

# Highlights of recent patch releases physics part

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2 April 2015

The logo for Geant 4, featuring the text "Geant 4" in a stylized, brown, serif font with a slight shadow effect, set against a light green rectangular background.

# Outline

- Overview of fixes for physics
  - 9.6p04
  - 10.0p04
  - 10.1p01
- EM physics fixes highlights
- Hadronic physics fixes highlights

# Common fixes in 9.6p04, 10.0p04, 10.1p01

- `G4ProcessManager::SetProcessOrderingToSecond()` – fix for all PhysicsLists
- `G4HadronicProcess` - added check on dynamic mass of secondary corresponds to PDG mass
- `G4CascadeInterface` – fixed possible infinite loop and momentum balance fail
- `G4LundStringFragmentation` - fixed crash of anti-sigma-capture crash at Hydrogen
- `G4MuMinusCaptureAtRest` - fixed time of secondaries in muon minus capture at rest

# Fixes for 9.6p04

- **G4BinaryCascade** – fixed crash in  $p + d$  and  $d + H$  reactions
- **G4InuclNuclei** – fixed floating point exception
- **G4IntraNucleiCascader** – fixed memory leak (#1584)
- **G4MuMinusCaptureAtRest** – use simplified model for  $d$  and  $He4$  to avoid infinite loop
- **G4AntiProtonAnnihilationAtRest** – fixed bug in wrong target sampling

# Fixes for 10.0p04 and 10.1p01

- **G4INCLXXPhysicsListHelper** – do not add  
G4NeutronTrackingCut for Physics List with HP

# Fixes for 10.1p01 (1/3)

- **G4Material** – new default temperature 20C for NIST gases
- Added decay channels eta\_prime into 2 gamma and omega+gamma
- Electromagnetic builders – change multiple scattering options:
  - **Opt4, WVI** - do not use displacement beyond boundary by default
  - **Opt4** - enable UseDistanceToBoundary (as used by Opt3)
- **G4HadronElasticPhysics** – do not use CHIPS cross section by default
- **G4eeToHadrons** – fixed kinematics in ISR sampling
- **G4eeTo3pi** – improved sampling
- **G4GoudsmithSaundersonMscModel** – return back to 10.0 version of sampling

# Fixes for 10.1p01 (2/3)

- **G4KleinNishinaModel, G4PEEffFluoModel** – fixed rare crash in sampling when de-excitation energy slightly larger than available energy
- **G4EmParameterMessenger** – CSDA flag may be set only PreInit state
- **EM tables** are stored to files system only from master thread
- **G4VEmModel, G4VFluctuationModel** – random engine pointer is initialized in **StartTracking()** method for each new track
  - fixed critical problem reported by CMS

# Fixes for 10.1p01 (3/3)

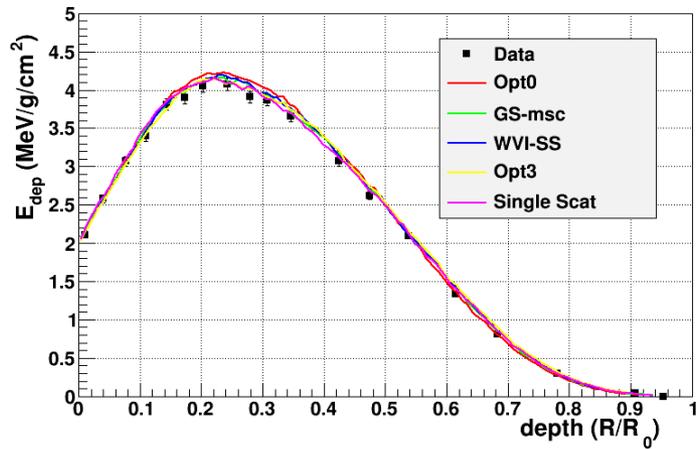
- **G4ComponentGGHadronNucleusXsc** fixed for Hydrogen target
- **CHIPS x-sections** – removed wrong checks on particle type
- **G4DiffuseElastic** – fixed numerical problem for low-energy neutrons
- **G4NuclNuclDiffuseElastic** – fixed problem in Be-Be scattering (#1691)
- **Photon\_evaporation** sub-library fixes:
  - Energy balance for the case of internal conversion
  - Internal conversion disabled by default for hadron-nucleus interactions
  - Isomer production disabled by default by time limit
    - Providing reproducibility
    - Removing fake gamma lines in radioactive decay
- **G4GEMProbability** – fixed numerical problem for the case of very high excitation
- **G4NeutronHPInelasticCompFS** – fixed #1710

# EM physics validation results

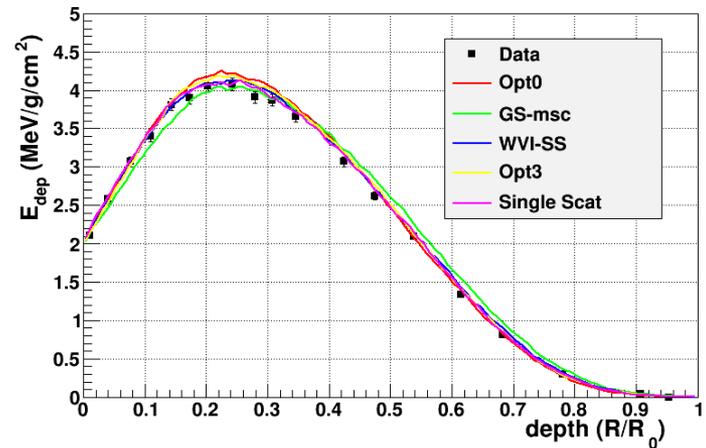
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# Sandia data for 0.5 MeV e- in Al

