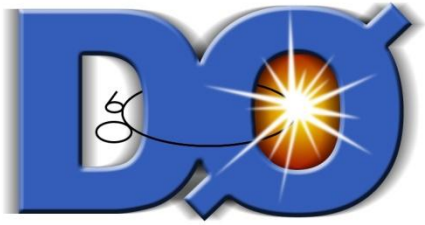

σ(Z+b-jet)/σ(Z+jet) Measurement With DØ at FNAL

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On Behalf of the DØ Collaboration

Motivation

- Important background to the SM Higgs search in the ZH channel.
- Probe of b-quark PDF, important for gb→hb & single-top studies
- Measurement of ratio σ(Z+b) / σ(Z+j) benefits from cancellations of many systematics ⇒ precise comparison with theory

Previous measurements

⇒ DØ @ 180 pb^{-1} : PRL94, 161801 (2005)

σ(Zb)/σ(Zj) = 0.021 ± 0.005 (ee + μμ)

⇒ CDF @ 2 fb^{-1} : PRD79, 052008 (2009)

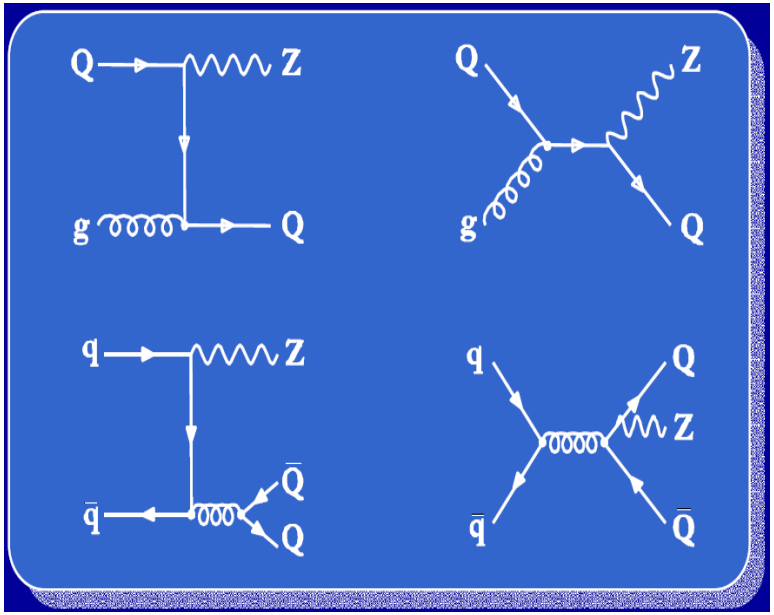
σ(Zb)/σ(Zj) = .0208±0.0047 (ee + μμ)

σ(Zb) = 0.85±0.14(stat)±0.12 (syst) pb

NLO Theory (PRD 69, 074021, 2004)

