NUE SELECTION IN THE ND280 UPGRADE

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OUTLINE

- NuE simulation update
  - new analysis samples generated → respin the efficiency analysis
- NuE topology selection
  - first look at the CC0π/CC1π/CCOther selection
- Iso-target electron selection
  - gain efficiency with selecting iso-target electrons

NUE SELECTION GENERAL PLAN

lepton from ν

1. Select Highest Momentum track with $p > 200\ MeV/c$
2. Make sure it comes from Target/FGD
3. Track has long segment in TPC

Identify electron

4. Use TPC dE/dx info
5. Additional PID
   a) main track uses ECal → ECal segment is shower-like
   b) main track doesn't use ECal → more strict dE/dx cut

6. Veto cuts
   - TPC/ECal upstream veto, pair veto

if unsuccessful with TPC → look for iso-target electrons

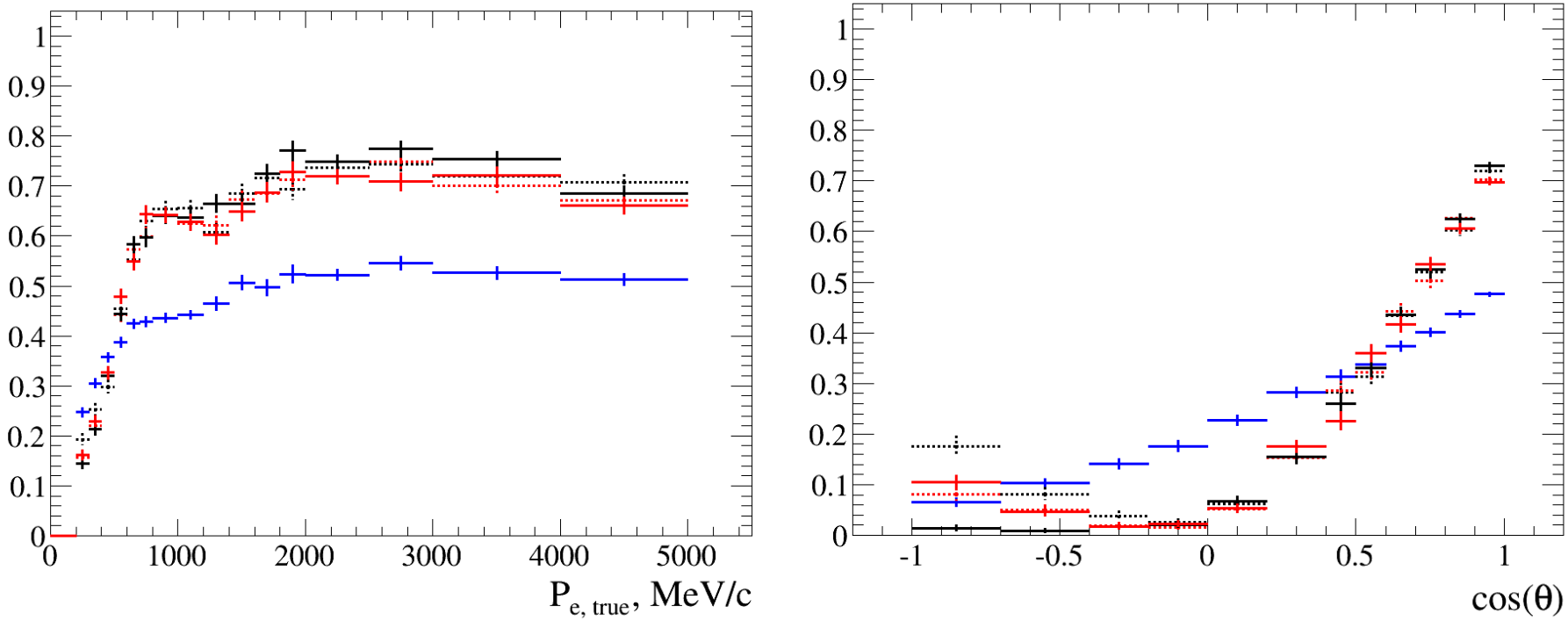
Separate topologies
CC0π, CC1π, CCOther

NUE SIMULATION UPDATE

- From the previous workshop:
  - All electron tracks with $p > 100$ MeV are stored
  - Nu spectrum bug fixed

