MINISTERIO DE EDUCACIÓN Y CIENCIA

AÑO de la CIENCIA 2007

CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

Towards a Frontcap design

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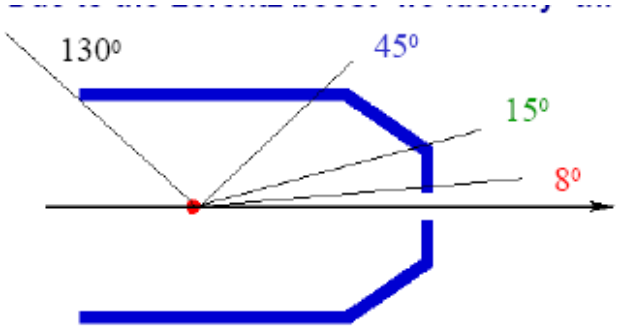
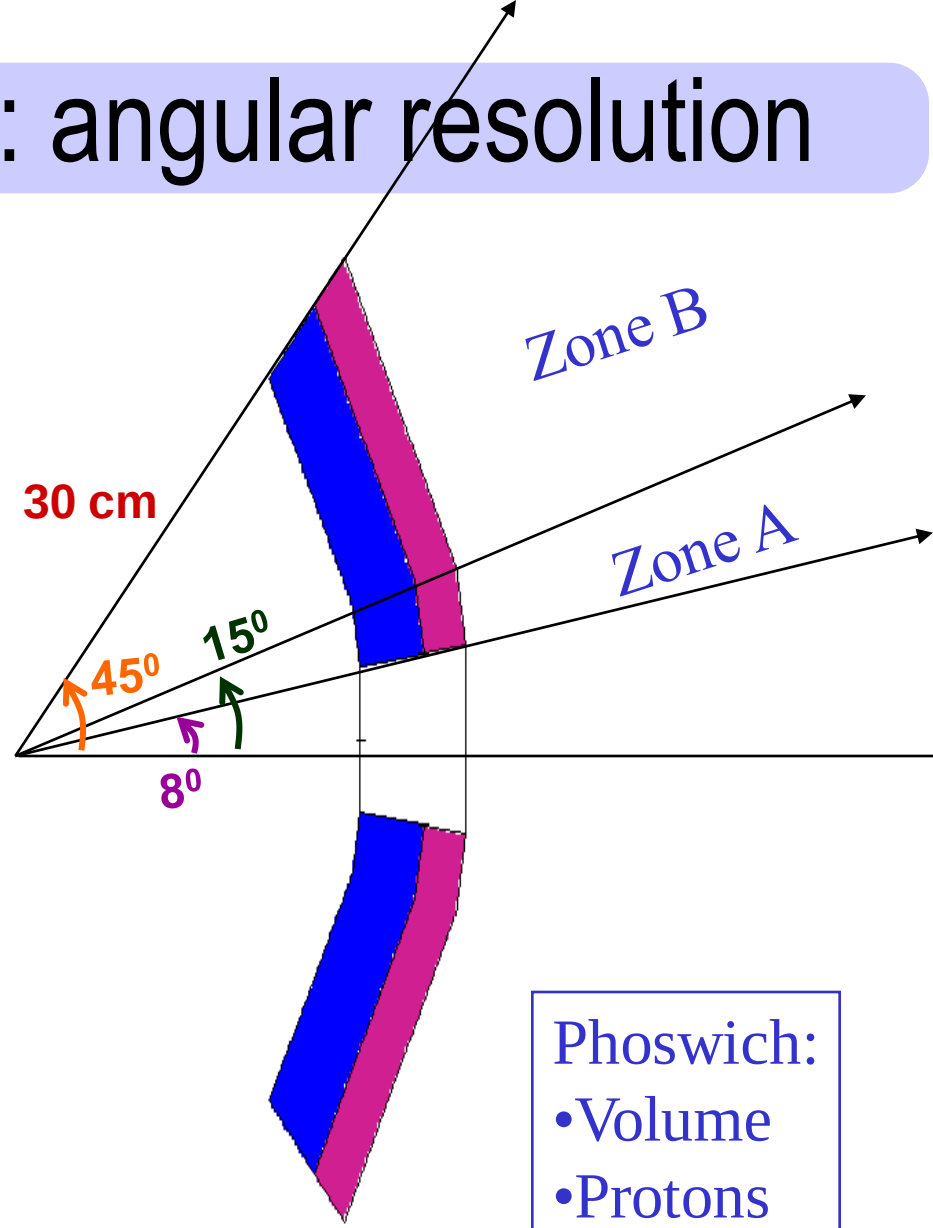
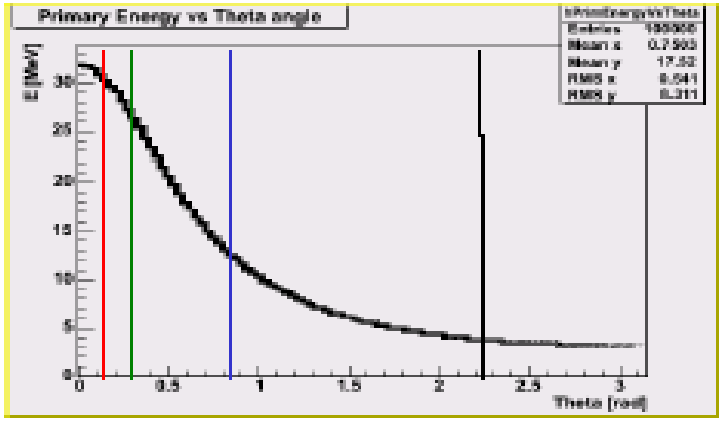
Crystal size: angular resolution



