BCAL Simulation

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Action Items

1. Investigate and possibly modify the simulation to include a time/energy profile of the shower in a cell in order to more accurately represent real data timing
   Status: ongoing

2. Confirm 17ns mean time is understood for data sample shown
   Status: Confirmed (see next slide)

3. Understand source of 600 count pedestal and 8.5 count width in SiPM test data
   Is the current leading to the 600 count create a problem?
   Status: Spoke with Fernando: Offset between pre-amp and fADC adustable

4. Find status of BCAL discriminators (leading edge or constant fraction and is it a final decision)
   Status: Spoke with Fernando: This has been finalized to be LE

5. Write down suggested procedure for determining thresholds based on fixed bandwidth requirement and circulate via e-mail
   Status: ongoing (see later slides)

6. Modify BCAL calibration constants in repository to reflect most recent SiPM measurements
   Confirm first that they correspond to expected operating mode
   Status: nearly complete (see slides)

7. Send out details (including code) used to determine BCAL reconstruction efficiency
   *Status: Complete*

Mean time

2. Confirm 17ns mean time is understood for data sample shown

- For photons incident on the center of the BCAL at 90°
  - Time of flight from R=0 to R=64.3+3 cm
    - 67.3cm / 30cm/ns = 2.24 ns
  - Propagation time to end of BCAL
    - 195cm / 16.75cm/ns = 11.64 ns
  - Total time:
    - 2.24 ns + 11.64 ns = 13.88 ns

Single fADC (Downstream)

Max: 14.06
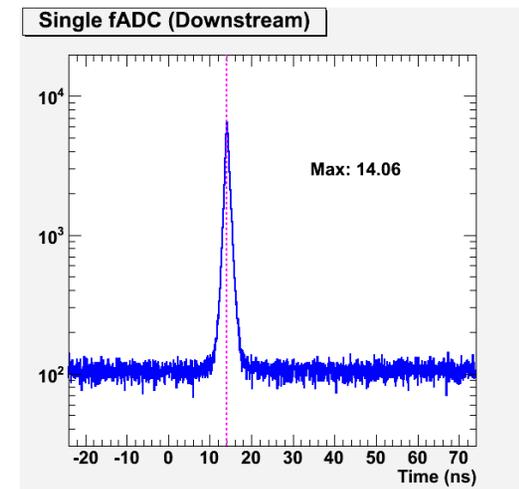
Source of Pedestal Width

From GlueX-doc-1754:

measured pedestal width: 8.6/61.7 = 0.139
(or 13.9% of single PE signal)

The source of this width is assumed to be a combination of electronic noise from:

SiPM – width increase like sqrt(N_{tiles})
pre-amp – width does not increase with N_{tiles}

The top plot shows the two extremes of the pedestal width being due to the pre-amp only or the SiPM only

The bottom plot shows integrated spectrum of the top with thresholds based on 120 dark hits/event (fine segmentation)

