Calo ZS Studies

Jaebeom Park

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Tower energy extraction

Chi2 cut of min(10^4, ADC*ADC/100)

Sample 6 - Sample 0 > threshold ➡️ Energy = Template fit

Sample 6 - Sample 0 <= threshold ➡️ Energy = Sample 6 - Sample 0

**Pedestal & threshold**

- Data : Hardware ZS on DCM2 account for 2 sigma of ped. fluctuation in beam data

- MC : Embedded ped. fluctuation from No beam + bias on data without zero suppression

  - Currently a uniform ZS threshold cut applied — plan to load ch-by-ch tuned zs thresholds

Why does this matter?

- Template fit is known to have a "positive bias" + "higher" value than Post-Pre (Sample 6 -Sample 0)

- Hardware ZS is not optimized for '*all of the noise*' but to effectively reject noise to secure bandwidth

- Is the threshold high enough to ensure no bias on tower energies

  - No energy correction on Post-Pre applied at the moment

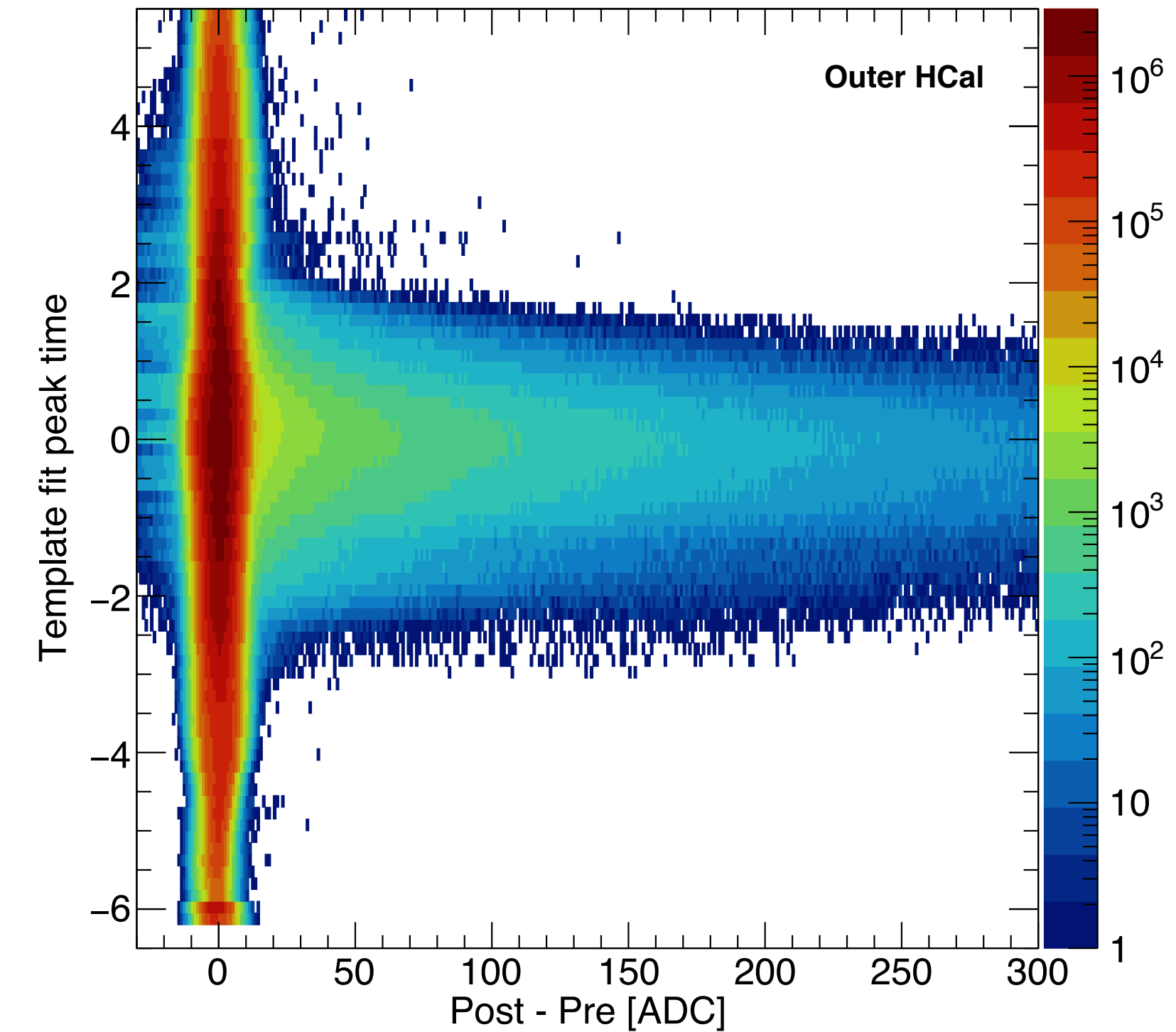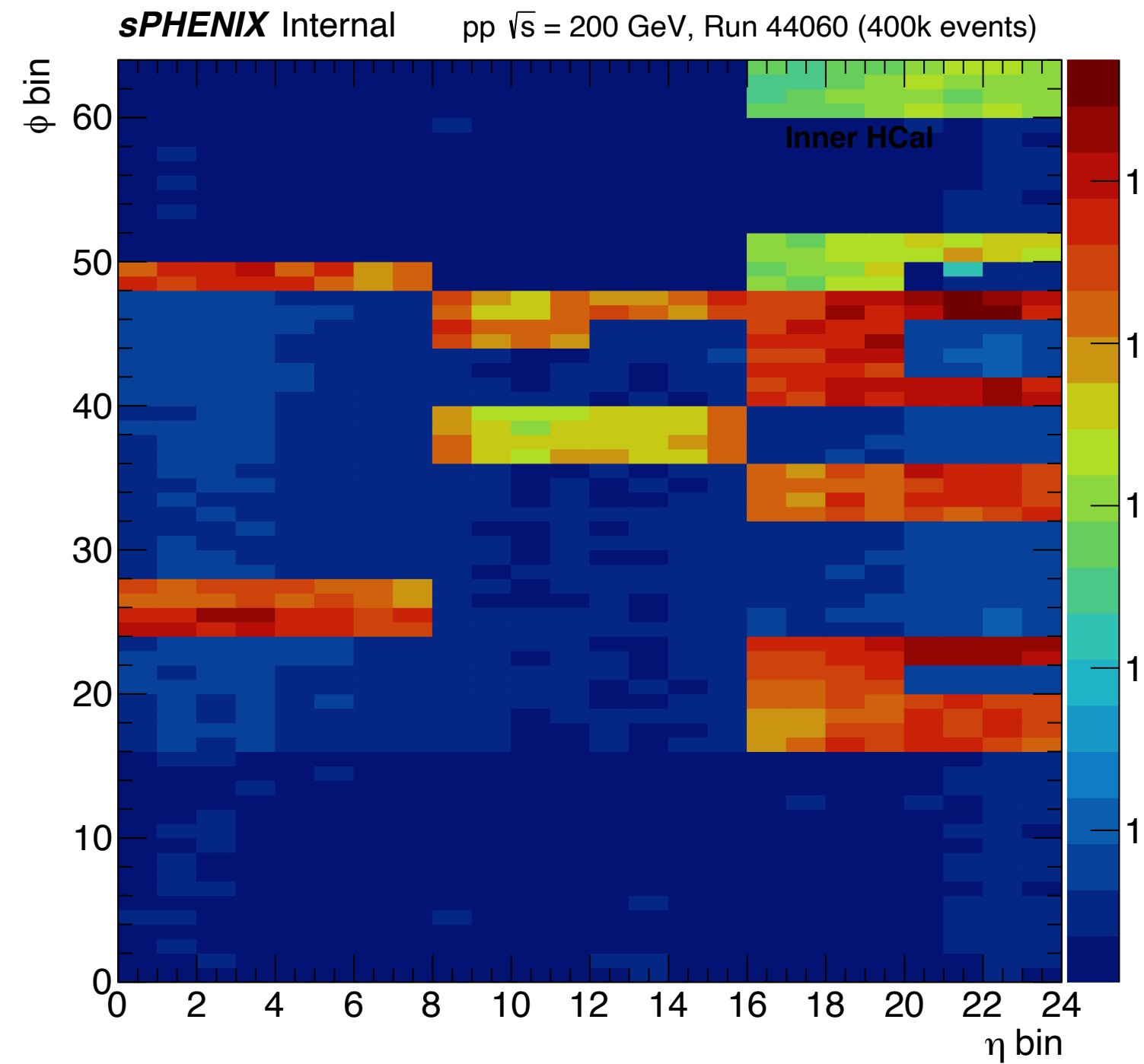 - Even ~1 ADC positive bias per tower —> GeV level shift in a R=0.4 jet
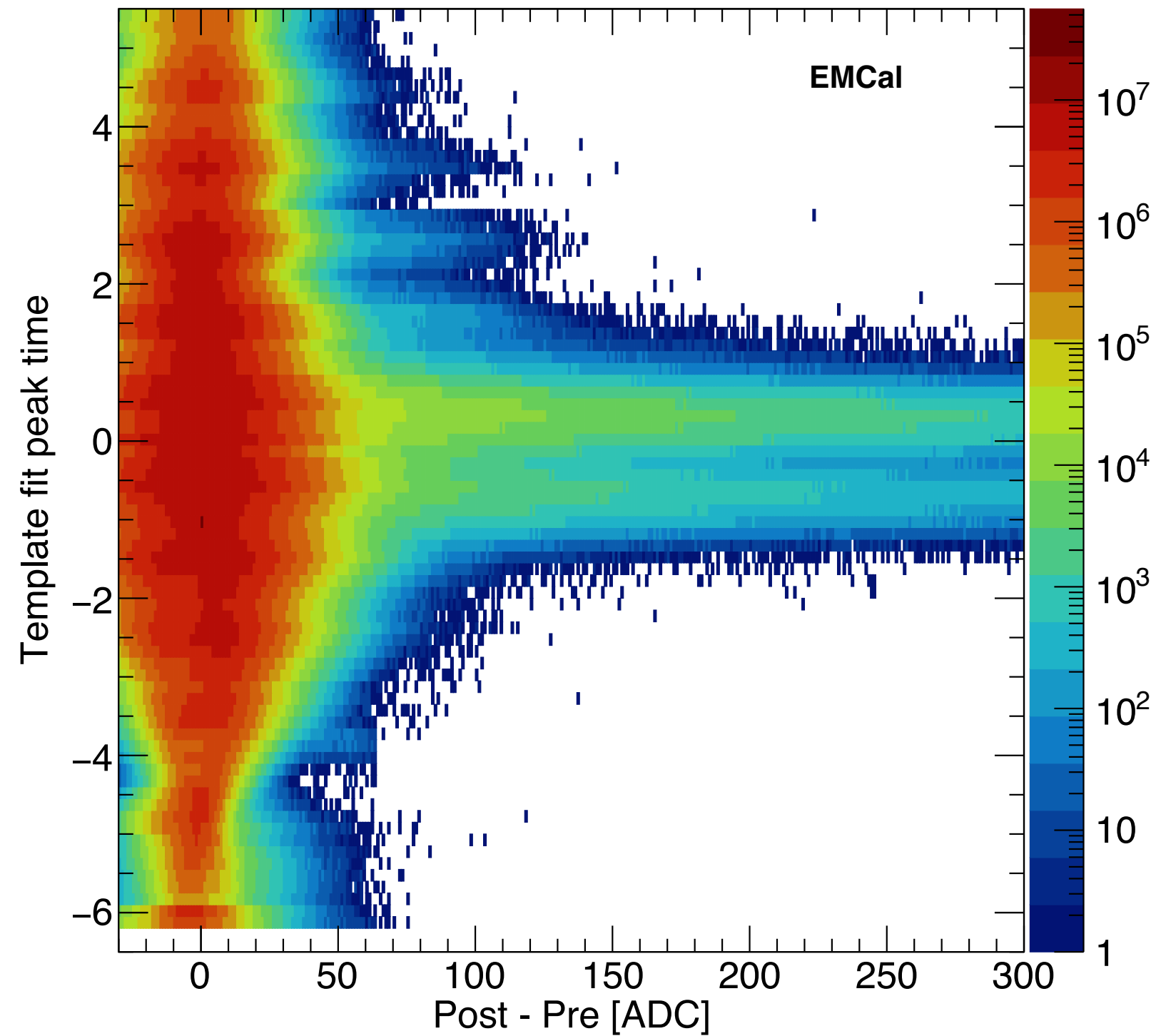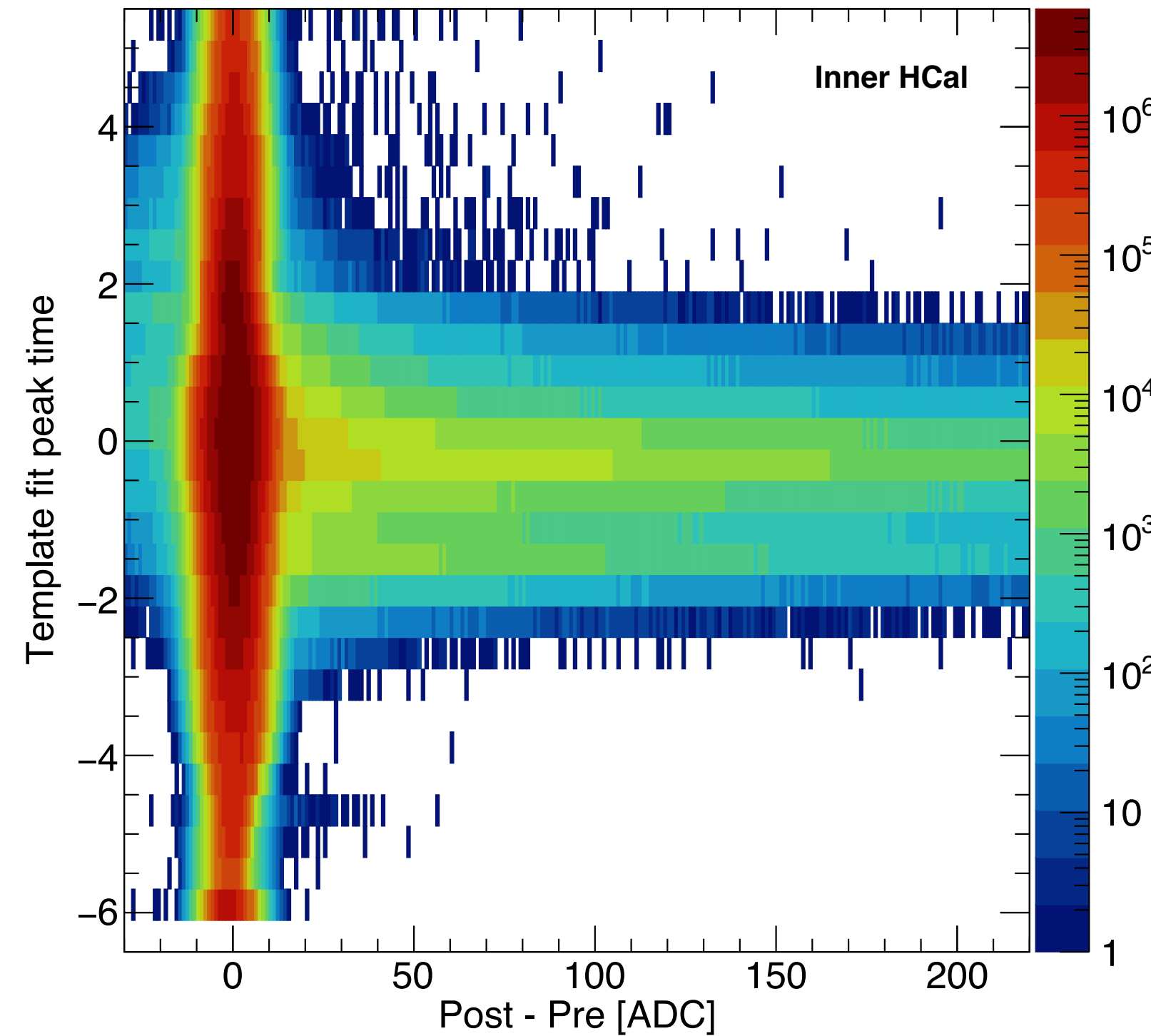
- Post - Pre vs Template Fit peak time position

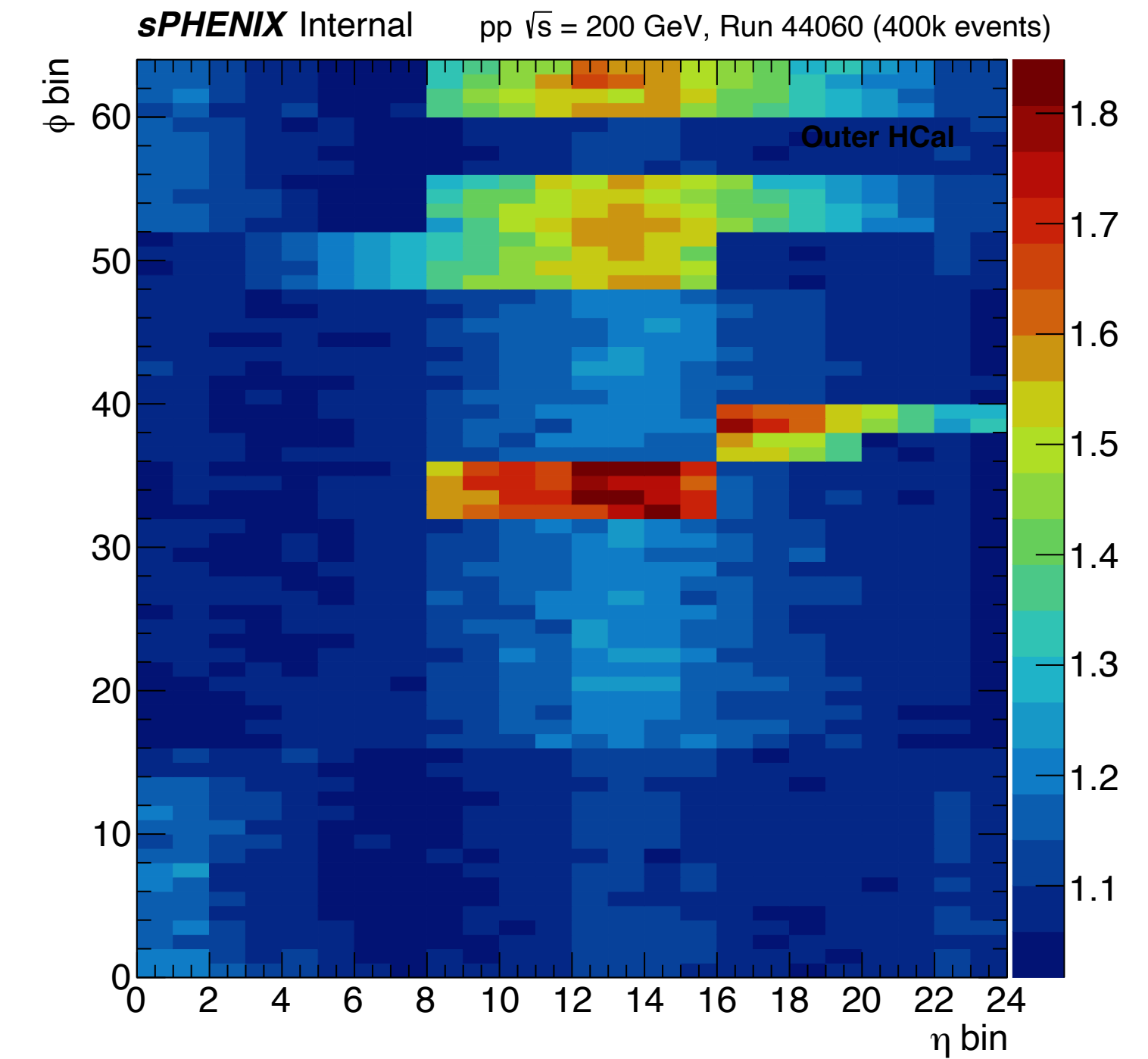- Wide out of time events in emcal even for ~50 ADC threshold

