Search for neutral SUSY Higgs bosons in $\tau\tau$ and $b+\tau\tau$ final states in $p\bar{p}$ collisions at 1.96 TeV

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For D0 and CDF collaboration

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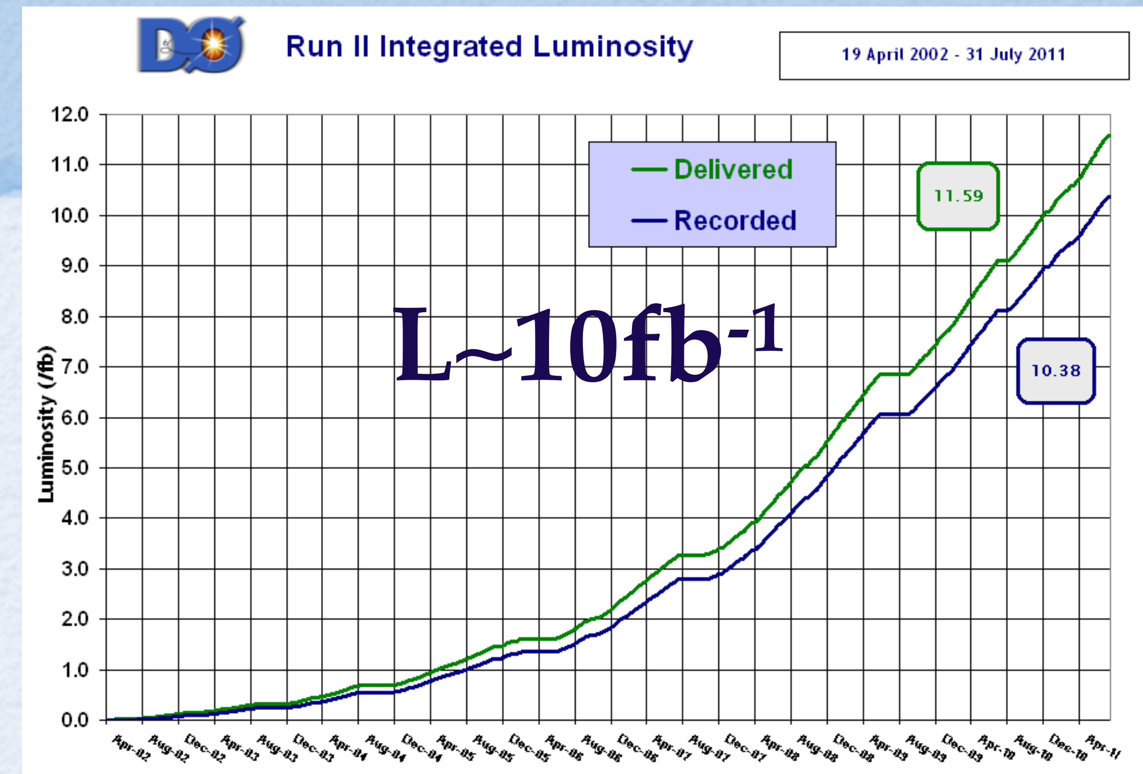
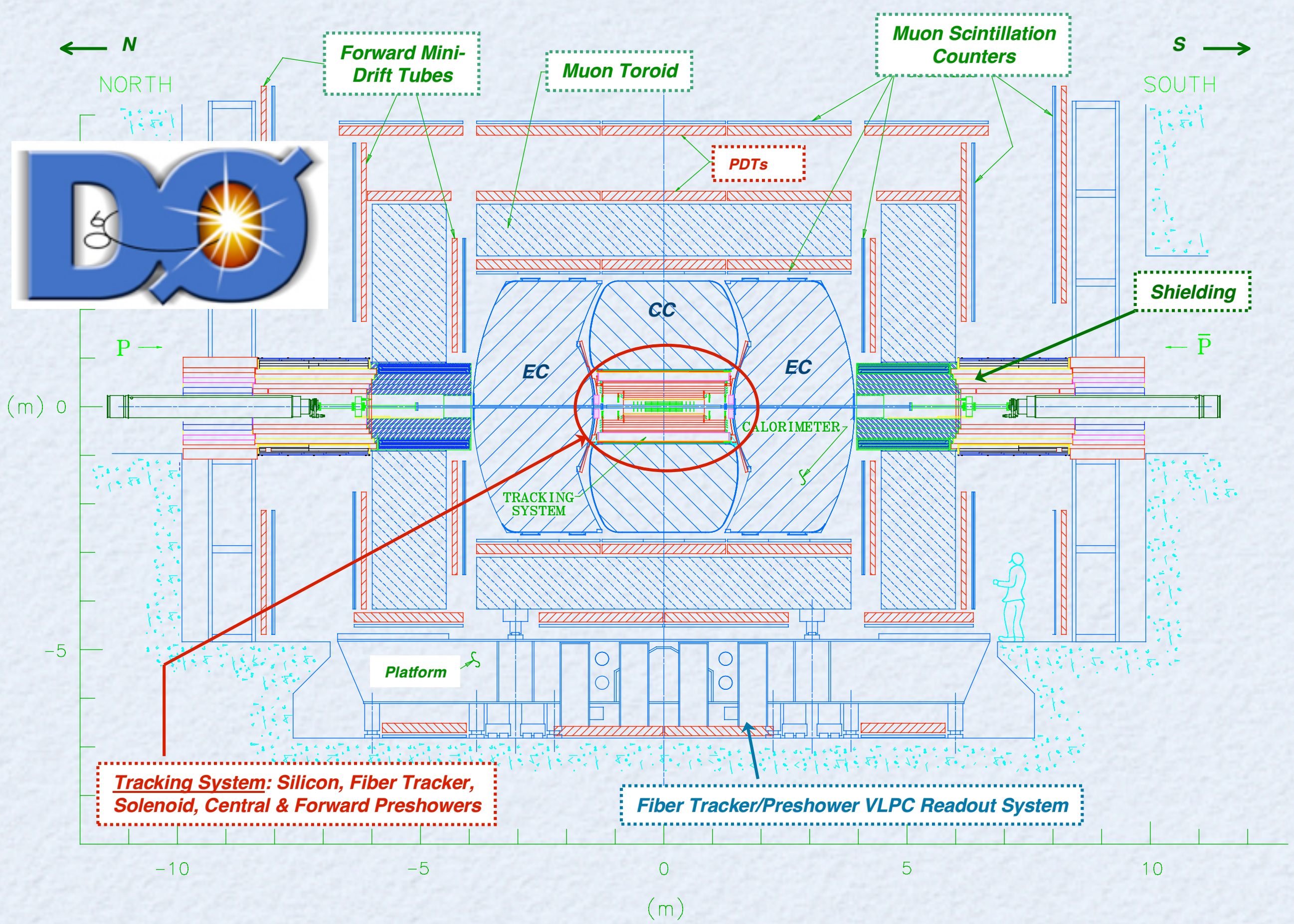
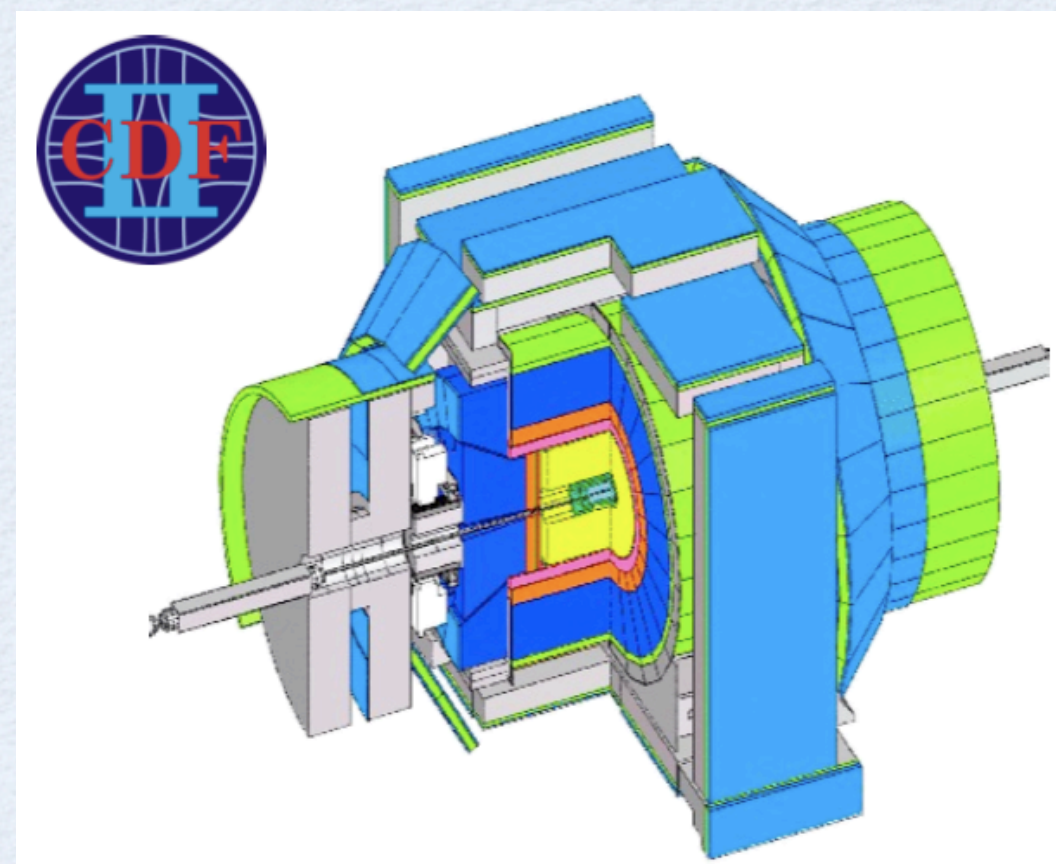
STATE UNIVERSITY OF NEW YORK STONY BROOK PHYSICS AND ASTRONOMY

