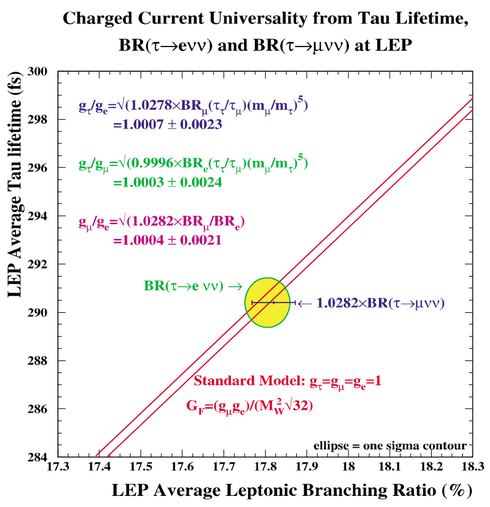
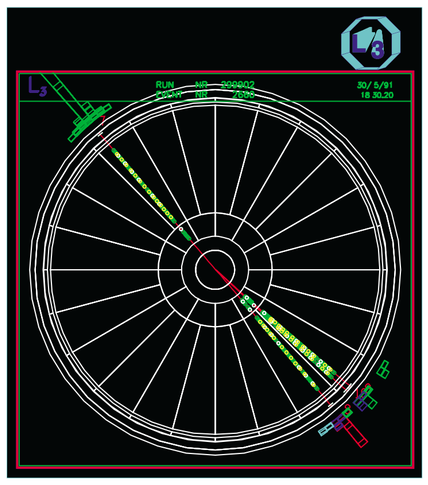
LEP Tau, b Physics & Searches

The LEP data samples have also allowed precise measurements of tau and heavy flavour physics, and searches for new physics such as SUSY, or the missing piece of the electroweak Standard Model, the Higgs boson.

Tau physics

Precise measurements of tau lepton properties from LEP1 together with the mass measurement from BES have solved pre-LEP puzzles such as the discrepancy of the lifetime and leptonic branching ratio measurements.

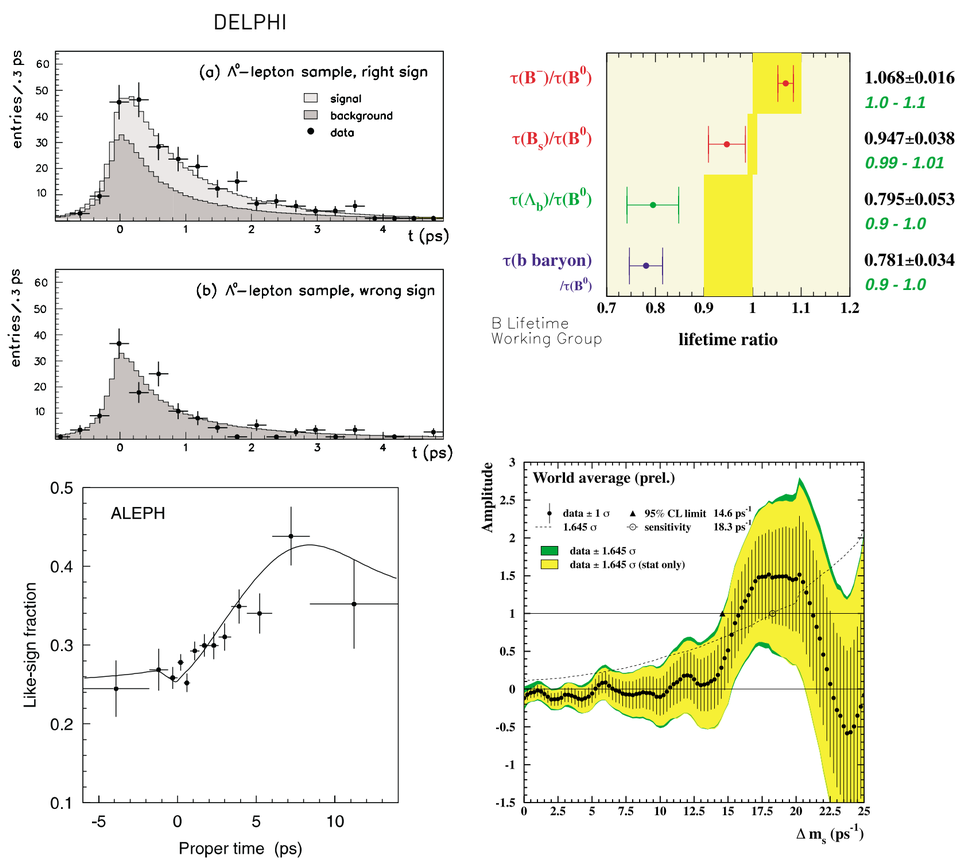




$e^+e^- \to \tau^+\tau^-$ in the L3 detector, from LEP1.