Data : Ratio of template vs post-pre
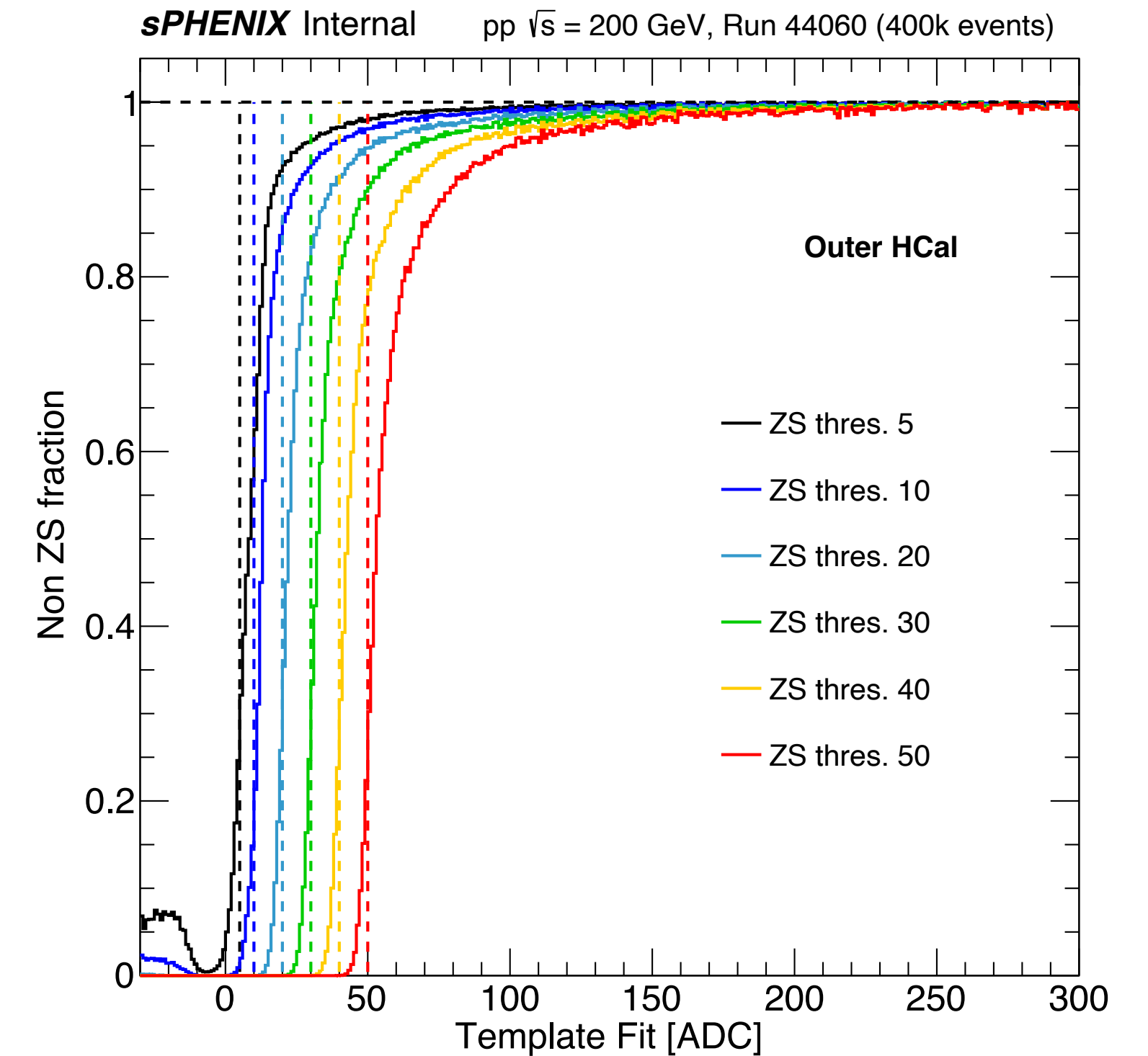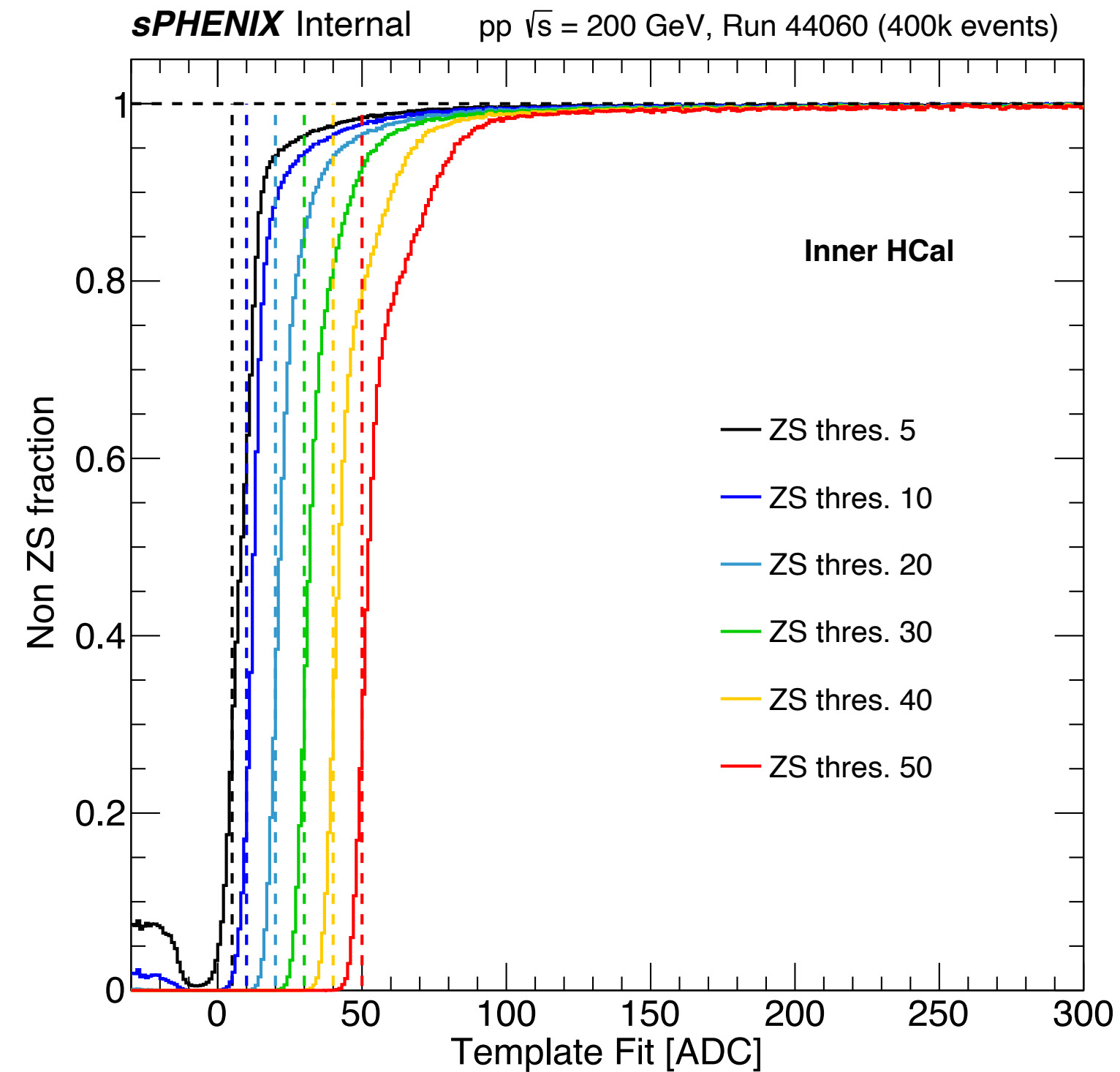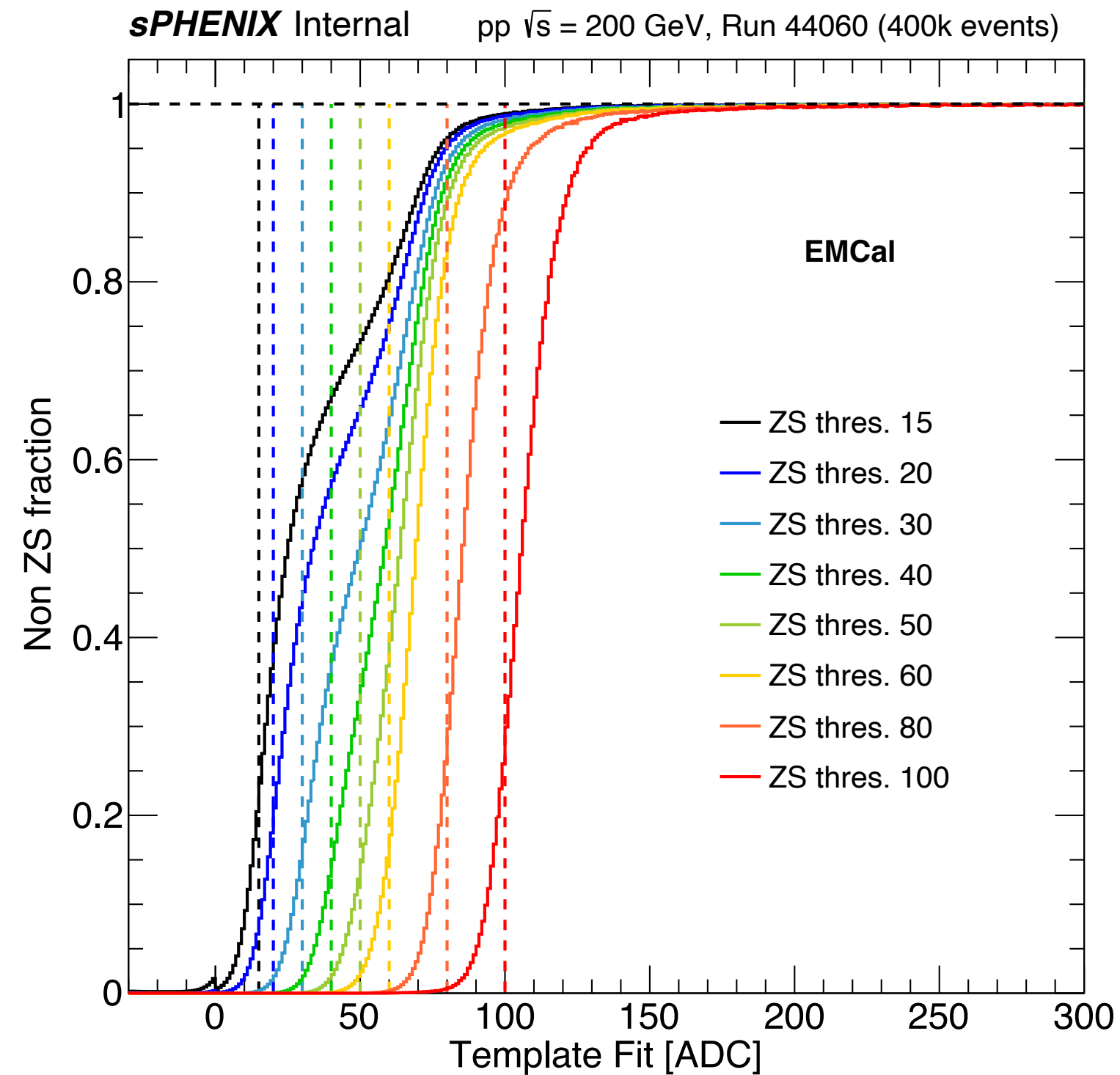
EMCal
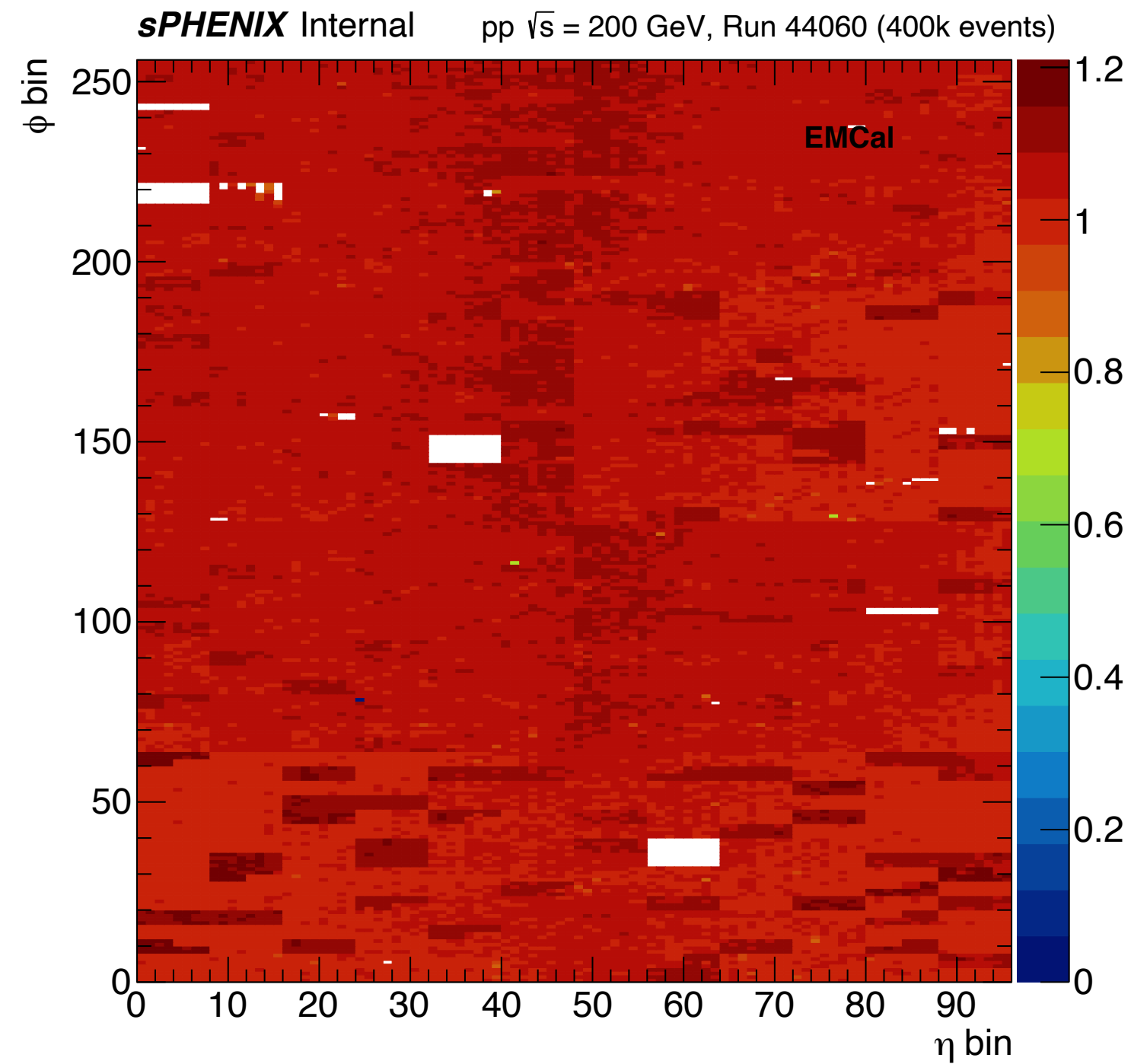
Inner HCal

Outer HCal

- Template / post-pre for post-pre ADC > 60

- Overall higher energy values for template fit than post-pre
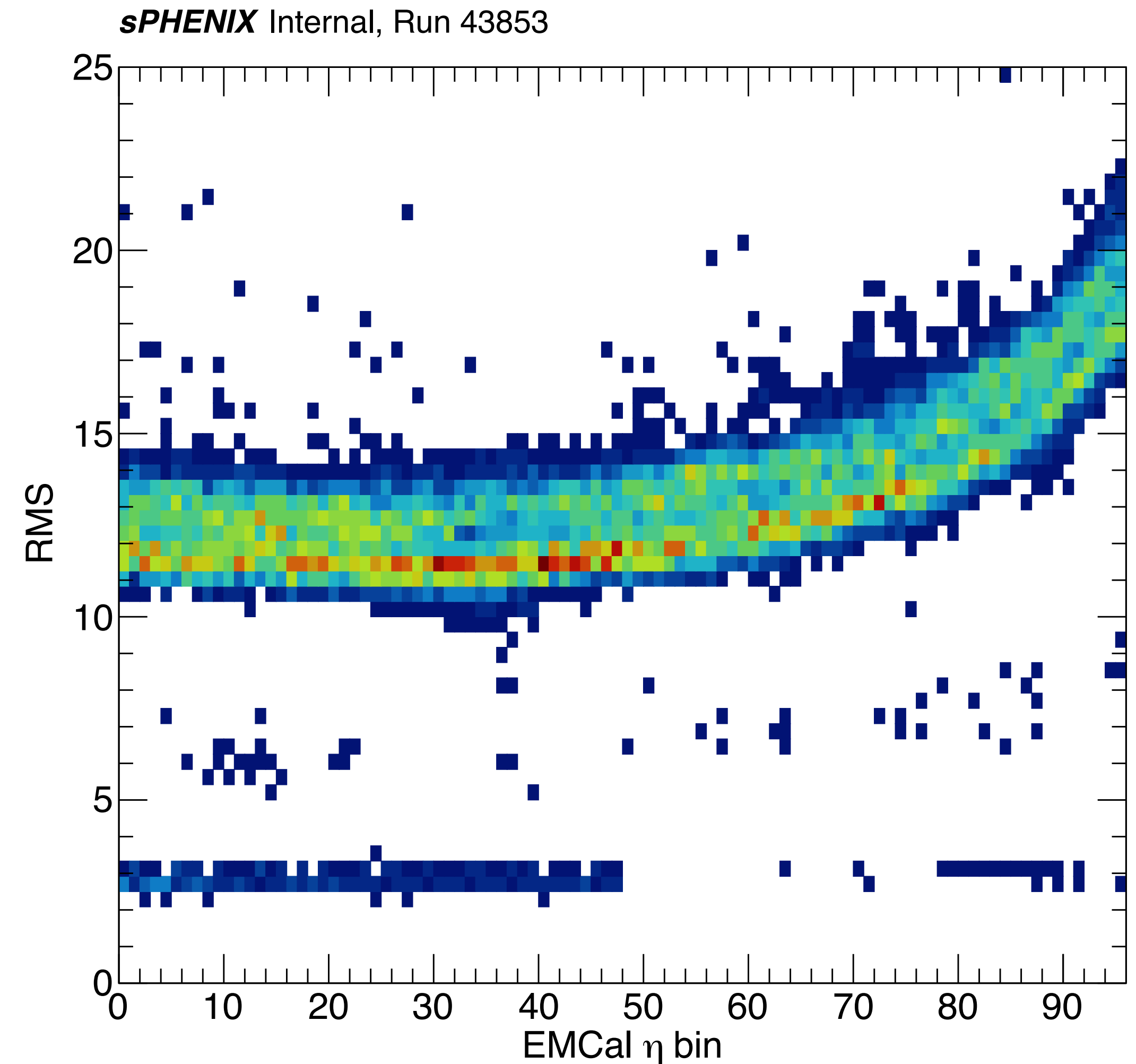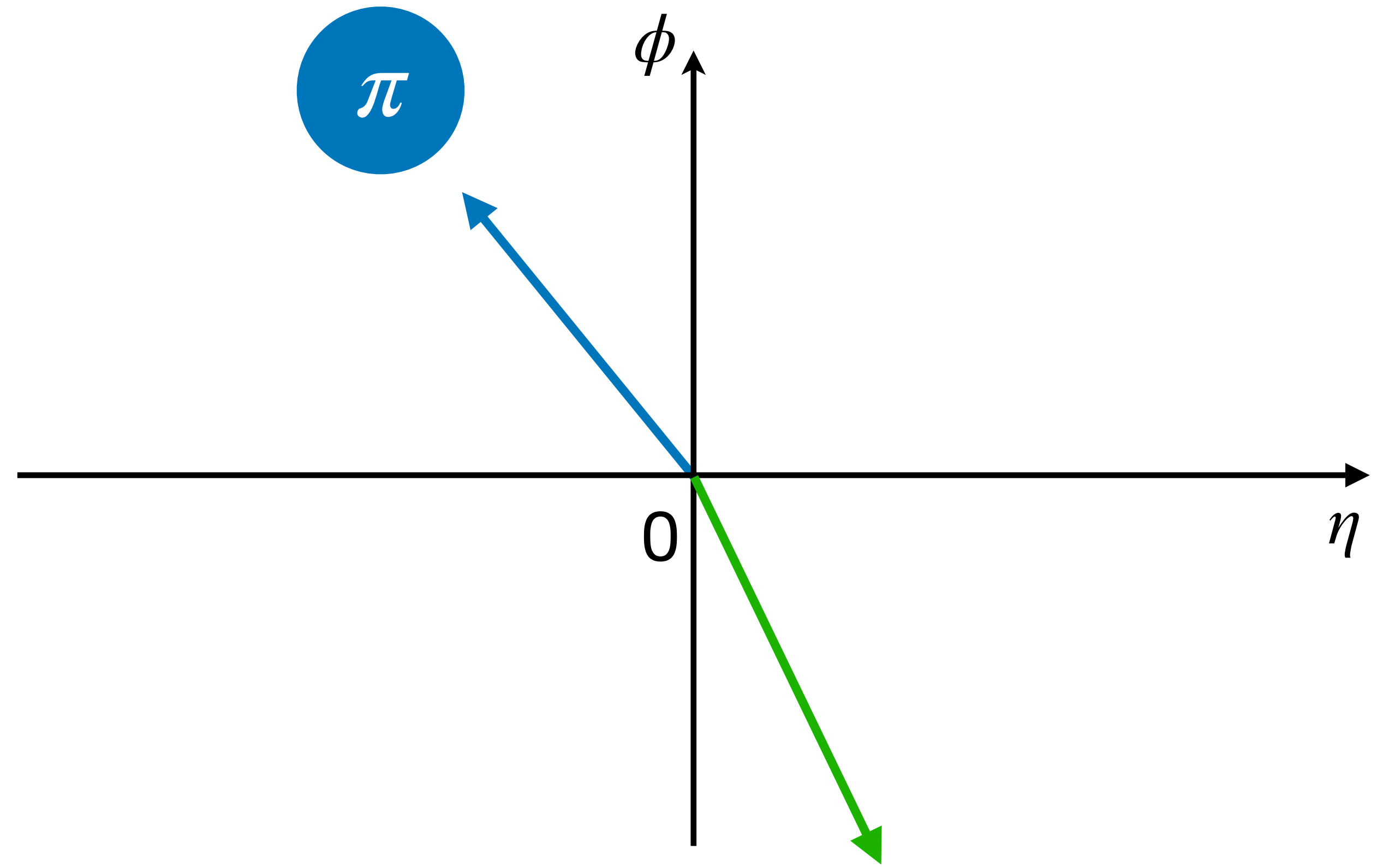
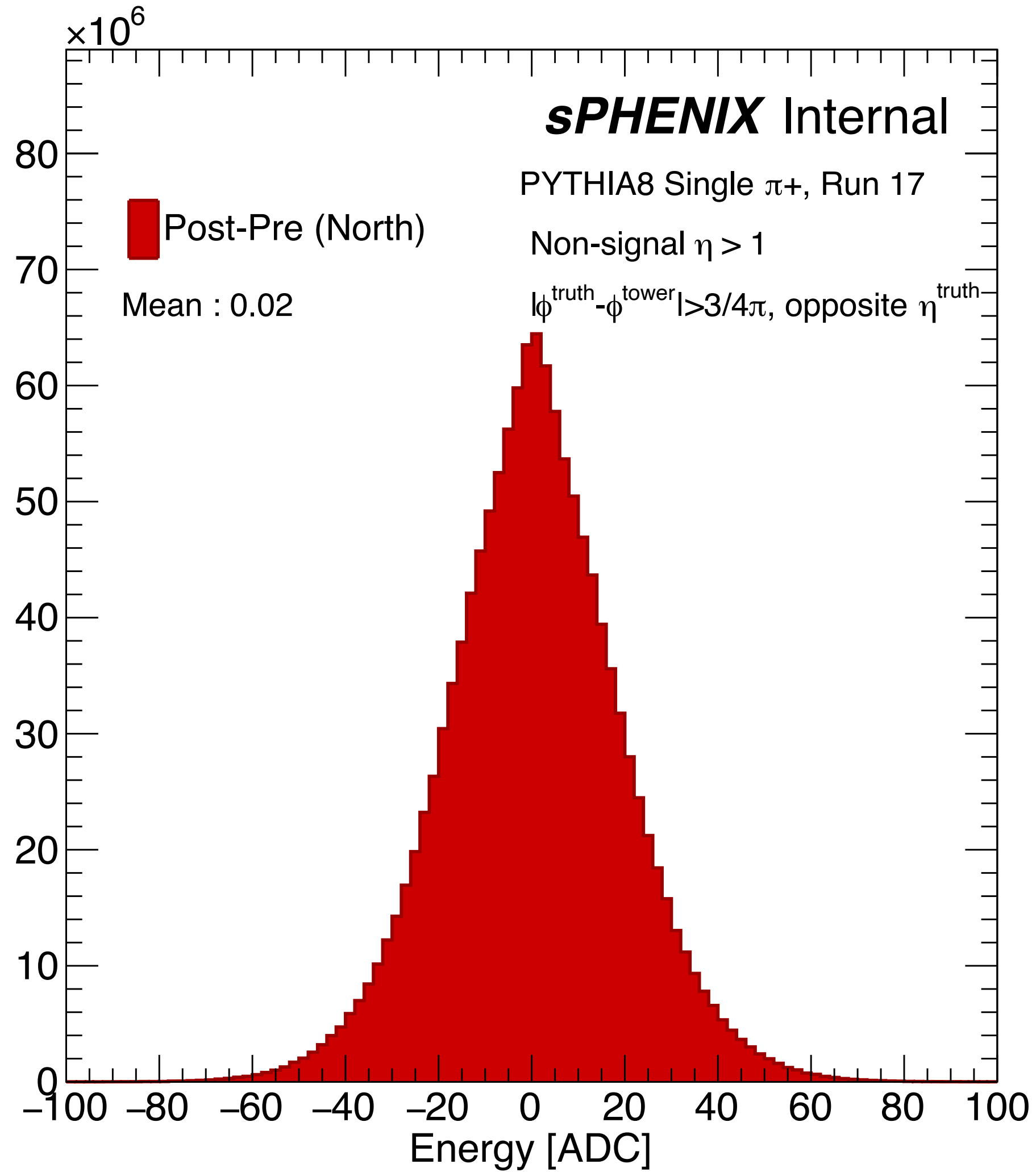# Data : Suppression fraction

