Update on Kinematic Fits

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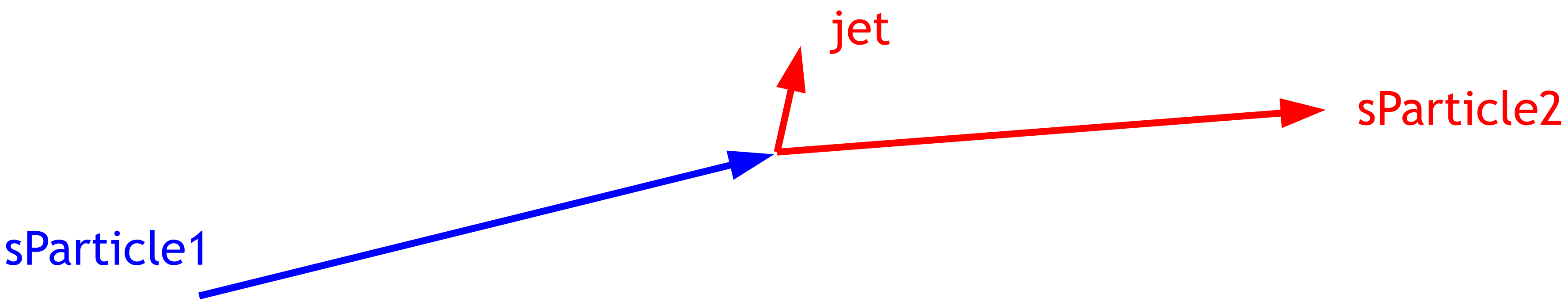
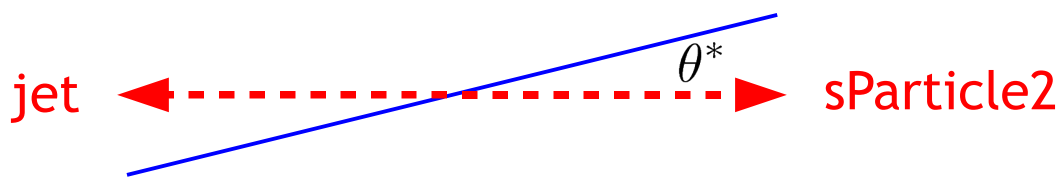
Susy Group Meeting – Hamburg – 30th June 09

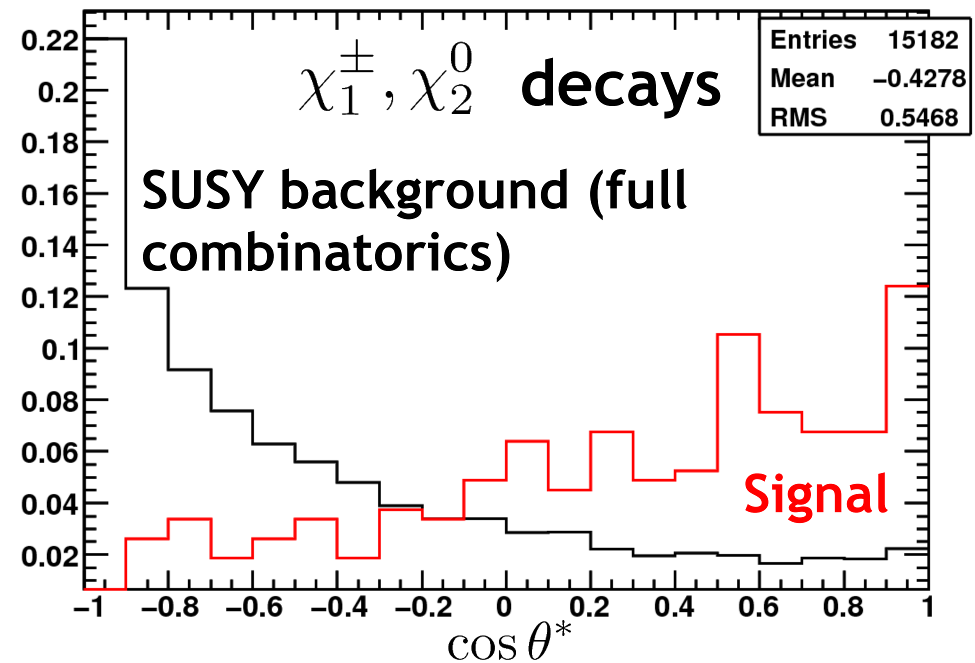
Angular Distributions

- Huge combinatorial background → Large invariant mass combinations, e.g.



