

Kinematic Fits in the Leptonic Channel

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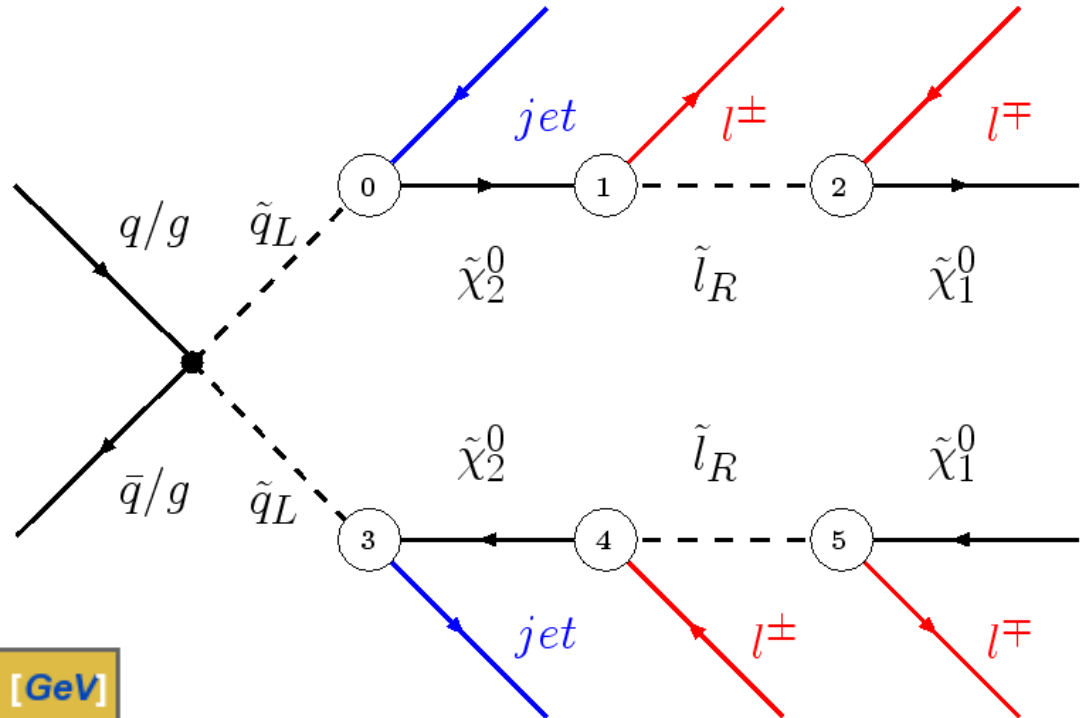
Motivation

- Determine (or at least constrain) masses of SUSY particles
- Method: kinematic fit of certain decay topologies
 - Combine final states to yield intermediate particle masses
- Challenges:
 - Unknown LSP momenta
 - Combinatorial problem
 - Backgrounds from standard model & SUSY
- Leptonic signature vs. Hadronic channel
 - (Strongly) reduced combinatorics
 - Better momentum resolution w.r.t. Jets
 - Easier (standard model) background reduction
 - (Much) smaller branching ratios
 - Nothing for first data

Benchmarkpoint & Cascade

mSUGRA Parameters

	SPS1a
m_0	100 GeV
$m_{1/2}$	250 GeV
A_0	-100 GeV
$\tan(\beta)$	10
μ	>0



Particle	Mass [GeV]	ΔM to next [GeV]
\tilde{g}	606	39 / 44
\tilde{q}_L	567 (ud) / 562 (cs)	387 / 382
$\tilde{\chi}_2^0$	180	37
\tilde{l}_R^\pm	143	46
$\tilde{\chi}_1^0$	97	

Leptonic Cascade

- 2 jets + 2x2 OSSF leptons
- 16/32 possible combinations
- $BR = 1.7 \times 10^{-3}$

X-section: ~ 36 pb @ 14 TeV

Signal Selection

- Using generator info to pick the correct cascade
- Only accept generated events passing cuts after smearing with detector resolution (Toy MC)
- Selection Efficiency: 45%
- Fake Rate (if not using generator selection): 51%

