

Fermiophobic Higgs Bosons at LEP

Aura Rosca

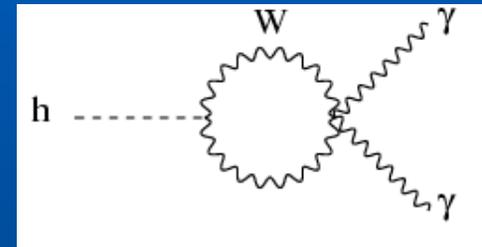
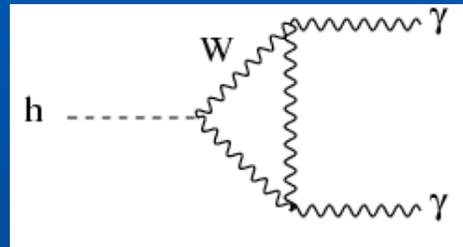
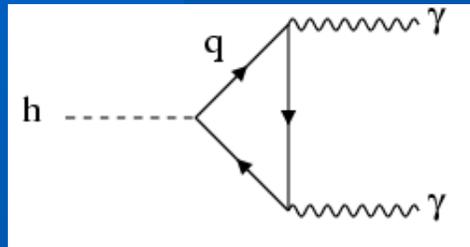
DESY-Zeuthen

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Introduction

- Standard Model postulates one complex Higgs doublet and predicts one neutral scalar boson of unknown mass.
- Present mass limit: $m_{H_{SM}} > 114.4 \text{ GeV}$
- Important to study extended Higgs models and search for processes not expected in the SM:
 - For example, fermiophobic Higgs bosons having enhanced branching fractions into gauge bosons.

Fermiophobic Higgs Bosons

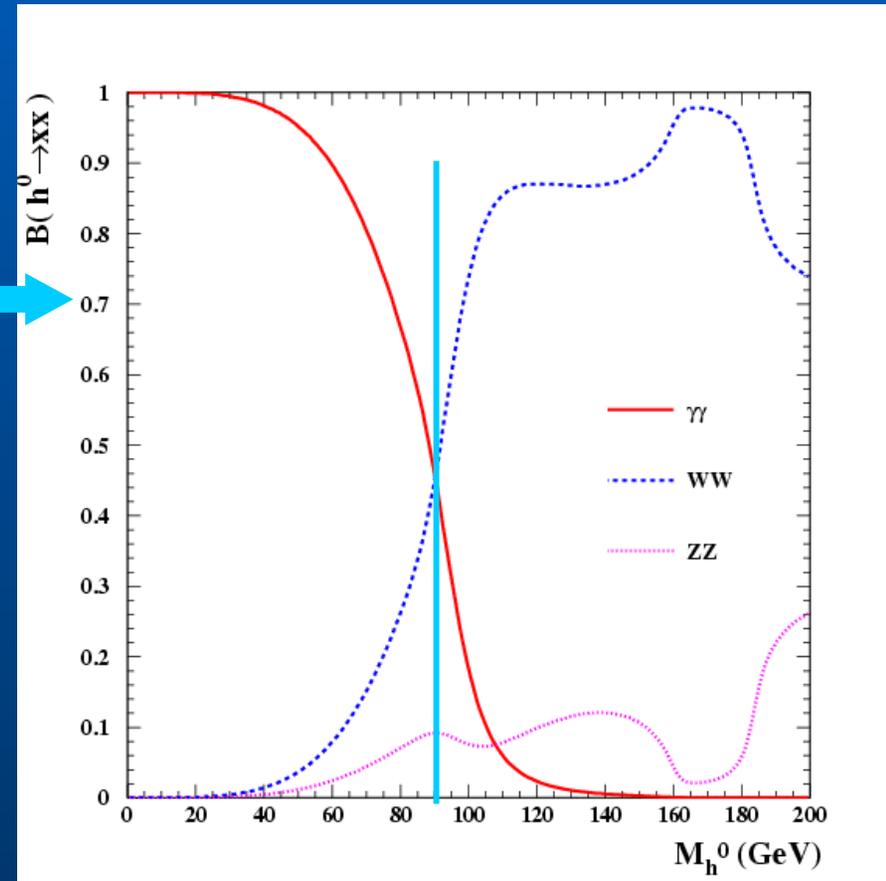


- Several models predict enhancements of the Higgs photonic branching fraction:

- For example, fermiophobic 2HD model of type I, where all fermions are assumed to couple to the same scalar field, and the couplings can be suppressed simultaneously by appropriate parameter choices.

