The bb production cross section at CDF

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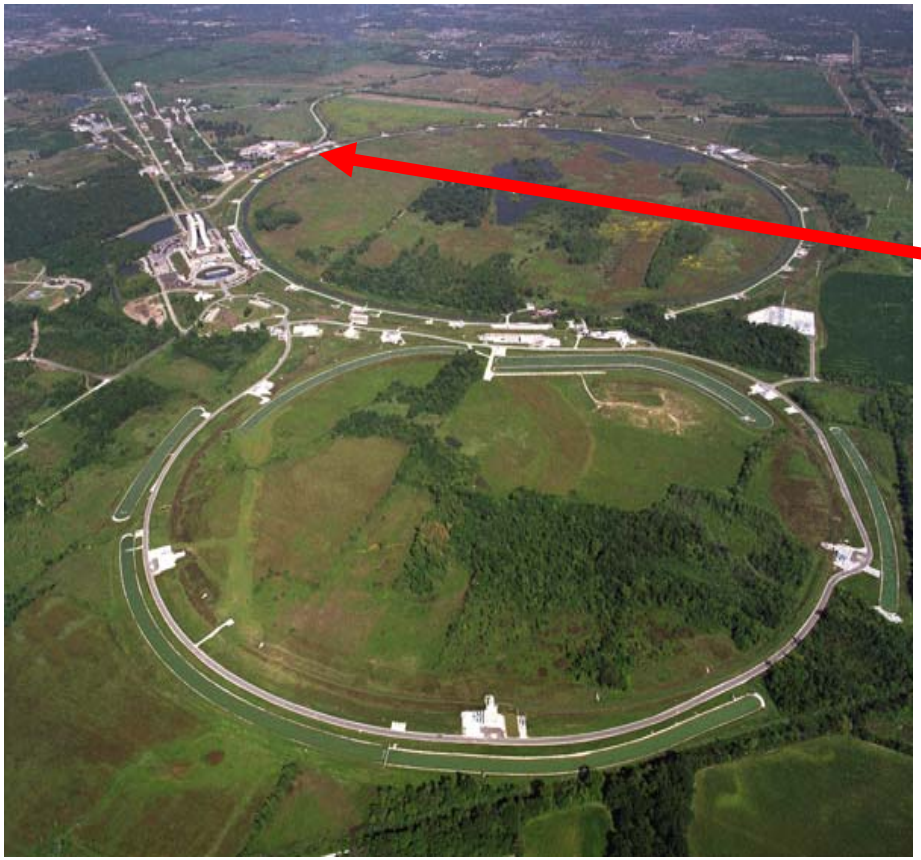
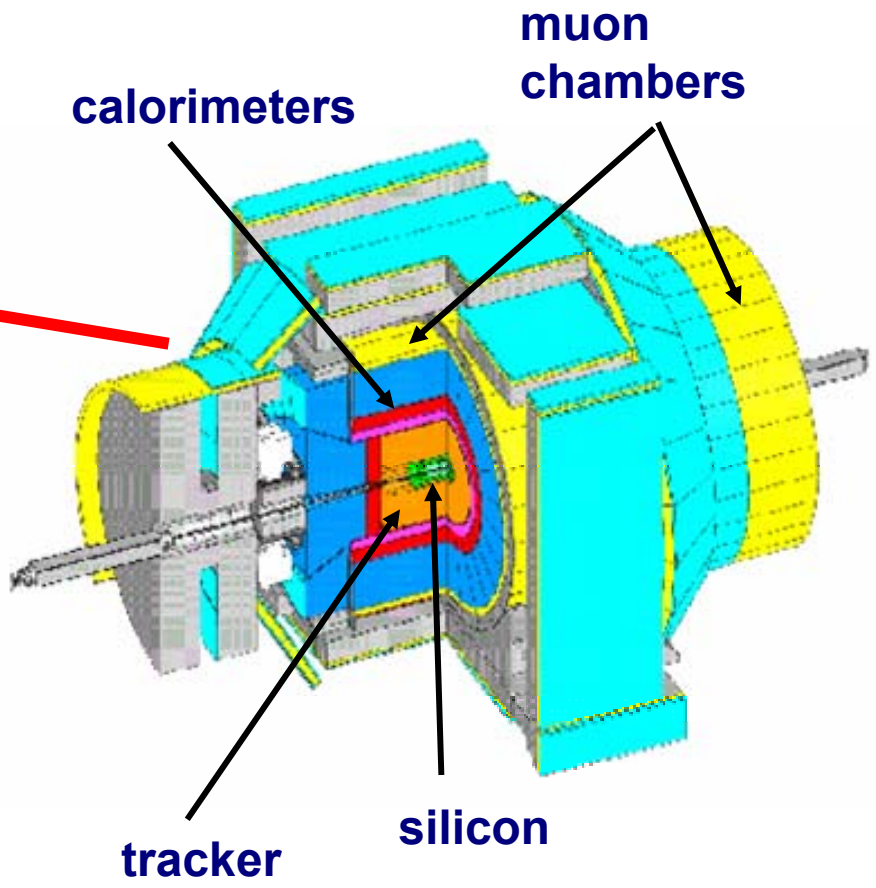
- The TeVatron And The CDF Detector
- Motivation
- Production Mechanisms
- B tagging
- Cross Section Measurement
- Conclusions

