UNICOR correlation analysis package

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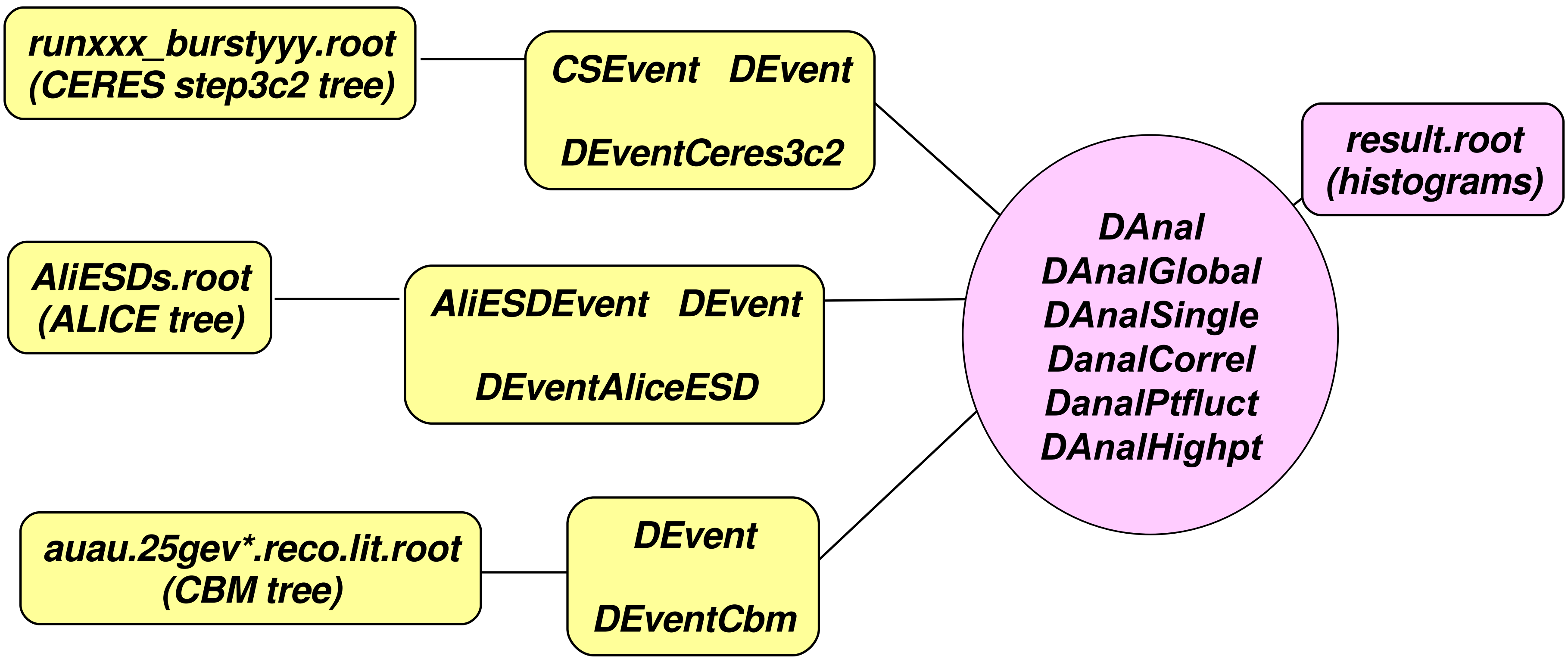
- ***loop over events*** ***...from CERES, ALICE, CBM...***
- ***fill two-track histograms*** ***...multidimensional***
- ***store histograms on root file*** ***...in an eternally readable format***

Why same analysis for different experiments?

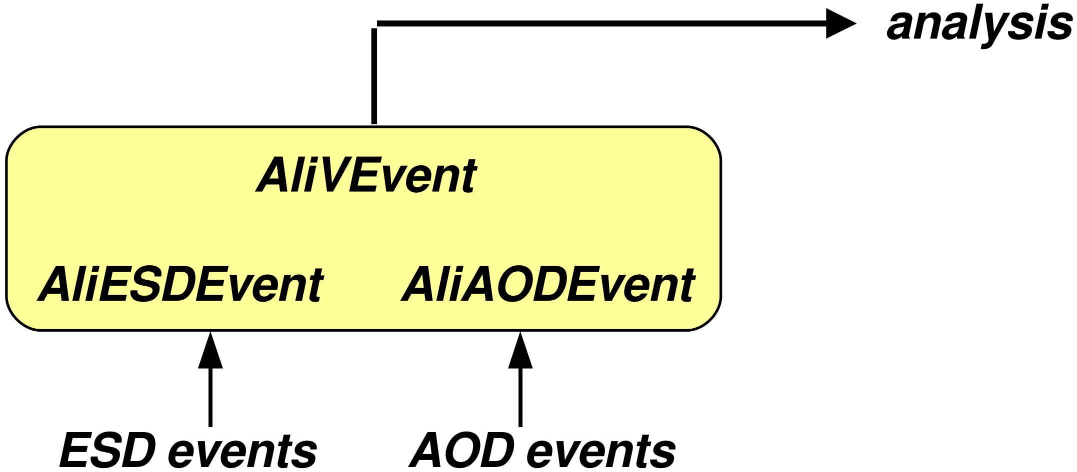
- ***correlation analysis is to 90% experiment-independent***
- ***methods developed within one experiment can be applied to the others***
- ***analysis can be tested against known experiment***
- ***better comparison between experiments***

analysis scheme



implementation of experiment-independence (inspired by the Alice ESD/AOD dilemma)

ALICE solution



my solution

Why multidimensional histograms?

Example: HBT correlation function in 8-dim histogram

tru/mix/rot	3 bins
centrality	5 bins
pair y	4 bins
pair phi wrt. event plane	8 bins
pair pt	7 bins
q-polar angle	8 bins
q-azimuthal angle	16 bins
q-magnitude	64 bins

P. Danielewicz's dream: two-particle tensor.
Complete info, like pair ntuple -- but binned.

27,525,120 bins, 210 MB. Too big?

for comparison: traditional way of histogramming

```
for (fl=0; fl<2; fl++) {
for (pp=0; pp<5; pp++) {
for (th=0; th<3; th++) {
for (ph=0; ph<1; ph++) {
  sprintf(myst,"%s%d%d%d%s%s_%s",trmi[fl],pp,th,ph,pnam[i0],pnam[i1],"qinv");
  h1[fl][pp][th][ph][i0][i1][0] =  new TH1D(myst,myst,500,0,5);
  sprintf(myst,"%s%d%d%d%s%s_%s",trmi[fl],pp,th,ph,pnam[i0],pnam[i1],"minv");
  h1[fl][pp][th][ph][i0][i1][1] =  new TH1D(myst,myst,500,0,5);
  sprintf(myst,"%s%d%d%d%s%s_%s",trmi[fl],pp,th,ph,pnam[i0],pnam[i1],"dtheta:dphi");
  h2[fl][pp][th][ph][i0][i1][0] =  new TH2D(myst,myst,50,-250,250,50,-50,50);
  sprintf(myst,"%s%d%d%d%s%s_%s",trmi[fl],pp,th,ph,pnam[i0],pnam[i1],"qper:qpar");
  h2[fl][pp][th][ph][i0][i1][1] =  new TH2D(myst,myst,20,0.0,0.2,40,-0.2,0.2);
  sprintf(myst,"%s%d%d%d%s%s_%s",trmi[fl],pp,th,ph,pnam[i0],pnam[i1],"qout:qside:qlong");
  h3[fl][pp][th][ph][i0][i1][0] =  new TH3D(myst,myst,30,-0.15,0.15,30,-0.15,0.15,30,-0.15,0.15);
}
}
}
}
```

array of histograms, same size, less convenient handling

DHN class

(441 lines of code, here essentials of header file)

```
class DHN : public TH1D {

 public:
  DHN() : TH1D(), fNdim(0)                    {printf("DHN object created\n");}
  DHN(Char_t *nam, Int_t ndim, TAxis **ax);  // constructor from scratch
  DHN(Char_t *filename, Char_t *name);       // constructor from file
  virtual ~DHN()                              {printf("DHN object %s deleted\n",GetName());}
  Int_t GetNdim() const                       {return fNdim;}
  TAxis *GetAxis(Int_t i) const               {return (TAxis*) &fAxis[i];}

  Int_t Fill(Double_t *xx, Double_t y=1);    // fill histo
  Int_t Fill(Double_t x0, Double_t x1, ...);// fill histo

  Int_t Write() const;                        // save histo and axis on file

  // project along (integrate over) one axis
  DHN  *ProjectAlong(char *nam, Int_t dim, Int_t first=-1, Int_t last=-1);
  // project on 1-dim histogram
  TH1D *ProjectOn(char *nam, Int_t dim, Int_t *first=0, Int_t *last=0) const;
  // project on 1-dim histogram
  TH1D *ProjectOn(char *nam, Int_t dim, Double_t *first, Double_t *last);
  // project on 2-dim histogram
  TH2D *ProjectOn(char *nam, Int_t dim0, Int_t dim1, Int_t *first=0, Int_t *last=0) const;

 protected:

  Int_t       fNdim;                          // number of dimensions
  TAxis       fAxis[fMaxNdim];                // axes
```

