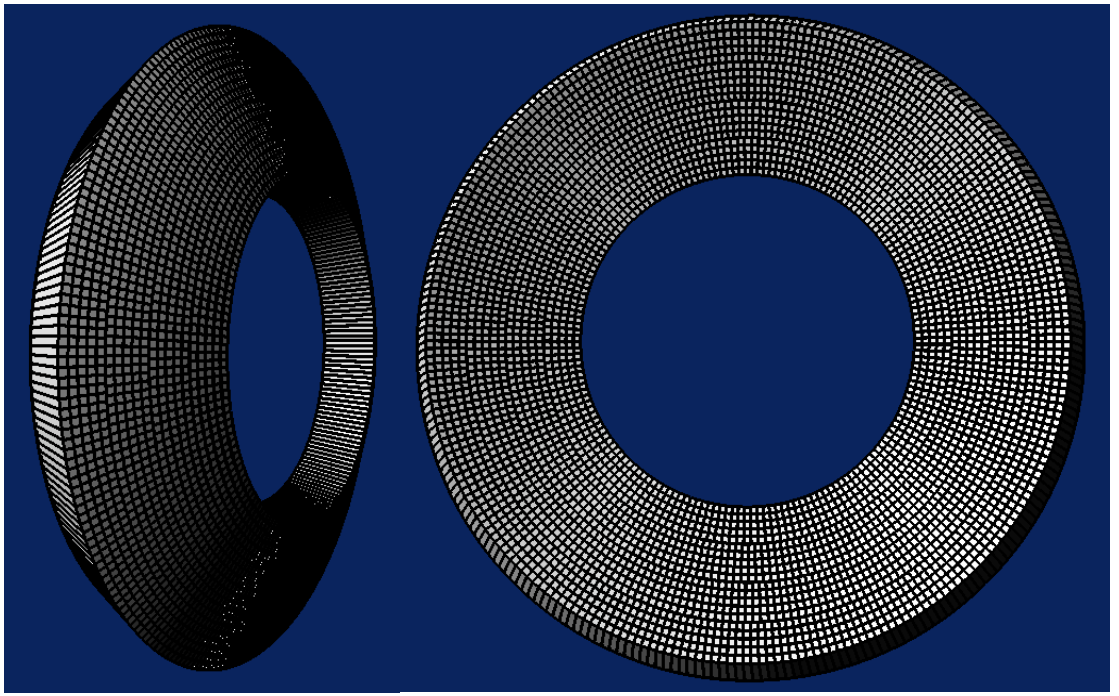
Fwd ECAL Simulation

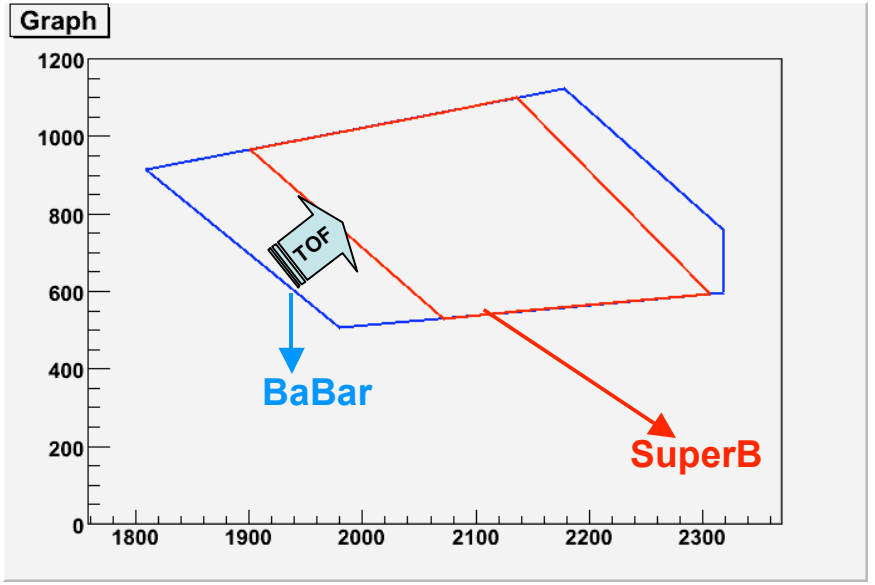
SuperB Workshop
LAL, Orasy
15-18/02/2009