B hadrons

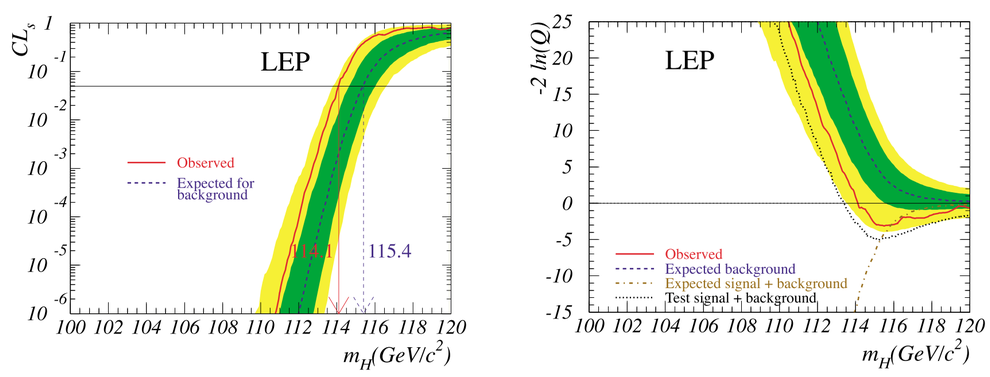
Precise b-hadron lifetime measurements have been made. Theory is unable to explain the low value for baryons.



The time dependence of $B^0\overline{B^0}$ oscillations was also first seen at LEP1. Hints of B_s^0 oscillations are seen around $\Delta m_s = 18 ps^{-1}$.

Standard Model Higgs boson search

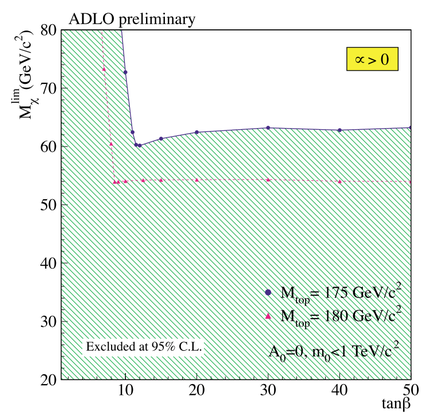
A small number of very clean Higgs candidate events ($e^+e^- \to ZH$) caused excitement at LEP in 2000. With the latest analyses and the full dataset, a Higgs boson with mass below 114.1 GeV is excluded at 95%CL. The likelihood ratio $Q(m_H) = (L(s+b))/(L(b))$ (plotted as -2lnQ) shows that the combined LEP data are more consistent with a Higgs boson of mass 115.6 GeV than with background only. However the significance of the deviation from background expectation, $(1 - CL_b)$ is 3.5×10^{-2}, only about $2\ \sigma$. The relative probabilities of signal+background and background only can be seen in the plot on the right.



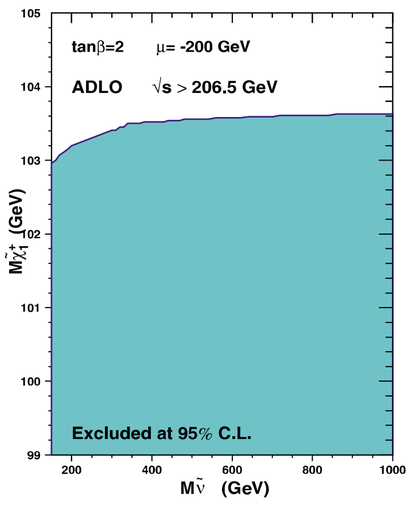
SUSY

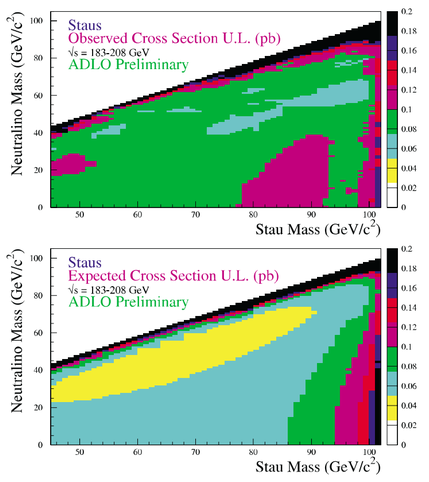
LEP is sensitive to many possible new phenomena, including SUSY. The signals are varied, with combinations of leptons, jets and/or missing energy in many topologies. Some SUSY particles would be produced with a very large cross-section in e^+e^- annihilation with sufficient centre-of-mass energy.

