EMC Summary

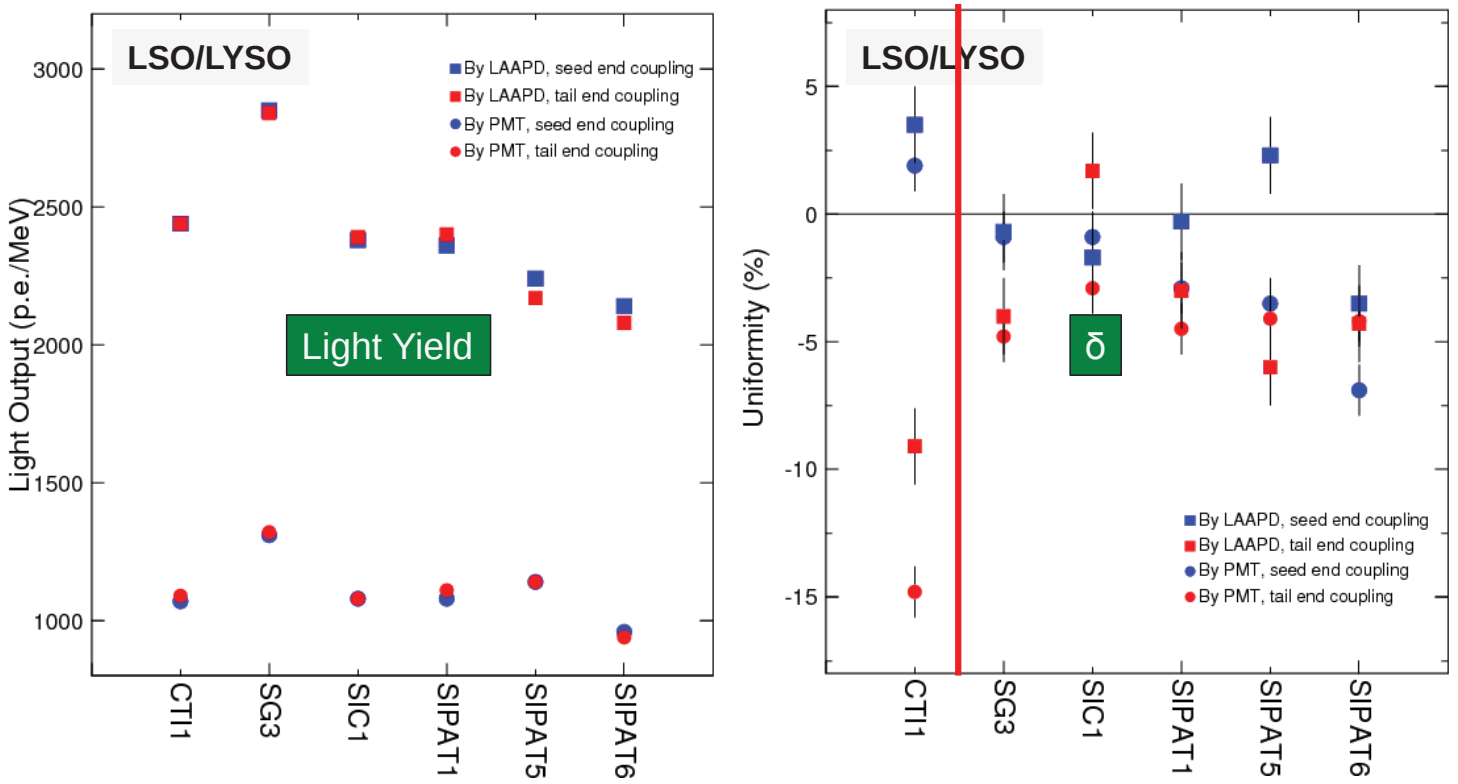
- Possibly three major calorimeter components:
  - Barrel – exisitng BaBar, except new electronics
  - Forward EMC – new LYSO
  - Backward EMC – Pb-scintillator
- Crystals
- Mechanical
- Electronics
- Simulation
- Backward endcap
- Test beam

LYSO(Ce) Crystals

- Vendors
  - SIC: Shanghai Institute of Ceramics (2 furnaces LYSO)
  - SIPAT: Sichuan Institute of Piezoelectric and Acousto-optic Technology (6 furnaces LYSO)
  - Saint-Gobain (Bicron)
- Towards crystal specifications (Renyuan Zhu)
  - Uniformity (GEANT)
  - Light yield
  - Light pulse FWHM (for extracting intrinsic resolution)
  - Transmittance and emission
  - [Also tolerances: $+0/-0.1$ mm]

Crystal Uniformity

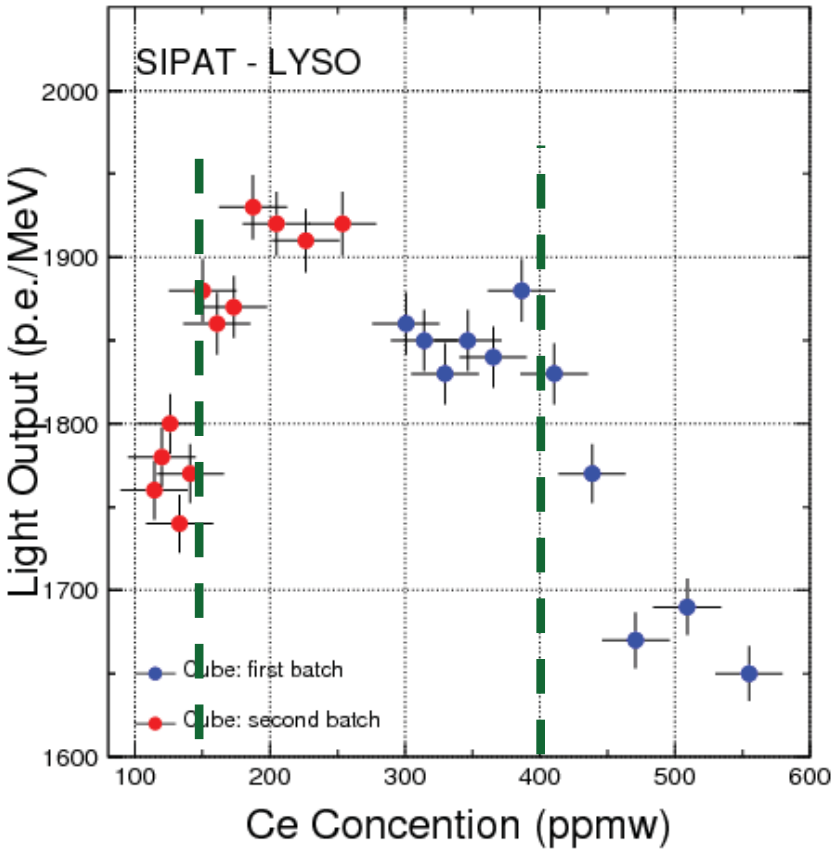
SG-L3 has high light yield. LYSO more uniform than LSO

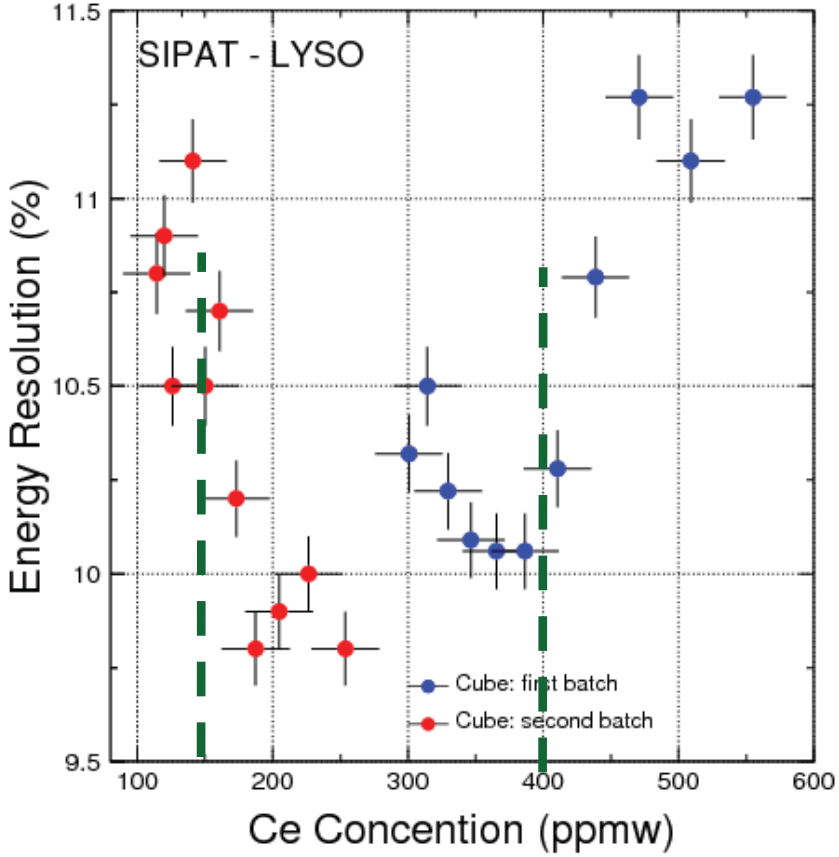


Need to develop specification, and a method for tuning uniformity. CMS measuring fixtures available.