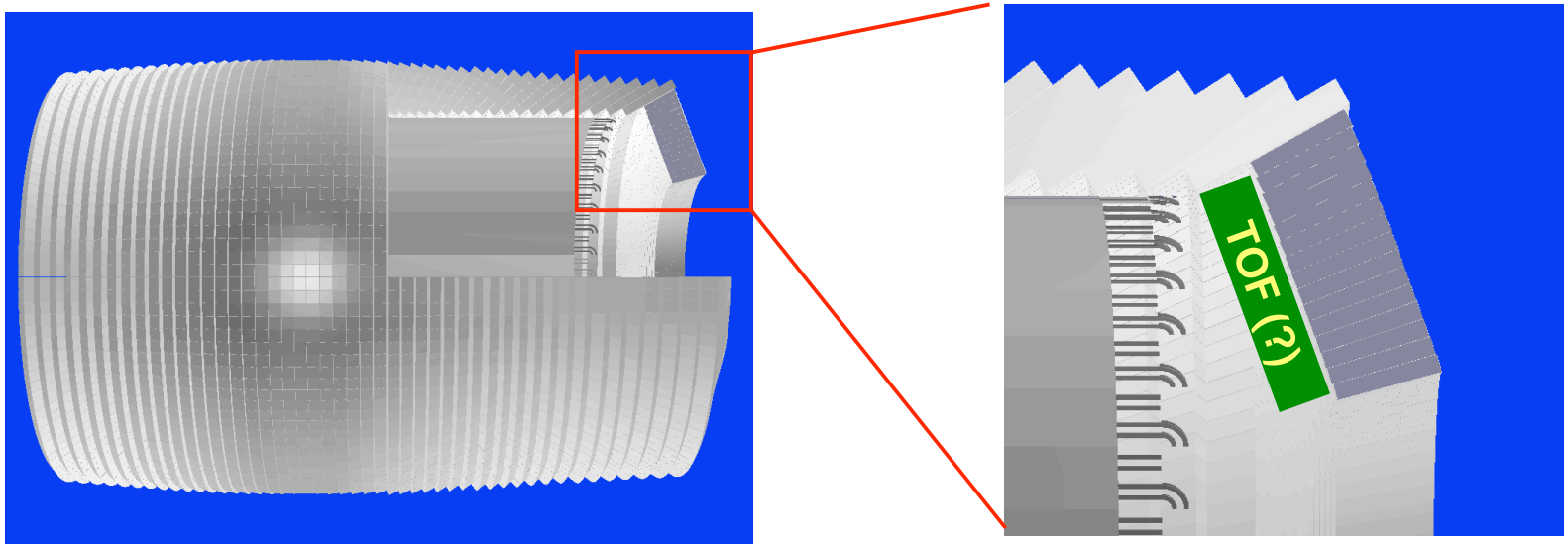


C. Cecchi - S. Germani
INFN Perugia

Fwd ECAL Geometry Envelop

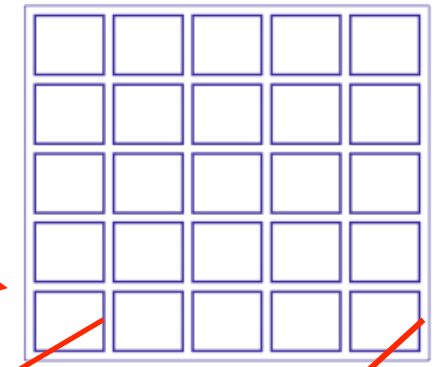
- Fill the same BaBar angular region but
  - leave space for TOF: ΔZ = (100 mm)*cos(22.7)
  - Xtals material : LSO (LYSO)
    - Xtal depth = 200 mm (~17.5 X_0)

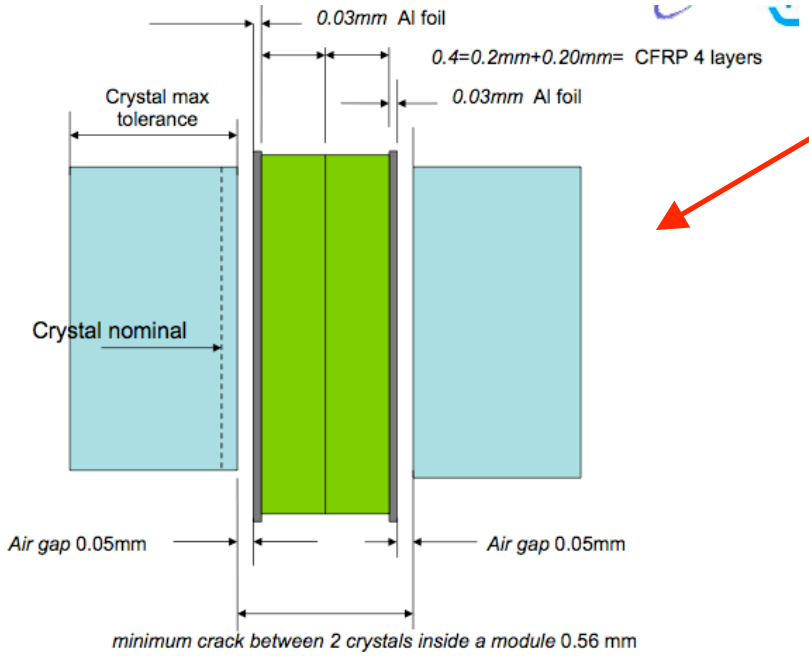


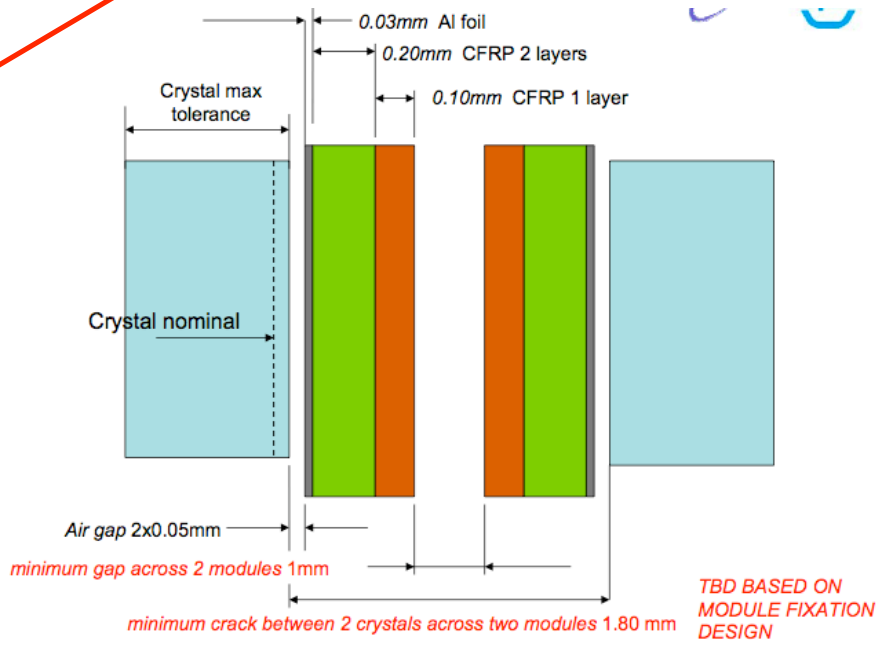


Dead material options

- Carbon Fiber reinforced plastic support structure
  - Naive version : almost no air gap between modules and crystals but correct CF thickness
  - Mechanical engineer version (C. Gargiulo INFN Roma1)
- Only optical isolation (tyvek) crystals holded from back face (to be investigated further)