The TeVatron and CDF

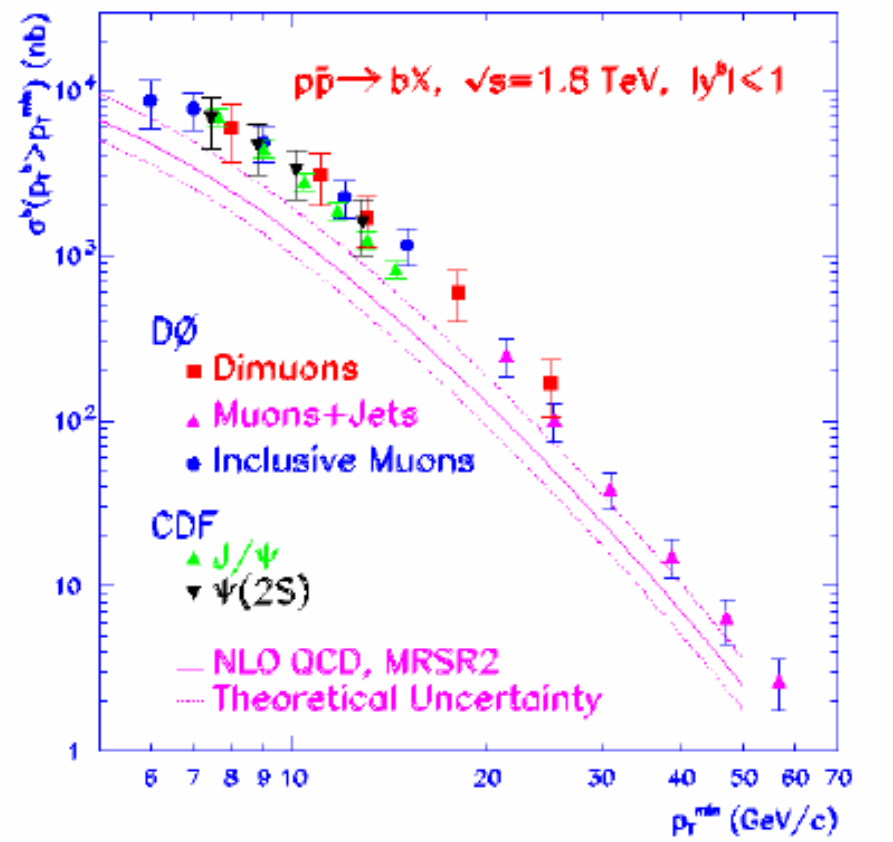




$\sqrt{s} = 1.96\text{TeV}$

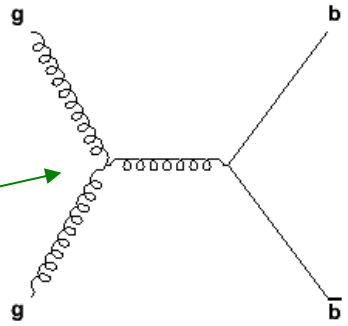
Motivation

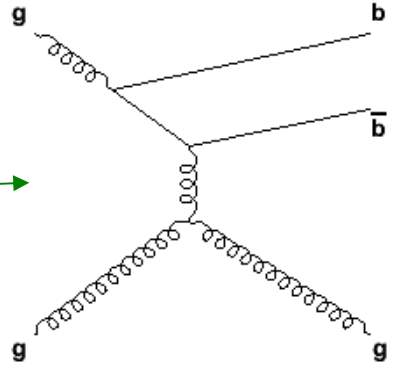
- Run 1 Discrepancy
  - Measured rate is factor of 2 higher than predicted by NLO QCD
  - Also seen at HERA
- Excess could indicate new physics or different production mix
- Important test of NLO QCD

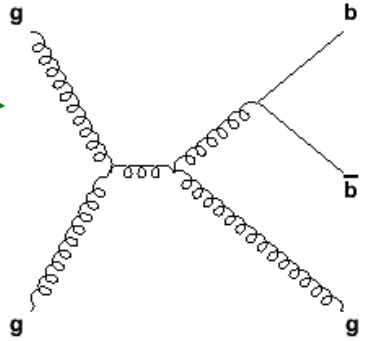


Production Mechanisms

- Leading order and next to leading order can be split into three classes
  - Flavour Creation
    - qq annihilation/gluon fusion
  - Flavour Excitation
    - Scattering of a b out of the initial-state into the final-state by a gluon or by a light quark
  - Gluon Splitting
    - Pair created within parton shower or during the fragmentation process of a gluon or a light quark

