

EMC OPTIONS RESOLUTION STUDY



2nd Collaboration Meeting
LNF

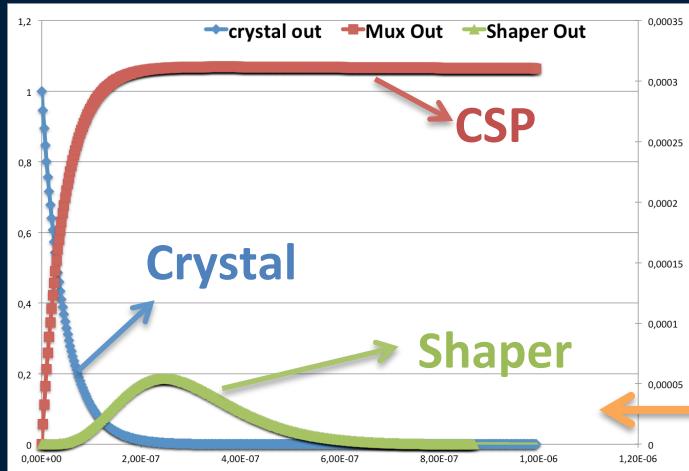
13/12/2011

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OUTLINE

- Electronic signal shape
 - Changing Crystal and Shaping Time
- Electronic signal amplitude
 - Changing Crystal and Shaping Time
- Electronic Signal/Noise
- EMC Options simulation and performance evaluation

SHAPER SIGNAL

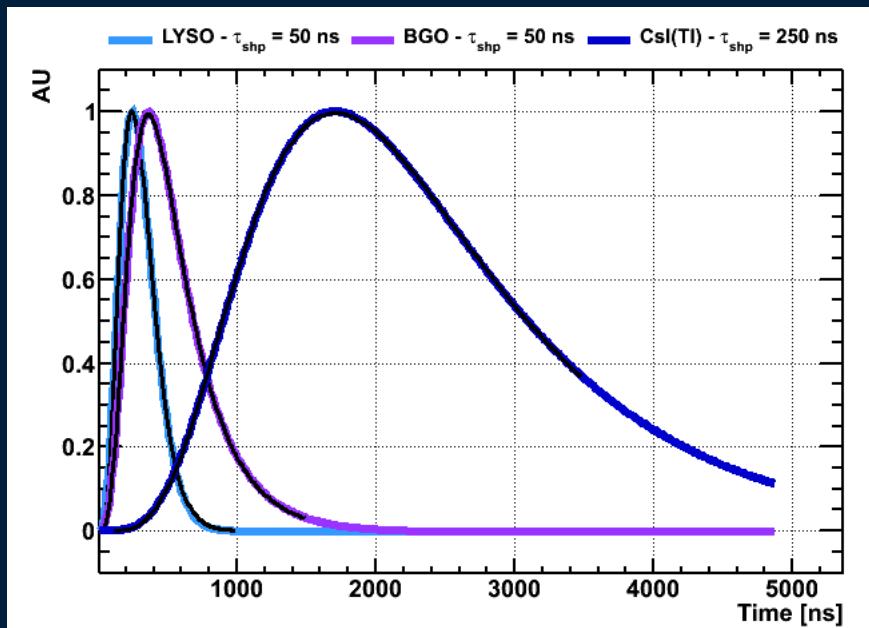


Crystal

CSP

Shaper

- ✓ Shaper output is Gaussian when input signal is a step function
- ✓ Shaping time is the σ of the output Gaussian signal
- ✓ Use Tool provided by Valerio to evaluate the response of the Crystal-CSP-Shaper chain



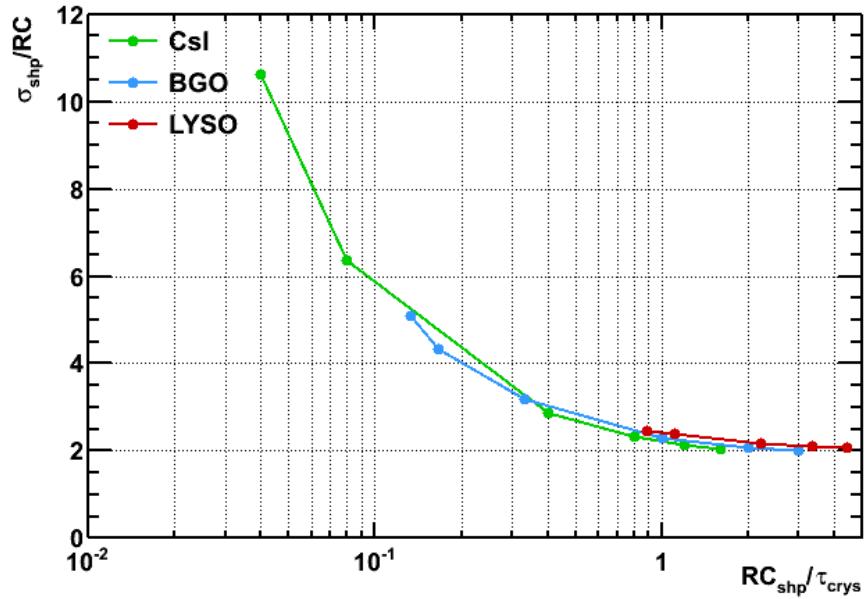
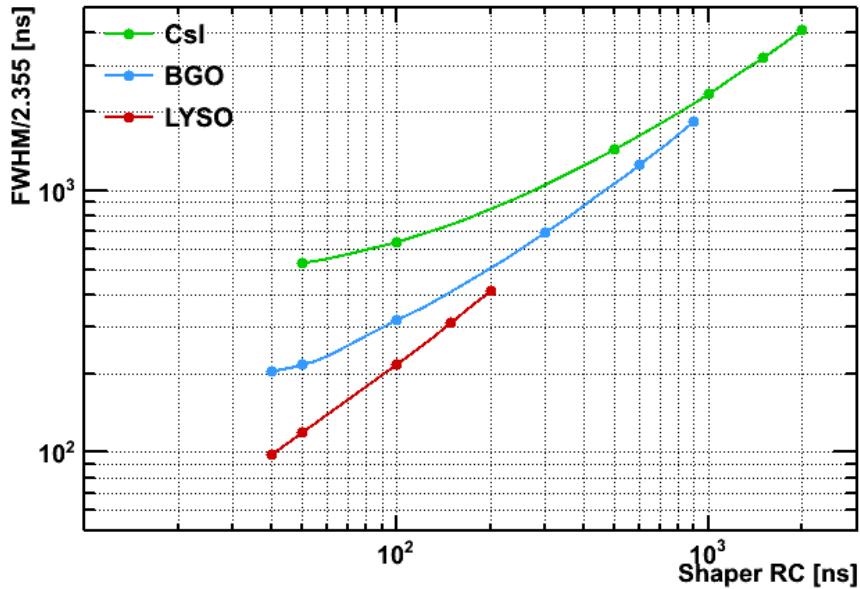
To change shaping time you need to modify RC (τ_{shp}) time constant for the integrating circuits

