Higgs searches in DELPHI

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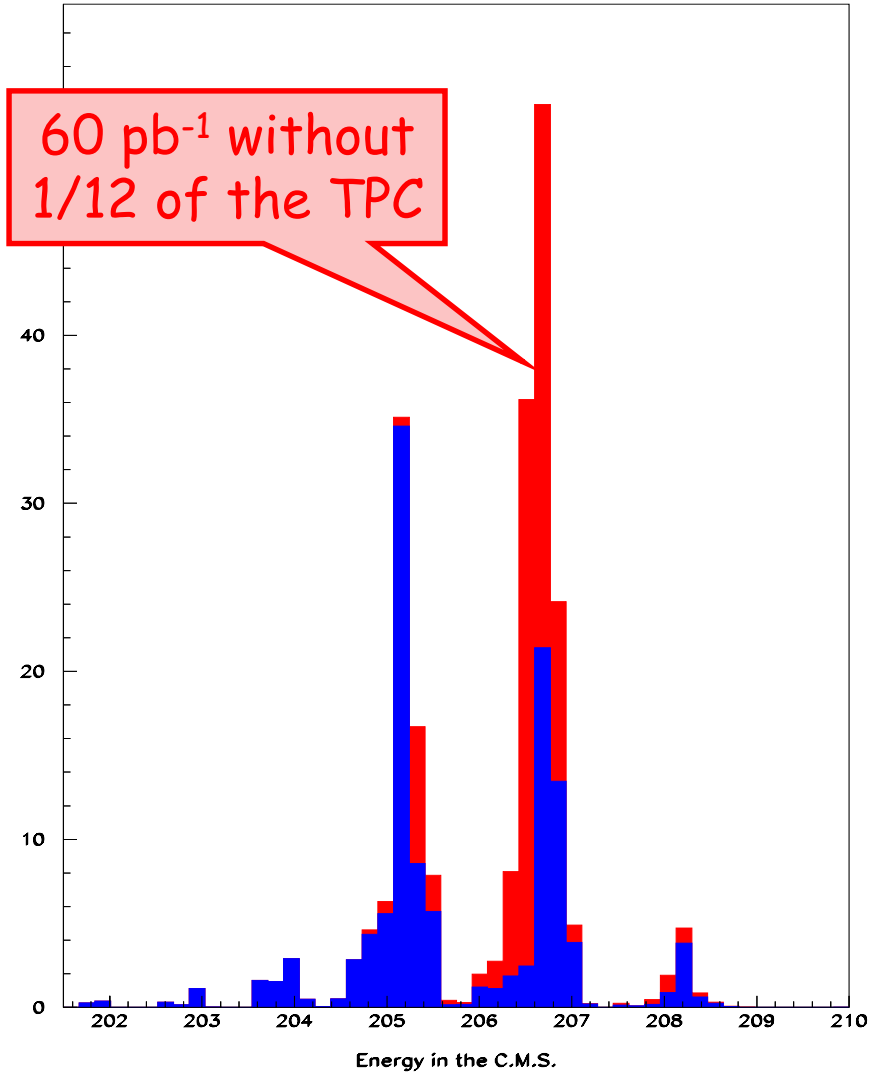
Outline

- Data samples
- Neutral Higgs search in the Standard Model
- Neutral Higgs in the MSSM
- Charged Higgs
- Invisible Higgs

Data Samples

The data collected during the year 2000 correspond to a total of 224.1 pb^{-1}.

E_{cm} (GeV)	Integrated Luminosity (pb^{-1})
202.6	2.3
203.9	6.7
204.8	10.5
205.2	62.5
206.2	18.2
206.7	115.2
208.2	8.7

