Beyond the Standard Model neutral Higgs searches at the Tevatron

Nils Krumnack (Baylor University)
on behalf of the CDF and D0 collaborations

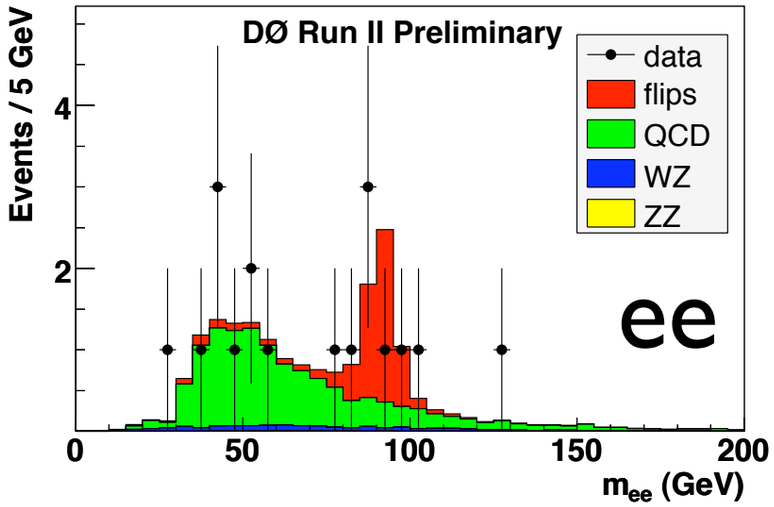
Higgs beyond the SM

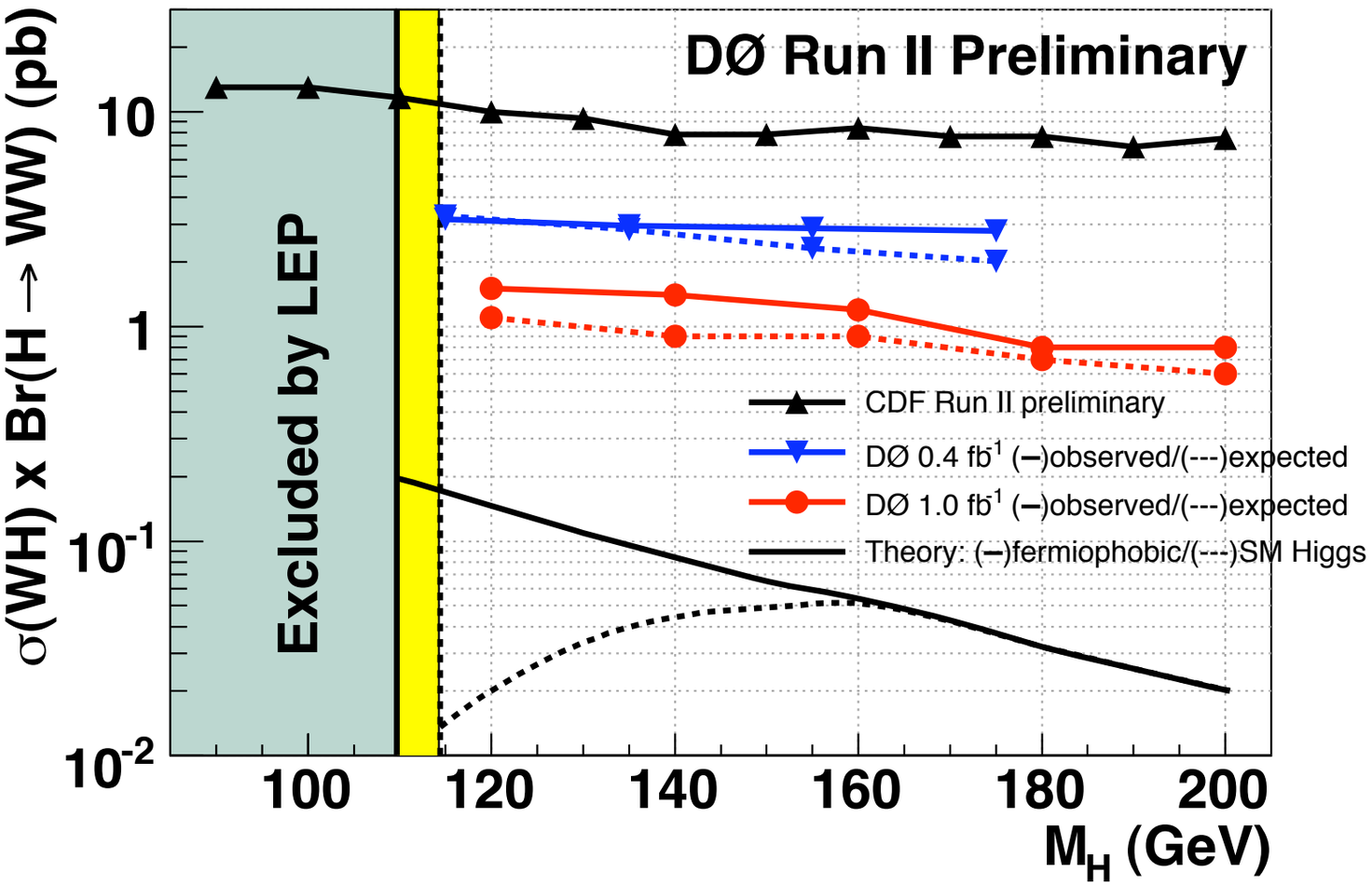
- most efforts centered on finding a standard model Higgs
  - however standard model incomplete
- most SM extensions predict Higgs bosons as well
  - often similar to SM Higgs, but different couplings

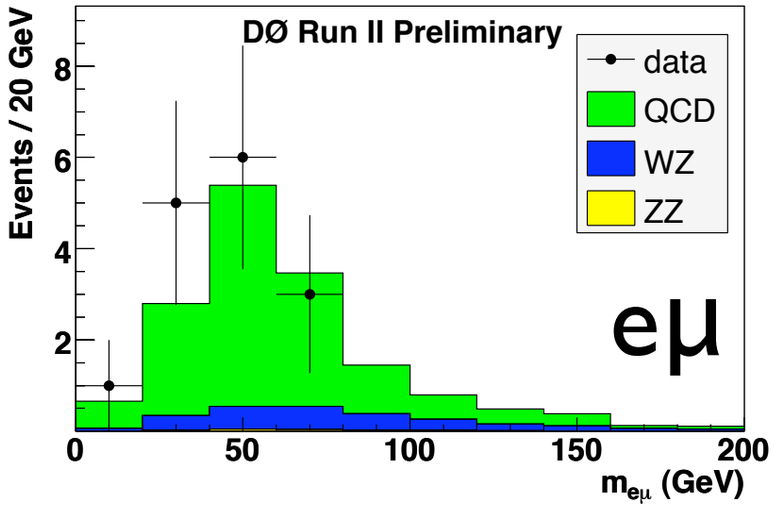
- fermiophobic Higgs (part I)
  - Higgs only (mostly) couples to bosons
  - Higgs decays predominantly into $\gamma\gamma$ or WW (depending on Higgs mass)
  - most searches double as standard model searches
- MSSM Higgs (part II)
  - predicts 5 Higgs bosons: h, H, A, $H^{\pm}$
  - h, H, A similar to SM Higgs
  - couplings different enough to warrant special searches

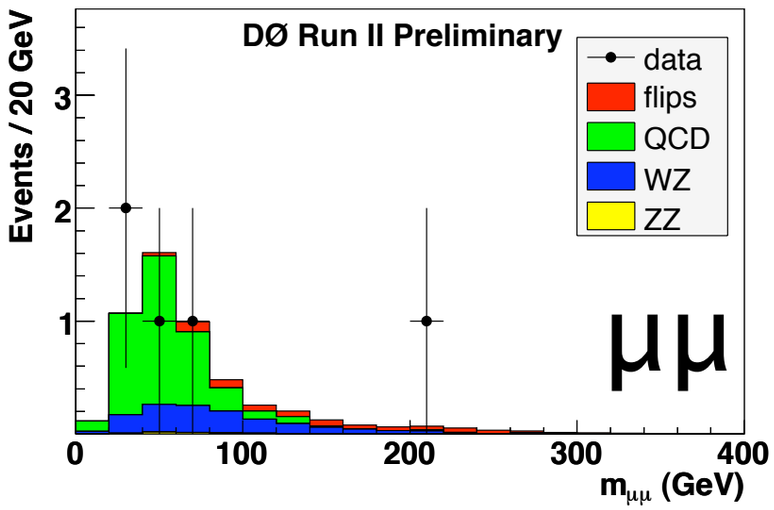
D0: WWW search

- searching for WH→WWW
  - less backgrounds than H→WW
- looking for two like-sign leptons
  - veto on third lepton
- set mass dependent limit





