XI GDRE Workshop, Nantes, 2011

Update of Epos Femto package
and
Status of kaon femtoscopy with Epos

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in collaboration with K. Werner

Outline

- What is new in Epos Femto?
- Base line in pp@900GeV
- pp@7TeV with EPOS
  - $\pi^+\pi^+$ *arxiv:1104.2405*
  - K+K+ status:

    two EOS

    pi+pi+ and K+K+

    Comparison with ALICE

Conclusion

Epos Femto package Updates

There are 4 papers where Epos Femto calculation included

The code is modifying according new tasks.

We added new histogram routine mtx.h -> reduce memory + increase speed

New tree routine -> remove memory leak + increase speed

New tasks -> pair + condition (kTs, Mults, cuts)

It was pion-pion study only.

Now we are starting calculation for kaon-kaon

Multiple task in one job

Epos Femto Tree File

```
//--- header tree ---
Int_t iversn; //version number
Int_t laproj; //projectile Z
Int_t maproj; //projectile A
Int_t latarg; //target Z
Int_t matarg; //target A
Float_t engy; //energy/nucleon in
Int_t nfreeze;//blocksize for give
Int_t nfull;  //number of nfreeze
```

```
//--- epos tree ---
Int_t      np ; // number of particles in event
Float_t    bim; // centrality (multiplicity) variable
Float_t *  zus; // different meaning depending on ptl type:
                // partons: presently unused
                // hadrons:  decay information :
                // -999 : hadron is decay product from decay
                //        in cascade part (mother unknown)
                //   -1 : hadron is decay product, mother not stored
                //   >0 : hadron is decay product, mother index = zus
                //   -2 : no mother
Float_t *  px ; //  -+
Float_t *  py ; //   |  particle
Float_t *  pz ; //   | four momentum
Float_t *  en ; //  -+
Float_t *  x  ; //  -+
Float_t *  y  ; //   | particle
Float_t *  z  ; //   | four position
Float_t *  t  ; //  -+
Int_t   *  id ; // particle id (epos code)
Int_t   *  ist; // status and particle type
                //  0 and 1 ... hadrons (0 = last generation)
                //  21 ........ partons
                //  25 ........ intermediate out-Born partons
                //  29 ........ string
Int_t   *  ior; // origin (particle index)
Int_t   *  jor; // origin (particle index)
                // ior>0, jor=0 : ior is origin
                // ior>0, jor>0 : origins from  ior to jor
                // ior=0, jor=0 : no origin
```

Epos Femto Matrix Histograms

Book

```
   class mtx
//=======================
{
public:
  //to do:
  //TH1D **hopt;

  //S-func
  TH1D ***hco;
  TH1D ***hcomo;
  TH1D ***hradi;

  TH1D ****hRoslall;
  TH1D ****hRosldir;

  //CF's
  TH1D ****hcfA;
  TH1D ****hcfo;
  TH1D ****hcfs;
  TH1D ****hcfl;
  TH3D ****h3cf;
  //single technical histograms...
  TH1F **hk_t;
  TH2F **hkt_q;
  TH1F **hNevents;
  TH1F **hmixnum;
```

Fill

```
//..Correlation..functions..
for(Int_t v=0;v<fnKtBins;v++) {
  if( k_T>fKtMin[v] && k_T<fKtMax[v] ) {
    //1d
    hMat->hcfA[cCe][v][Kw]->Fill(Qinv,w3[Kw]);
    //projections
    if(Qs<q3cut&&Ql<q3cut) hMat->hcfo[cCe][v][Kw]->Fill(Qo,w3[Kw]);
    if(Qo<q3cut&&Ql<q3cut) hMat->hcfs[cCe][v][Kw]->Fill(Qs,w3[Kw]);
    if(Qo<q3cut&&Qs<q3cut) hMat->hcfl[cCe][v][Kw]->Fill(Ql,w3[Kw]);
    //3d
    hMat->h3cf[cCe][v][Kw]->Fill(Qo,Qs,Ql,w3[Kw]);
  }
}
```

Write

```
for(Int_t uc=0; uc<puCentrality; uc++) {
  for(Int_t j=0;j<pkt;j++){
    for(Int_t K=0;K<3;K++){
    hcfA[uc][j][K]->Write();
    hcfo[uc][j][K]->Write();
    hcfs[uc][j][K]->Write();
    hcfl[uc][j][K]->Write();
    h3cf[uc][j][K]->Write();
    }
    for(int m=0;m<4;m++) {
      hRoslall[uc][j][m]->Write();
      hRosldir[uc][j][m]->Write();
    }
  }
}
```

Non-femtoscopic effects (base line in pp@900GeV, VI WPCF, Kiev, 2010)

Non-femtoscpic effects with EPOS

- ππ correlation in pp at √s=900GeV Epos 2.05 model calculation
- k_T intervals [100,250],[250,400],[400-550],[550-700],[700-1000] MeV/c
- High multiplicity $dN_{ch}/d\eta(0)=12.9$
- Full correlation function with mixing procedure (femto and non-femto):

  $CF = [dN_{real}/dq_{inv} * W(r,p)] / [dN_{mixed}/dq_{inv}]$

- Pure femtoscopic correlation function (femto):

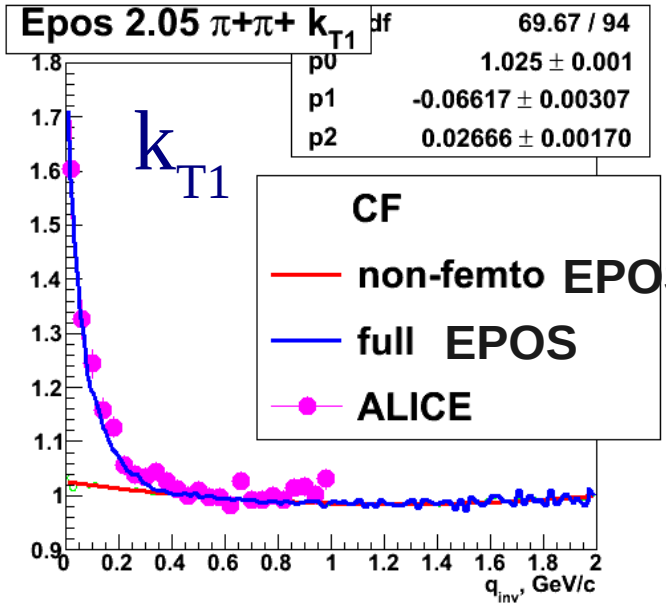
  $CF= [dN_{real}/dq_{inv} * W(r,p)] / [dN_{real}/dq_{inv}]$, where W is pure femtoscopic weight from Lednicky's code (QS only)

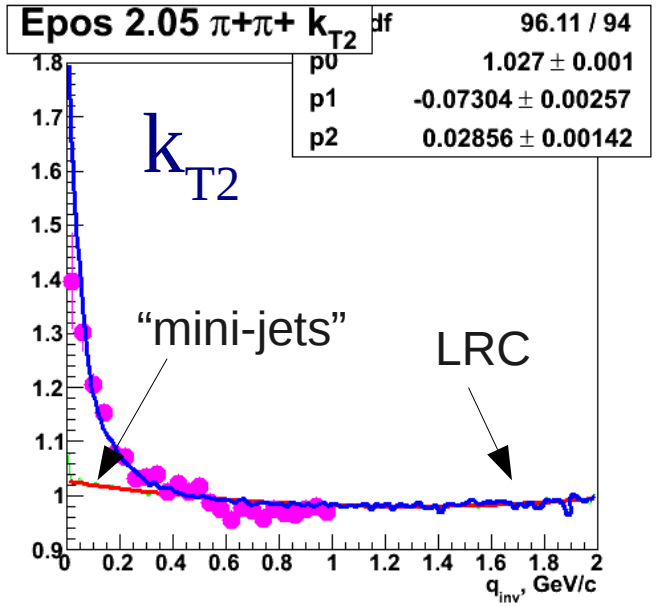
- Pure Epos correlation function (base line):

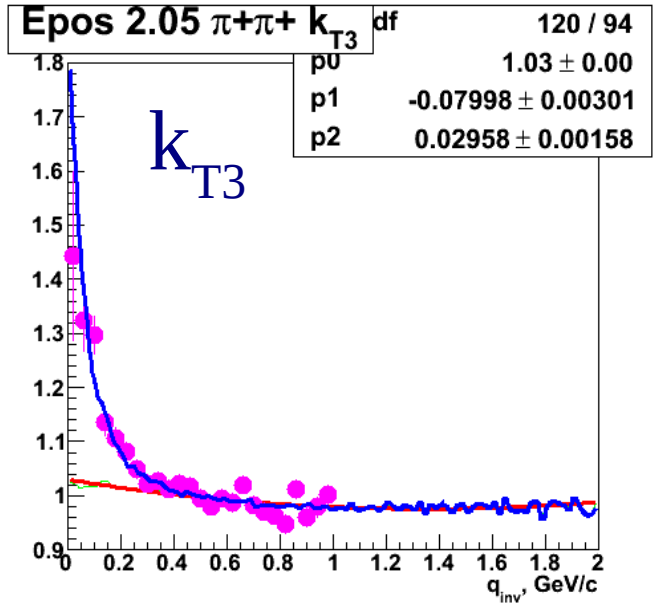
  $CF = [dN_{real}/dq_{inv}] / [dN_{mixed}/dq_{inv}]$

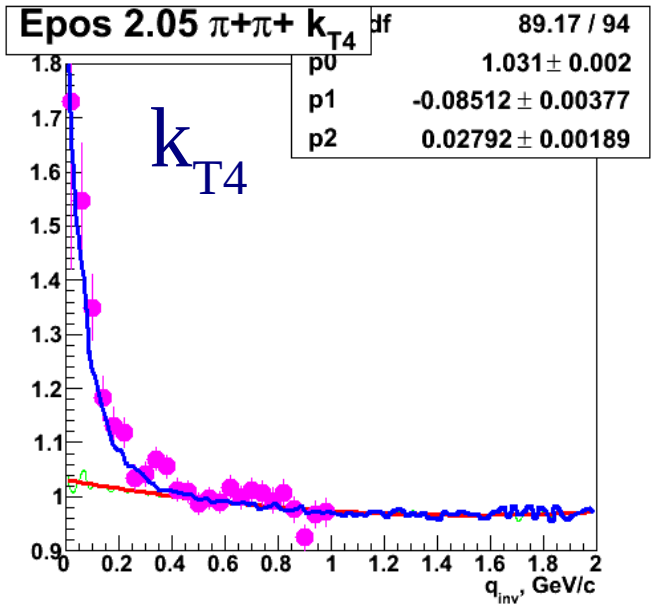
Epos non-femto: $a+bq_{inv}+cq_{inv}^2$

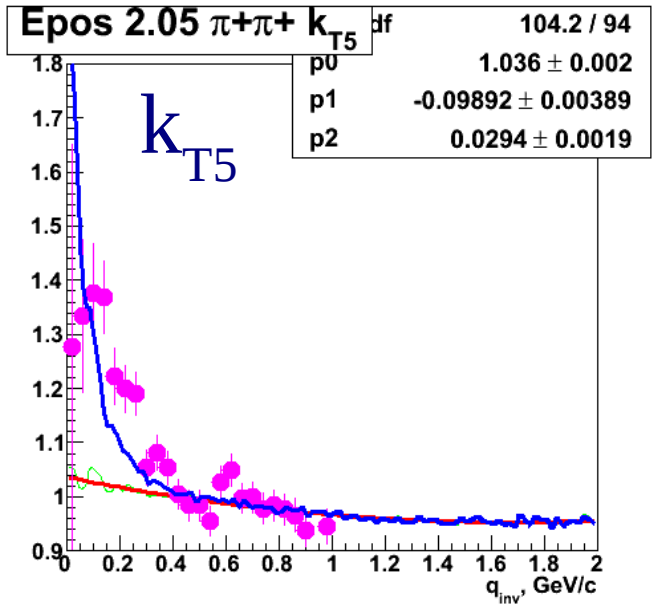
Points are ALICE ππ correlation in pp$\sqrt{s}$=900GeV data [arXiv:1007.0516v1 hep-ex]

