PHENO 2004, Madison (WI), 27 April 2004

New top quark pair production measurements at DØ

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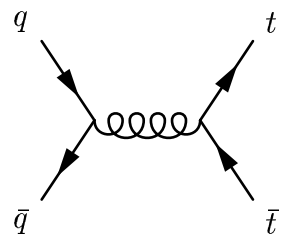
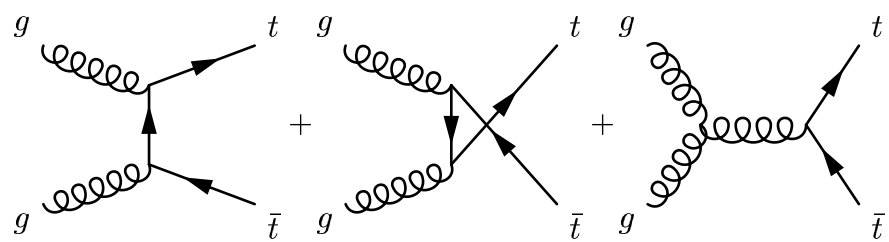
for the DØ Collaboration

$t\bar{t}$ production in $p\bar{p}$ collisions

production process		contribution to $\sigma(t\bar{t})$ at 1.96 TeV
$q\bar{q}$ annihilation		≈85%
gluon interaction		≈15%

≈1000 top pairs expected in 150 pb^{-1}

(single top production: see yesterday's talks)

top quark decay modes

experimental approach: reconstruct specific top pair decay modes

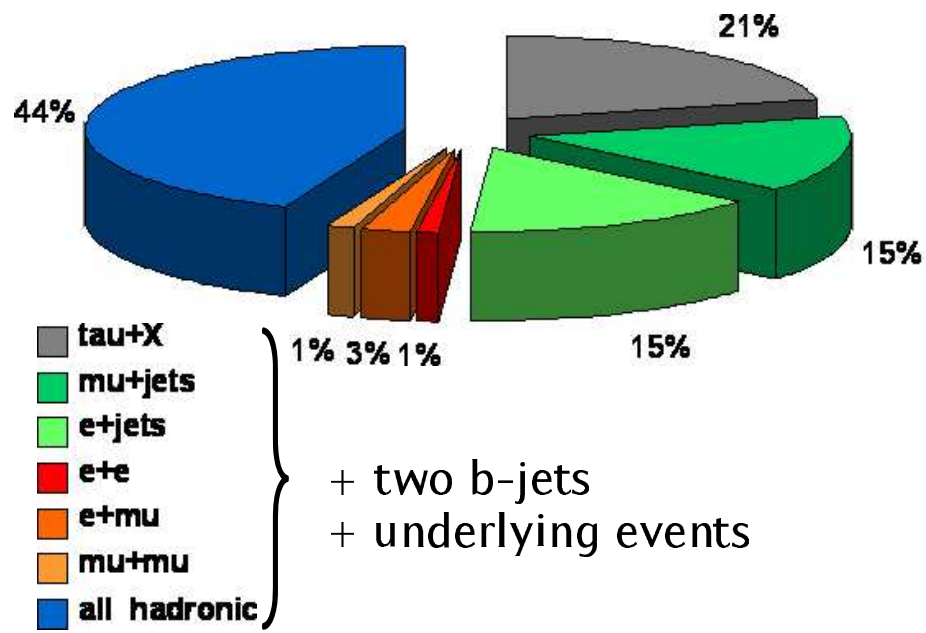
per top quark:

BR(t→Wb)≈100%
W decay determines topology

- b-jet + two jets (W→qq)
- b-jet + electron (W→eν)
- b-jet + muon (W→ $\mu\nu$)
- b-jet + tau (W→ $\tau\nu$)

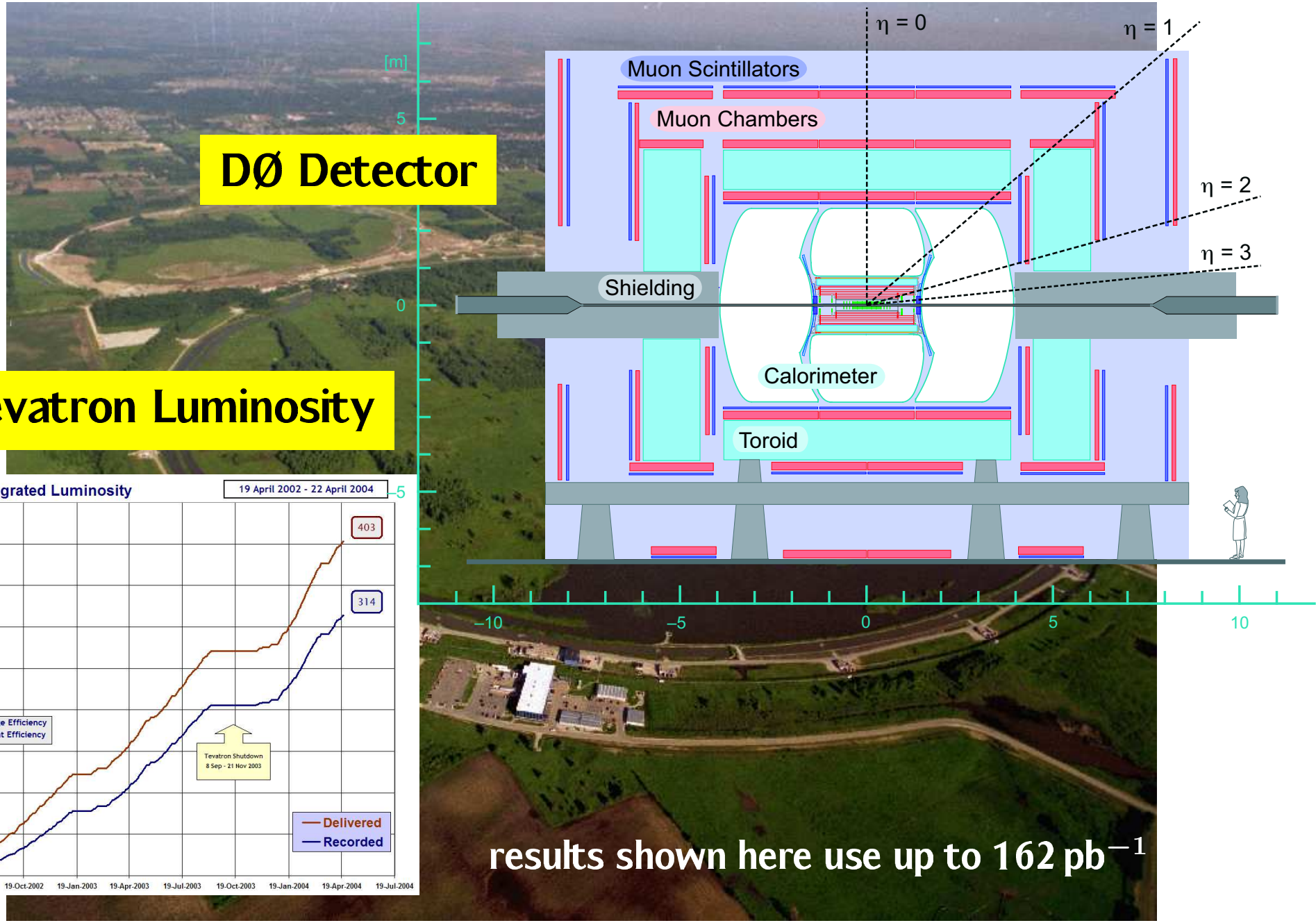
taus not treated separately
(included in e,μ channels)

