EMC SUMMARY

C. Cecchi

F. Porter

Outline:

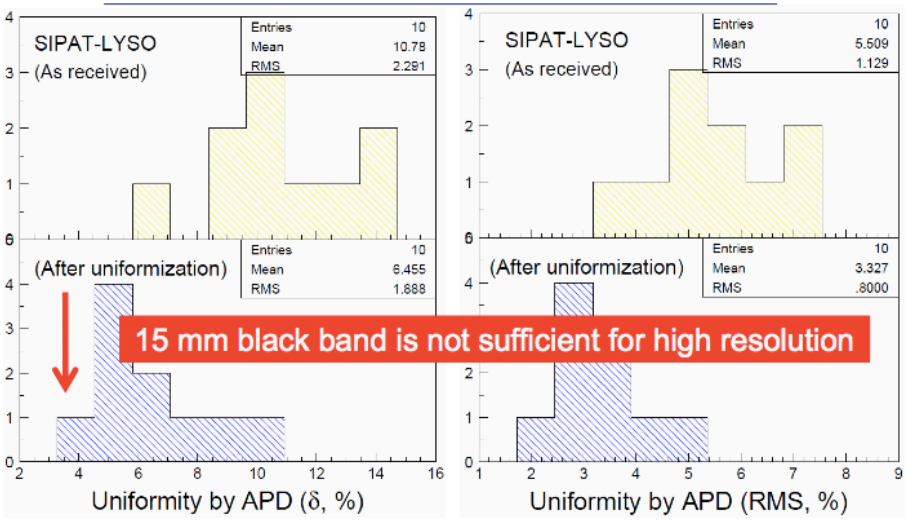
- **-Crystals**
- **-Simulation**
- **-TB data**
- **-Electronics**
- **-Alternatives to LYSO**
- **-BWD calorimeter**

Progress on crystals

Perugia INFN Istituto Nazionale di Fisica Nucleare

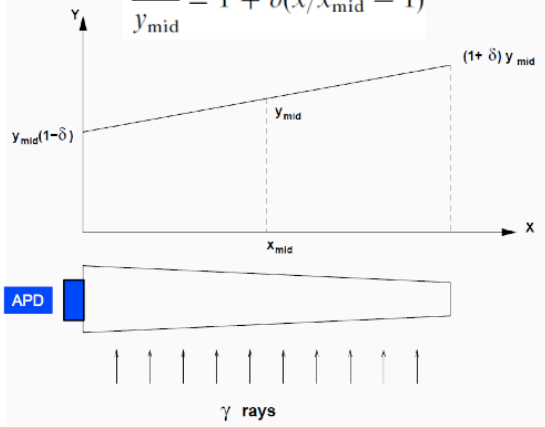
Distribution of Non-Uniformity

Non-uniformity reduced from 10.8% and 5.5% to 6.5% and 3.3% for δ and rms respectively

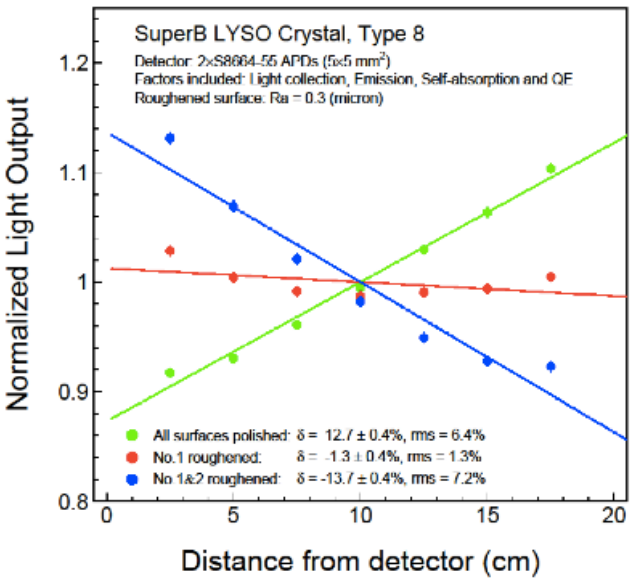


Light Response Non-Uniformity: δ

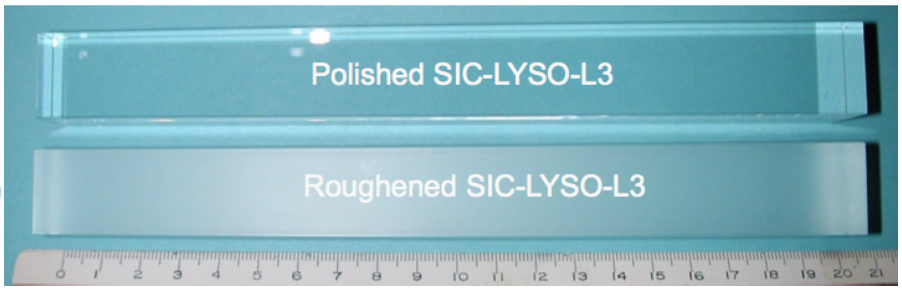
$$\frac{y}{y_{mid}} = 1 + \delta(x/x_{mid} - 1)$$



Real Exercise: Roughening SIC-LYSO-L3The smallest side surface of SIC-LYSO-L3 was roughened to Ra = 0.3 at SIC via a two step process