Jets			Leptons		
N	p_T	$ \eta $	N	p_T	$ \eta $
4	>30 <i>GeV</i>	<3.5	2x2OSSF	>10 <i>GeV</i>	<2.5

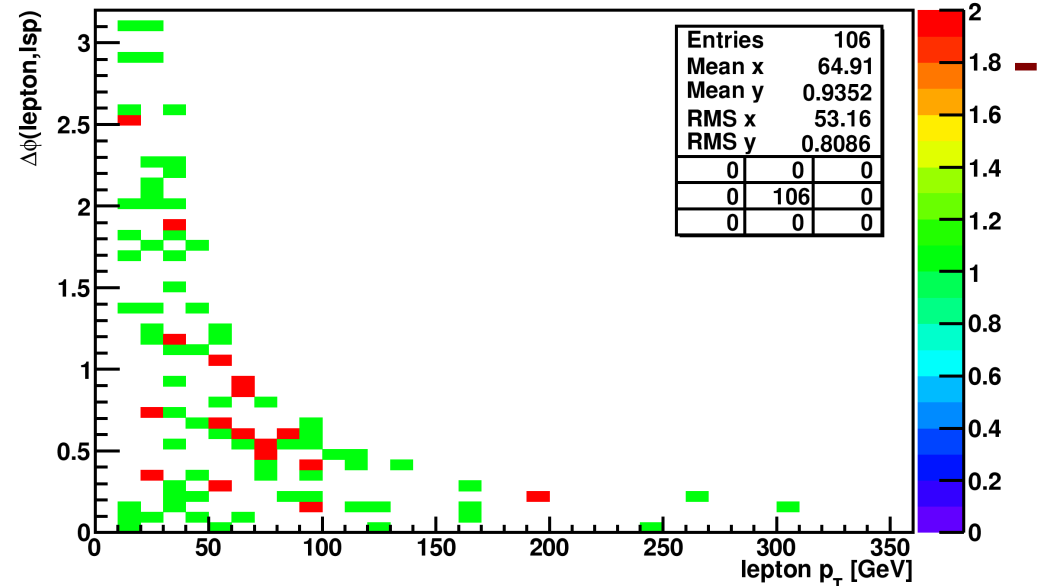
- Using muons and electrons

Settings

- LSP starting values
 - Take direction from 'last' lepton
 - Scale to fulfill slepton mass constraint
 - Only good approximation for higher lepton p_T
- Uncertainties on constraints taken from MC to obtain 'ideal'

Uncertainty/Width	RMS [GeV]	New choice [GeV]
$\Gamma_{\tilde{q}_L}$	17.33	18.
$\Gamma_{\tilde{\chi}_2^0}$	0.45	0.5
$\Gamma_{\tilde{l}_R}$	0.56	0.5
$\Delta p_x / \Delta p_y$	24.73	25.0

lower lepton p_T vs. $d\Phi(\text{lepton}, \text{lsp})$



- KinFit Convergence criteria

Iterations	Max. ΔS	Max. $ F $	Converging Fraction
100	0.1	no. of constr.	94%
100	0.01	no. of constr./10	47%
100	0.01	no. of constr.	82%

