EMC status e richieste 2010

Claudia Cecchi

Riunione referees SuperB

The electromagnetic calorimeter

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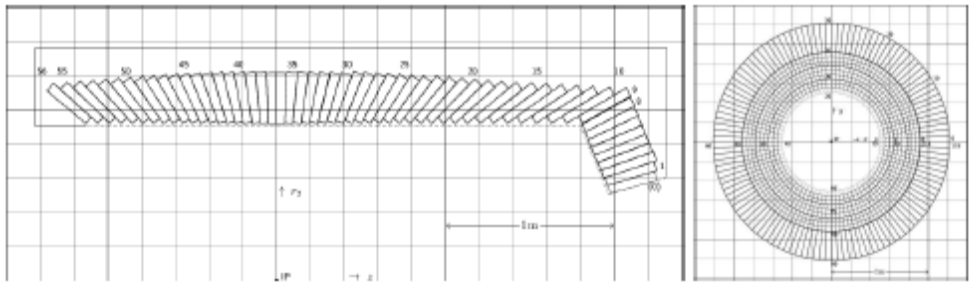

BaBar Barrel
5760 CsI(Tl) Crystals

$$\frac{\sigma_E}{E} = \frac{2.30\%}{\sqrt[4]{E(GeV)}} \oplus 1.35\% \qquad \sigma_\theta = \frac{4mrad}{\sqrt{E(GeV)}}$$

Essential detector to measure energy and direction of g and e, discriminate between e and p, and detect neutral hadrons

* Barrel
  * BaBar barrel crystals not suffering signs of radiation damage. They're sufficiently fast and radiation hard for SuperB needs
    ➔**They can be reused.** <u>(Would have been) most expensive detector component</u>
  * Background dominated by radiative Bhabhas. IR shielding design is crucial
* Endcaps
  * Best possible hermiticity important for key physics measurements
  * New forward endcap
  * backward endcap is an option

Forward and backward EMC

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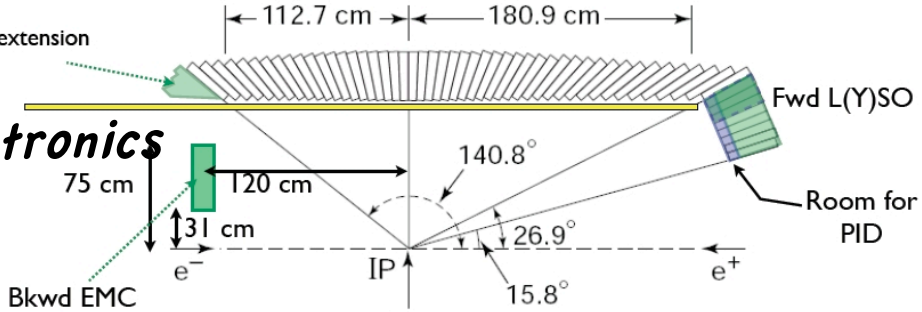
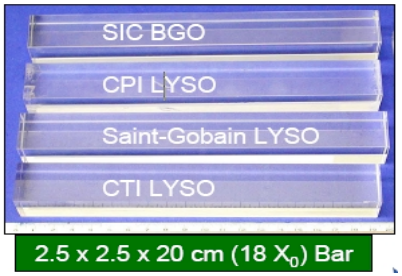
* Forward endcap
  - BaBar CsI(Tl) endcap inadequate for higher rates and radiation dose of SuperB
    - *Need finer granularity*
    - *Faster crystals and readout electronics*
    - *comparable total X0*



  - Option 1: LYSO crystals
    - 👍 frees 10cm for a forw. PID system
    - 👍 radiation hard, fast, small Moliere radius, good light yield
    - 👎 expensive (~40$/cc) at the moment
  - Option 2: retain 3 outer rings of CsI(Tl), LYSO the others
    - 👍 less expensive
    - 👎 no space for forw. PID system



* Backward endcap (option)
  - Pb- scintillating fibers spiral geometry with readout to SiPMs

Recoil Physics

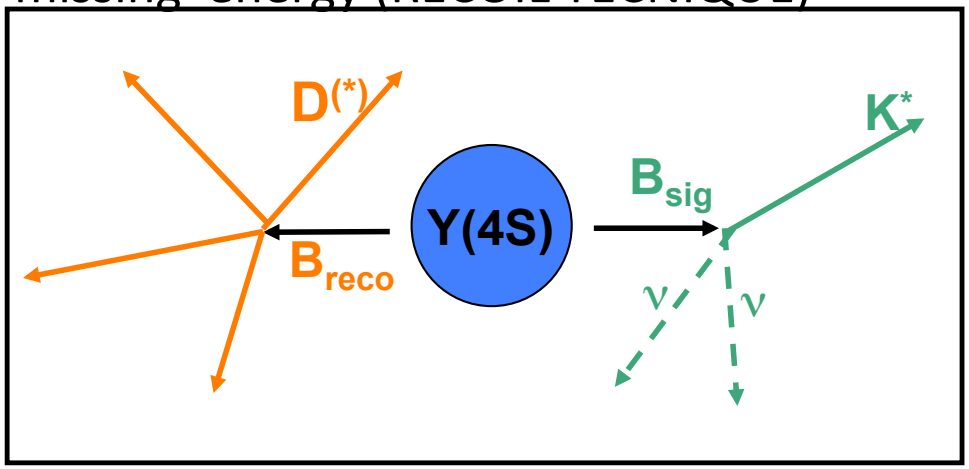
* In many BaBar analysis, one of the 2 B's is reconstructed in hadronic or semileptonic modes:

SL Breco	HAD Breco
$B \to D^{(*)} l \nu$	$B \to D^{(*)} n_1 \pi\ n_2 K\ n_3\ K_s\ n_4\ \pi^0$

reconstruction efficiency $O(10^{-2} \div 10^{-3})$

* High statistic and clean sample
* Allow to search for rare decays with missing energy (RECOIL TECNIQUE)
  - $B \to \tau\nu$
  - $B \to K^{(*)}\nu\nu$
  - $B \to$ invisible
  - .....

