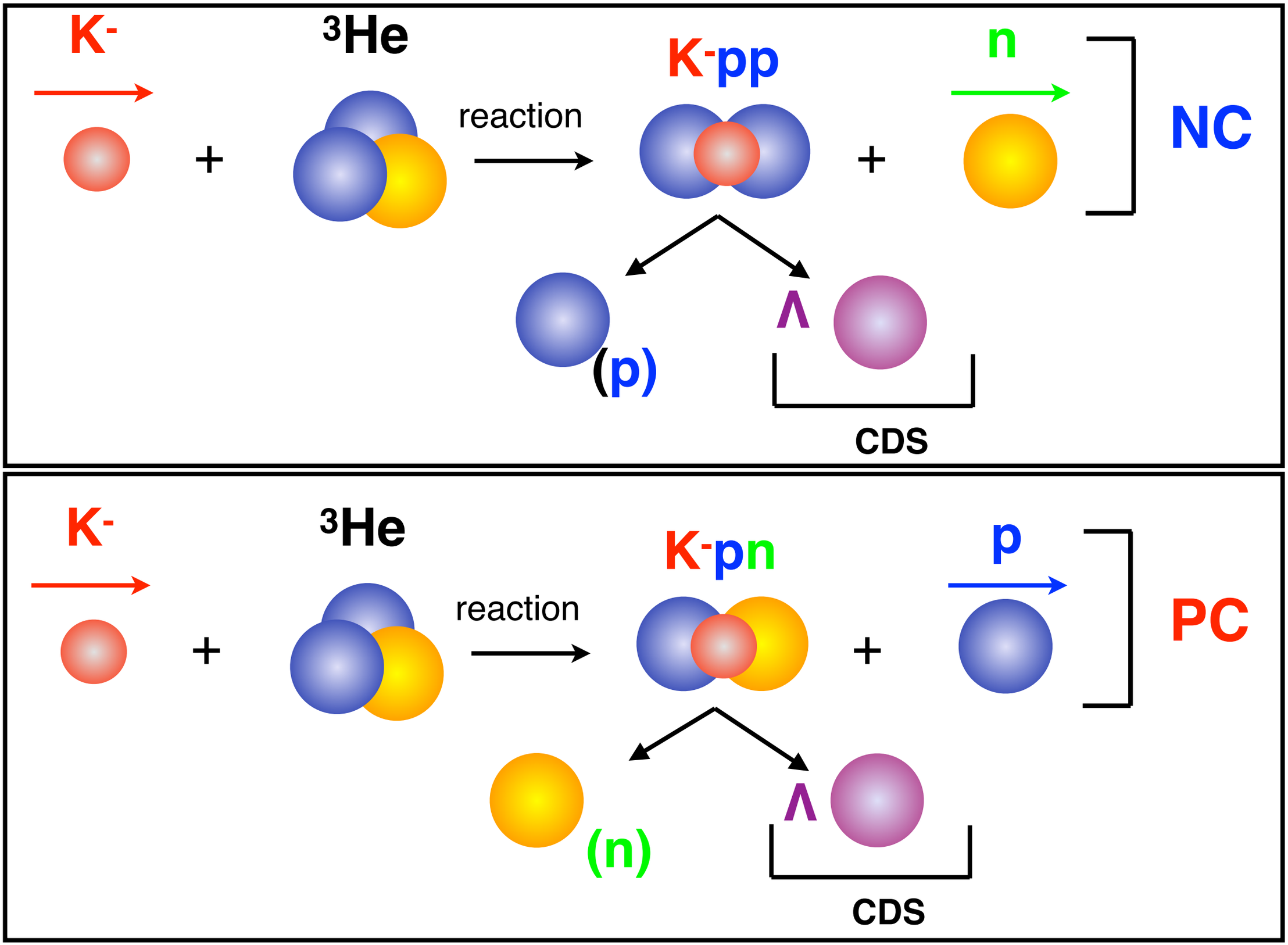


^{3}He(K^-, p)



- x 7 data compared with E15^{1st}
- Similar line shape: Quasi-elastic peak + tail towards bound region.
- NC detection efficiency ~ 0.3