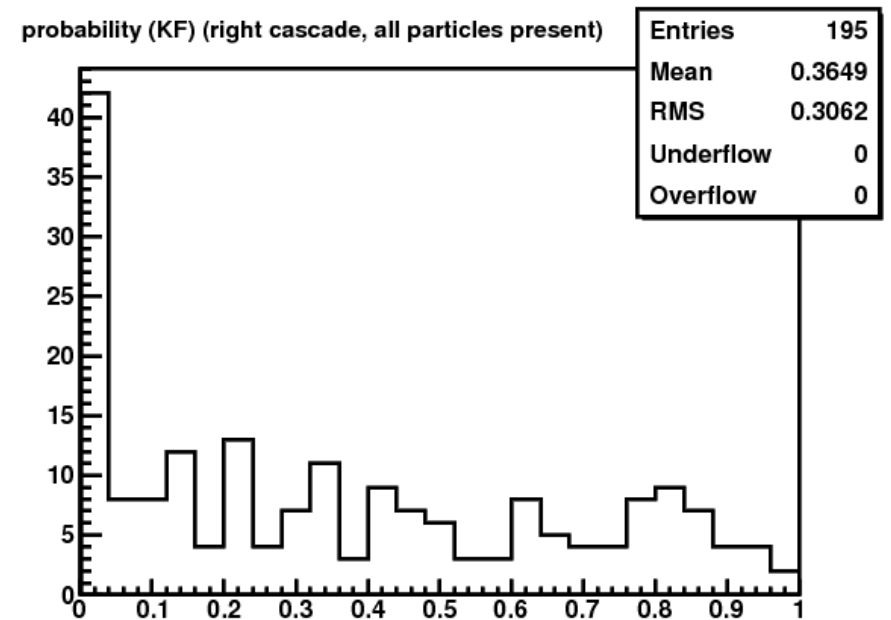
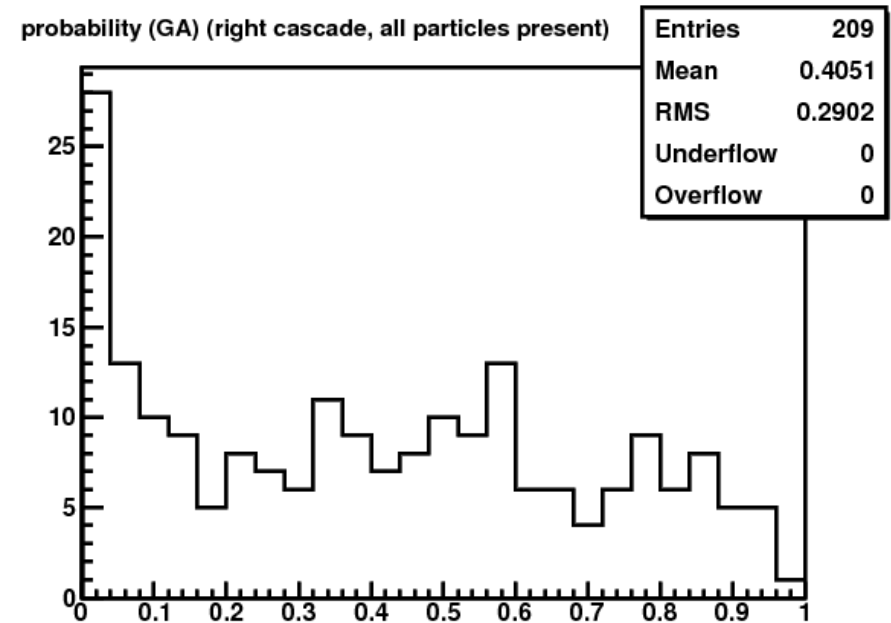
- GA Evolution Parameters (not yet varied)

No. of children	200
No. of survivors	10
No. of generations	500

- Time dependent mutation rate: $0.1 + 0.9 \cdot \exp(-N_{\text{generation}}/30)$

