

# *SUSY breaking and all that ...*

1. Is SUSY dead?

→ *no, why?*

2. Is the MSSM dead?

→ *no, not at all*

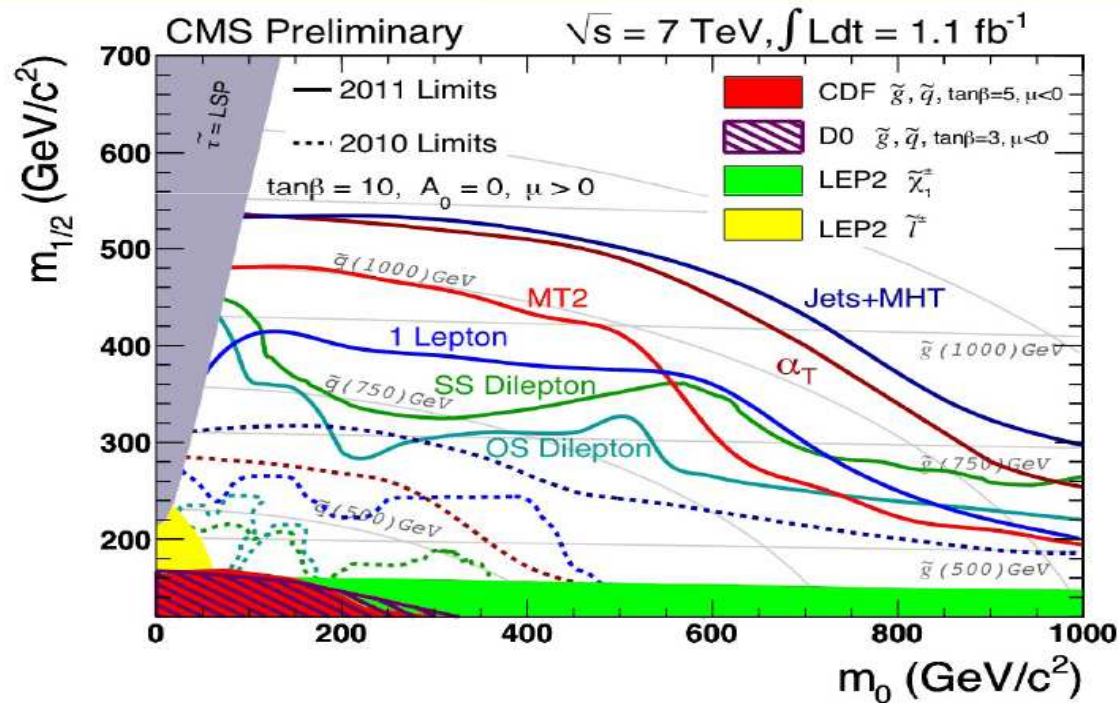
3. Is the CMSSM dead?

→ *not really, just under tension.....still under work*

*But what's about other breaking scenarios?*

# Flash LHC results (not most recent)

- First LHC results based on  $L=1.1\text{fb}^{-1}$  :
  - Exclusion bounds in mSUGRA for coloured spectrum
- CMS:



mSUGRA scenario

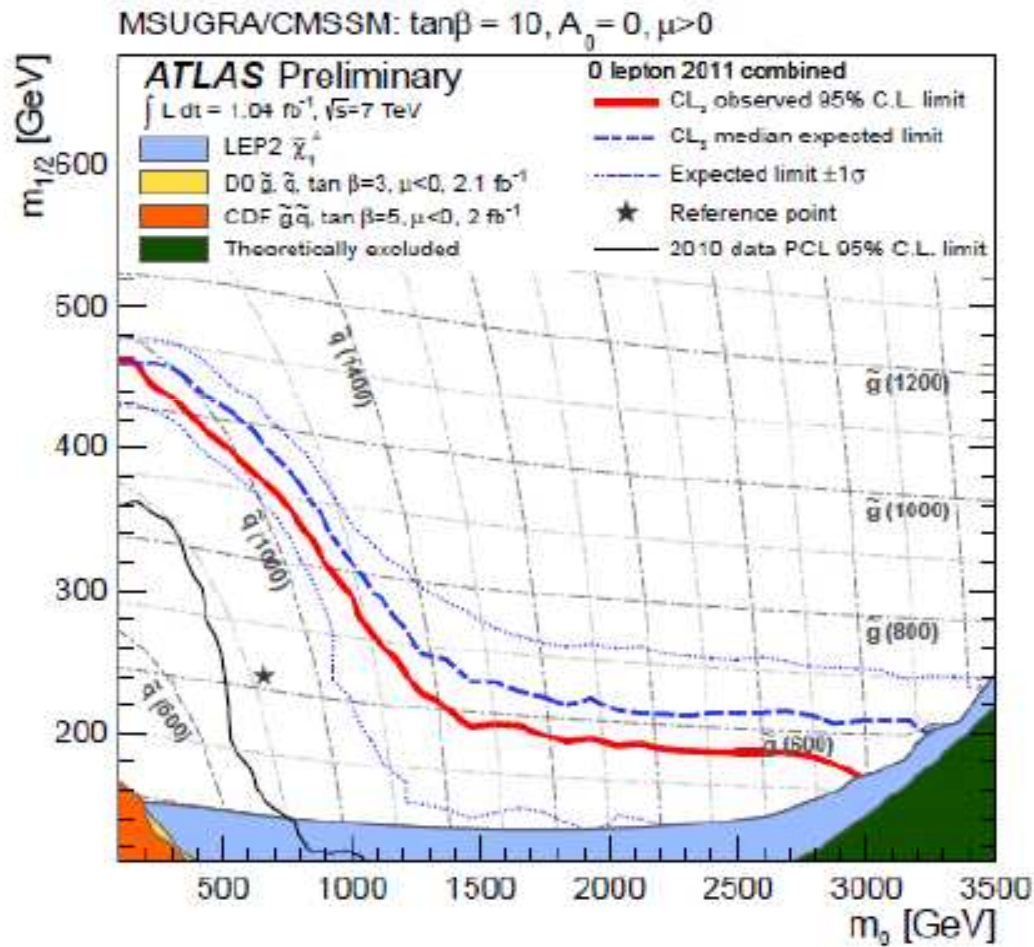
- $g, q > 1200\text{ GeV}$

Interpretation in mSUGRA

See plenary talk, S. Padhi

# Flash LHC results, cont.

- ATLAS-result:  $1.04 \text{ fb}^{-1}$

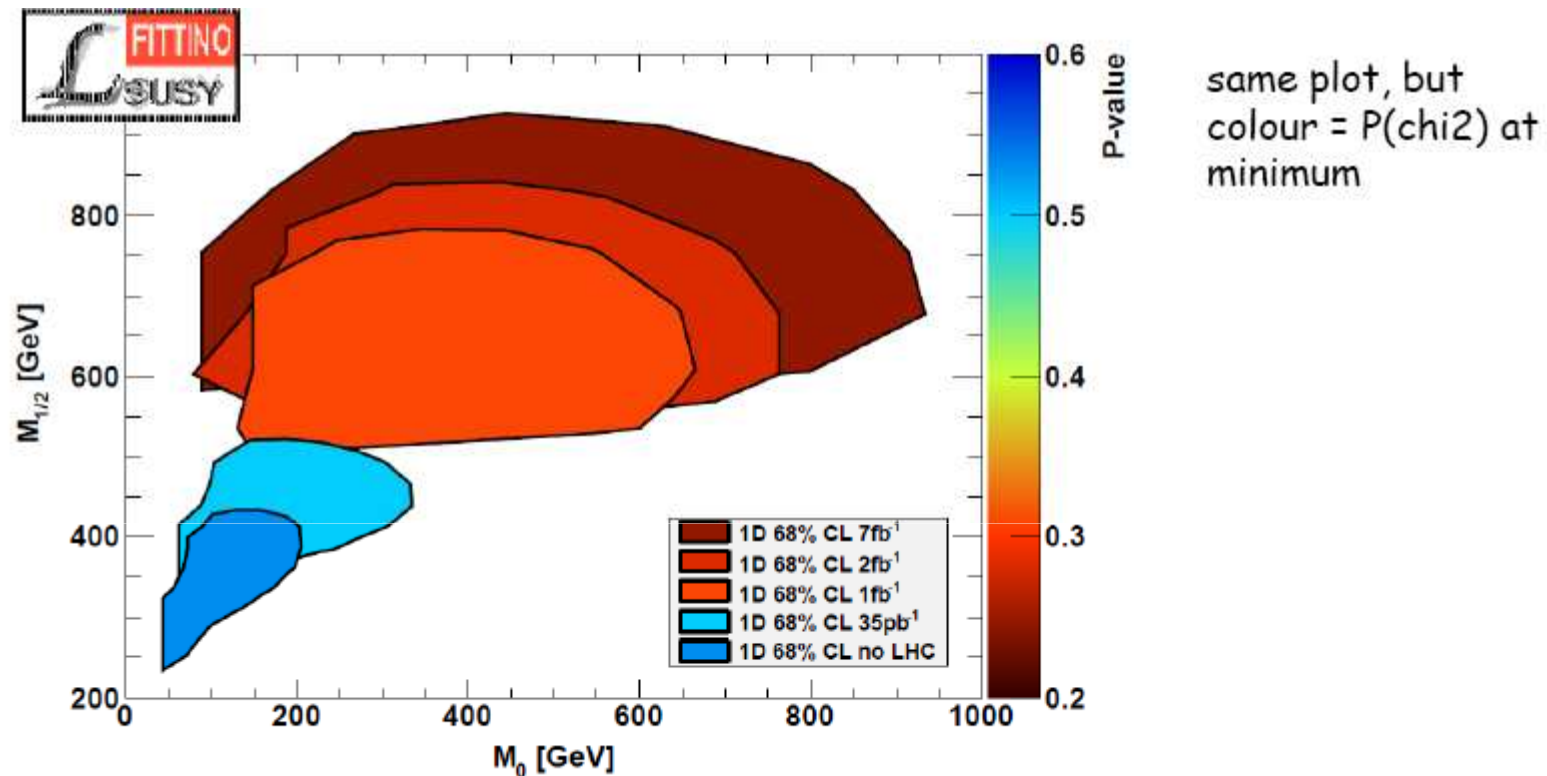


mSUGRA scenario

- equal  $q, g > 980 \text{ GeV}$

Interpretation in mSUGRA

# *mSUGRA-fit including 'all' bounds*



- yes: some tension is building up (of course)
  - but no: even with  $7\text{fb}^{-1}$  not a really bad overall fit.  
(even if you don't like  $\text{prob}(\chi^2)$  as an absolute measure - it should be fine as relative measure. Current ( $1\text{fb}^{-1}$ ) best fit only a factor two less likely than pre-LHC)
- even if no discovery by end 2011 one can't safely say CMSSM/mSugra is dead...

*Talk by K. Desch, yesterday in WG1*

## *But – is mSUGRA the full truth?*

- Remember: we have 105 new SUSY parameters (instead of only 4) ...
  - ‘everything’ is possible
  - but the full MSSM is a more long-term goal
  - No ‘real’ fitting option
- Relation between particles depends crucially on the SUSY breaking scenario
  - Study different breaking scenarios with also only a few parameters
  - ***Get a feeling whether we walk on the right interpretation path....***

# *Free parameters in the MSSM*

- mass matrices are 3 x 3 hermitian  
→  $m_Q^2, m_u^2, m_d^2, m_L^2, m_e^2$  : 45 parameters
- gaugino masses  $M_1, M_2, M_3$  are complex numbers: 6
- trilinear couplings  $a_u, a_d, a_e$  are 3 x 3 complex matrices: 54
- bilinear coupling  $b$  is 2 x 2 matrix: 4
- Higgs masses  $m_{Hu}^2, m_{Hd}^2$  : 2  
→ altogether 111 parameter ???

