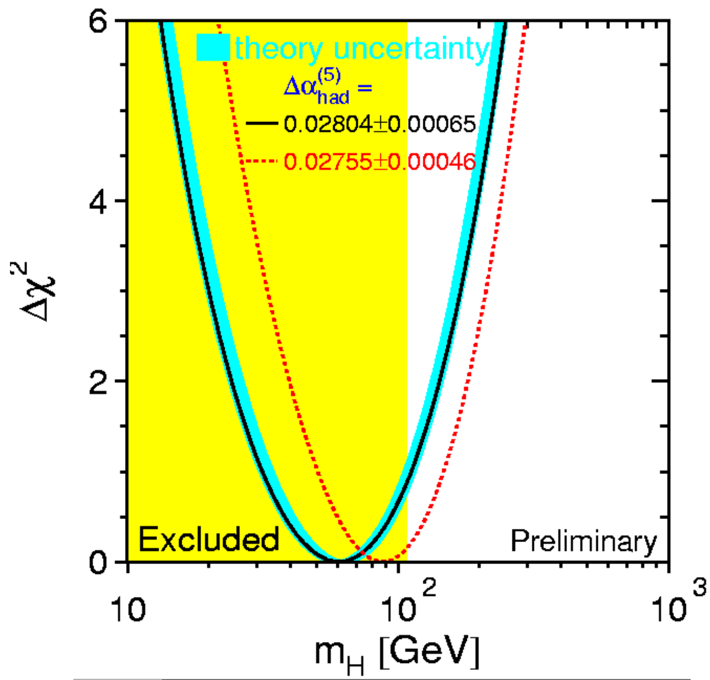
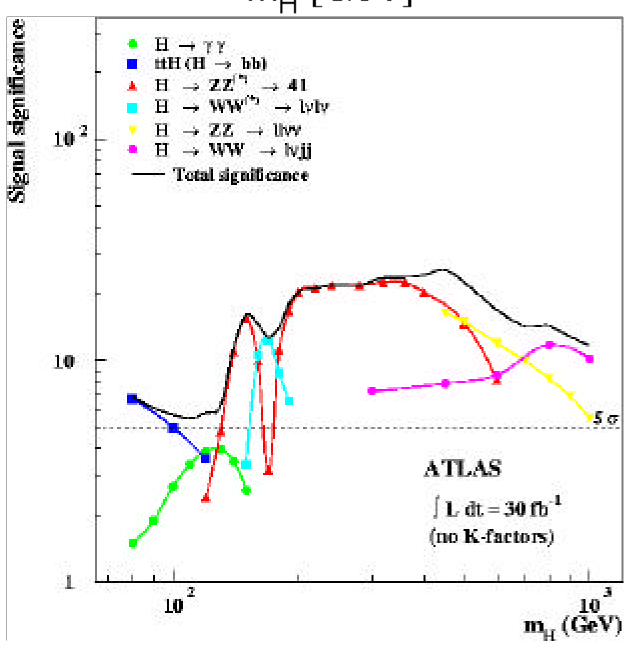
Linear Collider and a Very Heavy Higgs