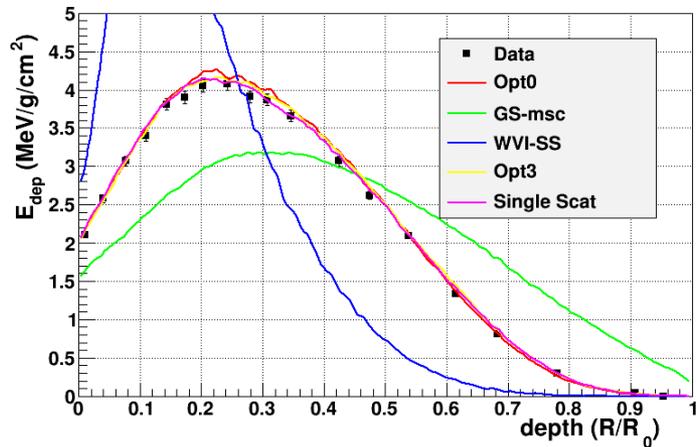
e<sup>-</sup> 0.521 MeV in Al, Geant4 9.6p04



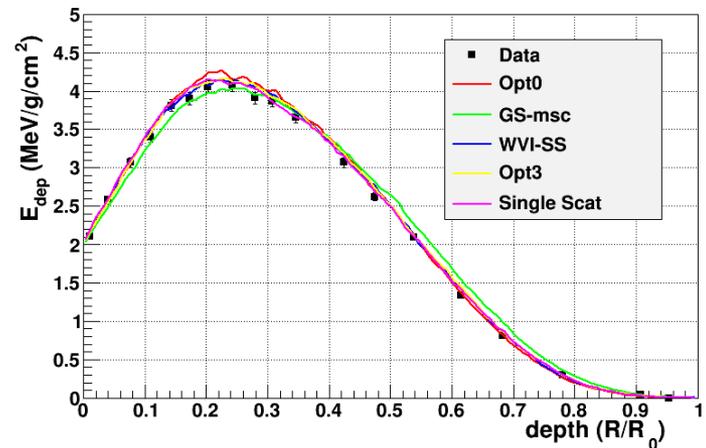
e<sup>-</sup> 0.521 MeV in Al, Geant4 10.0p03

