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# CMS H4 ECAL testbeam data comparison with simulation

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a) INFN Trieste

b) Cornell University

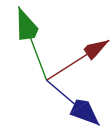
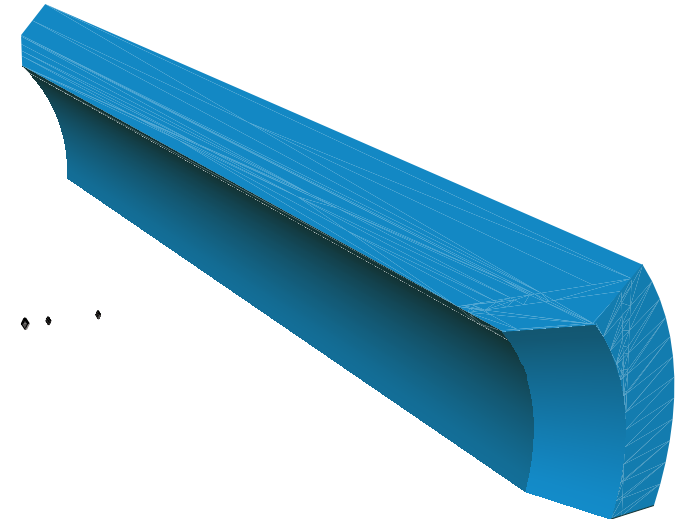
c) INFN Roma1

LCG Physics Validation meeting

9<sup>th</sup> may 2007

# The ECAL H4 testbeam simulation

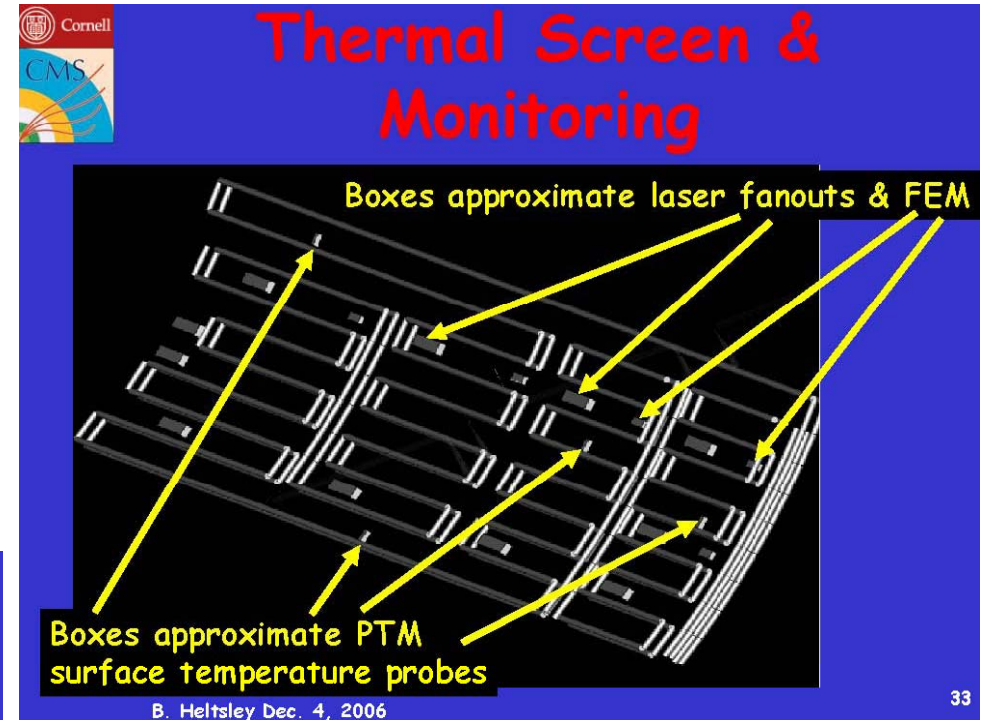
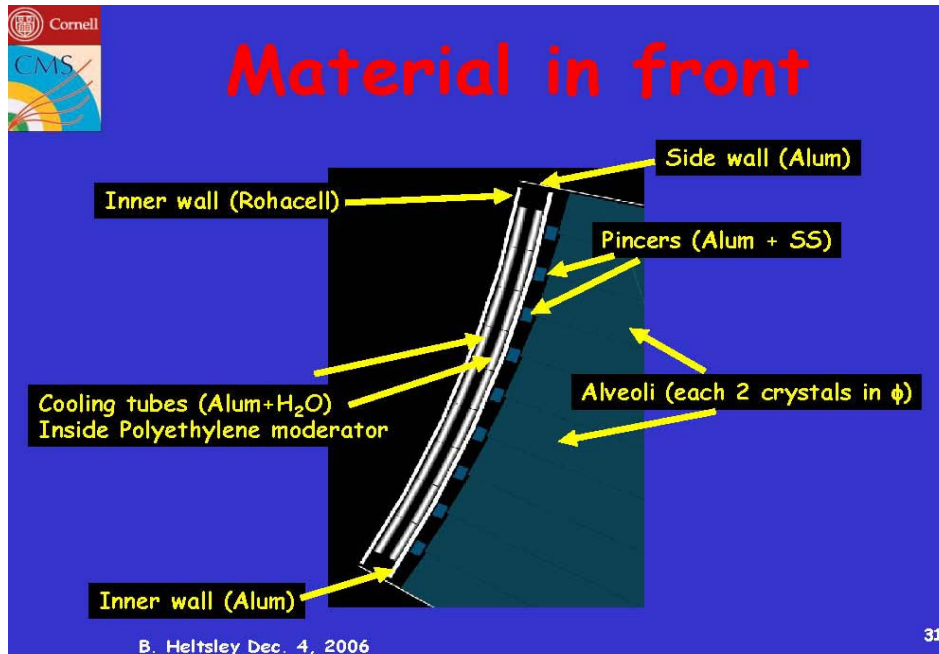
- A first TB simulation version is in place from the very beginning of the testbeam, now several (recent) improvements over the first setup
- Geometry:
  - Algorithmic ECAL Barrel geometry
  - Beam line geometry starting from the last bending magnet
    - including the full hodoscope description with reconstructed signal built from simulated hits in fibers...
- Geant4: G4.8.2p01 with QGSP\_EMV
  - G4.7.1 vs G4.8.1p02 vs G4.8.2p01
  - different physics lists (QGSP, QGSP\_EMV) and versions of em physics (52, 71, standard)
- No modellization/simulation of synchrotron radiation