2 of the SuperB golden channels for the physics program



Perugia's contribution(I)

* Implement the reconstruction of Hadronic B modes (Had Breco) in Fast Simulation

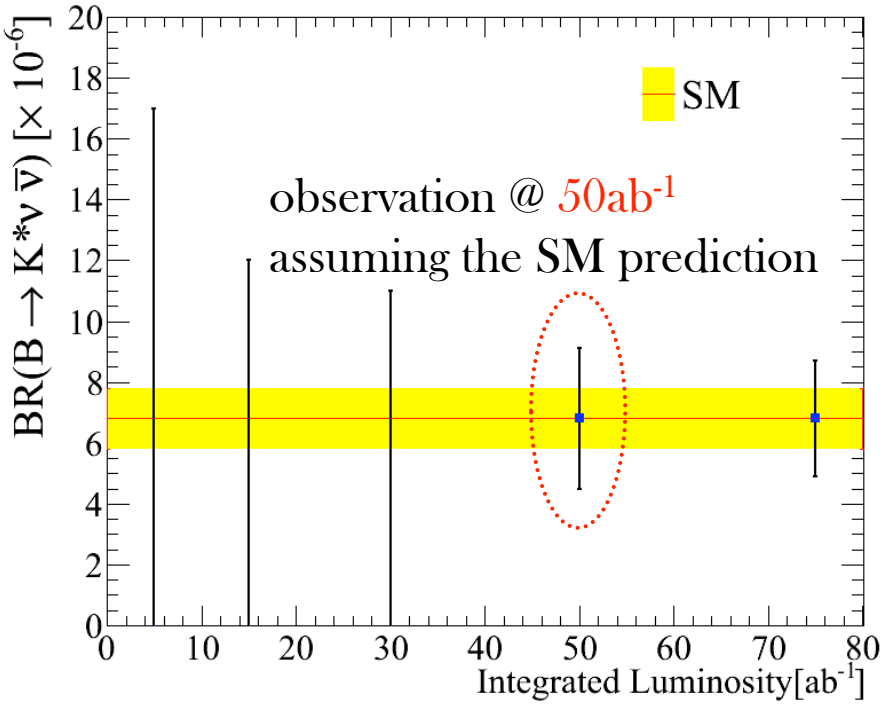
* Evaluate the performances of HAD Breco reconstruction in the SuperB beam configuration
* Reconstruct rare decays (B->$K^{(*)}\nu\nu$, B->$\tau\nu$) recoiling against HAD Breco and evaluate the sensitivity

* What is the impact of..
  - different PID devices
  - backward EMC
  - different energy resolution due to different forward EMC geometry
  - vertex resolution by vertex detector (and drift chambers)

Perugia's contribution(II)

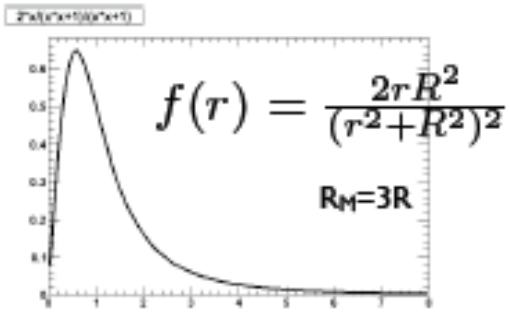
* Expected sensitivity for the B→K*νν channel at SuperB
  - take the BaBar analysis as starting point
  - rescale stat. and syst. (~stat.) errors considering the improvements due to the SuperB beam configuration in term of signal reconstruction efficiency and background rejection

* Ongoing studies of sensitivity as a function of the detector configurations



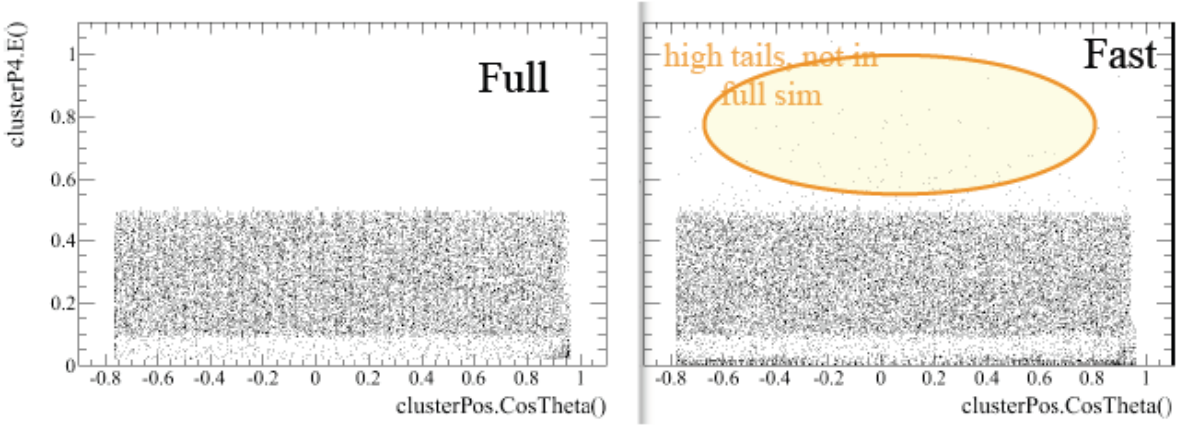
FAST SIM

Geometry description in 3 xml files: Barrel cylinder, FWD cone, BCK disk
individual crystals are not simulated
EMC properties in a config xml file: segmentation, Molière radii, Energy fluctuations, Calibration parameters…

