Mass effects in the initial state shower

Graeme Nail (Manchester)

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Outline

- Implementation
- Current Progress
- Plots
- Next steps

Why?

- Heavy quark masses become relevant in relation to the scale of the process
- Drell Yan
- $b + q \to t + q'$
- $b + g \to Z + b$
- …

Implementation

- ME looks like $b + \bar{b} \to Z \to l^+ + l^-$
- Implement a pre-cascade handler
- Evolve back to a gluon
- ME now looks like
$$g + g \to \bar{b} + b + (\bar{b} + b \to Z) \to \bar{b} + b + l^+ + l^-$$
- Full parton shower takes over

Kinematics

- Quasi-collinear limit (pT and mass are small, but pT/m is not)

$$p'_\pm = \frac{x_\pm}{z_\pm} n_\pm + \frac{m(p'_\pm)^2}{\frac{x_\pm}{z_\pm} s} n_\mp$$

- Sudakov decomposition

$$p_\pm = z_\pm p'_\pm + \Gamma_\pm n_\mp + k_\pm$$
$$q_\pm = (1 - z_\pm) p'_\pm - \Gamma_\pm n_\mp - k_\pm$$

- Preserve invariant mass and longitudinal rapidity of partonic system

$$\Gamma_\pm = \frac{(1 - z_\pm)^2 m(p'_\pm)^2 - m(q_\pm)^2 + k_\pm^2}{(1 - z_\pm) \frac{x_\pm}{z_\pm} s}$$

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Veto Algorithm

- Splitting Function

$$P_{g\to Q\overline{Q}}(z,m,p_T) = 1 - 2z(1-z) + \frac{2z(1-z)m^2}{m^2+p_T^2}$$

- Sudakov

$$\Delta(\tilde{q}_0,\tilde{q},x,m_Q) = \exp\left\{-\int_{\tilde{q}}^{\tilde{q}_0}\frac{\mathrm{d}\tilde{q}'^2}{\tilde{q}'^2}\int_x^{z_+}\mathrm{d}z\ \frac{\alpha_S(z,\tilde{q})}{2\pi}P_{g\to Q\overline{Q}}(z,m_Q,p_\mathrm{T})\frac{\frac{x}{z}f_g(\frac{x}{z},\tilde{q}')}{f_Q(x,\tilde{q}')}\right\}$$

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Current Progress

- Veto Algorithm
- Kinematics
- Updated event record (bugs)
- Starting comparisons with MCFM

