E15 Status Report

- ✓ **Analysis Status of ^{3}He(K^{-},Λp)n in E15^{1st}**
- ✓ **Status of E15^{2nd}**

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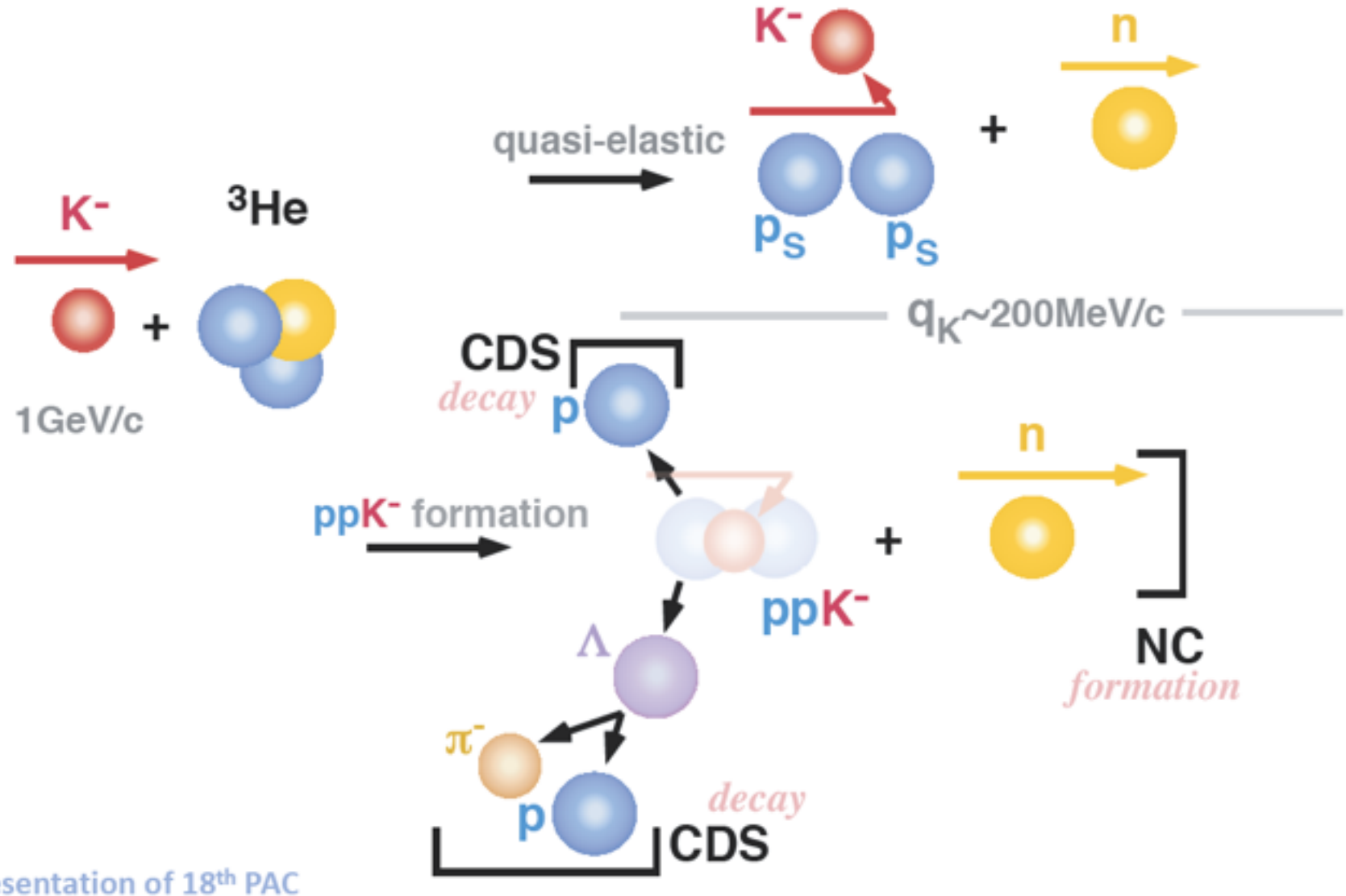
for the E15 Collaboration

E15: "K⁻pp" search via ^{3}He(K⁻,n) @p_K=1GeV/c

for efficient "ppK" formation — *without 2NA background*

Formation & Decay — *Y decay can be rejected*



Formation vs Decay

PTEP(2015)061D01

Formation channel

semi-inclusive

$K^- + {}^3He \rightarrow n + X\ (\theta_n=0)$

- excess below threshold
  background-free
- contribution from
  $\Lambda(1405)n + p_S$ (2NA)
  may exist