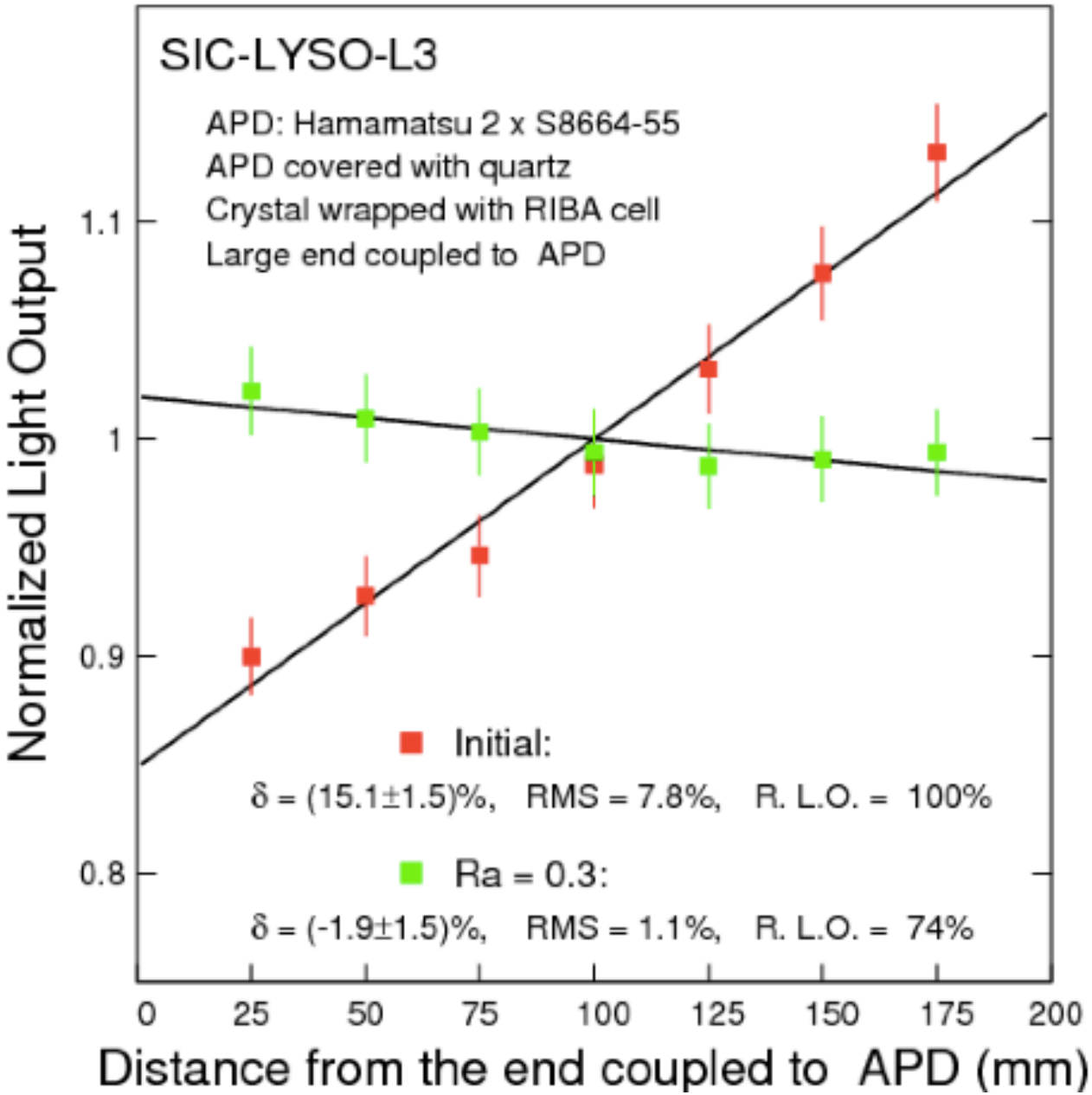
- The optical focusing, effect dominates non-uniformity: δ is about 13% for all polished surfaces.
- Roughened surface(s) can compensate the optical focusing effect.
- The best result is achieved by roughening only one side surface.



1st: lapped to Ra = 0.5 by using 11 μm Al_2O_3 powder for 10 min with 2.5 kg weight.
2nd: lapped to Ra = 0.3 by using 6.5 μm SiC powder for 3 min with 1.5 kg weight.

Relative Light Output & Uniformity

Ra = 0.3 uniformize this crystal to < 2%. Ra = 0.25 seems the best for this sample.

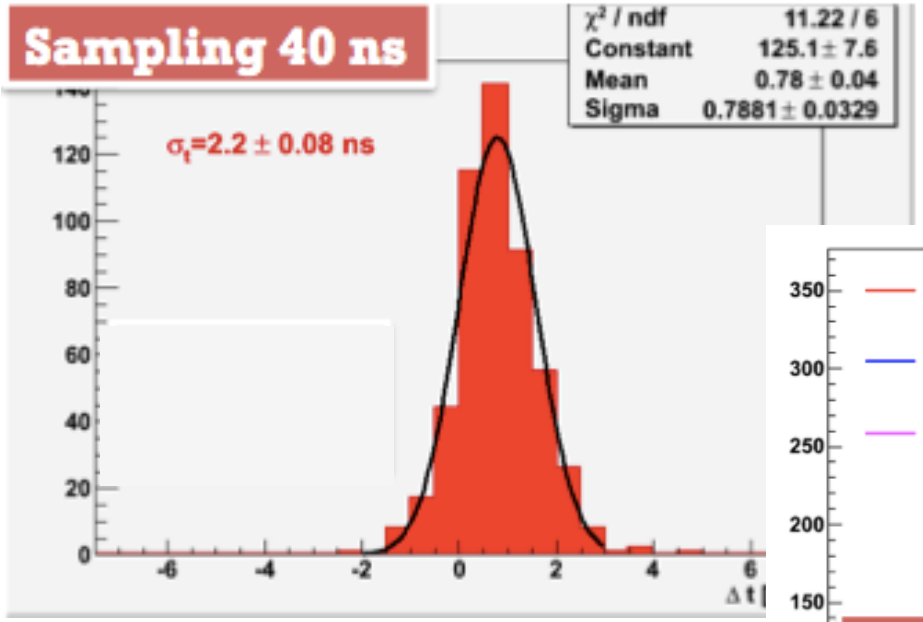


Simulation studies: bckg, time resolution

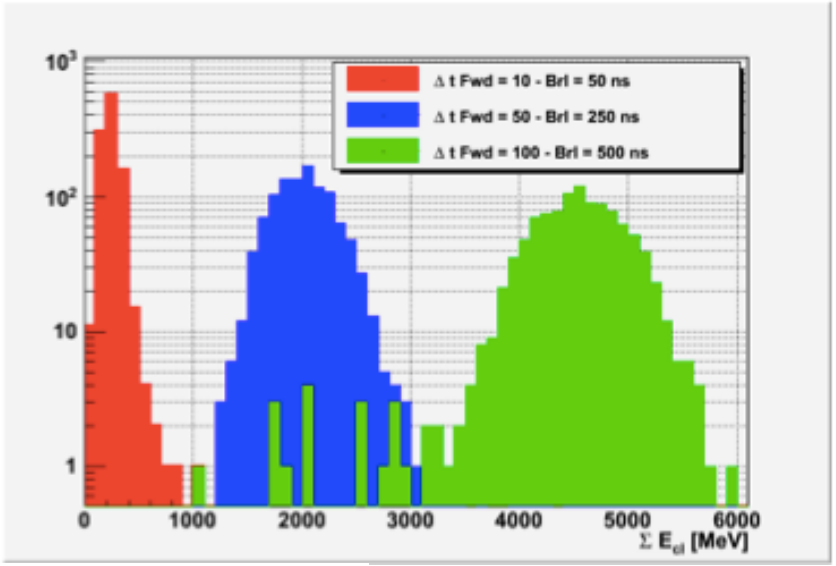
Perugia INFN Istituto Nazionale di Fisica Nucleare

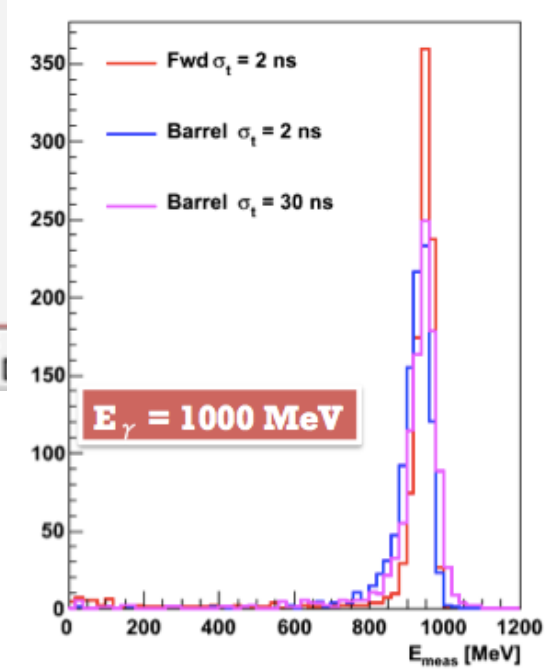
Crystal Time Resolution for LYSO taken from TB measuremnts:
→Take crystal time from signal peak fit
→Plot t(X1)-t(X2)
→Perform Gauss Fit
→ Time resolution = σ /sqrt(2)