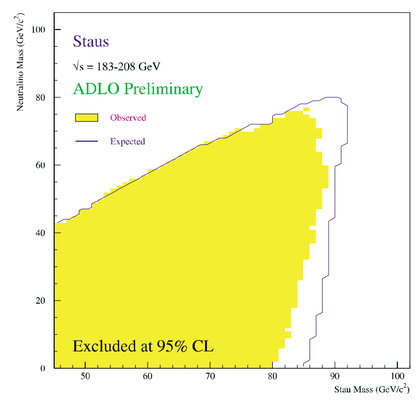
The mass limit for the lightest neutralino depends on the value of $\tan\beta$ and other assumptions. In mSUGRA, an absloute lower limit of about 60 GeV can be set for a top mass of 175 GeV, which has implications for neutralino cold dark matter.



The search reach for pair produced particles is up to half the centre-of-mass energy. This example shows the mass limit for chargino production as a function of sneutrino mass.



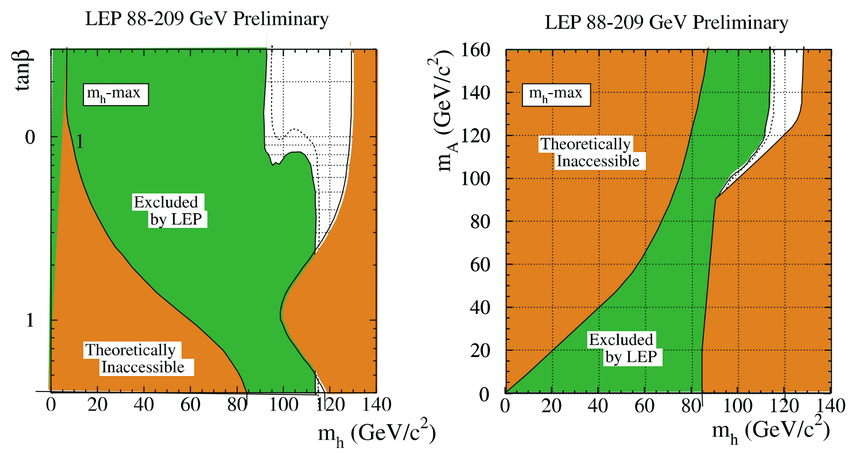


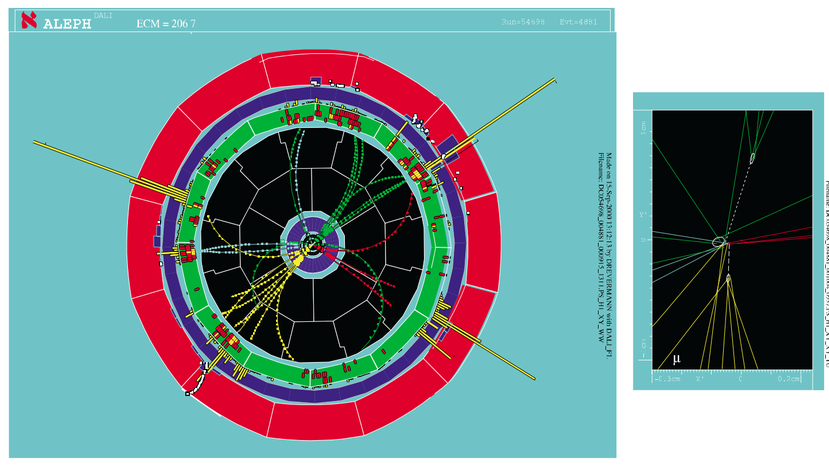


The two plots above show the observed and expected cross-section limits for stau production (left), and the corresponding constraint on the stau mass in the MSSM (right).

MSSM Higgs boson search

Important regions of SUSY parameter space are also excluded in the Higgs sector.





ALEPH 4-jet Higgs candidate. Secondary b decay vertices can be seen by zooming in on tracks inside the beam pipe.

CERN GRAPHIC DESIGN DTP