Search for Anomalous Heavy-Flavor Jet Production in Association With W Bosons at DØ

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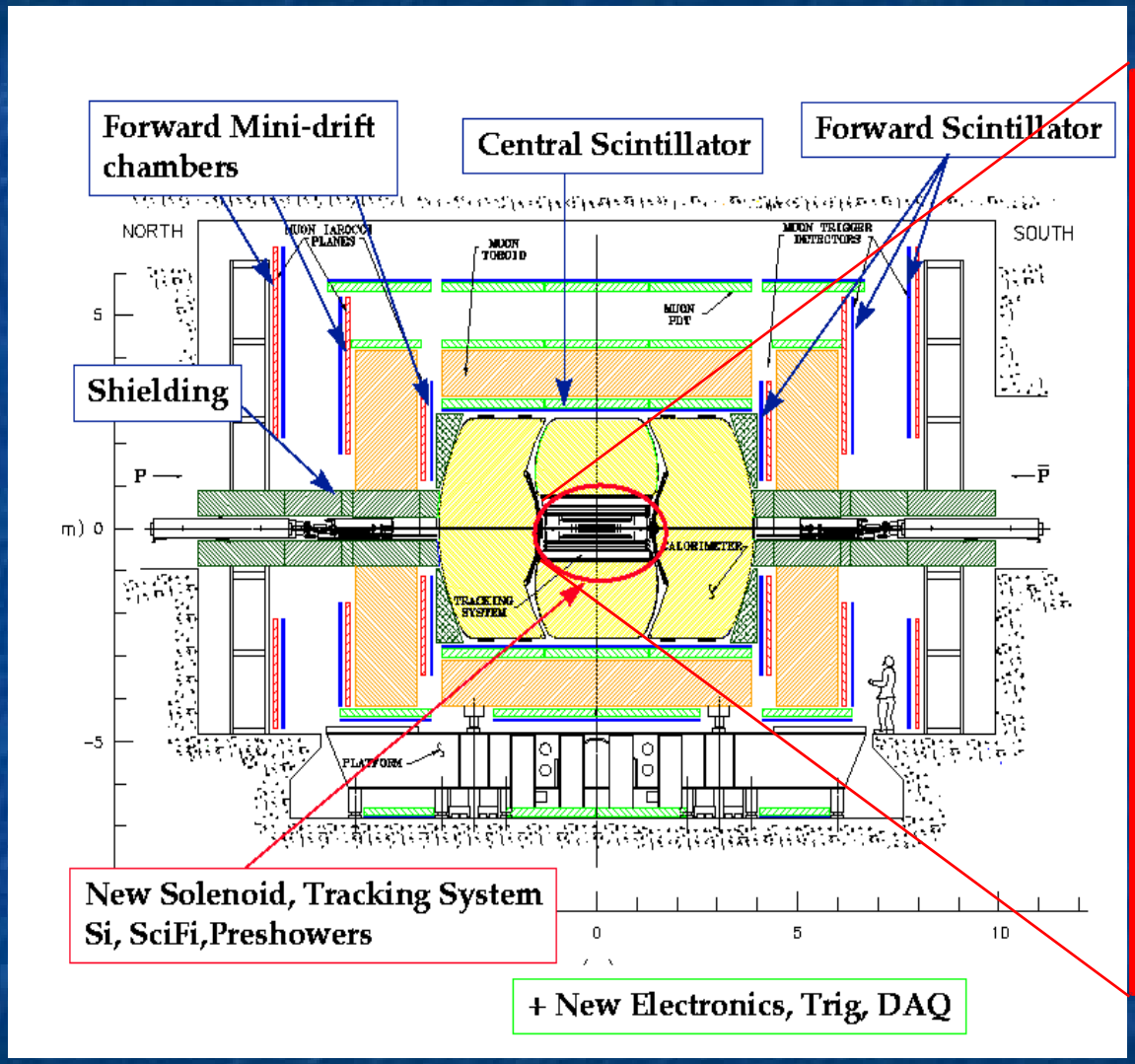
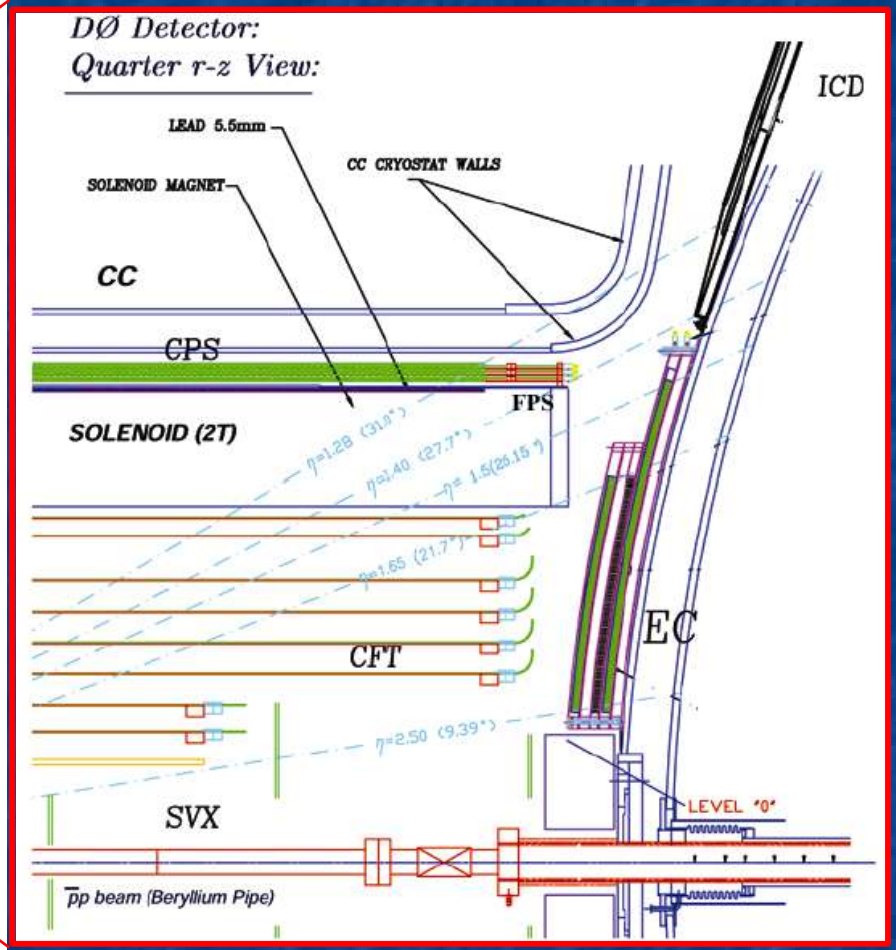
On behalf of the DØ Collaboration

Tevatron Run II

The collider has reached its design luminosity of 1.0×10^{32} $cm^{-2}s^{-1}$!!!

