

# BCAL Smearing

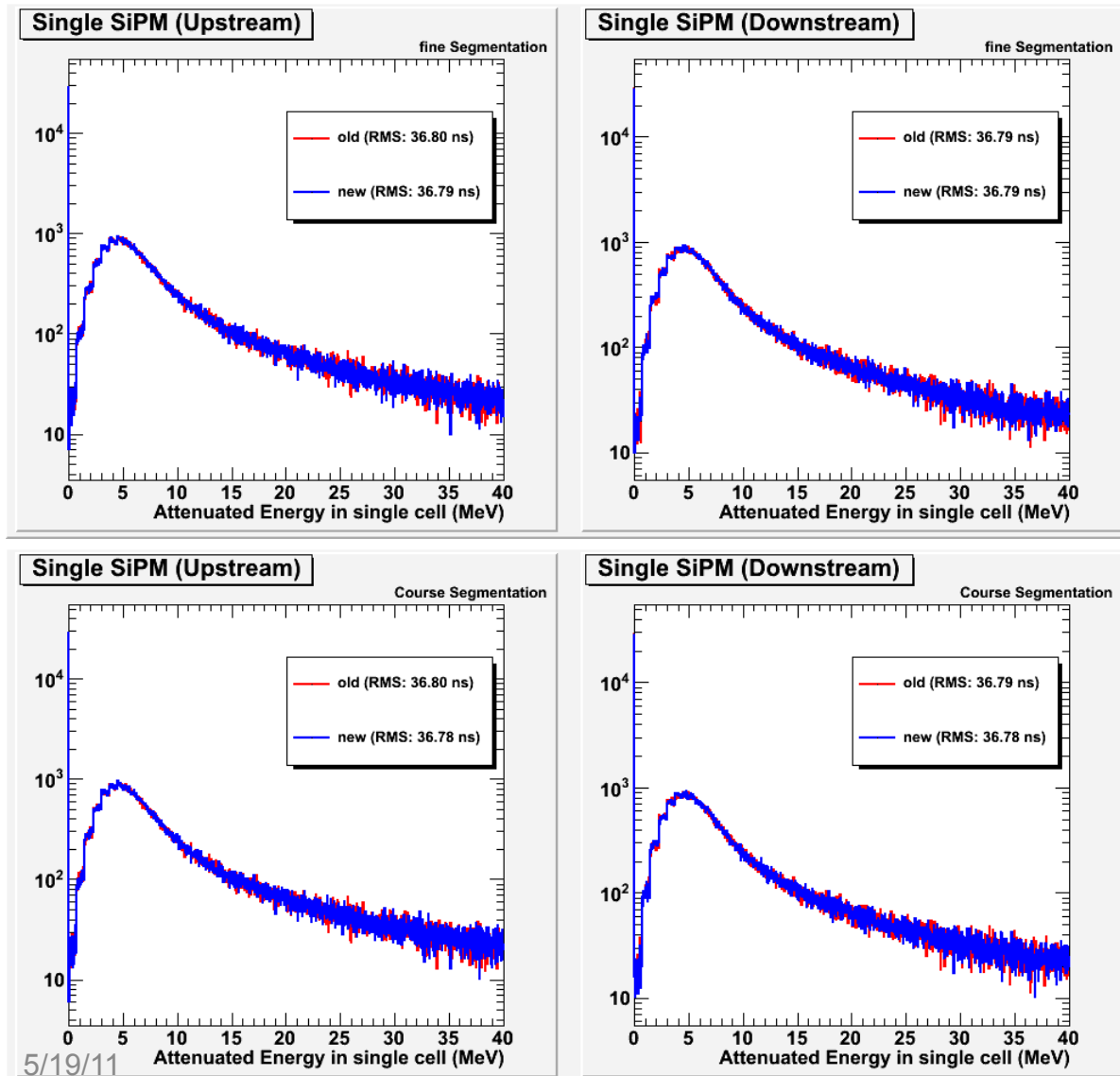
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# Introduction

