VALIDATION OF GEANT4 10.4 WITH CMS TEST-BEAM DATA

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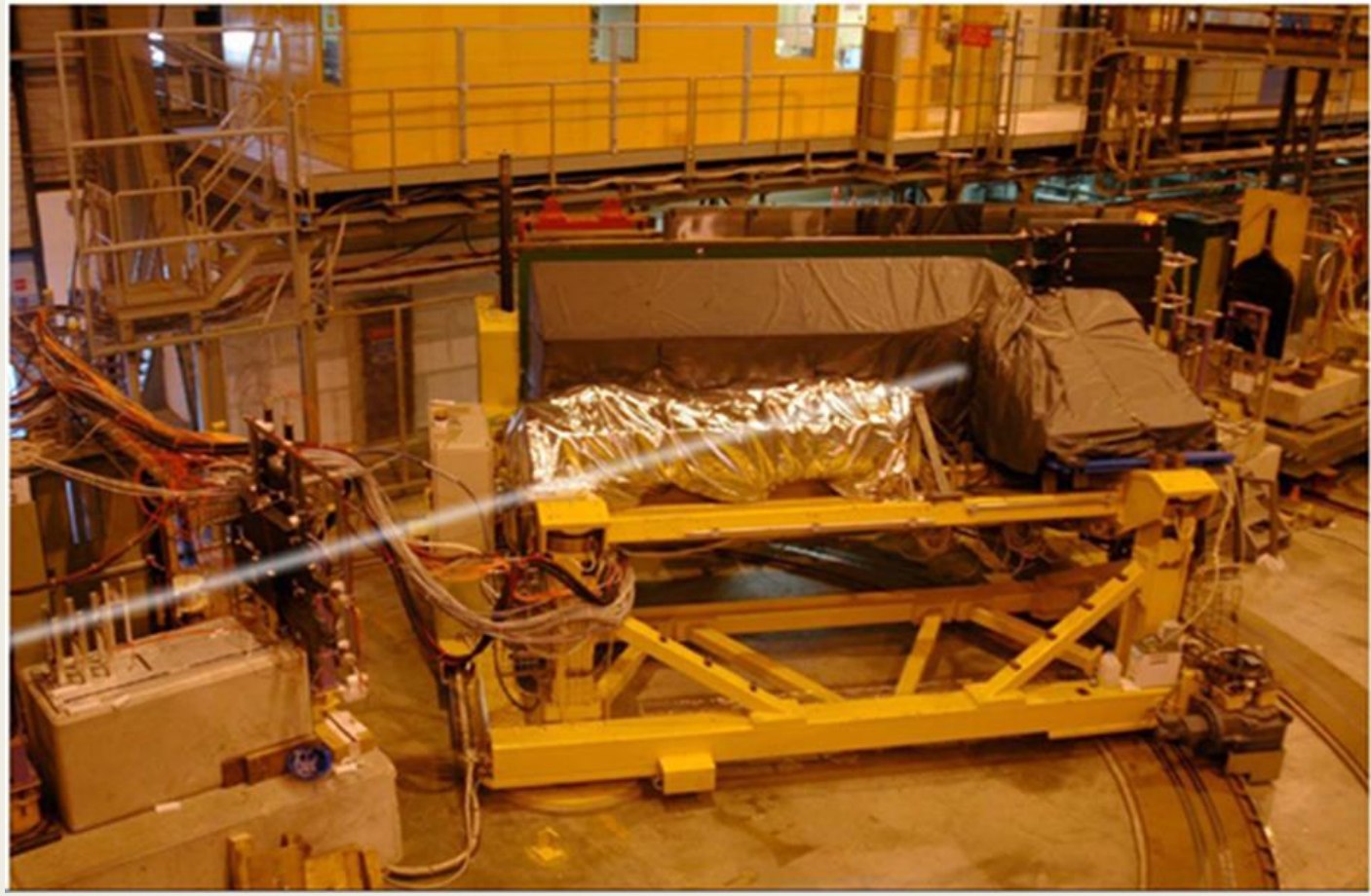
Outline

- Migration of CMSSW to Geant4 10.4
- Results of TB2006 validation
- Conclusions



Migration of CMSSW to Geant4 10.4

- This is a minor release – no interface change compared to Geant4 10.2
  - *More clean-up and optimizations*
  - *Technical fixes*
  - *Compatible with new compilers (c++11)*
  - *Integration of each new reference version does not require any change in CMSSW libraries*
- More performant geometry in 10.4
  - *This is essential for CMS because >50% CPU of the SIM step is spent for tracking in field and geometry*
  - *G4Box, G4Trap, G4Tubs… – cleanup and speedup are in progress*
  - *G4MultiUnion – new approach for complex shapes*
  - *G4ExtrudedSolid – new simplified constructor and faster computations are planned*
    - Of concern for HGCal
  - *Better interfaces to VecGeom*
- Physics models improvements
  - *Stable results are required for use 10.4 in 2018 production*

Geant4 TB2006 in CMSSW

- CMS Notes 2008/025, 2008/034, 2010/007
  - *CMS collected data with prototype of barrel HCAL and barrel ECAL super- module in the H2 test beam area at CERN during 2006.*
  - *Special action was taken to go down to 1 GeV hadron beam*
  - *Beam particle identification from Cherenkov and TOF detectors*
  - *Measured mean energy deposition, width and energy fractions in ECAL and HCAL*
- Geant4 reference tags are integrated inside CMSSW in the ROOT6 branch
  - *We switch from 10.4beta -> 10.3ref08 -> 10.3ref09->10.3ref11->10.4cand01*
- Recent results are obtained for TB 2006:
  - *CMSSW_9_3_4 – Geant4 10.2p02*
  - *CMSSW_10_0_ROOT6_X_2017-11-28-2300 – Geant4 10.4cand01*
  - *Only for FTFP_BERT_EMM (CMS default) Physics List*

Conclusions

- There is practically no difference between Geant4 10.2p02 and 10.4cand01 calorimeter results
  - *Marginal improvement for pbar*
  - *Marginal degradation for kaons*
- Disagreements between TB2006 data and simulation are stable
  - *Pion response in data below 10 GeV is slightly wider than in simulation*
    - This provides biased MIP fraction in Ecal for pi- (>10%) and RMS for response when MIP energy in Ecal
  - *Pbar mean response is overestimated in simulation (~5%)*
  - *Kaon mean response is underestimated (~10%)*
  - *FTF and Bertini models are responsible*
    - Improvements are needed for both models