

Pion Electroproduction from LD2

π^-/π^+ PID Study



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LD2 Runs

Run lists: 2022 Q2 = 1.6, W = 3.08, -tmin = 0.03. EBeam = 6.395 GeV

LD+

Beam current 32 uA. 10279 pi-n events. $\theta_{SHMS}=5.50$ (Right)

- 16421-30
- 16433-35
- 16439-44

Beam current 75 uA. 10162 pi-n events. $\theta_{SHMS}=7.50$ (Left)

- 16445-57
- 16461-71
- 16473-78
- 16480

LD-

Beam current 2.5 uA. 5035 pions. $\theta_{SHMS}=6.00$ (Left)

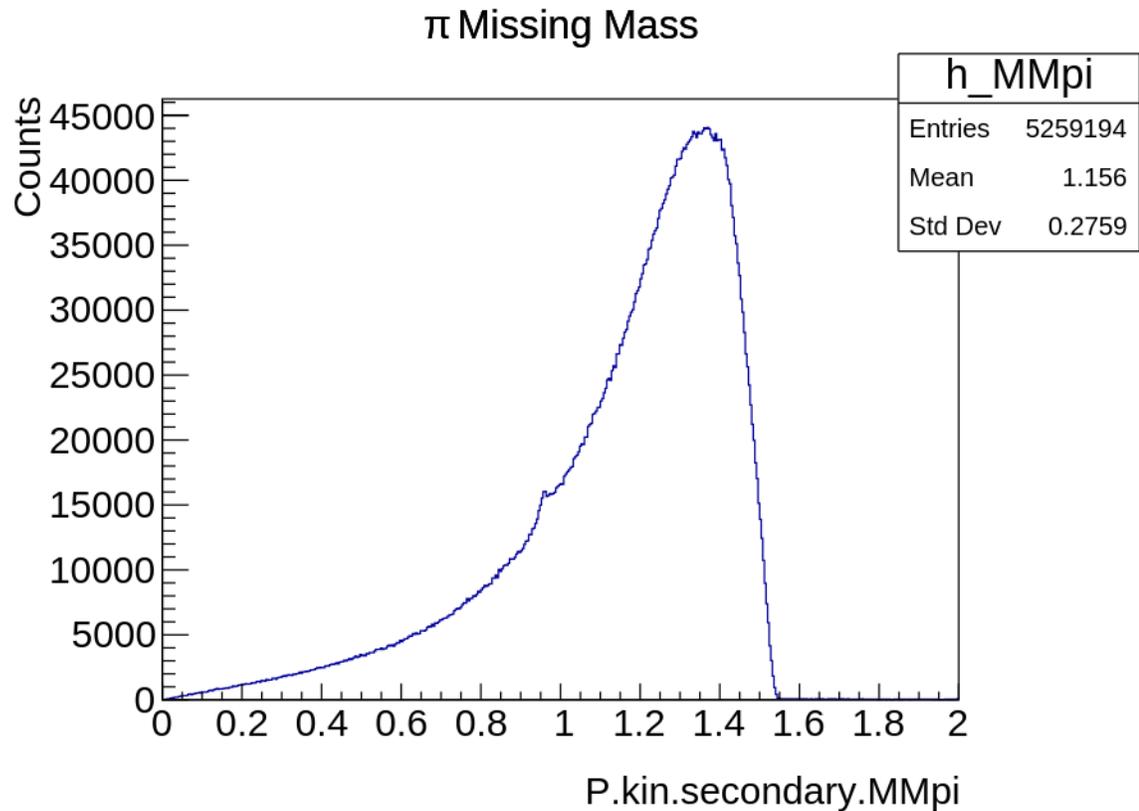
- 16770-71
- 16773-16855

Beam current 8 uA. 5133 pions. $\theta_{SHMS}=7.50$ (Left-2)

- 16626-27
- 16630-32
- 16634-35
- 16638-52
- 16654-69
- 16673-82

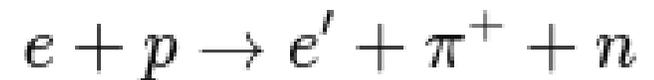
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LD+ Initial Settings



$$R_L = \frac{\sigma(n(e, e'\pi^-)p)}{\sigma(p(e, e'\pi^+)n)} = \frac{|A_v - A_s|^2}{|A_v + A_s|^2}$$

