



ALICE Geant4 Simulations

Geant4 Technical Forum

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27-03-2012



Recent Productions

2



- LHC12a3a - **Geant4 v9.4.p03**, anchor run 126007, QGSP_BERT_EMV+optical, 1M events
- LHC12a3b - **Geant4 v9.5**, anchor run 126007, QGSP_BERT_EMV+optical, 1 M events

Check of compatibility of two Geant4 versions

New PL

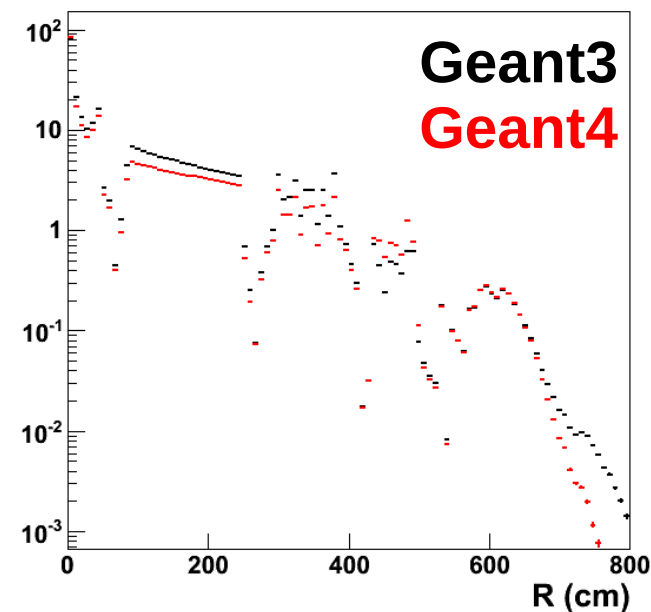
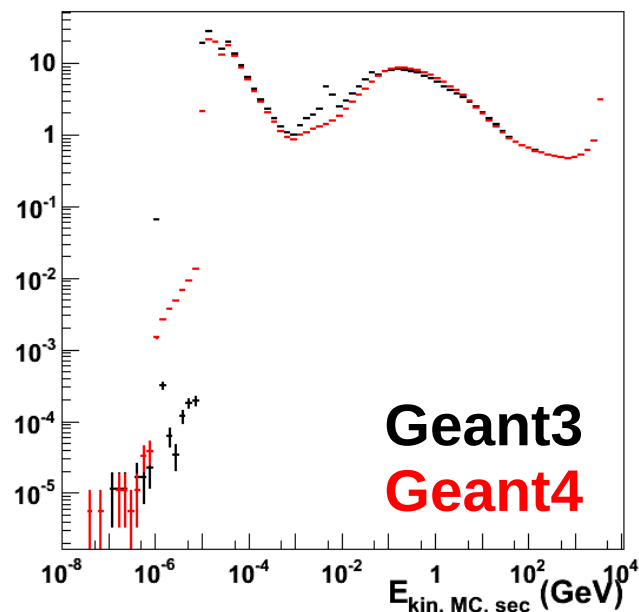
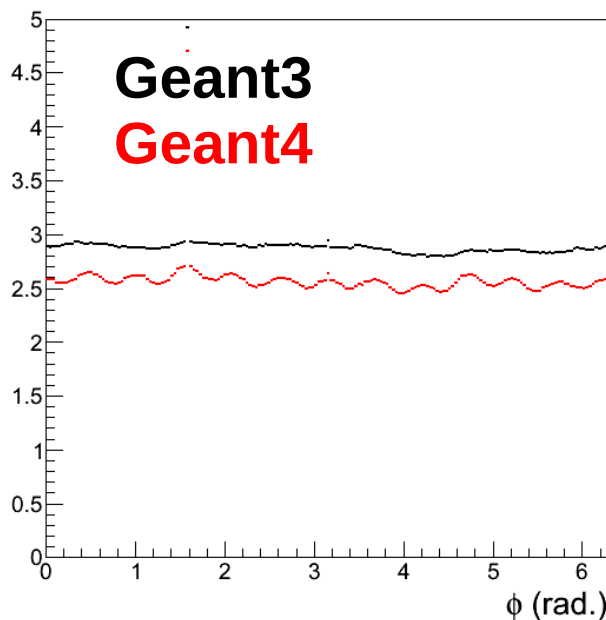
- LHC12a3c - **Geant4 v9.5**, anchor run 119862, **FTFP_BERT_EMV**+optical, 2M events
- LHC12a3d - **Geant3**, anchor run 119862, 2M events

Requested for systematic studies for ALICE analyses

- LHC12a3e - **Geant4 v9.4.p03**, anchor run 119161, QGSP_BERT_EMV+optical, 2M events
- LHC11h3a Geant3 anchor run 119161

Requested for systematic studies for ALICE analyses

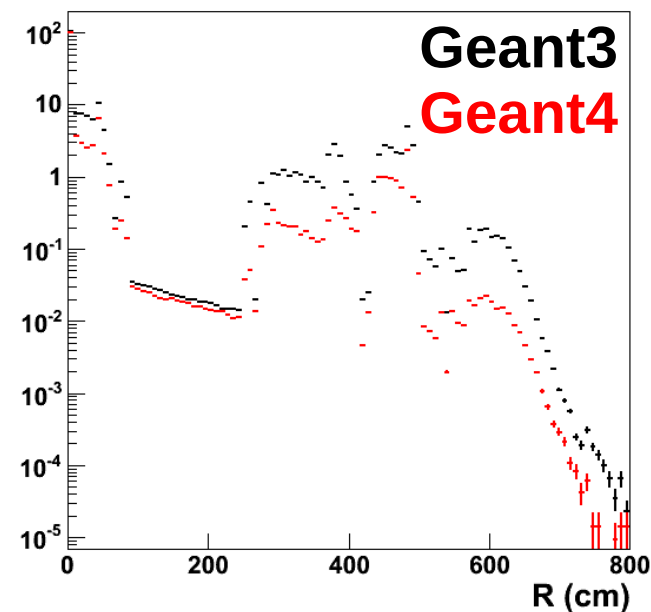
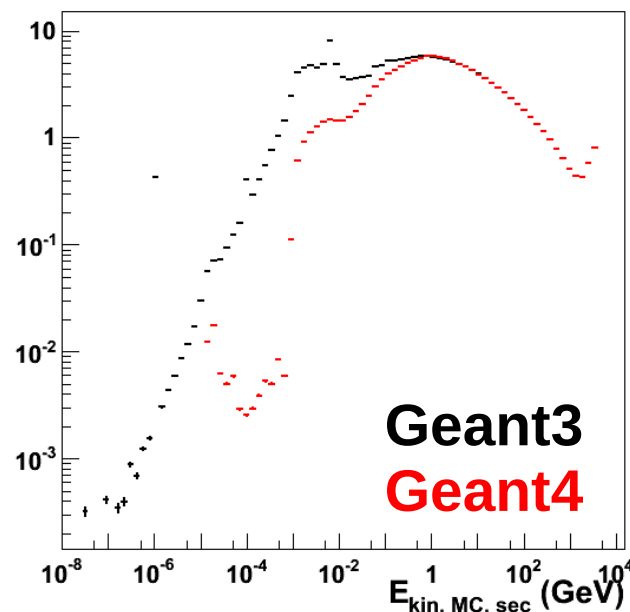
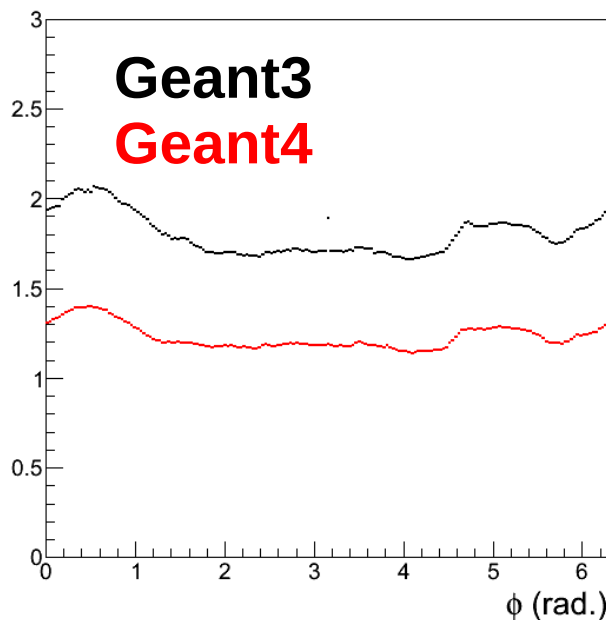
Charged Secondaries



- Geant3 produced more charged secondaries than Geant4 (factor 1.2)
 - At all ϕ
 - At all R
 - at intermediate E_{kin} (e.g. 10^{-2} GeV)
- Geant4 charged secondaries show a stronger modulation with phi than Geant3 secondaries

