Dijet Mass Spectra and Search for Quark Compositeness

MANOJ K. JHA
(INFN BOLOGNA)
On behalf of
CDF Collaborations

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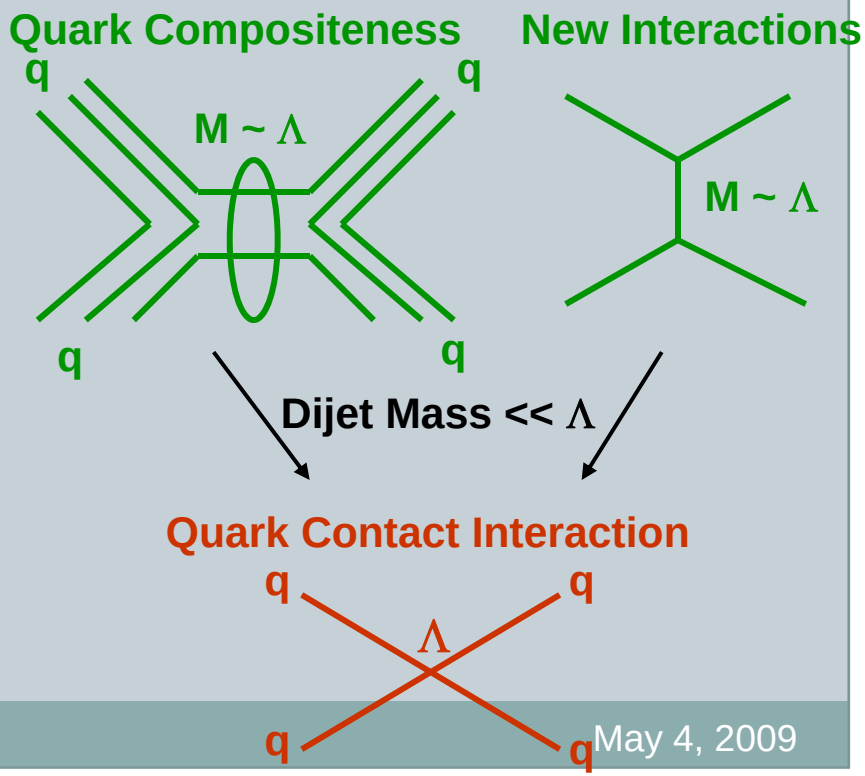
Overview

- Motivation
- Data and MC Sample
- Xsec From MC Sample
  - Backgrd and Signal
- Trigger Efficiency
- Dijet Cross Sections
- Next Plan

Motivation

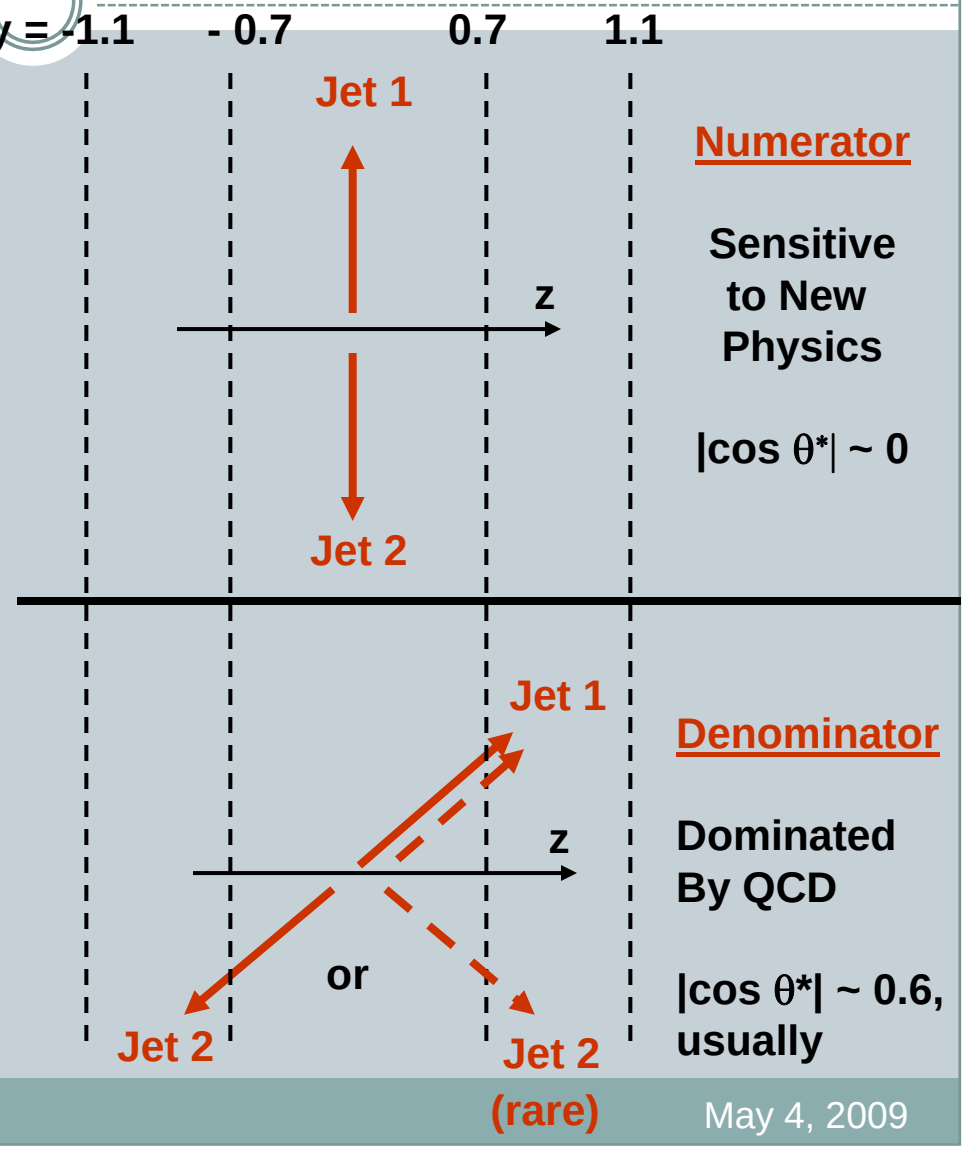
- **Test of perturbative QCD**
  - **Measurement of the dijet mass spectrum provides fundamental tests of pQCD over many order of magnitude in cross section: complimentary analysis of the inclusive jet cross section measurement.**

