

Physics Issues Addressed in 9.6p01

V. Ivanchenko for Geant4 Collaboration

26 March 2013

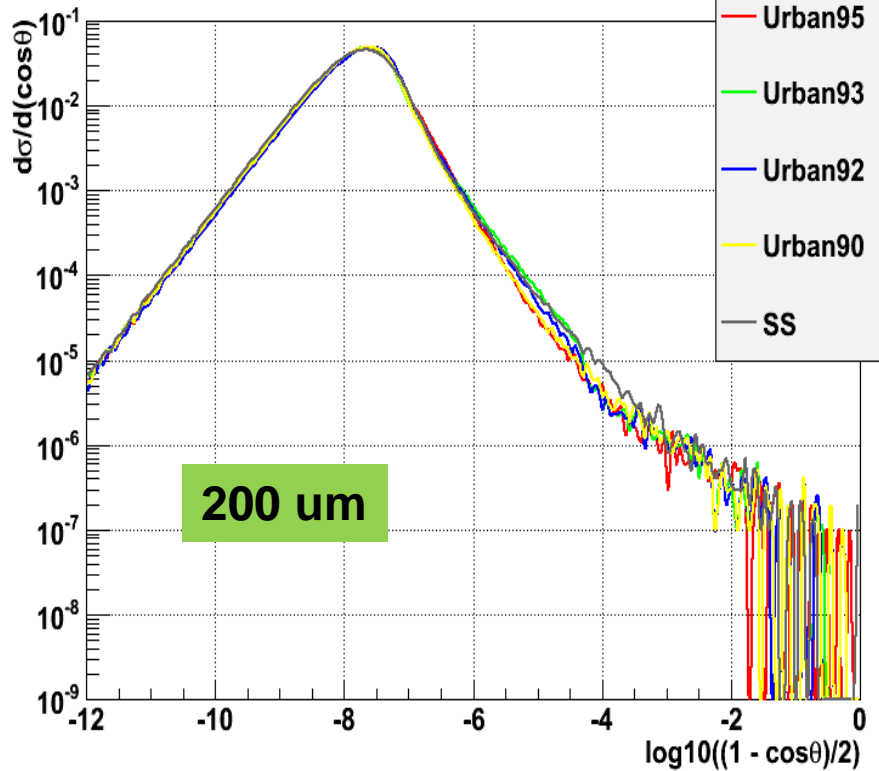
The logo for Geant 4, featuring the text "Geant 4" in a stylized, brown, serif font with a slight shadow effect, set against a light green rectangular background.

Multiple scattering

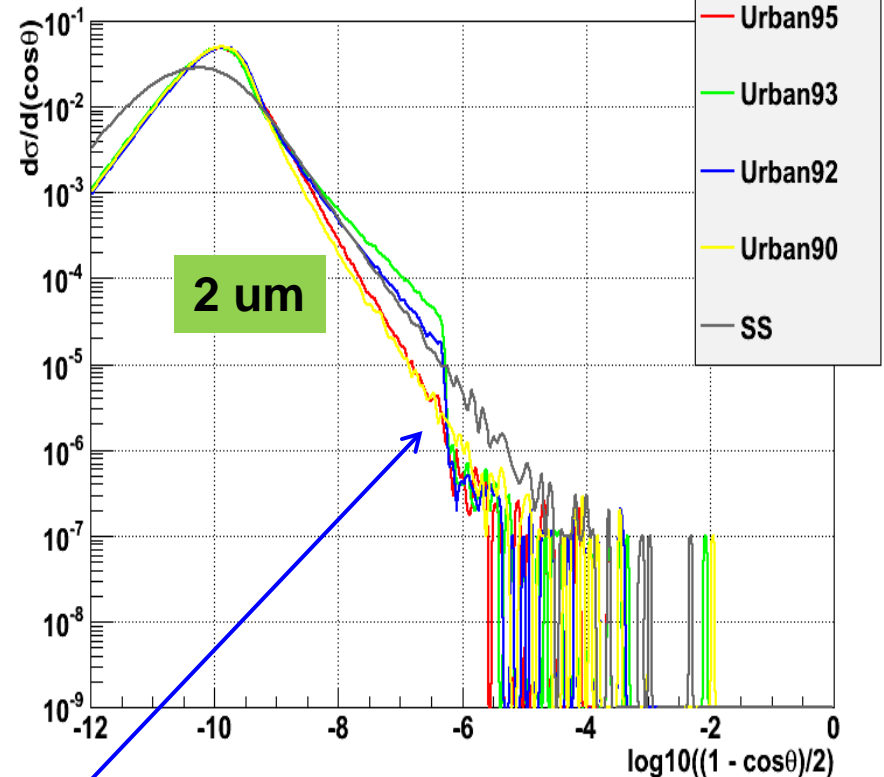
- Fixed bug #1403: trajectory in magnetic field is incorrect if material is not galactic vacuum
 - The bug was connected with migration of multiple scattering actions from PostStep to AlongStep
 - The fix was done inside G4VMultipleScattering classes
G4VMscModel: corrected signature of method SampleScattering().
 - Correction was propagated to all msc models
- Fixed problem reported by ATLAS of G4UrbanMscModel93
 - In 2012 a fast fix (protection) was introduced to address ATLAS report on rare bad scattering in tracker of high energy electrons
 - A cut have been added into sampling of the tail of distribution
 - It was shown that EM shower shape was slightly affected
 - There were problems to reproduce the problem in a simple setup
 - For 9.6p01 the problem was fully understood and fixed
 - Thanks to ATLAS team efforts for analysis of the problem and test productions

