Kinematic Fits in the Leptonic Channel

Benedikt Mura

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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

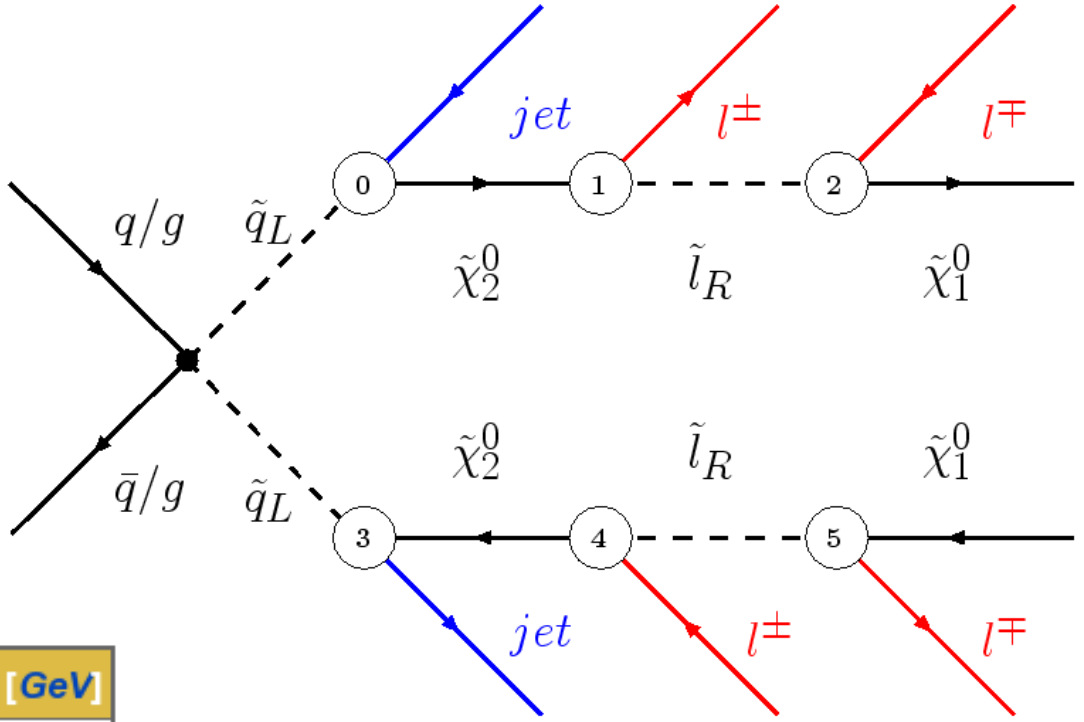
Benchmarkpoint & Cascade

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	

X-section: ~36 pb @ 14 TeV



Leptonic Cascade

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

Signal Selection

- Using generator info to pick the correct cascade
- Only accept generated events passing cuts after smearing with detector resolution (Toy MC)