- In rest frame of SUSY particles: angular distribution $\cos\theta^*$ of decay products with respect to flight direction of decaying particle should be ~isotropic (for spin 0)
- $\cos\theta^*$ for typical background 4-vector configurations are not uniformly distributed (smaller angles preferred)





Many decay angles in SUSY cascades

→ **Use event kinematics to reduce combinatorial bg reduction**

Take Likelihood functions for signal (background) from generator information (fit results)

Likelihood ratio: $\mathcal{L} = \frac{L_{\text{signal}}}{L_{\text{signal}} + L_{\text{bg}}}$

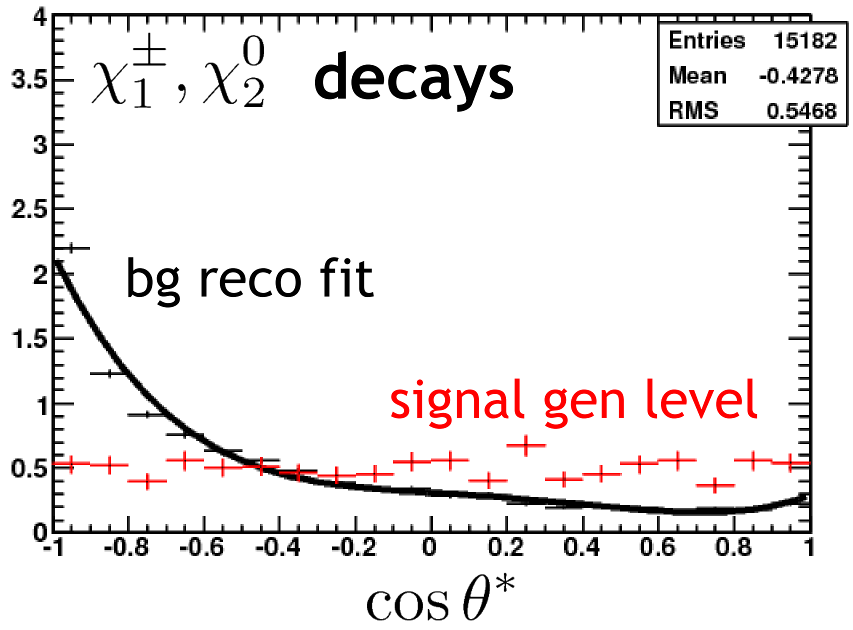
Relation between χ^2 and likelihood

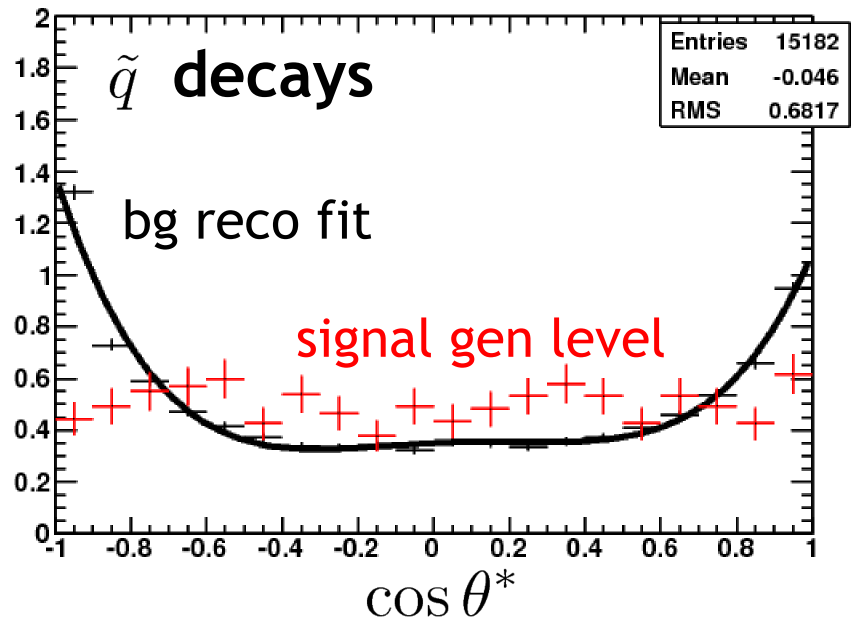
$$\mathcal{L} = \exp\left(\frac{-\chi^2}{2}\right)$$

