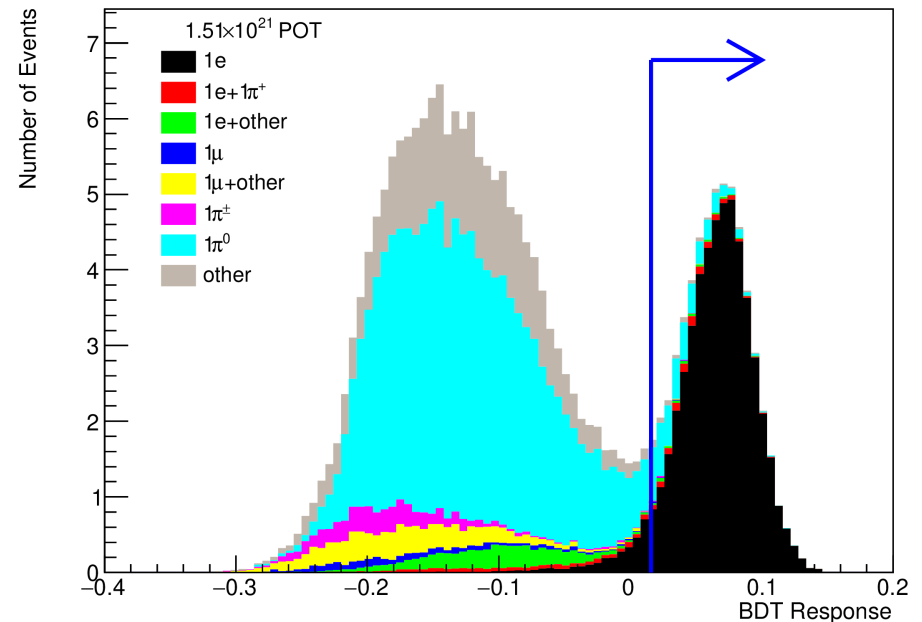# ν_e CCQE/CC1π^+ Selection Studies

Trevor Towstego
ν_e CCQE/CC1π^+ Meeting
December 12, 2019

New ν_e CCQE Sample

- Updated "intersection" plots comparing old vs. new ν_e CCQE samples

1.51×10^{21} POT	
osc. $\nu_e/\bar{\nu}_e$ CC	**other**
42.64	15.11
1e	**not 1e**
50.92	6.82

Old vs. New Comparison

| 1.51×10^{21} POT	osc $\nu_e/\bar{\nu}_e$ CC	int $\nu_e/\bar{\nu}_e$ CC	$\nu_\mu/\bar{\nu}_\mu$ CC	NC
old sample	40.17	8.14	0.27	4.26
new sample	42.43	8.90	0.17	5.55

Old vs. New: Intersections

- **Top left:**   **rejected by old, selected by new** ◄——— Plots on following slides
- Top right: rejected by both samples
- Bottom left: selected by both samples
- Bottom right: selected by old, rejected by new