A_v = isovector amplitude
 A_s = isoscalar amplitude



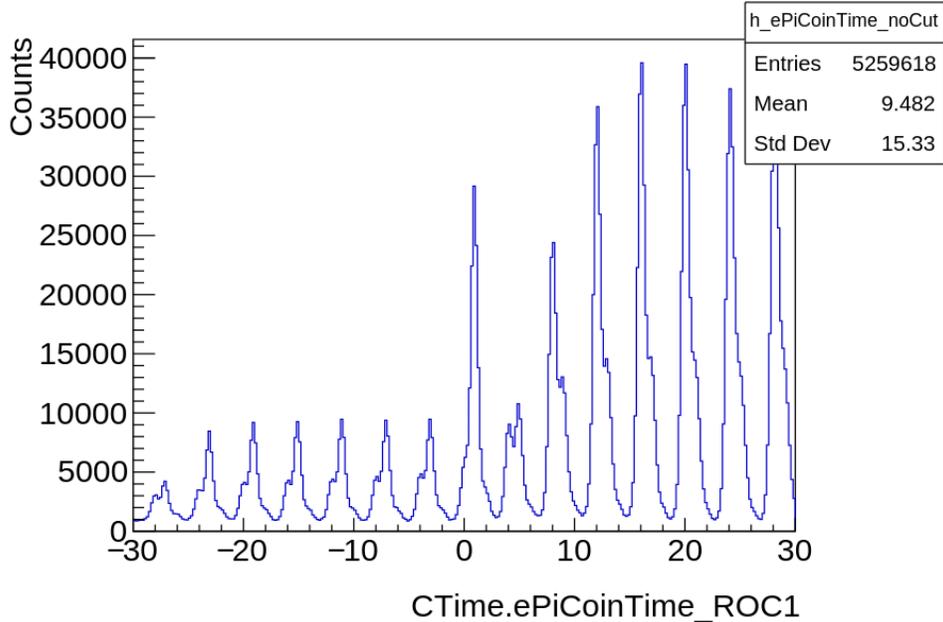
Timing cuts

Initial study of coin time, RF time and random subtraction

22/02/26

Coin Time - LD+ 32 uA

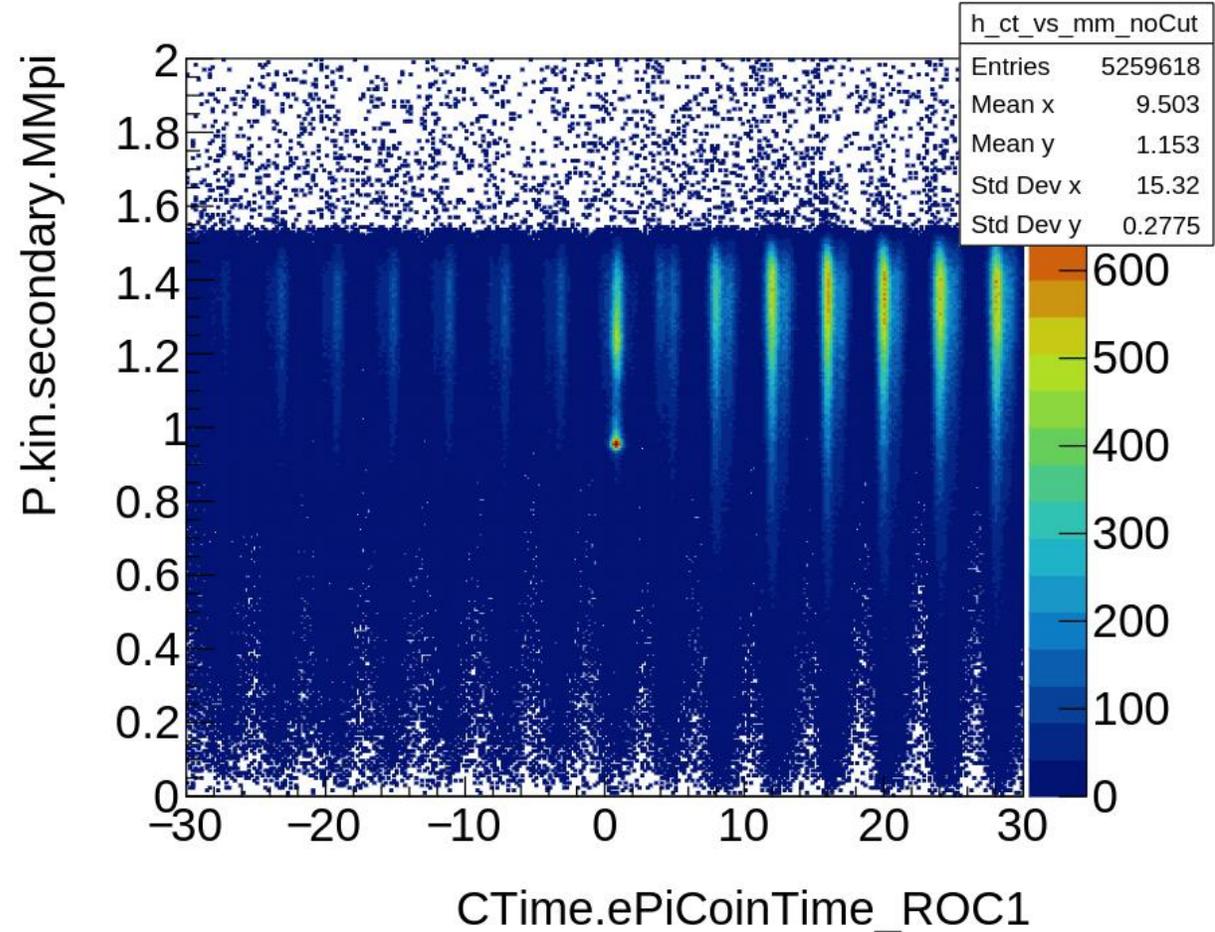
e- π Coin Time (no cuts)



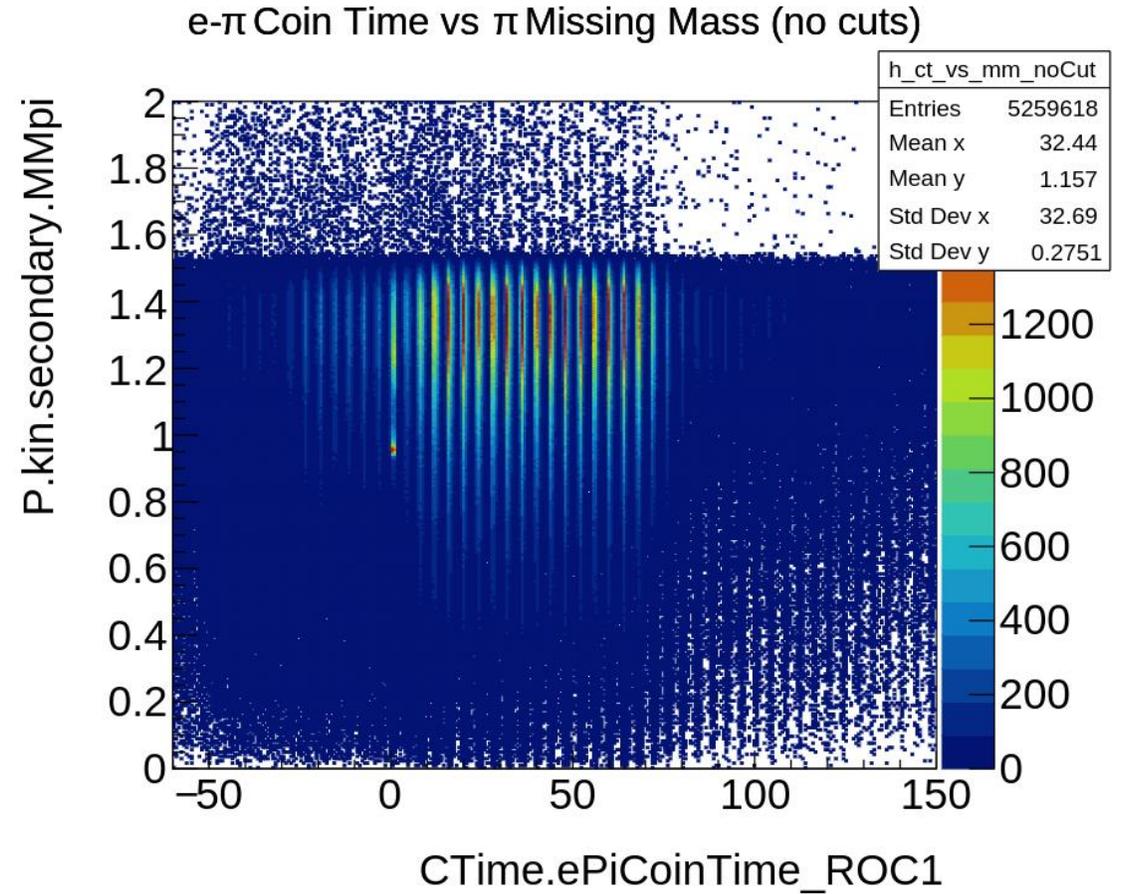
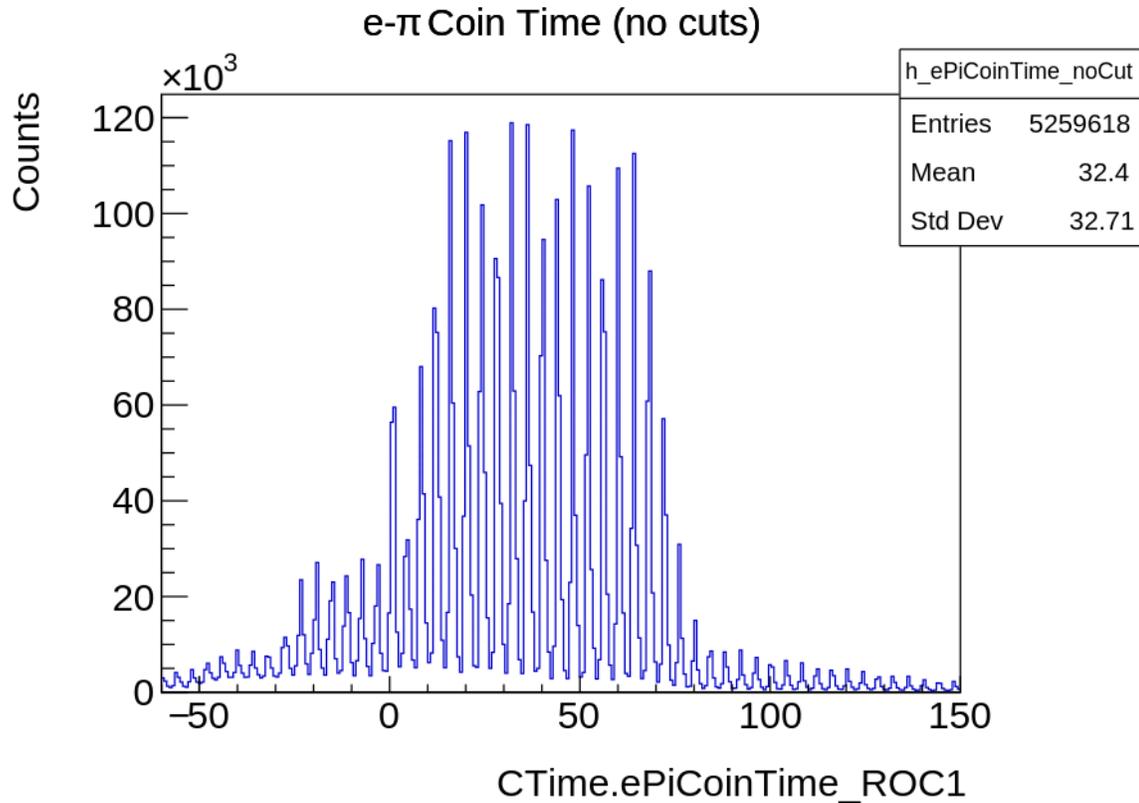
The coincidence time (Coin Time) is the time difference between signals in SHMS and HMS arms.

