Interferometry of direct photons in Pb+Pb collisions at 158 AGeV

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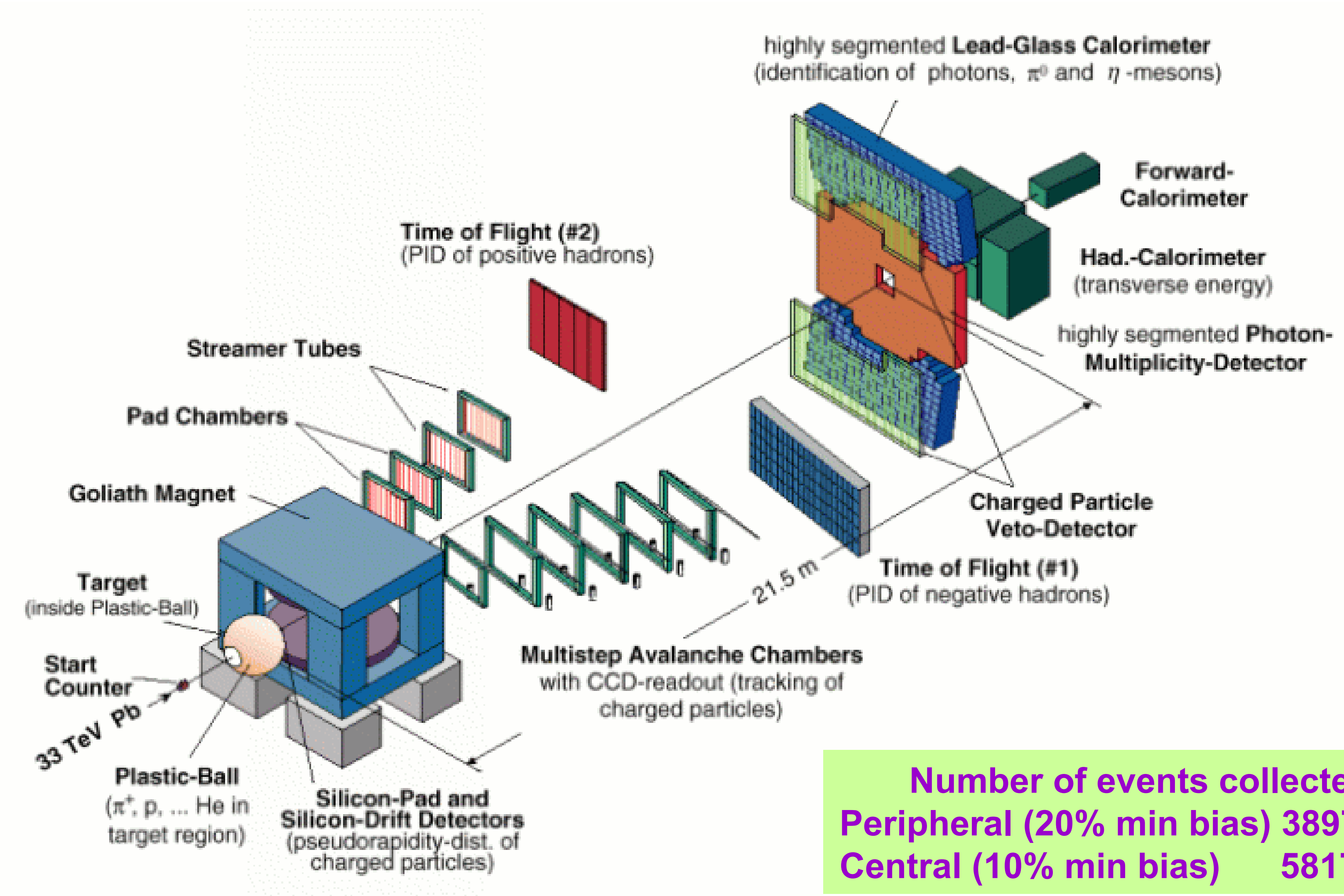
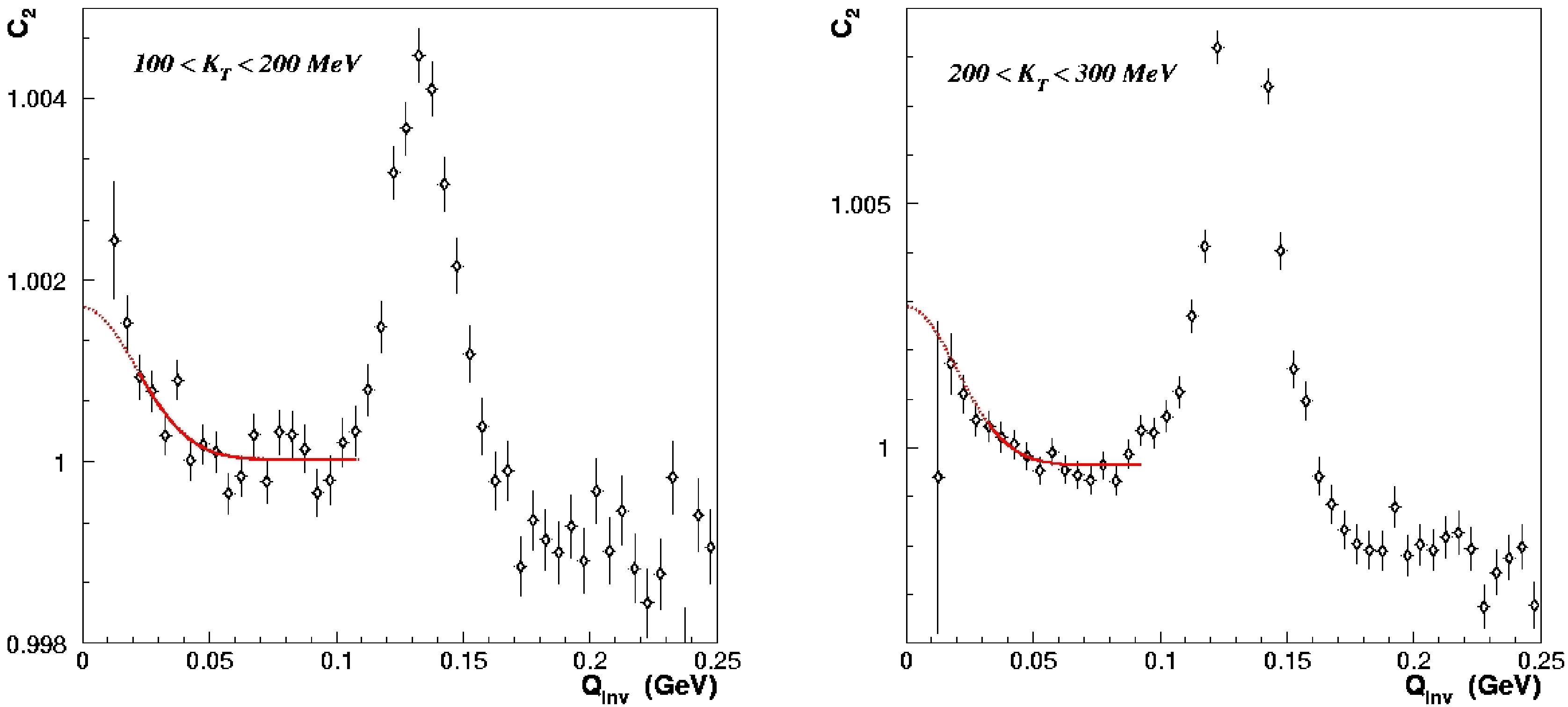
for WA98 collaboration.

