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BayesFits
Bayesian Implications of Current LHC and XENON100 Search Limits for the Constrained MSSM

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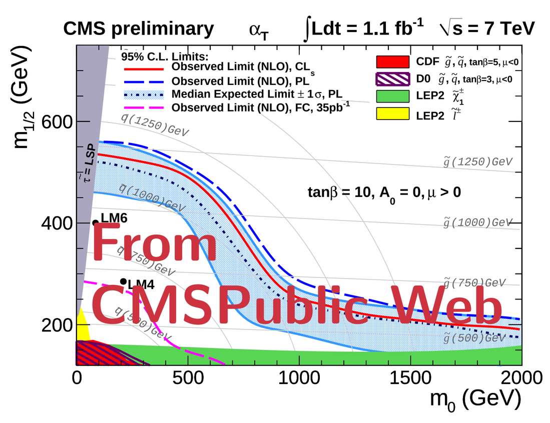
BayesFITS

- We fit the CMSSM to experimental data with **Bayesian statistics**
- Frequentist statistics considers the likelihood — the probability of obtaining the experimental data given the CMSSM's parameters
- **Bayesian statistics considers the the posterior** — the probability of the CMSSM's parameters given the experimental data
- Find the posterior with Bayes' theorem;

$$p(m_0, m_{1/2}, A_0, \tan\beta | d) \propto \mathcal{L}(m_0, m_{1/2}, A_0, \tan\beta) \times \pi(m_0, m_{1/2}, A_0, \tan\beta)$$

- Requires that we articulate our prior knowledge of the CMSSM's parameters in the prior, $\pi(m_0, m_{1/2}, A_0, \tan\beta)$
- We use an updated version of SuperBayeS package to perform a Bayesian analysis of the CMSSM's parameter space

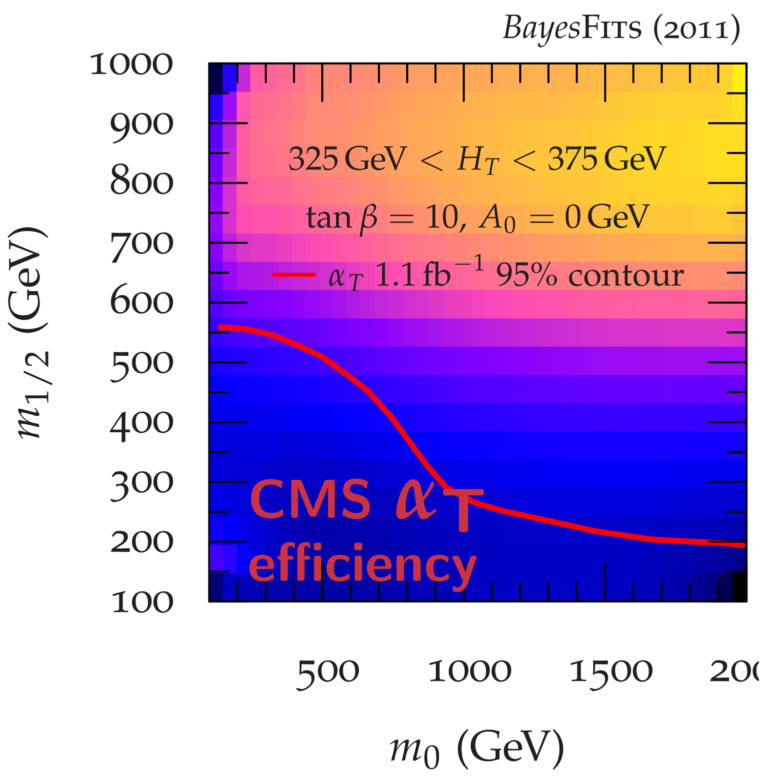
CMS α_T 1.1/fb search for supersymmetry at the LHC

