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MSSM Constraints from Higgs Boson Searches

André Sopczak

Lancaster University

Outline

- MSSM Higgs limits from
  LEP-1 to 209 GeV.
- Comparison of ‘benchmark’ and
  a more general parameter scan.
- Three Higgs boson signal hypothesis.
- Conclusions and Outlook.

Motivation

- Indentification of mass parameter regions where a discovery is still possible.
- Determination of mass limits in the Minimal Supersymmetric Standard Model (MSSM).
- Testing hypotheses taking into account all possible scenarios.

MSSM Parameter

- $(\tan\beta,\, m_{\mathrm{A}})$
- m_{sq}: squark mass (M_{SUSY})
- m_{g}: gaugino masse (M_2)
- μ: mixing of Higgs doublets
- A: mixing in the scalar top sector

  $A \cdot m_{\mathrm{sq}} - \frac{\mu}{tan\beta}$

Parameter Ranges

- m_{A}: 0 to 1000 GeV
- $\tan\beta$: 0.5 to 50
- m_{sq}: 200 to 1000 GeV
- m_{g}: 200 to 1000 GeV
- μ: -500 to 500 GeV
- A: -2 to 2

SUSYGEN: $M_2 \leftrightarrow 2 \cdot m_{\mathrm{g}}$, $\mu \leftrightarrow -\mu$

Latest Scan Results

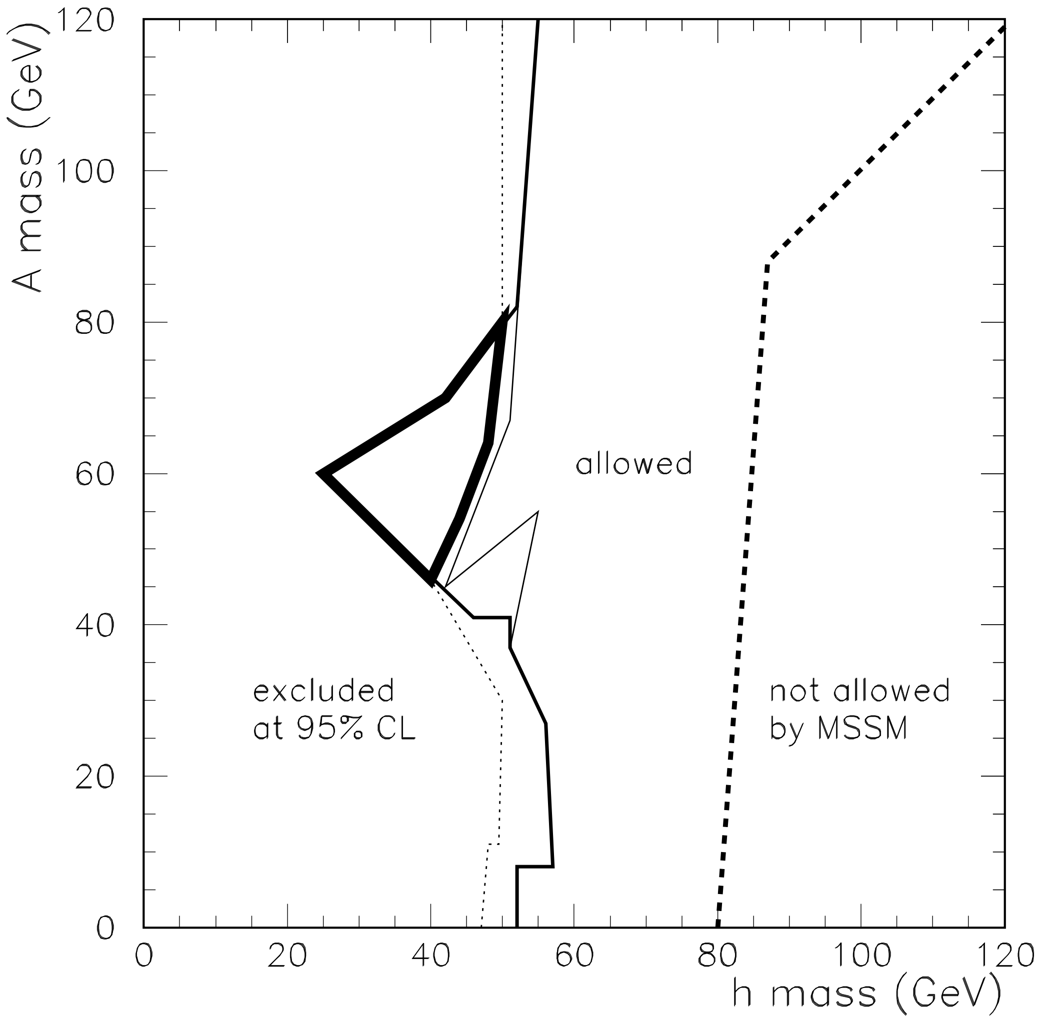
161 GeV to 209 GeV DELPHI data:

hZ and hA searches

189 GeV to 209 GeV DELPHI data:

invisible Higgs searches

LEP1 $(m_{\mathrm{h}}, m_{\mathrm{A}})$



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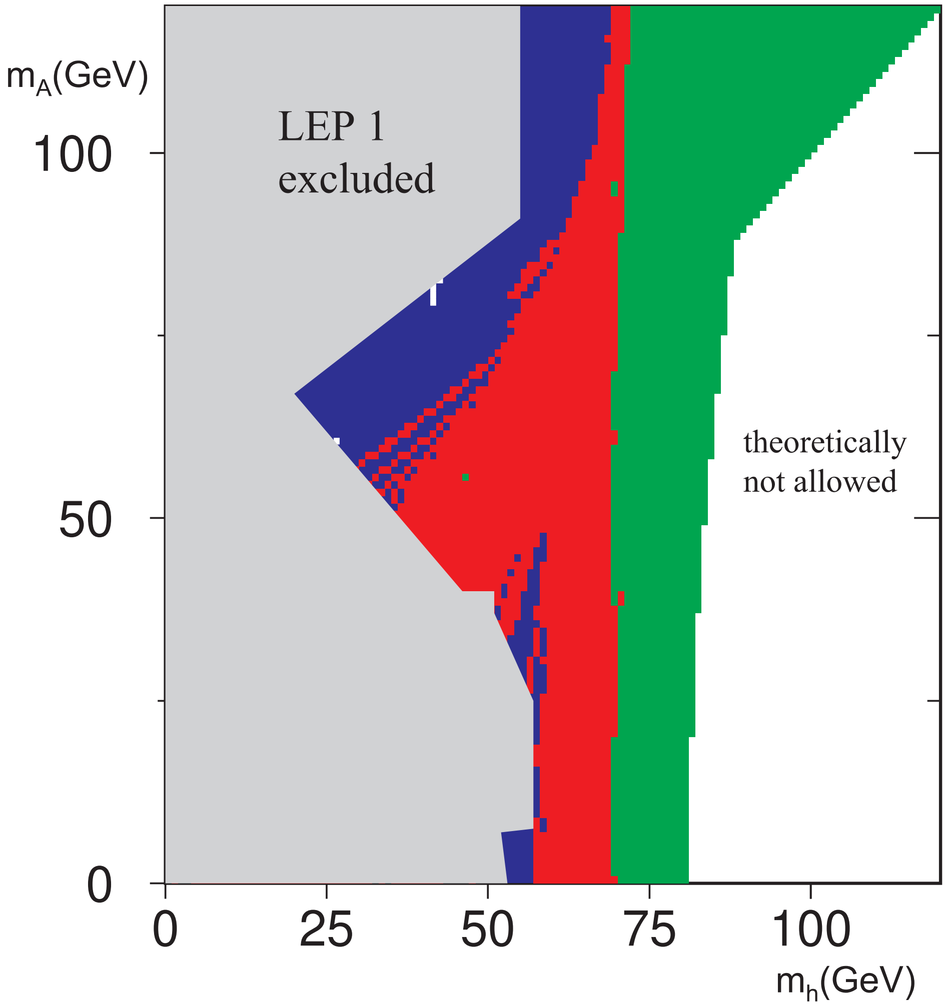
172 GeV $(m_{\rm h}, m_{\rm A})$



