Matter and the Universe

Topic 1: Fundamental Particles and Forces

Interpretation of the Higgs signal in supersymmetric models

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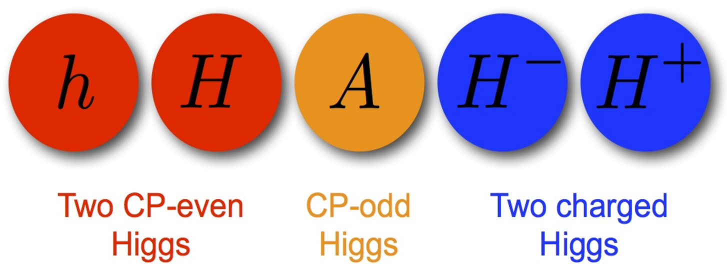
MSSM Higgs sector

The minimal supersymmetric Standard Model (MSSM) has five physical Higgs bosons:



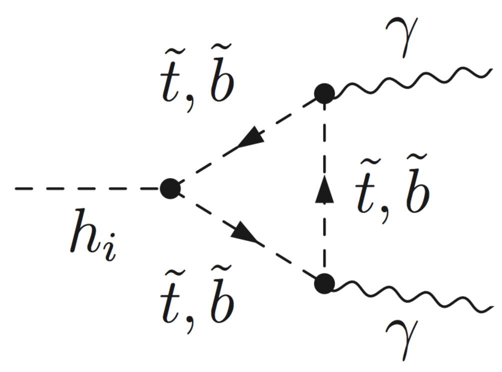
The discovered Higgs boson at ~ 126 GeV can be interpreted as the lightest CP-even Higgs, h, of the MSSM.
In models with extended Higgs sectors also the interpretation as the second-lightest CP-even Higgs is possible

Measurement of the Higgs signal strengh

Best fit signal strength for each decay channel:

$$\mu_i = \frac{\sigma(pp \to H) \times BR(H \to i)}{\sigma^{\rm SM}(pp \to H) \times BR^{\rm SM}(H \to i)}$$

- Results compatible with the SM
- Deviations are not statistically significant
- Many other 'new physics' interpretations are possible