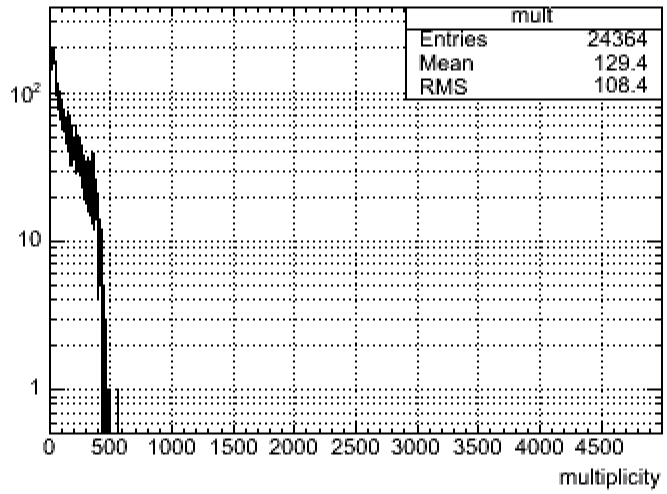
some results

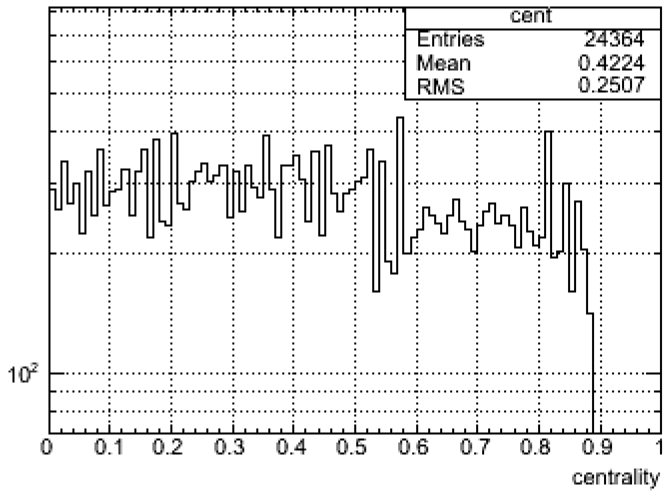
CERES/SPS	PbAu	158 AGeV	exp	24k
ALICE/LHC	pp	sqrt(s)=10 TeV	sim	0.4-2M
CBM/SIS300	AuAu	25 AGeV	sim	44k

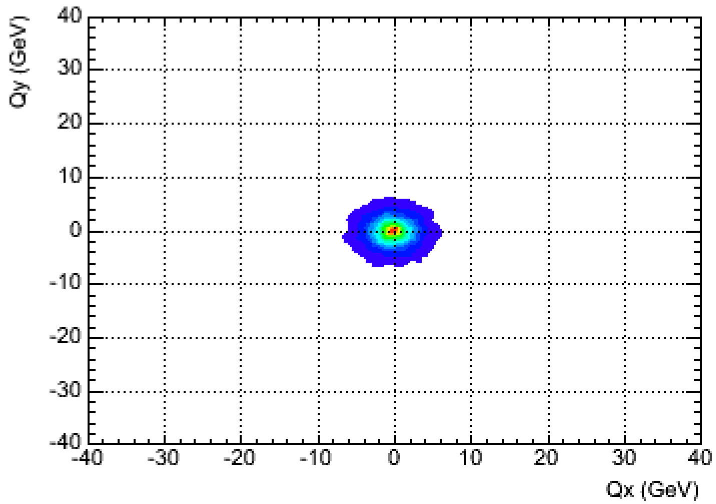
disclaimer:

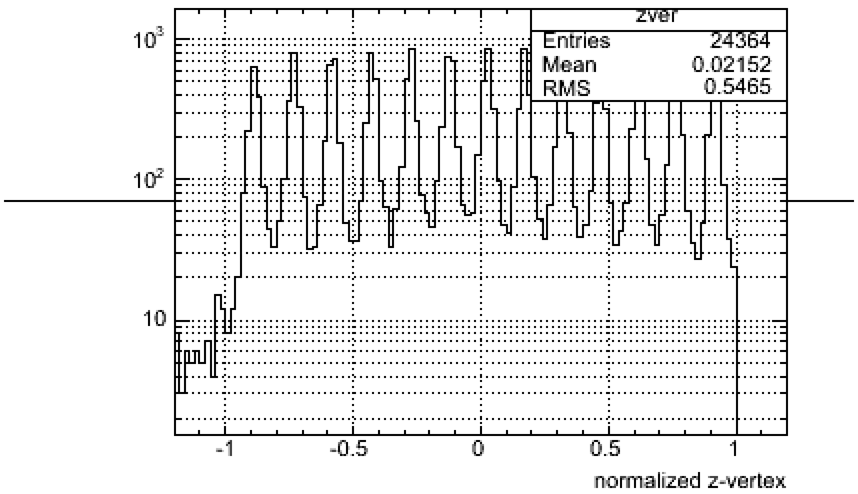
- no (serious) particle identification
- no two-track cut

