HCAL Reconstruction: MC Correction Functions Update

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Introduction

- Have derived (improved) MC correction functions for OOT PU
- Same derivation method as used for data
- Procedure:
  - Run Alexandre's ratio method on zero PU MC
  - Derive correction functions based on the pulse shape
  - Use the same definitions, fits, and methods as in data
  - Validate results on MC with OOT PU

Method

- Process a high-p_T QCD sample in two ways:
  - No pileup: for MC truth comparison (DONE)
  - With pileup: for validation (Processing)
- Compare results event-by-event, channel-by-channel:
  - No pileup
  - vs. with pileup and no corrections
  - vs. with pileup and corrections

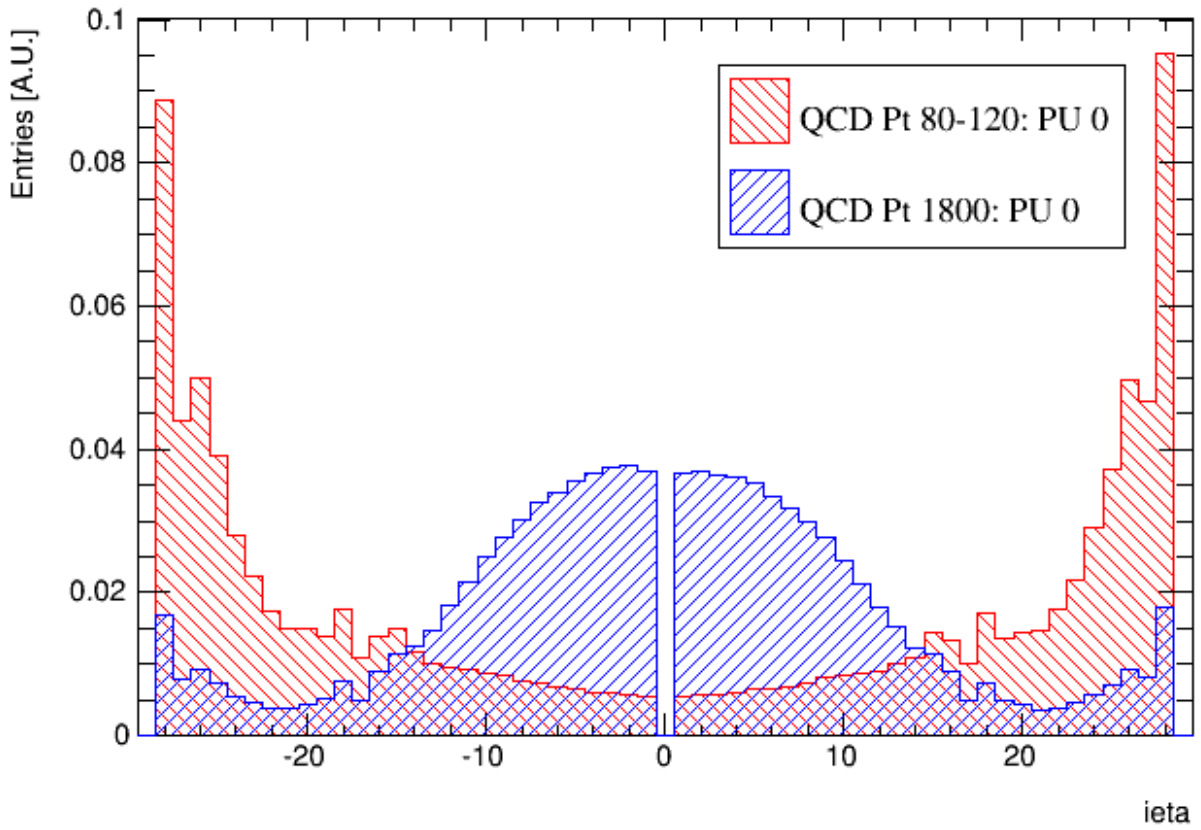
Datasets

- Consider three GEN-SIM datasets (no PU) at T1_US_FNAL:

Dataset	Production release
/MinBias_TuneZ2star_13TeV-pythia6/Summer13-START53_V7C-v1/GEN-SIM	CMSSW_5_3_10_patch2
/QCD_Pt-1800_TuneZ2star_13TeV_pythia6/Fall13-POSTLS162_V1-v1/GEN-SIM	CMSSW_6_2_0_patch1
/QCD_Pt-80to120_TuneZ2star_13TeV_pythia6/Fall13-POSTLS162_V1-v1/GEN-SIM	CMSSW_6_2_0_patch1

- QCD_Pt-1800 dataset:
  - HcalNoiseAnalyzer ntuples on FNAL EOS: /eos/uscms/store/user/eberry/QCD1800MC/
- QCD_Pt-80to120 dataset:
  - HcalNoiseAnalyzer ntuples on FNAL EOS: /eos/uscms/store/user/eberry/QCD80to120MC/
- MinBias dataset:
  - HcalNoiseAnalyzer ntuples on FNAL EOS: /eos/uscms/store/user/eberry/MinBiasMC/

Comparison in ieta



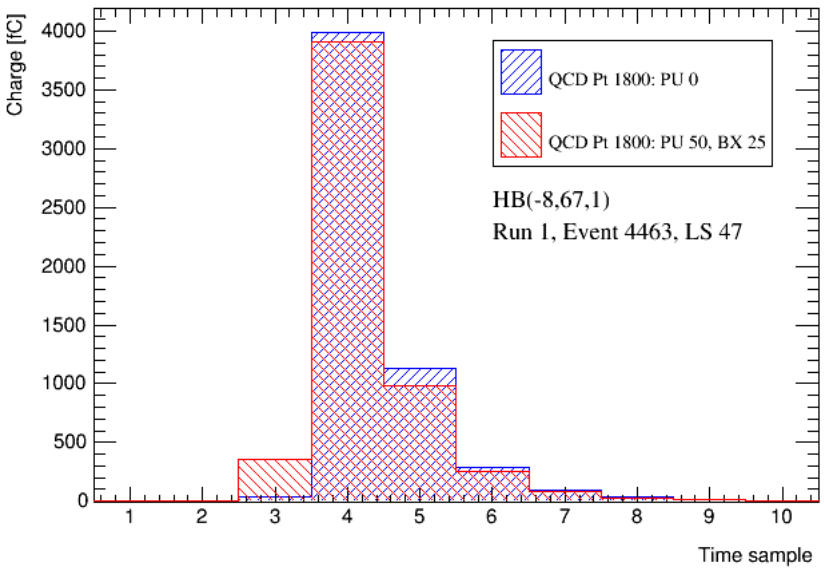
- QCD_Pt-80to120 dataset more focused on HE (good)

Processing pileup sample

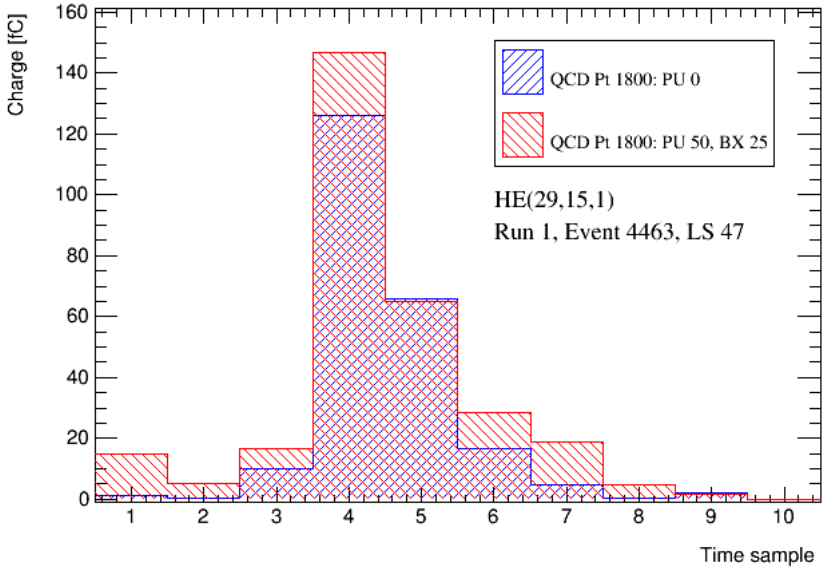
- Need to overlay `QCD` with `MinBias`
- Use `MixingModule` in `CMSSW_6_2_8`
- Pileup scenario: `AVE_50_BX_25ns`
- Two stages:
  - 1) `DIGI`, `L1`, `DIGI2RAW`, `HLT`
  - 2) `RAW2DIGI` `L1Reco` `RECO`
- Stage 1 all done: cmsDriver and python cfg
- Stage 2 all done: cmsDriver and python cfg
- High PU is VERY CPU intensive: 2 minutes/event

PU vs. No PU single digi comparison

single DIGI comparison: HB



single DIGI comparison: HE



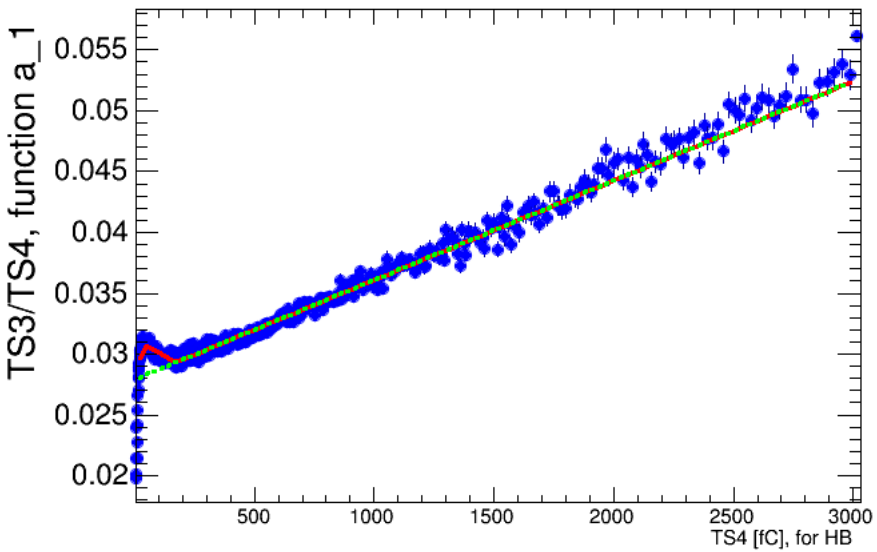
- HE as expected.
- HB as expected in TS3. Strangeness in TS4 + TS5.
- Focusing on HE

Fits

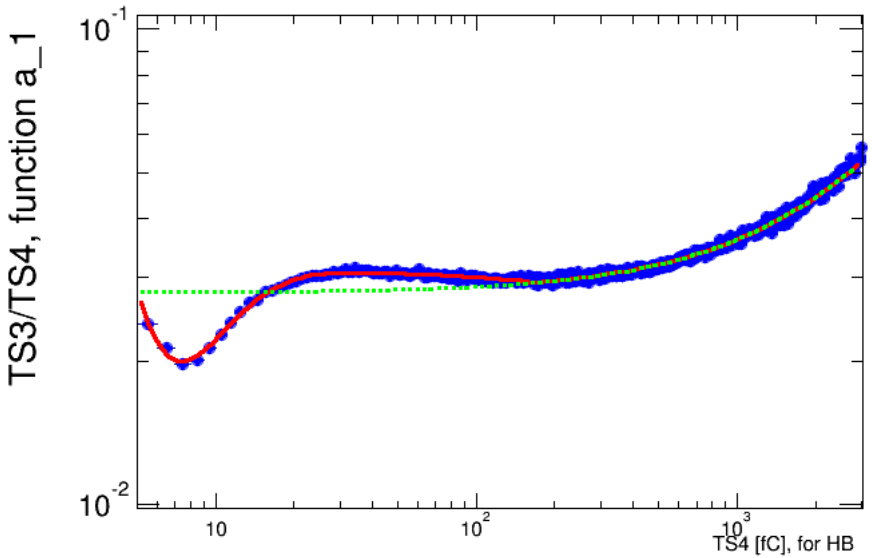
- Fits have been improved! Better agreement now.
- Parameters available on GitHub
- Same functions as Alexandre for a1, a2, a3
  - 6 polynomials: 1 for each of 6 regions
- For a_1, this function works better on MC:
  if $x < [6]$: $f(x) = [0] \cdot \text{Exp}([1] + [2] \cdot x) + [3] + [4] \cdot x$
  if $x > [6]$: $f(x) = [5] \cdot (x - [6]) + c$
  - c is chosen to ensure continuity of $f(x)$ at $[6]$

Function fitting on zero pileup sample: a_1

Fit of a_1 in HB (lin)



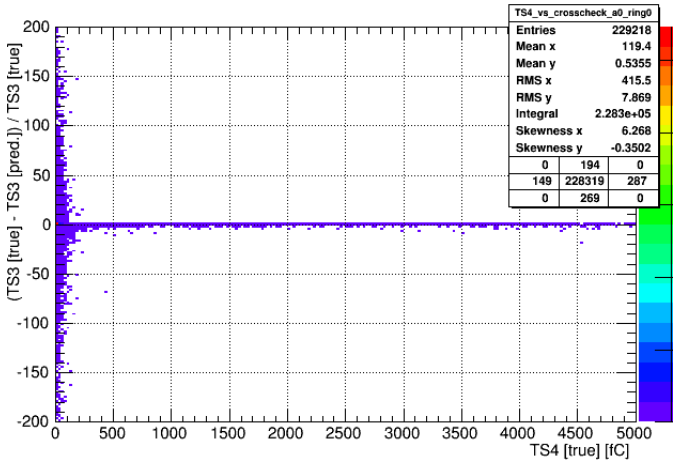
Fit of a_1 in HB (log)



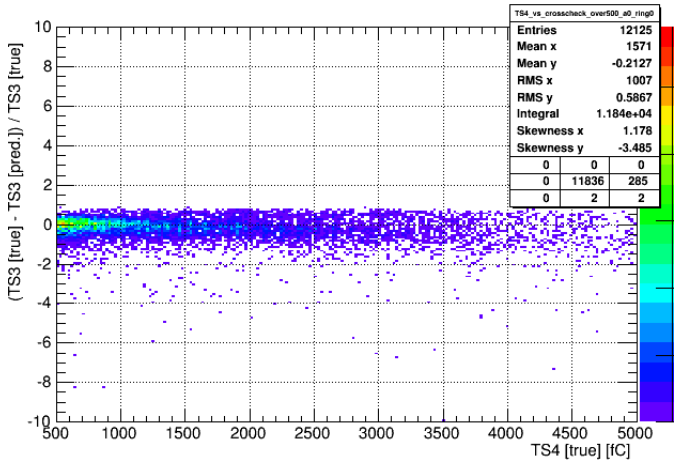
- Fit done on zero pileup sample: use only green line
- Fits now extend to TS4 = 3000 fC
- Parameters available on GitHub

Function validation on zero pileup sample: a_1 2D

Validation of a_1 in HB (TS4 > 0 fC)



