Initial Geometry in Hydrodynamic Calculations

P. Kolb, U. Heinz, P. Huovinen,
K. Eskola, K. Tuominen, hep-ph/0103234,
Nucl. Phys. A, in press

Nuclear density distribution:

$$\rho_A(\vec{r}) = \frac{\rho_0}{e^{(r-R_0)/3}+1} \qquad \text{Woods-Saxon}$$

$$\int d^3r\, \rho_A(\vec{r}) = A$$

$\rho_0 = 0.17\ \text{fm}^{-3}$

$R_0(A) = 1.12\, A^{1/3} - 0.86\, A^{-1/3} = \begin{cases} 6.37\ \text{fm} & {}^{197}\text{Au} \\ 6.48\ \text{fm} & {}^{207}\text{Pb} \end{cases}$

$\Xi = 0.54\ \text{fm}$

Nuclear thickness function:

$$T_A(\vec{s}) = \int_{-\infty}^{\infty} dz\, \rho_A(\vec{s}, z), \qquad \int d^2s\, T_A(\vec{s}) = A$$

Total N-N cross section:

$\sigma = 32\ \text{mb}$ @ $\sqrt{s} = 17\ \text{GeV}$ $\quad \sigma = 40\ \text{mb}$ @ $\sqrt{s} = 130\ \text{GeV}$

Initialization scenarios

Physics dominated by soft (nonperturbative) scattering processes; density of wounded nucleons:

$$n_{\mathrm{WN}}(x,y;b) = T_A\Big(x+b/2,y\Big)\left[1-\left(1-\frac{\sigma}{B}T_B\Big(x-b/2,y\Big)\right)^B\right] + T_B\Big(x-b/2,y\Big)\left[1-\left(1-\frac{\sigma}{A}T_A\Big(x+b/2,y\Big)\right)^A\right]$$

Physics dominated by hard (perturbative) scattering processes; density of binary collisions:

$$n_{\mathrm{BC}}(x,y;b) = \sigma \cdot T_A\Big(x+b/2,y\Big)T_B\Big(x-b/2,y\Big)$$

with the nuclear thickness function

$$T_A(x,y) = \int_{-\infty}^{\infty} \rho_A(x,y,z)$$

and a Woods-Saxon density profile

$$\rho_A(x,y,z) = \frac{\rho_0}{1+\exp((r-R_0)/a)}$$

$$\epsilon(x) \approx s^{4/3}(x)$$

$K_i = K_i(\tau_0)$ adjusted such that final $\frac{dN_{ch}}{dy}$ (5% most central) agrees with experiment.

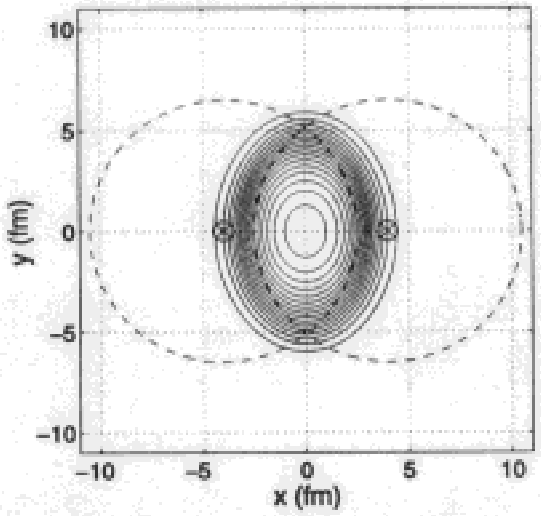
Initialization at equilibration time τ_0

different scattering mechanisms responsible for energy (entropy) deposition in the reaction volume:

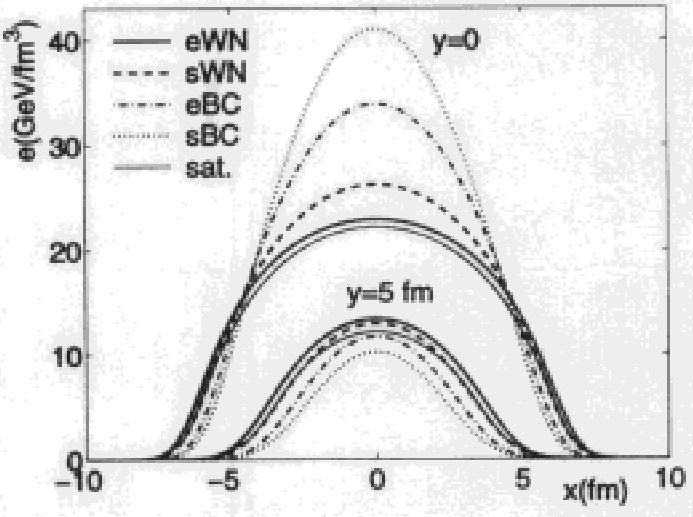
soft	$\rightarrow e(x,y;b;\tau_0) = K_{\mathrm{eWN}} n_{\mathrm{WN}}(x,y;b)$	*eWN*
	$\rightarrow s(x,y;b;\tau_0) = K_{\mathrm{sWN}} n_{\mathrm{WN}}(x,y;b)$	*sWN*
hard	$\rightarrow e(x,y;b;\tau_0) = K_{\mathrm{eBC}} n_{\mathrm{BC}}(x,y;b)$	*eBC*
	$\rightarrow s(x,y;b;\tau_0) = K_{\mathrm{sBC}} n_{\mathrm{BC}}(x,y;b)$	*sBC*