Outline

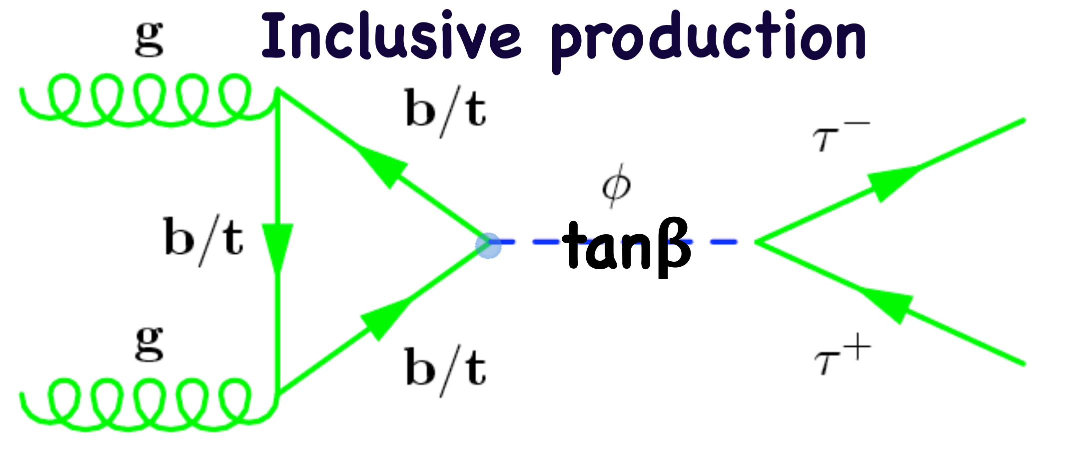
- ➪ Introduction
- ➪ MSSM Higgs Searches L=1.8-7.3 fb^{-1}
- ✷ Inclusive production $h \rightarrow \tau\tau$ final state
- ✷ Associated production $hb \rightarrow \tau\tau b$ final state

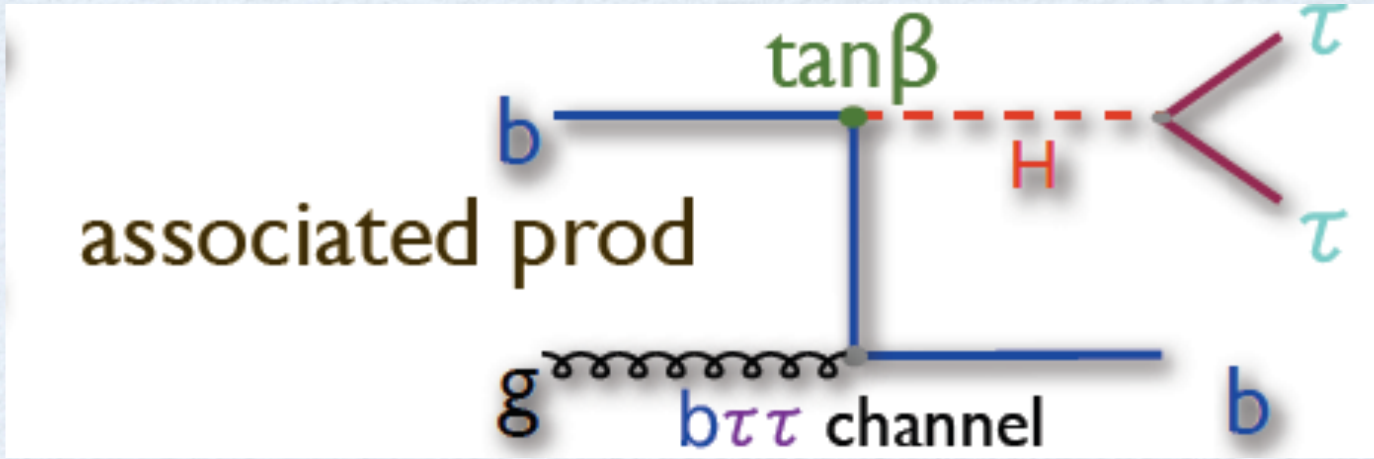






MSSM Higgs production in ττ channels

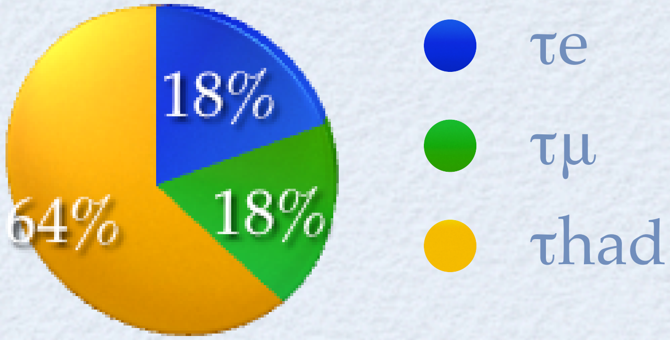




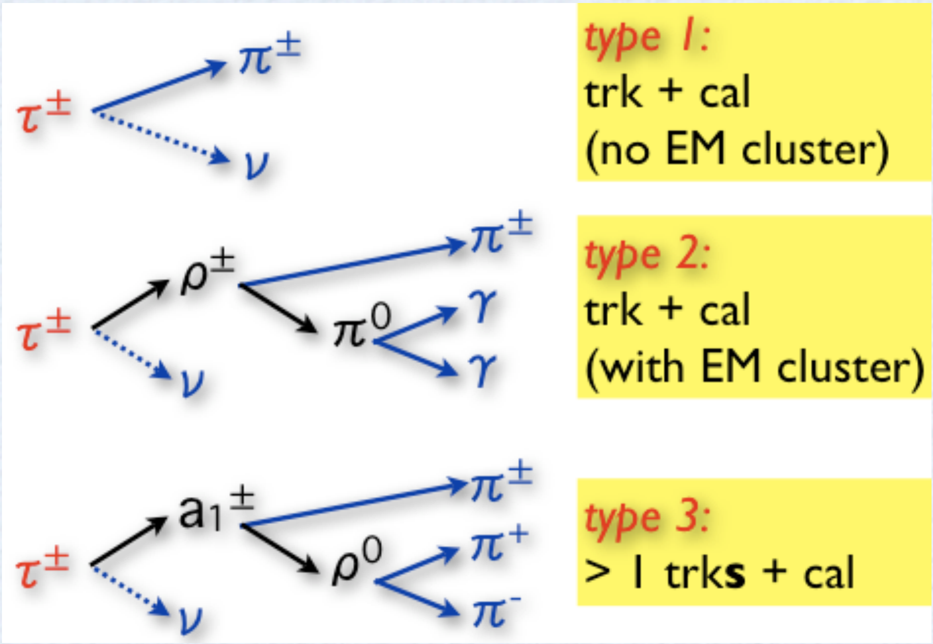
- MSSM : 2 Higgs doublets coupling to down-type (vev v^d) and up-type quarks (vev v^u)
- Production cross section is enhanced by $\tan^2\beta$, $\tan\beta$ defined as v^u/v^d.
- Since one expects $\tan\beta \sim m_{top}/m_{bottom}$, high $\tan\beta$ region ~35 is interesting.
- After EW breaking 3 neutral Higgs (h/H/A ~Φ) and 2 charged Higgs physical states
  ✷ Parameter space controlled by M_A and tanβ at tree level
- **✷ ττ modes are much less sensitive to radiative corrections**
- **For ττ modes, $BR_{\tau\tau}$ ≈ 10%. For $b\bar{b}$ modes, $BR_{b\bar{b}}$ ≈ 90% (Results at Tevatron in Craig Group's talk this morning)**

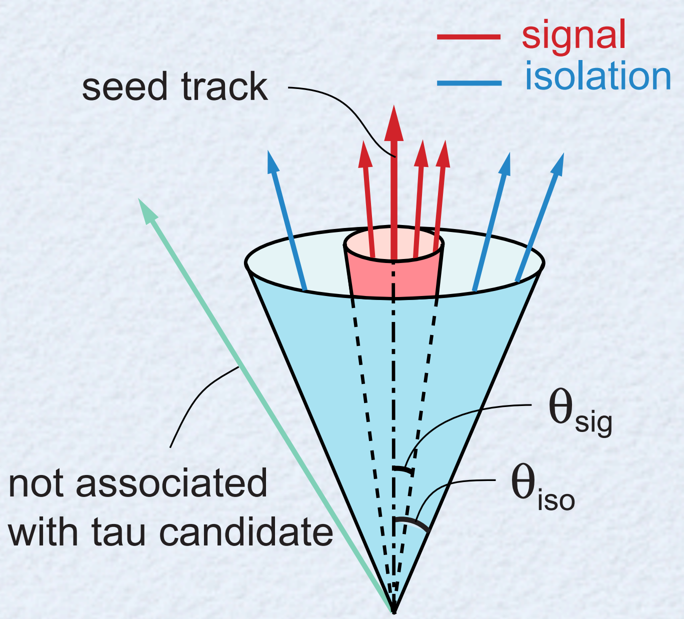
τ Identification

➪ **Hadronic τ decay is important for the channels**



✸ **Identification challenging due to soft decay products, one or three prong decay and multijet background**





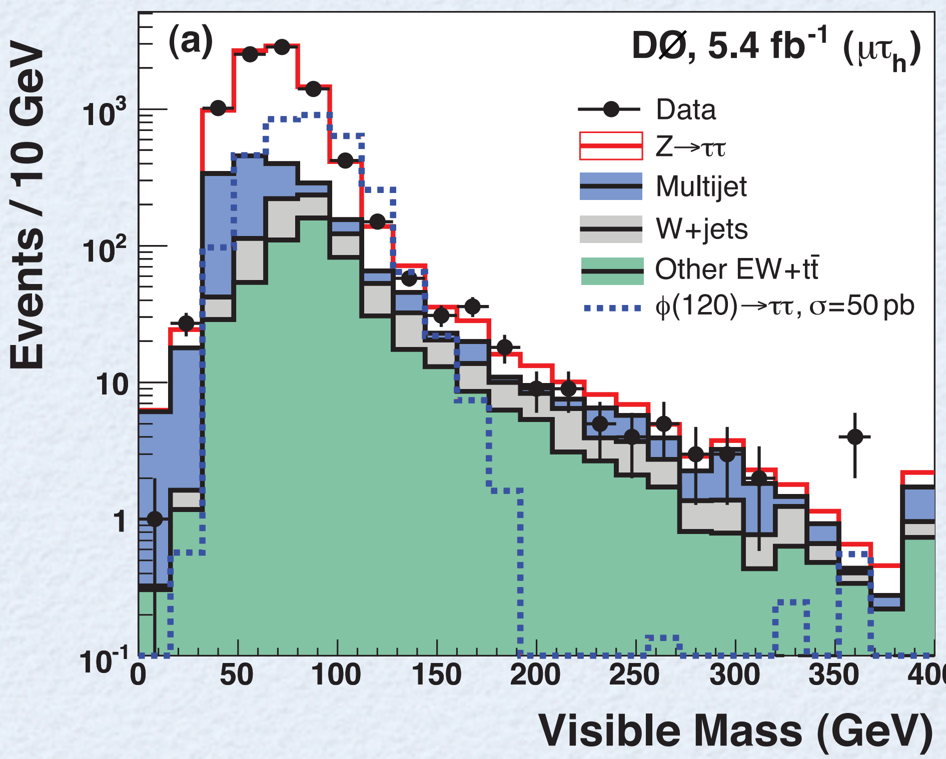
✸ *NN based on isolation, shower shape, trk-cal consistency variables*