The DØ Upgrade



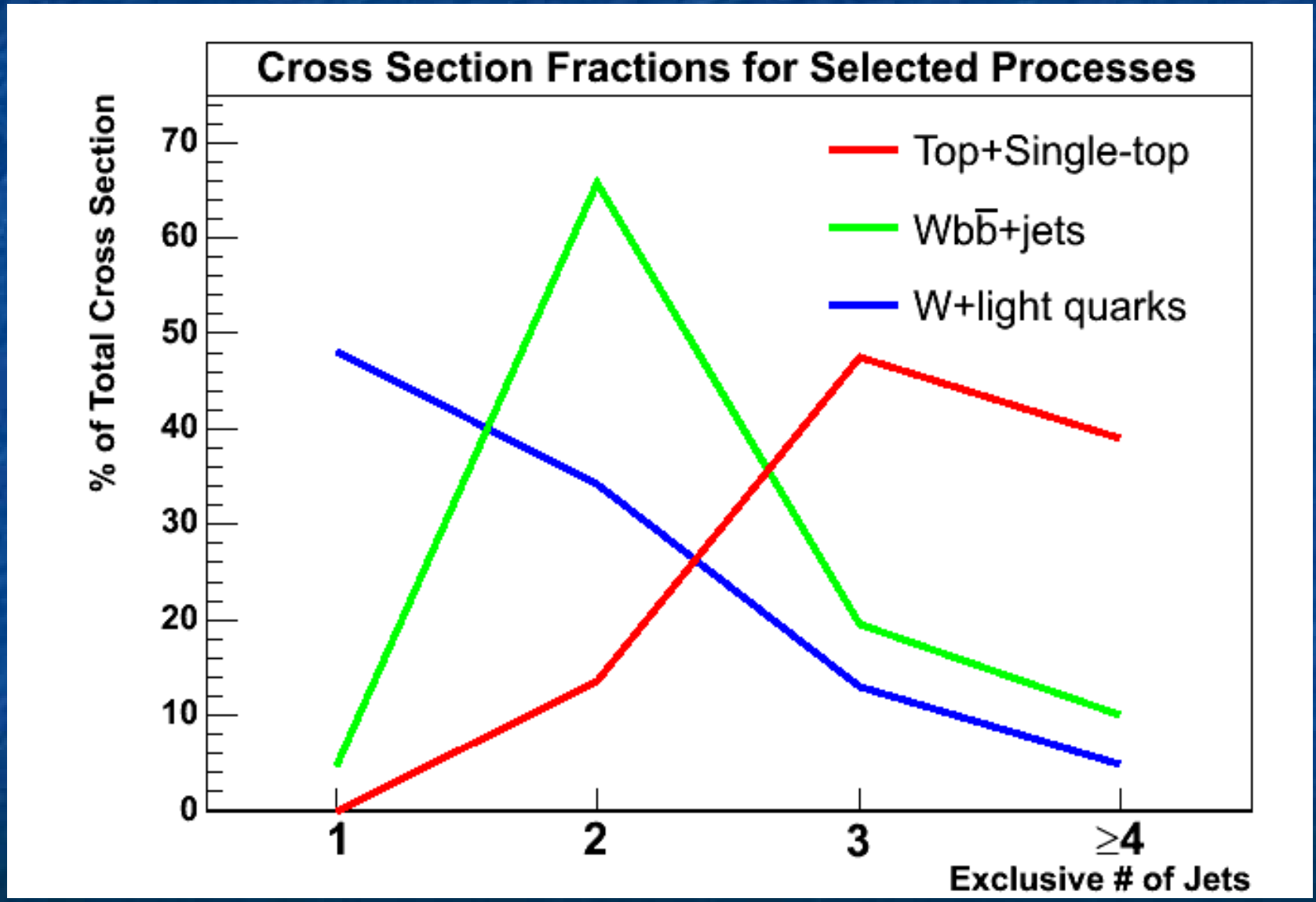


- Muon coverage to $|\eta|<2.0$
- Silicon & Fiber Trackers
  - allows for b-Tagging

Heavy-Flavor Jet Production at the Tevatron

- Inclusive W boson production contains a lot of physics
- W + heavy-flavor jets represents a more concentrated sample for many of these processes
  - Wbb, Top, Higgs / SUSY searches, Technicolor…
- Furthermore, W+heavy-flavor jets can be a (*large*) **background** for many analyses
  - Top, Higgs, SUSY, Technicolor...
- Our description of the data is improving
  - Alpgen MC normalized to MCFM cross sections provides for more accurate predictions

Event Topology Matters a Lot

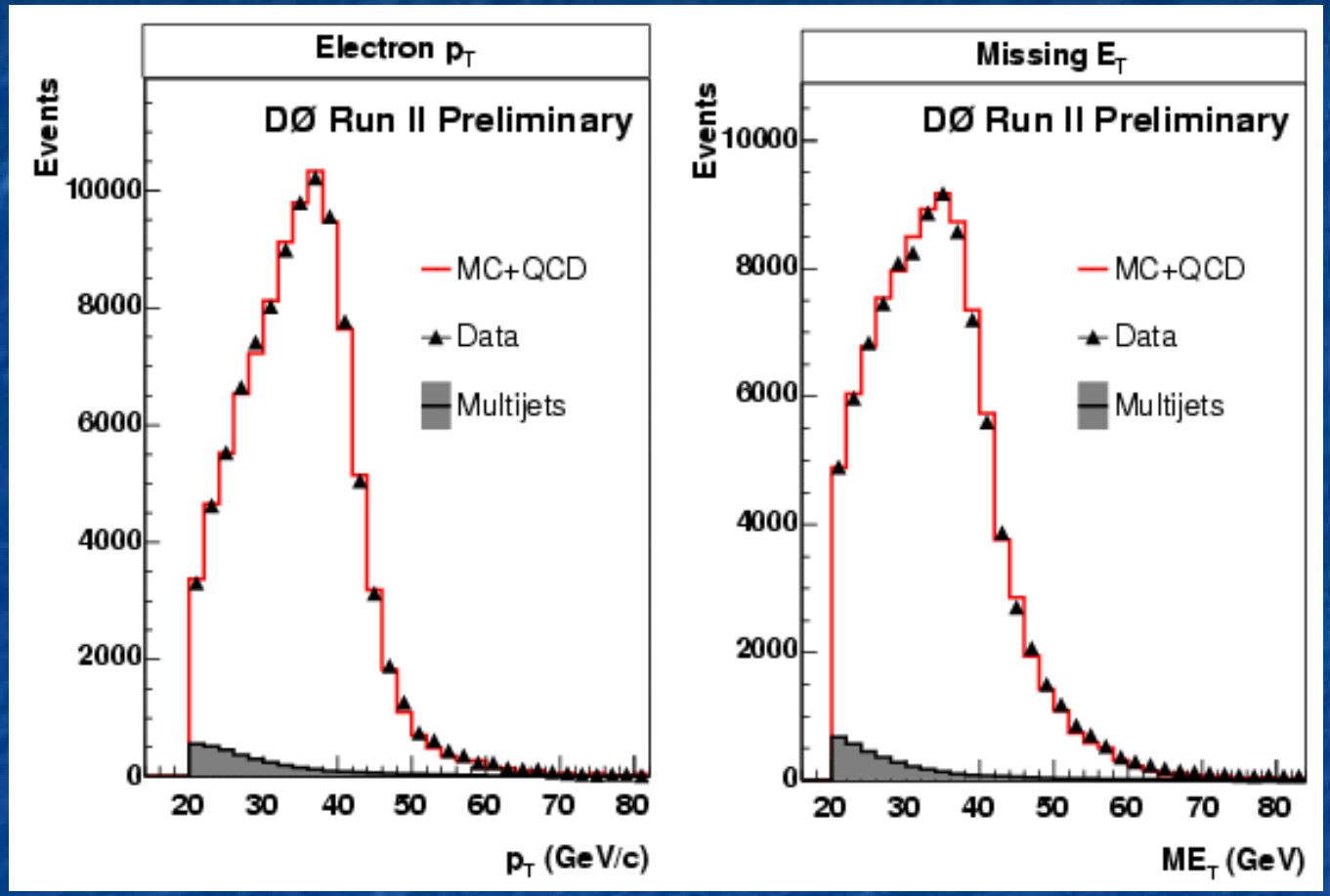


W+Heavy-Flavor Jets: The Search Process

1) Select $W \to e\nu$ and $W \to \mu\nu$ decays
2) b-Tag good jets using **S**econdary **V**ertex b-**T**agging (SVT) and **S**oft **L**epton b-**T**agging (SLT)
3) Evaluate b-Tag overlaps, ie simultaneous SVT+SLT for any jet

