

# HCAL Reconstruction: MC Correction Functions Update

Edmund Berry<sup>1</sup>

<sup>1</sup>Brown University

Tuesday, May 6, 2014



BROWN

# 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 two 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-1800 dataset:

- [DAS link](#)
- 93453 ( $\sim 100k$ ) events, 95 files
- HcalNoiseAnalyzer ntuples on FNAL EOS:  
/eos/uscms/store/user/eberry/QCD1800MC/

- MinBias dataset:

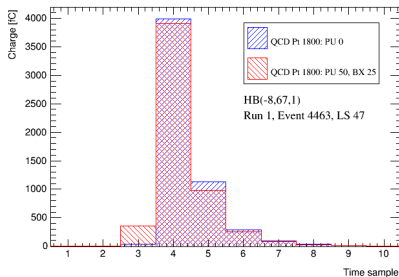
- [DAS link](#)
- 9999424 ( $\sim 10M$ ) events, 946 files
- HcalNoiseAnalyzer ntuples on FNAL EOS:  
/eos/uscms/store/user/eberry/MinBiasMC/

# Processing pileup sample

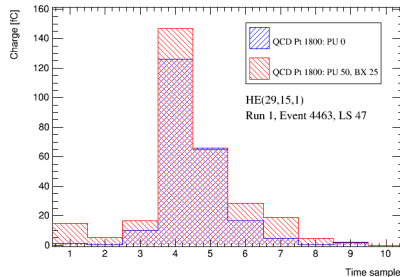
- Need to overlay QCD with MinBias
- Use `MixingModule` in `CMSSW_6_2_8`
- Pileup scenario: `AVE_50_BX_25ns`
- Two stages:
  - 1) DIGI, L1, DIGI2RAW, HLT
  - 2) RAW2DIGI L1Reco RECO
- Stage 1 all done: `cmsDriver` and `python cfg`
- Stage 2 part done: `cmsDriver` and `python cfg`
- High PU is **VERY**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

# PU vs. No PU single digi comparison

## single DIGI comparison: HB

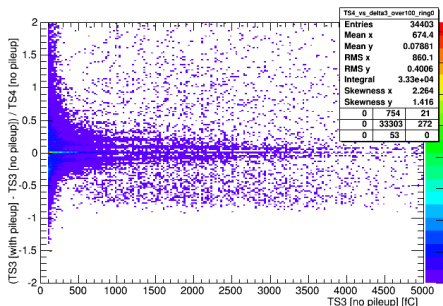


## single DIGI comparison: HE



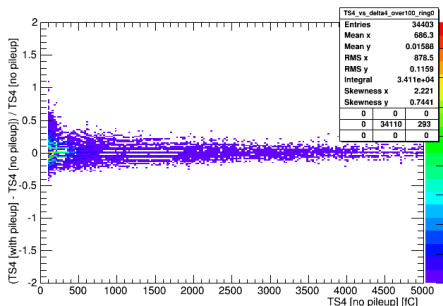
- HE as expected.
- HB as expected in TS3. Strangeness in TS4 + TS5.
- Bug in MixingModule? Investigating with M. Hildreth.

# PU vs. No PU broad comp.: TS3 in HB



- x-axis: TS3 no PU
- y-axis:  $(\text{TS3 with PU} - \text{TS3 no PU}) / \text{TS3 no PU}$

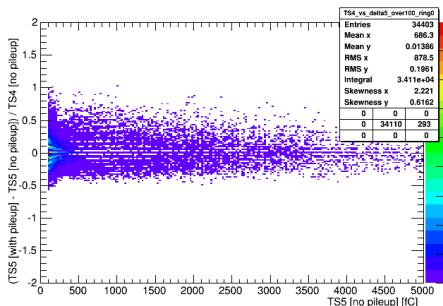
# PU vs. No PU broad comp.: TS4 in HB



- x-axis: TS4 no PU
- y-axis:  $(\text{TS4 with PU} - \text{TS4 no PU}) / \text{TS4 no PU}$

