## What I have been up to recently …

Michael Krämer (RWTH Aachen)

- ▶ SUSY particle production:
  NLO corrections (`Prospino`) $\oplus$ threshold resummation

- ▶ MSSM Higgs production:
  NLO corrections; scheme dependence

- ▶ Monojet production in ADD models:
  NLO QCD corrections

- ▶ BSM parameter determination

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- SUSY particle production:
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  NLO QCD corrections

- BSM parameter determination
  (with Lindert, O'Leary & Dreiner, Desch, Wienemann)

# BSM parameter determination

Consider standard SUSY cascade
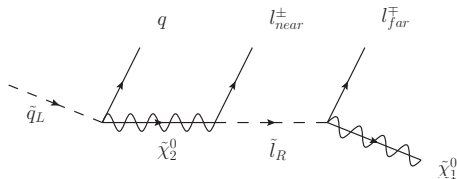


- ▶ measure endpoints of invariant mass distributions
  $m_{ll}$, $m_{qll}$, $m_{ql(\text{high})}$, $m_{ql(\text{low})}$ & solve for masses
  (Hinchliffe et al., Allanach et al., Gjelsten et al., . . . )

- ▶ fit high-scale model, e.g. using `Fittino`, `Sfitter`, `SuperBayeS`,. . .

| Parameter | Nominal Value | Fit value | | Error |
|---|---|---|---|---|
| $M_0$ [GeV] | 100 | 96.74 | $\pm$ | 4.17 |
| $M_{1/2}$ [GeV] | 250 | 248.8 | $\pm$ | 3.5 |
| $\tan\beta$ | 10 | 9.75 | $\pm$ | 4.75 |
| $A_0$ [GeV] | $-100$ | $-106.8$ | $\pm$ | 58.3 |

## BSM parameter determination

Can the analysis of shapes of distributions

- improve the precision of parameter determination;

- resolve ambiguities in mass fits;

- discriminate models (eg. SUSY $\leftrightarrow$ UED)?

# Shapes: improve precision of parameter determination?

Variation about SPS1a within `Fittino` errors: $M_{1/2} = 248.8 \pm 10$ GeV
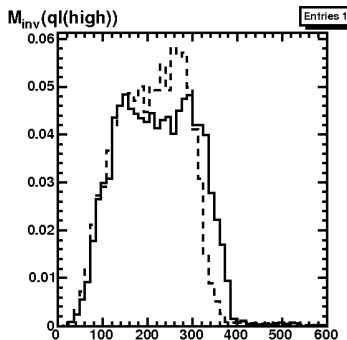


→ differences in shapes are small for SPS1a-type scenarios

→ also true for 18-parameter MSSM fit (`Fittino`)

# Shapes: resolve ambiguities in mass fits?

### Edge inversion may yield ambiguities in masses

SPS1a scenario ($M_0 = 100$ GeV, $M_{1/2} = 250$ GeV)

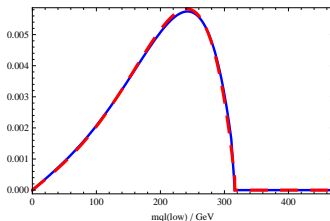| masses / GeV | $m_{\tilde{\chi}_1^0}$ | $m_{\tilde{l}_R}$ | $m_{\tilde{\chi}_2^0}$ | $m_{\tilde{q}_L}$ |
|---|---|---|---|---|
| real | 97.2 | 142.8 | 180.1 | 564.5 |
| mimic | 112.9 | 160.8 | 196.5 | 584.3 |
| edges / GeV | $m_{ll}^{max}$ | $m_{qll}^{max}$ | $m_{ql}^{max}(high)$ | $m_{ql}^{max}(low)$ |
| | 80.4 | 450.4 | 391.9 | 316.2 |

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Shapes (e.g. $m_{ql}^{max}(low)$):



$\rightarrow$ SPS1a and its mimic point cannot be distinguished by shapes

# Shapes: resolve ambiguities in mass fits?

## Edge inversion may yield ambiguities in masses

Alternative scenario ($M_0 = 200$ GeV, $M_{1/2} = 350$ GeV)

| masses / GeV | $m_{\tilde{\chi}_1^0}$ | $m_{\tilde{l}_R}$ | $m_{\tilde{\chi}_2^0}$ | $m_{\tilde{q}_L}$ |
|---|---|---|---|---|
| real | 140.6 | 241.6 | 263.7 | 779.6 |
| mimic | 103.1 | 116.1 | 219.7 | 736.3 |
| edges / GeV | $m_{ll}^{max}$ | $m_{qll}^{max}$ | $m_{ql}^{max}(high)$ | $m_{ql}^{max}(low)$ |
| | 86.0 | 620.7 | 596.6 | 294.3 |

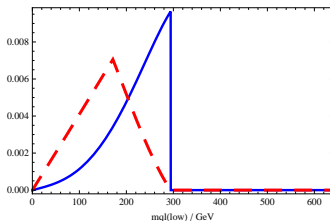# Shapes: resolve ambiguities in mass fits?

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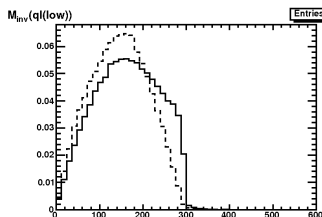


$\rightarrow$ looks more promising, but. . .

# Shapes: resolve ambiguities in mass fits?

## Edge inversion may yield ambiguities in masses

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Shapes (e.g. $m_{ql}^{max}(low)$):



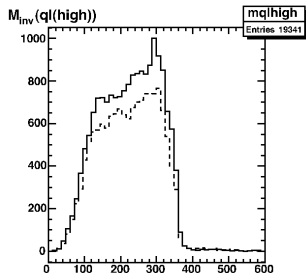$\rightarrow$ ... smeared by SUSY backgrounds (combinatorics)

# Shapes: discriminate models (eg. SUSY ↔ UED)?

Spin measurements from shapes are hard! (Barr; Smillie, Webber; ...)

Compare Herwig++ with and without spin correlations



→ typically effects of $\mathcal{O}(10\%)$ (cf. gluino spin (MK, Popenda, Spira, Zerwas))

→ more spin information in cross section and primary distributions
(cf. Kane et al.; Lykken et al.; ...)

# We don't give up (yet). . .

- ▶ study alternative mass distributions (Matchev et al.):
  shapes may be important, but also problems from combinatorics

- ▶ relax simple mSUGRA assumptions,
  e.g. to allow for splitting in scalar masses

- ▶ study non-standard RGE running

- ▶ extend analysis to other models (UED, little Higgs,. . . )

- ▶ . . .