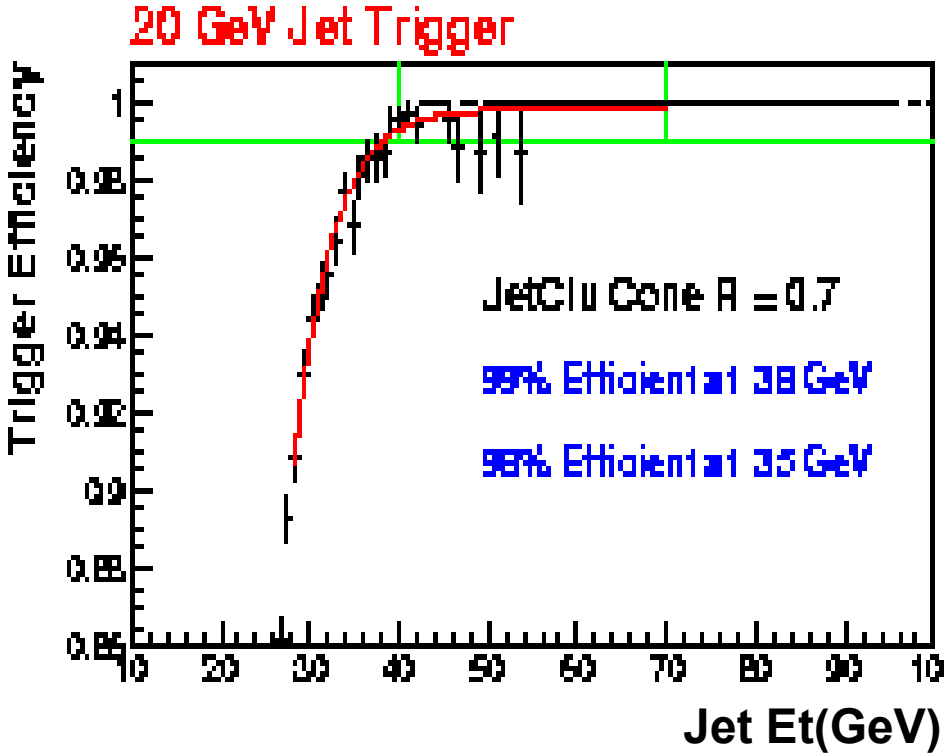






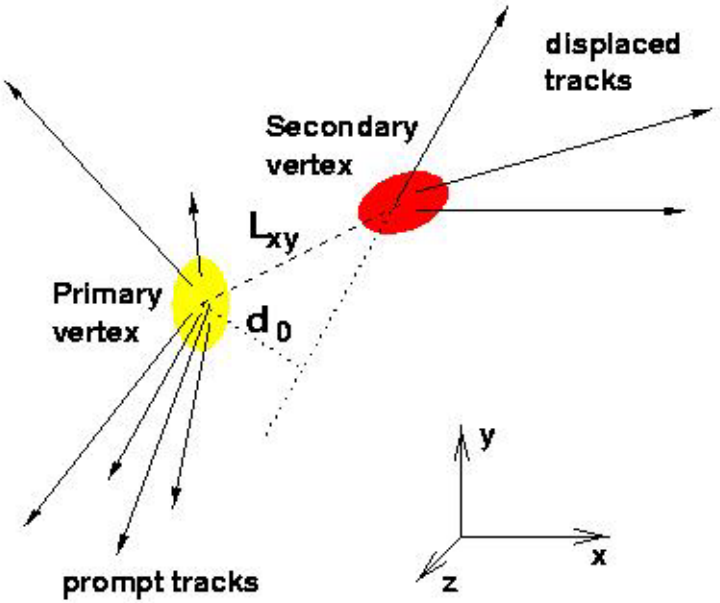
Data Sample

- 20GeV jet triggered sample
  - Three level trigger
    - Level 1: single tower in calorimeter >5GeV
    - Level 2: calorimeter cluster >15GeV
    - Level 3: reconstructed jet >20GeV
- 32pb^{-1} of data
  - Collected 11/02 – 03/03



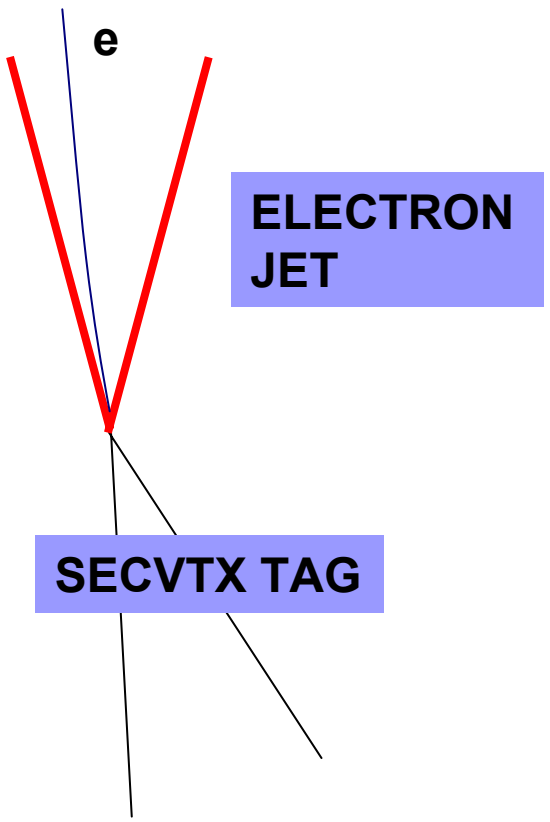
CDF's b Tagging Algorithm - SECVTX

- Secondary Vertex Tagger
- Tracks from secondary vertex have large impact parameter
- Selects these tracks to form a vertex



SECVTX b Tagging Efficiency - Event Selection

- Determine efficiency from data using electron triggered sample
- Event Selection
  - Look for jet: Et > 15GeV
  - require electron to lie within jet: $\Delta R < 0.7$ "electron jet"
  - Ask for a second SECVTX tagged jet: $\Delta\phi > 2.0$ rad
- Try to tag electron jet with SECVTX



