Nonuniformity in the BaBar Monte Carlo

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SLAC
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Introduction

- Energy resolution is degraded if the response of a calorimeter is not uniform throughout its volume
- Uniformity specifications were established for the EMC Crystals (BaBar Note 175)
  - Uniformity coefficients are correction factors to the energy deposited in each of eight sections of a single crystal

\[
E_{\text{Tot}} = \sum_{i=1}^{8} c_i E_i
\]

- The file EmcSim/EmcXtalUniformity.dat is a table of ‘standard’ (measured) uniformity coefficients which can be loaded into the conditions database
  - ‘Standard’ uniformity coefficients are based on measurements made with a radioactive source at different positions along each crystal
  - ‘Standard’ uniformity coefficients exist only for the barrel crystals
Introduction

- To date, BaBar MC by ‘default’ does not apply nonuniformity corrections, but the capability to do this was built into BaBar MC
- We want to study the effects of implementing nonuniformities on single photons
  - Should nonuniformities be simulated?
  - What is the effect of applying extremely large nonuniformities?
- Any nonuniformity introduces an energy dependence in the EMC response
  - Implementation requires a new MC calibration
  - Is it worth it?
Method

- Special `EmcXtalUniformity.dat` files were created in which ALL crystals have uniformity variations of 10%, 20%, and 50% from end-to-end
  - `EmcXtalUniformity.dat` must be loaded into the `/emc/EmcUnifDataP` condition of a private CDB

- Single photon events are generated in Moose at different energies: $E_{\text{gen}} = 100, 500, 1000, 4000$ MeV
  - Release 14.4.2
  - Single photons generated uniformly in $\cos(\theta)$
  - Background mixing turned off
  - To turn on uniformity, in `MooseProduction.tcl`:
    ```tcl
    module talk EmcGHitsToWaveform
    setXtalProfile set true
    exit
    ```
Method

- Simulations will be performed using the different sets of uniformity coefficients
  - Default MC = coeff. turned off
  - Standard MC = measured uniformity coefficients turned on
  - 10%, 20%, 50% MC = generated uniformity coefficients turned on

- Analysis of resulting energy distributions are done using Analysis 21 and PAW ntuples.
  - CalEnergy()/E_{gen} distributions are fit with the Novosibirsk function
    - Measure peak and resolution
Results

- The distributions are rescaled to move the peak to unity:
Results

The peak value measured from the Novosibirsk fit.
This is the rescaling factor used to move the measured peak to equal the true energy.

Energy resolution for 'standard' and 'default' MC along with the standard NIM parameterization.

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Conclusion

- Implementation of the uniformity coefficients does require a new MC calibration due to the associated energy dependence.
- When large uniformities are applied, the ‘Aaron effect’ becomes evident.
- So application of uniformity coefficients could improve MC, but is it worth the effort?