Tag Jets in Vector Boson Fusion

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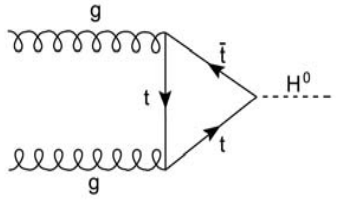
HERA and LHC Workshop, 27/03/04

SM Higgs at LHC

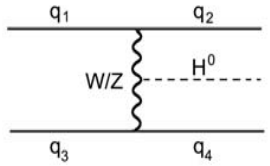
Production:

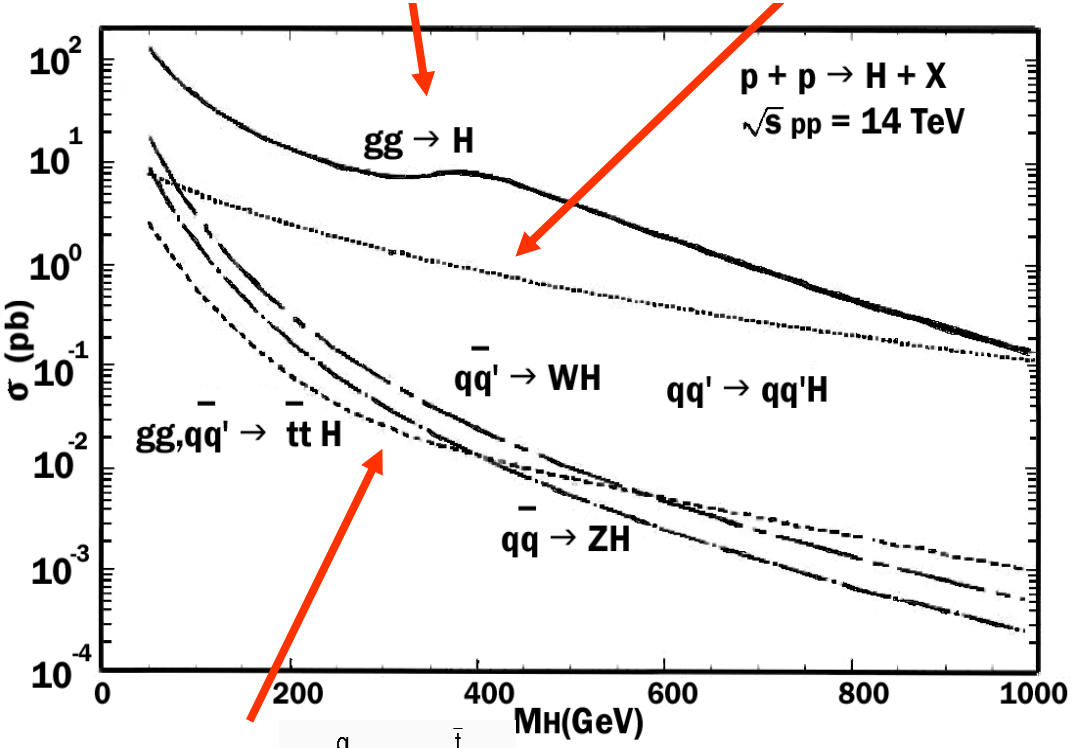
- **Direct**
  - gg → H
    - Dominant
    - Large background at masses close to LEP limit
  - qq →qqH (VBF)
    - Distinct final state
- **Associated**
  - ttH, WH, ZH
    - Small cross-section