- Fraction of non zero-suppressed towers vs template fit ADC

- Smearing effect causing a turn-on curve shape in ZS fraction vs template fit

- Smooth turn on > 60 ADC ZS threshold in EMCal (30 seems enough for HCal)

Data : Corrected energy
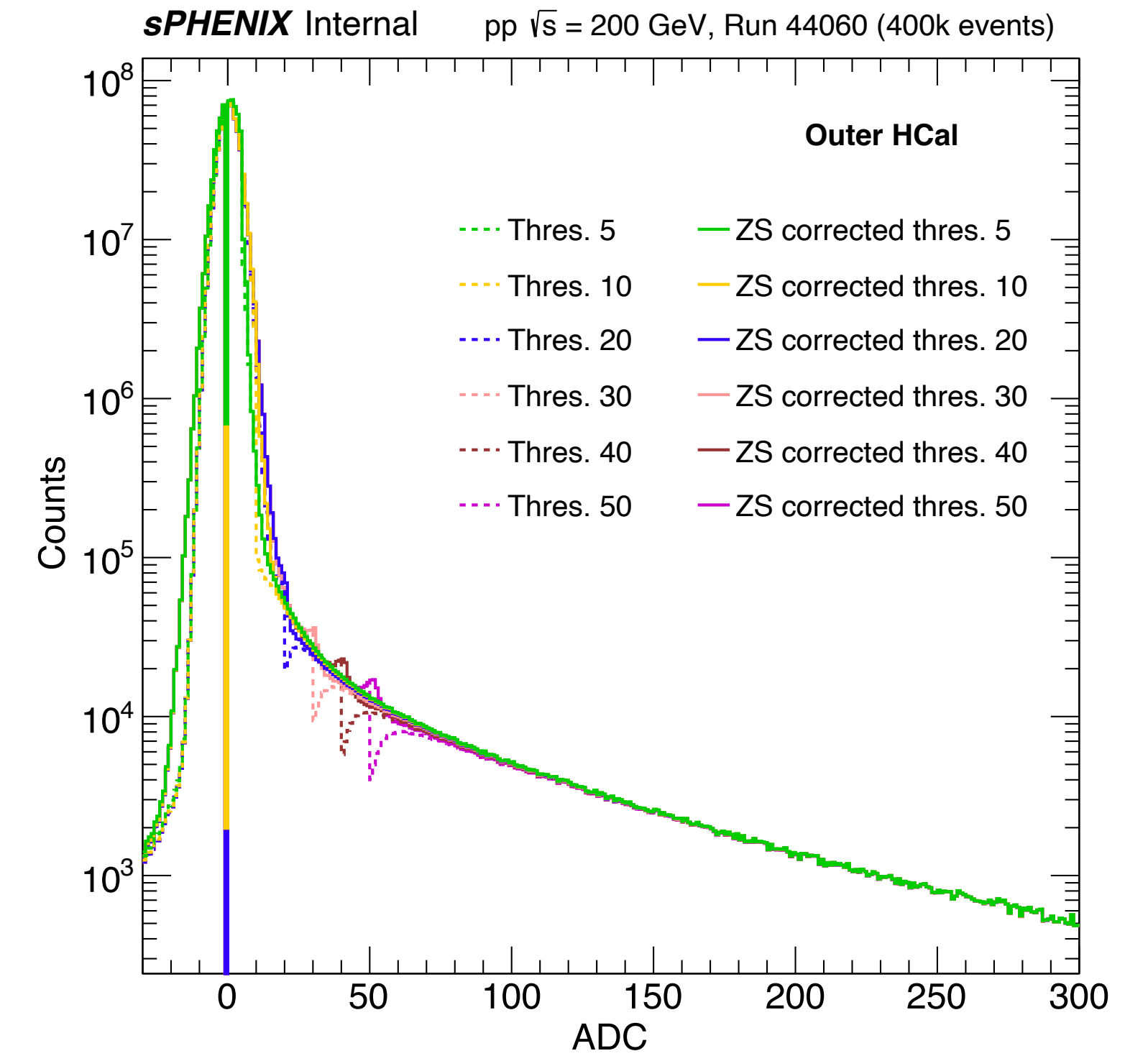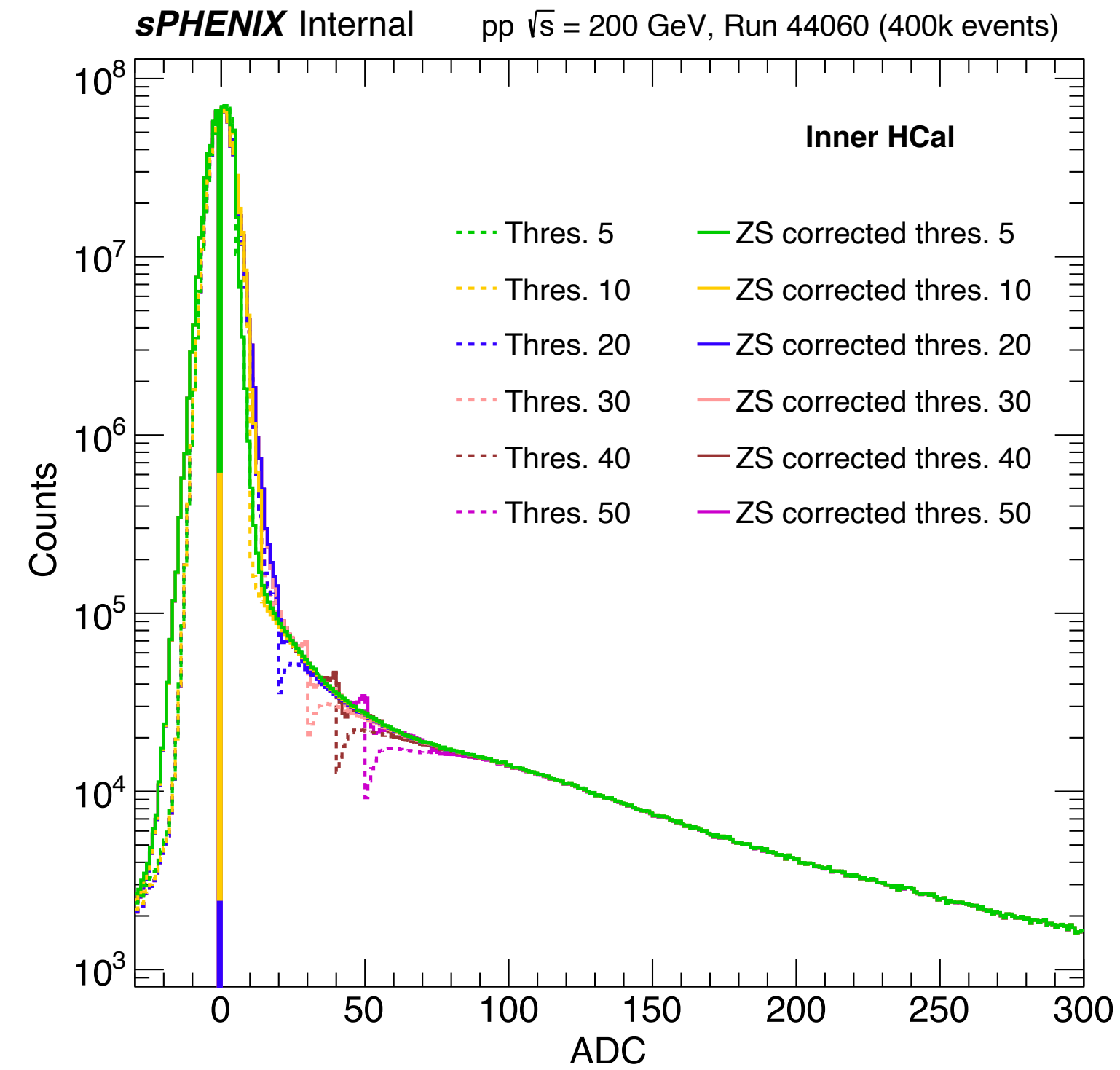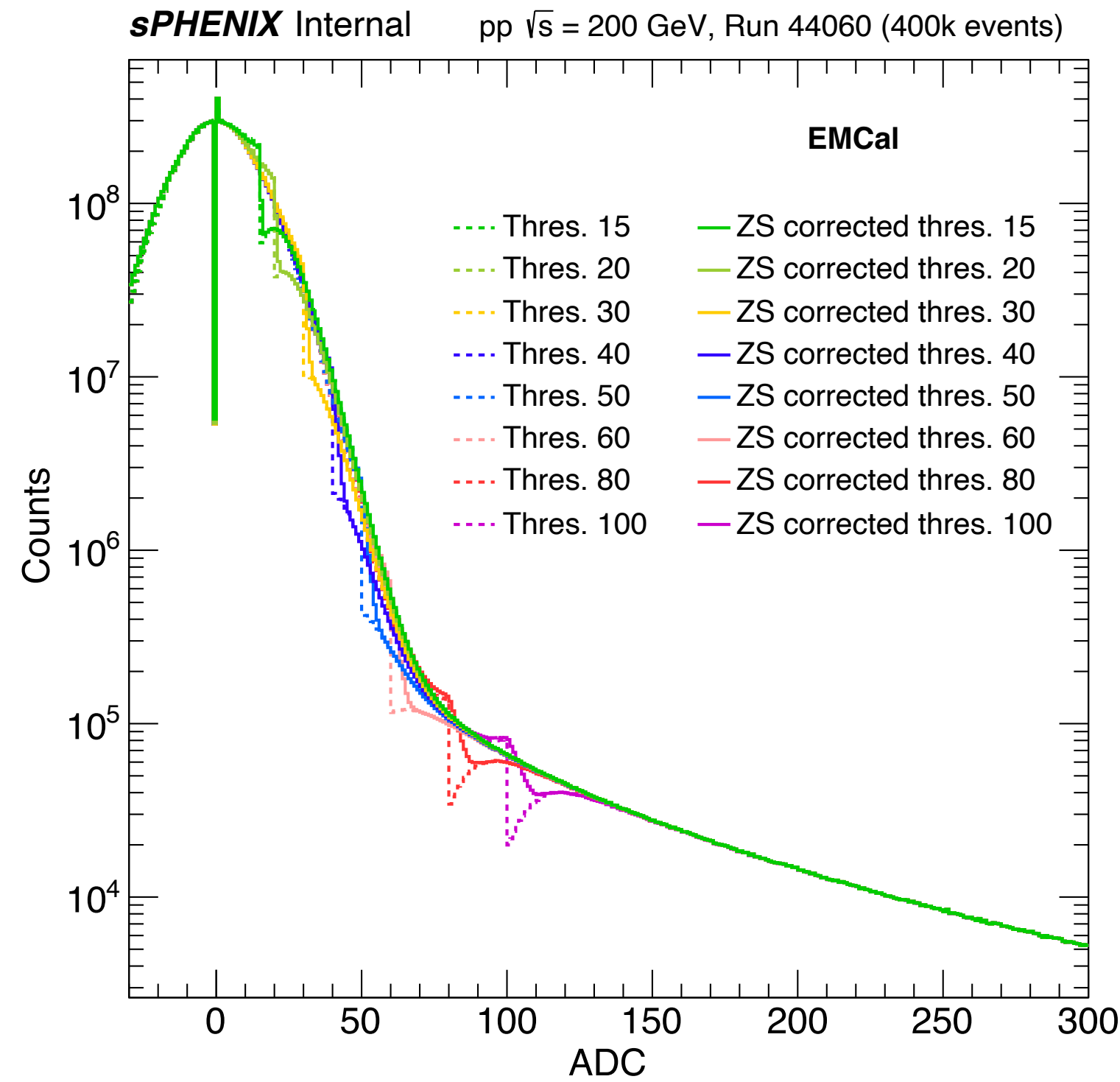
- ZS energy corrected based on higher energy template fit results
- Bump near threshold — could be still smearing effect / different cross calibration factors for lower energies

MC : Pedestal fluctuation

- Data-driven RMS varying vs eta up to ~20 ADC counts

- Consistent with no beam + bias on results

- MC CaloWaveform :

  Pedestal fluctuations emulated with embedding to
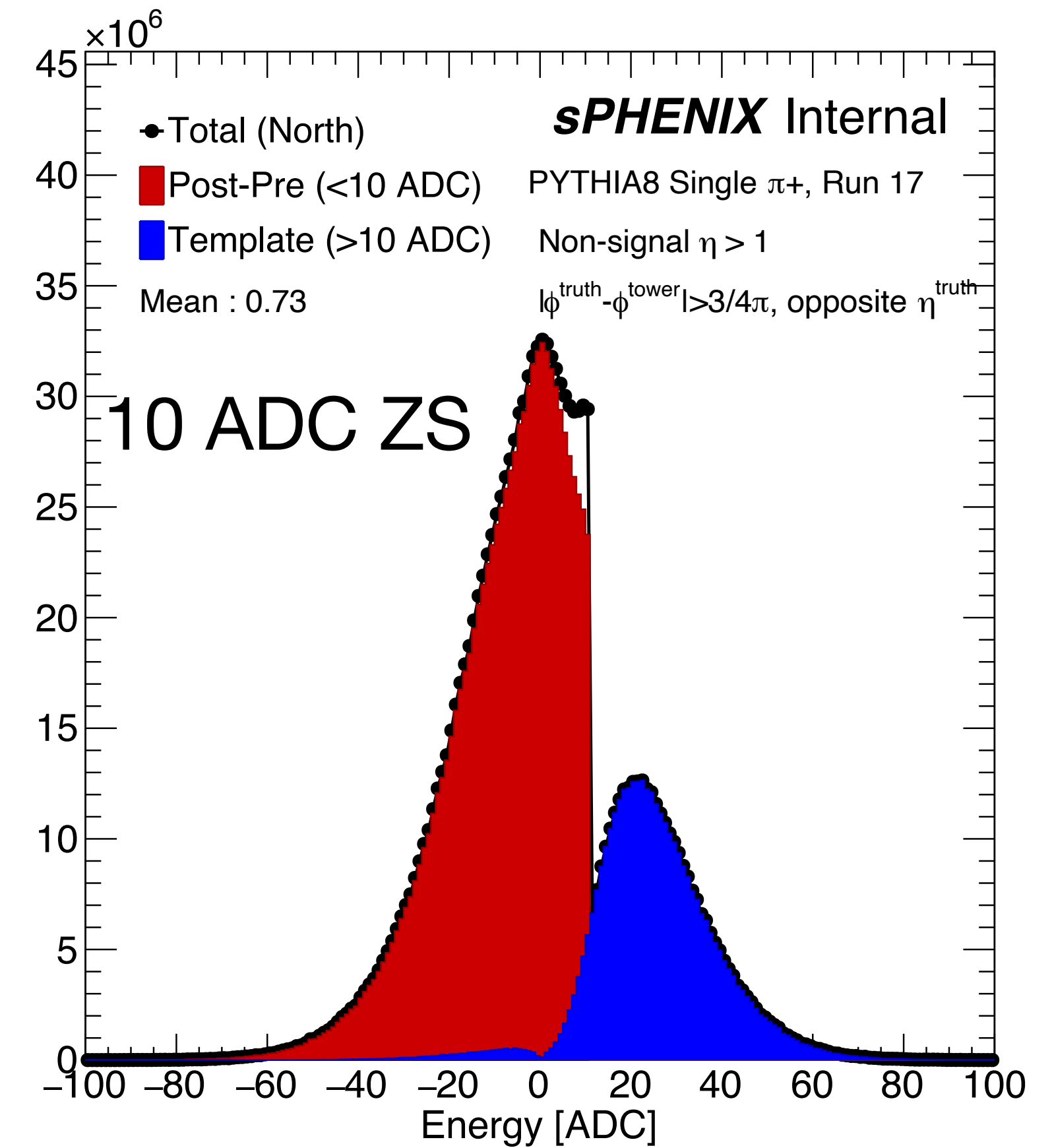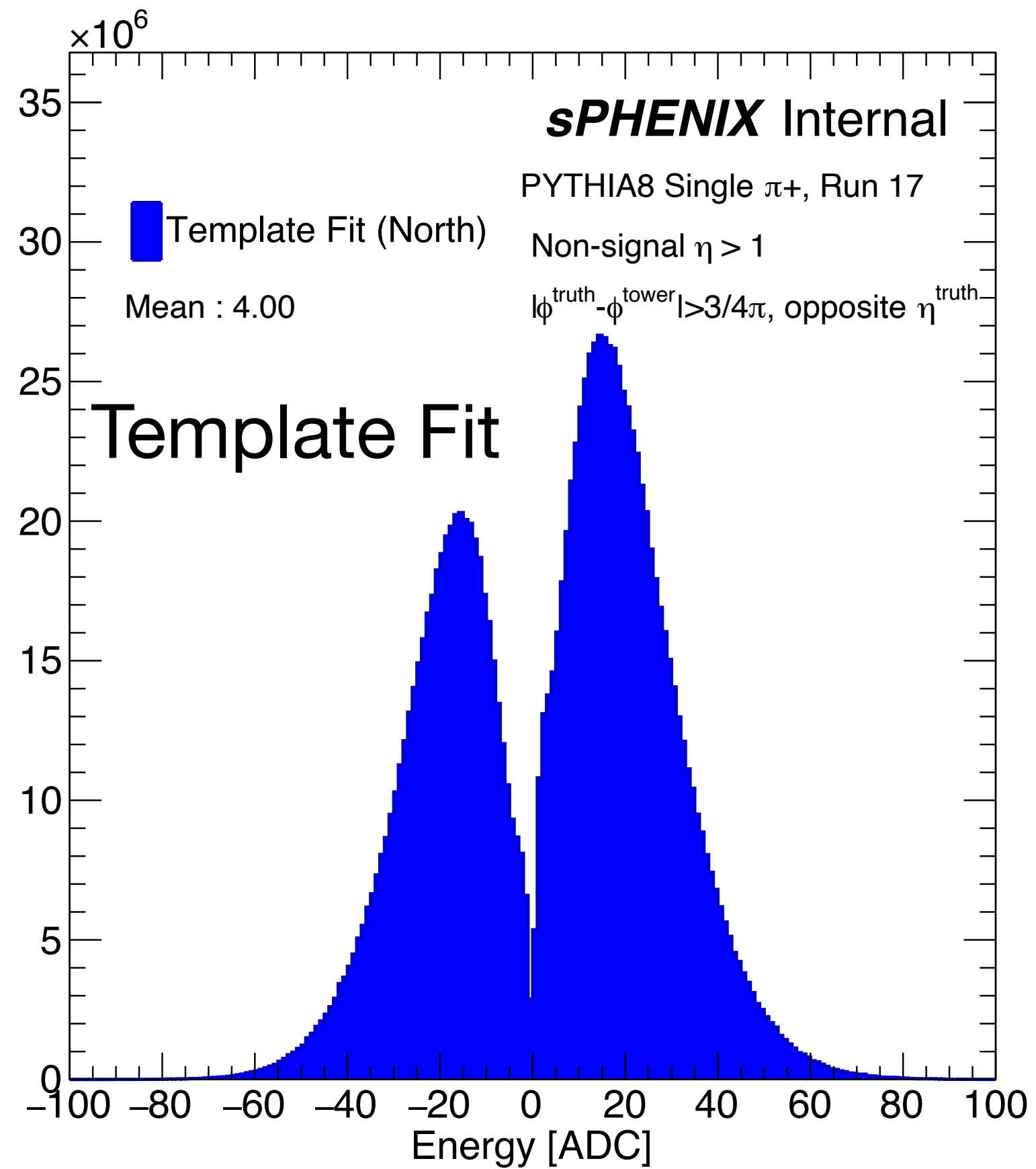
  no beam + bias voltage on data w/o ZS

