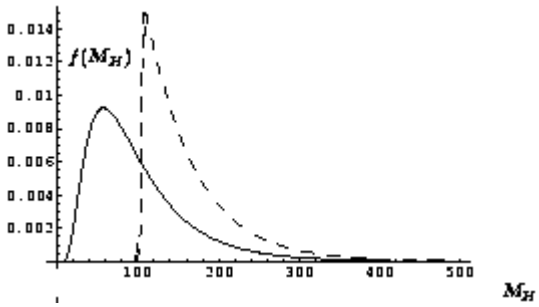
Heavy “SM-like” Higgs

Standard Model fits exclude Higgs above 260-290 GeV at 95% C.L. using precision fits alone (solid) and direct search results (dashed)

G D’Agostini, G. Degrassi, hep-ph-0001269



However, limits can be made to be no longer valid using higher dimension operators (more than 3+1 spacetime), or if one additional heavy weak-singlet fermion is introduced, or ...

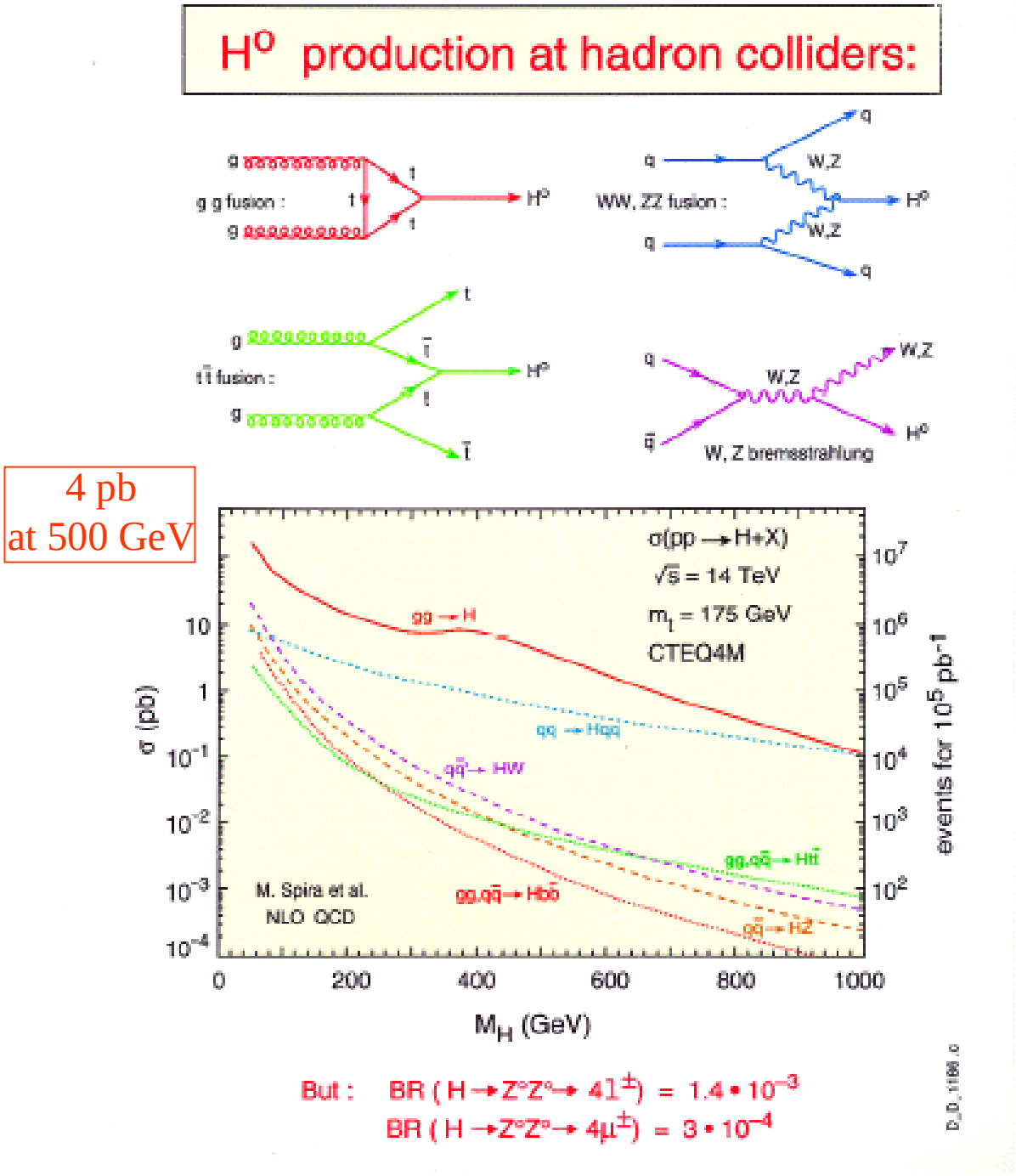
See discussion in Quigg, hep-ph-0001145 and references therein