Geant4=G4 v9.5 FTFP_BERT_EMV+optical

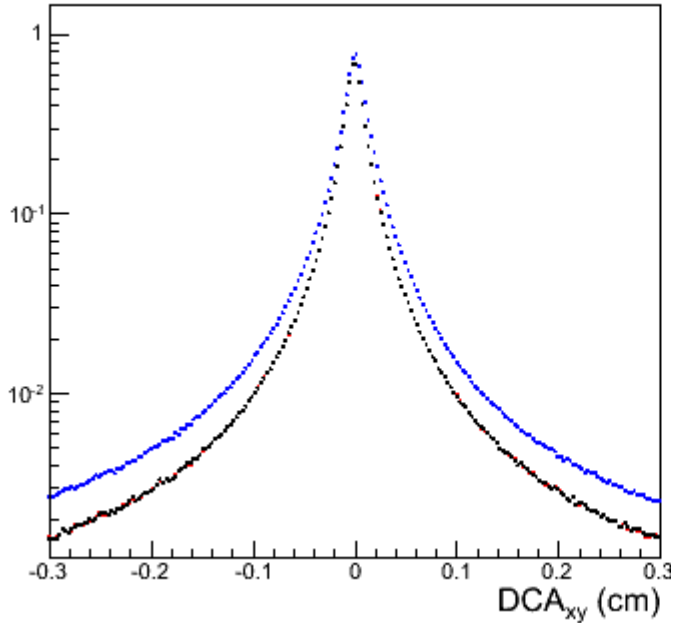
Neutral Secondaries



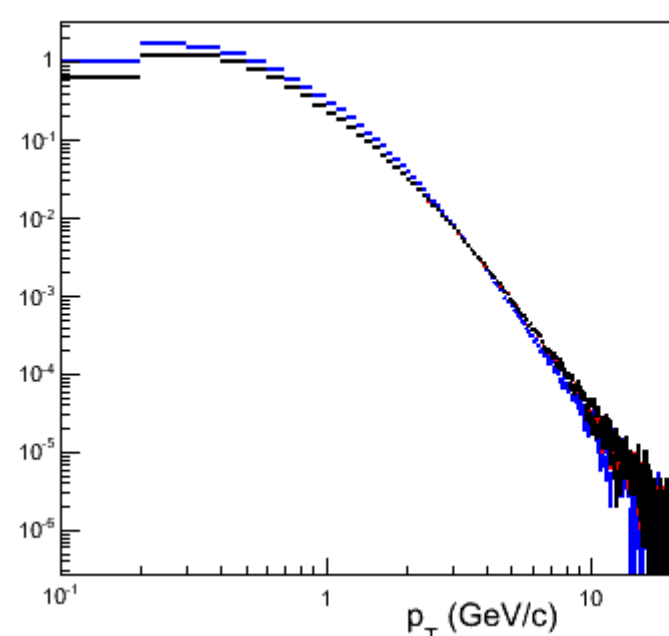
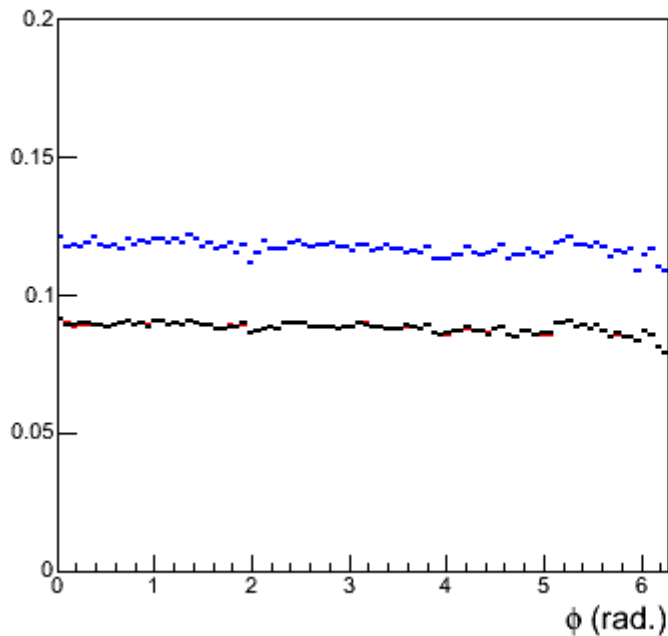
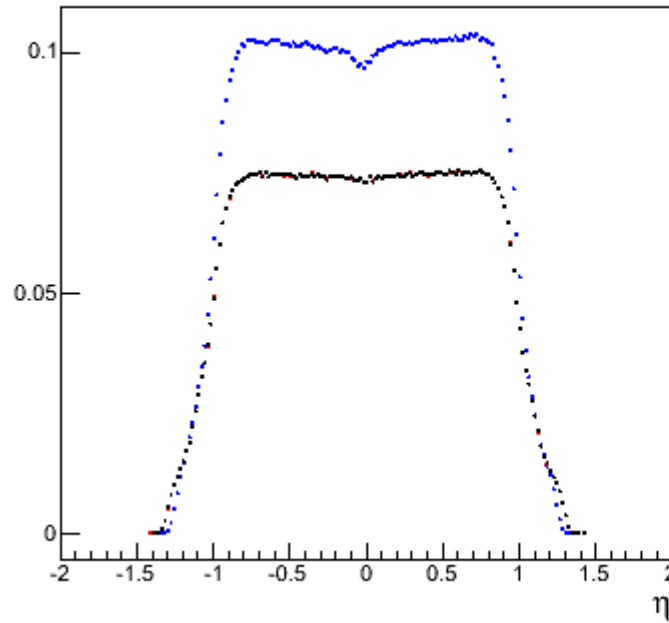
- Geant3 produced more neutral secondaries than Geant4 (factor 1.5)
 - At all ϕ
 - At all R, except TPC range
 - Especially at intermediate and low E_{kin}

Geant4=G4 v9.5 FTFP_BERT_EMV+optical

Global tracks



Global tracks



- Properties of reconstructed ITS-TPC tracks are similar in Geant3 and Geant4
- Event generator Pythia6 Perugia-0 underestimates particle yield but shape of distribution is similar

