Underlying Event in Herwig++ - Status report

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UE in Herwig++
based on [Butterworth, Forshaw, Seymour '96]

- fully working model included in `Herwig++ 2.1`
- Based on the eikonalization of the cross section $pp \to jj$ with $p_T > p_T^{min}$ (σ^{inc}).

$$\sigma_{inel} = \int d^2b \sum_{m=1}^{\infty} \frac{(A(b)\sigma^{inc})^m}{m!} e^{-A(b)\sigma^{inc}} = \int d^2b(1-e^{-A(b)\sigma^{inc}})$$

- $A(b)$ is the overlap function of the two colliding particles.

$$A(b = |\mathbf{b}|) = \int d^2\mathbf{b}' G_{h_1}(\mathbf{b}')\ G_{h_2}(\mathbf{b}-\mathbf{b}')$$

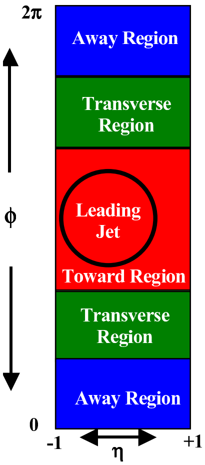
$$G_{\bar{p}}(\mathbf{b}) = G_p(\mathbf{b}) = \int \frac{d^2\mathbf{k}}{2\pi} \frac{e^{\mathbf{k}\cdot\mathbf{b}}}{(1+\mathbf{k}^2/\mu^2)^2}$$

Exp. analysis

R. Field's TVT analysis; PRD65,092002

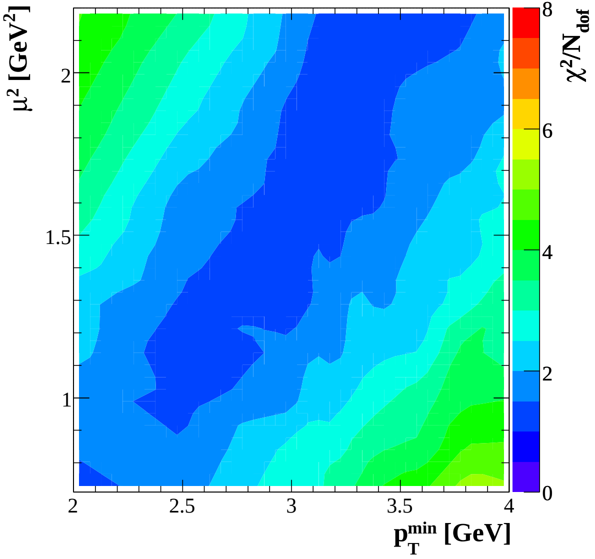
- non standard jet algorithm used to reconstruct jet with largest scalar ptsum: leading jet
- define 3 regions with respect to ϕ of the leading jet: towards, transverse, away
- plot $\langle N^{chg} \rangle$ and $\langle p_{T,sum}^{chg} \rangle$ for each of these regions

