Status of Geant4 Validation

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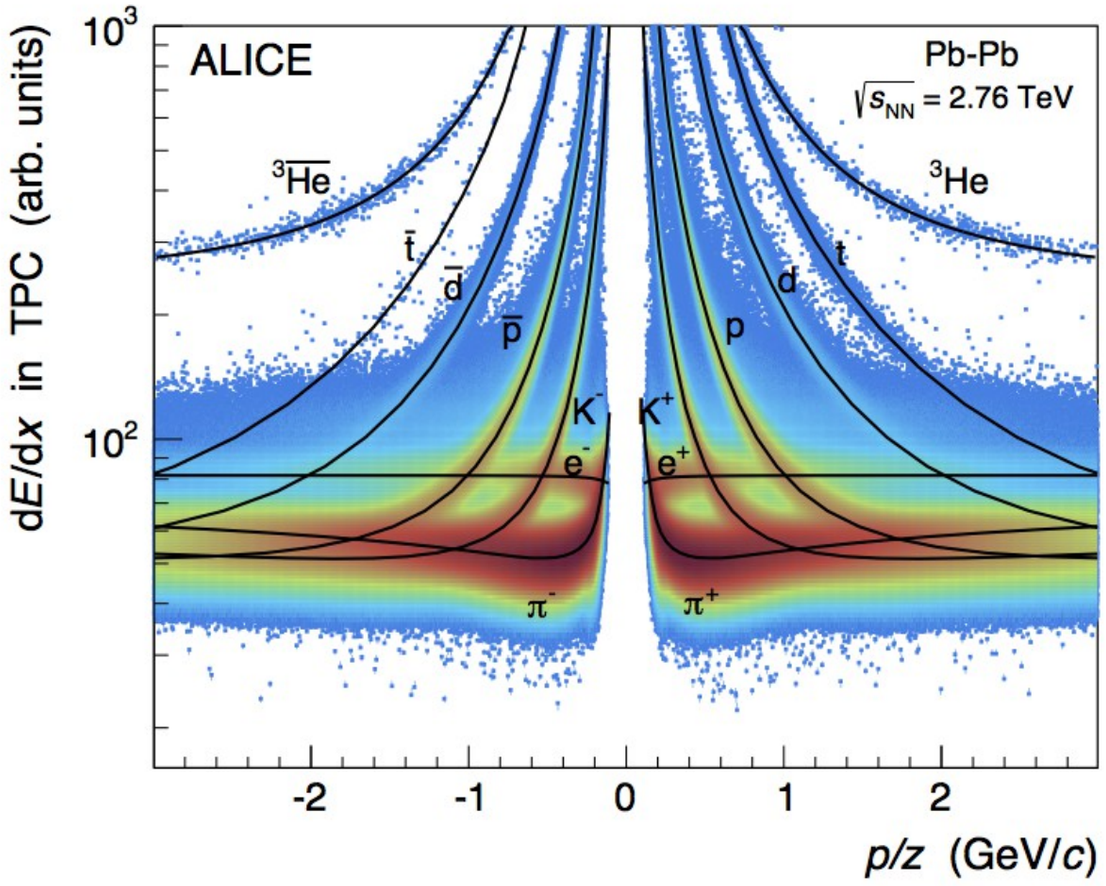
Ongoing Activities

- Geant4 in production
  - Anti-nuclei studies
- Geant4 test production
  - General-purpose Monte Carlo corresponding to Pass 4 of 2010 RAW
  - Physics validation
- Geant4 Transition Radiation Tests

Geant4 in Production

GEANT4 and anti-nuclei (1)

- The physics of (anti-)nuclei has evolved from a side topic to one of the major efforts in ALICE:
  - 4 papers submitted only this year and many more in the pipeline!
  - Ambitious plans for run 2 and one of the cornerstones of the physics program of run 3.
- Propagation of anti-nuclei remains a challenge:
  - Missing constraints from data
  - Cross-sections are large
  - Both inelastic and elastic hadronic play an important role.
  - Also the modelling of the final state in elastic hadronic scattering is crucial.



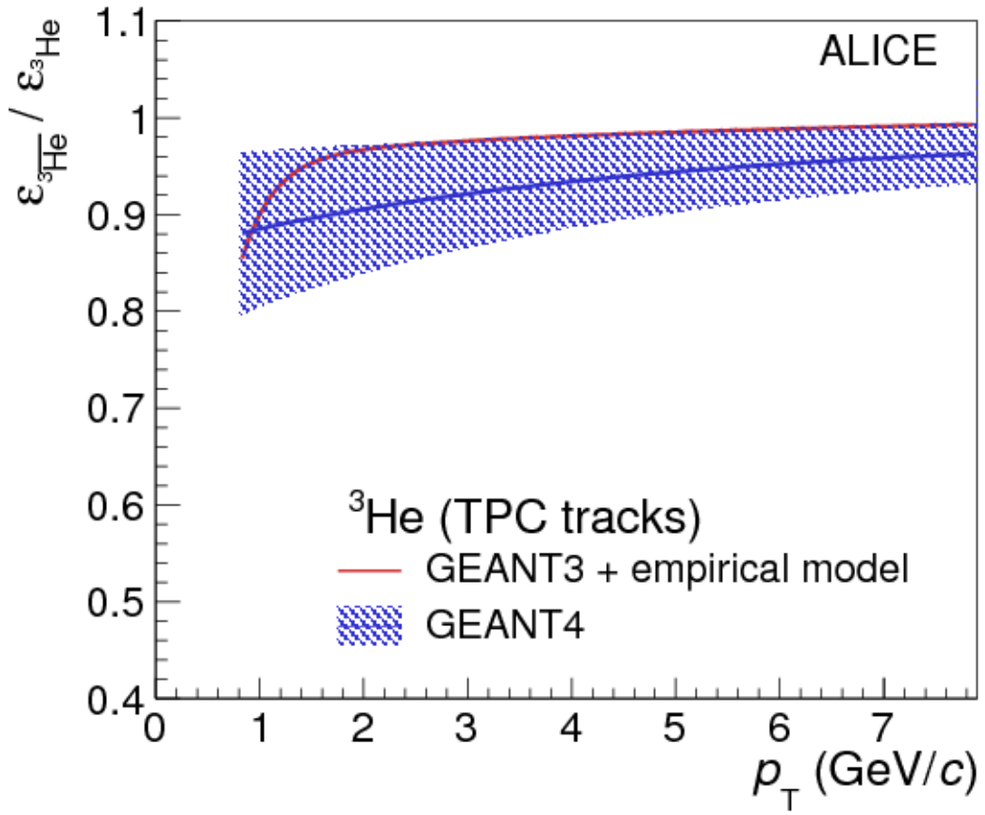
A. Kalweit

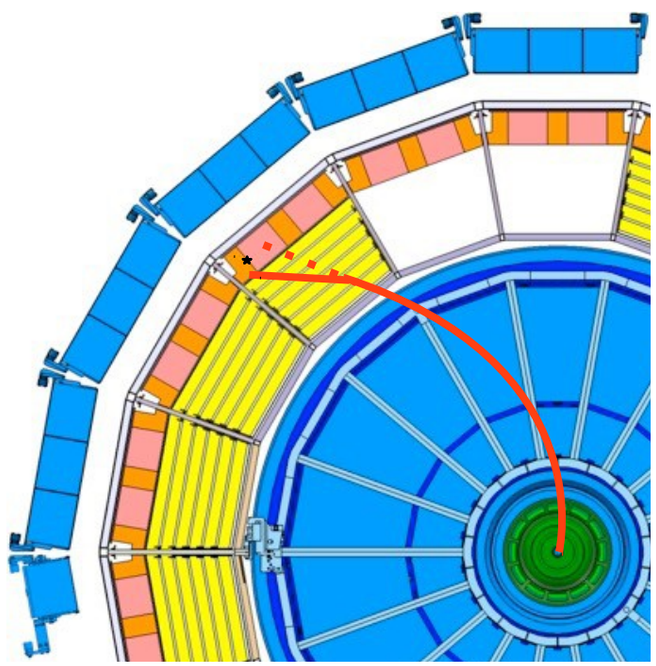
GEANT4 and anti-nuclei (2)

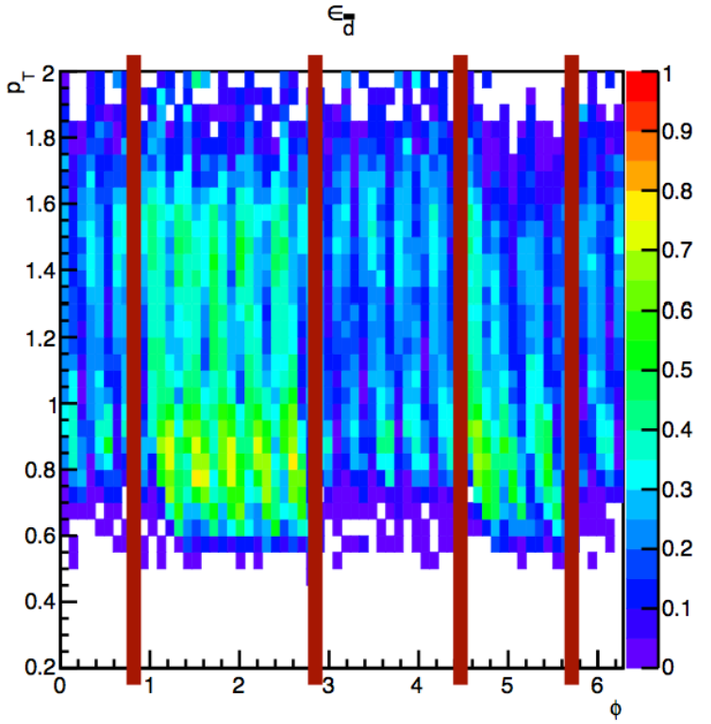
- Geant4 is the only code that offers the best available model at the moment (also used by e.g. AMS).

- Several recent successful small productions for the systematic study of hadronic interaction effects which were used in the publications: e.g. LHC15g7 and LHC15b2_32.

- By studying absorption effects in the material between TPC and TOF, we might be able to improve the modelling in collaboration with the Geant4 crew (Alexander is in contact with Alberto Ribon) in order to reduce the systematic uncertainties.







from M. Puccio

Test productions anchored to LHC10 Data

Geant4 Test Production

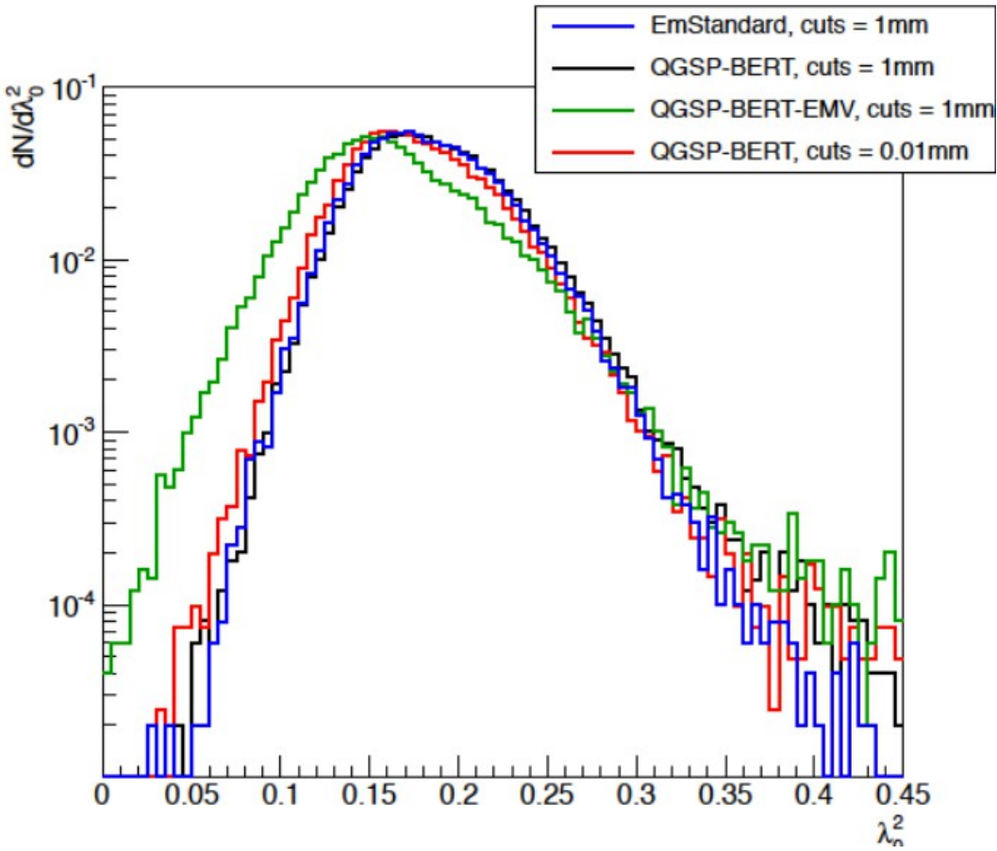
- Geant4 validation production anchored to LHC10 pass4
  - p-p, 7 TeV
  - Pythia low-pt tune 350 (Perugia 2011)
- Geant4 10.1.p03
- Geant4 VMC 3.2.p1
- ROOT alice/v5-34-30
- AliRoot v5-05-Rev-22h
  - Back-porting fixes from recent versions of AliRoot to the version which was used for the data processing and the GRID production with GEANT3