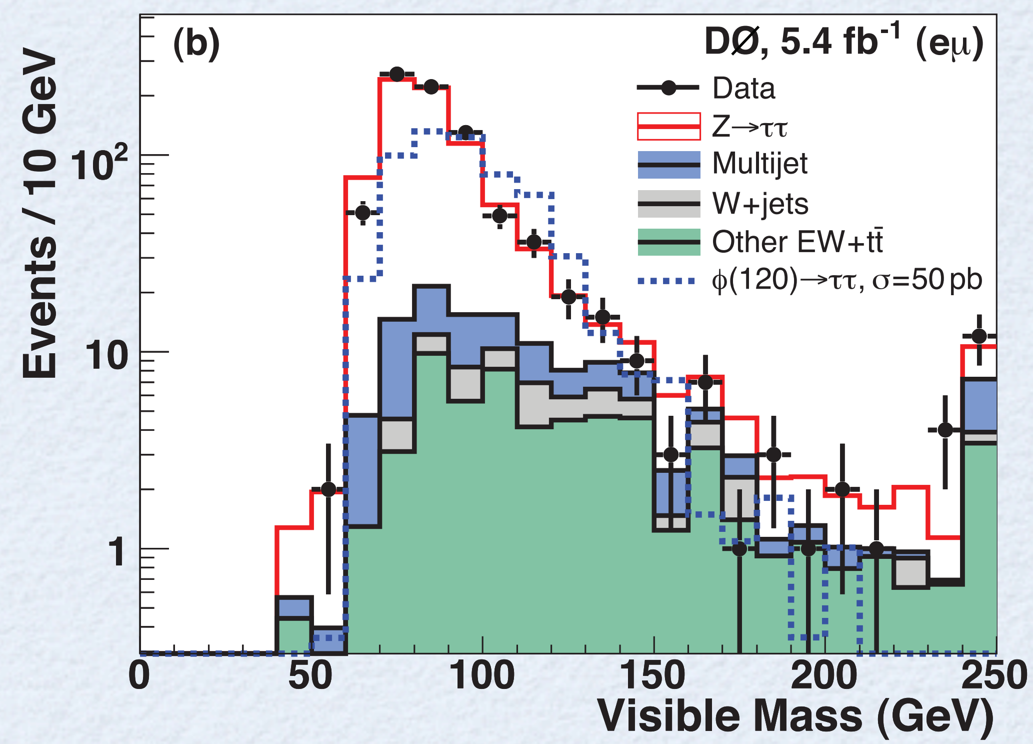
✸ Narrow isolated cone around seed track

Inclusive $h \to \tau_e\tau_h, \tau_\mu\tau_h$ @D0 (5.4 fb^{-1})

- $\mu\tau$ channel, one isolated muon and an isolated hadronic tau
- Additional preselection cut $\Delta\phi > 0.5$ to suppress $Z_{\mu\mu}$ and $M_T < 50$ to suppress w+jets
- $e\mu$ channel, events with at least one muon and an OS electron
- Additional cuts $\Sigma pT > 70$, $M_{Tmin} < 10$ and $\Delta\phi(l, \not{P}_T) < 0.3$ to reject $t\bar{t}$, w+jets, WW

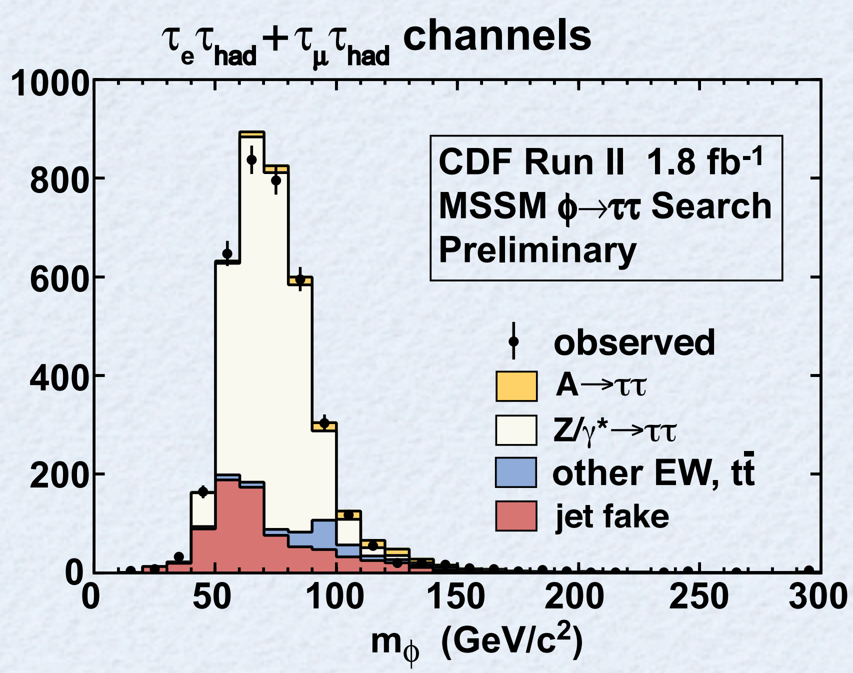
$$\ast M_{vis} = \sqrt{(P_{\tau 1} + P_{\tau 2} + \not{P}_T)^2}$$

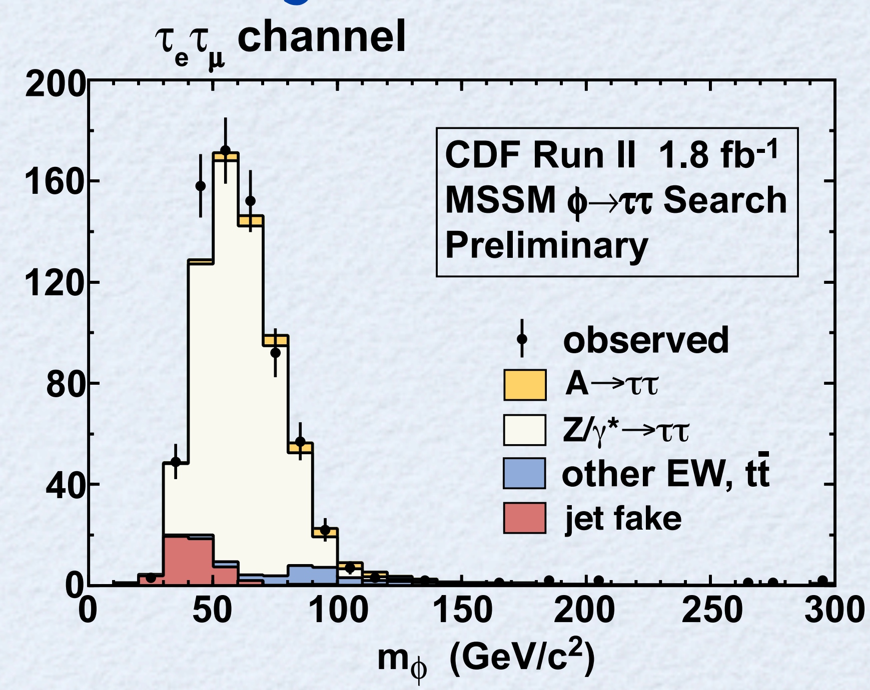


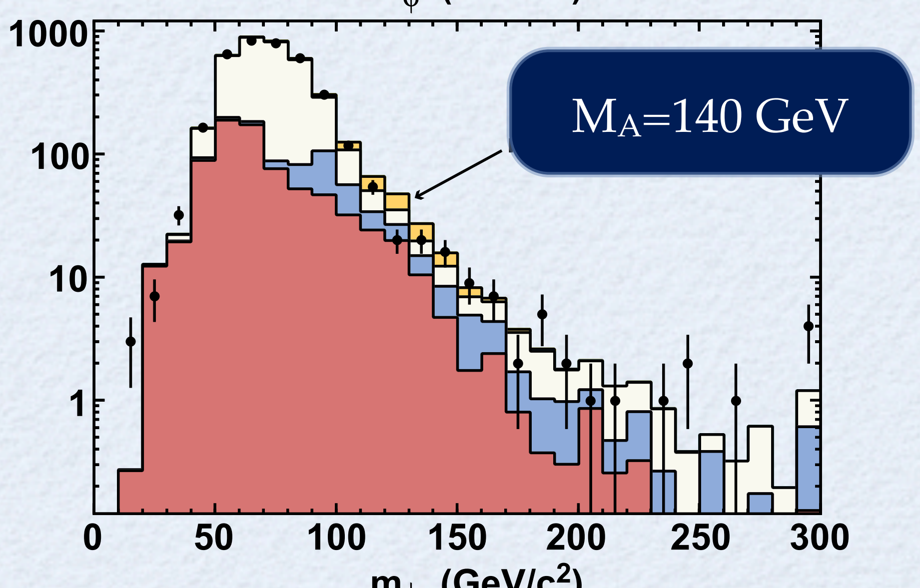


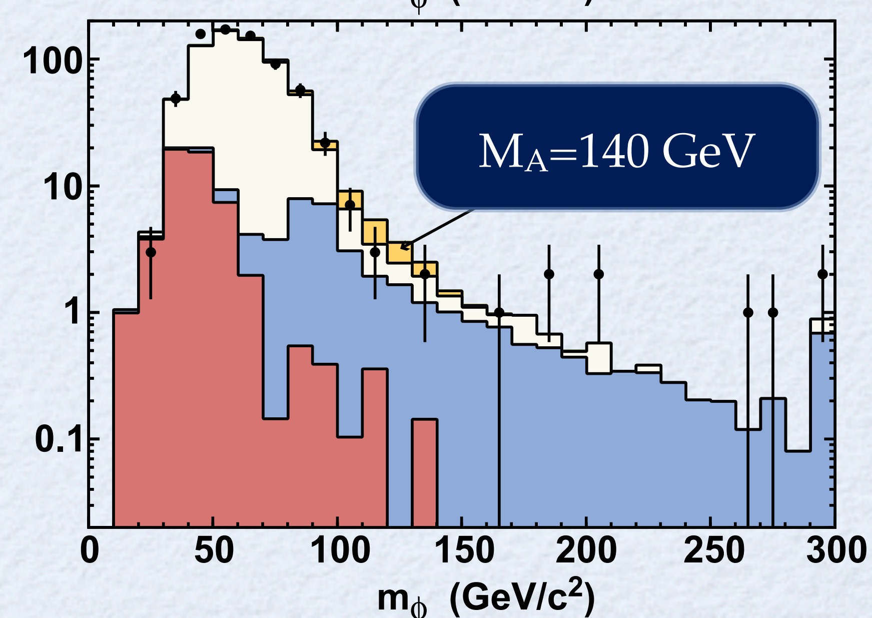
h→τμτh, τeτh, τμτe @ CDF (1.8 fb-1)

