

Test Beam Study of FPID Impact **on Fwd-EMC**

SuperB Detector Geometry
Task Forces joint Meeting

CalTech

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Intro

A prototype 5x5 LYSO crystals matrix has been tested at the CERN T10 beam test facility in October 2010.

Among other things a study of the effect of the material in front of the calorimeter has been performed:

- Aluminium: 20mm, 40mm and 80mm
- **Quartz: 5mm, 15mm and 30mm**
- Active Quartz Bar (DIRC like)

see A. Rossi talk:

<http://agenda.infn.it/getFile.py/access?contribId=101&sessionId=7&resId=0&materialId=slides&confId=2902>

CAVEAT: Test beam data analysis is not yet completed (PRELIMINARY results)

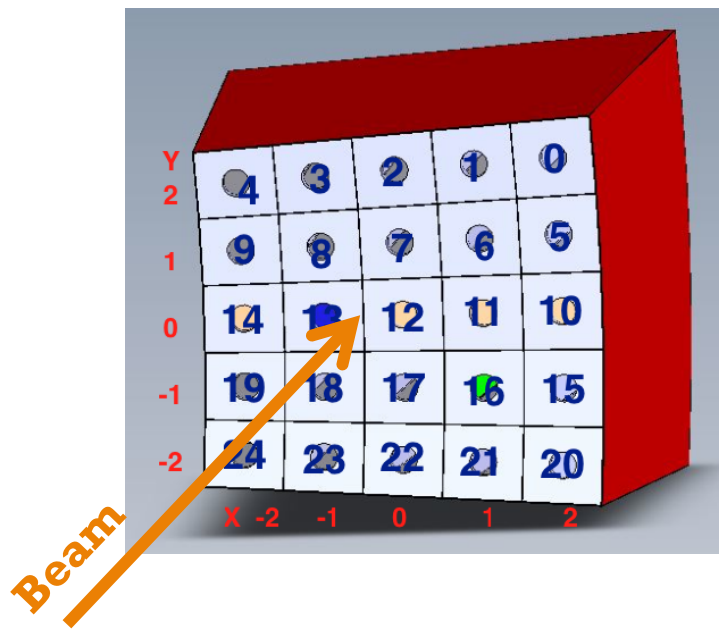
Summary:

- Crystals and Matrix
- T10 beam line
- MC simulation
- Data – MC comparison (quick look)
- Quartz thickness effects study
- Conclusions

TB Matrix

TB Matrix is very close to the final design of a Fwd-Endacp EMC Module:

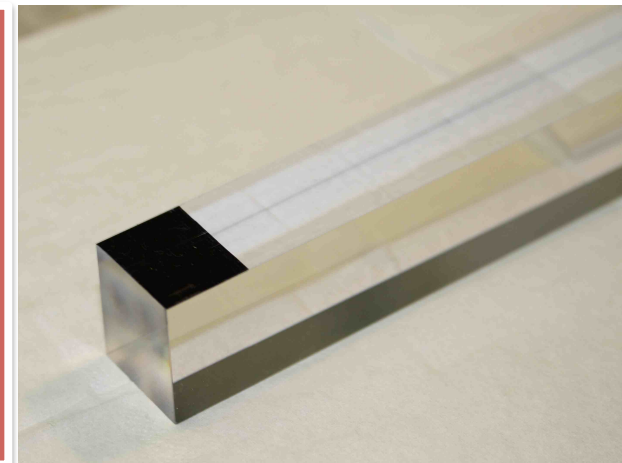
- 5x5 crystals
- Projective geometry
- Glass fiber structure
- 20 crystals instrumented with APDs
- 5 crystals instrumented with PIN diodes



