Update on Kinematic Fits in the Leptonic Channel

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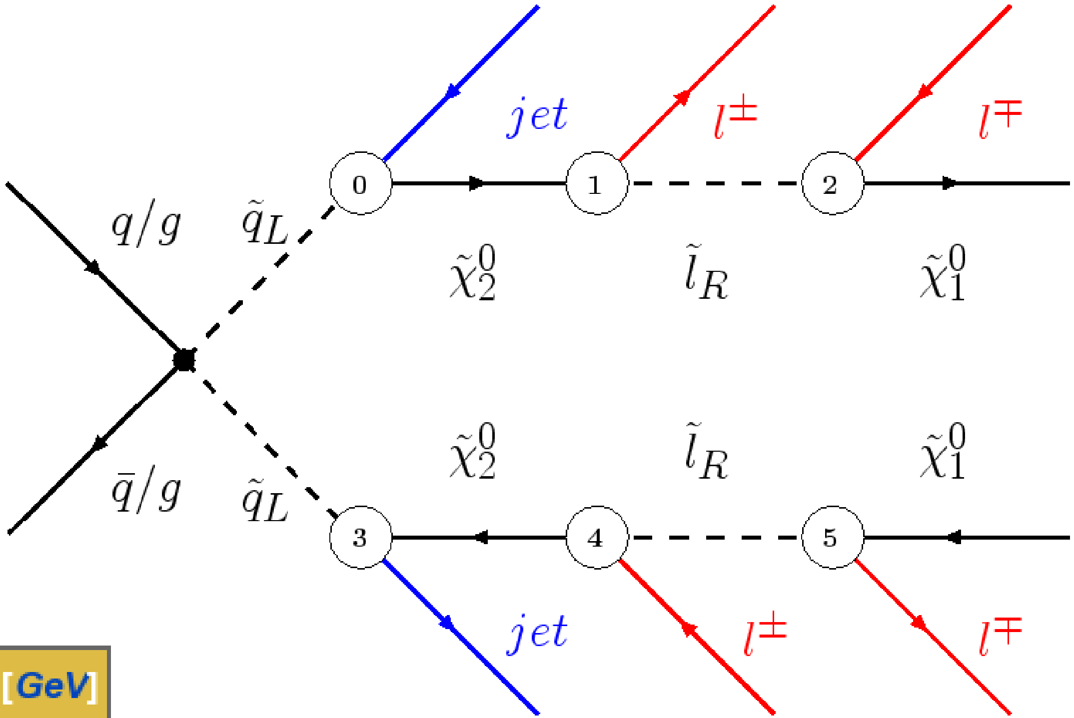
Benchmarkpoint & Cascade

