



Search for Charged Higgs Bosons at LEP

Mattias Ellert, Uppsala University

**Sixth International Workshop on Tau Lepton
Physics, Victoria, 18–21 September 2000**



Outline

- **Physics motivation**
- **Cross-section and decay channels**
- **The DELPHI analysis**
 - τ polarisation
- **Combined results from all LEP experiments**



Physics Motivation

- **Charged Higgs bosons are predicted by extensions to the Standard Model containing two SU(2) Higgs doublets (2HDM)**
- **MSSM: $m(H^\pm) > m(W^\pm)$ at tree level**
- **Evidence for H^\pm with $m(H^\pm) < m(W^\pm)$ would be a signature of new Physics different from MSSM**



Pair Production at LEP

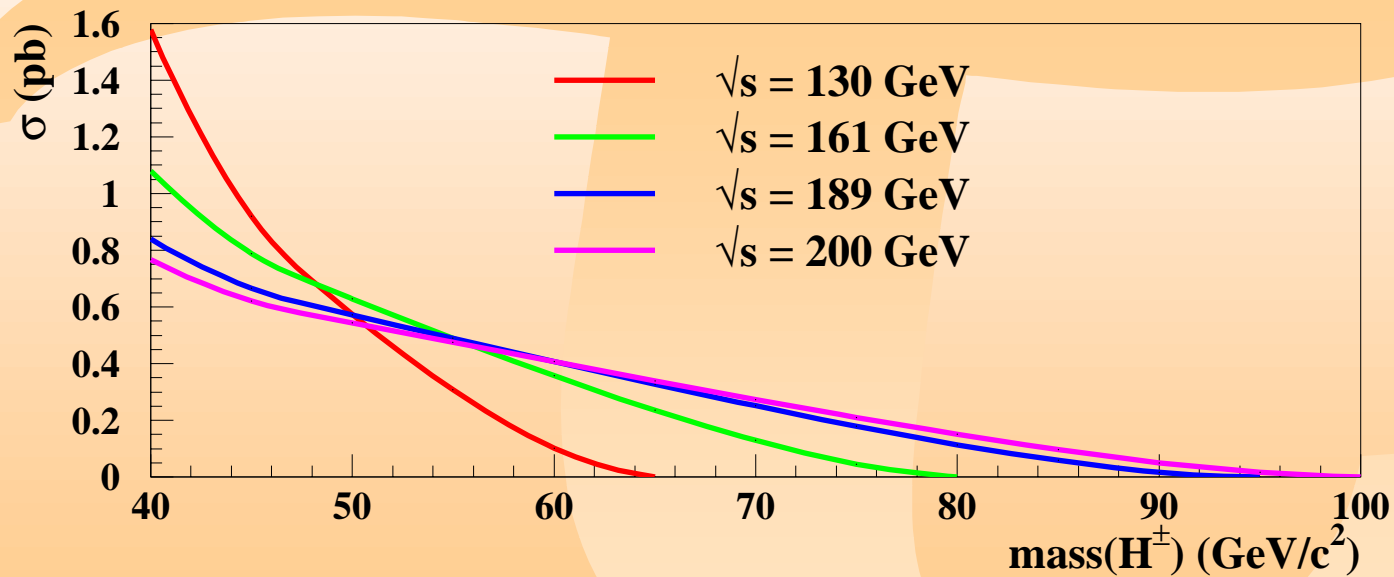
$$e^+ e^- \rightarrow Z^0 / \gamma \rightarrow H^+ H^-$$

The cross-section depends on the collision energy and the mass of the charged Higgs boson H^\pm



