

Extracting π^+ Yield

Finalising PID cuts, normalising and integrating pion yield

27/03/26

Final PID cuts

HMS

- $H.cal.etottracknorm > 0.6$
- $H.cer.npeSum > 2.0$

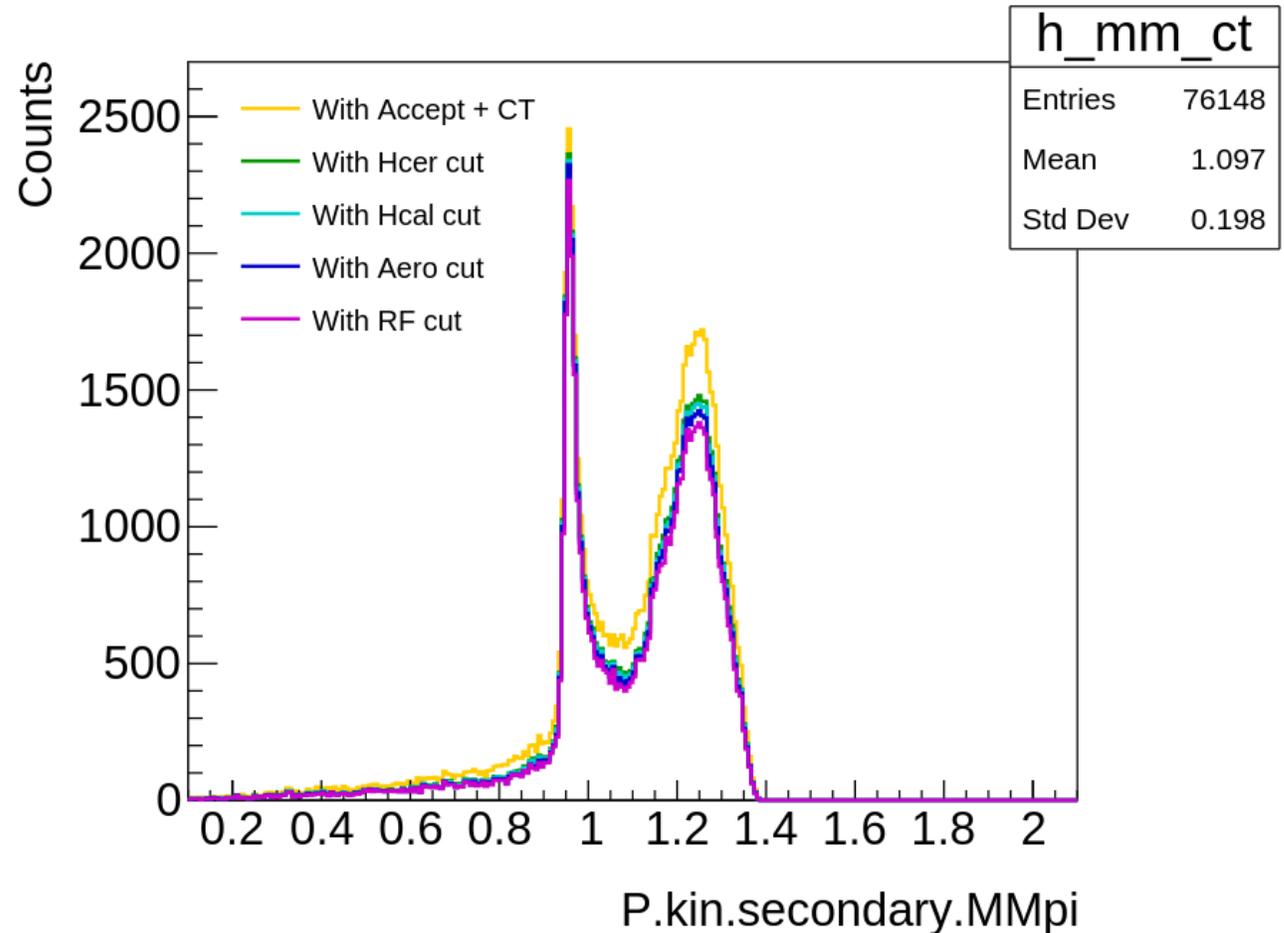
SHMS

- $P.aero.npeSum > 0.2$
- $1.4 < RFTIME.SHMS_RFtimeDist < 3.2$

Timing

- $abs(CTime.ePiCoinTime_ROC1 - 0.881) < 2.0$

Missing Mass after each cut



Final PID cuts – log counts

HMS

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SHMS

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Timing

- $abs(CTime.ePiCoinTime_ROC1 - 0.881) < 2.0$
- $1.4 < RFTIME.SHMS_RFtimeDist < 3.2$