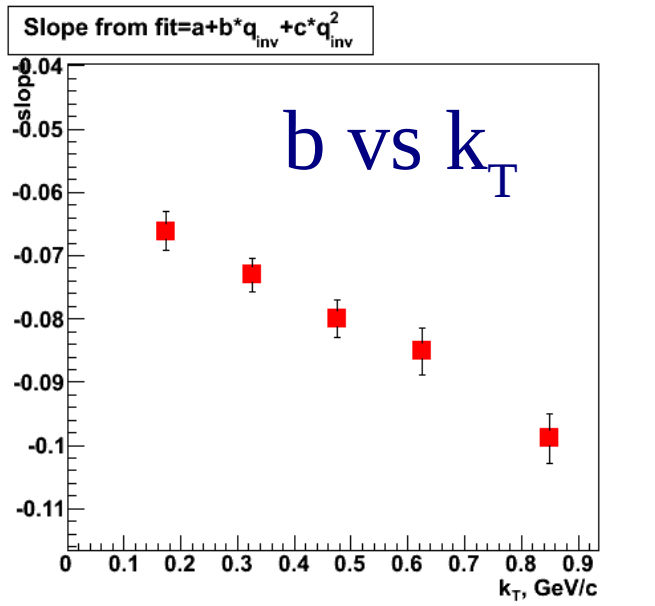




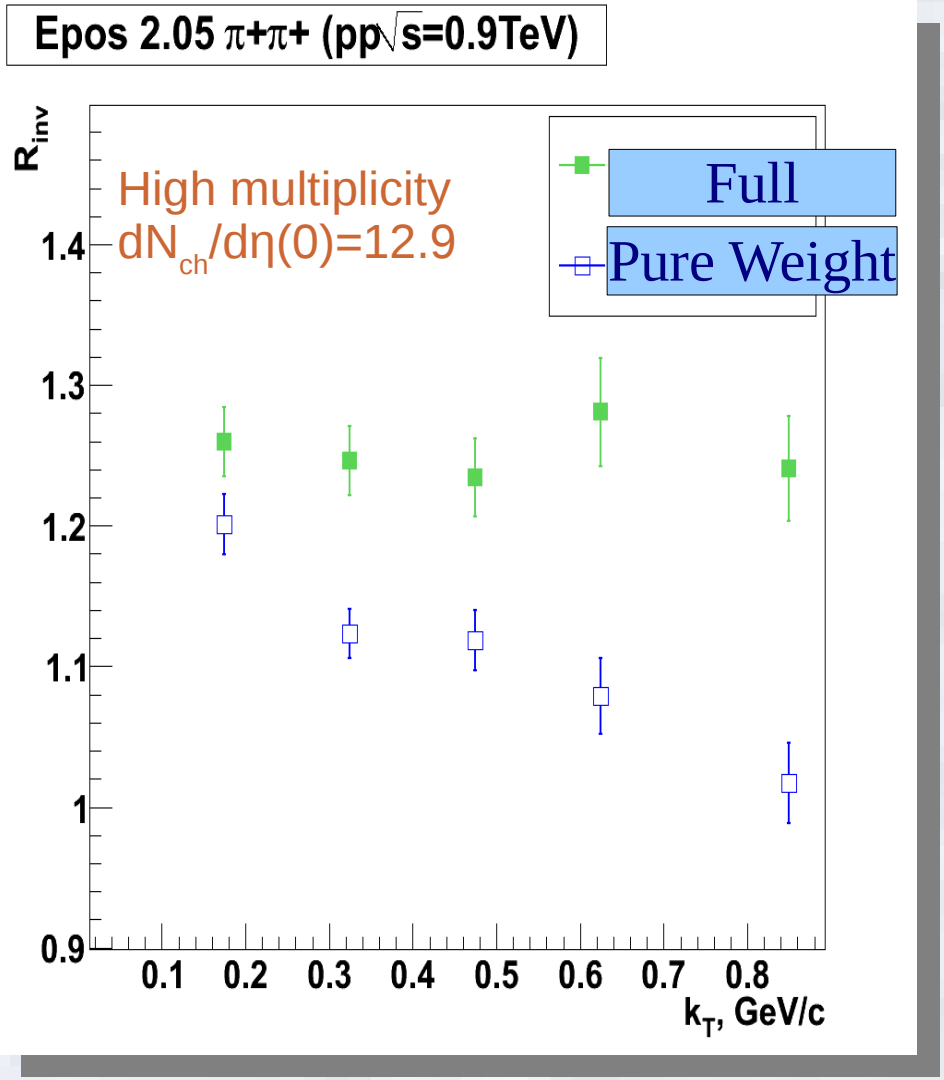


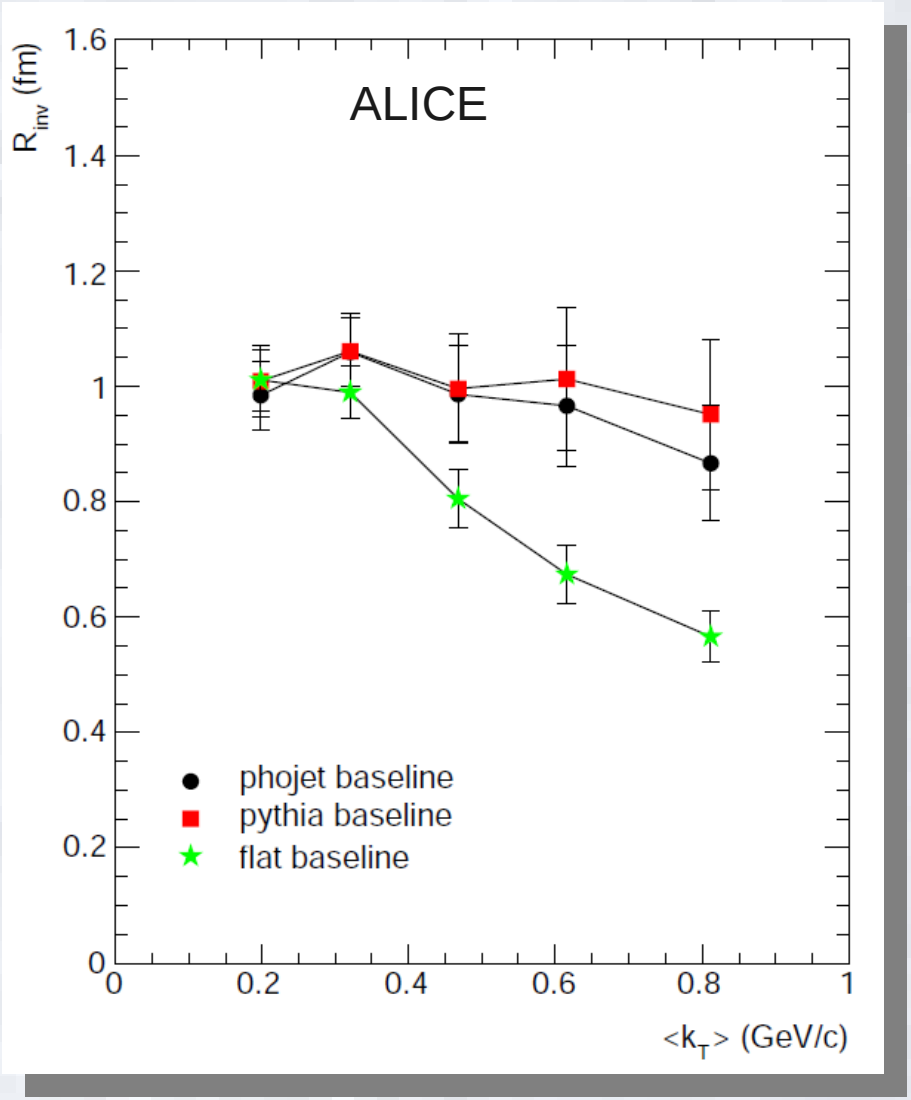






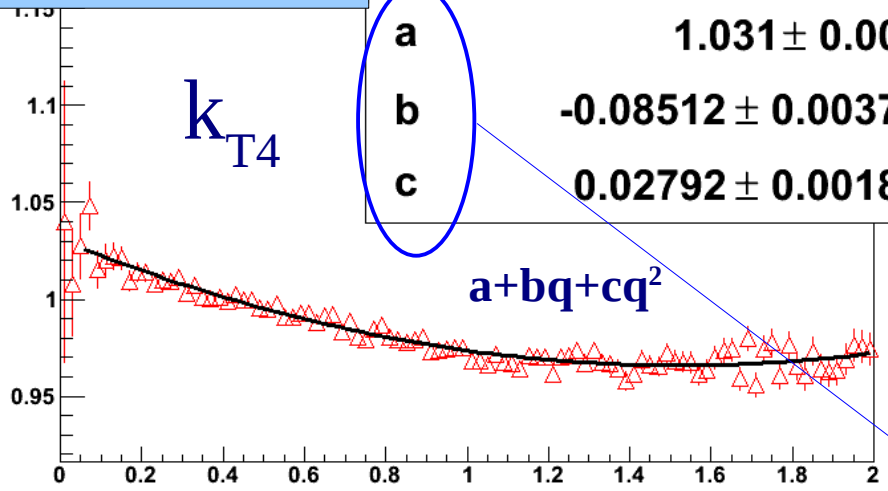
R_{inv} pure and full



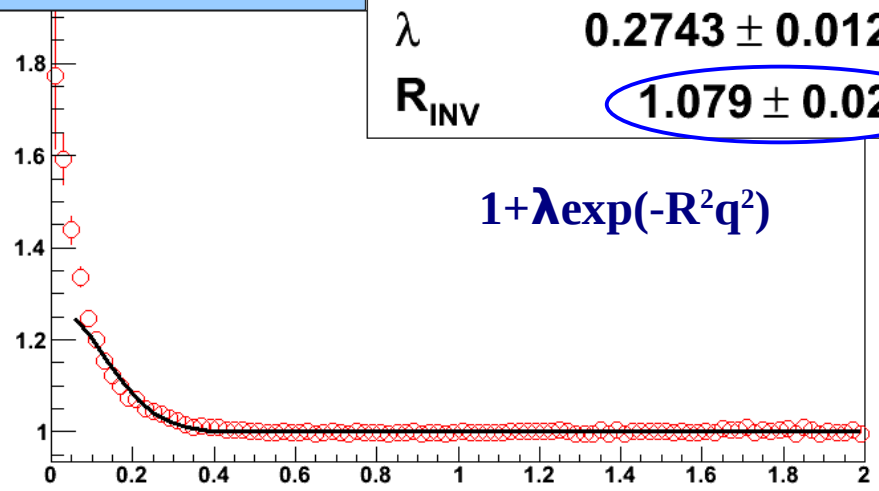


Epos: non-femto, pure, real/mix

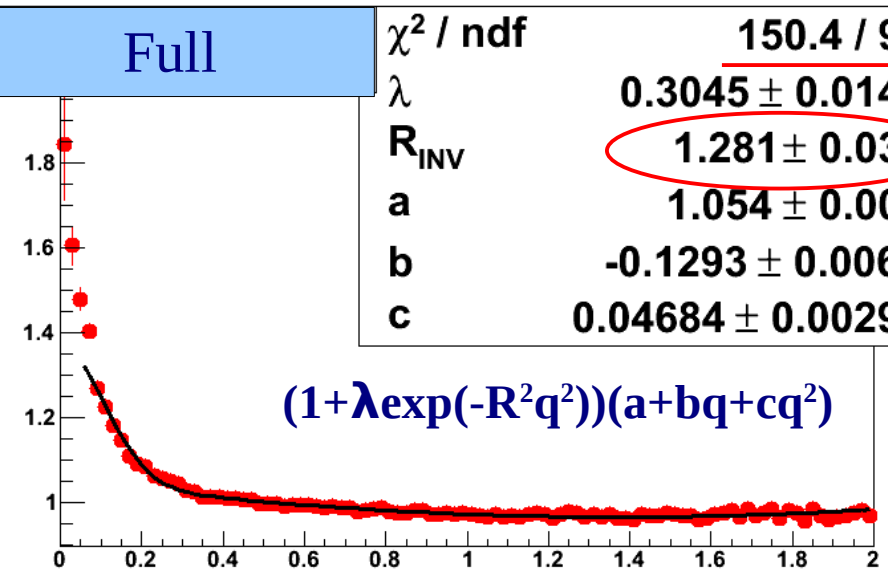
Non-femto



Pure Weight



Full



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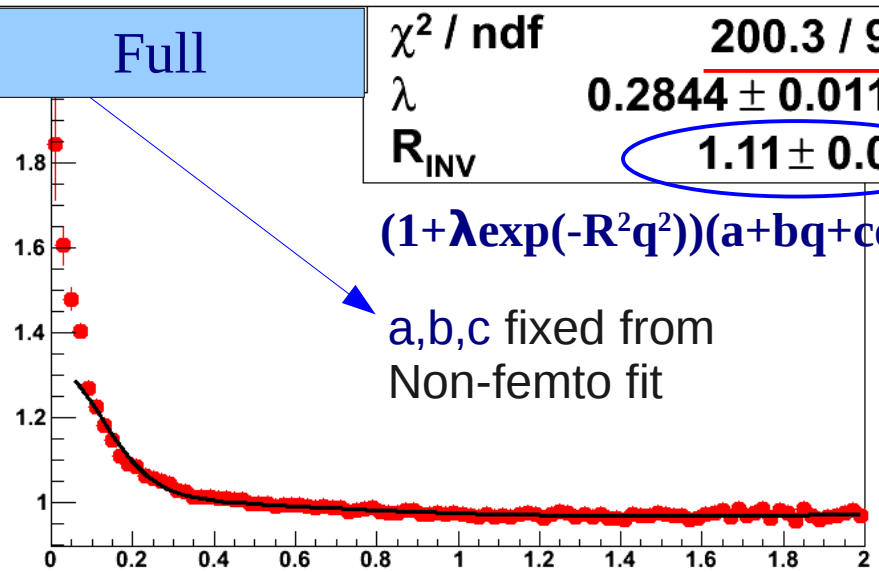


pp @ 7 TeV

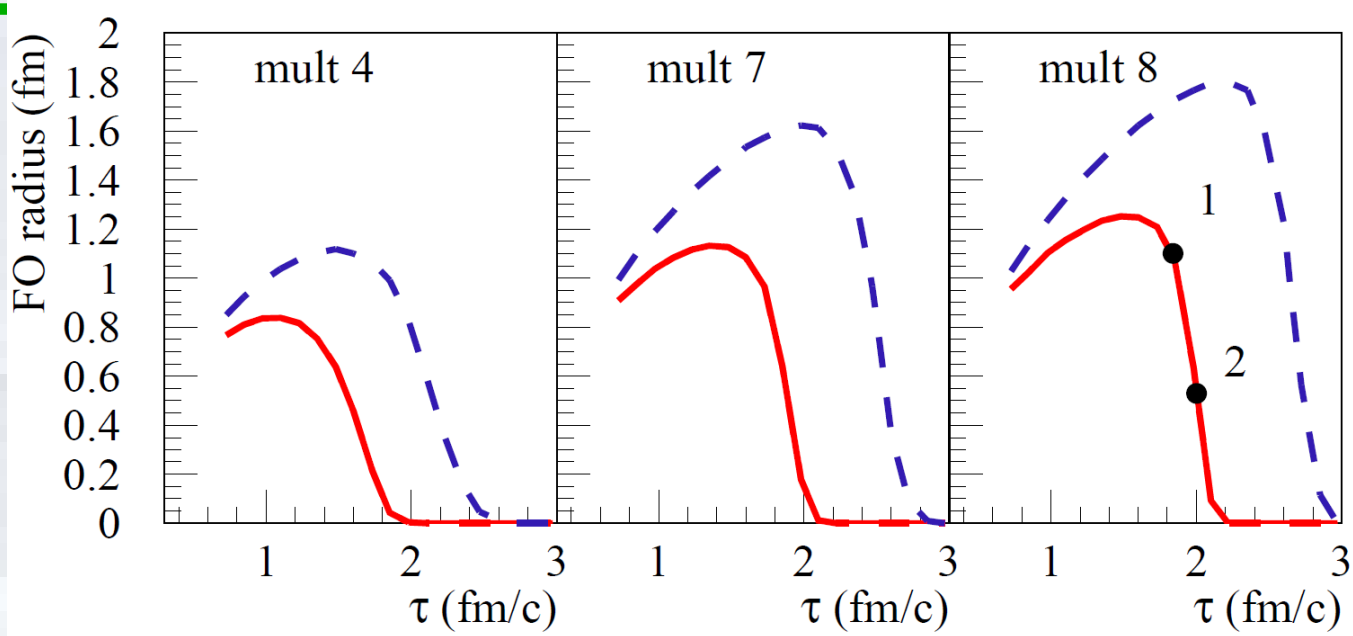
ππ paper and EOS

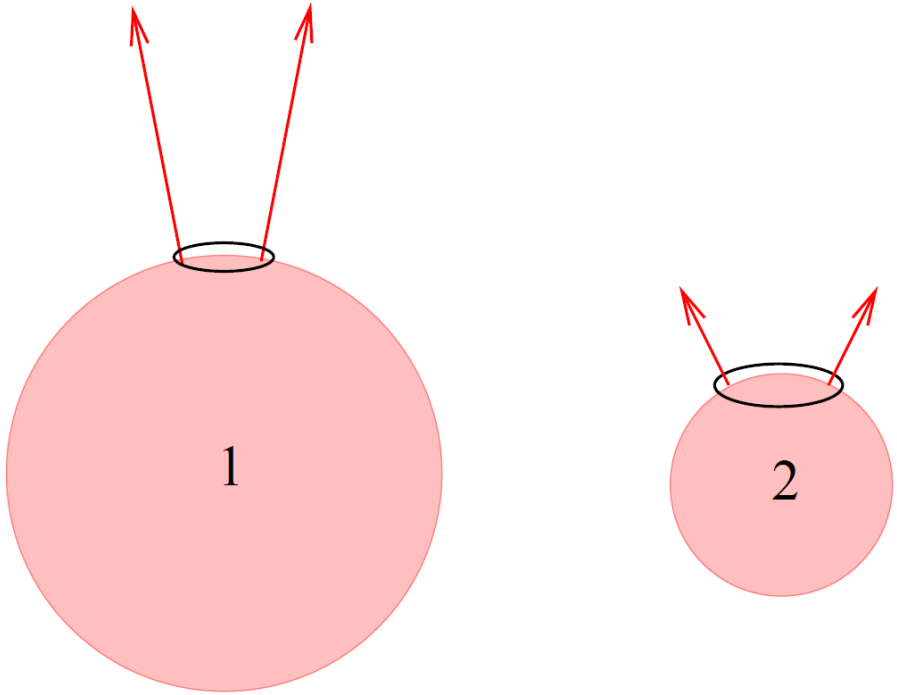
There are two EOS in ππ paper [arxiv:1104.2405]:

1. Fodor arxiv:1007.2580

2. Karsch arxiv:0911.2215

The transition temperature is much lower and the transition is much smoother in EOS 1, compared to EOS 2



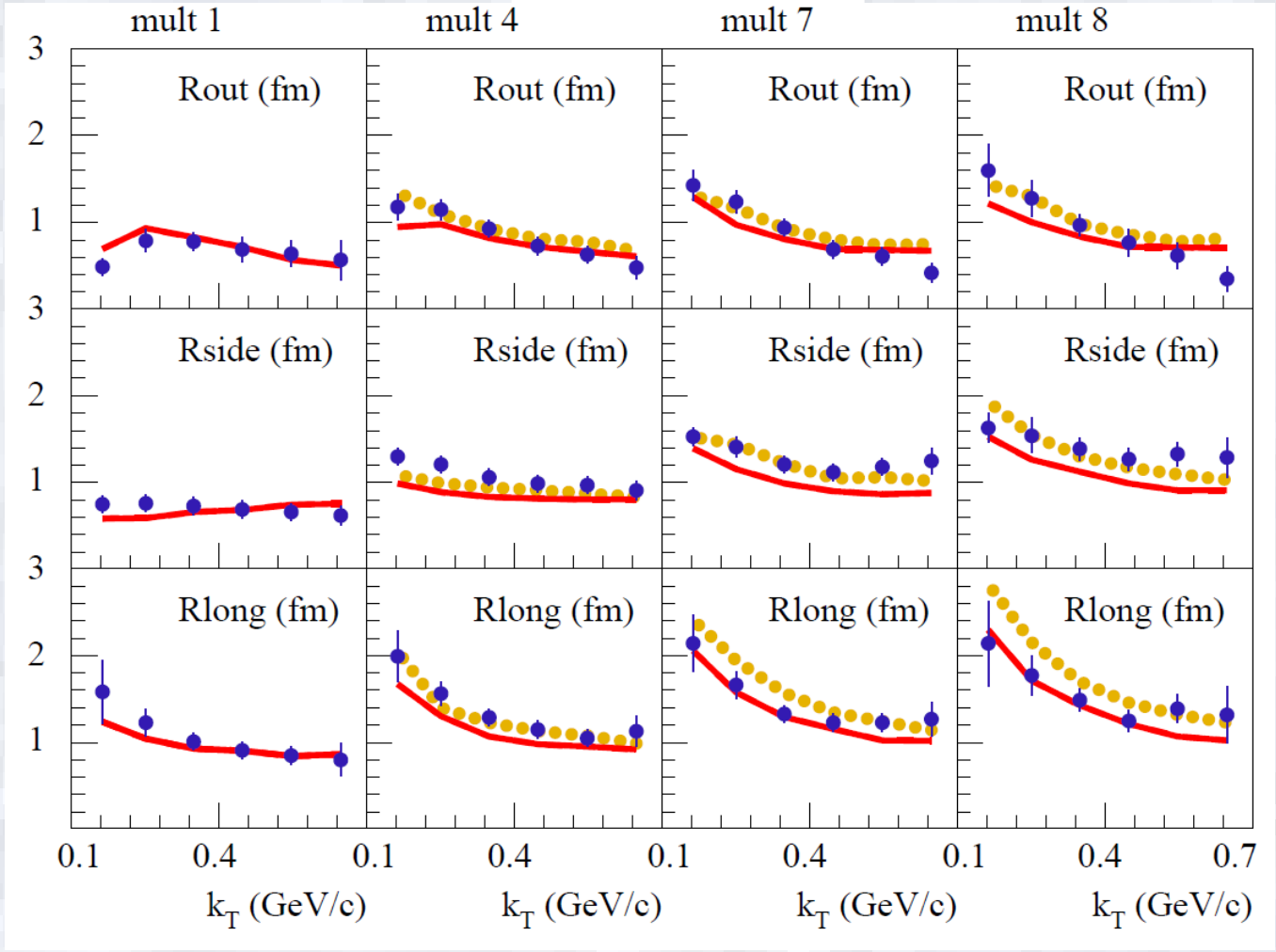


pipi paper, comparison with ALICE data

Big difference in FO radii becomes smaller in final result due to an intense hadronic rescattering in case of early FO for Fodor EOS.

arxiv:1104.2405

Fodor: **solid line**
Karsch: **dotted line**



K+K+ in Epos Femto

K+K+ in pp at 7 TeV:

k_T ranges: 0.2-0.35, 0.35-0.5, 0.5-0.7, 0.7-1.0 GeV/c (same as Ludmila's study)

Multiplicity ranges Nch: 1-11, 12-22, 23-149

Eta range: $|\eta|<1.2$

Cuts: $0.13 < |pT| < 2.0$ GeV/c

Two EOS (see arXiv:1104.2405):

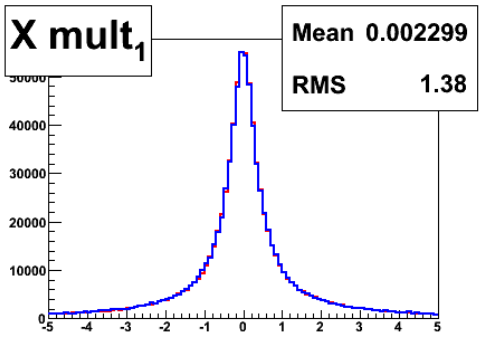
1. Fodor arxiv:1007.2580 [4.3 Mevents]

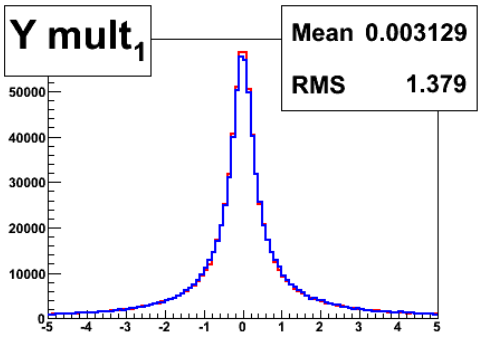
2. Karsch arxiv:0911.2215 [1.6 Mevents]

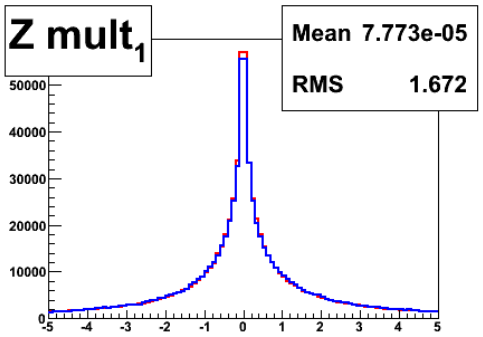
CF -> Quantum Statistics only

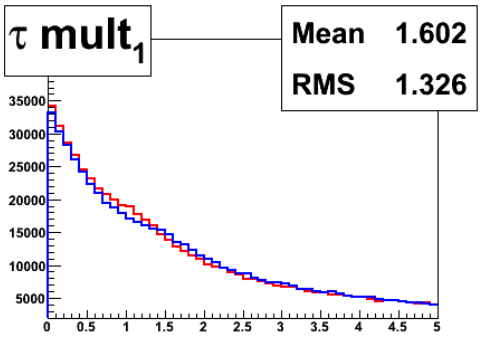
CF histogram bins: 100 bins, 0-2 GeV/c

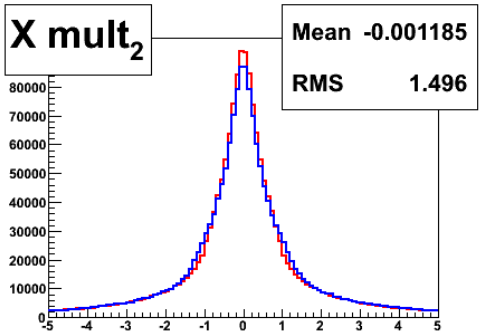
K+ space-time (Fodor and Karsch EOS)

