University of Amsterdam

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KM3NeT

No-hit inclusion

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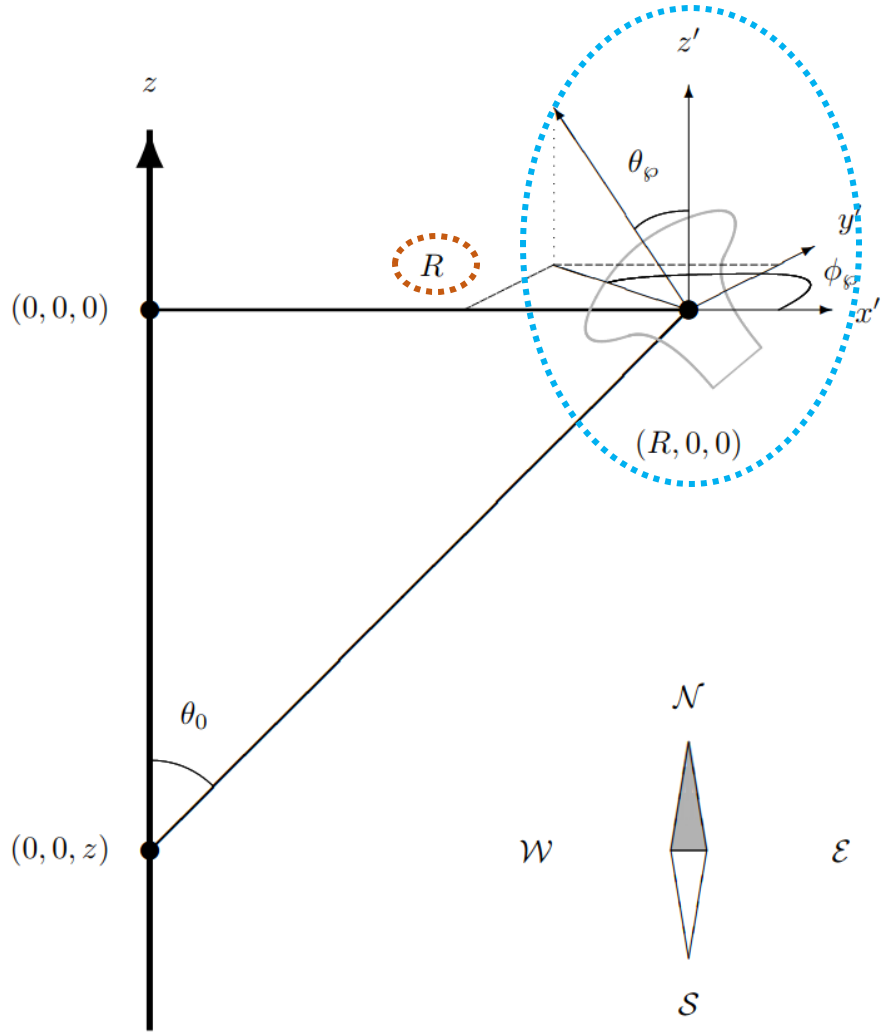
Track reconstruction

- Five(-and-a-half) stages:
  1. JMuonPrefit → Directional grid scan
  2. JMuonSimplex (JMuonStart) } Directional MLE
  3. JMuonGandalf } Directional MLE
     - Based on arrival time PDF written by Maarten
     - Function of:
       1. E: the muon energy
       2. **R**: radial distance to PMT
       3. **Θ & φ**: PMT orientation
       4. Δt: arrival time difference w.r.t. direct Cherenkov
  4. JMuonStart → Finds track origin
     - Back-project hits onto track
     - Determine first emission point above background level
  5. JMuonEnergy → Energy MLE
     - Likelihood based on hit probabilities
     - Use hits / no-hits within cylinder surrounding muon path



JPDF documentation – Maarten de Jong (see doxygen)
Track reco documentation - Brían Ó Fearraigh (see doxygen)