Cross-section

H^+H^- production cross-section





Three Different Final States



- **Hadronic**

- $H^+ H^- \rightarrow c\bar{s} \bar{c}s$

- **Semileptonic**

- $H^+ H^- \rightarrow c\bar{s} \tau \bar{\nu}_\tau / \tau^+ \nu_\tau \bar{c}s$

- **Leptonic**

- $H^+ H^- \rightarrow \tau^+ \nu_\tau \tau^- \bar{\nu}_\tau$



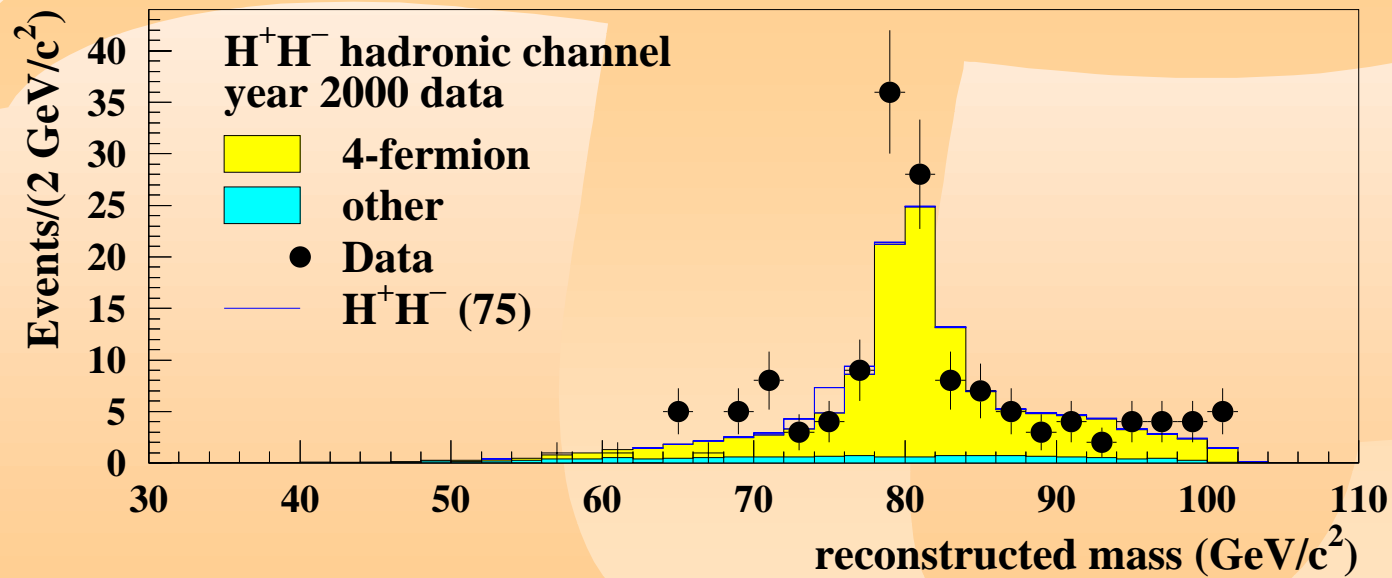
Hadronic Channel

- **4 hadronic jets**
- **mass reconstruction using a kinematic fit of 2 equal mass objects**
- **discrimination against W pairs using production angle measurements, and c- and s-quark tagging**