# Geometry

Same ECAL algorithmic description as in new CMS simulation,  
B. Heltsley

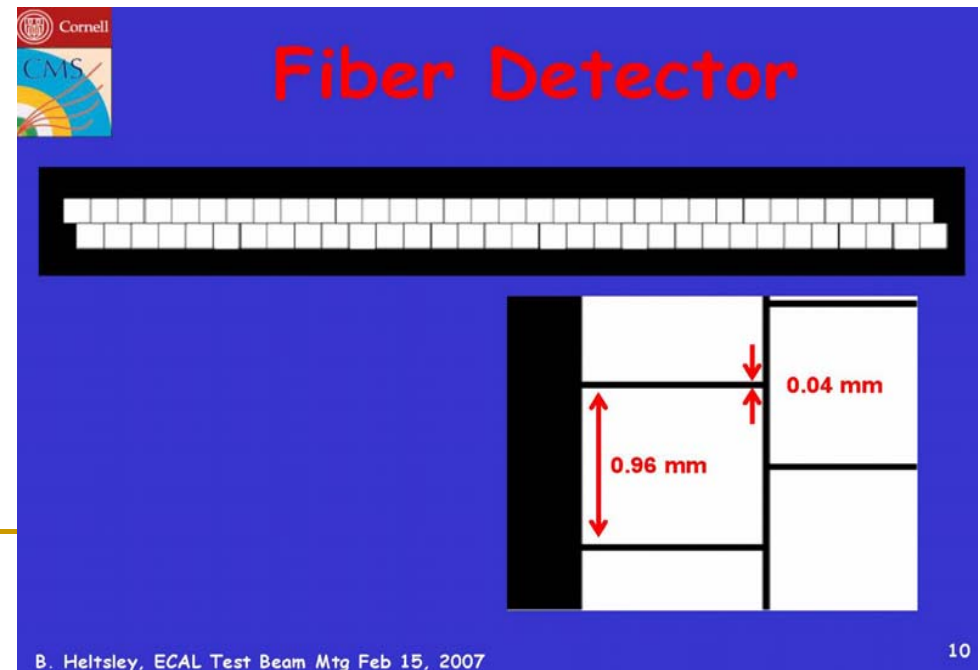
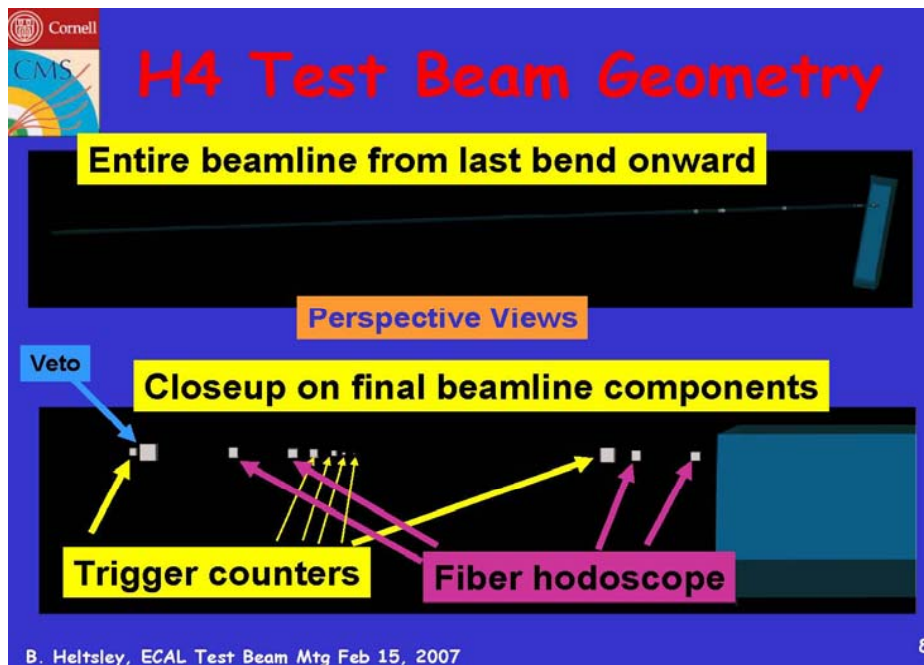
Both material location and amount adjusted using comparison with the measured weights of components