$M(H)=88^{+60}_{-37}$ GeV





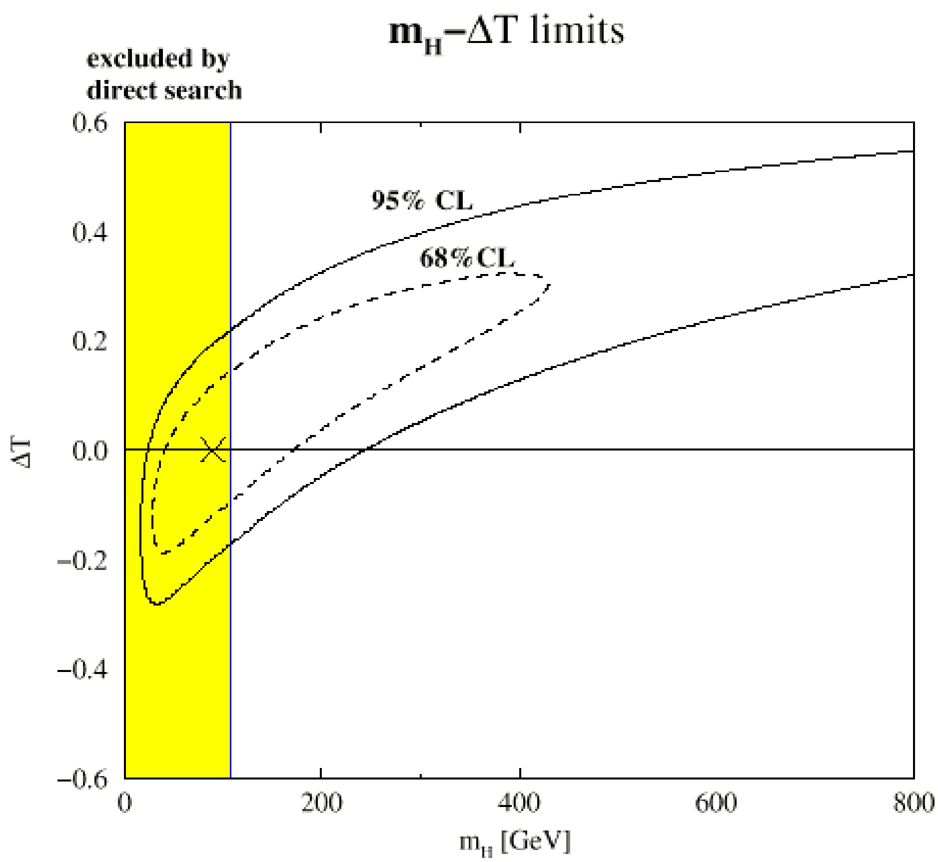
- Is M(H) > M(tt) possible?
- If so, what will LHC know?
- What will LHC not know?
- What does a LC measure?
- How do results depend on sqrt(s) and luminosity?

LHC discovery reach out to 1TeV

“SM-like” heavy Higgs

Limits can be made to be no longer valid using higher dimension operators, or if an additional heavy weak-singlet fermion is introduced, or ...

See discussion in Quigg, hep-ph-0001145 and references therein. Listen to M. Peskin’s talk later in this conference.