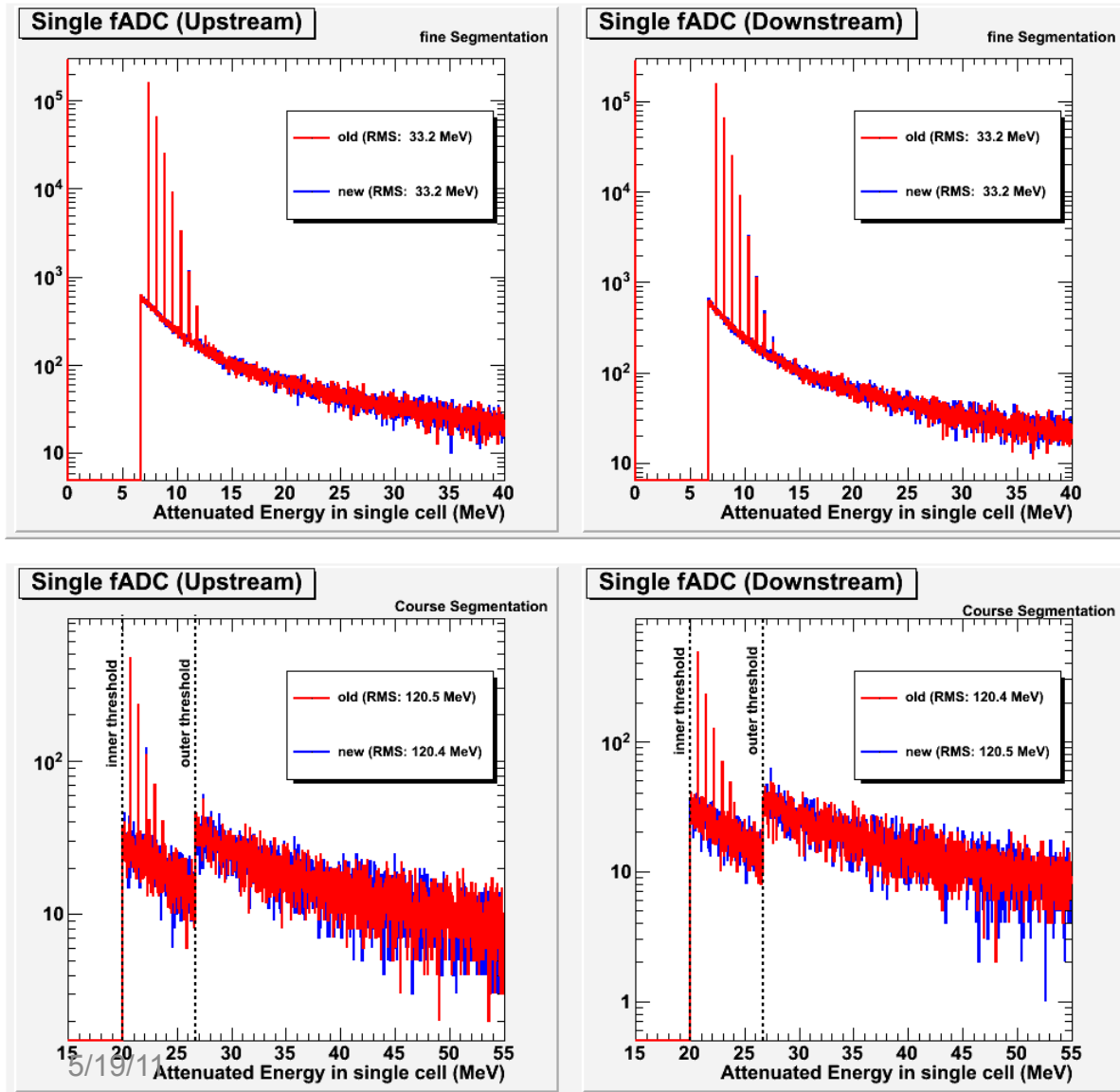
- The BCAL is different from most detector systems in that it requires significantly more processing outside of *hdgeant*
- Only deposited energy in each cell is recorded by *hdgeant*. **Attenuation, sampling fluctuations, dark pulse hits, SiPM summing, and discriminator thresholds** are all implemented in *mcsmeas*
- The BCAL specific code in *mcsmeas* was broken off into a separate file and then much of the content re-written to make it easier to modify for the forthcoming MC studies
- The following slides will show a comparison between the new code and the old code followed by some modifications that add more realism