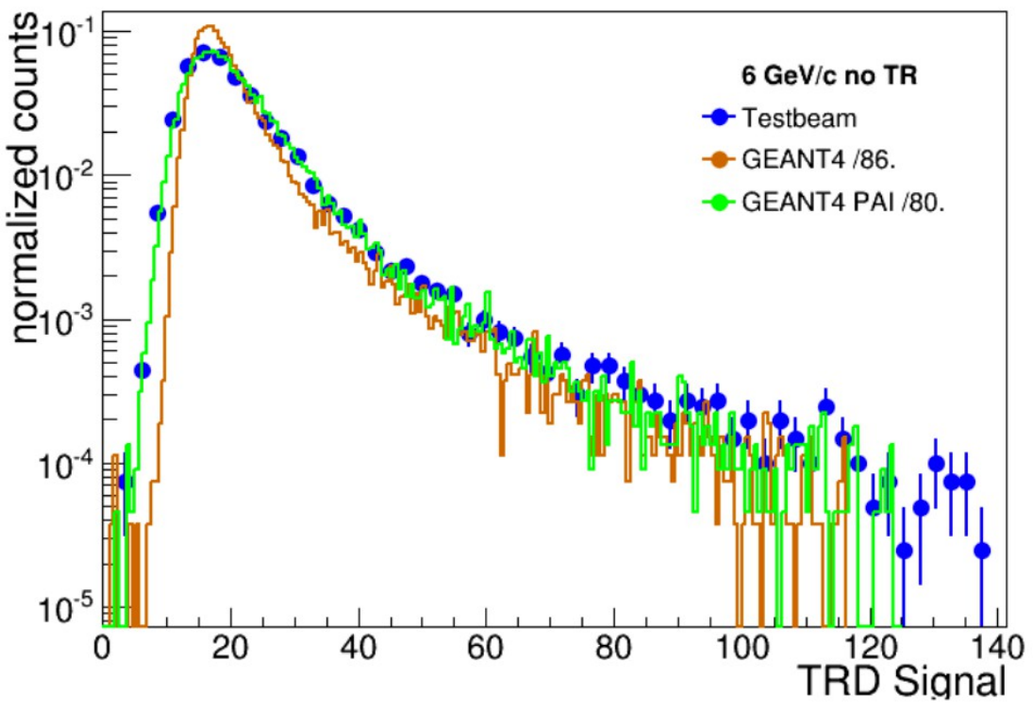
Geant4 Physics Configuration

- Defined in Config.C
- **FTFP_BERT_EMV** physics list
- + G4OpticalPhysics
- + EmStandard_opt0 in EM calorimeter regions
  - Wrong shower shapes with _EMV
- + PAI model in TRD regions
  - Activated via UI commands defined in Geant4 VMC

G4 Developments

- Calorimeters
  - Possibility to use fast electromagnetic physics option (EMV) for all detectors except calorimeters
    - wrong shower shapes with EMV
- d*E*/d*x* in TRD
  - Use PAI model
  - Adjust scaling factor between d*E*/d*x* and TRD signal





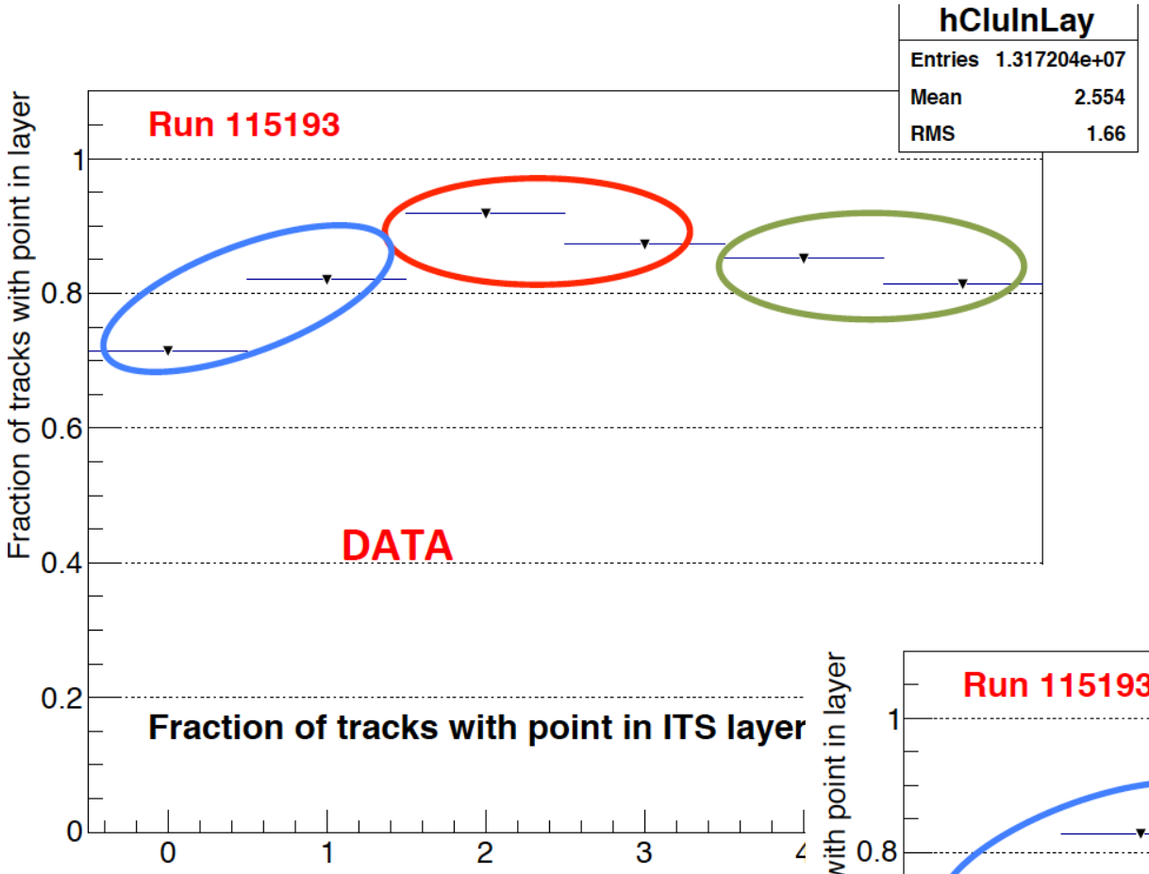
Geant4 in Config.C

```
TG4RunConfiguration* runConfiguration
  = new TG4RunConfiguration("geomRoot", "FTFP_BERT_EMV+optical", …);
TGeant4* geant4
  = new TGeant4("TGeant4", "The Geant4 Monte Carlo : FTFP_BERT_EMV",
                runConfiguration);

// Geant4 & Geant4 setting (verbose level, other parameters)


// PAI for TRD
geant4->ProcessGeantCommand("/mcPhysics/emModel/setEmModel  PAI");
geant4->ProcessGeantCommand("/mcPhysics/emModel/setRegions  TRD_Gas-mix");
geant4->ProcessGeantCommand("/mcPhysics/emModel/setParticles  all");

// Precise Msc for EMCAL
geant4->ProcessGeantCommand("/mcPhysics/emModel/setEmModel  SpecialUrbanMsc");
geant4->ProcessGeantCommand("/mcPhysics/emModel/setRegions  EMCAL_Lead$
                                                    EMCAL_Scintillator$");
geant4->ProcessGeantCommand("/mcPhysics/emModel/setParticles  e- e+");
```

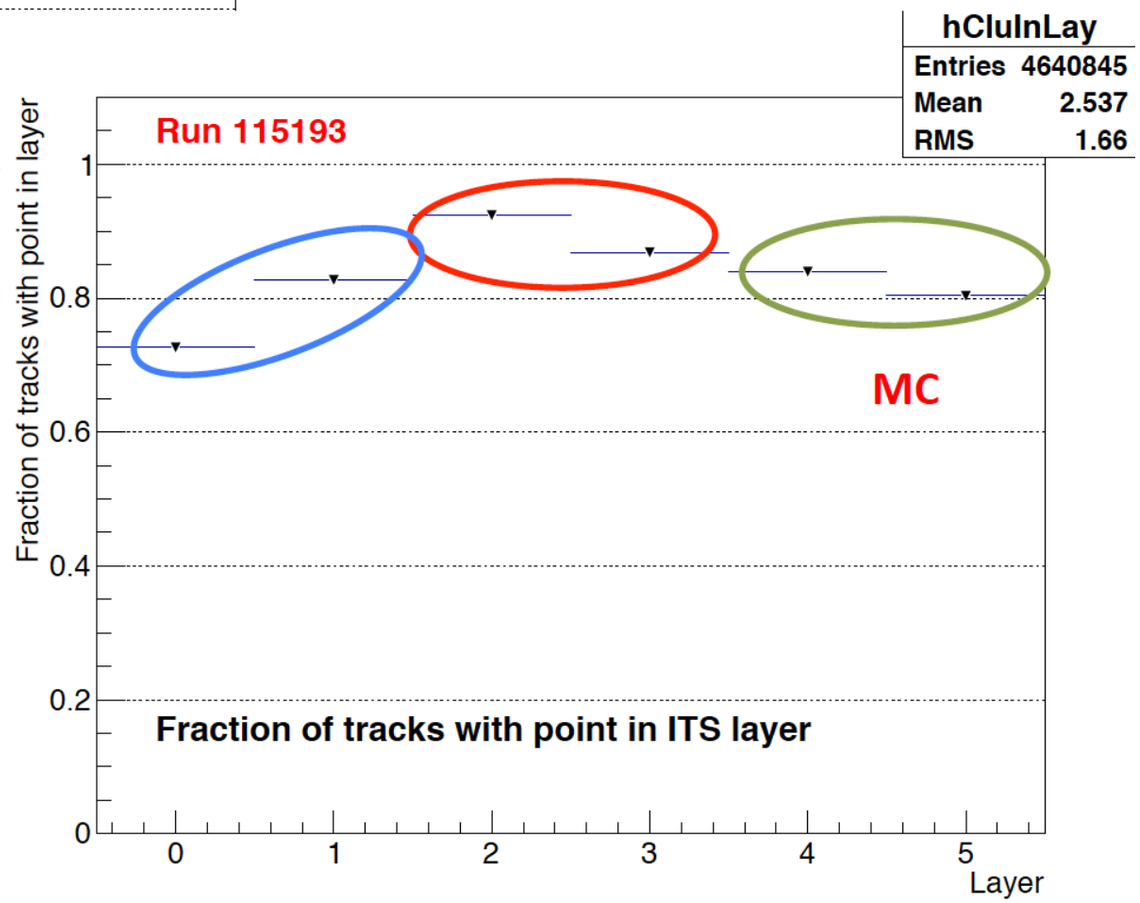
Geant4 Problem Reports

- Switched from 10.1.p02 + own patch for G4Navigator to **10.1.p03** with the fix in Geant4 navigation
  - No own patches or customizations
  - The fix prevents from the Fatal exception from G4MultiLevelLocator::EstimateIntersectionPoint() which happened “frequently” in GRID productions and caused invalidating all previously simulated events in the concerned, aborted run
  - The fix works ok
- #1832 failing /process/optical/setTrackSecondariesFirst command
  - Not critical, a work around found
- Calling SD detector from G4OpticalBoundary process causing an additional step-call from user code
  - This call is made optional in Geant4 development version

