Energy resolution of PARIS calorimeter with phoswitch type crystals

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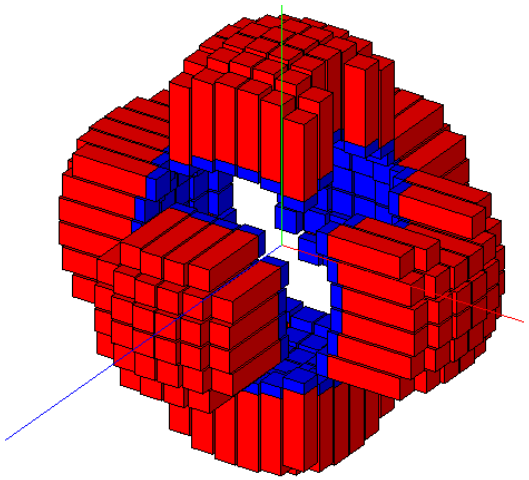
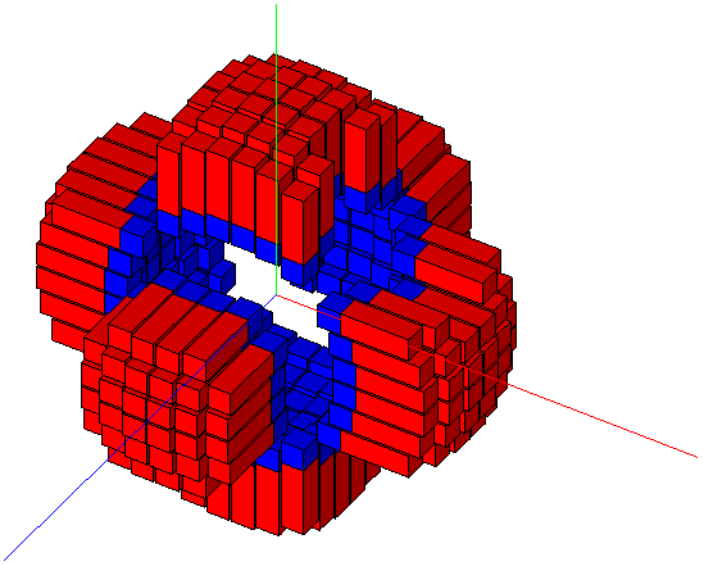
Introduction

GEANT4 simulations were performed to investigate energy resolution in the phoswitch type detectors.

Two different sizes of crystals were chosen:



2”x2”x1” $LaBr_3$ + 2”x2”x7” CsI

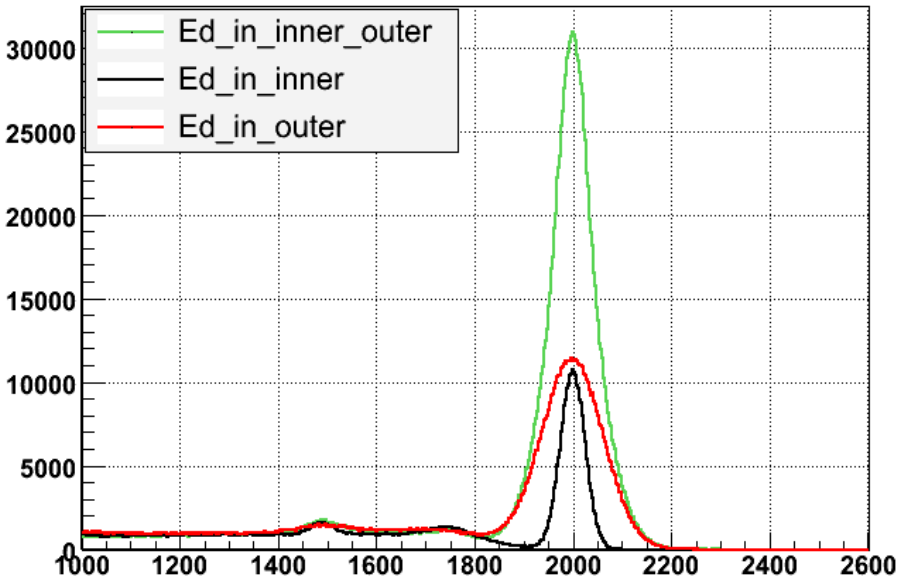


2”x2”x2” $LaBr_3$ + 2”x2”x6” CsI

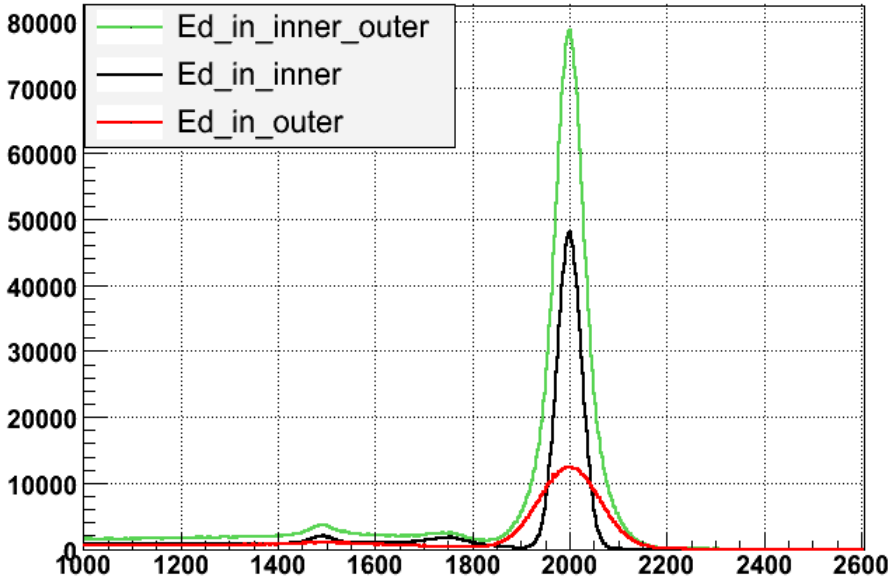
Technical informations

- Gamma energy deposits in scintillators, calculated in GEANT4, were smeared event by event by Gauss functions.
- FWHM of that gauss was dependent on the energy of deposed energy as $A*E^{-1/2}$, coefficient A was equal 0.76 for $LaBr_3$ and 2.06 for CsI. That provided FWHM at 662 keV 3% for $LaBr_3$ and 8% for CsI.
- In simulations only one gamma was emitted at once so there were no problems with reconstruction of energy deposited in nearby crystals.

Sample spectra (2MeV)



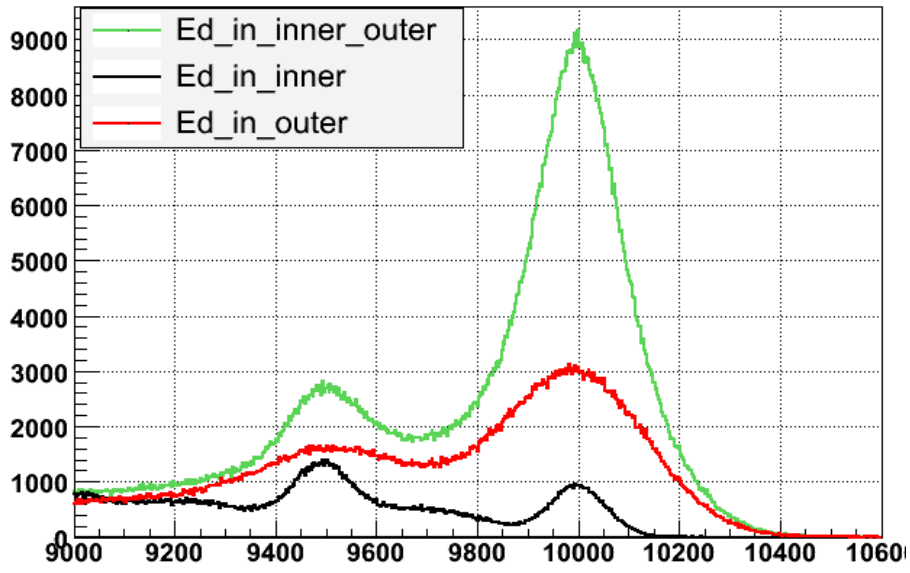
2”x2”x1”



