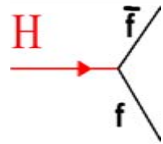


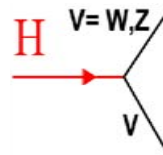
2. Higgs-Boson Searches

1. Standard Model Couplings of the Higgs
2. Limits on Higgs boson mass from radiative corrections
3. Direct Higgs Searches as LEP
4. Higgs production in $p\bar{p}$ collisions (LHC + Tevatron)

2.1 Standard Model Couplings of the Higgs



$$g_{f\bar{f}H} = \frac{em_f}{2M_W \sin \vartheta_W}$$



$$g_{WWH} = \frac{eM_W}{\sin \vartheta_W}$$

$$g_{ZZH} = \frac{eM_Z}{\sin \vartheta_W \cos \vartheta_W}$$

$$\frac{g^2}{8M_W^2} = \frac{G_F}{\sqrt{2}} \Rightarrow g_{WWH} = 2(\sqrt{2}G_F)^{\frac{1}{2}} M_W^2$$

Standard Model: Experimental Tests of Electroweak Interaction

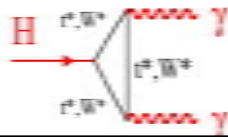
Higgs decay widths

$$\Gamma(H \rightarrow f\bar{f}) = N_c \frac{G_F m_f^2 M_H}{4\pi\sqrt{2}} \left(1 - \frac{4m_f^2}{M_H^2}\right)^{\frac{3}{2}}$$

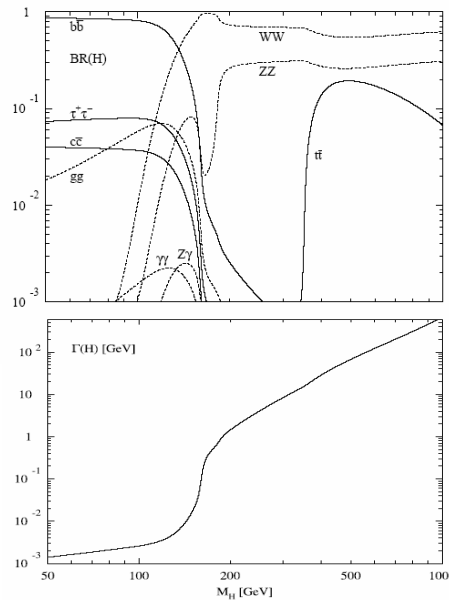
$$\Gamma(H \rightarrow W^+W^-) = \frac{G_F M_H^3}{8\pi\sqrt{2}} \left(1 - 4\frac{M_W^2}{M_H^2}\right)^{\frac{1}{2}} \left(1 - \frac{4M_W^2}{M_H^2} + \frac{12M_W^4}{M_H^4}\right)$$

$$\Gamma(H \rightarrow Z^0Z^0) = \frac{G_F M_H^3}{16\pi\sqrt{2}} \frac{M_W^2}{M_Z^2} \left(1 - \frac{4M_Z^2}{M_H^2}\right)^{\frac{1}{2}} \left(1 - \frac{4M_Z^2}{M_H^2} + 12\frac{M_Z^4}{M_H^4}\right)$$

$$\Gamma(H \rightarrow \gamma\gamma) = \frac{\alpha^2 G_F M_H^3}{128\pi^3 \sqrt{2}} \left| \sum_q 3e^2 I_q \left(\frac{m_q^2}{M_H^2}\right) + I_W \left(\frac{M_W^2}{M_H^2}\right) \right|^2$$

