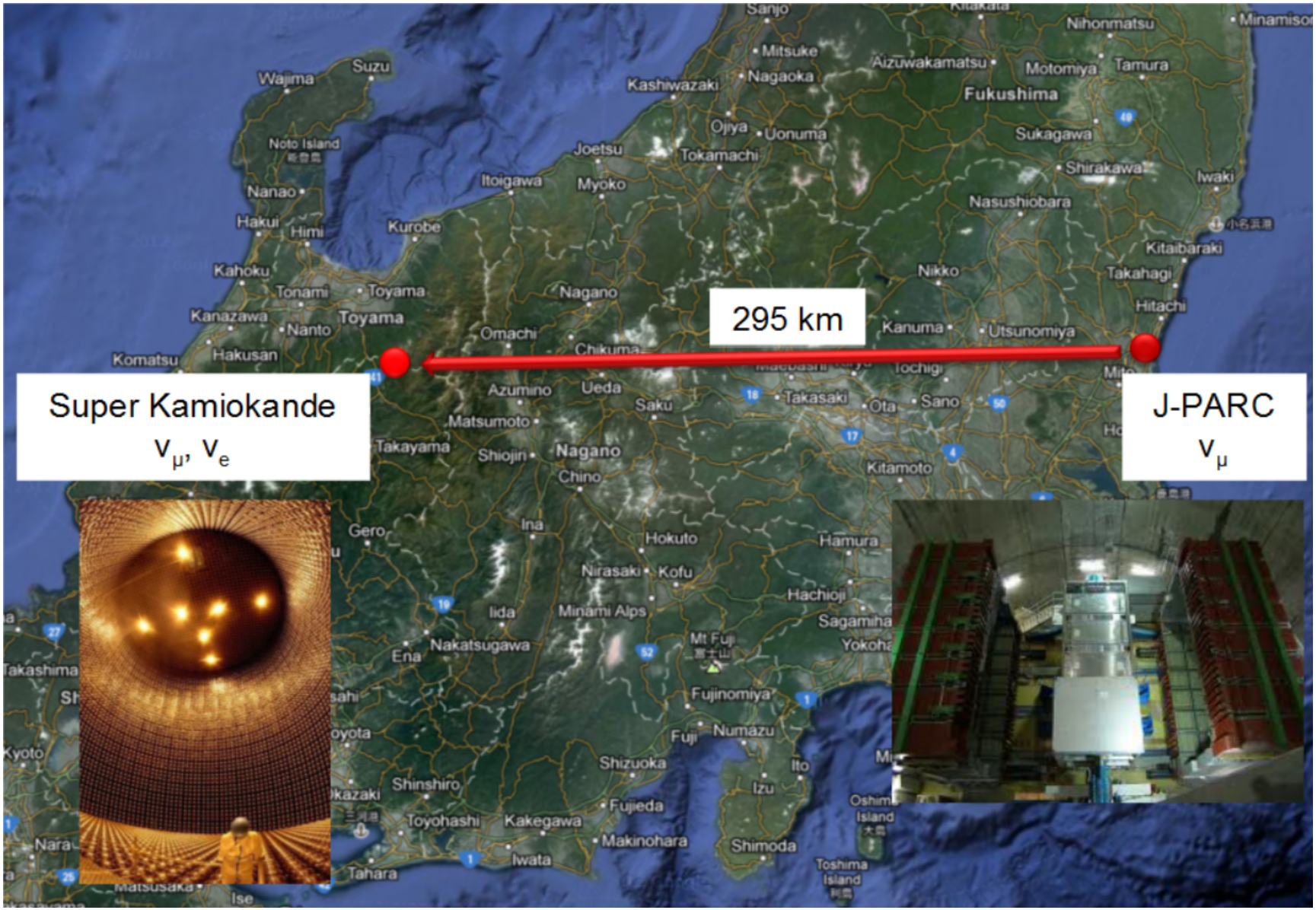
A Charged-Current π^0 Analysis at the T2K Near Detector

D. Shaw[1]

[1]Department of Physics
Lancaster University

22/03/16 - IOP HEPP Conference

The T2K Experiment



The ND280

0.2 T Magnet

Plastic scintillator detectors:

Fine Grained Detector (FGD)

