Tevatron Results on BSM Higgs Searches

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Outline

- Introduction
- Fermiophobic Higgs
- MSSM Higgs
  - Charged Higgs
  - Neutral Higgs
- MSSM Combination
- Conclusions

The BSM Higgs World

Fermiophobic Higgs:

- Assuming no Higgs couplings to fermions
- In this case, the BR($h_f \rightarrow \gamma\gamma$) is much bigger than the SM one
- Same coupling to W and Z bosons as in the SM

MSSM Higgs:

In the MSSM we expect 5 Higgs bosons: h, H, A and $H^{\pm}$

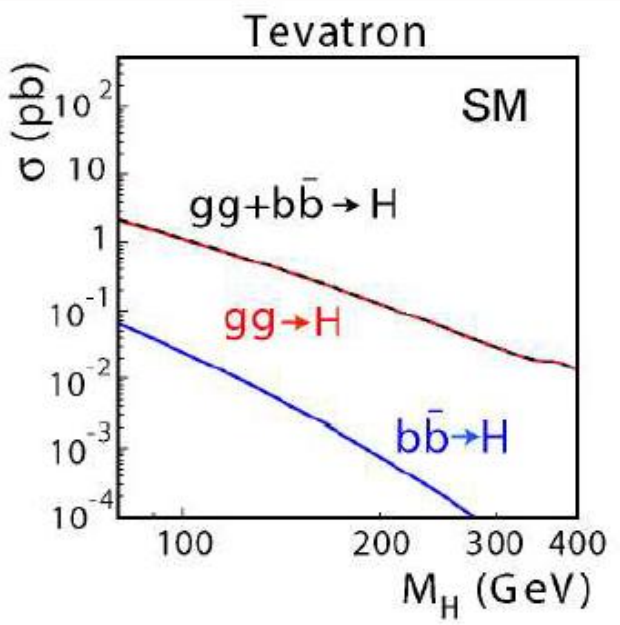
Charged Higgs:

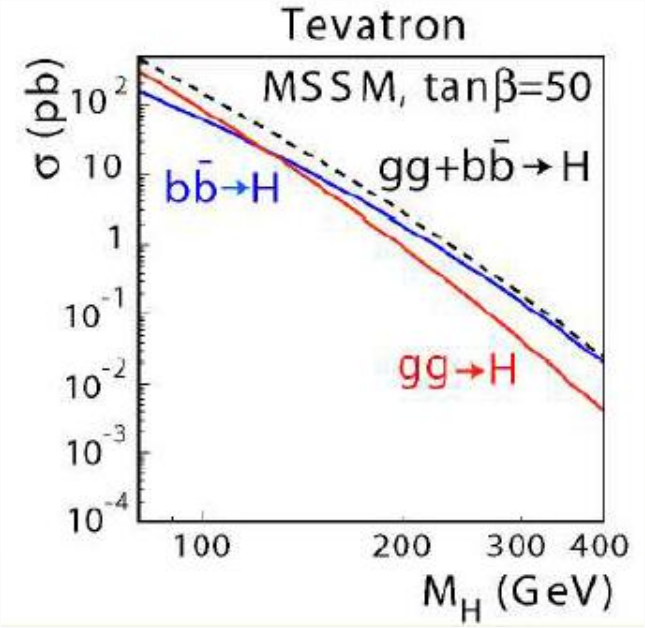
- Sensitive to MSSM production if $tan\beta \leq 1$ and $m_H \leq 130$ GeV/c^2
- Appears in the $t\bar{t}$ decay

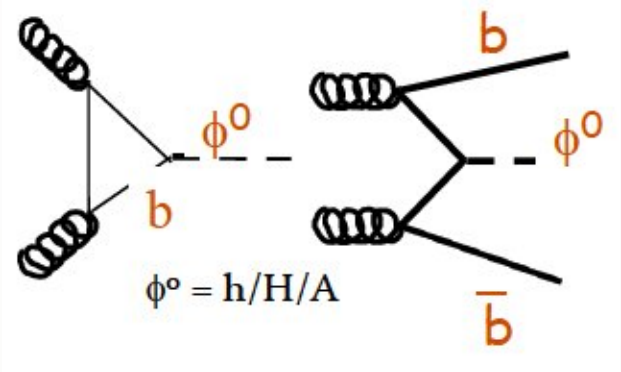
The BSM Higgs World

Neutral Higgs

- For large *tanβ*: A is degenerate in mass with h or H and the cross section is enhanced (coupling to down-type quarks)
- bottom-quark loop enters in the production diagrams, and associated production (Hbb) has a significant contribution.
- The degenerate state ϕ decays into $\tau\tau$ (10%) and bb (90%)







Final States at Tevatron

Tevatron

Proton-antiproton collisions at 1.96 TeV center of mass energy.
Tevatron was providing the highest collision energy until December 09!!!

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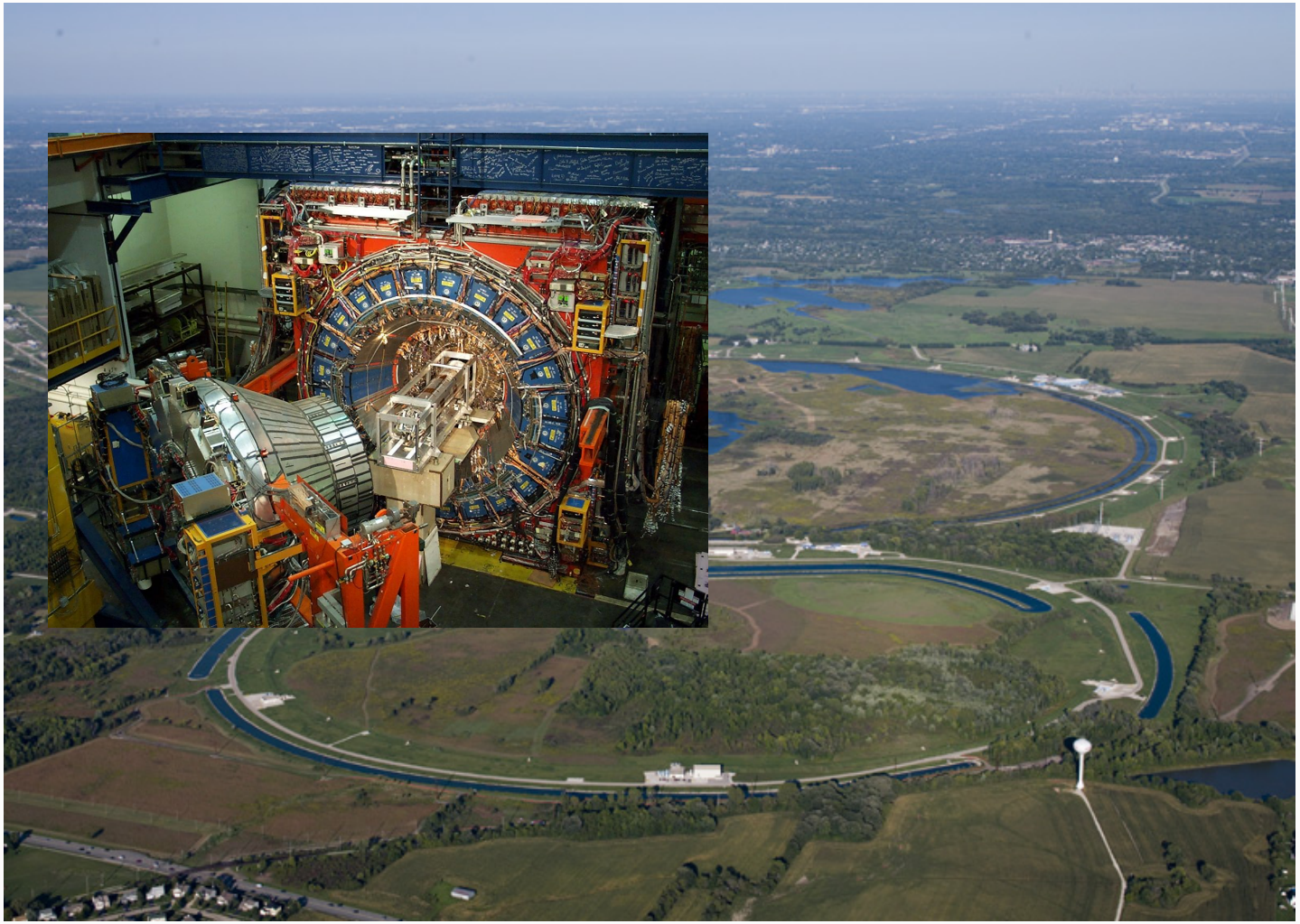