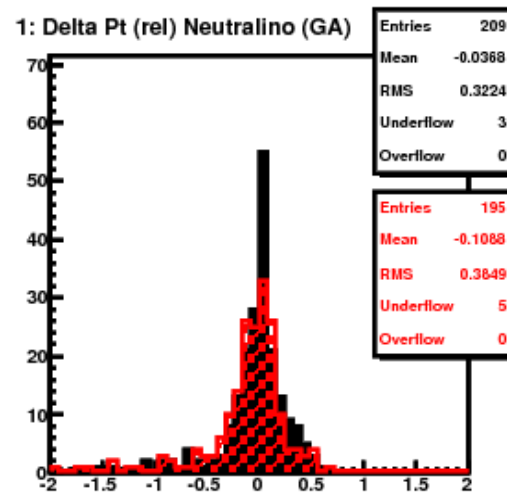
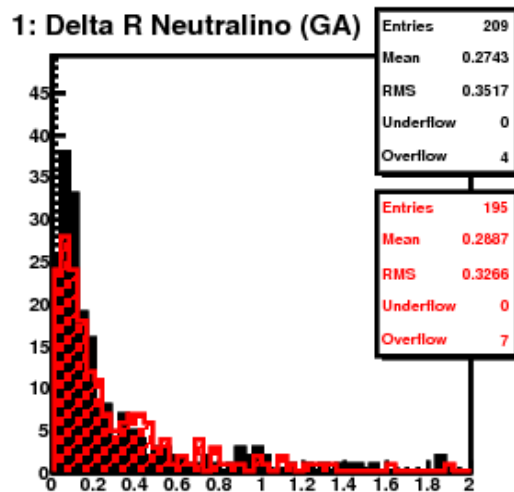
Fit w/o Combinatorics

- Now using larger event sample (209 events)
- New 'convergence' criteria
- GA (longer evolution)
 - 500 generations
 - 1000 children
- KF (tighter conv. Criteria)
 - Max. 500 iterations
 - $|F| < 0.1 * \text{NumConstr.}$

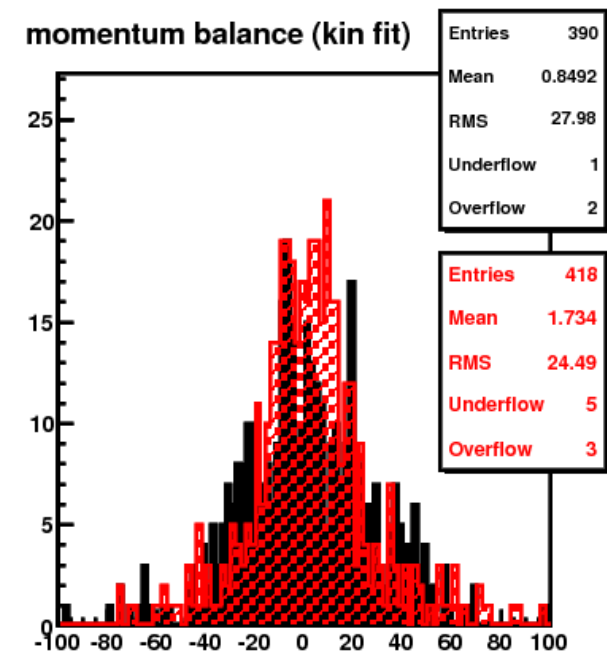
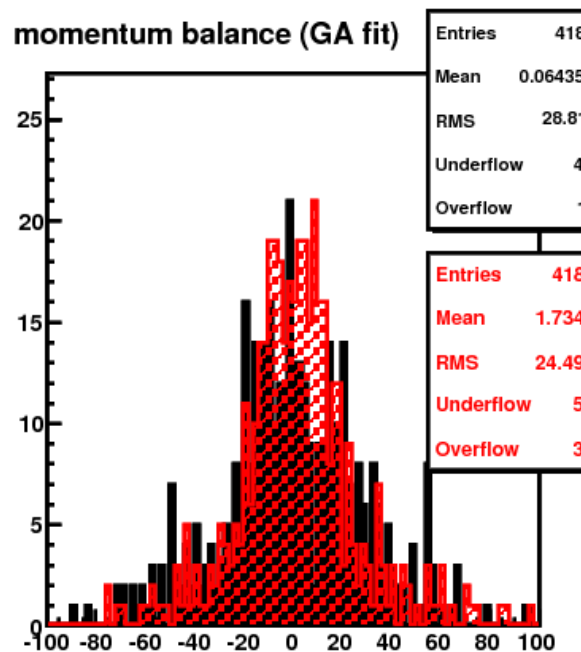


