Multi-vertex fiTQun for pion scattering measurements in WCTE
Strategy

Institut de Física
d'Altes Energies

Table of Contents

fiTQun

- FiTQun is a maximum likelihood estimation event reconstruction algorithm for WC experiments,

- FiTQun steps:
  1. Vertex pre-fitting,
  2. Hit clustering,
  3. Single-ring reconstruction,
  4. Multi-ring reconstruction.

- likelihood, function of the particle parameters specifying initial condition:
  - vertex position x, y, z, time t,
  - zenith angle and azimuth of the direction θ, ϕ,
  - momentum p,
  - Eloss (visible energy), only for pion.

$$L(\mathbf{x}) = \prod_{j}^{unhit} P_j(unhit|\mathbf{x}) \prod_{i}^{hit} P_i(hit|\mathbf{x}) f_q(q_i|\mathbf{x}) f_t(t_i|\mathbf{x})$$

Likelihood to maximise | Candidate track hypothesis | Probability of no hit at PMT | Probability of hit at PMT | Hit charge probability density | Hit time probability density

Preparation for Multi-Vertex fiTQun

- Normal fiTQun only find the pion upstream track →
- Multi-Vertex needed to find pion scattering vertex ↘
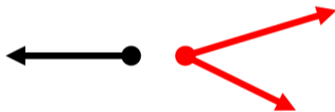
1. Reconstruct the first ring

2. Search the second ring assuming the primary vertex.

3. Search the third ring assuming the primary vertex.

1. Reconstruct the first ring

2. Search second vertex

3. Search the second ring assuming the second vertex.

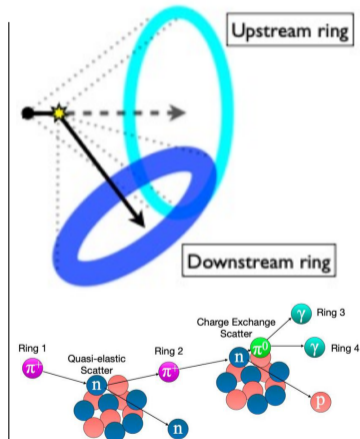4. Search the third ring assuming the second vertex.

Figure: Pion scattering processes in WCTE

Strategy

1. Single Vertex fit ✓
2. Multi-ring Separation ✓
3. Implementation of Multi-Vertex fit ✓
4. ~~Comparing Single Vertex and Multi-Vertex~~
5. Multi-Vertex fit with constraint

Strategy

- First ring:
  1. Fix parameters: x, angle θ, ϕ
  2. Constrain parameters: y, z, t
  3. Free parameters: momentum, and Eloss
- Second ring:
  1. Constrain parameters: y, z
- Things to consider:
  1. Short tracks (not enough Cherenkov light, should be ignored in true information)
  2. Angle less than 20°(fiTQun is merging automatically rings below 20°as it is most likely scattering), needs to change or be careful between 1st and 2nde ring
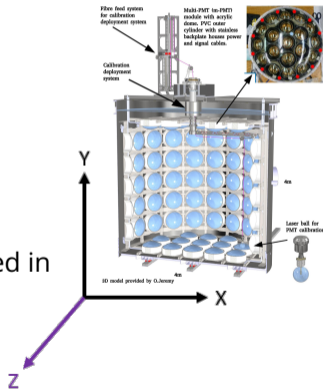
Strategy

- Some possible interactions seen through WCSim track list to also consider:
    1. 2 rings pion scattering,
    2. pi0 appearance,
    3. scattering with new pi+ appearance.