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

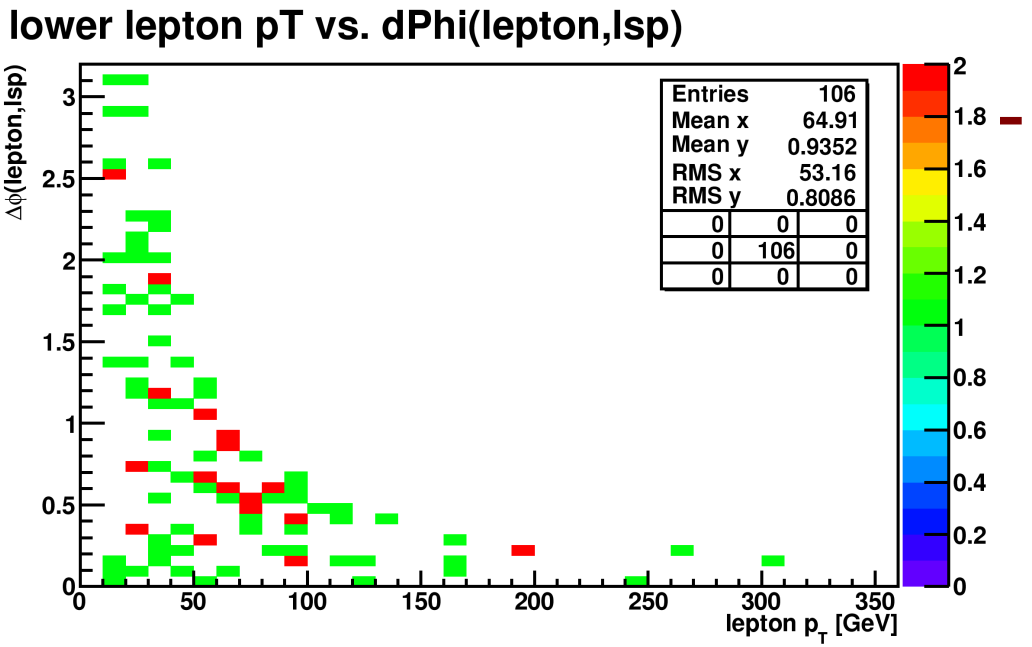
- Using muons and electrons

- Selection Efficiency: 45%
- Fake Rate (if not using generator selection): 51%

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' residuals

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



- KinFit Convergence criteria

Iterations	Max. ΔS	Max. $\lvert F \rvert$	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)

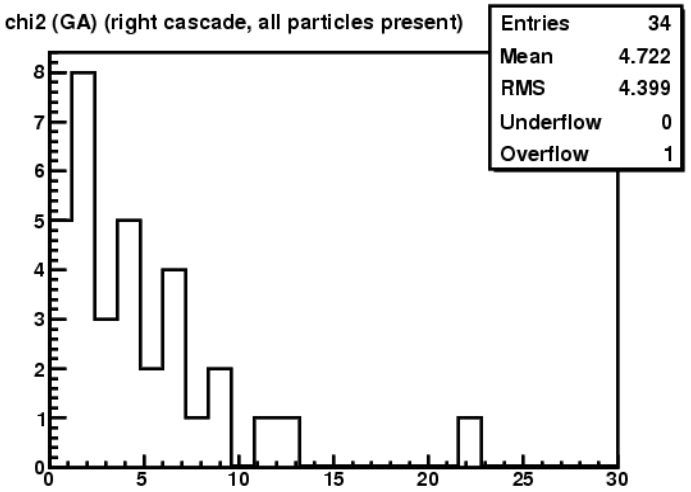
No. of children	200
No. of survivors	10
No. of generations	500

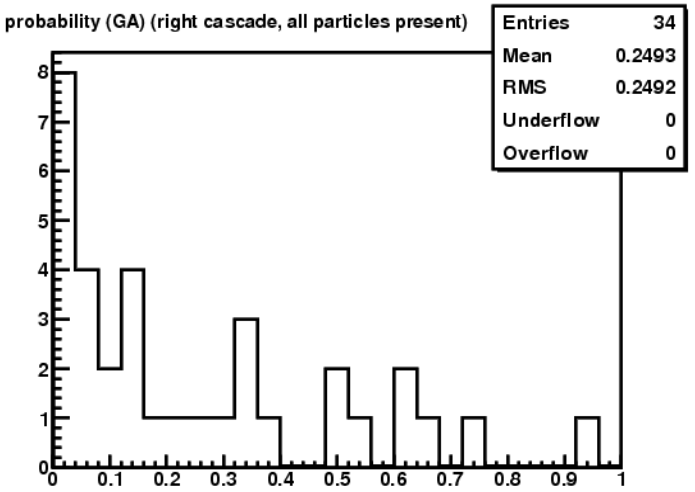
  - Time dependent mutation rate: $0.1+0.9*\exp(-N_{generation}/30)$

