Comparison of LHC observables with different codes

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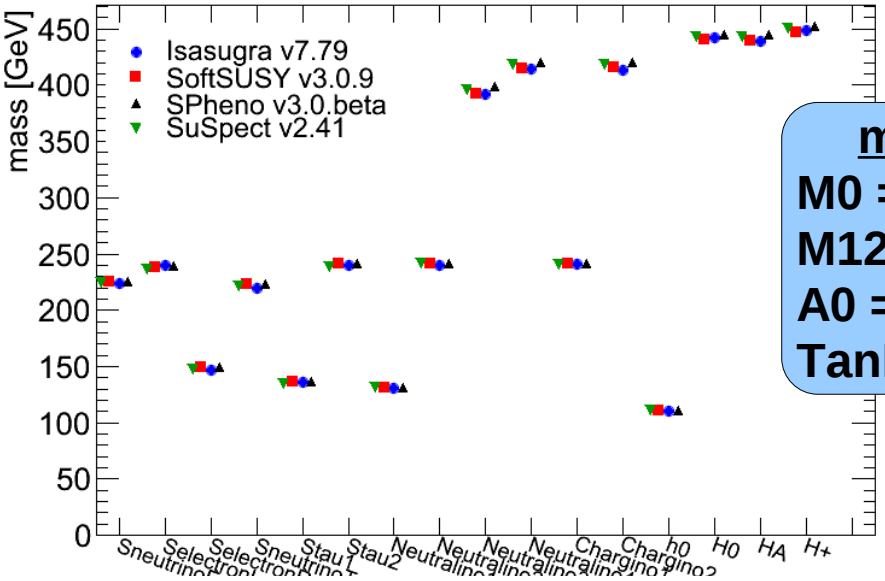
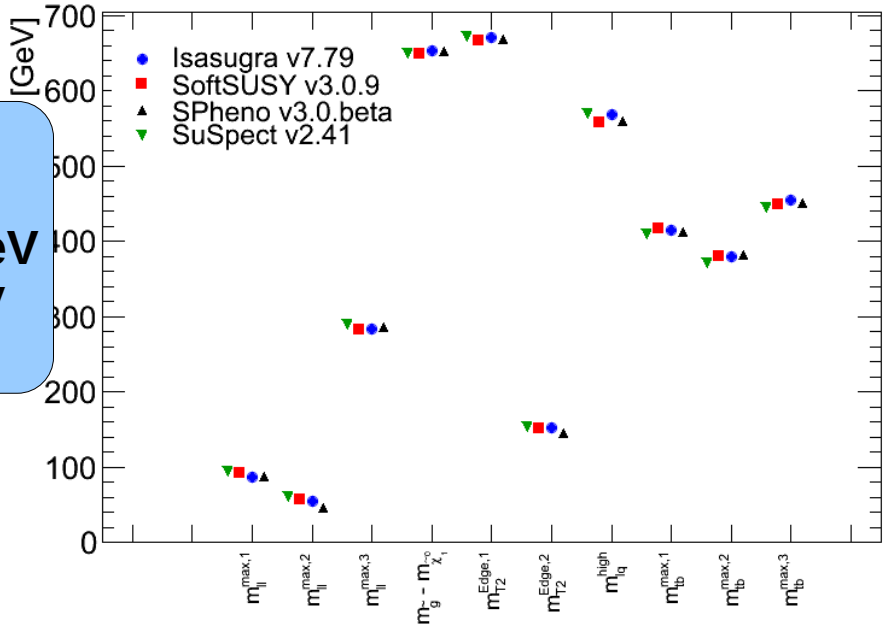
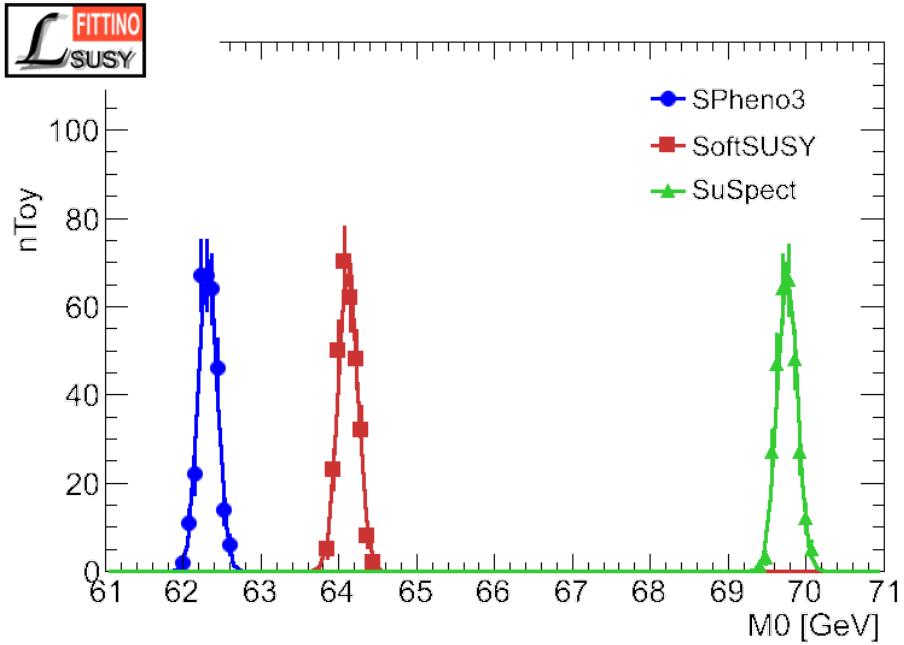
Last Time . . .