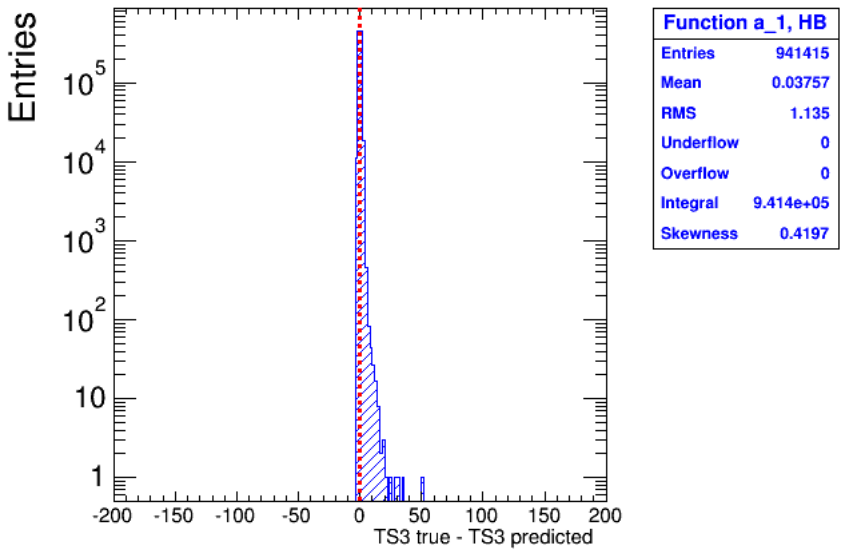
Validation of a_1 in HB (TS4 > 500 fC)



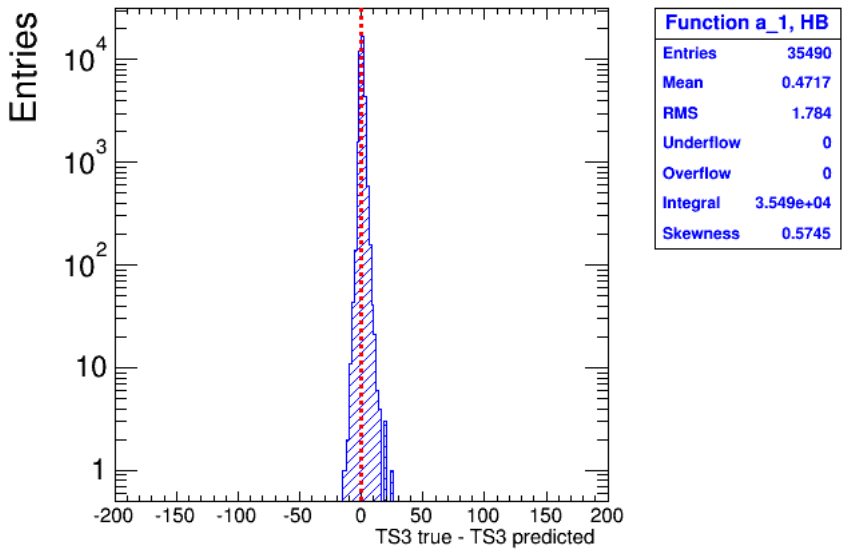
- Done on zero pileup sample
- *y*-axis: (TS3 true - TS3 pred.) / TS3 true
- *x*-axis: TS4 true
- Spread all at low energy

Function validation on zero pileup sample: a_1 1D

Validation of a_1 in HB (TS4 < 50 fC)



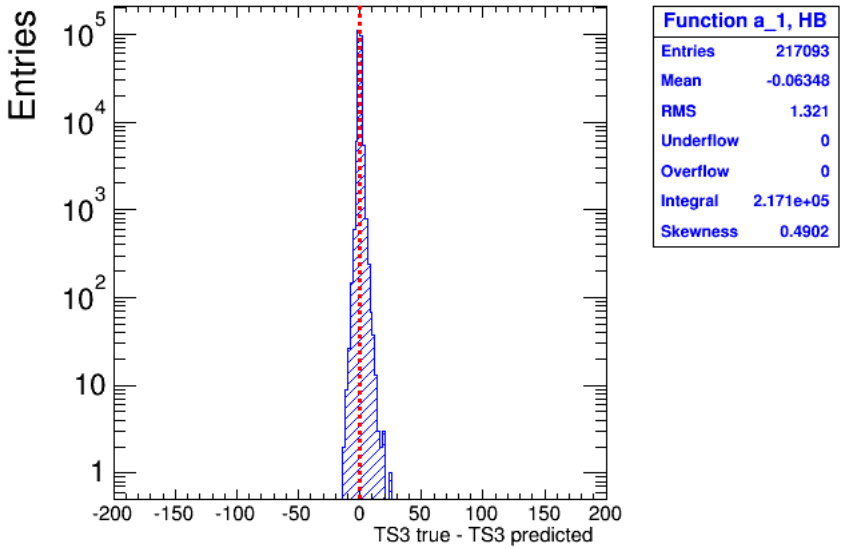
Validation of a_1 in HB (TS4 > 50 fC)



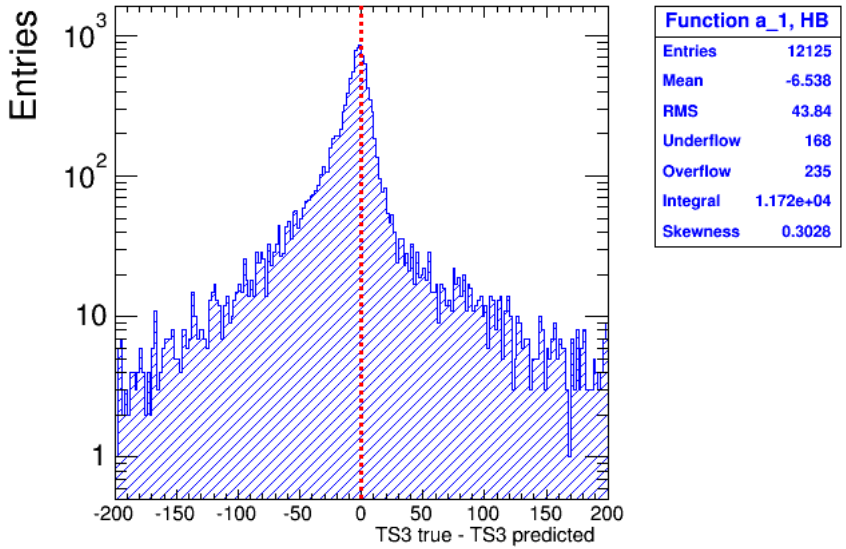
- Done on high pileup, QCD80to120 sample
- x-axis: TS3 true - TS3 predicted

Function validation on zero pileup sample: a_1 1D

Validation of a_1 in HB (TS4 < 500 fC)



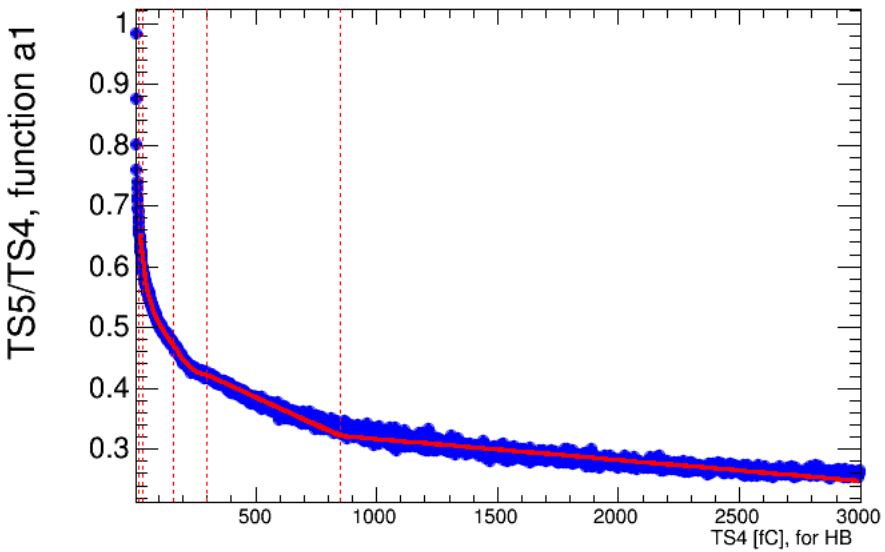
Validation of a_1 in HB (TS4 > 500 fC)



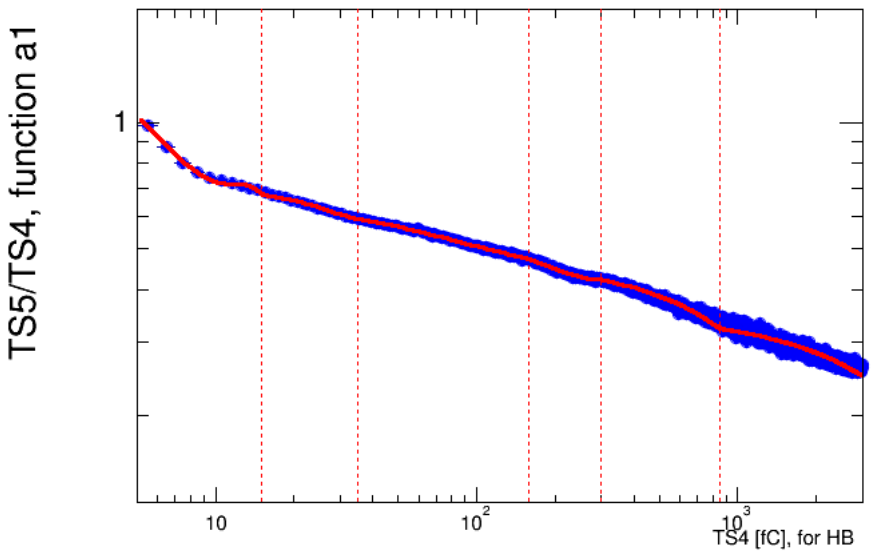
- Done on high pileup, QCD1800 sample
- *x*-axis: TS3 true - TS3 predicted

Function fitting on zero pileup sample: a1

Fit of a1 in HB (lin)



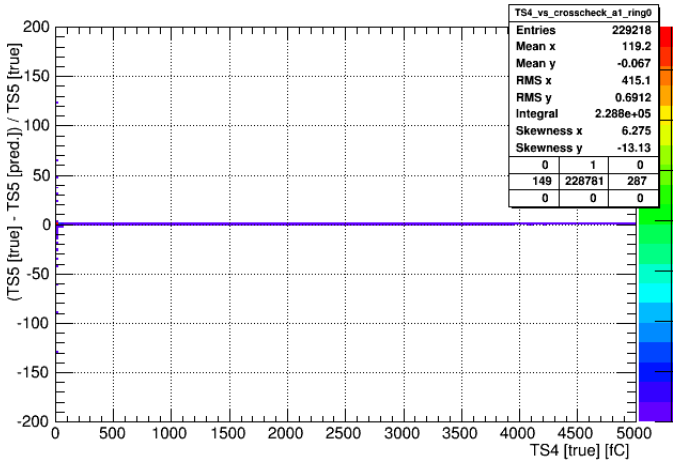
Fit of a1 in HB (log)



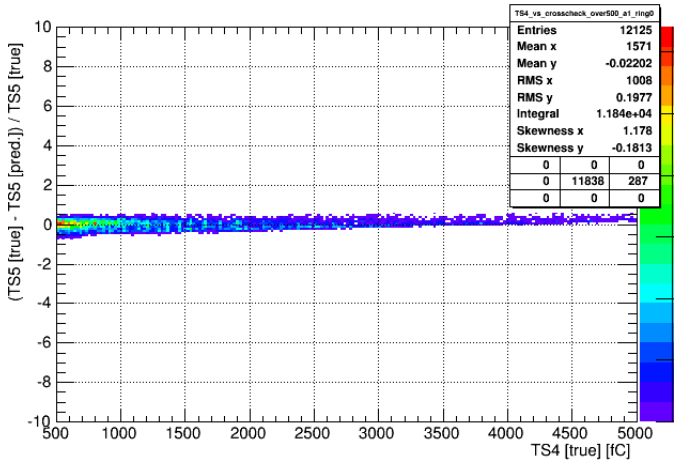
- Fit done on zero pileup sample
- Red lines correspond to fit ranges (Alexandre's functions)
- Parameters available on GitHub

Function validation on zero pileup sample: a1 2D

Validation of a1 in HB (TS4 > 0 fC)



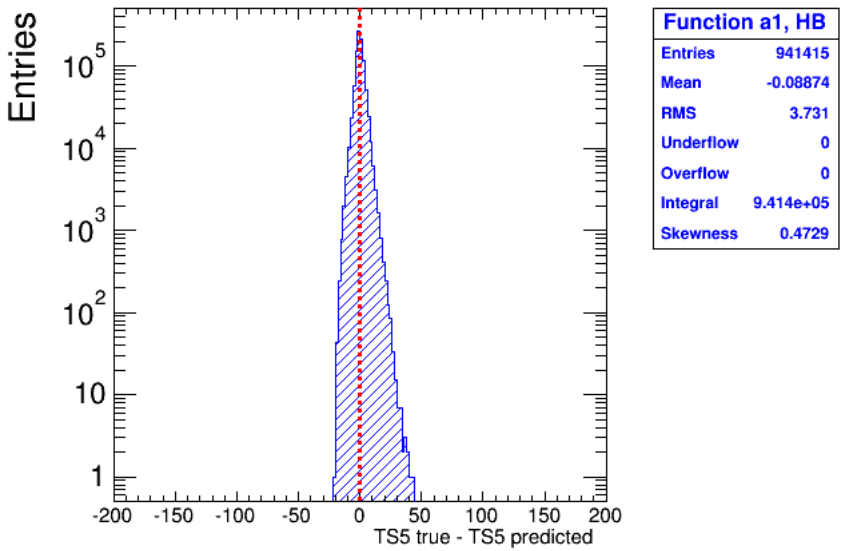
Validation of a1 in HB (TS4 > 500 fC)



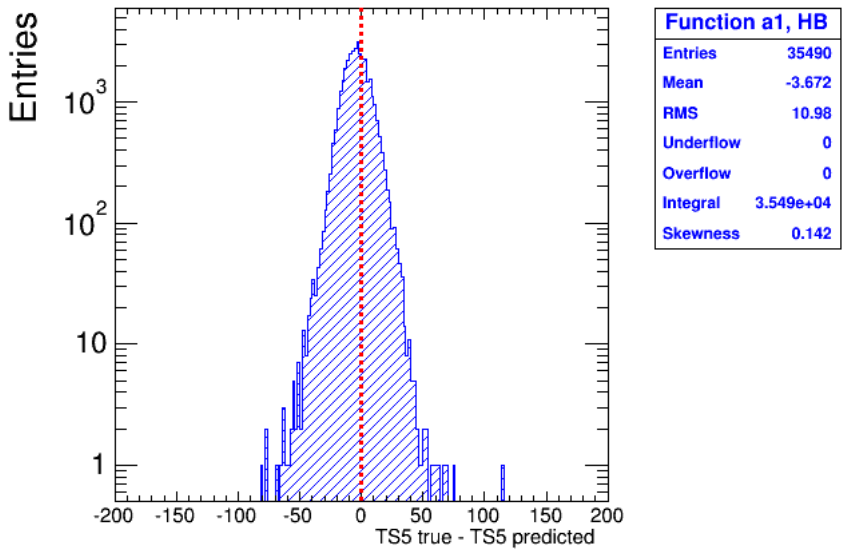
- Done on zero pileup sample
- *y*-axis: (TS5 true - TS5 pred.) / TS5 true
- *x*-axis: TS4 true
- Better performance than a_1

Function validation on zero pileup sample: a1 1D

Validation of a1 in HB (TS4 < 50 fC)