Relevant for H4:  
material description in front of  
crystals

# Beam line description

- From the last magnet determining the momentum: 270m of beam line,  $0.2 \times 10^{-4}$ 
  - Multiple scattering matters ( $\sim 50 \mu\text{rad}$  deviation)
  - Not all shot events reach the trigger scintillators, trigger emulation
- All passive materials except hodoscopes, energy hits in the hodoscope volume are recorded from simulation
  - Raw pattern of fired hits is obtained putting a threshold on the hit energy (emulating a close to 100% fiber efficiency)



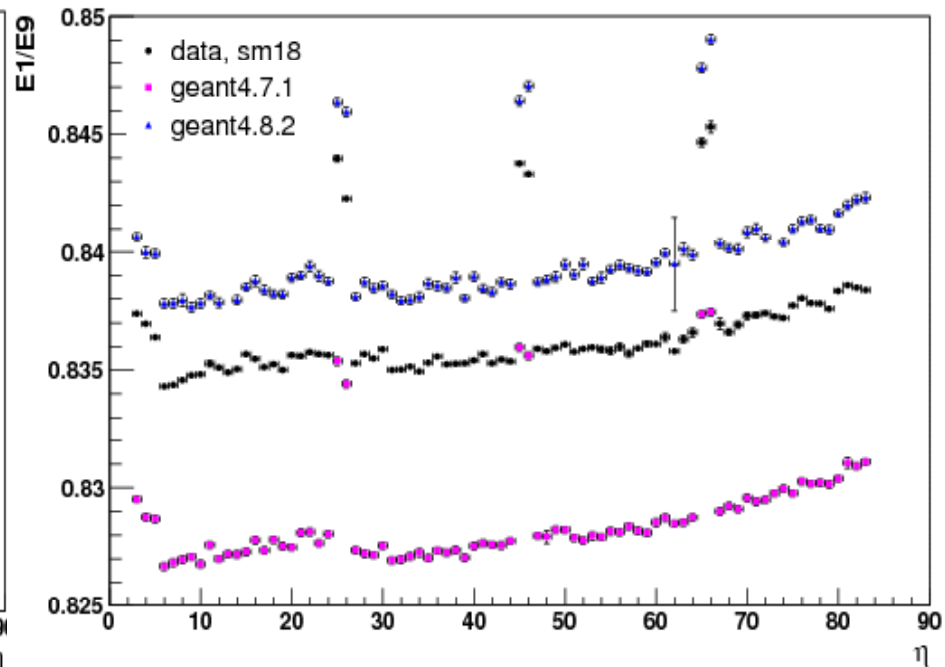
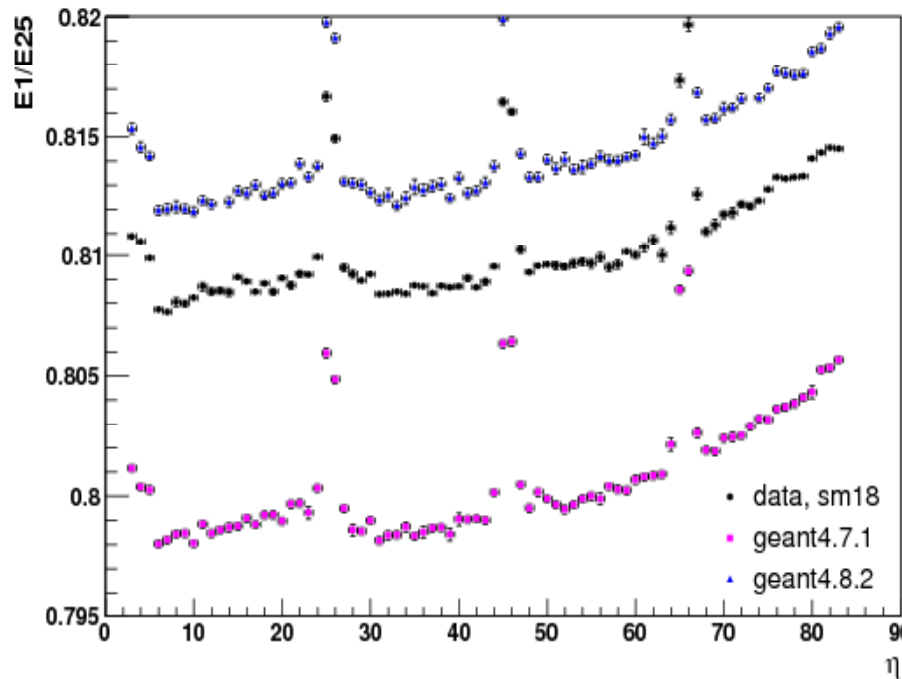
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# Geant4 versions

- Tests have been done with
  - G4.7.1p02, e.g. the old H4 CMSSW simulation
  - G4.8.1p02, intermediate step (CMSSW\_1\_3\_0)
  - G4.8.2p01, e.g. the newest one available (CMSSW\_1\_4\_0)
- Physics lists:
  - In G4.7.1p02: QGSP physics list,
  - In others: QGSP and QGSP\_EMV