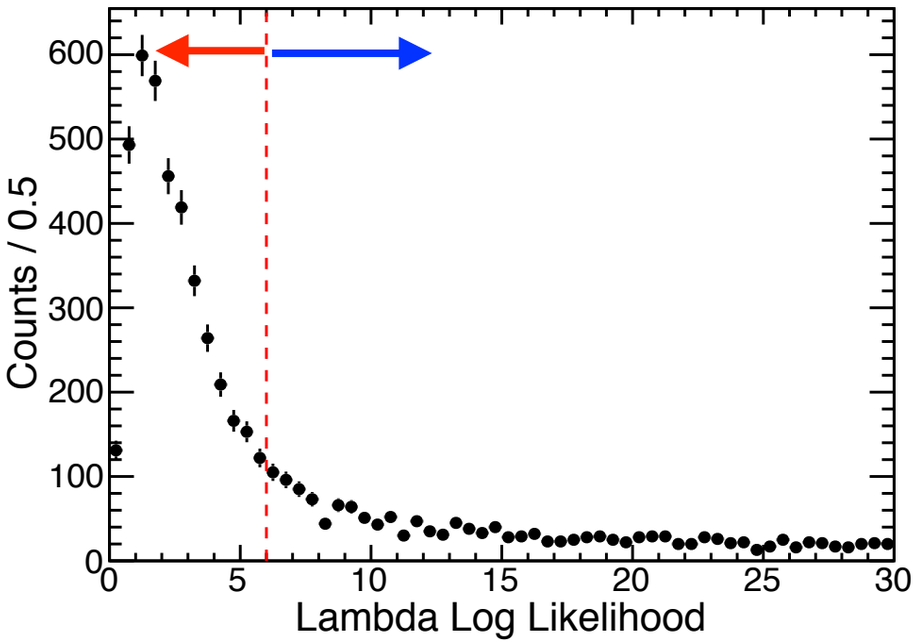
Exclusive analysis

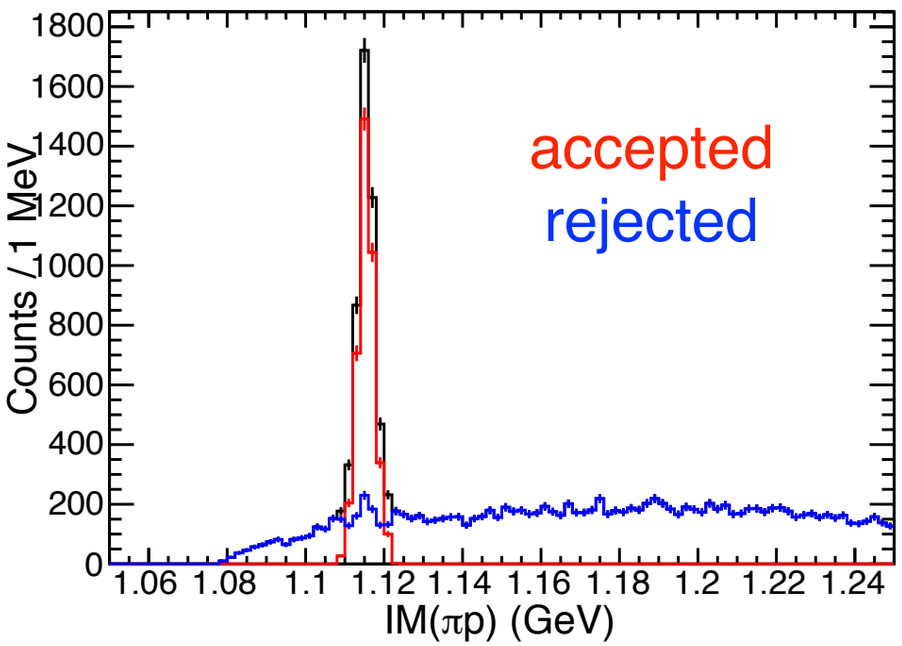


Λ selection

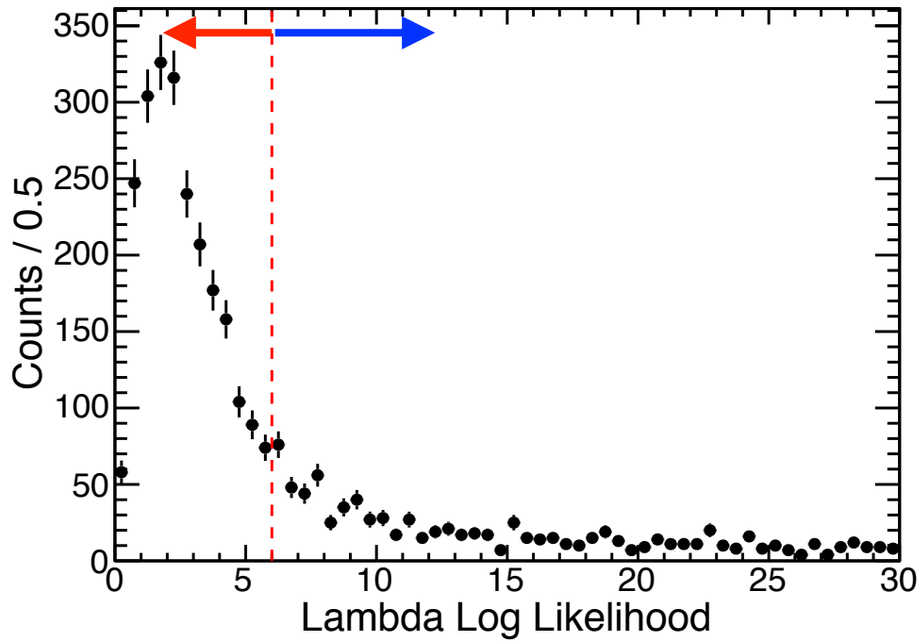
Likelihood was calculated
using DCA(πp), DCA(KΛ), and πp invariant mass.

