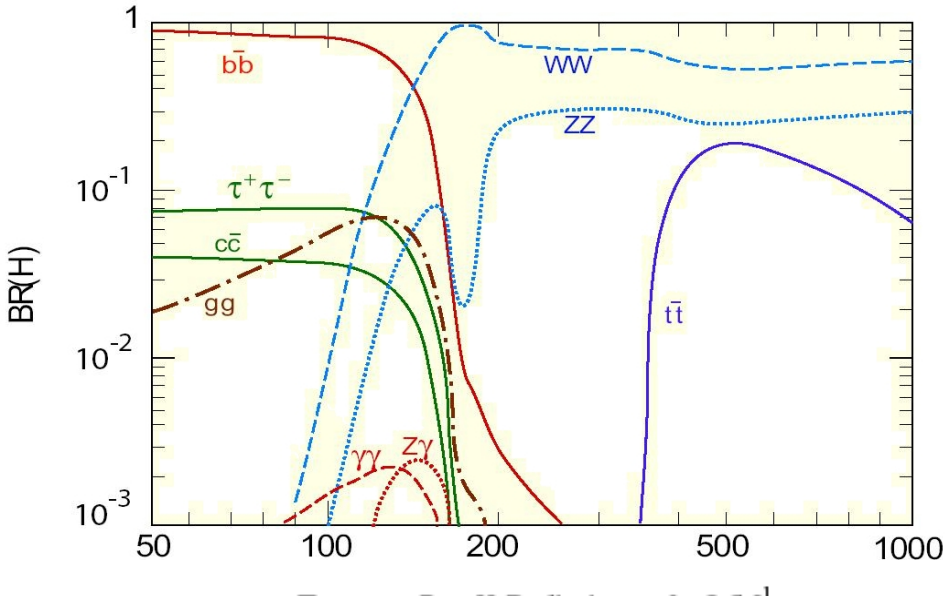
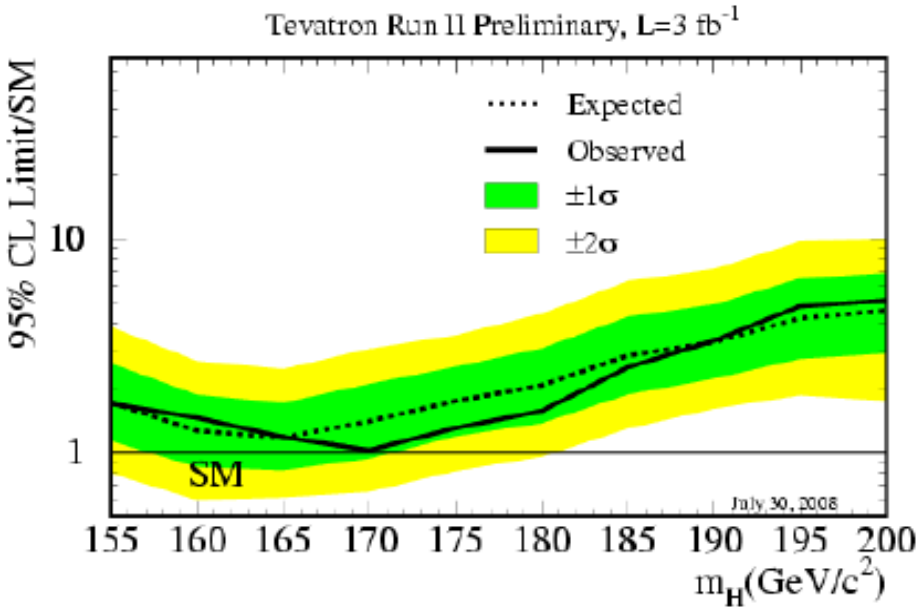
Physics Requirements





Performance specifications from a few "benchmark" channels:

Higgs

$H \rightarrow \gamma\gamma$ and $H \rightarrow 4e$

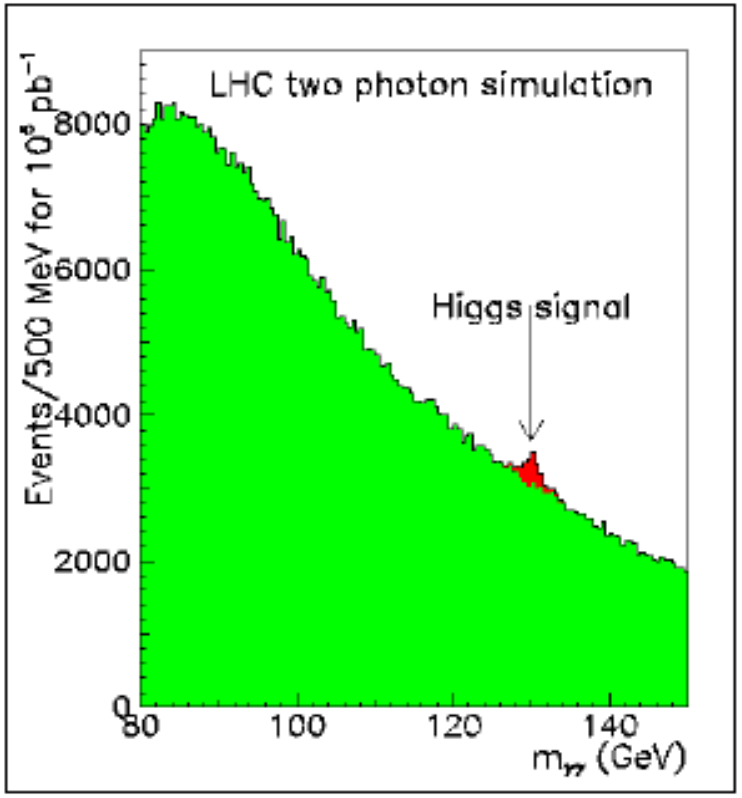
Heavy Vector Bosons

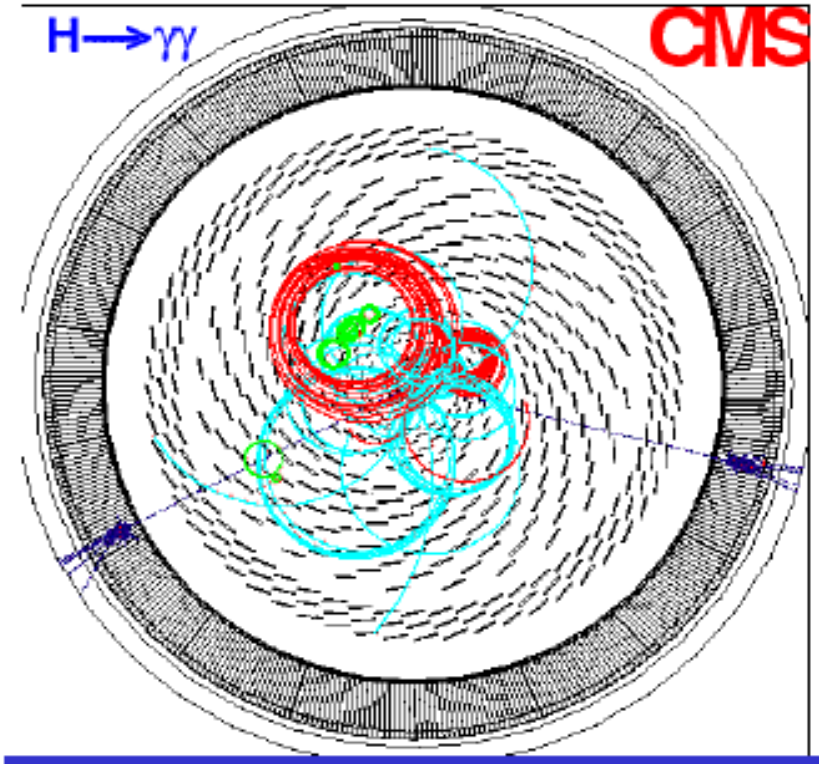
$W' \rightarrow e\nu$ and $Z' \rightarrow e^+e^-$