- eτ/μτ channel, one isolated electron/muon and an OS hadronic tau
- eμ channel, events with one central muon and one central OS electron
- partially reconstructed di-tau mass fitted with data for signal exclusion



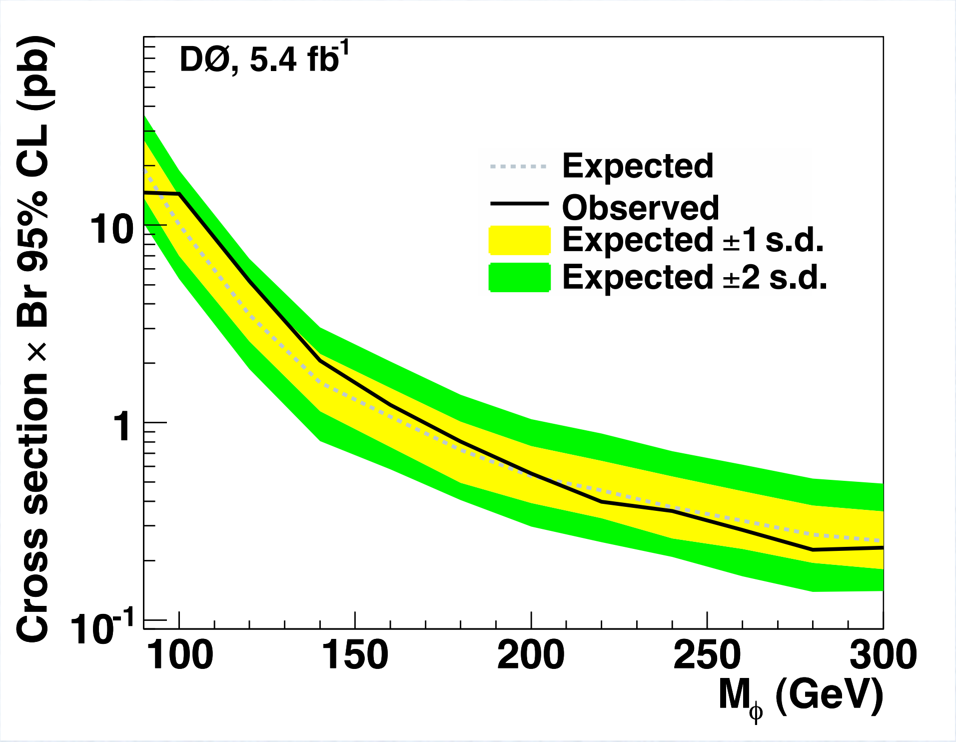


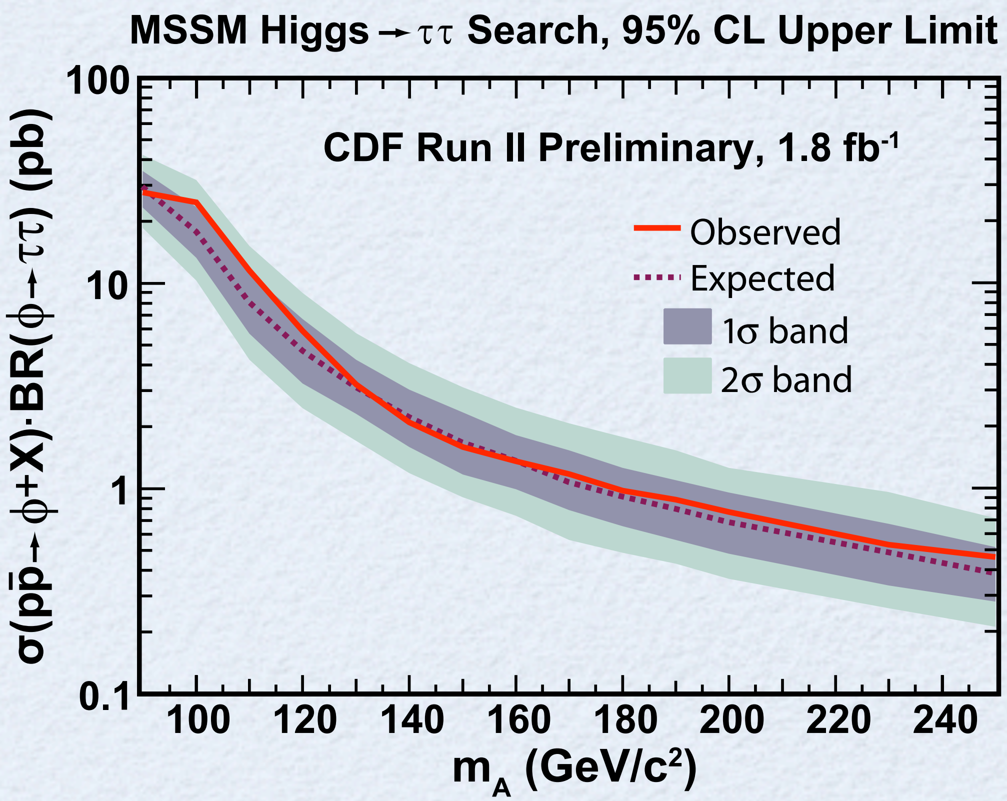




Model independent limit on h→ττ production

- In D0, data are found to be consistent with SM expectations
- A modified frequentist approach used to set upper limits on the cross section times branching ratio in the Higgs boson mass ranging from 90 to 300 GeV
- Similarly CDF observed no signal evidence for mass range of 90 to 250 GeV





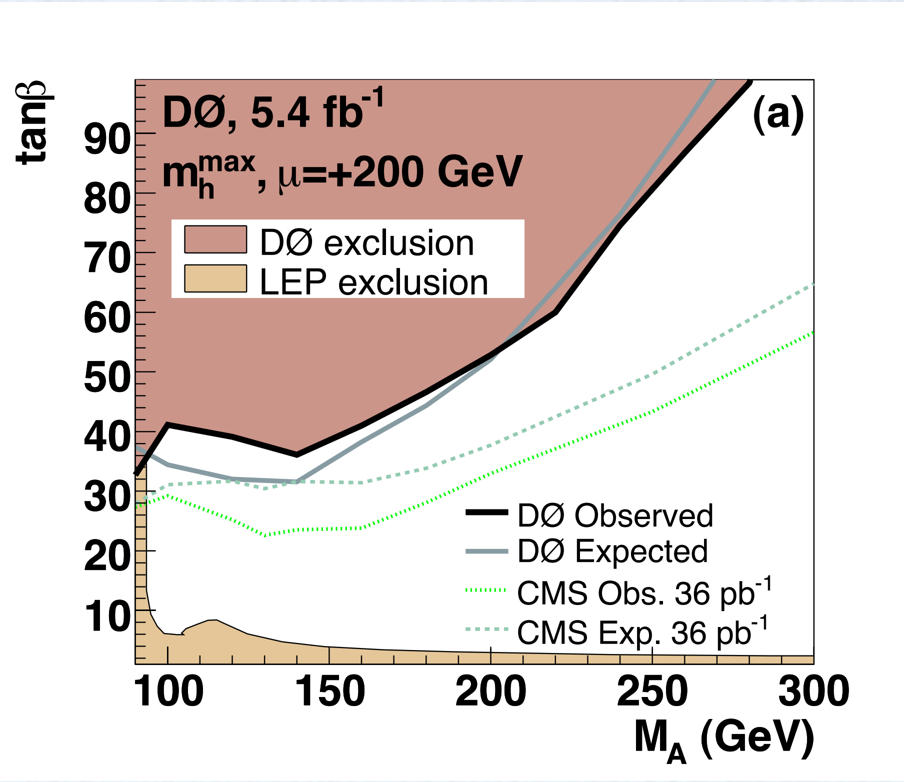
Results in MSSM scenarios h→ττ searches

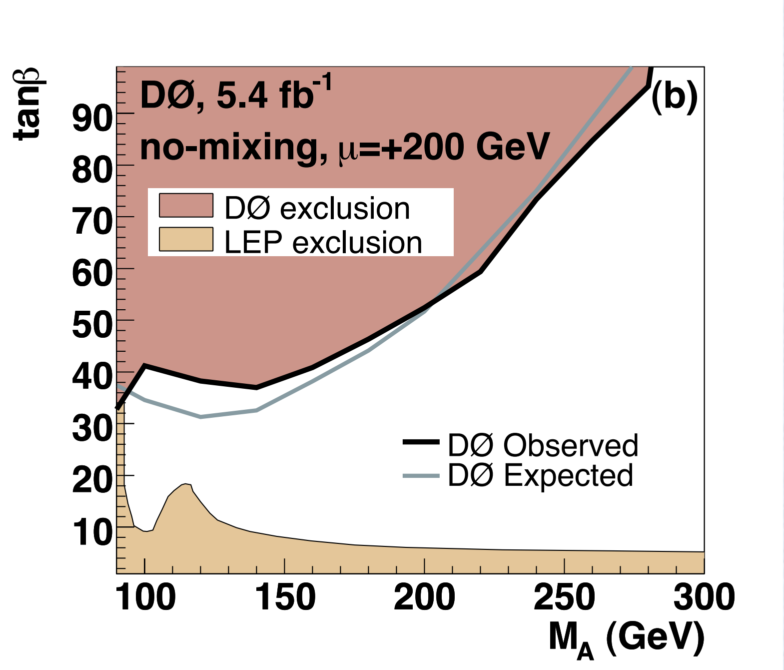
- In the MSSM parameter space, excluding tanβ values expected limit down to 30 for Higgs boson masses below 170 GeV for D0

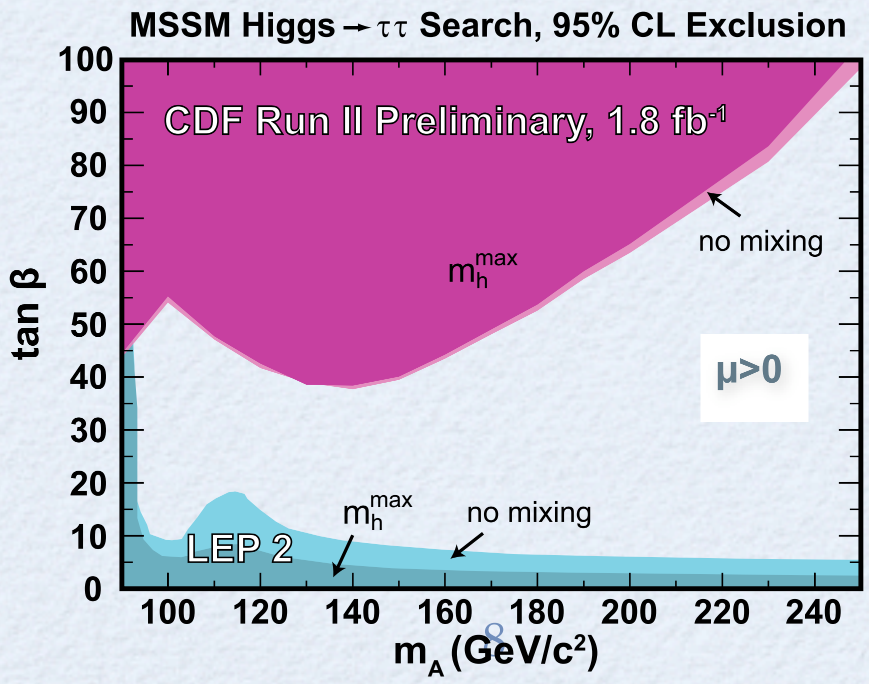
- Similarly CDF excluded tanβ values down to 45