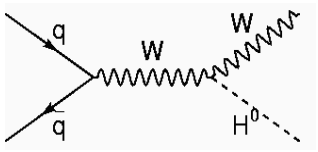
gg → H

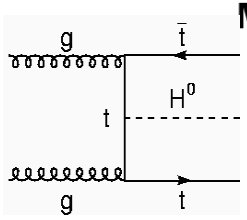


VBF





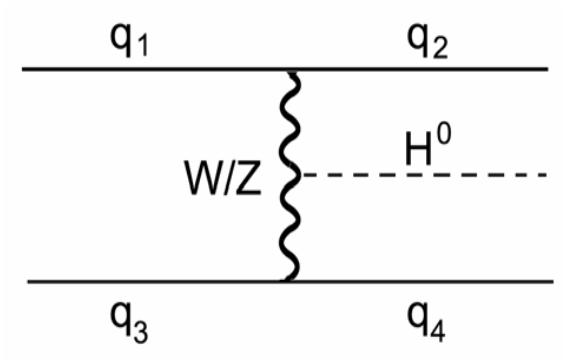


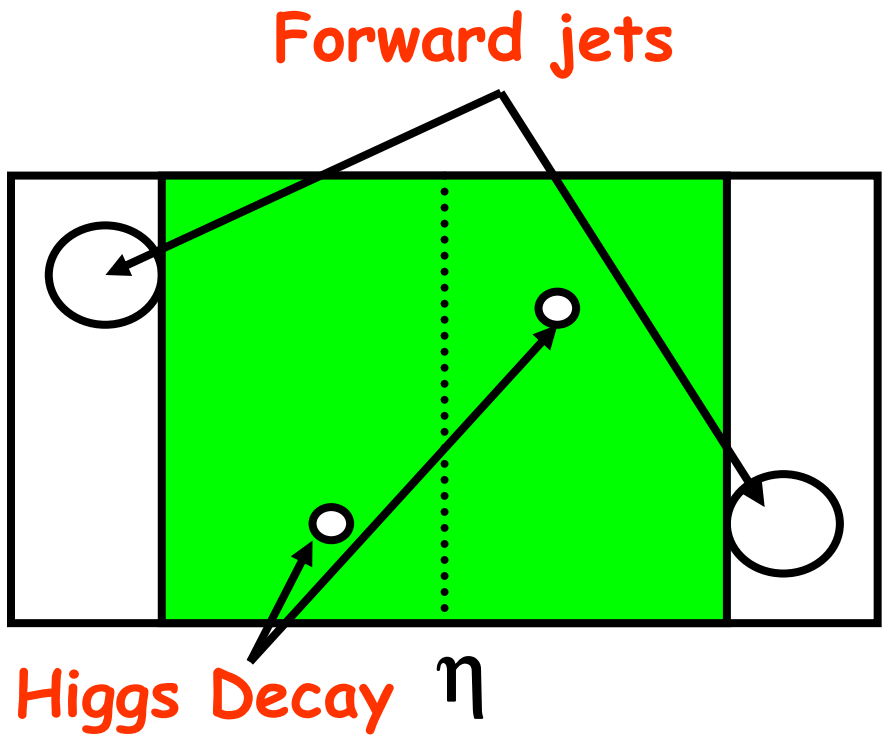


Associated

Low Mass Higgs via VBF

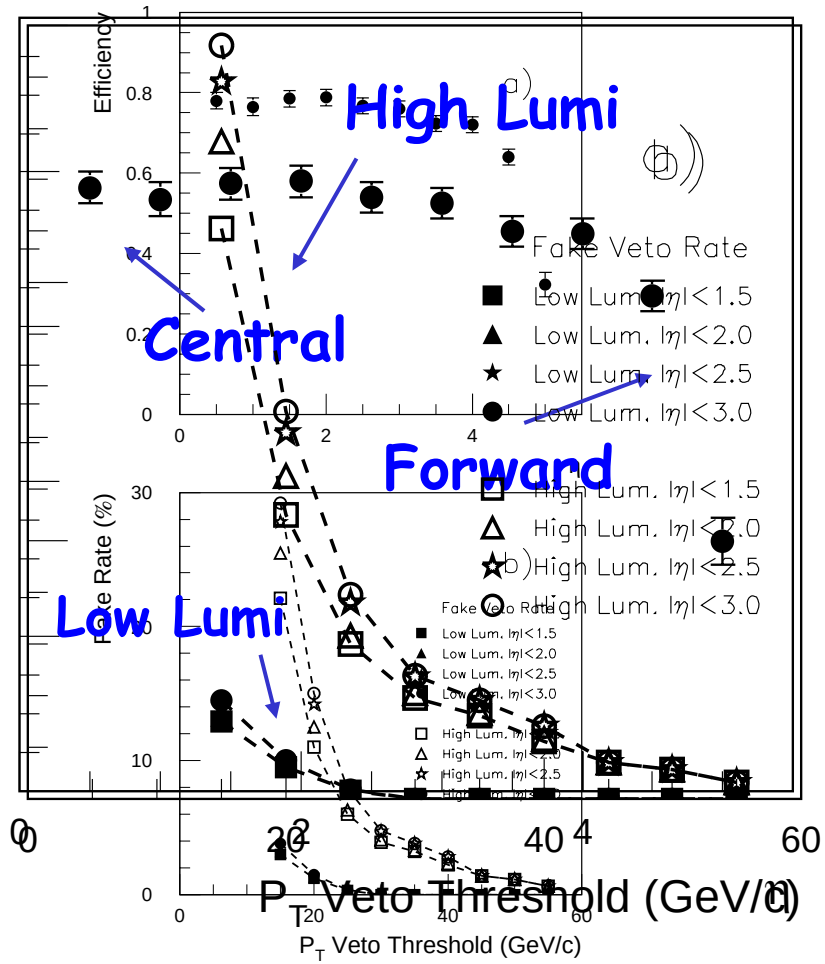
- Wisconsin Phenomenology Institute (D.Rainwater, D.Zeppenfeld et al.):
  - Two high P_T jets with large $\Delta\eta$ separation
  - Strong discovery potential for low Higgs mass
  - Helps measuring couplings
  - Invisible Higgs decays
- Feasibility studies
  - CMS Note 2003/033
  - ATLAS SN-ATLAS-2003-024
    - Updates in progress





