

PHENO 2004, Madison (WI), 27 April 2004

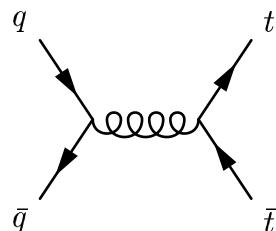
New top quark pair production measurements at DØ

Kristian Harder, Kansas State University,
for the DØ Collaboration

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

production
process

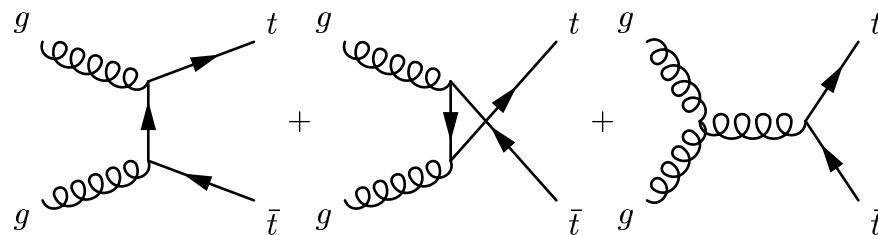
$q\bar{q}$ annihilation



contribution to
 $\sigma(t\bar{t})$ at 1.96 TeV

$\approx 85\%$

gluon interaction



$\approx 15\%$

≈ 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:

$\text{BR}(t \rightarrow W b) \approx 100\%$

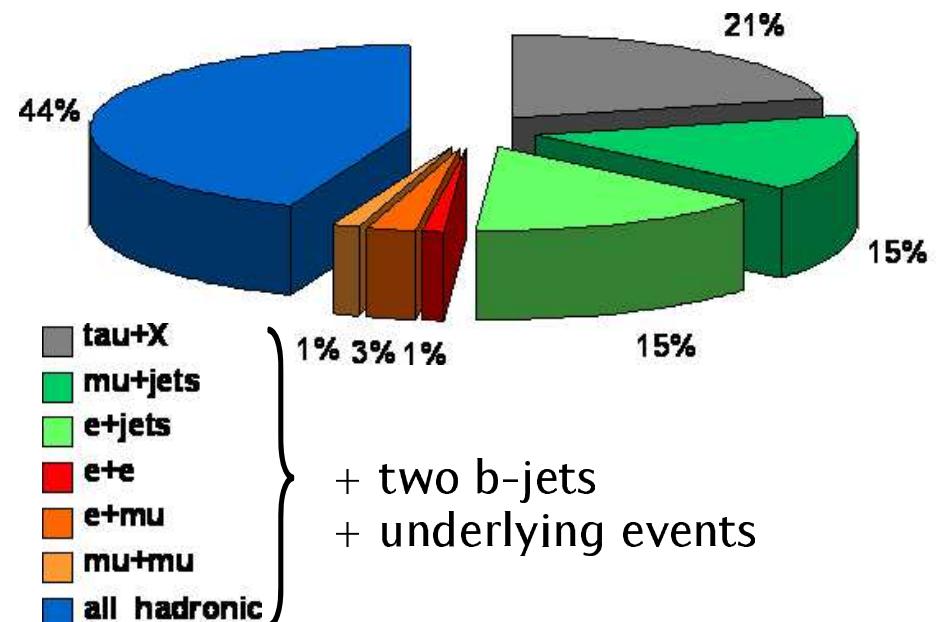
W decay determines topology

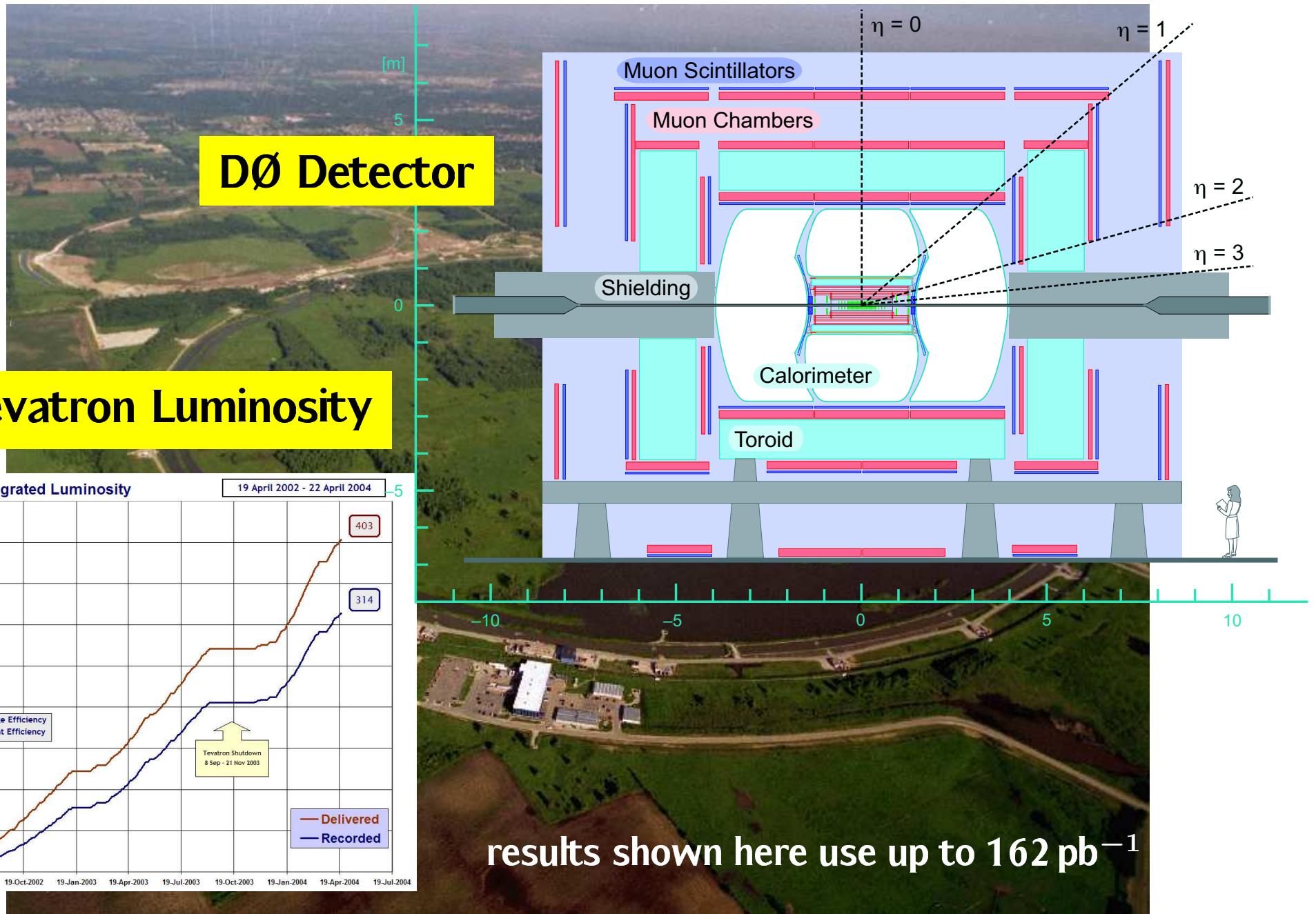
- b-jet + two jets ($W \rightarrow q\bar{q}$)
- b-jet + electron ($W \rightarrow e\nu$)
- b-jet + muon ($W \rightarrow \mu\nu$)
- b-jet + tau ($W \rightarrow \tau\nu$)



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

top pairs:





DØ top pair production analyses

new for Winter conferences 2004:

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

for Summer conferences 2003:

- $e+\text{jets}$, $\mu+\text{jets}$ (soft lepton tag) $92..94 \text{ pb}^{-1}$
- $e+\text{jets}$, $\mu+\text{jets}$ (lifetime tags) $40..50 \text{ pb}^{-1}$



Dilepton analysis

selection:

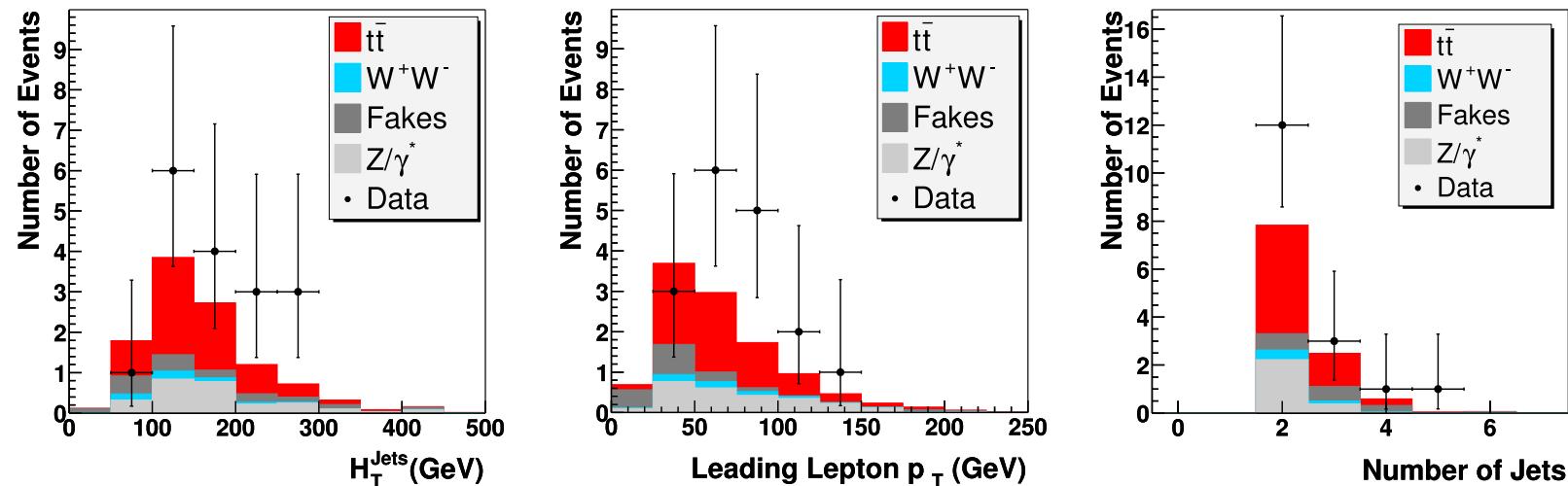
- two isolated leptons with $p_T > 15 \text{ GeV}$ (ee: 20 GeV)
electrons: EM cluster, matched track, likelihood fit
muons: track segments in muon layers, matched track
- missing $E_T > 35 \text{ GeV}$ (e μ : 25 GeV)
- two jets with $p_T > 20 \text{ GeV}$
- large H_T (total sum of jet p_T)

main backgrounds:

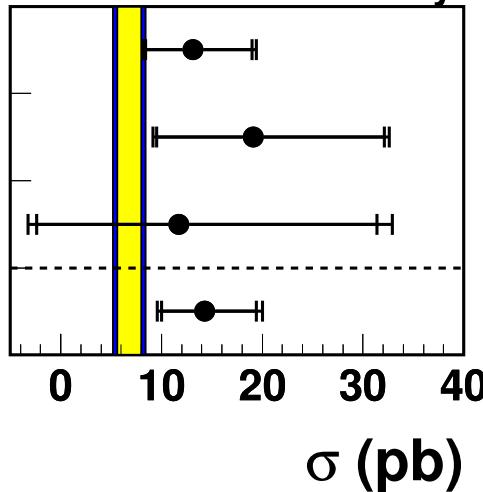
- $Z/\gamma^* \rightarrow \ell^+\ell^-$
- fake electrons, muons

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

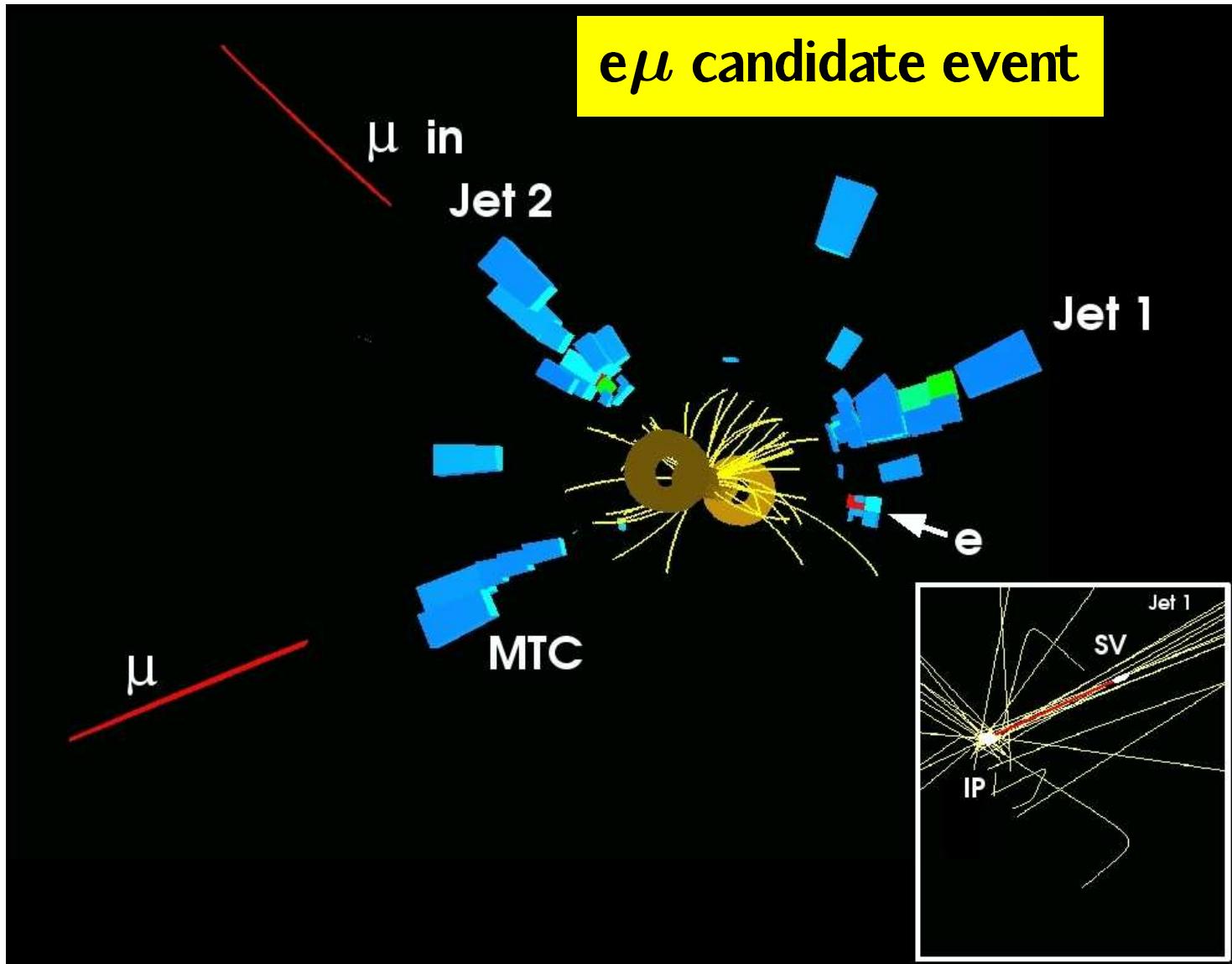


DØ Run II Preliminary



ee	$13.1^{+5.9}_{-4.7}(\text{stat})^{+2.2}_{-1.7}(\text{syst}) \pm 0.9(\text{lumi}) \text{ pb}$
$\mu\mu$	$19.1^{+13.0}_{-9.6}(\text{stat})^{+3.7}_{-2.6}(\text{syst}) \pm 1.2(\text{lumi}) \text{ pb}$
dilepton	$11.7^{+19.7}_{-14.1}(\text{stat})^{+7.9}_{-5.0}(\text{syst}) \pm 0.8(\text{lumi}) \text{ pb}$
e μ	$14.3^{+5.1}_{-4.3}(\text{stat})^{+2.6}_{-1.9}(\text{syst}) \pm 0.9(\text{lumi}) \text{ pb}$

Do we see something interesting here?