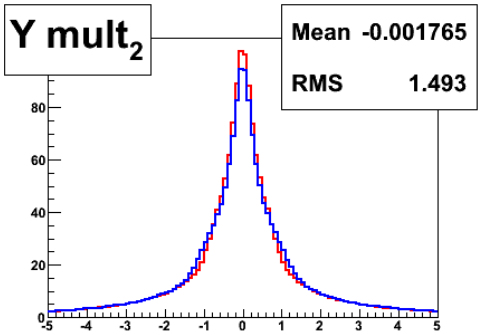


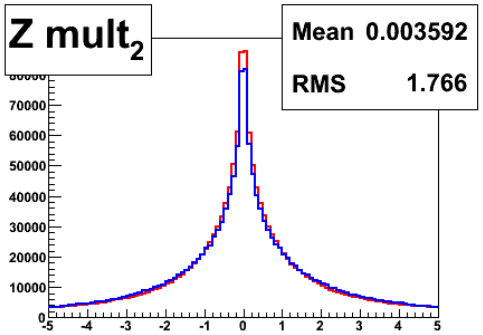


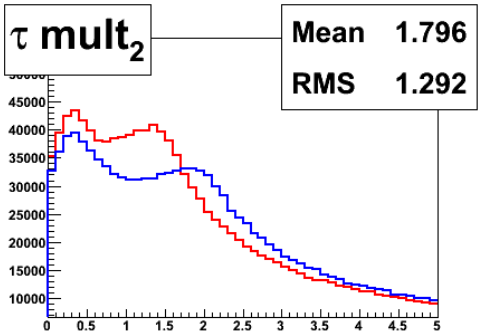


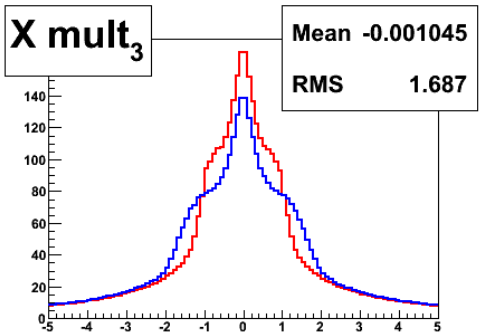


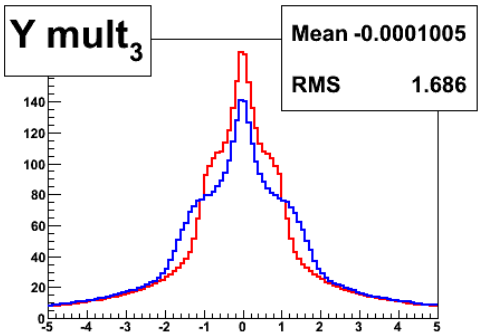


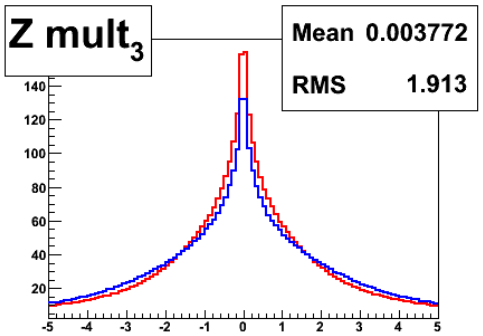


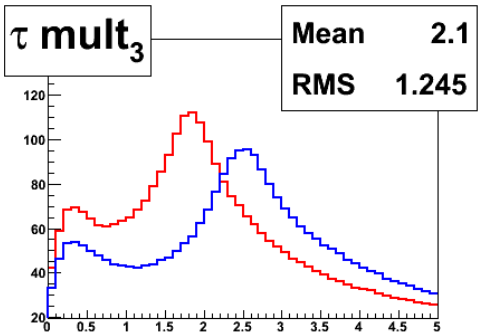






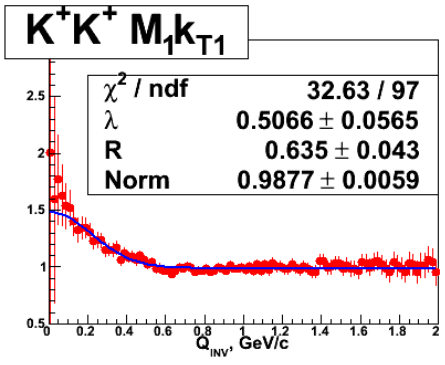


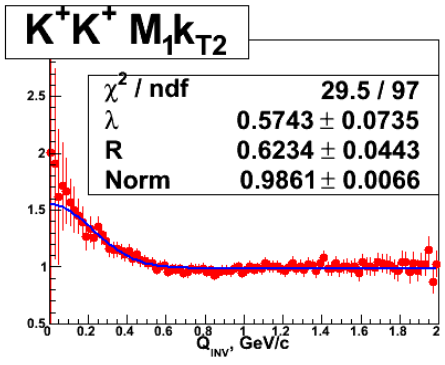


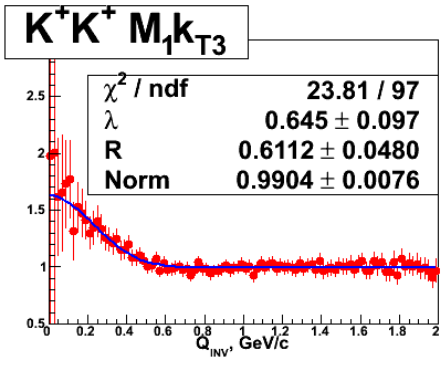


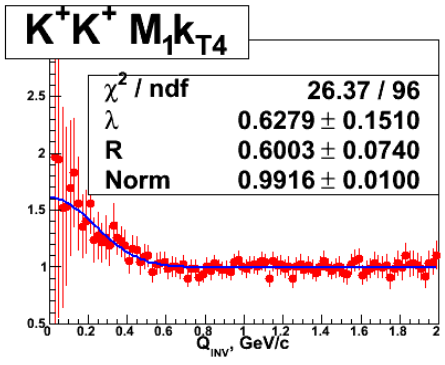
K+K+ CF vs multiplicity and k_T

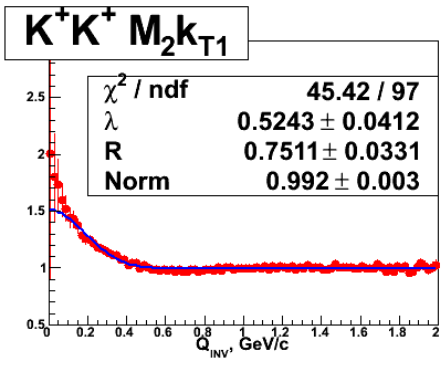
Fodor EOS

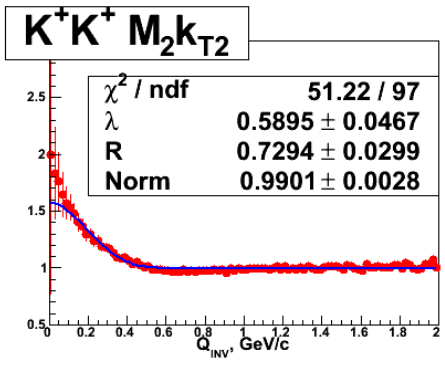


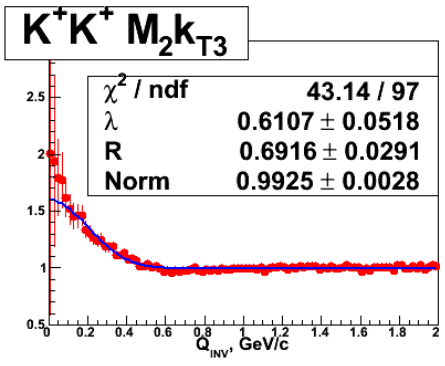


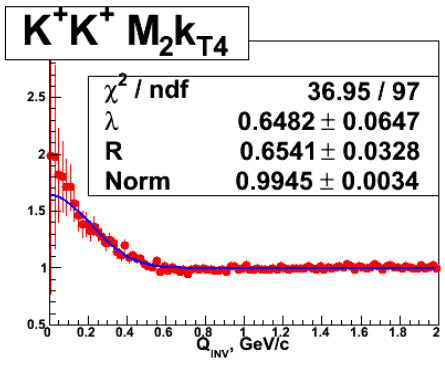


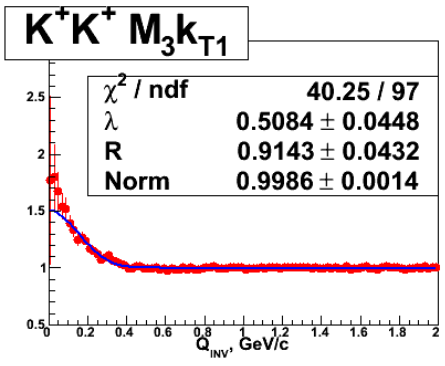


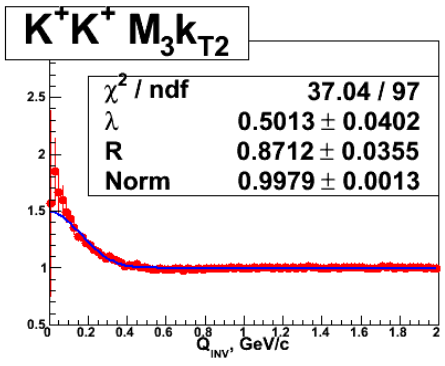


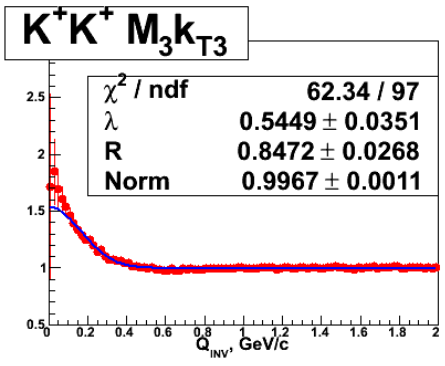


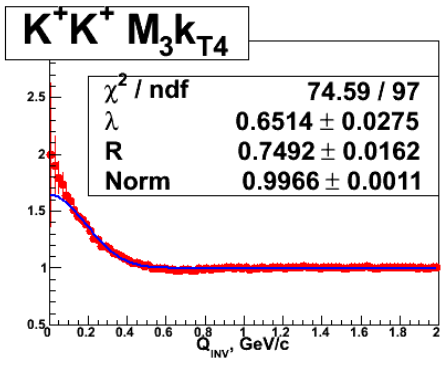






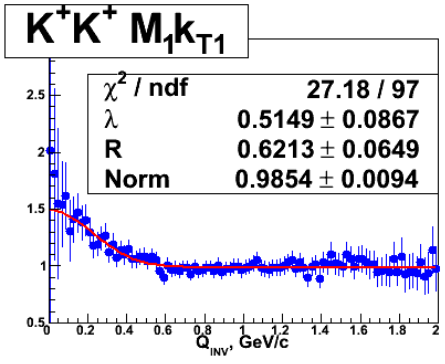


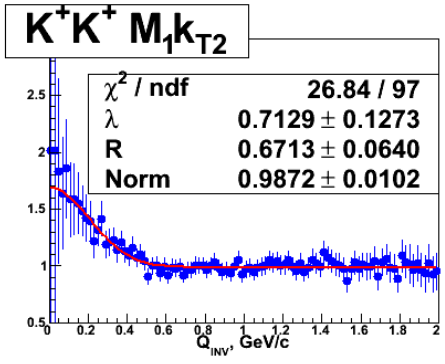


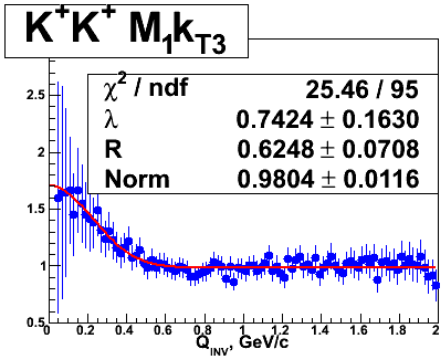


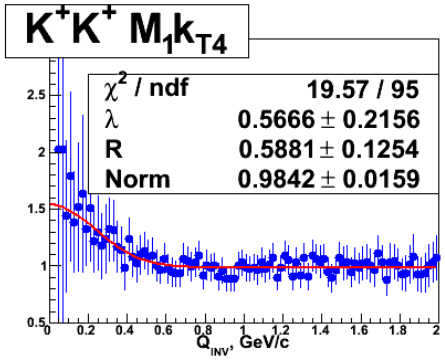
K+K+ CF vs multiplicity and k_T

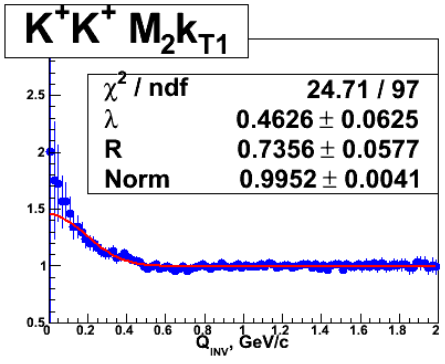
Karsch EOS

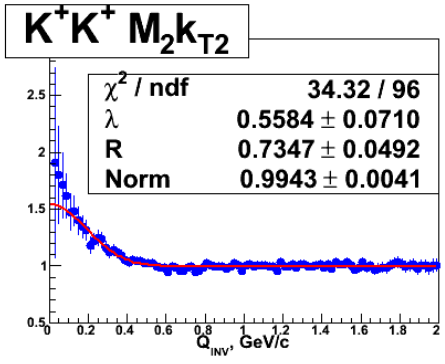


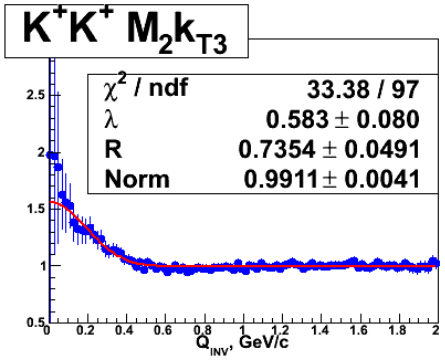


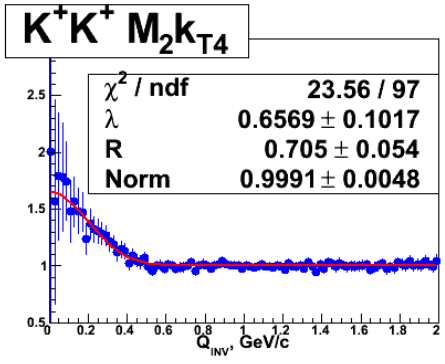


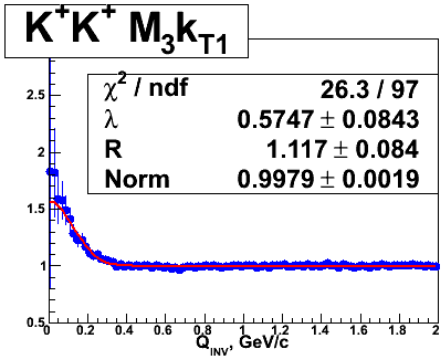


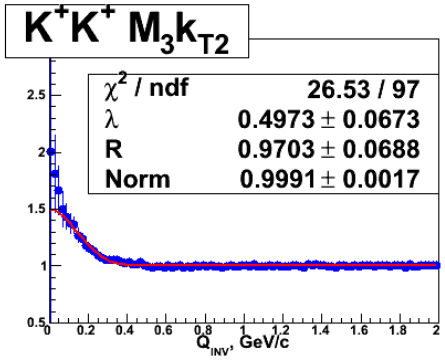


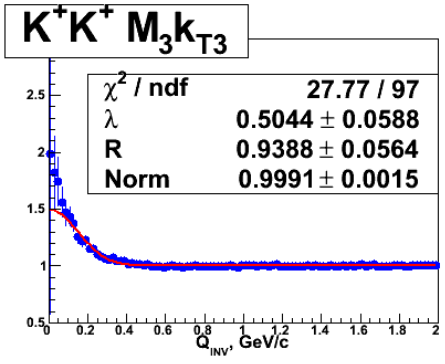


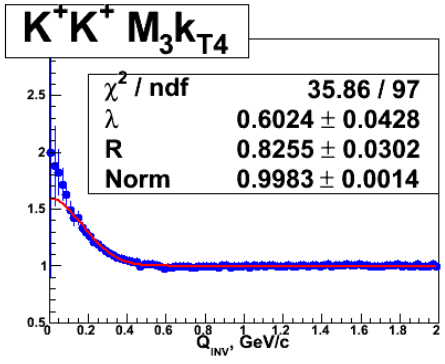




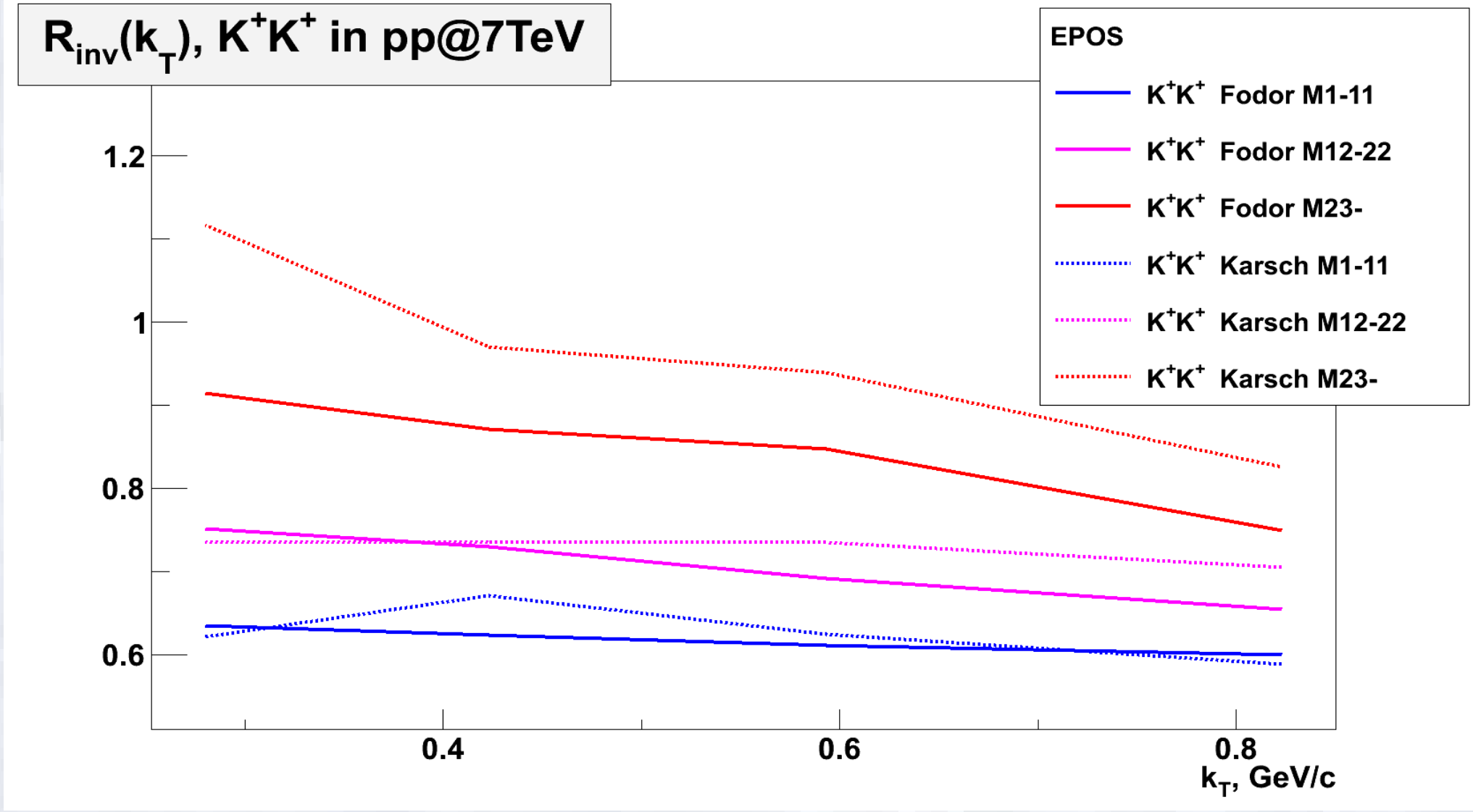




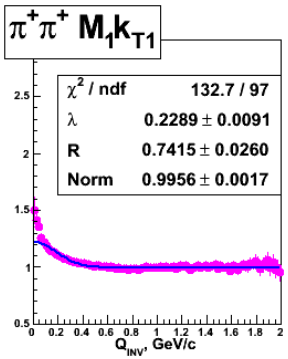


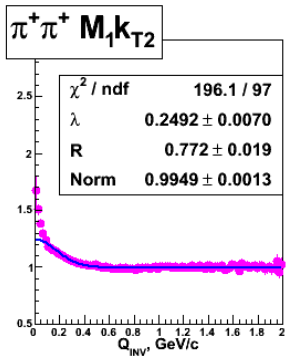


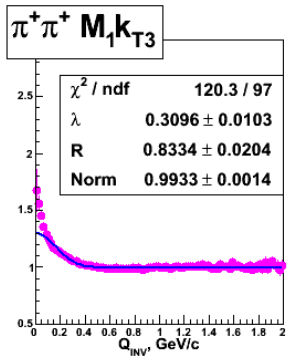
K+K+ Radii versus k_T and multiplicity

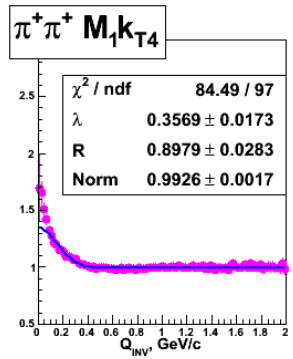


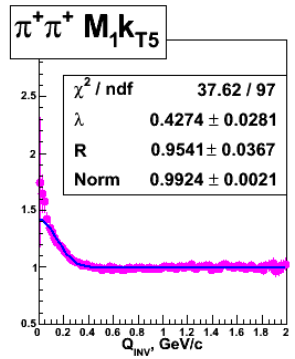
$\pi^+\pi^+$ versus k_T and Multiplicity

