Standard EM in 10.2-beta

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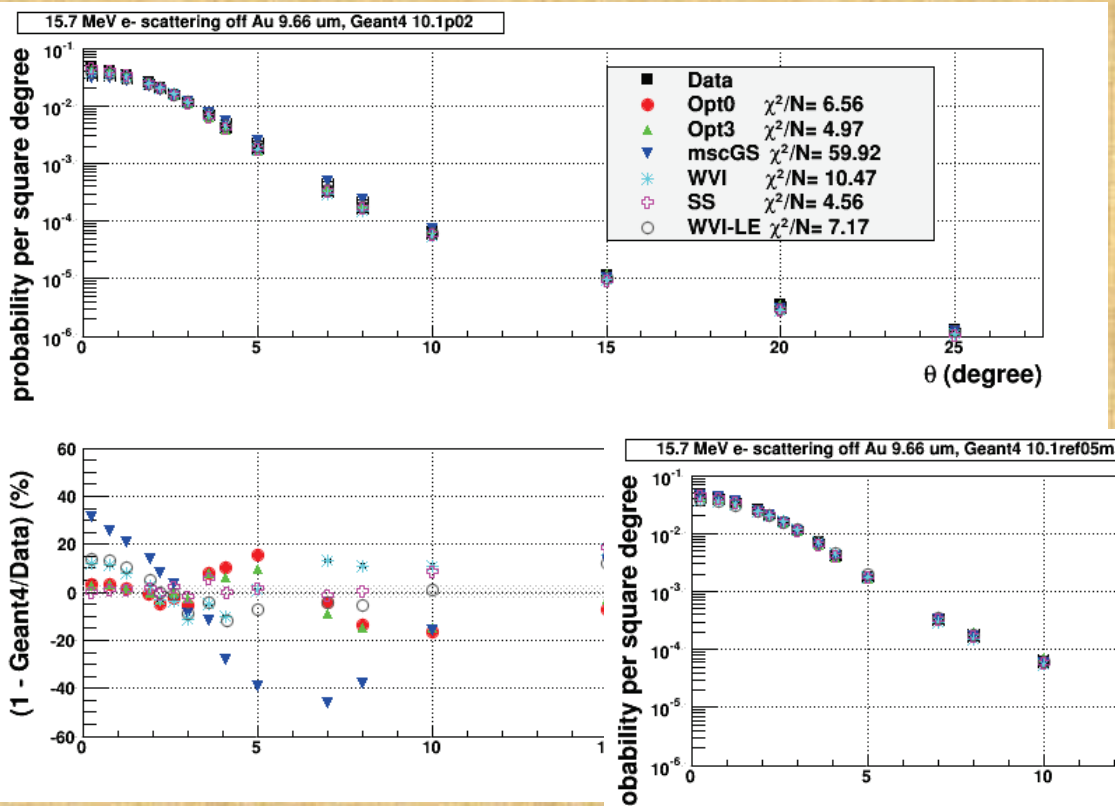
EM modifications for 10.1p02

- Define random engine pointer at each step for all models (fixing CMS problem)
  - This provides minor CPU degradation
- Fixed PAI models for MT applications and for the case of several G4Regions where the model is enabled
- Fixed sampling of positron annihilation into 3 pions
- New validation results are available

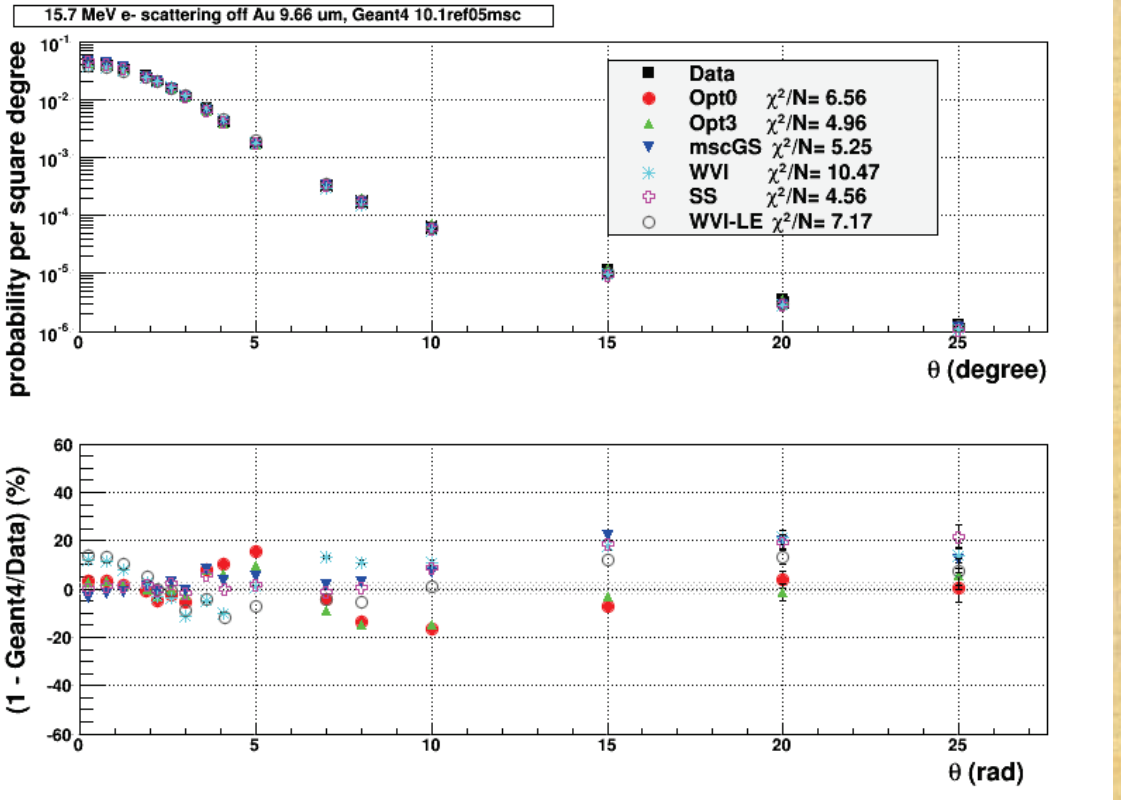
EM modifications for 10.2beta

- 10.1patch02 modifications
  - Engine pointers
  - PAI models
- Goudsmit-Saunderson model
  - Complete review and rewitten by Mihaly Novak
- Urban model updates:
  - Special treatment of positrons
  - Material dependent step limitation (using Reff(R, Zeff))
  - Code reorganisation
  - Alternative sampling of the lateral displacement (disabled by defult)
- Improve Wentzel-VI and single scattering model model
  - More accurate sampling of spin term in single scattering
  - Disable lteral displacement for muons and hadrons
- Added extra EM parameters
- Improved G4EmCalculator
- Added possibility to configure PAI, MicroElec, and DNA models by UI commands
- Validation results for 10.2beta are available