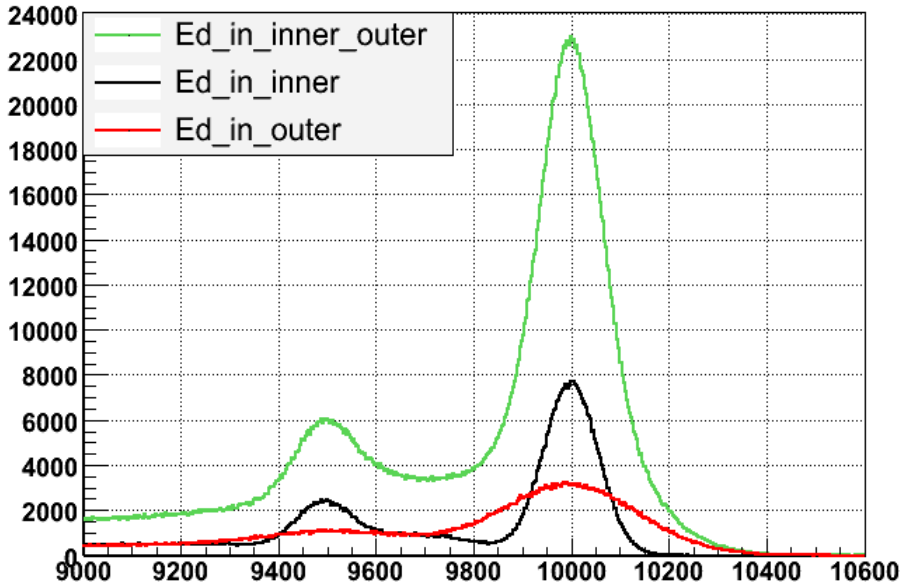
2”x2”x2”

- Shape of spectra obtained for gamma energy 2 and 10 MeV. On each picture black line is a $LaBr_3$ spectrum, red line is CsI spectrum, and green line is sum of energy deposited in $LaBr_3$ and CsI.

Sample spectra (10MeV)

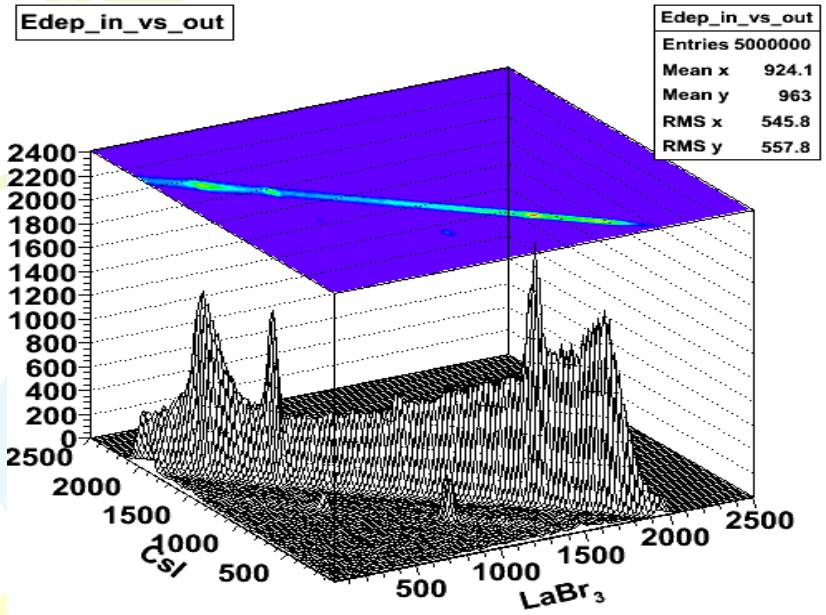


2”x2”x1”

