Geant4 Simulation for AFTER

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Probing the Strong Interaction at A Fixed Target ExpeRiments with the LHC beams,
12 - 17 January 2014, Les Houches

Outline

- Geant4 physics
- Application setup
- Output

Physics List (1)

- Geant4 = toolkit
- It's up to the users to define their physics setup
- Physics lists = define physics for a specific application domains
  - Several physics lists are provided with Geant4 but users can customize it or define their own PL using physics processes defined in Geant4 or their own processes
- The PL recommended for LHC experiments: FTFP_BERT
  - Geant4 expert was asked for confirmation:
  - *Fritiof (FTF) should be fine up to at least 1 TeV, so for 7 TeV it is not clear how reliable it is. It is difficult to say, also because it has never be tested at that energies...*
  - *Alternatively, instead of FTFP_BERT, one could consider QGSP_BERT. It should be valid to higher energies however its current implementation is not optimal and is being revised this year*

Physics List (2)

- More details
- Physics Reference Manual
  - *http://cern.ch/geant4/UserDocumentation/UsersGuides/PhysicsReferenceManual/fo/PhysicsReferenceManual.pdf (link)*
  - *~ 600 pages*
- Presentation by M.Verderi,LLR for Geant4 tutorial for Ecole Doctorale MIPEGE, Orsay, 2013:
  - Introduction & Overview
  - *http://ivana.home.cern.ch/ivana/ED-Geant4/presentations/VIII-1-physics_more.pdf (link)*
  - *~ 110 slides (only)*

Physics Processes

With FTFP_BERT physics lists:

/particle/select proton

/particle/process/dump

[1]=== process[msc :Electromagnetic] Active

[2]=== process[hIoni :Electromagnetic] Active

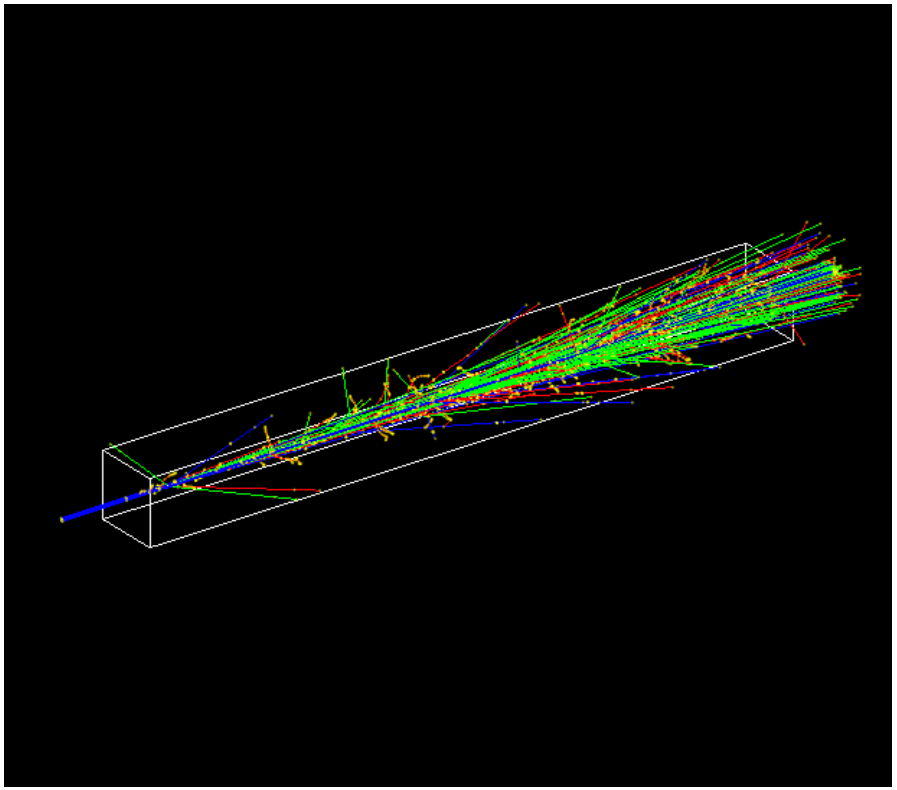
[3]=== process[hBrems :Electromagnetic] Active

[4]=== process[hPairProd :Electromagnetic] Active

[5]=== process[hadElastic :Hadronic] Active

[6]=== process[protonInelastic :Hadronic] Active

Application Setup (1)