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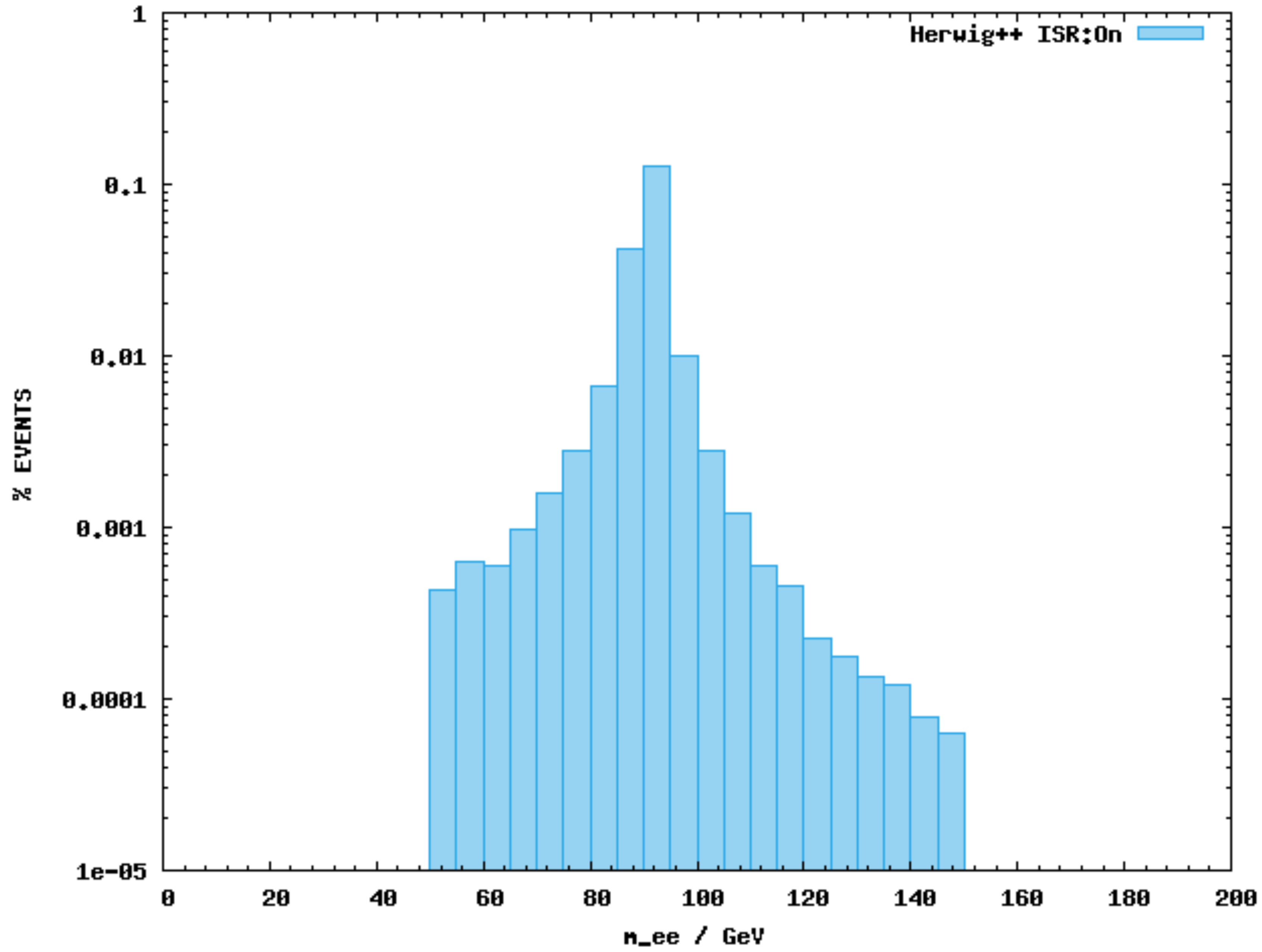
