Some aspects of KK femtoscopy in ALICE

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OutLine

- Physics Motivation of KK femtoscopy
- Experimental results
- Distortions of KK correlation function:
  - PID's of Kaons
  - Pair PID
  - Splitting-merging
  - Resonances ($v\tau \geq$ source size): K*, Φ
- Conclusion and future plans

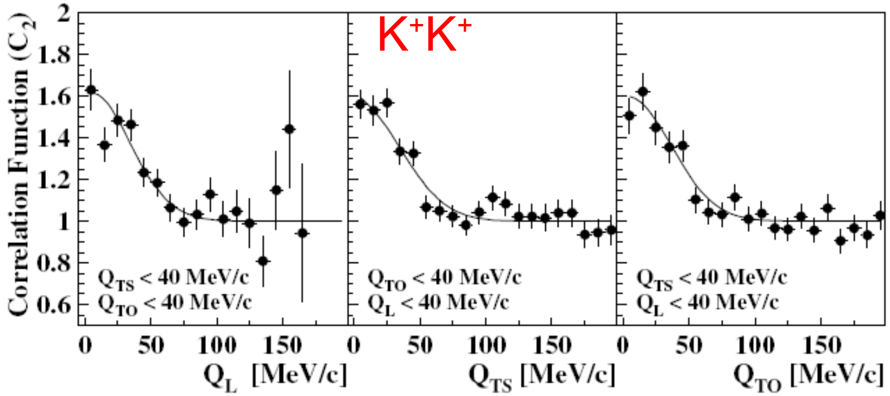
Physics motivation

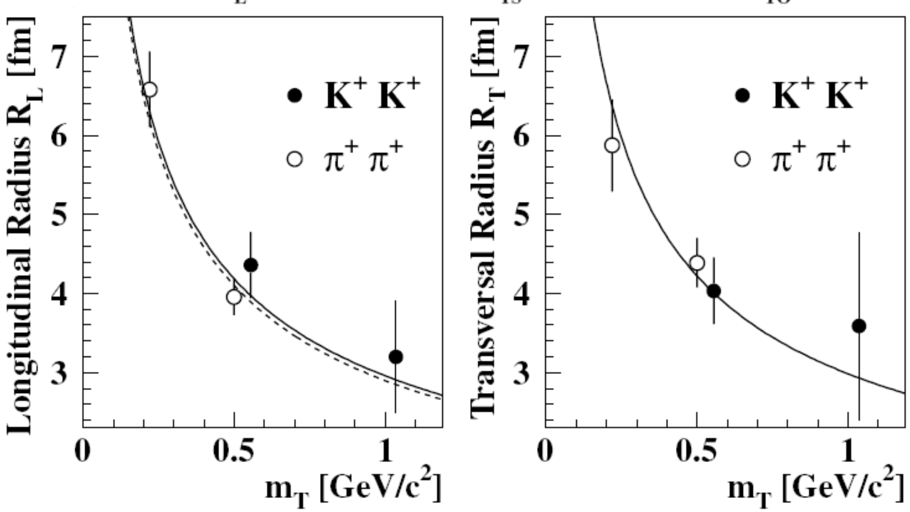
- Measured space-time extent of the particle emitting region for KK is pure than for ππ.
- Kaon femtoscopy signal is cleaner than pion femtoscopy signal since Kaons are less affected by resonance decay.
- The m_T dependence: $m_T(KK) > m_T(\pi\pi)$.
- The strangeness distillation mechanism could lead to strong temporal emission asymmetries between kaons and anti-kaons *[S.Soff et al., J.Phys.G23,2095(1997);D.Ardouin et al.,Phys.Lett.B446,191(1999)].*
- Due to the highest branching ratio of Φ meson is KK the ΦΦ residual correlations could be seen from KK correlation function.

Experimental results

CERN-SPS: Pb+Pb at 158 AGeV/c

[PRL,87(2001)112301]

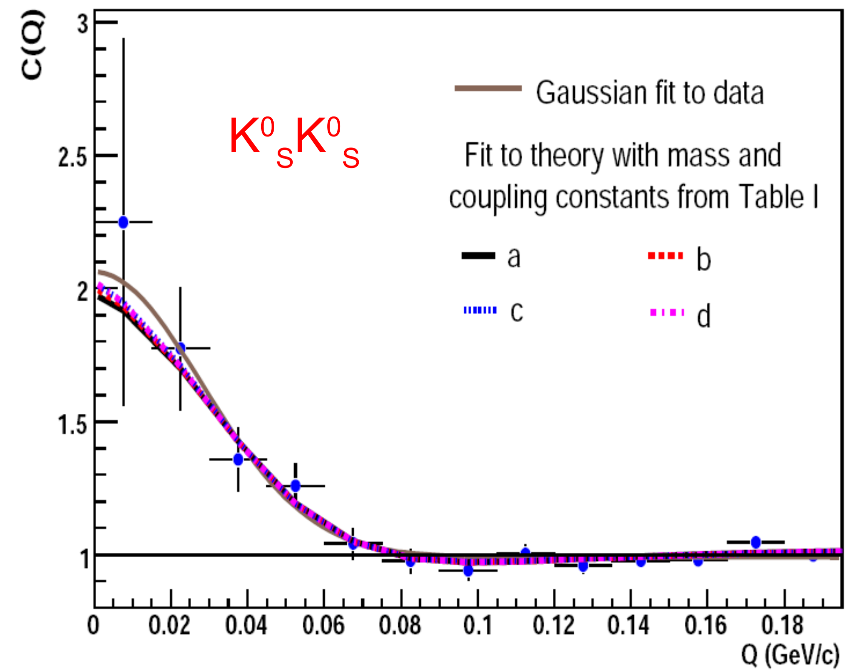




The duration time
$\Delta\tau = \mathrm{sqrt}(r^2_{out} - r^2_{side})/\beta =$
$2.2 \pm 5.2(\mathrm{stat.}) \pm 5.1(\mathrm{sys})$ fm

RHIC-STAR: Au+Au sqrt(S_{NN})=200GeV

[Phys.Rev.C 74 (2006),054902]

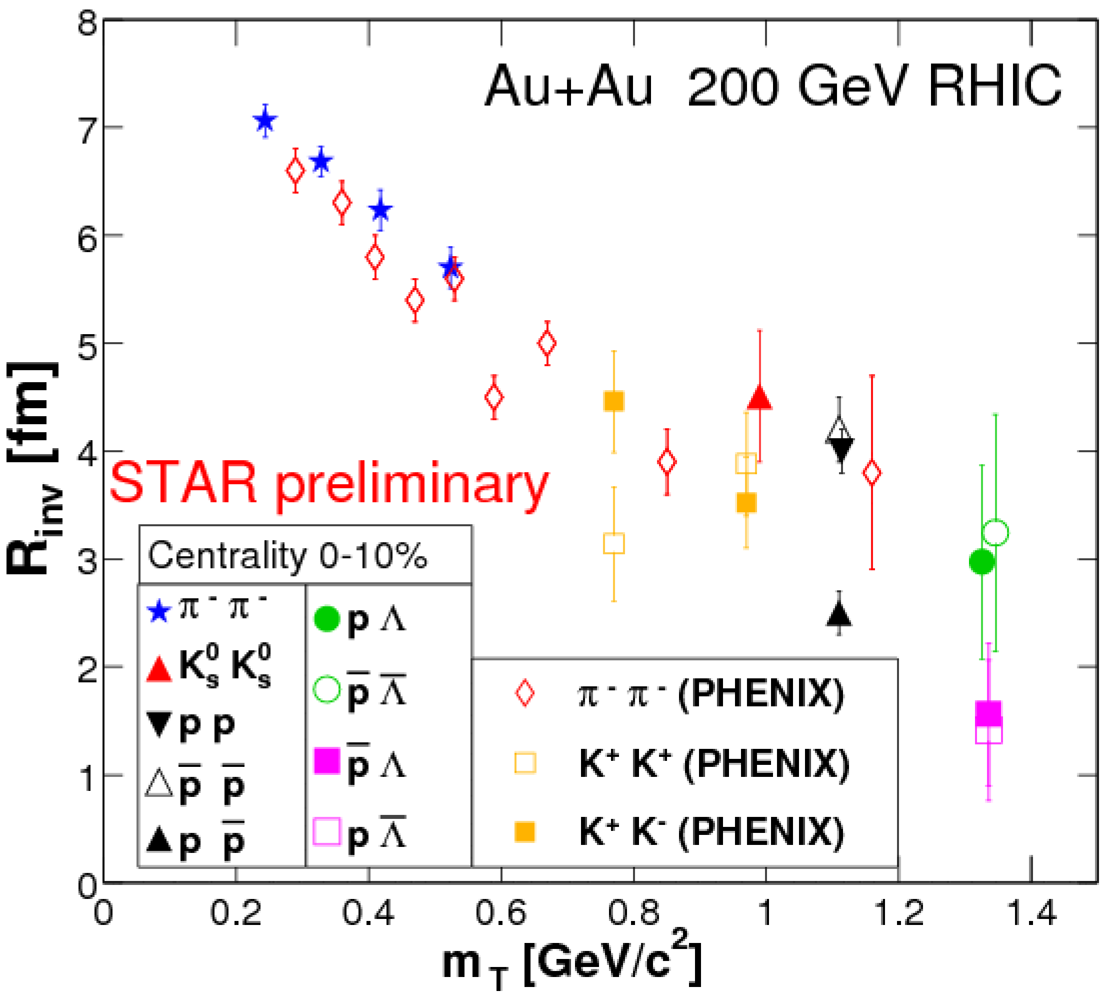


R = 4.09 ± 0.46(stat.) ± 0.31(sys) fm and λ = 0.92±0.23(stat)±0.13(sys) at the mean transversemass $\langle m_T \rangle$ = 1.07 GeV.