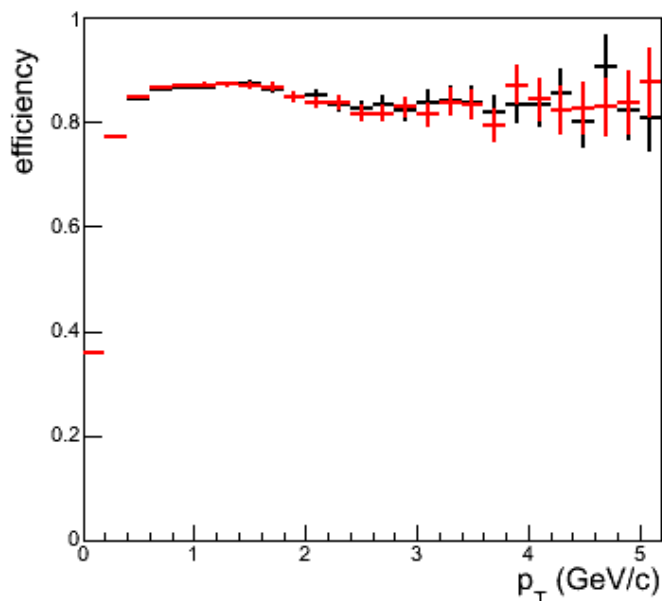
— **Geant3**

— **Geant4**

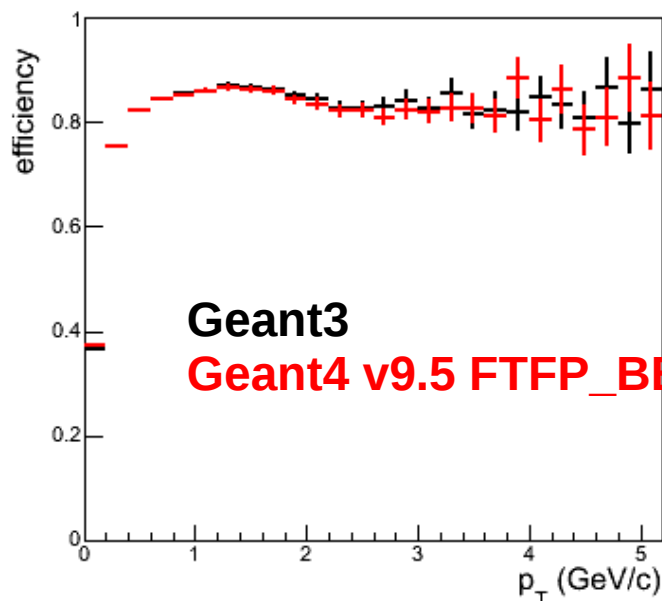
v9.5 FTFP_BERT_EMV+optical

— **ALICE**

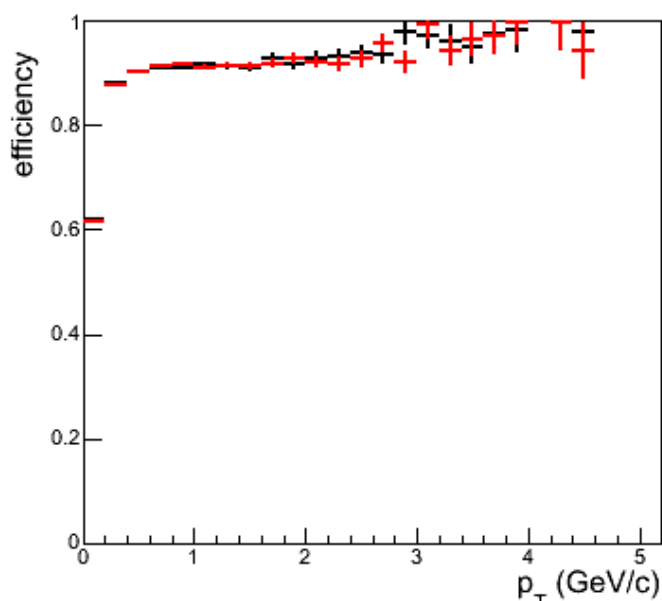
Global tracks



TPC tracks

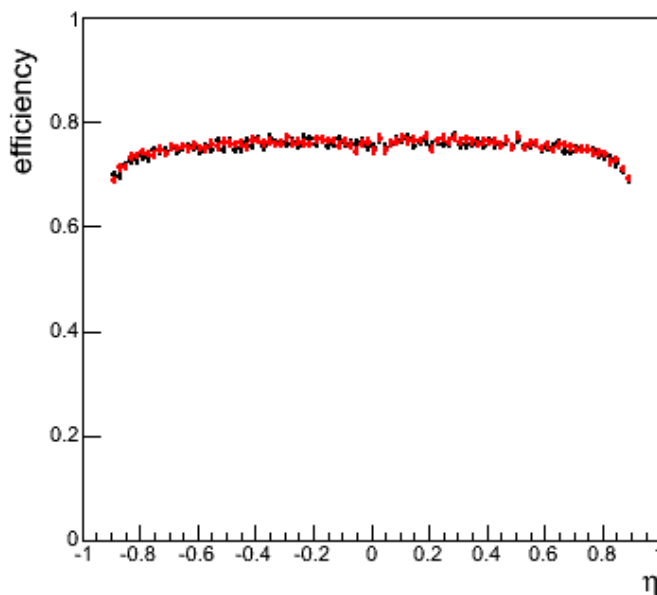
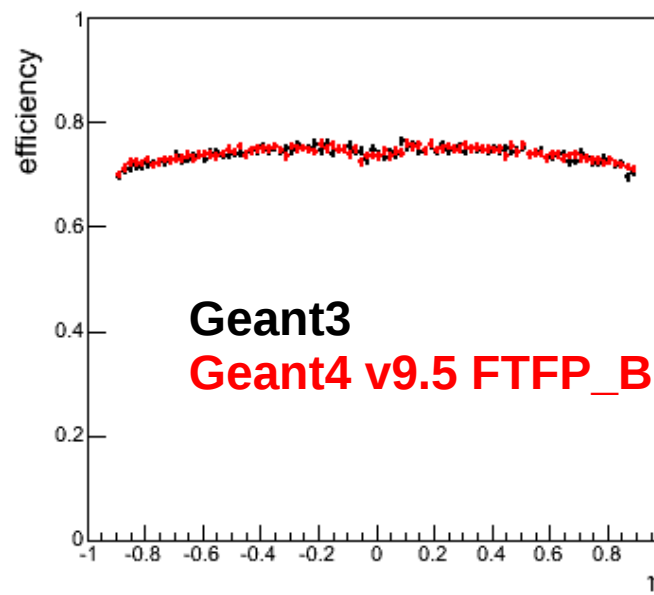


ITS_SA tracks



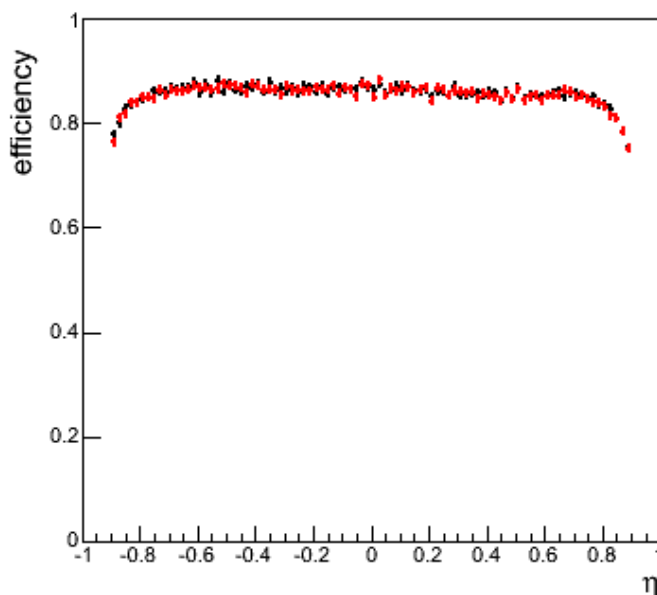
- Reconstruction efficiency of ITS-TPC tracks measured in Geant3 and Geant4 simulations are in good agreement with each other

ITS-TPC Reconstruction Efficiency η

Global tracks**TPC tracks**

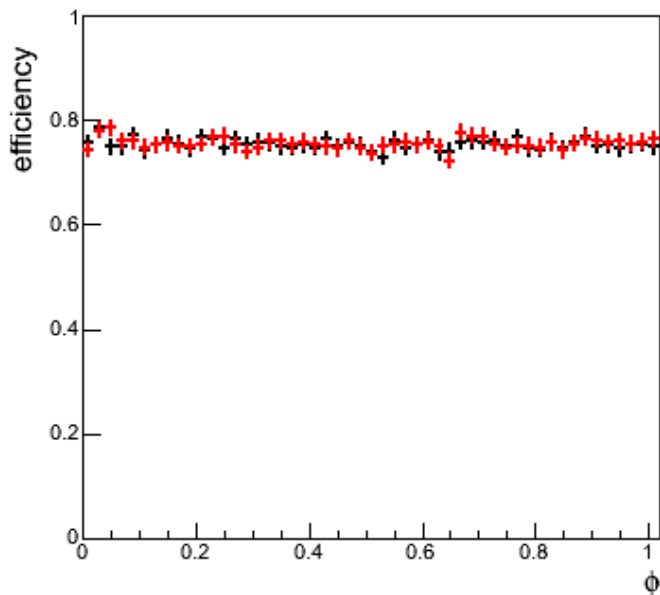
Geant3

Geant4 v9.5 FTFP_BERT_EMV+optical

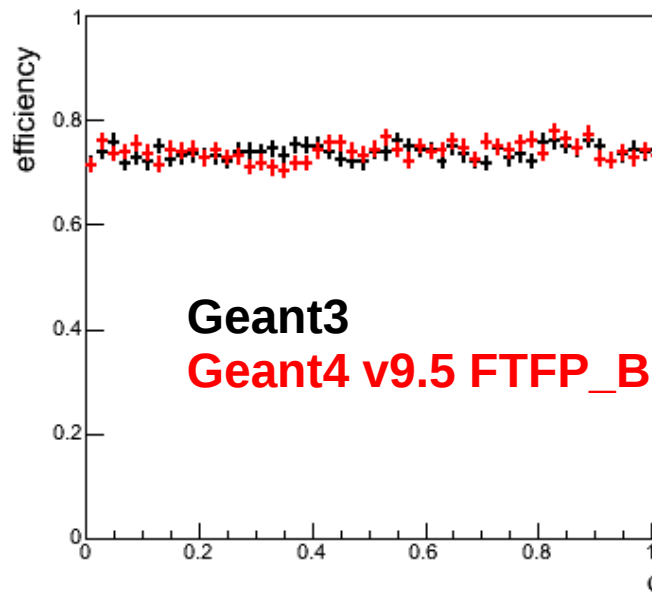
ITS_SA tracks

- Reconstruction efficiency of ITS-TPC tracks measured in Geant3 and Geant4 simulations are in good agreement with each other