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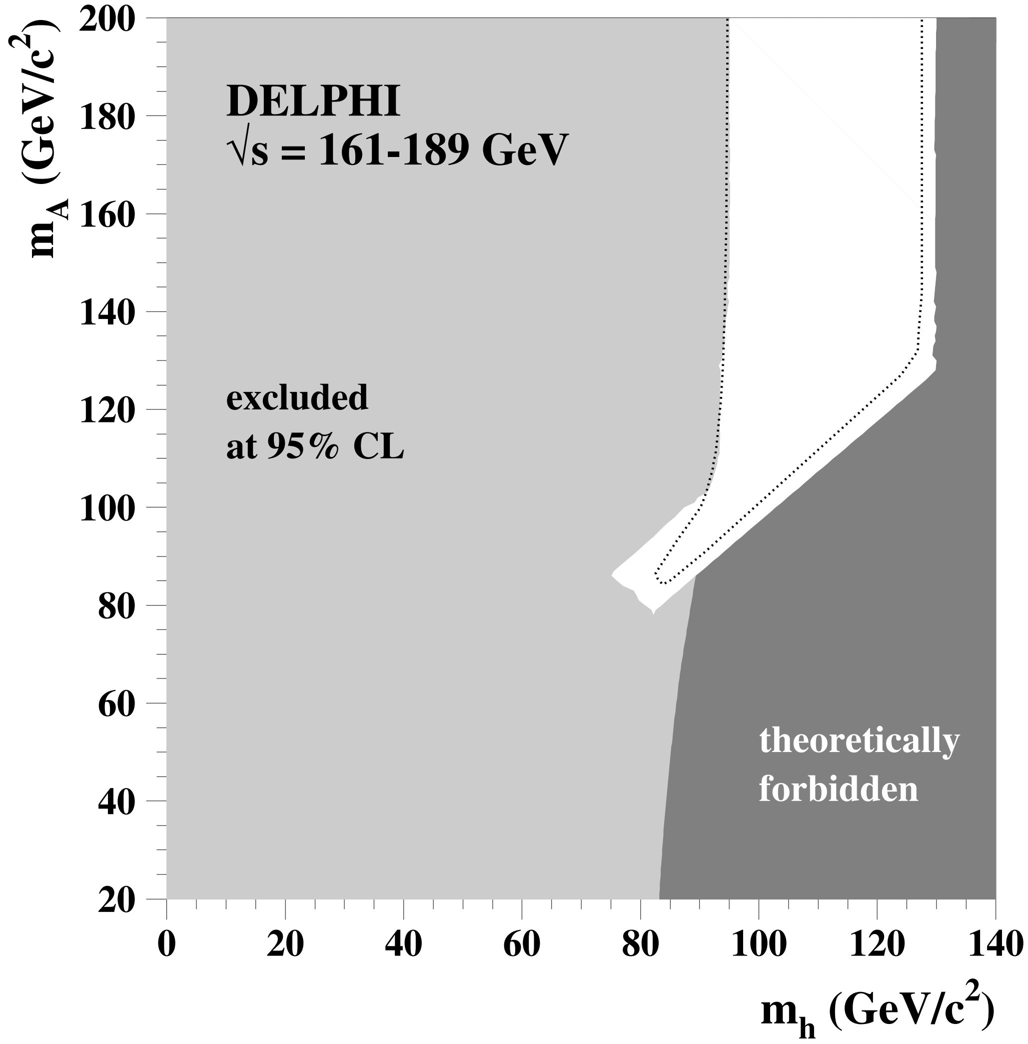
189 GeV $(m_{\mathrm{h}}, m_{\mathrm{A}})$



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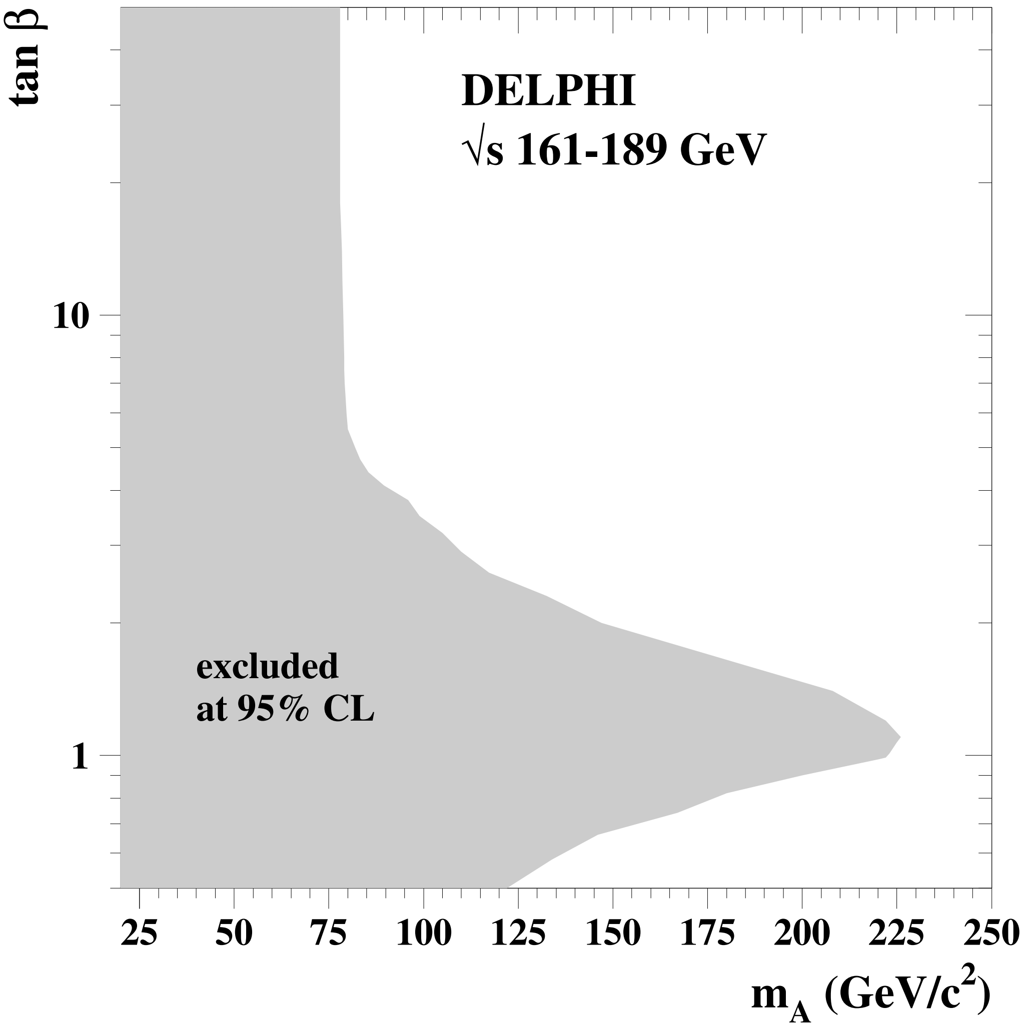
189 GeV $(m_{\mathrm{A}}, \tan\beta)$



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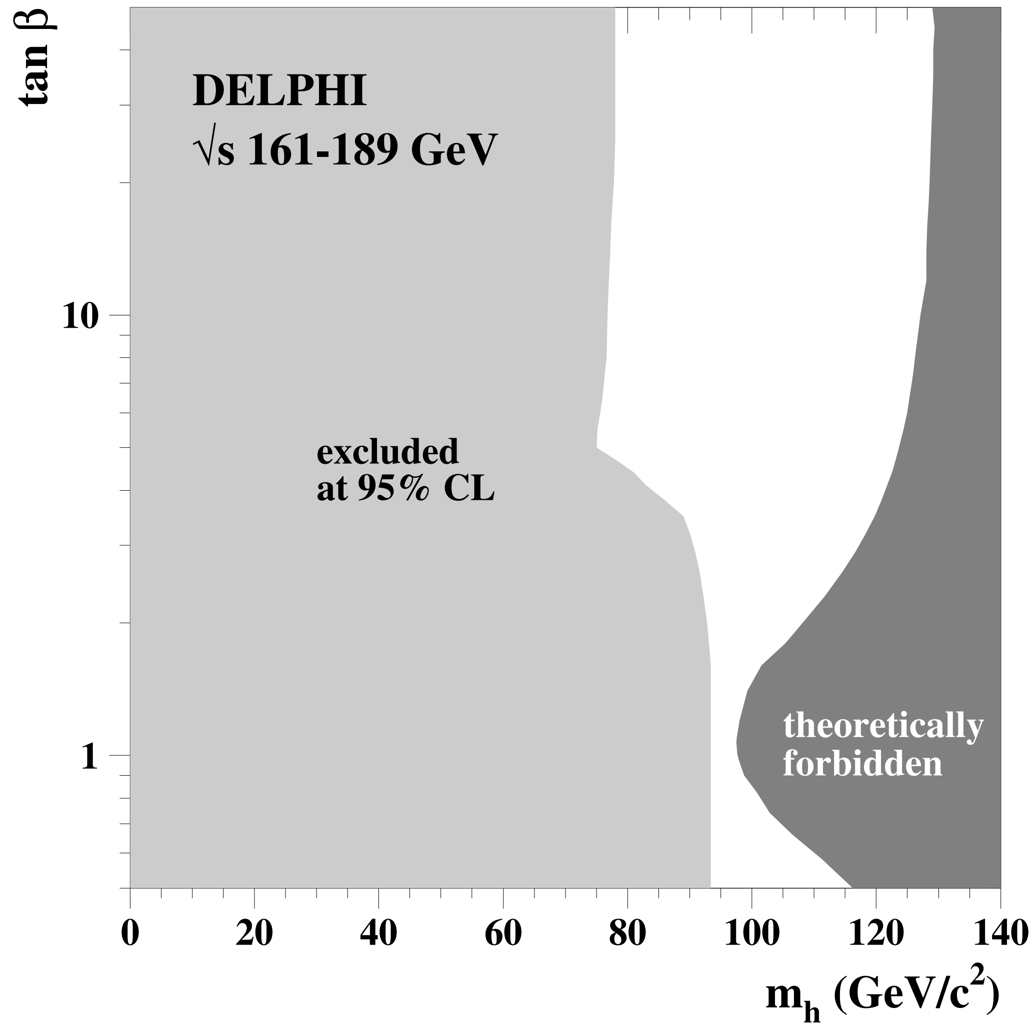
189 GeV $(m_{\rm h}, \tan\beta)$