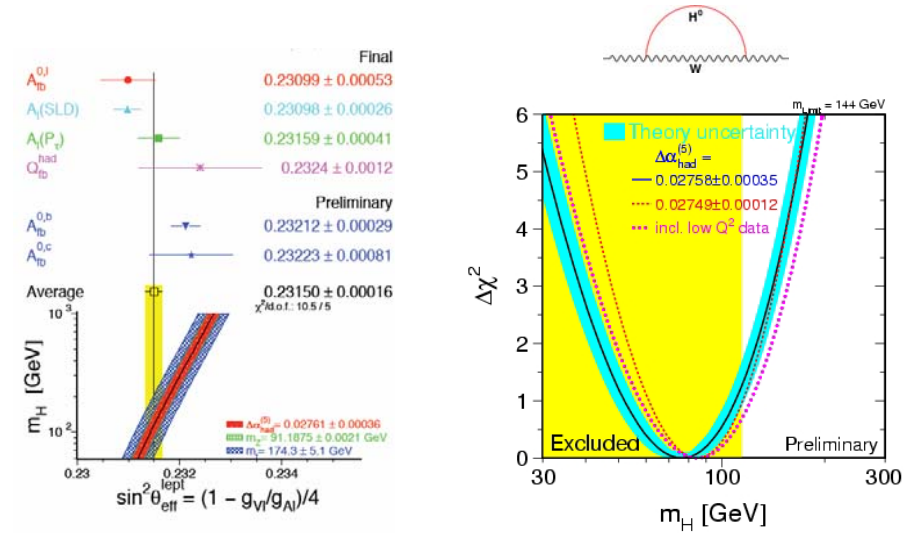


Partial and total Higgs decay widths



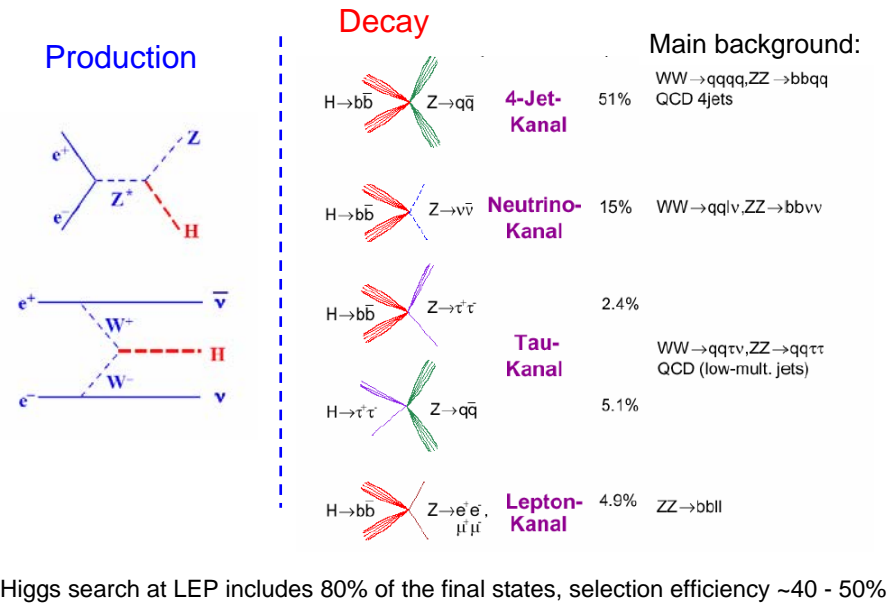
For very heavy Higgs masses (>500 GeV) the discovery becomes more difficult !

2.2 Limits on Higgs boson mass from radiative corrections

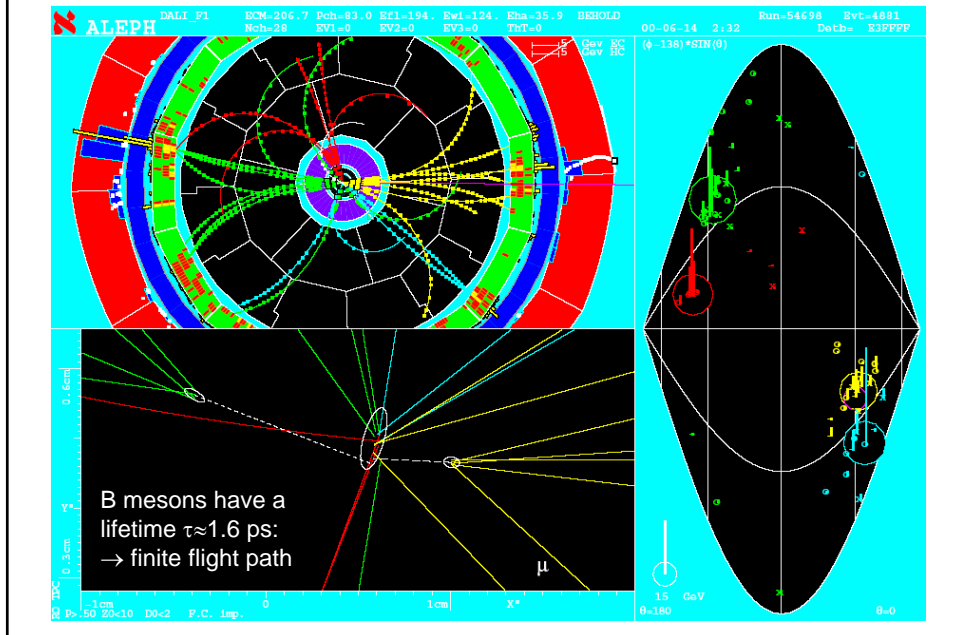


- Lepton asymmetries prefer low Higgs mass
- Quark asymmetries prefer larger Higgs mass

