Comparison of e.m. showers in g3 and g4 in CMS

Kati Lassila-Perini
CMS — Helsinki Institute of Physics

- **Motivation:**
  - **to validate the change from g3 (CMSIM) to g4 (OSCAR) for the CMS ECAL and electron/photon reconstruction.**
- **Program of work:**
  - **Compare unconverted 30 GeV photons incident (with a constant angle and position) to a crystal of the CMS $PbWO_4$ calorimeter simulated by CMSIM and OSCAR.**
  - **Record: total E deposit, E in maximum crystal, E in 3×3 and 5×5 crystals around the maximum**
    ⇒ E resolution, lateral shower shape.
  - **Study the dependence on production and tracking cuts and choose an operating point for the large CMS simulation production.**

Simulation setup

- **OSCAR_2_2_0_pre2b and CMSIM127**
- **The physics cuts in OSCAR:**
  - Cuts in OSCAR set in energy to ease the comparison with CMSIM.
  - **Production cuts:** infinite for e+/e- (no delta-rays)
    varied for photons (Bremsstrahlung)
  - **Tracking cuts:** varied.

Production cuts:

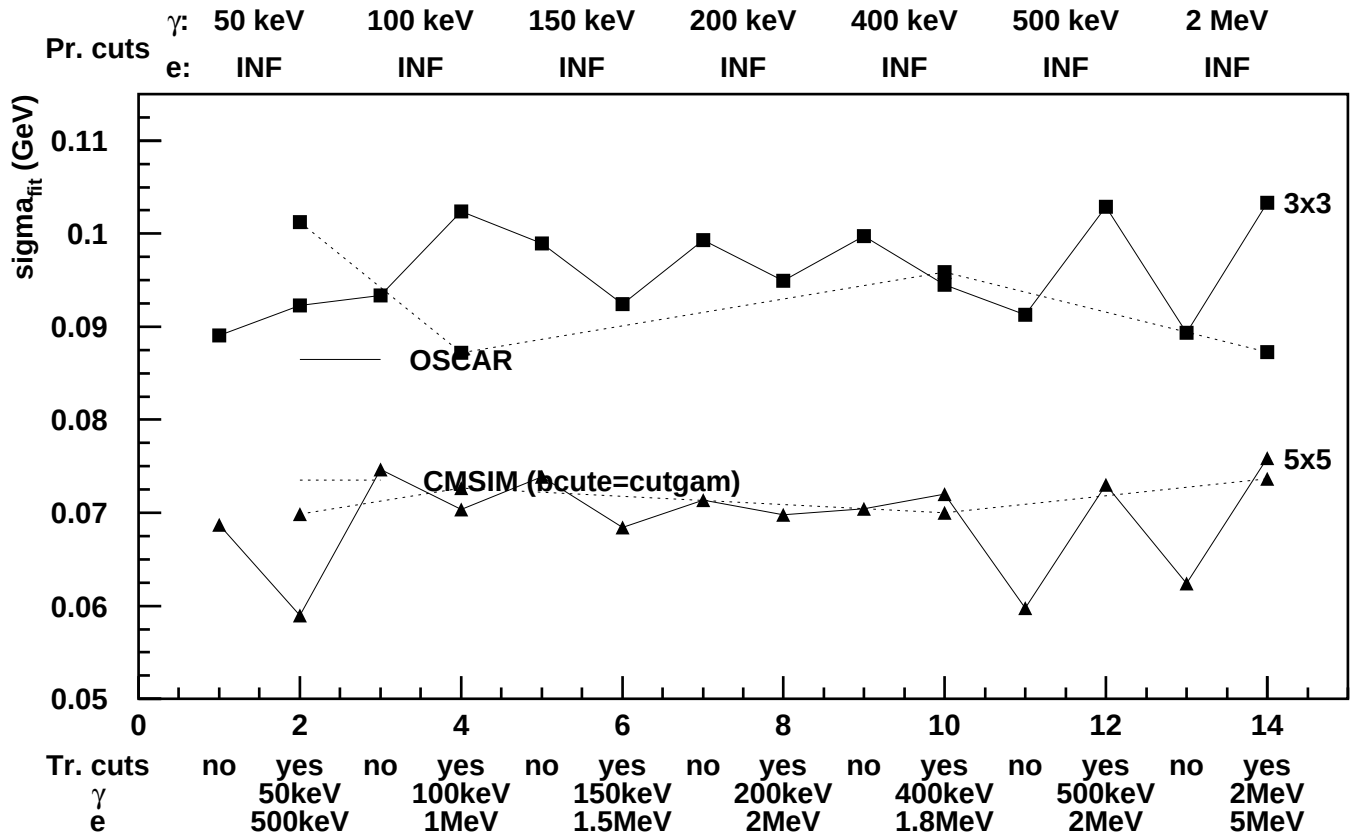
γ:	50keV	100keV	150keV	200keV	400 MeV	500keV	2MeV
e:	INF	INF	INF	INF	INF	INF	INF