SECVTX b Tagging Efficiency

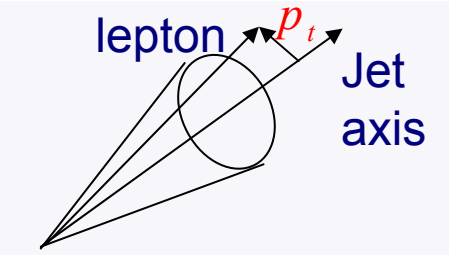
- Event Selection will contain “mistagged” jets from charm and light quarks
- Purity needs to be found
  - F_{betag} : b fraction of tagged electron jets
  - F_{bejet} : b fraction of electron jets

$$\varepsilon_b = \frac{F_{betag} \cdot N_{etag}}{F_{bejet} \cdot N_{ejet}}$$

SECVTX b Tagging Efficiency

Measuring b fraction of electron jets

- Electron pt relative to jet axis different for jets from b's compared to lights and c's



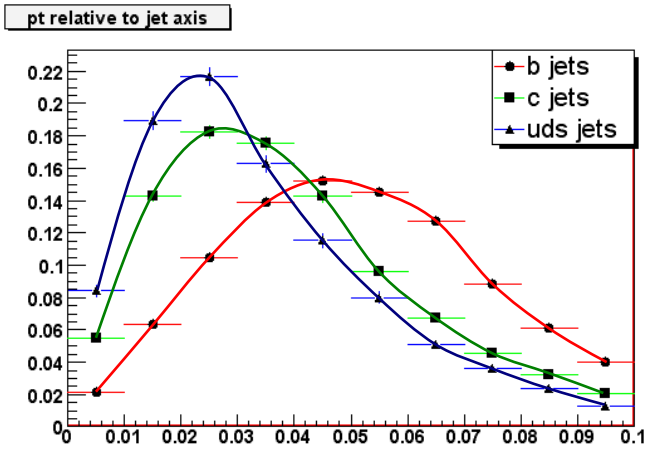
- Find pt spectrum from Monte Carlo for b jets, c jets and light quark jets
- Fit templates to corresponding spectrum in data

Measuring b fraction of SECVTX tagged electron jets

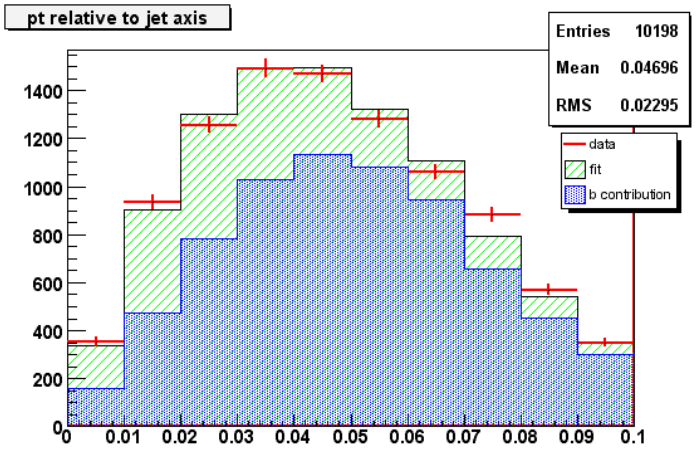
- Similar technique – use secondary vertex mass as template