2.3 Direct Higgs Searches as LEP

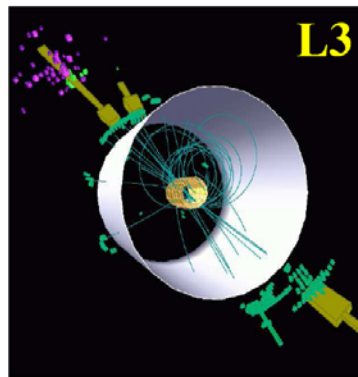


Higgs candidate with $M_H=114$ GeV



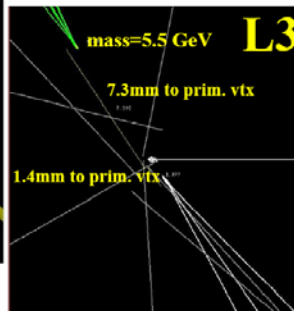
Another candidate with $M_H=115$ GeV

most significant H $\nu\nu$ candidate



measured H mass=115 GeV
 H mass resolution ~ 3 GeV

Secondary vtx's view



Standard Model: Experimental Tests of Electroweak Interaction

LEP Higgs candidates w/ $M \sim 115$ GeV

	Expt	E_{cm}	channel	M^{rec} (GeV)	$\ln(1 + s/b)$ @ 115 GeV	prev. rank.
1	A	206.6	4 jet	114.1	1.76	1
2	A	206.6	4 jet	114.4	1.44	2
3	A	206.4	4 jet	109.9	0.59	3
4	L	206.4	Emiss	115.0	0.53	4
5	A	205.1	Lept.	117.3	0.49	7
6	A	206.5	Tau	115.2	0.45	8
7	O	206.4	4 jet	108.2	0.43	5
8	A	206.4	4 jet	114.4	0.41	9
9	L	206.4	4 jet	108.3	0.30	12
10	D	206.6	4 jet	110.7	0.28	
11	A	207.4	4 jet	102.8	0.27	14
12	D	206.6	4 jet	97.4	0.23	11
13	O	201.5	Emiss	111.2	0.22	
14	L	206.0	Emiss	110.1	0.21	17
15	A	206.5	4 jet	114.2	0.19	
16	D	206.6	4 jet	108.2	0.19	
17	L	206.6	4 jet	109.6	0.18	

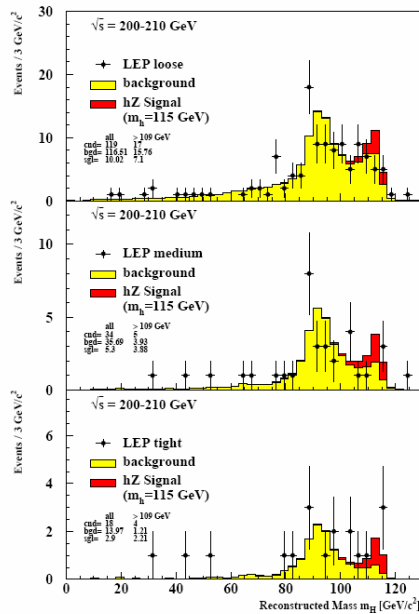
17 data events
with $s/b > 0.2$

for that selection,
we expect
15.8 background
and 8.4 signal.