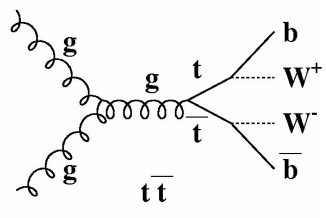
Major Experimental Issues

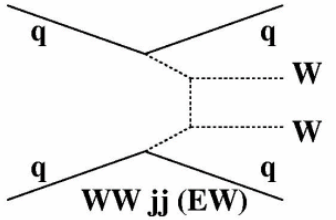
- Major experimental issues addressed with a full detector simulation (Geant3)
- Tagging forward jets:
  - Efficiencies critical
  - Full simulation used
  - Double tag efficiency ~50%
- Central jet veto:
  - Pile up effects introduce fake central jets
    - Effect small at low luminosity
    - Serious concern at high luminosity
  - Very sensitive to underlying effect
    - Detailed studies underway



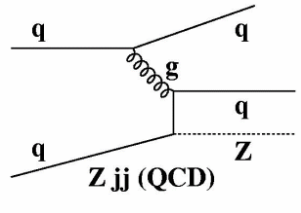
Low Mass Higgs via VBF

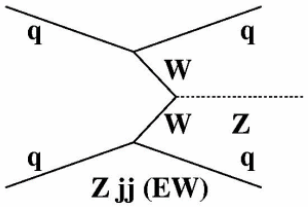
- H->WW*->llνν, lνqq. Strongest in 125<M_H<190 GeV
  - Main background:
    - tt EW WWjj
    - W + 4 jets



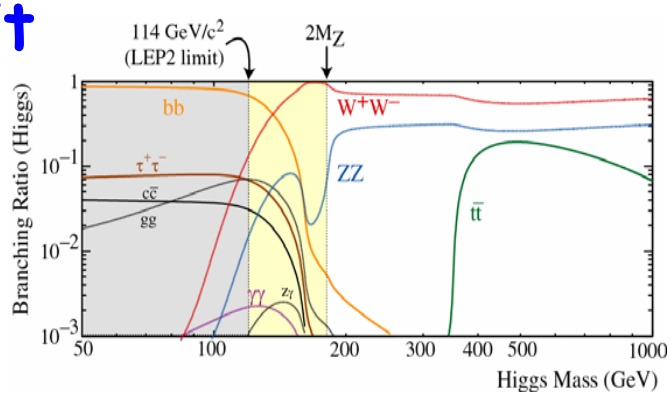


- H->ττ->ll, lh (+ptmiss). Strong around LEP limit
  - Main background
    - QCD and EW Zjj





- H->γγ. Contributes around LEP limit
  - Main background
    - Real and fake non-resonant γγ