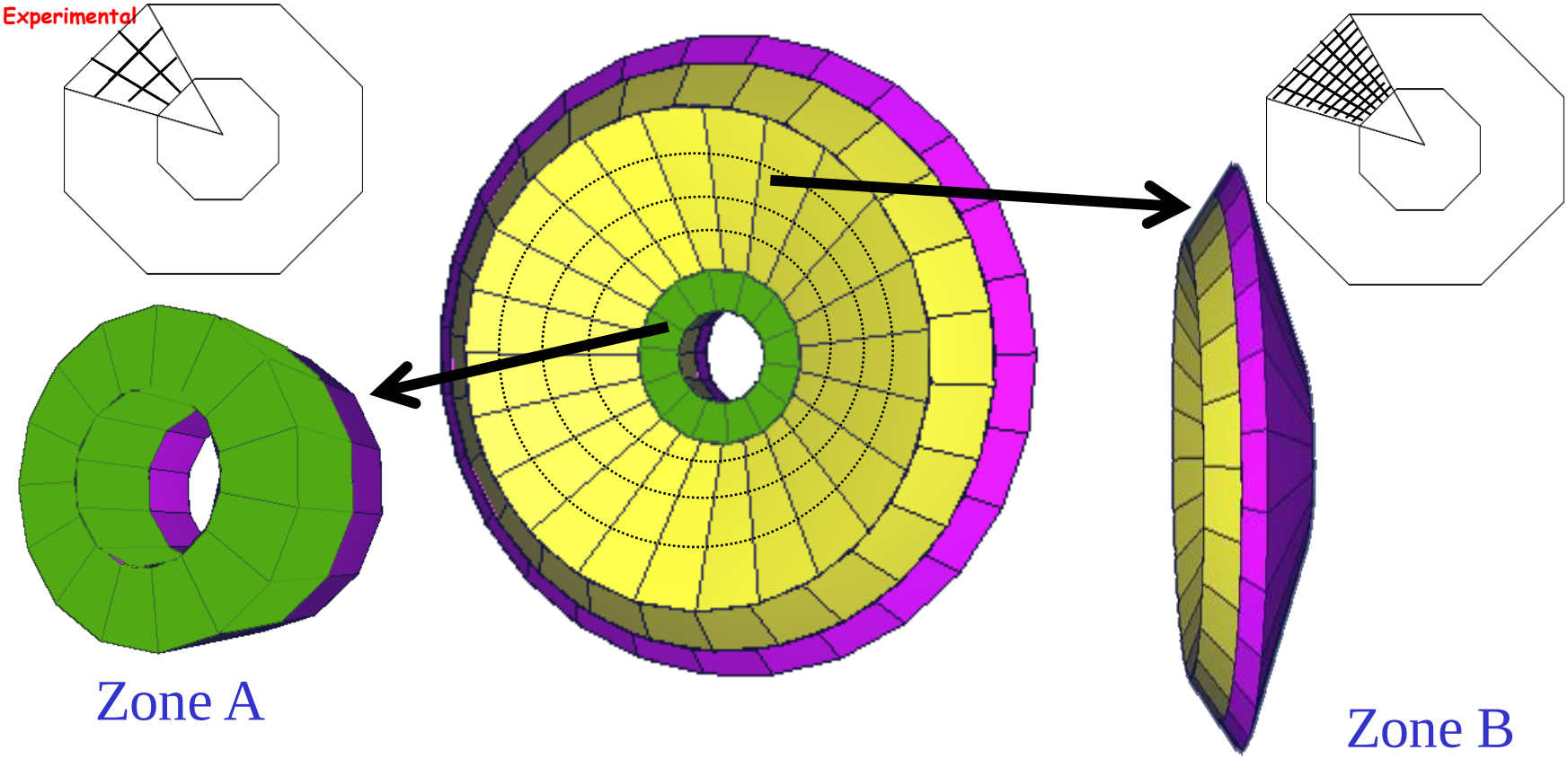




E_{CM} = 10 MeV β = 0.82

Phoswich:
- Volume
- Protons

Crystal size → # of crystals



Zone A

Zone B

8-15^0

⇒8 sectors,
3 cystals/sector, 3 rings
Total: 72 crystals of 3 types

15 -45^0