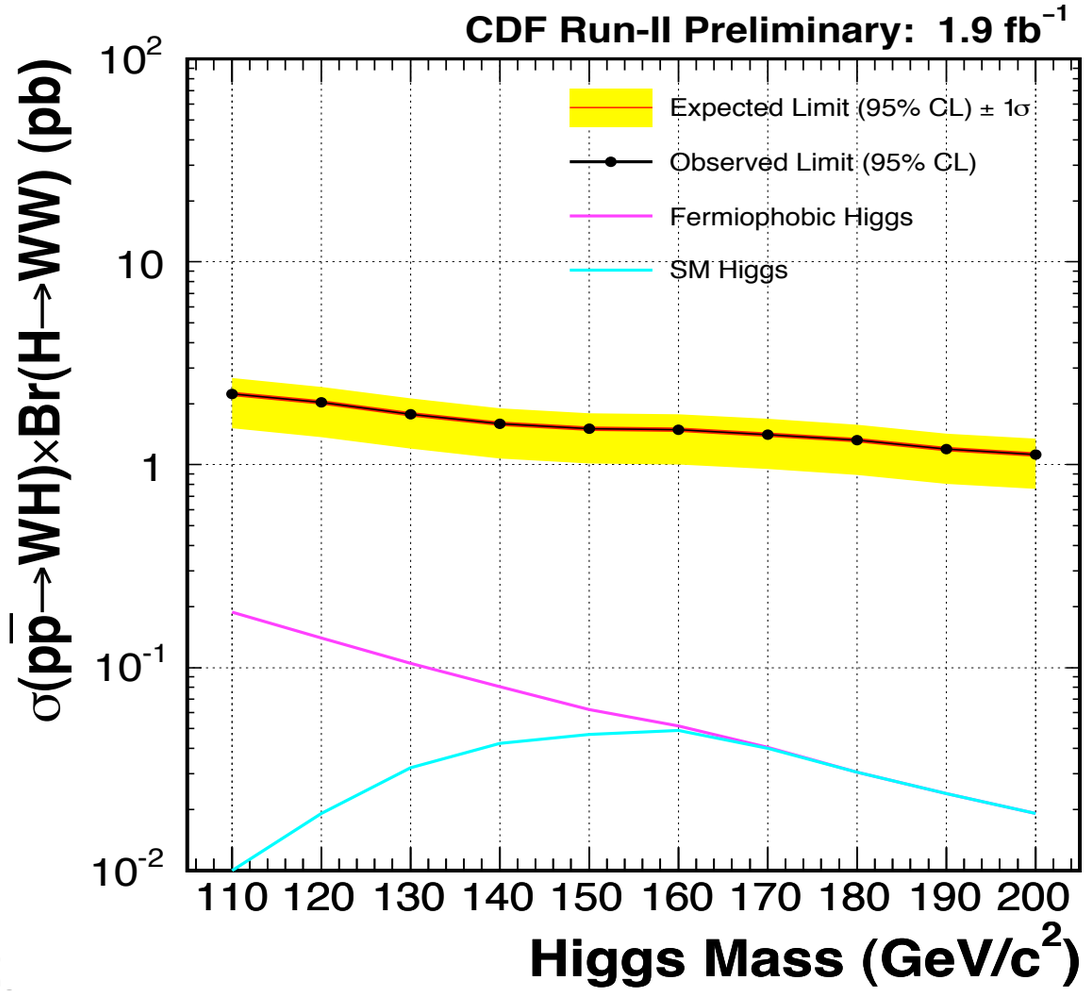


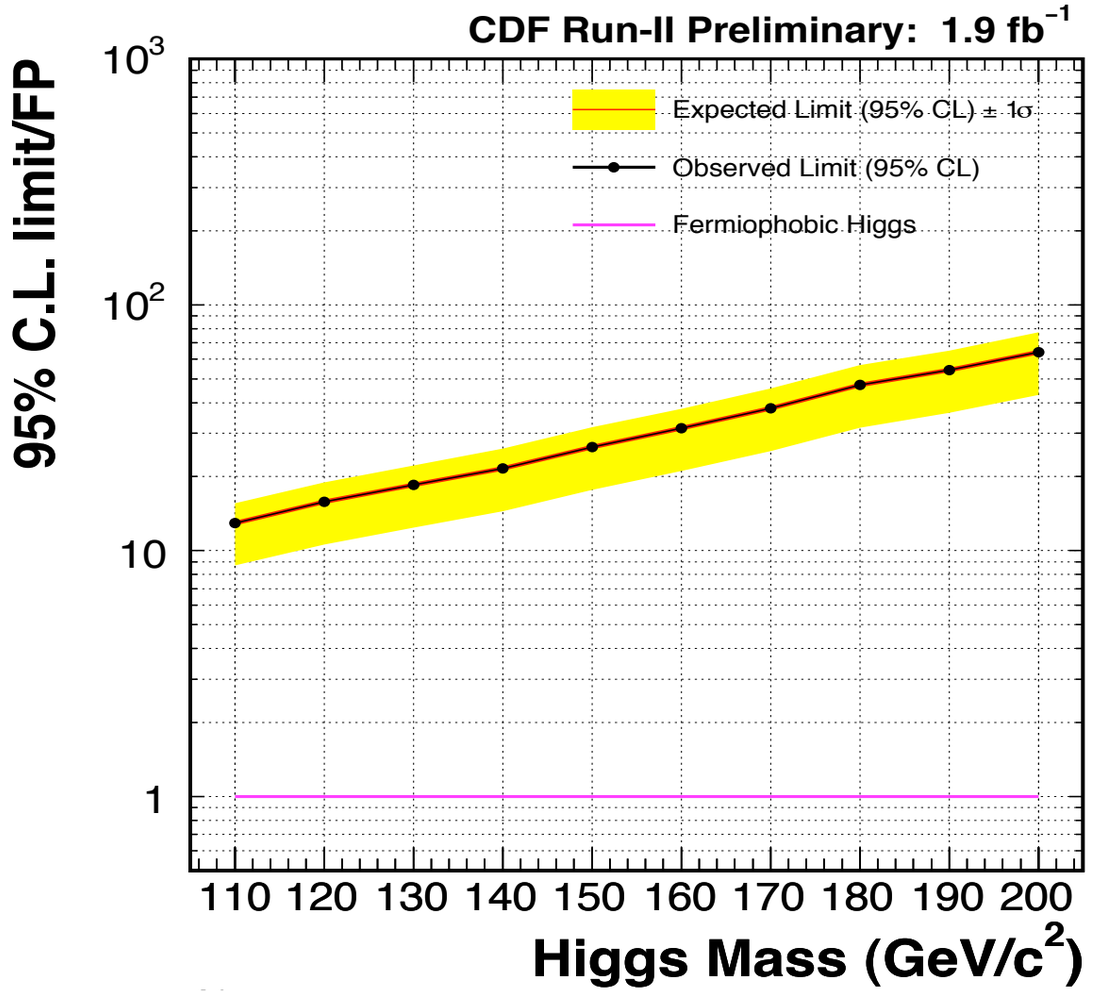


CDF: WWW search

- looking for exactly two same charge leptons
- split sample by lepton types
- simple counting experiment
- extract limits as function of m_H