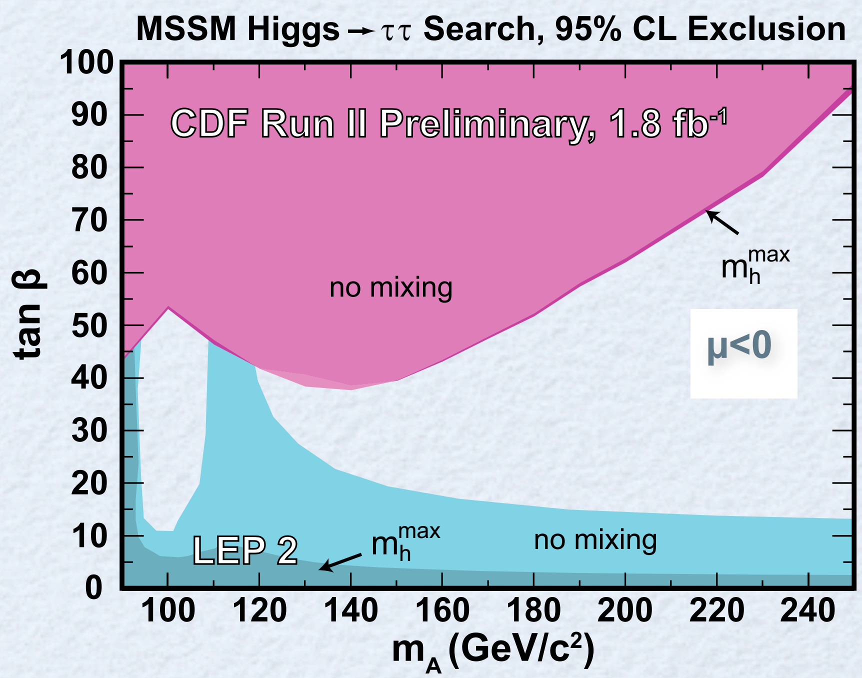
- MSSM benchmark scenarios with mixing and no mixing shown for D0 and CDF

- Nearly as good as with first CMS result







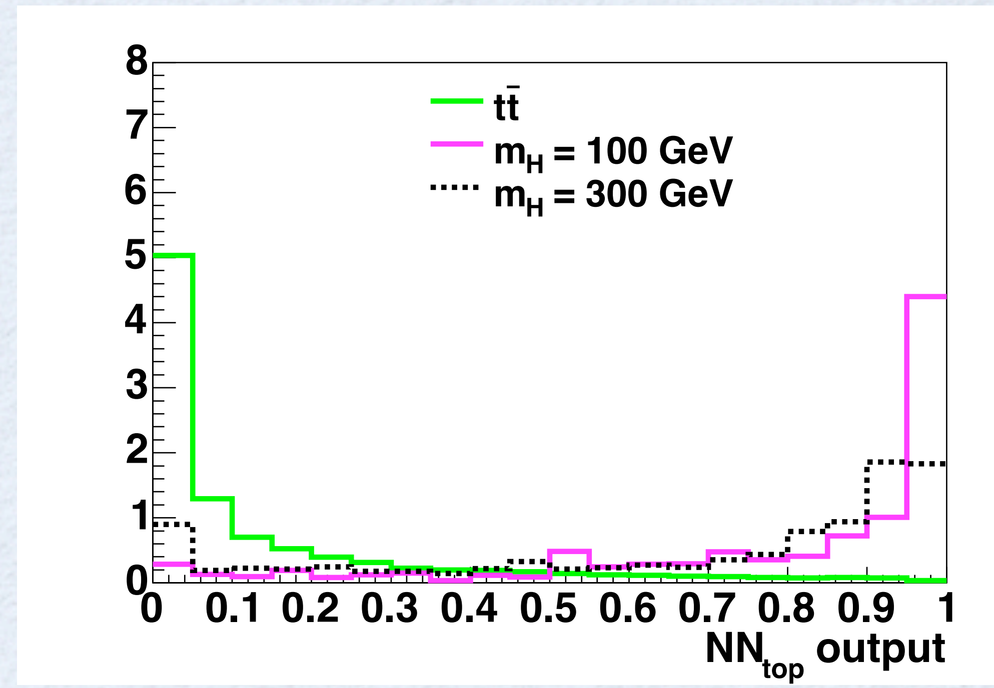


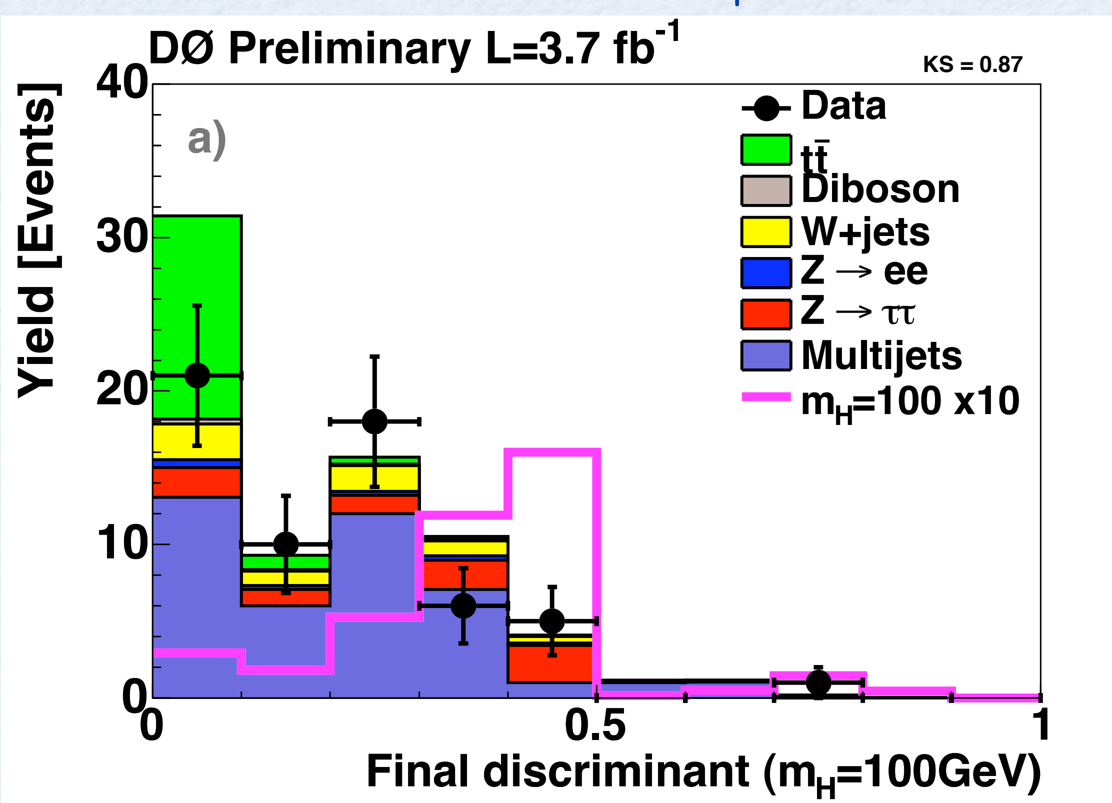
$hb \rightarrow b\tau_e\tau_h$ ($3.7 fb^{-1}$) @ D0

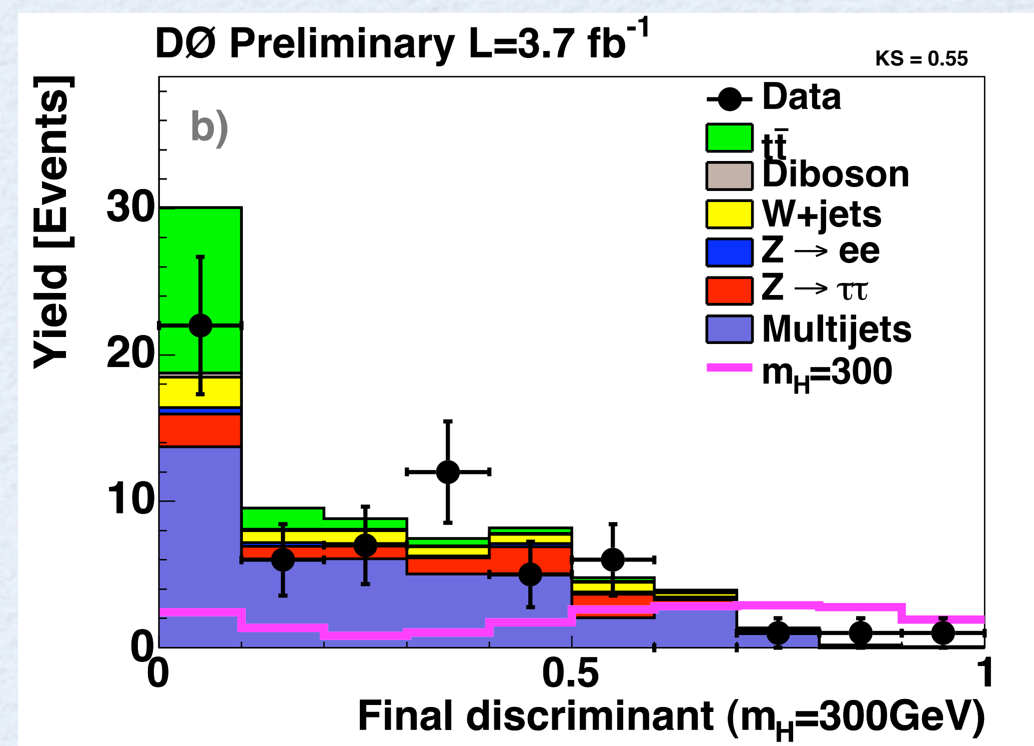
✷ Complimentary to inclusive ττ production, associated production with b quark searches exist