Cerium doping

Optimum [Ce]: 150 to 400 ppmw



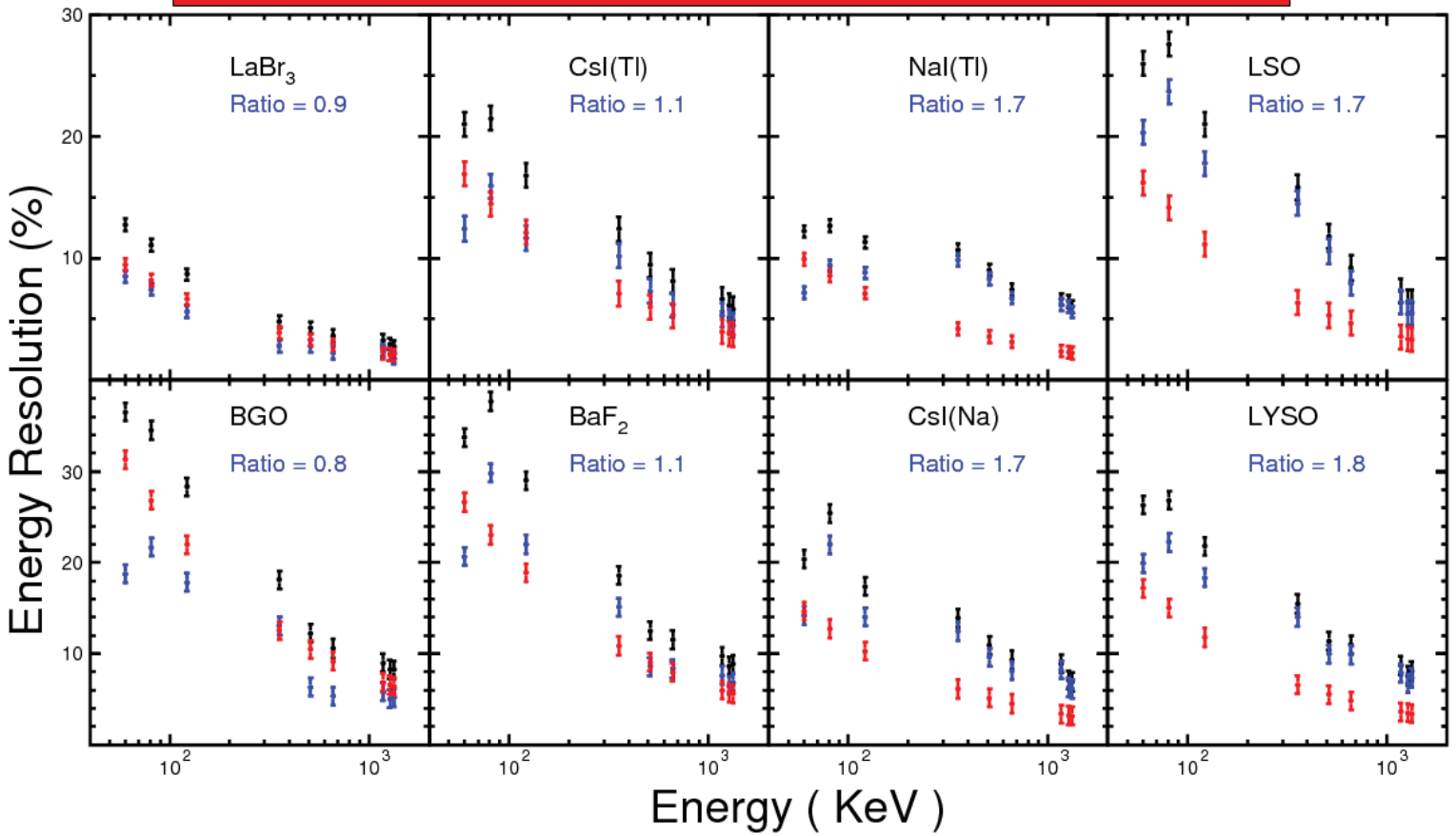


Intrinsic component of resolution is substantial

Statistical & Intrinsic Resolutions

$\sigma^2 = \sigma^2_{intrinsic} + \sigma^2_{statistical}$, ratio = $\sigma_{intrinsic} / \sigma_{statistical}$

Good crystals: BGO and $LaBr_3$



(resolution is FWHM)

Mechanical (Forward EMC)

- General crystal layout: 20 rings of crystals arranged in four groups of 5 layers each. Each group of five layers arranged in modules five crystals wide. The number of modules in a ring is a multiple of 2×3

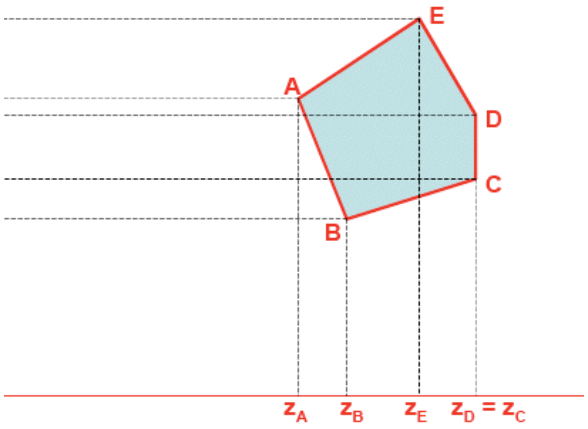
Group	Number of modules	Number of crsytals
1	36	900
2	42	1050
3	48	1200
4	54	1350
Total		4500

- Crystal Alveolar (carbon or glass fiber)
  - Experience from CMS
  - At least one vendor interested, trying for more
  - Prototype with test beam

- Pointing algorithm
  - Much discussion on where barrel crystals really point; thought to be understood now.
  - Propose to project endcap onto a circle around IP in theta; projective in phi (as barrel).
- System boundaries

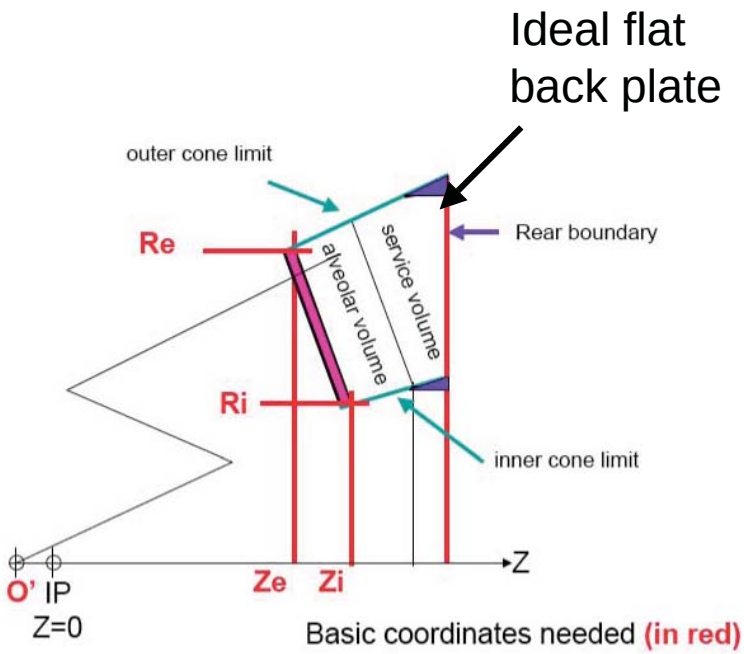
Babar

r_A="915.254079110629" z_A="1808.9490179276"
r_B="505.747713468808" z_B="1979.86389412623"
r_C="597.965158490213" z_C="2318.78072095699"
r_D="758.762982134662" z_D="2318.78072095699"
r_E="1123.3793002059" z_E="2177.88847145028"



