

~~DØ Gossips~~ Results
for **ICHEP 2010**

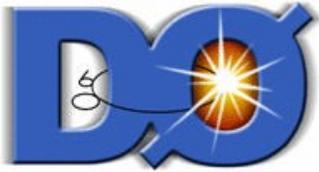
Fermilab Joint Experimental-Theoretical Seminar
16 July 2010

Marco Verzocchi

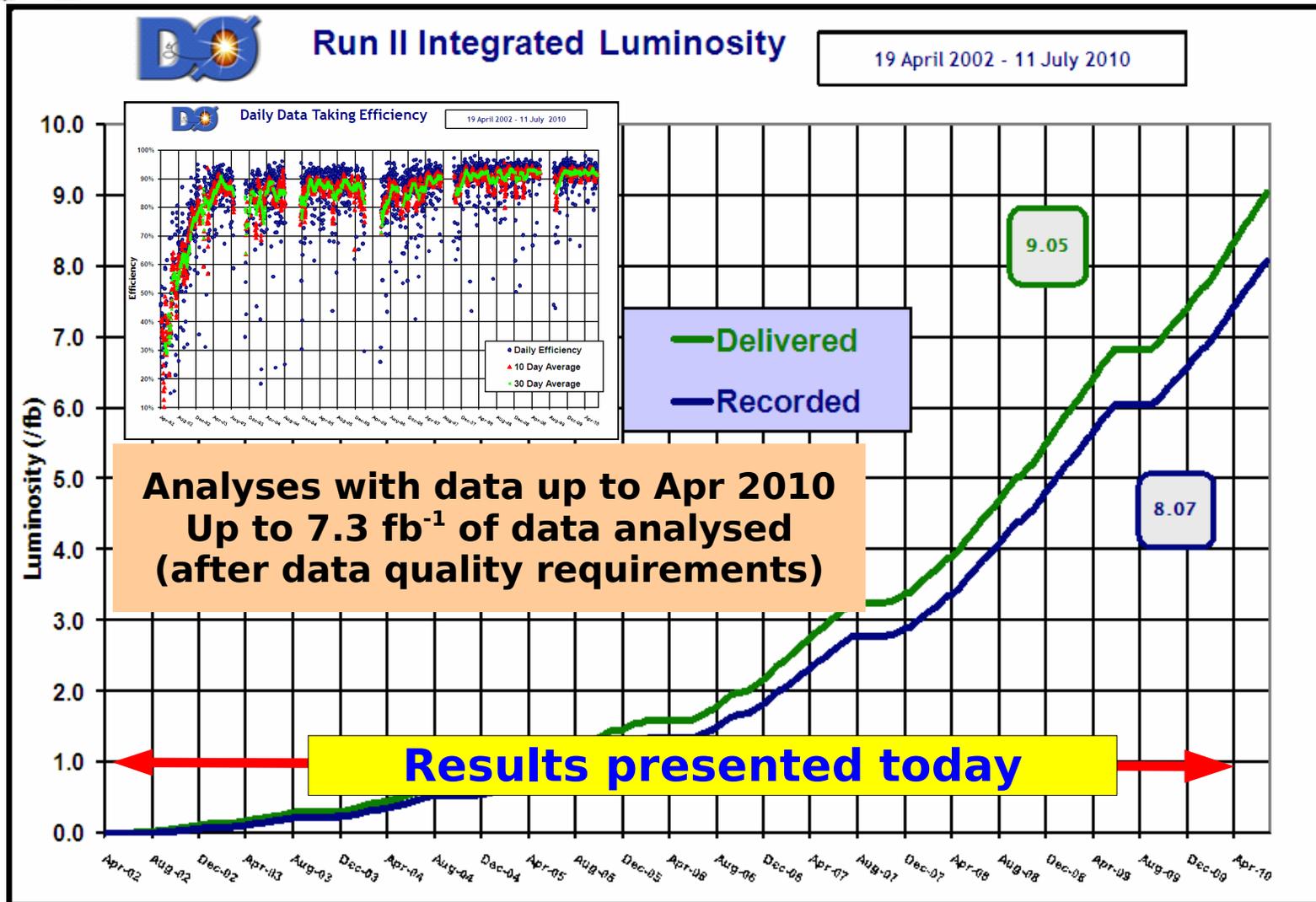
 Fermi National Accelerator Laboratory

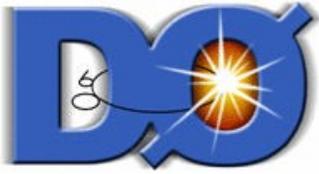


492 Collaborators in 86 Institutions from 19 Countries
Many thanks to all of them for the results presented today



Thanks to the Beams Division

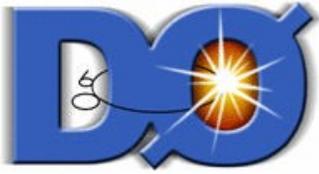




Outline

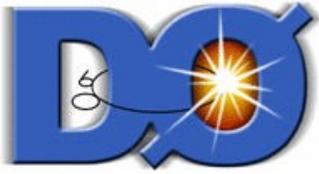
- **QCD and Electroweak Physics**
 - Elastic cross section
 - Weak bosons production
- **Top Physics**
 - Cross sections
- **Searches for New Physics**
 - In heavy quarks systems
 - New models
- **Searches for the Higgs Boson**
 - SM Higgs Searches
 - BSM Higgs Searches
- **Conclusions**

- **77 abstracts submitted to ICHEP**
 - 2 plenary presentations
 - 20 parallel presentations

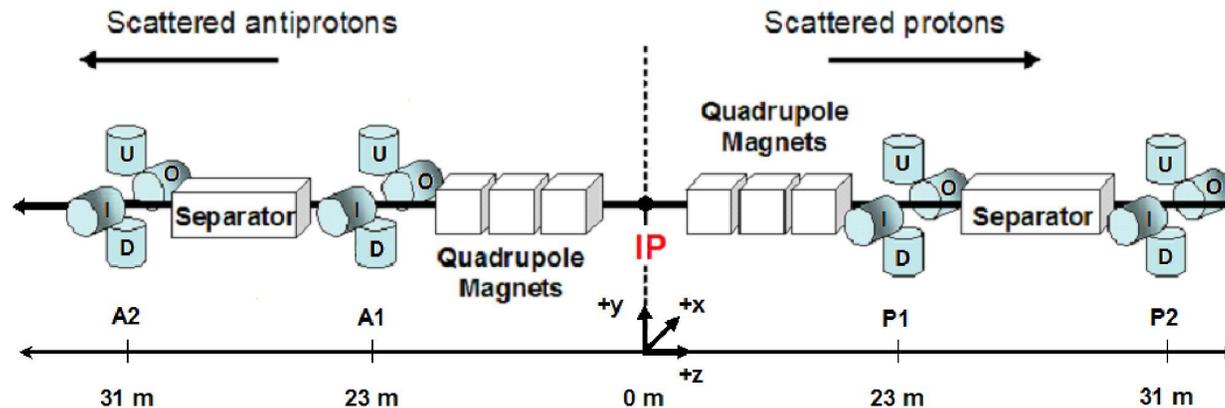


The X Files

- **Will NOT discuss today**
 - **DØ Higgs Combination**
- **CP Violation in B_s system**
 - **New measurement using $B_s \rightarrow J/\psi\phi$**
 - **Combination of DØ constraints on CP violation in B_s system**
- **These results will be presented at ICHEP**
 - **Still in internal DØ review (combined CDF+DØ review)**
 - **Higgs combinations**
 - **Parallel session presentation by M. Mulhearn (DØ only)**
 - **Plenary presentation by B. Kilminster (Tevatron combination)**
 - **CP Violation in B_s system**
 - **Parallel session presentation by R. van Kooten**
 - **Plenary presentation by G. Borissov**

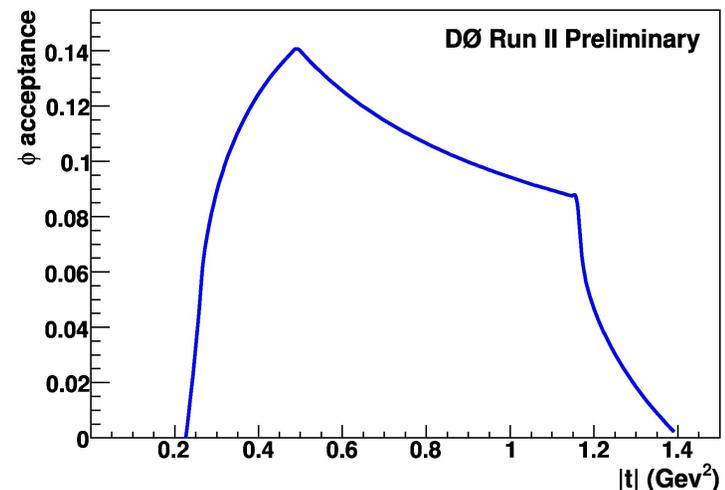


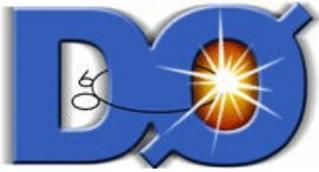
Elastic Cross Section (I)



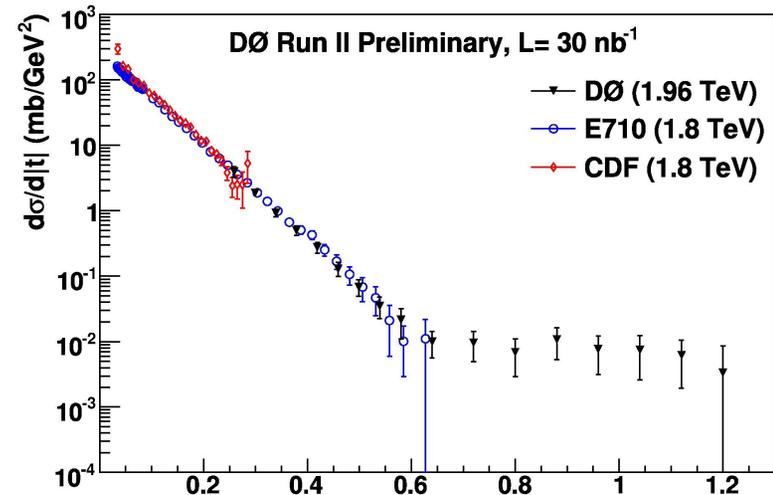
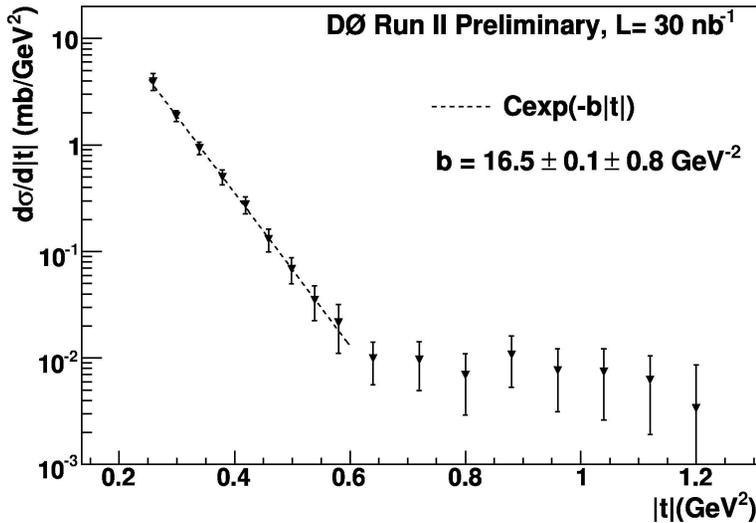
Use 30 nb^{-1} of data collected in special store with increased β^*

DØ roman pots detectors:
Scintillating fiber detectors providing tracking and triggering information plus scintillator tiles for timing





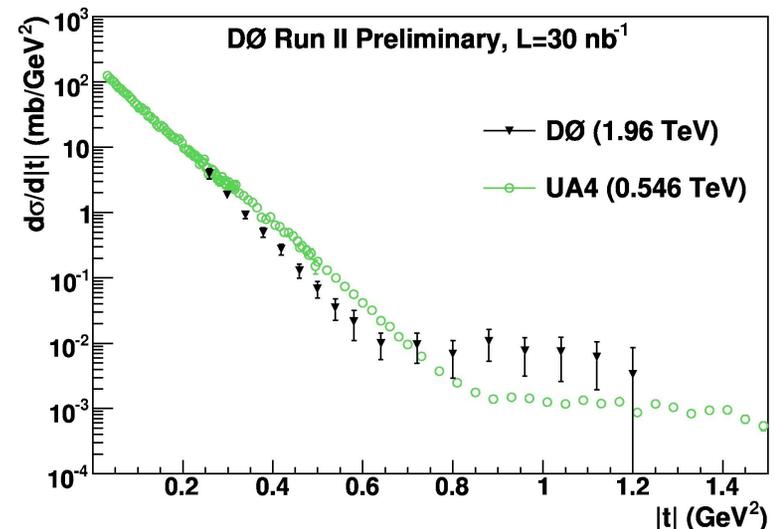
Elastic Cross Section (II)

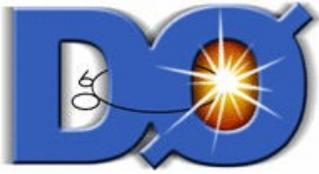


Measure $d\sigma/d|t|$ in region dominated by nuclear scattering

Slope consistent with Run I measurements (E710/CDF)

First observation of diffractive minimum at Tevatron energies (move to lower $|t|$ as \sqrt{s} increases)





Weak Bosons Production (I)

Measure $d\sigma/dp_T$ for inclusive Z boson production (455k $Z \rightarrow ee$ /
511k $Z \rightarrow \mu\mu$ decays) with 7.3 fb^{-1} of data

Investigate possibility of small-x broadening of Z p_T distribution
at low p_T

Minimize detector resolution effects: use new technique requiring
only measurements of leptons' directions

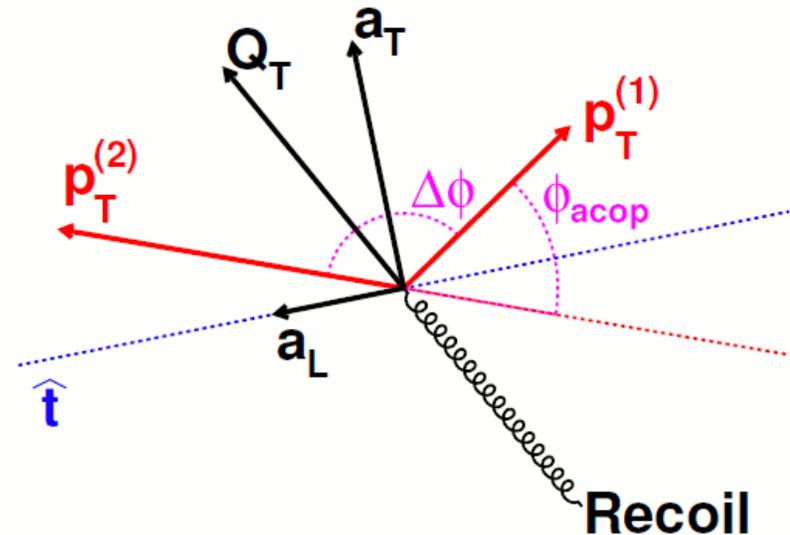
Define:

$$\phi_{\text{acop}} = \pi - \Delta\phi_{\parallel}$$

$$\cos\theta_{\eta}^* = \tanh((\eta^- - \eta^+)/2)$$

$$\phi_{\eta}^* = \tan(\phi_{\text{acop}}/2) \sin(\theta_{\eta}^*)$$

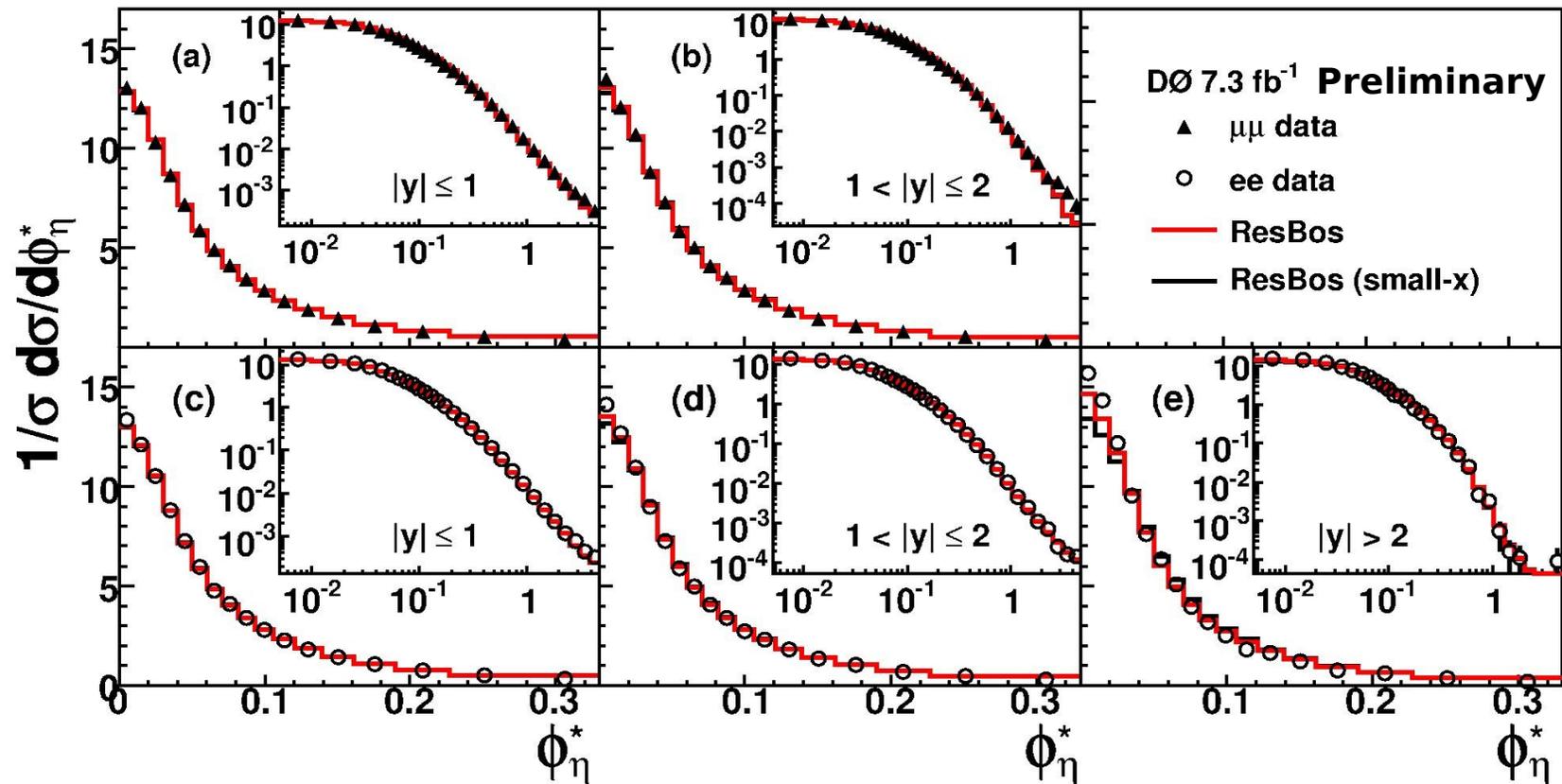
Perform measurement of
 $d\sigma/d\phi_{\eta}^*$ in bins of the Z rapidity y

