Progress Update

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2-Ring ν_e CC1π^+ Meeting

November 28, 2018

v0 (trial 9) all ν_e CC as Signal

NTrees=1500, MaxDepth=7, MinNodeSize=0.05, NCuts=50

- See performance of selection when defining all ν_e CC events as signal for BDT training
- Use **v0** pre-BDT cuts with **trial 9** variables
- Check kinematic reconstruction performance

Pre-BDT cuts	
v1	**v0**
- FCFV - not 1Re/1Re1de - possible 2Repi • <u>0 de</u>: 2Reπ, 2Rπe, and 3Reππ sub-samples • <u>1 de</u>: 1Re, 2Ree, 2Reπ, 2Rπe, 2Rμe, and 3Reππ sub-samples - 1/2 sub-events - E_{rec}(1e,1π) < 1.5 GeV	- FCFV - not 1Re/1Re1de - 1/2 sub-events - E_{rec}(1e,1π) < 1.5 GeV

	BDT variables								
	1R v 1R nll	1R v 2R nll	2R v 2R nll	2R v 3R nll	3R v 3R nll	3R v 4R nll	1R+2R kinematics	E_{rec}, towall e, towall π, p_{low}, $m_{\pi 0}$, (*d2se*)	1R+2R+ 3R fit indices
Trial 8	■	■	■	■	■		■	■	■
Trial 9	■	■	■	■	■	■	■	■	■

v0 (trial 9) all ν_e CC as Signal

NTrees=1500, MaxDepth=7, MinNodeSize=0.05, NCuts=50

0de											
	1e1π$^{+/-}$	**1e**	**1e other**	**1μ1π$^{+/-}$**	**1μ**	**1μ other**	**0l$^{+/-}$ 1π^{+}**	**0l$^{+/-}$ 1π^{-}**	**0l$^{+/-}$ 1π^{0}**	**0l$^{+/-}$ Nπ**	**0l$^{+/-}$ other**
FCFV	5.08	46.83	6.66	11.13	47.24	24.92	7.54	10.63	83.37	16.81	17.60
BDT in	1.88	5.62	1.87	2.80	24.13	3.43	5.99	8.76	63.83	6.60	13.47
BDT out	1.11	4.27	1.12	0.12	0.22	0.38	0.35	0.33	3.30	1.38	0.66
1de											
	1e1π$^{+/-}$	**1e**	**1e other**	**1μ1π$^{+/-}$**	**1μ**	**1μ other**	**0l$^{+/-}$ 1π^{+}**	**0l$^{+/-}$ 1π^{-}**	**0l$^{+/-}$ 1π^{0}**	**0l$^{+/-}$ Nπ**	**0l$^{+/-}$ other**
FCFV	7.48	5.24	2.68	38.78	148.00	60.21	10.26	3.33	4.58	15.24	6.31
BDT in	3.43	0.94	0.44	15.35	99.46	12.15	8.98	2.54	2.76	6.89	5.00
BDT out	2.44	0.69	0.11	0.14	0.09	0.47	0.12	0.09	0.18	0.37	0.16

0de				
	sig	**bkg**	**FOM**	**δFOM**
FCFV	58.57	219.25		
BDT in	9.29	129.00		
BDT out	6.43	6.73	1.773	0.019

1de				
	sig	**bkg**	**FOM**	**δFOM**
FCFV	15.40	286.66		
BDT in	4.81	153.14		
BDT out	3.25	1.63	1.470	0.020

Here, signal defined as all ν_e CC events

v1 (trial 8) BDT event breakdown

NTrees=10000, MaxDepth=7, MinNodeSize=0.05, NCuts=50

(best performing BDT architecture for both 0de and 1de)