Experimental setup



Number of events collected:
Peripheral (20% min bias) 3897935
Central (10% min bias) 5817217

Two-photon correlation function.

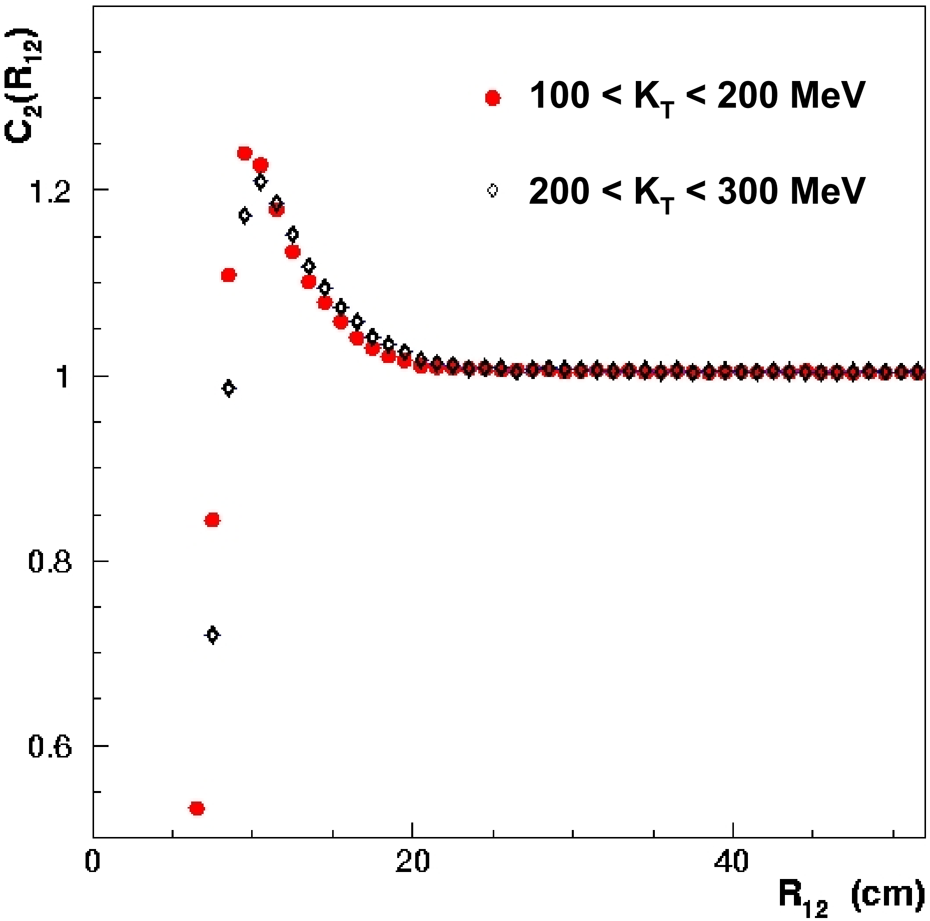


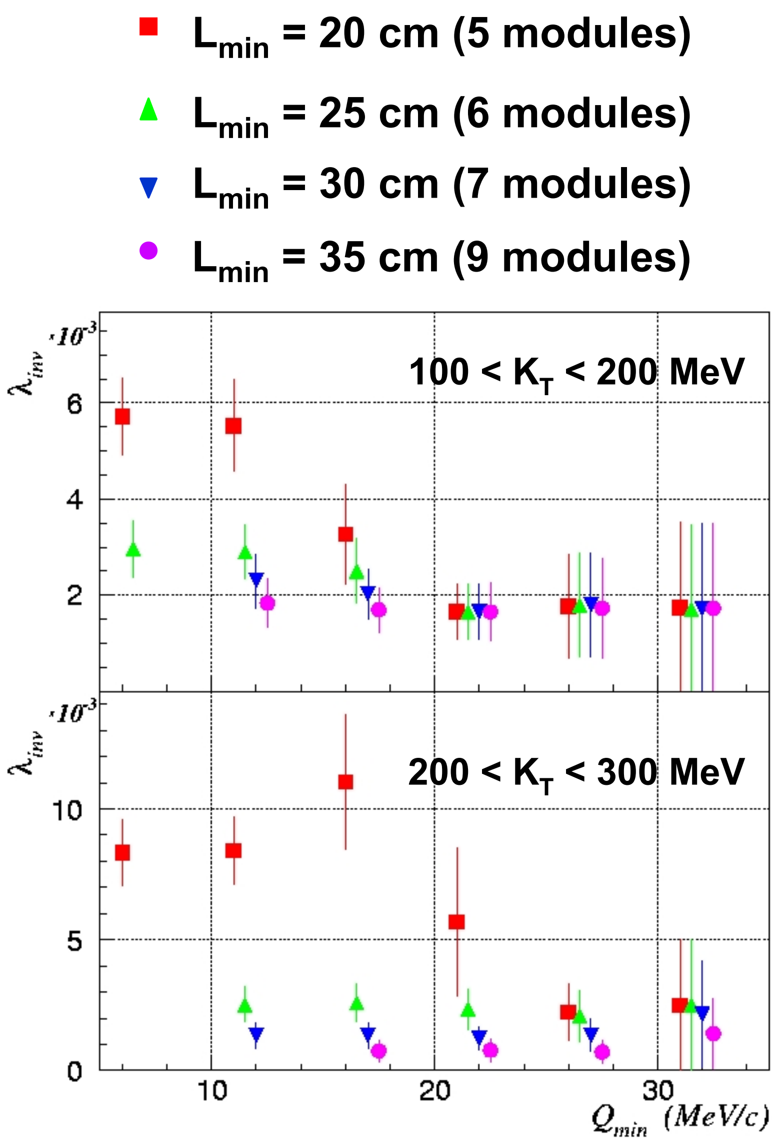
$\lambda \sim 2 \cdot 10^{-3}$

Possible sources of distortion of correlation function