Output signal shape depends on

- ✓ Shaping Time
- ✓ Input signal

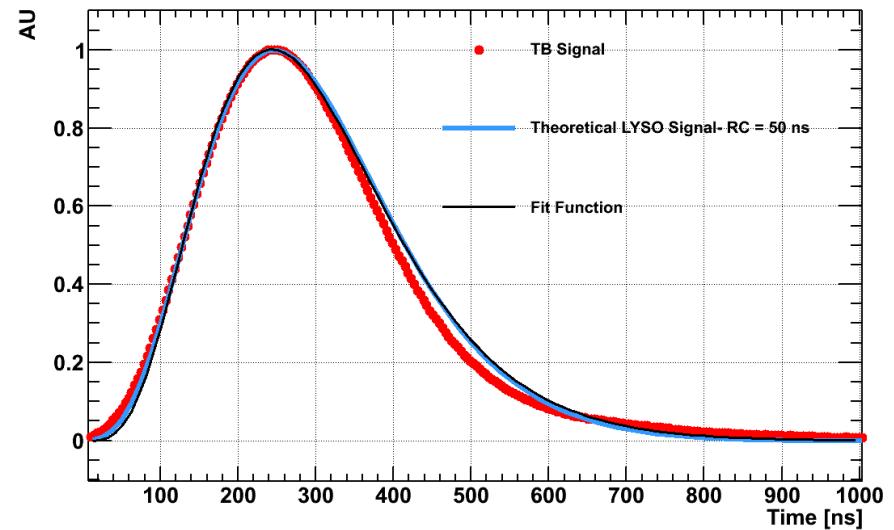
Crystal Type affects Shaper output

SIGNAL SHAPING TIME



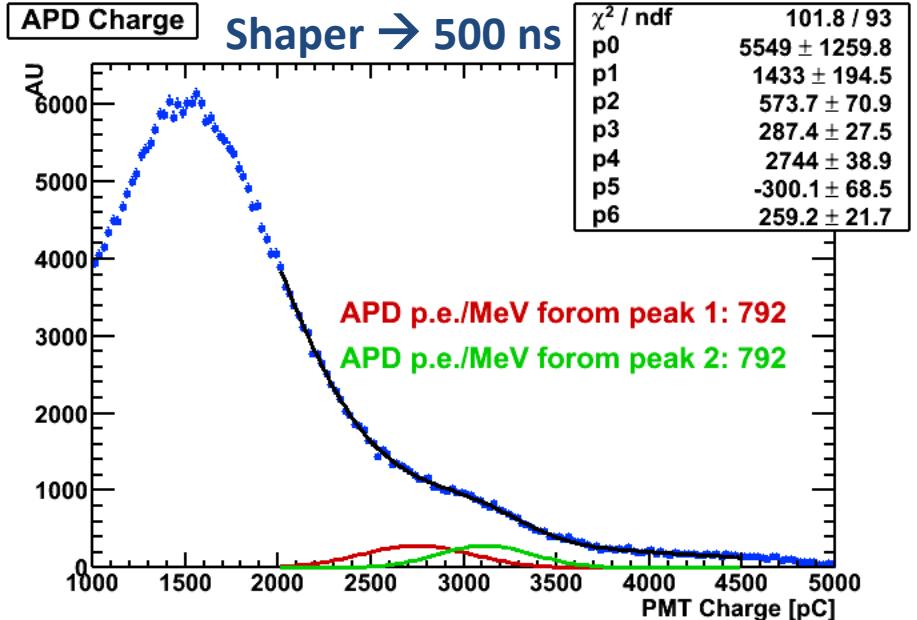
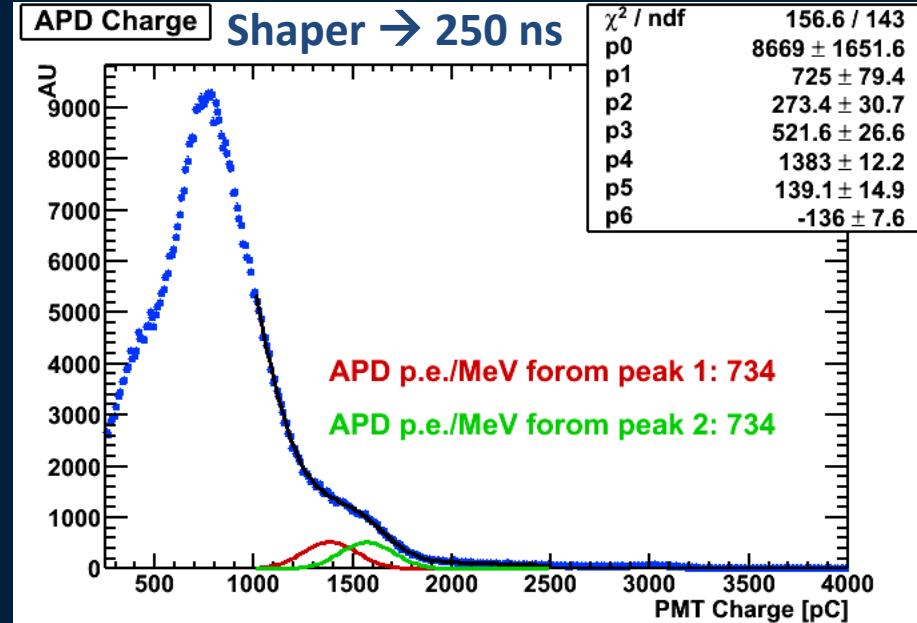
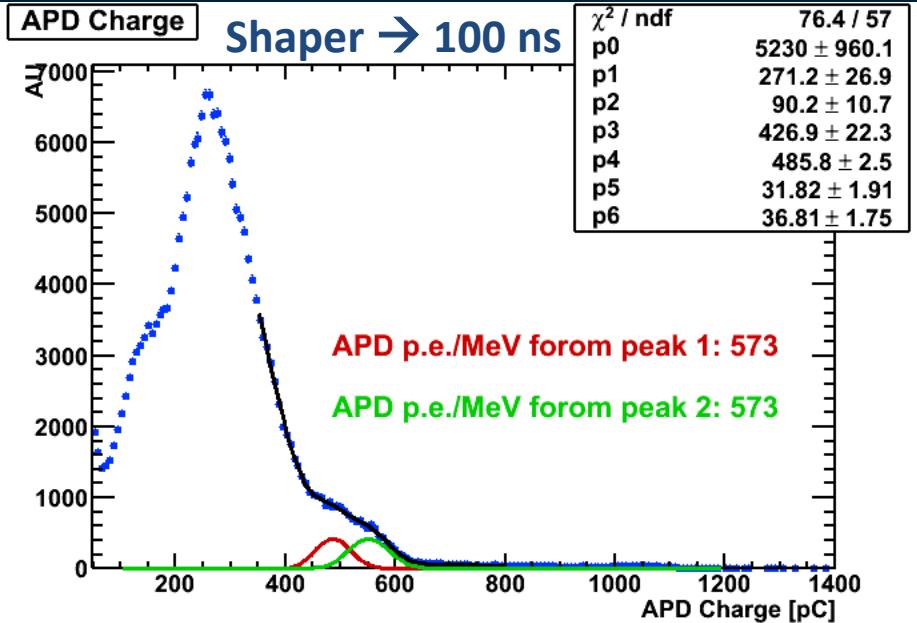
- ✓ Minimal Signal width (FWHM) given by crystal τ
- ✓ When Shaping Time $\gg \tau$ $\sigma \rightarrow 2\text{RC}$
- ✓ Signal Shape and Shaping Time = 2RC relation confirmed by TB data

If $\tau_{\text{shp}} = \text{RC} = 1/2$ Shaping Time
 Is the fraction of integrated signal =
 $S_{\text{shp}} = S_{\text{xtal}}[1 - \exp(-\tau_{\text{shp}}/\tau_{\text{xtal}})]$?