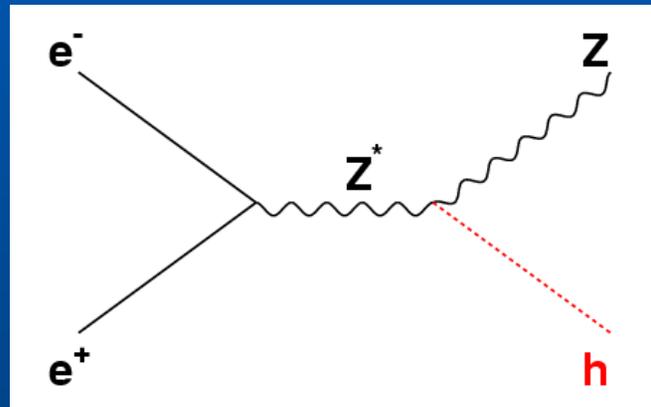
Benchmark Fermiophobic Model

- SM branching fractions, BUT no fermionic couplings:
 - Dominant decay into photons for masses lower than 90 GeV
 - Dominant decay into weak gauge bosons for masses greater than 90 GeV
- SM production cross section



Production and Decay

- Higgsstrahlung production:



- Photonic decay
 - investigated by all LEP experiments
- Weak bosons decay
 - investigated by L3

Final States

- **Decay $h \rightarrow \gamma\gamma$**

- Search channels

$$Zh \rightarrow q\bar{q}\gamma\gamma \quad 70\%$$

$$\rightarrow \nu\bar{\nu}\gamma\gamma \quad 20\%$$

$$\rightarrow \ell^+\ell^-\gamma\gamma \quad 10\%$$

$$\ell = e, \mu, \tau$$

- Background from double ISR photons

- **Decay $h \rightarrow WW^*, ZZ^*$**

- Search channels

$$Zh \rightarrow q\bar{q}q\bar{q}q\bar{q}$$

$$\rightarrow q\bar{q}q\bar{q}\ell\nu$$

$$\rightarrow q\bar{q}\ell\nu\ell\nu$$

$$\rightarrow \nu\bar{\nu}q\bar{q}q\bar{q}$$

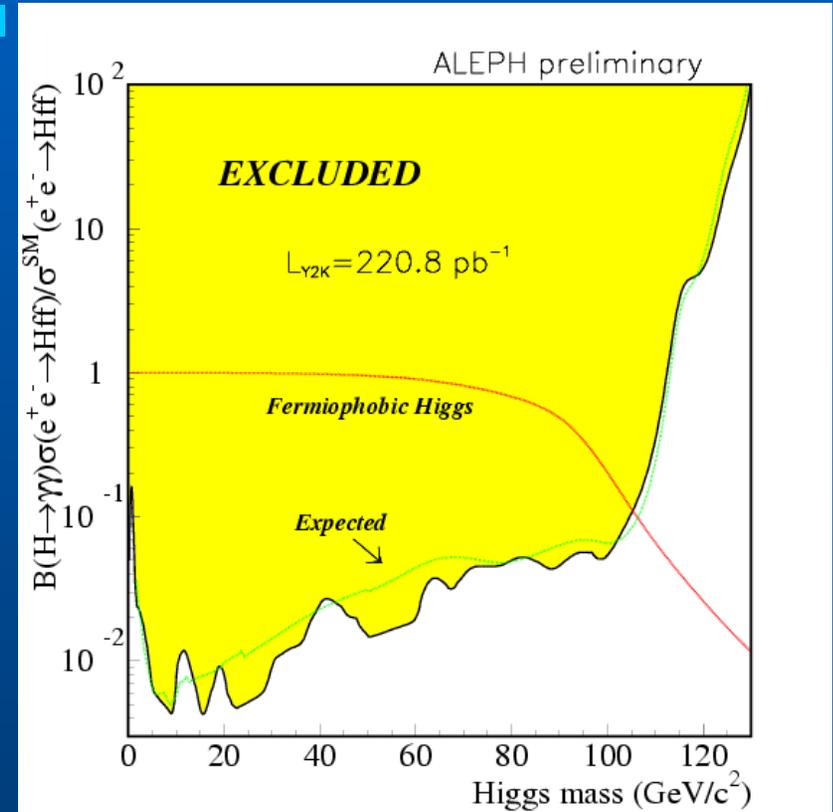
$$\rightarrow \nu\bar{\nu}q\bar{q}\ell\nu$$

$$\rightarrow \ell^+\ell^-\bar{q}q\bar{q}q\bar{q}$$

- 92% of the decay modes searched for.