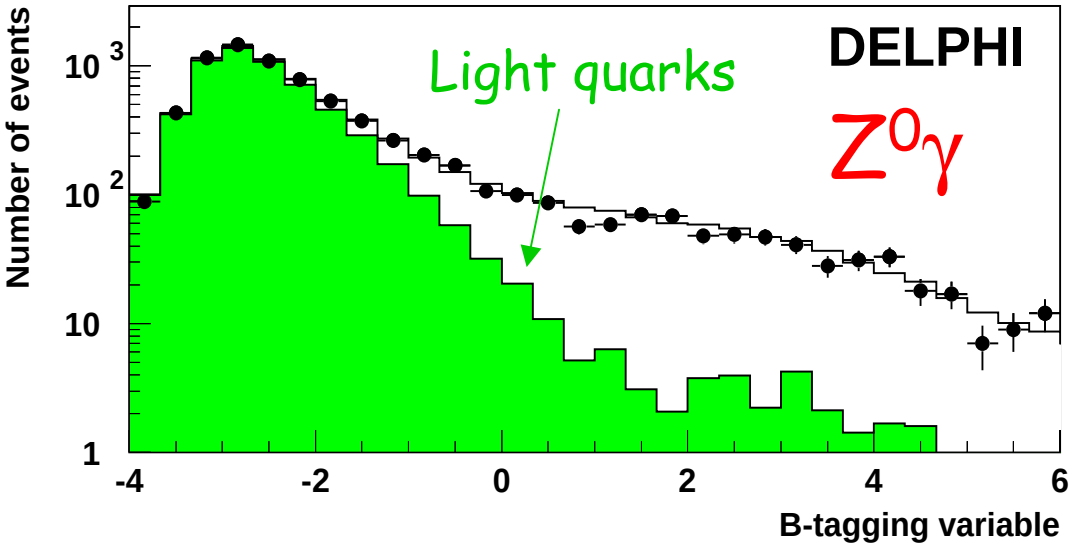


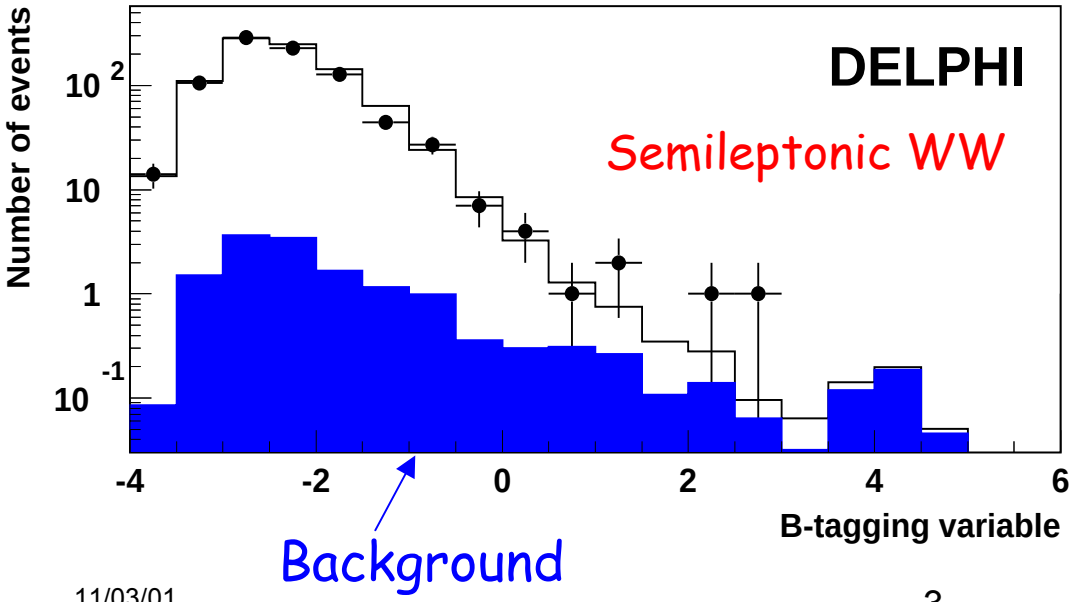
B-tagging calibration

The Impact Parameter resolution has been calibrated using high energy 4 jets events.

Only tracks with negative IP where used, so the calibration is not correlated with physics measurements.

The data-MC agreement on the B-tagging variable is satisfactory.





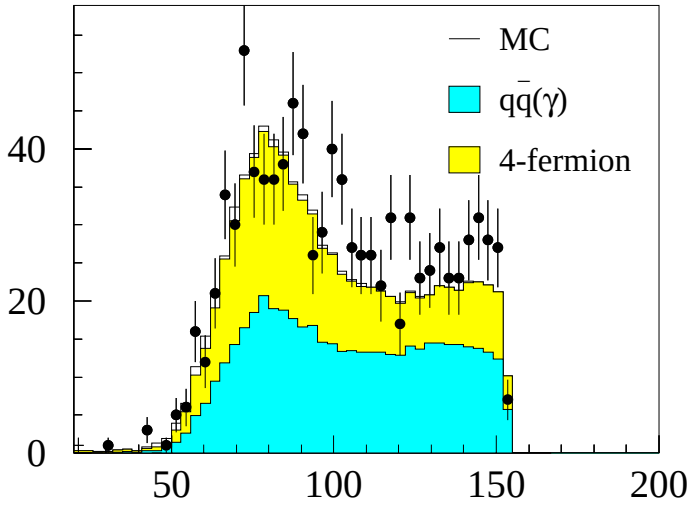
Hνν channel

The analysis is based on a preselection aimed at reducing the $\gamma\gamma$ and $qq(\gamma)$ background (ε_{114} = 67%), followed by a cut on a multi-dimensional variable.

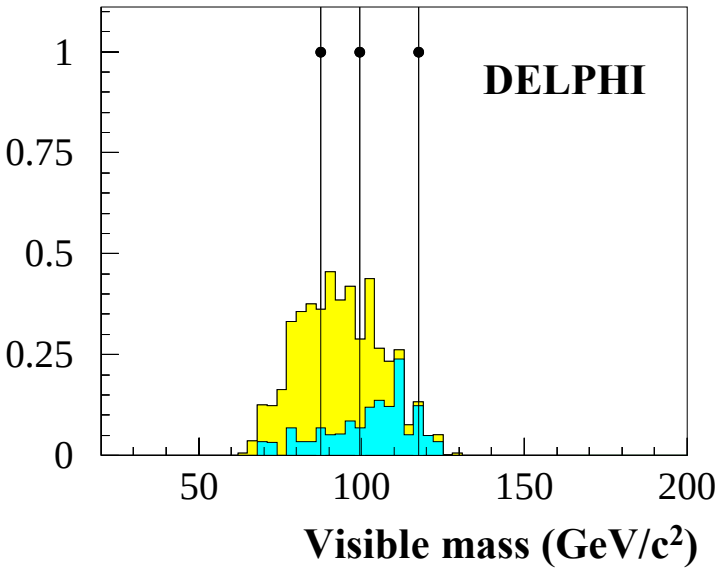
The cuts were optimized for very low background:

	Data	Total BKG	$qq(\gamma)$	4 ferm.
Presel	970	880	467	390
Tight	3	4.9	1.4	3.5

Preselection



Tight Selection



Hee, Hμμ and Hττ channels

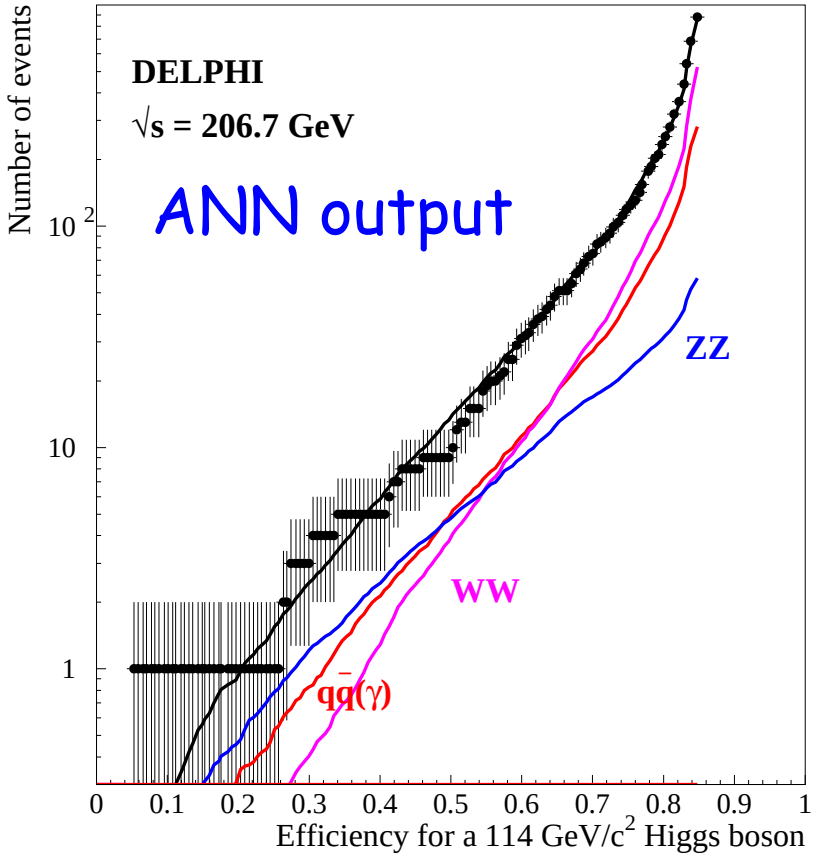
	Data	BKG	qq(γ)	4-ferm	ε_{114}
μμ pre	3780	3763	2671	1067	81 %
μμ tight	2	3.6	0.1	3.5	56 %
ee pre	1242	1172	745	416	78 %
ee tight	1	3.5	0.1	3.2	49 %
ττ pre	9180	8913	5425	3468	98 %
ττ tight	2	4.1	0.1	4.0	19 %

ee and μμ analysis use the reconstructed Higgs mass and the b-tagging variable x_b as input to the two-dim CL calculation; the ττ analysis uses M_H and a discriminating variable based on x_b and on the kinematics of the τ jets.