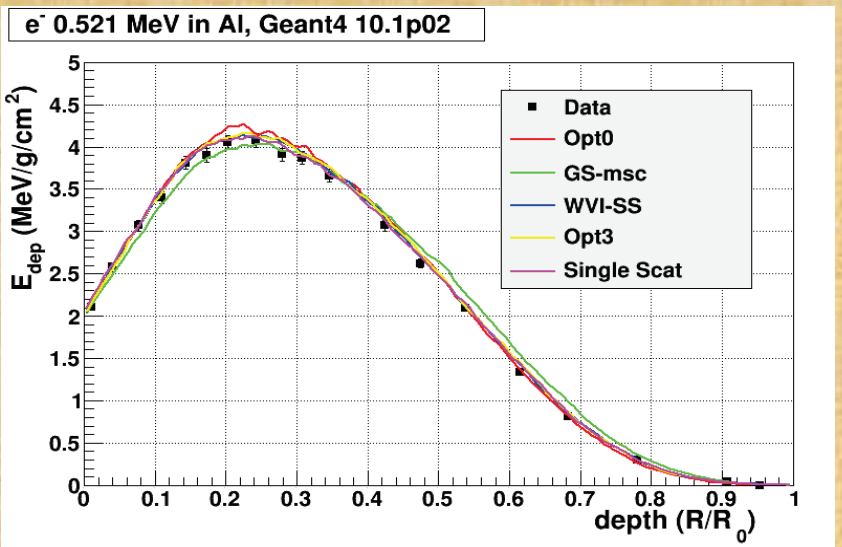
Hanson data for e- scattering off thin foil