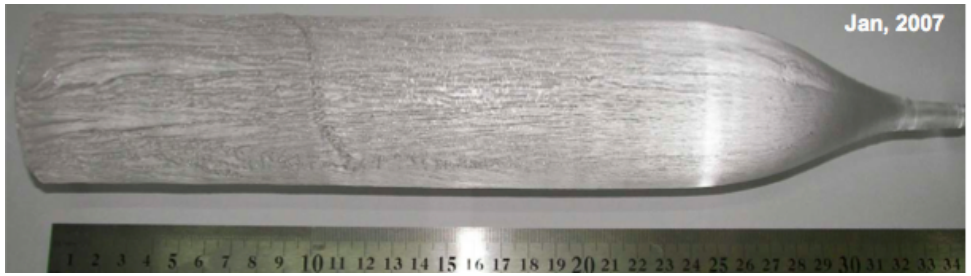


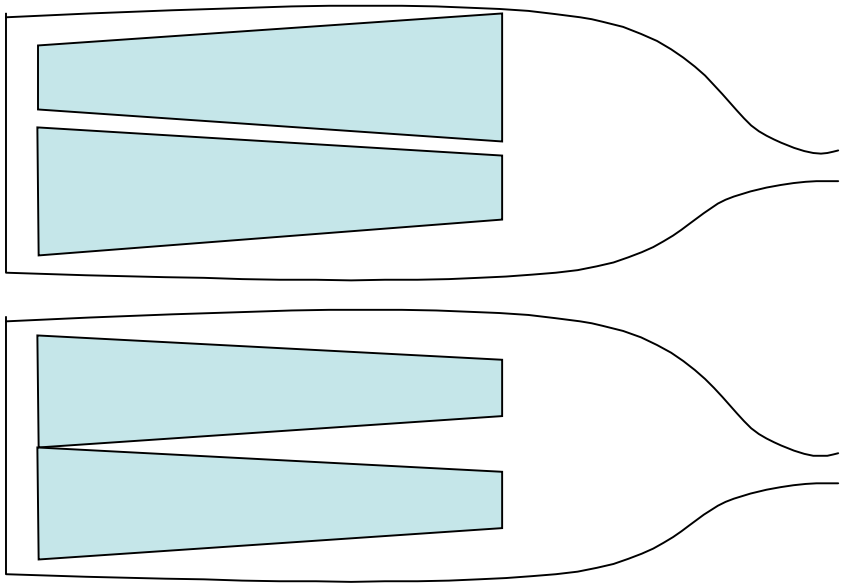




Crystal size constraints

- Due to maximum boule size (SIPAT) there are some constraints on Crystal size
- Crystal size constraints depend also on whether Ce doping uniformity will be an issue
  - For production
  - For ECAL performances





W/O Uniformity Issue:

Back Face < 26.3 mm
Front Face < 23 mm

With Uniformity Issue:

Back Face < 25 mm

Crystals Dimensions

LSO crystas

- depth: 20 cm ~17.5 X_0
- Crystas arranged in 20 rings within 5x5 modules

Ring	A	B	C	D	E	F
1	19.52	23.05	18.66	21.53	25.53	20.58
2	20.30	23.01	19.44	22.40	25.49	21.45
3	21.08	22.98	20.22	23.27	25.46	22.31
4	21.86	22.95	20.99	24.13	25.43	23.18
5	22.63	22.82	21.77	24.99	25.29	24.04
6	19.92	22.90	19.18	22.02	25.38	21.19
7	20.58	22.89	19.84	22.75	25.37	21.93
8	21.24	22.87	20.49	23.49	25.35	22.66
9	21.90	22.86	21.15	24.22	25.34	23.39
10	22.55	22.76	21.80	24.95	25.23	24.11
11	20.16	22.85	19.50	22.31	25.33	21.57
12	20.73	22.85	20.07	22.95	25.33	22.21
13	21.31	22.86	20.64	23.59	25.34	22.85
14	21.89	22.87	21.22	24.23	25.35	23.48
15	22.46	22.80	21.79	24.87	25.27	24.12
16	20.83	22.90	20.21	23.07	25.38	22.38
17	21.36	22.92	20.73	23.65	25.40	22.96
18	21.88	22.95	21.26	24.23	25.43	23.54
19	22.41	22.98	21.78	24.82	25.46	24.12
20	22.93	22.93	22.30	25.40	25.40	24.70