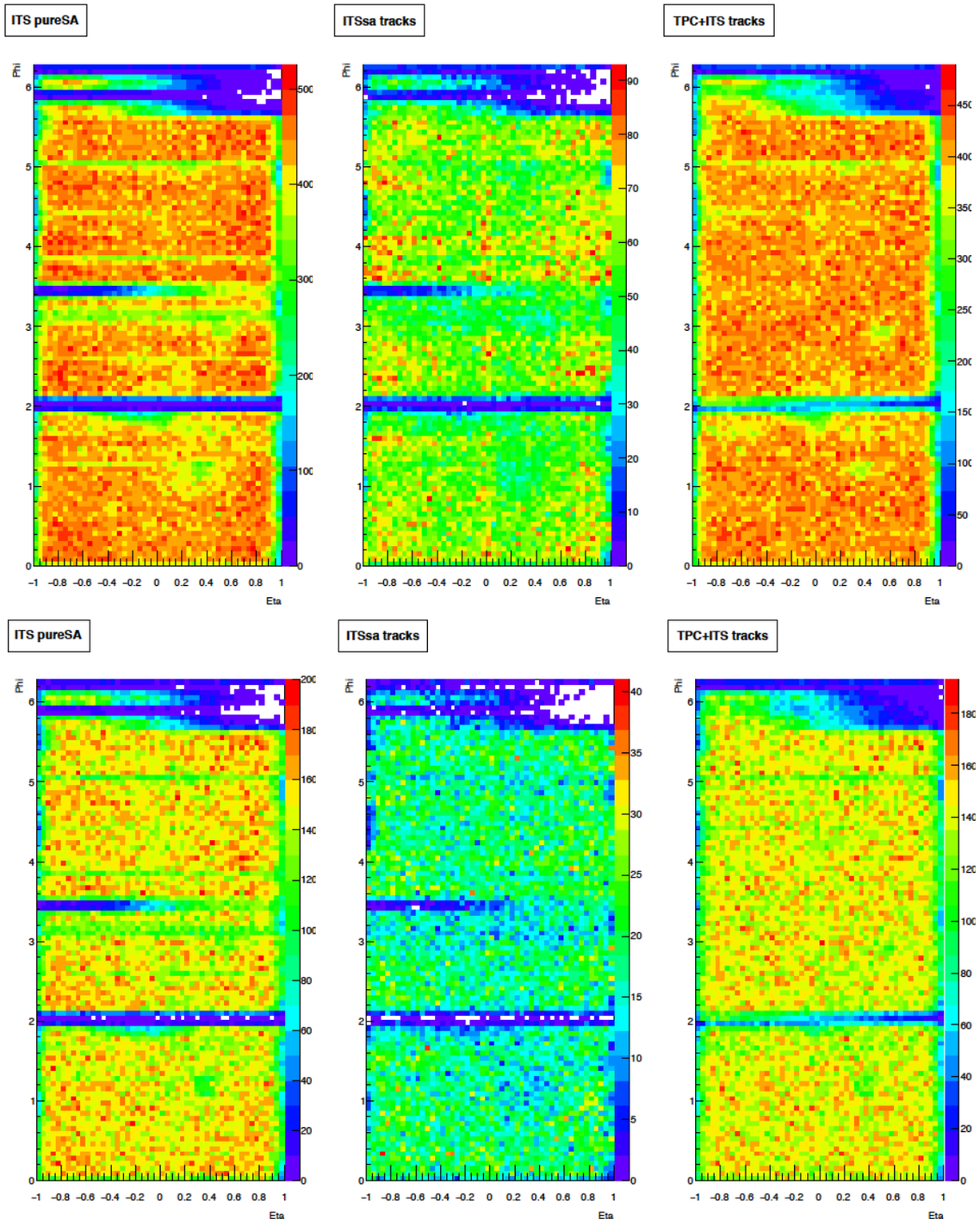
Inner Tracking System (ITS)
Track Points



