
The CMS photon resolution and the Tracker-ECAL interface

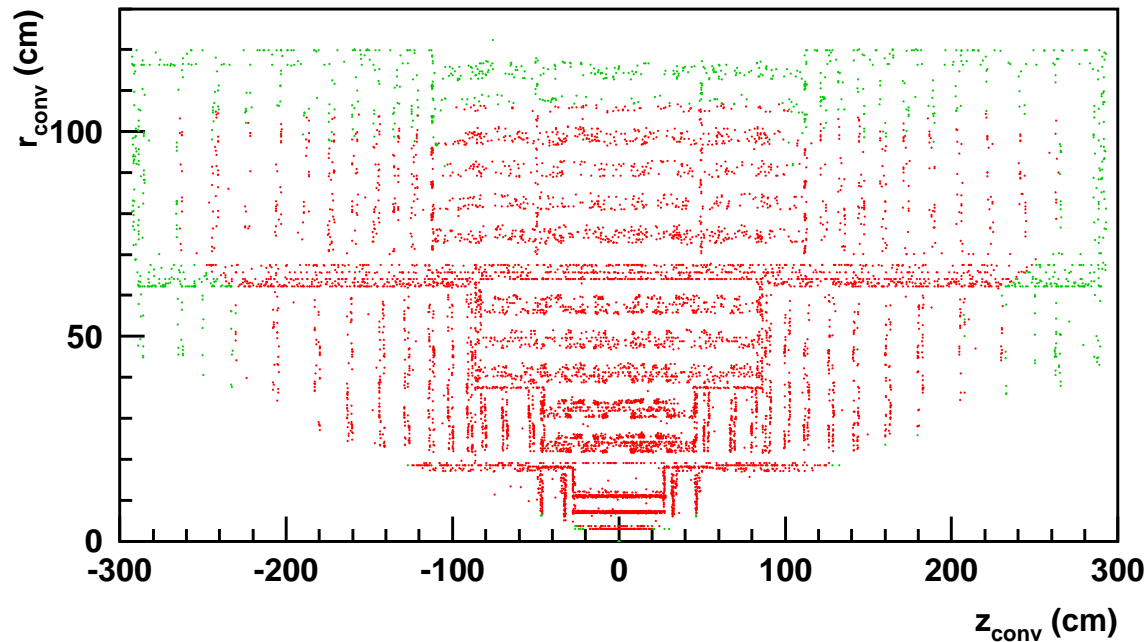
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Helsinki Institute of Physics

CMS week – Tracker General Meeting
7.6.2000

Tracker as seen by photons

Conversions points in the tracker material in front of the ECAL:

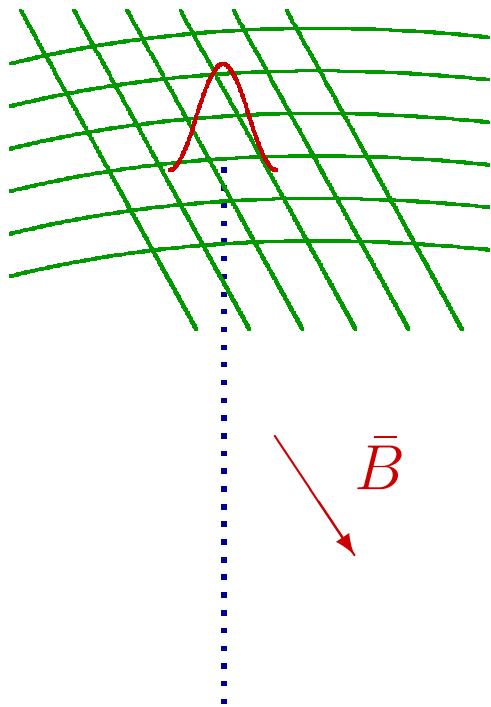
- potentially visible conversions
- invisible conversions



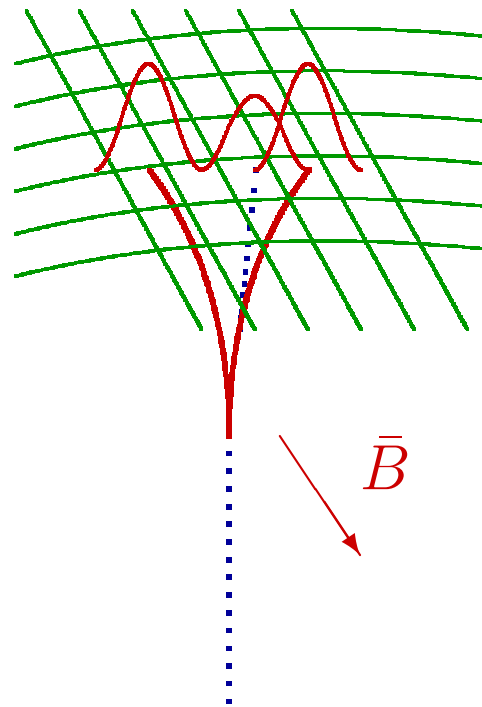
NB: the exact tracker layout has no importance in what follows.

