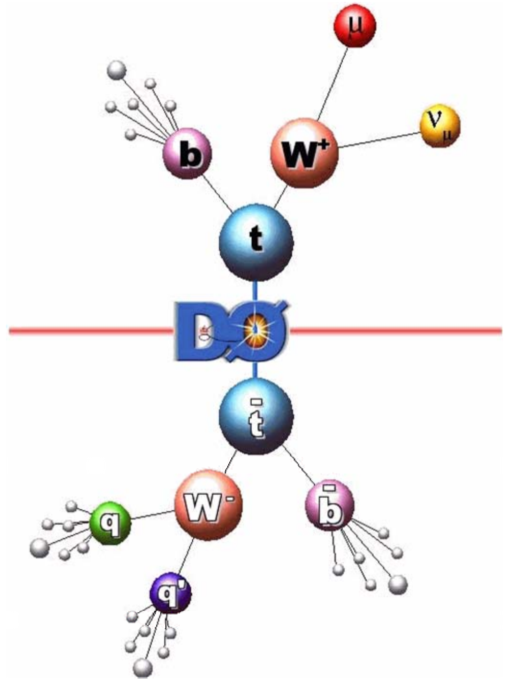


Top Quark Physics at DØ

Marek Zieliński
University of Rochester

According to Run I Colleagues…

When Trish discovers Ned works exclusively with top quarks, she will be putty in his hands.

…Top is Hot!

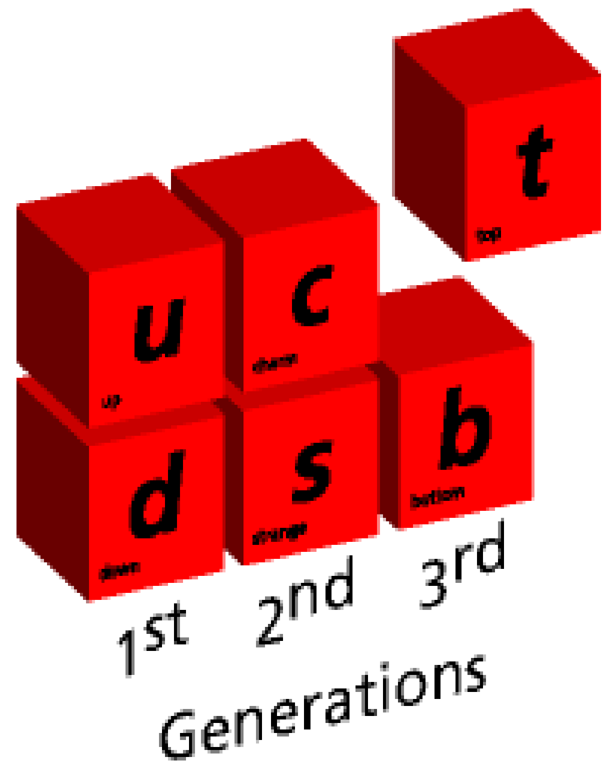
Motivations for Studying Top

- Special place in the Standard Model (SM):
  - ➔ The only known fermion with mass at the natural electroweak scale (40 times larger than its isospin partner, the b-quark)
  - ➔ Large Yukawa coupling to Higgs boson (G_t~1)
    - ❖ A window into the problem of EWSB?
- Top quark mass sets constraints on SM extensions
- New physics may appear in production (e.g. topcolor) or in decay (e.g. charged Higgs)
- Can only be studied at Tevatron prior to LHC

A Brief History of Top

Top quark was expected in the Standard Model as a partner of b-quark in the SU(2) doublet of weak isospin for the third family of quarks

- Observed by CDF and DØ in 1995
- Final Run I top analyses based on ~110 pb^{-1}:
  - ➔ Production cross sections in many channels
  - ➔ Mass
  - ➔ Event kinematics
  - ➔ W helicity measurement
  - ➔ Limits on single top production, rare/non-SM decays
  - ➔ Overall consistency with SM
  - ➔ But: statistics limited
    - ❖ only ~100 analyzable top events in Run I
- Run II top physics program will take full advantage of higher statistics:
  - ➔ Better precision
  - ➔ Searches for deviations from SM

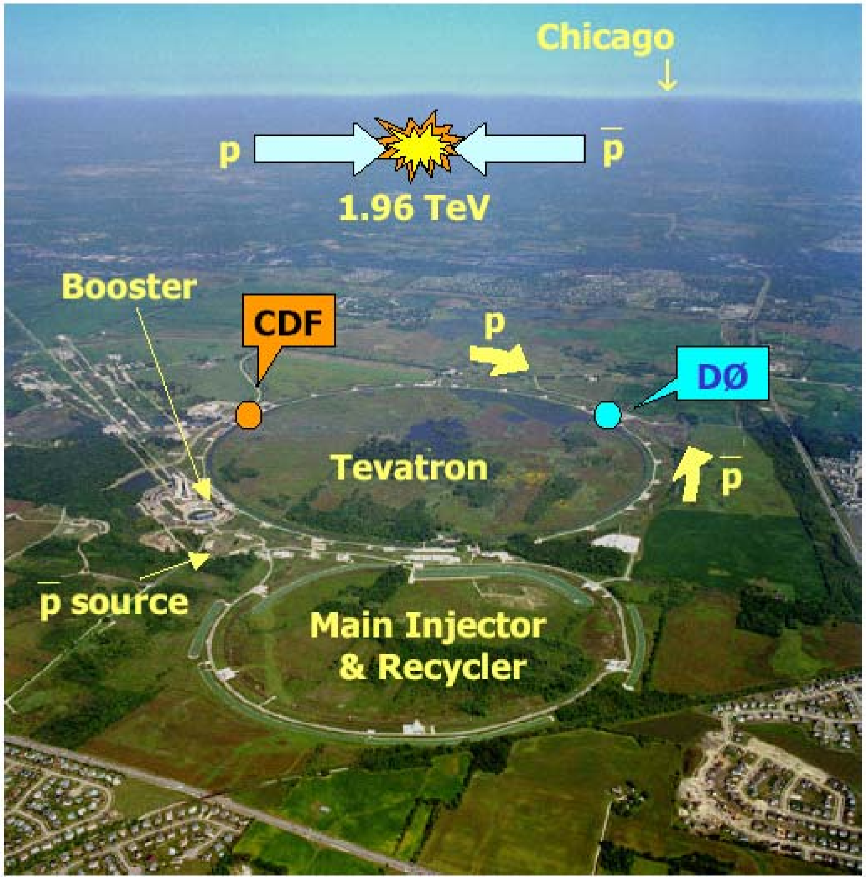


Tevatron Collider in Run II

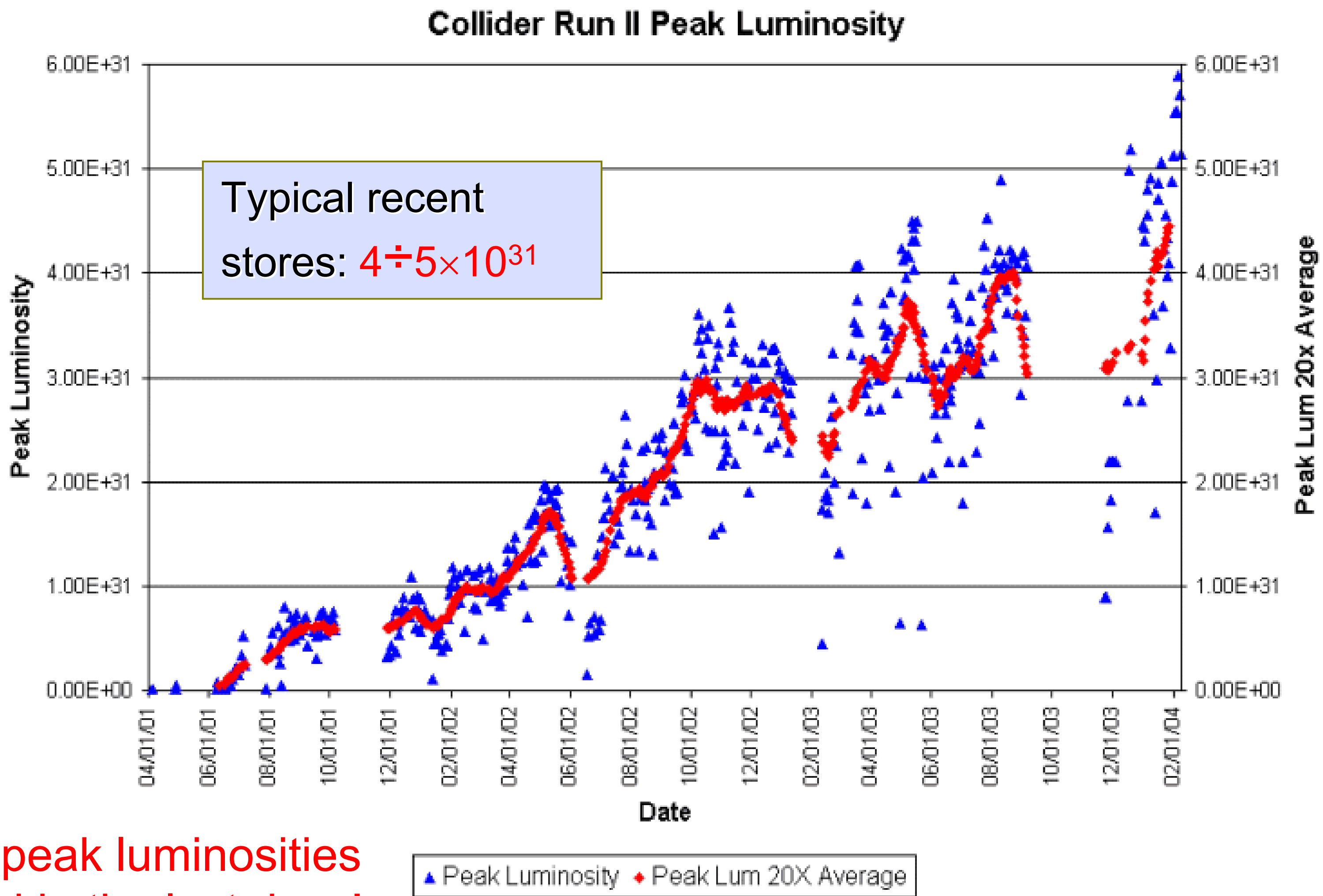
- The Tevatron is a proton-antiproton collider with energy of 980 GeV/beam

$\sqrt{s} = \mathbf{1.96\ TeV\ in\ Run\ II\ (1.8\ TeV\ Run\ I)}$

  - → ~40% increase in top cross section
- 36 p and $\bar{p}$ bunches → 396 ns between bunch crossing
  - → 6x6 bunches with 3.5μs in Run I
  - → Experiments required new electronics, trigger, DAQ
- Increased instantaneous luminosity