Hqq channel

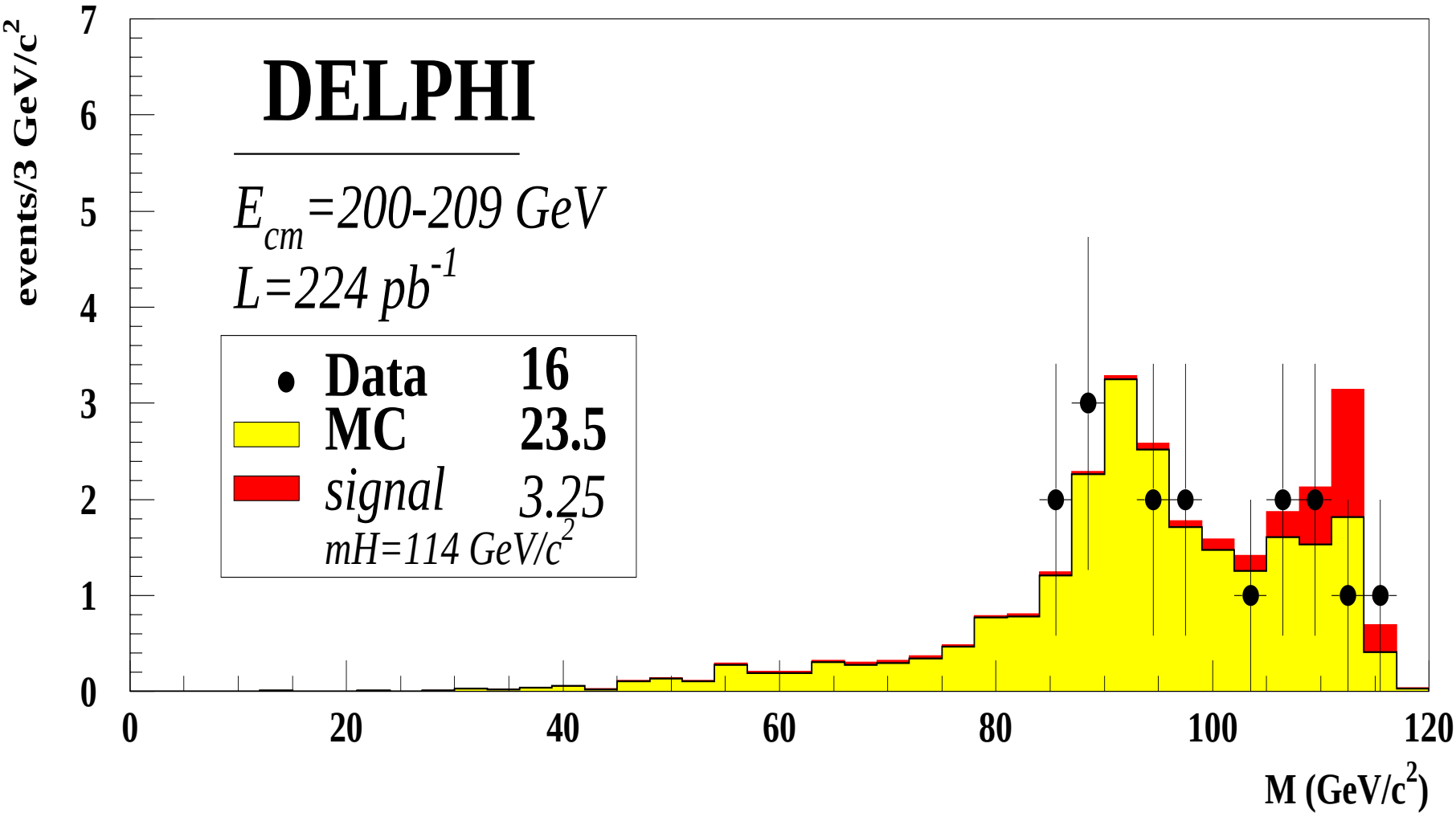
The analysis is based on an artificial neural network combining:

- An enhanced B-tagging estimator
- A set of kinematical variables to suppress WW and ZZ background.
- A set of anti-qq(γ) variables



	Data	BKG	qq(γ)	4-ferm	ε_{114}
qq pre	2266	2342	680	1662	85 %
qq tight	8	7.4	2.8	4.6	36 %