Measuring the converted photons

Normal photon

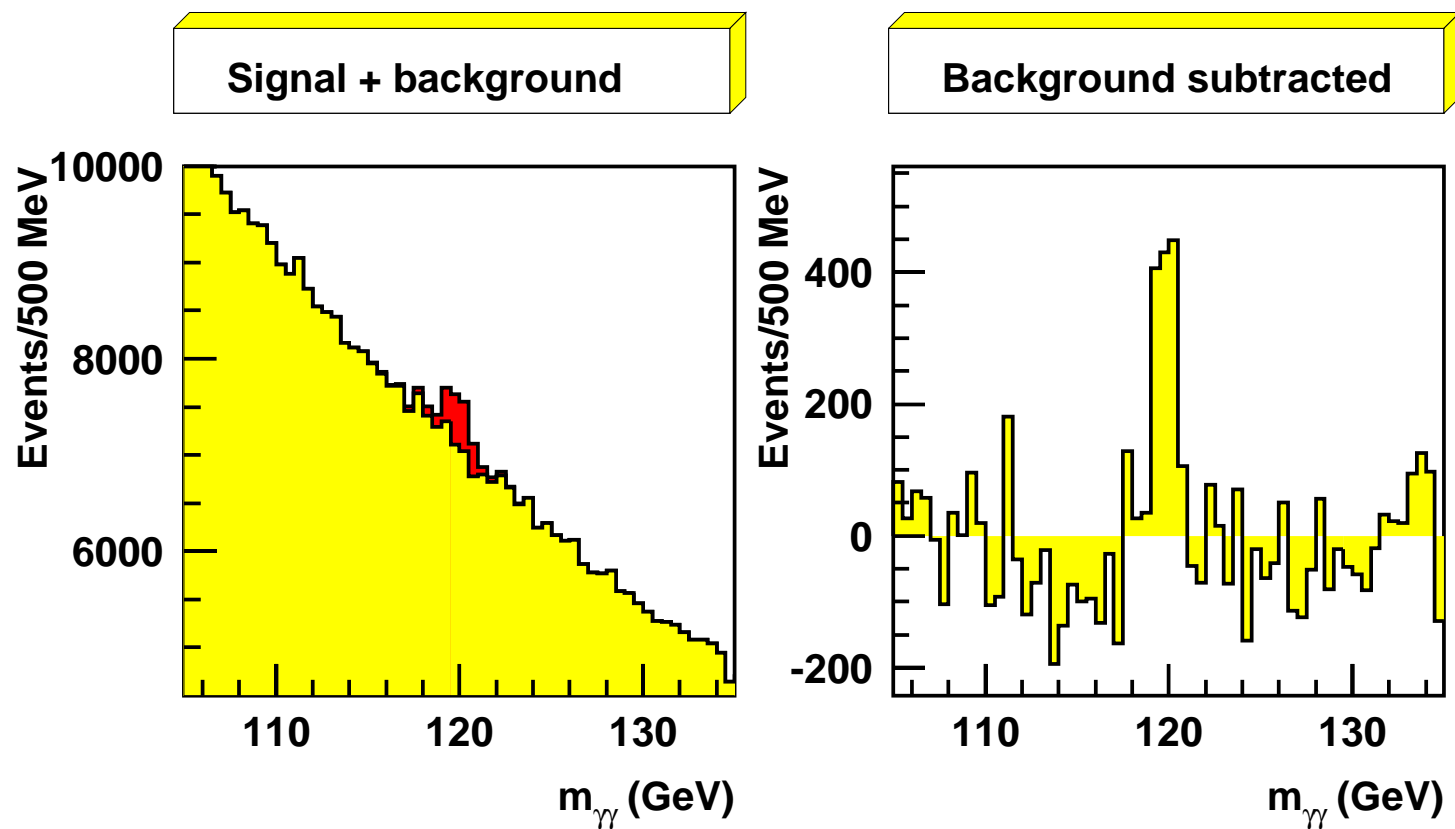


Converted photon

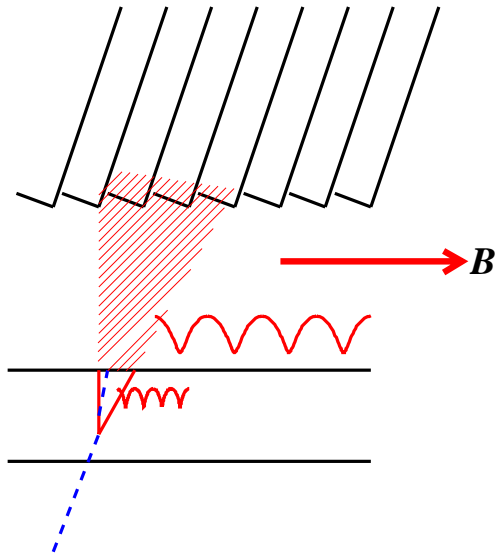


$H \rightarrow \gamma\gamma$: The importance of the resolution and efficiency

$m_H = 120 \text{ GeV}$ signal collected in 100 fb^{-1}



Invisible conversions



Important parameters:

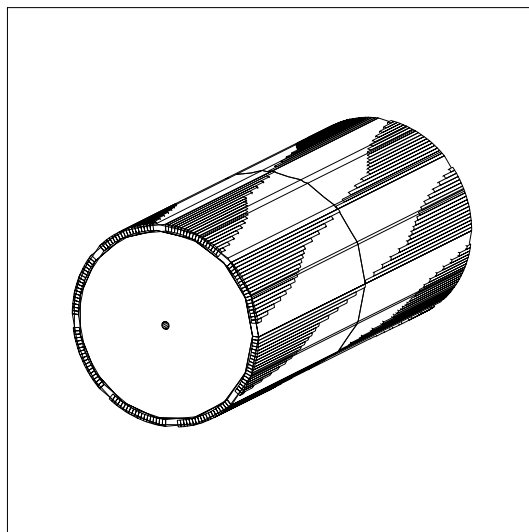
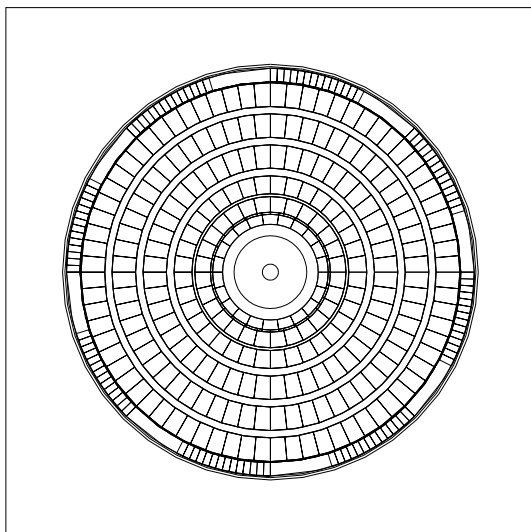
- **amount** of material after active tracker layers in X_0 's
- **distribution** of the material
- **gap** between the material and the crystals.

The presence of material will affect

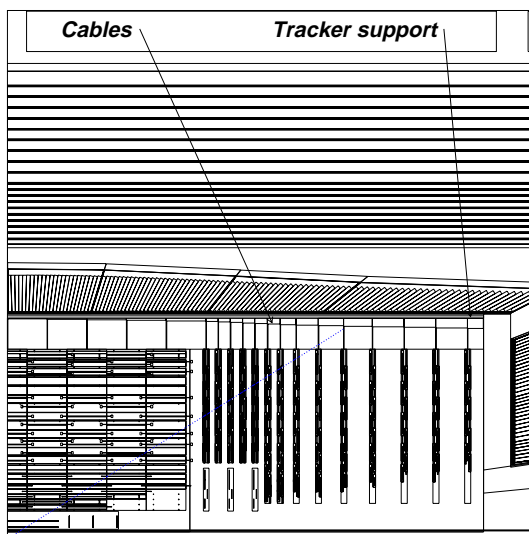
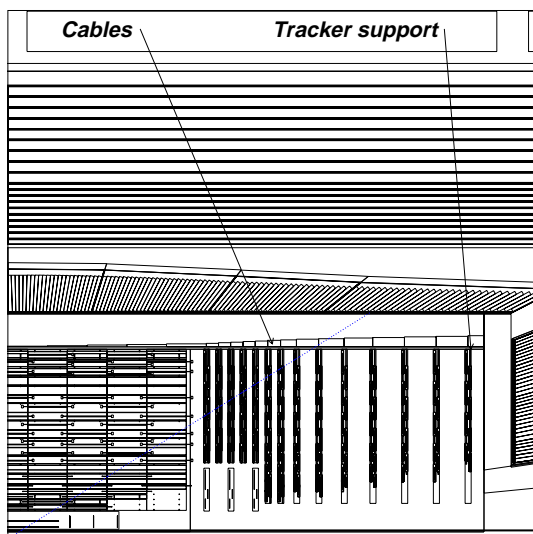
- **energy resolution** (energy loss)
- π^0 **rejection** (shower shape).