SECVTX b Tagging Efficiency

electron jets

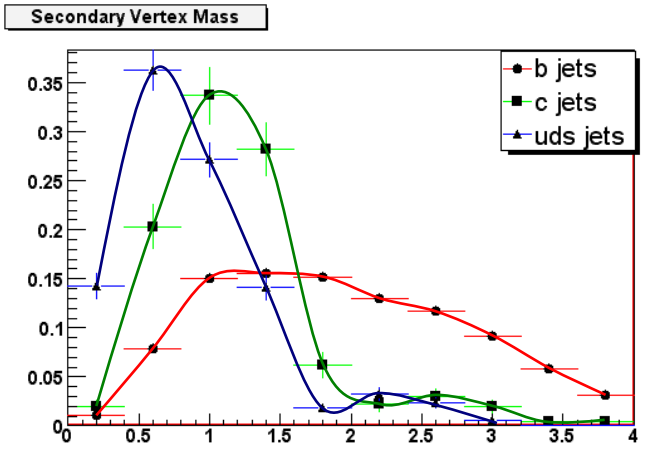


MC Pt_{rel} /jet Et

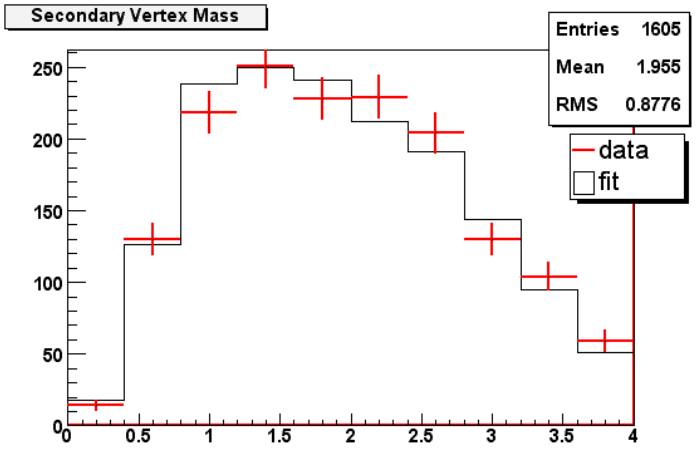


Fit to data Pt_{rel} /jet Et

Tagged electron jets



Mass (GeV)



Mass (GeV)

SECVTX b Tagging Efficiency

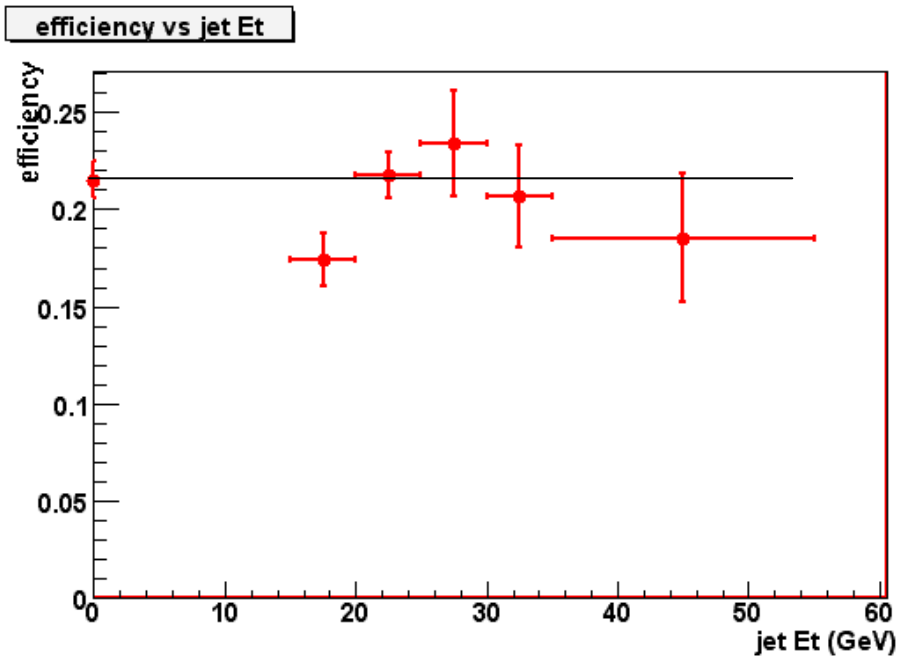
1.00 +/– 0.02 — F_{betag}

1605 — N_{etag}

$$\varepsilon_b = \frac{F_{betag} \cdot N_{etag}}{F_{bejet} \cdot N_{ejet}} = 0.22 +/- 0.01$$