Example of an event of 10p in H target

Primary:

Proton, 1 TeV

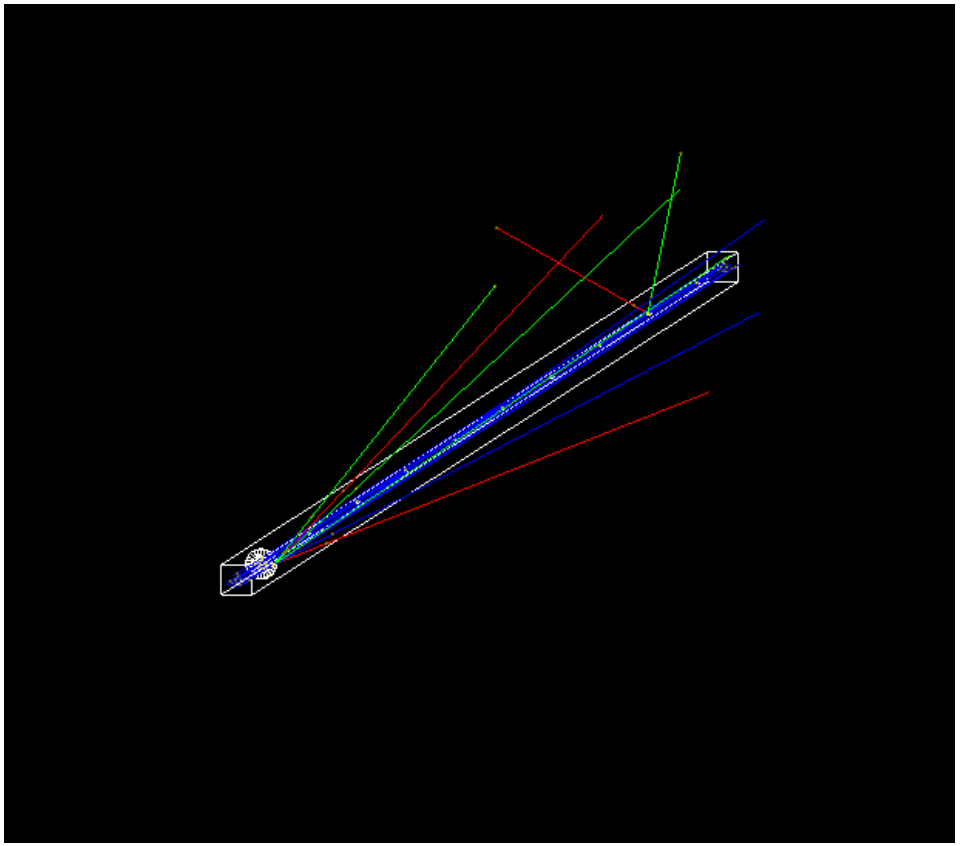
x,y randomized with Gaussian distribution with sigma = 1.5 mm

Target: Hydrogen:

targetSizeXY = 10.*cm;

targetSizeZ = 100.*cm;

Application Setup (2)



Example of an event of 10p in Pb target

Primary:

Same in previous setup

Target:

Pb, [Be, Al, Cu, In, W, U]:

nofRings = 10;

target0SizeR = 5.*mm;

target0SizeZ = 1.*mm;

targetSizeR = 0.5*mm;

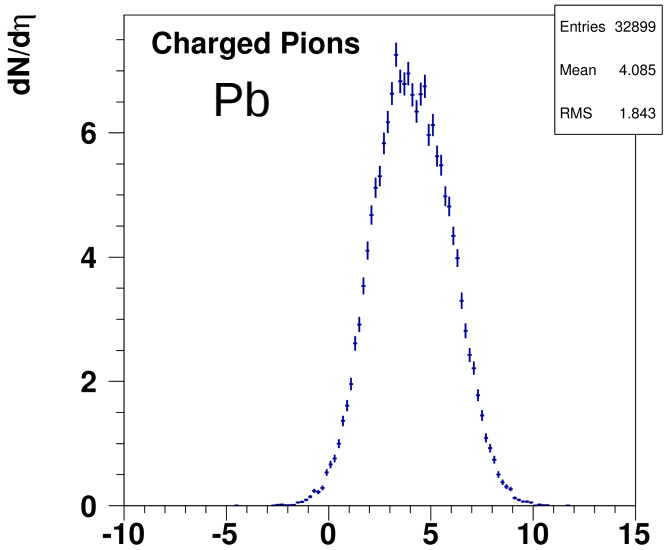
targetSizeZ = 1.*mm;