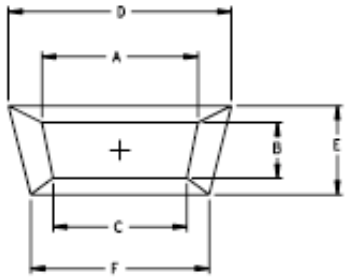
175 Xtals/Ring
35 Modules

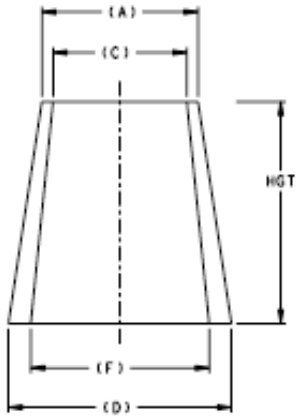
205 Xtals/Ring
41 Modules

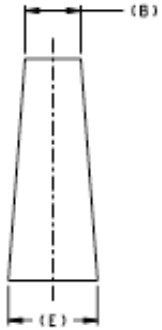
235 Xtals/Ring
45 Modules

260 Xtals/Ring
52 Modules

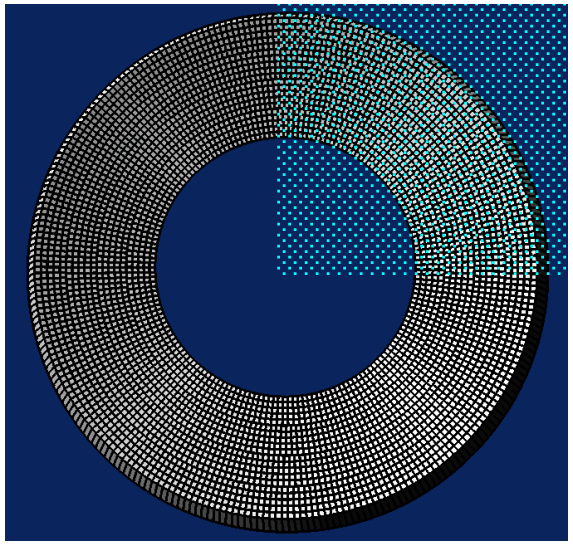
~4400 Crystals



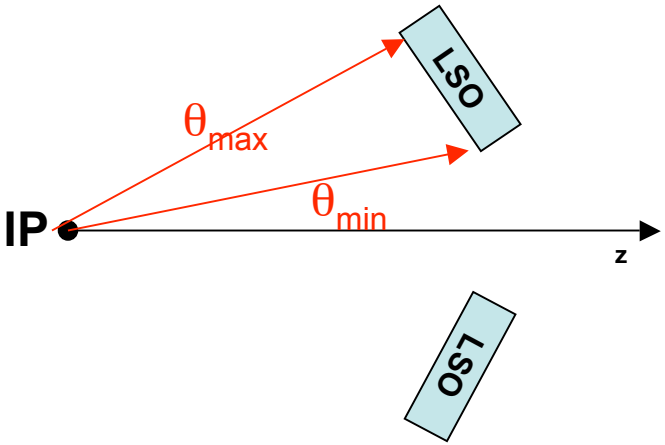




Generated beams



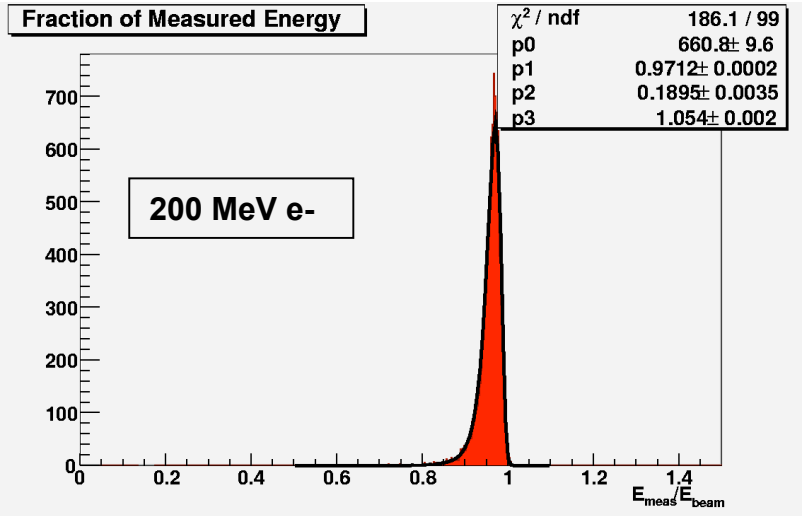
- Particles:
  - e- γ
- Energies:
  - 50, 100, 200, 350, 500, 750, 1000, 2000, 5000, 7000 MeV
- Surface:
  - Particles uniformely distribuited in one quandrant between θ_{min} - θ_{max}
- Primary vertex position:
  - Interaction point (x=y=z=0)



Energy Reconstruction

Algorithm:

1. Get Xtal deposited energy
2. Perform Poisson smearing with 8k pe/MeV
3. Assign 1% calibration error to crystals
   - Reconstruct with 8k±1% pe/MeV
4. Apply minimum energy cut for each xtal
   - 1 MeV to be tuned
5. Sum Xtal energy



Comments:

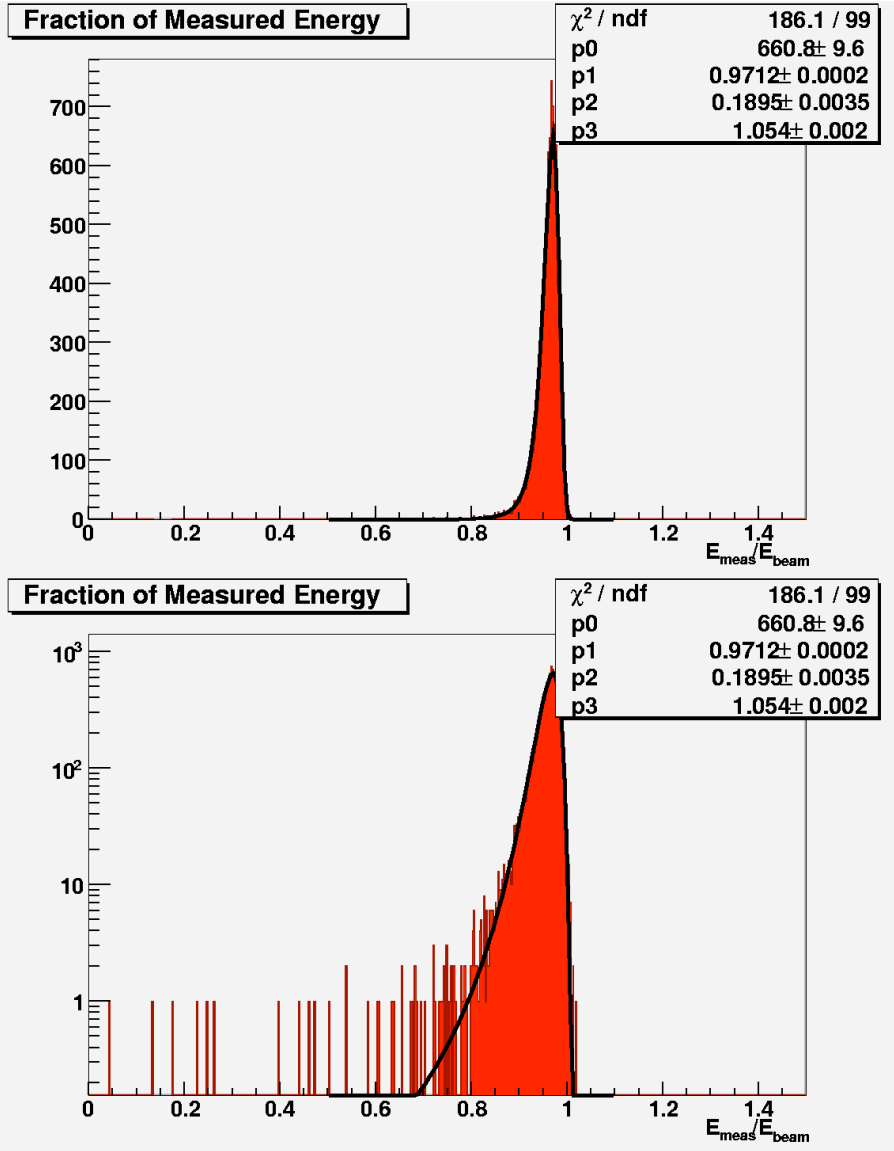
- All distributions have asymmetric low energy tails
  - Backsplash for low E particles
  - Forward leakege for high E particles
- Energy distributions fit with asymmetric Gauss function: $\sigma = \sigma(E)$
- Proposed parameterisation uses fit of p1,p2,p3 vs Energy