Performance

- Similar resolution for fitted parameters in GA and KF



- Constraints well fulfilled
 - Improvement for KF due to tighter conv. criteria

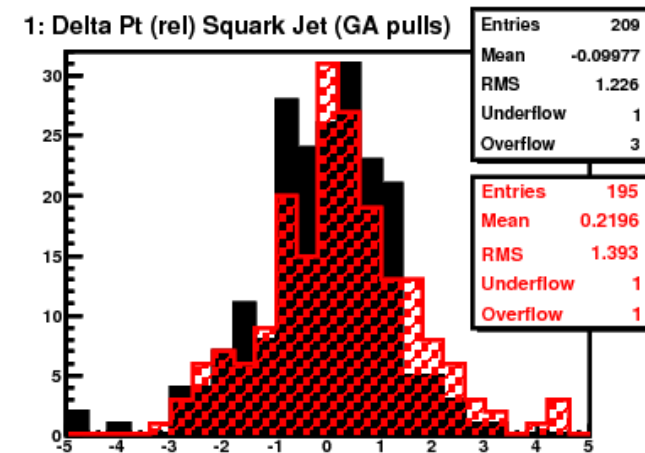
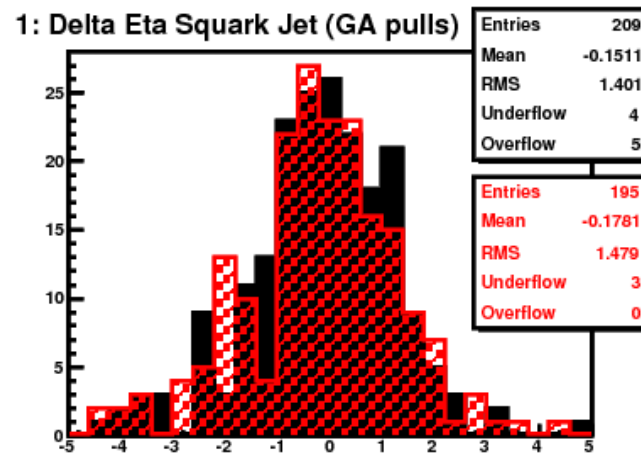
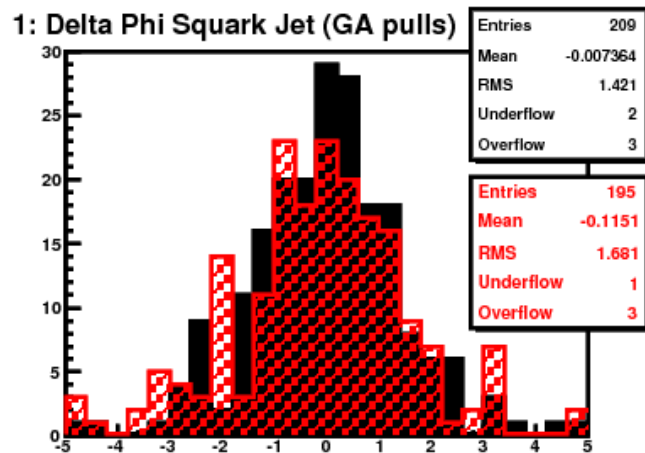


Pulls

- Fixed calculation of pulls:
- Width too large (should be 1)
- Quite long tails
- All uncertainty assumptions correct?
- Chi2 definition correct?