Reconstructed π^0 Mass

nue CCQE/CC1pi+ Meeting
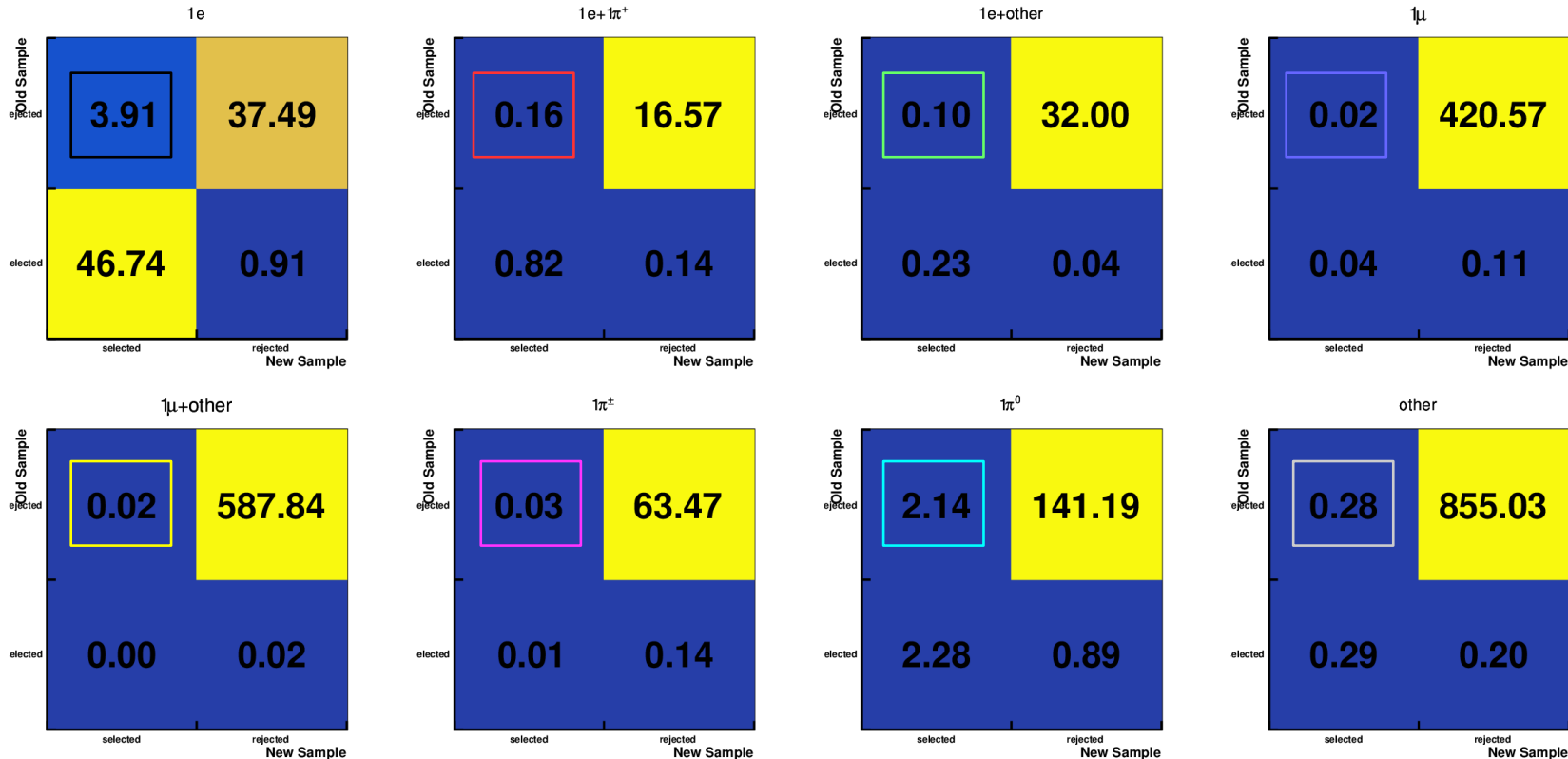
Reconstructed cos(θ_ee)
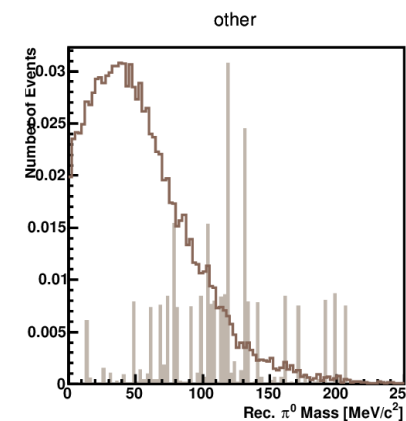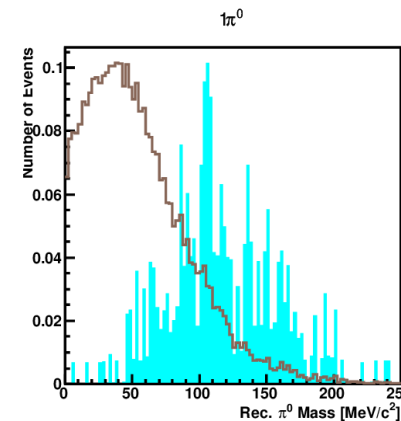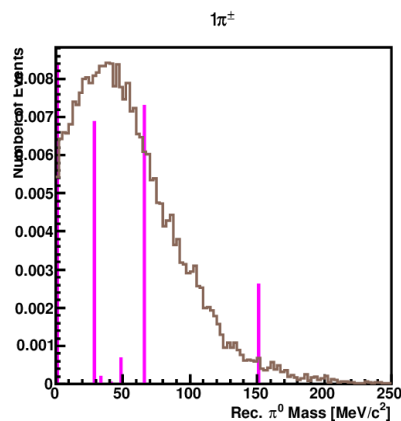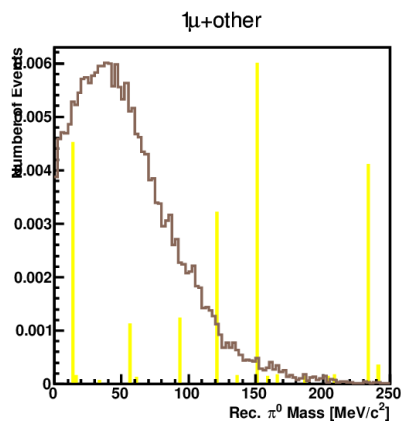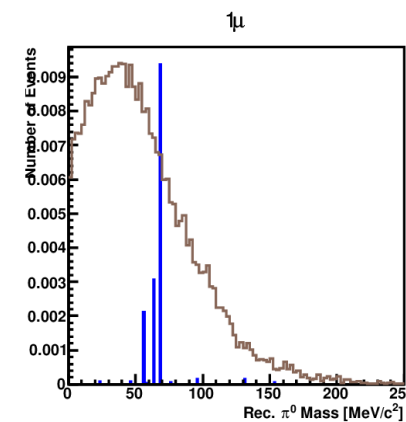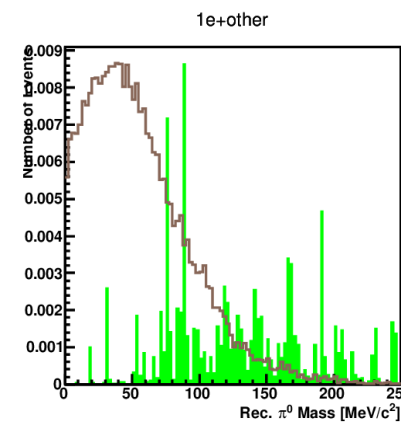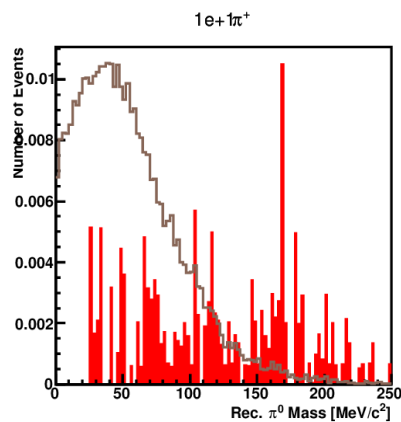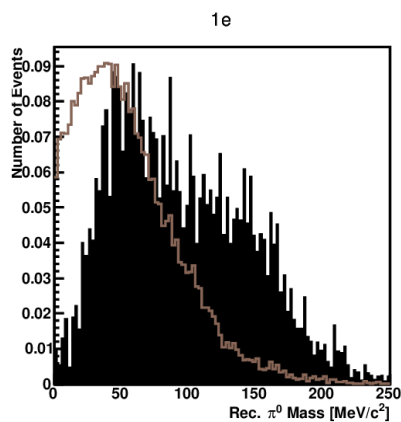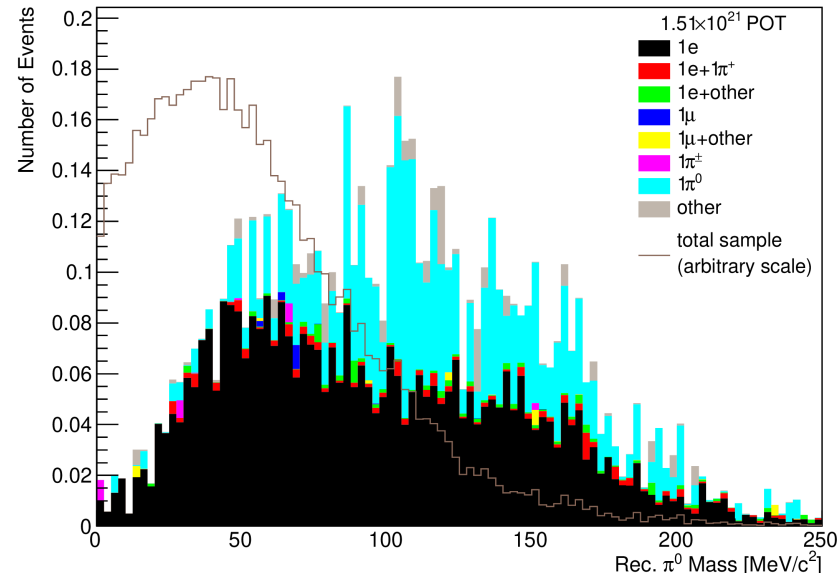
$$\text{Reconstructed } \cos(\theta_{ee})$$
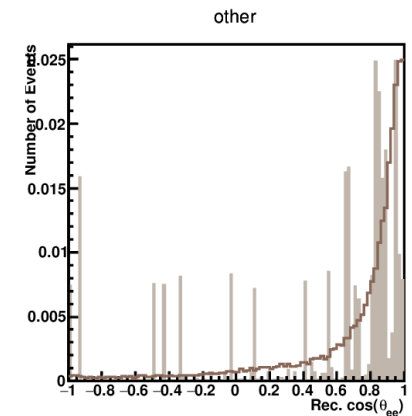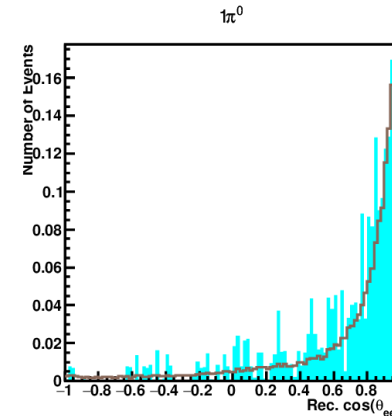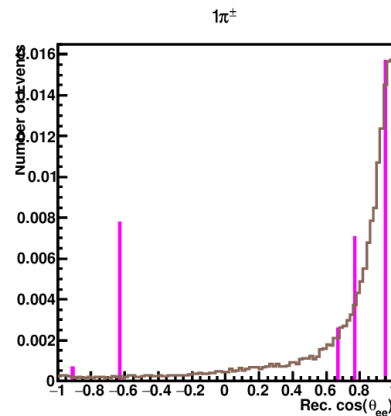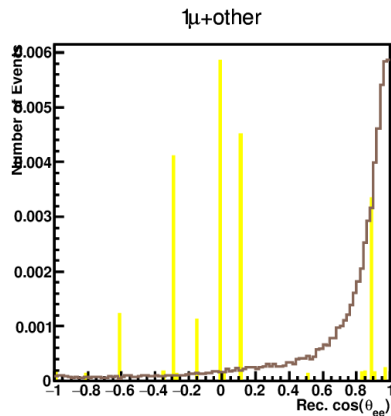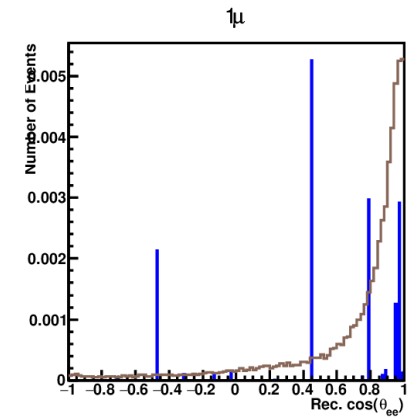
Reconstructed ν Energy