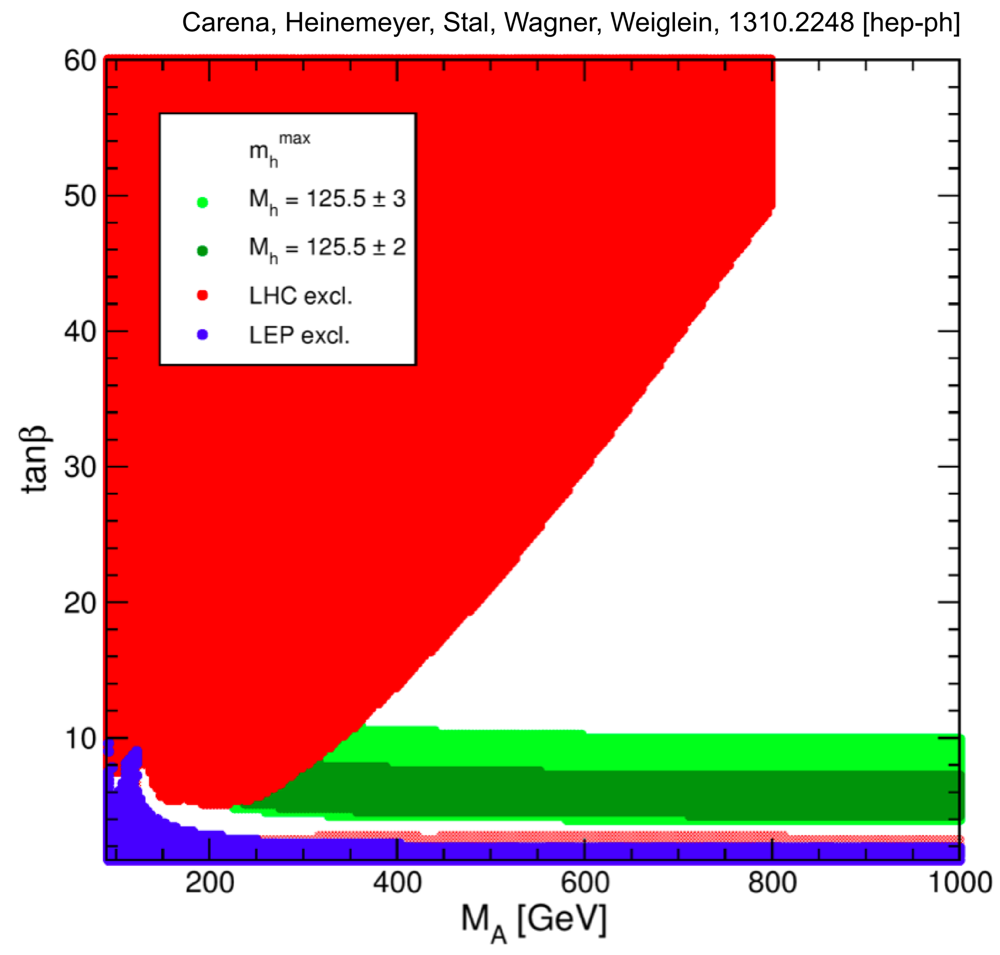


Interpretation of the Higgs signal as the light CP-even Higgs

The interpretation of the light CP-even Higgs as the state at 126 GeV leads to a lower bound on the CP-odd Higgs mass, M_A, of around 200 GeV.

Consequences:

- MSSM is in the "decoupling limit"
- State at 126 GeV has SM- like couplings
- No large deviation of the measured properties from SM expected



Fitting the MSSM to the Higgs and low-energy data

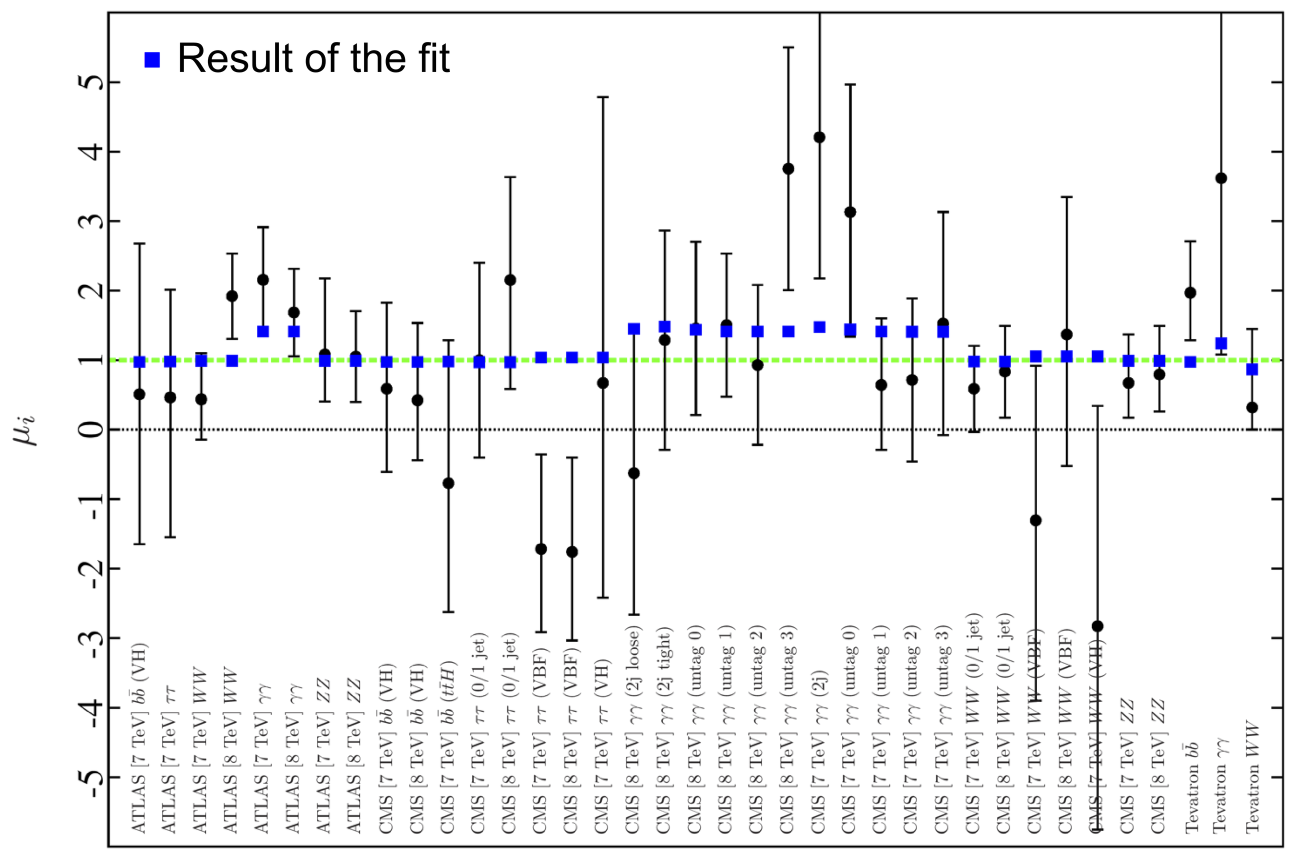
We performed a random scan over the MSSM parameter space, for each point we calculate