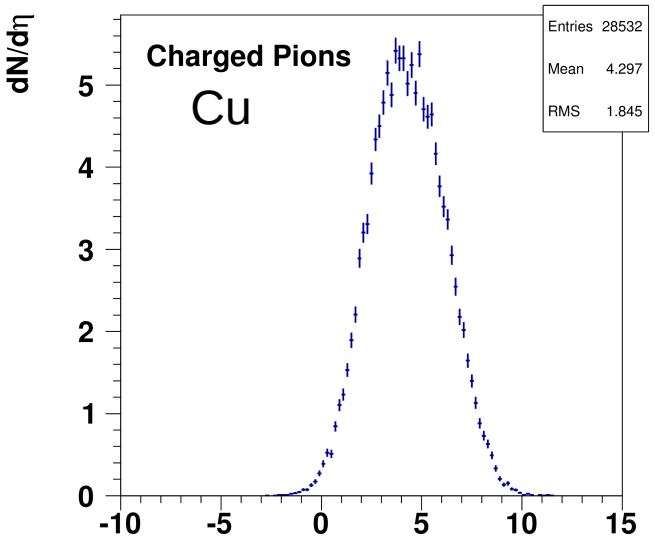
ringDistance = 10.*cm;

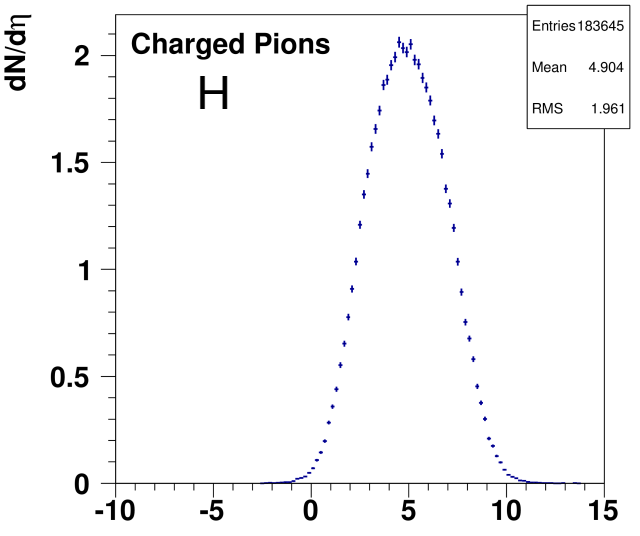
Output

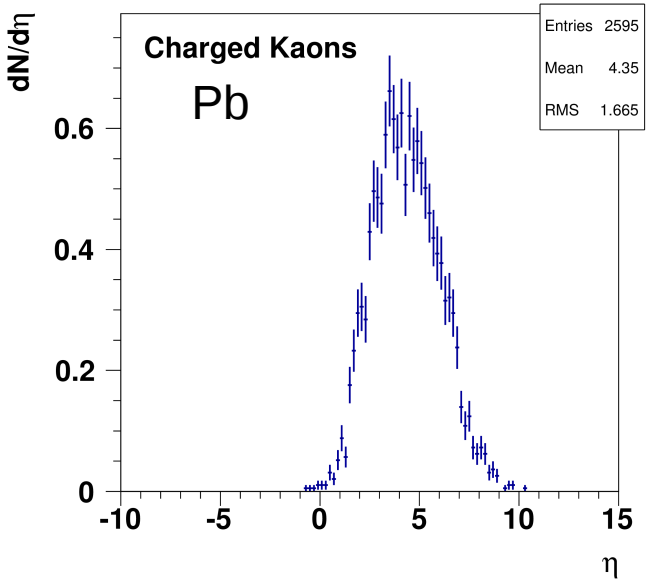
- Using g4tools (Geant4 integrated analysis tools) with Root output
- Ntuple primaries: proton at exit from the target
- Ntuple secondaries: at the creation point (vertex)
- In both:
  - Px, Py, Pz, Etot, X, Y, Z, PDG, event (1p = 1 event), isInelastic