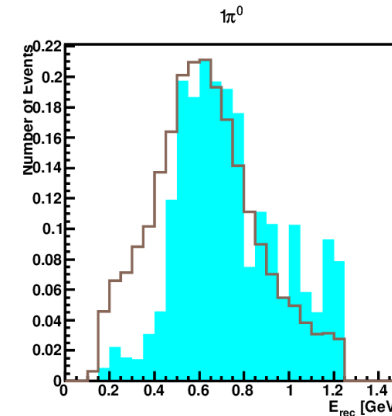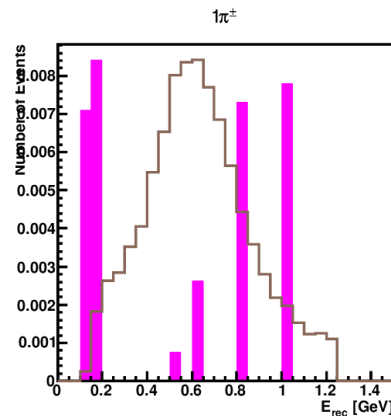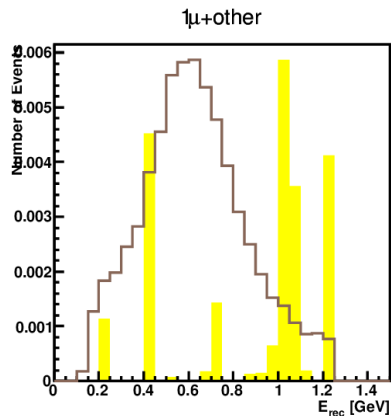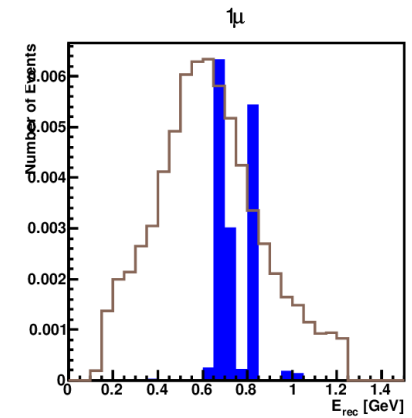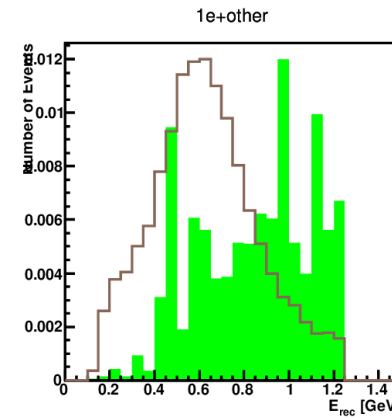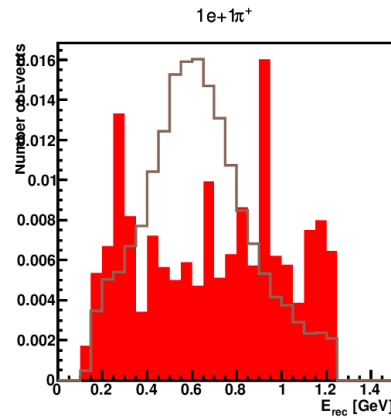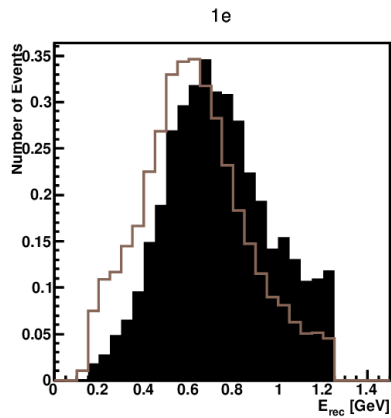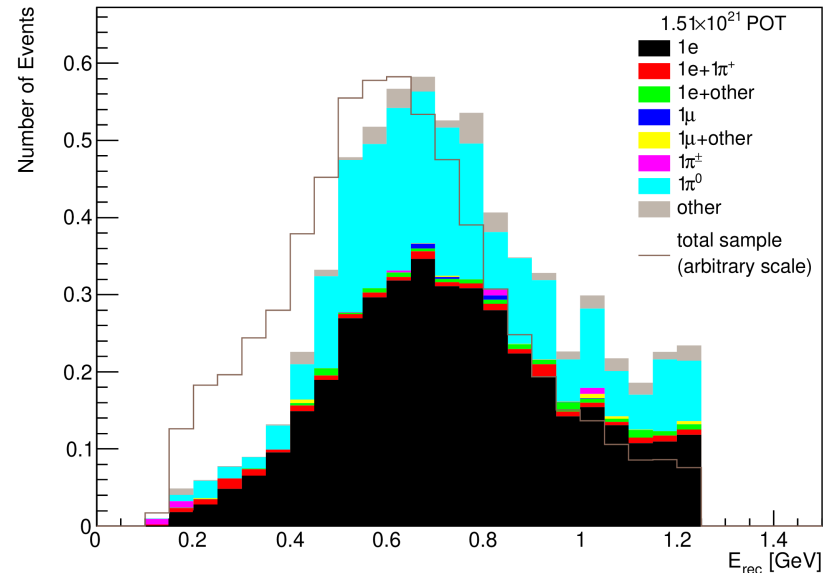
True ν Energy
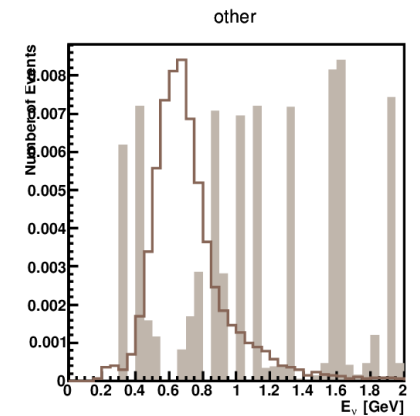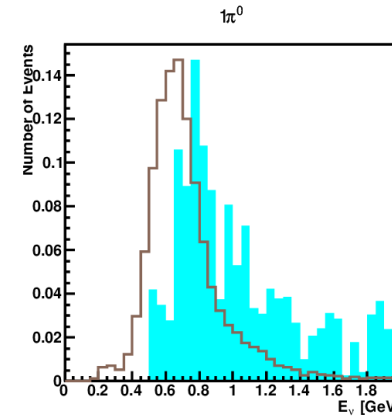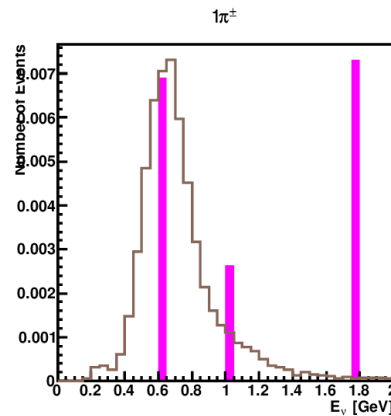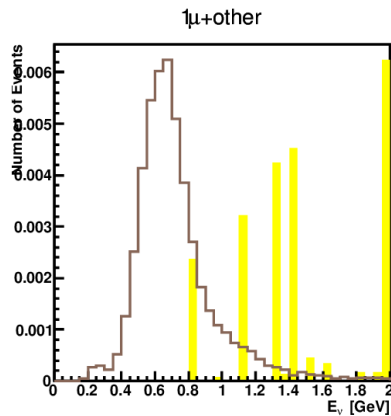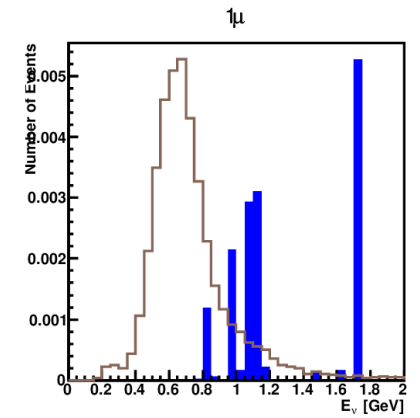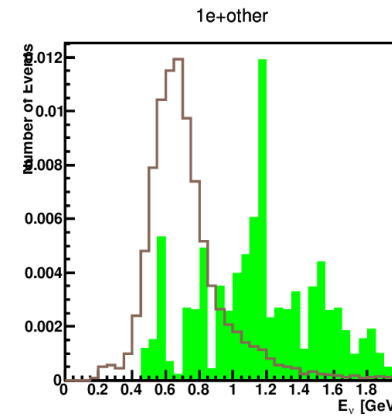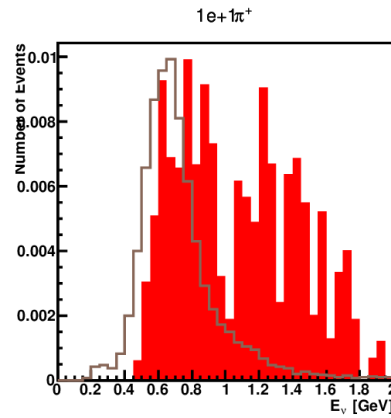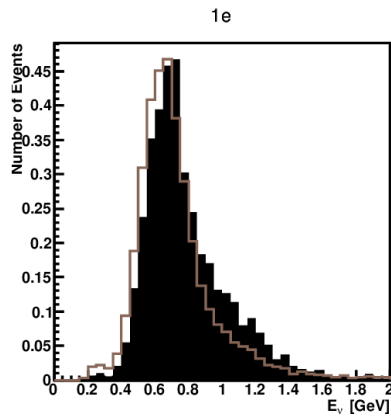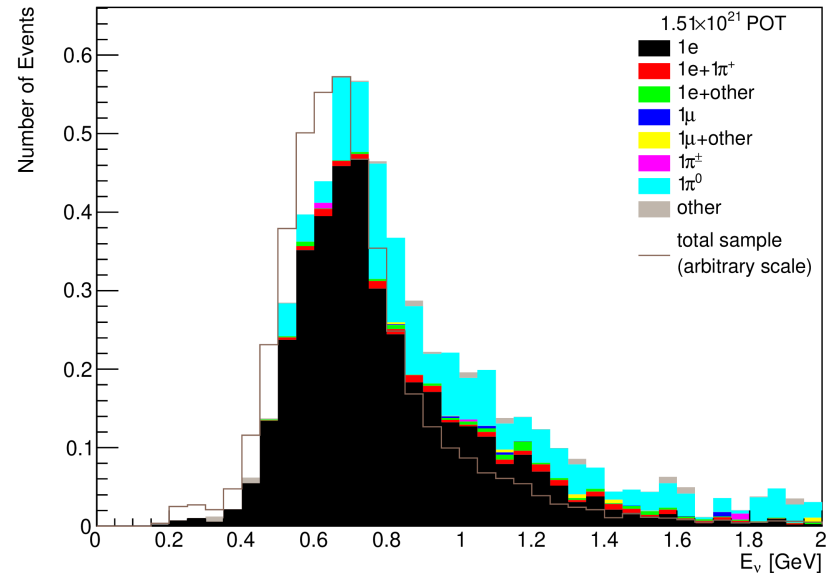
DWall