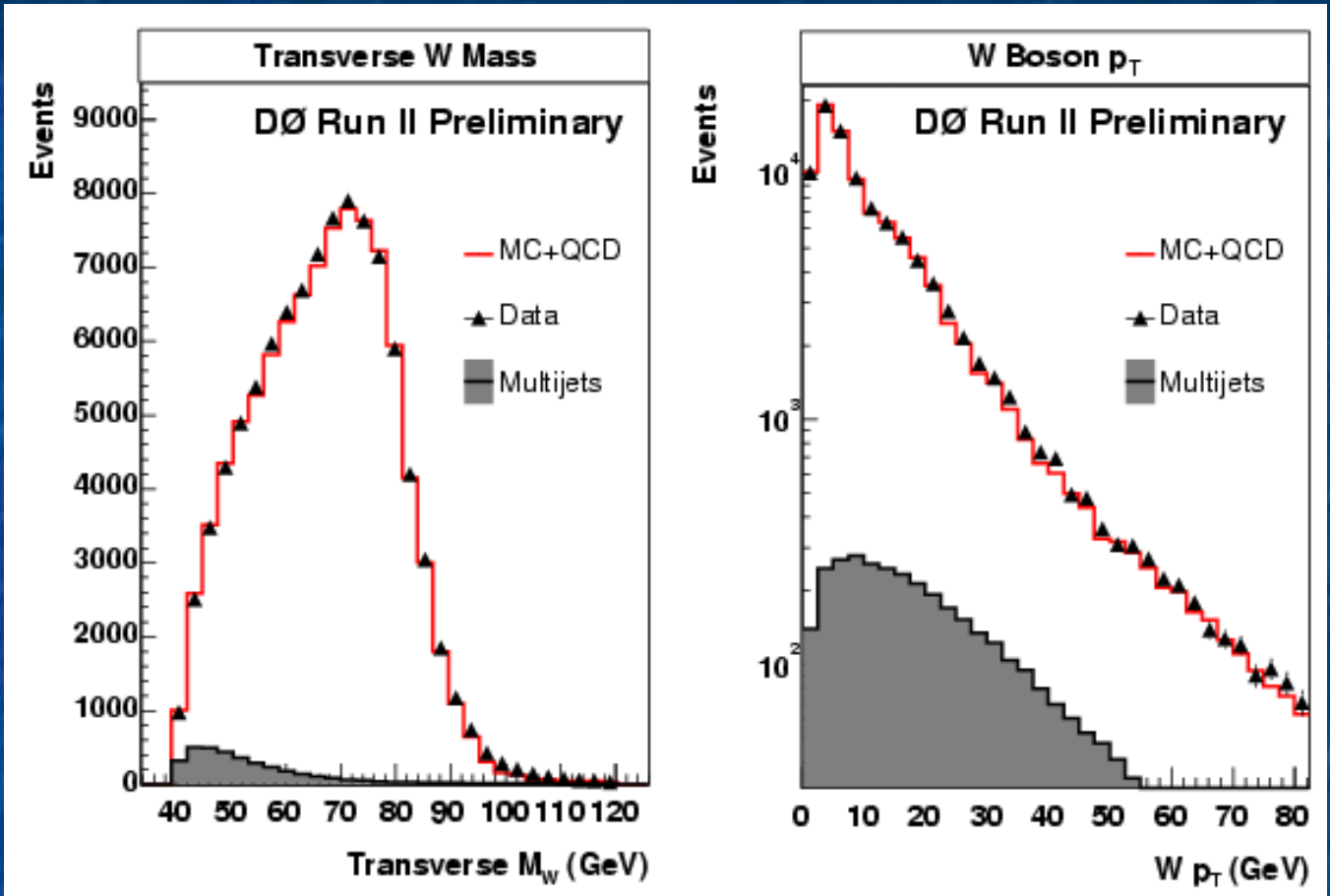
W→eν Selection: Electron & MET

- Require one isolated electron with a matching track
  - $p_T > 20$ GeV/c
  - $|\eta| < 1.1$
- Require the MET to be at least 20 GeV



Luminosity = 164 pb^{-1}

W→eν Selection: W Boson

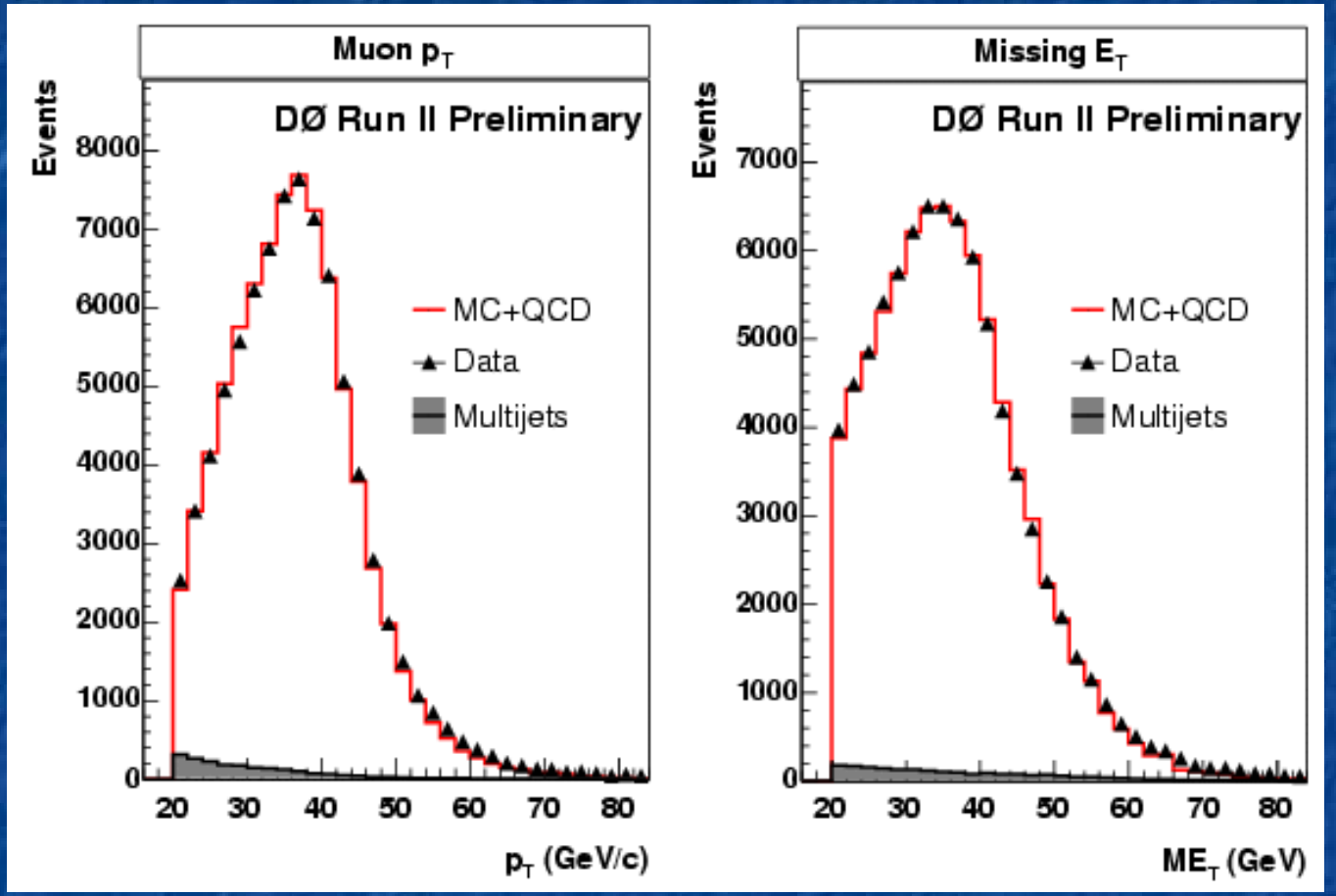


- Transverse W mass reconstruction requirements:
  - $\Delta\phi$(electron,MET) > $\pi/8$
  - 40 GeV/c^2 < M_{WT} < 120 GeV/c^2