✷ b tagging reduces z+jets irreducible background

- Exactly one isolated electron, exactly one reconstructed hadronic tau and at least one jet
- NN_b cut on b tagged sample
- Final Discriminant=$NN_{top}*(LL_{MJ}+10)/20$

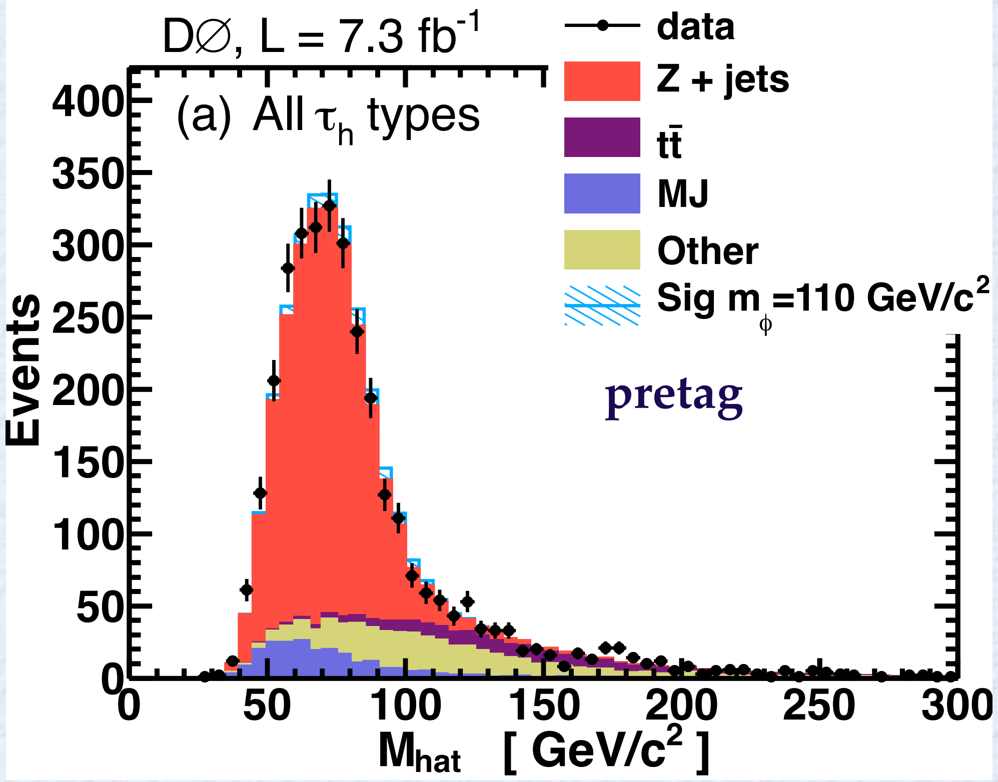


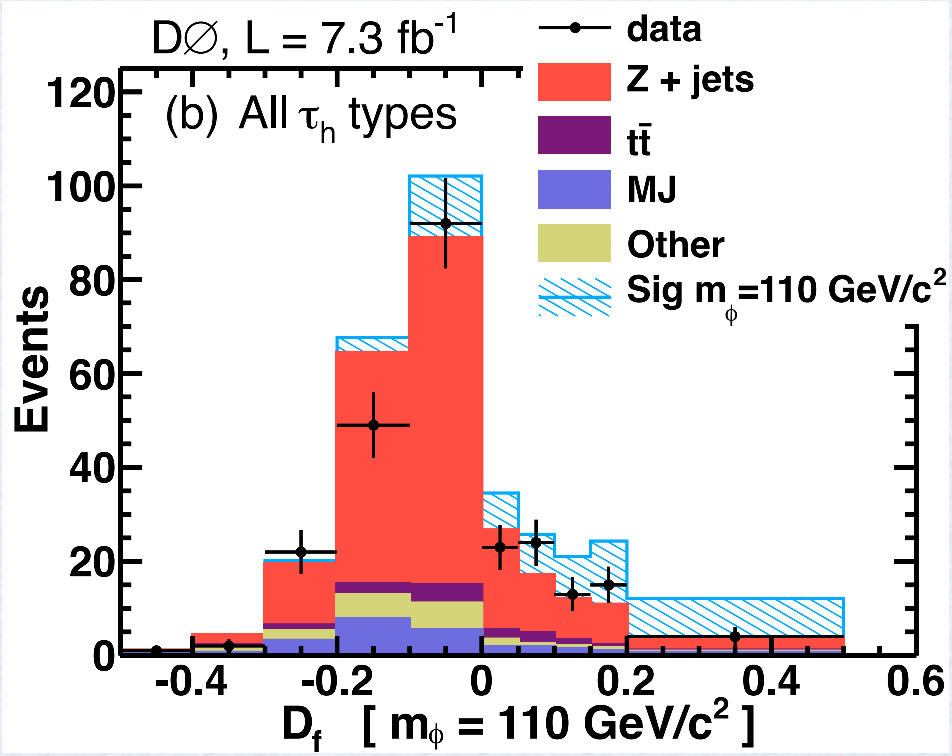


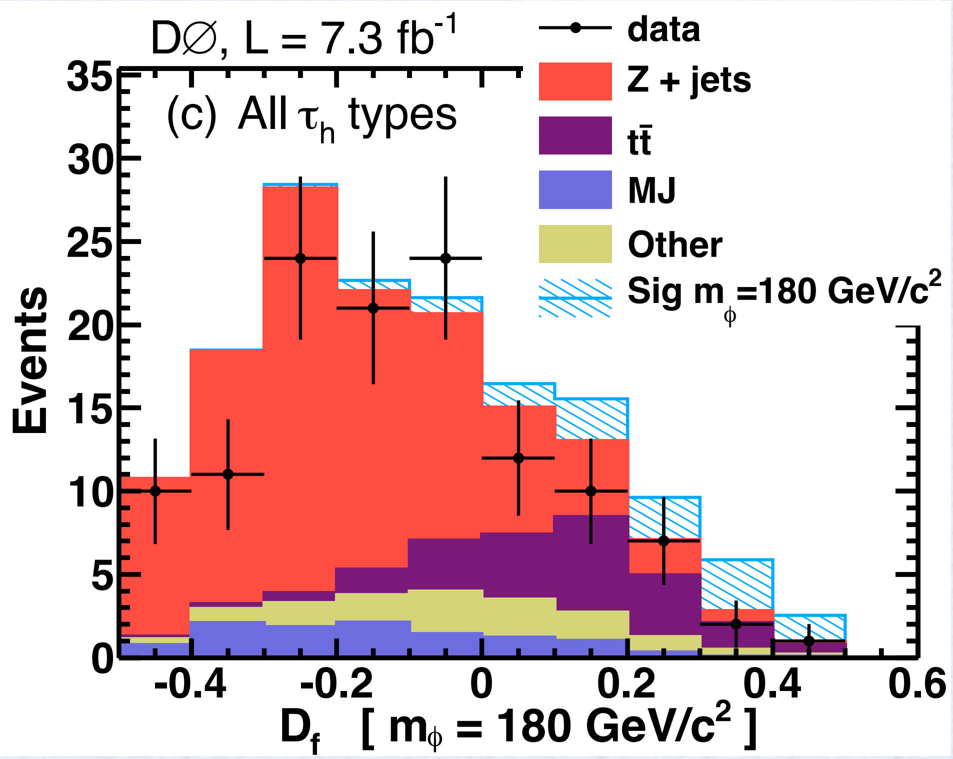


$hb \rightarrow b\tau_\mu\tau_h$ (7.3 fb^{-1}) @D0

- Exactly one isolated muon, exactly one reconstructed hadronic tau, and at least one jet
- b tagged sample at least one jet to have $NN_b > 0.25$
- Final likelihood discriminant formed by D_{mj}, D_{tt}, NN_b and M_{hat}