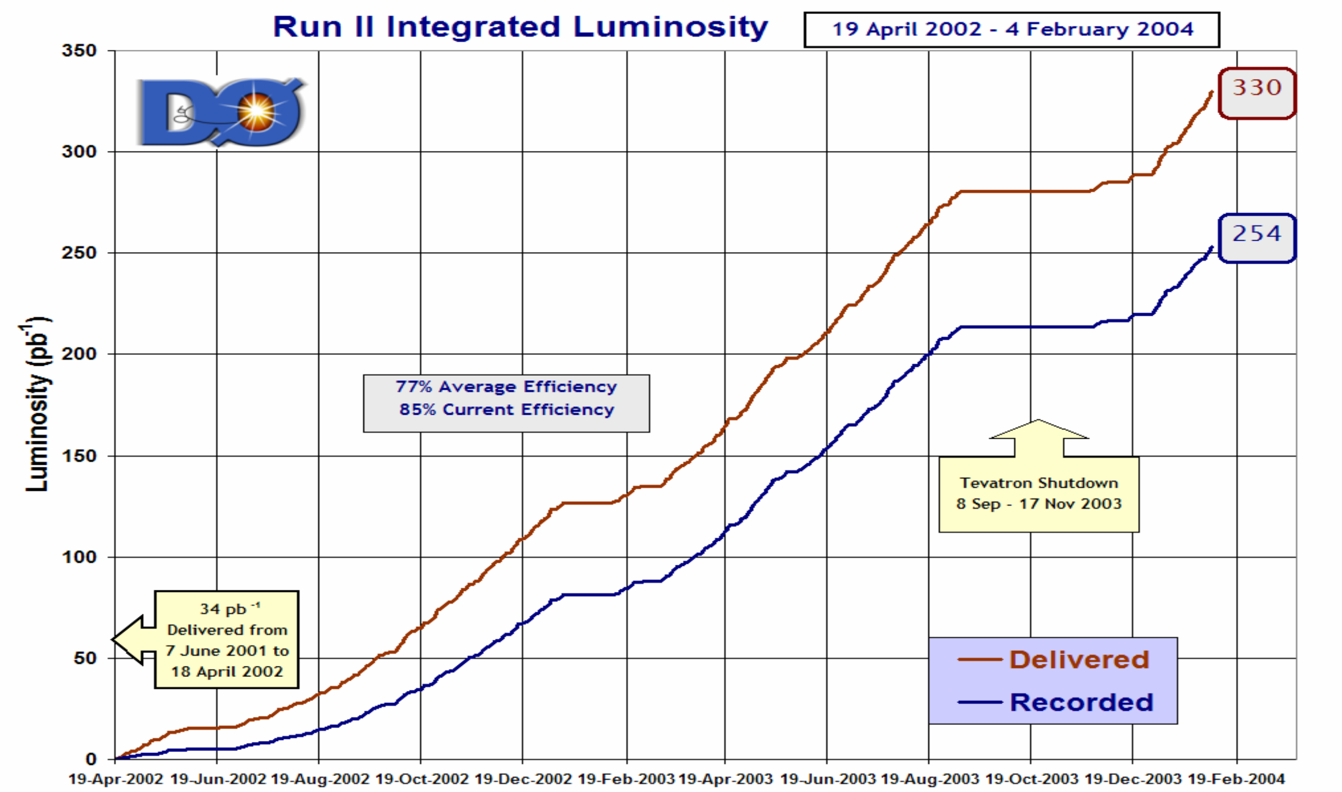
Tevatron Peak Luminosity



Record peak luminosities achieved in the last days!
-- up to ~6×10^{31}

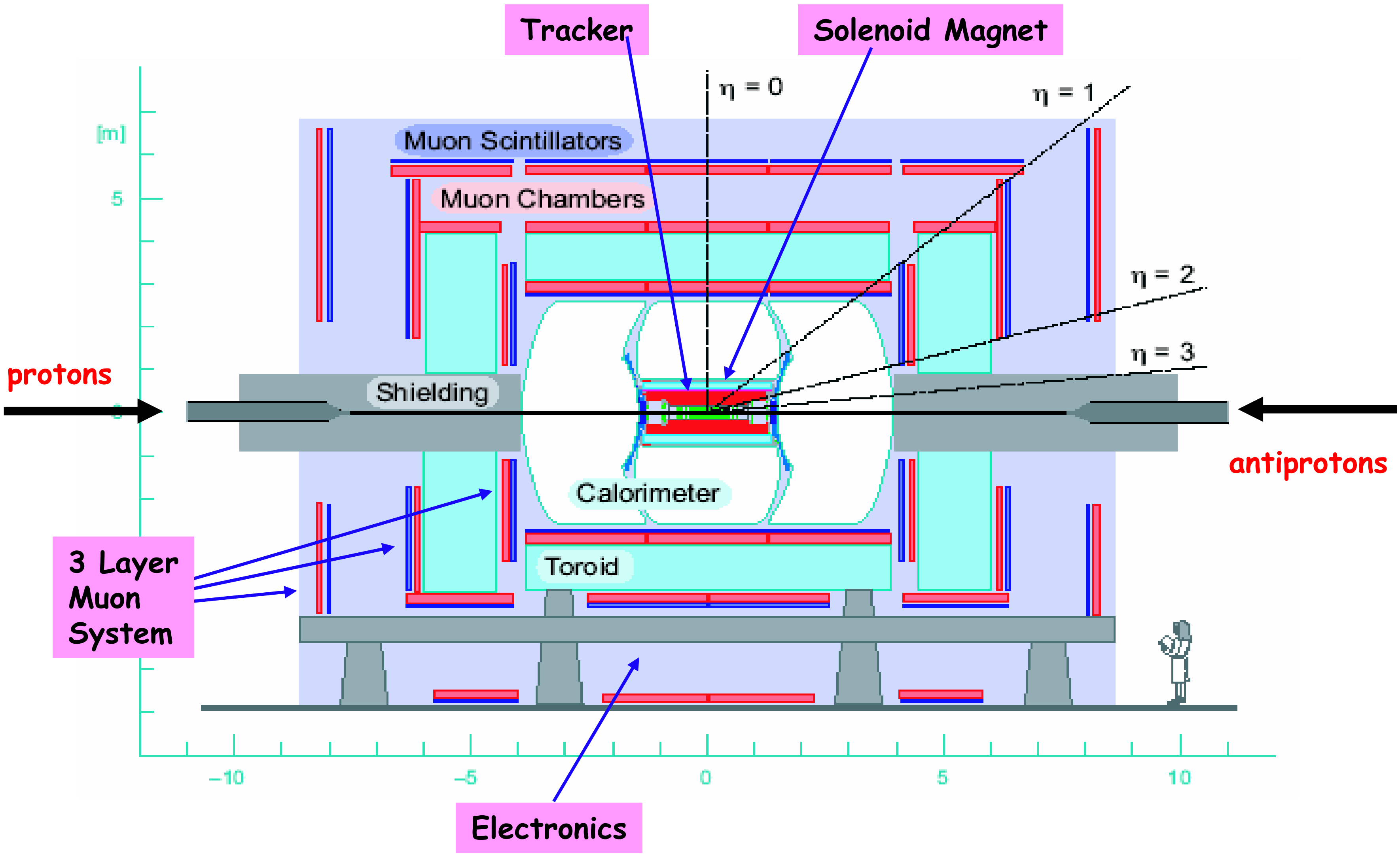
Run IIa goal: 8×10^{31}

Integrated Luminosity at DØ

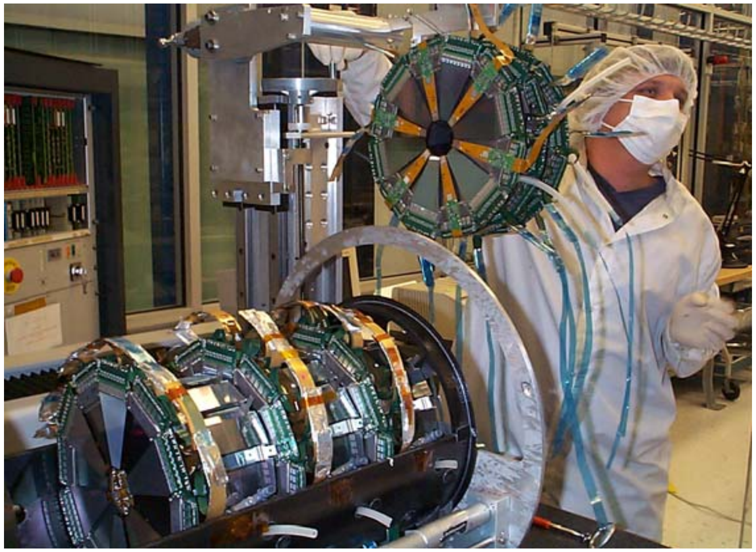


- Already have ~250 pb^{-1} of data on tape
- **Goal for 2004**: additional 230-370 pb^{-1} delivered
- At long last, CDF and DØ will use common value of inelastic cross section for the luminosity determination (60.7±2.4 mb)
- Most of the results presented today are from first ~100 pb^{-1}

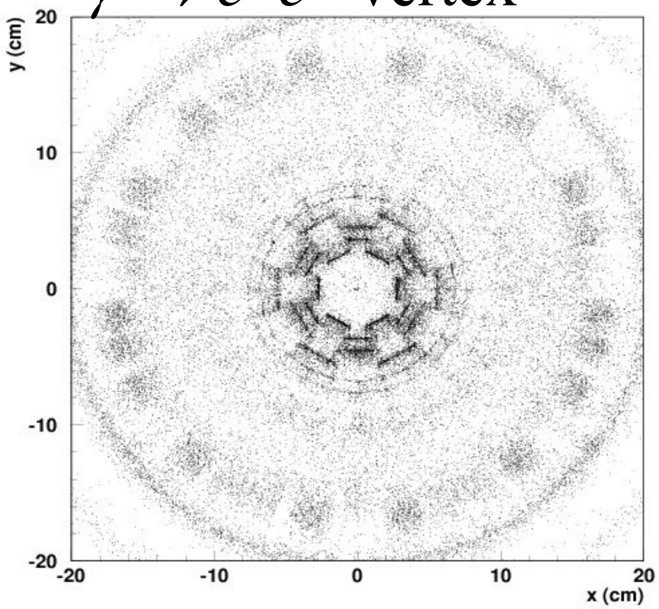
DØ Detector in Run II

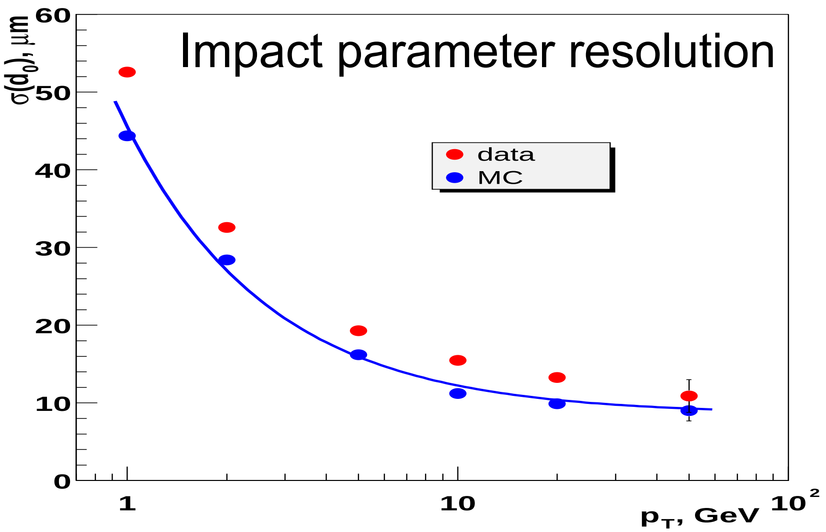


Silicon Detector

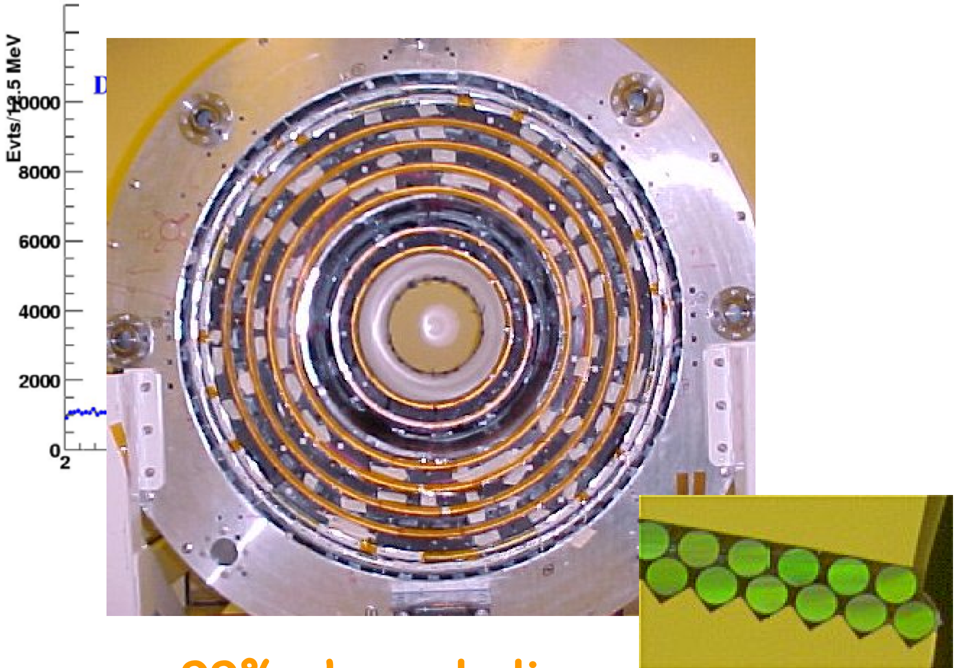


$\gamma \rightarrow e^+e^-$ vertex

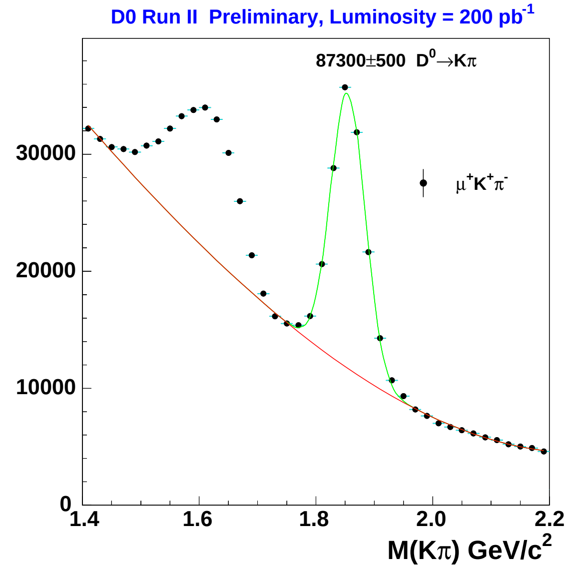




Fiber Tracker

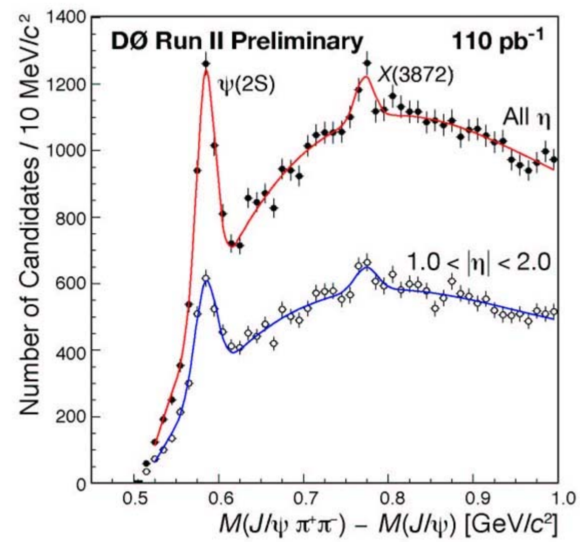


~ 99% channels live

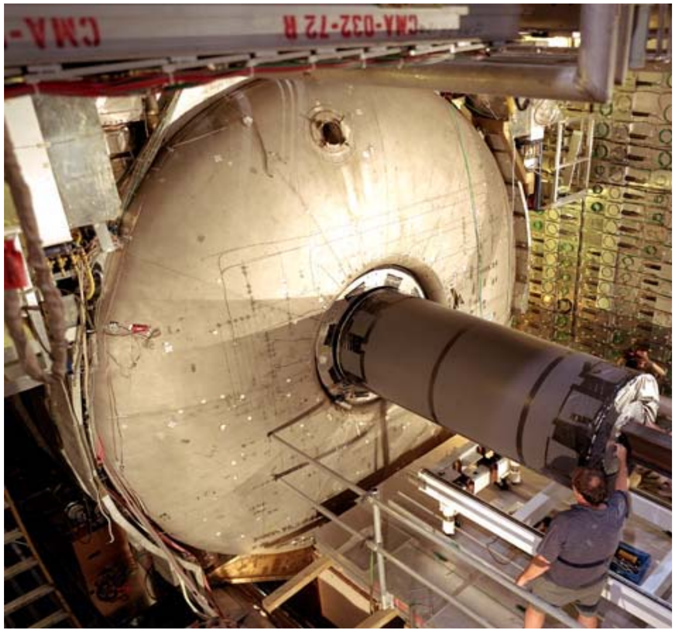


8 super layers of scintillating fibers, each layer with one axial and one stereo doublet