BDT trained using true 1e1$\pi^{+/-}$ as signal

0de											
	1e1$\pi^{+/-}$	**1e**	**1e other**	**1μ1$\pi^{+/-}$**	**1μ**	**1μ other**	**0l$^{+/-}$ 1π^{+}**	**0l$^{+/-}$ 1π^{-}**	**0l$^{+/-}$ 1π^{0}**	**0l$^{+/-}$ Nπ**	**0l$^{+/-}$ other**
FCFV	5.08	46.83	6.66	11.13	47.24	24.92	7.53	10.63	83.37	16.81	17.60
BDT in	0.79	0.32	0.03	0.07	0.16	0.14	0.34	0.41	1.22	0.36	0.46
BDT out	0.60	0.03	0.01	0.01	0.00	0.03	0.05	0.05	0.07	0.10	0.03
1de											
	1e1$\pi^{+/-}$	**1e**	**1e other**	**1μ1$\pi^{+/-}$**	**1μ**	**1μ other**	**0l$^{+/-}$ 1π^{+}**	**0l$^{+/-}$ 1π^{-}**	**0l$^{+/-}$ 1π^{0}**	**0l$^{+/-}$ Nπ**	**0l$^{+/-}$ other**
FCFV	7.48	5.24	2.68	38.78	148.00	60.21	10.26	3.33	4.58	15.24	6.31
BDT in	3.08	0.89	0.09	1.94	3.60	2.37	1.79	0.51	1.79	1.61	2.23
BDT out	2.15	0.19	0.02	0.06	0.02	0.24	0.04	0.02	0.08	0.13	0.09

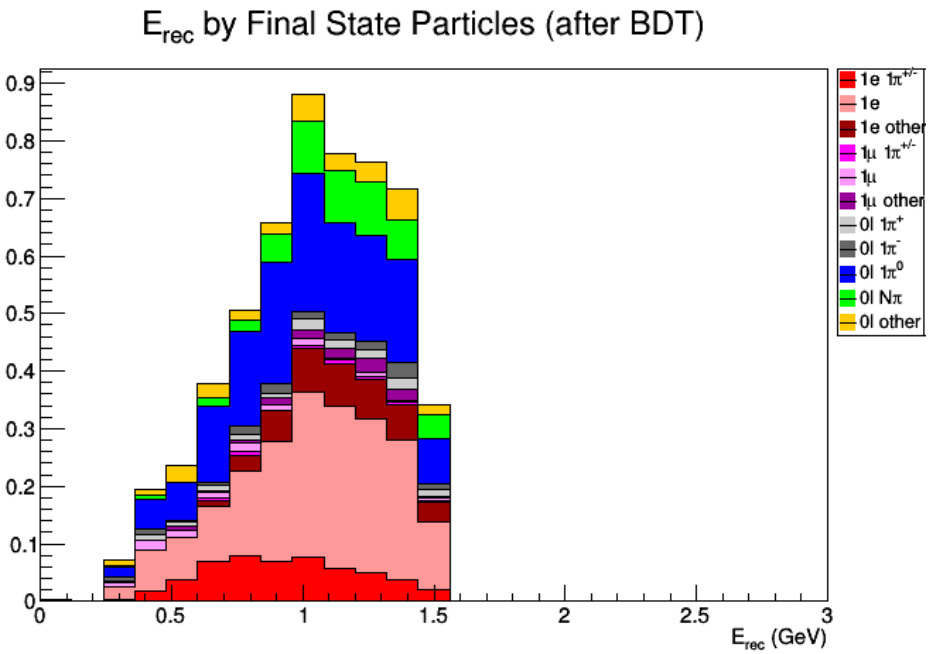
0de				
	sig	**bkg**	**FOM**	**δFOM**
FCFV	58.57	219.23		
BDT in	1.14	3.16		
BDT out	0.64	0.33	0.648	0.019

1de				
	sig	**bkg**	**FOM**	**δFOM**
FCFV	15.40	286.71		
BDT in	4.06	15.84		
BDT out	2.36	0.69	1.353	0.019