problem with ihts in SDD solved



Tracking:
ITS stand-alone and global



DATA

ITSpure SA tracks,

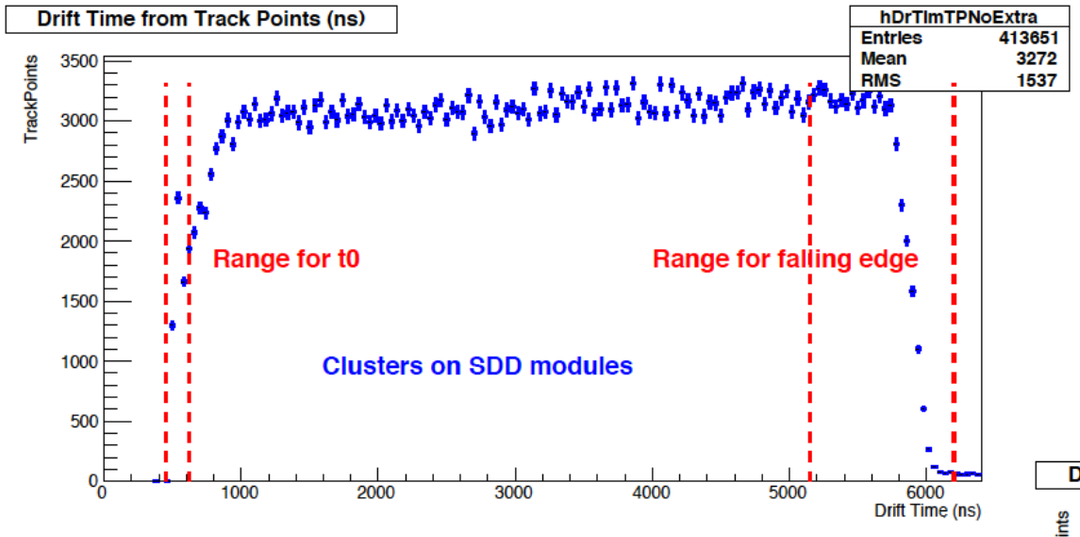
ITSsa tracks

TPC+ITS tracks

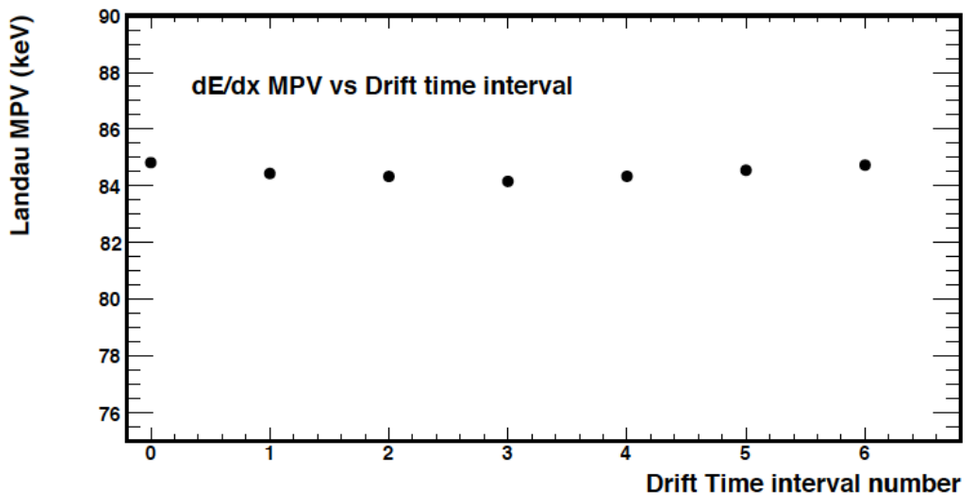
(η, ϕ) distributions

MC

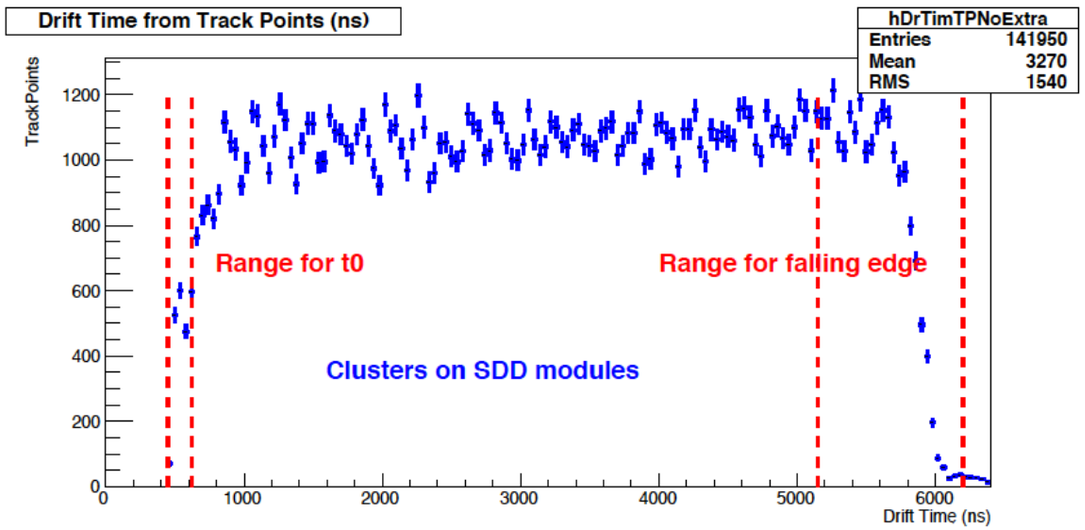
Silicon Drift Detector



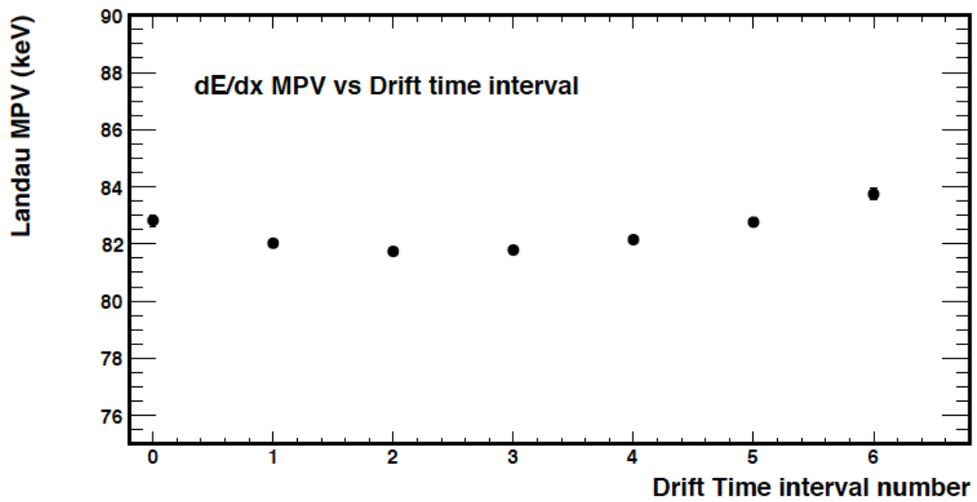
DATA



drift time from track points
dE/dx MPV vs drift time

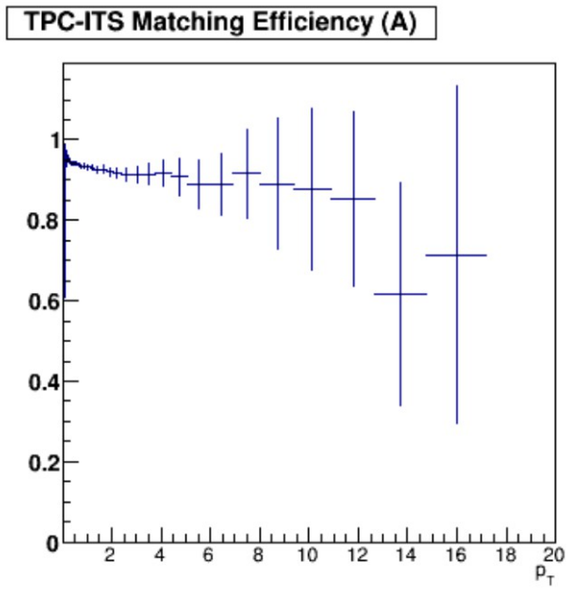


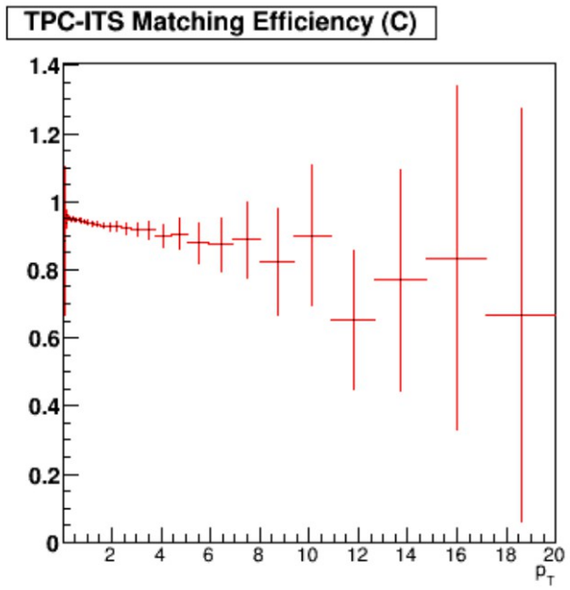
MC

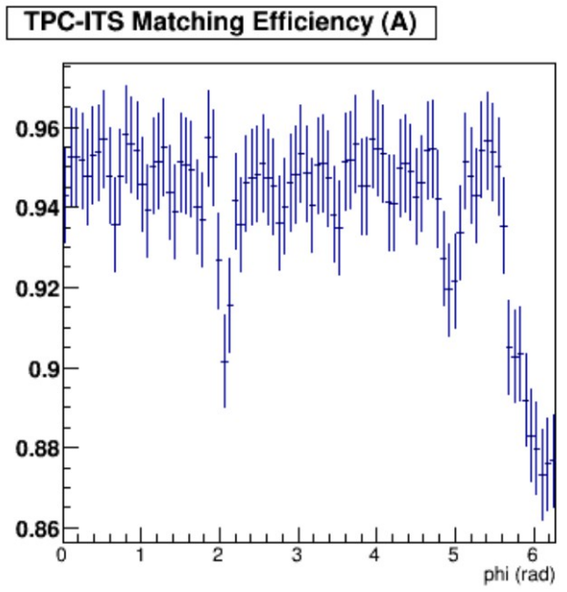


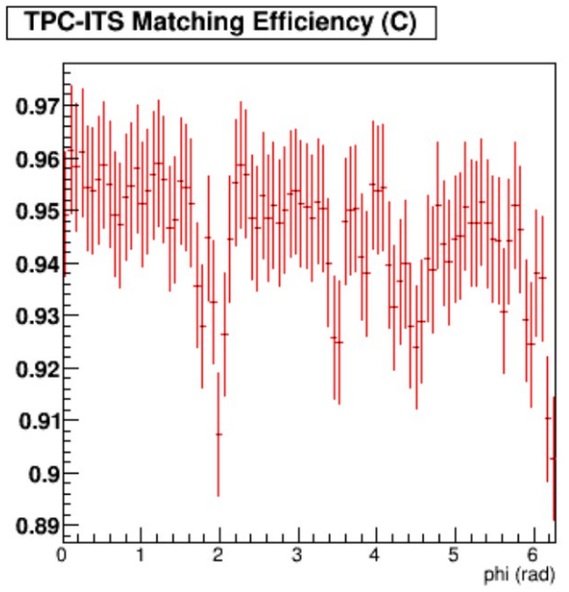