saturation model : Eskola, Kajantie, Tuominen, PLB 497 (2001) 39

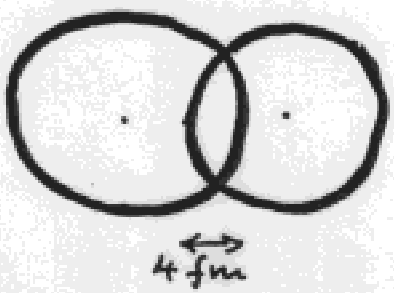
eWN, $b = 7$ fm



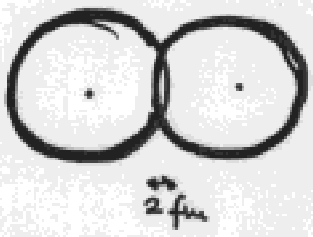
different models, $b = 0$ fm

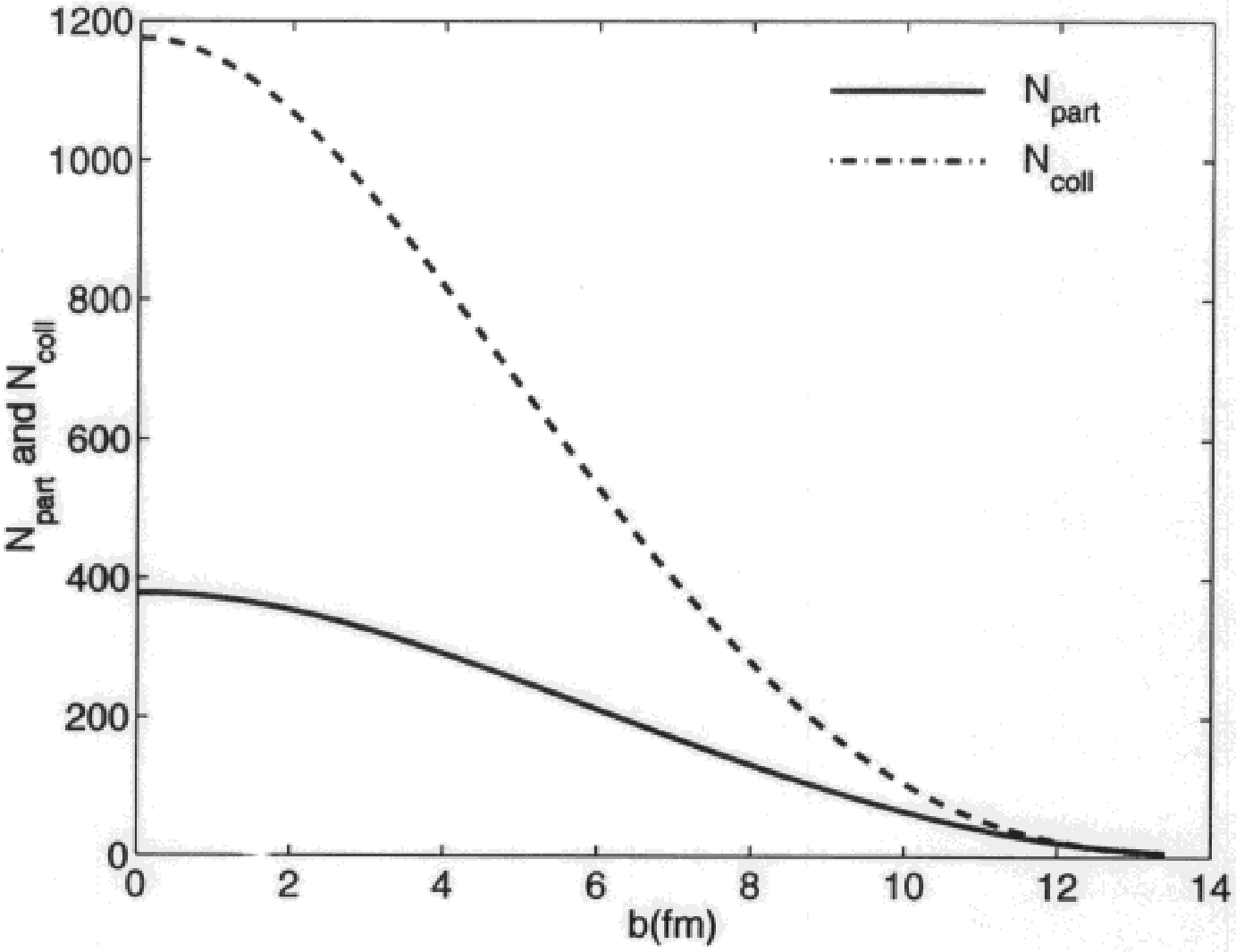


$N_{part} = 100 \triangleq b = 9$ fm



$N_{part} = 50 \triangleq b = 11$ fm




1200
1000
800
600
400
200
0
0
2
4
6
8
10
12
14
b(fm)
N_part and N_coll
N_part
N_coll

Hydrodynamics with boost-invariant longitudinal expansion $\rightarrow \frac{dS}{dy} = \text{conserved} \leftrightarrow \frac{dN_{ch}^{observed}}{dy}$

$$\frac{dN_{ch}}{dy} \sim N_{WN} \quad \leftrightarrow \quad s(\vec{r}; \tau_0; \vec{b}) \sim n_{WN}(\vec{r}; \vec{b})$$

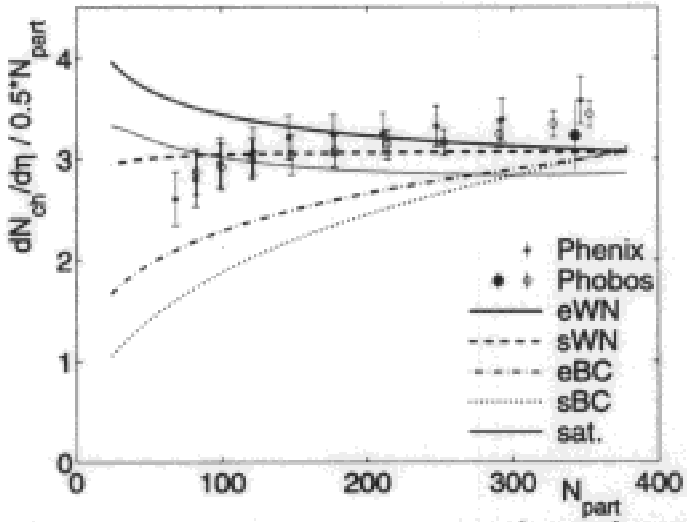
We have

$$N_{BC}(b) \sim N_{WN}^{4/3}(b) \quad \text{and} \quad s^{4/3}(\vec{r}; \tau_0) \sim e(\vec{r}; \tau_0)$$