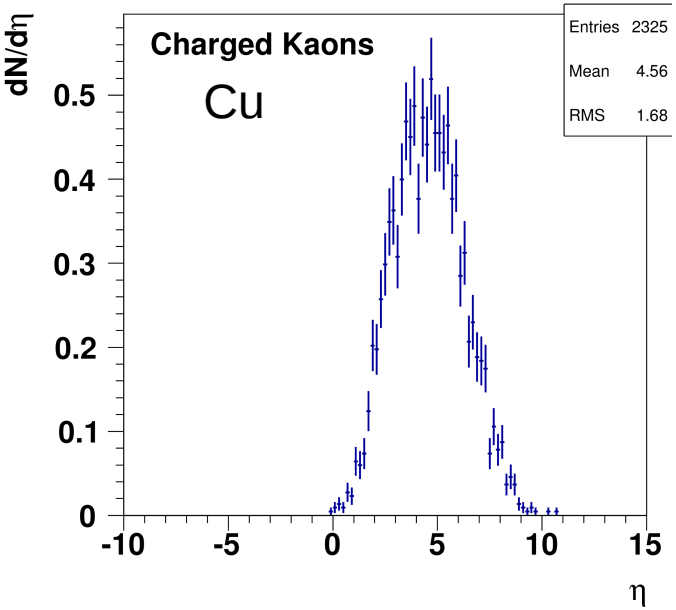
Results (1)