Fit w/o Combinatorics

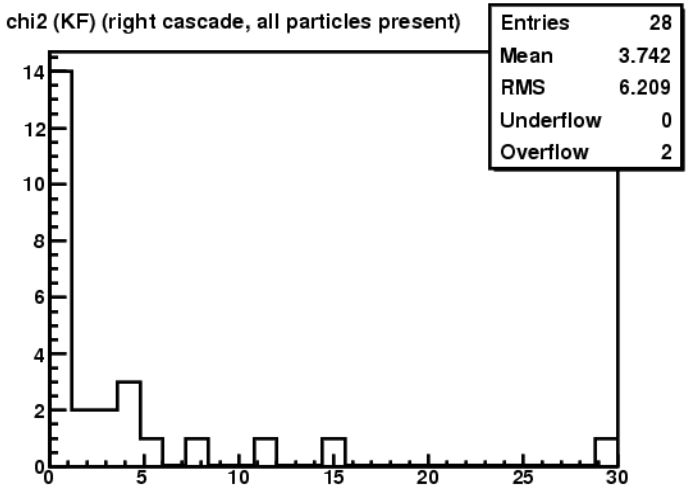
- Check performance with the correct lepton/jet assignment
  - Chi2 & Prob strongly depend on chosen uncertainty, look ok here

