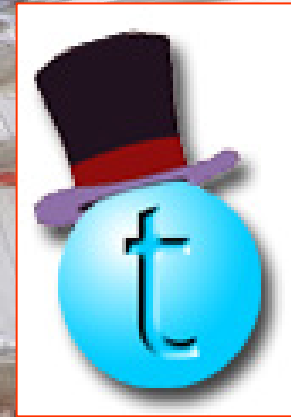


TeV4LHC WORKSHOP



Single Top Production

at the Tevatron



TeV4LHC
Feb 5, 2005
Top/EW Parallel Sessions

Gordon Watts
University of Washington
Seattle

Start of Workshop

Single Top Theory - Qing-Hong Cao

Single Top Experiment - R. Schwienhorst

Won't Repeat
too much, I
hope!

Working Group Meeting

Single top: Simulations & Strategies; Zack Sullivan

Single top in MCFM; Keith Ellis

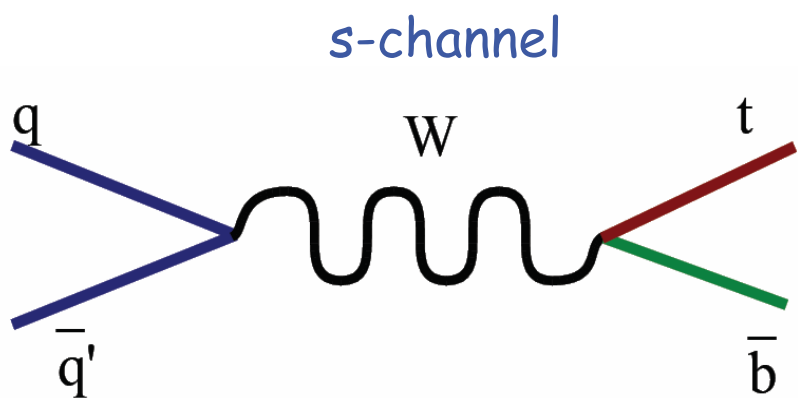
Effective NLO generator SingleTop from CompHEP;

Edward Boos

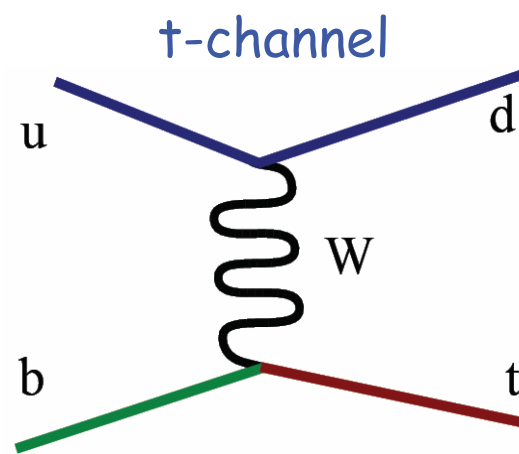
Electroweak & Single Top Plans (Discussion)

BNL

Single Top Production: Ellis



$$\sigma_{\text{NLO}} = 0.88\text{pb} \pm 8\%$$



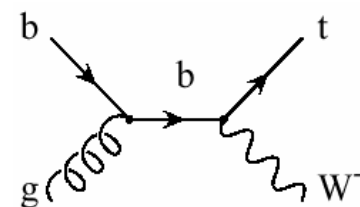
$$\sigma_{\text{NLO}} = 1.98\text{pb} \pm 11\%$$