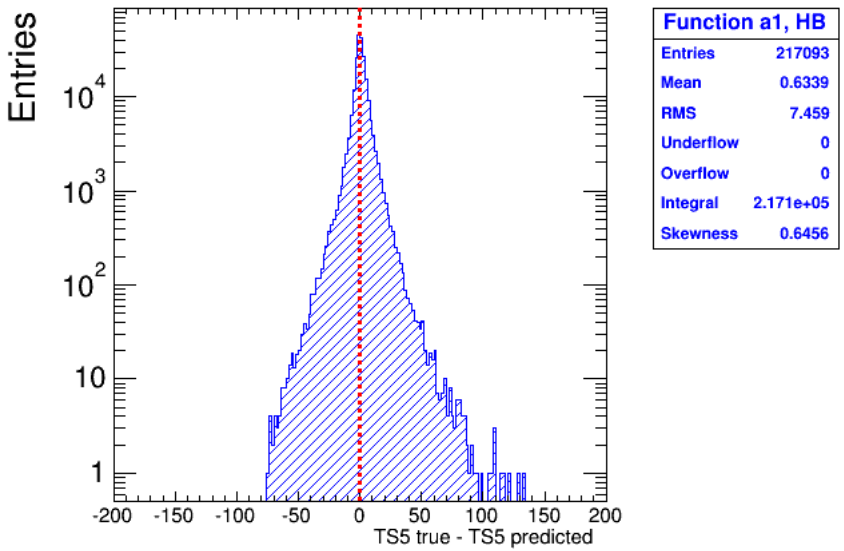
Validation of a1 in HB (TS4 > 50 fC)



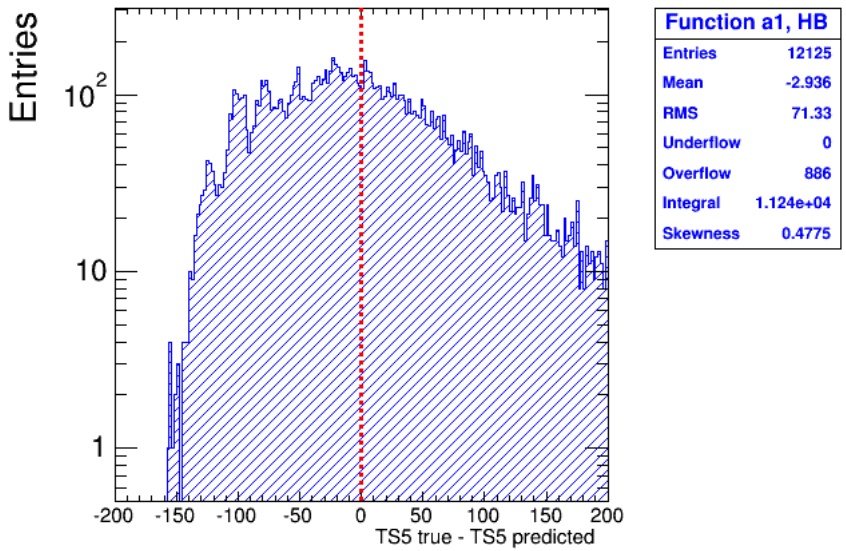
- Done on high pileup, QCD80to120 sample
- x-axis: TS5 true - TS5 predicted

Function validation on zero pileup sample: a1 1D

Validation of a1 in HB (TS4 < 500 fC)



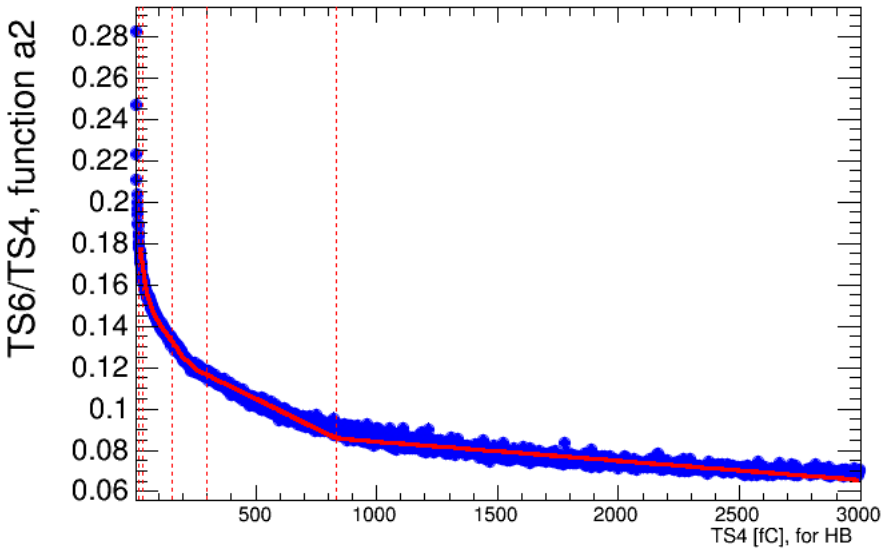
Validation of a1 in HB (TS4 > 500 fC)



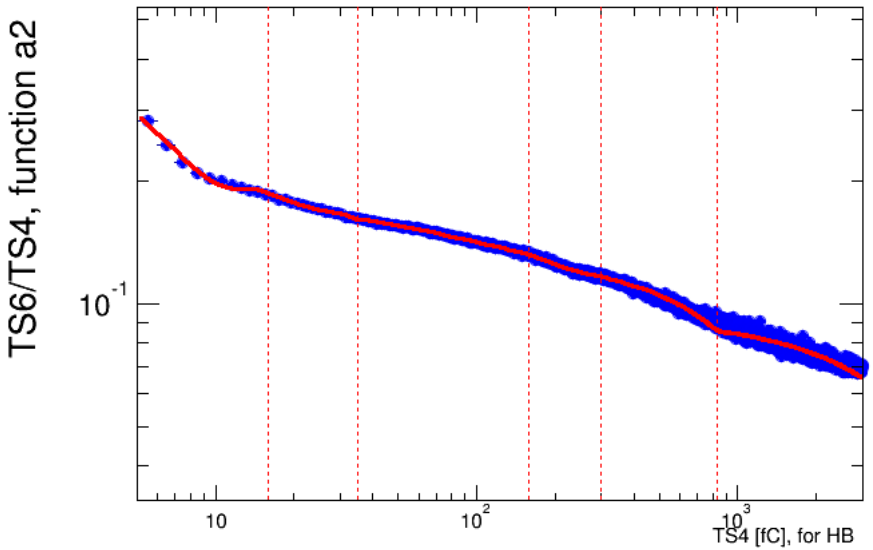
- Done on high pileup, QCD1800 sample
- *x*-axis: TS5 true - TS5 predicted

Function fitting on zero pileup sample: a2

Fit of a2 in HB (lin)



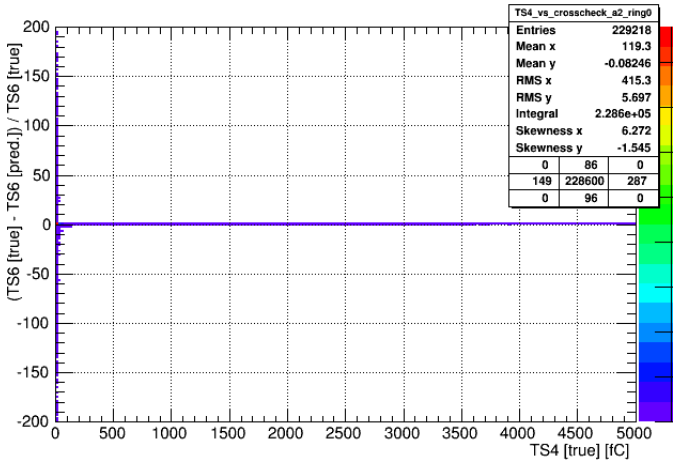
Fit of a2 in HB (log)



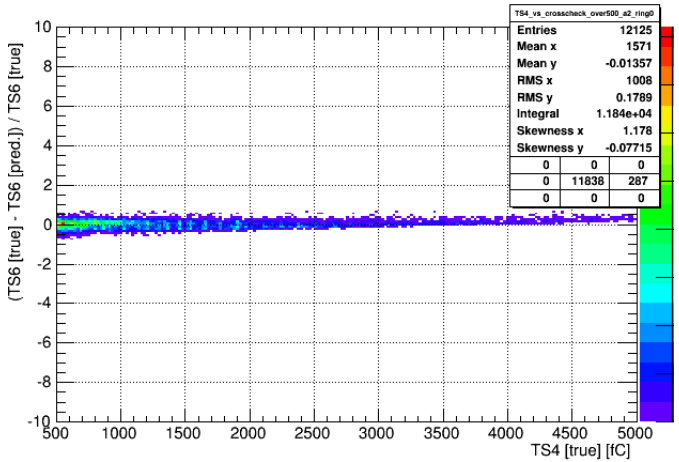
- Fit done on zero pileup sample
- Red lines correspond to fit ranges (Alexandre's functions)
- Parameters available on GitHub

Function validation on zero pileup sample: a2 2D

Validation of a2 in HB (TS4 > 0 fC)



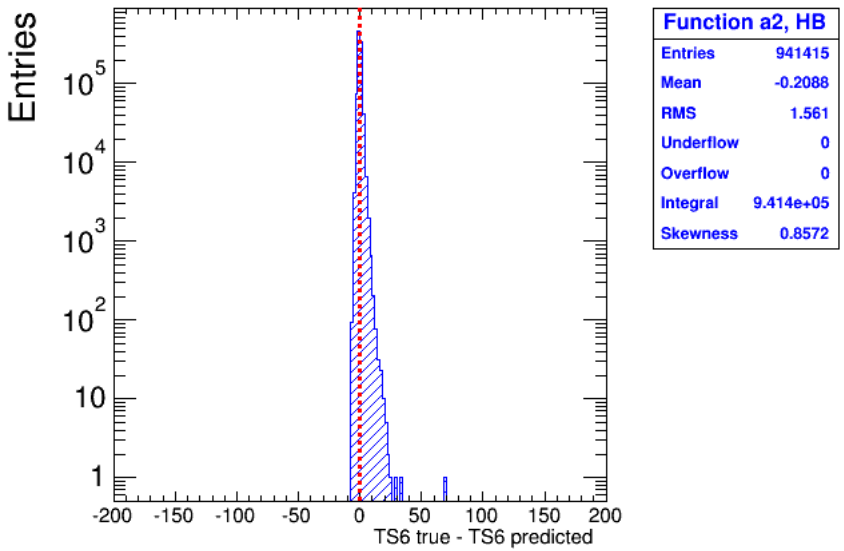
Validation of a2 in HB (TS4 > 500 fC)



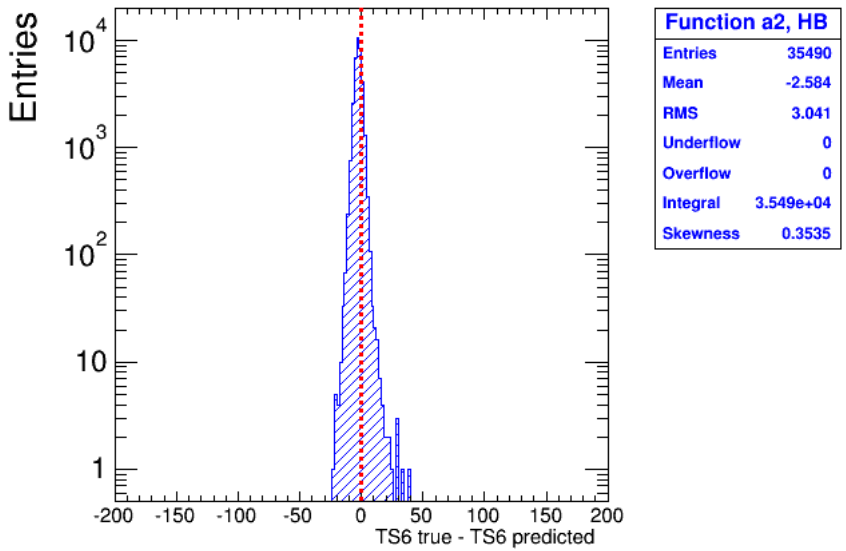
- Done on zero pileup sample
- *y*-axis: (TS6 true - TS6 pred.) / TS6 true
- *x*-axis: TS4 true
- Better performance than a_1

Function validation on zero pileup sample: a2 1D

Validation of a2 in HB (TS4 < 50 fC)



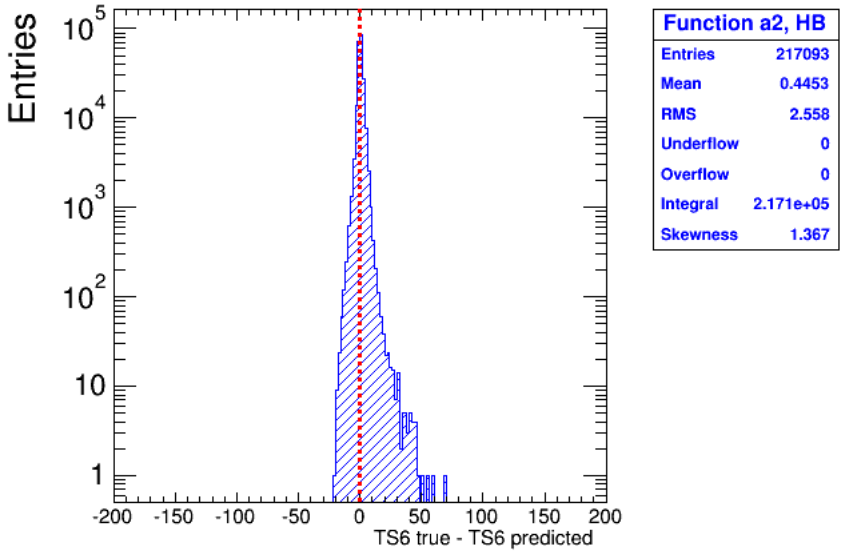
Validation of a2 in HB (TS4 > 50 fC)



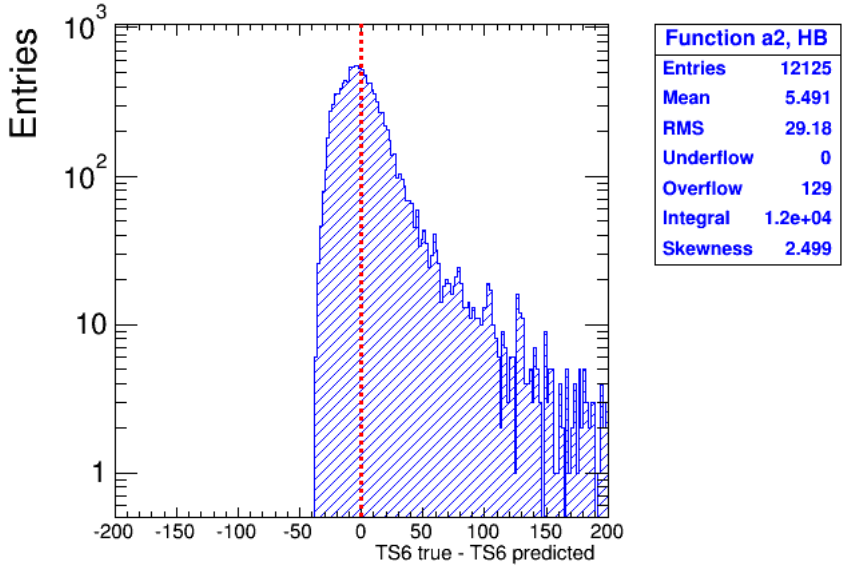
- Done on high pileup, QCD80to120 sample
- x-axis: TS6 true - TS6 predicted