⇒8 sectors, 6 crystals/sector ring,10 rings
Total: 480 crystals of 10 types

Angular resolution

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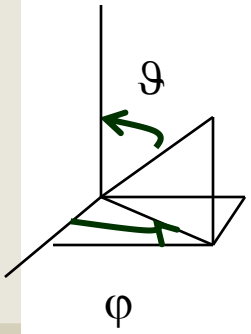
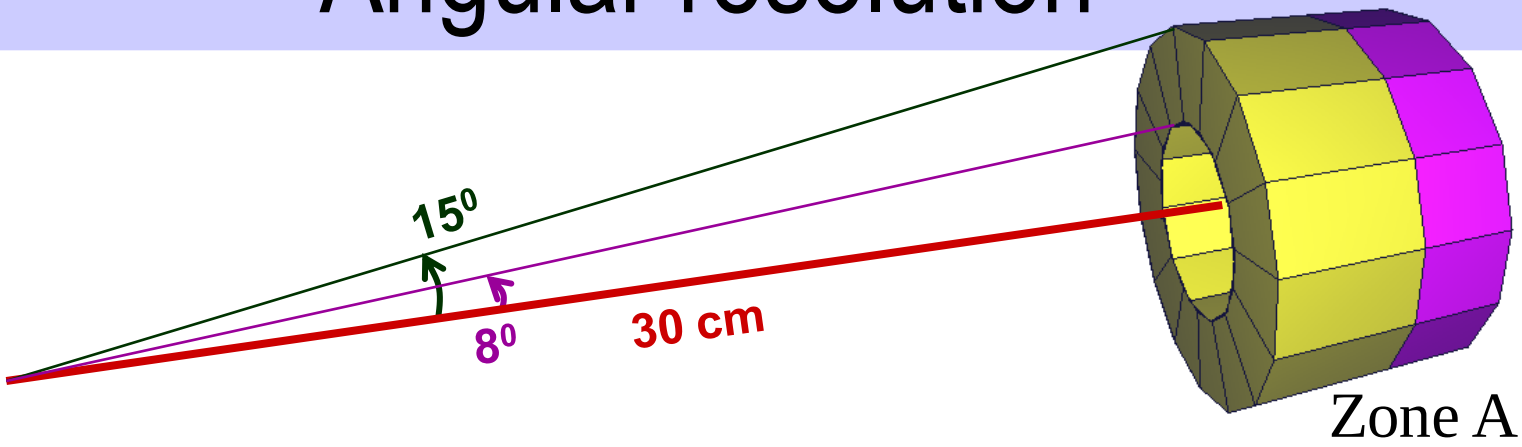
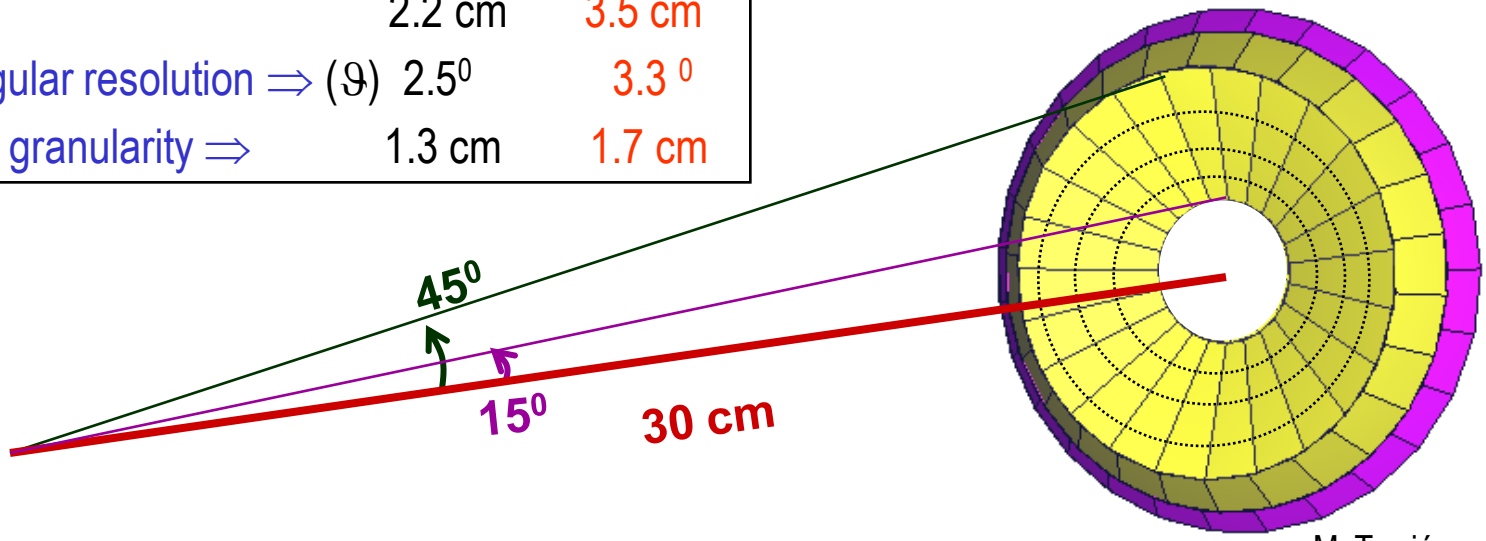