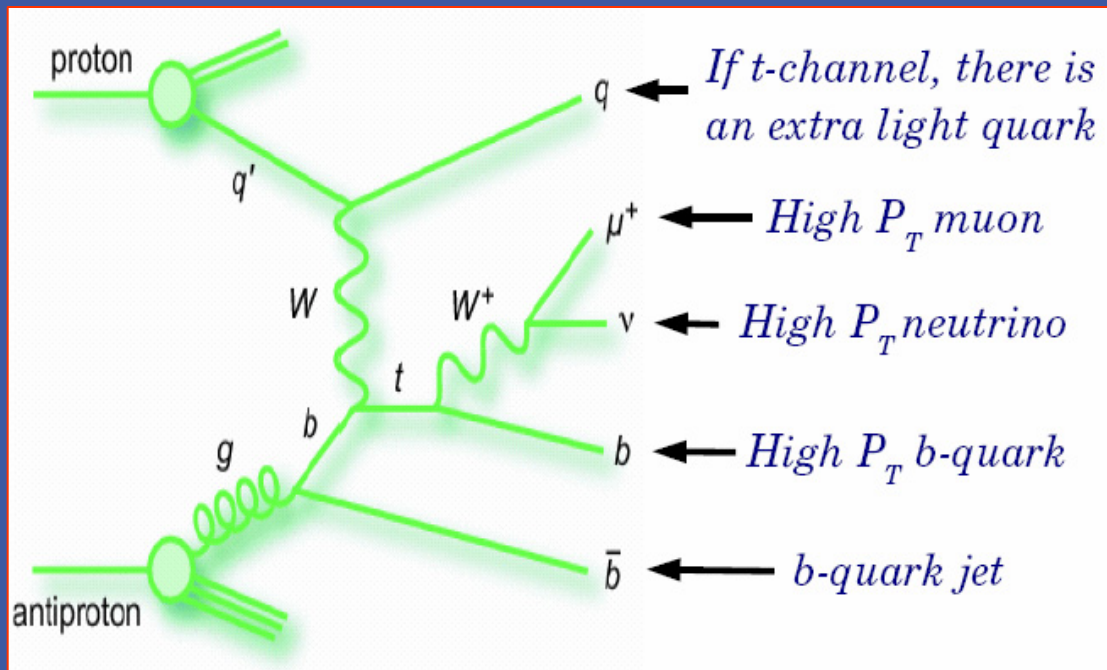
hep-hp/207055 (Harris, Laenen, Phaf, Sullivan, Weinzierl)

⇒ Top decay to Wb , W to leptons

⇒ W to jets has too high a QCD background

Too small for the Tevatron (LHC?) Tait
- hep-ph/990352





Signal for s and t channel mostly similar

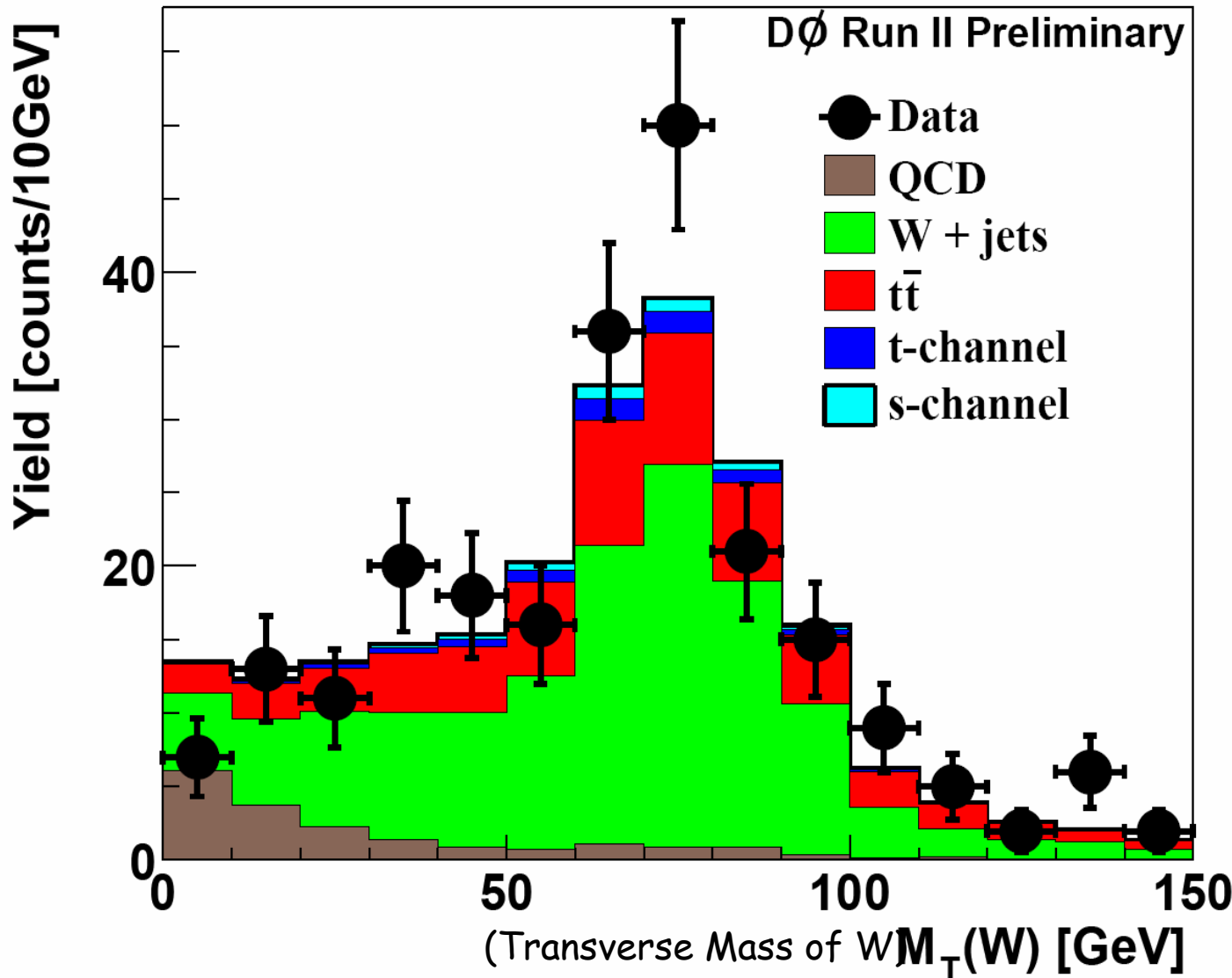
- Lepton + Missing E_T + Jets
 - t -channel extra b tends to be forward
 - Similar to top pair production, but with less jets
- Harder Signal To Find