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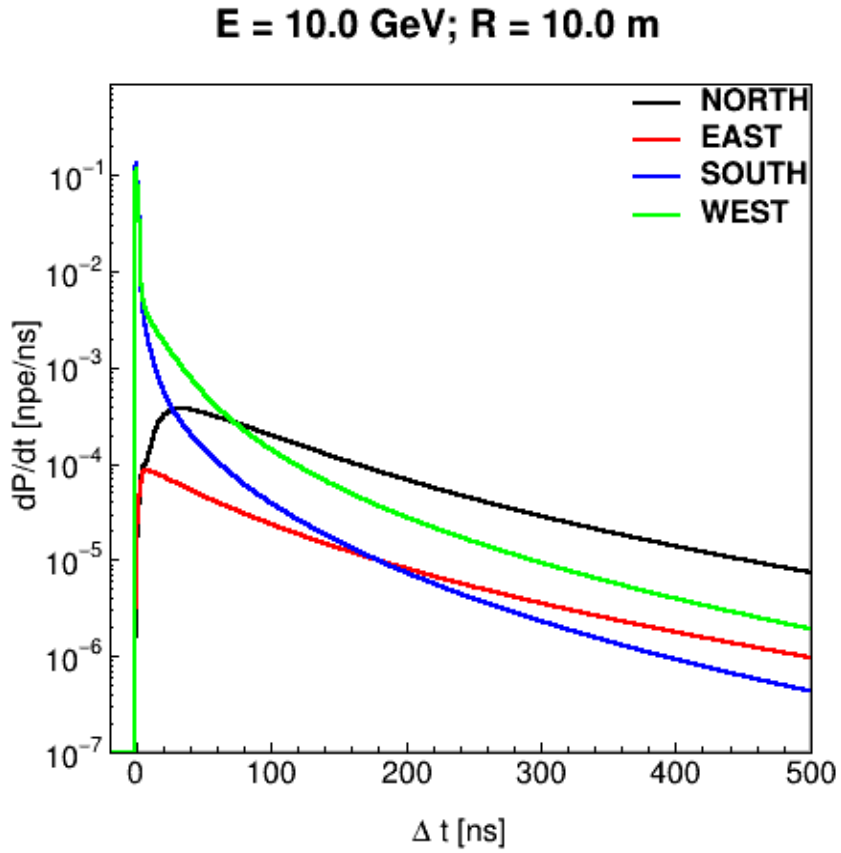