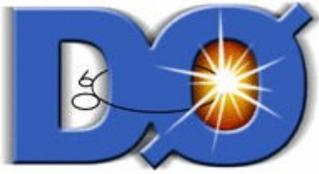




Weak Bosons Production (II)

Compare results with Resbos calculation (with/without small-x broadening)

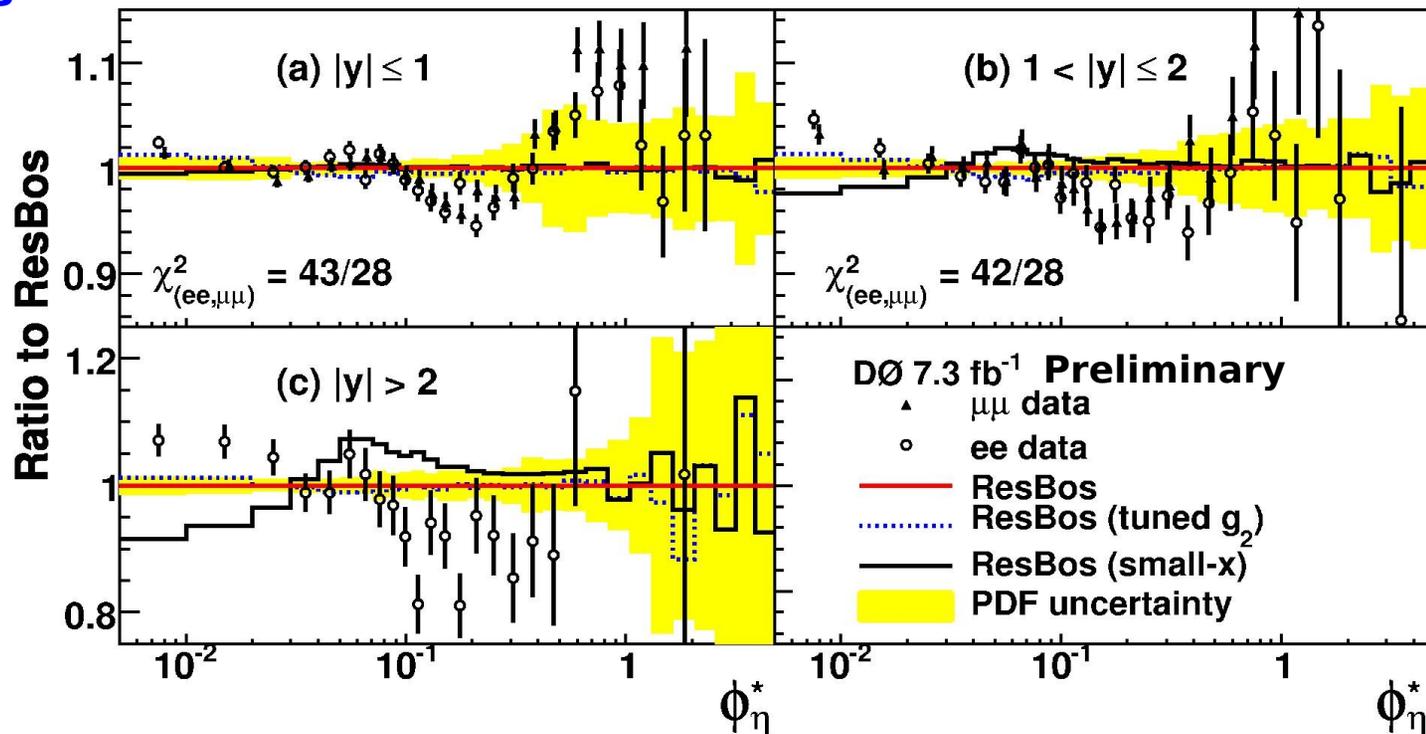




Weak Bosons Production (III)

Resbos does not describe differential cross section at this level of precision

Even tuning g_2 parameter of Resbos does not resolve the data/MC discrepancies



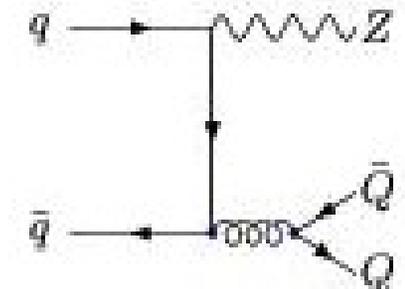
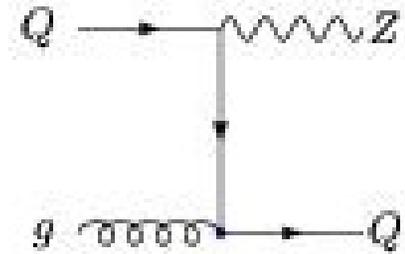
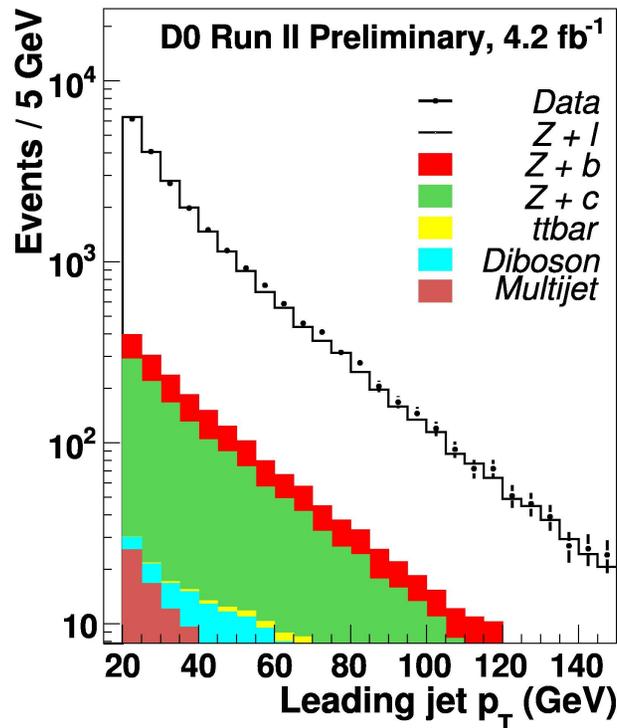
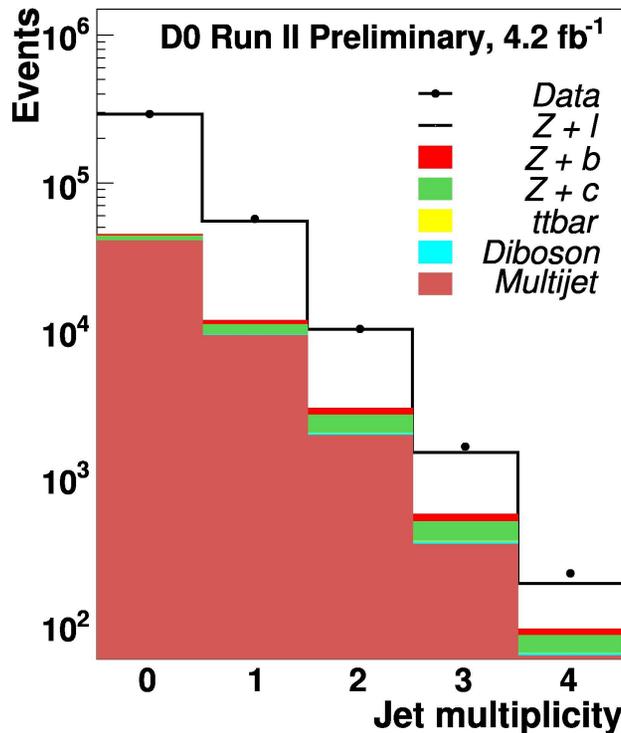
Electron data forward rapidities clearly disfavor presence of small-x broadening effects



Weak Bosons Production (IV)

Measured $\sigma(Z+b)/\sigma(Z+j)$ ratio using 4.2 fb^{-1} of data

Use fit to b-tagging probability to extract fraction of signal/background in Z+jets sample



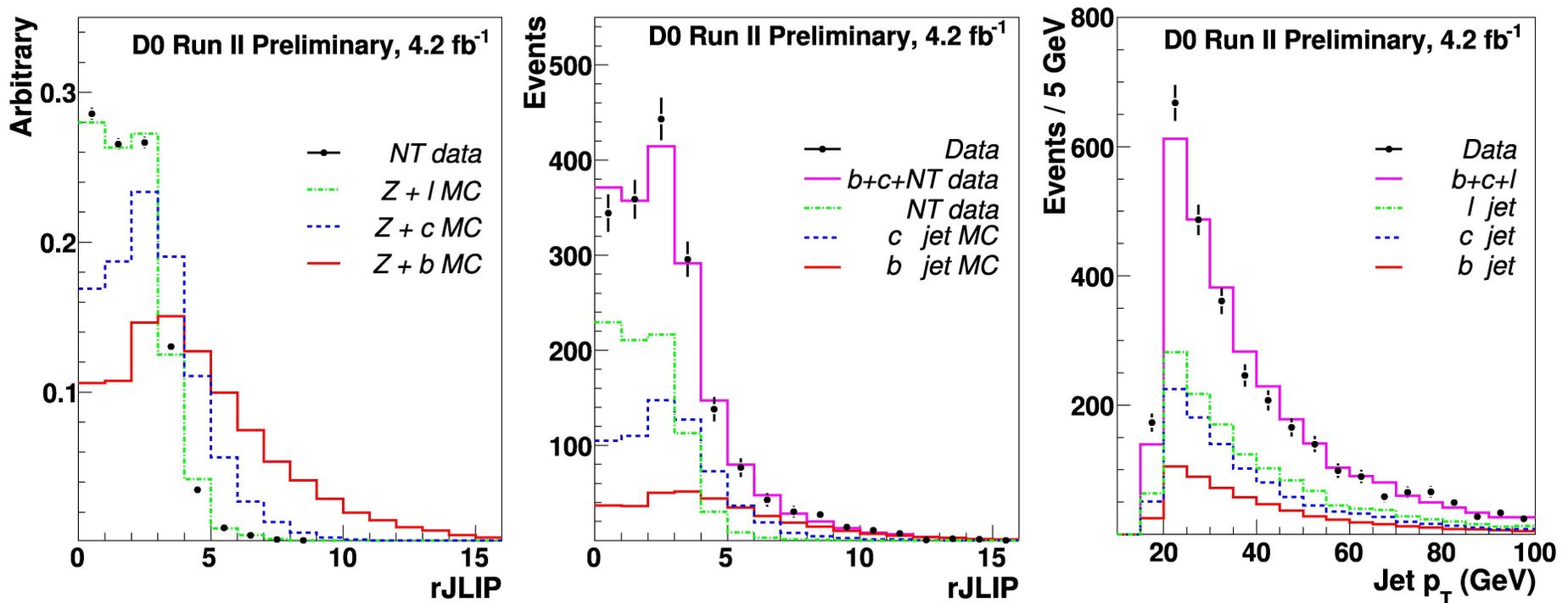


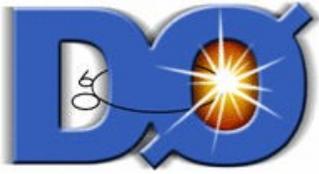
Weak Bosons Production (V)

For central jets ($|\eta| < 1$) with $p_T > 20$ GeV:

$$\sigma(Z+b)/\sigma(Z+j) = 0.0176 \pm 0.0024(\text{stat}) \pm 0.0023(\text{syst})$$

in agreement with NLO QCD calculations (0.018 ± 0.004)





Diboson Production (I)

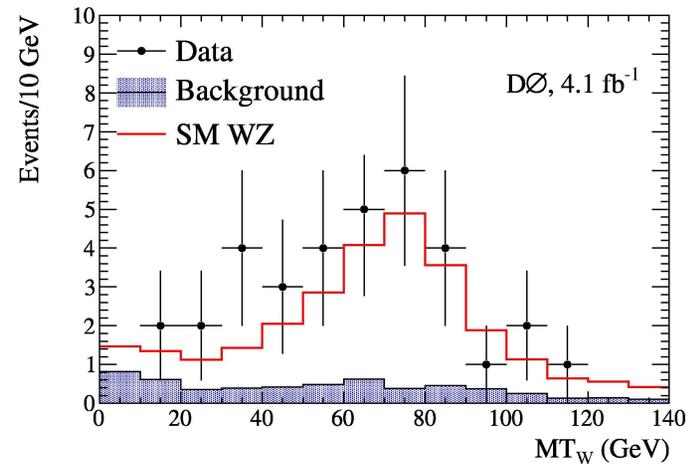
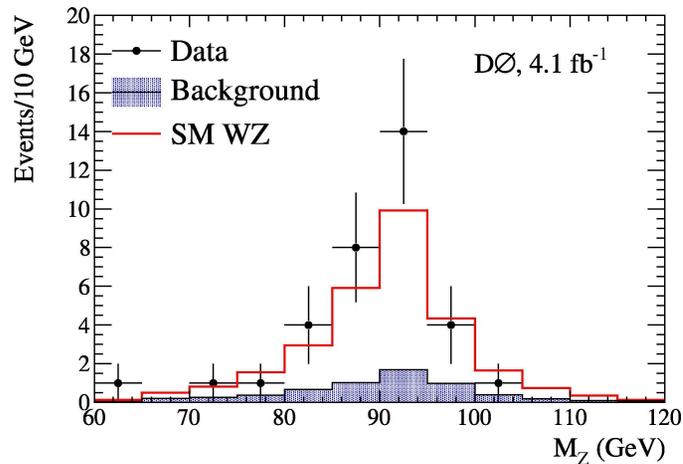
Measure $\sigma(WZ)$ cross section with 4.1 fb^{-1}

Trilepton + missing E_T final state

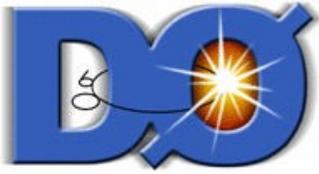
34 events observed in data, 6.0 ± 0.4 expected background

$$\sigma = 3.90^{+1.06}_{-0.90} \text{ pb}$$

(SM: 3.45 pb)



[arXiv.org:1006.0671 \[hep-ex\]](https://arxiv.org/abs/1006.0671)

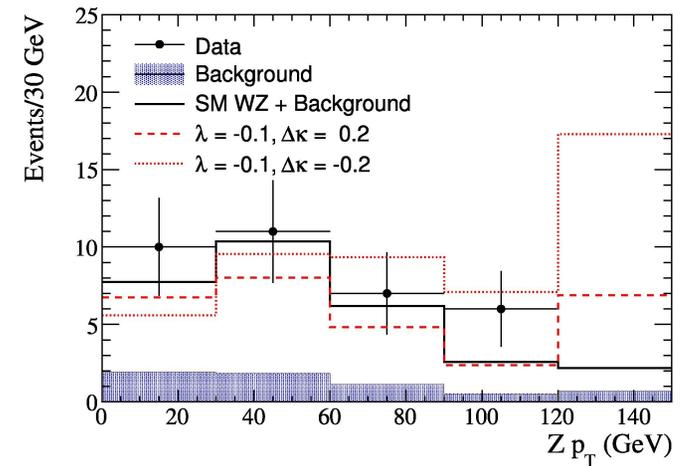


Diboson Production (II)

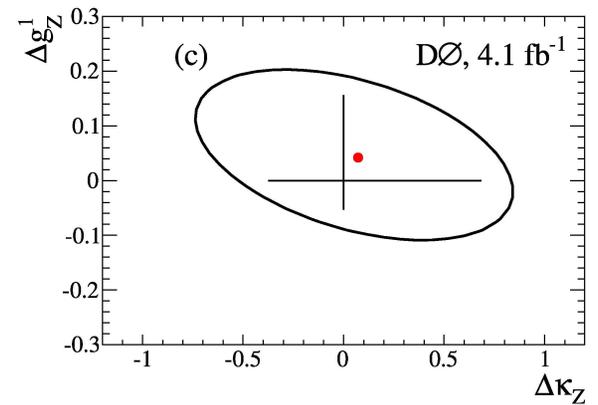
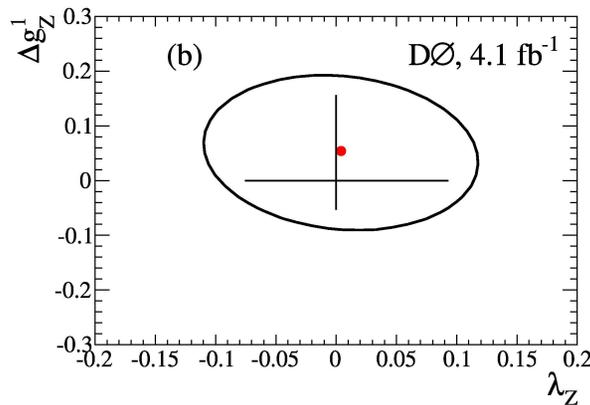
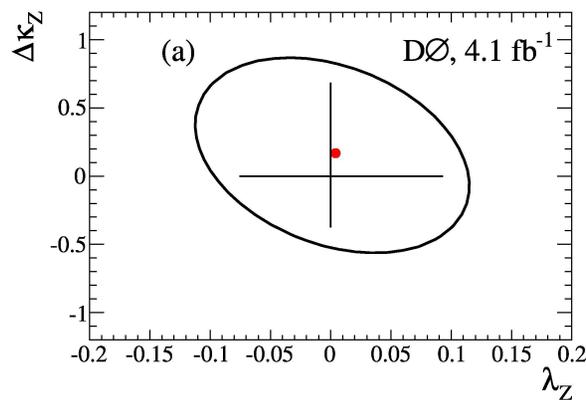
Use p_T distribution of the Z boson in the WZ events to set most stringent limits on TGC at WWZ vertex

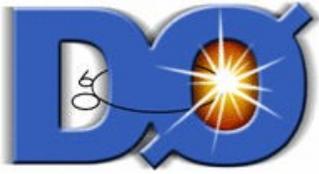
Using the $SU(2) \otimes U(1)$ constraints on the couplings obtain (for $\Lambda = 2$ TeV):

- $-0.075 < \lambda_Z < 0.093$
- $-0.053 < \Delta g_Z^1 < 0.156$
- $-0.376 < \Delta \kappa_Z < 0.686$



arXiv.org:1006.0671 [hep-ex]