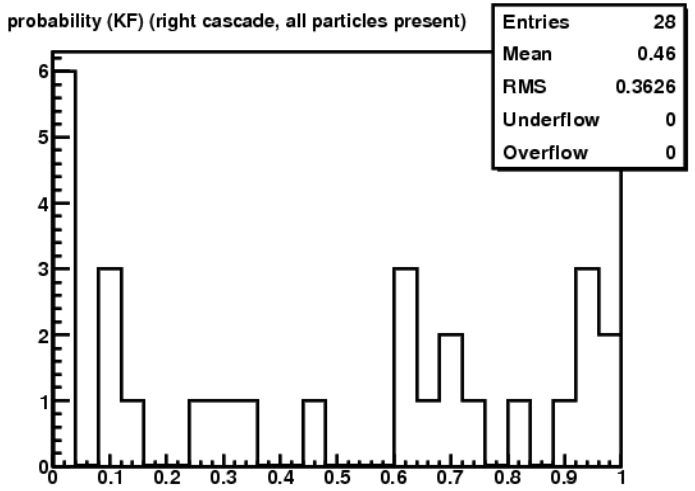
Genetic Algorithm





Kinematic Fit



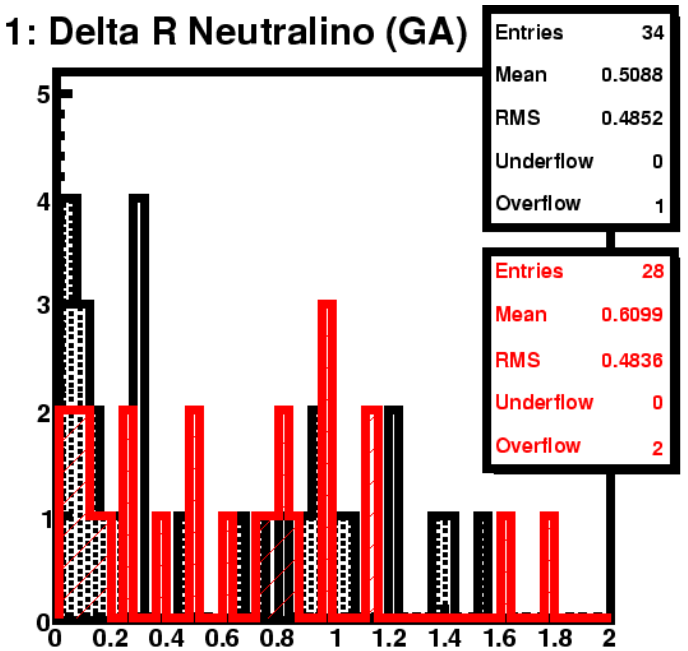


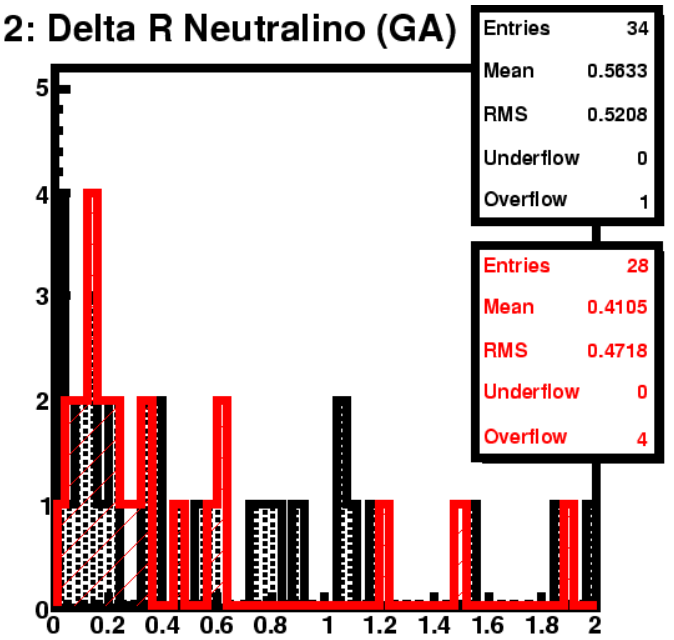
Fit w/o Combinatorics

- Similar performance of GA and KinFit in resolution of final state kinematics
- LSP momentum better reconstructed in GA