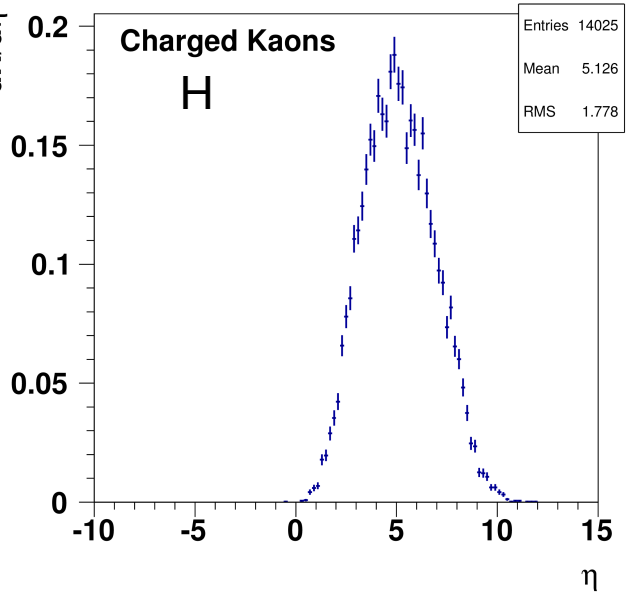












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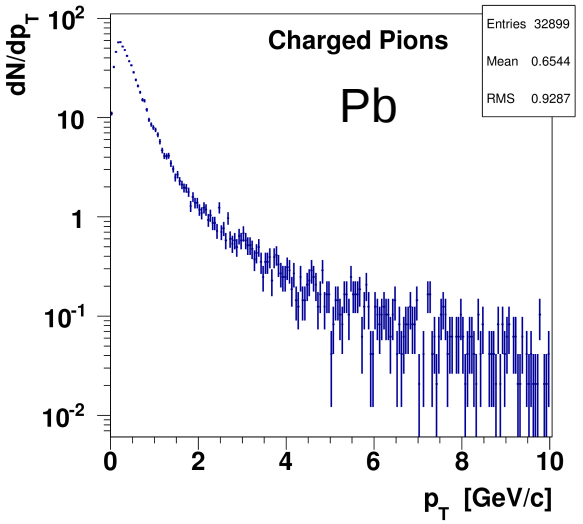
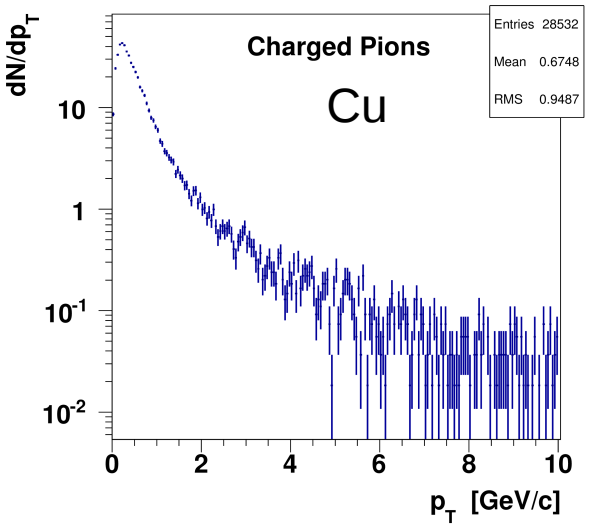
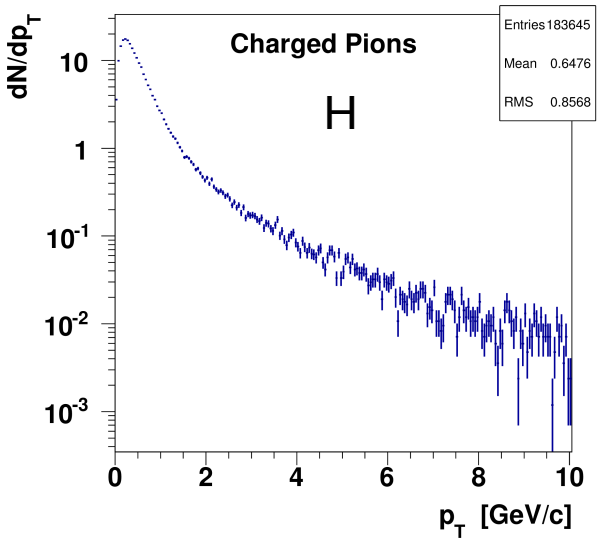
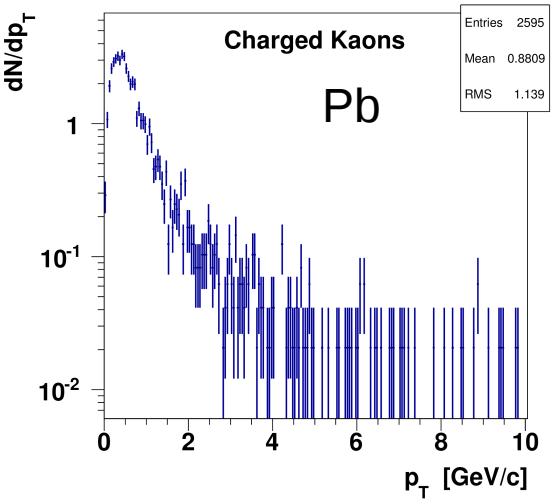
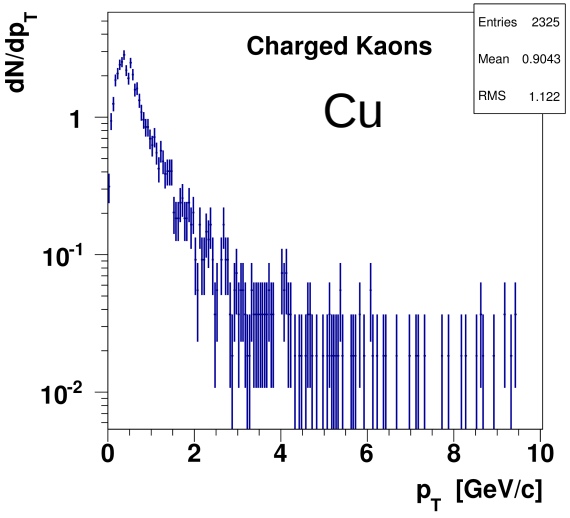
Results (2)

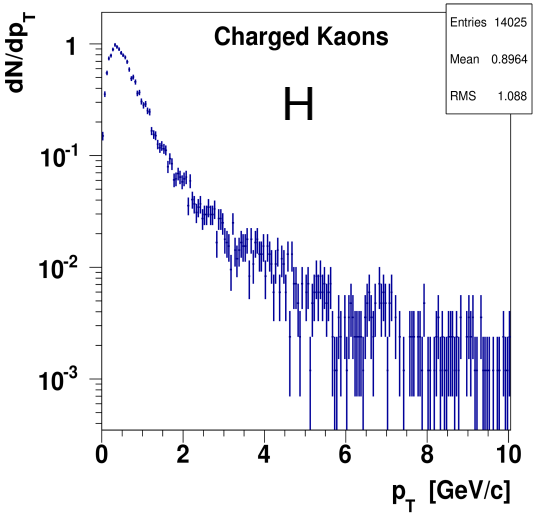

Charged Pions
Pb
Entries 32899
Mean 0.6544
RMS 0.9287
dN/dp_T
p_T [GeV/c]


Charged Pions
Cu
Entries 28532
Mean 0.6748
RMS 0.9487
dN/dp_T
p_T [GeV/c]