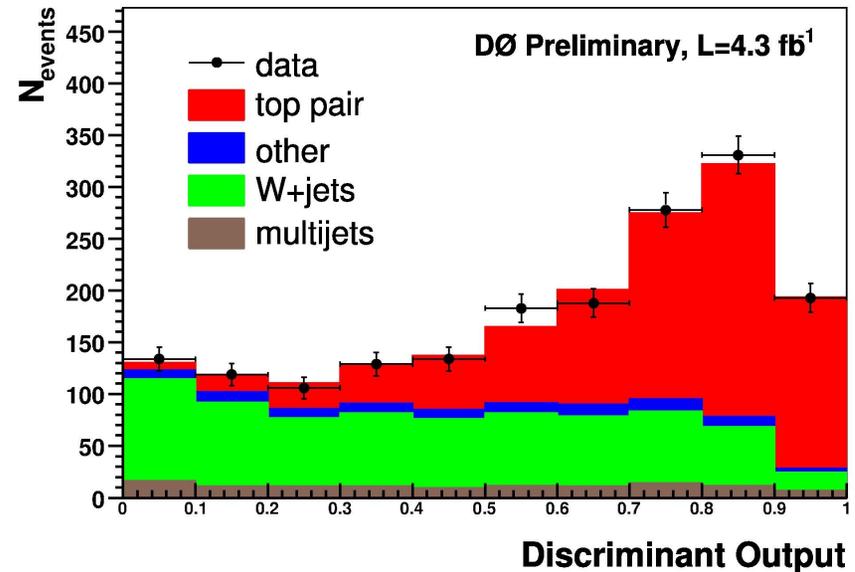
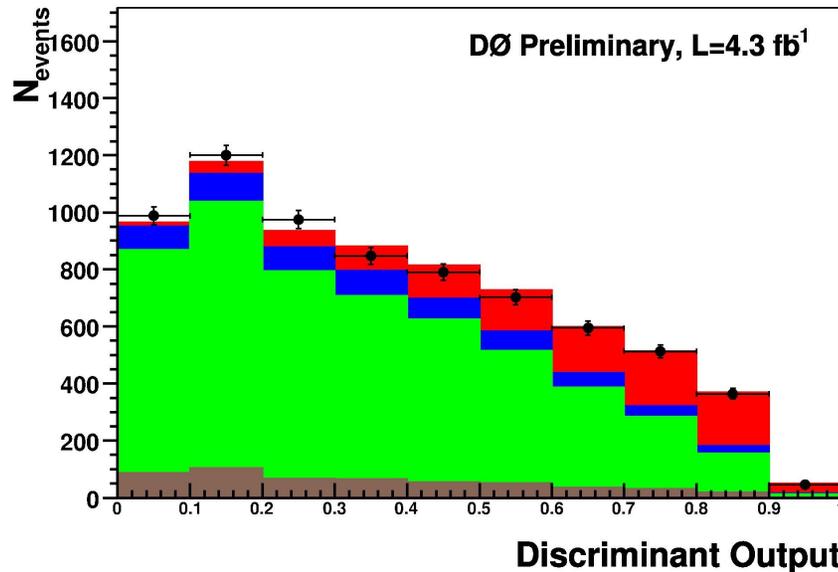
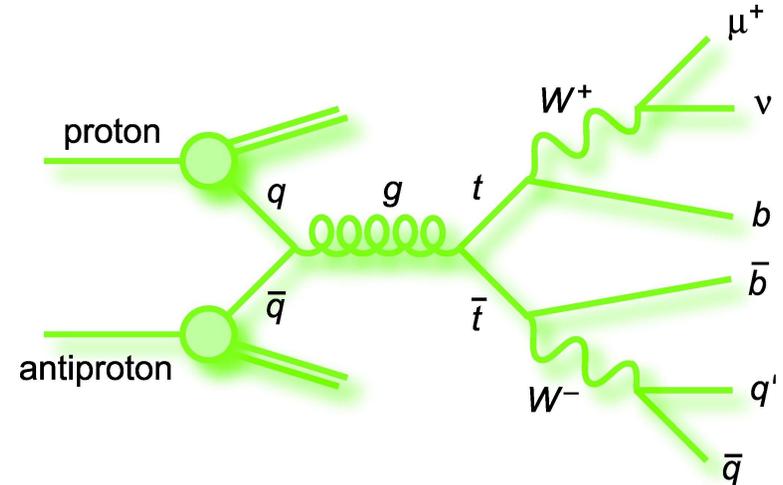


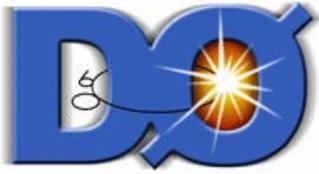
Top Production (I)

Top pairs production cross section:
two measurements in the lepton +
jets final state (with/without using
b-tagging), using 4.3 fb^{-1}

Topological cross section
measurement: $\sigma = 7.70^{+0.79}_{-0.70} \text{ pb}$

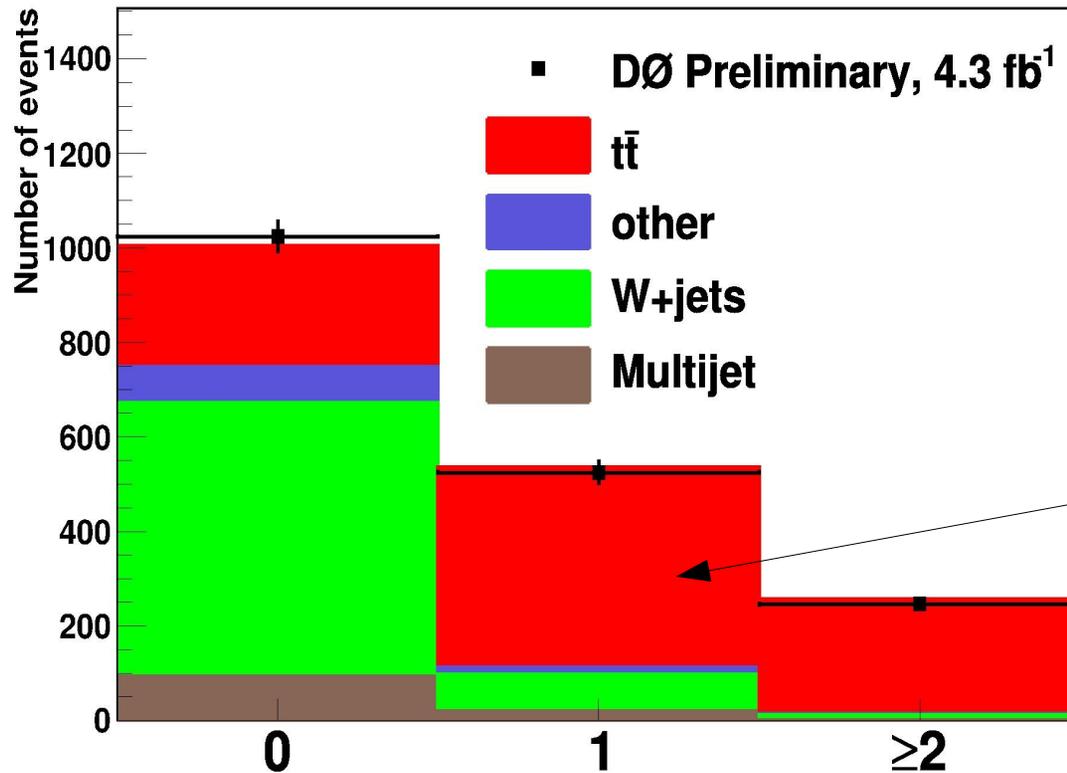
QCD: $\sigma = 7.46^{+0.48}_{-0.67} \text{ pb}$



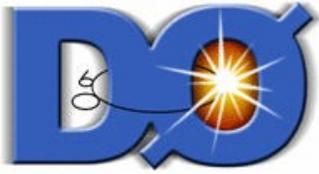


Top Production (II)

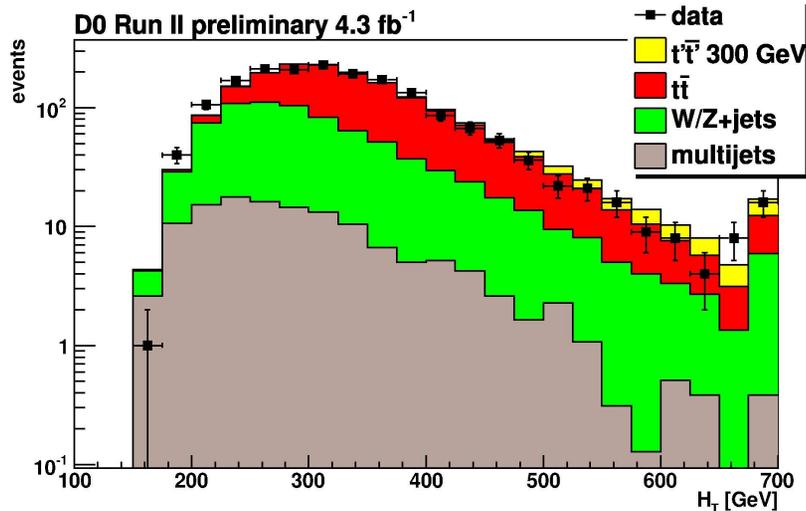
b-tagging cross section measurement: $\sigma = 7.93^{+1.04}_{-0.91}$ pb



Now need 4 digits to count top pair events in the best channel



t' Search (I)



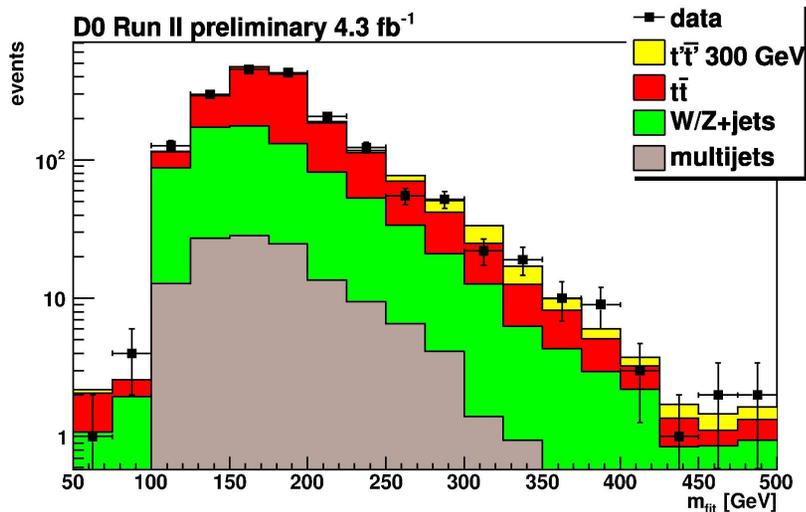
Use 4.3 fb⁻¹

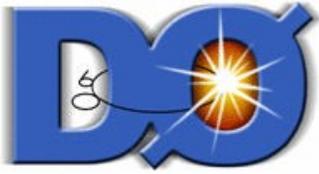
Similar selection to top cross section measurement

Use H_T and $m_{t'}$ to build 2D discriminant

Slight excess observed in data

Set lower limit on t' mass

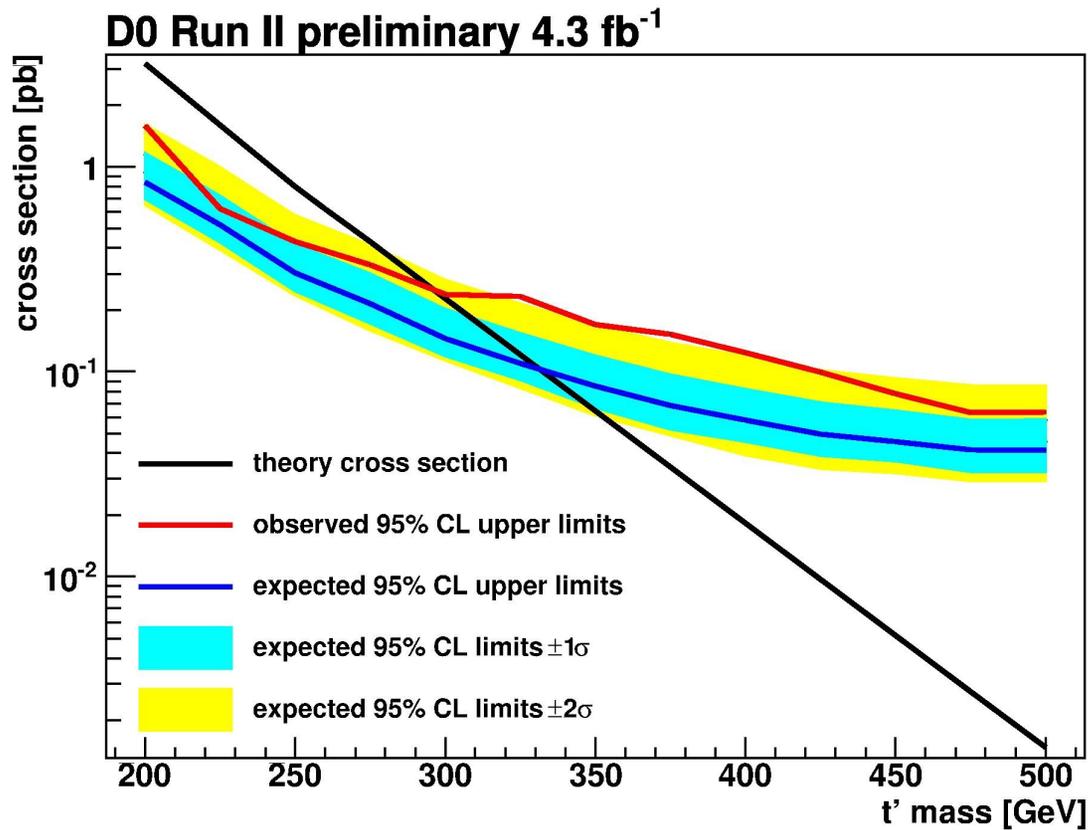


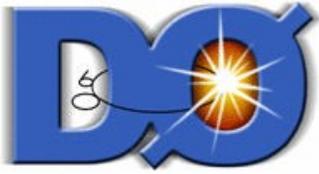


t' Search (II)

Expected limit $m_{t'} > 330$ GeV

Observed limit $m_{t'} > 296$ GeV @ 95% C.L.





Searches with Top Quarks (I)

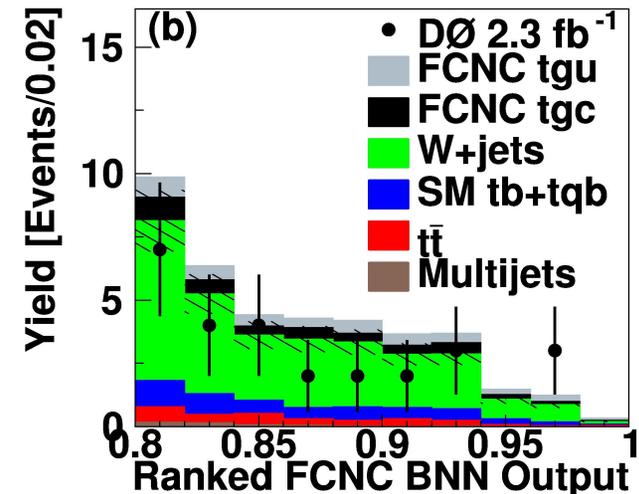
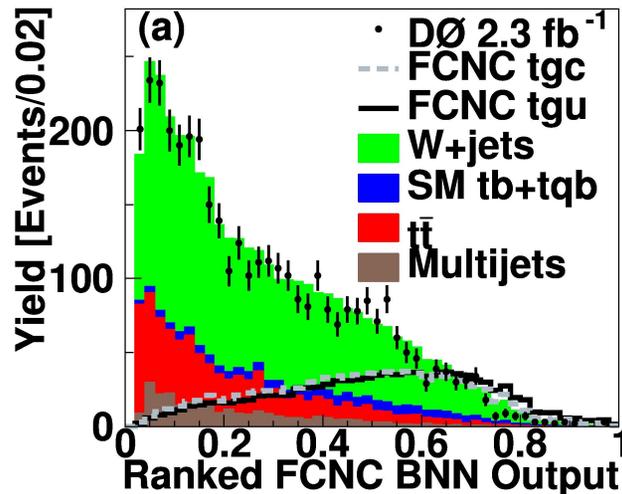
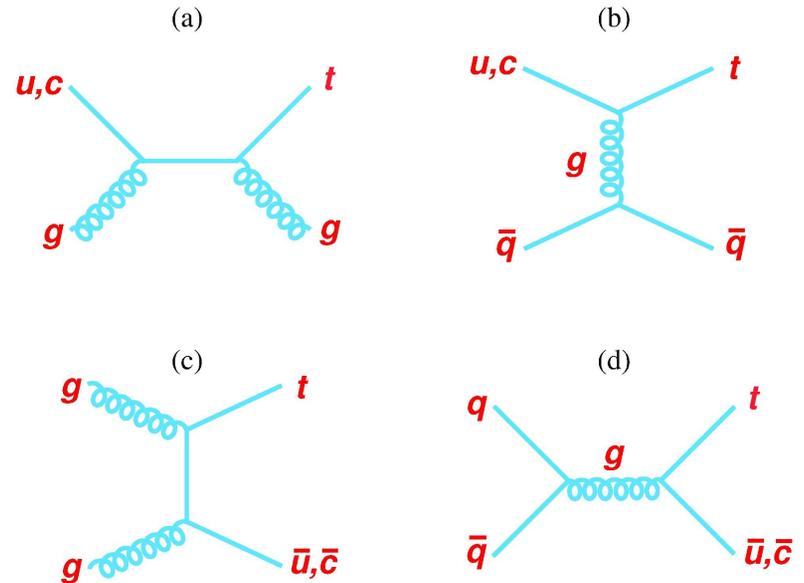
Start from single top sample (2.3 fb^{-1} of data, DØ observation)

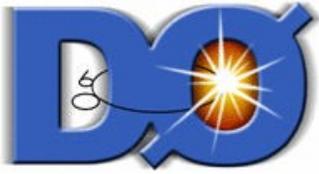
Search for FCNC giving in tgu/tgc vertices

Increase single top production rate

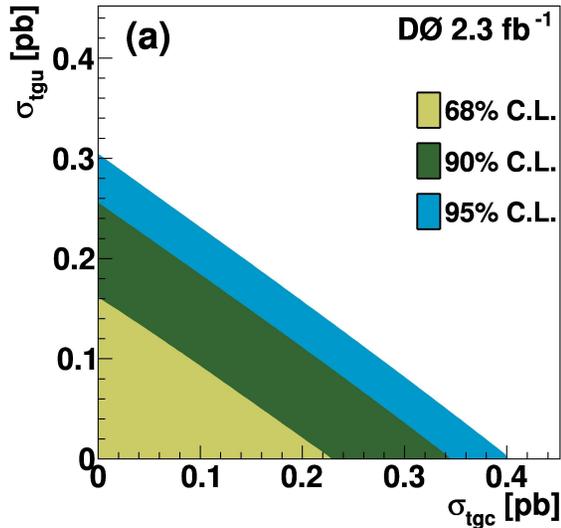
Discriminate via BNN

arXiv.org:1006.3575 [hep-ex]