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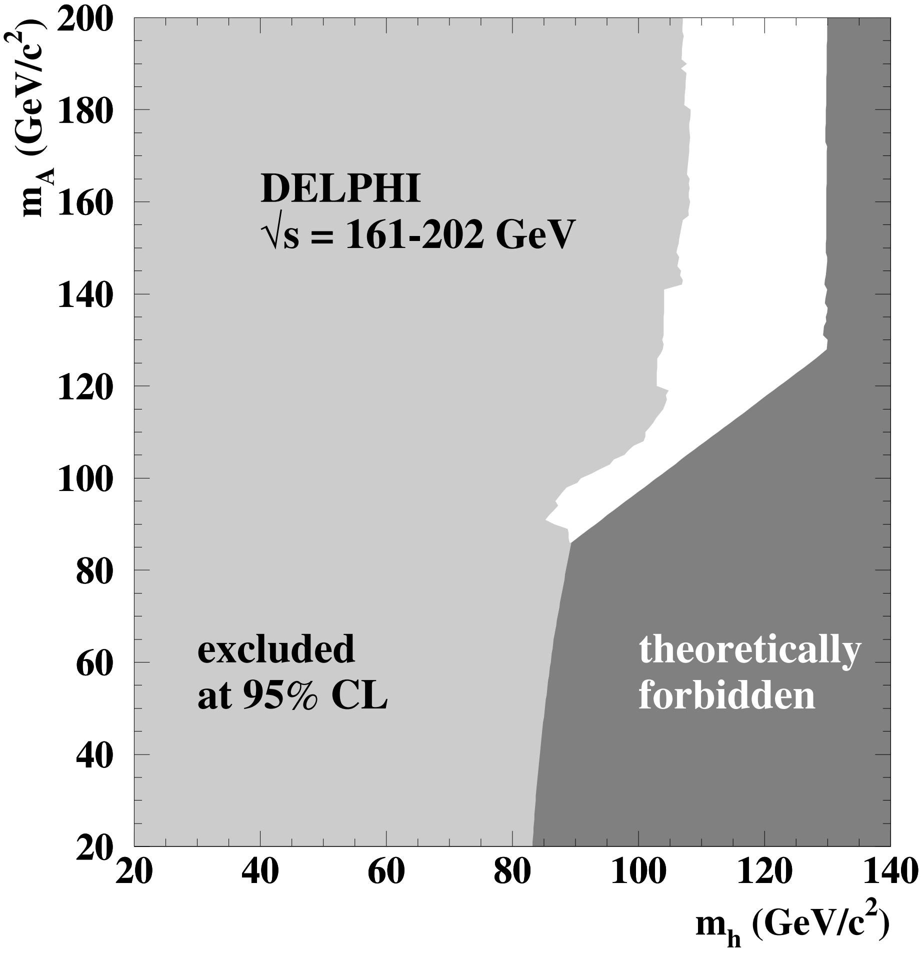
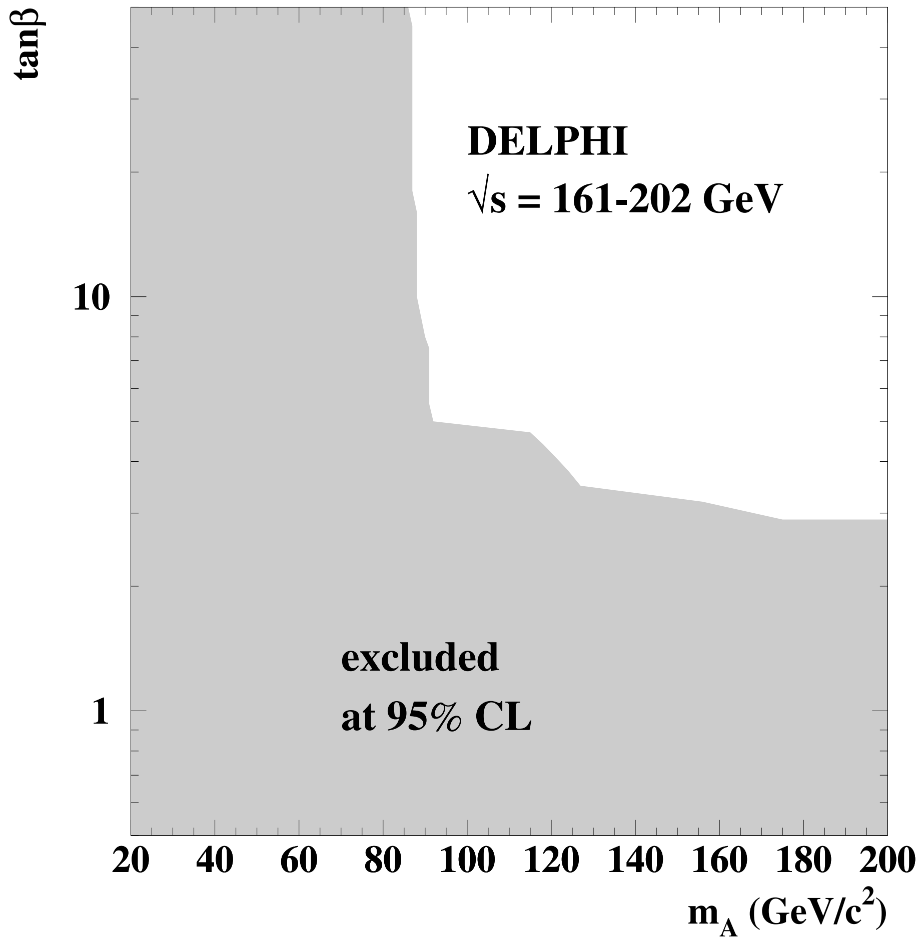
202 GeV $(m_{\mathrm{h}}, m_{\mathrm{A}})$