Luminosity = 164 pb^{-1}

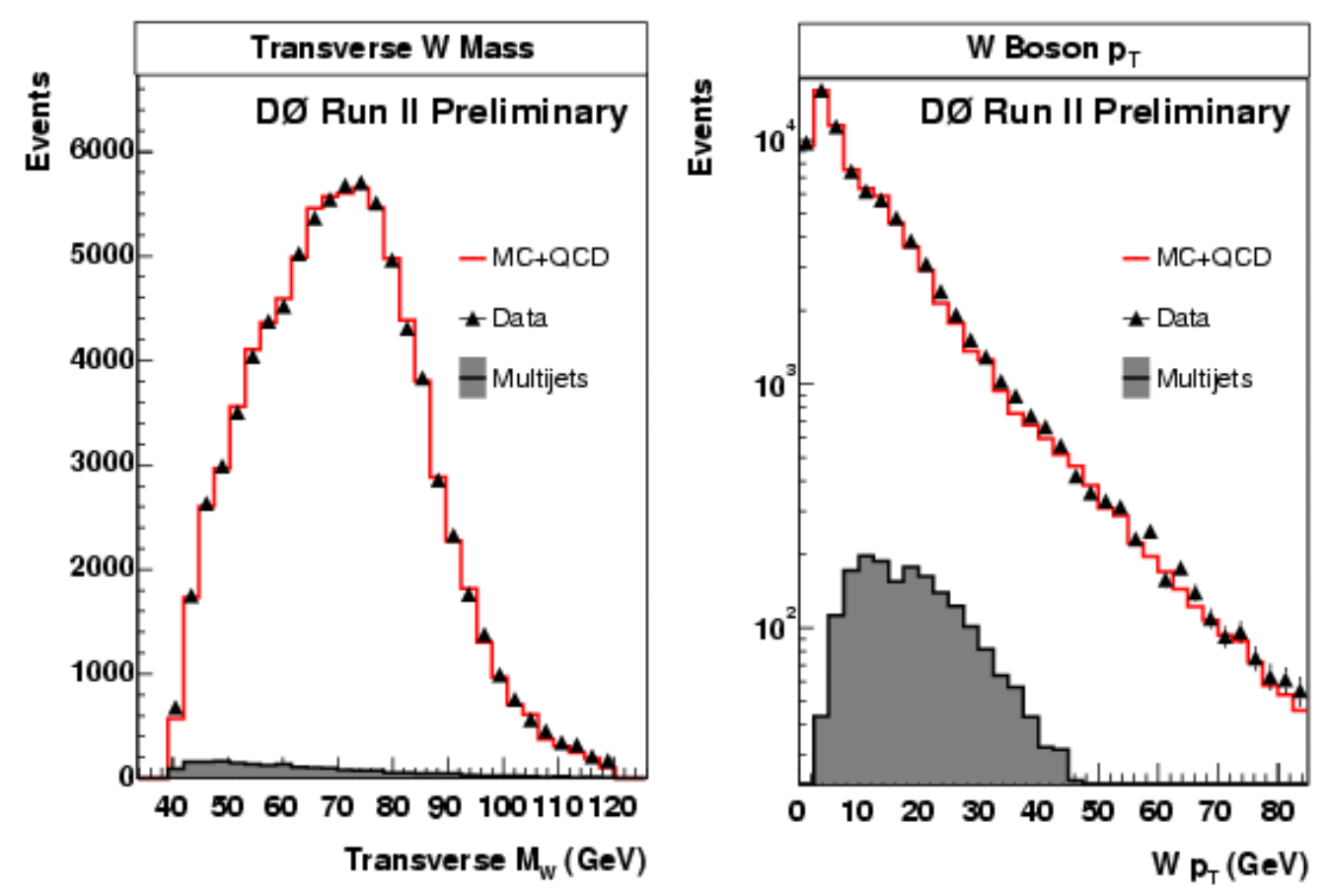
W→$\mu\nu$ Selection: Muon & MET

- Same MET selection as W→eν
  - MET > 20 GeV
- Require one isolated muon with a matching track
  - p_T > 20 GeV/c, $|\eta| < 1.6$



Luminosity = 145 pb^{-1}

W→$\mu\nu$ Selection: W Boson

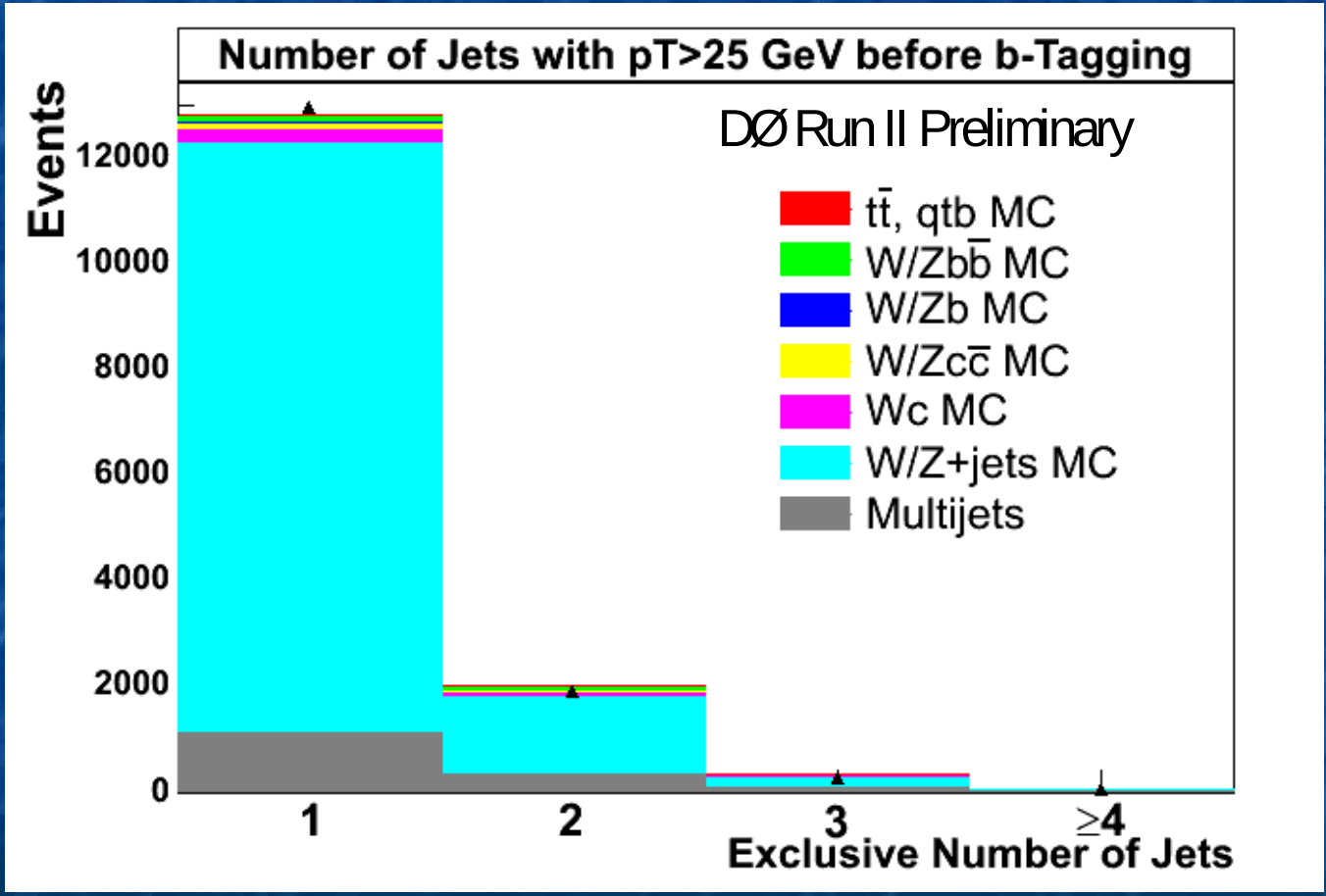


- Transverse W mass reconstruction requirements:
  - $\Delta\phi$(muon,MET) > $\pi/8$
  - 40 GeV/c^2 < M_{WT} < 120 GeV/c^2