As a starting point, the heavy-Higgs group will consider Higgs with mass > 350 GeV and with SM couplings and properties. In particular,

Ecm =800 GeV
M(H) = 500 GeV
Γ(H) = 70 GeV
σ(Hνν) = 10 fb
σ(HZ) = 6 fb
B(WW) = 55%
B(ZZ) = 25%
B(ttbar) = 20%

LHC Capabilities

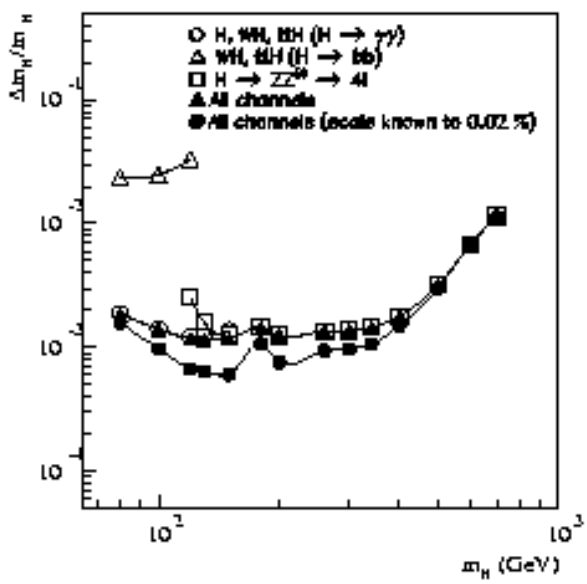
(Daniel Denegri,Circle Line Talk)

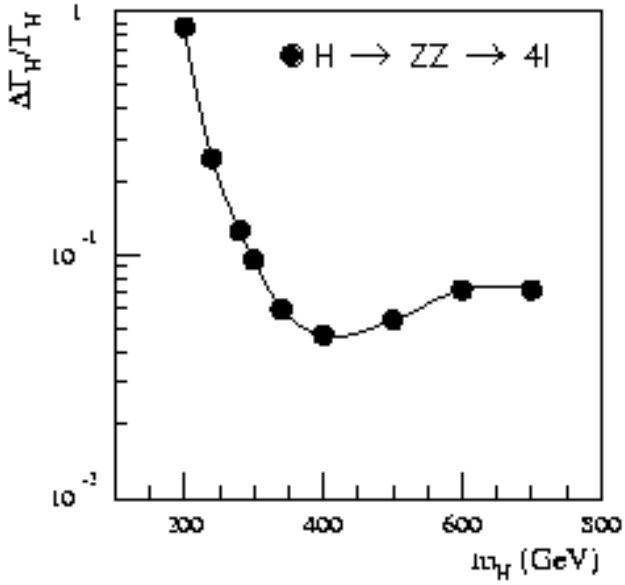


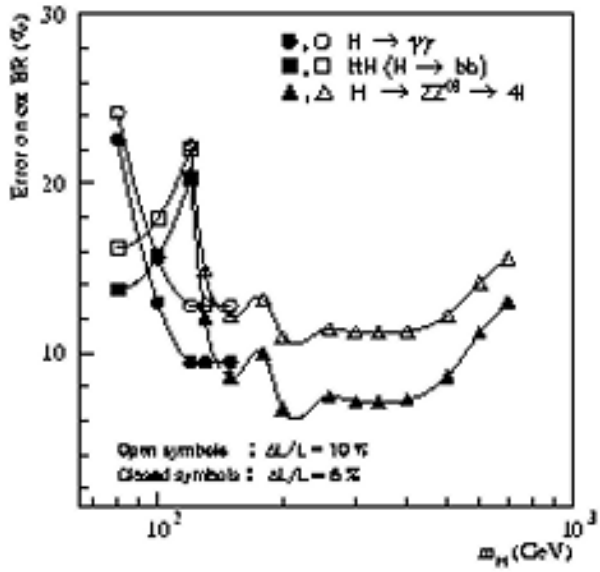
LHC Capabilities

(ATLAS TDR Chap 19: 300 fb-1)