Results from Aleph

- Data at $\sqrt{s} = 88 - 209 \text{ GeV}$
- Total integrated luminosity is 893 pb^{-1}
- Global analysis, inclusive Z selection
- Data: 23 events
- Bkgd: 30.8 events



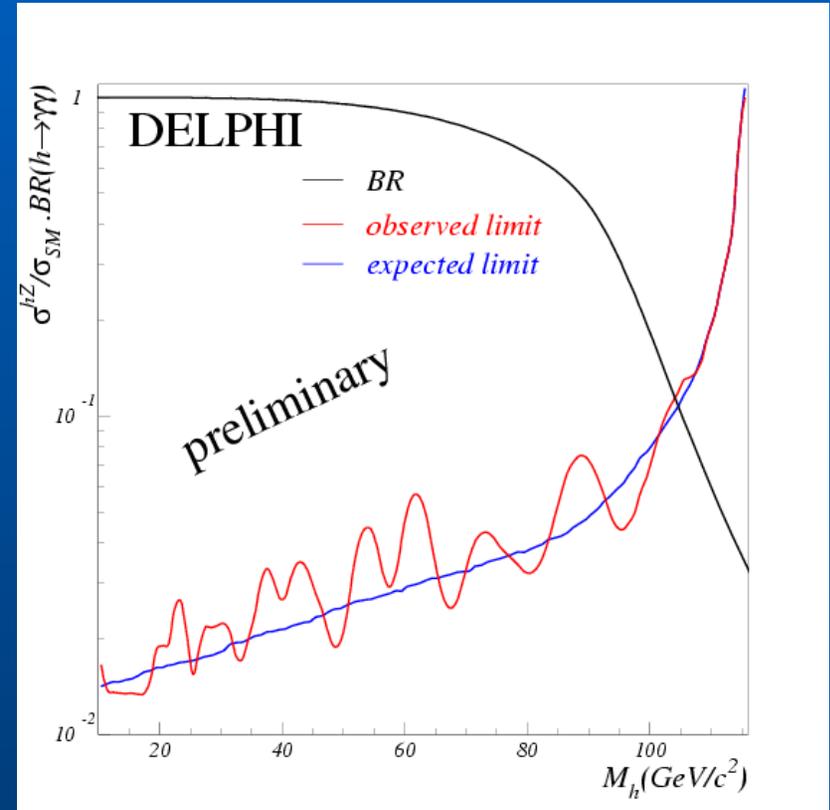
FINAL RESULTS

Submitted to Phys. Lett.B

$m_h > 105.4 \text{ GeV}$
(at 95% CL)

Results from Delphi

- Data at $\sqrt{s} = 183 - 209 \text{ GeV}$
- Total integrated luminosity is 650 pb^{-1}
- All Z decay channels
- Data: 54 events
- Bkgd: 51.6 events