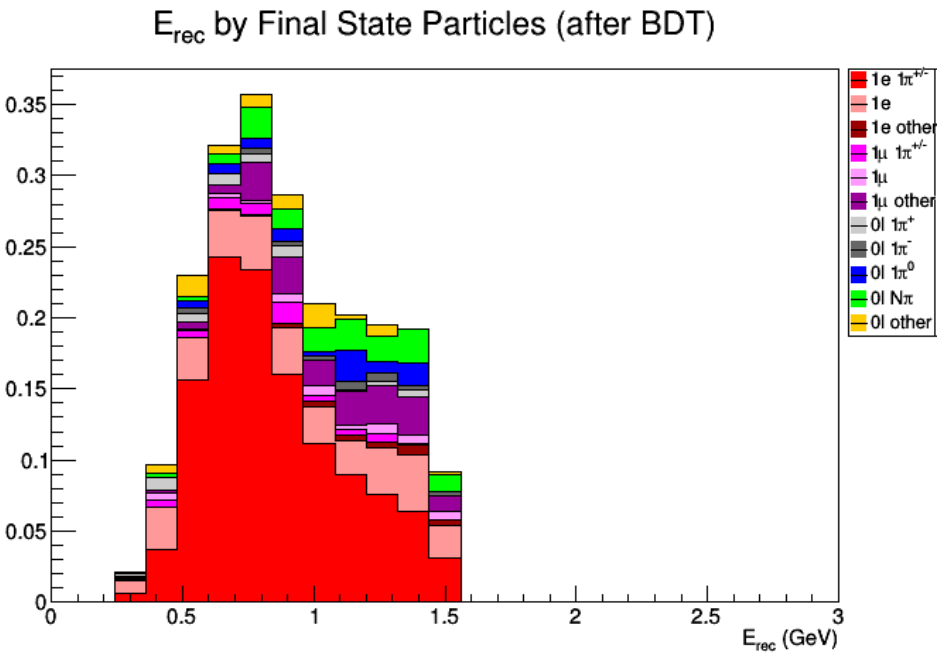
Here, signal defined as all ν_e CC events