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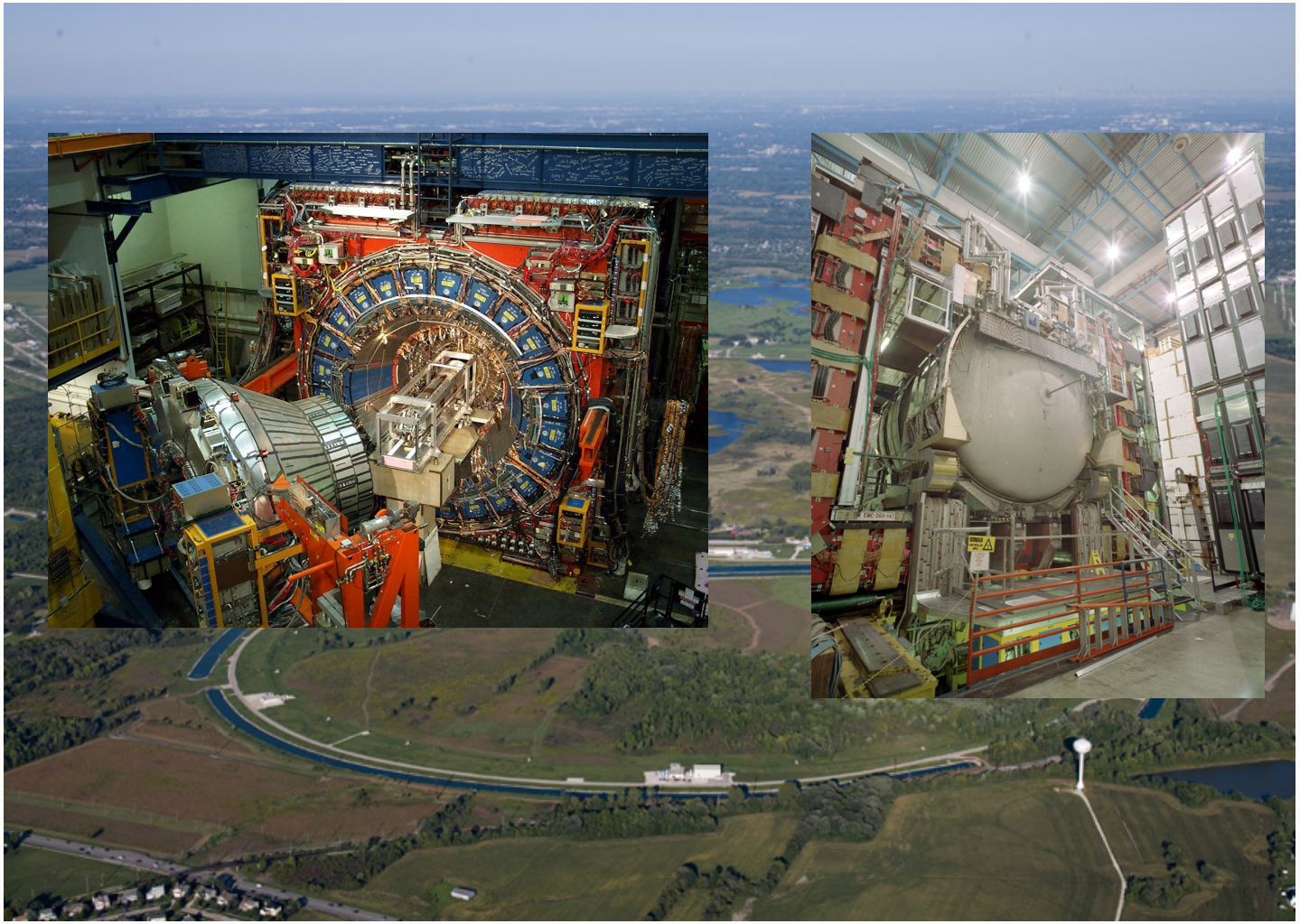


Fermiophobic Higgs (I)

Searching for a diphoton mass resonance

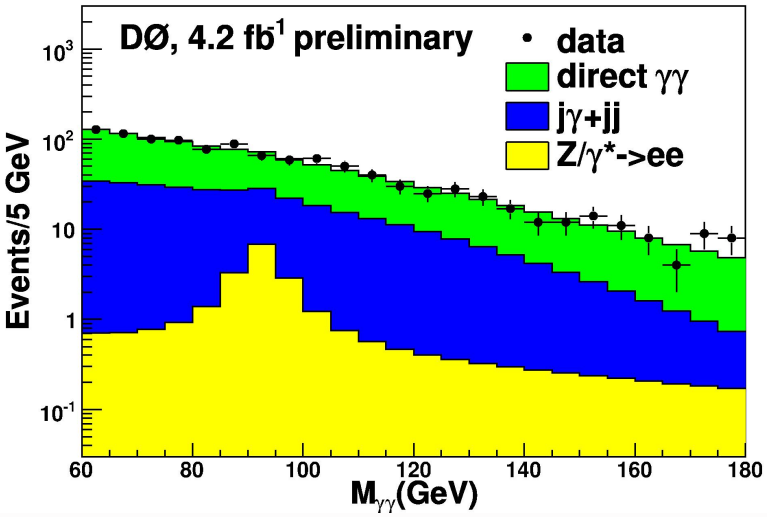
- Diphoton resolution < 3 %
- Better mass resolution than jets

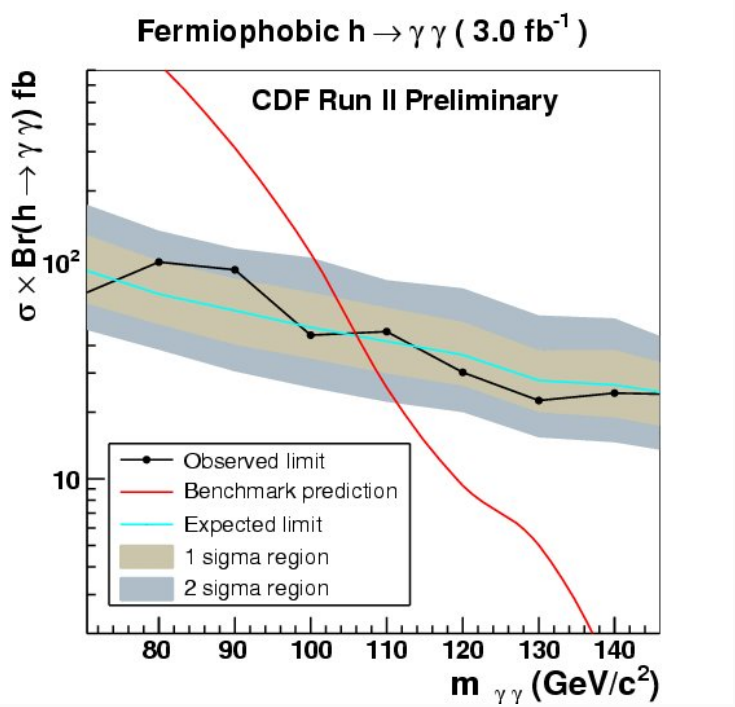
CDF:

- $p_{T,\gamma\gamma} > 75$ GeV/c^2
- Background shape from sidebands

DØ:

- $p_{T,\gamma\gamma} > 35$ GeV/c^2
- Background from MC and data

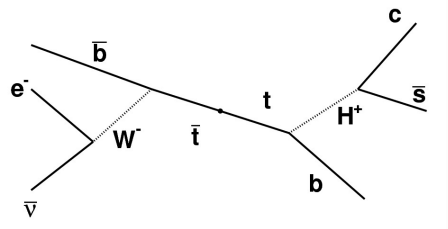




MSSM Higgs Analyses

Charged Higgs

Search in the top pair sample: a top quark decays to a charged Higgs

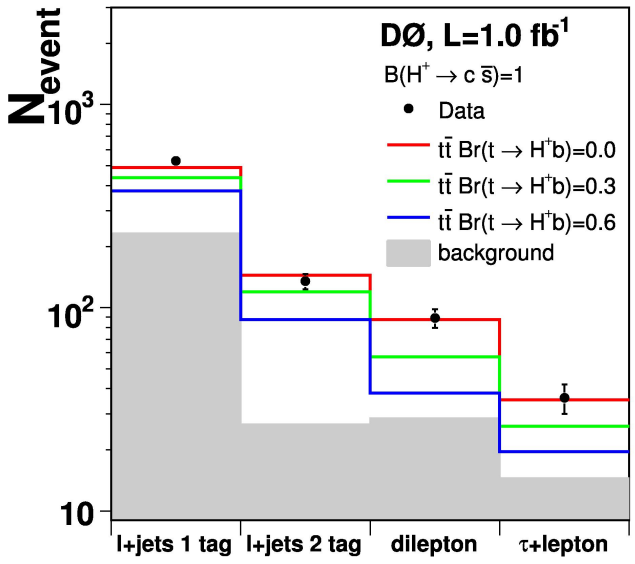


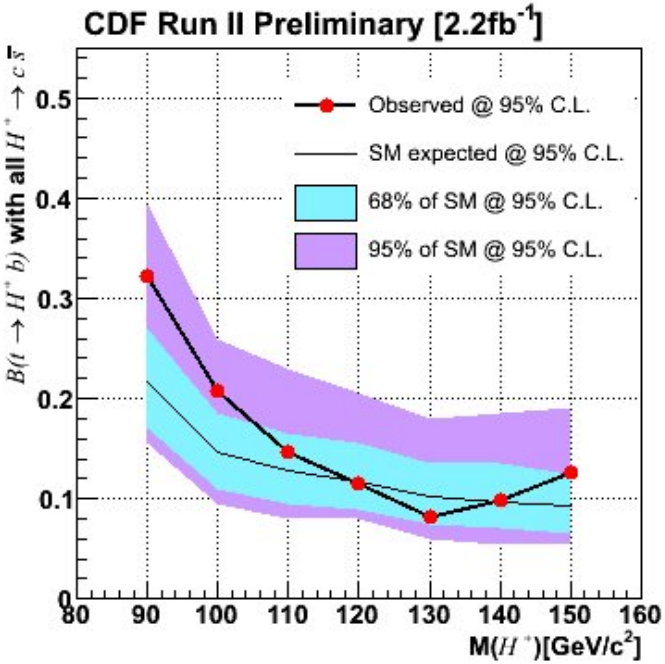
Two escenarios considered in terms of Higgs decay:

- $H^{\pm} \rightarrow cs$ (Leptophobic model)
- $H^{\pm} \rightarrow \tau\nu$ (Tauonic model)

Event selection:

- High p_T leptons
- Large $\not{E}_T$
- b-tagging requirements





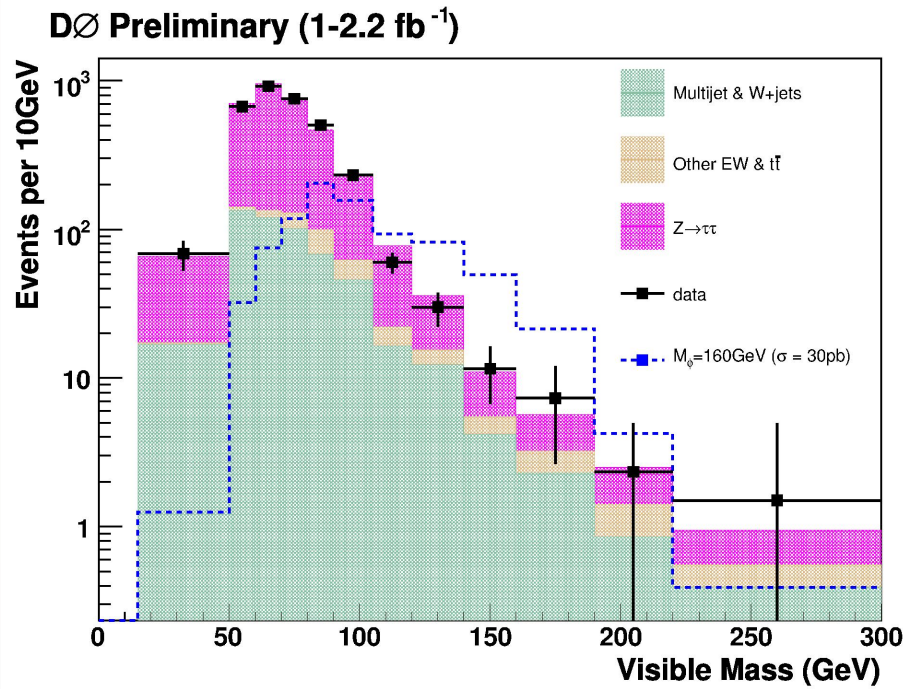
$\phi \rightarrow \tau\tau$ (I)

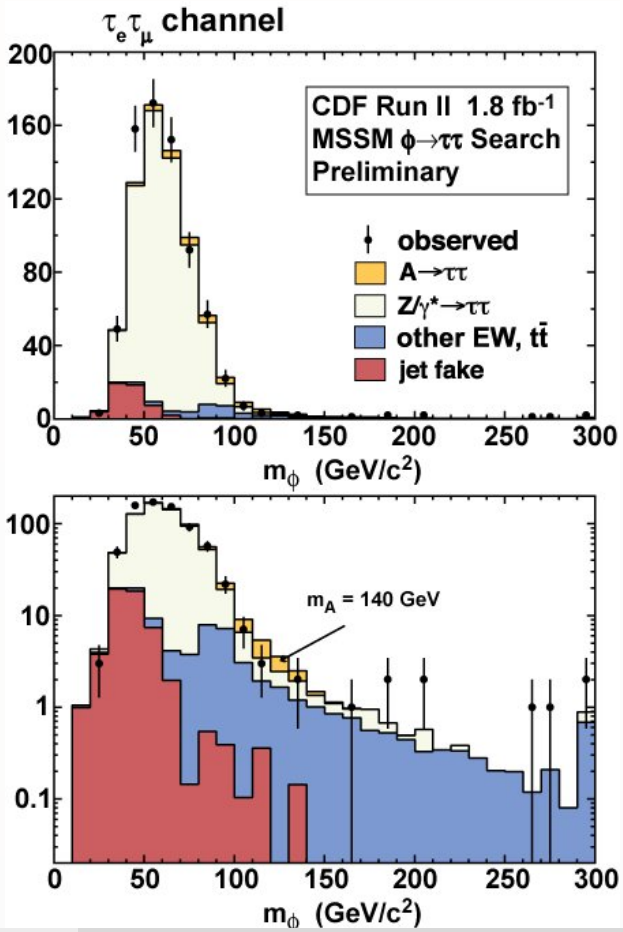
The analysis was performed using one leptonic τ and one leptonic or hadronic τ (**three different channels:** $\tau_e\tau_{had}, \tau_\mu\tau_{had}, \tau_e\tau_\mu$)

- Main background $\Rightarrow$ Drell-Yan production of tau pairs

Key point: hadronic τ reconstruction and ID

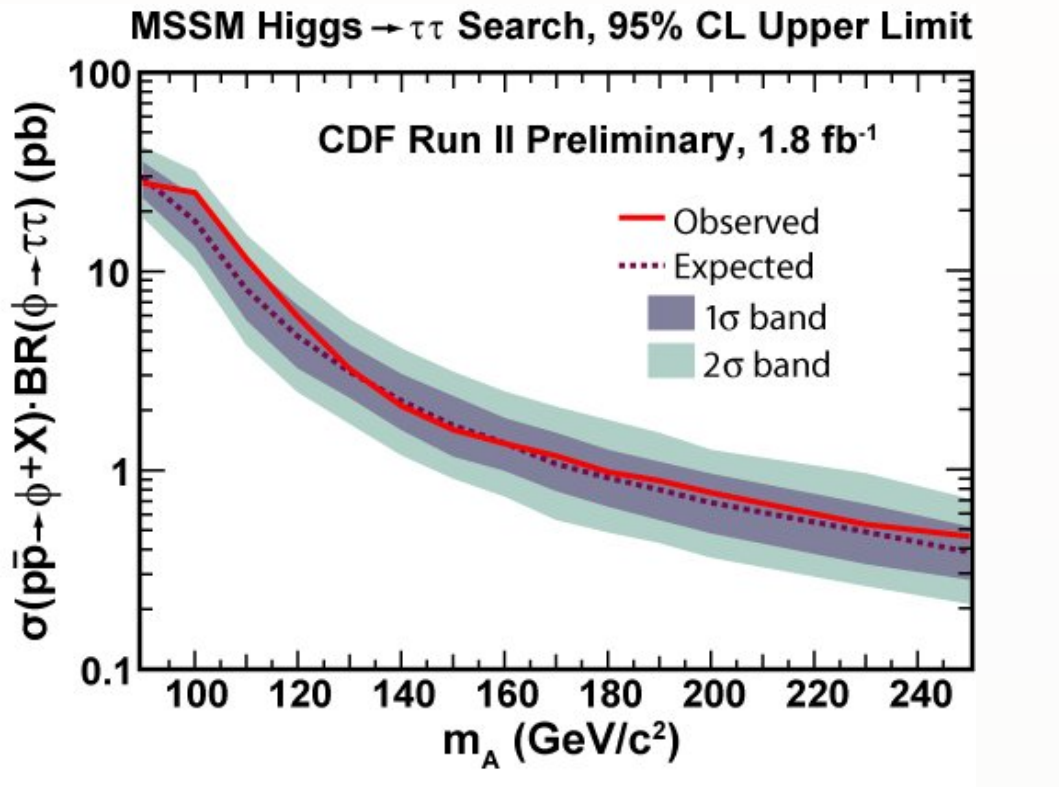
m$_{vis}$: sum of tau products and $\not{E}_T$

