# Study on the angular uncertainty of the directional reconstruction

A study for the IceCube experiment

Fabian Block
Summer Student
Zeuthen, 08.09.2015

HELMHOLTZ | GEMEINSCHAFT

DESY

About the simulation

> ## Simulates muon-neutrinos in IceCube

- Reaction of neutrinos

- Propagation of muon

- Measuring of Cherenkov light by DOMs

> ## Reconstruction of track

- Based on measured data

- ' MPE'-likelihood reconstruction
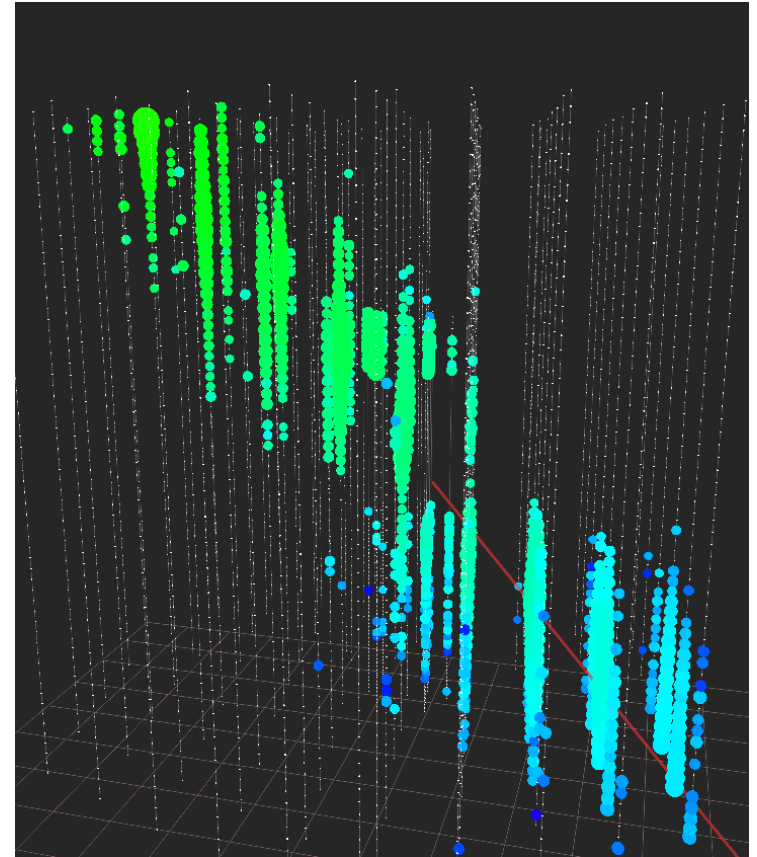
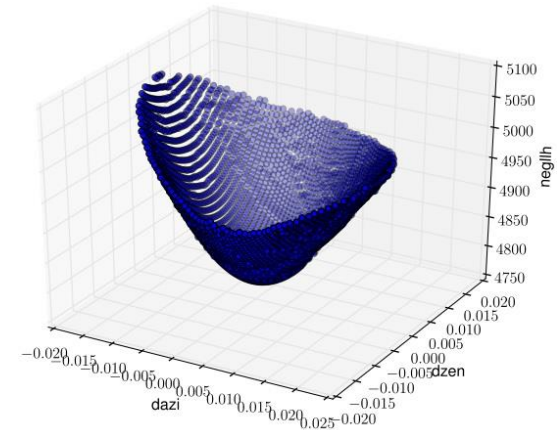# Directional reconstruction: True and estimated error