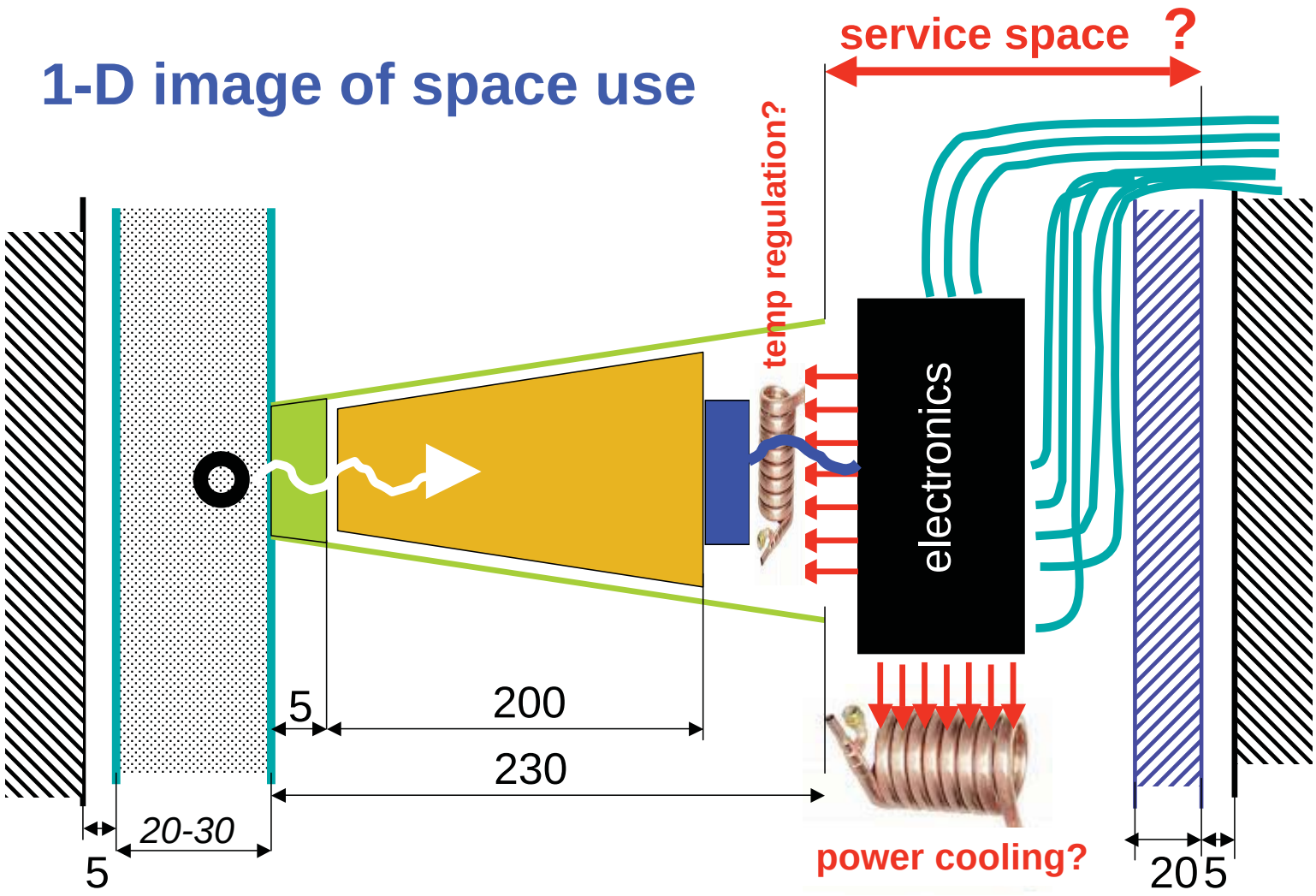
from S.Germani

SuperB



Basic coordinates needed **(in red)**

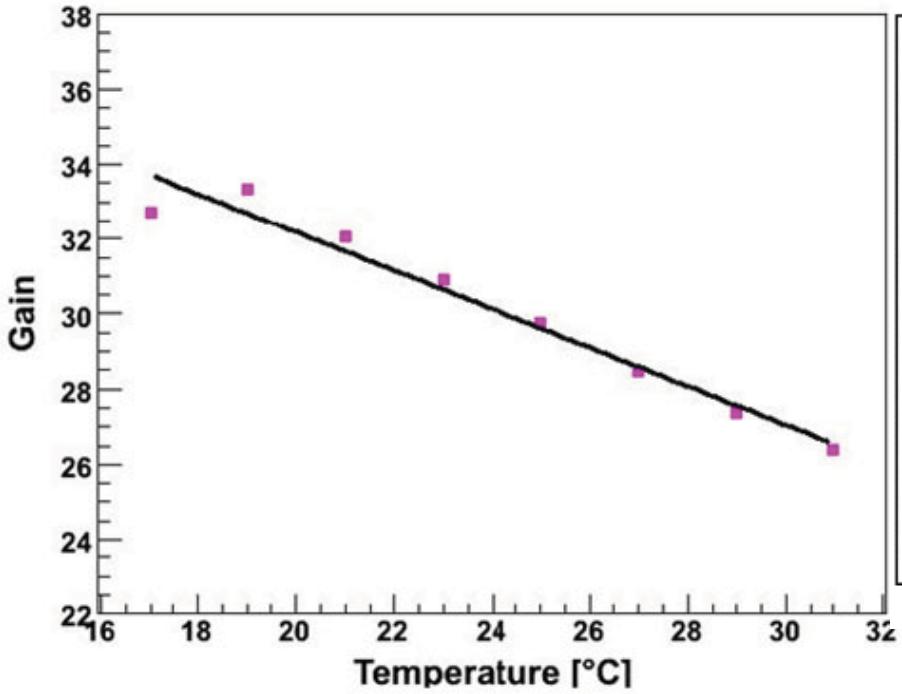
Schematic layout of components inside forward EMC boundary



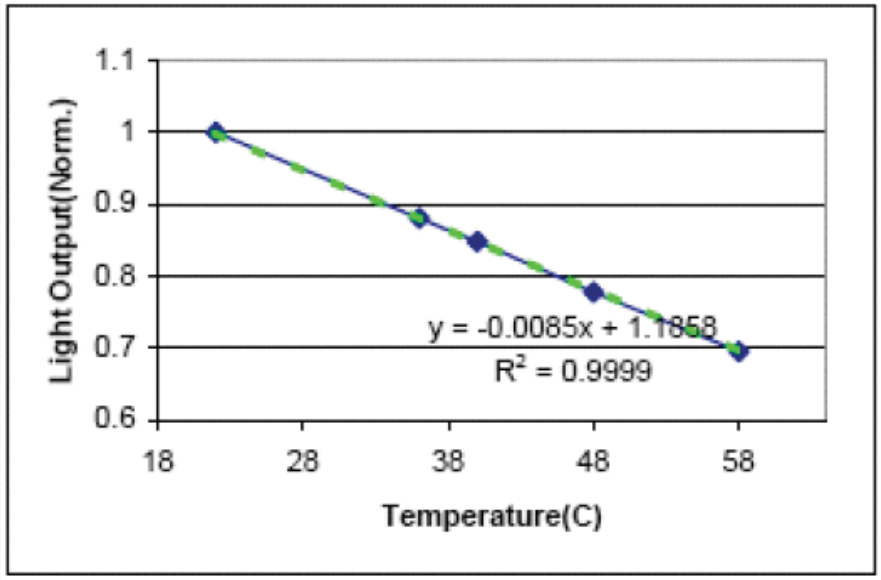
Mechanical - Cooling, Calibration system