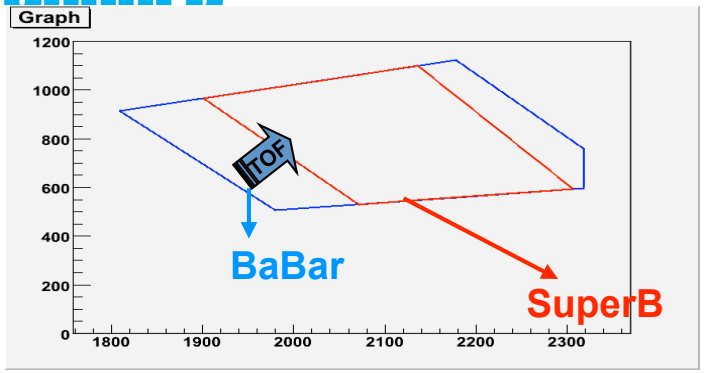


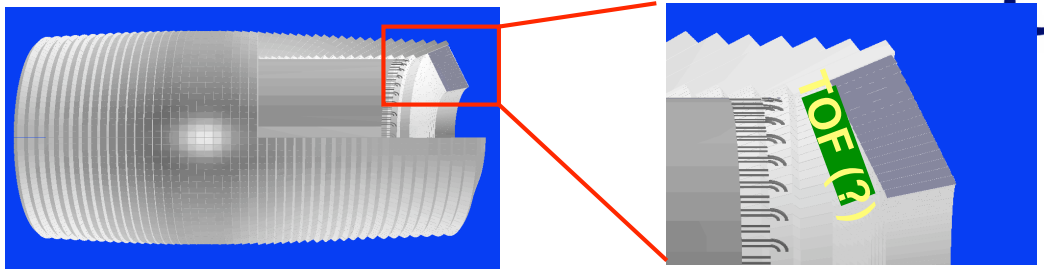
3 types of clusters are simulated:
- MIP straight line energy prop. path length
- EM showers
- Hadron showers fraction of energy to form an EM-like cluster the rest to form an irregular cluster

Comparison fast-full with photons
100MeV → 500MeV

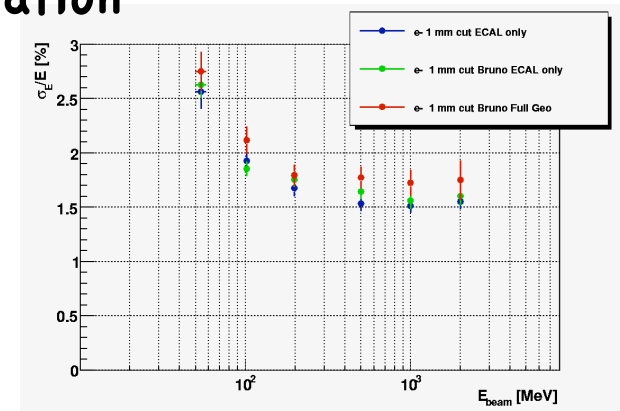


FULL G4 SIM (PG)