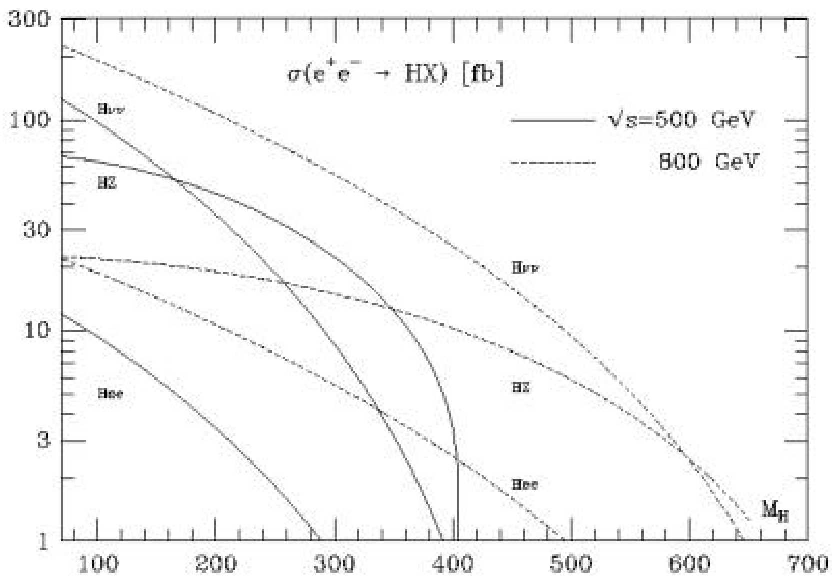


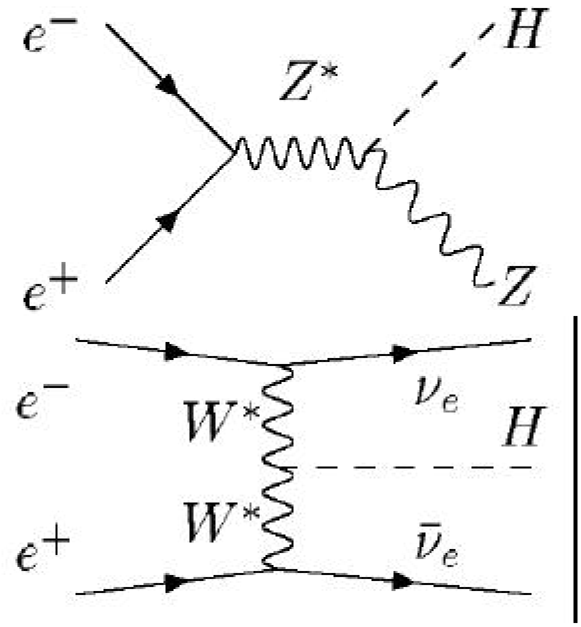
Chivukula, Evans, Holbling: hep-ph/0002022

For example, if there is an additional physics at some high mass scale, the Higgs could still behave SM-like with a mass much higher than precision EW fits suggest.