The difference between the two thresholds is <0.25 PE or < 200keV

Conclusion: The source of the pedestal width plays a minor role in determining the threshold for fine segmentation scheme.
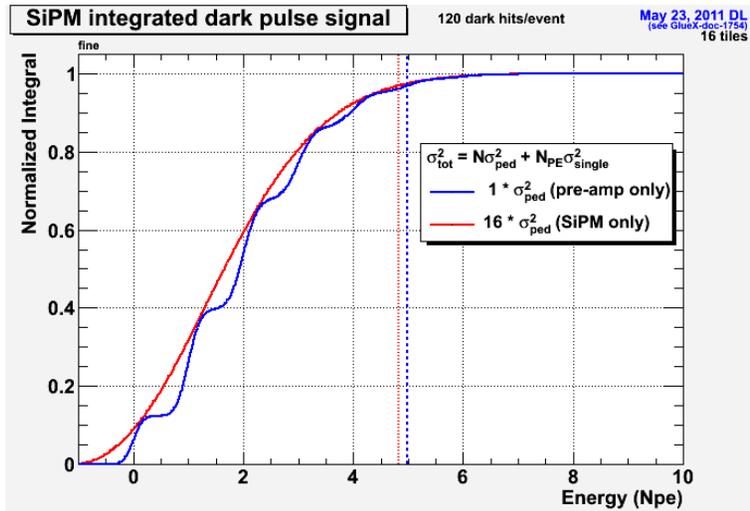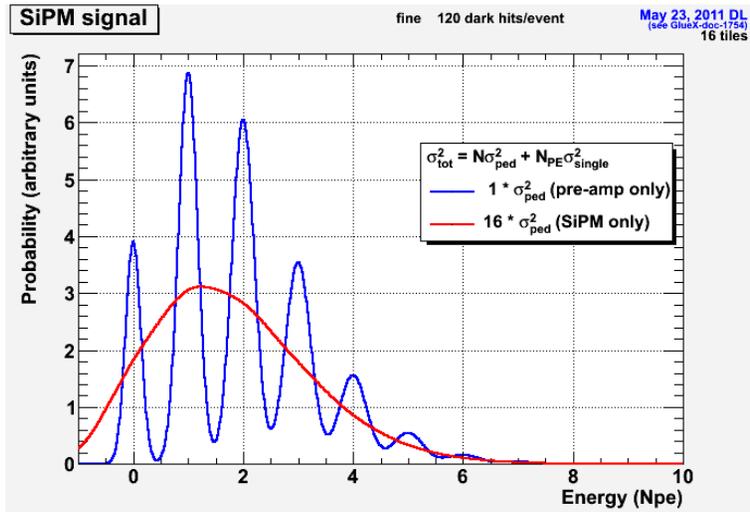
Source of Pedestal Width For Course Segmentation
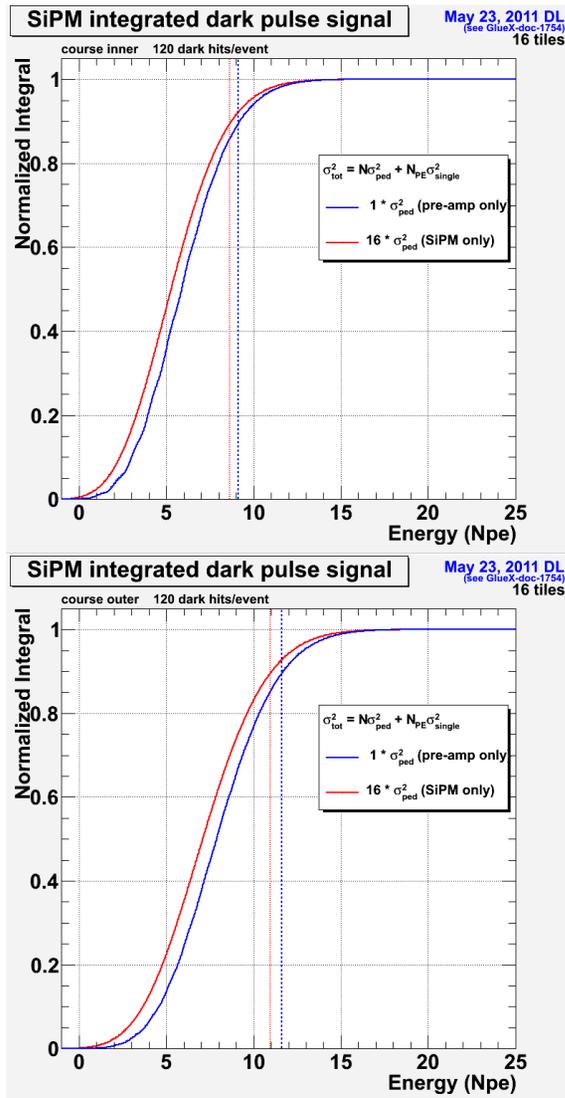
Course segmentation scheme sums 3 or 4 SiPM signals corresponding to the inner and outer regions respectively

Top plot is sum of 3 (inner) and bottom is sum of 4 (outer)

Assuming 120 dark hits per event, these plots show the integrated signals seen by the discriminators for the inner and outer regions

In both cases, the threshold is changed by about 0.5 PE or less corresponding to a difference of <375keV

Conclusion: The source of the pedestal width plays a minor role in determining the threshold for course segmentation scheme.

Determining the threshold

Total number of SiPMs: 48*2*(6*4 + 4*4) = 3840

Summed channels, Inner: 48*2*(2*4) = 768
Summed channels, Outer: 48*2*(2*2) = 384

Digitized values/hit Inner: 3
Digitized values/hit Outer: 2

Digitized values/event from BCAL: 120*2 = 240
(from last week's proposed scheme which kept 1 ADC and 1 TDC value)

Ratio of dark hits to summed channels kept same for inner and outer:

$$N_{digi} = 3N_{inner} + 2N_{outer} \qquad \frac{N_{inner}}{768} = \frac{N_{outer}}{384} \qquad \left. \begin{array}{l} N_{inner} \approx 69 \\ N_{outer} \approx 34 \end{array} \right\rangle \; 103$$

Recommendation: Fix the average number of digitized values from BCAL per event due to dark hits at 240 values/event.
(real hits will add to this)

Updates to CalibDB

Several values are about to be updated in the calibDB based on new SiPM measurements (and some not-so-new values)

Name	Old	New
BCAL_DARKRATE_GHZ	0.041	0.0176
BCAL_XTALK_FRACT	0.03	0.157
BCAL_DEVICEPDE	0.12	0.21
BCAL_SAMPLING_FRACT	0.15	0.125
BCAL_SIGMA_SIG_REALTIVE	-	0.105
BCAL_SIGMA_PED_REALTIVE	-	0.139
BCAL_AVG_DARK_DIGI_VALS_PER_EVENT	-	240
BCAL_MAXOCCUPANCY_FRACT	0.05	-
BCAL_CELLOUTERTHRESHOLD	0.001	-
Bcal_CellInnerThreshold	0.	-

Next Steps

- Finish implementing code in mcsmear to calculate threshold based on fixed number of digitized values due to dark hits

- Repeat Sascha's M.C. calculation of expected BCAL digitized values/event as function of threshold

- Continue investigation of angle resolution due to timing for both segmentation schemes