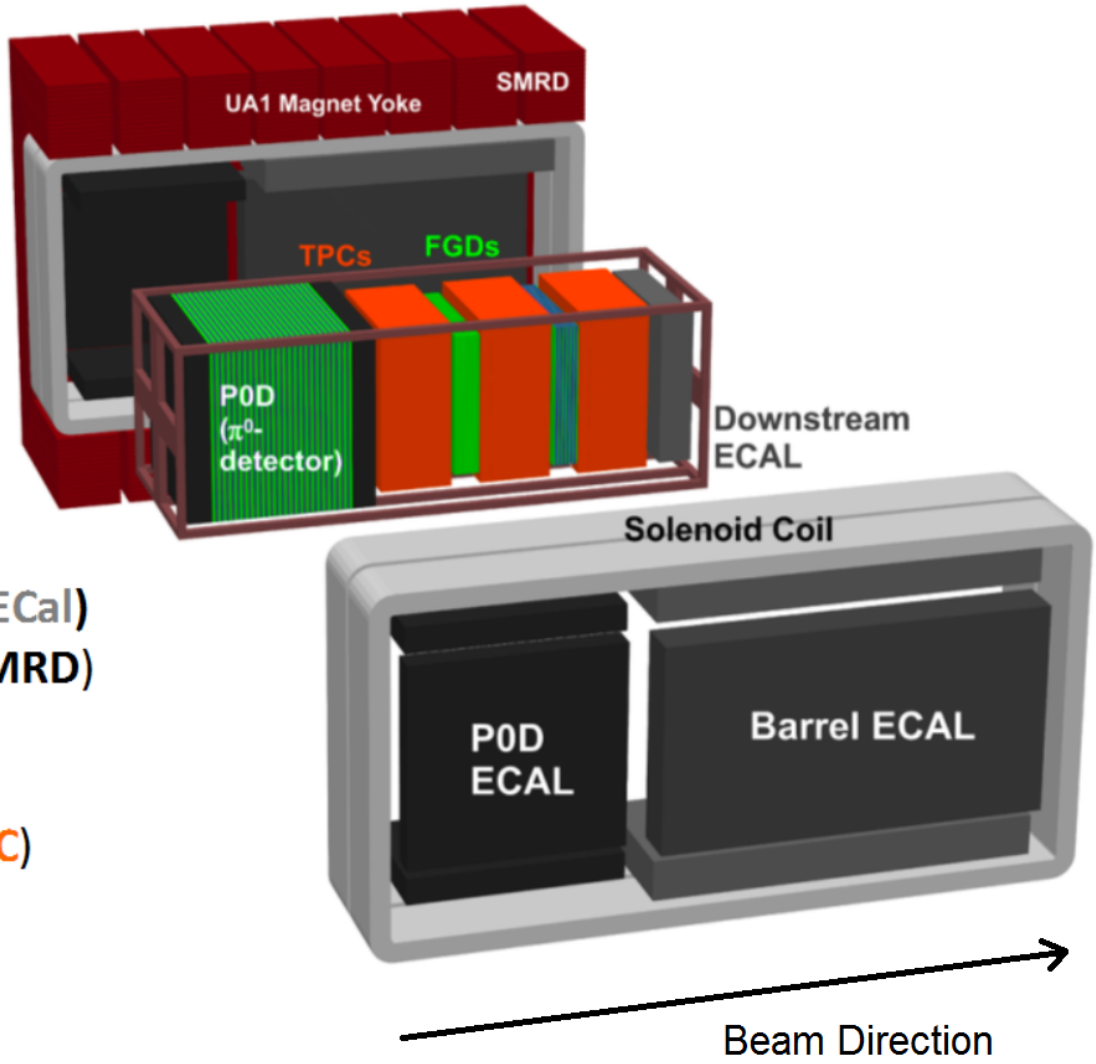
Pi0 Detector (P0D)

Electromagnetic Calorimeter (ECal)

Side Muon Range Detector (SMRD)

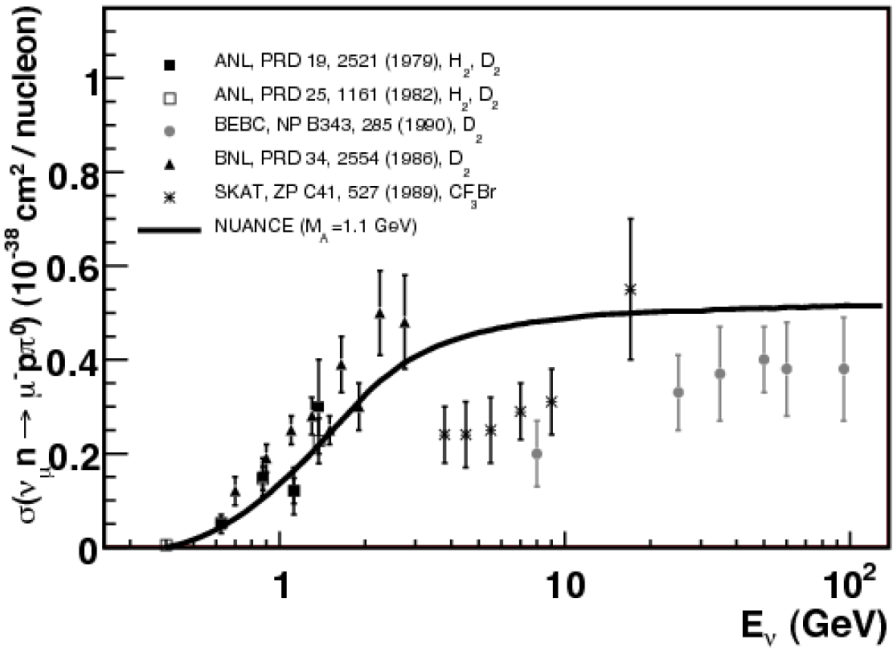
Gaseous Argon

Time Projection Chambers (TPC)