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	

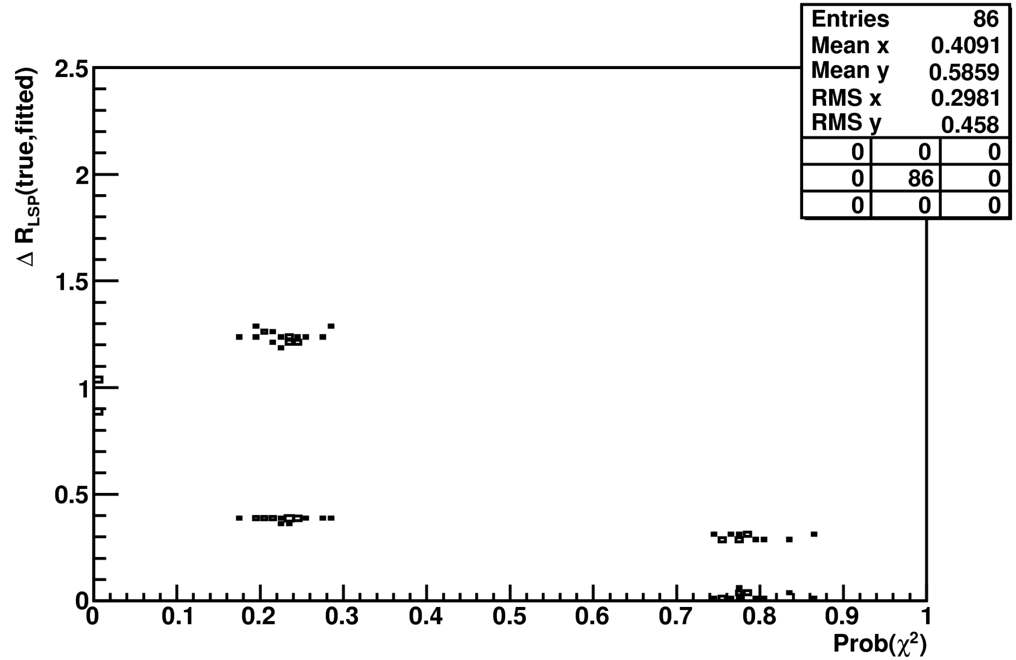
X-section: ~36 pb @ 14 TeV

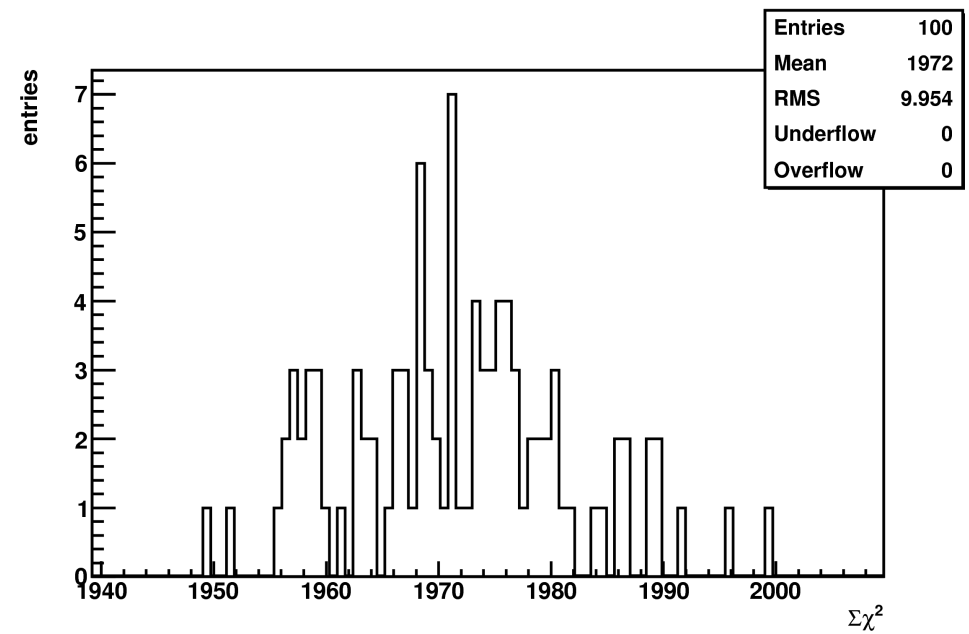
Leptonic Cascade

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

Problem: Stability of the Fit

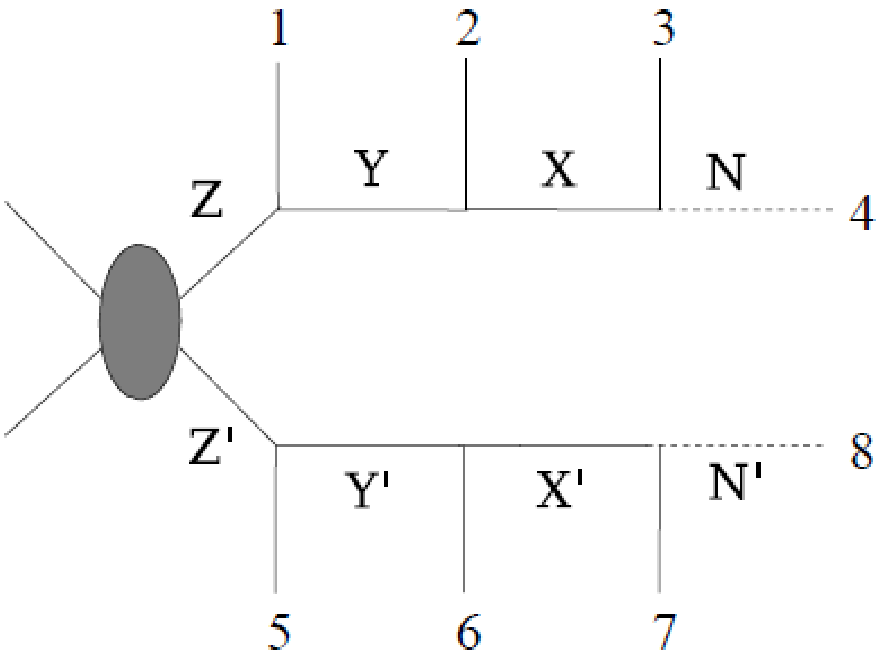
- Some events in which
  - Fit finds several minima, depending on initial values for unmeasured momenta
  - Convergence criteria not ideal -> spread in Prob(χ^2) when repeating with other starting values
- Significant fluctuations in the final likelihood
- So far: random start values
- More intelligent choice
  - Less work for the fit
  - Better convergence