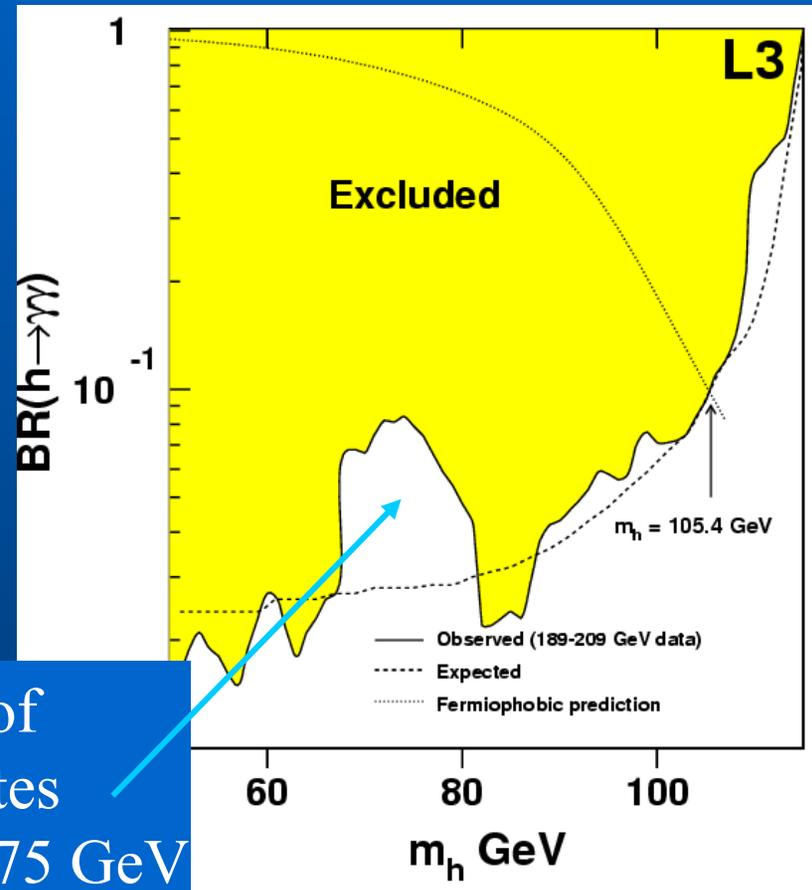
PRELIMINARY RESULTS

DELPHI 2002-086 PHYS 921

$m_h > 104.1 \text{ GeV}$
(at 95% CL)

Results from L3

- Data at $\sqrt{s} = 189 - 209 \text{ GeV}$
- Total integrated luminosity is 600 pb^{-1}
- All Z decay channels
- Data: 62 events
- Bkgd: 72.0 events



Excess of candidates at $m_h \approx 75 \text{ GeV}$

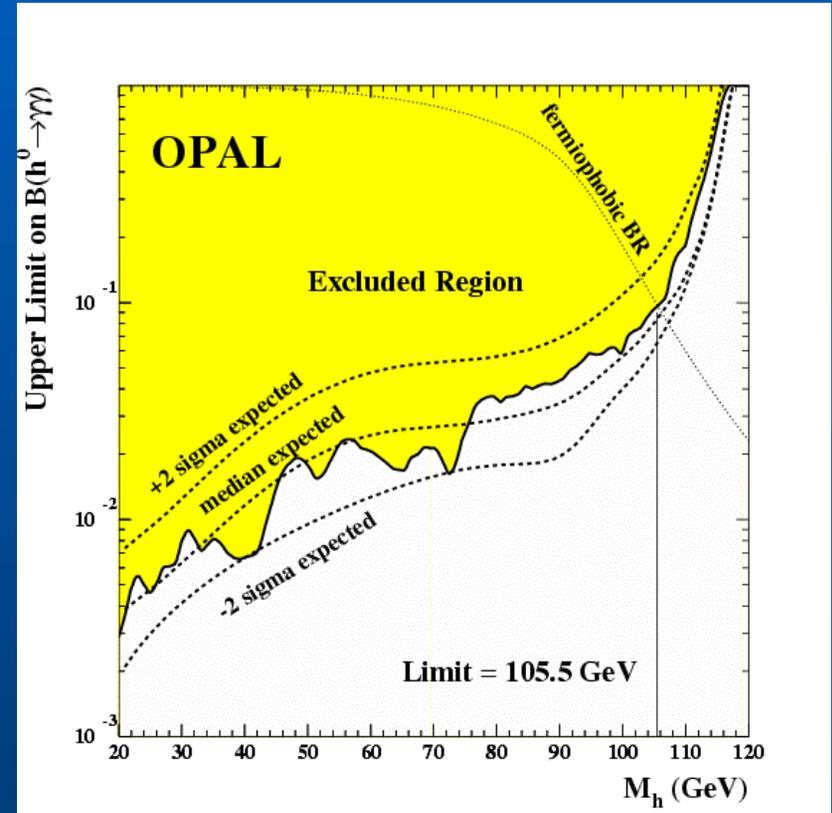
FINAL RESULTS

Phys. Lett. B 534 (2002) 28.