CERES global variables

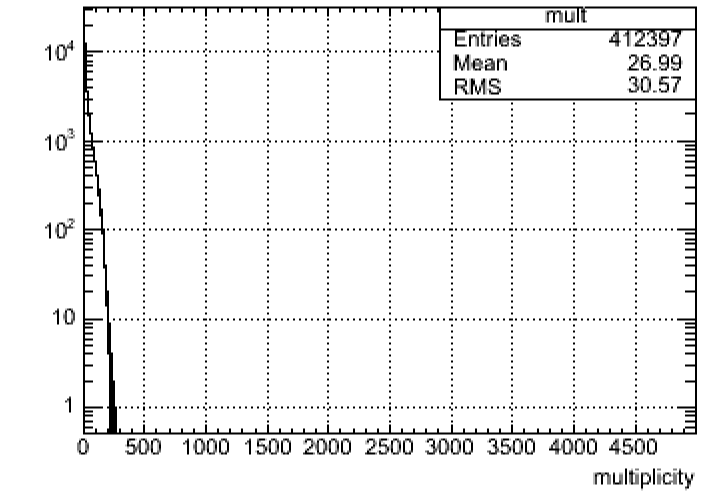


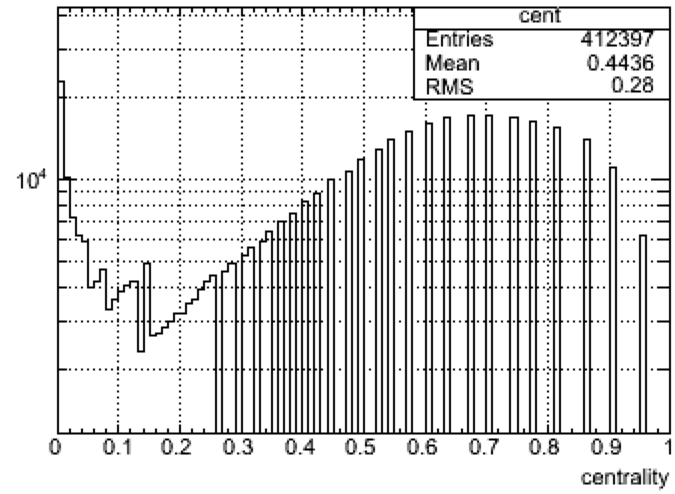


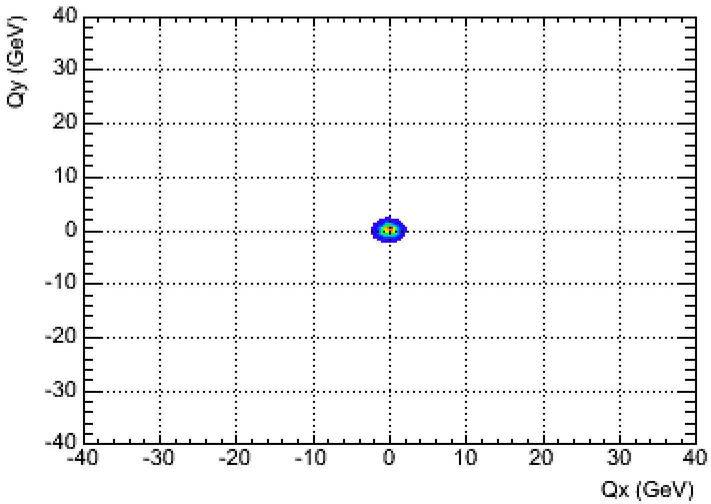


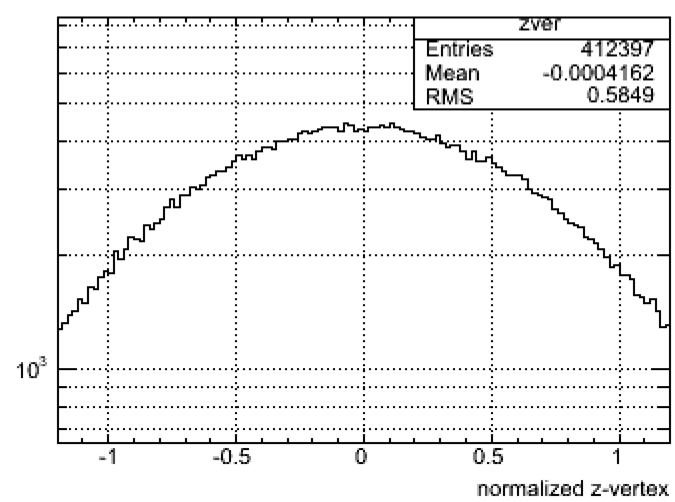


ALICE global variables

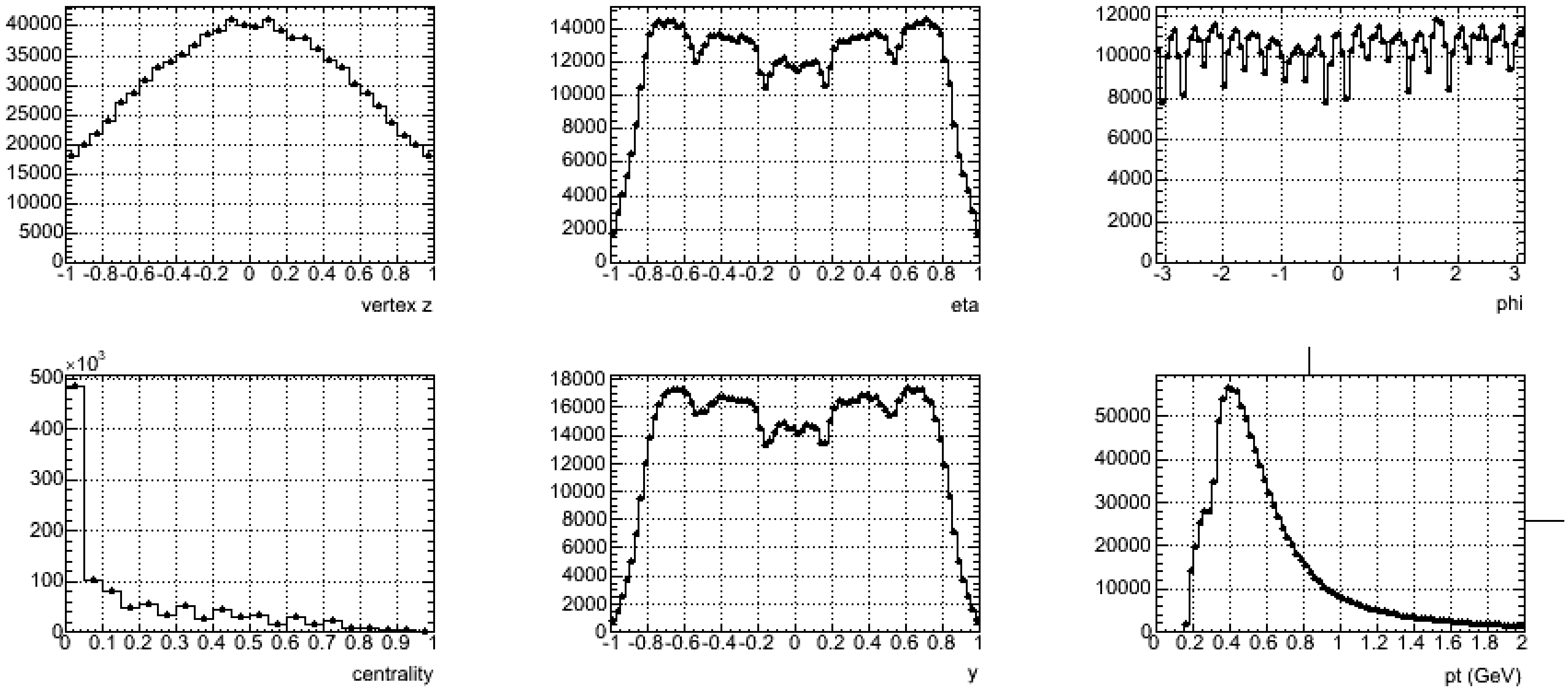




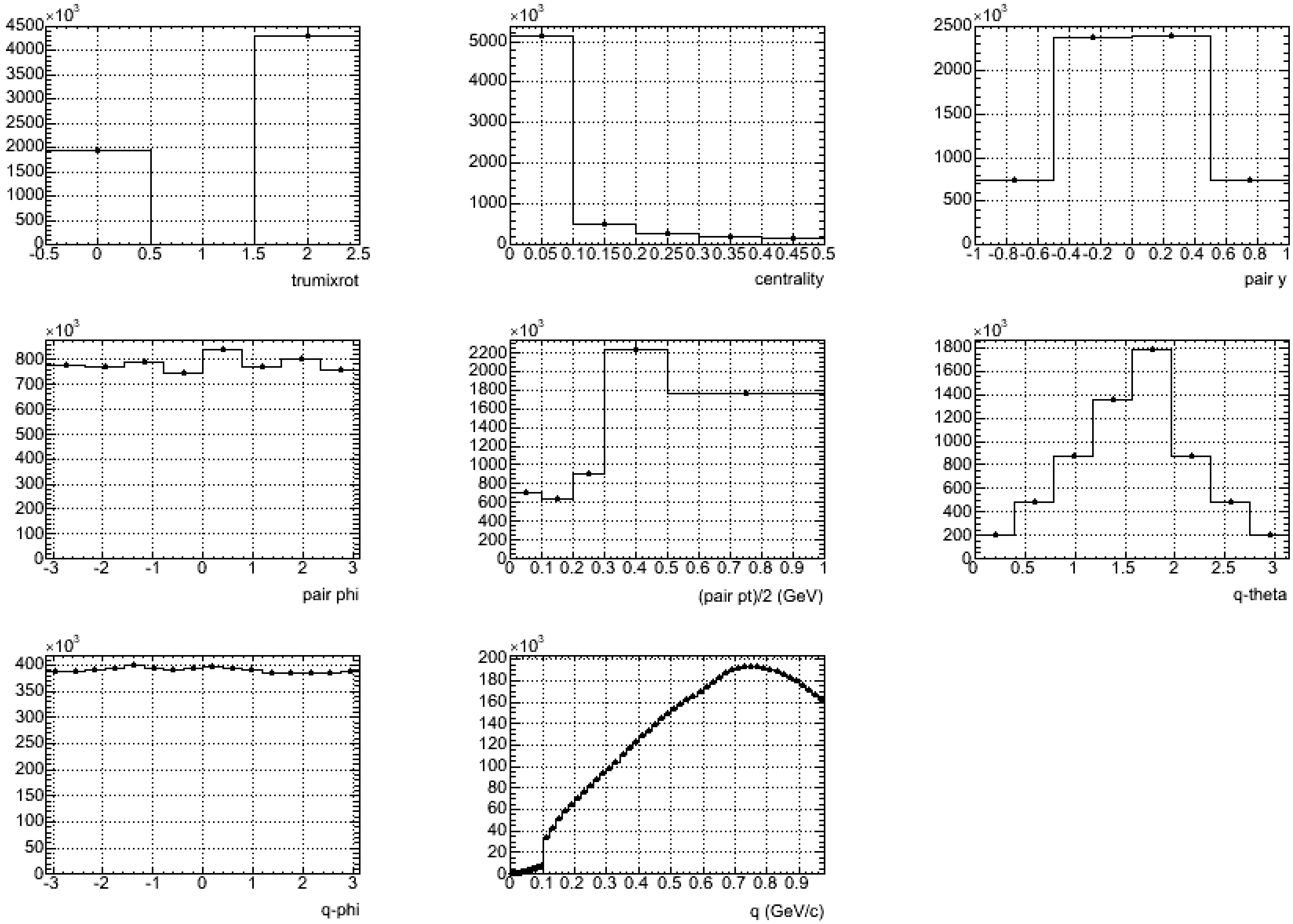




ALICE singles

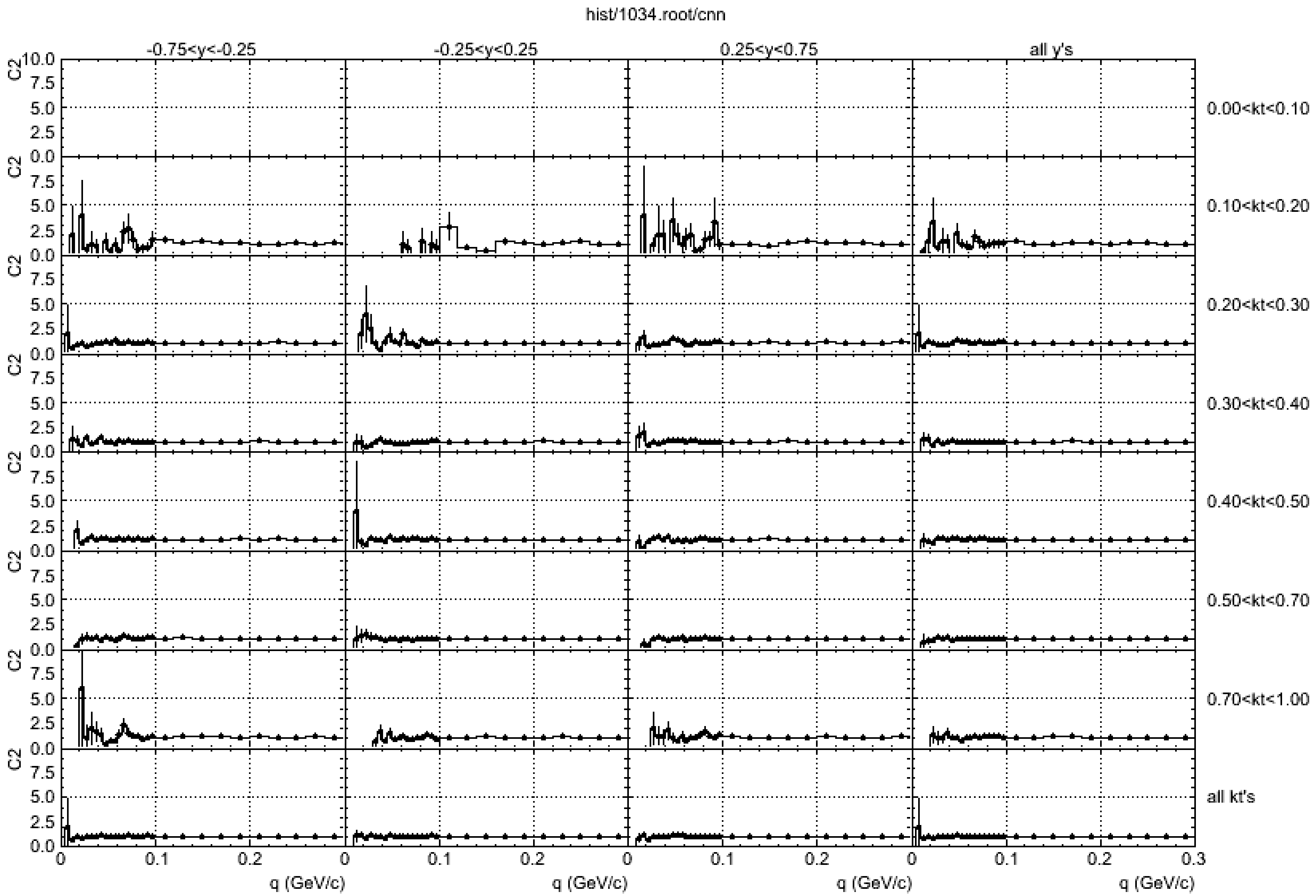


ALICE HBT correlations (projections)