$$B\ell^2 \approx 0.5\mathrm{Tm}^2 \Rightarrow$$ **Compact**

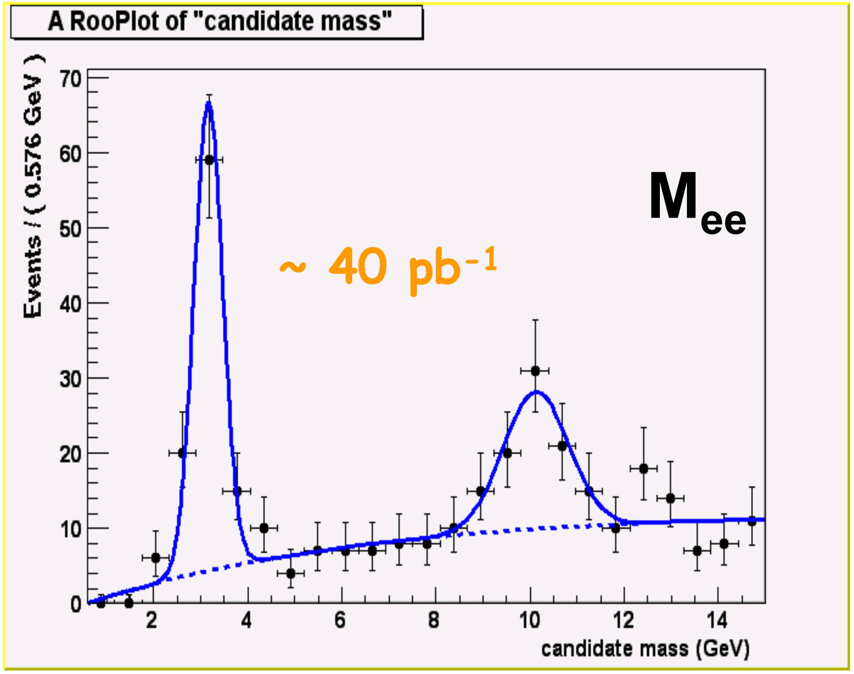


Calorimeter



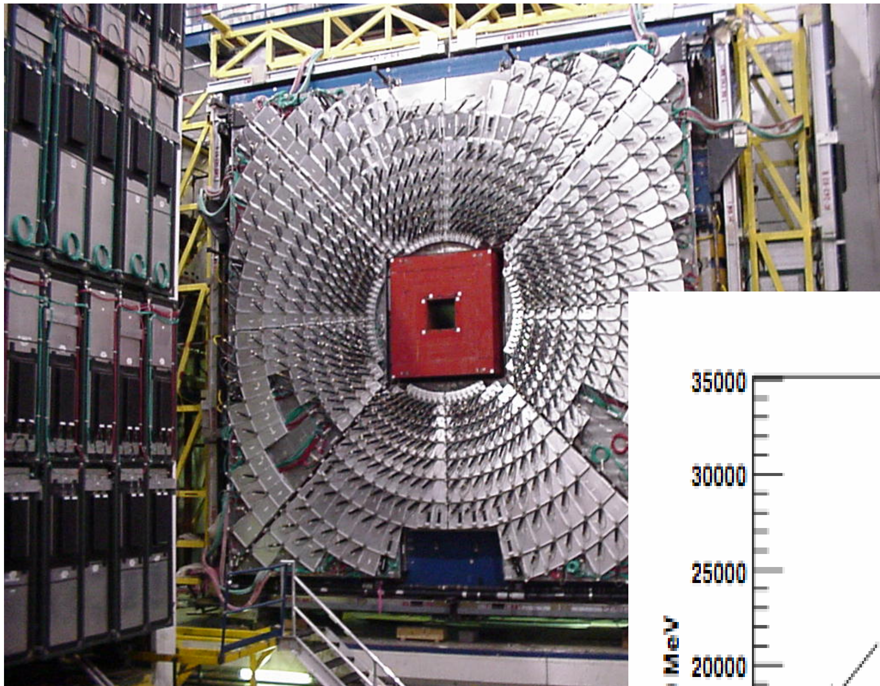
~99% channels live

Same detector, new electronics



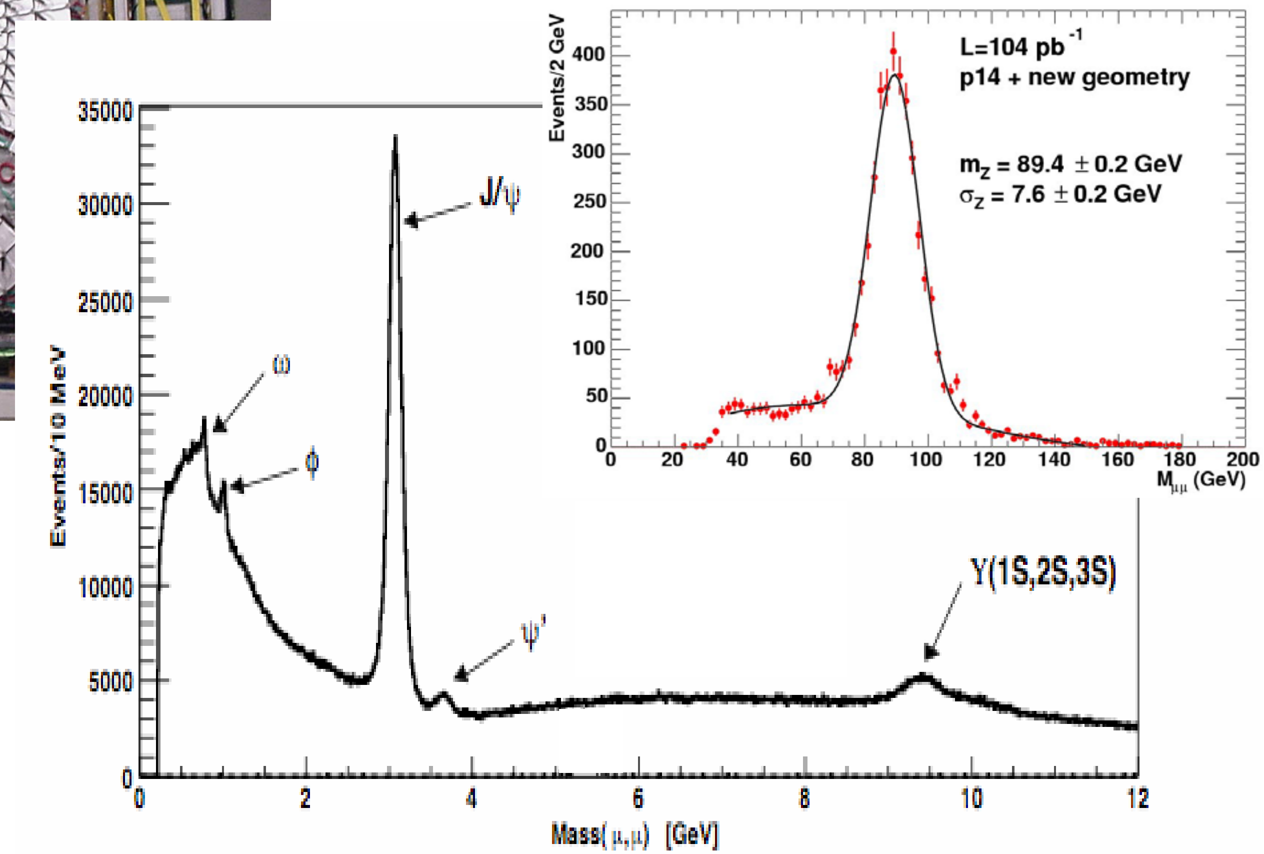
"Old" calorimeter with the new tracker = new possibilities…

Muon System



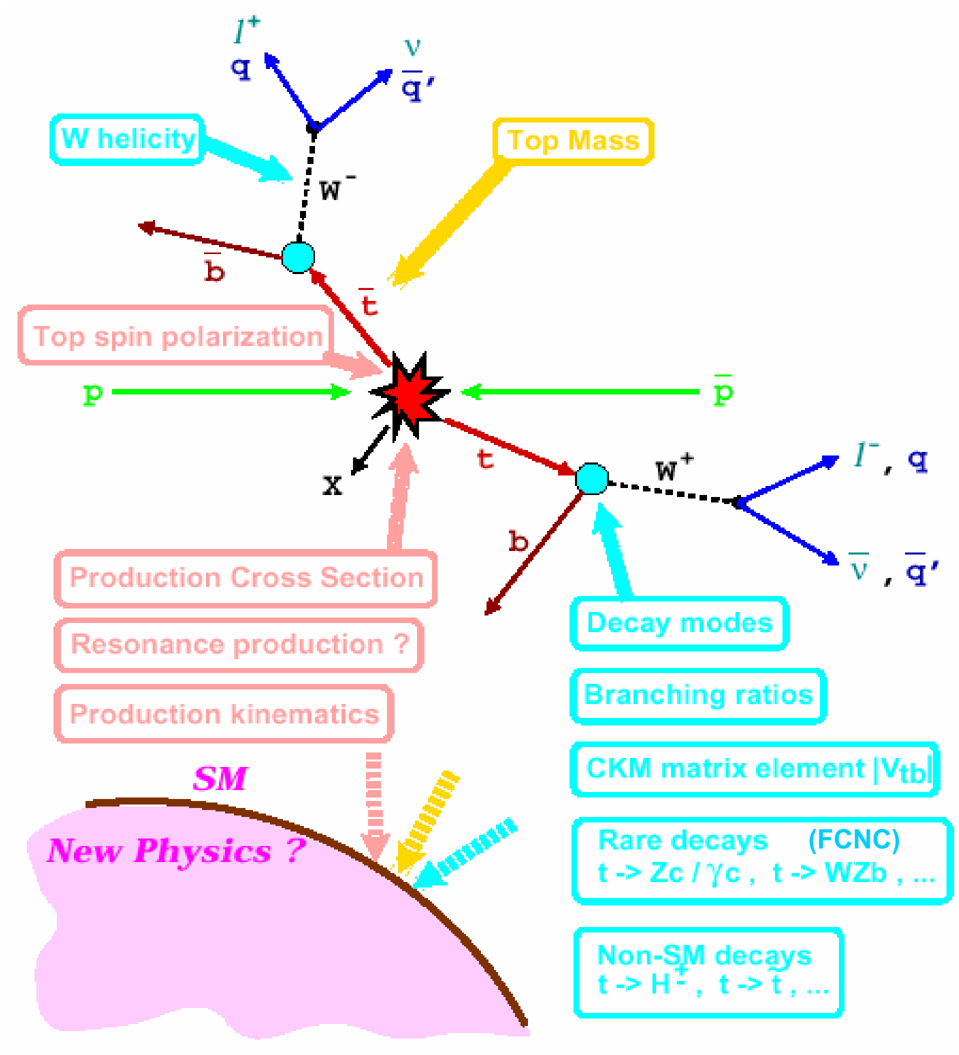
99+% channels live

Run I central muon detector
New forward muon detector
and many scintillator counters…



A key upgrade
of DØ muon detection
is the magnetic central
tracker…

Top Physics in Run II



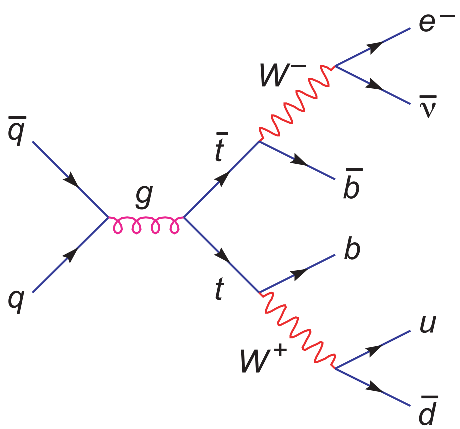
- In Run II we hope to address questions such as:
  - ➔ Why is top so heavy?
  - ➔ Is the third generation special?
  - ➔ Is top involved in EWSB?
  - ➔ Is it connected to new physics?

Main goals:

- Cross section
- Mass
- W helicity
- Single top
- Couplings
- Rare decays

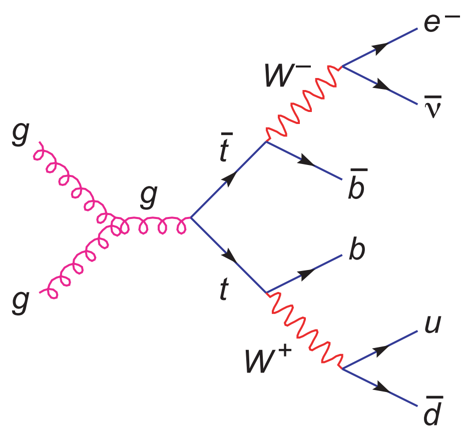
Top Quark Production

B(t→Wb) = 100%



(a)

85 %



(b)

15 %

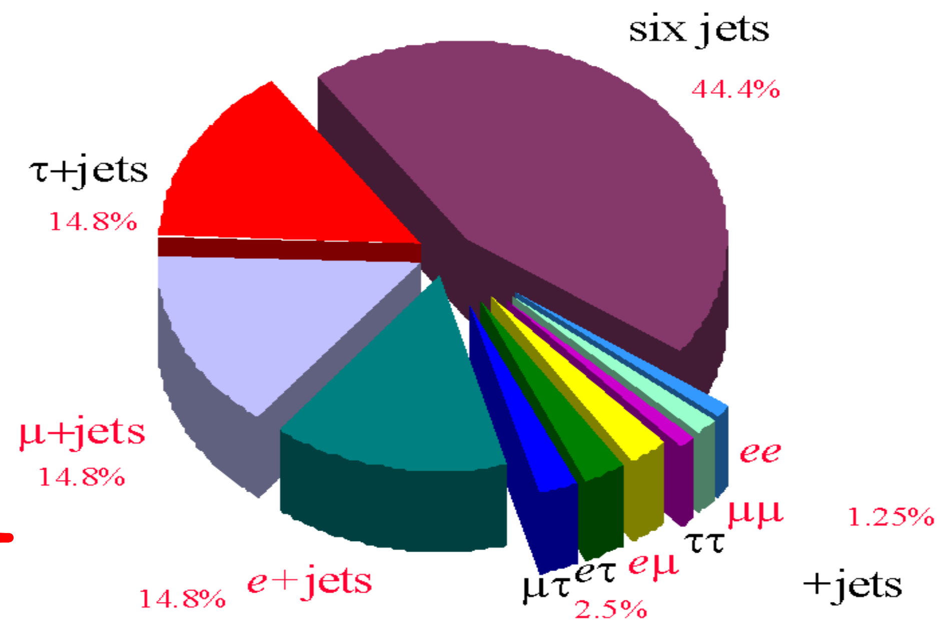
- In Run II (1.96 TeV) the cross section is expected to be ~40% higher than in Run I (1.8 TeV)
- Measurements require detailed understanding of detector, backgrounds and selection efficiencies

	Run I	Run II	
luminosity	**0.1 fb^{-1}**	**2 fb^{-1}**	**8 fb^{-1}**
$\sigma(p\bar{p} \to t\bar{t})$	**5 pb**	**7 pb**	**7 pb**
N top produced	**500**	**14000**	**56000**

RunII (2 fb^{-1})
$\delta\sigma_{t\bar{t}} / \sigma_{t\bar{t}} \leq 10\%$

Top Quark Decays

- $t\bar{t}$ final states are classified according to the W decay modes
- Dilepton (ee, μμ, eμ)
  - ➔ Both W's decay leptonically
  - ➔ BR = 5%
- Lepton (e or μ) + jets
  - ➔ One W decays leptonically, the other one hadronically
  - ➔ BR = 30%
- All-hadronic
  - ➔ Both W's decay hadronically
  - ➔ BR = 44%
- τ + X
  - ➔ BR = 21%



