Uncertainties on top quark mass due to modeling

For DØ *collaboration*
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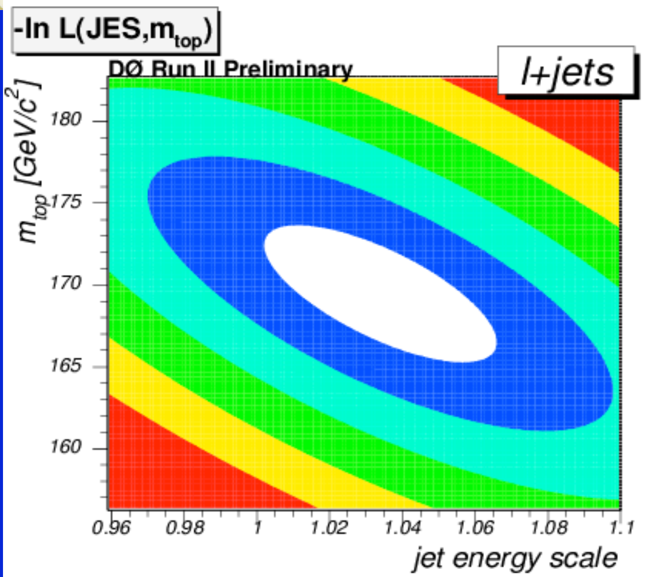
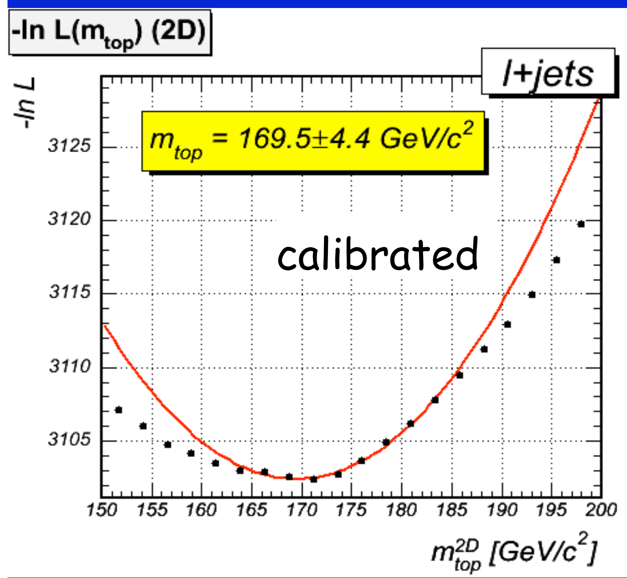
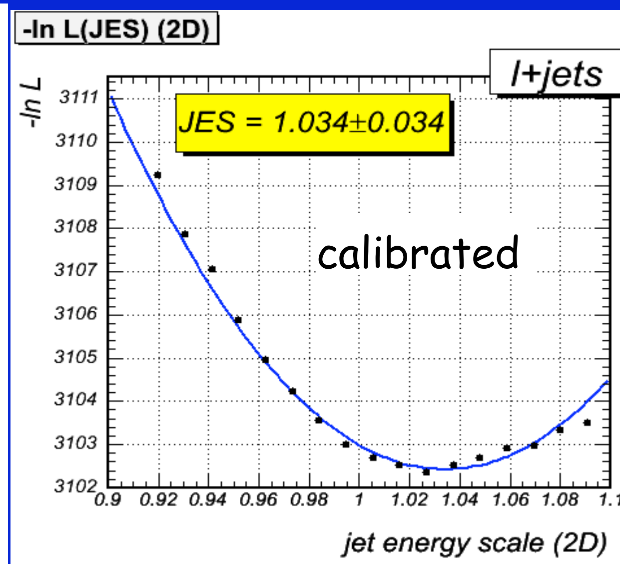
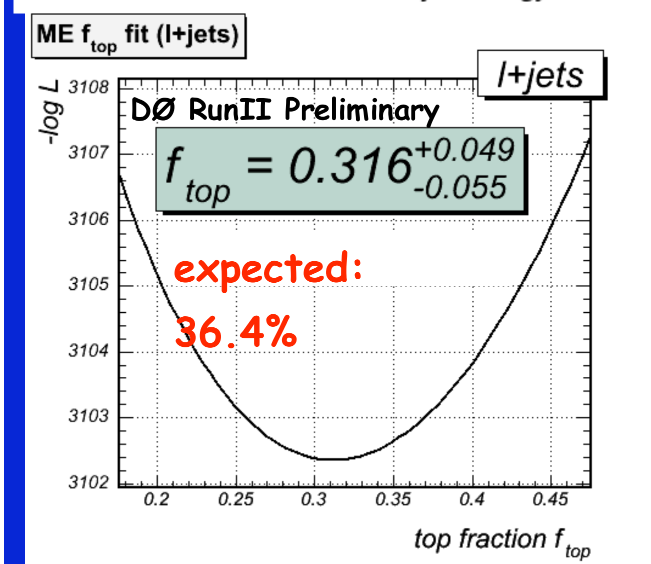
Top mass workshop at FNAL, 10/11/05