Motivation

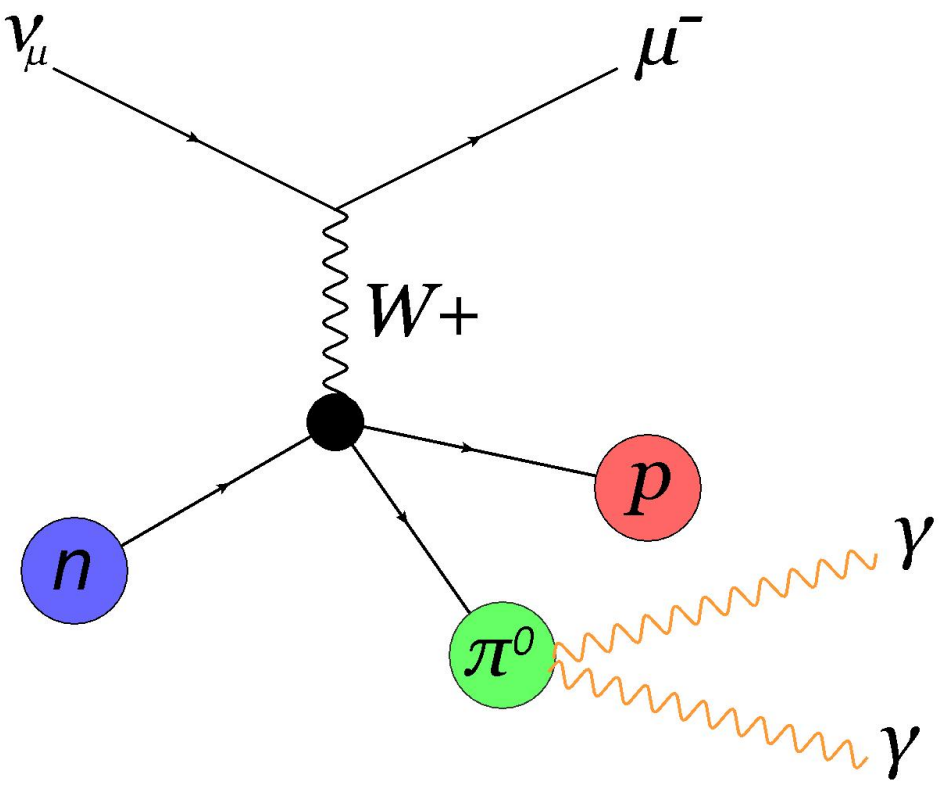
- Will lead to a CCπ^0 muon-neutrino cross section measurement.
- Most measurements come from experiments in the 1980's.



- Measuring an absolute cross section will improve Monte Carlo simulations and reduce the systematic error for other analyses.
- T2K flux and cross section models can be constrained using the number of CCπ^0 interactions at the ND280.