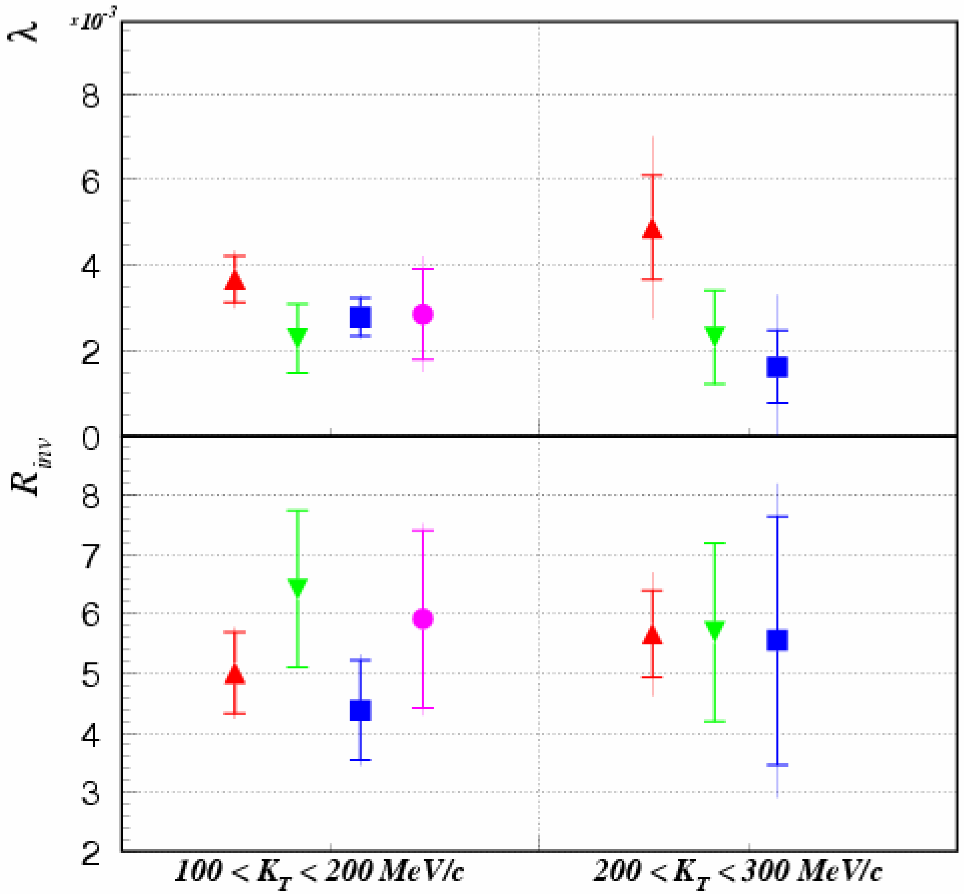
- Apparatus effects (cluster splitting and merging)
- Hadron misidentification
- Photon conversion
- Photon background correlations:
  - Bose-Einstein correlations of parent π^0;
  - Collective (elliptic) flow;
  - Residual correlations due to decays of resonances;