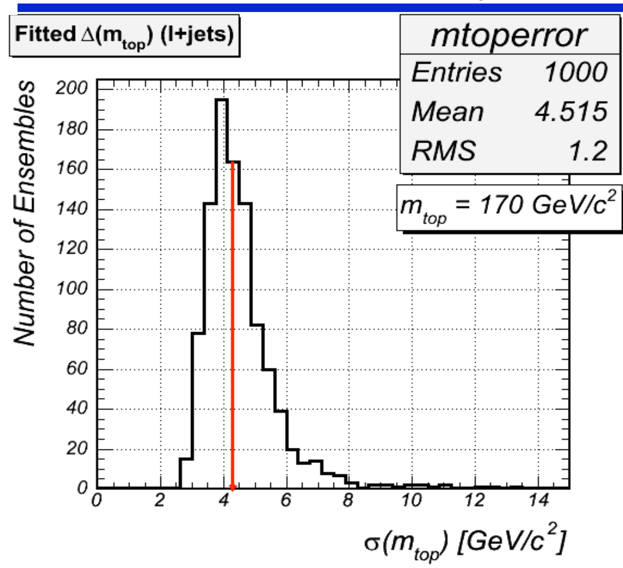
M_t=169.5±4.4 GeV/c^2
JES=1.034±0.034

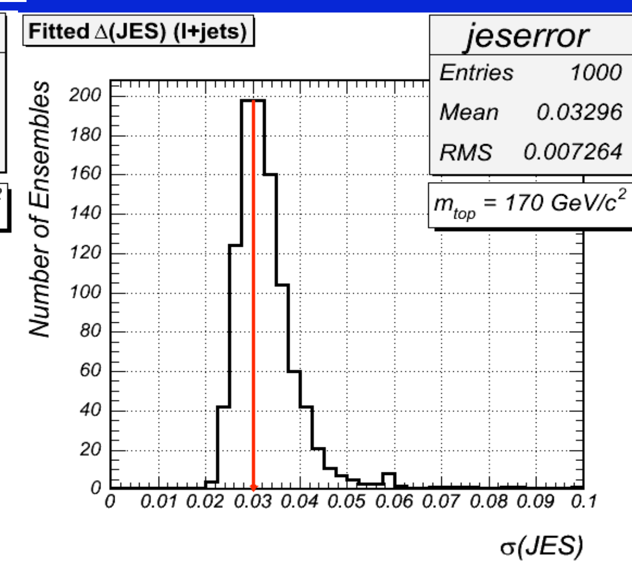












Systematics summary

Source of uncertainty	DM_t (GeV/c^2)
B-jet energy scale	+1.32-1.25
Signal modeling (gluons rad)	0.34
Background modeling	0.32
Signal fraction	+0.5-0.17
QCD contribution	0.67
MC calibration	0.38
trigger	0.08
PDF’s	0.07
Total	+1.7-1.6

B-jet energy scale

. **Relative data/MC b/light jet energy scale ratio**

- **fragmentation: +-0.71 GeV/c^2**

 → different amounts of p^0, different p^+ momentum spectrum

 → fragmentation uncertainties lead to uncertainty in b/light JES ratio

compare MC samples with different fragmentation models:

Peterson fragmentation with e_b=0.00191

Bowler fragmentation with r_t=0.69

- **calorimeter response: +0.85 -0.75 GeV/c^2**

 uncertainties in the h/e response ratio

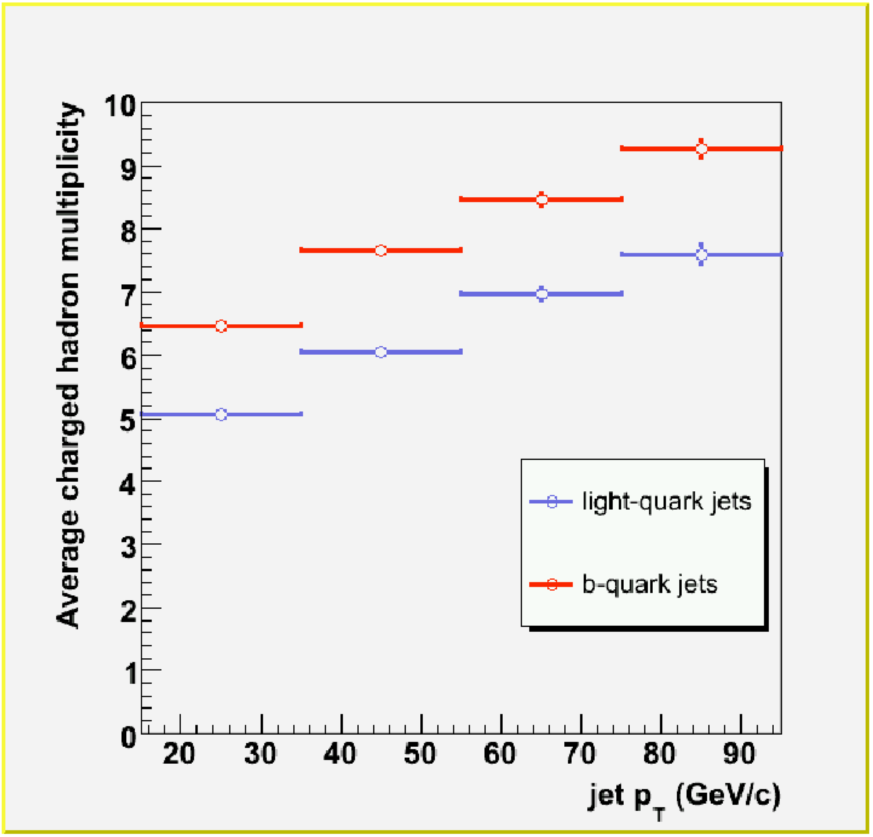
 + charged hadron energy fraction of b jets > that of light jets

