eK^+ coincidence time and missing mass w/ SIDIS data

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eK Coincidence Time Calculation

- For p(e,e'K^+)Λ reaction, coincidence time is the relative time between electron and K^+ scattering off the target; ideally peaks at zero
- Trigger time is only recorded **after** the moment when electron and K^+ scatters off the target
- Time taken for particles to arrive from the target to the hodo-plane needs be subtracted from the trigger time, using following corrections:
  - Time taken if they arrive to the focal plane (fp) following the central path
  - Time taken if they did not follow the central path
  - Fluctuation in fp time w.r.t central time
  - Signal propagation time and other effects (i.e. offset)
- Formalism similar to the one Latif used for h(e,ep) coincidence time; most up-to-date version of hcana/replay should consist of ee^+, ep, $e\pi^+$, and eK^+ coincidence times (Ctime.eKCoinTime_ROC1 for eK^+)

SHMS cointime correction:

$$\Delta t^P = \frac{L^P_{central}}{v_K} + \frac{\Delta L^P}{v_K} + \left(t^P_{hod} - t^P_{fp}\right)$$

HMS cointime correction:

$$\Delta t^H = \frac{L^H_{central}}{v_e} + \frac{\Delta L^H}{v_e} + \left(t^H_{hod} - t^H_{fp}\right)$$

Corrected Coincidence Time:

$$t^{coin}_{corr} = \left(t_{trig-1} - \Delta t^P\right) - \left(t_{trig-4} - \Delta t^H\right) + \delta_{offset}$$

More information on the implementation can be found in :
> hcana/src/THcCoinTime.*

Kinematics Setting Used

- Q^2 = 3.10 GeV^2
- W = 2.78 GeV
- I_{beam} = 40 μA

HMS Setting (-ve polarity)

- P_{HMS} = 5.27 GeV/c
- Θ_{HMS} = 13.5°

SHMS Setting (+ve polarity)

- P_{SHMS} = 5.05 GeV/c
- Θ_{SHMS} = 12.0° (14.0°)

Kinematic Group 1

Kinematics: x=0.31, Q2=3.10 GeV2

HMS settings: p=-5.27 GeV, theta = 13.5

SHMS polarity: positive

#	HMS P	HMS Theta	SHMS P	SHMS Theta	x	Q2	z	p_t	W'2	nom muA	RHMS Khz	RSHMS kHz	evnts K/hr	accid/ real	trg6 Hz	Done?
1	-5.27	13.5	5.05	12.0	0.31	3.10	0.90	-0.06	1.16	40.0	11.3	28.5	24.6	0.06	16.6	yes
2	-5.27	13.5	5.05	14.0	0.31	3.10	0.90	0.12	1.14	40.0	11.3	10.6	23.8	0.02	9.3	yes
3	-5.27	13.5	3.37	12.0	0.31	3.10	0.60	-0.04	3.35	40.0	11.3	178.1	99.4	0.16	140.0	yes
4	-5.27	13.5	3.37	14.0	0.31	3.10	0.60	0.08	3.34	40.0	11.3	81.1	97.8	0.07	78.0	yes
5	-5.27	13.5	2.53	8.0	0.31	3.10	0.45	-0.21	4.35	13.5	3.8	476.2	23.5	0.63	108.9	yes
6	-5.27	13.5	2.53	10.0	0.31	3.10	0.45	-0.12	4.41	22.8	6.4	472.9	46.2	0.54	186.6	yes
7	-5.27	13.5	2.53	12.0	0.31	3.10	0.45	-0.03	4.44	39.6	11.2	470.3	89.5	0.49	327.1	yes, taken twice
8	-5.27	13.5	2.53	14.0	0.31	3.10	0.45	0.06	4.44	40.0	11.3	265.6	88.3	0.28	197.5	yes
9	-5.27	13.5	2.53	16.0	0.31	3.10	0.45	0.15	4.40	40.0	11.3	145.5	80.8	0.17	117.3	yes
10	-5.27	13.5	2.53	18.0	0.31	3.10	0.45	0.23	4.32	40.0	11.3	78.1	66.3	0.11	69.2	yes
11	-5.27	13.5	2.53	20.0	0.31	3.10	0.45	0.32	4.21	40.0	11.3	41.0	58.9	0.07	43.0	yes
12	-5.27	13.5	2.53	22.0	0.31	3.10	0.45	0.41	4.07	40.0	11.3	21.1	36.5	0.05	23.7	yes
13	-5.27	13.5	2.53	24.0	0.31	3.10	0.45	0.50	3.89	40.0	11.3	10.6	21.3	0.05	12.7	yes
14	-5.27	13.5	2.53	26.0	0.31	3.10	0.45	0.58	3.68	40.0	11.3	5.2	16.2	0.03	7.8	yes