Backgrounds

- W/Z + jets Production
- Fake Leptons
- Top Pair Production
- $WW, WZ, Z\tau\tau$, etc.

Anything with a lepton + jets signature

Relative Sizes Of Backgrounds

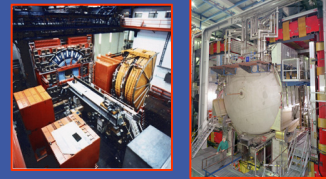


W Is Largest Background!

Also one of hardest to get right!

This plot is after a single b-tag required!

From DØ Analysis, after selection cuts and requiring a b-tag.



Common Analysis Strategy

Pre-selection
Cuts



Final Cuts



Limit Fitting

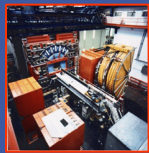
Clean up the data, remove detector backgrounds.
Does not maximize S:B.

Maximize S:B

Use maximum likelihood or shape fitting

Quick Comment On Preselection Cuts

Both CDF and DØ cut on the number of jets.

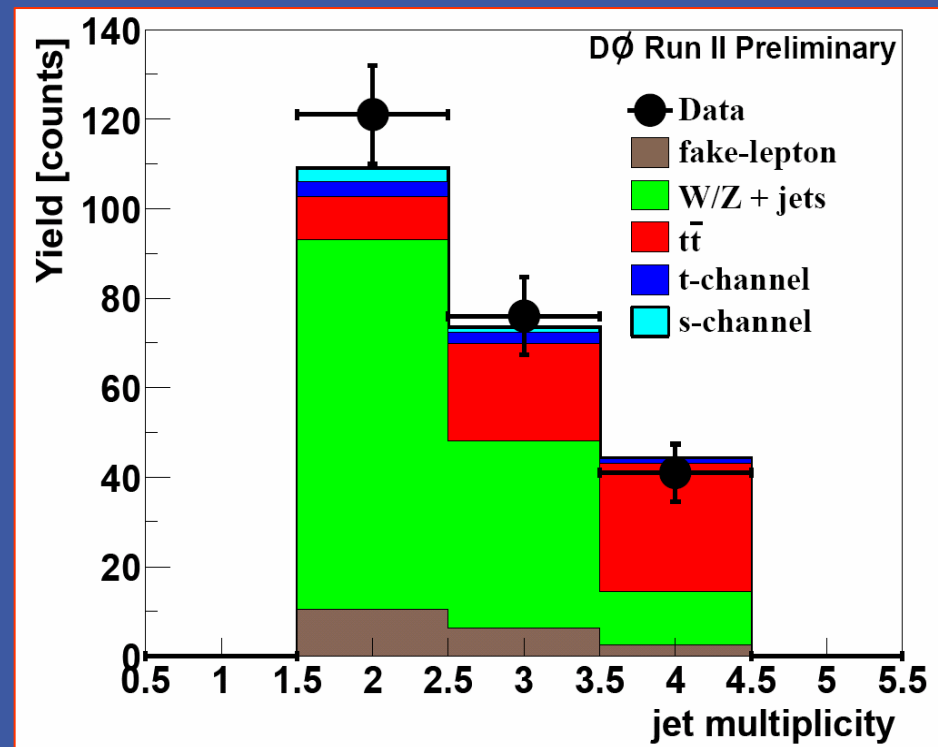


Exactly 2 jets $E_T > 15 \text{ GeV}$ $|\eta| < 2.8$



$2 \leq N_j \leq 4$

The motivation is pretty clear 



