

Progress Update

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v0/v1 pre-BDT Cuts, Trial 8 Variables

v1 only

v1 pre-BDT cuts		
	0 decay e	1 decay e
FCFV	Wall > 50 cm	
not 1Re	not 1Re-like (TN319)	
sub-sample selection	2Re π , 2R π e, and 3Re $\pi\pi$ sub-samples	1Re, 2Ree, 2Re π , 2R π e, 2R μ e, and 3Re $\pi\pi$ sub-samples
0 decay e	1 sub-event	2 sub-events
E_{rec}^*	$E_{\text{rec}}(p_e, p_\pi) < 1.5 \text{ GeV}$	

Trial 8 BDT variables
1R v 1R -ln(L)
1R v 2R -ln(L)
2R v 2R -ln(L)
2R v 3R -ln(L)
3R v 3R -ln(L)
1R+2R fit kinematics
fiTQun fit indices of 1R, 2R, and 3R fits
E_{rec}^* , towall e*, towall π^* , p_{low}^* , $m_{\pi 0}$

* Event reconstruction
done using fiTQun's
2Re π -like fit

v1 0 decay e (training signal = $1e^{\pm}1\pi^{\pm}$)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	4.63	45.01	8.93	8.96	41.60	32.68	7.69	12.16	83.11	17.28	15.76		4.63	273.17	0.28
pre-BDT	0.77	0.20	0.17	0.09	0.14	0.18	0.36	0.46	1.21	0.40	0.33		0.77	3.53	0.37
post-BDT	0.51	0.01	0.03	0.01	0.00	0.03	0.02	0.02	0.03	0.09	0.01		0.51	0.24	0.59
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	9.04	39.19	2.29	1.12	4.10	2.82	83.29	135.95					9.04	268.76	0.54
pre-BDT	0.72	0.27	0.04	0.01	0.05	0.04	0.41	2.75					0.72	3.57	0.35
post-BDT	0.46	0.01	0.03	0.00	0.02	0.03	0.04	0.16					0.46	0.29	0.53
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	38.06	20.50	83.29	135.95									38.06	239.69	2.28
pre-BDT	0.78	0.35	0.41	2.75									0.78	3.52	0.38
post-BDT	0.38	0.17	0.04	0.16									0.38	0.37	0.44

ν_0 decay e (training signal = $1e^\pm 1\pi^\pm$)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	4.63	45.01	8.93	8.96	41.60	32.68	7.69	12.16	83.11	17.28	15.76		4.63	273.17	0.28
pre-BDT	1.81	5.23	2.25	2.46	22.83	5.05	6.05	10.18	63.68	6.88	11.84		1.81	136.45	0.15
post-BDT	0.50	0.01	0.02	0.00	0.00	0.03	0.02	0.02	0.03	0.08	0.01		0.50	0.24	0.58
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCoher	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	9.04	39.19	2.29	1.12	4.10	2.82	83.29	135.95					9.04	268.76	0.54
pre-BDT	2.80	4.49	0.38	0.09	1.24	0.28	30.39	98.59					2.80	135.46	0.24
post-BDT	0.45	0.01	0.03	0.00	0.02	0.02	0.04	0.17					0.45	0.29	0.52
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	38.06	20.50	83.29	135.95									38.06	239.69	2.28
pre-BDT	6.93	2.36	30.39	98.59									6.93	131.34	0.59
post-BDT	0.38	0.15	0.04	0.17									0.38	0.36	0.44

Very similar performance between ν_0 and ν_1

ν_e decay e (training signal = $\nu_e/\bar{\nu}_e$ CC1 $\pi^\pm$)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	4.63	45.01	8.93	8.96	41.60	32.68	7.69	12.16	83.11	17.28	15.76		4.63	273.16	0.28
pre-BDT	0.77	0.20	0.17	0.09	0.14	0.18	0.36	0.46	1.21	0.40	0.33		0.77	3.53	0.37
post-BDT	0.55	0.01	0.04	0.00	0.00	0.04	0.04	0.02	0.06	0.09	0.02		0.55	0.33	0.59
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	9.04	39.19	2.29	1.12	4.10	2.82	83.29	135.95					9.04	268.76	0.54
pre-BDT	0.72	0.27	0.04	0.01	0.05	0.04	0.41	2.75					0.72	3.57	0.35
post-BDT	0.51	0.02	0.03	0.00	0.02	0.03	0.05	0.23					0.51	0.38	0.54
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	38.06	20.50	83.29	135.95									38.06	239.70	2.28
pre-BDT	0.78	0.35	0.41	2.75									0.78	3.52	0.38
post-BDT	0.43	0.18	0.05	0.23									0.43	0.46	0.45