Apparatus effects





Hadrons and photon conversion

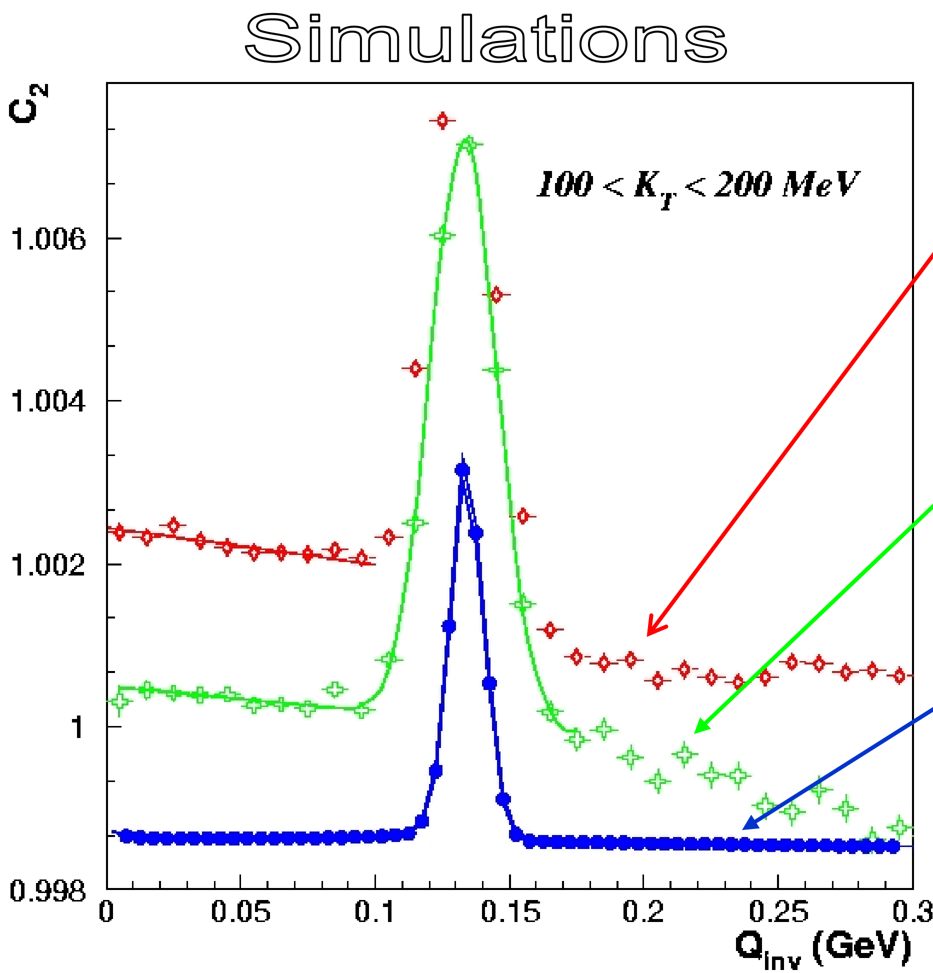


Contamination, (charged + neutral)

pid	100<K_T<200	200<K_T<300
"All"	(37 + 4)%	(22 + 4)%
"Narrow"	(16 + 1)%	(4 + 1)%
"Neutral"	(1 + 4)%	(1 + 4)%
"Narrow neutral"	(1 + 1)%	(1 + 1)%

$$\lambda^{obs} = \frac{1}{2}\frac{(N_\gamma^{dir})^2}{(N_\gamma^{tot} + cont)^2} = \frac{\lambda^{true}}{(1 + cont/\ N_\gamma^{tot})^2}$$