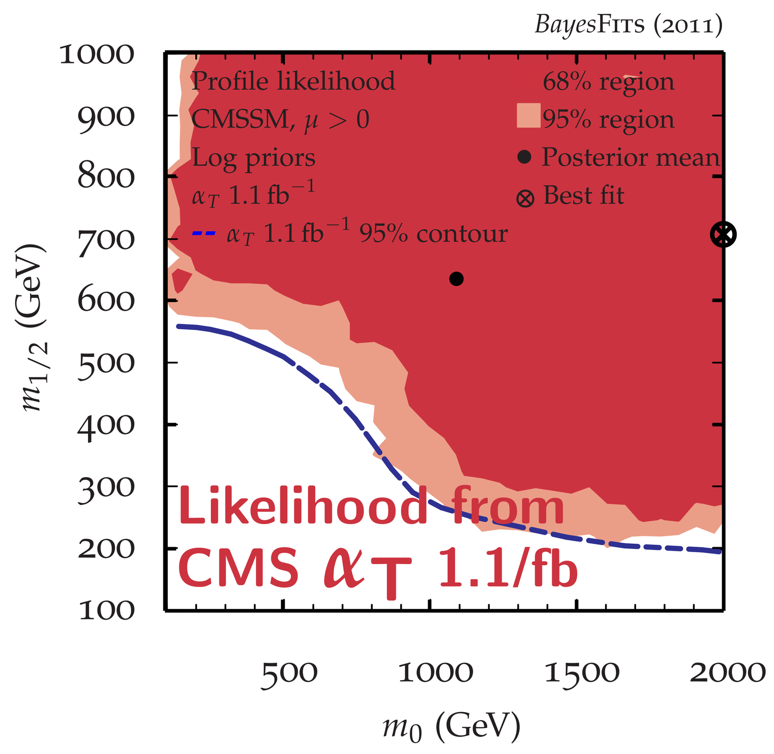


- CMS collaboration searched for supersymmetry at the LHC
- Looked for jets and missing energy
- Discriminator against SM background was kinematic α_T variable
- Number of observed events was in statistical agreement with the SM
- Resulting in a **95% exclusion contour** on the CMSSM's $(m_0, m_{1/2})$ plane

Our strategy:

- **Simulate the α_T search at the event level**
- Calculate the cross section for the production of sparticles and the α_T efficiency with PYTHIA





Our strategy:

- Find number of supersymmetric events on the whole $(m_0, m_{1/2})$ plane with $s = \epsilon \times \sigma \times \int L$
- Calculate the likelihood at each point on the whole $(m_0, m_{1/2})$ plane — **our likelihood map** — with Poisson: $\mathcal{L} = e^{-s+b}(s+b)^o/o!$
- Calculate our 95% exclusion contour with the PL method with $\Delta\chi^2 = 5.99$

Result:

- **Excellent agreement** between our 95% contour (edge of ■ region) and the official CMS α_T 95% contour (— — — line)
- **Validates our likelihood map and methodology**

XENON100 direct detection

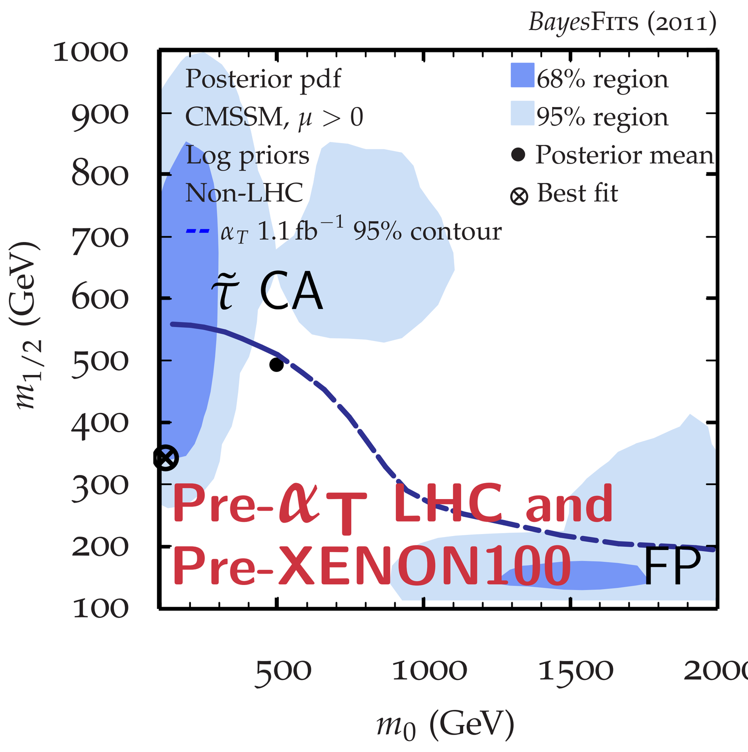
- XENON100 released a **90% exclusion contour on the (m_χ, σ_p^{SI})** plane from the null result of its direct detection experiment
- We smooth this contour with a Gaussian describing the significant theoretical uncertainties in the σ_p^{SI} calculation