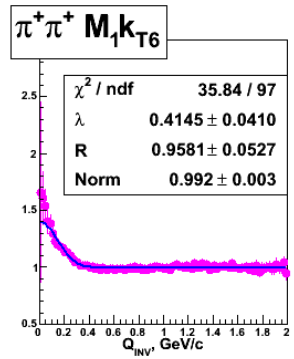


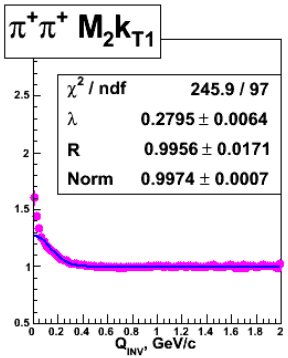


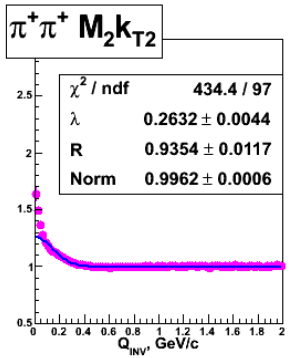


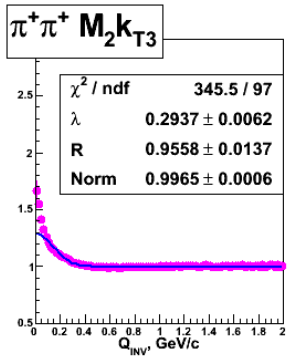


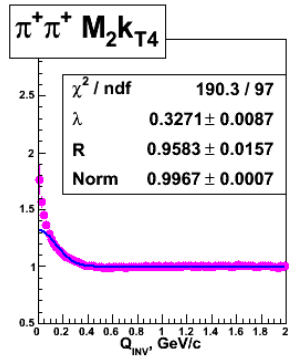


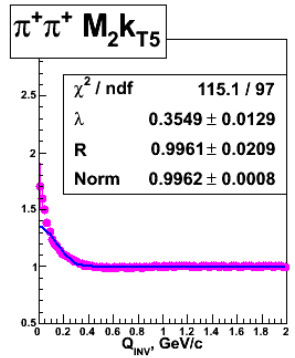


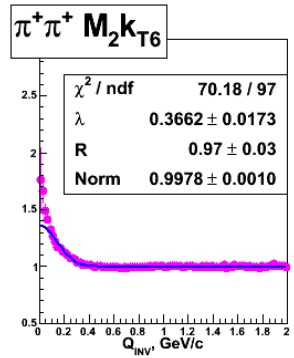


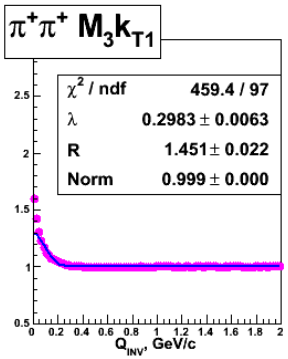


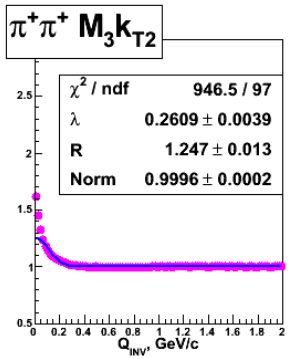


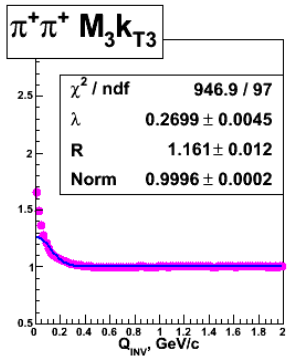


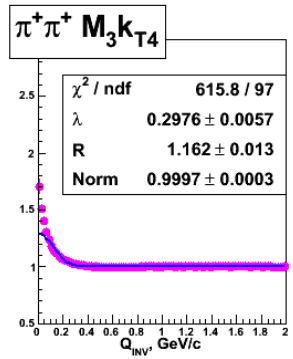


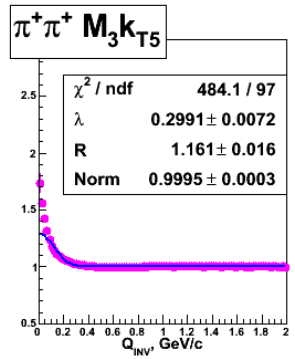


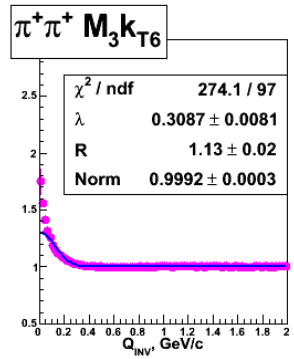




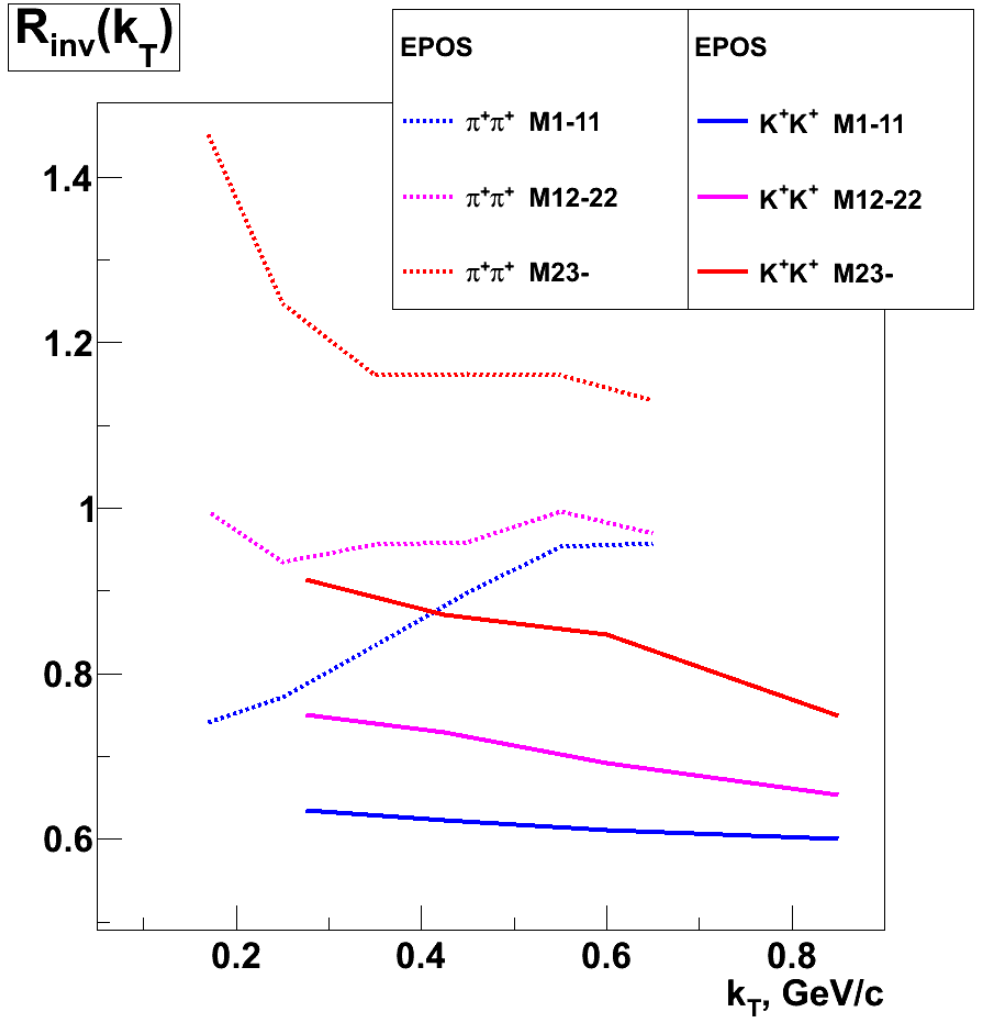


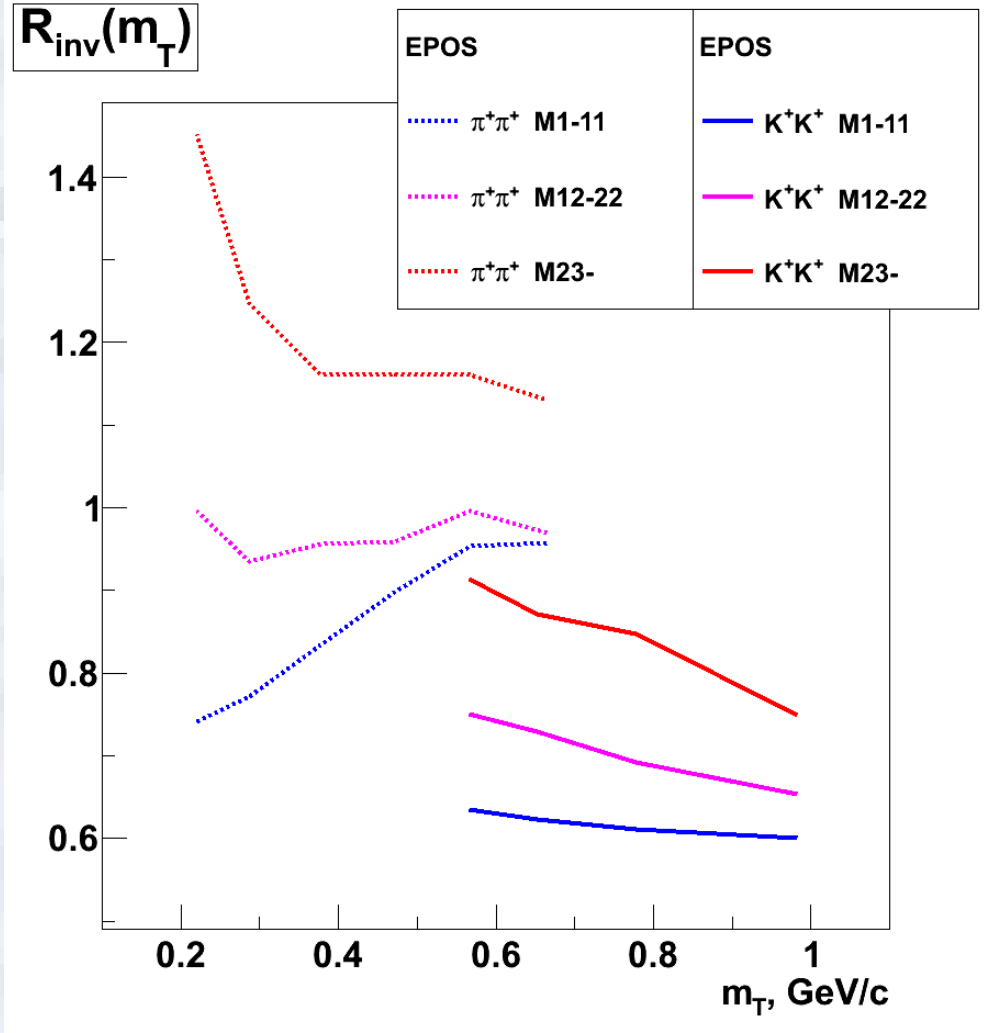






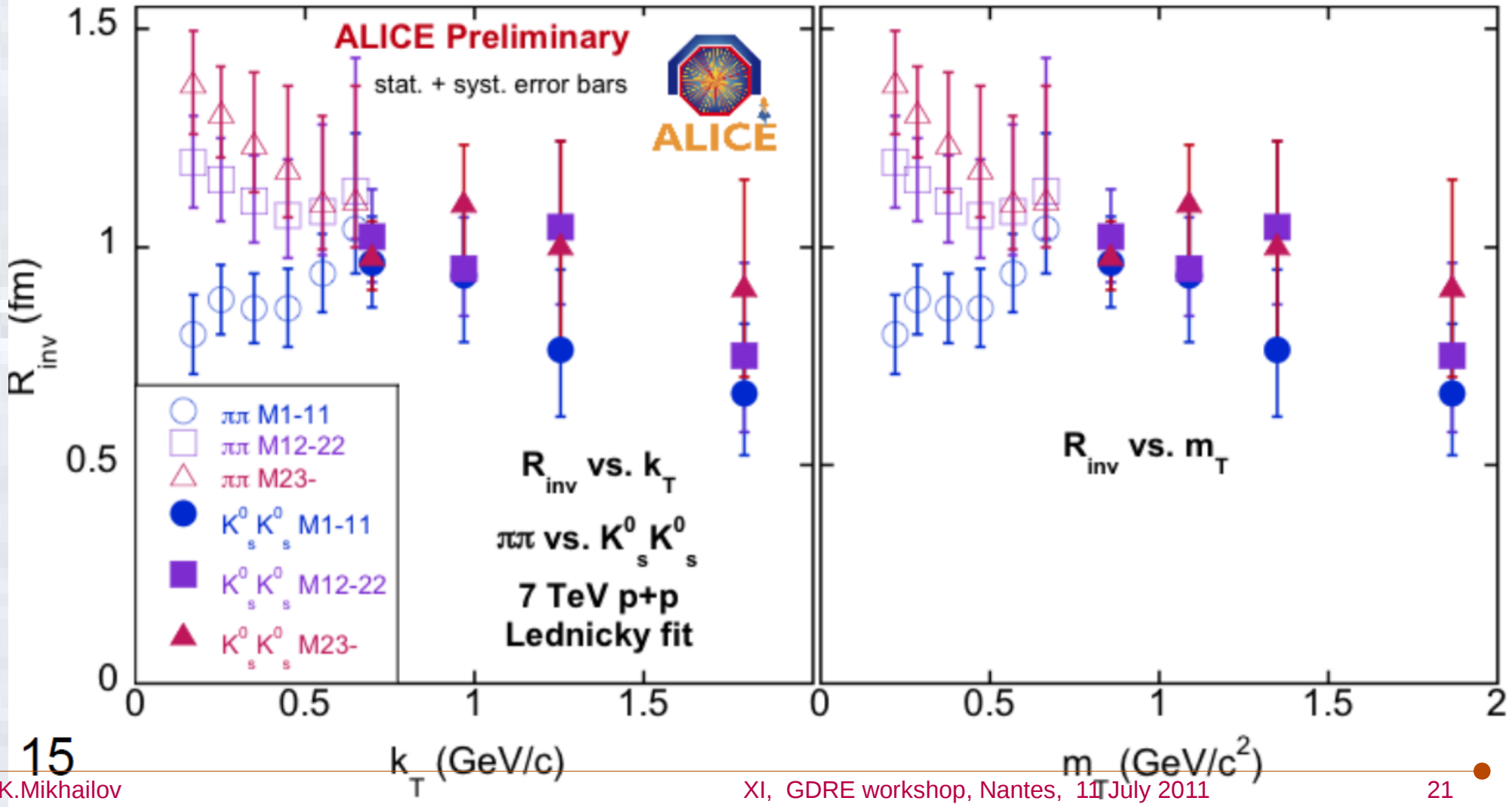
π+π+ and K+K+ radii versus k_T (Fodor)