Kinematic Group 2

Kinematics: x=0.31, Q2=3.10 GeV2

HMS settings: p=-5.27 GeV, theta = 13.5

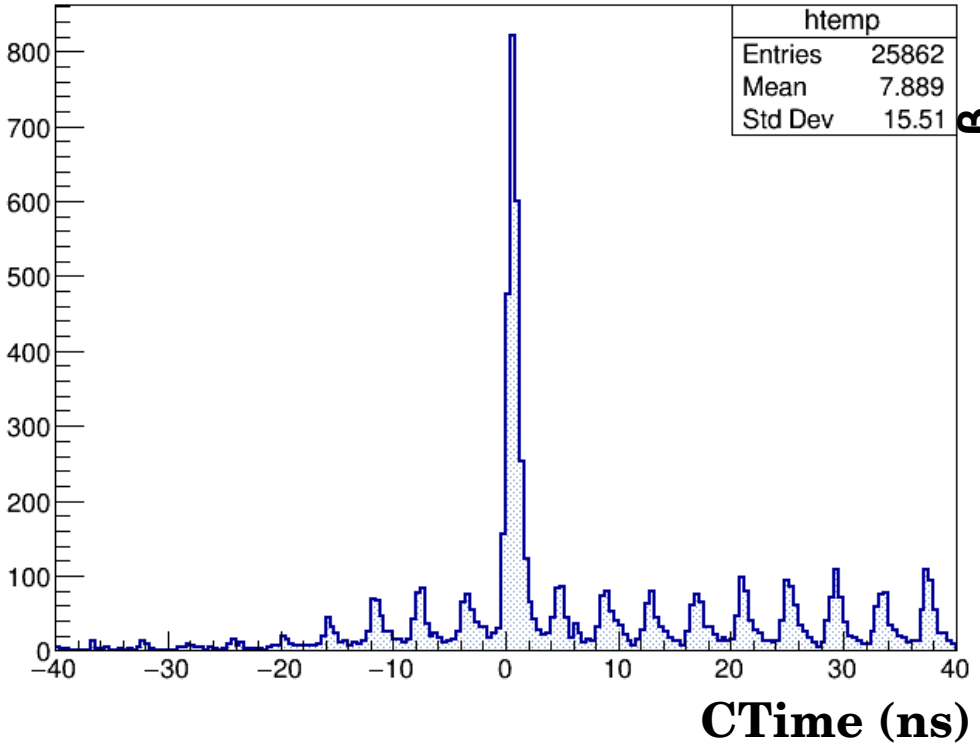
SHMS polarity: negative

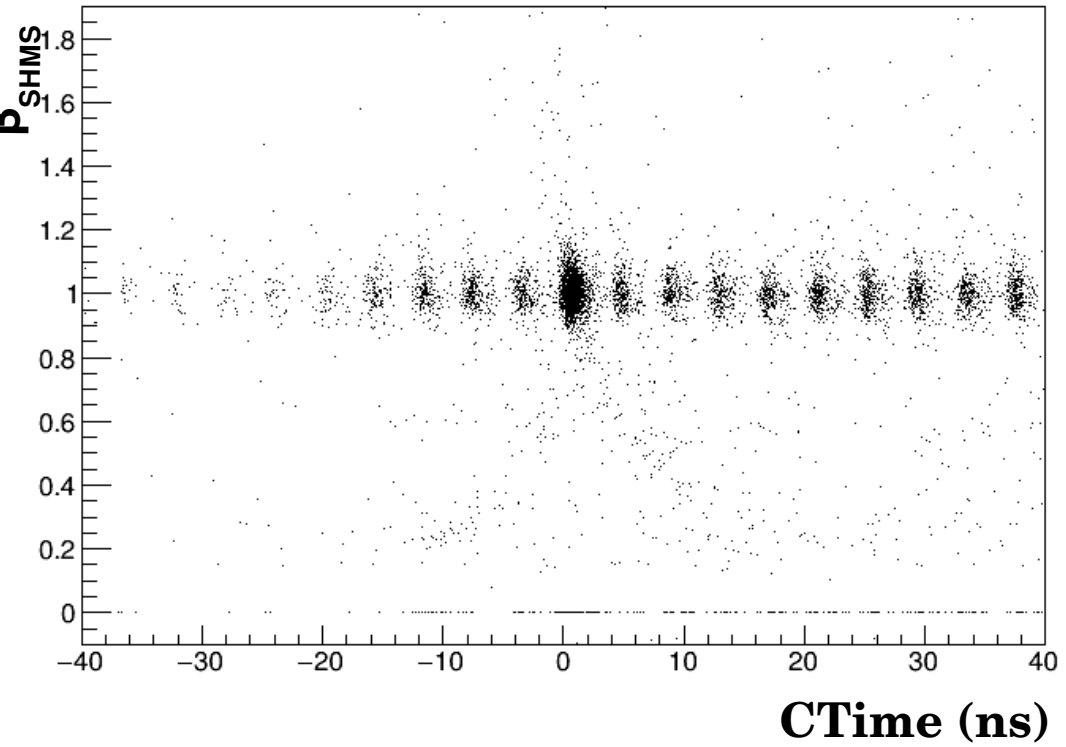
#	HMS P	HMS Theta	SHMS P	SHMS Theta	x	Q2	z	p_t	W'2	nom muA	RHMS Khz	RSHMS kHz	evnts K/hr	accid/ real	trg6 Hz	Done?
1	-5.27	13.5	-5.05	12.0	0.31	3.10	0.90	-0.06	1.16	40.0	11.3	28.5	24.6	0.06	16.6	yes
2	-5.27	13.5	-5.05	14.0	0.31	3.10	0.90	0.12	1.14	40.0	11.3	10.6	23.8	0.02	9.3	yes
3	-5.27	13.5	-3.37	12.0	0.31	3.10	0.60	-0.04	3.35	40.0	11.3	178.1	99.4	0.16	140.0	yes
4	-5.27	13.5	-3.37	14.0	0.31	3.10	0.60	0.08	3.34	40.0	11.3	81.1	97.8	0.07	78.0	yes
5	-5.27	13.5	-2.53	8.0	0.31	3.10	0.45	-0.21	4.35	13.5	3.8	476.2	23.5	0.63	108.9	yes