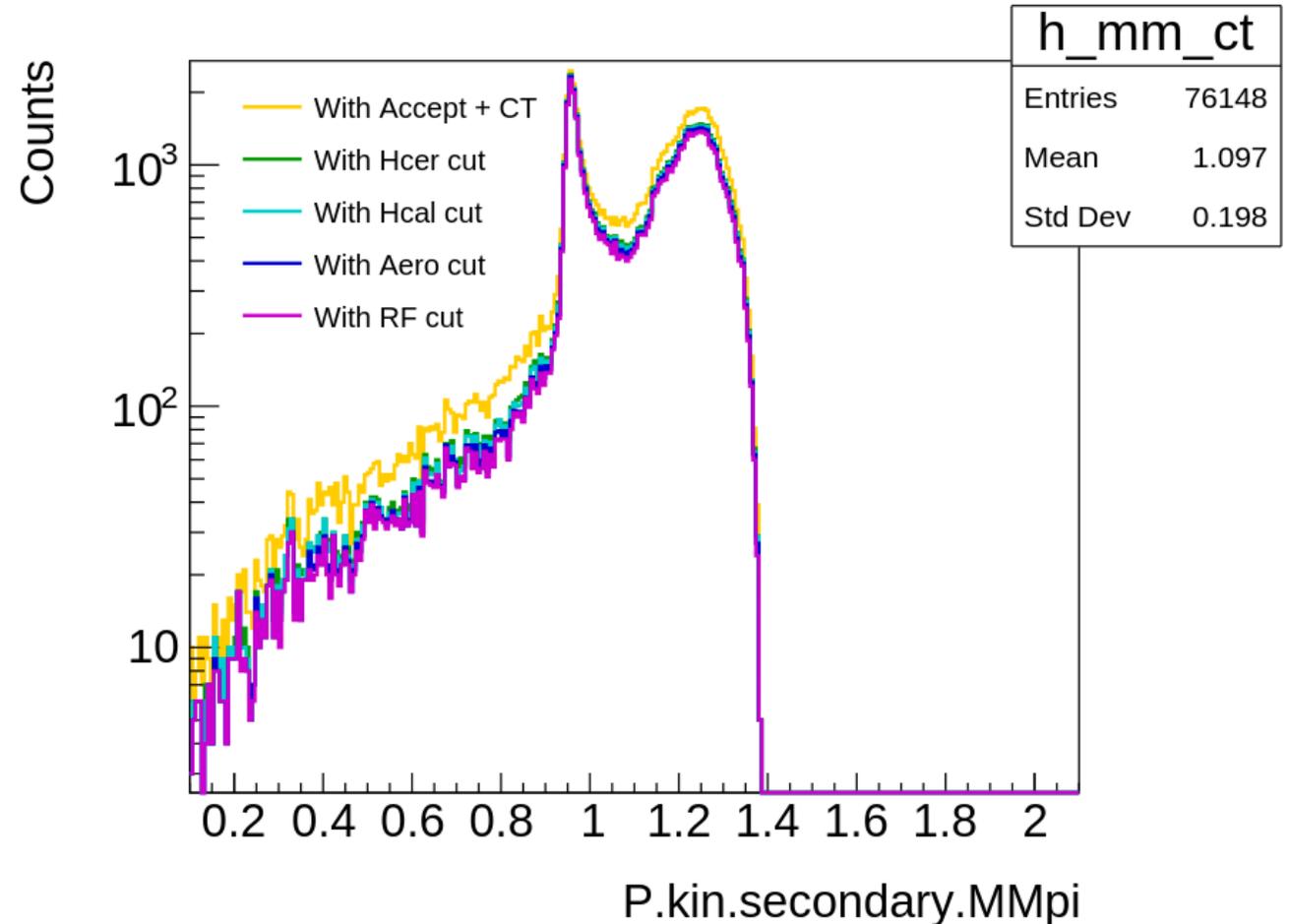
Can see the effects of each cut more.

HCal & HCer – removes hadrons from HMS

PAero – SHMS Cherenkov light pion ID

RF – SHMS ToF pion ID

Missing Mass after each cut



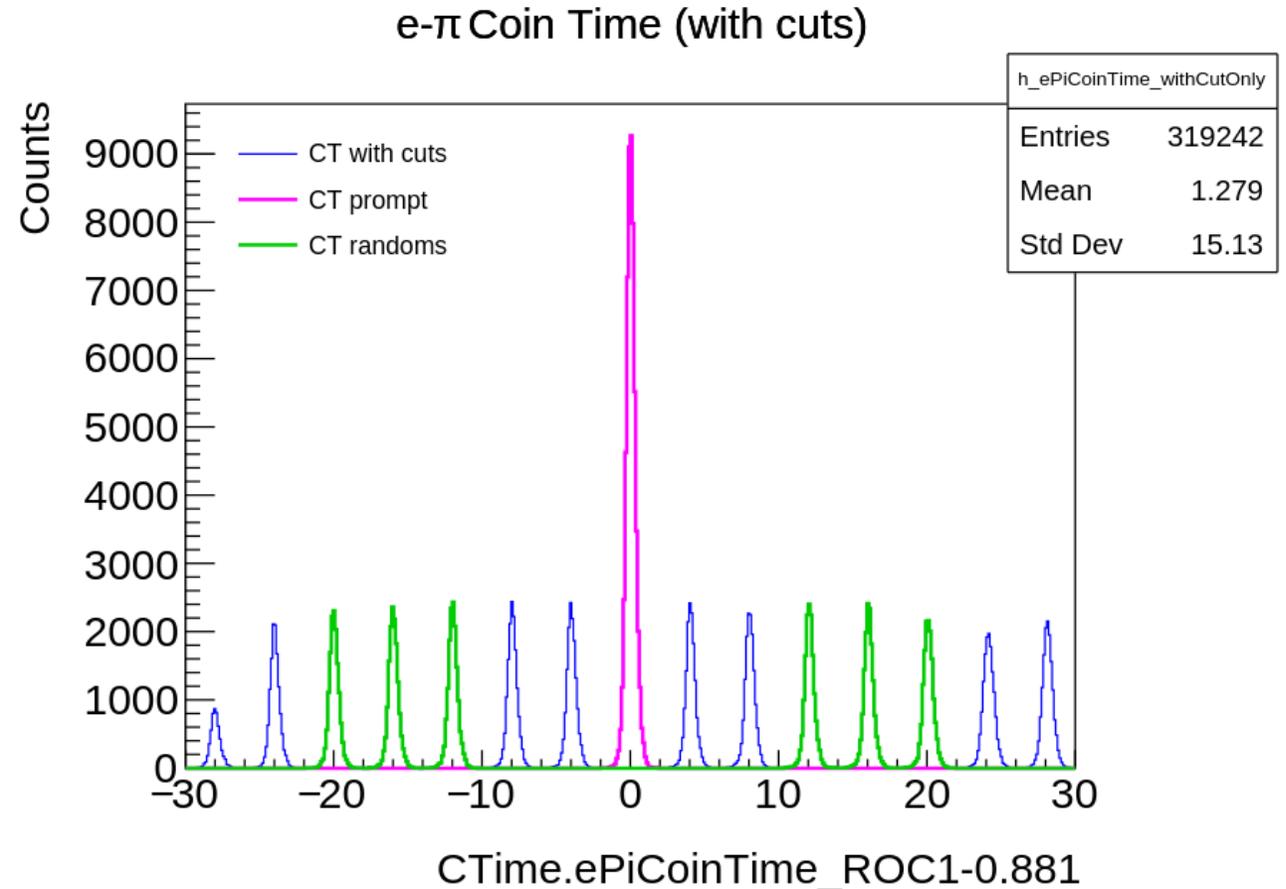
Random subtraction (recap)

