Applying Matrix Element Corrections to PYTHIA ala Frank

Preliminary Results

Stephen Mrenna
Fermilab Computing Division and Univ. of Michigan
http://www-cpd.fnal.gov/personal/mrenna

with P. Richardson and F. Krauss

PARTON SHOWER MACHINERY

ENGINE — SUDAKOV FORM FACTOR

PROB. OF NO EMISSION

SOFT + COLLINEAR APPROX.

FUEL — $F \equiv$ HARD SCALE / RESOLUTION SCALE / FACTORIZATION SCALE

POWERS THE SUDAKOV

$E \equiv$ LOWER SCALE $\sim \Lambda_{QCD}$

EMISSION CONTROL

COHERENCE

ANGULAR ORDERING

STOPS PARTON POLLUTION

IMPROVING P.S.

MAKING "BETTER" APPROXIMATIONS

LL → NLL (SUDAKOV)

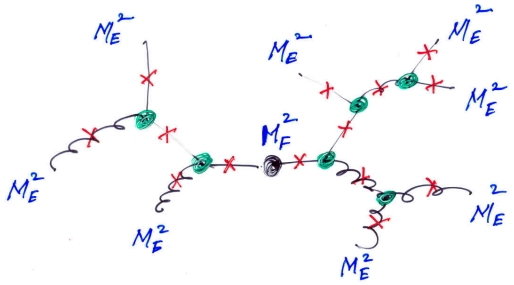
SOFT COLLINEAR → HARD WIDE-ANGLE

(REPLACE DGLAP $P_{ij}(z)$ WITH MATRIX ELEMENT)

PRACTICALLY, CAN ONLY CALCULATE M.E.s TO SOME SMALL MULTIPLICITY

BELOW SOME RESOLUTION SCALE, MUST RELY ON STANDARD PARTON SHOWER

PARTON SHOWER TERMINATES AT SOME RESOLUTION SCALE



X ≡ SUDAKOV

● ≡ SOFT-COLLINEAR APPROX. TO M.E.

CCKW → REPLACE $\bullet^{(M)}$ WITH $|M.E.|^{2(M)}$

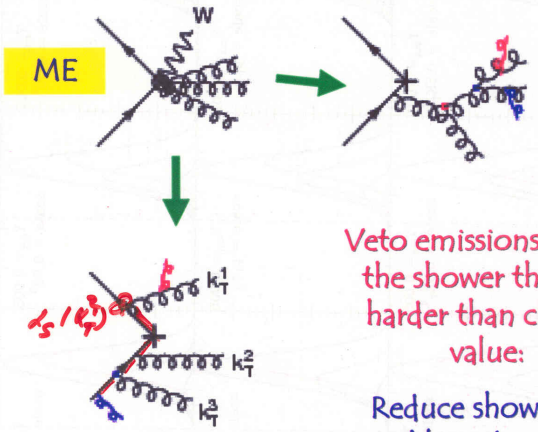
USE NLL X

NOW RESTART SHOWER DOWN TO $M_{E_0}^2 < M_F^2$

$M_{E_0}^2 \sim \Lambda_{QCD}^2$ HADRONIZATION MODEL

4

ME to PS Mapping



Veto emissions within the shower that are harder than cluster value:

Reduce showering variable and continue

Stephen Mrenna

USING PYTHIA (HERWIG)

WELL-TESTED
POPULAR & VENERABLE
GOOD HADRONIZATION MODELS

1. REALLY A LL GENERATOR

   AT LEAST α_s IS LO IN PS : $\frac{2\pi}{b_0 \log\left(\frac{k^2}{\Lambda^2}\right)}$

2. USES "EXACT" KINEMATICS

   BUT DON'T KNOW WHAT WILL HAPPEN TO A DAUGHTER

3. SHOWER IS "NATURALLY" M^2 ORDERED

   θ-ORDERING BY VETO

   PHASE SPACE OF AN EXACT k_T CLUSTERED SHOWER IS NOT THE SAME

k_T^2-clus vs M^2 $\quad a \to bc$

$M^2 = 2 E_b E_c (1 - \cos\theta_{bc})$ ← IF $m_b = 0$, $m_c = 0$!