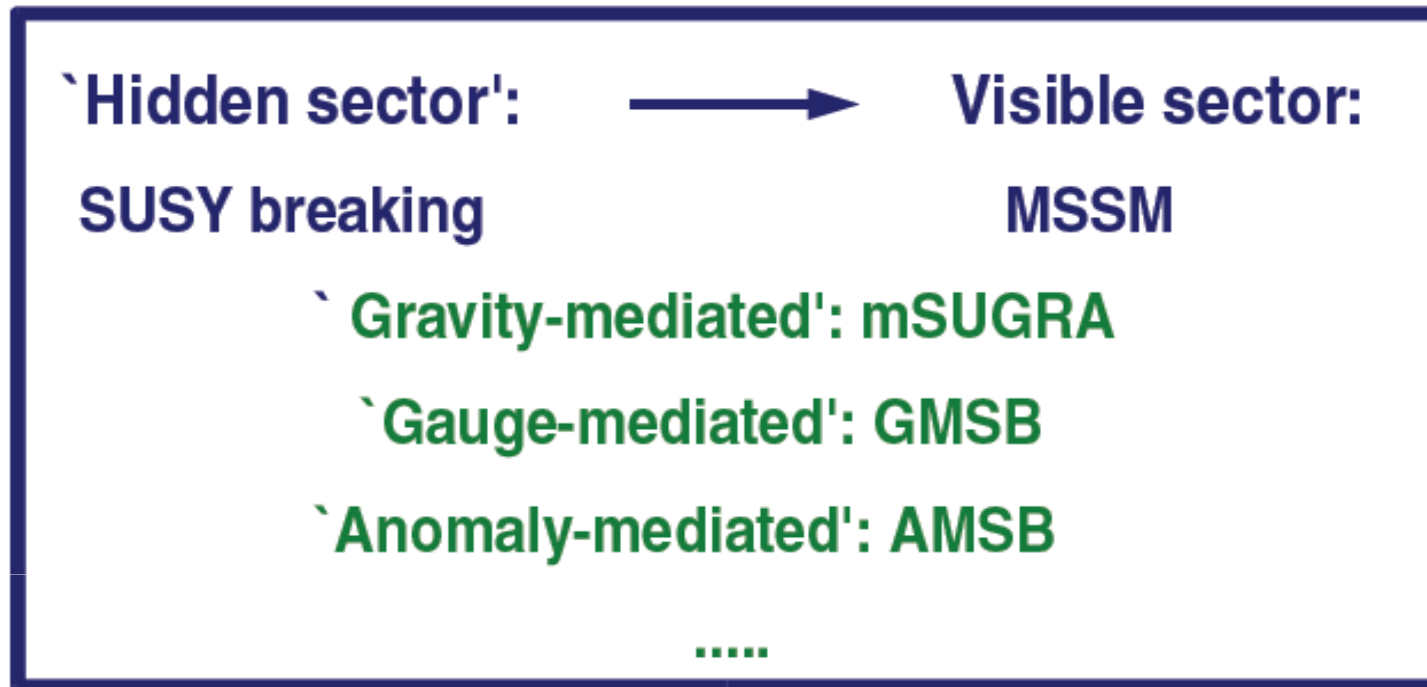
Symmetries (lepton + baryon number, Peccei-Quinn, R symmetry) lead to 'rotations':

-4 non-trivial field redefinitions

-2 in the Higgs sector (since minimal model only 2 parameters in the Higgs sector)

→ remain 105 free new parameters in the MSSM!

# *SUSY breaking*



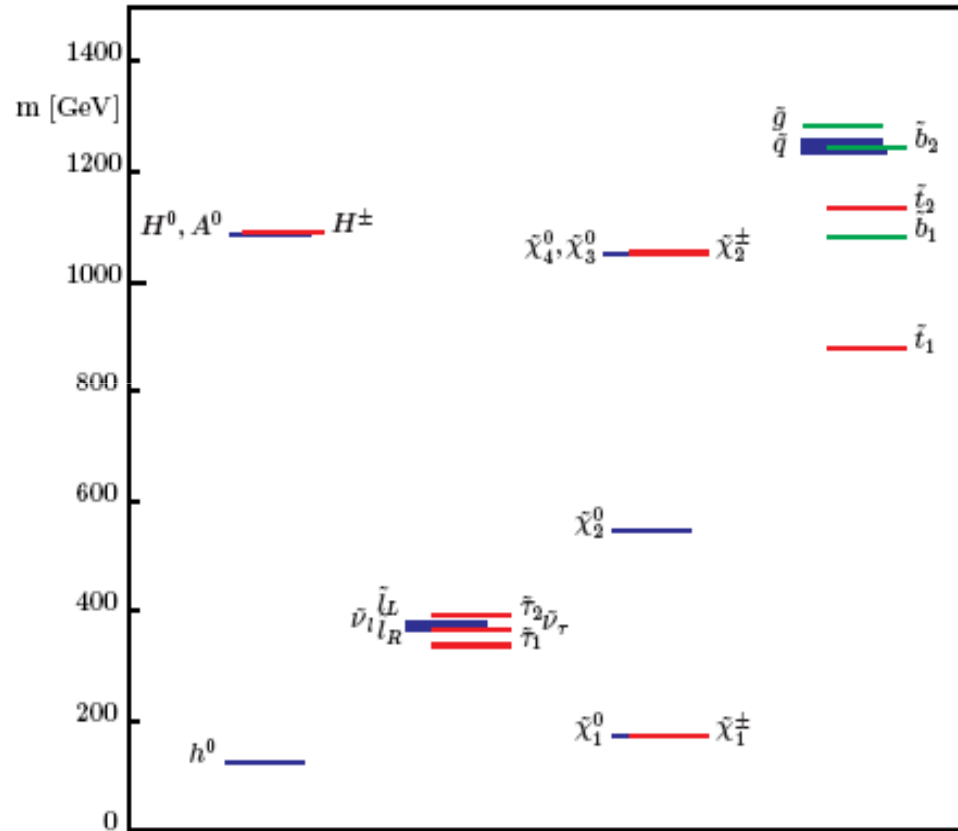
- **SUGRA**: mediating interactions are gravitational  $m_0, m_{1/2}, \tan\beta, A_0, \text{sign}(\mu)$
- **GMSB**: mediating interactions are ordinary electroweak and QCD gauge interactions  $\Lambda, M_{\text{mess}}, N_{\text{mess}}, \tan\beta, \text{sign}(\mu)$
- **AMSB**: SUSY breaking happens on a different brane in a higher-dimensional theory  $m_0, m_{\text{aux}}, \tan\beta, \text{sign}(\mu)$