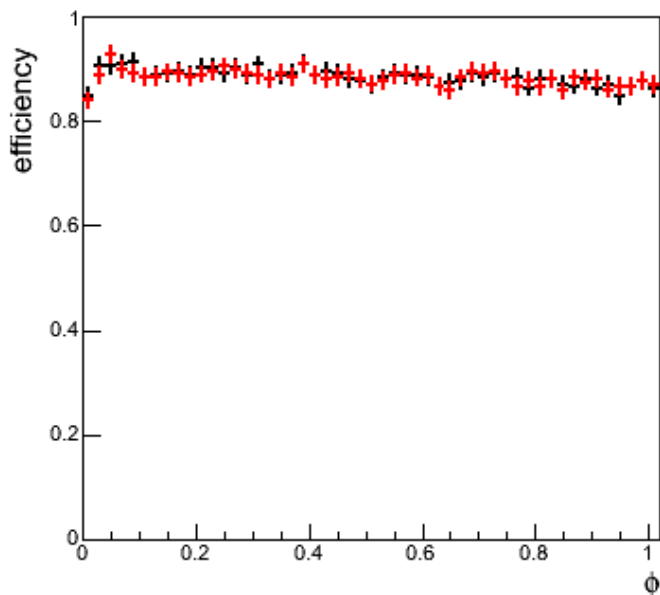
Global tracks



TPC tracks

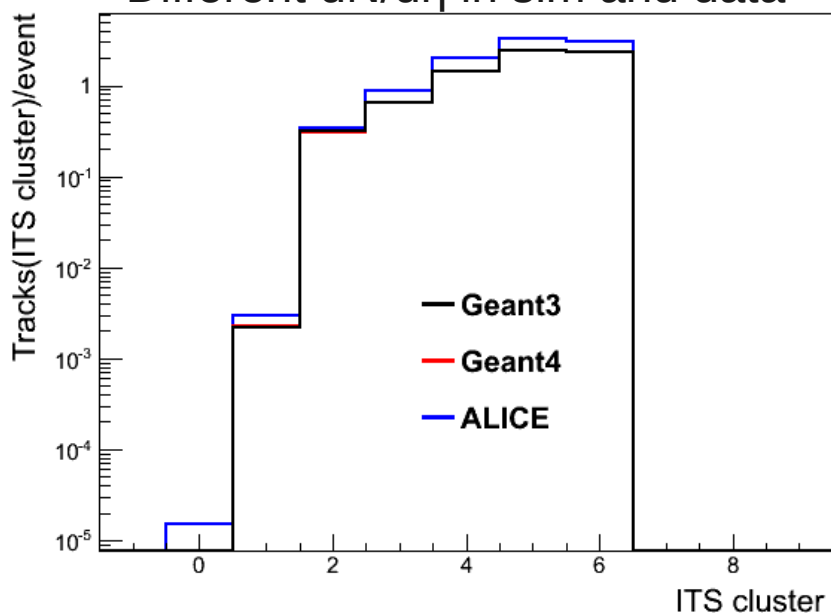


ITS_SA tracks

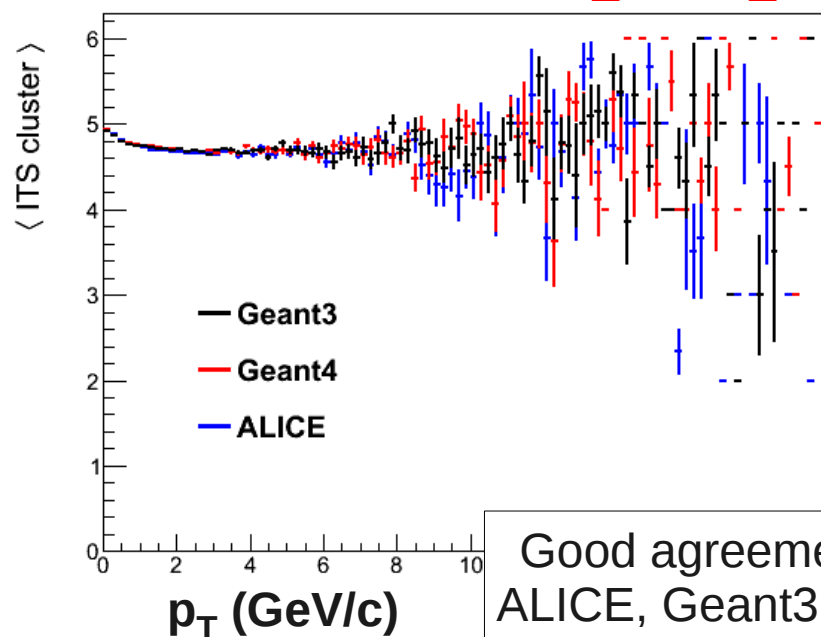


- Reconstruction efficiency of ITS-TPC tracks measured in Geant3 and Geant4 simulations are in good agreement with each other

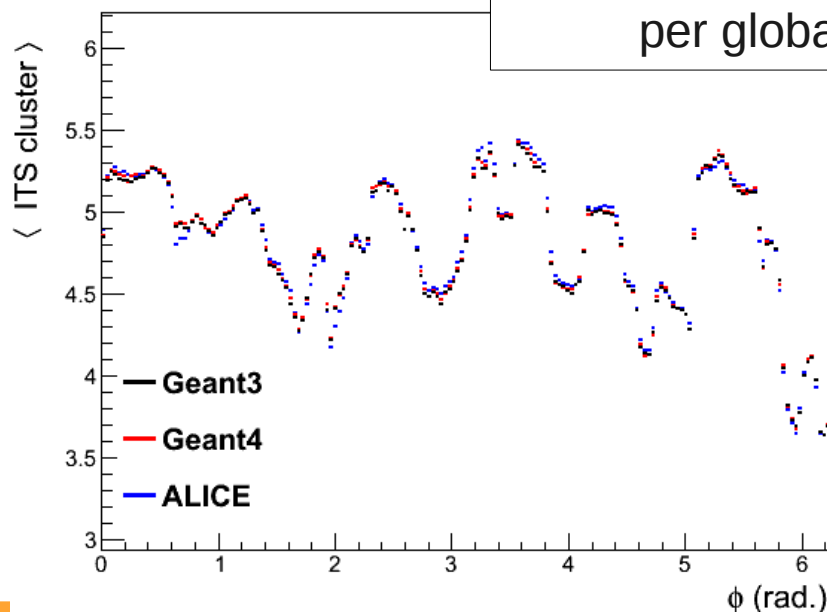
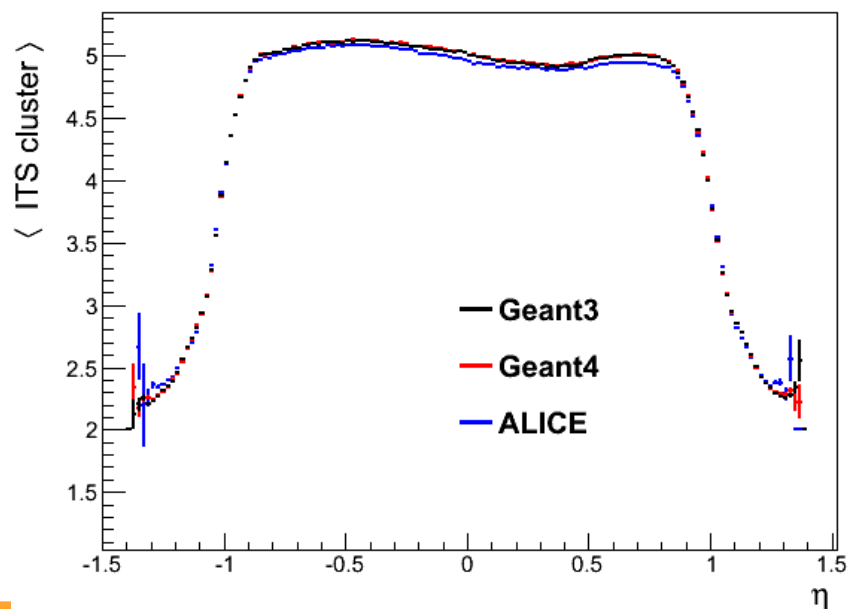
Different $dN/d\eta$ in sim and data



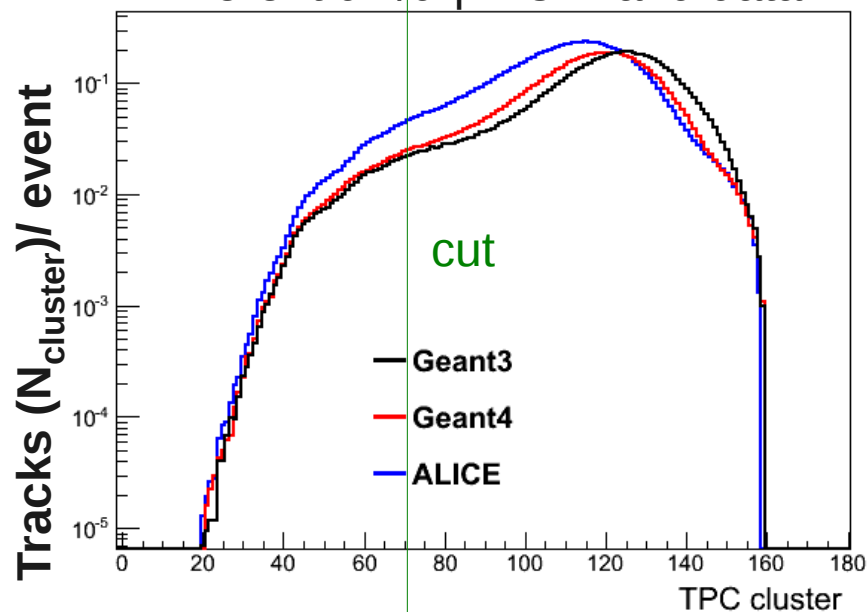
Geant4 v9.5 FTFP_BERT_EMV+optical



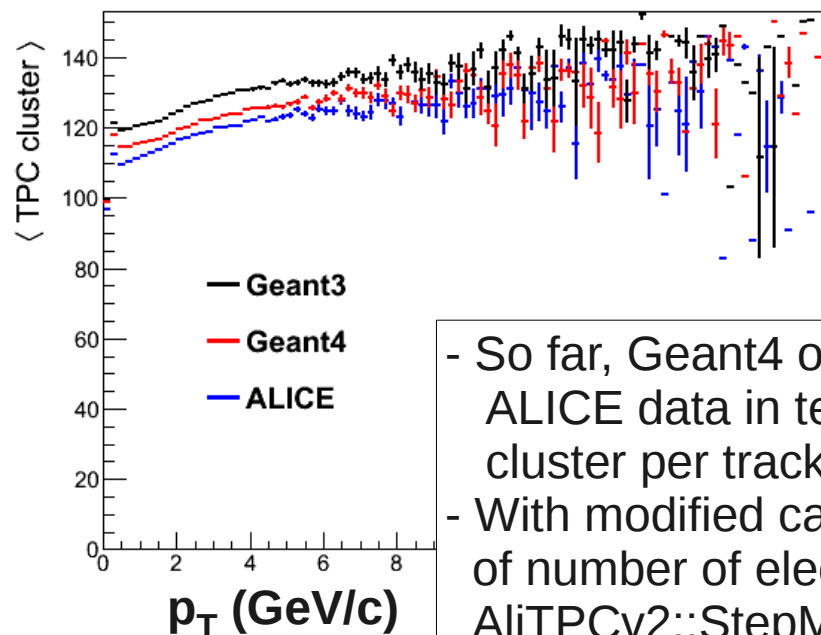
Good agreement between ALICE, Geant3 and Geant4 in terms of ITS clusters per global track