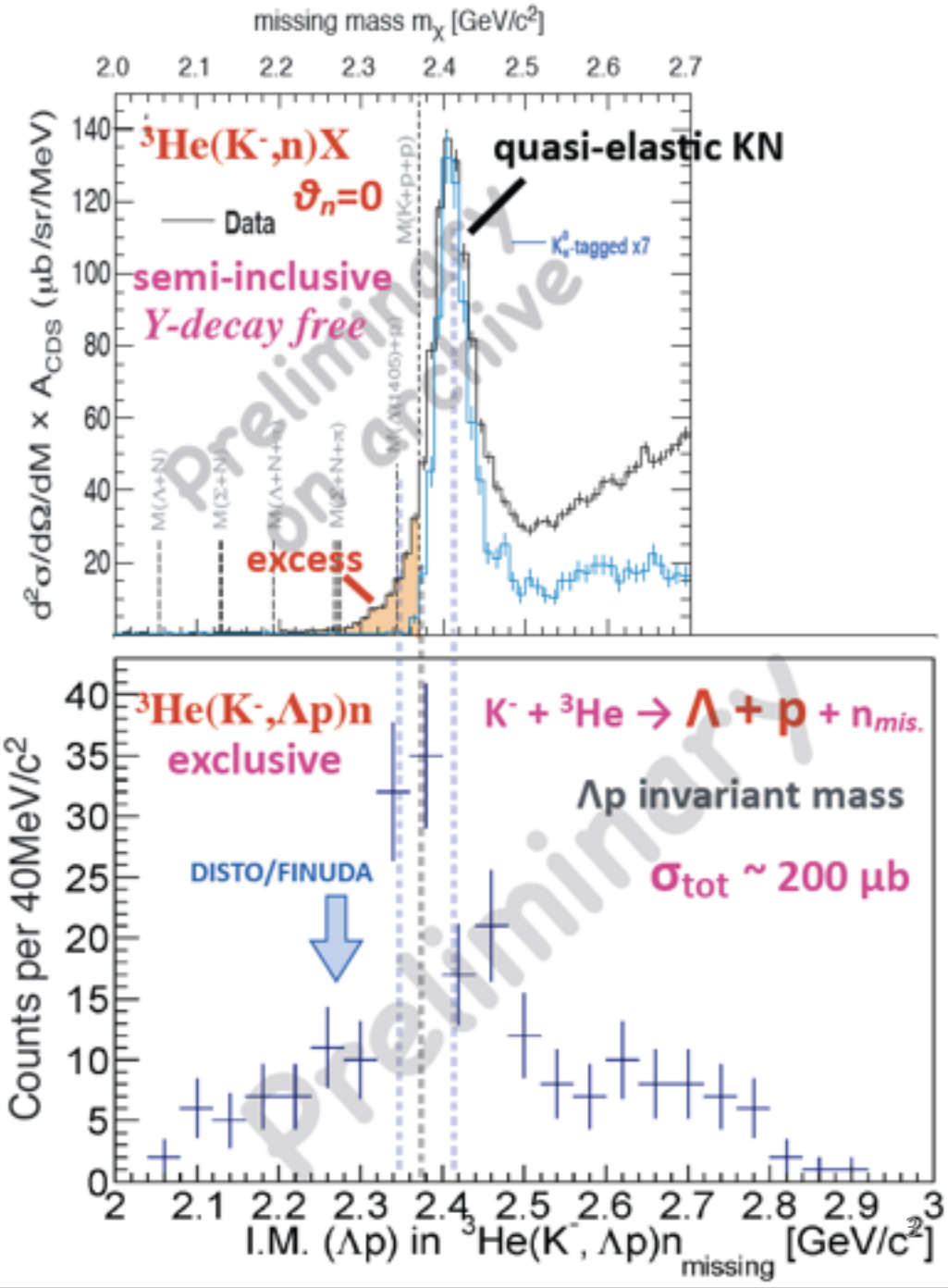
paper in preparation

Decay channel

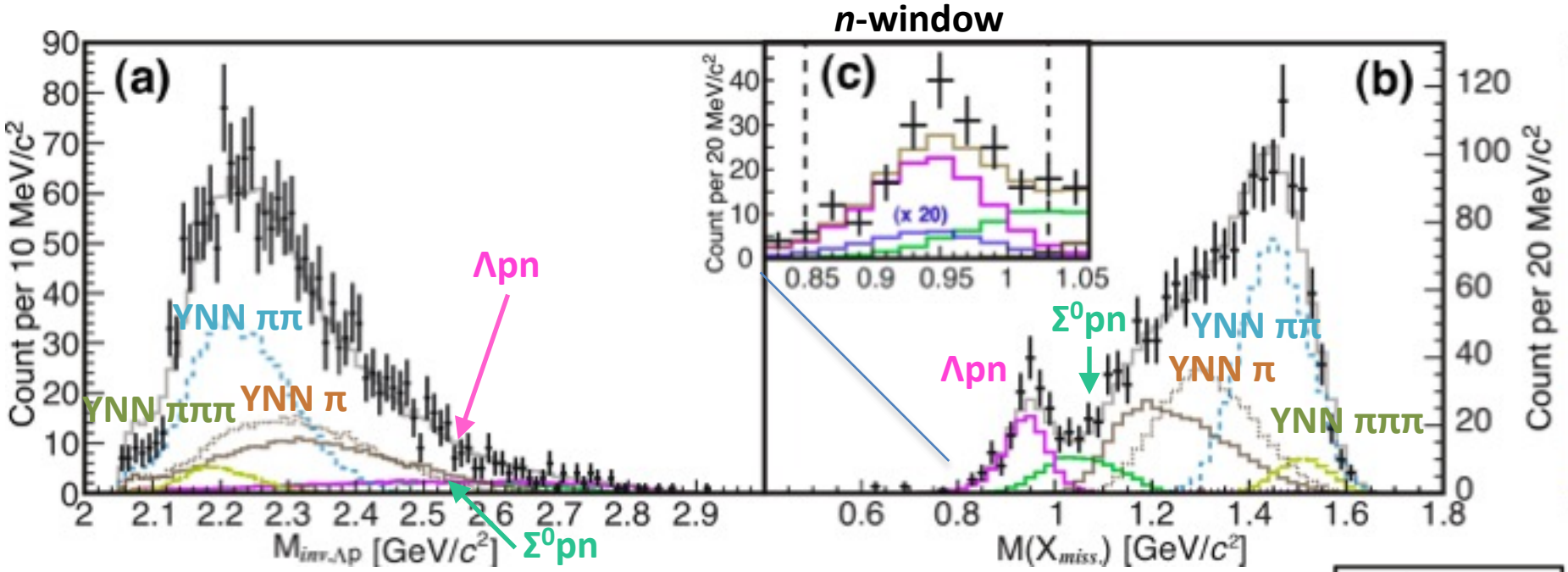
exclusive

$K^- + {}^3He \rightarrow \Lambda + p + n_{mis.}$

- excess exist near threshold
- cannot be $\Lambda(1405)n + p_S$ (2NA), because F.S.= $\Lambda p n$
- contamination $\Sigma^0 < 20\%$



Λp invariant mass & missing mass



Identify neutron by kinematics

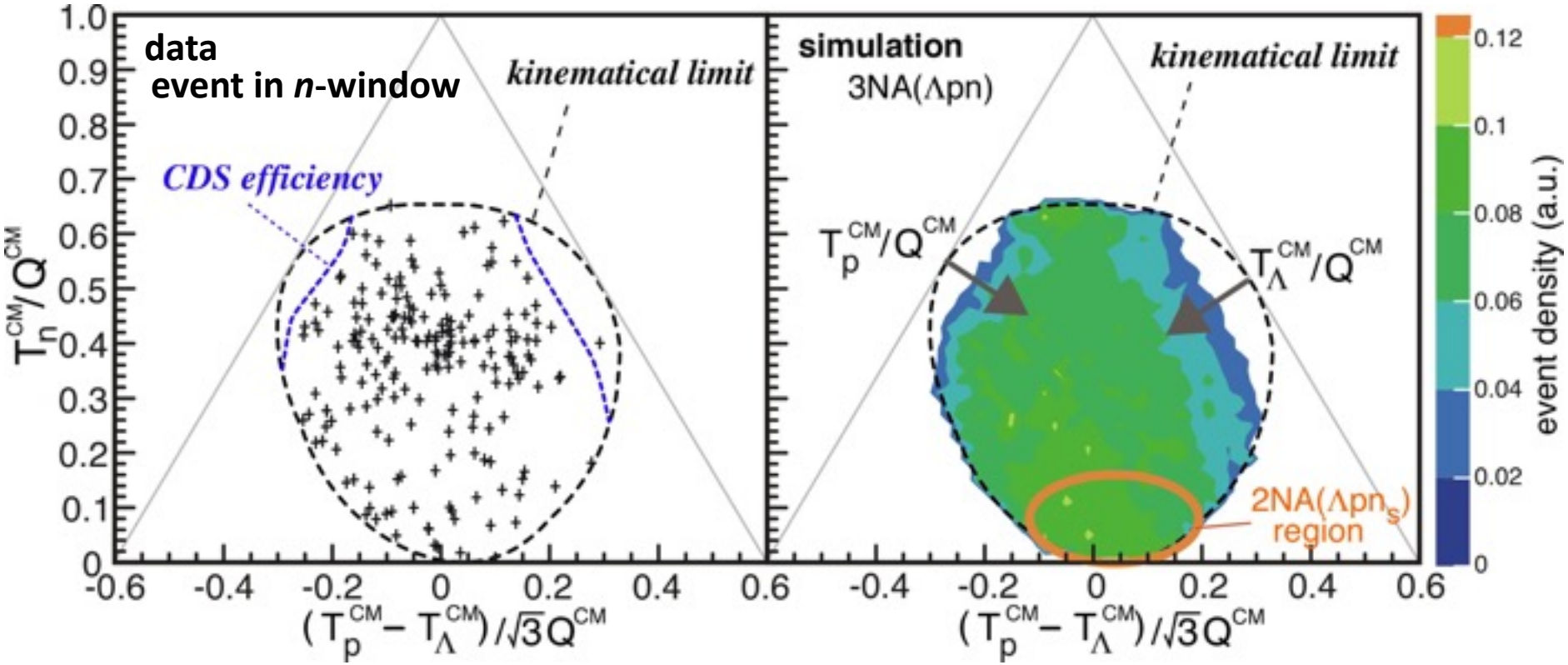
$$K^- + {}^3He \rightarrow \Lambda + p + n_{mis.}$$