Hadronic Channel

DELPHI preliminary





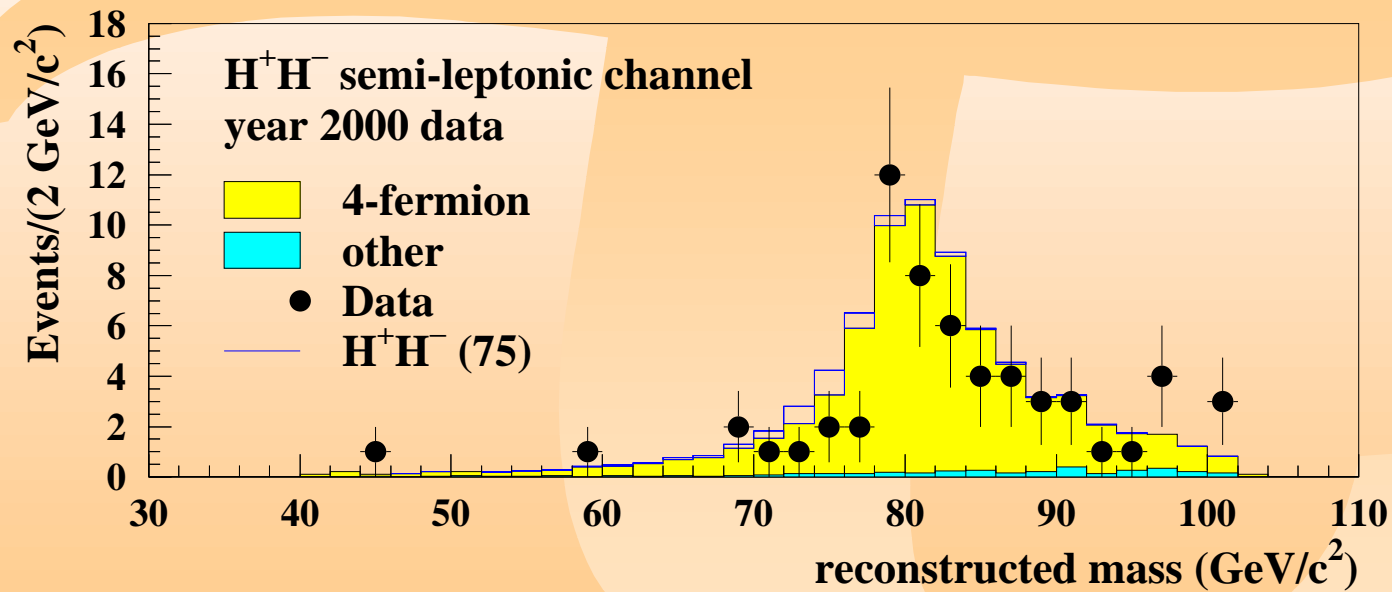
Semileptonic Channel

- **Two hadronic jets and one slim τ jet**
- **Mass reconstruction possible**
- **Discriminator against W pairs based on production and decay angles and particle identification**



Semileptonic Channel

DELPHI preliminary





Leptonic Channel

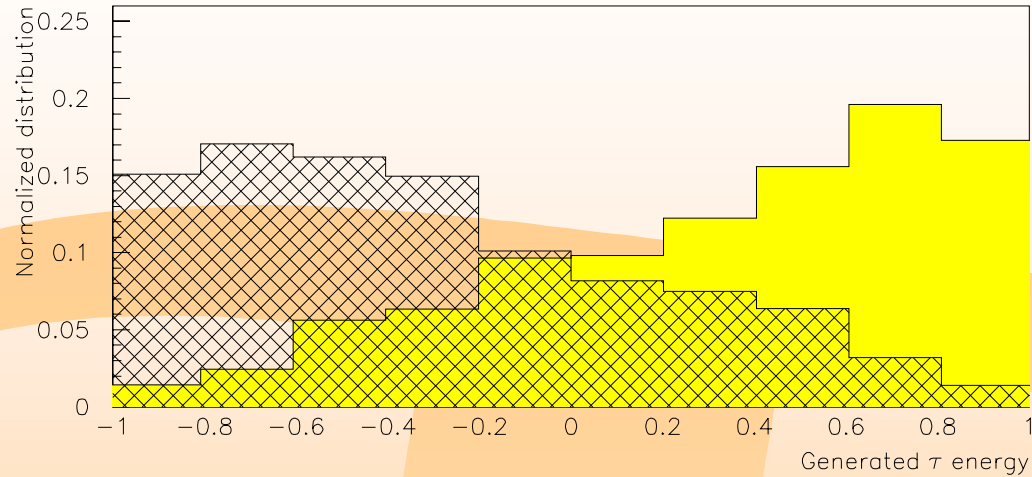
- **2 slim jets + missing energy**
- **Discriminator against W pairs based on the jet polar angles and a τ polarisation estimator**
- **No mass reconstruction**