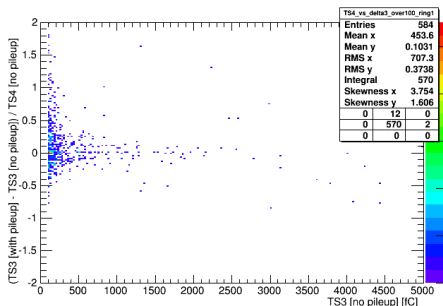


# PU vs. No PU broad comp.: TS5 in HB



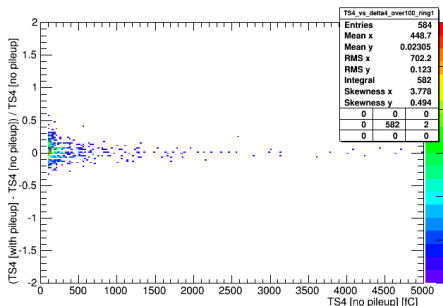
- x-axis: TS5 no PU
- y-axis:  $(\text{TS5 with PU} - \text{TS5 no PU}) / \text{TS5 no PU}$

# PU vs. No PU broad comp.: TS3 in HE 17:20



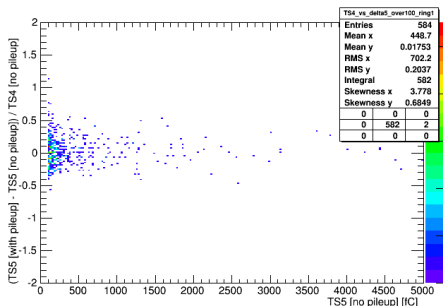
- x-axis: TS3 no PU
- y-axis:  $(TS3 \text{ with PU} - TS3 \text{ no PU}) / TS3 \text{ no PU}$

# PU vs. No PU broad comp.: TS4 in HE 17:20



- x-axis: TS4 no PU
- y-axis:  $(\text{TS4 with PU} - \text{TS4 no PU}) / \text{TS4 no PU}$

# PU vs. No PU broad comp.: TS5 in HE 17:20



- x-axis: TS5 no pileup
- y-axis:  $(TS5 \text{ with PU} - TS5 \text{ no pileup}) / TS5 \text{ no pileup}$

# Pileup conclusion

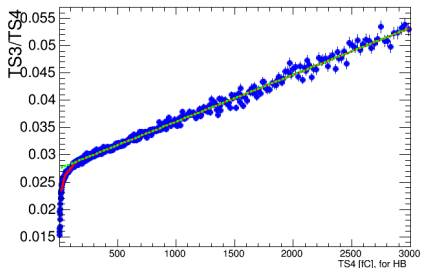
- It is strange that the PU digis are sometimes lower than no-PU digis
- M. Hildreth has seen the single DIGI plots and code
- More investigation required
- Have some pointers on where to look from M. Hildreth

# Fits

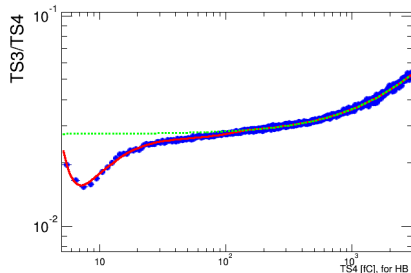
- Fits have been improved! Better agreement now.
- Parameters available on [GitHub](#)
- Same functions as Alexandre for a1, a2, a3
  - 6 polynomials: 1 for each of 6 regions
- For a\_1, this function works better on MC:
  - if  $x < [6]$ :  $f(x) = [0] \cdot \text{Exp}([1] + [2] \cdot x) + [3] + [4] \cdot x$
  - 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)



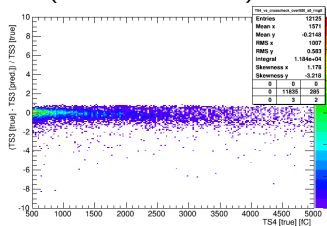
## Fit of a\_1 in HB (log)



- Fit done on zero pileup sample
- Fits now extend to  $TS4 = 3000$  fC
- Parameters available on [GitHub](#)