Function validation on zero pileup sample: a2 1D

Validation of a2 in HB (TS4 < 500 fC)



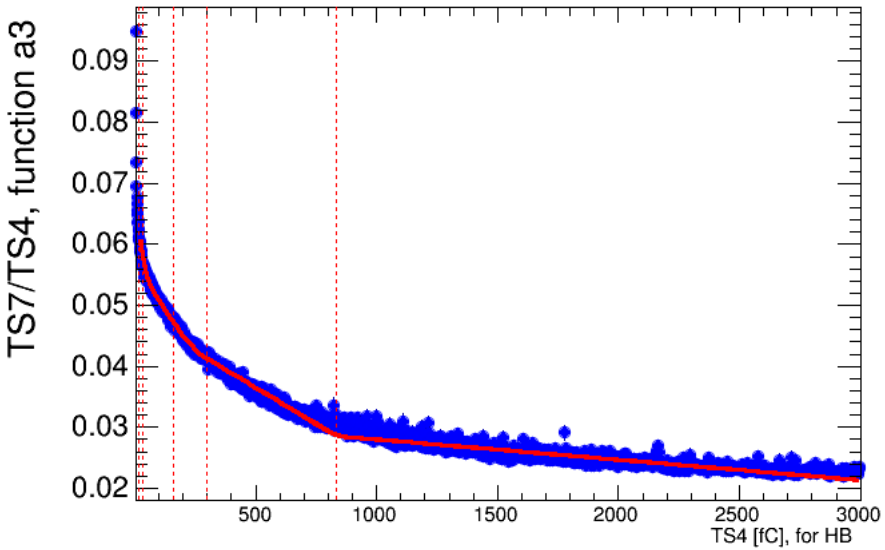
Validation of a2 in HB (TS4 > 500 fC)



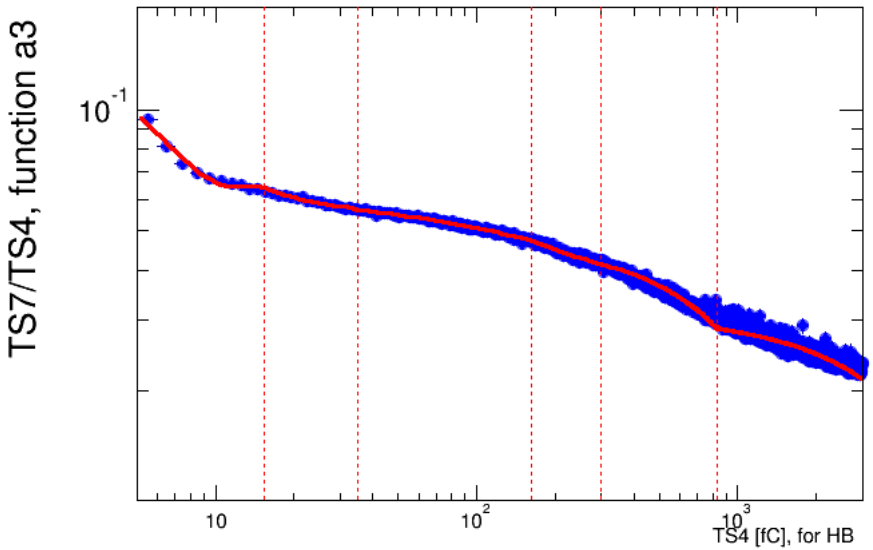
- Done on high pileup, QCD1800 sample
- x-axis: TS6 true - TS6 predicted

Function fitting on zero pileup sample: a3 2D

Fit of a3 in HB (lin)



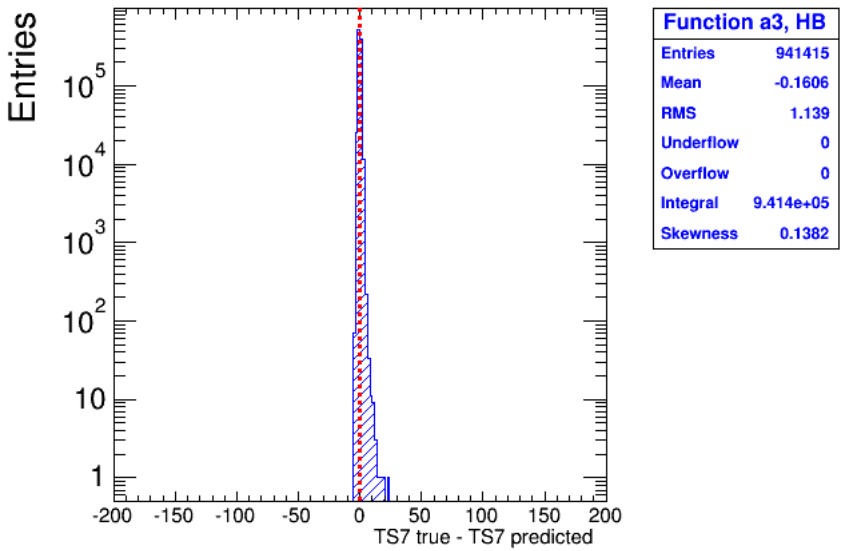
Fit of a3 in HB (log)



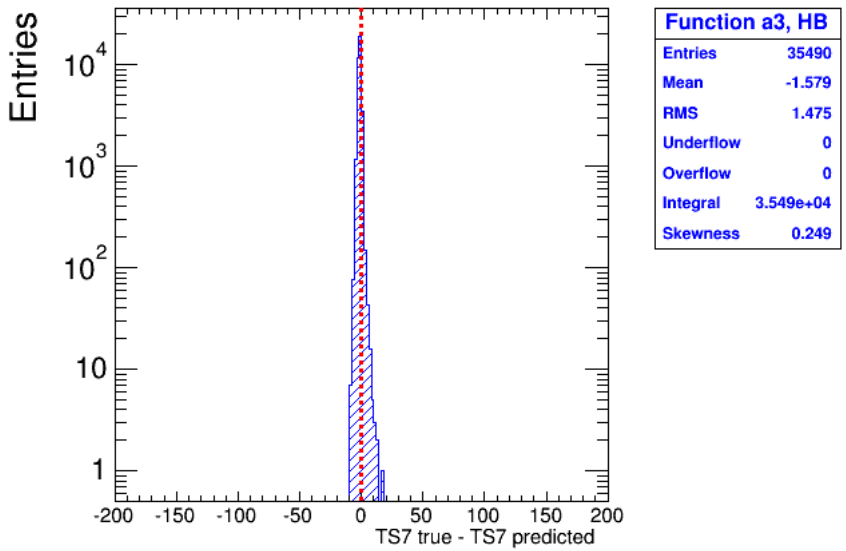
- Fit done on zero pileup sample
- Red lines correspond to fit ranges (Alexandre's functions)
- Parameters available on GitHub

Function validation on zero pileup sample: a3 1D

Validation of a3 in HB (TS4 < 50 fC)



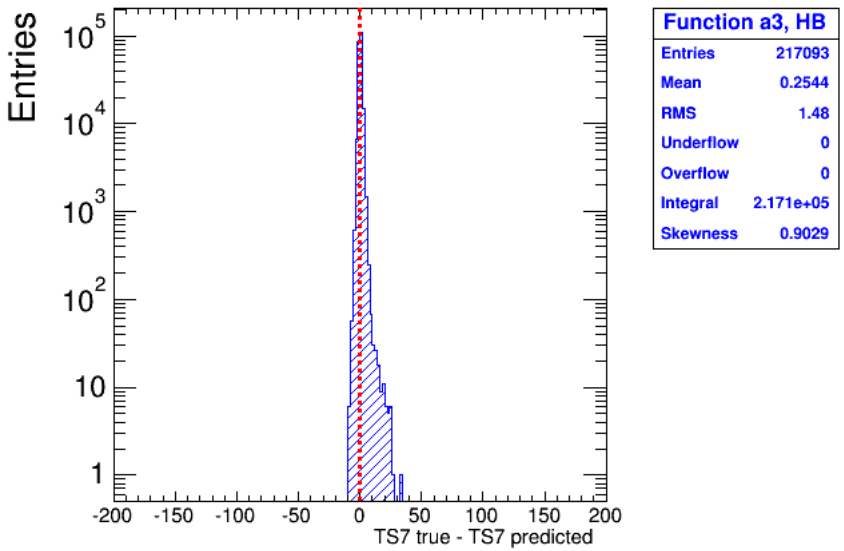
Validation of a3 in HB (TS4 > 50 fC)



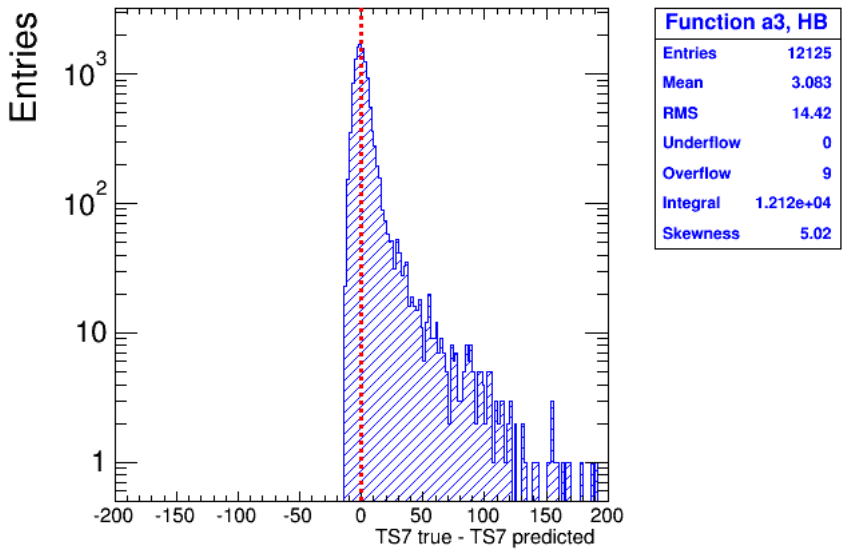
- Done on high pileup, QCD80to120 sample
- x-axis: TS7 true - TS7 predicted

Function validation on zero pileup sample: a3 1D

Validation of a3 in HB (TS4 < 500 fC)



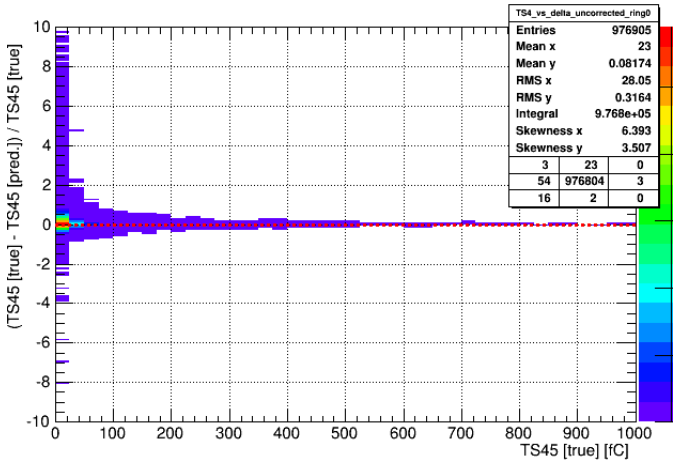
Validation of a3 in HB (TS4 > 500 fC)



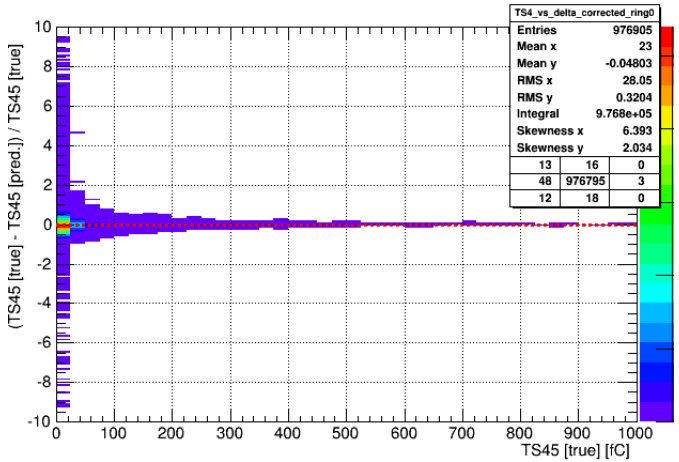
- Done on high pileup, QCD1800 sample
- x-axis: TS7 true - TS7 predicted

Results in HB: 2D

No correction applied



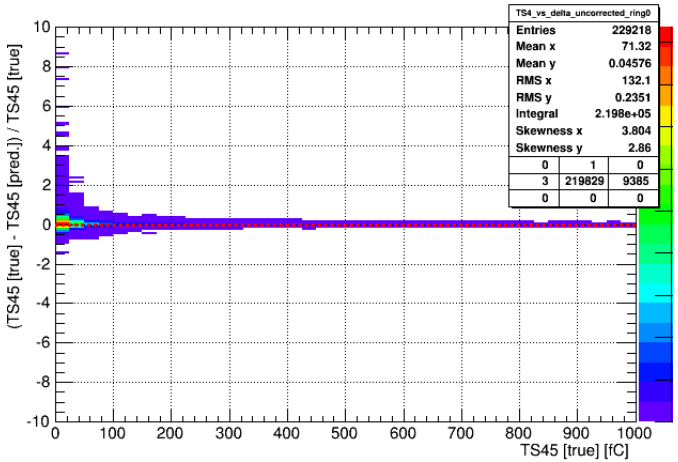
With correction applied



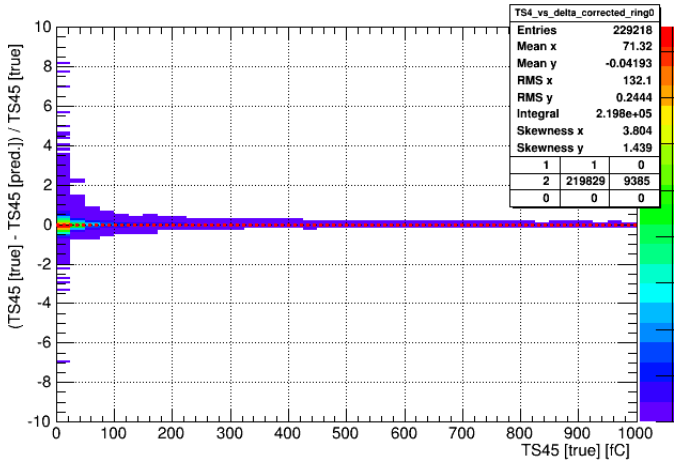
- Done on high pileup, QCD80to120 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HB: 2D