To know components in *n*-window, we conducted

global fit both Λp invariant-mass & missing mass

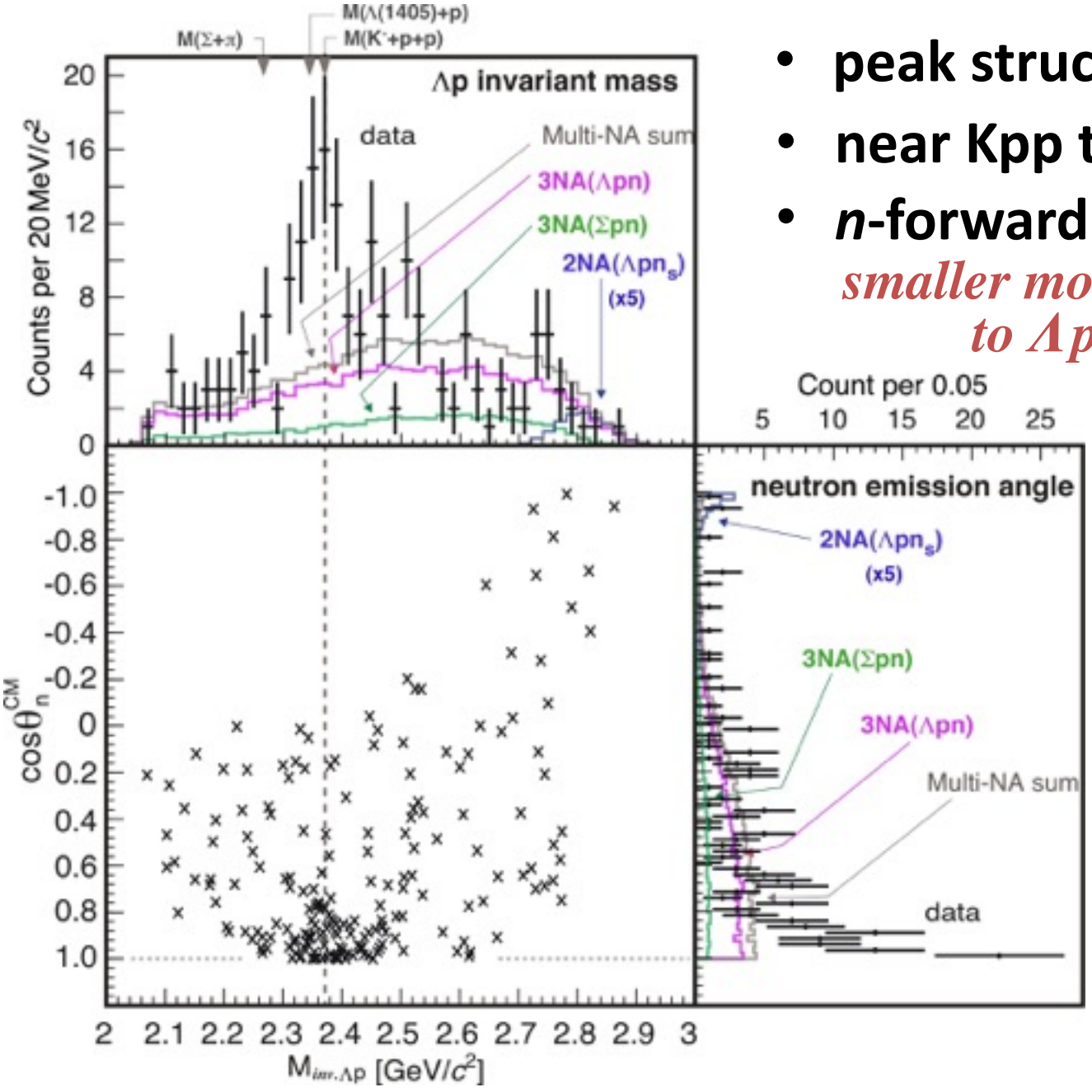
$$\textit{cf.}\ \mathbf{3NA}(\boldsymbol{\Lambda pn}):\quad \frac{d^2\sigma_{3\mathrm{NA}(\Lambda\mathrm{pn})}}{dT_n^{CM}\,d\cos\theta_n^{CM}} \propto \rho_3\,(\Lambda pn)$$

Events on Dalitz plot



- Event concentration at $T_n^{CM}/Q^{CM} \sim 0.4$

Global fit result for *n*-window



- peak structure exist
- near Kpp threshold
- *n*-forward

smaller momentum transfer to Λp preferred!