## Function validation on zero pileup sample: a 1

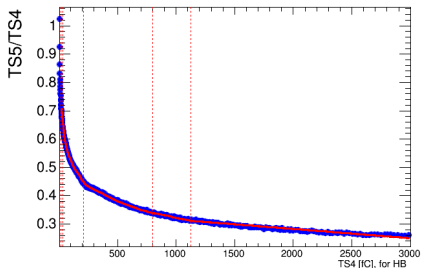
Validation of a\_1 in HB  
(TS4 > 500 fC)



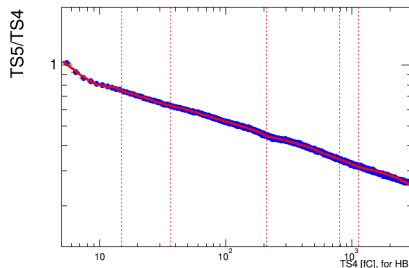


# Function fitting on zero pileup sample: a1

## Fit of a1 in HB (lin)



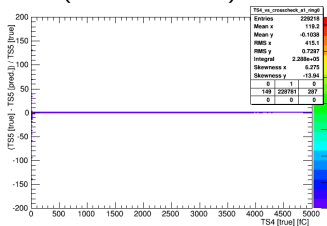
## Fit of a1 in HB (log)



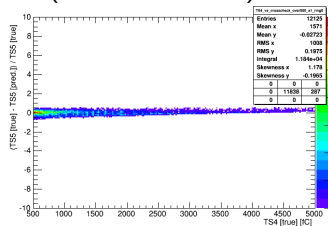
- Fit done on zero pileup sample
- Red lines correspond to fit ranges (Alexandre's functions)
- Parameters available on [GitHub](#)

# Function validation on zero pileup sample: a1

Validation of a1 in HB  
(TS4 > 0 fC)



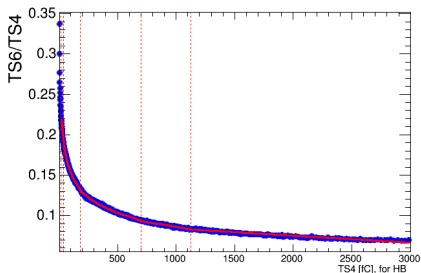
Validation of a1 in HB  
(TS4 > 500 fC)



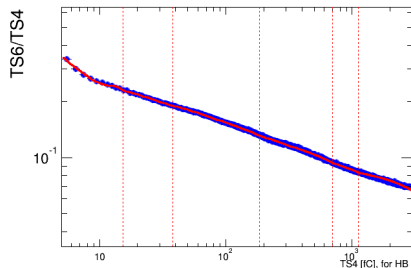
- Done on zero pileup sample
- y-axis: (TS5 true - TS5 pred.) / TS5 true
- x-axis: TS4 true
- Better performance than a\_1

# Function fitting on zero pileup sample: a2

## Fit of a2 in HB (lin)



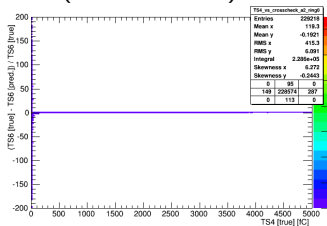
## Fit of a2 in HB (log)



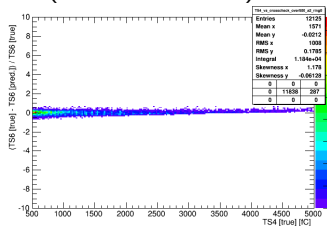
- Fit done on zero pileup sample
- Red lines correspond to fit ranges (Alexandre's functions)
- Parameters available on [GitHub](#)

## Function validation on zero pileup sample: a2

Validation of a2 in HB  
(TS4 > 0 fC)