LYSO Crystal

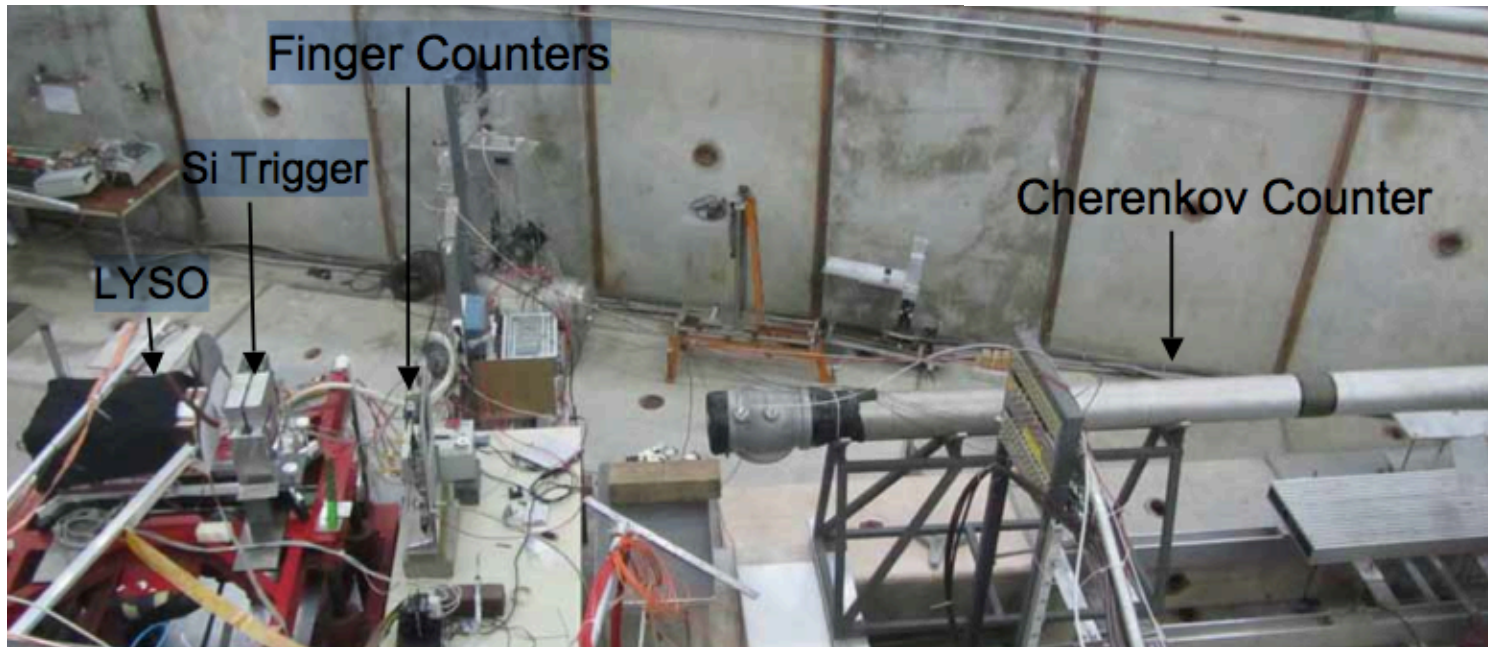
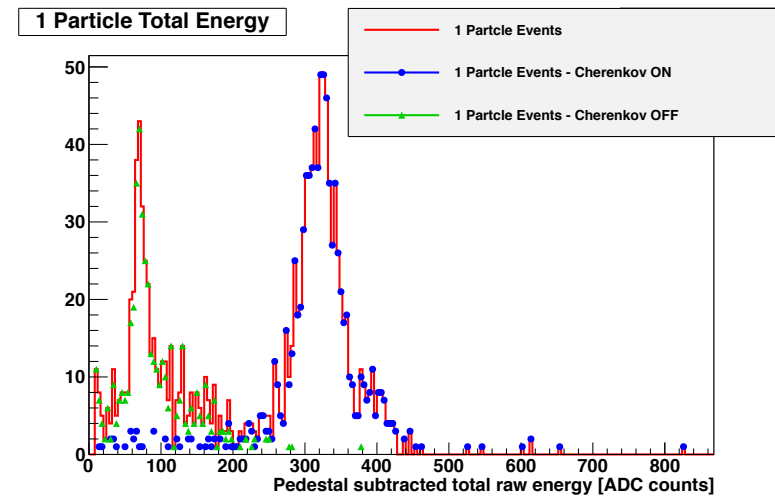
Each crystal was painted with a 15mm black strip on the smaller end to keep uniformity within 5%

- ▶ For a better uniformization each crystal need a specific black strip width
- ▶ Nee to measure uniformity for all the crystals (it was not possible before the TB)