Just to remind: X_0 (Al) = 8.9 cm, 10% X_0 (Al) = 0.89 cm
 X_0 (Cu) = 1.4 cm, 10% X_0 (Cu) = 0.14 cm

The studied configurations



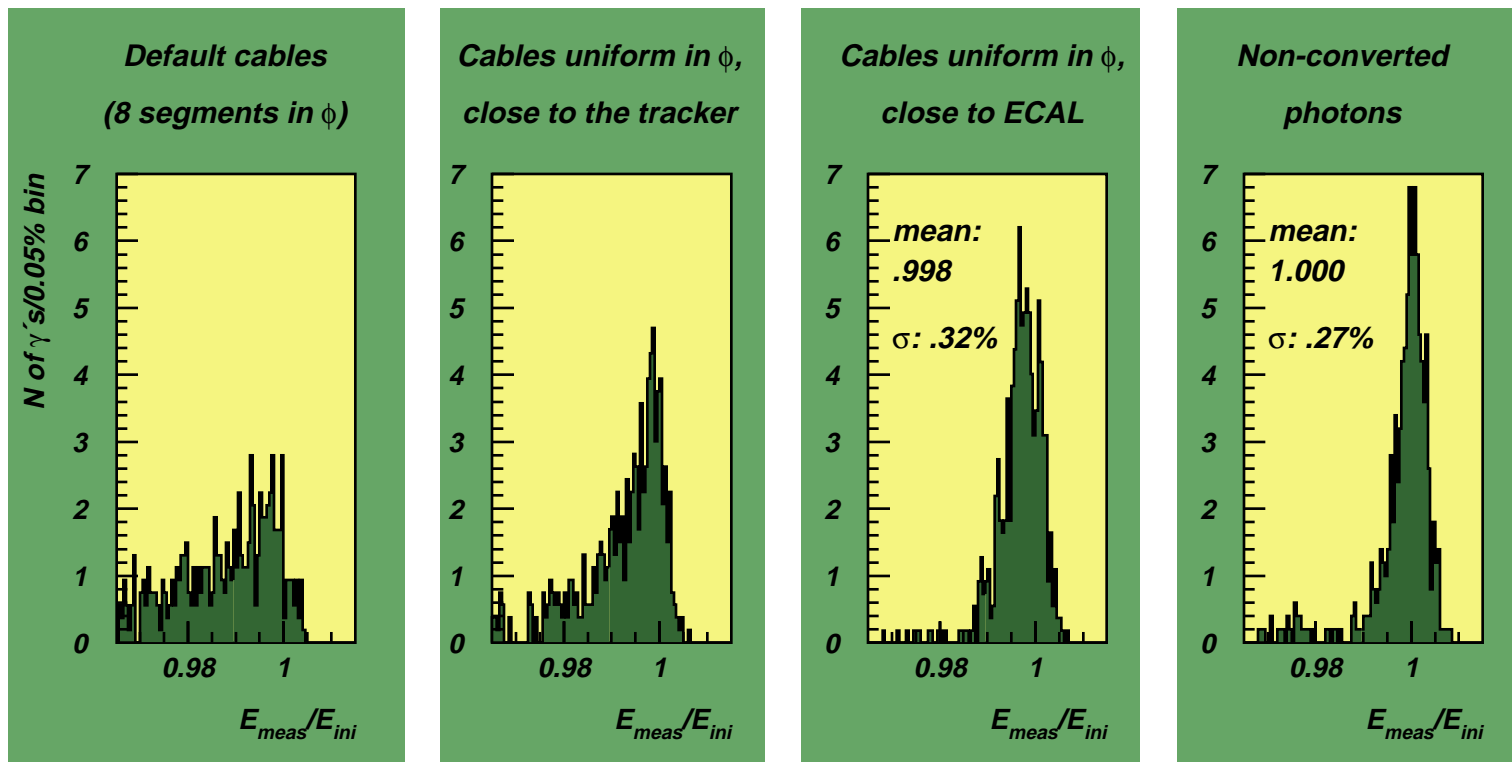
“Default”:
cable segments in ϕ



Modifications:
cables uniform in ϕ
close and far from the
crystals

Late conversions

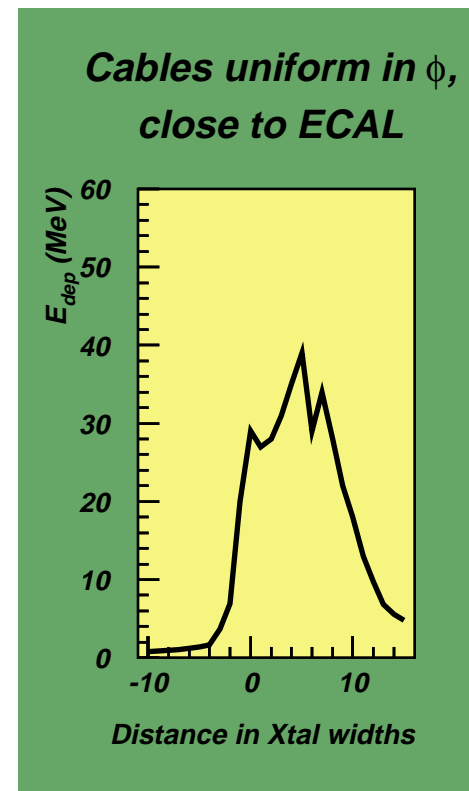
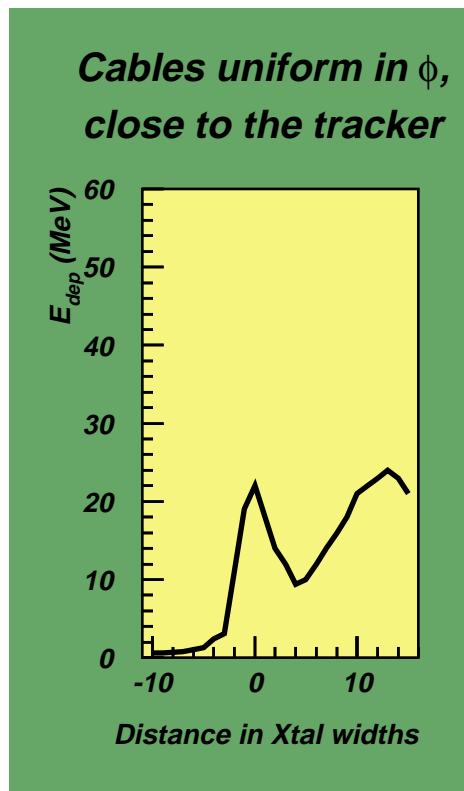