All jets analysis

selection:

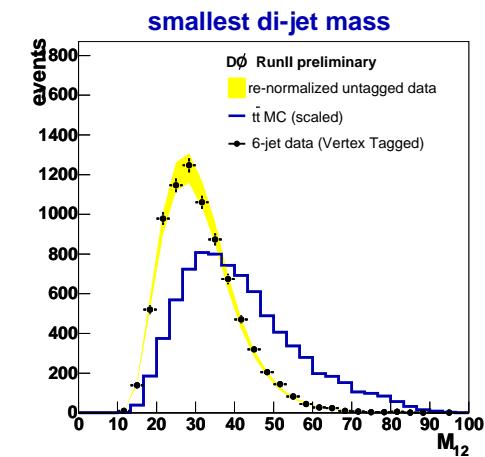
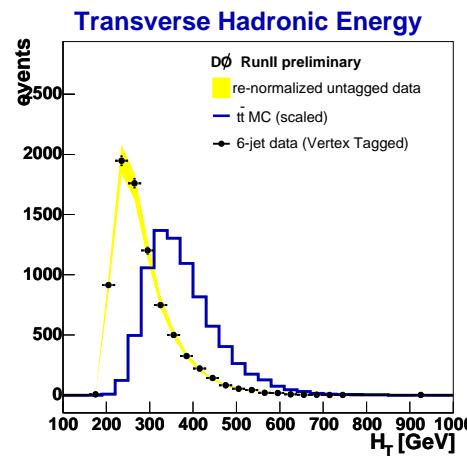
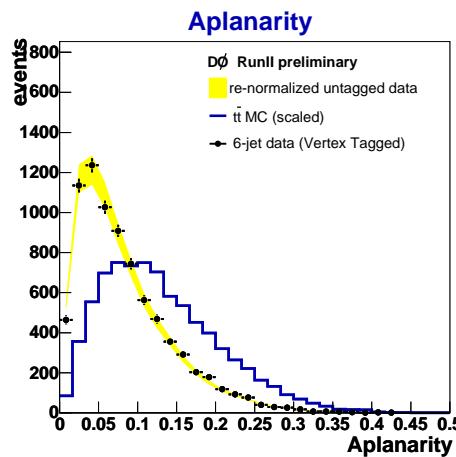
- 6 jets with $p_T > 15 \text{ GeV}$
- exactly 1 jet with secondary vertex (lifetime significance > 7)
- no isolated leptons

main backgrounds:

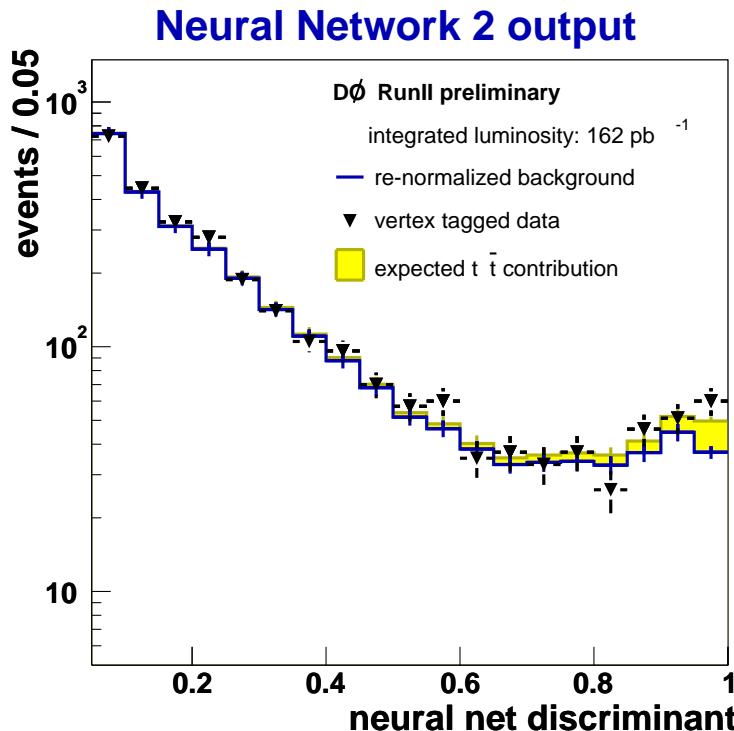
- QCD multi-jet events

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)