LAB MEASUREMENTS

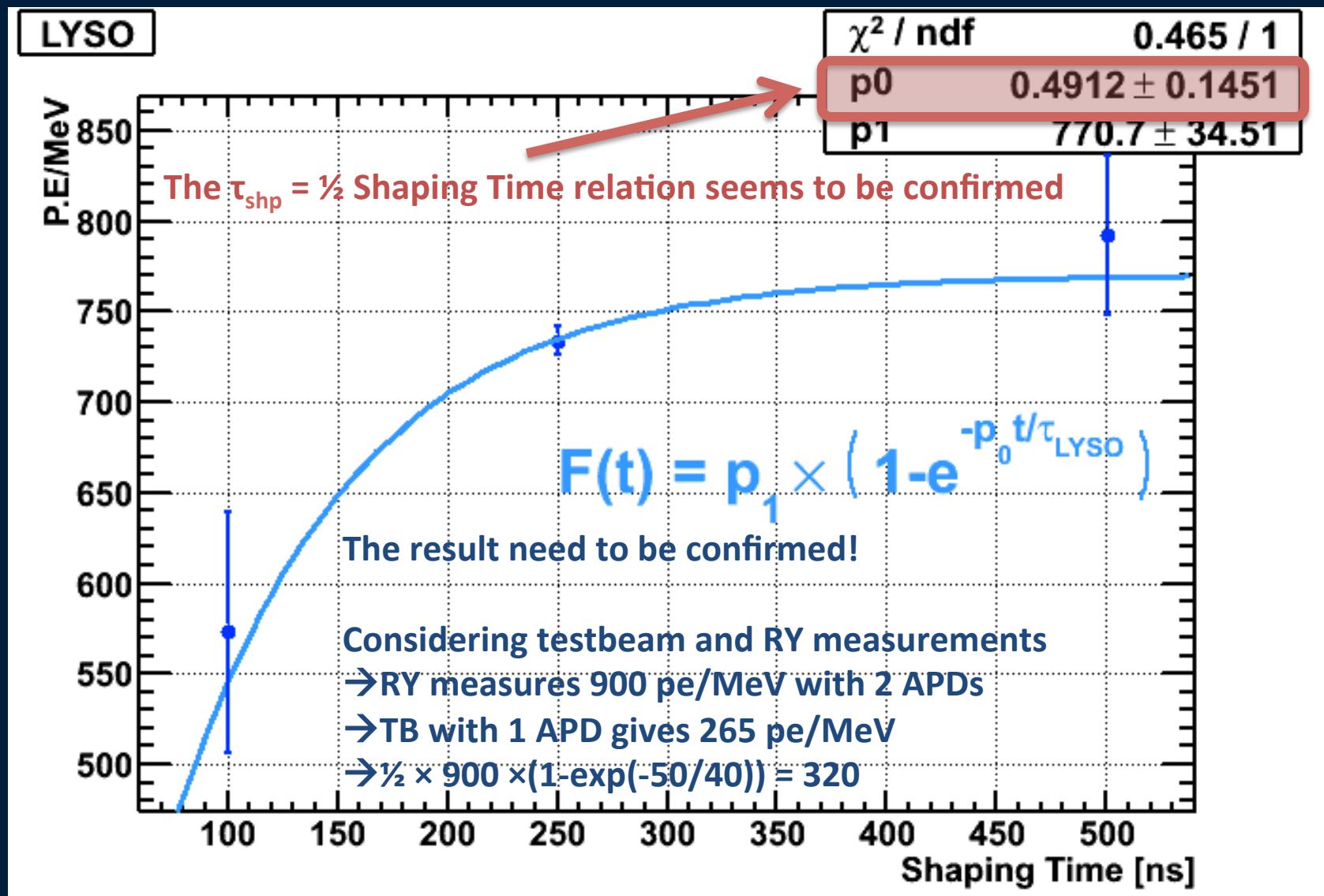
LYSO PEAK FIT



Measurements with ^{60}Co source

Fit to get emitted gammas position (charge)

PE/MeV vs SHAPING TIME



SIGNAL/NOISE

S/N EVALUATION STRATEGY

- All the S/N evaluations start from TB experience
 - ✓ Electronic Noise RMS is the same for CERN and BTF TB (~ 2 ADC counts)
 - Noise is mainly generated at the Shaper Level
 - S/N depends on the Signal Amplitude at Shaper Level
 - ✓ Signal at BTF is ~ 1500 ADC @ 200 MeV
 - ✓ BTF attenuation = 0.175
 - ✓ Estimated BTF pe/MeV = 265
 - ✓ BTF APD gain ~ 35
 - ✓ BTF TB is with 1 APD/Crystal
- LYSO simulation assumptions
 - ✓ 2 APD/crystal
 - ✓ APD gain ~ 50
 - ✓ No Signal Attenuation (for a totally realistic approach the two range ADC readout should be implemented)
- $\text{SN(LYSO)} = 50/35 \times 1/0.175 \times 2 \times \text{SN(BTF)}$

S/N FOR ALTERNATIVE CRYSTALS

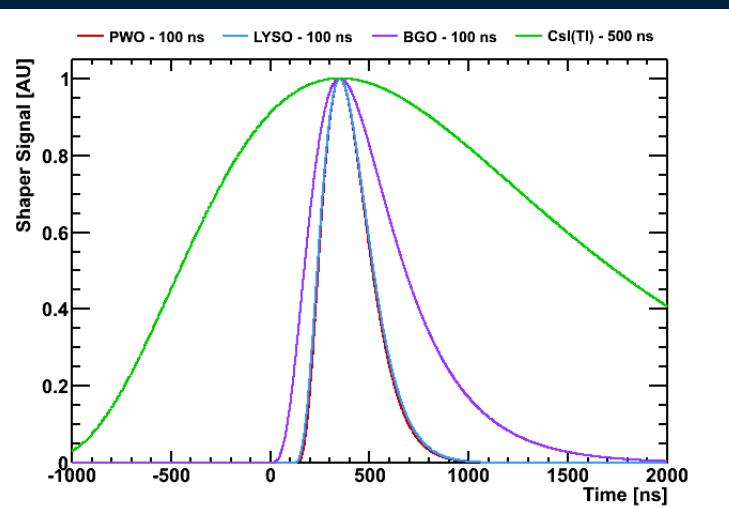
Crystal	LO [pe/MeV]	Reference
PWO	35	Panda and CMS
BGO	225	RY paper
CsI	36	Alessandro Meas
CsI(Tl)	7000	BaBar

Crystal	Sensor	Sensor Area	Gain	Shaping Time	Integrated Fraction	Effective pe/MeV	SN/SN(BTF)
LYSO	APD	0.5 cm ²	50	100 ns	711 %	530	16
PWO	APD	2 cm ²	50	100ns	81 %	28	0.86
BGO	APD	0.5 cm ²	50	200 ns	28 %	64	3.9
BGO	APD	0.5 cm ²	50	100 ns	15 %	35	2.1
CsI	PP	10 cm ²	180	100 ns	81 %	29	3.2
CsI	PP	20 cm ²	180	100 ns	81 %	58	6.4
CsI(Tl)	PIN	4 cm ²	1	500 ns	21 %	1550	0.95
CsI(Tl)	APD	4 cm ²	50	500 ns	21 %	1550	48
CsI(Tl)	APD	0.5 cm ²	50	500 ns	21 %	190	6