@ $M_H = 115$ GeV



Consistent w/
background

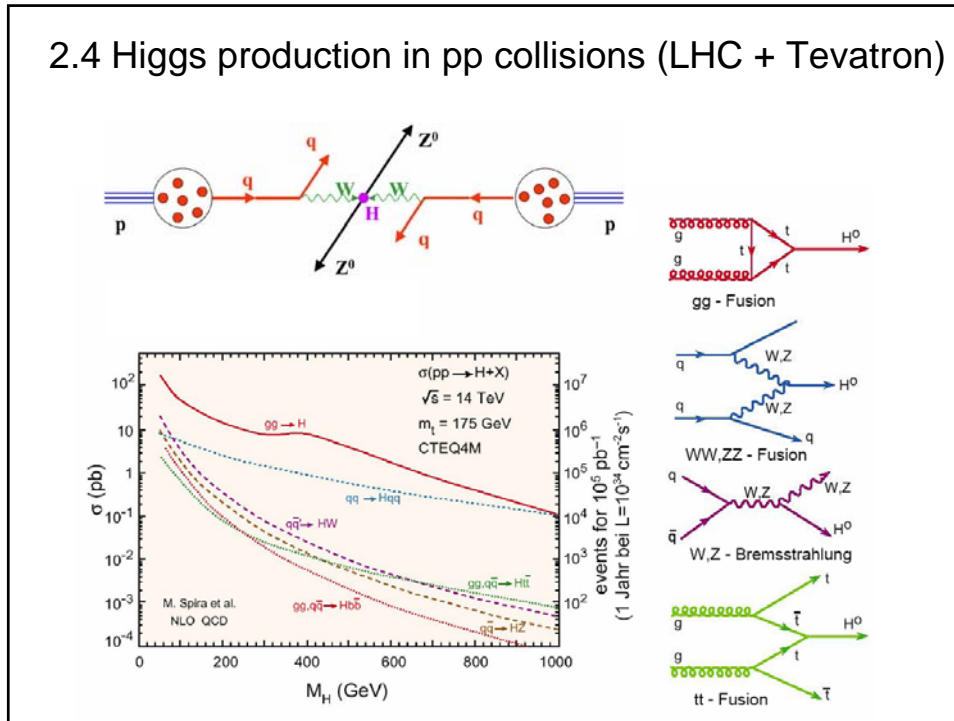


Invariant mass of
Higgs candidates:

LEP Summary: No signal
above background seen

LEP excludes a
114.4 GeV Higgs
boson @ 95% CL.
(expected 115.3
GeV)

2.4 Higgs production in pp collisions (LHC + Tevatron)



Higgs decay channels

At LEP: Searches were done using

$$H \rightarrow b\bar{b} \quad M_H > 114 \text{ GeV}$$

At TEVATRON:

$$ZH \rightarrow \ell^+ \ell^- b\bar{b}$$

$$H \rightarrow W^+ W^-$$

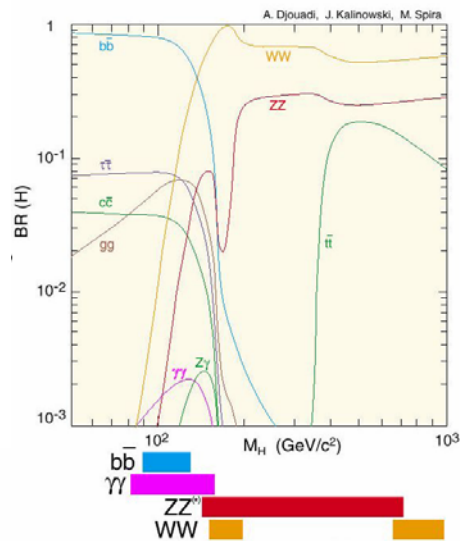
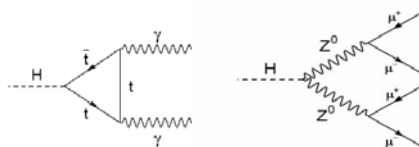
At LHC:

- $m_H < 150$ GeV: $H \rightarrow \gamma\gamma$

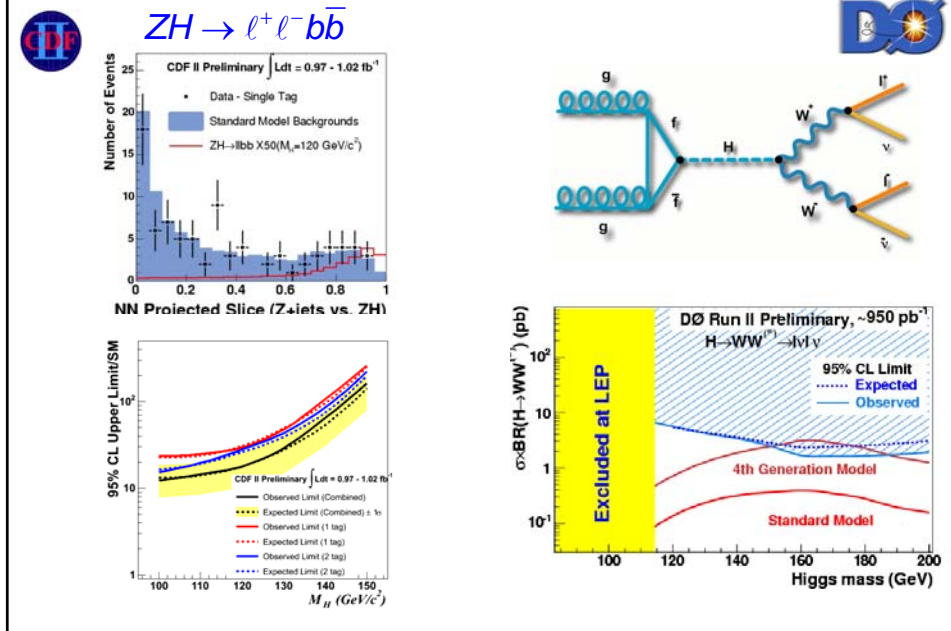
- $150 \text{ GeV} < m_H < 1 \text{ TeV}$

$$H \rightarrow ZZ^{(*)}$$

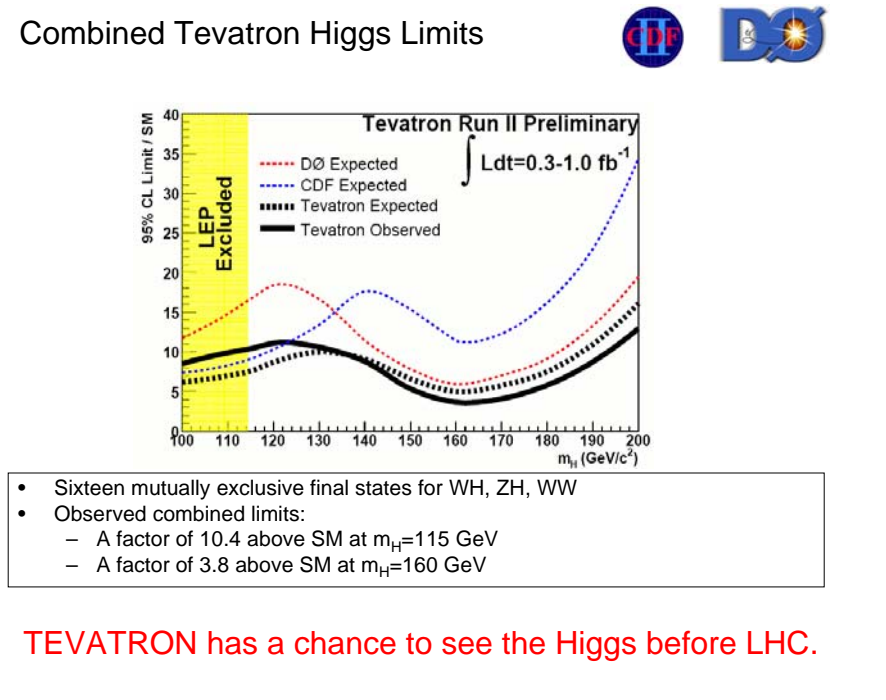
$$H \rightarrow W^+ W^-$$



Higgs Search at TEVATRON



Combined Tevatron Higgs Limits



Standard Model: Experimental Tests of Electroweak Interaction

Higgs Search at LHC

$$M_H < 2 M_W$$

$H \rightarrow b\bar{b}$ Not possible
(background level)

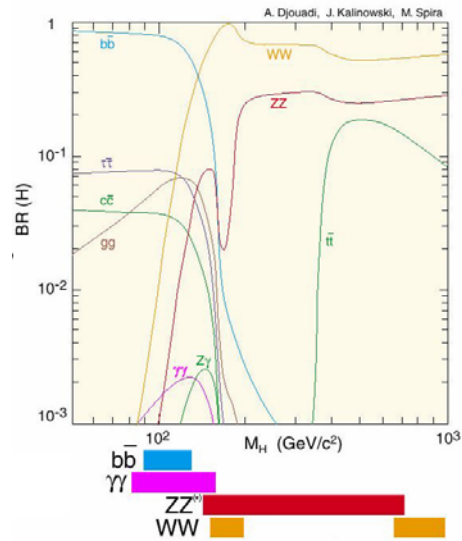
$H \rightarrow \gamma\gamma$ very challenging