Analytical solution

- Calculate LSP momenta analytically from event hypothesis
  - exploiting the mass hypothesis and all but the LSP-mass constraint
- Get linear system of equation by substitution of p^2-terms by mass values/hypotheses



$$\begin{aligned}(p_1+p_2+p_3+p_4)^2 &= M_Z^2\\ (p_2+p_3+p_4)^2 &= M_Y^2\\ (p_3+p_4)^2 &= M_X^2\\ p_4^2 &= M_N^2\end{aligned}$$

Do not use this constraint

$$\begin{aligned}-2p_1\cdot p_4 &= M_Y^2-M_Z^2+2p_1\cdot p_2+2p_1\cdot p_3+m_1^2\equiv S_1\\ -2p_2\cdot p_4 &= M_X^2-M_Y^2+2p_2\cdot p_3+m_2^2\equiv S_2\\ -2p_3\cdot p_4 &= M_N^2-M_X^2+m_3^2\equiv S_3\end{aligned}$$

Analytical Solution

- 3 more equations from 2nd branch

$$-2p_5 \cdot p_8 = M_{Y'}^2 - M_{Z'}^2 + 2p_5 \cdot p_6 + 2p_5 \cdot p_7 + m_5^2 \equiv S_5$$
$$-2p_6 \cdot p_8 = M_{X'}^2 - M_{Y'}^2 + 2p_6 \cdot p_7 + m_6^2 \equiv S_6$$
$$-2p_7 \cdot p_8 = M_{N'}^2 - M_{X'}^2 + m_7^2 \equiv S_7$$

- 2 from the momentum balance

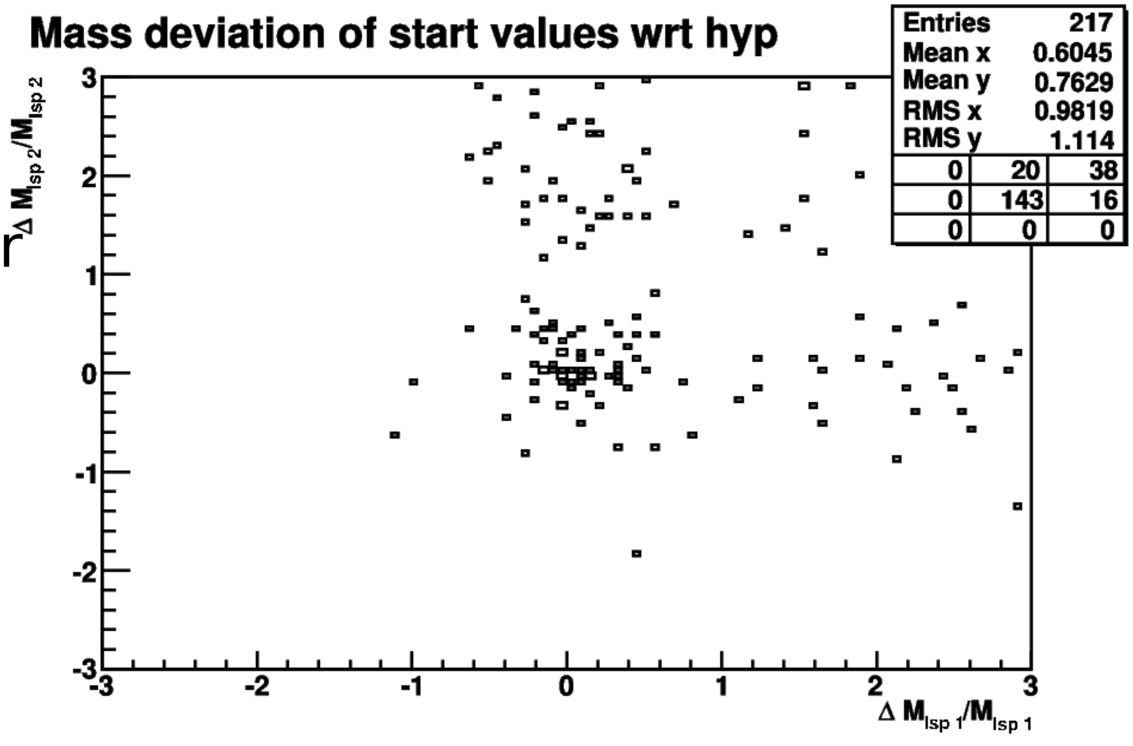
$$p_4^x + p_8^x = p_{\text{miss}}^x \equiv S_4$$
$$p_4^y + p_8^y = p_{\text{miss}}^y \equiv S_8$$

