

Wire-Cell PR selection: truth-matching update

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SBND Wire-Cell Meeting
Oct 1st, 2026



Updates

1. I have updated the way I perform truth-reco matching to use charge cluster overlap instead of 'nearest' association.
2. I have looked at the $\nu_e CC$ efficiency on the nue sample.
3. I have extracted POT information from stage1 files to be able to compare data vs MC + offbeam data for purity.

Efficiency/Purity

$$\text{Efficiency} = \frac{\text{signal } \nu \text{ of class X, whose best-matched}^* \text{ candidate passes the selection for X}}{\text{all signal } \nu\text{'s of class X}}$$

$$\text{Purity} = \frac{\text{selected candidates of class X whose best-matched}^* \text{ true } \nu \text{ is class X}}{\text{all selected candidates of class X}}$$

* both definitions require **matching** between true neutrinos and reco candidates

Truth-reco matching

- Moving to a **charge overlap** approach, instead of ‘nearest’ match.
- Build **IoU matrix** between reco and true objects (same approach used by SPINE)
 - Matrix is unique, but matching might not be bi-directional.
 - Match is the max value over row (for purity) or column (for efficiency)

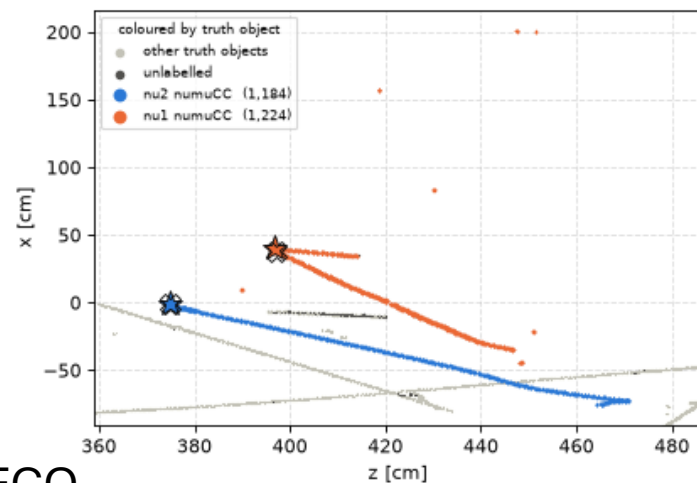
	Truth object #1	Truth object #2	...	
Reco object #1	IoU_11	IoU_12		
Reco object #2	IoU_21	IoU_22		
...				

$$IoU = \frac{shared\ pts}{(truth\ pts + reco\ pts - shared\ pts)}$$

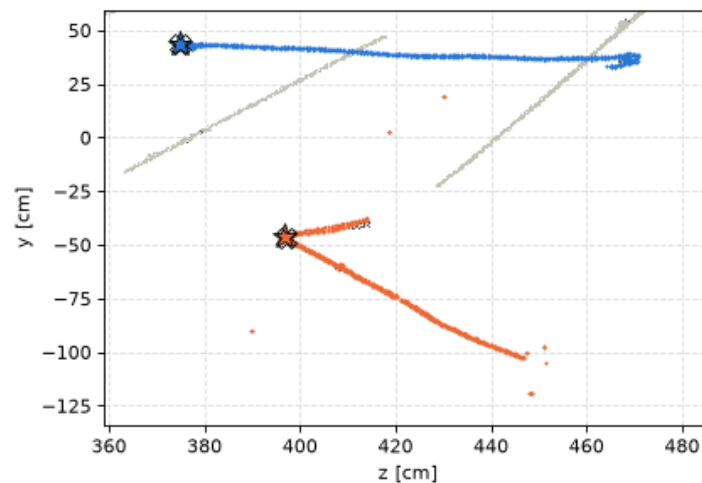
IoU = points shared / total points
where you remove double-counting
by subtracting shared from the total

Example 1

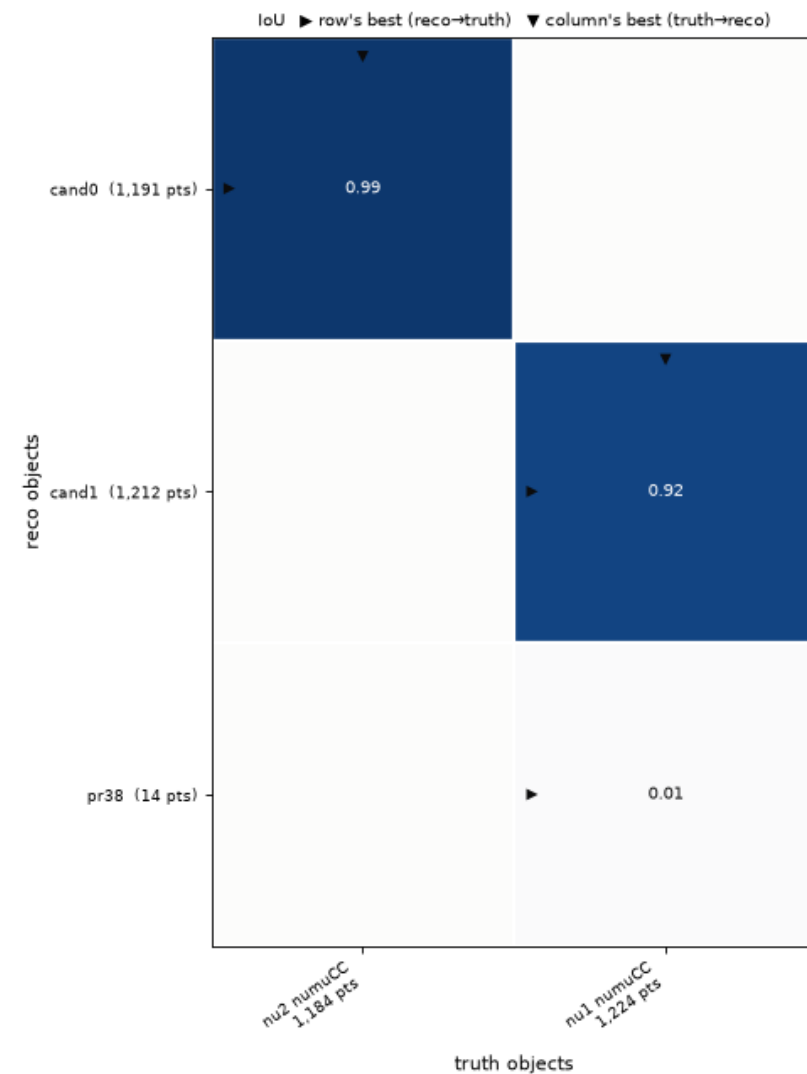
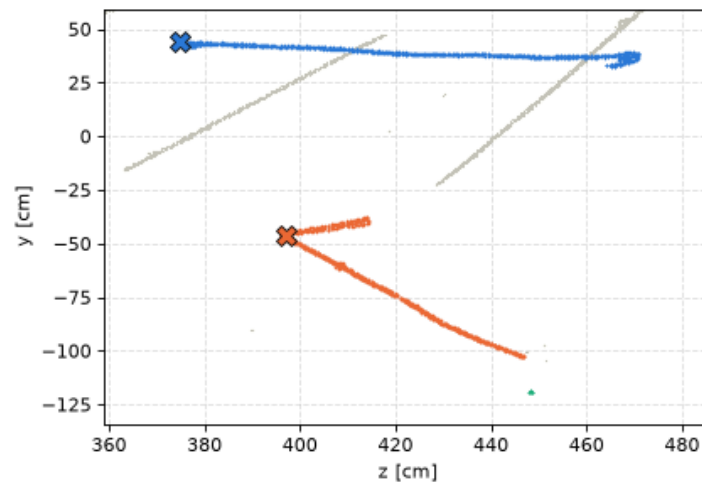
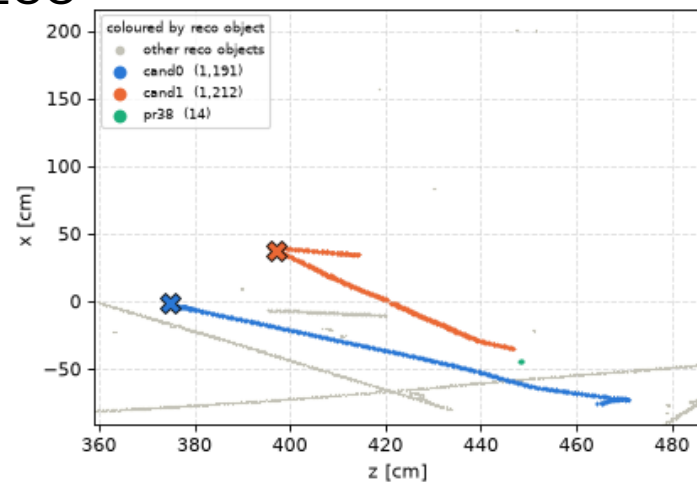
TRUTH