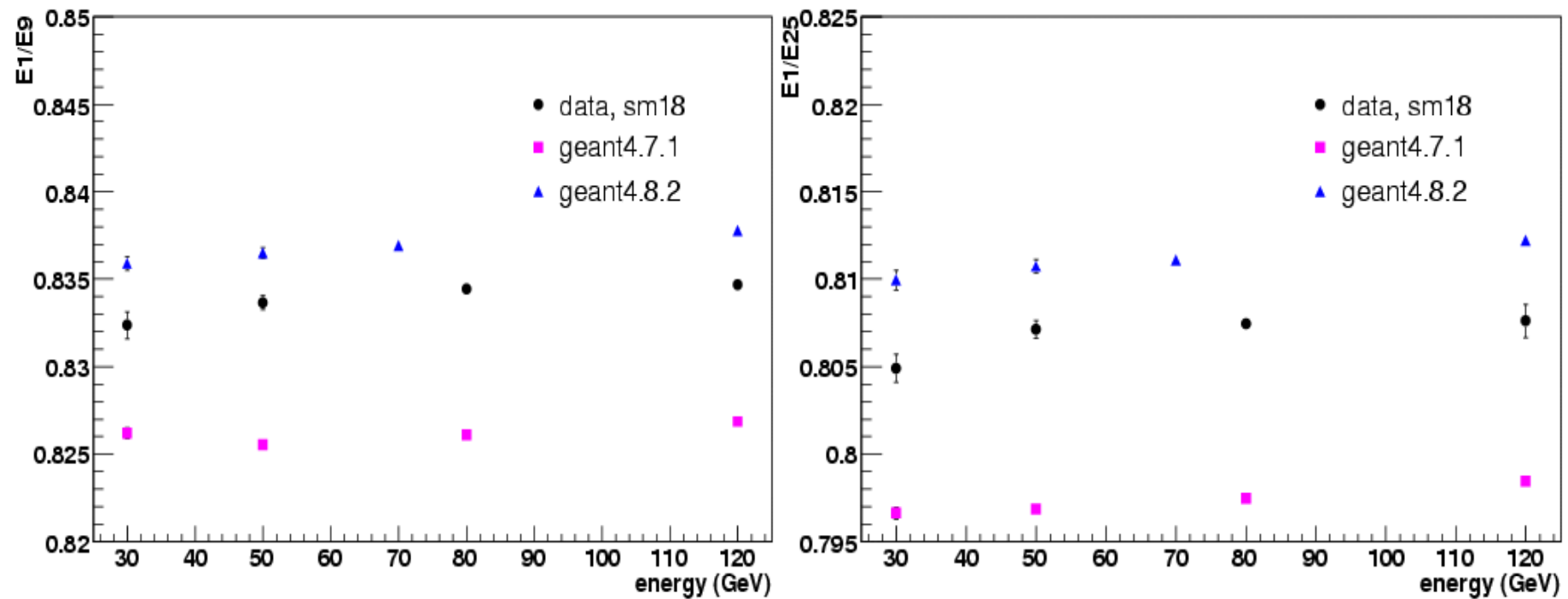
# Lateral containment

- offset between data and simulation
- the different treatment of multiple scattering in G4.8.2.p01 moved the lateral containment from our reference G4.7.1
  - data - 'old' sim difference: up to 1%
  - data - 'new' sim difference: 0.3-0.4%