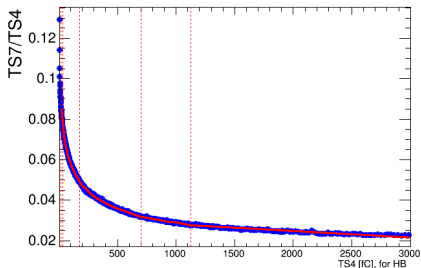
Validation of a2 in HB  
(TS4 > 500 fC)



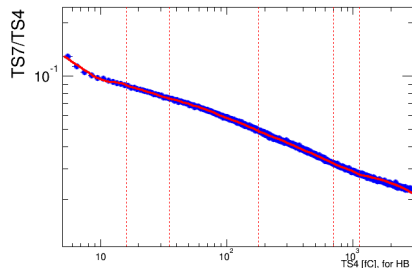
- Done on zero pileup sample
- y-axis:  $(\text{TS6 true} - \text{TS6 pred.}) / \text{TS6 true}$
- x-axis: TS4 true
- Better performance than a 1

# Function fitting on zero pileup sample: a3

## Fit of a3 in HB (lin)

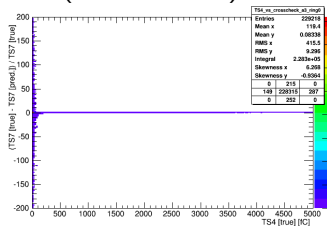


## Fit of a3 in HB (log)

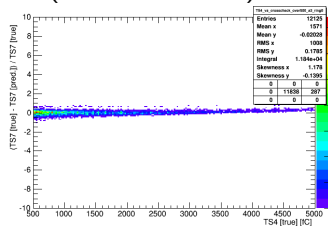


- Fit done on zero pileup sample
- Red lines correspond to fit ranges (Alexandre's functions)
- Parameters available on [GitHub](#)

## Function validation on zero pileup sample: a3

Validation of a3 in HB  
(TS4 > 0 fC)

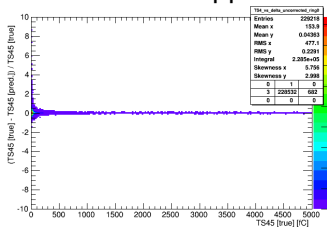
Validation of a3 in HB  
(TS4 > 500 fC)



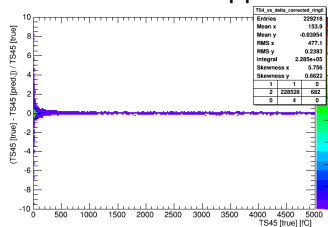
- Done on zero pileup sample
- y-axis:  $(\text{TS7 true} - \text{TS7 pred.}) / \text{TS7 true}$
- x-axis: TS4 true
- Better performance than a 1

# Results in HB

## No correction applied



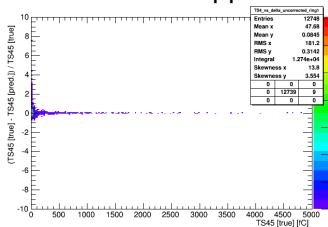
## With correction applied



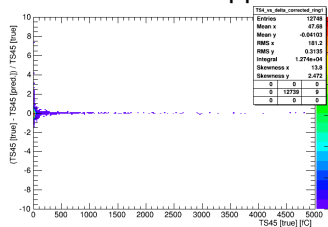
- Done on high pileup sample
- y-axis:  $(TS45 \text{ true} - TS45 \text{ pred.}) / TS45 \text{ true}$
- x-axis: TS45 true
- Large disc. for  $TS45 > 1000 \text{ fC}$  (where fits are good)

## Results in HE: 17:20

No correction applied



With correction applied



- Done on high pileup sample
- y-axis:  $(TS45 \text{ true} - TS45 \text{ pred.}) / TS45 \text{ true}$
- x-axis: TS45 true
- Need more statistics to see if problems from HB persist



# Conclusion

- 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
- Method now passes sanity checks!
- Separate: strange features observed after MixingModule
  - MC with PU often has less charge than MC without PU
  - Investigating with pointers from M. Hildreth
- Suggestion: look at QCD 80-120
  - Working on this (still processing)