6	-5.27	13.5	-2.53	10.0	0.31	3.10	0.45	-0.12	4.41	22.8	6.4	472.9	46.2	0.54	186.6	yes
7	-5.27	13.5	-2.53	12.0	0.31	3.10	0.45	-0.03	4.44	39.6	11.2	470.3	89.5	0.49	327.1	yes
8	-5.27	13.5	-2.53	14.0	0.31	3.10	0.45	0.06	4.44	40.0	11.3	265.6	88.3	0.28	197.5	yes
9	-5.27	13.5	-2.53	16.0	0.31	3.10	0.45	0.15	4.40	40.0	11.3	145.5	80.8	0.17	117.3	yes
10	-5.27	13.5	-2.53	18.0	0.31	3.10	0.45	0.23	4.32	40.0	11.3	78.1	66.3	0.11	69.2	yes
11	-5.27	13.5	-2.53	20.0	0.31	3.10	0.45	0.32	4.21	40.0	11.3	41.0	58.9	0.07	43.0	yes
12	-5.27	13.5	-2.53	22.0	0.31	3.10	0.45	0.41	4.07	40.0	11.3	21.1	36.5	0.05	23.7	yes
13	-5.27	13.5	-2.53	24.0	0.31	3.10	0.45	0.50	3.89	40.0	11.3	10.6	21.3	0.05	12.7	yes
14	-5.27	13.5	-2.53	26.0	0.31	3.10	0.45	0.58	3.68	40.0	11.3	5.2	16.2	0.03	7.8	yes