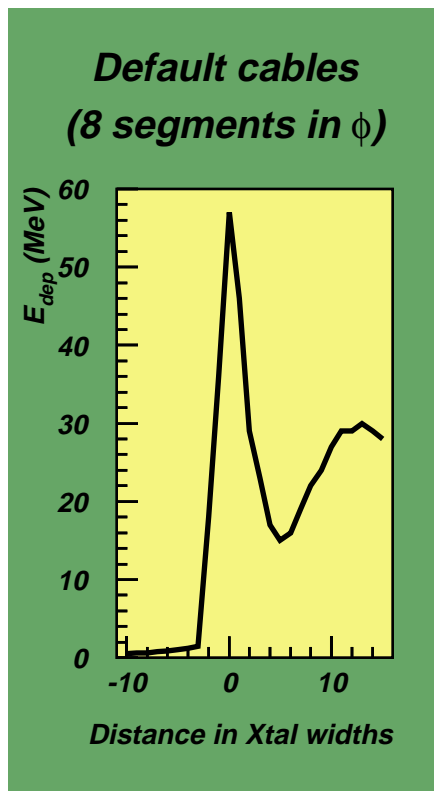
- ➔ *Photons that convert late cannot be distinguished from the non converting photons with the tracker data.*
- ➔ *The tracker cable layout can be optimised to minimise the damage to the photon energy measurement.*
- ➔ *Samples of 85 GeV photons converting $r > 115\text{cm}$ at $\eta=1.25$ in three different cable geometries:*