A Standard Model Higgs boson of 170 GeV is excluded at 95% CL at Tevatron

Physics Requirements

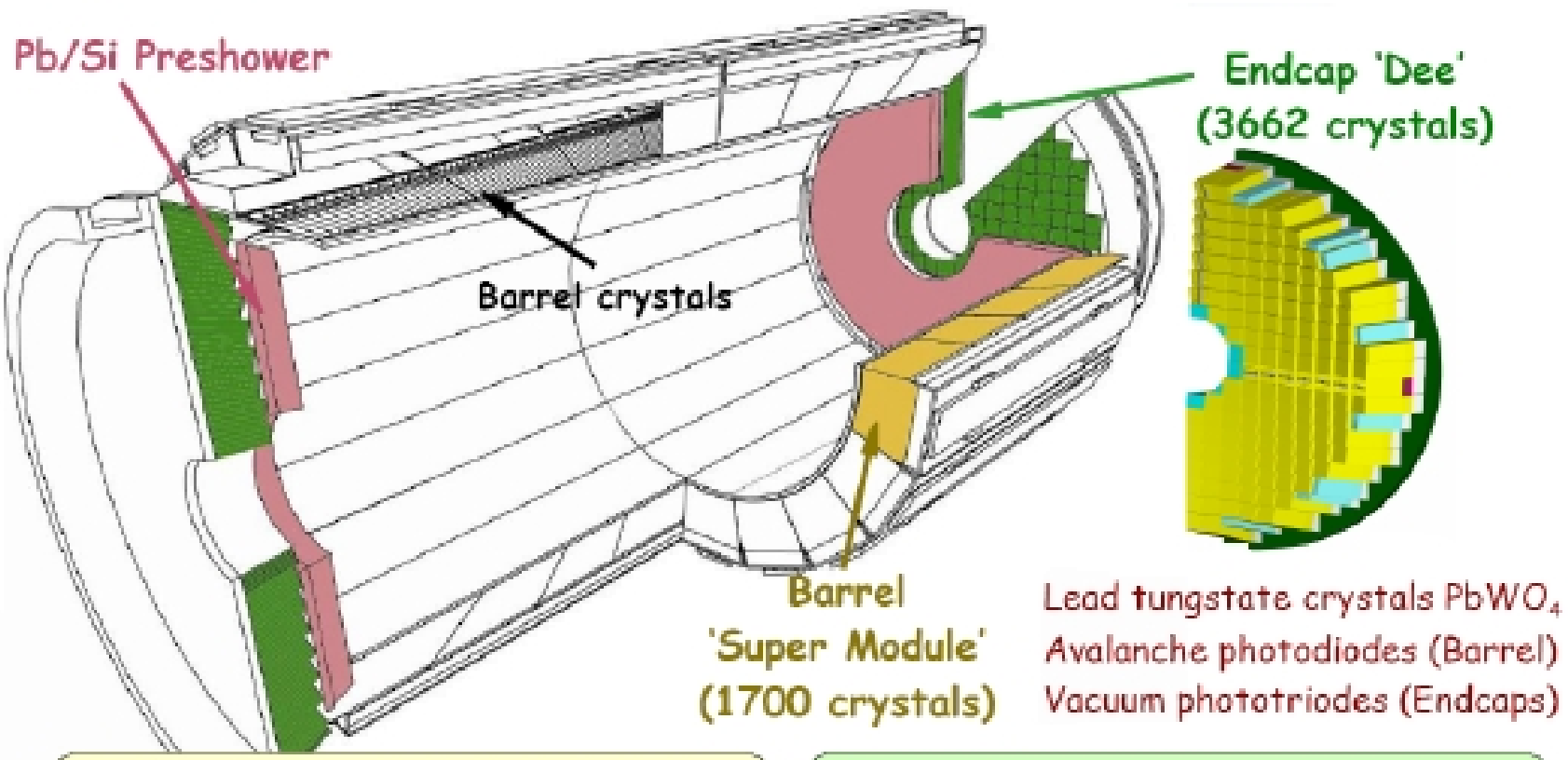
Design is set by the requirement to observe the decay of the Higgs into two gamma's.





- Precision Energy and Angular measurement of gammas and electrons
- Best feasible energy resolution.
- Efficient photon reconstruction
- Good Angular Resolution measurement for electromagnetic showers.
- Good separation of gammas from π^0's.