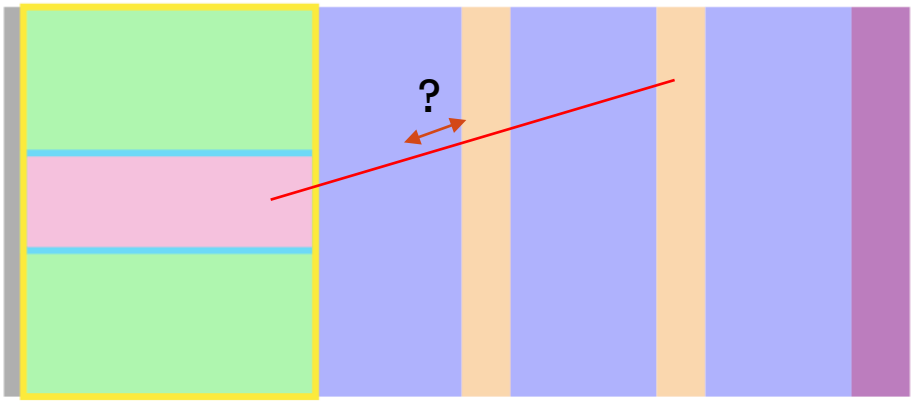
by Davide & Claudio

- Apply the NuE selection for the new files
  - efficiency for the TPC NuE CC inclusive selection:



FWD/BWD TRACK SEPARATION

- Reconstruct the track direction:
  - by default all tracks are forward going
  - if 2 detectors successfully determine timing → can specify track direction
- What is "successfully determine timing":
  - have 2 detectors for timing determination with $(t_1, \sigma_1), (t_2, \sigma_2)$ compare $t_1 - t_2$ vs $N\sqrt{\sigma_1^2 + \sigma_2^2}$.
  - test N=0,2,3



FWD/BWD TRACK SEPARATION

600 ps no TarToF	Target		FGD1		FGD2		Total	
	Eff	Pur	Eff	Pur	Eff	Pur	Eff	Pur
0	53.2	65.1	50.3	69.8	44.6	60.9	43.2	65.2
2 sigma	54.3	66.7	51.5	71.5	49.2	71.7	45.0	69.3
3 sigma	54.4	66.6	51.4	71.5	49.3	71.8	45.0	69.3

2σ difference in timing is enough for flipping the track and preventing false flipping

2 sigma	Target		FGD1		FGD2		Total	
	Eff	Pur	Eff	Pur	Eff	Pur	Eff	Pur
600 ps	54.3	66.7	51.5	71.5	49.2	71.7	45.0	69.3
600 ps*	54.9	71.7	51.7	71.2	49.4	72.3	45.3	71.7
150 ps	54.4	66.6	51.4	71.6	49.3	71.9	45.0	69.3
150 ps*	54.8	71.7	51.7	70.9	49.4	72.3	45.3	71.6

No significant difference between time counters configurations

* additional ToF counters over target

NUE TOPOLOGY SELECTION

- With T2K-II proposed statistics ($20\times10^{21}POT$) can try to select NuE topologies

- Look for pions with:
  - TPC tracks:
    - long TPC track
    - PID based on the dE/dx
    - e^+/e^- besides main one are treated as π^0
  - Iso-target tracks:
    - track starts and ends inside target
    - use PID accuracy from target simulation studies
    - separation μ/π from e/p is 70% effective (8% contamination)
    - separation e from p is suggested 100% effective

NUE TOPOLOGY SELECTION

- Use NuE selection with TPC to separate topologies
- Purity is based on the NuE samples only at the moment

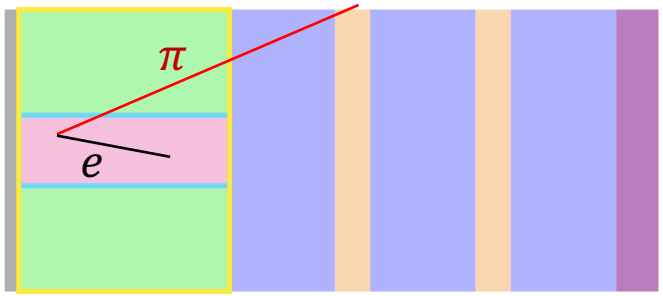
Purity	**Target**	**FGD1**	**FGD2**	**Total**
CC0π	68.3	61.4	60.2	**63.5**
CC1π	62.1	67.5	65.5	**64.8**
CCOther	48.0	67.4	65.8	**54.5**