	events
bkg	141.7±9.2
sig(m_H=110)	0.938±0.050
sig(m_H=160)	0.272±0.016
data	134

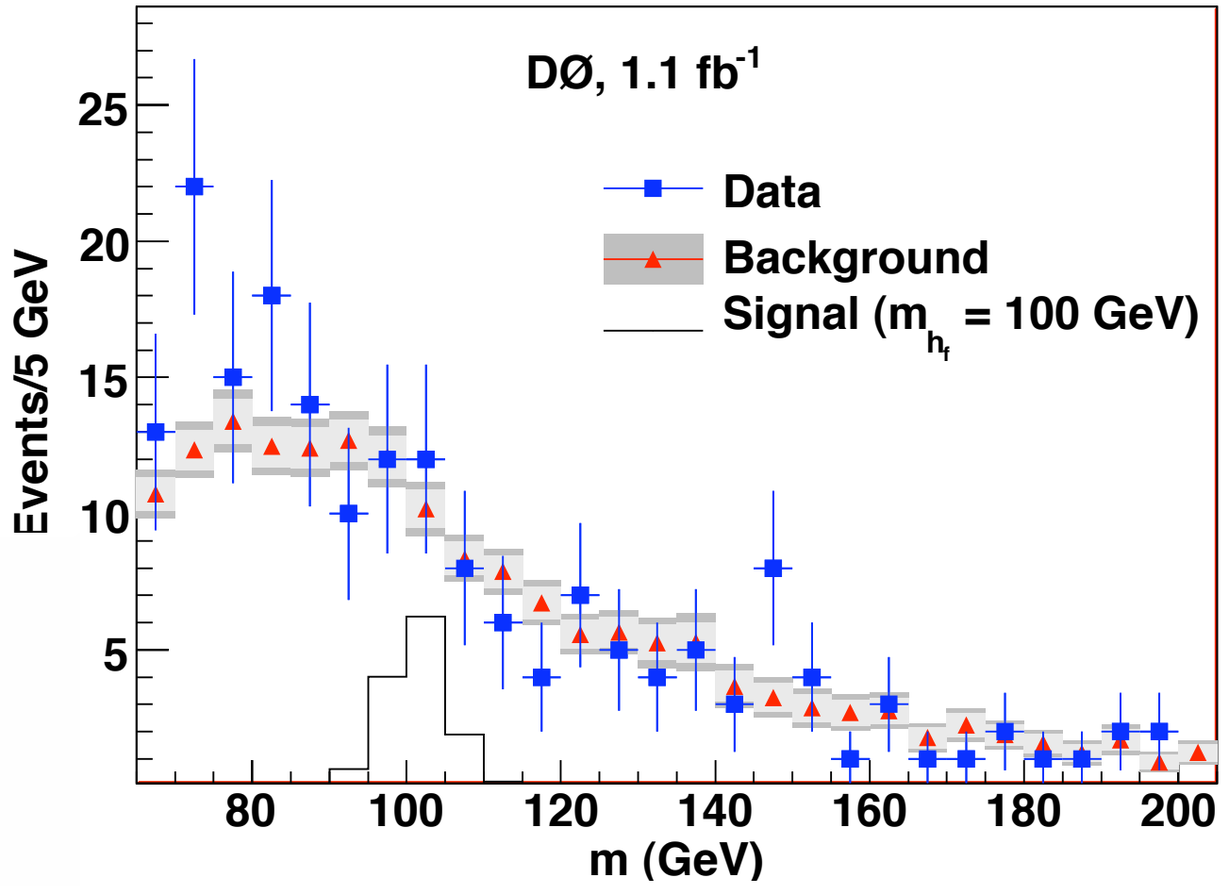


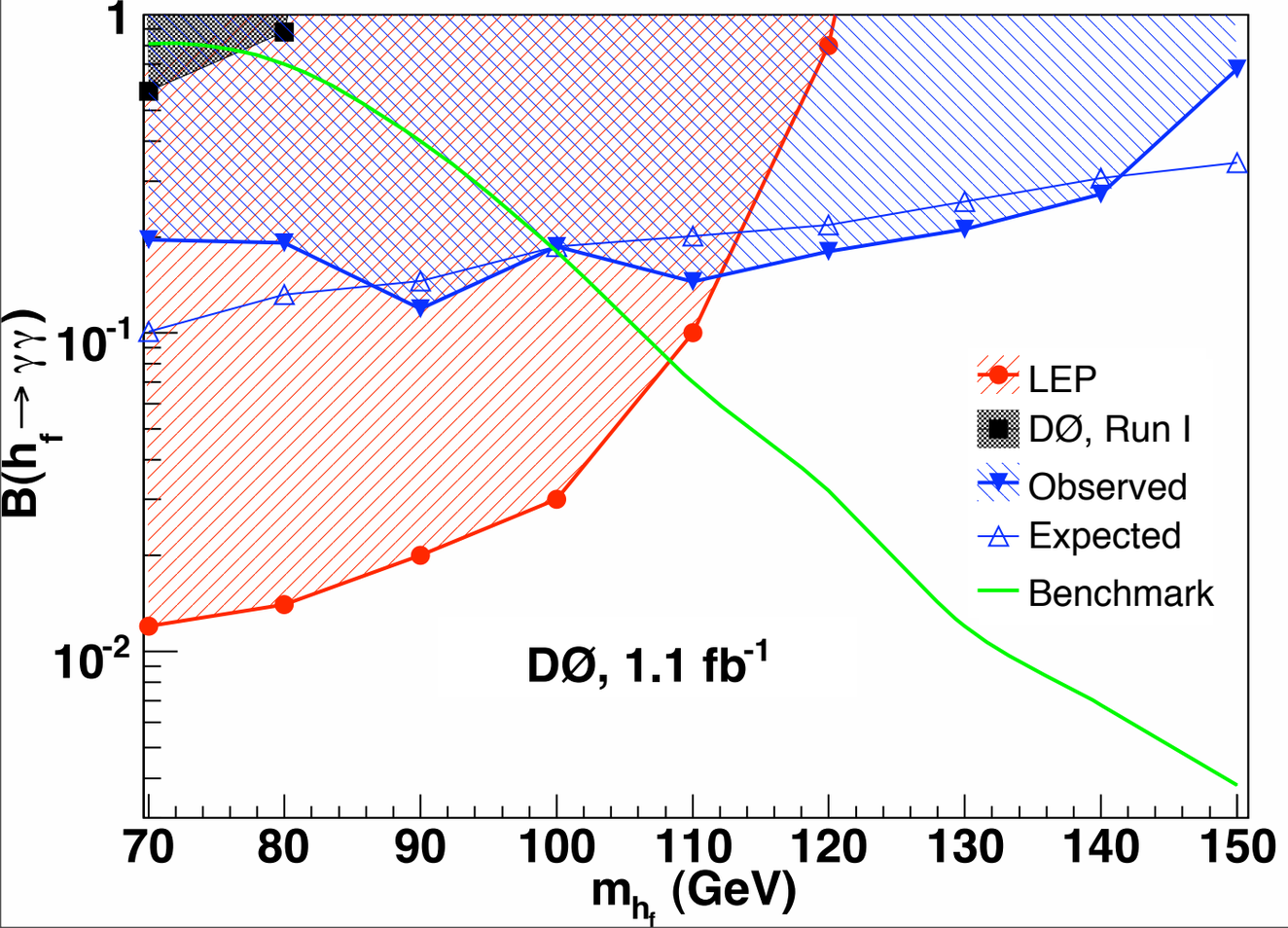


BSM Hig

D0: γγ search

- using neural network to distinguish photons from jets
- searching for excess in di-photon mass

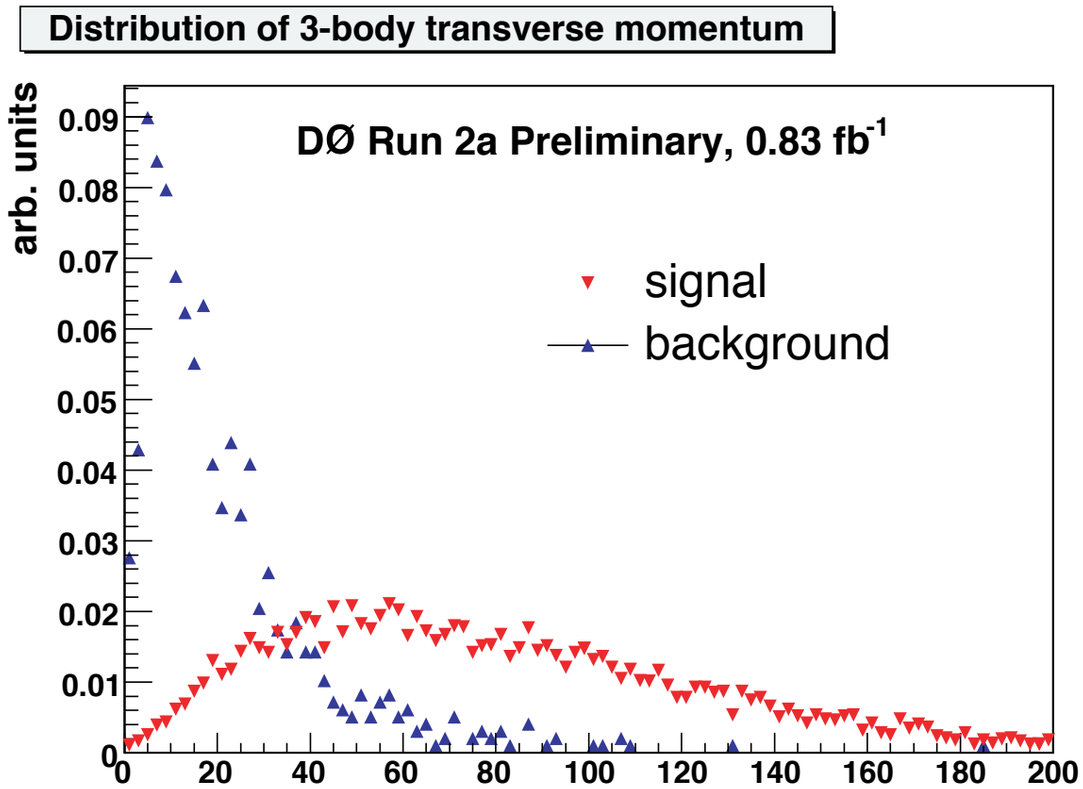


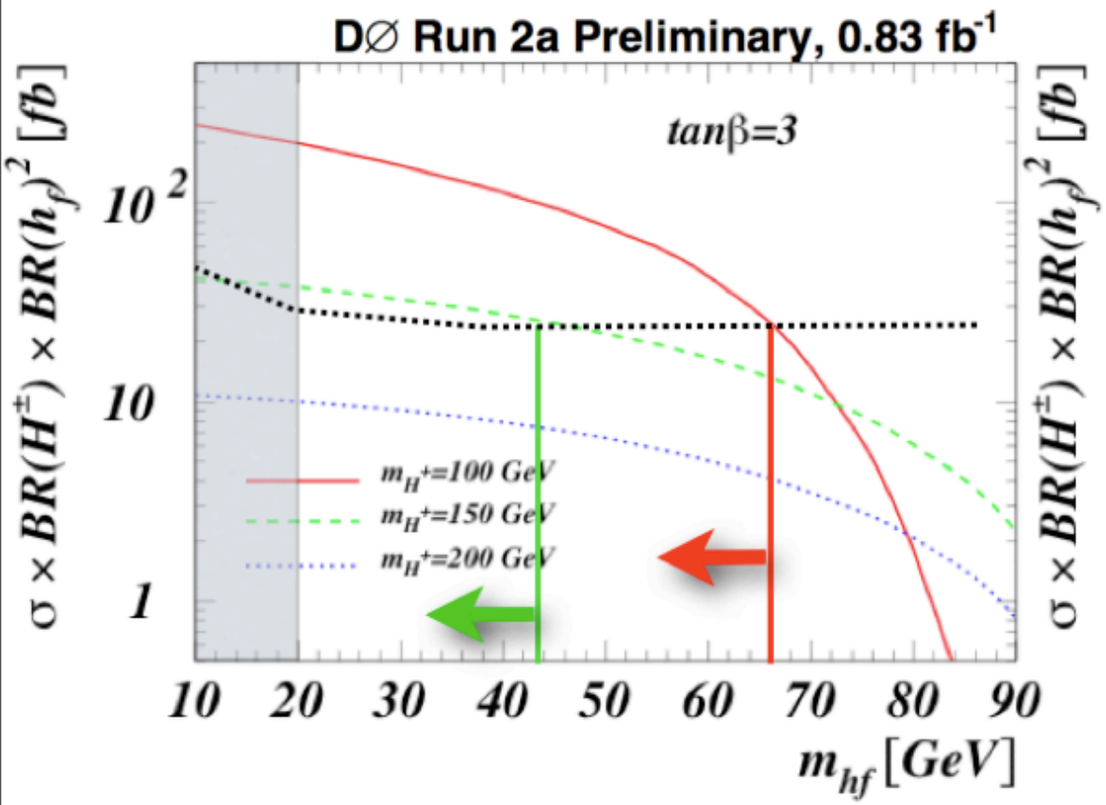


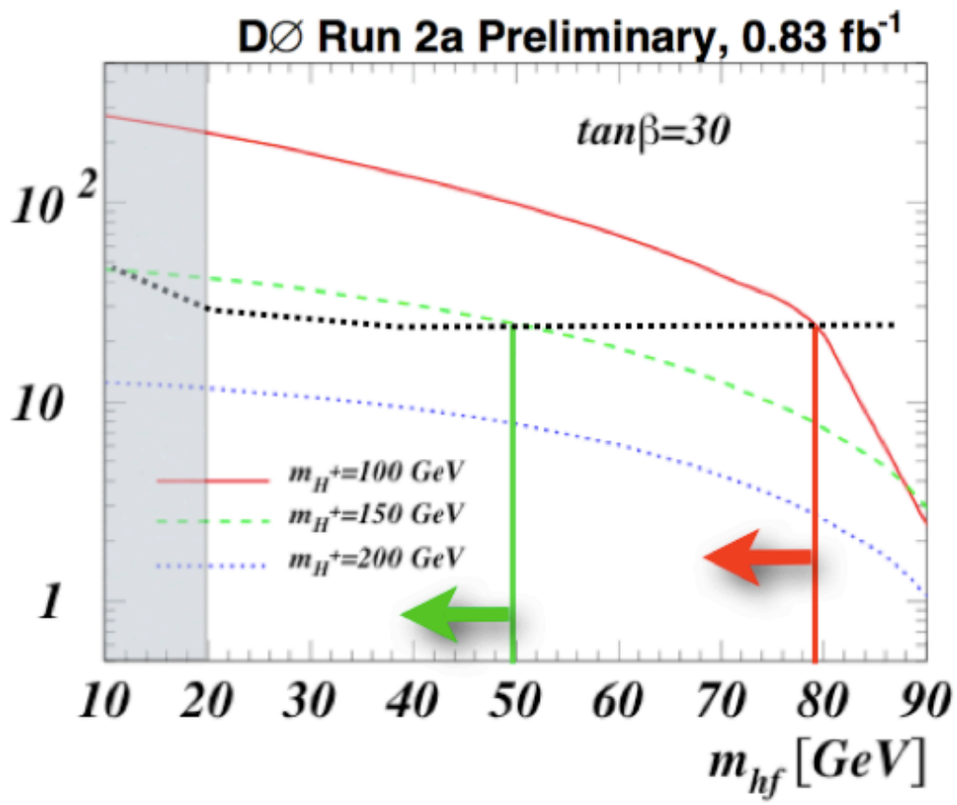
- setting limit as a function of the Higgs mass
- new results coming soon