# Single SiPM Energy



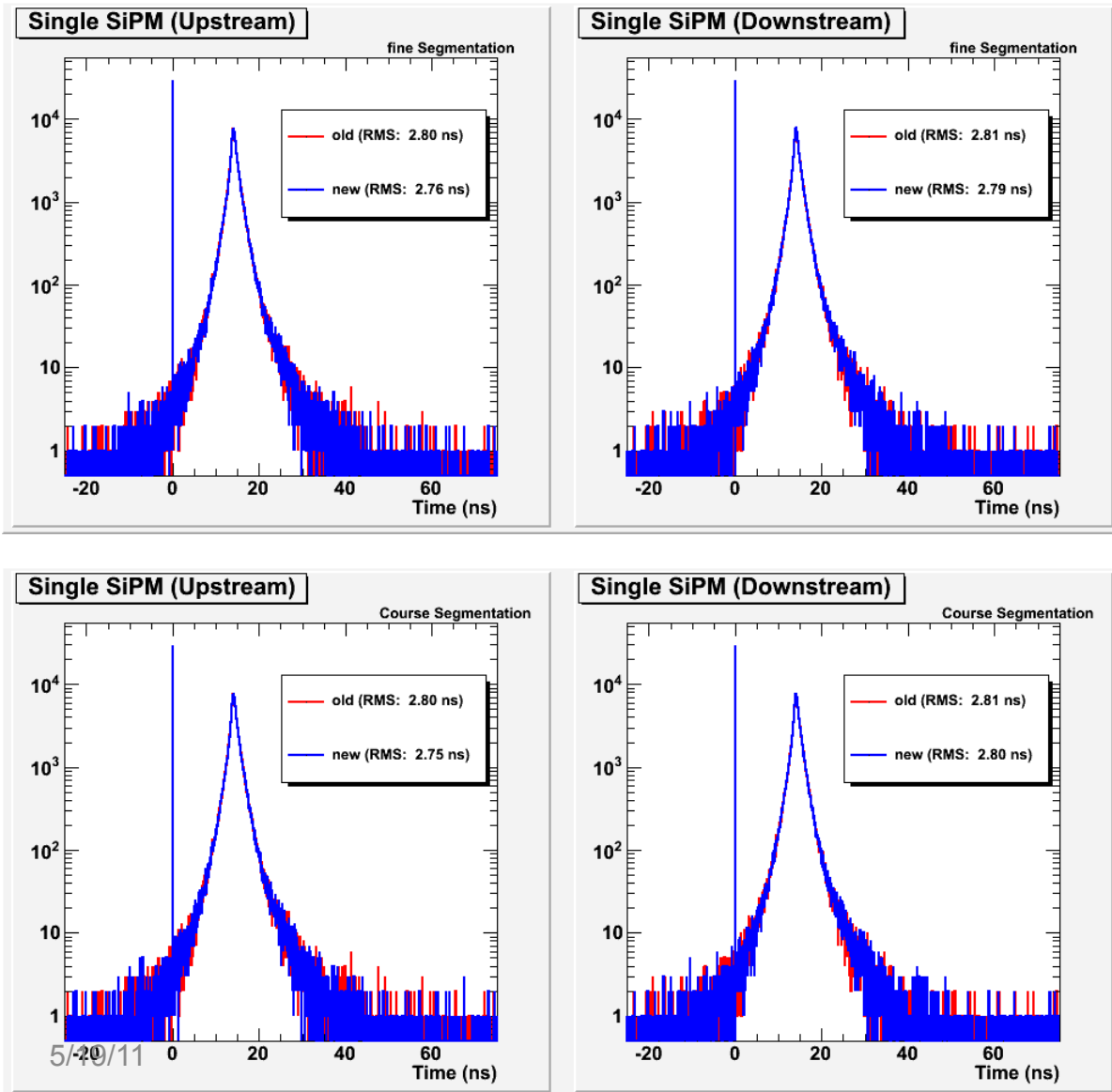
- Continuum due to energy deposition
- No threshold applied at this stage
- Steps on left side due to dark pulses being added with discrete energy values
- RMS values exclude hits with zero energy