Assuming a Breit-Wigner

– introduce simplest assumption

S-wave pole & Breit-Wigner formula & Gaussian form-factor

not valid near threshold though

Breit-Wigner

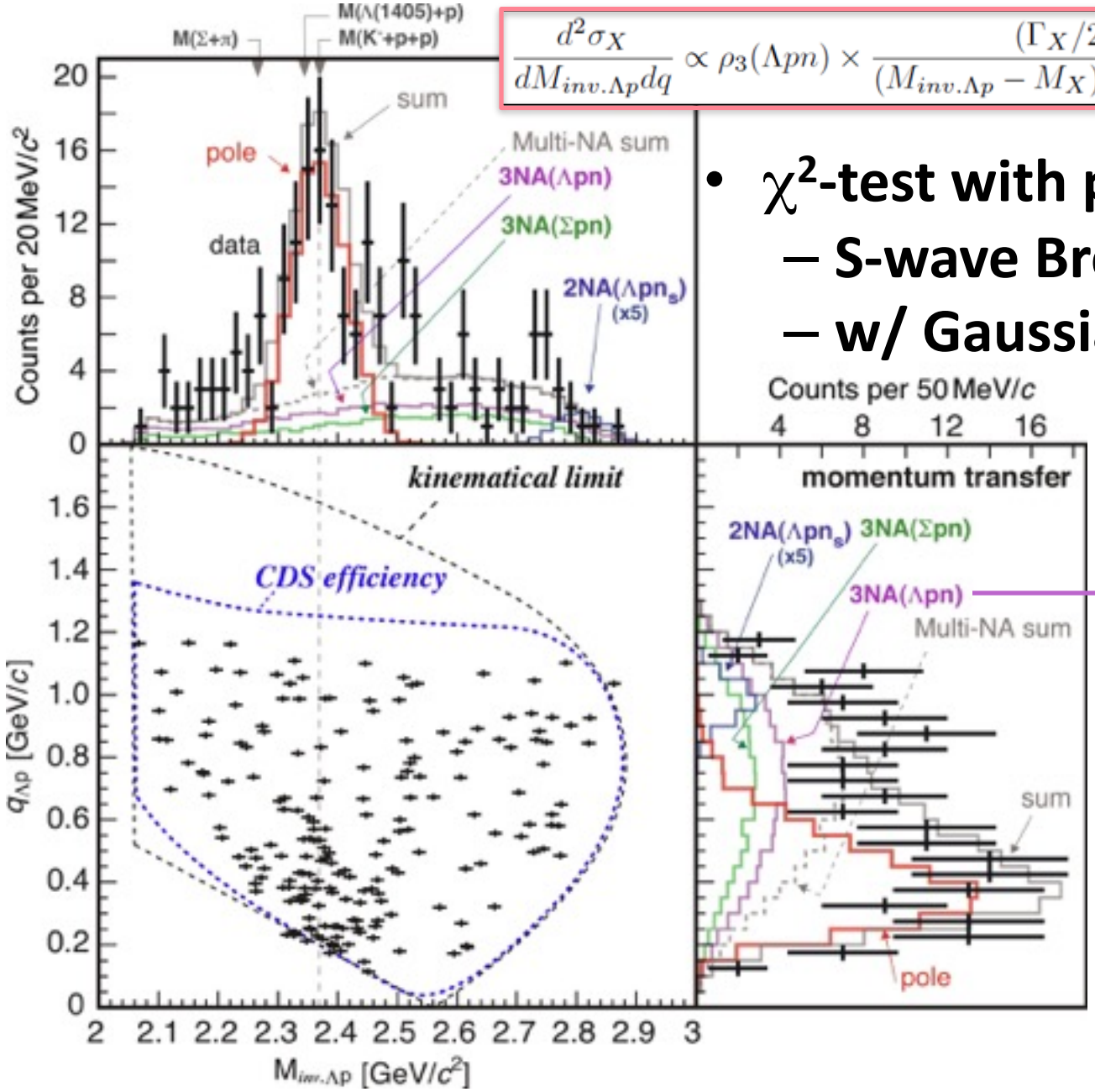
$$\frac{d^2\sigma_X}{dM_{inv.\Lambda p}dq} \propto \rho_3(\Lambda pn) \times \frac{(\Gamma_X/2)^2}{(M_{inv.\Lambda p} - M_X)^2 + (\Gamma_X/2)^2} \times |\exp(-q^2/2Q_X^2)|^2,$$

Lorentz invariant phase-space

form-factor²

Assuming a Breit-Wigner

$$\frac{d^2\sigma_X}{dM_{inv.\Lambda p}dq} \propto \rho_3(\Lambda pn) \times \frac{(\Gamma_X/2)^2}{(M_{inv.\Lambda p} - M_X)^2 + (\Gamma_X/2)^2} \times |\exp(-q^2/2Q_X^2)|^2,$$



- χ^2-test with pole & 3NA(Ypn)
  - S-wave Breit-Wigner pole
  - w/ Gaussian form-factor

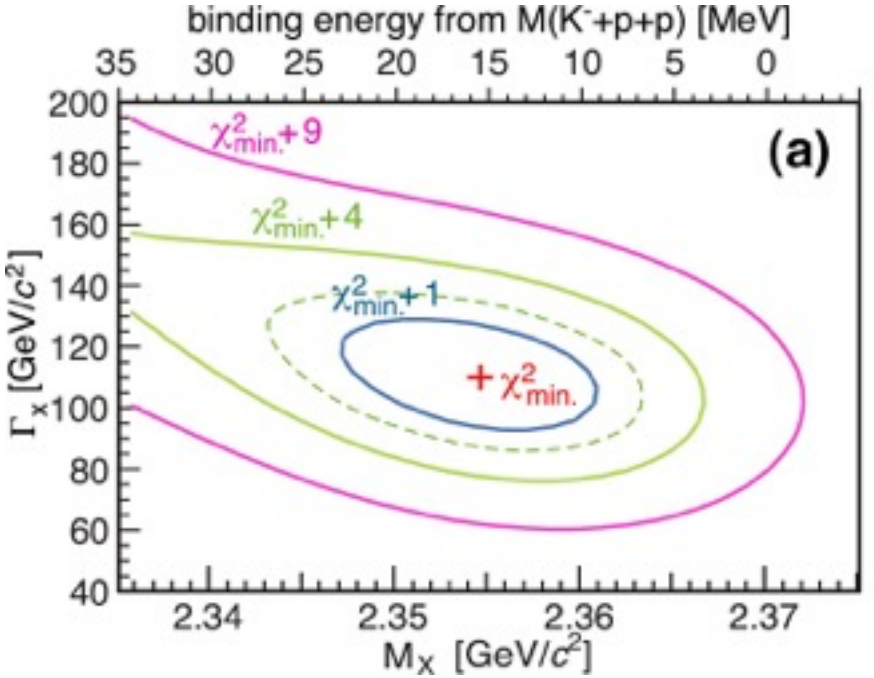
$$\frac{d^2\sigma_{3\mathrm{NA}(\Lambda\mathrm{pn})}}{dT_n^{CM}d\cos\theta_n^{CM}} \propto \rho_3(\Lambda pn)$$

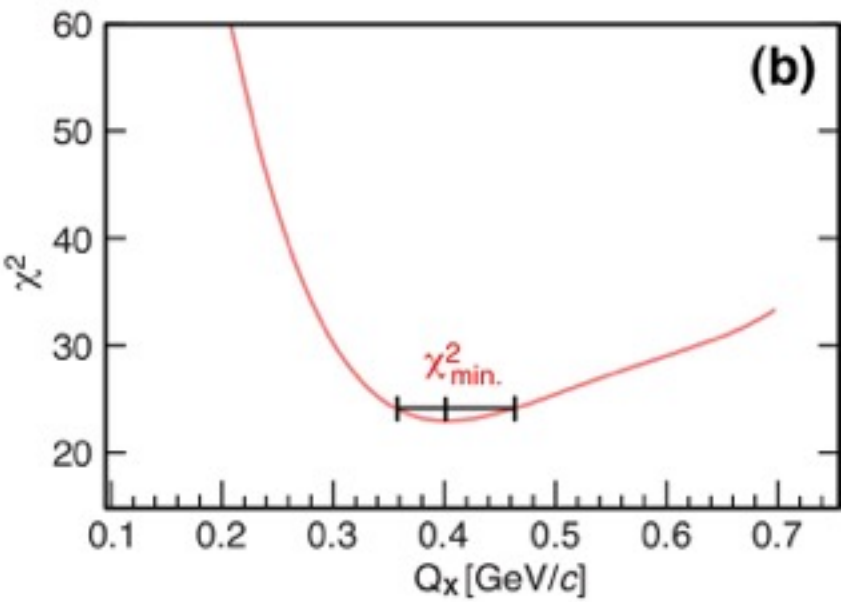
Assuming a Breit-Wigner

- **3 dim. fitting for M_X, Γ_X, Q_X**

$$\frac{d^2\sigma_X}{dM_{inv.\Lambda p}dq} \propto \rho_3(\Lambda pn) \times \frac{(\Gamma_X/2)^2}{(M_{inv.\Lambda p} - M_X)^2 + (\Gamma_X/2)^2} \times |\exp(-q^2/2Q_X^2)|^2,$$