Experimental results II

RHIC-PHENIX: Au+Au sqrt(S_{NN})=200GeV

[M. Heffner J., Phys. G 30 (2004) S1043-S1047], [nucl-ex/0510014]



- an approximately "universal" m_T dependence is usually attributed to collective flow
- KK one dimensional radius 3-5 fm

Simulations: software and input

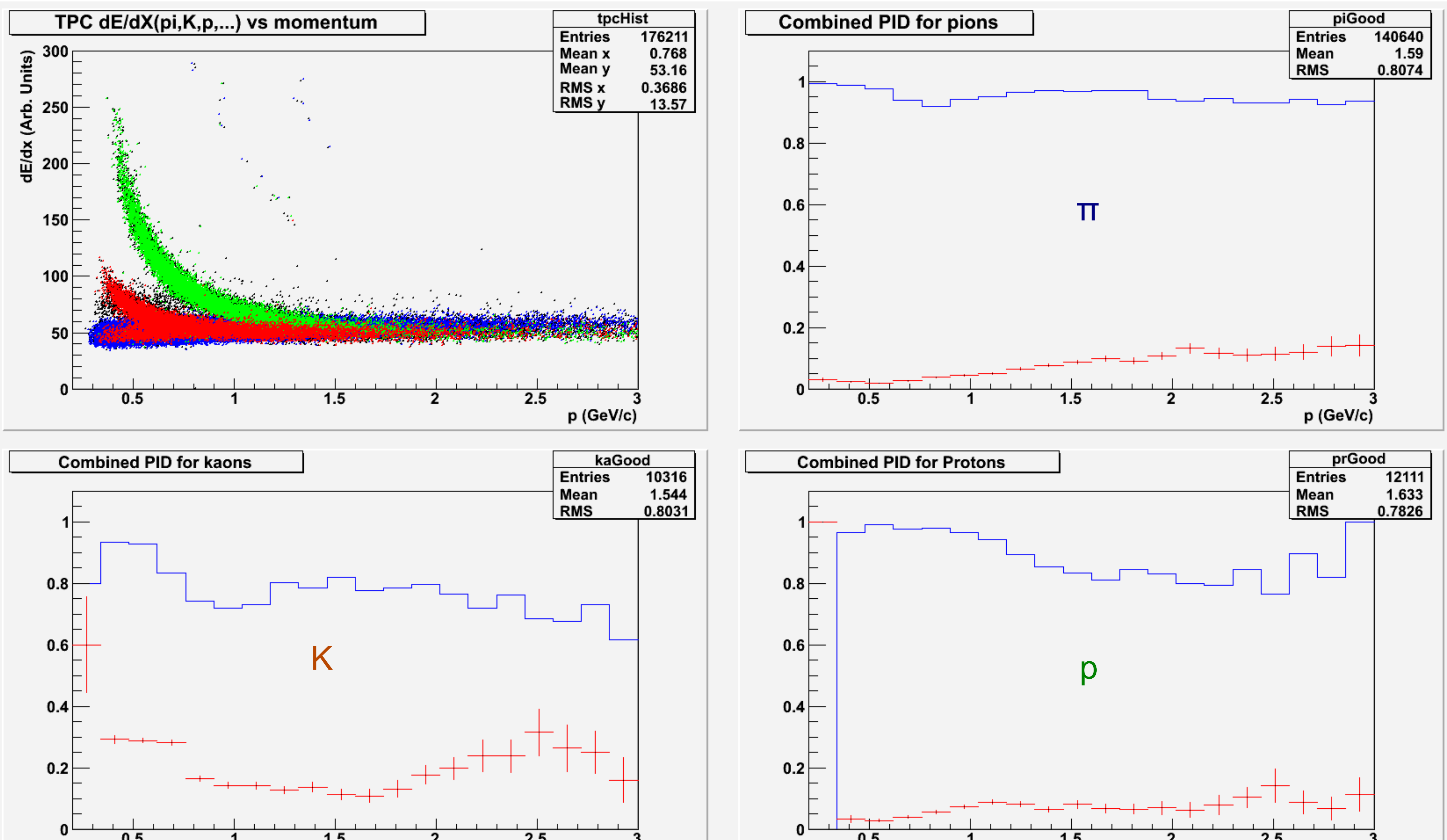
- Aliroot v4-10-Rev-02
- AliFemto from svn/trunk
- Local analysis of 650 events
- PDC2007: HIJING PbPb 5.5 TeV

- 1D K^+K^+ correlations
- $0.1 < P_T < 1.0$ GeV/c
- Anti-splitting cut
- Gaussian distr.: $d^3N/d^3\mathbf{r}^* \sim \exp(-\mathbf{r}^{*2}/(4r_0^2))$

  K^+K^+ r_0: 2 and 5 fm
- Source size for kaons from K* decay ($v\tau$=2.6fm)

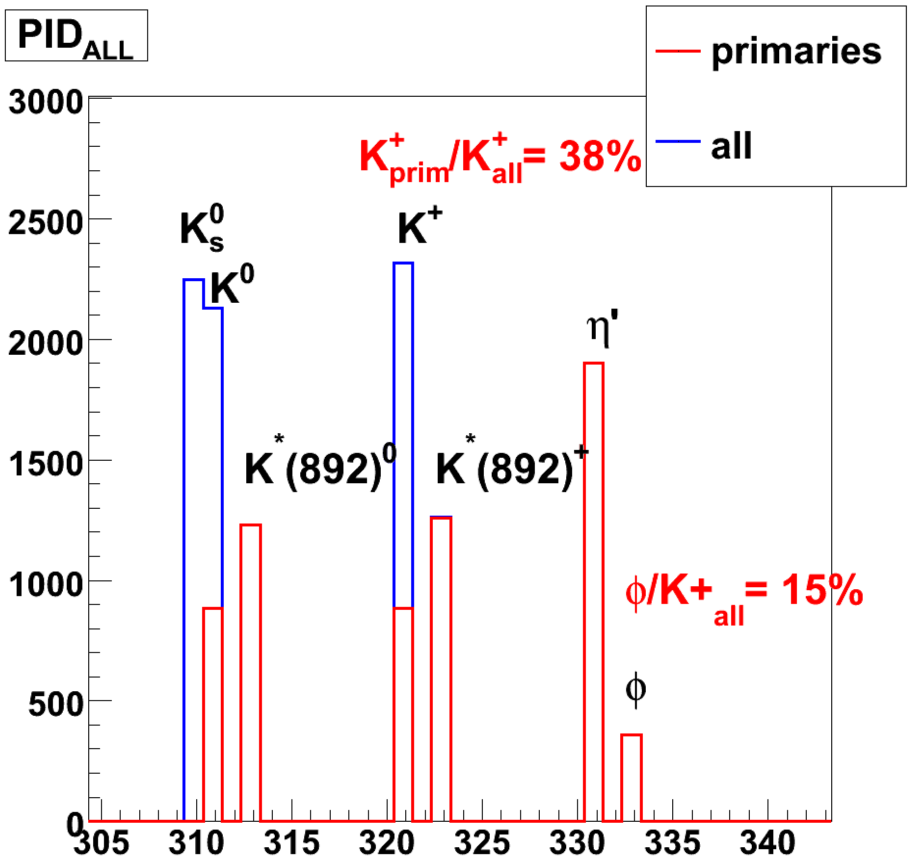
PID study

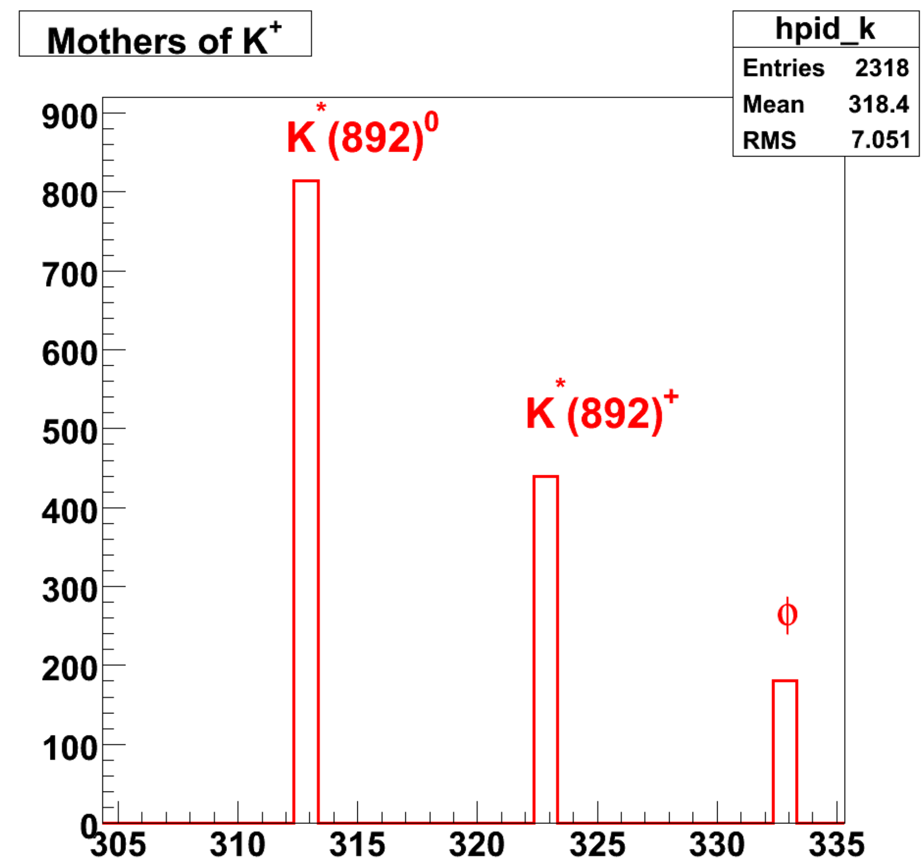
```
//                  e,   mu,   pi,    K,    p
Double_t c[5]={0.064,0.089,0.82,0.075,0.086};
```



K+ Mothers

One event PbPb@5.5 TeV HIJING (galice.root)

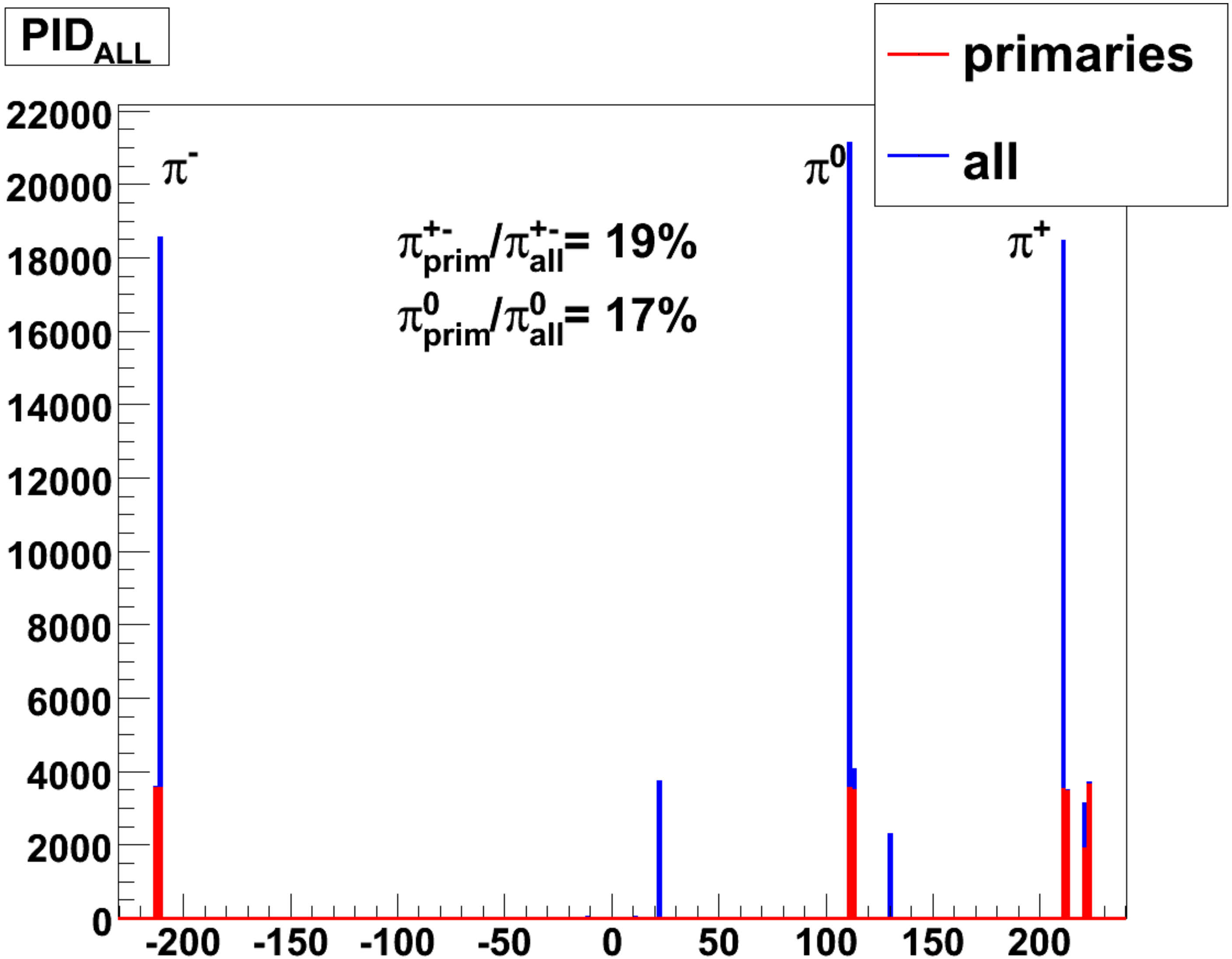




K^+_{direct} 38% $K_{K^*(892)0}$ 35% $K_{K^*(892)+}$ 19% K_Φ 8%,
it is two times better than π+ (π^+_{prim}/π^+_{all} =19%)