# Summed cells for fADC



- Continuum due to energy deposition
- Sharp cutoffs due to thresholds
- Discrete spikes due to fADC channels with dark pulses only (no energy deposition)
- RMS values exclude hits with zero energy

# Single SiPM timing



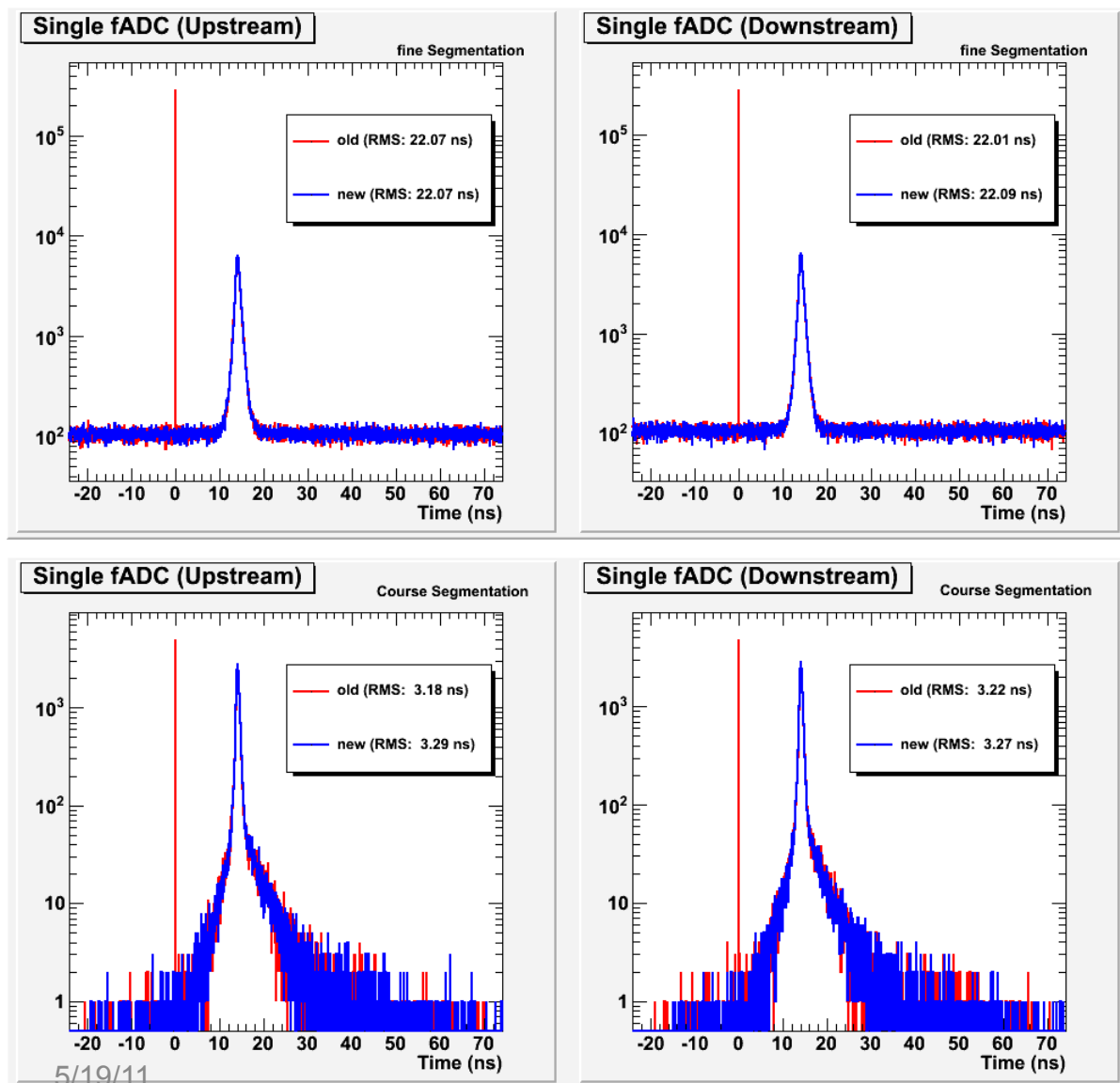
- Individual SiPM hits do not have a threshold applied (they are considered “truth” information)

- SiPM distributions should be the same for both segmentation schemes. These plots just verify this.