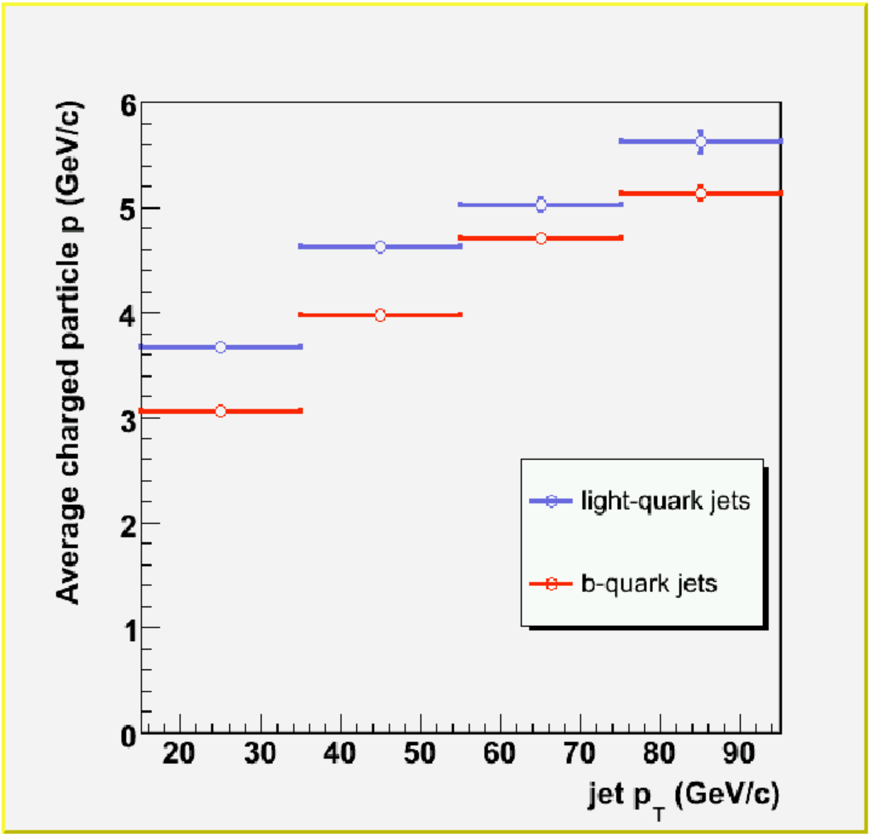
 → corresponding uncertainty in the b/light JES ratio

- **Difference in p_T spectrum of b-jets and jets from W-decay: 0.7 GeV/c^2**

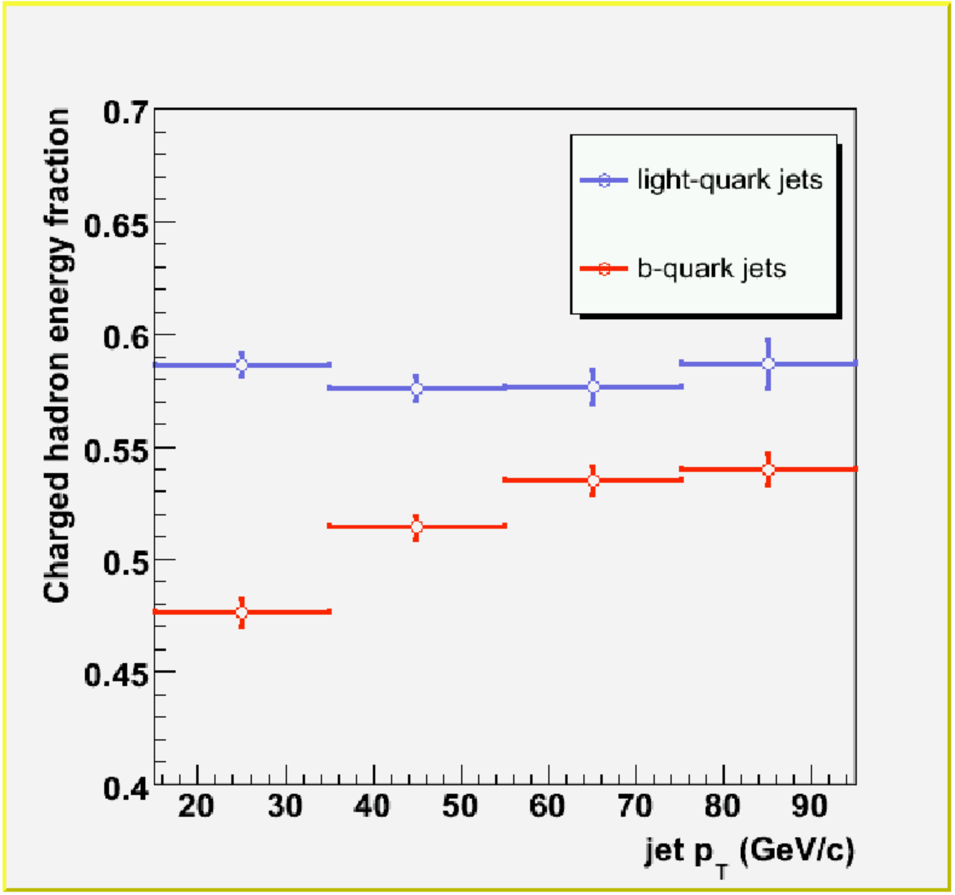
B and light quark jet kinematics

- On average b-jets contain 2 more soft pions
- Pion momenta are softer for b-jets