$$\rightarrow \chi^2 = -2 \cdot \log \mathcal{L}$$

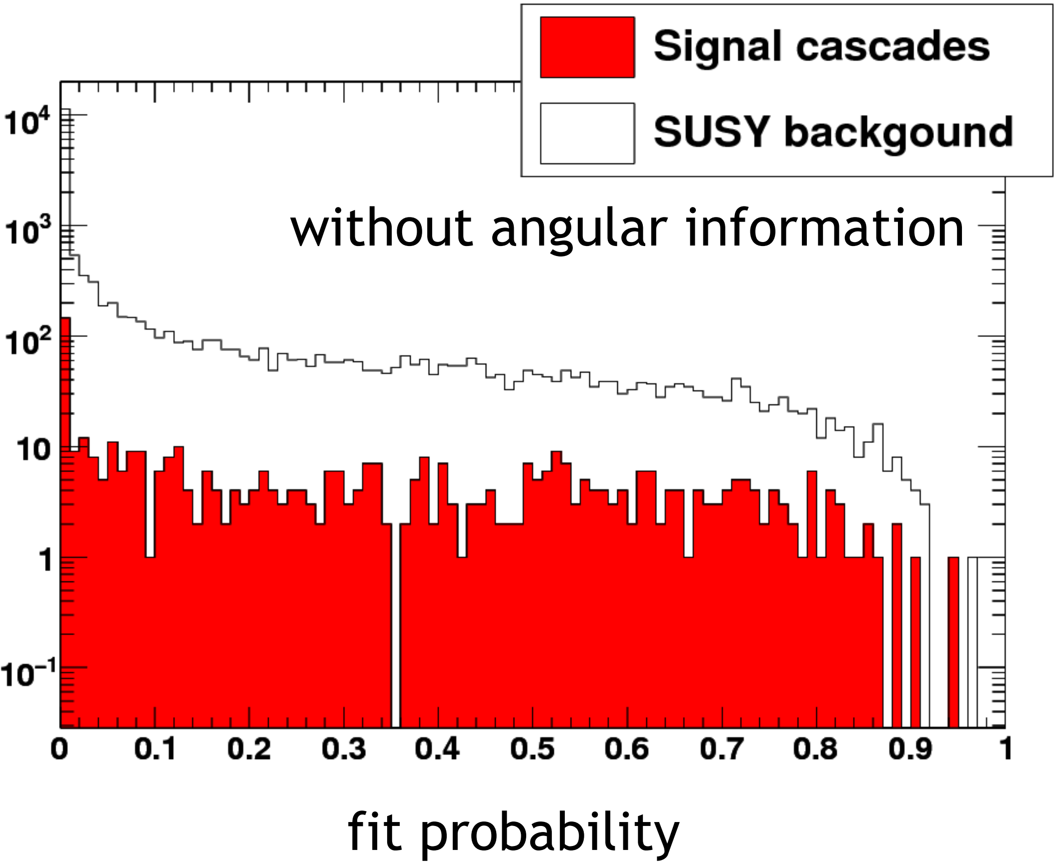
Two squark and two chargino/neutralino decays yield four new contributions to fitness function