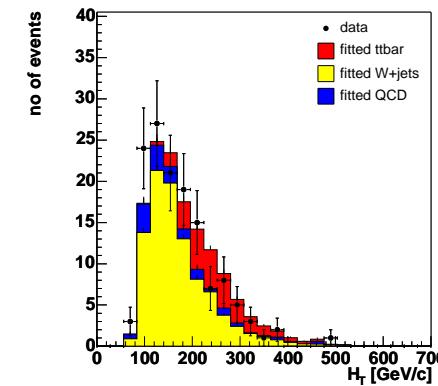
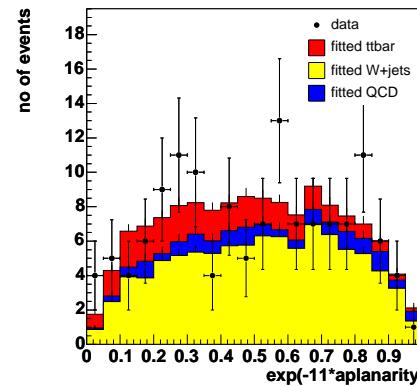
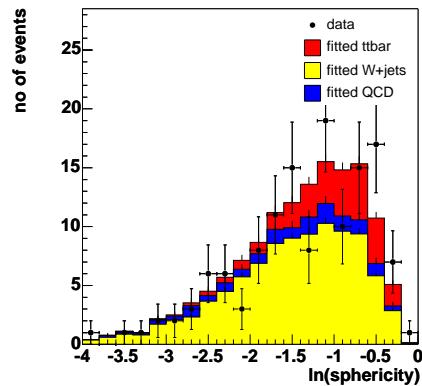
selection:

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

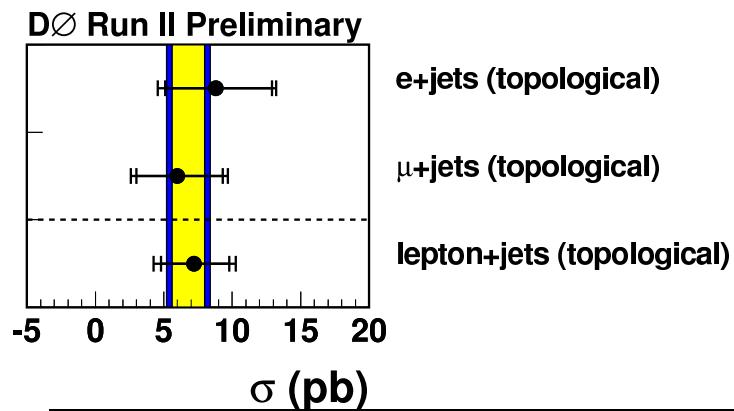
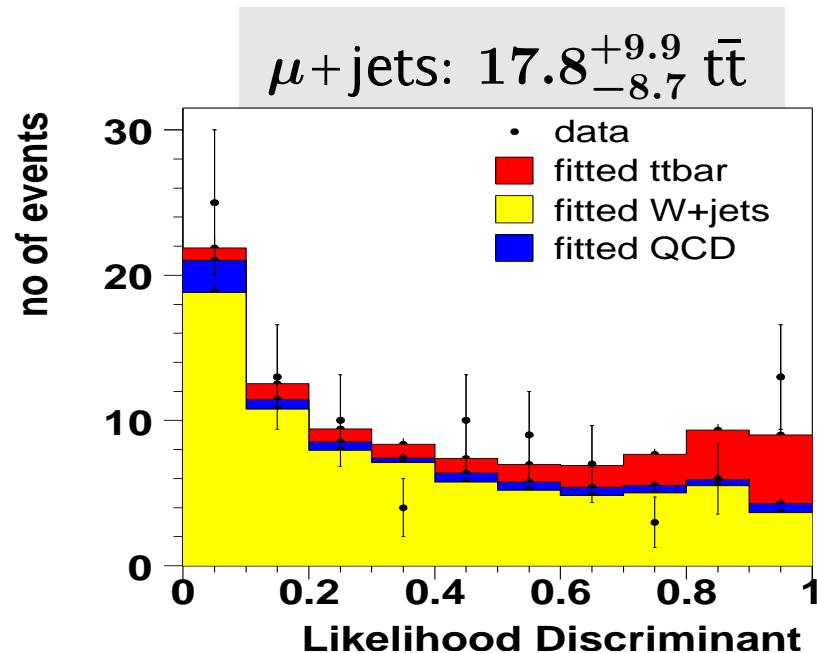
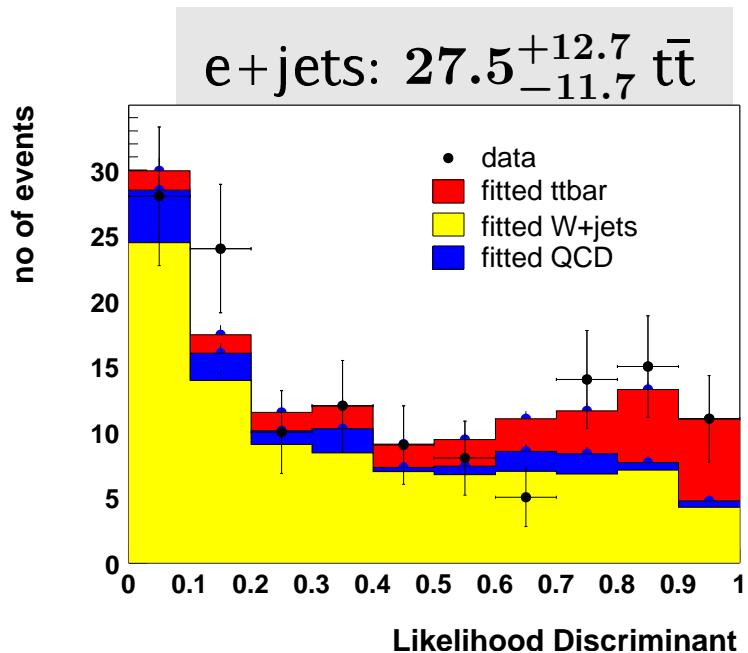
main backgrounds:

- W+jets
- fake leptons

event topological variables are combined to likelihood discriminant



Lepton+jets (topological): results



$8.8^{+4.1}_{-3.7}(\text{stat})^{+1.6}_{-2.1}(\text{syst}) \pm 0.6(\text{lumi}) \text{ pb}$
 $6.0^{+3.4}_{-3.0}(\text{stat})^{+1.6}_{-1.6}(\text{syst}) \pm 0.4(\text{lumi}) \text{ pb}$
 $7.2^{+2.6}_{-2.4}(\text{stat})^{+1.6}_{-1.7}(\text{syst}) \pm 0.5(\text{lumi}) \text{ pb}$



Lepton+jets (soft lepton tag)

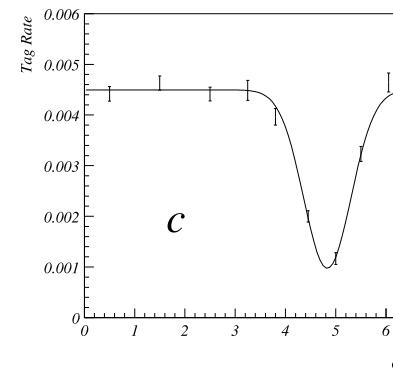
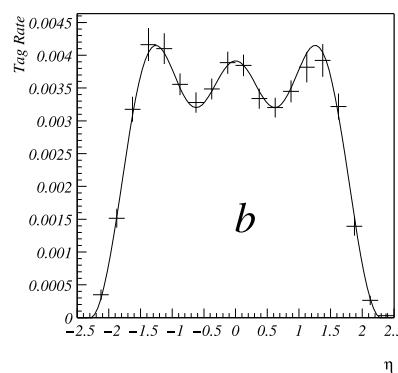
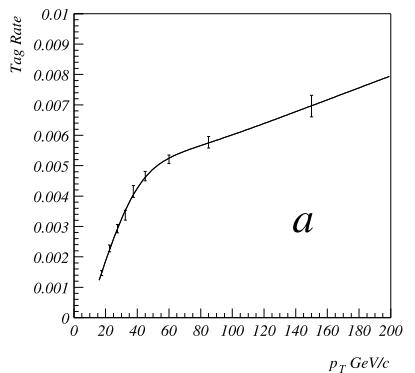
almost same event selection as topological analysis, plus:

- 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):

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

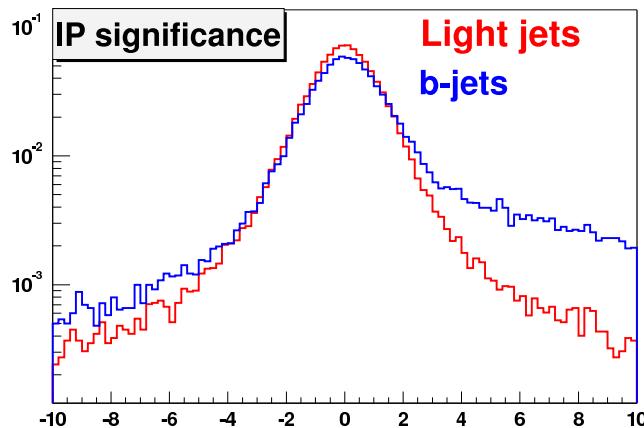


Lepton+jets (b lifetime tag)

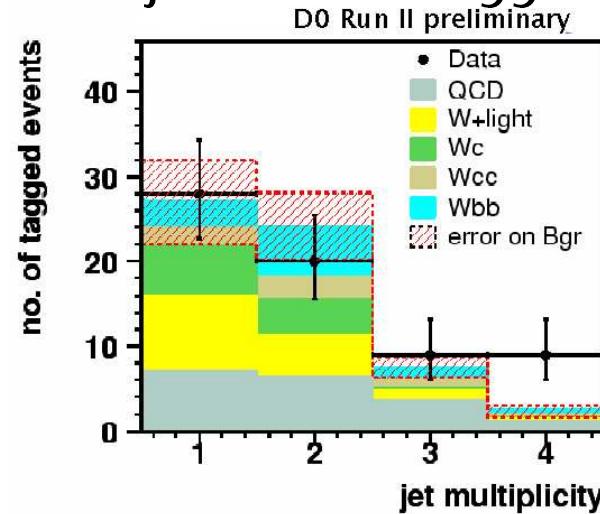
very similar event selection as topological analysis
plus: at least one jet has lifetime tag. two algorithms:

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

CSIP:



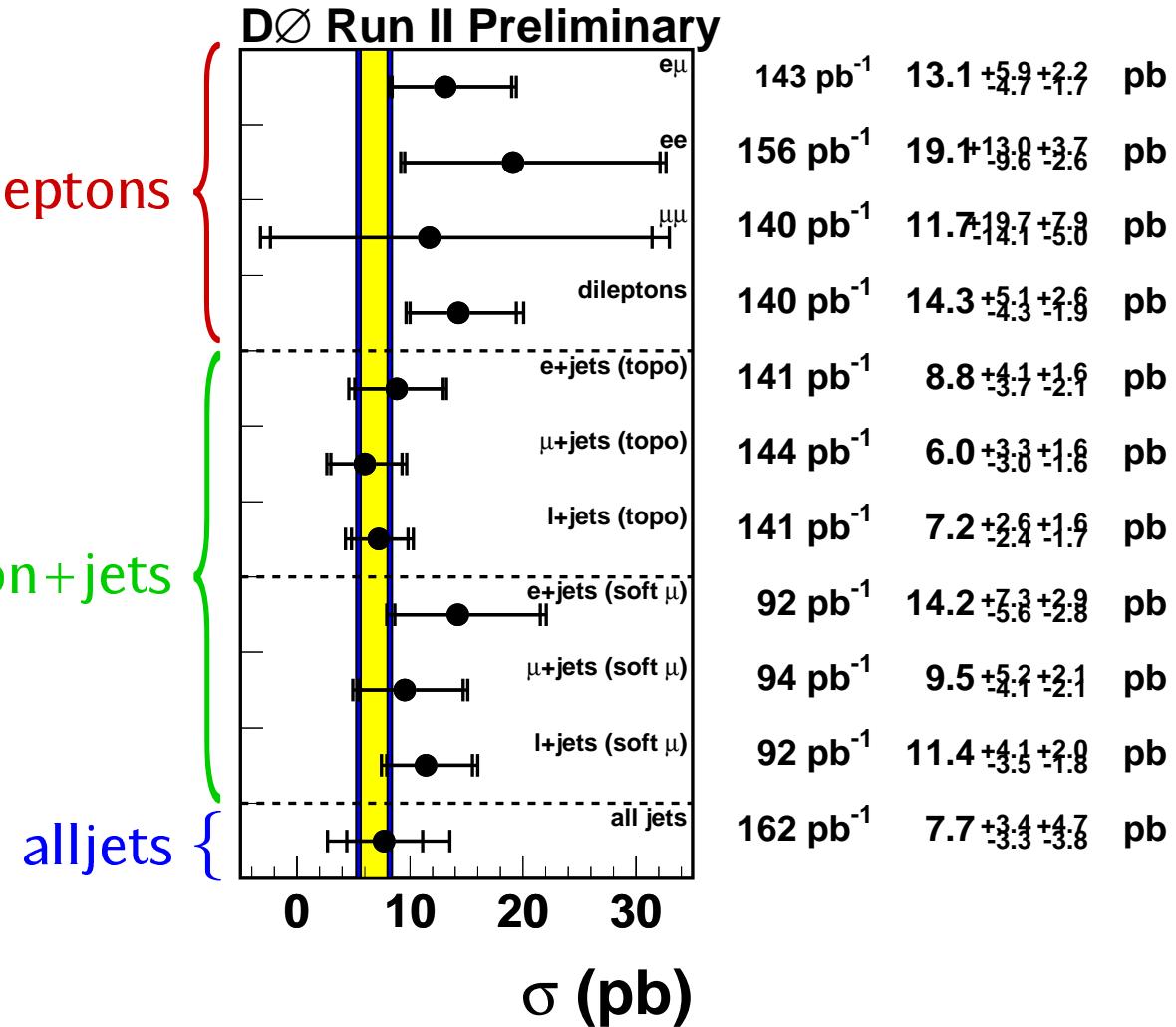
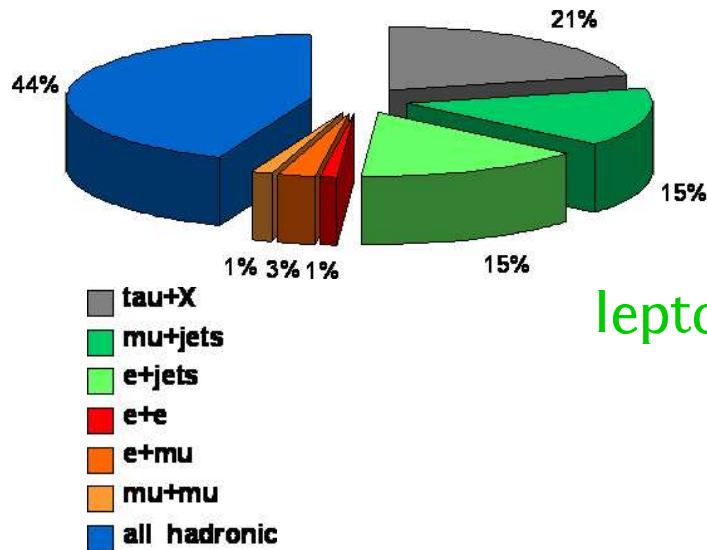
SVT: jet mult of tagged events



cross-section result for 50 pb^{-1} ($e+\text{jets}$), 40 pb^{-1} ($\mu+\text{jets}$):