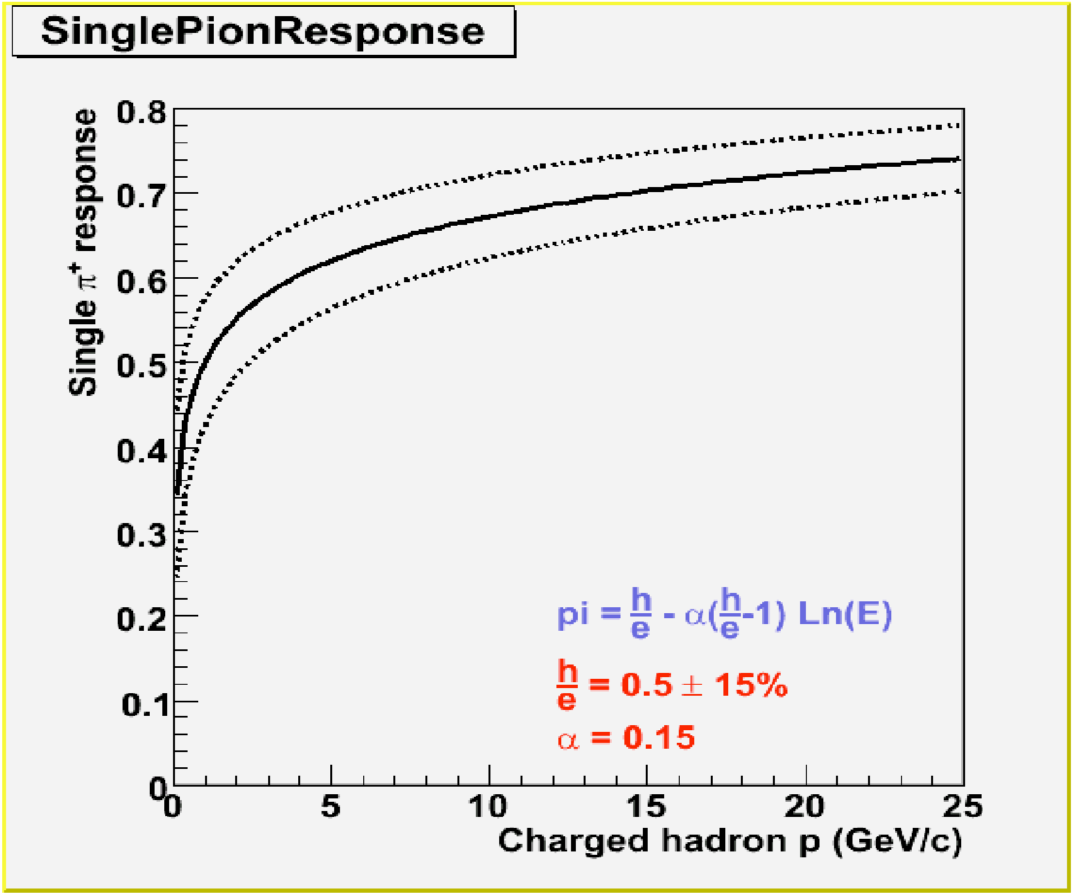


Charged hadron energy fraction

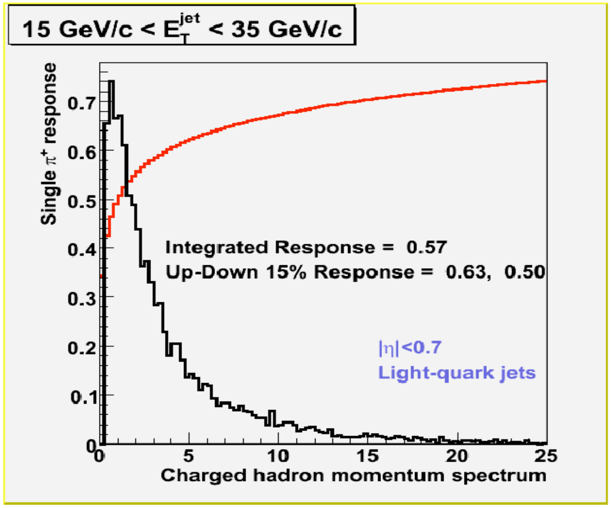


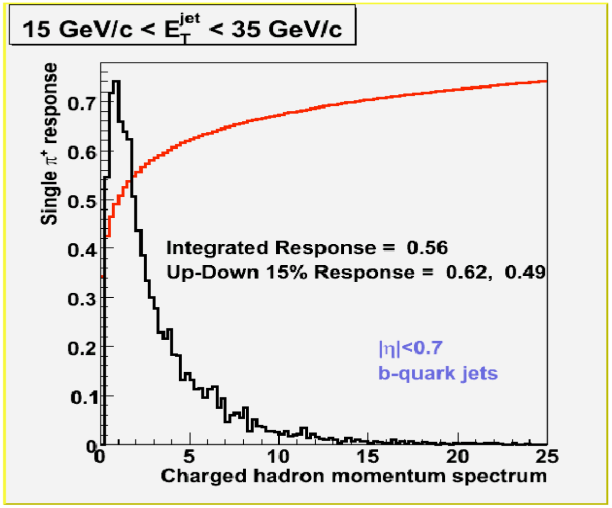
- For jets with p_T>20GeV/c
- Light-quark jet: $<F_{charged}>=0.58$
- b-quark jet: $<F_{charged}>=0.52$

Single pion response



Functional form under study
(Jan Stark, Ariel Schwartzman, Chris Tully)