D0: γγγ search

- assume $h_f VV$ is suppressed
  - use $h_f VH$ vertex instead
  - $W^* \rightarrow h_f H \rightarrow h_f h_f W \rightarrow \gamma\gamma\gamma(\gamma)+X$
- look for excess at high transverse momentum of tri-photon system
- setting model depending limits



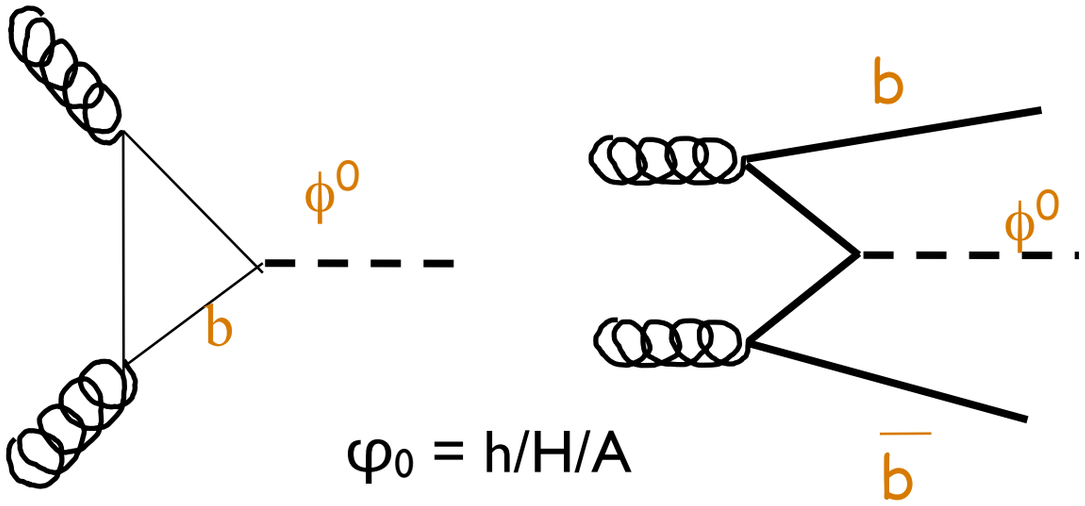


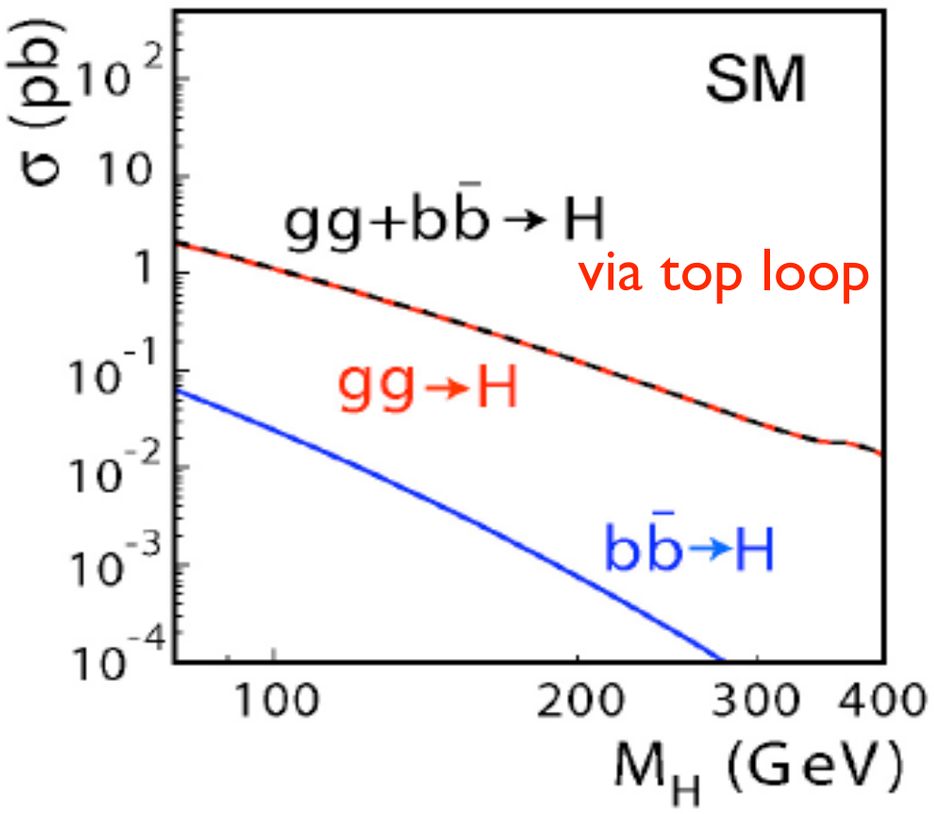


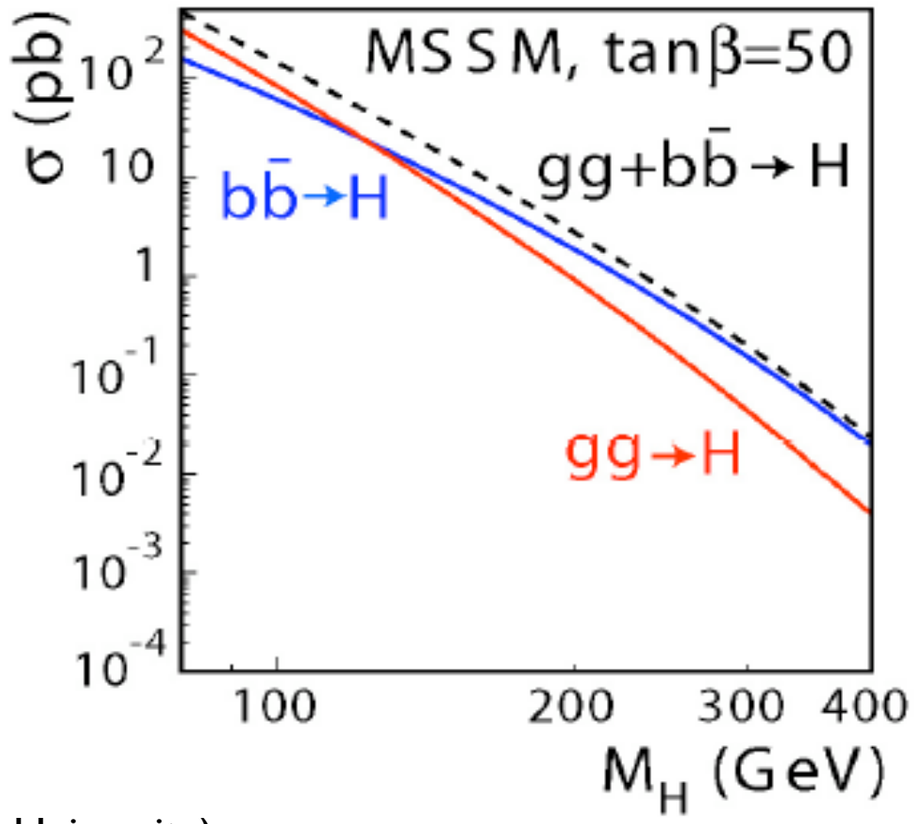
H_T>30	
SM bkg	1.1 ±0.2
data	0

MSSM Higgs

- Processes involving bottom quarks (down-type) can be enhanced (goes like $\tan^2\beta$)
- Boost from femtobarns to picobarns
- dominant decays to bb (90%) and $\tau\tau$ (10%)
  - $\tau\tau$ has much lower backgrounds