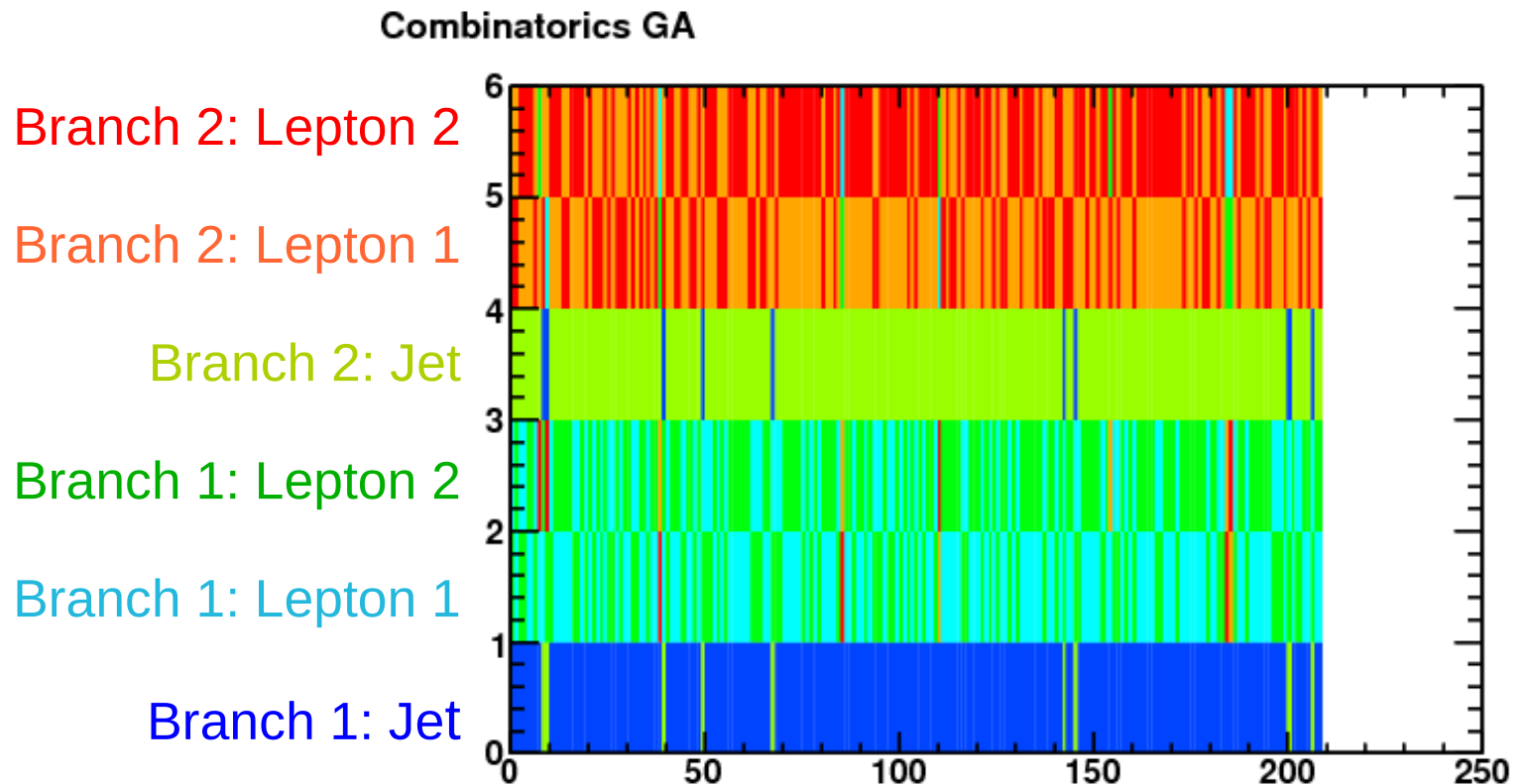
$$p_i = \frac{E_i^{fit} - E_i^{meas}}{\sigma_{\Delta E_i}} = \frac{\Delta E_i}{\sigma_{\Delta E_i}}$$
$$\sigma_{\Delta E_i} = \sqrt{\sigma_{E_i}^2 - \sigma_{E_i^{fit}}^2}$$

- Similar for GA & KF



Fit incl. Combinatorics

- Very good assignment of particles to branches
 - Again similar performance of GA and KF
 - 88/209 events have correct assignment
 - $\sim 7\%$ events with a particle on the wrong branch



Comparison

- Compare Chi2 to fit w/o combinatorics
 - When correct combination was found the chi2 is very close to the chi2 w/o combinatorics (blue dots)
 - When a wrong combination was found the chi2 is in a few cases larger than the chi2 w/o comb. (red crosses above 0) → problem in finding the minimum?