A central peak indicates prompt events - detection of a pion and electron from same interaction.

e- π Coin Time vs π Missing Mass (no cuts)



Structure



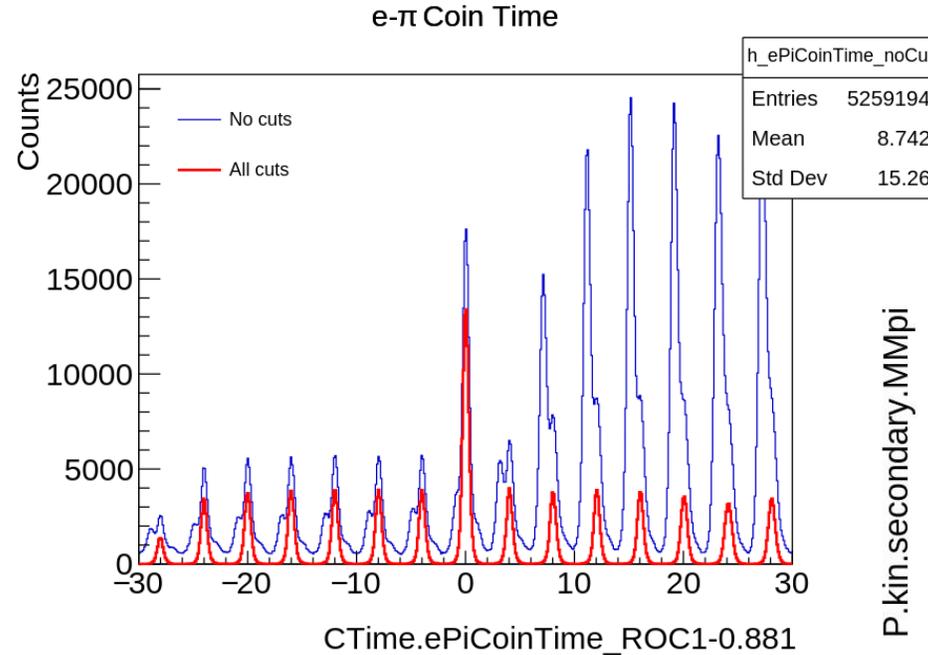
What is the reason for the large random flux above 0?

Initial PID Cuts

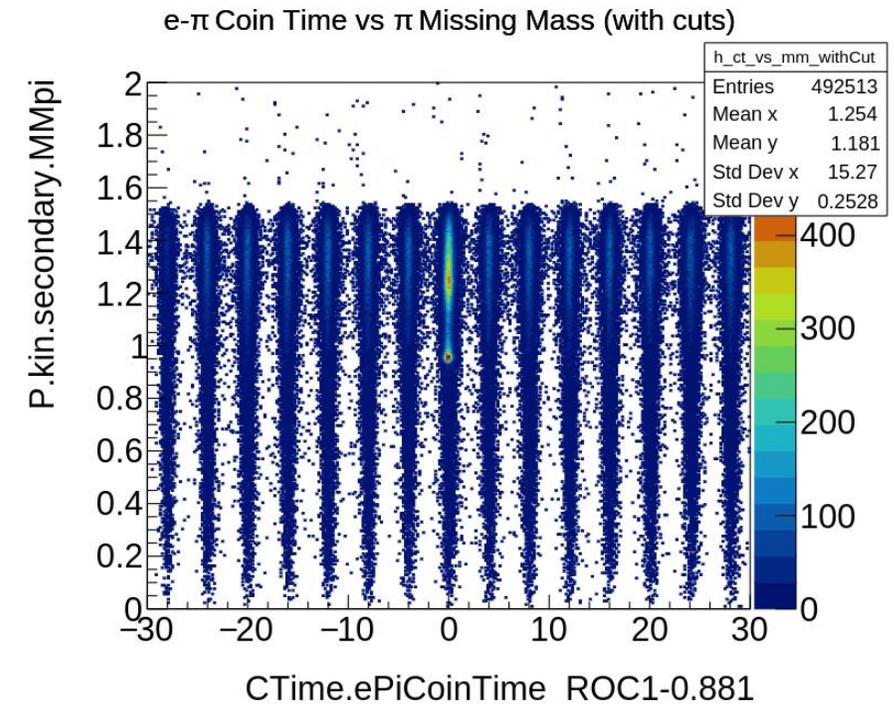
Initial PID Cuts

- $H.cal.etottracknorm > 0.7$
- $H.cer.npeSum > 2.0$
- $P.aero.npeSum > 2.0$
- $P.hgcer.npeSum > 2.0$

Given in Das' paper as some initial starting points.



Prompt peak **shifted** to zero by **-0.881** ns offset

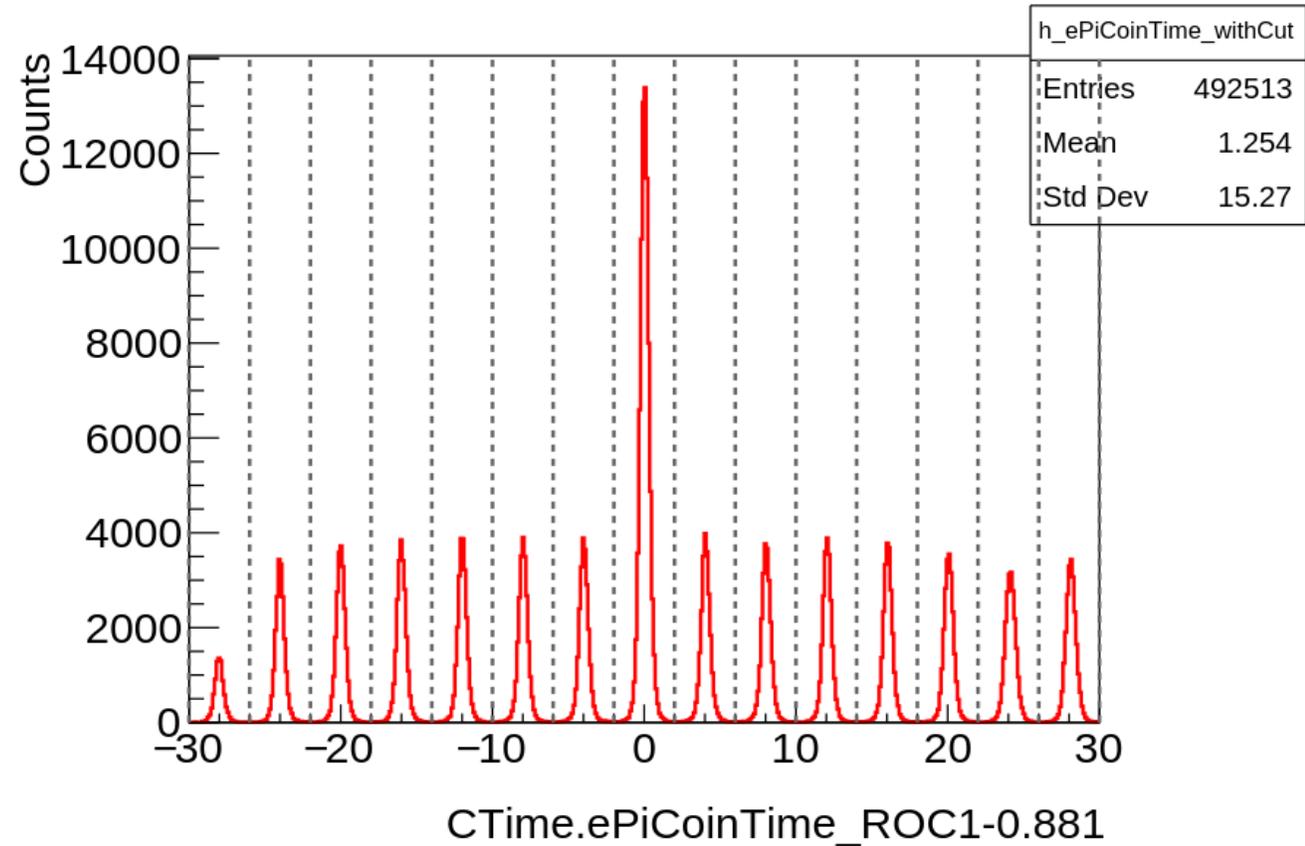


RF Spacing

Prompt and random coincidences in
clear **4 ns** windows – RF spacing.