Temperature dependence of light output, gain

LYSO(Ce)	-0.2%/C to -0.85%/C (?)
CsI	0.4%/C
APD	-1.5%/C

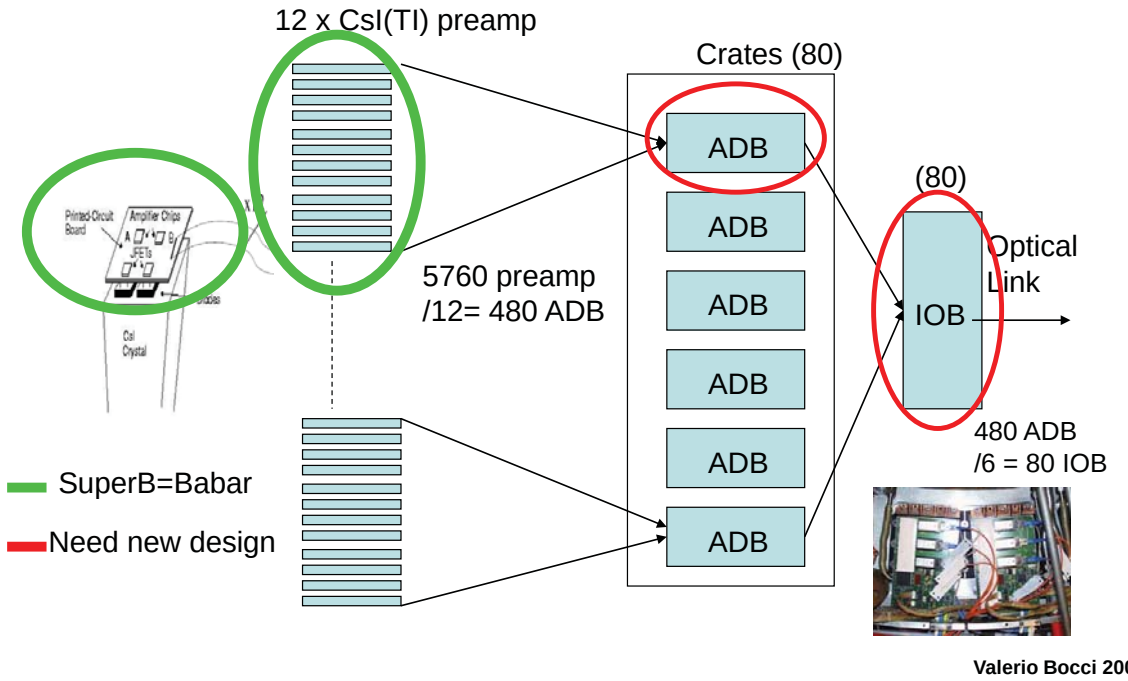


APD gain vs temperature (ALICE)



LYSO output vs temperature

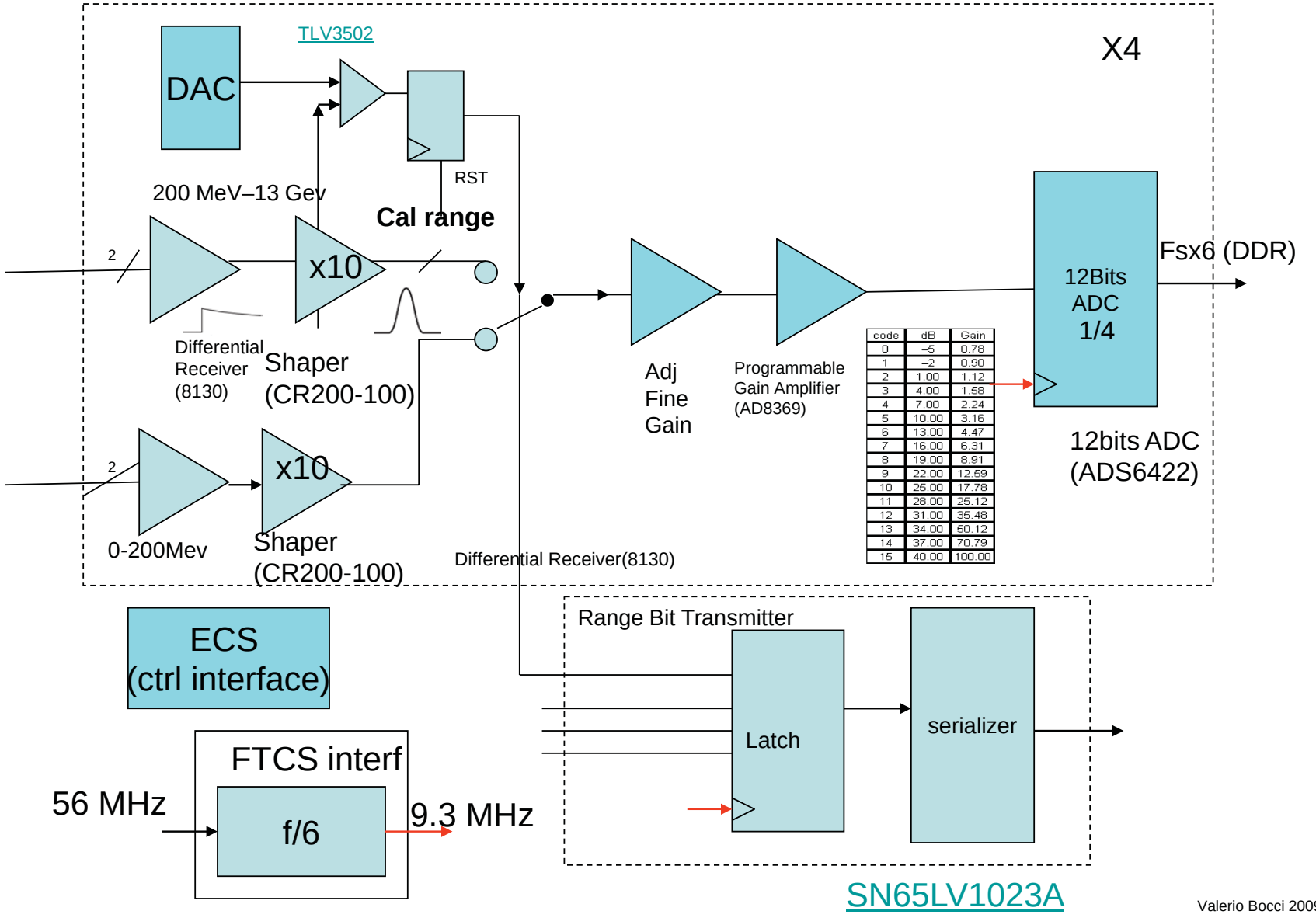
Electronics (Valerio Bocci)



Working on prototypes to test concept and components; provide a system to study parameters.

- Two 5×5 mm APDs or 10×20 mm with 1 or 2 PIN diodes (should have two for redundancy)
- "Very Front End" (VFE) board with charge sensitive preamp and line drivers for $\times 1/4$ and $\times 16$ ranges.