	Zone A	Zone B
✓ Polar angular resolution ⇒	(φ) 3.2 ⁰	4.6 ⁰
granularity ⇒	1.2 cm	1.3 cm
	2.2 cm	3.5 cm
✓ Azimutal angular resolution ⇒	(ϑ) 2.5⁰	3.3 ⁰
granularity ⇒	1.3 cm	1.7 cm



Material: detector requirements

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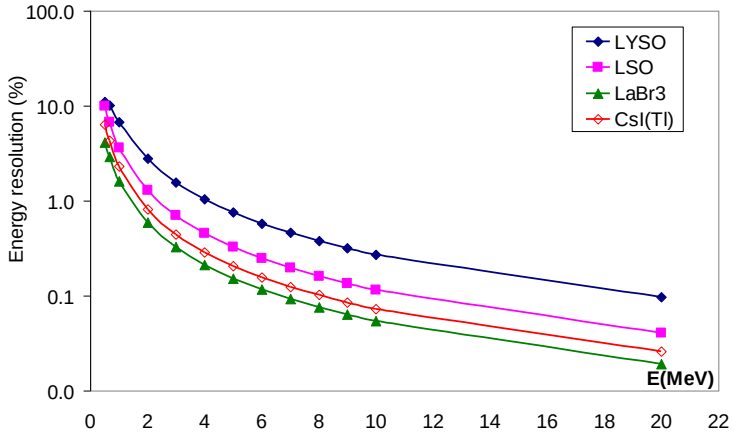
✓Detector requirements

- Absorption coefficient α Z^4
- Energy resolution
  - ~3% $\Delta E / E$ @ 1 MeV

Material	Z_{eff}
LSO	66
LYSO	64.5
CsI	54
$LaBr_3$	46.9



	Resolution (%)			
E(MeV)	$LaBr_3$	CsI	LSO	LYSO
0.662	2.9	4.3	6.78	10.2
1	1.62	2.32	3.65	6.8
5	0.15	0.21	0.33	0.8
10	0.05	0.07	0.12	0.3
20	0.02	0.03	0.04	0.1

- Chemical, thermal and mechanical stability $\Rightarrow$ hygroscopic problem
- Practical manufacturing $\Rightarrow$ price/cm^3

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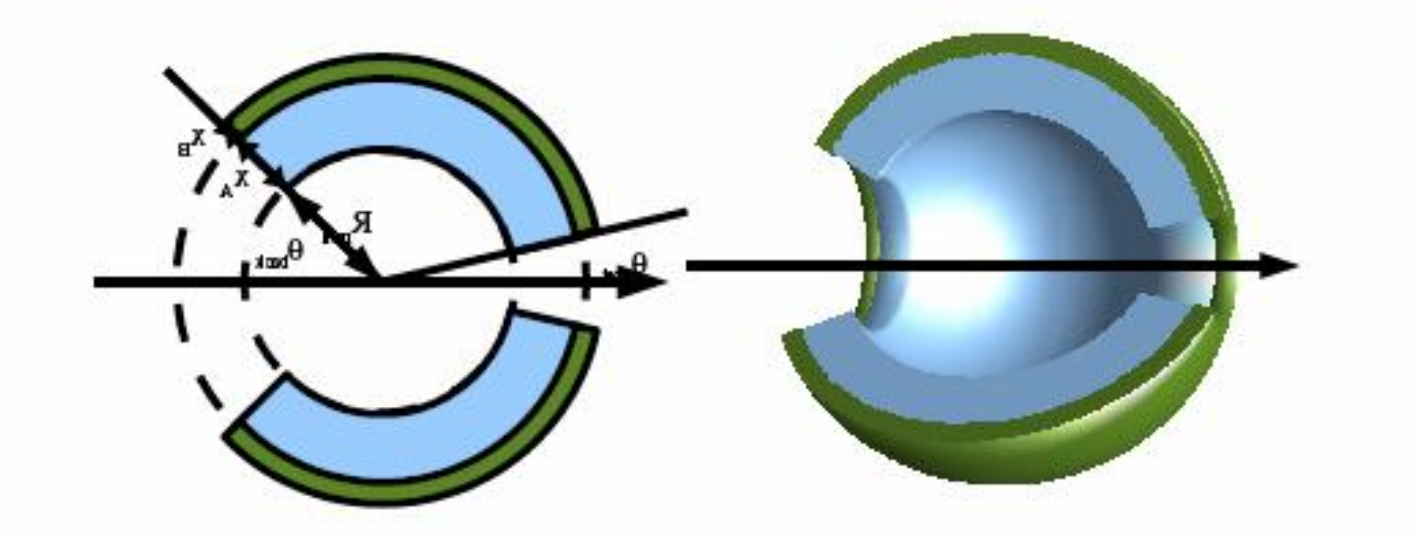
Volume consideration