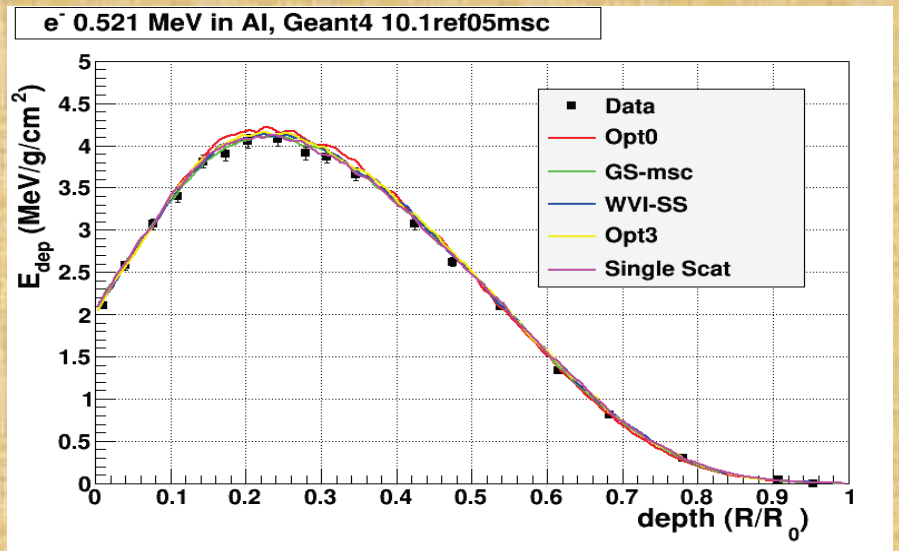


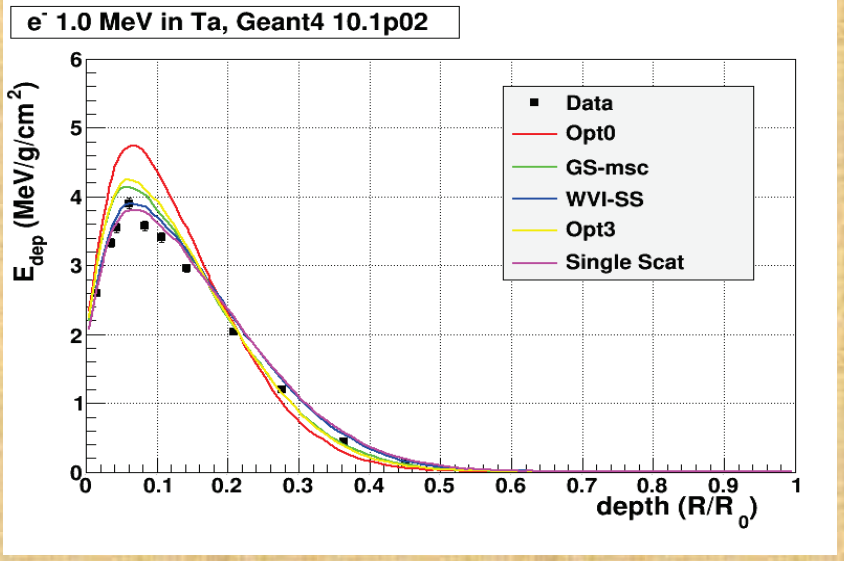
Significant improvement of GS model

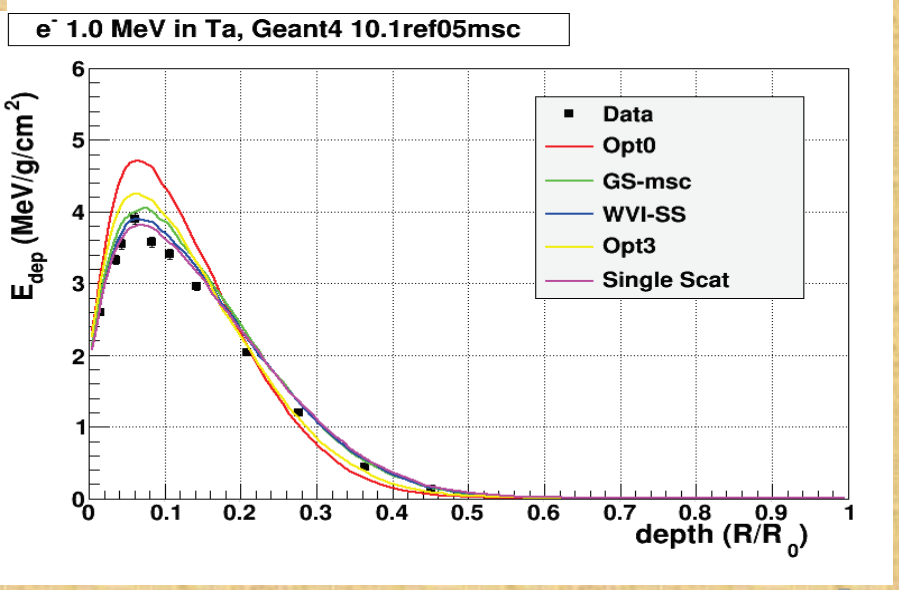


Sandia data - backscattering



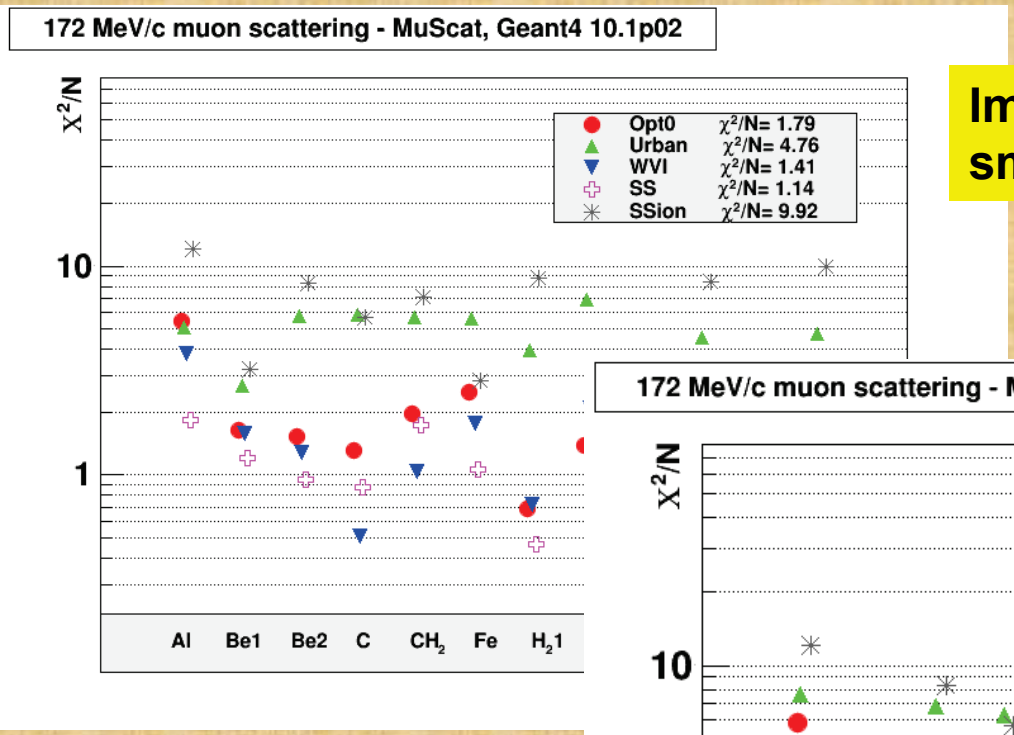