No correction applied



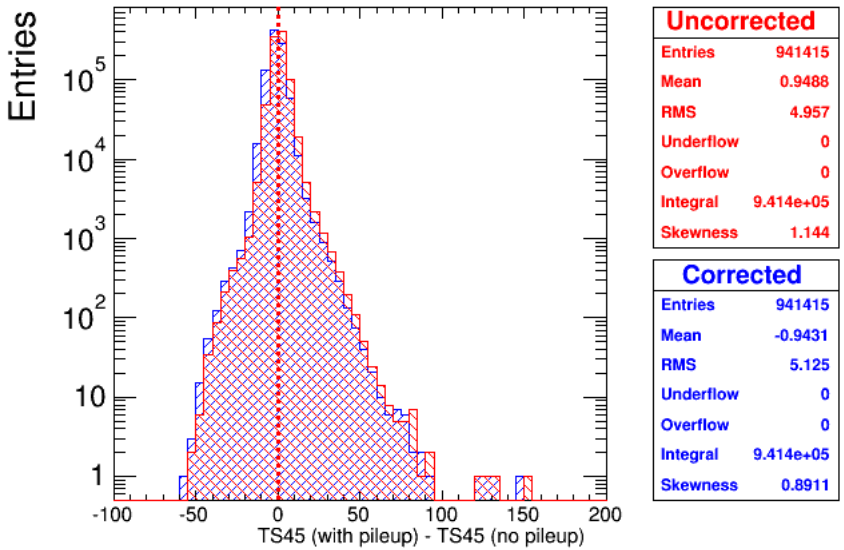
With correction applied



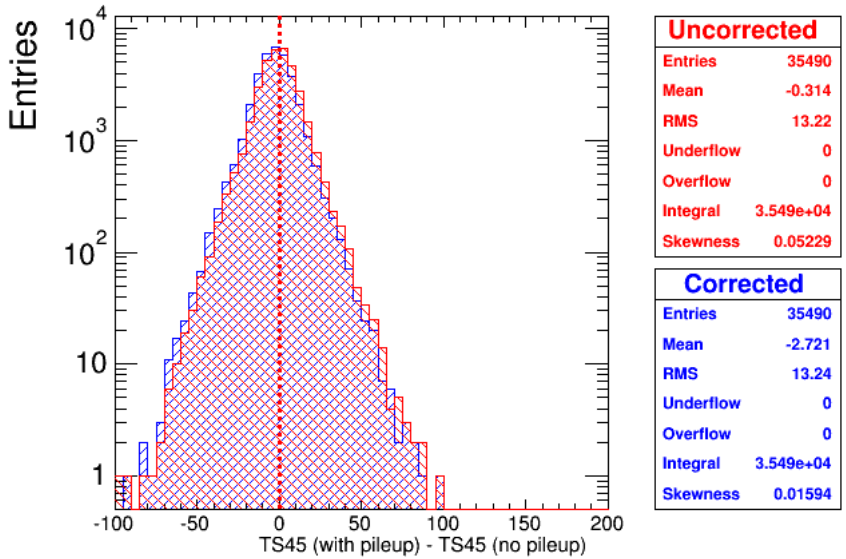
- Done on high pileup, QCD1800 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HB: 1D

TS4 < 50 fC



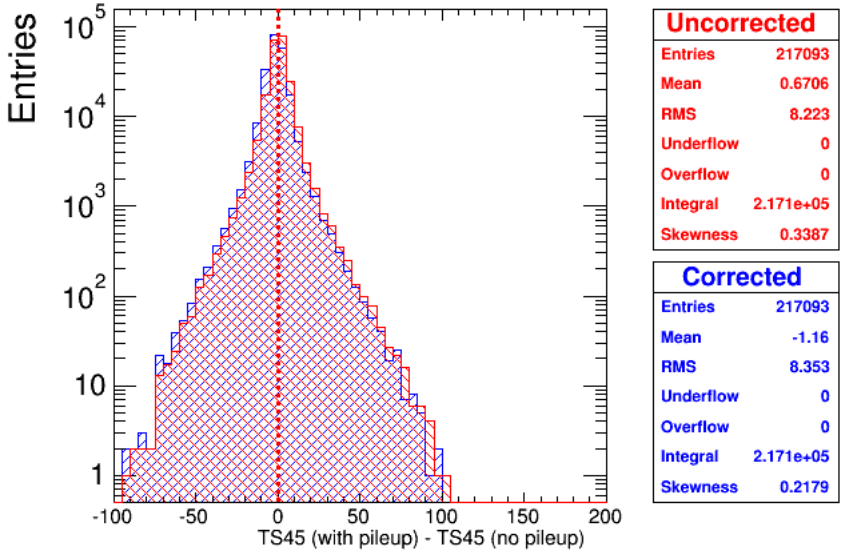
TS4 > 50 fC



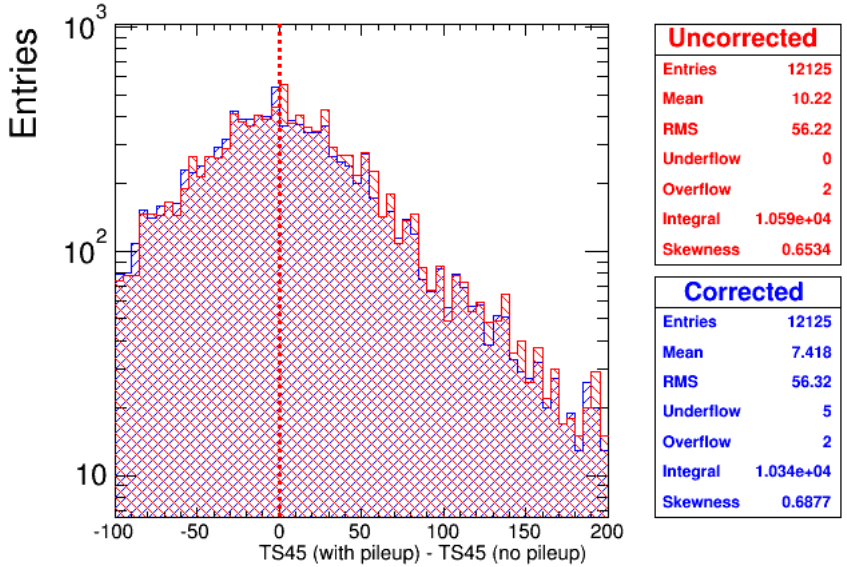
- Done on high pileup, QCD80to120 sample
- x-axis: TS45 true - TS45 pred, y-axis: Entries
- Corrections make little difference in the barrel

Results in HB: 1D

TS4 < 500 fC



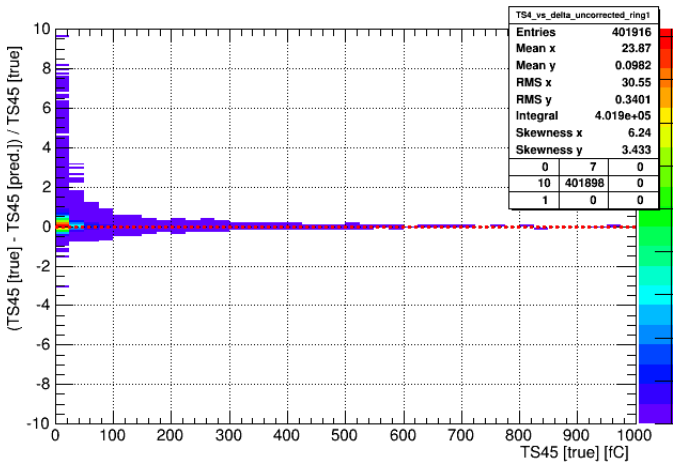
TS4 > 500 fC



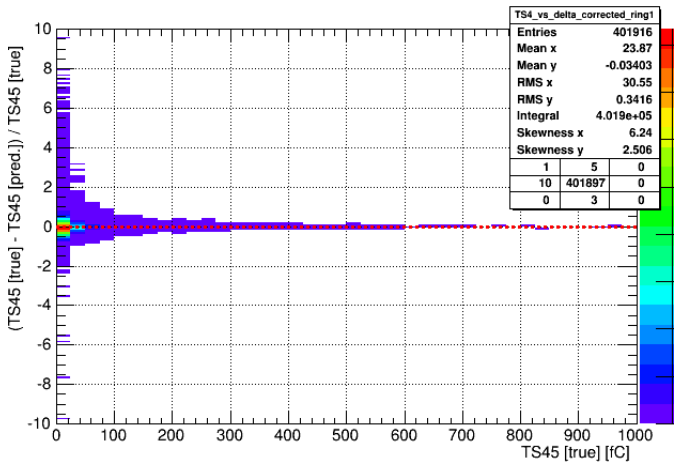
- Done on high pileup, QCD1800 sample
- x-axis: TS45 true - TS45 pred, y-axis: Entries
- Corrections make little difference in the barrel

Results in HE 17-20: 2D

No correction applied



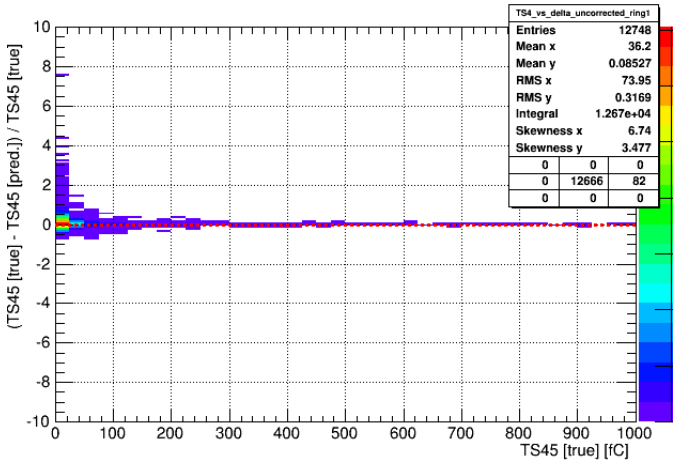
With correction applied



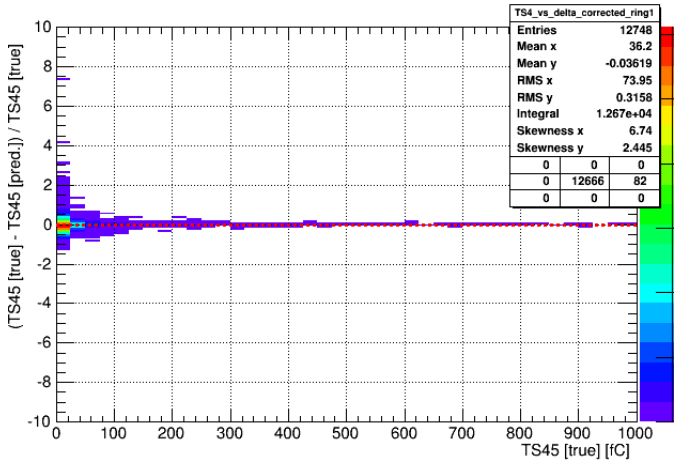
- Done on high pileup, QCD80to120 sample
- y-axis: (TS45 true - TS45 pred.) / TS45 true
- x-axis: TS45 true

Results in HE 17-20: 2D

No correction applied



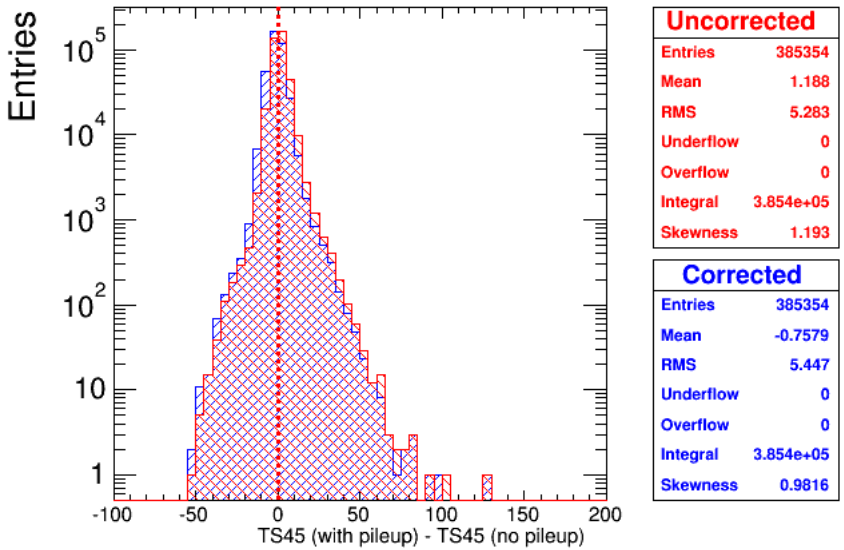
With correction applied



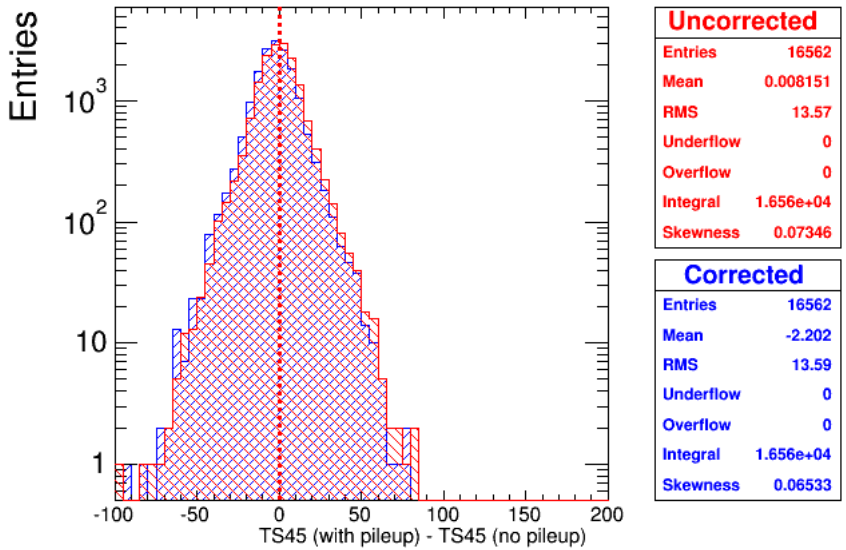
- Done on high pileup, QCD1800 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HE 17-20: 1D

TS4 < 50 fC



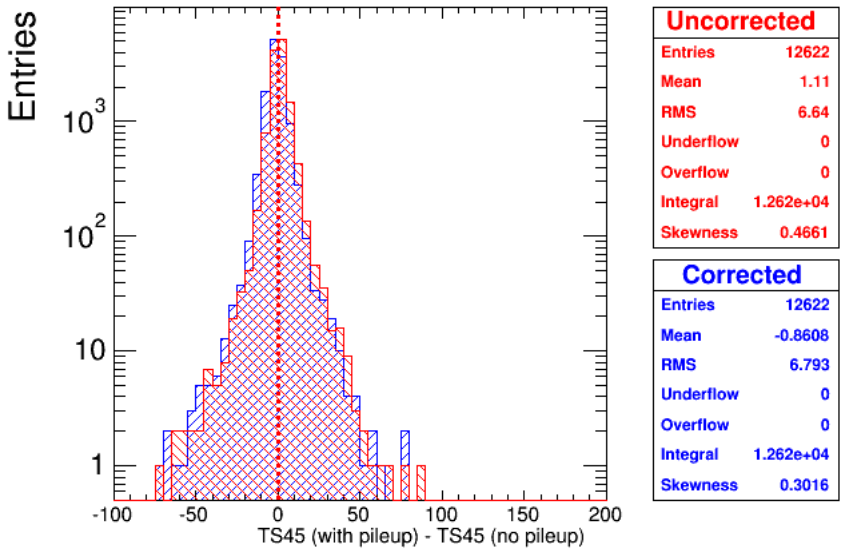
TS4 > 50 fC



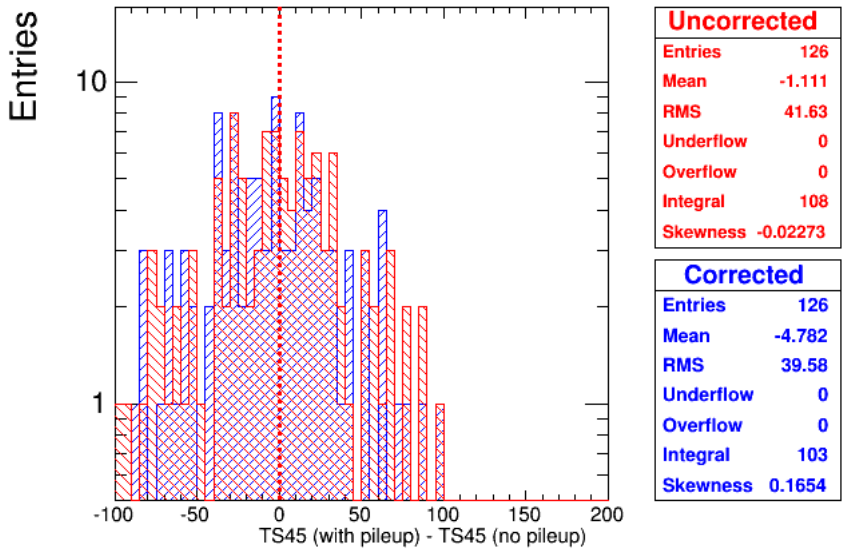
- Done on high pileup, QCD80to120 sample
- *x*-axis: TS45 true - TS45 pred, *y*-axis: Entries
- Start to see effect of corrections in the low-eta endcap