A "jet"-theorist: "Dude. What's a jet?"

Would prefer energy based variables like H_T

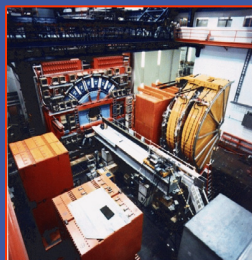
Even with those, however, N_J is powerful.

Current state-of-the art is described by the ZTOP program

<http://home.fnal.gov/~zack/ZTOP/ZTOP.html>

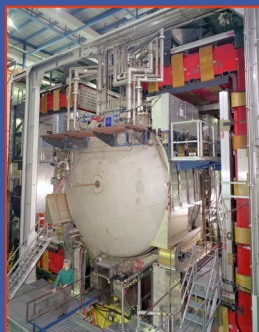
Not an event generator, so...

The trick is in getting the t-channel correct...



Re-weights MADEVENT to fit the ZTOP distributions

Generate $bq, gq \rightarrow t+b+q'$ separately...



Modified version of CompHEP

Match $2 \rightarrow 2$ and $2 \rightarrow 3$ process using $b p_T$ for cross over

See Boo's talk from last meeting

Comparison with ZTOP shows no difference

W+Jets with Heavy Flavor is most important

- Jet Double Counting issues
- HF fractions - both b and c

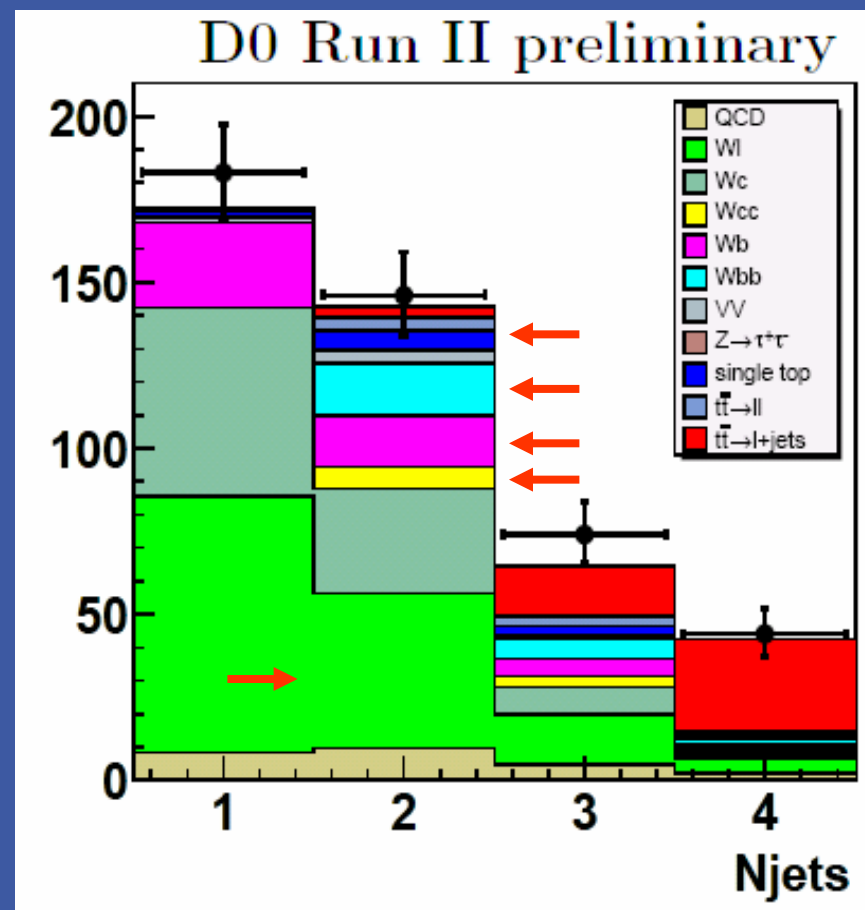
(charm tagging not measured!)