Production and Decay

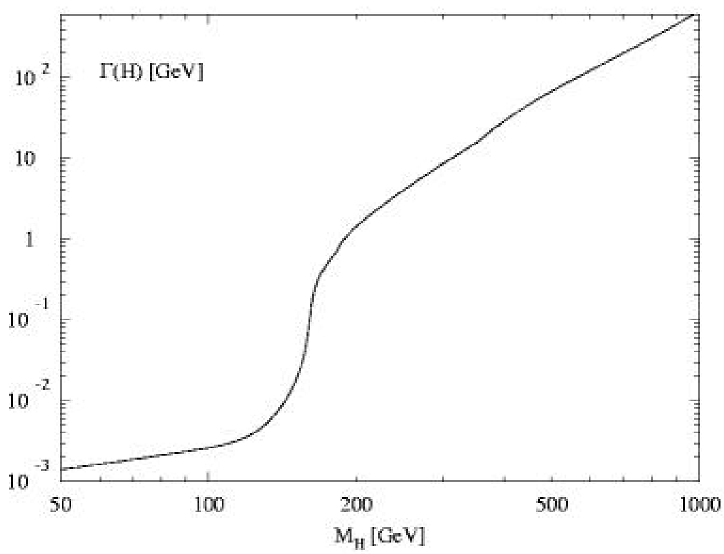
HZ and WW fusion

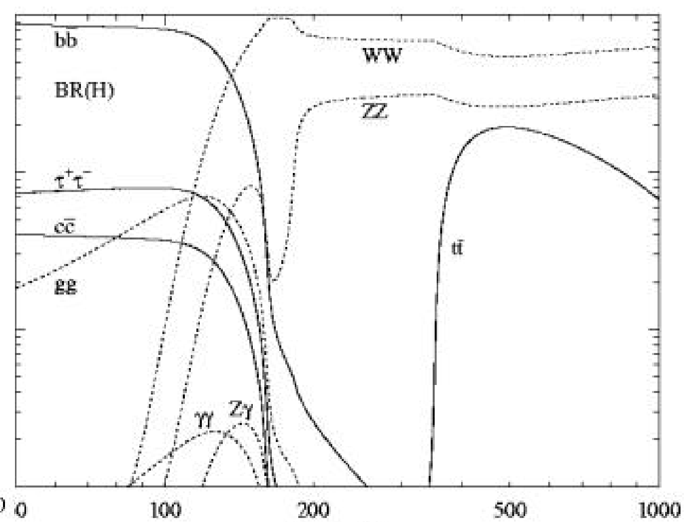




For M_H=500 GeV

Width is 70 GeV and BRs: WW/ZZ/tt =55/25/20%

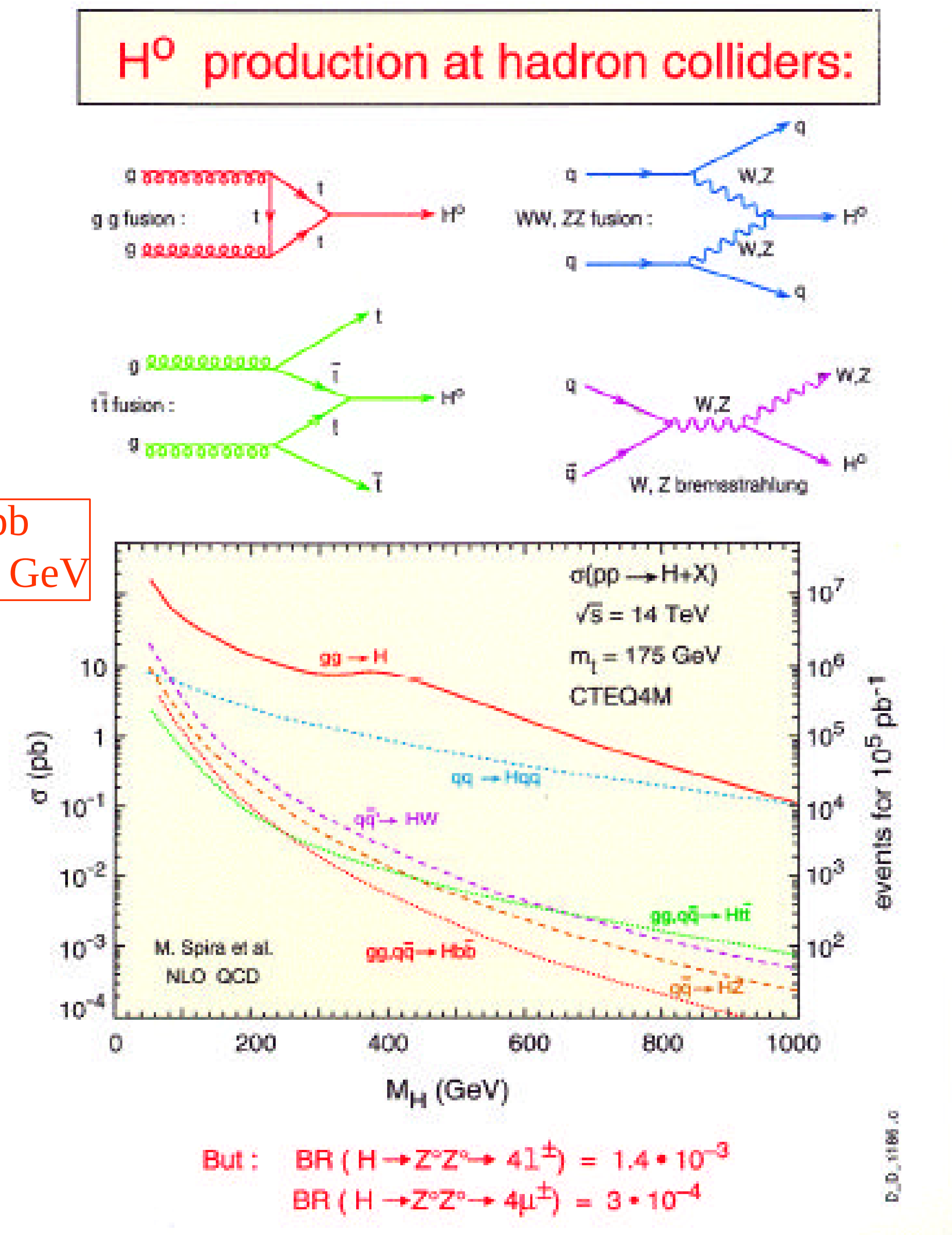




hep-ph/9710439

LHC Capabilities

(Daniel Denegri,Circle Line Talk)