$m_h > 105.4 \text{ GeV}$
(at 95% CL)

Results from Opal

- Data at $\sqrt{s} = 88 - 209 \text{ GeV}$
- Total integrated luminosity is $\approx 900 \text{ pb}^{-1}$
- All Z decay channels
- Data: 124 events
- Bkgd: 135.2 events



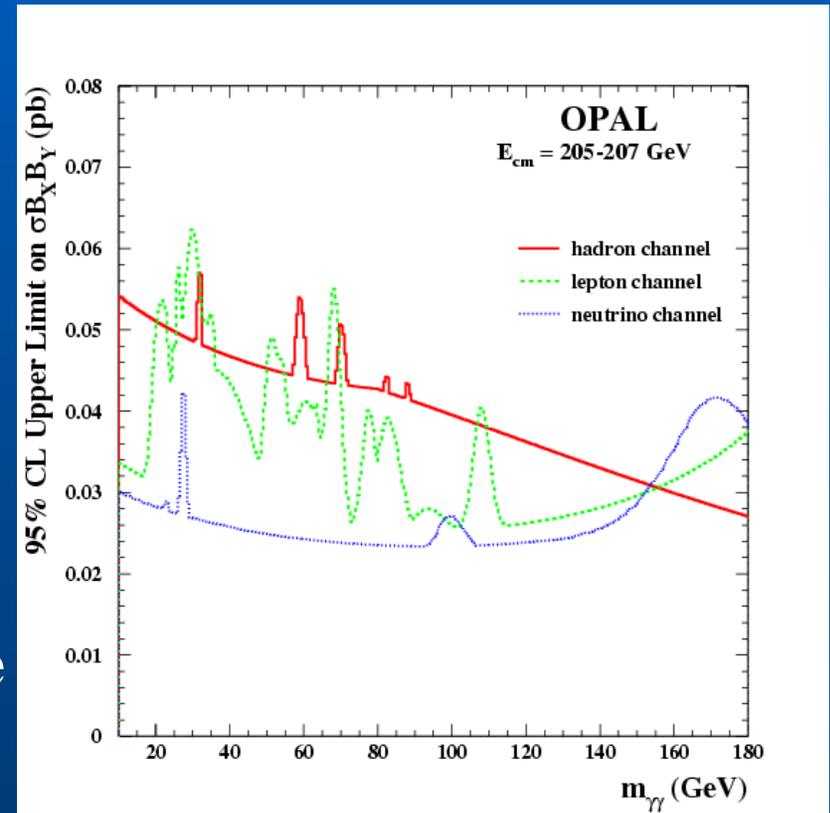
FINAL RESULTS

Submitted to Phys. Lett.B

$m_h > 105.5 \text{ GeV}$
(at 95% CL)

General Search Results by Opal

- Data at
 $\sqrt{s} = 205 - 207 \text{ GeV}$
- Total integrated luminosity is $\approx 200 \text{ pb}^{-1}$
- $e^+e^- \rightarrow XY$
 $X \rightarrow \gamma\gamma$, scalar particle
 $Y \rightarrow f\bar{f}$, scalar or vector particle