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.

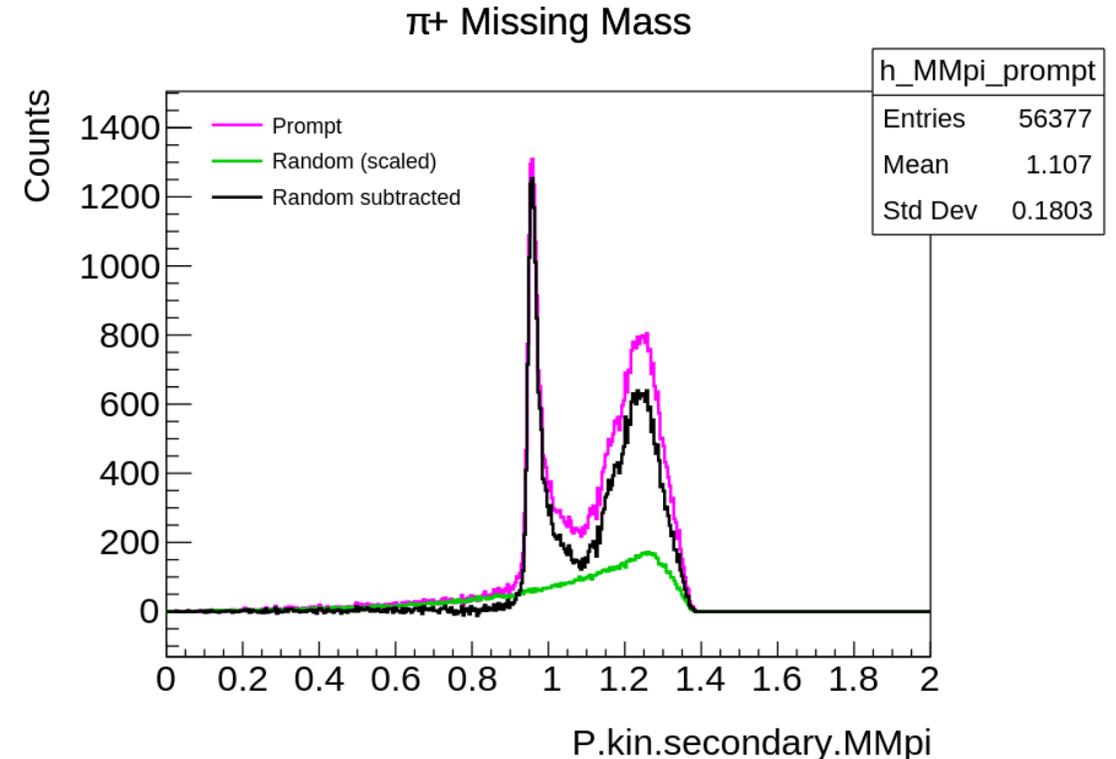
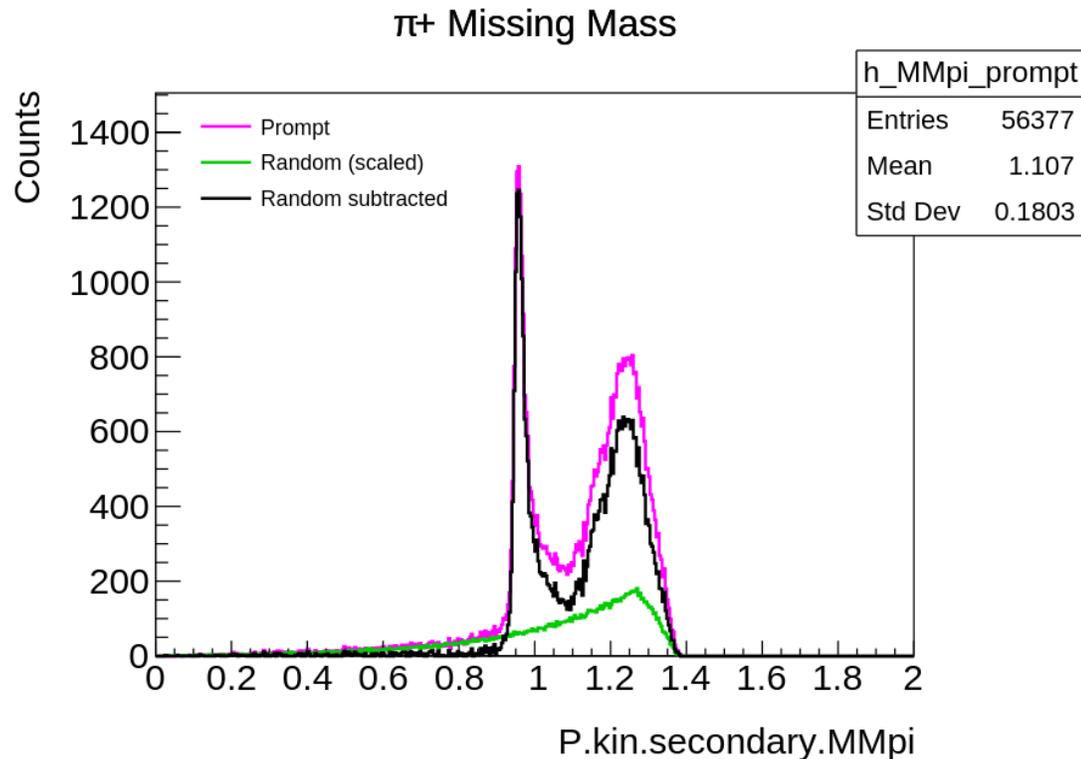
$$N_{\text{prompt}} = \frac{1}{6} N_{\text{random}}$$