Standard Model Higgs: mass plot

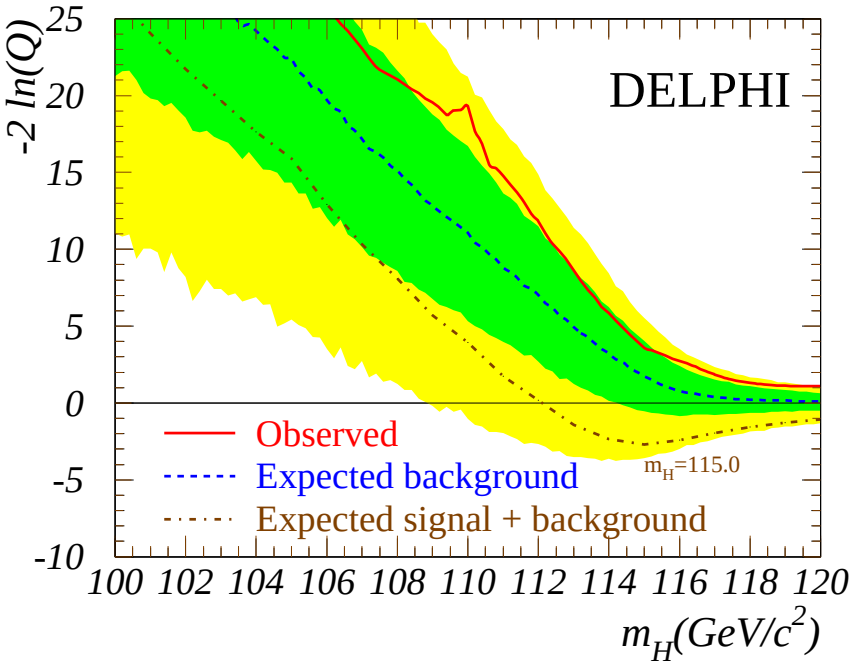


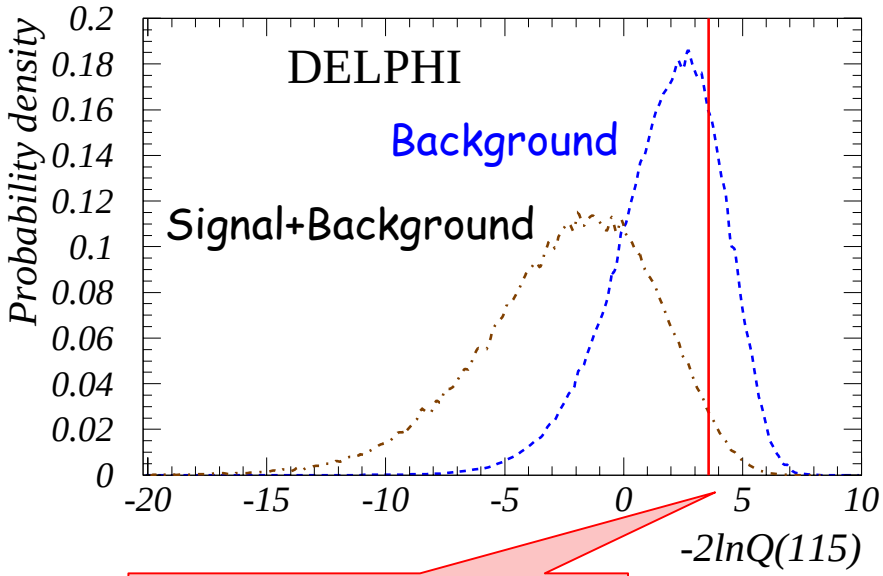
Standard Model Higgs: CL

The test statistic likelihood ratio Q is defined as:

$$\ln(Q) = -S + \sum_i \ln(1 + s_i / b_i)$$

Q is used to define signal and signal+background confidence levels; CL_s is estimated as CL_{s+b}/CL_b

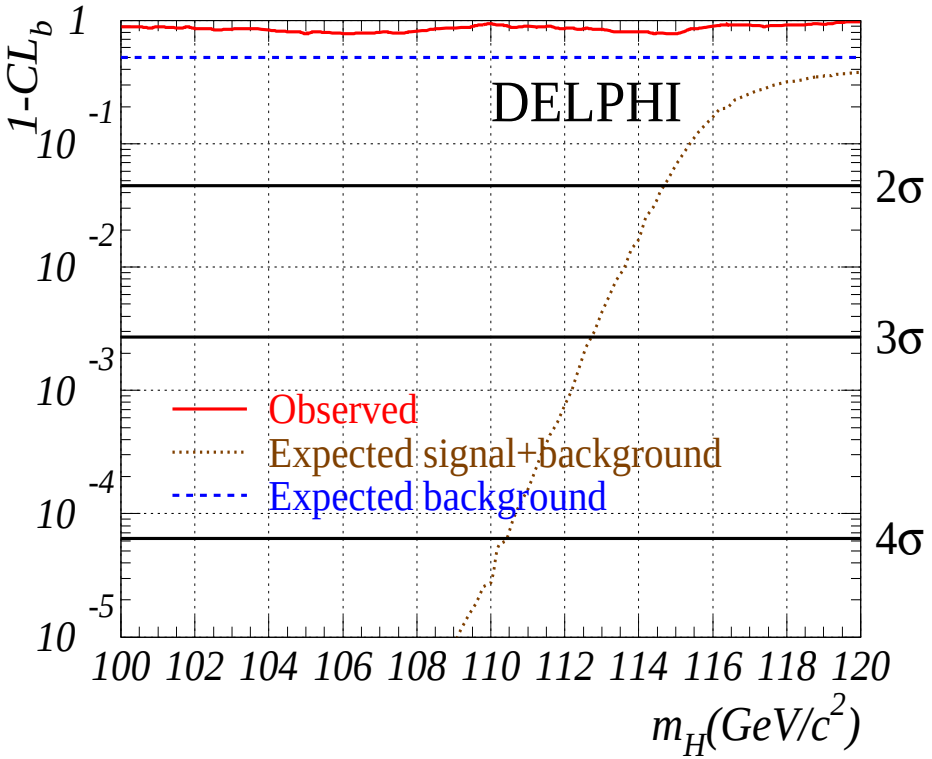


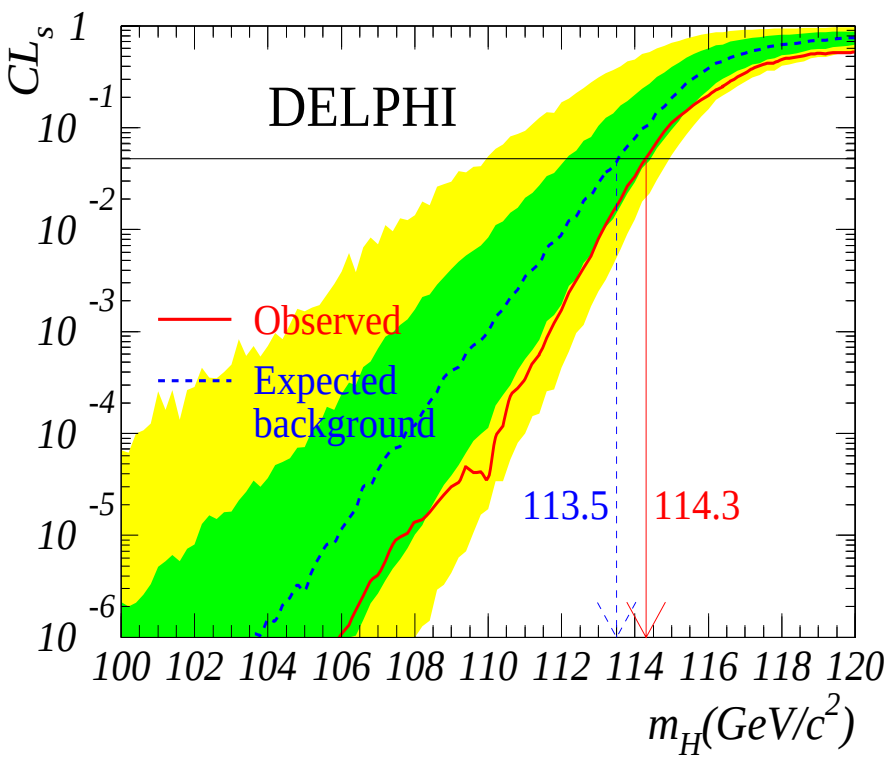


$CL_s(M_H=115) = 12\%$

SM Higgs Mass Limit

The one σ deficit in the number of observed events gives a 95% CL lower M_{H^0} limit of 114.3 GeV/c^2, while the expected median limit is 113.5 GeV/c^2.