BNB MC -- r716 s92 e23: works: two candidates on two neutrinos



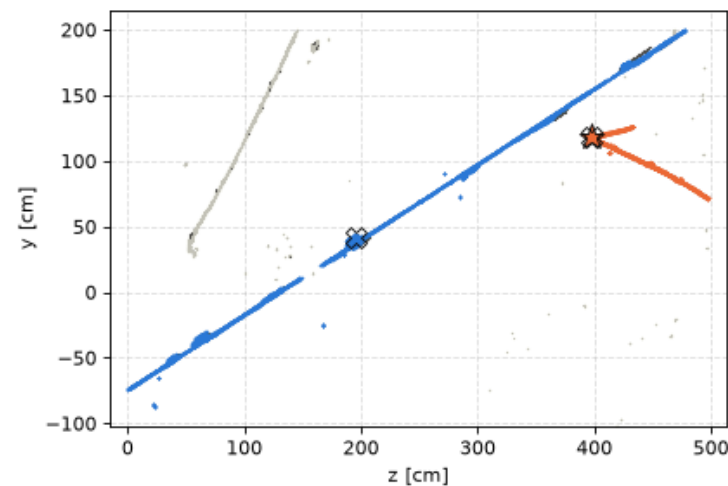
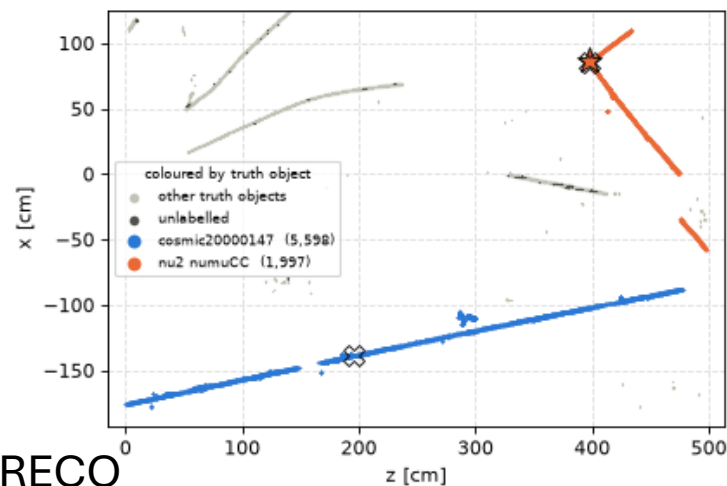
RECO



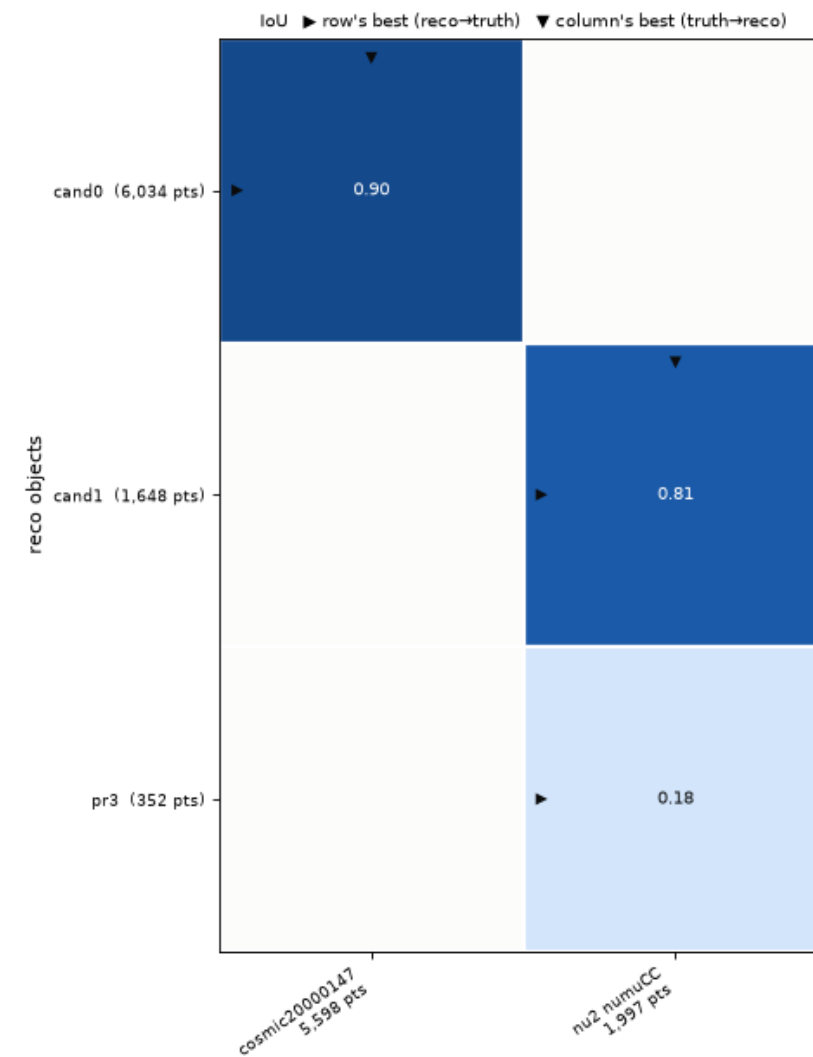
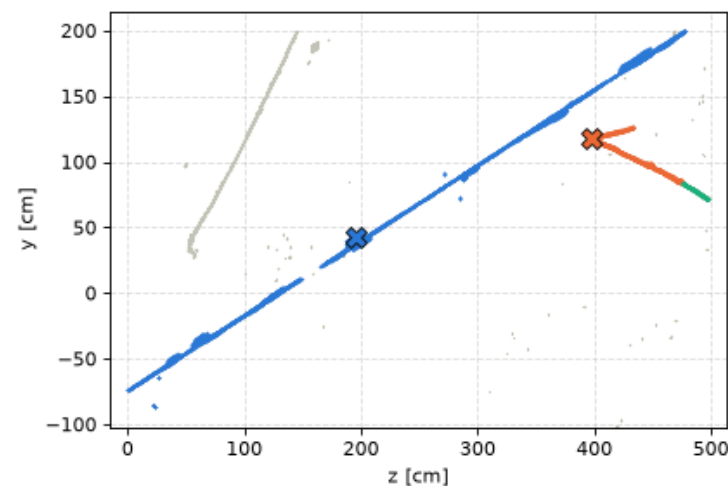
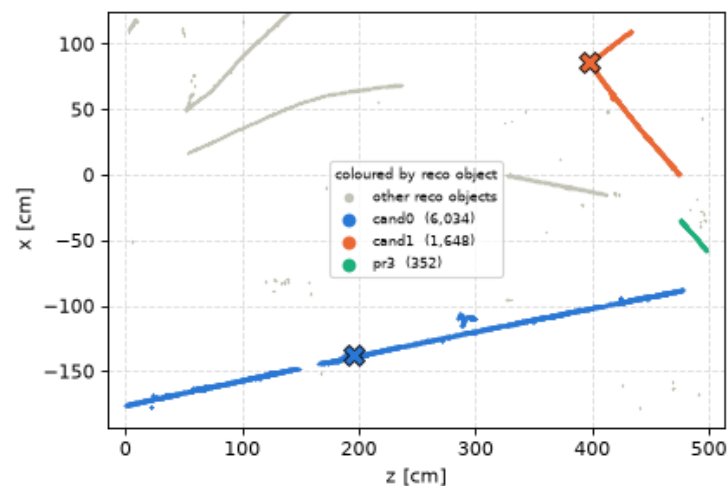
Example 2

TRUTH

BNB MC -- r712 s3 e46: vertex: 2nd candidate on already-matched nu | charge: cosmic



