Comparing ZS to VR

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Overview

- In order to validate the zero suppression done in the FED:
  
  - Previously, Puneeth Kalavase studied this with one module on the x-y table; the fibers were split and sent to two FEDs, one with and one without zero suppression. (See http://indico.cern.ch/conferenceDisplay.py?confId=15243).
  
  - I have compared an interleaved set of TIF cosmic runs taken in VR and ZS mode: runs 6502=VR, 6505=ZS, 6507=VR).
Reminder of ZS algorithm

• Each channel has two thresholds:
  – LowThresh = 2*noise, e.g.
  – HiThresh = 5*noise, e.g.
• Any channel with ADC>HiThresh passes.
• Any channel with ADC>LowThresh passes if its neighbor also has ADC>LoThresh.
• Any channel between two passed channels also passes.
• Neighbor checking does not cross chip boundaries.
• All done after pedestal subtraction and CM subtraction.
Pedestals and Noise

- Simulating zero suppression requires the pedestals and noise.
- I calculate these myself because it is easier to do and to understand what I did.
- I mask from consideration any channels with anomalous noise.
Pedestals and Noise

Bad channel masking requires care to avoid masking the wings.

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Apply event-by-event pedestal fits to suppress common-mode and wing noise.
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Correct for gain variation by normalizing all chips to have the same average noise.

Call a strip bad unless $3.2 < N < 4.8$

That masks about 0.2% of channels.
Compare ZS to VRsimZS

Fairly good agreement at first look.

A few things to note:
  FED’s ZS gives a bump at 130. Known low pedestal effect.
  Overflow bin at 254. New in simulation.
  Not too good at low charge.
Compare ZS to VRsimZS

Look at TIB only.

Simulation is shifted left.

Real ZS has a shoulder between 15 and 20.

This shoulder can be suppressed by masking a few modules. I will work to understand those particular modules later.
Compare ZS to VRsimZS

Look at TOB only.

At low charge, simulation is shifted left.

There is a large shoulder (probably from the, non-gaussian, wing noise) that is reasonably well modelled.
Understanding the shift

The shift of ADC-PED in the simulation looks like I am mis-measuring the pedestals and the noise.

The agreement is improved by:
- Decreasing the pedestals by -0.3 in TIB and -0.7 in TOB.
- Increasing the noise by x1.08

While trying to understand why the pedestals and noise are different, I observed time dependence in the pedestals…
Time-dependent pedestals

In VR runs, pedestals oscillate.

Shown here is one TIB module.

There are 100 events * 768 chan
So the uncertainty on each bin is about 0.01. Variation is statistically significant.
In VR run, pedestals oscillate.

TOB (overlaid in red) has a different signature but some correlation with TIB.

The differences are small, e.g., less than the noise. But, a pedestal shift will have a large effect on the occupancy after zero suppression…
The oscillating pedestals cause oscillating occupancy.

One hypothesis is that varying laser temperatures cause gain changes. But, I should see that in the ZS run, and I do not.

Gain changes should be common mode and so removed by CMS.

Replacing the SiStripMedianCommonModeNoiseSubtraction with homegrown code fixes the occupancy variation.

Investigating. Correct peds for now.
Time-dependent occupancy

Just for fun, here is what happens in this weekend’s run for the same two modules.
Compare ZS to VRsimZS

After correcting the pedestals and noise, the simulated ZS matches the real ZS reasonably well in TIB.

![Graph showing comparison between ADC minus pedestal in TIB for VR and ZS runs.](Image)
Compare ZS to VRsimZS

After correcting the pedestals and noise, the simulated ZS matches the real ZS reasonably well in TIB and TOB.
Compare ZS to VRsimZS

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Note that this is number of passed strips in the whole run, not percent occupancy.

I’ll show average percent occupancy later.
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Effect of higher thresholds

With a reasonably validated simulation, we can study the effect of higher thresholds.
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~0.07% at the nominal threshold
~0.007% at Thr=3.

I estimate that the irreducible cosmic contribution is 0.005%.

Noise occupancy will be negligible even in min bias.

Normalization is only valid for Chan<512
Effect of higher thresholds

With a reasonably validated simulation, we can study the effect of higher thresholds.
Effect of higher thresholds

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~0.1% at the nominal threshold
~0.01% at Thr=3.

I estimate that the irreducible cosmic contribution is 0.005%.

Noise occupancy will be negligible in min bias, with appropriate Thr.
Landau’s for comparison

VR run 6507
ZS run 6505
Conclusions

Zero suppression simulation “mostly” matches FED output after some tweaks.

There are some details still to be understood.

Pedestal variations observed and thought to be due to temperature dependent gain variations.

Noise occupancy is quite low and can be made negligible with slightly higher thresholds.

Still to do:
  - Understand pedestal shift
  - Check anomalous modules and bad channels