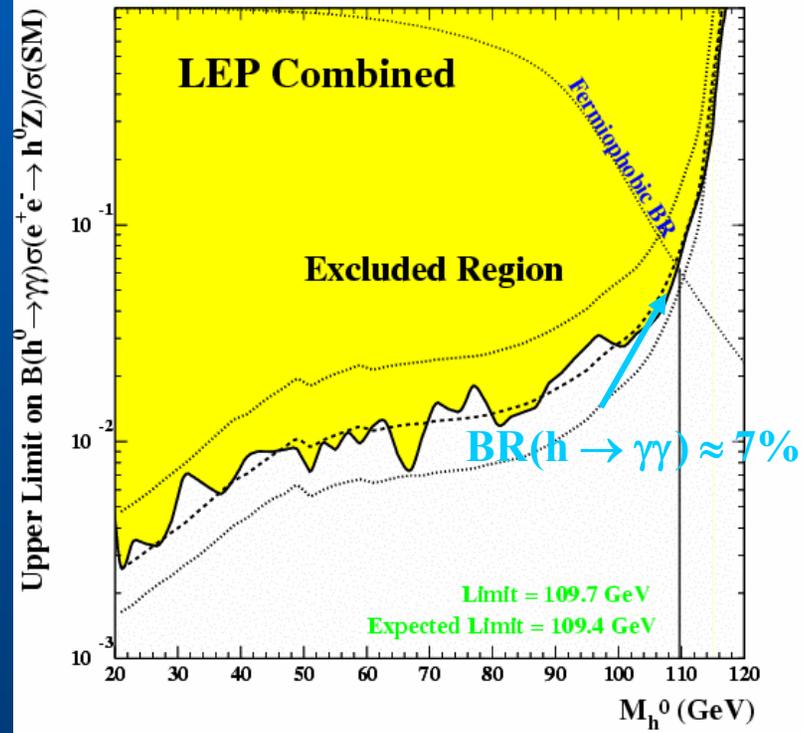
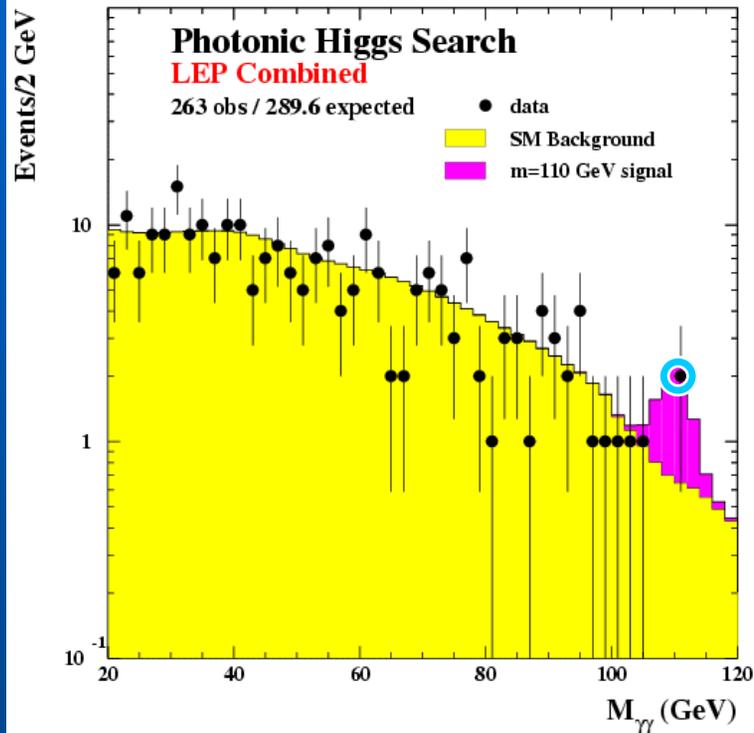
FINAL RESULTS