mSUGRA
M0 = 70 GeV
M12 = 330 GeV
A0 = 400 GeV
TanBeta = 13





- Differences in mass spectra O(1%)
- In rare cases differences in predicted observables much larger
  - here: $\Delta m_{\tau\tau}^{max} \approx 34\%$
- Impact on Fitted Parameter may be significant
- It was assumed that all variables which might be measured at SPS1a could be measured at this point, too

Update . . .

- Comparison for various values of tan β in the m0-m12 plane
- Slightly more detailed example study on the possible impact on fit results for "problematic" points

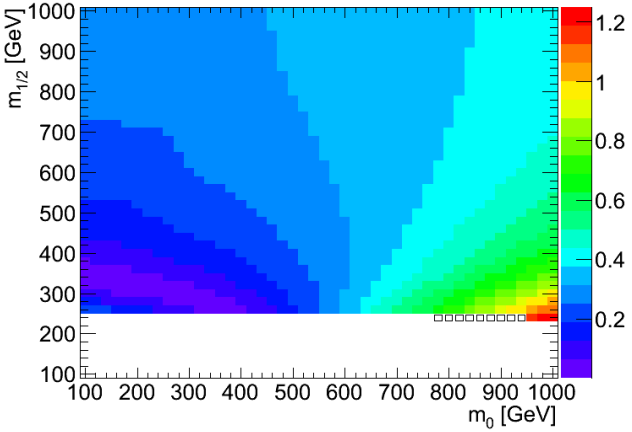
Comparison for Common Observables

- **Used Codes:**
  - **SoftSUSY 3.1.5**
  - **IsaSugra 7.80**
  - **SuSpect v2.41**
    - **For decays: S-Decay 1.3 & H-Decay 3.4**
  - **Spheno v3beta51**
- **mSUGRA parameterspace, in the following**
  - **A0 = 100 GeV || A0 = -400 GeV**
  - **tanβ = 10 || tanβ = 40**
  - **100 GeV <= m0 <= 1000 GeV**
  - **100 GeV <= m12 <= 1000 GeV**
  - **sign μ = +1**

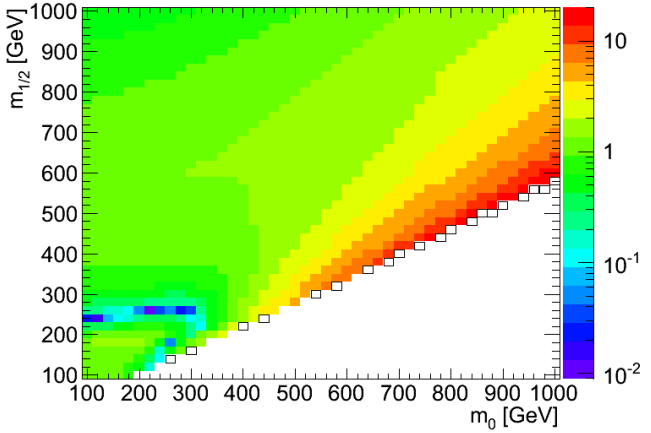
- **Here: short summary of some plots only, will focus on SoftSUSY vs SPheno**

- **Plots show unsigned relative difference, wrt SPheno v3beta51**
  - **Pink points: respective decay chain / parameter point not allowed by SPheno, but allowed by other calculator**
  - **Black points: vice versa**