EMC OPTIONS PERFORMANCE SIMULATION

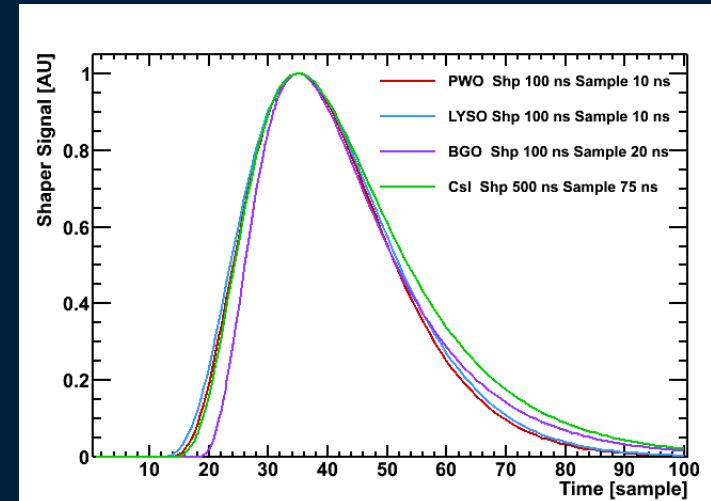
SIMULATION DETAILS

- ✓ Geometry
 - ✓ Default Fwd SuperB geoemetry for LYSO, BGO and PWO
 - ✓ BaBar fro Barrel and CsI Fwd
- ✓ Simulated Particles
 - ✓ Single photons + Radiadive Bhabha
- ✓ Signal Shape from Valerio's Tool
- ✓ Noise spectrum and level from TB
- ✓ Clustering algorithm similar to BaBar one