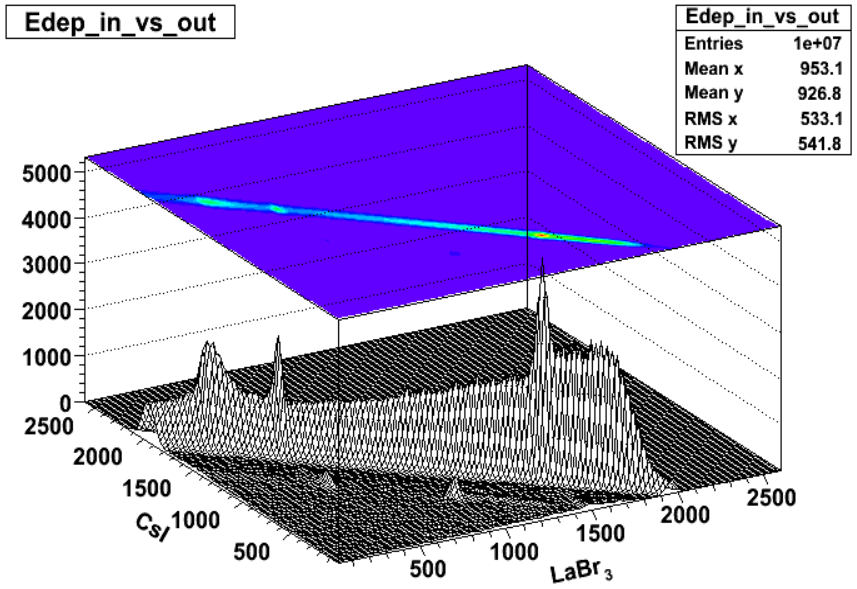


2”x2”x2”

Energy deposit in $LaBr_3$ vs CsI (2MeV)



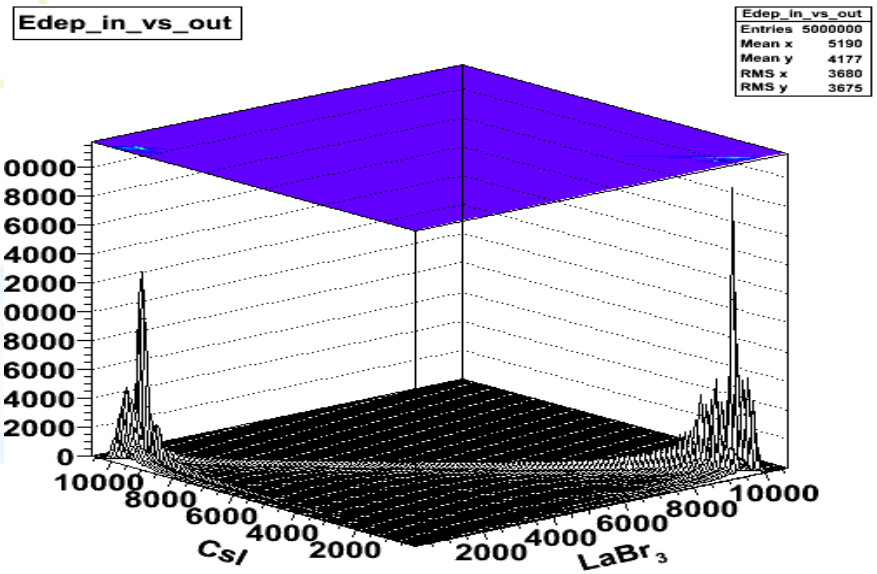
2”x2”x1”



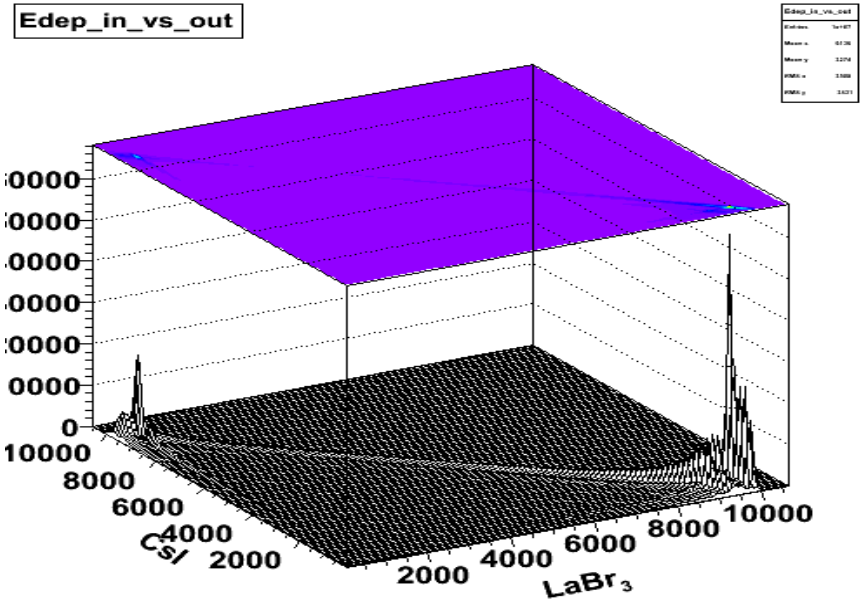
2”x2”x2”