σ(Zb)/σ(Zj) : 0.018 ± 0.004

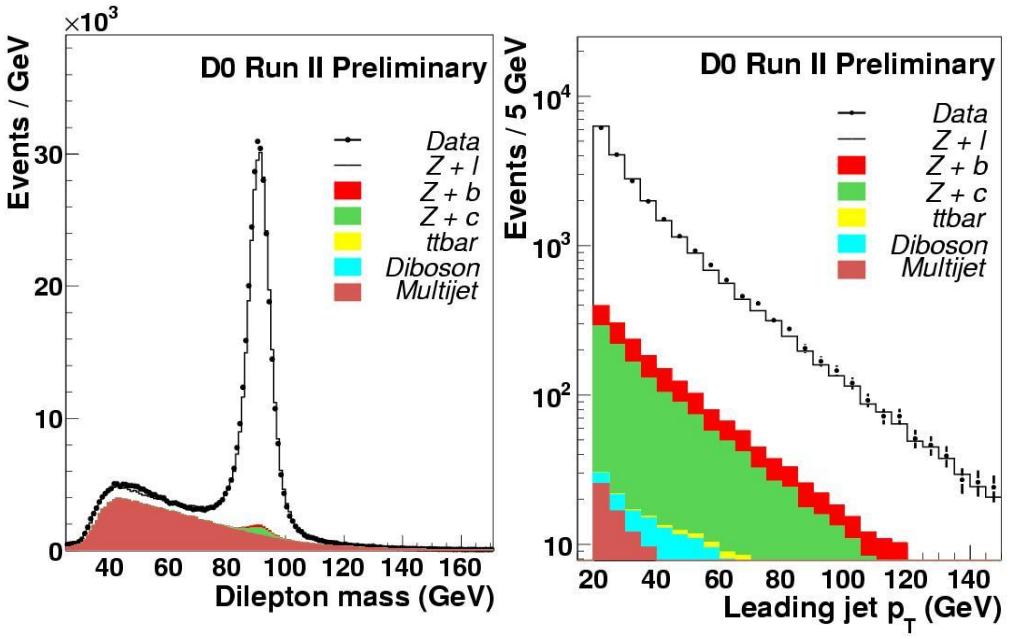
σ(Z+b) : 0.45 ± 0.007



Event Selection

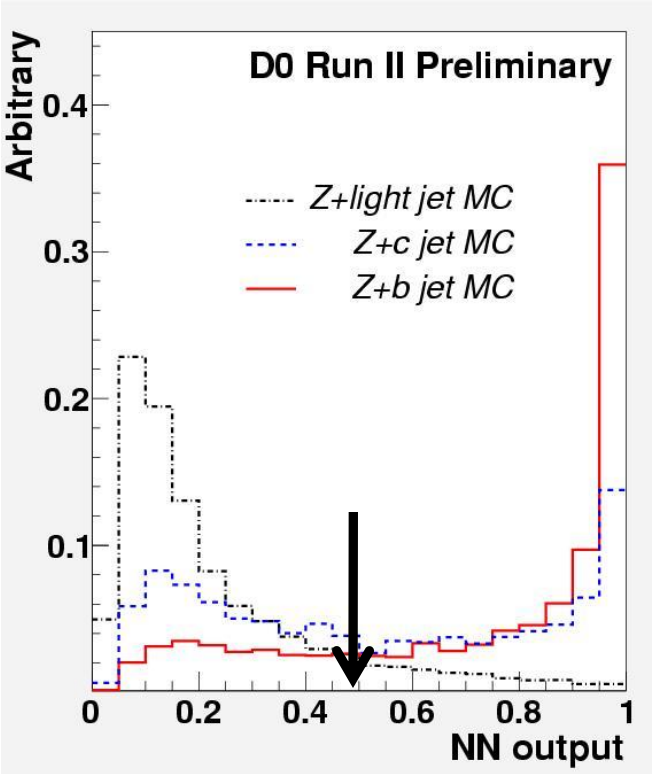
- 4.2 fb^{-1} data
- Pretag Selection:
  - Dilepton mass $70 \leq m \leq 110$ GeV
  - At least one jet
    - $p_T > 20$ GeV; $|\eta_{det}| < 1.1$
- Tagged Selection:
  - Apply NN algorithm to enrich in b-jets

- Alpgen + Pythia: Z+jets, ttbar
- Pythia: Diboson
- Multijet: Extracted from data



B-tagger

- Event Selection:
  - Dilepton mass $70 \leq m \leq 110$ GeV
  - At least one jet
    - $p_T > 20$ GeV; $|\eta_{det}| < 1.1$
- Tagged Sample:
  - Apply Neural Network algorithm on jets to enrich in b jets (NN > .5)
  - Use rJLIP variable to discriminate between b, c and light jets
    - rJLIP calculates probability of jet coming from primary vertex using tracks after the track with the largest IP has been removed
- Use data for light template, pythia+alpgen for b, c templates
- Use log likelihood fit to extract Z+b tagged jet events