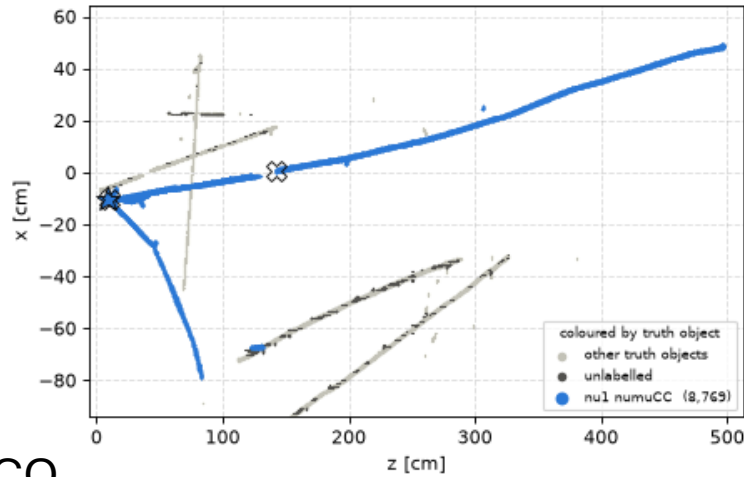
RECO



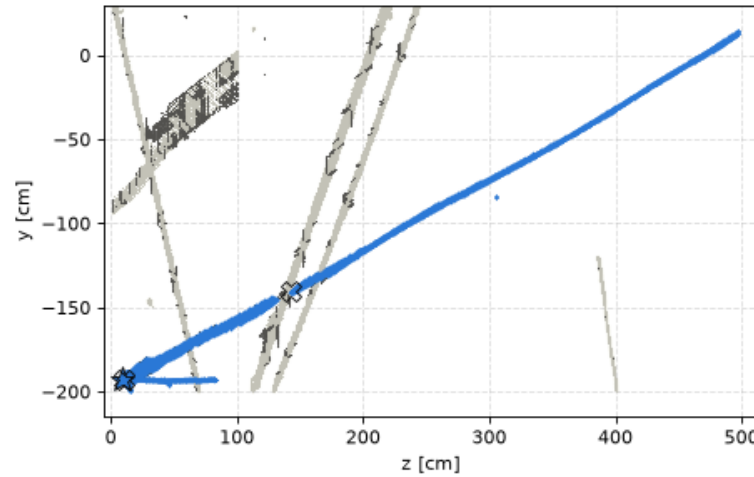
Example 3

Neutrino crosses the cathode → split in two candidates
Match is not bi-directional...

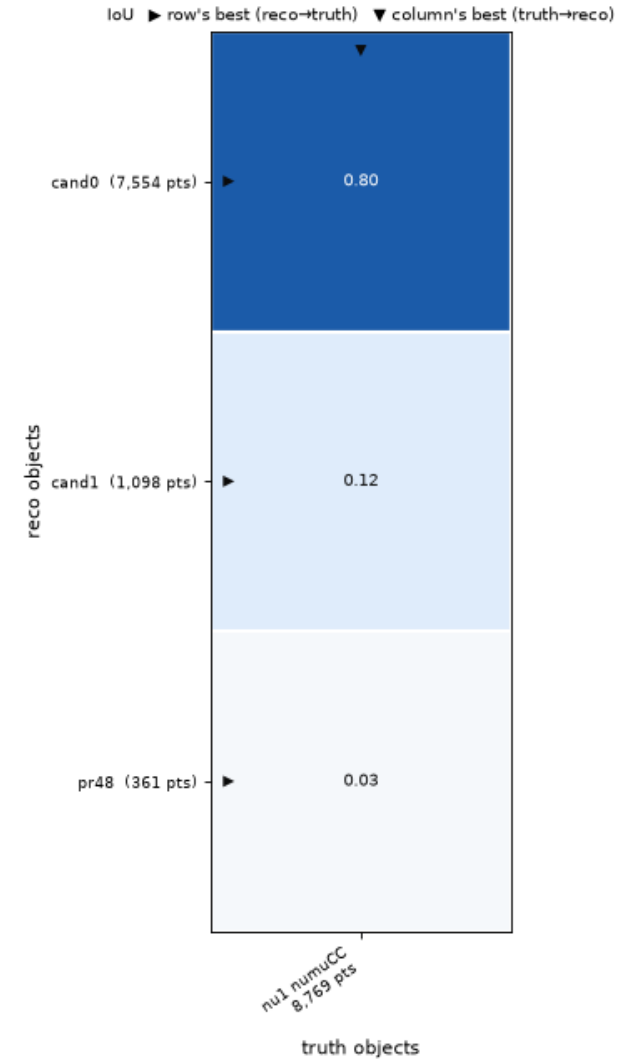
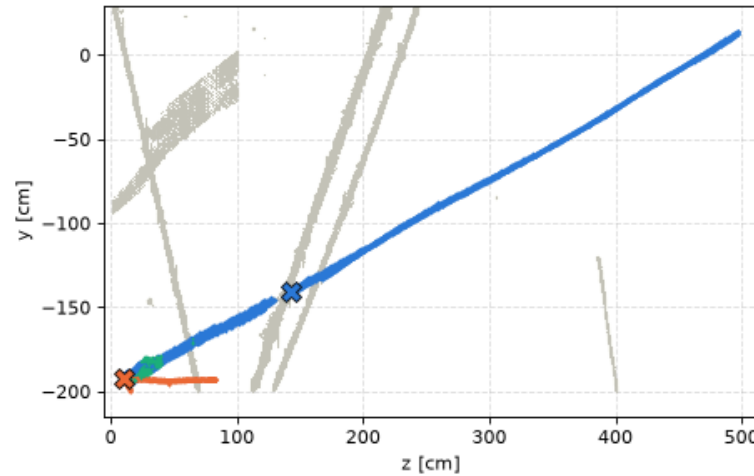
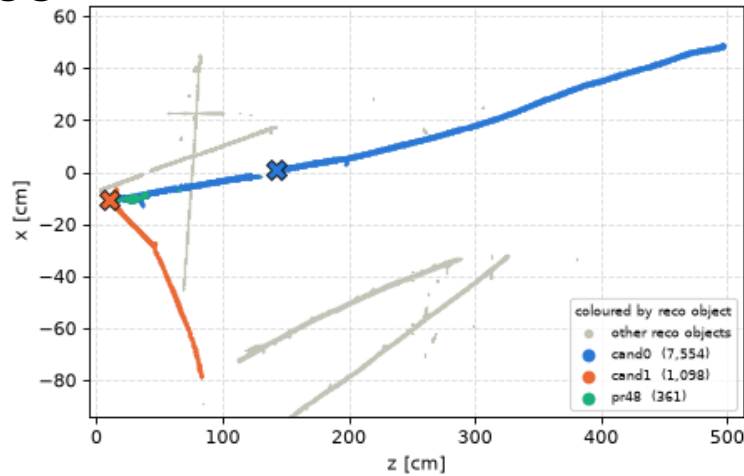
TRUTH