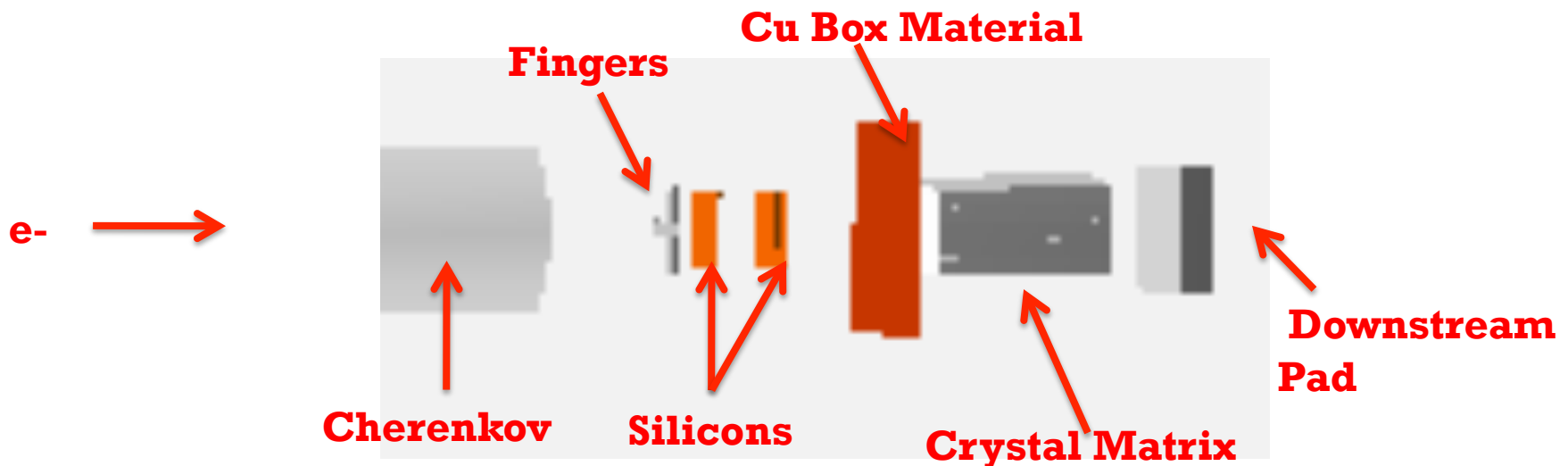
T10 Test Area

- Cherenkov Detector
- Two finger scintillators (2x2 cm²)
- 4 Si planes (2x and 2y)
- LYSO Matrix



Simulation Geometry

All elements of the T10 line have been included in the simulation geometry

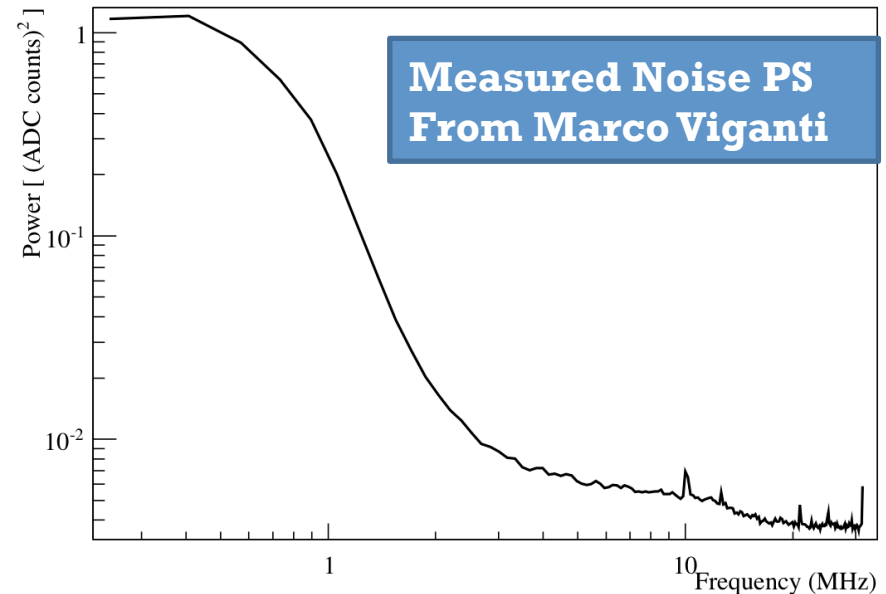


For more details on TB simulation studies see:

<http://agenda.infn.it/getFile.py/access?contribId=102&sessionId=7&resId=0&materialId=slides&confId=2902>