202 GeV $(m_{\rm A}, \tan\beta)$



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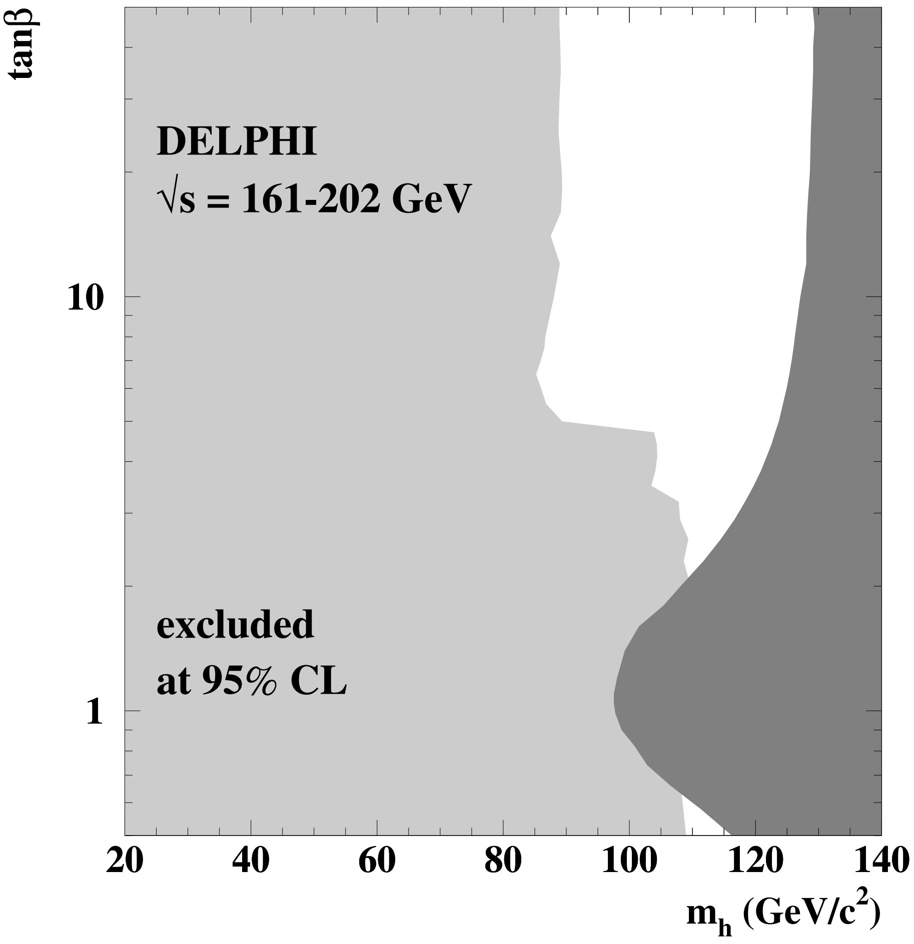
202 GeV $(m_{\mathrm{h}}, \tan\beta)$



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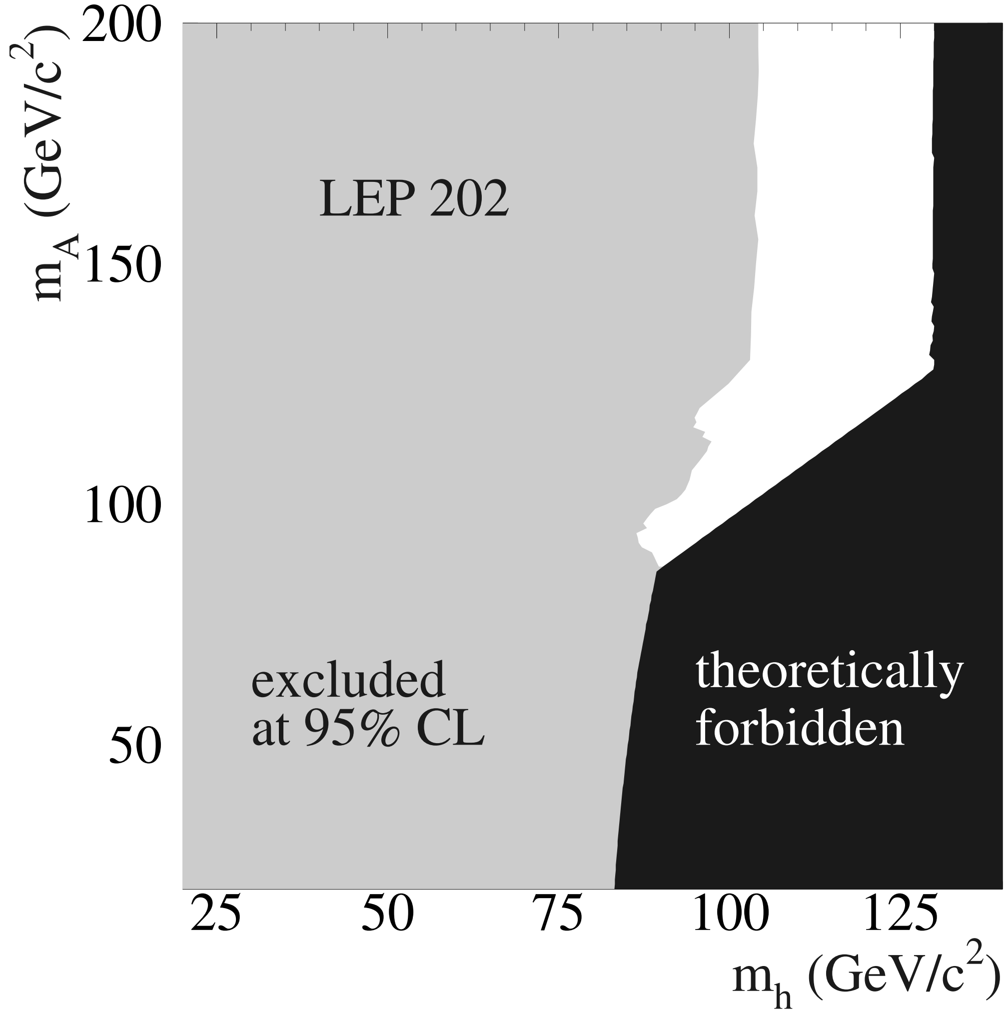
LEP 202 GeV $(m_\mathrm{h}, m_\mathrm{A})$



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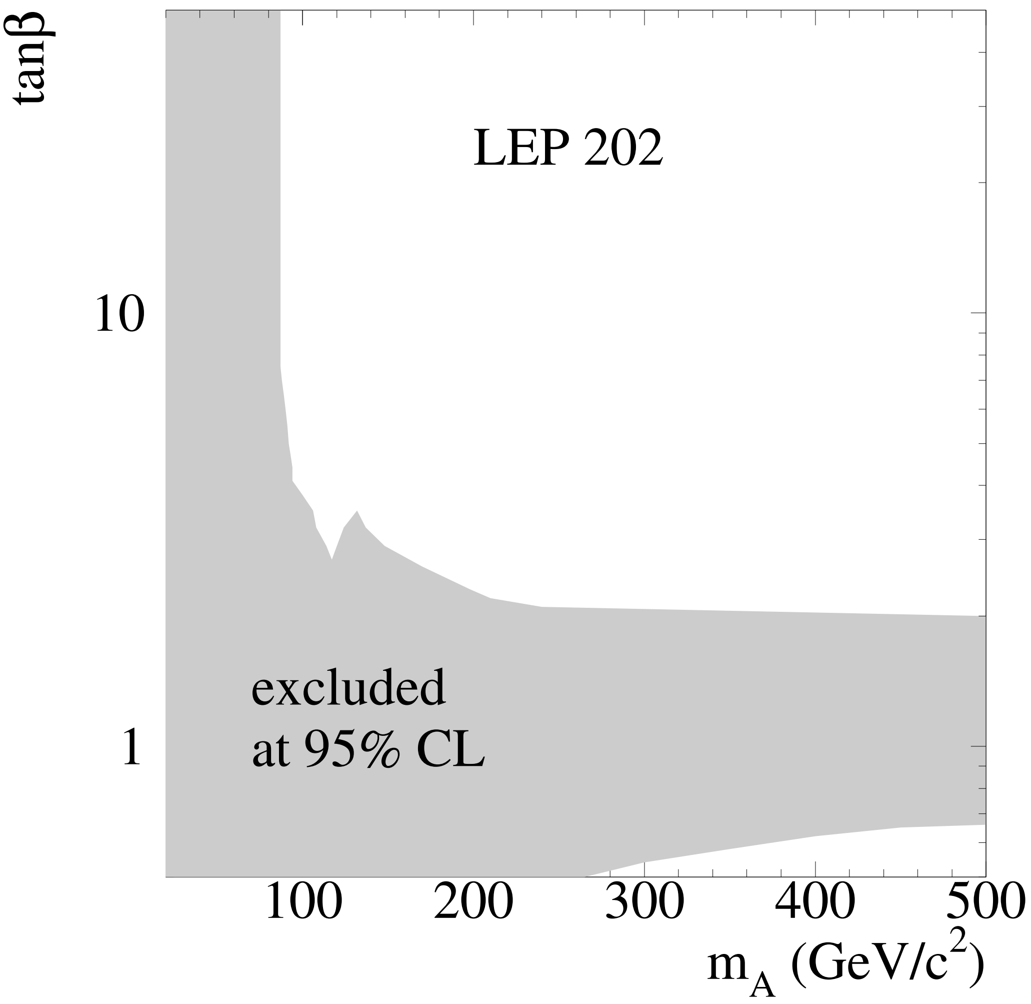
LEP 202 GeV $(m_{\mathrm{A}}, \tan\beta)$