ALICE HBT correlations

10 TeV pp pythia. Track cuts: neg, ncsl 120, dca, pid.



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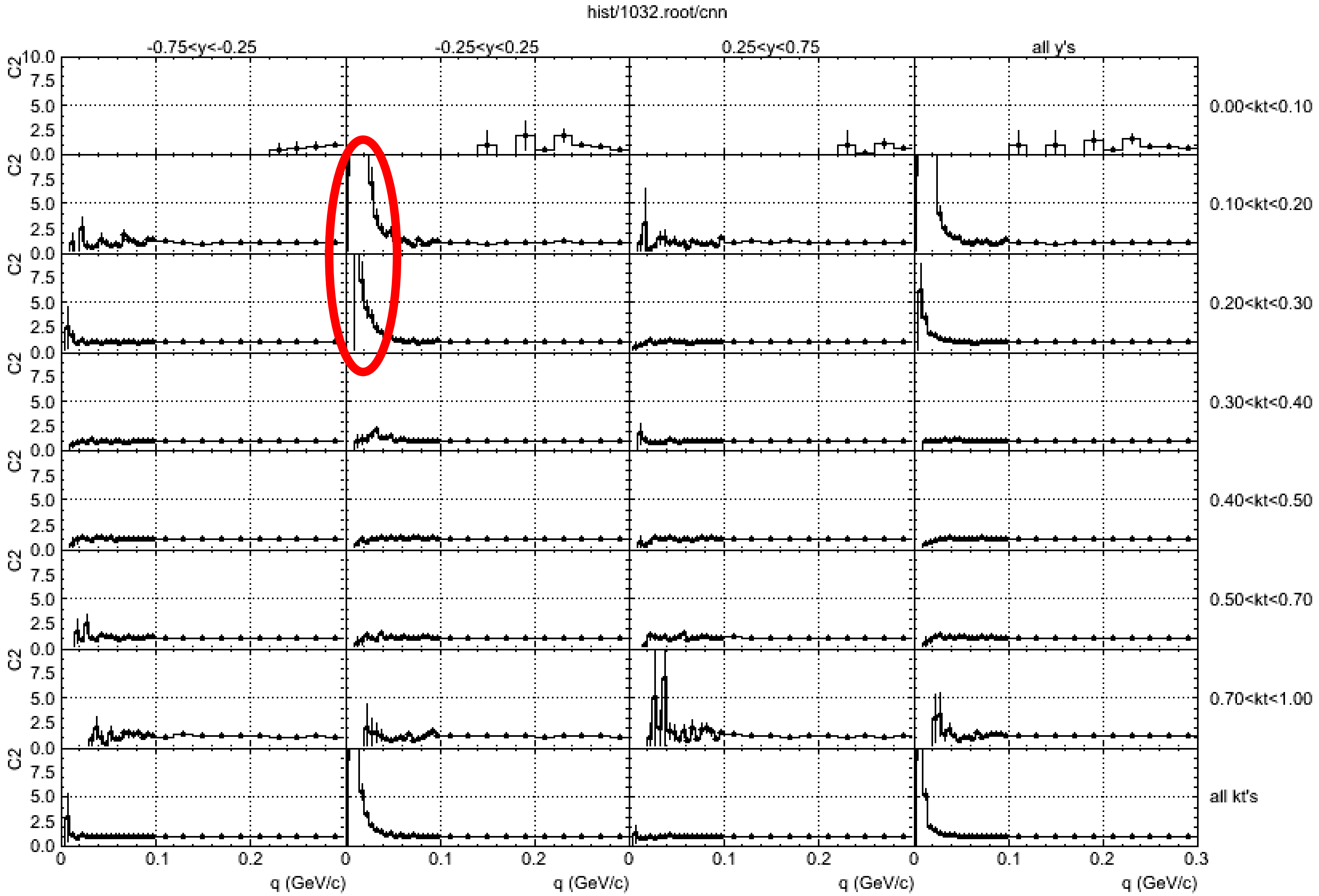
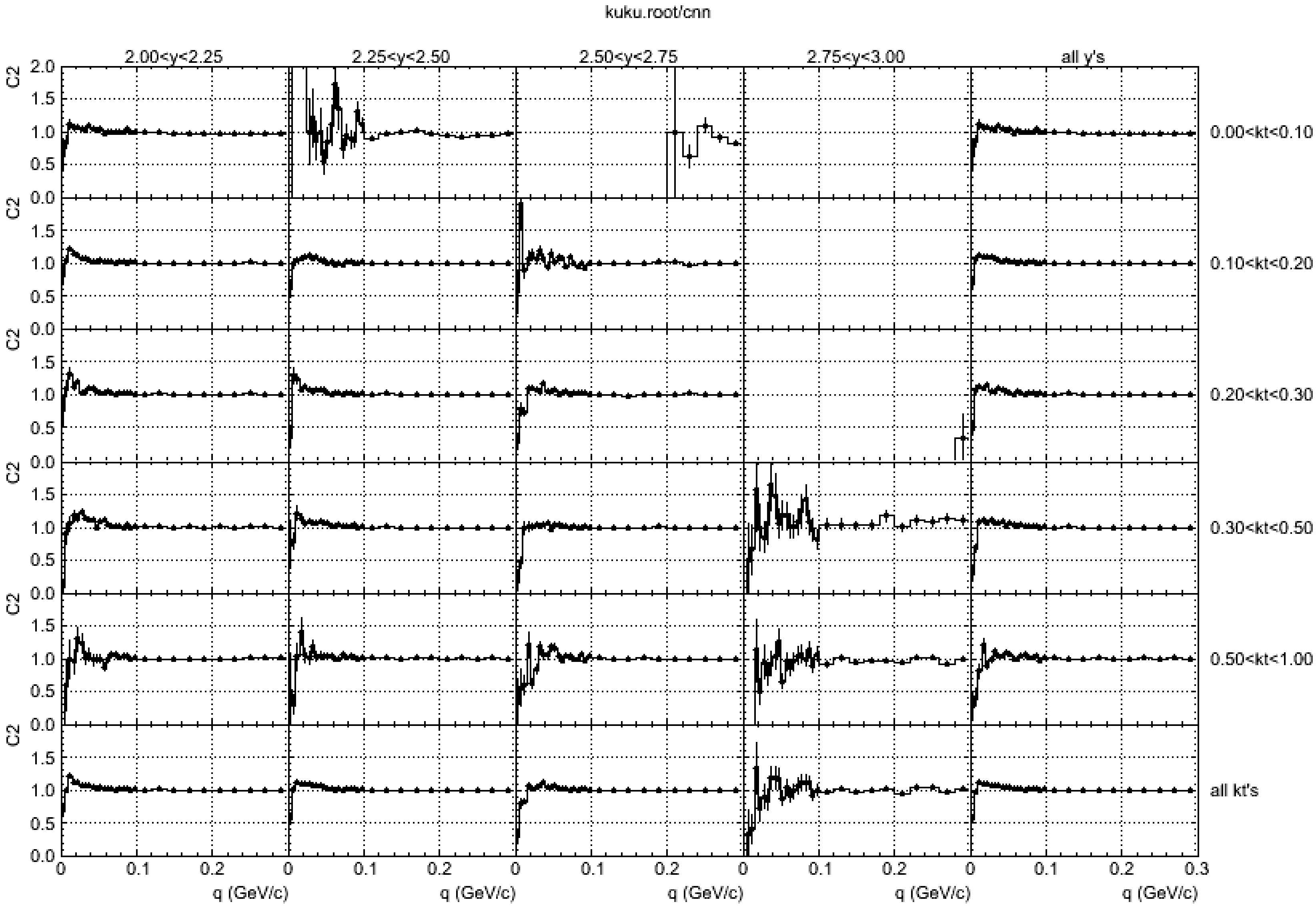
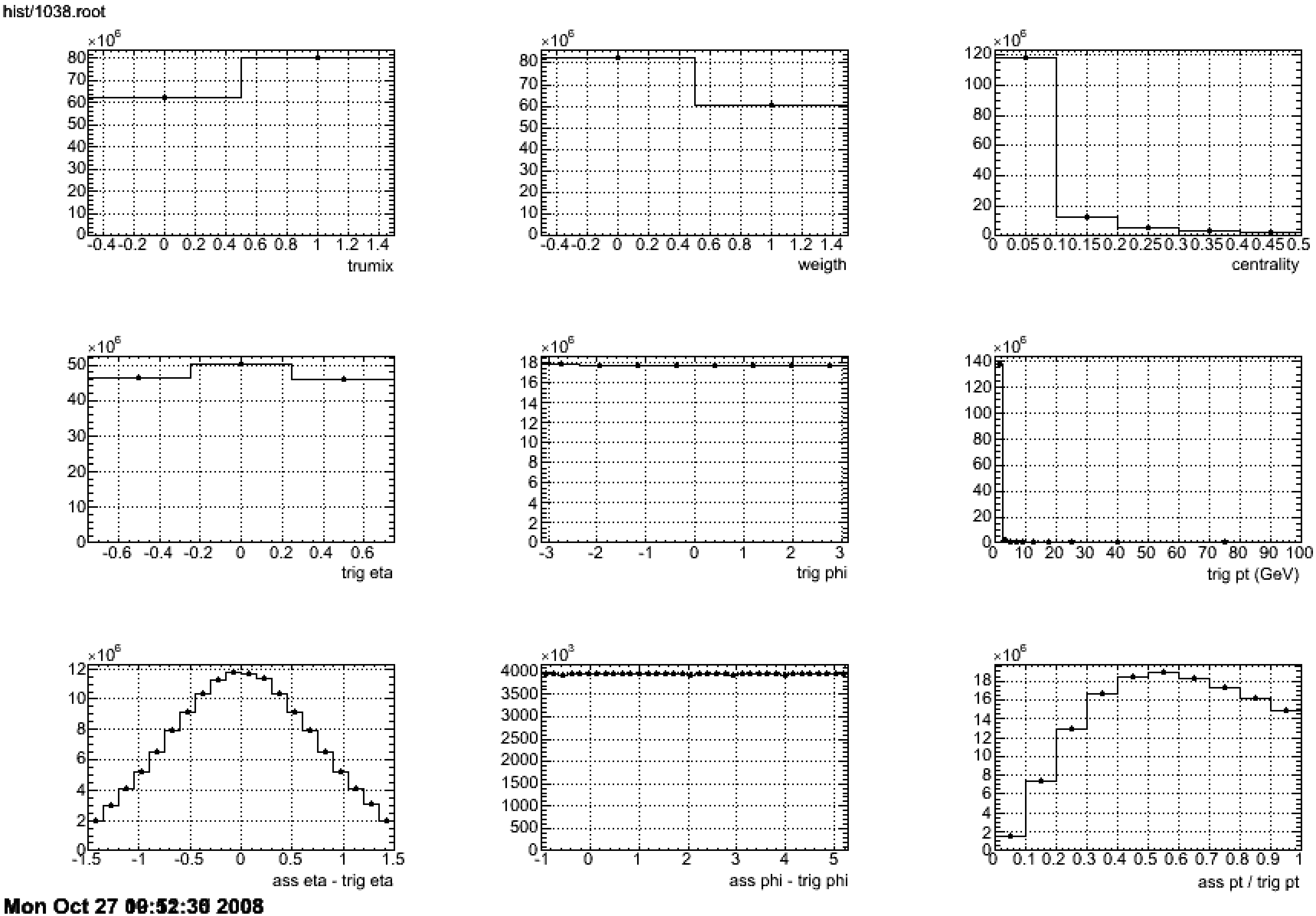