CDF uses ALPGEN to understand the HF fractions

DØ uses Data to simulate W+Jets background - but is switching to MC (ALPGEN)

Bowen, Ellis, Strassler:
understand W(b,c) as it affects shape variables!

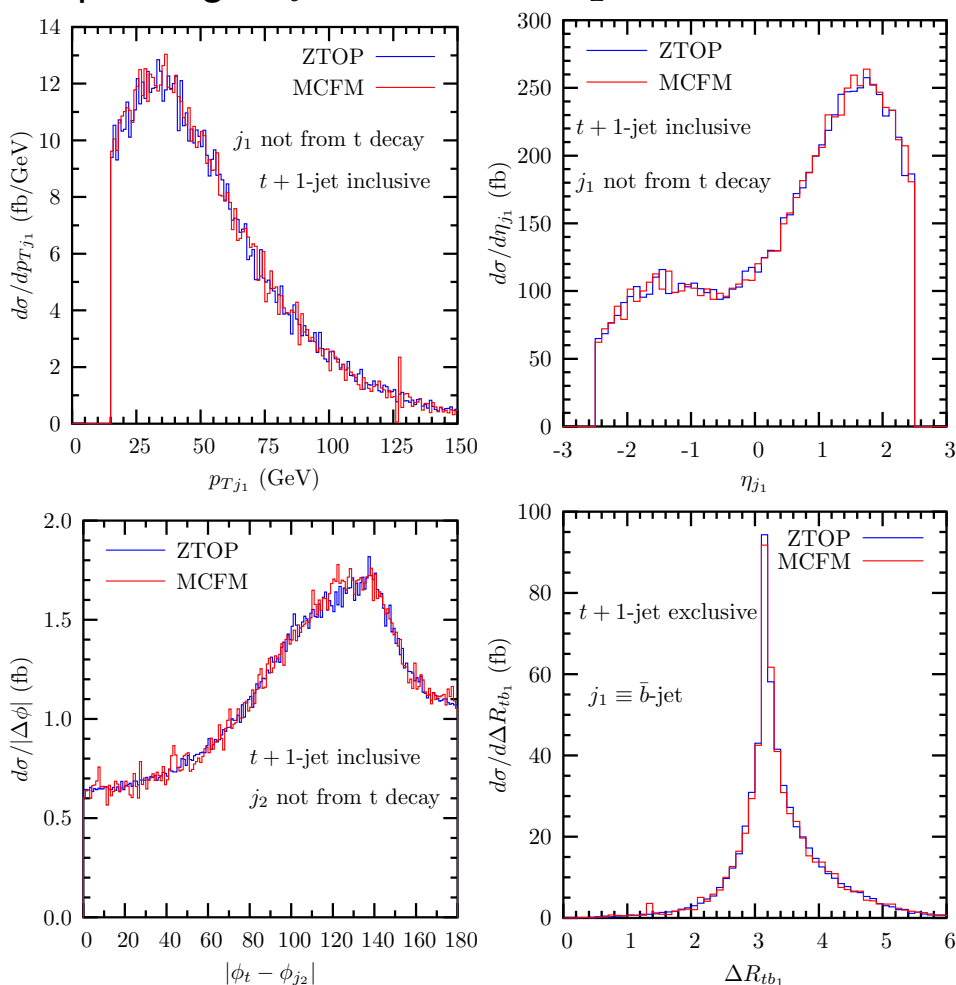
Number of events, after tagging, from various sources 



Progress report: single-top in MCFM and ZTOP

- I added hooks to MCFM that provide fractional event weight (bwgt) for t -channel single-top.
- Corrected some minor internal bugs in MCFM 4.01.
- MCFM 4.02(?) will agree “100%” with ZTOP.