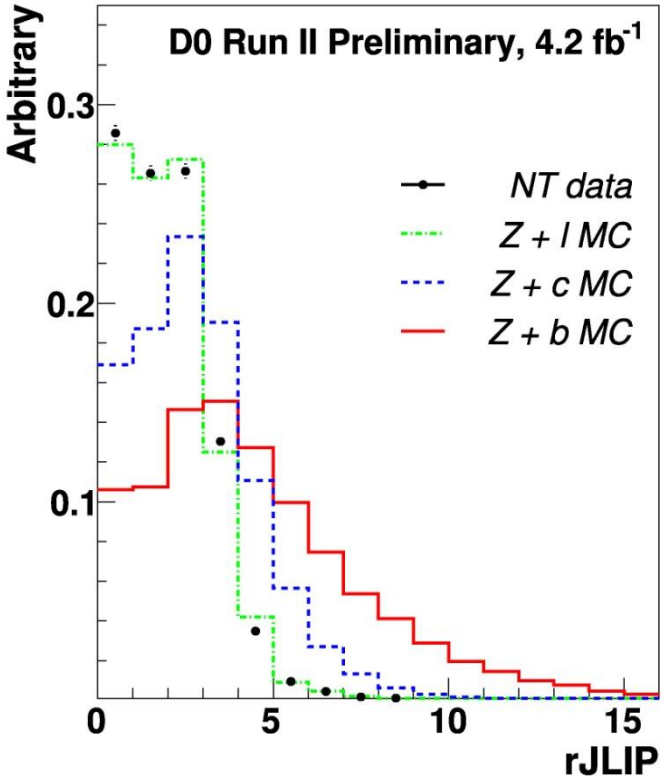
rJLIP Discriminator

- JLIP calculates the probability that a jet originates from a primary vertex using the impact parameter of the tracks
- Reduced JLIP (rJLIP) removes the track least likely to have come from the primary vertex, and then recalculates JLIP

$$rJLIP = -\ln \prod_{l}^{N_{Tracks}-1} P^{l}_{Track}$$

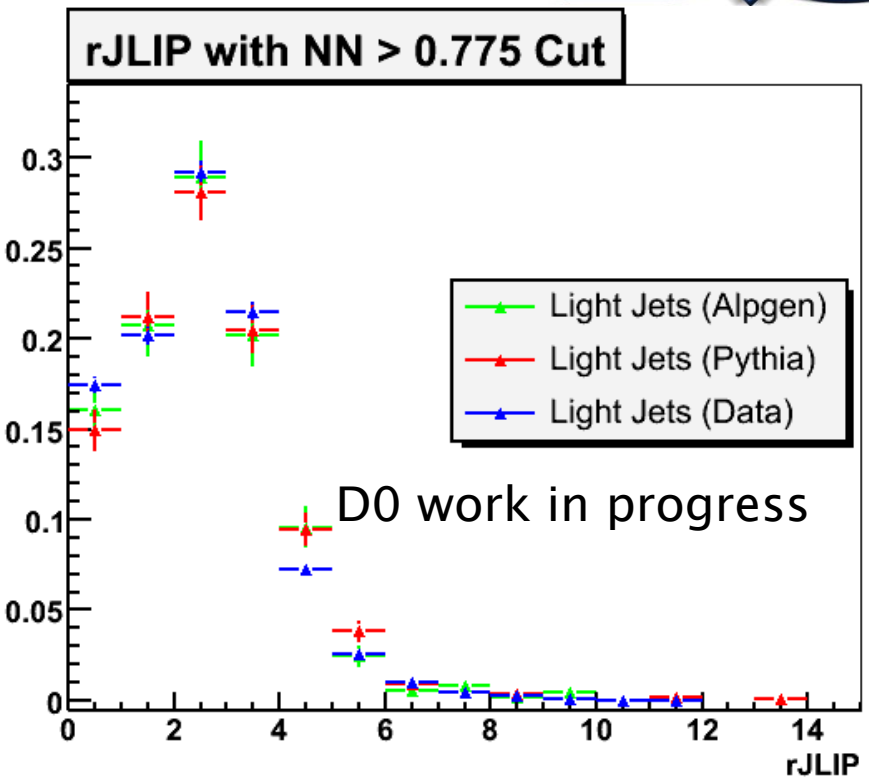
- This provides a good discriminator between b,c and light jets

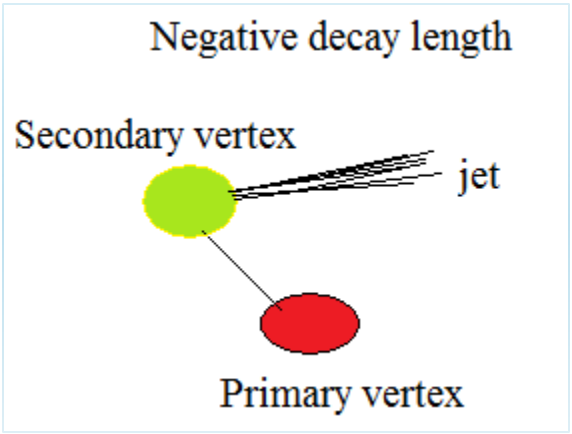
- Apply a NN cut > .5 on jet, then look at rJLIP use resultant rJLIP distributions