● **Feature of schemes: lead to 'characteristic' mass spectra**

# How are the mass spectra?

- Just take 'good old' AMSB--'SPS9'

Allanach et al hep-ph/0202233



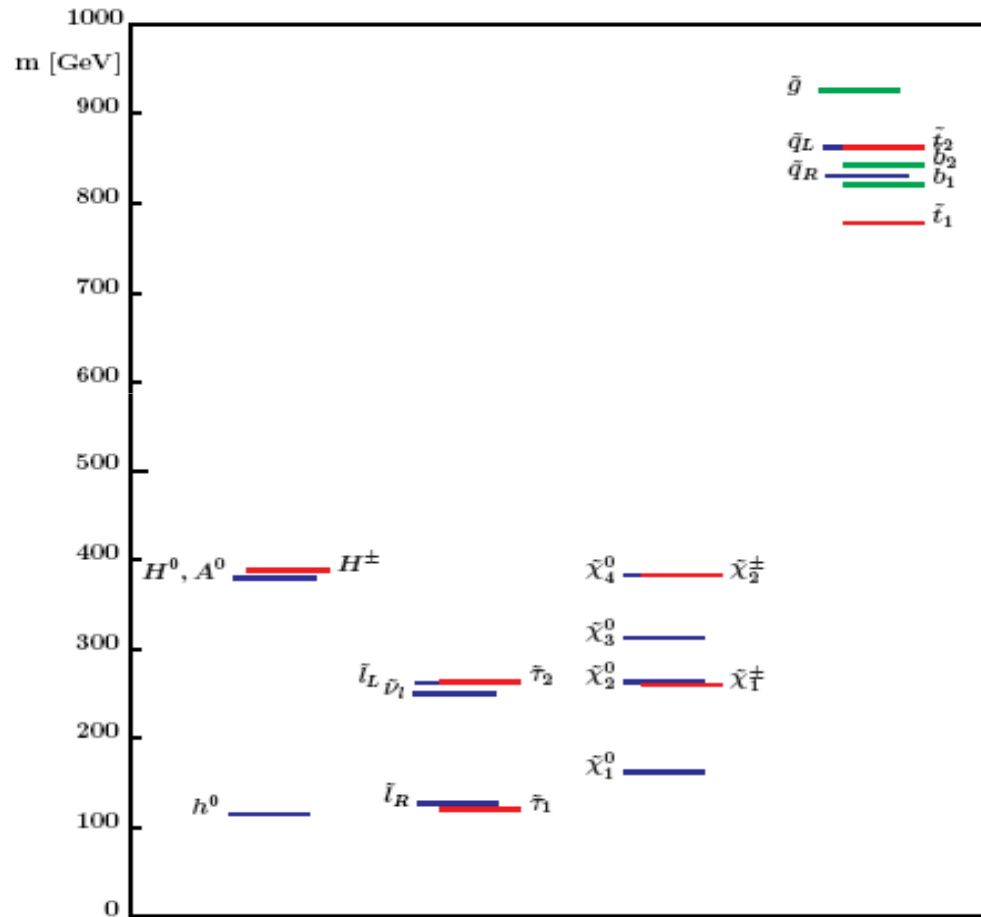
Uli Martyn, Nabil Ghodbane, hep-ph/0201233