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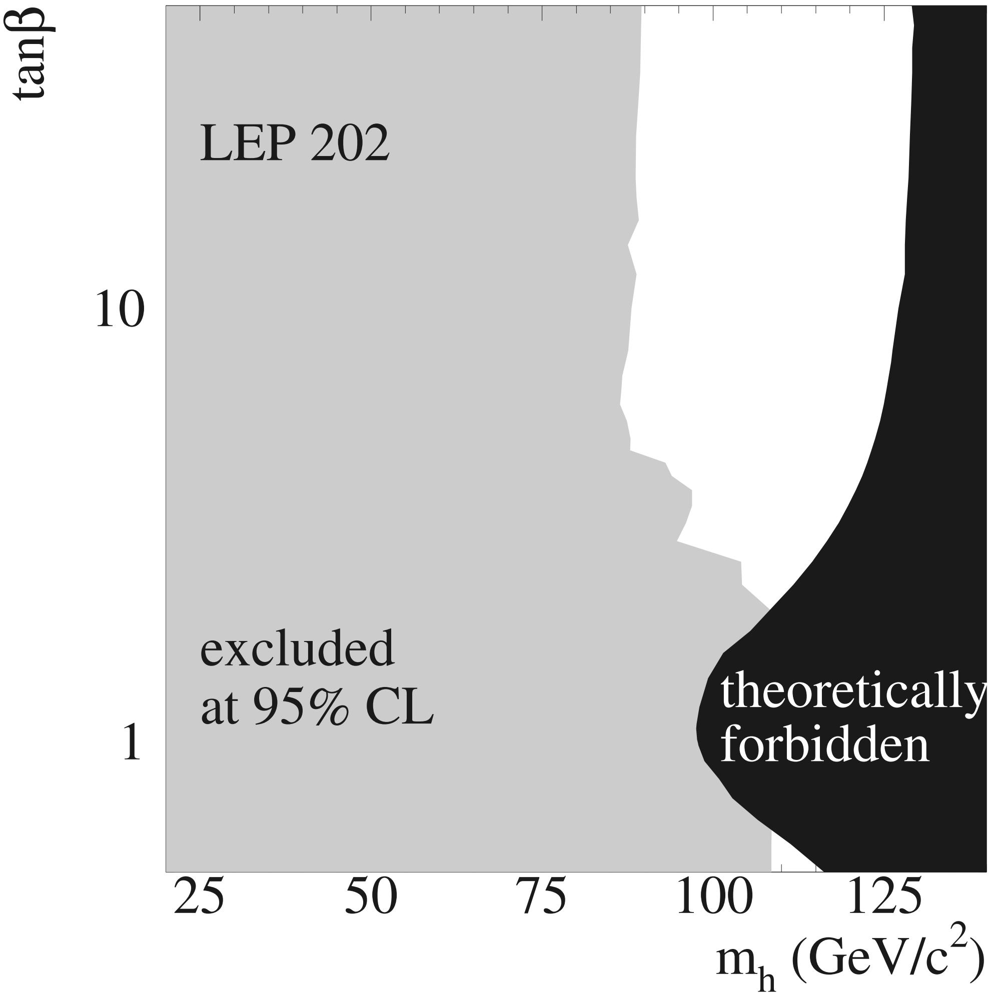
LEP 202 GeV $(m_{\rm h}, \tan\beta)$



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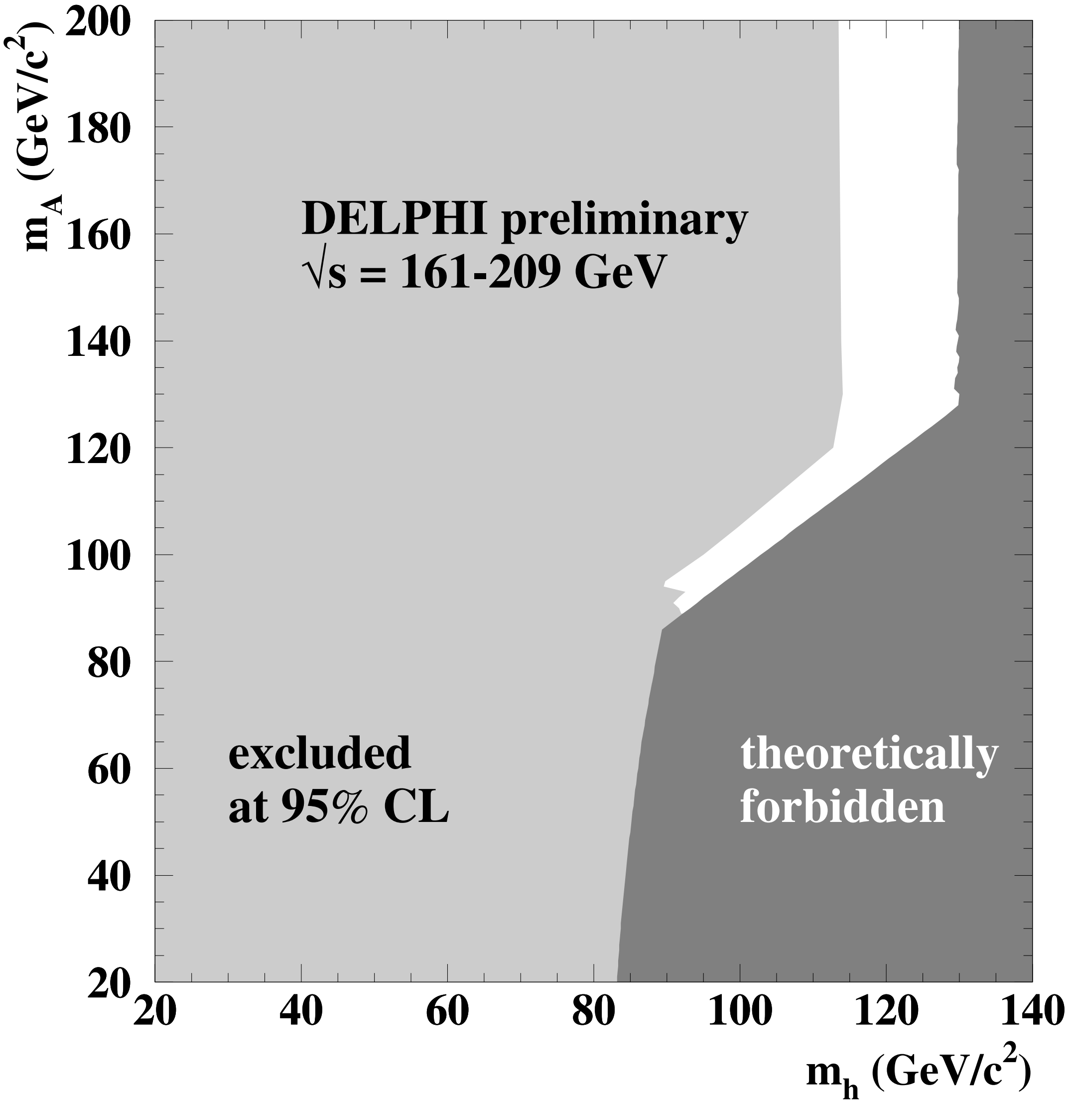
209 GeV $(m_{\mathrm{h}}, m_{\mathrm{A}})$



