Progress Update

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2-Ring ν_e CC1π^+ Meeting

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Overview

- Supervisory Committee Meeting last week
  - Finalise samples over next month or two
  - Finish systematic error studies by end of 2019
  - Start writing thesis in early 2020
  - Spend some time in 2020 working on more advanced machine learning techniques
    - Convolutional neural networks for multi-ring PID, generative adversarial networks
    - Alternatively, focus on oscillation analysis?
- Large update to BDT code to make it much easier to test and compare different pre-BDT cuts and BDT training variables
  - Some interesting results shown today

v1 pre-BDT Cuts, Trial 8 Variables

v1 pre-BDT cuts		
	0 decay e	**1 decay e**
FCFV	Wall > 50 cm	
not 1Re	not 1Re-like (TN319)	
sub-sample selection	2Reπ, 2Rπe, and 3Reππ sub-samples	1Re, 2Ree, 2Reπ, 2Rπe, 2Rμe, and 3Reππ sub-samples
0 decay e	1 sub-event	2 sub-events
E_{rec}*	$E_{rec}(p_e,p_\pi) < 1.5$ 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 2Reπ-like fit

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

Note: slightly modified visible FSP definitions to account for other possible hadrons (p, K^+) and require that electrons be above Cherenkov threshold

0 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

0 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

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

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

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	3.01	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

Current Work

- Currently testing BDTs without pre-BDT sub-sample selection
- Starting this week: inclusive BDT
  - Reject 1-ring ν_e CCQE, 1-ring ν_e CC1π^+, and 2-ring ν_e CC1π^+
  - Train BDT to select for remaining ν_e CC