STATUS REPORT

on

Rapidity and transverse momentum dependence of ππ Bose-Einstein correlations measured at 20,30,40,80 and 158 AGeV beam energy

Stefan Kniege
Institut für Kernphysik
Frankfurt

NA49 Collaboration Meeting
Geneva, 05.10.2003

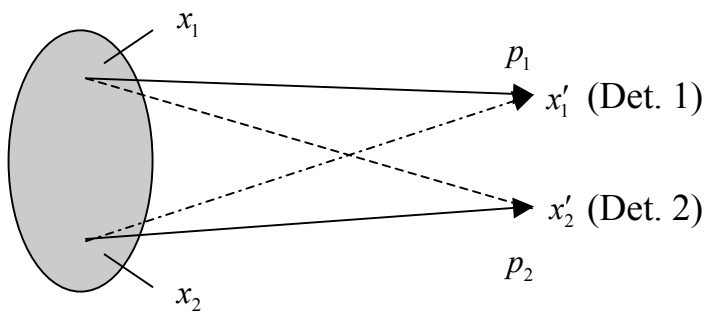
Outline

- Introduction
- Problems
- Preliminary results
- Comparison to earlier measurements and other experiments
- To do´s

Introduction

Objective:

Determine spacial and temporal quantities of the source by means of Bose- Einstein- correlations



$$Two-Particle-Corr. \Leftrightarrow P(p_1)\cdot P(p_2) \neq P(p_1,p_2)$$

Single-particle-distribution

Probabilty-amplitude for the detection of a particle with momentum p emitted at a given source point x (wave function approach)

$$\Psi(p: x \rightarrow x') = \underbrace{A(p,x)\cdot e^{i\phi(x)}}_{\text{emission term}} \underbrace{\cdot e^{ip\Box(x-x')}}_{\text{propagation term}}$$

p : 4-momentum x : space-time point

Introduction

probability distribution:

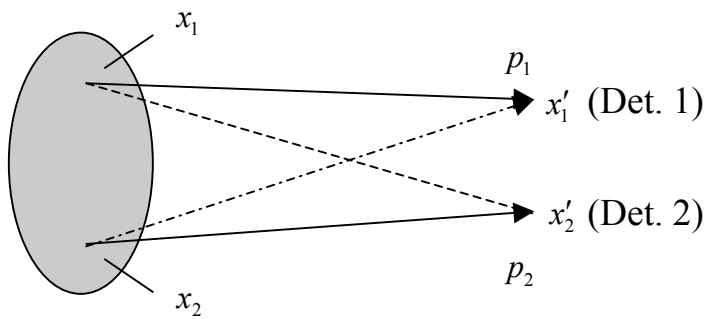
(chaotic source)

$$P(p) = |\sum_x A(p,x)\cdot e^{i\phi(x)}\cdot e^{ip\cdot(x-x')}|^2 = \sum_x A^2(p,x)$$

$$P(p) = \int dx\,\rho(x)A^2(p,x)$$

Two- particle-distribution

- **simultaneuos detection of two particles of momenta p1 and p2 (two possible ways)**
- **symmetrisation of the probabiltiy amplitude required by Bose-Einstein statistics**



probability amplitude:

$$\Psi(p_1p_2 : x_1x_2 \to x_1'x_2') = \frac{1}{\sqrt{2}}\Big\{A(p_1,x_1)e^{i\phi(x_1)}e^{ip_i\cdot(x_1-x_1')}\cdot A(p_2,x_2)e^{i\phi(x_2)}e^{ip_2\cdot(x_2-x_2')}$$
$$+\underbrace{A(p_2,x_1)e^{i\phi(x_1)}e^{ip_i\cdot(x_1-x_2')}}_{(p_2,x_1\to x_2')}\cdot\underbrace{A(p_1,x_2)e^{i\phi(x_2)}e^{ip_2\cdot(x_2-x_1')}}_{(p_2,x_2\to x_1')}\Big\}$$

Introduction

probability distribution (chaotic source)

$$P(p_1,p_2) = P(p_1)P(p_2)\left(1+\left|\int dx e^{i(p_1-p_2)\cdot x}\rho_{eff}(x;p_1,p_2)\right|^2\right)$$

Correlation function

effective density $\rho_{eff}(x,p_1,p_2) = \dfrac{\rho(x)A(p_1,x)A(p_2,x)}{\sqrt{P(p_1)P(p_2)}}$

$$C_2(q,p_1,p_2) = \frac{P(p_1,p_2)}{P(p_1)P(p_2)} = 1+\left|\rho_{eff}(x;p_1,p_2)\right|^2$$

momentum space $C_2(q) \xrightarrow{FT} \rho(x)$ position space

Mass- shell- condition $E^2 = m^2 + \vec{p}^2$

Only 3 indep. components in C_2 $\xrightarrow{model}$ **space-time depencence of ρ**

Introduction

Measurement:

$$C_2(q,p_1,p_2)=\frac{P(p_1,p_2)}{P(p_1)P(p_2)}=N\cdot\frac{S(q,p_1,p_2)}{B(q,p_1,p_2)}\cdot C$$

S: tracks from the same event

B: tracks from the diffrent events

Fit to the measured C_2:

- **Gaussian parametrisation of the correlationfunction**
- **Bertsch-Pratt-Parametrisation:** q_{out} : , q_{side} : , q_{long} : $(p_{z1}-p_{z2})$ — **Kt : ½(p_{t1}+p_{t2})**

$$C_2(q,p_1,p_2)_{BP}=1+\lambda\cdot\exp(-q_s^2\cdot R_s^2-q_o^2\cdot R_o^2-q_l^2\cdot R_l^2-2\cdot q_o q_l\cdot R_{ol}^2)$$

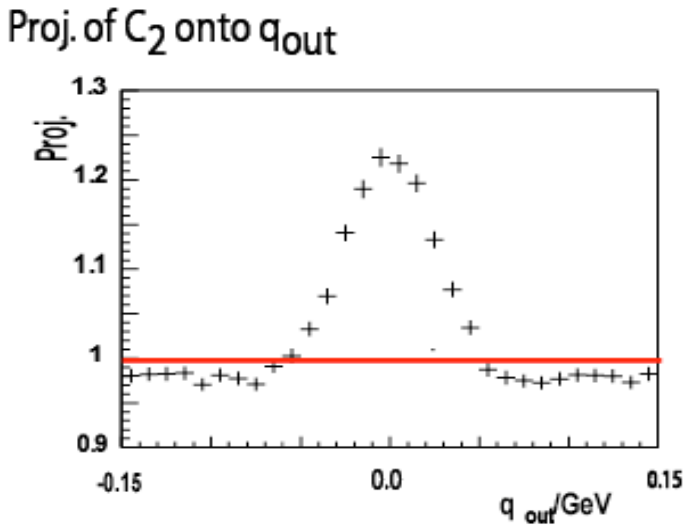
- **Extraction of source parameters by fitting $C_2(q,k)_{BP}$ to the data.**
- **Model dependant interpretation.**

Problems

High Kt region at mid-rapidity:

(Kt: 0.3-0.5 ; Y: 2.9-3.4)