Results in HE 17-20: 1D

TS4 < 500 fC



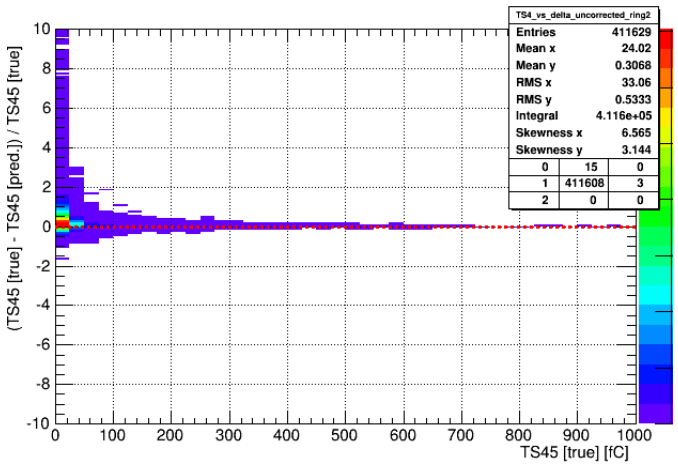
TS4 > 500 fC



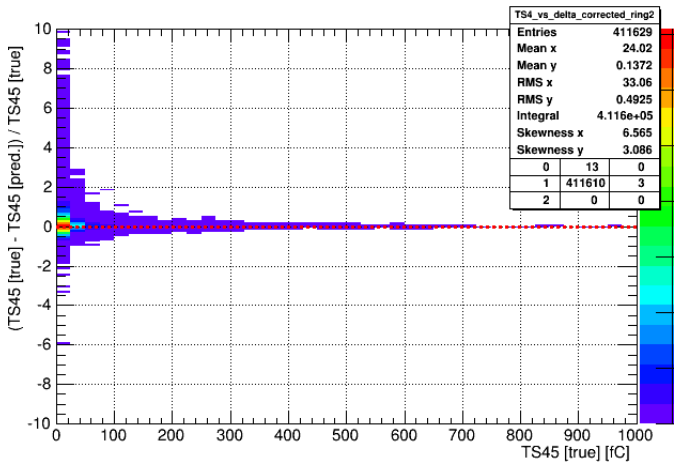
- Done on high pileup, QCD1800 sample
- x-axis: TS45 true - TS45 pred, y-axis: Entries
- Start to see effect of corrections in the low-eta endcap

Results in HE 21-23: 2D

No correction applied



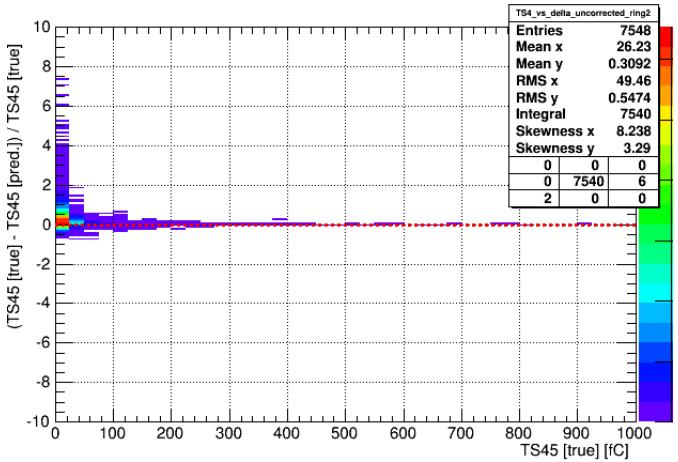
With correction applied



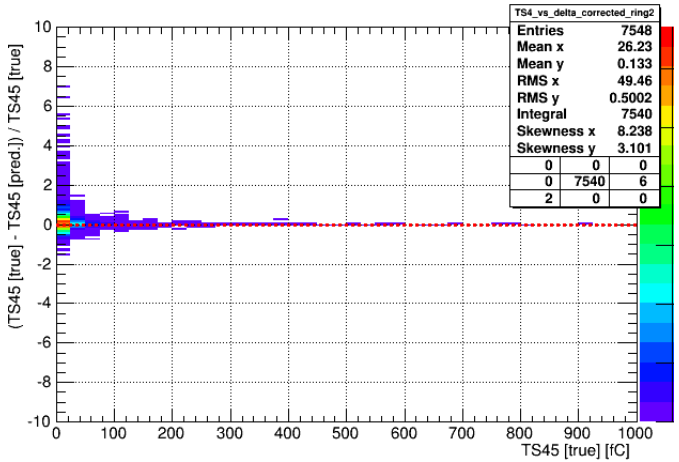
- Done on high pileup, QCD80to120 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HE 21-23: 2D

No correction applied



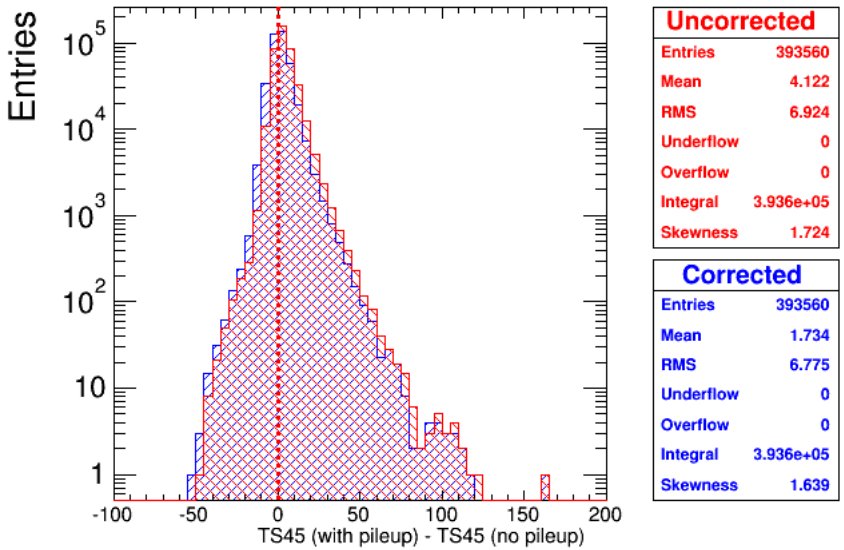
With correction applied



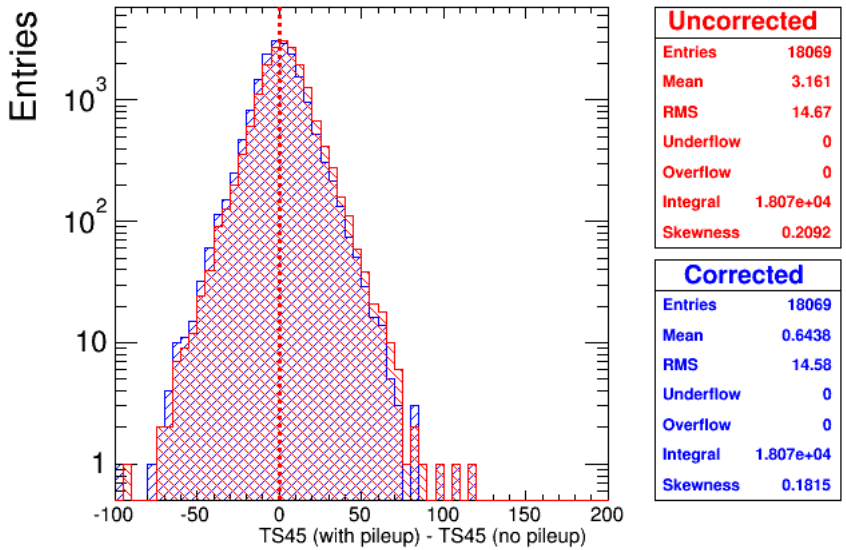
- Done on high pileup, QCD1800 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HE 21-23: 1D

TS4 < 50 fC



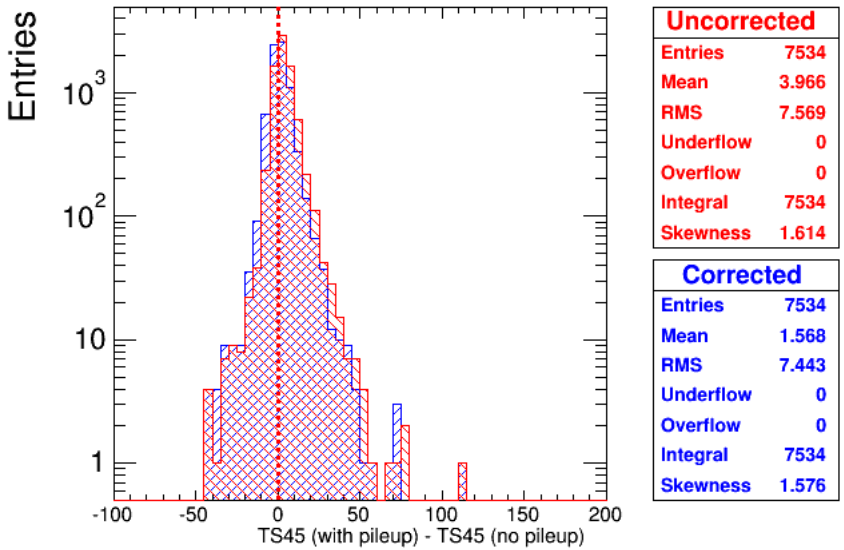
TS4 > 50 fC



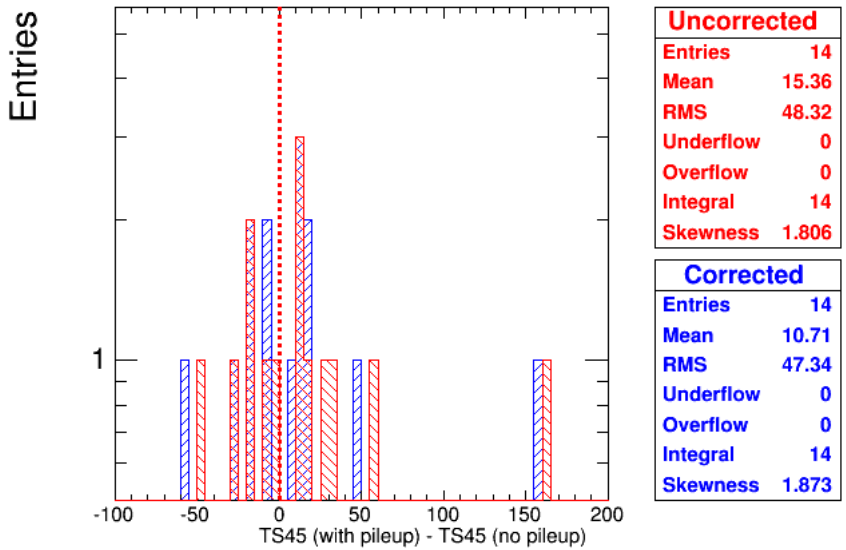
- Done on high pileup, QCD80to120 sample
- x-axis: TS45 true - TS45 pred, y-axis: Entries
- Start to see effect of corrections in the low-eta endcap

Results in HE 21-23: 1D

TS4 < 500 fC



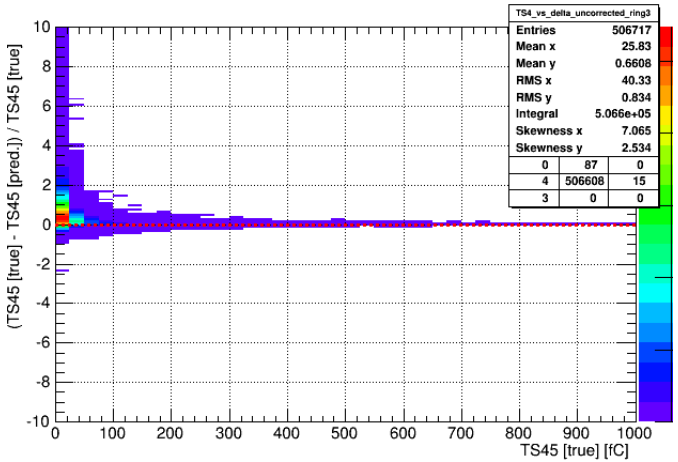
TS4 > 500 fC



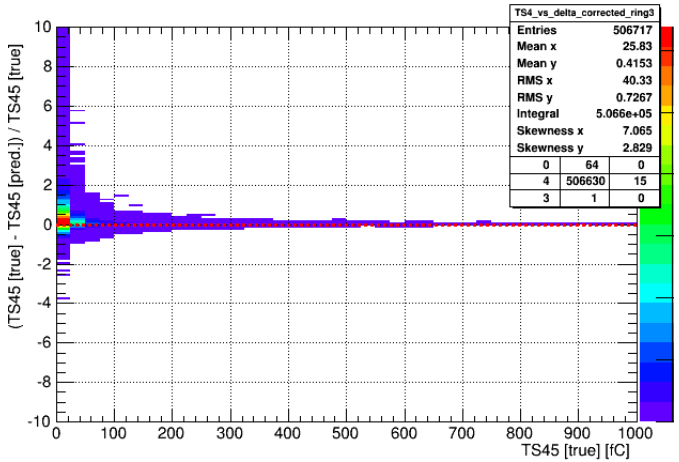
- Done on high pileup, QCD1800 sample
- *x*-axis: TS45 true - TS45 pred, *y*-axis: Entries
- Start to see effect of corrections in the low-eta endcap