Luminosity = 145 pb^{-1}

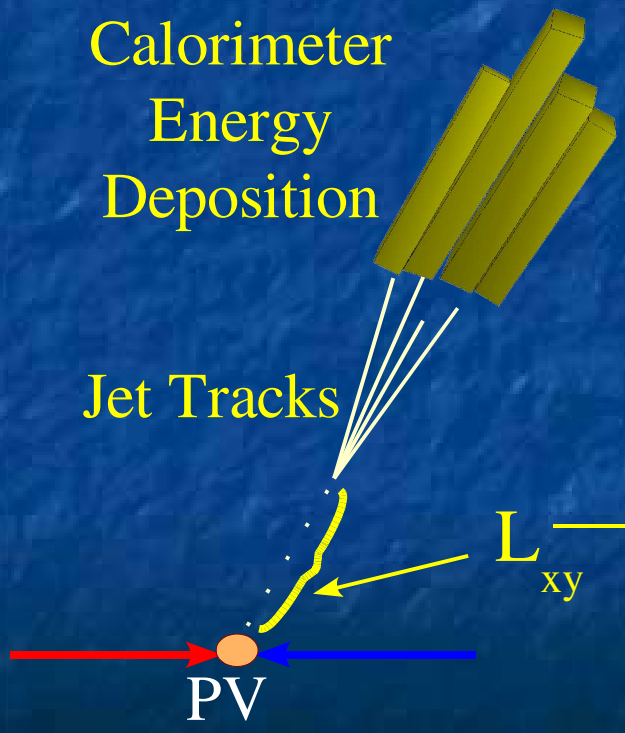
Jet Multiplicities Before b-Tagging

- Consider jets with
  - $p_T > 25$ GeV/c
  - $|\eta| < 2.5$

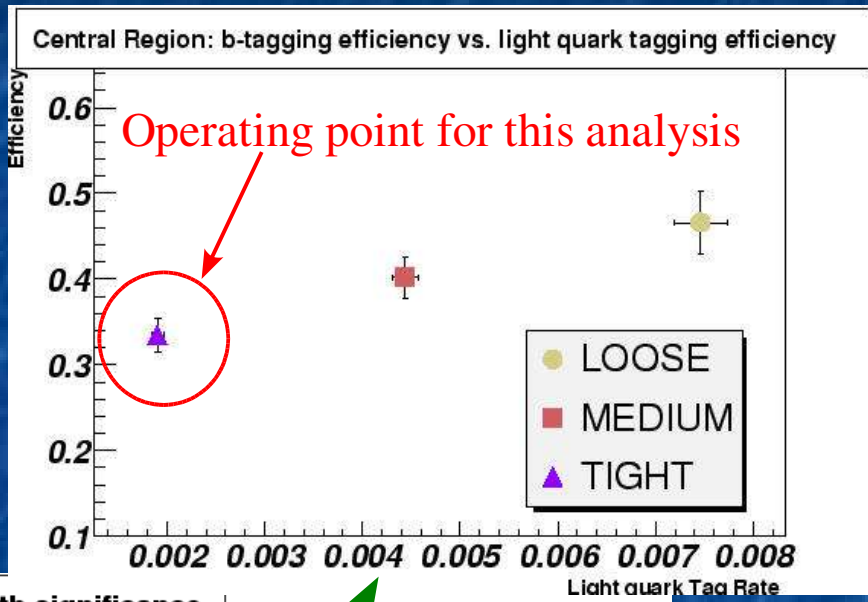


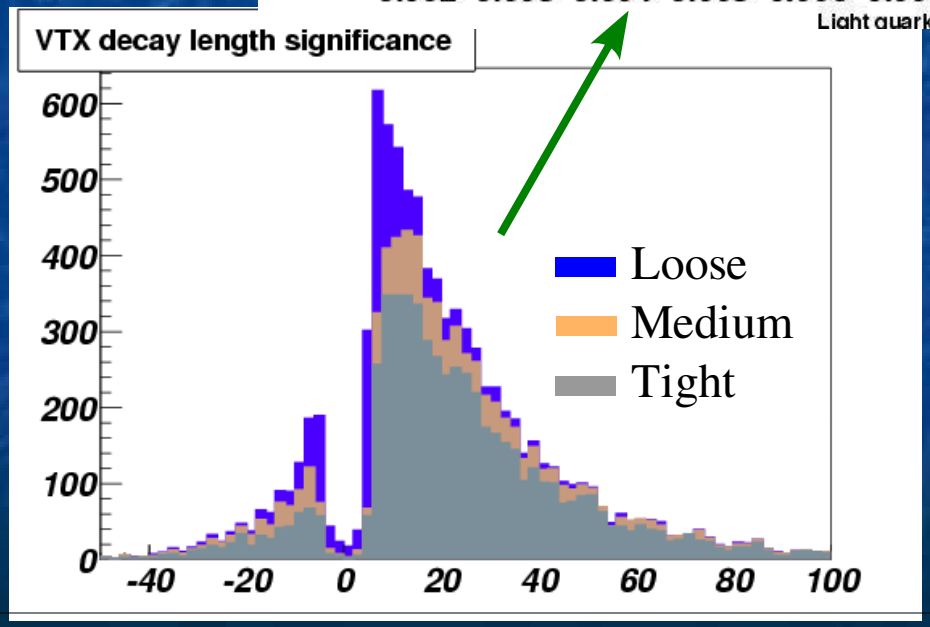
Secondary Vertexing

- Secondary Vertices are formed with tracks away from the PV
- Decay Length Significance (DLS) is the primary selection variable