BNB MC -- r472 s36 e40: one way: a split between two candidates

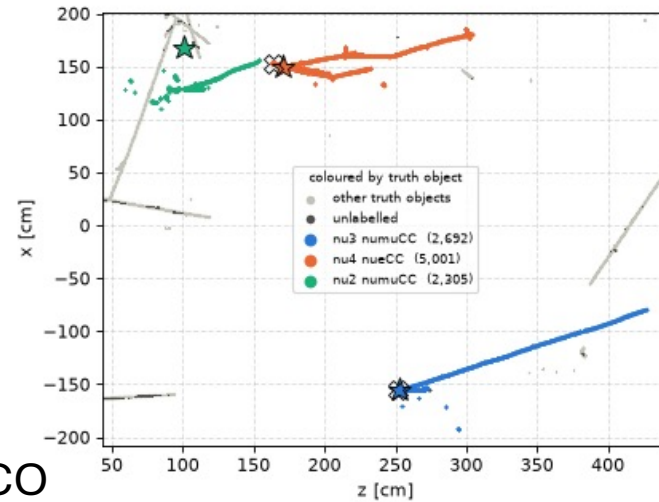


RECO

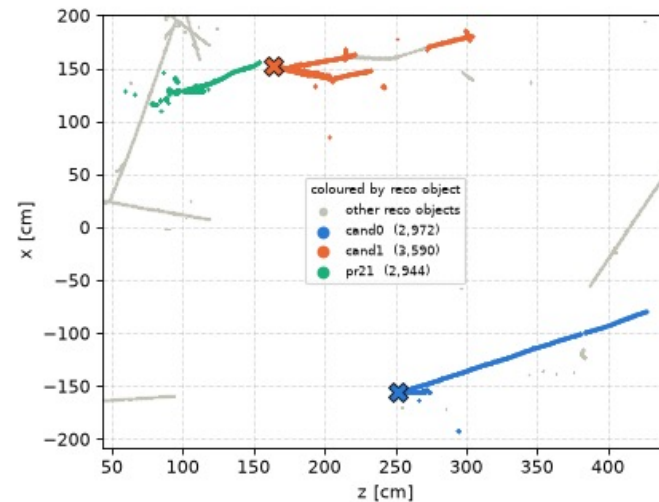


Example 4

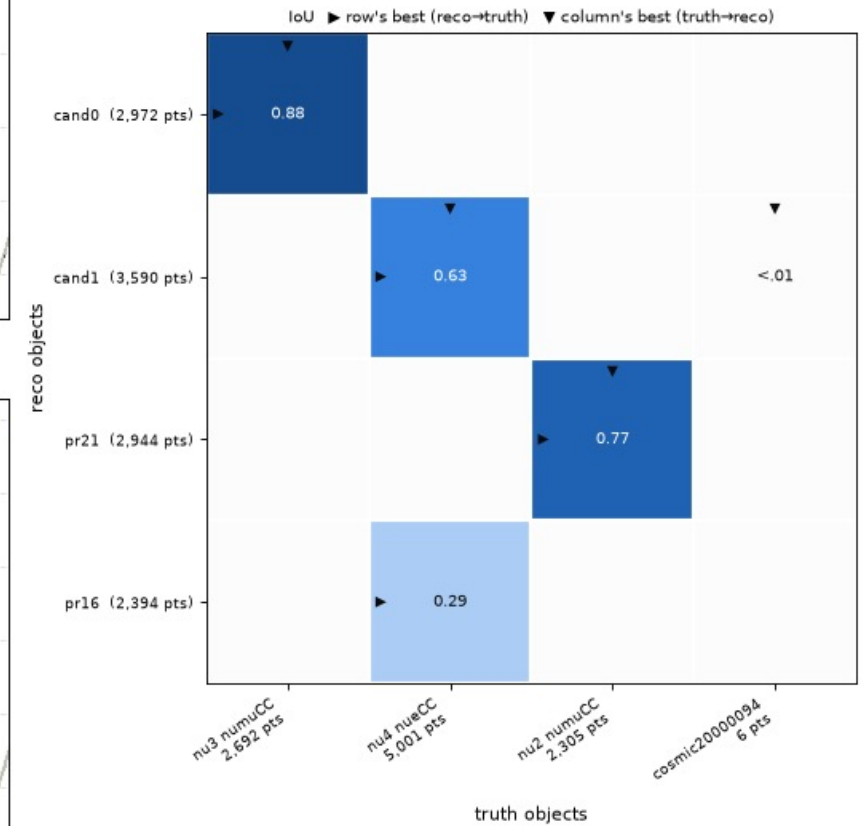
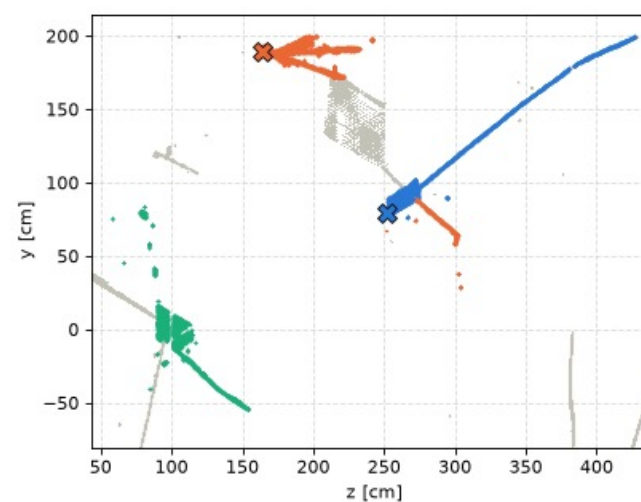
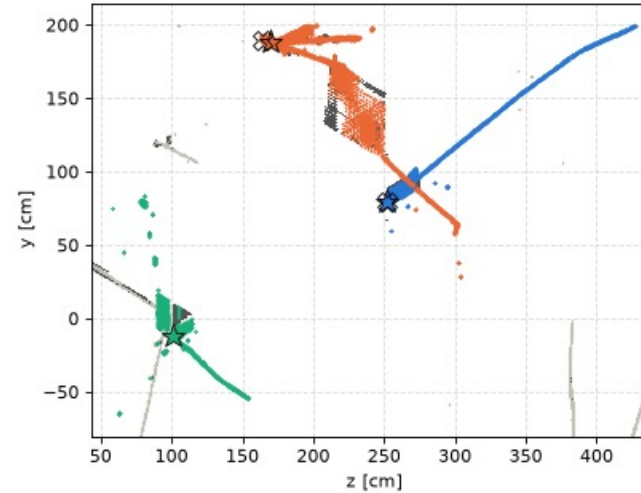
TRUTH