Results in HE 24-25: 2D

No correction applied



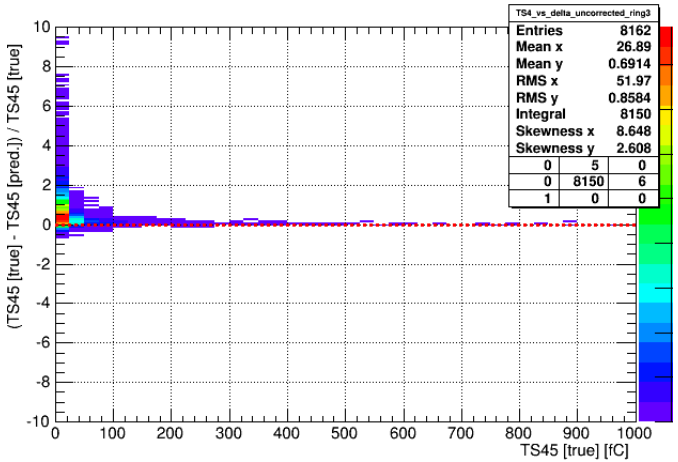
With correction applied



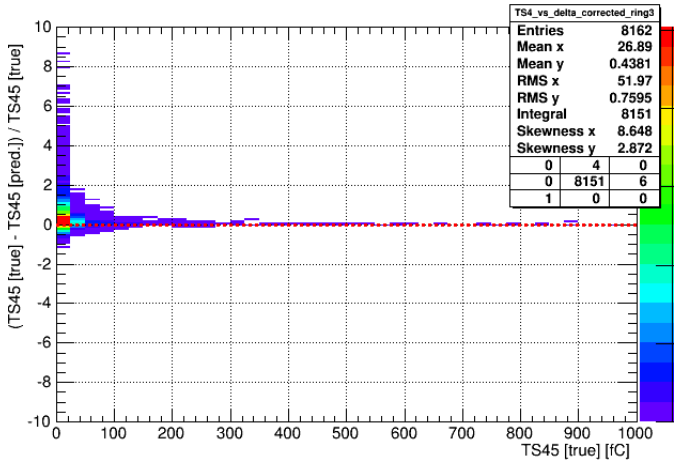
- Done on high pileup, QCD80to120 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HE 24-25: 2D

No correction applied



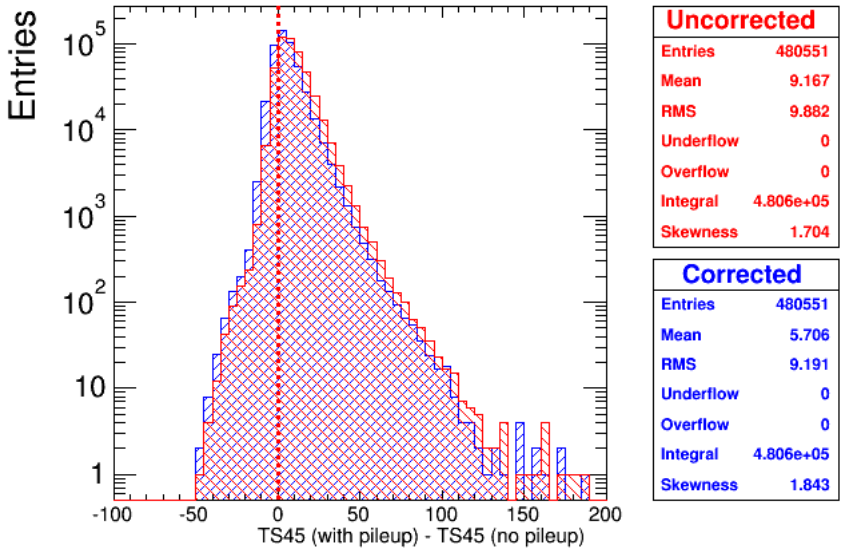
With correction applied



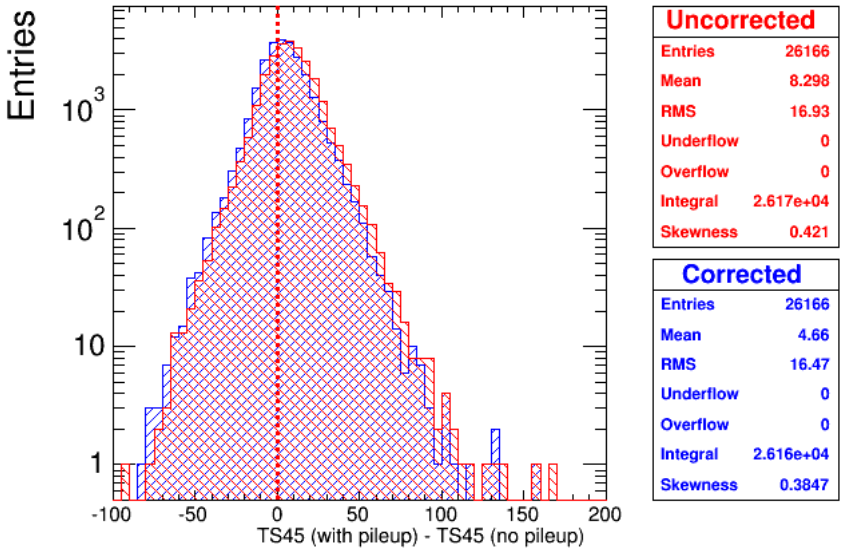
- Done on high pileup, QCD1800 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HE 24-25: 1D

TS4 < 50 fC



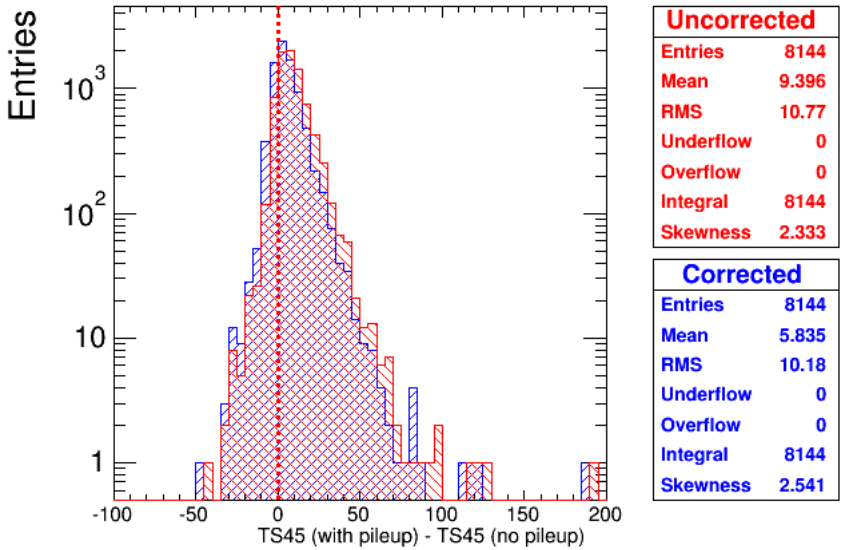
TS4 > 50 fC



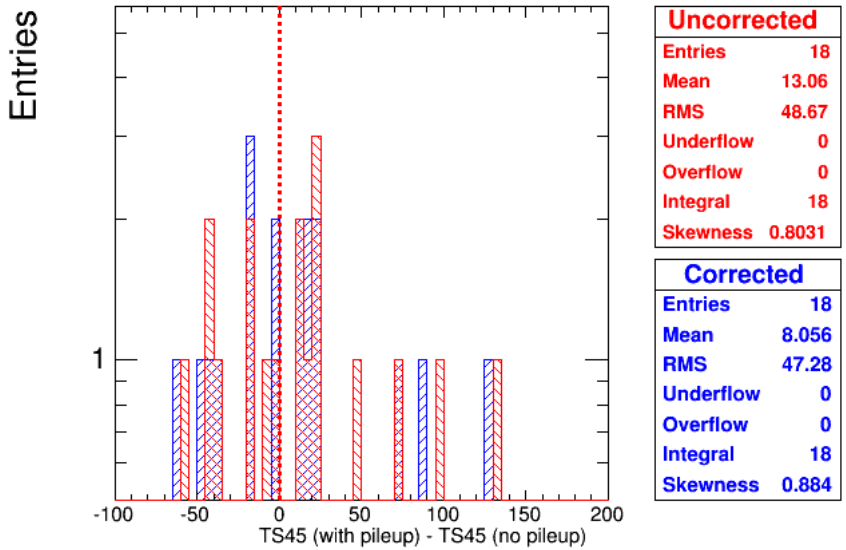
- Done on high pileup, QCD80to120 sample
- *x*-axis: TS45 true - TS45 pred, *y*-axis: Entries

Results in HE 24-25: 1D

TS4 < 500 fC



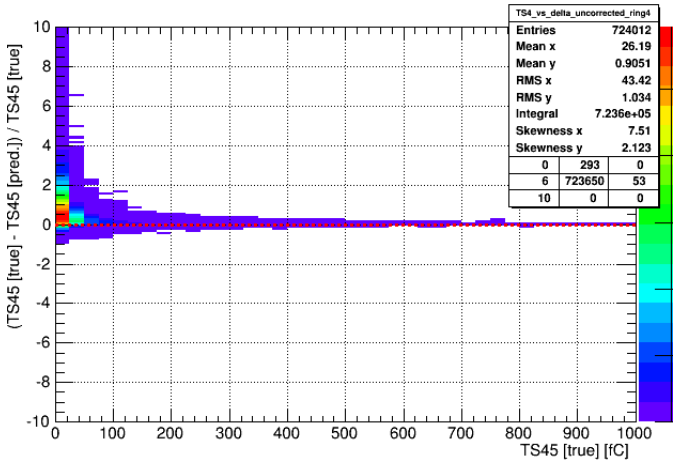
TS4 > 500 fC



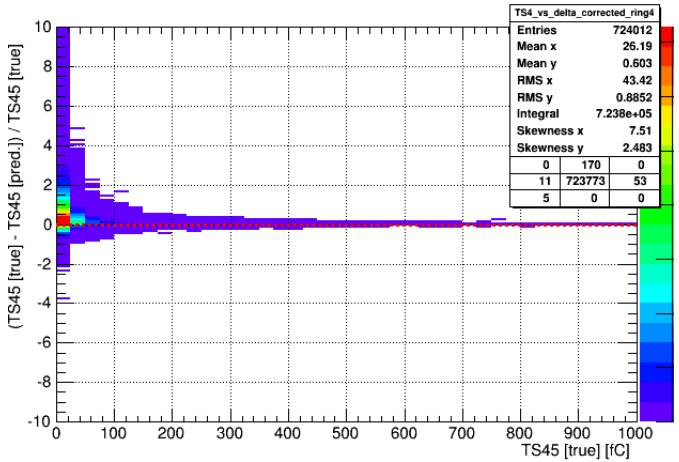
- Done on high pileup, QCD1800 sample
- *x*-axis: TS45 true - TS45 pred, *y*-axis: Entries

Results in HE 26-27: 2D

No correction applied



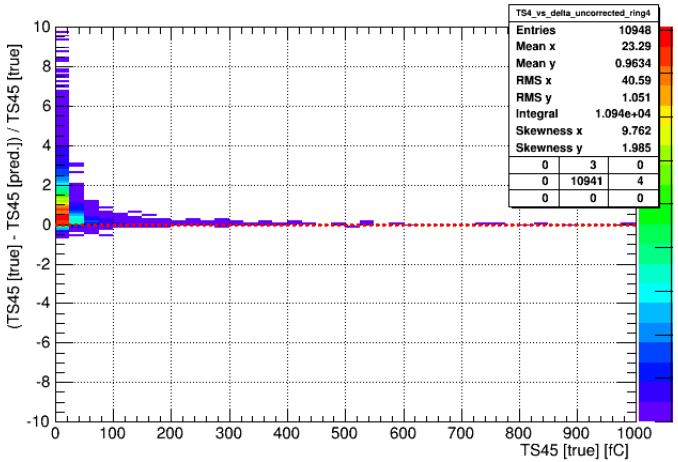
With correction applied



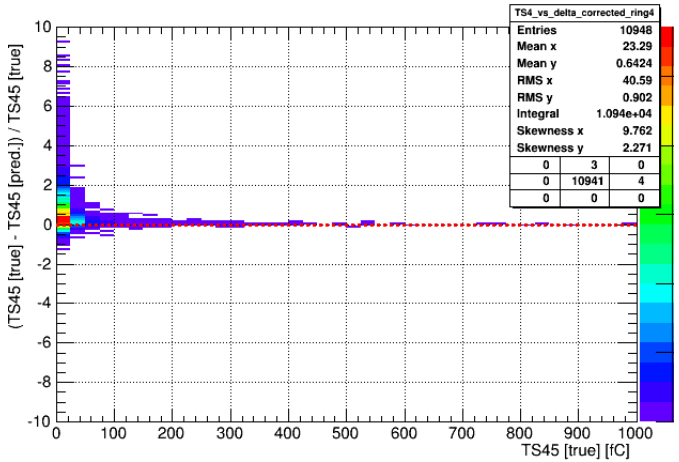
- Done on high pileup, QCD80to120 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HE 26-27: 2D

No correction applied



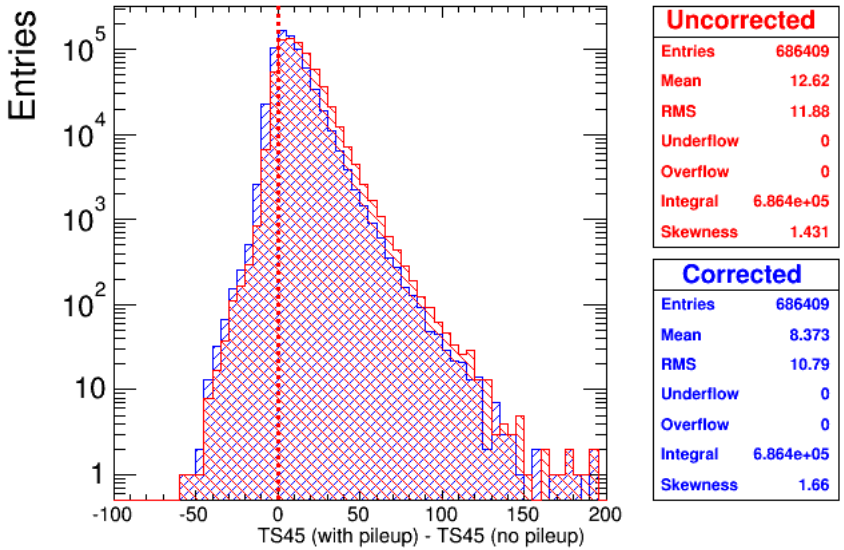
With correction applied



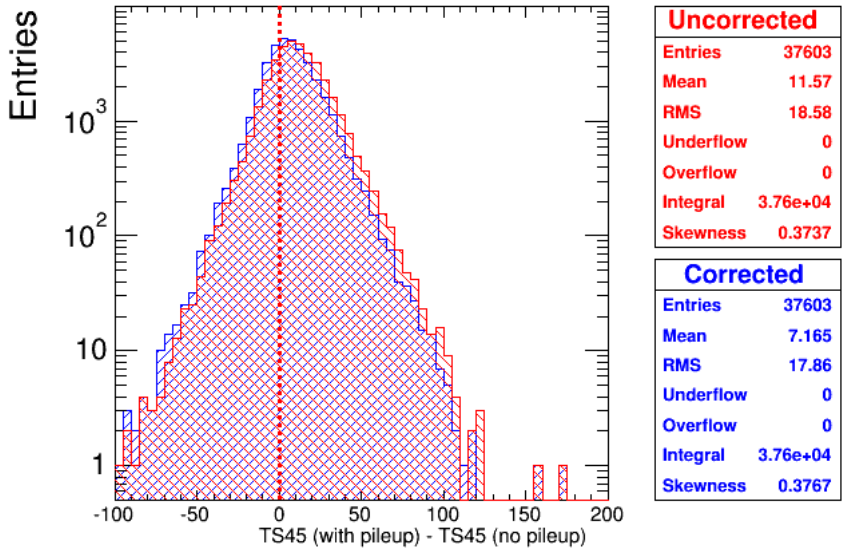
- Done on high pileup, QCD1800 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HE 26-27: 1D