0.73 +/– 0.02 — F_{bejet}

10198 — N_{ejet}



Cross Section Measurement

Event Selection

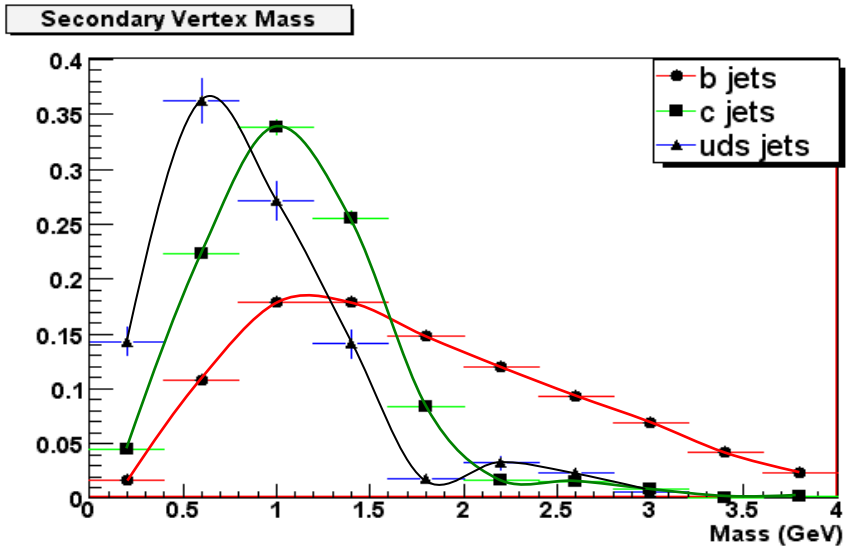
- Two SECVTX tagged jets
- $|\eta| < 1.2$
- Corrected $Et_{jet1} > 30GeV$

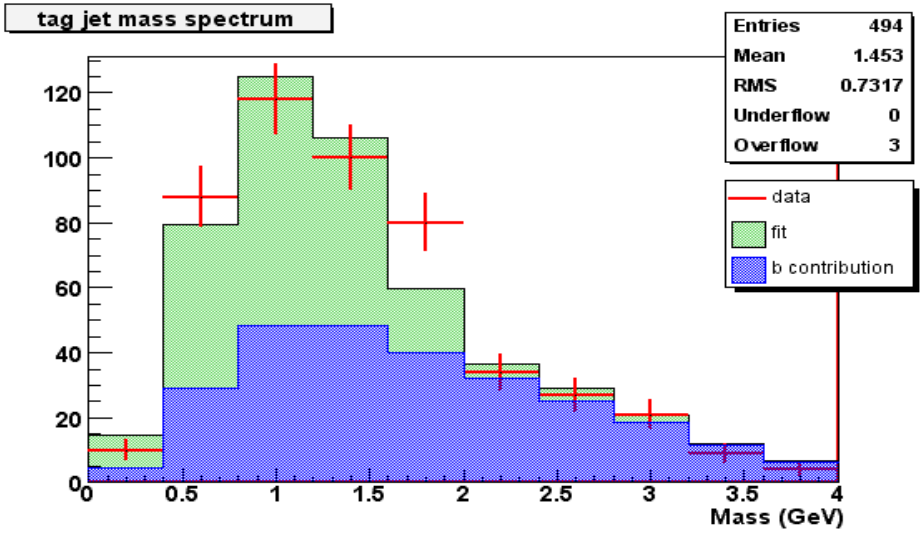
$$\sigma(|\eta|<1.2) = \frac{N^{events} \cdot p^{events}}{\varepsilon_b^2 \cdot \varepsilon_{jet} \cdot \varepsilon_{trig} \cdot \int L}$$

- SECVTX will also tag jets from charm
  - Purity needs to be determined before cross section can be measured

Cross Section Measurement – Purity of Sample

- Same technique as used for tagging efficiency
  - Use secondary vertex mass spectrum of the two tagged jets
- Also used in heavy flavour + photon analysis





Conclusions

- Measuring the bb production cross section
  - Using secondary vertex tagger
  - Required efficiencies and purities have been calculated
- Systematic errors are being calculated
- Consulting with theorists to get a NLO QCD prediction to compare result to
  - important test
- Long standing discrepancy needs to be figured out