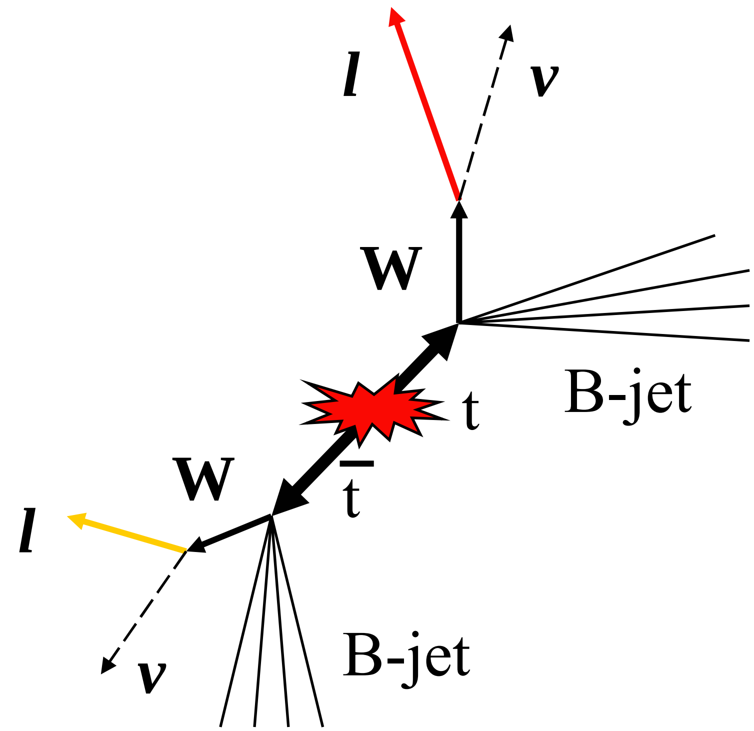
Most favorable channels for top physics

More challenging backgrounds, but measurements still possible

Top Decays: Dilepton Channels

- Event selection:
  - ➔ 2 high P_T isolated charged leptons (e,μ)
  - ➔ Neutrinos: large missing E_T
  - ➔ At least 2 jets (b-jets)
  - ➔ Large scalar sum of E_T's for all measured "objects" (leptons, jets)
- Backgrounds
  - ➔ Irreducible ("Physics"):
    - ❖ WW/WZ, $Z\rightarrow\tau\tau$ determined from MC
    - ❖ $Z/\gamma^*\rightarrow$ ee,μμ from data
  - ➔ Instrumental:
    - ❖ fake leptons in W+jets events
    - ❖ fake leptons and missing E_T in multi-jet events

    measured from data
- Compared to lepton+jets:
  - ➔ Cleaner signal (2 high P_T leptons)
  - ➔ Smaller systematics (fewer jets)



$t(\rightarrow W^{+}b)\ \bar{t}(\rightarrow W^{-}b)$

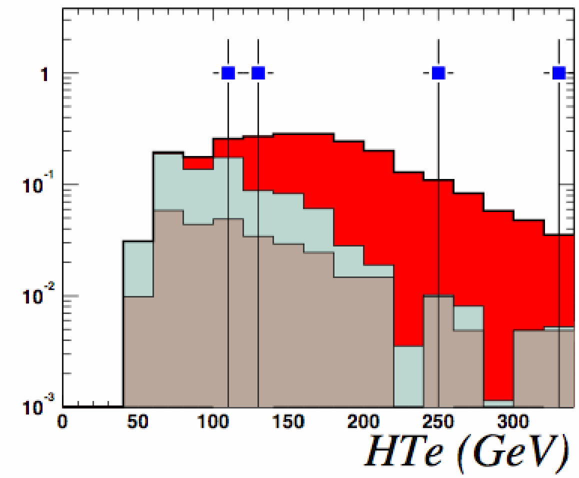
$\quad \hookrightarrow e^{+},\mu^{+} \qquad \hookrightarrow e^{-},\mu^{-}$

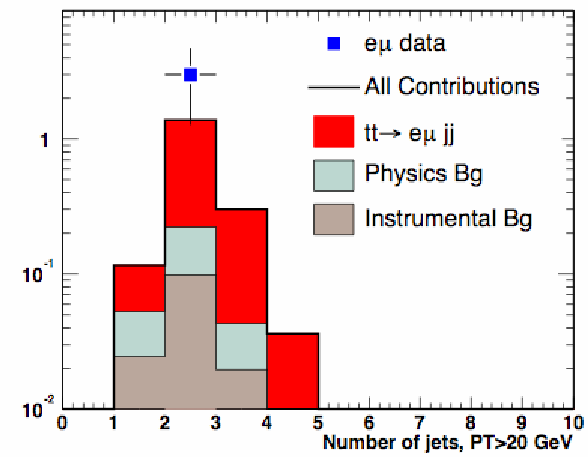
Dilepton Cross Sections

Results from first 90 – 110 pb^{-1}

- ee channel
  - ➔ Observe 2 events, background 0.6 ± 0.5
- μμ channel
  - ➔ Observe 0 events, background 0.7 ± 0.2
- eμ channel
  - ➔ Observe 3 events, background 0.6 ± 0.2

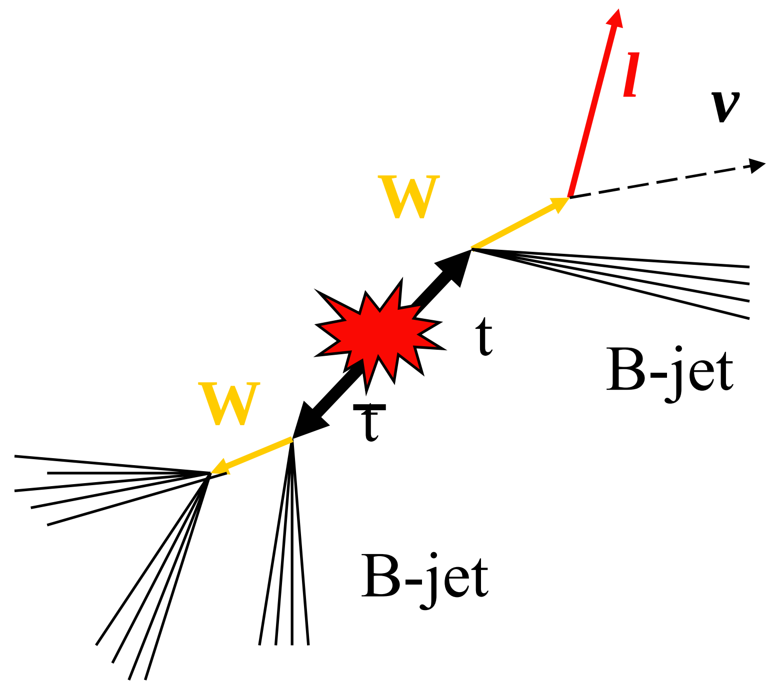
$$\sigma_{t\bar{t}} = 8.7\ ^{+6.4}_{-4.7}(\mathrm{stat})\ ^{+2.7}_{-2.0}(\mathrm{syst}) \pm 0.9(\mathrm{lum})\ \mathrm{pb}$$





Top Decays: Lepton+Jets Channels

- Event preselection:
  - ➔ 1 high P_T isolated charged lepton (e,μ)
  - ➔ Neutrinos: large missing E_T
  - ➔ Large jet multiplicity
- Backgrounds:
  - ➔ W+jets and multi-jet processes with fake leptons
- Compared to dileptons:
  - ➔ Larger yield
  - ➔ Higher background
- Improved techniques:
  - ➔ make use of event topology
  - ➔ tag *b* jets



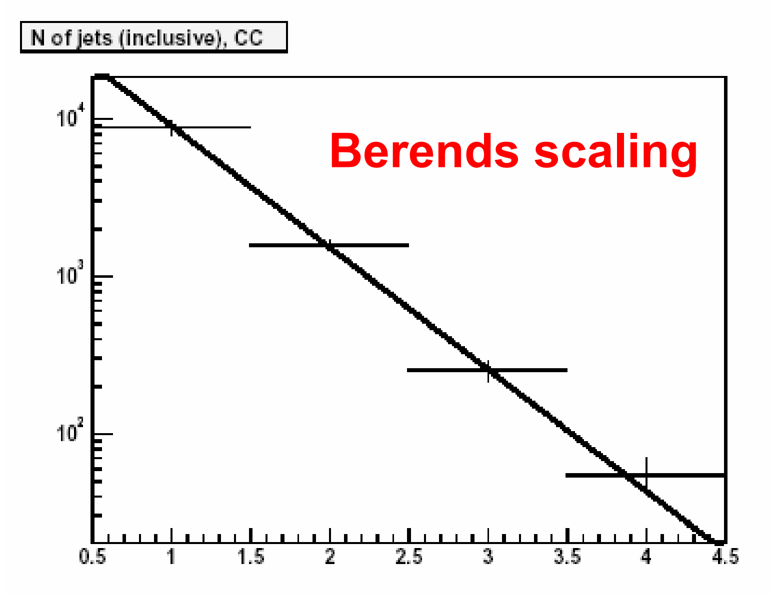
$t(\rightarrow W^{\pm}b)\ \bar{t}(\rightarrow Wb)$

$\quad\llcorner\rightarrow e^{\pm},\mu^{\pm} \qquad \llcorner\rightarrow q\bar{q}$

Lepton+Jets Analysis

- Topological analysis
  - ➔ Preselect a sample enriched in W events
  - ➔ Evaluate QCD multijet background from the studies of lepton isolation in low and high missing E_T regions
    - ❖ **μ+jets: due to heavy flavor decays**
    - ❖ **e+jets: due to fake "e" from jets (π^0 and γ)**
  - ➔ Estimate W+jets background for events with ≥4 jets using the Berends scaling method
    - ❖ Now replaced with a Likelihood-based discrimination
  - ➔ Select events with "top-like" topologies: ≥ 4 jets, large H_T and Aplanarity

"Matrix" method



N_{jets}

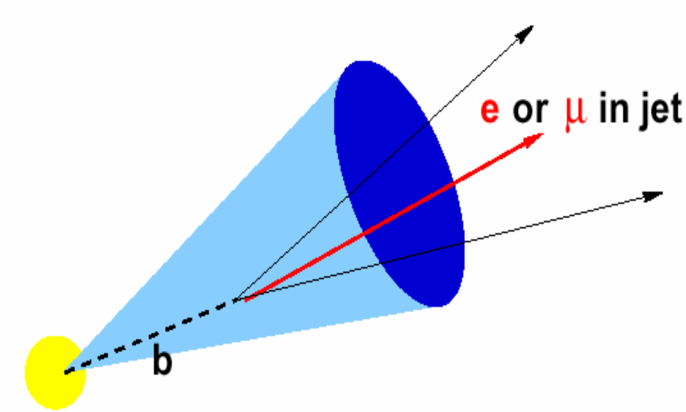
e+jets:

- Observe 12 events
- Background 6.8±1.6

μ+jets:

- Observe 14 events
- Background 11.7±1.9

Cross Section with Soft Lepton Tag



- $b \to \ell \nu c$ (BR ~ 20%)
- $b \to c \to \ell \nu s$ (BR ~ 20%)

Soft Lepton Tag:

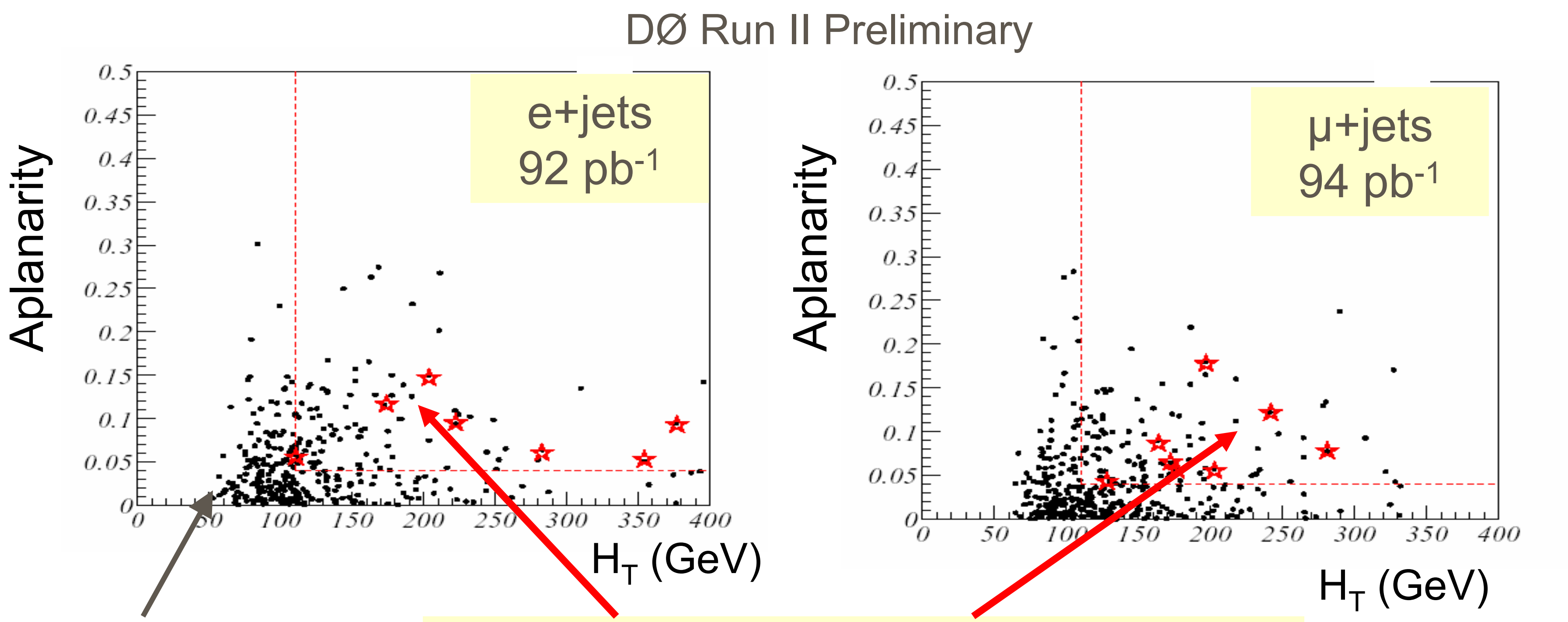
- Exploits semi-leptonic decays of the b quarks
  - ➔ These leptons have a softer P_T spectrum than leptons from W/Z
  - ➔ They are not isolated
- same preselection as topological analysis
- ≥ 3 jets (relaxed jet requirement)
- softer topological cuts

- e+jets/μ:
  - ➔ Observe 7 events
  - ➔ Background 1.1±0.9
- μ+jets/μ:
  - ➔ Observe 8 events
  - ➔ Background 2.2±1.0