Searches with Top Quarks (II)

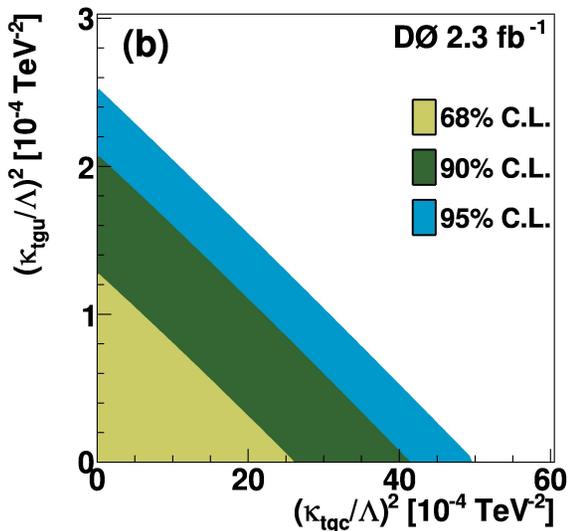


Obtain limits on cross section for single top production via FCNC

- $\sigma_{tgu} < 0.20 \text{ pb @ 95\% CL}$
- $\sigma_{tgc} < 0.37 \text{ pb @ 95\% CL}$

Obtain limits on couplings at tgc/tgu vertices

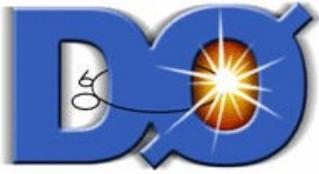
- $\kappa_{tgu}/\Lambda < 0.013 \text{ TeV}^{-1}$ Λ is new physics
- $\kappa_{tgc}/\Lambda < 0.013 \text{ TeV}^{-1}$ scale (0 (1 TeV))



Expressed in terms of branching ratios

- $\text{BR}(t \rightarrow ug) < 2.0 \cdot 10^{-4}$
- $\text{BR}(t \rightarrow cg) < 3.7 \cdot 10^{-3}$

arXiv.org:1006.3575 [hep-ex]



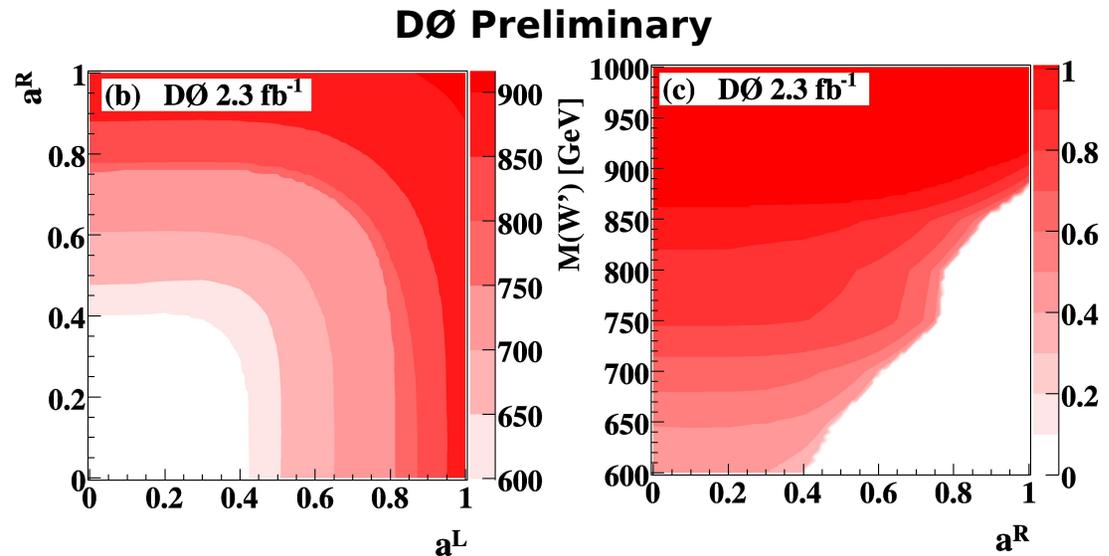
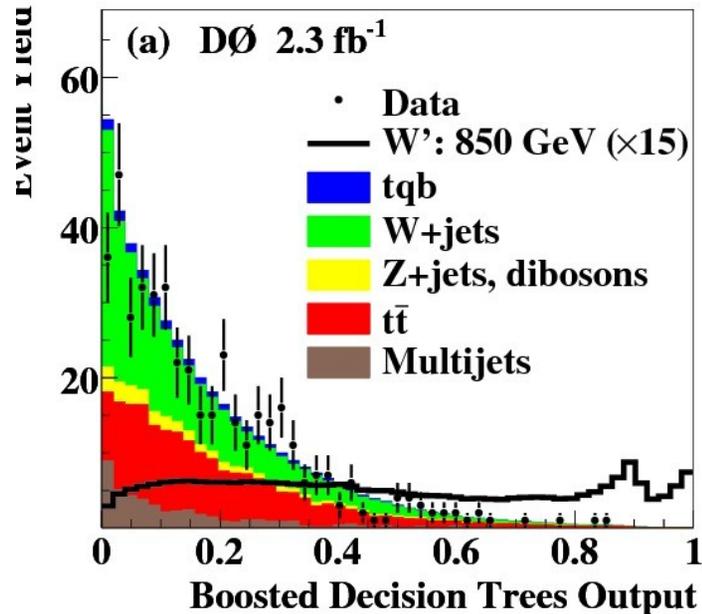
Searches with Top Quarks (III)

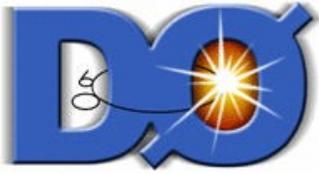
Search for additional contributions to single top production from W' exchange

Allow for R/L-handed W' and consider (1st time) also mixed case

Use BDT to separate signal from backgrounds

Present limits in plane of a_L/a_R couplings, $M_{W'}$





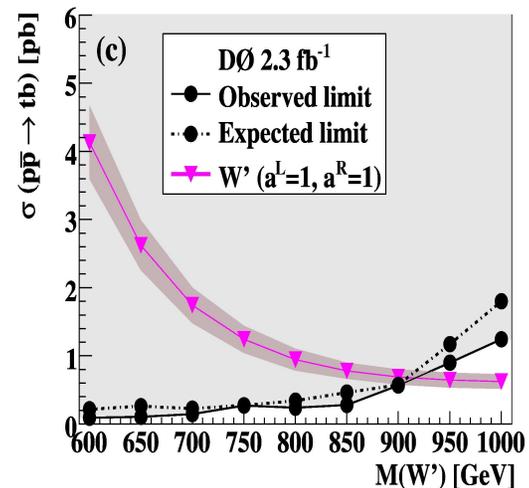
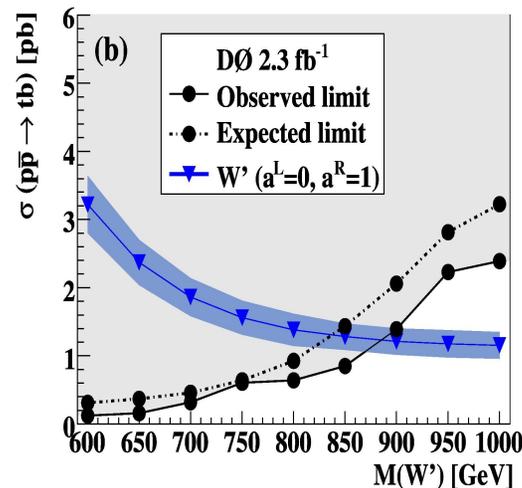
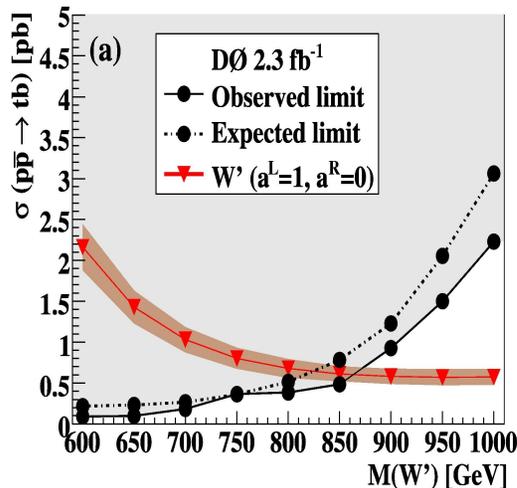
Searches with top Quarks (IV)

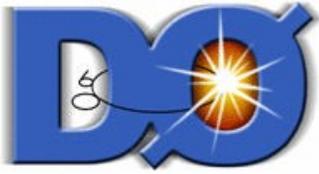
Assume SM couplings ($a=1$), set limits on $m_{W'}$

- $M_{W'} > 863$ GeV (L couplings)
- $M_{W'} > 885$ GeV (R couplings, $M_{W'} < m_{\nu R}$)
- $M_{W'} > 890$ GeV (R couplings, $M_{W'} > m_{\nu R}$)
- $M_{W'} > 916$ GeV (both L/R couplings)

(all limits @ 95% CL)

DØ Preliminary

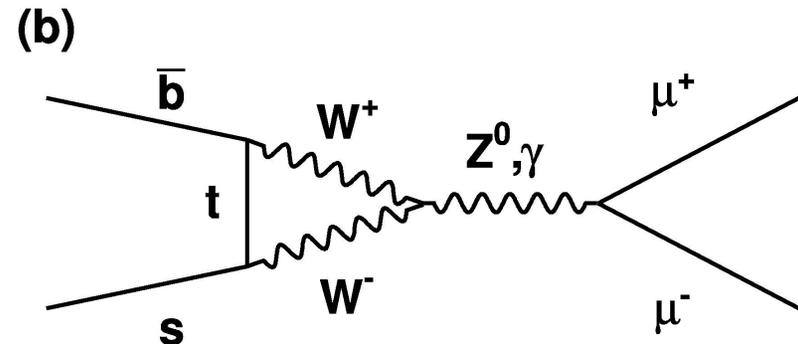
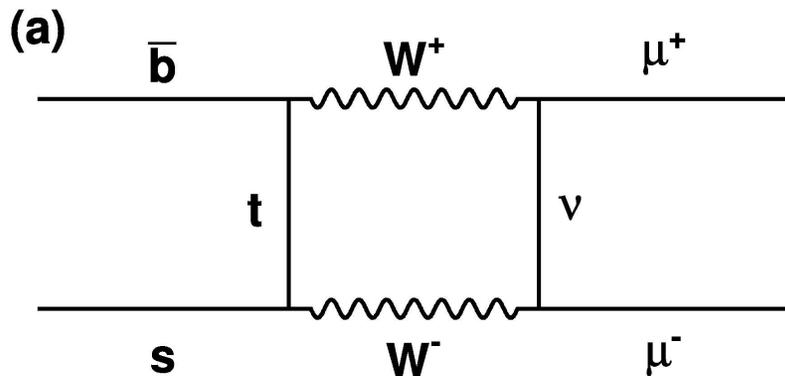




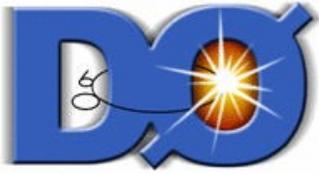
Searches with b Quarks (I)

Search for $B_s \rightarrow \mu\mu$ using 6.1 fb^{-1}

- Branching ratio in the SM $3.6 \cdot 10^{-9}$
- Improved muon identification / increased acceptance
- Separate signal/background with 2D discriminant (mass, NN)
- Blind analysis
- Normalize to $B^+ \rightarrow J/\psi K^+$



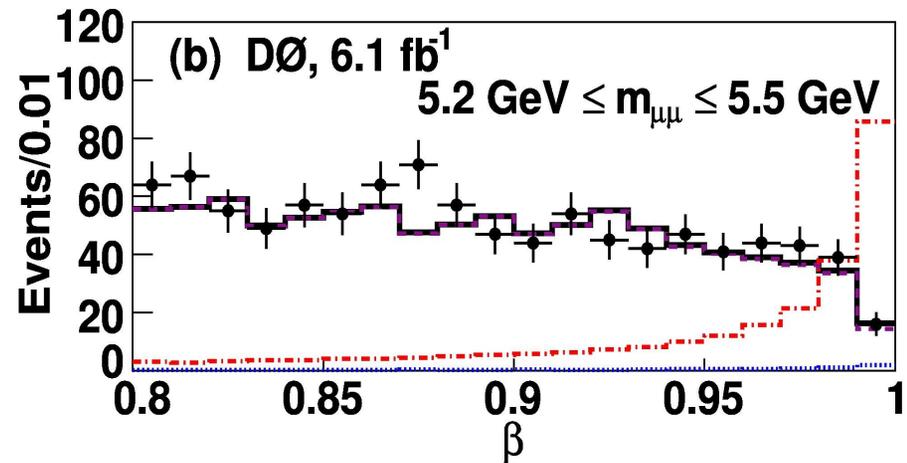
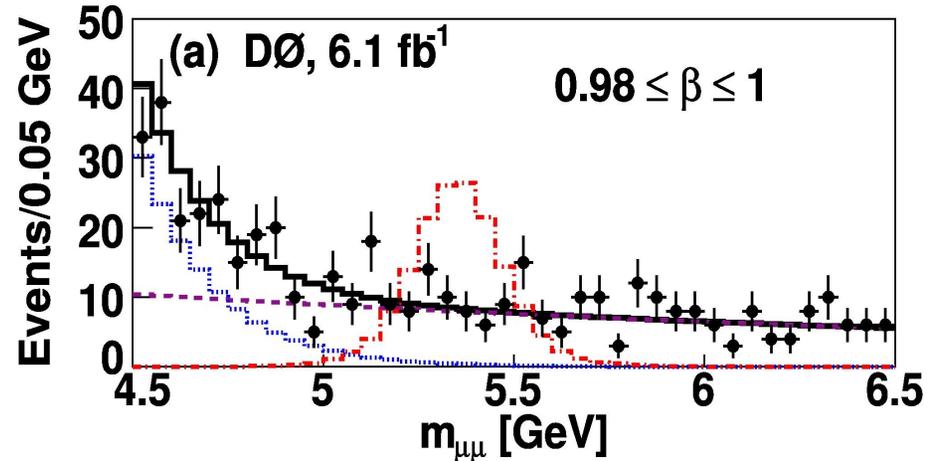
arXiv.org:1006.3469 [hep-ex]



Searches with b Quarks (II)

Search for $B_s \rightarrow \mu\mu$ using 6.1 fb^{-1}

- Expected BR limit: $4.0 \cdot 10^{-8}$
- Observed limit $5.1 \cdot 10^{-8}$



arXiv.org:1006.3469 [hep-ex]

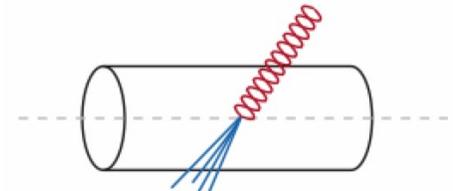
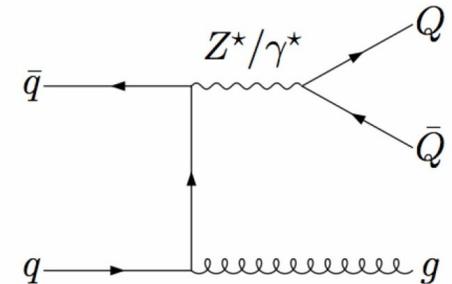


New Physics (I)

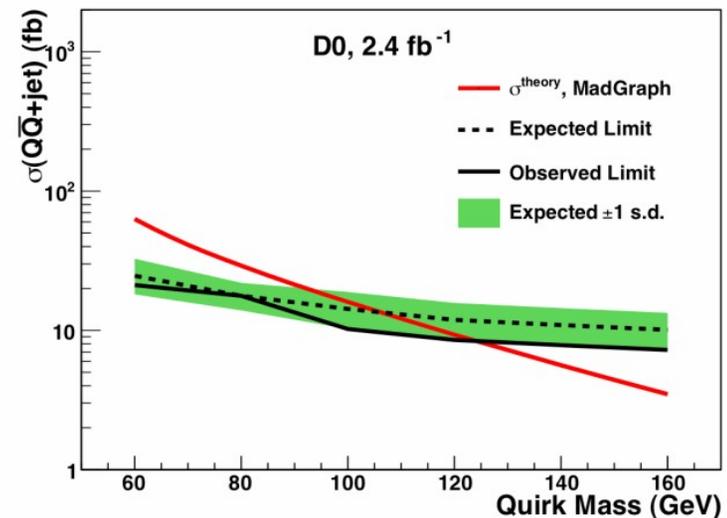
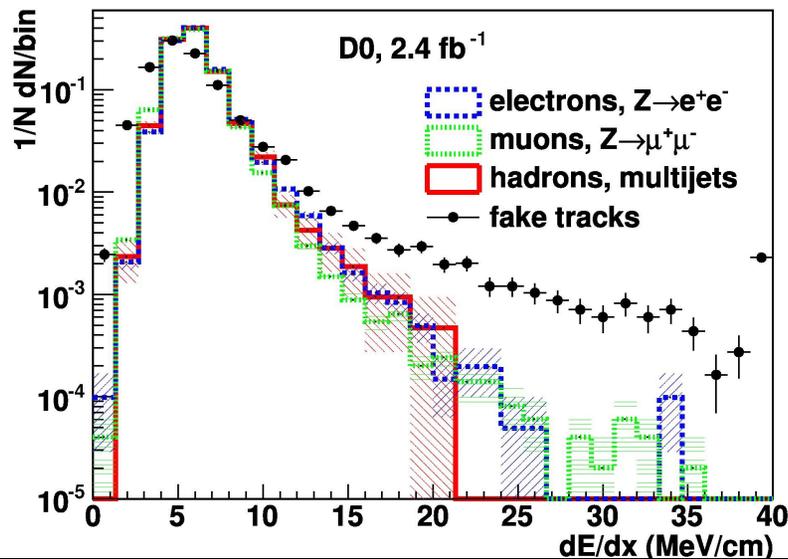
Quirks: carrier of new fermion number

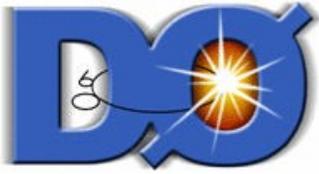
Pair produced
Form metastable bound states

Study recoil against jet
Search for single heavy ionizing particle
Use dE/dx in silicon detector



DØ Preliminary





New Physics (II)

Leptonic Jets (5.8 fb^{-1})