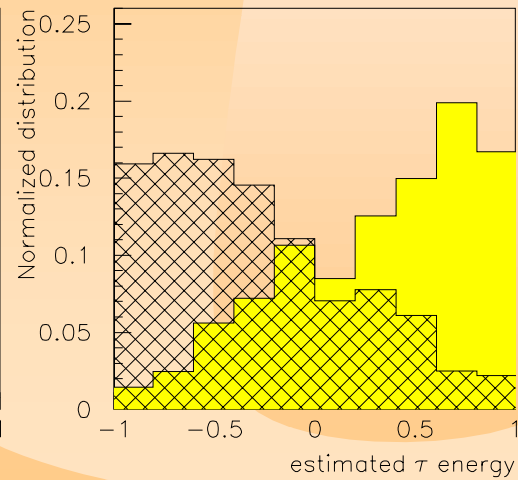
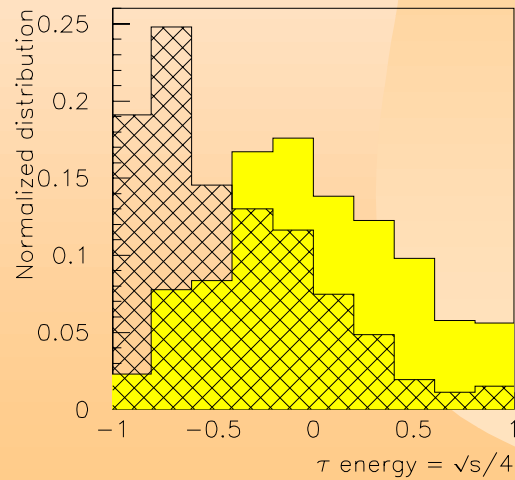
τ polarisation

- W^\pm (spin 1) $\Rightarrow P(\tau) = +1$
- H^\pm (spin 0) $\Rightarrow P(\tau) = -1$
- The τ candidates are classified according to their decay modes:
 - $e, \mu, \pi, \pi+n\gamma, 3\pi$ and others
- For each decay mode a different polarisation estimator is used