Simulated Effects

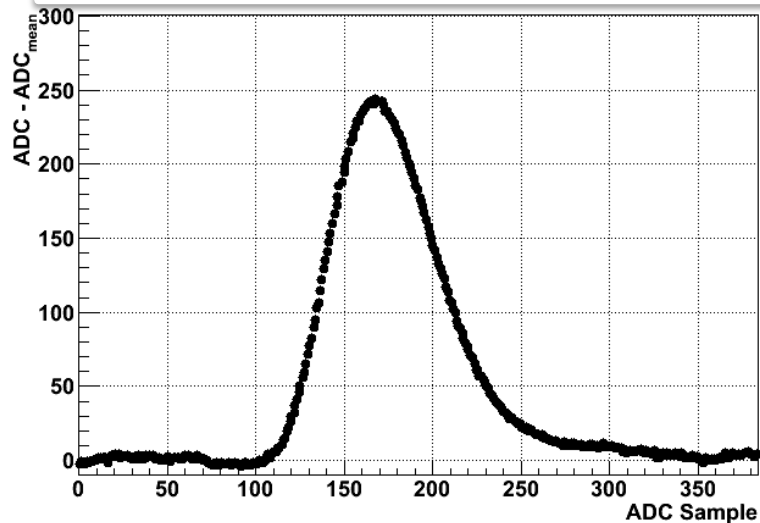
- Crystals LY non-uniformity
 - Use Gauss distribution to assign non uniformity from RY measurements
 - Mean = 4.5% RMS = 0.6%
- Photostatistics
 - 450 PE/MeV
- Intercalibration Error
 - Default is 1% (maybe too small)
 - Need to be estimated correctly
- Beam Energy Spread
 - 0.7% from T10 line description
- Noise and Signal
 - Use measured noise PS for each crystal (from Marco Vignati)
 - Use ADC counts/MeV as measured in the data
 - Emulate ADC sampling procedure
 - Add fixed shape Gauss function to random noise according to PS and noise RMS