From Hall C wiki SIDIS runplan (**Runs 3420 onwards**)

Plots in this work are from Run #3423 and #3424

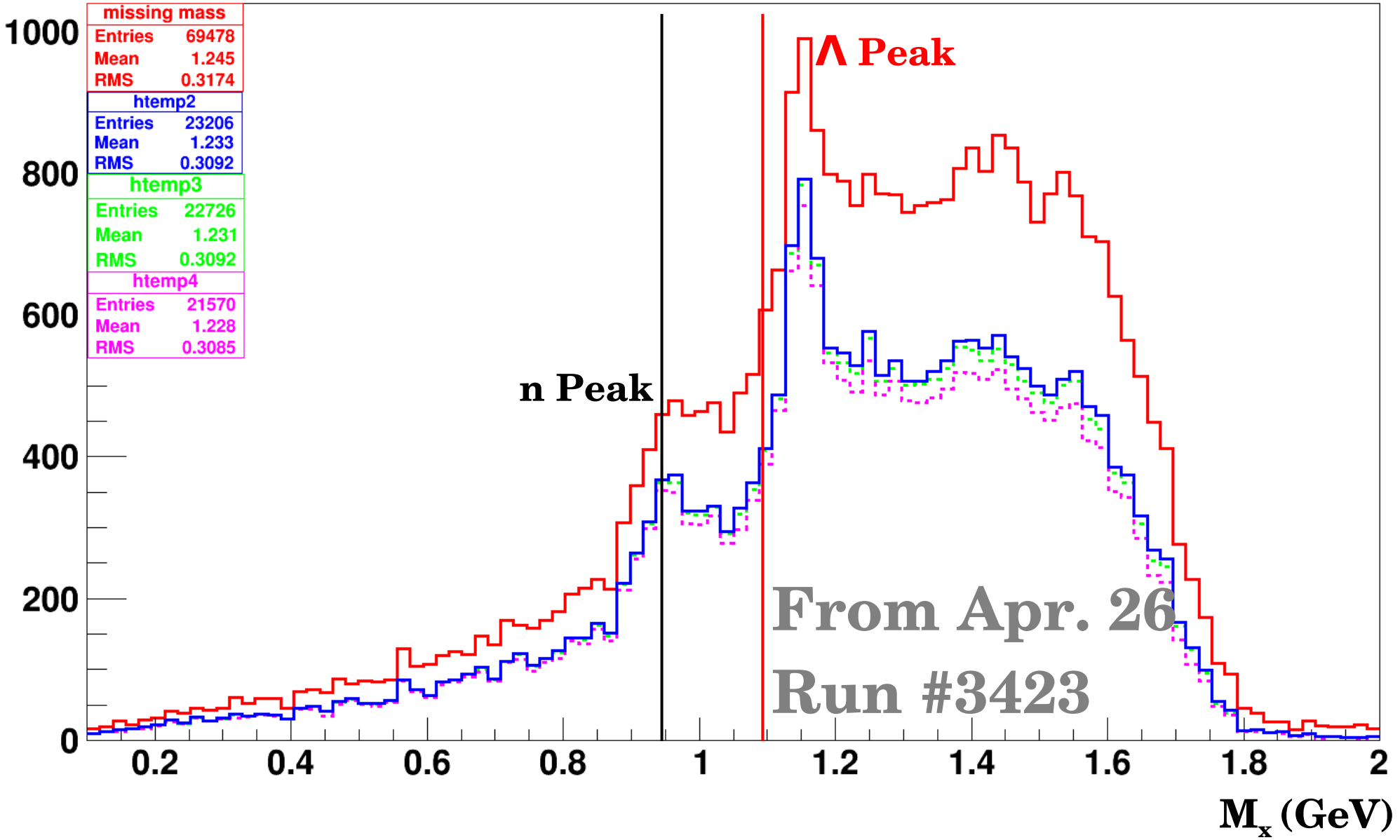
Run #3423