> ## True error Ψ

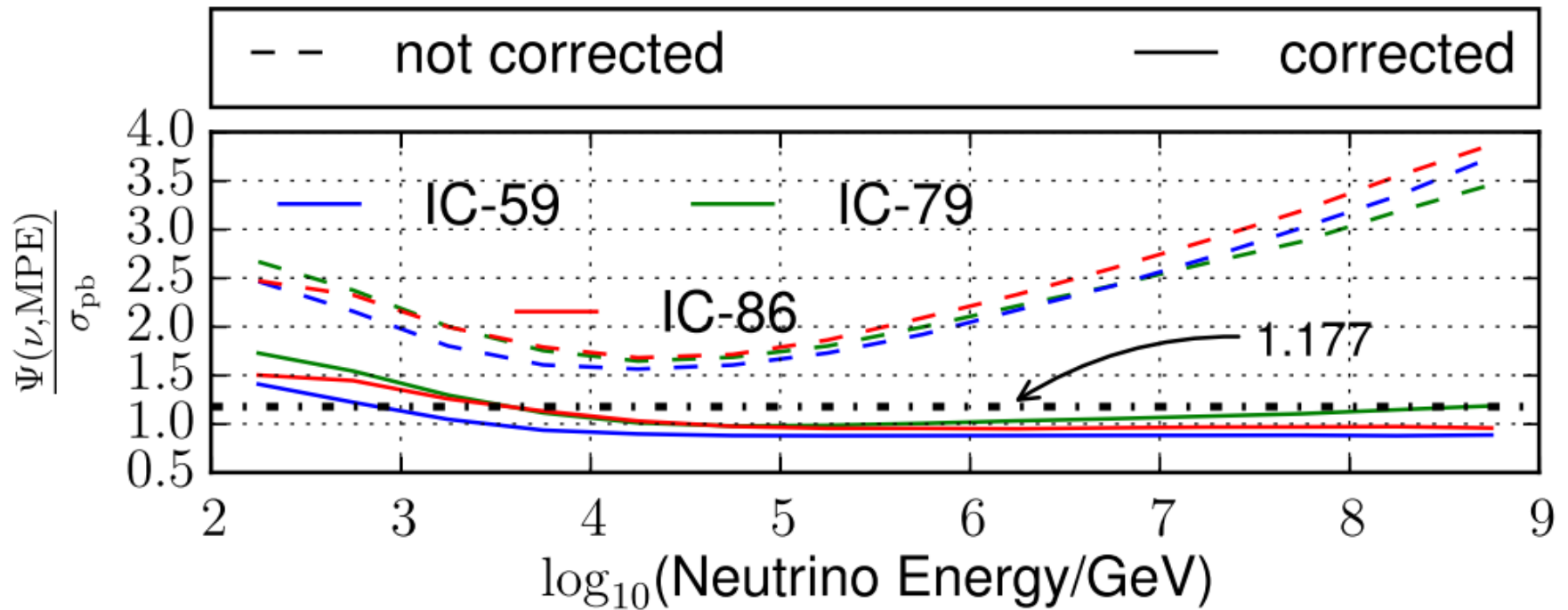- Error between reconstructed and real track
- Only possible in a simulation
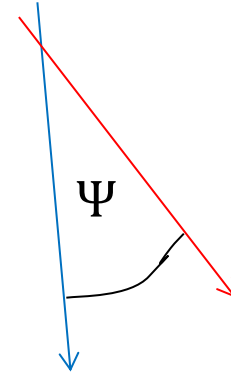
> ## Estimated error σ

- Through likelihood scan
- Applied to measured data

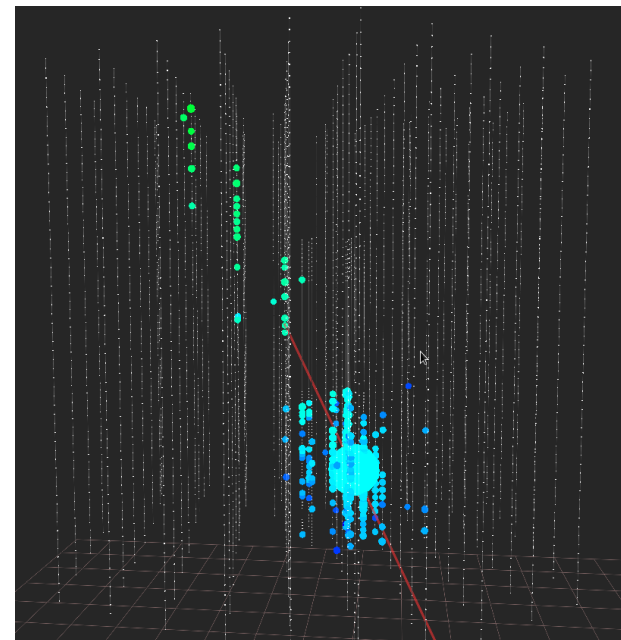> ## In theory: Ψ/σ=1.177 (see arXiv:astro-ph/0403367v, Till Neuhoeffler)
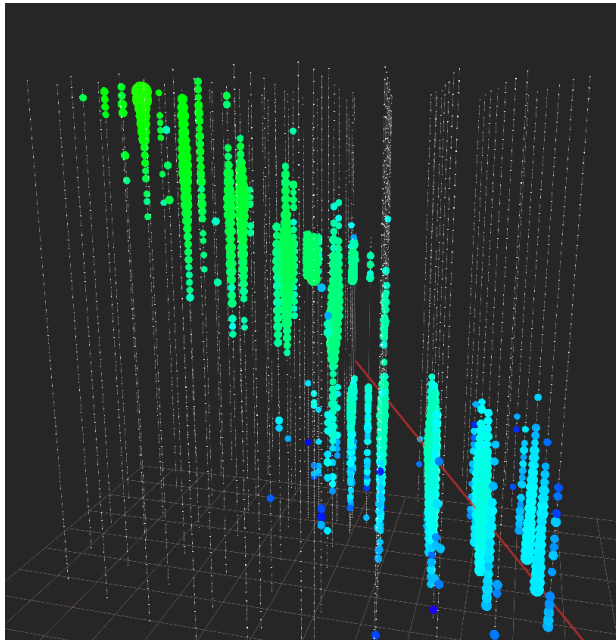
by Thorsten Glüsenkamp