$\longrightarrow$ use χ^2 of describing the data as benchmark



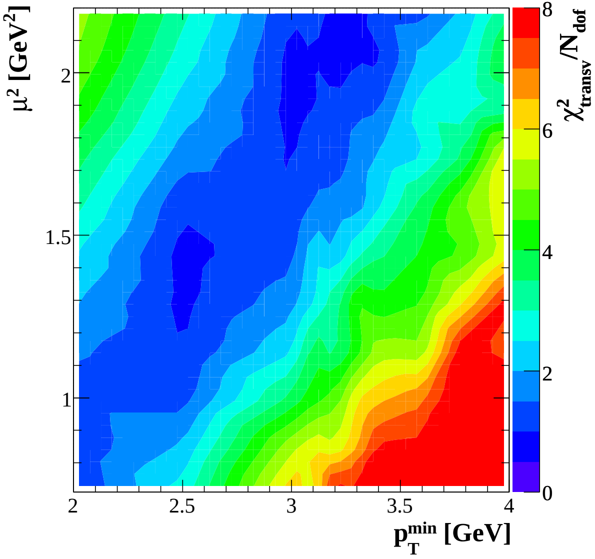
Parameter Scan

all regions



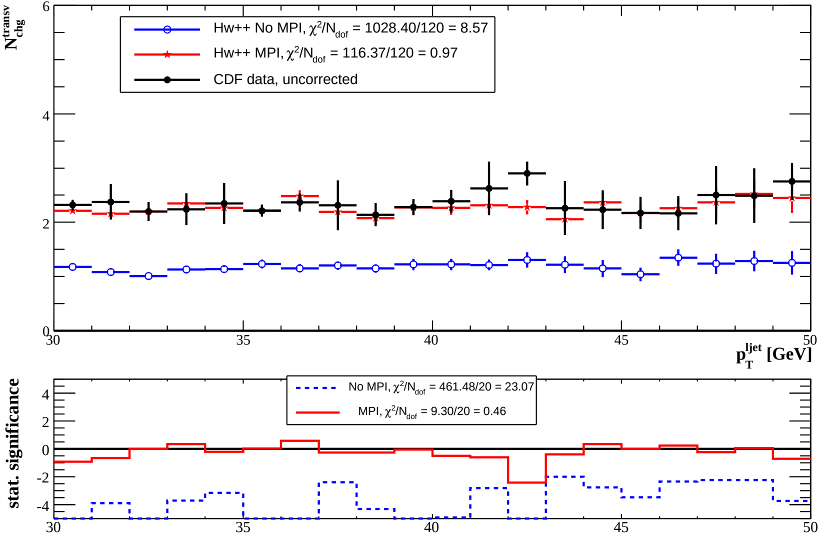
Parameter Scan

only transverse region



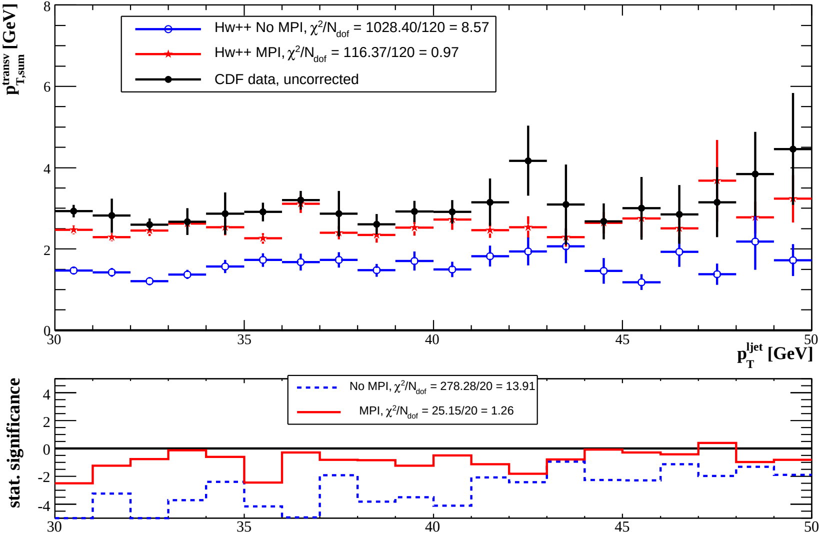
Best fit: N^{chg}_{transv}

$p_T^{min} = 3.2$ GeV, $\mu^2 = 1.75$ GeV^2



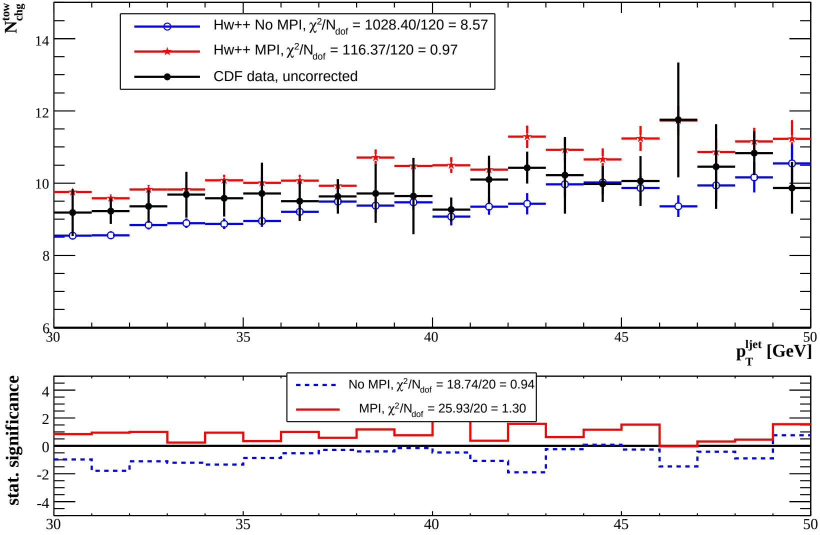
Best fit: $p_{T,sum}^{transv}$

$p_T^{min} = 3.2$ GeV, $\mu^2 = 1.75$ GeV^2



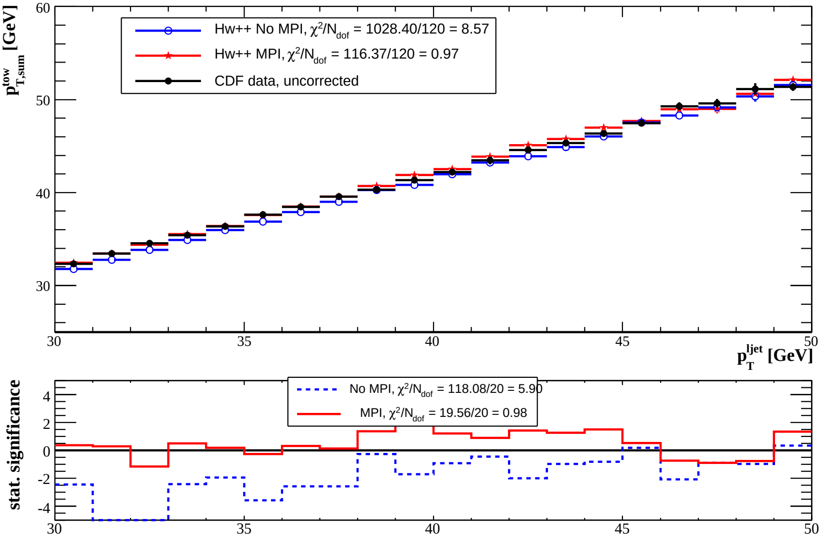
Best fit: N_{tow}^{chg}

$p_T^{min} = 3.2$ GeV, $\mu^2 = 1.75$ GeV^2



Best fit: $p_{T,sum}^{tow}$

$p_T^{min} = 3.2$ GeV, $\mu^2 = 1.75$ GeV^2



double parton scattering

Occurance of several signal processes in one collision. The assumption of the independence of additional scatters leads to ($p_n(x) = \frac{x^n}{n!} e^{-x}$):

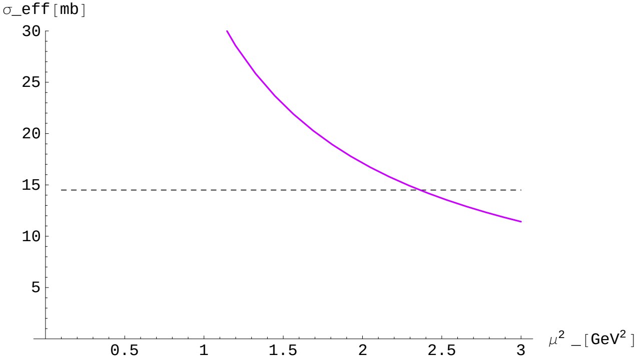
$$\sigma_{n,m}(\sigma_a, \sigma_b) = \int d^2b \; p_n(A(b)\sigma_a) \; p_m(A(b)\sigma_b)$$