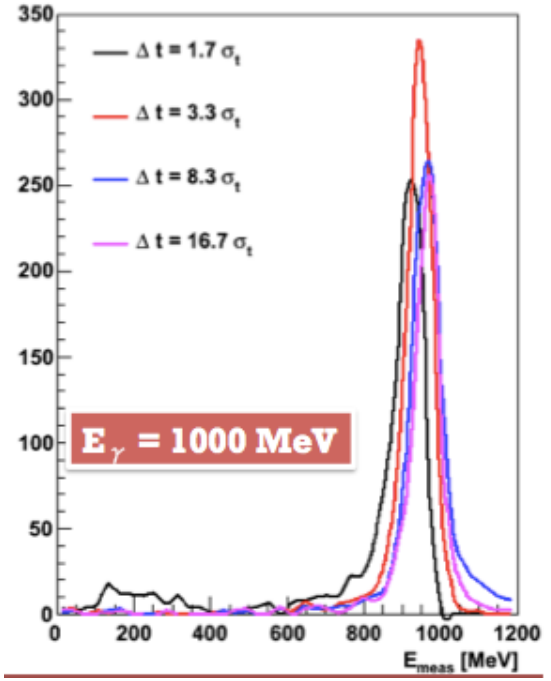
Sampling 40 ns



Sum of Cluster Energy

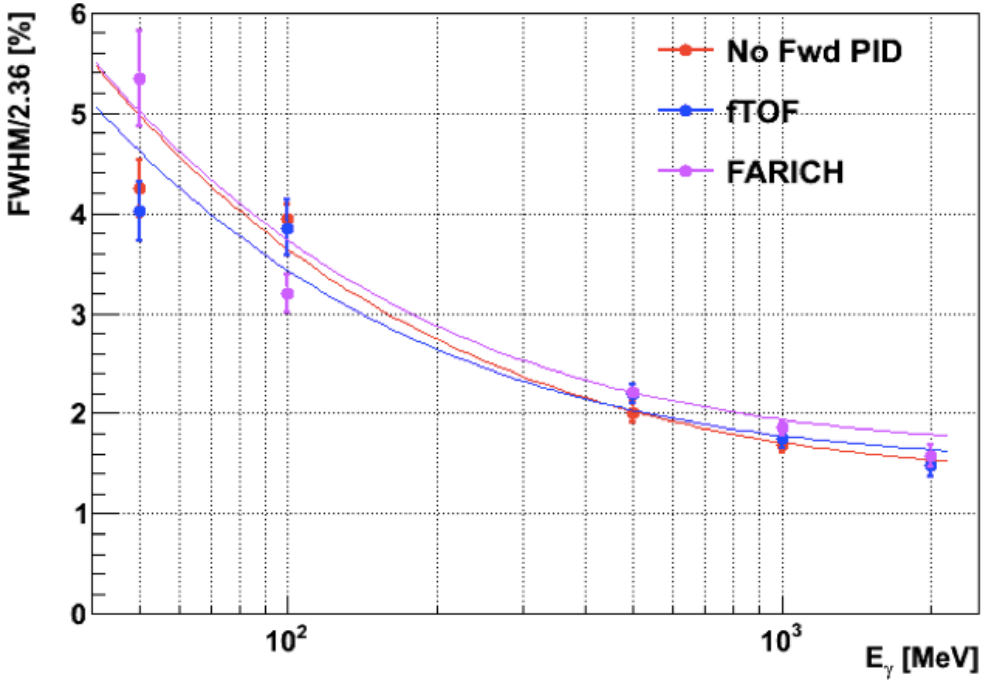




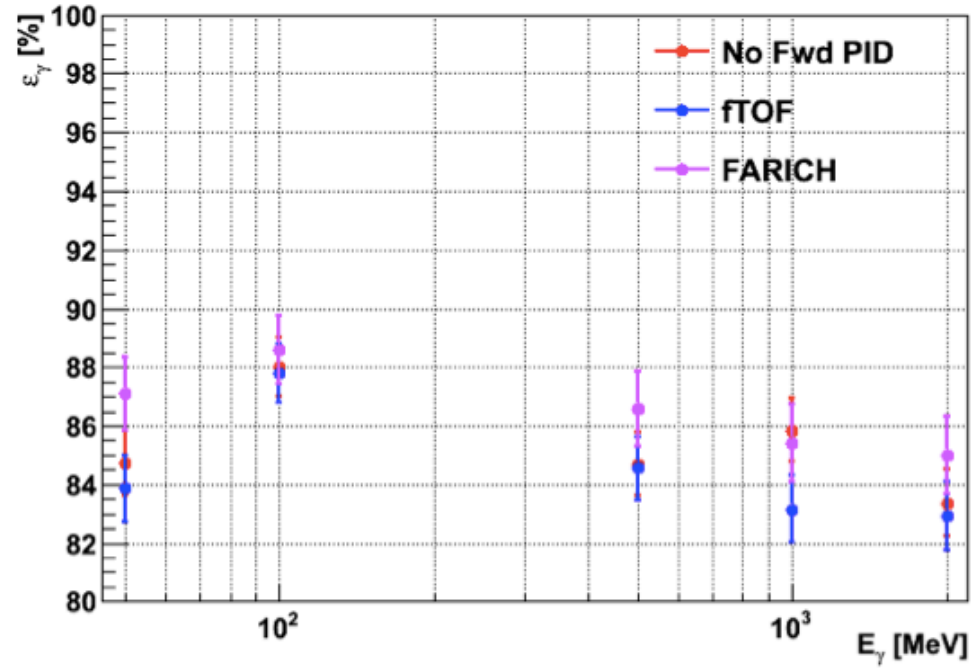


Simulation studies: FWD PID

Fwd EMC Energy Resolution

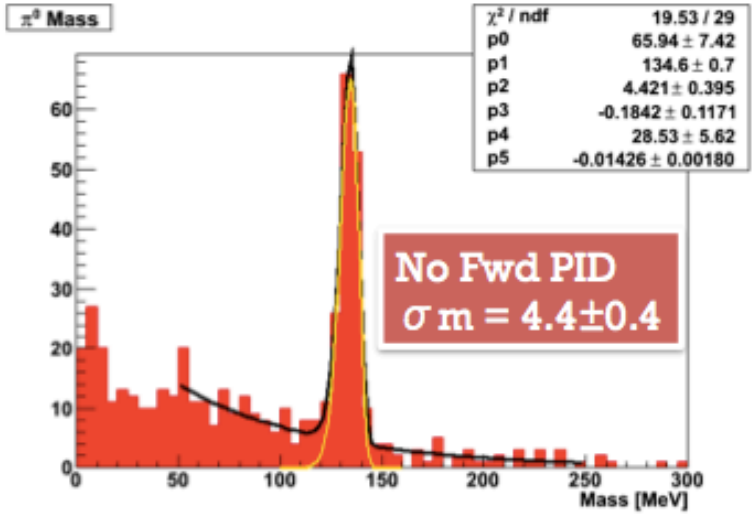


Fwd EMC γ Efficinecy



Which conclusion?
More statistics to reduce errors?
Factorize effects?