- **Search for new physics:**
  - **Quark compositeness**
  - **New interactions from massive particles exchanged between partons.**



Dijet Ratio: Simple Angular Measurement

- **Dijet Ratio = N(|y|<0.7)/N(0.7<|y|<1.1)**
  - Number of events in which each leading jet has |y|<0.7, divided by the number in which each leading jet has 0.7<|y|<1.1
- **Simple measurement of angle distribution**
  - The numerator and denominator are defined based on their rapidities. Easy control of systematic uncertainties.



Data and MC Samples

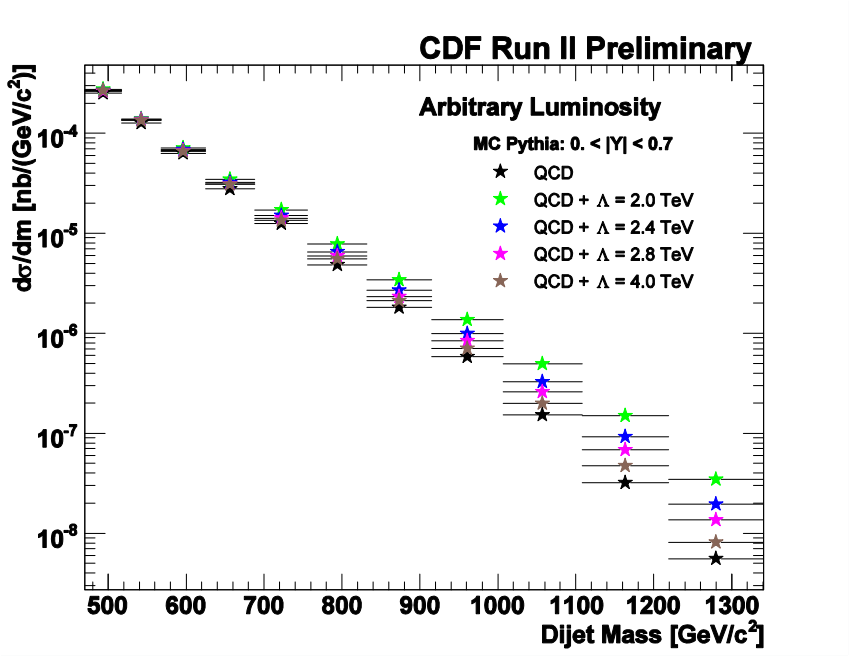
- **Data:**
  - **Luminosity: 3.03 fb^{-1}**
- **MC**
  - **QCD: Pythia 6.2, Tune A**
  - **Use NLOJET++ to understand higher order effects (NLO vs LO), scale dependence, and PDF uncertainty (CTEQ66)**
  - **Quark compositeness signals generated with Pythia 6.2**
    - Canonical model among left handed composite quarks given by Eichten, Lane and Peskin.
    - All quarks participating in contact interaction.
    - Different values of $\Lambda = 2.0, 2.4, 2.8$, and 4.0 TeV