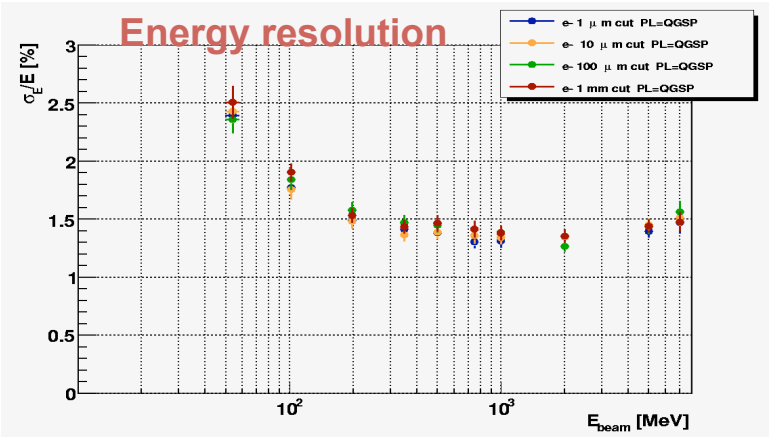


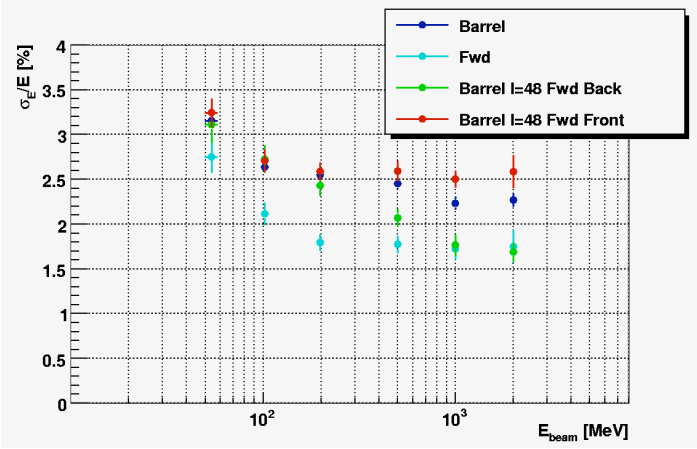


Comparison Bruno with standalone simulation



Treshold tuning: 1mm cut do not affect the resolution





Start to investigate transition region between barrel and endcap

Crystals

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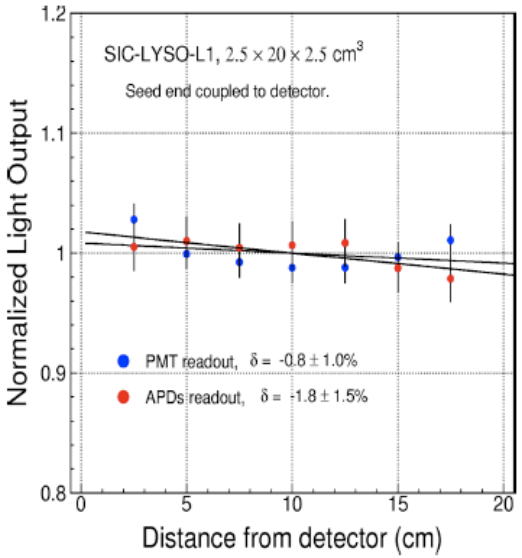
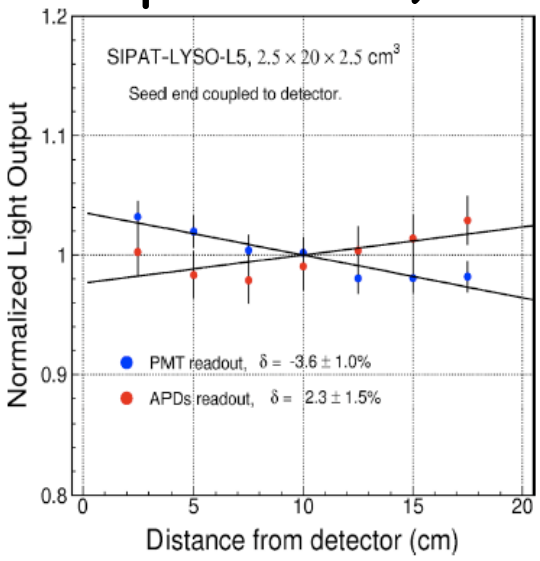
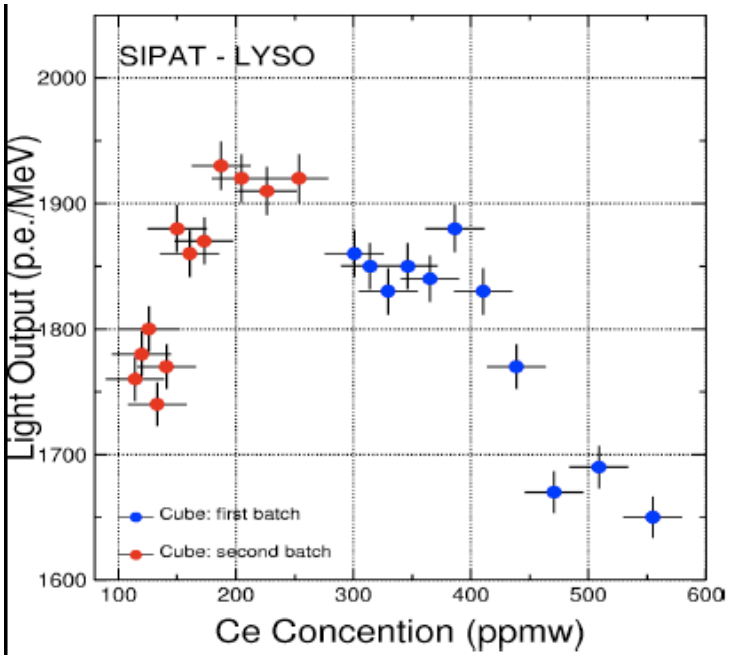
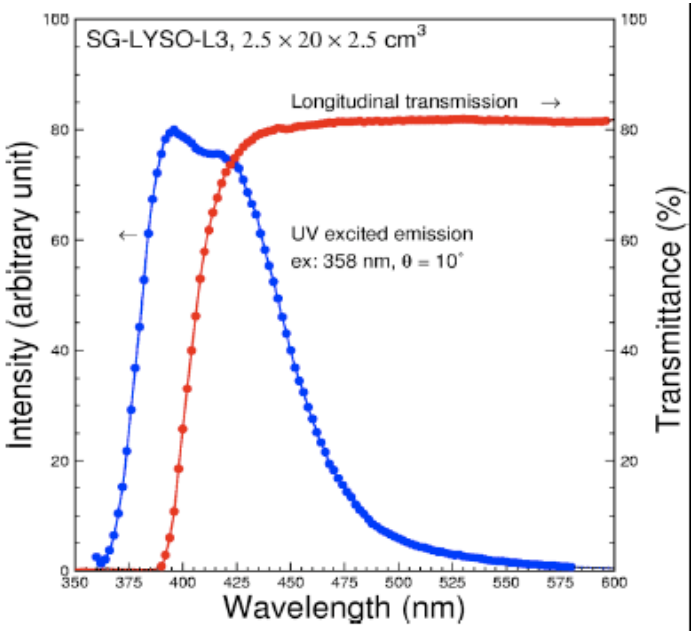
Large difference observed in LRU with PMT and ADP in one sample SYPAT LYSO (not observed in other SG-LYSO sample or BGO)



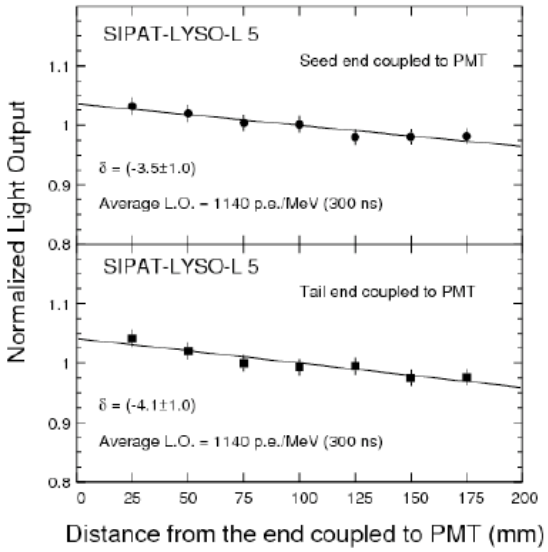


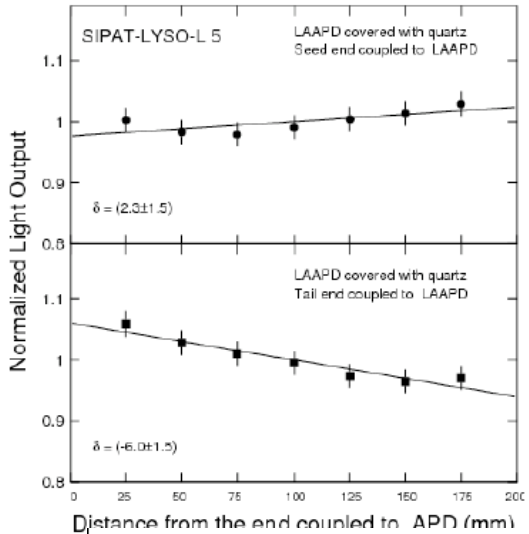
LO is a function of CE concentration is also a result of interplay between transmittance and emission