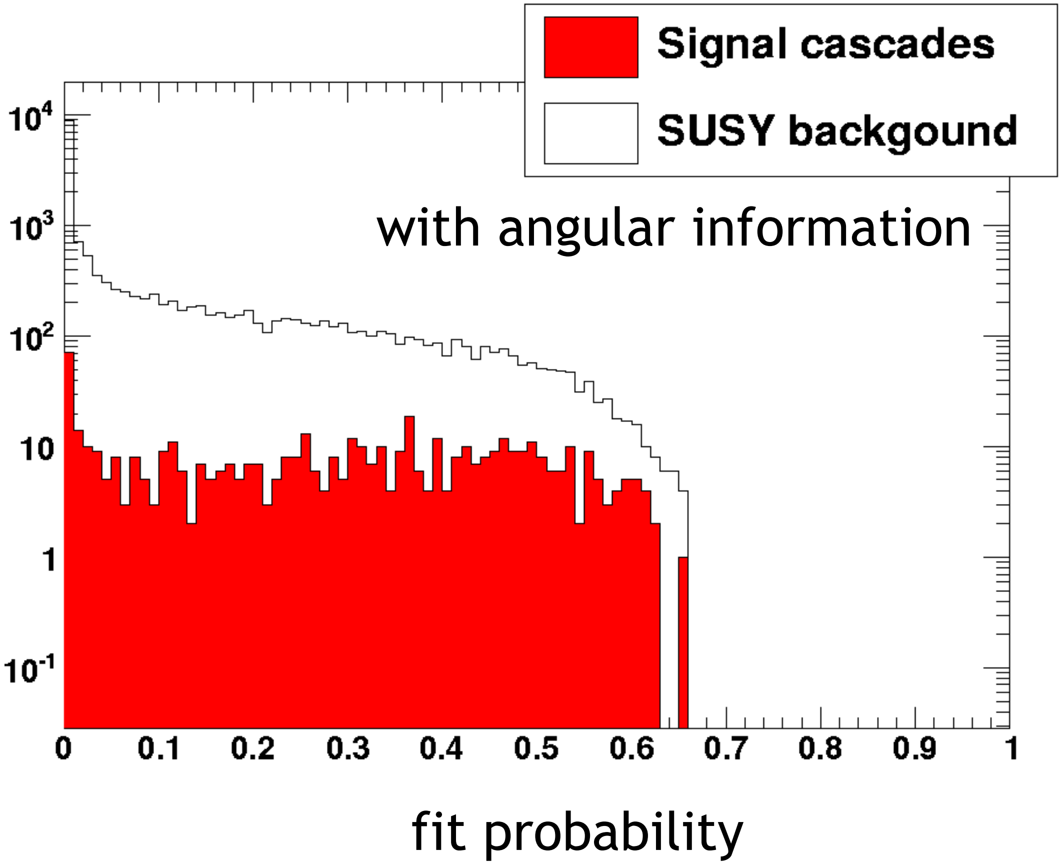
Potential problem: signal is ~ uniformly distributed, but now particular regions are preferred → some signal events more converge with wrong combination





- As expected, usage of angular variables changes probability distribution of signal and background in different ways
- Additional χ^2 term correspond **NOT** to normal distributed measurement → **deviation from flat distribution**
- **Way out:** use angular information after the fit (e.g. event weighting ...)