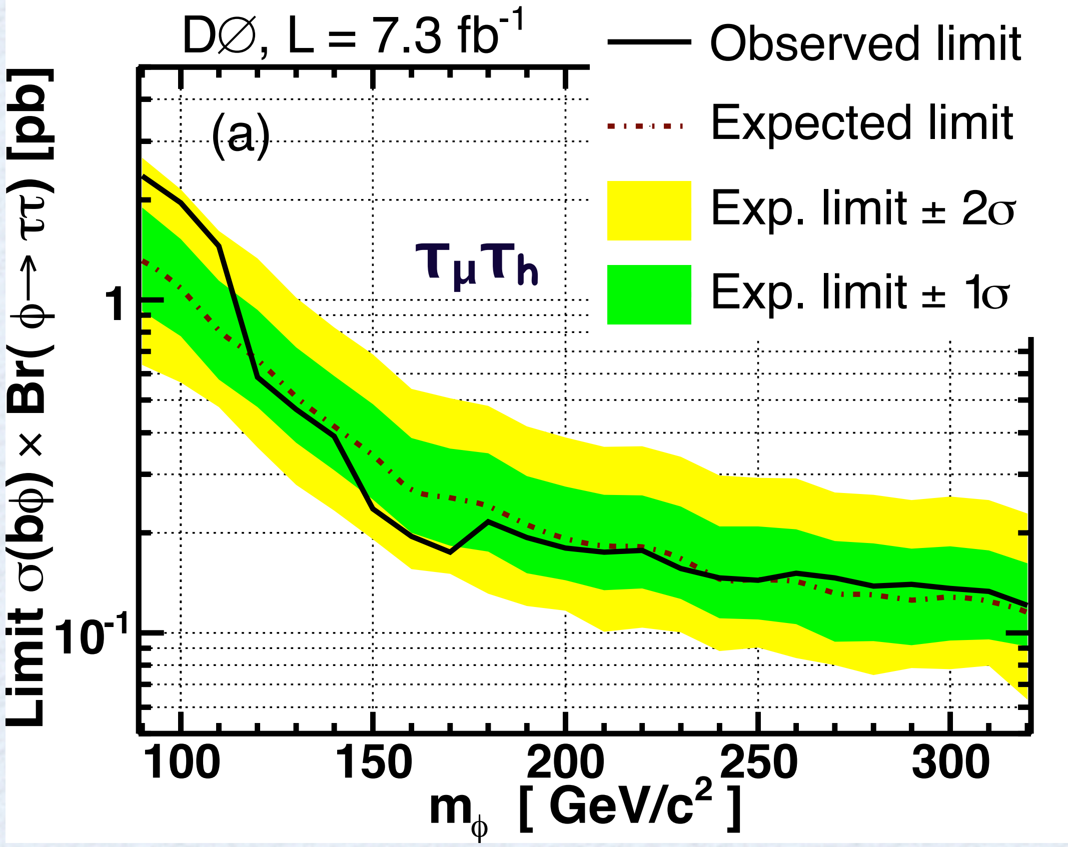


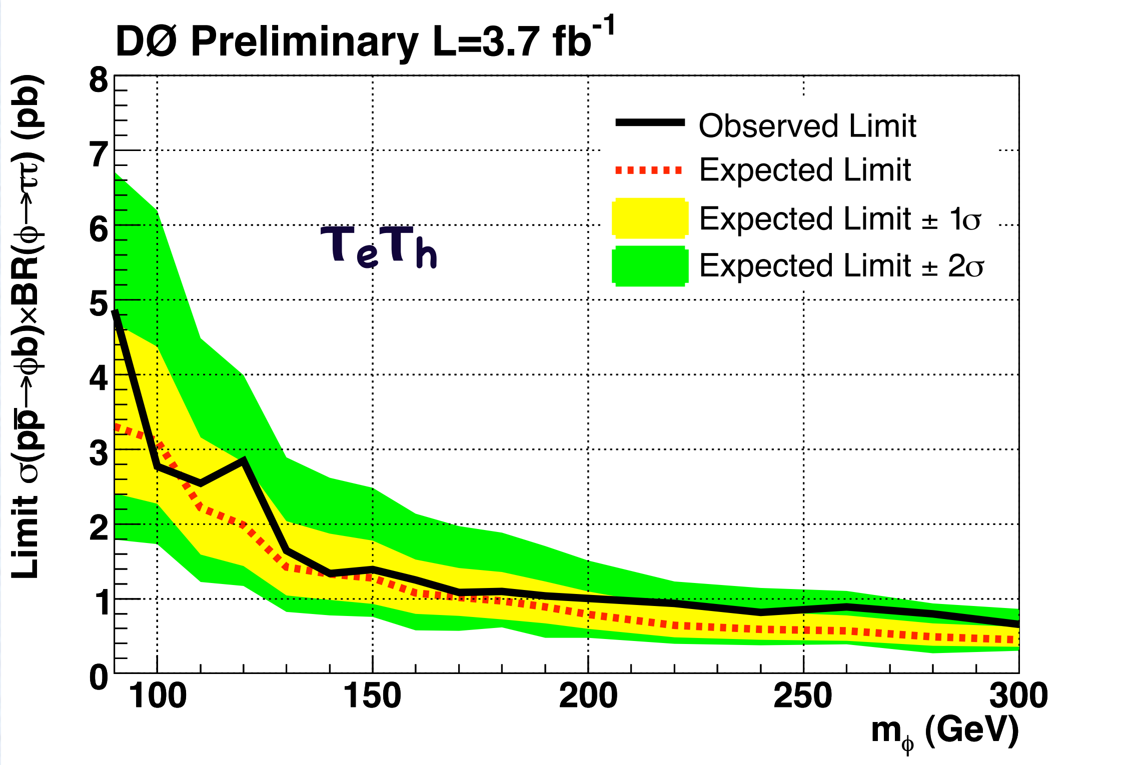




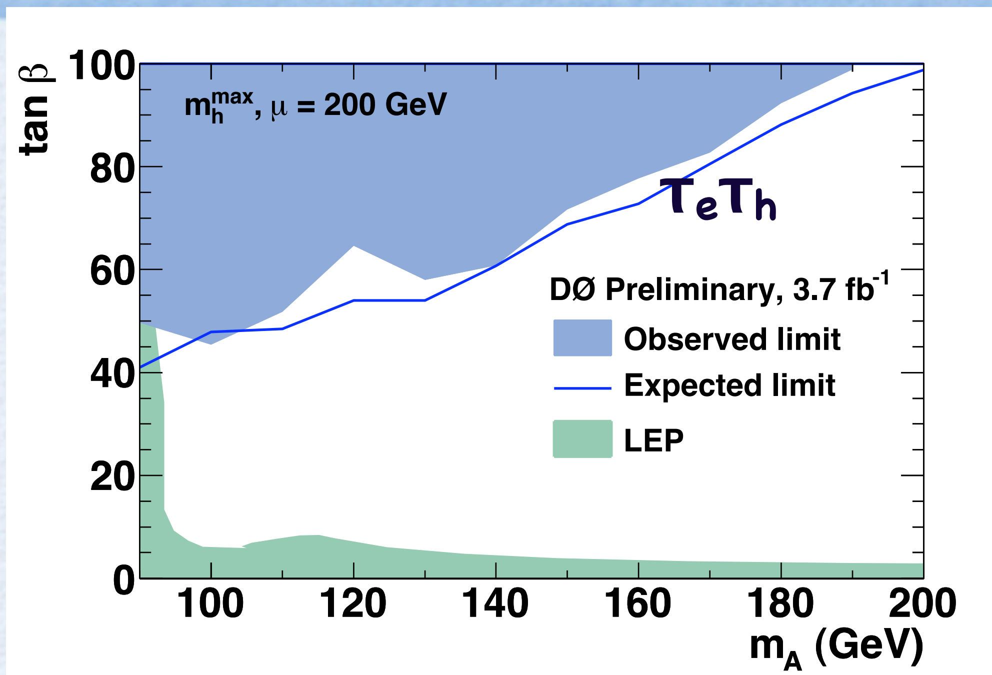
Limits on $hb \to b\tau_\mu\tau_h$, $b\tau_e\tau_h$ @ D0

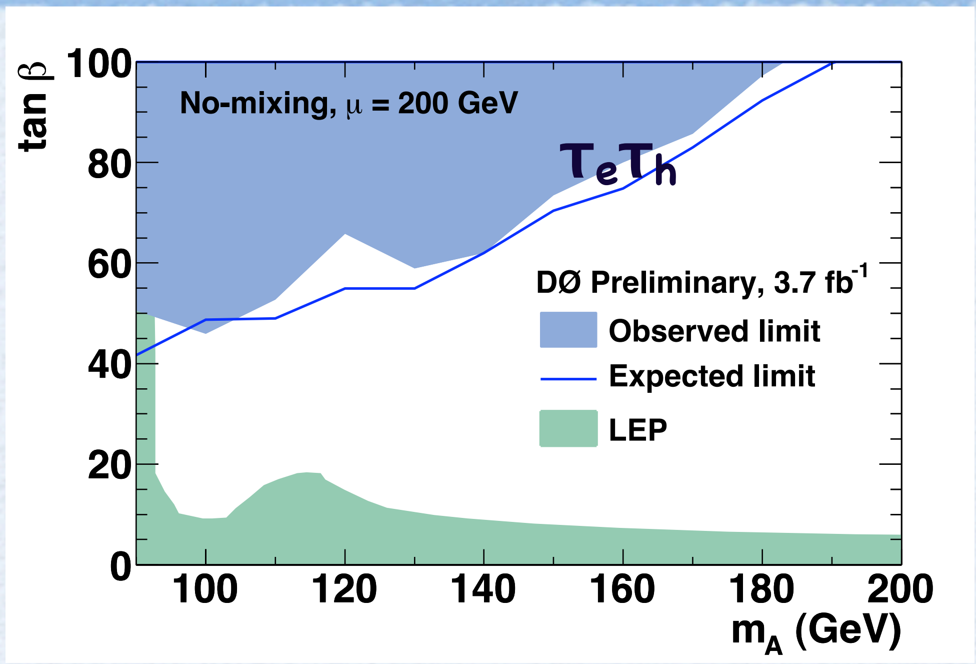
- D0 data are found to be consistent with SM expectations
- D0 sets upper limits on the cross section times branching ratio in the Higgs boson mass range from 90 to 320 GeV using a modified frequentist approach.



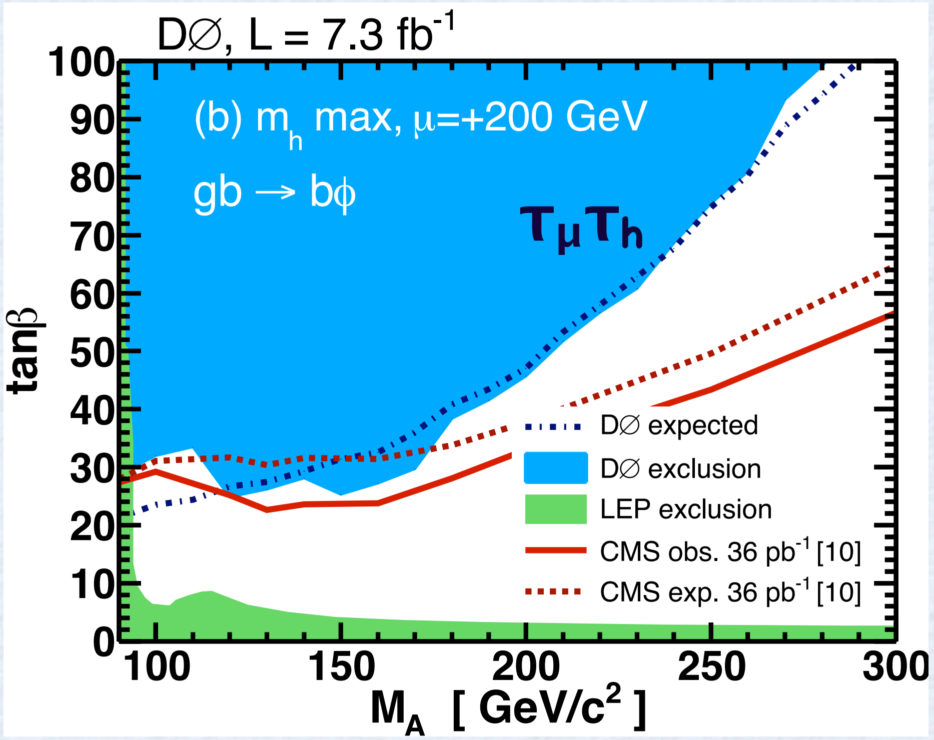


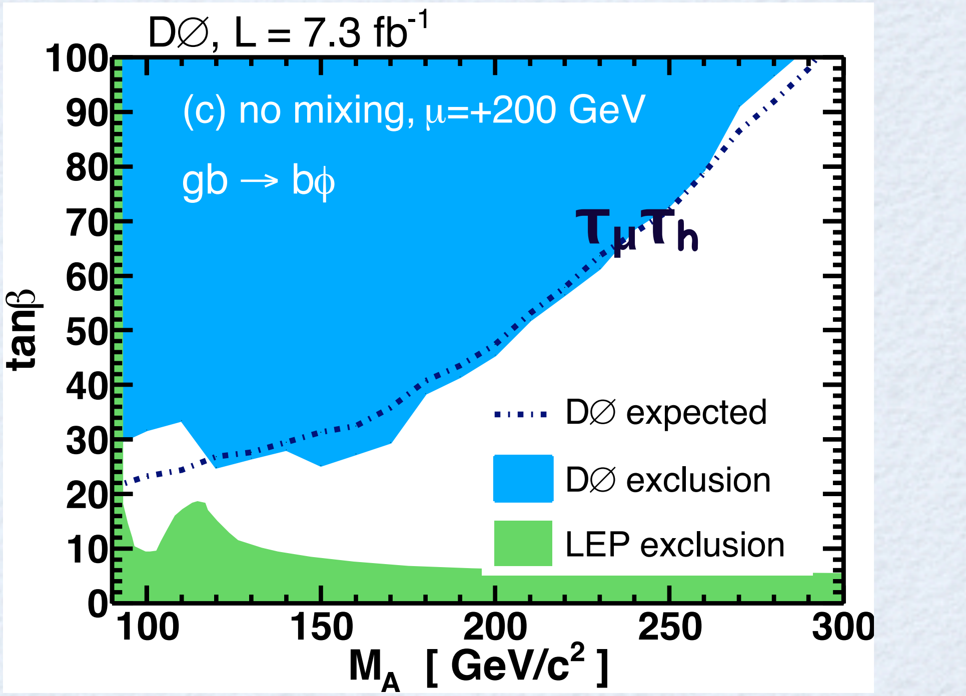
MSSM parameter exclusion for $hb \rightarrow b\tau\tau$