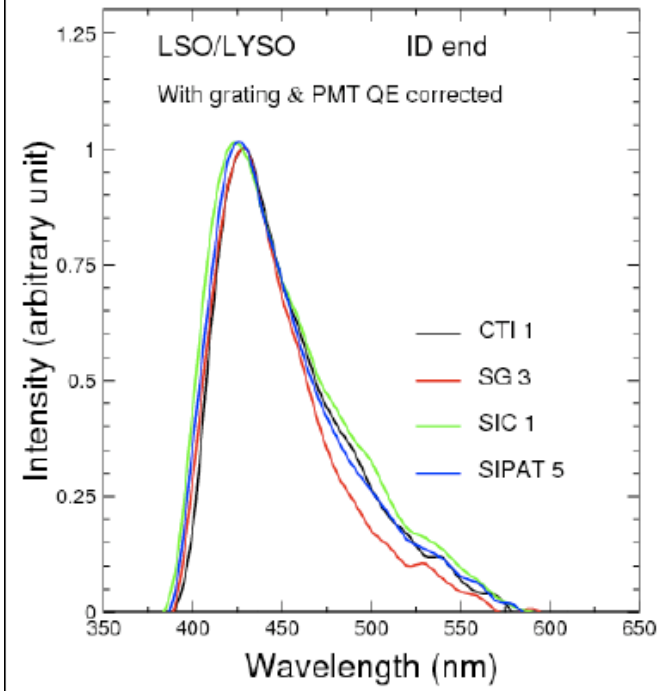
Ce doping optimized for the uniformity measured with PMT. Difference observed between PMT and APD.

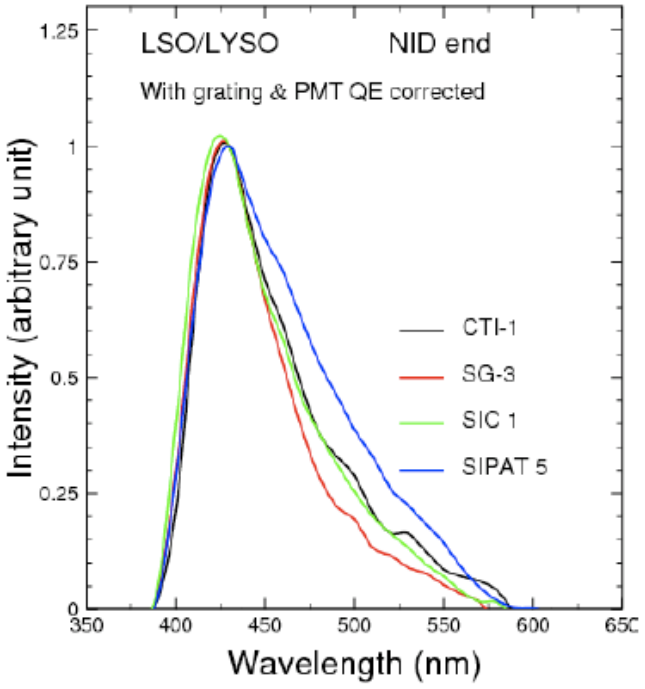




SIPAT-LYSO has an extra green emission component at the tail end wich could explaind the difference between APD and PMT

Contamination seems to be a little larger for SIPAT LYSO sample

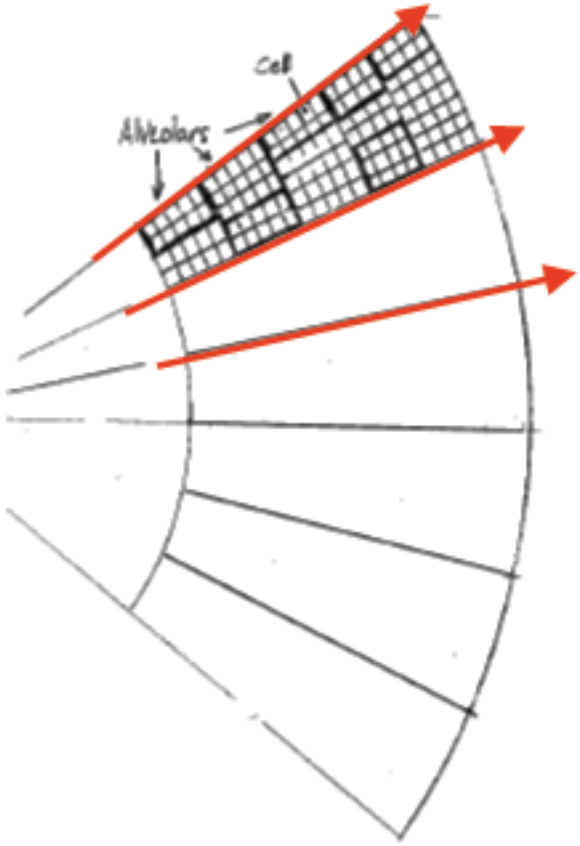




MECHANICS (M. Lebeau + PG)

Structural design starting base inspired from previous structures (L3, BaBar, CMS)
Design progress will take information from BT specific tests defined for structural information, FEA, spaces for services and boundary imposed by integration.

LYSO is a brittle crystal with high Young module, LYSO mechanical properties are under study in Ancona on small samples 5x5x100mm3 (superB is 25x25x200mm3). Annealed and not annealed samples are under test.