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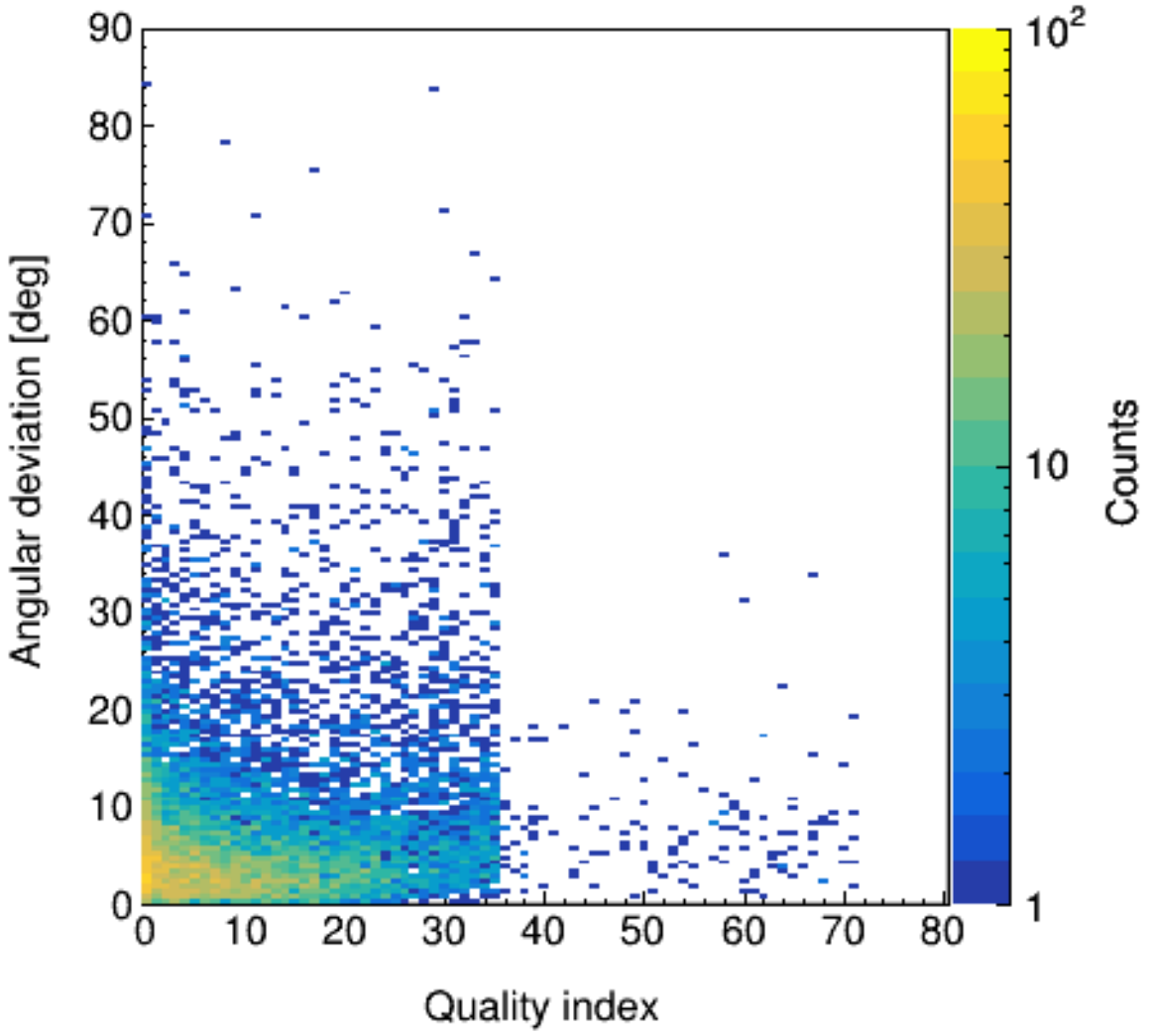
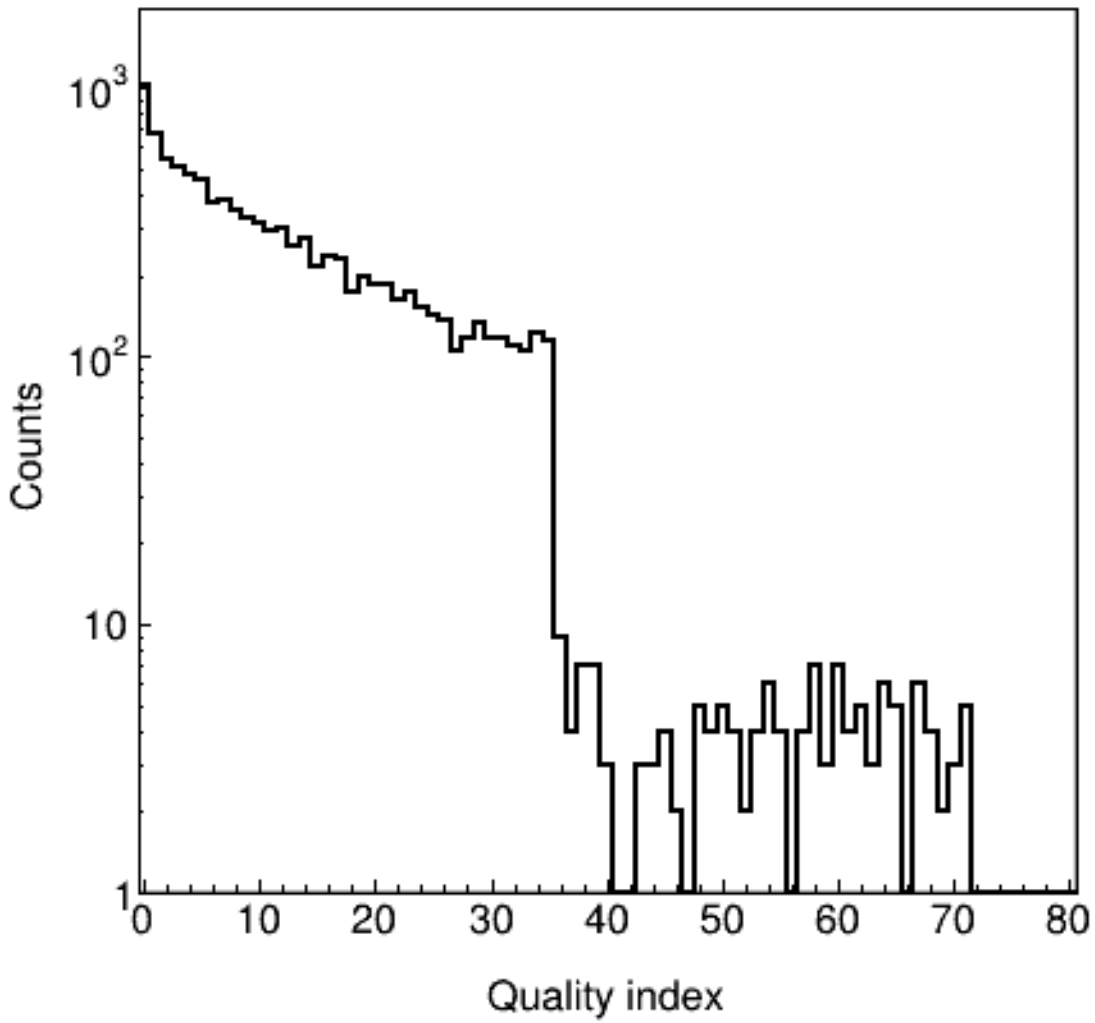
Directionality performance