Effect of Urban93 protection in thin Silicon layers (Geant4 9.5p01)

e- 2 GeV 200 um Si



e- 2 GeV 200 um Si



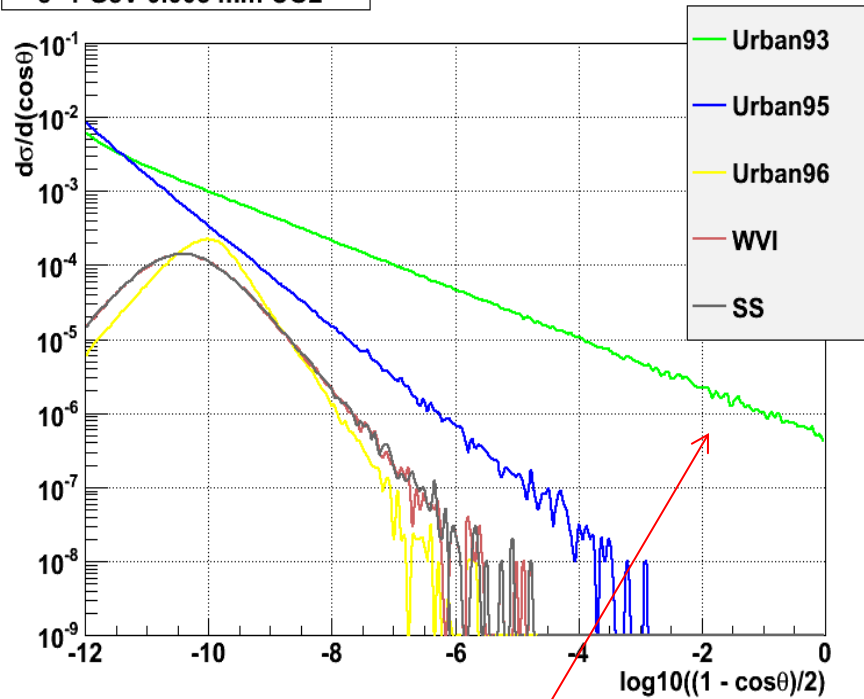
Effect is not visible for larger step size

Protection is Cut to reduce the excessive tail of Urban 93
Side effect on electron line shape tail on per mille level