Negative Tagged Jets

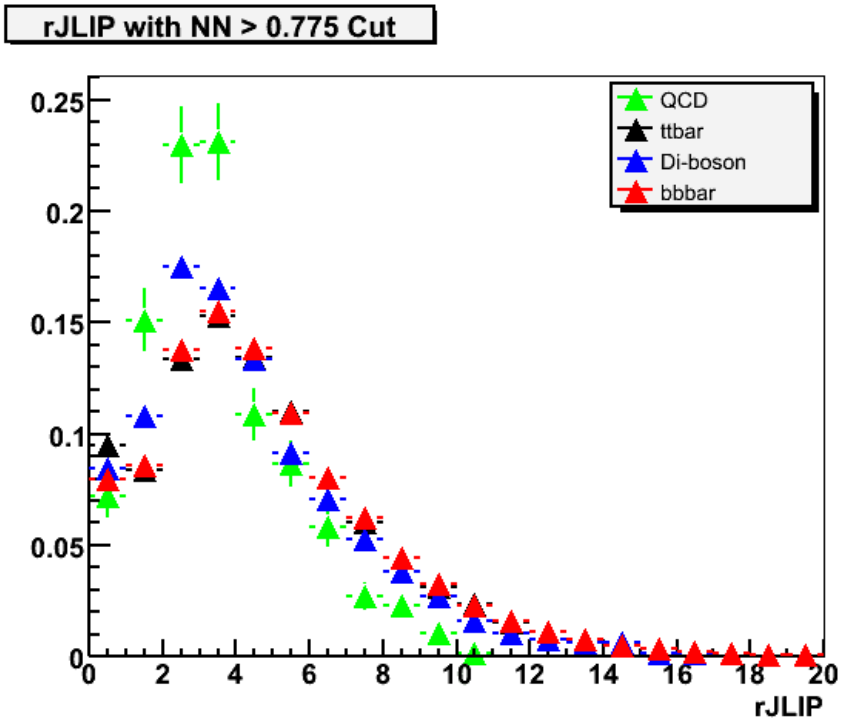
- Negative tagged jets are jets with negative inputs to NN algorithm (e.g. negative decay length)
- Negative tagged rJLIP template is similar to light jet MC
  - use light jet rJLIP shape measured in data





Background Subtraction

- ZZ, WZ, WW, ttbar and qcd are subtracted from data
- QCD is taken from data, diboson and ttbar from MC
- Shape of BG rJLIP is much more b-like than data like (since dominated by real b-jets)
  - Simply scaling down data by number of BG events would bias our sample



Ratio Calculation

$$\frac{\sigma(Z+b)}{\sigma(Z+j)} = \frac{P_b}{\varepsilon_b N * \varepsilon_f}$$