sPHENIX Internal, Run 43853

sPHENIX Internal

PYTHIA8 Single $\pi+$, Run 17

Non-signal $\eta > 1$

$|\phi^{truth}-\phi^{tower}|>3/4\pi$, opposite η^{truth}
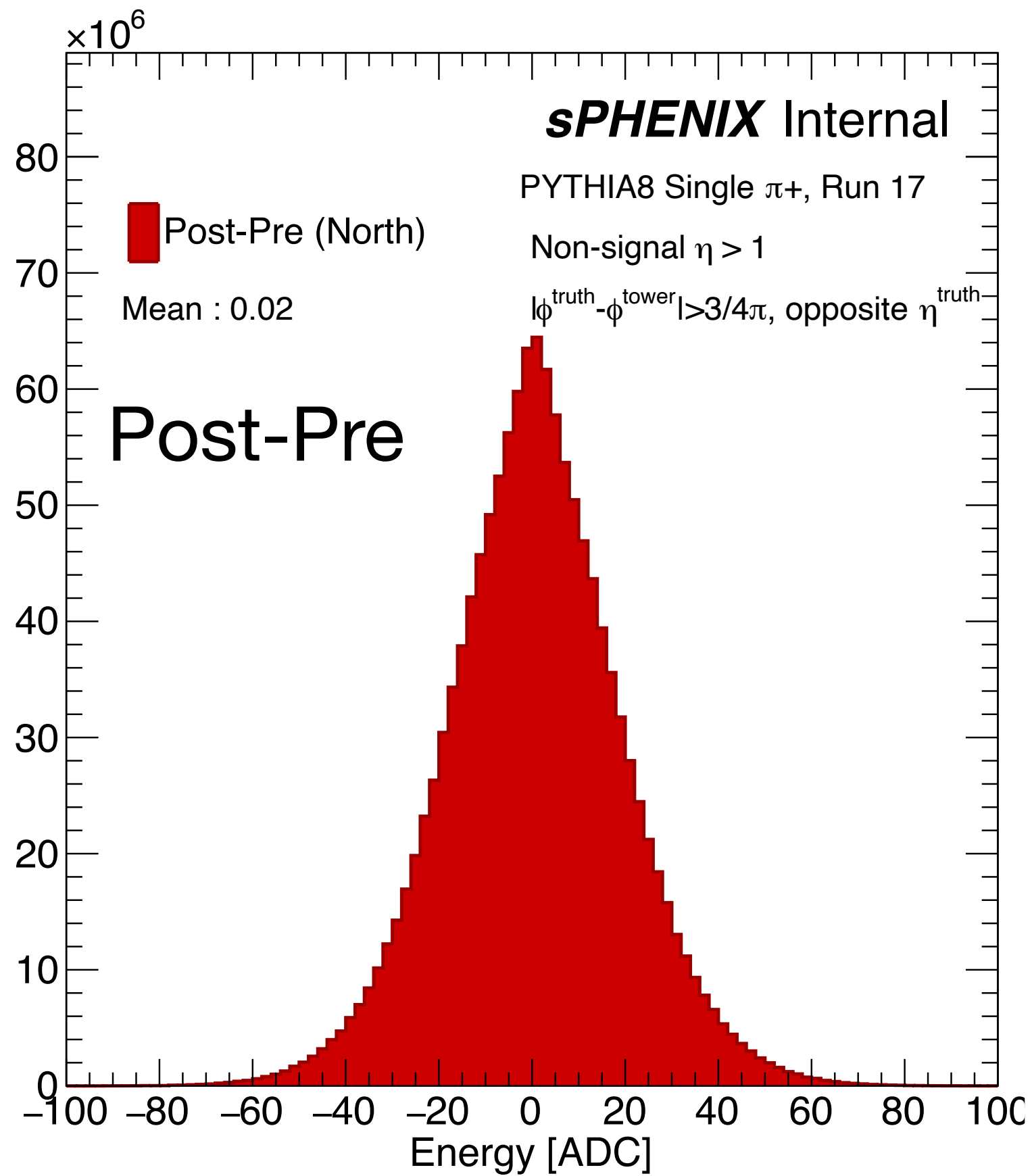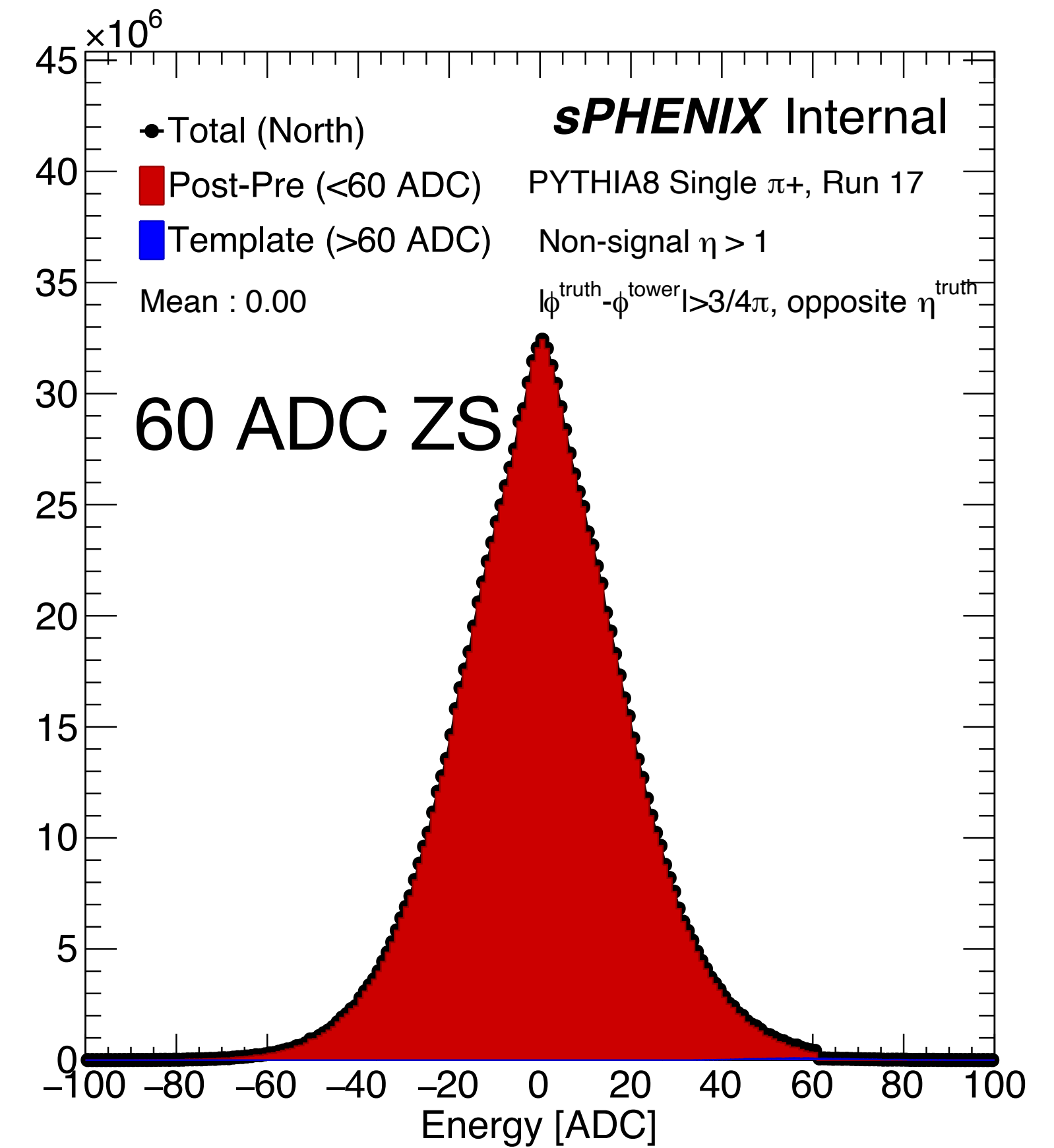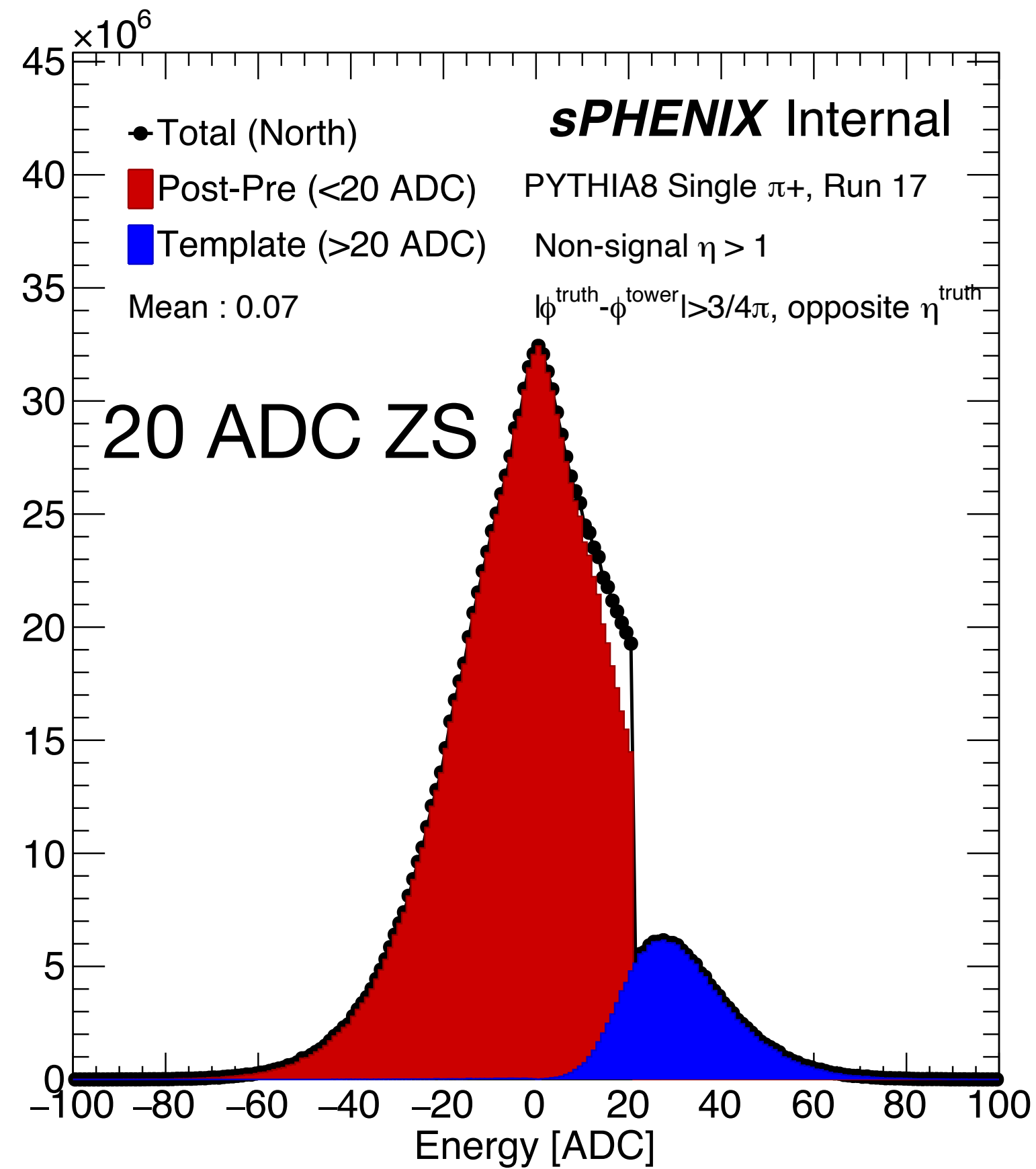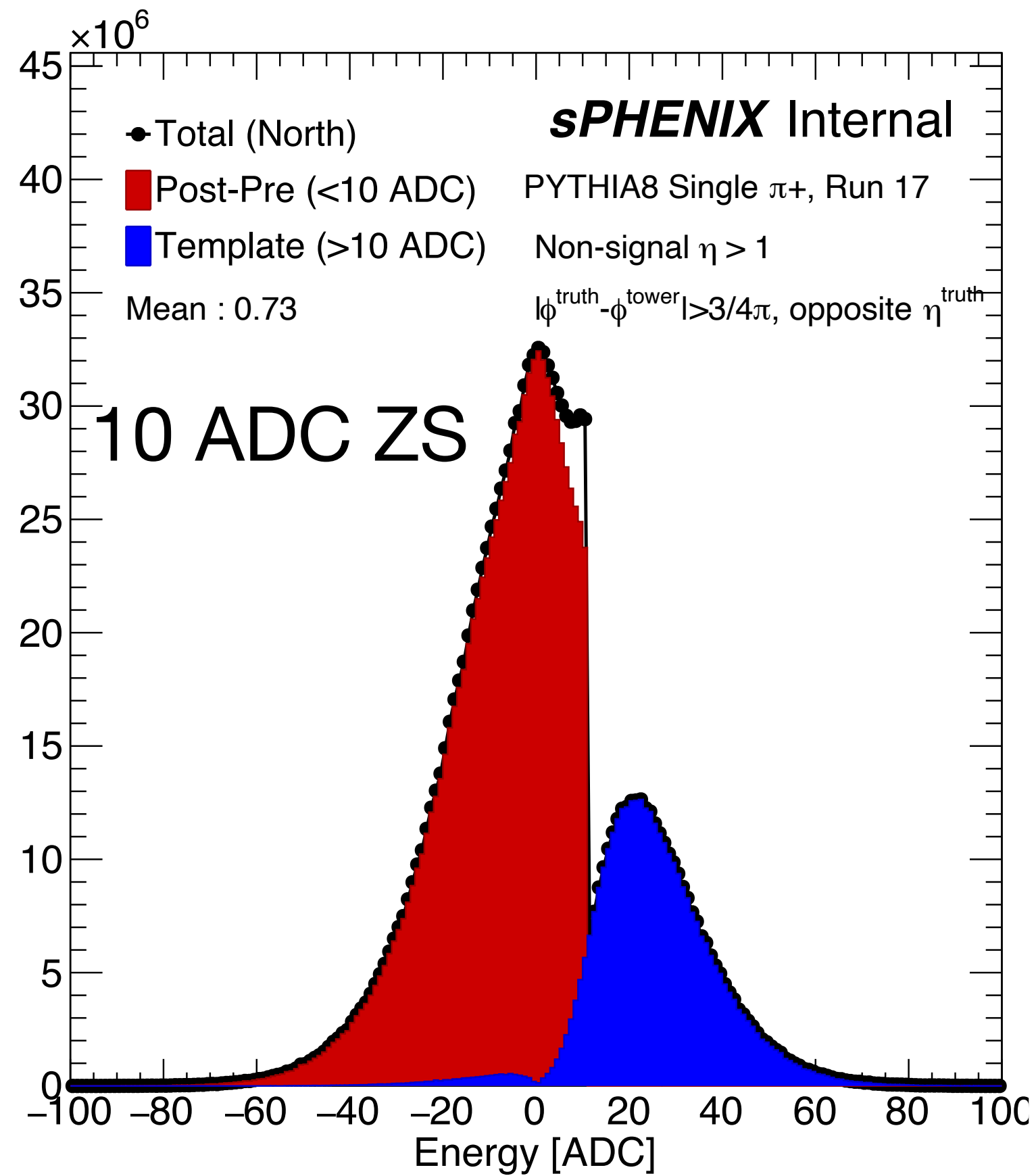
Post-Pre (North)

Mean : 0.02

Selected towers : ensure no signal contribution
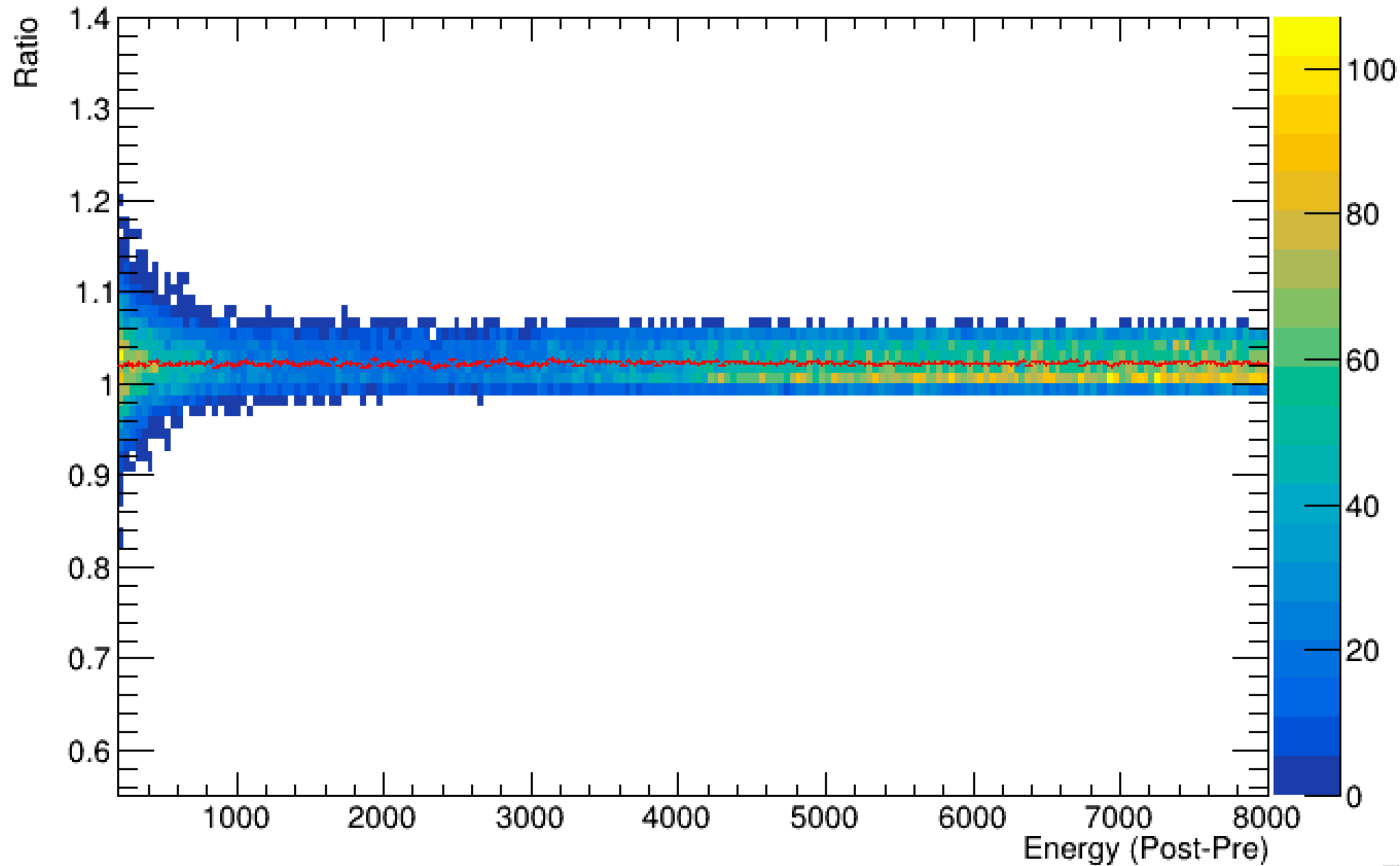
Example of ~20 ADC 1 sigma ped. fluctuation for emcal

- Positive bias for template fit (known)
- 10 ADC software ZS level — example of too low th.—> Smearing effect causes bump structure near threshold

- Getting similar mean for pure Post-Pre only in ~60 ADC ZS threshold
- Need to put a high enough software ZS level to ensure no bias on the pedestal from the template fit

- Template/Post-Pre response vs energy

- ~5% difference in the EMCal north side

  —> Similar to data above 60 ADC

- Uniform across input energy

■ Tower isGood : !(noCalib + isHot + badChi2)

○ Jet tower input : removing towers for isHot or badChi2 or noCalib or isNotInstr

○ EMCal cluster : removing towers for !isGood or badTime

○ Topo cluster : removing towers for !isGood

○ Cluster Isolation : removing towers for isHot or badChi2 or isNotInstr or badTime

Perhaps a good time to converge for a single usage of a *good* tower status?