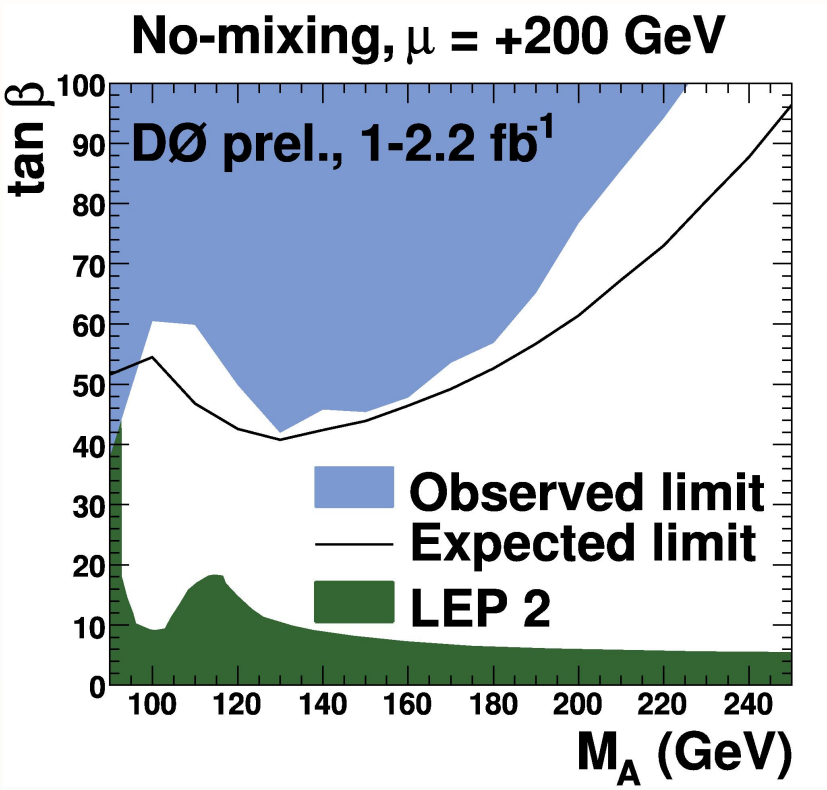




$\phi \to \tau\tau$ (II)

95% C.L. Exclusion limit in terms of cross section & $\tan\beta - m_A$ plane

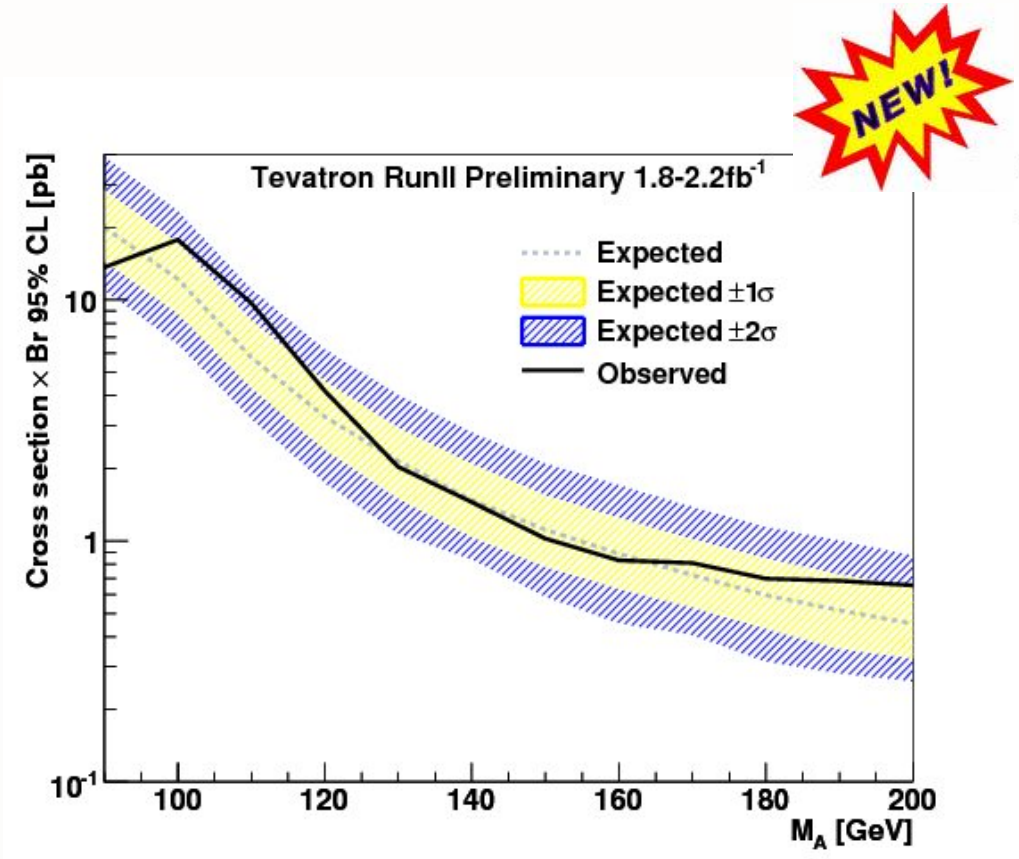


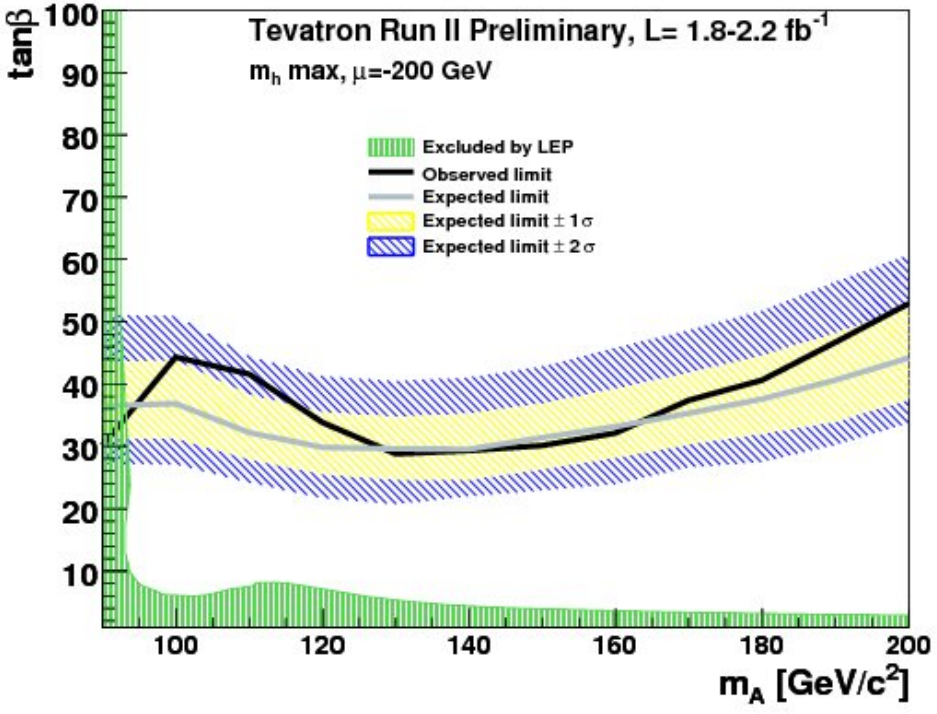


CDF: Phys. Rev. Lett. 103, 201801 (2009).