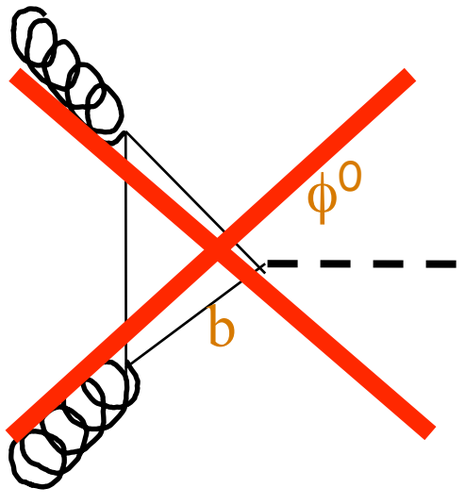




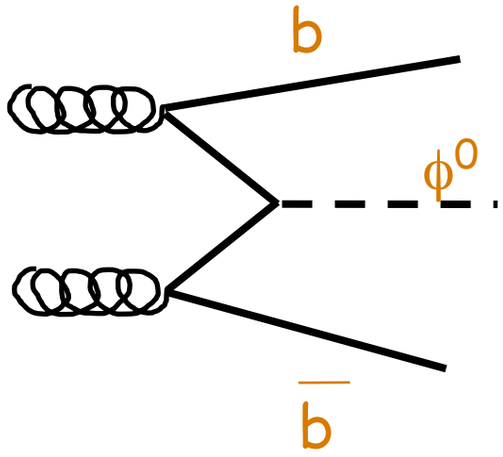


bbb search

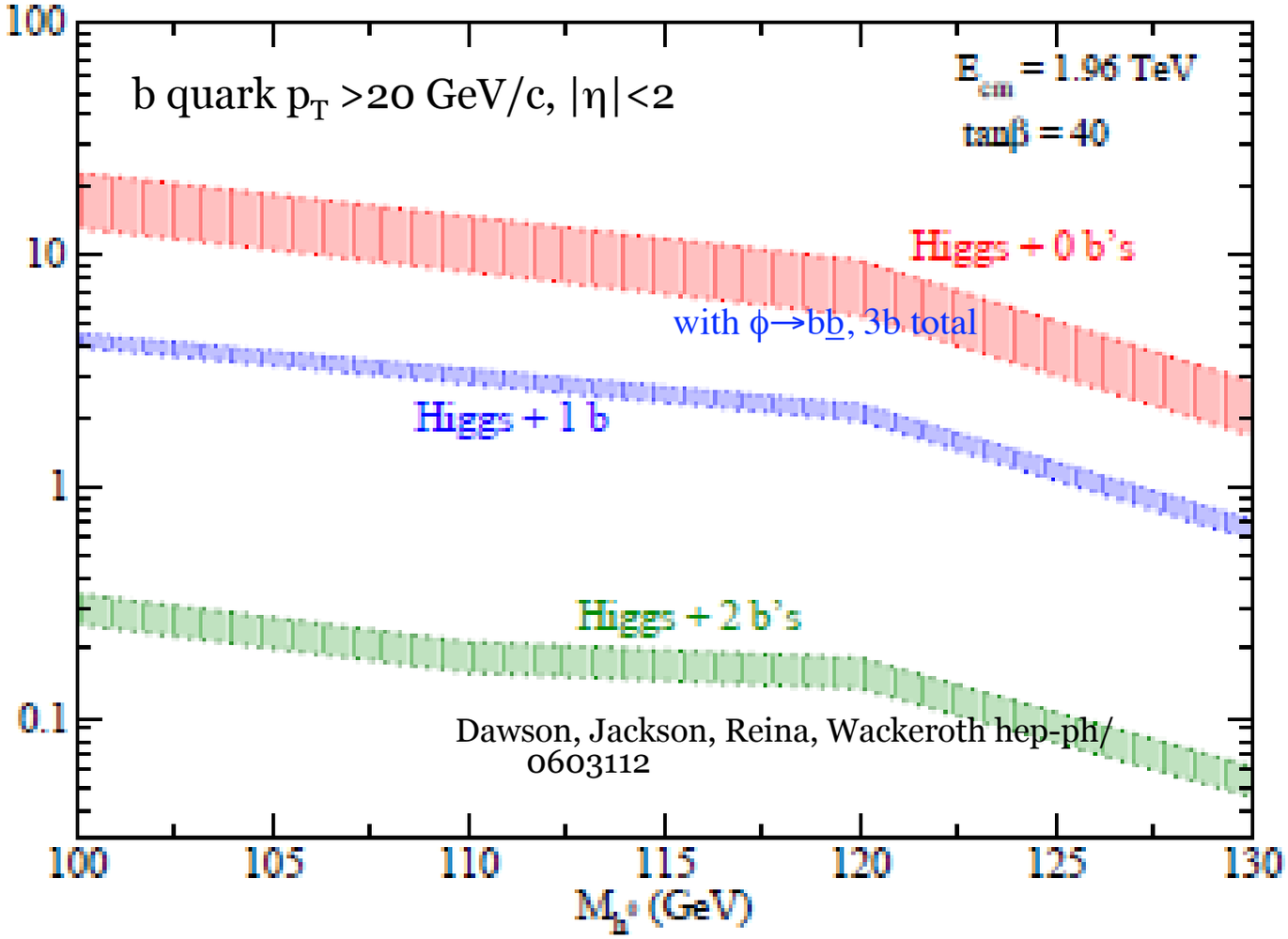
- at high tanβ predominant decay is to bb (BR=90%)
- direct search for H→bb is hard
  - lots of QCD background