$H \rightarrow \tau\tau$ Attractive alternative

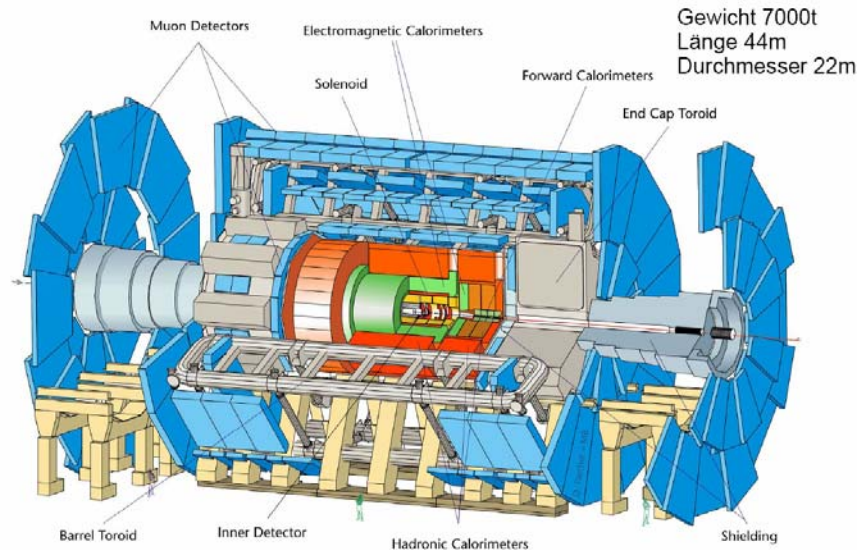
$$M_H > 2 M_W$$

$H \rightarrow WW^{(*)} \rightarrow l\nu l\nu$

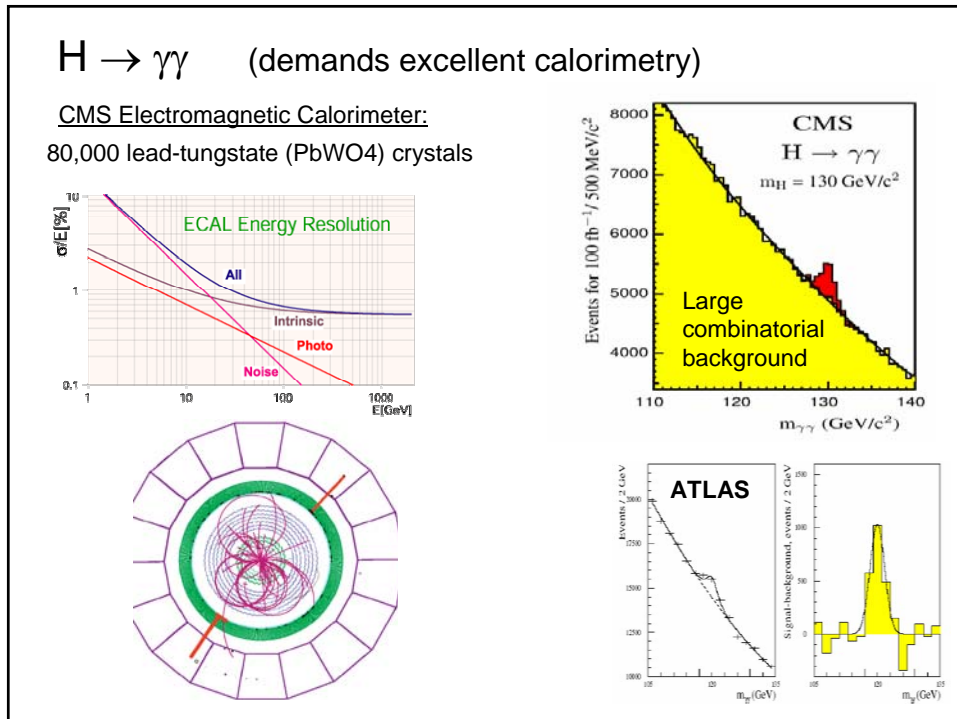
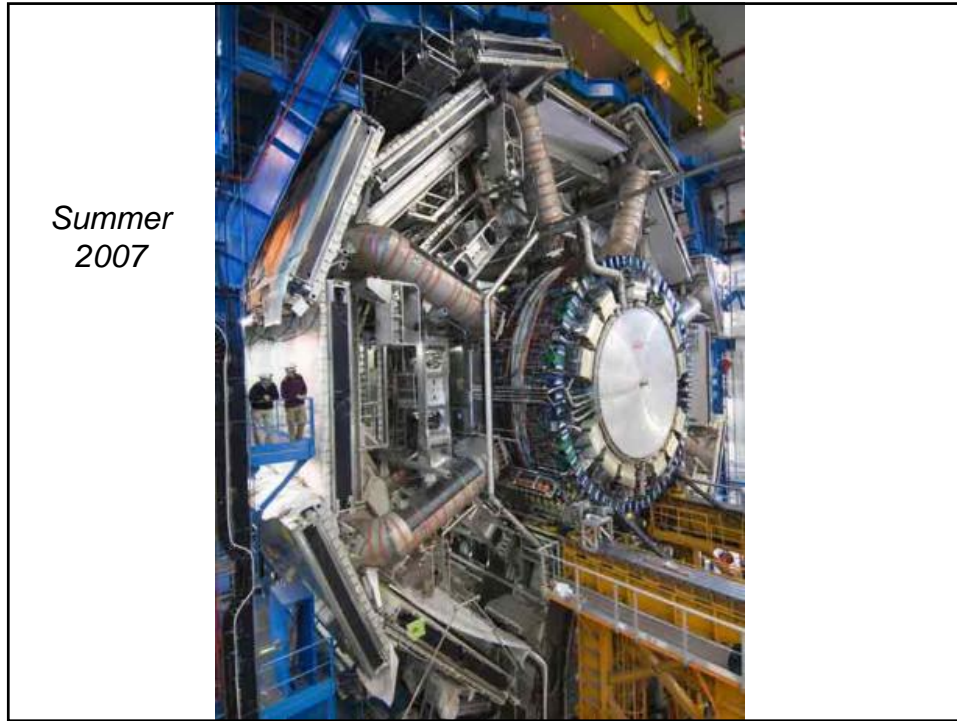
$H \rightarrow ZZ^{(*)} \rightarrow llll$
"golden" channel