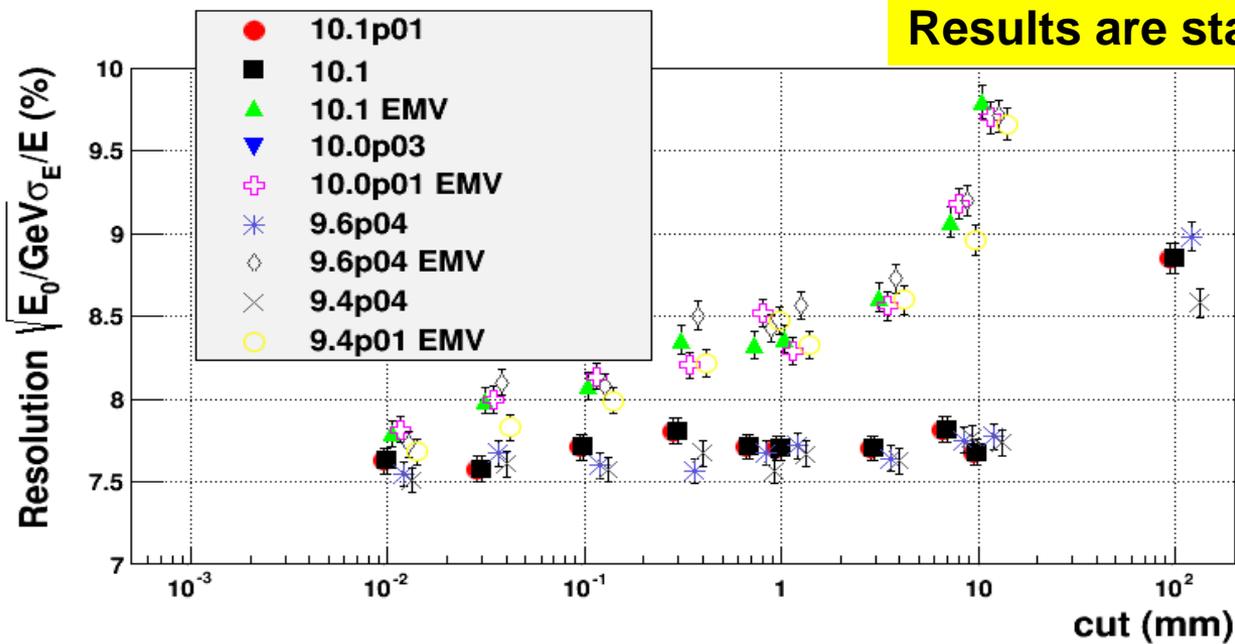
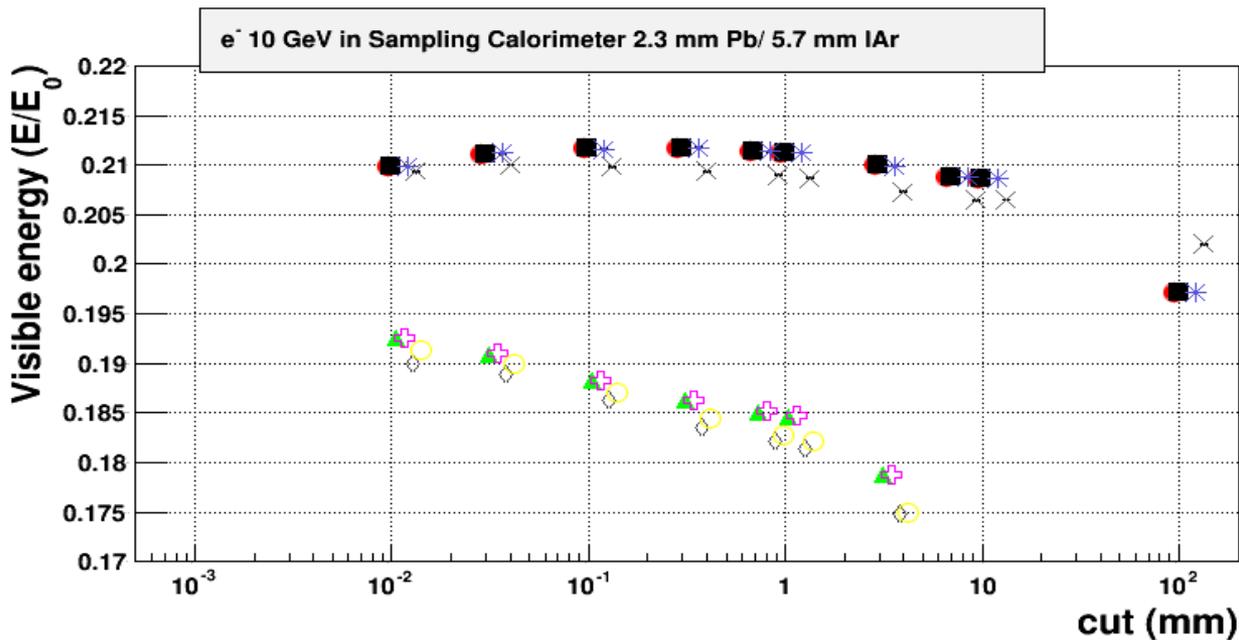