- Only cells which hdgeant reports had energy deposited are included here

- RMS values exclude hits at t=0

# Summed cells timing for TDC



- Single SiPMs have dark hit times assigned randomly from -25ns to 75ns

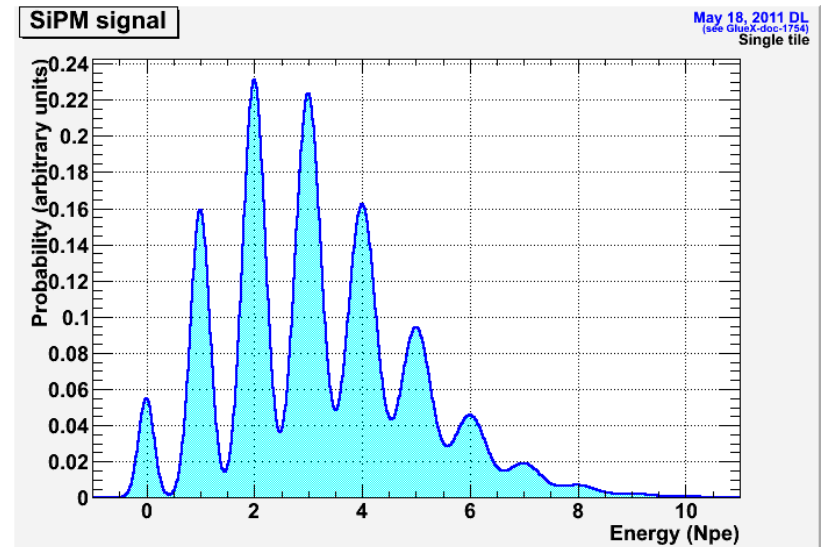
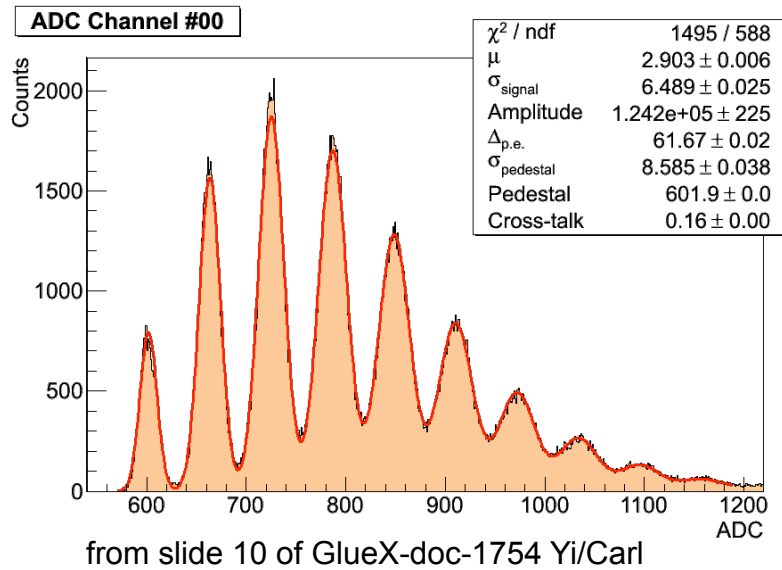
- Summed cells with only dark hits will then have a peaked distribution centered at +25ns

- If any energy is deposited in the cell, the dark pulses for that cell are treated as occurring at the same time as the deposited energy

- New code drops fADC hits with  $E < \text{thresh}$  rather than report them as  $E=0, t=0$