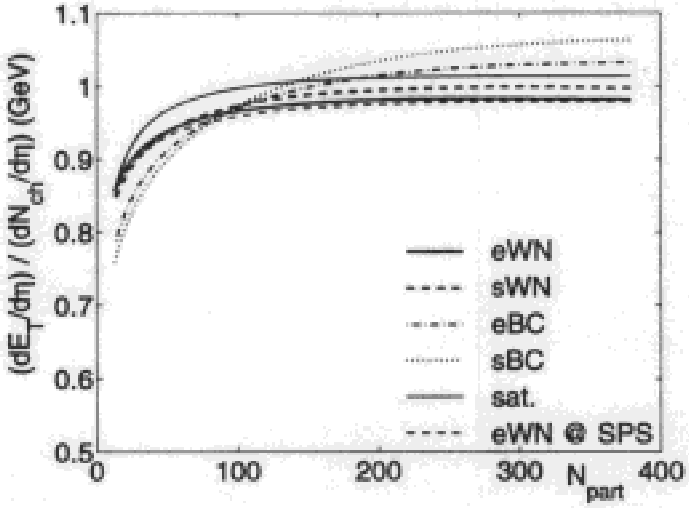
Multiplicities and transverse energy

PHENIX-collaboration, K. Adcox et al., Phys. Rev. Lett. 86 (2001) 3500
G. Roland for the PHOBOS-collaboration at QM 2001