- **Undershoot of the baseline over a wide range in q_{out}**
  (first shown by Peter Seyboth at CM Nov. 2002)
- **„Holes“ in the 2-dim projection onto q_{long}-q_{out}**

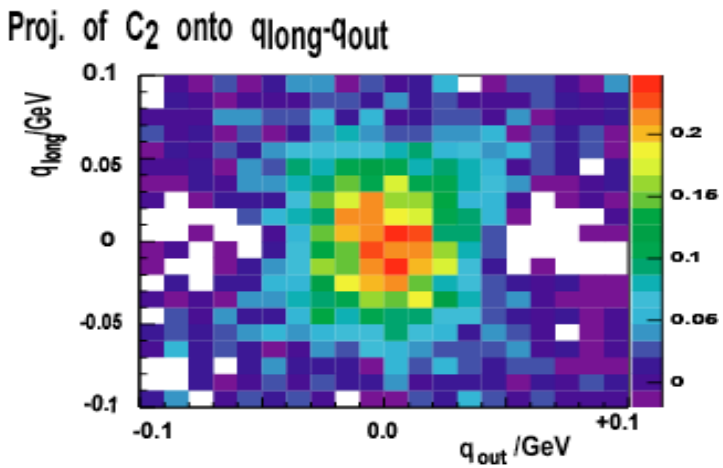


Possible explanation

Different Kt- and Qinv- dependence of the parameters

→ **different Coulomb- effect for the parameters.**

Coulomb-correction only depends on q_{inv}



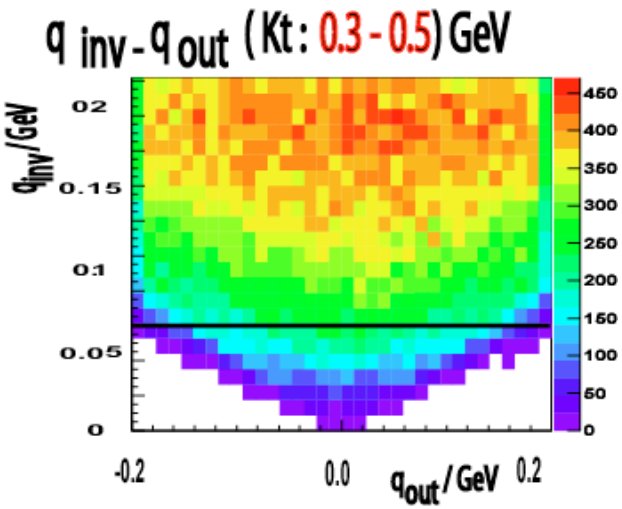
Problems

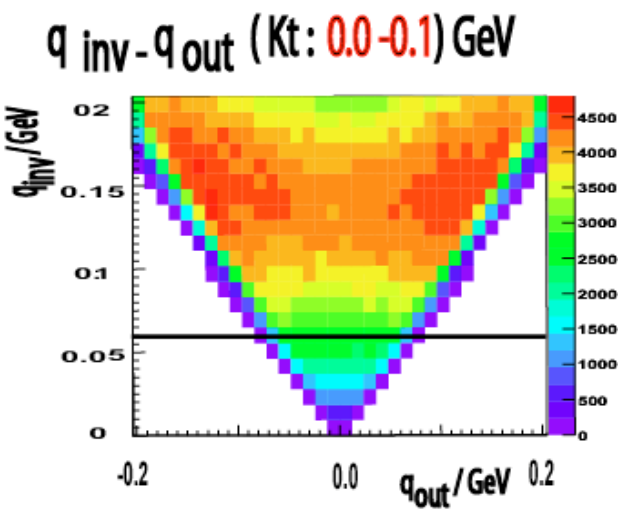
Q_{inv} vs. Q_{out}:

- Large fraction of pairs with large q_{out} but low q_{inv} at high Kt

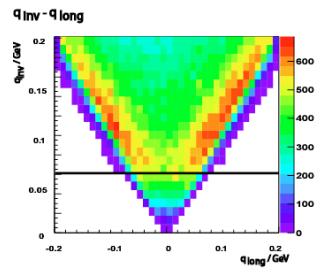
→ still Coulomb- effect at large qout

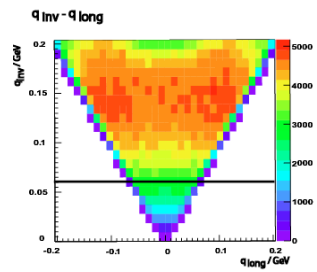
- different to low Kt





q_{long}



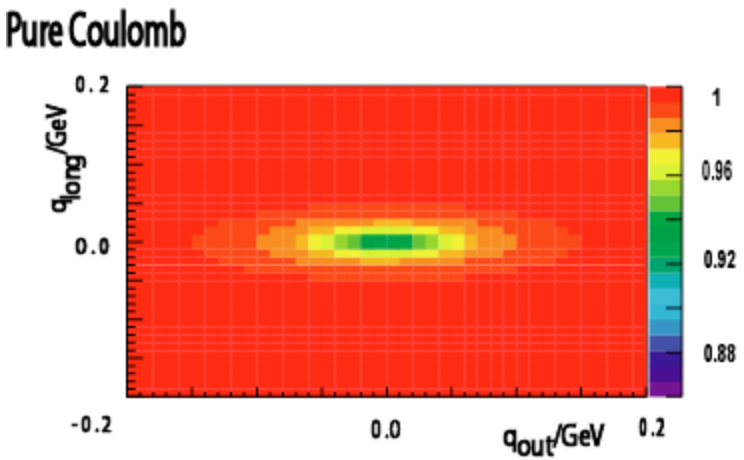


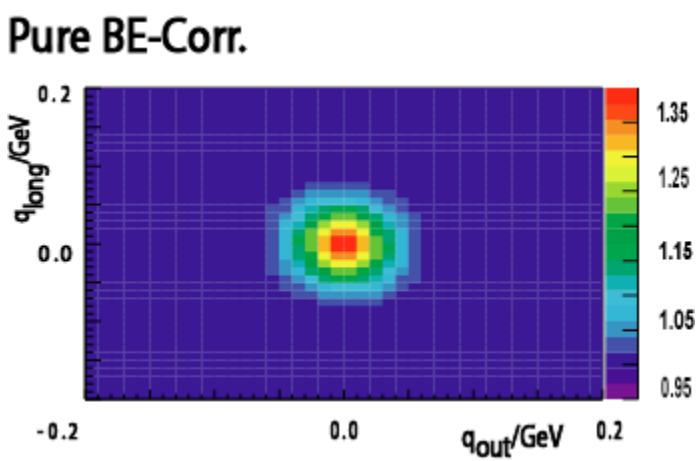
Kinematic effect:

qout: ∥ Kt

qlong / qside: ⊥ Kt

Test at high Kt: (0.3-0.5) GeV





Pure Coulomb:

calc. for each bin of the projection

(<r> = 25 fm Sinyukov)