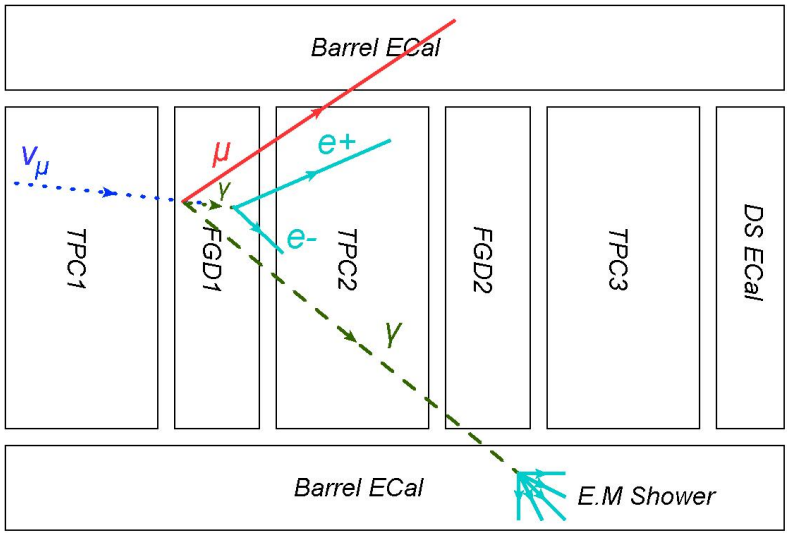
Analysis Goals

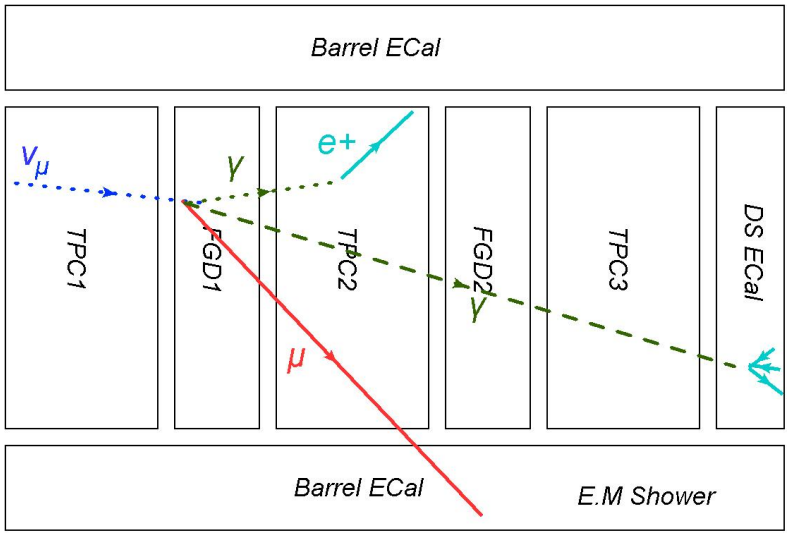
- Identify charged-current (CC) events from ν_μ by selecting events where a μ^- is produced in one of the FGDs.
- These can produce π^0s. Decay photons from these π^0s are identified using the ECal and FGDs/TPCs (Tracker).
- Signal : μ + Nπ^0 + X (N=1 for Exclusive Measurement)



Conversion topologies of interest

- Reconstructed e^+e^- pair in the tracker + an isolated ECal object.
- Single, second-highest momentum e^- or e^+-like track in the tracker + an isolated ECal object.

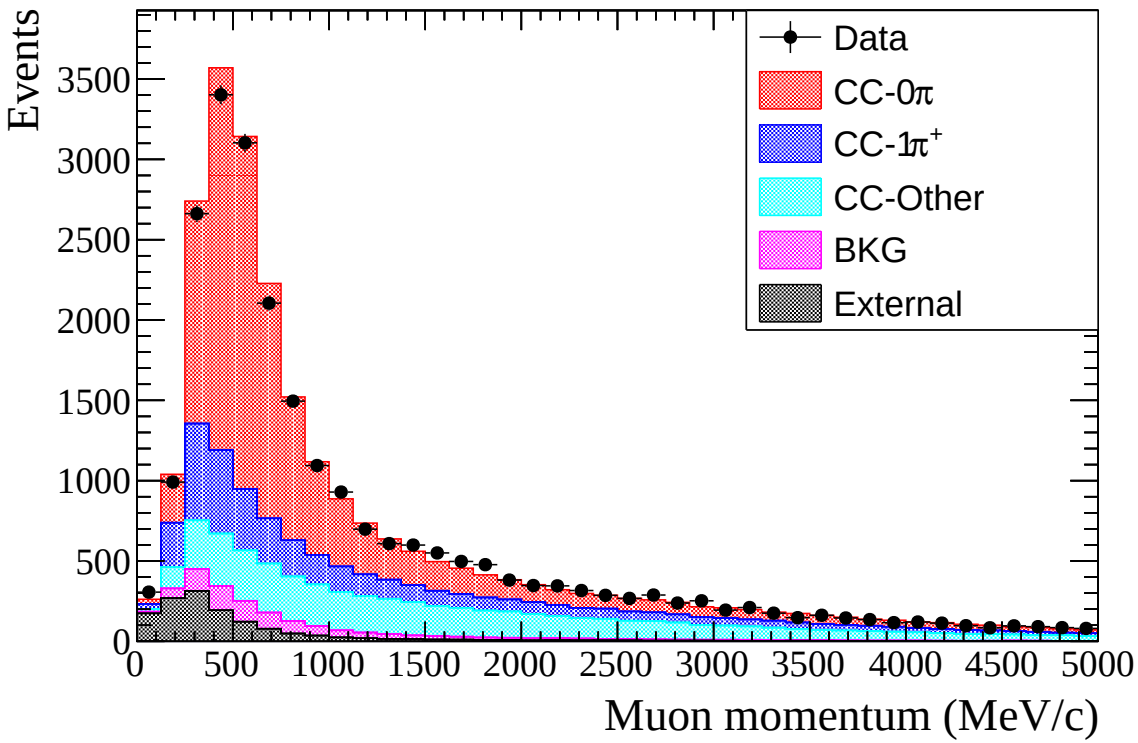




Basic Event Selection

Identify μ^- using standard ν_μ CC selection:

- μ^- track must start in FGD1 or FGD2 fiducial volume and be forward going.
- This track must have good quality.
- track must be μ-like and not e-like.
- Efficiency : 50% Purity : 86%.