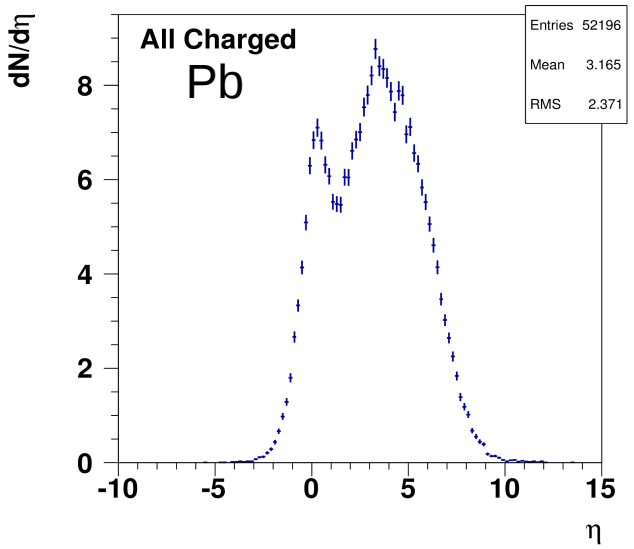

Charged Pions
H
Entries 183645
Mean 0.6476
RMS 0.8568
dN/dp_T
p_T [GeV/c]

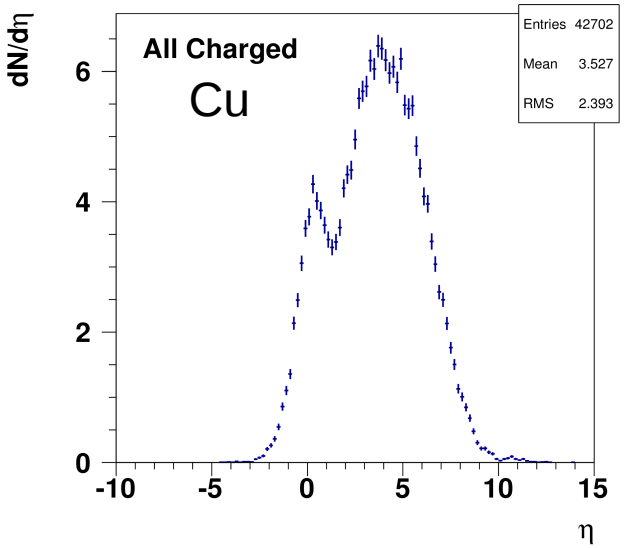

Charged Kaons
Pb
Entries 2595
Mean 0.8809
RMS 1.139
dN/dp_T
p_T [GeV/c]

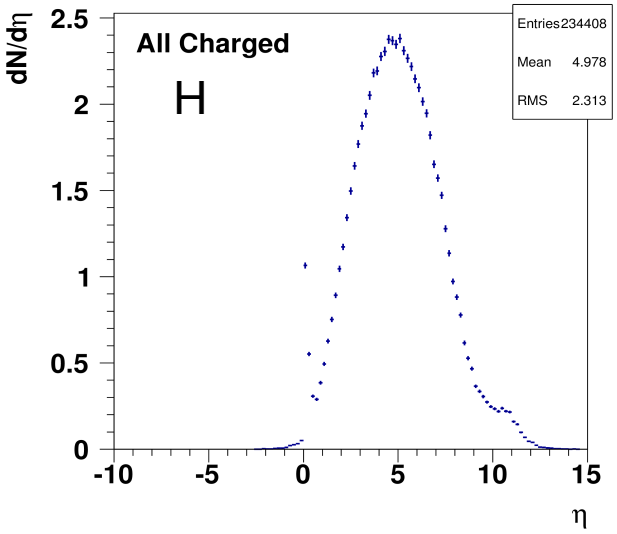

Charged Kaons
Cu
Entries 2325
Mean 0.9043
RMS 1.122
dN/dp_T
p_T [GeV/c]


Charged Kaons
H
Entries 14025
Mean 0.8964
RMS 1.088
dN/dp_T
p_T [GeV/c]

Results (3)


All Charged
Pb
Entries 52196
Mean 3.165
RMS 2.371
dN/dη
η


All Charged
Cu
Entries 42702
Mean 3.527
RMS 2.393
dN/dη
η


All Charged
H
Entries 234408
Mean 4.978
RMS 2.313
dN/dη
η