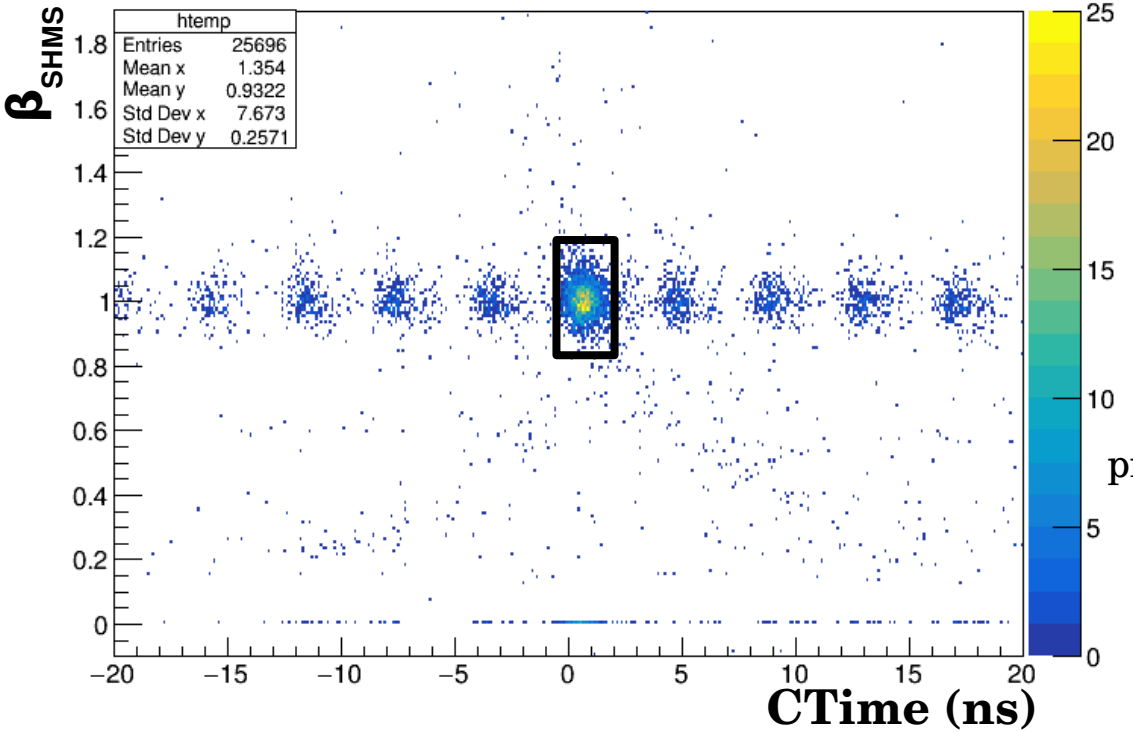
- Note that the beam bunches are 4ns apart (NOT 2ns like for the Fpi-2)
- Only real coincidences were taken into account