Photon background correlations



$\pi^0\pi^0$ Bose-Einstein correlations:

Slope: $-(4.5\pm0.4)\cdot10^{-3}$ (GeV^{-1})

Elliptic flow:

Slope: $-(3.1\pm0.4)\cdot10^{-3}$ (GeV^{-1})

Decays of resonances:

$K^0_s \rightarrow 2\pi^0 \rightarrow 4\gamma$

$K^0_L \rightarrow 3\pi^0 \rightarrow 6\gamma$

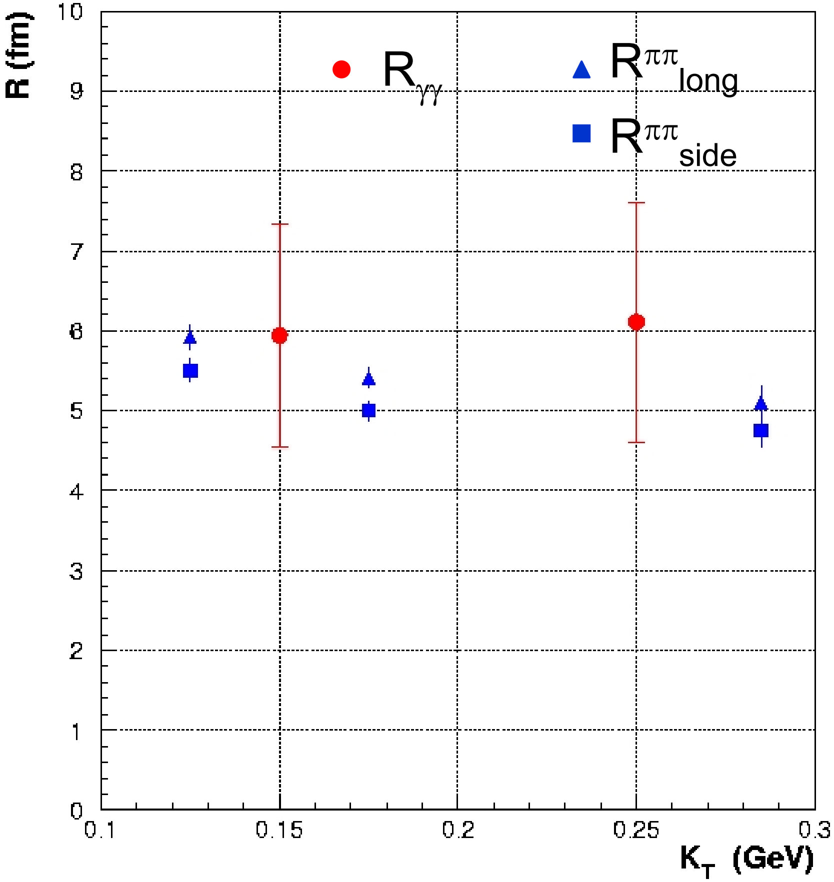
$\eta \rightarrow 3\pi^0 \rightarrow 6\gamma$

$\omega \rightarrow \pi^0\gamma \rightarrow 3\gamma$

Invariant correlation radius

$$C_2(Q_{inv}) = 1 + \lambda/(4\pi) \int d\mathbf{o} \exp\{ - Q_{inv}^2 (R_s^2 \sin^2\theta \sin^2\phi + R_l^2 \sin^2\theta \cos^2\phi) - (Q_{inv}^2 + 4K_T^2)\cos^2\theta R_o^2 \}$$

(for massless particles!)