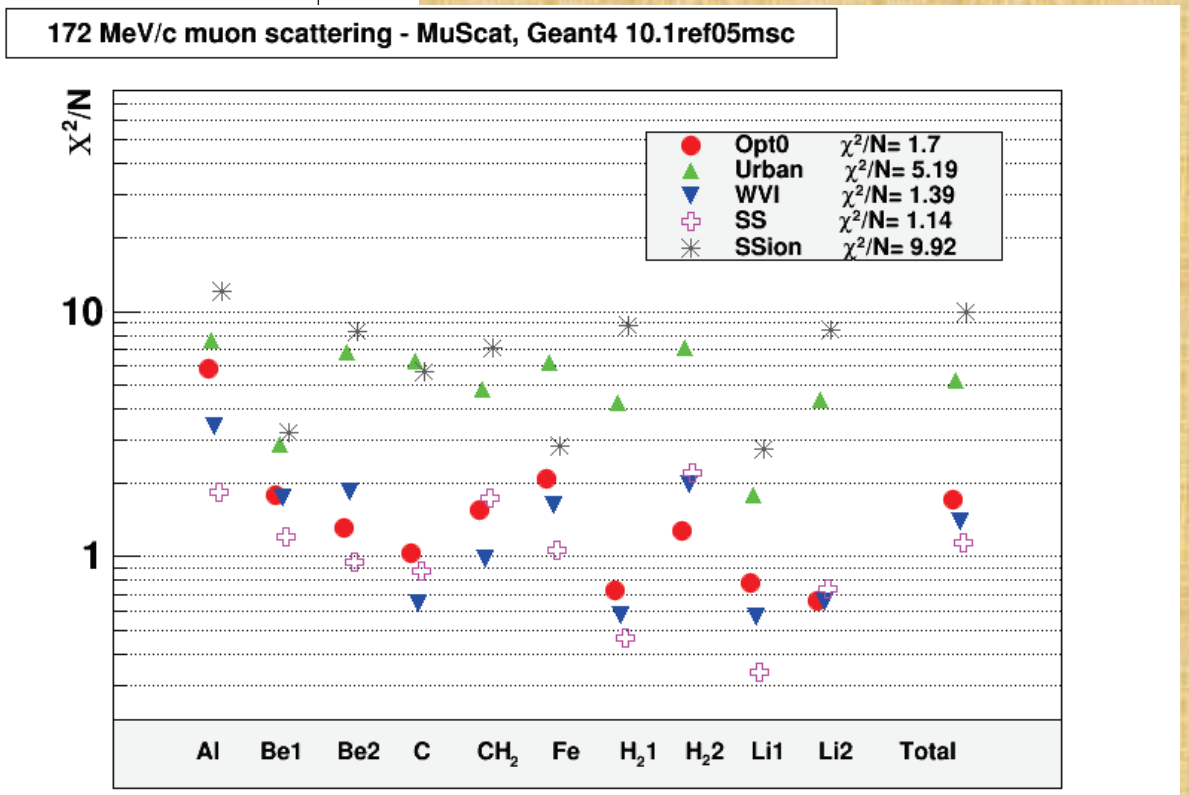


Improved GS results

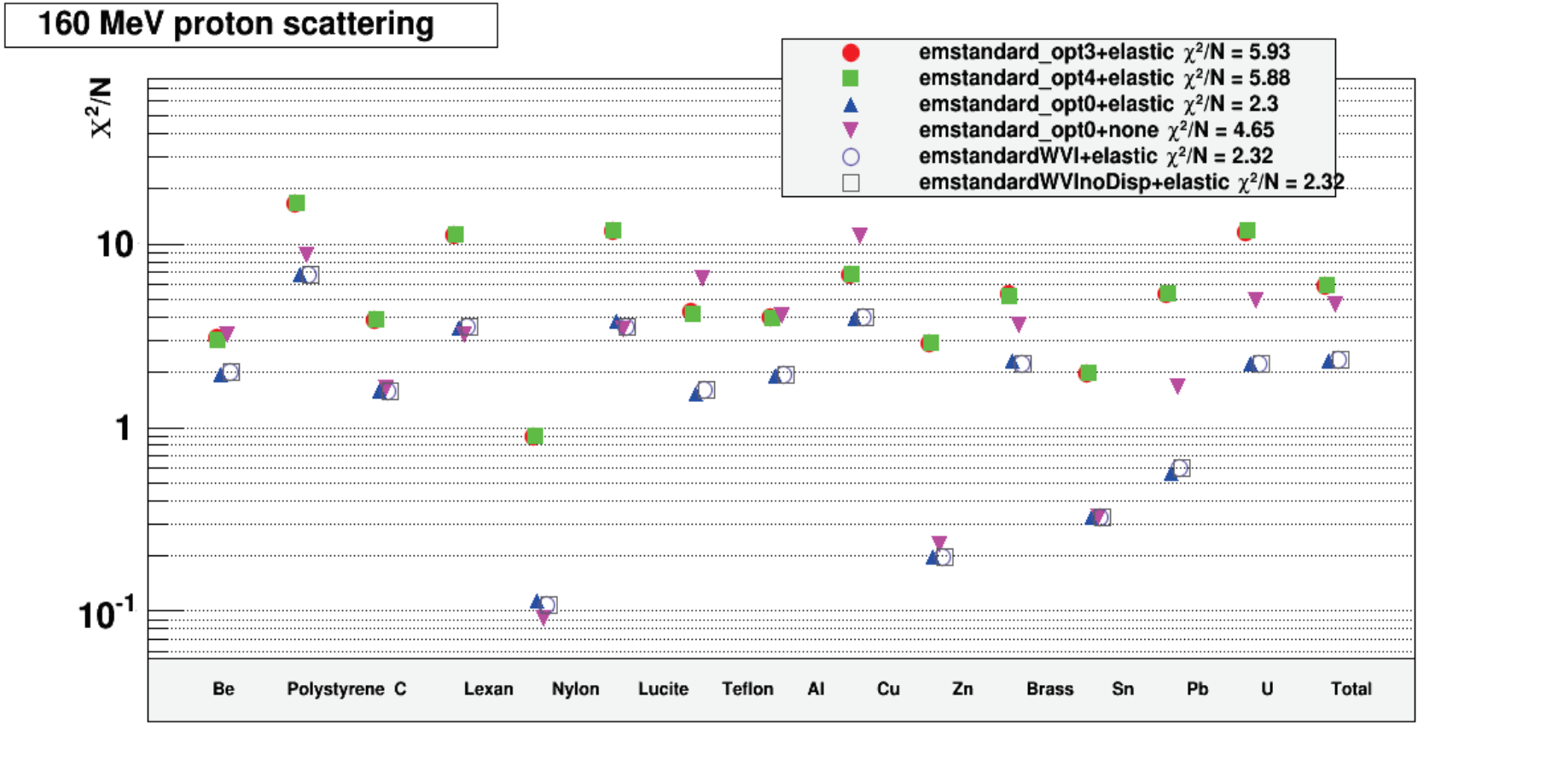
MuScat data – muon scattering off thin targets



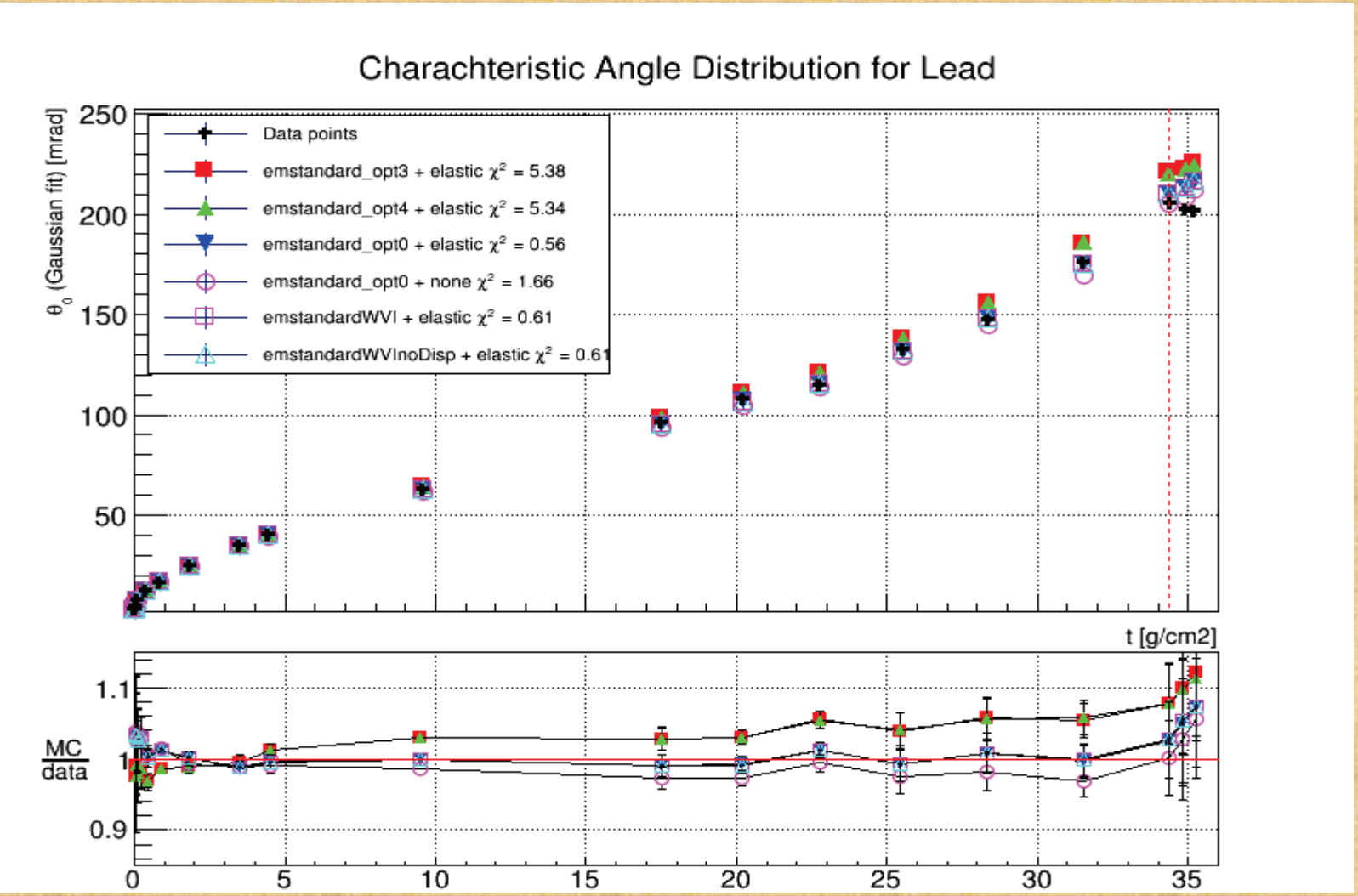
Improved single scattering model
small degradation of Urban model