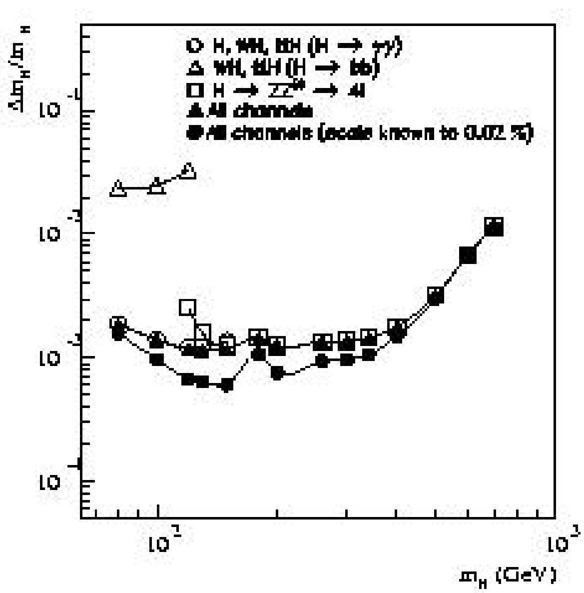


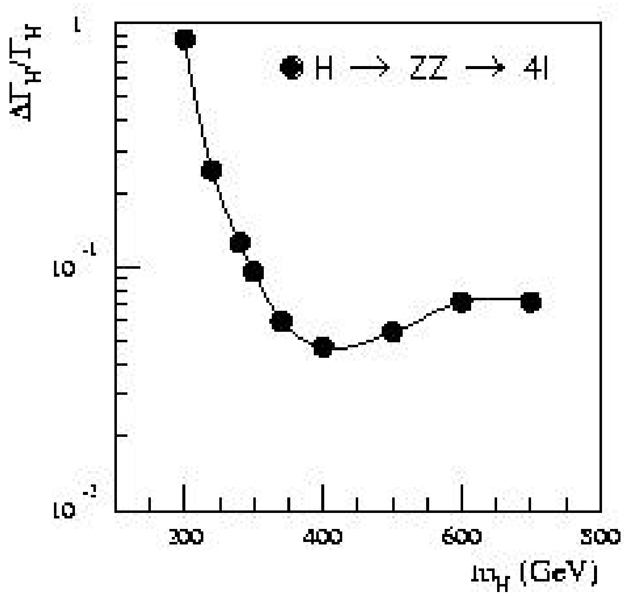
4 pb
at 500 GeV

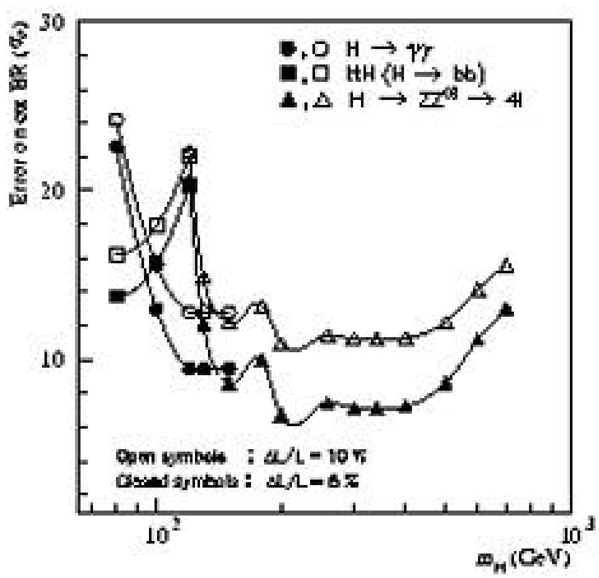
LHC Capabilities

(ATLAS TDR Chap 19: 300 fb-1)