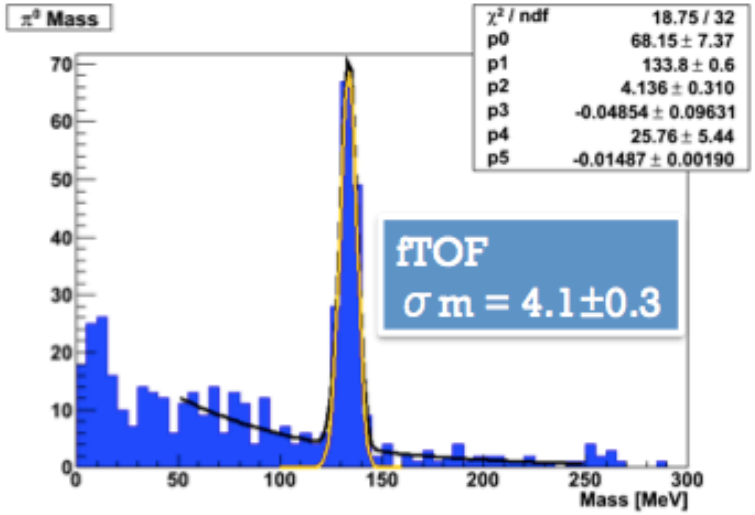
π^0 Mass

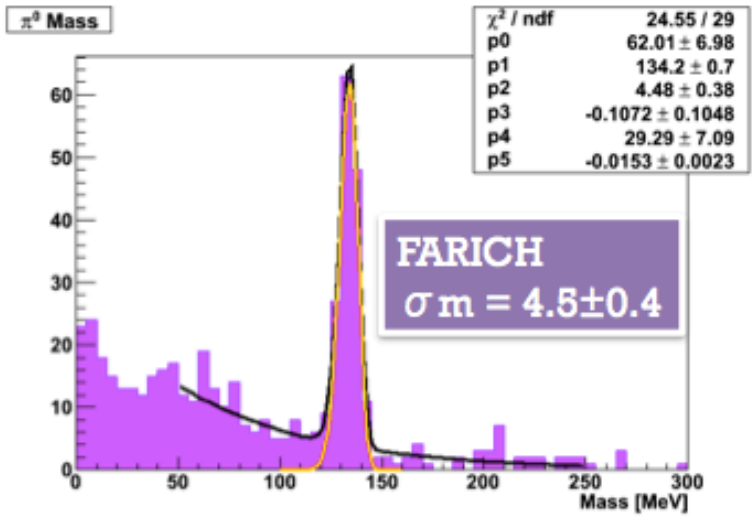


π^0 with Ek = 1 GeV
Both clusters in Fwd Endcap
Fit: Background + Novosibirsk

$\varepsilon_{\text{fTOF/NoPID}} = 98.0 \pm 1.2$

$\varepsilon_{\text{FARICH/NoPID}} = 96.5 \pm 1.5$

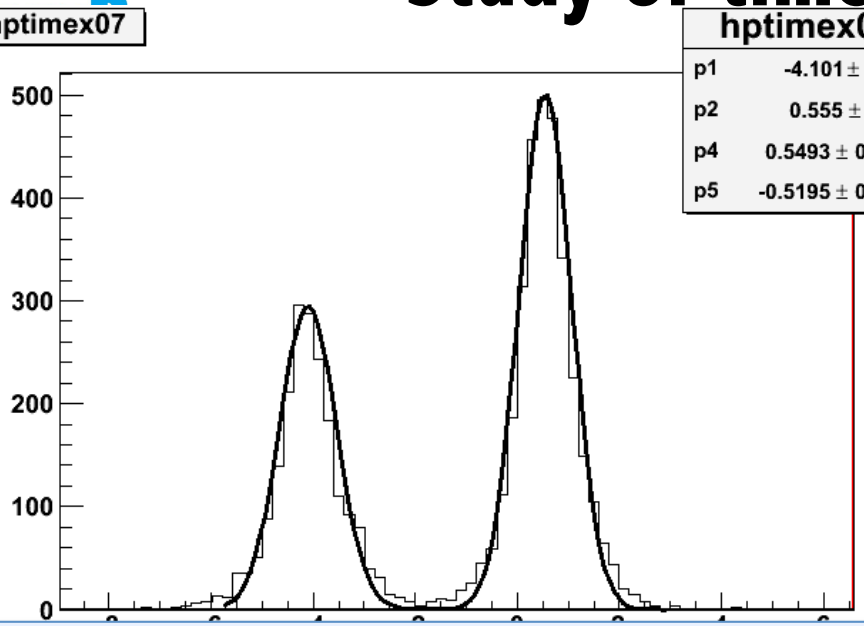




Fwd PID Effects on EMC

- fTOF and FARICH effects on pions mass resolution are negligible
- fTOF and FARICH effects on pions detection efficiency is very small

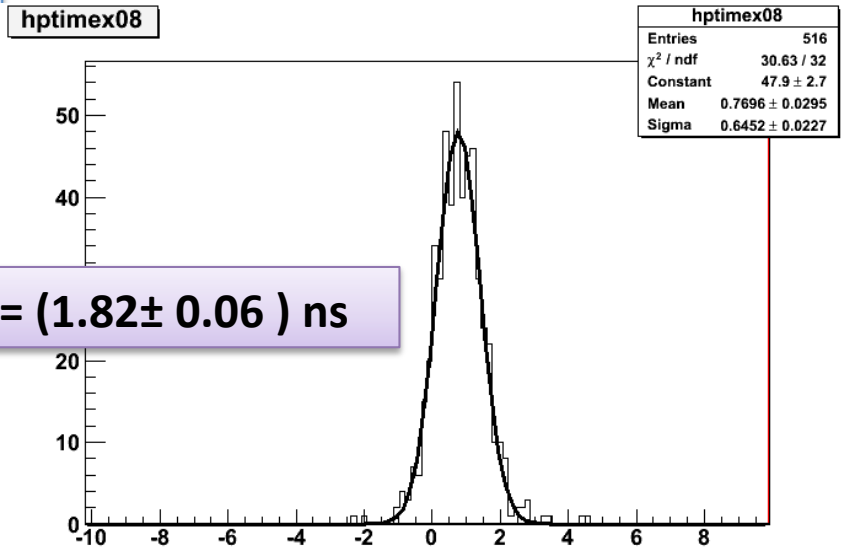
Study of time resolution (data)



distance between peaks about 4 adc sample (1 ADC sample =4ns) → 16 ns shift when ADC loose the phase.