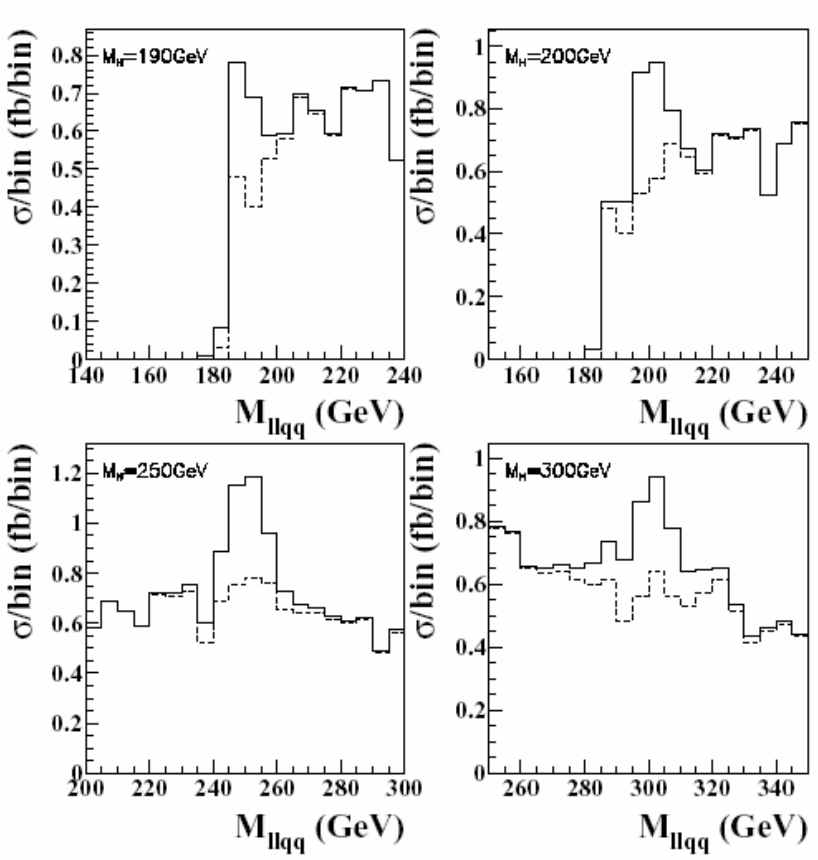
Intermediate Mass Higgs via VBF

- Used for first time $H \rightarrow WW \rightarrow ll$ and $H \rightarrow ZZ \rightarrow llqq$ associated with two hard jets for intermediate masses ($2M_Z < M_H < 500$ GeV)
  - By using kinematic fits obtain ($\delta M/M \approx 2.5\%$) with $H \rightarrow ZZ \rightarrow llqq$
- Discovery confirmation and direct measurement of couplings ratio