$$F(x) = P_0 e^{-\frac{(x-P_1)^2}{2[P_2(P_3-x)]^2}}$$

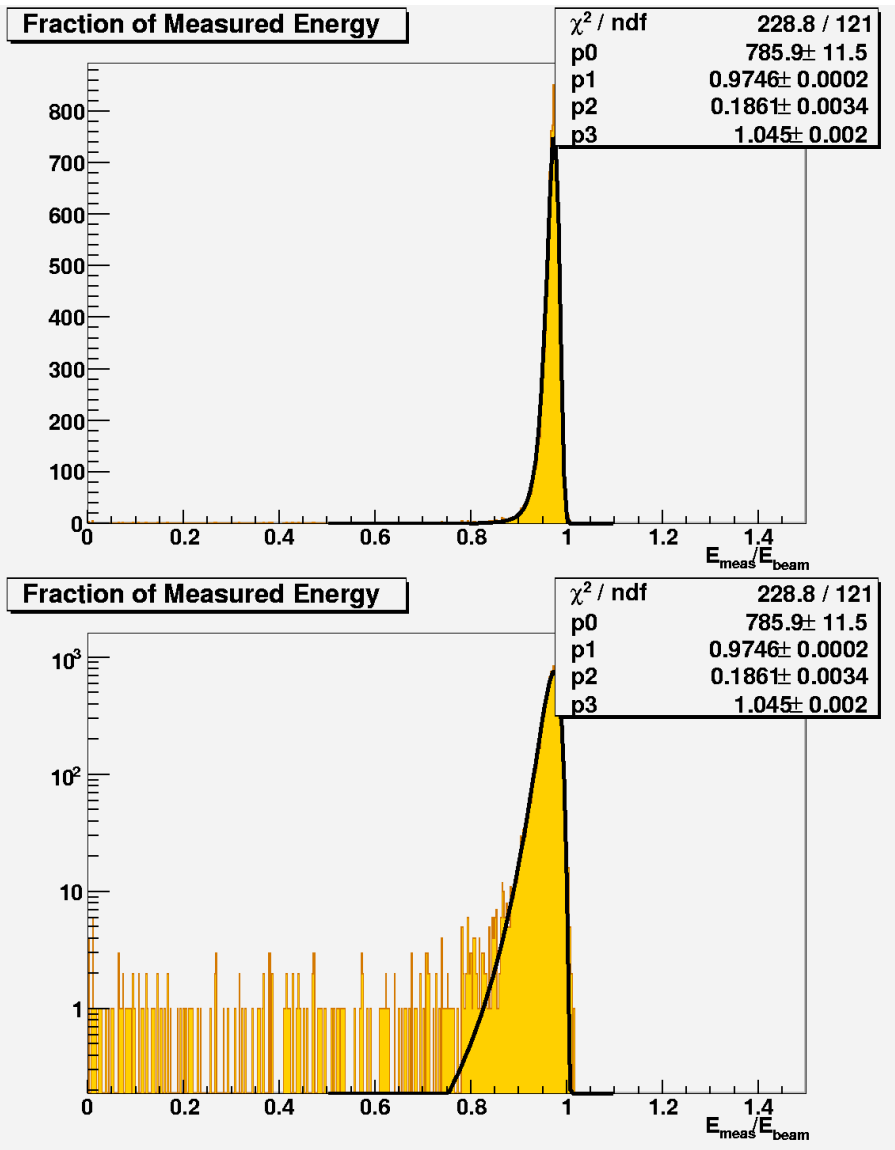
- P1 : most probable value (mpv)
- P2(P3-x) : running σ