- In total: 8 linear equations for 8 fourvector components

$$\mathbf{P} = (p_4^x, p_4^y, p_4^z, E_4, p_8^x, p_8^y, p_8^z, E_8)$$

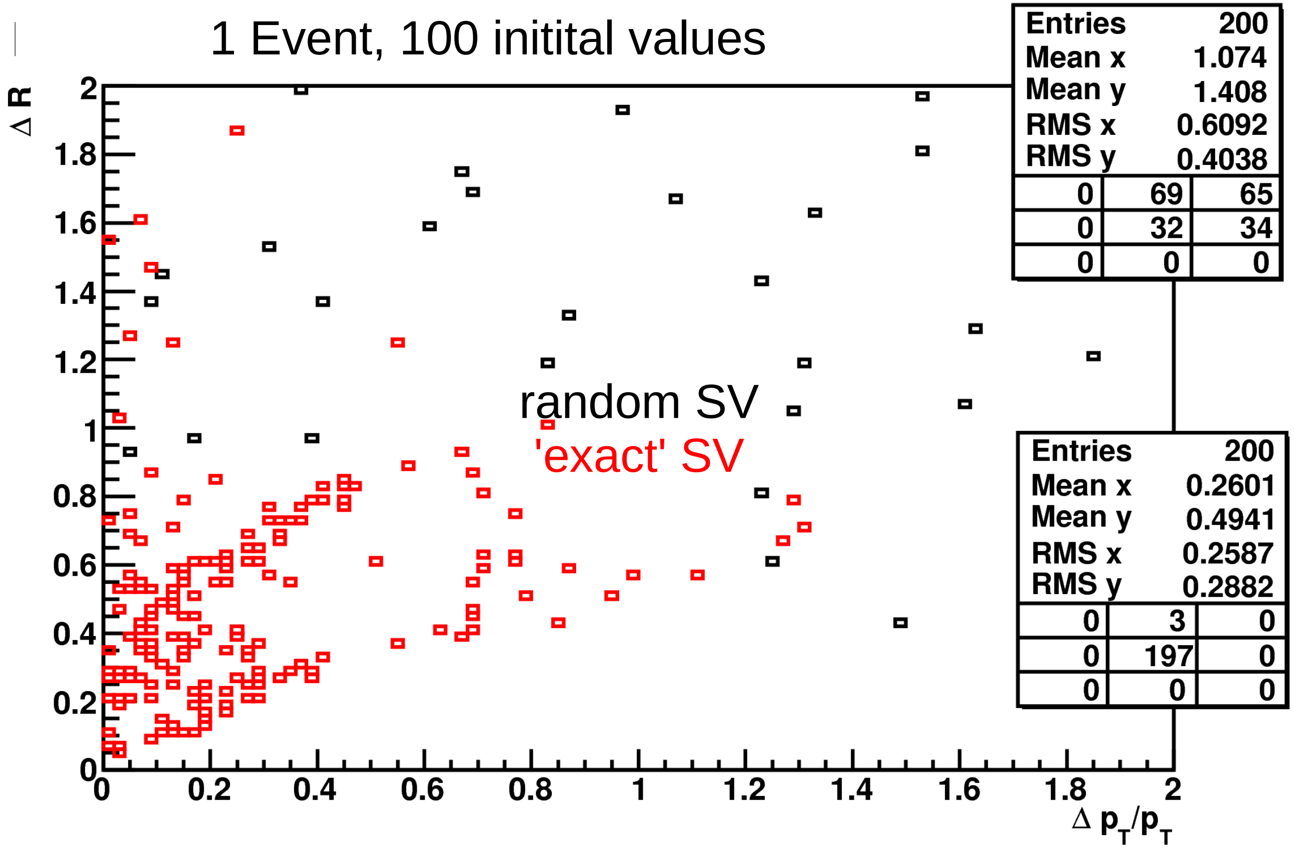
- Solution via matrix inversion

- Note: Constraints only fulfilled if $m^2=p^2$ is true for all particles
- Deviation due to measurement uncertainties and imperfect p_T-balance



Comparison: LSP Position

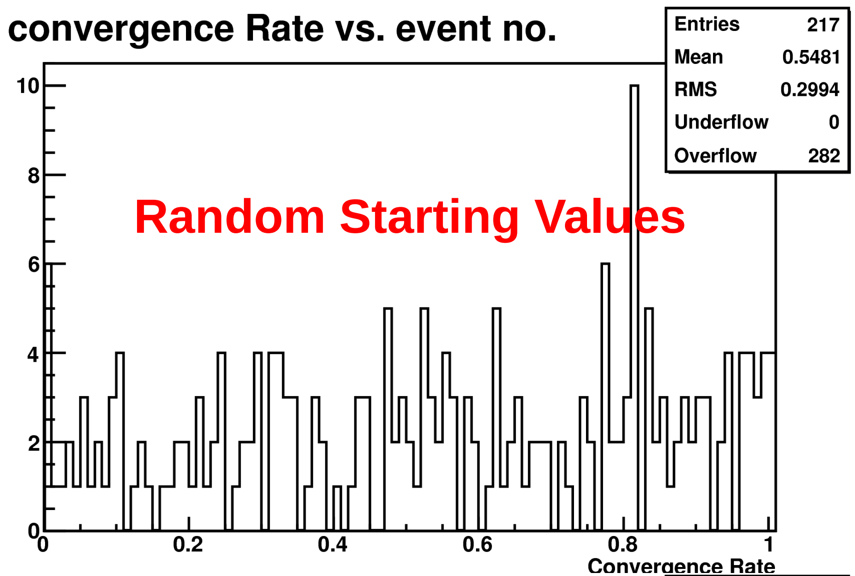
- Smear jets with their resolution to get a variation in the starting values
- Check 'distance' to true LSP momenta
- Much better agreement of calculated values with true LSP momenta