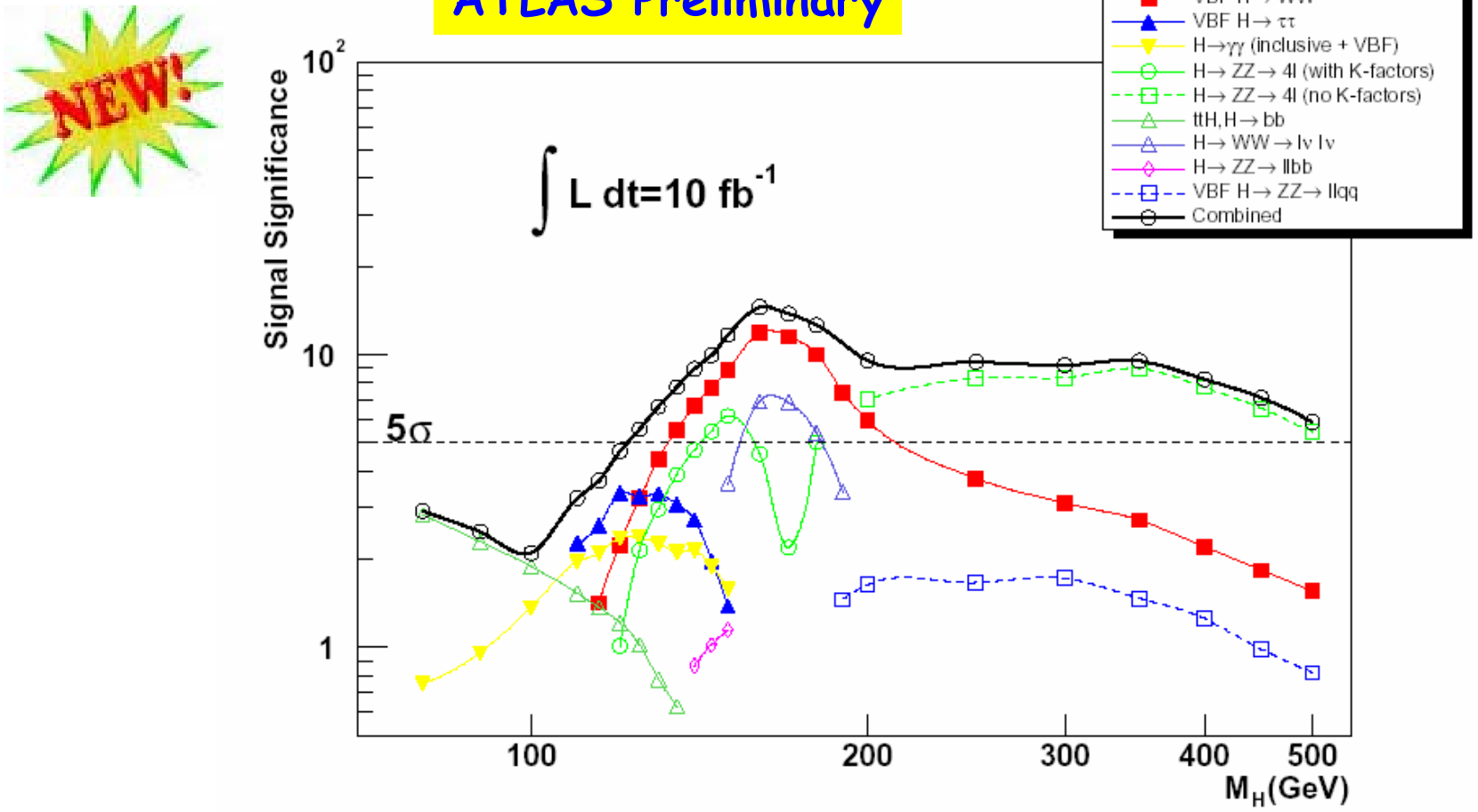
$$\frac{\sigma \times BR(qqH \rightarrow qqWW)}{\sigma \times BR(qqH \rightarrow qqZZ)} = \frac{\Gamma_{HWW}}{\Gamma_{HZZ}}$$

NEW!