Can now define the **prompt** coin time
cut as:

$$-2 < (\text{CoinTime} - 0.881) > 2$$



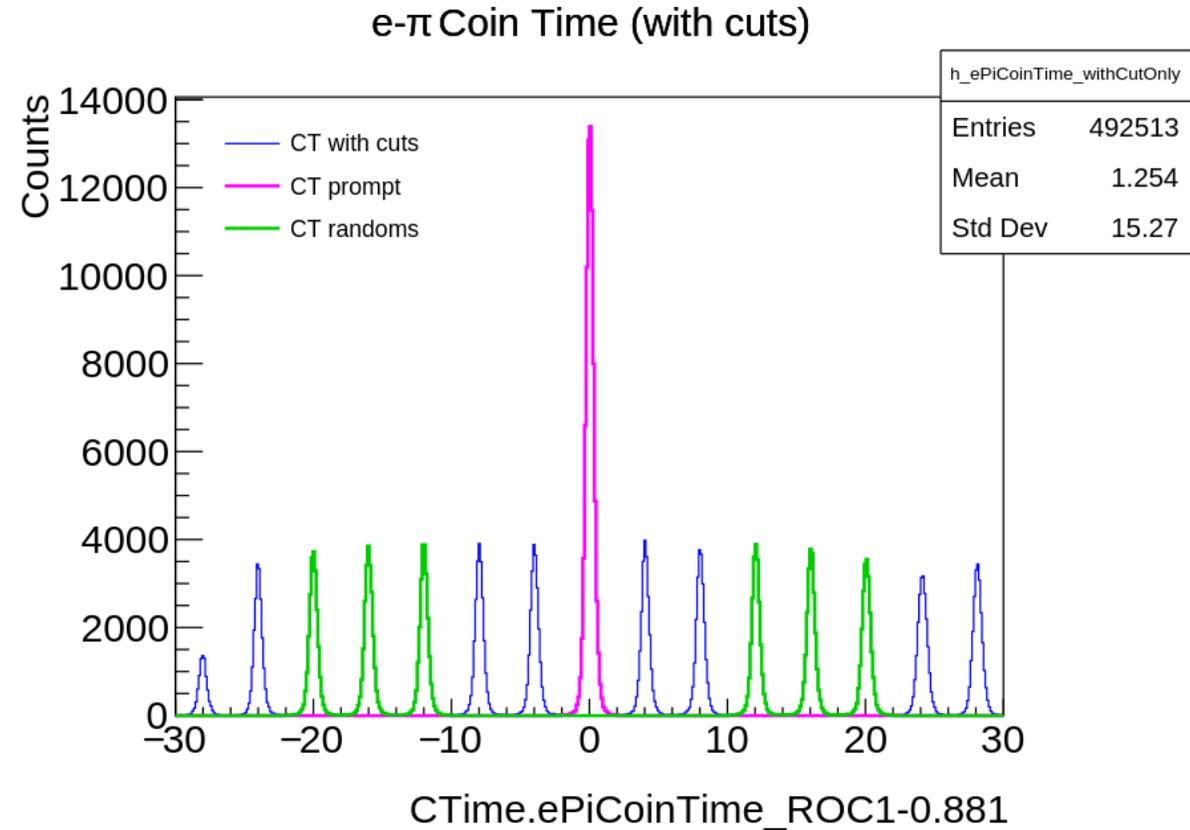
Random Subtraction

True pion yield:

Prompt yield – scaled sum of random windows

- Including **6** random 4ns windows from allows the **background** to be estimated.
- Skipping those next to prompt to avoid including real events.