Event Selection and Jet Corrections

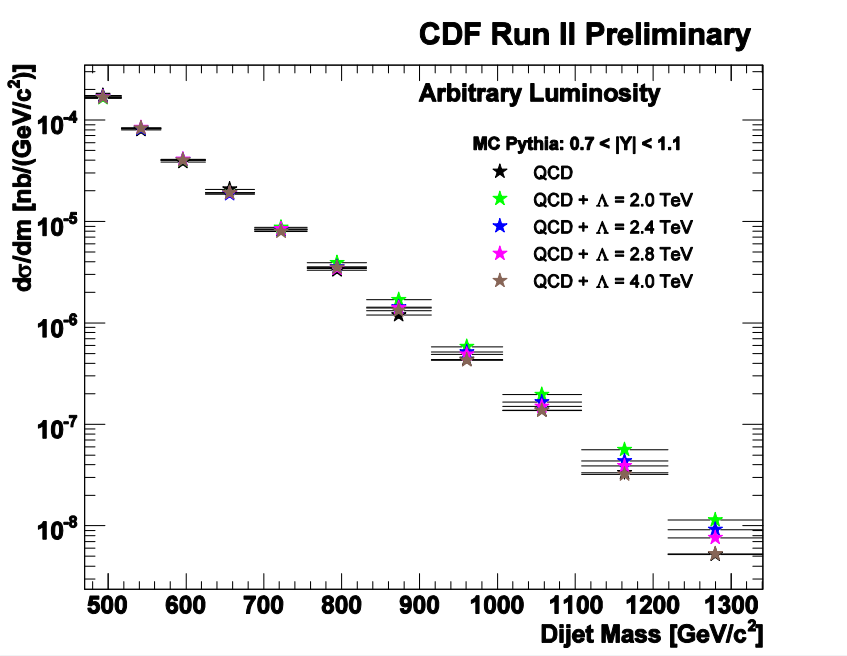
- **Reconstruct jets using the Midpoint algorithm with cone size=0.7**
- **Basic event selections:**
  - Primary vertex $|z| < 60$ cm
    - Ensure the events are well contained within the detector.
  - Missing Et significance cut: $MET/\sqrt{\sum E_T} < \min(3 + (5/400) * P_T^{jet1}, 6)$
    - Reduce the backgrounds from cosmic ray.
- **Jet corrections:**
  - Relative correction:
    - To make the jet energy response uniform in rapidity.
  - Pileup correction:
    - Correction for additional p-p- interactions in same bunch crossing.
  - Absolute correction:
    - Correction for non-linear response of calorimeter jet energy.