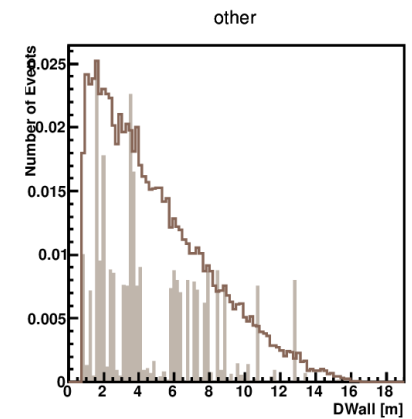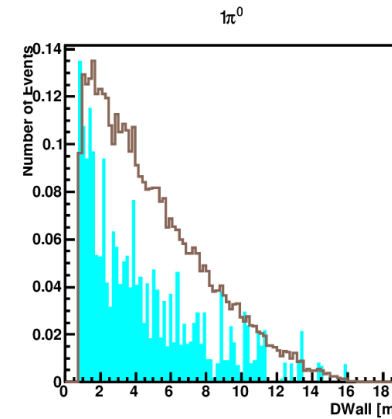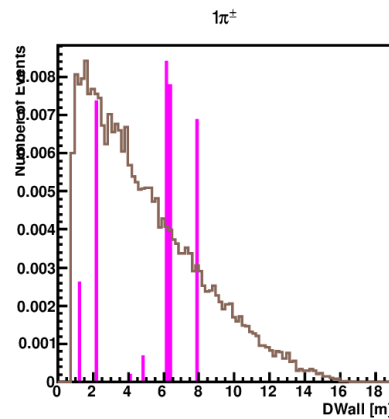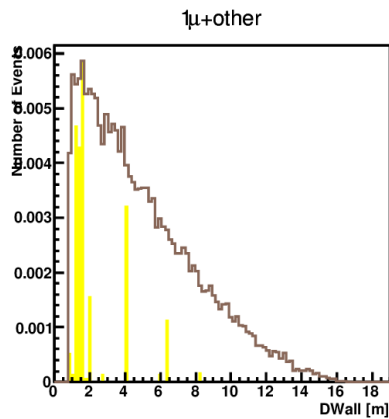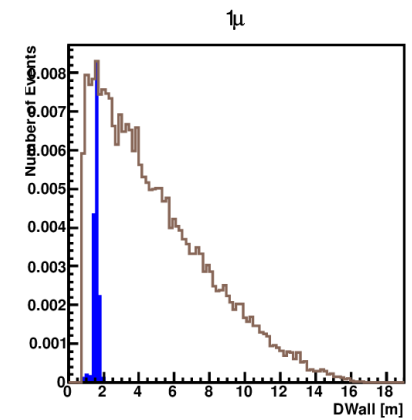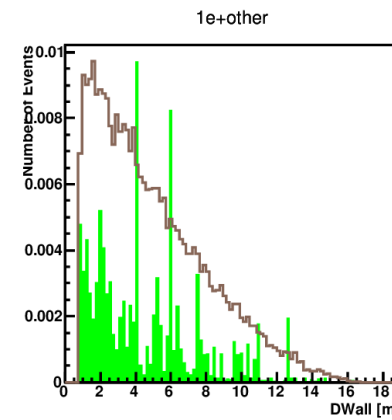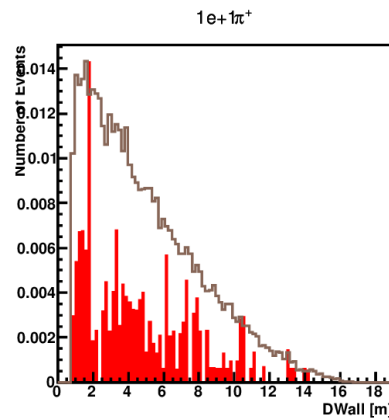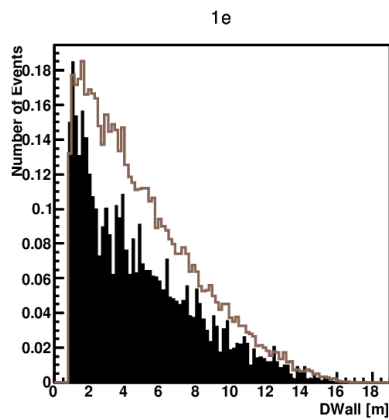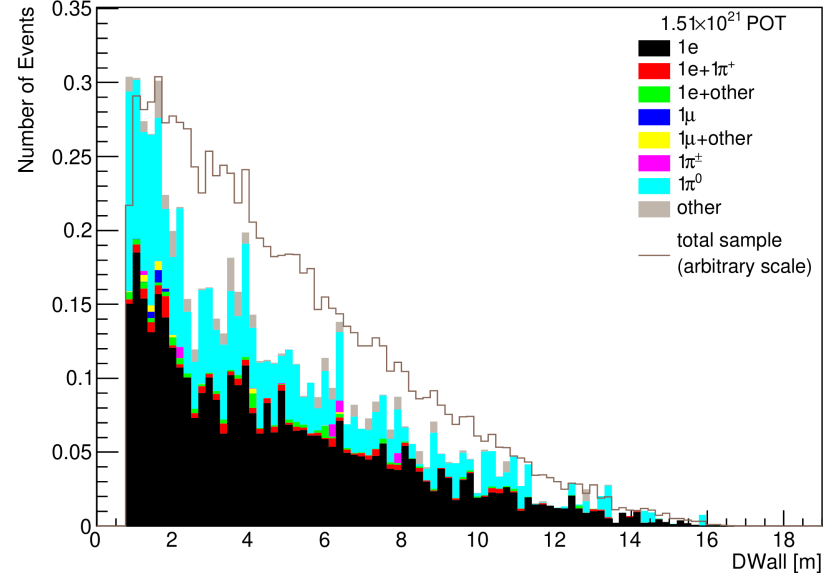
ToWall
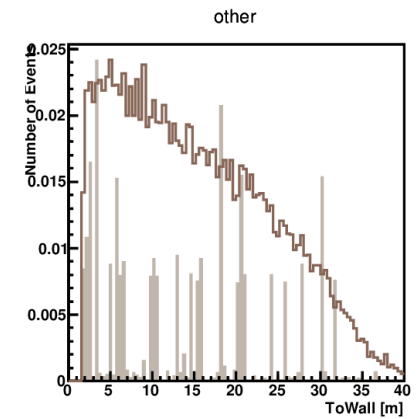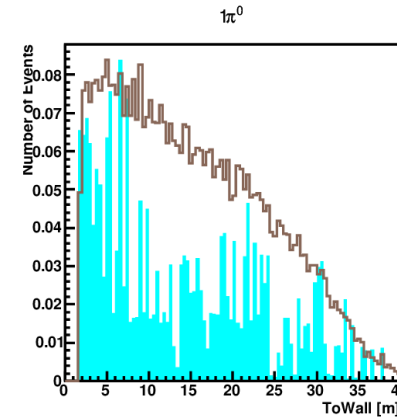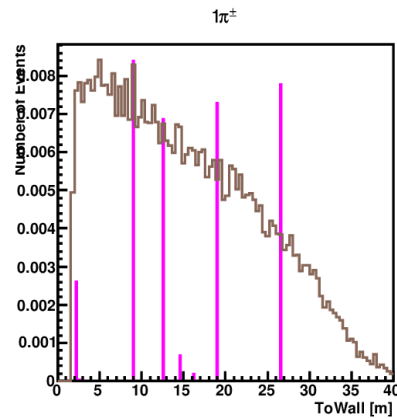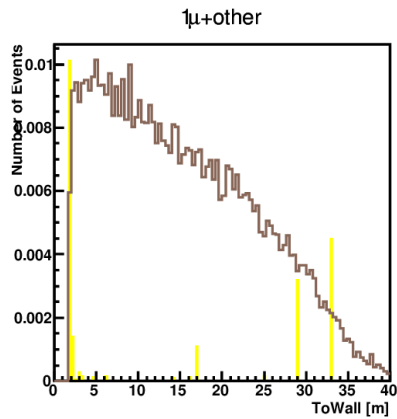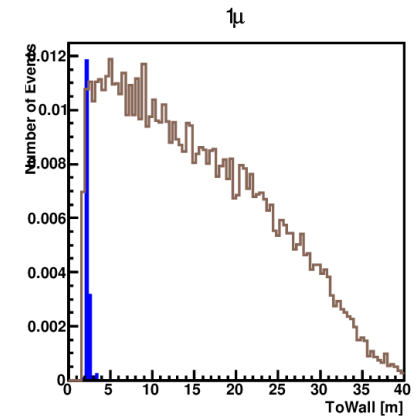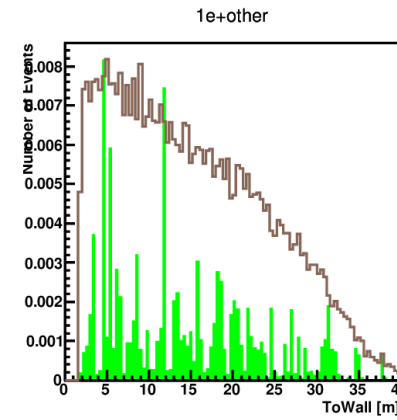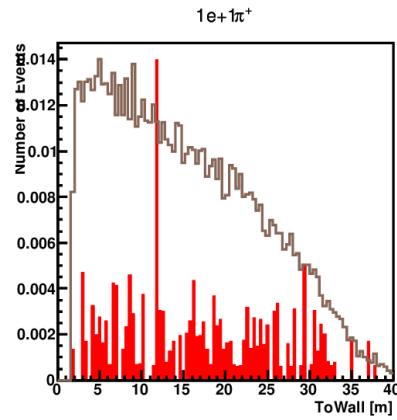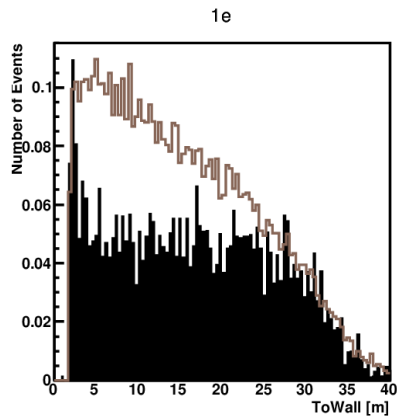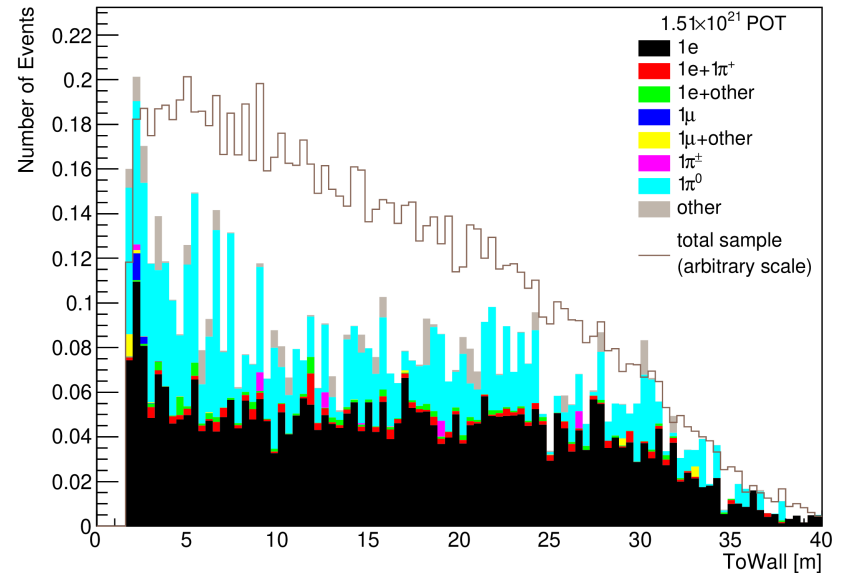
Revisiting E_{rec} Cut in 2-Ring ν_e CC1π^+ Sample