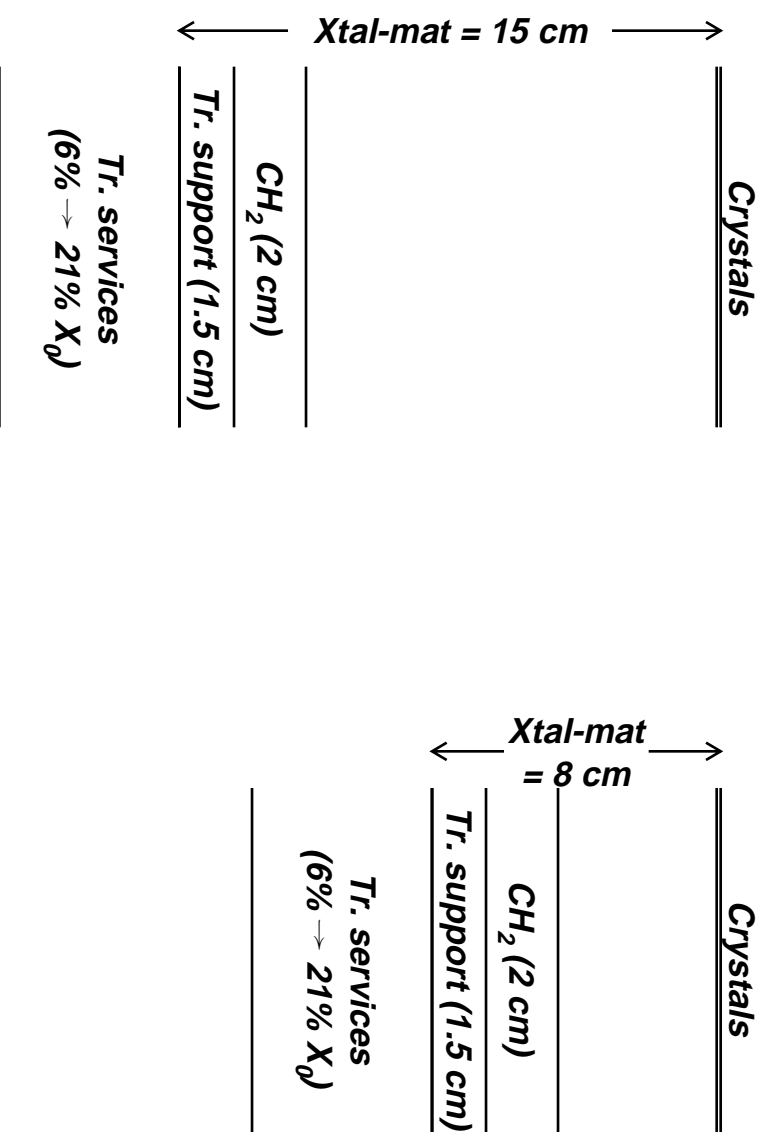
Tracker cables before ECAL

Energy deposit in the cables

➔ *Due to the field, low energy secondary particles curl back, if there is a large air gap between the crystals and the cables*



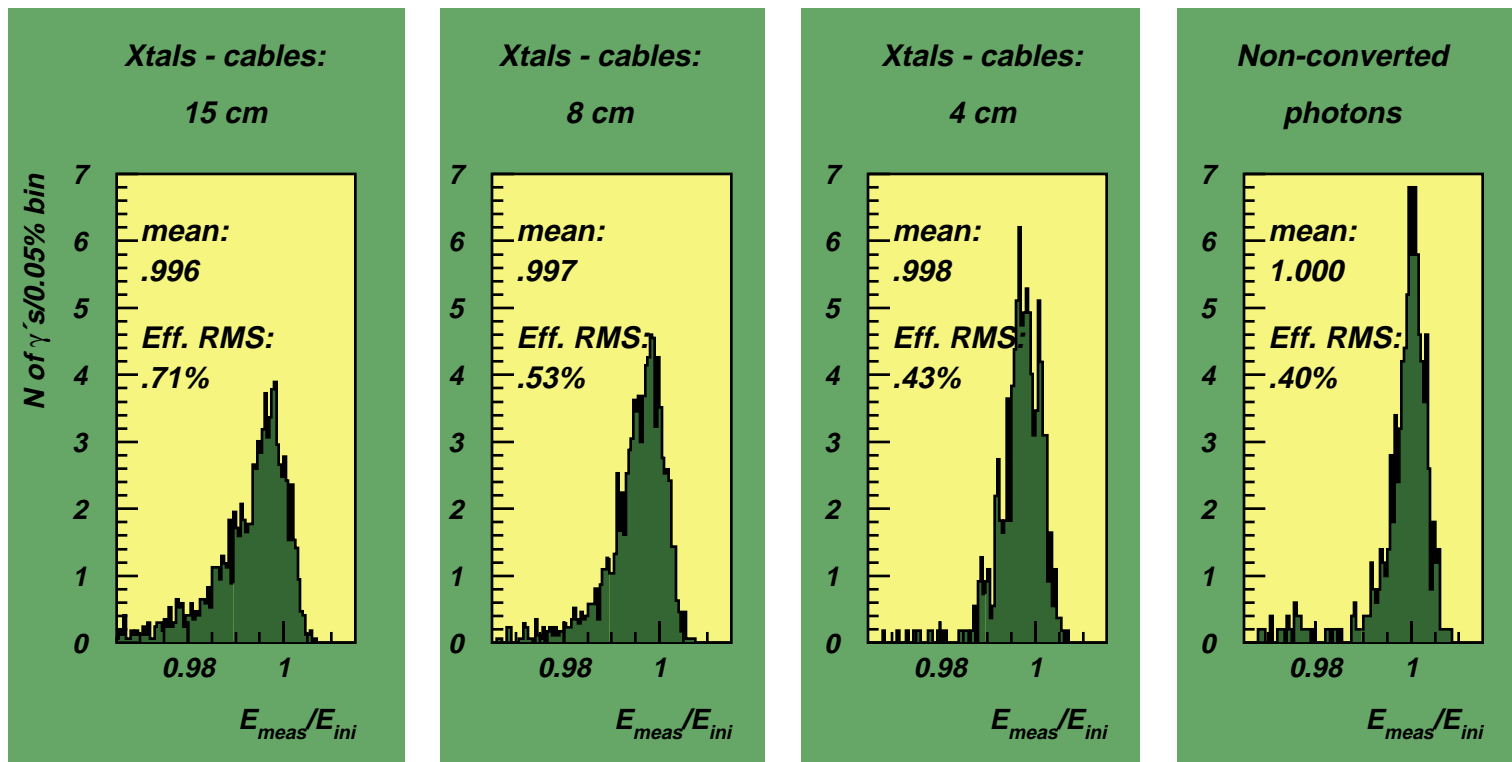
Studied configurations



The study has been done with 85 GeV photons at $\eta = 1.25$ converting after the last but one tracking layer.