- First look:
  - Target is good for CC0π and not so good for CCOther → further tuning of iso-target pion selection needed
  - Overall purity is about 55-60%
- Next steps:
  - check the purity for NuE+NuMu samples
  - investigate the background
  - study the possibility of ECal usage

ISO TARGET NUE SELECTION

- With dE/dx = 10 MeV/cm half of 1 GeV electrons stops at 1m while the target is 2m long
- Low efficiency for target for FWD/BWD going tracks

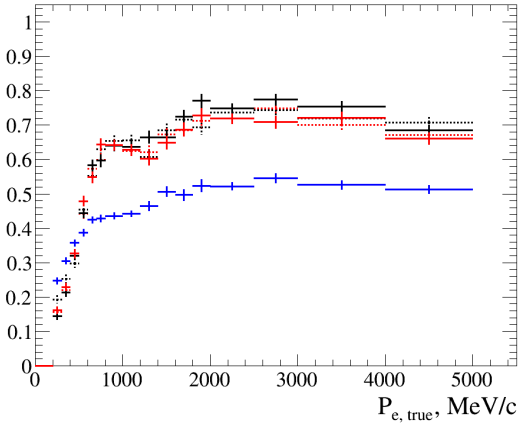
- Simplified iso-target electron selection:
  1. No successfully selected TPC electron track
  2. Find all the iso-target tracks
  3. Look for long (L > 60cm) track
  4. Identify as <u>not</u> a μ/π

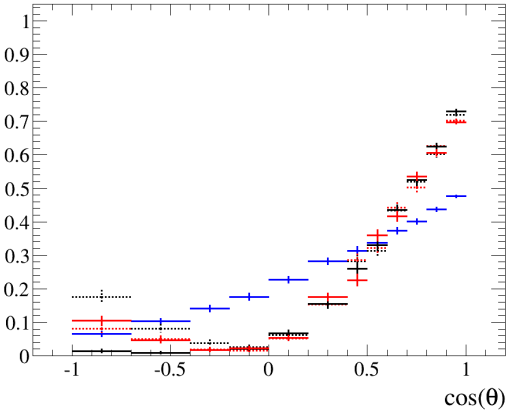


Next steps:

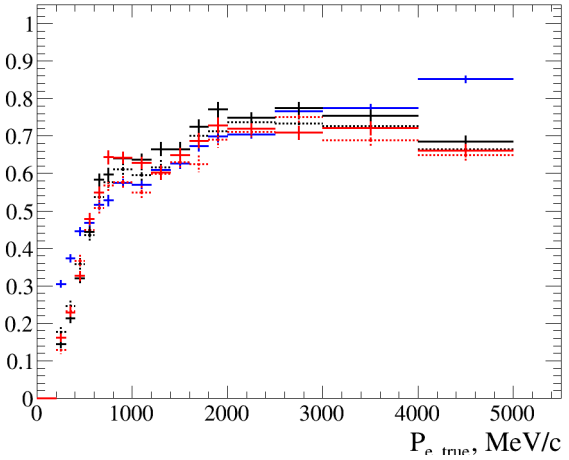
- use detailed target PID based on true momentum/theta
- optimize track length cut