- Asynchrony between ADC modules (16ns)
- Asynchrony between ADC channels
- Degradation of signal in ADC 3

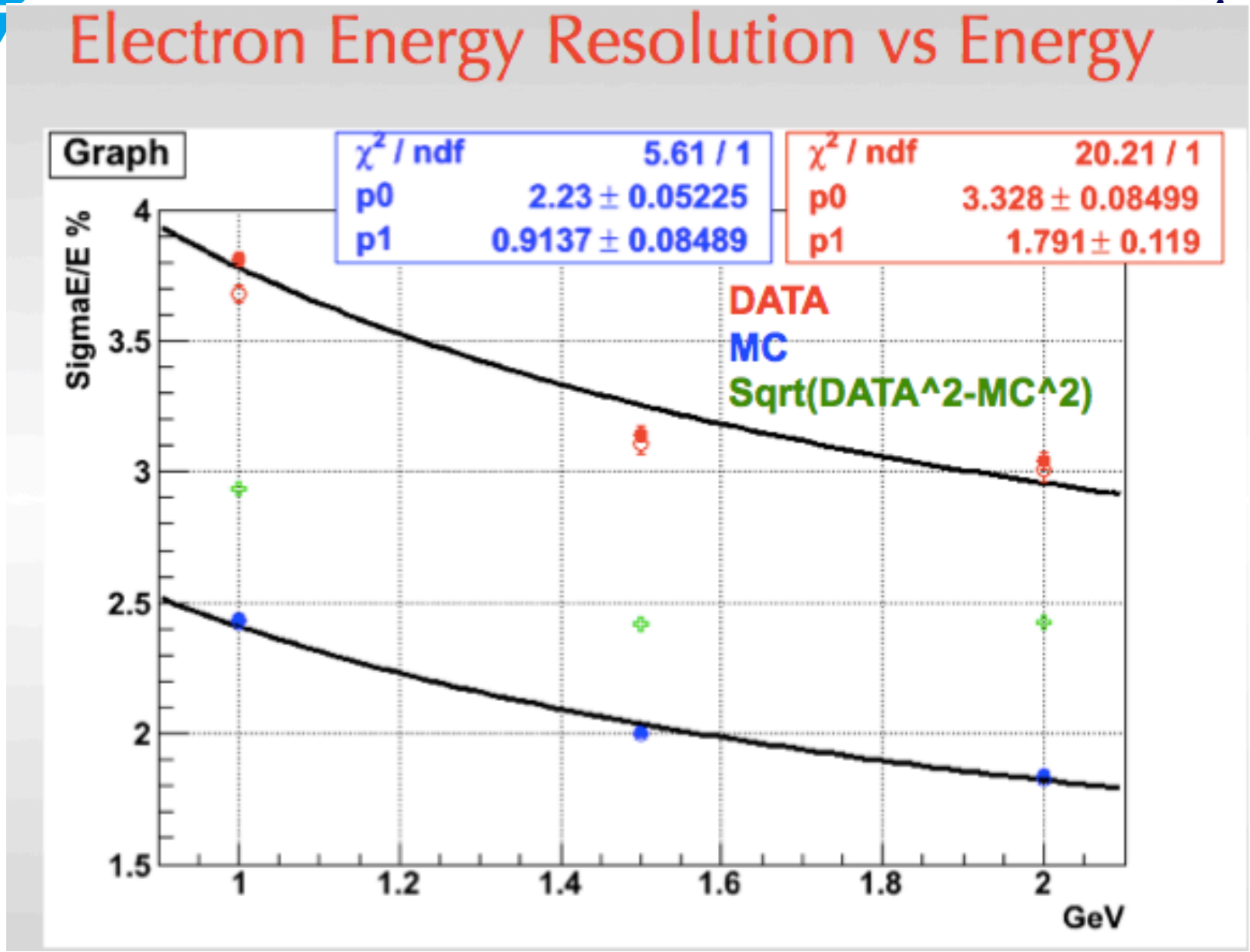
1. **Reproduce problems**
2. **Offline correction algorithm?**
3. **Try to solve with Fan In Out**



σ= (1.82± 0.06) ns

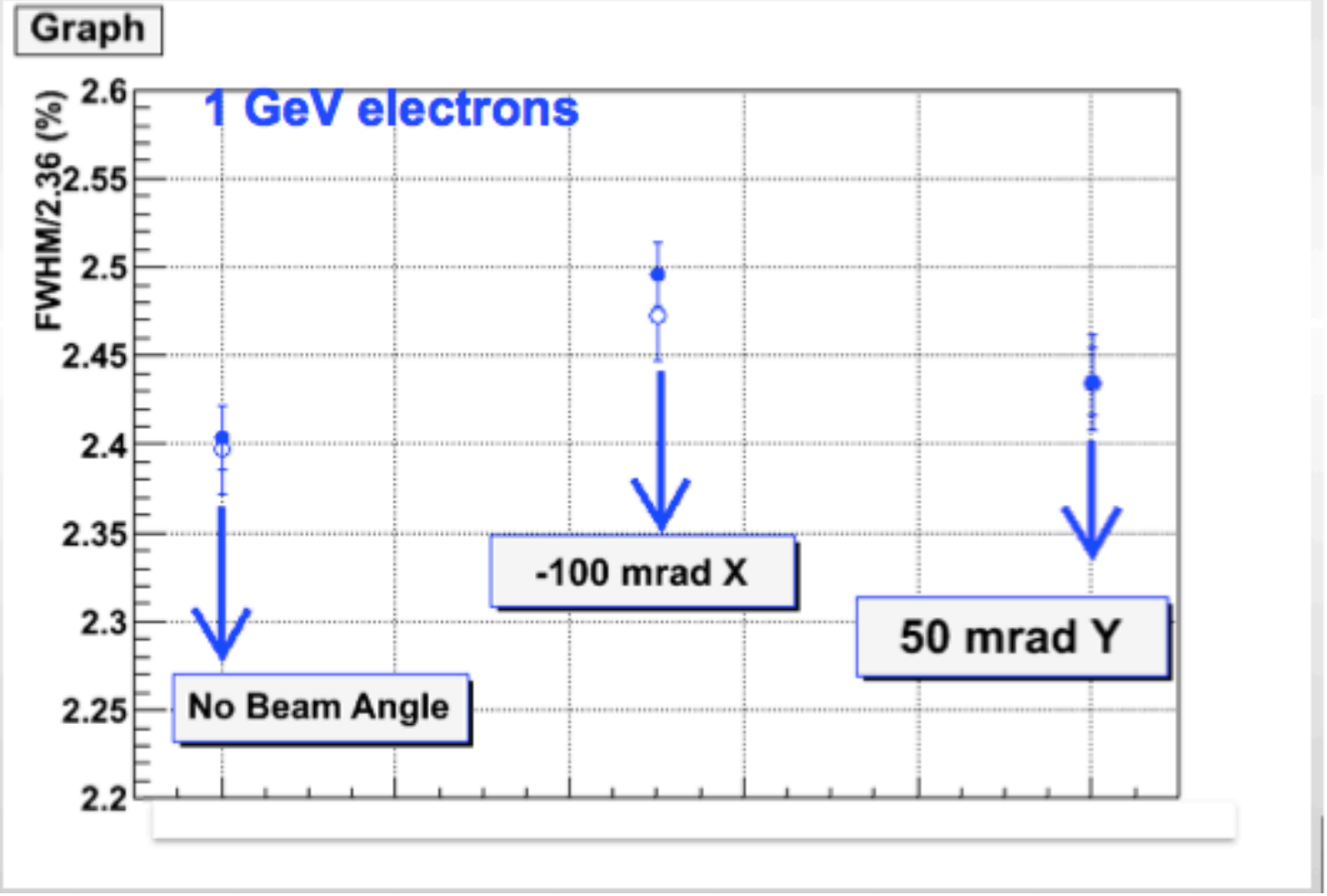
It is possible to study the time resolution with crystals in the same ADC modules

TB data….