v0 (trial 9) all ν_e CC sig: E_{rec}

0 decay e



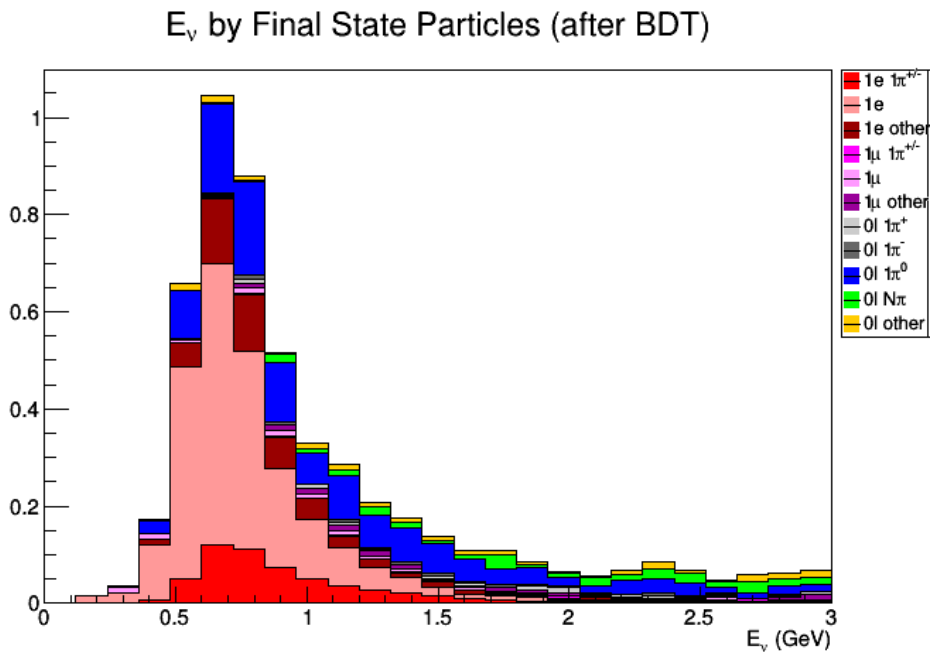
1 decay e



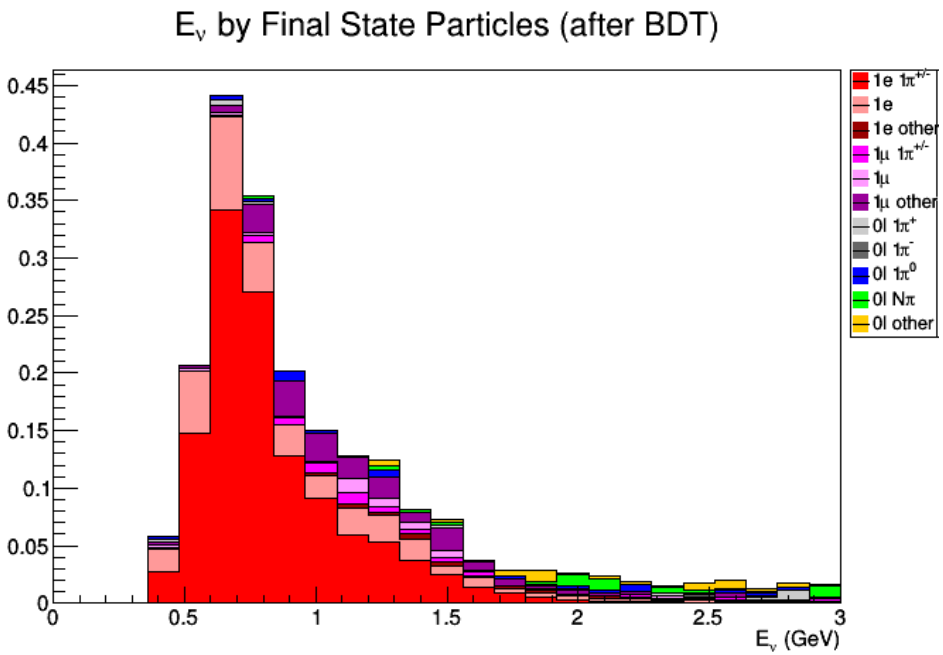
$$E_\nu = \frac{m_e^2 + m_{\pi^+}^2 - 2\,m_N\left(E_e + E_{\pi^+}\right) + 2\,p_e \cdot p_{\pi^+}}{2\left(E_e + E_{\pi^+} - \left|p_e\right|\cos\theta_{\nu e} - \left|p_{\pi^+}\right|\cos\theta_{\nu\pi^+} - m_N\right)}$$