In the case of small cross sections and one interaction each, this leads to

$$\begin{aligned}\sigma_{1,1}(\sigma_a, \sigma_b) &= \int d^2b \; A^2(b)\sigma_a\sigma_b \\ &= \sigma_a\sigma_b \; \underbrace{\int d^2b \; A^2(b)}_{1/\sigma_{eff}}\end{aligned}$$

σ_{eff} measured in [CDF coll. PRD 56, 3811 (1997)]

$$\sigma_{eff} = 14.5 \pm 1.7\ ^{+1.7}_{-2.3}\ \text{mb}$$



double parton scattering 2

Occurance of several signal processes in one collision and low pt jet events:

$$\sigma_{n,m,k}(\sigma_a, \sigma_b, \sigma_{soft}) = \int d^2b \, p_n(A(b)\sigma_a) \, p_m(A(b)\sigma_b) \, p_k(A(b)\sigma_{soft})$$

Probability of k soft jet events

$$P_k = \frac{\sigma_{n,m,k}}{\sum_{\ell=0}^{\infty} \sigma_{n,m,\ell}} = \frac{\int d^2b \; p_n \; p_m \; p_k}{\int d^2b \; p_n \; p_m}$$

The double parton scattering cross section from the slides before would be

$$\sigma_{DP} = \sum_{\ell=0}^{\infty} \sigma_{1,1,\ell}$$

Next Steps

- Double/multiple parton scattering + low p_T jets
- Modeling of the soft part below p_T^{min}