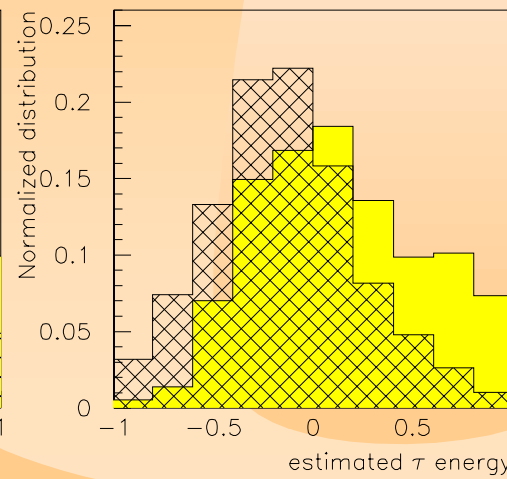
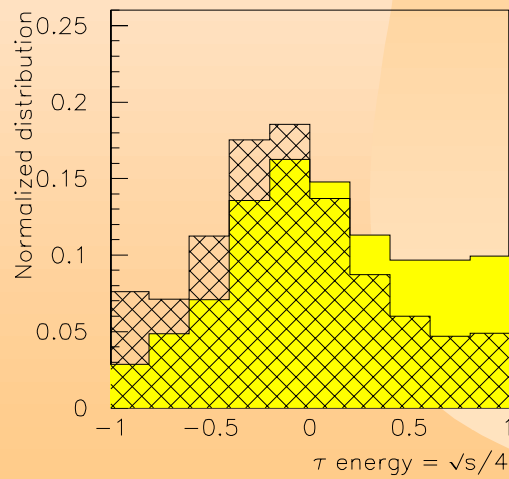
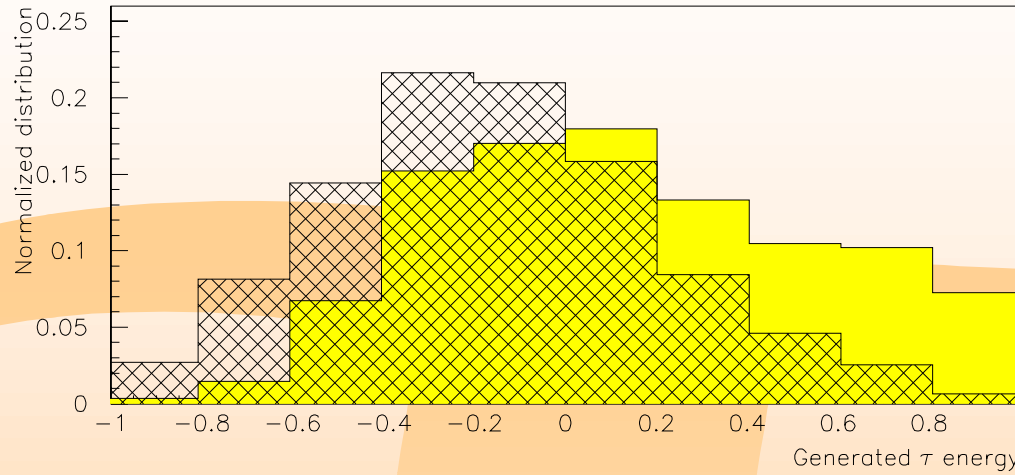
Search for Charged Higgs Bosons at LEP – Mattias Ellert, Uppsala University