About the simulation

> ## Toy Monte-Carlo simulation

- Topologies: 1) Muon 2) Muon + cascade

- Muon has linear light yield (reality: logarithmic)

- No detector simulation

Approach – from simplicity to complexity

Approach – from simplicity to complexity

1. Fix vertex with Monte-Carlo truth

   - Only reconstruction in directional parameters

   - Influence of cascades

Approach – from simplicity to complexity

1. Fix vertex with Monte-Carlo truth

   - Only reconstruction in directional parameters
   - Influence of cascades

2. Flexible vertex with Monte-Carlo truth

   - Reconstruction in vertex and directional parameters
   - Influence of cascades

Approach – from simplicity to complexity

1. Fix vertex with Monte-Carlo truth

   - Only reconstruction in directional parameters
   - Influence of cascades

2. Flexible vertex with Monte-Carlo truth

   - Reconstruction in vertex and directional parameters
   - Influence of cascades

3. Flexible vertex with linefit

   - Reconstruction in vertex and directional parameters
   - Influence of cascades

Approach – from simplicity to complexity

1. Fix vertex with Monte-Carlo truth

   - Only reconstruction in directional parameters

   - Influence of cascades

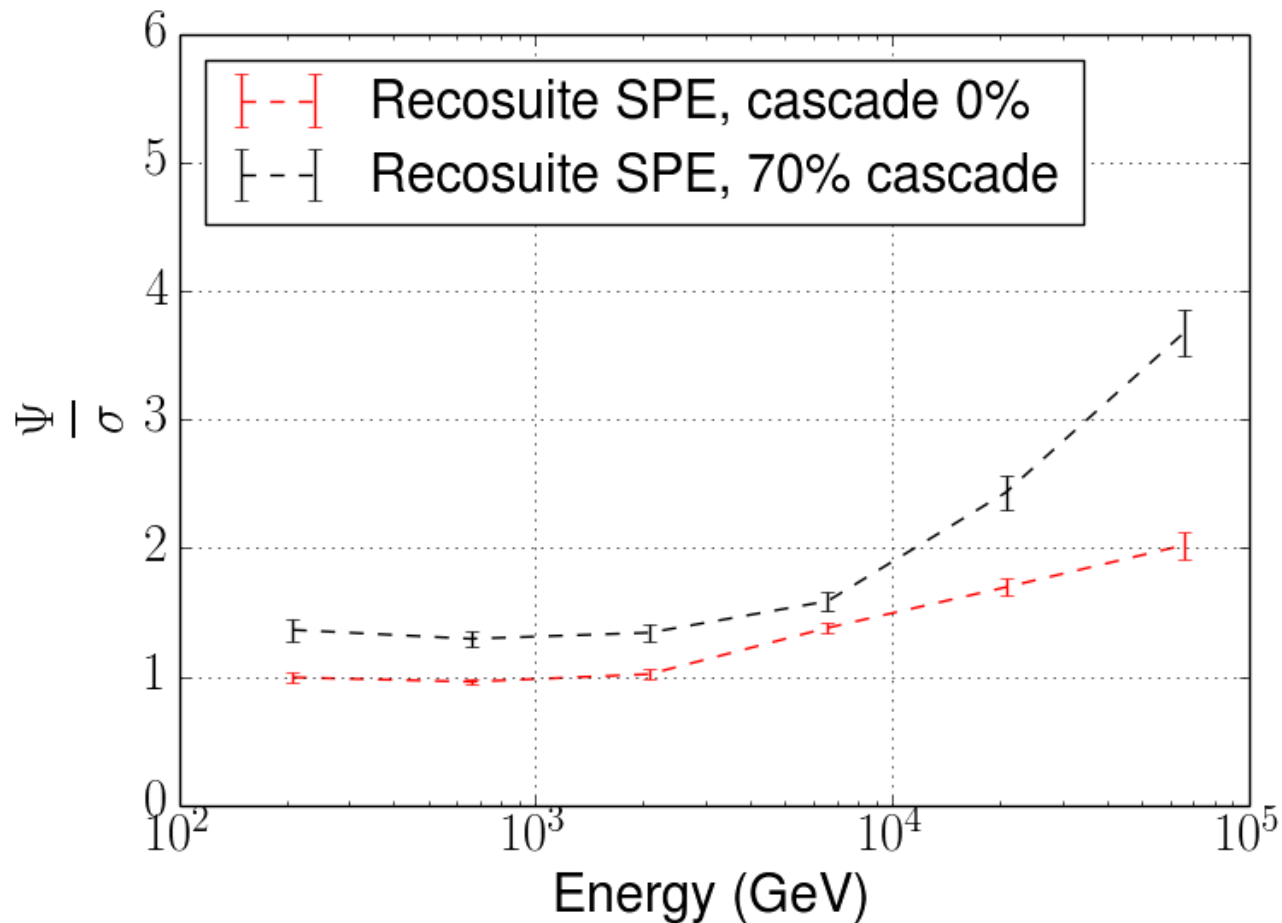2. Flexible vertex with Monte-Carlo truth

