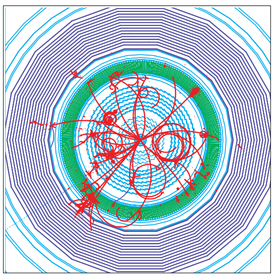
New physics

Supersymmetry (SUSY) postulates a deeper relationship between matter particles (spin-1/2 or "fermions") and force carriers (integer spin or "bosons") than the Standard Model (SM). In SUSY, each fermion has a "superpartner" of spin-0 while each boson has a spin-1/2 superpartner. The Higgs sector is also extended to at least five Higgs bosons in the Minimal Supersymmetric Standard Model (MSSM). To this day, no superpartners have been observed: SUSY must be a broken symmetry, i.e. the superpartners must have masses different than those of their partner particles.

Despite the doubling of the spectrum of particles, SUSY has many merits: it is elegant; assuming the existence of superpartners with TeV-scale masses, the Strong, Weak and Electromagnetic force strengths become equal at the same energy of ~ 10^{16} GeV (the "GUT scale"); it also provides a natural explanation of why the Higgs mass can be low ($\lesssim$ 1 TeV). In SUSY theories, there is even room for explaining the dark matter in the Universe as being due to "neutralinos". If SUSY is a true symmetry of Nature and it is realized at the TeV scale, it will almost certainly be seen in CMS

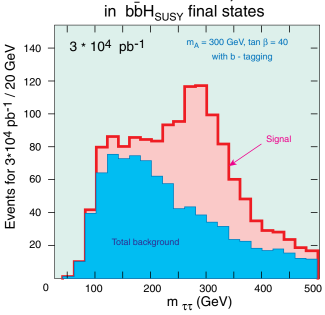
SUSY Higgs bosons

$H \to \tau\tau \to e + \tau_{jet}$ ("3-prong")



charged particles with p_t>1 GeV and |η| < 2.5 are shown

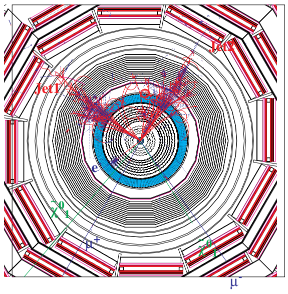
$A, H, h \to \tau\tau \to e/\mu + \tau_{jet} + E_t^{miss}$ in $b\bar{b}H_{SUSY}$ final states



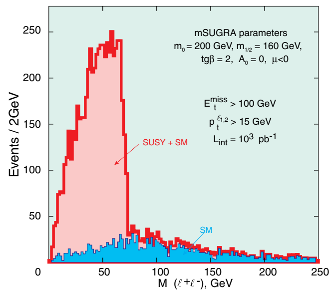
In the MSSM there are 5 Higgs bosons: h^0, H^0, A^0 and $H^\pm$ decaying through a variety of decay modes to γ, $e^\pm$, $\mu^\pm$, $\tau^\pm$ and jets in final states. Above left: an example of a SUSY Higgs decay in CMS. On the right is the reconstructed $\tau\,\tau$ mass spectrum

Sparticle discovery ranges

SUSY event with 3 lepton + 2 Jets signature

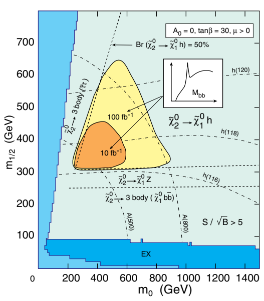


Inclusive $\ell^+\ell^- + E_t^{miss}$ final states



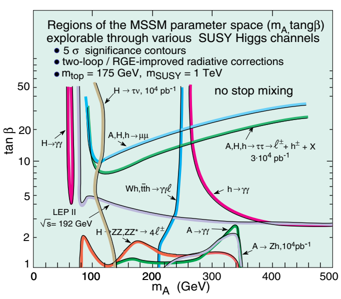
Production of sparticles may reveal itself though some spectacular kinematical spectra, with a pronounced "edge" in the $\ell^+\ell^-$ mass spectrum reflecting $\tilde{\chi}_2^0 \to \ell^+\ell^-\tilde{\chi}_1^0$ production and decay. An example of such an edge in the inclusive di-lepton mass spectrum and of an event with tri-lepton are shown above

h^0 in mSUGRA

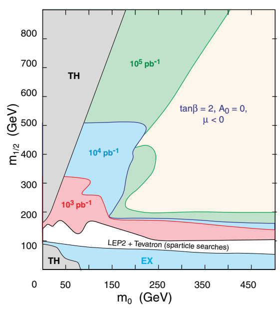


Example of the domain of parameter space of mSUGRA-MSSM where the $h^0 \to b\bar{b}$ can be observed

Higgs bosons in MSSM

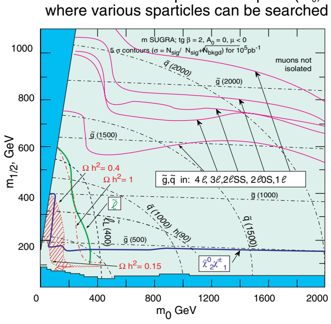


The search for the various MSSM Higgs bosons in different decay modes allows the exploration of most of the parameter region (tangβ,m_A)



Domain of mSUGRA parameter space where the "edge" in $\ell^+\ell^-$ mass, in inclusive isolated two - leptons + E_t^{miss} final states, should be visible at various luminosities

Domains of mSUGRA parameter space (m_0,$m_{1/2}$) where various sparticles can be searched



Gluinos and squarks can be looked for in various channels with leptons + E_t^{miss} + jets and discovered for masses up to ~ 2.2 TeV. Sleptons can be discovered for masses up to ~ 350 GeV. The region of parameter space $0.15 \lesssim \Omega h^2 \lesssim 0.4$ — where $\tilde{\chi}_1^0$ would be the Cold Dark Matter particle — is contained well within the explorable region