TS4 < 50 fC



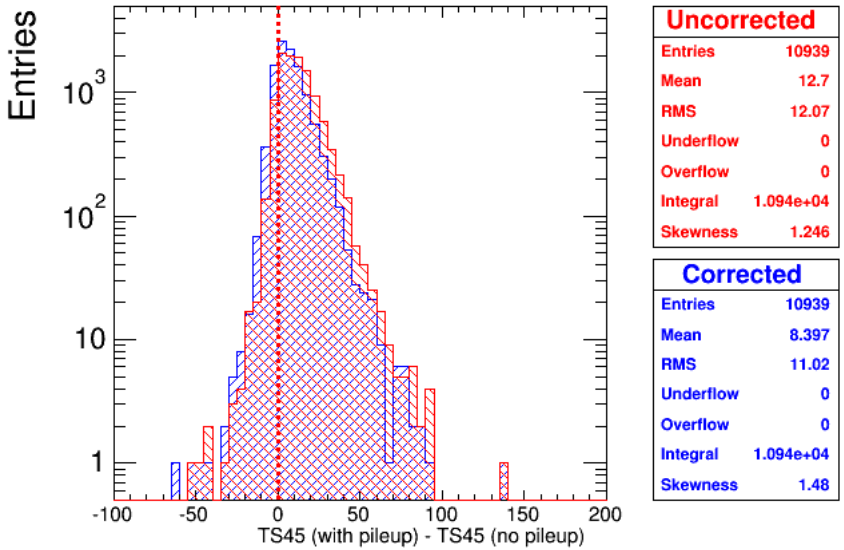
TS4 > 50 fC



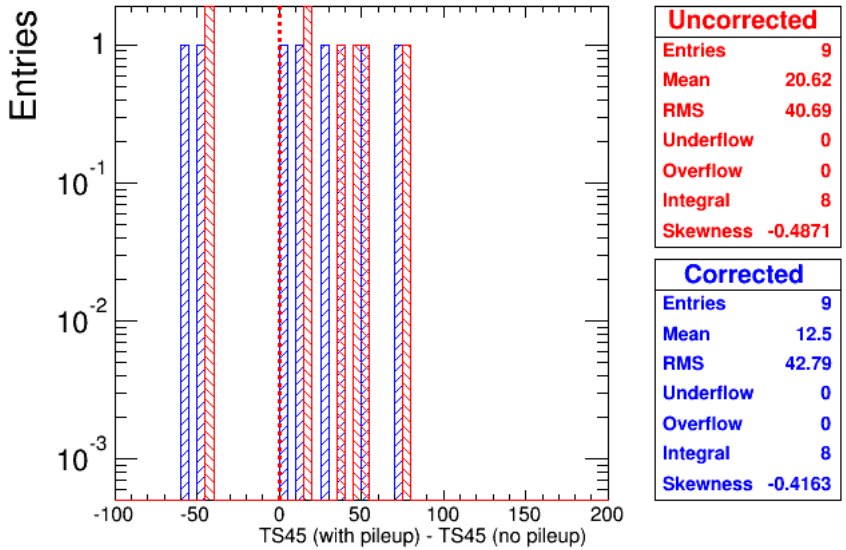
- Done on high pileup, QCD80to120 sample
- *x*-axis: TS45 true - TS45 pred, *y*-axis: Entries

Results in HE 26-27: 1D

TS4 < 500 fC



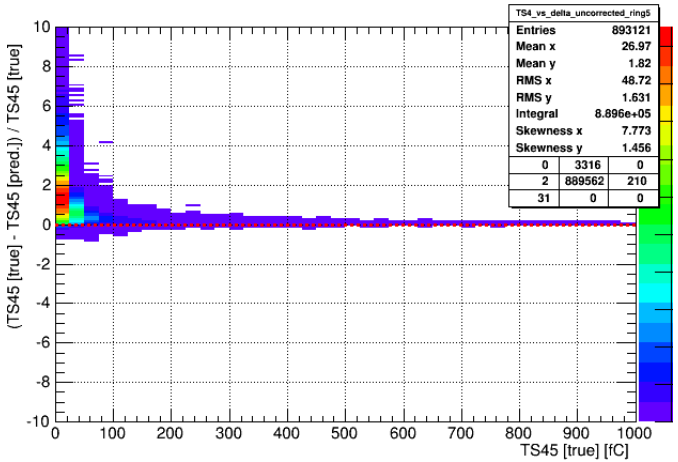
TS4 > 500 fC



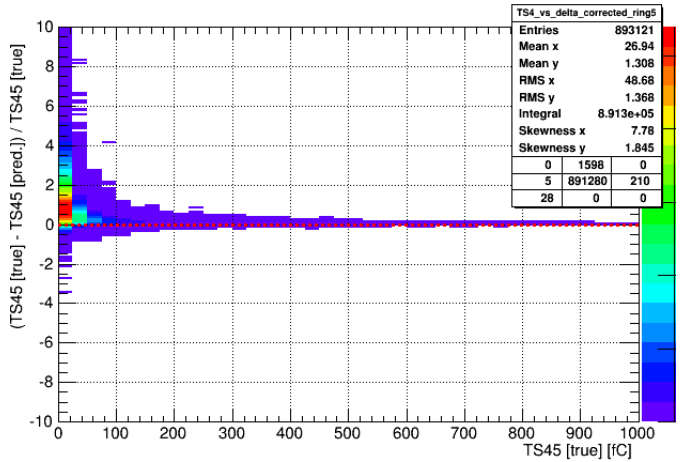
- Done on high pileup, QCD1800 sample
- x-axis: TS45 true - TS45 pred, y-axis: Entries

Results in HE 28-28: 2D

No correction applied



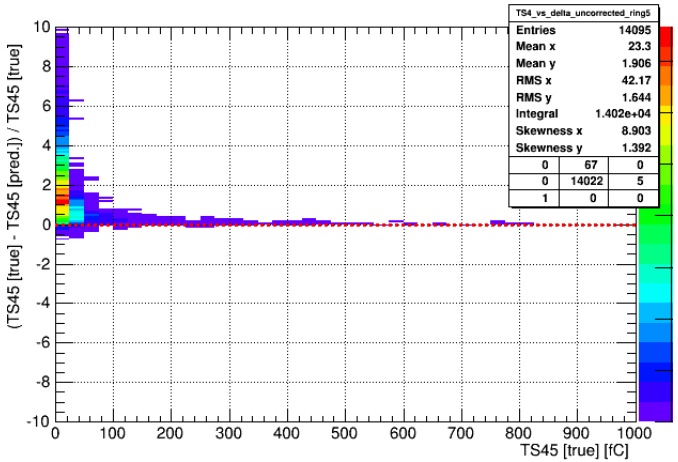
With correction applied



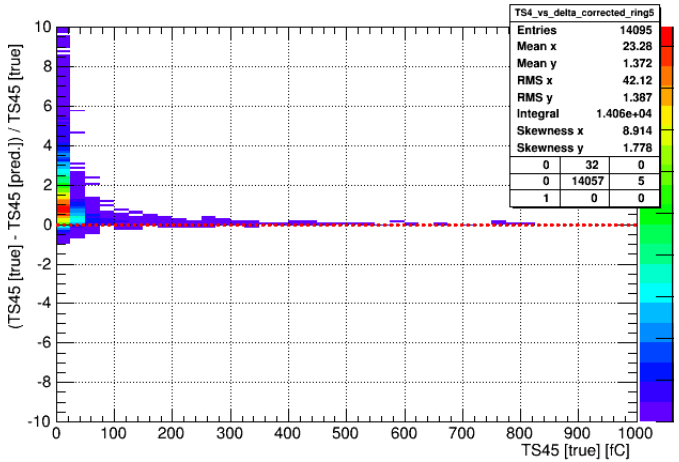
- Done on high pileup, QCD80to120 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HE 28-28: 2D

No correction applied



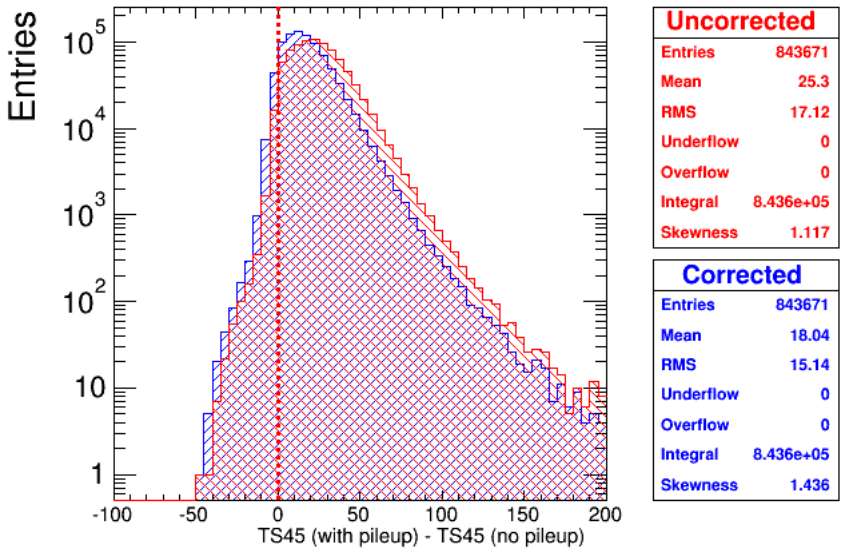
With correction applied



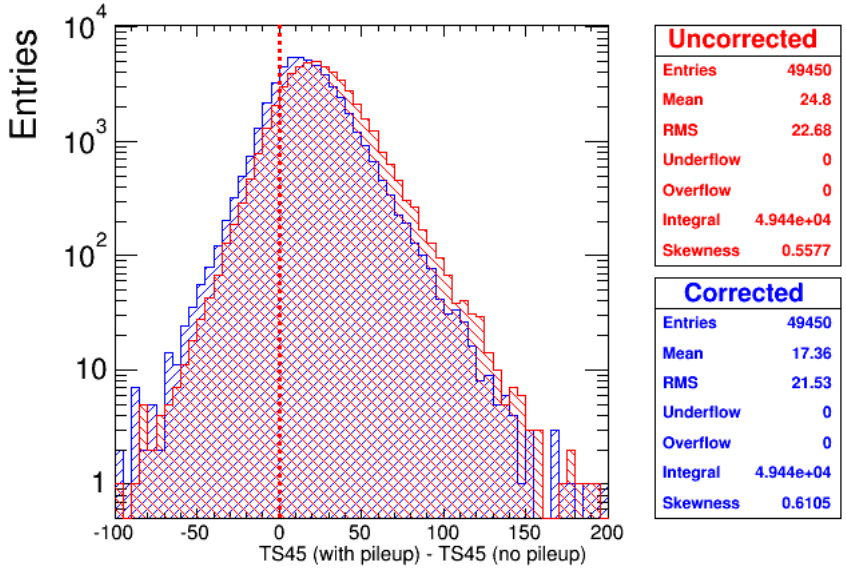
- Done on high pileup, QCD1800 sample
- *y*-axis: (TS45 true - TS45 pred.) / TS45 true
- *x*-axis: TS45 true

Results in HE 28-28: 1D

TS4 < 50 fC



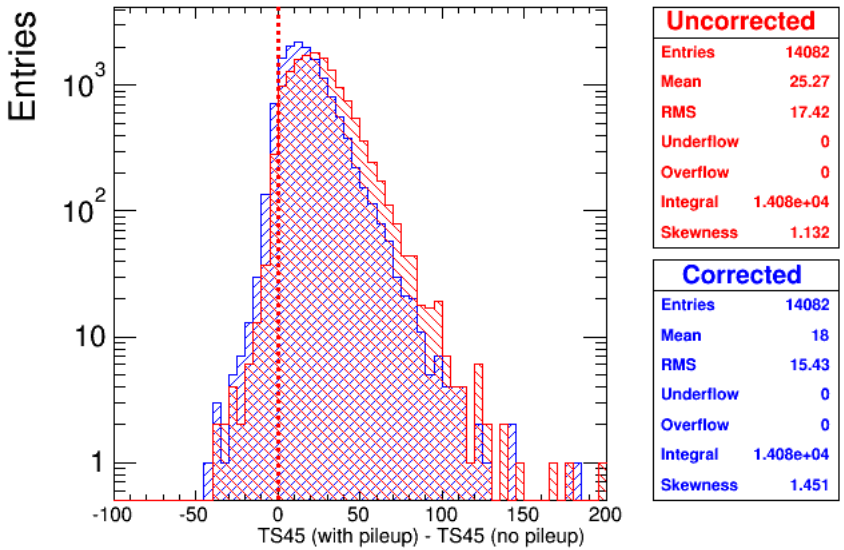
TS4 > 50 fC



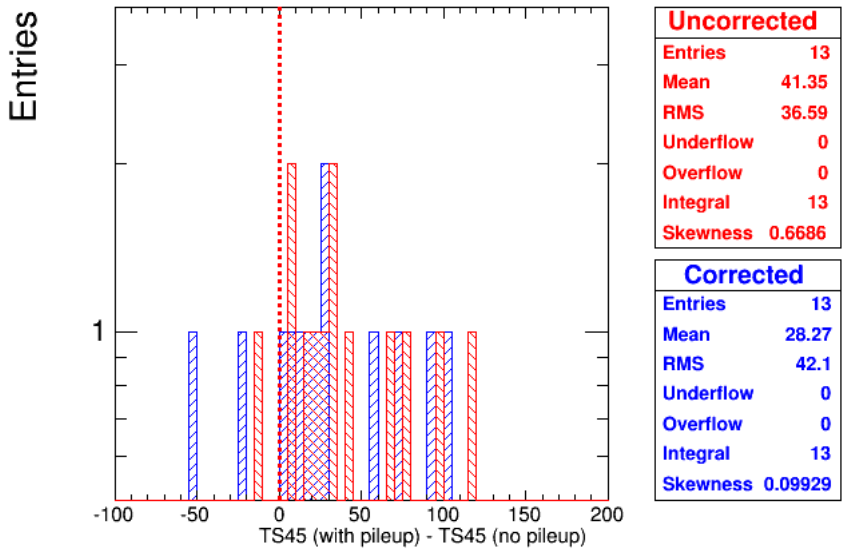
- Done on high pileup, QCD80to120 sample
- x-axis: TS45 true - TS45 pred, y-axis: Entries
- Effect of corrections is most dramatic here

Results in HE 28-28: 1D

TS4 < 500 fC



TS4 > 500 fC



- Done on high pileup, QCD1800 sample
- x-axis: TS45 true - TS45 pred, y-axis: Entries
- Effect of corrections is most dramatic here

Conclusion 1

- Processed zero-PU samples: OK for shape studies
- Processed high-PU samples: OK for validation
- Fit functions ready to go using Alexandre's method:
  - Improved over fit functions from earlier talks
  - Fit functions model the zero-PU pulse shapes well
  - Fit functions now predict the high-PU pulses well
- Pictures of all fits available here

Conclusion 2

- Pileup corrections help a bit, especially at high eta
- Three type of pileup to think about:
  - 1. OOT PU in TS3
  - 2. In-time PU
  - 3. OOT PU in TS5
- This method only helps with type 1
  - This correction offers improvement, not perfection
- Could we do better?
  - OOT PU in TS5: hard...
  - In-time PU: FastJet-type corrections
    - (subtract using density)?