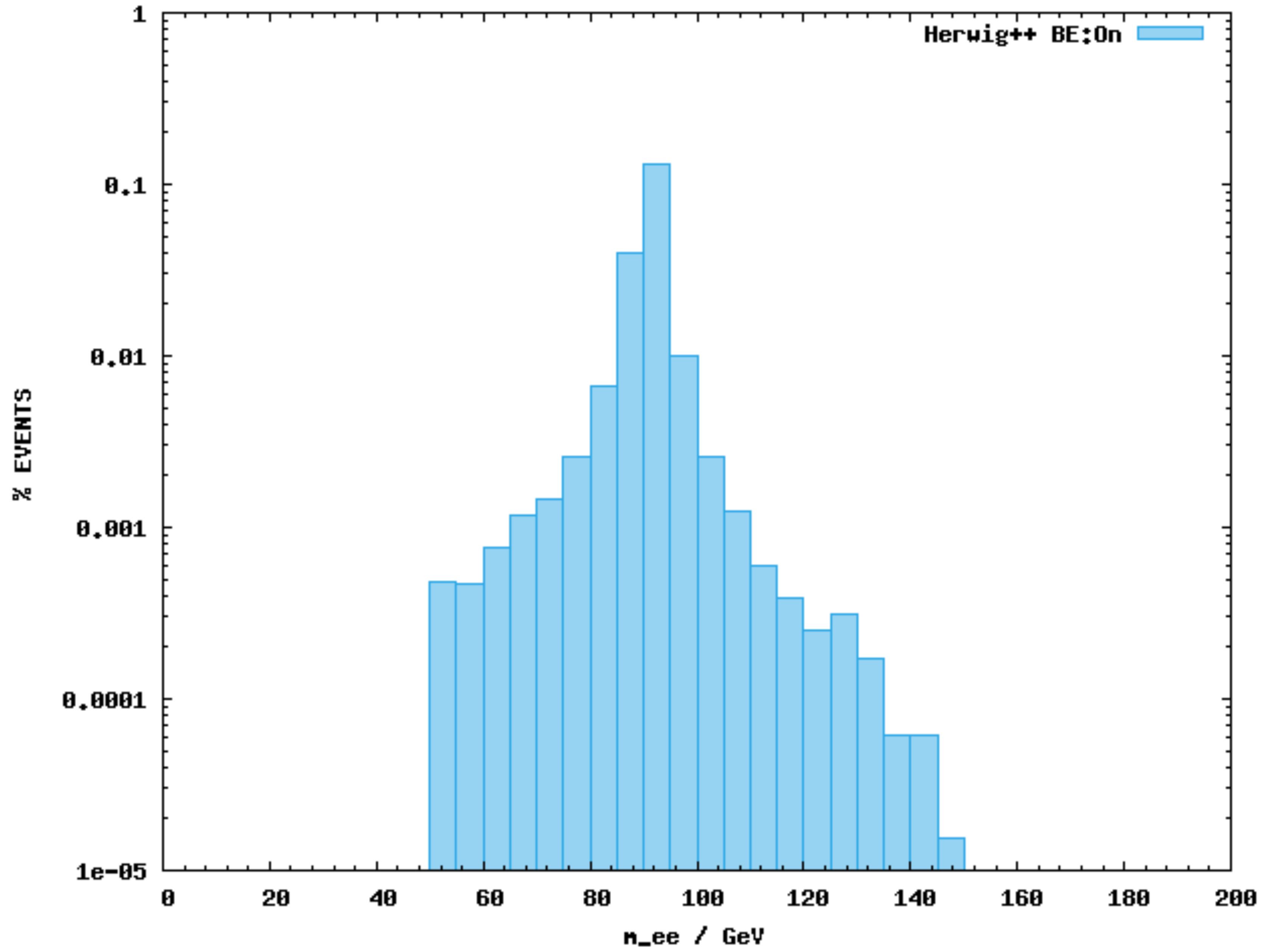
Comparison to MCFM