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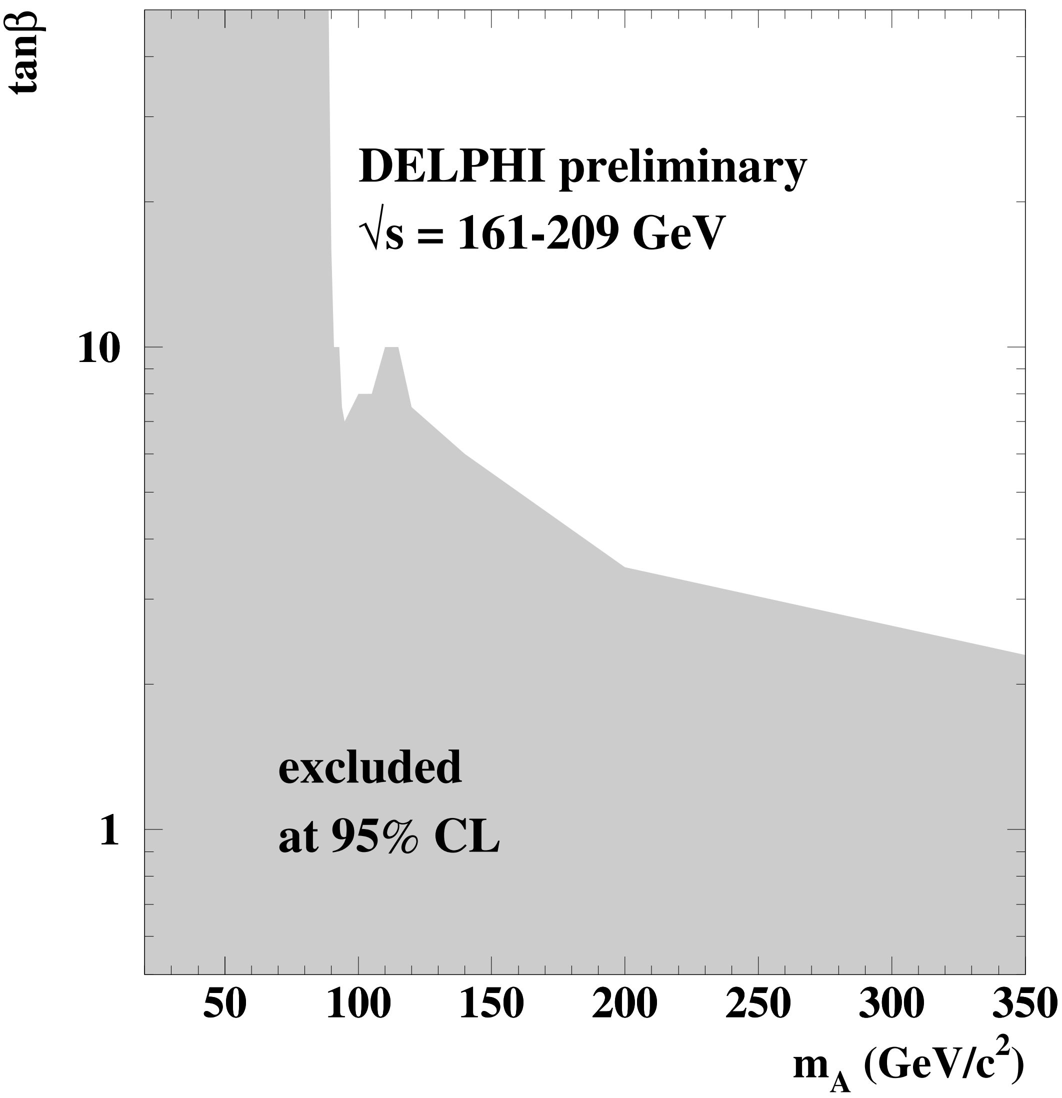
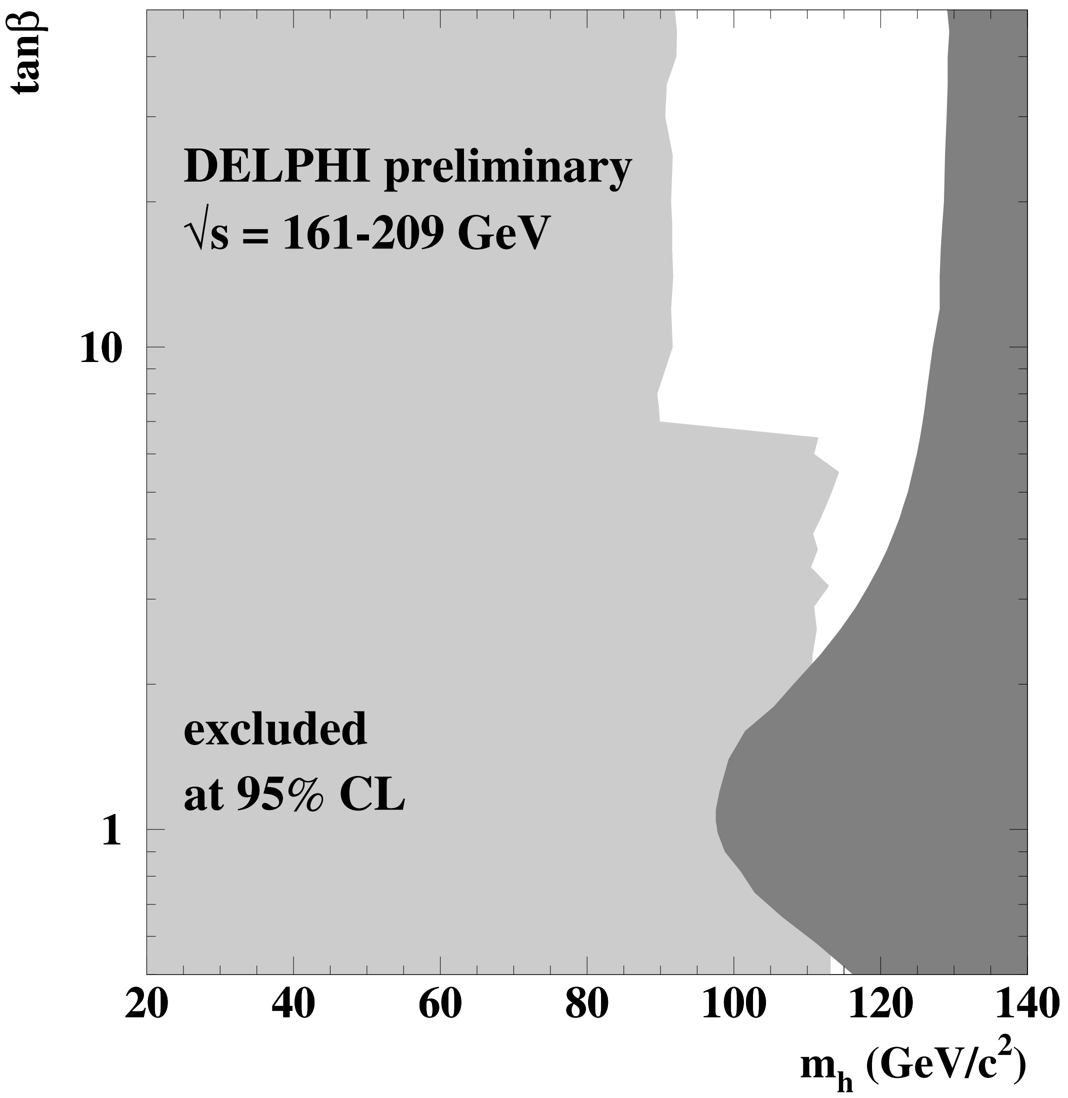
209 GeV $(m_{\mathrm{A}}, \tan\beta)$



209 GeV $(m_{\rm h}, \tan\beta)$



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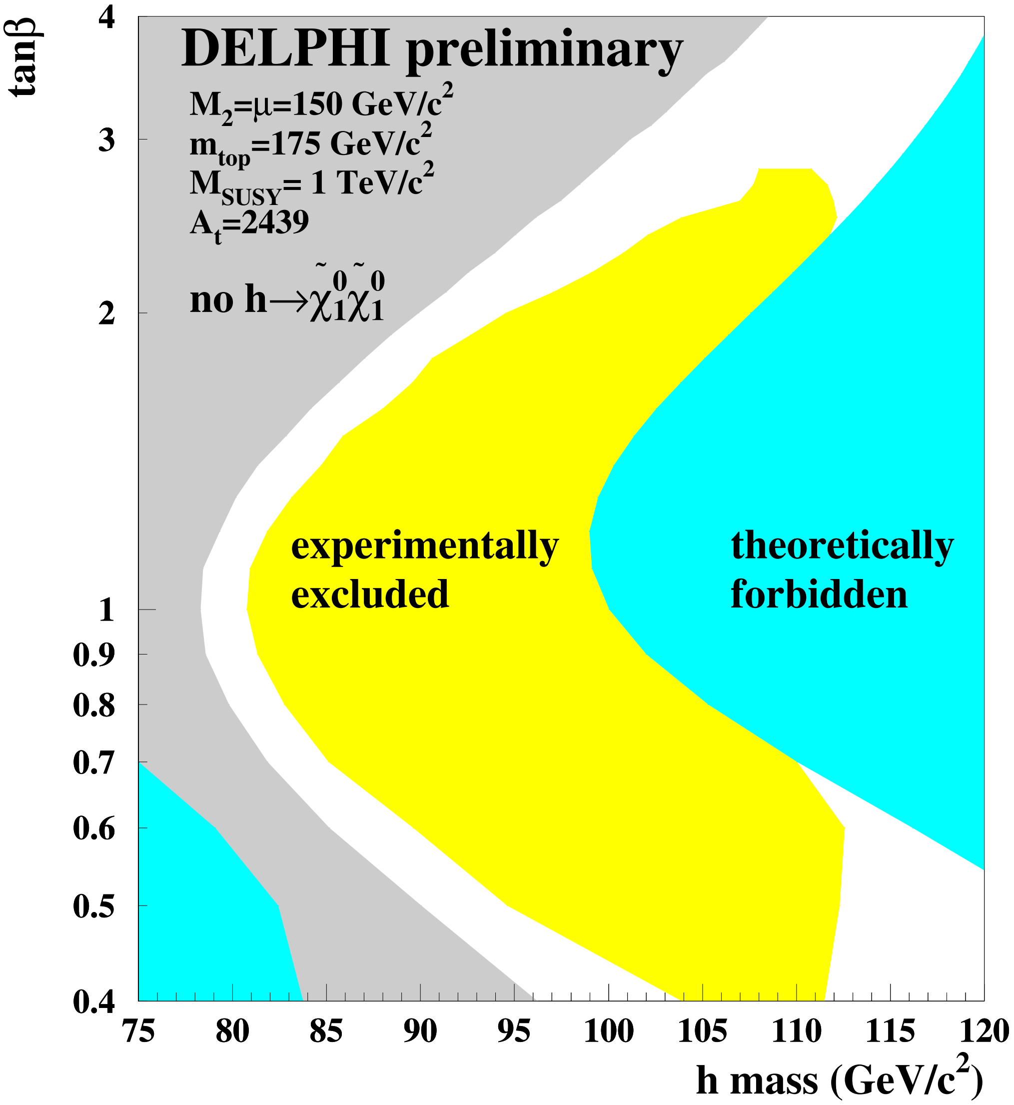
209 GeV Invisible Higgs