- Need to put high enough software ZS to not biased from the template fit

  - Tests ongoing for embedding same ch-by-ch ZS level based on hardware thresholds

  - The 'high enough' threshold should eliminate out of time contributions

    — or need to introduce timing cut

- Cross calibration corrections (template vs post-pre) for low-energies below software ZDC

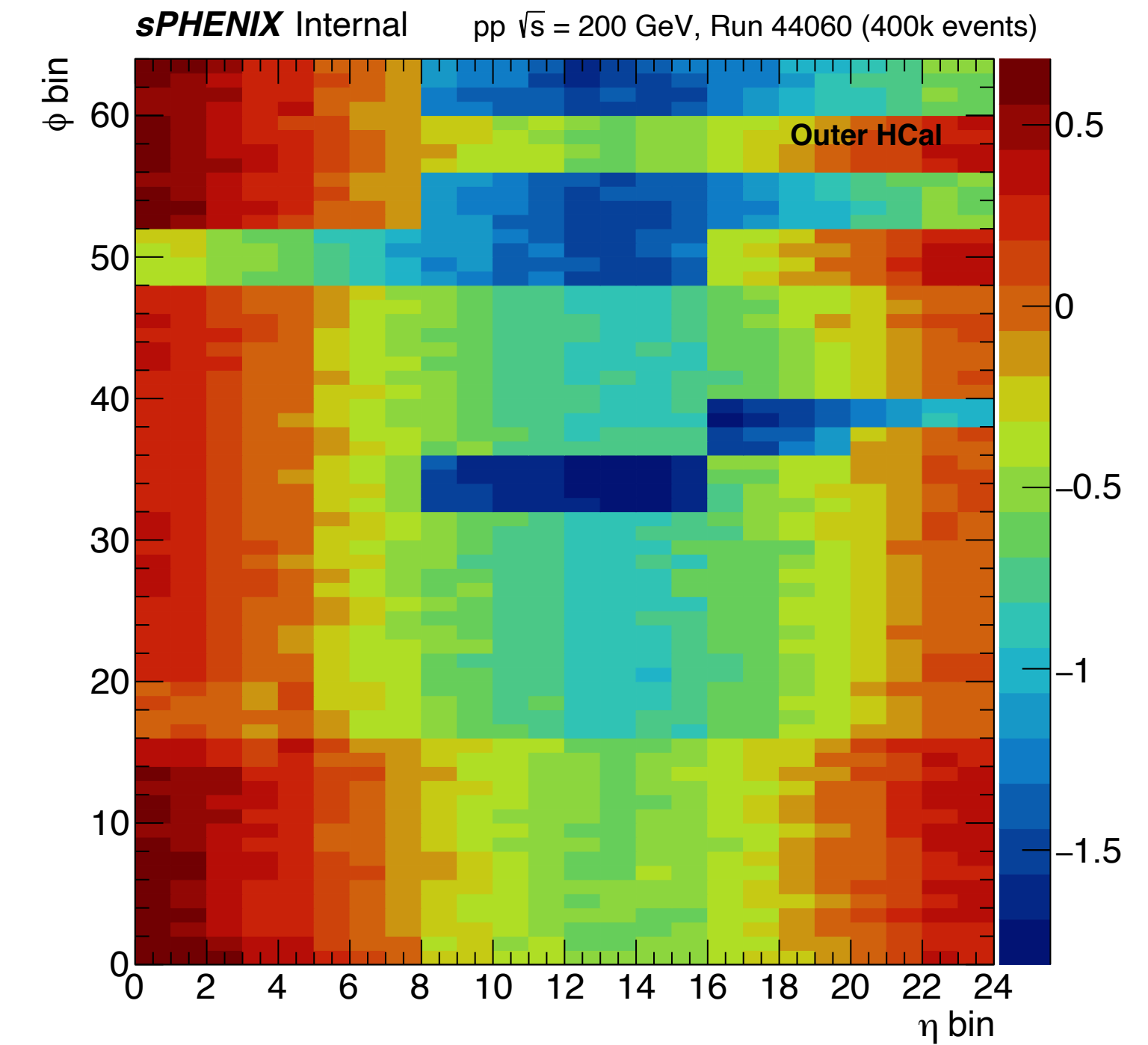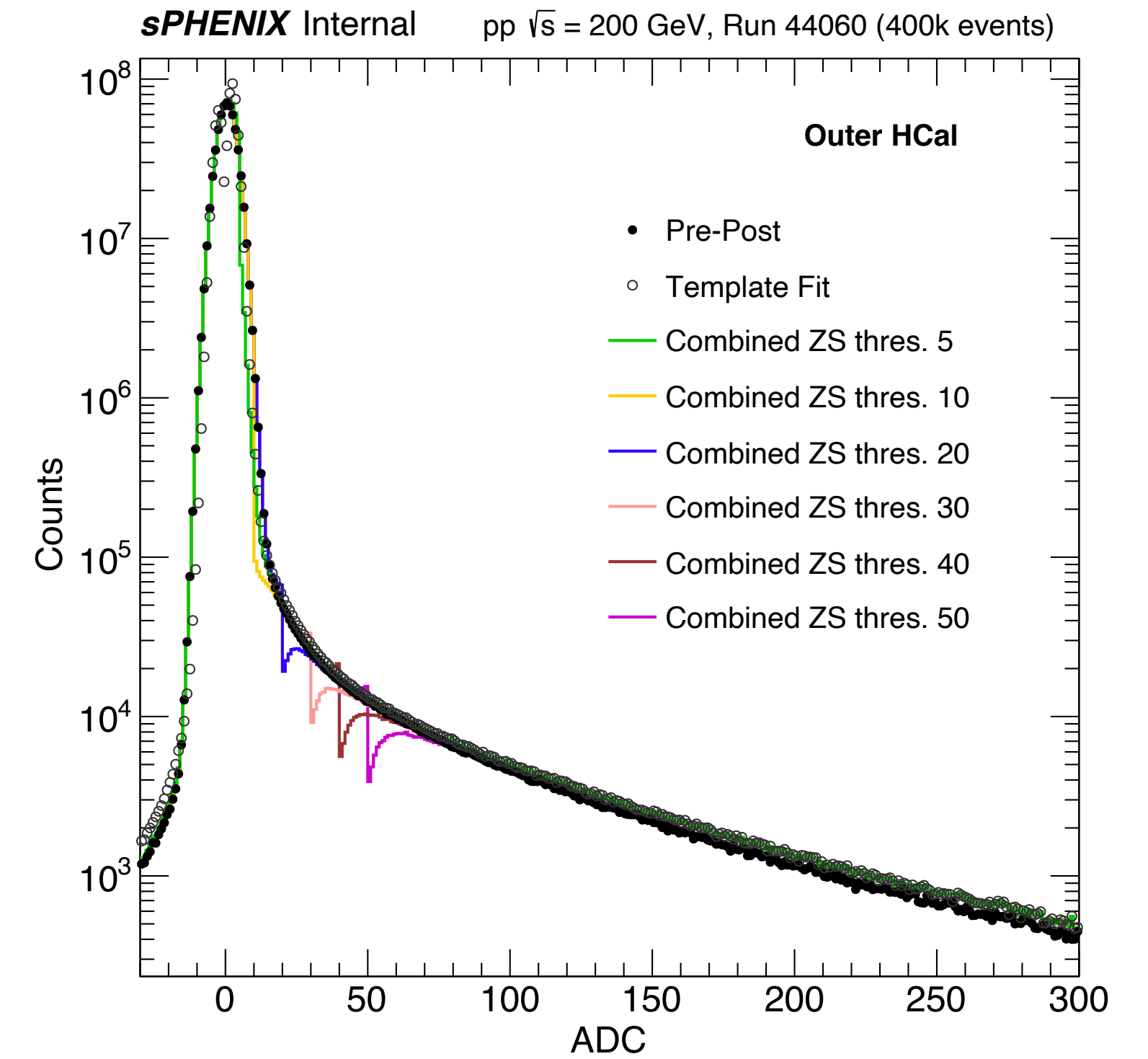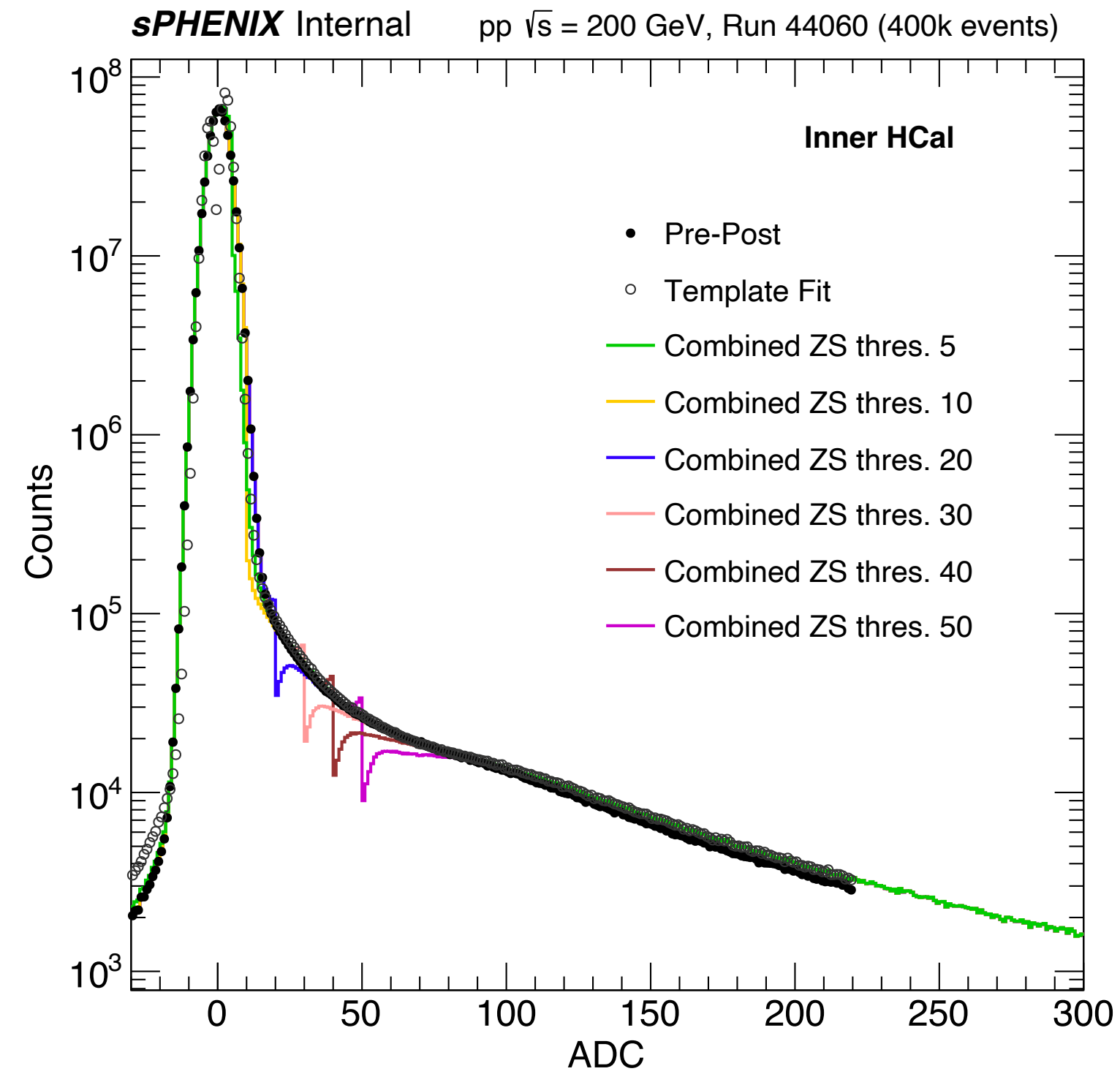- Finalize "isGood" function and apply it everywhere consistently
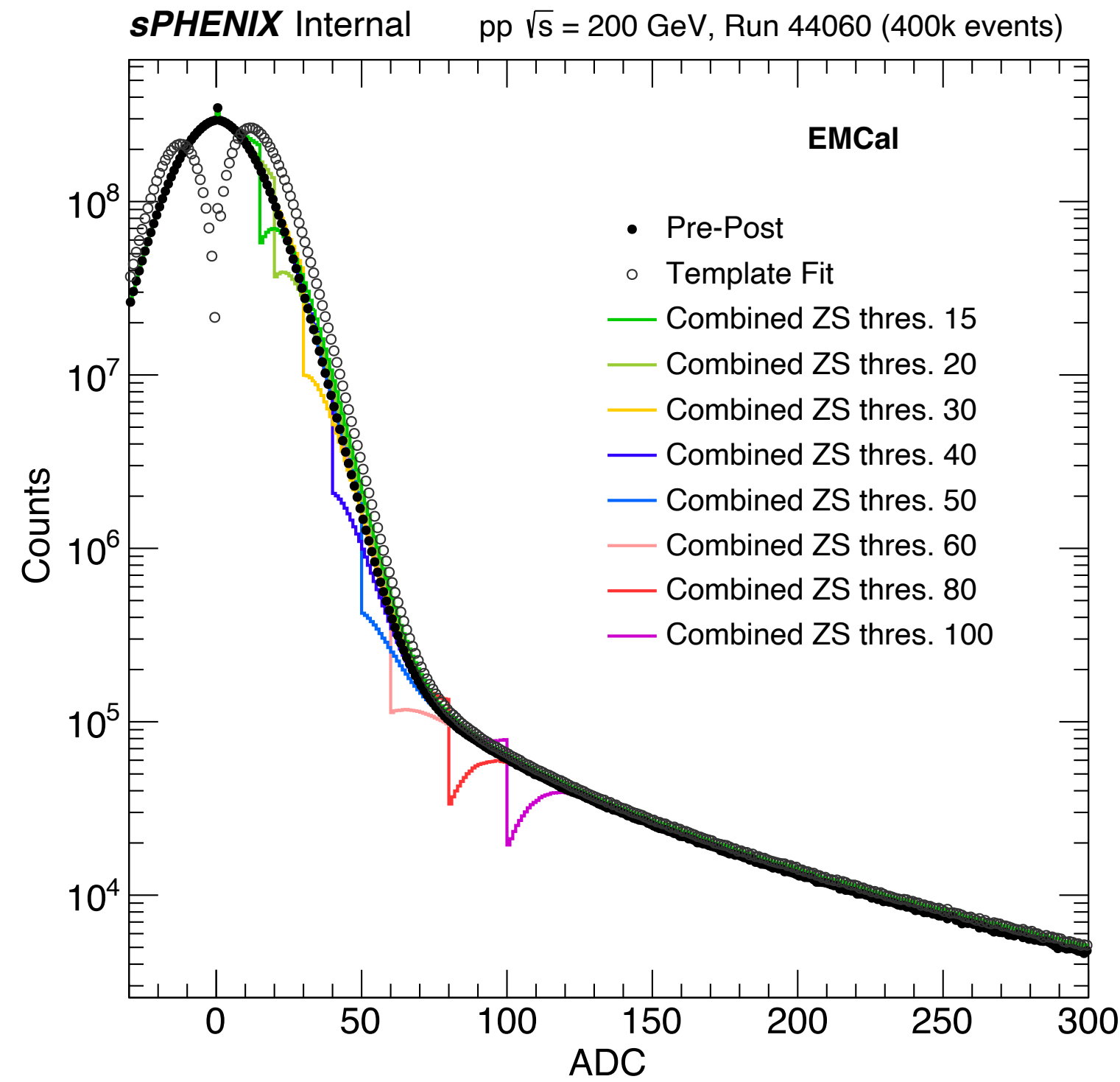
Back-up
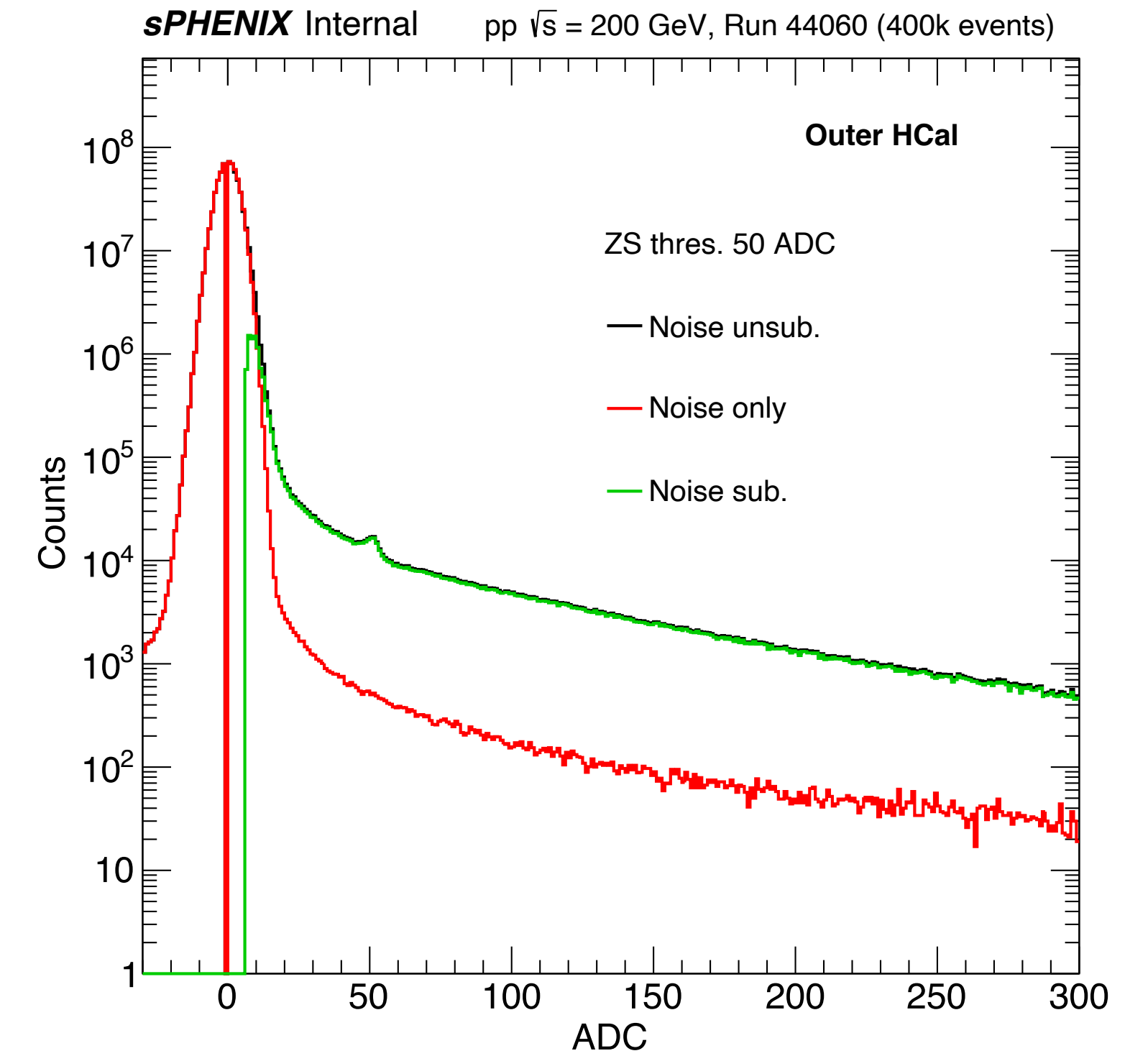
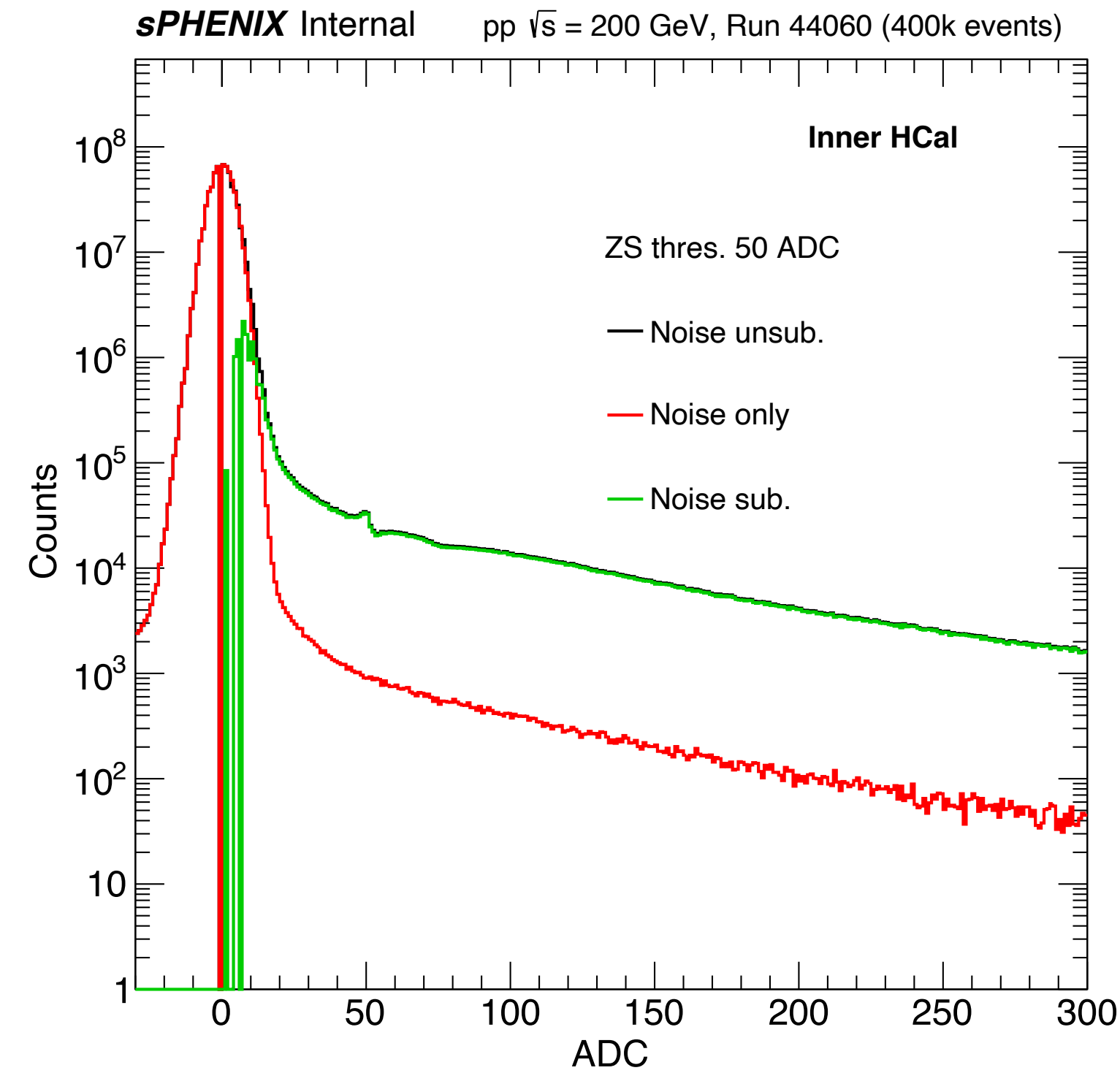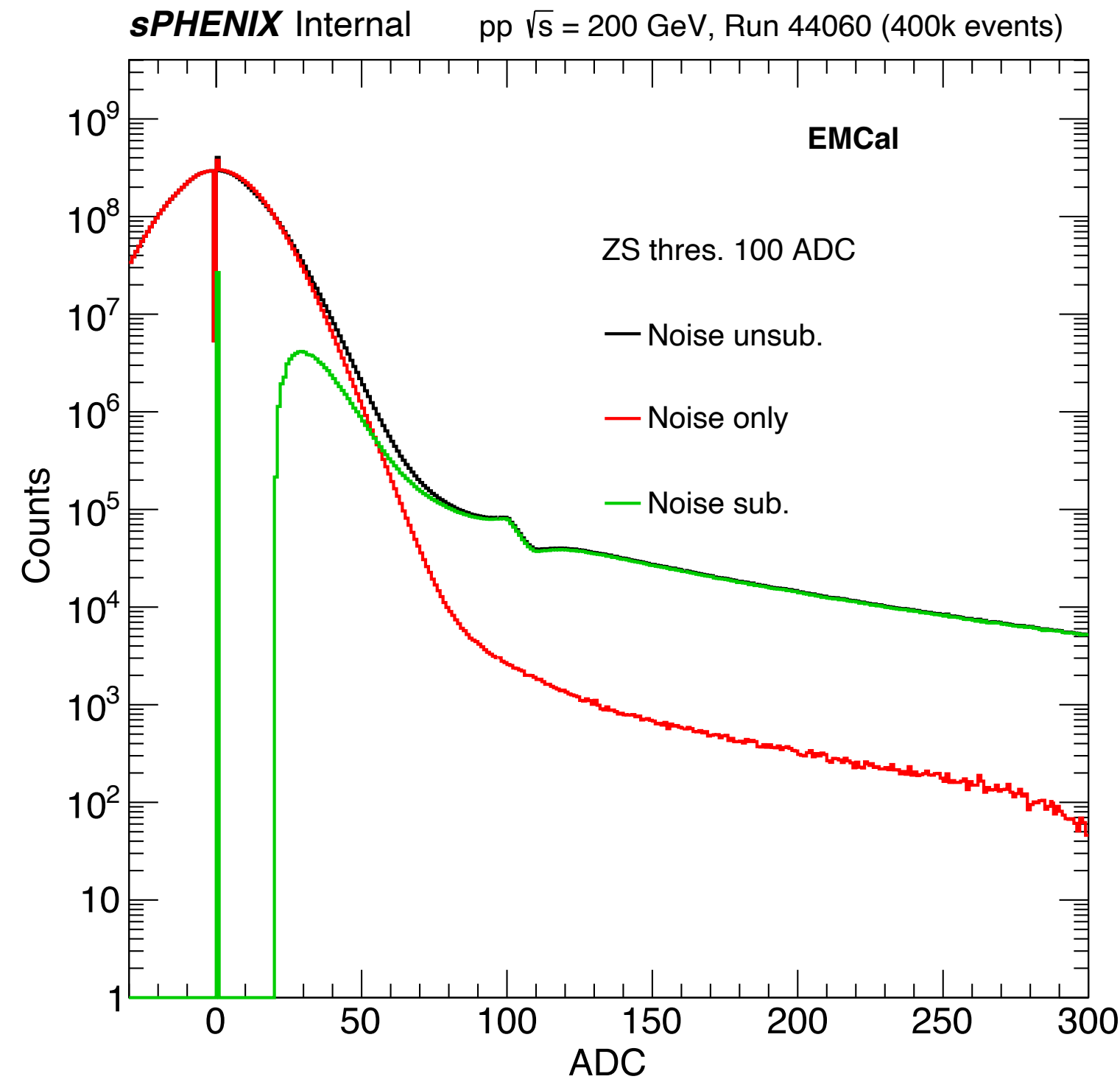# Timing of template