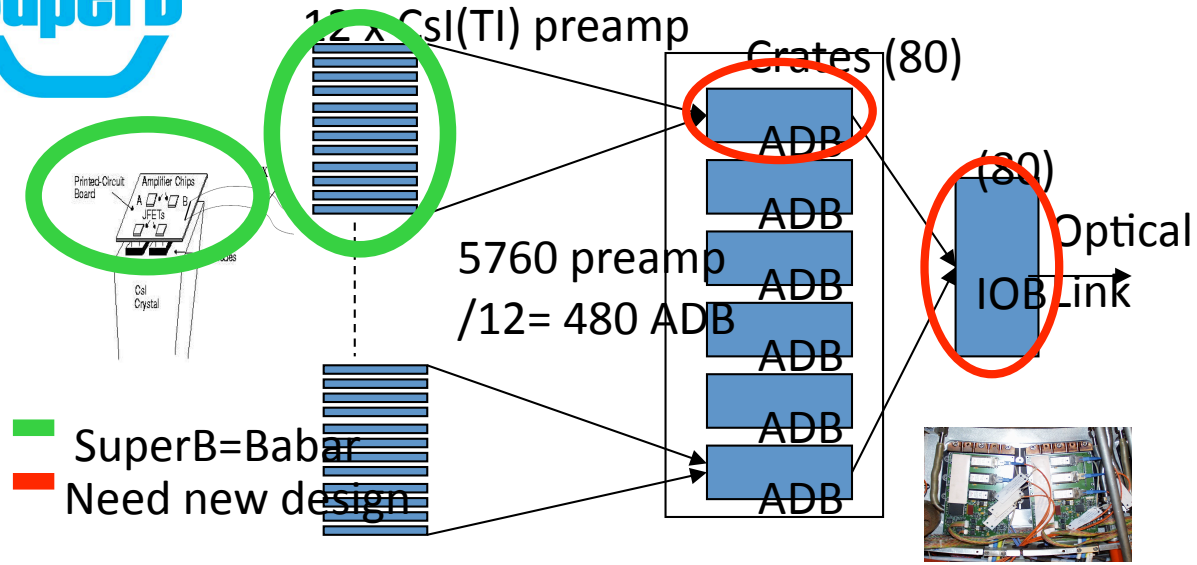


- Rear part of cell walls results after module assembly in a kind of rigid **lattice**
- Radial (straight) connections can only go through modular splits given by some ϕ **symmetry**
- ϕ symmetry contributes to precision in the construction process by forming **assembly steps**

Number of 5x5 modules (Perugia geometry)
35 - 41- 45 - 53
Suggested evolution symmetry 2x3
36 - 42 - 48 - 54

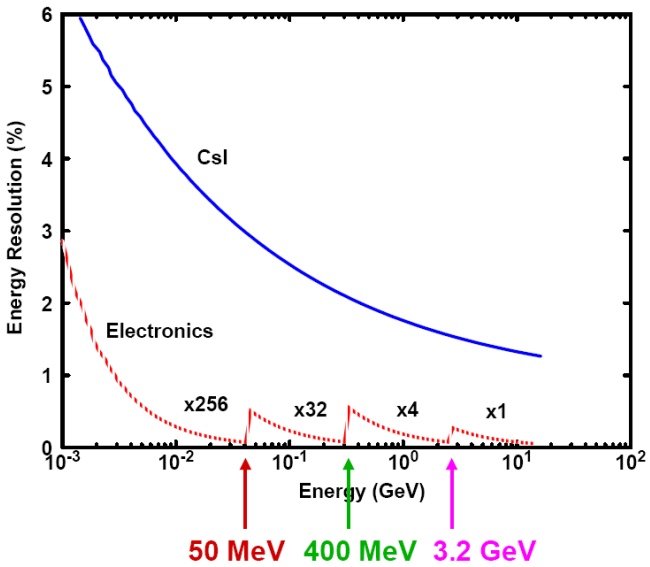
Small changes in crystal dimensions

BARREL FE electronics (ROME)



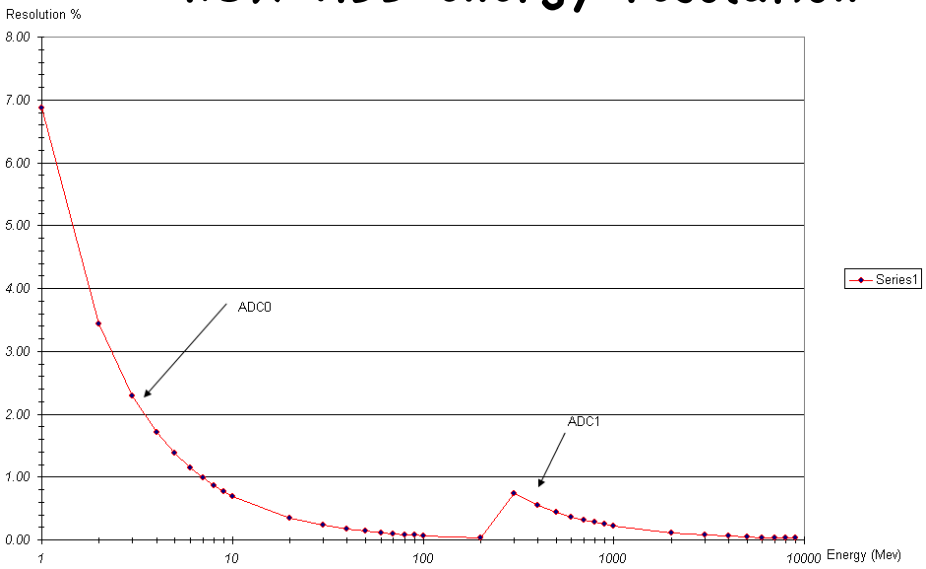
Perugia

OLD ADB energy resolution



- Design new board
- Mechanical constraints: re-use of the crate structures
- use new ADC with more bits
- less power consumption
- reduce number of gain ranges x1 and x32
- Use the new superB ECS and FCTS interfaces

NEW ADB energy resolution



EMC endcap FE read out option (ROME + PG)

2 x APD (5x5mm) or

2 x PIN (10x10mm) or

Number of Lyso crystals =3600
(Number CsI(Tl) Forward endcap babar x4)

1 x PIN (20x10mm) or

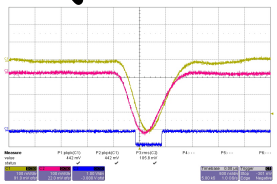
CSP + shaper

or

TIA

or

TA



- We start to test Charge sensitive preamp at Beam Test Facility in Frascati

- Design a preamplifier for EMC FWD with a x1 and x32 output compatible with Barrel preamp
- Design a new ADB board compatible with the old mechanical structure
- Design a new IOB compatible with the new FCTS and ECS system