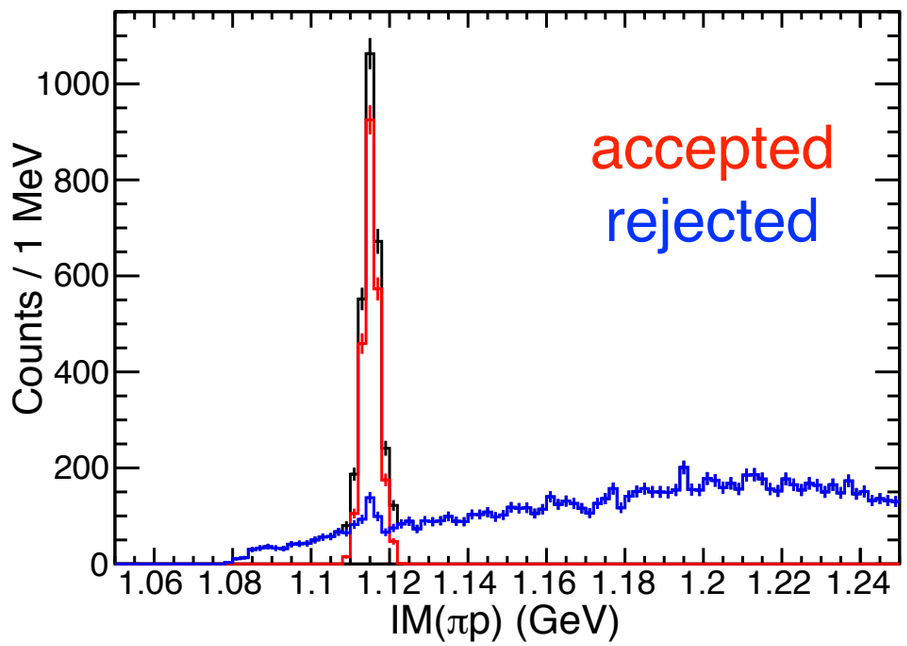
with forward neutron





with forward proton

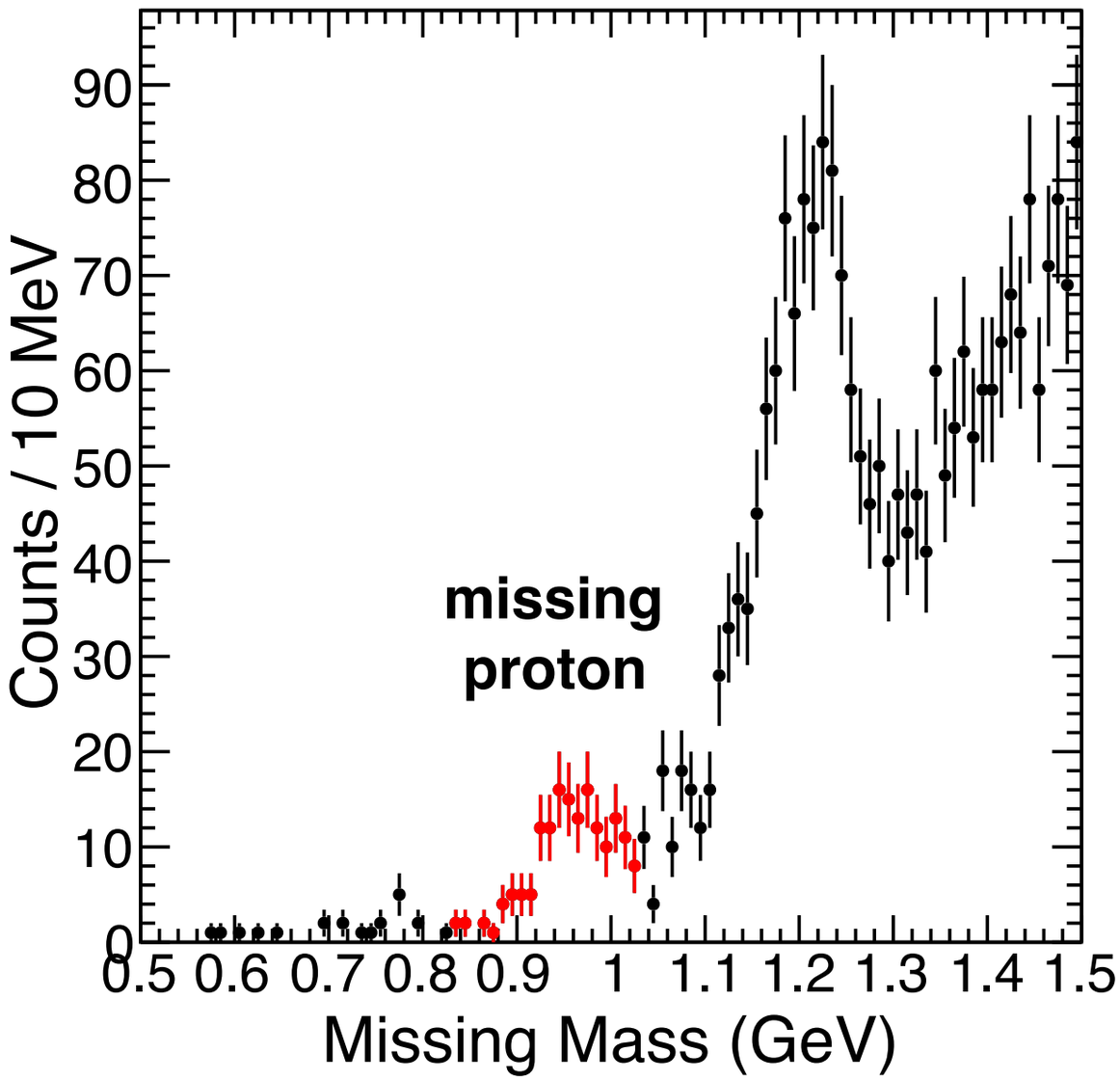




