Benchmark Models, Planes and Lines
for Future SUSY Searches at the LHC

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based on collaboration with
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1. The goal

2. The proposal

3. The future

1. The goal

Request from ATLAS/CMS:

"We will present our SUSY search results. In which model interpretation are you theorists interested?"

1. Clear definition of various models ("simplified" versions of the MSSM)

2. Clear recommendation for (2-dimensional) planes for the model dependent presentation of the SUSY search results

3. Definition of new benchmark points (within the defined scenarios) for dedicated detector studies
   [CMS: yes; ATLAS: not so relevant]

2. The proposal

2. A) Definition of models ("dictionary")

$\rightarrow$ supplemented with a brief description of phenomenological features

1. The constrained MSSM

   CMSSM: $m_{1/2}, m_0, A_0, \tan\beta, \text{sign}(\mu)$

2. The minimal Supergravity model

   CMSSM with additional constraints: $A_0 = B_0 + m_0$, $m_{3/2} = m_0$

   mSUGRA: $m_{1/2}, m_0, A_0, \text{sign}(\mu)$

   VCMSSM: (Very Constrained MSSM)
   as mSUGRA, but with free $m_{3/2}$

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3. The Non-Universal Higgs mass model

CMSSM with a splitting of scalar parameters in sfermion and Higgs sector at the GUT scale

NUHM1: $m_{1/2}, m_0, m_H, A_0, \tan\beta, \text{sign}(\mu)$

$\rightarrow$ trade m_H at M_{GUT} for M_A or μ at M_{EW}

If the two Higgs doublets live in different multiplets:

NUHM2: $m_{1/2}, m_0, m_{H_u}, m_{H_d}, A_0, \tan\beta, \text{sign}(\mu)$

$\rightarrow$ trade m_{H_u}, m_{H_d} at M_{GUT} for M_A and μ at M_{EW}

4. Gauge mediated SUSY-breaking

mGMSB: $M_{\text{mess}}, N_{\text{mess}}, \Lambda, \tan\beta, \text{sign}(\mu)$

5. Anomaly mediated SUSY-breaking

mAMSB: $m_{\text{aux}}, m_0, \tan\beta, \text{sign}(\mu)$

6. Mixed modulus-anomaly mediated SUSY-breaking

$\rightarrow$ inspired by models of string compactification with fluxes

MM-AMSB: $m_{3/2}, \alpha, \tan\beta, \text{sign}(\mu), n_i, l_a$

7. CMSSM with RPV

RPV-CMSSM: $m_{1/2}, m_0, A_0, \tan\beta, \text{sign}(\mu), \Lambda$

$$\Lambda \in \{\lambda_{ijk}, \lambda'_{ijk}, \lambda''_{ijk}, \kappa\}$$

8. Phenomenological MSSM

$\rightarrow$ to fix the notation, but not recommended (so far)
for model interpretation!

pMSSM: $M_{1,2,3};\ m_{\tilde{f}_{Q,U,D,L,E}}^{3\text{rd gen}},\ m_{\tilde{f}_{Q,U,D,L,E}}^{1\text{st/2nd gen}};\ A_{t,b,\tau,\mu=e};\ \mu, M_A, \tan\beta$

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2. B) Definition of Planes, Lines, Points

Idea: Re-use the SPS points (partially ruled out by ATLAS/CMS already)
        and slopes (world wide consensus!) for the definition:
$\Rightarrow$ Definition of planes that contain the points/slopes

Example I: SPS 1a (CMSSM):

$m_0 = 100$ GeV, $m_{1/2} = 250$ GeV, $A_0 = -100$ GeV, $\tan\beta = 10$

$\Rightarrow$ plane: $(m_{1/2}, m_0)$ with $A_0 = -100$ GeV, $\tan\beta = 10$

$\Rightarrow$ slope: $A_0 = -100$ GeV, $\tan\beta = 10$, $m_0 = 0.4\, m_{1/2}$

$\Rightarrow$ points: vary $m_{1/2}$ in steps of 50 GeV,
            take next point that is not (yet) excluded

pro:
agreed upon points/lines, simple defintition, robust against LHC data

con:
All experimental constraints only fulfilled in small part of plane
(but not the purpose of the planes!)

Example II: SPS7 (mGMSB with stau NLSP):

$\Rightarrow$ plane: $(M_{\text{mess}}, \Lambda)$ with $N_{\text{mess}} = 3$, $\tan\beta = 15$

$\Rightarrow$ slope, points . . .

Example III: SPS8 (mGMSB with neutralino NLSP):

$\Rightarrow$ plane: $(M_{\text{mess}}, \Lambda)$ with $N_{\text{mess}} = 1$, $\tan\beta = 15$

$\Rightarrow$ slope, points . . .

Example IV: SPS9 (mAMSB):

$\Rightarrow$ plane: (m_{aux}, m_0) with $\tan\beta = 10$

$\Rightarrow$ slope, points . . .

Alternative idea for the suggestion of lines/points:

— Take one model.
— Take current best-fit point(s).
— Evaluate points under the assumption that the LHC does not find SUSY
  for various luminosities.
$\Rightarrow$ line/points

pro:

fits serve as additional motivation, exp. constraints fulfilled along the line

con:

various fits exist, extrapolation requires substantial work, non-trivial
lines/points not necessarily in the planes (or complicated definition of
planes)

3. The future

We need feedback from ATLAS/CMS!

Are we on the right track?

– finish model defintion
  add some key-features of the spectra of each model

– finish line/point definition

– ...