JUNE TB@BTF (PG + Rome)

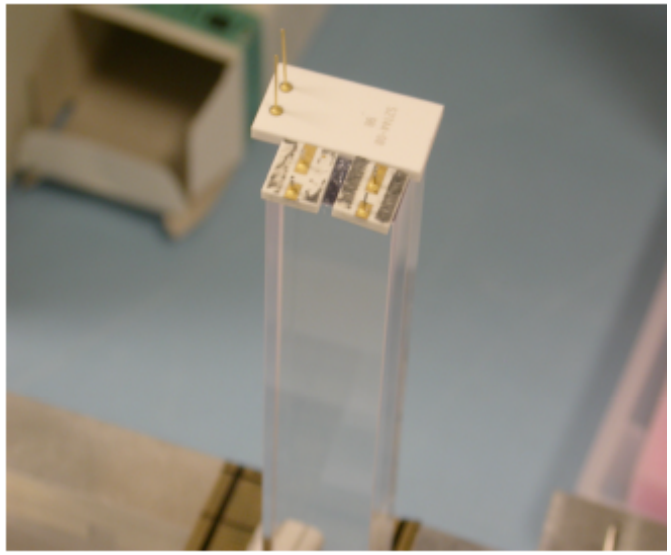
Perugia

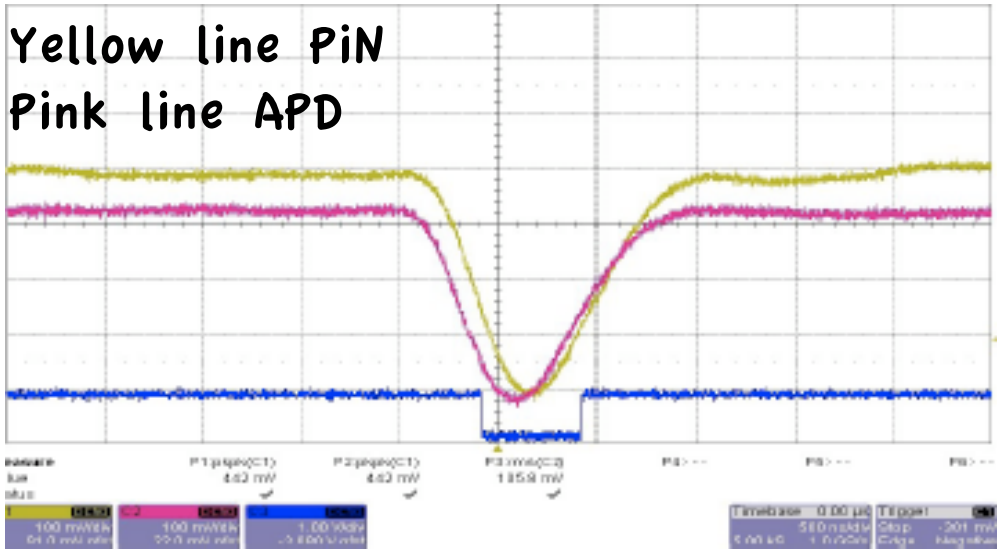
Istituto Nazionale di Fisica Nucleare

1 LYSO crystal (2x2x20cm3) with two different readout

1 PiN photodiode S2744-08 (1x2cm2) read by CREMAT CSP CR110 (gain 1.4V/pC) + CREMAT shaper CR200, 250ns shaping time

2 APD S8664-55 (0.5x0.5cm2) read by CREMAT CSP CR110 (gain 0.15V/pC) + CREMAT shaper CR200, 250ns shaping time

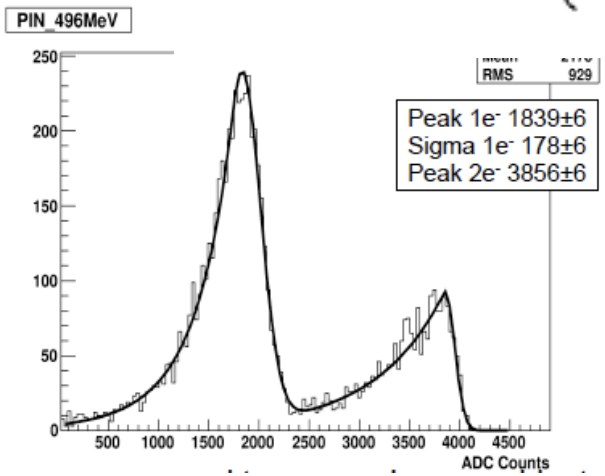




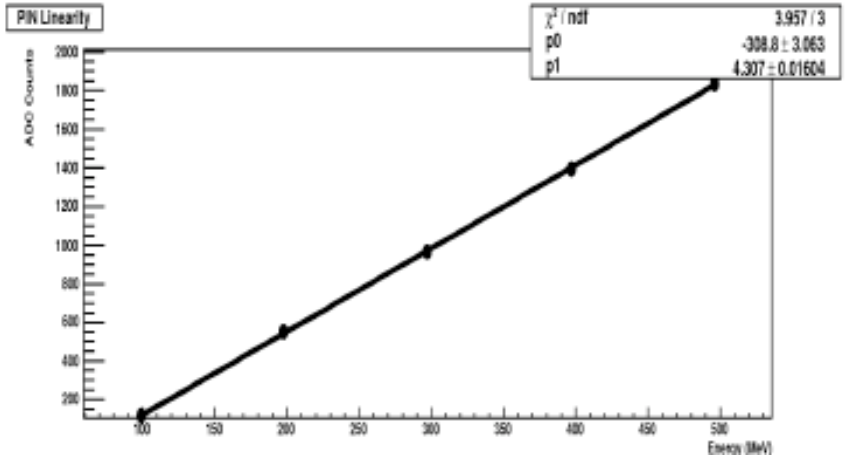
$$f(x;\alpha,n,\bar{x},\sigma) = N \cdot \begin{cases} \exp(-\frac{(x-\bar{x})^2}{2\sigma^2}), & \text{for } \frac{x-\bar{x}}{\sigma} > -\alpha \\ A \cdot (B - \frac{x-\bar{x}}{\sigma})^{-n}, & \text{for } \frac{x-\bar{x}}{\sigma} \leqslant -\alpha \end{cases}$$