too much background

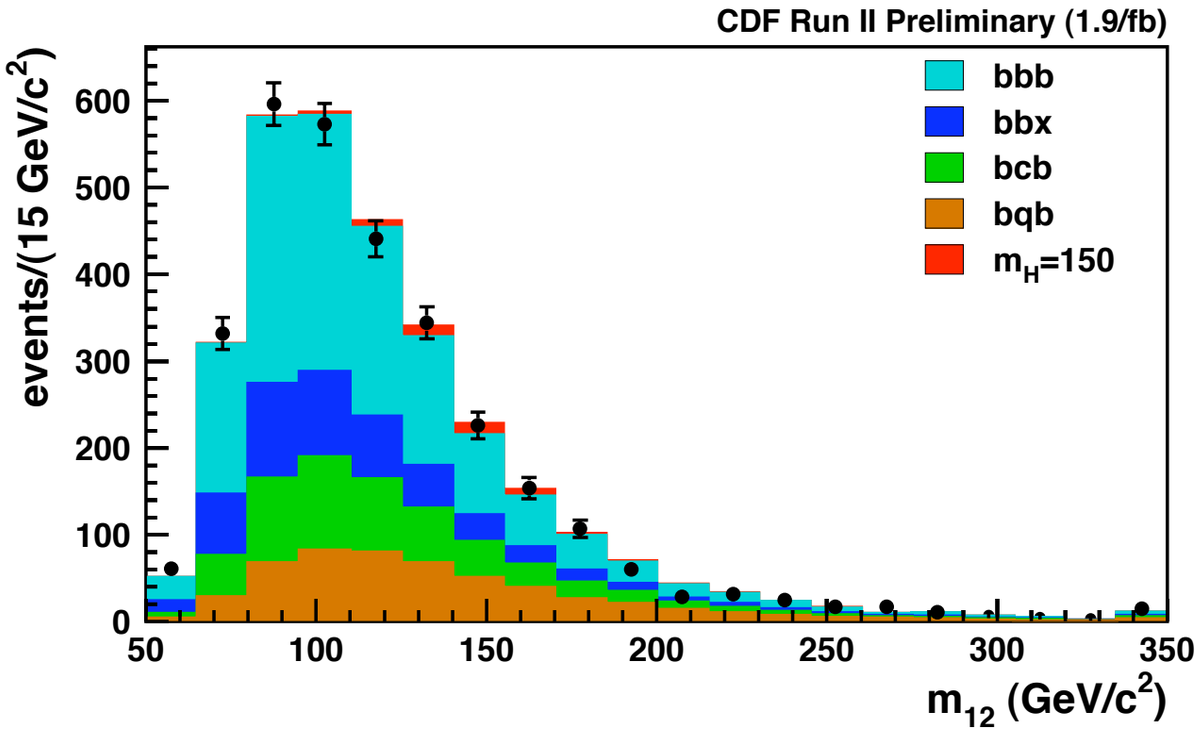


- search for bH→bbb instead
  - best signal to background

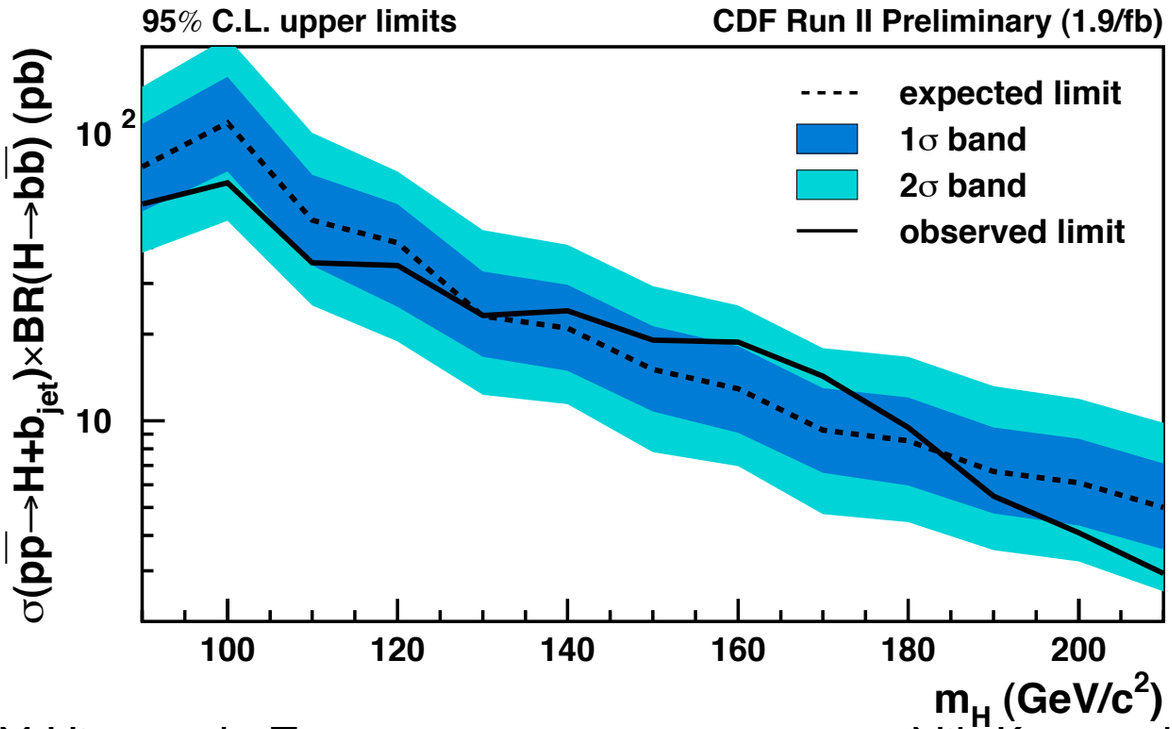


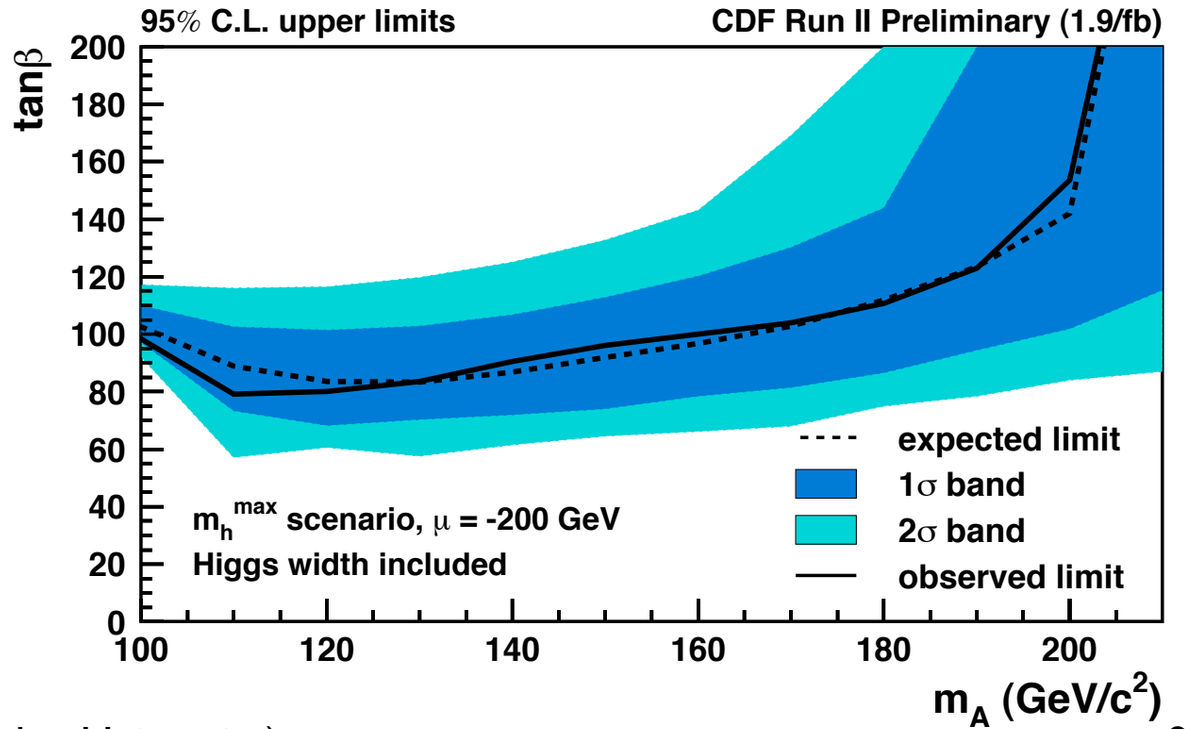
CDF: bbb search

- fitting two and three tag distributions to obtain signal and background contributions
- extract cross section limit from signal fit
- convert cross section limit to tanβ limit



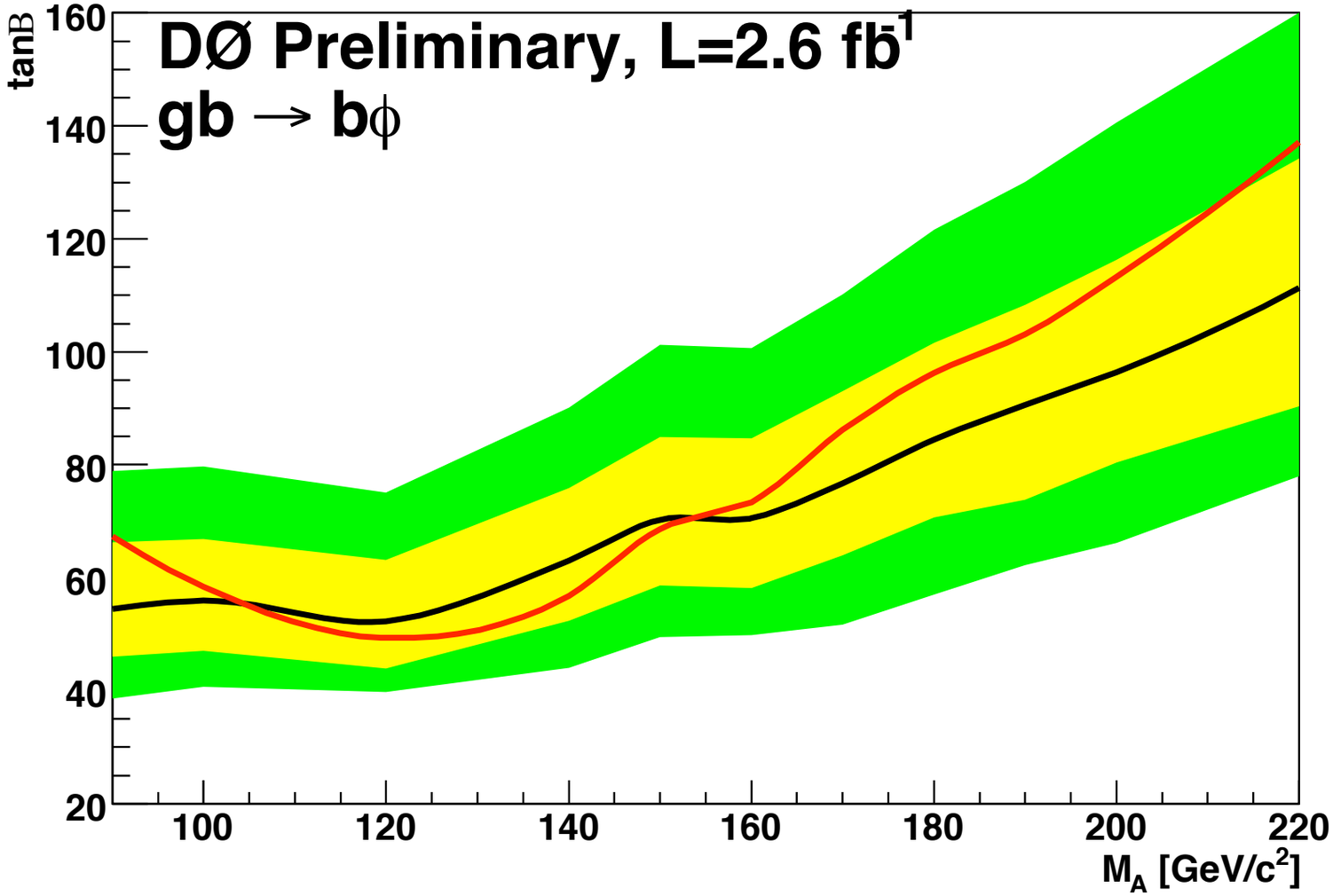
tanβ limit

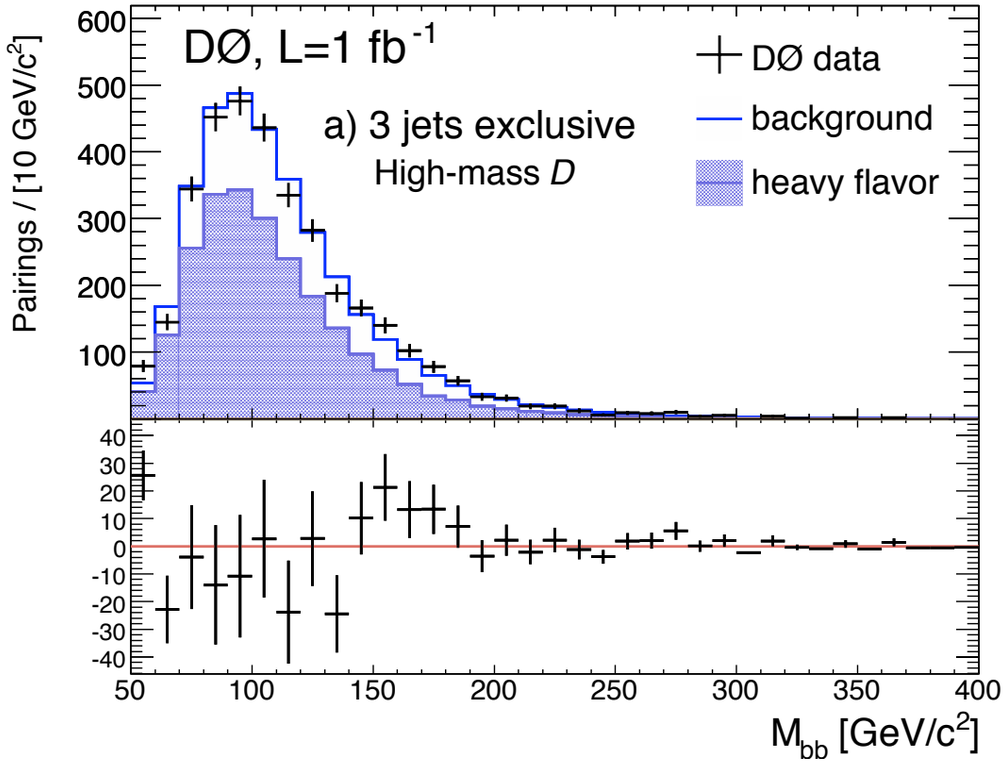


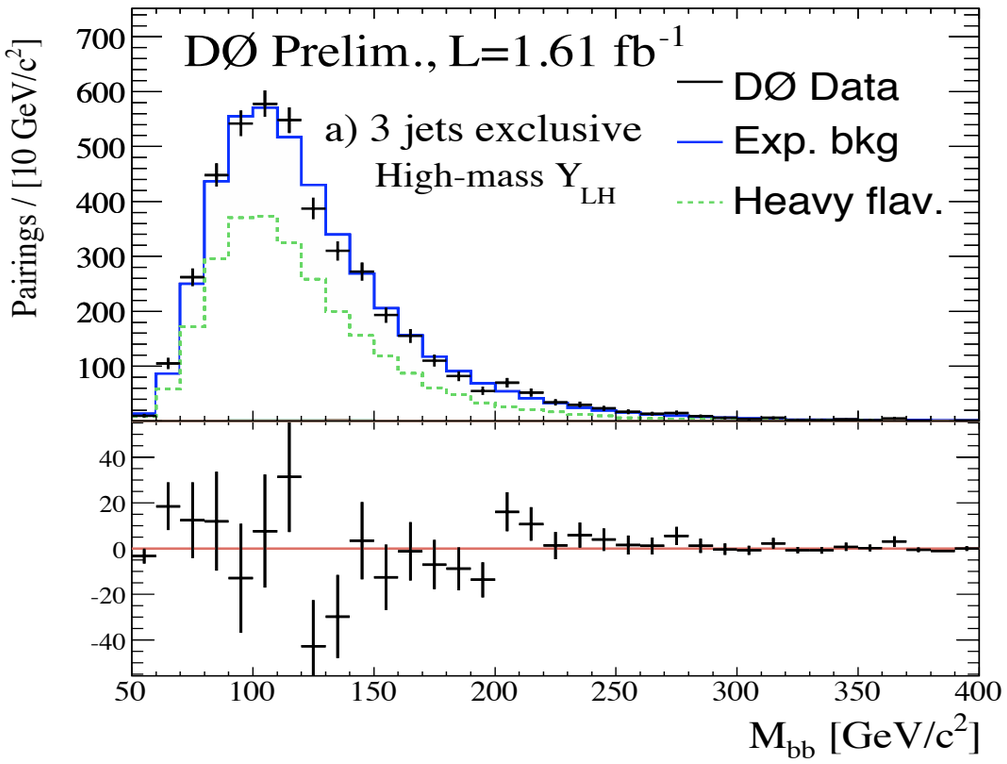


D0: bbb search

- split signal into 3, 4, 5 jet bins
- fit two and three tag distributions to obtain signal and background rates
- extract tanβ, m_A limits for several points in parameter space