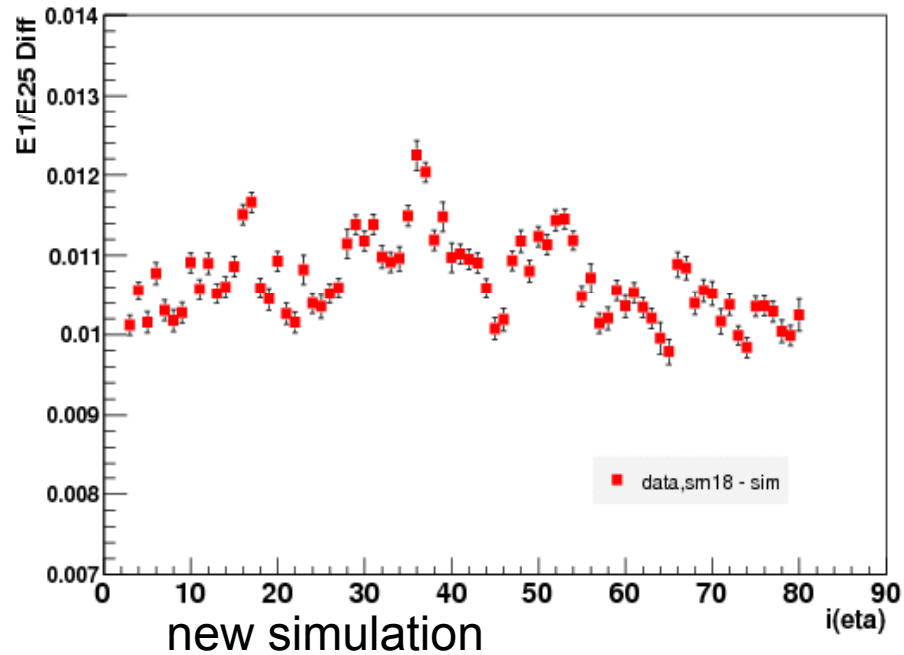


# Lateral containment

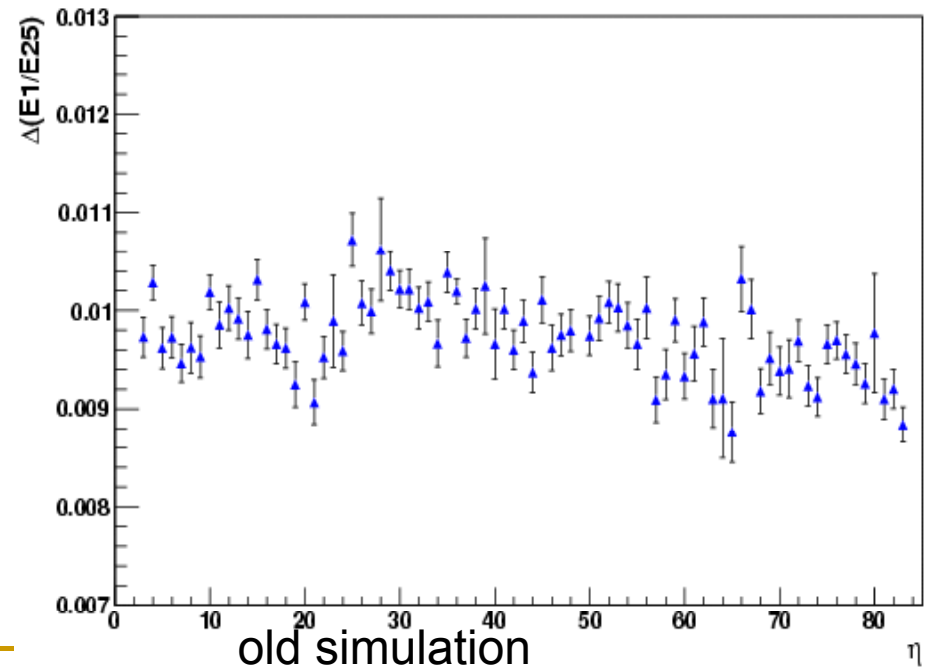
- no dependence of the data-simulation offset on the energy



# The offset trend

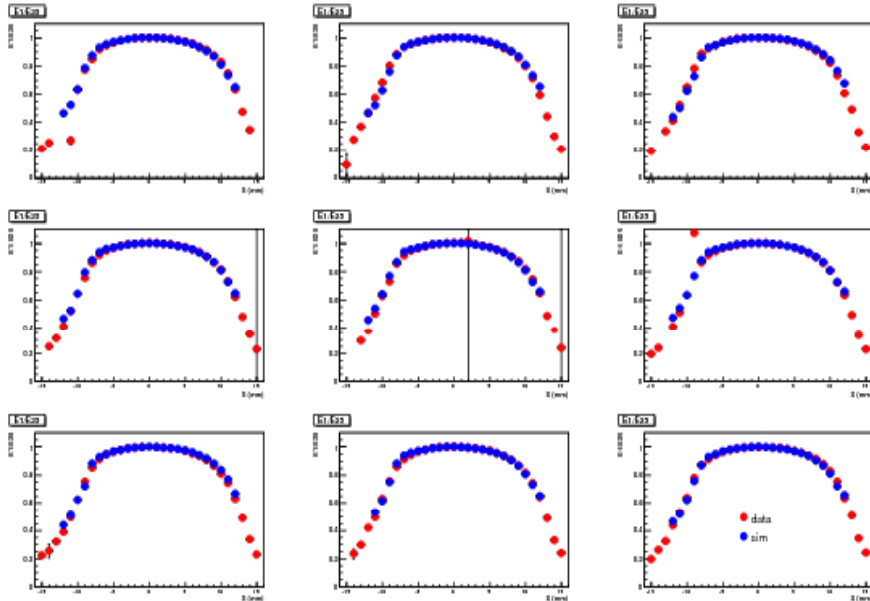


data – simulation,  
difference in the containment vs eta:  
no evident trend is visible





# Containment ratios versus X and Y

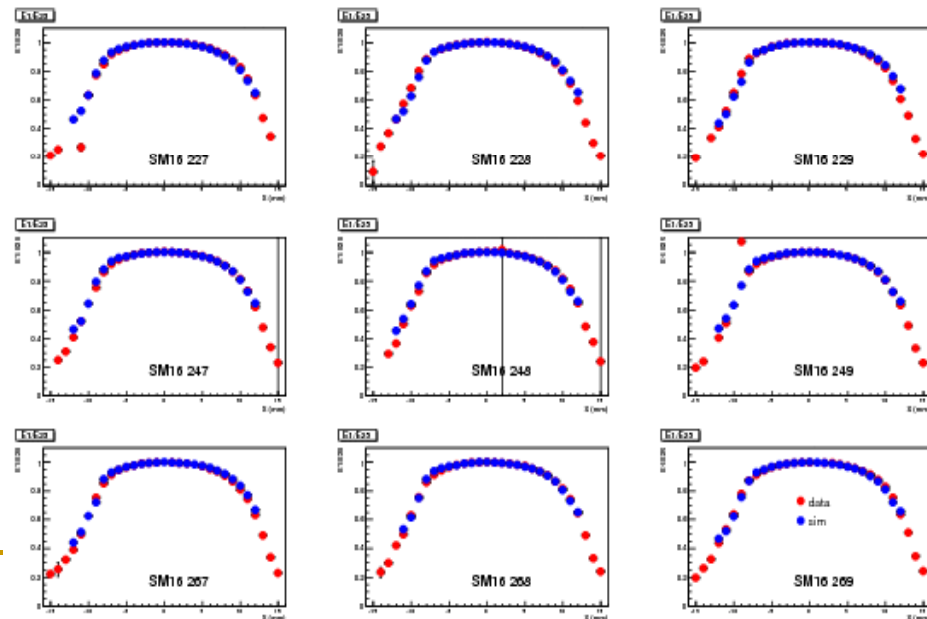


E1/E25 versus X

old simulation, geant 471,  
compatible results with new sim as well

trend of the ratios versus the  
impact point well reproduced  
All over the supermodule