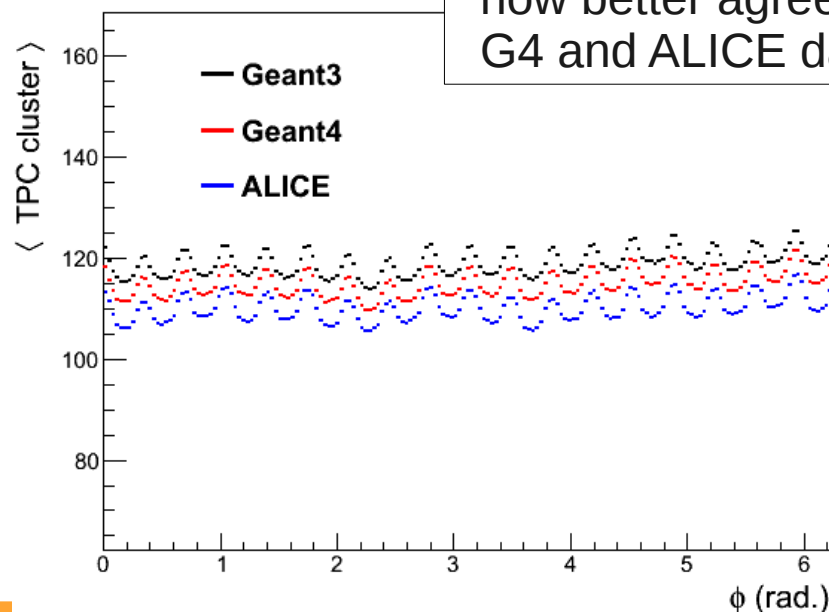
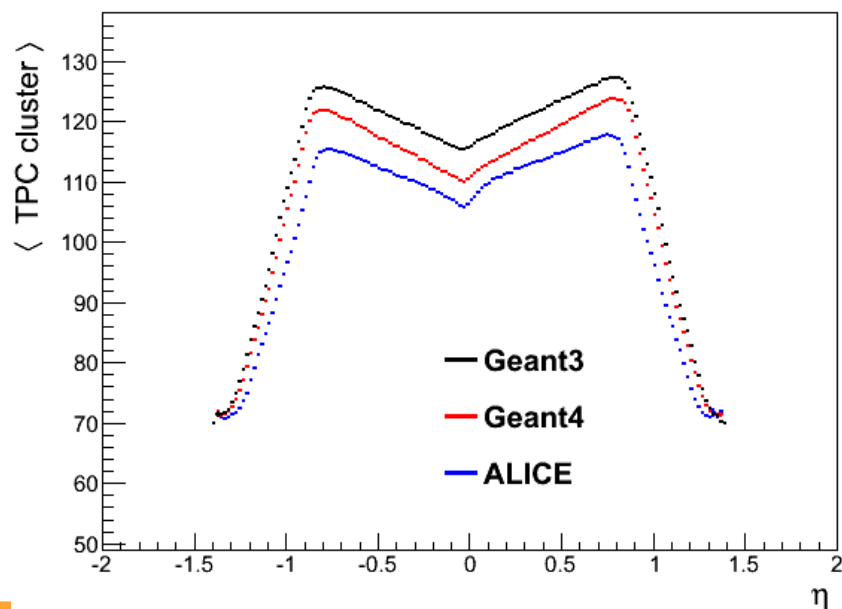
Different $dN/d\eta$ in sim and data



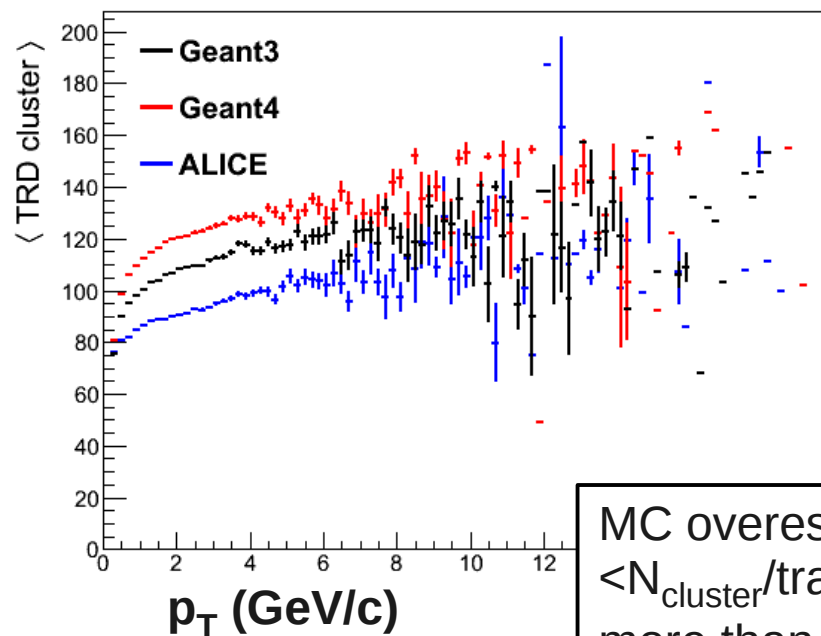
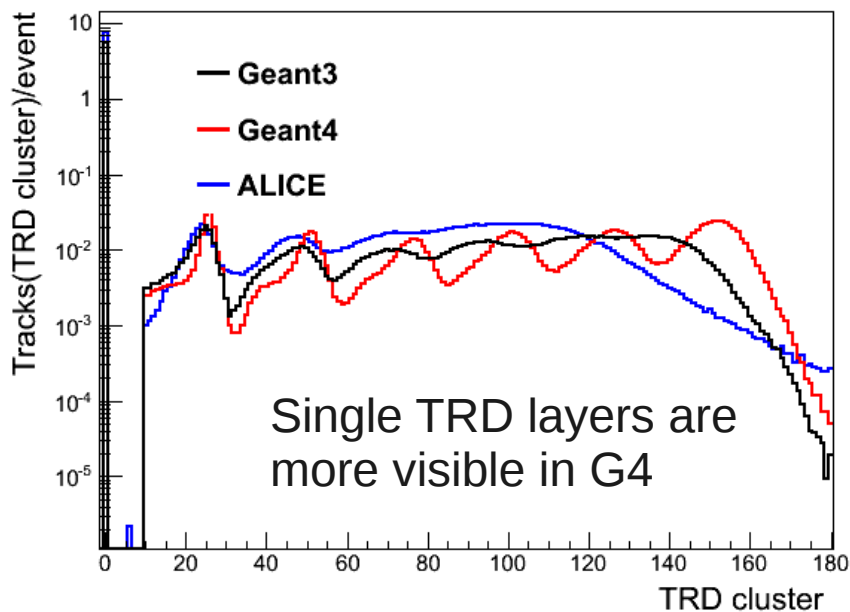
Geant4 v9.5 FTTP_BERT_EMV+optical



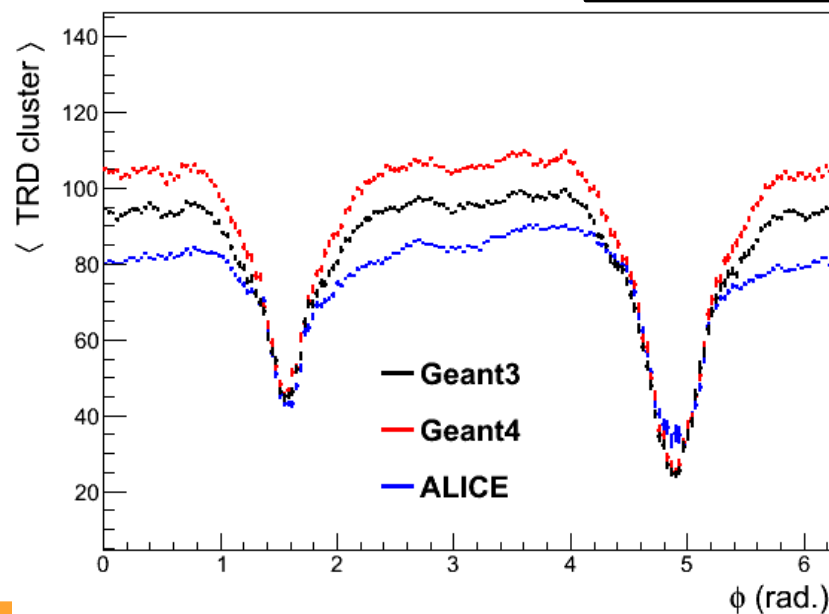
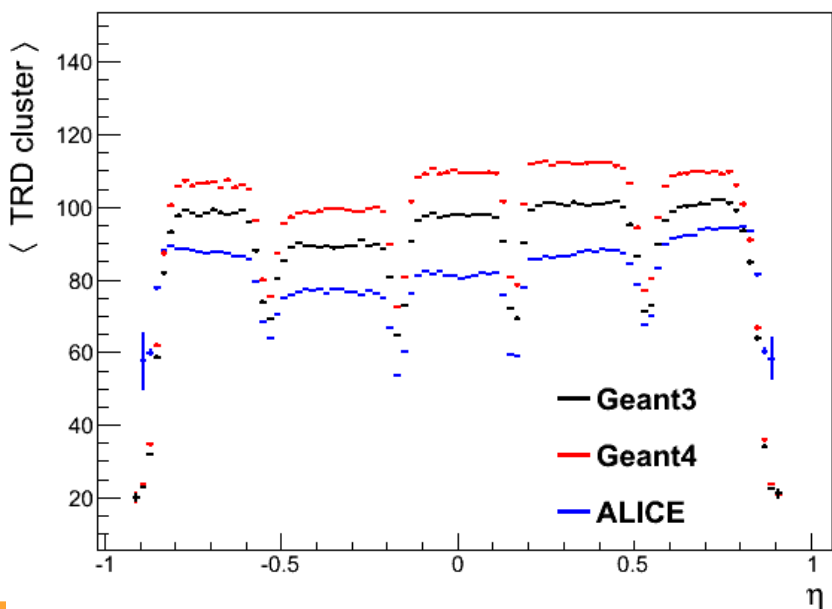
- So far, Geant4 overestimated ALICE data in terms of TPC cluster per track.
- With modified calculation of number of electrons in AliTPCv2::StepManager, now better agreement between G4 and ALICE data