Selection in the the CCπ^0 Analysis

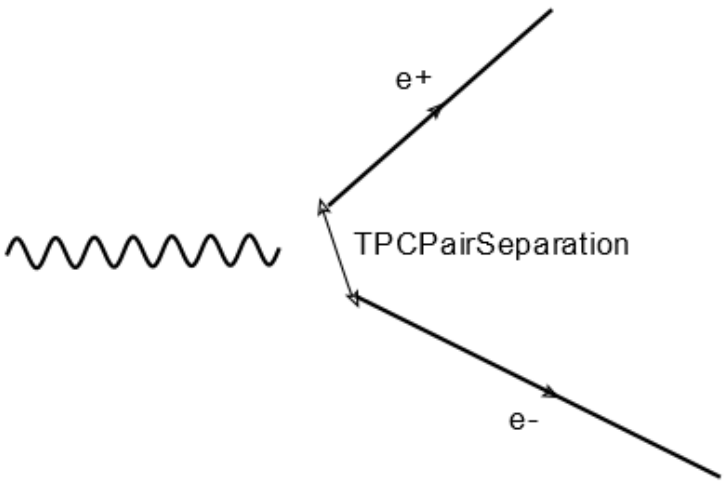
Consider all tracks that are not the μ^-.

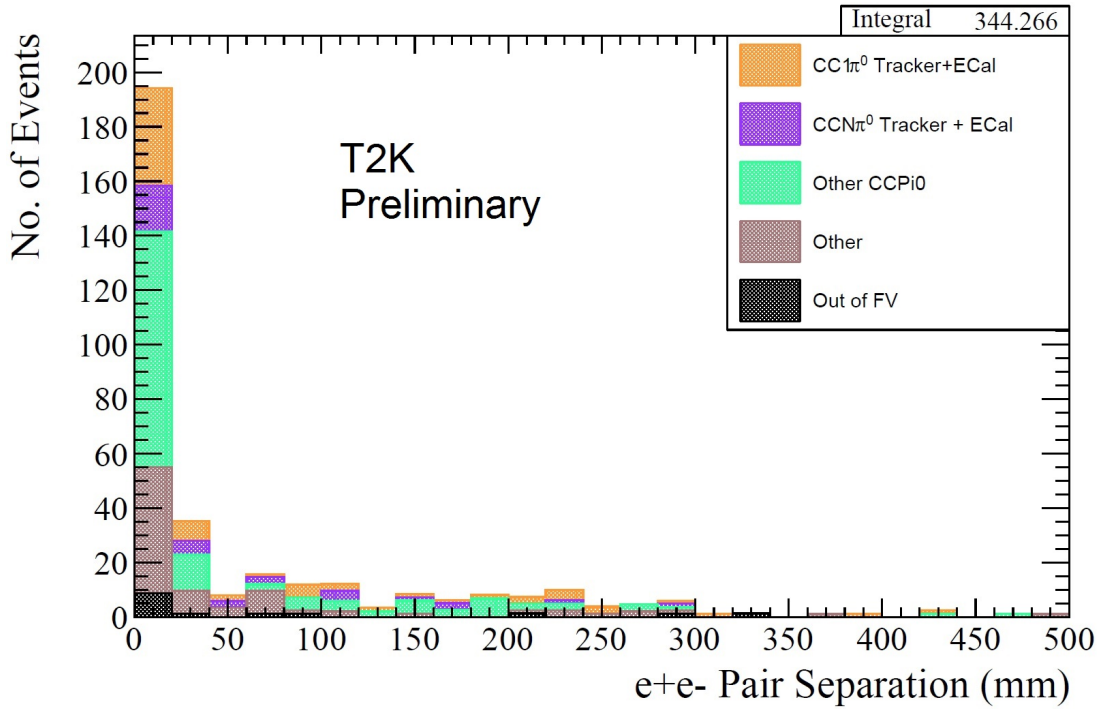
- Find all positive and negative tracks in the event.
  - Good quality.
  - dE/dx that is e^- or e^+-like.
  - Momentum should be within a given range.
- Find Isolated ECal objects.
  - Look like showering photons.
- π^0 decay photon candidates are built from these tracks/pairs and showers.
- Candidate π^0s are built from the decay photon candidates.

Selection in the the CCπ^0 Package

e+e- Pair Separation Cut

- This cut requires that the distance between the reconstructed start position of each pair constituent is less than a given value.
- Currently under investigation.