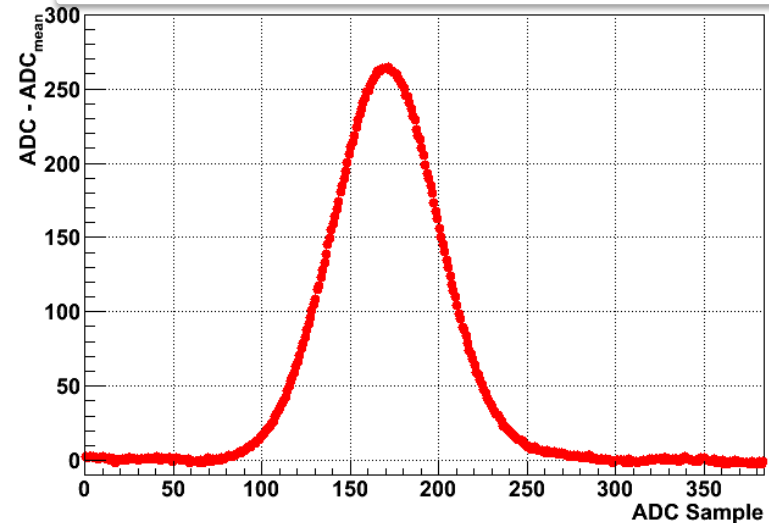
Noise + Signal simulation

Signal Amplitude = Peak height

Noise + signal example
from DATA



Noise + signal example
from PS+Gauss

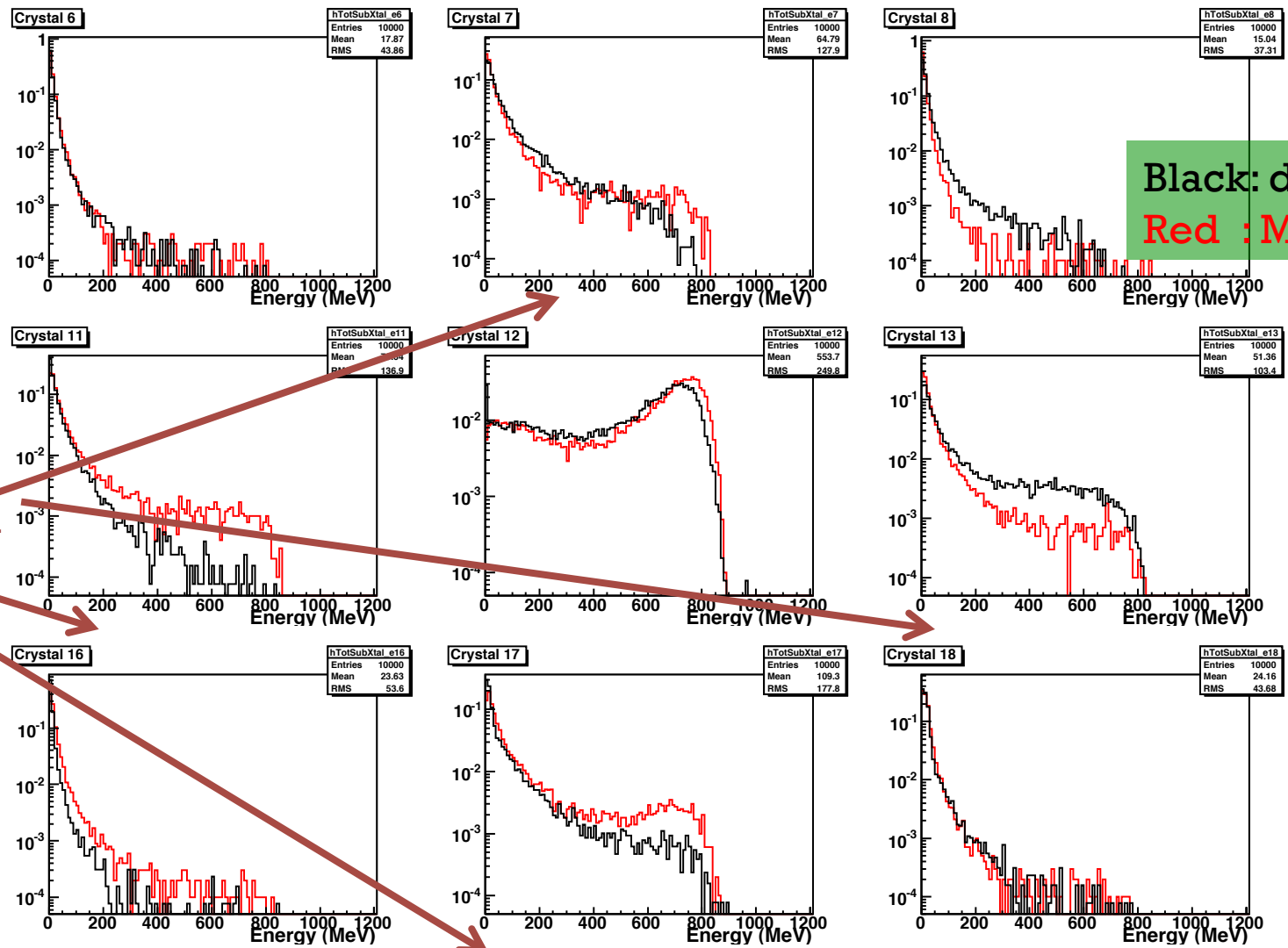


Thresholds:

- Low Gain \rightarrow 2 Noise RMS (\sim 16 MeV)
 - Very High : default value in SuperB FullSim is 1 MeV
- High Gain \rightarrow 3 Noise RMS (\sim 7 MeV)
 - Still quite high (default value in SuperB FullSim is 1 MeV)