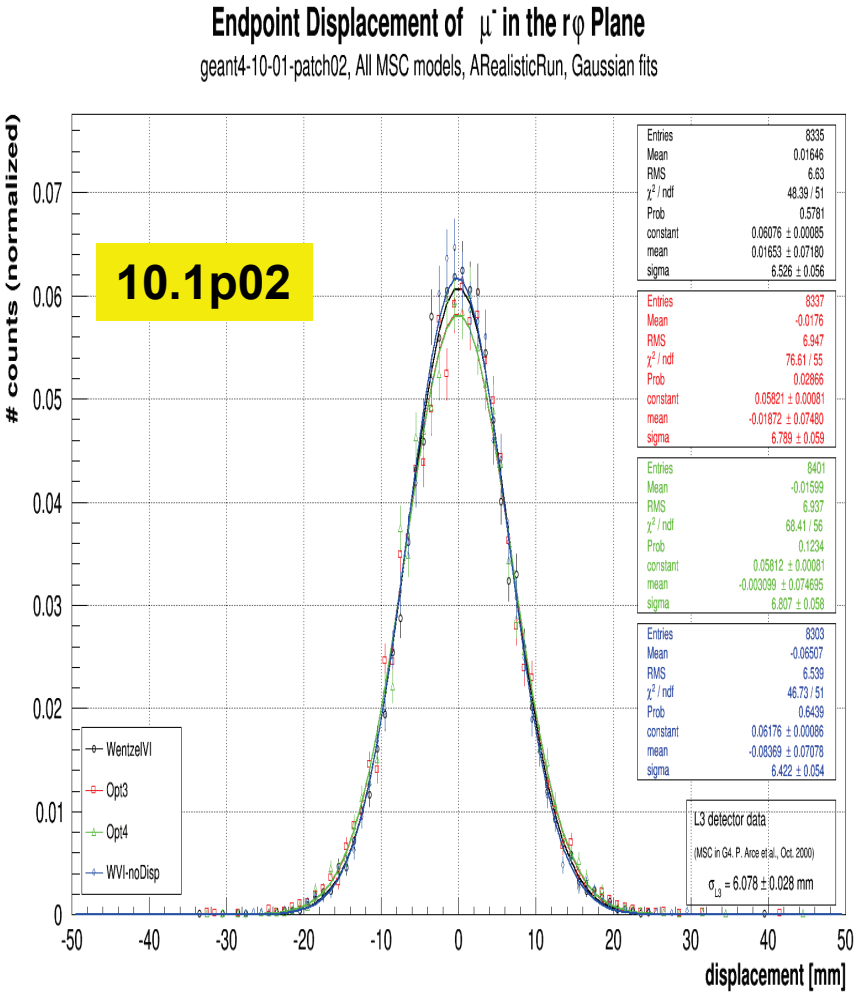
Thick proton scattering benchmark for 10.2beta