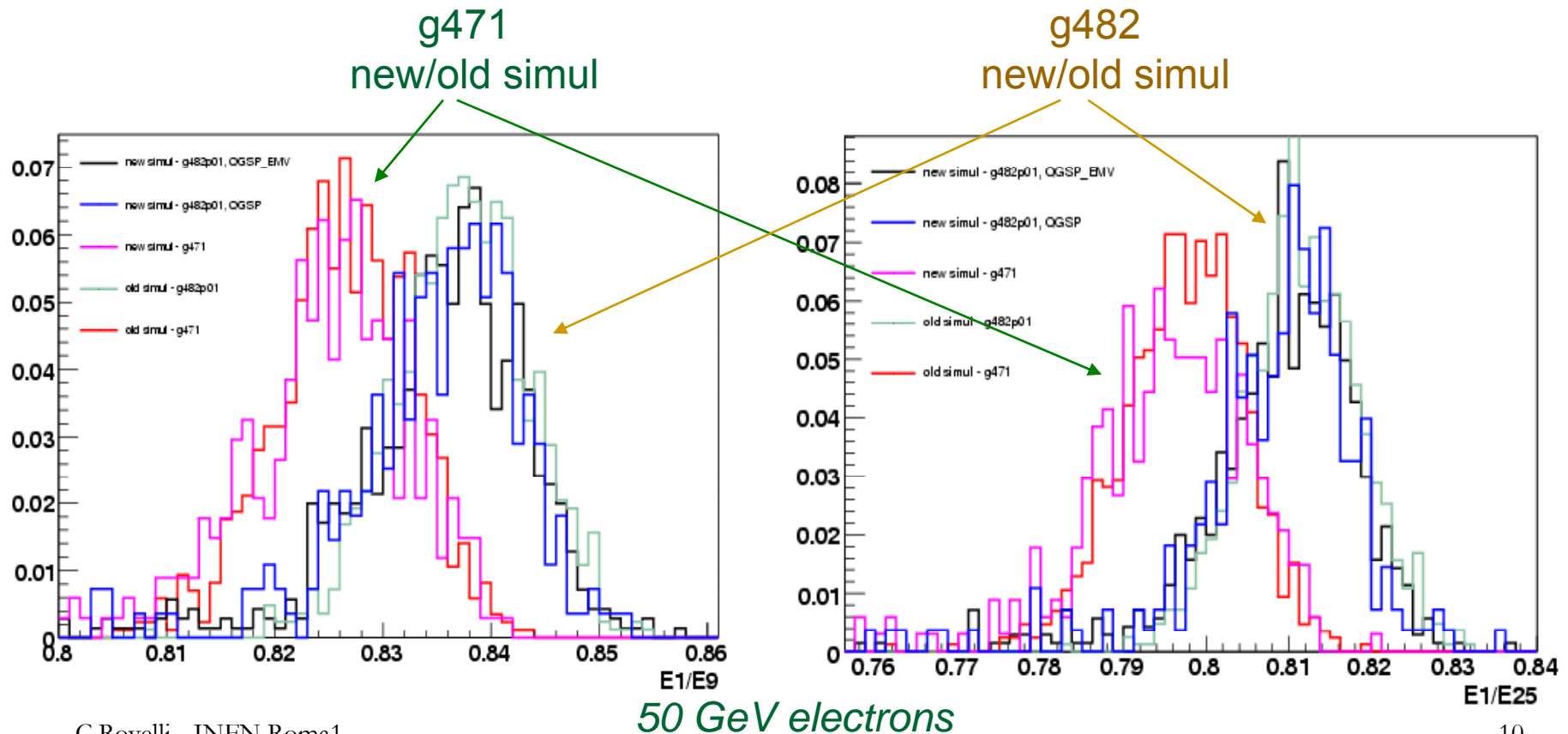
same behaviour in  
close crystals (3x3, 5x5 matrix)