Decreasing quality

$$Q = -\ln\left(\prod_{i=0}^{N}\frac{S_i}{B_i}\right)$$

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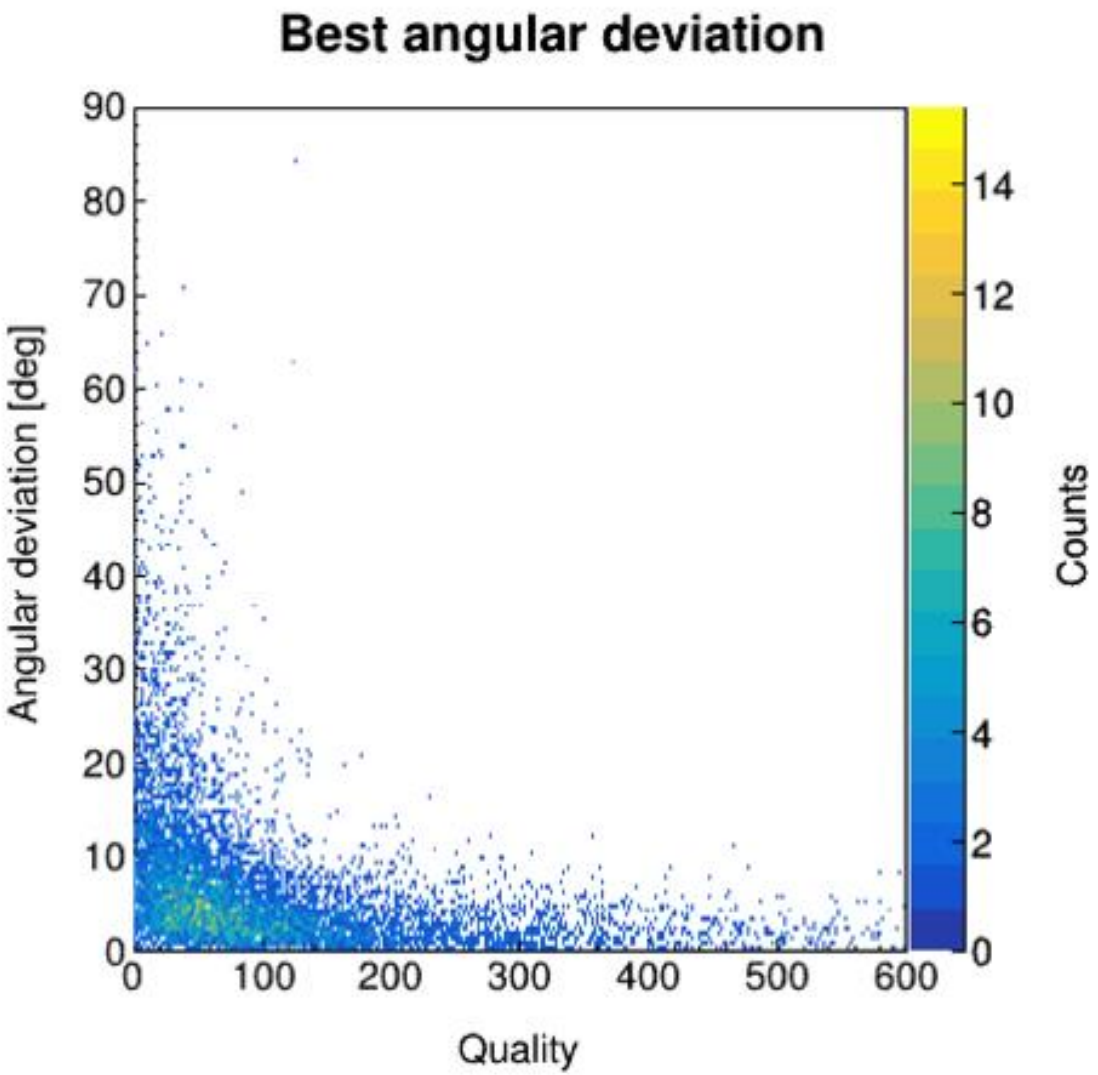