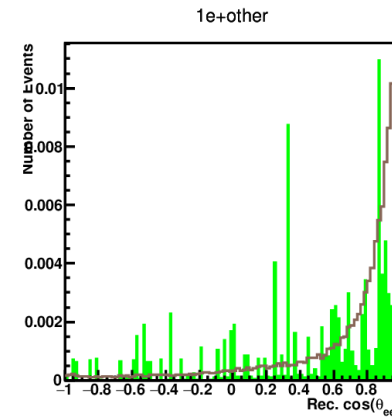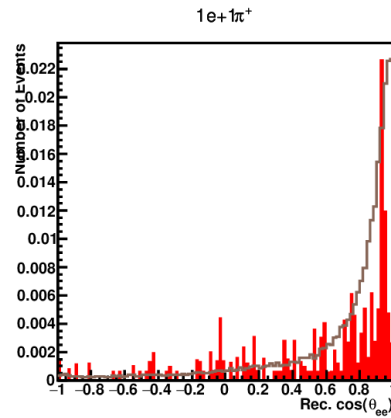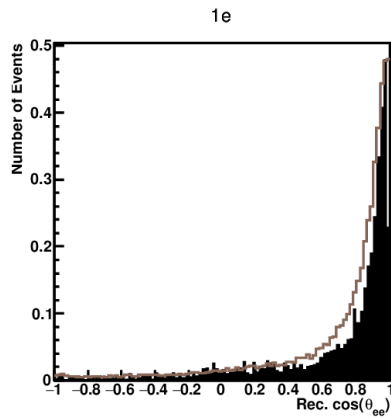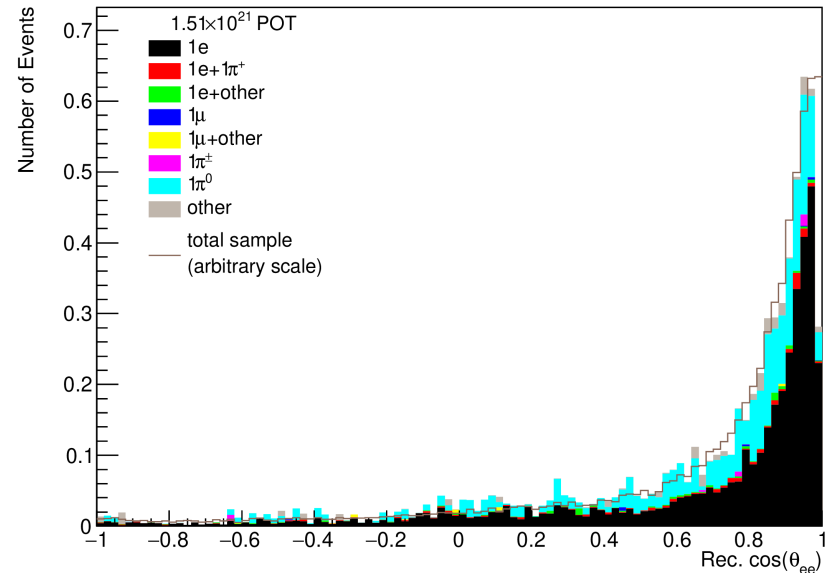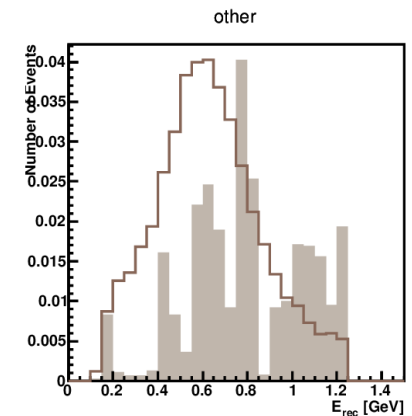- Concerns regarding π^+ momentum dependence brought up at T2K CM in November