top pairs:

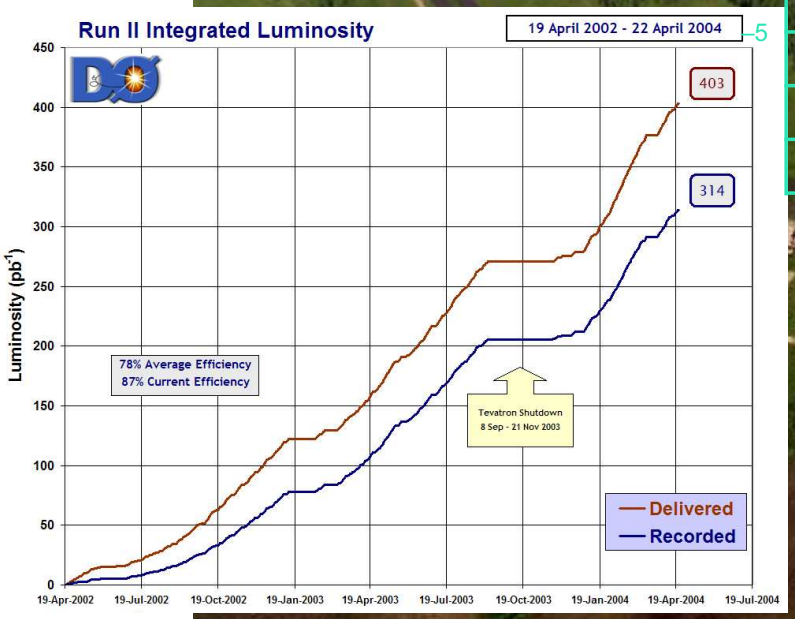


+ two b-jets
+ underlying events

DØ Detector



Tevatron Luminosity



results shown here use up to 162 pb^{-1}

DØ top pair production analyses

new for Winter conferences 2004:

• dilepton (ee, eμ, $\mu\mu$)	140..156 pb^{-1}
• e+jets, μ+jets (topological)	141..144 pb^{-1}
• all jets, with secondary vertex tag	162 pb^{-1}

for Summer conferences 2003:

• e+jets, μ+jets (soft lepton tag)	92..94 pb^{-1}
• e+jets, μ+jets (lifetime tags)	40..50 pb^{-1}

Dilepton analysis

selection:

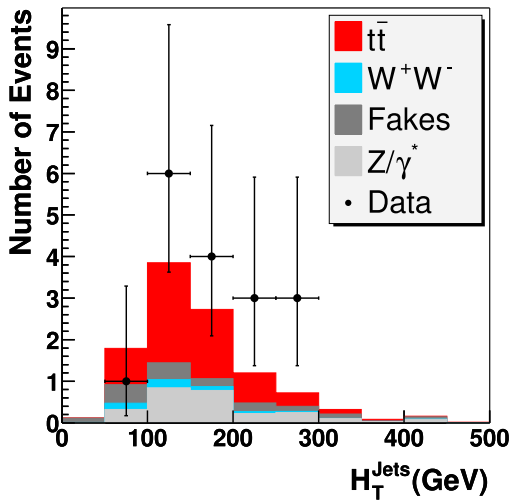
- two isolated leptons with $p_T > 15$ GeV (ee: 20 GeV)
  electrons: EM cluster, matched track, likelihood fit
  muons: track segments in muon layers, matched track
- missing $E_T > 35$ GeV (eμ: 25 GeV)
- two jets with $p_T > 20$ GeV
- large H_T (total sum of jet p_T)

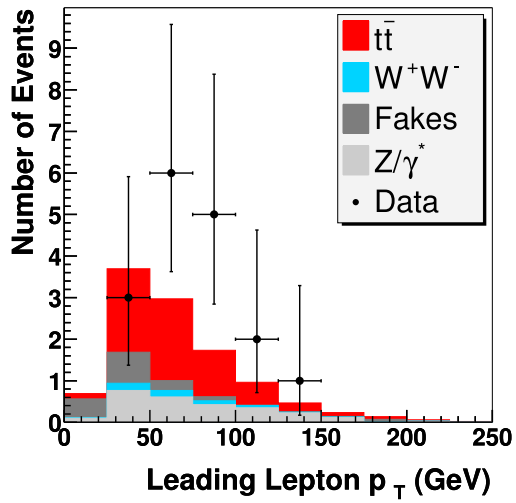
main backgrounds:

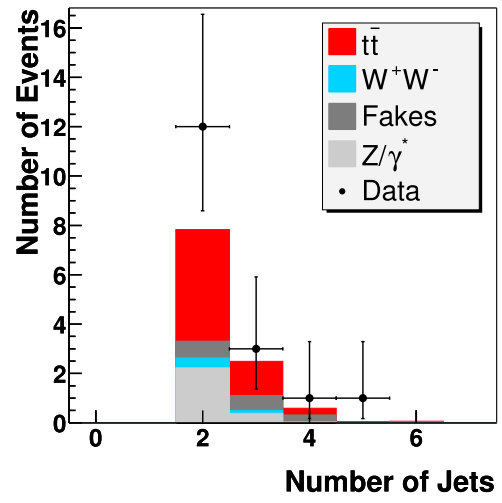
- $Z/\gamma^* \longrightarrow \ell^+\ell^-$
- fake electrons, muons

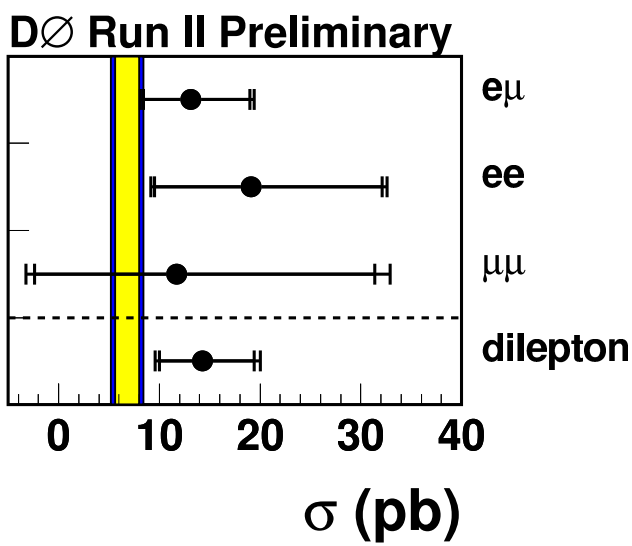
Category	ee	$\mu\mu$	$e\mu$	$\ell\ell$
Z/γ^*	0.15 ± 0.10	2.04 ± 0.49	0.47 ± 0.17	2.66 ± 0.53
WW	0.14 ± 0.08	0.10 ± 0.04	0.29 ± 0.06	0.53 ± 0.11
Fakes	0.91 ± 0.30	0.46 ± 0.20	0.19 ± 0.06	1.56 ± 0.36
Total background	1.20 ± 0.33	2.61 ± 0.53	0.95 ± 0.19	4.76 ± 0.65
Expected signal	1.39 ± 0.19	0.83 ± 0.15	3.77 ± 0.44	5.99 ± 0.50
SM expectation	2.59 ± 0.38	3.44 ± 0.55	4.73 ± 0.49	10.76 ± 0.83
Selected events	5	4	8	17

Dilepton analysis: results









$13.1^{+5.9}_{-4.7}(\text{stat})^{+2.2}_{-1.7}(\text{syst})\pm 0.9(\text{lumi})$ pb

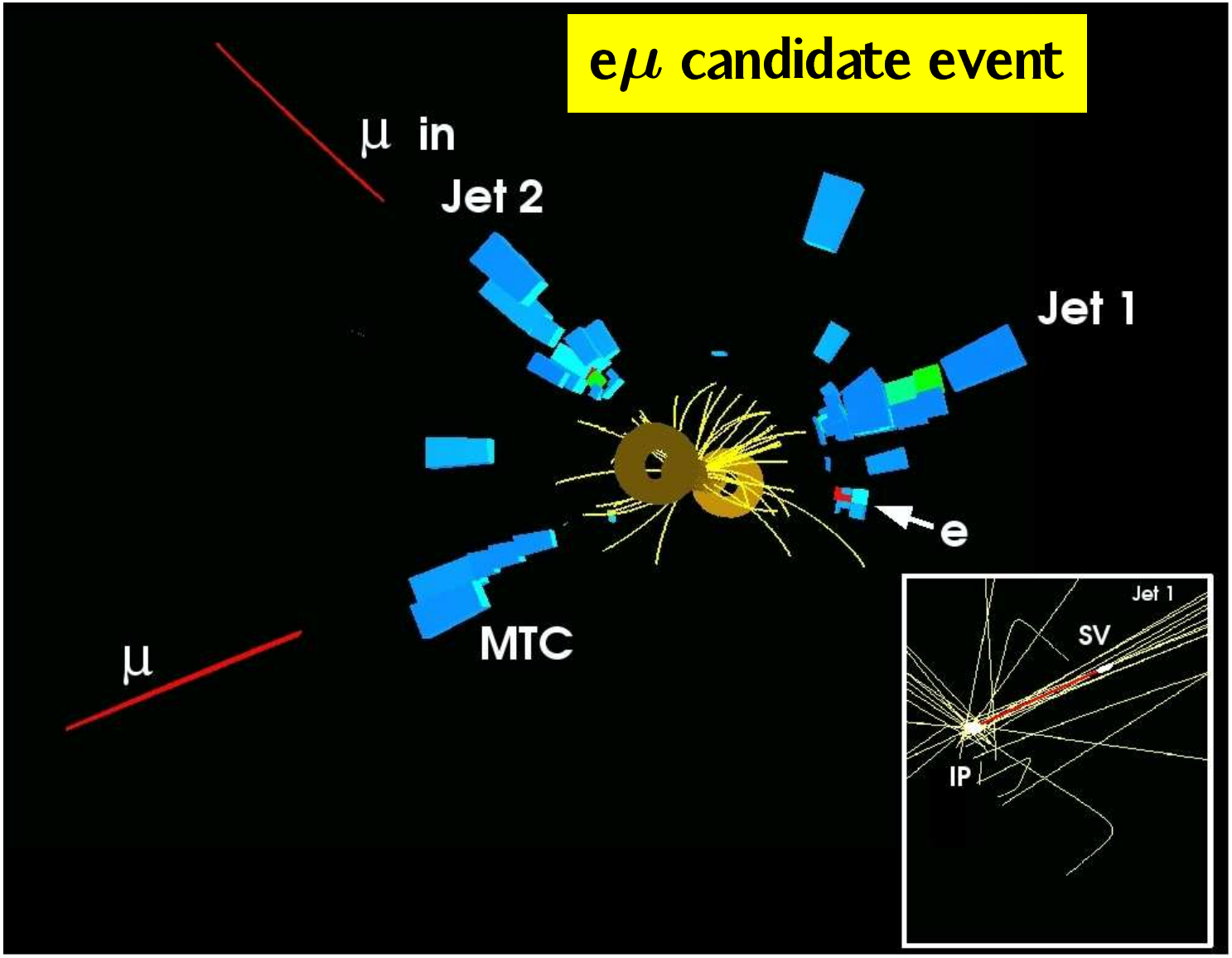
$19.1^{+13.0}_{-9.6}(\text{stat})^{+3.7}_{-2.6}(\text{syst})\pm 1.2(\text{lumi})$ pb