Although, Breit-Wigner is not valid near threshold





E15 2nd stage

May, 2013 (Run#49c)	24 kW (30 Tppp, 6s)	140 k/spill	88 h	5.1×10^9

x10

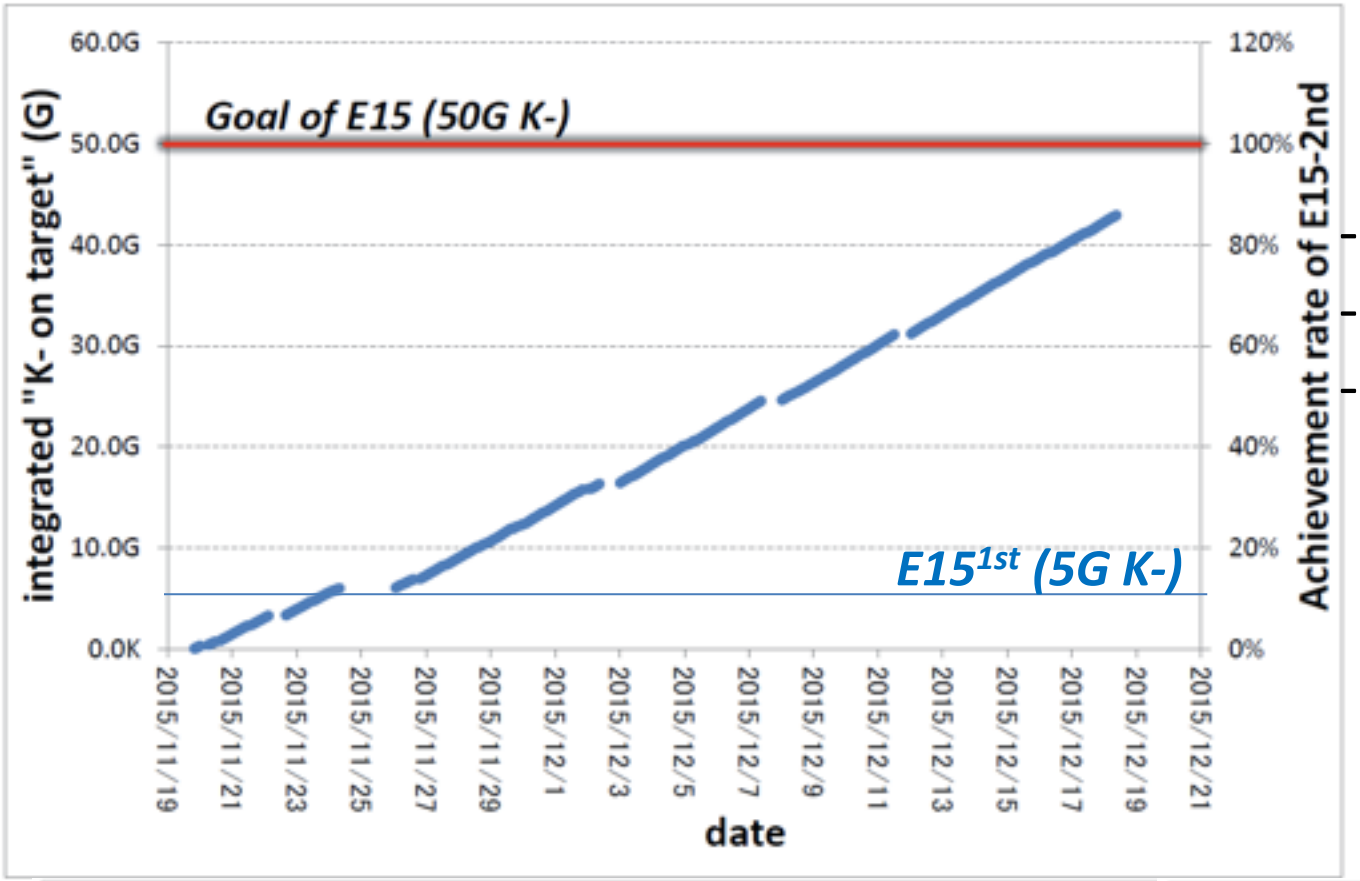
E15 2nd: 50×10^9 kaons on target

The goal of the E15 2nd

1. confirm the spectral shape of the Λp invariant-mass by the exclusive measurement of $^3He(K^-, \Lambda p)n_{mis.}$
2. explore the neutron spectrum at $\theta_{lab}=0$ with aid of kinematically complete measurement of $^3He(K^-, \Lambda pn)$
3. extend study on other channel, like $^3He(K^-, \Sigma\pi pn)$