Energy distribution examples

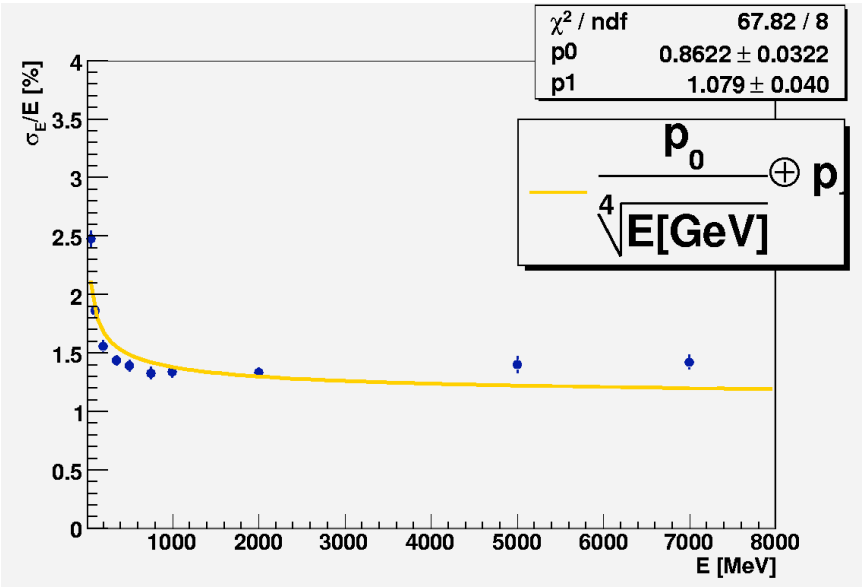
200 MeV e-



2 GeV e-



Energy Resolution vs Energy: e-

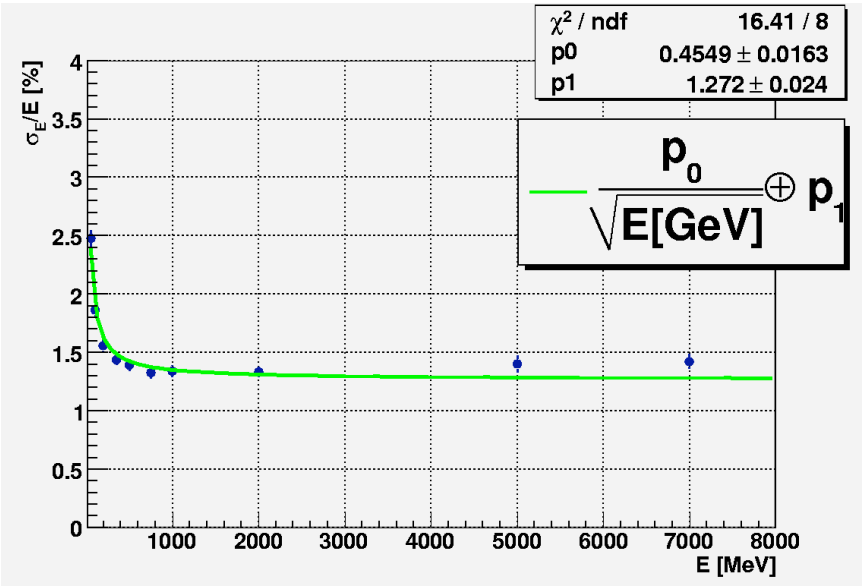


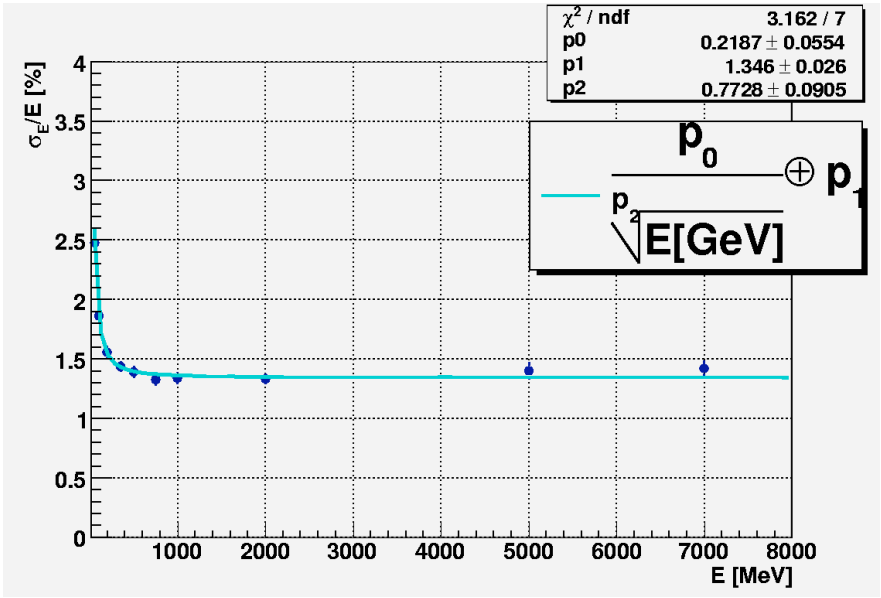
- To show the energy resolution use the running sigma value at the peak : σ(mpv)
  - Slightly underestimates real width
- Fit measured points with

$$\frac{\sigma(E)}{E} = \frac{p_0}{\sqrt[4]{E[GeV]}} \oplus p_1$$

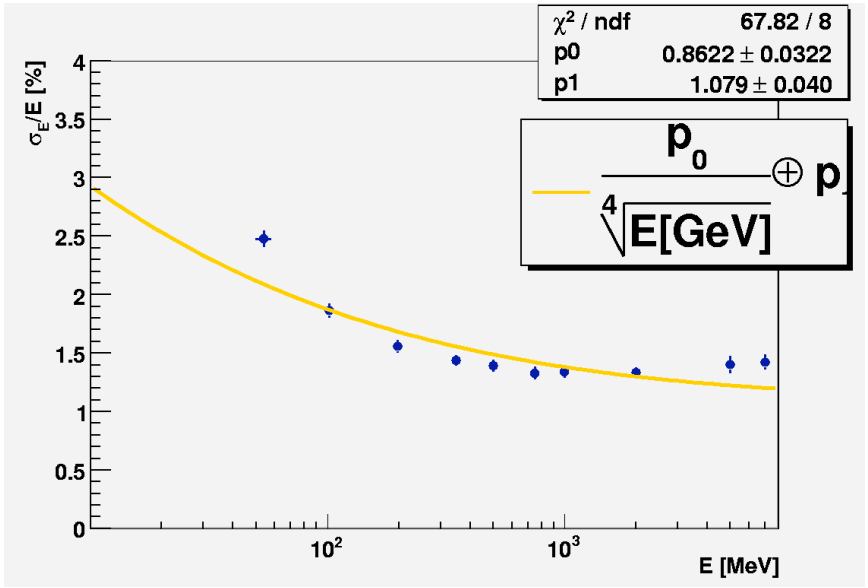
$$\frac{\sigma(E)}{E} = \frac{p_0}{\sqrt{E[GeV]}} \oplus p_1$$