CERES HBT correlations (denominator by rotating)



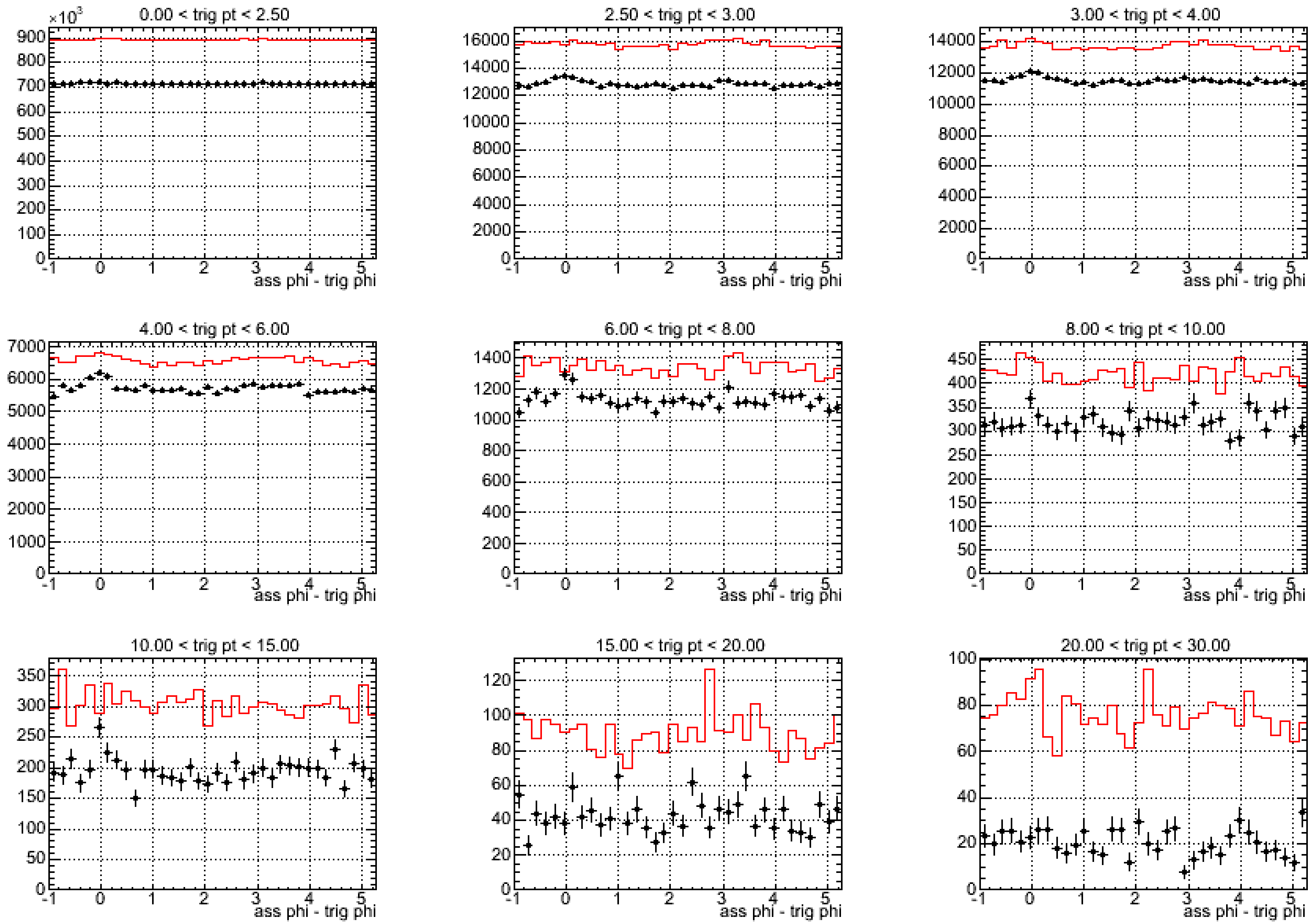
newest addition: ALICE high pt correlations

(thanks Jason Ulery)



ALICE high pt correlations, projections on dphi

10 TeV pythia pp. 0.5 M events



summary of UNICOR features

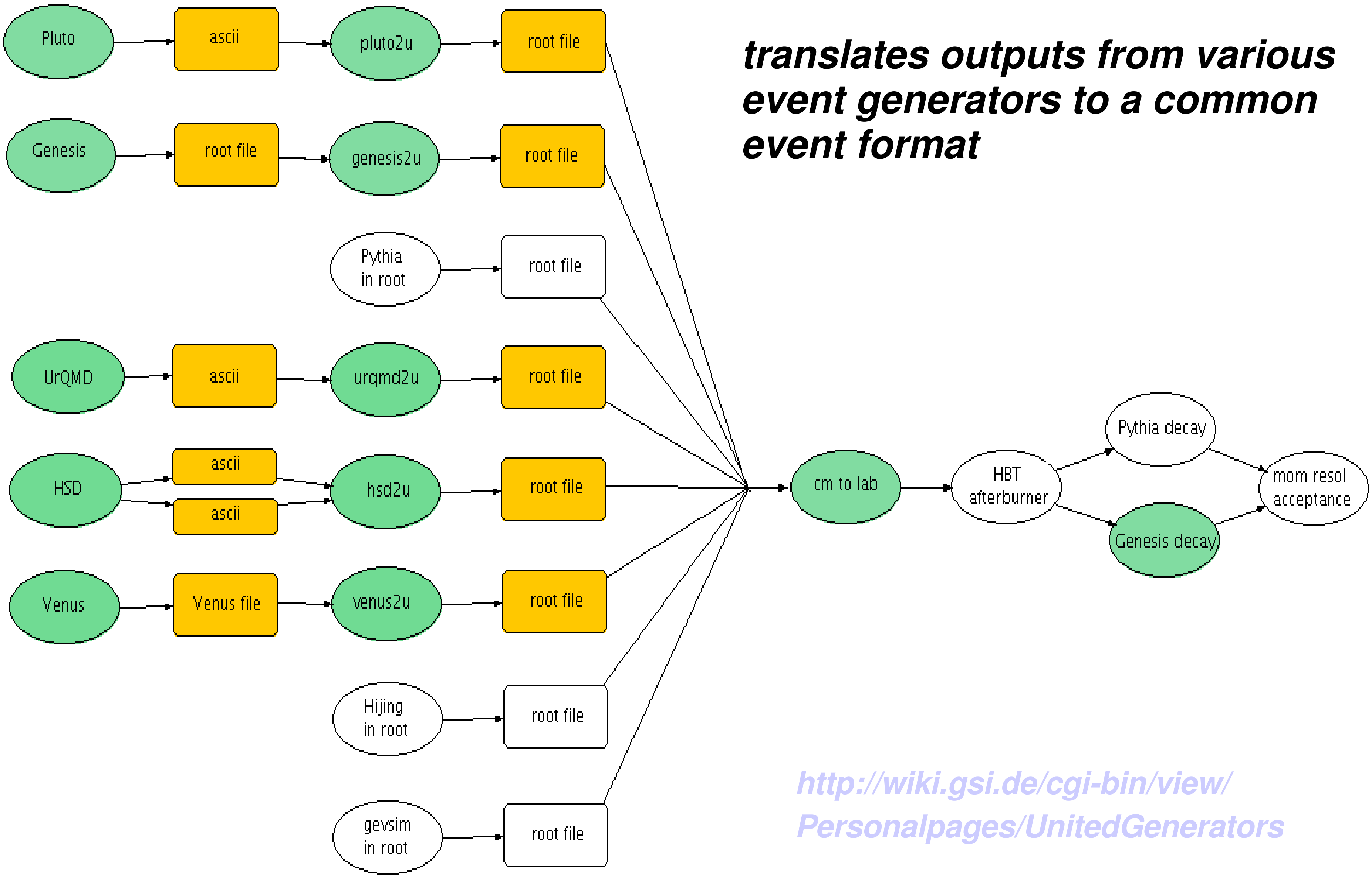
- ***experiment independent***
- ***uses multidimensional histograms***
- ***simple (2000 lines of code)***