➢ to extract more information on the $K^{bar}N$ interaction

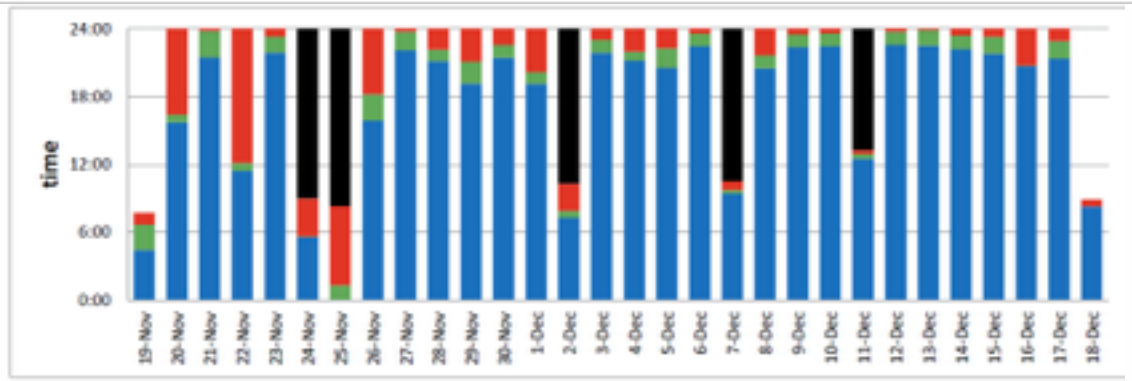
E15[2nd] in RUN#65

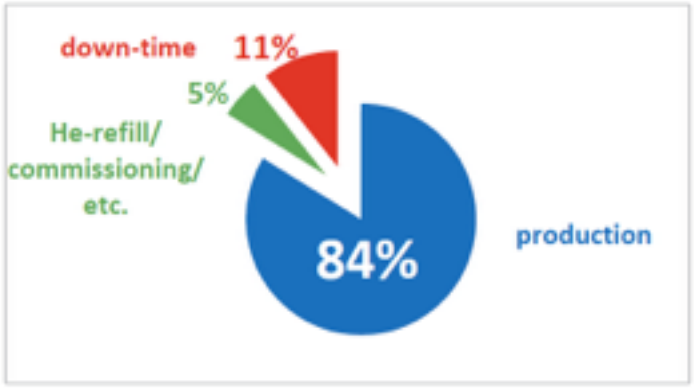


- Nov.19-Dec.18
- 39/42kW (5.52s)
- Production=519.6h (125kW*week)

43G KOT

= 86% of goal





Status of the E15 Experiment

- ***~10% of the approved proposal*** was successfully carried out in 2013/2015.

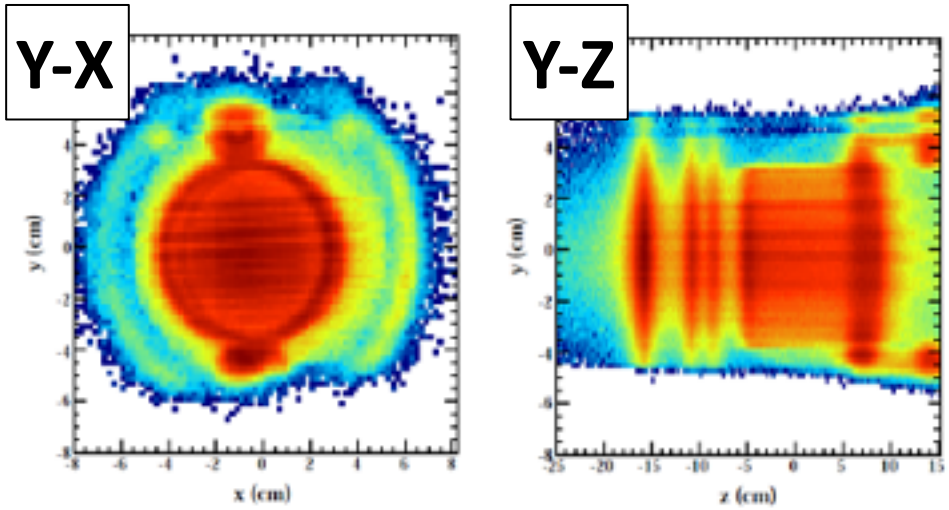
	Exp. Target	Primary-beam intensity	Secondary-kaon intensity	Duration	Kaons on target (w/ tgt selection)
May, 2013 (Run#49c)	E15[1st] ^{3}He	24 kW (30 Tppp, 6s)	140 k/spill	88 h	5.3 x 10^9
Apr-May, 2015 (Run#62)	calibration H_2	26.5 kW (33 Tppp, 6s)	130 k/spill	73 h	3.7 x 10^9
Apr-May, 2015 (Run#62)	calibration D_2	26.5 kW (33 Tppp, 6s)	130 k/spill	53 h	2.8 x 10^9
Nov-Dec, 2015 (Run#65)	E15[2nd] **^{3}He**	**42 kW (48 Tppp, 5.52s)**	**190k/spill**	**520h**	**43 x 10^9**

** production target: Au 50% loss, spill length: 2s, spill duty factor: 35~45%, K/pi ratio: ~1/2*

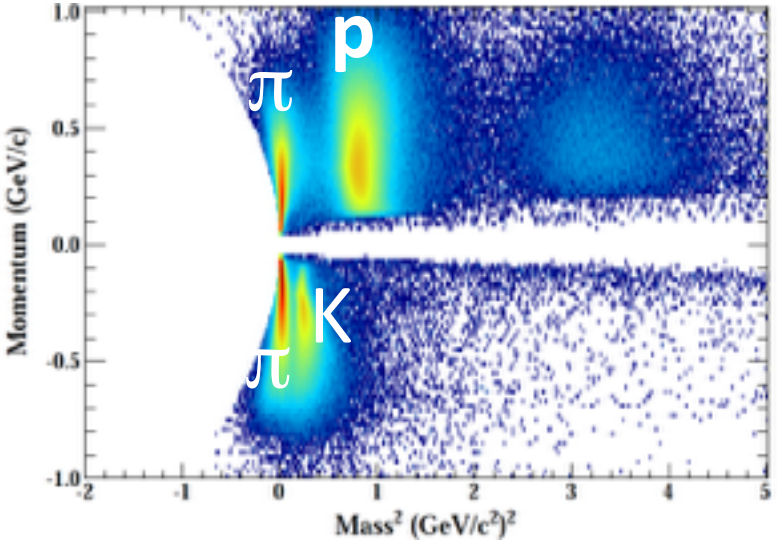
** ~70% of beam kaons hit the fiducial volume of ^{3}He target*

