PYTHIA Simulation of Quirks at Tevatron

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ongoing work with

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Model

Kang, Luty arXiv:0805.4642

Microscopic Strings

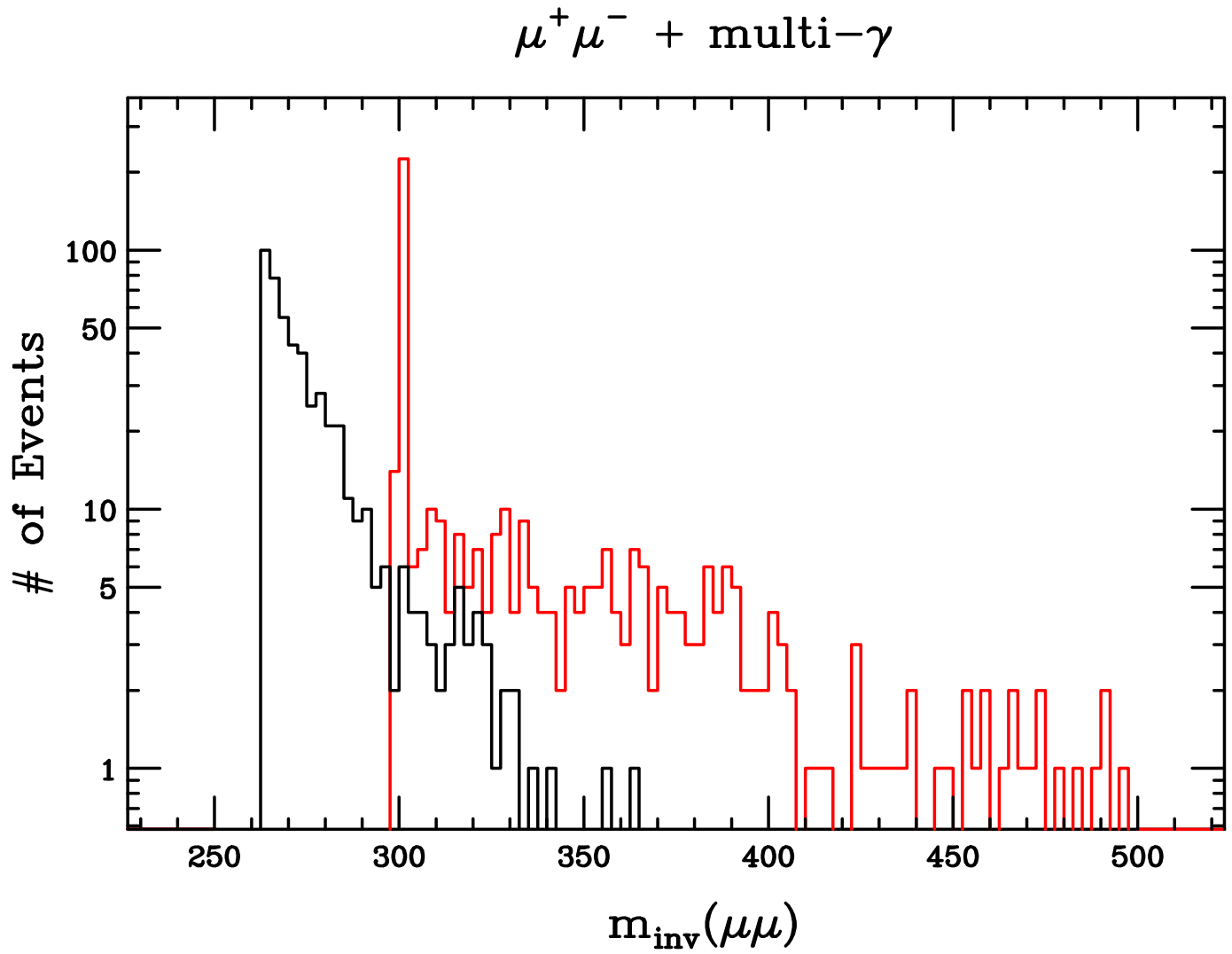
MeV $\lesssim \Lambda \ll m_Q$, quirk Q: fundamental in new 'infracolor' group

- Production
  - Needs to carry EW or QCD charge, strongly produced
  - Carries infracolor charge, has to be PAIR produced as IC singlet
- QCD String and Infracolor String Formation
  - QCD string fragments into QCD hadrons and Qq hadrons
  - Infracolor string oscillates, loses engergy with each crossing
    $\sigma \sim$ geometrical; interaction rate $\sim$ 1/crossing
    Assume $\Lambda_{QCD} > \Lambda$, no IC glueball radiation
  - $\pi^0 \to \gamma\gamma$, focus on γs. No π^0 reconstruction.
- $Q\bar{Q}$ bound state decays/annihilates into gg, $q\bar{q}$ or $\ell^+\ell^-$
  $BR(Q\bar{Q} \to \ell\ell) \sim \alpha^2/N_C^2$
- Prompt decay/annihilation

Simplications

- One flavor of heavy quirk
- Only at PYTHIA level. No detector simulation.
- Begin by looking at lepton channels.