RECO

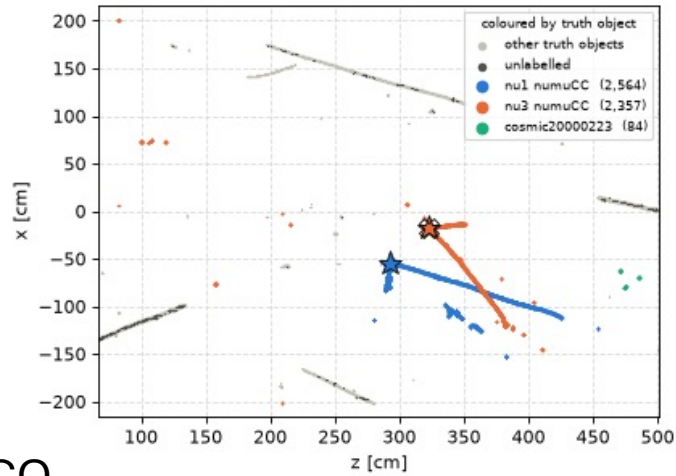


nueCC-filtered MC -- r291 s92 e697: works: two candidates among three neutrinos

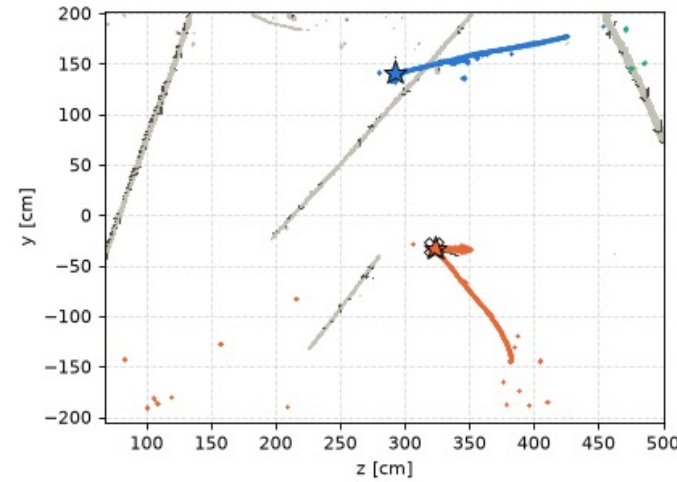


Example 5

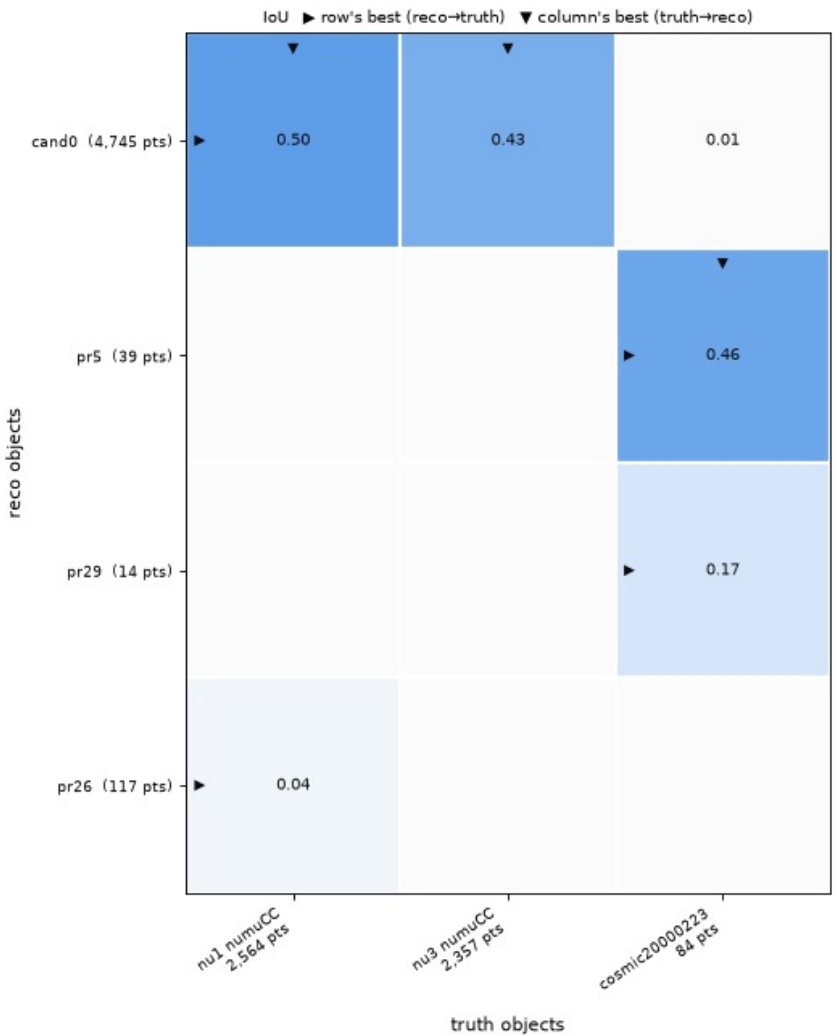
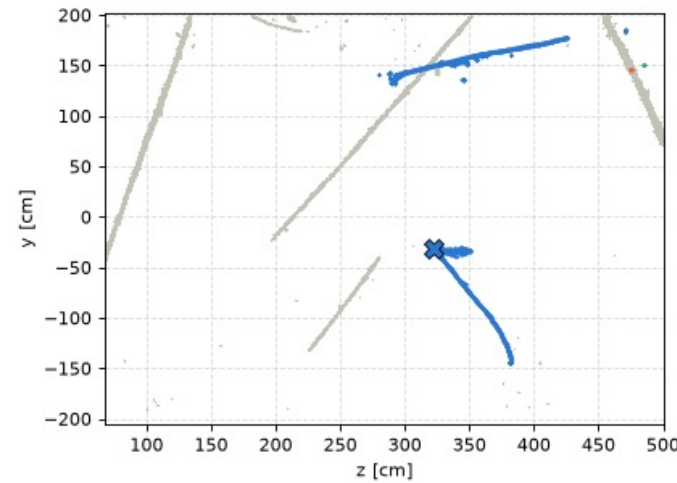
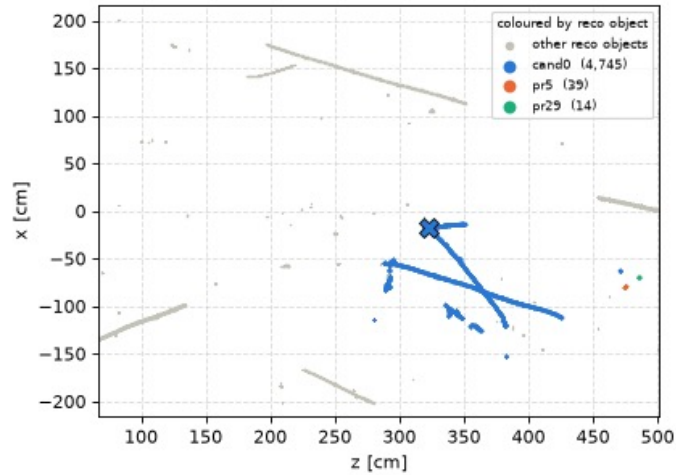
TRUTH



BNB MC -- r715 s47 e19: one way: two neutrinos in one candidate



RECO



Notes

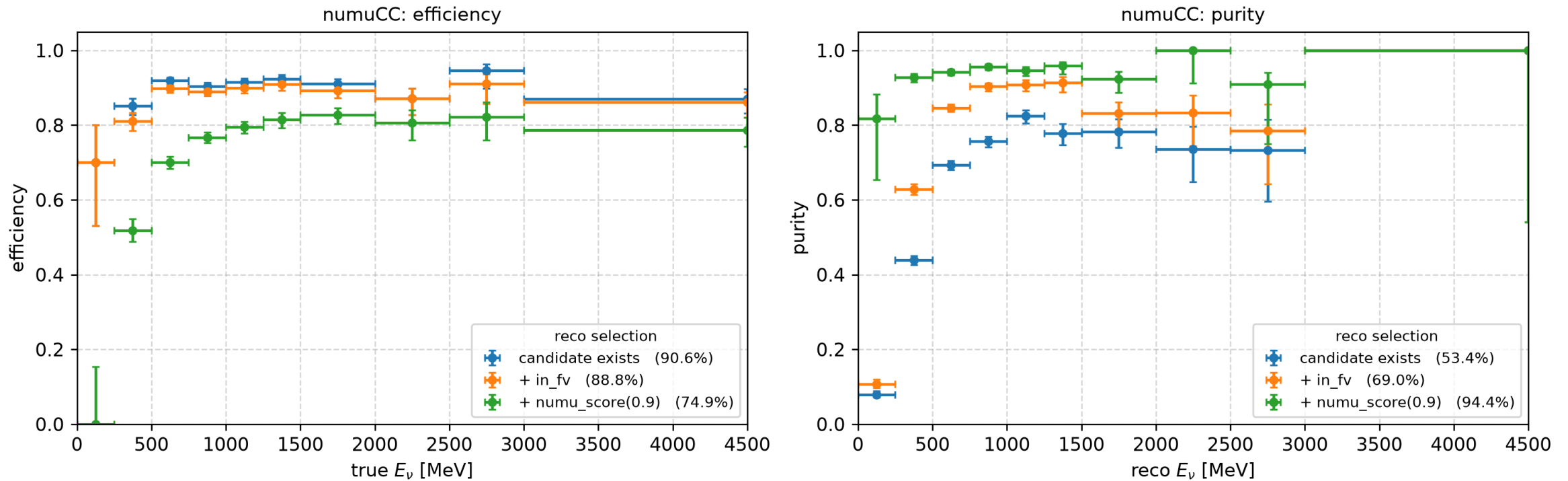
- Many clusters might be included in a Q-L bundle.
- Some of them end up being demoted/ignored when reconstructing the neutrino (T_kine output)
 - e.g., tagged as cosmic and removed when summing up reco_Enu.
- What survived this cleanup was not explicitly recorded.
- Xin has prepared an [update](#) to fix it.
- The current matching uses the segments stored in the Bee particle-flow tree → for both truth and reco.