Signal Xsec for Different Values of Λ

0. < |Y| < 0.7



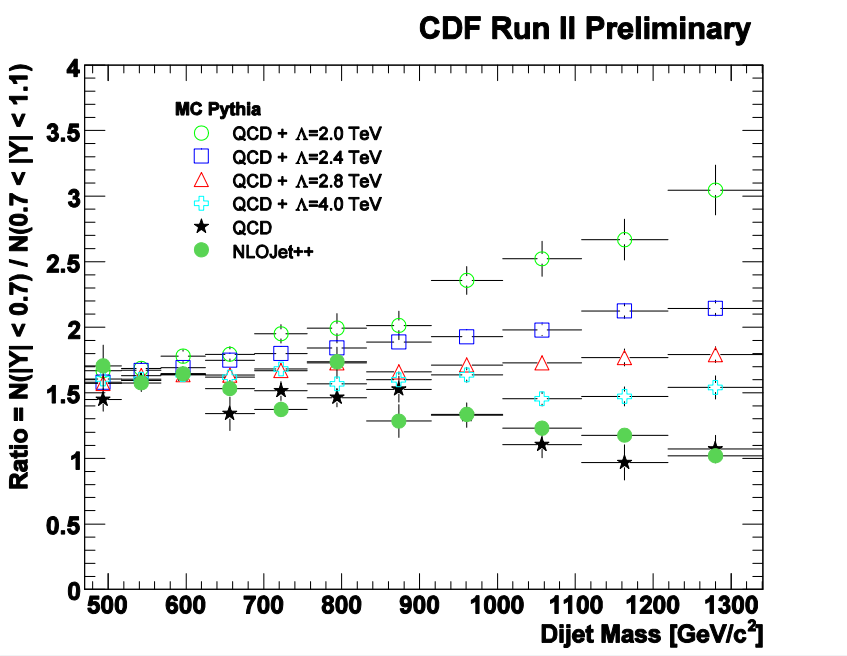
0.7 < |Y| < 1.1



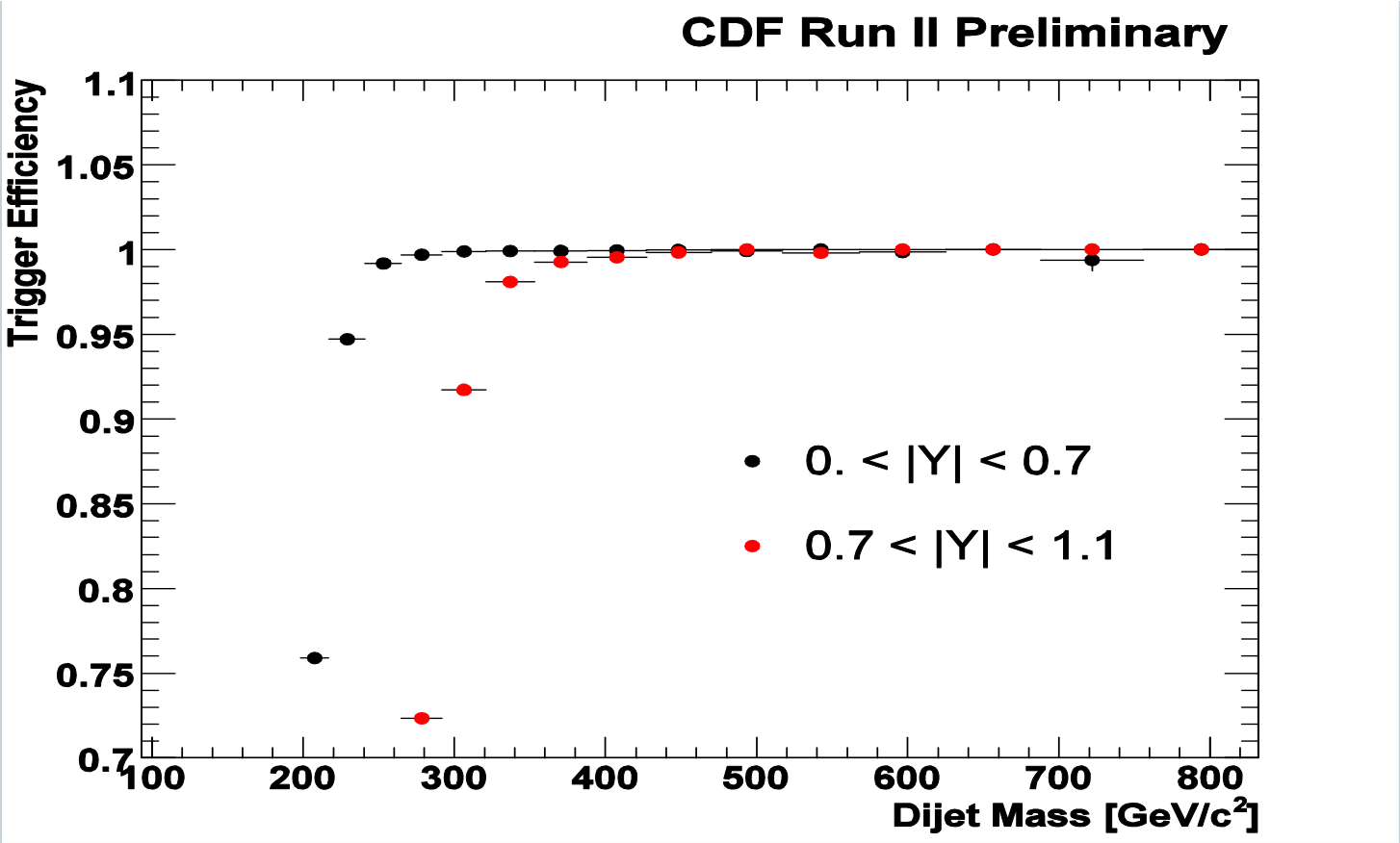
- **Signal cross sections increases with dijet mass.**
- **Lower the compositeness scale higher the cross sections.**

Dijet Ratio

- Ratio from Pythia & NLOJet++ shows the similar behavior (large theoretical uncertainty cancel out to some extent).
- Dijet ratio from signal increases with dijet mass.
- Smaller compositeness scale have larger effect on dijet ratio.