Cross section:

$$11.4^{+4.1}_{-3.5}(stat.)^{+2.0}_{-1.8}(sys.)\ \mathrm{pb}$$

Lepton + Jets Kinematics



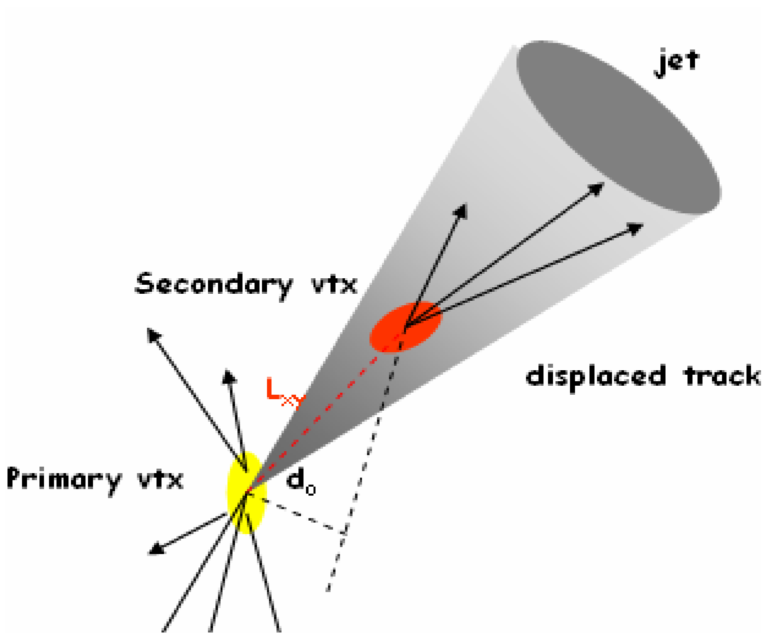
Events preselected before tagging

Events tagged by soft leptons populate the top signal region

DØ lepton+jets combined:

$$\sigma_{t\bar{t}} = 8.0\ ^{+2.4}_{-2.1}(\text{stat})\ ^{+1.7}_{-1.5}(\text{syst}) \pm 0.8(\text{lum})\ \text{pb}$$

Top Cross Section: b-tagging



- Signature of a b decay is a displaced vertex
  - ➔ Long lifetime of b-hadrons ($c\tau$ ~ 450 μm) * boost
  - ➔ B hadrons travel L ~ 3 mm before they decay

Secondary Vertex Tag (SVT)

- Jet is tagged as *b* jet
  if signed decay length significance >5

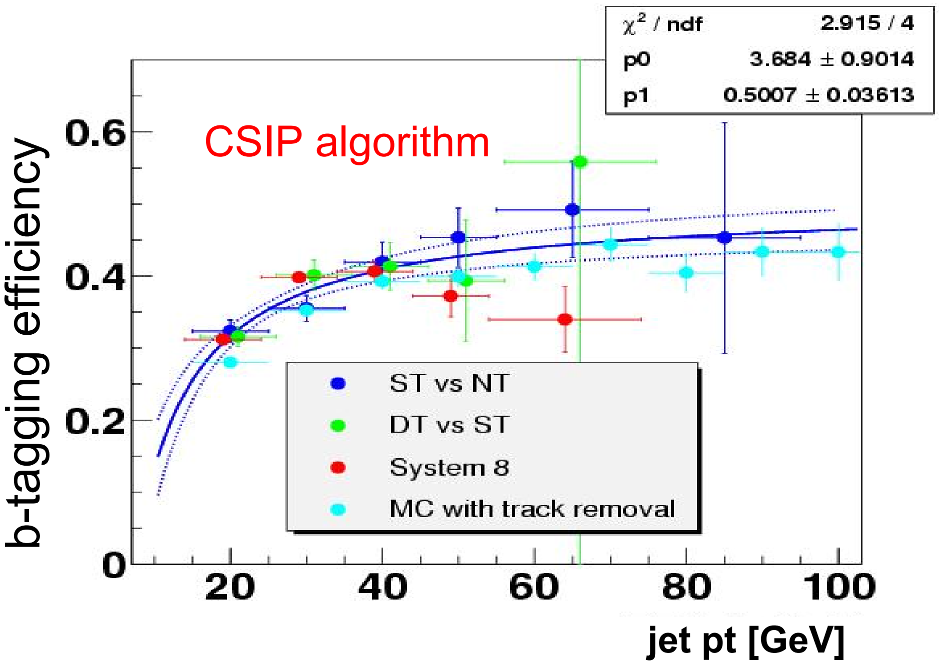
Counting Signed Impact Parameter tag (CSIP)

- $S = IP/\sigma(IP)$
  Impact Parameter significance
- Jet is positively tagged if it has
  - ➔ at least two tracks with S>3 or
  - ➔ at least three tracks with S>2

B-tagging clearly is:
- very helpful for top studies
- essential for many other aspects of the Run II physics program

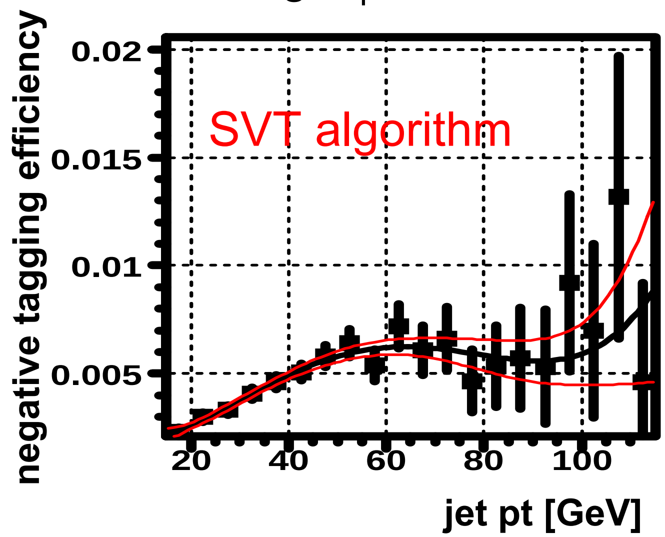
b-tagging Efficiency and Mistag Rate

Use a muon-in-jet sample enriched in $b\bar{b}$ content (at least one of the jets contains a muon, most likely from *b* or c semi-leptonic decay)



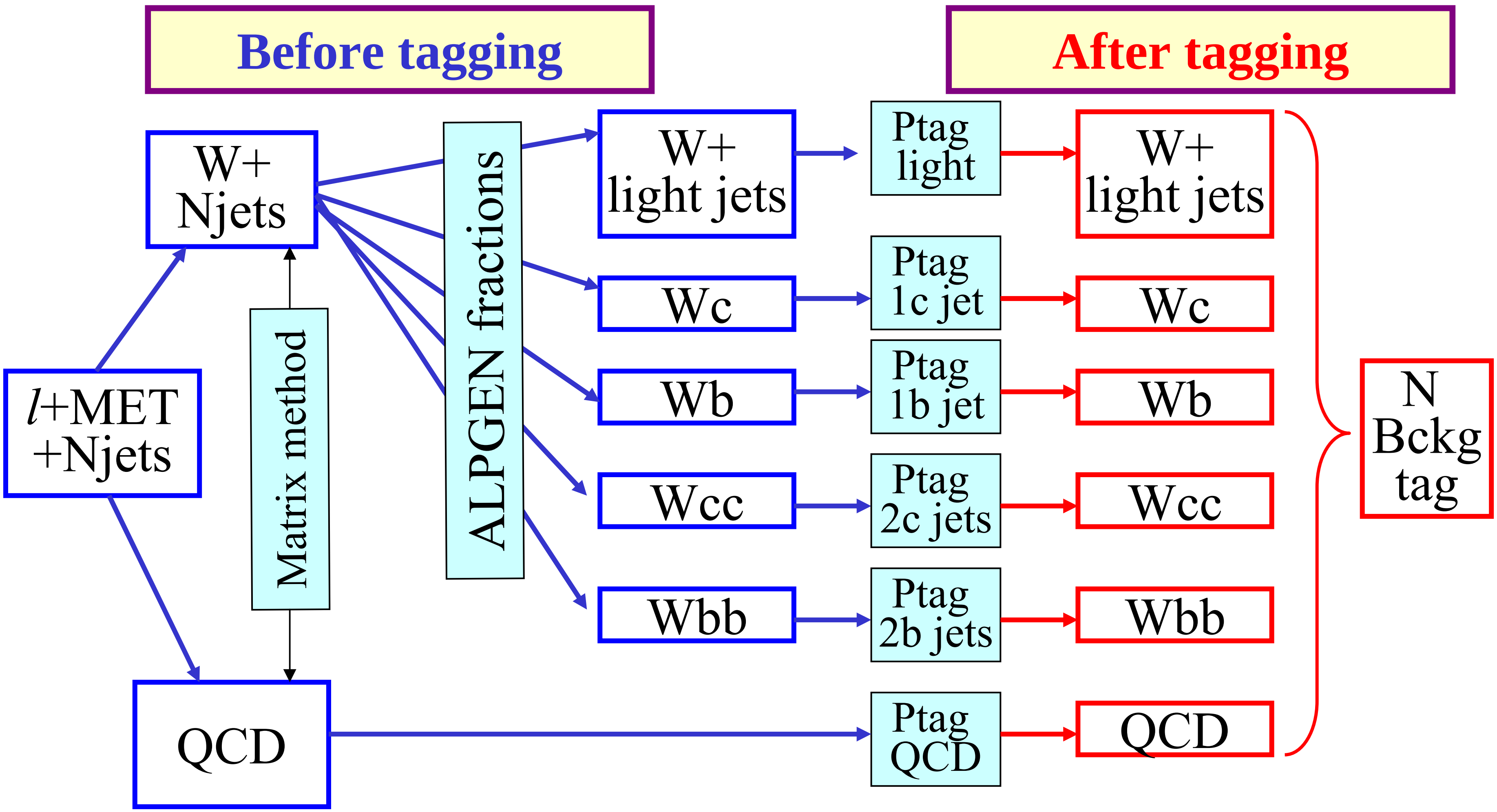
(for "taggable" jets; taggability requires ≥2 tracks and conditions on SMT hits)

- Positive tag of a light flavor jet is a mistag
  - ➔ Measure from the rate of jets with negative IP (reversed tagging cut on significance) in low- missing E_T data



  - ➔ Correct for heavy flavor and long lived particles which are not fully removed

b-tagging Analysis



$t\bar{t}$ cross section is determined from the excess of the observed number of tagged events above the predicted background for $N_{jets} \geq 3$

b-tagging: Top Signal and Background

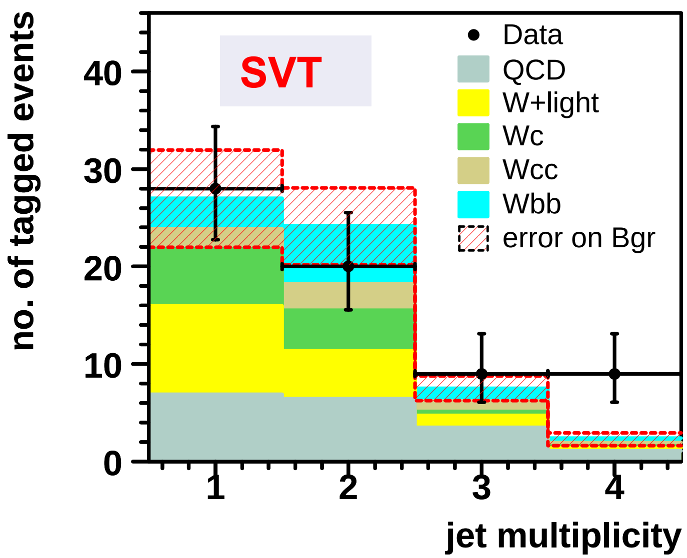
W+jets background

- event tagging probabilities from MC, but using efficiency and mistag rate from data

QCD background

- from generic QCD data sample and the "matrix" method

DØ Run II preliminary



CSIP Number of Events

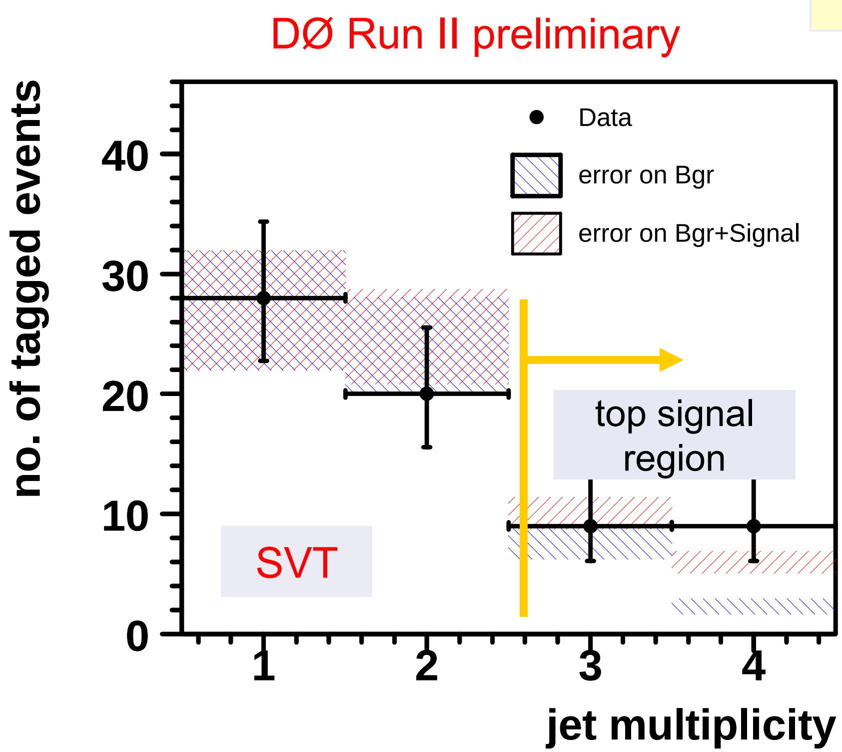
lepton + jets	1 jet	2 jet	3 jet	≥ 4 jet
W + jets MC	22.3 ± 4.7	18.7 ± 3.4	4.4 ± 0.9	1.4 ± 0.4
QCD data	8.2 ± 1.4	7.6 ± 1.2	3.9 ± 0.9	1.1 ± 0.4
Total bkgr	30.6 ± 5.0	26.4 ± 3.5	8.3 ± 1.3	2.5 ± 0.7
Expected $t\bar{t}$		0.7±0.1	2.8 ± 0.2	4.0 ± 0.6
Bkgr + $t\bar{t}$	30.6 ± 5.0	27.1 ± 3.6	11.1 ± 1.4	6.5 ± 1.0
tagged	34	27	13	6