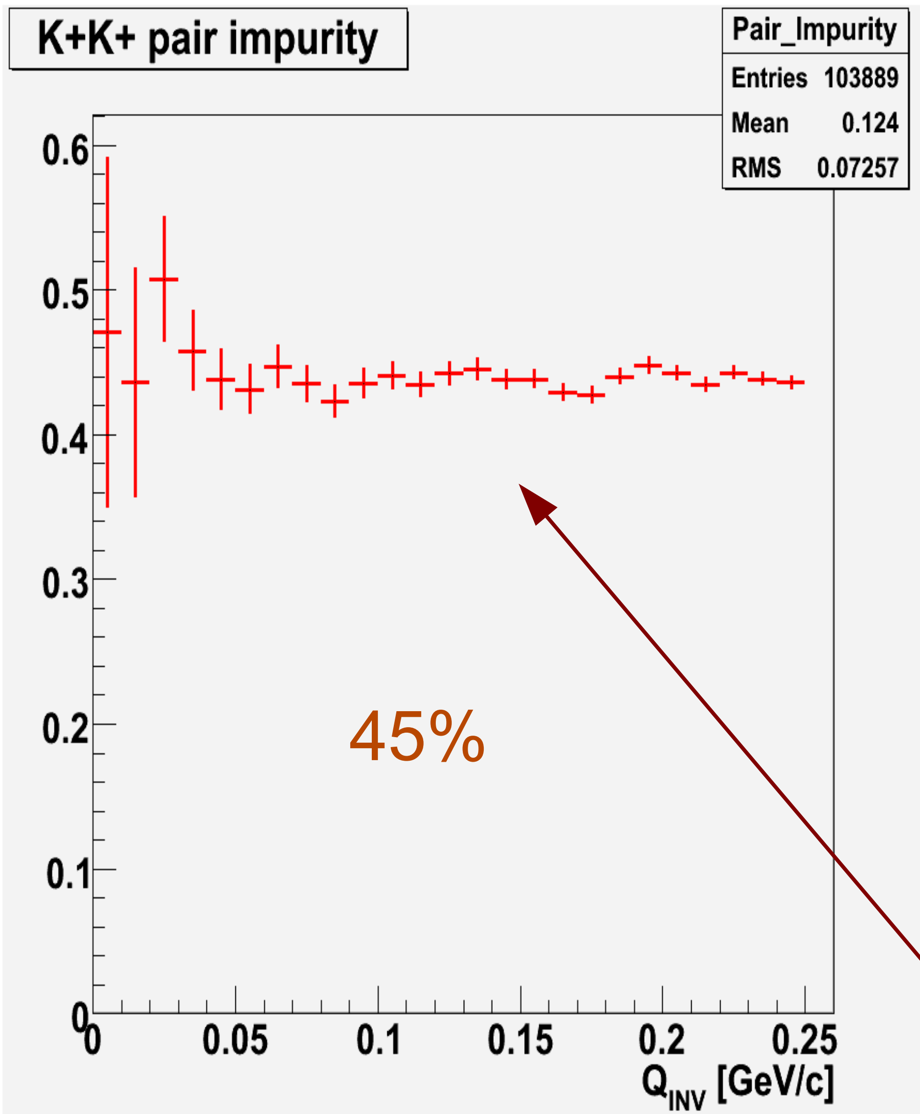
π PID

One event PbPb@5.5 TeV HIJING (galice.root)



Pair PID

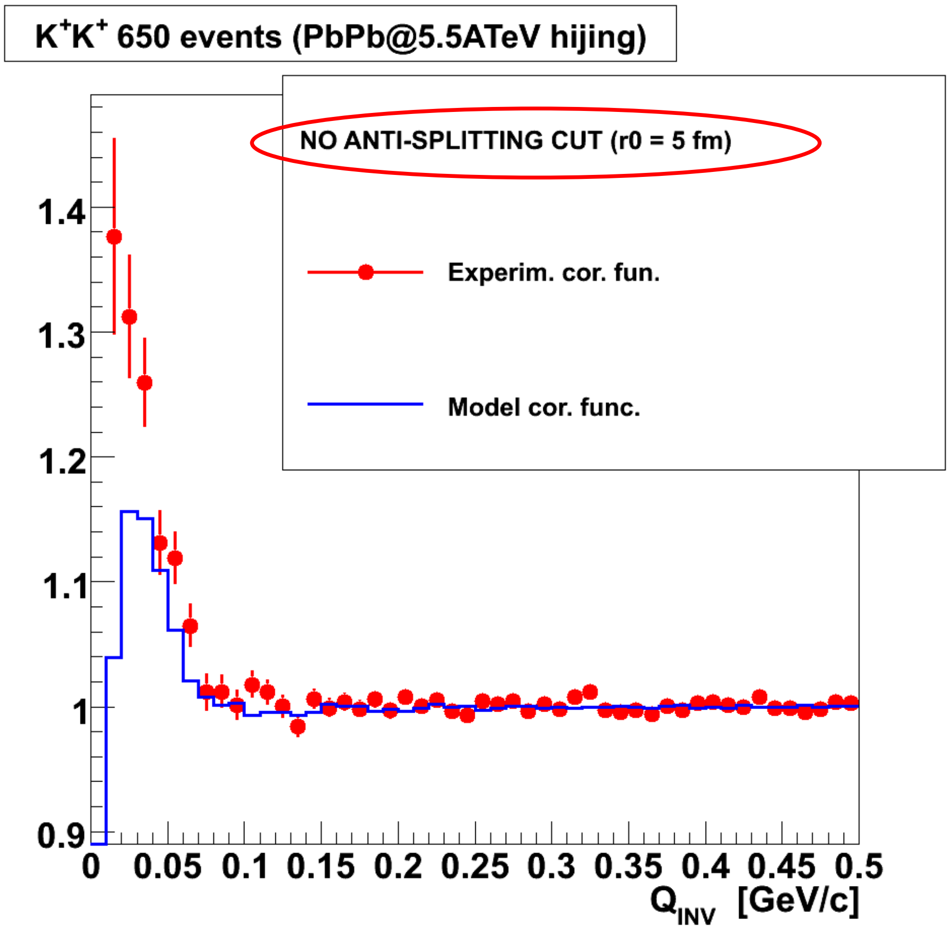
100 events PbPb@5.5 TeV HIJING Q_{INV}<0.25GeV/c

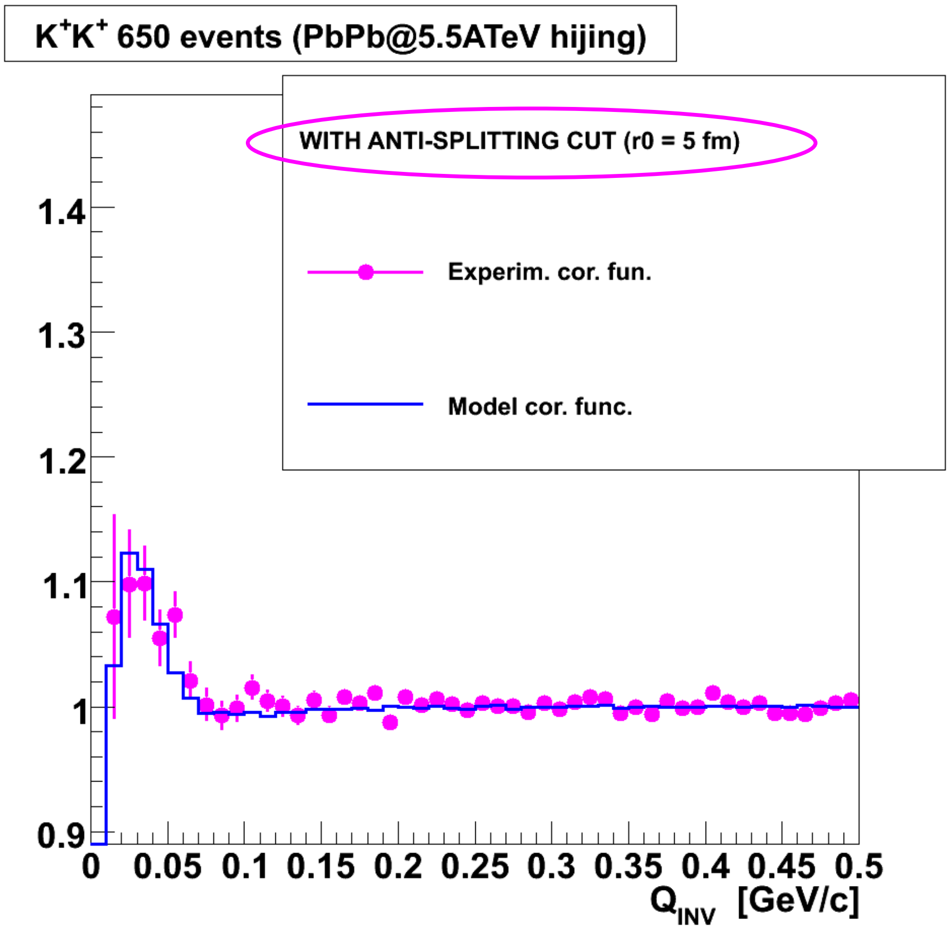


$K_{dir}K_{dir}$	*7%*	7222(6.95165%)
$K_{dir}K_{K^{*}0}$		15298(14.7253%)
$K_{dir}K_{K^{*}+}$		7652(7.36555%)
$K_{K^{*}0}K_{K^{*}+}$	*39%*	8181(7.87475%)
$K_{K^{*}+}K_{K^{*}+}$		2067(1.98962%)
$K_{K^{*}0}K_{K^{*}0}$		8077(7.77464%)
$K_{dir}K_{\Phi}$		3129(3.01187%)
$K_{\Phi}K_{\Phi}$		345(0.332085%)
$K_{K^{*}0}(K_{K^{*}+})K_{\Phi}$		5022(4.83401%)
Other exotic ($K_{dir}K_{D0}$,...)		1352(1.30139%)
$(KK)_{fake}$		46896(45.1405%)
Total		103889 (100%)

Remove splitting (r_0=5fm)