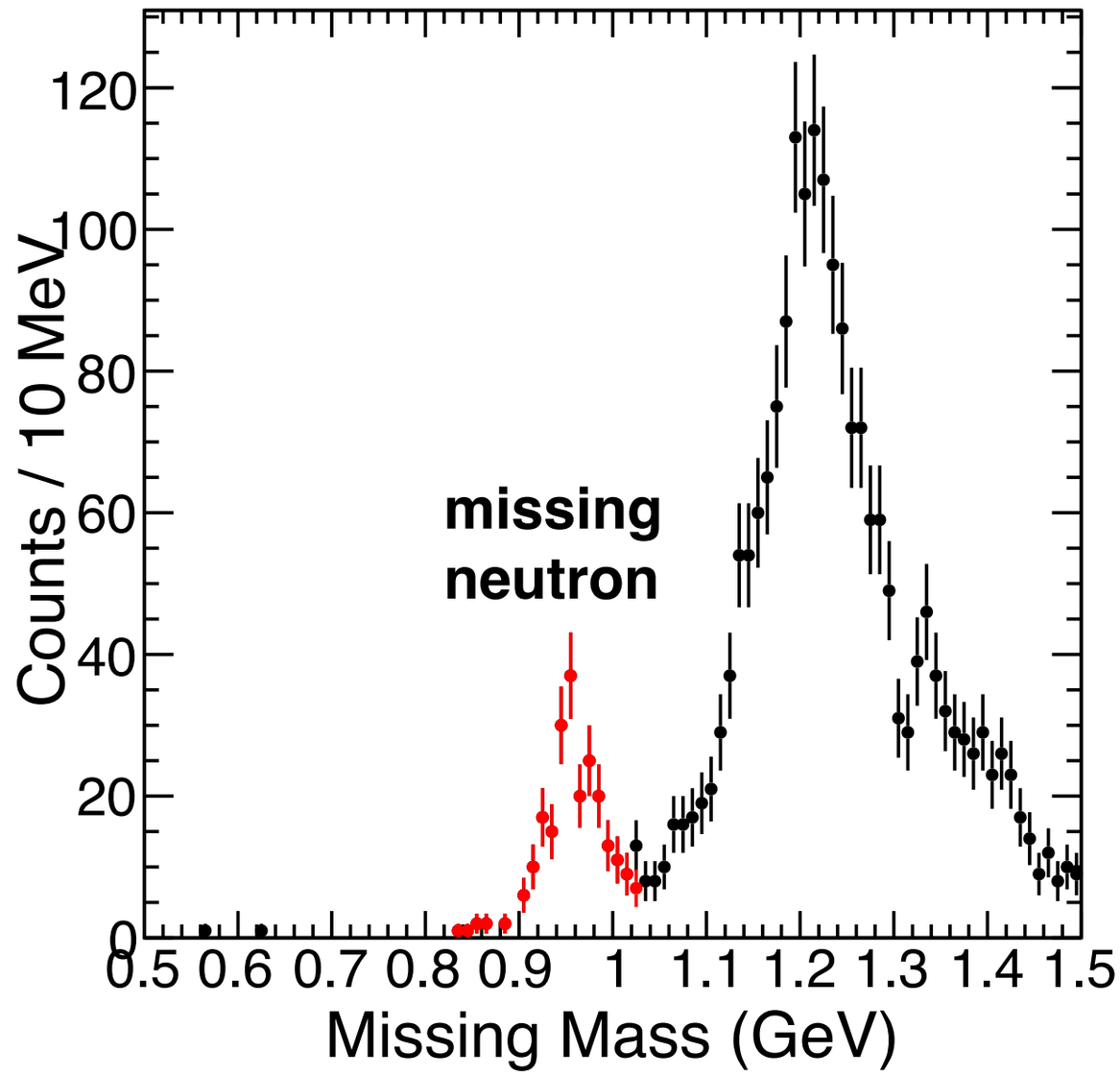
Good identification of Λ with a similar method used in Λp analysis by T. Yamaga.