v0 (trial 9) all ν_e CC sig: E_ν

0 decay e

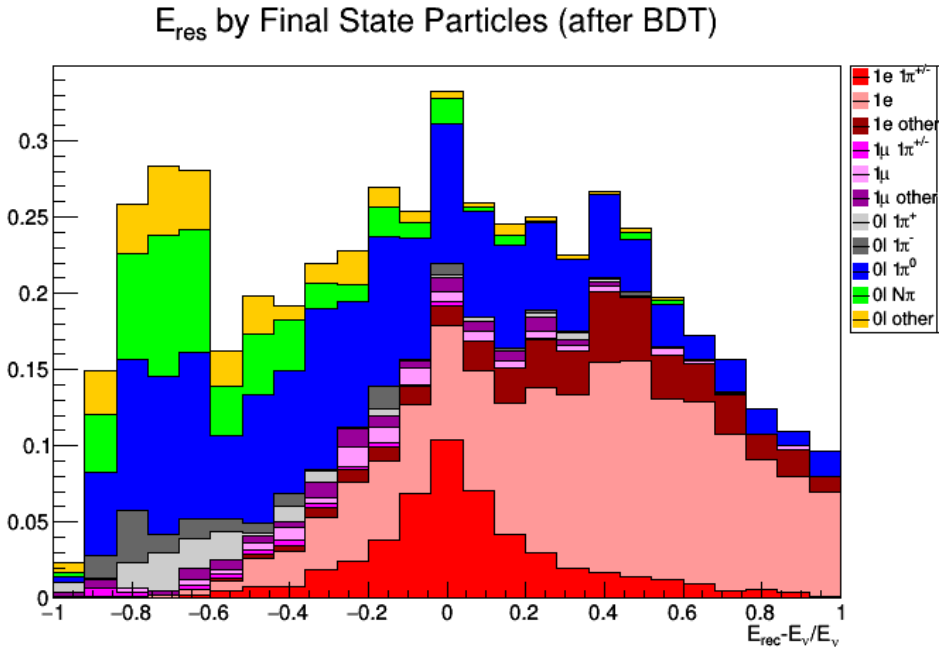


1 decay e

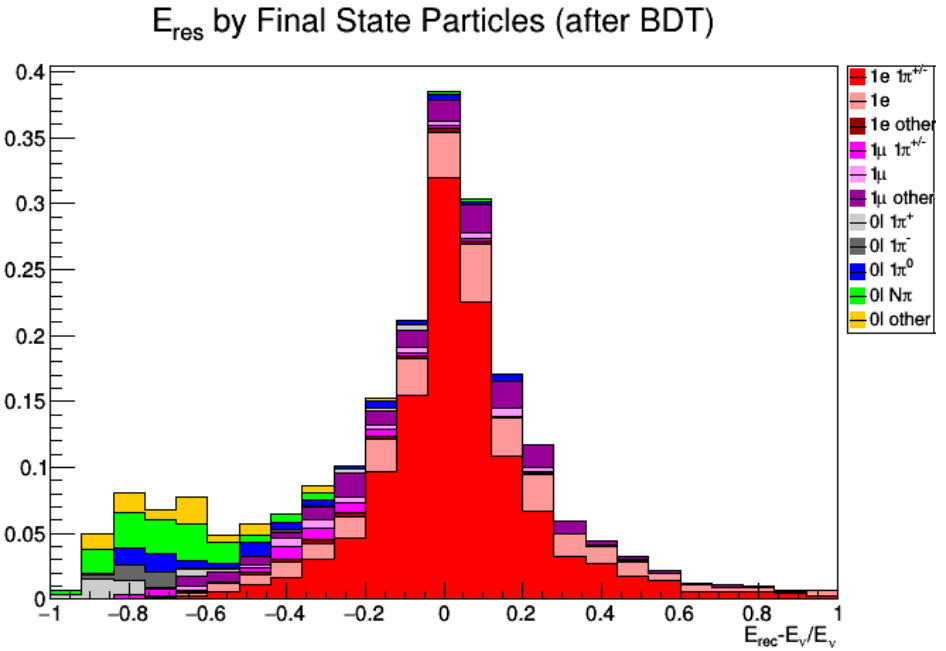


v0 (trial 9) all ν_e CC sig: E_{res}

0 decay e



1 decay e



Mike:

- Train 0de sample using 1e as signal, adjust E_{rec} equation accordingly
  - May see reduction in 0l $1\pi^0$ background

$$E_\nu = \frac{m_e^2 + m_{\pi^+}^2 - 2\,m_N\left(E_e + E_{\pi^+}\right) + 2\,p_e \cdot p_{\pi^+}}{2\left(E_e + E_{\pi^+} - |p_e|\cos\theta_{\nu e} - |p_{\pi^+}|\cos\theta_{\nu\pi^+} - m_N\right)}$$

Future Work & Thoughts

- Look at pion travel distance in relation to $\cos(\theta_{e\pi}^{rec})$, and narrow down which sub-sample(s) is/are responsible
- Get GENIE installed and start generating events with NuWro and GENIE
  - Looking at hep_ml to use BDTs for multi-dimensional MC re-weighting
  - Investigate concerns regarding over-training to NEUT
    - Adapt BDT architecture accordingly
- Possible overlap with Yoshida-san
  - She plans to start looking at systematics after the collaboration meeting
  - Discuss possible coordination next week