$\phi \rightarrow \tau\tau$ (III) - CDF and DØ combined limits

95% C.L. Exclusion limits





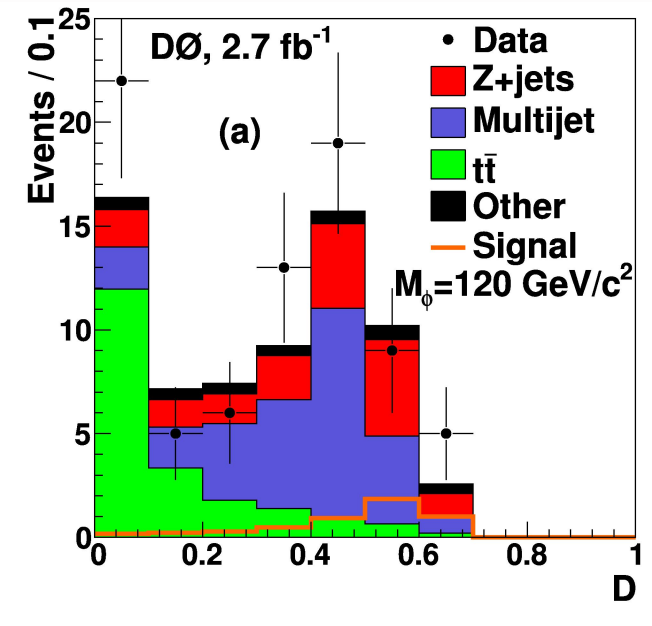
Tevatron combination

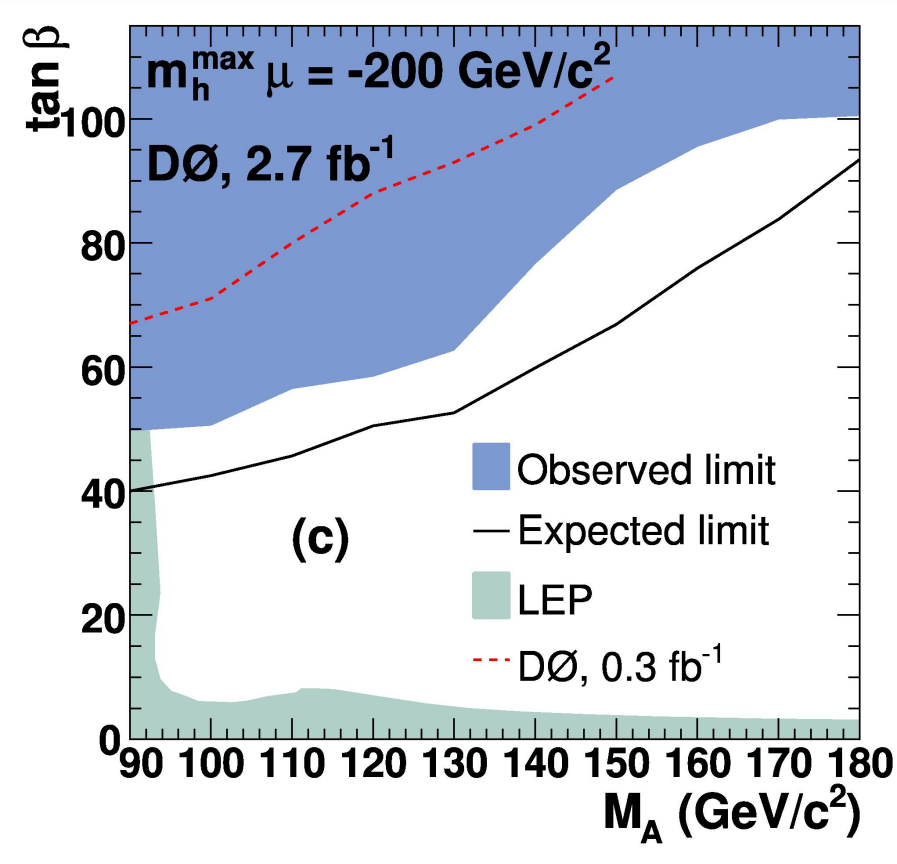
$b\phi \rightarrow b\tau_\mu\tau_{had}$

The analysis was performed using one muonic τ, one hadronic τ and one b-jet

The b-tagging enhances the sensitivity

Main backgrounds: $t\bar{t}$ and QCD multijets





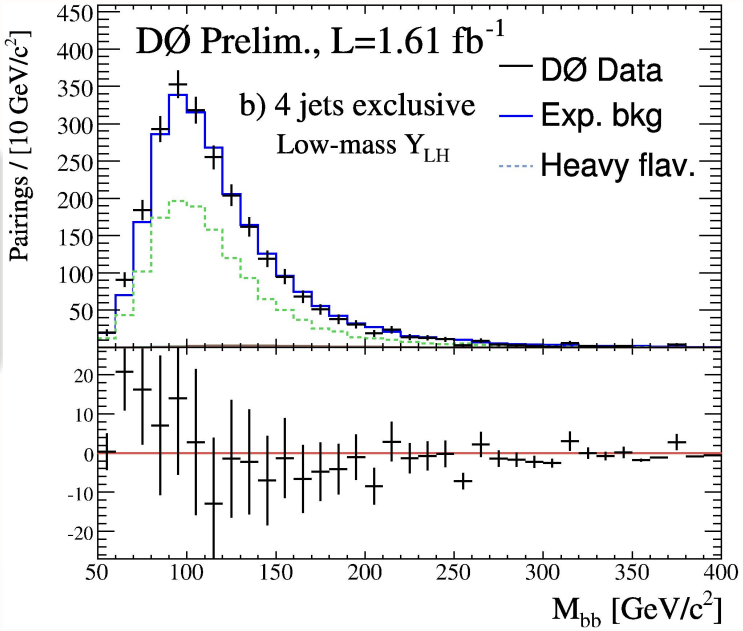
Submitted to PRL

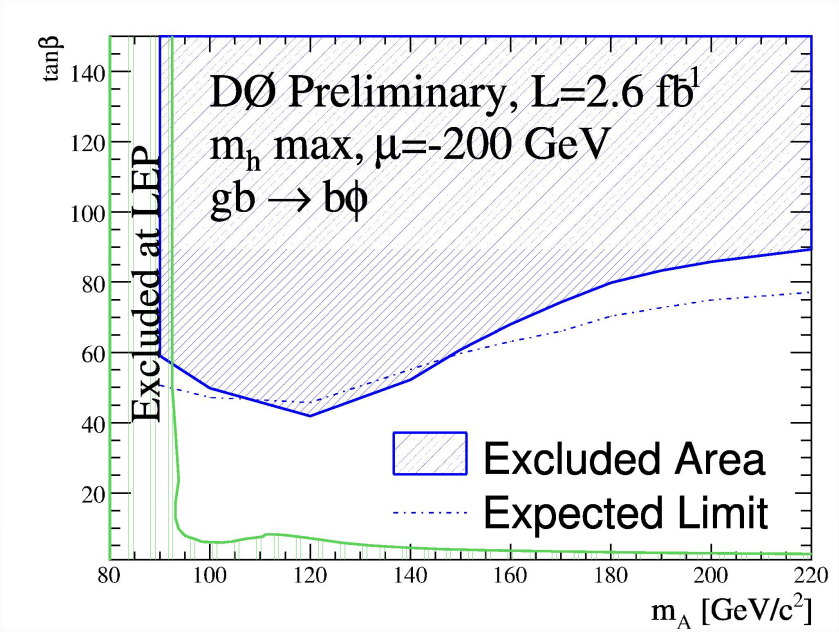
$b\phi \rightarrow bb\bar{b}$ (I)

Higgs production in association with b-quarks is enhanced in the MSSM (with large tanβ)

$b\phi \rightarrow bbb$

- Exclusive regions depending on jet multiplicity
- Understanding the quark content of 3 jets is not trivial
- The heavy-flavour tagging is the key tool
- Heavy- flavour Multijets (QCD) from data