TPC-ITS Matching Efficiency

Data

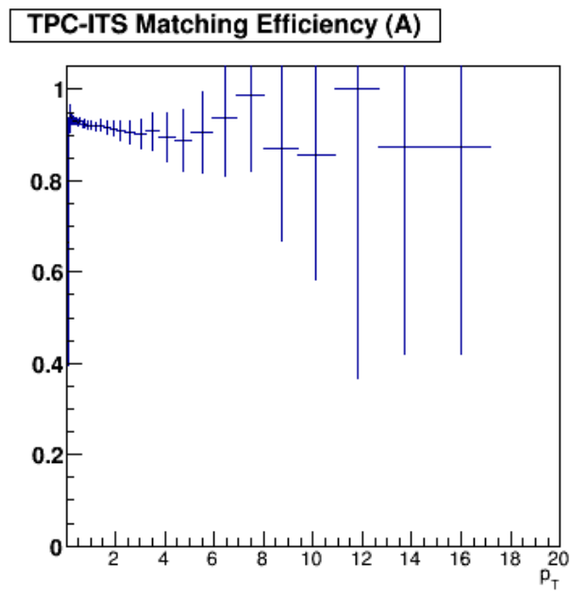


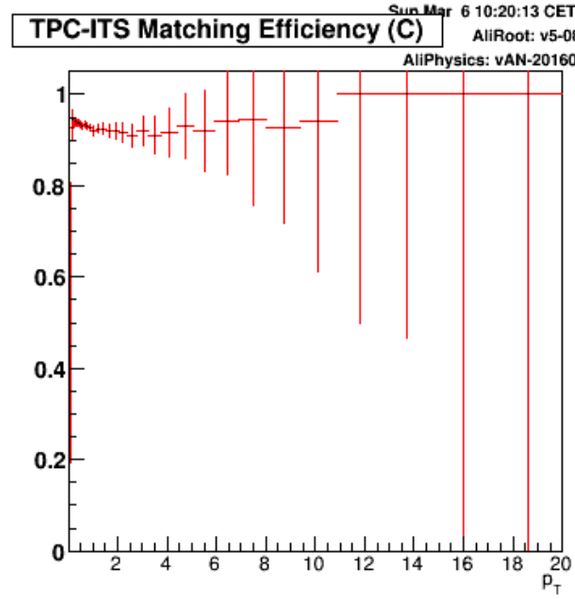


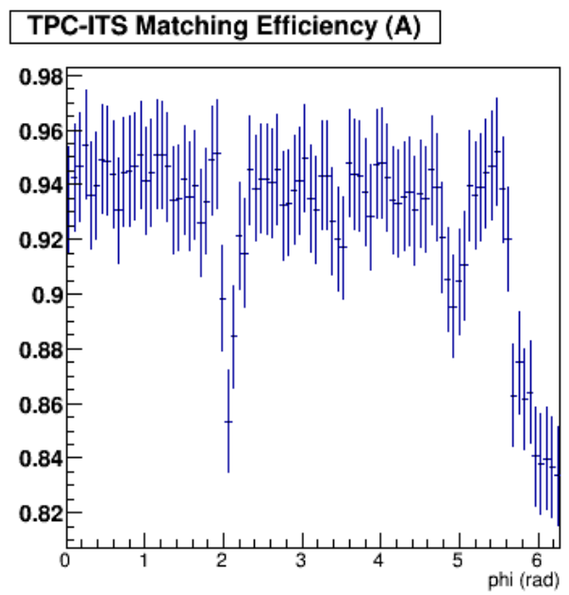


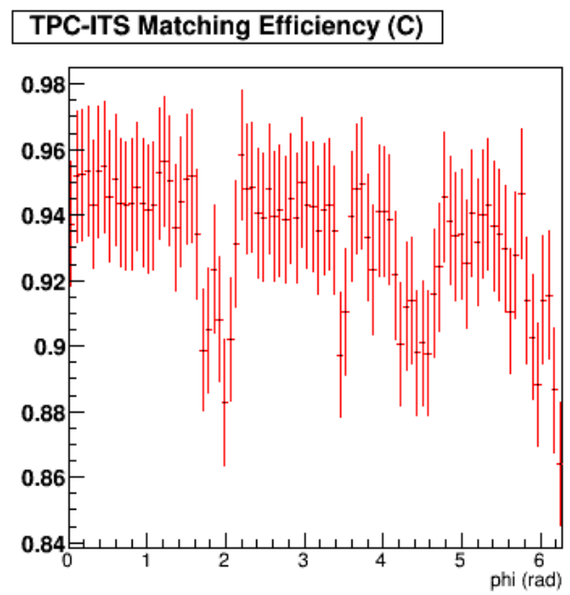


Geant4



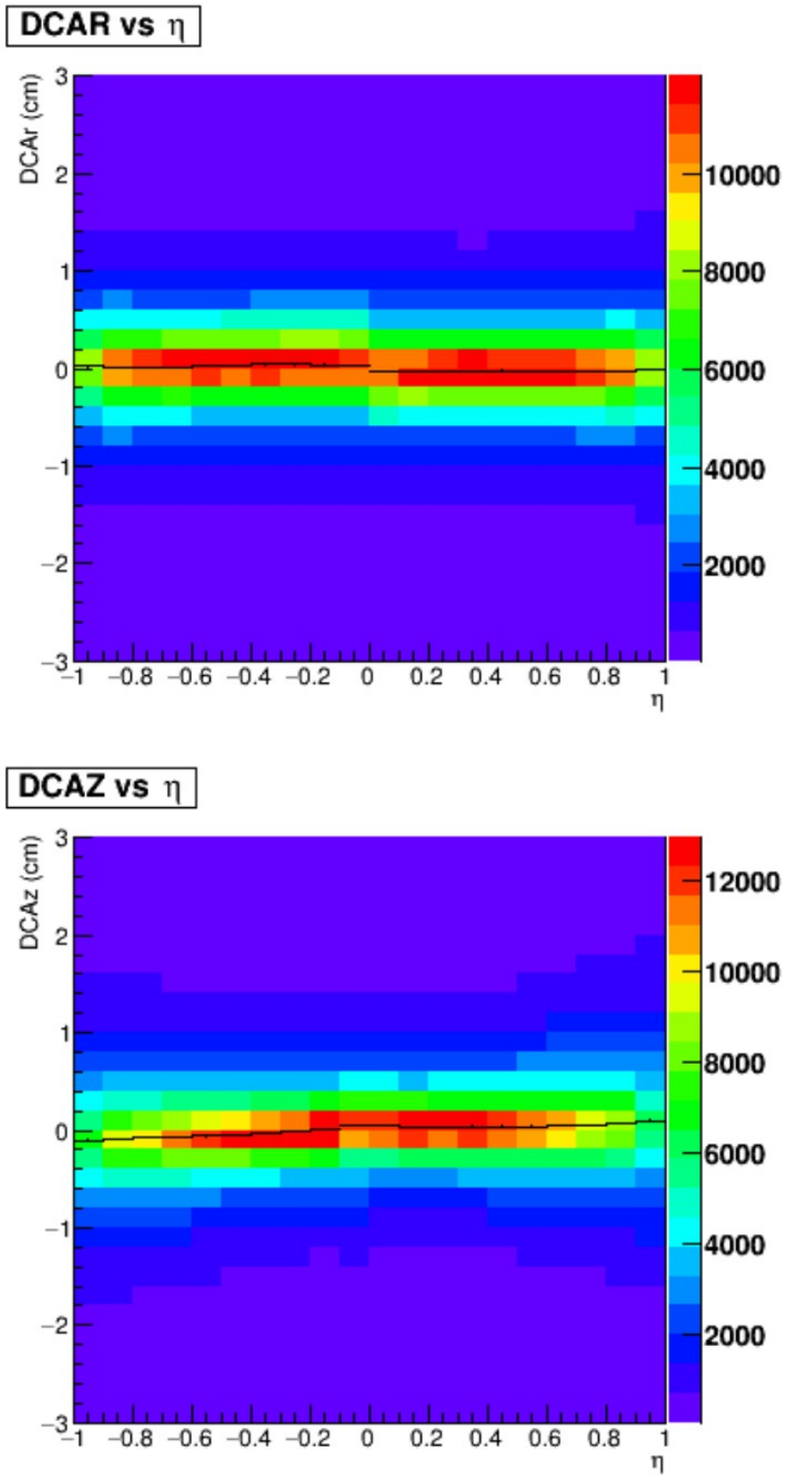




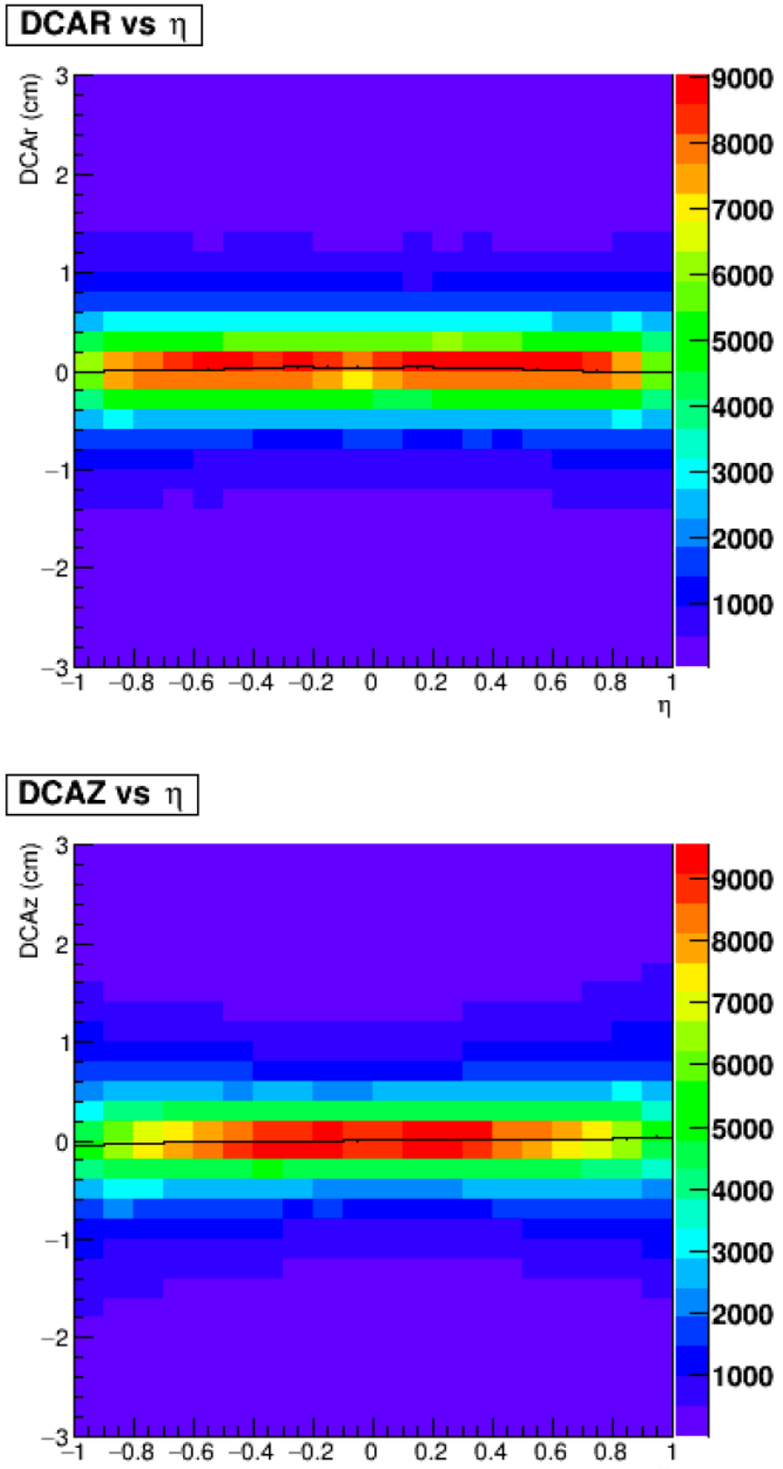


TPC DCA

Data

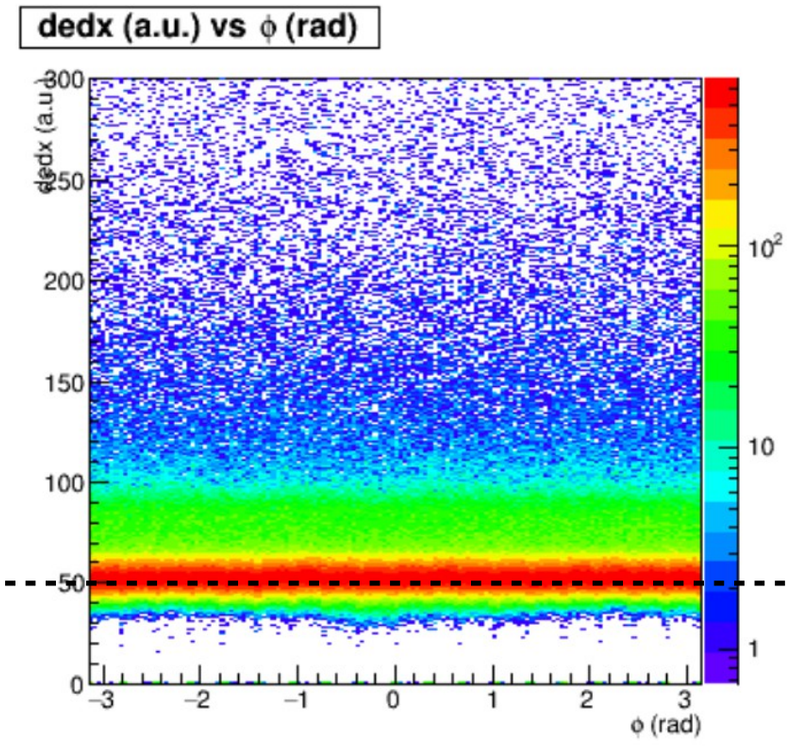


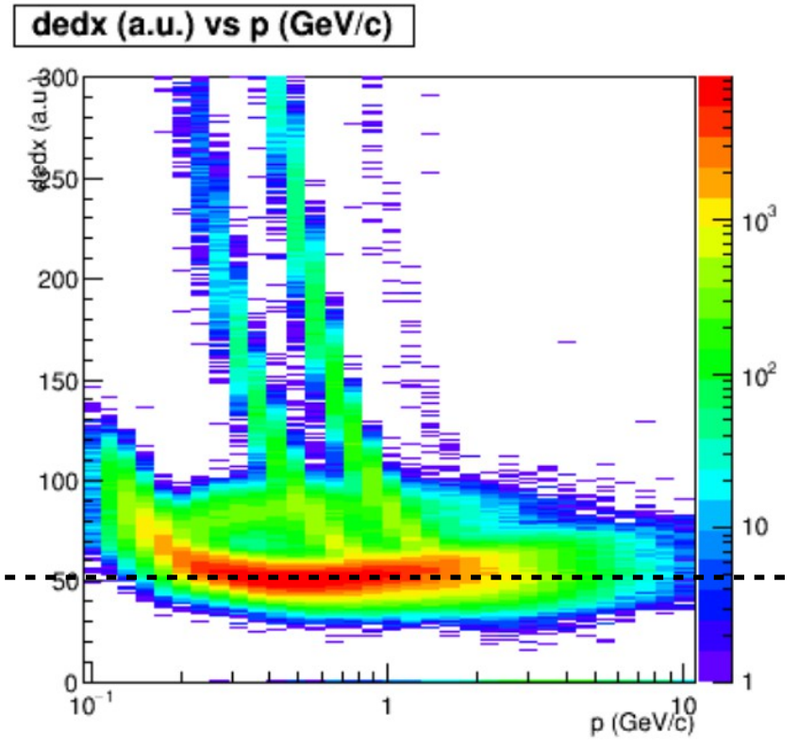
Geant4



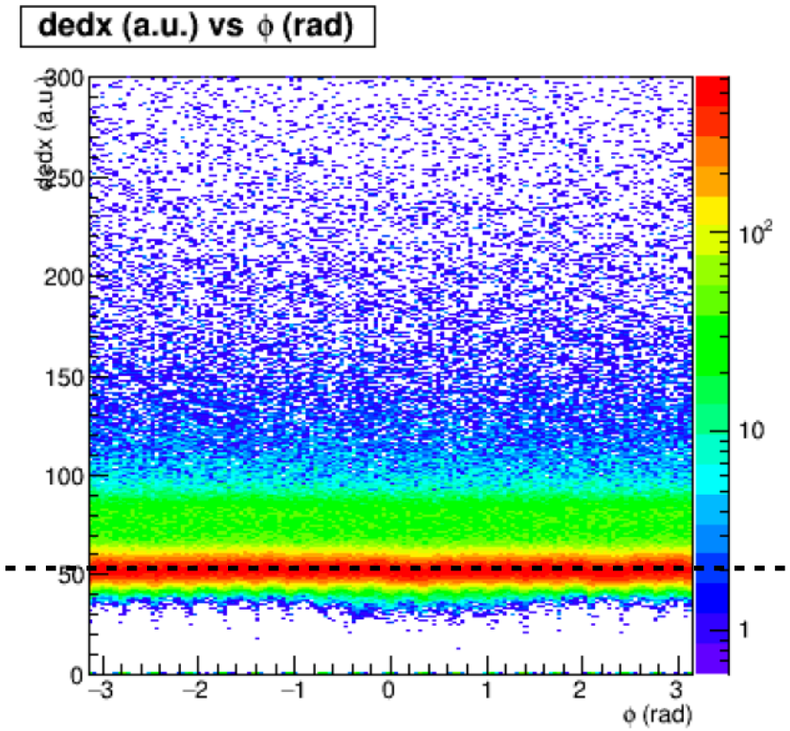
TPC PID

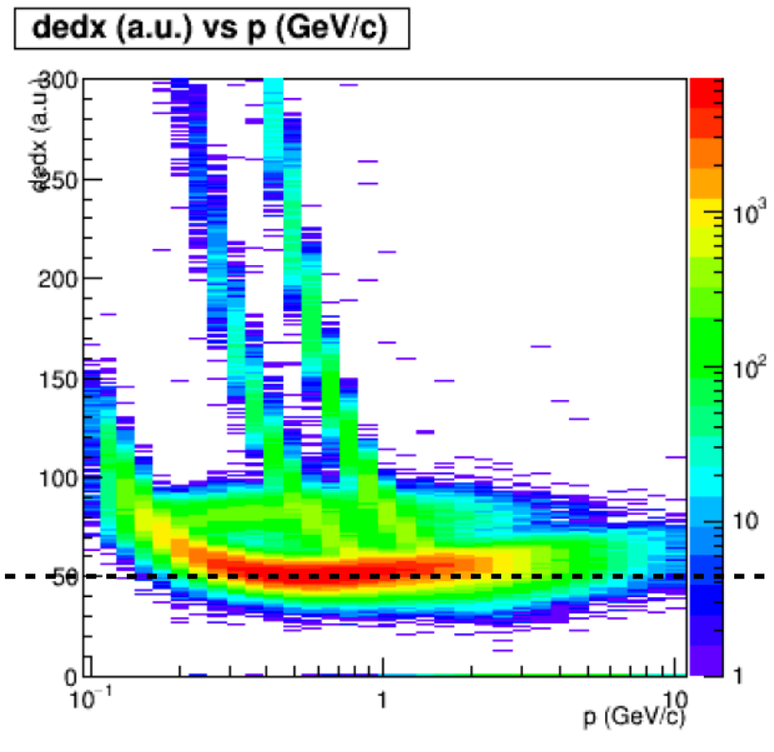
Data



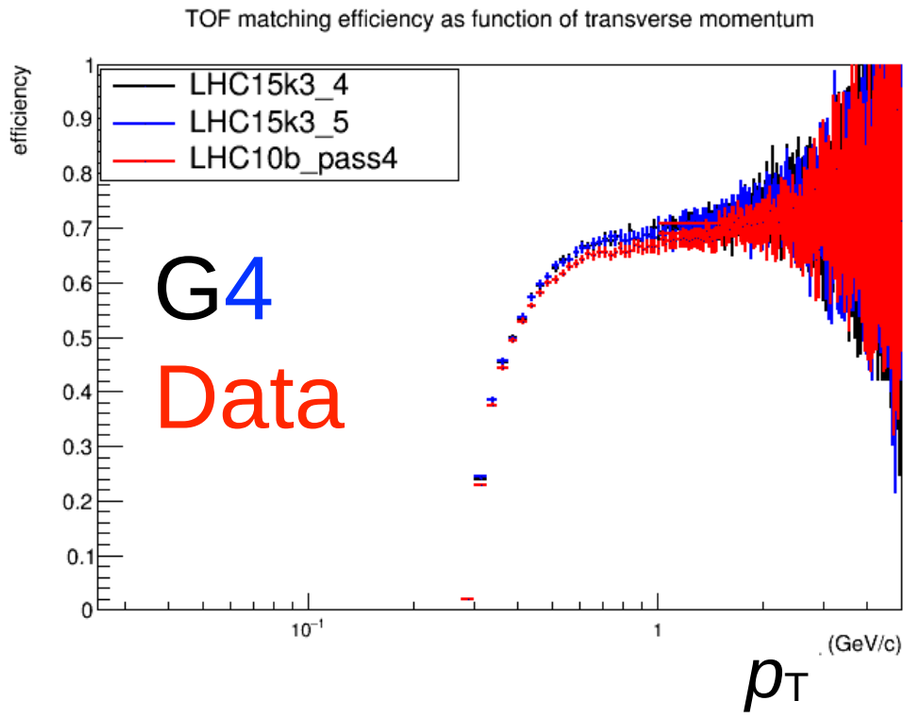