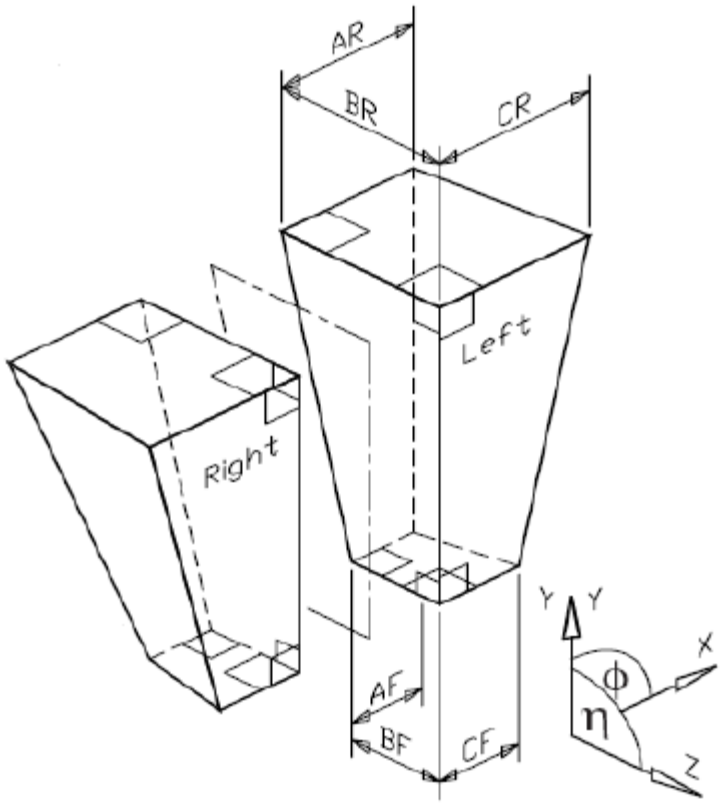
CMS - Crystals EMCal



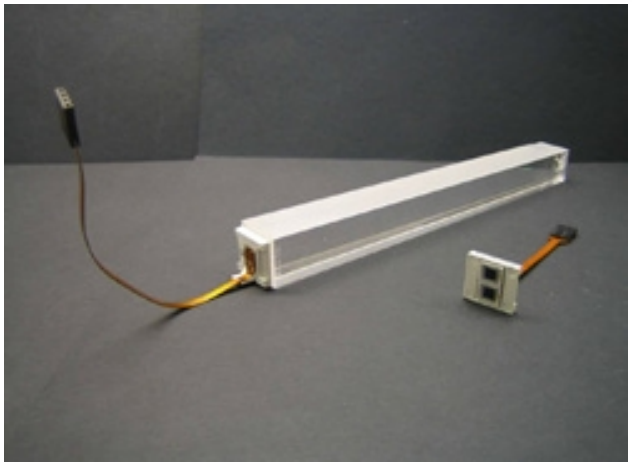
Barrel: $|\eta| < 1.48$
36 Super Modules
61200 crystals ($2 \times 2 \times 23$ cm^3)

Endcaps: $1.48 < |\eta| < 3.0$
4 Dees
14648 crystals ($3 \times 3 \times 22$ cm^3)

Crystal Specifications



Radiation Length	0.89 cm
Moliere Radius	2.0 cm
Hardness	4 Moh
Index of refraction	2.2
Peak emission	440 nm
Light emission	85% in 25 nsec
Light Yield	100 photons/MeV
Temp Dependence	-2%/°C at 20 °C.