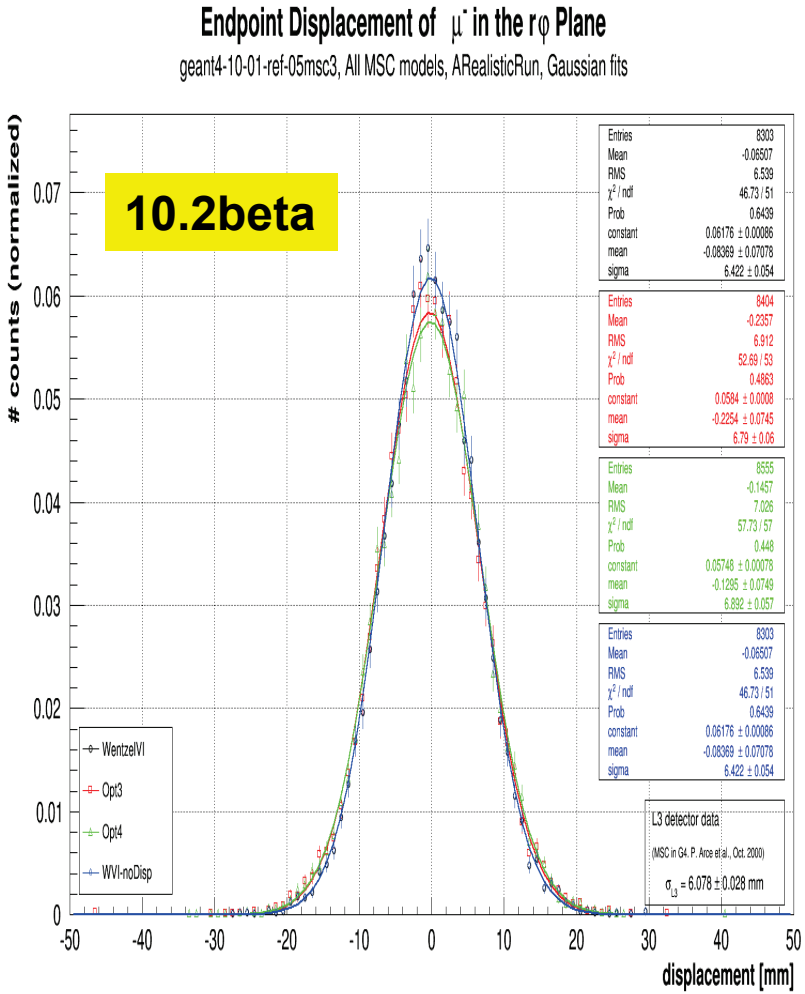


Thick proton scattering benchmark for 10.2beta



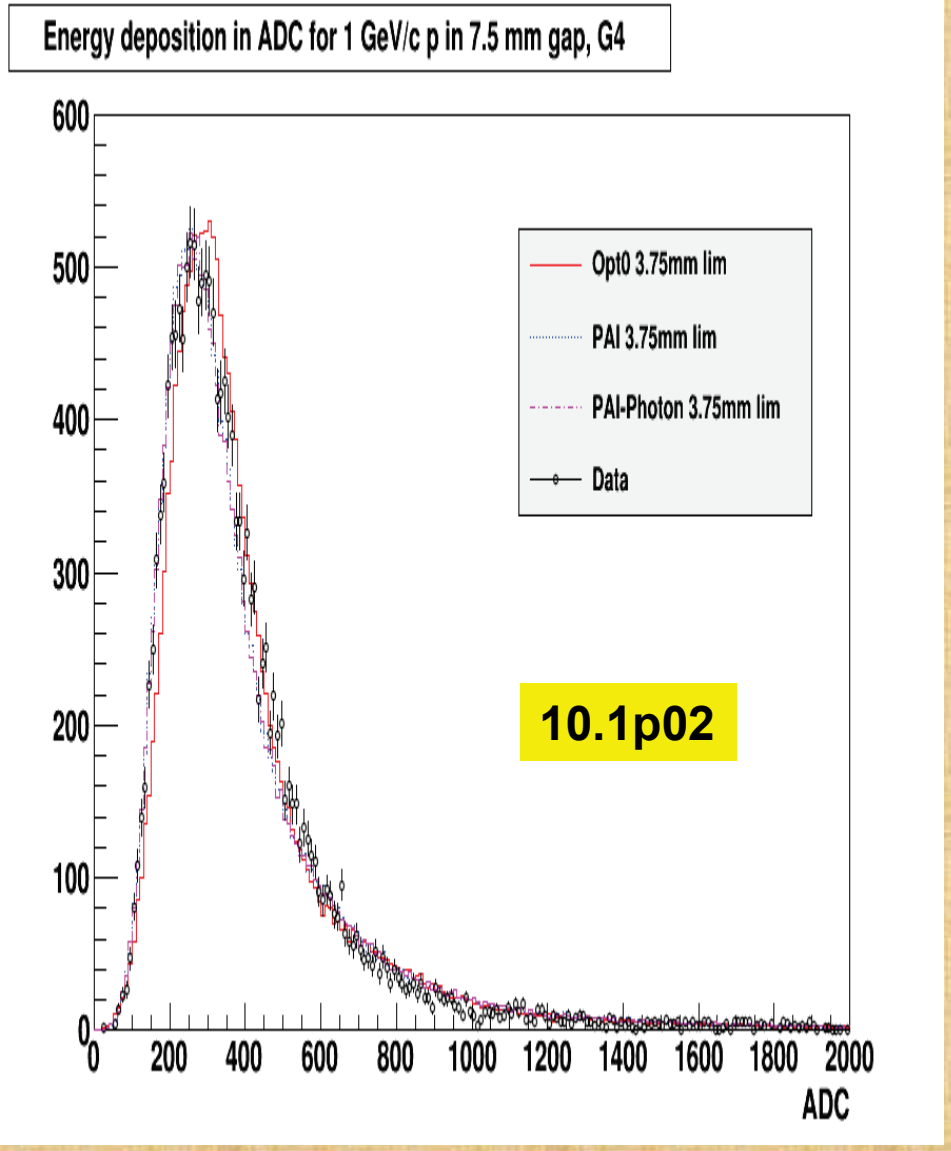
L3 muons from Z->μ+μ–

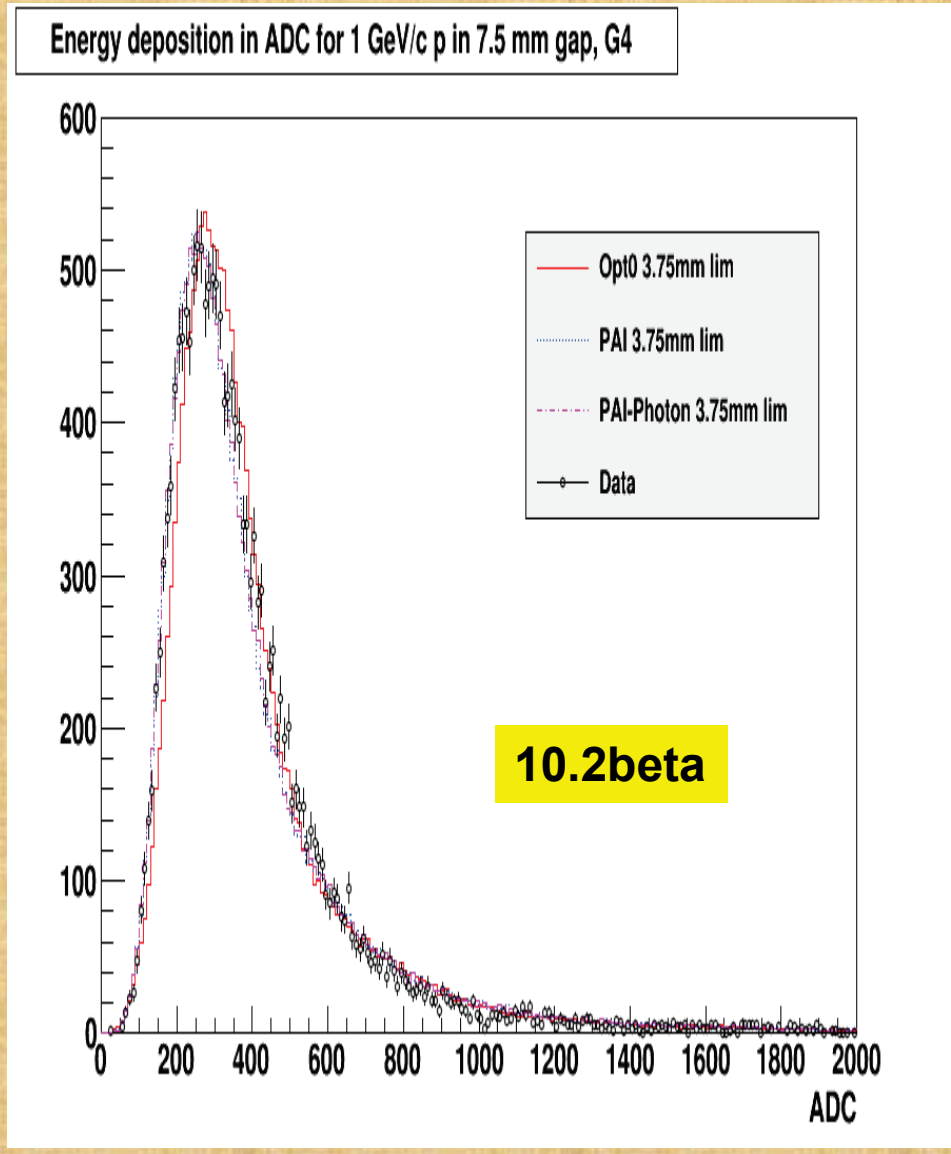




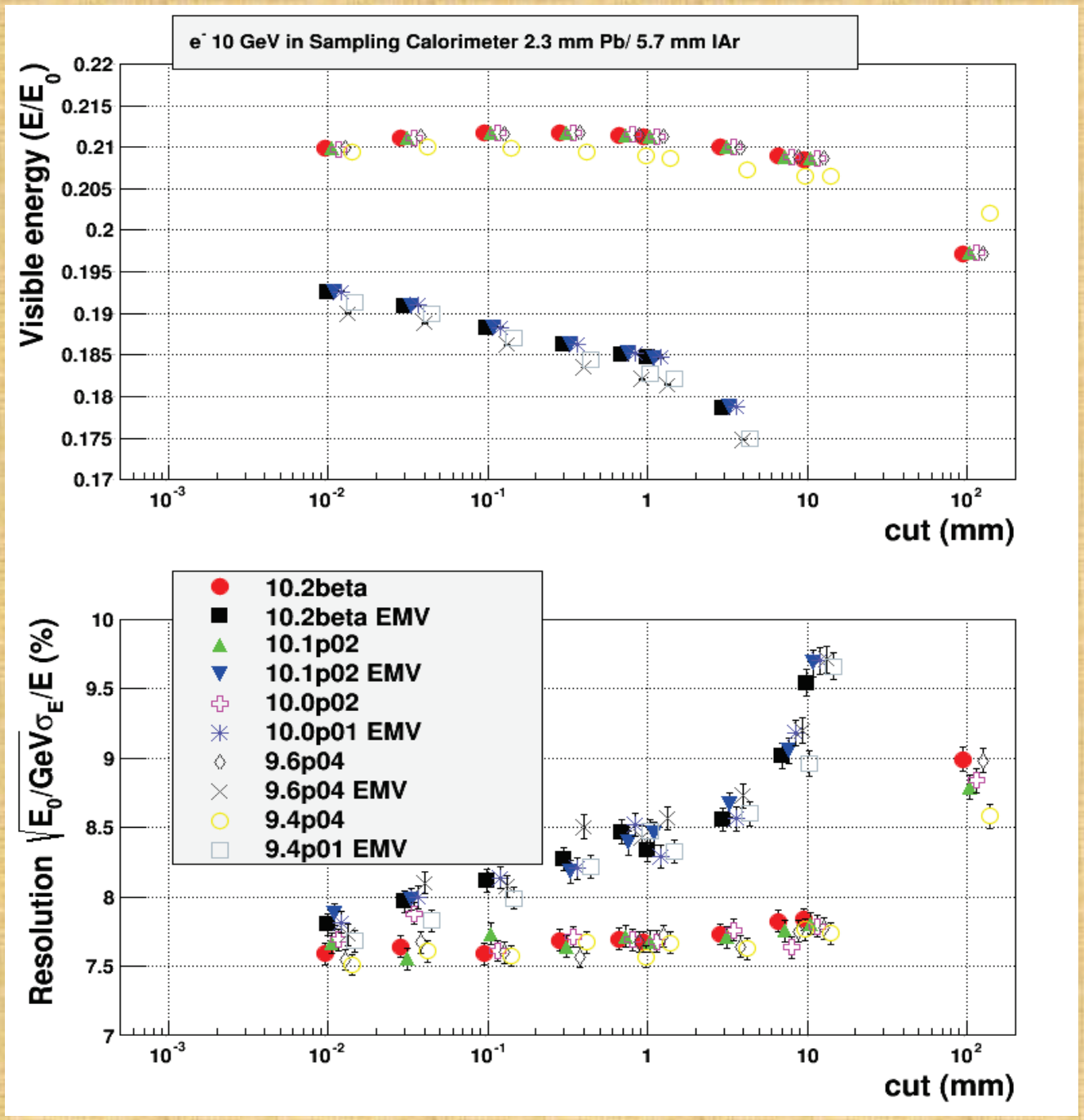
WVI no displacement provides the same result as Opt0

ALICE test beam for ionisation in TPC gas





ATLAS barrel type simplified calorimeter results



Summary

- EM testing suite for 10.1p02 and 10.2beta show good results
  - We do not expect change of calorimeter response and other applications
- New GS model demonstrates a good performance and we need
  - extend validation of updated model
  - prepared for usage in part of production Physics Lists for 10.2 in December
- New configuration options are introduced to be dicussed below