$$N_{\text{prompt}} - \frac{1}{6} N_{\text{random}}$$



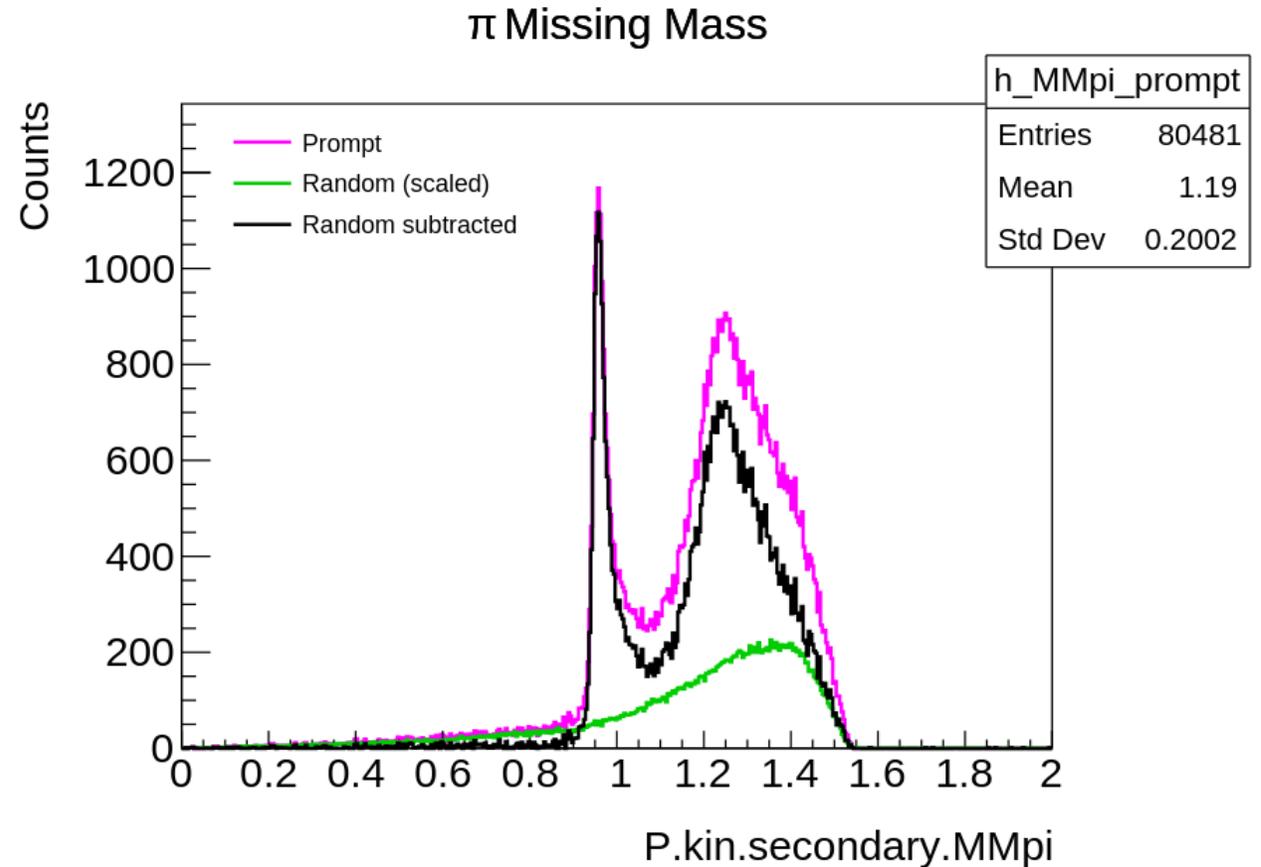
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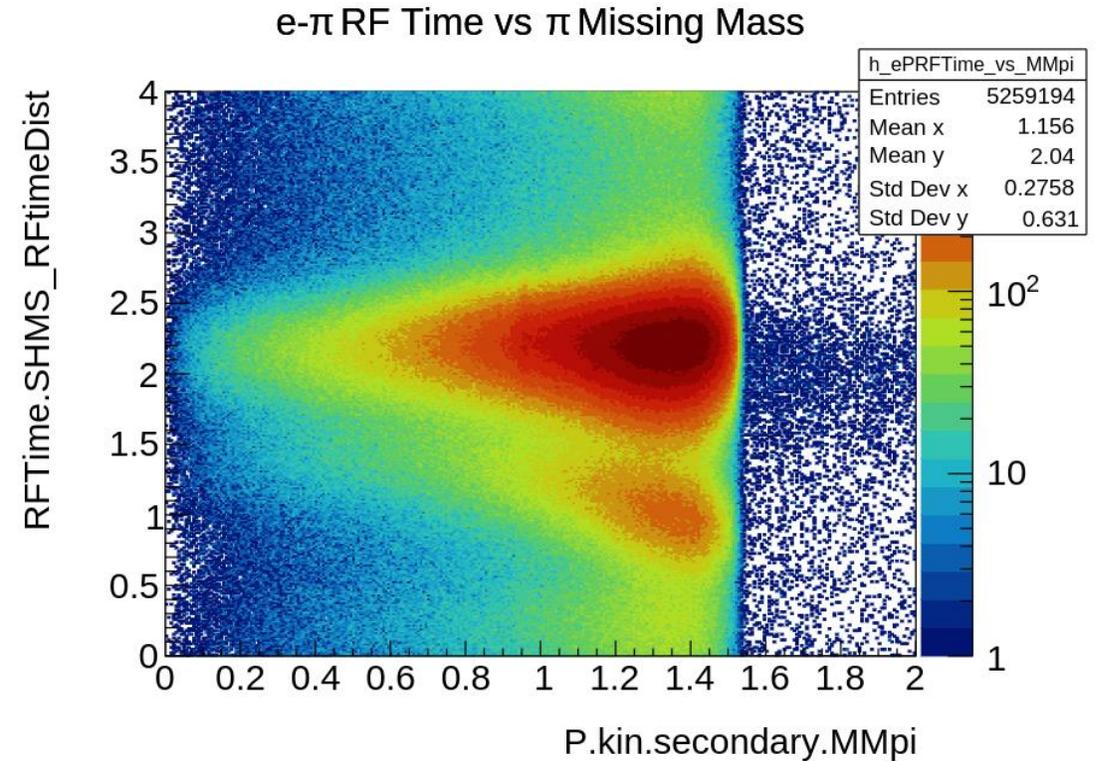
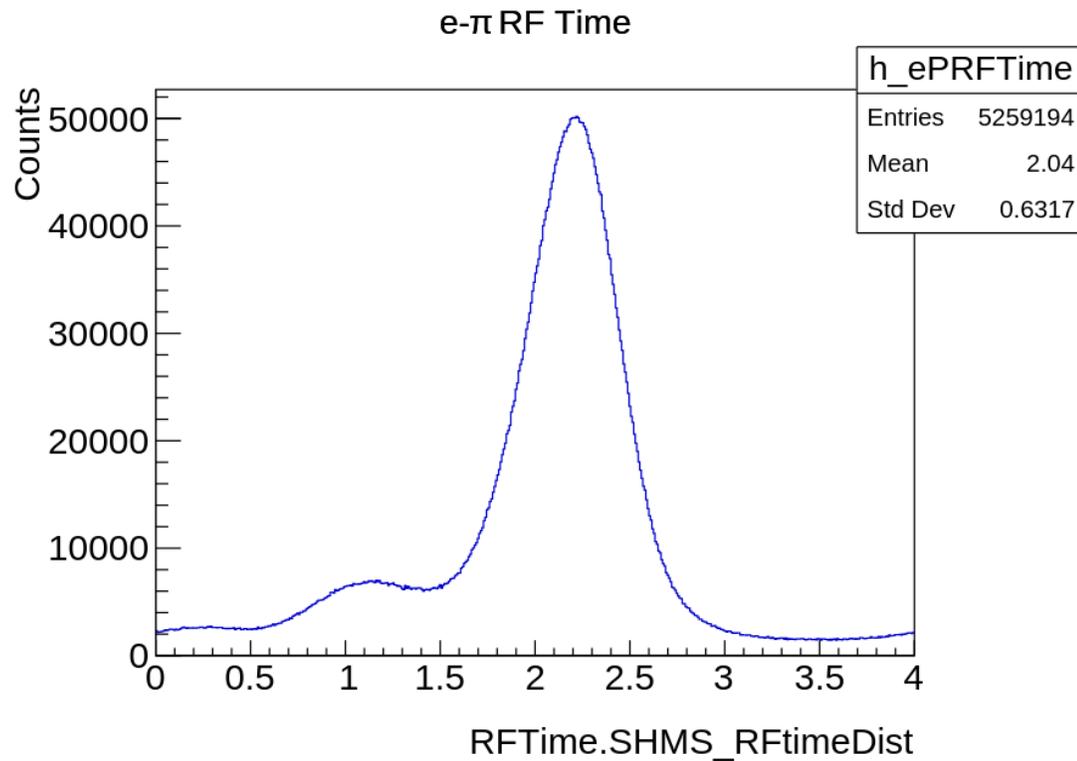
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RF Time