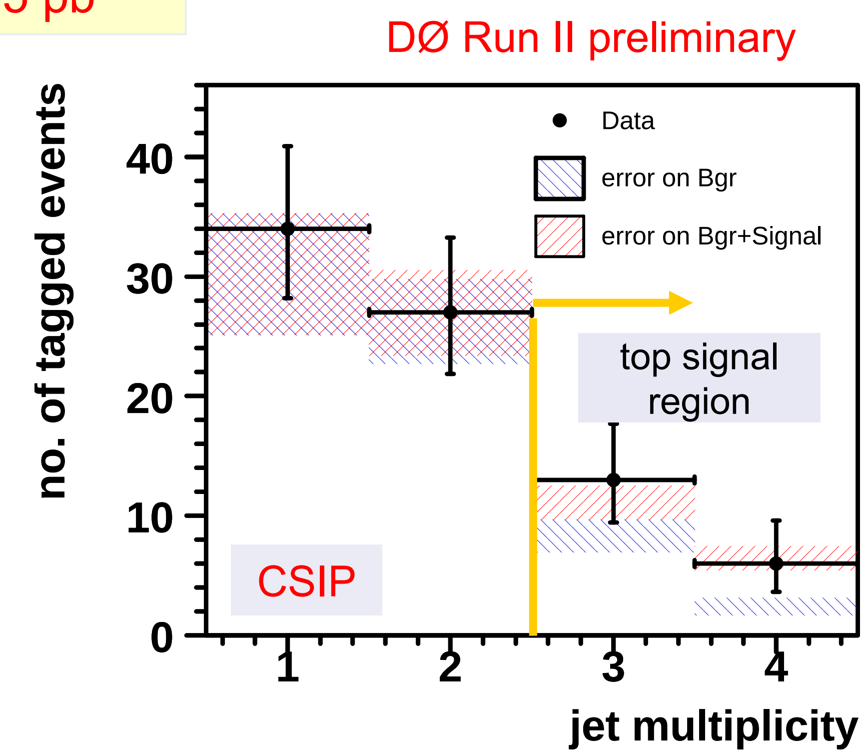
$t\bar{t}$ tagging probability

lepton+≥4jets	CSIP	SVT
$P_{t\bar{t}}^{tag}$	(45.7±4.9)%	(41.8±4.7)%

Cross Section with b-tagging

45 pb^{-1}

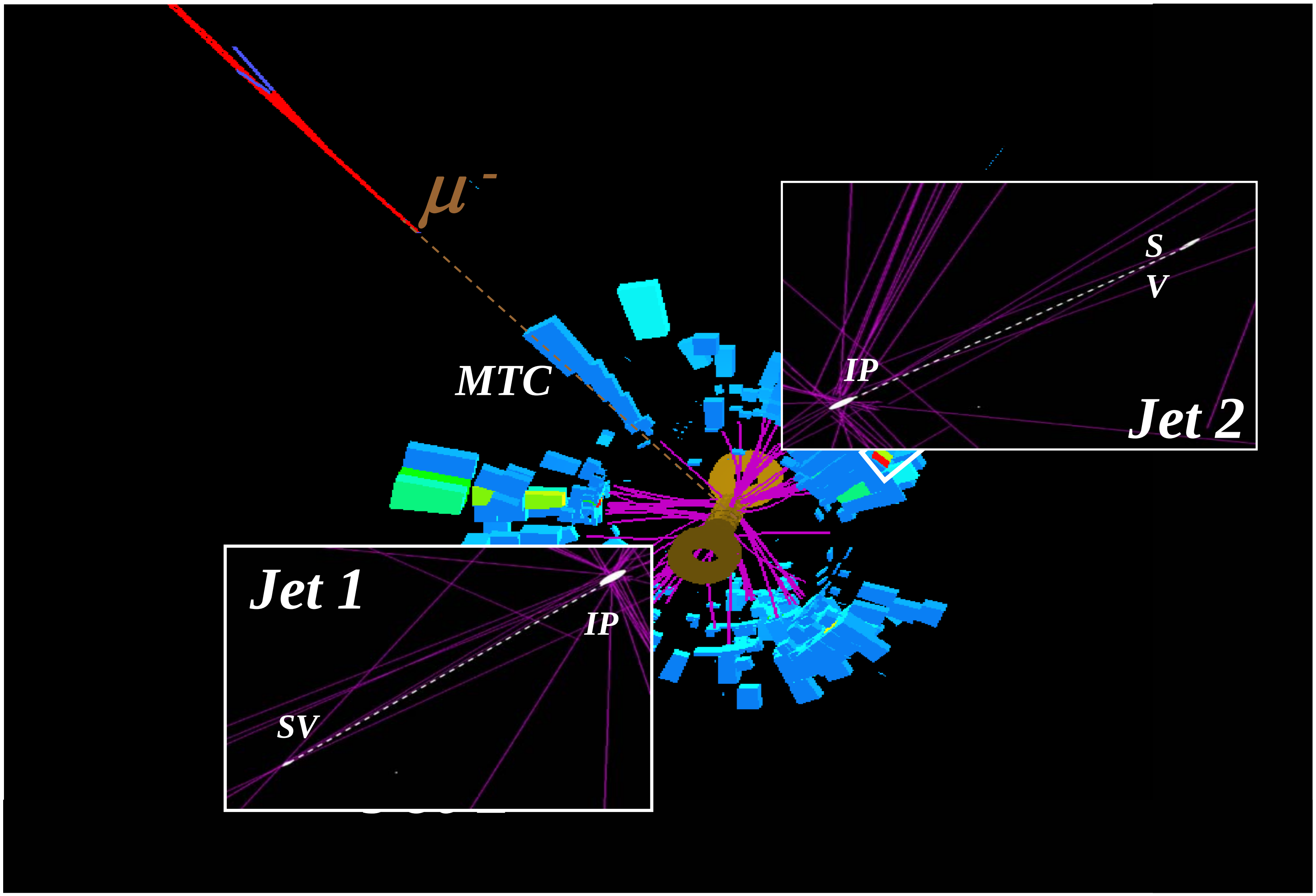




CSIP $\sigma_{t\bar{t}} = 7.4^{+4.4}_{-3.6}(stat)^{+2.1}_{-1.8}(syst) \pm 0.7(lumi)pb$

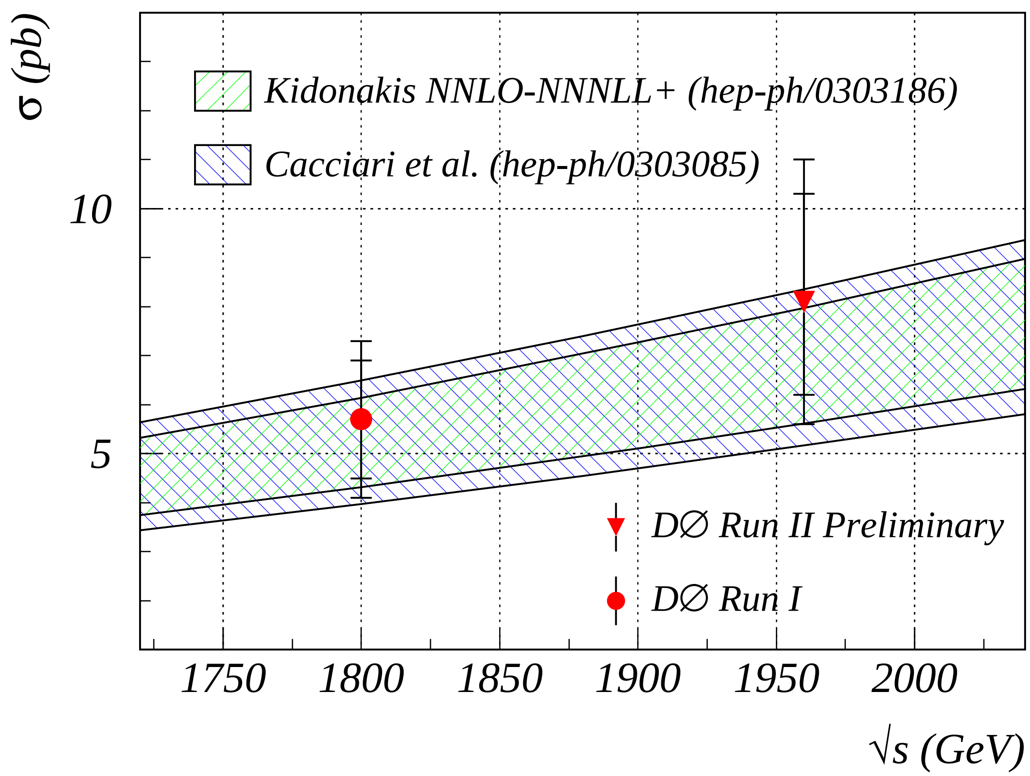
SVT $\sigma_{t\bar{t}} = 10.8^{+4.9}_{-4.0}(stat)^{+2.1}_{-2.0}(syst) \pm 1.1(lumi)pb$

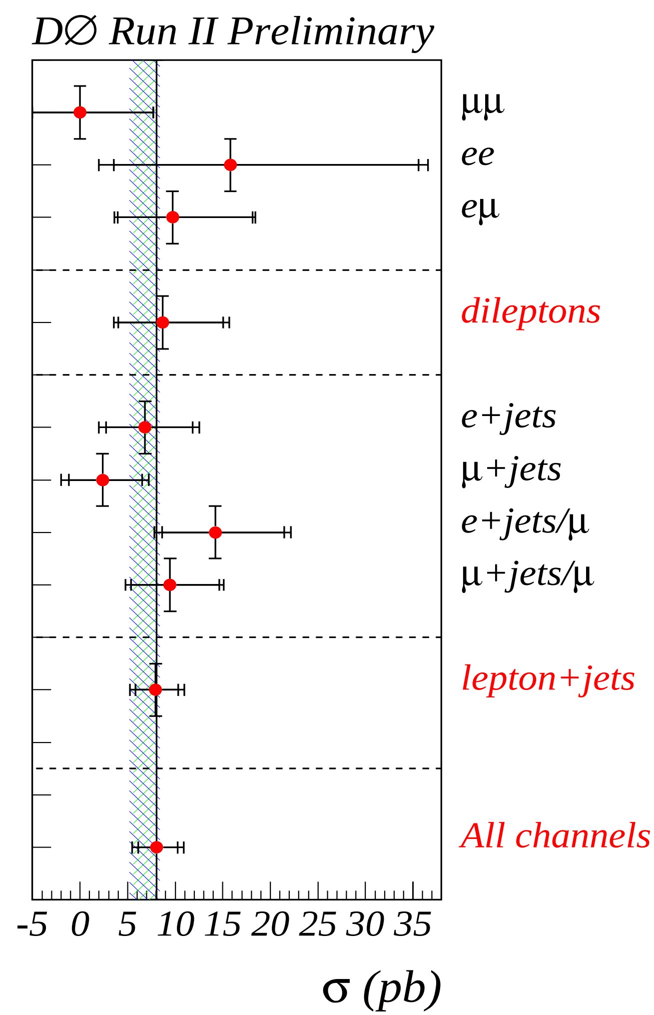
μ+jets Double Tagged Event



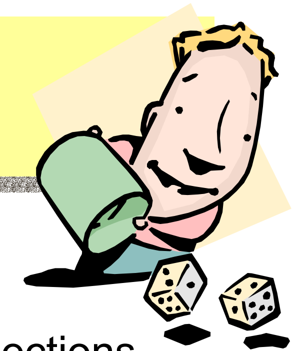
Cross Section Summary

- Check consistency among the channels
- Compare with NNLO-NNNLL calculation
- Look at dependence on center-of-mass energy





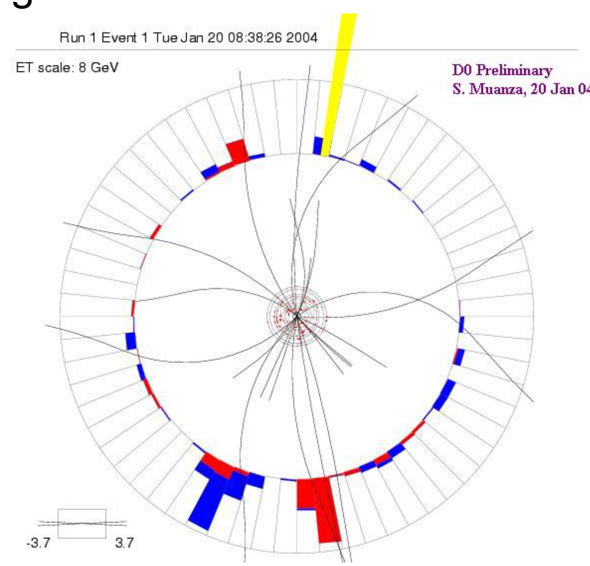
The Monte Carlo Game…



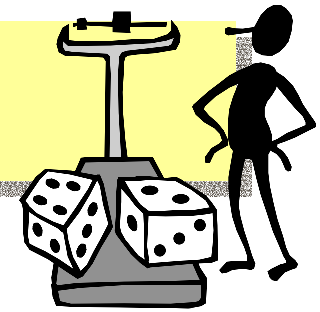
- We all want to be the MLM's "better physicist"; nonetheless, MC is heavily used in the top measurements:
  - ➔ Acceptances, efficiencies, background subtractions, templates, "calibration" of extracted results…
- We generate parton-level samples using:
  - ➔ Alpgen for: ttbar, Wjjjj, Wjjj, Wjj, Wj, Zjj, Zj, WWjj, WWj, WW…
  - ➔ CompHep for single top signal: tb, tqb
- Interface to:
  - ➔ Pythia or Herwig for parton showering and fragmentation
  - ➔ Taola for tau-decays
  - ➔ EvtGen for decays of B-states
- "Cutting edge" approach, but adds a lot of effort to MC generation…
  - ➔ Need to develop a user-friendlier production setup

- Problems:
  - ➔ only LO accuracy for cross sections - large uncertainty, scale dependence; onto MC@NLO!
  - ➔ possible "double-counting" of jets from hard process and parton showers
  - ➔ working towards use of "parton-jet matching" (CKKW, MLM, other variants); simple matching applied at analysis level e.g. for cross sections with b-tagging

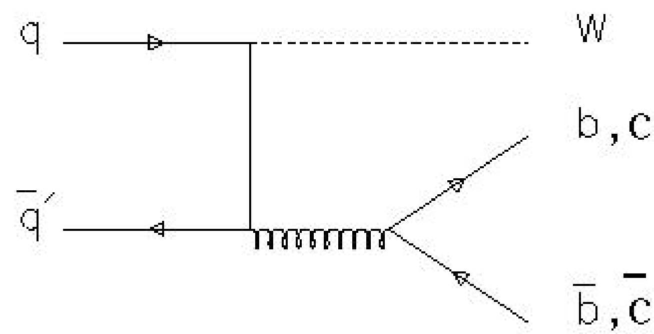
A W+1jet event from Mrenna's matched W+jets samples – large simulation in progress



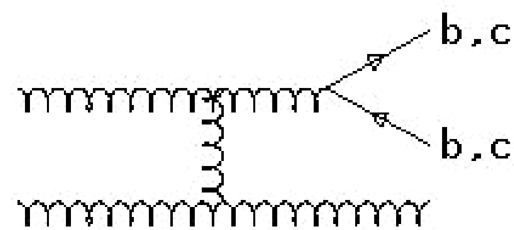
Can We Trust Monte Carlo's?