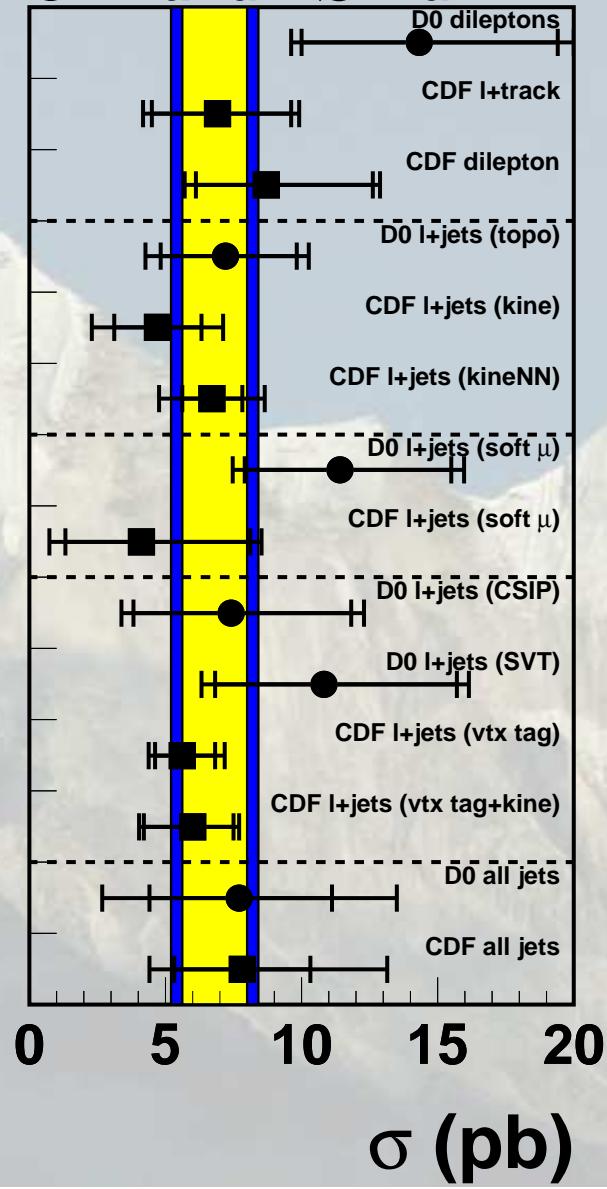
$$\begin{aligned}\text{SVT: } & 10.8^{+4.9}_{-4.0}(\text{stat})^{+2.1}_{-2.0}(\text{syst}) \pm 1.1(\text{lumi}) \\ \text{CSIP: } & 7.4^{+4.4}_{-3.6}(\text{stat})^{+2.1}_{-1.8}(\text{syst}) \pm 0.7(\text{lumi})\end{aligned}$$

Overview of individual results

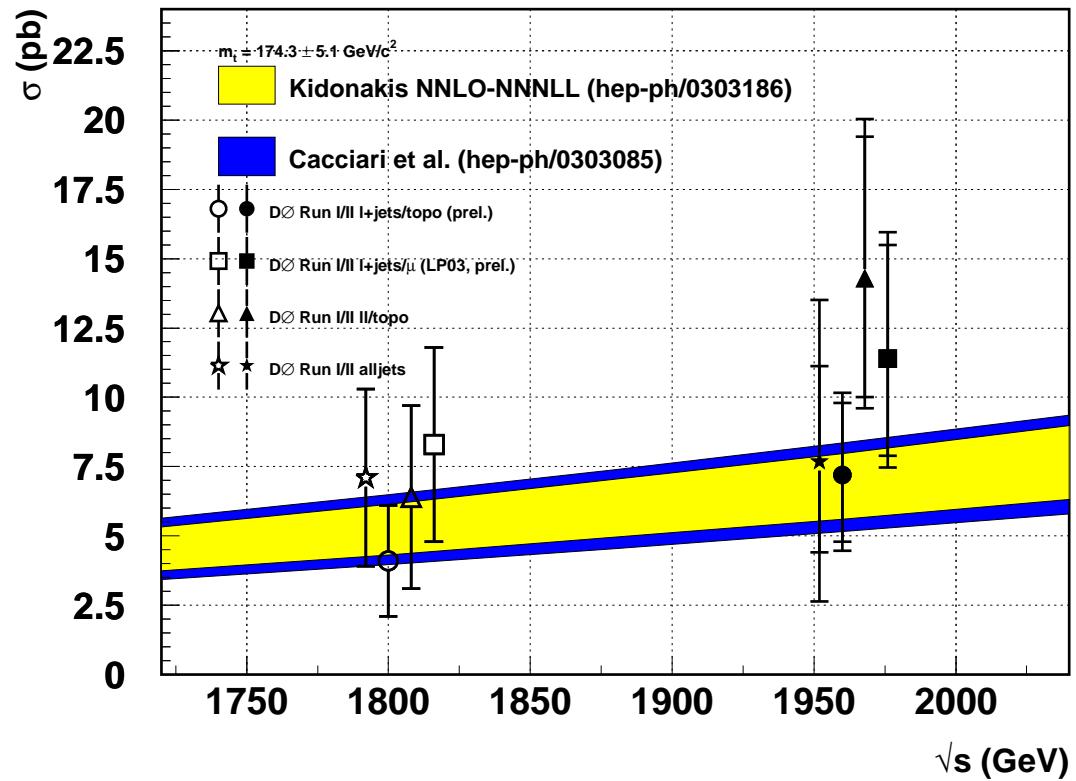


“tops of the world”

CDF and DØ Run II Preliminary



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