G4EmParameters class

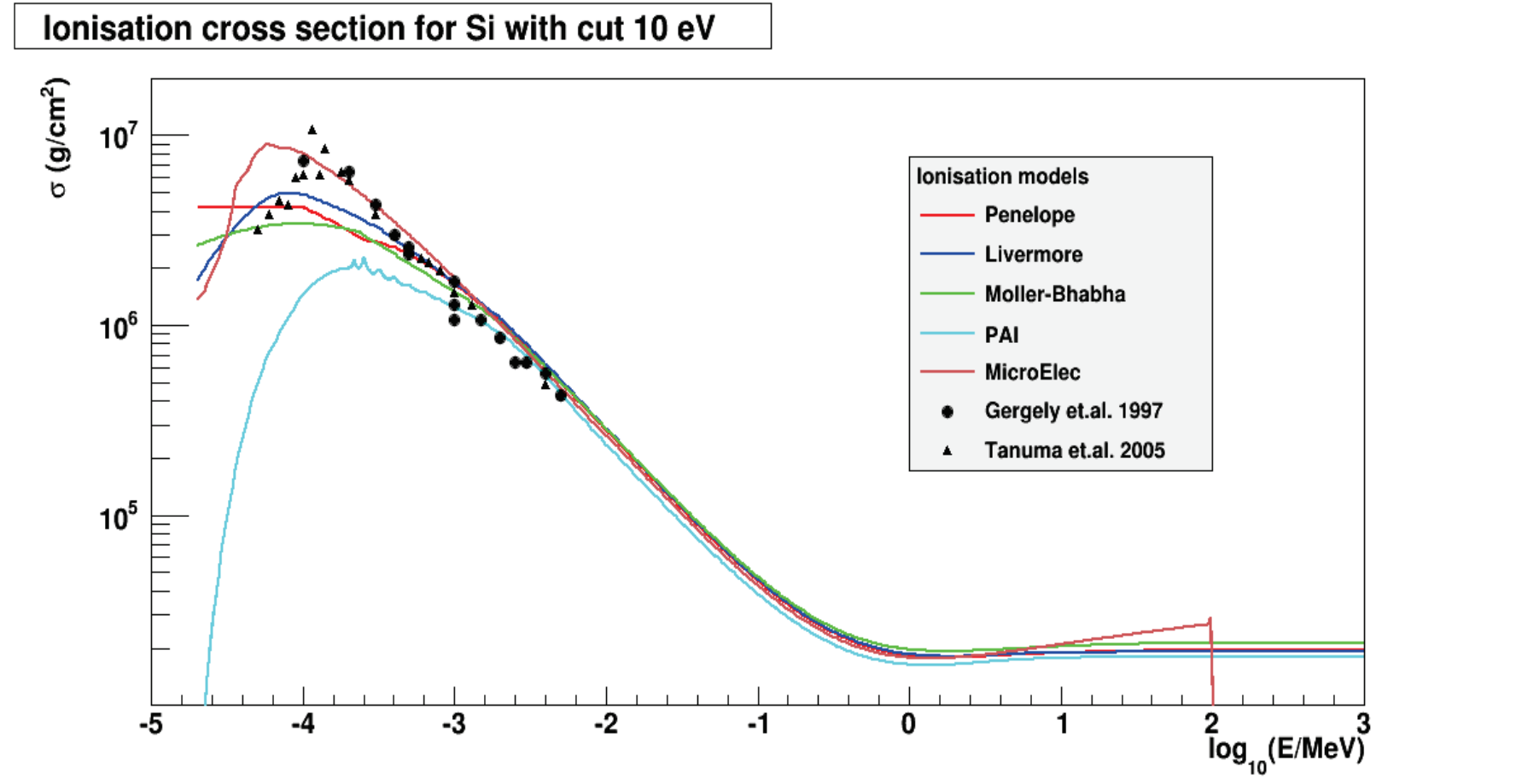
- This class was introduced in 10.1
  - Pure singleton, keeps all EM parameters, c++ and UI interfaces
  - Clean definition of parameters essential for the MT mode
  - EM model, processes, and infrastructure classes read parameters at initialisation
    - In past parameters were set by infrastructure classes
- New UI commands in 10.2beta:

```
/process/em/augerCascade          true
/process/msc/RangeFactorMuHad  0.2
/process/msc/StepLimitMuHad      Simple
/process/em/pixeXSmodel            name
/process/em/pixeElecXSmodel       name
/process/em/AddPAIRegion          all MyRegion PAI
/process/em/AddMicroElecRegion   MyRegion
/process/em/AddDNARegion          MyRegion opt0
```