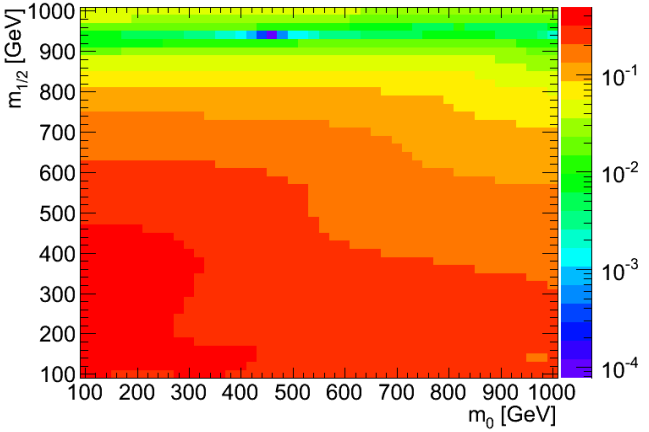
Relative differences



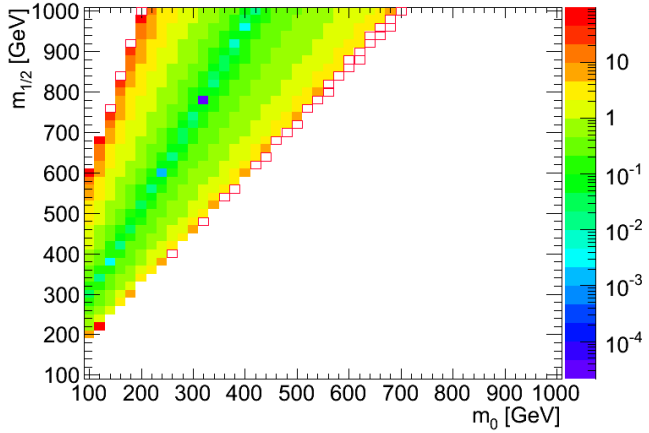
$m_{\chi+1}$



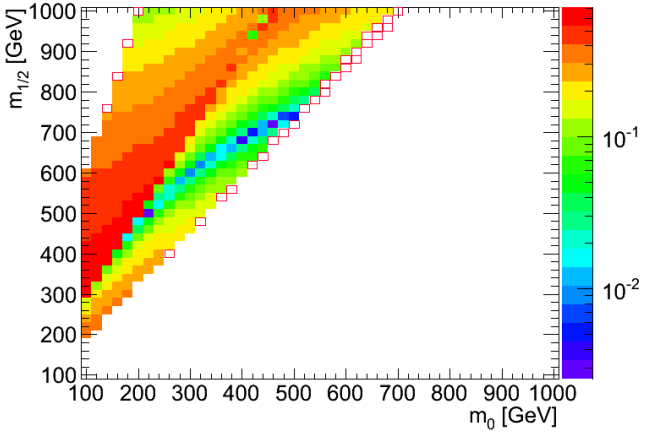
$m_{tb}(b_1, \chi^+_1)$



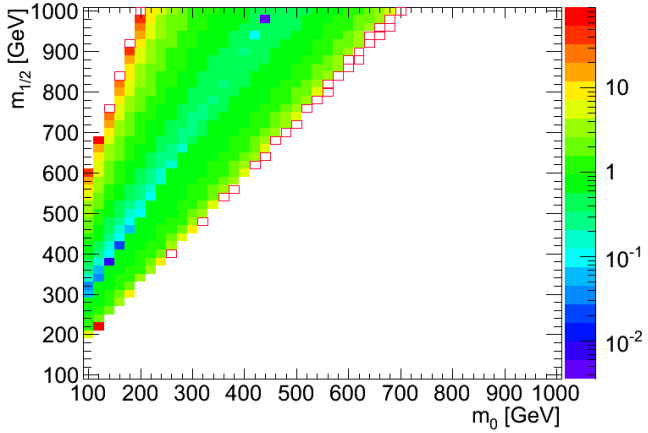
$m_{T2}(q_R, \chi^0_1)$



m_{ll}

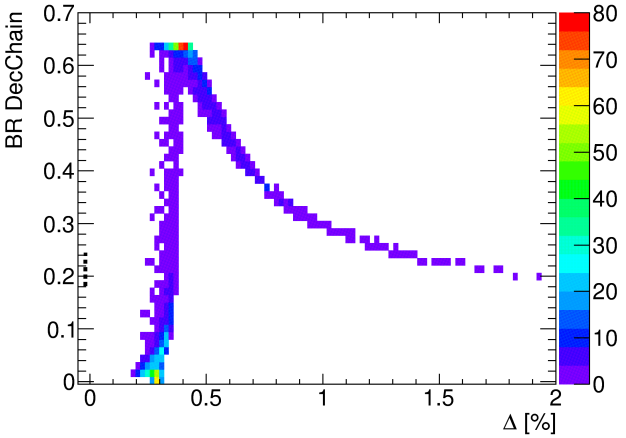


m_{lq}^{high}

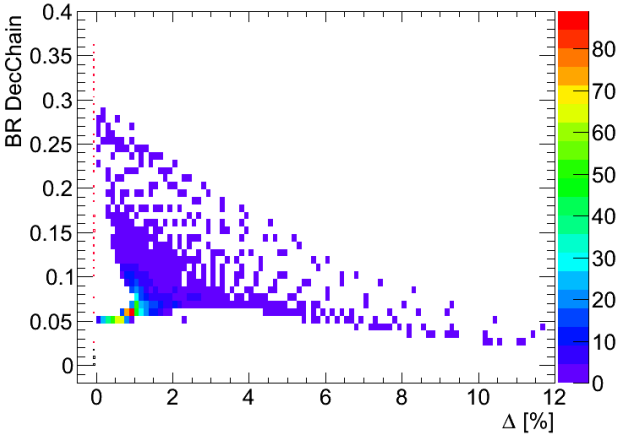


m_{lq}^{low}

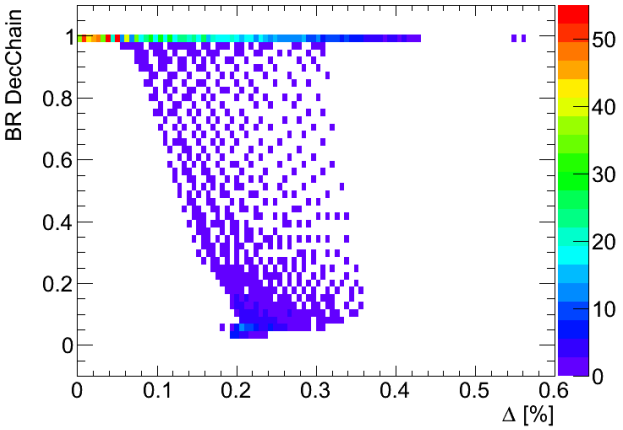
Difference vs Branching Fraction



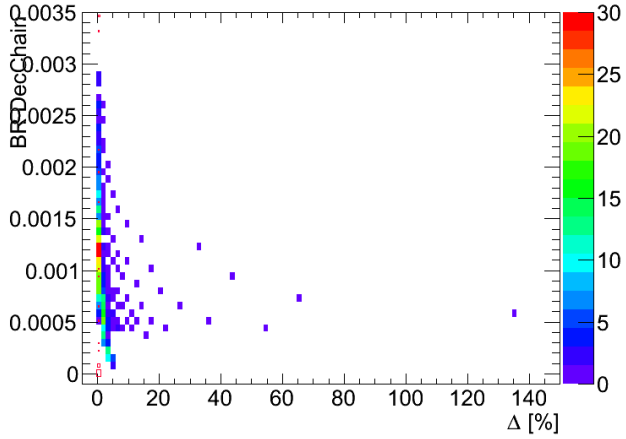
$m_{\chi+1}$



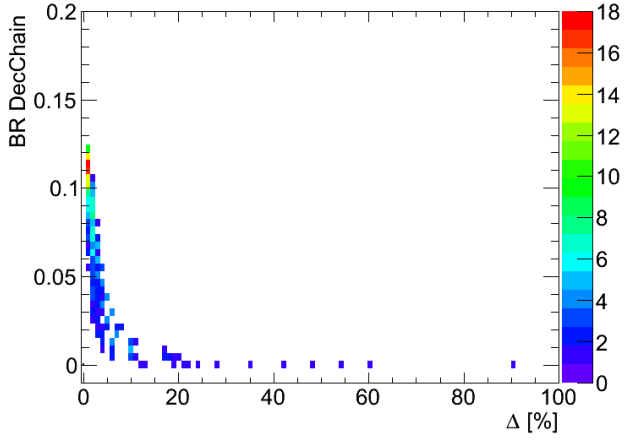
$m_{tb}(b_1, \chi^+_1)$



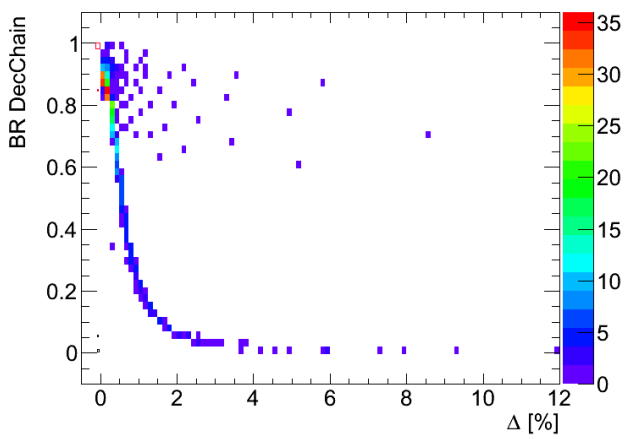
$m_{T2}(q_R, \chi^0_1)$



$m_{ll}(l_R)$



$m_{ll}\ (l_L)$



$m_{\tau\tau}$

What do large differneces arise from?

m_0	$m_{1/2}$	$m^{SP}_{\tilde{\chi}^0_2}$	$m^{SP}_{\tilde{l}_R}$	$m^{SP}_{\tilde{\chi}^0_1}$	$m^{SO}_{\tilde{\chi}^0_2}$	$m^{SO}_{\tilde{l}_R}$	$m^{SO}_{\tilde{\chi}^0_1}$	$\Delta[\%]$			$m^{max,SP}_{ll}$	$m^{max,SO}_{ll}$	Δ [%]
120	660	521.3	278.4	276.7	520.0	278.4	275.7	0.25	0.00	0.36	48.63	61.02	25.47
140	740	587.7	313.0	312.1	586.3	313.4	310.9	0.24	0.13	0.37	37.69	62.46	65.71
160	820	654.2	348.0	347.6	652.5	348.4	346.3	0.26	0.11	0.37	26.55	60.48	127.78
180	880	704.0	376.5	374.3	702.2	377.0	372.9	0.25	0.13	0.37	64.21	87.13	35.69