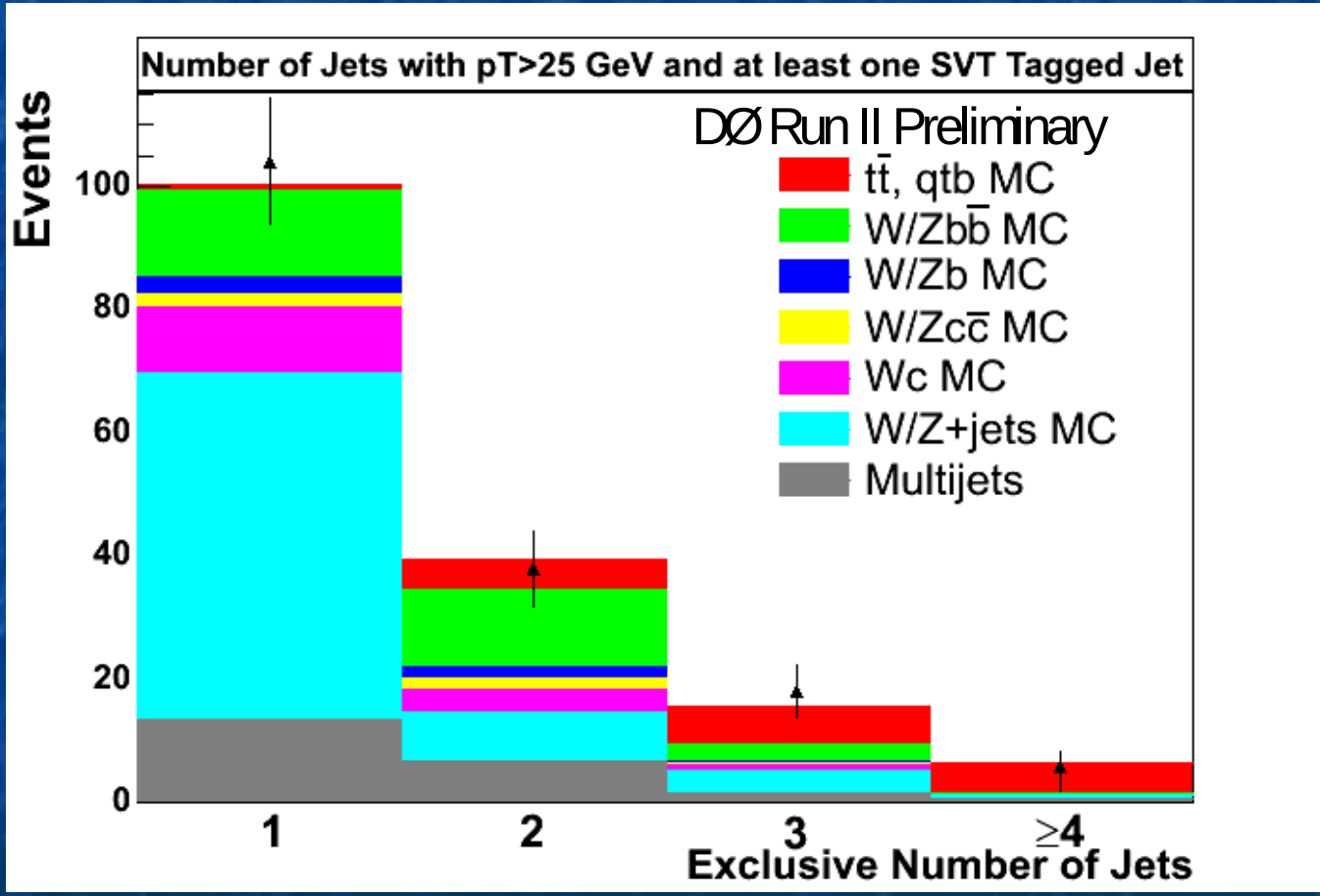
$$DLS = \frac{L_{xy}}{\sigma_{xy}}$$





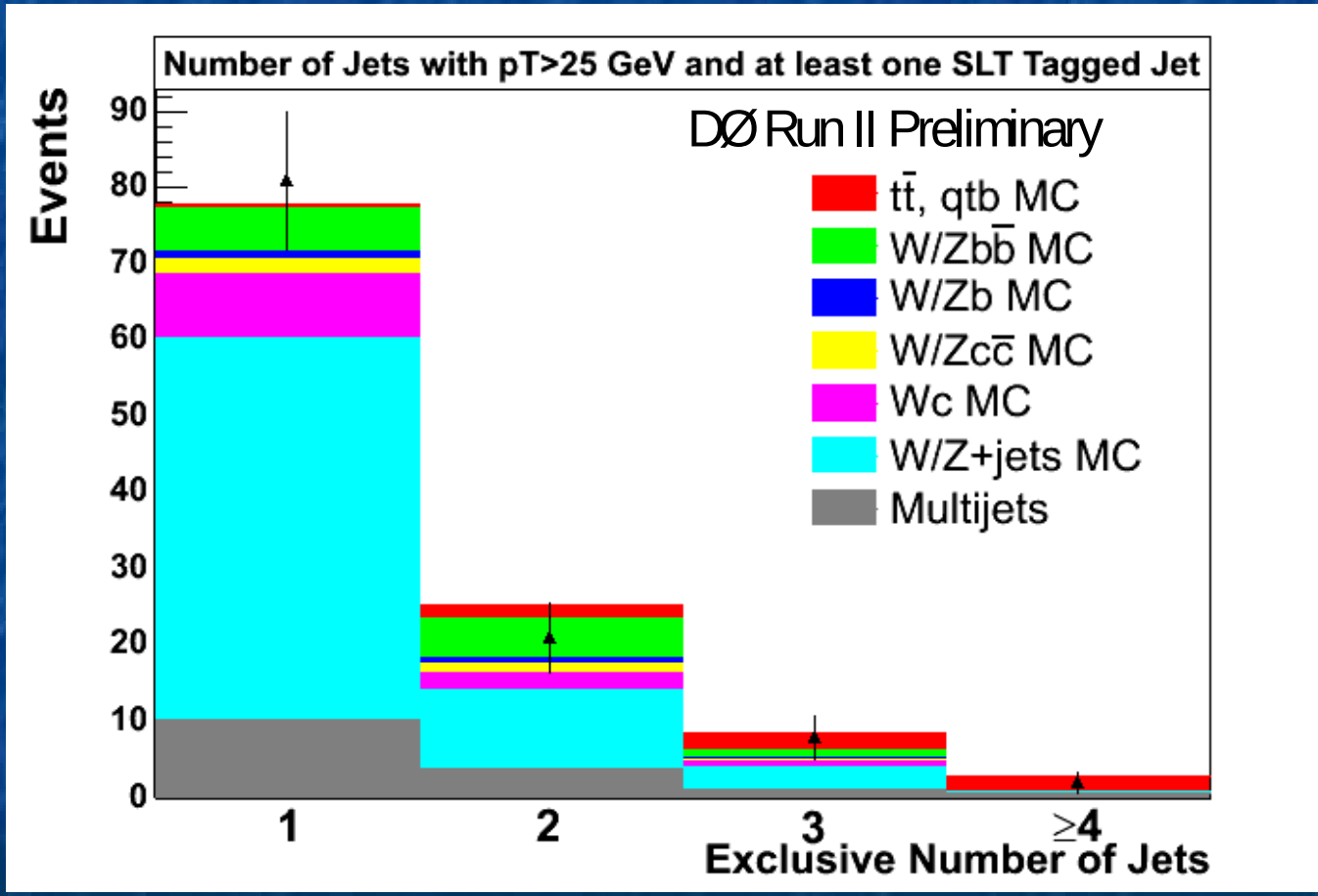
Secondary Vertex b-Tagging

- Exclusive jet multiplicity for events with at least 1 SVT



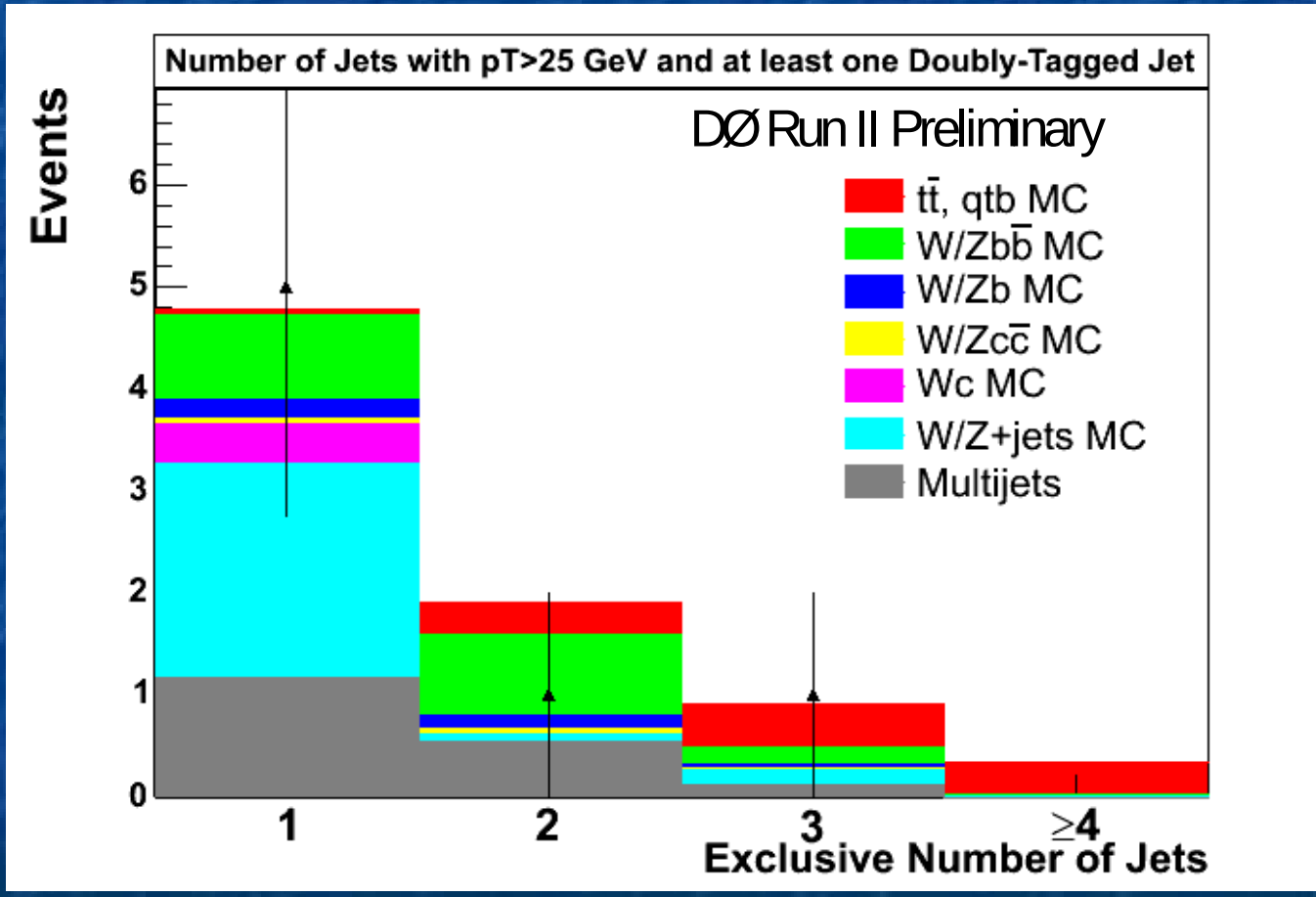
Soft Muon b-Tagging

- Soft muon b-Tag is defined for muons with
  - 4 GeV/c < p_T < 15 GeV/c