After updating m_t , CKM, and G_F - details in future writeup.



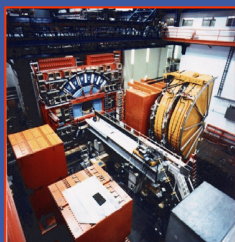
- (Small) MCFM issue left: uses $\text{scale}=m_t$ everywhere, instead of double-DIS scales ($\mu_l=Q^2, \mu_h=Q^2+m_t^2$).

First job done!

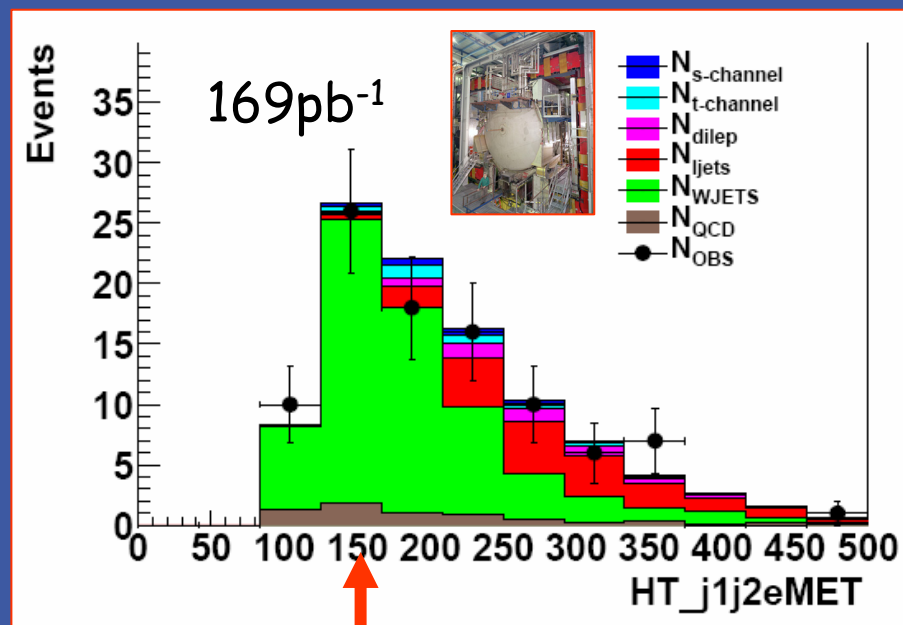
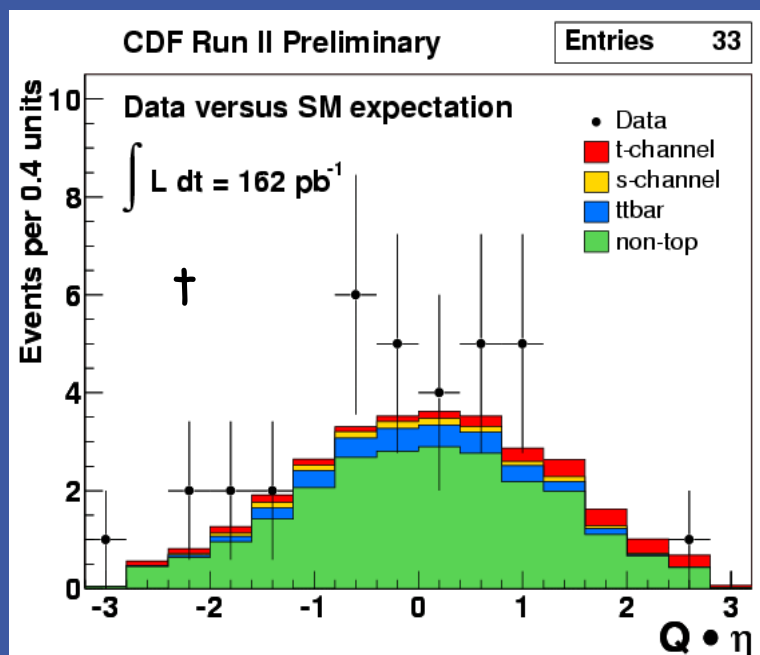
Keith Ellis and/or I will look at spin-correlations next.