π

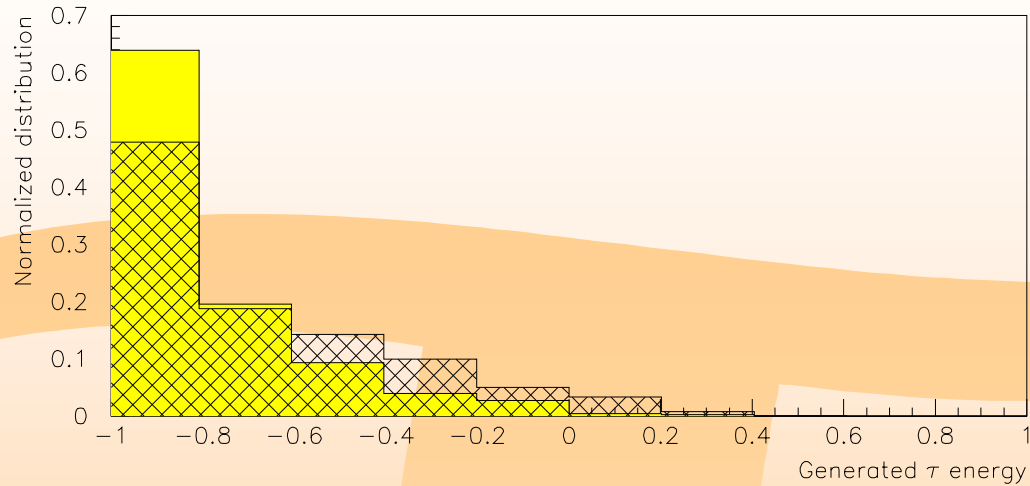


Search for Charged Higgs Bosons at LEP – Mattias Ellert, Uppsala University

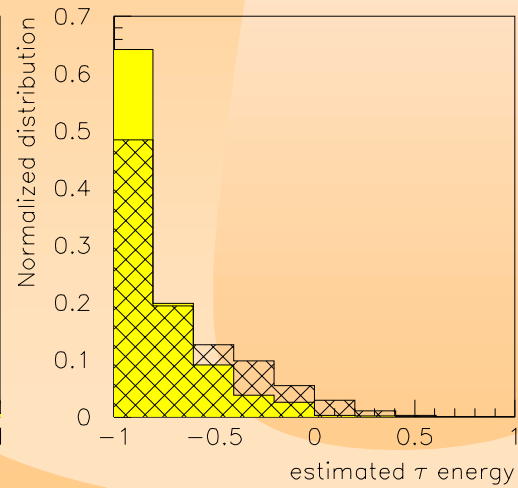
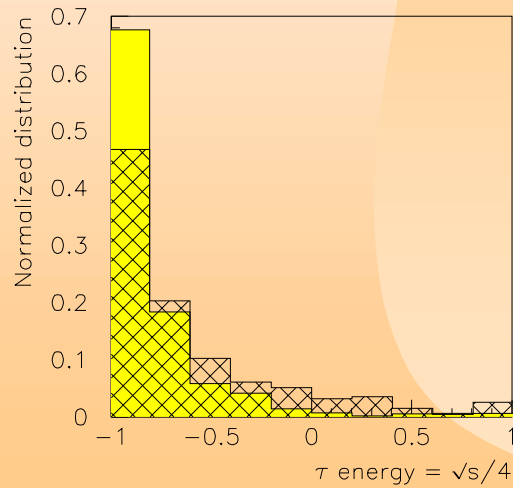