Electron Energy Resolution vs Energy
Graph
χ² / ndf 5.61 / 1
p0 2.23 ± 0.05225
p1 0.9137 ± 0.08489
χ² / ndf 20.21 / 1
p0 3.328 ± 0.08499
p1 1.791 ± 0.119
DATA
MC
Sqrt(DATA^2-MC^2)
SigmaE/E %
4
3.5
3
2.5
2
1.5
1
1.2
1.4
1.6
1.8
2
GeV

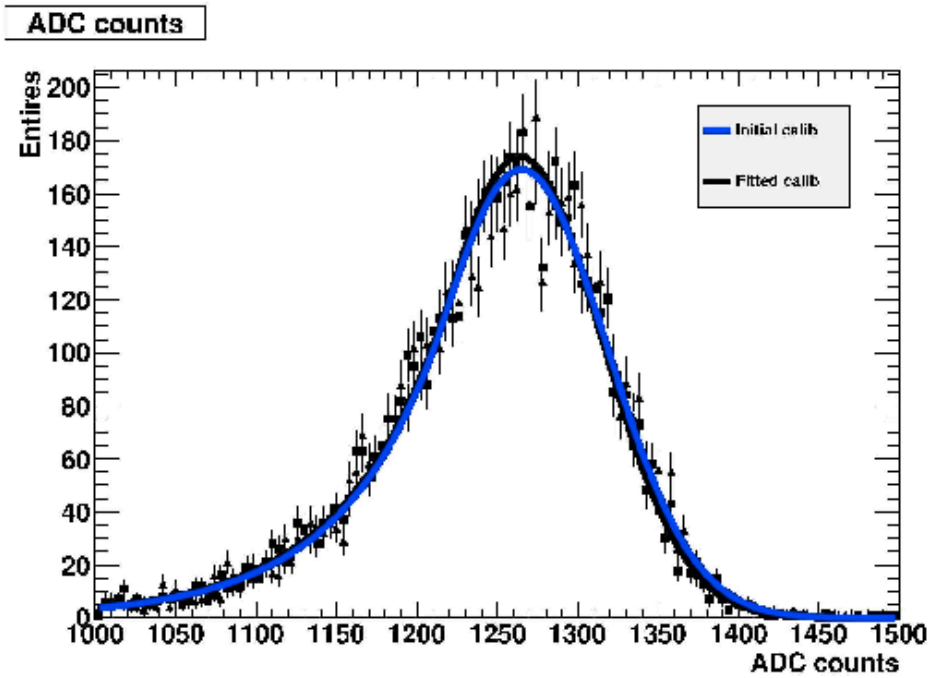
Energy resolution versus beam angle

Beam angle sligthly affects the Energy Resolution
Not enough to reach DATA agreement



Try some improvement on resolution (data)

- Fit simultaneously all intercalibration constants to get the “best” energy resolution.
- Energy resolution taken as the core resolution of a binned fit to the data with a crystal Ball function (a fit is performed for each set of parameters).
- Include temperature corrections determined during TB*



Initial Resolution

σ_E/E = 4.2 ± 0.1 %

HWHM/E = 5.1 %

Fitted resolution

σ_E/E = 4.0 ± 0.1 %

HWHM/E = 4.9 %

Uncertainty on σ_E = 1.7%

Proof of principle: the method seems to work, but require more statistics to produce stable results.

Small improvement in σE/E (a few percent) for 1 GeV Runs, similar conclusion if the new calibration constants provided by Elisa are used.

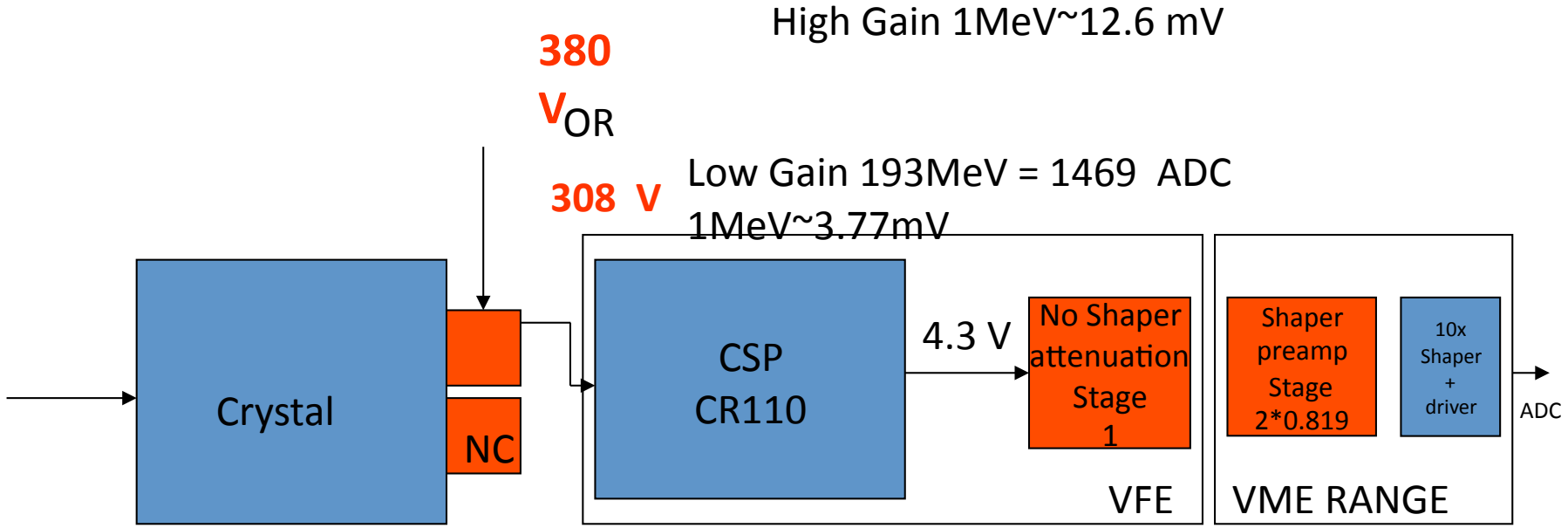
Difference in resolution seems to suggest that the intercalibration uncertainty is around 1-1.5%.