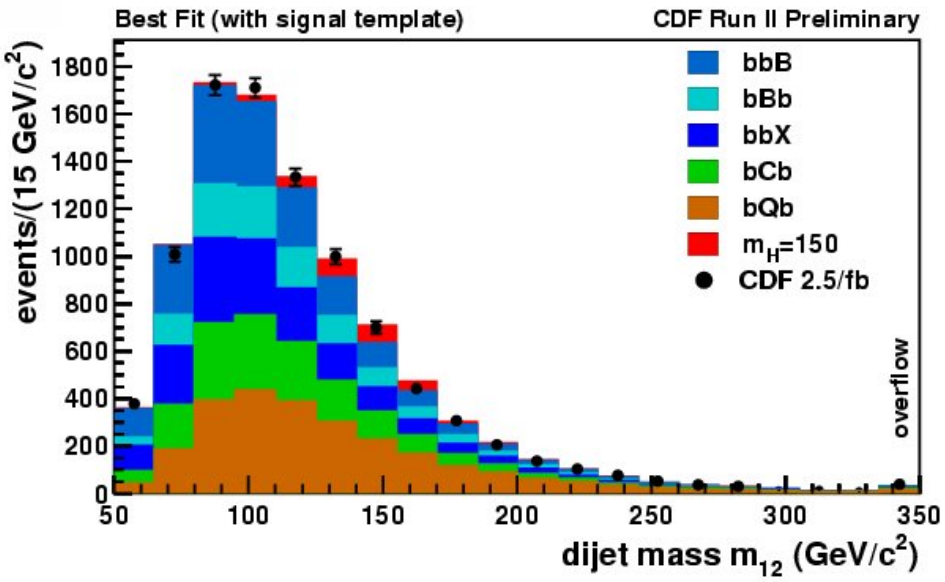


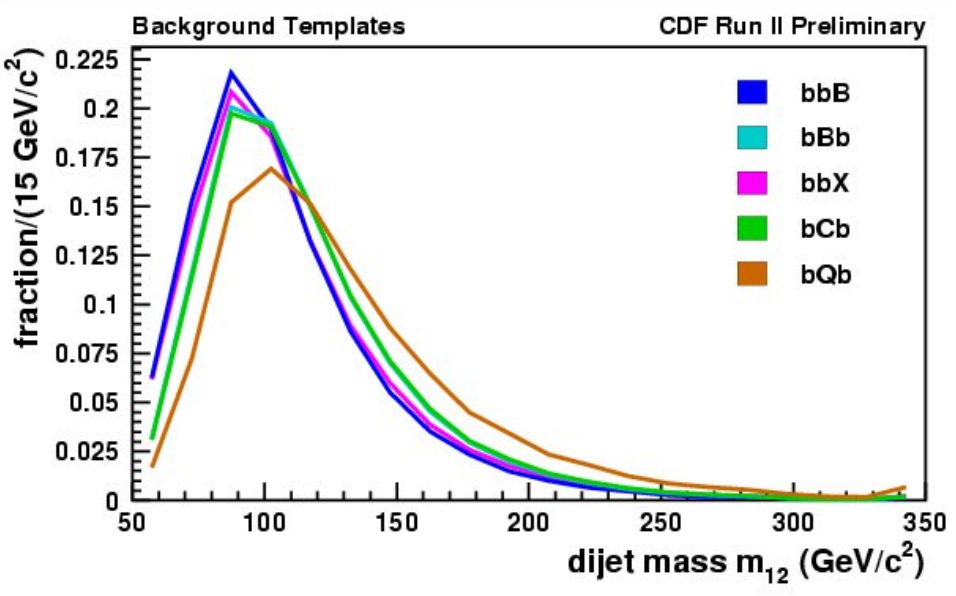


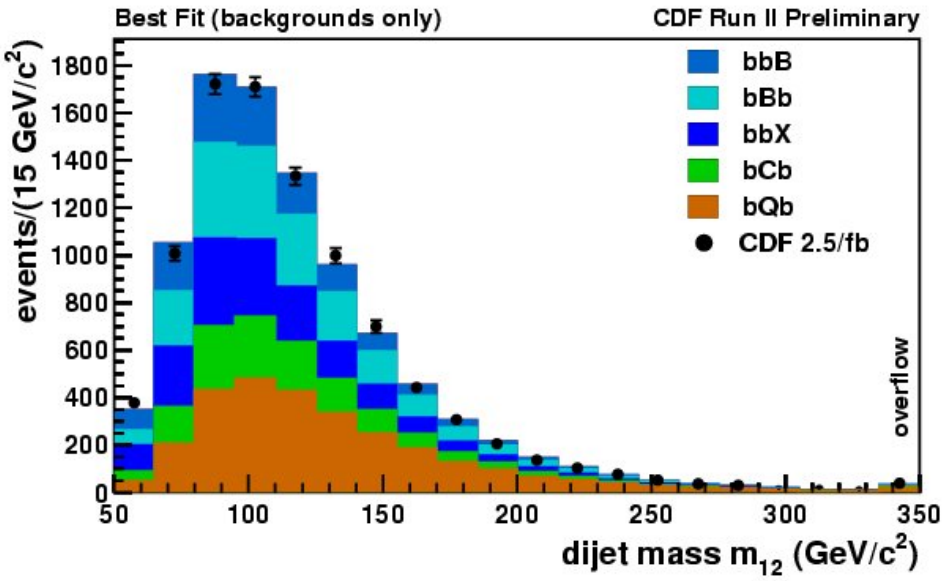
$b\phi \rightarrow bb\bar{b}$ (II)

NEW!

- Fully data-driven background estimate
- Mostly bb+ tag of any flavor (b,c,mistag)
- Flavor separation using tag properties







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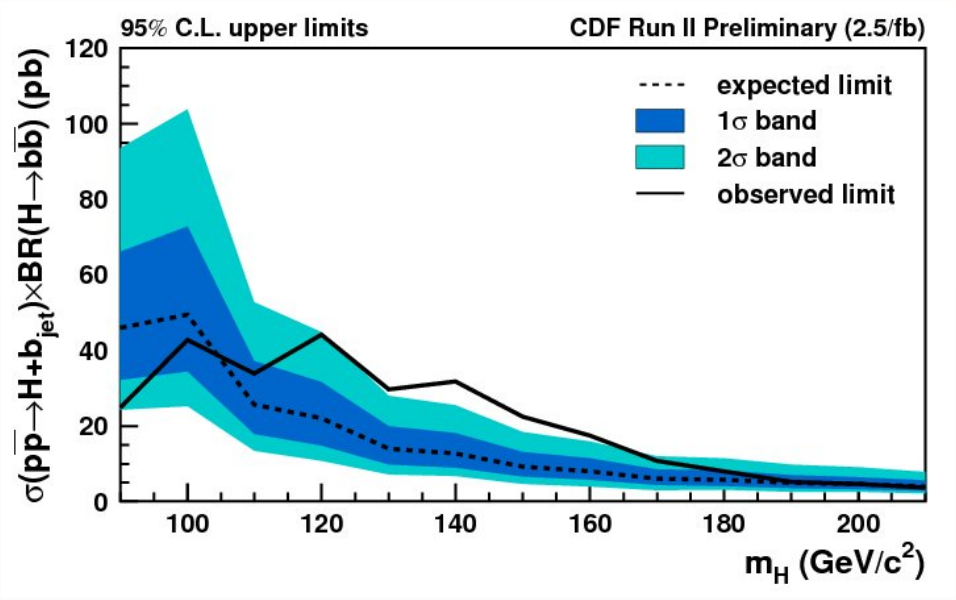
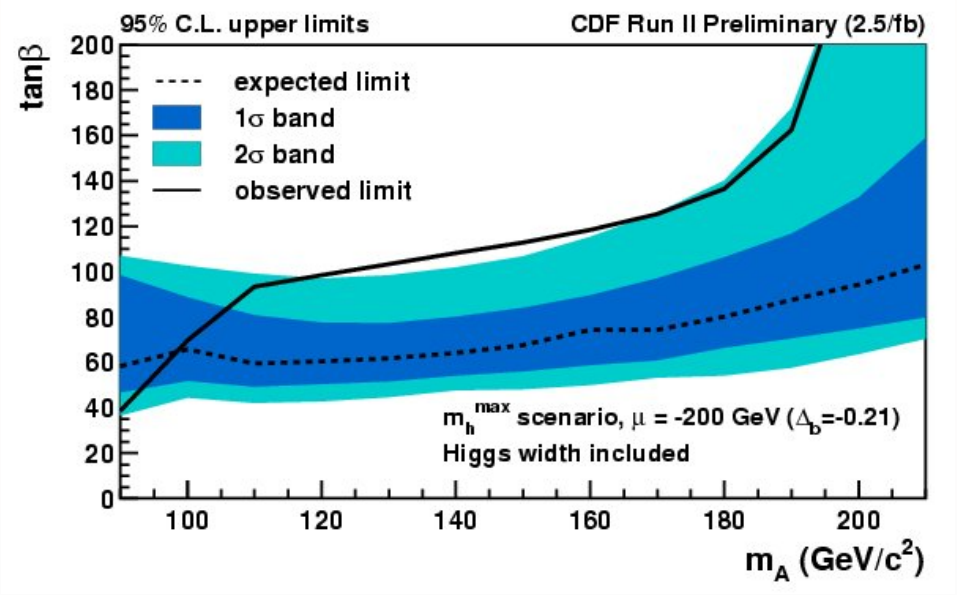




Limits on $\sigma \times BR$ are general limits on ANY narrow $b\bar{b}$ resonance produced in association with another b