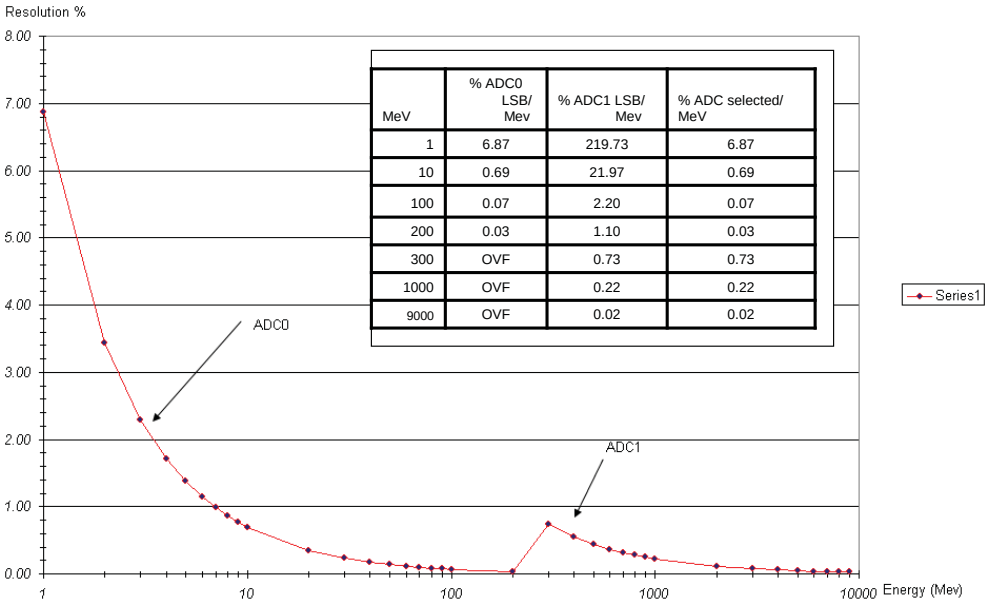
Digitizer Board Prototype



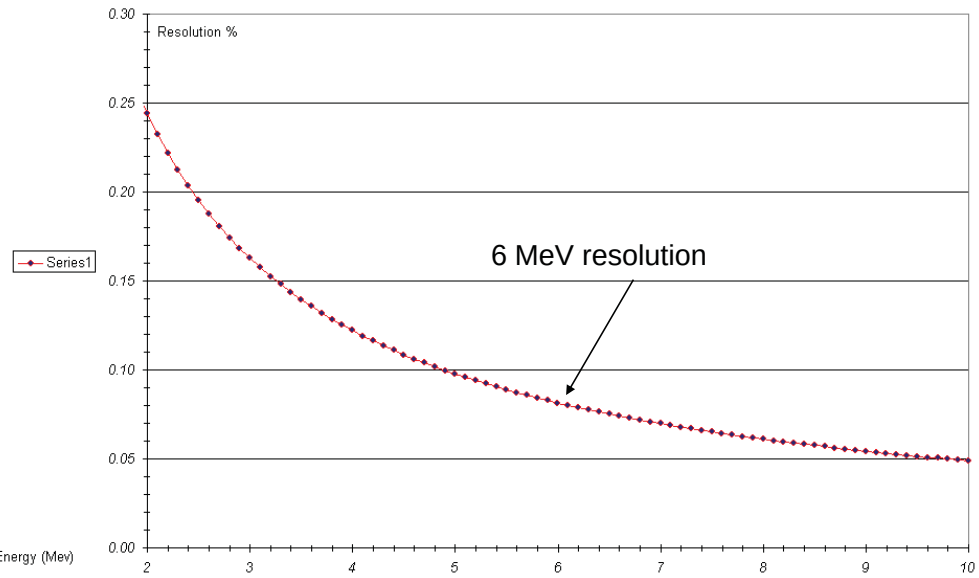
Calibration range

Added a calibration range for 6 MeV source calibration

Energy resolution vs Energy



MeV	% ADC0 LSB/ Mev	% ADC1 LSB/ Mev	% ADC selected/ MeV
1	6.87	219.73	6.87
10	0.69	21.97	0.69
100	0.07	2.20	0.07
200	0.03	1.10	0.03
300	OVF	0.73	0.73
1000	OVF	0.22	0.22
9000	OVF	0.02	0.02



E (MeV)

Electronics Prototype Schedule

- Finalize prototype schematics: November 2009
- PCB layout: January 2010
- Mount PCB: February 2010
- Lab testing: February-March 2010
- First prototype boards: April 2010
- Test beam run: April 12 – May 2, 2010

Full Simulation (Stefano Germani)

- Full GEANT4 (Bruno) studies
  - Barrel-endcap transition

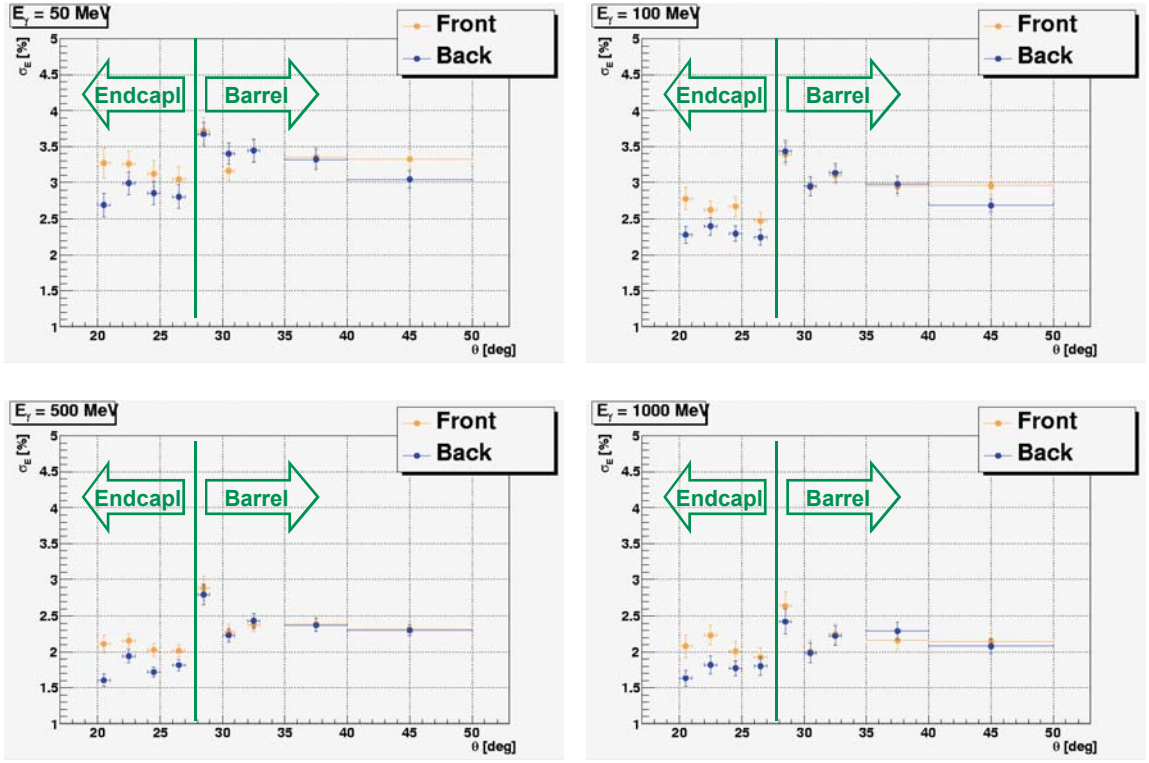
    5mm no-go + 10 mm C fiber

    Two configurations: aligned with barrel and moved back for forward PID
  - Effect of forward PID material
  - Beam-strahlung background

(preliminary results)