- RMS values exclude hits at  $t=0$

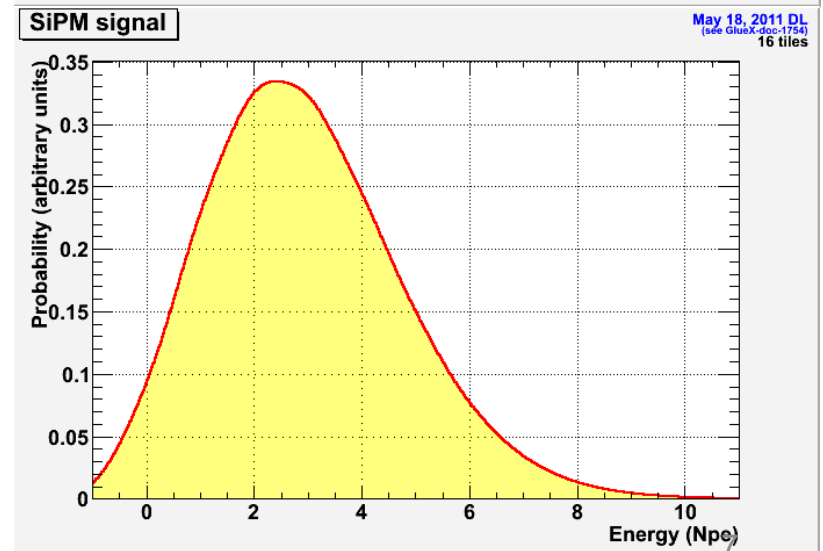
# Connection to SiPM tests



The top two plots indicate the single tile distribution of a SiPM readout where the number of photoelectrons is clearly visible.

The bottom shows what happens when the pedestal sigma is widened by sqrt(16) to account for a 4x4 array.

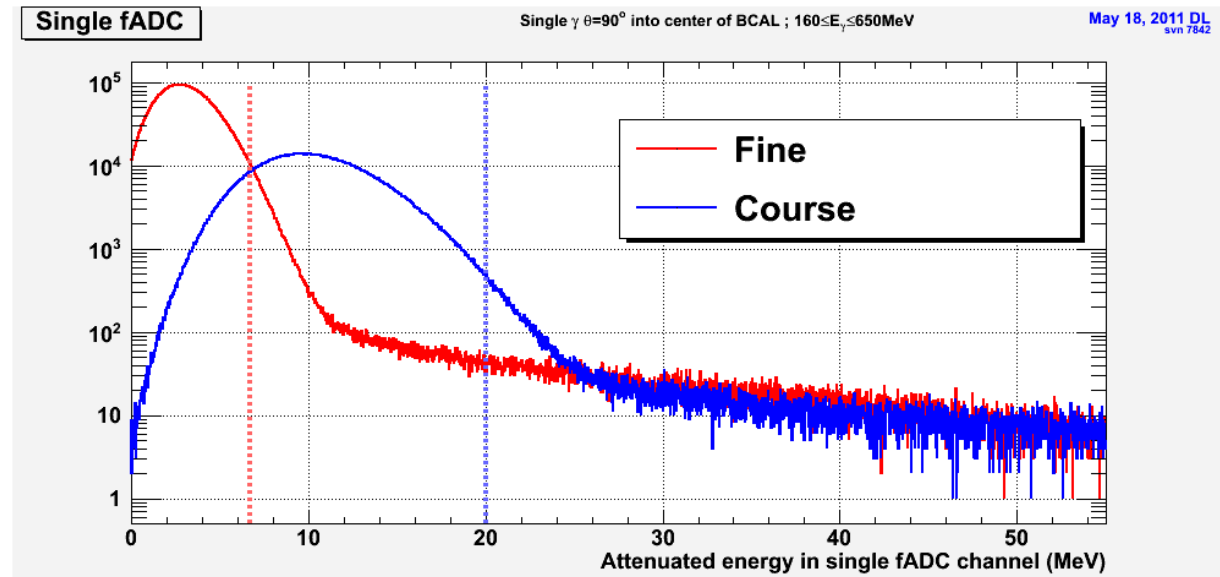
*n.b. the mean of the Poisson scaling function used for the bottom plot is NOT scaled by 16 for purposes of illustration*



# Smearred Dark Hits

Attenuated energy presented to the discriminator for both segmentation schemes

Dark hits are now properly smeared with a sigma calculated using the number of photoelectrons



Inner channel thresholds are shown as calculated using the classic code

For the course segmentation, the threshold calculated for fine was simply scaled by 3 (i.e. the number of summed SiPMs)



# Determining the threshold

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

Original estimate for occupancy:  $3840*5\% = 192$  hits/event  
*(this includes real hits and dark-pulse only hits)*