- 2D plots provides information about energy deposition share between two shells.

Energy deposit in $LaBr_3$ vs CsI (10MeV)



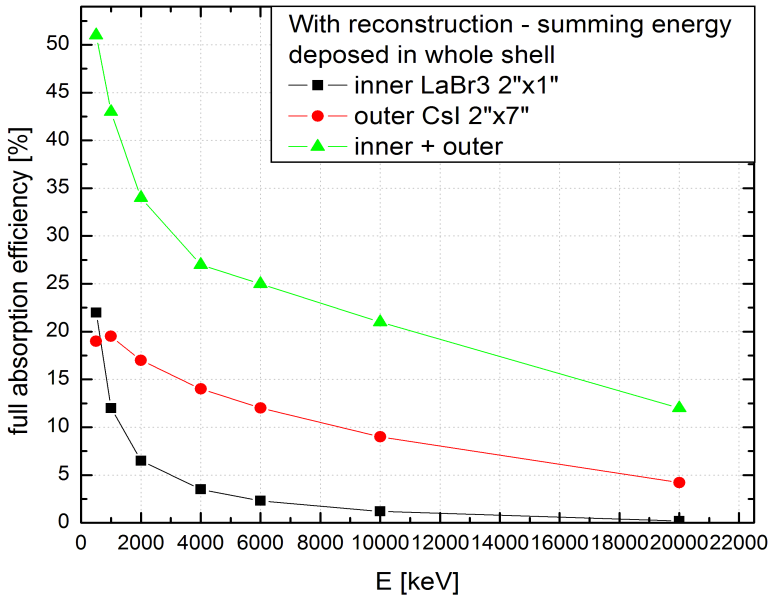
2”x2”x1”



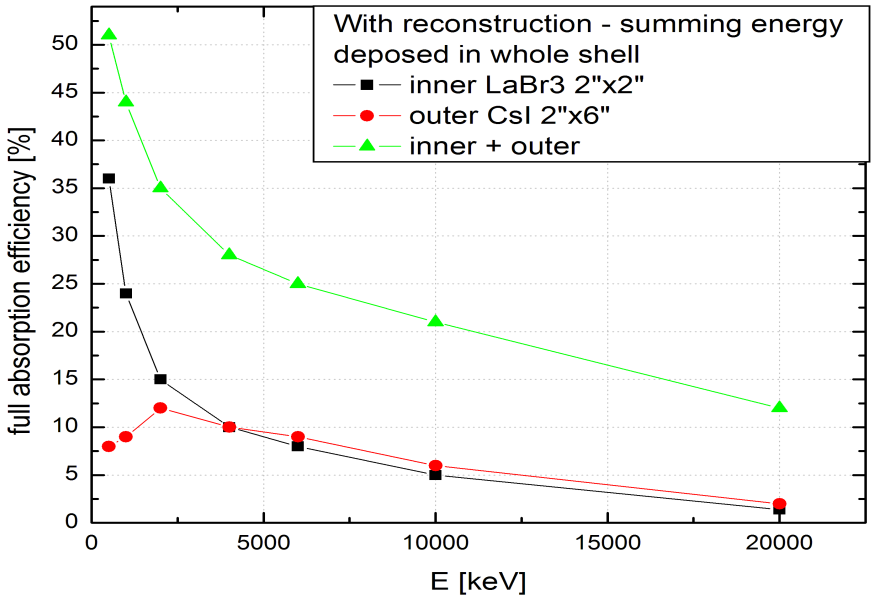
2”x2”x2”

Because of pair creation in $LaBr_3$ there are many events when 511 keV is deponed in CsI and rest of energy in $LaBr_3$.