e<sup>-</sup> 0.521 MeV in Al, Geant4 10.1



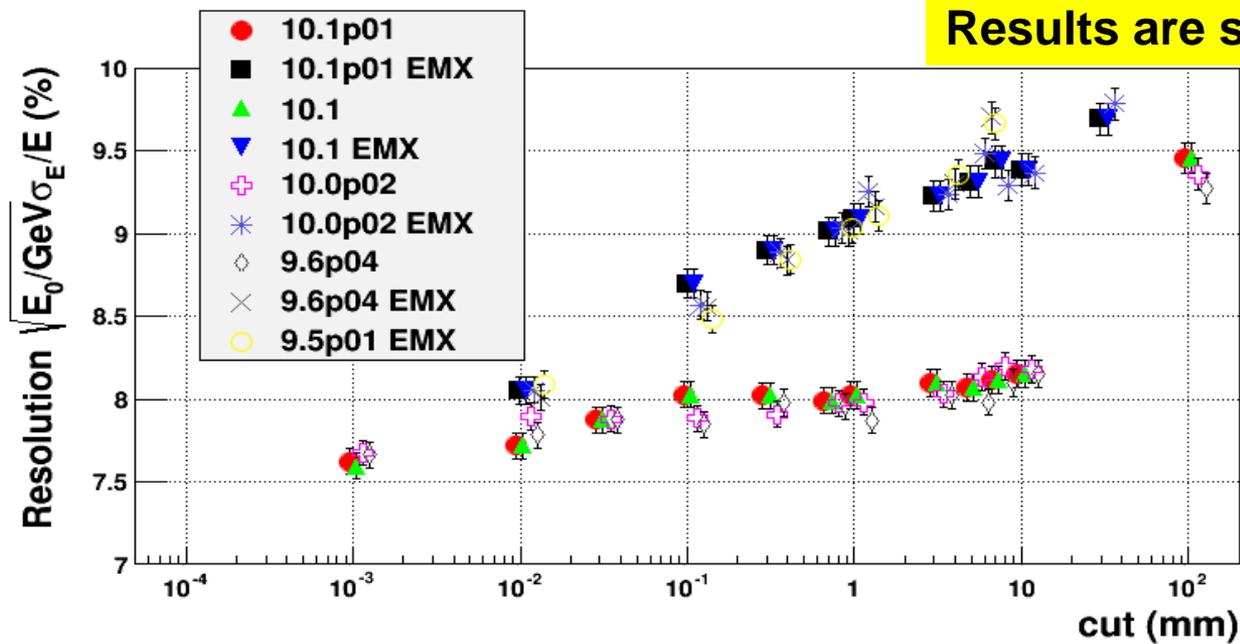
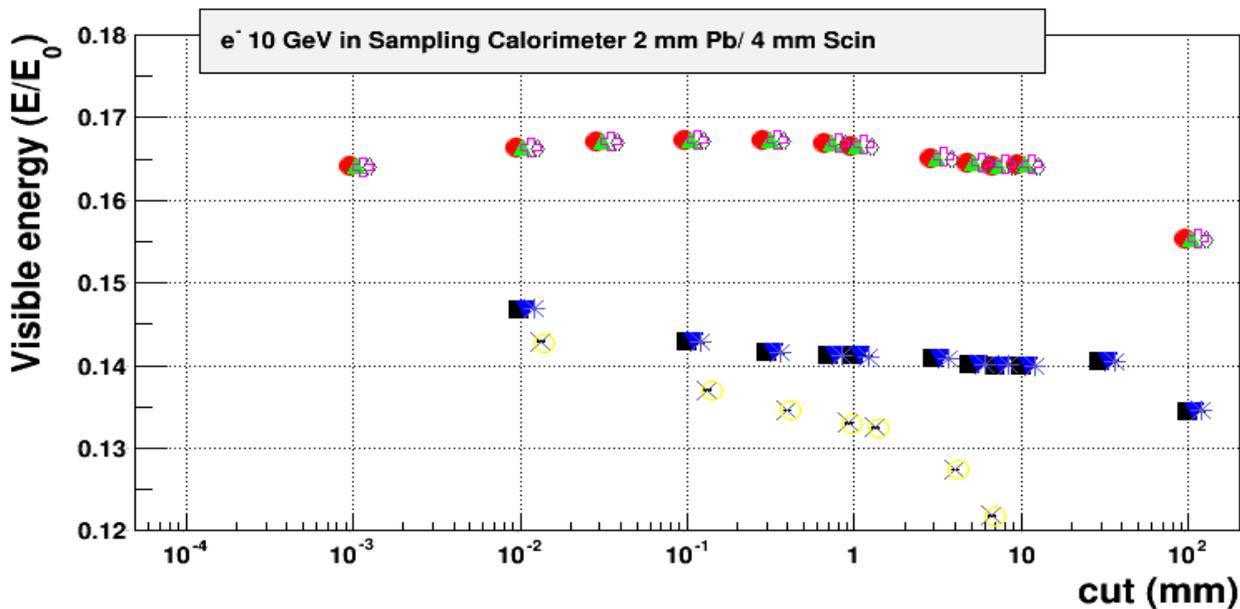
e<sup>-</sup> 0.521 MeV in Al, Geant4 10.1p01