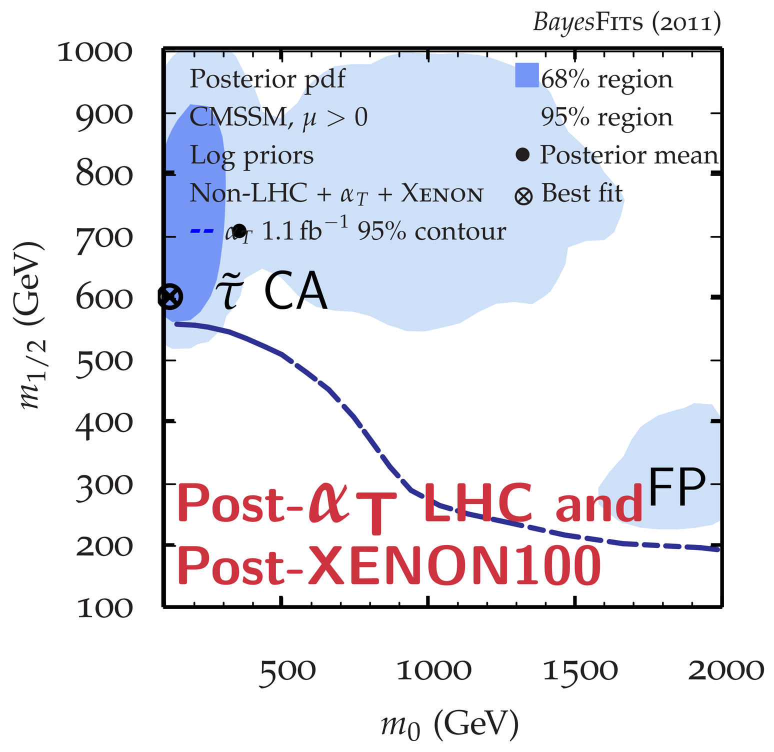
Non-LHC constraints on supersymmetry

The significant Non-LHC constraints on the CMSSM are:

- WMAP7 constraint on the relic density of the neutralino, $\Omega_\chi h^2$
- LEP and Tevatron limits on sparticle masses and $m_h > 114.4$ GeV
- Loop contributions to Δa_μ, $b \to s\gamma$ and $B_s \to \mu^+\mu^-$

Results — 68% and 95% Bayesian credible regions for CMSSM with likelihood from Non-LHC, XENON100 and α_T





- The ■ (■) region contains 68% (95%) of the posterior
- Log priors for m_0 and $m_{1/2}$
- ● is the posterior mean
- ⊗ is the best-fit point

Pre-α_T and pre-XENON100

- Two modes on the CMSSM's $(m_0, m_{1/2})$ plane — the stau co-annihilation region (at $\tilde\tau$ CA) and the focus point region (at FP)
- Credible regions (■ and ■) include low-mass regions below the CMS α_T 95% contour (— — — line)

Post-α_T and post-XENON100

- Stau co-annihilation region (at $\tilde\tau$ CA) is severed by the α_T likelihood
- **Focus point region (at FP) is only present at 95%**
- α_T experiment takes a **deep bite into the low-mass region of the CMSSM's $(m_0, m_{1/2})$ plane** that was favoured by previous experiments
- and pushes the best-fit point (⊗) to **larger values of $m_{1/2}$**