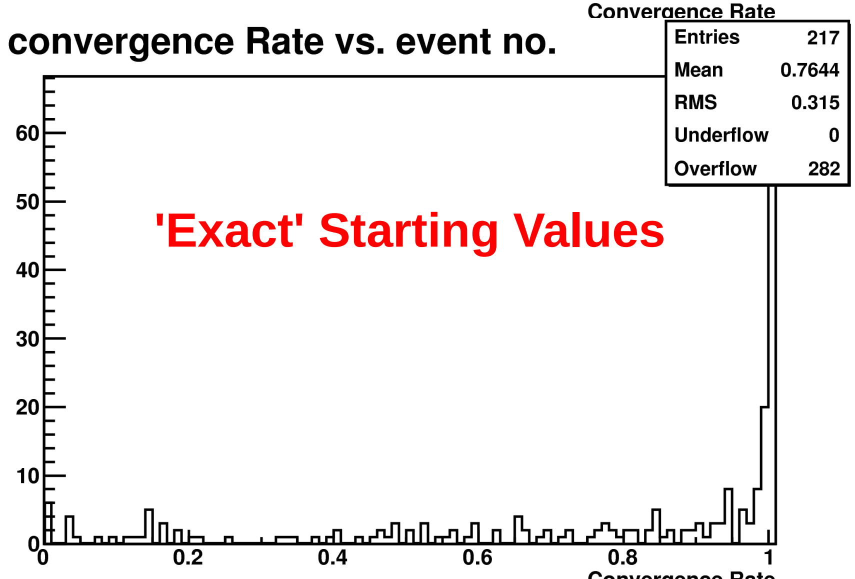


Comparison: Convergence

- Convergence rate in 100 fits

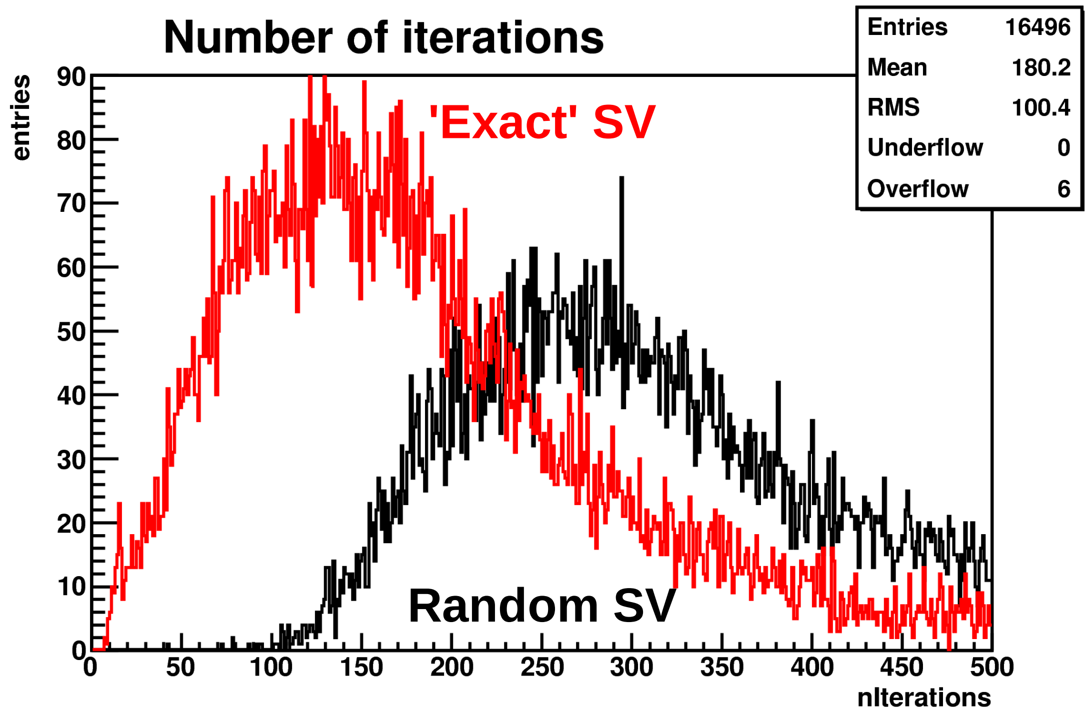
(Signal, no combonatorics)





- Number of iterations

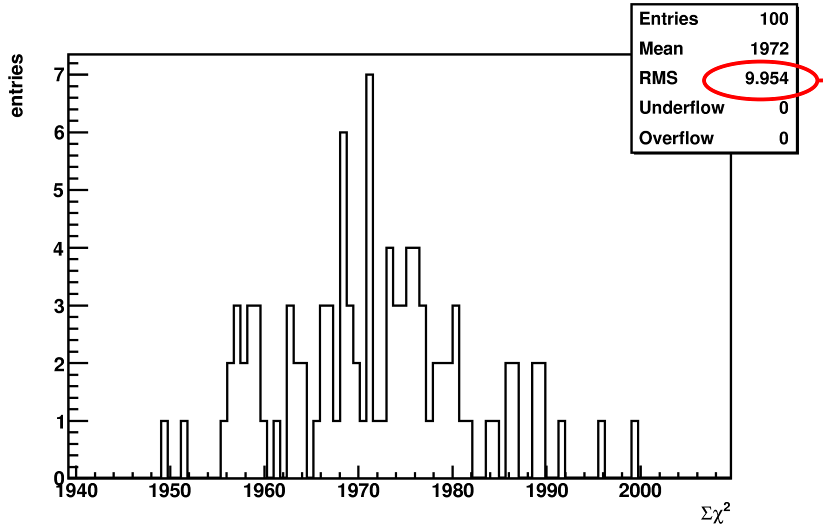
(Signal, no combonatorics)