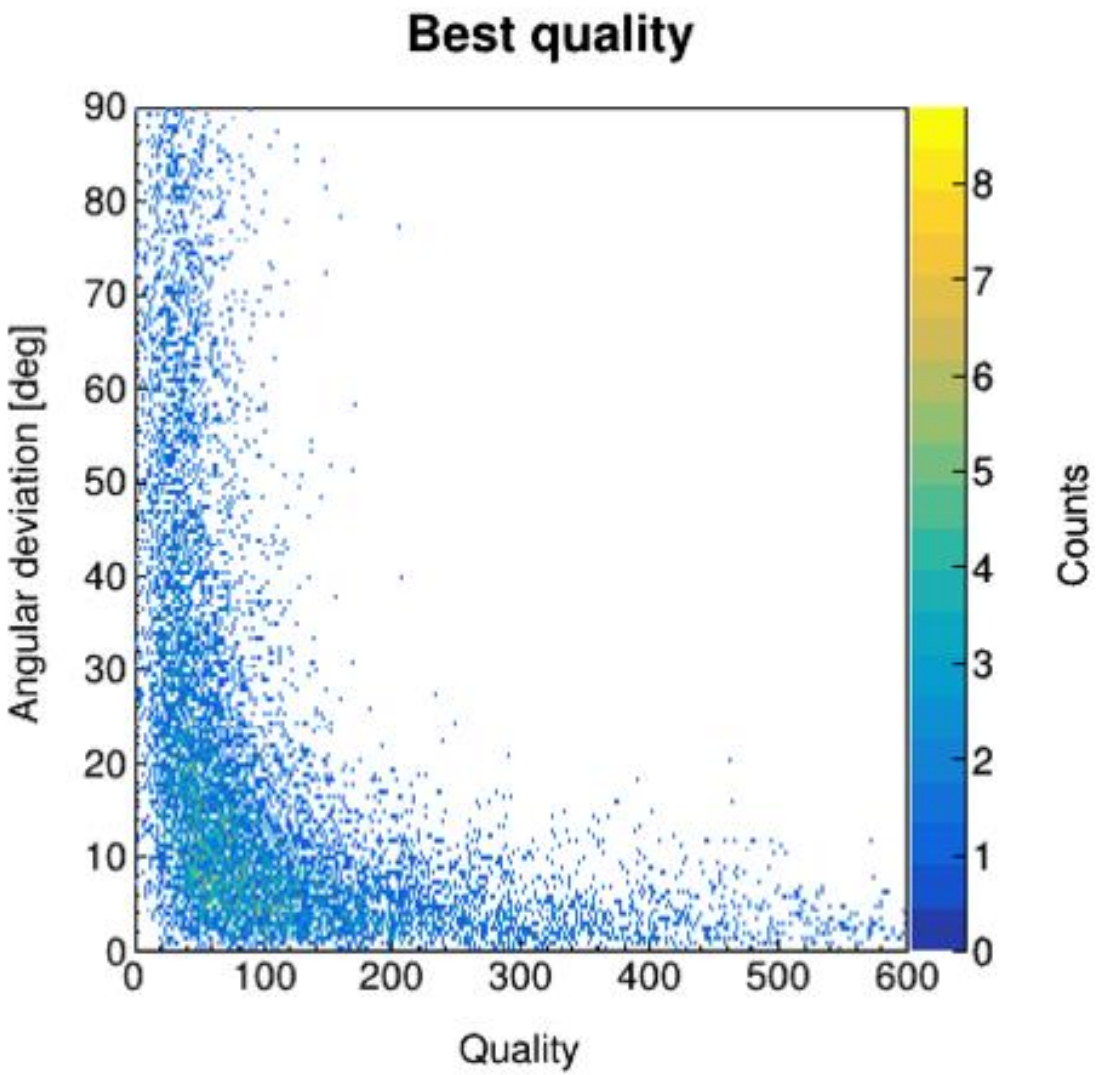

No-hit inclusion

- Best quality fits do not always yield smallest angular deviation

- But we are not exploiting all available topological information
  - No-hits also contain information!

- Not implemented previously for 2 reasons:
  1. Muon track length not yet accounted for previously
  2. For high energies in ARCA, no-hits are negligible

Plan

- Focus on ORCA muon neutrino MC-data first

- Use JMuonGandalf and JEnergy as stepping stones

  1. Loop over hits ⟹ loop over PMTs
  2. Include computation expected number of hits (using Jpp muon PDFs)
  3. Determine no-hit likelihood
     - Including threshold inefficiency
  4. Multiply hit and no-hit likelihoods

- Compare fit results with and without no-hit information