- ***can quickly yield simple physics results (two-pion HBT, pt-fluctuations, high pt correlations)***
- ***not intended to compete with sophisticated analyses (but can be compared to them in simple cases)***

backup

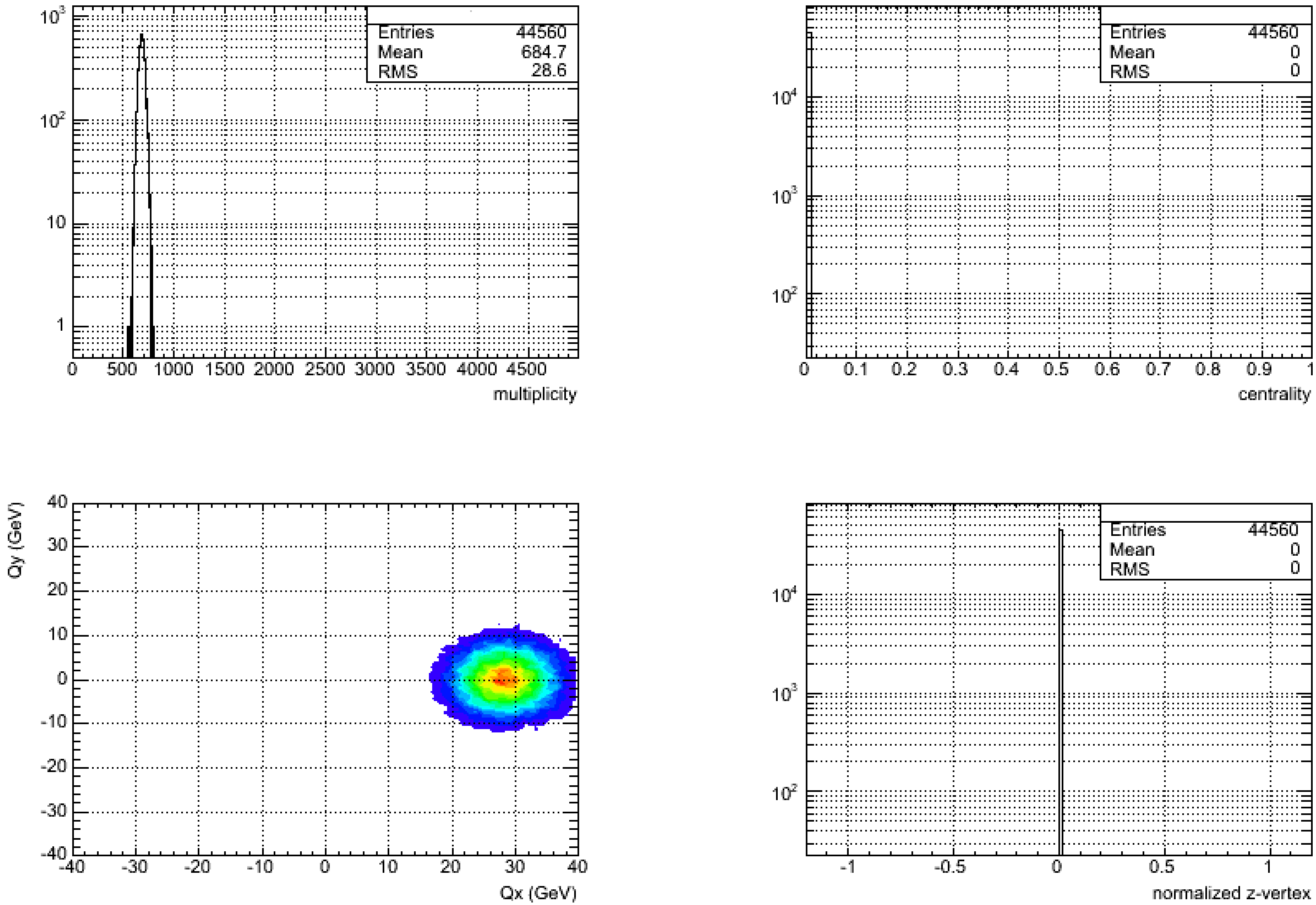
United Generators project at GSI, 2005-2008

translates outputs from various event generators to a common event format

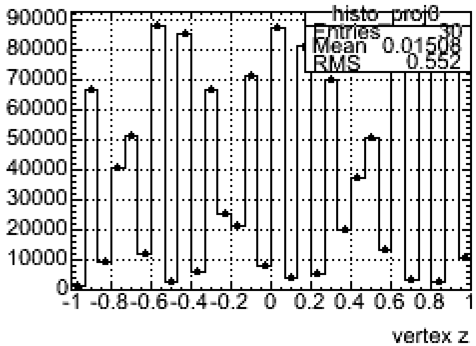


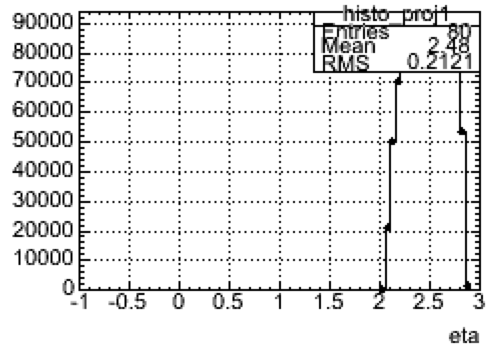
http://wiki.gsi.de/cgi-bin/view/Personalpages/UnitedGenerators