Missing proton/neutron

^{3}He(K$^-$, Λn)



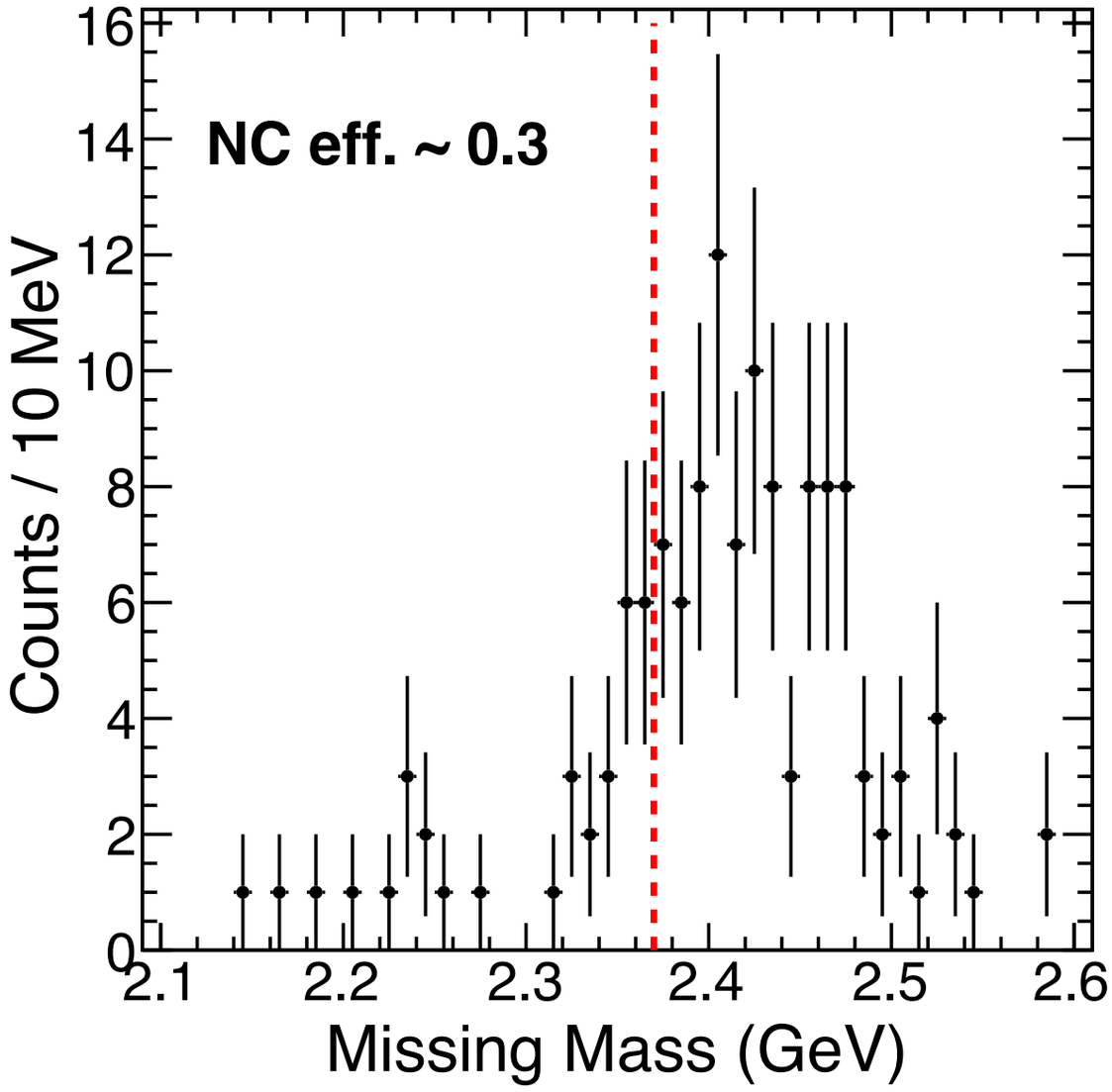
^{3}He(K$^-$, Λp)