$11.7^{+19.7}_{-14.1}(\text{stat})^{+7.9}_{-5.0}(\text{syst})\pm 0.8(\text{lumi})$ pb

$14.3^{+5.1}_{-4.3}(\text{stat})^{+2.6}_{-1.9}(\text{syst})\pm 0.9(\text{lumi})$ pb

Do we see something interesting here?

eμ candidate event



All jets analysis

selection:

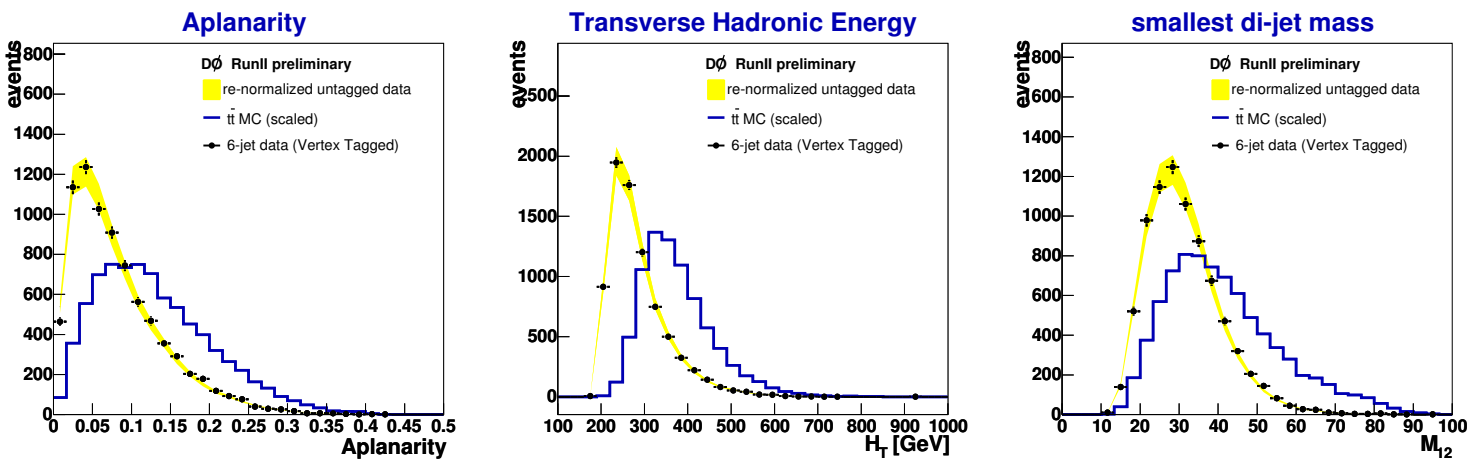
- 6 jets with $p_T > 15$ GeV
- exactly 1 jet with secondary vertex (lifetime significance > 7)
- no isolated leptons

main backgrounds:

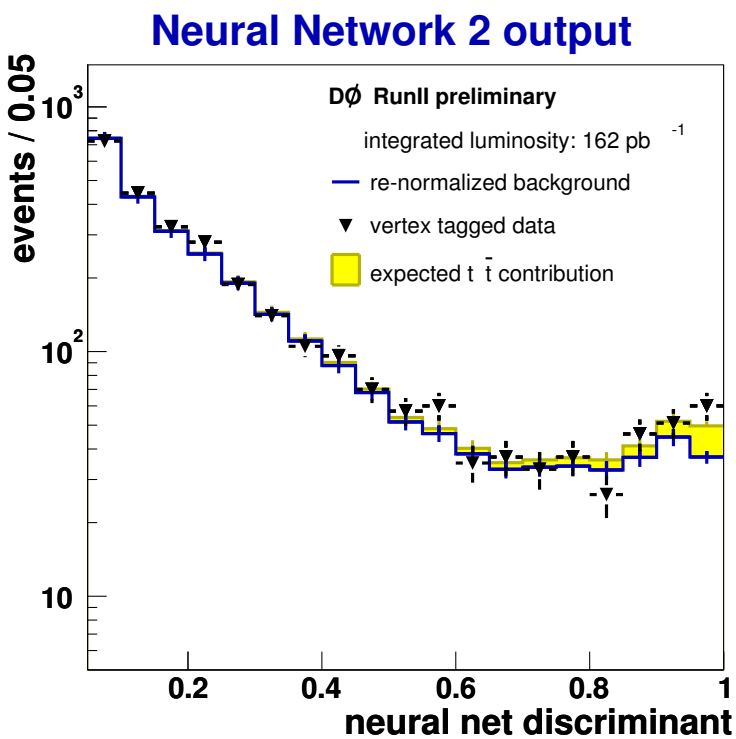
- QCD multi-jet events

large background level,
signal/background discrimination by correlated variables

➡ use Artificial Neural Networks



All jets analysis: results



select candidates above 0.75:
220 events
background expectation: 186 ± 5

$$\sigma(t\bar{t})_{\text{alljets}} = 7.7^{+3.4}_{-3.3}(\text{stat})^{+4.7}_{-3.7}(\text{syst})\pm 0.5(\text{lumi})\,\text{pb}$$

Lepton+jets (topological)