EMCal
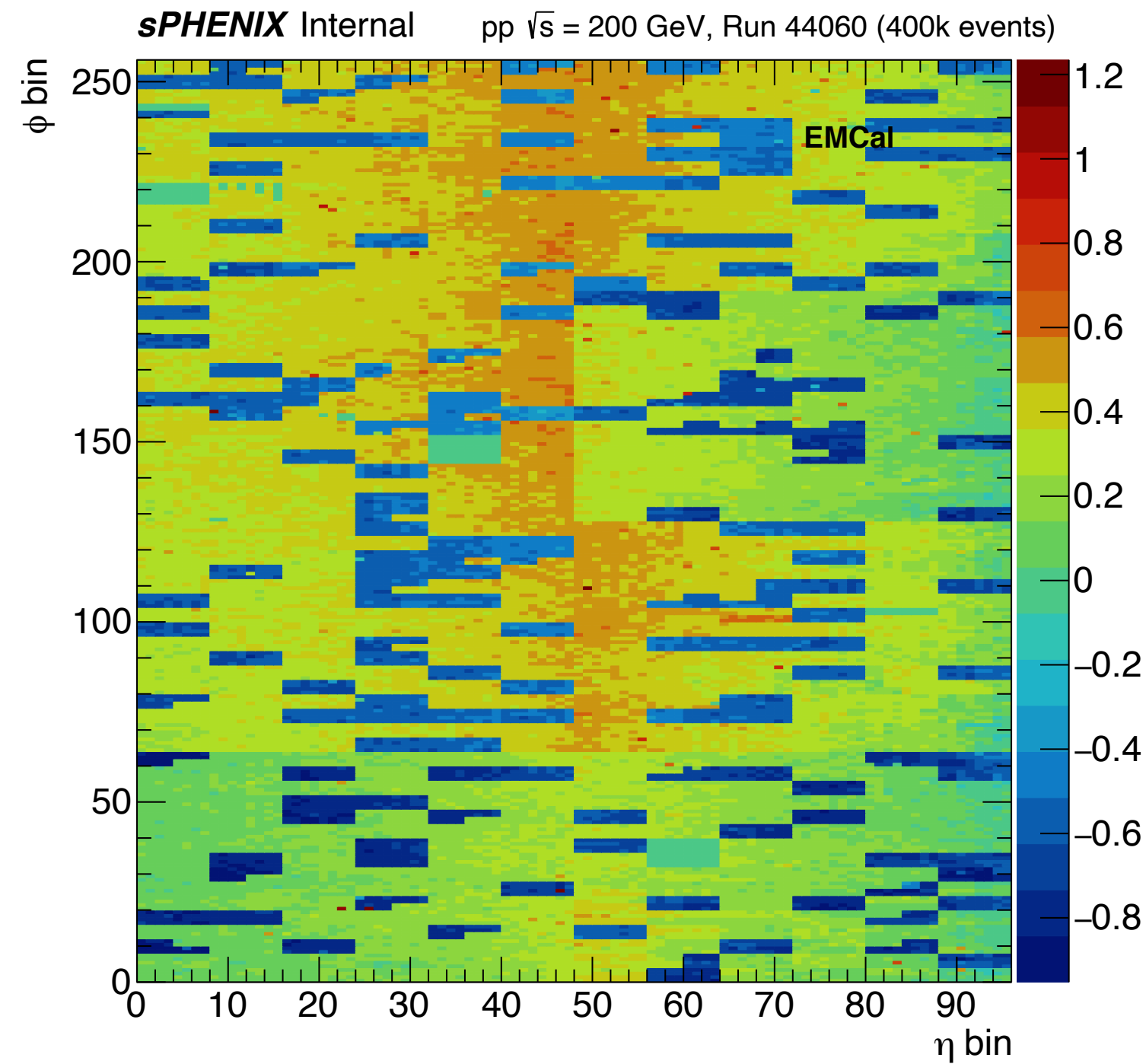
Inner HCal
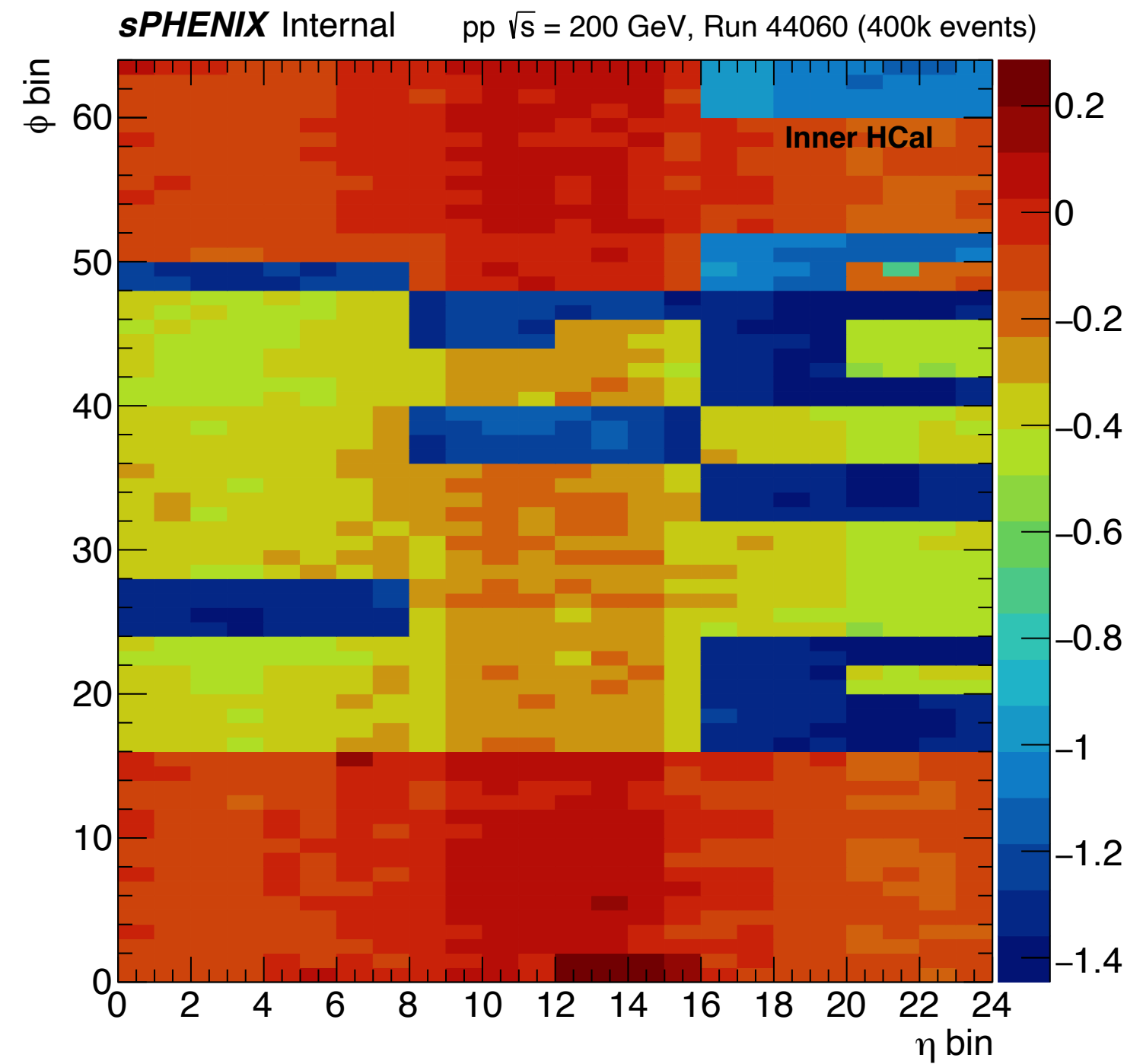
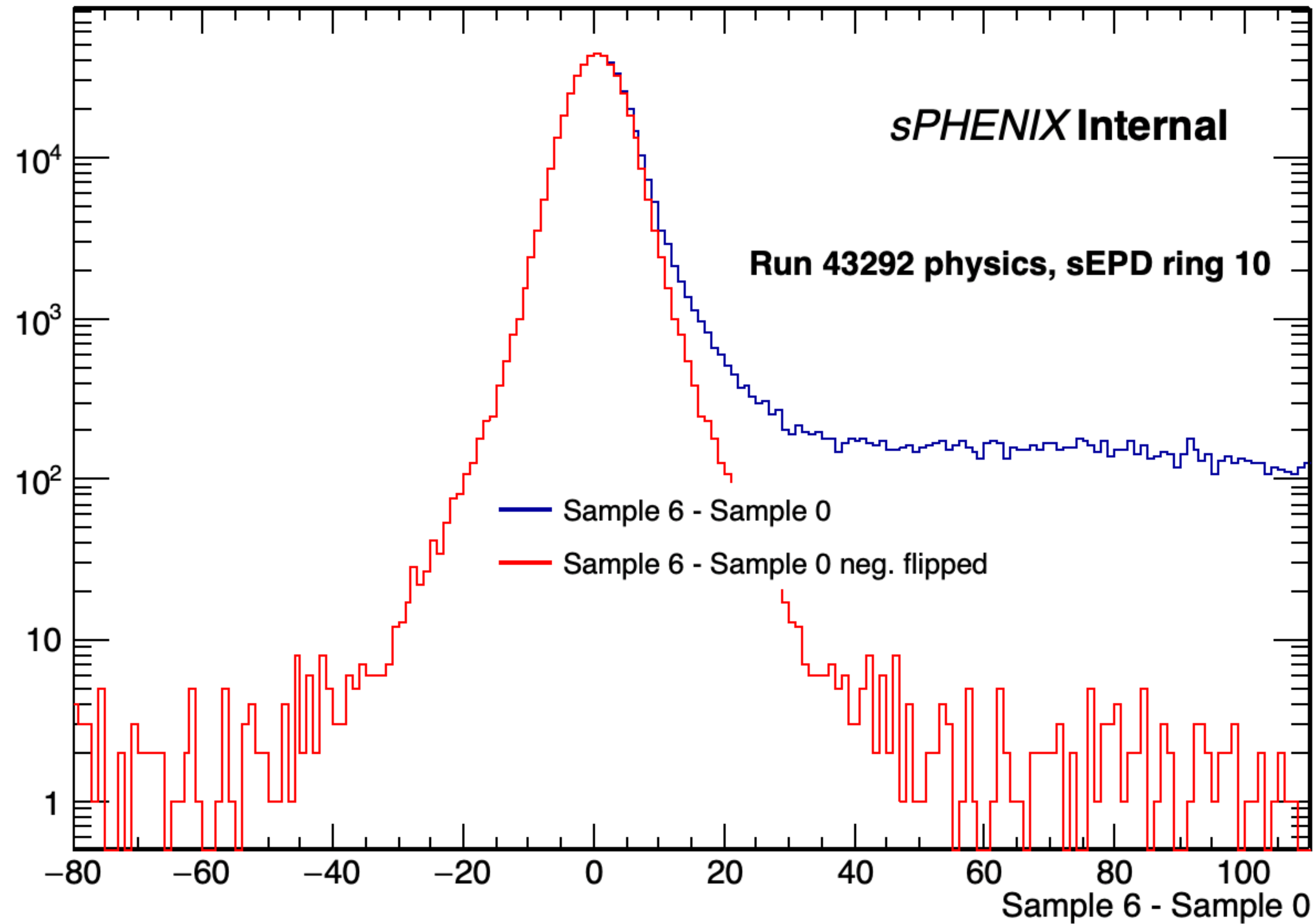## Outer HCal

- Template Fit peak position for ADC > 60

- Combined ADC distribution
  - If Post-Pre > Threshold –> Template fit
  - else if Post-Pre <= Threshold –> Post-Pre

- Need to study with higher energy data or simulation for calibration of Post-Pre

- Noise derived from the negative side of the Post-Pre ADC distribution
- Bump structure near the threshold to switch to template fit