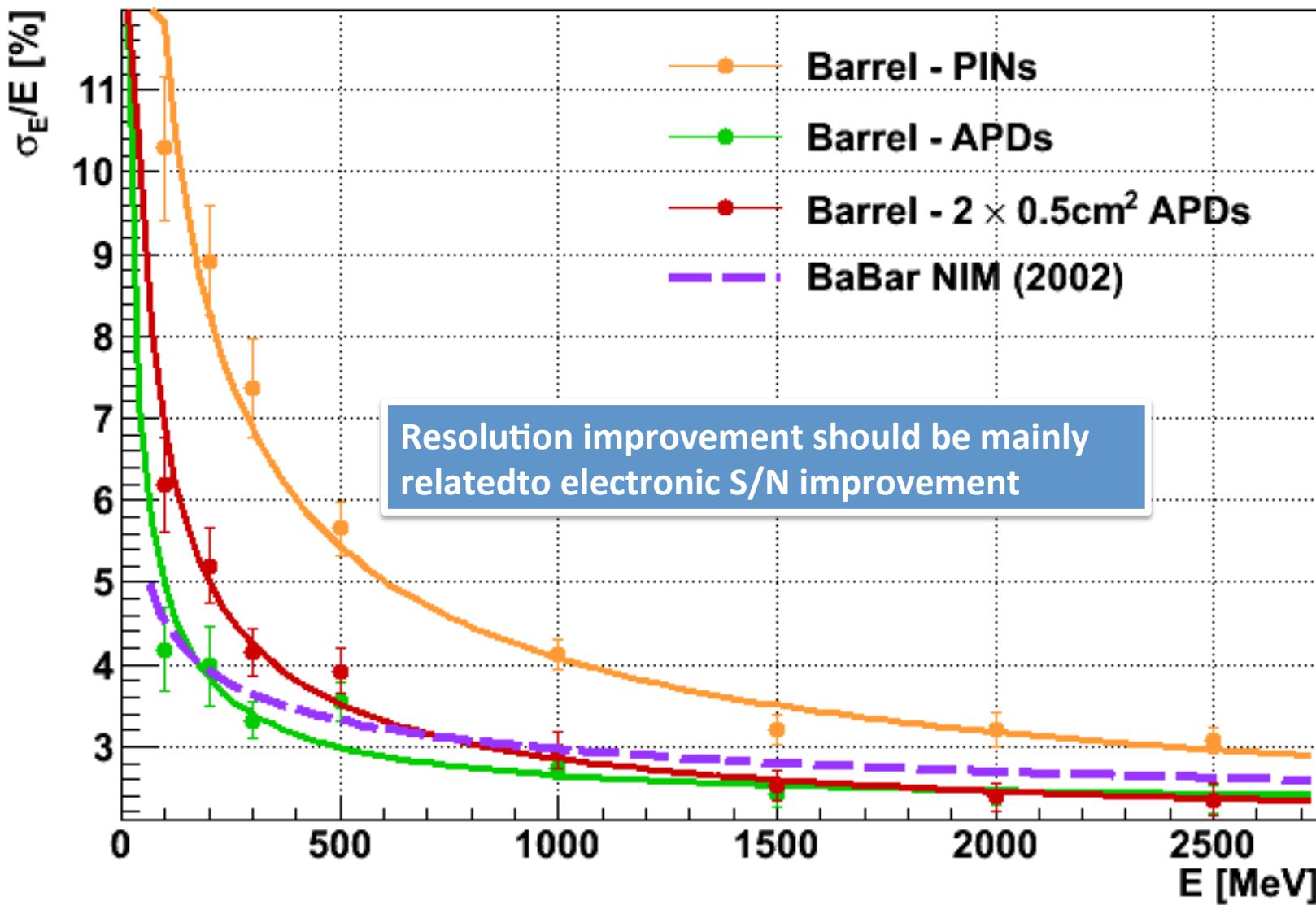


Simulated signals Shapes

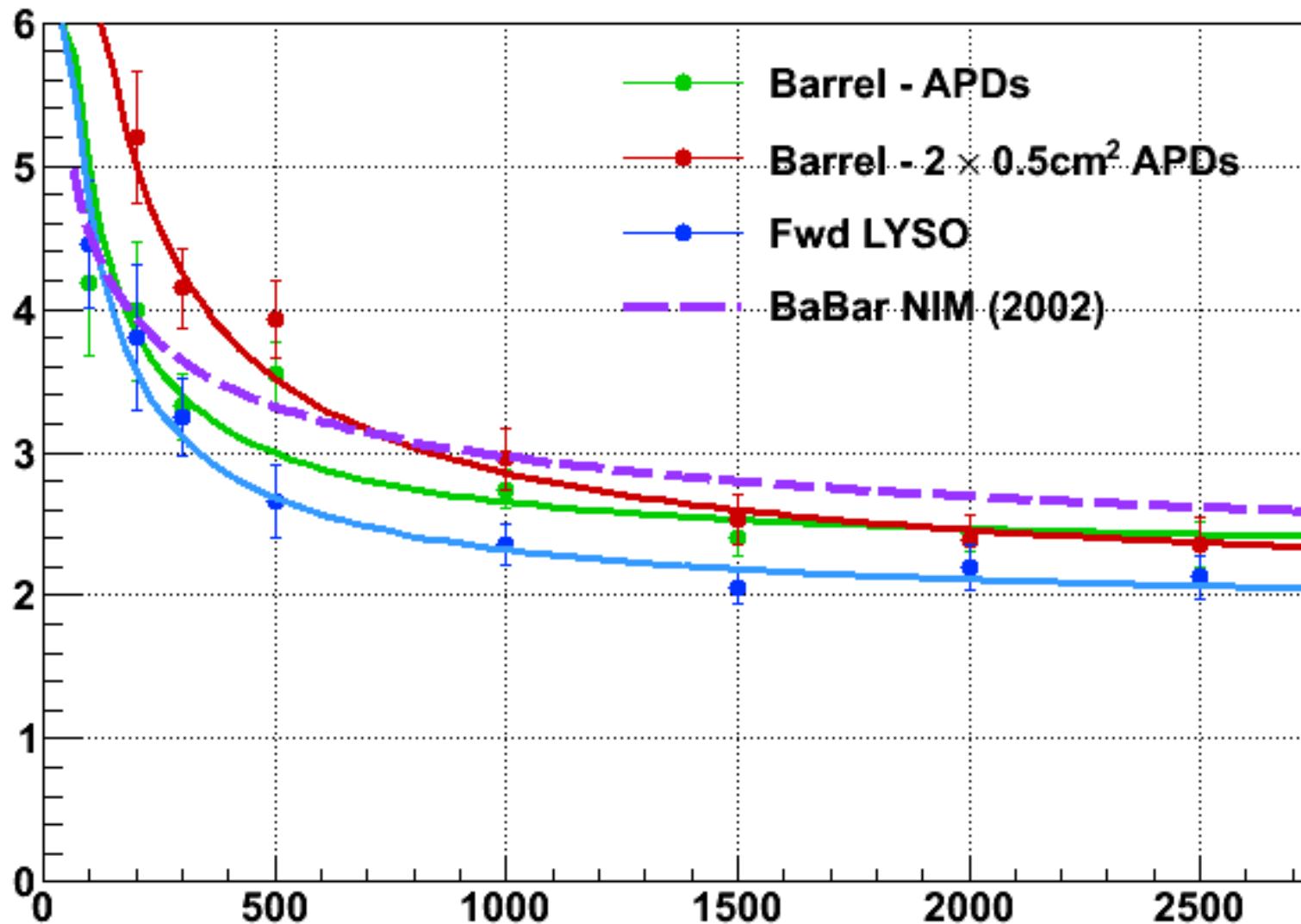
Simulated Siignal Shape and sampling



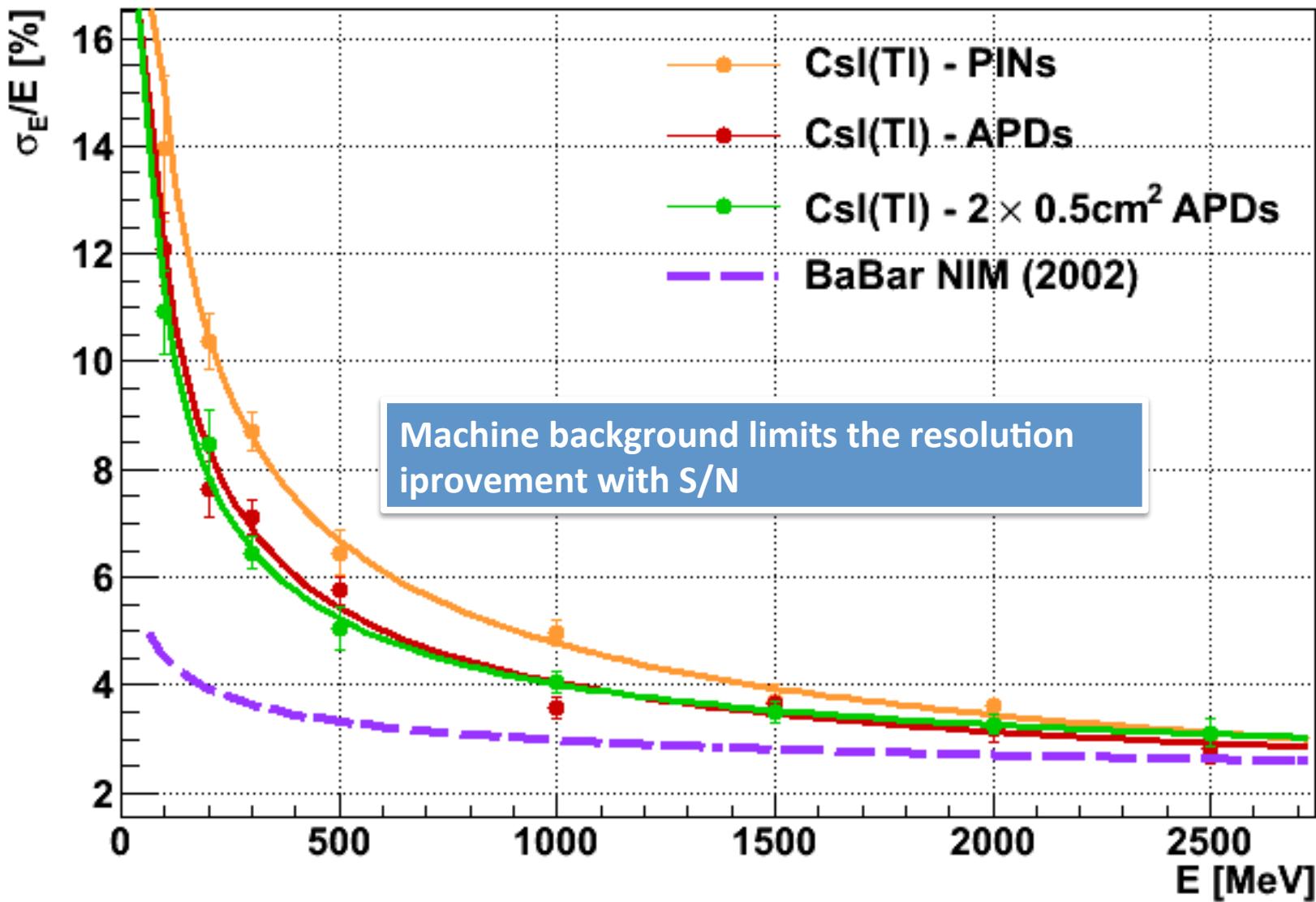
BARREL OPTIONS



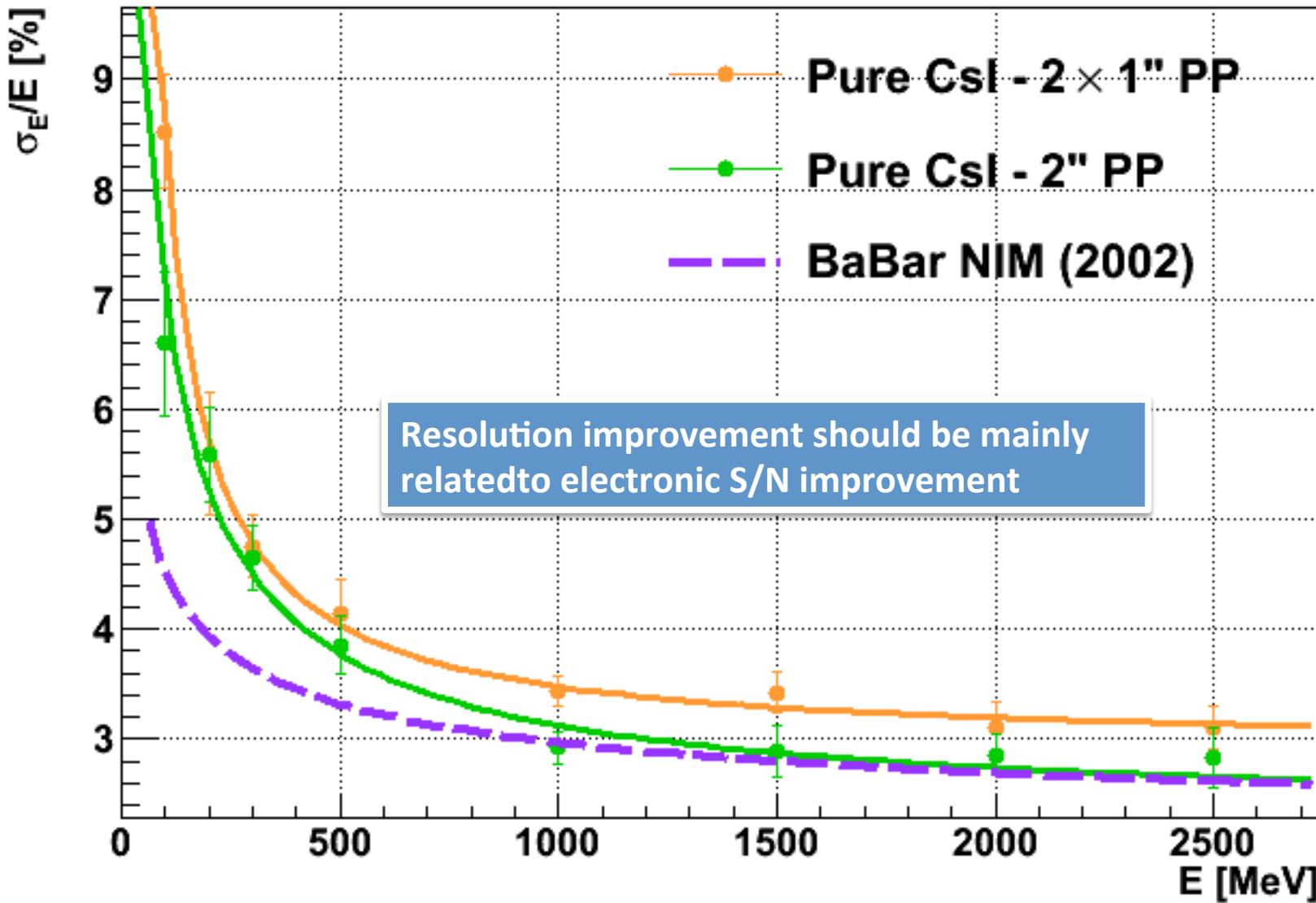
BARREL AND LYSO FWD



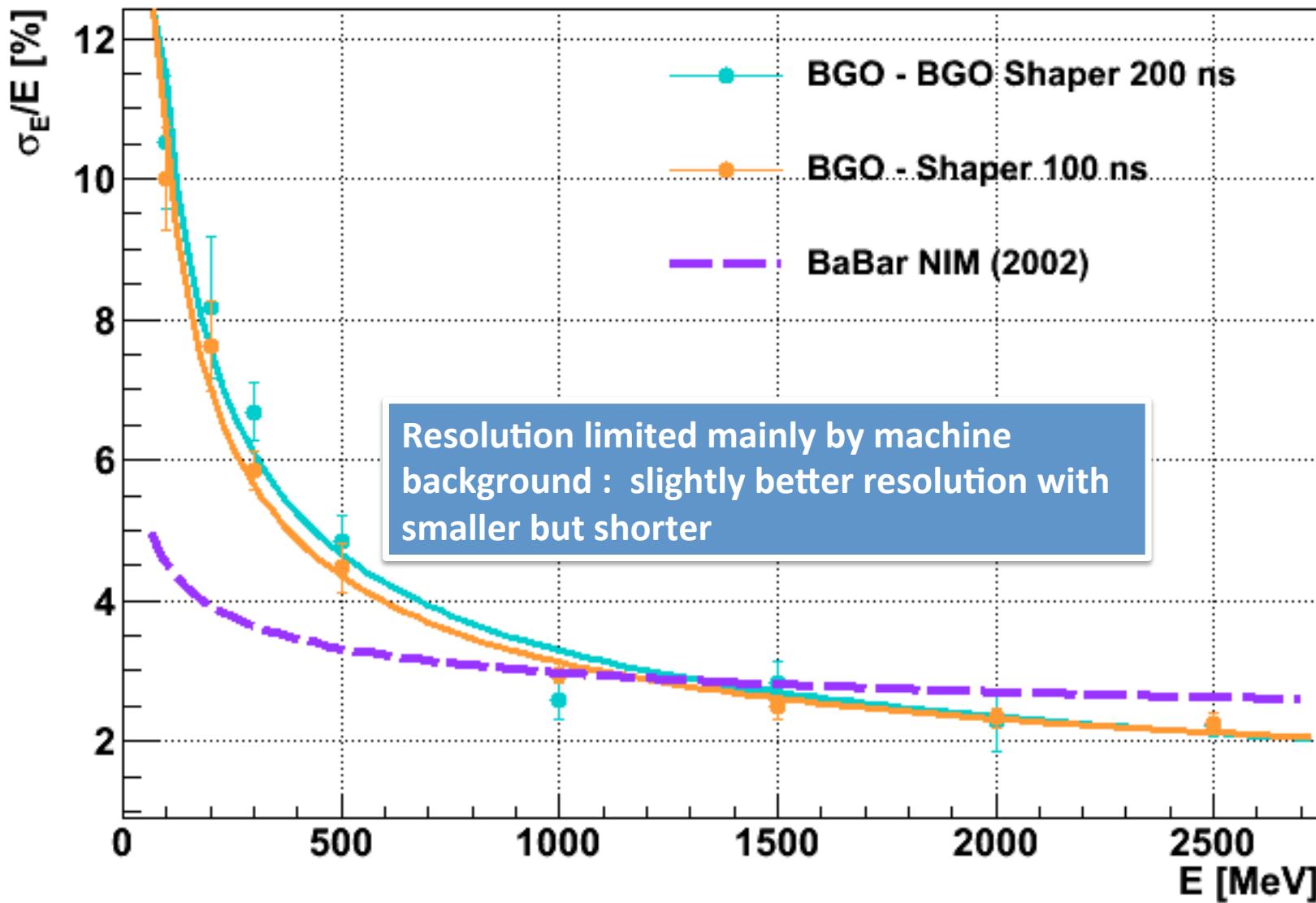
CsI(Tl) FWD OPTIONS



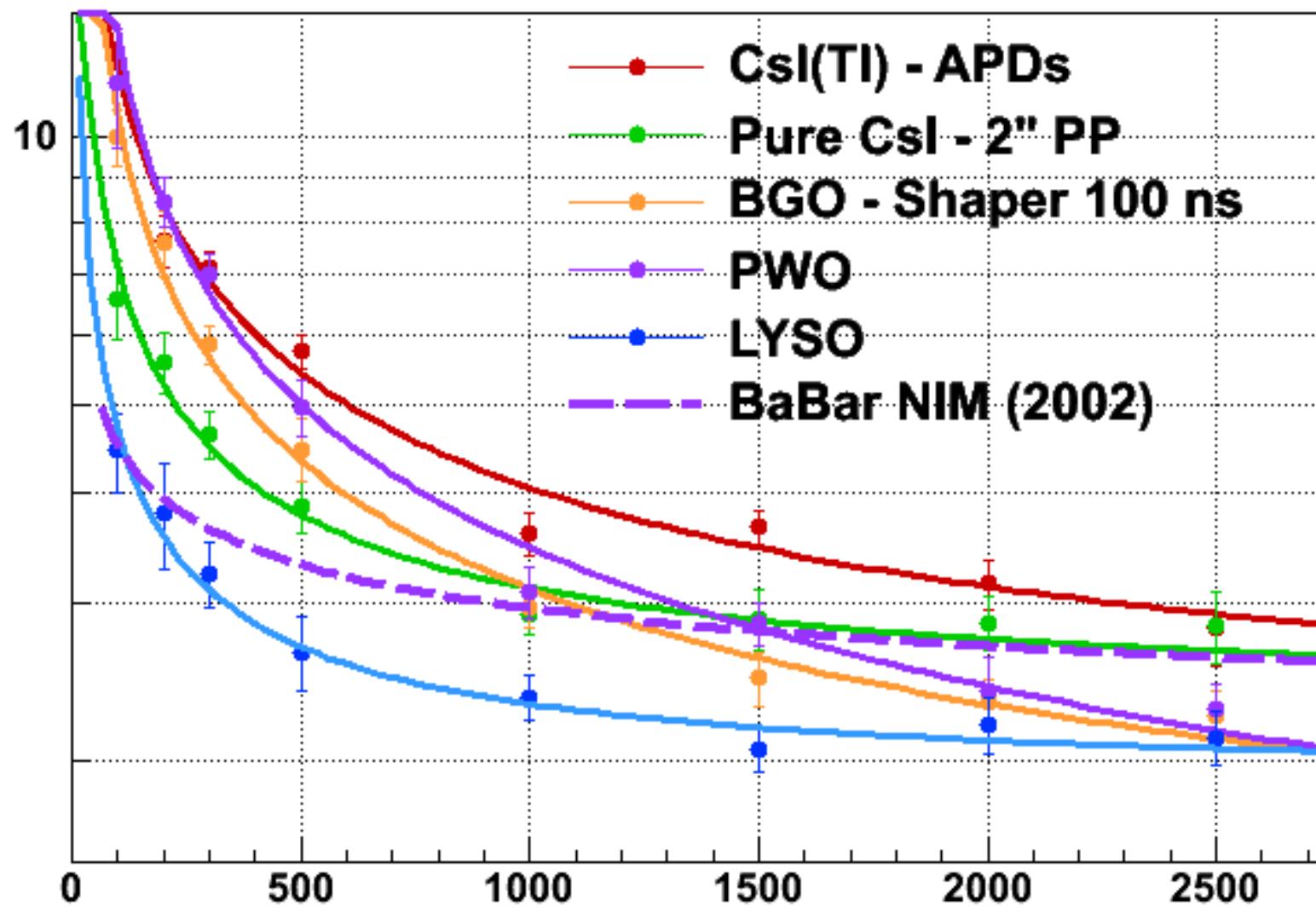