MSSM Higgs search

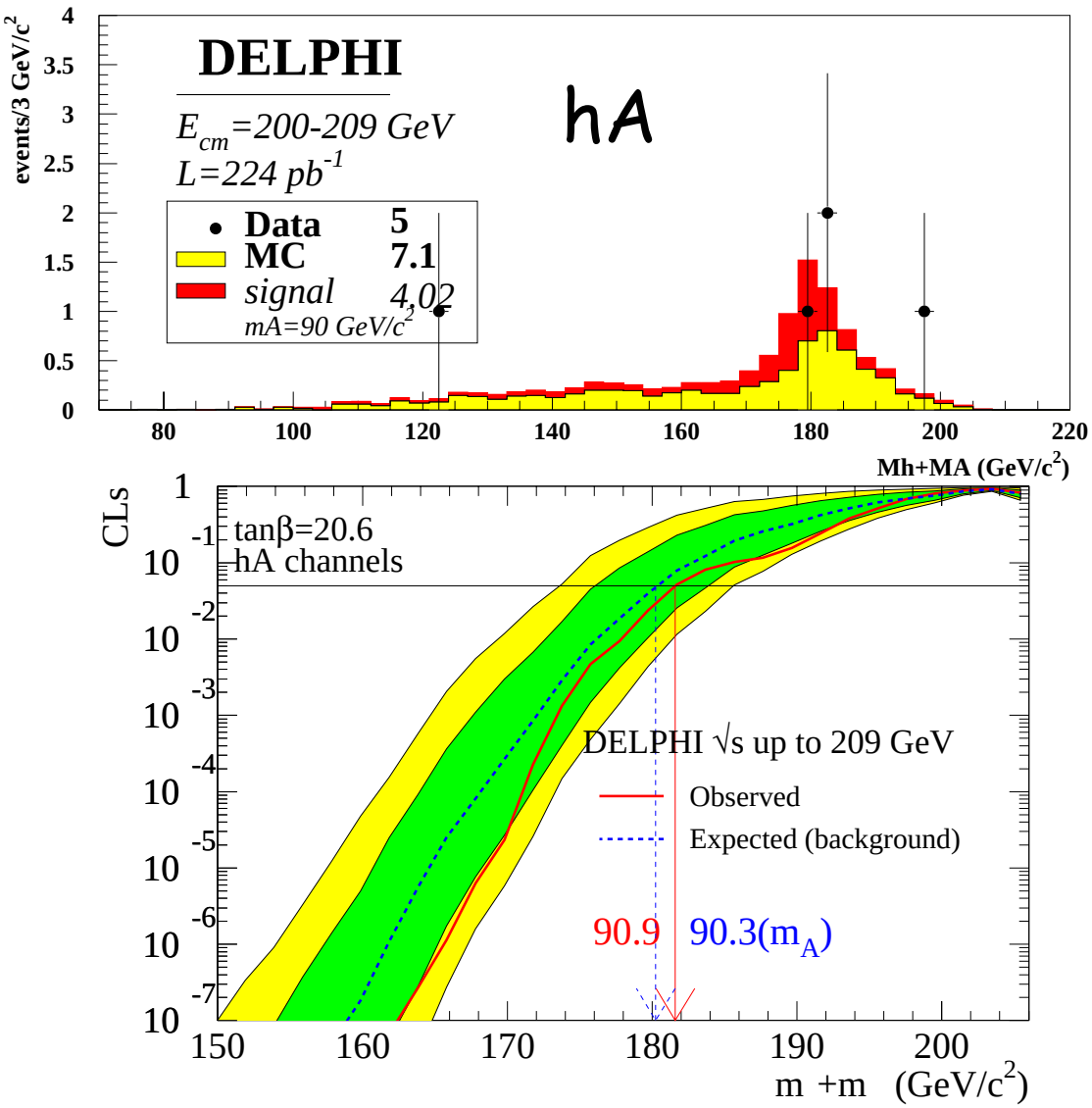
The hZ search is covered by the SM analysis; the hA search is performed with ττbb and a 4b-jets analysis derived from the SM ones.

Scanning the MSSM parameter space in two extreme scenarios (max mh and no mixing) we obtain