Data-MC : Crystal Energy Deposit

1 GeV



Black: data
Red: MC

MC beam position need to be optimized

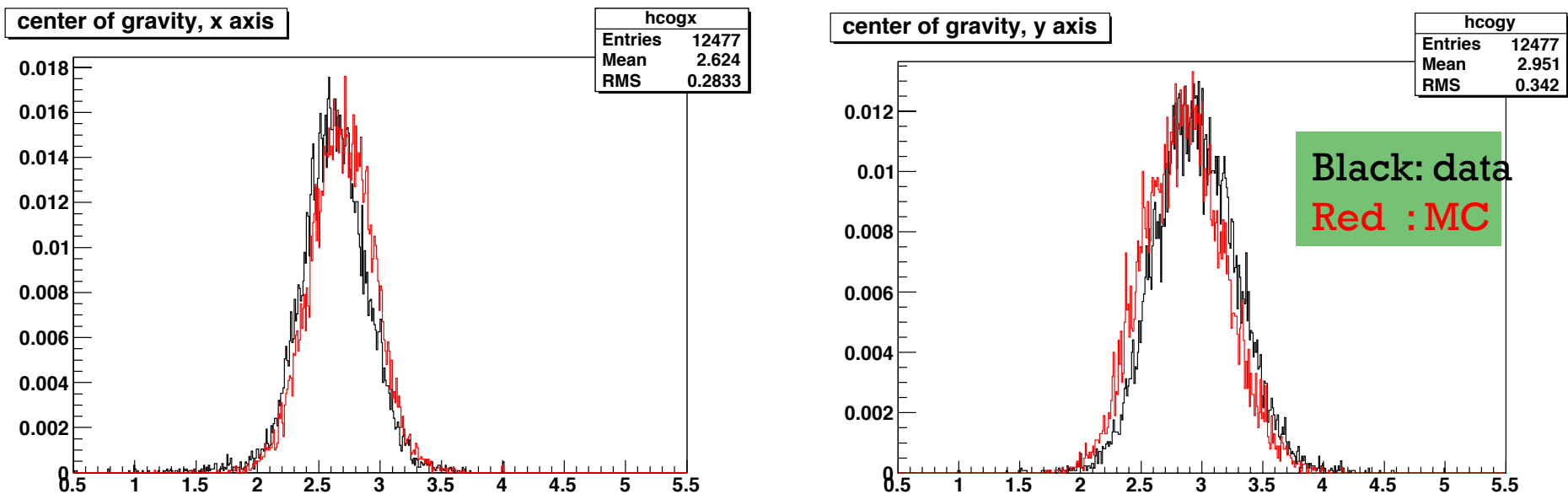
For more details on Data-MC comparison see A. Rossi:

<http://agenda.infn.it/getFile.py/access?contribId=103&sessionId=7&resId=0&materialId=slides&confId=2902>

Energy Center of Gravity

Position (0,0) equal to the left bottom corner of the matrix

MC beam position need to be optimized but COG distributions between Data and MC look similar



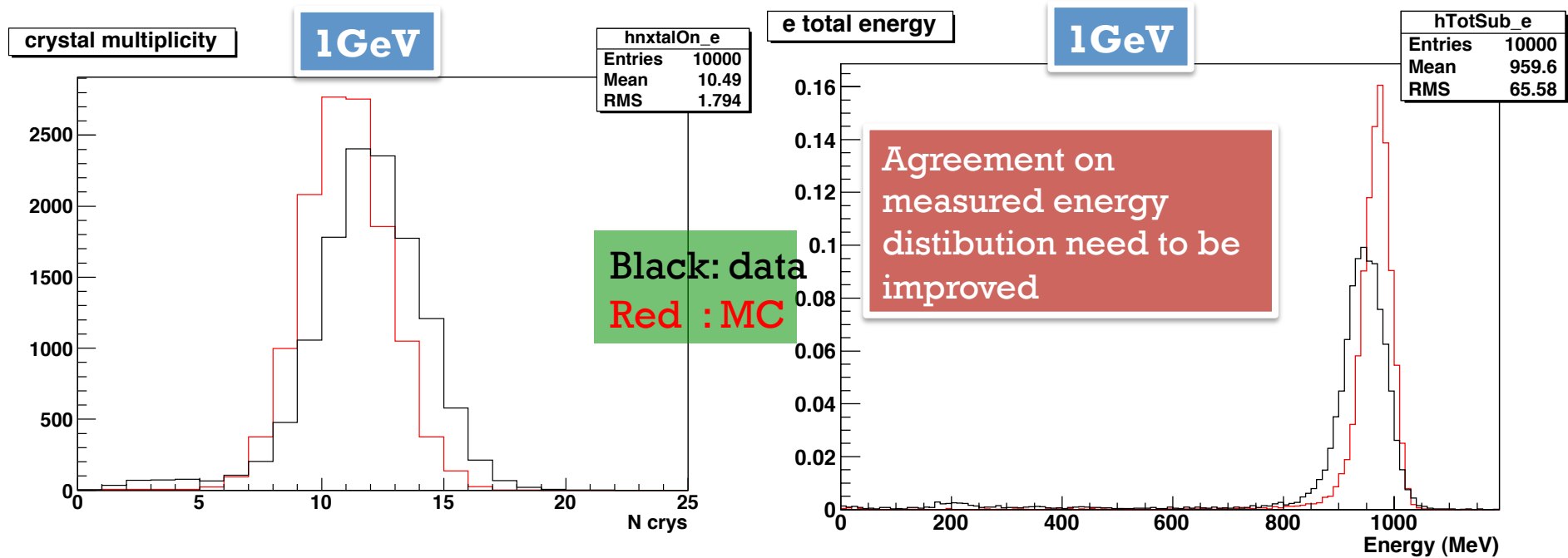
Crystals Multiplicity and Measured Energy