~~Comparison to MCFM~~

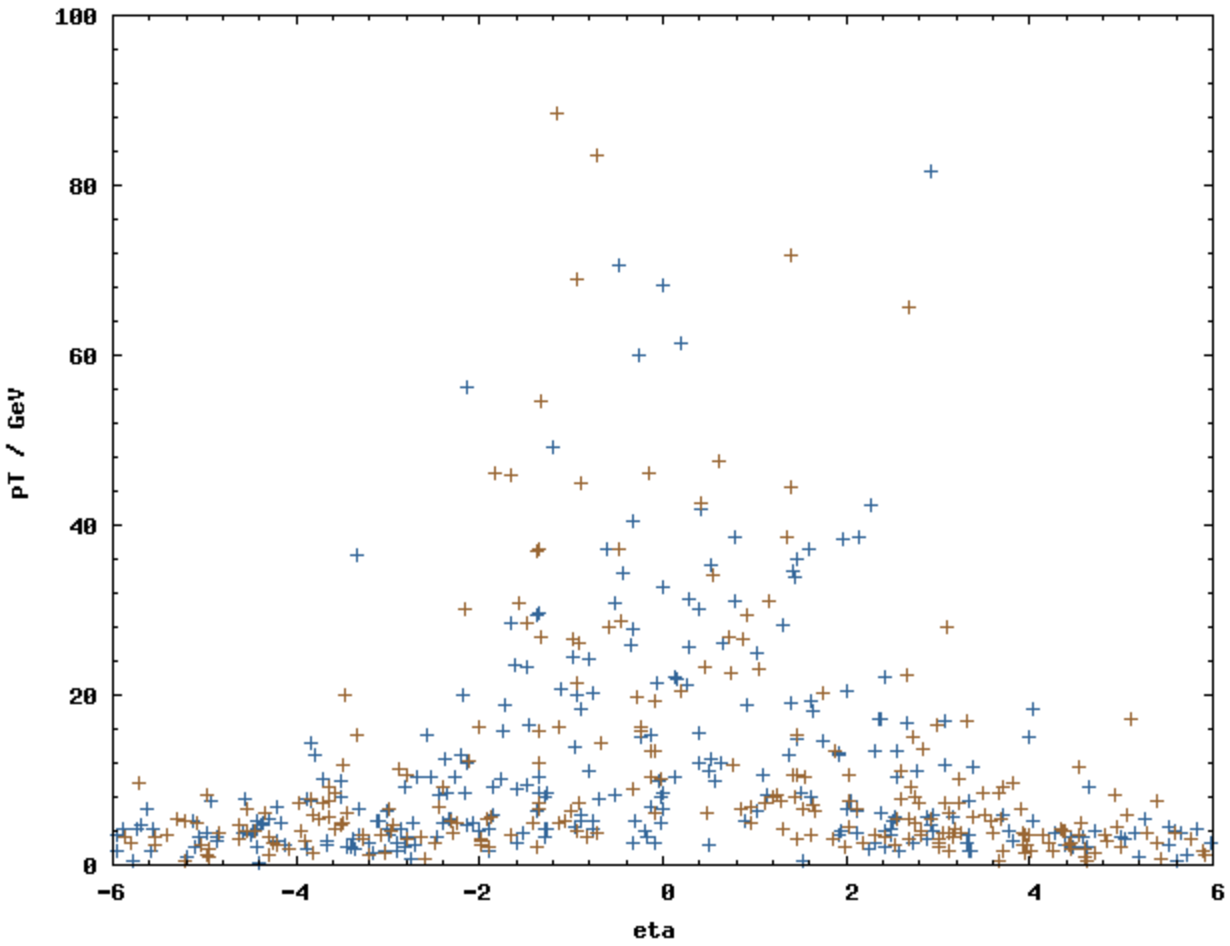
Invariant Mass

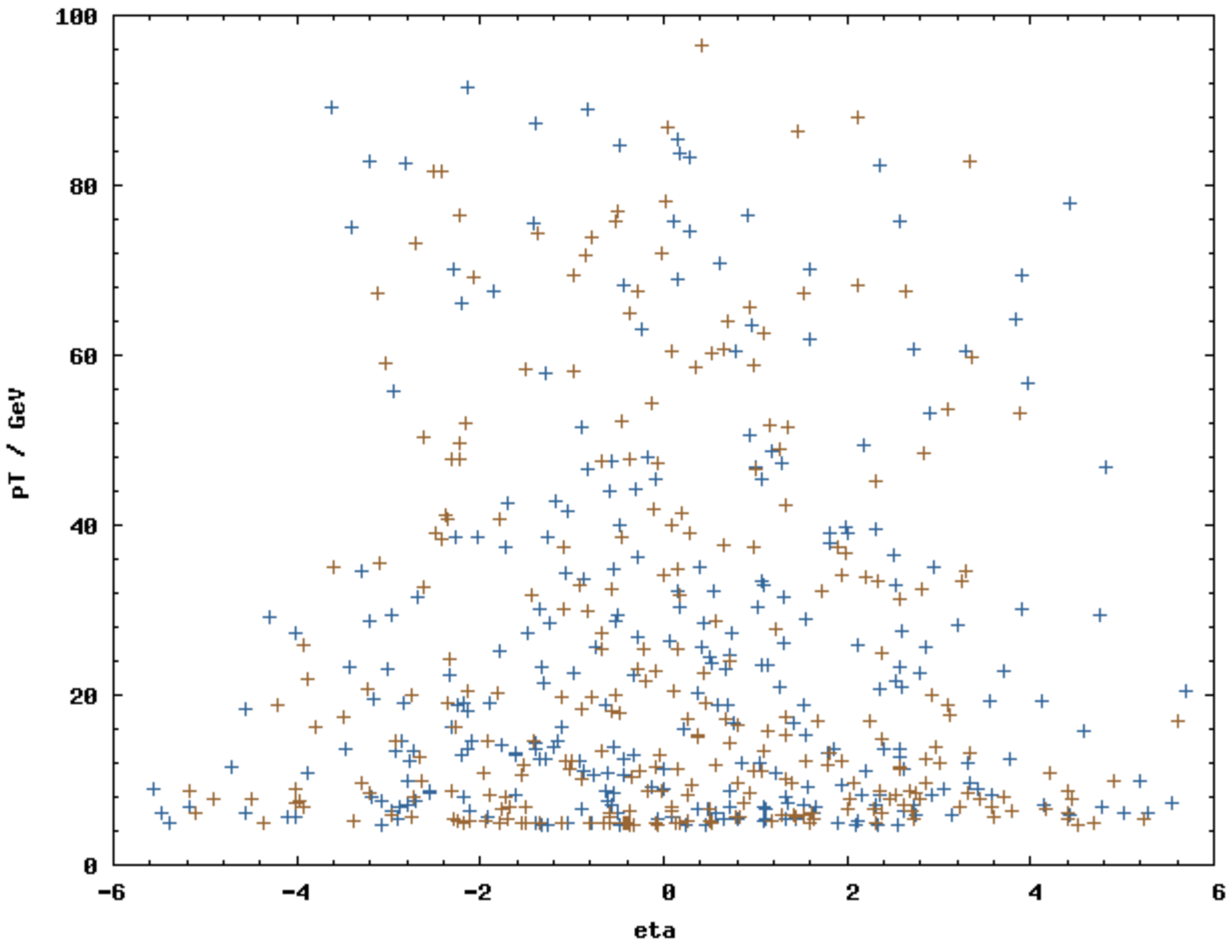


Invariant Mass



p_T, η distribution





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Next Steps

- Comparison with MCFM
  - Cuts/Masses/Analysis
  - Ordering variable (pT, pT/(1-z),…)
- Incorporate into full shower
- Comparison with data

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