Spectrometer Performances in E15^{2nd}

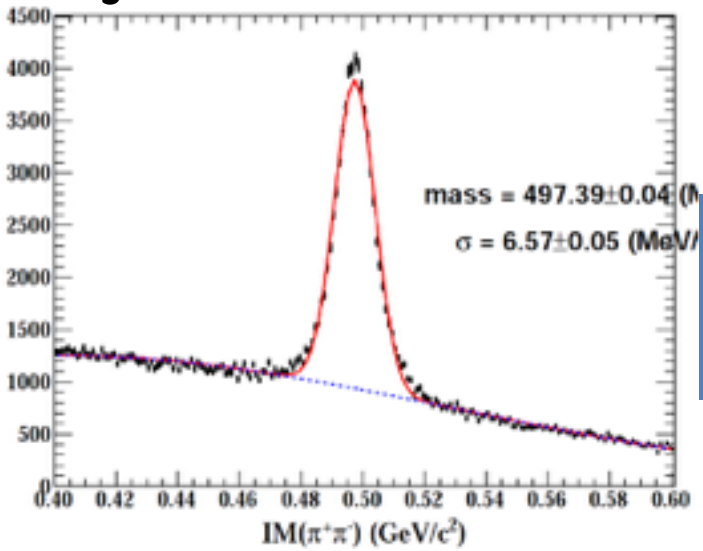
- Event-vertex reconstruction



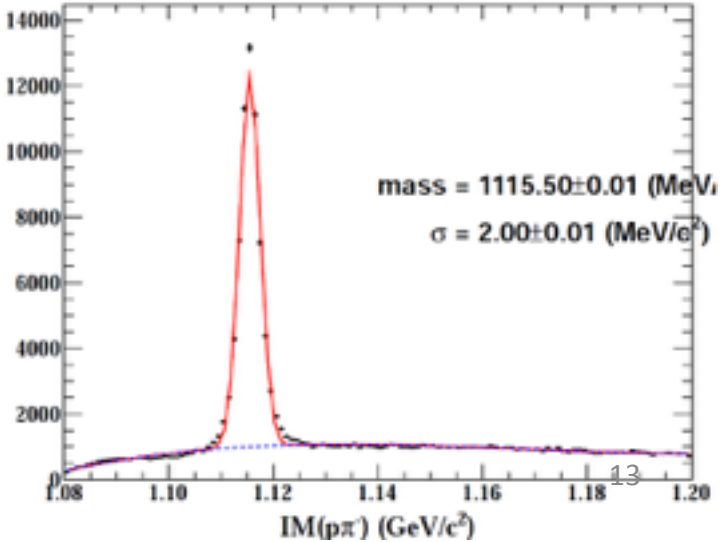
- PID with CDS



- $K^0_s \rightarrow \pi^+\pi^-$ reconstruction

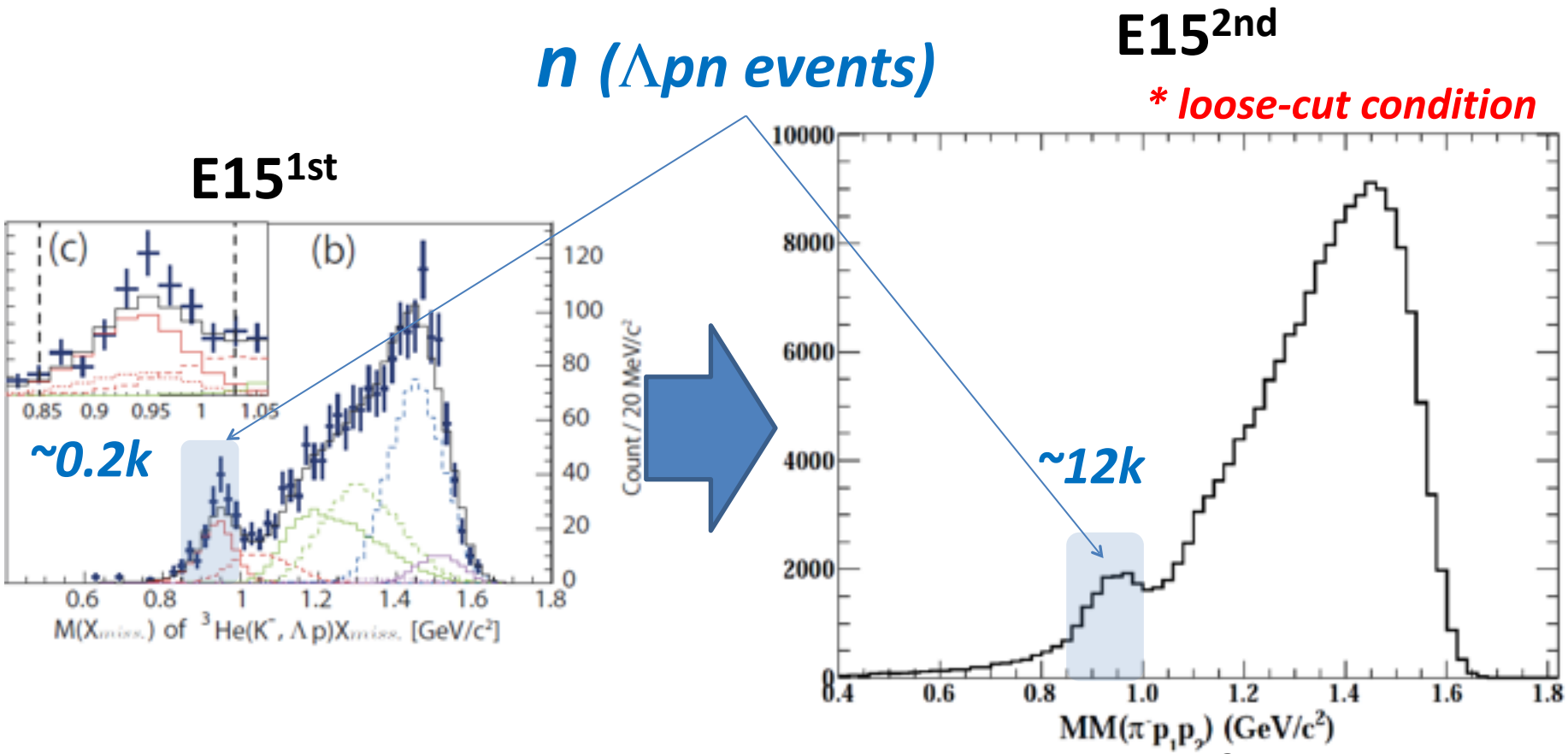


- $\Lambda \rightarrow p\pi^-$ reconstruction



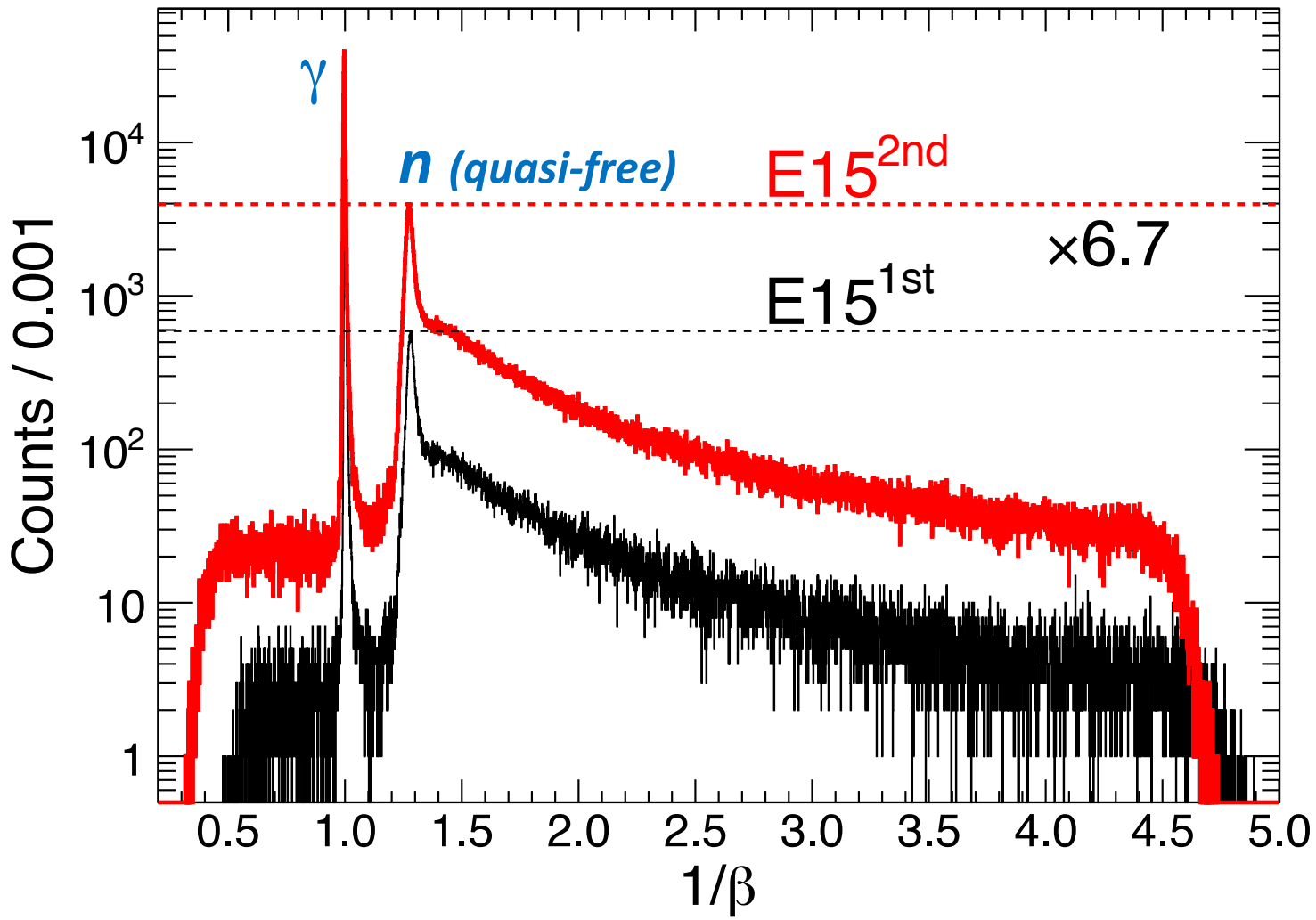
All detectors worked well

^{3}He(K$^-$,Λp) events in E15^{2nd}



- **Dedicated trigger (CDH3) was introduced for ^{3}He(K-,Λp)n**
- ^{3}He(K-,Λp) events increase by 50~60 times compared with E15^{1st} data as expected

^{3}He(K$^-$,n) events in E15^{2nd}



- ^{3}He(K-,n) events increase by ~7 times compared with E15^{1st} data as expected

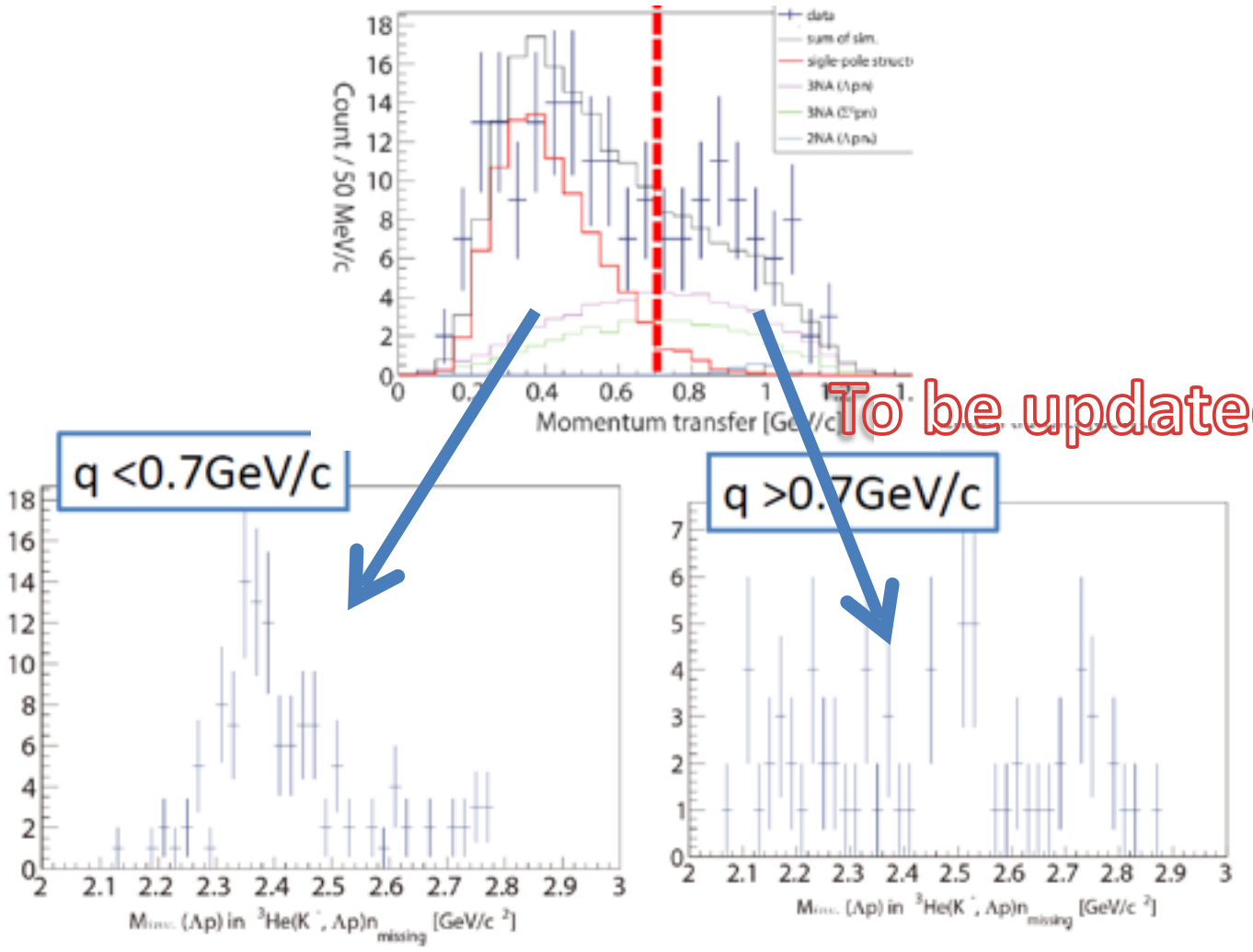
Summary

- **Analysis status of E15^{1st}**
  - Semi-inclusive ^{3}He(K^{-},n)X: **PTEP(2015)061D01**
  - Exclusive ^{3}He(K^{-},Λp)$n_{mis.}$: ***paper in preparation***

- **E15^{2nd} was successfully carried out in Run#65**
  - 43G KOT (~ 86% of goal) was accumulated
    - E15^{2nd} was about done
    - E15^{3rd} be discussed after analyzing new data of E15^{2nd}
  - Analysis is going on
    - ^{3}He(K,Λp)n analysis → will be ~x50
    - ^{3}He(K,Λpn) analysis → will be ~x7

Backup

Momentum-Transfer Dependence



- **More statistics is needed** to investigate the origin of the structure via kinematical dependence

$$\frac{d^2\sigma_{\mathrm{3NA}(\Lambda \mathrm{pn})}}{dT_n^{CM} d\cos\theta_n^{CM}} \propto \rho_3\left(\Lambda pn\right)$$