Worst case: 5 μm step in CO_2

Msc93 no fix

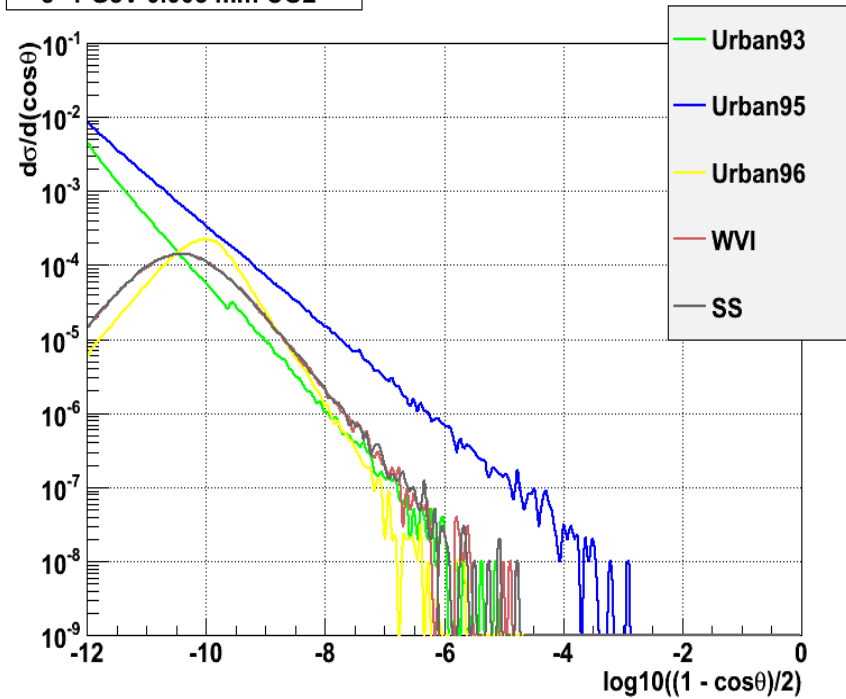
e- 1 GeV 0.005 mm CO_2



Msc93 tail is too big
It is the main problem of the
Msc93 model, no such problem
in other Urban models

Msc93 fix (29 Jan 2013)

e- 1 GeV 0.005 mm CO_2



Msc93 tail similar to single scattering
The recent version msc96 is fully
coincide with single scattering

Other EM problems fixed in 9.6p01

- **Fixed problem report #1402:** no fluorescence gamma in G4LivermorePhotoElectricModel
- **Fixed problem report #1404:** printout in destructor of G4eeTo3PiModel is removed
- **In all Urban msc models extended initialisation of model classes in the StartTracking() method to avoid rare cases of non-reproducibility**

Hadronic physics: cross sections

- **Fixed problem report #1424:** significant memory leak in ion cross-sections
- **Fixes in the new class `G4ComponentAntiNuclNuclearXS`:**
 - Consider anti-protons and anti-neutrons as default particles and ensure that the class may be used also for anti-hyperons
 - **Fixed defects reported by the Coverity tool (mainly pedantic initialisation)**
 - **Class description added**

Hadronic Physics: cascades

- **Fixed problem report #1334:** inside the Binary cascade `G4Scatterer::GetTimeToInteraction()`; one shortcut in the calculation of time was missed, as only one of the two particles was checked. Physics unchanged, but small performance gain of few percent
- **Fixed problem report #1421:** Geant4 hadronic models should not call `abort()` or `exit()`:
 - Mainly inside `INCL++`
 - Also inside `G4NeutronHPThermalScattering`
- **Fixed problem report #1418:** Fix for logic error in `G4QMDGroundStateNucleus::packNucleons()`

Radioactive decay

- **Fixed problem report #1359:** radioactive decay on flight does not conserve energy
 - Problem was fixed by adding of the boost to decay products
 - The parent energy is considered for fully stripped ion
 - Some difference in energy/momentum balance is still visible but at much less level than before

Physics Lists

- **G4EmStandardPhysics_option4**: substituted the new low-energy Compton model (developed by Monarch University) by the old Livermore Compton model to avoid numerical problems in high statistic runs
- Monarch University Compton scattering model is already fixed and the fix will be available with the next patch

Geant 4

Summary

- Some problems were identified in Geant4 EM and hadronic physics
- We strongly recommend to migrate to 9.6p01
- Known problems of 9.6p01 (to be fixed in the next patch):
 - New Compton scattering model developed by Monash University group has rare numerical problem
 - Livermore ionisation models has problem with low-energy limit
 - for Opt4 this low-energy limit should be increased:
`/process/eLoss/minKinEnergy 100 eV`