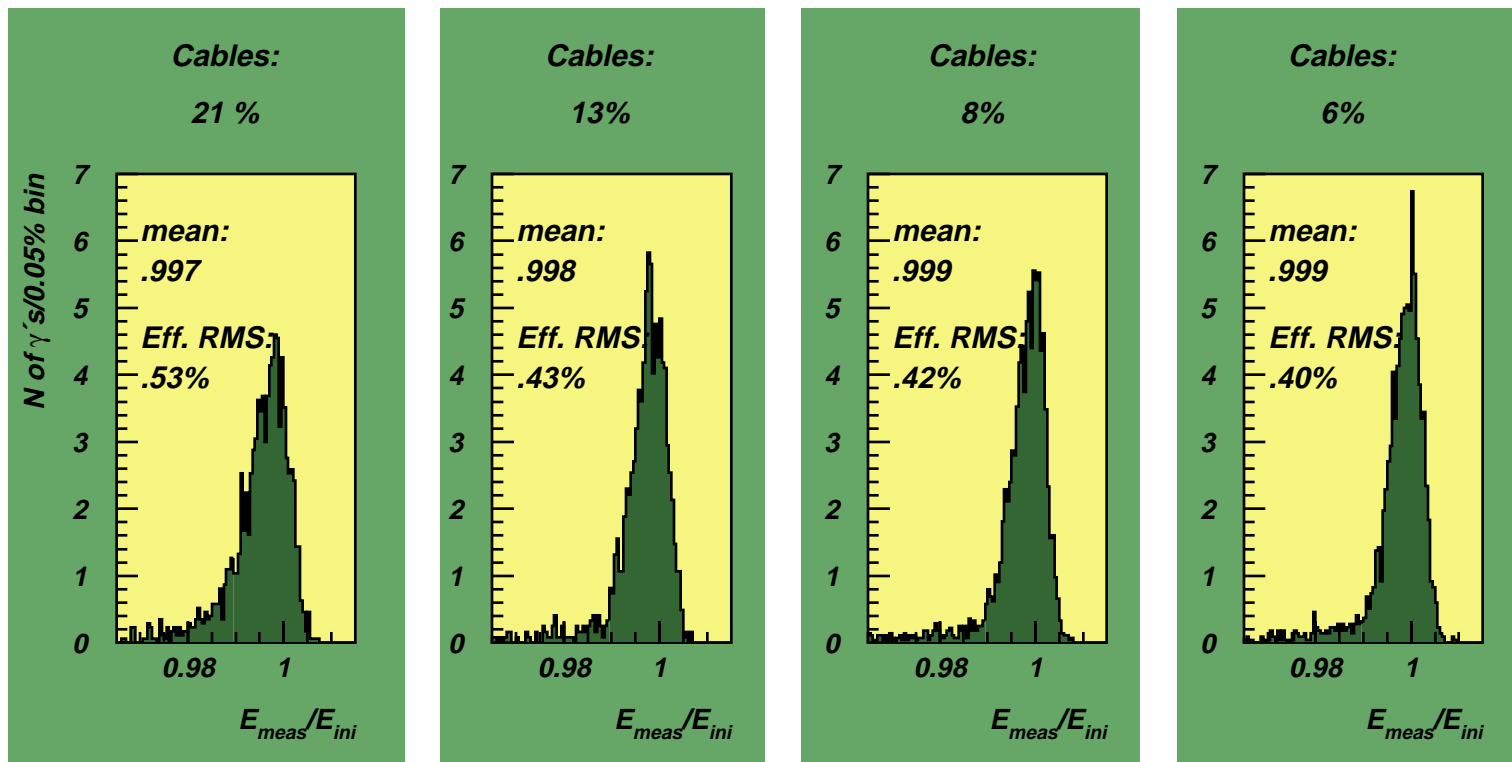
Late conversions: distance

- *The effect of cables on the energy measurement of late conversions (amount of cable material 21% X_0 radially, uniform in ϕ) for the two new configurations compared with the optimal case of the previous study (distance_(Xtal-mat.) = 4 cm) and the non-converting photons*