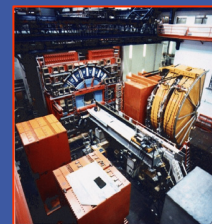


Require a single b-quark tag and $H_T > 150$ GeV



BTag + Use Shape Variables and fit for limit





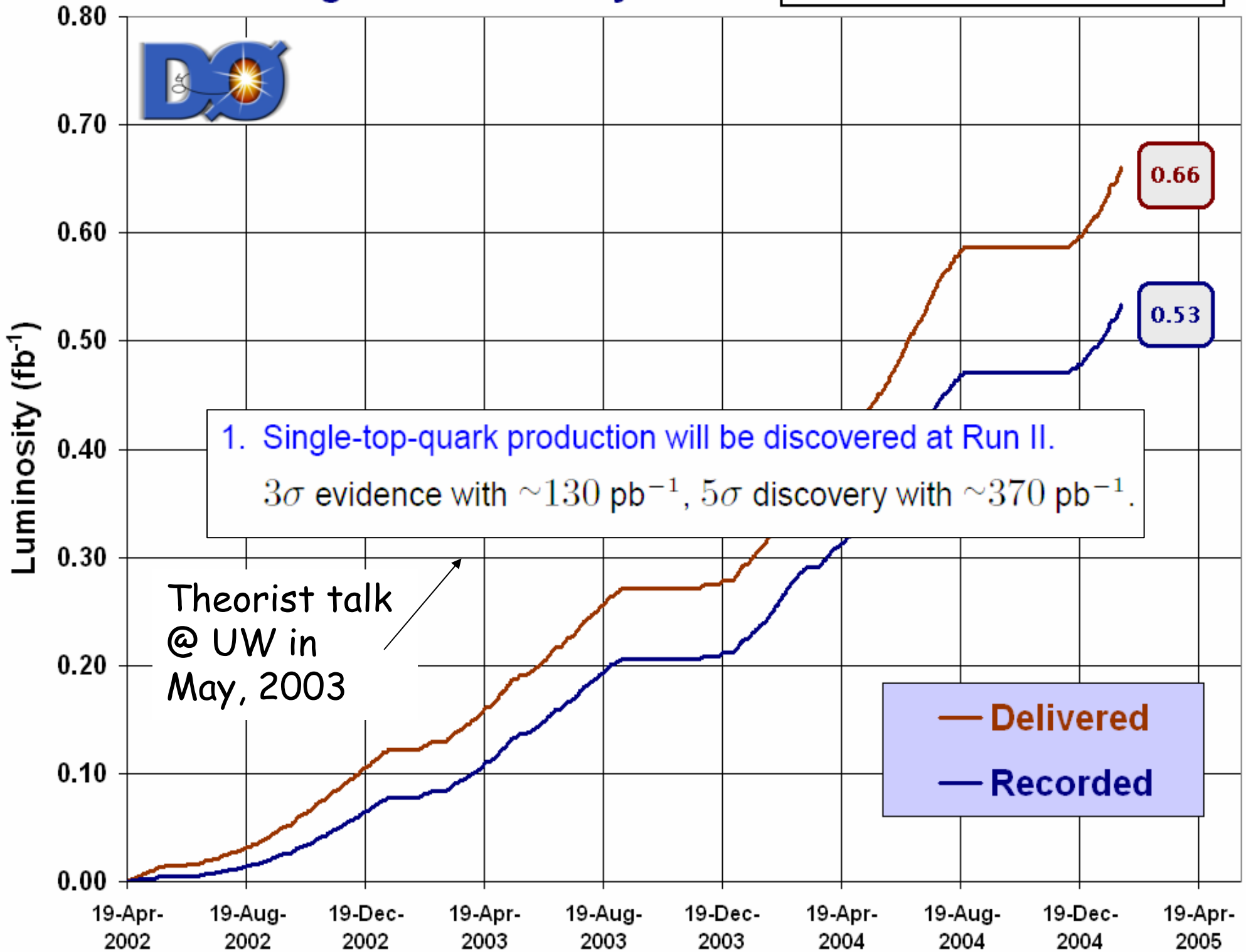
95% C.L. limits Observed (Expected)