$k_T^2\text{-clus} = 2 \min(E_b^2, E_c^2)(1 - \cos\theta_{bc})$

$= \min\left(\frac{E_b}{E_c}, \frac{E_c}{E_b}\right) M^2$

$= \min\left(\frac{z}{1-z}, \frac{1-z}{z}\right) M^2$

ALTERNATIVE: GUESS AT m_b^2, m_c^2

- $m_b^2 = m_c^2 = \left(\frac{k_T^{\text{VETO}}}{2}\right)^2$ (1)

EITHER WAY, NOT A SHARP TRANSITION AT k_T^{VETO} (UNLESS $\sqrt{s} \to \infty$)

- $\left(k_T^{\text{VETO}}\right)^2 + \left(z^2 + (1-z)^2\right) m_{b,c}^2$ (2)

$\alpha_s\left(p_T^2 = z(1-z)M^2\right) \to \alpha_s\left(\frac{1}{4} k_T^2\text{-clus}\right)$ (3)

K_T^{CLUS} IS POST-MORTEM

WE ARE MODIFYING HOW THE PISTONS MOVE

(α) ARE THERE "BETTER" PARTON-LEVEL CUTS?

YET, SOMETHING LIKE K_T^{CLUS} IS THEORETICALLY MOTIVATED

... COULD VETO SHOWERS AFTERWARDS

(β) CAN WE RELAX THE "PHILOSOPHY"?

"NODAL" VALUES OF K_T^{CLUS} ARE NOT A GOOD STARTING POINT

$$K_T^2 = \min\left(\frac{E_b}{E_c}, \frac{E_c}{E_b}\right) M^2 \leq M^2$$

START AT M^2 OR $c \cdot K_T^2$ $c > 1$

LOWEST & HIGHEST MULTIPLICITIES HAVE MOST REASONABLE BEHAVIOR

OBVIOUSLY, SOME TWEAKING IS NECESSARY

OTHER QUESTIONS

1. WHY NOT JUST VETO AT THE END?

TIME CONSUMING?

2. DO WE HAVE THE "FULL" FIXED ORDER CORRECTION

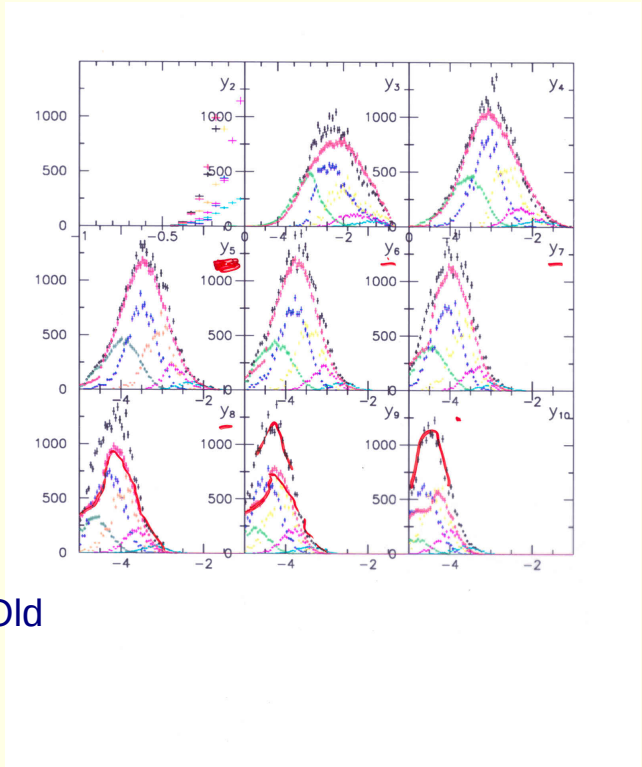
INSTEAD OF $\sum_i |M.E.|^2_{\text{ORDER } i} \xrightarrow{\text{CLUST}}$ "(P.S.)"

DO $(P.S.) + \sum_i \left(|M.E.|^2_{\text{ORDER } i} - (P.S.)|_{\text{ORDER } i} \right)$

I - PIECE

7

Shape Variables at LEP



Black=New, Red=Old