Random subtracted MM

Cout>> minimum subtracted = **-10**

Integral of h_MMpi_sub from 0.45 to 0.85 = **401.333** - so it is okay!



Dummy target

Background subtraction from cell walls. Aluminum 7075 dummy target on target ladder to mimic contribution from LD2 target cell walls.

Dummy 2022 runs:

LD2+

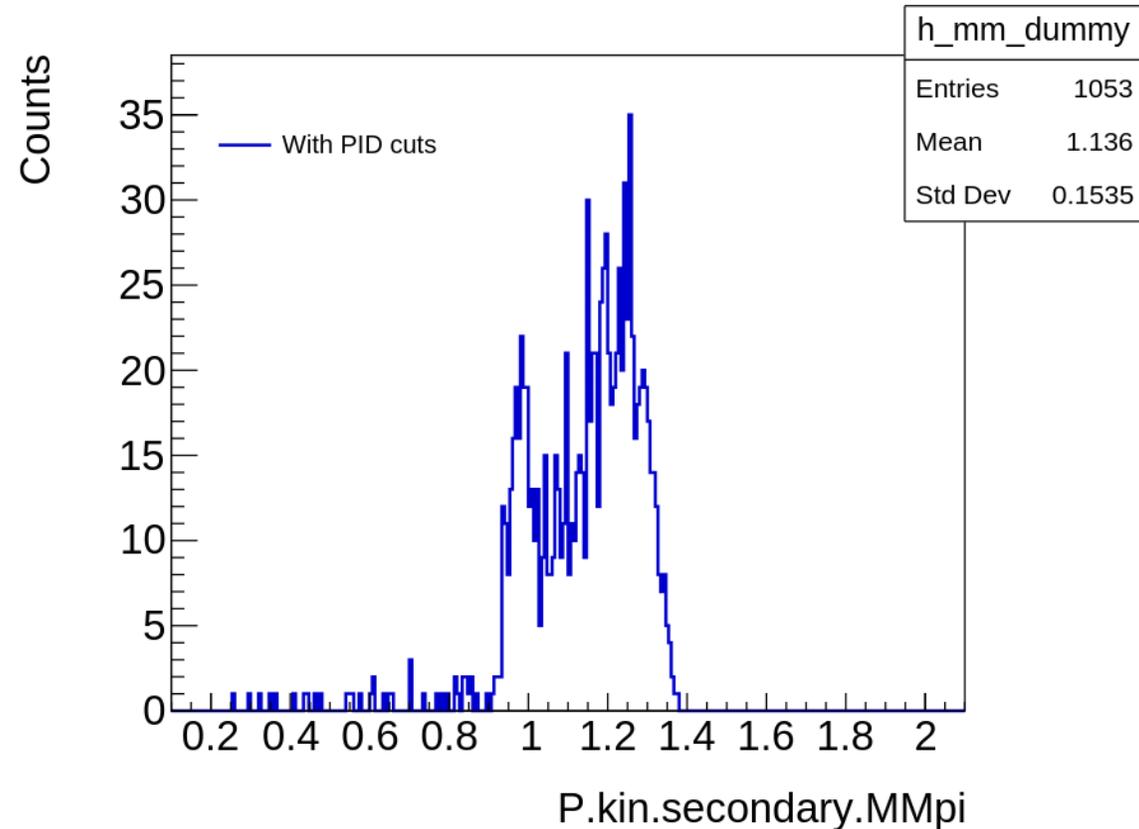
- 32 uA: 16418 – 16420
- 75 uA: 16483, 16485