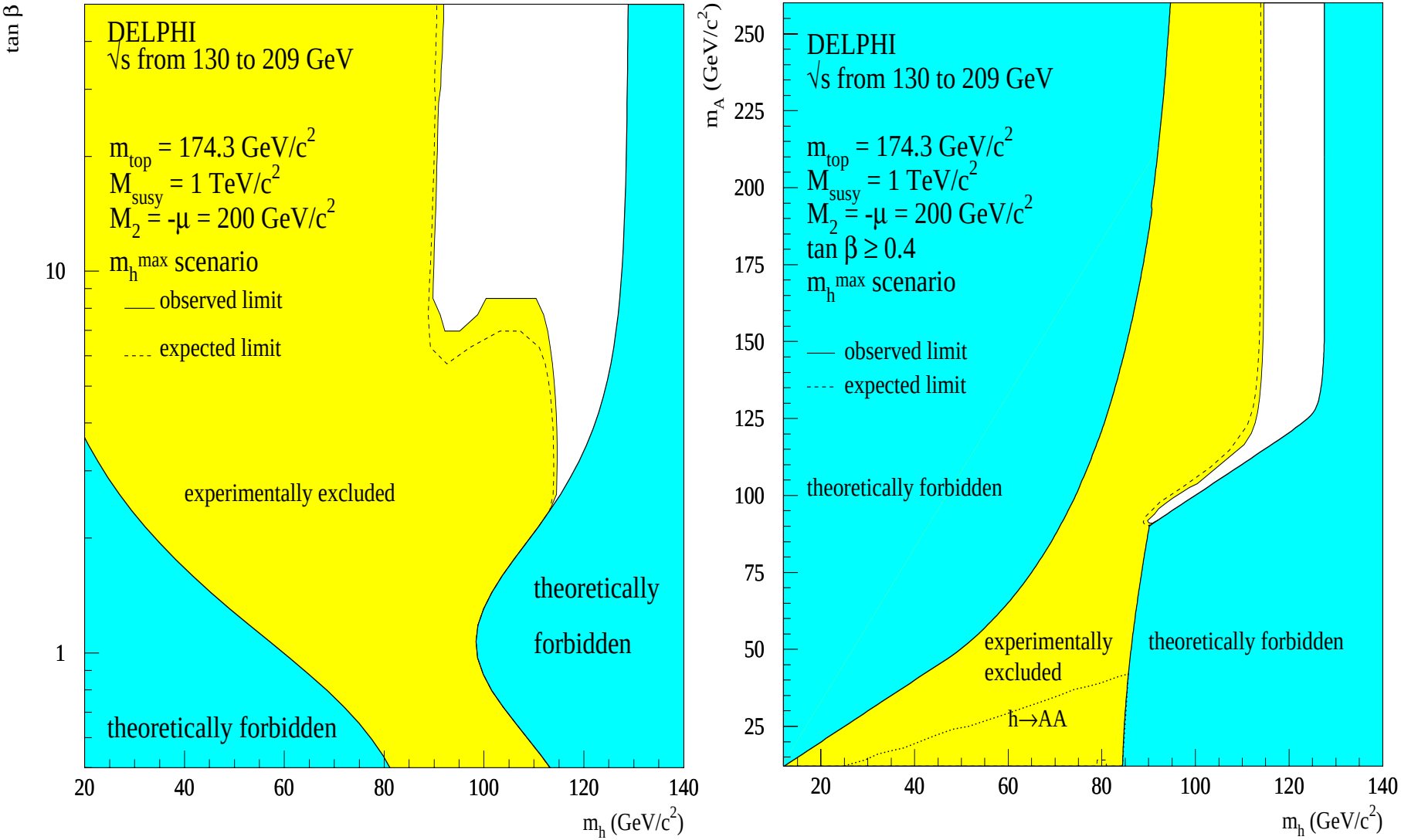
$m_h > 89.8\ GeV/c^2$

$m_A > 90.8\ GeV/c^2$

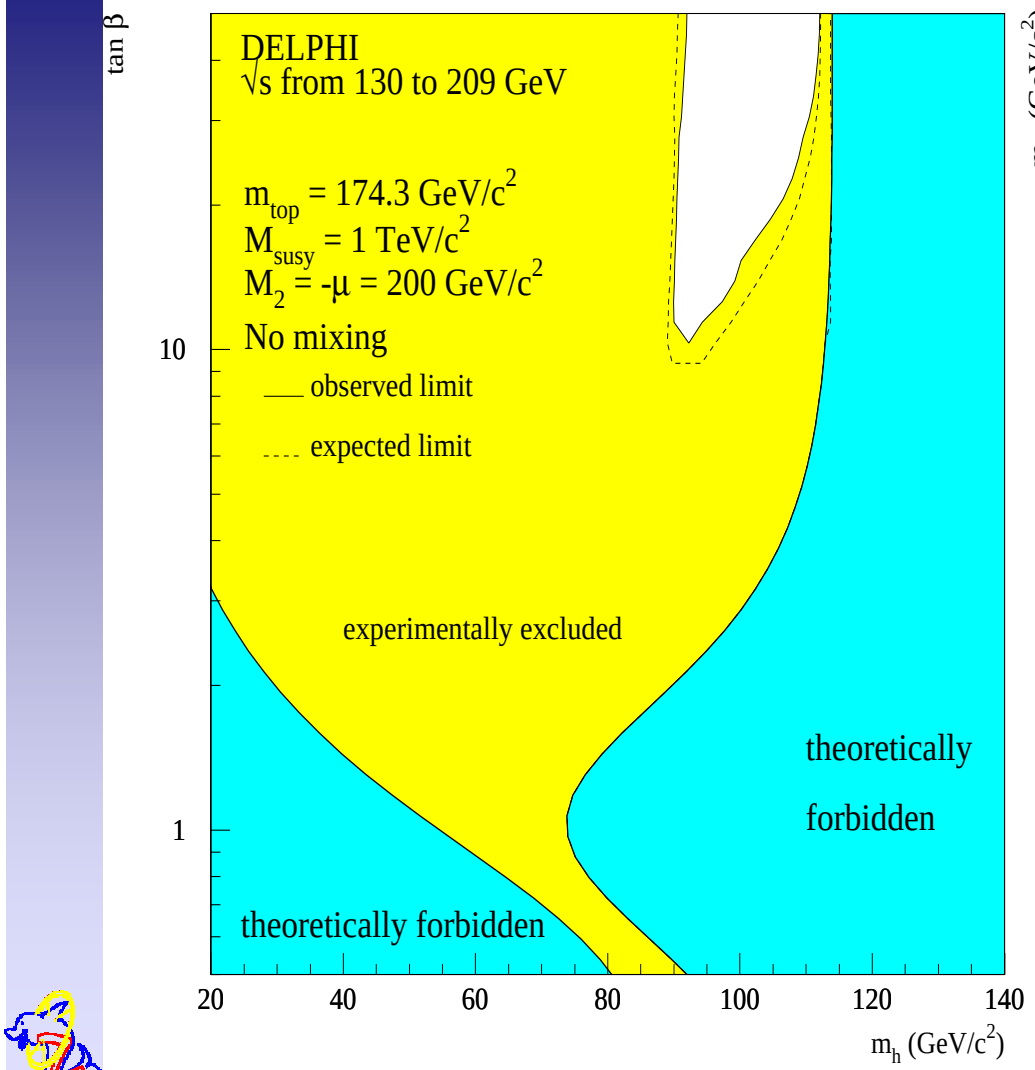
for tan(β) > 0.6

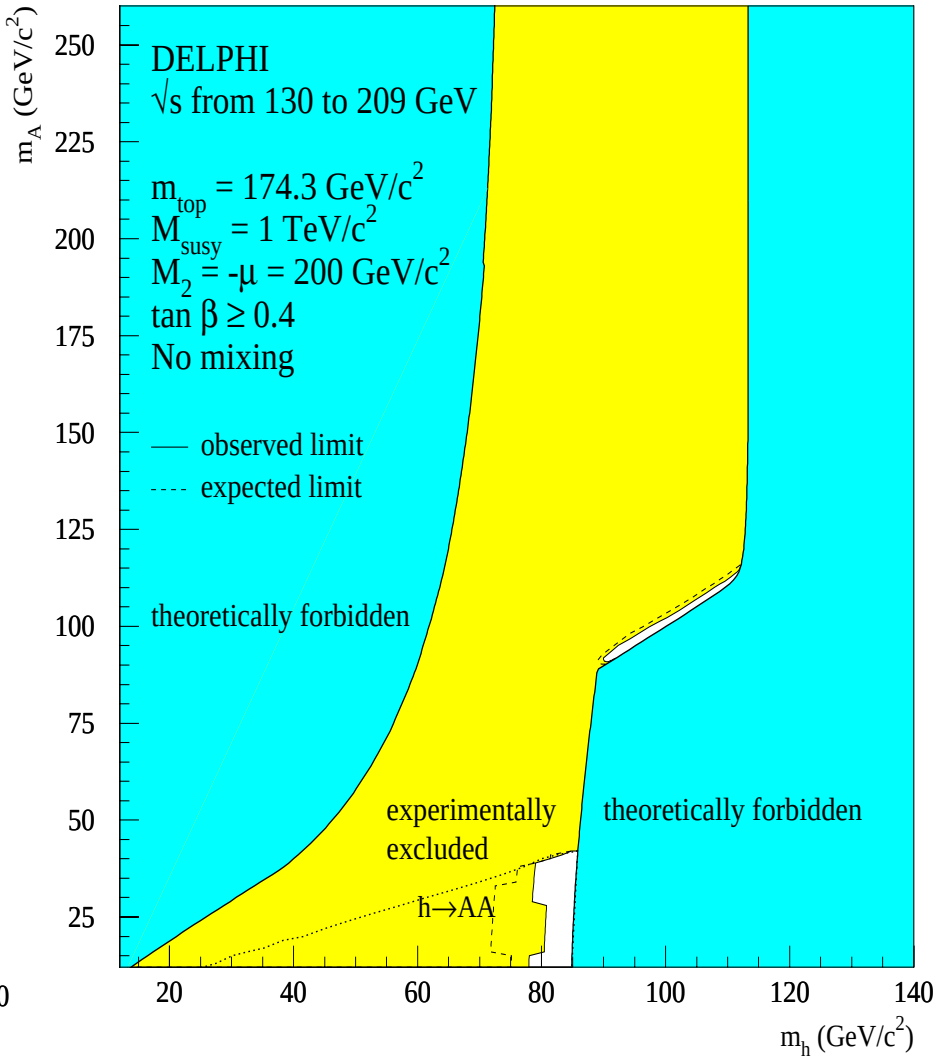


MSSM: m_h^{max} scenario



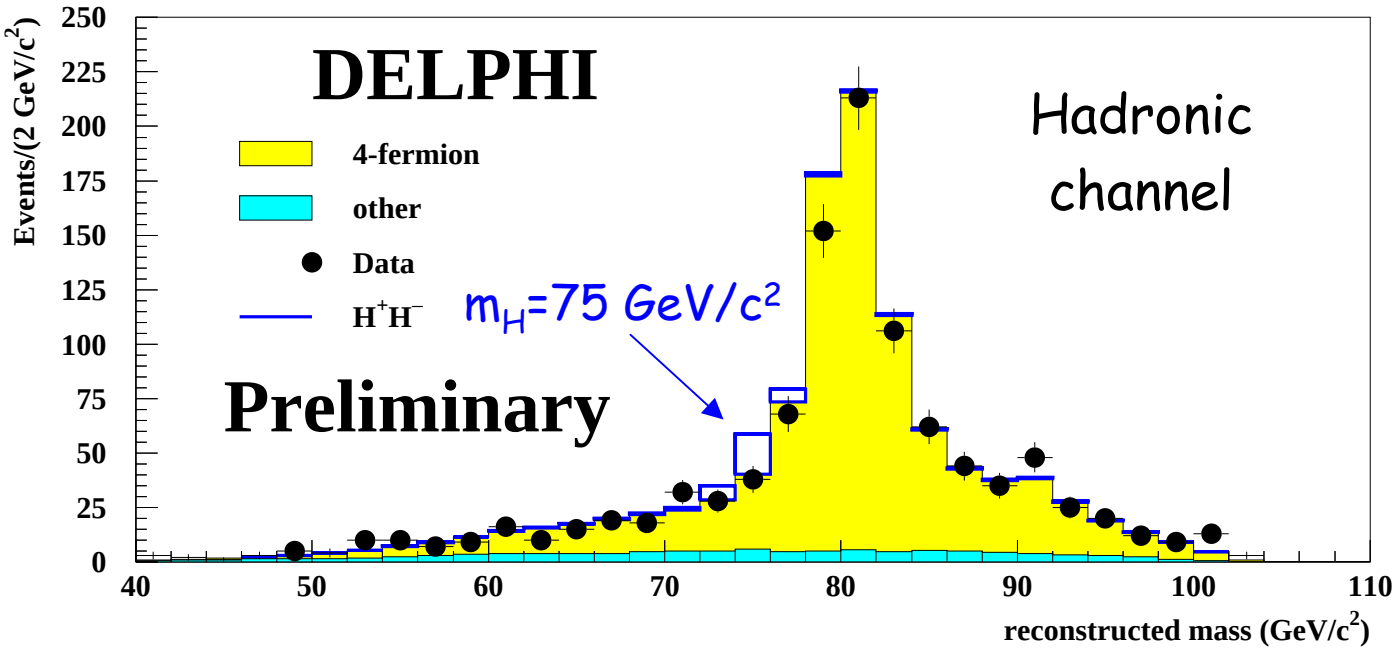
MSSM: No Mixing scenario





Charged Higgs search

The charged Higgs can decay in $\tau\nu_\tau$ or cs, so the analysis looks for $\tau\nu_\tau\tau\nu_\tau$, $cscs$ and $cs\tau\nu_\tau$ final states. The Br($\tau\nu_\tau$) is considered a free parameter.