PURE CsI FWD OPTIONS



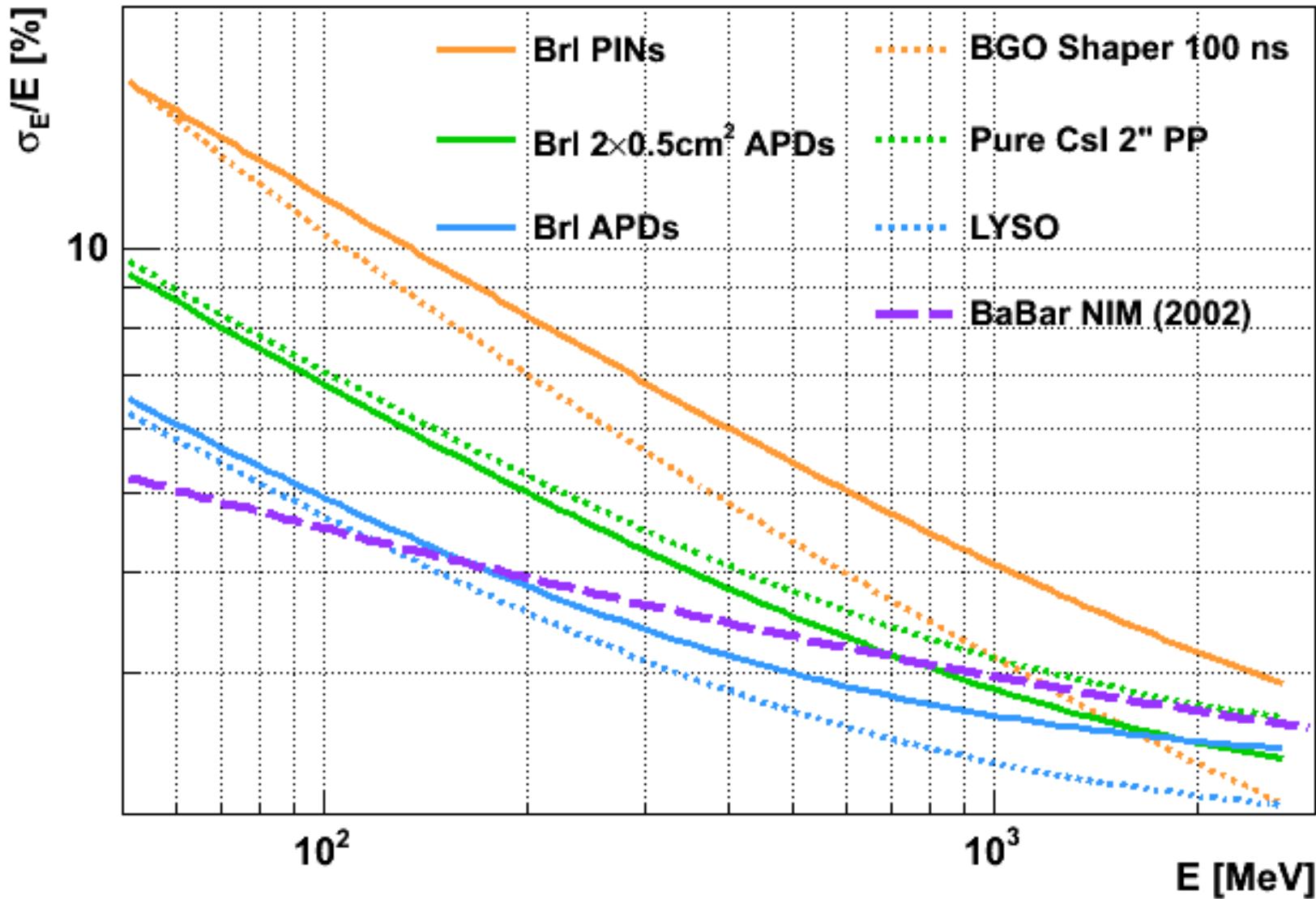
FWD BGO OPTIONS



SELECTED FWD OPTIONS

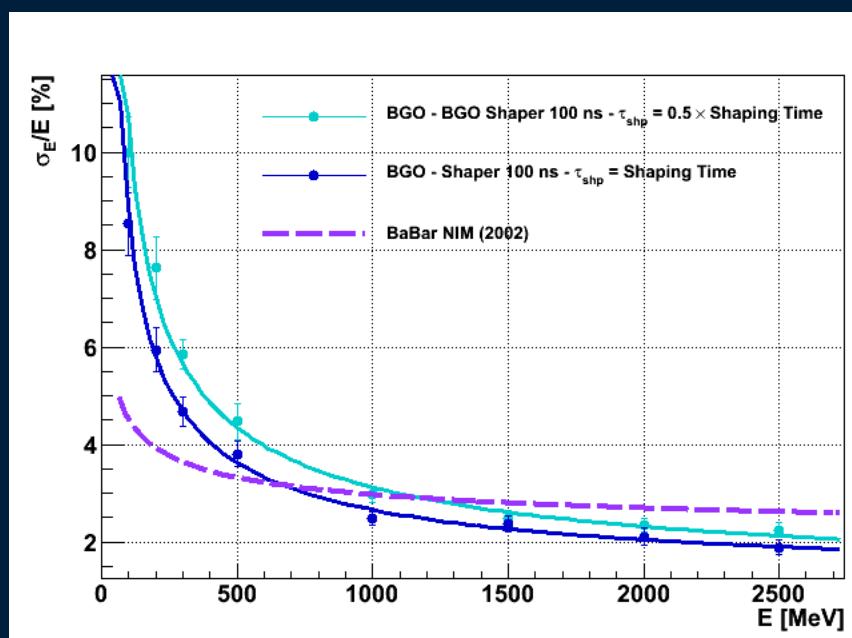
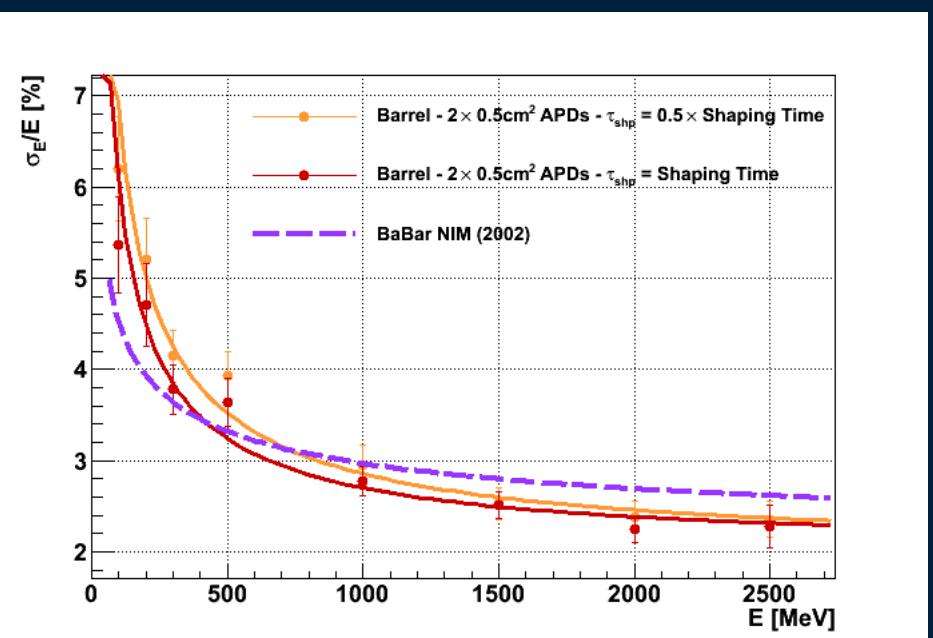


EMC GLOBAL RESOLUTION LEVELS



EFFECT OF THE $T_{\text{shp}} = \frac{1}{2}$ SHAPING TIME?

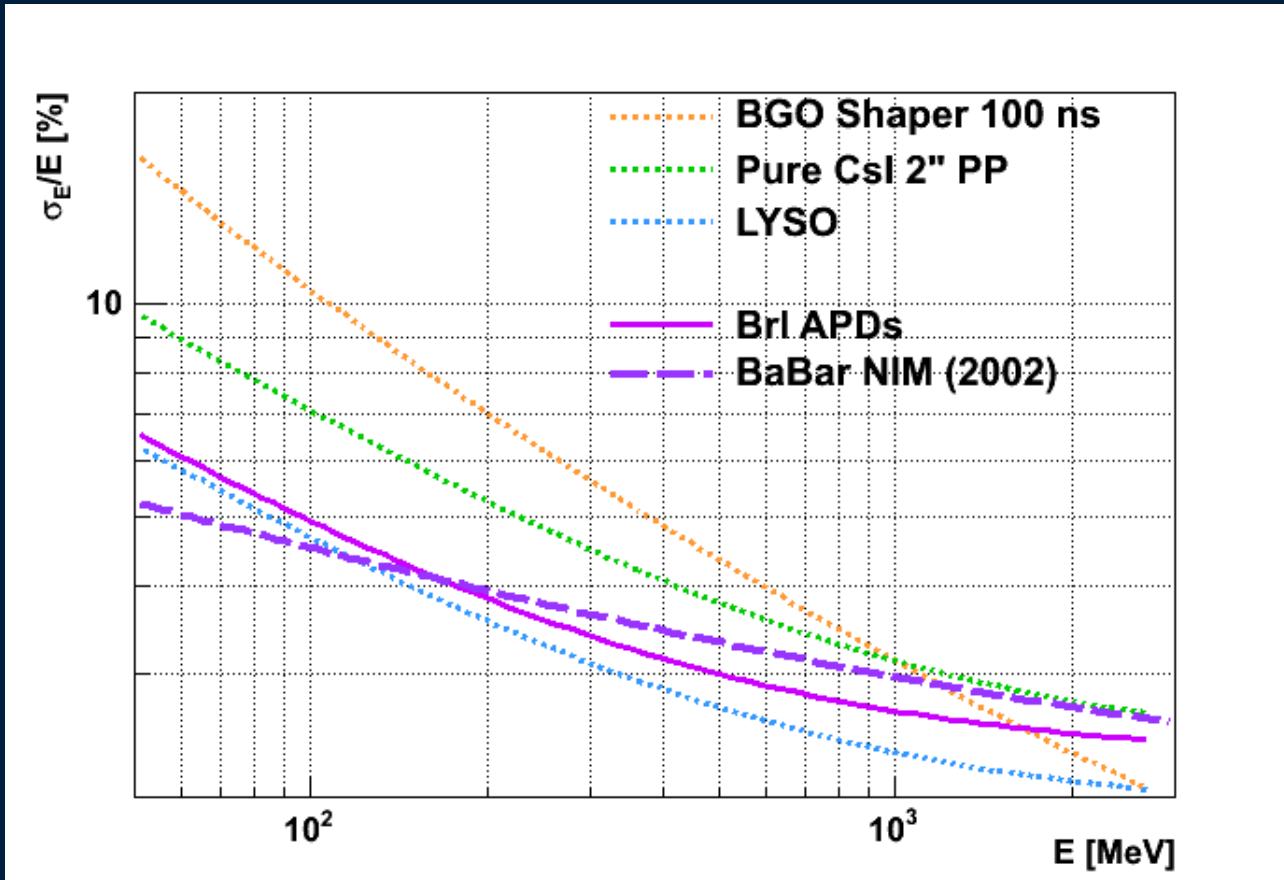
- Try to evaluate the effect of the $\tau_{\text{shp}} = \frac{1}{2}$ Shaping Time choice
- Compare results with $\tau_{\text{shp}} = 1$ Shaping Time option for slower crystals



Not huge but not negligible effect → need to be sure of the τ_{shp} - Shaping Time relation!

PERFORMANCE STUDY WITH FASTSIM

Resolution for 3 Fwd options and the best Barrel option ingested in FastSim to study the physics impact of the energy resolution



See Elisa's talk

CONCLUSIONS

- Electronic signal shape depends on crystal type and shaping time
- Electronic signal amplitude :
 - $\tau_{\text{shp}} = \frac{1}{2} \text{ Shaping Time (to be confirmed!)} \)$
- Wide range of resulting energy resolution
 - Some parameter values or assumptions are critical: need to make sure all of them are correct