200	960	770.5	411.5	410.0	768.4	412.1	408.4	0.27	0.15	0.39	55.57	86.71	56.04

- Points with huge relative and absolute differences
- Could we measure them given there is SUSY and given the corresponding mSUGRA point is the correct model for SUSY breaking?

- Performed very basic study:
  - Run ATLAS Monte Carlo Generation for points in question (Herwig+Jimmy, SUSY input from IsaSugra)
  - Count number of produced second lightest neutralinos at generator level
  - Multiply number by product of branching fractions for the decay chain

  - This does not take into account reconstruction/trigger efficiencies, selection efficiencies, acceptance, background, . . .
  - Provided number probably too large – consider them a very rough estimate

Impact on "realistic" Fits?

- As an example: Study points which show a large difference in the di-lepton endpoint m_{ll} (χ^0_2, μ_R, χ^0_1) tan β = 10, A0 = 100
- Look at points which show a larger difference than 10%

M0 [GeV]	M12 [GeV]	Total Crosssection [pb]	Expected number of decay chains in 10fb-1 @ 14 TeV
100	580	0.60	~10
100	600	0.49	~10
120	220	86.94	~500
120	640	0.33	~4
120	660	0.28	~3
120	680	0.23	~2
140	720	0.17	~1
140	740	0.14	~1
160	800	0.09	<1
160	820	0.07	<1
180	860	0.05	<1
180	880	0.05	<1