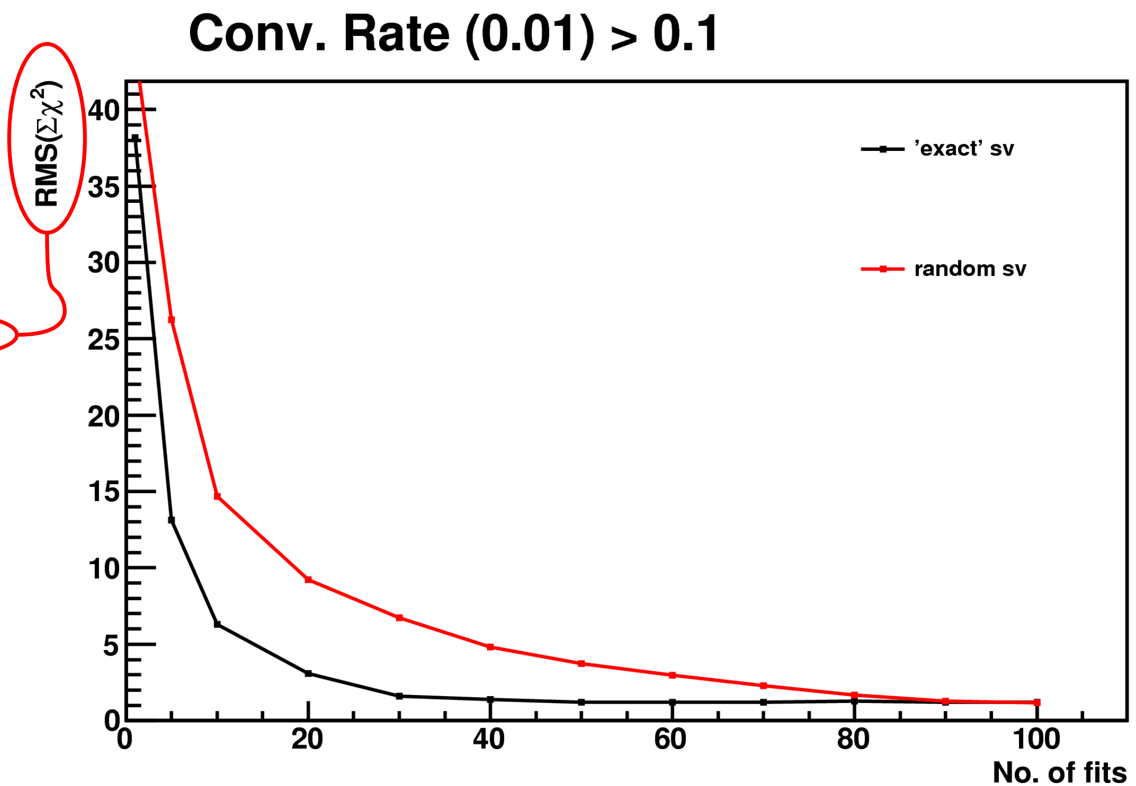


Repeating the fit

- How many fits are necessary to get a stable result?
- Vary number of repetitions per event & combination
- Calculate likelihood in each of the 100 runs