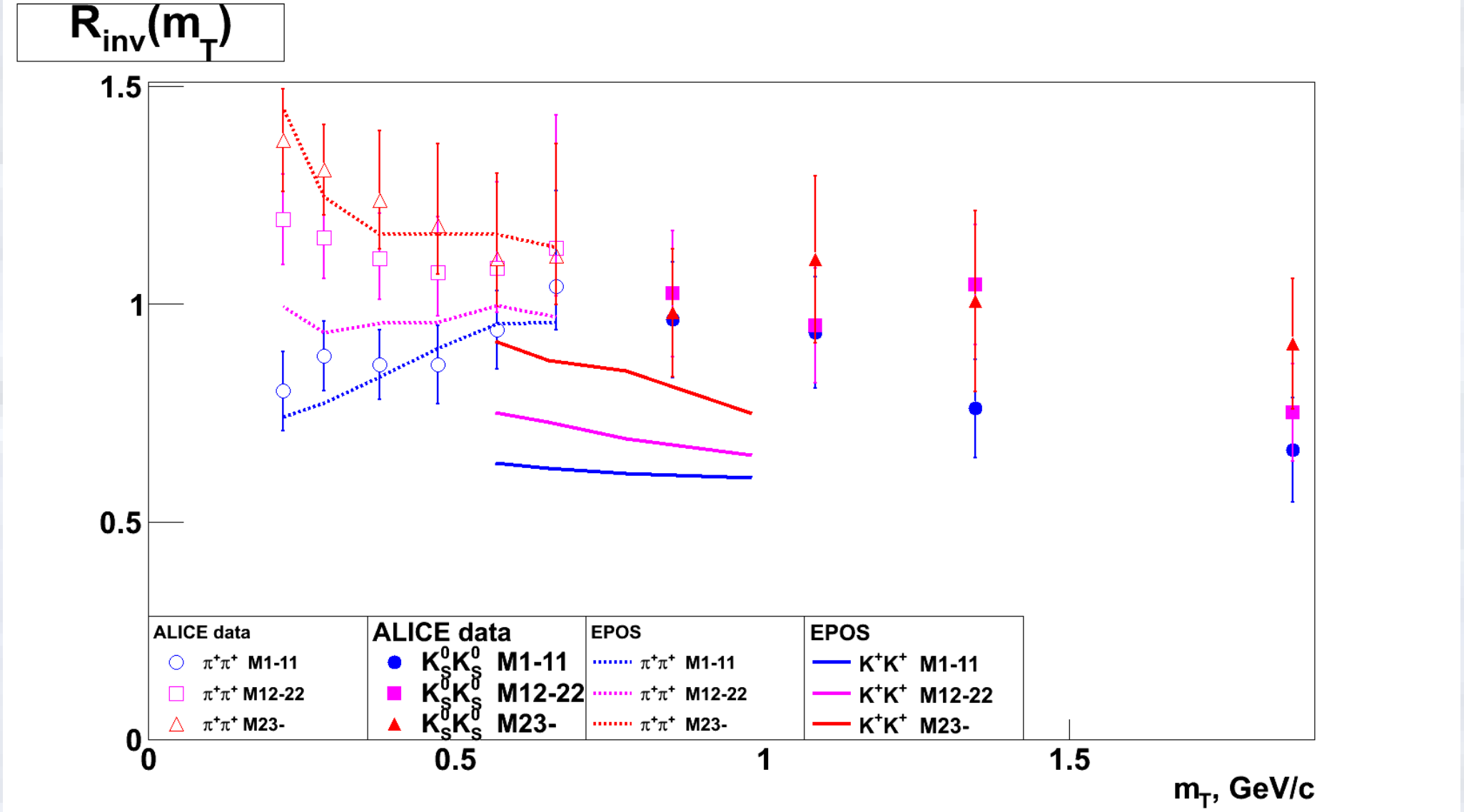


QM' 2011 T. Humanic

Averaged R_{inv} vs. k_T , m_T and multiplicity bin from Lednicky code fits compared with ALICE ππ correlation data statistical + systematic error bars (including ±10% shift in baseline parameters)

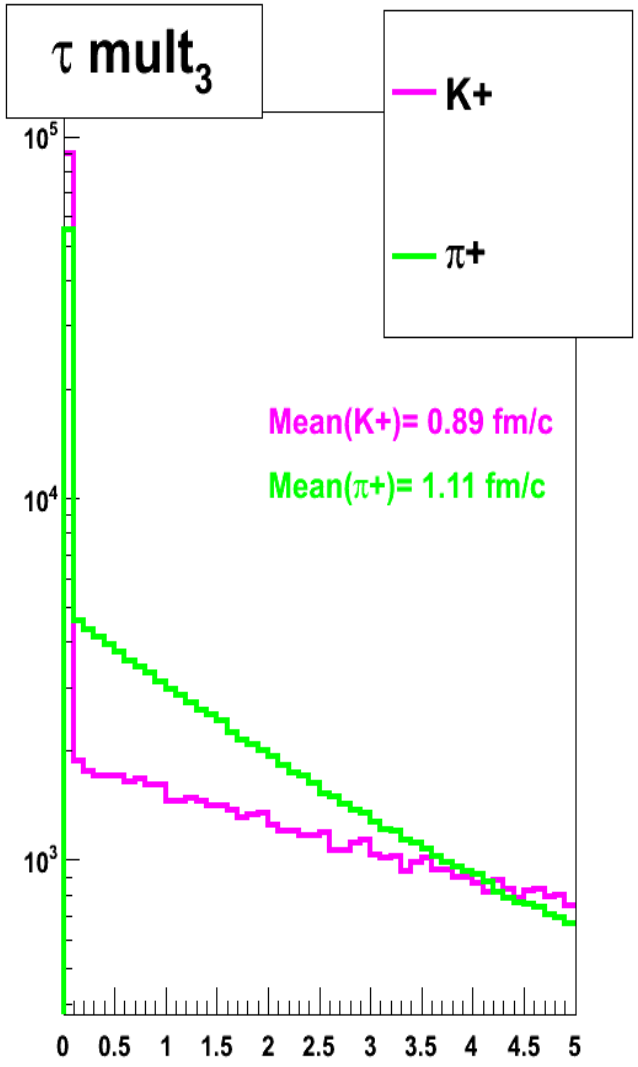


EPOS (preliminary) and ALICE data



Pion and koan time distribution

W/O Hydro&Cascade



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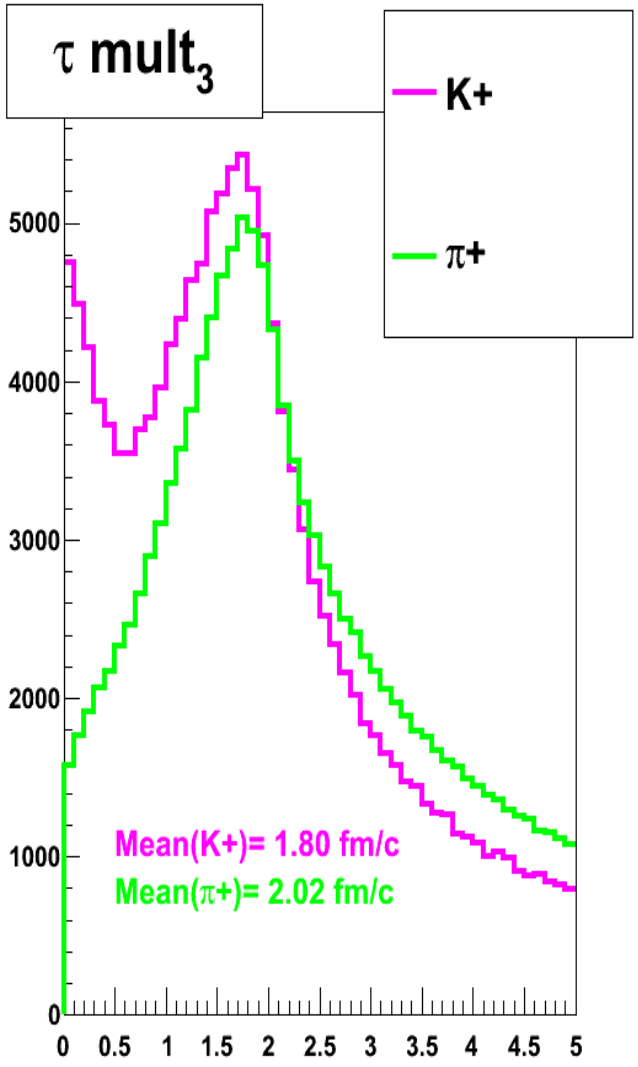
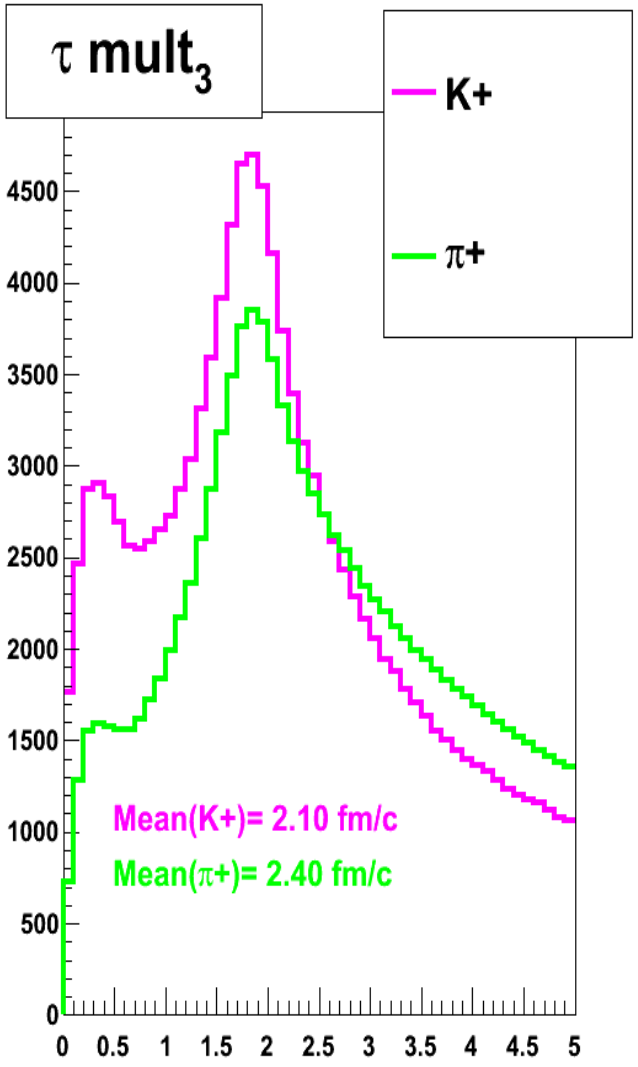


Full calculation

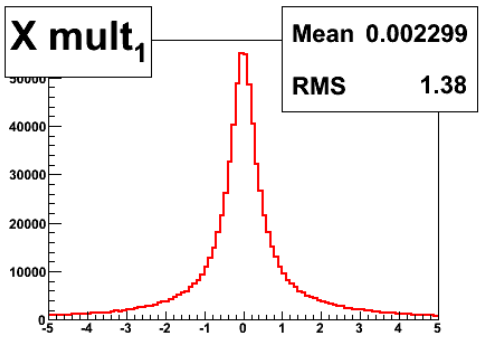


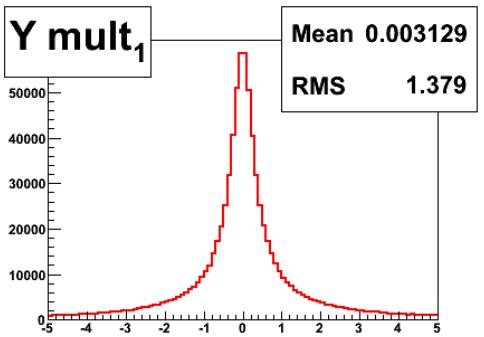
Conclusions

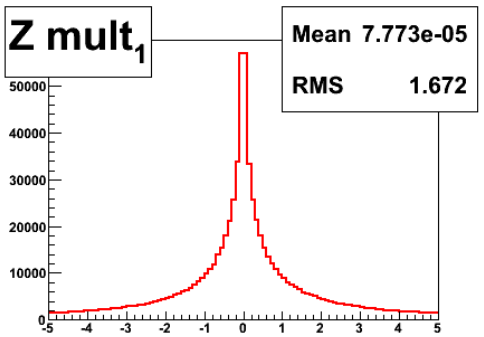
- The Epos Femto package was updated
- It is better to compare the shape of CF instead of radii
- The preliminary results for KK in EPOS was shown
- Preliminary results from EPOS show that radii for kaon source are smaller that one for pion
- EPOS radii for K+K+ have multiplicity and m_T dependence, but values of radius are smaller in comparison with ALICE data
- We have to compare EPOS calculation with data for kaon spectra (is not published yet) to “tune up” kaons in EPOS

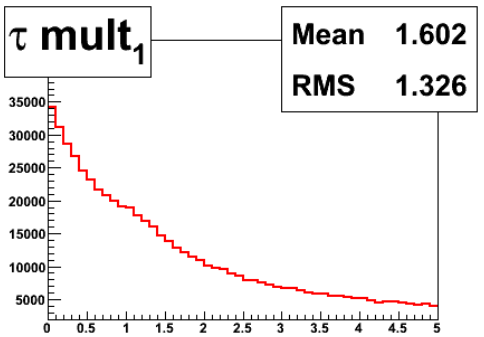
Title backup

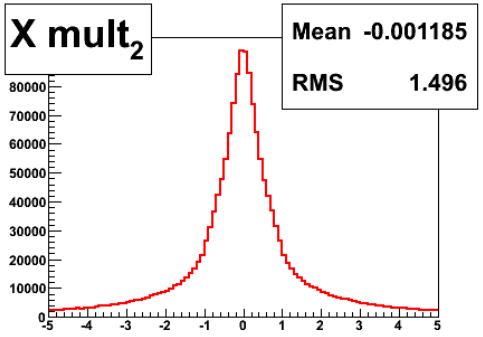
K+ space-time (Fodor EOS)