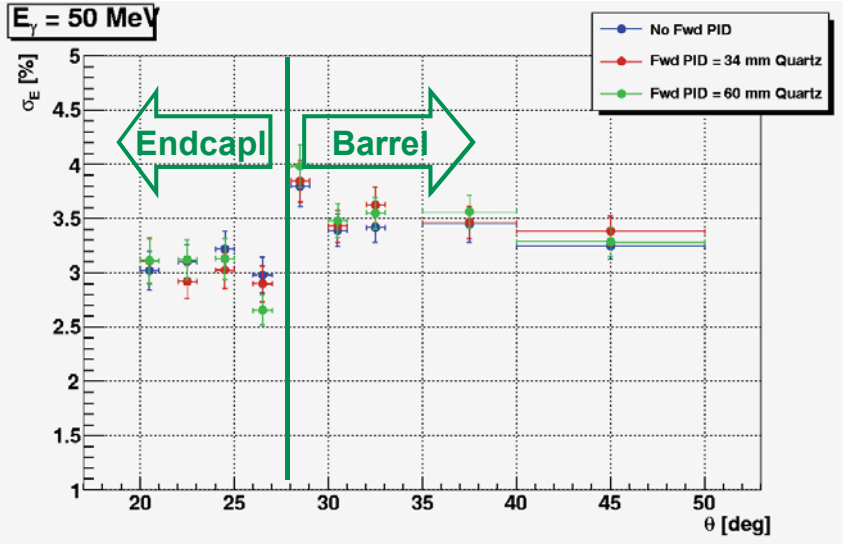
Barrel-endcap transition study

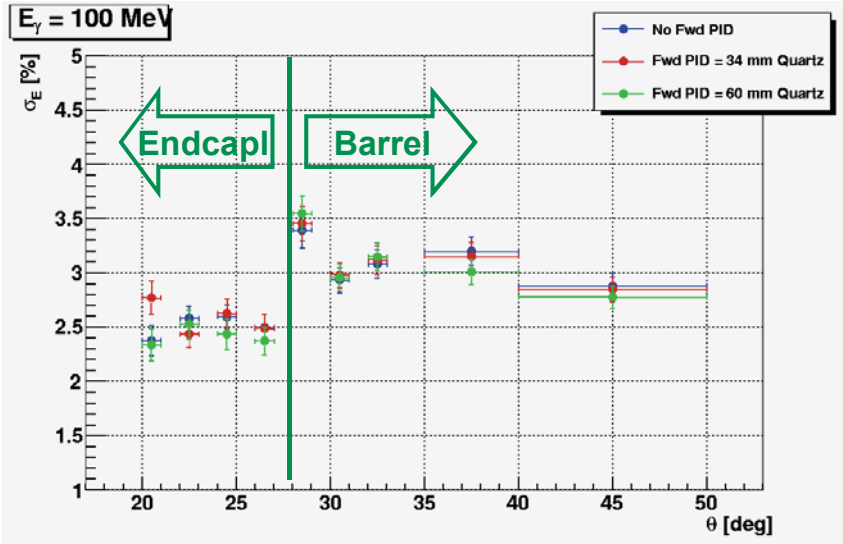
Energy resolution vs Theta

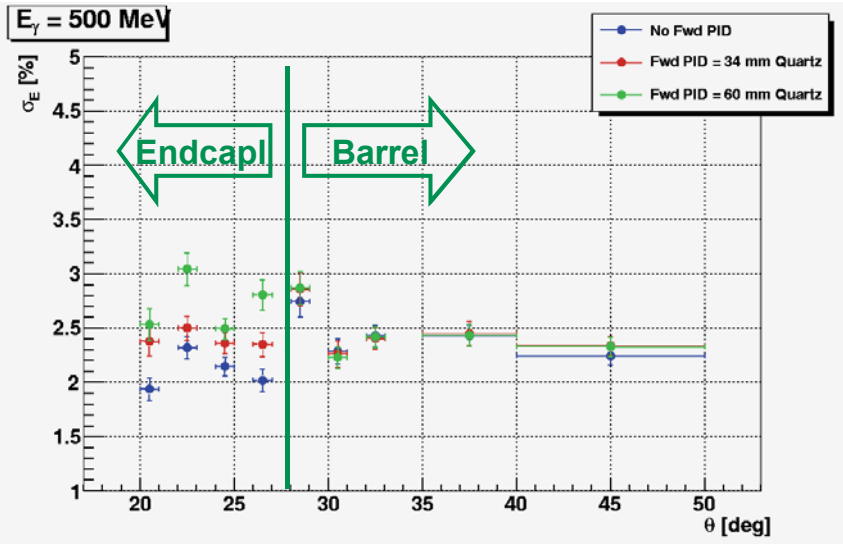


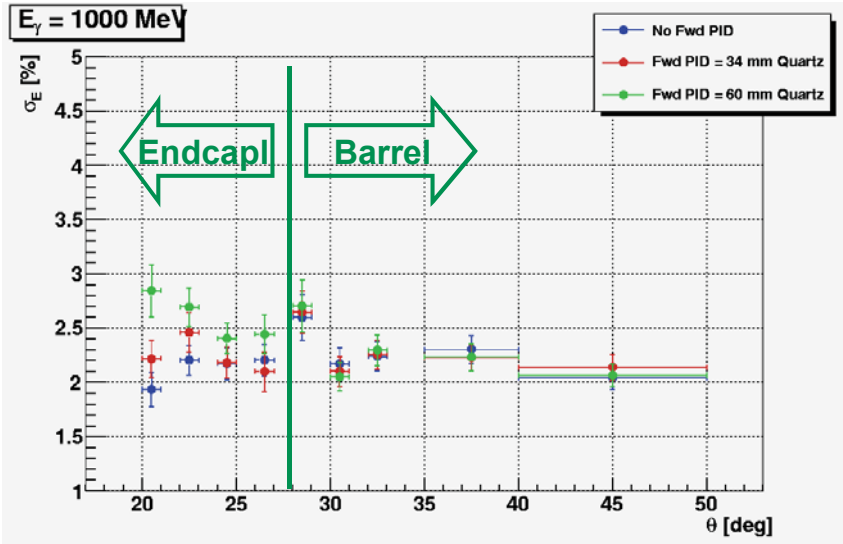
- Will realistic clustering change apparent conclusions?
  - e.g., Effect on efficiency from tails
- Need to understand why pushing back appears to improve resolution

Fwd PID material effect









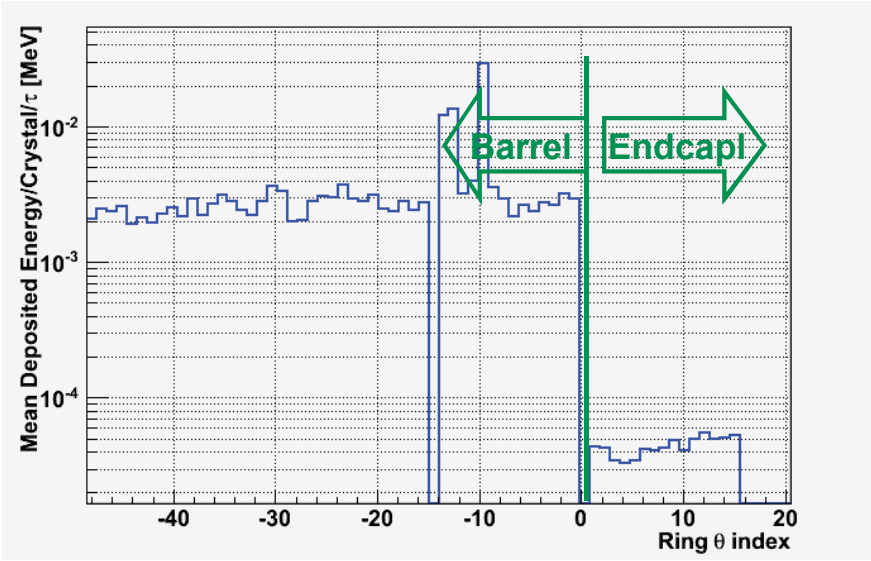
Beam-strahlung study

1400 beam-strahlung events = 6.1 μs of SuperB running

[n.b., old version of code used]

Mean Energy deposit per crystal in one decay constant

- CsI : 64% 680 ns + 36% 3.34 μs
- LSO 40 ns

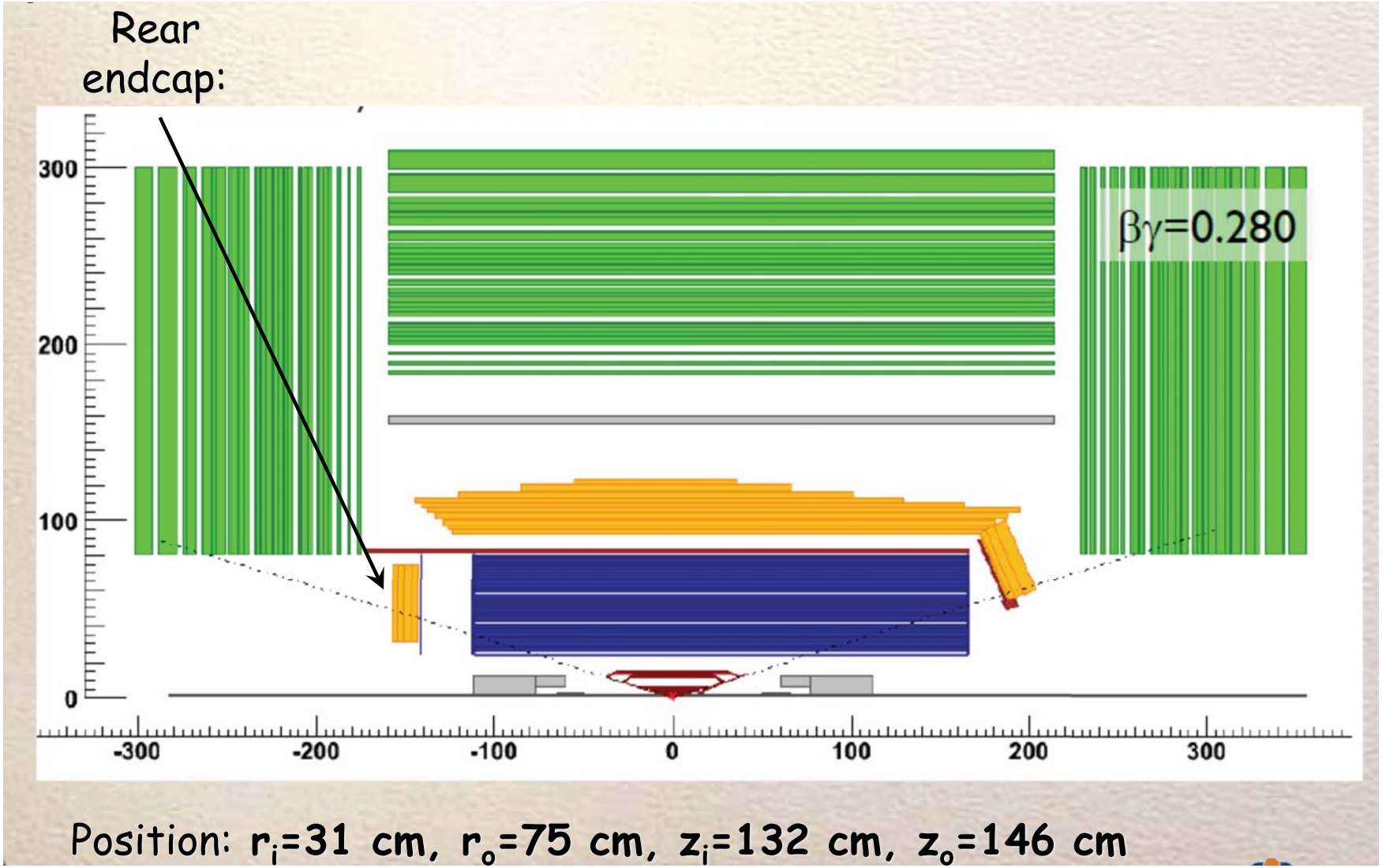


Beam-strahlung appears not to be a problem

Fastsim (Chih-hsiang Cheng)