Geant4 v9.5 FTFP_BERT_EMV+optical

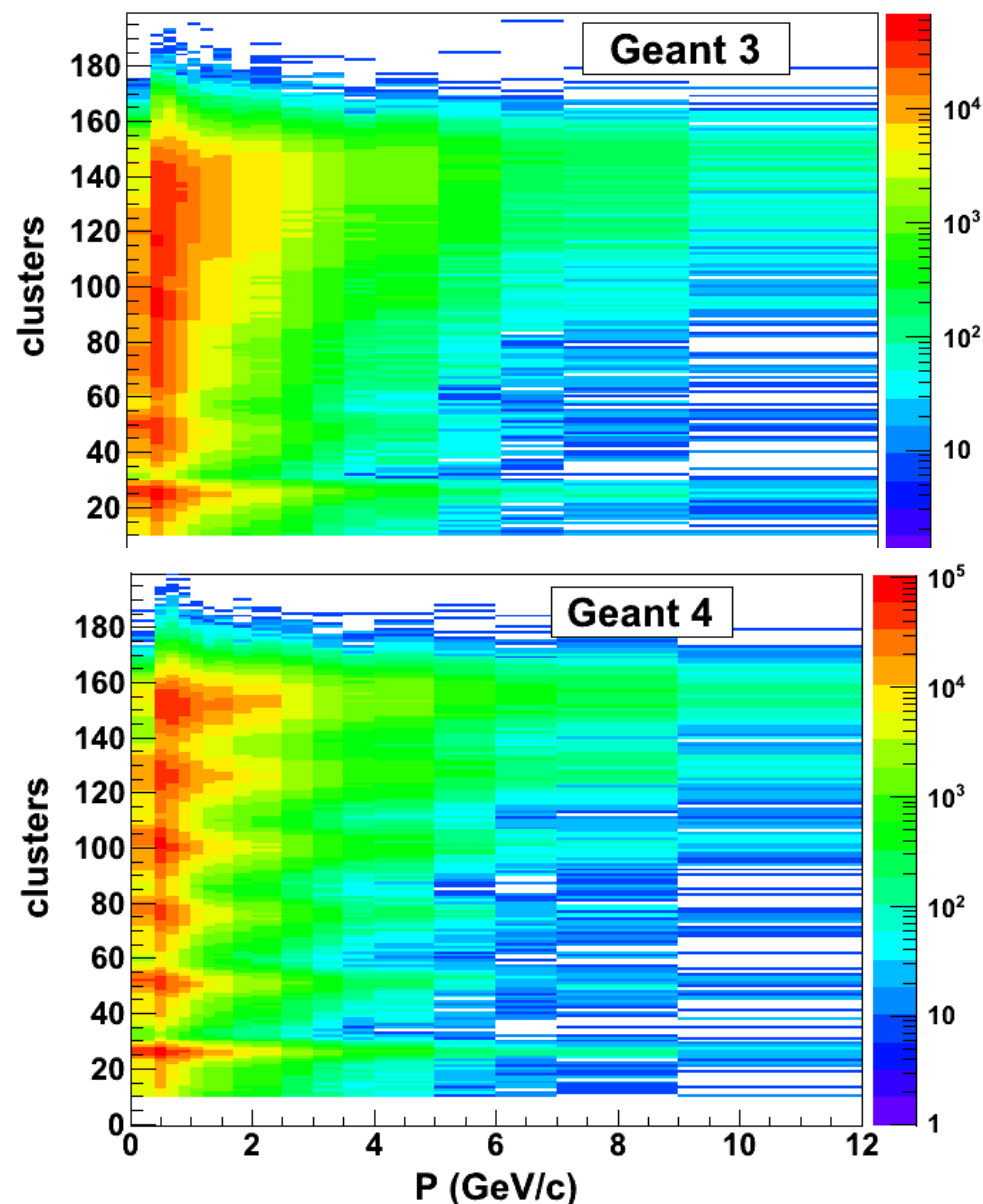


MC overestimate
 $\langle N_{\text{cluster}}/\text{track} \rangle$, G4
more than G3



TRD clusters

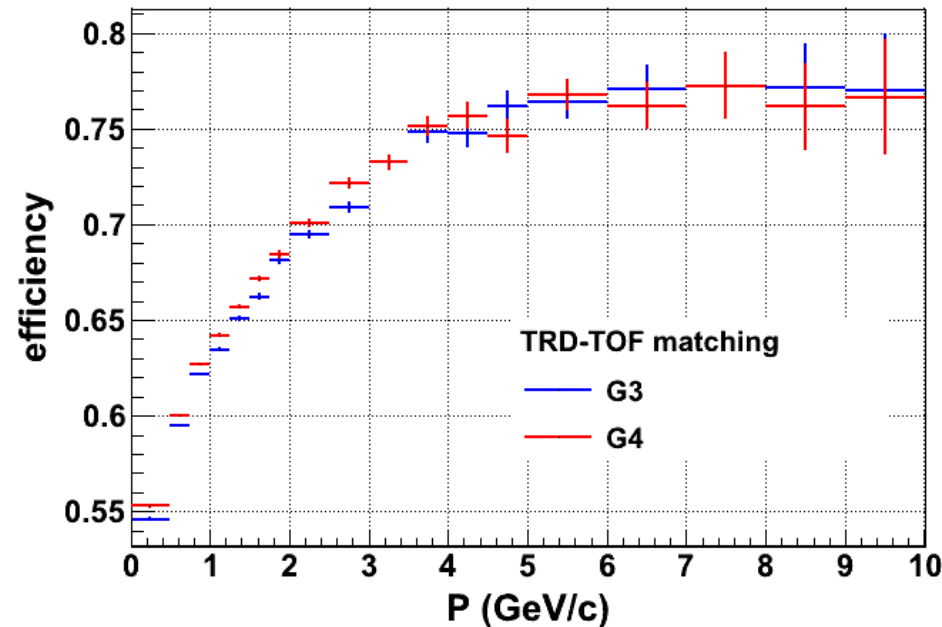
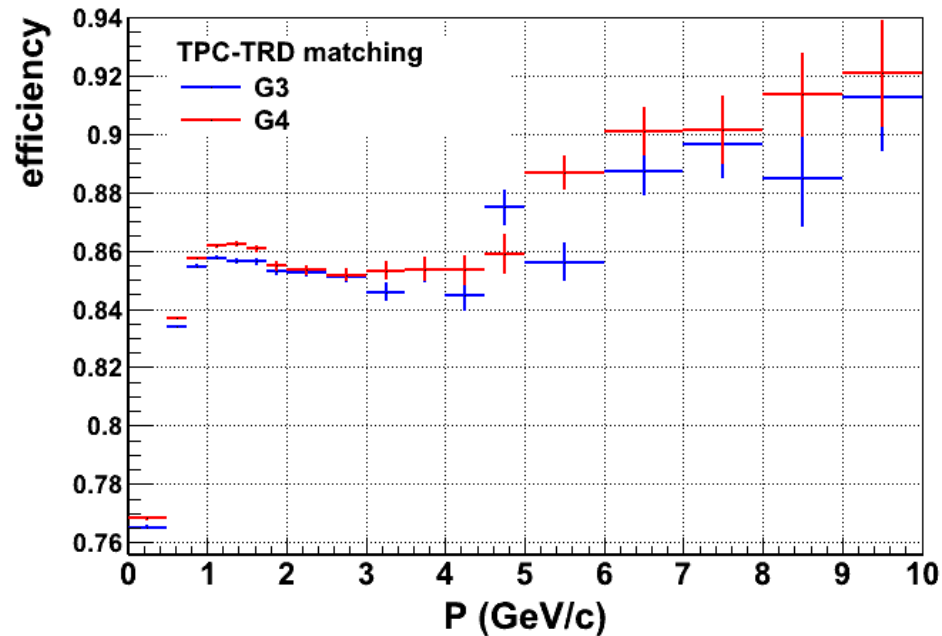
Geant4 v9.5 FTFP_BERT_EMV+optical