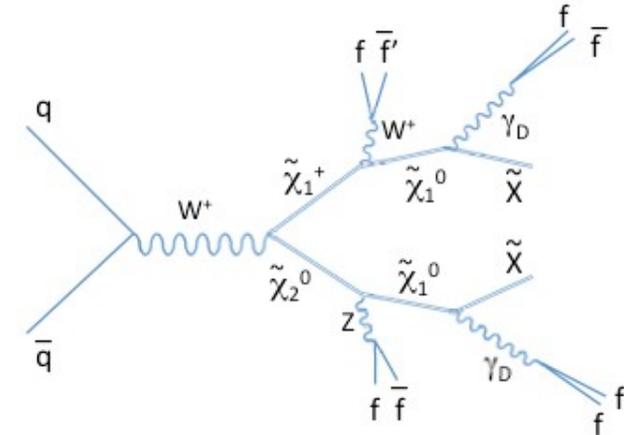
Arise in Hidden Valley models

Jets of electrons/muons

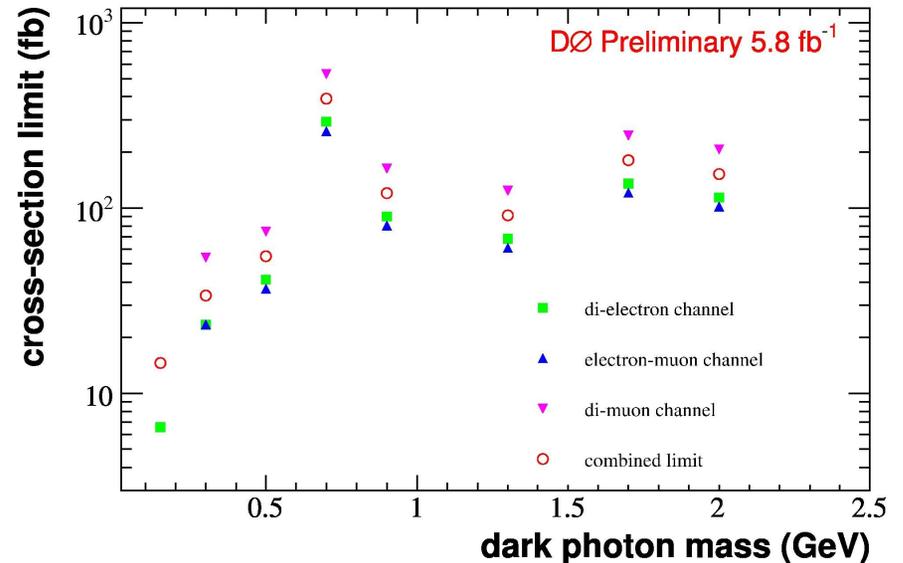
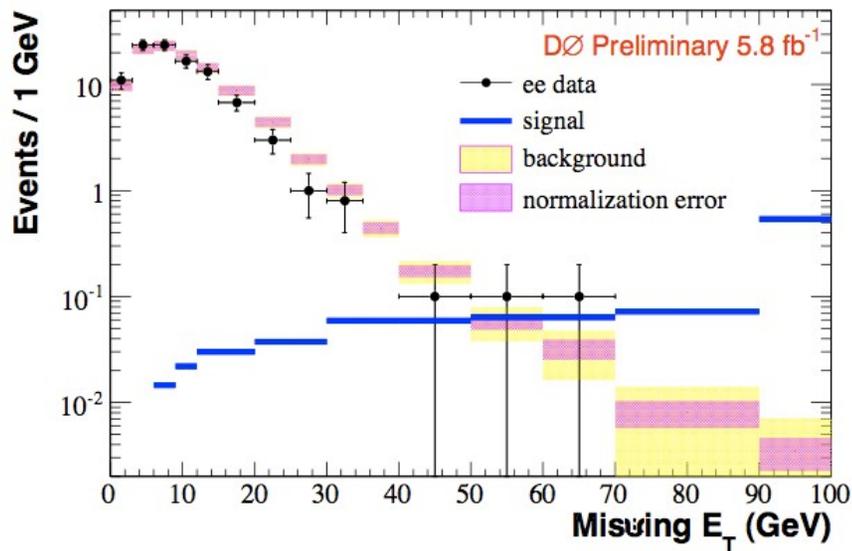
Change isolation cuts

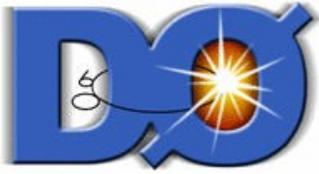
Final state: 2 leptonic jets + missing E_T

Use rate + invariant mass of leptons



DØ Preliminary



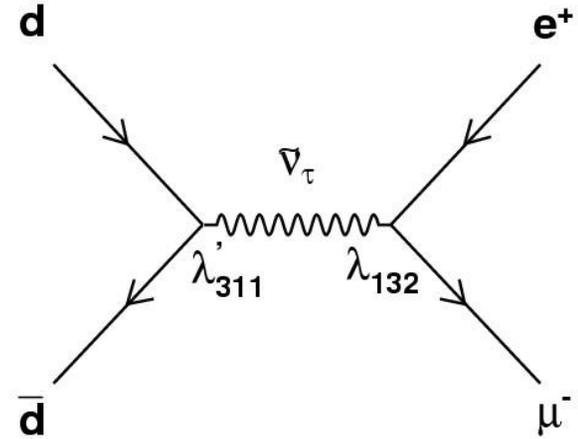


New Physics (III)

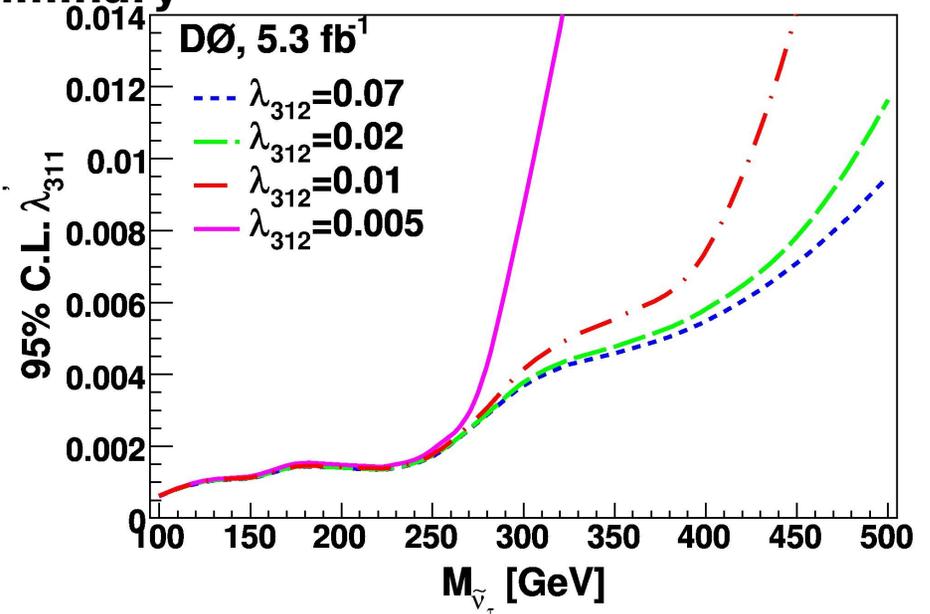
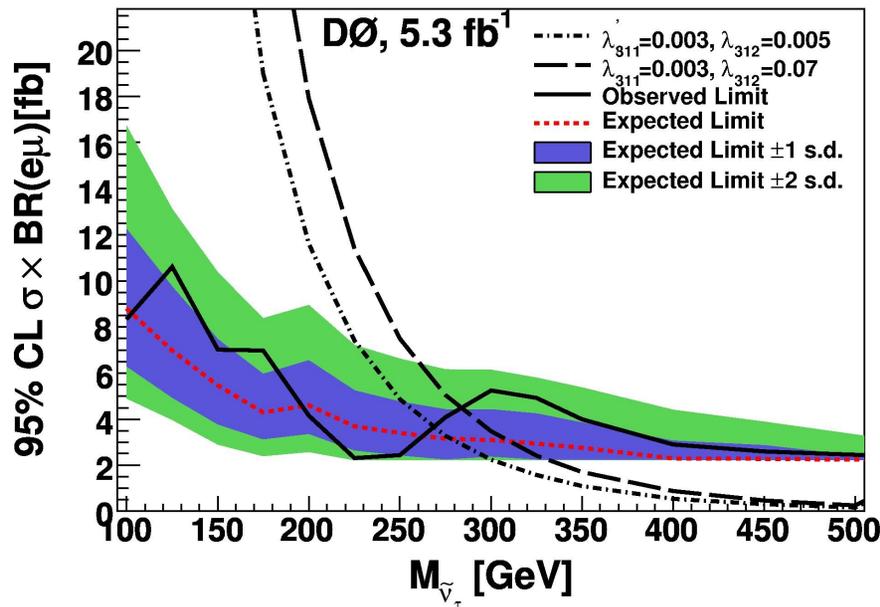
RPV SUSY with sneutrinos $\rightarrow e\mu$ (5.3 fb^{-1})

Search for back-to-back electron/muon pair with large invariant mass

Main background $Z/\gamma^* \rightarrow \tau\tau \rightarrow e\mu$



DØ Preliminary





New Physics (IV)

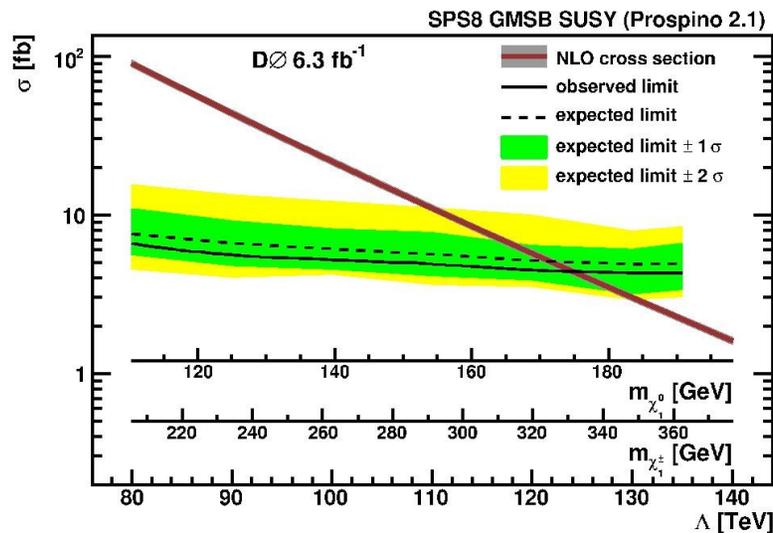
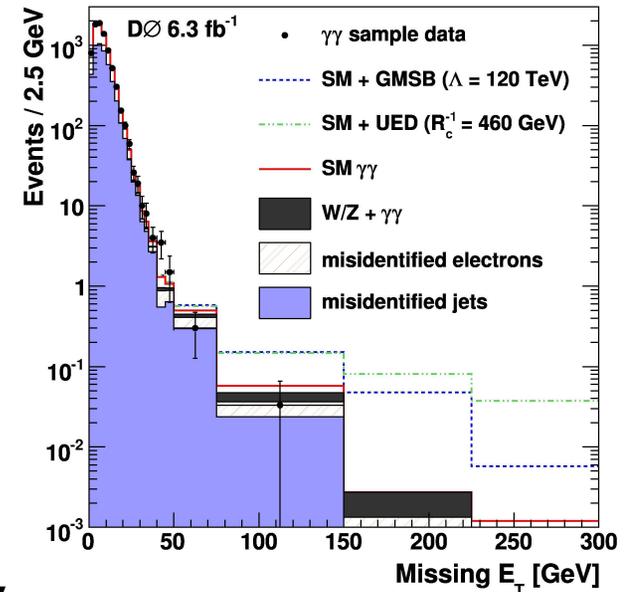
Gravity Mediated SUSY breaking or Extra Dimensions UED in diphoton + missing E_T final states (6.3 fb^{-1})

4 events observed with missing $E_T > 50 \text{ GeV}$

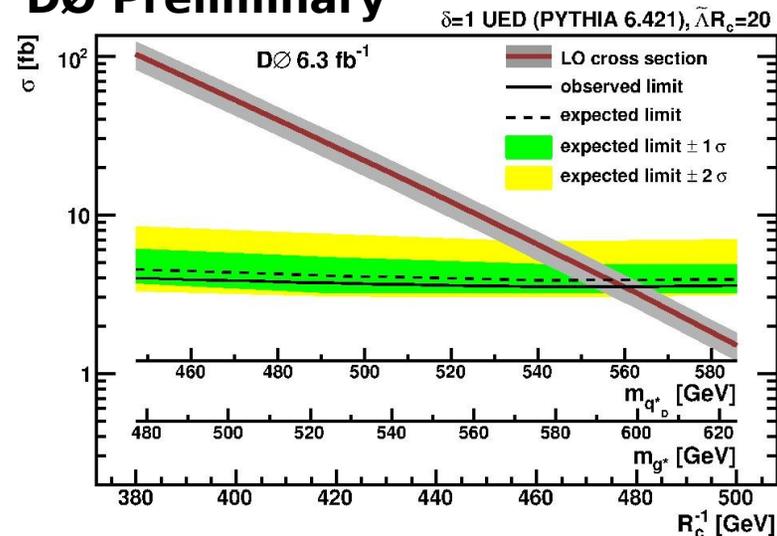
6.9 ± 1.0 expected from background

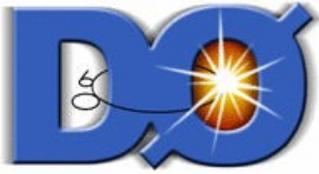
Limits: $\Lambda_{\text{GMSB}} > 124 \text{ TeV}$

$R_c^{-1} > 477 \text{ GeV}$ @ 95% CL



DØ Preliminary

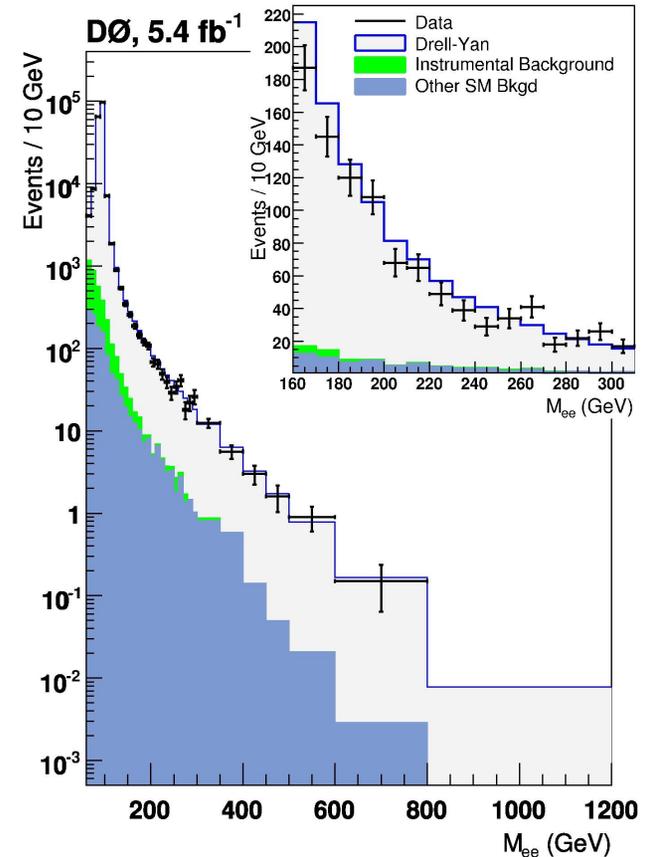
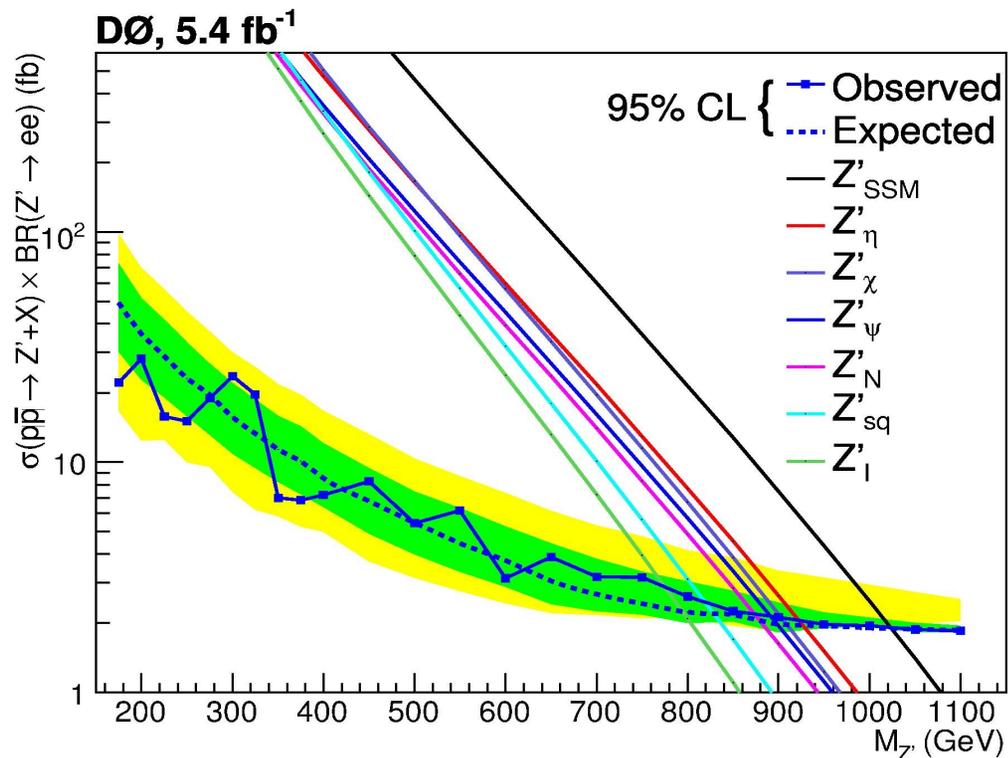




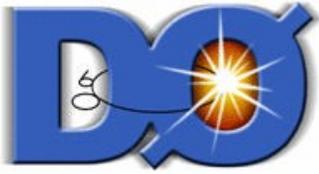
New Physics (V)

Dielectron resonances (Z') (5.4 fb^{-1})