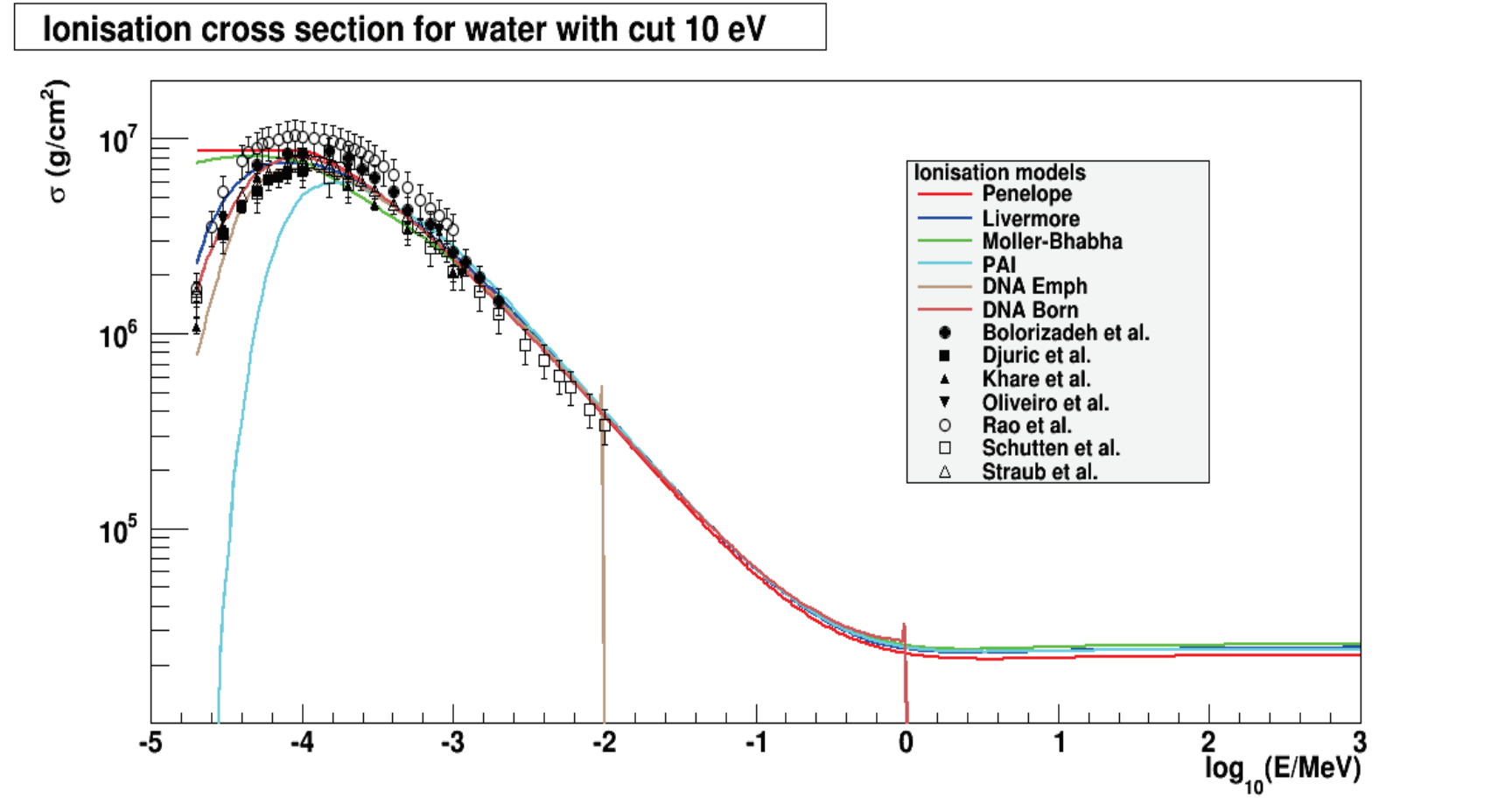
Configration of PAI, MicroElec, DNA

- The goal is to have easy and clean combination of condense history processes/models and discrete processes models
- Can be applied on top of any EM physics from physics_list library
- Defines special physics for the region
  - May be defined for several regions
  - If defined for the world is propagated for all other regions
- Limitation of the method:
  - It is not possible to have standard physics for a region while special physics is defined to the world
  - Condense history physics (standard, livermore, or Penelope) should be configured for the world
- During implementation of the method some problems were identified
  - There are internal applicability limits for the discrete models

Cross section of electron ionisation in Silicon



Cross section of electron ionisation in Liquid water



Proposal

- Add tracking cuts for e+- and muon-hadrons into G4EmParameters separately for discrete and continues processes
- For Physics List with discrete processes use new G4LowECapture
- For condense history case implement tracking cut within G4VEnergyLossProcess