Use 4l modes where l=e or μ







For M(Higgs) = 500 GeV

σ x B(4l) = 3.2 fb

390 events (A x ε =40%)

Mass measured to………. 0.3 %

Width measured to……..…. 6 %

σB(H->ZZ) measured to... 12 %

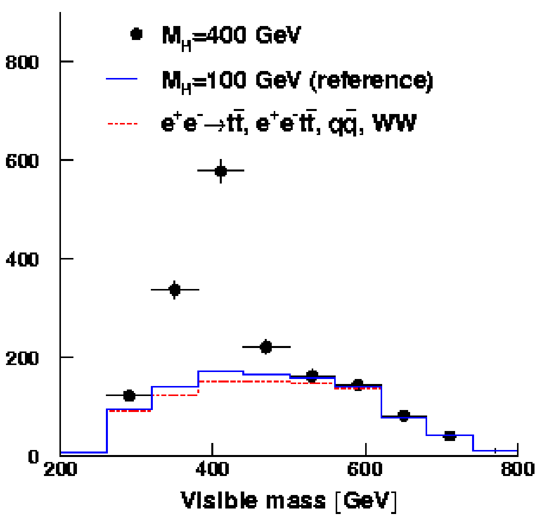
(assuming 10% luminosity error)

Note: for M(Higgs) >700 GeV, the width becomes so large as to change what it means to make a precision measurement.

LC Capabilities

(Alcaraz and Morales, hep-ph/0012109)

- Measurement of the Top Yukawa coupling
  - W W -> H -> t t production
    - NextCalibur w/ISR/beamstrahlung 4-fermion
    - Pandora for top decays (spin correlations)
    - Pythia (final hadronization)
  - Backgrounds generated with Pythia
    - qq and W W production
    - Direct tt production, eett, Ztt
  - Detector simulated with SIMDET
  - Analysis (suppress backgrounds):
    - No isolated leptons and t t -> 6 jets (2 b's)
    - Missing Et > 50 GeV and Mx > 200 GeV
    - Jet combinations for W's and t's



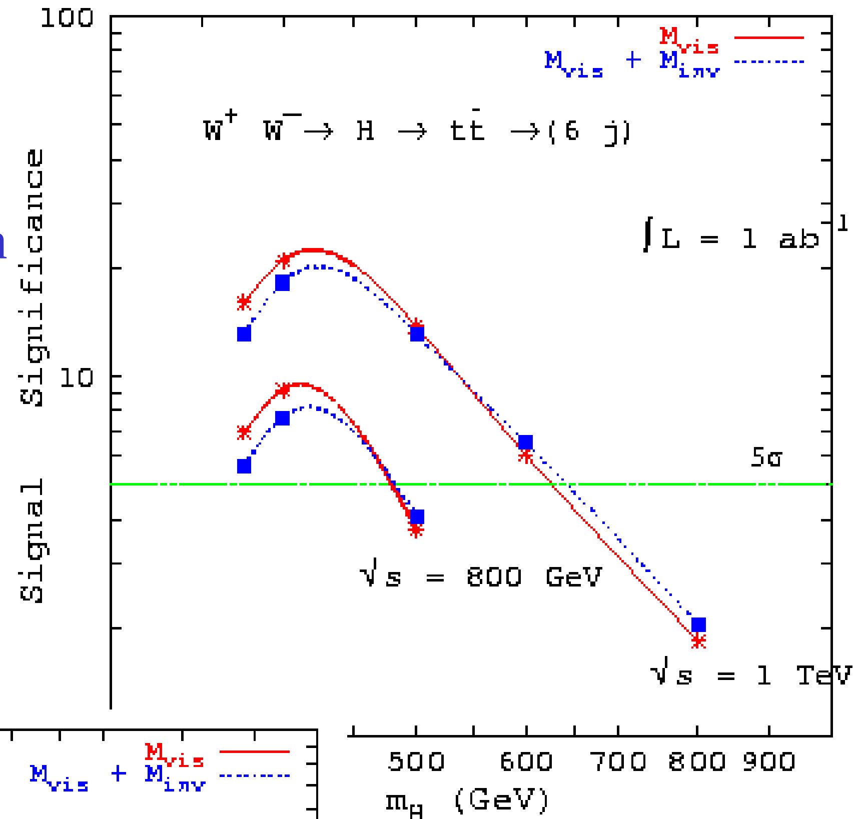
For sqrt(s)=1 TeV,
Acceptance after cuts is ~ 15%