Multiplicity:

→ Number of crystal with a signal maximum value greater than 6 ADC counts ($3 \cdot \sigma_{\text{noise}}$)

Measured Energy:

→ Sum of the energy of all the crystals above threshold

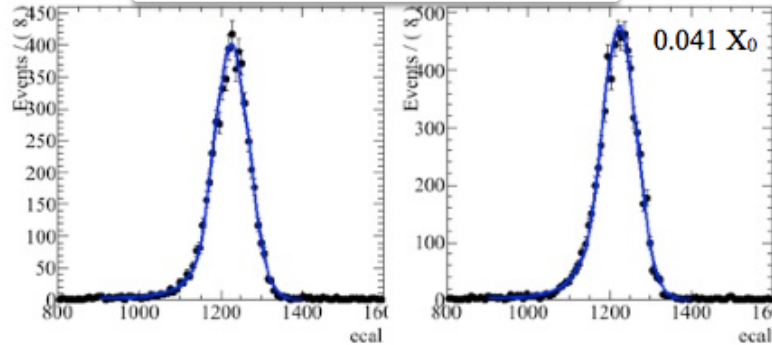


Fit to Measured Energy Distributions

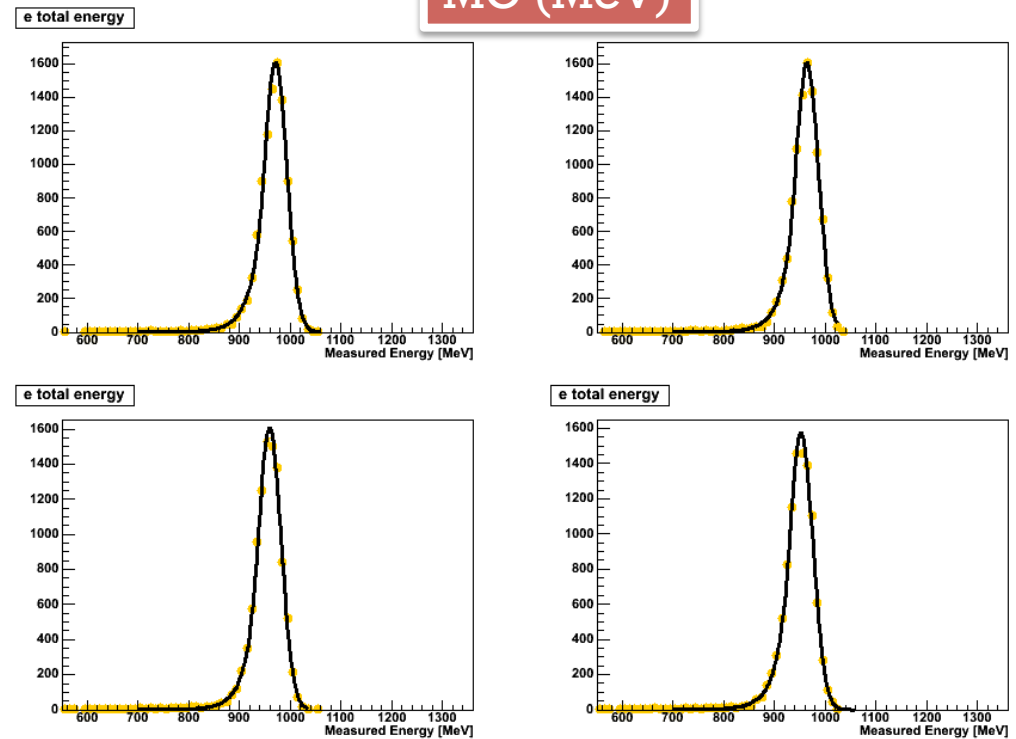
A Crystal Ball function fit is performed to the measured energy distribution

The energy resolution resolution is taken as the FWHM/2.36

DATA (ADC counts)