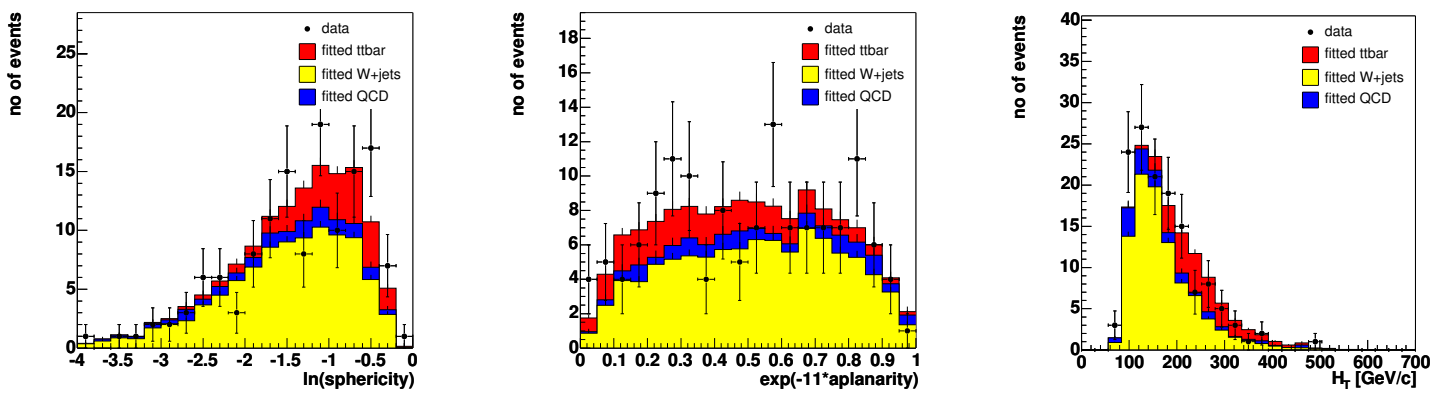
selection:

- one isolated lepton with $p_T > 20$ GeV
  electrons: EM cluster, matched track, likelihood fit
  muons: track segments in muon layers, matched track
- missing $E_T > 17$ GeV (μ), > 20 GeV (e)
- four jets with $p_T > 15$ GeV

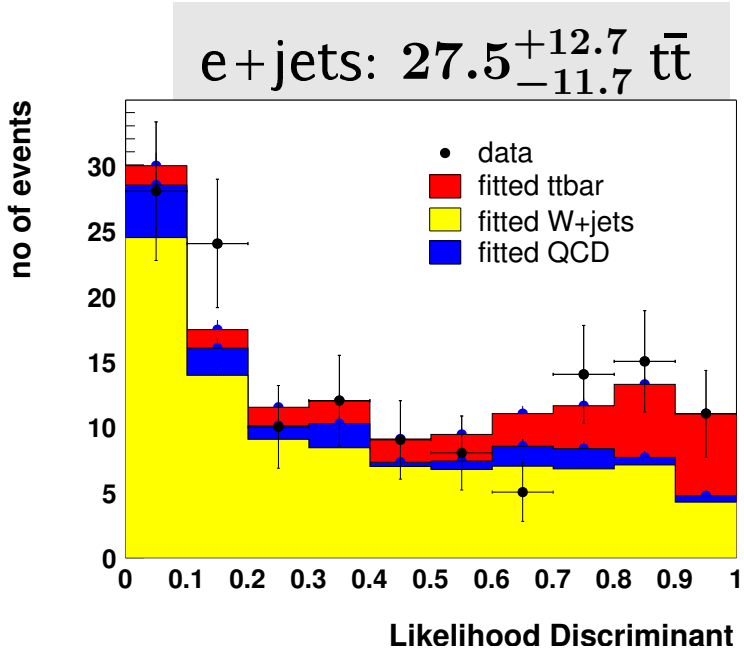
main backgrounds:

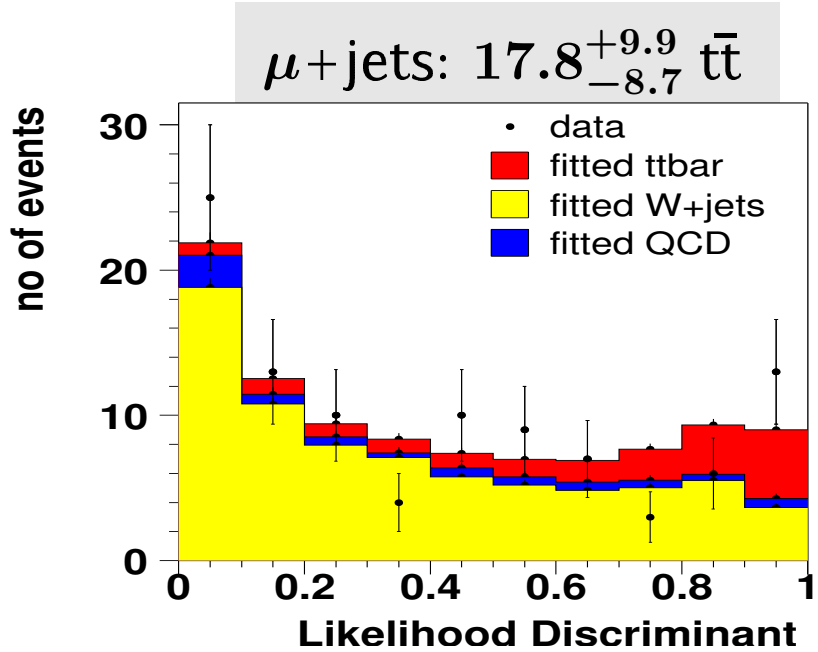
- W+jets
- fake leptons

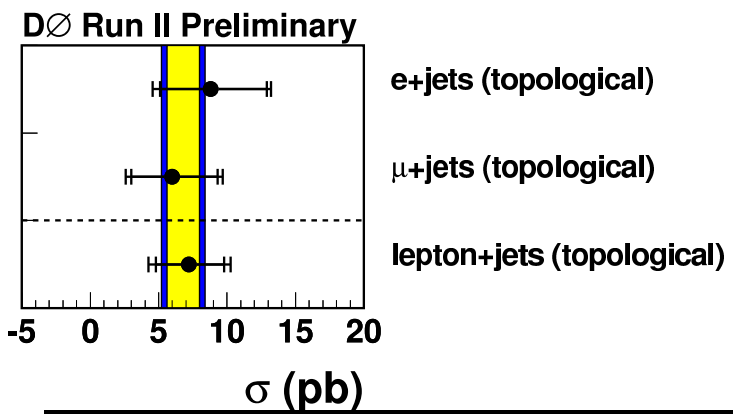
event topological variables are combined to likelihood discriminant