Genetic Algortihm

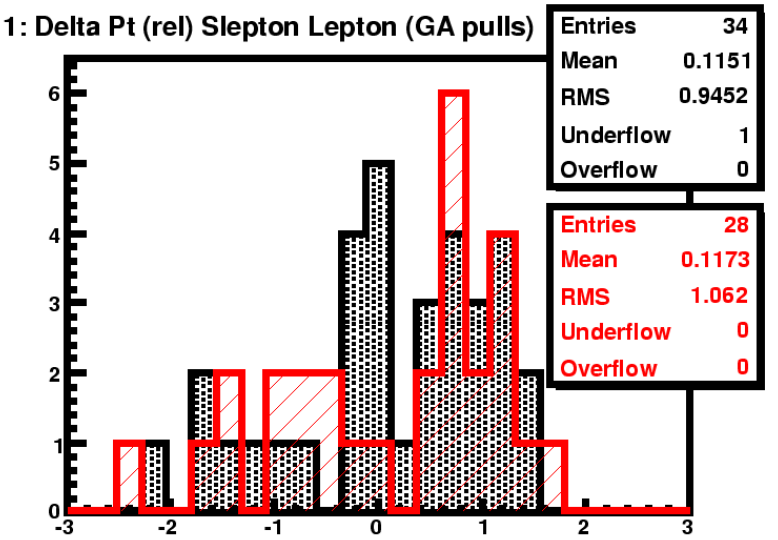
KinFitter





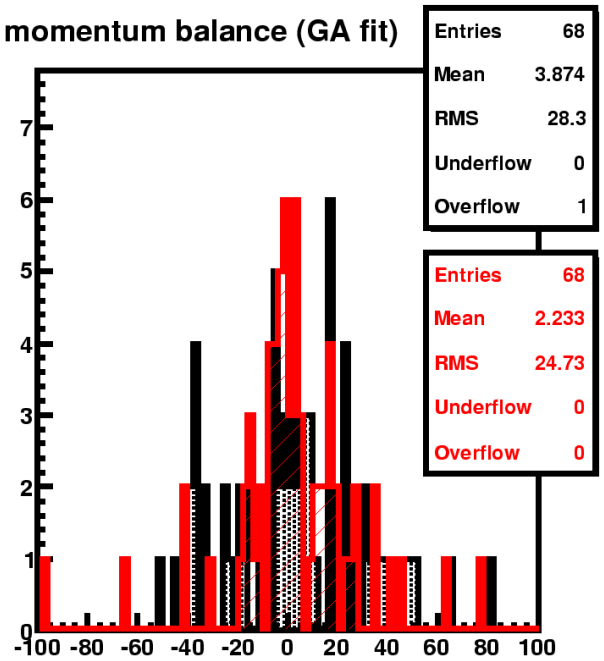
Fit w/o Combinatorics

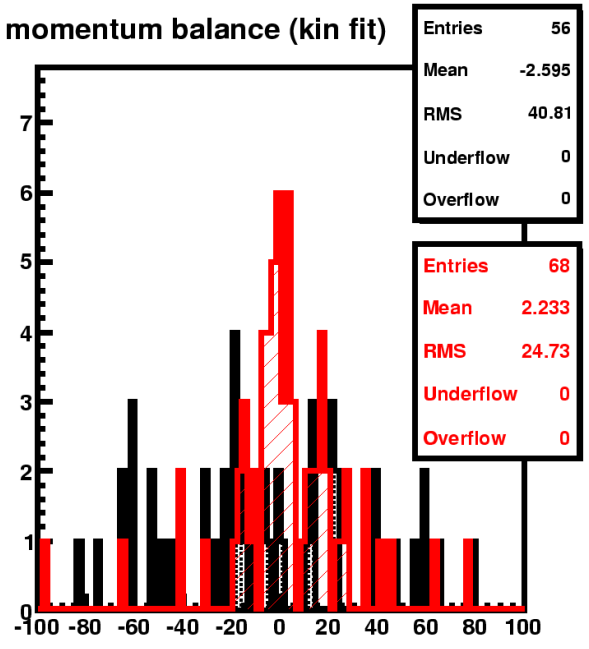
- Constraints in general fulfilled after fit
  - Momentum balance a bit more problematic (related to LSP momentum)
  - Pulls (w.r.t truth) not really gaussian



KinFitter

Genetic Algortihm





KinFitter

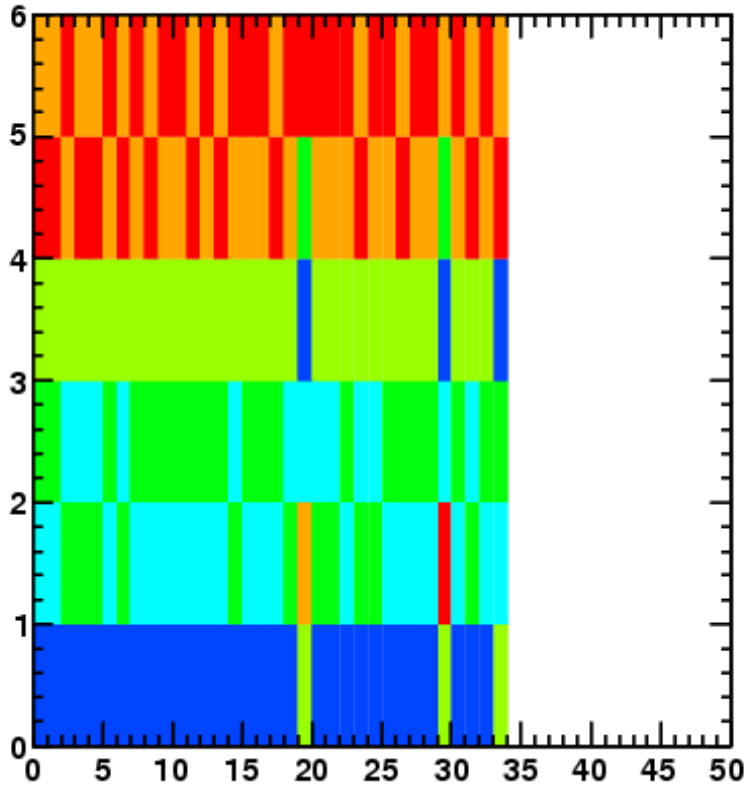
Genetic Algortihm

RMS before fit: 48.39

Fit with Combinatorics

- Still looking at the details
- Combinatorial problem:
  - Almost perfect assignment of jet to lepton pair
  - Leptons often exchanged

Combinatorics GA



Combinatorics KinFitter