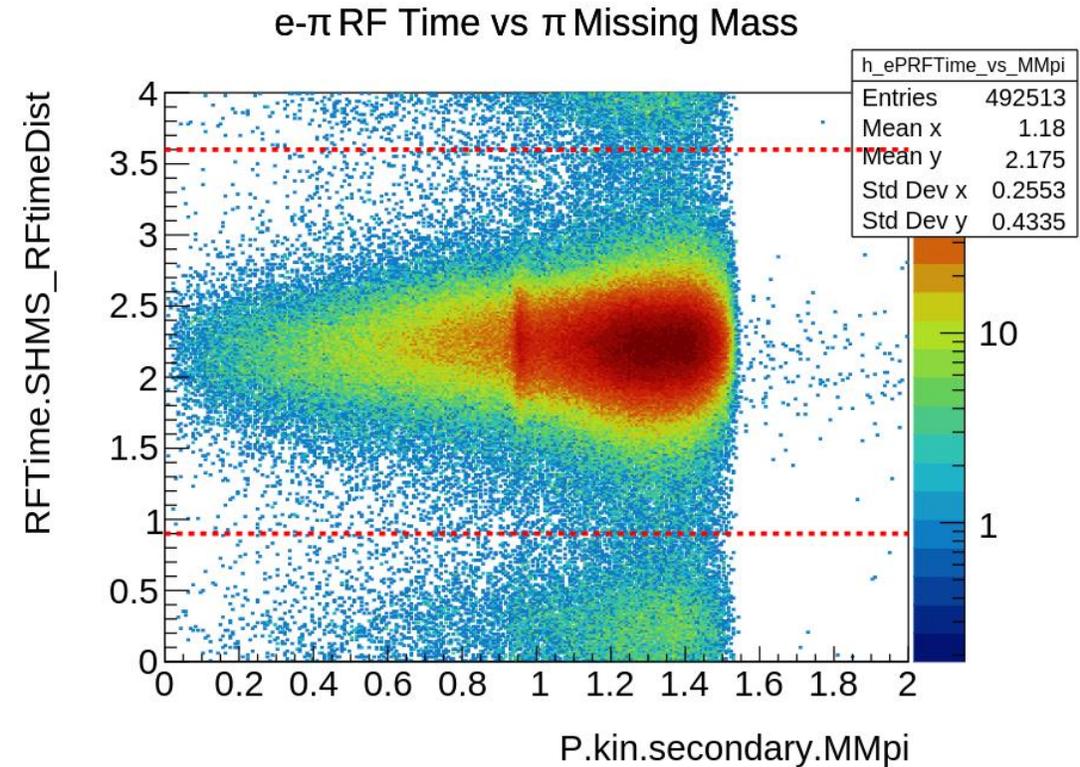
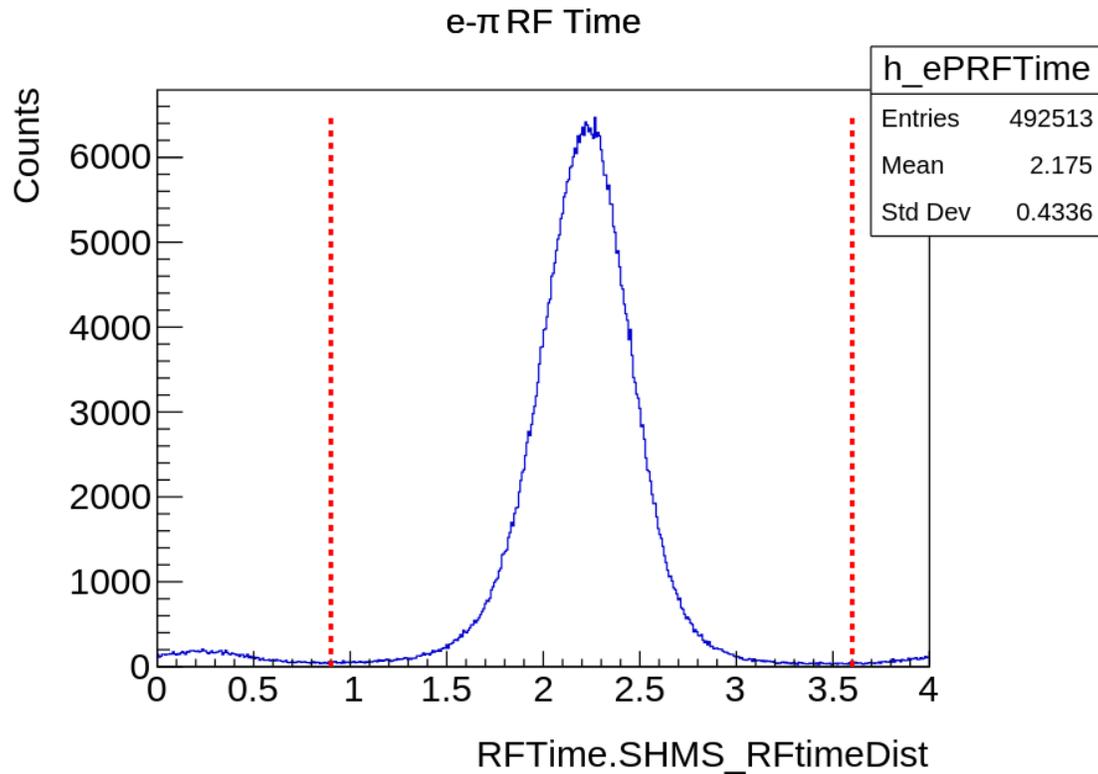
Beam bunch spacing 4ns

Pions in large peak and protons in smaller.



RF Time – with PID cuts (no CT)

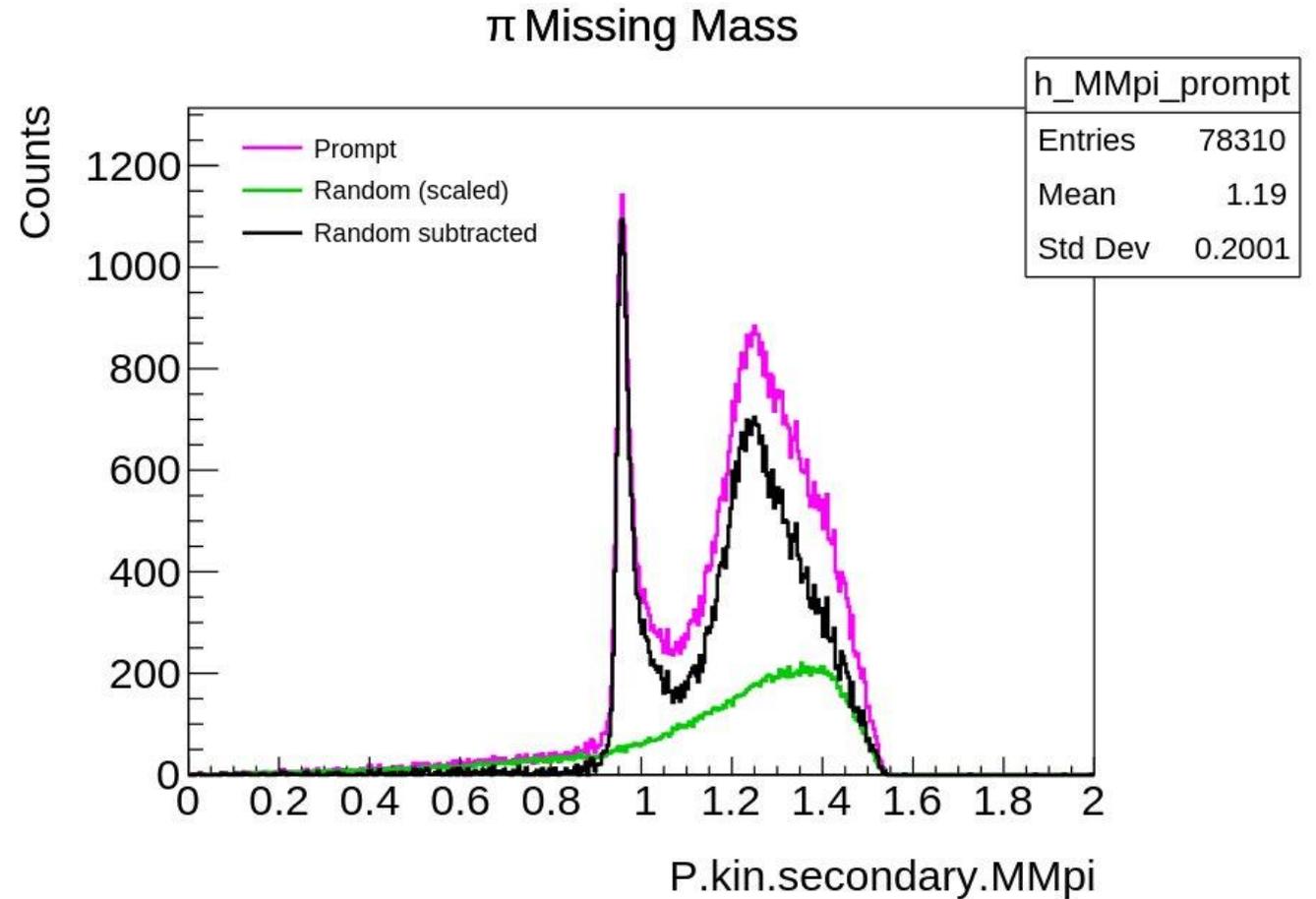
$0.9 < RF < 3.6$



Final Timing Cuts

- $H.cal.etottracknorm > 0.7$
- $H.cer.npeSum > 2.0$
- $P.aero.npeSum > 2.0$
- $P.hgcer.npeSum > 2.0$

- **$abs(CTime.ePiCoinTime_ROC1-0.881) < 2.0$**
- **$0.9 < RFTIME.SHMS_RFtimeDist < 3.6$**