Lepton+jets (topological): results







$8.8^{+4.1}_{-3.7}(\text{stat})^{+1.6}_{-2.1}(\text{syst})\pm 0.6(\text{lumi})$ pb

$6.0^{+3.4}_{-3.0}(\text{stat})^{+1.6}_{-1.6}(\text{syst})\pm 0.4(\text{lumi})$ pb

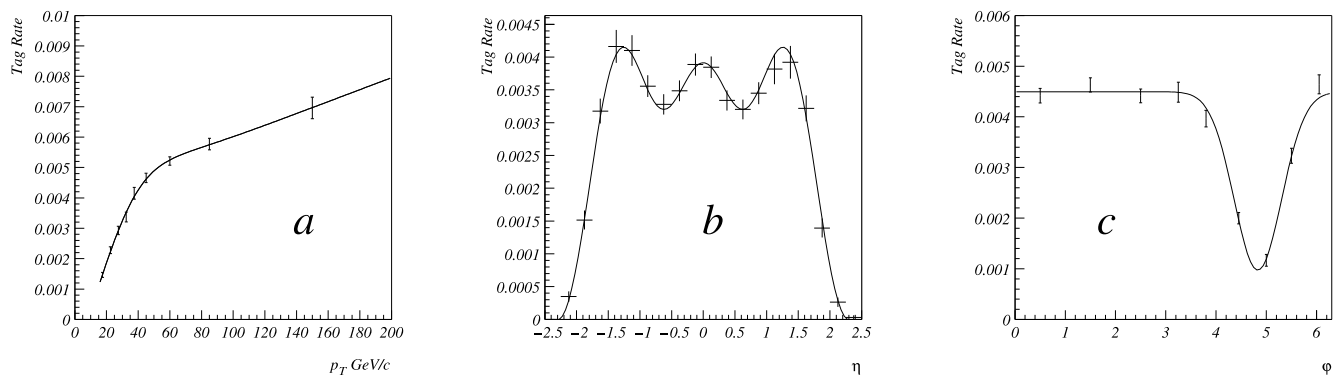
$7.2^{+2.6}_{-2.4}(\text{stat})^{+1.6}_{-1.7}(\text{syst})\pm 0.5(\text{lumi})$ pb

Lepton+jets (soft lepton tag)

almost same event selection as topological analysis, plus:

- transverse jet energy sum $H_T > 110\,\text{GeV}$
- require a soft muon ($p_T > 4\,\text{GeV}$) in one jet

soft muons in $t\bar{t}$ from b$\rightarrow \mu$, b$\rightarrow$c$\rightarrow \mu$, W$\rightarrow$c$\rightarrow \mu$
0.42 muons per $t\bar{t}$ event expected!
tag rate dependence on jet p_T, η, ϕ:



cross-section result (92 pb^{-1}, 15 candidates):

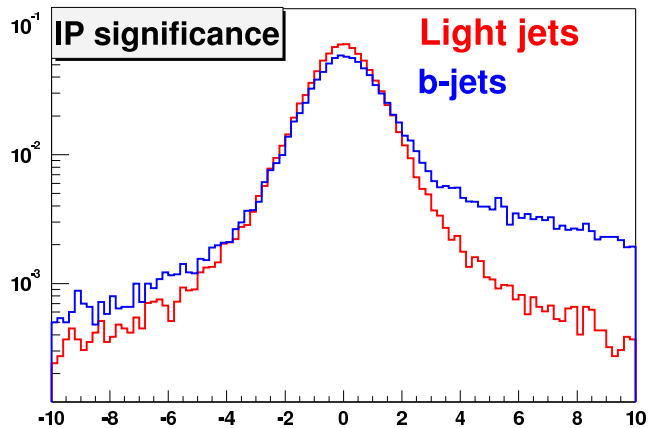
$$11.4^{+4.1}_{-3.5}(\text{stat})^{+2.0}_{-1.8}(\text{syst})\pm 1.1(\text{lumi})$$

Lepton+jets (b lifetime tag)

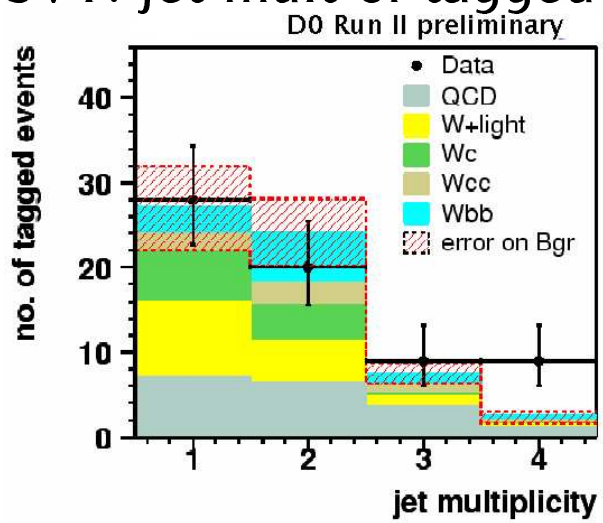
very similar event selection as topological analysis
plus: at least one jet has lifetime tag. two algorithms:

- secondary vertex tagger (SVT)
- counting signed impact parameters (CSIP):

CSIP:



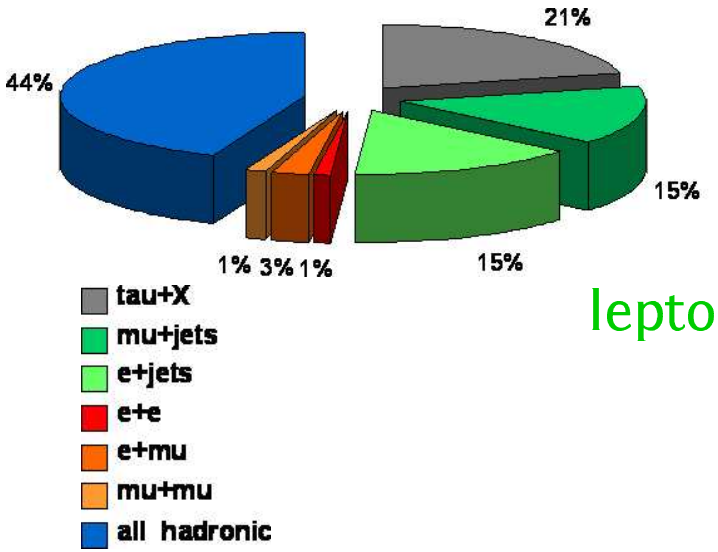
SVT: jet mult of tagged events

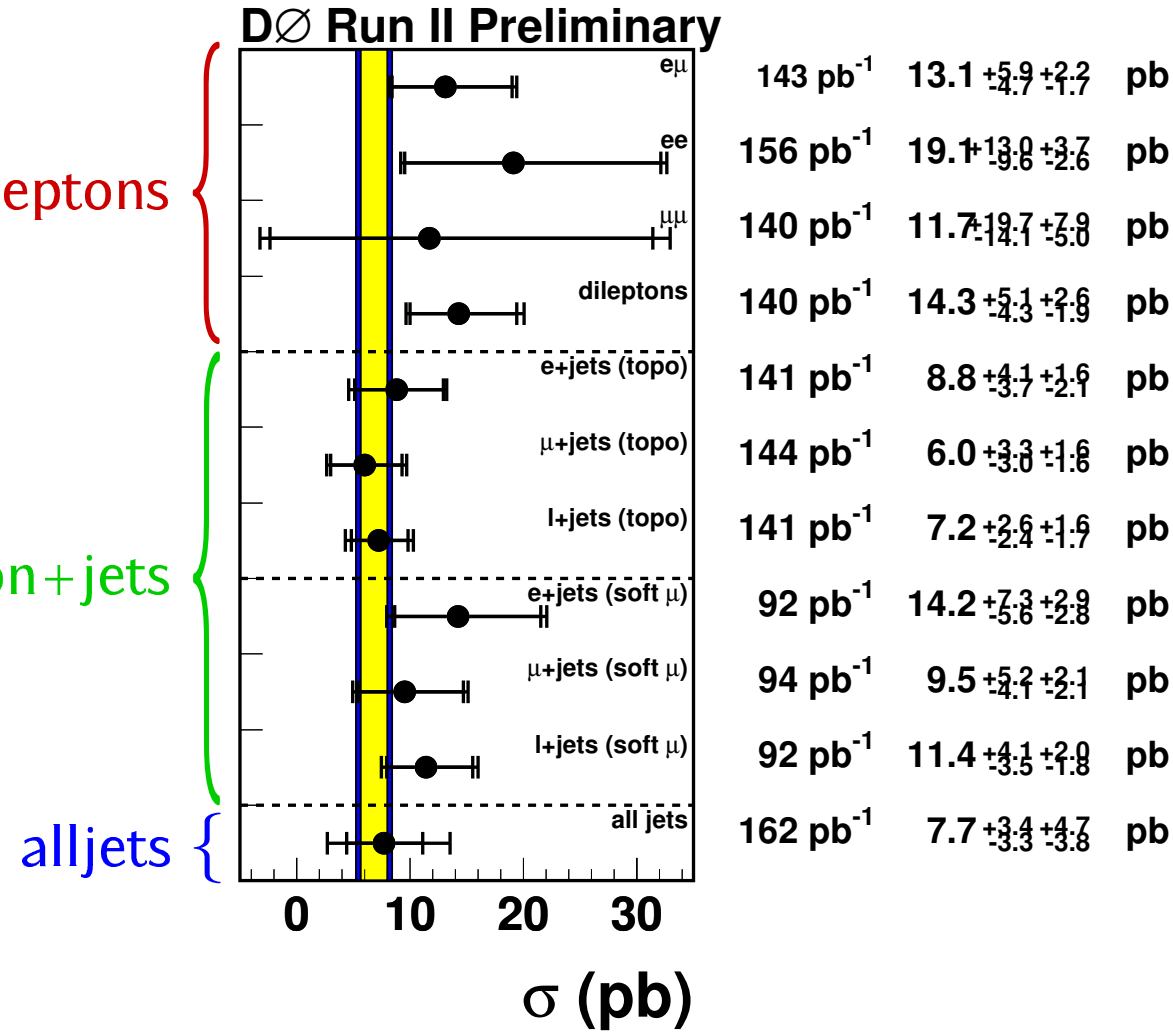


cross-section result for 50 pb^{-1} (e+jets), 40 pb^{-1} (μ+jets):

SVT: $10.8^{+4.9}_{-4.0}$(stat)$^{+2.1}_{-2.0}$(syst)± 1.1(lumi)
CSIP: $7.4^{+4.4}_{-3.6}$(stat)$^{+2.1}_{-1.8}$(syst)± 0.7(lumi)