Large $\tan\beta$ enhances the bbH coupling, but also increases the width

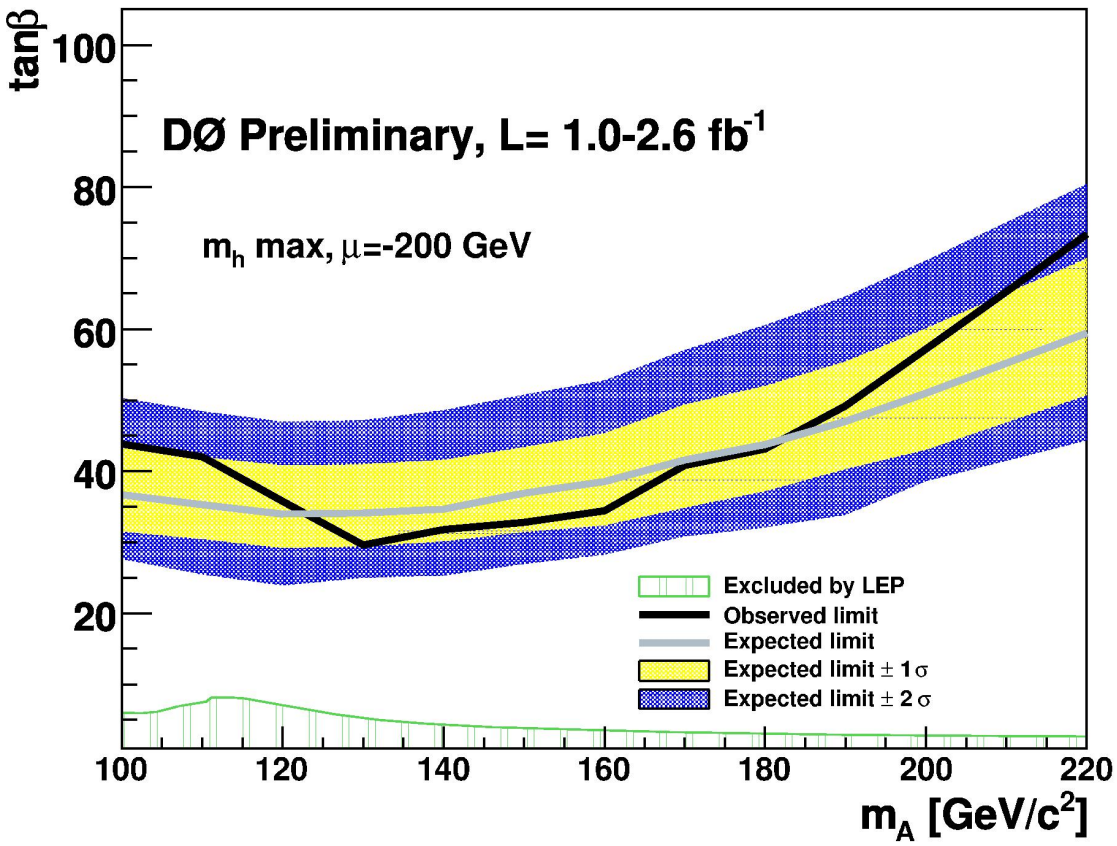
DØ Combination

Combined upper limits on MSSM Higgs-boson at DØ

Combination of the three different channels:

- $\phi \rightarrow \tau^+\tau^-$
- $b\phi \rightarrow bbb$
- $b\phi \rightarrow \tau^+\tau^- b$

Analyses with luminosities from 1.0 to 2.6 fb^{-1}



New Tevatron combinations expected next Summer

Summary

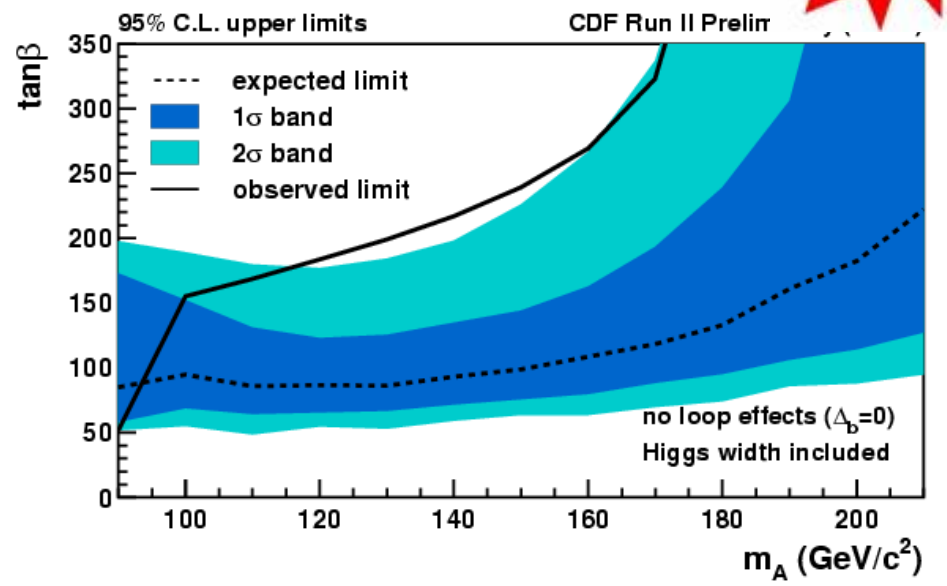
- Tevatron and experiments are performing really well
  - ~ 8 fb^{-1} delivered
  - ~ 7 fb^{-1} recorded
- No evidence of BSM Higgs in up to 4 fb^{-1} of data
- The Higgs program is continuously producing new results (and improving limits)
- New tools under development to increase sensitivity

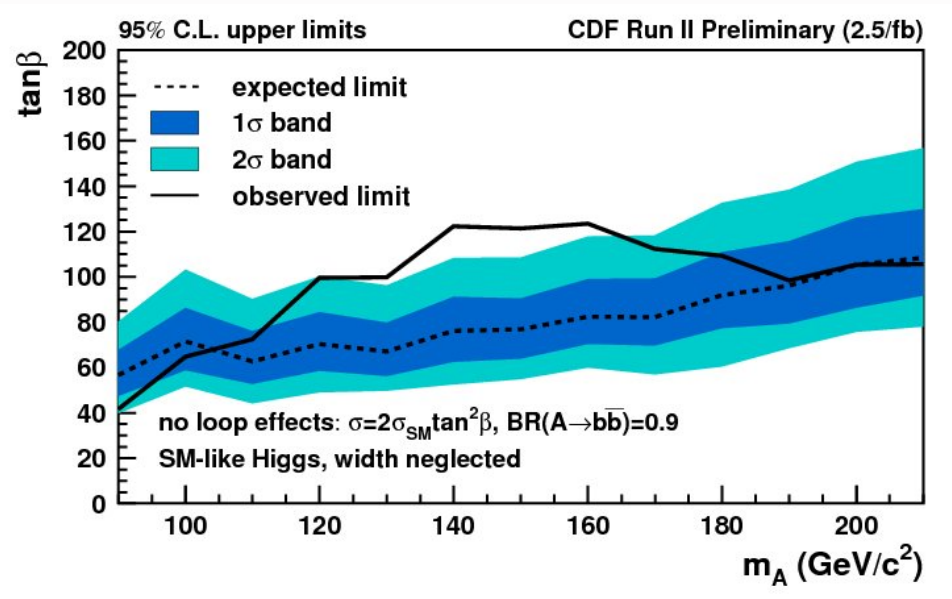
Tevatron is a nice place to find new physics,
we have plenty of data !!!

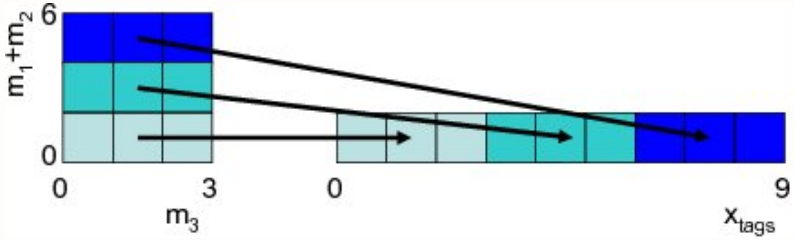
More information:
http://www-cdf.fnal.gov/physics/exotic/exotic.html
http://www-d0.fnal.gov/Run2Physics/WWW/results.htm