- Improved modeling of resolution
- Forward/backward calorimeters resolution ad hoc for now
- Too many π^0's still in fastim
- Track-cluster matching tuning in progress.
- Model gaps between crystals by making active region smaller
- Model signal timing with linear rise (t_r) and exponential tail ($\tau = 10t_r$); in a window of width $\pm\tau$.
  Barrel/backward: $\tau = 1$ μs
  Forward: $\tau = 0.1$ μs

Backward Endcap (Gerald Eigen)

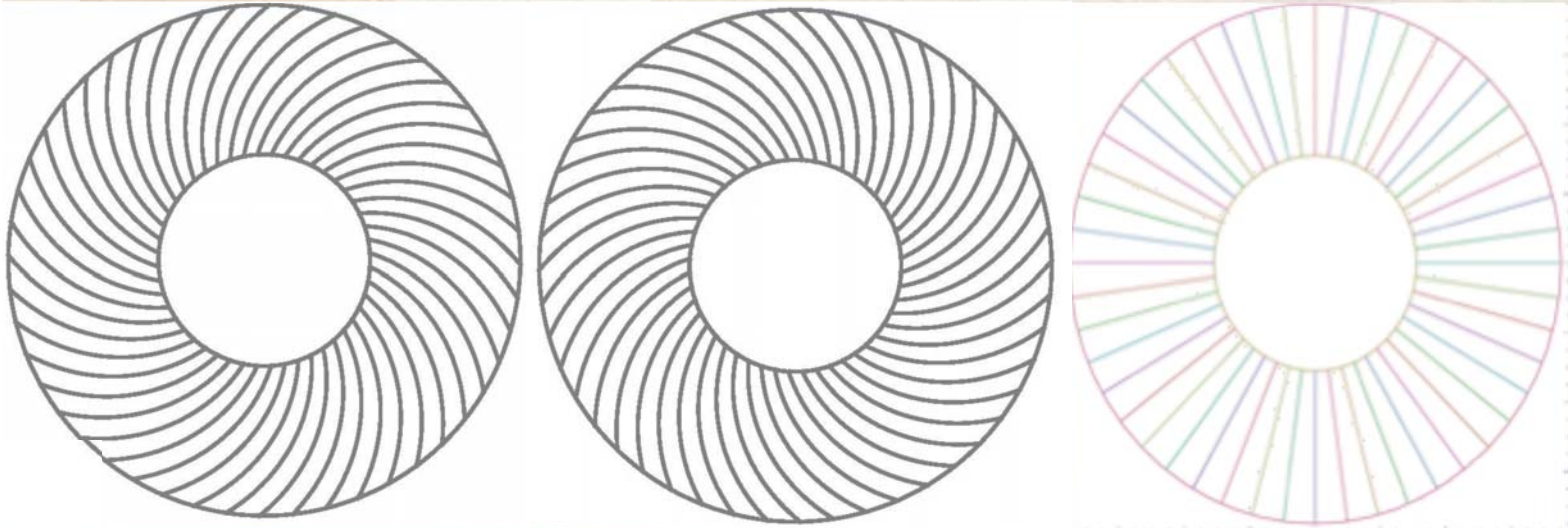


Backward Endcap

Layout of Scintillator Planes

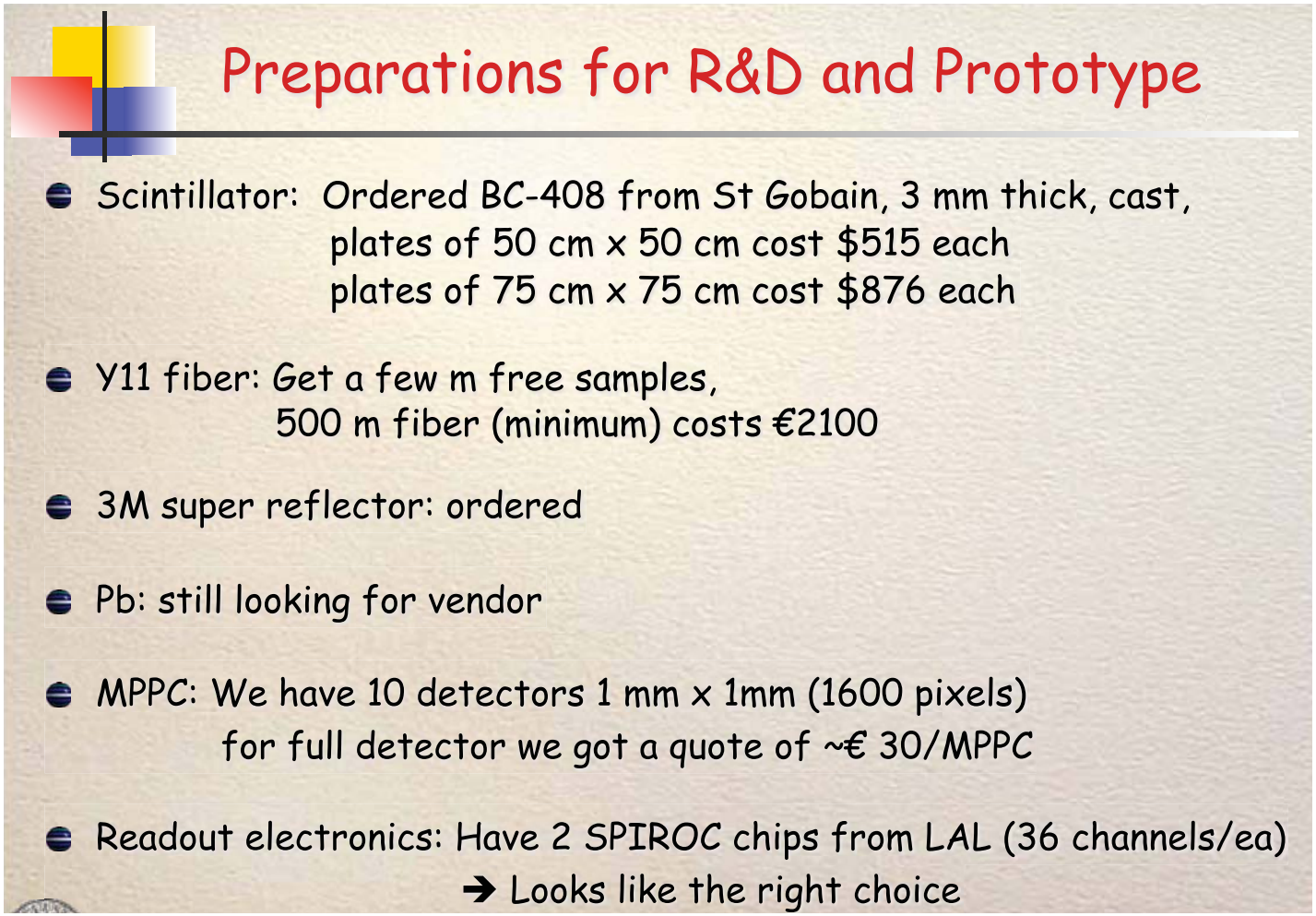
- Alternate 3 different strip shapes 8 times ➔24 layers in total
- There are 48 strips per layer yielding 1152 strips
- Due to the different strip shapes each layer needs to be assembled completely ➔ no split into halves is possible
  ➔ need to remove beam pipe if calorimeter has to be taken out