$\nu_\mu CC$ efficiency/purity

BNB MC

Based on the new truth-reco matching

BNB MC -- numuCC: signal = true: in_fv & edep_min(100) & numucc

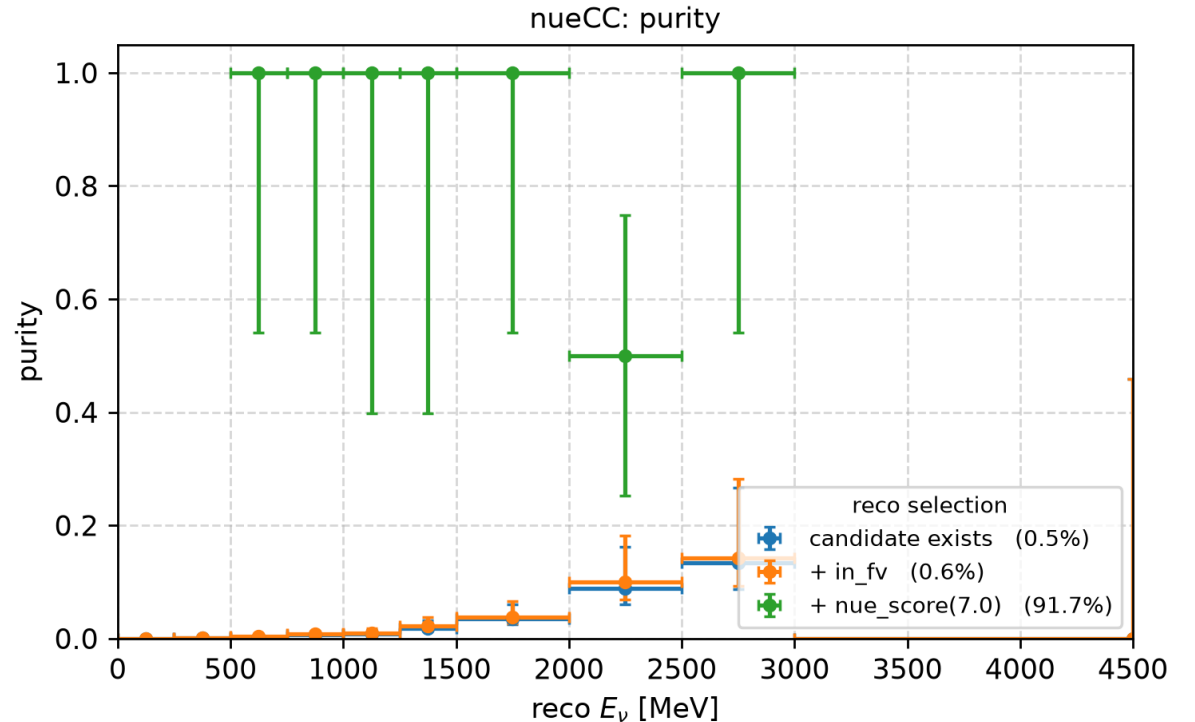
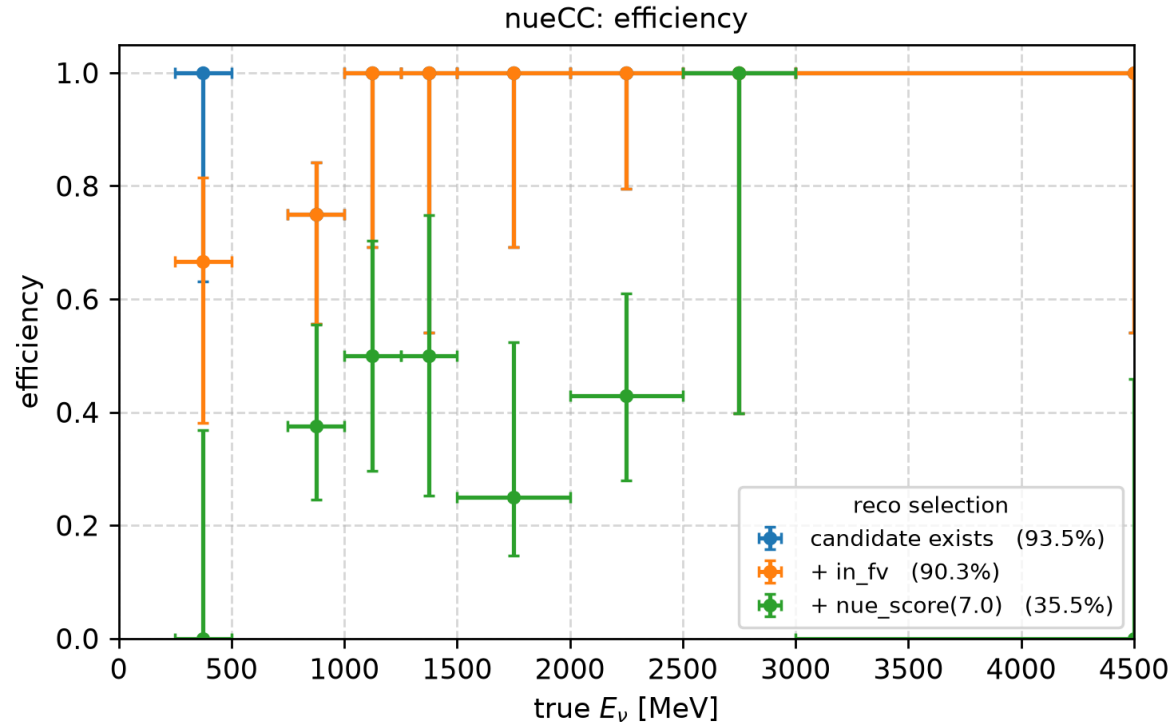


$\nu_e CC$ efficiency/purity

BNB MC

Based on the new truth-reco matching

BNB MC -- nueCC: signal = true: in_fv & edep_min(75) & nuecc

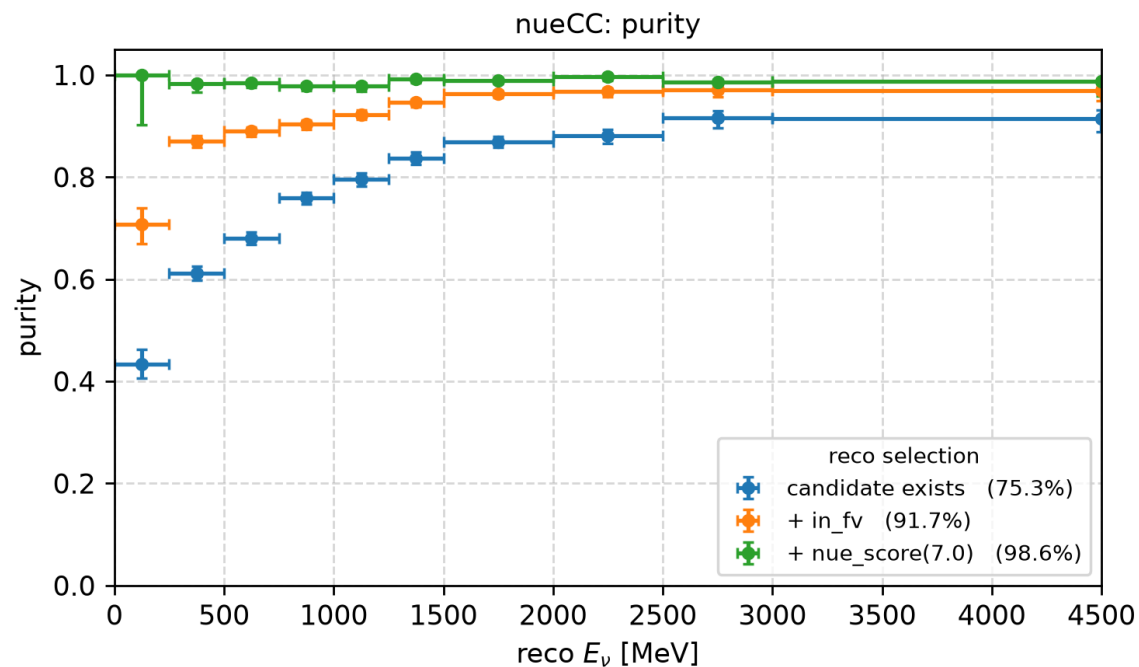
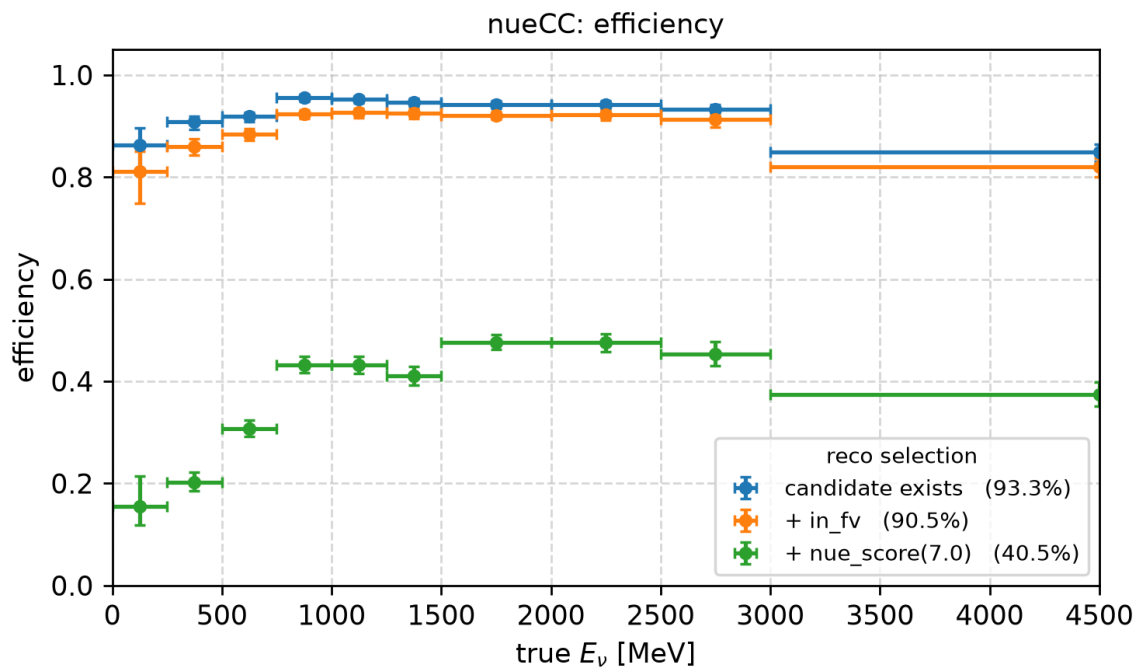