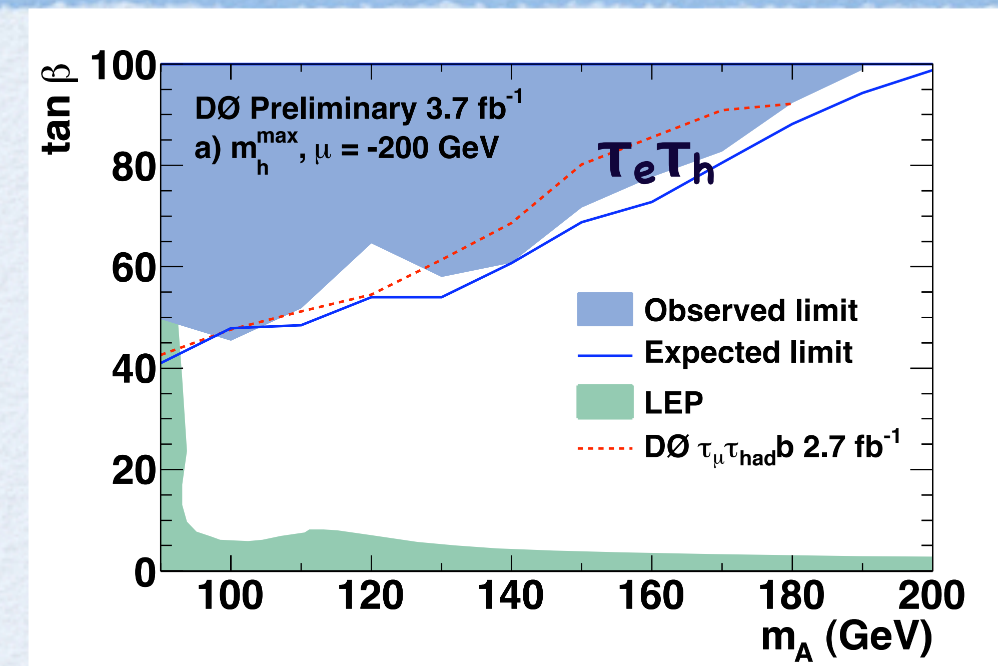


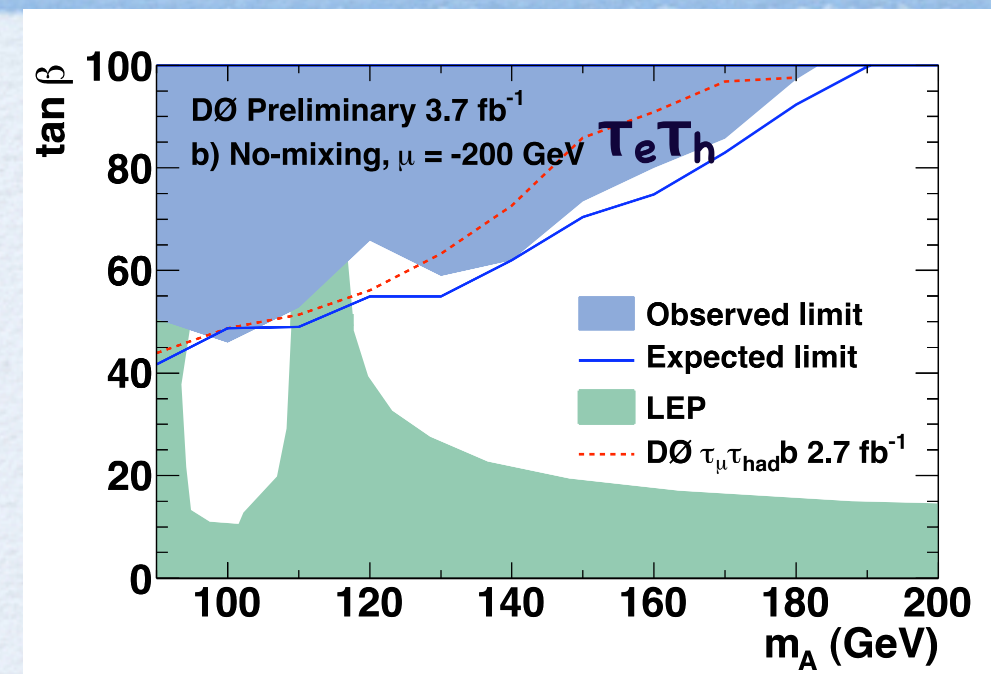
In the MSSM two benchmark scenarios are shown excluding tan β values down to 40 in $b\tau_e\tau_h$ (25 in $b\tau_\mu\tau_h$) for Higgs boson masses below 170 GeV in +μ parameter space



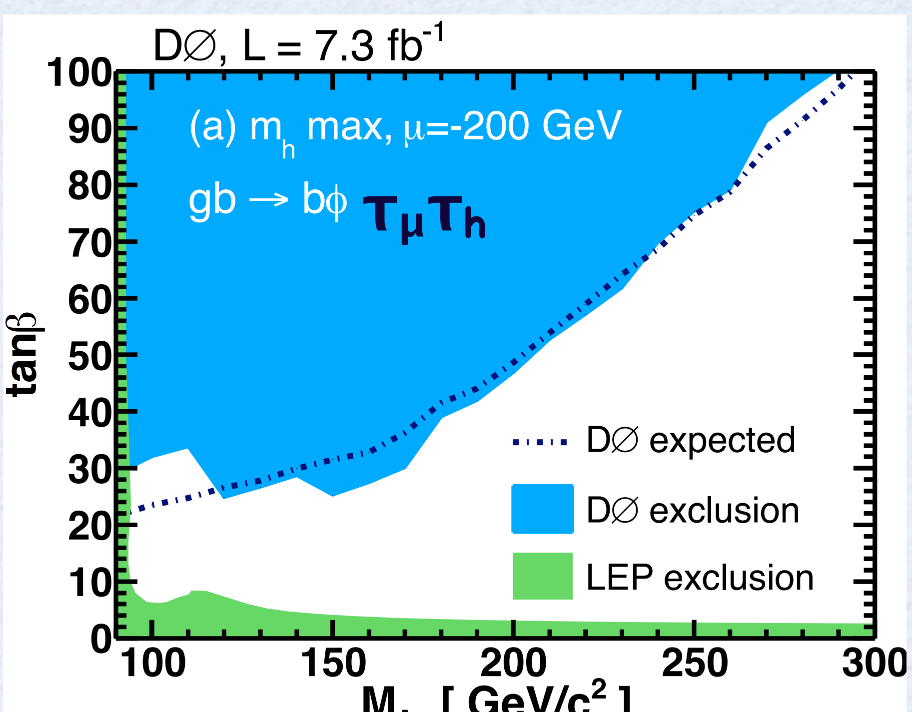


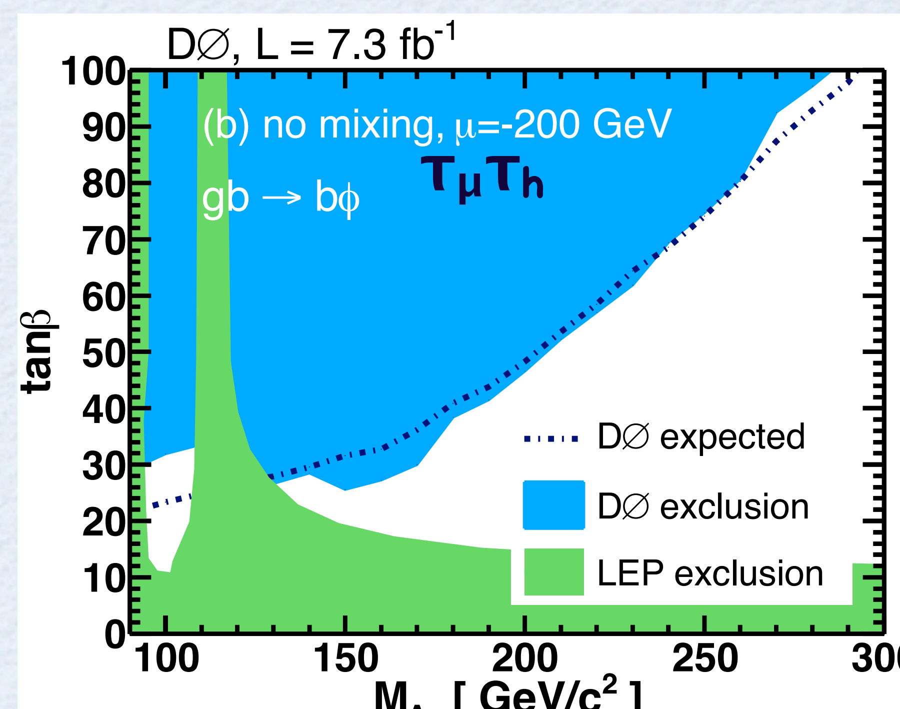
MSSM parameter exclusion for hb→bττ





In the MSSM two benchmark scenarios, excluding tan β values down to 40 in $b\tau_e\tau_h$ (25 in $b\tau_\mu\tau_h$) for Higgs boson masses below 170 GeV in -μ parameter space





Conclusions

➪ MSSM Higgs Searches in complimentary $\tau\tau$ and $\tau\tau b$ channels exclude interesting regions of the SUSY parameter space

➪ These limits are the most stringent limits at Tevatron. Combination of Tevatron MSSM channels will be presented in Louise Suter's talk this morning.

✷ Tevatron sensitivity comparable to first LHC results. In EPS 2011, CMS updated results excluding tan β values down to 15.

- Thanks !