Relative b-to-light Response Uncertainty

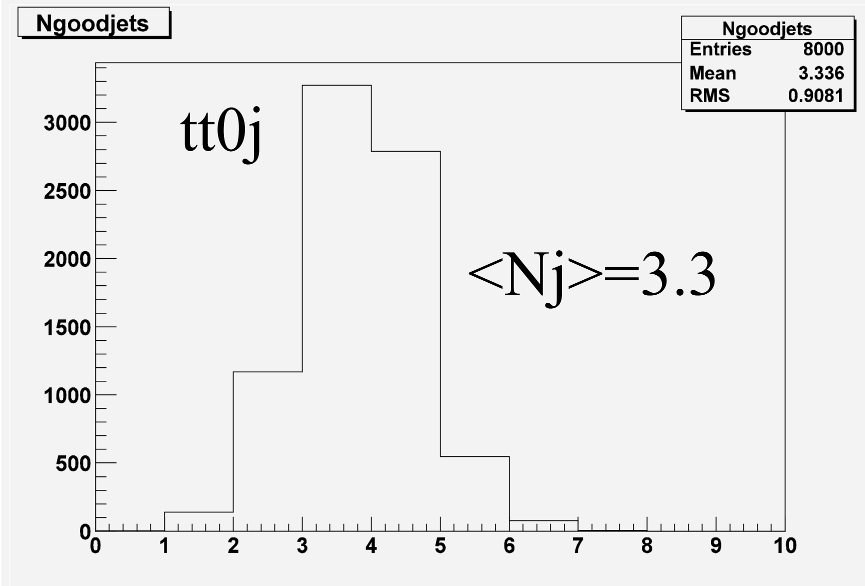
Jet pT range	$\frac{\bar{f}_q}{\bar{f}_b}-1(\%)$	$\Delta\bar{R}^h\,(\%)$	Total (%)
15 GeV/c < E_t < 35 GeV/c	24	+12.7 -10.9	+3.0 -3.6
35 GeV/c < E_t < 55 GeV/c	15	+10.5 -10.5	+1.6 -1.6
55 GeV/c < E_t < 75 GeV/c	10	+10.3 -10.3	+1.0 -1.0
75 GeV/c < E_t < 95 GeV/c	9	+10.2 -10.7	+0.9 -1.0

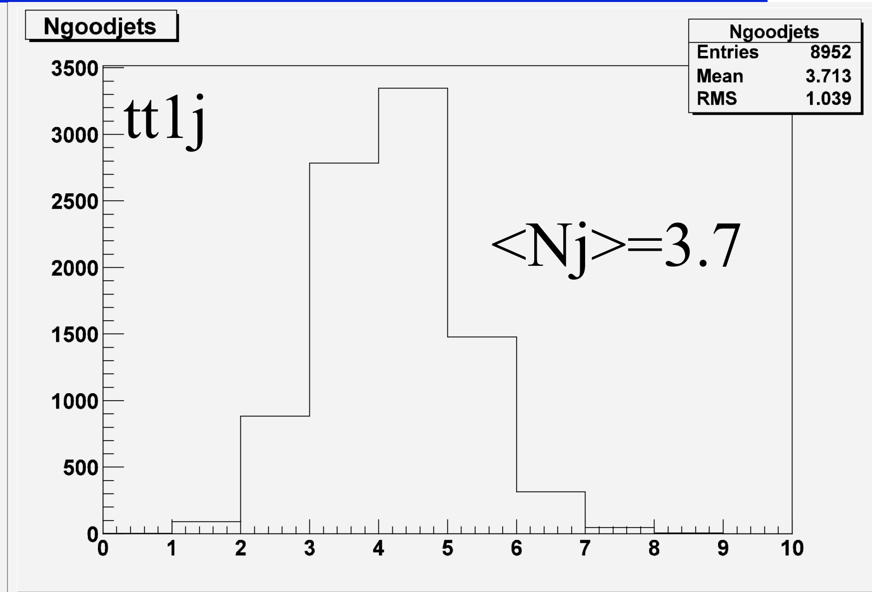
Result for inclusive jet sample (E_T > 20GeV) = +1.5% -1.3%

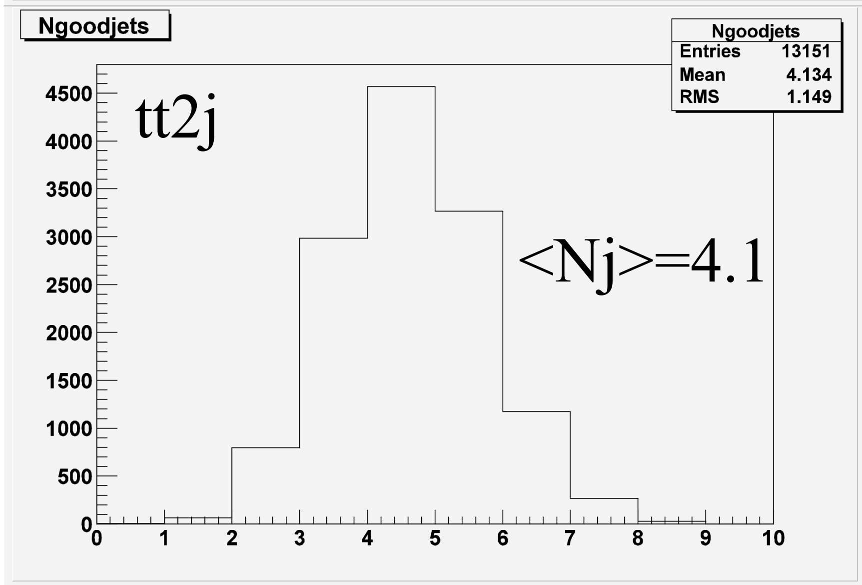
Gluon radiation

- The effect is reduced by
  - Requiring four and only four jets in the final state
  - High P_T cut on jets
- Yet in ~20% of the events there is at least one jet that is not matched (DR(parton-jet)<0.5) to top decay products
  - These events are interpreted as background by ME method
- We study this systematic by examining ALPGEN ttj sample and varying its relative fraction between 0 and 30% (verified on our data by examining the fraction of events with the 5^{th} jet)
- Final effect on top mass 0.34 GeV/c^2

Njets







- Each process can produce a spectrum of jet multiplicities
- How do we combine tt0j,tt1j,tt2j?