E1/E25 versus Y

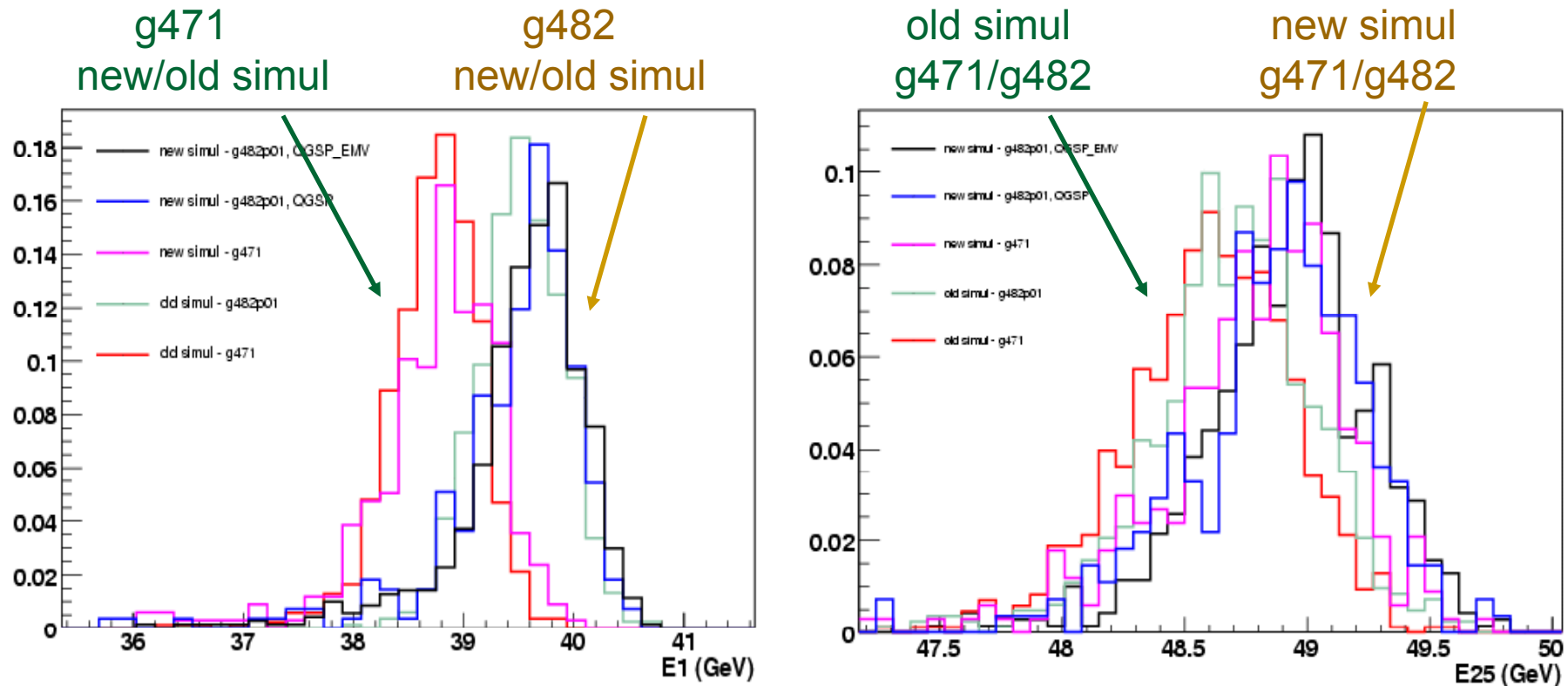
# Different simulation versions: ratios

- The changes in the ratios seem to be due to the G4 version only
- (Apparently) no effect of the new geometry/beam line description



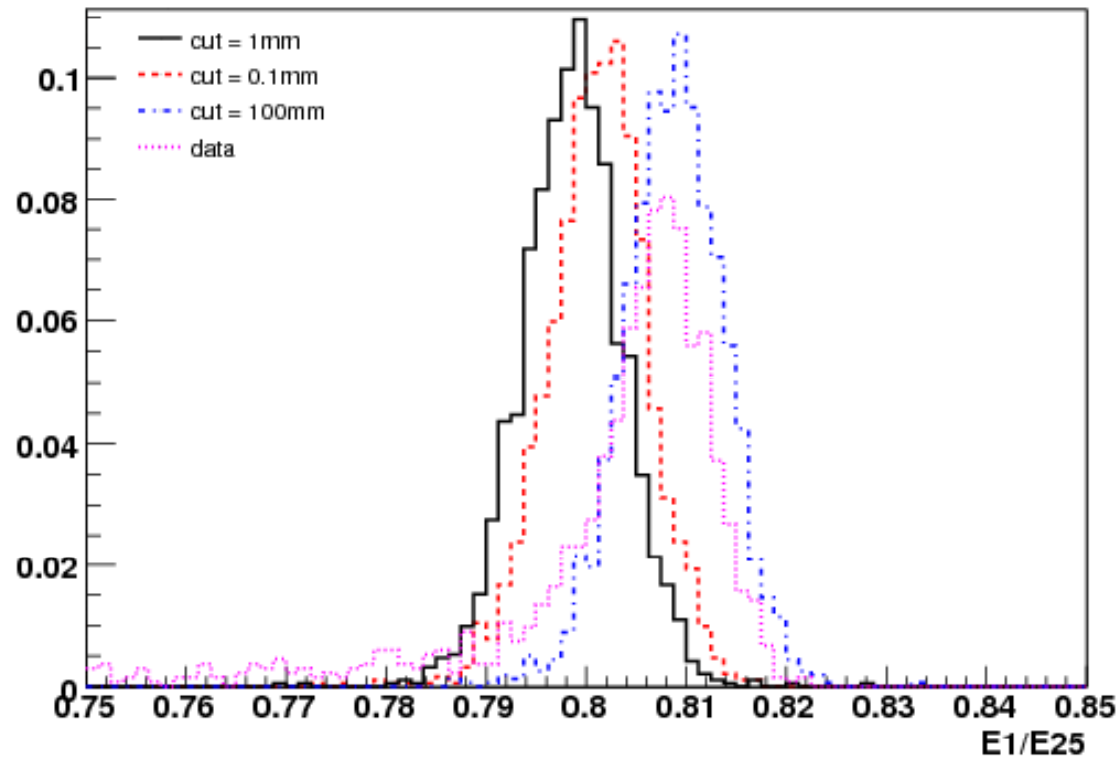
# Different simulation: absolute values

- The shower core (E1) is mainly influenced by the G4 version
- When larger matrices (E25) are considered, the new geometry starts dominating
- Similar effects seen at the simHits level in the validation