R/cm	x_a/cm	x_b/cm	Vol_a/cm³	%	Vol_b/cm³	Vol/cm³	%
30	10	5	21955	70.5	16087	38029	122.1
30	6	4	11657	37.4	10286	21943	70.5
30	8	2	16530	53.1	5413	21943	70.5
30	13	0	31139	100.0	0	31139	100
30	15	0	38029	122.1	0	38029	122.1

Simulations: crystal length

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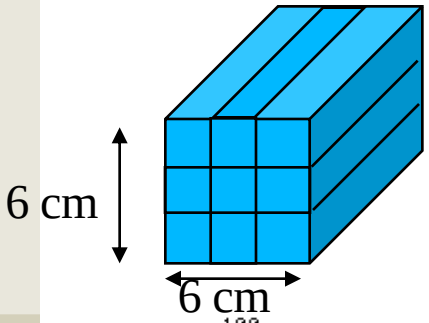
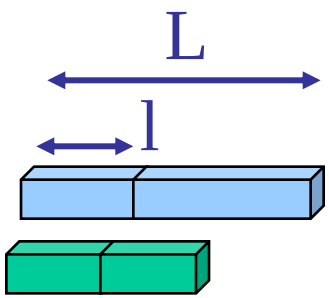
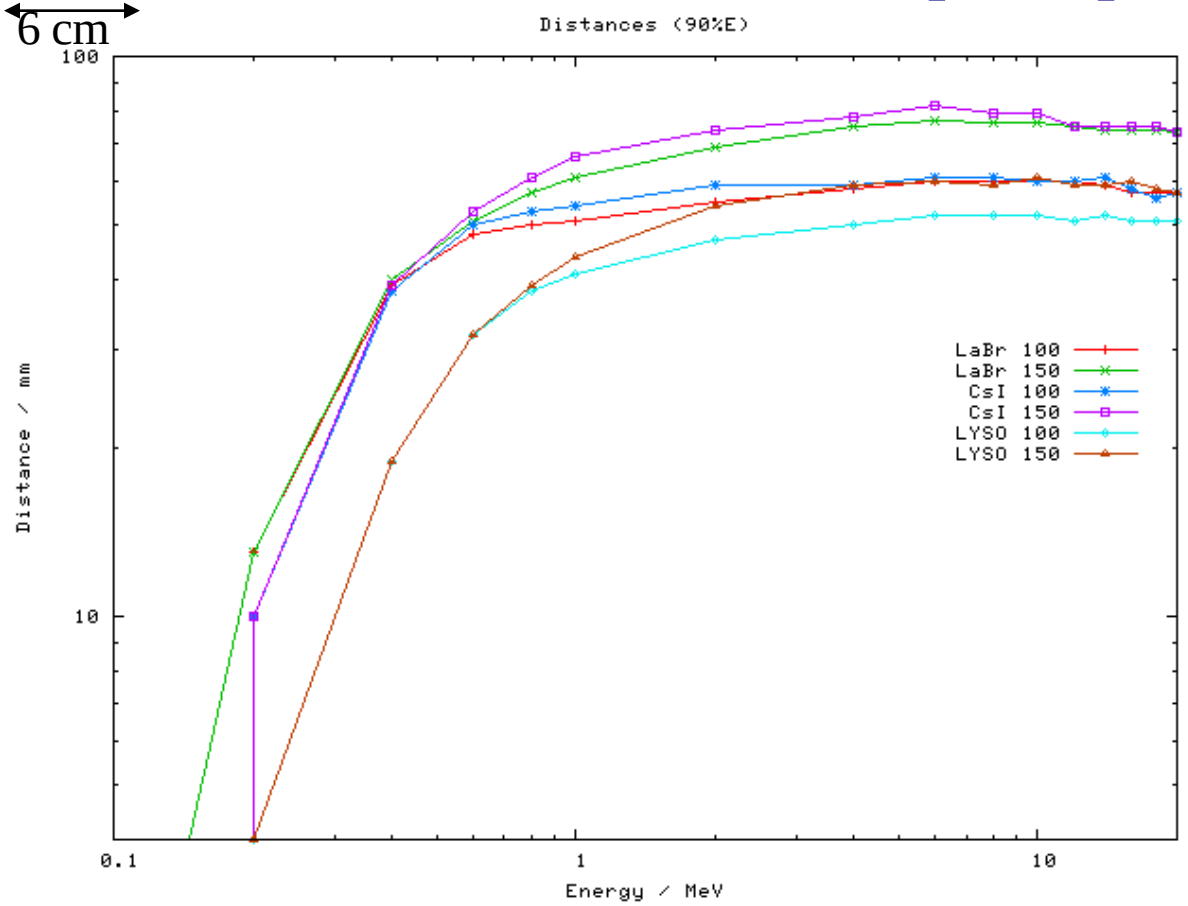