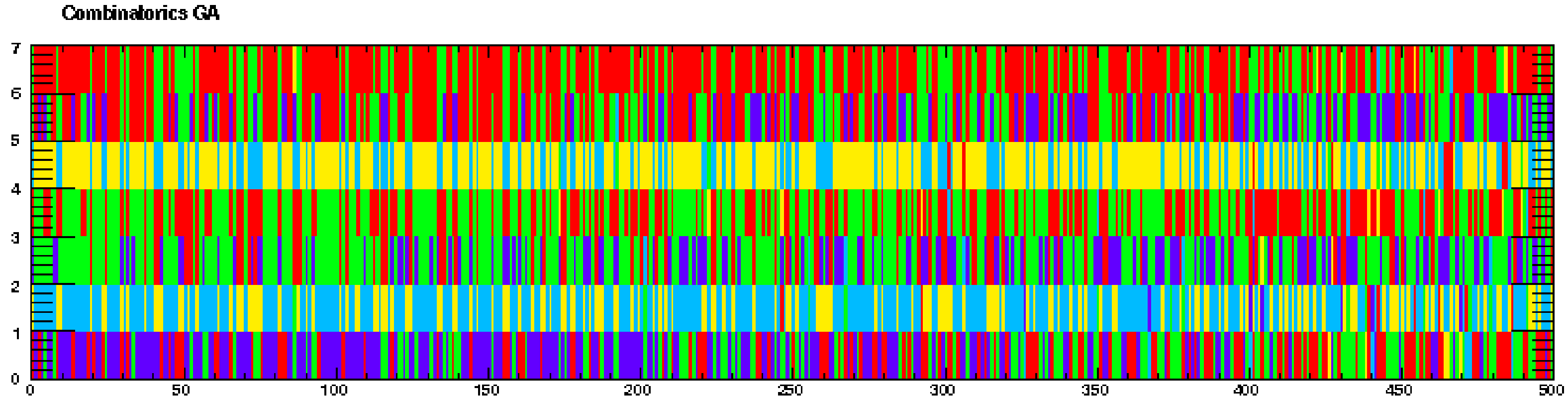


Validation of Genetic Algorithm

- **Questions:**
  - *Why does a wrong combination provide a better fit than the true combination?*
  - *What is going wrong with the true combination?*
- So far it was shown that the converged solution provides a reasonable probability distribution and the constraints are fulfilled
- Now we want to check if the fit converges at the **global** and not a **local** minimum
  - **Cha llenge:** How do we know which is the global minimum?
  - **But what we can do:** Compare the GA results including full combinatorics with GA results using the true jet combination!

Validation of GA - Old implementation

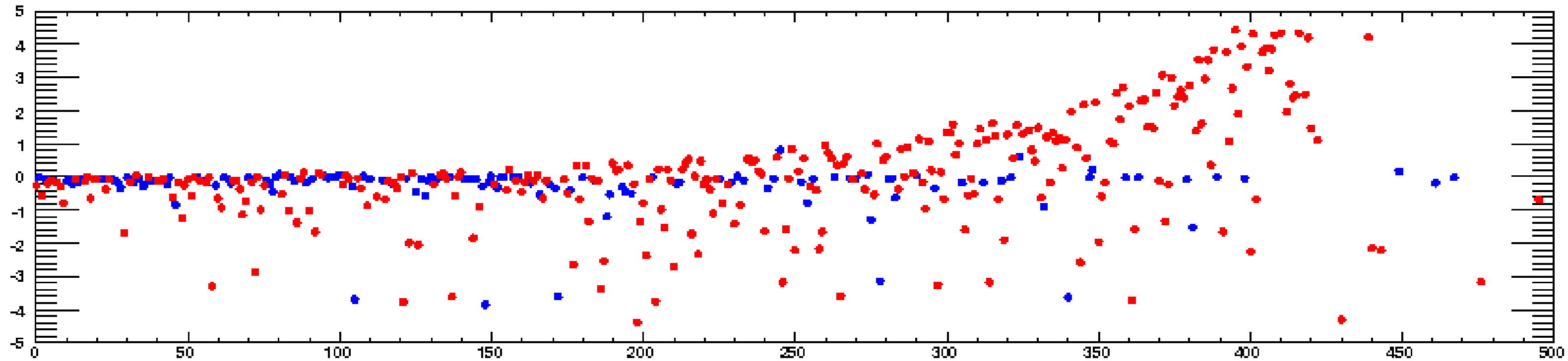
Old implementation:
N_{best} individuals survive independent on jet combination



$$\Delta\chi^2 = \chi^2_{\text{fit including combinatorics}} - \chi^2_{\text{fit with true jet combination}}$$