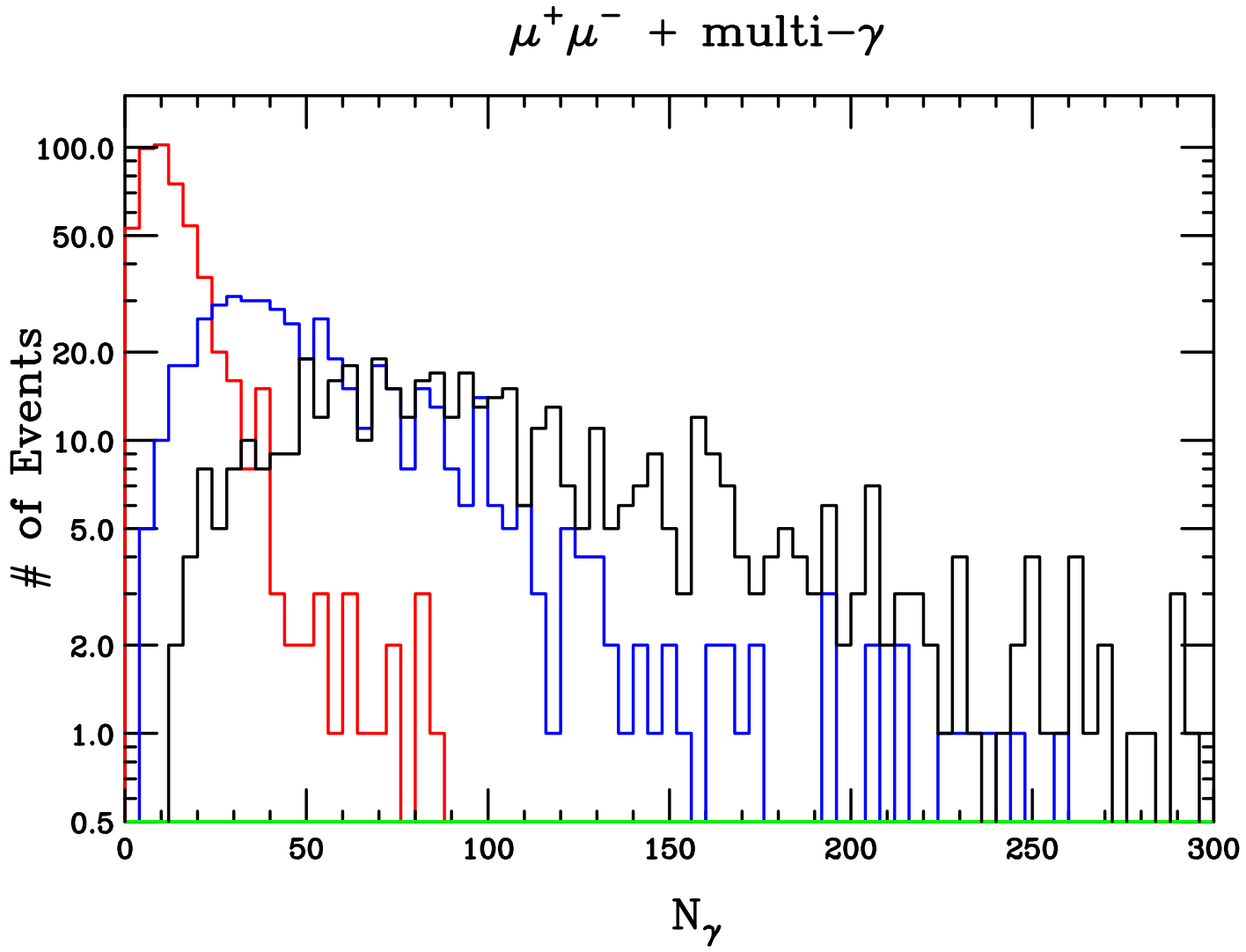
Invariant Mass of $\mu^+\mu^-$



$Q\bar{Q}$ system resembles a narrow resonance

Cross section not normalized!