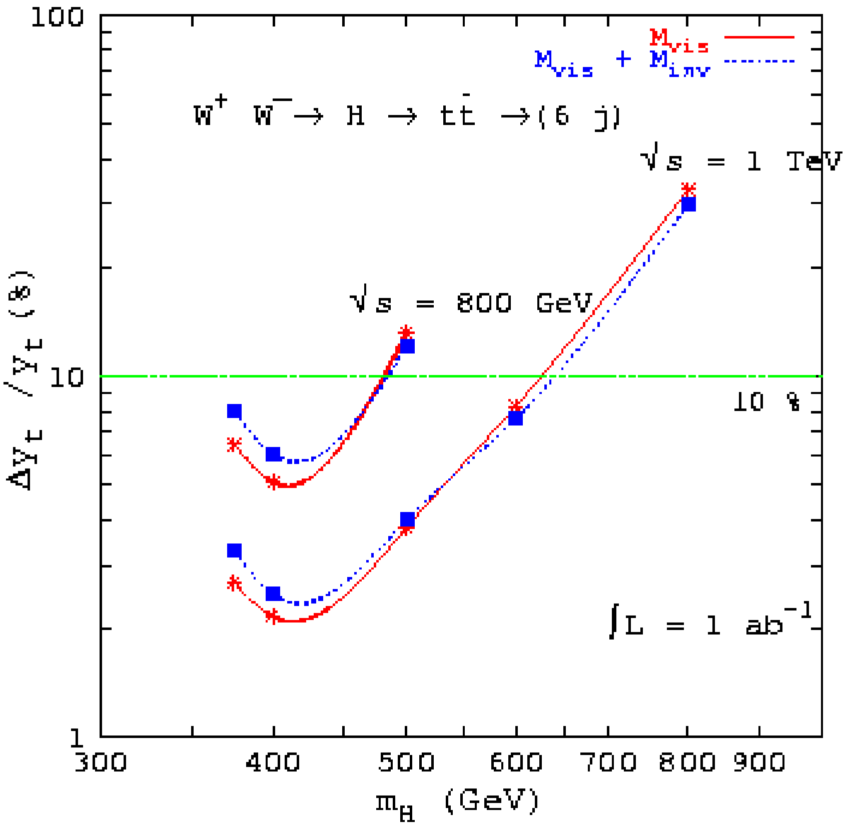
For MH=400 GeV,
695 signal events over 993 bkgd