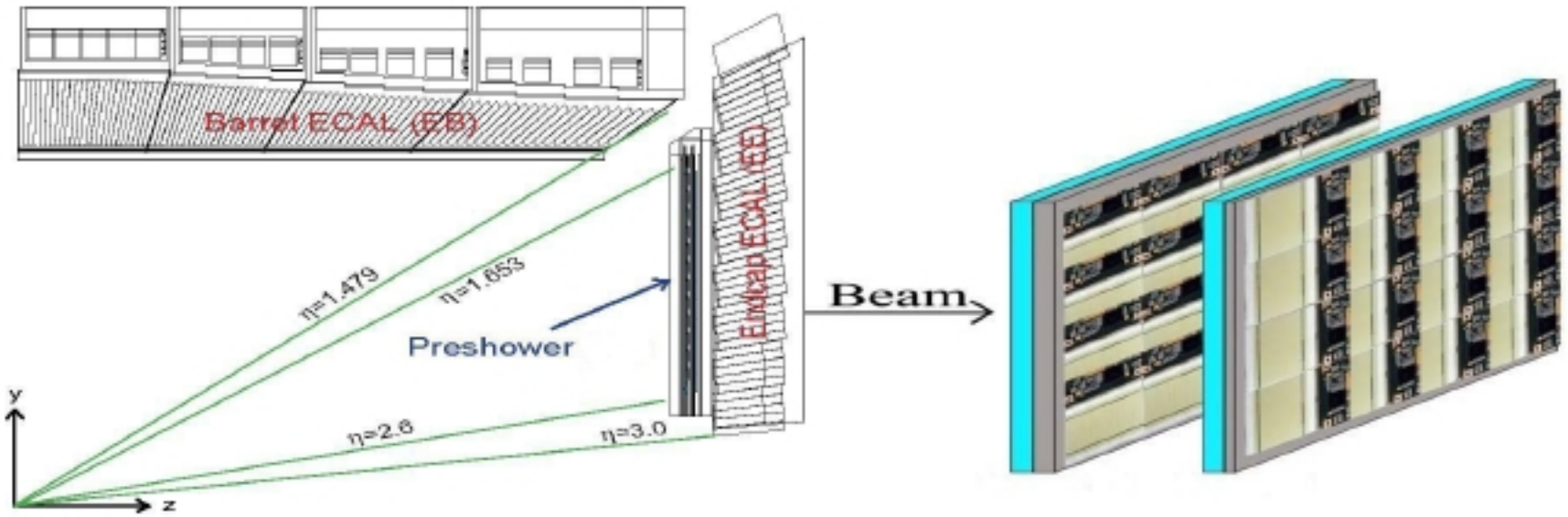


Strengths and Weakness

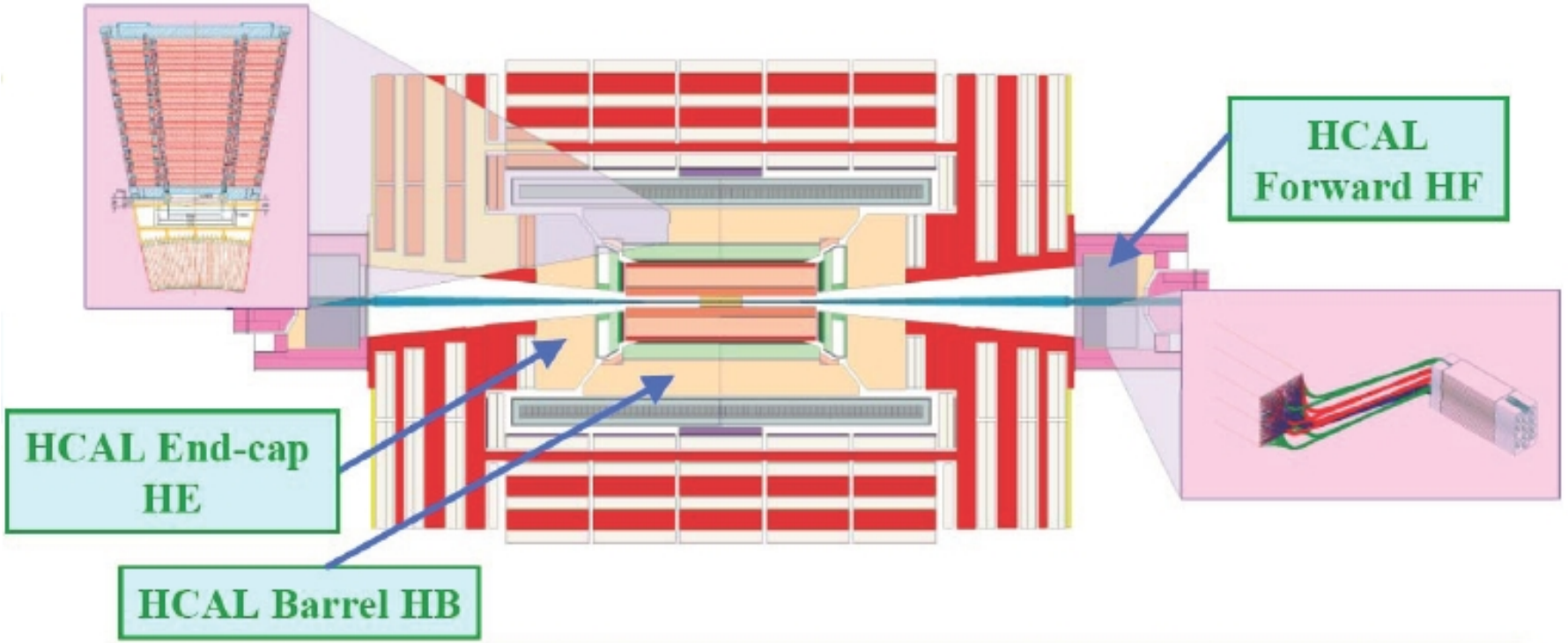
- Homogenous calorimeter with very low stochastic term aims to excellent energy resolution, the measure of the γ angle relies on vertex reconstruction from tracking
- Fully active scintillators type calorimeter
- Excelent energy resolution
- Fast and with high granularity
- Longitudinal dimensions: 25 X_0 ~ 22 cm, very compact
- But expensive, difficult to manufacture and maintain