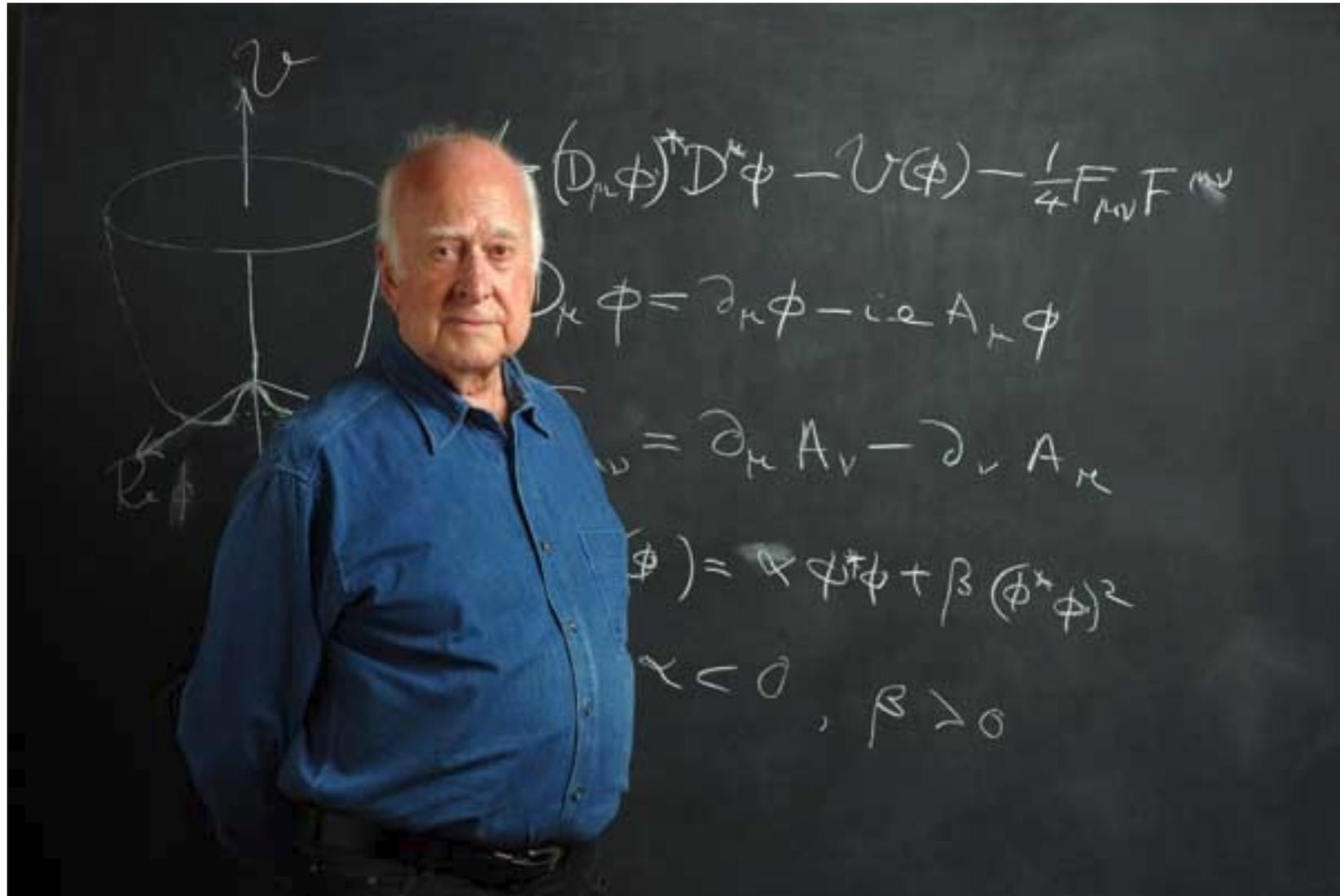
**No excess observed, set limit on SSM
 Z' mass at 1.023 TeV @ 95% CL**

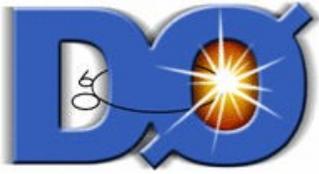


DØ Preliminary



Higgs ~~Gossips~~ Results





Higgs Gossips



Quantum Diaries Survivor
Staff Science Writer



And for once, **I feel totally free to speculate** without the fear of being crucified. If you have followed my past blog adventures for long enough, you know that in at least a couple of occasions my posts have created some friction.

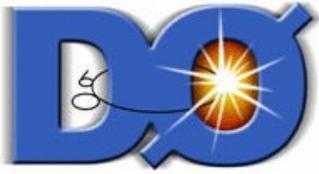
Blogging can mean walking on a rope for particle physicists involved in large collaborations - the ways of the internet are infinite, really: you never know where trouble may come from! The chance to piss someone off forces bloggers to avoid making names even when they discuss humorous incidents; the internal rules of the experiments they participate in make bloggers wary of even discussing stuff that is approved for public distribution. A daily application of self-censoring review procedures before hitting the "submit" button must be enforced.

But not this time. I am sure of one thing: I know nothing at all, so I can certainly talk about it without violating any rule! It so happens that I have heard voices about a possible new "three-sigma" Higgs effect, and I do not even know which experiment this comes from! Surely, no single experiment can get mad at me this time if I tell you what it is about, right ?

...Right. Well, I am not totally sure, but I am willing to declare that I have the right to express myself here, to some extent at least! So let me spill my guts. They are almost empty anyways...

The Rumor

It reached my ear, from two different, possibly independent sources, that an experiment at the Tevatron is about to release some evidence of a light Higgs boson signal. **some say a three-sigma effect, others do not make explicit claims but talk of a unexpected result.** That the result comes from the Tevatron is for sure, since the LHC experiments do not have nearly enough data yet to search for that elusive particle, and other particle physics experiments in the world have not nearly enough energy to produce it.....

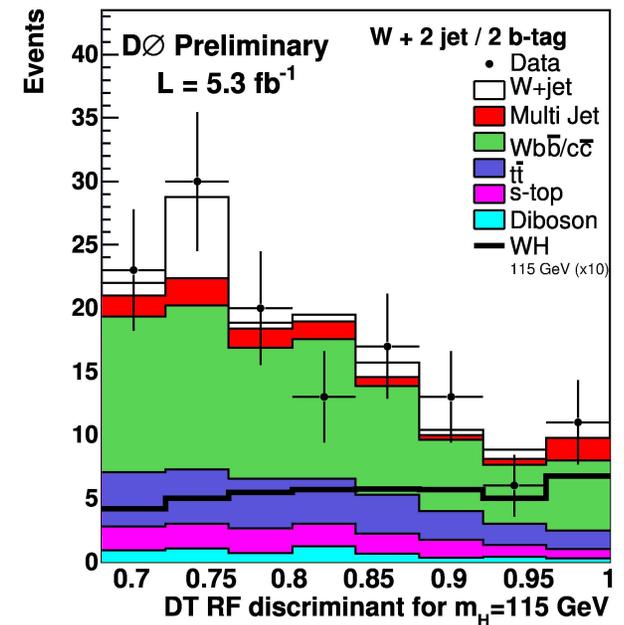
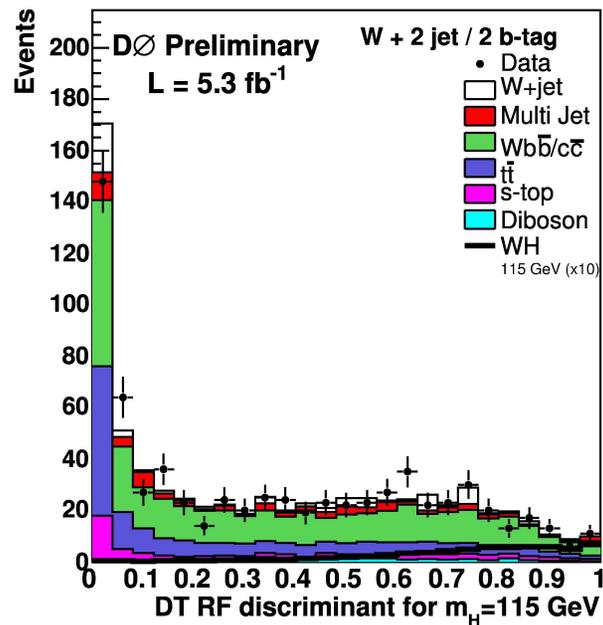
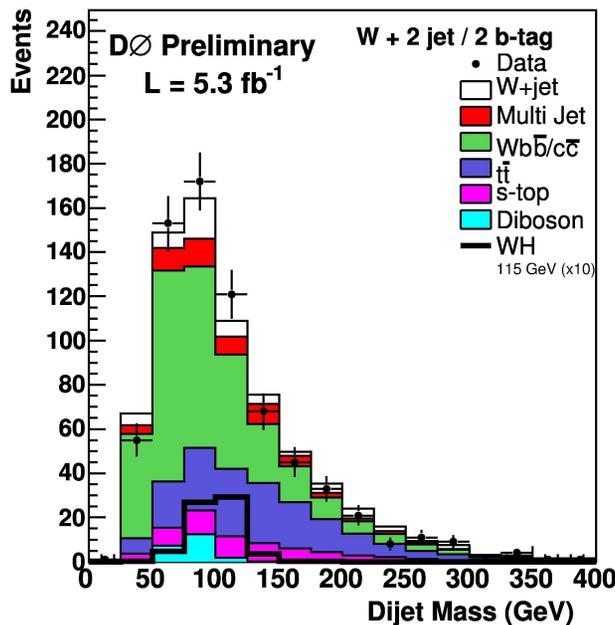
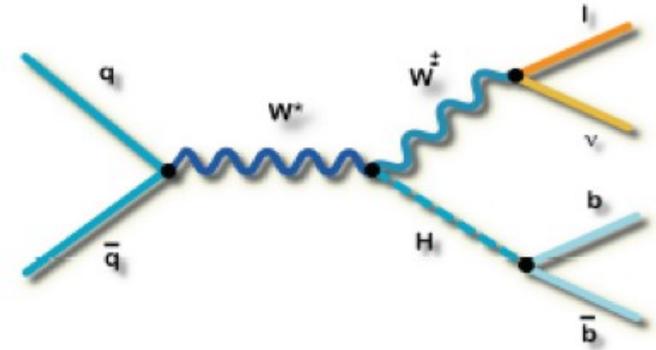


Higgs Results (I)

Search for WH associated production

Results with 5.3 fb^{-1} of data

Improvements in b-tagging / systematics
Using Random Forest discriminant





Higgs Results (II)

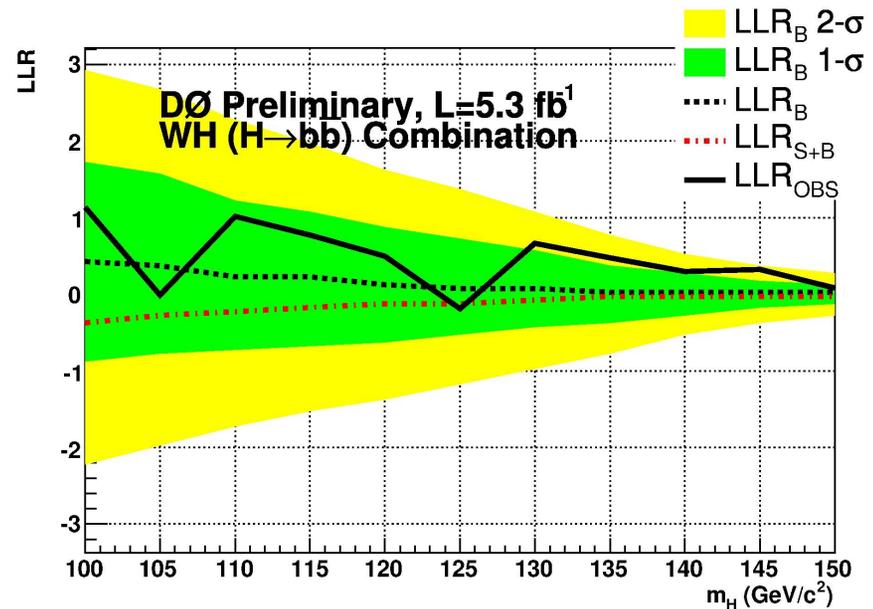
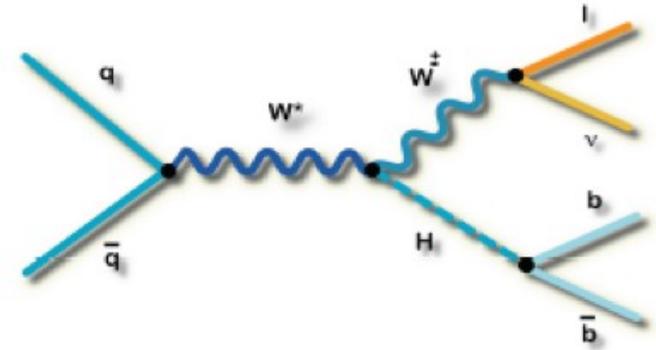
Search for WH associated production

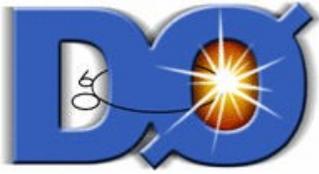
Results with 5.3 fb^{-1} of data

Improvements in b-tagging / systematics
Using Random Forest discriminant

Expected 95% CL limit for
 $M_H = 115 \text{ GeV}$: $4.7 * \text{SM}$

Observed $4.0 * \text{SM}$



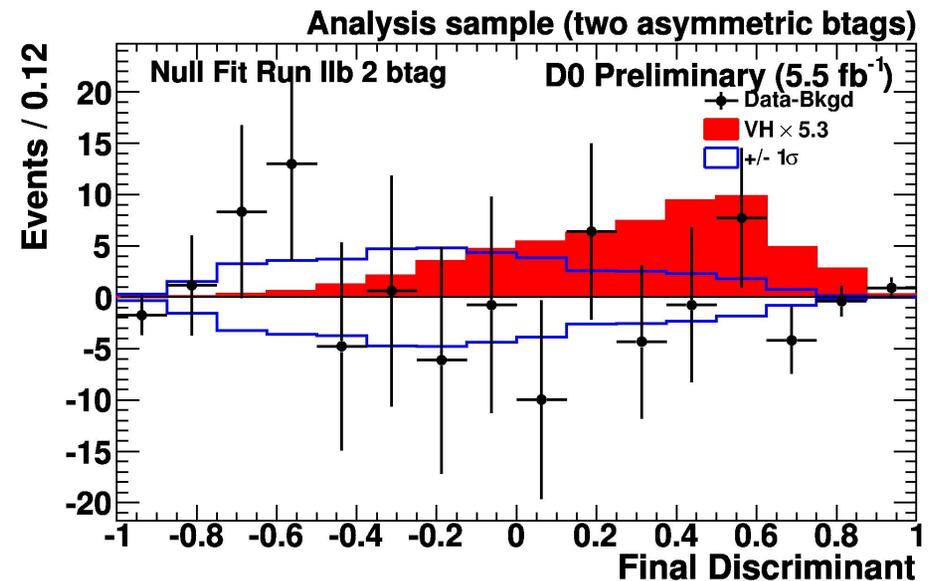
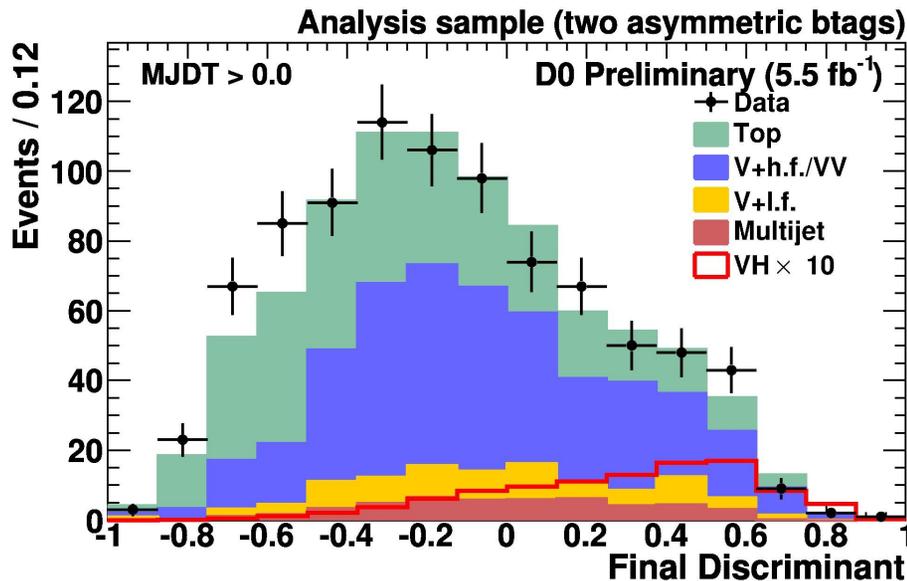


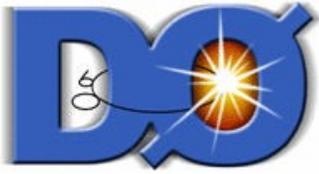
Higgs Results (III)

Search for ZH associated production with $Z \rightarrow \nu\nu$ $H \rightarrow b\bar{b}$

Final state with 2 acoplanar b-jets and missing E_T

Updated double tag results with 6.4 fb^{-1} of data



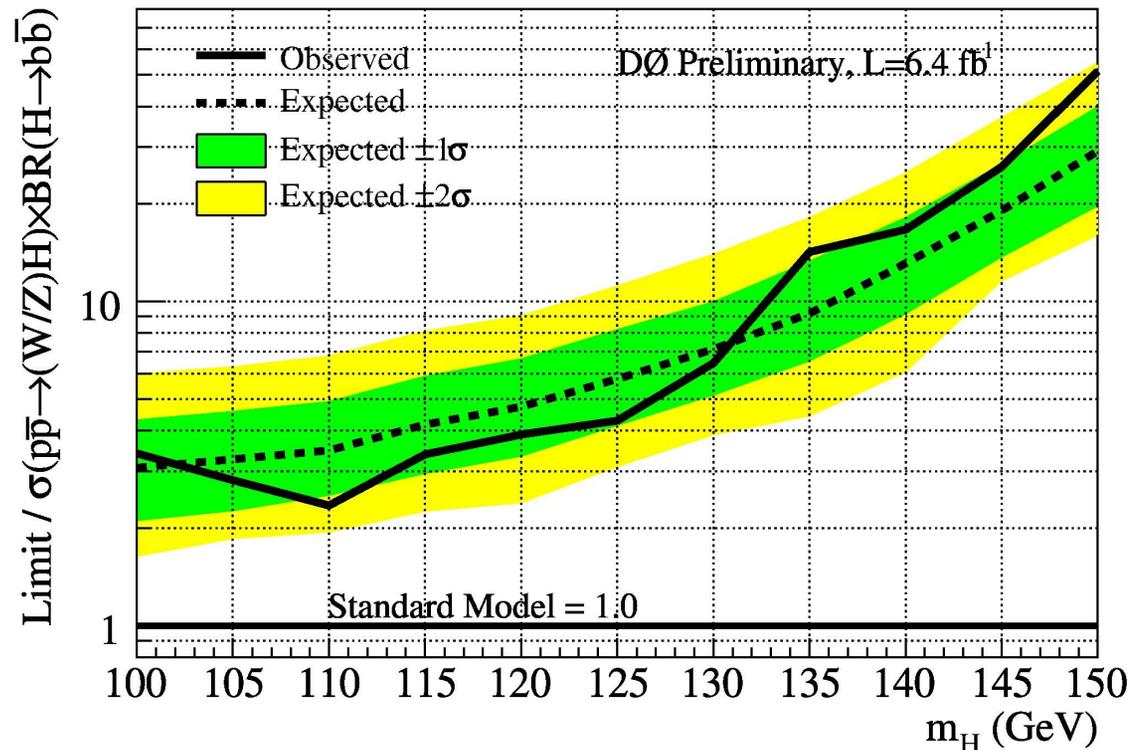


Higgs Results (IV)