Timing cuts

Initial study of coin time, RF time and random subtraction

06/03/26

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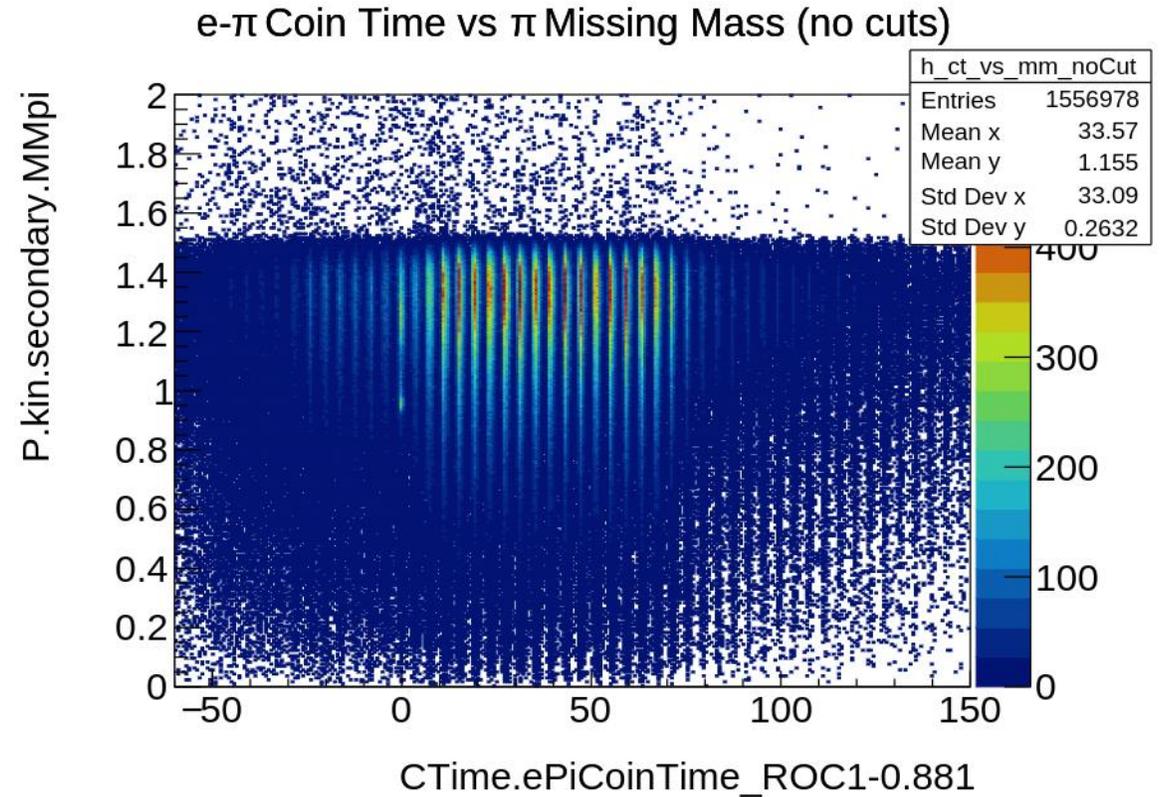
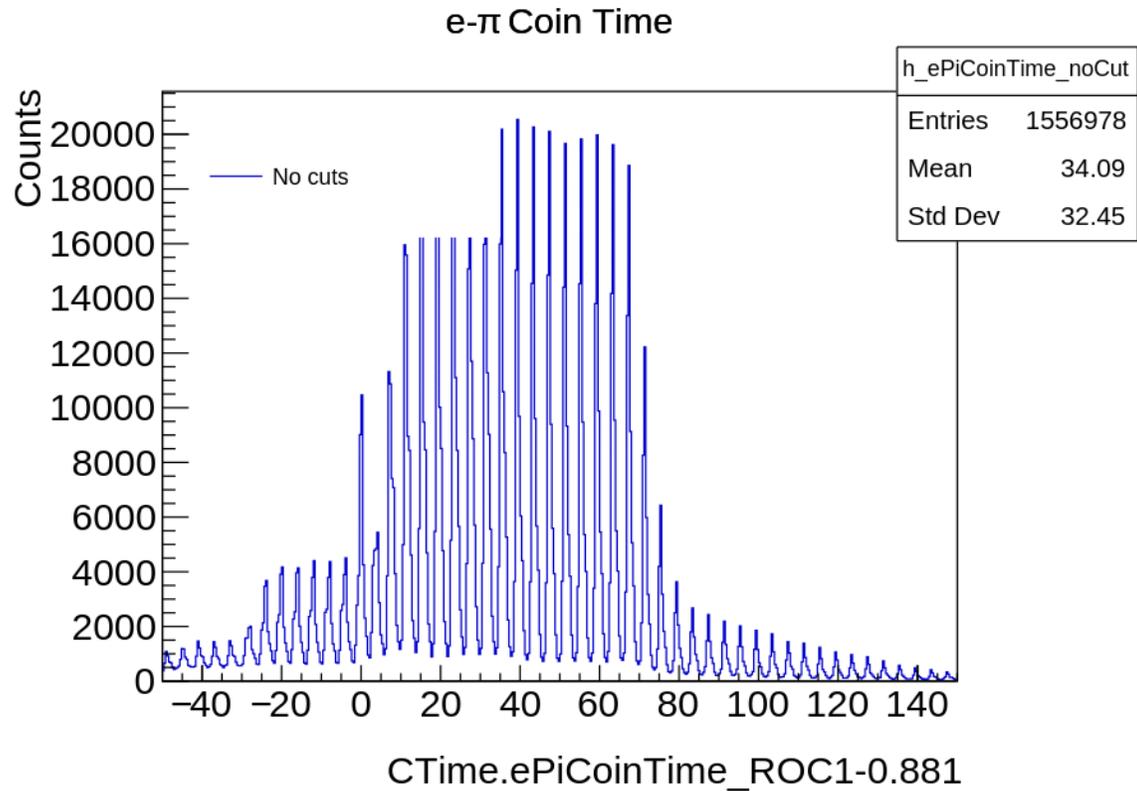
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Coin Time - LD+ 75 uA