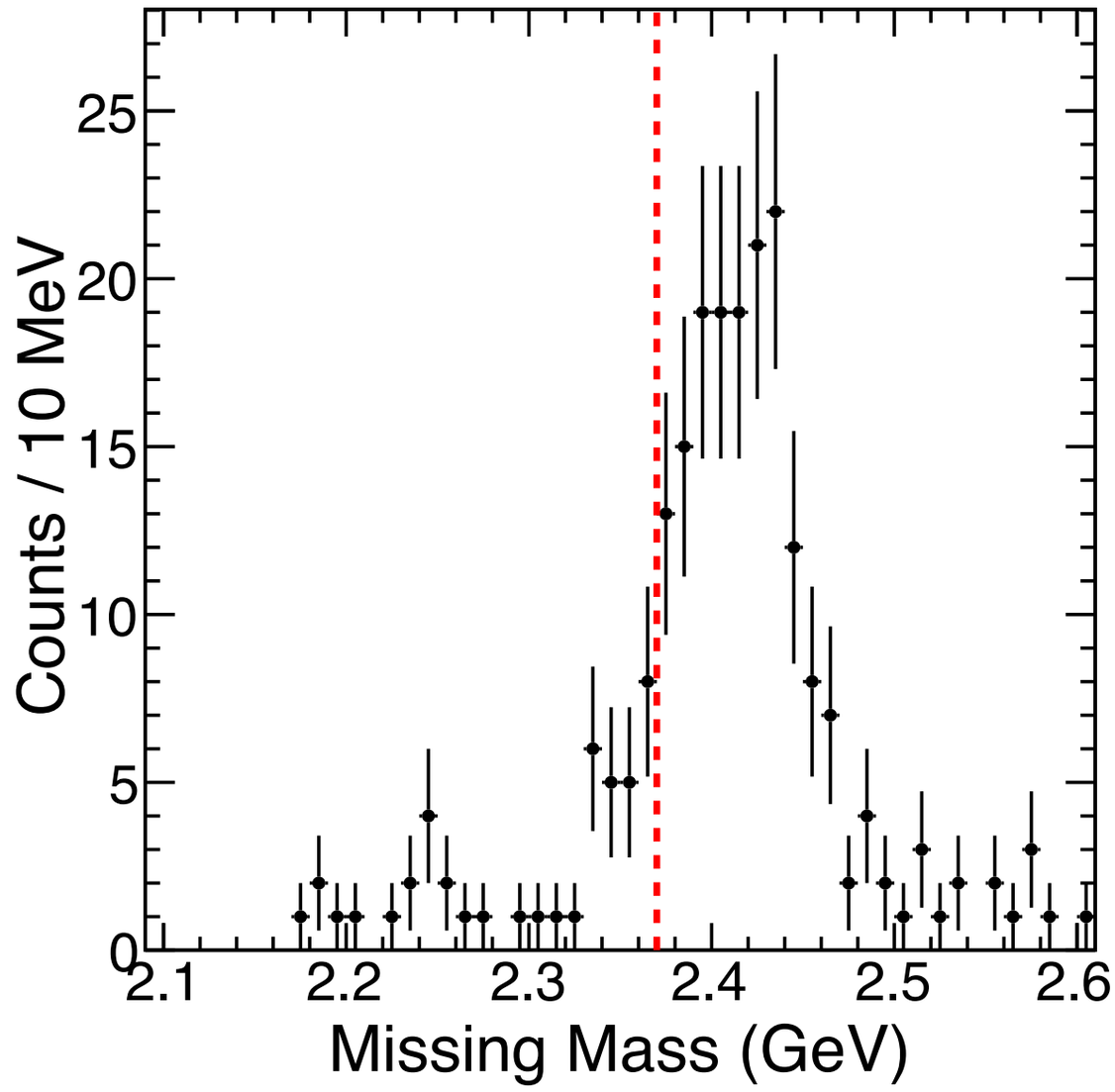
Missing proton/neutron peaks are clearly observed.
Some contamination from Σ⁰ might exist.

(K⁻, n/p) : Λpn final states

^{3}He(K⁻, n)