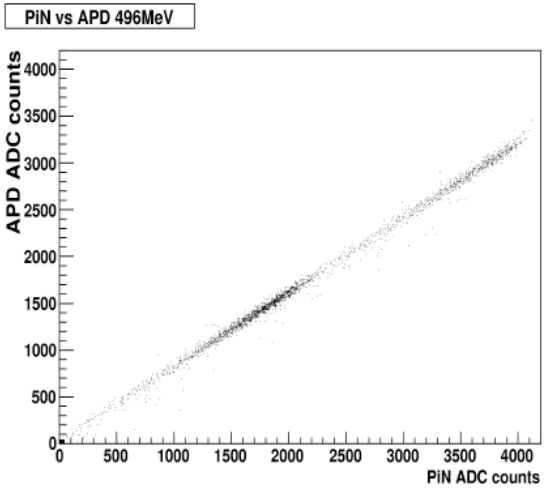
$$A = \left(\frac{n}{|\alpha|}\right)^n \cdot \exp\left(-\frac{|\alpha|^2}{2}\right)$$

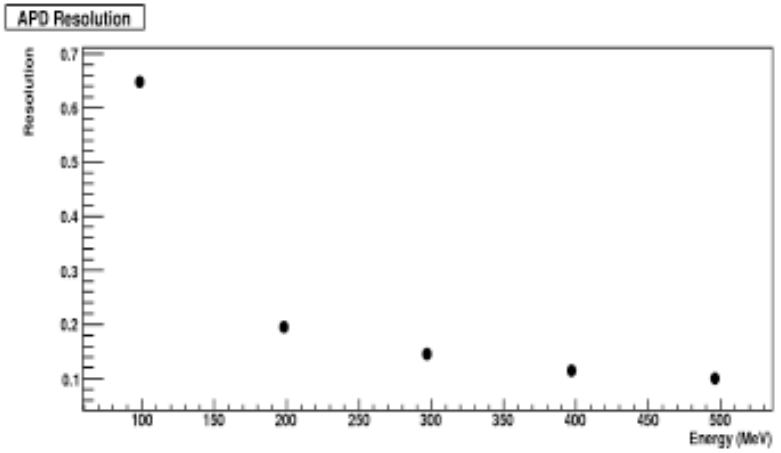
$$B = \frac{n}{|\alpha|} - |\alpha|$$



1 e- and 2e- peaks are well separated







November 09 TB@BTF (PG + Rome)

Spostato inizio 2010 no fascio BTF

Put under test matrix of 5x5 LYSO crystals + external ring of CsI crystals (CLEO)

Crystal procurement:

-8 crystals ordered at St. Gobain by INFN
-4 to be ordered by INFN
-13 will be ordered by Caltech
- finalizing dimensions
- CsI crystals for the external ring will be at Caltech by end of June

Electronics: 2 options

1) Rome and Perugia are working on a new readout with PD → 50 readout channels for November
2) Caltech has 50 channels available with APD's + CMS DAQ

Mechanics:

-Carbon fiber or glass fiber structure
- CAD drawing of the structure by June (INFN)
- visiting producer beginning of July
- delivery in October

Simulation: available, tested and running

Perugia activities

- Fast simulation (E. Manoni, A. Rossi)
  - Partecipazione al DGWG (Detector Geometry Working Group), ottimizzazione del rivelatore attraverso lo studio dei canali di fisica
- Full simulation (C. Cecchi, S. Germani)
  - Geometria completa, matrice TB, studio risoluzione calorimetro, confronto standalone simulation con programma di simulazione ufficiale, studio regione di raccordo Barrel-Endcap
- Geometry, mechanics (C. Cecchi, S. Germani)
  - Studio geometria completa del calorimetro in relazione alle dimensioni dei cristalli, alle loro caratteristiche meccaniche e ai constraints derivanti dalla struttura meccanica
- Test Beam (C. Cecchi, S. Germani, P. Lubrano, A. Rossi)
  - TB con un cristallo a Giugno, primi risultati
  - TB BTF Aprile 2010 + TB CERN autunno 2010
- Electronics (P. Lubrano, A. Papi)
  - In collaborazione con Roma1, studio per elettronica di lettura per TB e per il calorimetro FWD completo nel TDR + parte di refurbishment del Barrel

FTE e richieste 2010 Perugia

C. Cecchi	0.3
S. Germani	0.4
P. Lubrano	0.3
E. Manoni	0.5
D. Rinaldi	0.5
	2.0

MI: 3 settimane TB, 4 persone — 10 Keuro
visita ditte per la meccanica 5 visite,2 gg,2 persone — 4.2 keuro

ME: responsabilita' specifiche (EMC Cecchi) — 1.6 Keuro
3 settimane TB CERN 3 persone — 17.2 Keuro

Consumi:
telescopio per test elettronica
(2 fotomoltiplicatori Hamamatsu R1306 1 Keuro
2 scintillatori (tipo NE102A) 1 cm X 2 cm X 10 cm
1 Keuro — 2.0 Keuro

Attivita' 2010 Roma1 e richieste

- **Realizzazione prototipi elettronica per il TDR (Bocci con LABE e Perugia)**
- **Collaborazione a realizzazione struttura meccanica TB EMC (consulenza di Gargiulo)**
- **Realizzazione di due test beam (tendenzialmente BTF + CERN)**
- **Convenership WG su specttroscopia (insieme ad A. Polosa)**
  - **Scrittura della parte di fisica del TDR (in particolare spettroscopia)**

ME: 2 settimane TB CERN 2 persone 5.5 Keuro

Consumi:
costruzione prototipi digitizer per TDR 7.5 Keuro