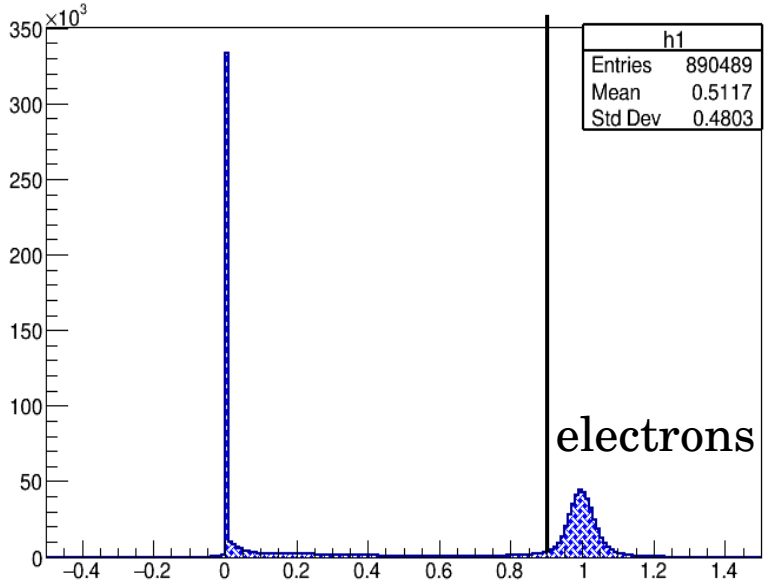
Missing Mass (M_x)



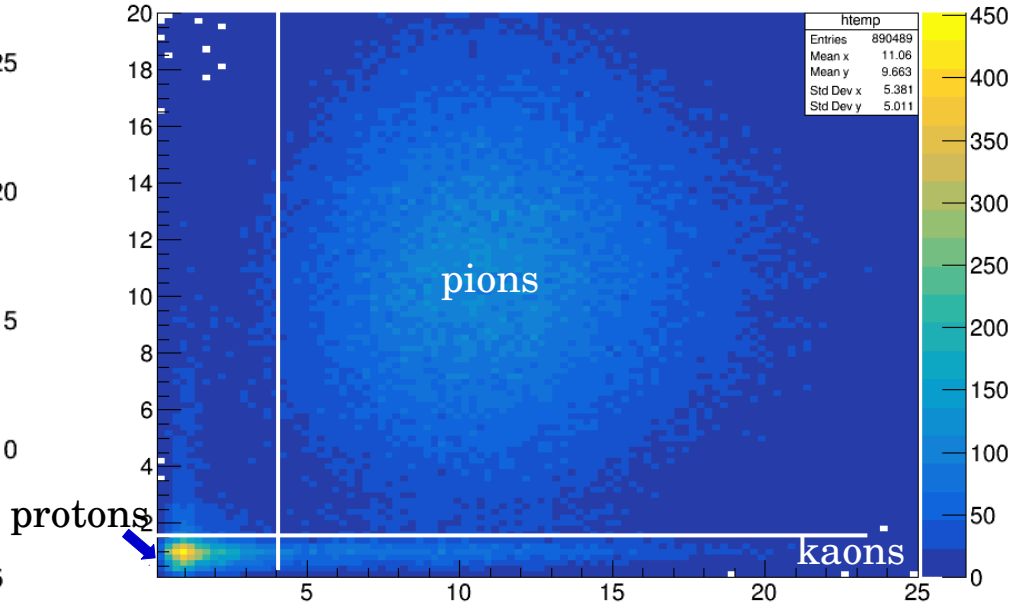
What changed?

- Data replayed with kaon mass (instead of pion mass) in the SHMS
- Spectrometer acceptance cuts added (some issues with SHMS delta cuts)
- Tighter PID cuts than before:
  - Nomalized HMS calorimeter energy > **0.9**
  - HGC total npe < **1.5**
  - Aerogel total npe > **4.0**
- SHMS beta vs coincidence cuts applied
- Edges of the aluminum cell-wall (+/- 0.5 cm) removed