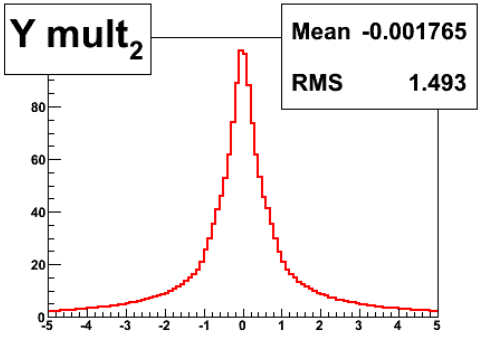


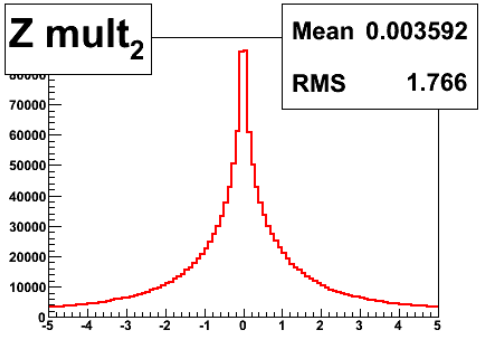


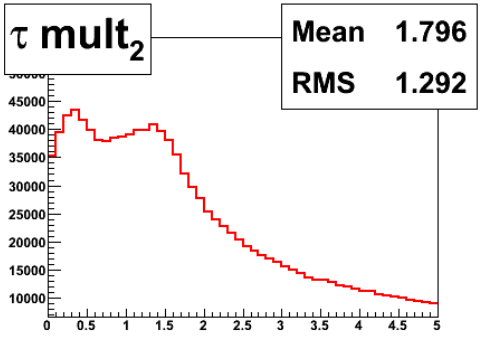


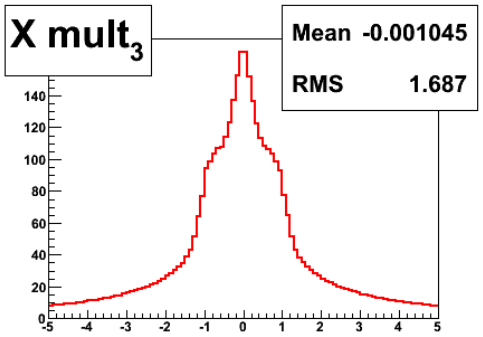


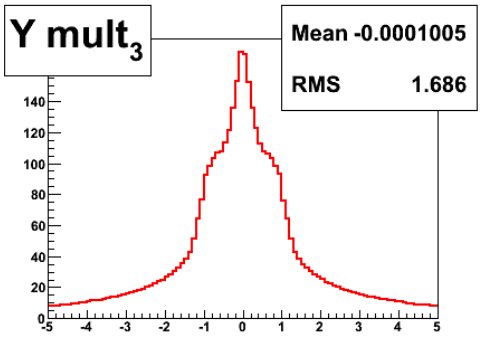


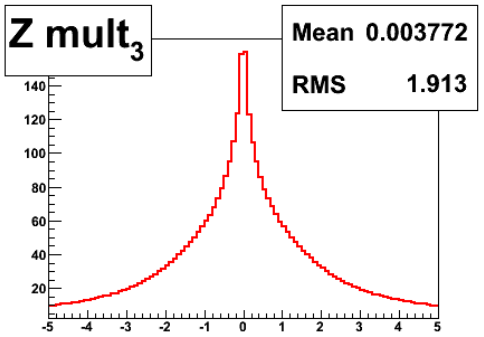


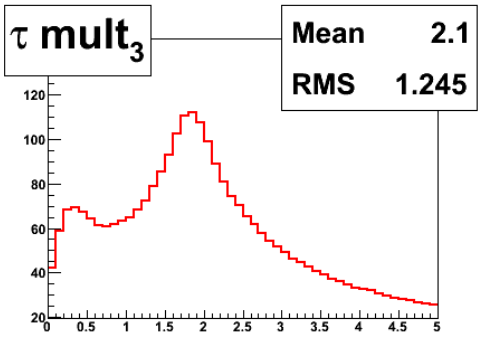




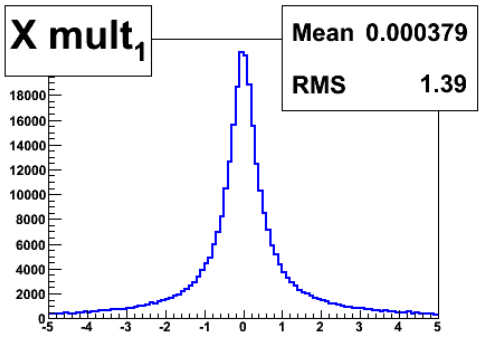


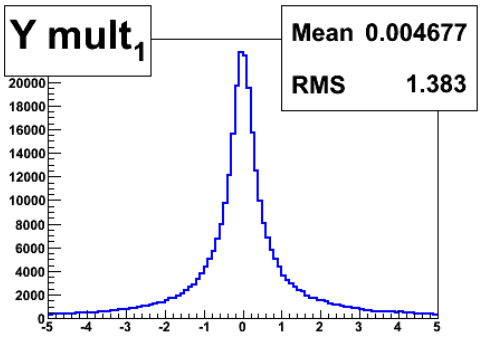


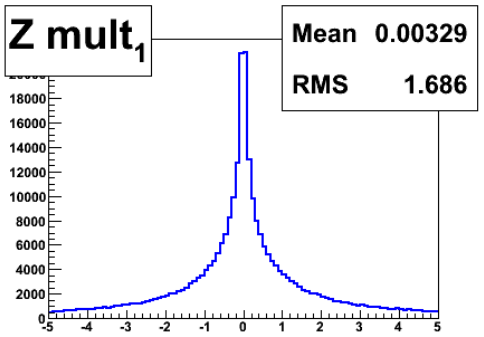


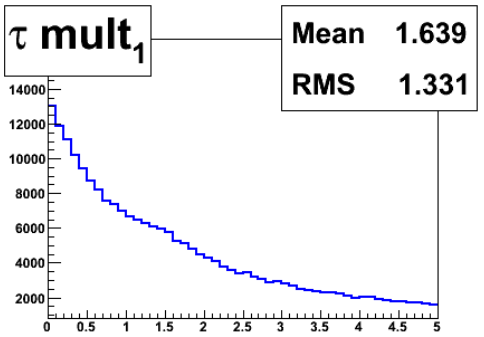


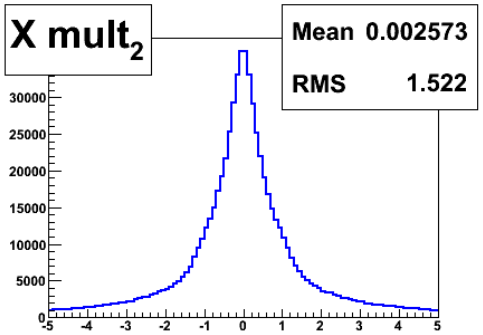
K+ space-time (Karsch EOS)

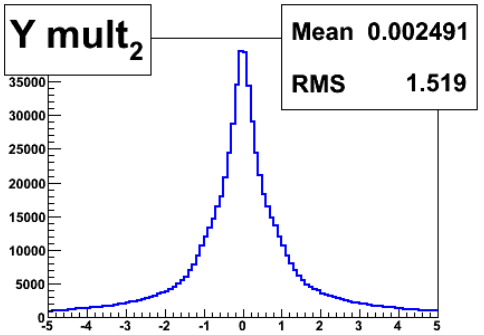


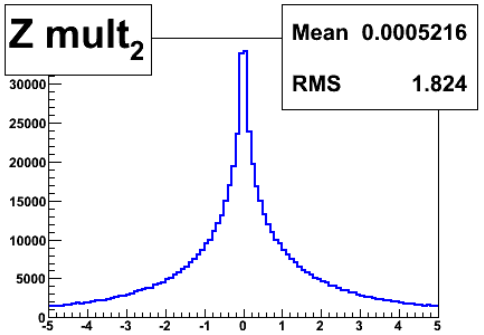


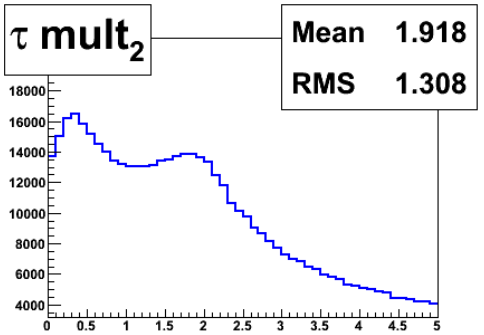


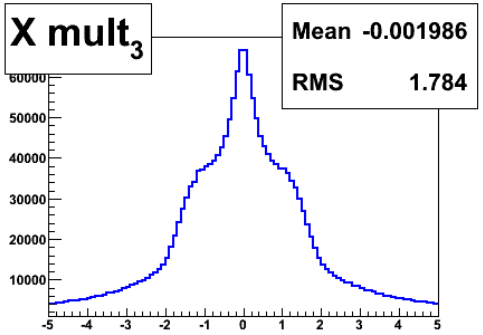


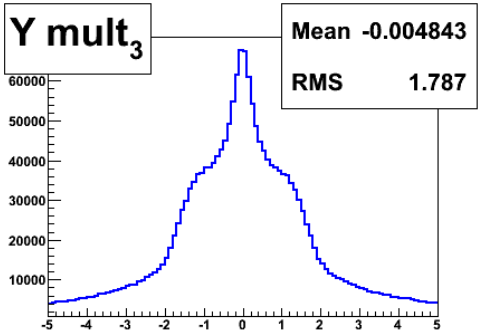


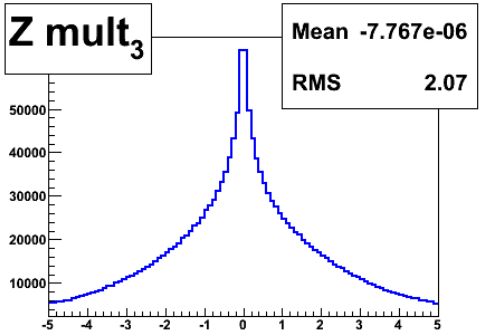


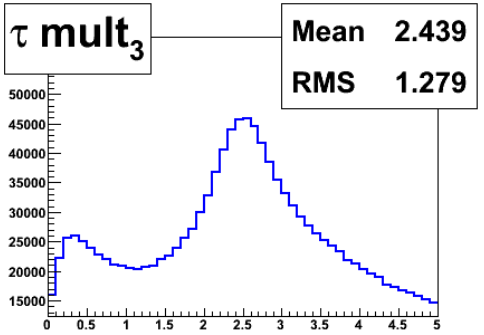






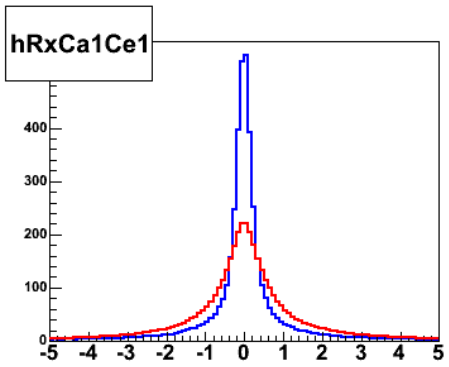


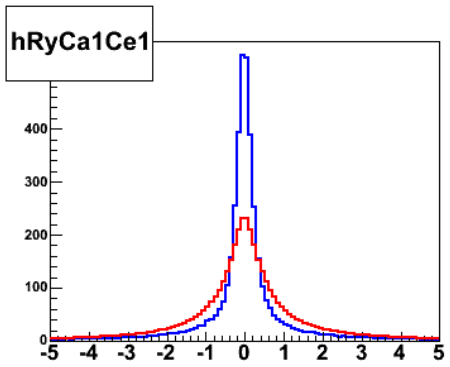


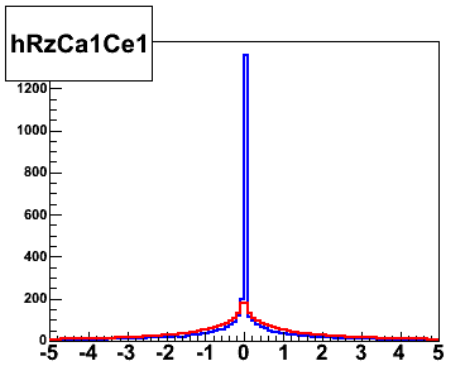


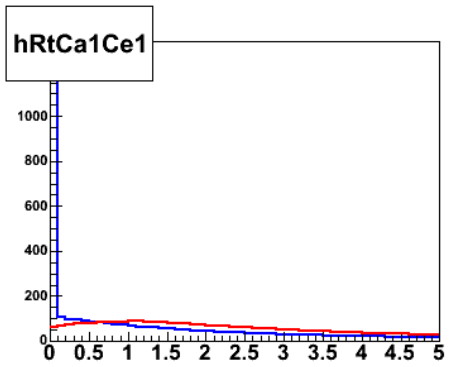
π+π+ space-time (Fodor EOS)

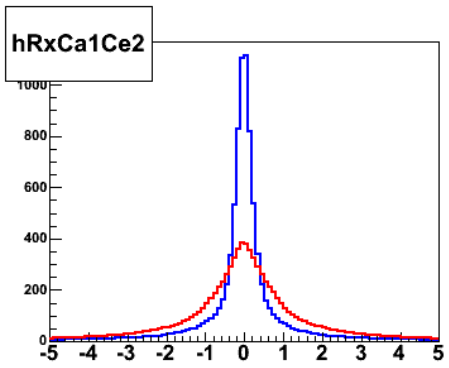
Red full calculation, Blue w/o Hydro&Cascade