CMS Preshower

- Purpose of the Preshower: identify two closely spaced photons from π^0 decays (main background of $H \rightarrow \gamma\gamma$) in order to separate these photons from single photons, much finer granularity!
- may also contribute to energy measurement
- placed in front of the end-cap ECAL, consists of two absorbers (lead,3X0) and two orthogonal planes of silicon strip sensors



CMS - HCal



- Hadronic Barrel and End-cap calorimeters are sampling calorimeters with 50 mm thick copper absorber plates interleaved with 4 mm thick scintillator sheets.
- Hadronic Forward calorimeters are sampling calorimeters with steel absorbers and quartz fibers for read-out oriented ~parallel to the beam axis.

Resolution

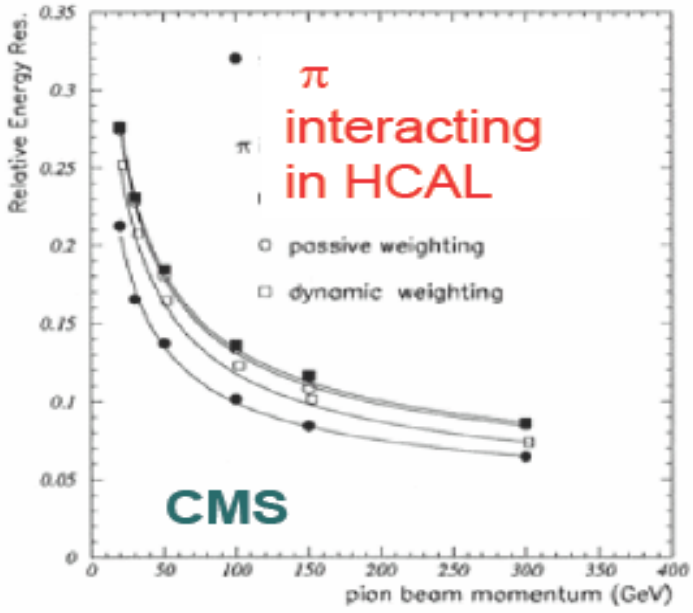
EM-CAL

$$\left(\frac{\sigma_E}{E}\right)^2 = \left(\frac{a}{\sqrt{E}}\right)^2 + \left(\frac{b}{E}\right)^2 + c^2$$

$$\sigma_\theta = \frac{d}{\sqrt{E}}$$

	Barrel	End-cap
a ~	2.7 %	2.9 %
b ~	142 MeV	200 MeV
c ~	0.40 %	0.27 %
d ~ 50 mrad		

H-CAL



$$\frac{\sigma}{E} = \frac{122\%}{\sqrt{E}} \oplus 5\%$$

Effect of different e/h + no longitudinal sampling in EM

$$\frac{\sigma}{E} = \frac{101\%}{\sqrt{E}} \oplus 4\%$$