- Geant4, MCNPX
- Photon distance range in the material to be detected in the photopeak





L	l
15 cm	6 cm
10 cm	5 cm

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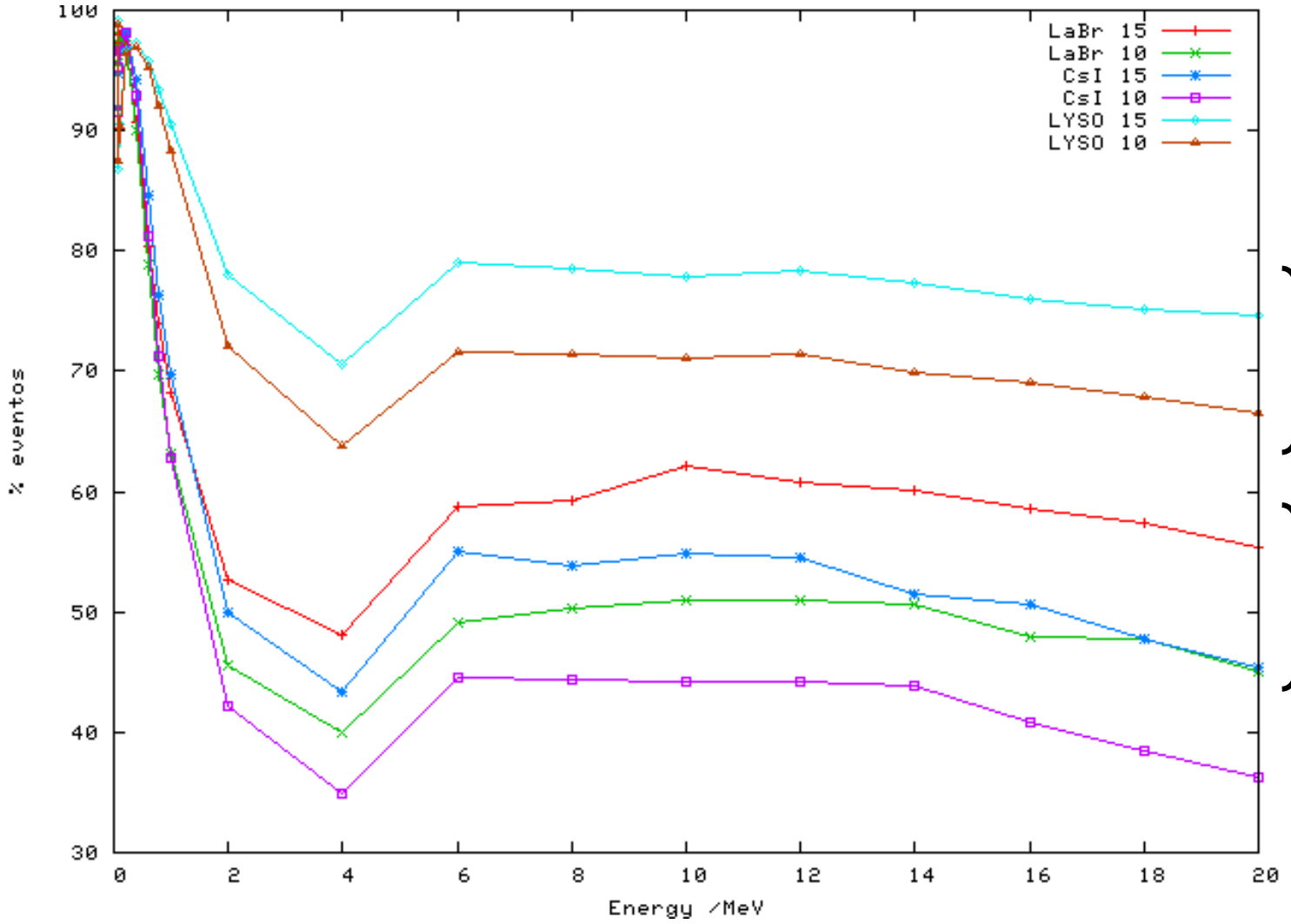
Simulations: crystal length