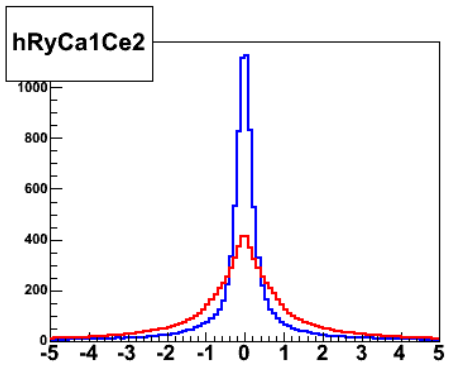


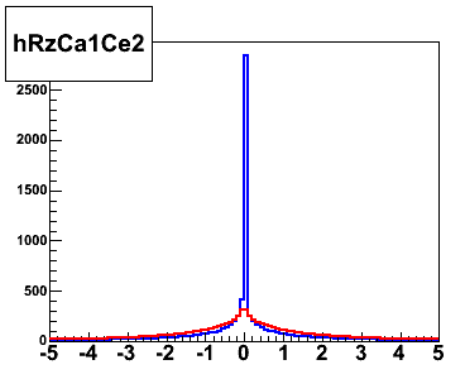


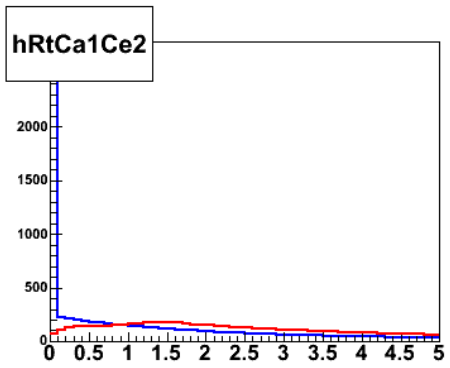


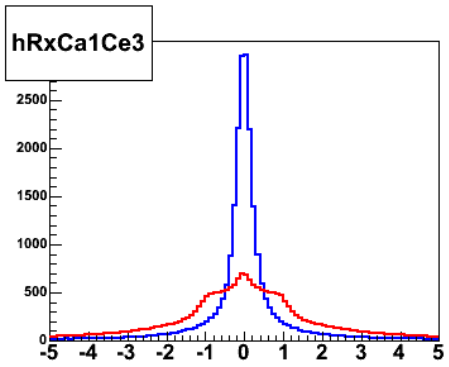


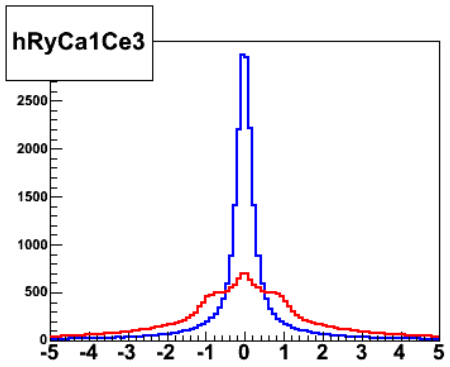


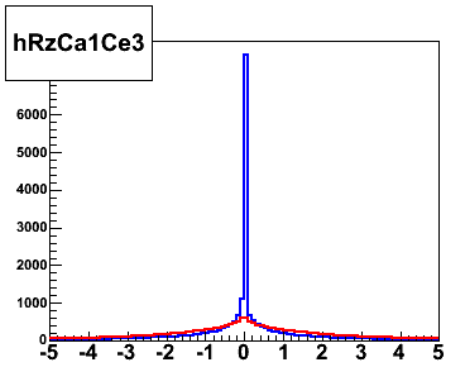


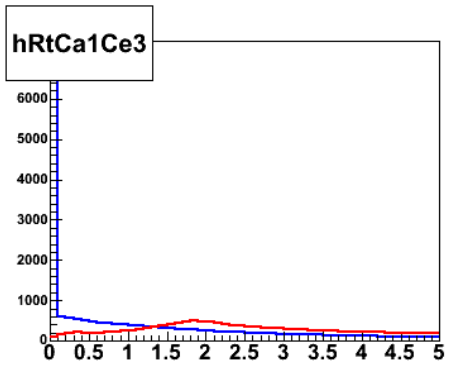












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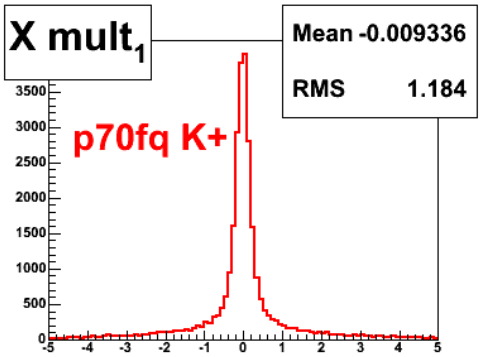
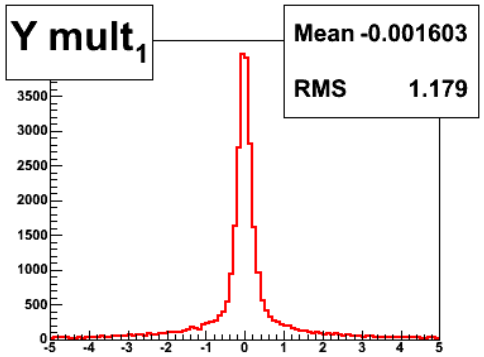
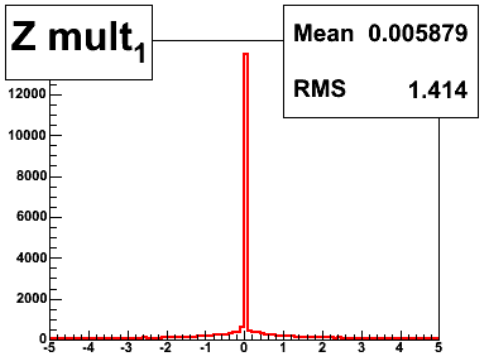
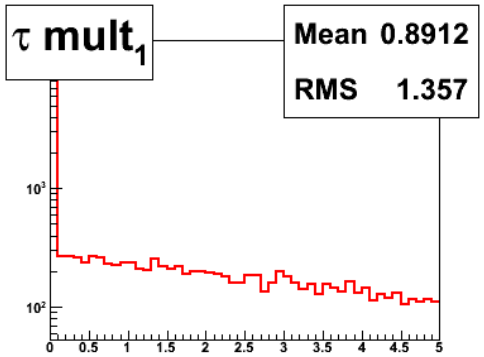
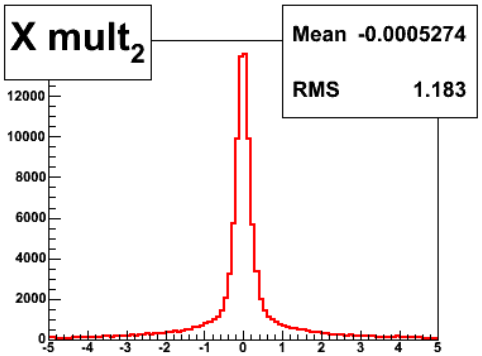
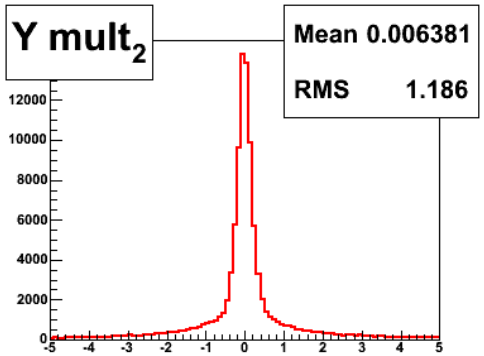


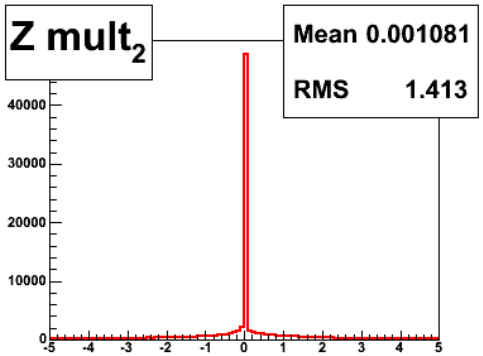


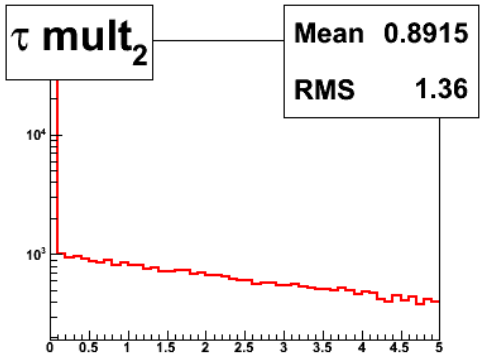


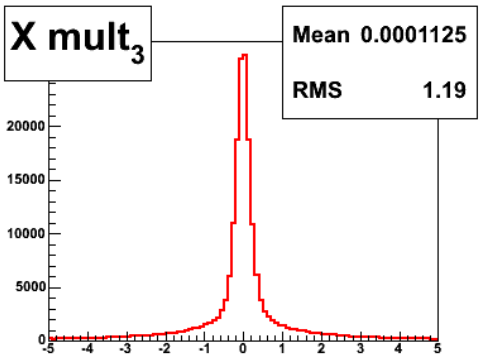


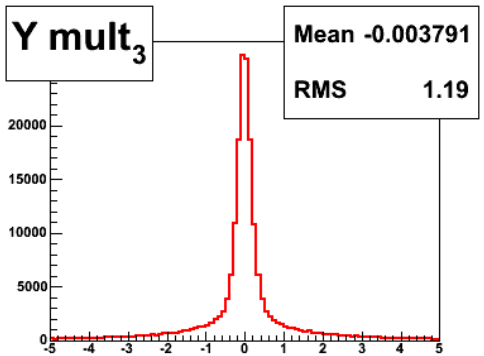


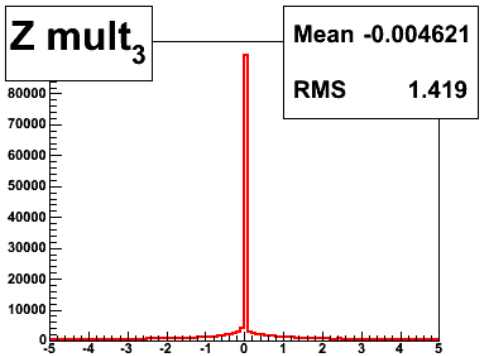


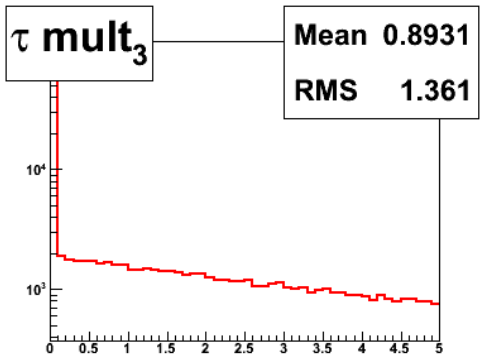




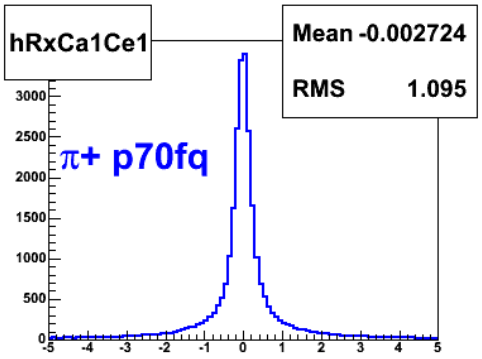


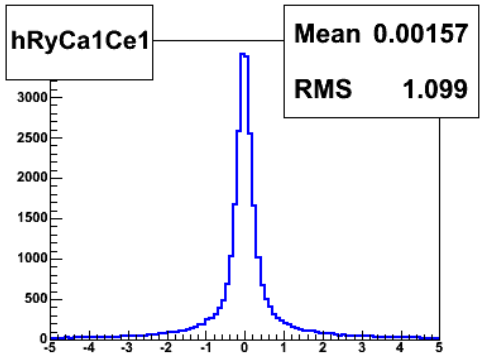


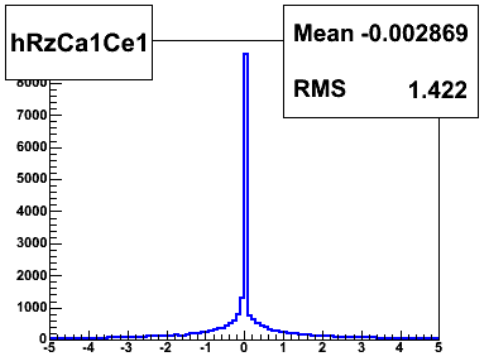


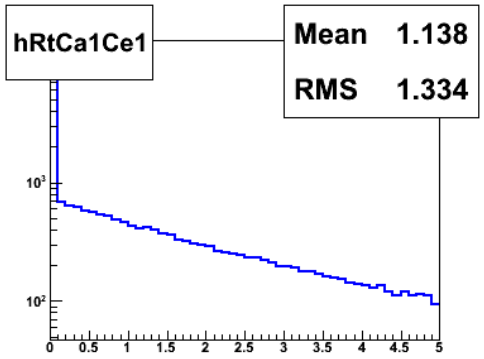


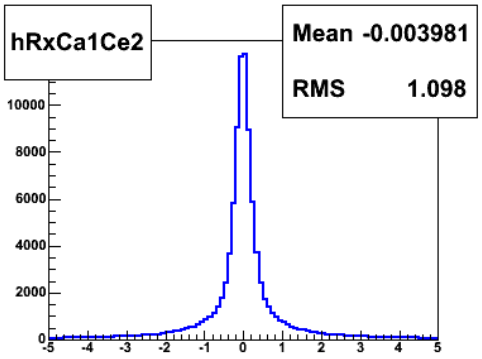
Space-time w/o HYDRO&Cascade

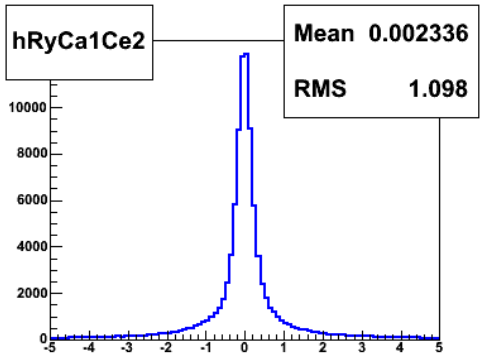


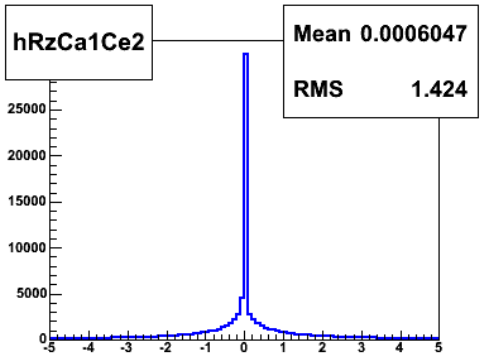


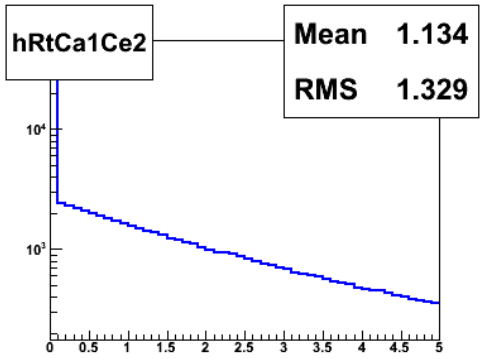


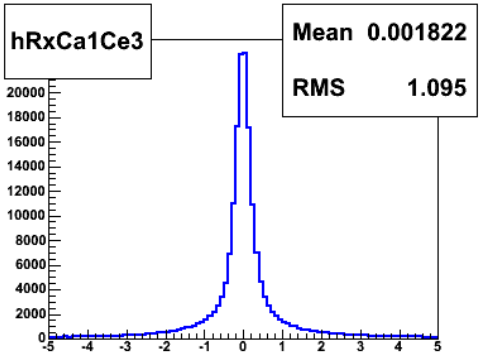


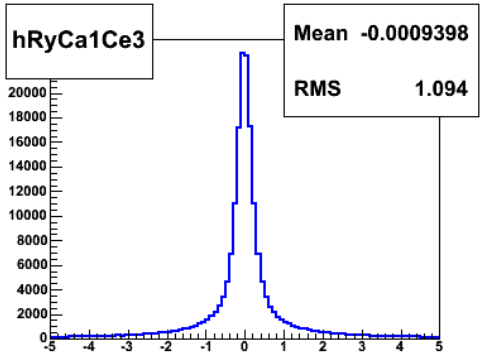


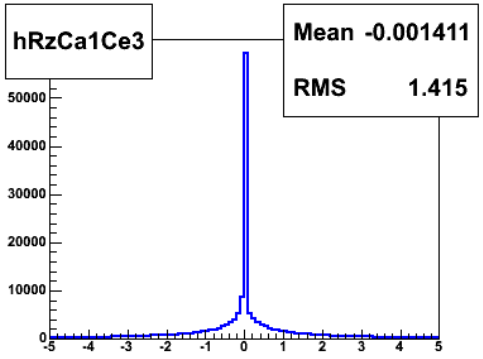


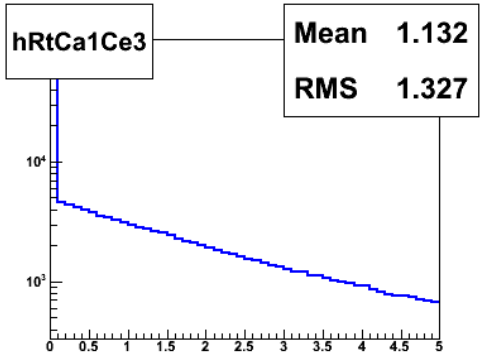












Space-time w/o HYDRO&Cascade