Use 4 l modes where l = e or μ







For M(Higgs) = 500 GeV

σ x B(4 l) = 3.2 fb

390 events (A x ε =40%)

Mass measured to…… 0.3 %

Width measured to……. 6 %

B(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.

Estimate of LC Capabilities

TESLA 800 GeV luminosity: 5 x 10^34
http://www.desy.de/~njwalker/ecfa-desy-wg4/parameter_list.html
Assume 5 yrs running at 10^7 s/year
gives $\int L$ = 2500 fb^-1 or 40K Higgs

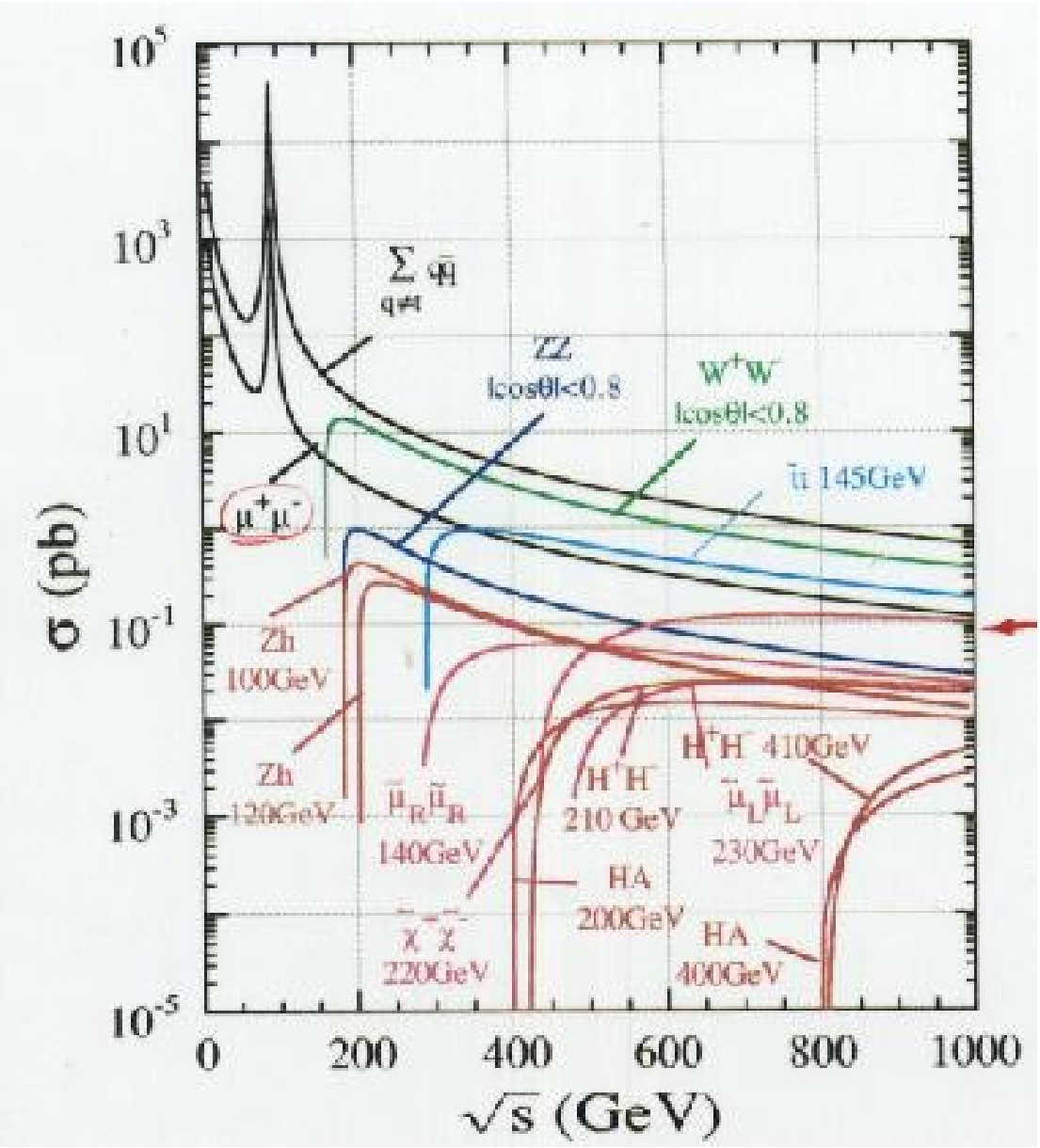
E_{cm} = 800 GeV
M(H) = 500 GeV
Γ(H) = 70 GeV
$\sigma(H\nu\nu)$ = 10 fb
$\sigma(HZ)$ = 6 fb
B(WW) = 55%
B(ZZ) = 25%
B(ttbar) = 20%