- Questions about why E_{rec} cut is needed

  - Originally implemented when doing cuts-based study to remove DIS backgrounds

  - This was years ago – haven't revisited since

- Is this E_{rec} cut necessary, and could we reduce π^+ momentum dependence by removing it?
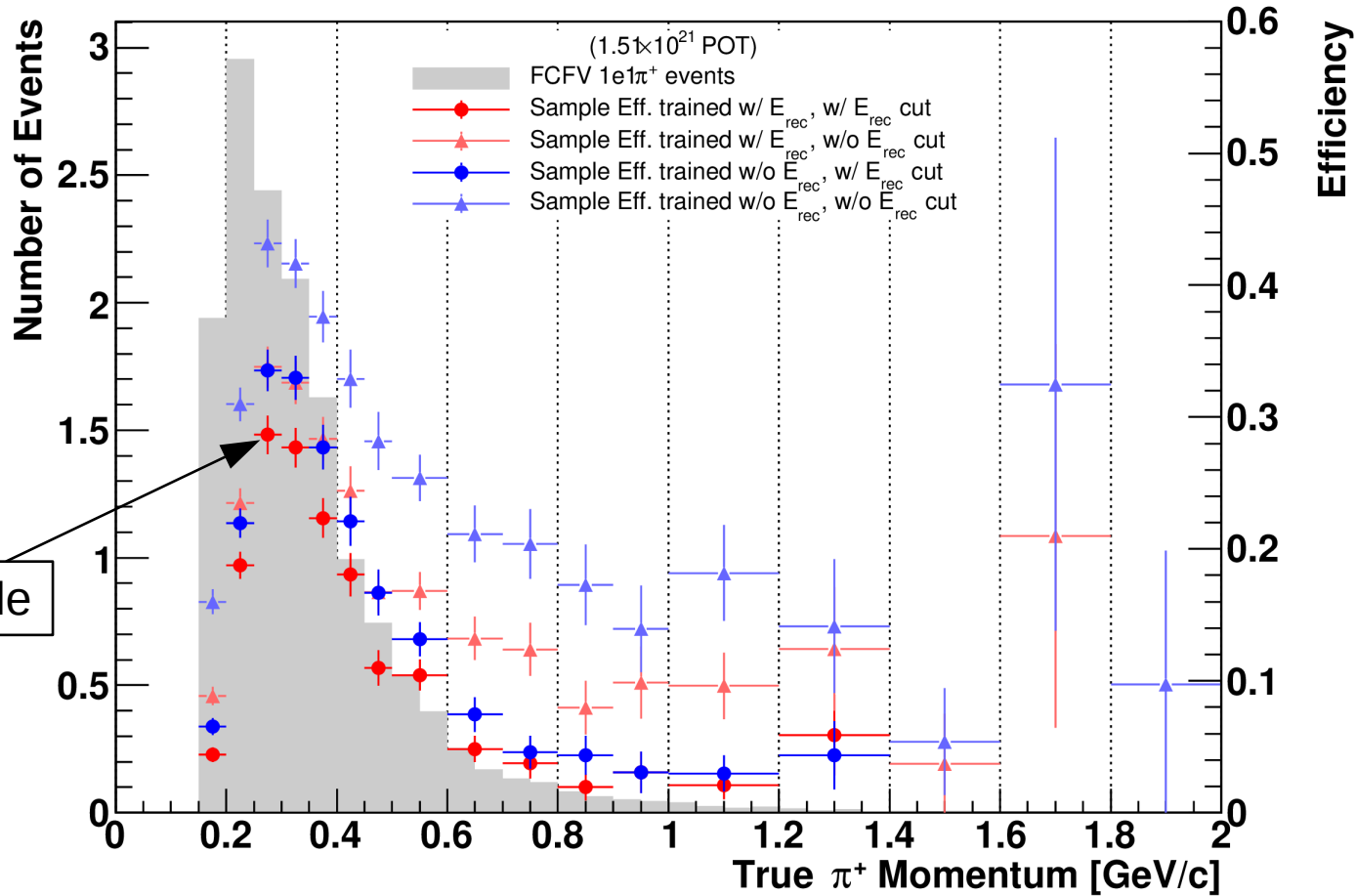
2-ring ν_e CC1π^+: 1e1π^+ Final State Events

π⁺ Momentum Dependence Comparison

2-ring ν_e CC1π⁺: 1e1π⁺ Final State Events

Red: E_{rec} cut applied to BDT training sample   ●: E_{rec} cut applied to final sample

Blue: No E_{rec} cut applied to BDT training sample   ▲ : No E_{rec} cut applied to final sample

π^+ Momentum Dependence Comparison

Relative efficiency of BDT

2-ring ν_e CC1π^+: 1e1π^+ Final State Events
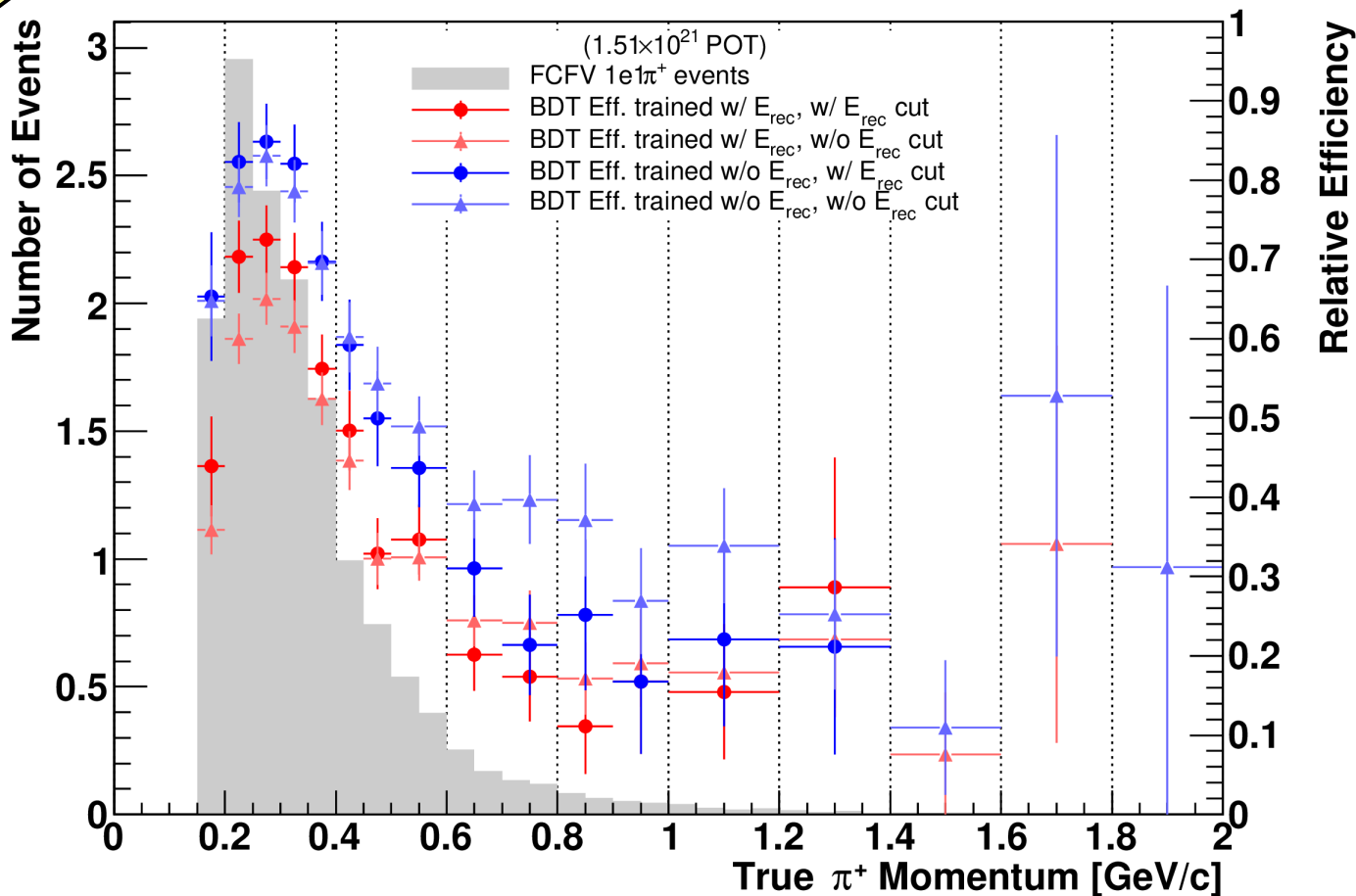
(1.51×10^{21} POT)

FCFV 1e1π^+ events
BDT Eff. trained w/ E_{rec}, w/ E_{rec} cut
BDT Eff. trained w/ E_{rec}, w/o E_{rec} cut
BDT Eff. trained w/o E_{rec}, w/ E_{rec} cut
BDT Eff. trained w/o E_{rec}, w/o E_{rec} cut

Red: E_{rec} cut applied to BDT training sample   •: E_{rec} cut applied to final sample