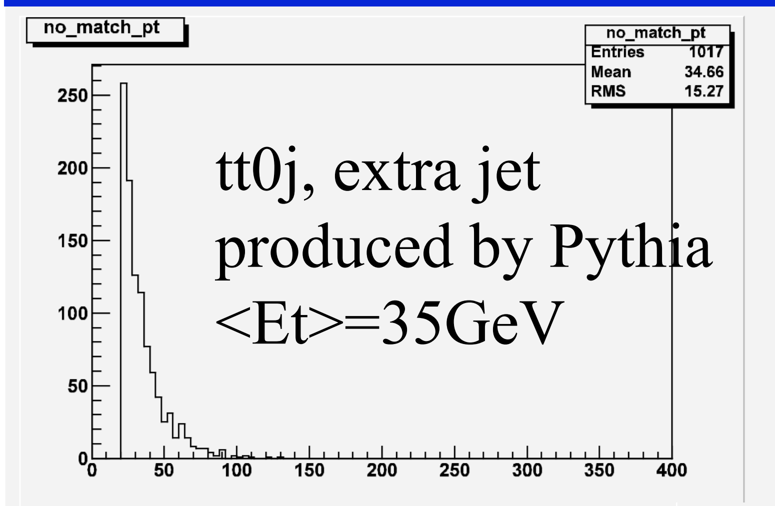
Approach #1: weighted sum

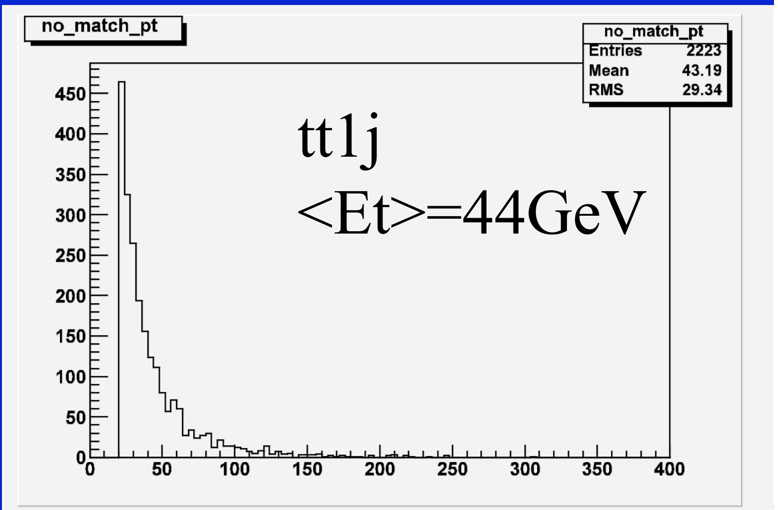
- Add processes straight up, weighted by cross section*selection efficiency:
  - Add contributions of tt0j, tt1j, tt2j
  - Double counting because tt0j includes radiation by Pythia

	tt0j	tt1j	tt2j
eff, %	13.9%	19.5%	23.3%
sigma, pb	6	2.5	0.56
sigma*eff	0.834	0.4875	0.13048
relative weight	57%	34%	9%

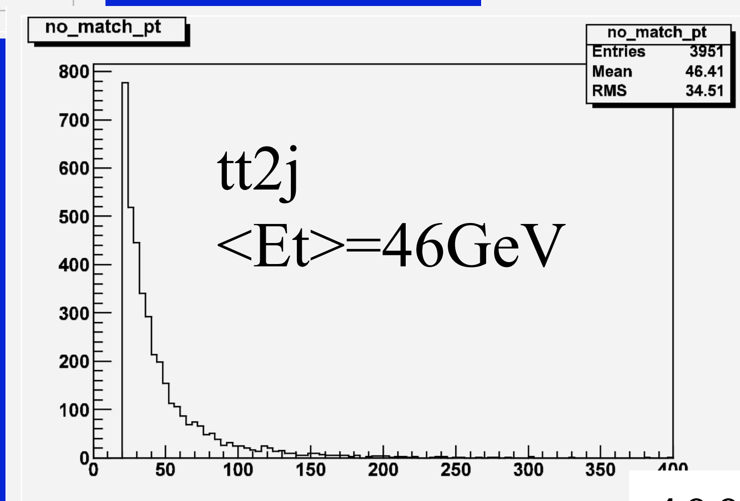
Approach #2: trust Pythia

- If Pythia includes radiation why not just trust Pythia?