   - Reconstruction in vertex and directional parameters

   - Influence of cascades

3. Flexible vertex with linefit

   - Reconstruction in vertex and directional parameters

   - Influence of cascades

1. Fix vertex with MCTruth

1. Fix vertex with MCTruth

> Decline of reconstruction precision through cascade

Approach – from simplicity to complexity

1. Fix vertex with Monte-Carlo truth

   - Only reconstruction in directional parameters

   - Influence of cascades

2. Flexible vertex with Monte-Carlo truth

   - Reconstruction in vertex and directional parameters

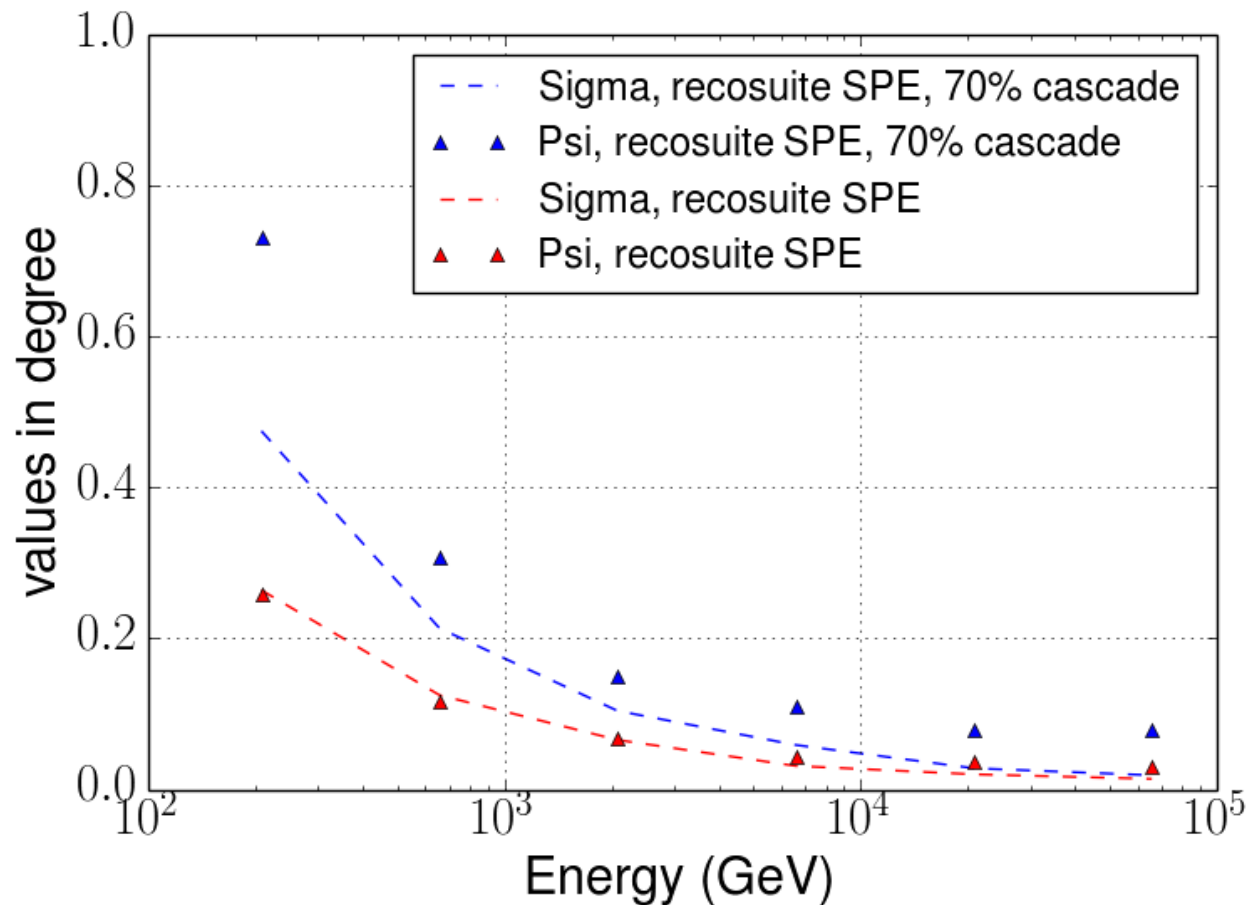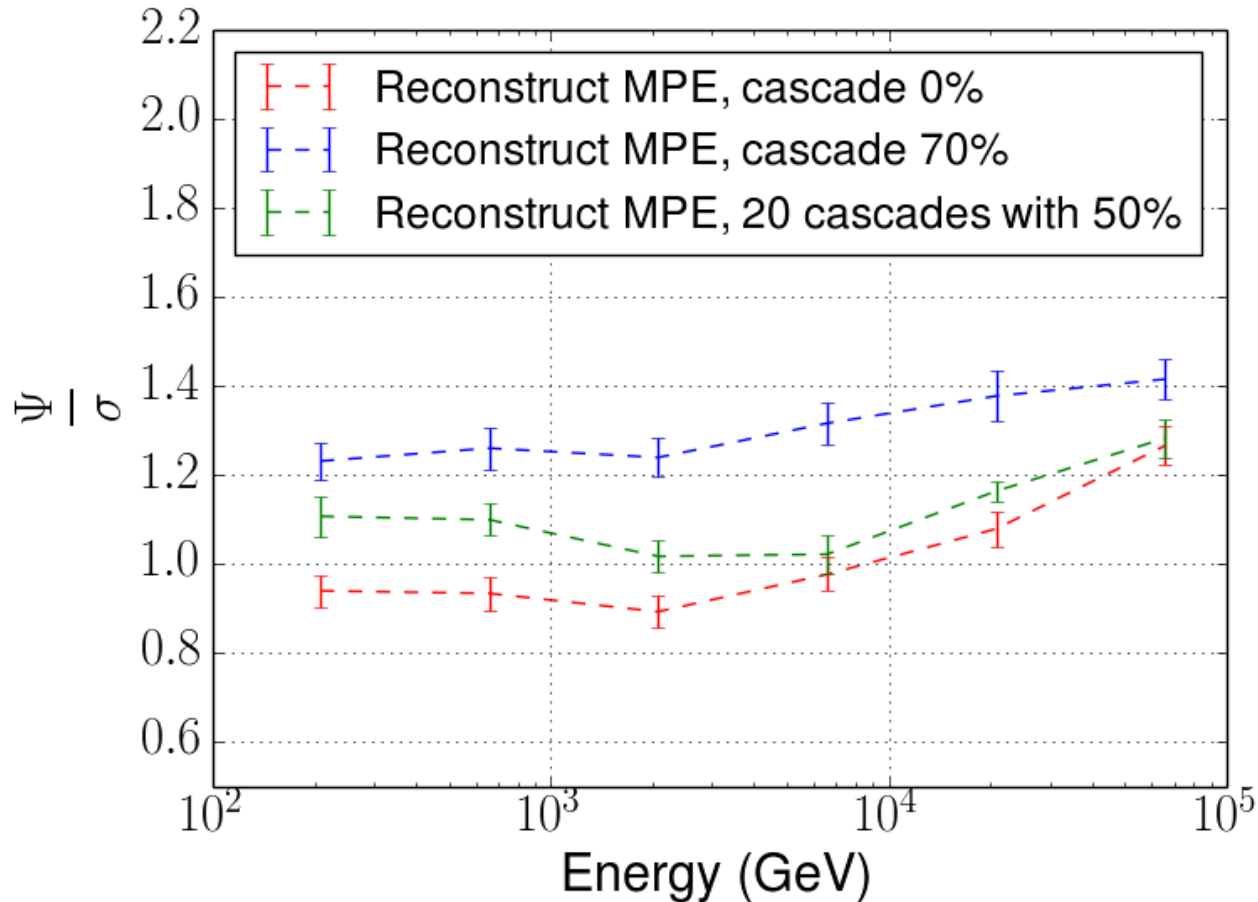   - Influence of cascades