ATLAS Preliminary

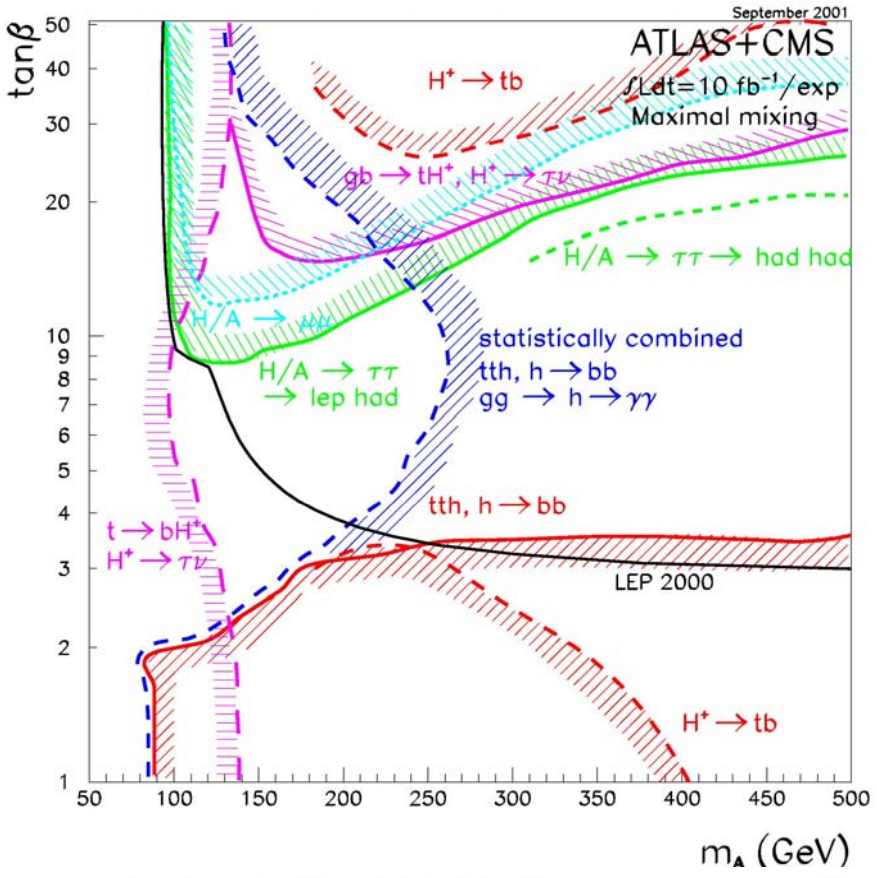


- ✓ Sensitivity to low mass SM Higgs dominated by VBF
- ✓ VBF studies extended to intermediate masses

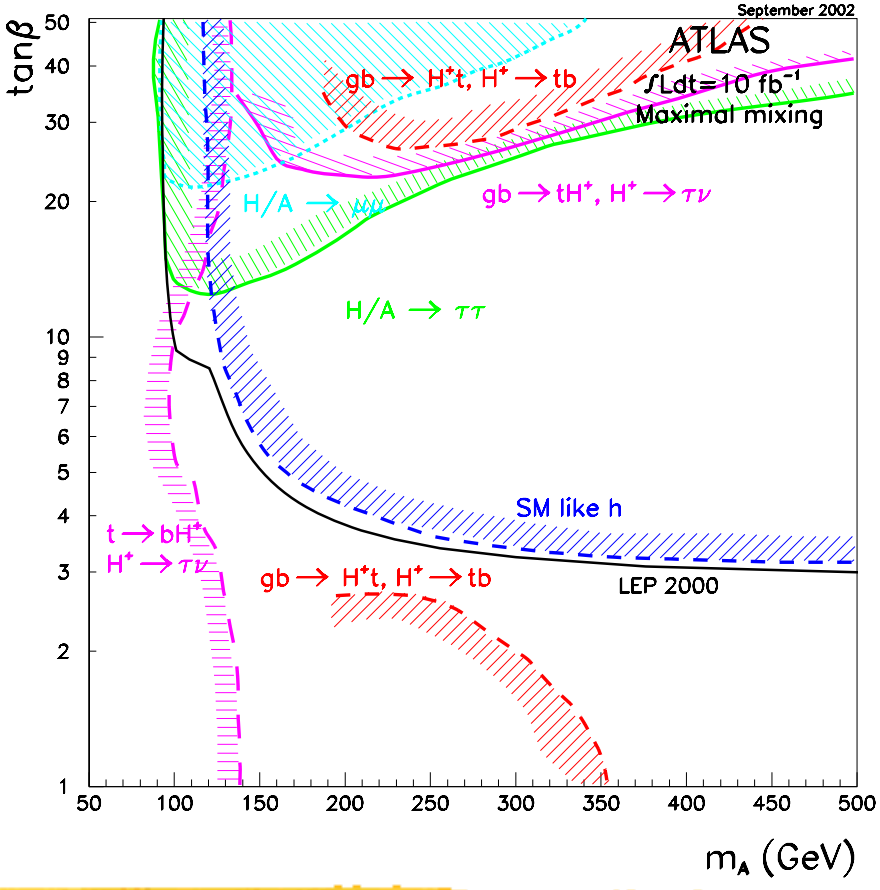


MSSM Higgs Discovery Potential

Two Experiments 10 fb^{-1} (No VBF)



One Experiment 10 fb^{-1} (With VBF)



Summary

- Searches associated with two hard jets dominate sensitivity for low mass Higgs
  - With Neural nets and likelihood techniques may reach 5σ effect for M_H>115 GeV with one experiment and 10 fb^{-1} assuming expected detector performance
- ATLAS has extended these searches to $2M_Z < M_H < 500$ GeV
- With these searches one experiment may cover all MSSM parameter space with 10 fb^{-1}
- Forward jet tagging efficiency crucial and understanding of central jet veto - crucial issues
  - Sensitive to underlying event. Studies with a full detector simulation underway