Tracking cuts:

γ:	50keV	100keV	150keV	200keV	400 MeV	500keV	2MeV
e:	500keV	1MeV	1.5MeV	2MeV	1.8MeV	2MeV	5MeV

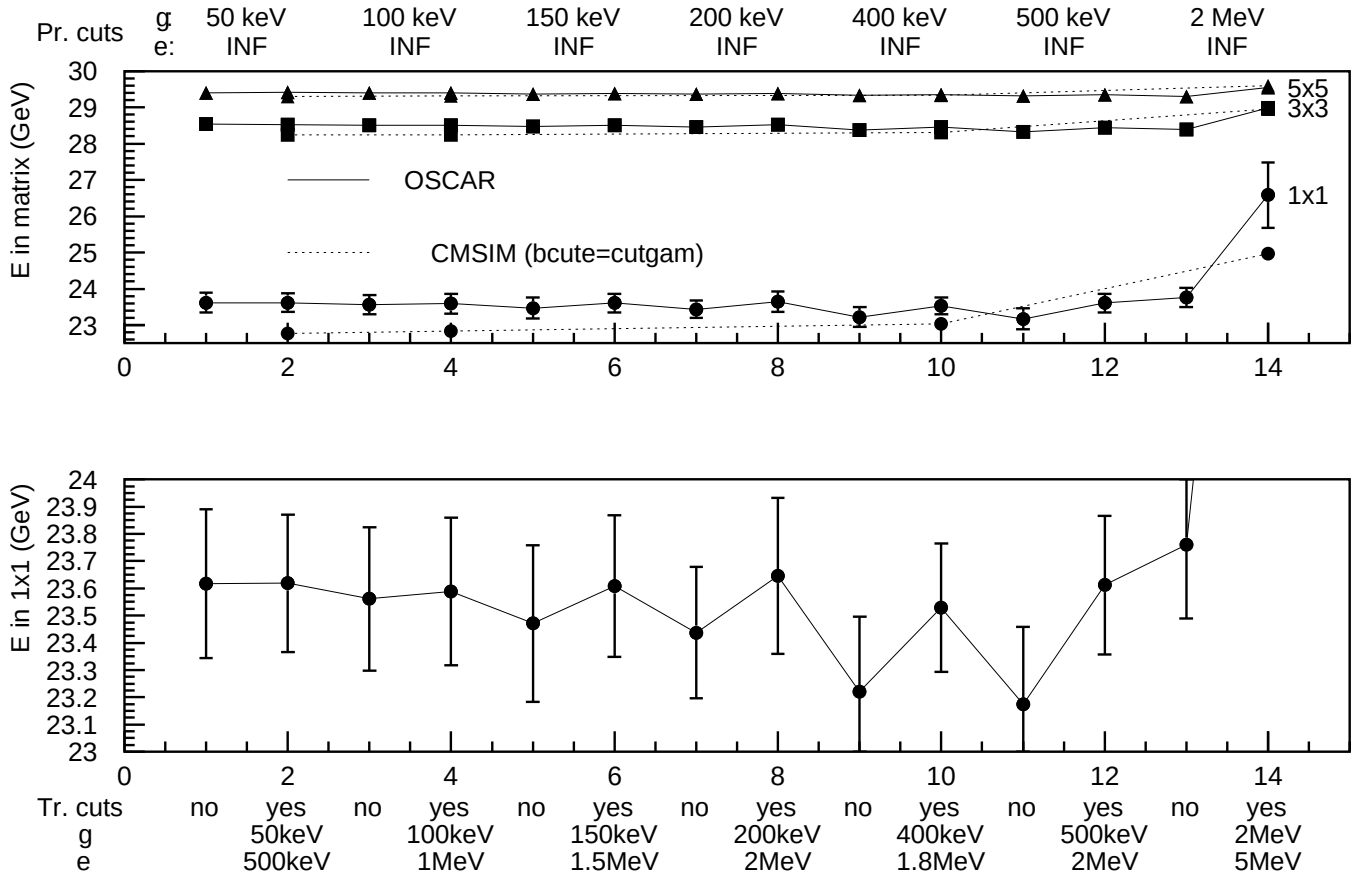
- **No magnetic field.**
- **No instrumental effects (noise and such) added.**

Resolution in 3×3 and 5×5 crystals



The errors in the fit are larger than the visible fluctuations.