$\nu_e \bar{\nu}_e$ decay e (training signal = $\nu_e \bar{\nu}_e$ CC1 $\pi^\pm$)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	4.63	45.01	8.93	8.96	41.60	32.68	7.69	12.16	83.11	17.28	15.76		4.63	273.16	0.28
pre-BDT	1.81	5.23	2.25	2.46	22.83	5.05	6.05	10.18	63.68	6.88	11.84		1.81	136.44	0.15
post-BDT	0.95	0.70	0.57	0.04	0.06	0.21	0.18	0.21	1.03	0.65	0.24		0.95	3.90	0.43
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	9.04	39.19	2.29	1.12	4.10	2.82	83.29	135.95					9.04	268.76	0.54
pre-BDT	2.80	4.49	0.38	0.09	1.24	0.28	30.39	98.59					2.80	135.46	0.24
post-BDT	1.21	0.50	0.10	0.01	0.32	0.09	0.31	2.31					1.21	3.65	0.55
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	38.06	20.50	83.29	135.95									38.06	239.70	2.28
pre-BDT	6.93	2.36	30.39	98.59									6.93	131.34	0.59
post-BDT	1.61	0.62	0.31	2.31									1.61	3.25	0.73

Significant difference in signal and background numbers across all definitions, but FOM variation highly dependent on signal definition. Modest efficiency improvement across all signal definitions.

ν_{10} decay e (training signal = $\nu_e/\bar{\nu}_e$ CC)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	4.63	45.01	8.93	8.96	41.60	32.68	7.69	12.16	83.11	17.28	15.76		4.63	272.98	0.28
pre-BDT	0.77	0.20	0.17	0.09	0.14	0.18	0.36	0.46	1.21	0.40	0.33		0.77	3.53	0.37
post-BDT	0.57	0.14	0.10	0.00	0.00	0.04	0.03	0.04	0.11	0.13	0.02		0.57	0.62	0.52
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	9.04	39.19	2.29	1.12	4.10	2.82	83.29	135.95					9.04	268.58	0.54
pre-BDT	0.72	0.27	0.04	0.01	0.05	0.04	0.41	2.75					0.72	3.57	0.35
post-BDT	0.53	0.19	0.03	0.00	0.04	0.03	0.04	0.33					0.53	0.66	0.48
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	38.06	20.50	83.29	135.95									38.06	239.74	2.28
pre-BDT	0.78	0.35	0.41	2.75									0.78	3.52	0.38
post-BDT	0.57	0.25	0.04	0.33									0.57	0.62	0.52

$\nu_0 \rightarrow e \text{ decay } e \text{ (training signal = } \nu_e / \bar{\nu}_e \text{ CC)}$

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	4.63	45.01	8.93	8.96	41.60	32.68	7.69	12.16	83.11	17.28	15.76		4.63	272.98	0.28
pre-BDT	1.81	5.23	2.25	2.46	22.83	5.05	6.05	10.18	63.68	6.88	11.84		1.81	136.46	0.15
post-BDT	1.19	4.11	1.39	0.10	0.16	0.49	0.31	0.39	3.68	1.55	0.75		1.19	12.94	0.32
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	9.04	39.19	2.29	1.12	4.10	2.82	83.29	135.95					9.04	268.58	0.54
pre-BDT	2.80	4.49	0.38	0.09	1.24	0.28	30.39	98.59					2.80	135.47	0.24
post-BDT	1.86	3.59	0.22	0.05	0.76	0.21	0.75	6.68					1.86	12.27	0.49
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	38.06	20.50	83.29	135.95									38.06	239.74	2.28
pre-BDT	6.93	2.36	30.39	98.59									6.93	131.35	0.59
post-BDT	5.00	1.69	0.75	6.68									5.00	9.13	1.33

Large improvement in efficiency. Large improvement in FOM for osc nue CC signal definition. Similar/reduced FOM for other signal definitions.