- energy deposition in TRD is quite sharp for all TRD tracklets in G4 as compared to G3 (and ALICE data)
- One possible explanation could be that the cuts for the delta ray electron production are too strong and only the energy deposition for the primary particles are taken into account
- “Cuts – ranges” seem to be in agreement
- Under further investigation

Plots by Ionut Arsene

TRD: track matching



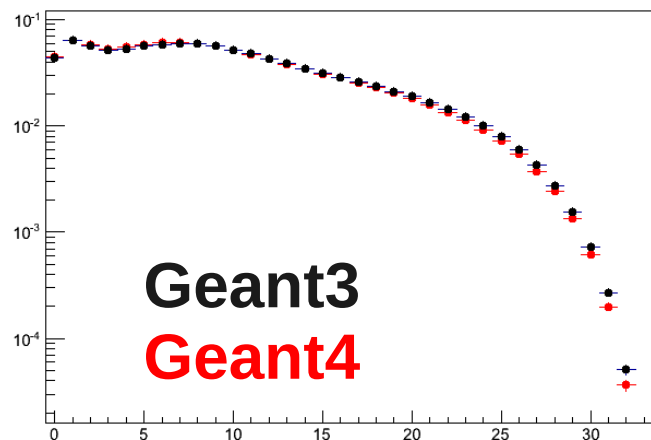
Geant4 v9.5 FTFP_BERT_EMV+optical

- Matching efficiency between TPC-TRD and TRD-TOP as function of transverse momentum is in agreement between Geant3 and Geant4 (and ALICE data)
- However, Geant4 results are slightly higher

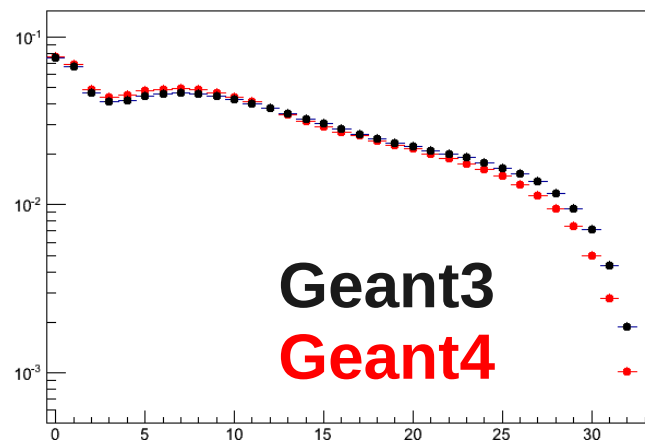
Plots by Ionut Arsene

V0 multiplicity

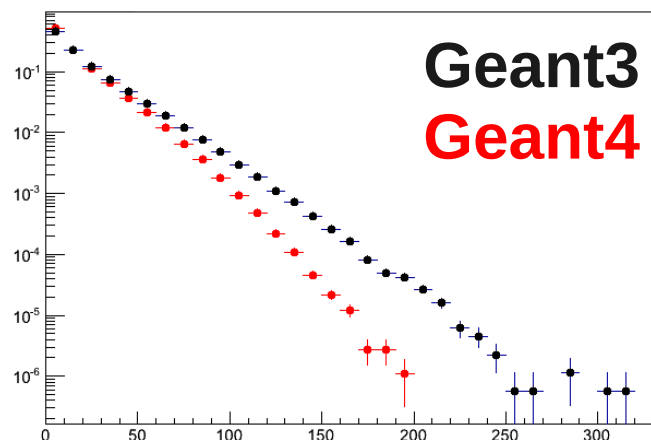
Geant4 v9.5 FTFP_BERT_EMV+optical



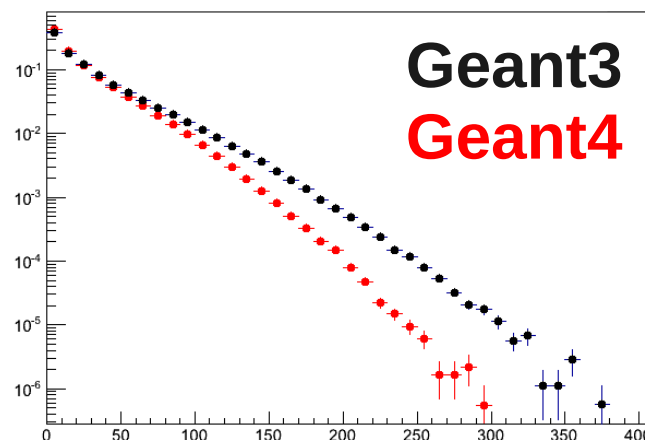
Number of fired scintillators V0A



Number of fired scintillators V0C



Reconstructed multiplicity V0A

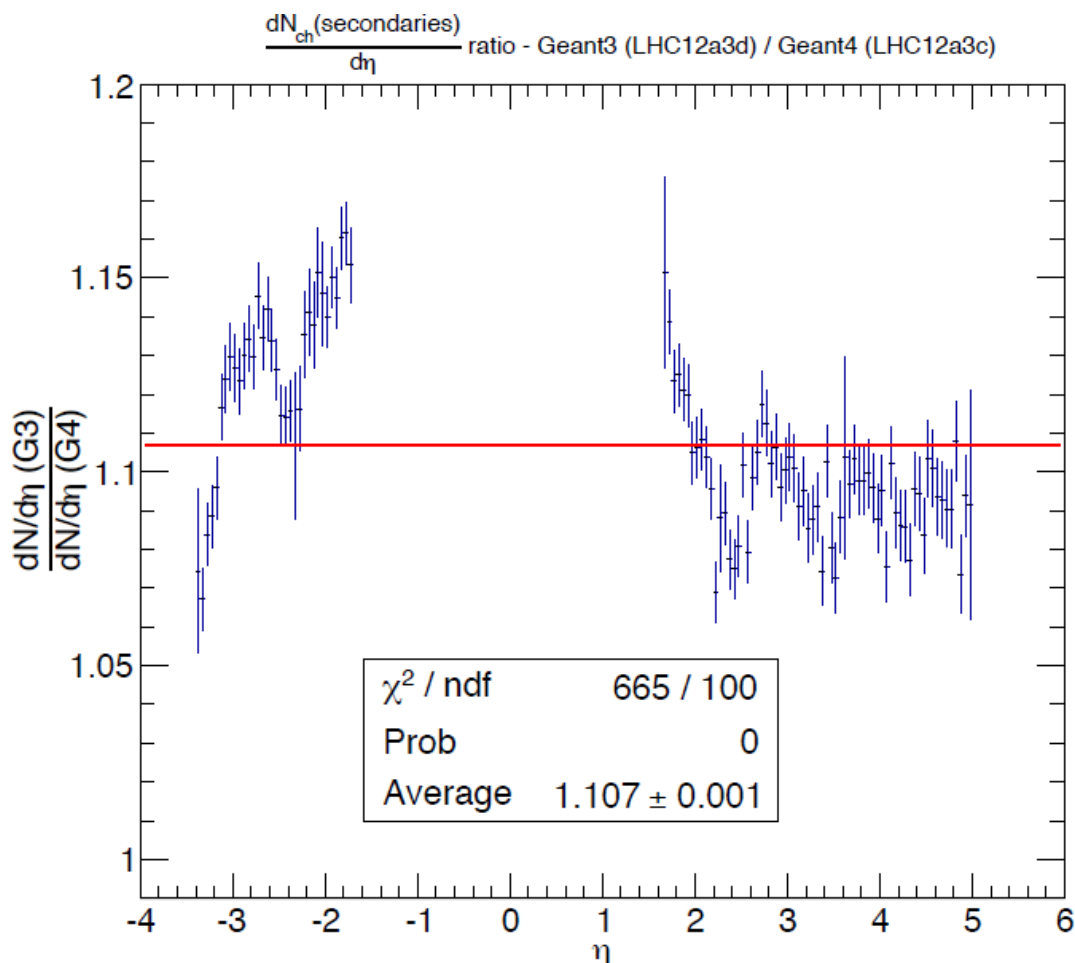


Reconstructed multiplicity V0C

- V0 scintillator hodoscope at $2.8 < \eta_{V0A} < 5.1$ and $-3.7 < \eta_{V0C} < -1.7$
- number of secondaries should be about half of total number on A side and $\sim 2/3 - 3/4$ on C side
- Number of secondaries seems to be much higher in G3