Not enough data for high energy runs (low APD gain) to get proper convergence of the fit

Electronics and Trigger

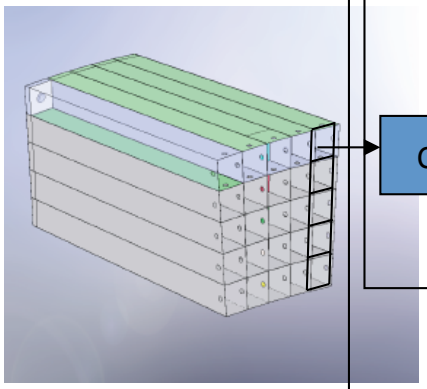
BTF in May

- study better the response of crystals
- electronics worked well during the CERN test beams and we understood the noise source (shaper)
- Do not touch to much the electronics to have more or less the same system to factorize problems.
- only adjust the amplification chain to lower energy scale of the BTF (100 Mev to 500 Mev)



Connect 1 CMS APD

EMC Forward tentative of Implementation



5 x 5 =25 crystal tower

CSP

X5

5 input

Σ

VFE

X5

Double Range shaper

X5

Range

VME Range Shaper

New Circuit Analog Sum over 5 input.

5 input

Σ

Analog Pulse Encoder

LVDS

$T = T_0 + T_{fix} + T_{jitter}$

Trigger Tower module

X 176 lvds Links

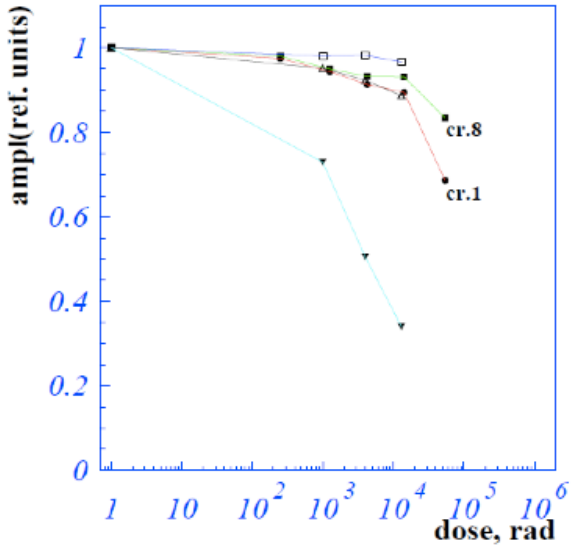
ALTERNATIVES to LYSO

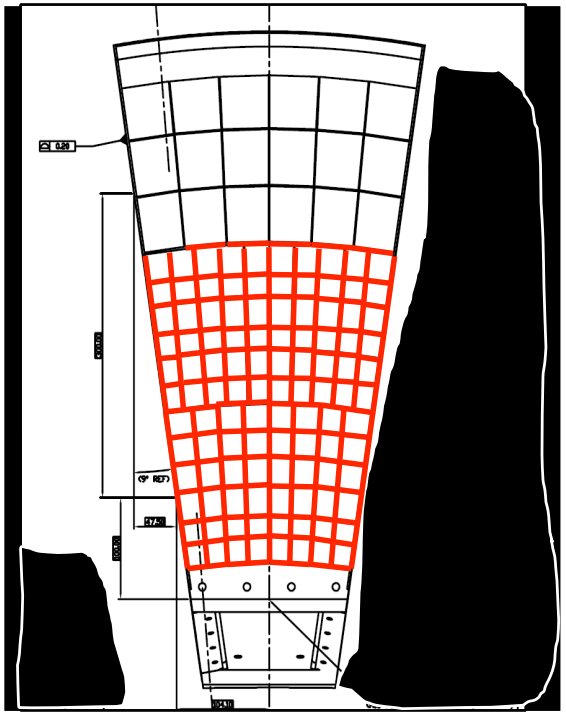
We have started to look into possible alternatives to LYSO (budget constraints)

1) Pure CsI forward calorimeter

-possible readout have to be studied (VPT, PP)

-Radiation hardness





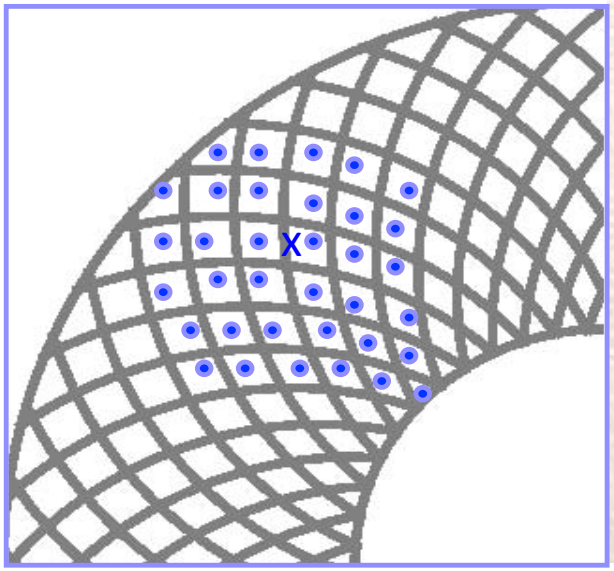
2) Replace only the inner most rings and retain the three outer rings of CsI(Tl)

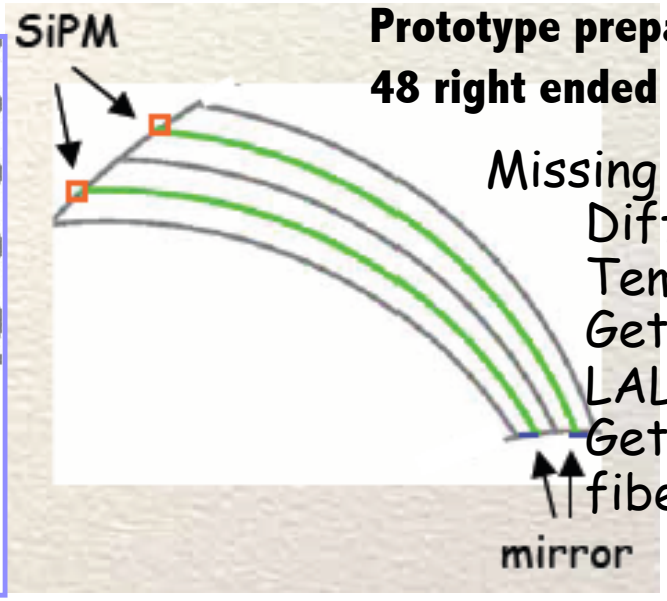
-save mechanics

Simulation will be developed for the two solution to have an Estimate of the expected resolution.