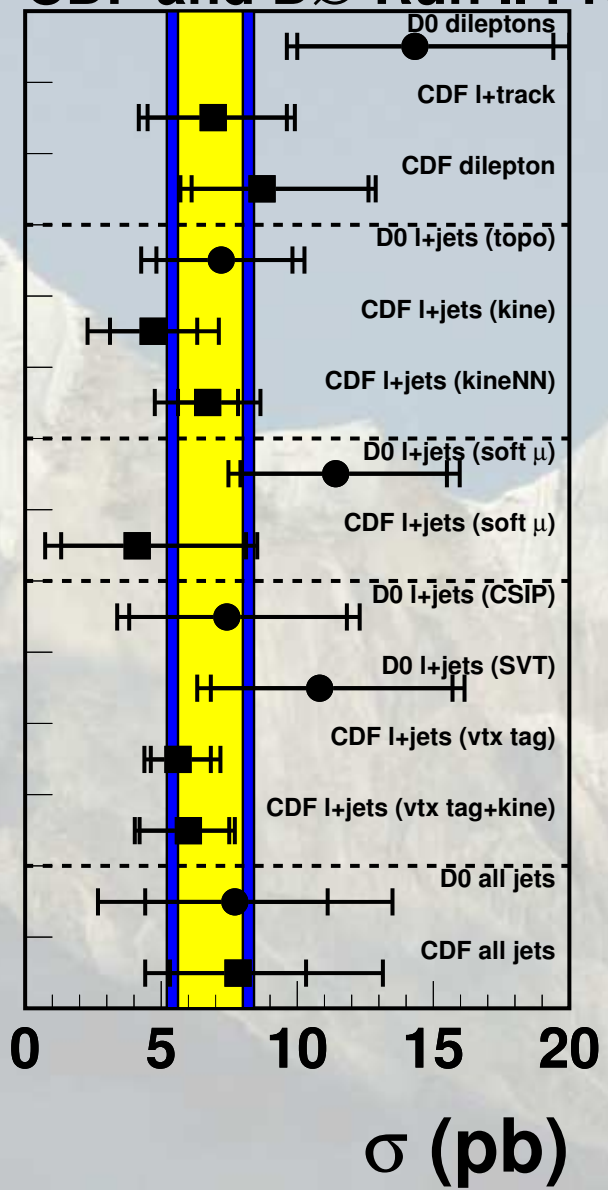
Overview of individual results





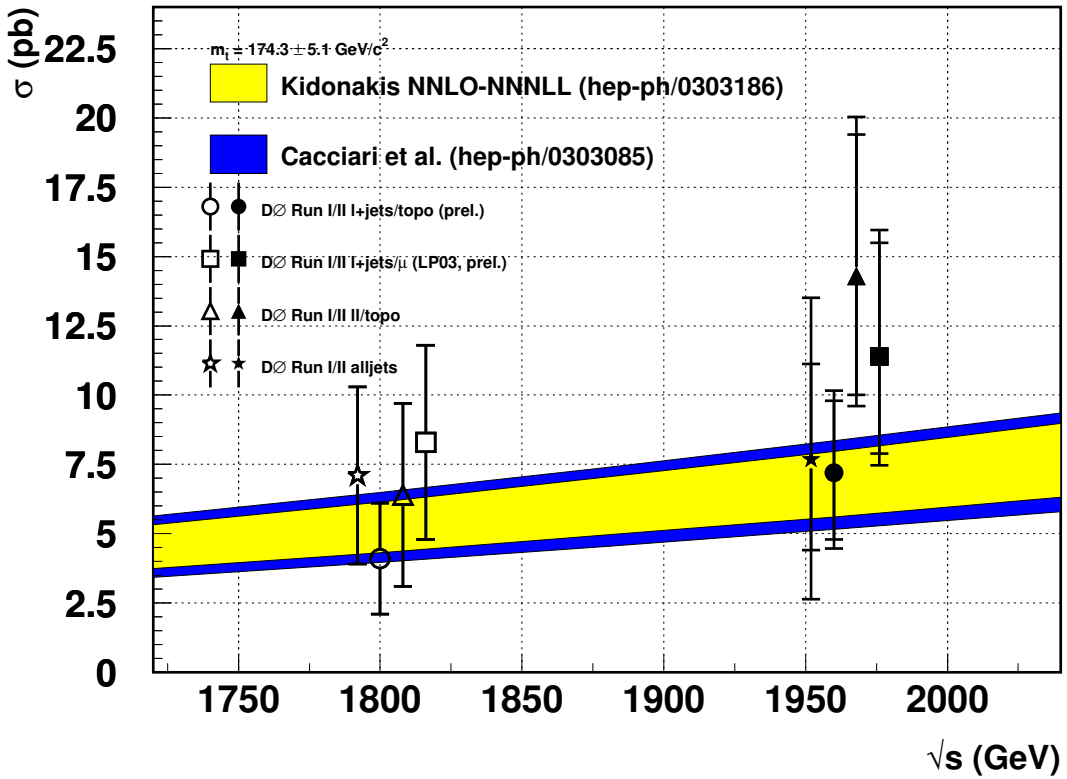
"*tops* of the world"

CDF and DØ Run II Preliminary



140 pb^{-1}	14.3 $^{+5.1}_{-4.3}$ $^{+2.6}_{-1.9}$	pb	D0 dileptons
202 pb^{-1}	6.9 $^{+2.7}_{-2.4}$ $^{+1.3}_{-1.3}$	pb	CDF l+track
193 pb^{-1}	8.7 $^{+3.9}_{-2.6}$ $^{+1.5}_{-1.5}$	pb	CDF dilepton
141 pb^{-1}	7.2 $^{+2.6}_{-2.4}$ $^{+1.6}_{-1.7}$	pb	D0 l+jets (topo)
195 pb^{-1}	4.7 $^{+1.6}_{-1.6}$ $^{+1.8}_{-1.8}$	pb	CDF l+jets (kine)
195 pb^{-1}	6.7 $^{+1.1}_{-1.1}$ $^{+1.6}_{-1.6}$	pb	CDF l+jets (kineNN)
92 pb^{-1}	11.4 $^{+4.1}_{-3.5}$ $^{+2.0}_{-1.8}$	pb	D0 l+jets (soft μ)
126 pb^{-1}	4.1 $^{+4.0}_{-2.8}$ $^{+1.9}_{-1.9}$	pb	CDF l+jets (soft μ)
40 pb^{-1}	7.4 $^{+4.4}_{-3.6}$ $^{+2.1}_{-1.8}$	pb	D0 l+jets (CSIP)
40 pb^{-1}	10.8 $^{+4.9}_{-4.0}$ $^{+2.1}_{-2.0}$	pb	D0 l+jets (SVT)
162 pb^{-1}	5.6 $^{+1.2}_{-1.0}$ $^{+1.0}_{-0.7}$	pb	CDF l+jets (vtx tag)
162 pb^{-1}	6.0 $^{+1.5}_{-1.8}$ $^{+0.8}_{-0.8}$	pb	CDF l+jets (vtx tag+kine)
162 pb^{-1}	7.7 $^{+3.4}_{-3.3}$ $^{+4.7}_{-3.8}$	pb	D0 all jets
165 pb^{-1}	7.8 $^{+2.5}_{-2.5}$ $^{+4.7}_{-2.3}$	pb	CDF all jets

energy evolution: comparison with Tevatron Run I



Where do we stand now?

- DØ has caught a significant amount of $t\bar{t}$ pairs in Run II
  have clearly re-established $t\bar{t}$ signal in Run II
- all channels compatible with standard model predictions
  but some channels show interesting tendencies!
- updates of Summer 2003 analyses (b tagging!) soon:
  - much larger data samples
  - all data reprocessed with improved calibration (JES) and much better track reconstruction
  - improved analysis methods, lepton isolation criteria
- aim at 10% precision with 2 fb^{-1} dataset