3. Flexible vertex with linefit

   - Reconstruction in vertex and directional parameters

   - Influence of cascades

> Nearly flat ratio Ψ/σ for every hypothesis

Approach – from simplicity to complexity

1. Fix vertex with Monte-Carlo truth

   - Only reconstruction in directional parameters

   - Influence of cascades

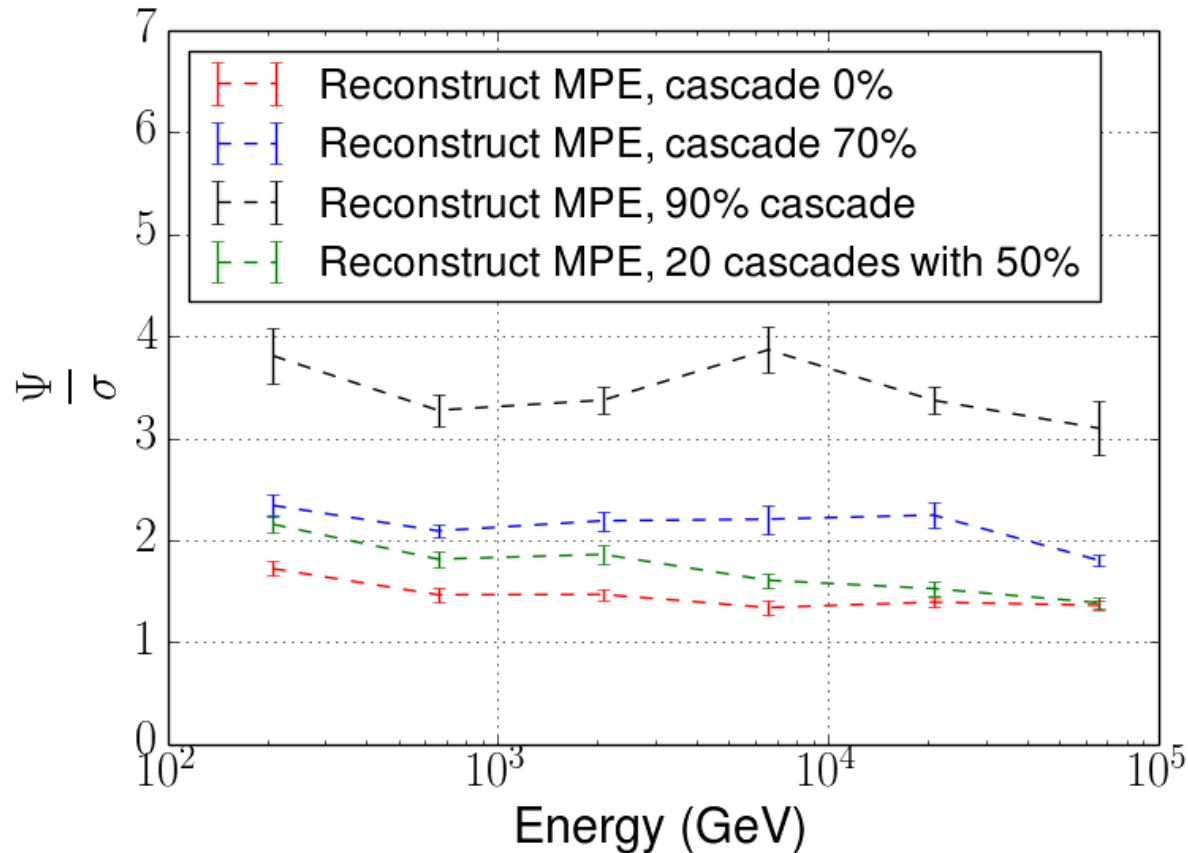2. Flexible vertex with Monte-Carlo truth