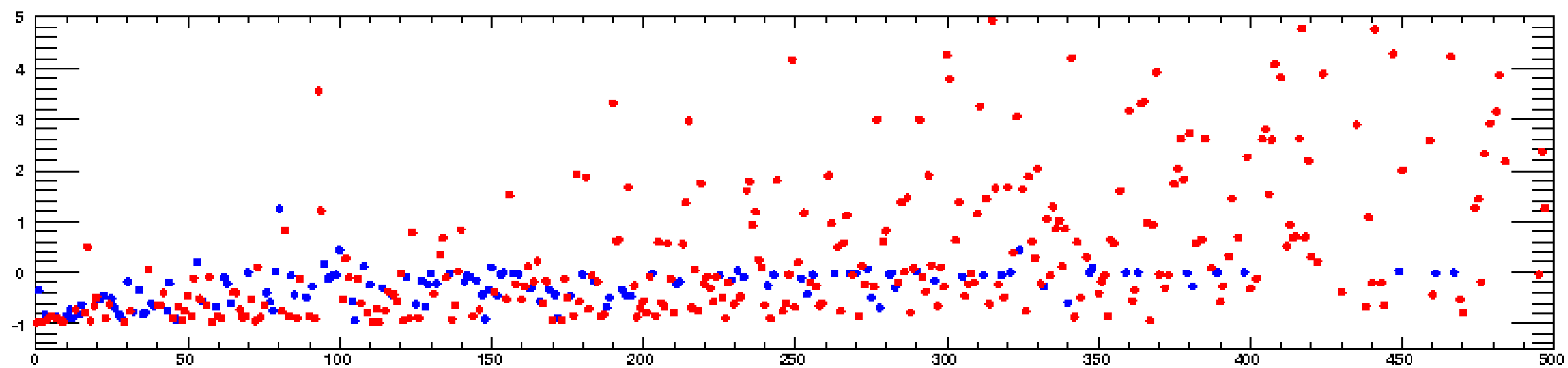
- **best == right** (blue)
- **best != right** (red)

Best is right for 128 of 500 events



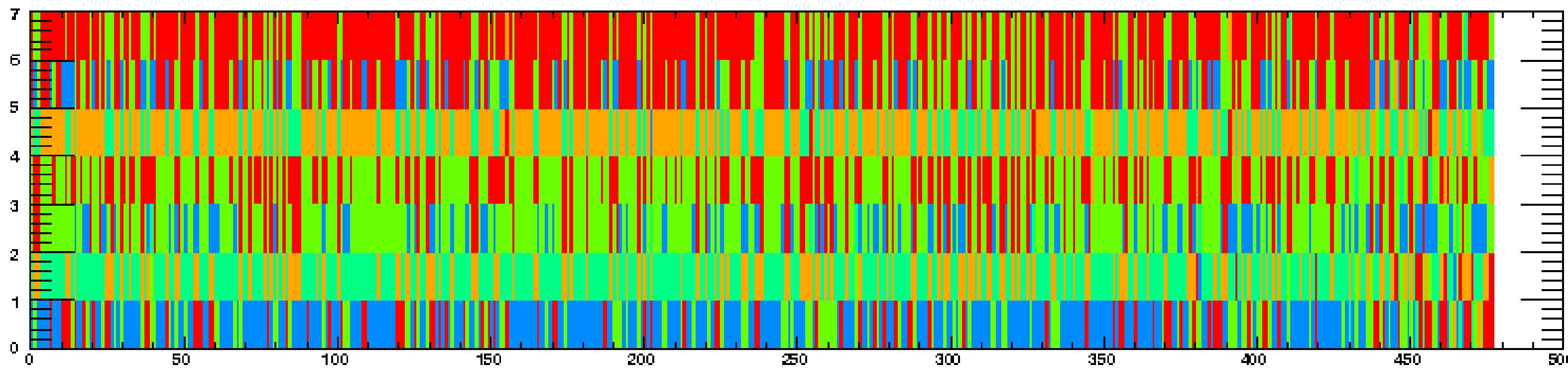
$$\Delta\chi^2 / \chi^2_{\text{fit with true jet combination}}$$

Negative values indicate that combi-fit has larger χ^2 than true-fit



Validation of GA - New implementation

New implementation: N_{best} individuals survive but not more than N_{same} of one jet combination + more children per coupling



$$\Delta\chi^2 = \chi^2_{\text{fit including combinatorics}} - \chi^2_{\text{fit with true jet combination}}$$