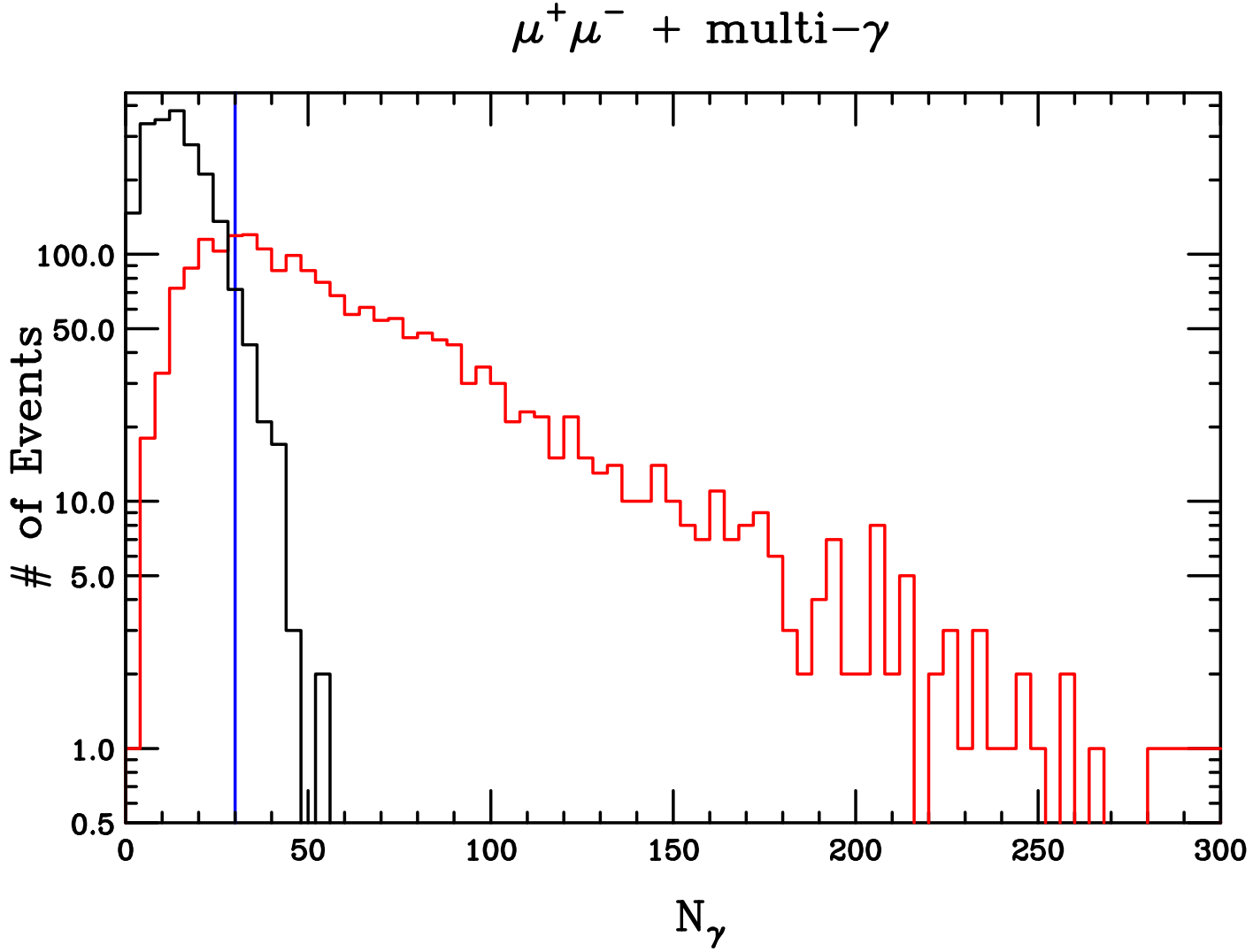
Number of Photons



- Photon p_T acceptance: $p_T(\gamma) \geq 500, 200, 20$ MeV
- Single Photon Efficiency?