LYSO
15 cm
10 cm

LaBr3
15 cm
10 cm

CsI
15 cm
10 cm

Phoswich: p-energy resolution

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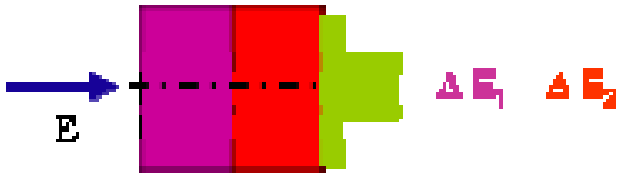
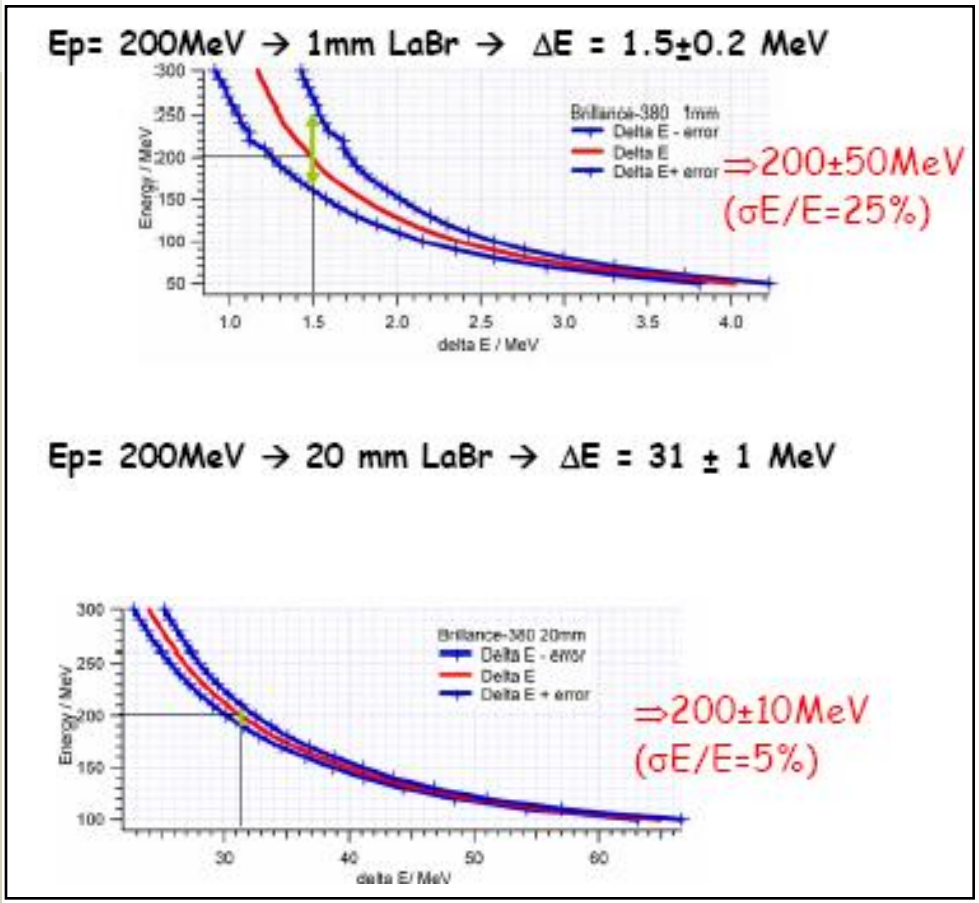
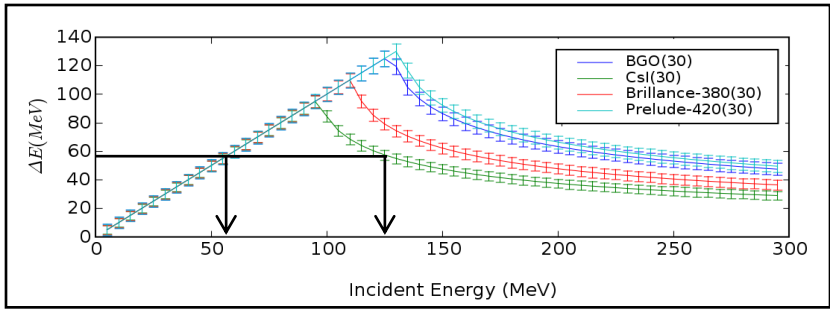




- ✓ If not fully stopped

  ⇒two ΔE detectors are required



- ✓ First detector should be thick in order to totally absorb protons up to rather high energy
- ✓ Second detector placed to solve the ambiguity on the signal

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Conclusions

- ✓ Phoswich solution is feasible for the detection of photons as well as for protons
- ✓ Optimization and tests underway