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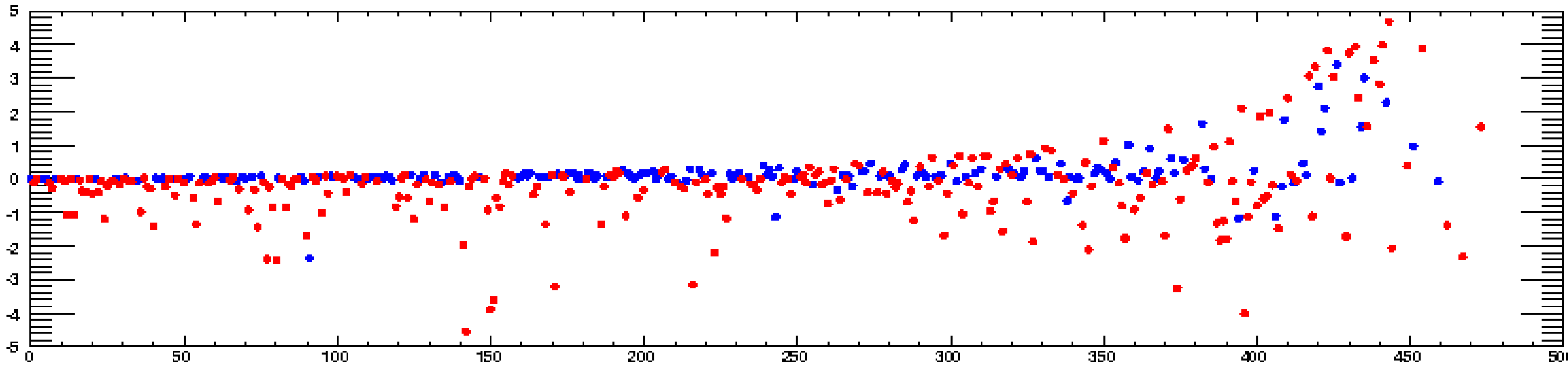
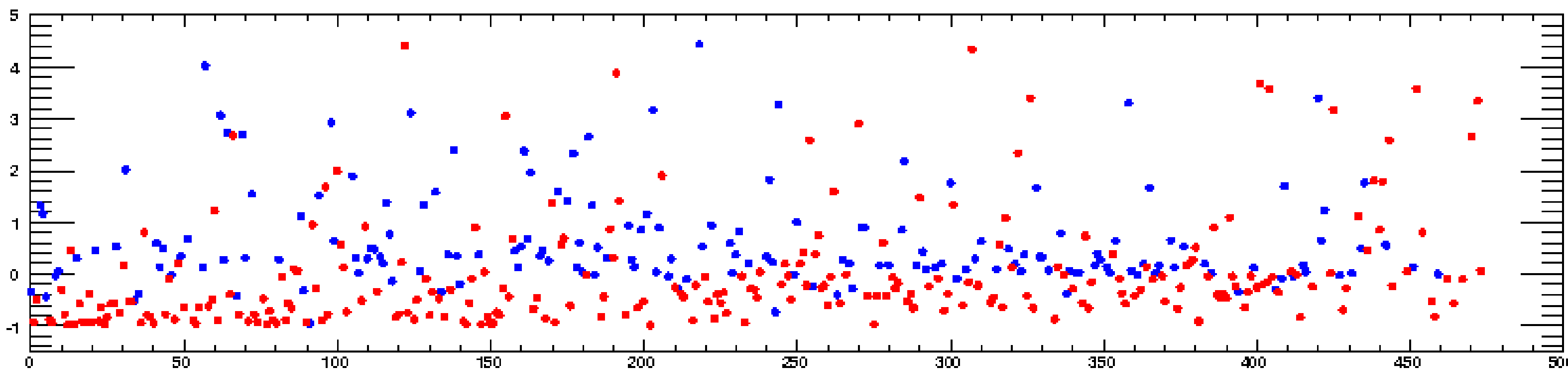


Best is right for 181 of 477 events

$$\Delta\chi^2 / \chi^2_{\text{fit with true jet combination}}$$



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