$$\chi^2 = \sum_{i=1}^{n_{\rm LHC}+n_{\rm Tev}} \frac{(\mu_i - \hat{\mu}_i)^2}{\sigma_i^2} + \frac{(M_{h,H} - \hat{M}_H)^2}{\sigma^2_{\hat{M}_H}} + \sum_{i=1}^{n_{\rm LEO}} \frac{(O_i - \hat{O}_i)^2}{\sigma_i^2}$$

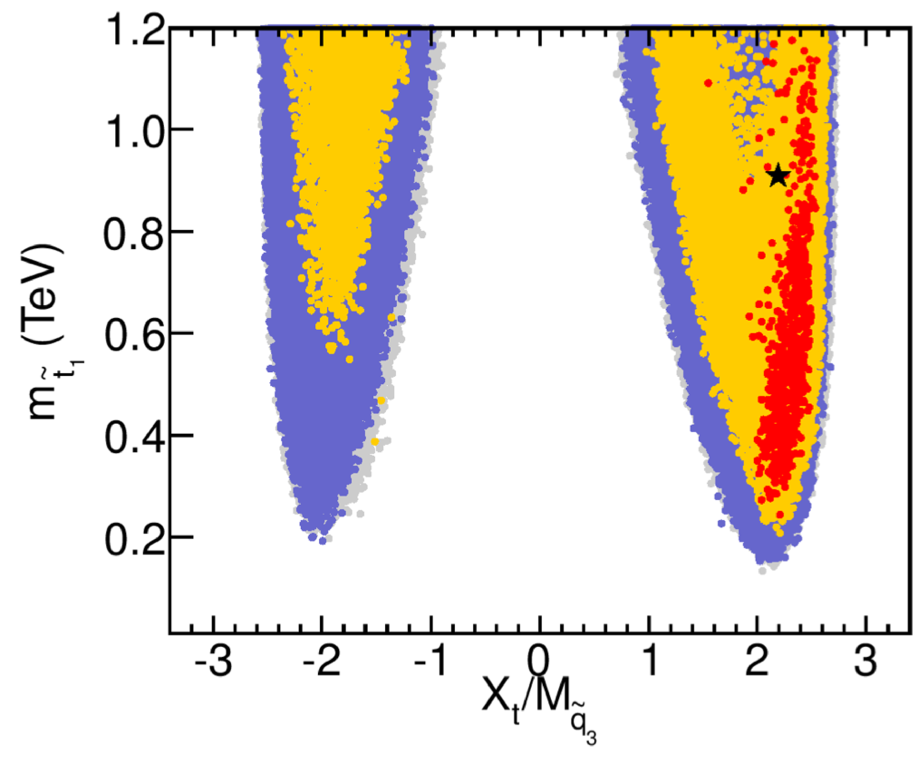
- Hatted quantities: experimental measurements
- LEO: low energy observables

The MSSM has the flexibility to describe deviations of the measurements from the SM prediction. However large deviations cannot be explained (decoupling limit).

The MSSM provides a good fit to the observables, similar (even slightly better) than the SM.



Constraints on the stop sector



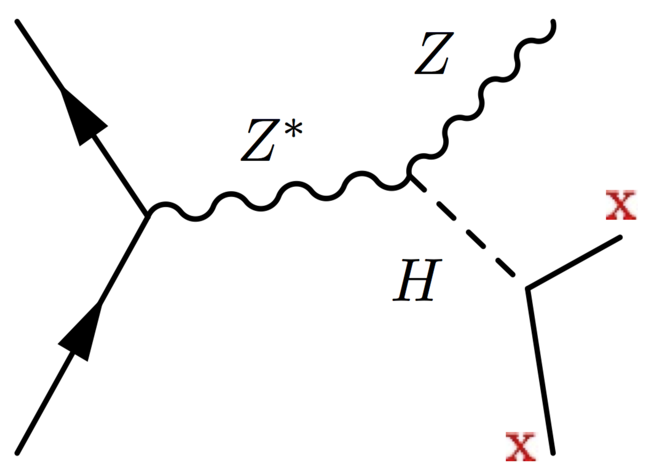
A light Higgs at 126 GeV requires large radiative corrections especially from tops / stops ⇒ Large mixing in the stop sector

The favored region of the fit includes points with stop masses down to ~ 200 GeV.