Number of Photons

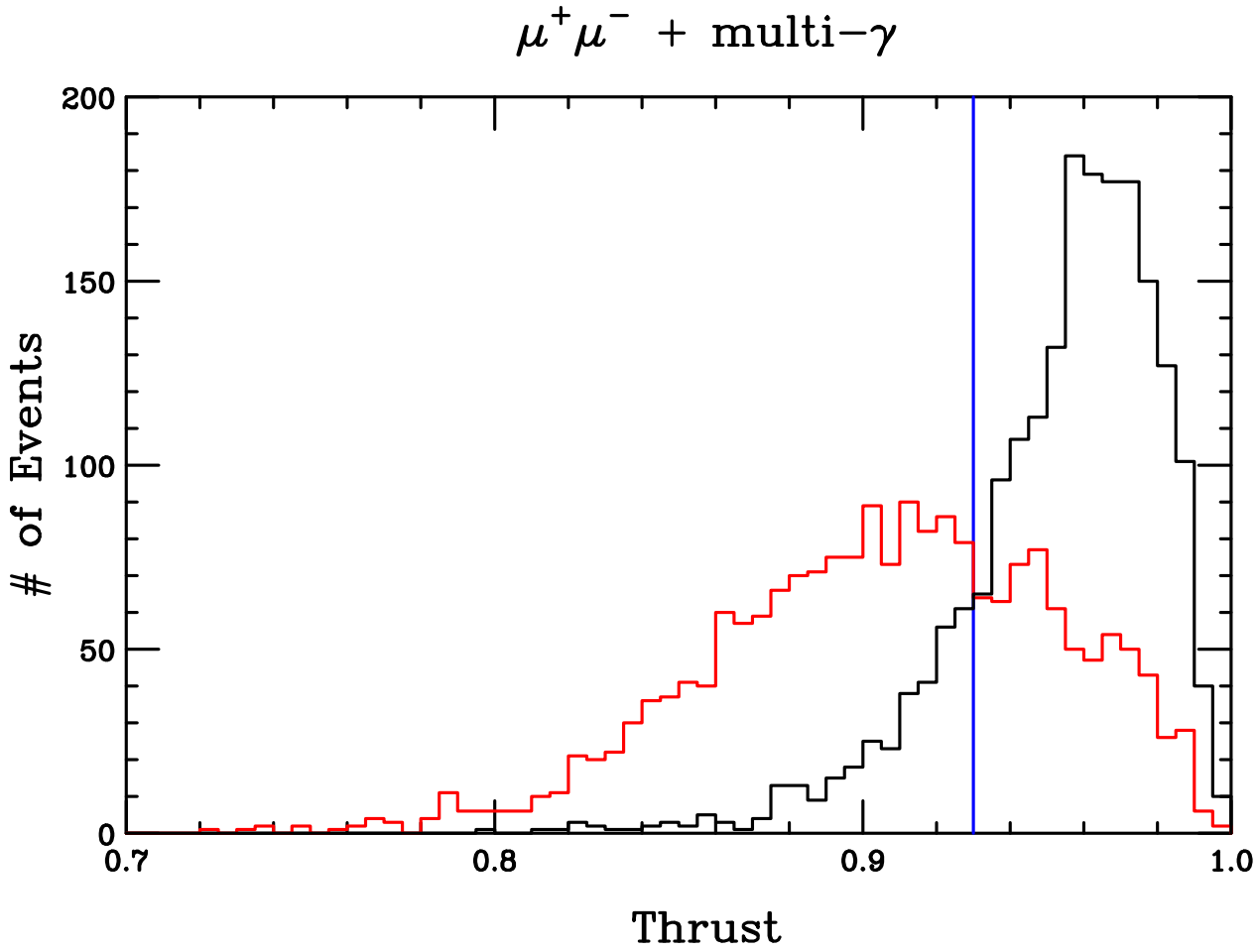
Signal vs. Background



$p_T(\gamma) \geq 200$ MeV

$\epsilon_s = 0.72$, $\epsilon_b = 0.045$, for $N_\gamma > 30$

