Quantization Study for L1 Cal Trigger

- For a given amount of noise, how big should the lsb be?
- Model:
  - Noise in a given calorimeter cell is Gaussian distributed with no correlations
  - Energy in a jet window is summed without truncation (for these studies, 36 calorimeter towers are used)
  - Cell energies are modeled as being either "flat" $E_C = E_0$ or "exponential" $P(E_C) = E_0^{-1} \exp(-E_C/E_0)$ where $E_0 = E_J/N_C$
  - Random noise added to each cell energy and then quantized
  - Study error and bias introduced by quantization
- Results:
  - Quantization error and bias when E = 0 is centered in a bin
  - Bias when E=0 is at the low edge of a bin

All plots are in "Noise" units where $\sigma_N = 1$

Conclusions

- RMS Quantization error well modeled by lsb/sqrt(12) for lsb < $2\sigma_N$
- For lsb > $2\sigma_N$, see significant increase in quantization error and bias
- Centering E=0 bin is important to avoid large bias
- Almost certainly need to account for small negative energies, perhaps by adding pedestal to quantized energy
- lsb = σ_N seems like a good choice (negligible quantization noise or bias)
- Now all we need to know is the noise…