Efficiency



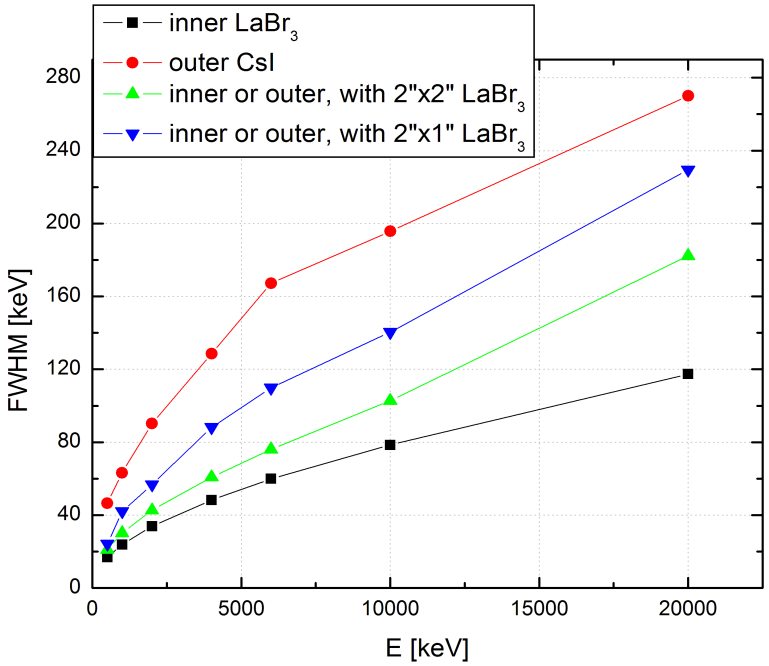
2”x2”x1”

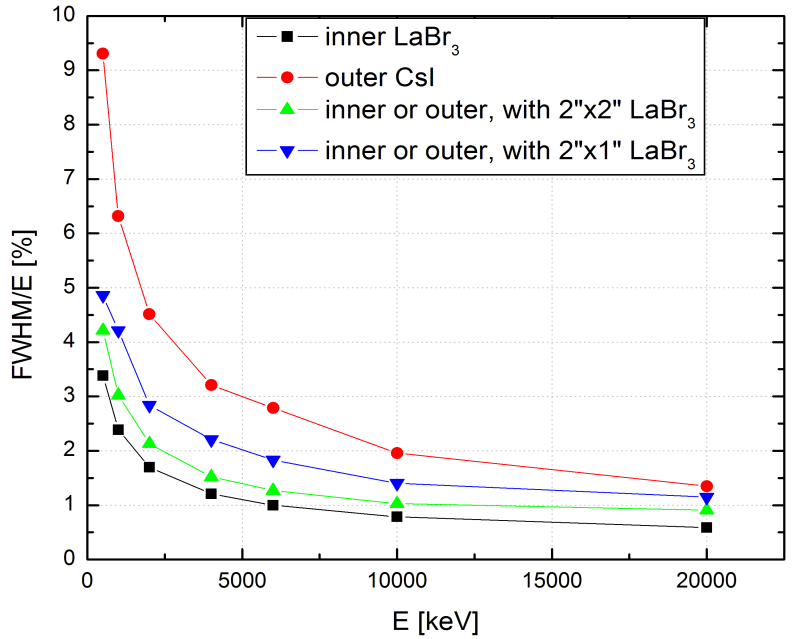


2”x2”x2”

For 500 keV it is 55% and decrease to nearly 15% at 20 000 keV (in summing inner+outer mode) .

Conclusions - FWHM





Increasing $LaBr_3$ shell length from 1” to 2” improves strongly peaks FWHM in “summing mode”. That “summing mode” is necessary to provides 25% efficiency at 5MeV.