Blue: No E_{rec} cut applied to BDT training sample   ▲: No E_{rec} cut applied to final sample

Sample Comparison

Final State

1.51×10^{21} POT	1e	1e+1π^+	1e+other	1μ	1μ+other	1$\pi^\pm$	1π^0	other
Nominal	0.13	2.68	0.17	0.00	0.32	0.06	0.13	0.45
No E$_{rec}$	0.91	4.75	0.92	0.01	1.62	0.12	0.58	2.10

NEUT Mode

1.51×10^{21} POT	$\nu_e/\bar{\nu}_e$ CC QE	$\nu_e/\bar{\nu}_e$ CC 1$\pi^\pm$	$\nu_e/\bar{\nu}_e$ CC other	$\nu_\mu/\bar{\nu}_\mu$ CC QE	$\nu_\mu/\bar{\nu}_\mu$ CC other	NC
Nominal	0.03	2.85	0.17	0.00	0.39	0.50
No E$_{rec}$	0.27	5.52	0.89	0.04	1.96	2.33

Neutrino Type

1.51×10^{21} POT	osc $\nu_e/\bar{\nu}_e$ CC	int $\nu_e/\bar{\nu}_e$ CC	$\nu_\mu/\bar{\nu}_\mu$ CC	NC
Nominal	2.32	0.73	0.40	0.50
No E$_{rec}$	3.32	3.36	2.00	2.33

- <u>Nominal</u>: E$_{rec}$ cut applied to training sample and final sample

- <u>No E$_{rec}$</u>: No E$_{rec}$ cut applied to training sample or final sample

BDT Comparison
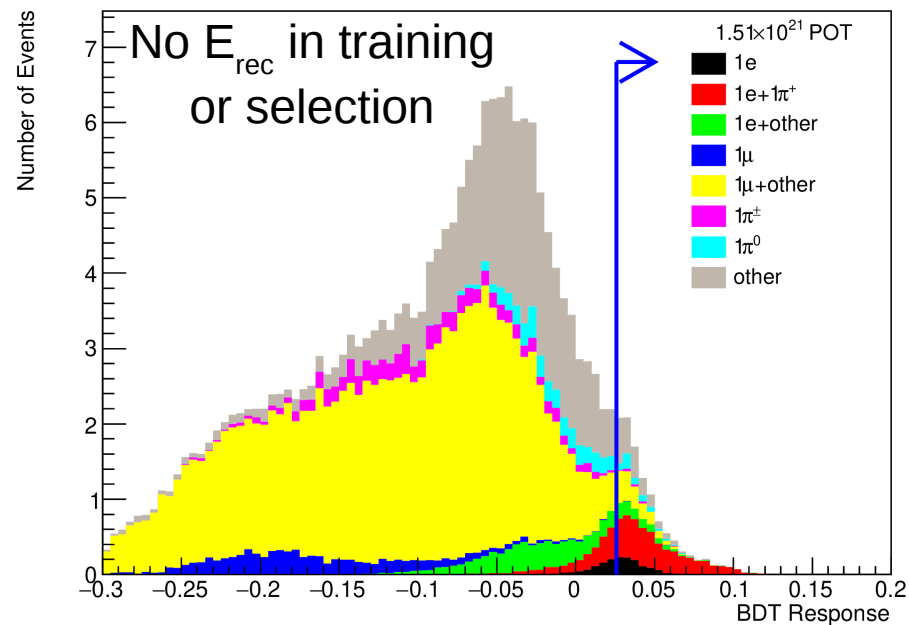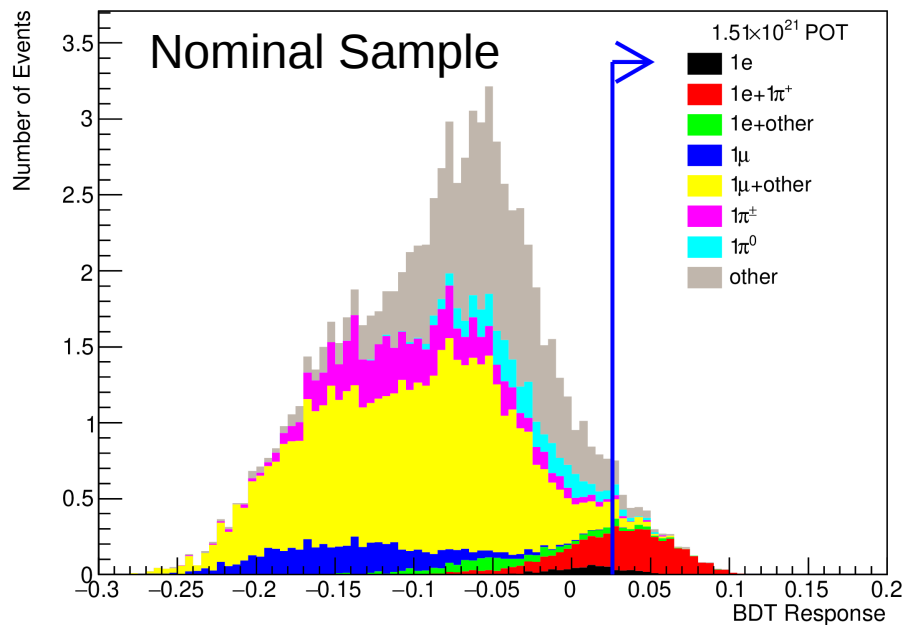
NEUT Modes Comparison

Significantly more backgrounds from

- CC/NC DIS
- CC/NC multi-π

E_{rec} Comparison

Thoughts

- Training without E_{rec} cut but applying E_{rec} cut to final sample doesn't seem to reduce π^+ momentum dependence

- For both BDTs, not applying the E_{rec} cut to the final sample reduces π^+ momentum dependence

  – But, introduces more backgrounds

Backup

Detailed Cutflow: New ν_e CCQE

Final State (FOM = 6.70)