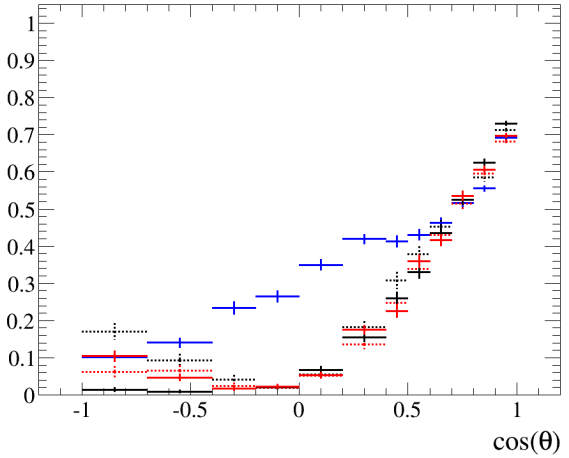
ISO TARGET NUE SELECTION





Select iso-target electrons





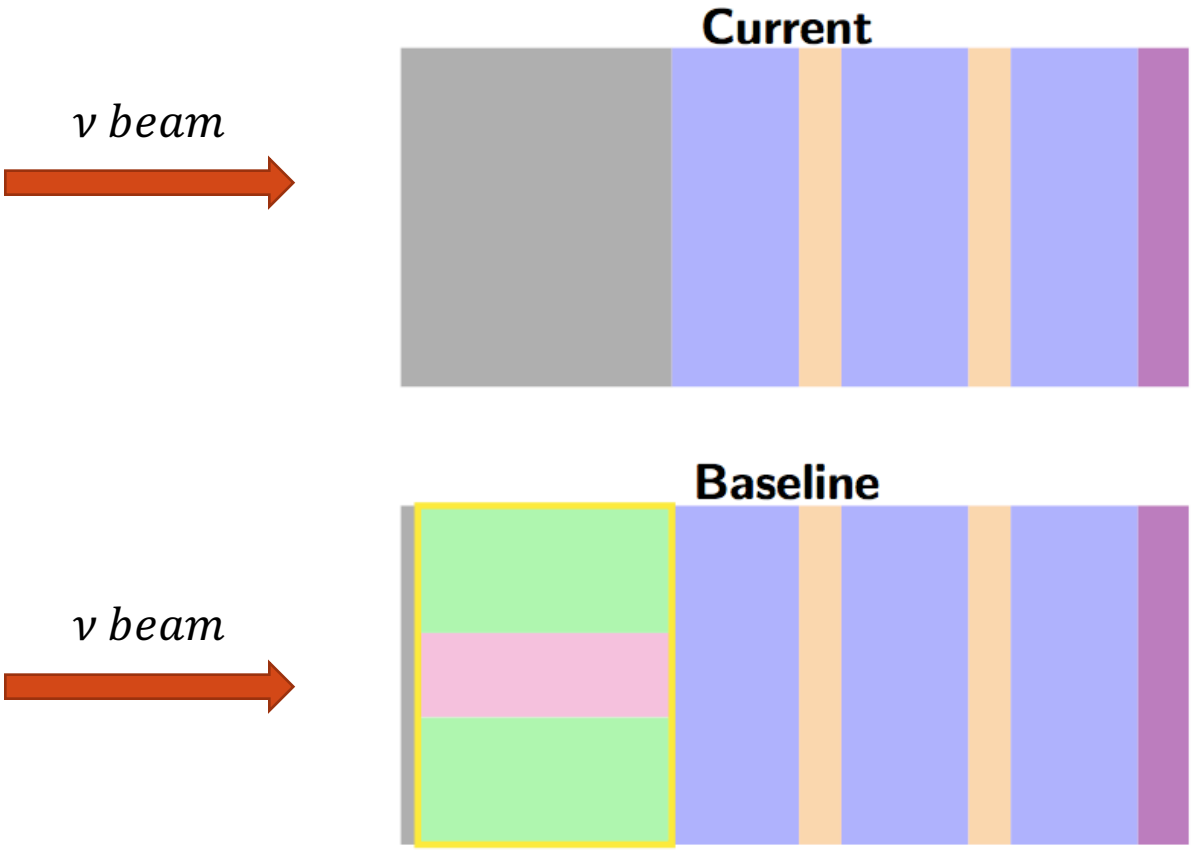
Purity for target remains high
66.7% → 66.5%
But further investigation needed

SUMMARY

- NuE simulation update fixed some bugs
  - analysis were rerun over the new files
- NuE topology selection
  - first look at the CC0π/CC1π/CCOther selection done
  - with the NuE samples
  - further plans:
    - check the purity for NuE+NuMu samples
    - investigate the background
    - study the possibility of ECal usage
- Iso-target electron selection
  - first simplified estimation of efficiency gain done
  - target efficiency reached the FGD one
  - further plans:
    - use detailed target PID based on true momentum/theta
    - optimize track length cut