sPHENIX Internal

Run 43292 physics, sEPD ring 10

Sample 6 - Sample 0
Sample 6 - Sample 0 neg. flipped

Sample 6 - Sample 0

- Idea to take negative side of "pre" and "post" to derive the noise level

- Ch-by-ch noise calculation and take RMS as ZS threshold

- Even with ZS, "pre" and "post" information are stored in the data stream

EMCal

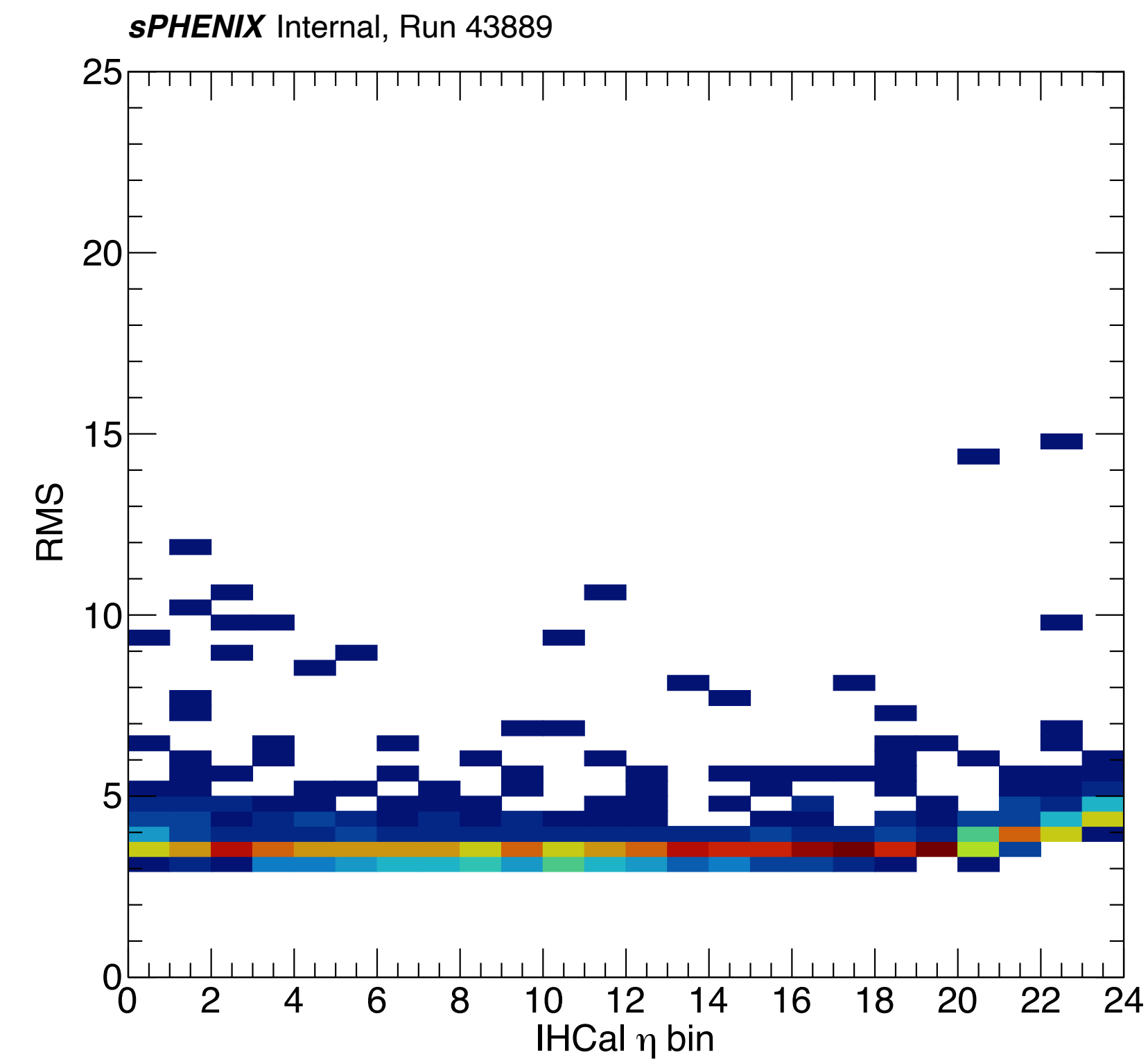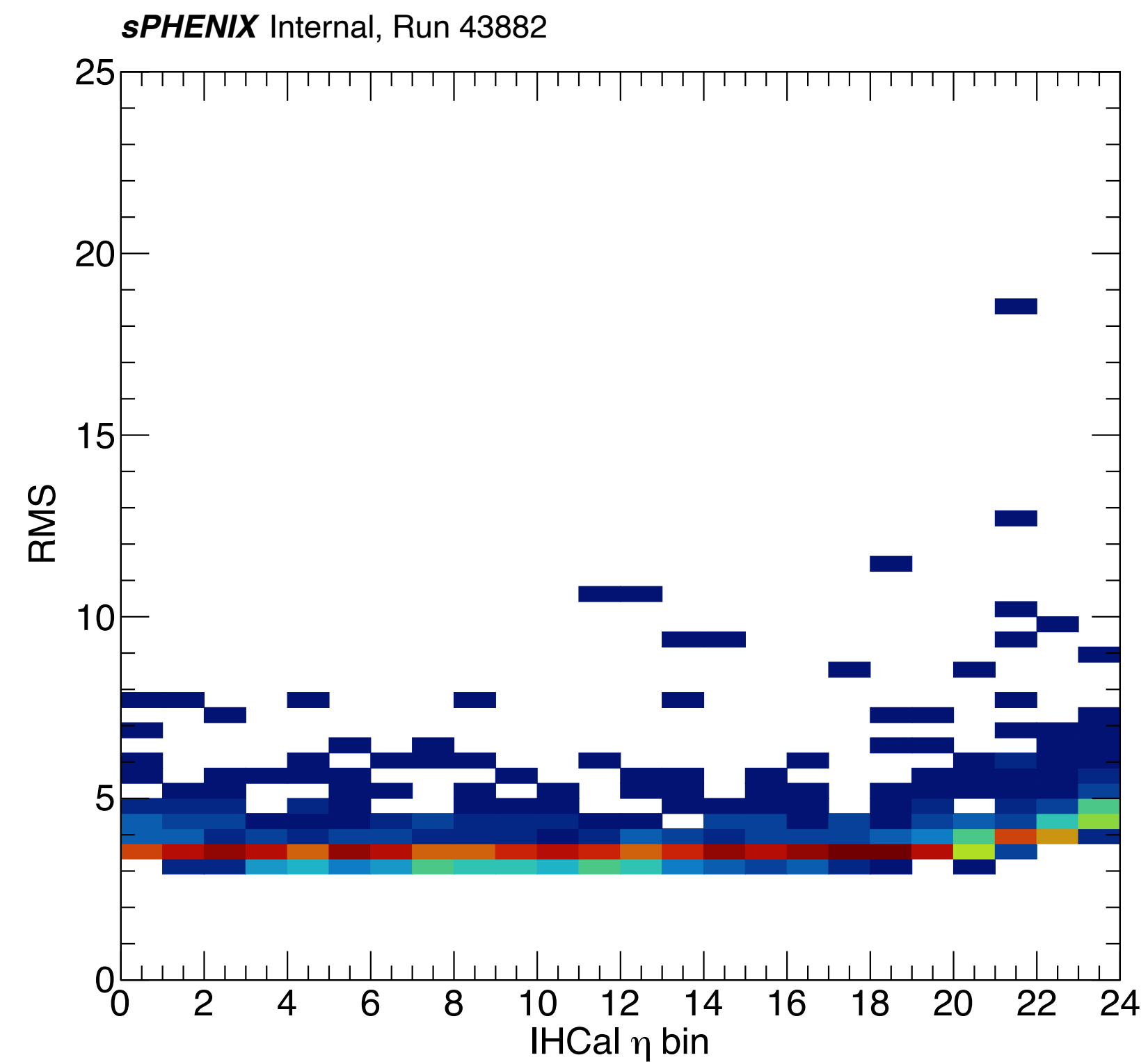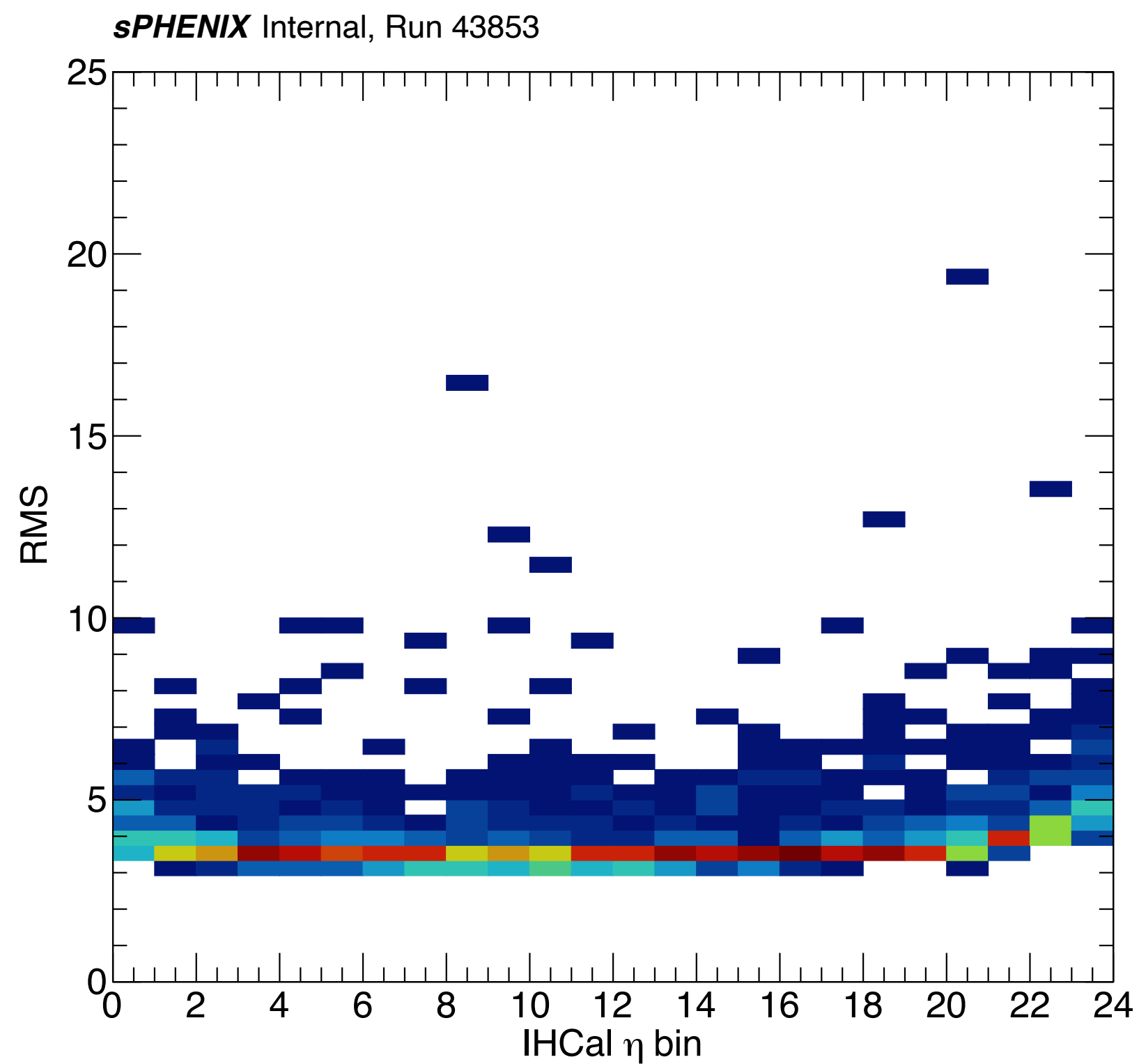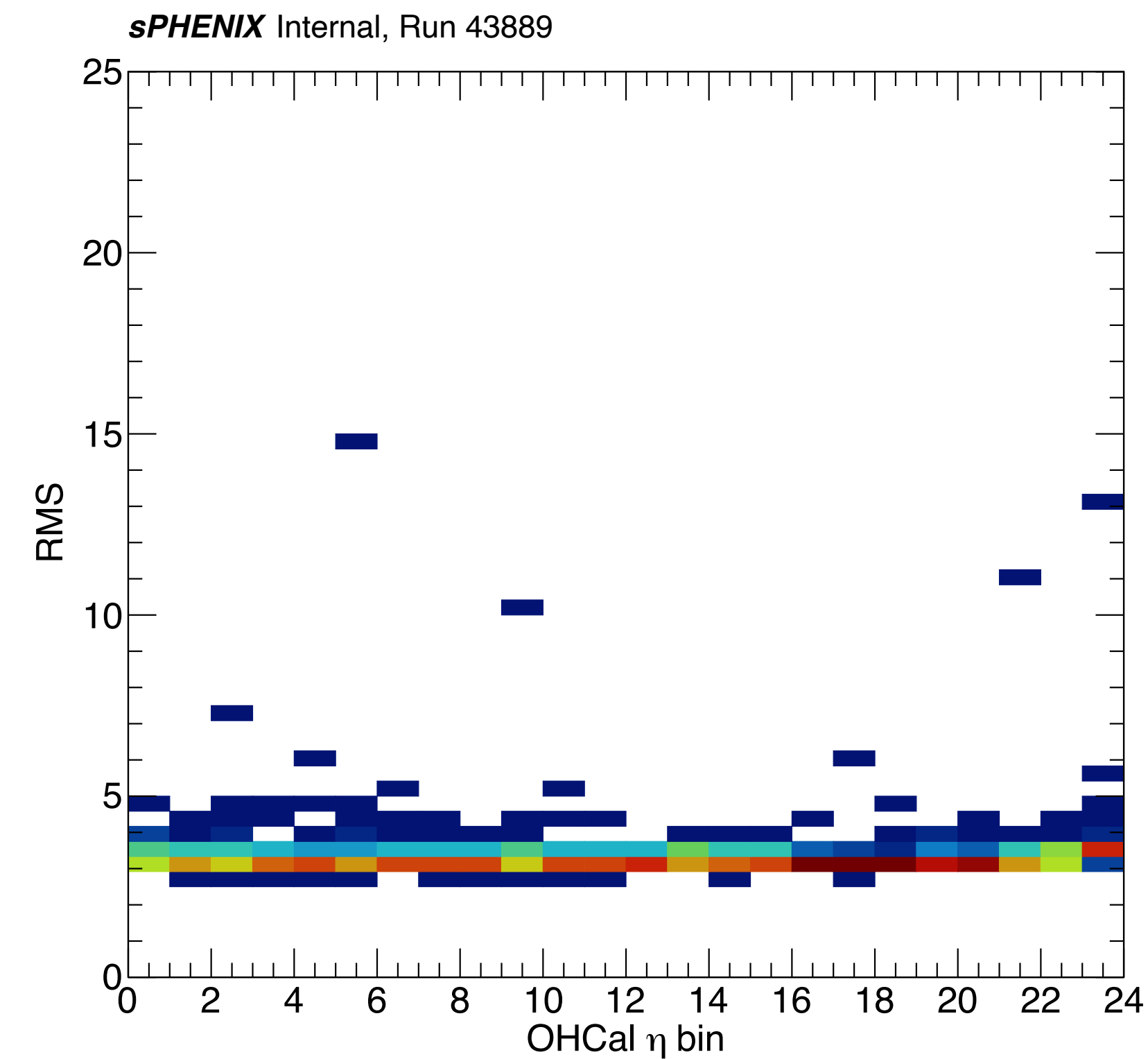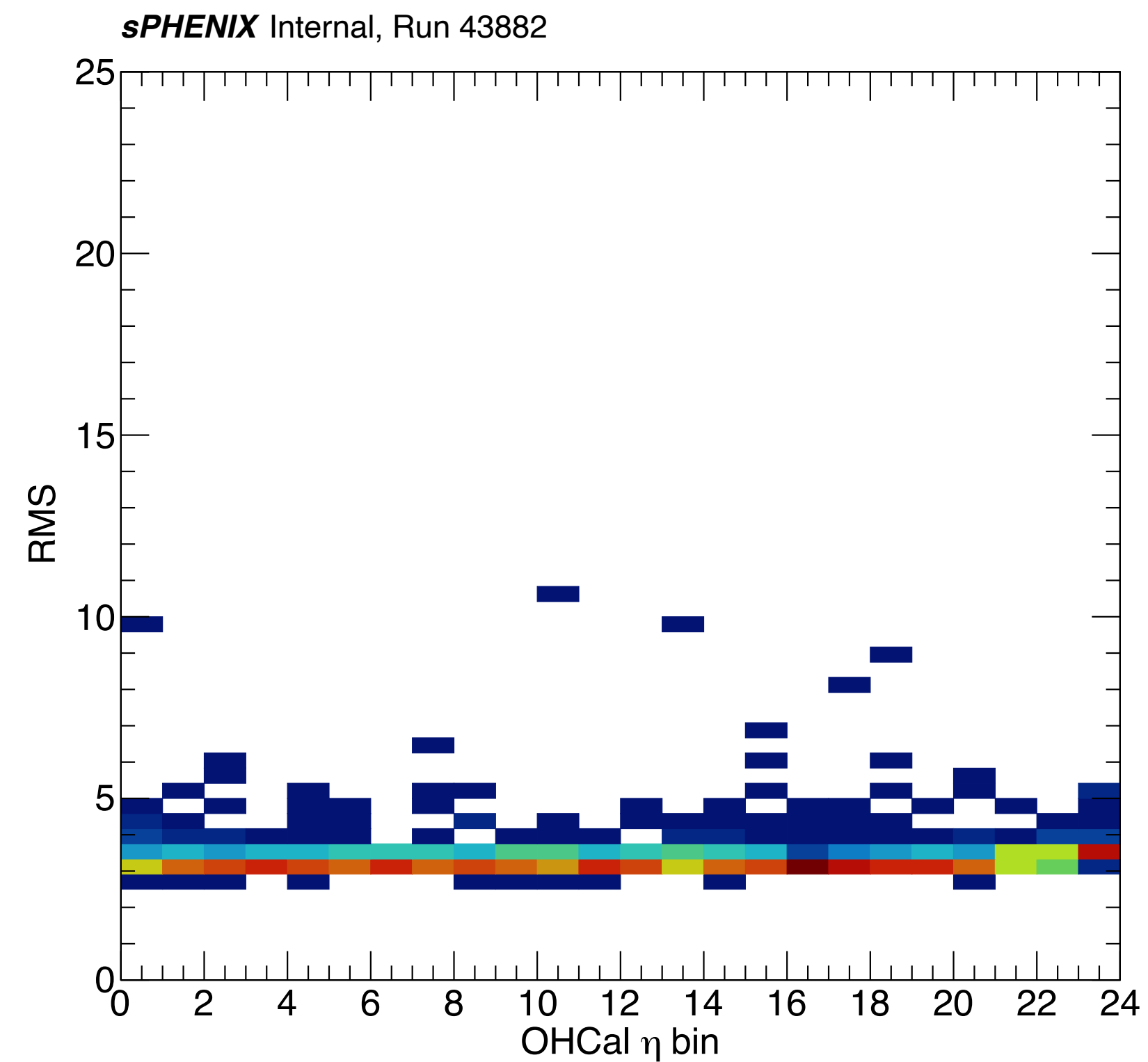Run 43853 (beginning of store)   Run 43882 (after ~5-6 hours of store)   Run 43889 (end of store)

IHCal

Run 43853 (beginning of store)

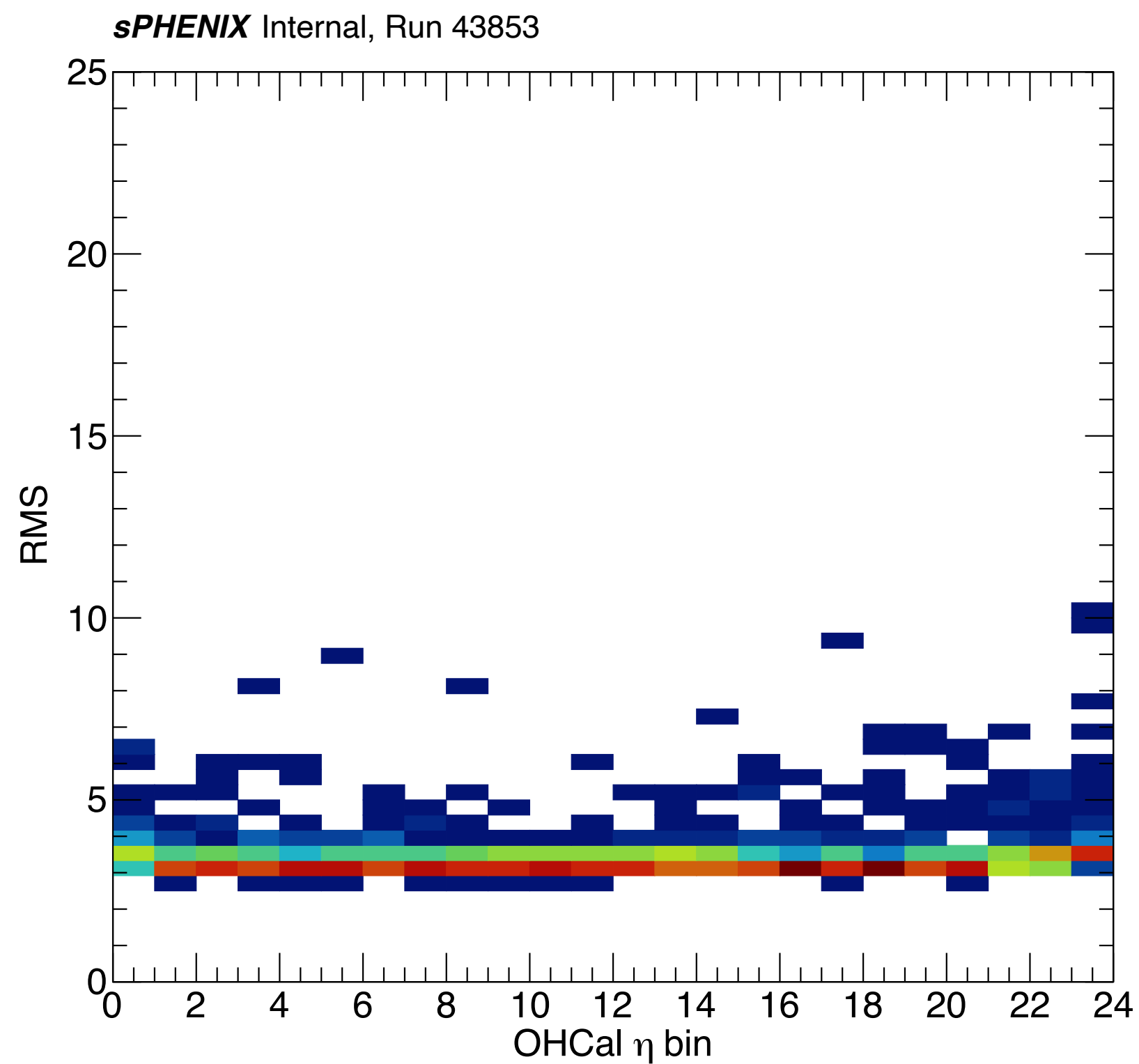Run 43882 (after ~5-6 hours of store)

Run 43889 (end of store)