Search for ZH associated production with $Z \rightarrow \nu\nu$ $H \rightarrow b\bar{b}$

Expected 95% CL limit for $M_H = 115$ GeV: $4.2 \times \text{SM}$

Observed $3.4 \times \text{SM}$



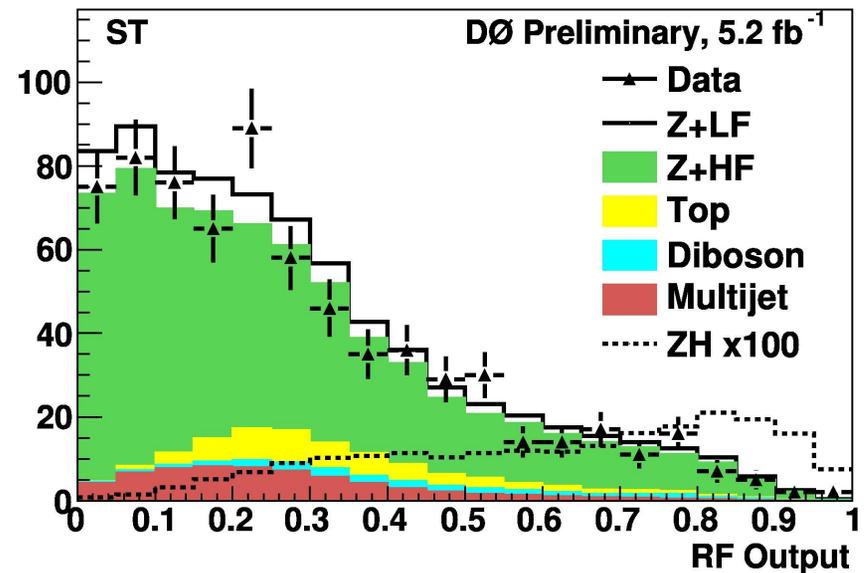
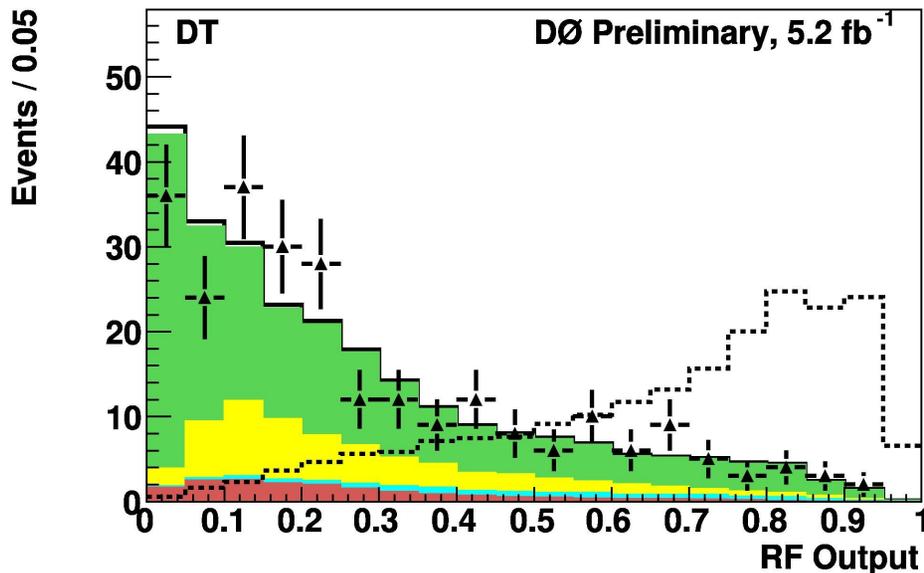


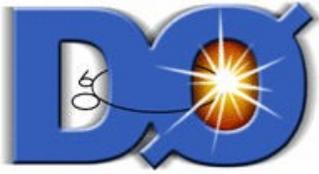
Higgs Results (V)

Search for ZH associated production with $Z \rightarrow ll$ $H \rightarrow bb$

2 updates:

- Publication to be submitted next week with 4.2 fb^{-1}
 - $Z \rightarrow ee$ and $Z \rightarrow \mu\mu$, use also μ +track and e +ICR object
- Preliminary result with 6.2 fb^{-1}
 - So far only two main channels (plots for RunIIb shown below)



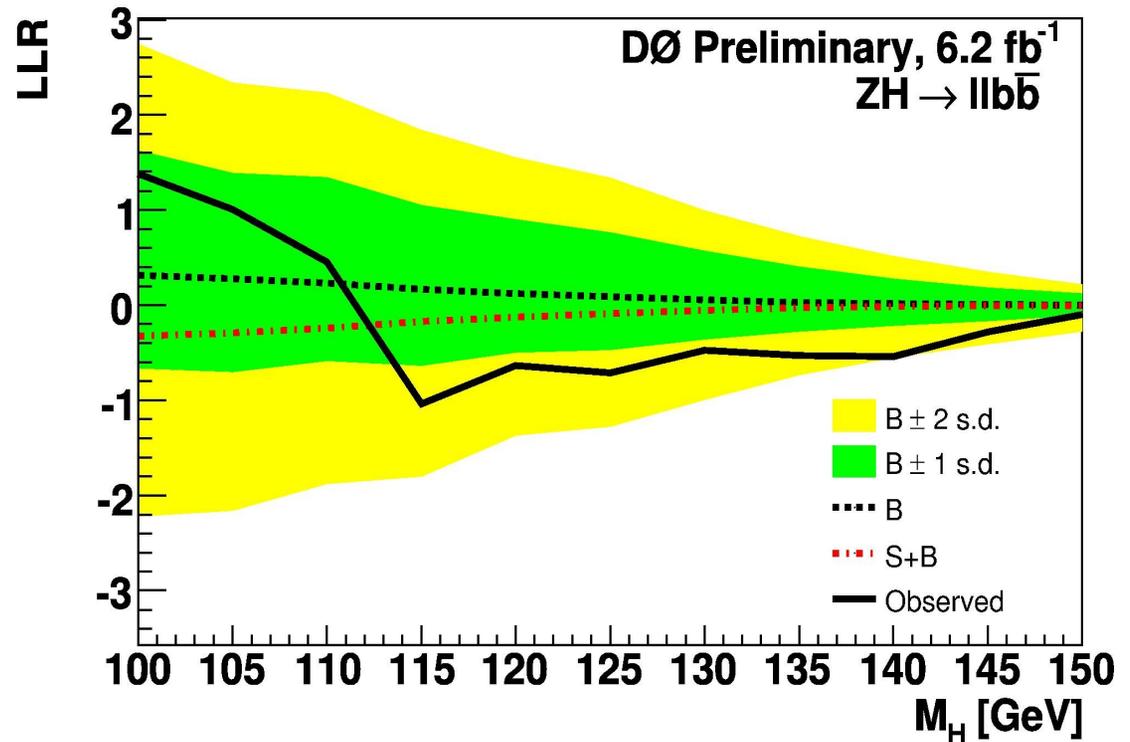


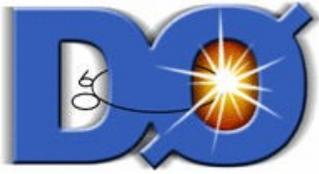
Higgs Results (VI)

Search for ZH associated production with $Z \rightarrow ll$ $H \rightarrow bb$

Expected 95% CL limit for $M_H = 115$ GeV: $5.7 \cdot SM$

Observed $8.0 \cdot SM$

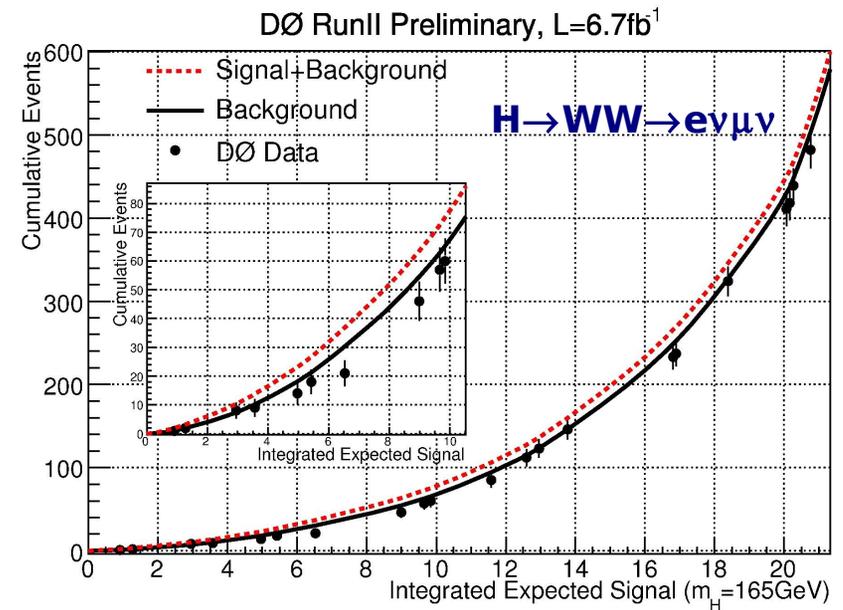
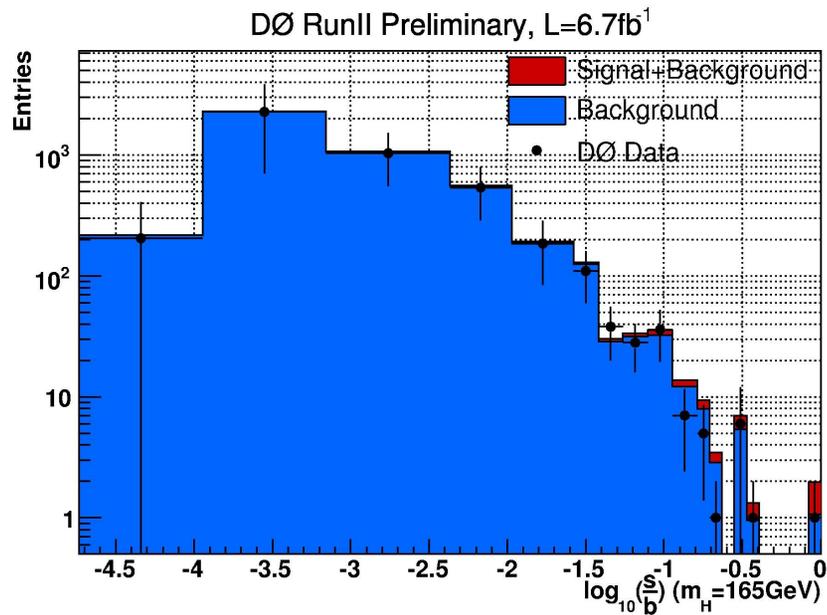
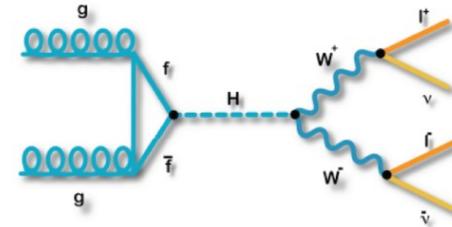


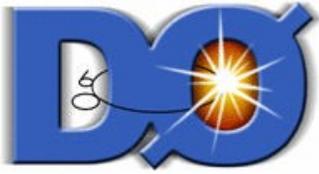


Higgs Results (VII)

Search for $H \rightarrow WW$

- Updated the most sensitive channel $WW \rightarrow e\nu\mu\nu$
- Split the analysis according to number of jets
- Z background rejection with BDT
- Final BDT discriminant
- Included all data up to April 2010 (6.7 fb^{-1})
- For $ee/\mu\mu$ final states using publication (5.4 fb^{-1}) results
- Working on addition of $\mu\tau$ final state

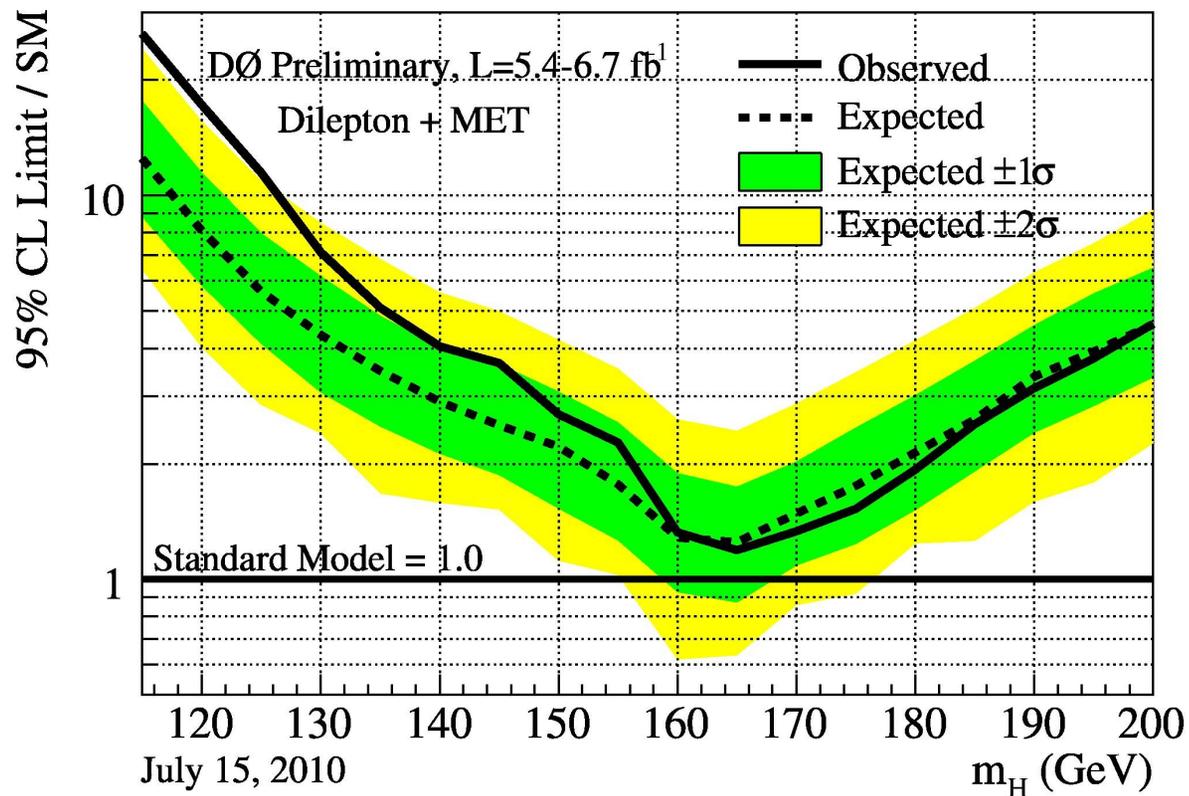


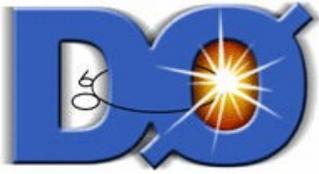


Higgs Results (VIII)

Search for $H \rightarrow WW$

- Expected 95% CL limit at $M_H=165$ GeV: $1.25 \cdot SM$
- Observed limit: $1.19 \cdot SM$
- Additional channels used to increase sensitivity

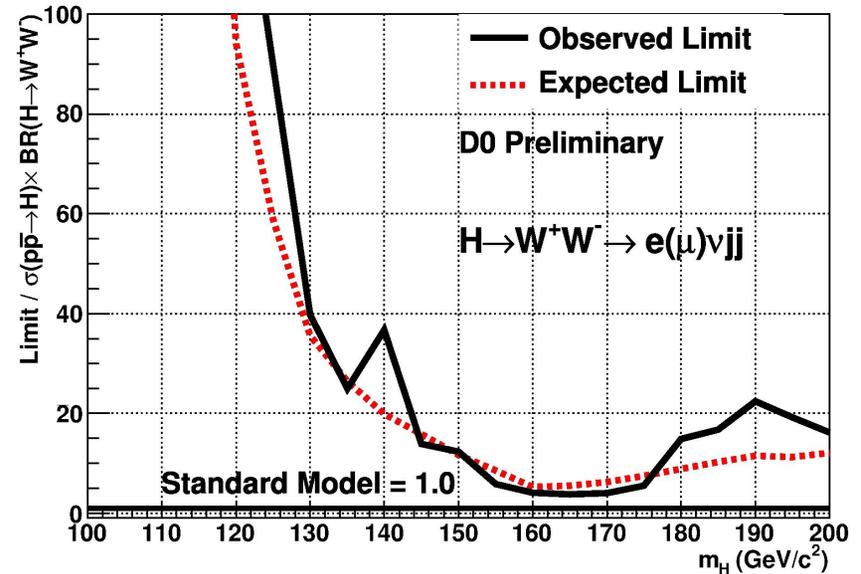
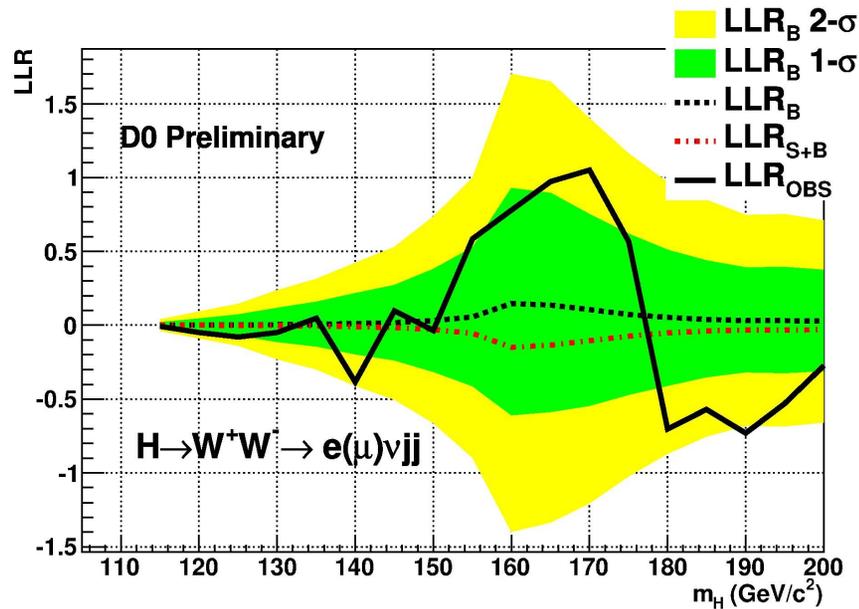
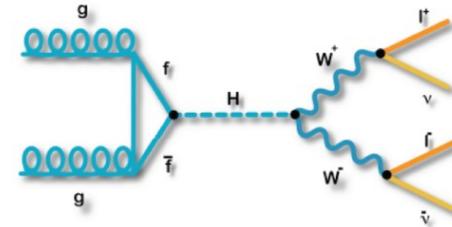