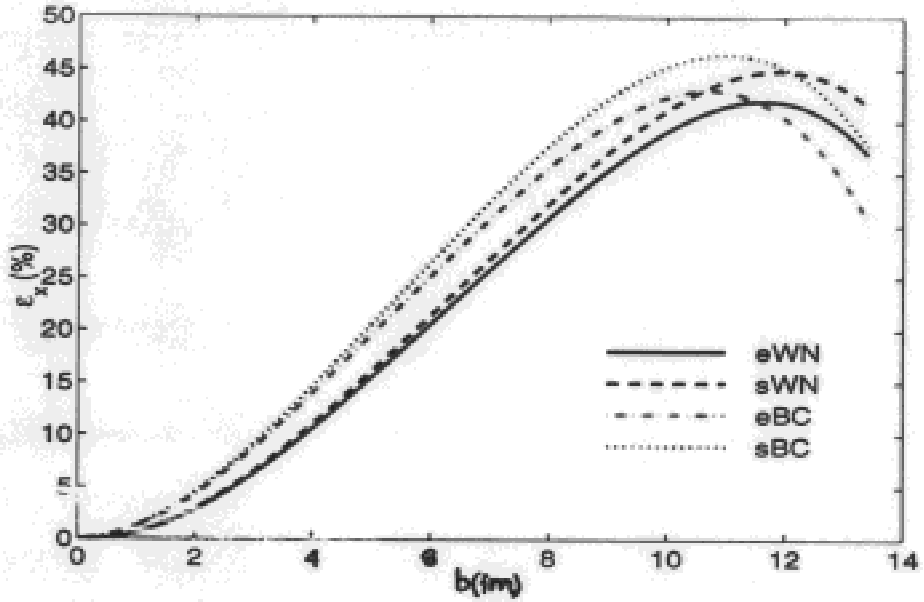
particle yield per participant pair



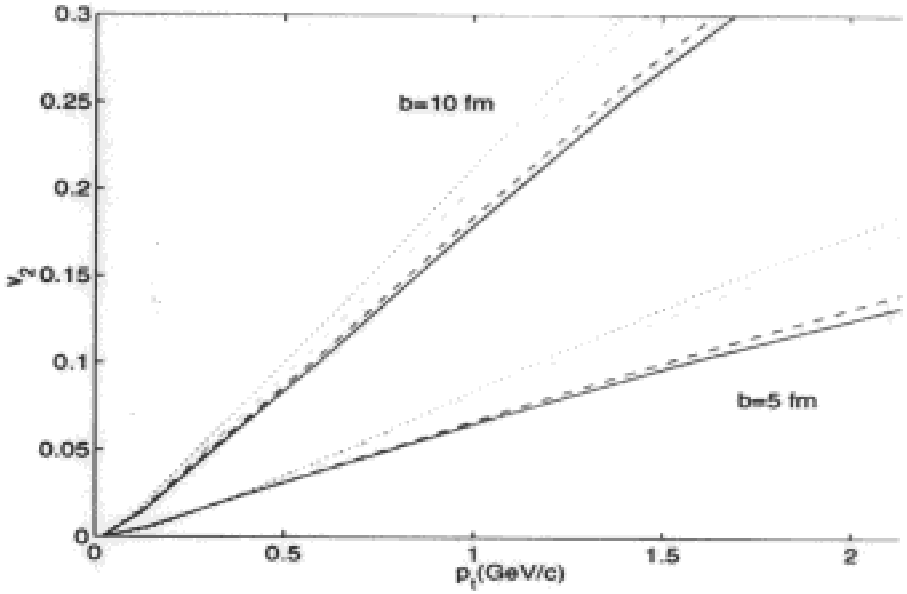
transverse energy per emitted particle



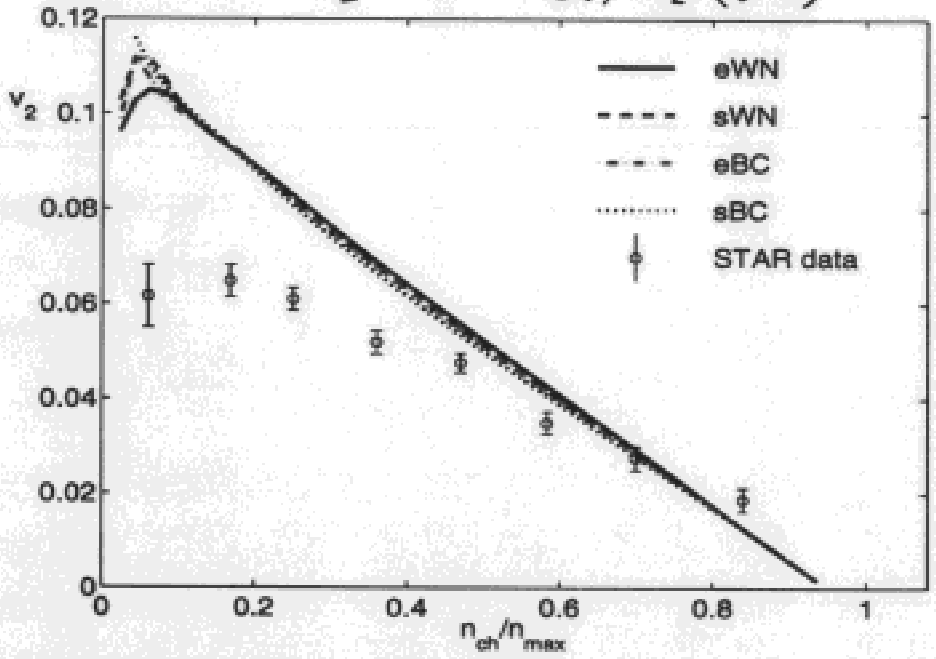
Initial spatial anisotropy ε_x