**Results are stable since 9.6**

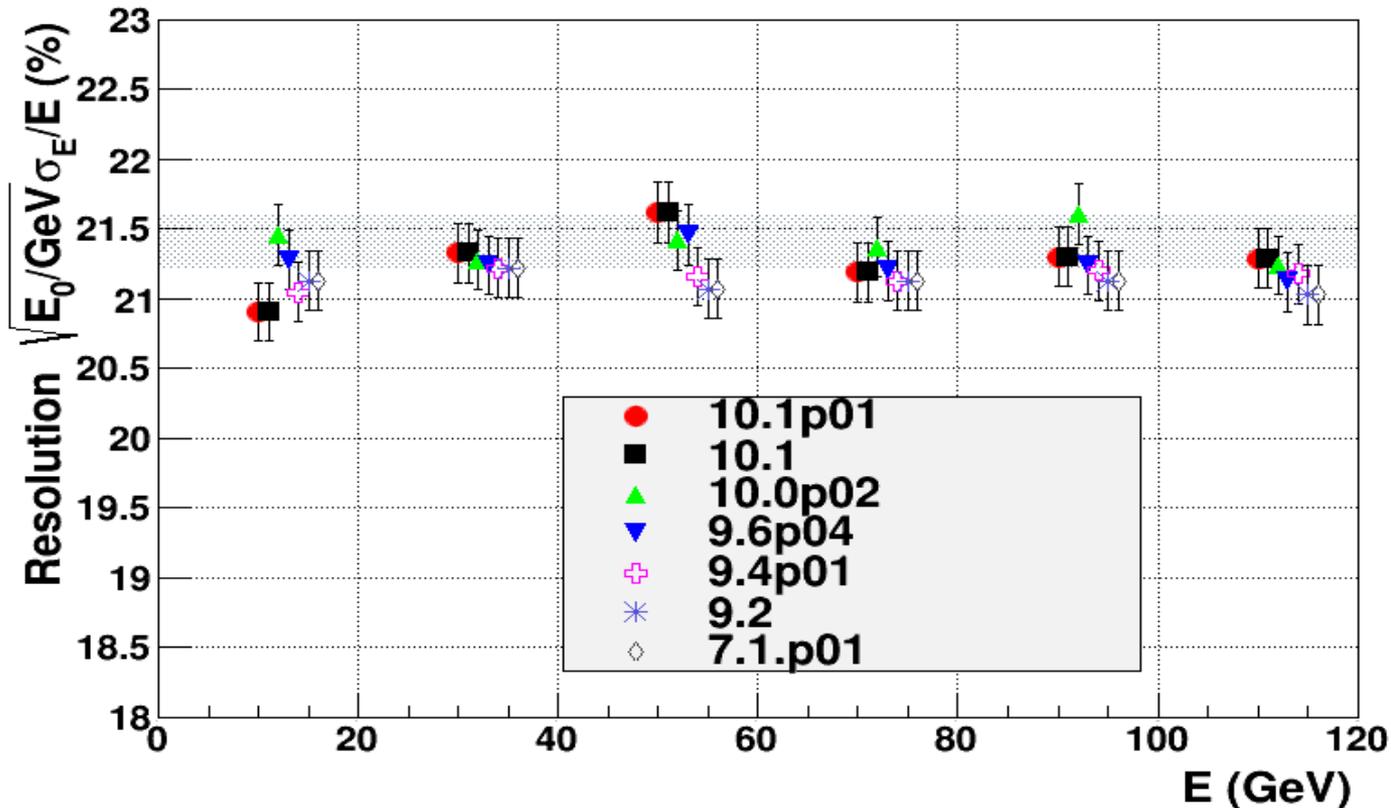
# LHCb type simplified calorimeter



Results are stable since 9.6

# ATLAS-HEC type of simplified calorimeter

$e^-$  in Sampling Calorimeter 2.5 cm Cu/ 0.8 cm IAr, cut = 0.7 mm



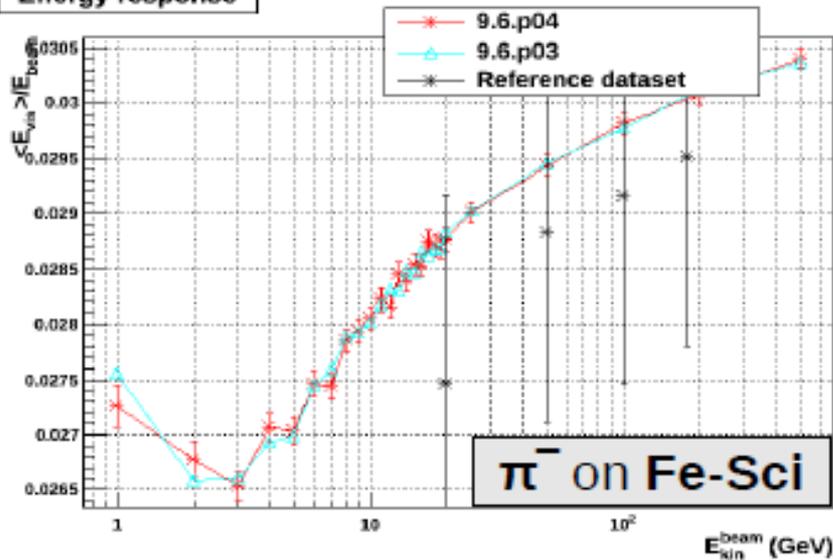
**We expect unchanged EM response for LHC detectors  
For Geant4 9.6p04, 10.0p04, and 10.1p01**

# Hadronic physics validation results

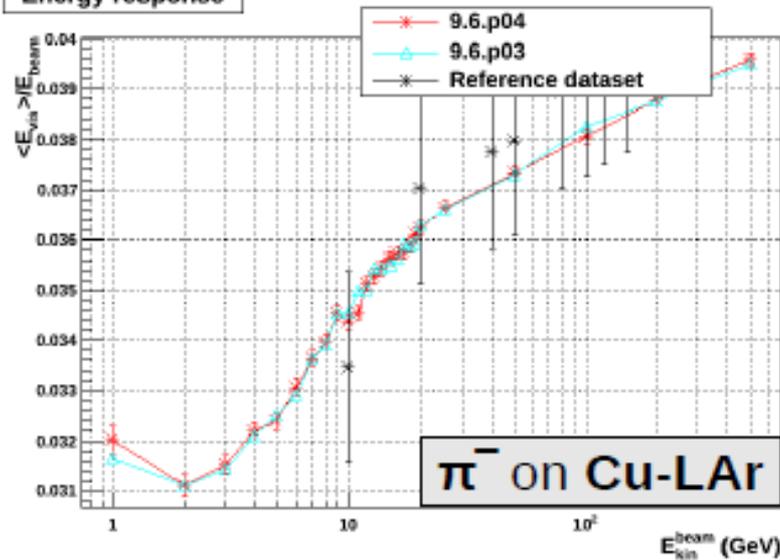
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# FTFP\_BERT : Energy Response