  - $|\eta_{det}| < 2.0$
  - Jets are tagged if the muon is within $\Delta R<0.5$ to the jet

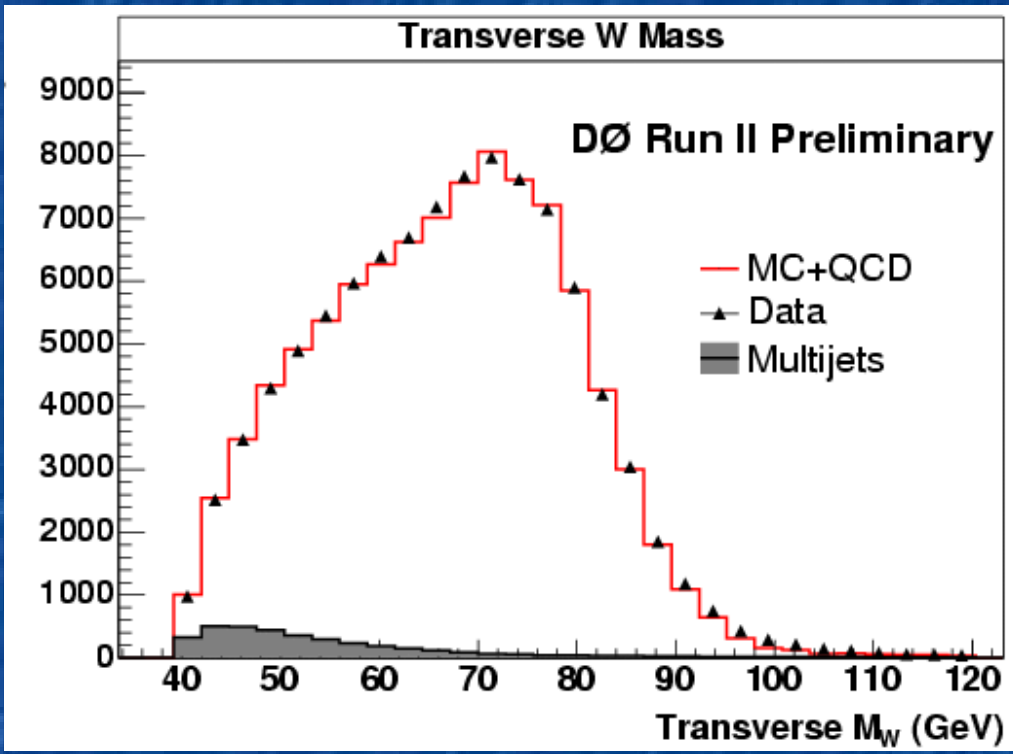


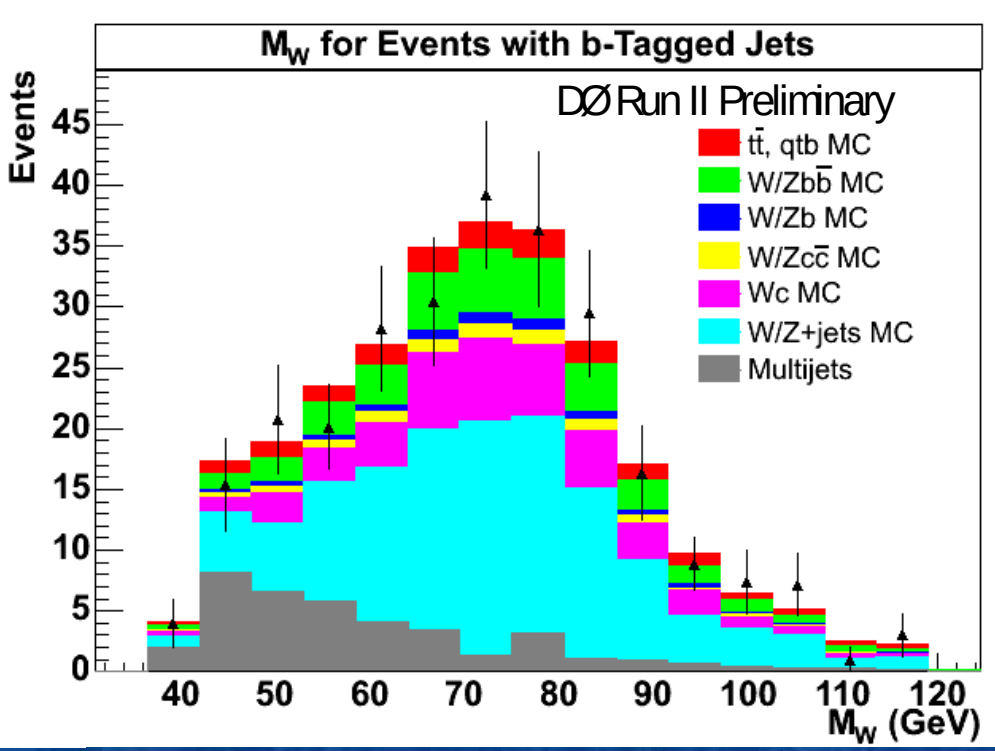
Doubly-tagged Jet Events

- Doubly b-Tagged jets require b-tags with both algorithms
  - TIGHT SVT
  - SLT
- Exclusive number of jets in events with at least one doubly b-Tagged jet