Avg. number of BCAL hits per event from L1 trigger simulations: 84 hits/event  
*(real hits only see GlueX-doc-1043)*

Total GlueX event size: ~15kB

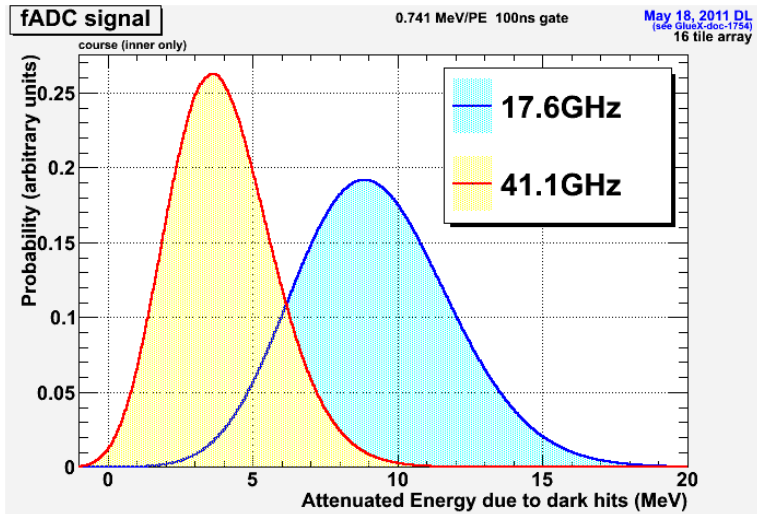
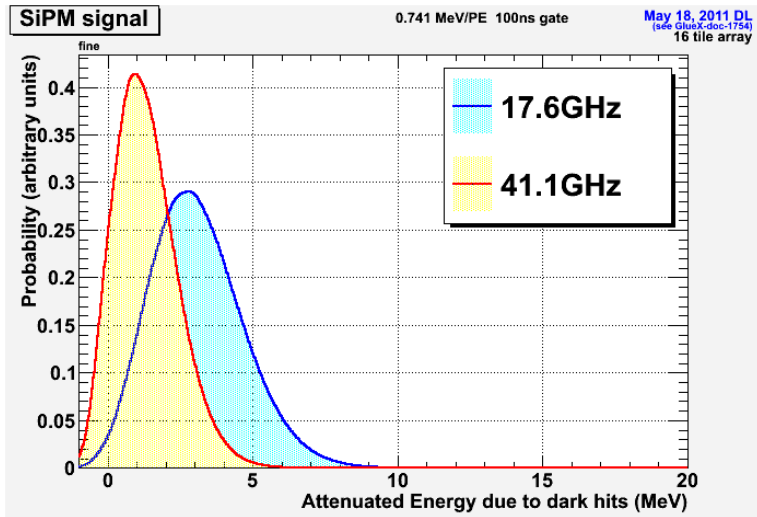
Contribution from BCAL fADC and TDC hits:  $84*2*4 = 672$  bytes/event

Contribution for 192 hits/event rate:  $192*2*4 = 1,536$  bytes/event

Increase in nominal event size: from ~15kB to ~15.8kB or 5.6%

**Recommendation:** Fix the average number of BCAL hits per event due to dark noise at 120 hits/event.  
*(real hits will add to this at ~80 hits/event to give ~200 hits/event total)*

# Dark Rate will affect Threshold



Thresholds will be set based on integral fraction of one of these curves being equal to the fraction of total fADC channels that 120 represents

The threshold will therefore be a strong function of the dark rate in the SiPMs

The most recent tests indicate the dark rate to be significantly less than what is in the calibDB

Conversely, the cross-talk is expected to be more (11% vs. 3%) than what is in the calibDB  
*(the plots here don't include any cross talk)*

# Summary/Outlook

- *mcsmeas* has been modified to produce more realistic dark hit energy distributions
- Some parameters have been updated to reflect the most recent SiPM measurements, but a review of them all is still needed
- Need to settle on the criteria for determining the threshold (120 dark hits/event?) and calculate thresholds based on that
- Once threshold issue is settled, repeat MC studies to look at efficiency and resolutions