- Feature:
  - heavy coloured
  - but also light
  - uncoloured spectrum
- Technical challenge:
  - Mass degeneration
  - Many  $\pi$ 's
- Only few pheno studies performed in the past



# What's about gauge mediation?

- Have a look on GMSB -- 'SPS7':



Again:

- a **heavy coloured spectrum** is natural in this scenario
- but also a **rather light electroweak sector**.....

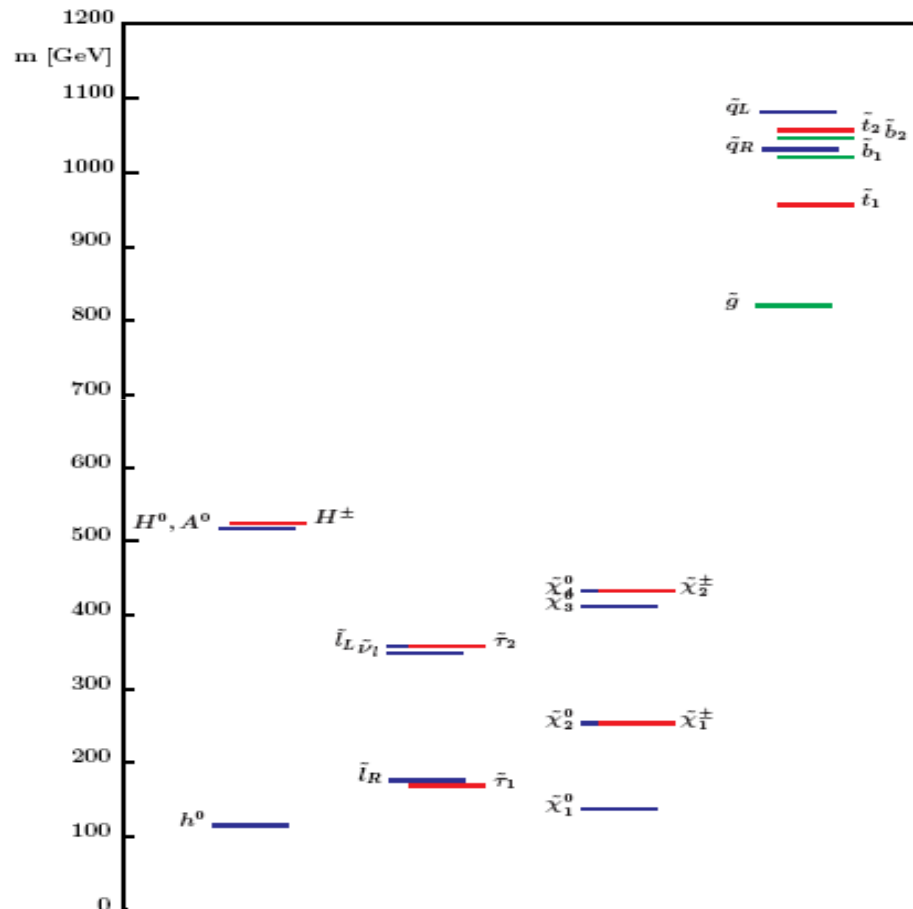
But: technical challenges

- many  $\tau$ 's, etc.
- *still many detailed studies missing! .....*

Uli Martyn, Nabil Ghodbane, hep-ph/0201233

# Remember good 'old' examples

- or also GMSB -- 'SPS8': *Allanach et al hep-ph/0202233*



- same feature: a **heavy coloured spectrum**
- but also a **rather light electroweak sector**.....

• But many  $\gamma$ 's .....

• **Only few studies exist**

*Uli Martyn, Nabil Ghodbane, hep-ph/0201233*

# *Open questions*

- *How do the bounds look like in such scenarios? In further scenarios (hybrids, etc.)?*
- *Are  $p_T$  cuts, etc. appropriate in such scenarios?*
- *If bounds for cross sections exist.....might this be enough for pheno's to draw conclusions themselves?*