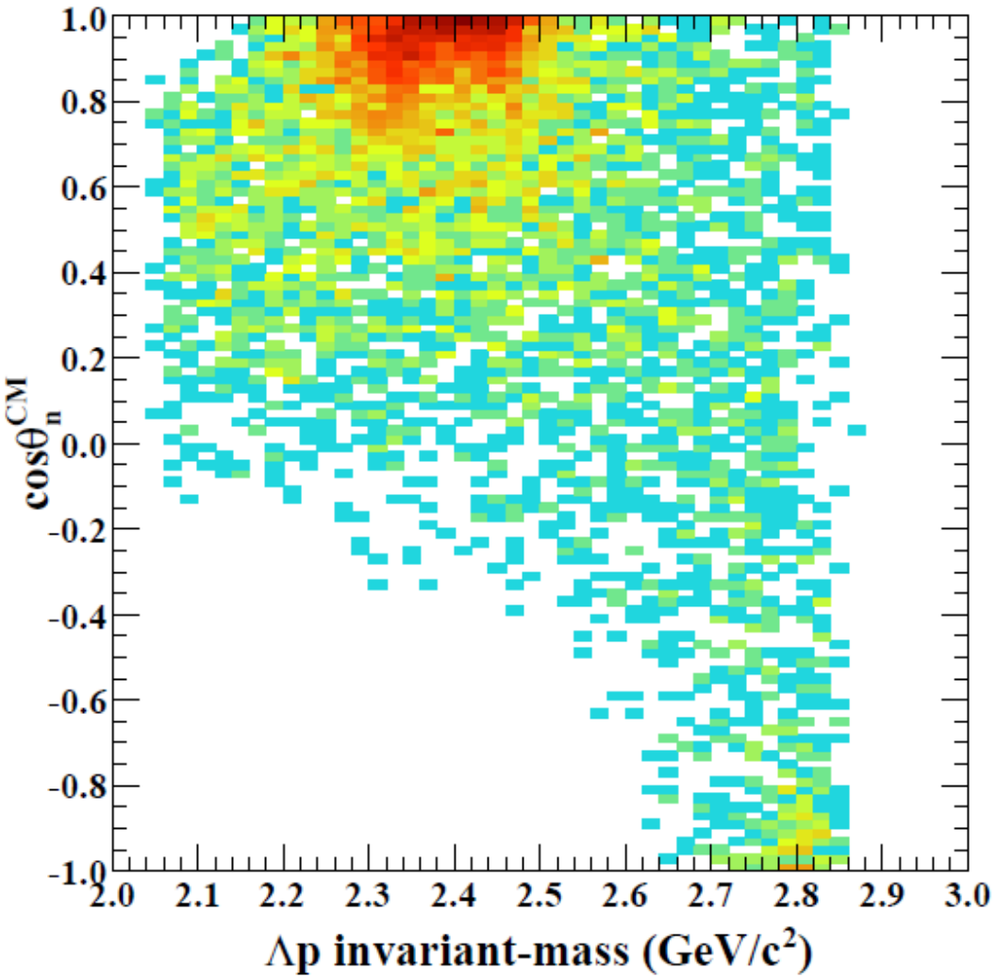


^{3}He(K⁻, p)