OHCal
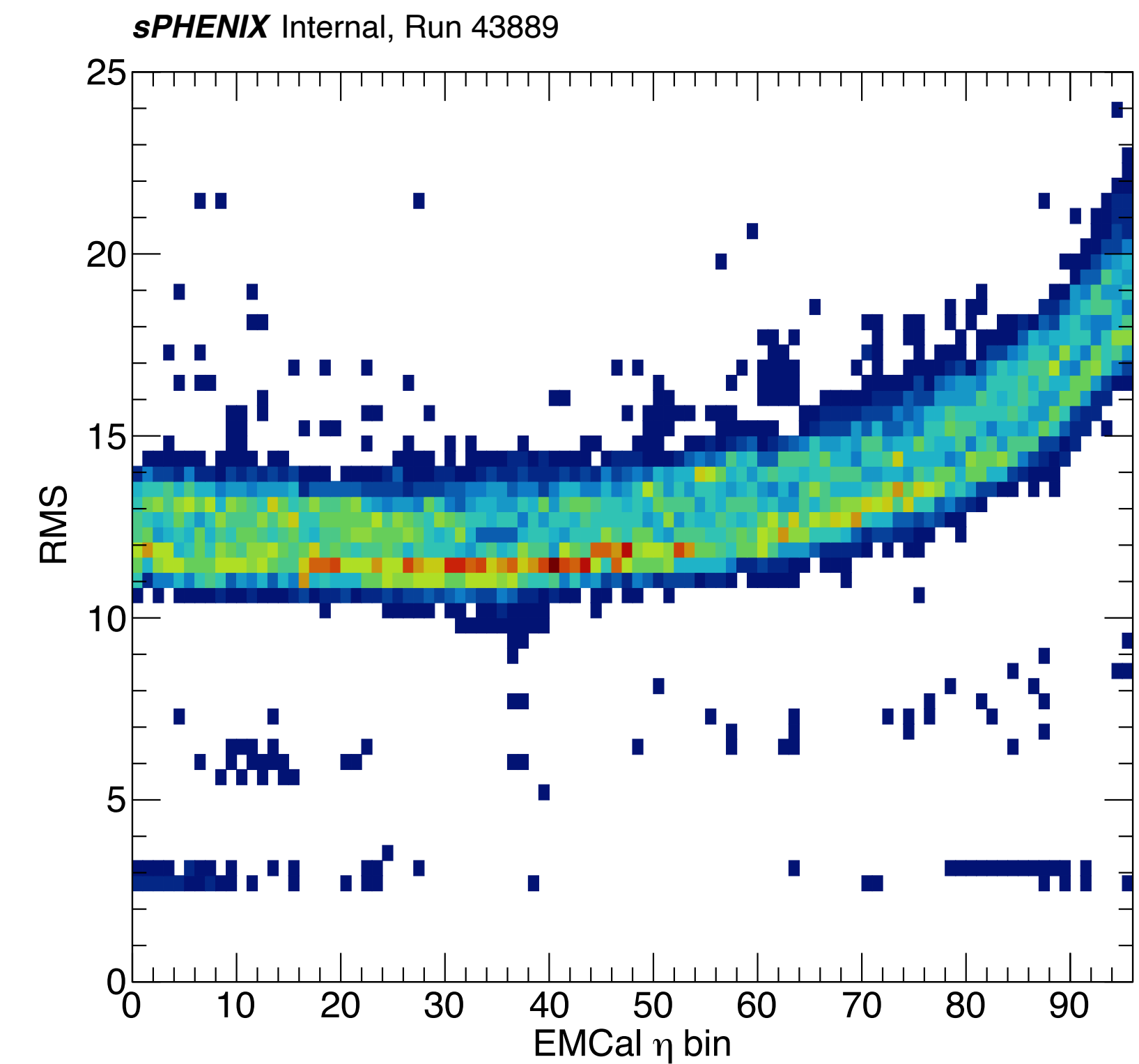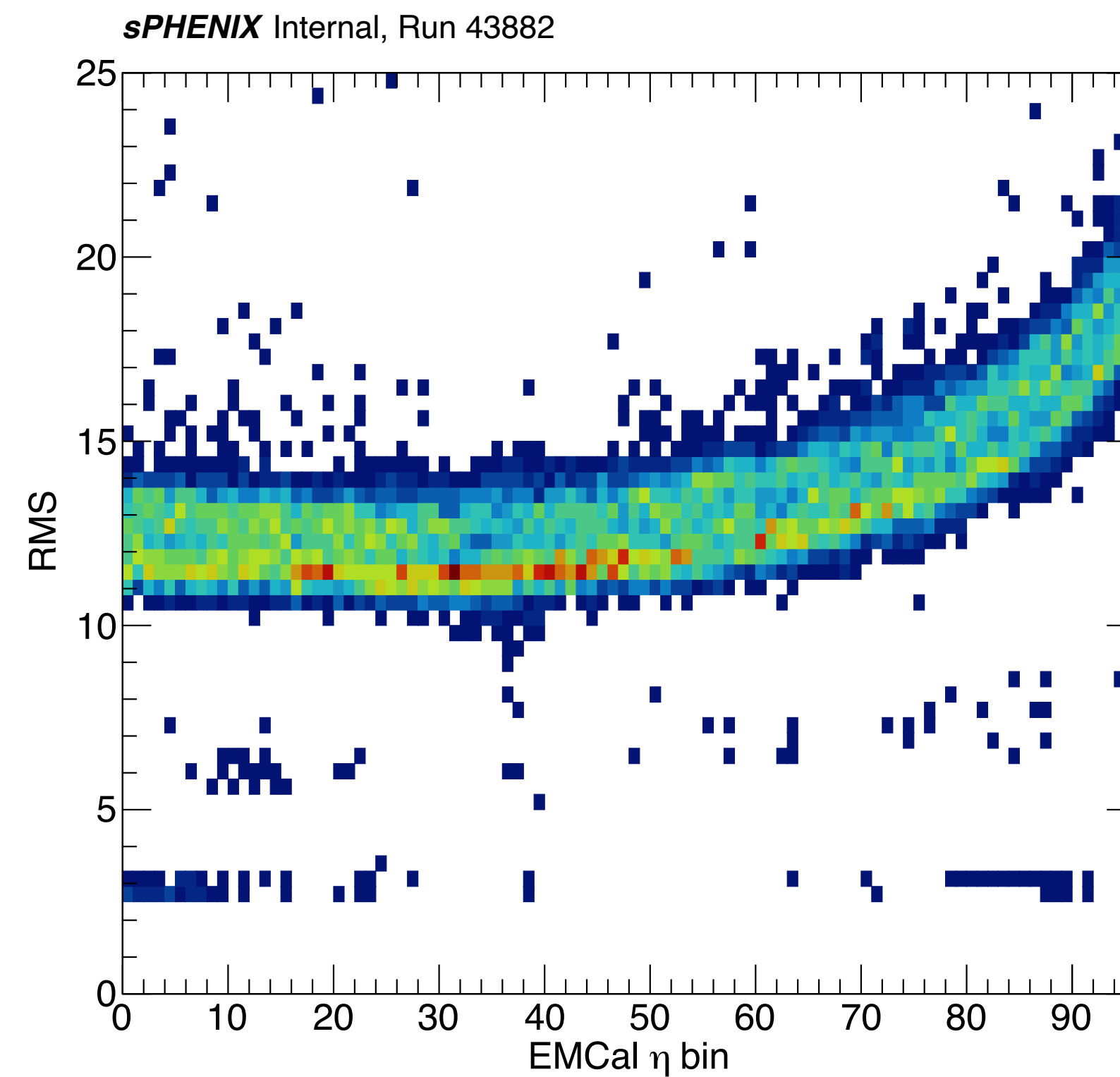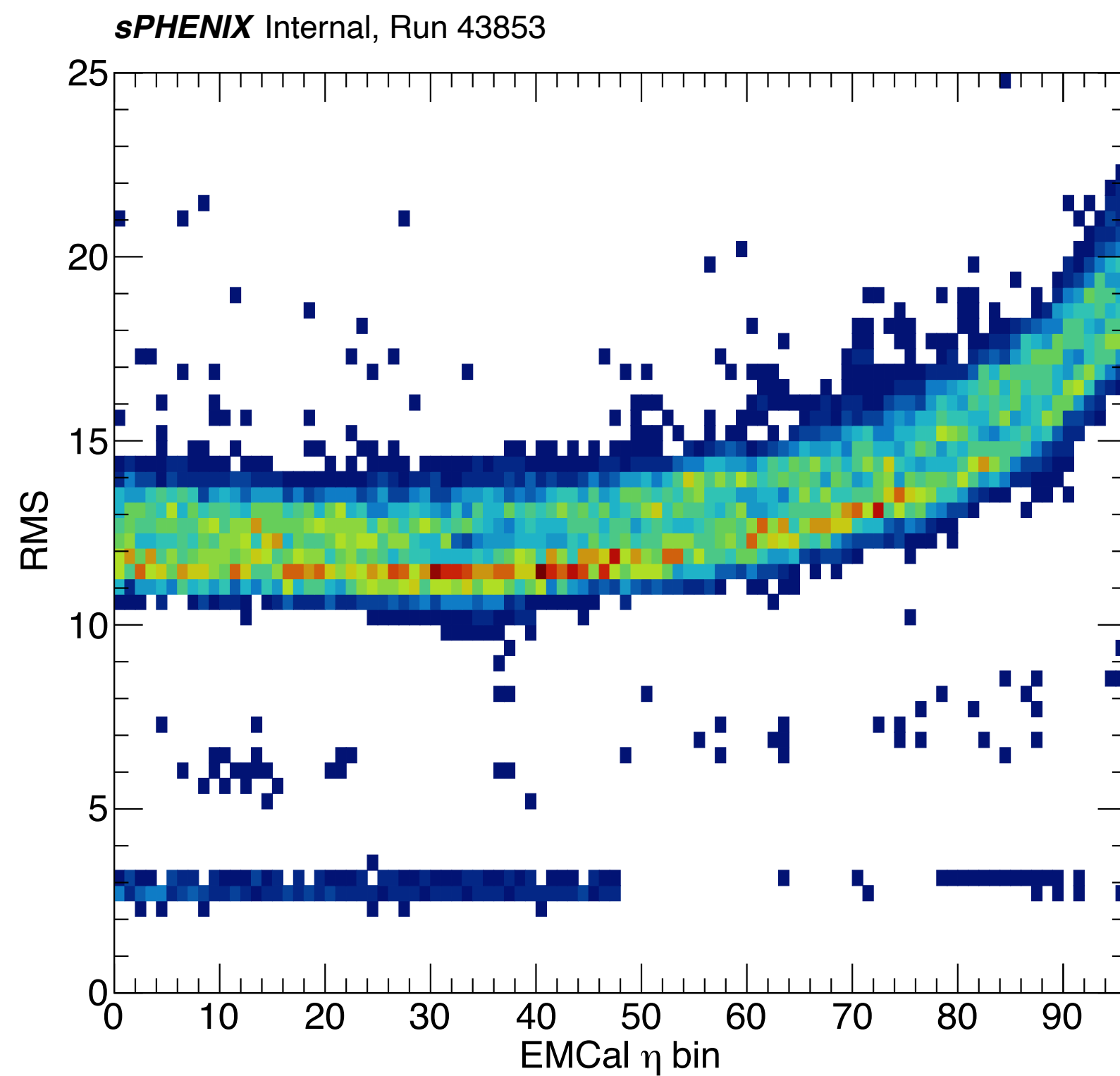
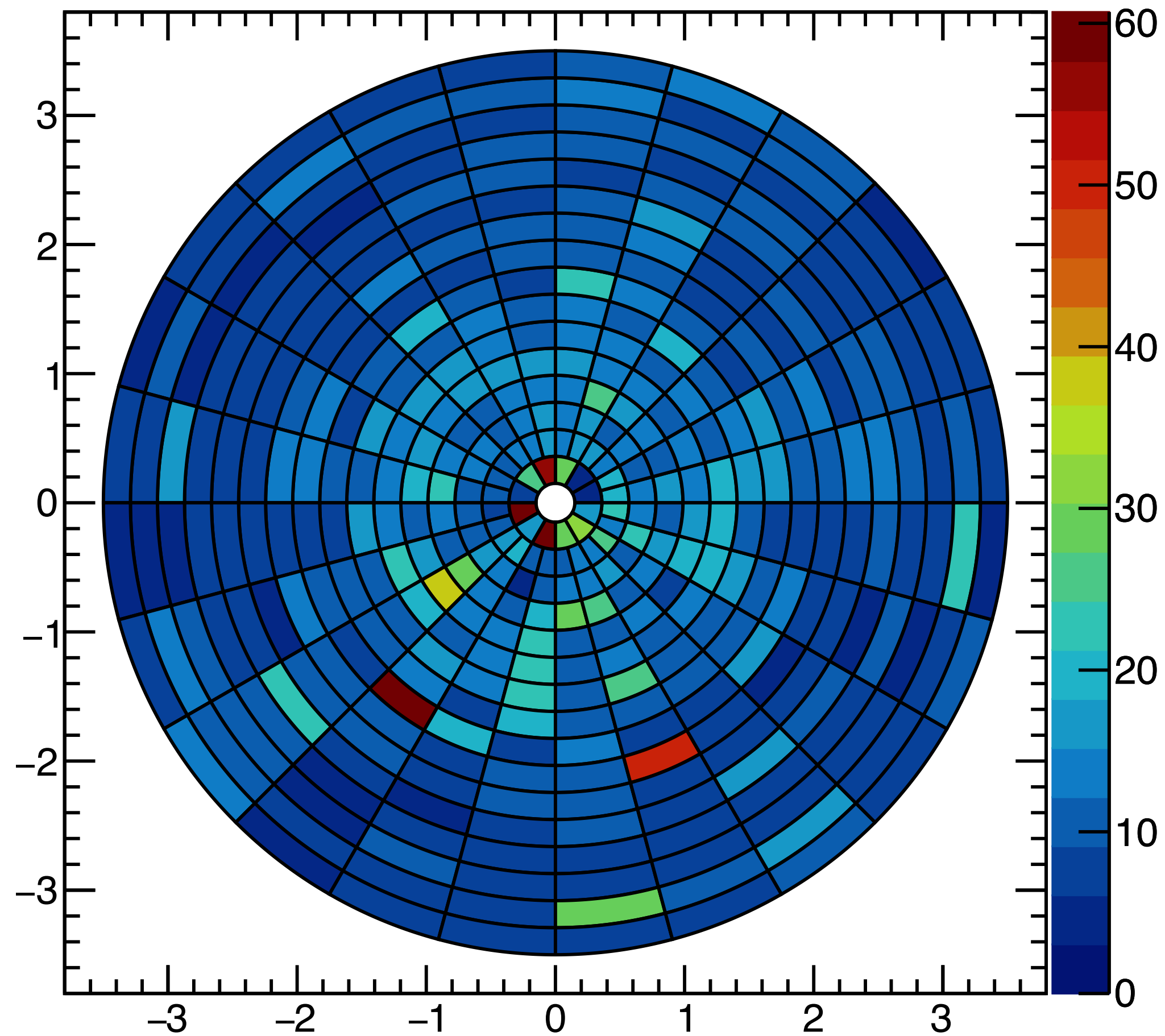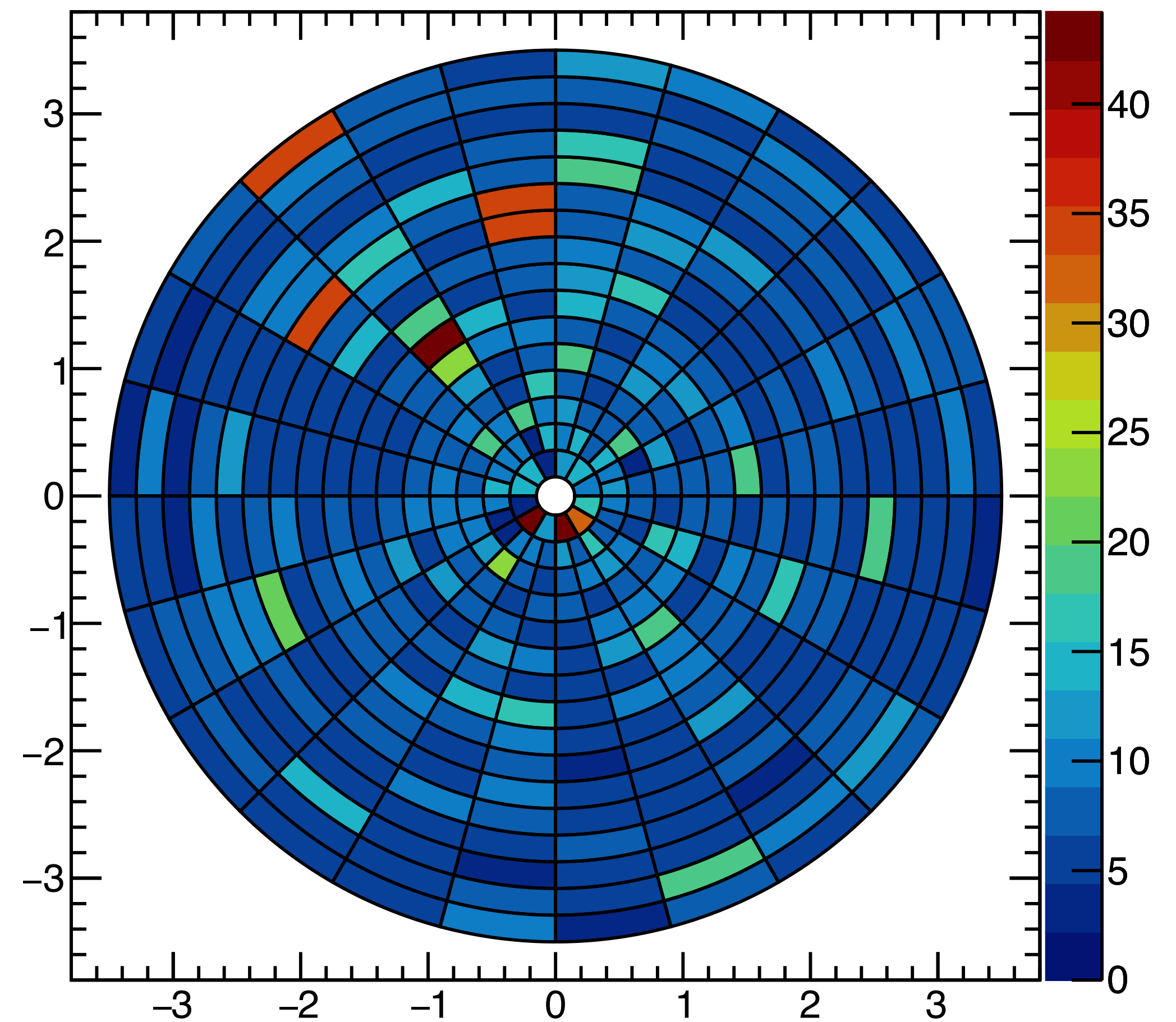Run 43853 (beginning of store)   Run 43882 (after ~5-6 hours of store)   Run 43889 (end of store)

Run 43853 physics (beginning of store)
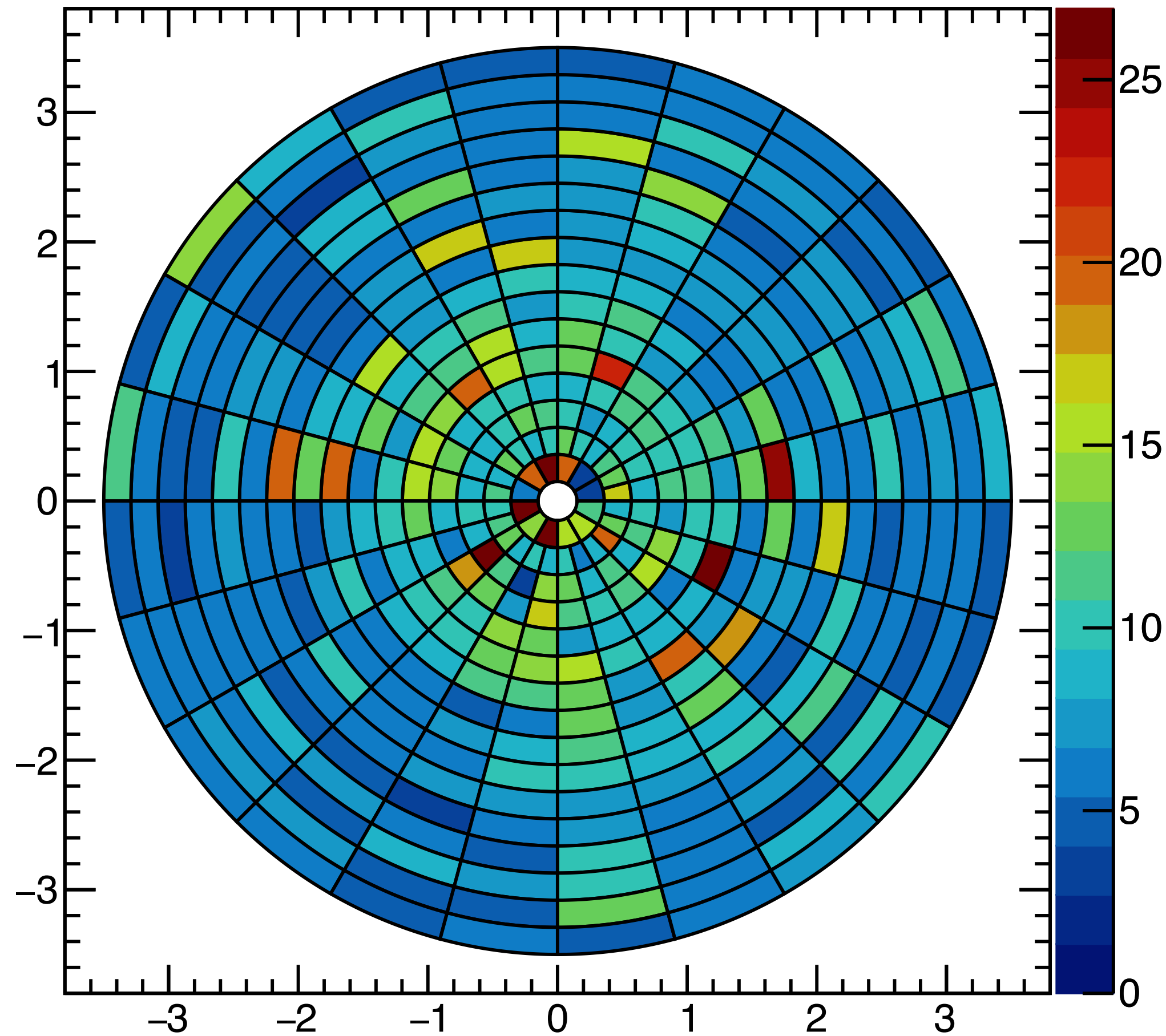

sPHENIX Internal, Run 43853, sEPD South

sPHENIX Internal, Run 43853, sEPD North
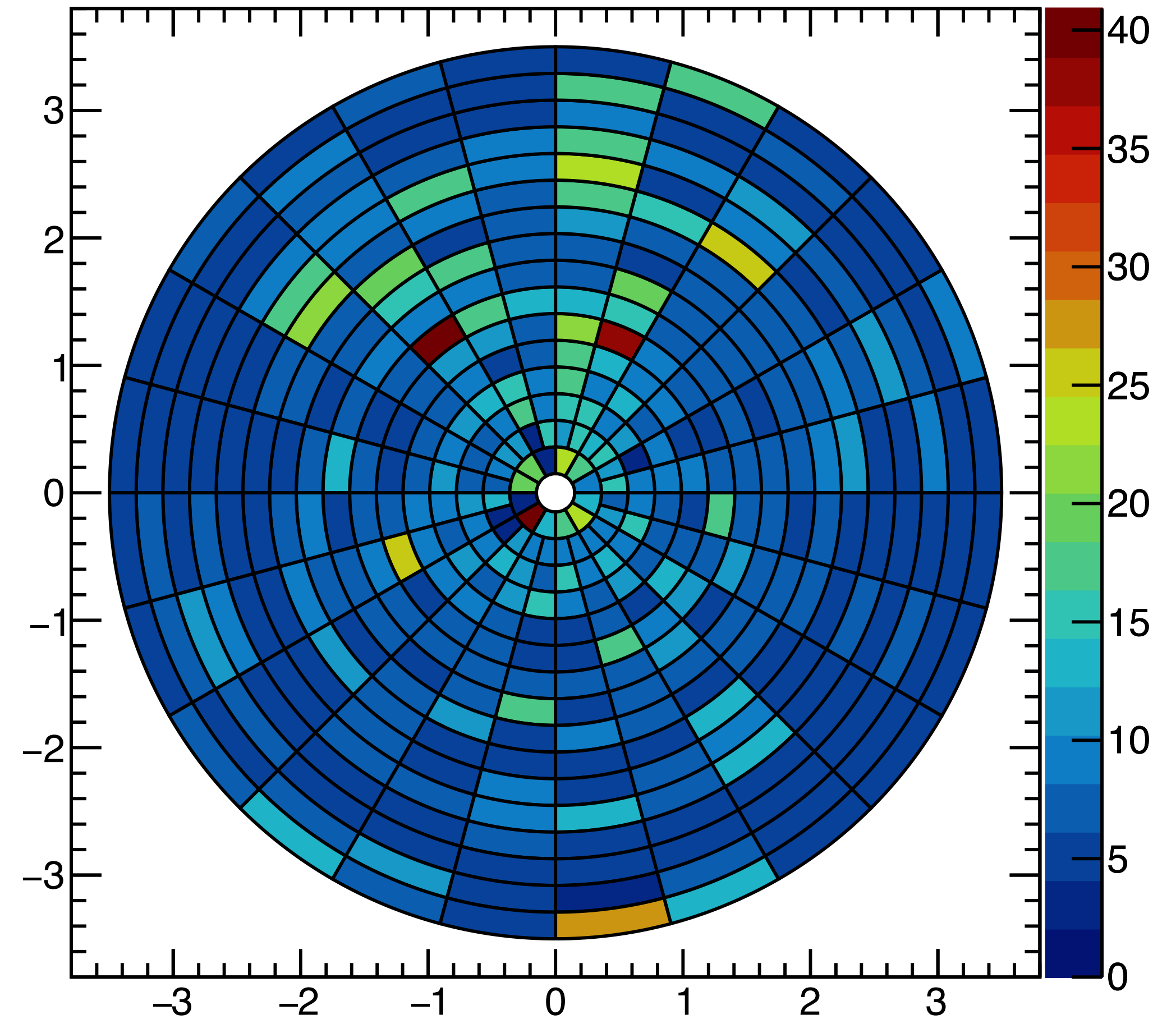
sEPD data-driven noise studies

Run 43882 physics (after ~5-6 hours of store)

sPHENIX Internal, Run 43882, sEPD South

sPHENIX Internal, Run 43882, sEPD North

sEPD data-driven noise studies

Run 43889 physics (end of the store)

sPHENIX Internal, Run 43889, sEPD South

sPHENIX Internal, Run 43889, sEPD North