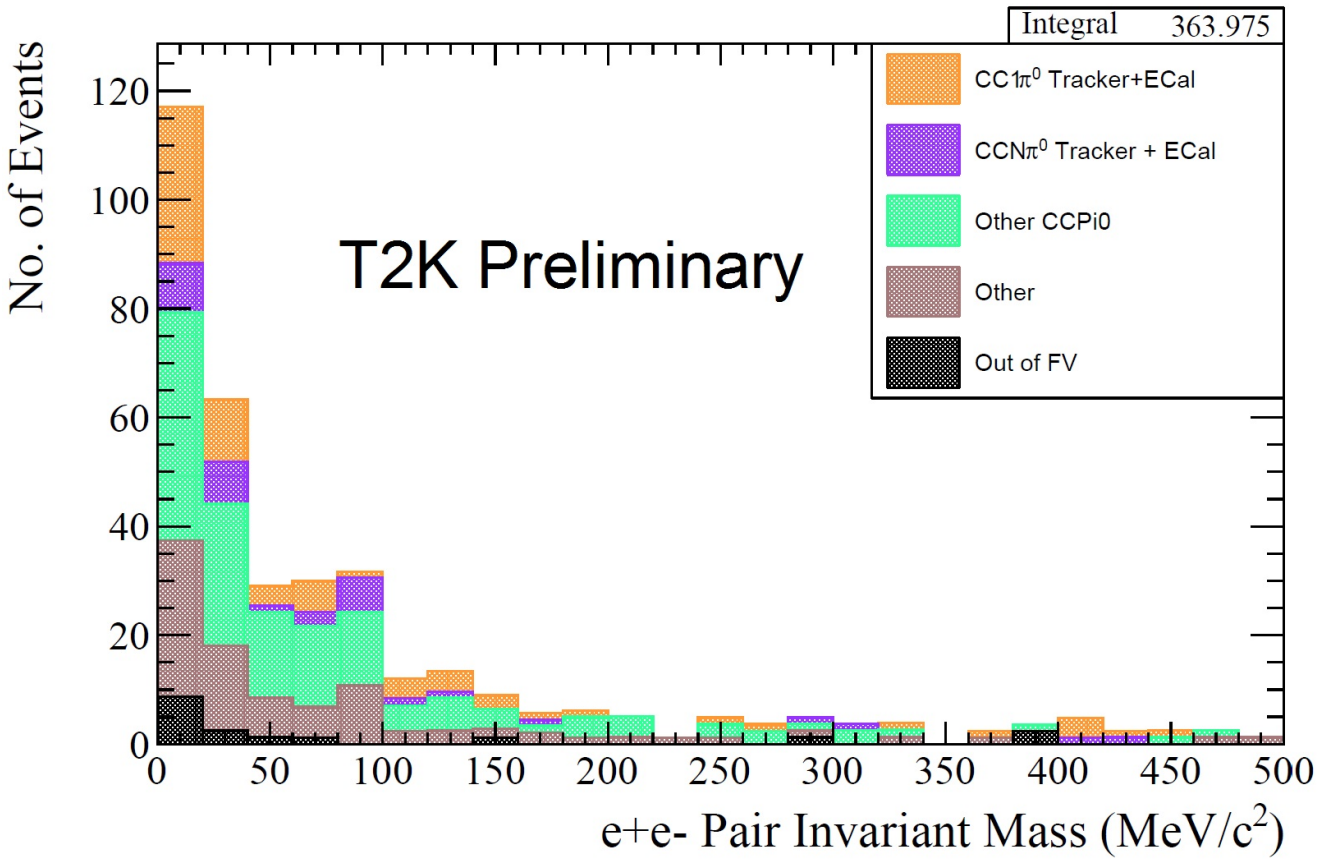




Selection in the the CCπ^0 Package

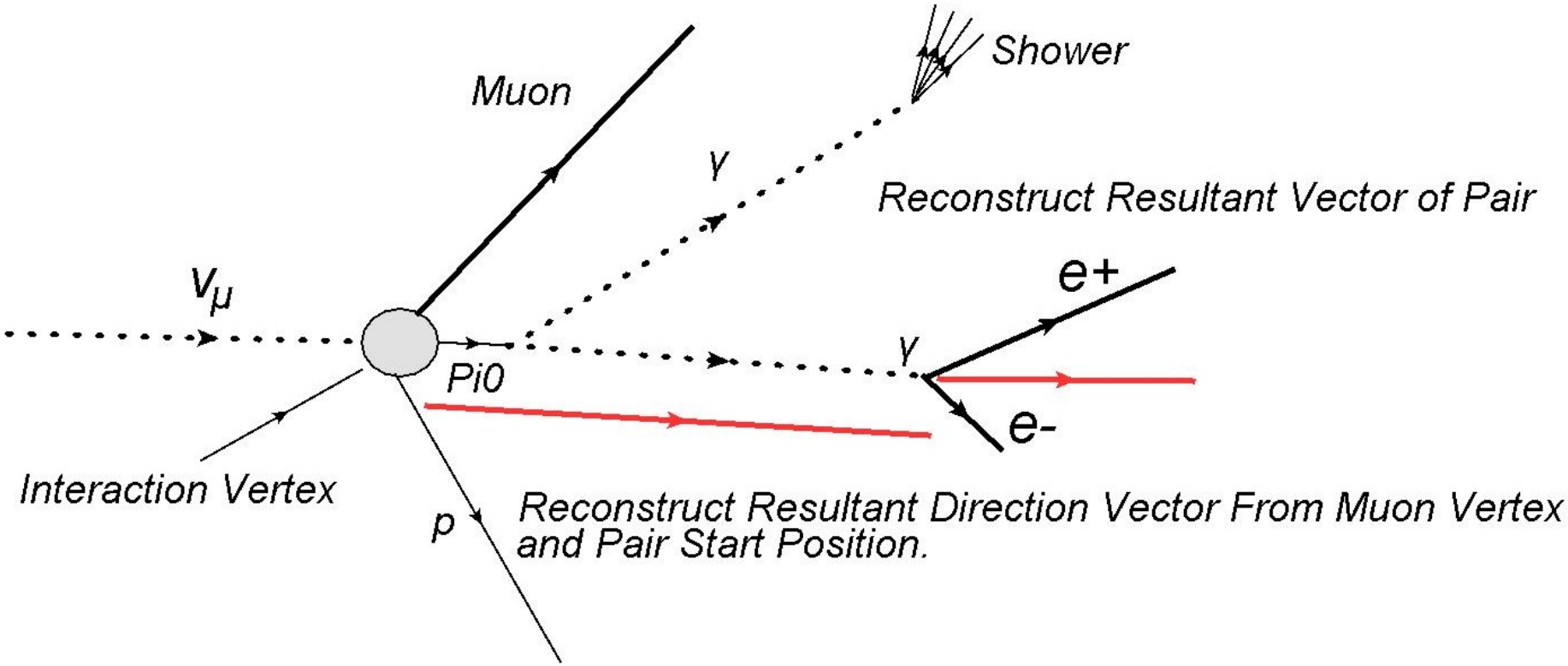
e+e- Pair Invariant Mass Cut

- Initially a bound of 50 MeV/c^2 was used for the reconstructed invariant mass of an e^+e^- pair.
- This was motivated by previous work done on a similar analysis.