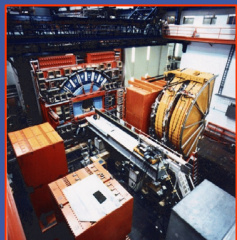
Channel	CDF (pb)	DØ (pb)
s+t	<17.8 (13.6)	<23 (20)
t	<10.1 (11.2)	<25 (23)
s	<13.6 (12.1)	<19 (16)

CDF benefits from the shape fitting

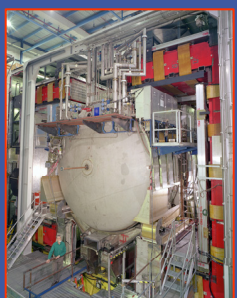
Run II Integrated Luminosity

19 April 2002 - 30 January 2005





Upgrade to modern b-quark tagging
Explore multivariate methods
Increased Dataset!



Multivariate Analysis using 250 pb⁻¹ of data under review.
W+Jets now using MC
If all goes well: winter conferences (paper?)...

Last paper published before discovery!

(I suspect)

Tev4LHC Longer Term, Smaller...

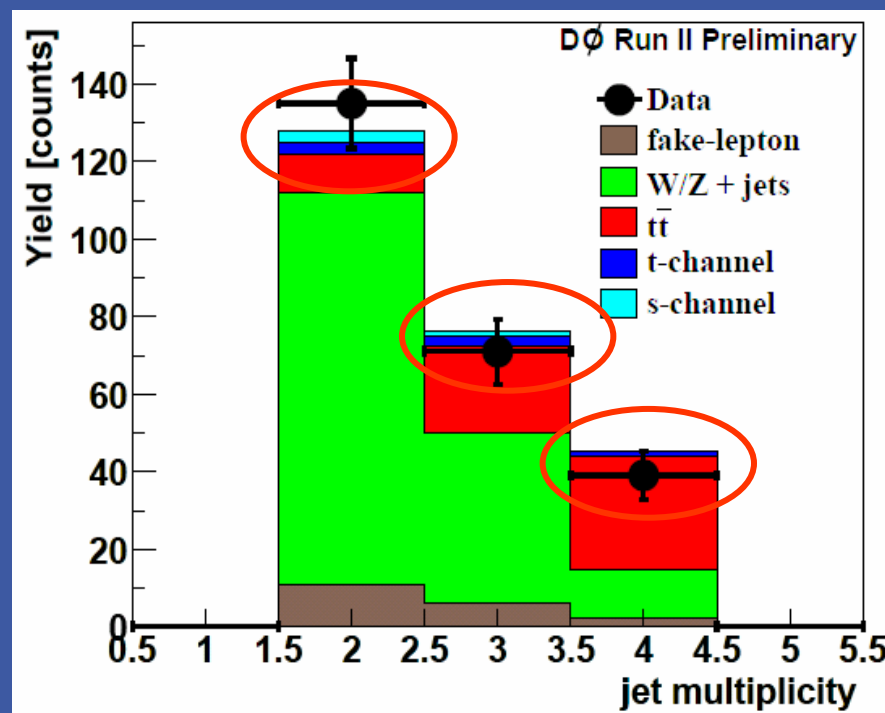
Lots on the to-do list...

- MC Generator Technology
 - MCFM for signal?
 - W+Jets with jet-matching for background
 - Studies of HF in W+Jets to reduce systematic errors.
- Better Objects
 - Better JES, better b-tagging
 - Trigger acceptance
- Multivariate Improvements
 - Further exploration of shape variables

Phase space of background and signal overlap

Need more than simple topological variables to extract signal from background!

Inputs rely on a better understanding of MC than we are currently used to!



Improved models and techniques

Do we correctly account for systematic errors

Supporting effort: understanding charm tagging

- Barring a disaster the Tevatron should discover Single Top
 - But not as soon as previously predicted!
- Major effort by the theory and experiment community to understand the backgrounds
 - New modeling techniques
 - Quantify our current understanding

Thanks to CDF and DØ Single Top Groups for help and plots!