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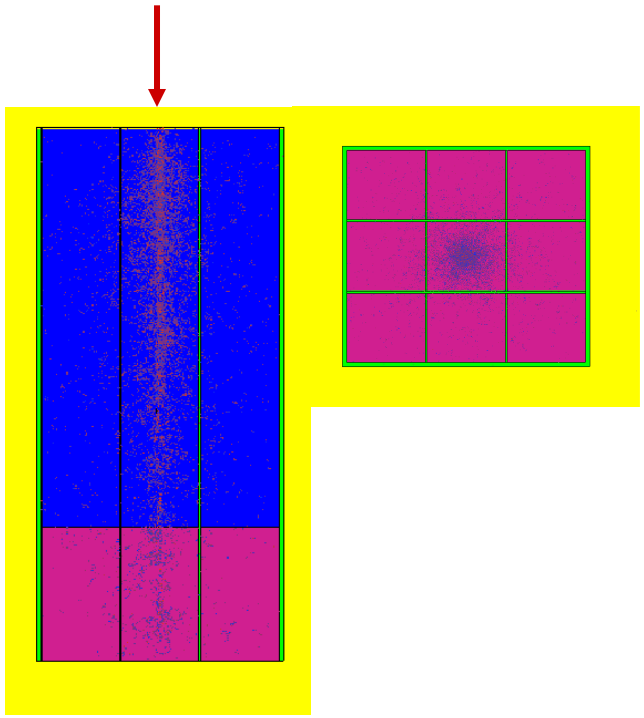
Simulations

- TOOLS: in parallel we are using Geant4 and MCNPX to double check that the simulations are consistent



- Crystal length study
- Individual detector size in the array

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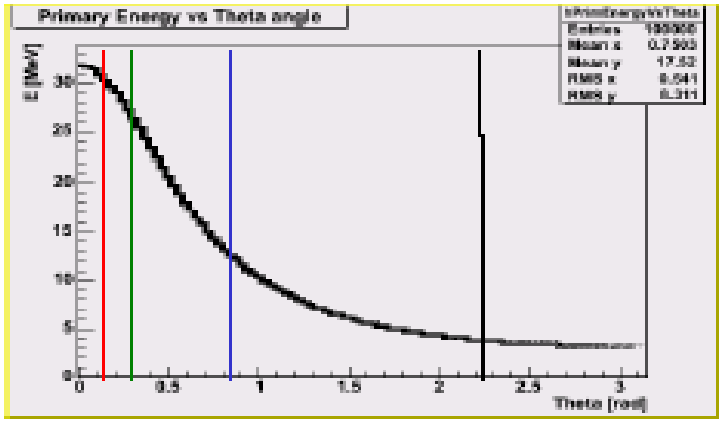
Phoswich proposal

- ✓ Our proposal for small angles is to use a phoswich detector



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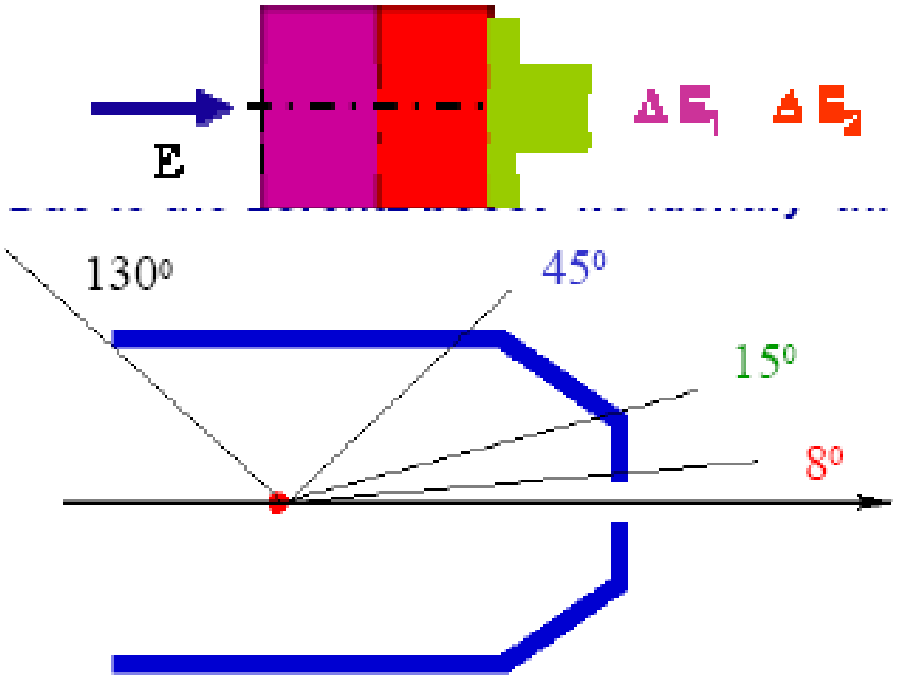

- Protons: particle telescope Δ
- Gammas: energy and efficier cost

LYSO 15-10 cm 99%