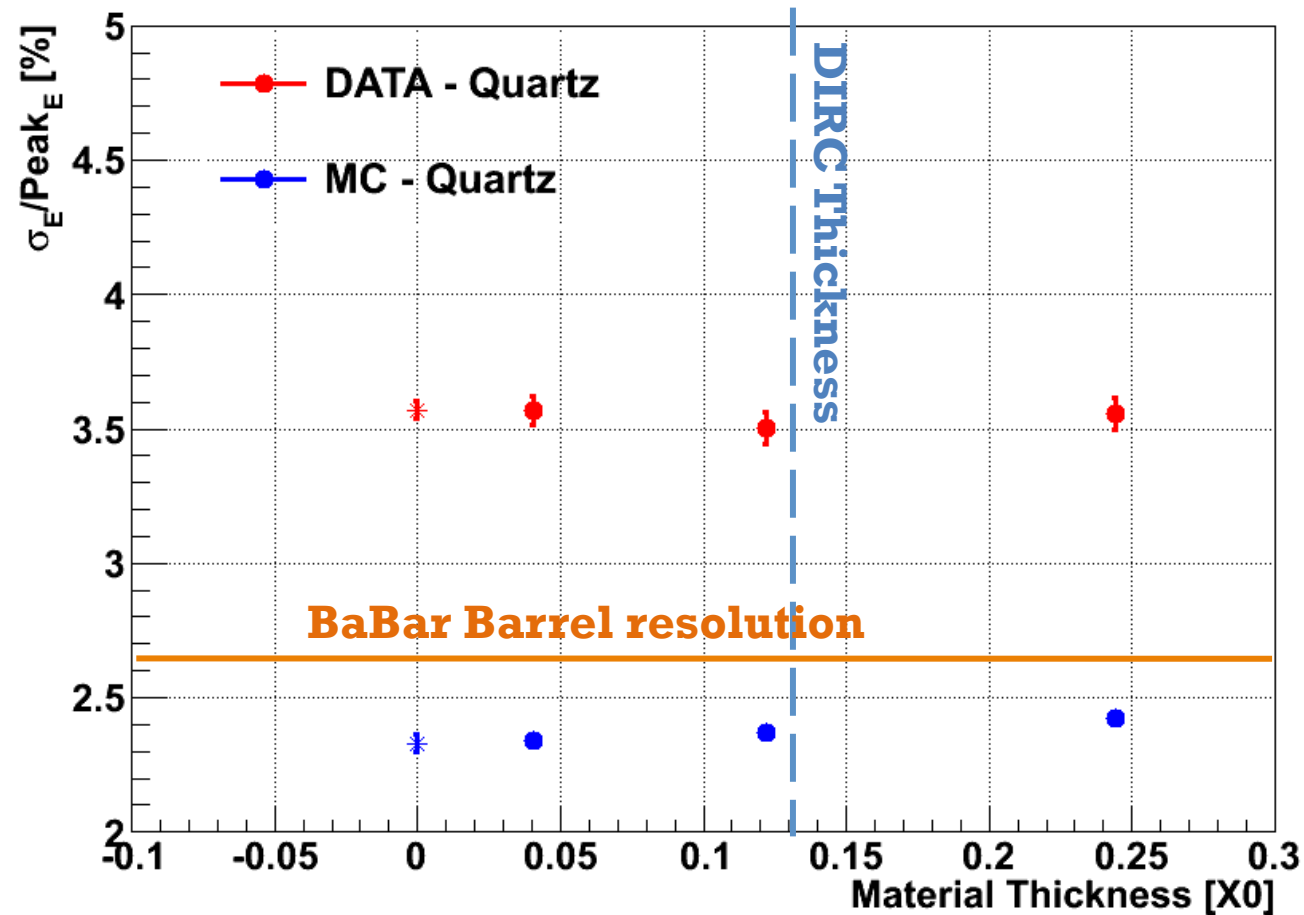
MC (MeV)



See C. Cheng talk

<http://agenda.infn.it/getFile.py/access?contribId=104&sessionId=7&resId=0&materialId=slides&confId=2902>

Resolution vs Quartz Thickness



Difference between Data and MC need to be understood

Data and MC agree that relative resolution change is small or negligible

Conclusions

- Several effects have been included in the simulations but more work and tuning is needed to reach Data – MC agreement on the energy resolution
- Even if basic resolution is different in the range up to 0.25% X0 upstream material effects are small for both Data and MC
- From previous studies on the full geometry we have seen that the clustering algorithm enhance the effect of upstream material on the energy resolution in a significant way. There is no clustering algorithm in the TB analysis.