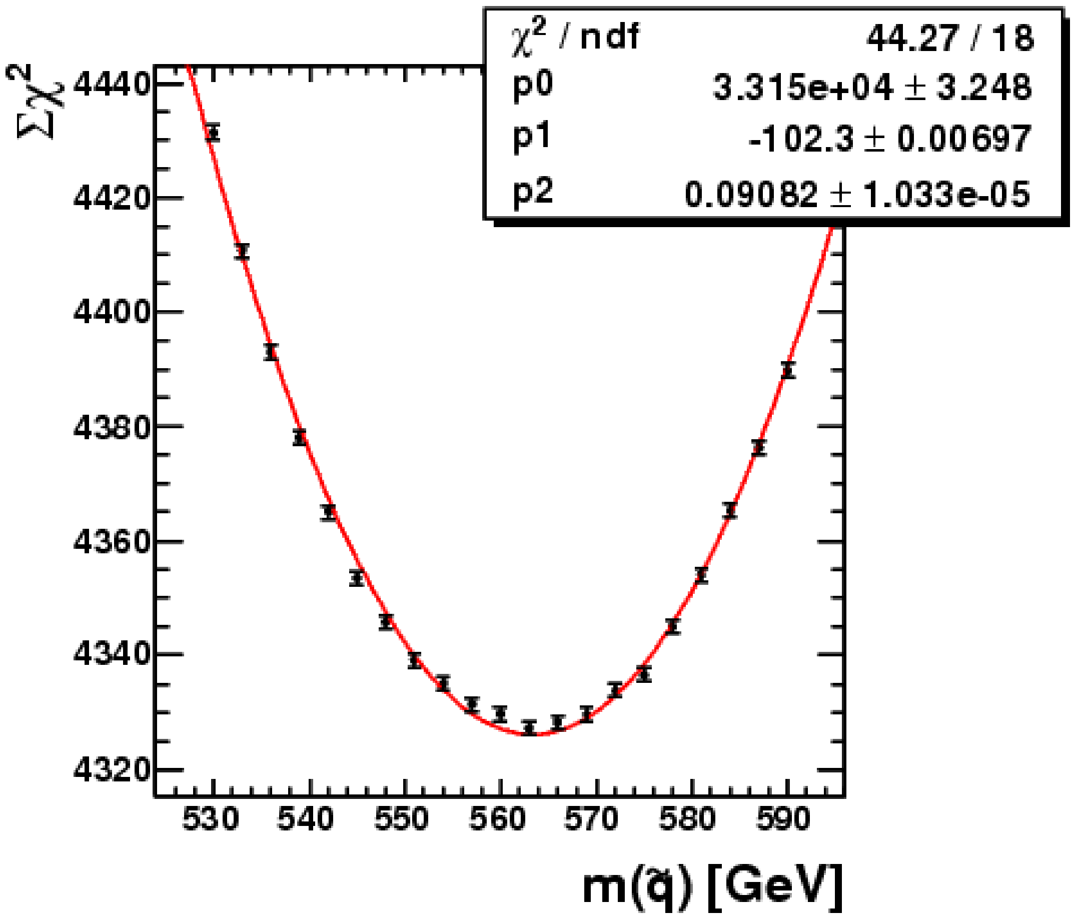
- Cut on event's convergence rate CR > 0.1
- Additional Cut: Prob(χ^2)>0.01





Scan with new Setting

- Use 'exact' LSP solution
  - fit 50 different initial values for each combination and event



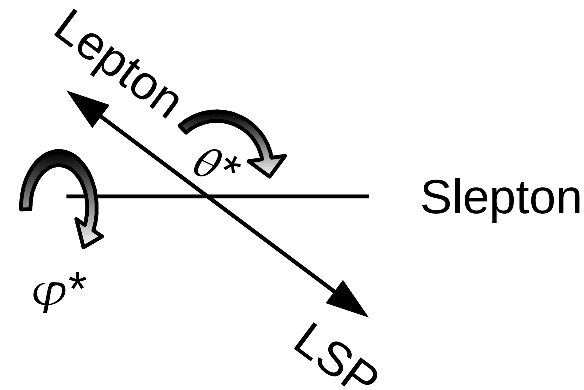
- Select events with CR>0.1 at best hypothesis
- CPU consumption reduced to 90 – 100 min. per hypothesis
- Started scan in all 4 masses
- Next: Test new solution for starting values which fulfill all mass constraints

Choice in Slepton Rest-frame

- Kinematics are known
- Only two variables (angles w.r.t flight direction of decaying particle in lab)
  - cos θ* und φ*
  - Energy given by masses

$$|\vec{p}_l^*| = \frac{M_{\tilde{q}}^2 - M_{LSP}^2 + M_l^2}{2 \cdot M_{\tilde{q}}}$$

- If decaying particle has spin 0 or is unpolarized: expect flat distributions



Idea:

- Dice values in this frame
  - transform to lab-frame
    - using momentum from lepton measurement
    - not without ambiguities (no details here)
- Transformed LSP momentum fulfills this mass constraint