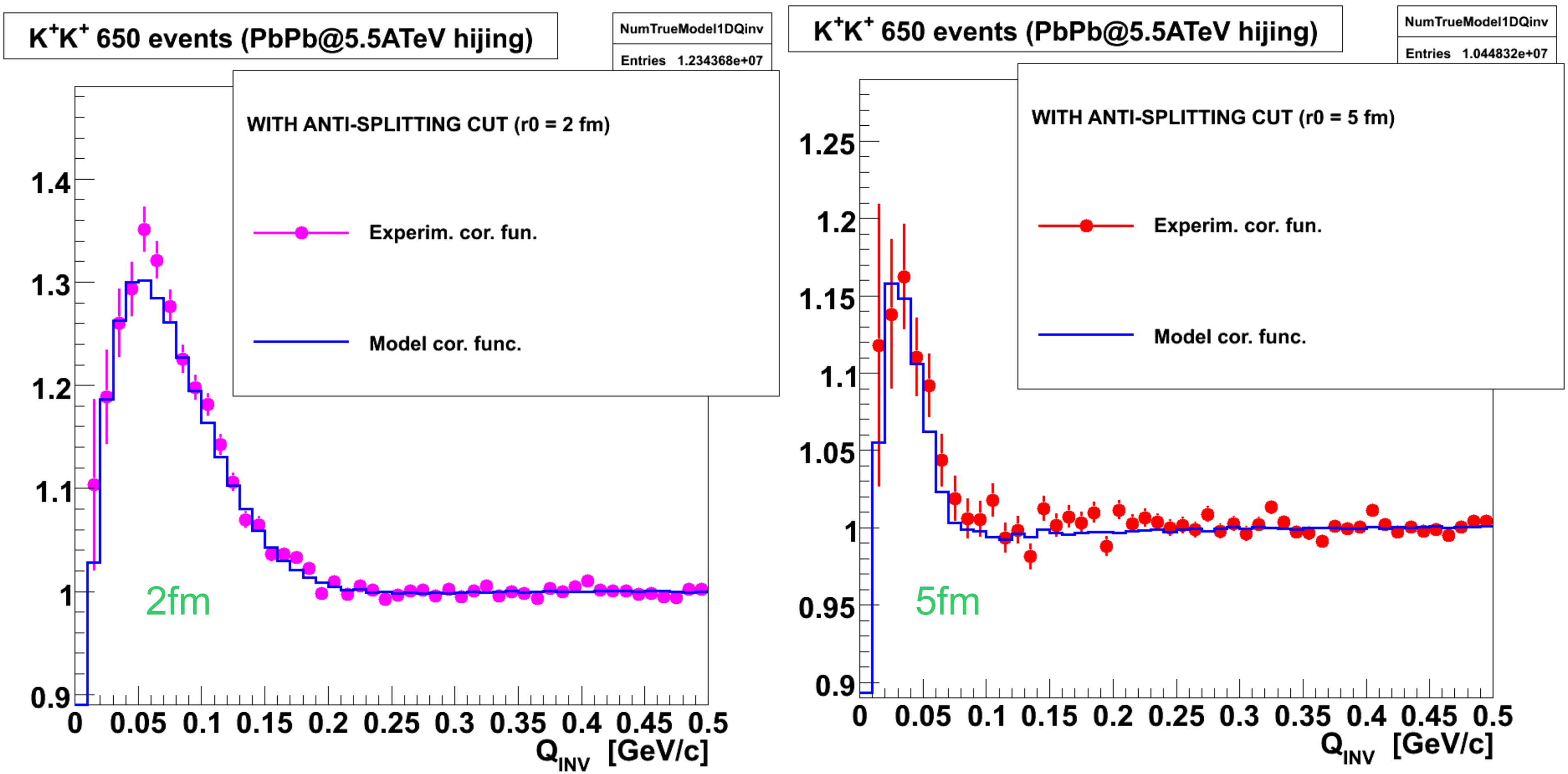
Splitting(merging) of tracks can change experimental CF at low Q_{INV}





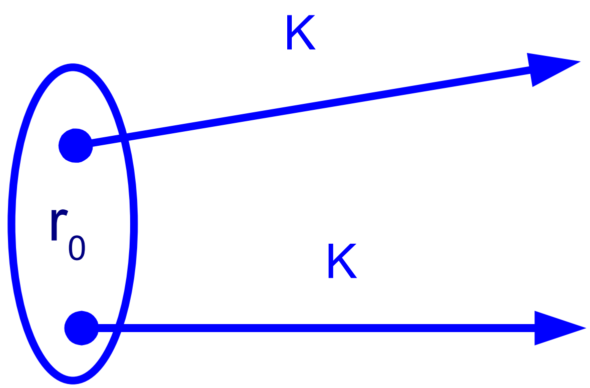
Test various source size

With Anti-Splitting cut

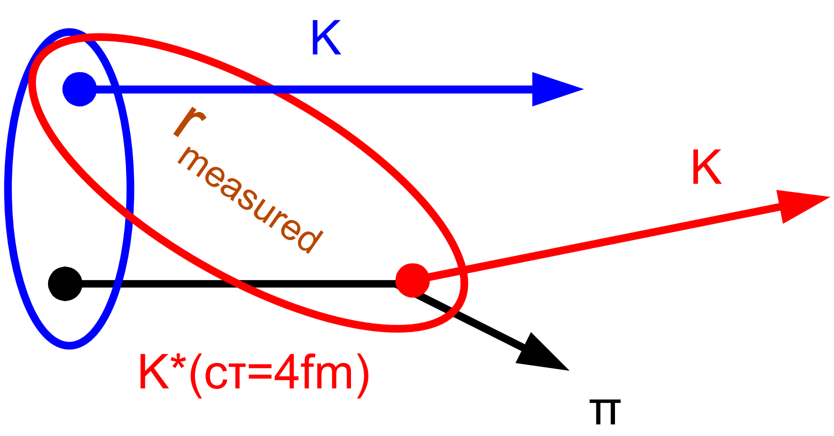


Source “expansion” due to K*

Both K are direct



One K is direct and the other one from K* decay



- $K_{dir}K_{dir}$ source size is

  smaller than

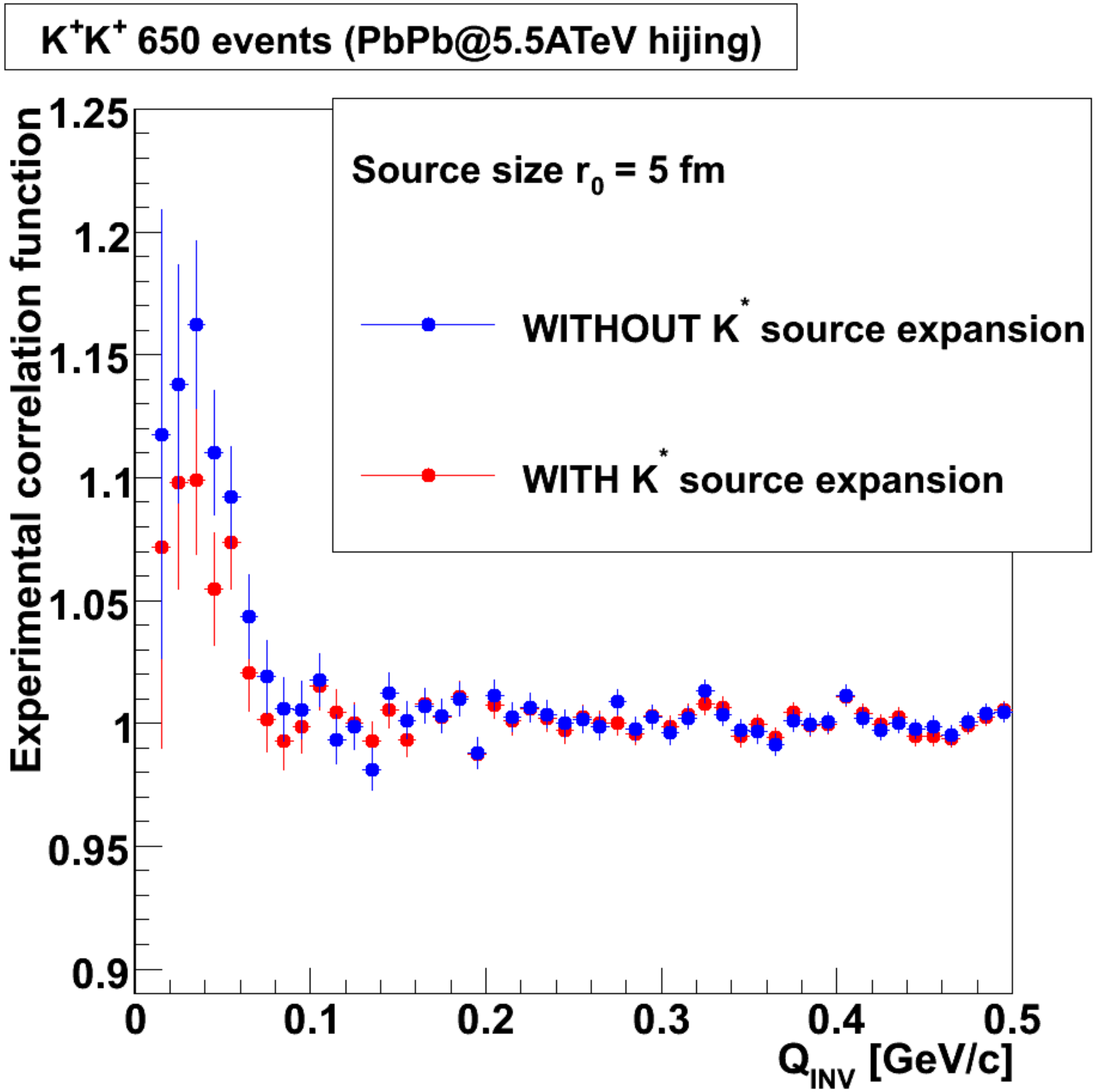
  $K_{dir}K_{K^*}$

  due to K* decay length
- Assume K* source size the same as $K_{dir}K_{dir}$ (r_0)
- Measured source in second case:

  $\mathrm{sqrt}(r_0^2+(v\tau)^2)$
- Estimate v form K* spectrum ($v\tau \sim 2.6$ fm)

K^+K^+ correlation function(r_0=5fm)

Source "expansion" due to K* decay (r_0=5fm, K* $v\tau$~2.6fm)



K^+K^+ source size was:

1. Both K^+ are direct

   r_0=5fm

2. One K^+ is direct and one from K*

   $r_0=\mathrm{sqrt}(5^2 + 2.6^2) = 5.6$fm

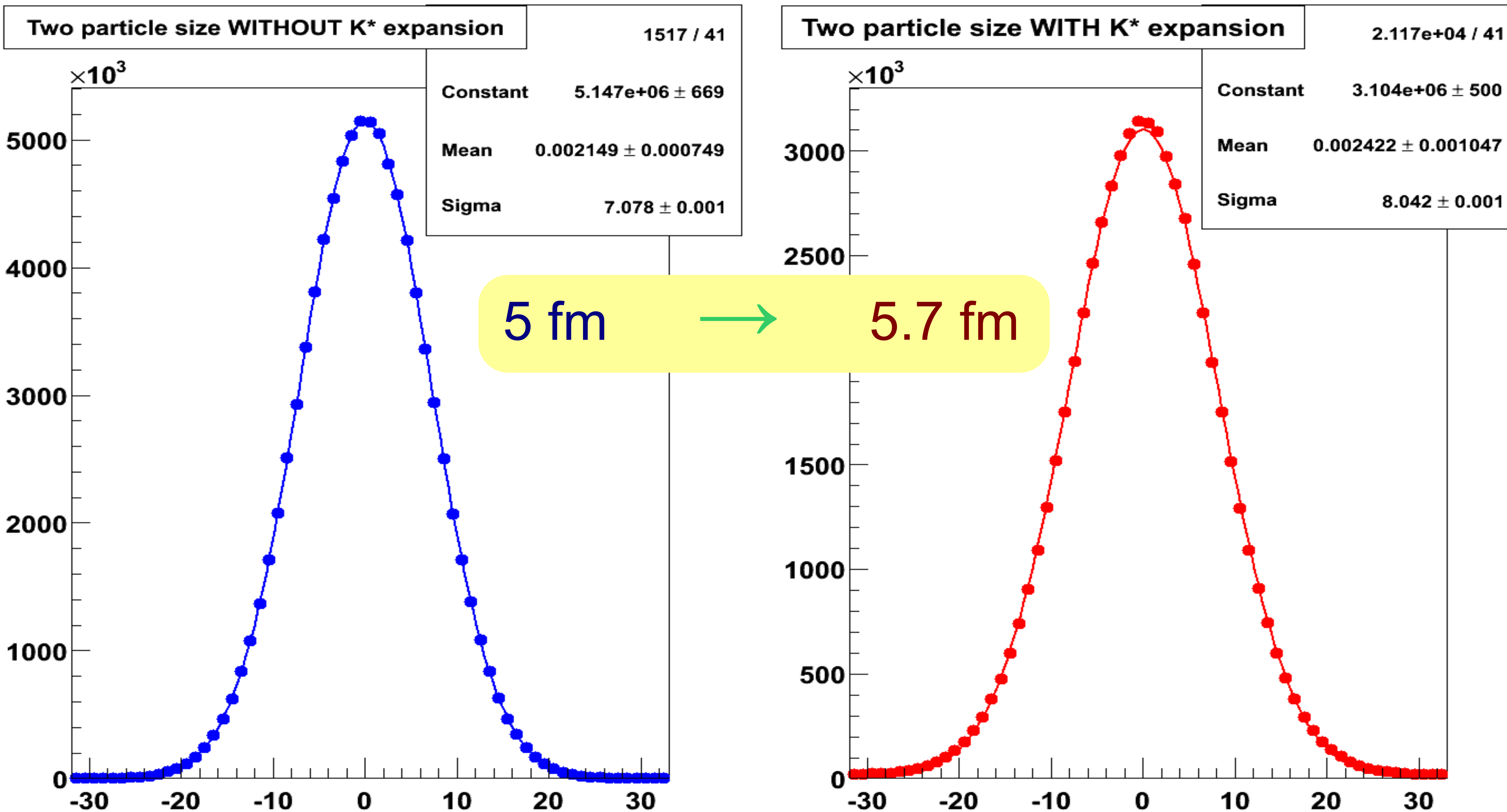
3. Both K^+ from K*

   $r_0=\mathrm{sqrt}(5^2 + 2.6^2 + 2.6^2) = 6.2$fm

4. Also some small amount of K^+ came from Φ meson, but it is small effect

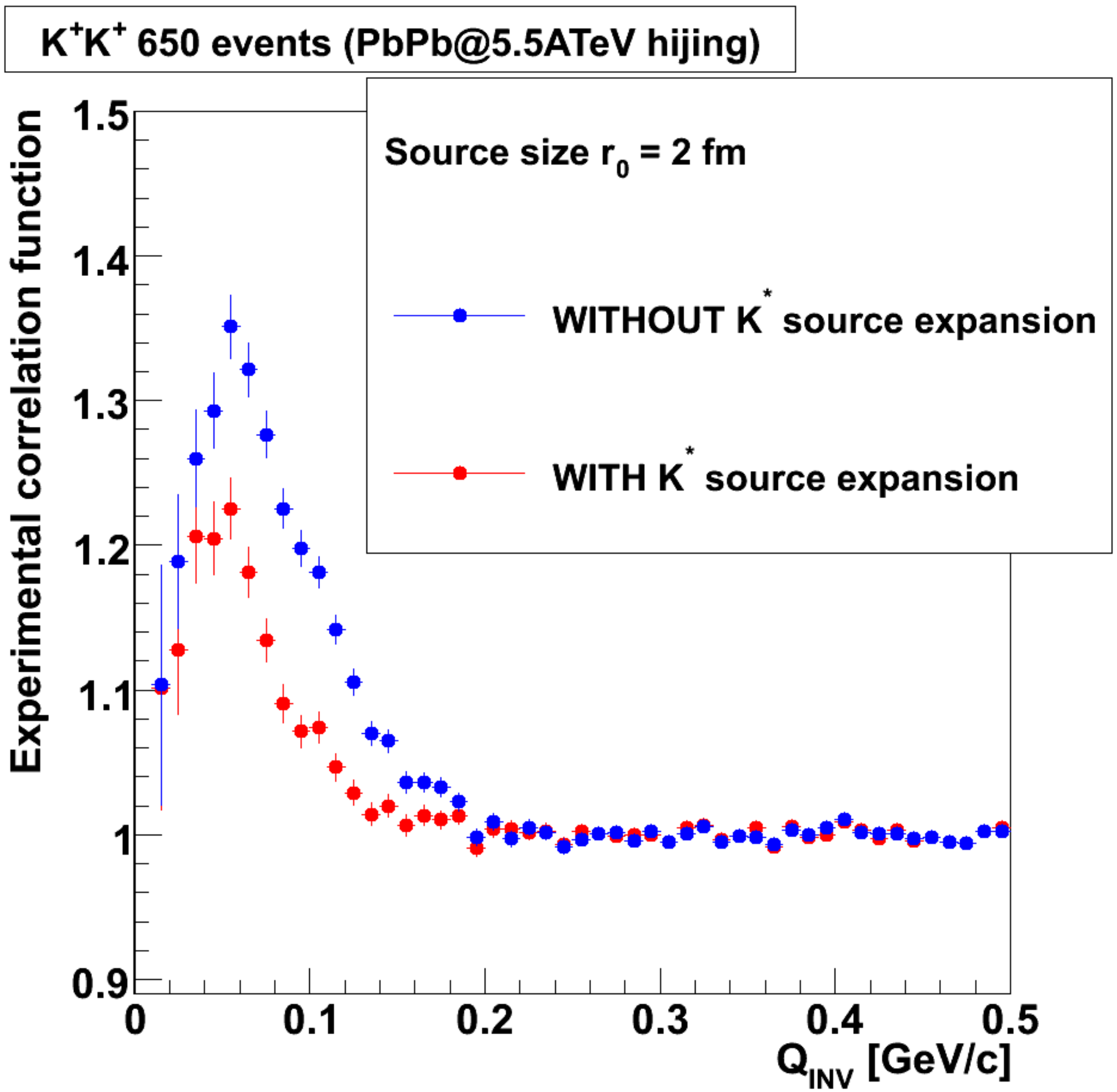
Space distribution (r_0=5fm)

Source “expansion” due to K* decay (r0=5fm, K* vτ~2.6fm)



K^+K^+ correlation function(r_0=2fm)

Source "expansion" due to K* decay (r_0=2fm, K* $v\tau$~2.6fm)



K^+K^+ source size:

1. Both K^+ are direct

   r_0=2fm

2. One K+ is direct and one from K^*

   $r_0=\mathrm{sqrt}(2^2 + 2.6^2) = 3.3$fm

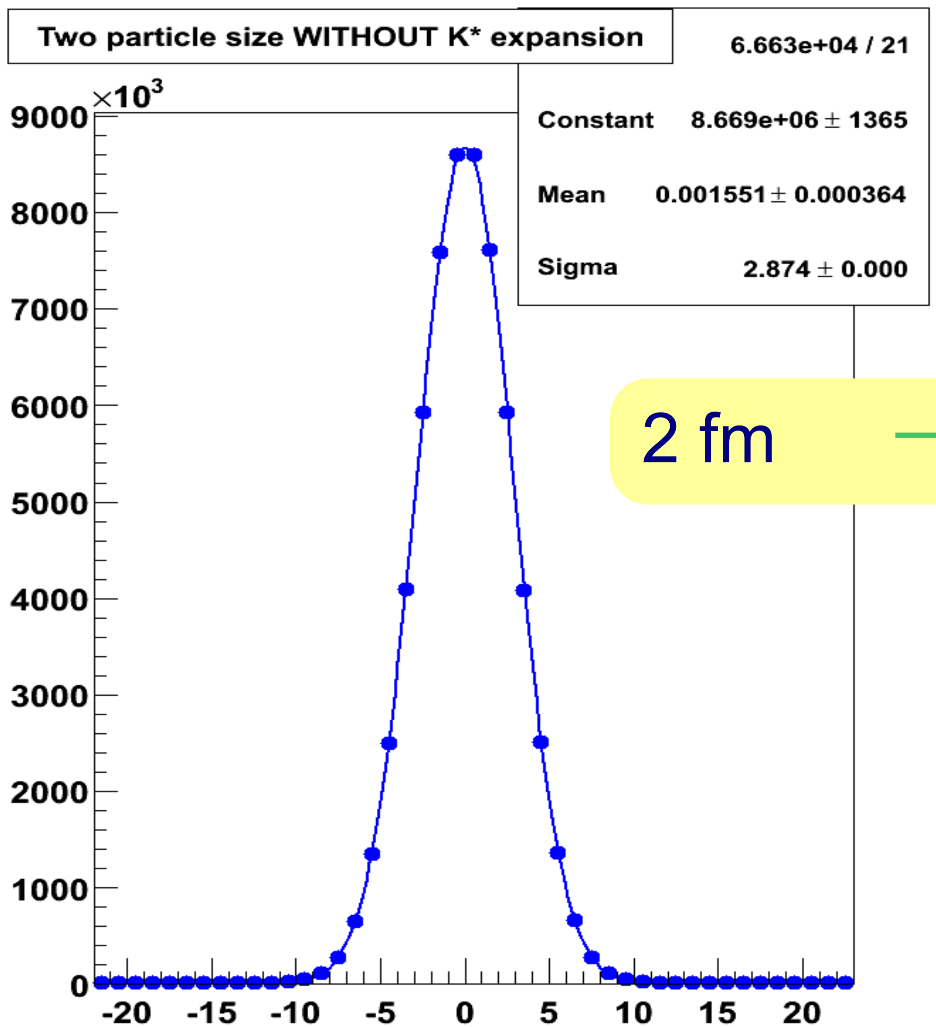
3. Both K^+ from K^*

   $r_0=\mathrm{sqrt}(2^2 + 2.6^2 + 2.6^2) = 4.2$ fm

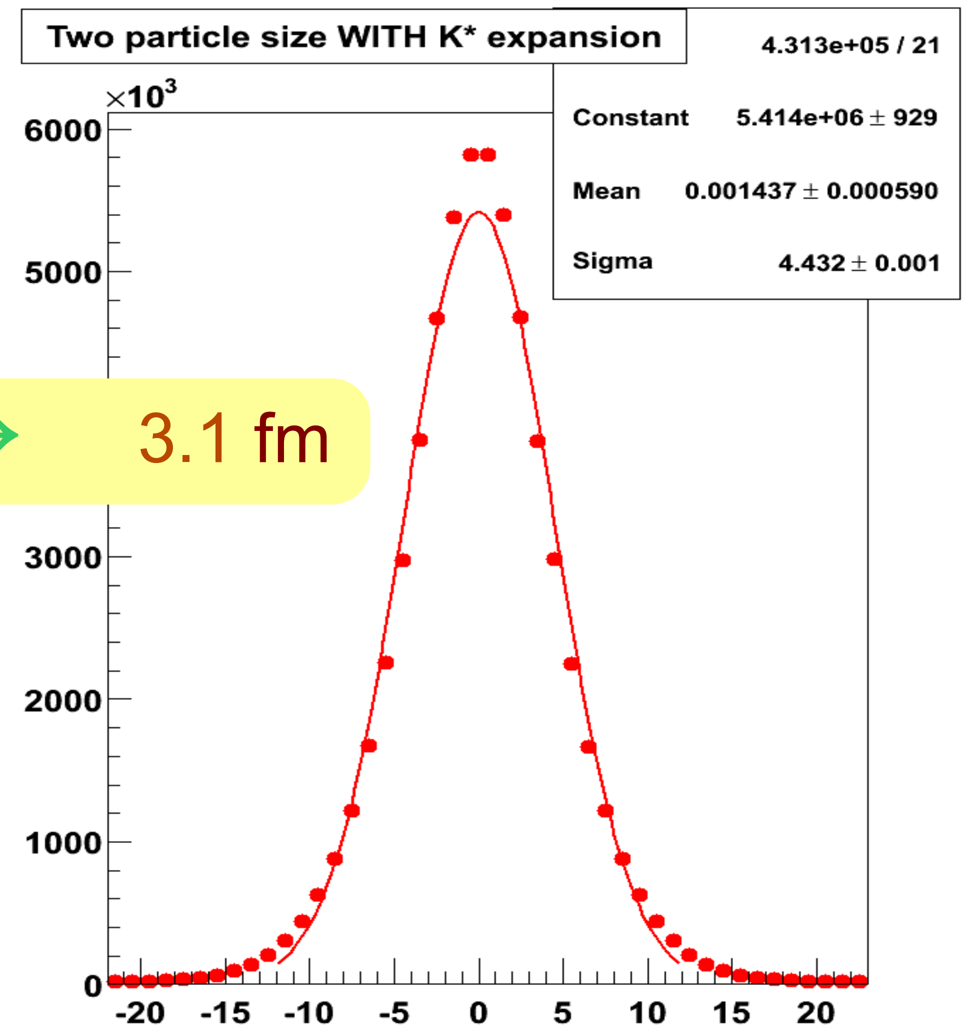
4. Also some small amount of K^+ came from Φ meson, but it is small effect

Space distribution (r_0=2 fm)

Source "expansion" due to K* decay (r_0=2fm, K* vτ~2.6fm)



2 fm → 3.1 fm



Conclusion and plans

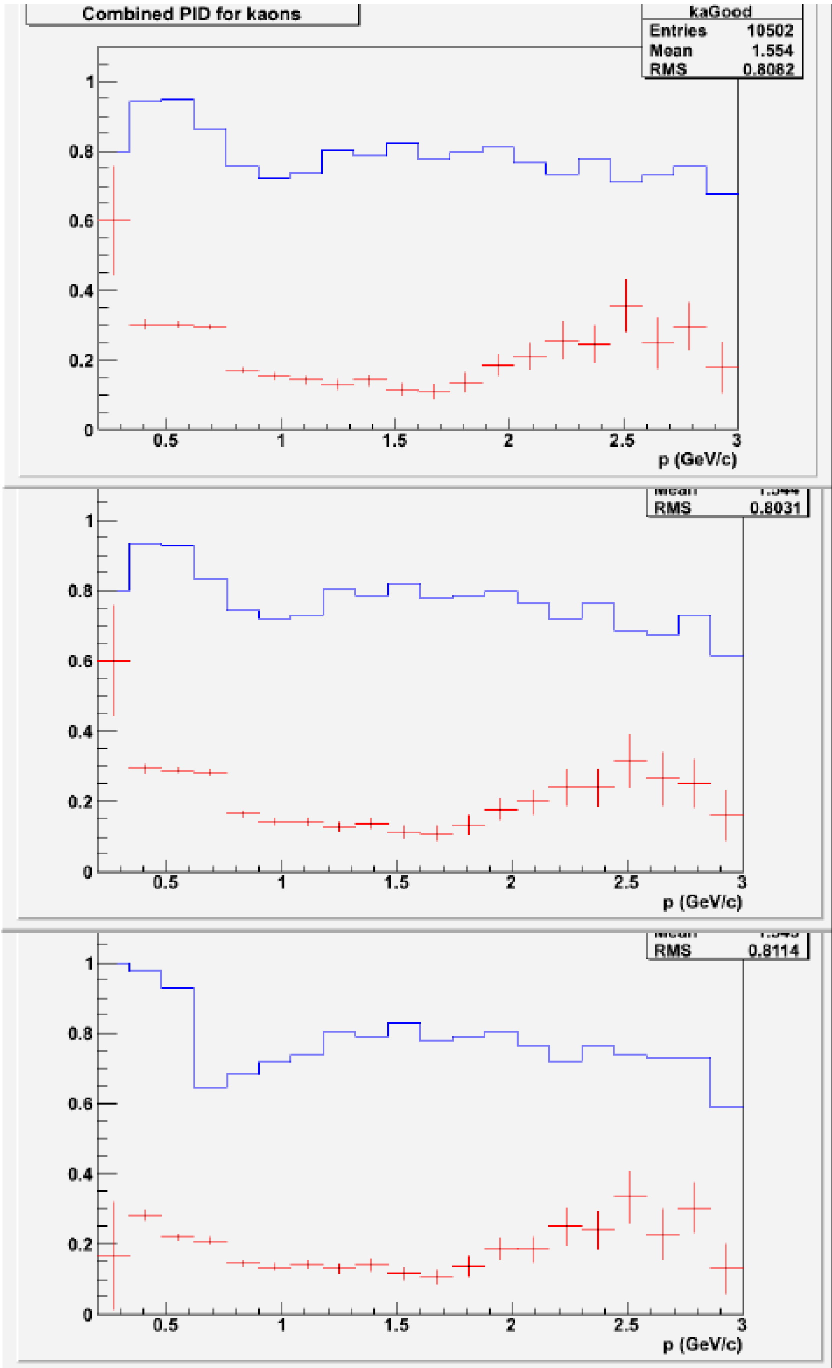
1. First step to ΦΦ femtoscopy is KK femtoscopy
2. There are several sources of the KK correlation function “distortion”:
   Single Kaon purity, Pair purity, Splitting-merging, Resonances

3. $K^0_S K^{+(-)}$ is for ΦΦ residual correlations
4. Test resonances in other freeze out generator (UHKM, Terminator)

Thank you for your attention!

Extra slides

PID-study



ALIROOT-PID's K (a priori)

// e, μ, π, K, p
Double_t c[5]={0.01, 0.01, 0.85, 0.10, 0.05};

PID's K (tuned up)

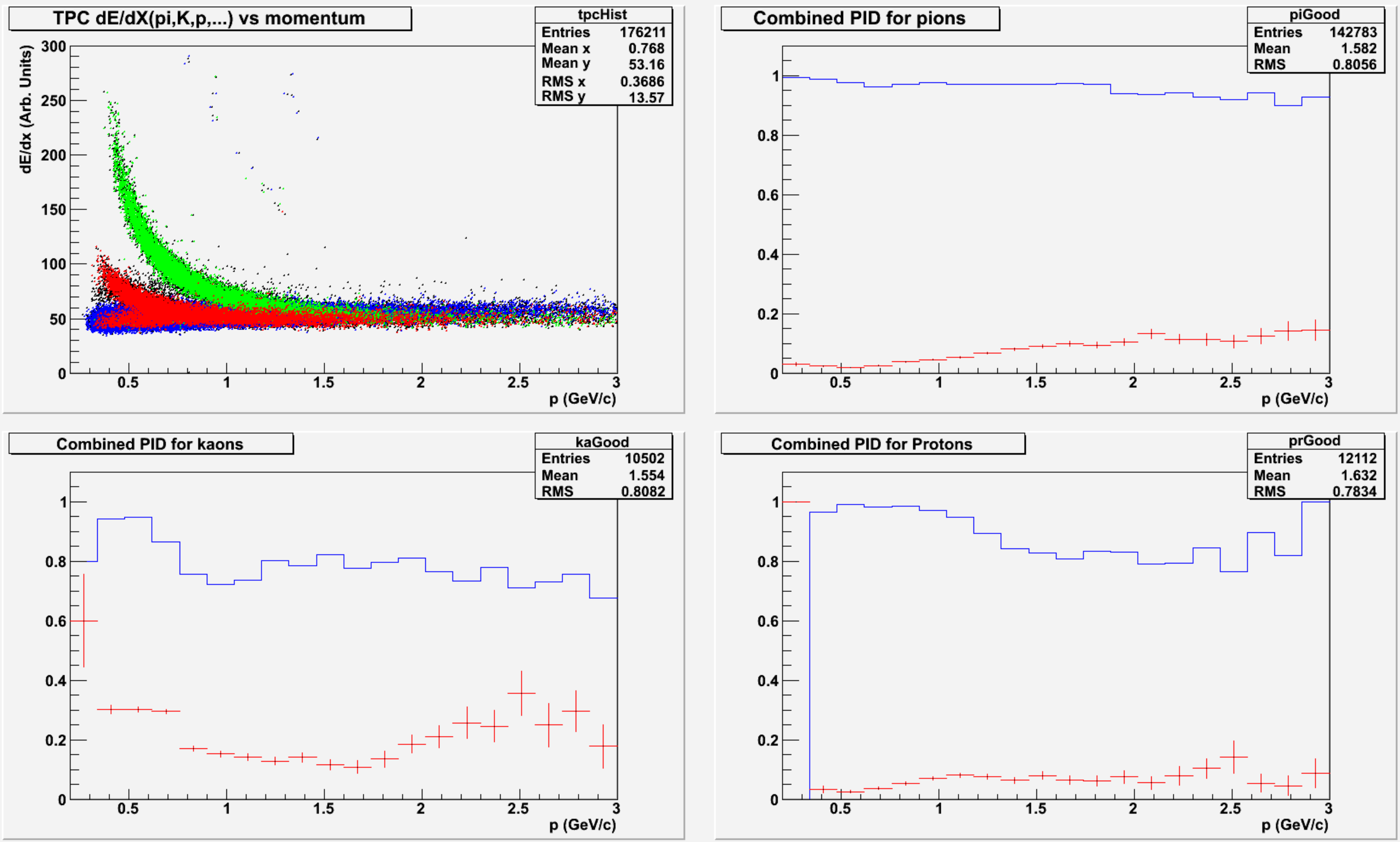
// e, mu, pi, K, p
Double_t c[5]={0.064,0.089,0.82,0.075,0.086};

PID's K (a priori & ITS is OFF)

// e, mu, pi, K, p
Double_t c[5]={0.01, 0.01, 0.85, 0.10, 0.05};