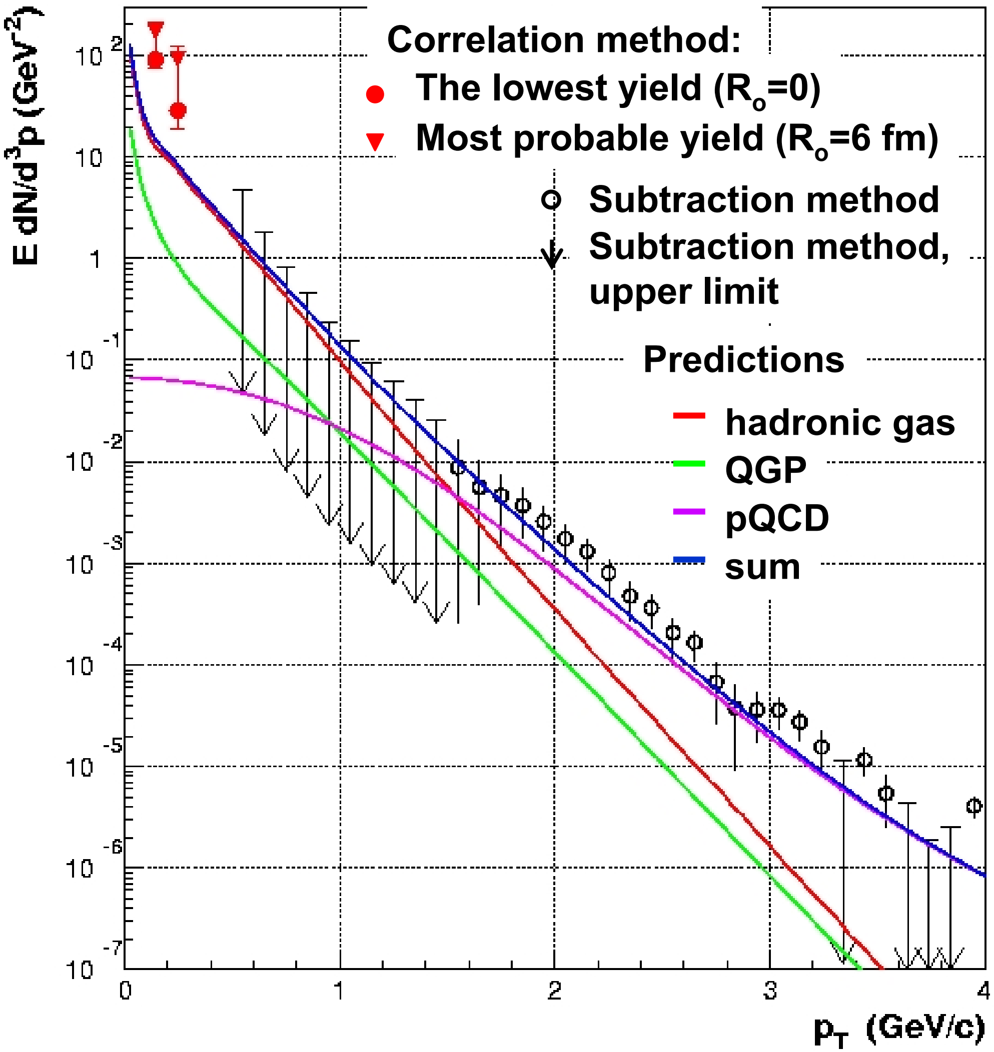


$$R_{inv} = f(R_s, R_l)$$

$$\lambda_{inv} = \lambda \frac{\mathrm{Erf}(2K_T R_o)}{2K_T R_o}$$

Pion correlation radii:
M.M. Aggarwal, et al., (WA98collbration), Phys. Rev. C67 (2003) 014906.

Yield of direct photons



$$N_\gamma^{dir} = N_\gamma^{total}\sqrt{2\lambda}$$

$$\lambda_{inv} = \lambda \frac{Erf(2K_T R_o)}{2K_T R_o}$$

Predictions:
S. Turbide, R. Rapp, and C. Gale, hep-ph/0308085.

Conclusions

- Direct photon correlations were measured for the first time in ultrarelativistic heavy ion collisions.
- We measured photon invariant correlation radius R_{inv} for two K_T bins, $100<K_T<200$ MeV and $200<K_T<300$ MeV. In both cases R_{inv} was very close to the pion correlation radii.
- Using invariant correlation strength parameter λ_{inv} we extracted *lower limit* on direct photon yield. Even this lower limit is considerably larger than existing theoretical predictions.

WA98 collaboration

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