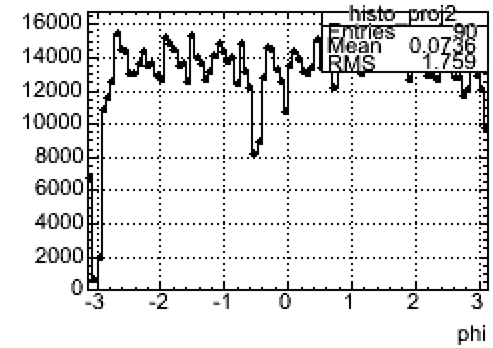
CBM global variables

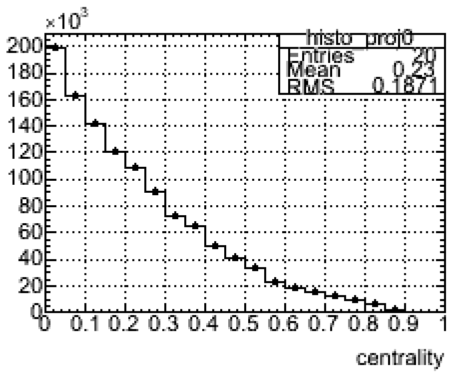


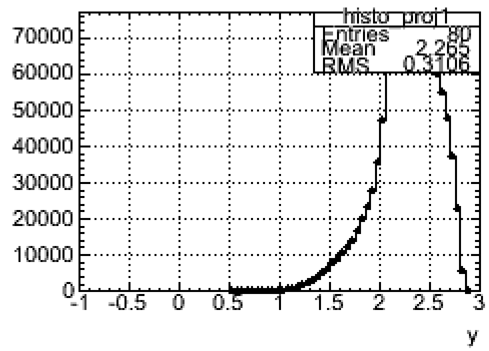
CERES singles

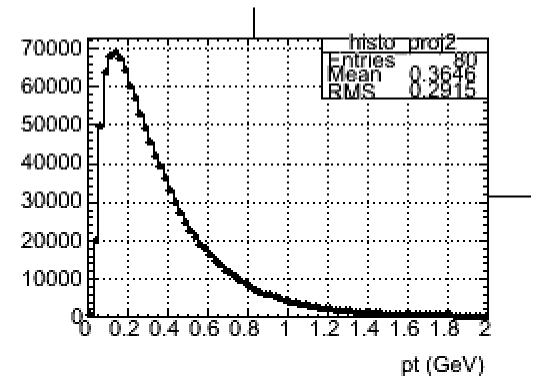




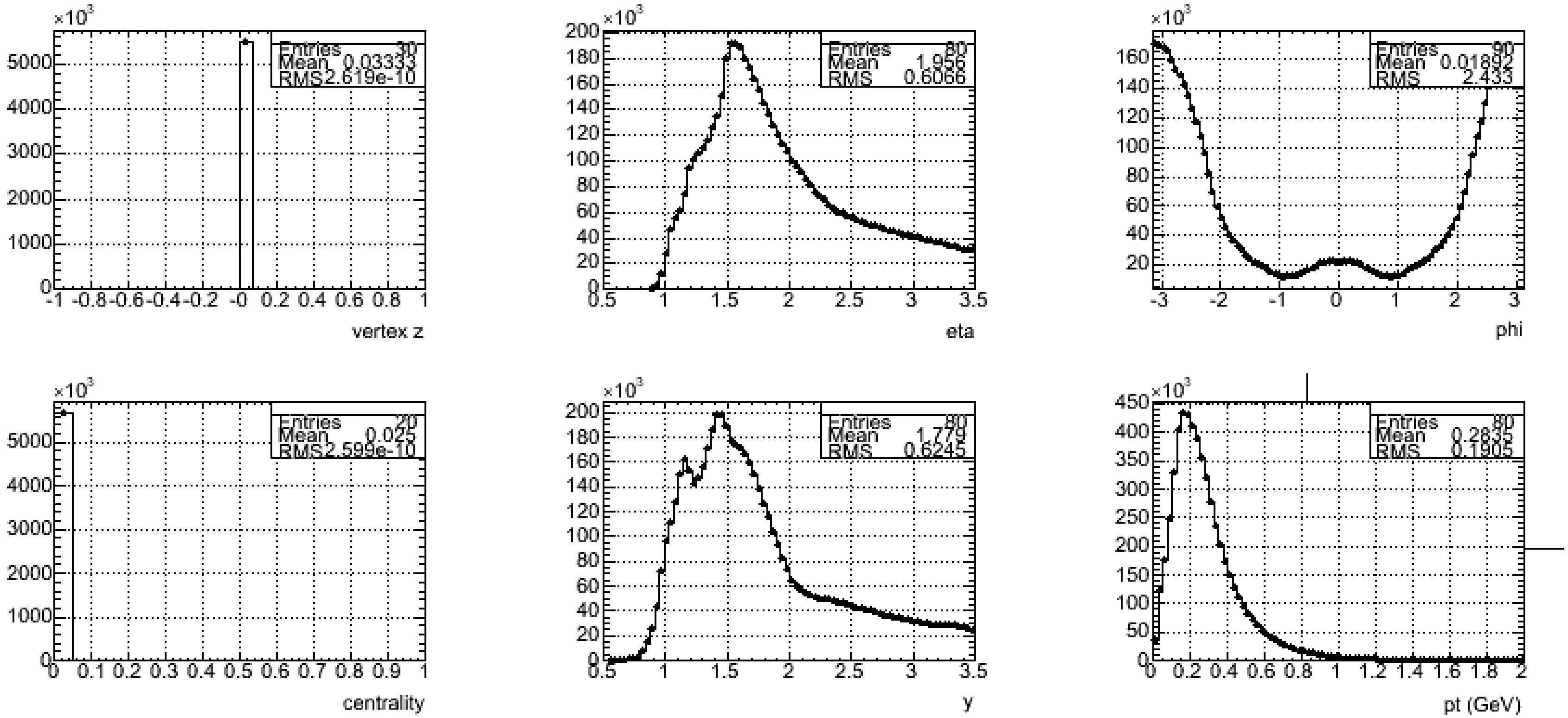






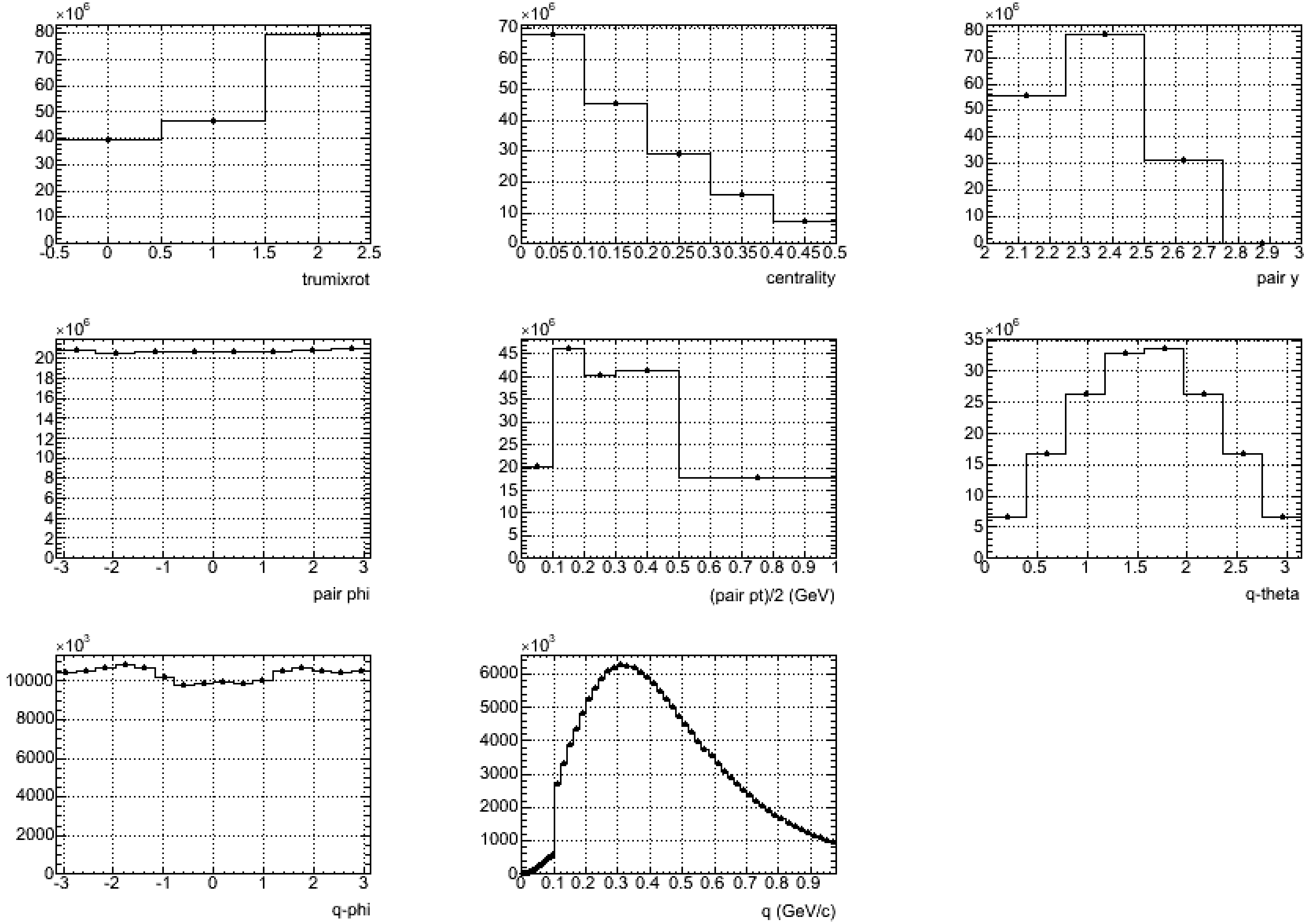


CBM singles

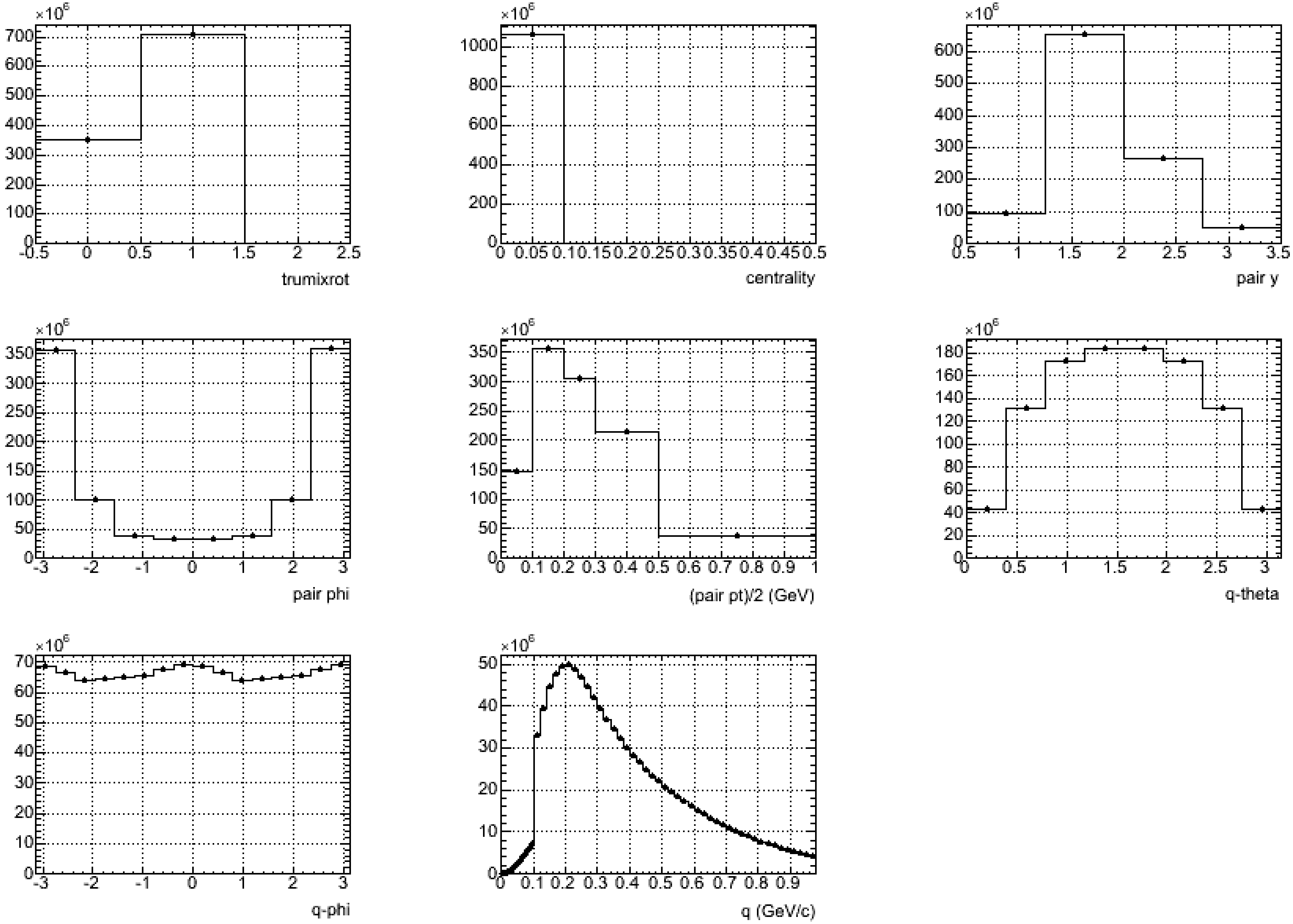


×10³
Entries 30
Mean 0.03333
RMS 2.619e-10
vertex z
×10³
Entries 80
Mean 1.956
RMS 0.6066
eta
×10³
Entries 90
Mean 0.01892
RMS 2.433
phi
×10³
Entries 20
Mean 0.025
RMS 2.599e-10
centrality
×10³
Entries 80
Mean 1.779
RMS 0.6245
y
×10³
Entries 80
Mean 0.2835
RMS 0.1905
pt (GeV)