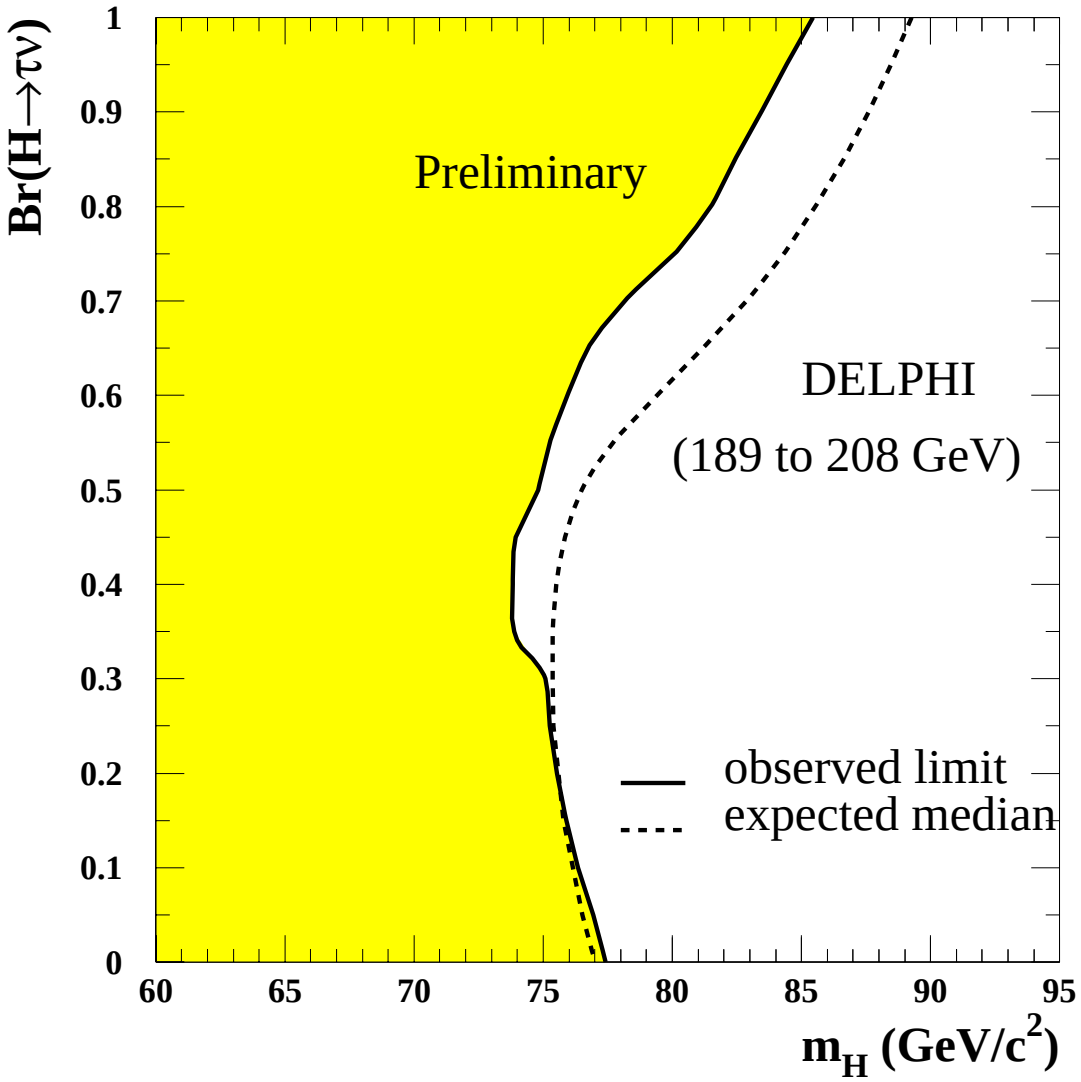
Charged Higgs: mass limit

	Data	Bkg	ε_{75}
$\tau\nu_\tau\tau\nu_\tau$	64	63.7	33.9 %
CSCS	1040	1059	33.9 %
$CS\tau\nu_\tau$	498	498	34.0 %

$m_{H^\pm} > 73.8\ GeV/c^2$

95% CL

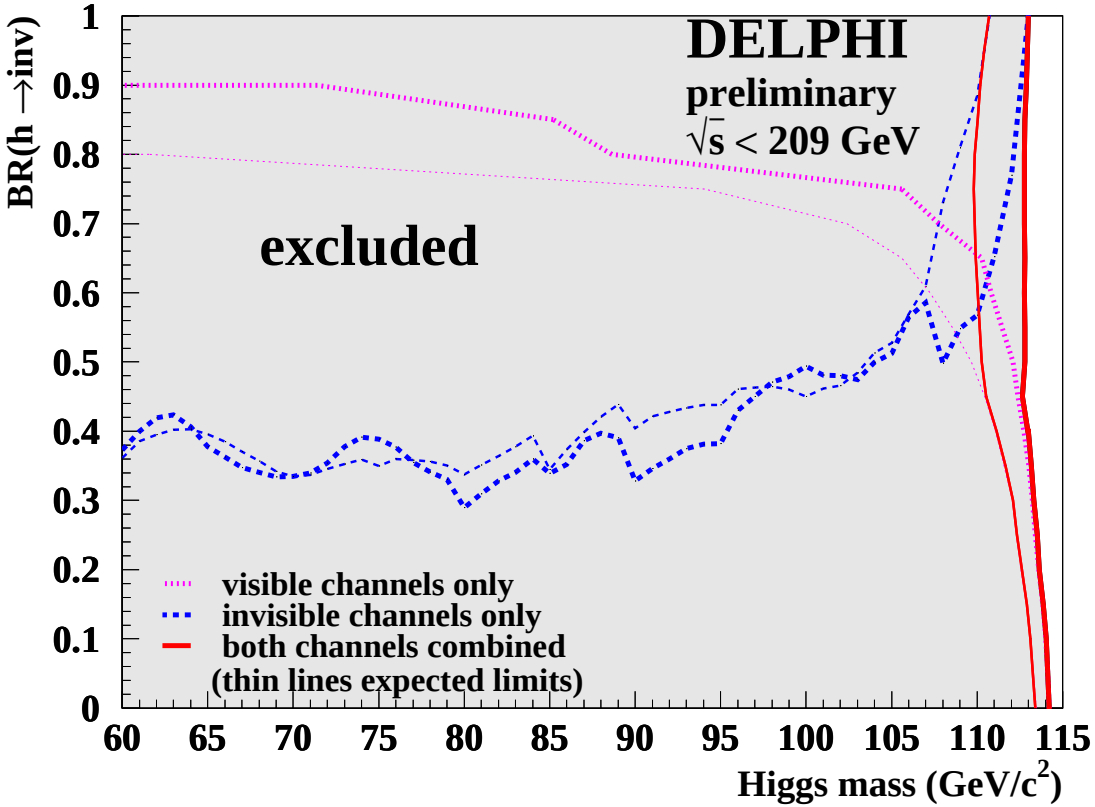
for any $Br(\tau\nu_\tau)$



Invisible Higgs

A search for acoplanar di-leptons or di-jets has been performed, looking for a neutral Higgs decaying into LSP and escaping detection.

This analysis can be combined with the SM Higgs search to put a lower bound on the mass independently from the invisible branching ratio.



$m_h > 113.0$ GeV/c^2 Br(inv) = 1

$m_h > 112.6$ GeV/c^2 any Br(inv)

Conclusions

- The events observed in all the channels are compatible with expectations from the Standard Model background.
- DELPHI can set the following 95 % CL lower bounds:

$$M_H > 114.3\ GeV/c^2$$
$$M_h > 89.8\ GeV/c^2$$
$$M_A > 90.8\ GeV/c^2$$
$$M_{H^\pm} > 73.8\ GeV/c^2$$
$$M_{Hinvis} > 113.0\ GeV/c^2$$