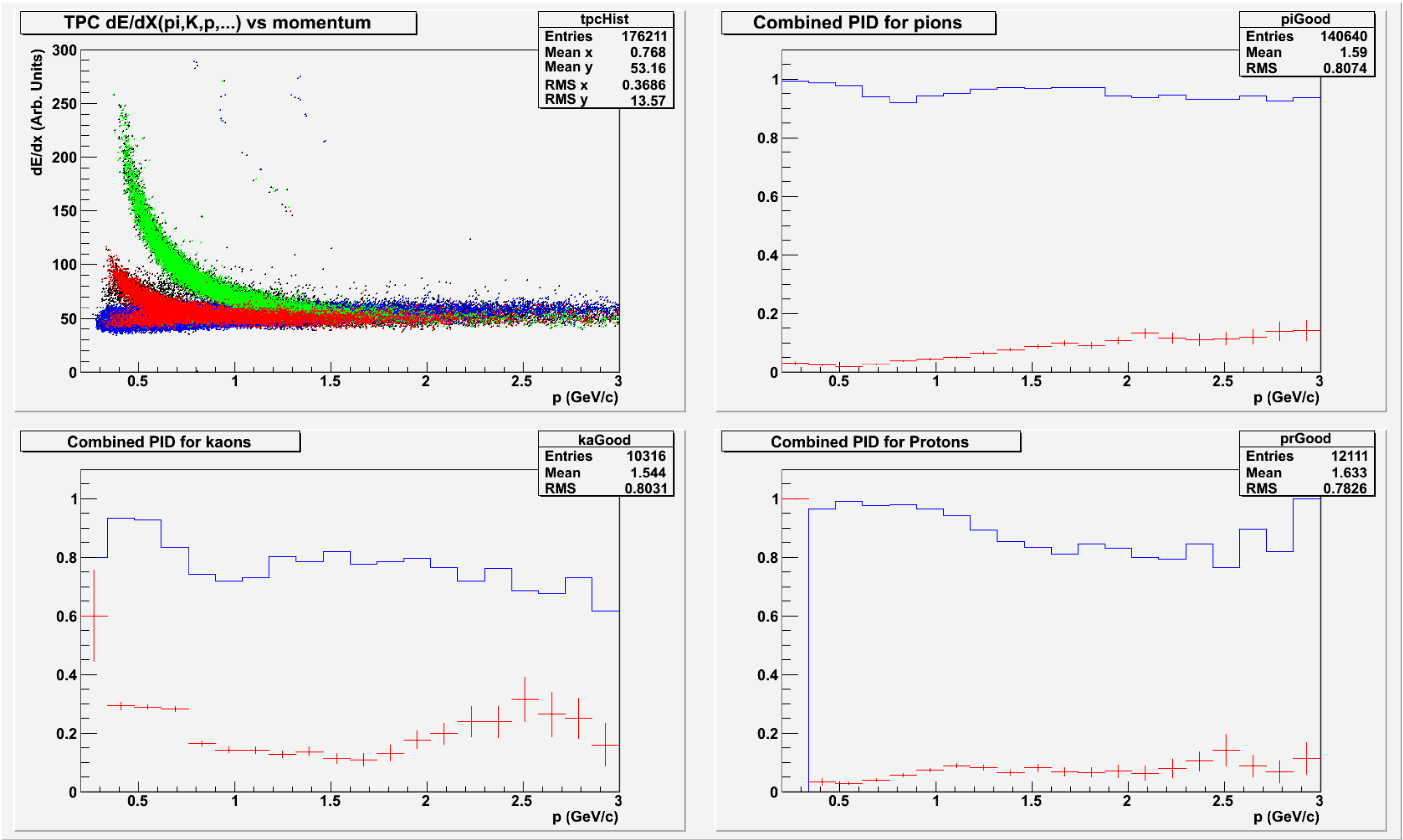
PID's pi,K,p (a priori)

```
//              e,   mu,   pi,    K,    p
Double_t c[5]={0.01, 0.01, 0.85, 0.10, 0.05};
```



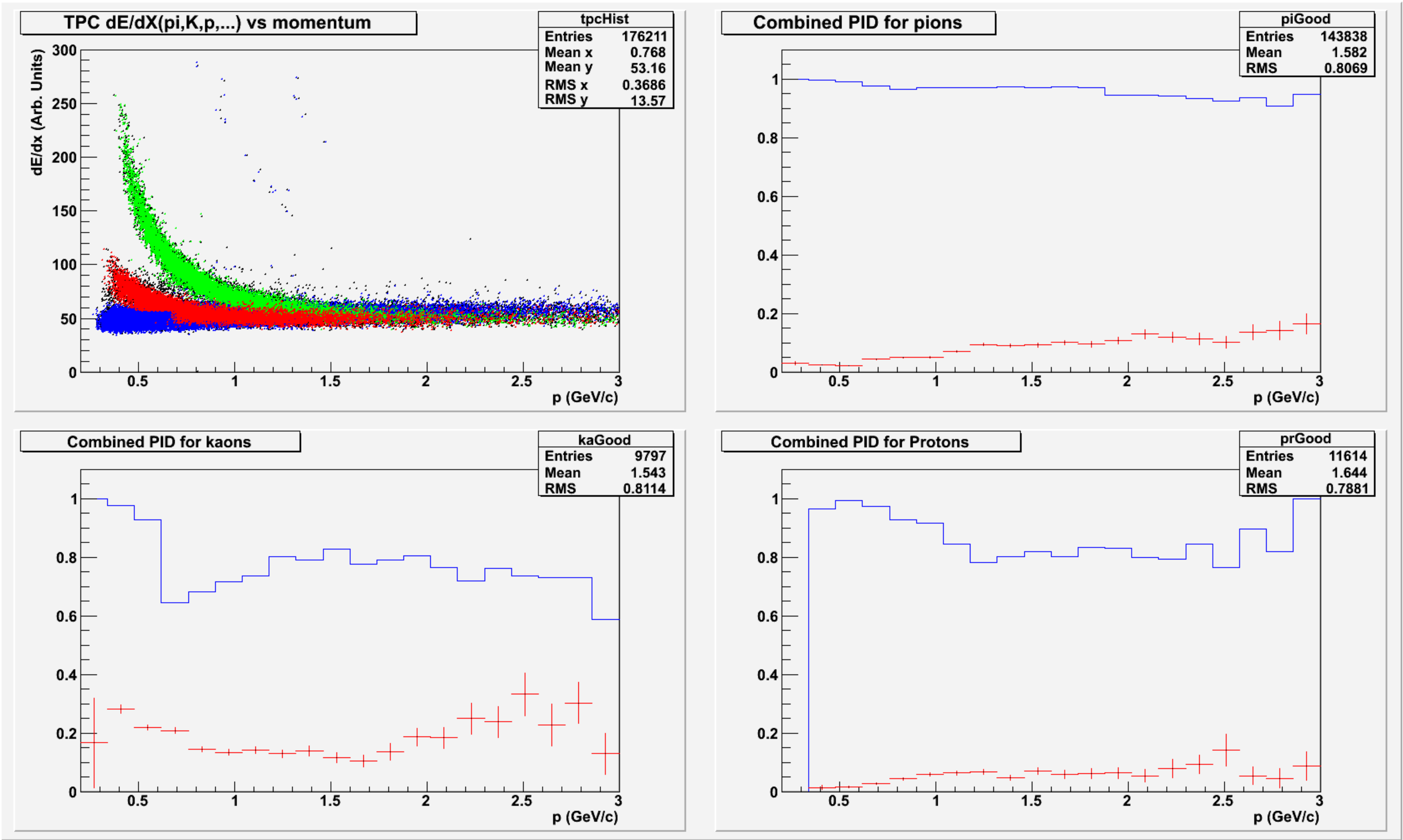
PID's pi,K,p (tuned up)

```
//                e,   mu,    pi,       K,    p
Double_t c[5]={0.064,0.089,0.82,0.075,0.086};
```



PID's pi,K,p (a priori & ITS is OFF)

// e, mu, pi, K, p
Double_t c[5]={0.01, 0.01, 0.85, 0.10, 0.05};