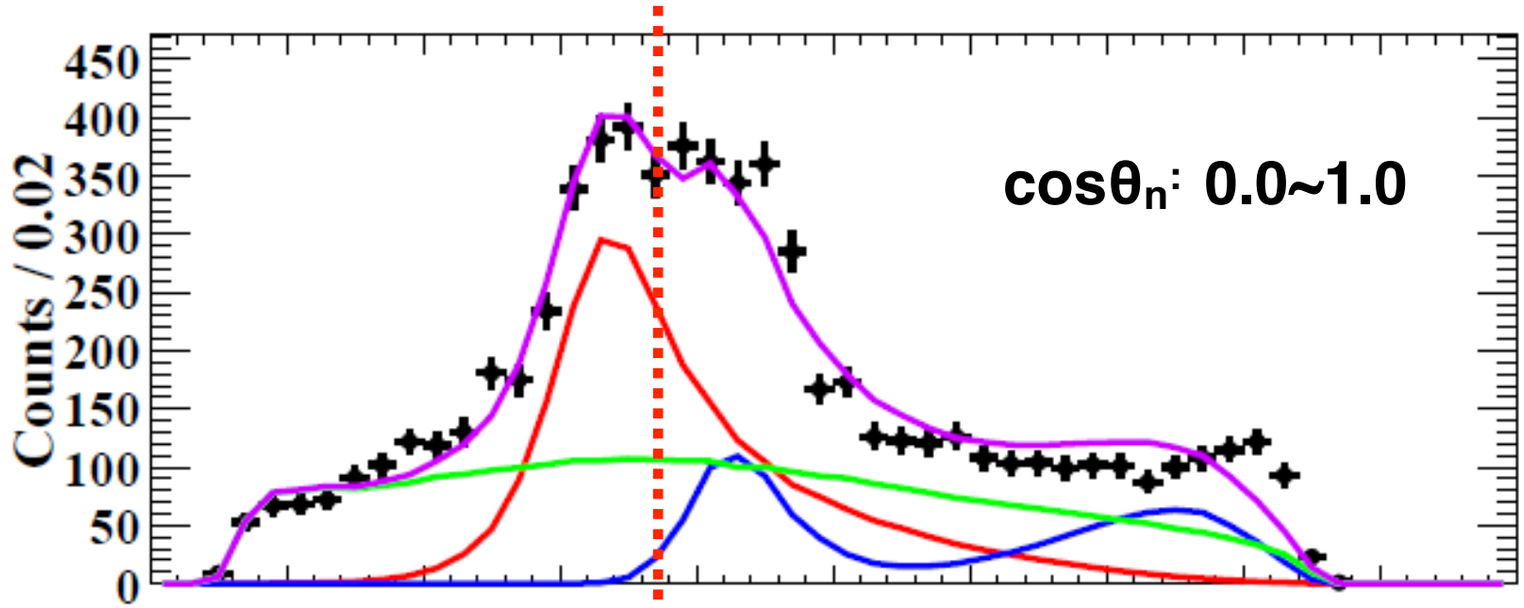


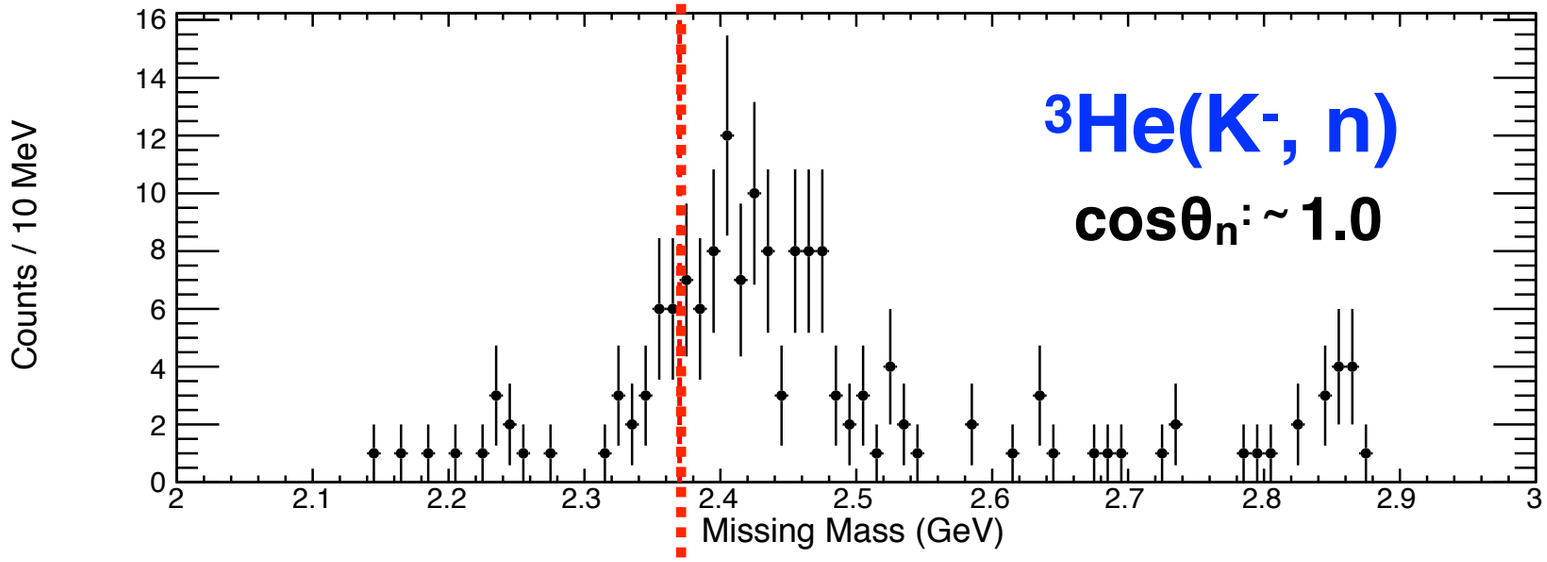
- Above the threshold: Quasi-elastic + 2 nucleon absorption
- Below the threshold: few events, need more careful analysis

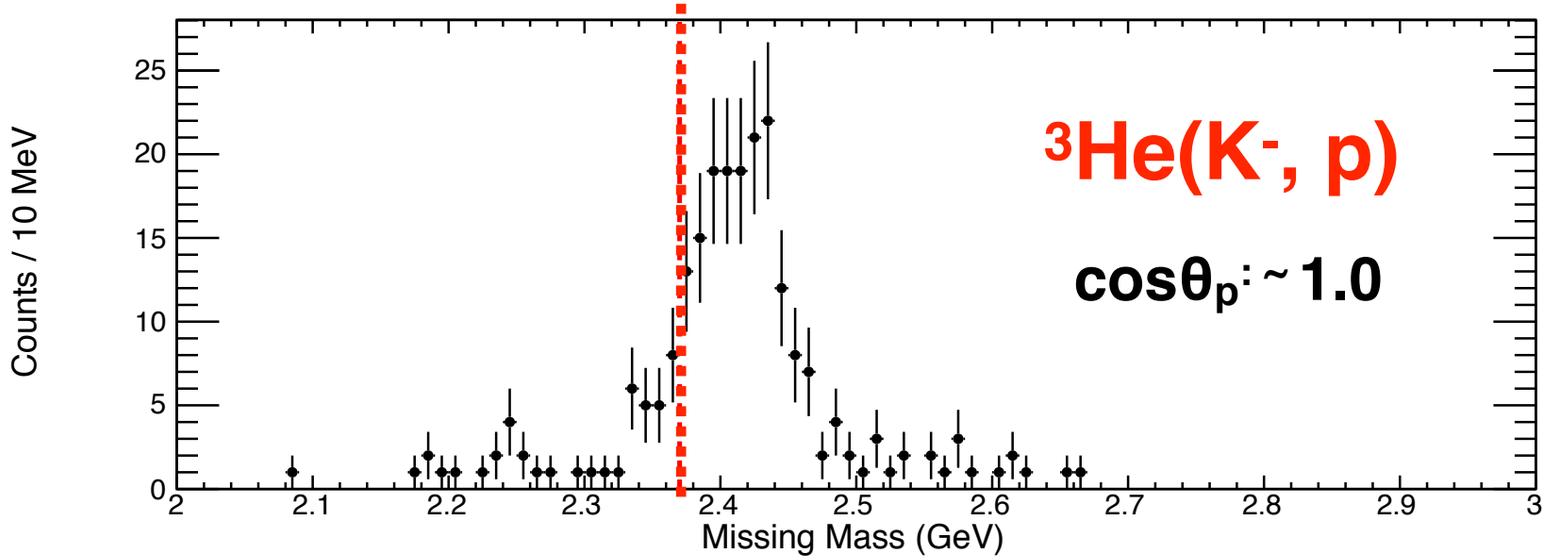
Angular dependence



QE+2NA is much enhanced at very forward angle







Summary

- **^{3}He(K^{-},n) & ^{3}He(K^{-},p) reactions were analyzed requiring Λpn final states.**
  - could provide information on the isospin-dependence of the $K^{bar}NN$ reaction.
  - Cross sections are to be derived…

- **Quasi-elastic + 2NA structures are observed**
  - consistent with Λp analysis in the CDS.