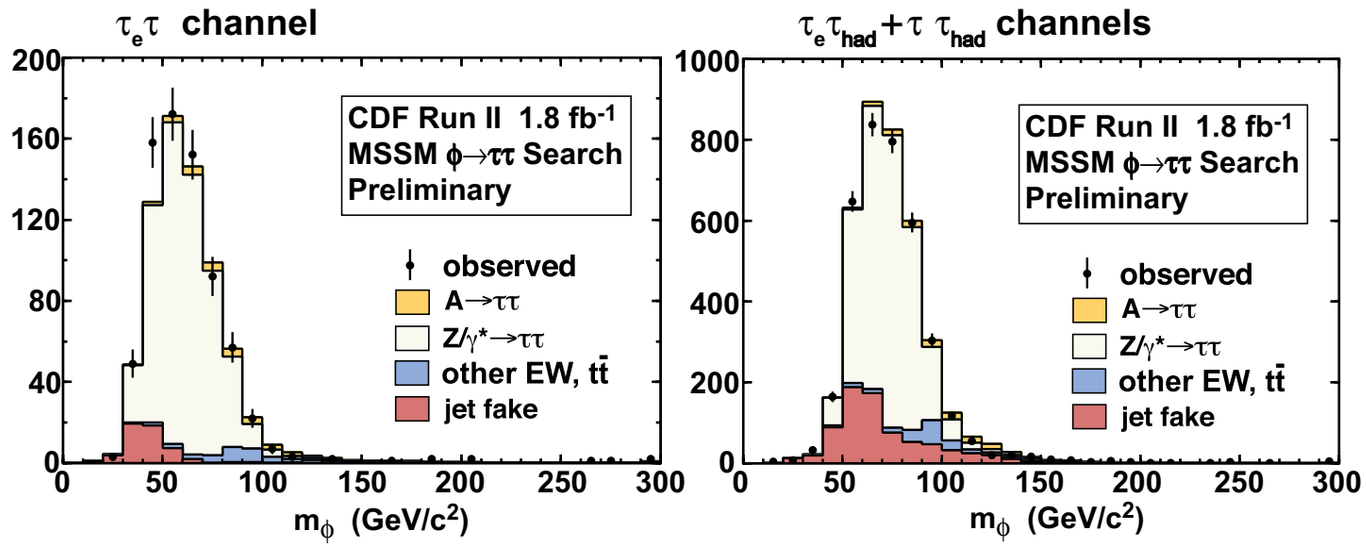


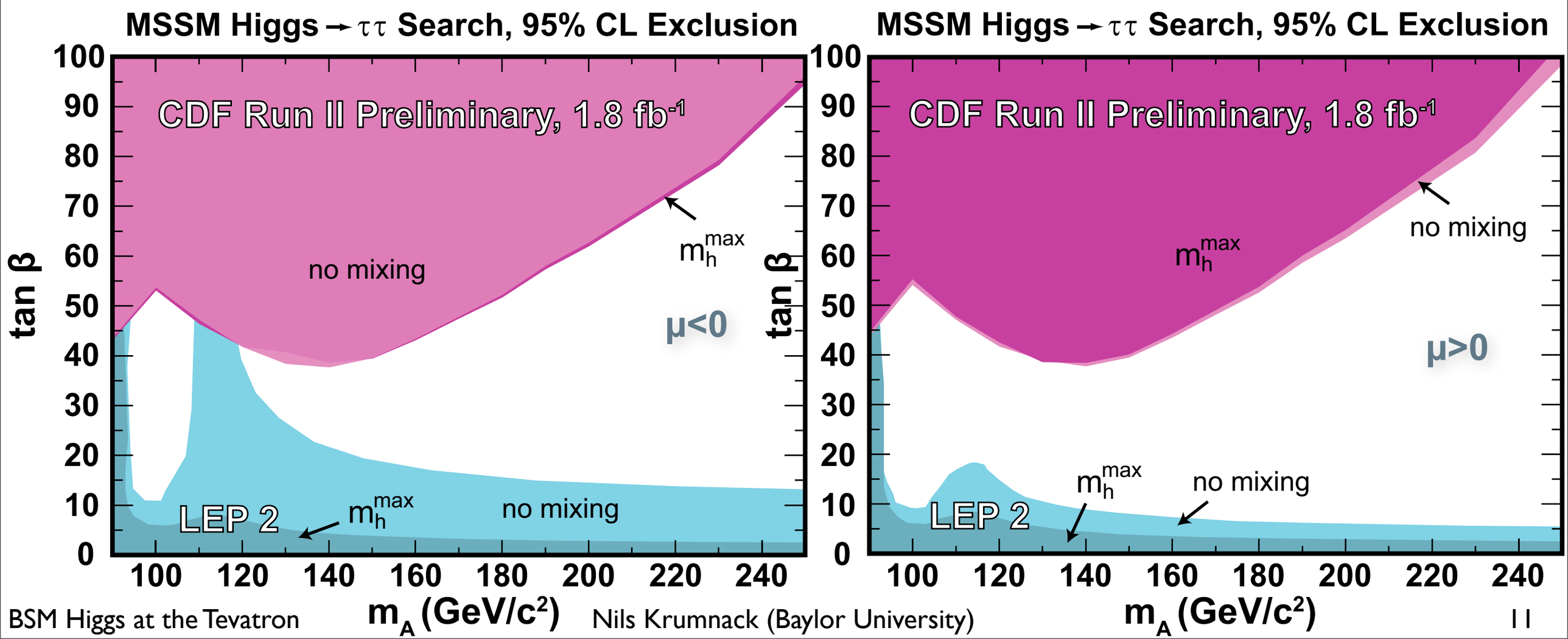




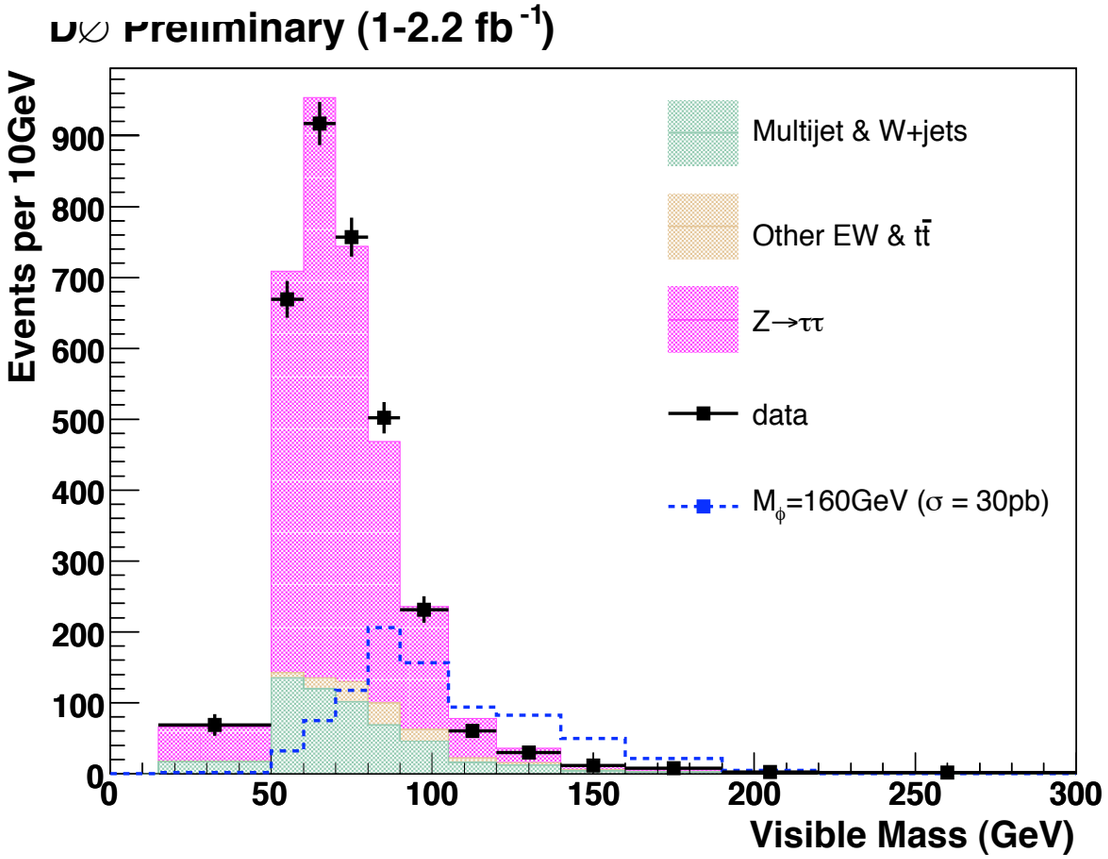
CDF: $\tau\tau$ search

- split sample according to τ decay mode
- fit signal template to visible di-tau mass spectrum
- extract limits in tanβ and m_A