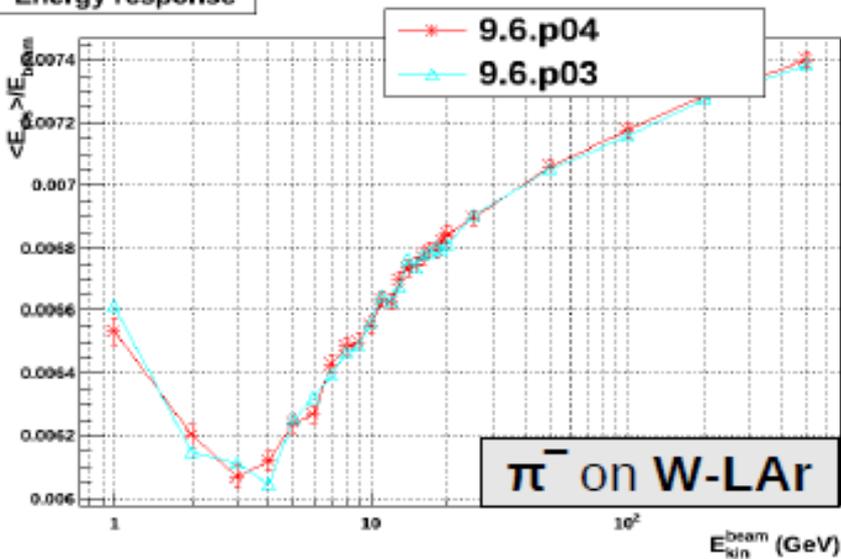
Energy response



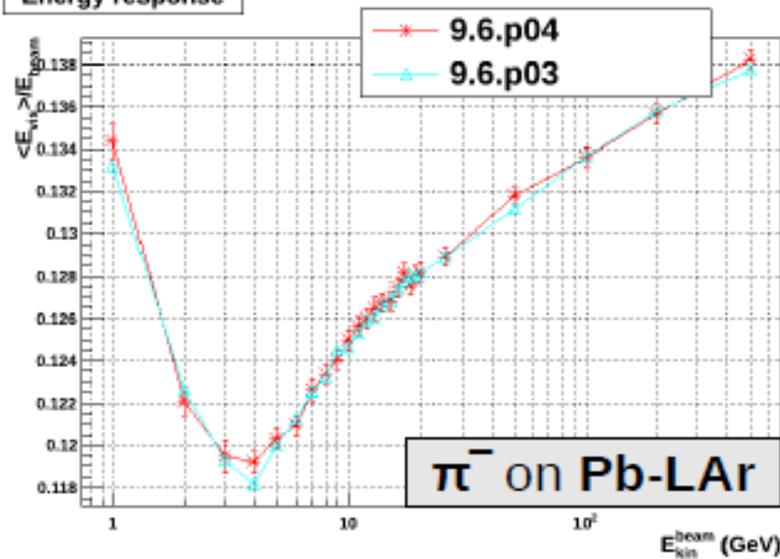
Energy response



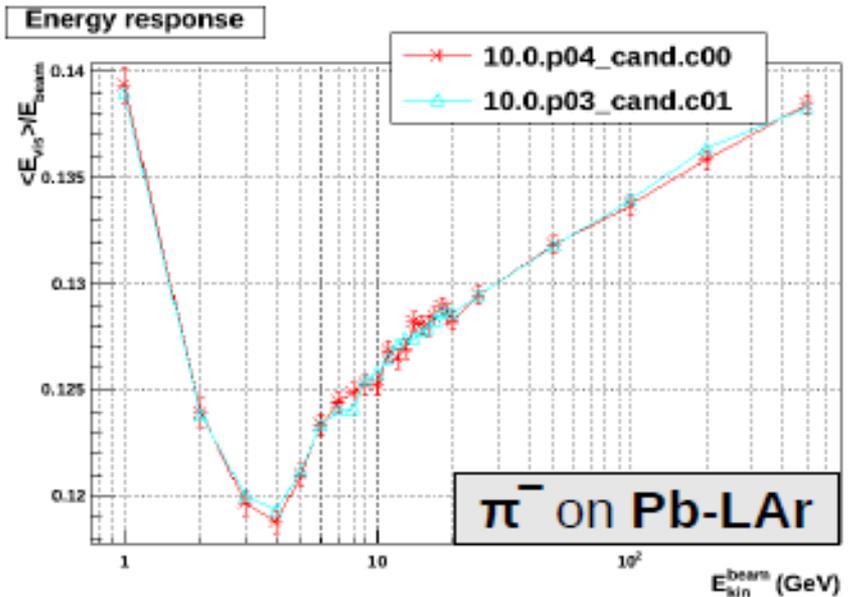
