

Atmospheric neutrino physics in JUNO: reconstruction of GeV interactions

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See also Poster 231
by Hongyue Duyang

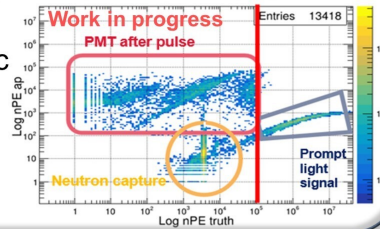
Why atmospheric neutrino reconstruction ?

-> Enhance JUNO sensitivity to neutrino mass ordering (NMO) via combined analysis with reactor anti-neutrinos

Atmospheric neutrinos in JUNO: MC simulation

- Simulation of charged current (CC) atmospheric neutrino interactions
- Fully contained (FC)
- Prompt signal trigger

$$nPE_{MC\ truth} > 10^5$$



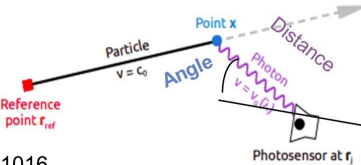
Novel technique: Topological reconstruction (directionality) [1]

Basic idea: Use the PMT detection probability to infer the reconstructed light emission topology

$$\hat{t}(x) = t_{ref} \pm \frac{|\hat{x} - \hat{r}_{ref}|}{c_0} + \frac{|\hat{r}_j - \hat{x}|}{v_g}$$

ref.point (any point in the track)

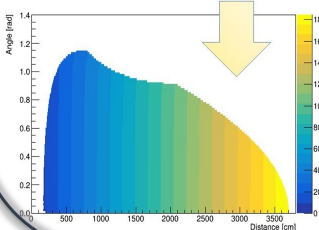
[1] H. Rebber *et al* 2021 *JINST* **16** P01016



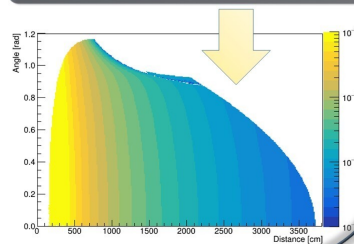
Analytical probability density functions:

Based on the scintillation average wavelength (436 nm)
Removing total reflection and re-emitted light

1. Mean propagation time of direct light:



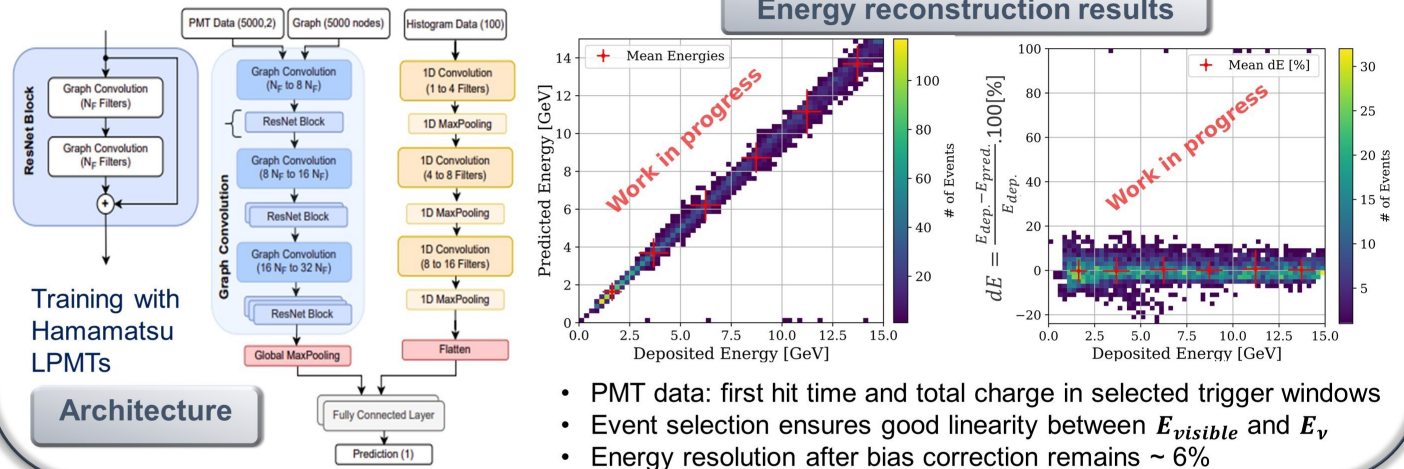
2. Detection probability



Conclusion:

JUNO will have potential to reconstruct energy and direction of atmospheric neutrinos

Neutrino energy reconstruction: Graph Convolutional Neural Network (GCN)



Neutrino direction reconstruction: topological reconstruction

Data [MC truth]

PMT data (17612 LPMTs): charge and hit time per PMT (400 ns event window)

Ref point: MC truth vertex smeared with 25 cm uncertainty + PMT time resolution

Direction reconstruction results: ν_μ atmo CC (3 GeV)

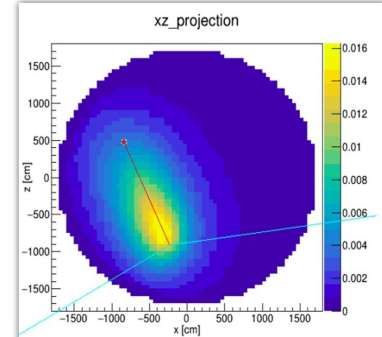
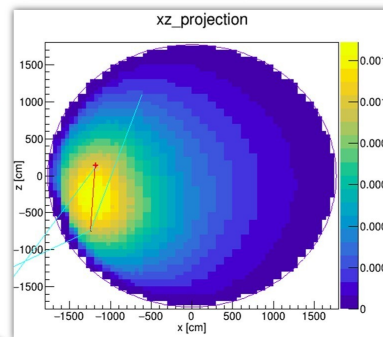
($E_{hadrons}$ non negligible)

($E_{hadrons}$ is negligible)

Red: primary track (MC truth) /// Blue: neutrinos
Results: 6 iterations with different mesh size

Muon with E = 3 GeV

Work in progress



Work in progress