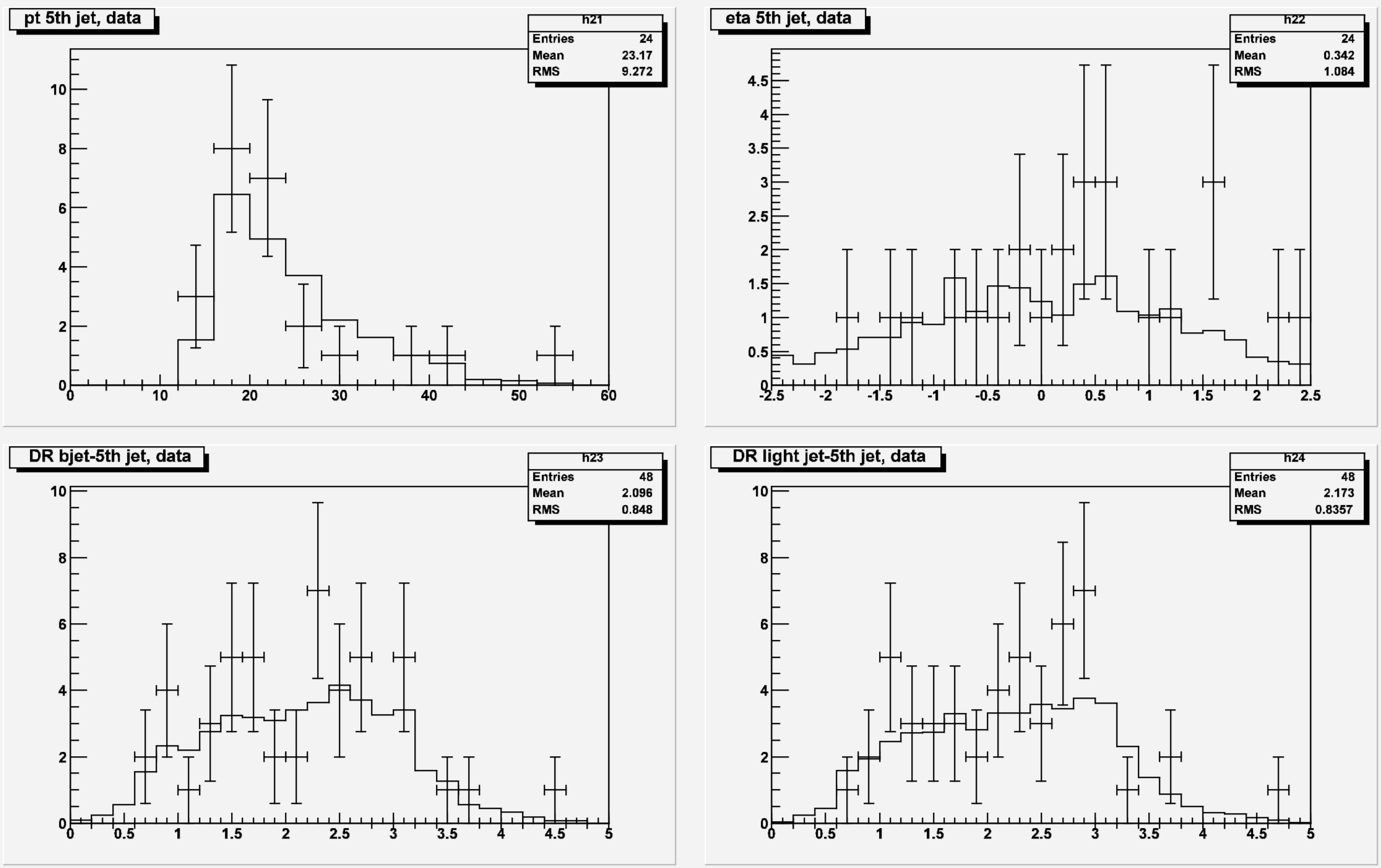
Pythia "radiation on-off" approach underestimates systematics!



400 GeV

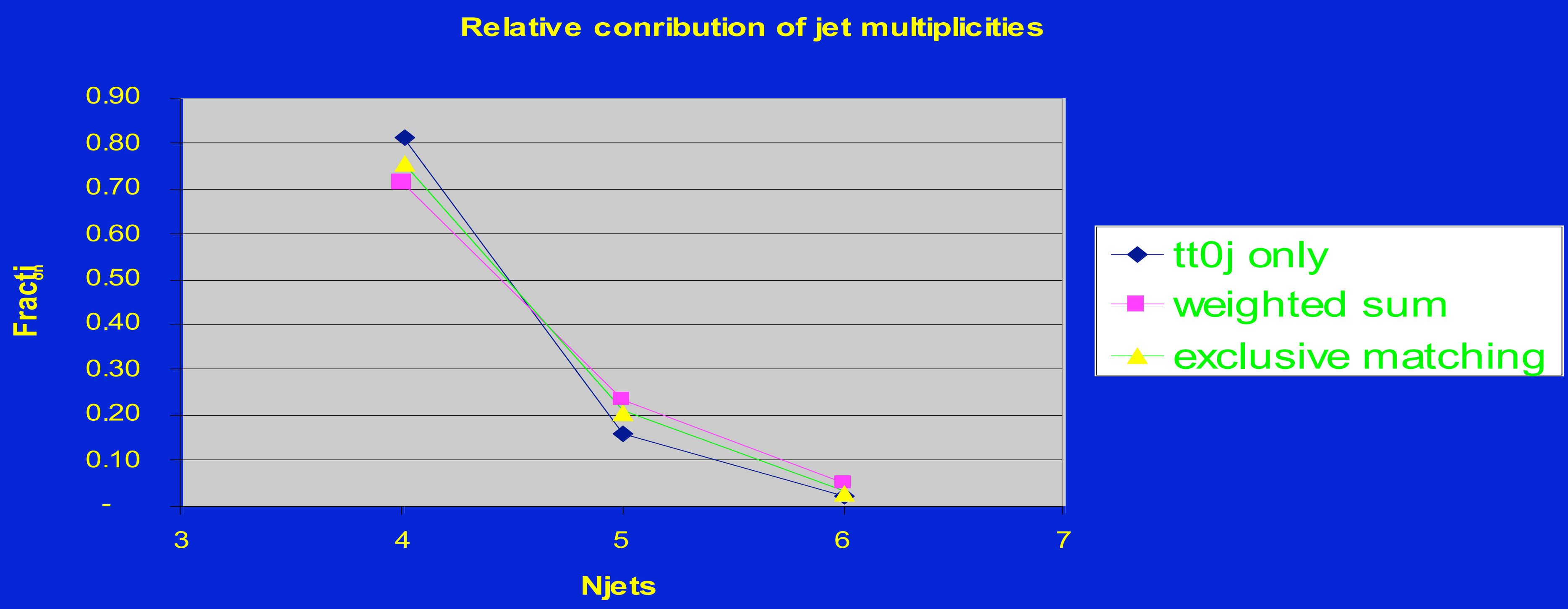
Kinematics of the x-tra jets: data to Alpgen+Pythia tt