Left-handed spiral | Right-handed spiral | Sectors



SuperB Workshop SLAC, October 6, 2009

Backward Endcap



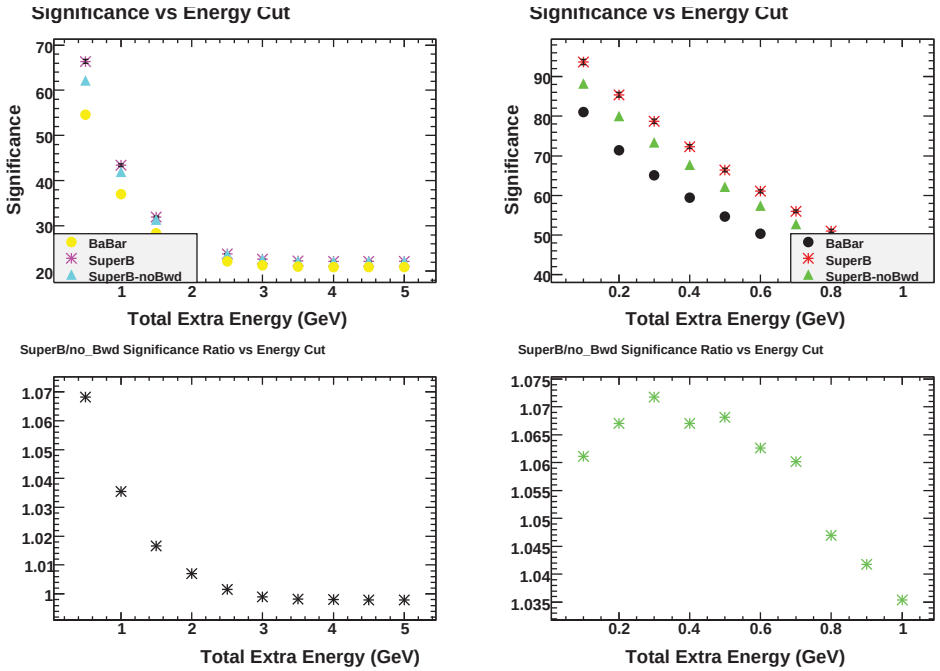
Multi-Pixel Photon Counter (MPPC) readout

Concern is neutrons, above $3 \times 10^9/\mathrm{cm}^2$ MPPC's show damage (high leakage current)

Backward Endcap – Study of physics impact

- Signal: $B \to \tau\nu$; Background: sum of 16 semileptonic B decay channels, such as $B \to D\ell\nu$.

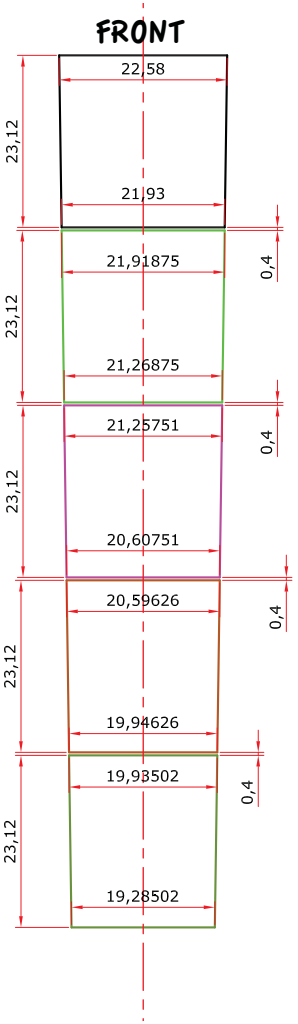
Now let's plot $S/\sqrt{S+B}$ as a function of cut on E_{extra}:

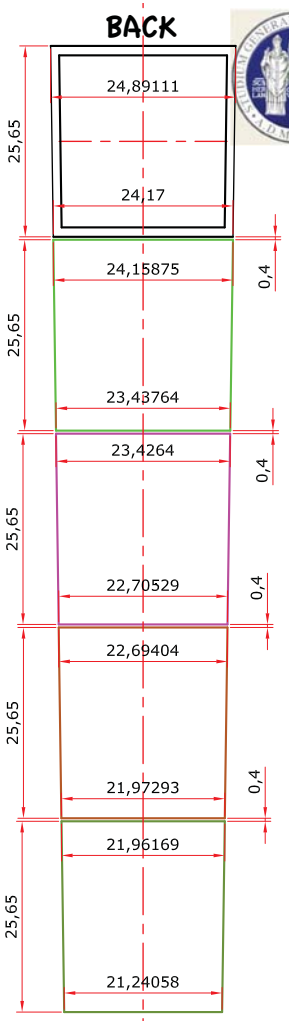


- Precision figure of merit improved by 7% with backward endcap.
- Interesting to look at $B \to K\nu\nu$ also.

Test Beam (Claudia Cecchi)

Planning a 5×5 LYSO array, surrounded by CsI (CLEO endcap) crystals.





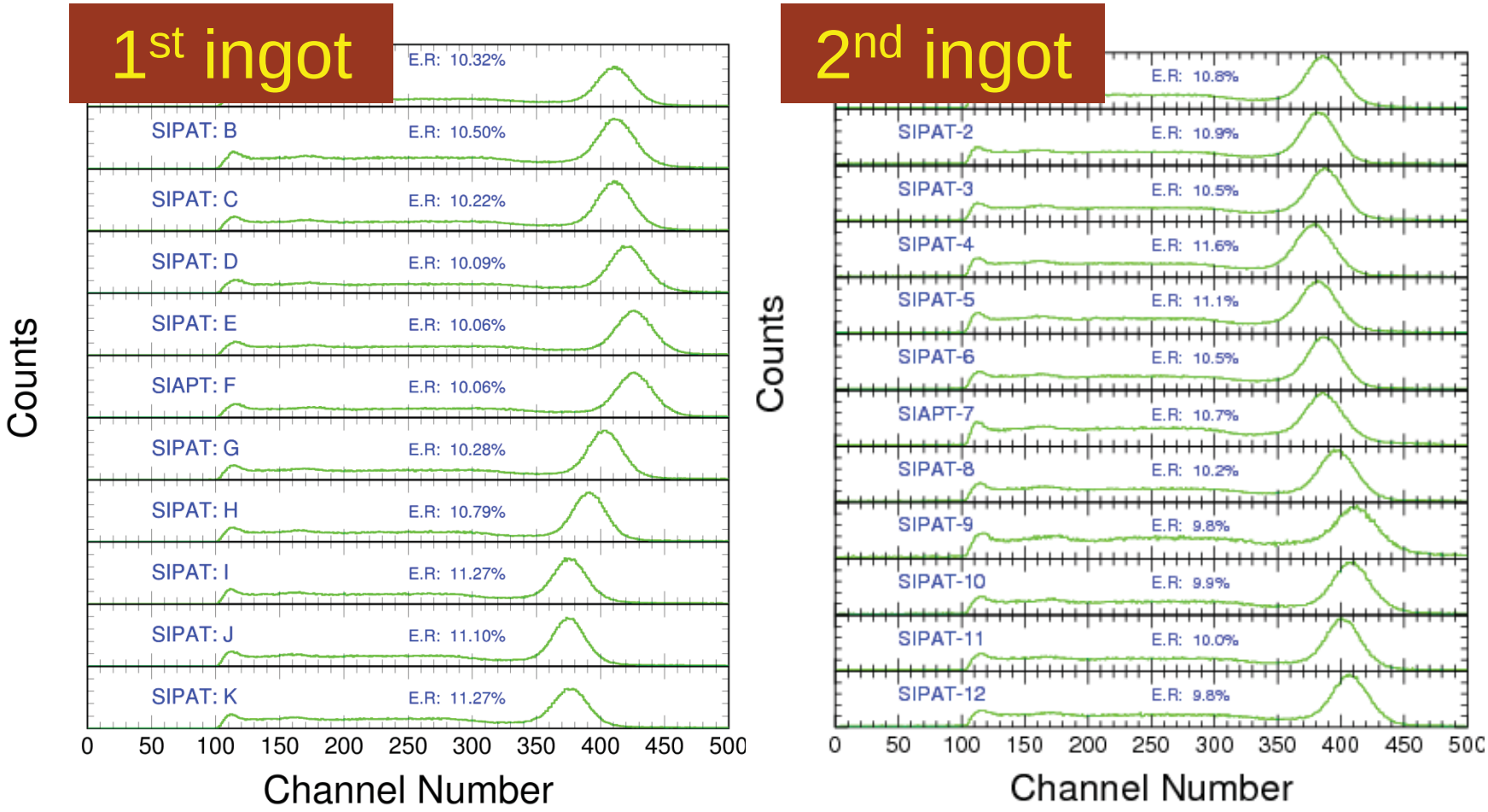
CAD design from
A. Piluso
Perugia

Forward EMC prototype Test Beam

- Crystals:
  - Perugia: 8 LYSO crystals ordered from Saint-Gobain. 4 more to be ordered
  - Caltech: Will order 13 LYSO crystals from China (SIC + SIPAT).
  - CLEO CsI crystals in hand at Caltech, with help from David Asner
- From 2009 test beam run, determined that beam position measurement needs to be better; planning a Si telescope
- Beam test at Frascati scheduled April 12 to May 2, 2010
- Plan a beam test at CERN (higher energy) in fall 2010

Things there isn't time for

Energy resolutions are position dependent, indicating possible correlation with the cerium concentration.



(CsI resolution $< 12.5\%$)

Backgrond partcles entering the EMC volume