The ATLAS Experiment at LHC

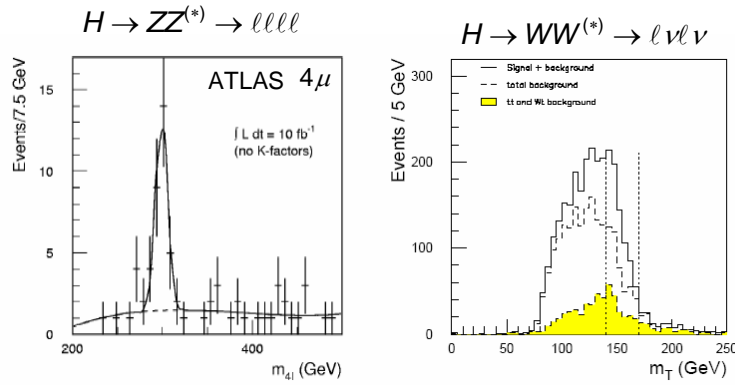


Standard Model: Experimental Tests of Electroweak Interaction



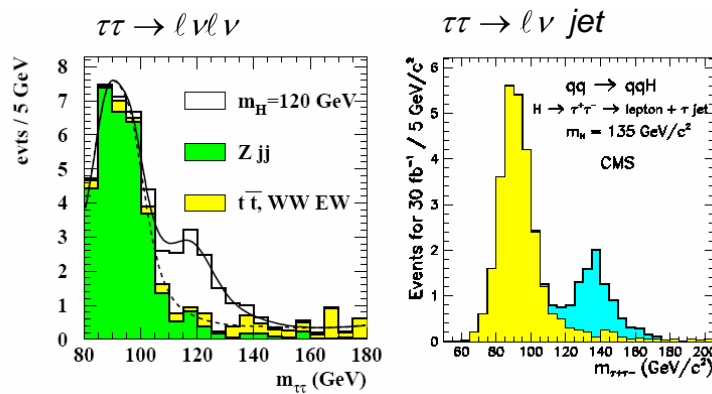
Standard Model: Experimental Tests of Electroweak Interaction

“Golden” Higgs decay channel



Not accessible for a light Higgs.

Tau decays of the Higgs: $qqH \rightarrow qq \tau\tau$



Promising alternative to $H \rightarrow \gamma\gamma$ for the low mass higgs.

Standard Model: Experimental Tests of Electroweak Interaction