$$\frac{\sigma(E)}{E} = \frac{p_0}{\left(E[GeV]\right)^{p_2}} \oplus p_1$$

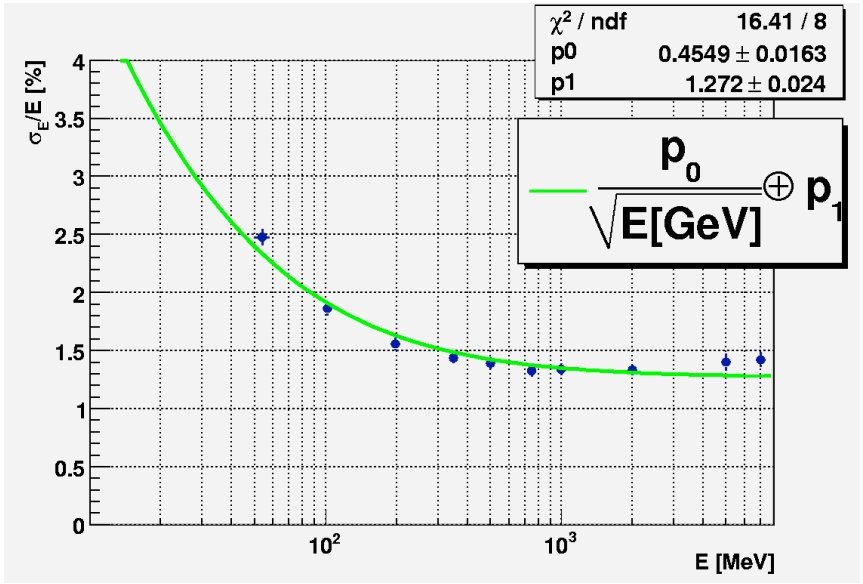


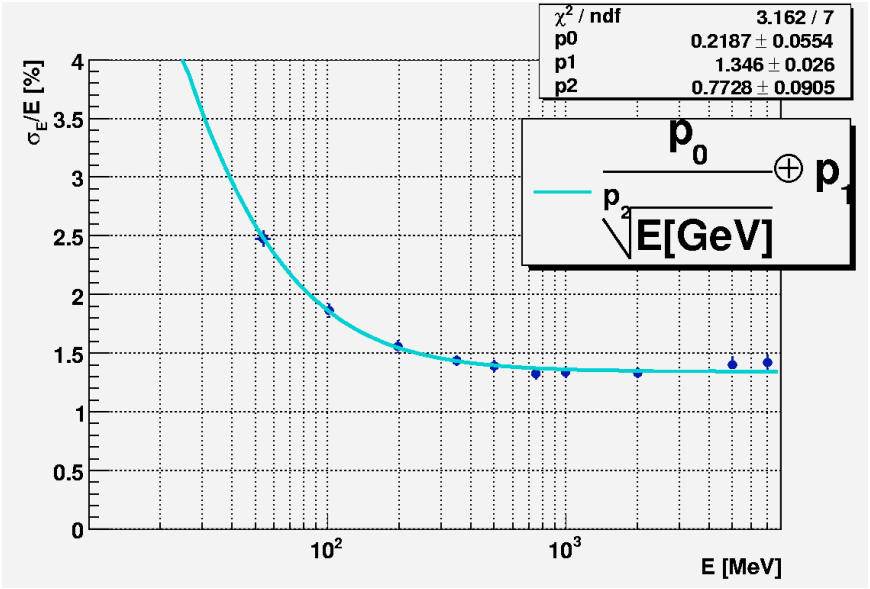


Energy Resolution vs Energy (log scale): e-

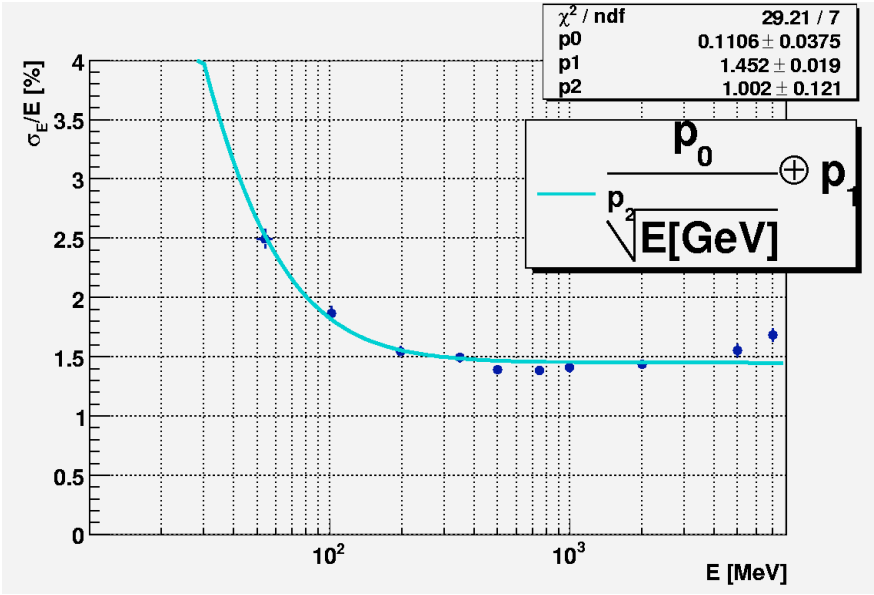


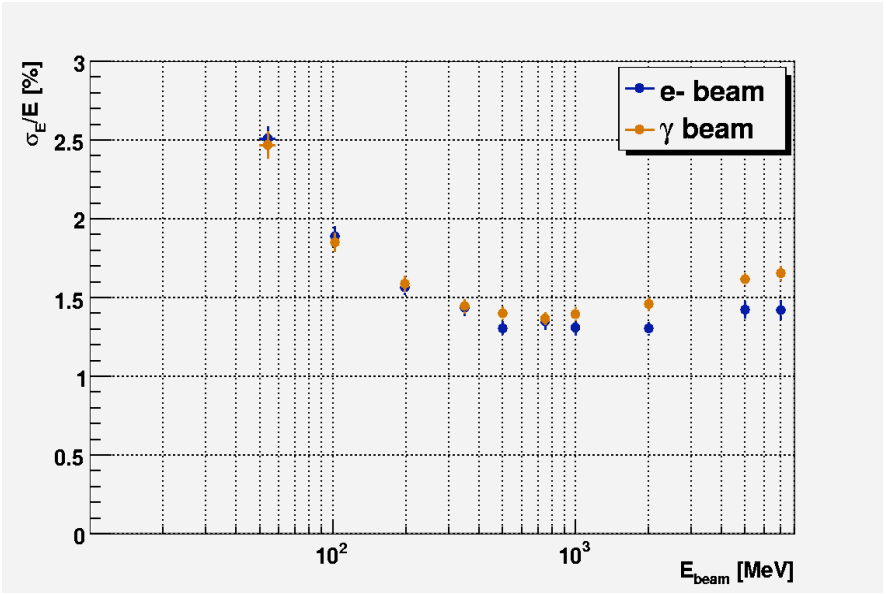
- The fit with sqrt[x](E) seems to give a better agreement
  - index = 0.77