LD2-

- 2.5 uA: 16791, 16814
- 8 uA: 16652, 16654

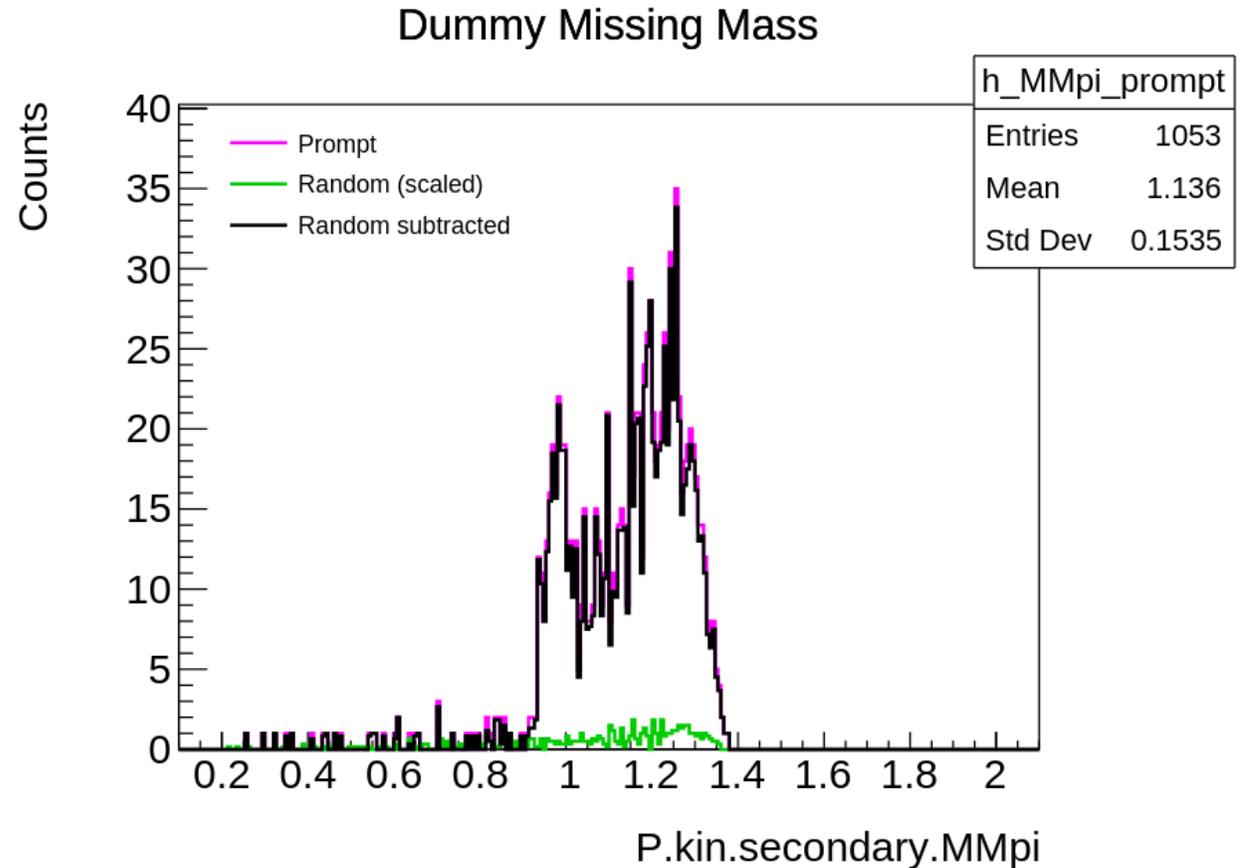
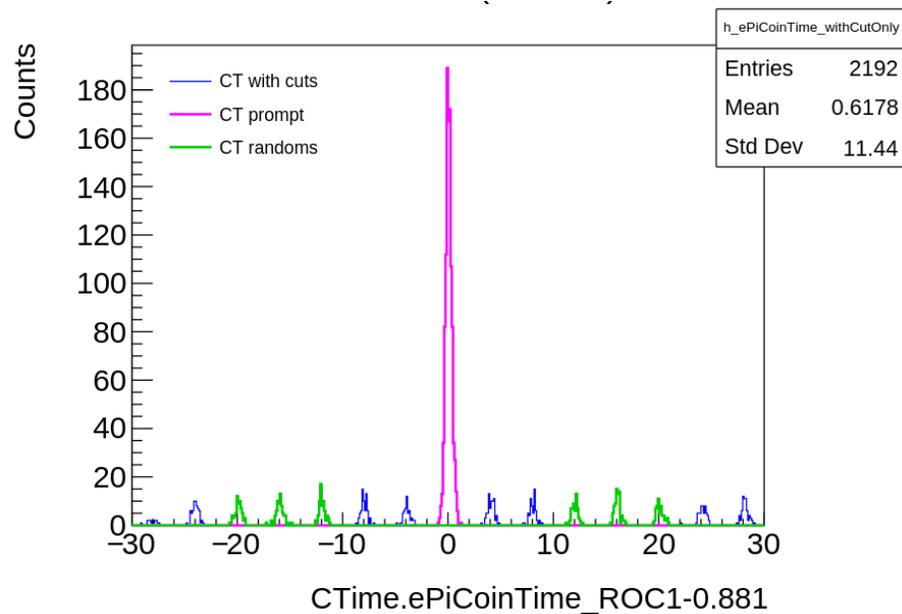
Need to subtract randoms..