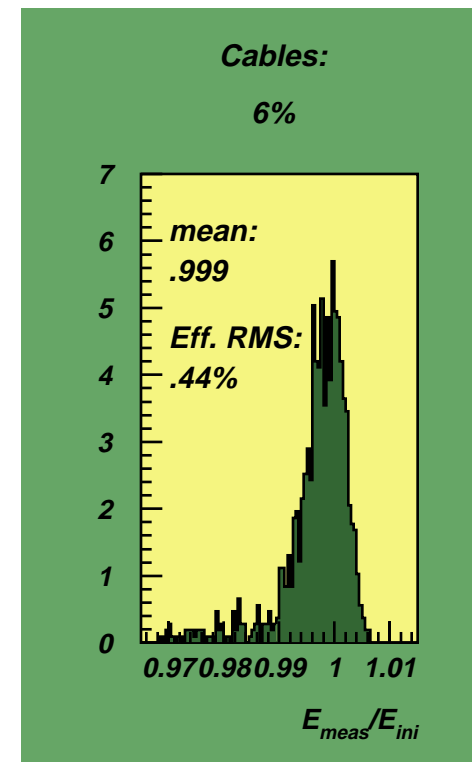
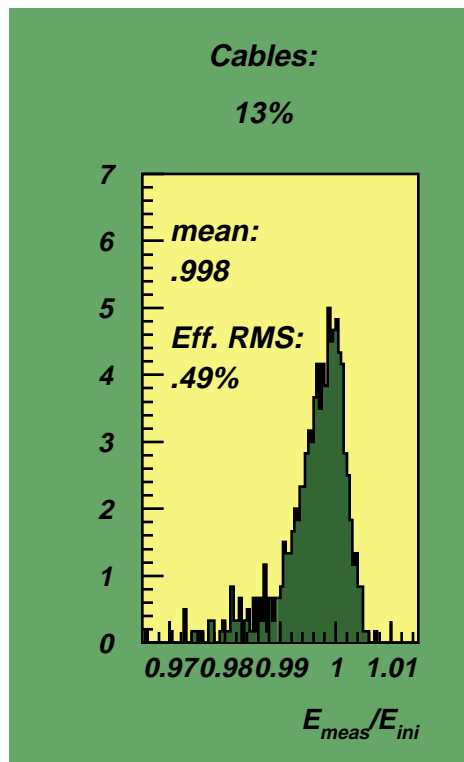
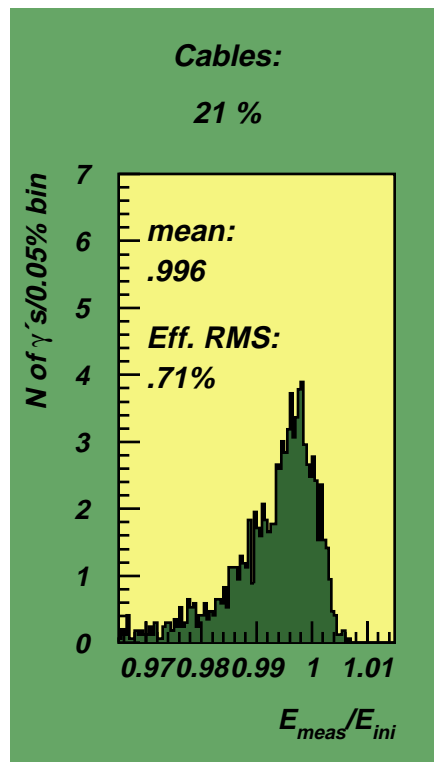
Late conversions: X_0 's

- ➔ *The effect of cables on the energy measurement of late conversions for 21%, 13%, 8% and 6% X_0 's of cable material (+2cm CH_2) when the distance between the cables and Xtals is 8 cm*



Late conversions: X_0 's

- *The effect of cables on the energy measurement of late conversions for 21%, 13%, 8% and 6% X_0 's of cable material (+2cm CH_2) when the distance between the cables and Xtals is 15 cm.*



Photon resolution degradation in the barrel

Detailed studies indicate that

- if the amount of material after the active tracker layers is large (radially $\approx 20\% X_0$), the gap between the material and the crystals has to be very small ($< 4\text{cm}$)
- if the gap cannot be small, the amount of material should **not be more than** $\approx 10\% X_0$ and it should be **uniformly** distributed in ϕ .

The facts:

Crystals start	$r = 129\text{ cm}$		
Basket bottom plate	$r = 127.7\text{ cm}$	\uparrow	\uparrow
Moderator foam starts	$r = 124.8\text{ cm}$		
ECAL envelope starts	$r = 123.8\text{ cm}$	5.7 cm	11.7 cm
Tracker envelope ends	$r = 123.3\text{ cm}$		
Tracker support tube ends	$r = 122\text{ cm (e.g.)}$	\downarrow	
Services end	$r = 116\text{ cm (e.g.)}$		\downarrow

\Rightarrow the gap is not small \Rightarrow minimize the amount of X_0 's!