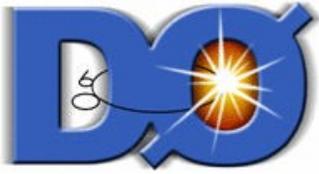


Higgs Results (IX)

Search for $H \rightarrow WW$

- Included (1st time) the $lvjj$ final state (5.4 fb^{-1})
- Expect 95%CL limit at $M_H = 165 \text{ GeV}$: $5.2 \times \text{SM}$
- Observed $4.1 \times \text{SM}$
- Contributes to improvement in sensitivity

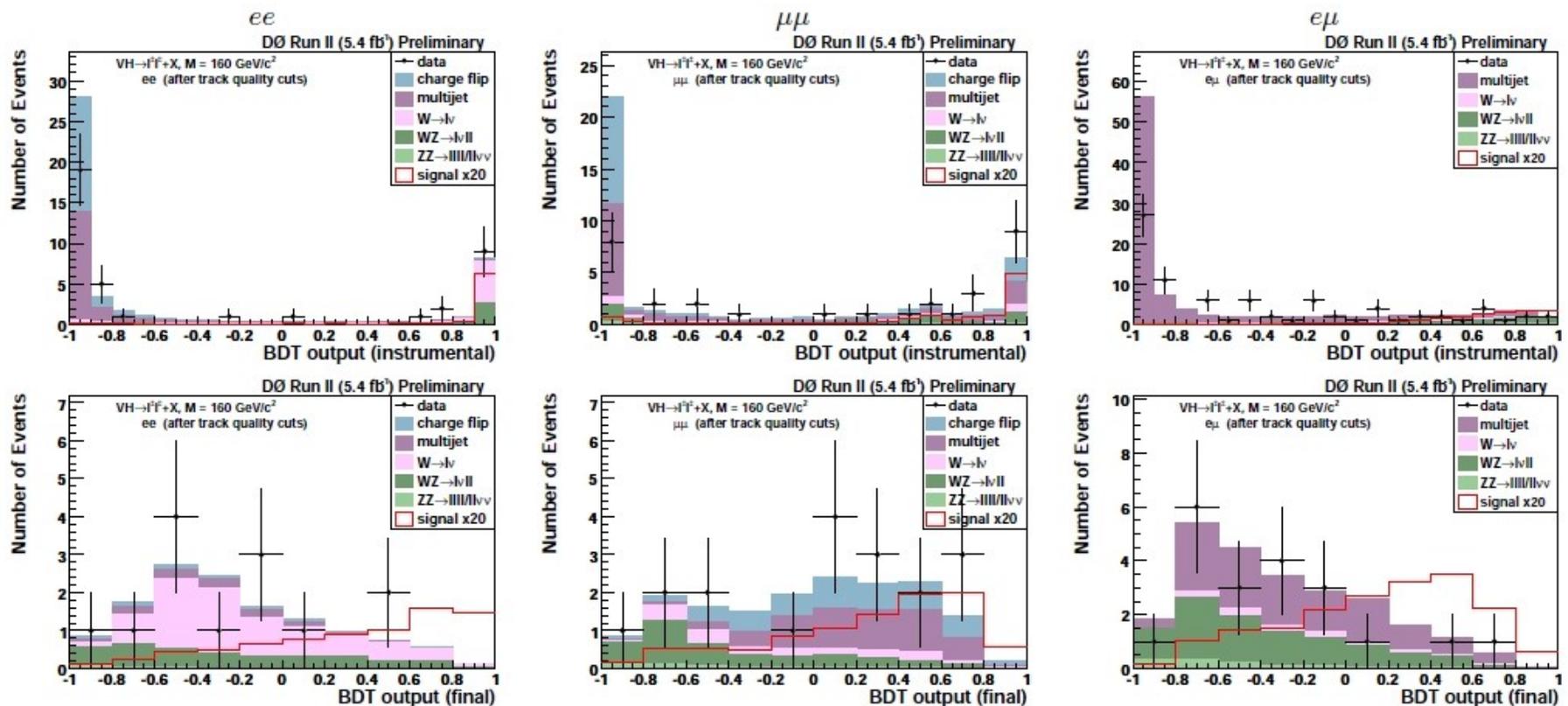


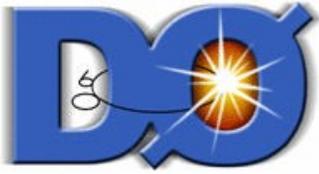


Higgs Results (X)

Search for WH/ZH associated production with $H \rightarrow WW$ in final states with like-sign dileptons

Major backgrounds: W+jets, charge mismeasurements

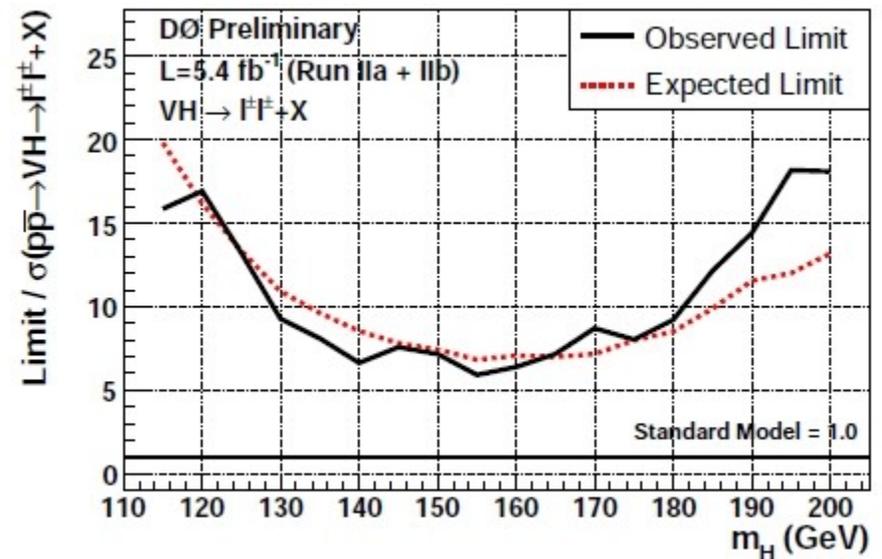
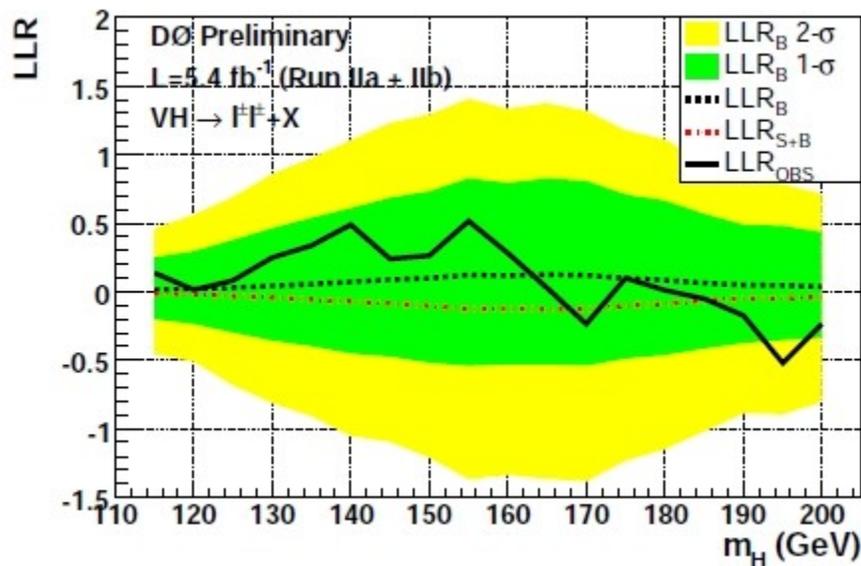


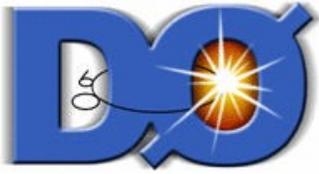


Higgs Results (XI)

Search for WH/ZH associated production with $H \rightarrow WW$ in final states with like-sign dileptons

Expected limit @ $M_H = 165$ GeV: $7.0 \cdot SM$ observed $7.2 \cdot SM$



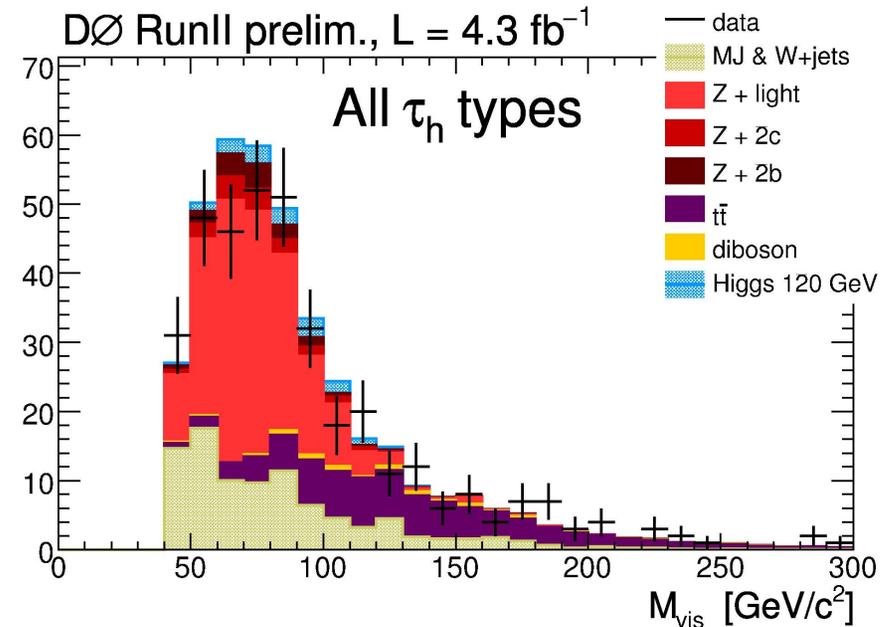
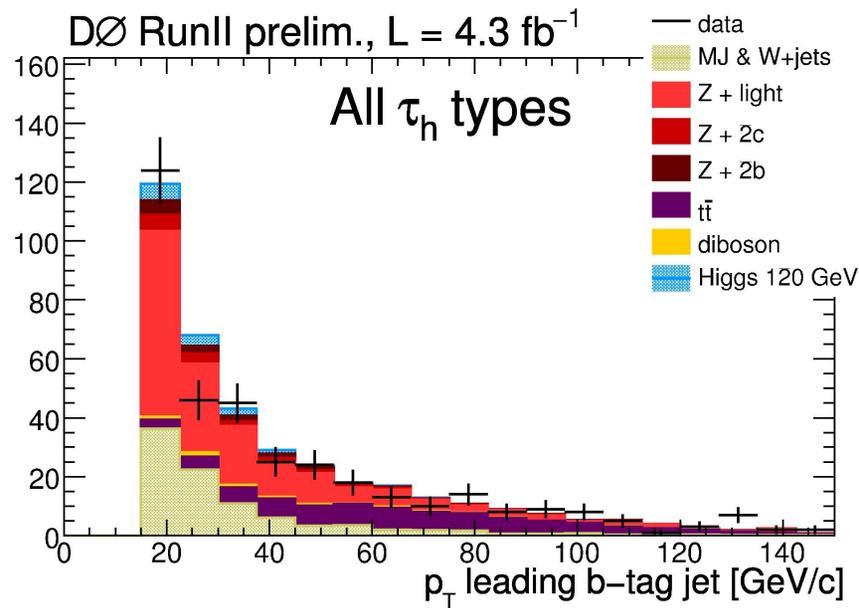


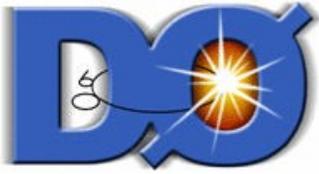
Higgs Results (XII)

Search for bH associated production with $b\mu\tau_{\text{had}}$ final state

New analysis on 4.3 fb^{-1} of data

Signal / background discriminant using 3 BDT

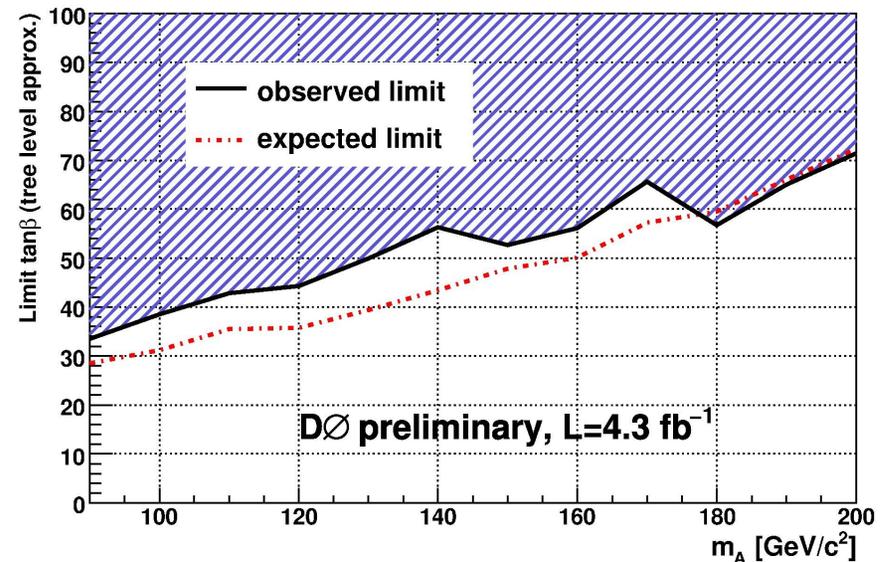
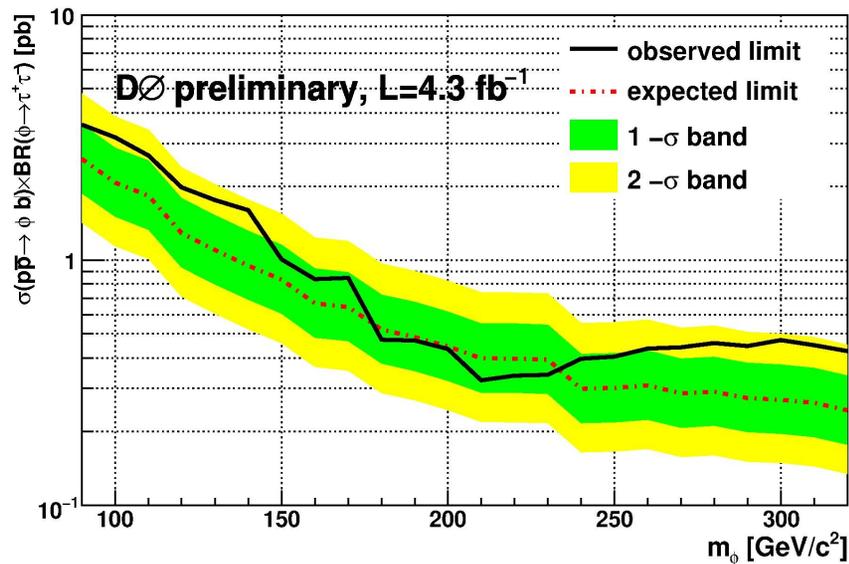


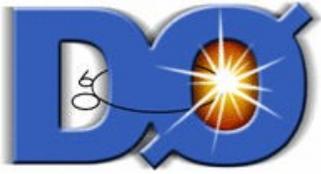


Higgs Results (XIII)

Search for bH associated production with $b\mu\tau_{\text{had}}$ final state

No excess observed in data, set model independent limit on the cross section, interpret within SUSY to set limit on $\tan\beta$

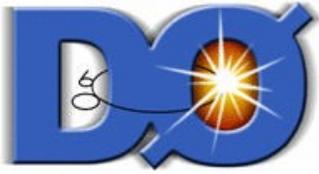




Predicting the Future ?

I would trust Paul the octopus more.....





Higgs Results

All analyses in the D0 SM Higgs combination have $> 4.2 \text{ fb}^{-1}$

Results available since yesterday in Tevatron Higgs WG, being reviewed by the Collaboration, no surprises

Most important channels with $> 6 \text{ fb}^{-1}$, aim for full dataset up to this week released publicly at Winter 2011 conferences

Continue sensitivity improvements / adding new channels

Looking forward to successful Higgs searches

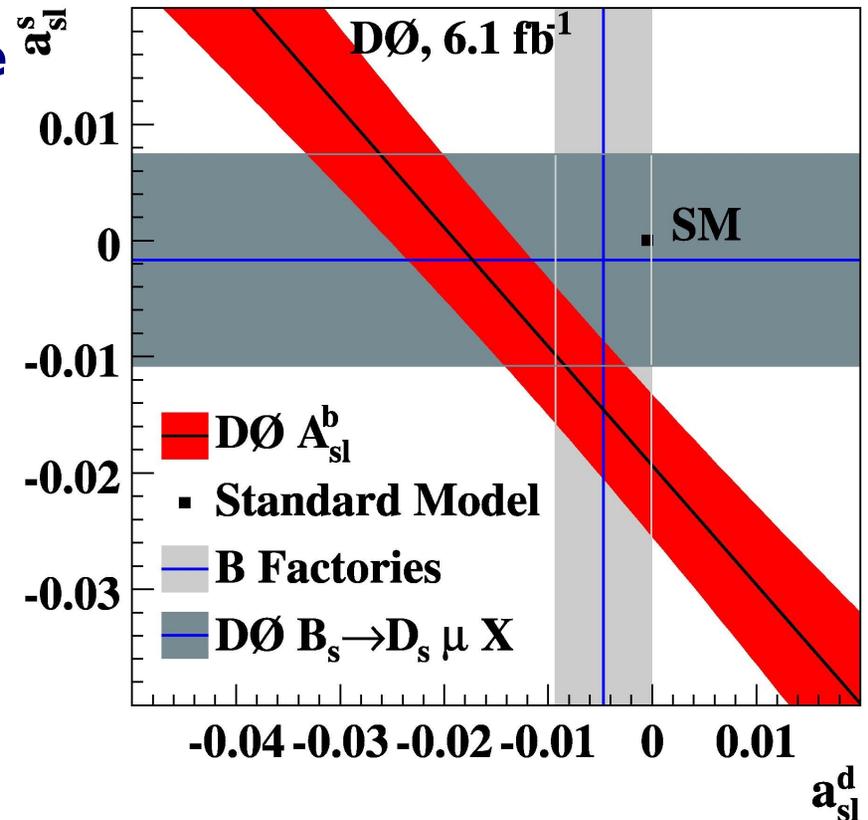


Conclusions

Presented a spectrum of the new results for ICHEP 2010
Few more to become available in the next few days
Many will be submitted for publication in the coming weeks

When we have new / exciting results you will see the announcement in Fermilab Today, hear about it in One West, read about it in physics journals

Accepted by PRD at 12:17 today



Public web pages for DØ results for ICHEP 2010:

<http://www-d0.fnal.gov/Run2Physics/D0ICHEP2010.html>