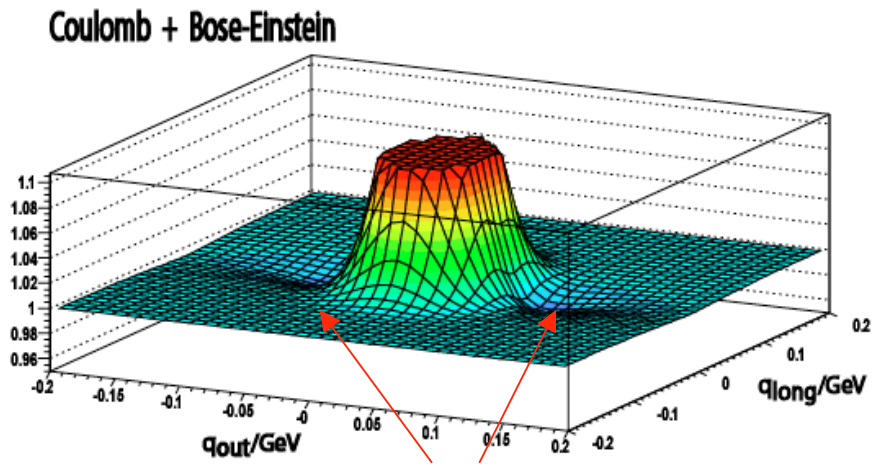
Pure BE-Corr:

construction of a theor. Correlation function

(Radii from data)

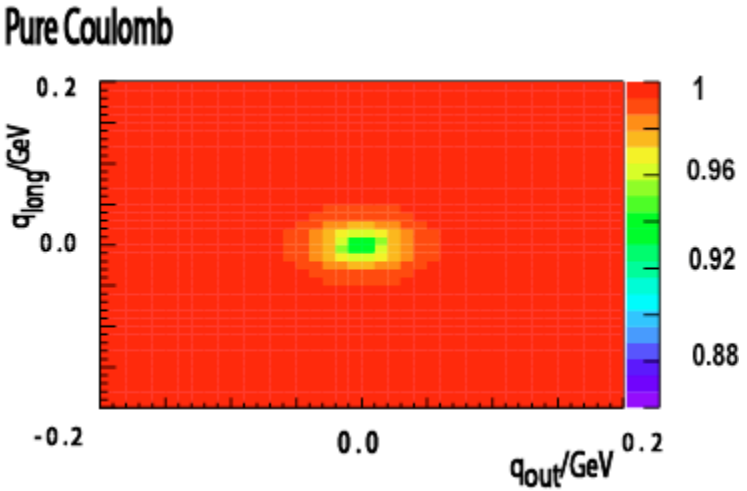
Coulomb + Bose-Einstein

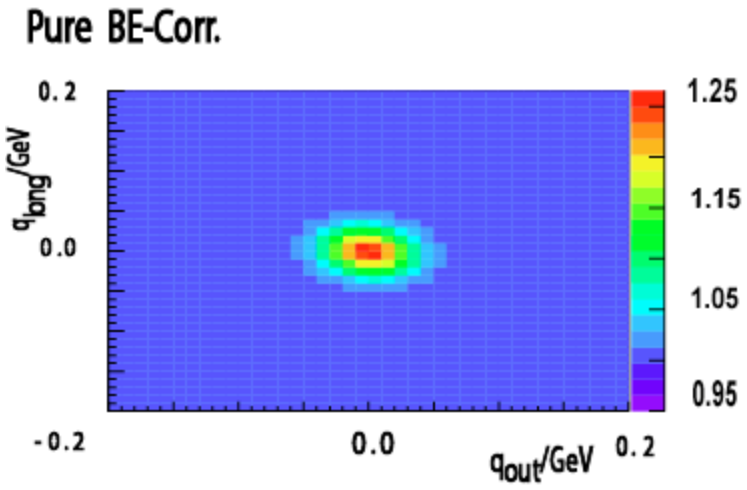
Multiplication of both plots →measured projection



„holes“

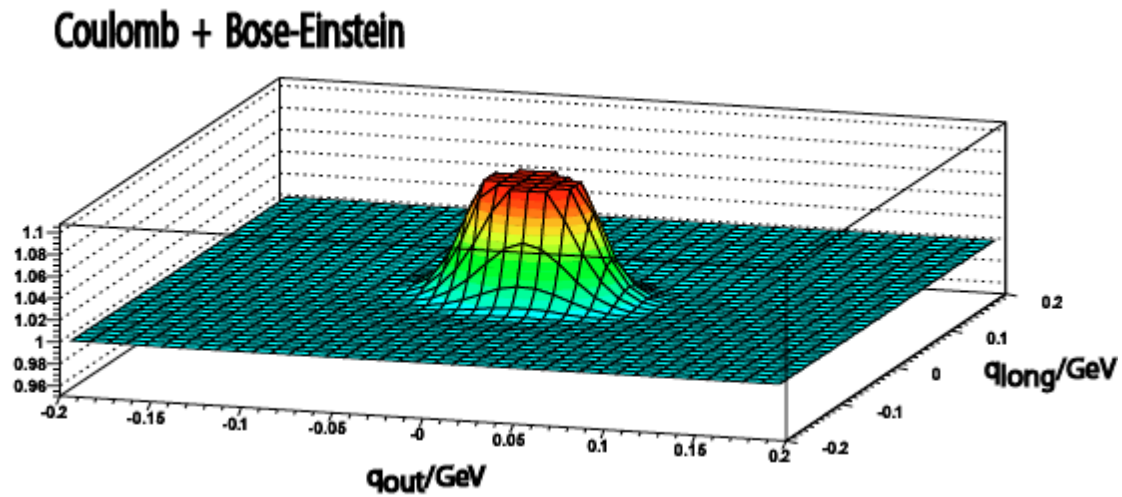
Test at low Kt : (0.0-0.1) GeV





Low Kt:

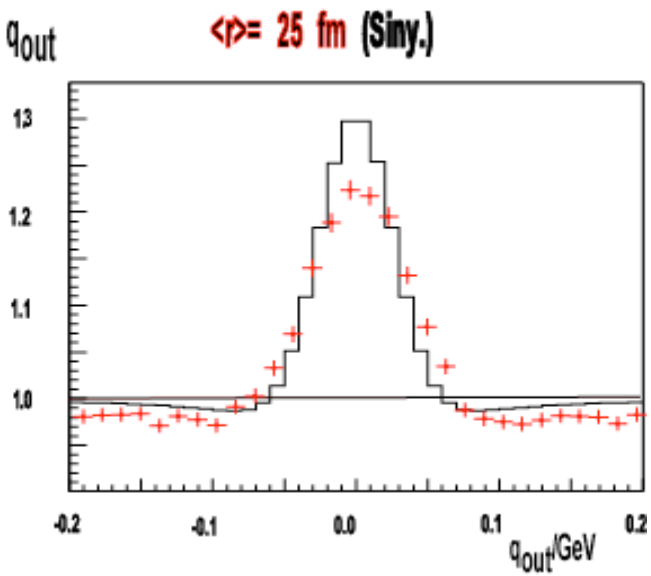
- **Radial symmetry of the coulomb- weights**
- **No „holes“ in the projection (no holes in the data)**