v1 1 decay e (training signal = $1e^{\pm}1\pi^{\pm}$)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	6.95	4.64	3.81	32.01	132.51	82.41	11.12	3.61	4.65	15.28	5.14		6.95	295.10	0.40
pre-BDT	3.01	0.76	0.25	1.78	2.84	3.37	1.77	0.55	1.96	1.46	2.16		3.01	16.89	0.67
post-BDT	2.16	0.18	0.08	0.08	0.02	0.28	0.07	0.03	0.08	0.13	0.13		2.16	1.08	1.20
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	10.57	0.52	2.31	1.21	0.54	0.26	246.94	39.72					10.57	291.49	0.61
pre-BDT	3.60	0.08	0.22	0.02	0.08	0.02	8.02	7.86					3.60	16.30	0.81
post-BDT	2.27	0.02	0.09	0.01	0.03	0.01	0.38	0.43					2.27	0.97	1.26
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	7.86	7.54	246.94	39.72									7.86	294.20	0.45
pre-BDT	2.93	1.08	8.02	7.86									2.93	16.96	0.66
post-BDT	1.86	0.57	0.38	0.43									1.86	1.39	1.03

v0 1 decay e (training signal = $1e^{\pm}1\pi^{\pm}$)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	6.95	4.64	3.81	32.01	132.51	82.41	11.12	3.61	4.65	15.28	5.14		6.95	295.10	0.40
pre-BDT	3.33	0.80	0.67	13.68	94.05	19.40	9.84	2.65	2.71	6.84	4.07		3.33	154.70	0.27
post-BDT	2.00	0.15	0.08	0.05	0.04	0.21	0.07	0.03	0.06	0.13	0.09		2.00	0.92	1.17
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	10.57	0.52	2.31	1.21	0.54	0.26	246.94	39.72					10.57	291.49	0.61
pre-BDT	3.94	0.09	0.48	0.14	0.13	0.03	127.18	26.06					3.94	154.10	0.31
post-BDT	2.09	0.02	0.08	0.01	0.03	0.01	0.30	0.39					2.09	0.83	1.22
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	7.86	7.54	246.94	39.72									7.86	294.20	0.45
pre-BDT	3.27	1.54	127.18	26.06									3.27	154.77	0.26
post-BDT	1.69	0.54	0.30	0.39									1.69	1.23	0.99

Reduction in efficiency and FOM across all signal definitions

ν_1 1 decay e (training signal = $\nu_e/\bar{\nu}_e$ CC1 $\pi^\pm$)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	6.95	4.64	3.81	32.01	132.51	82.41	11.12	3.61	4.65	15.28	5.14		6.95	295.15	0.40
pre-BDT	3.01	0.76	0.25	1.78	2.84	3.37	1.77	0.55	1.96	1.46	2.16		3.01	16.89	0.67
post-BDT	2.36	0.58	0.11	0.11	0.05	0.41	0.11	0.04	0.12	0.23	0.14		2.36	1.90	1.14
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	10.57	0.52	2.31	1.21	0.54	0.26	246.94	39.72					10.57	291.52	0.61
pre-BDT	3.60	0.08	0.22	0.02	0.08	0.02	8.02	7.86					3.60	16.30	0.81
post-BDT	2.82	0.04	0.12	0.01	0.05	0.01	0.57	0.63					2.82	1.44	1.37
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	7.86	7.54	246.94	39.72									7.86	294.24	0.45
pre-BDT	2.93	1.08	8.02	7.86									2.93	16.96	0.66
post-BDT	2.30	0.76	0.57	0.63									2.30	1.96	1.11

ν_0 1 decay e (training signal = $\nu_e/\bar{\nu}_e$ CC1 $\pi^\pm$)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	6.95	4.64	3.81	32.01	132.51	82.41	11.12	3.61	4.65	15.28	5.14		6.95	295.15	0.40
pre-BDT	3.33	0.80	0.67	13.68	94.05	19.40	9.84	2.65	2.71	6.84	4.07		3.33	154.70	0.27
post-BDT	2.23	0.56	0.11	0.08	0.03	0.26	0.10	0.05	0.11	0.17	0.13		2.23	1.59	1.14
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	10.57	0.52	2.31	1.21	0.54	0.26	246.94	39.72					10.57	291.52	0.61
pre-BDT	3.94	0.09	0.48	0.14	0.13	0.03	127.18	26.06					3.94	154.10	0.31
post-BDT	2.67	0.03	0.12	0.01	0.05	0.01	0.38	0.55					2.67	1.14	1.37
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	7.86	7.54	246.94	39.72									7.86	294.24	0.45
pre-BDT	3.27	1.54	127.18	26.06									3.27	154.77	0.26
post-BDT	2.20	0.69	0.38	0.55									2.20	1.62	1.12