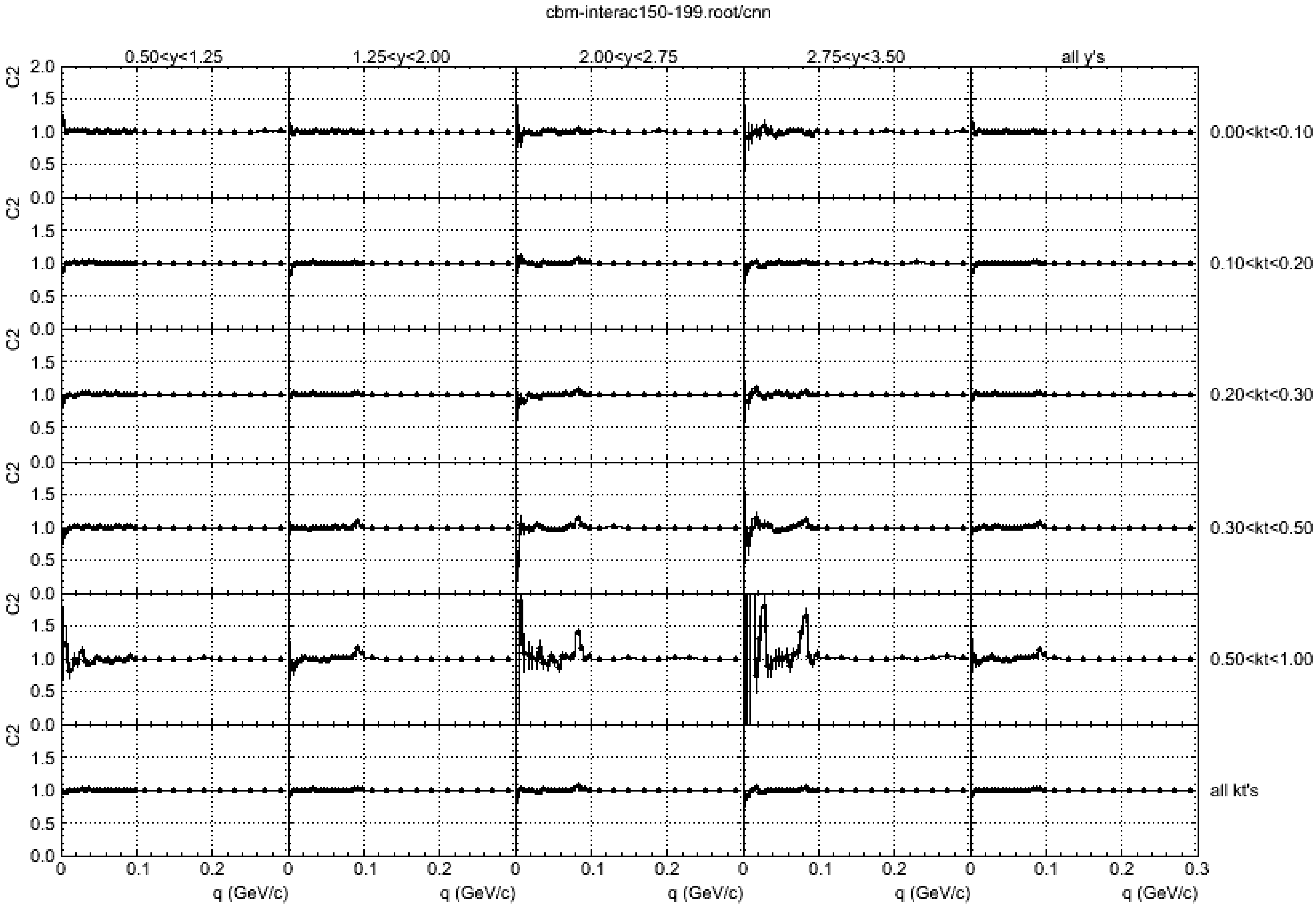
CERES correlations (projections)



CBM correlations (projections)



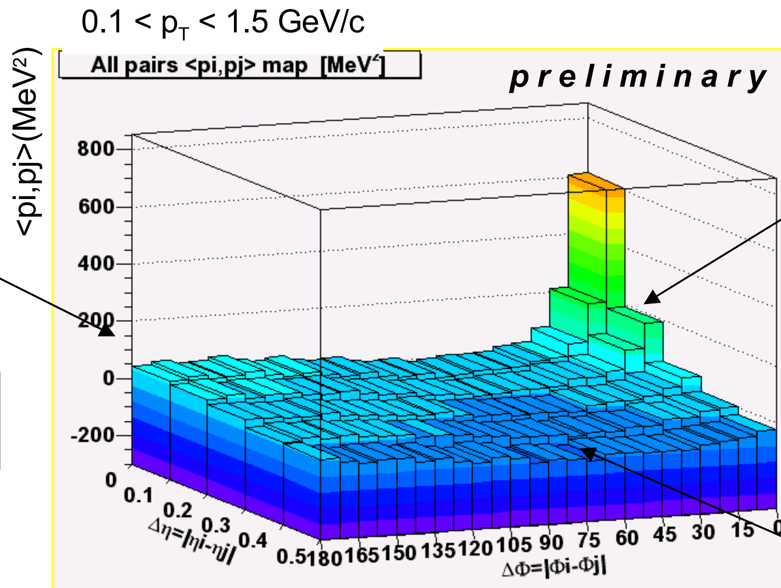
CBM correlations (denominator by event mixing)



pt fluctuation intro, CERES data

Pb+Au at 158 GeV per nucleon

Georgios Tsiledakis



away-side correlations

elliptic flow, jets?

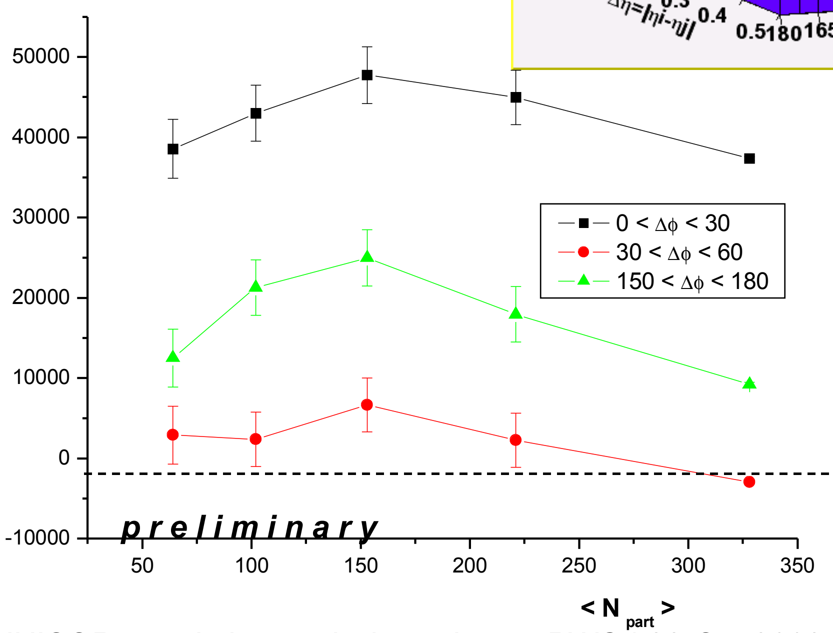
rich structure → averaging over Δφ and Δη is not good

short range correlations

confined to Q_{INV}<70 MeV
narrower and weaker for unlike pairs → HBT and Coulomb?

decline with Δη

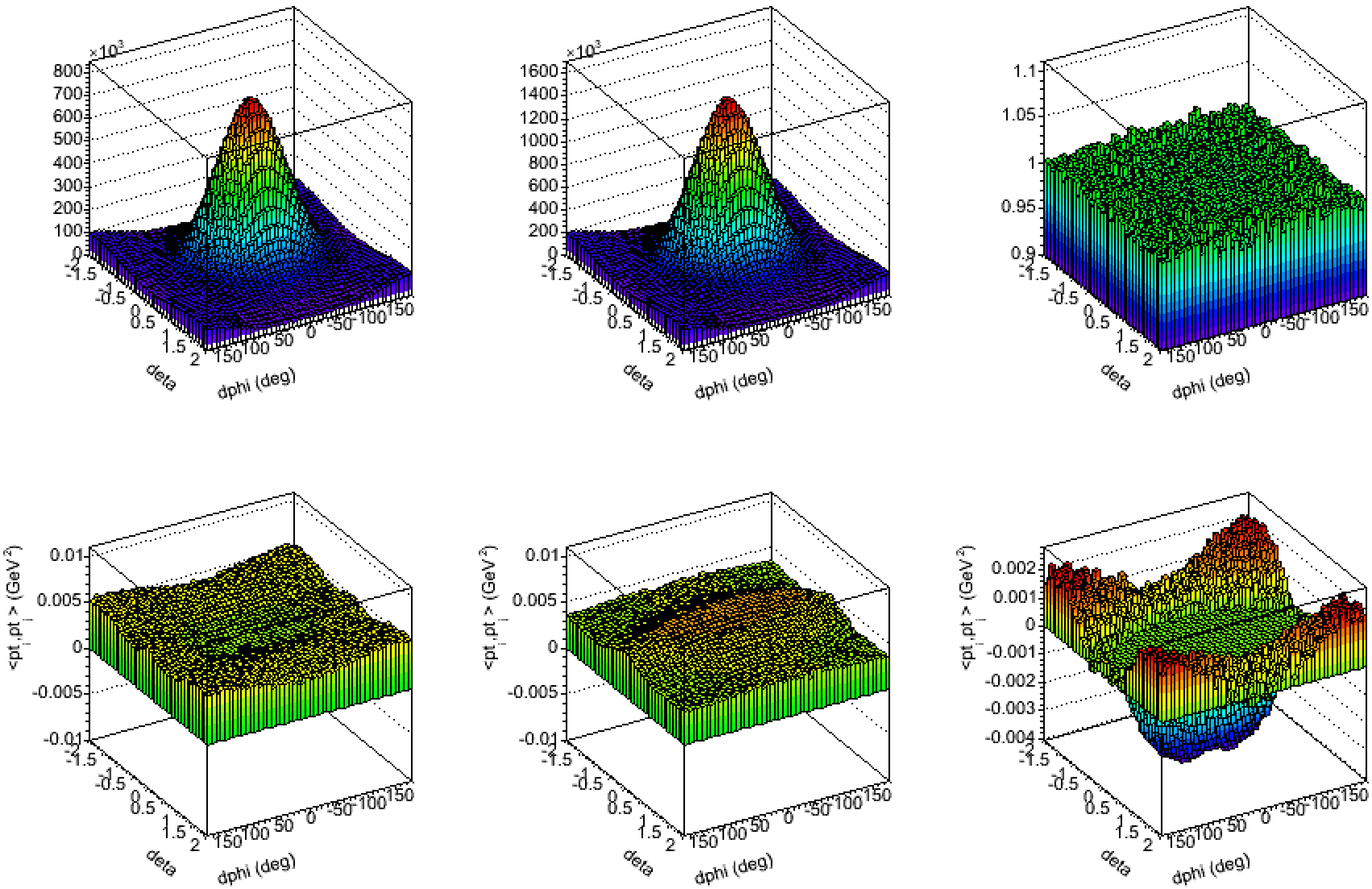
reproduced with event mixing
trivial effect of pt(η) dependence?



short range and away-side correlation produce the observed centrality dependence

region around Δφ = 45° is not affected by the elliptic flow, HBT, Coulomb, jets
→ look here for the critical point

CBM pt-fluctuations



why experiment-independence

For example, typical HBT analysis involves:

- particle momentum and id
- event, track, pair cuts

} 10%

- pairing, event mixing
- kinematics
- histogramming
- projecting, fitting
- Coulomb correction
- momentum resolution correction
- analysis of HBT radii etc.

} 90%