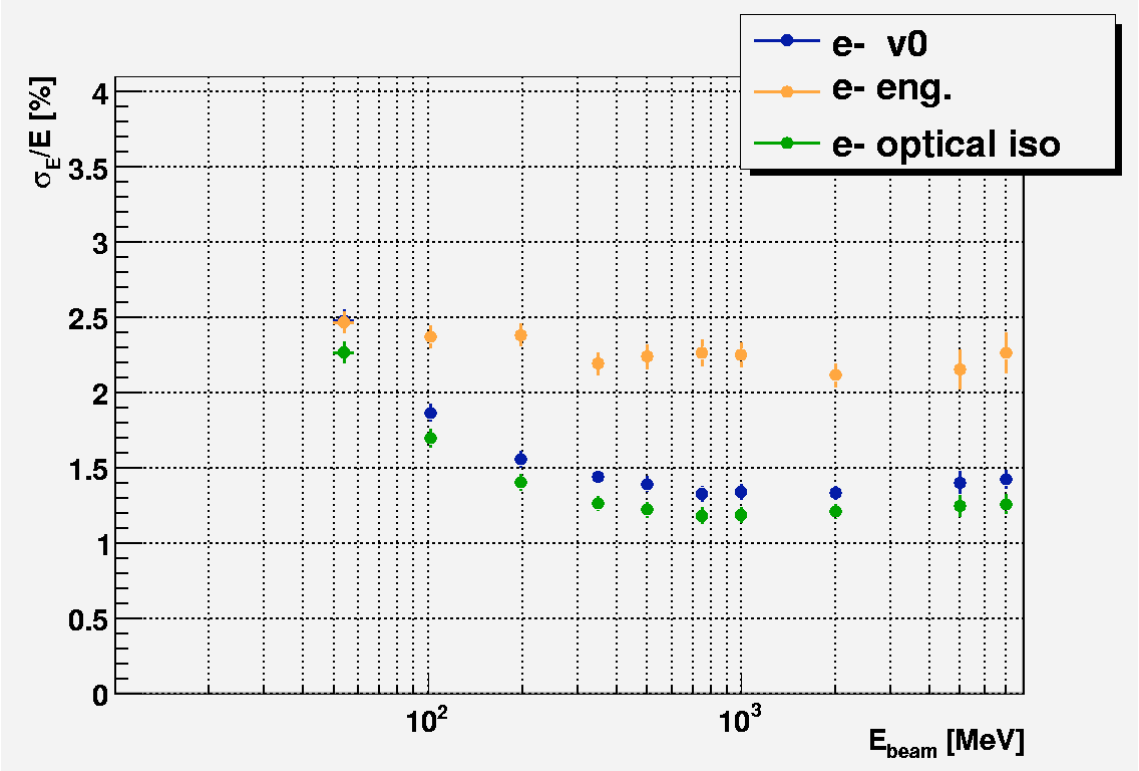
e- γ comparison





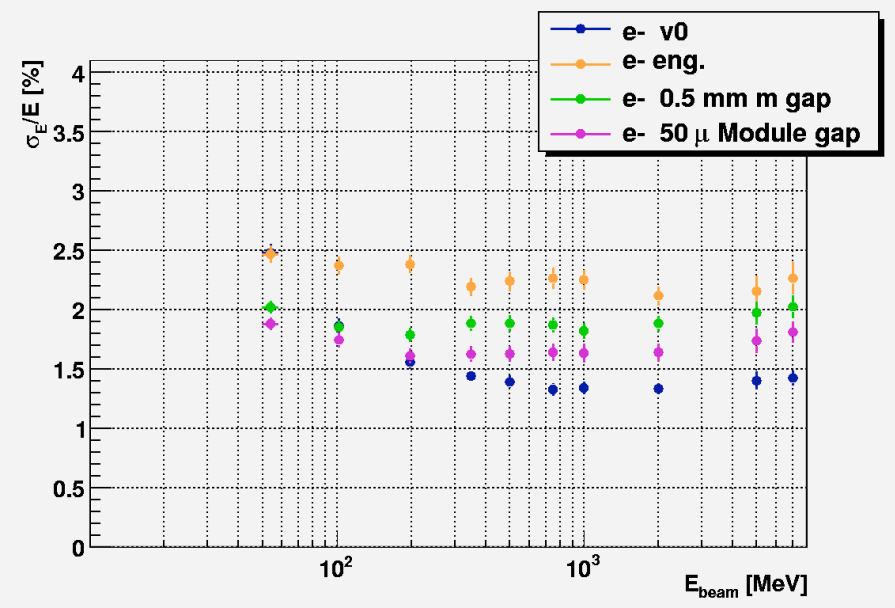
- electrons:
  - p0 = 0.21
  - p1 = 1.35
  - p2 = 0.77
- γ :
  - p0 = 0.11
  - p1 = 1.45
  - p2 = 1.0

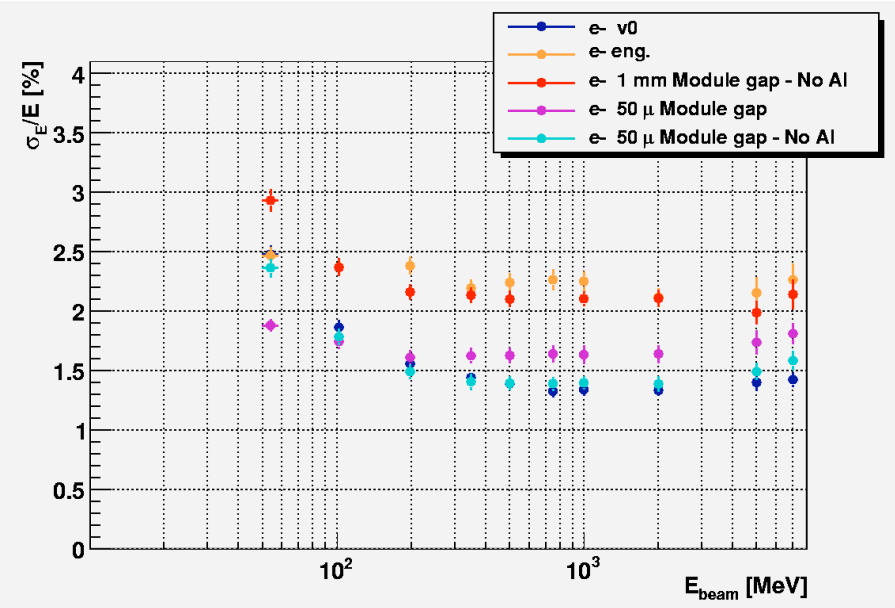
Main geometrical options



- Geometry options
  - naive
  - geometry from mechanical egineer
  - only opticla isolation
- Geometry with only optical isolation gives a small improvement
- Geometry with larger empty spaces worsen the resolution

What affect resolution?





- Empty gap between modules
  - has a big impact on the resolution
- Al layer
  - has some effect on the resolution
  - compared to the module gap effect is small

Conclusions

- Constraints on Fwd ECAL geometry are still evolving
  - Fwd PID
  - Limits on crystal size
- Several dead material option have been investigated
- Baseline has CF structure
  - Simulation with optical isolation only (Tyvek) shows some (small) improvement
- Al layer (30 μm) affect resolution but the effect is not large
- Empty space between modules seems to affect the resolution in a significant way