Transverse W Mass for Tagged Events





W→eν Selection **Tagged Jet Selection**

- Transverse M_W for events with at least one SVT or SLT provides a cross-check

Limits on Anomalous Production

- In the absence of a specific model for new physics, we can set limits on anomalous production per exclusive jet bin
  - Based on doubly-tagged jet sample
- Limits are calculated as 95% Confidence Levels (CL) using the LEP method
  - Errors are folded into expectation via a gaussian distribution

Source	W+1 jet	W+2 jets	W+3 jets	W+4 jets
SM Prediction	4.8±1.1	1.90±0.40	0.90±0.2	0.3±0.1
Data	5	1	1	0
95% CL Limit (Evts)	6.8	3.9	4.2	3

Limits on "SM-Like" Anomalous Production

- Assuming any anomalous production would have the same topolgies and efficiencies as SM processes, we can set cross section limits
  - Top-*like* production: consider **nJet = 2,3,4 bins**
  - Wbb-*like* production: consider **nJet = 1,2 bins**

Source	W+1,2 jets	W+2,3,4 jets
SM Prediction	6.7±1.3	3.2±0.5
Data	6	2
95% CL Limit (Evts)	6.7	4.5

Top-like Limit	-	15.6 pb
Wbb-like Limit	27.8 pb	-

Conclusions and Outlook

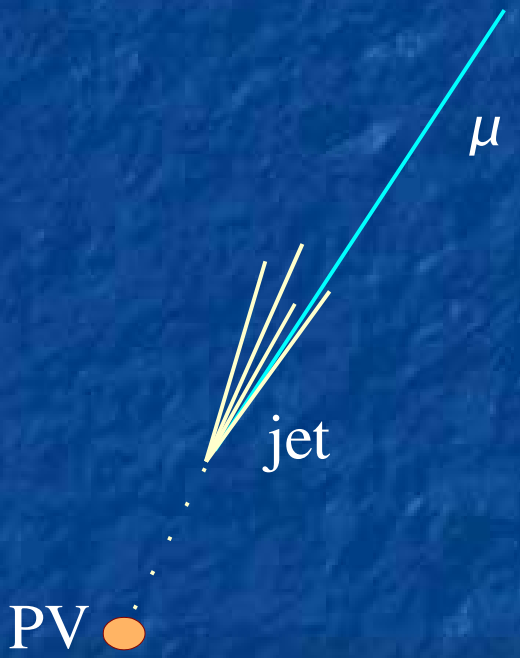
- Presented search results for anomalous heavy-flavor production in association with a W boson
- We find no evidence for physics beyond the SM prediction
- Used these results to set limits on anomalous heavy-flavor production

Source	W+1,2 jets	W+2,3,4 jets
Top-like Limit	-	15.6 pb
Wbb-like Limit	27.8 pb	-

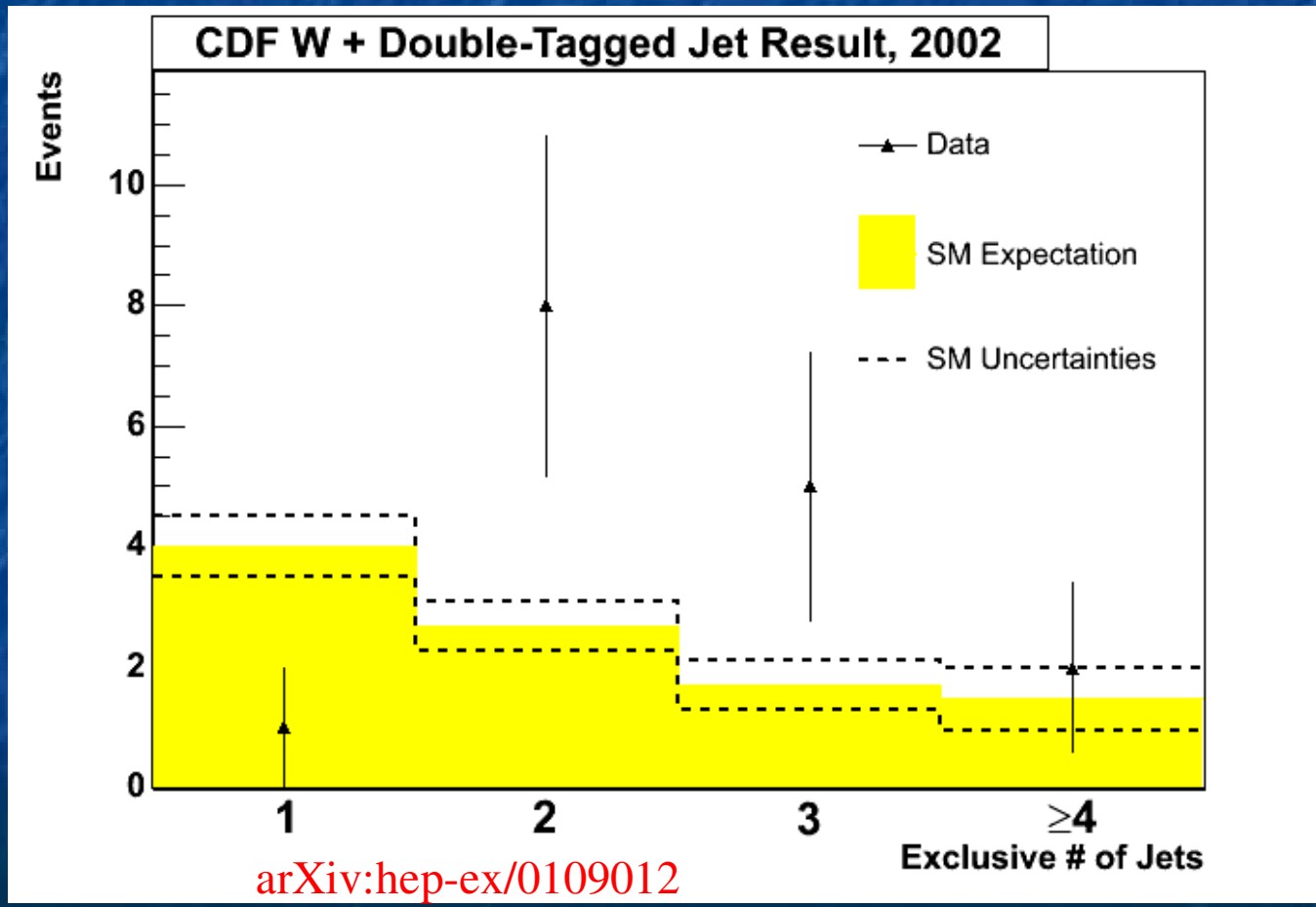
  - For scale, DØ Single-Top limit is 23 pb
- Expect improved results with increased data sample

CDF Superjets

- In RunI, CDF observed an anomaly in their W + doubly-tagged jet sample.



Doubly b-Tagged Jet



Comparison to the CDF Run I Result

- Care has been taken to achieve comparable purity levels
  - 4-Jet bin SVT tt purity:
    - CDF: 68%
    - DØ: 71%
  - 4-Jet SLT tt purity:
    - CDF: 42%
    - DØ: 67%
- But there are still efficiency differences

Analysis differences		
Source	**DØ**	**CDF**
MET	25 GeV	20 GeV
M_W Window	yes	no
Jet R	0.5	0.4
Jet E_T	25 GeV	15 GeV
SVX Signif	0.7	0.3
SLT type	muon only	muon + em
SLT lepton p_T	4 GeV	2 GeV