Submitted to Phys. Lett.B

$$\sigma \times \text{BR}_X \times \text{BR}_Y = 25 - 60 \text{ fb}$$

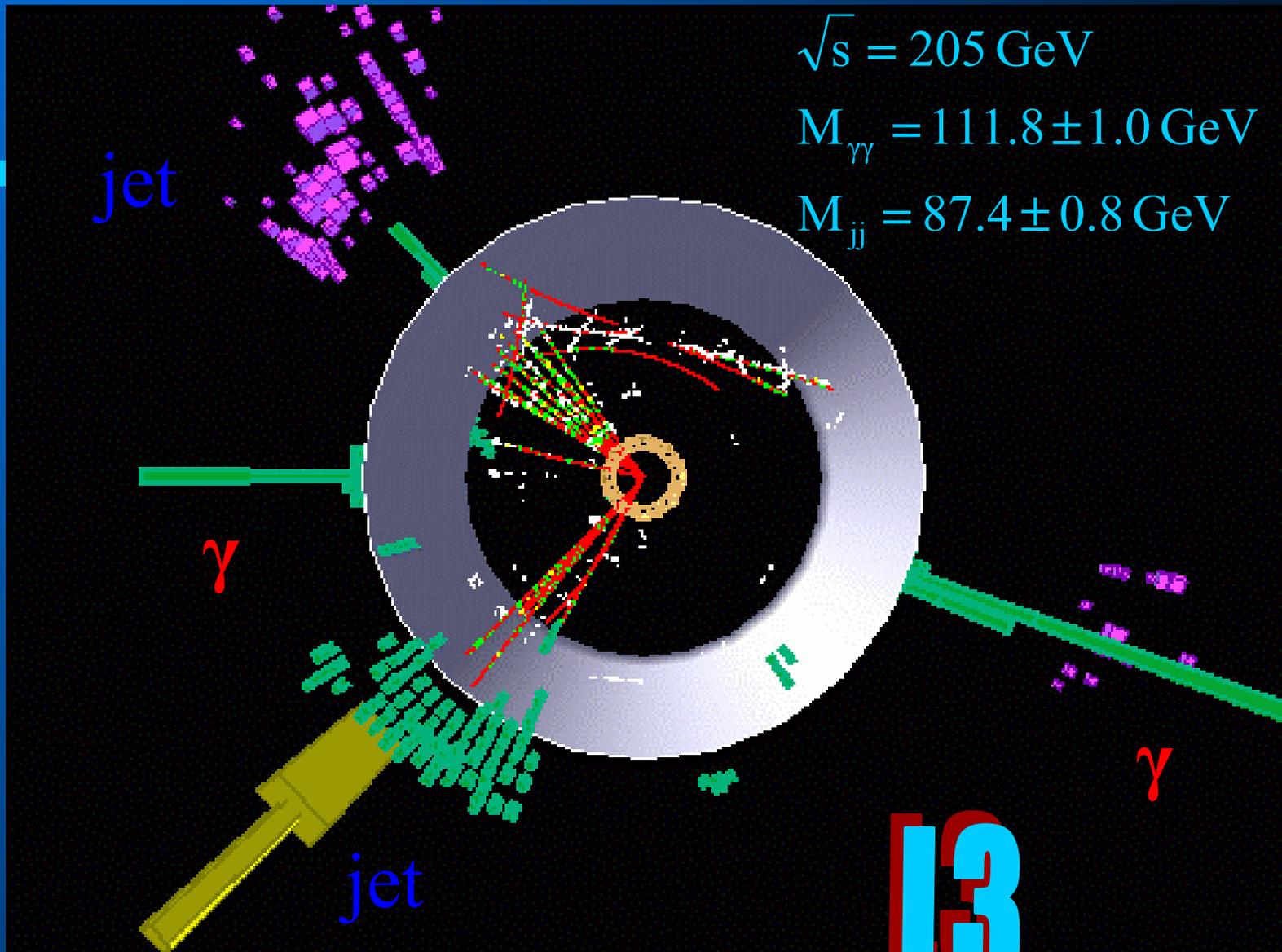
(at 95% CL)

LEP Combined Results



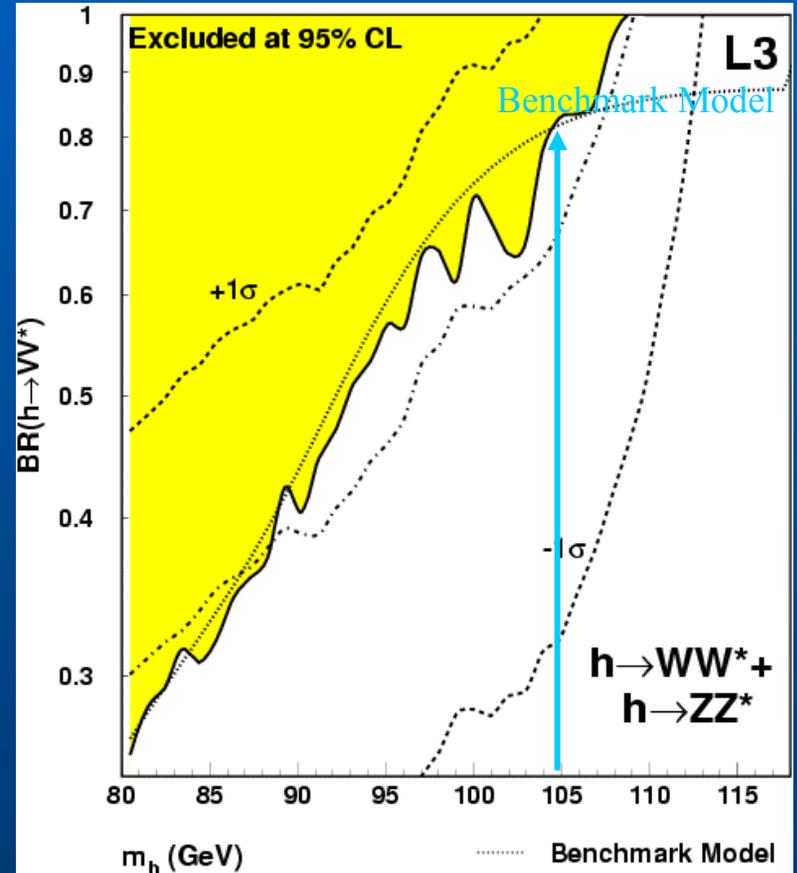
Data: 263 events
Bkgd: 289.6 events

$m_h > 109.7$ GeV
(at 95% CL)