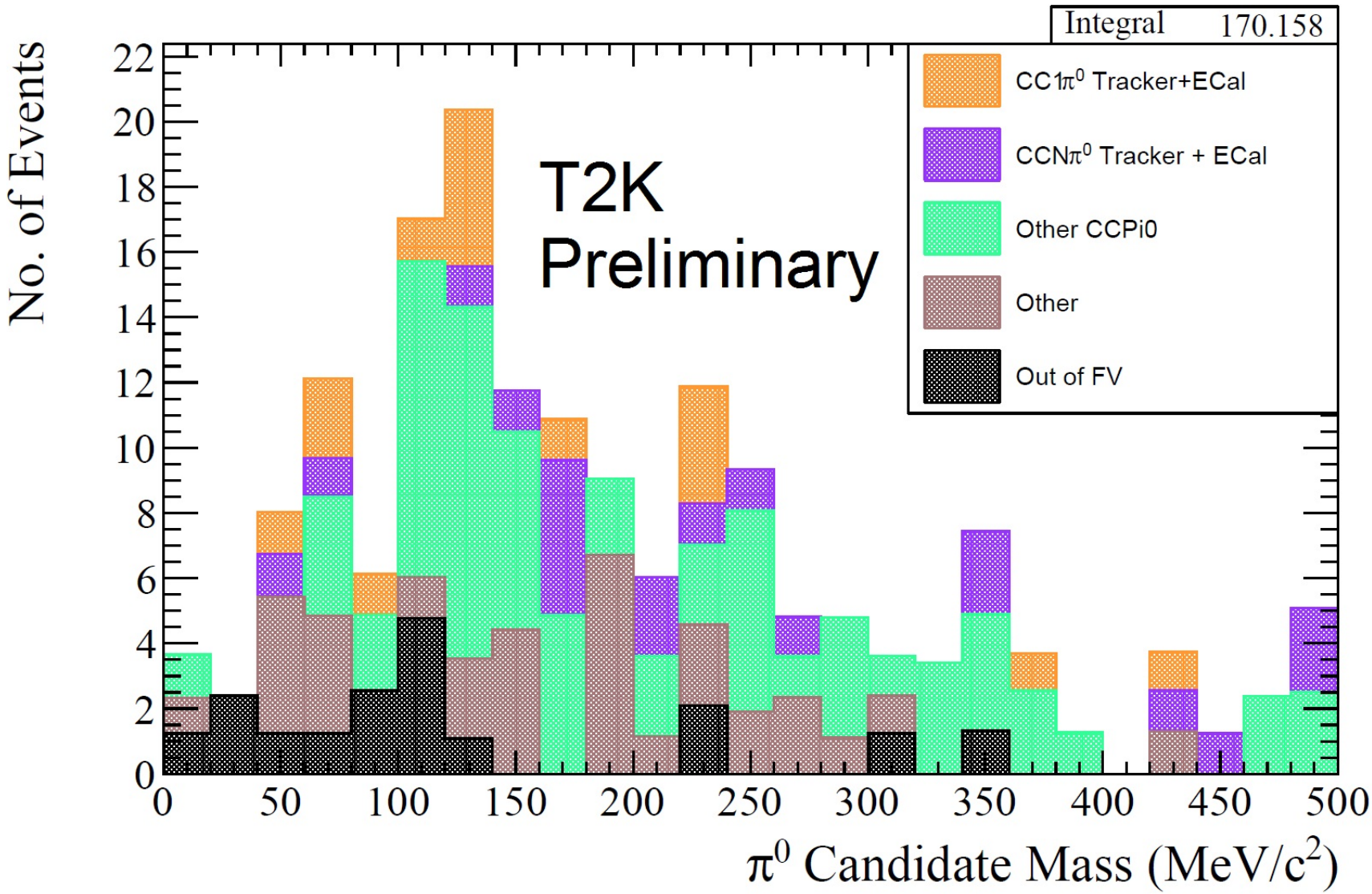


Selection in the the CCπ^0 Package

Muon Separation Cut

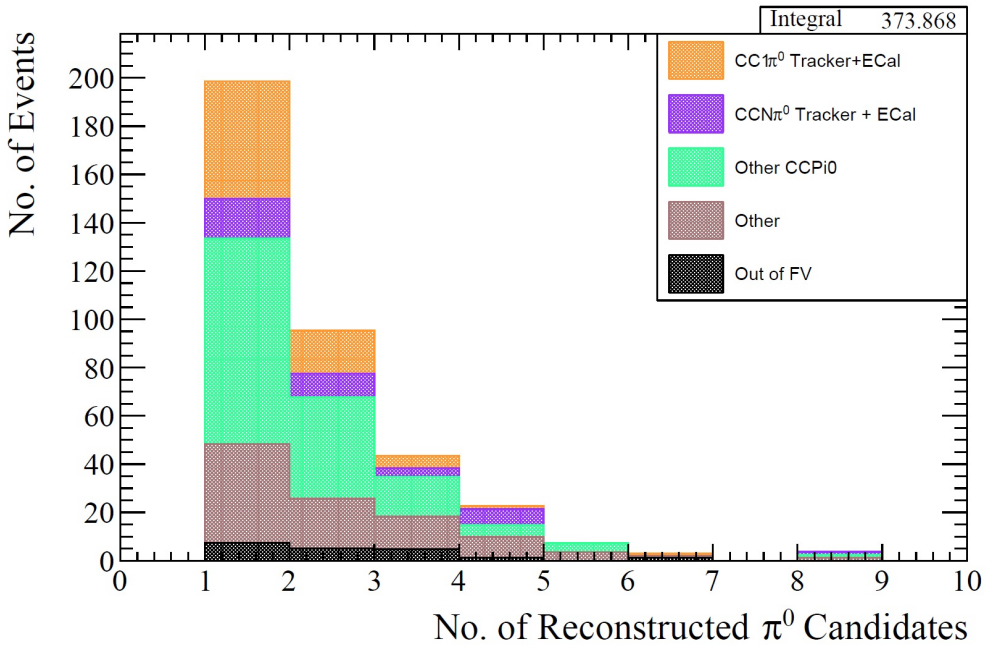


Reconstructed CCπ^0 Mass



Choosing the Correct π^0

- Combinatoric issue. If we have multiple π^0 candidates, how do we decide which one to use?
- Cannot cut strongly on the Invariant Mass as this would bias the final selection in terms of phase space.
- Currently, just take the highest momentum π^0 candidate.
- What better discriminators are there? A Multi-Variate Analysis is being investigated.



Purity and Efficiency for the Selection(s)

- The final selection statistics for the Tracker + ECal branch of the CCπ^0 selections are shown below. This will be optimised this with respect to the efficiency x purity metric.

	Exclusive Selection	Inclusive Selection
Purity	20.8%	71.6%
Efficiency	1.0%	1.3%
Efficiency x Purity	0.009	0.024

Summary

- Tracker+ECal selections for CCπ^0 Inclusive and Exclusive events in the T2K ND280 are in the final stages of optimisation.
- A utility which can be run to constrain parameters has been developed. This will be used to maximise the efficiency x purity metric.
- The primary physics goal of this analysis will be to measure the cross section of charged-current single π^0 production in the T2K near detector. It could also provide a constraint to future T2K oscillation analyses.