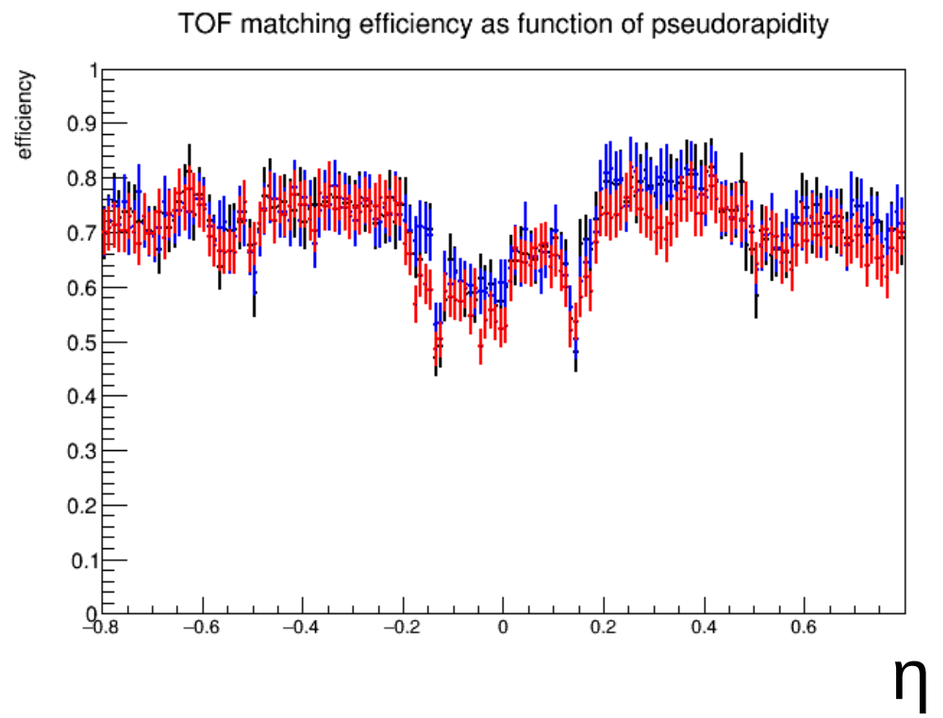
Geant4



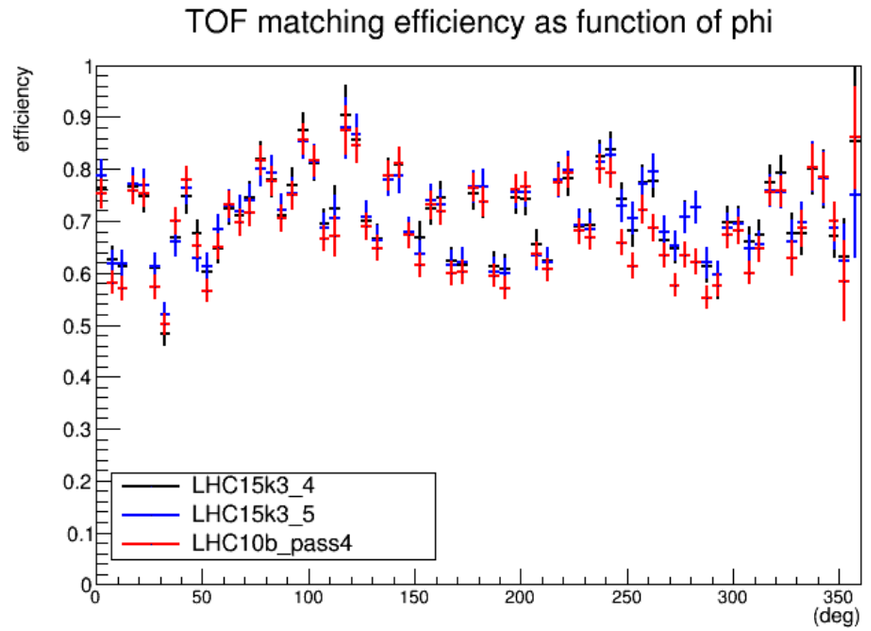


TOF Matching Efficiency

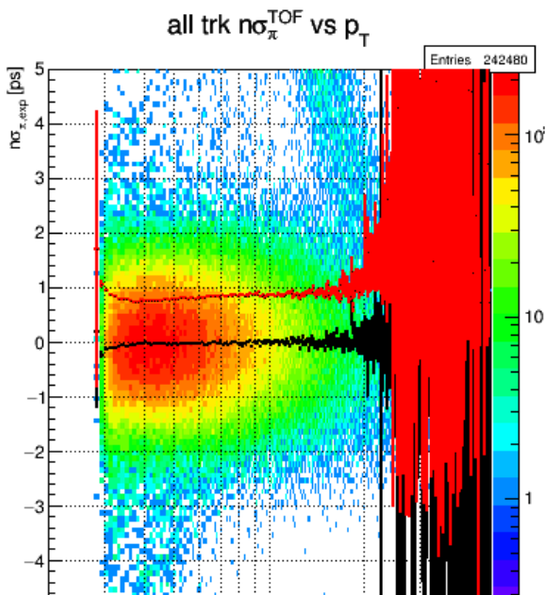


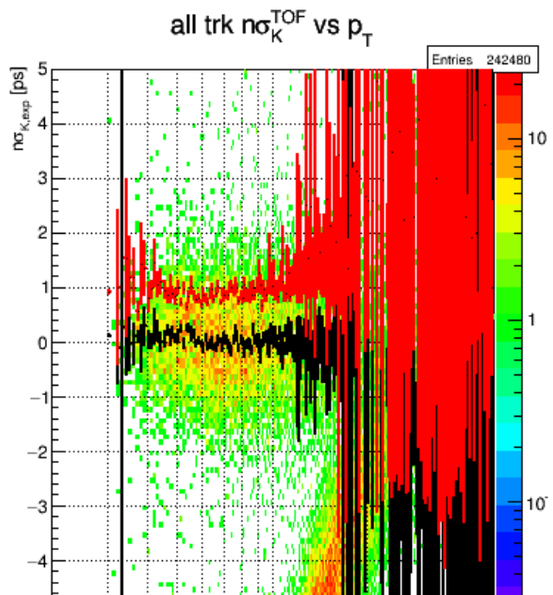


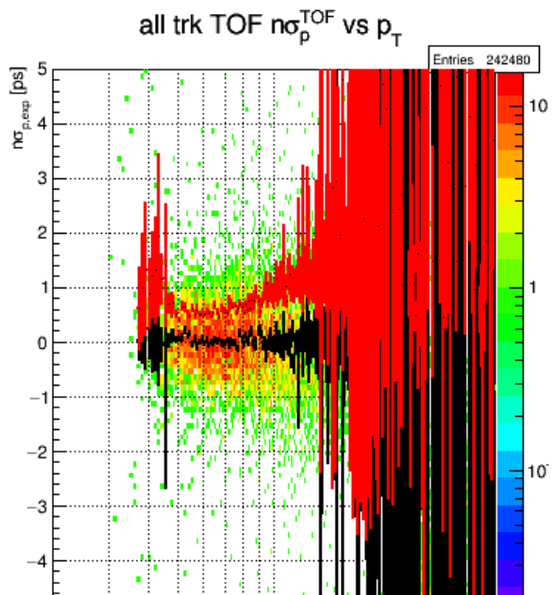
- ~ 2% of difference with respect to data (LHC10b pass4) observed in matching efficiency distributions vs p_T, η and φ



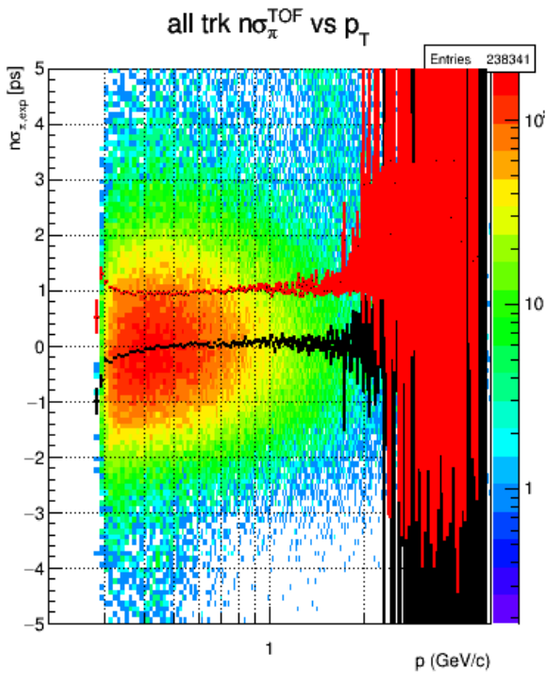
TOF PID

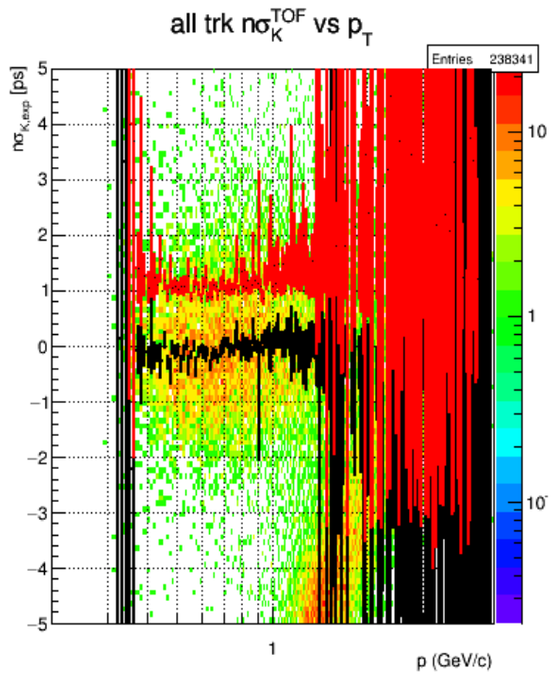


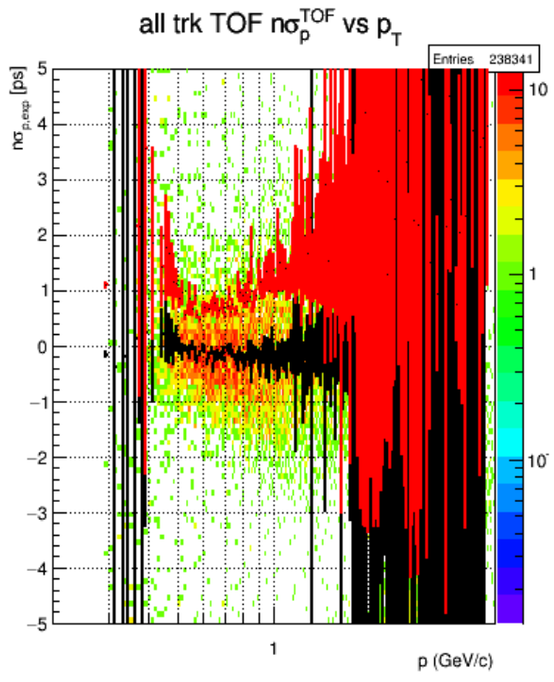




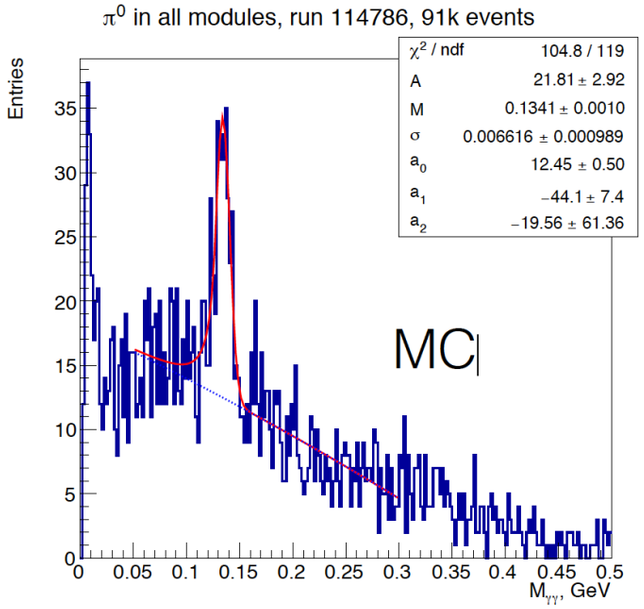
LHC15k3_3 (G4)