The $h \rightarrow WW^*, ZZ^*$ Decays

- Data at $\sqrt{s} = 200 - 209 \text{ GeV}$
- Total integrated luminosity is 336.4 pb^{-1}
- Data: 566 events
- Bkgd: 568.3 events
 - Dominant background from the $qqqqqq$ final state
 - Most sensitive channel is $qqqq\nu$



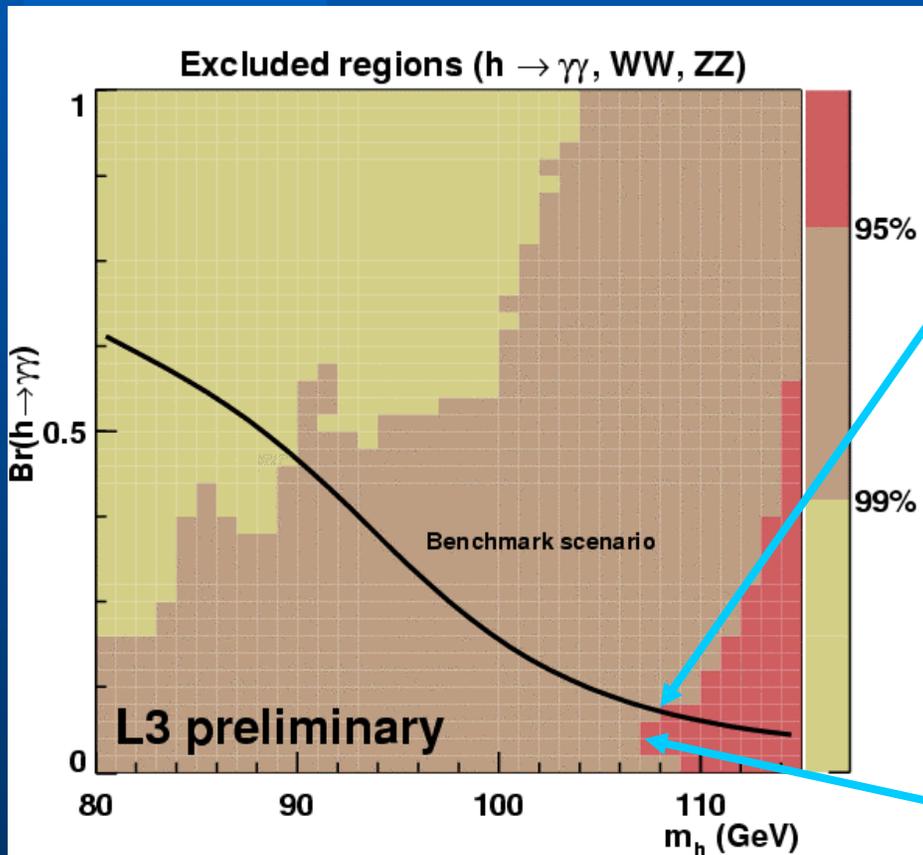
FINAL RESULTS

To be submitted to Phys. Lett.B

$m_h > 104.2 \text{ GeV}$

General Fermiophobic Results

- Assume $\text{BR}(h \rightarrow \gamma\gamma) + \text{BR}(h \rightarrow WW^*) + \text{BR}(h \rightarrow ZZ^*) = 1$



- Excluded regions in the plane $\text{BR}(h \rightarrow \gamma\gamma)$ vs m_h

- Observed limit
 $m_h > 108.3$ GeV
- Expected limit
 $m_h > 110.7$ GeV
- Compare to the L3 results using the photonic decay only:
 - Obs. 105.4 GeV
 - Exp. 105.3 GeV
- At any BR, SM production
 $m_h > 107$ GeV

Summary

- All LEP experiments searched for the production of a Higgs boson decaying into photons.
- No signal observed up to $m_h = 109.7$ GeV (LEP combined).
- Combination with WW^* and ZZ^* decays extends the L3 fermiophobic mass reach by 5 GeV.

Acknowledgements

- **Many thanks to all my colleagues for providing me with their results, and to LEP Higgs working group for their combination.**