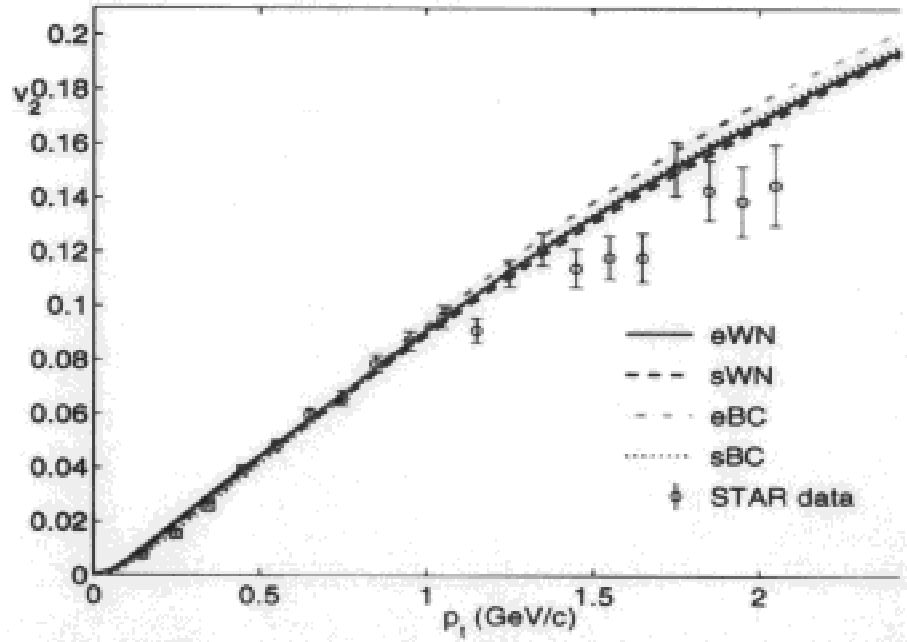
Final momentum anisotropy $v_2(p_t)$

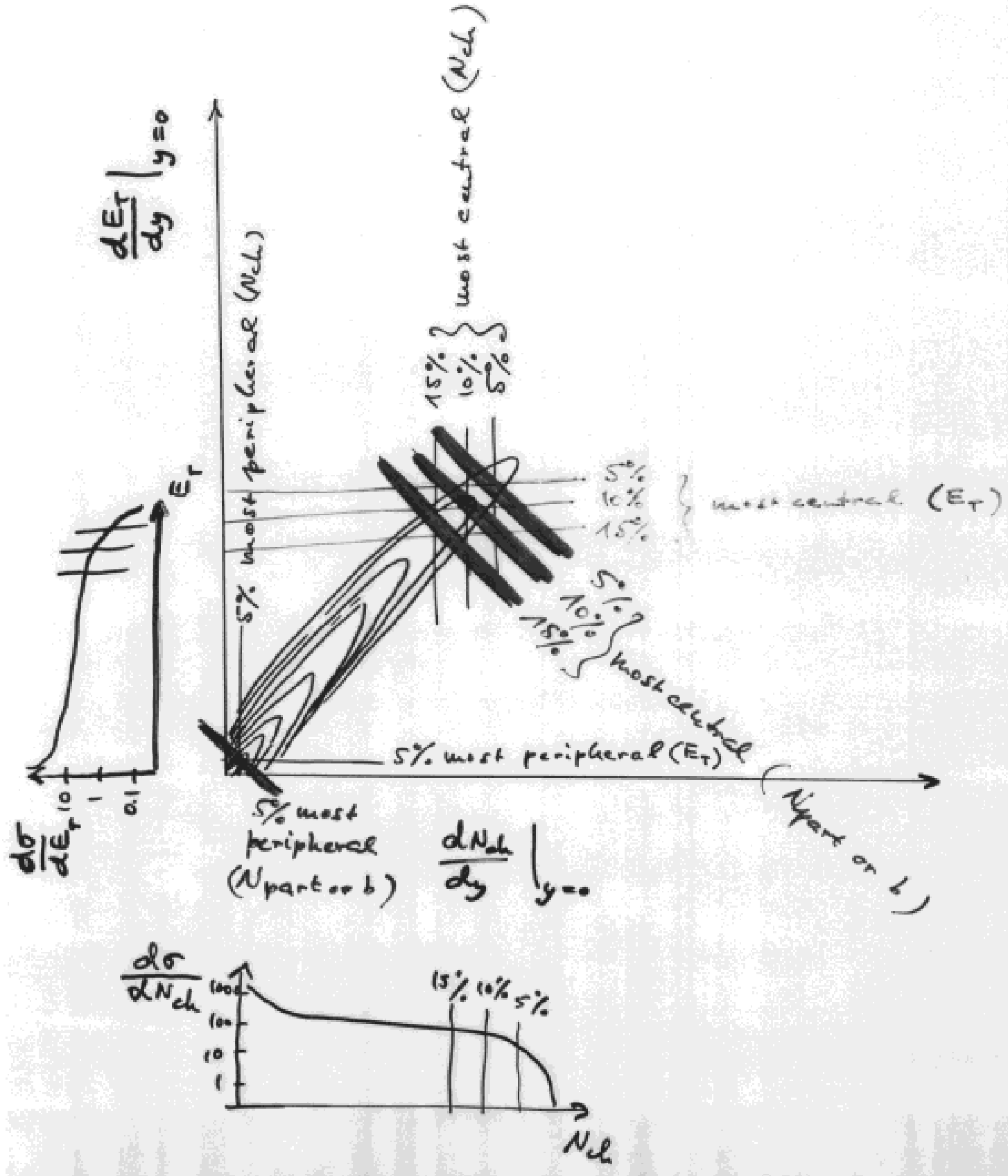


v_2 vs. $dn_{ch}/d\eta$ $(y=0)$



$v_2(p_t)$ for min. bias events



Ufff ....!

Fractions of total cross section