Similar performance in efficiency and FOM

v1 1 decay e (training signal = $v_e/\bar{v}_e$ CC)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	6.95	4.64	3.81	32.01	132.51	82.41	11.12	3.61	4.65	15.28	5.14		6.95	295.06	0.40
pre-BDT	3.01	0.76	0.25	1.78	2.84	3.37	1.77	0.55	1.96	1.46	2.16		3.01	16.89	0.67
post-BDT	2.48	0.60	0.16	0.09	0.05	0.44	0.14	0.06	0.17	0.27	0.16		2.48	2.14	1.15
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	10.57	0.52	2.31	1.21	0.54	0.26	246.97	39.72					10.57	291.49	0.61
pre-BDT	3.60	0.08	0.22	0.02	0.08	0.02	8.02	7.86					3.60	16.30	0.81
post-BDT	2.93	0.07	0.15	0.01	0.06	0.02	0.58	0.80					2.93	1.68	1.36
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	7.86	7.54	246.97	39.72									7.86	294.16	0.45
pre-BDT	2.93	1.08	8.02	7.86									2.93	16.96	0.66
post-BDT	2.40	0.84	0.58	0.80									2.40	2.22	1.12

ν_0 1 decay e (training signal = $\nu_e/\bar{\nu}_e$ CC)

visible FSP:	1e1pi+/-	1e	1e other	1mu1 pi+/-	1mu	1mu other	0l1pi+	0l1pi-	0l1pi0	0lNpi	0l other		sig (1e1pi+/-)	bkg	FOM
FCFV	6.95	4.64	3.81	32.01	132.51	82.41	11.12	3.61	4.65	15.28	5.14		6.95	295.06	0.40
pre-BDT	3.33	0.80	0.67	13.68	94.05	19.40	9.84	2.65	2.71	6.84	4.07		3.33	154.70	0.27
post-BDT	2.33	0.62	0.25	0.09	0.06	0.57	0.14	0.11	0.19	0.36	0.12		2.33	2.52	1.06
NEUT mode:	nue CC1pi+	nue CCQE	nue CCNpi	nue CCDIS	nue CCother	nuebar CC	numu CC	NC					sig (nue CC1pi+)	bkg	FOM
FCFV	10.57	0.52	2.31	1.21	0.54	0.26	246.97	39.72					10.57	291.49	0.61
pre-BDT	3.94	0.09	0.48	0.14	0.13	0.03	127.19	26.06					3.94	154.09	0.31
post-BDT	2.80	0.06	0.21	0.04	0.06	0.02	0.72	0.93					2.80	2.04	1.27
nu type:	osc nue CC	int nue CC	numu CC	NC									sig (osc nue CC)	bkg	FOM
FCFV	7.86	7.54	246.97	39.72									7.86	294.16	0.45
pre-BDT	3.27	1.54	127.19	26.06									3.27	154.76	0.26
post-BDT	2.32	0.88	0.72	0.93									2.32	2.53	1.05

Reduction in efficiency and FOM across all signal definitions

Summary

	Signal Definition	Maximum FOM	Pre-BDT Cuts Version	Training Signal
0 decay e	$1e^{\pm}1\pi^{\pm}$	0.59	v1	$\nu_e/\bar{\nu}_e$ CC1 $\pi^{\pm}$
		0.59	v1	$1e^{\pm}1\pi^{\pm}$
		0.58	v0	$1e^{\pm}1\pi^{\pm}$
	ν_e CC1 π^+	0.55	v0	$\nu_e/\bar{\nu}_e$ CC1 $\pi^{\pm}$
		0.54	v1	$\nu_e/\bar{\nu}_e$ CC1 $\pi^{\pm}$
	osc ν_e CC	1.33	v0	ν_e CC
1 decay e	$1e^{\pm}1\pi^{\pm}$	1.20	v1	$1e^{\pm}1\pi^{\pm}$
	ν_e CC1 π^+	1.37	v0	$\nu_e/\bar{\nu}_e$ CC1 $\pi^{\pm}$
		1.37	v1	$\nu_e/\bar{\nu}_e$ CC1 $\pi^{\pm}$
	osc ν_e CC	1.12	v0	$\nu_e/\bar{\nu}_e$ CC1 $\pi^{\pm}$
		1.12	v1	ν_e CC
		1.11	v1	$\nu_e/\bar{\nu}_e$ CC1 $\pi^{\pm}$

Current Work

- Inclusive BDT
 - Reject 1-ring ν_e CCQE, 1-ring ν_e CC1 π^+ , and 2-ring ν_e CC1 π^+
 - Train BDT to select for remaining ν_e CC
- BDTs trained with v0 pre-BDT cuts and no fitQun fit indices as training variables