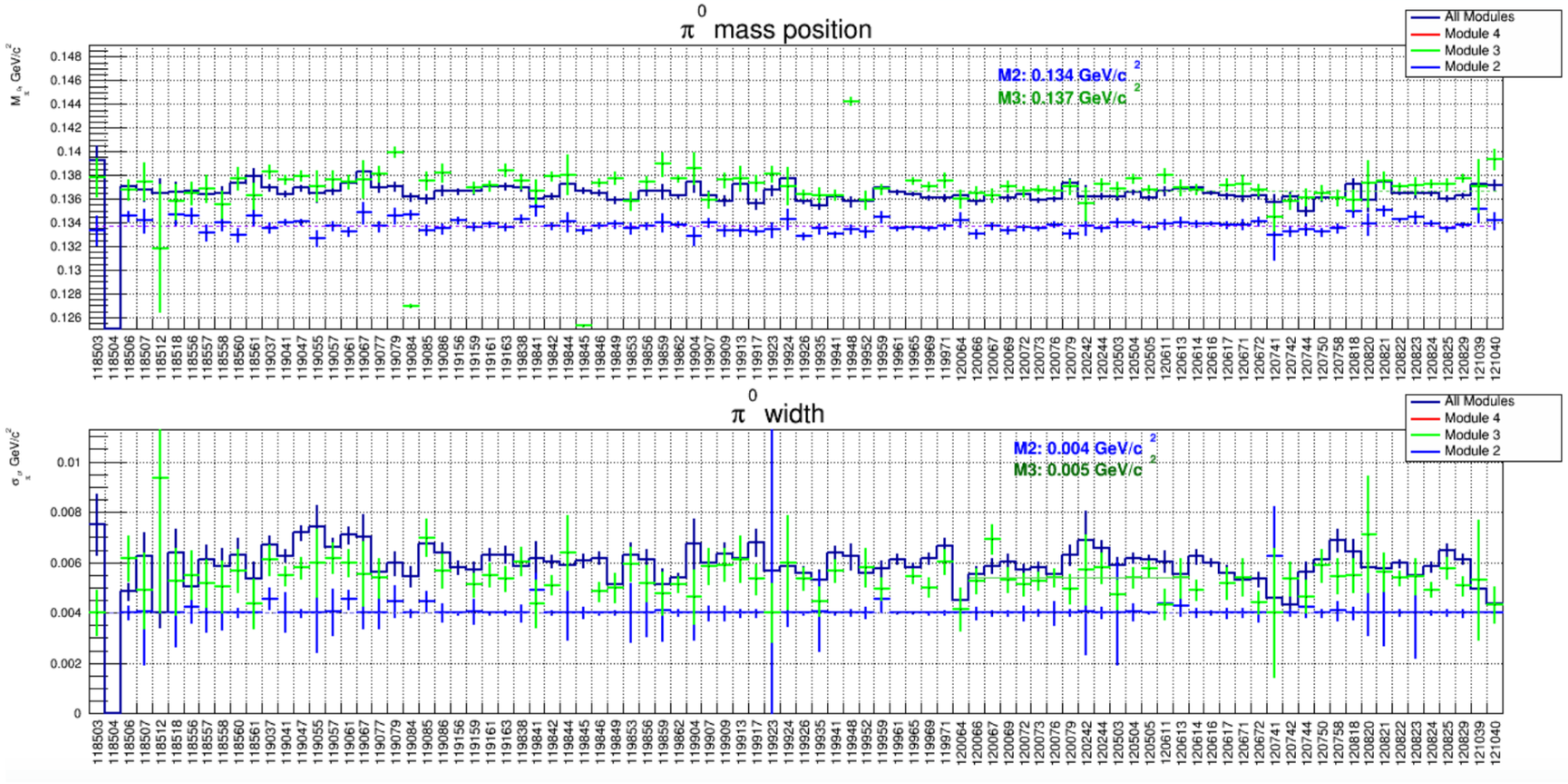


LHC10b pass4

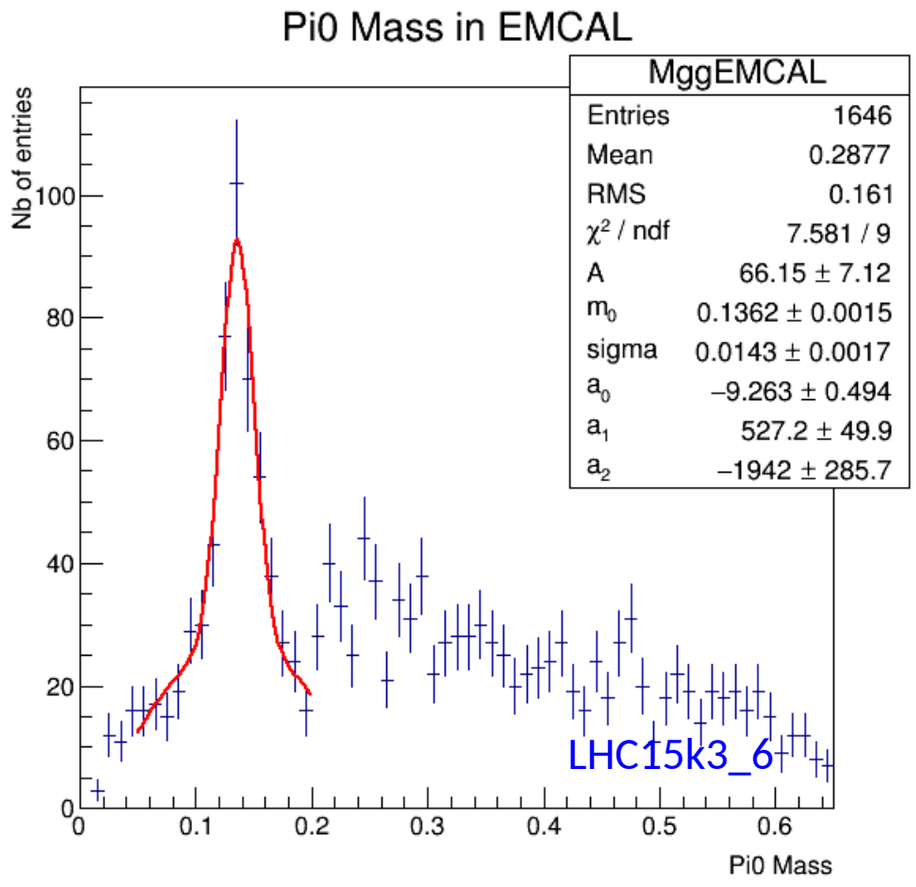


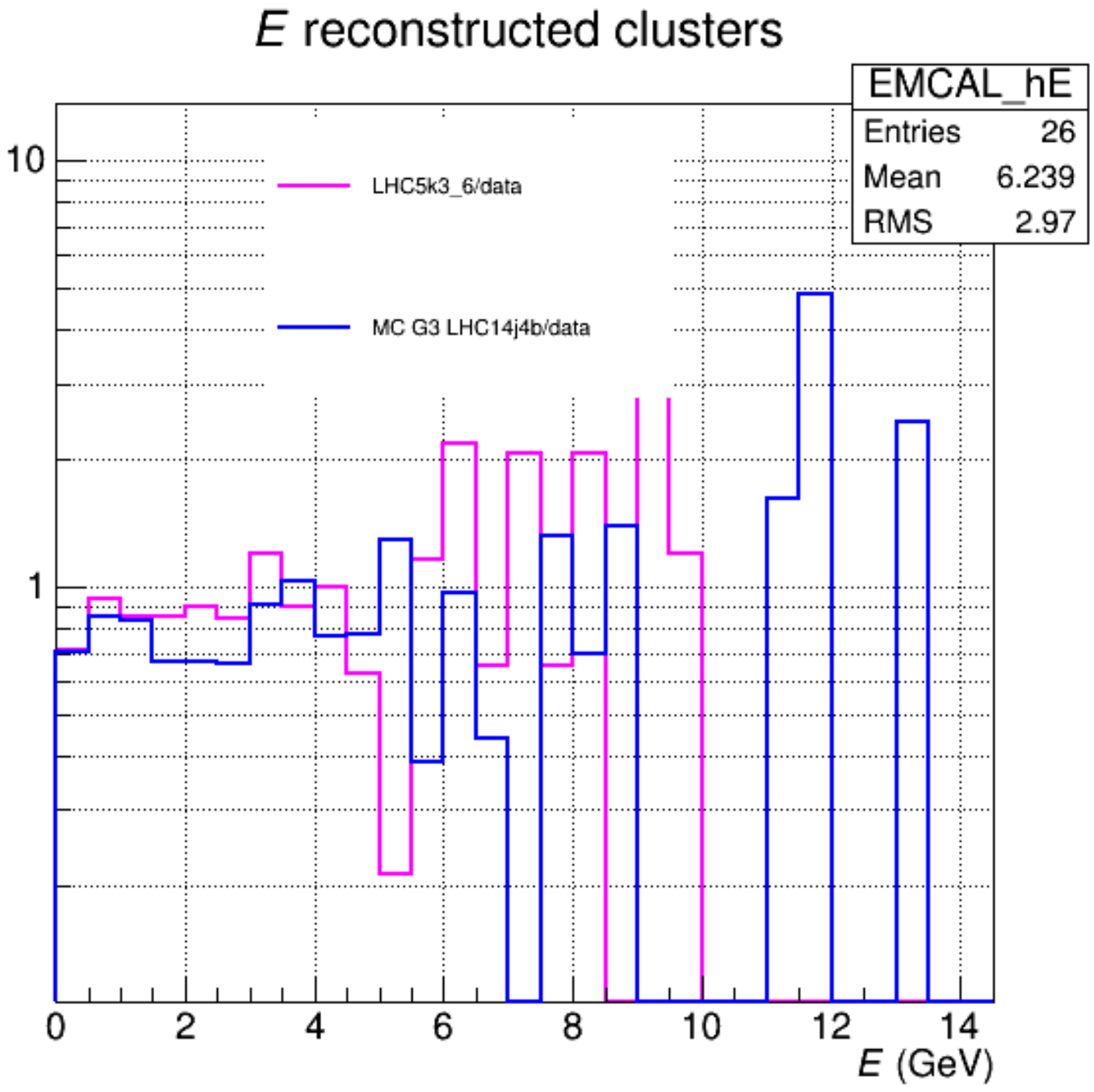
PHOS

Data (LHC10c pass4)



EMCAL

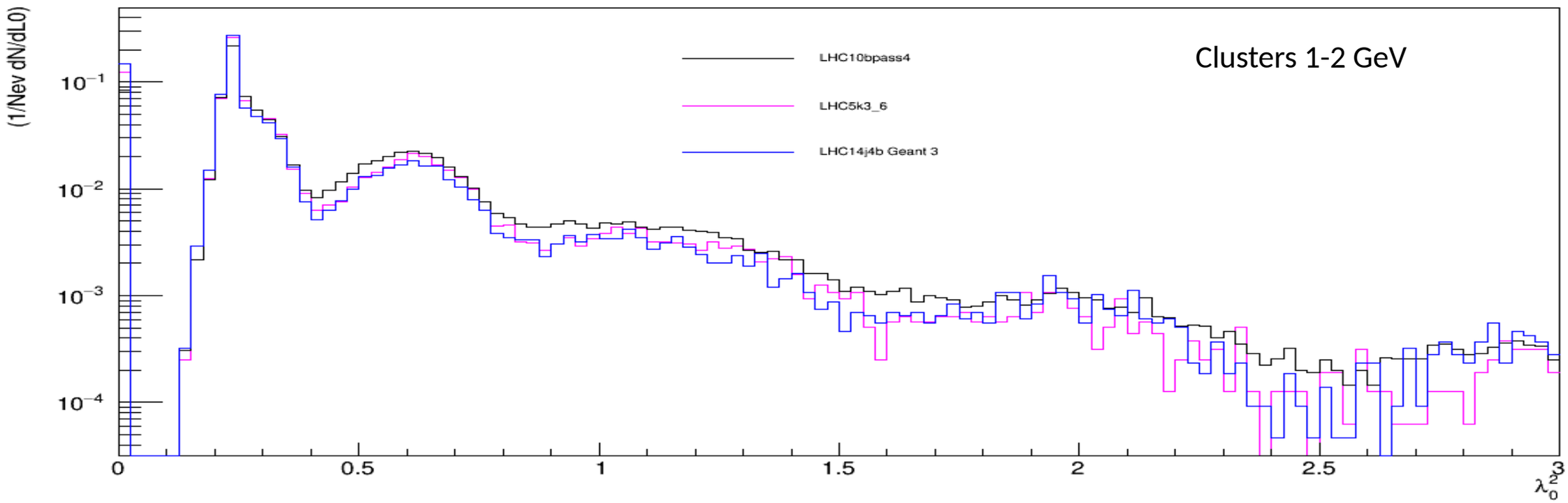


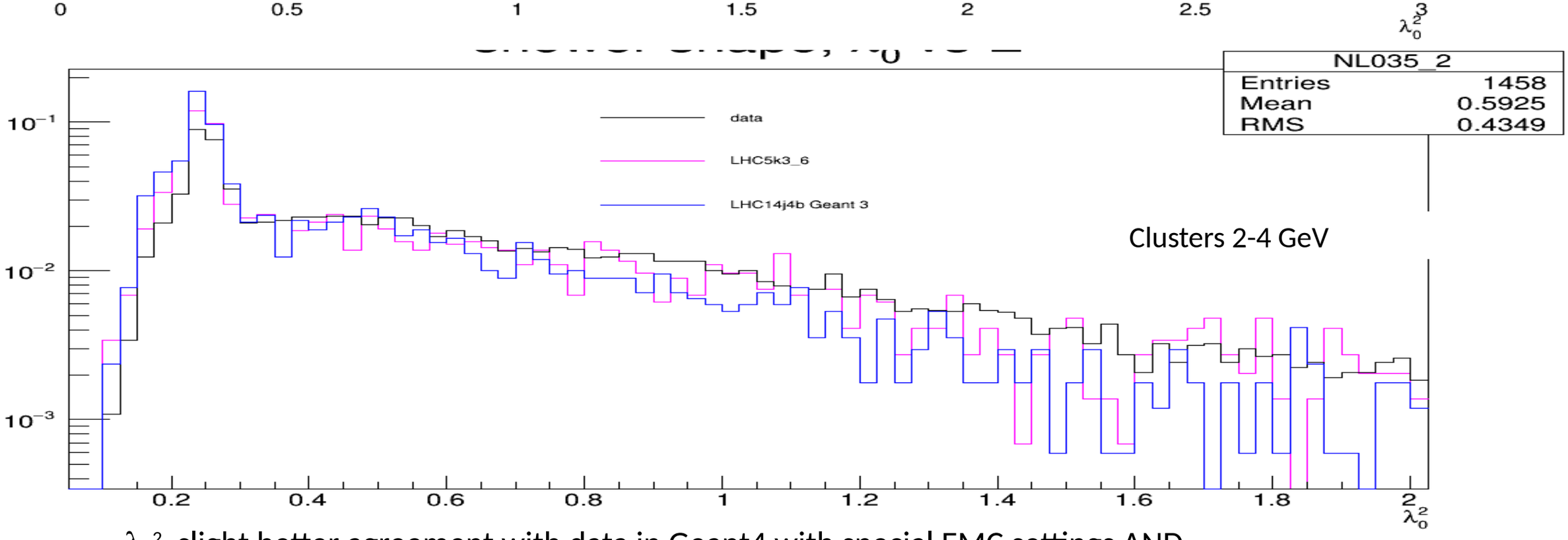


Raw cluster Energy →

Better cluster energy description in Geant 4 with proper Sampling fraction than without or with GEANT3