Assume 100% efficiency, no backgrounds, no systematic uncertainties:

$tt\gamma\ell\nu\nu bb$: 0.16 fb : 395 evts
$tt\gamma\ell\nu csbb$: 0.47 fb : 1185 evts
$tt\gamma\ell\nu jjbb$: 0.47 fb : 1185 evts
$tt\gamma ccssbb$: 0.36 fb : 889 evts
$tt\gamma csjjbb$: 0.71 fb : 1778 evts
$tt\gamma jjjjbb$: 0.36 fb : 889 evts
$tt\gamma$other: 0.67 fb : 1679 evts

$WW\gamma\ell\nu\nu$: 0.43 fb : 1100 evts
$WW\gamma\ell\nu cs$: 1.30 fb : 3300 evts
$WW\gamma\ell\nu jj$: 1.30 fb : 3300 evts
$WW\gamma ccss$: 0.98 fb : 2400 evts
$WW\gamma csjj$: 1.96 fb : 4900 evts
$WW\gamma jjjj$: 0.98 fb : 2400 evts
$WW\gamma$other: 1.85 fb : 4600 evts
$ZZ\gamma\ell\ell\ell\ell$: 0.018 fb : 46 evts
$ZZ\gamma\ell\ell\nu\nu$: 0.109 fb : 272 evts
$ZZ\gamma\ell\ell bb$: 0.083 fb : 207 evts
$ZZ\gamma\ell\ell cc$: 0.067 fb : 169 evts
$ZZ\gamma\ell\ell jj$: 0.230 fb : 575 evts
$ZZ\gamma\nu\nu\nu\nu$: 0.160 fb : 400 evts
$ZZ\gamma\nu\nu bb$: 0.243 fb : 608 evts
$ZZ\gamma\nu\nu cc$: 0.198 fb : 496 evts
$ZZ\gamma\nu\nu jj$: 0.677 fb :1692 evts
$ZZ\gamma bbbb$: 0.092 fb : 231 evts
$ZZ\gamma bbcc$: 0.151 fb : 377 evts
$ZZ\gamma bbjj$: 0.514 fb :1286 evts
$ZZ\gamma cccc$: 0.062 fb : 154 evts
$ZZ\gamma ccjj$: 0.420 fb :1049 evts
$ZZ\gamma jjjj$: 0.716 fb :1789 evts
$ZZ\gamma\tau X$: 0.267 fb : 668 evts

LC Backgrounds



Dominate backgrounds are WW, ZZ, tt production and are of order 1 pb (can be reduced with polarized beams).

Next Steps for study

- Mass(Higgs) Determination
  - Use recoil method
  - How precise to measure M_H?
    - M_W, M_t, and M_H are known
    - New physics?
- Total Width
  - Measure directly
  - Can LC do better than LHC?
  - New Physics?
- BR and couplings
  - LC looks cleaner for HZ vs $H\nu\nu$
  - What is LHC ability for couplings?
- Spin and parity determination
- Theory of a very heavy SM Higgs
- Estimates -> Generator Level -> Full MC