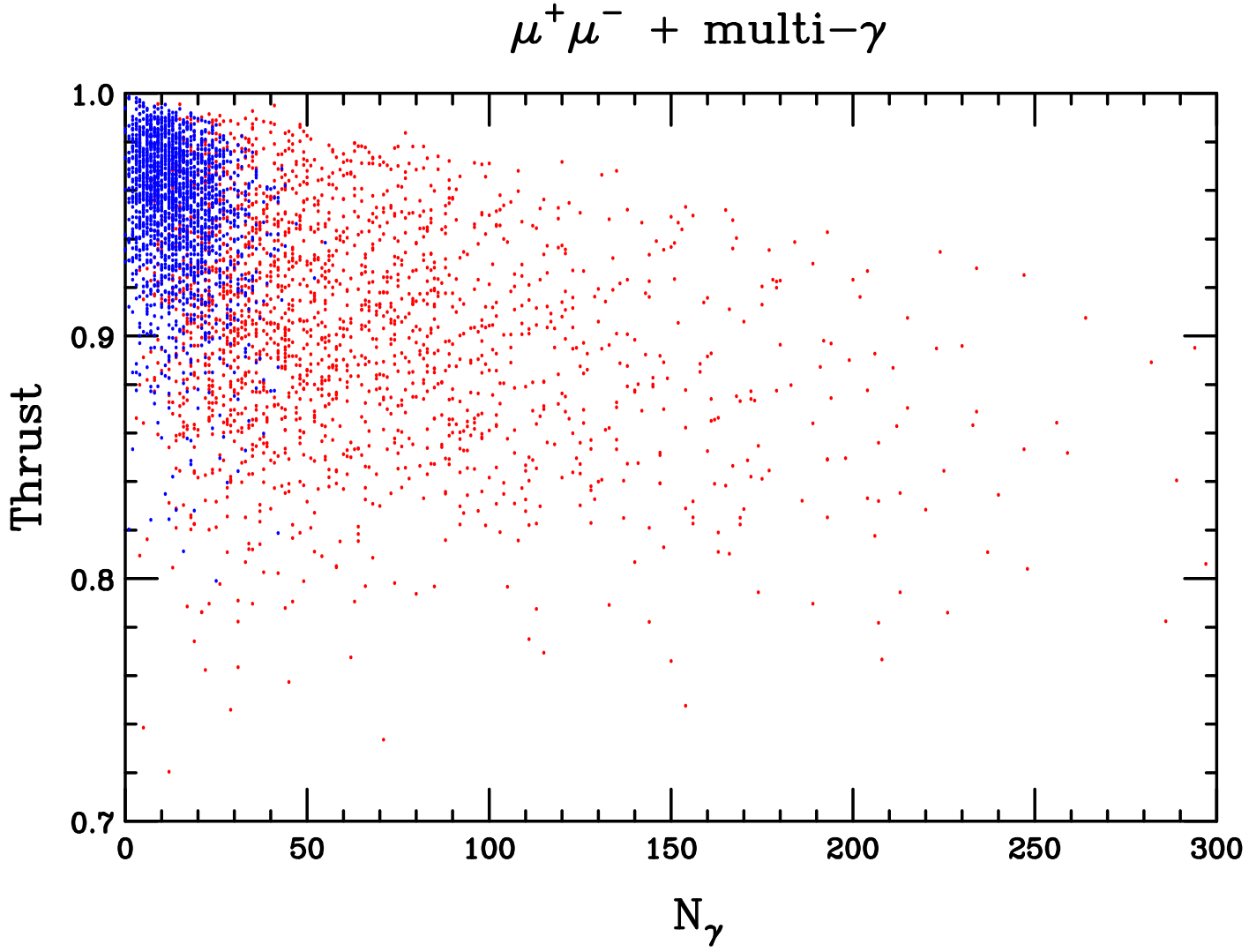
Thrust Distribution



$\epsilon_s = 0.78$, $\epsilon_b = 0.17$, for thrust < 0.93

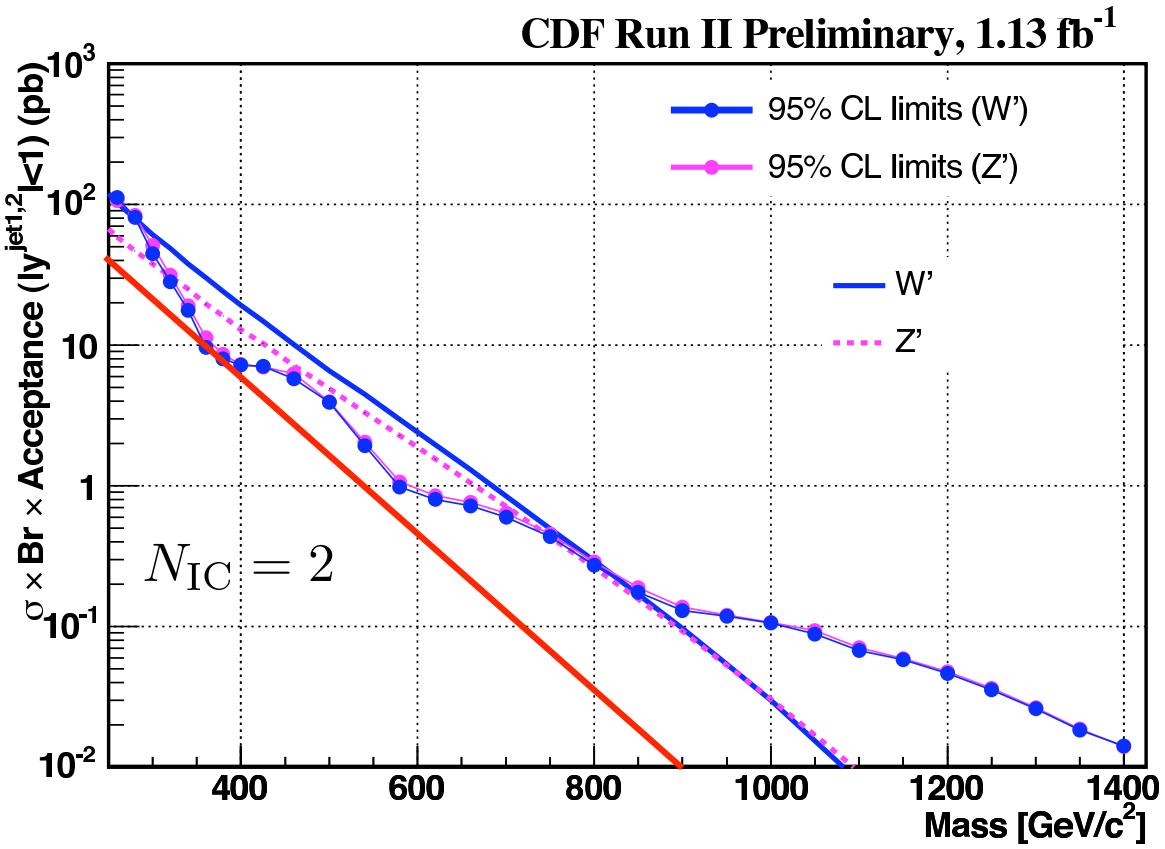
- High thrust from hard muon pairs.
- Photons bremmed off muons are nearly colinear.
- Fireball ($\sim$ spherical) from quirky strings reduces thrust.

N_γ vs. Thrust



Hadronic Mode (dijet+fireball)