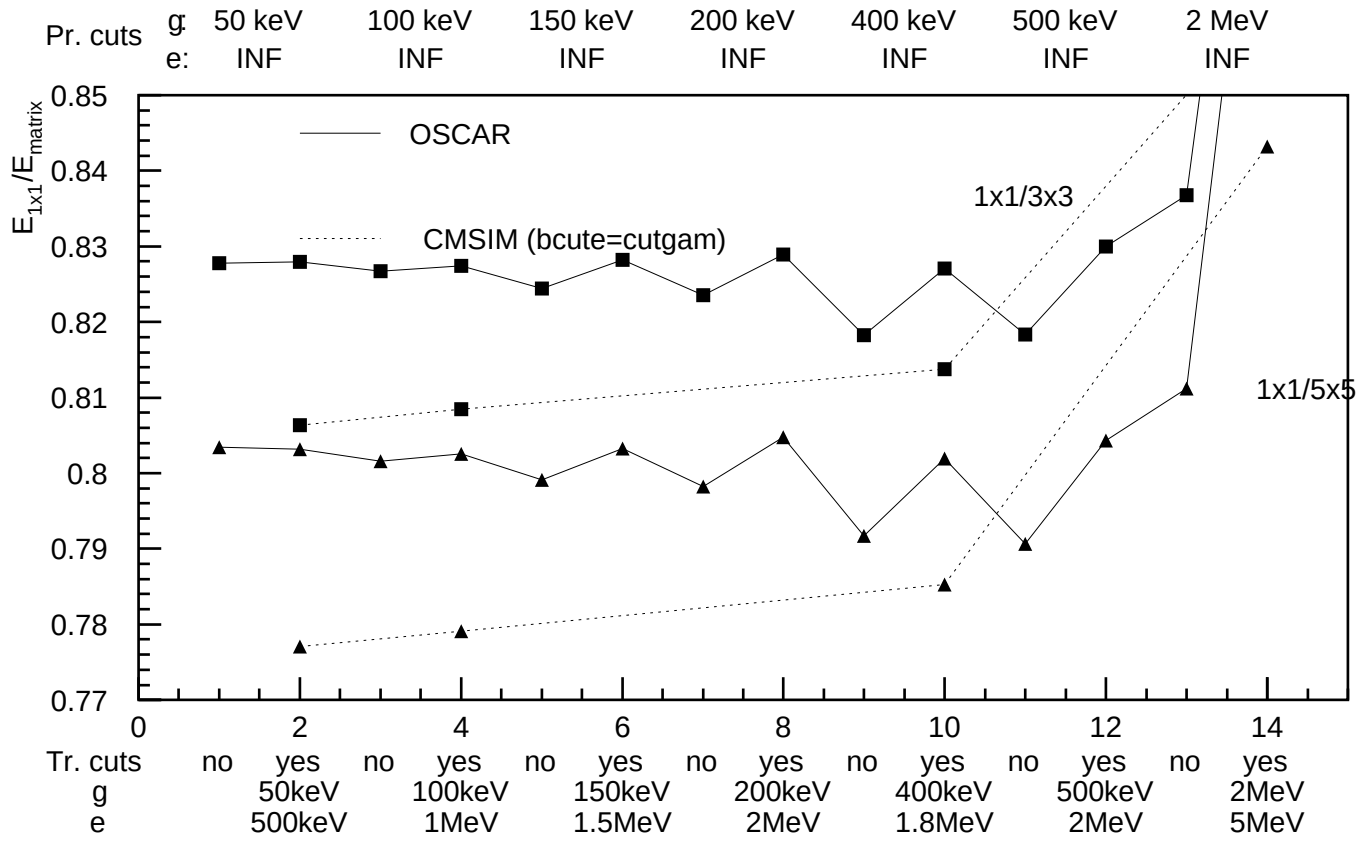
Mean energy in 1×1, 3×3 and 5×5 crystals



The initial, small decrease of the energy in 1×1 (3×3) when tracking cuts not used is somewhat unexpected, although minor effect

(as if energy deposit from continuous loss took place only at the end of the track).

Ratios 1×1/3×3 and 1×1/5×5



OSCAR showers narrower than those in CMSIM.

Conclusions

- **We are quite confident in the simulation of electromagnetic showers in g4.**
- **We are working on the detailed comparison between the test beam data and OSCAR.**
  - The first indications are in good agreement.
  - The previous detailed comparisons with g3 showed good agreement, although with a suggestion that the central core of the showers seemed slightly too wide in g3.
- **The issue of time consumption has been thoroughly studied and we are converging towards a conclusion which looks acceptable. We are working on the final numbers.**
  - Pure shower simulation in the simplest possible geometry (a $PbW0_4$ box) stand-alone in g3 and g4:

    $\Rightarrow$ g3: **0.36 s/evt**, g4: **1.0 s/evt** $\Rightarrow$ g4/g3 = 2.8

    (only a fraction of the total time in the full system, e.g. 20% in CMSIM).
  - The simple $PbW0_4$ block has been implemented to the full system to study the timing of its various components in absence of a complex geometry.