- Verification of generators is becoming increasingly crucial as the precision of the measurements improves
- One example: Alpgen fractions (in particular for Wbb) used in b-tagged analyses have not been yet verified on data
  - ➔ Direct checks difficult; expect only 4 double tagged events/100 pb^{-1}
  - ➔ In Run I, CDF used bbj sample to study $g \rightarrow bb$ splitting, found 1.4±0.19 scaling factor relative other b-production contributions in Herwig
    - ❖ **Wbb was scaled by this factor**
  - ➔ ~2000 double tagged bbj events/100 pb^{-1} (65 GeV trigger)
    - ❖ "easy" to study, but is it applicable to Wbb?
  - ➔ Would a study of $bb\gamma$ process be more relevant? (similar color flow as Wbb)
  - ➔ What would be the ways to tune Alpgen? (no obvious tuning parameter…)
  - ➔ Should one use "matched" samples?



versus

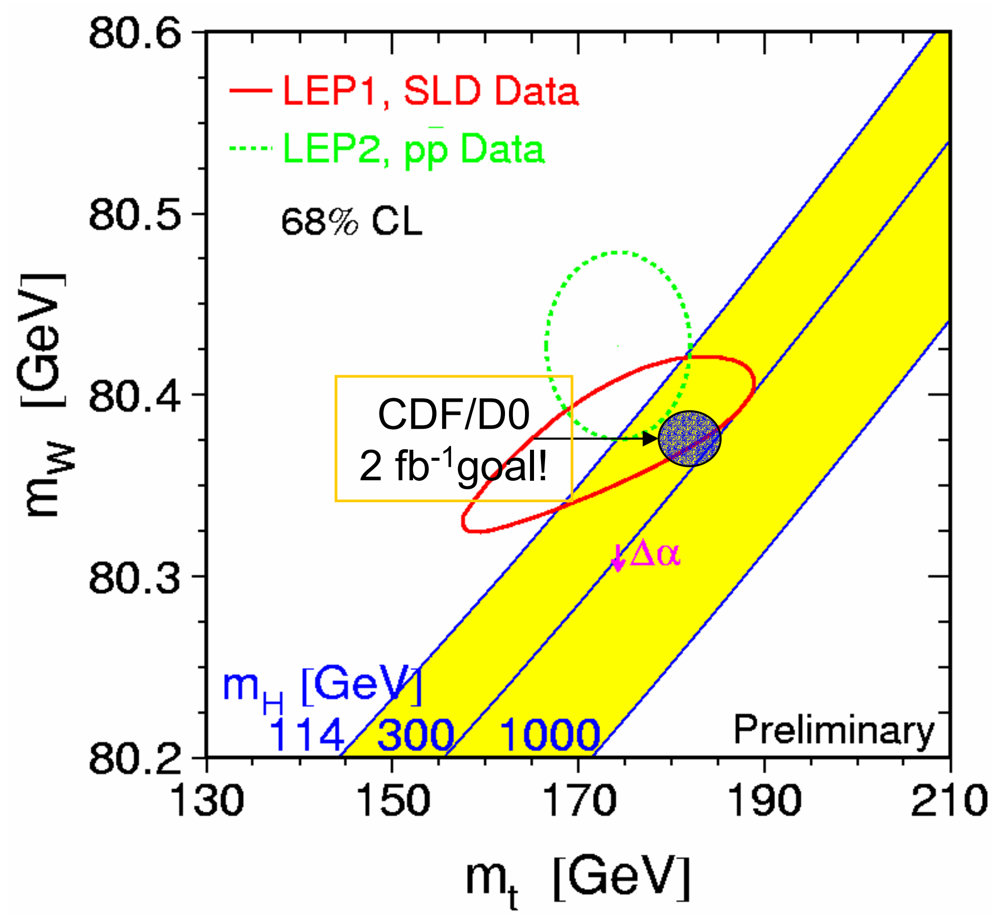


(plus other graphs, of course; can "separate" subproceses using distinct angular distributions)

A Wish for MC Soulmates…

The Top Quark Mass

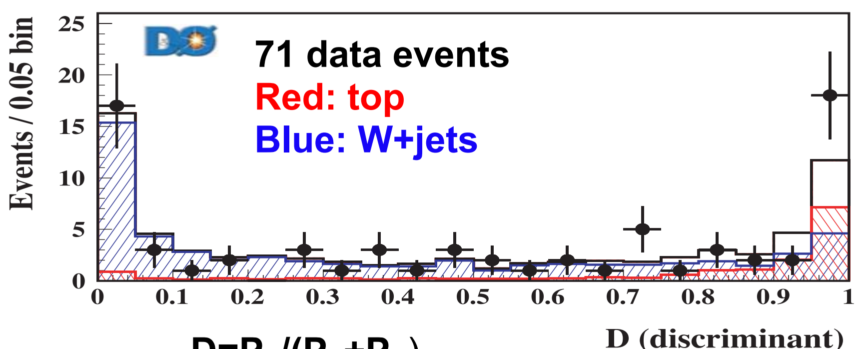
- Fundamental SM parameter
  - ➔ directly related to ttH coupling
  - ➔ affects radiative corrections to SM observables
- Highest precision essential!
- Experimental handles:
  - ➔ b-tagging: reduces background and combinatorial effects
  - ➔ increased statistics: data driven systematics scale with $1/\sqrt{N}$ (energy scale, influence of gluon radiation…)



With 2 fb^{-1} data can constrain $\Delta M_h/M_h$ to 35%

Measuring M_{top} in Lepton+Jets

- 1 unknown (p_z^{ν})
- Known:
  - ➔ 1 lepton and four jets, full momenta
  - ➔ neutrino px and py
  - ➔ 3 constraints
    - ❖ $m(l\nu) = m(qq) = m_W$
    - ❖ $m(l\nu b) = m(qqb)$
- 2C fit, but
  - ➔ don't know which jets go where:
    - ❖ 12 possible configurations
  - ➔ jets don't map perfectly to original quark kinematics
- Mass measurement using templates:
  - ➔ construct a variable X which has large correlation with M_{top}
  - ➔ determine distribution of X as a function of M_{top} for signal (MC)
  - ➔ determine distribution of X for background (MC and data)
  - ➔ combine and compare with data
- New alternative ("Matrix Element" method):
  - ➔ require only 4 jets -- removes ambiguities from additional jets
  - ➔ define event probability to be signal or background
    - ❖ based on knowledge of
      - Matrix Element for the processes
      - detector efficiencies and resolutions
    - ❖ use as much information about event as available
    - ❖ signal has a dependence on mass
  - ➔ construct likelihood for the sample
  - ➔ maximize by fitting to number of signal and background events, and scan versus M_{top}



$D = P_S/(P_S+P_B)$

Template vs Matrix Element

- OLD -Template method:
  - ➔ All the events are presented to the same template.
  - ➔ The template corresponds to a probability distribution for the entire sample, using a limited number of variables calculated from MC simulations.
  - ➔ The features of individual events are integrated (averaged) over the variables not considered in the template.

- NEW - Matrix Element method:
  - ➔ Each event has its own probability distribution
  - ➔ The event probability depends on all measured quantities for primary objects (except for unclustered energy).
  - ➔ The full information contained in each event contributes to the probability: well-measured events contribute more sharply than poorly-measured events.

Matrix Element Method in Gory Detail…

$\alpha = M_{top}$ **is to be estimated**

differential cross section (Matrix Element)

probability that a parton-level set of variables y will be measured as x

Probability of the measured event

$$P(x;\alpha) = \frac{1}{\sigma}\int d\sigma(y;\alpha)\, dq_1\, dq_2\, f(q_1)\, f(q_2)\, W(x,y)$$

Measured variables

Parton variables

PDFs

$$P(x;\alpha) = c_1 P_{ttbar}(x;\alpha) + c_2 P_{background}(x)$$

- Leading-Order ME for ttbar->lepton+jets; PDFs
- 12 jet permutations, all values of P_ν
- Phase space of 6-object final state
- Detector resolutions
- Integration over 2-body masses, energy of 1 jet from W

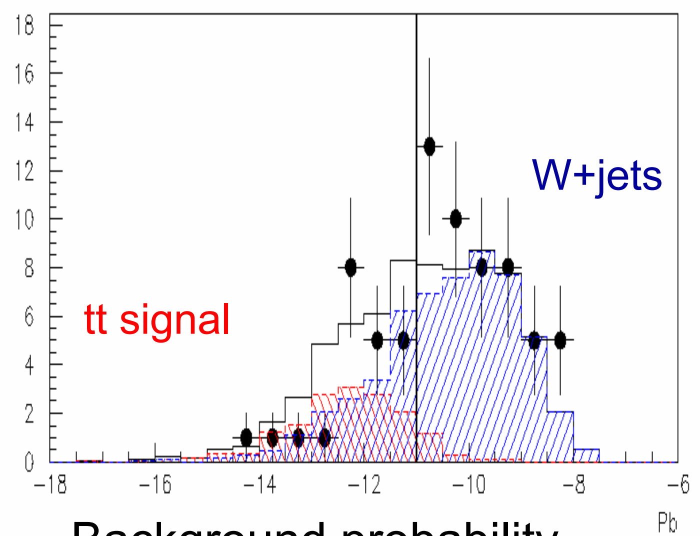
- Only *W*+jets, 80%
- VECBOS subroutines for *W*+jets ME
- Same detector resolutions as for signal
- All permutations, all values of $P\nu$
- Integration done over the jet energies

• Account for conditions to accept or reject an event (acceptance, efficiencies, trigger etc)

$$P_{observed}(x;\alpha) = Acc(x)P(x;\alpha)$$

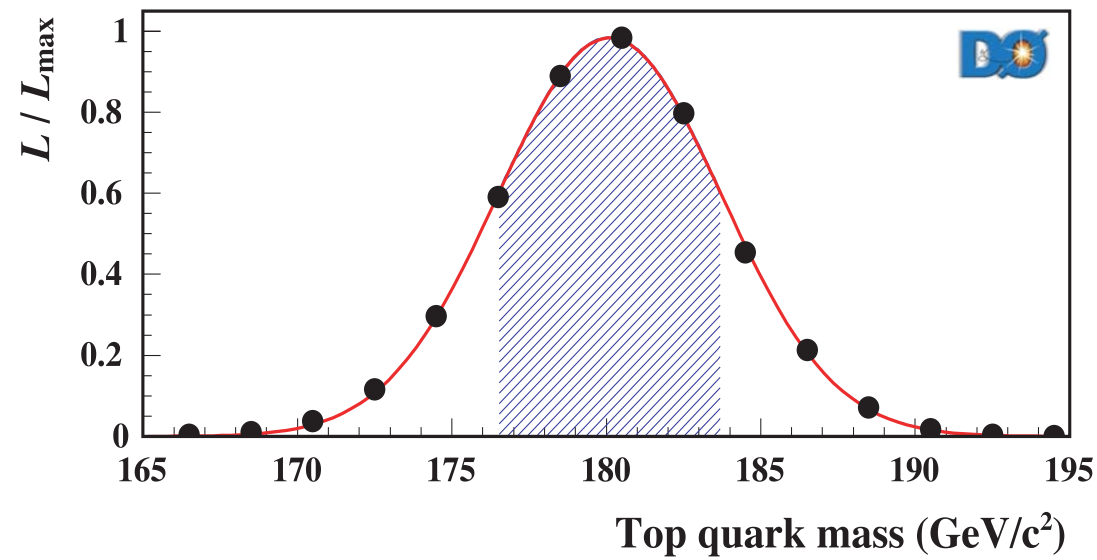
• Form a Likelihood as a function of: Top Mass, F_0 (longitudinal fraction of W bosons) etc

New Measurement of the Top Mass



Background probability

DØ Run I Preliminary – submitted to Nature



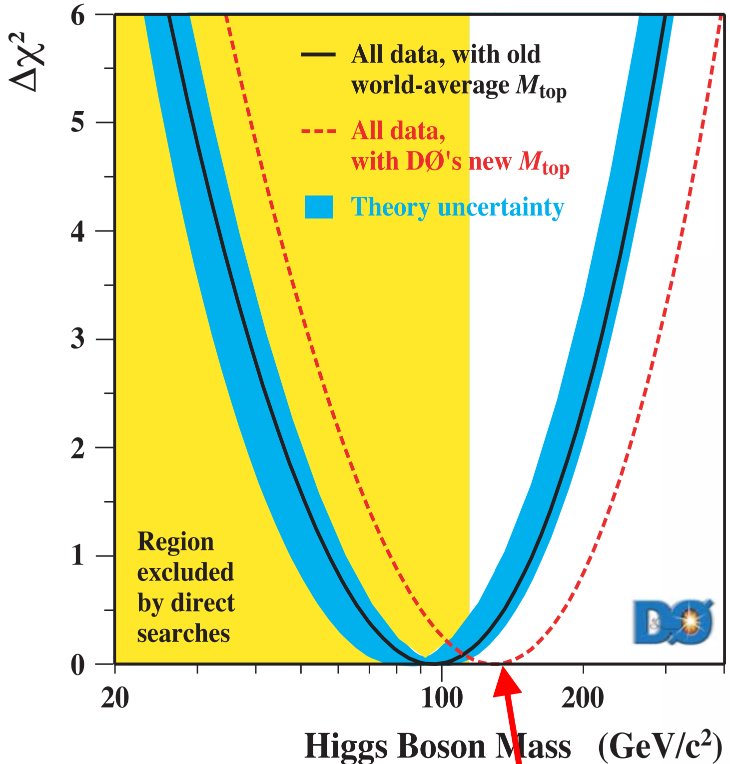
M_{top} = 180.1 ± 3.6 (stat) ± 4.0 (syst) GeV/c^2

After a cut on background probability (vertical line) to purify the sample, 22 events remain: 12 signal, 10 background

Previous DØ result using template method had statistical uncertainty of 5.6 GeV. New method is equivalent to 2.4 times more data!

Combined with DØ Run I dilepton result:

M_{top} = 179.0 ± 3.5 (stat) ± 3.8 (syst) GeV/c^2



This improved top mass measurement puts the most likely value of the Higgs mass above the experimentally excluded range.