Dijet Resonance Search



Assumes 100% annihilation at rest

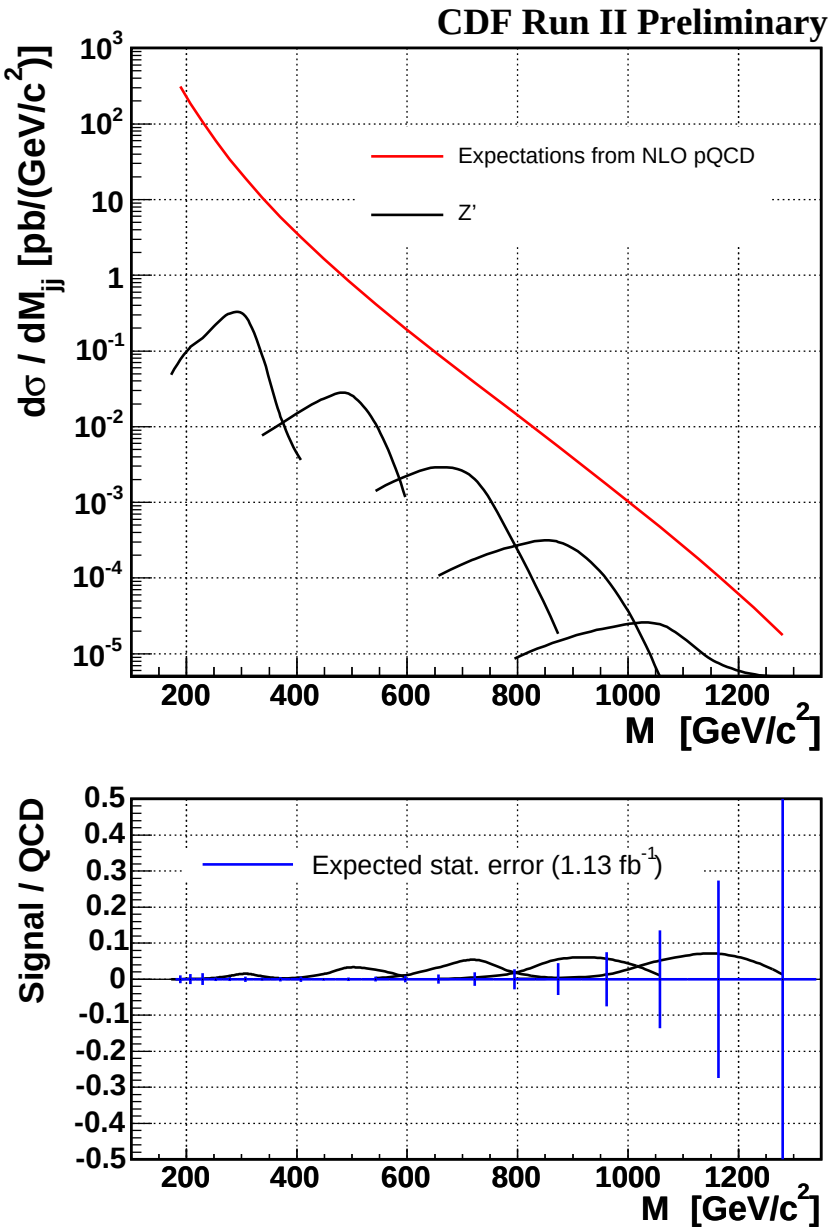
Signal and Background Efficiencies

$\sim 1\ fb^{-1}$ data

- $\sigma_B \sim$ 3nb, $B \sim 3e6$ events (with efficiency)
- $\sigma_S \sim$ 20pb, $S \sim 2e4$ events (without efficiency, $\epsilon \sim 0.1$?)
- $\epsilon S/\sqrt{B} \sim 1$
- additional efficiencies based on N_γ, thrust cuts etc.
  $\epsilon_S/\sqrt{\epsilon_B} \sim 0.6/\sqrt{0.008} \sim 6$