Plots by Cvetan Cheshkov

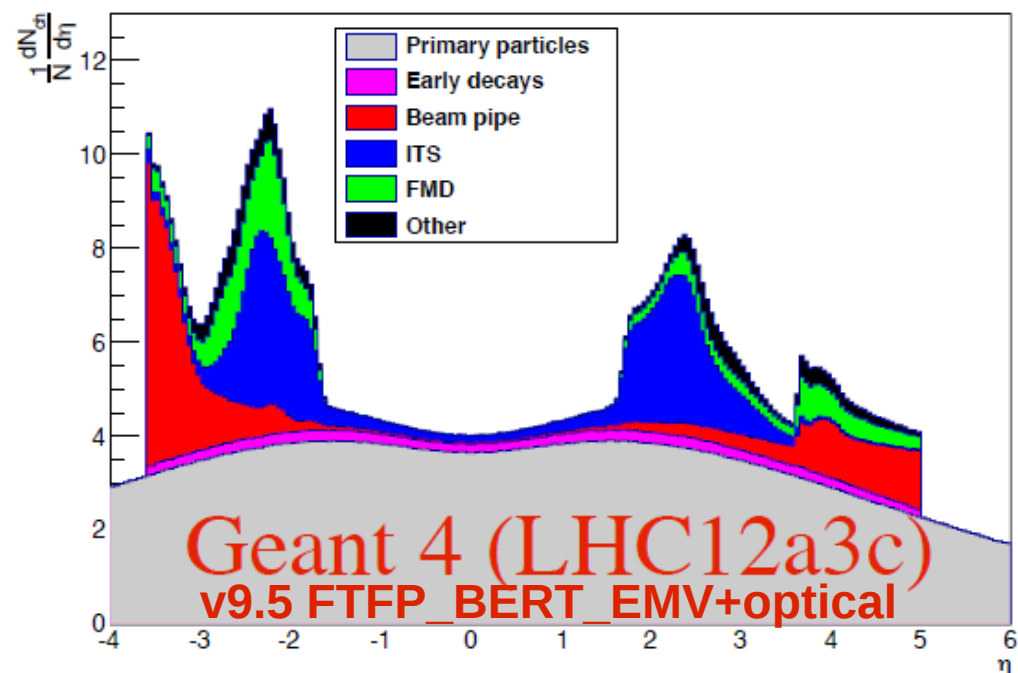
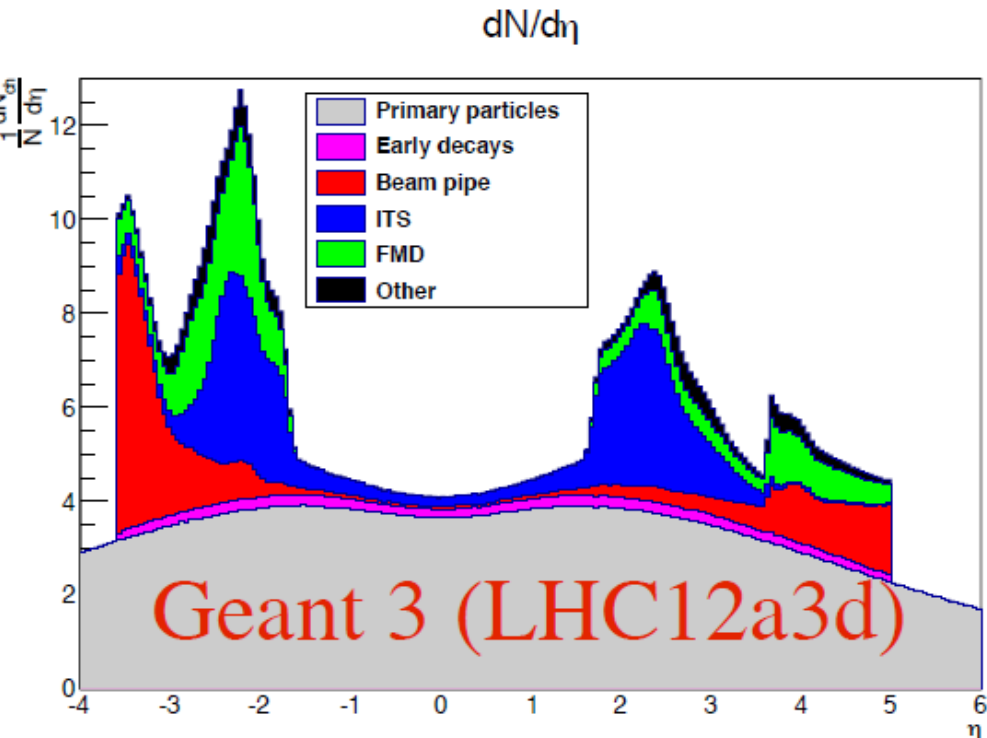
FMD: $dN/d\eta$ (charged secondaries)



- Forward multiplicity detector
- $dN/d\eta$ of secondary particles in the FMD (summed over all particle energies)
- Ratio of Geant3 to Geant 4
- On average 10% more secondaries in FMD with Geant3
- Local variations between 5 and 15%

Results by Alexander Hansen

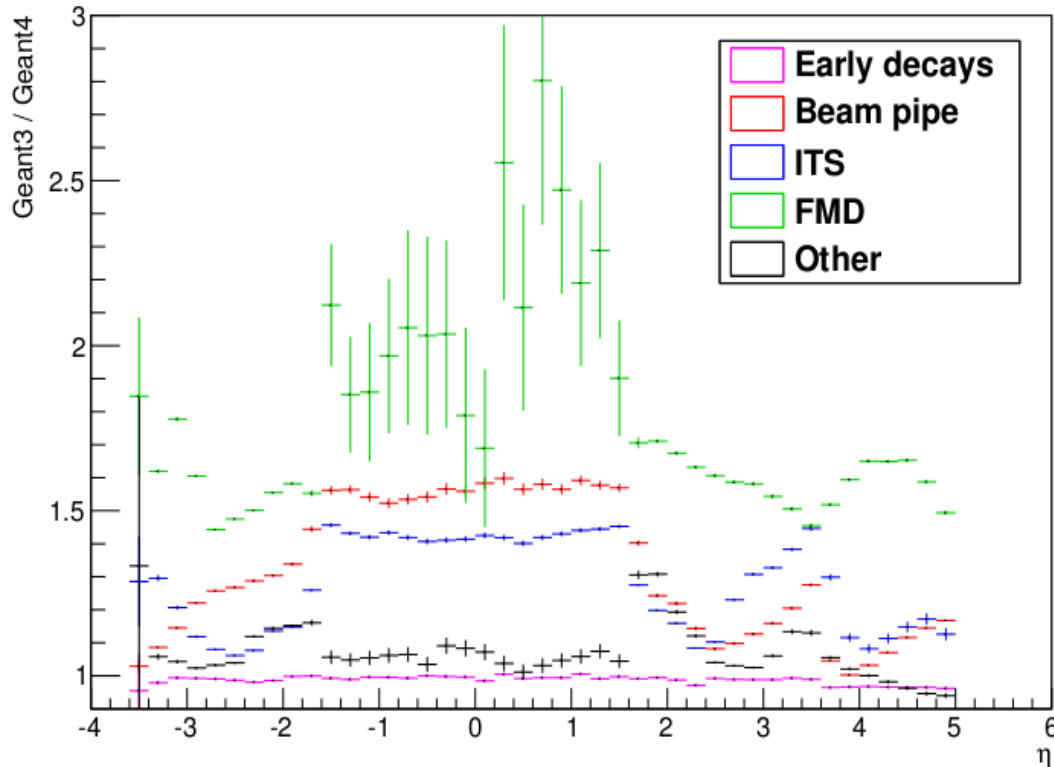
Geant4 v9.5 FTFP_BERT_EMV+optical



- Primary and secondary charged particles hitting FMD and SPD
- Secondaries broken down into contributing material
- Same message as previous slide: More secondaries in Geant3 than in Geant4 => Individual ratios on next slide

Results by Alexander Hansen

Ratio plot - Geant 3/Geant4



- Once again Geant3 / Geant4 (v9.5FTFP_BERT_EMV+opt) ratio (summed over all particle energies)
- Early decay contribution seems to be the same
- Beam pipe, ITS, FMD and other sources all show structures
- Note that at mid-rapidity FMD contributes with very little => The large variations observed are statistical, see big error bars

Results by Alexander Hansen

Timing compared to Geant3

	RunSimulation	Run
Geant3	100%	100%
G4 v9.4.p03 Q	365%	180%
G4 v9.5 Q	350%	195%
G4 v9.5 F	350%	185%

- RunSimulation = Transport
- Run: whole simulation including also digitization
- Q = QGSP_BERT_EMV+optical
- F = FTFP_BERT_EMV+optical
- Values are average results of 5 log files per production.
Variation of single results to average value is within ~20%



Open Issue with Geometry

- About 5% of the G4 jobs (similar for both Geant4 versions and physics lists) are aborted in the simulation phase
- Under investigation but difficult to reproduce

*** G4Exception : InvalidCondition

issued by : G4MultiLevelLocator::EstimateIntersectionPoint()

Error in advancing propagation.

The final curve point is not further along than the original!

*** Fatal Exception *** core dump ***

*** G4Exception: Aborting execution ***



Summary & Outlook

- Good description of primaries
- Underestimation of secondaries
 - Detailed per-detector studies are ongoing in order to identify differences
- Improved description of TPC
 - Before, Geant4 simulation produced much higher signal per track compared to ALICE and Geant3
 - Now, Geant4 in better agreement with data than Geant3
- Geant4 is currently used for systematics studies within ALICE
- We have performed also simulations using the Geant-Fluka interface of Geant3
 - Additional reference
- Transition to Geant4 planned for long shutdown in 2013