Missing Mass of Dummy Runs



Dummy random subtraction

We apply every cut/subtraction from LD2 target to the dummy target:



Need to scale by integrated charge and target wall thickness...

Dummy correction factor

For the **LD2+ 32 uA** runs:

- Total dummy charge: $Q = 164.723$ mC
- Al 7075 density = 2.81 g/cm³
- Dummy target configuration:
 - Upstream: 0.1703 ± 0.0002 g/cm² of 0.116 ± 0.0086 mm
 - Downstream (tip): 0.1677 ± 0.0002 g/cm² of 0.184 ± 0.021 mm
- Dummy correction factor:

**Dummy walls (g/cm²)/
real target walls (g/cm²)**

4 Target Thicknesses

[2]

4.1 Cells

Hydrogen loops entrance and exit window thicknesses are given below. Loop 1 is in standby with helium gas. Loop 2 is connected to the H2 panel and Loop 3 is connected to the D2 panel.

Target	Entrance (mm)	Exit (mm)	Length (mm)	Material
Loop 1 (10 cm)	0.130 ± 0.012	0.188 ± 0.013 Tip 0.184 ± 0.017 wall	100 ± 0.26	AL 7075
Loop 2 (10 cm)	0.150 ± 0.011	0.191 ± 0.019 Tip 0.219 ± 0.018 wall	100 ± 0.26	AL 7075
Loop 3 (10 cm)	0.116 ± 0.0086	0.184 ± 0.021 Tip 0.14 ± 0.023 wall	100 ± 0.26	AL 7075

Entrance windows are fabricated from Al7075 (lot 377271B2)
[CMTR HT 377271B2 | Jefferson Lab Electronic Logbook \(jlab.org\)](#)

Exit windows are fabricated from Al7075 (lot # 308151)
[Material Certification \(lot # 308151\) for AL7075 to be used for Hall C 10 cm exit windows | Jefferson Lab Electronic Logbook \(jlab.org\)](#)

4.2 Dummy Targets

The dummy targets are aluminum foils mounted on separate frames with foils located at Z positions corresponding to the cryotarget exit and entrance windows.

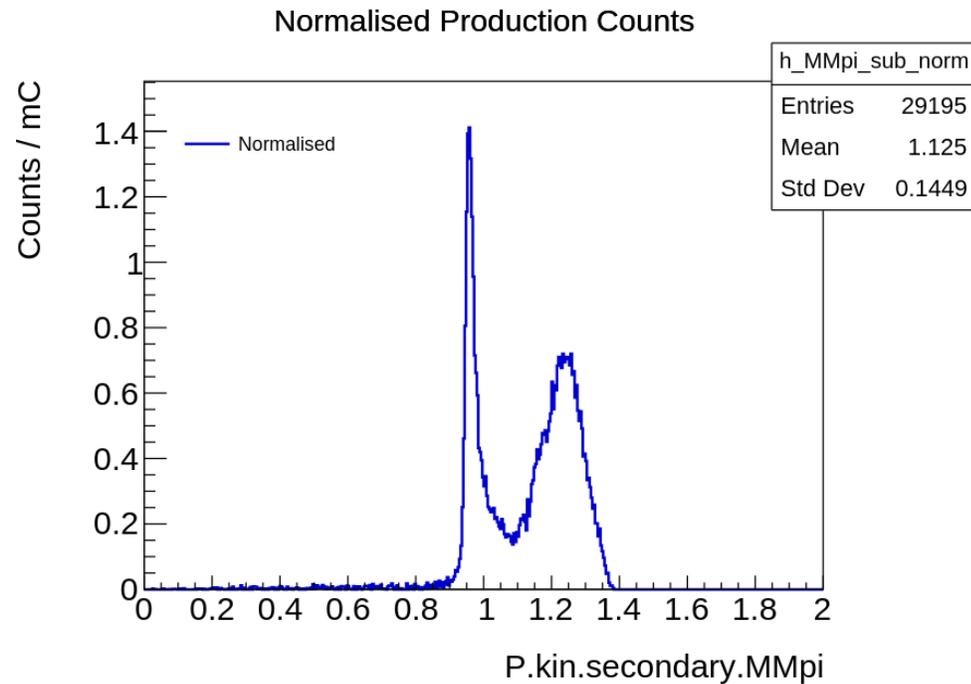
[Certs for dummy target foils 0.05" and 0.032" thick | Jefferson Lab Electronic Logbook \(jlab.org\)](#)

Target	Thickness Total (g/cm ²)	Material
10 cm Dummy Upstream	0.1703 ± 0.0002	Al 7075
10 cm Dummy Downstream	0.1677 ± 0.0002	Al 7075