Hadronic Energy Resolution

CDF Simulations for Dijet Resonances

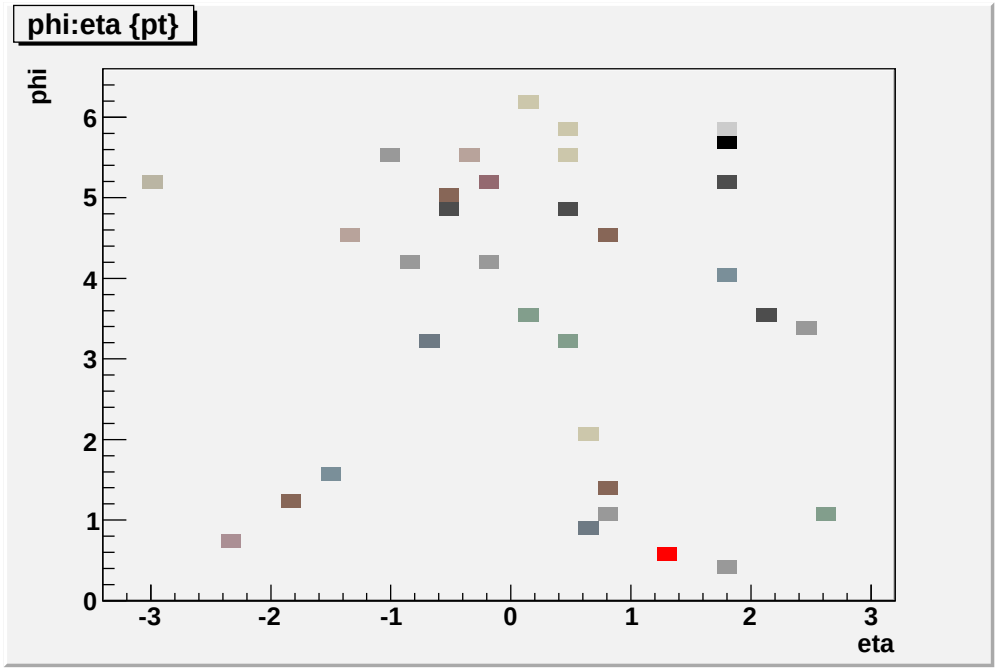


Summary

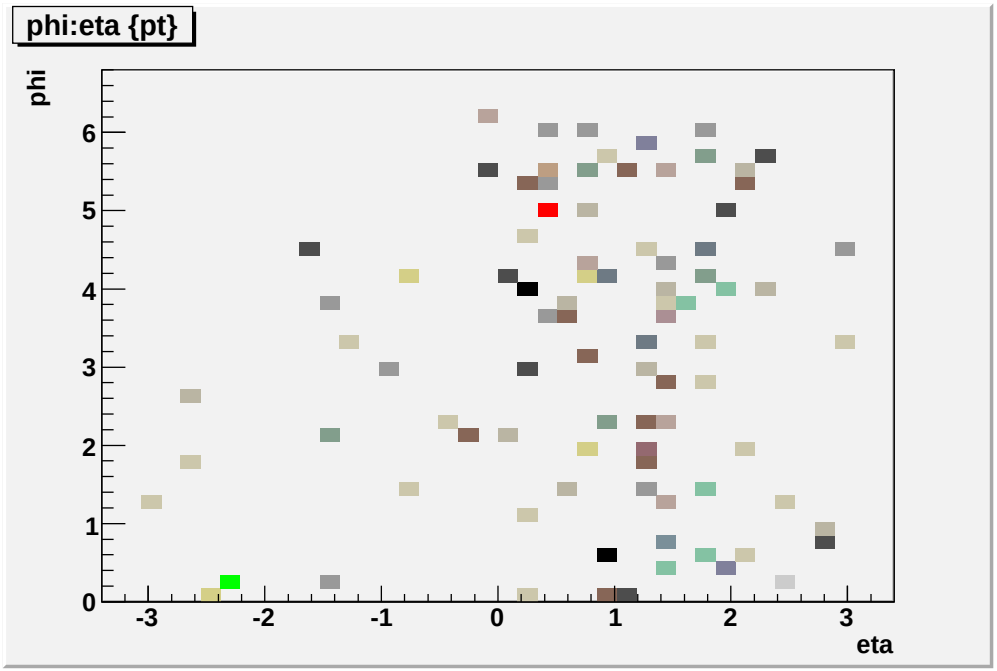
- Fireball signature. Particle multiplicity, event shape ...
- Issues: high multiplicity efficiency, soft photon/hadron resolution ...
- Interesting phenomenology, despite constrained model parameter space and multiple simplifications
- More ingredients can be added for more complicated events

Event examples

$N_\gamma = 34$

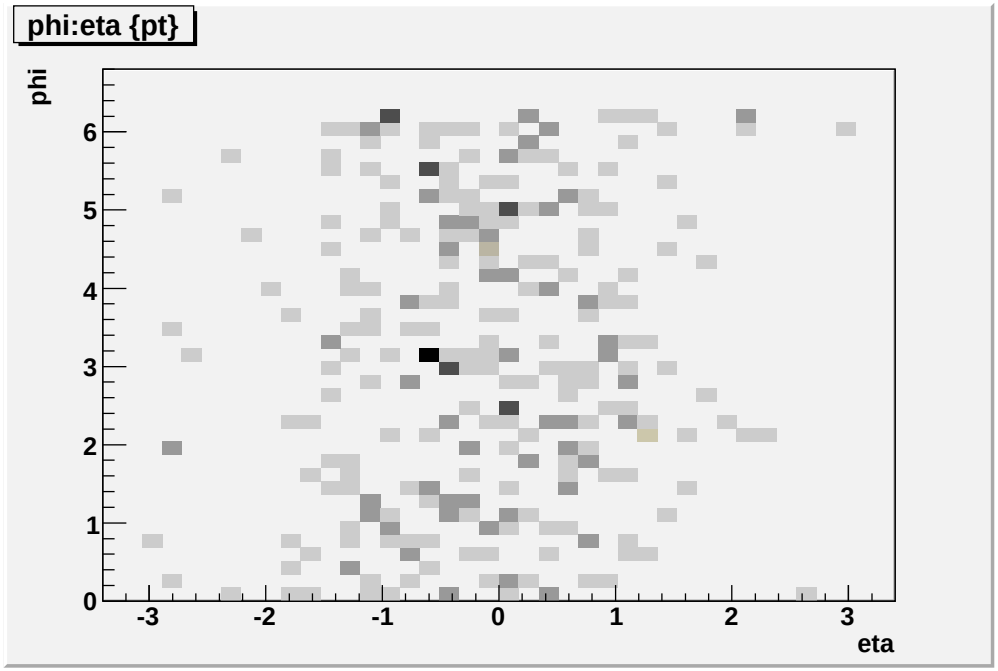


$N_\gamma = 95$



Event examples

$$N_\gamma = 279$$



Hadronic Energy Resolution

CDF Simulations for 800GeV Dijet Resonances