3π

Search for Charged Higgs Bosons at LEP – Mattias Ellert, Uppsala University



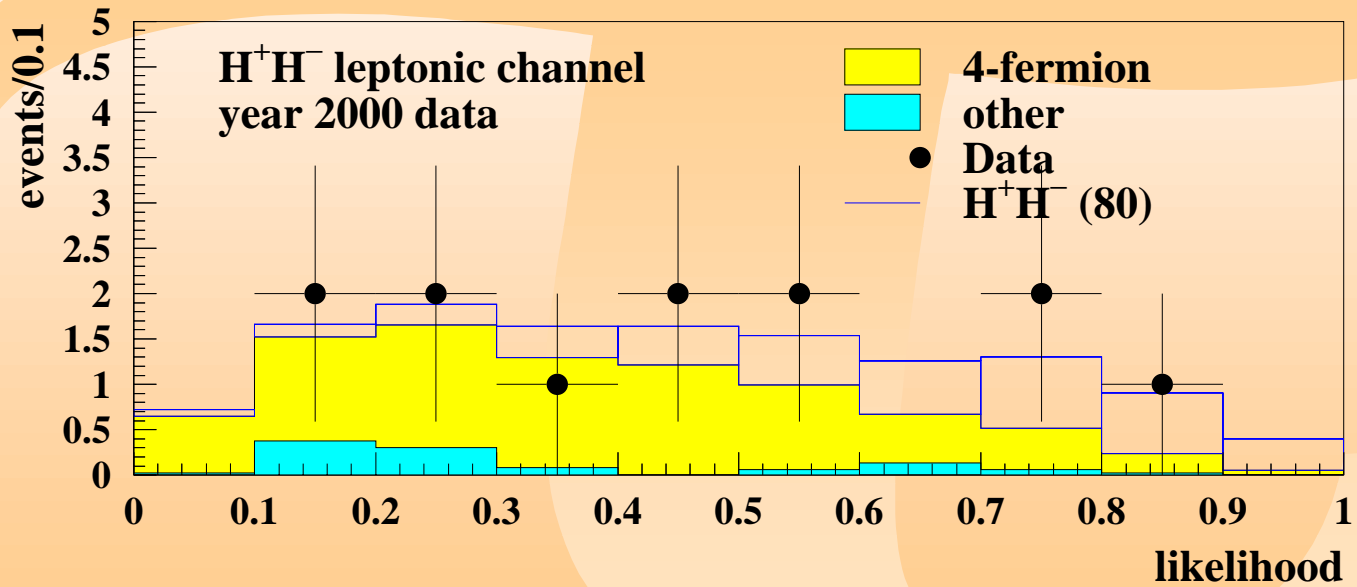
μ





Leptonic channel

DELPHI preliminary

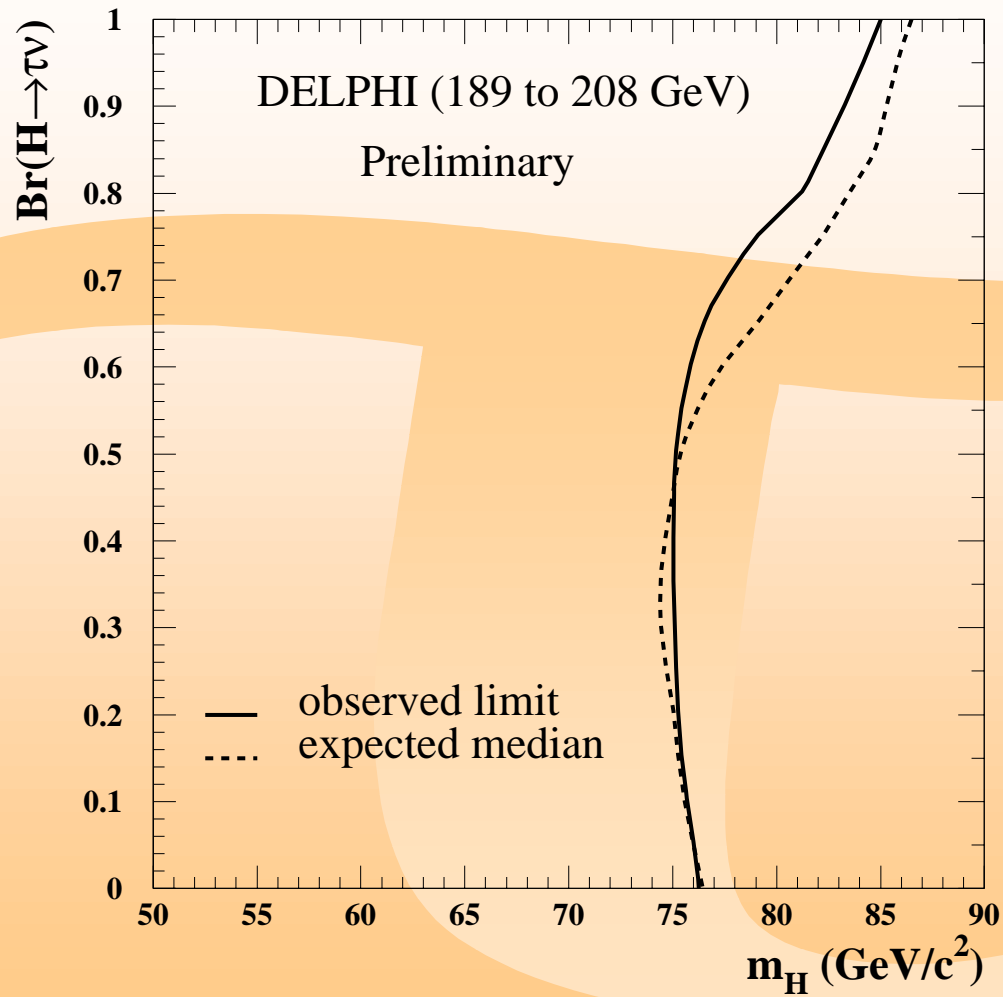




Exclusion Limit

- **No significant excess found**
- **A 95% exclusion limit is set in a parameter space spanned by $m(H^\pm)$ and $BR(H^+ \rightarrow \tau^+ \nu_\tau)$ using a likelihood ratio Monte Carlo method**