   - Reconstruction in vertex and directional parameters

   - Influence of cascades

3. Flexible vertex with linefit

   - Reconstruction in vertex and directional parameters
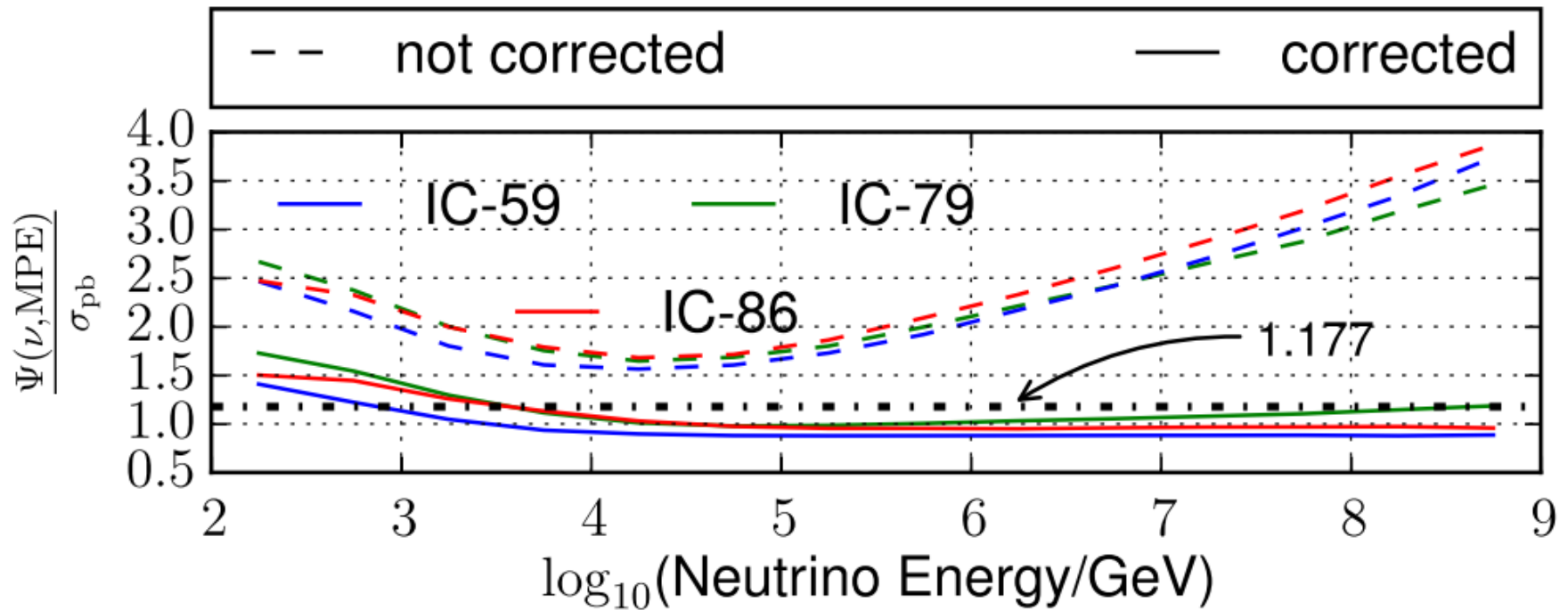
   - Influence of cascades

3. Flexible vertex with linefit

> Nearly flat ratio Ψ/σ for every hypothesis ➔ no light yield effect

> Cascades have a higher ratio

> increasing muon energy ➔ increasing probability for cascades ➔ increasing ratio Ψ/σ

Summary

> Flatness of Ψ/σ for pure track

- No influence of higher light yield

Summary

> Flatness of Ψ/σ for pure track

  - No influence of higher light yield

> Influence of cascades

  - Increasing ratio for all energies

Summary

> Flatness of Ψ/σ for pure track

  ▪ No influence of higher light yield

> Influence of cascades

  ▪ Increasing ratio for all energies

  ➔ Need for a better cascade reconstruction