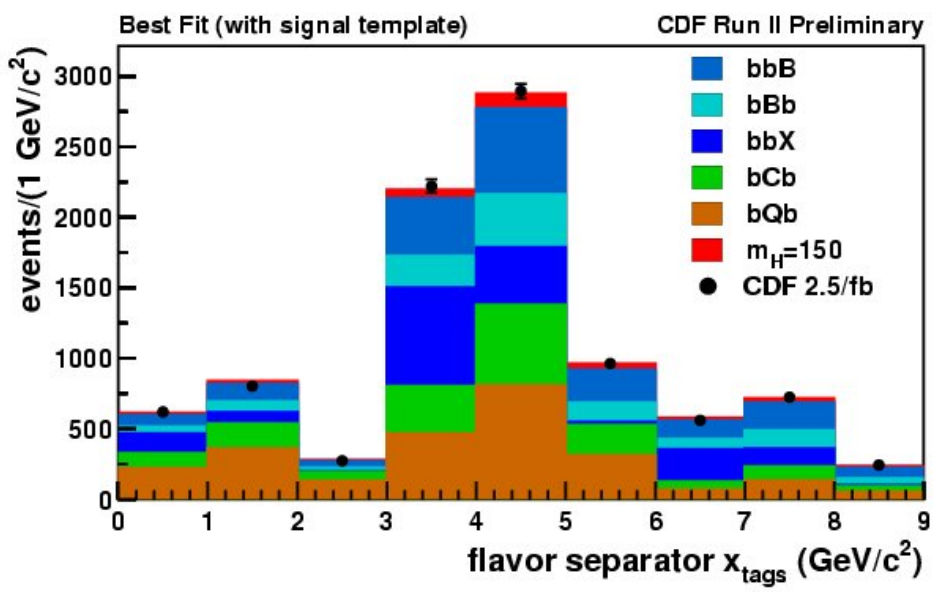
Backup Slides

$b\phi \rightarrow bb\bar{b}$



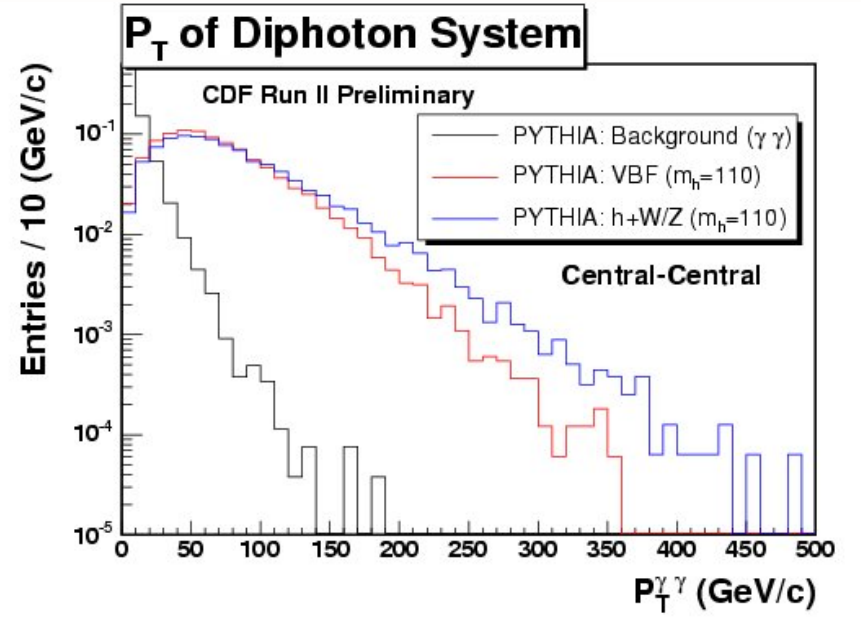


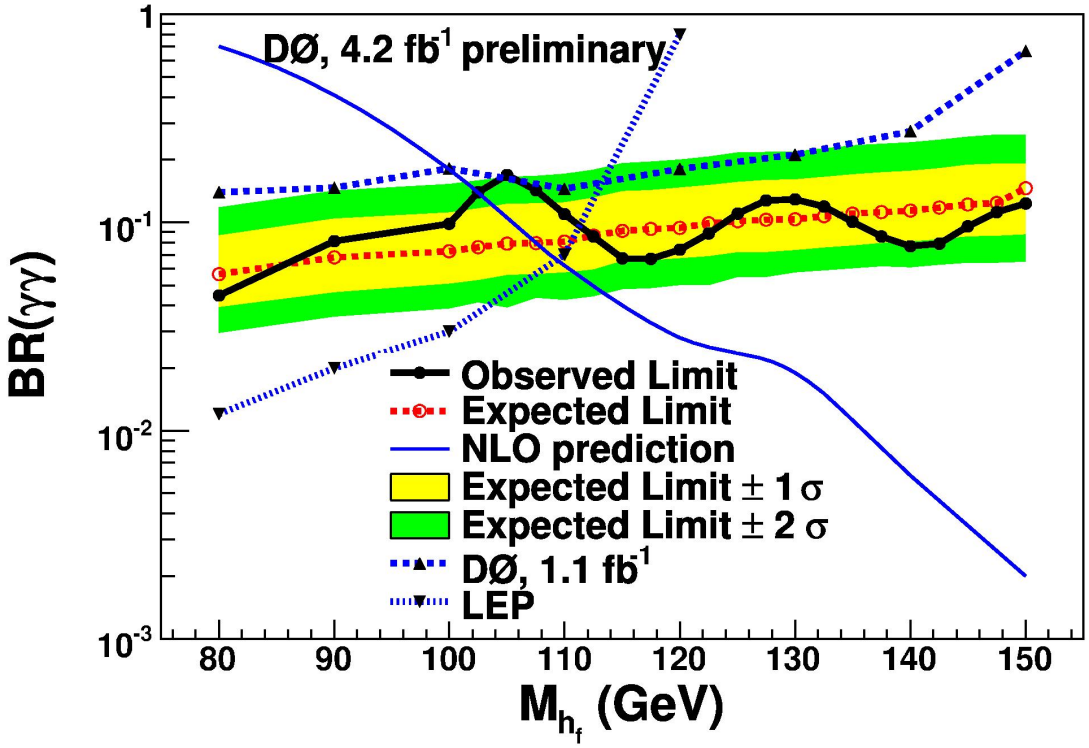


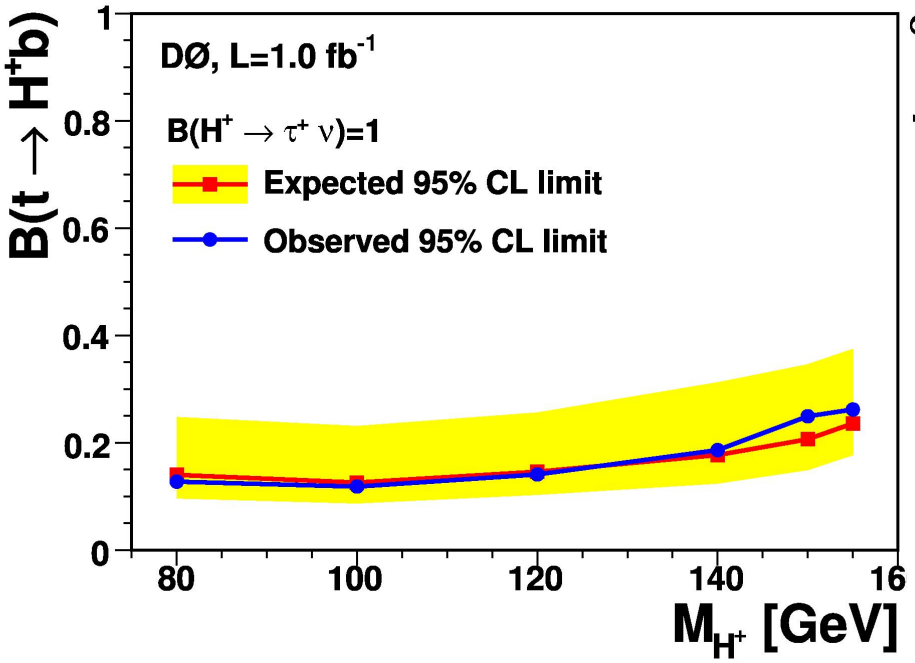
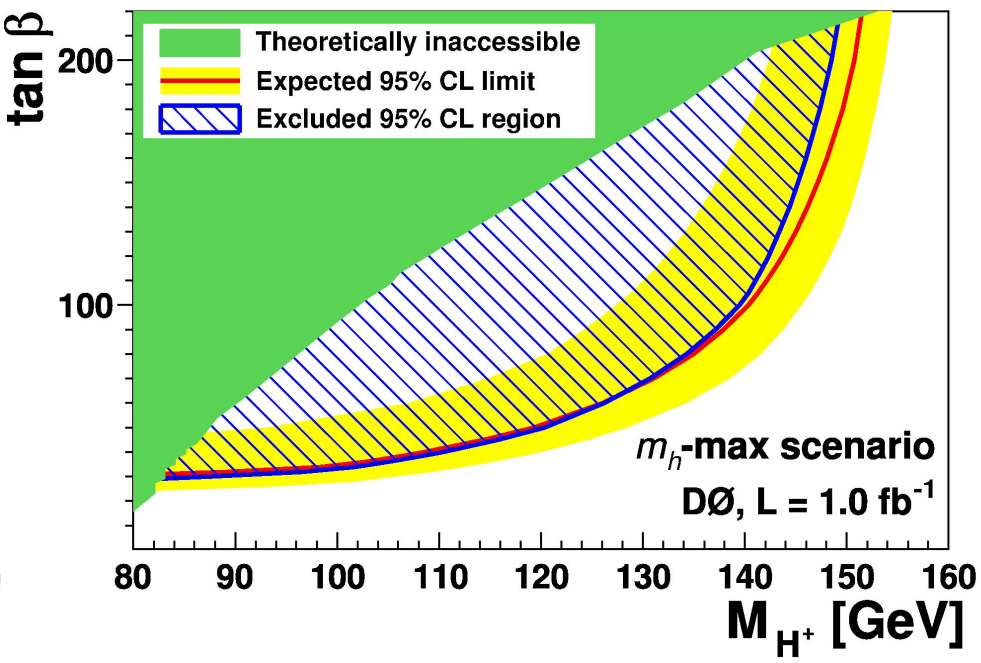


Fermiophobic Higgs

95% C.L. Exclusion limit in terms of cross section





CDF: Phys. Rev. Lett. 103, 061803 (2009)

Charged Higgs