$\nu_e CC$ efficiency/purity

nue-filtered MC

Based on the new truth-reco matching

nueCC-filtered MC -- nueCC: signal = true: in_fv & edep_min(75) & nuecc
every event holds a true nueCC: purity counts only what shares an event with one

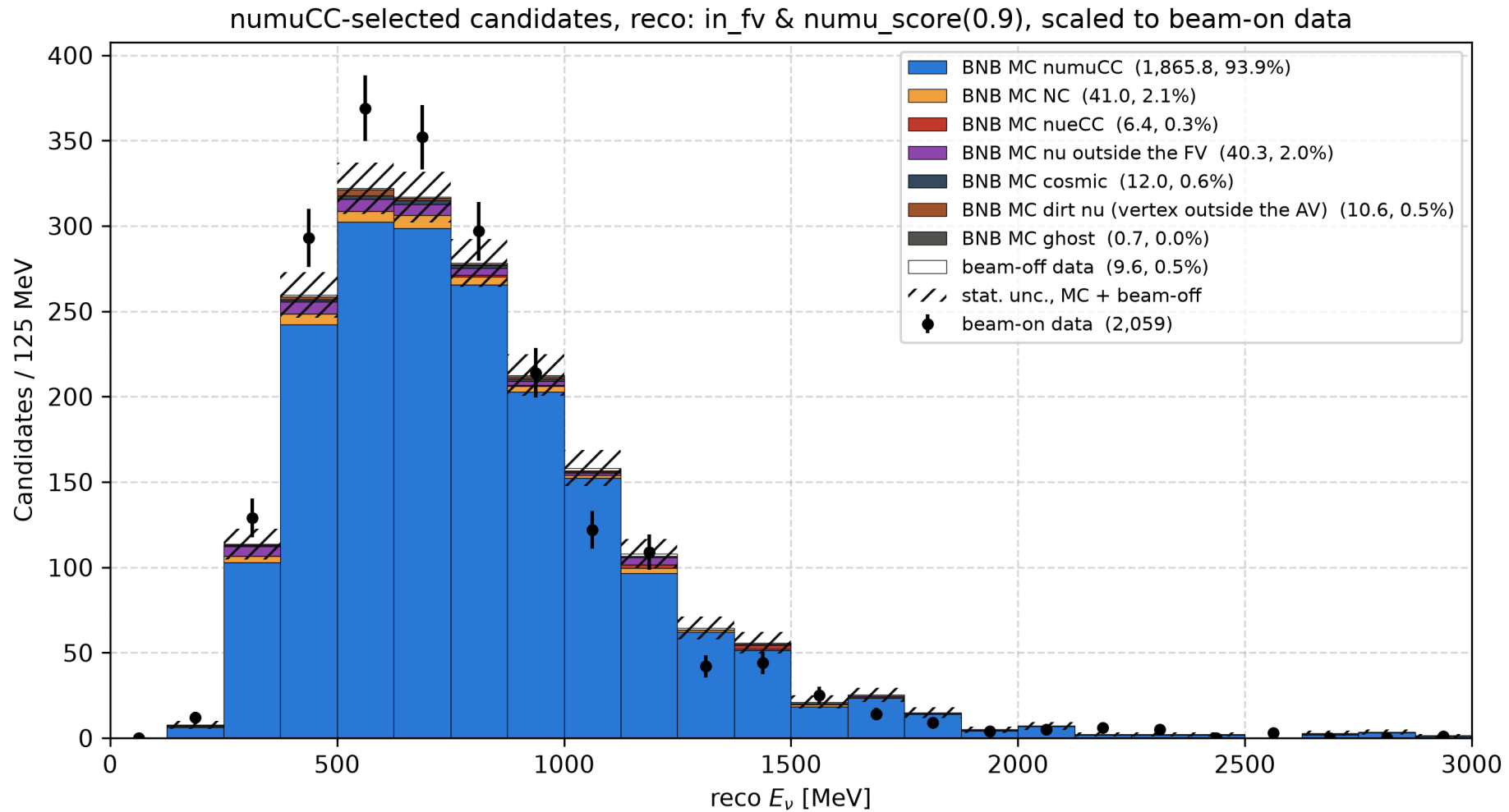


POT Dumper

- I wrote a quick and dirty POT dumper module:
 - <https://github.com/SBNSoftware/sbndcode/commit/564cc6d8bb831d47c0d8b46ed193c23d192307ad>
- Combining the official POT producers + simple analyzer module to dump POT summary into a CSV file.
 - Input: reco1 files
- MC rescaled: $MC = MC * \frac{POT_{data}}{POT_{MC}};$
- Off-beam rescaled: $off = off * (1 - f) \frac{G_{data}}{G_{offbeam}} \quad (f=0.0725)$