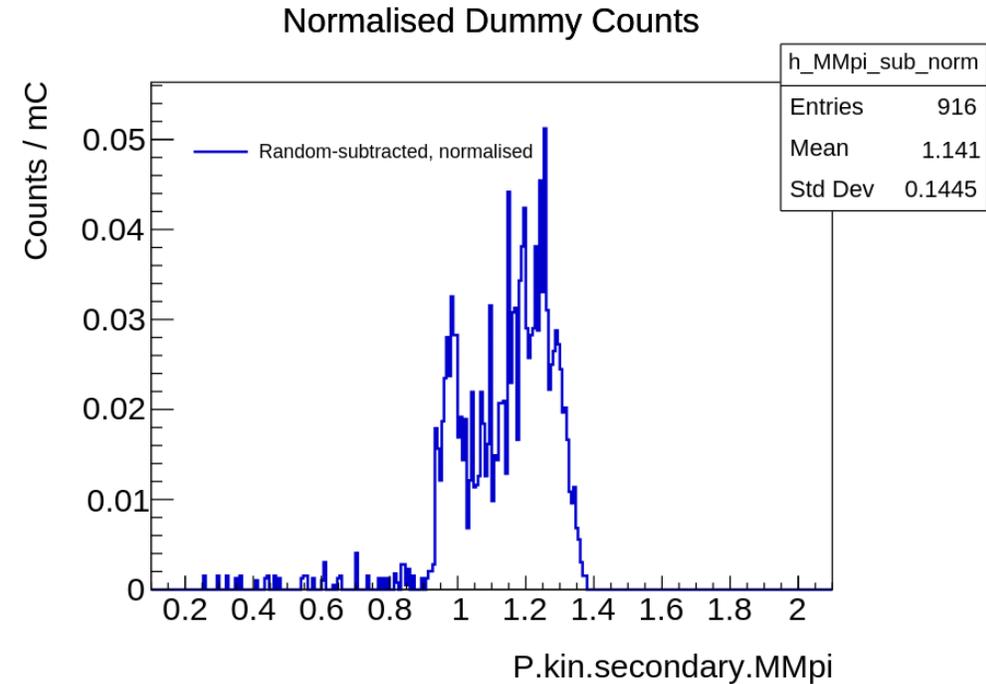
Normalise yields by charge

- Total target charge: $Q = 887.679$ mC
- Total dummy charge: $Q = 164.723$ mC
- Dummy correction factor: $f = 4.009$