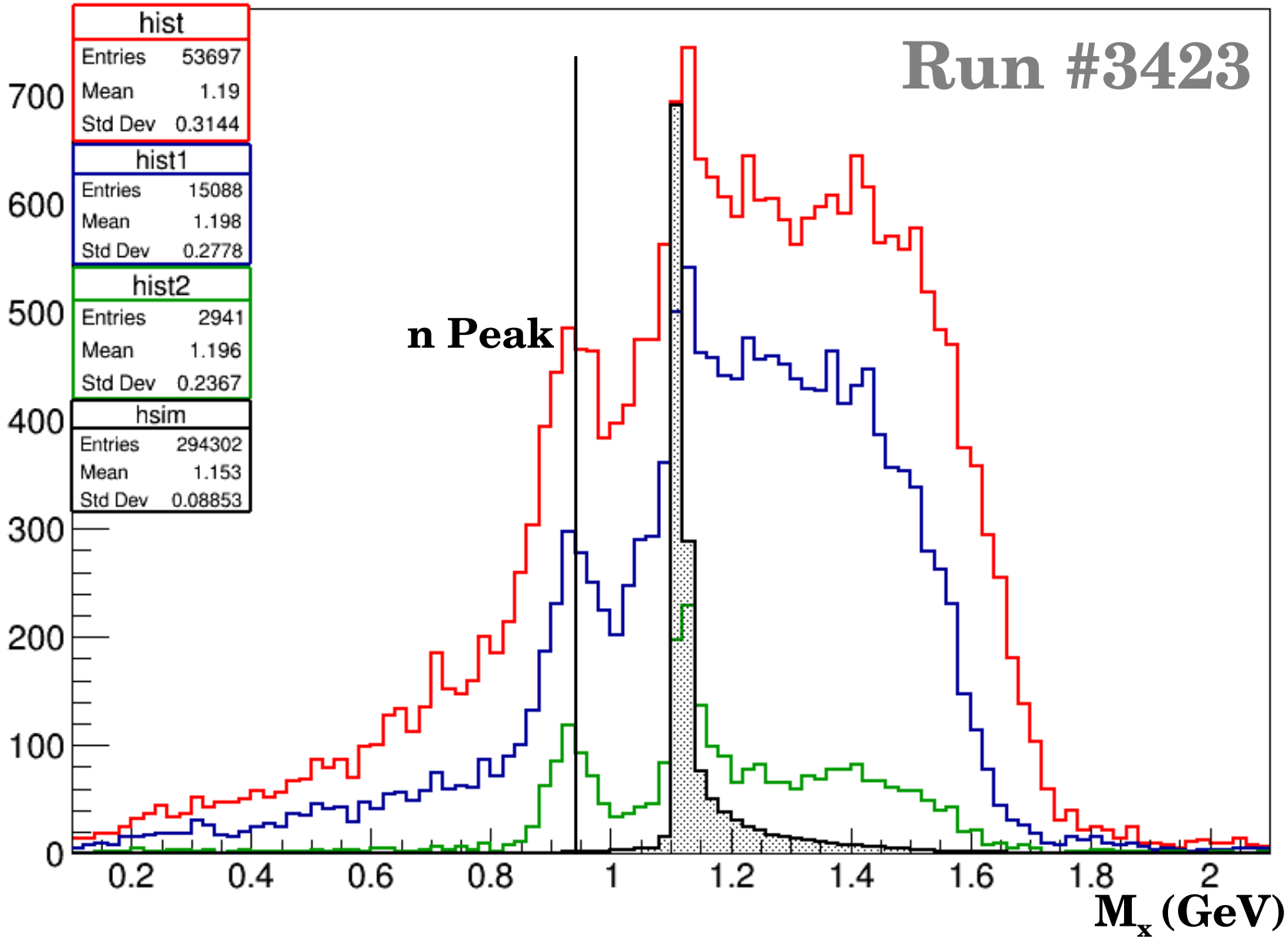




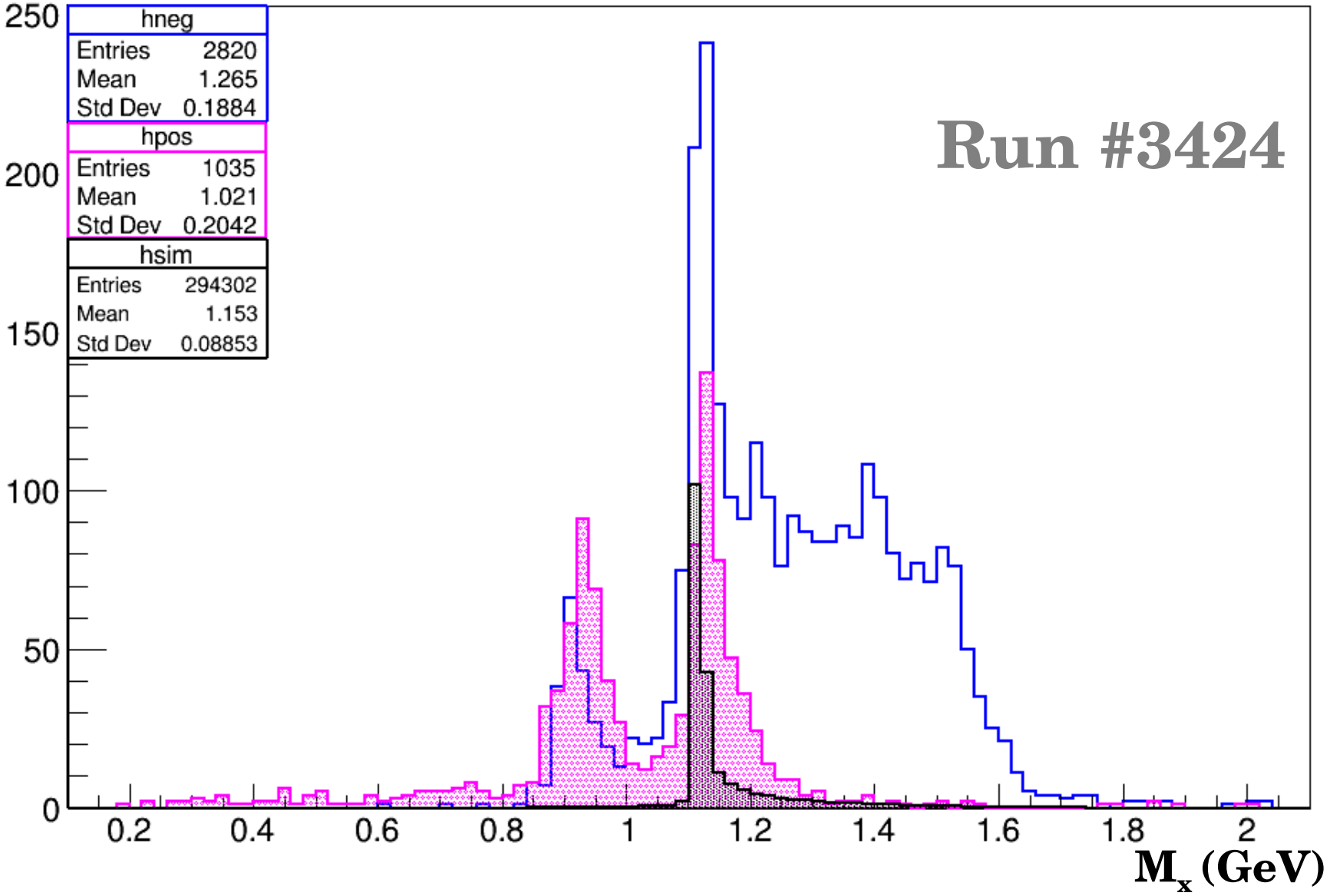
HMS calorimeter energy normalized to the central momentum



HGC vs Aerogeal total # of photoelectrons



- Λ missing mass (M_x) agrees with the SIMC
- Distribution for $M_x > 1.2$ improved significantly after beta-cointime cut
- **BUT** the neutron peak due to epi events still persists



- With the SHMS δ < 0, the neutron peak becomes smaller
- Distribution at higher M_x improved quite significantly for negative SHMS δ but the neutron peak became more pronounced
- Is this because of the SIDIS physics?

Further Work

- p(e,e'π^+)n SIMC simulation completed; however the missing mass distribution from SIMC needs to be re-calculated with the kaon mass for a better comparison with replayed data
- β-cointime cut does not take into account any accidental coincidences (although a huge improvement is not expected)
- Runs #3423 and #3424 seems to be at the kinematics end point (?) so look at more SIDIS runs