# To remove the offset

to remove the offset, possible change of production cut parameters  
BUT the production cut should be enlarged too much... not physical!

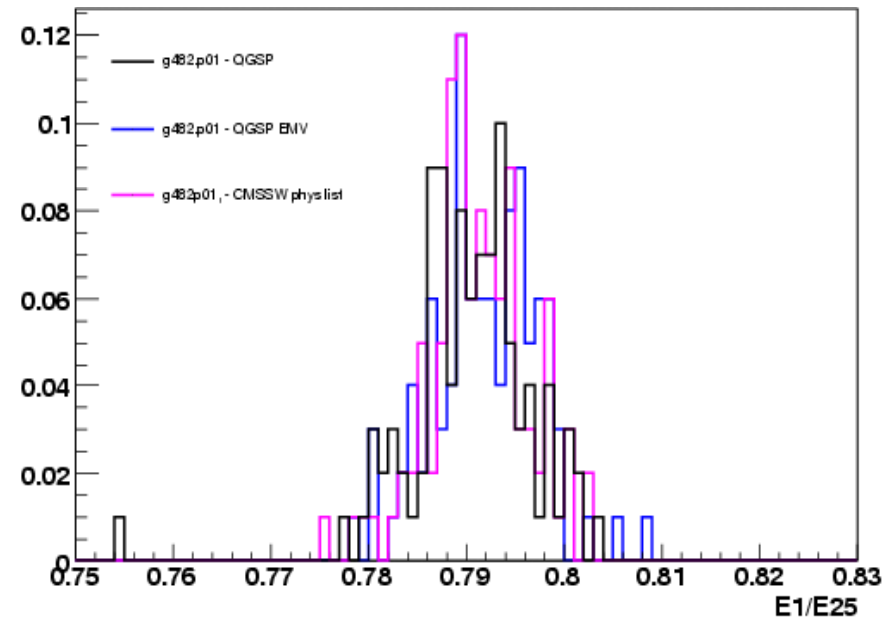
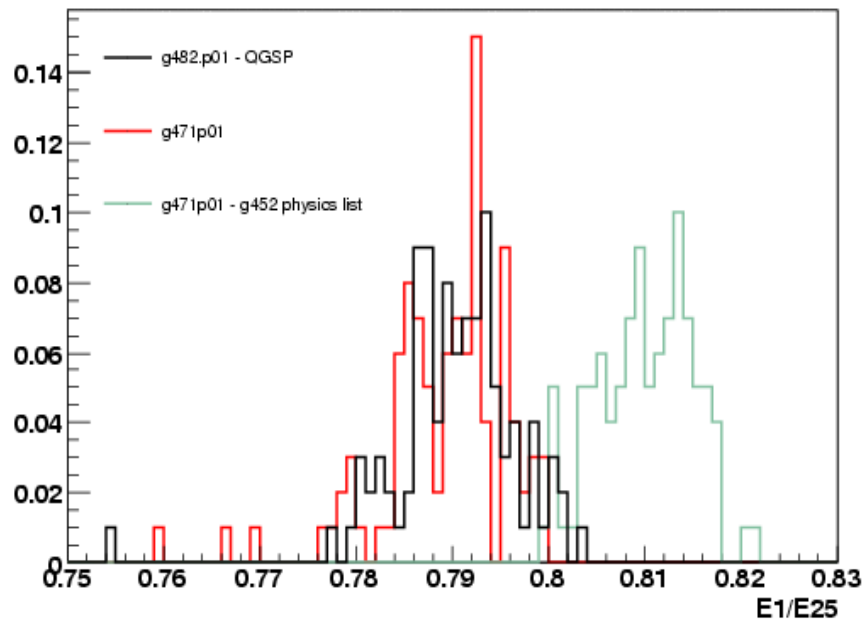


old simulation, geant 471

only gammas  
production cut changed

# Standalone G4 tests

- Serious problem: no major difference between g471 and g482 is seen when running a standalone geant example reproducing the CMS ECAL: why?? Under analysis!!
- In the past we were able to find differences between g452 and g471 using the same example
- No change when comparing different physics list at this level (hadronic processes turned on as well)



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# Conclusions

- Extensive comparisons between data and montecarlo have been done using the data collected at the H4 CMS ECAL testbeam
- A testbeam dedicated simulation including the beam line material is available. Different G4 versions and physics lists have been tested
- An offset between data and simulation is seen.  
There is no dependence of the offset on the energy or eta
  - G4 changes move the offset value in ratios
    - changes in ratios not seen using standalone geant ??
  - Geometry changes move the reconstructed energy distributions