Detector Cuts

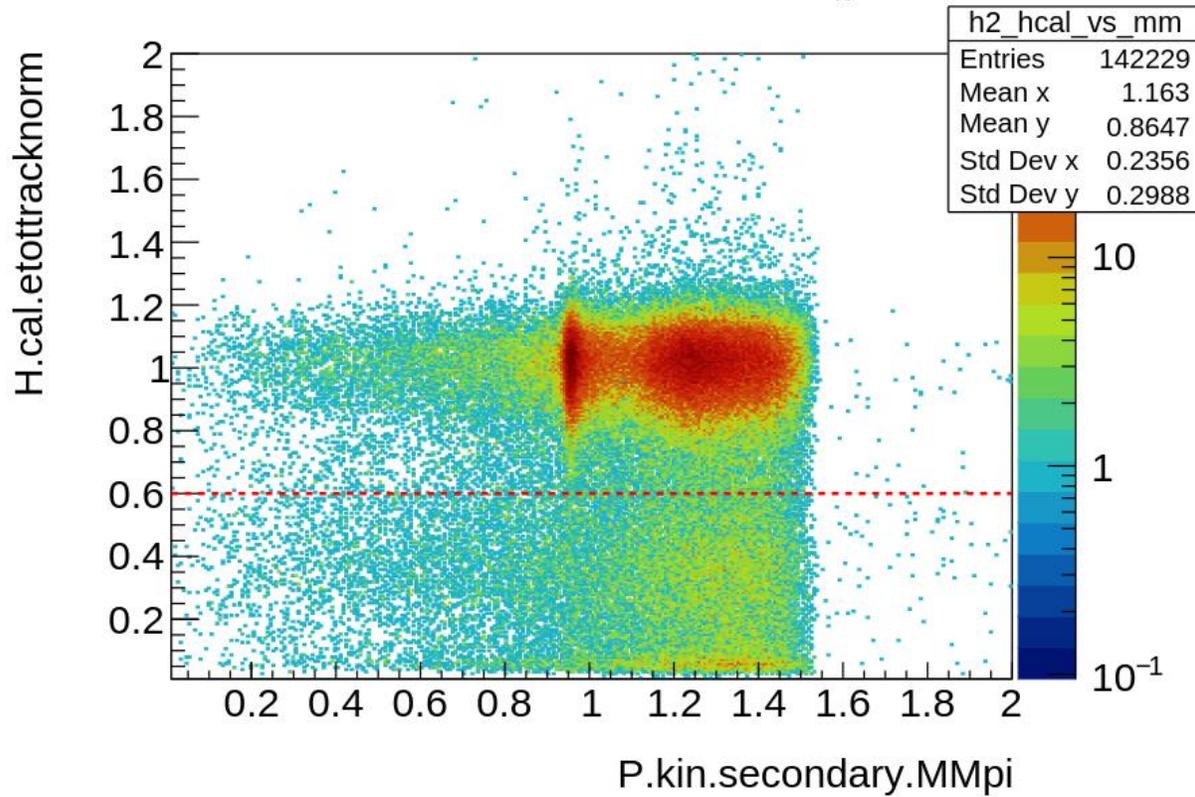
Refining HMS and SHMS cuts

06/03/26

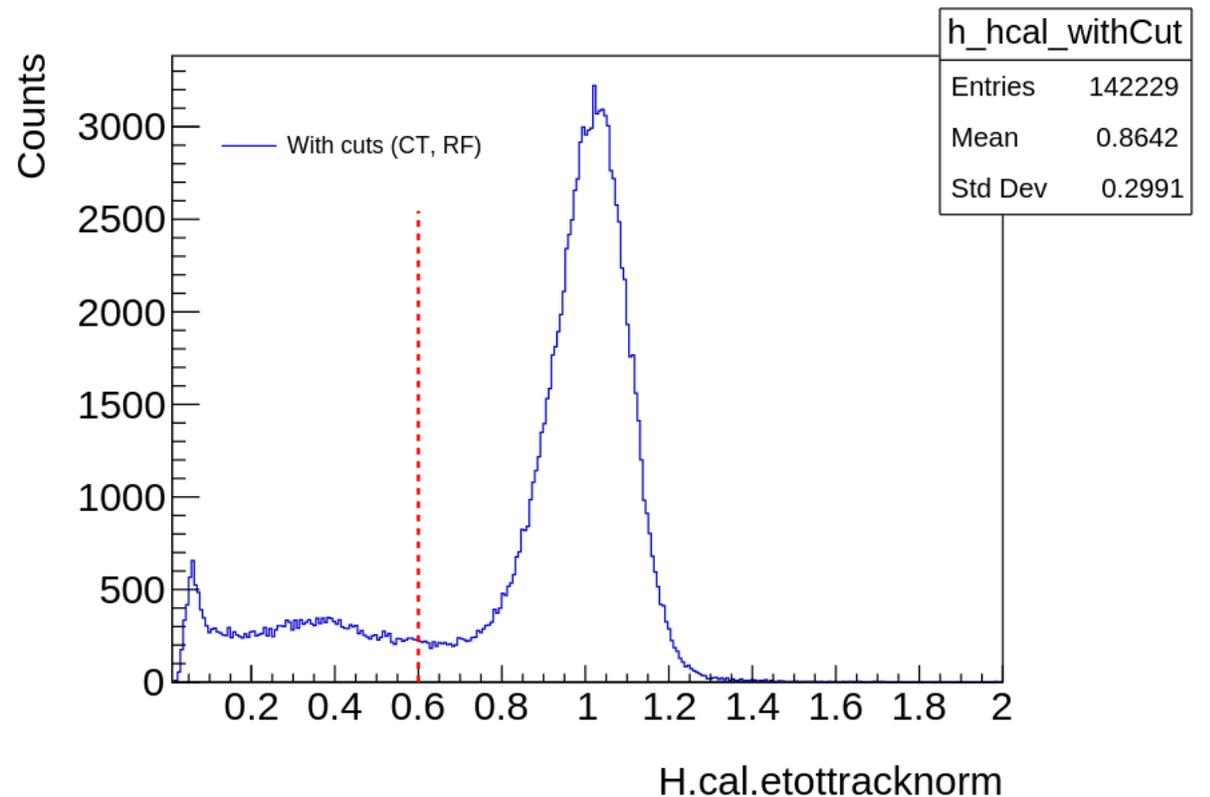
HMS – HCal (with timing cuts)

HCal > 0.6

H.cal.etottracknorm vs MM_{π}



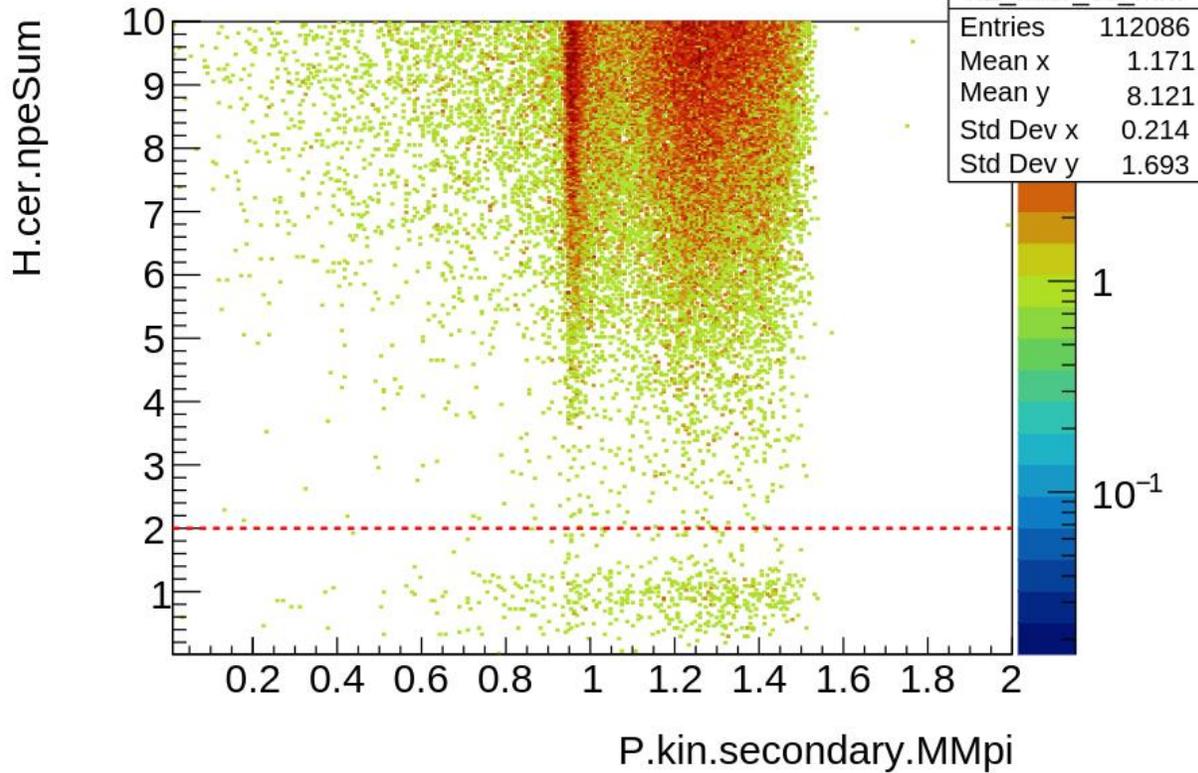
H.cal.etottracknorm



HMS – HCer (CT + RF + HCal cuts)

HCer > 2.0

H.cer.npeSum vs MM_{π}



H.cer.npeSum