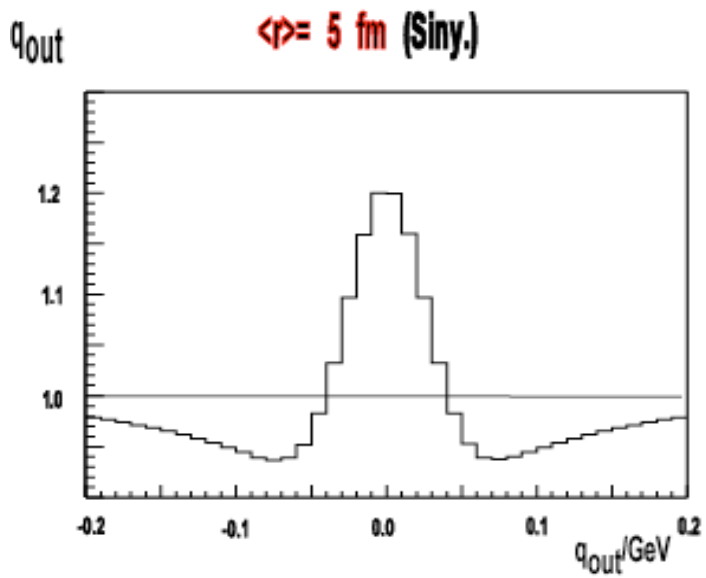


Conclusion

- The „holes“ could be explained in terms of Coulomb-interaction but
- The effect in q_{out} can not be explained quantitatively assuming <r> = 25 fm (Sinyukov).

Our measurements confirm the value 25 fm.





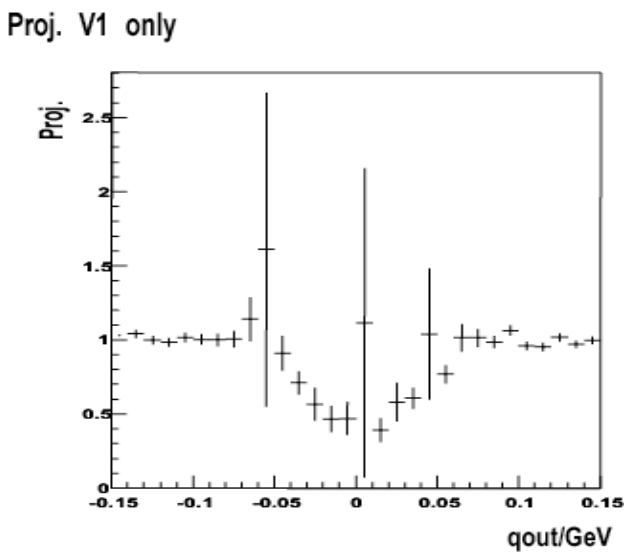
Open question

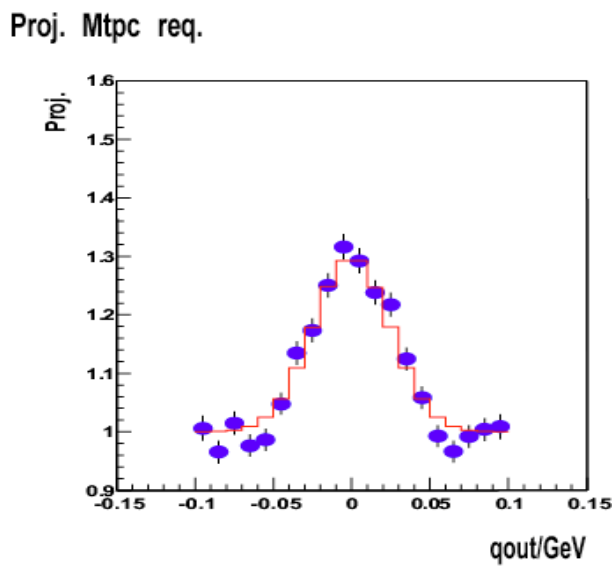
We have acceptance in VTPC1 and in the MTPC´s for the bin

Kt: (0.3-0.5)GeV , Y: (2.9-3.4) but

Completely different correlation for Vertex1 only and MTPC req pairs!

A new production with local momenta for Vertex1 could shed light on the problem





Preliminary results 20GeV

Event-Cuts:

VertexX: (-0.2 , 0.2) cm

VertexY: (-0.2 , 0.2) cm

VertexZ: (-581.35 , 580.8) cm

Track-Cuts:

bx: (-4.0 , 4,0) cm

by: (-2.0 , 2.0) cm

charge: -1

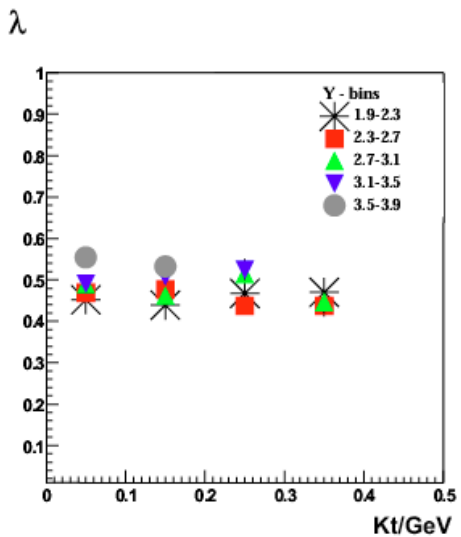
Npoints: 30 (global)

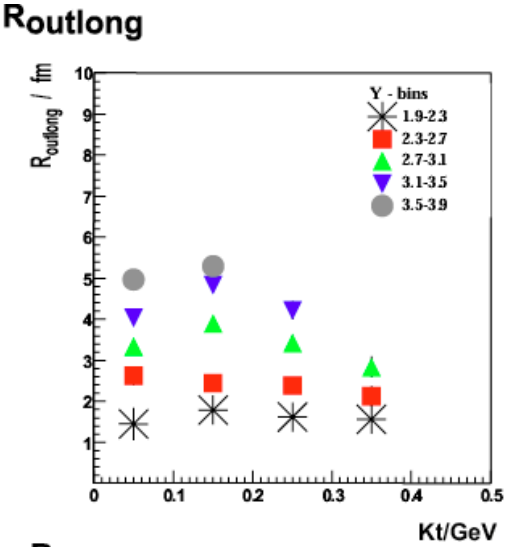
NpointsToNMaxPoints: 0.5 (global)

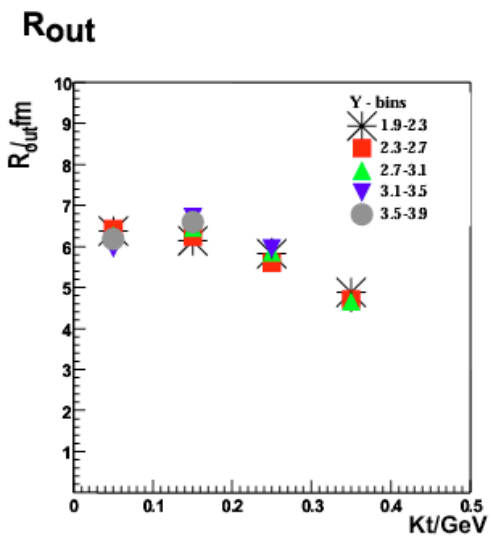
DedxSigma: (0.85 , 1.15)