Backward endcap

12 X0 Pb-scintillator sampling calorimeter, 24 layers of 0.3 mm thick scintillator strips and 0.28 mm thick Pb plates





Prototype preparation, 48 left handed spirals and 48 right ended

Missing components:
- Diffuse reflector sheets and paint
- Temperature sensors
- Get 3 more SPIROC boards from LAL
- Get calibration board and clear fibers from Prague

96 logarithmic spiral strips
48 radial sector strips
strips could be ready for stacking earliest middle of June

Main issue is manpower ➔ find collaborators
- New post doc next summer from AIDA funds
- started contact with DESY group

It seems that DESY can help in any case on strip production which has been the bottelneck in the last months

MPPC radiation issuse

If the n radiation level turns out to be to high in the backward EC EMC we can switch to 20 μm or 15 μm pixel detectors that work fine after 10^{11} n/mm^2

Fast sim: energy smearing

Motivations and analysis strategy

- September production ntuple: neutral energy smearing not applied
- @ Caltech: analysis of September sample to evaluate the impact of Bwd EMC used as veto device
-without smearing, results can be too optimistic
-Need to re-compute impact of Bwd EMC veto including resolution effects:
-make a new production for the BBbar sample is too time consuming
-apply smearing off-line
-validate smearing algorithm on signal and single particle MCs
-apply off line smearing on both BBbar and signal samples from September production
- repeat the analysis and compare S/sqrt(B+B) w and w/o Eextra_bwd veto

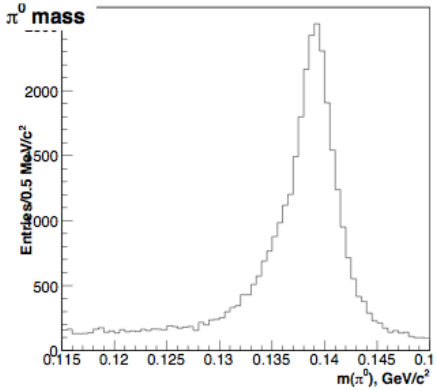
CHECK FAST SIM CODE IS ONGOING.
SEE HOW THIS AFFECT RESULTS.

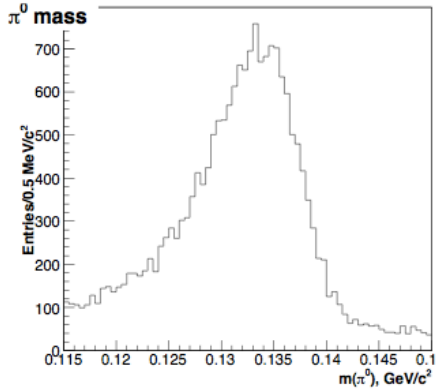
SMEARING OFF			
$B^0 \to K^{*0}\nu\bar{\nu}$			
Sample	N_{sel}	$N_{sel,Bwd}$	ε
$B^0 \to K^{*0}\nu\bar{\nu}$	786	778	$(99.98 \pm 0.36)\%$
B^0 had cocktail	181	143	$(79.0 \pm 3.0)\%$
$\Delta Sign/Sign$	$(11.4 \pm 1.9)\%$		
$B^+ \to K^{*+}(K_S\pi^+)\nu\bar{\nu}$			
Sample	N_{sel}	$N_{sel,Bwd}$	ε
$B^+ \to K^{*+}\nu\bar{\nu}$	233	232	$(99.57 \pm 0.43)\%$
B^+ had cocktail	136	114	$(83.8 \pm 3.2)\%$
$\Delta Sign/Sign$	$(8.7 \pm 1.9)\%$		
$B^+ \to K^{*+}(K^+\pi^0)\nu\bar{\nu}$			
Sample	N_{sel}	$N_{sel,Bwd}$	ε
$B^+ \to K^{*+}\nu\bar{\nu}$	227	222	$(97.8 \pm 1.0)\%$
B^+ had cocktail	75	65	$(86.7 \pm 3.9)\%$
$\Delta Sign/Sign$	$(5.0 \pm 2.4)\%$		

SMEARING ON			
$B^0 \to K^{*0}\nu\bar{\nu}$			
Sample	N_{sel}	$N_{sel,Bwd}$	ε
$B^0 \to K^{*0}\nu\bar{\nu}$	786	778	$(99.98 \pm 0.36)\%$
B^0 had cocktail	181	146	$(80.7 \pm 2.9)\%$
$\Delta Sign/Sign$	$(10.2 \pm 1.8)\%$		
$B^+ \to K^{*+}(K_S\pi^+)\nu\bar{\nu}$			
Sample	N_{sel}	$N_{sel,Bwd}$	ε
$B^+ \to K^{*+}\nu\bar{\nu}$	233	232	$(99.57 \pm 0.43)\%$
B^+ had cocktail	136	114	$(83.8 \pm 3.2)\%$
$\Delta Sign/Sign$	$(8.7 \pm 1.9)\%$		
$B^+ \to K^{*+}(K^+\pi^0)\nu\bar{\nu}$			
Sample	N_{sel}	$N_{sel,Bwd}$	ε
$B^+ \to K^{*+}\nu\bar{\nu}$	227	221	$(97.4 \pm 1.1)\%$
B^+ had cocktail	75	65	$(86.7 \pm 3.9)\%$
$\Delta Sign/Sign$	$(4.6 \pm 2.4)\%$		

B→τν Event

Signal $B_{sig} \to \tau\nu$ decay	τ BF from PDG	Mimicking bkg	Mimicking τ bkg
$B_{sig} \to \tau\nu, \tau \to e\nu\nu$	17.36%	$B \to e\nu + X$	$B \to \tau\nu X, \tau \to e\nu\nu$
$B_{sig} \to \tau\nu, \tau \to \mu\nu\nu$	17.85%	$B \to \mu\nu + X$	$B \to \tau\nu X, \tau \to \mu\nu\nu$
$B_{sig} \to \tau\nu, \tau \to \pi\nu$	10.91%	$B \to \pi + X$	$B \to \tau\nu X, \tau \to \pi\nu$
$B_{sig} \to \tau\nu, \tau \to \rho\nu$	25.51%	$B \to \rho + X$	$B \to \tau\nu X, \tau \to \rho\nu$
$B_{sig} \to \tau\nu, \tau \to a_1\nu$	9.32%	$B \to a_1 + X$	$B \to \tau\nu X, \tau \to a_1\nu$
$B_{sig} \to \tau\nu, \tau \to \pi 2\pi^0\nu$	9.29%	$B \to \pi 2\pi^0 + X$	$B \to \tau\nu X, \tau \to \pi 2\pi^0\nu$
$\tau \to$ all 6	90.24%	$B \to$ anything	$B \to \tau\nu X, \tau \to$ all 6





CHECK FAST SIM CODE IS ONGOING.
SEE HOW THIS AFFECT RESULTS.

Cutting on Eextra in Backward EMC for V0.2.6 increases:

☞ S/B by ~15-20% depending on τ decay mode

☞ S/√S + B by ~3-5%

Proper energy smearing (V0.2.7) lowers these numbers insignificantly

Conclusions

Important progress on crystal understanding in terms of LRU

2 more test beams are foreseen in May and September

1) "same" configuration as CERN (try to understand resolution)
2) "best" possible configuration (2 APD's + roughening of 1 face of the crystals)

Electronics and trigger improvement and developing is ongoing

Analysis of the CERN test beam is continuing, very detailed effects are under study

BWD calorimeter: prototype construction is ongoing

Physics studies using BWD calorimeter as veto show consistent results with previous meetings → 5-10% relative gain in significance

CHECK FAST SIM CODE IS ONGOING.

SEE HOW THIS AFFECT RESULTS.