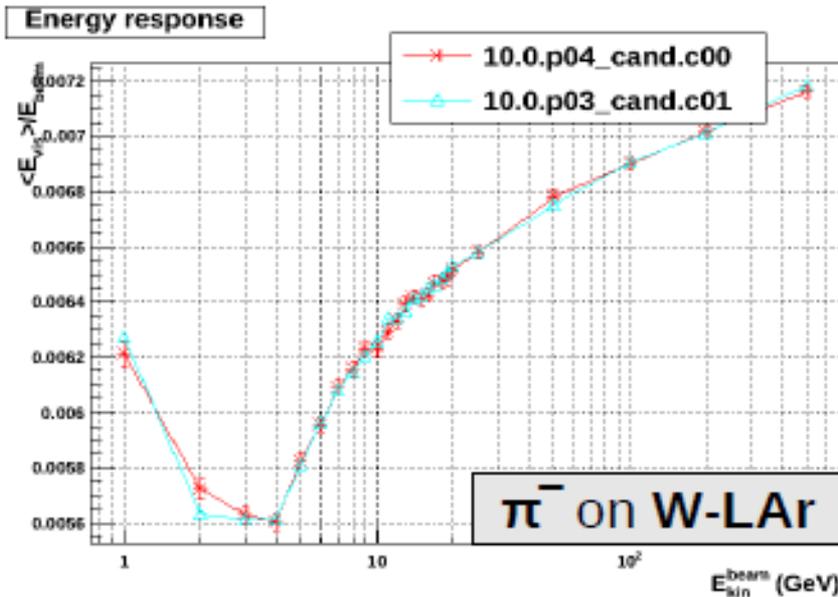
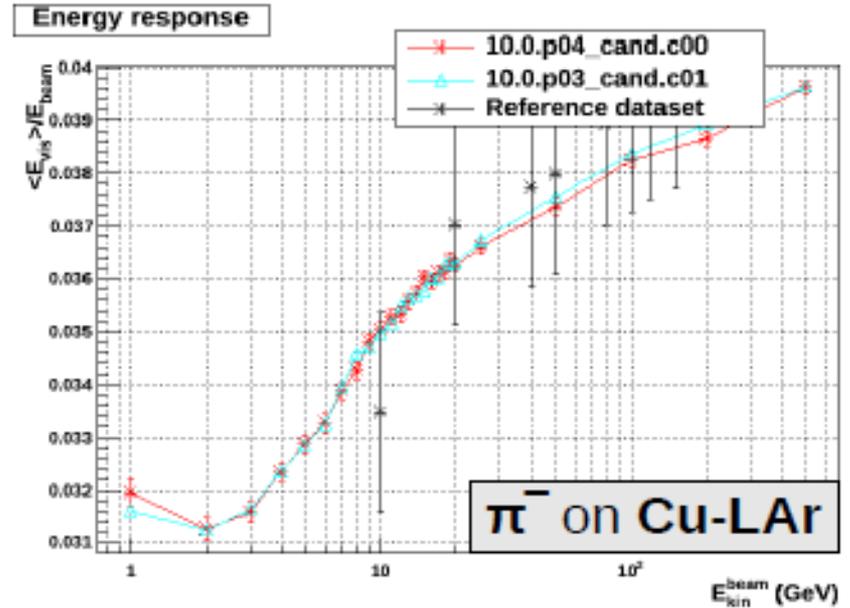
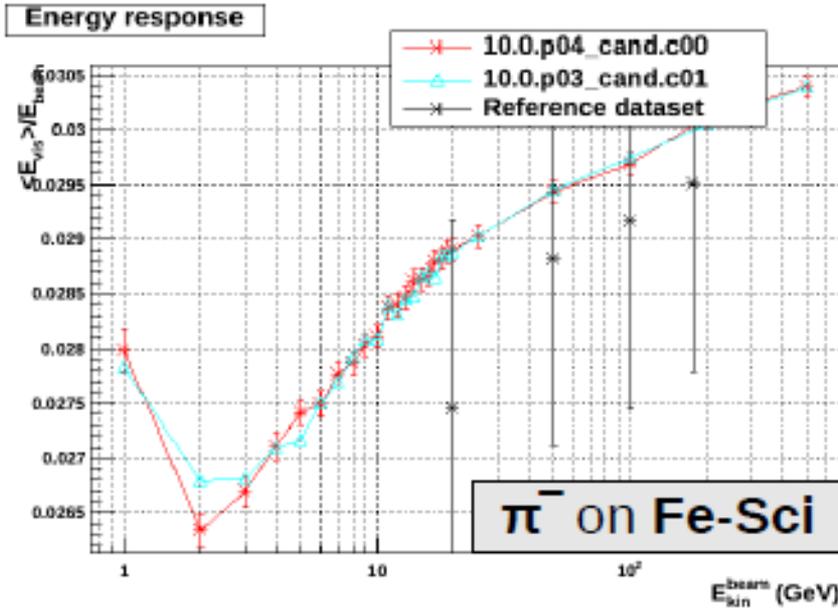
Energy response