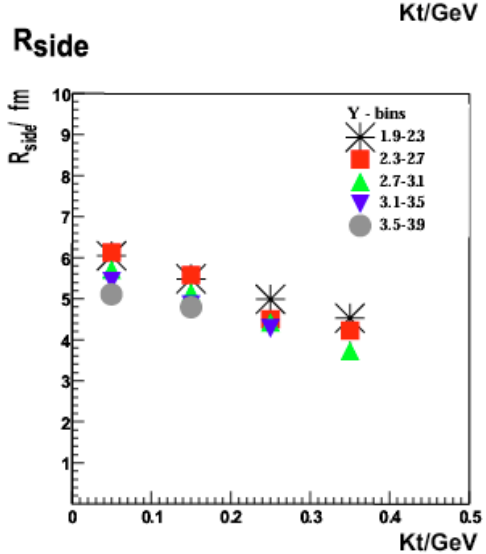
TwoTrackCuts:

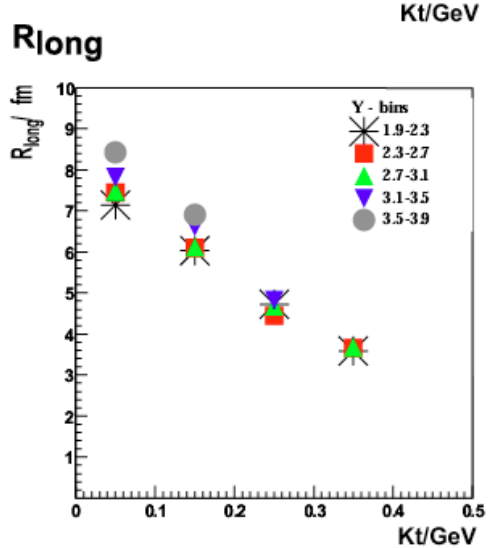
MinDist: 3.0 cm











Preliminary results 30GeV

Event-Cuts:

VertexX: (-0.18 , 0.23) cm

VertexY: (-0.18 , 0.25) cm

VertexZ: (-581.55 , 580.95) cm

Track-Cuts:

bx: (-5.0 , 5.0) cm

by: (-5.0 , 5.0) cm

charge: -1

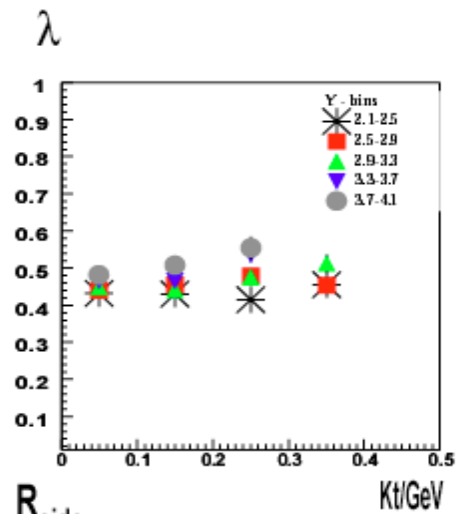
Npoints: 30 (global)

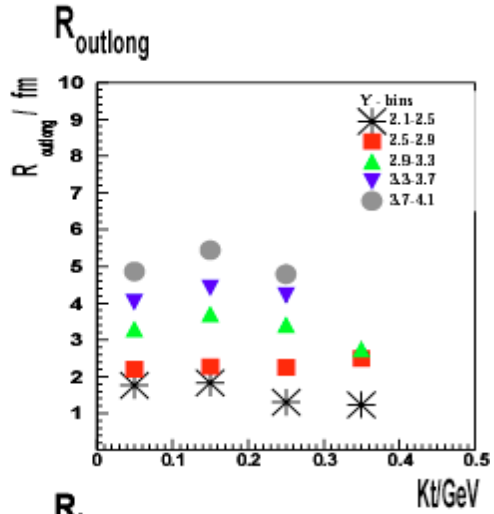
NpointsToNMaxPoints: 0.5 (global)

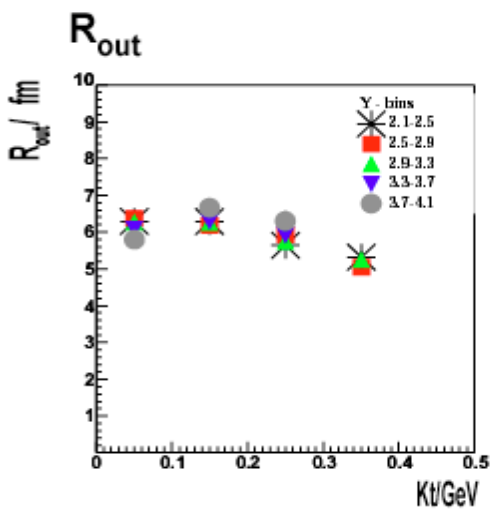
DedxSigma: (0.85 , 1.15)

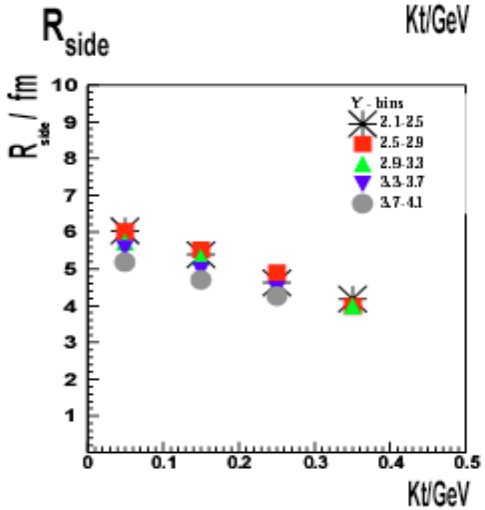
TwoTrackCuts:

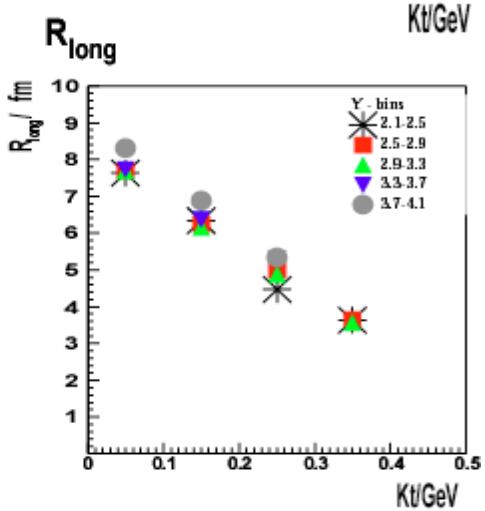
MinDist: 3.0 cm











Preliminary results 40GeV

Event-Cuts:

VertexX: (-0.15 , 0.25) cm

VertexY: (-0.35 , 0.28) cm

VertexZ: (-581.3 , 580.75) cm

Track-Cuts:

bx: (-5.0 , 5.0) cm

by: (-5.0 , 5.0) cm

charge: -1

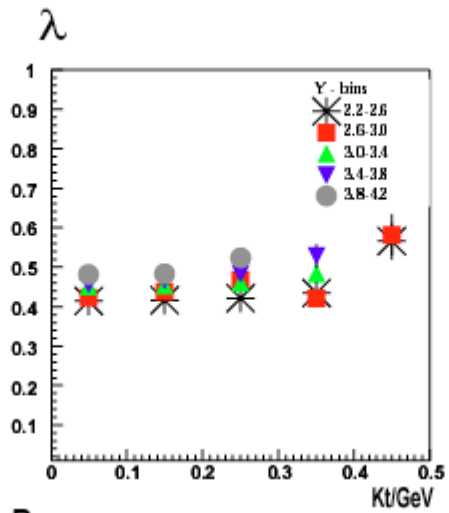
Npoints: 30 (global)

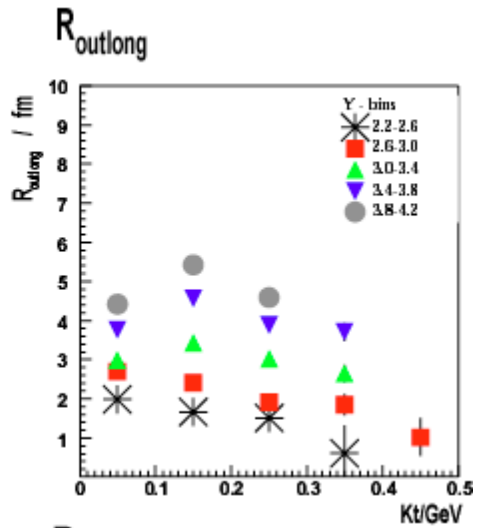
NpointsToNMaxPoints: 0.5 (global)

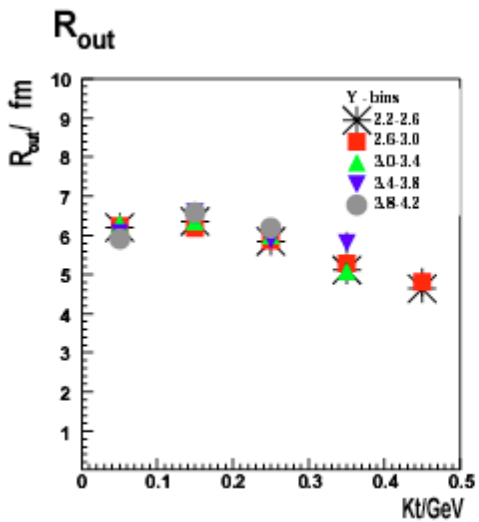
DedxSigma: (0.85 , 1.15)

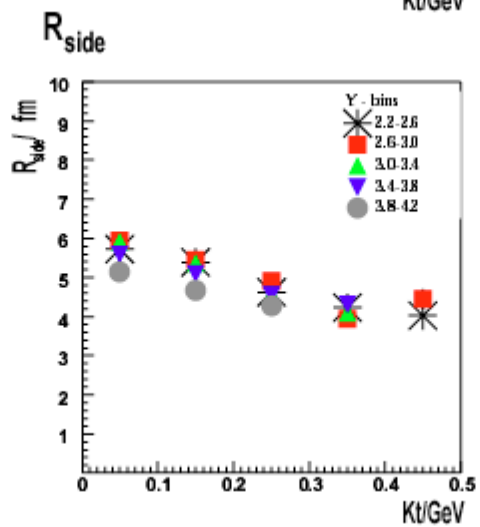
TwoTrackCuts:

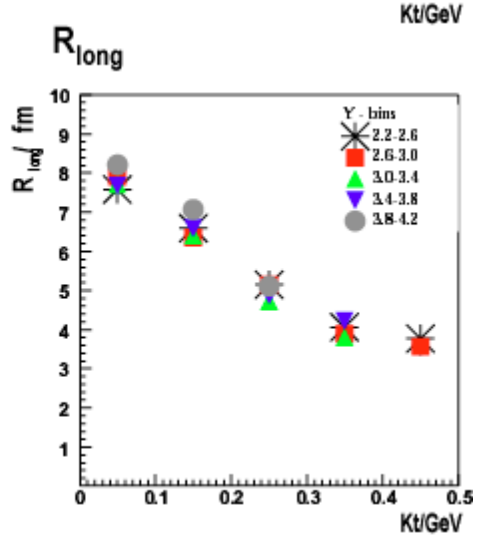
MinDist: 3.0 cm











Preliminary results 80GeV

Event-Cuts:

VertexX: (-0.25 , 0.42) cm

VertexY: (-0.18 , 0.1) cm

VertexZ: (-581.45 , 580.75) cm

Track-Cuts:

bx: (-7.0 , 7.0) cm

by: (-4.0 , 4.0) cm

charge: -1

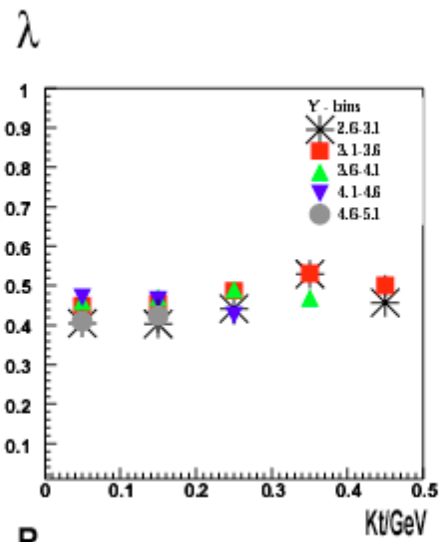
Npoints: 30 (global)

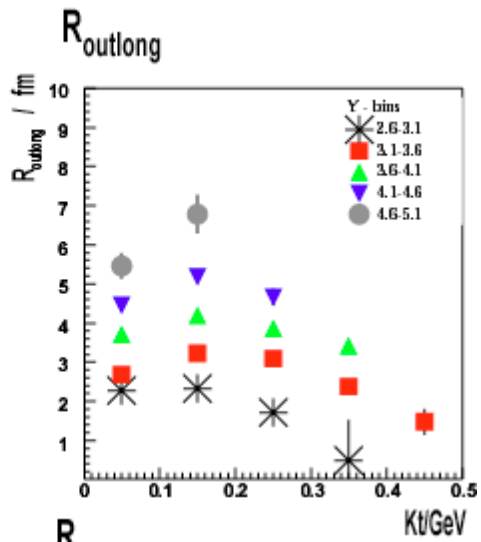
NpointsToNMaxPoints: 0.5 (global)

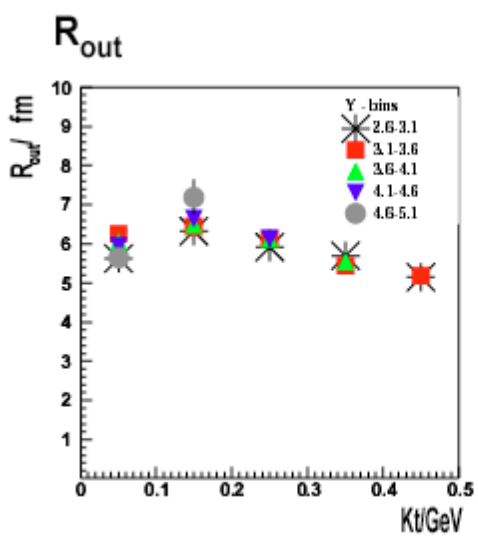
DedxSigma: (0.85 , 1.15)