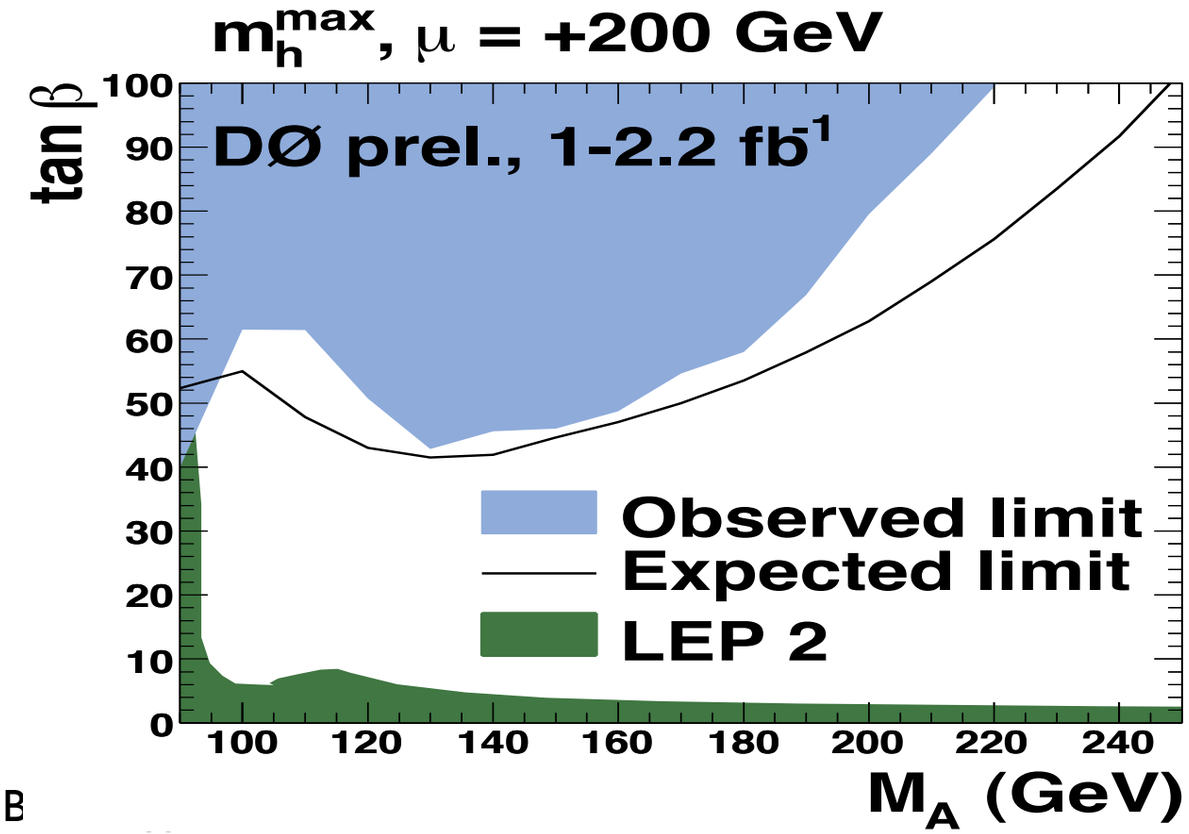


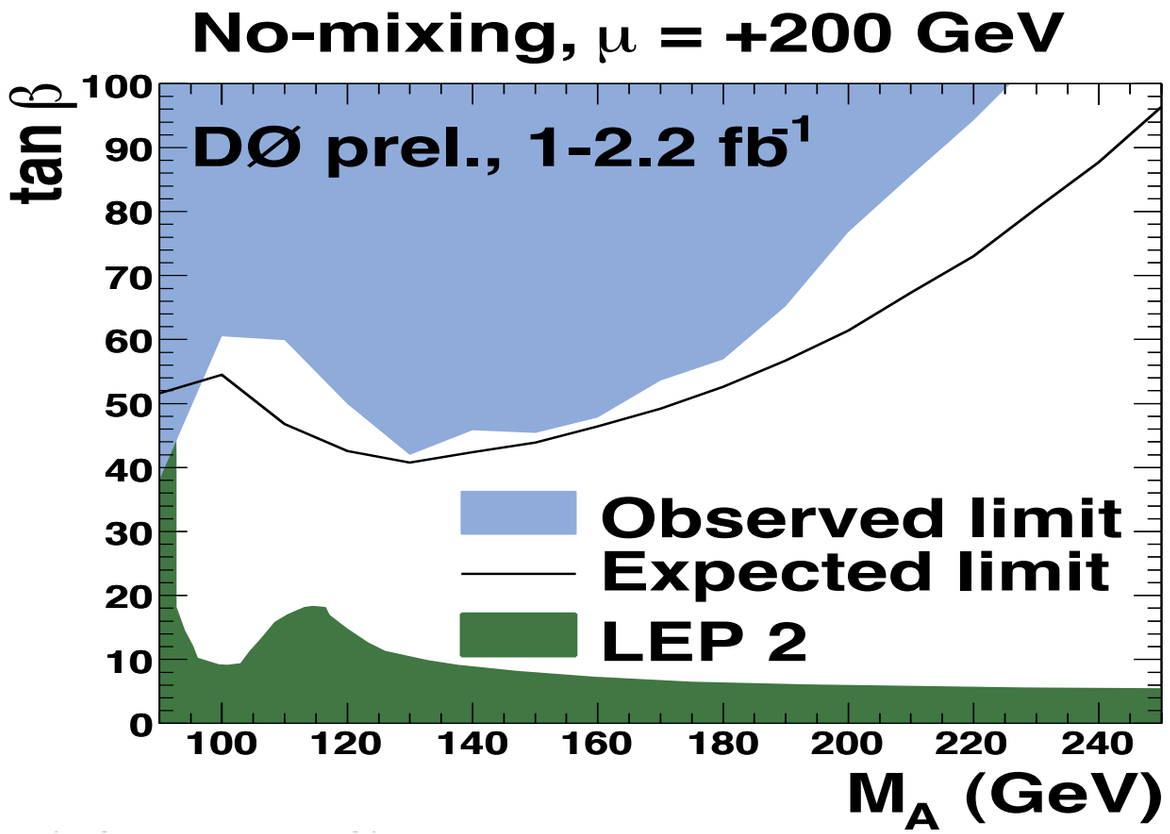


D0: $\tau\tau$ search



- split sample by τ decay mode and run period
- fit signal template to visible mass
- extract limits in tanβ and m_A

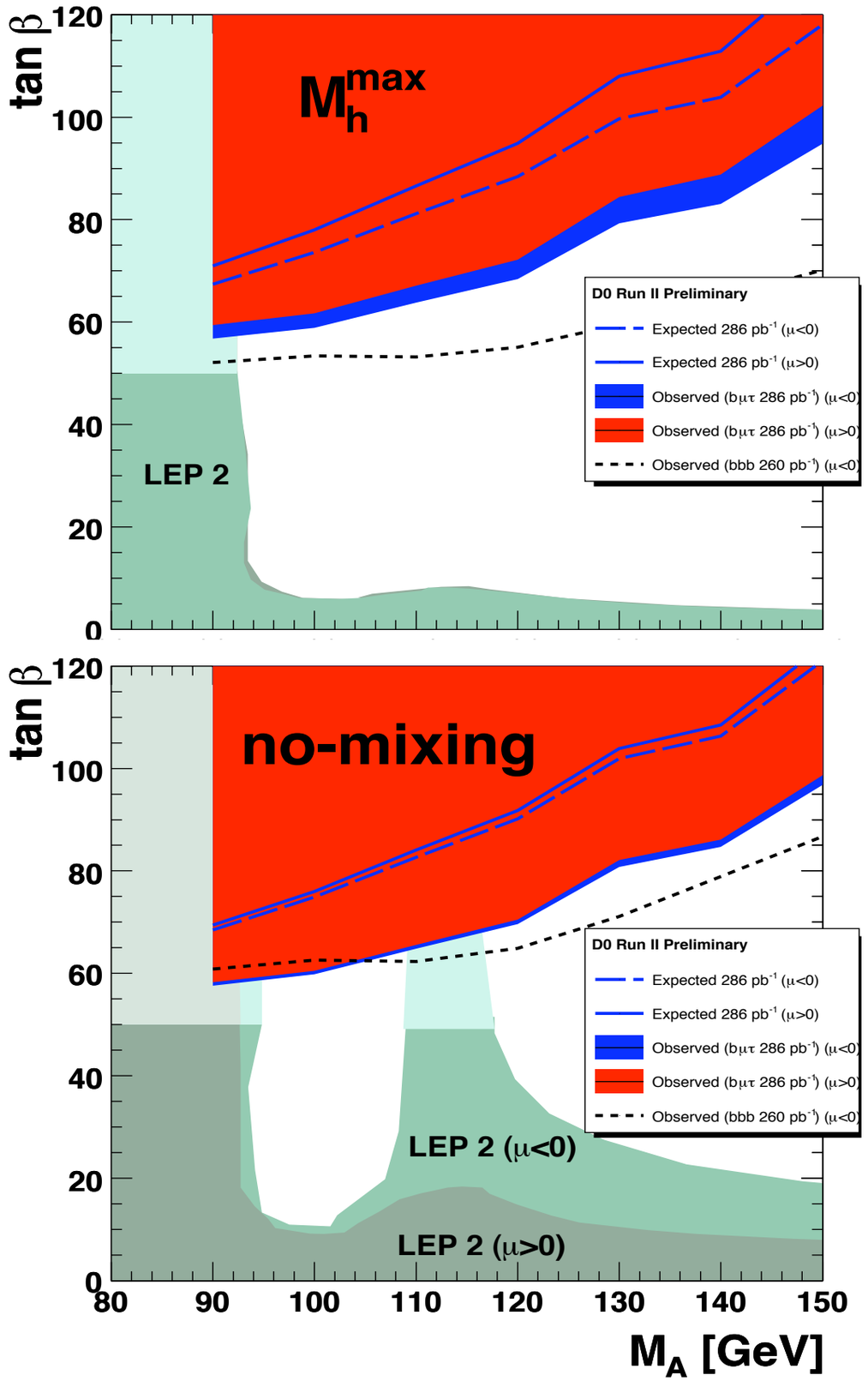




D0: $b\tau\tau$ search

- analogous to bbb search
  - looking for $\tau\tau$ + b
- one τ decays to μ, one to hadrons (τ_h)
- split sample by τ_h decay type
- perform counting experiment
- extract tanβ, m_A limits
- improved analysis on the way

τ_h type	I	II	III
bkg	1.2±0.2	2.6±0.3	2.5±0.2
signal	0.6±0.1	3.5±0.5	1.2±0.2
data	0	1	2



Summary & Outlook

- CDF and D0 are looking actively for Higgs in the context of new physics models
- lots of parameter space and models to cover
- many standard model searches can double as BSM searches
- so far no sign of the Higgs

- more results which are to be released soon
- still lots of data to come
- working on combining these results into overall limits

- still chance that some day we will do more than set limits

- CDF: http://www-cdf.fnal.gov/physics/new/hdg/hdg.html
- D0: http://www-d0.fnal.gov/Run2Physics/WWW/results/higgs.htm