Higgs as a portal to dark matter

If dark matter consists of particles lighter than ~ 63 GeV, the decay of the Higgs into a pair of dark matter particles (which would not interact with the detector) is kinematically open and could occur, even if the Higgs couples with SM strength to all SM particles.

Invisible Higgs decays ⇒ Insight into Dark Matter.

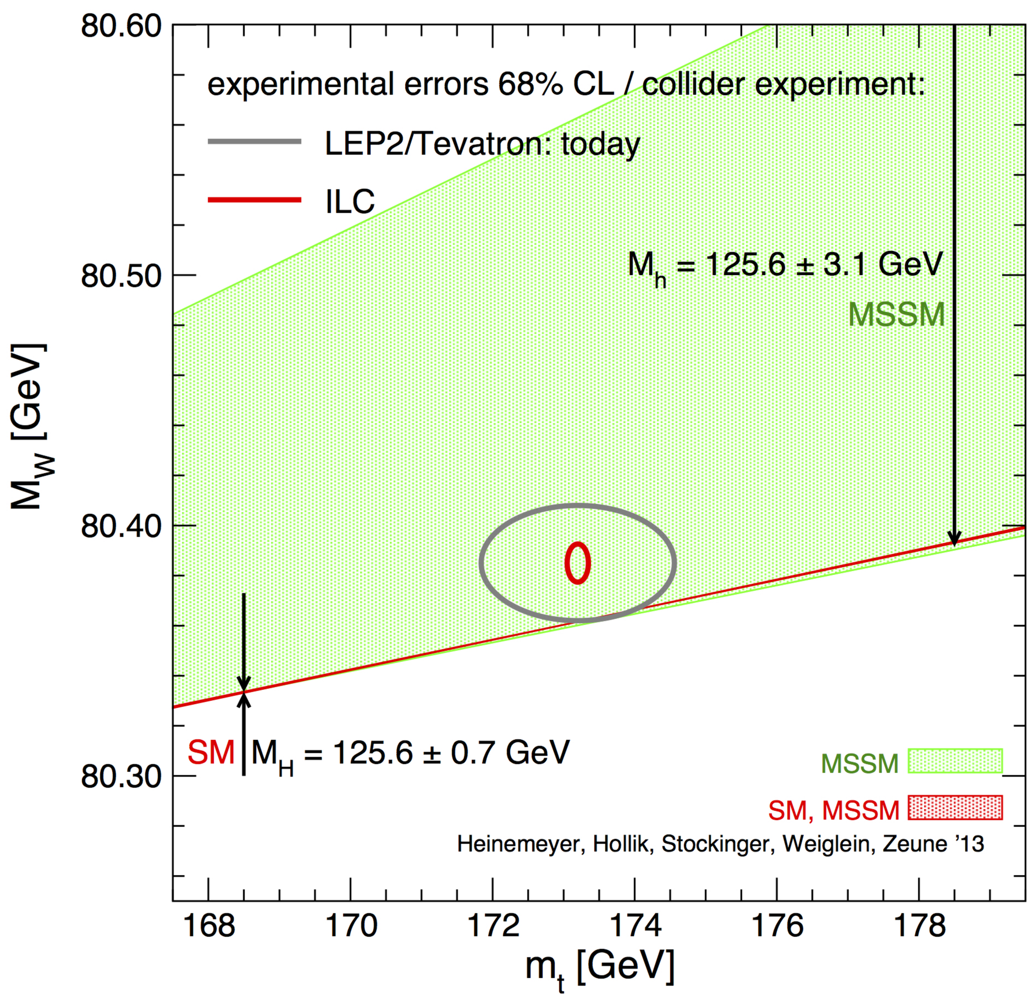


Indirect constraints from electroweak precision data

The prediction for the W-boson mass is highly sensitive to loop contributions of 'new-physics'.

Precise measurement +
precise calculation in SM and SUSY models:

- Test SUSY models
- Distinguish between the SM and SUSY
- Constrain the SUSY parameter space



Currently slight preference for a non-zero SUSY contribution. More precise measurement would enhance the sensitivity for distinguishing between the SM and the MSSM.

⇒ **The properties of the observed Higgs boson are compatible with the SM so far, but many other interpretations are equally well possible (e.g. MSSM)**

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