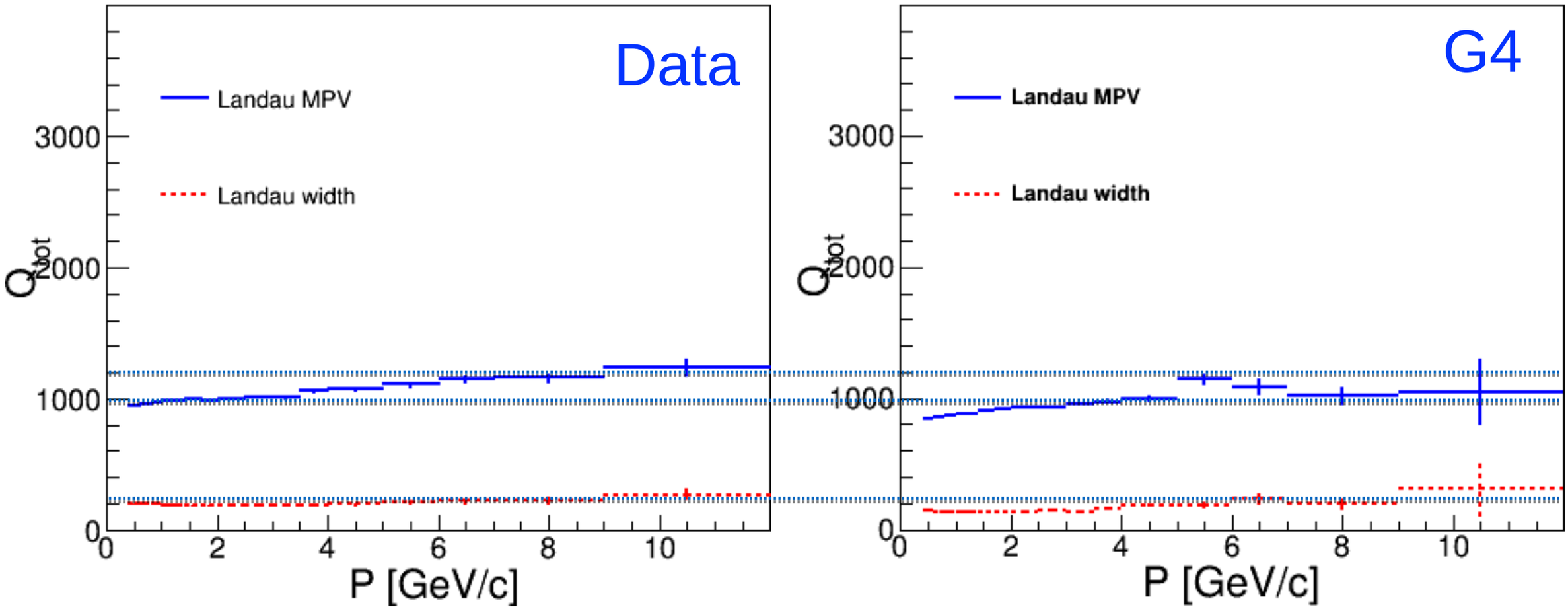
Raw cluster λ_0^2 (main axis of ShowerShape)





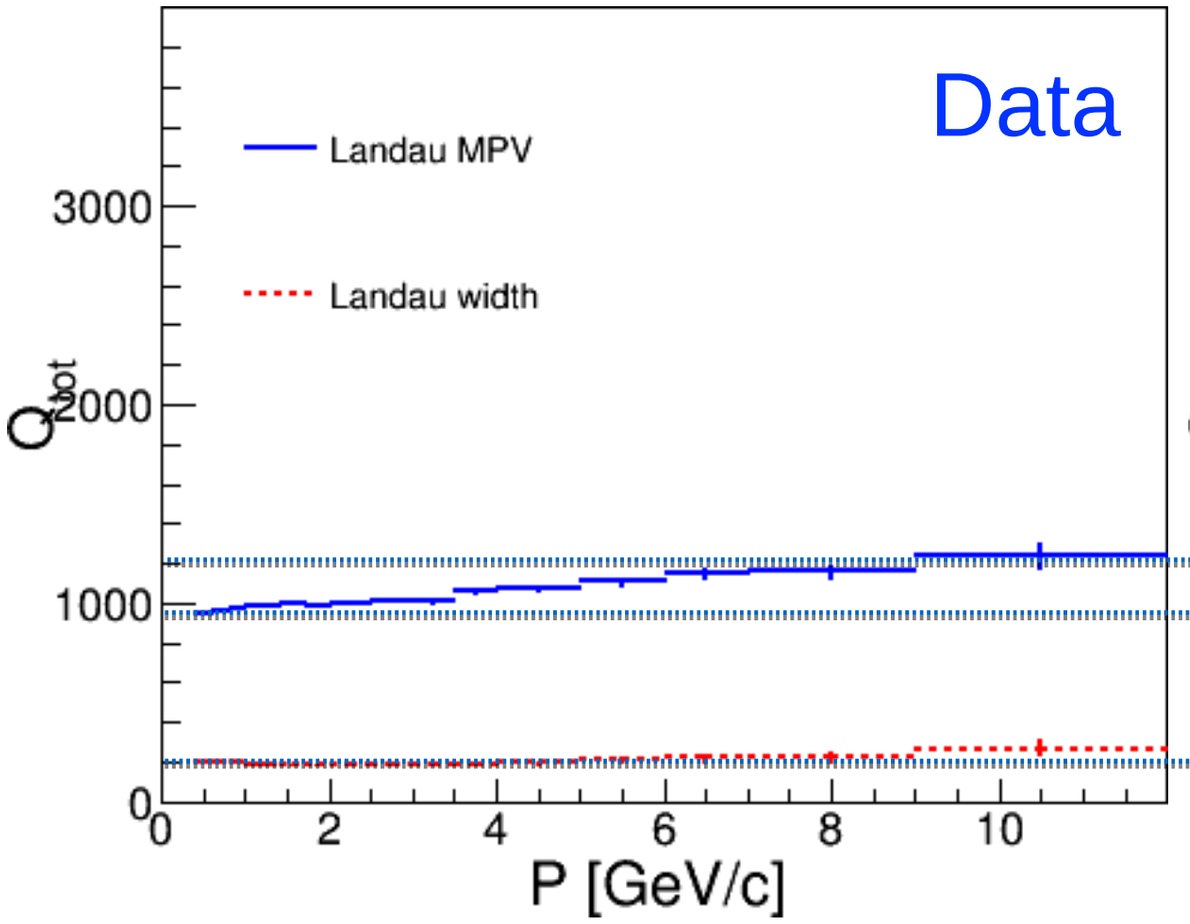
λ_0^2 slight better agreement with data in Geant4 with special EMC settings AND proper sampling

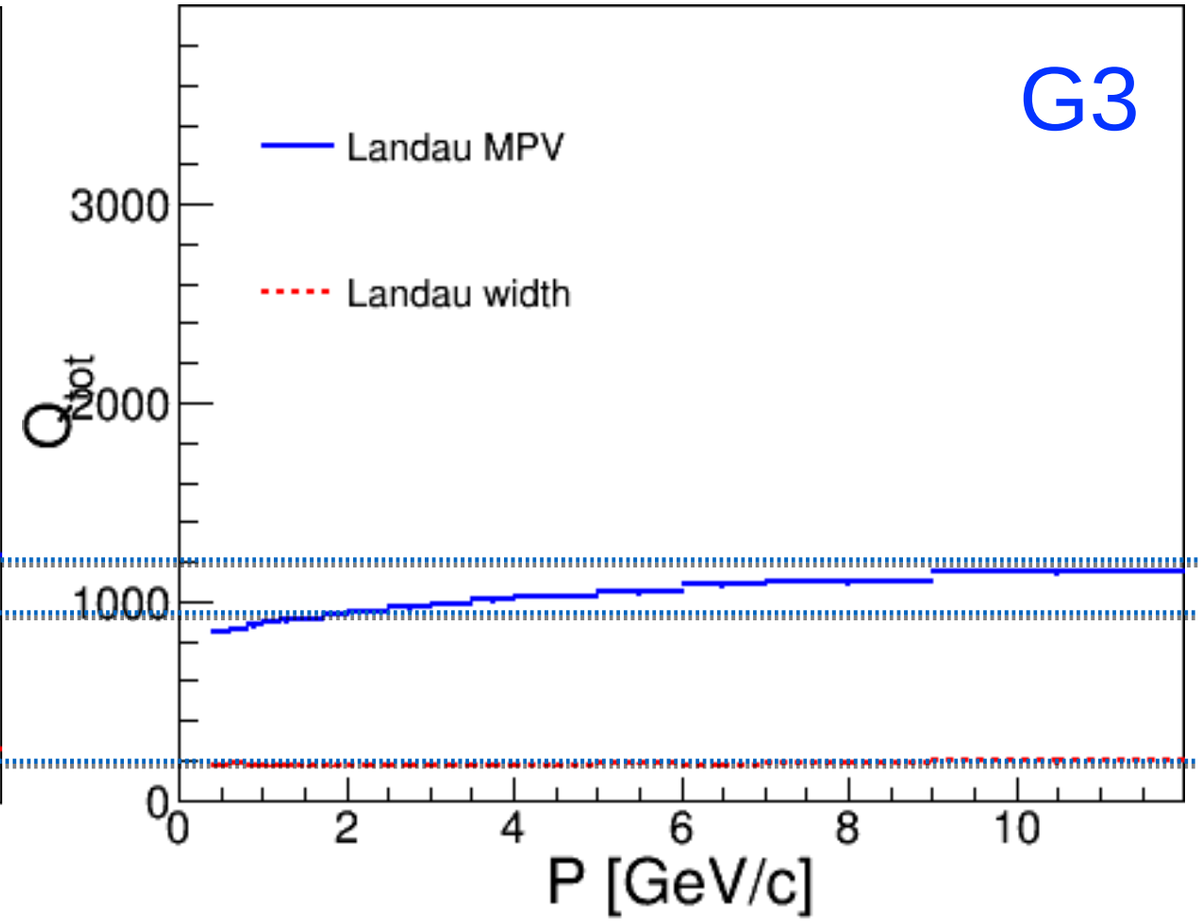
TRD Total Charge



Still worse agreement than with GEANT3 (see the next slide)

TRD Total Charge





Geant4 Transition Radiation Tests

Geant4 Transition Radiation tests

- Revised example TestEm10 (I.H. + V. Ivantchenko)
  - Code clean-up, revised scoring, physicsList changed to a modular physics list and introduced TransitionRadiationPhysics builder
- Geant4 VMC 3.3 - added support for transition radiation physics:
  - Added TG4TransitionRadiation physics builder, implemented according to the Geant4 extended example TestEm10
  - Added new command to define a radiator:

    /mcDet/setRadiator ...
- Starting tests by TRD detector experts
  - More feedback will follow

Conclusions

- Successful use of Geant4 for anti-nuclei studies in close collaboration with Geant4 hadronic physics group
- General Geant4 validation via test productions anchored to LHC10 data is ongoing
  - For most detectors, the agreement Geant4/data is at the same level as GEANT3/data
  - Worse agreement, observed in TRD, is under investigation
- Geant4 10.1.p03 with FTFP_BERT_EMV + G4OpticalPhysics + special models in selected regions
  - The fix to the long standing problem in navigation works ok
  - Minor problems reported were already fixed
  - Requirement for the integration of ALICE special Urban multiple-scattering model in Geant4