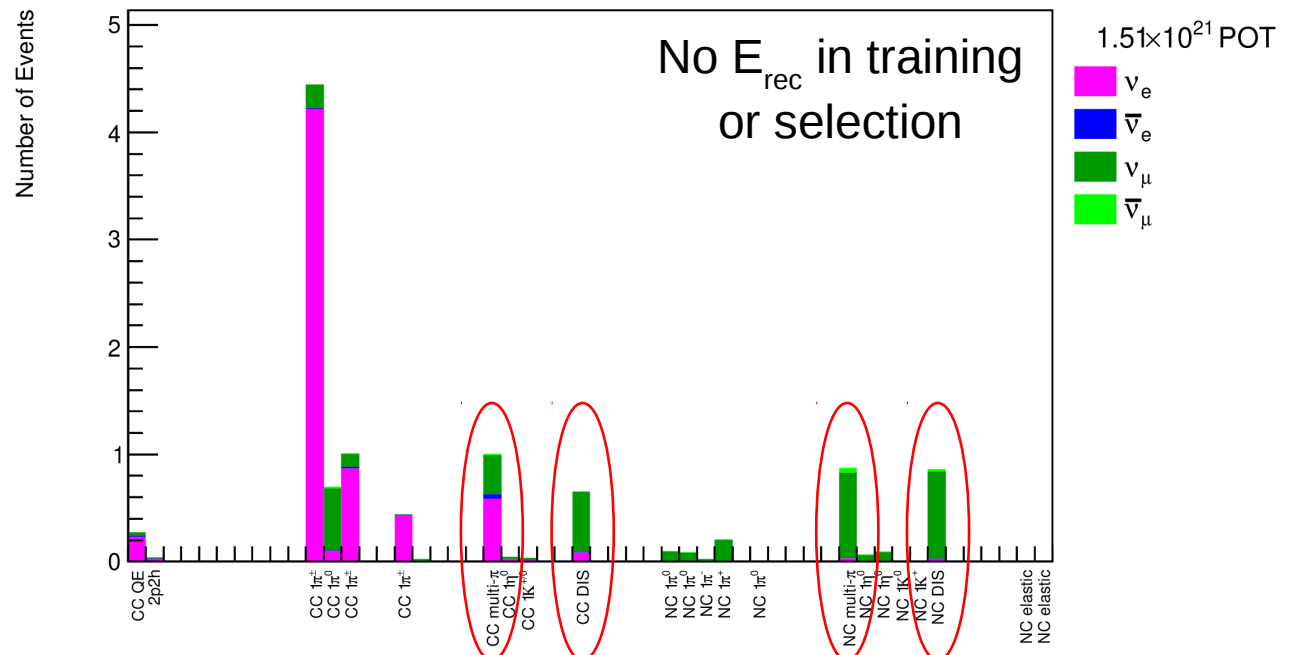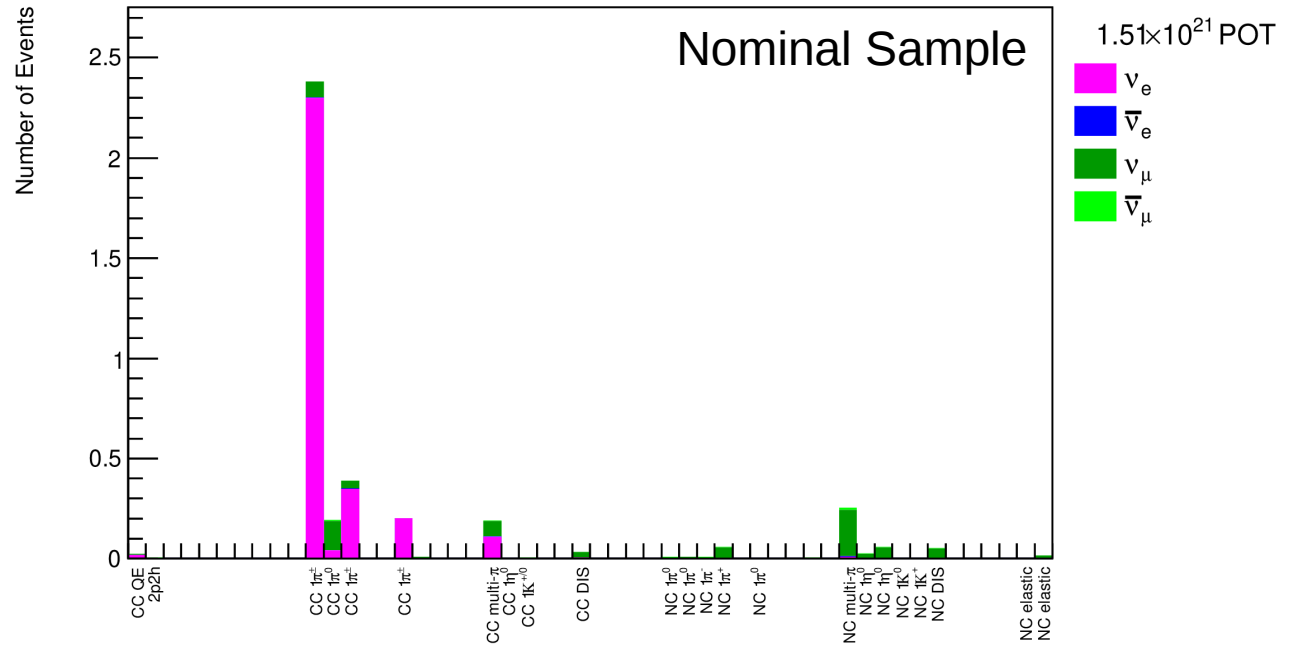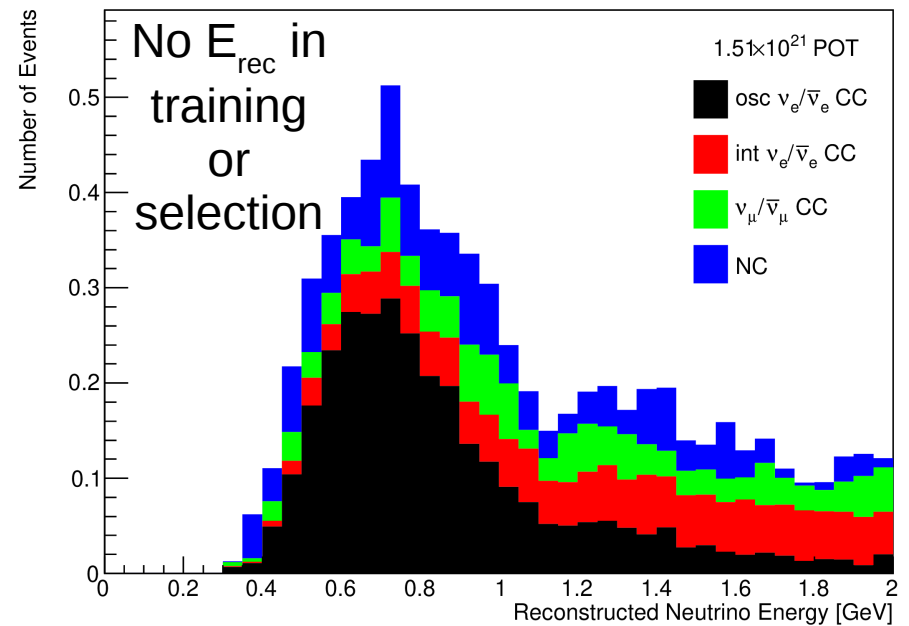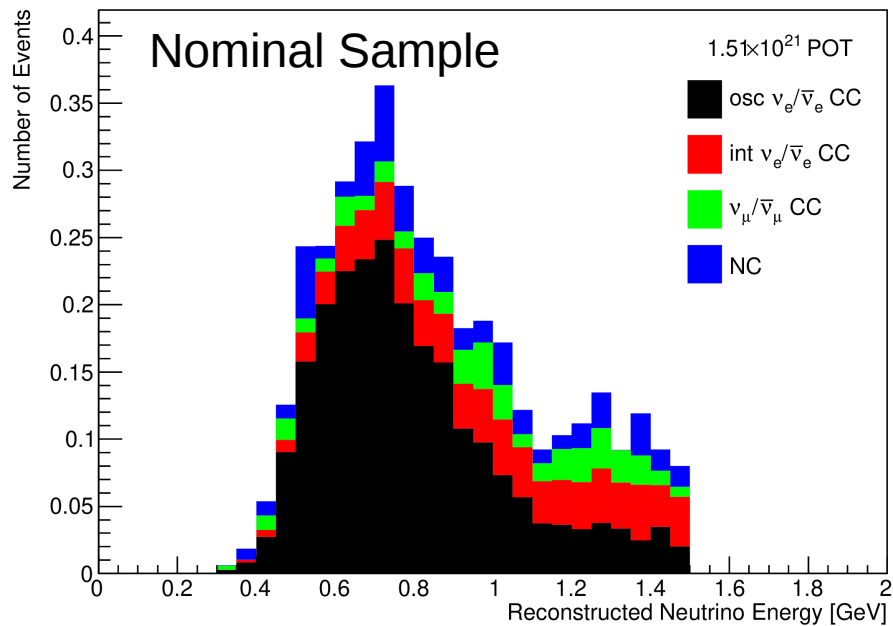| *1.51×10²¹ POT*	1e	1e+1π⁺	1e+other	1μ	1μ+other	1π±	1π⁰	other
All	89.05	17.68	32.36	420.74	587.88	63.65	146.50	855.79
FCFV	69.08	13.67	24.58	252.33	358.87	19.27	115.82	140.37
Not 1Rμ	69.03	13.66	24.58	34.84	341.03	13.82	115.78	138.99
0 decay e	63.68	3.77	15.52	6.71	55.82	6.20	110.67	60.91
E$_{rec}$ < 1.25 GeV	53.81	2.67	6.24	2.57	9.40	6.14	105.27	37.47
BDT cut	50.65	0.97	0.33	0.06	0.03	0.04	4.42	0.57

NEUT Mode (FOM = 5.98)

1.51×10²¹ POT	$\nu_e/\bar{\nu}_e$ CC QE	$\nu_e/\bar{\nu}_e$ CC 1π±	$\nu_e/\bar{\nu}_e$ CC other	$\nu_\mu/\bar{\nu}_\mu$ CC QE	$\nu_\mu/\bar{\nu}_\mu$ CC other	NC
All	74.53	36.95	27.36	377.57	706.00	991.26
FCFV	58.31	27.37	20.25	221.33	423.43	243.28
Not 1Rμ	58.27	27.34	20.25	33.60	375.83	236.42
0 decay e	57.44	12.36	12.28	9.73	58.39	173.06
E$_{rec}$ < 1.25 GeV	48.00	8.96	4.92	3.64	9.72	148.33
BDT cut	45.18	4.75	1.41	0.11	0.06	5.55

Neutrino Type (FOM = 5.62)

1.51×10²¹ POT	osc $\nu_e/\bar{\nu}_e$ CC	int $\nu_e/\bar{\nu}_e$ CC	$\nu_\mu/\bar{\nu}_\mu$ CC	NC
All	83.57	55.26	1083.57	991.26
FCFV	64.00	41.93	644.76	243.28
Not 1Rμ	63.94	41.92	409.43	236.42
0 decay e	52.97	29.12	68.12	173.06
E$_{rec}$ < 1.25 GeV	49.78	12.11	13.36	148.33
BDT cut	42.43	8.90	0.17	5.55

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