Search for Charged Higgs Bosons at LEP – Mattias Ellert, Uppsala University



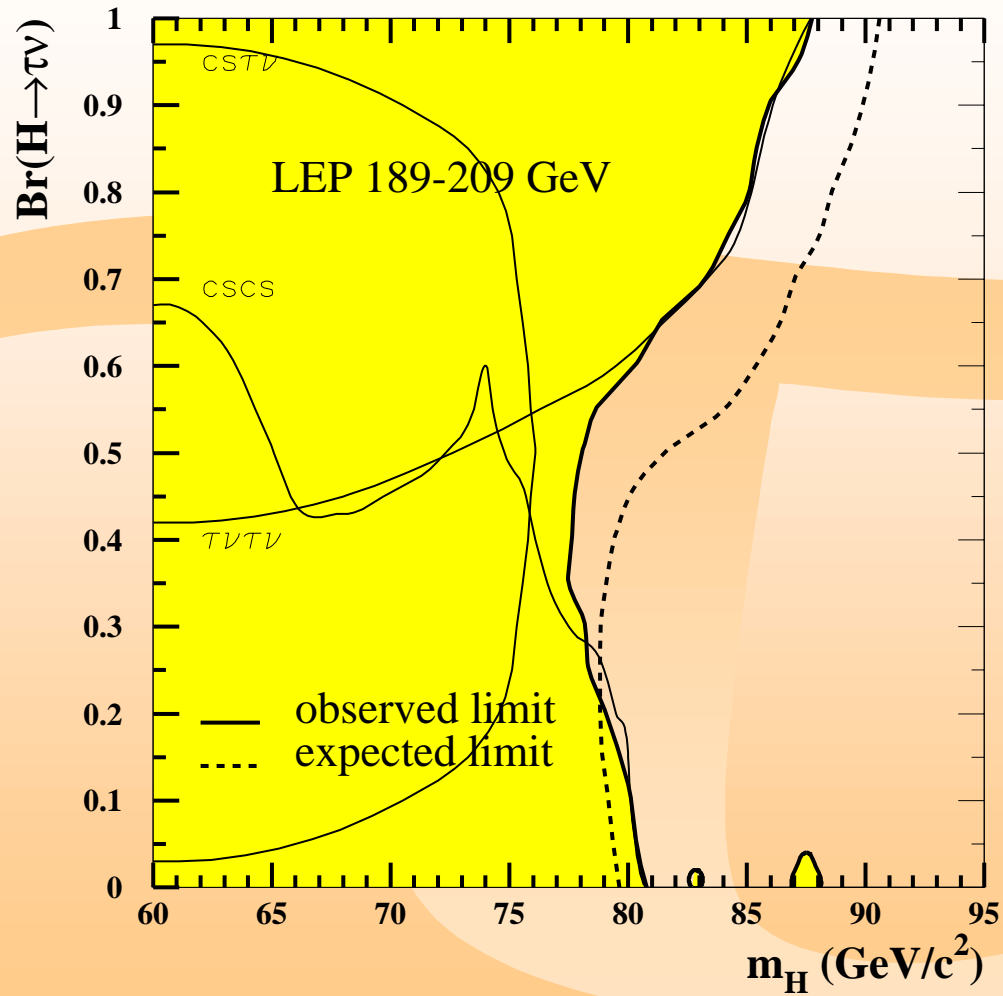


Combining data from all LEP experiments



- In order to obtain a limit using the largest possible data sample the LEP Higgs Working Group has calculated a limit using data from all LEP experiments (Aleph, DELPHI, L3 & Opal)

Search for Charged Higgs Bosons at LEP – Mattias Ellert, Uppsala University





Conclusion

- **Limits calculated in the 2HDM**
- **Mass limit using DELPHI data:
75.0 GeV/c² for all BR(H⁺ → τ⁺ν_τ)**
- **Mass limit calculated using data from
all LEP experiments:
77.4 GeV/c² for all BR(H⁺ → τ⁺ν_τ)**