Reconstruction of neutrino induced NC-1π⁰ using the T2K-ND280 tracker
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1. The T2K experiment

- Second generation long-baseline neutrino experiment for precision measurements of oscillation parameters:
  - \( \nu_e \rightarrow \nu_x \) appearance: B\(_x\)
  - \( \nu_e \rightarrow \nu_x \) disappearance: B\(_y\) \( \Delta m^2 \)
  - Intense neutrino beam at 2.5° off-axis resulting in narrow band beam peaked at E ~0.6 GeV

3. Off-axis near detector at 280m : ND280

- Embedded in UA1 dipole magnet to measure beam and neutrino interactions before oscillation
  - P0D: Highly segmented tracking calorimeter dedicated to NC-\( \pi^0 \) measurement
  - Tracker region designed for charged current interaction

5. e⁺e⁻ pair selection

- Select two TPC tracks starting in tracker region that have opposite charges
  - 40 < Momentum < 1000 MeV/c
  - front separation < 15 mm
  - pair invariant mass < 50 MeV/c²

7. Electromagnetic Calorimeter selection

- Efficiency = 20%
- Purity ~ 80%

2. Backgrounds to appearance measurement

- NC-1π⁰ is one of the largest background and systematic error to \( \nu_x \) appearance measurement at T2K.

4. NC 1-π⁰ signal definition & topology in tracker

- NC-1π⁰ definition is one π⁰ decay and any proton or neutron but no muon or other meson

6. Vertex reconstruction

- Pair production point obtained from point of closest approach of e⁺ and e⁻
- Pair is typically created a few cm from the vertex
- Estimate most probable vertex position from pair start position using y mean free path
- Direction of other photon is determined from point of entrance in ECal and vertex

8. Background rejection cuts

- Reject beam bunches with:
  - Any tracks upstream in the P0D
  - Any muon candidates
  - ECal objects > 4
  - Tracker tracks > 9
  - Any tracks upstream of vertex position

9. Final selection & summary

- Requires \( \pi^0 \) invariant mass < 500 MeV/c²
- Present \( \pi^0 \) reconstruction efficiency is 9% and purity is 20%
- Preliminary estimation of number of selected signal events for Run I+II+II p.o.t is 25 events
- Accurate \( \pi^0 \) decay reconstruction demonstrated with FGD/TPC e⁺/e⁻ pair + Ecal cluster
- Topology with one \( \gamma \) conversion close to vertex and second \( \gamma \) showering ring is low energy and not reconstructed
- Work in progress to optimise selection and minimise CC and external backgrounds