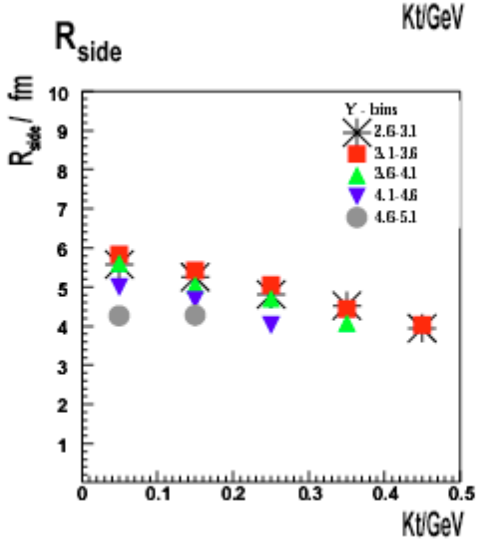
TwoTrackCuts:

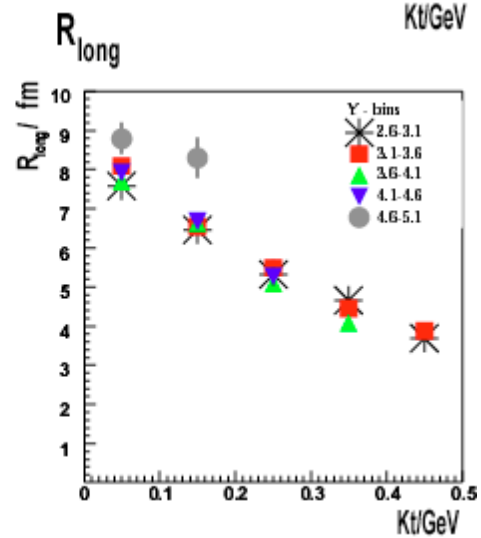
MinDist: 3.0 cm











Preliminary results 160GeV

Event-Cuts:

VertexX: (-0.15 , 0.1) cm

VertexY: (-0.1 , 0.1) cm

VertexZ: (-581,35 , 580.8) cm

Track-Cuts:

bx: (-5.0 , 5.0) cm

by: (-5.0 , 5.0) cm

charge: -1

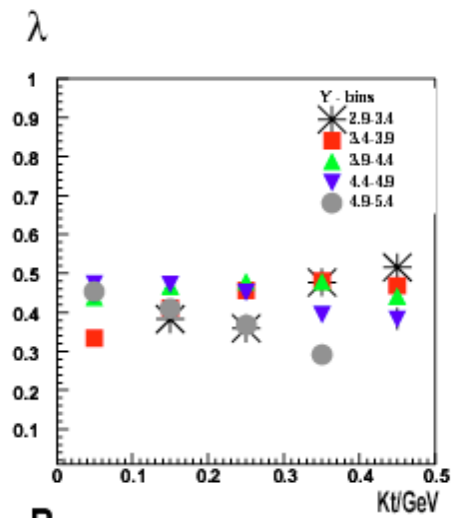
Npoints: 30 (global)

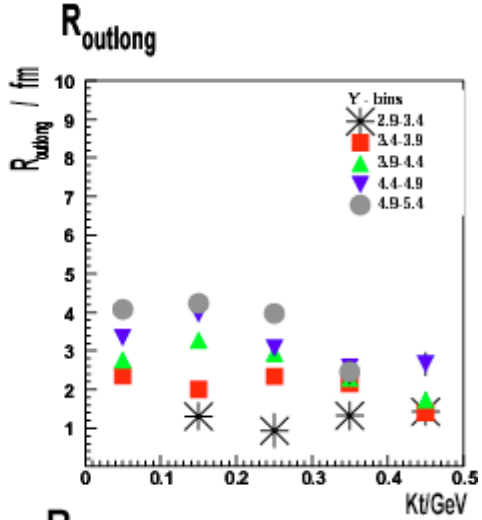
NpointsToNMaxPoints: 0.5 (global)

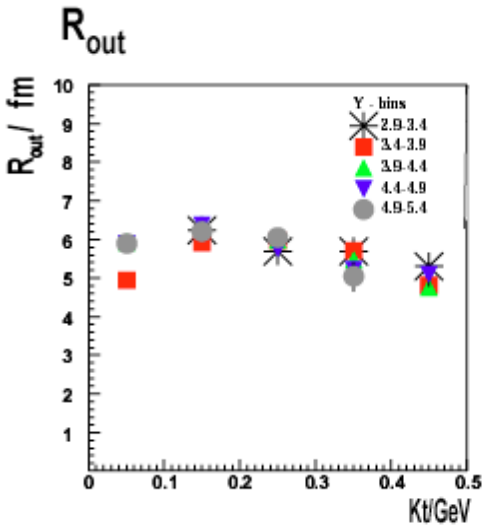
DedxSigma: (0.85 , 1.15)

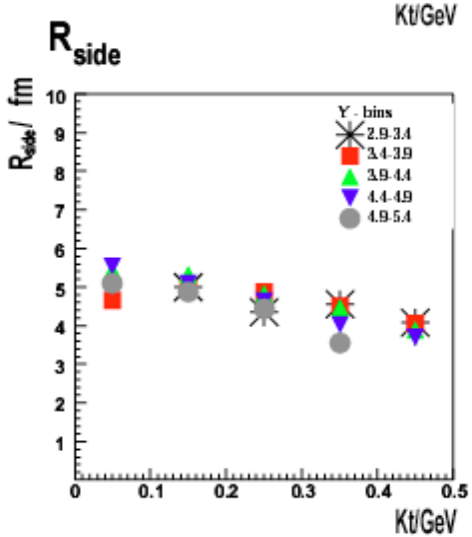
TwoTrackCuts:

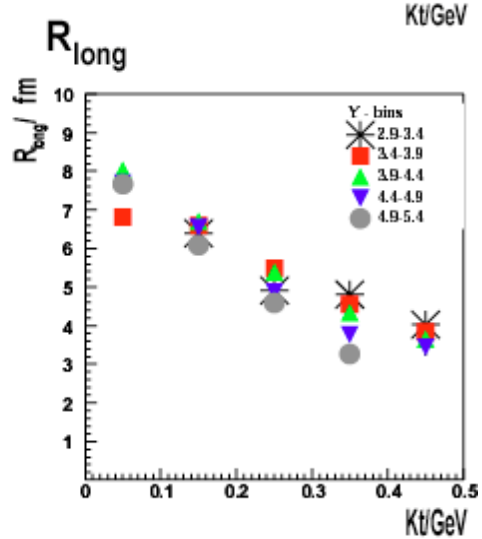
MinDist: 3.0 cm









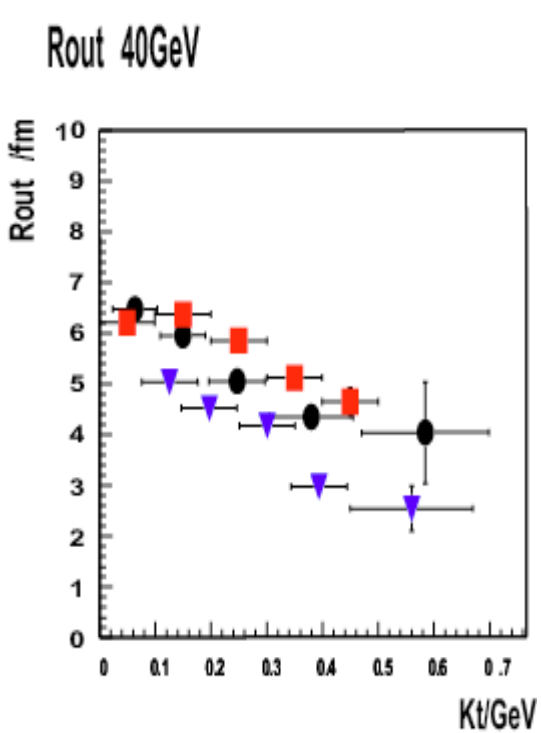


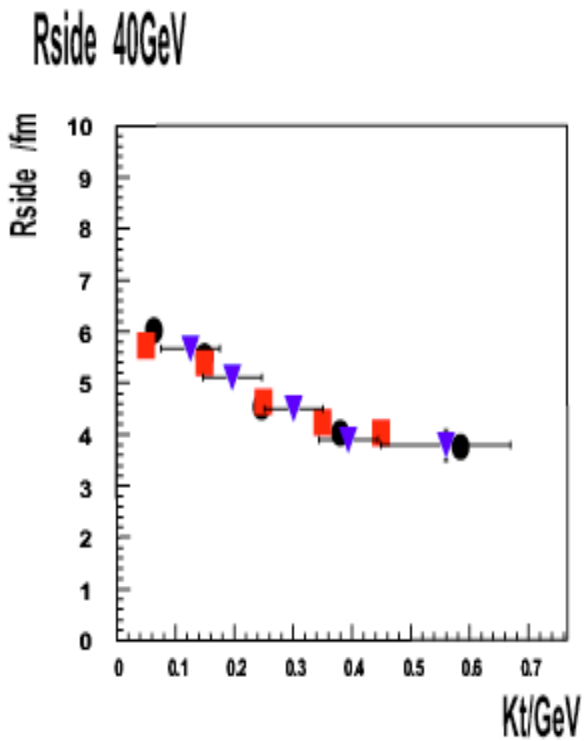
Comparison (40GeV)

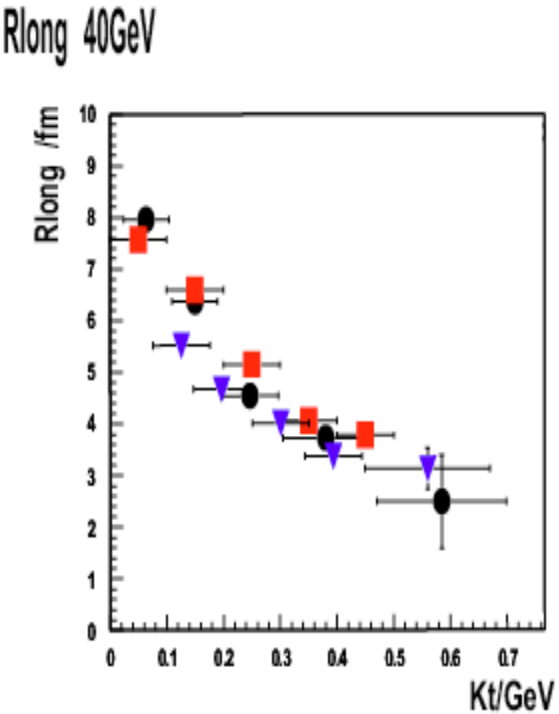
- QM 2002: Y(2.2-2.7)
- CERES : Y(2.0-2.5)
- New(prel.): Y(2.2-2.6)

Reasons for differences :

- coulomb-correction (Sinyukov,Braun-Munziger)
- lambda parameter







Comparison (40GeV)

λ–parameter:

Measured value determined by:

- „Purity“ „p“ of the source (pairs of not identical particles)
- Chaoticity of the source

New data:

$$C_2(q,k)_{BP} = 1 + \lambda(k) \cdot \exp(-q_s^2 \cdot R_s^2 - .....)$$

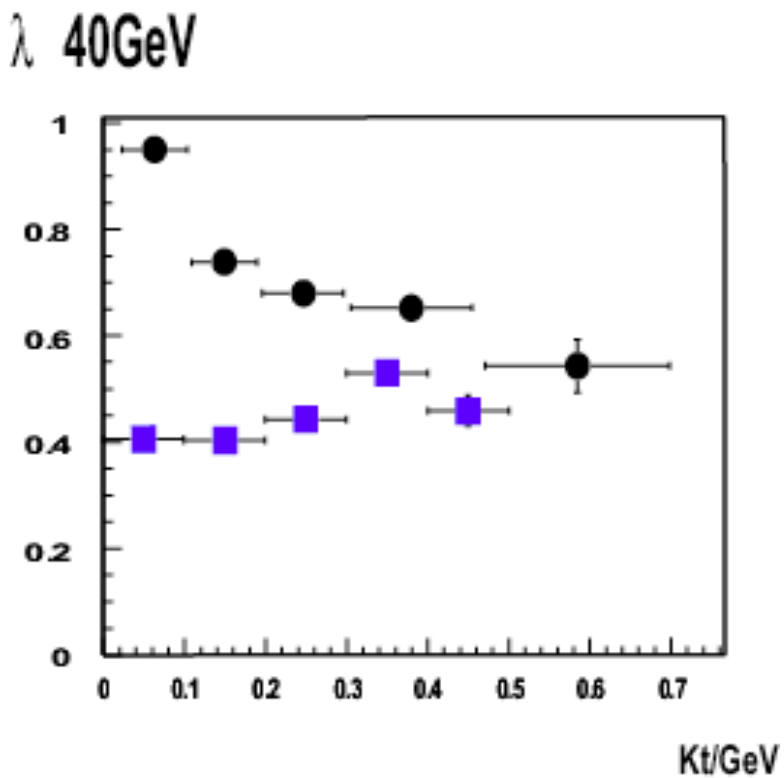
λ includes both effects

QM 2002:

$$C_2(q,k) = p \cdot (C_2(q,k)_{BP}) + (1-p)$$

λ corrected for purity

- QM 2002: Y(2.2-2.7)
- New(prel.): Y(2.2-2.6)



To do´s

- **Determine the „purity“ for the all bins.**
- **Correction for finite momentum resolution**

  (lower momenta and magn. field at 20,30 AGeV)
- **Optimize cuts (e.g. dEdx)**
- **New production with local momenta in Vertex1**
- **Model-dependent interpretation of the source parameters**

  (lifetime, emissiontime, volume ...)