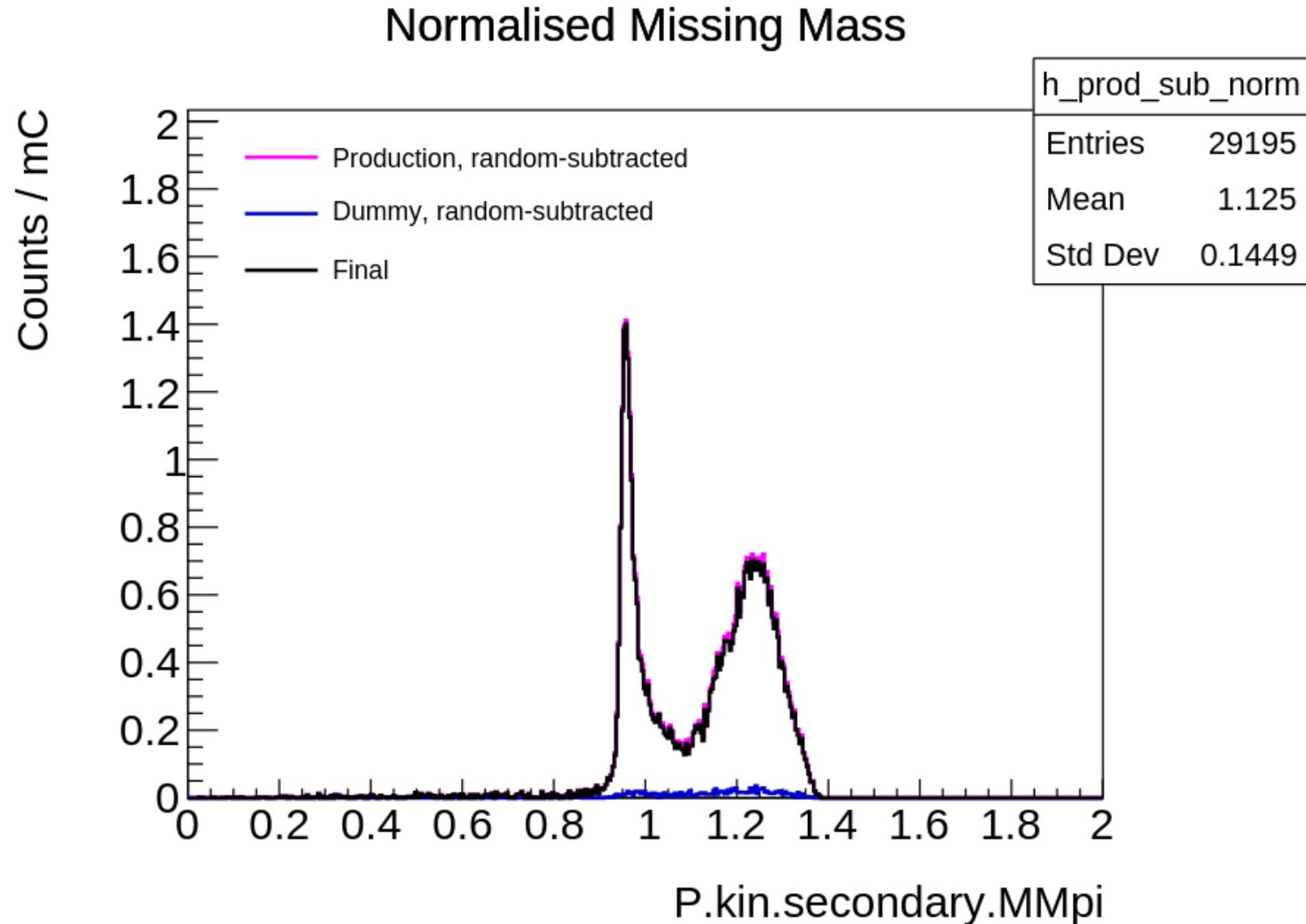
N/Q



N/(f x Q)

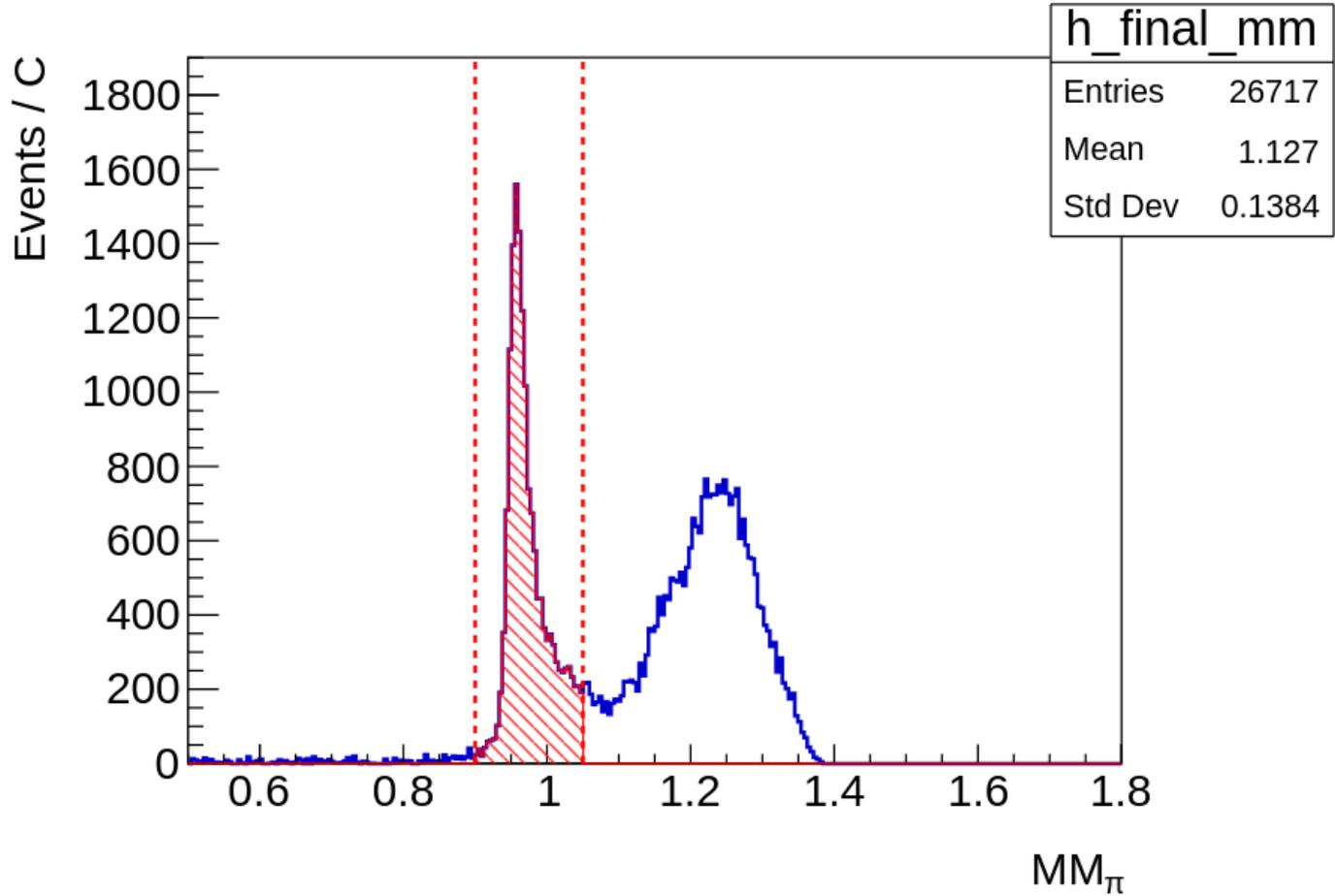


Normalise yields by charge



Preliminary π^+ yield

Final Missing Mass



Normalised π^+ yield:
[0.9, 1.05] = **15745.3 π^+ /C**

Next Steps ~ two weeks

1. Investigate detector efficiencies using Junaid's report and Alicia's code to find the effective charge for both targets.
2. Use these efficiencies to "re-normalise" the final prelim yield for this π^+ dataset.
3. Write a macro/macros that combines and plots everything needed to find yield - just clean code up to make π^- easier !
4. IOP conference – poster (DNP)