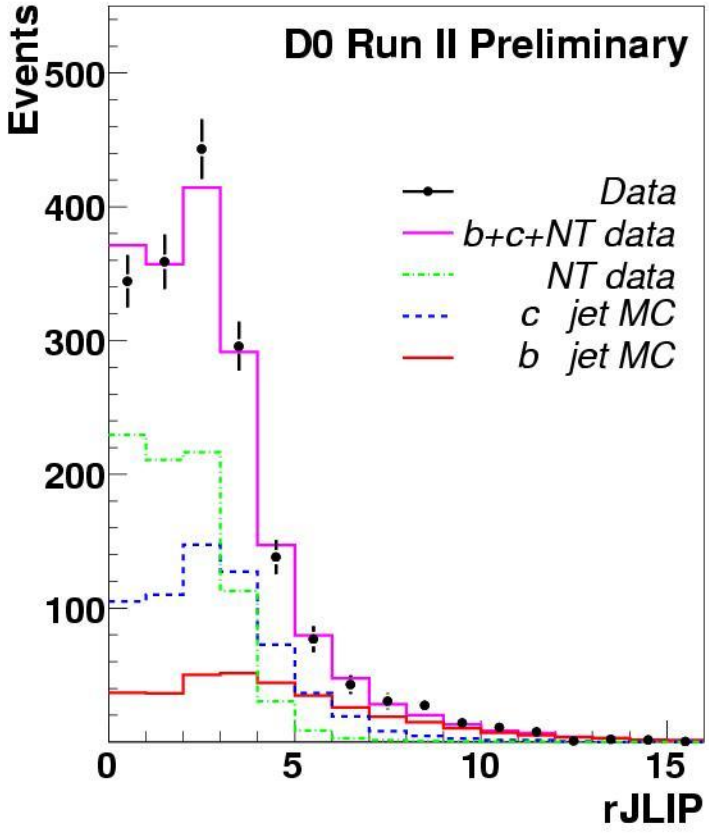
$$N = N_b + N_c + N_l$$

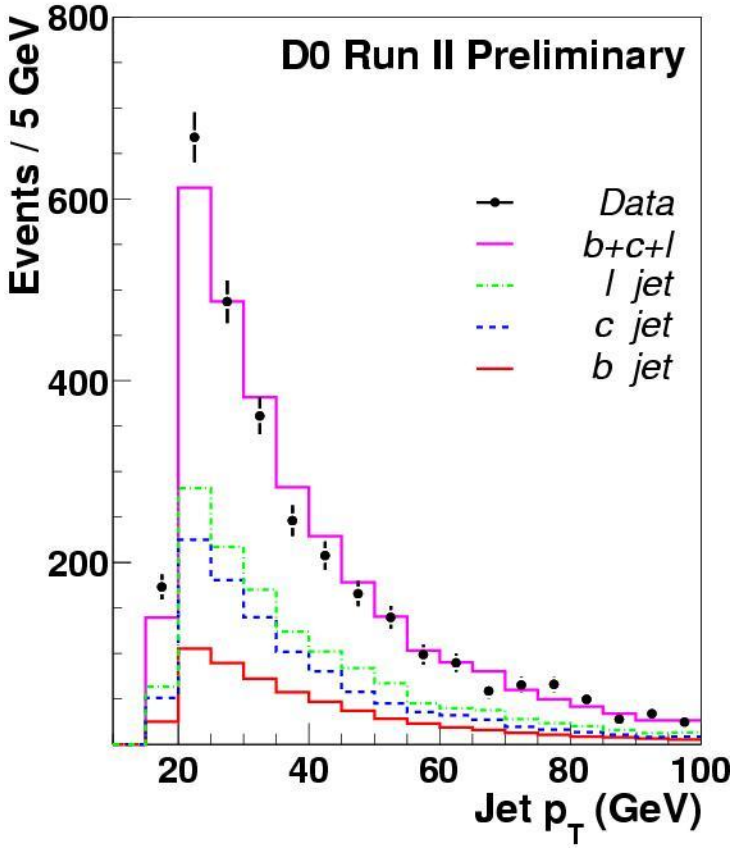
$$P = P_b + P_c + P_l$$

$$P_b = \varepsilon_b N_b$$

- N is number of Z+jet events
- N_b is the number of Z+b pretagged events
- P is number of Z+b-tag event
- P_b, P_l, P_c are the corresponding b, l, and c fractions given by the maximum likelihood fit of rJLIP templates to data
- ϵ_b is b-tag efficiency , ϵ_f is the efficiency differences in ratio
- Ratio calculation benefits from cancellation of many systematics

σ(Z+b)/σ(Z+jet)





Z+b fraction	.191±0.030
Z+c fraction	.384±0.072
Z+light fraction	.424±0.054
Z+b/Z+jet ratio	0.0176±0.0024±0.0023

Summary

- Preliminary result for $\sigma(Z+b)/\sigma(Z+jet)$ at 4.2 fb^{-1}
  - $0.0176 \pm 0.0024 \pm 0.0023$ agrees well with theoretical prediction; 0.0184 ± 0.0022
- Look for publication for updated analysis soon! A lot of improvements have been made!

- Extra Slides

Sytematic Uncertainties

- Measurement of Z+b/Z+j benefits from cancellation of many uncertainties.
- Insensitive to detector effects to first order : (a) lepton trigger efficiencies, (b) jet energy scale, (c) reconstruction efficiencies of leptons and jets, (d) energy resolution.
- However, sensitive to any differences observed between light and heavy jets. The difference is treated as a source of systematic uncertainty.

Source	Flucuation (%)
B-tag/mistag rate	2.4%
Taggability	1.0%
Jet energy scale	~3%
JES b vs. light	~5%
Jet Reco, b vs l	~2%
JER	~-3%