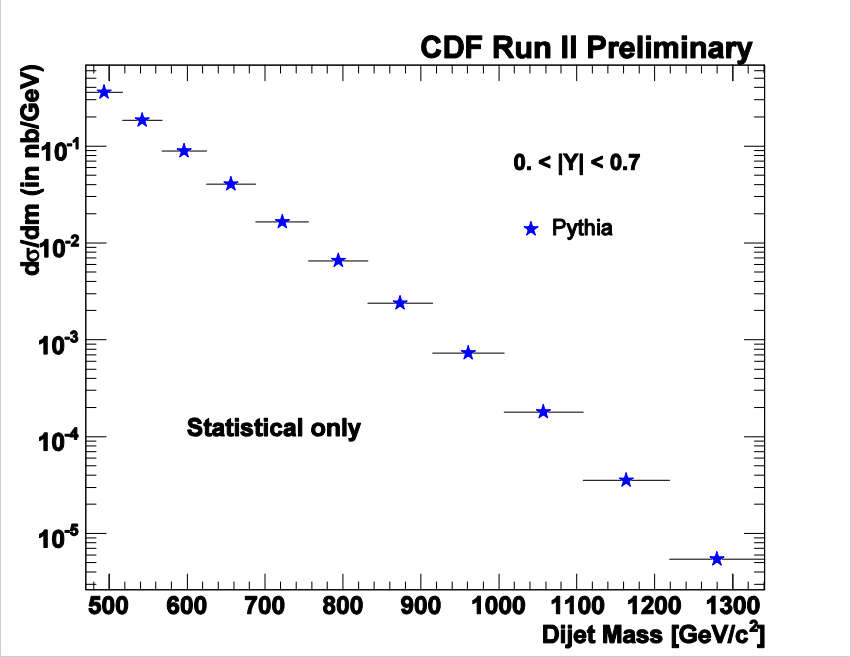
Trigger Efficiency



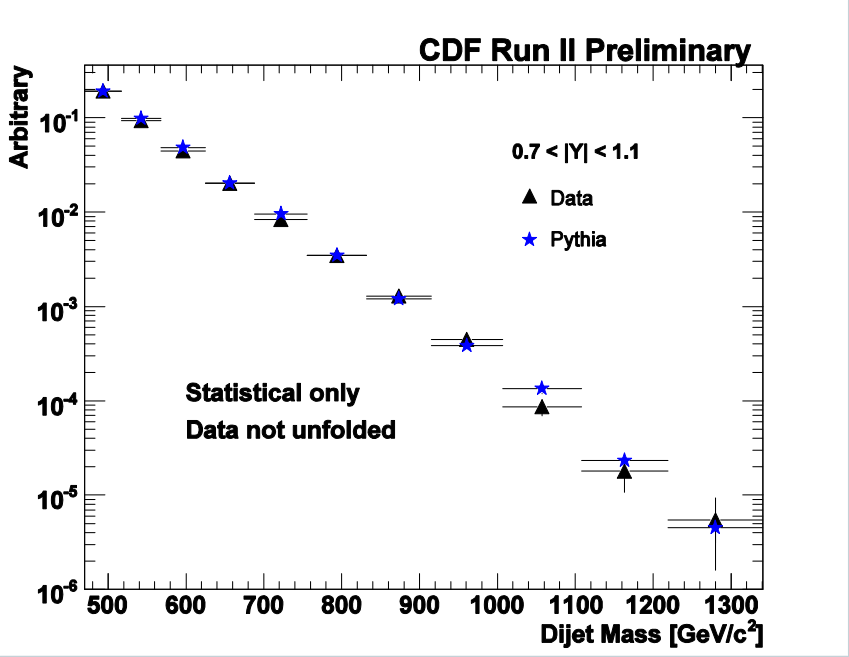
- **Only bins in which trigger efficiencies are greater than 99.5% are used for the measurement.**

Dijet cross sections

0. < |Y| < 0.7



0.7 < |Y| < 1.1



- **Error bars are only statistical.**
- **Data has not been corrected which removes smearing effects in the energy measurement of the calorimeter.**

Next Plan

- **Apply jet energy corrections which has not been applied, like unfolding.**
- **Consider systematics from all other sources, like**
  - **Jet Energy Scale**
  - **Jet Energy Resolution**
  - **Parton Distribution Functions**
  - **Unfolding, Pileup , dijet mass spectra reweighing, etc.**
- **Obtain final results on compositeness**