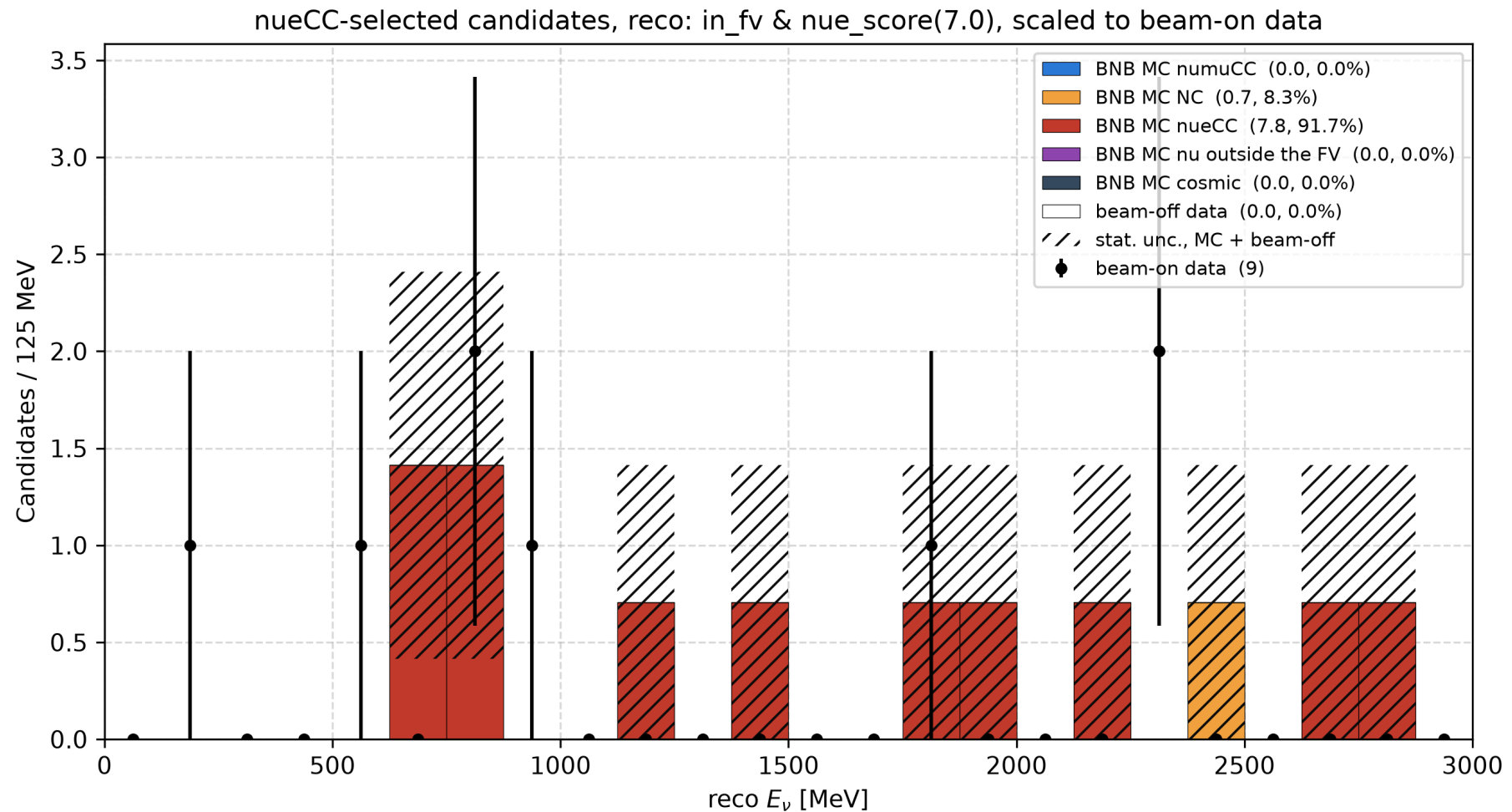
Stacked plot $\nu_\mu CC$

Data POT 5.109e+17



Stacked plot $\nu_e CC$

Data POT 5.109e+17



Back-up

Updates

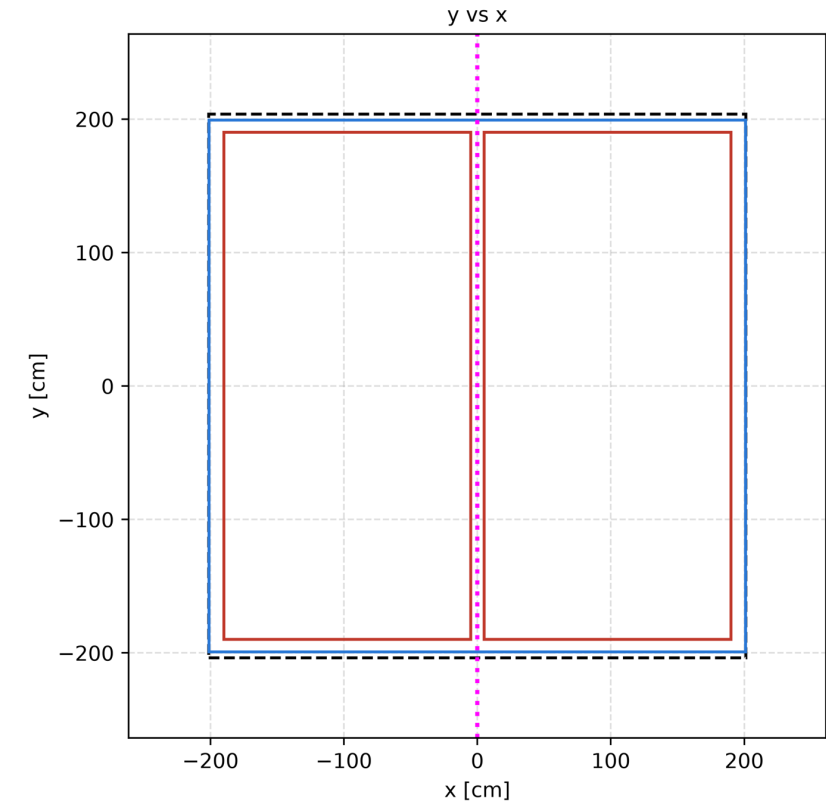
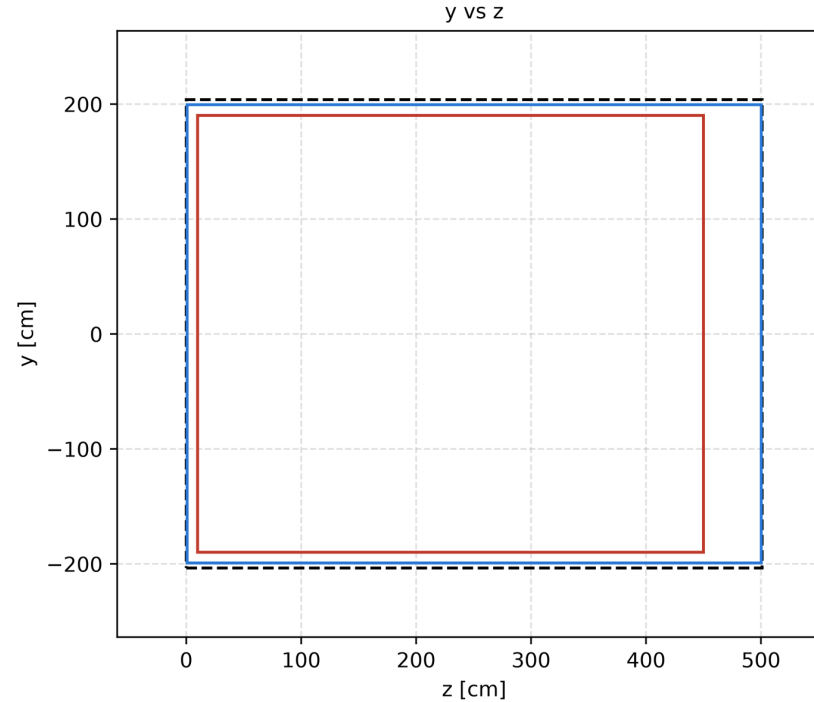
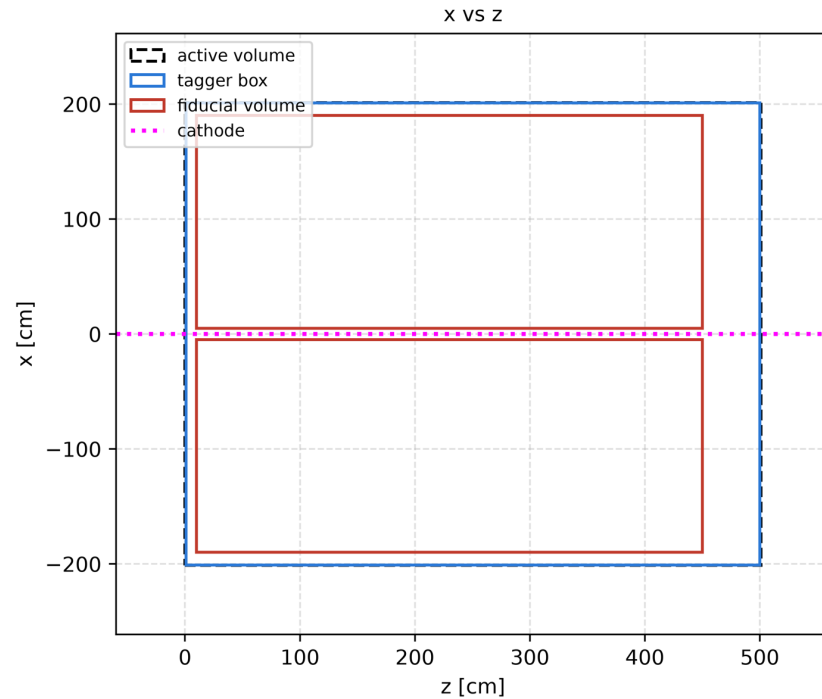
Previously:

- Signal = true ν_μ CC (ν_e CC) with edep > 0 MeV and vertex in AV
- Selection:
 - PR selects neutrino candidate (implicit)
 - BDT numu (nue) score

New:

- Signal = true ν_μ CC (ν_e CC) with edep > 100 MeV (75 MeV) and vertex in FV
- Selection:
 - PR selects neutrino candidate (implicit)
 - Reconstructed vertex in FV
 - BDT numu (nue) score

Fiducial volume



10 cm inward from each wall.
50 cm inward from the downstream z wall
5 cm away from each side of the cathode

Selection cuts

Signal for $\nu_\mu CC$: edep > 100 MeV && vertex in FV

Progressive cuts	Efficiency	Purity
Candidate exists	3,265/3,500 = 93.3%	3,265/6,076 = 53.7%
+ vertex in FV	3,192/3,500 = 91.2%	3,192/4,605 = 69.3%
+ numu_score > 0.9	2,647/3,500 = 75.6%	2,647/2,799 = 94.6%

Signal for $\nu_e CC$: edep > 75 MeV && vertex in FV

Progressive cuts	Efficiency	Purity
Candidate exists	29/31 = 93.5%	29/6,076 = 0.5%
+ vertex in FV	28/31 = 90.3%	28/4,605 = 0.6%
+ nue_score > 7.0	11/31 = 35.5%	11/12 = 91.7%