180	900	0.04	<1
200	940	0.03	<1
200	960	0.03	<1
200	980	0.02	<1

This endpoint in Di-Lepton spectrum probably not measurable at any of these points, except 120,220

Reference: At SPS1a, we would expect ~24.000

No reason to worry?

Case study: tan β = 10, A0 = 100, m0 = 120 GeV, m12 = 220 GeV

Quantity	SPheno	SoftSUSY	Relative Difference
$m_{\tilde{\chi}_2^0}$	152.4	152.1	0.20%
$m_{\tilde{l}_R}$	152.0	152.0	0.00%
$m_{\tilde{\chi}_1^0}$	83.9	83.7	0.24%
m_{ll}^{max}	9.20	4.60	50%

- **Large discrepancy in observable**
  - **Observable probably not measurable with 10fb-1@14 TeV**
  - **If it is:**
    - **Expected experimental uncertainty might in the same order of magnitude as difference in prediction**
    - **Impact on Fit is expected to be marginal (?)**

Summary

- Differences in theory predictions near kinematic borders may become very large
- In most cases large differences correspond to small branching fractions
- Respective observables will most likely not be measured at these points with 10fb-1 at 14 TeV
- However, results shown here are preliminary
- More Crosschecks and detailed studies to be done (?)
  - Branching fractions not yet checked here

- Doesn't answer the question how to deal with differences and mixups of predictions during a fit . . .