- Look at E_T, h, DR(b-5th jet), DR(jet from W-5th jet)



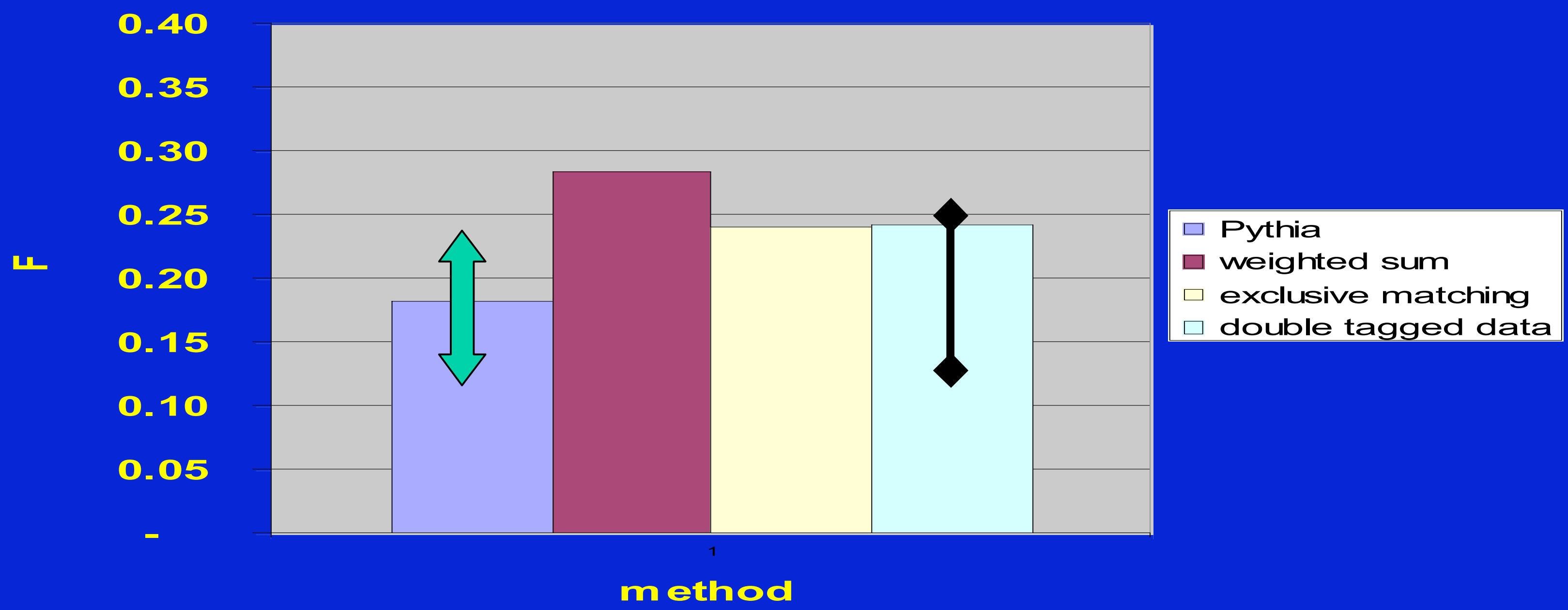
Approach #3: exclusive production

- tt0j for W+4jet bin, tt1j for W+5j, tt2j for W+6j



Verification with data

- Can constraint the fraction of ttj by measuring the fraction of F=N(Nj>=5)/N(Nj>=4)



In systematics study we vary between pure tt and weighted sum

Signal/Background Modeling

- **QCD background**: +-0.67 GeV/c^2

  Rederive calibration including QCD events from data (lepton anti-isolation)

  (note: sample statistics limited) can be reduced in the future

- **W+jets modeling**: +-0.32 GeV/c^2

  study effect of a different factorization scale for W+jets events

  $(\langle p_{T,j}\rangle^2$ instead of $m_W^2 + Sp_{T,j}^2)$

- **PDF uncertainty**: +-0.07 GeV/c^2

  CTEQ6M provides systematic variations of the PDFs

  reweight ensembles to compare CTEQ6M with its systematic variations

  (by default the measurement uses CTEQ5L throughout:

  use a LO matrix element, and for consistency with simulation)

Conclusions

- Model dependent systematics on top mass include
  - Difference in b and light JES
    - Fragmentation
    - Charged fraction
  - Gluon radiation (x-tra jet modeling)
  - Factorization scale of W+jets production
  - PDF's