Results of Top Yukawa Study

5σ excess observed for MH < 500 GeV even with sqrt(s) = 800 GeV

For sqrt(s) = 1 TeV, 5σ excess observed for MH < 650 GeV



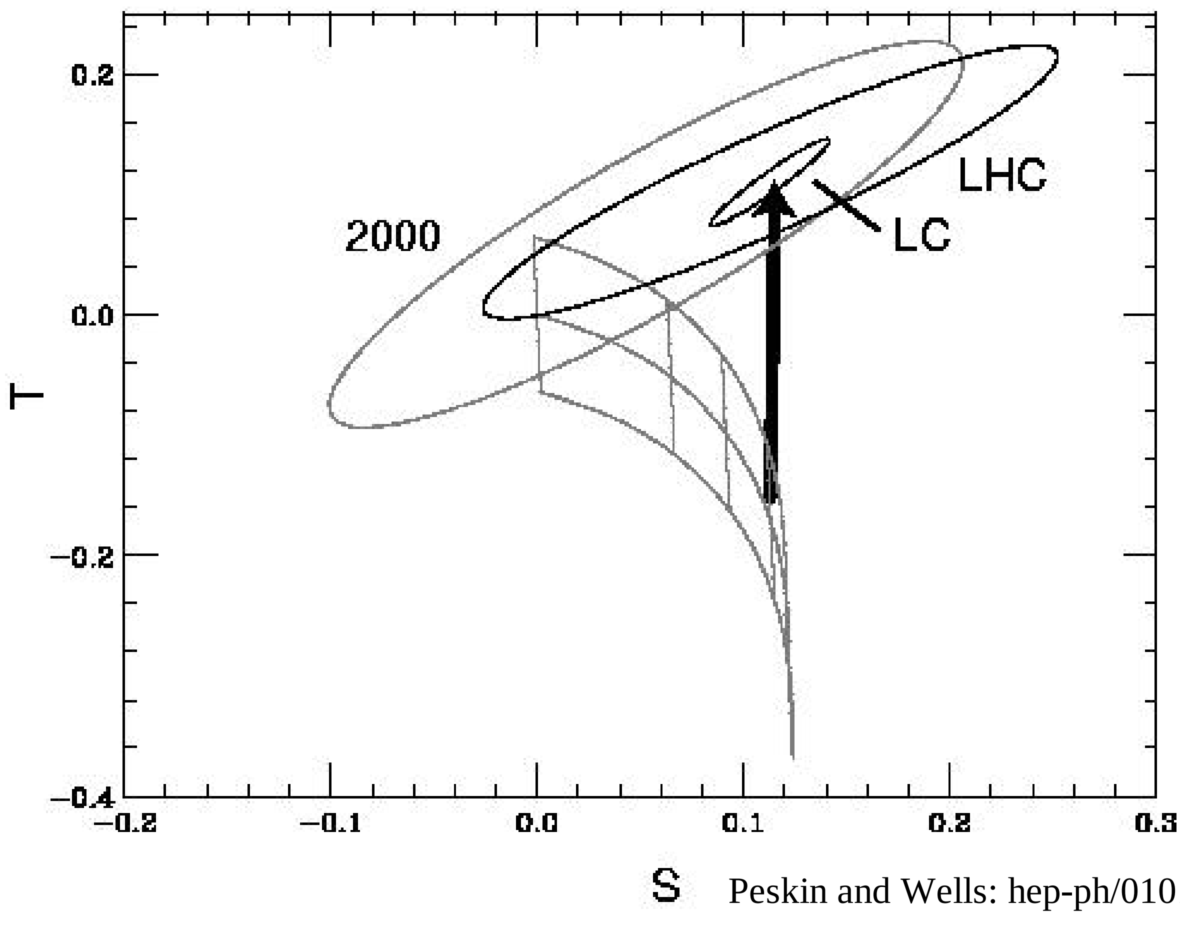


Top Yukawa coupling can be extracted to a precision better than ~10% over the region where >5σ excess is observed.

Giga-Z option

If M_H is really very heavy then there is new physics. Besides trying to get a few 100's of H -> tt events, a LC can be run on the Z pole to improve the precision electroweak parameters.

This will greatly constrain remaining models.



Peskin and Wells: hep-ph/0101342

Conclusions

- Linear Collider is useful in a very heavy Higgs scenario even for M_H ~ 500 GeV.
- High luminosity and large CM energy help
- If nature is really like this, then perhaps Giga-Z running can shed light on the underlying physics

- Open to ideas to pursue this further at Snowmass
  - HZ production
    - Contribution is not insignificant
    - Extra handle with identifying the Z
    - Z identification also helps with background
  - Include sensitivity to WW/ZZ decays
  - Final states with 6 or more fermions
    - Energy flow
    - b and c tagging
  - Giga-Z mode