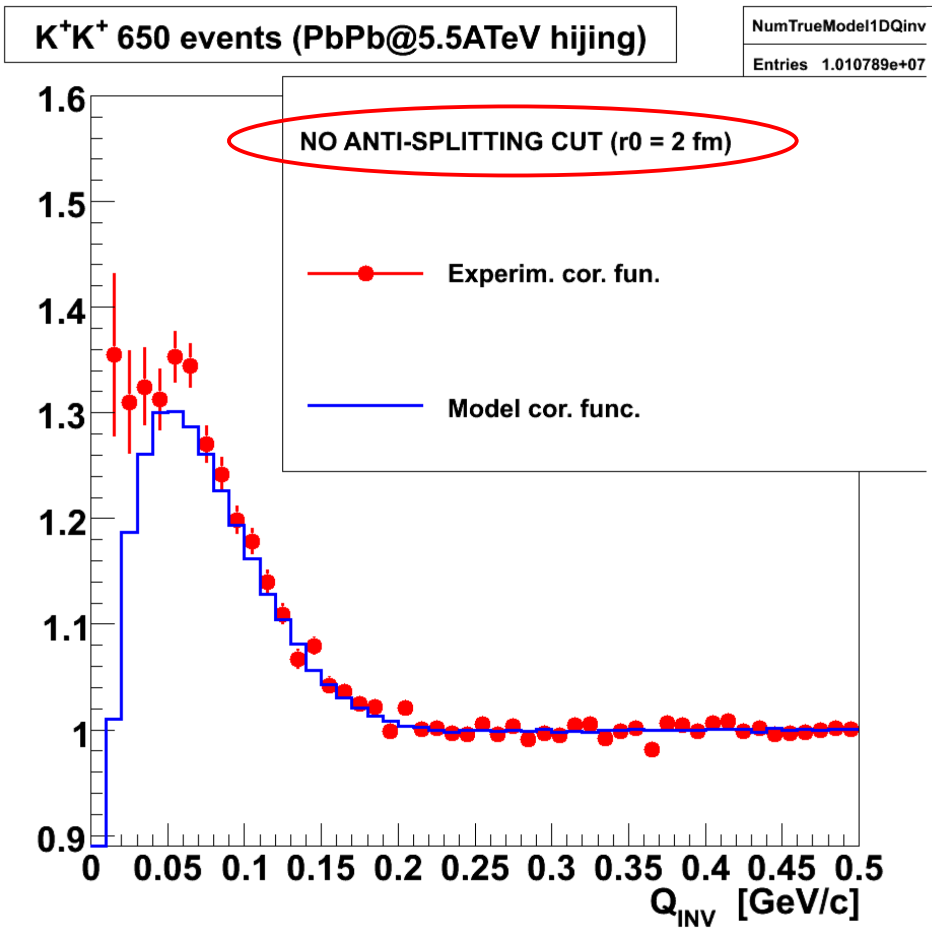


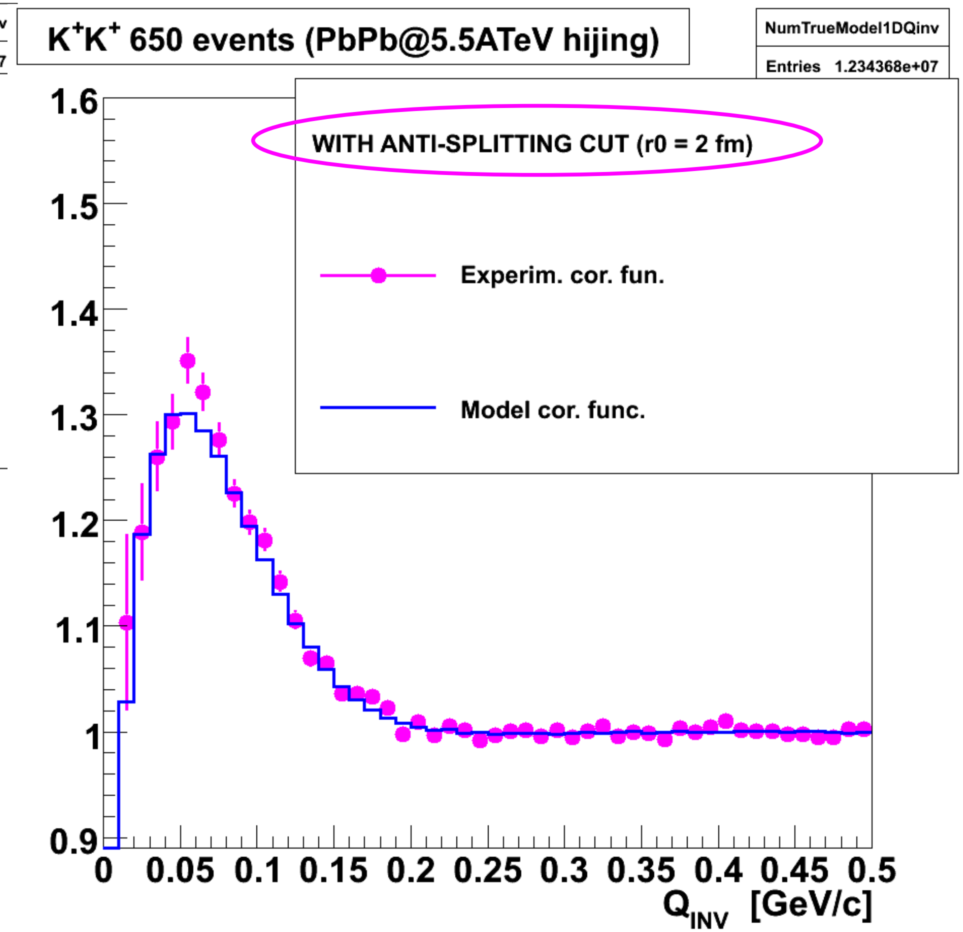
Remove splitting -User Macro

```
// Splitting(merging) of tracks can change the experimental correlation function
//            at low Q_inv

// Adam's procedure removes this effect
// Pair cut designed to remove split and shared tracks

AliFemtoShareQualityTPCEntranceSepPairCut *sqpc =
                                      new AliFemtoShareQualityTPCEntranceSepPairCut();

// Set maximim allowed "quality" for the pair
//  1.0 - accept all pairs
// -0.5 - reject all pairs
// a reasonable value should lie between 0.0 and 0.5

sqpc->SetShareQualityMax(0.3);

// Set maximum allowed shared hits fraction per pair
//  1.0 - accept all pairs
//  0.0 - reject all pairs
// a reasonable value is small but nno-zero (0.05)

sqpc->SetShareFractionMax(0.05);

// Set minimum allowed separation between nominal TPC entrance points
// of the two tracks in the pair
// 0.0 - accept all pairs
// a reasonable value is 3.0 [cm]

sqpc->SetTPCEntranceSepMinimum(3.);
```

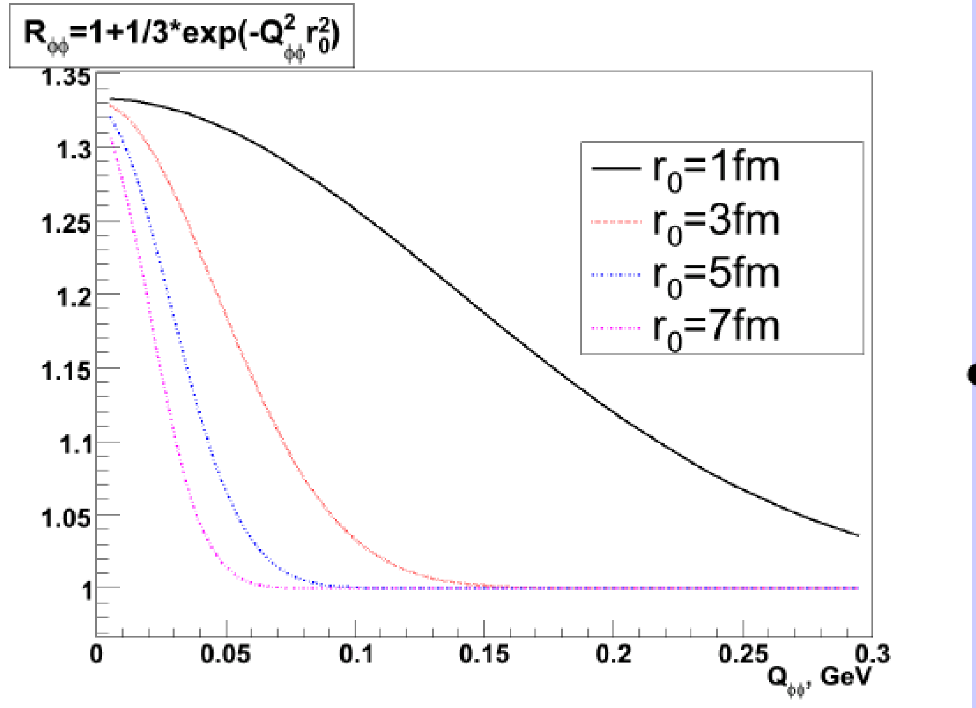
Remove splitting (r_0=2fm)

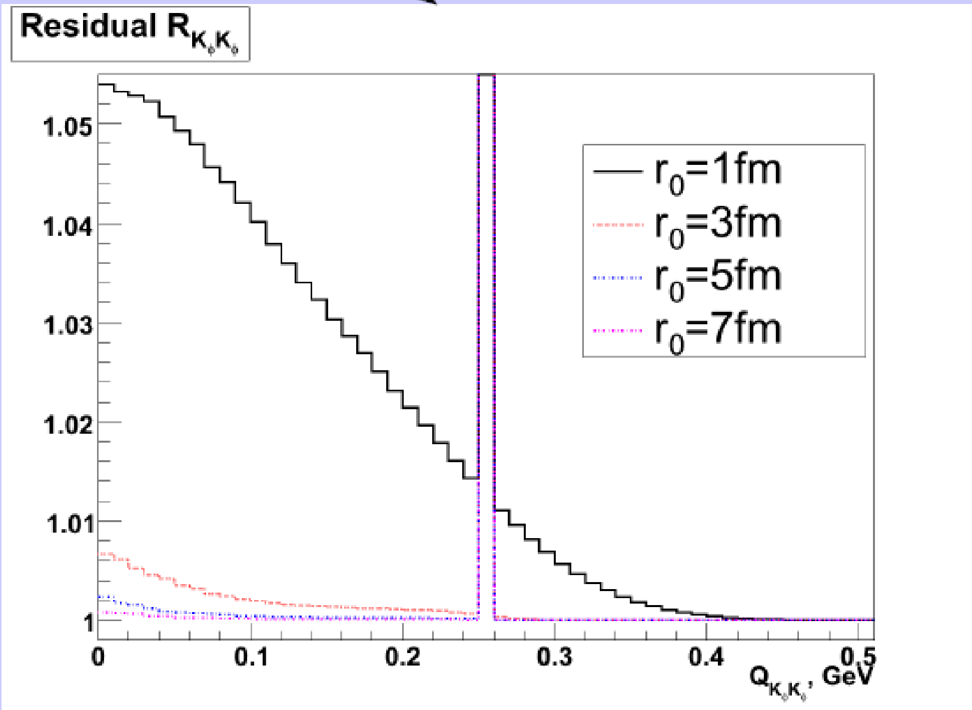
Splitting(merging) of tracks can change experimental CF at low Q_{INV}





Residual correlations for $\phi\phi$ correlations

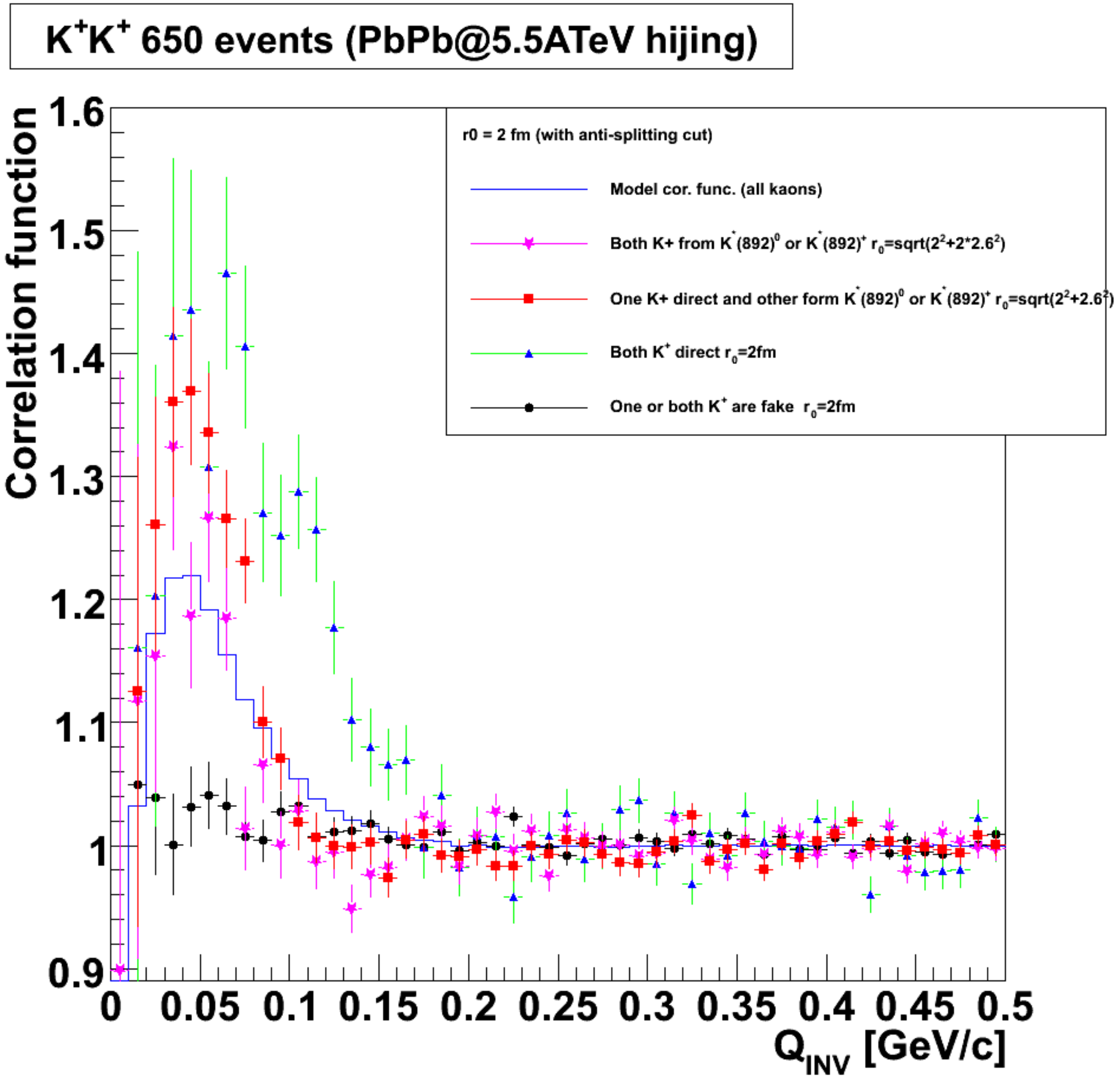




Residual correlations could be sensitive to small fraction of droplets.

Different contribution to KK cof.fun.

- Direct kaons source size r0=2fm
- Assume K* flying with c
- K+ and K+(from K*) source size $r0=\sqrt{2^2 + 2.6^2}$
- Both K+ from K* source size $r0=\sqrt{2^2 + 2*2.6^2}$
- Experimentally, we are measuring bigger size!!!



Title