Energy response

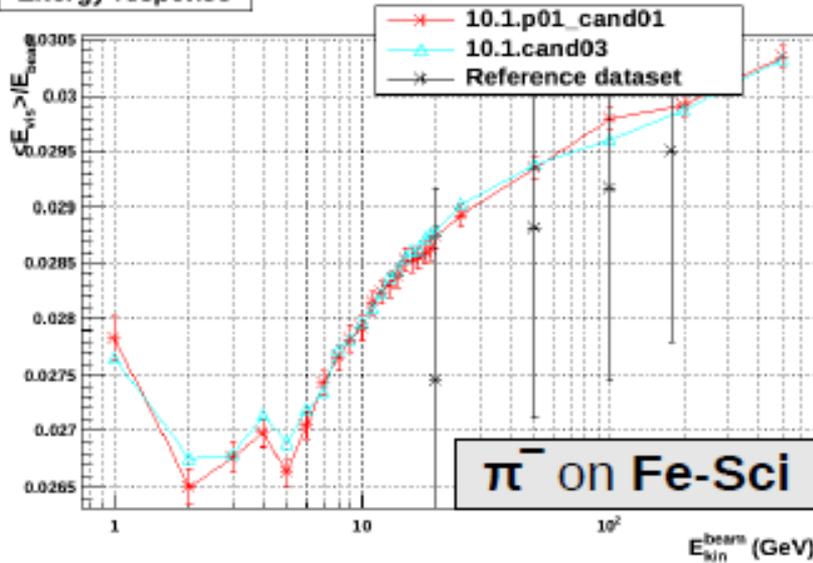


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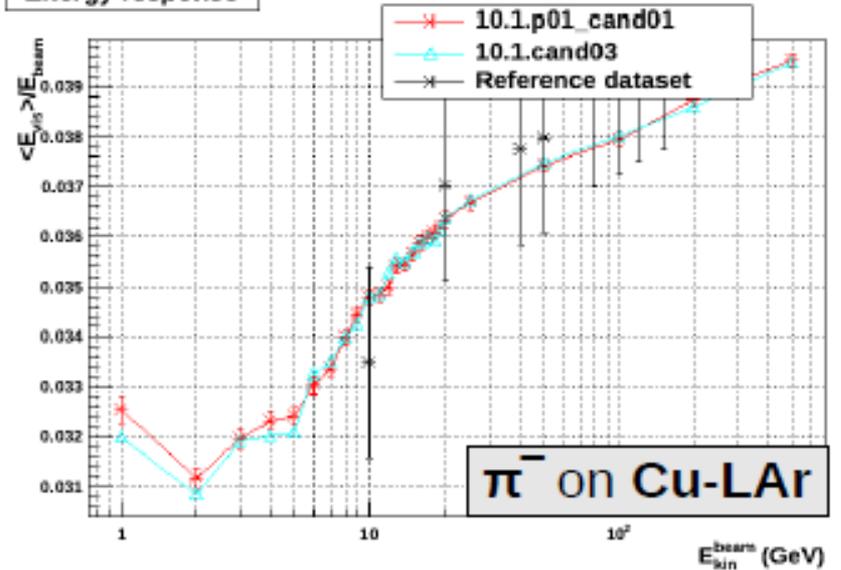


# FTFP\_BERT : Energy Response

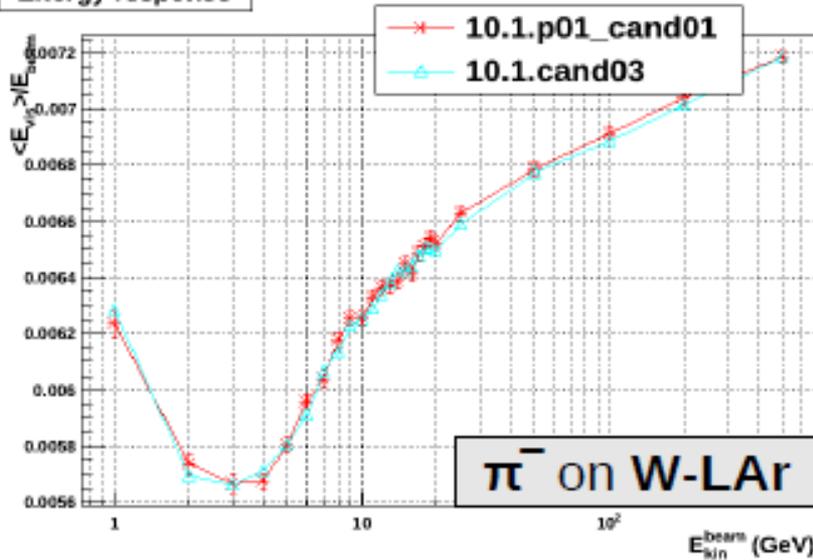
Energy response



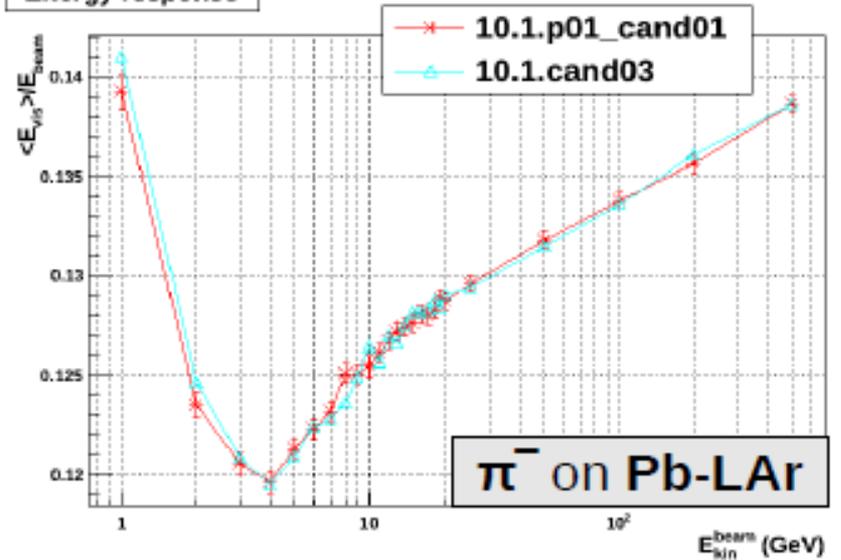
Energy response



Energy response



Energy response



# Conclusions

- Recent patches [9.6p04](#), [10.0p04](#), [10.1p01](#) provide mainly robustness fixes reducing probability of crashes and numerical exception in massive production
- Responses of LHC detectors should be unchanged