Importance



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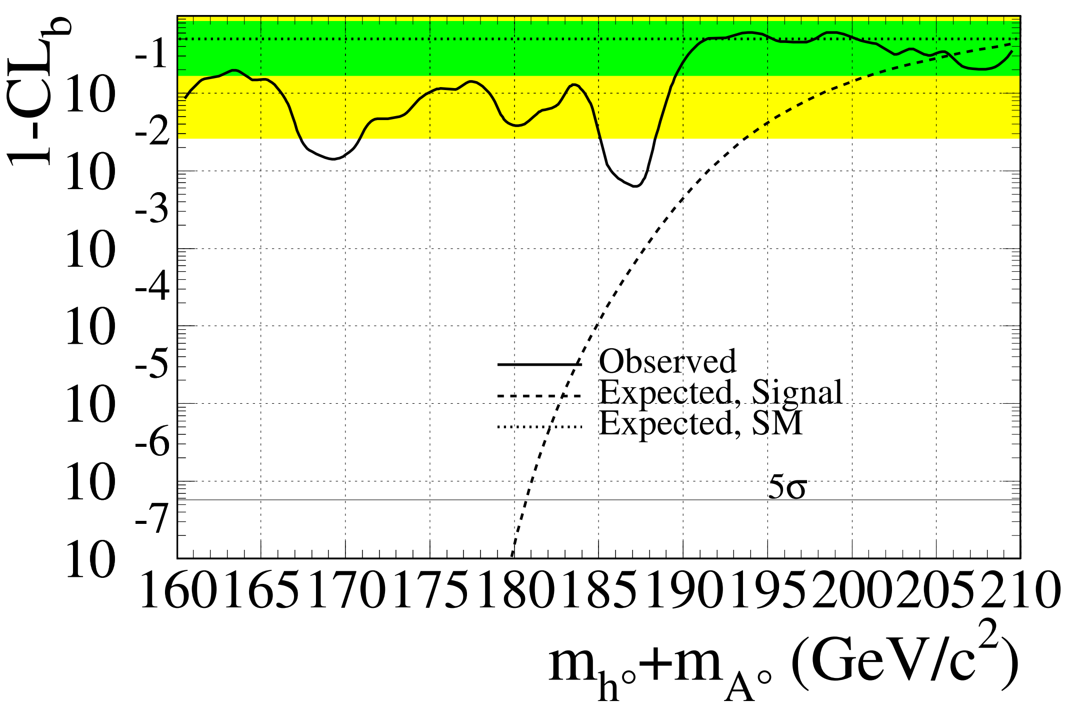
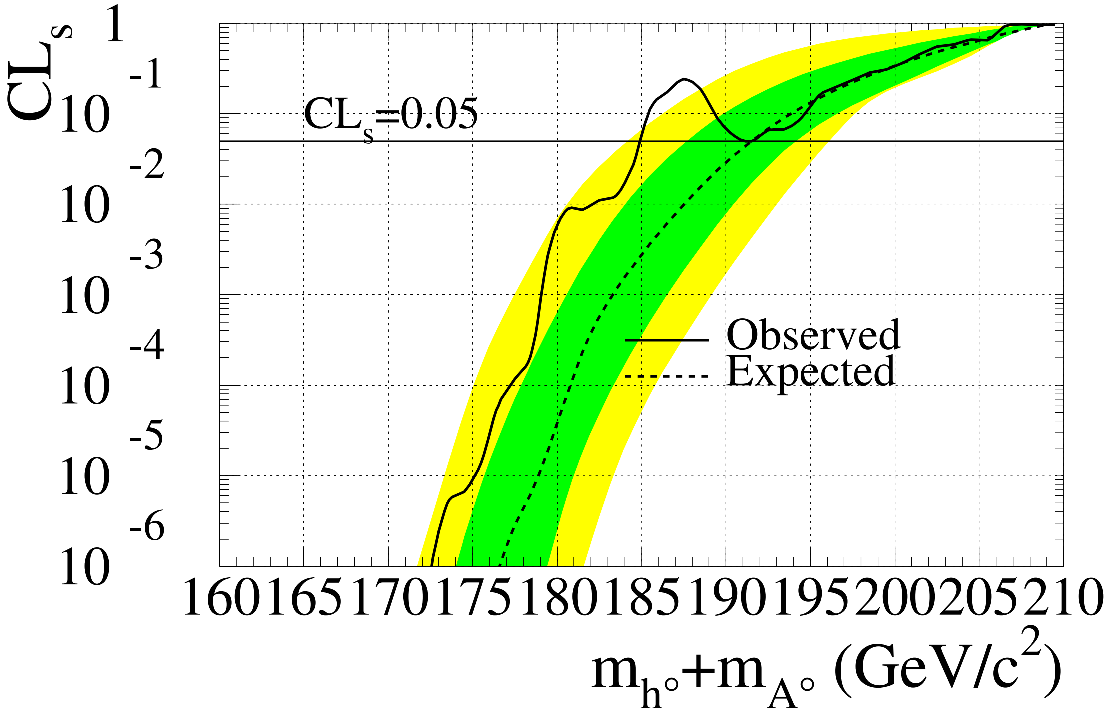
MSSM: HZ, hA, hZ Hypothesis

m_{A}	m_{h}	m_{H}	$\tan\beta$	m_{sq}
90	90.0	114.0	16	1000
100	99.3	114.0	16	1000
M_2	μ	A	$\sigma^{208}_{\mathrm{HZ}}$	$\sigma^{208}_{\mathrm{hA}}$
500	500	0	118	44
500	-500	0	97	8

$$\sigma_{\mathrm{hZ}}/\sigma_{\mathrm{H_{SM}Z}} = \sin^2(\beta - \alpha) = \xi^2 \approx 0.1$$