Rochester theses:

Juan Estrada – Top mass

Florencia Canelli – W helicity

DOE Pulse

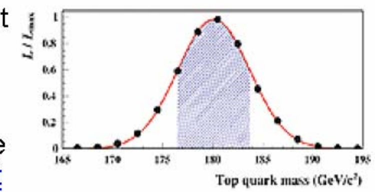
Science and Technology Highlights from the DOE National Laboratories

Number 150 **January 26, 2004**

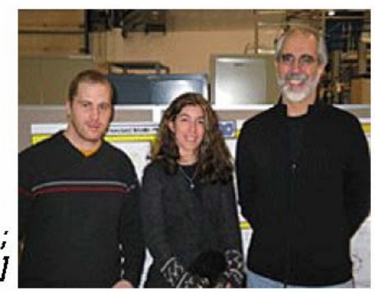
Precise top measurement means Higgs looming larger in Fermilab estimations

The mass of the top quark—about equivalent to that of a gold nucleus—reflects some of the crucial aspects of the Standard Model of particle physics, and is correlated with the mass of the still-unobserved Higgs particle and mechanism that give mass its origins. Scientists at the DZero experiment of DOE's Fermilab, using approaches made possible by more powerful computing available for data analysis, have reduced the statistical uncertainty in the measurement of top quark mass corresponding to a factor of 2.4 increase in the size of the data sample. This measurement is as accurate as all previous measurements combined, and suggests a Higgs mass a bit larger than previously thought.

[Mike Perricone, 630/840-5678; mikep@fnal.gov]



The solid line represents a Gaussian fit of the top mass. The most likely mass of the top quark is 180.1 GeV/c2, and the hatched band indicates the +/- 3.6 GeV/c2 statistical uncertainty on the fit and on the extracted mass.



(L-R) Juan Estrada (Fermilab), Florencia Canelli (UCLA) and Gaston Gutierrez (Fermilab) are responisble for this new precision measurement of the top mass.

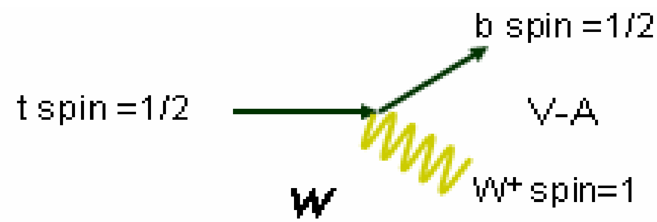
W Helicity Measurement

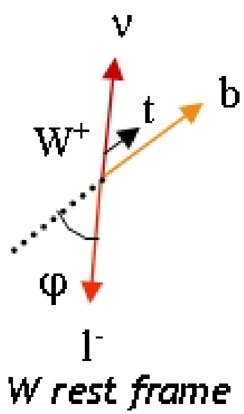
- Top quark decays as a free particle -- before it can hadronize (lifetime 0.5×10^{-24} s)
  - ➔ The top quark spin information is transferred directly to its decay products
  - ➔ Unique opportunity to study weak interactions of a free quark, at the natural electroweak mass scale!
- SM Prediction:
  - ➔ W helicity fractions in top decays are determined by M_{top}, M_W, and the V-A structure of the tWb vertex.

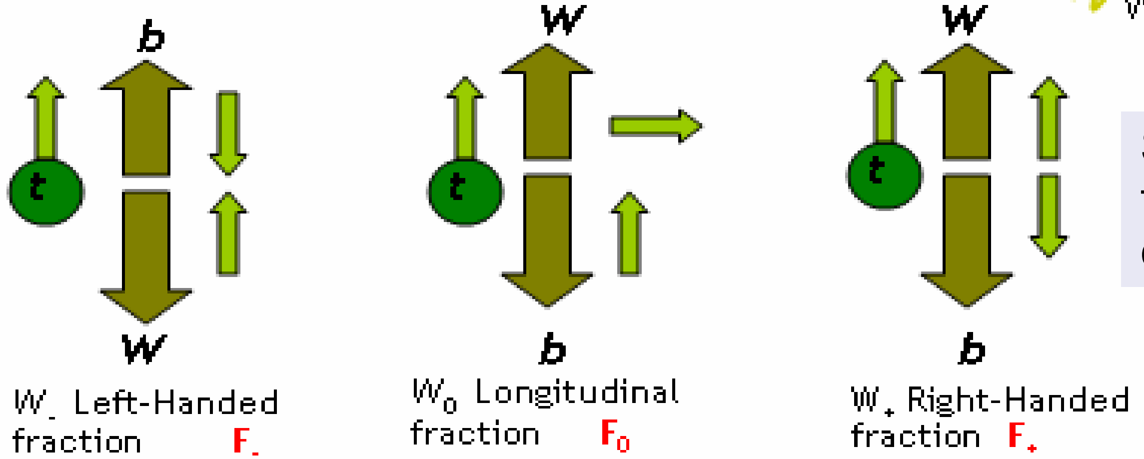
$$F_- = 0.3, \quad F_0 = 0.7, \quad F_+ = 0$$

Helicity of the W in Top Events

SM Top quark has a V-A charged current weak interaction (as it is for all the other fermions)







Suppressed by the V-A coupling

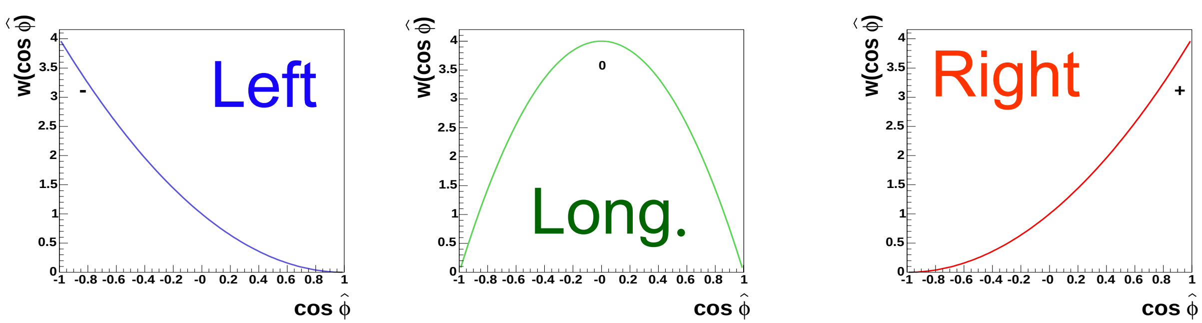
$$w(\cos\varphi_{l\bar{b}}) = F_- \cdot \frac{3}{8}(1-\cos\varphi_{l\bar{b}})^2 + F_0 \cdot \frac{3}{8}(1-\cos^2\varphi_{l\bar{b}}) + F_+ \cdot \frac{3}{8}(1+\cos\varphi_{l\bar{b}})^2$$

In SM:

F_- = 0.3,

F_0 = 0.7,

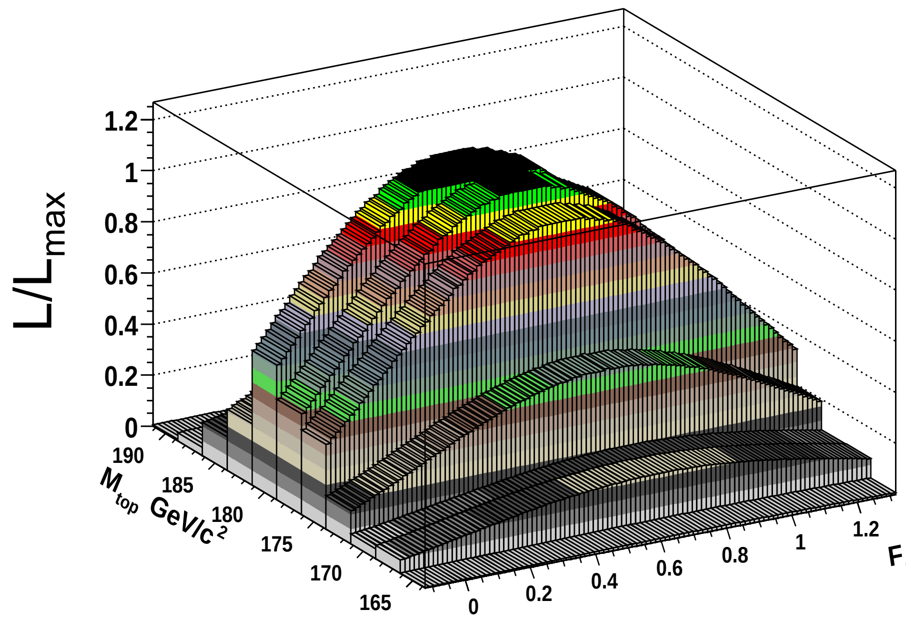
F_+ = 0



W Helicity Results

- New DØ Run I measurement:
  - ➔ ME for signal has been extended to include a generalized dependence on F_0
    - ❖ $F_+=0$ was assumed
  - ➔ systematic error on the measurement of F_0 includes uncertainty in the top mass
    - ❖ Integrated over M_{top} (assuming no prior)

22 events: 12 signal, 10 background



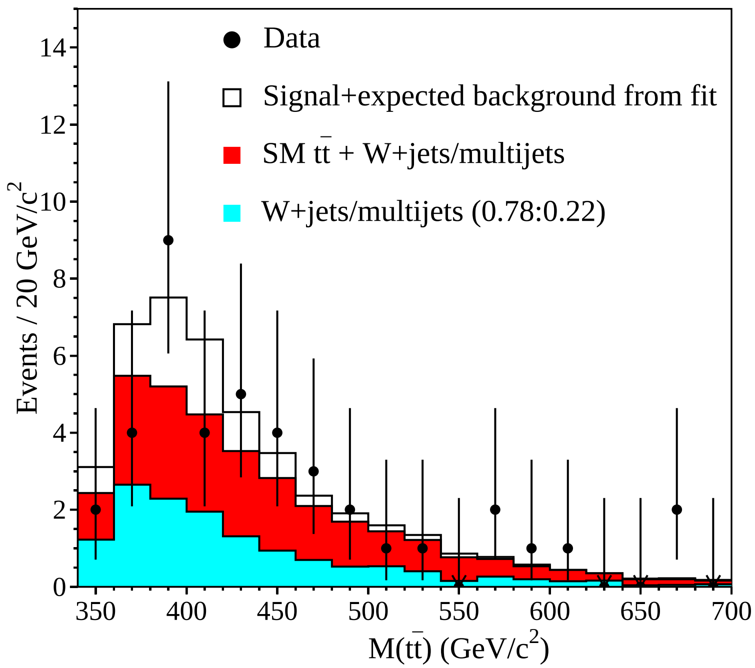
Preliminary DØ Run I result

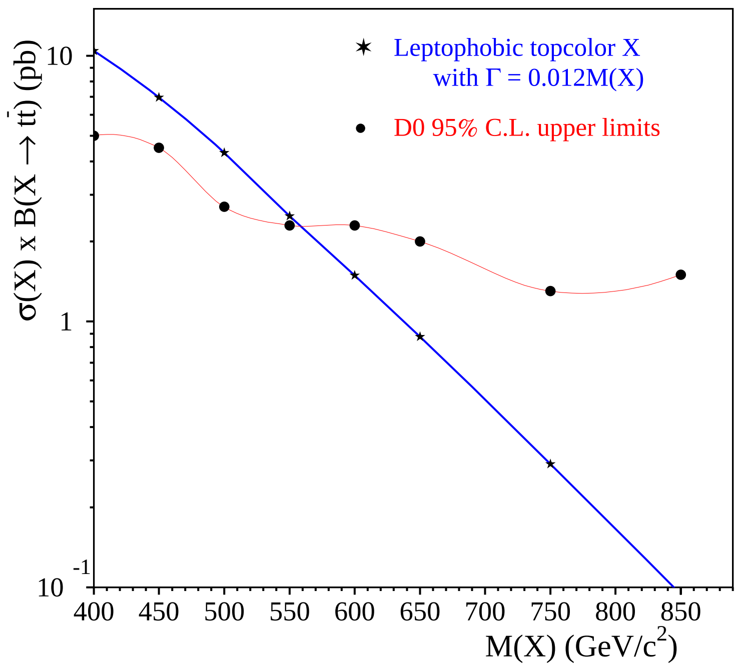
$$F_0 = 0.56 \pm 0.31\ (\text{stat}) \pm 0.04\ (\text{syst})$$

ME Method: Comments and Issues

- Contribution from ~50% of top events is “lost” when requiring exactly 4 jets (for tt+≥1jets, or tt with a jet lost and replaced by a ISR/FSR jet)
  - ➔ Could the analysis be improved by using a higher-order ME?
- In the presence of background, extracted values of M_{top} and F_0 are shifted from input values (by ~0.5 GeV and ~0.1, resp.)
  - ➔ The measurement is calibrated using MC
  - ➔ The shifts go away after requiring a match between jets and partons
  - ➔ Could the analysis benefit from using parton-jet matched simulations? (for both signal and background)
- The systematic error is dominated by the error on jet energy scale. With improved Run II stats, this will soon be the limiting issue!
  - ➔ Consider calibrating JES in the same sample by scanning the likelihood vs M_W
  - ➔ Need to control shifts in M_W due to radiation and experimental effects – the work is just starting…
- This technique can (and will) be used for other studies – e.g. Higgs searches
  - ➔ It would greatly help to have the various new calculations done for MC’s also available as “calculators” of differential cross sections, for given input kinematics

Looking for New Physics with Top: A Search for Narrow $t\bar{t}$ Resonances





- Model independent search for a narrow resonance → 95% CL limits on σ_X*B
- Topcolor-assisted technicolor predicts a Z' boson that couples preferably to the third quark generation and not to leptons (leptophobic): X → $t\bar{t}$
- We exclude a narrow X boson with M_X < 560 GeV/c^2
  - ➔ Assumed $\Gamma_X = 0.012\ M_X$

Many Ongoing Run II Analyses…

Electroweak

W/Z cross sections, dibosons and anomalous couplings, charge and rapidity asymmetry, …

Top Quark

top quark pair production cross section measurements,
top quark mass and decay properties,
searches for single top quark production,

QCD

inclusive jet cross section, dijet mass and angular distributions, diffraction, …

Heavy flavor

resonance reconstructions, masses, lifetimes,
branching fractions, rare decays, B_s mixing, …

New phenomena searches

Higgs bosons, supersymmetry, leptoquarks, large extra dimensions, Z' …

About 50 publications in the works!

Conclusions and Outlook

- The top quark is back!
- First Run II results cover a variety of channels and topics and are improving rapidly
- The Tevatron is the unique top quark factory until LHC
- We already have 2x Run I dataset on tape being analyzed
- We still expect at least 50x more data compared to Run I!
- Our physics reach is well beyond the luminosity increase, thanks to detector upgrades and higher Tevatron energy
- Smarter analysis techniques are making BIG impact!

We are ready for precision top physics

– and hopefully top surprises!