BACK UP

CONFIGURATIONS

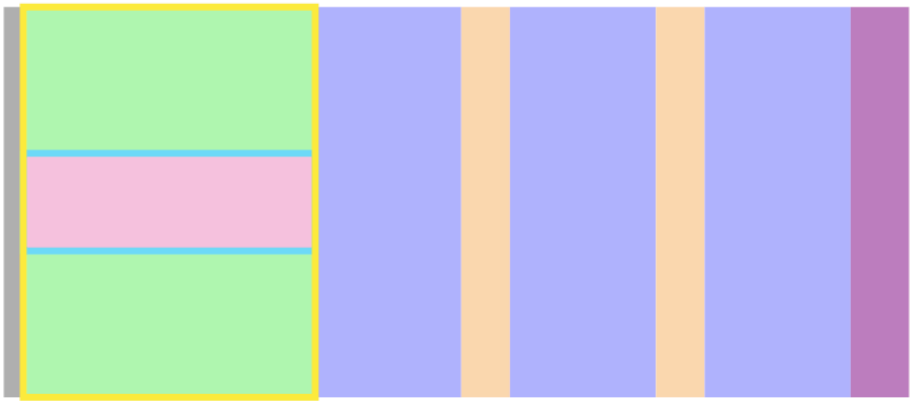


New target, FGD, VTPC, HTPC, P0D, DsECal, ToF counters

Schematics not on scale, only basket is represented

TOF MEASUREMENT

- Configuration:



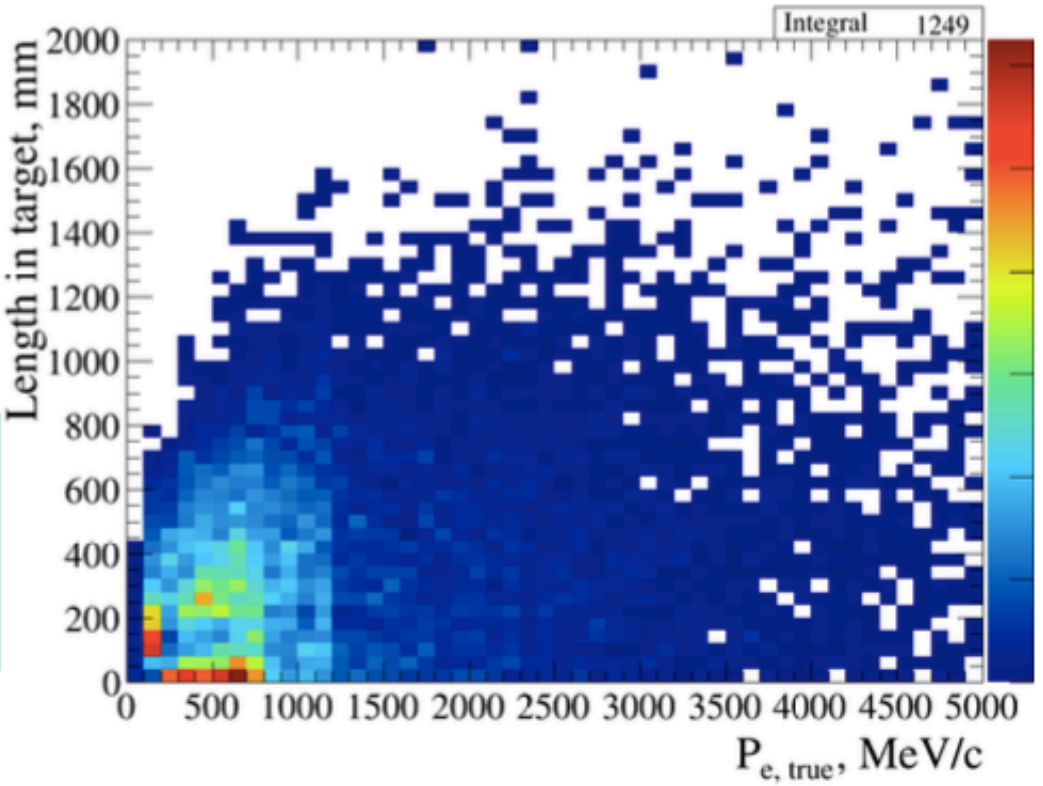
- 6 ToF counters around the Target+HTPC box
- 2 possible additionnal ToF counters between Target and HTPC

- Goals:
  - Separate forward/backward tracks
  - Separate protons/positrons
  - Reject OOFV. Expect small effect for NuE selection

ELECTRON IN THE TARGET

- Loose ½ forward going electrons → need to check this
- dE/dx for our energies is $\approx 10\ MeV/cm$
- For $p \approx 1GeV$ stop all electrons at 1 m → reduce efficiency for forward going electrons by factor of 2

Electron tracks that exit target VS initial momentum:



Impossible to detect forward going electrons from the first part of the 2 m target

Will be interesting to study iso-target electron tracks as we expect quite large amount of such events