LEP: hA





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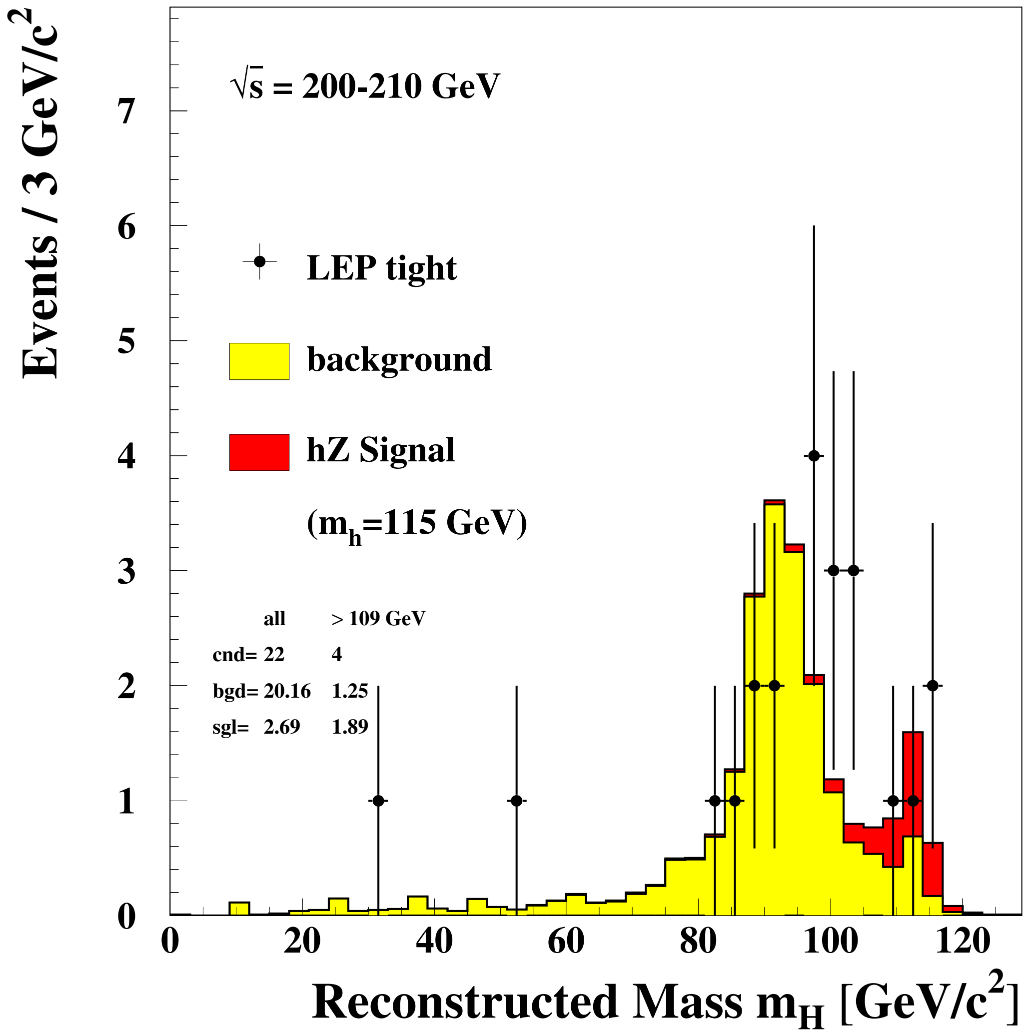
LEP: HZ and hZ



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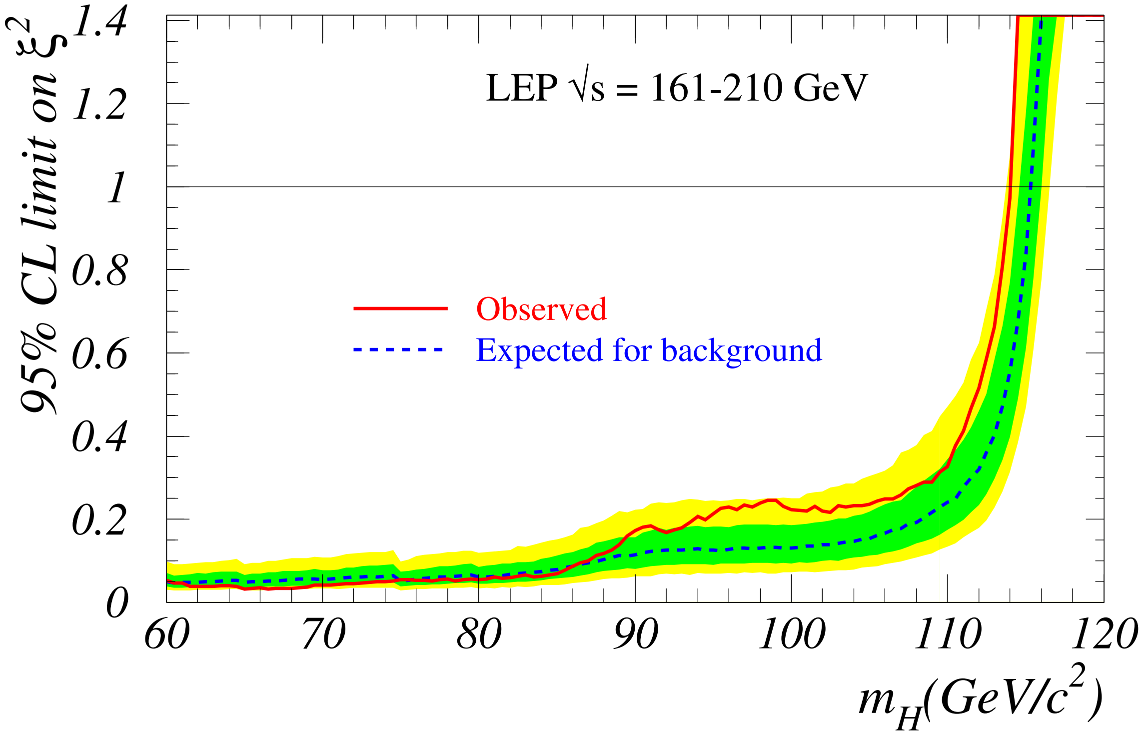
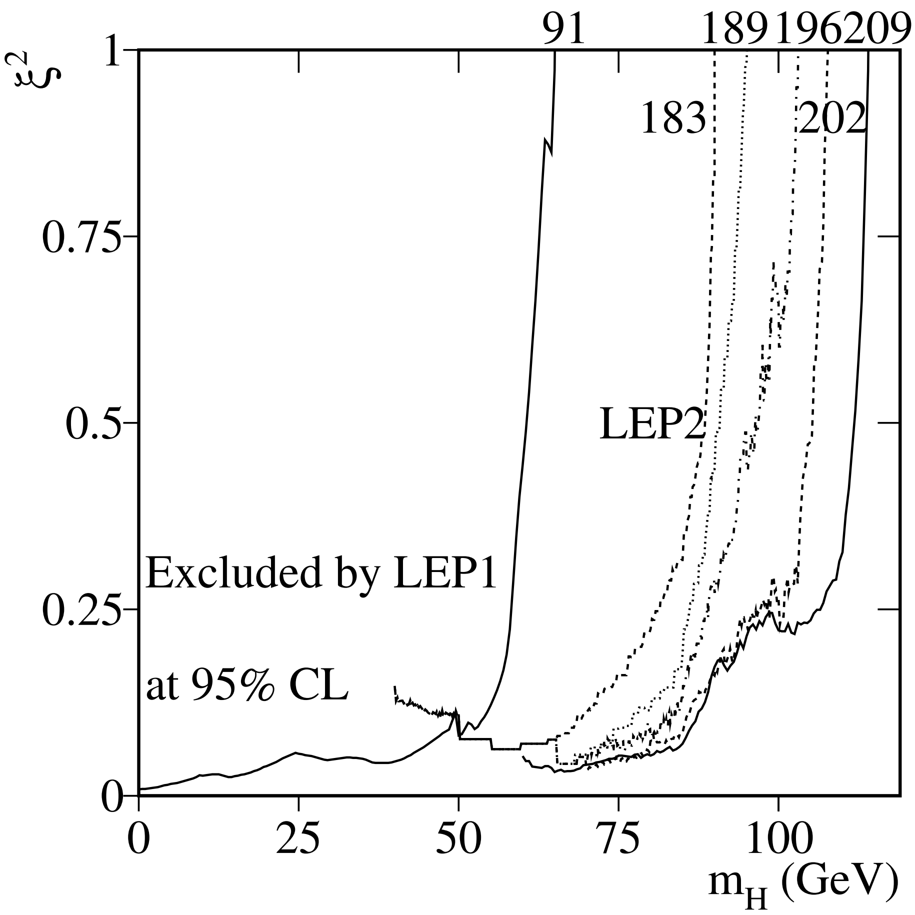
Limits on $\sin^2(\beta - \alpha)$





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Conclusions and Outlook

- 209 GeV DELPHI data: only a small reduction of benchmark limits.

  Mass limits 89 GeV, both for scalar and pseudoscalar Higgs bosons.

		Benchmark		Scan	
$\sqrt{s}$ (GeV)	Data	m_{h}	m_{A}	m_{h}	m_{A}
91 [1, 2]	L3	41.0	none	25	none
172 [3, 4]	DELPHI	59.5	51.0	30	none
183 [5, 6]	DELPHI	74.4	75.2	67	75
189 [7, 8]	DELPHI	82.6	84.1	75	78
189 [9]	OPAL	74.8	76.5	72	76
202 [10]	DELPHI	86.1	87.2	85	86
202 [11, 12]	ADLO	88.3	88.4	86	87
209 [13, 14]	DELPHI	89.6	90.7	89	89

- Three Higgs boson hypothesis in LEP data:
  Heavier scalar at 115 GeV: HZ
  Lighter scalar and pseudo-scalar at 95 GeV: hA
  Matching MSSM parameters.
  Some support by hZ candidates around 100 GeV.

Outlook:

- MSSM scan with complete LEP data.
- Optimization of parameter points for the most likely MSSM hypothesis.
- Determination of minimal CL_{b}.

References

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