Progress Update

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UofT Neutrino/DM Meeting
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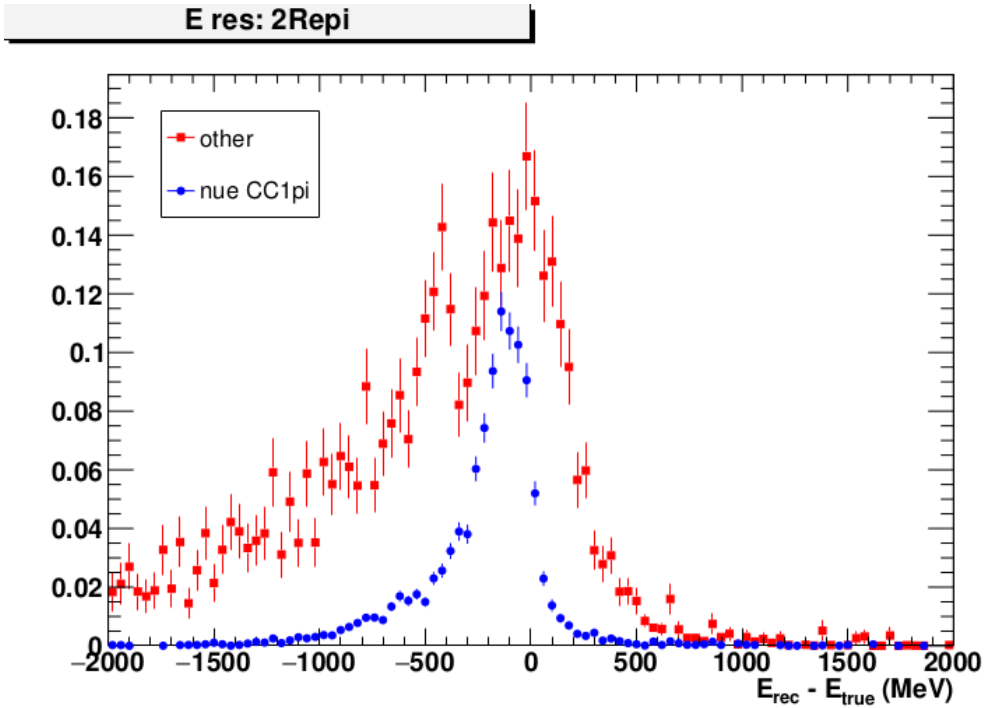
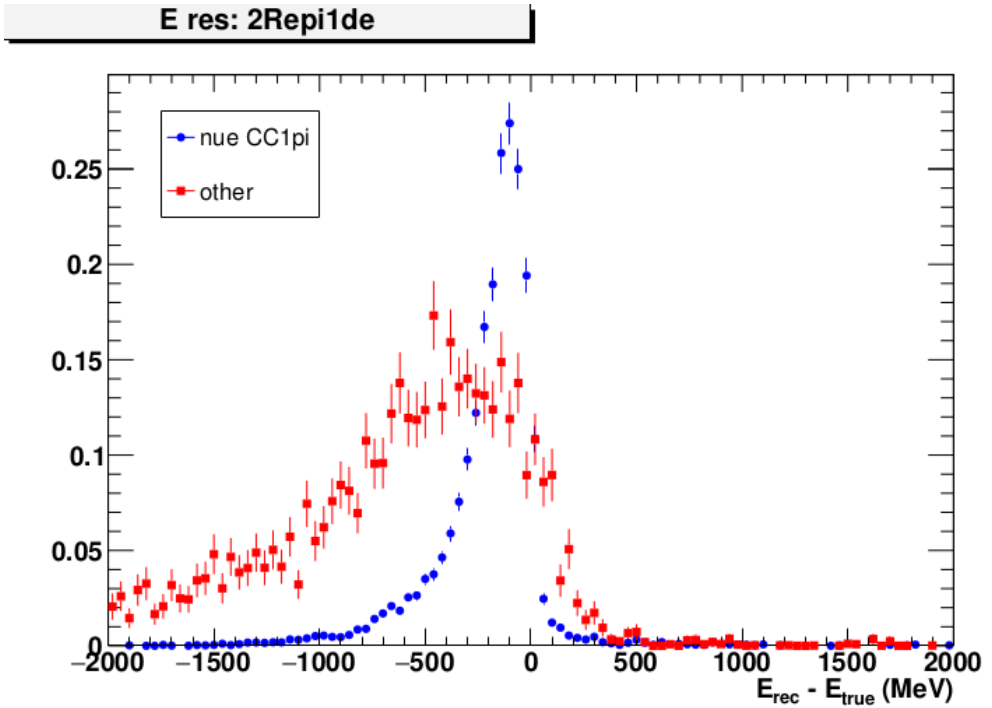
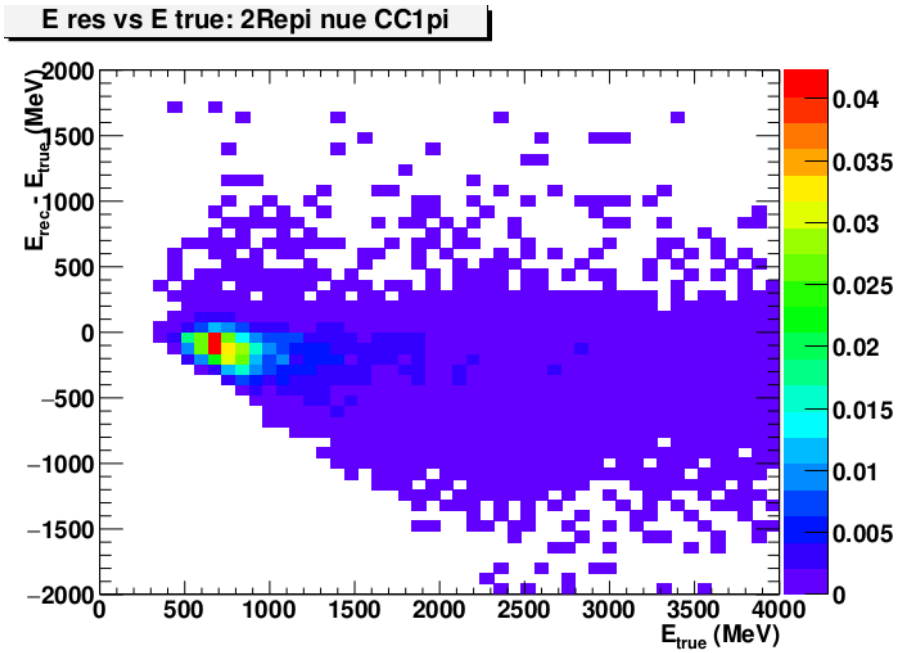
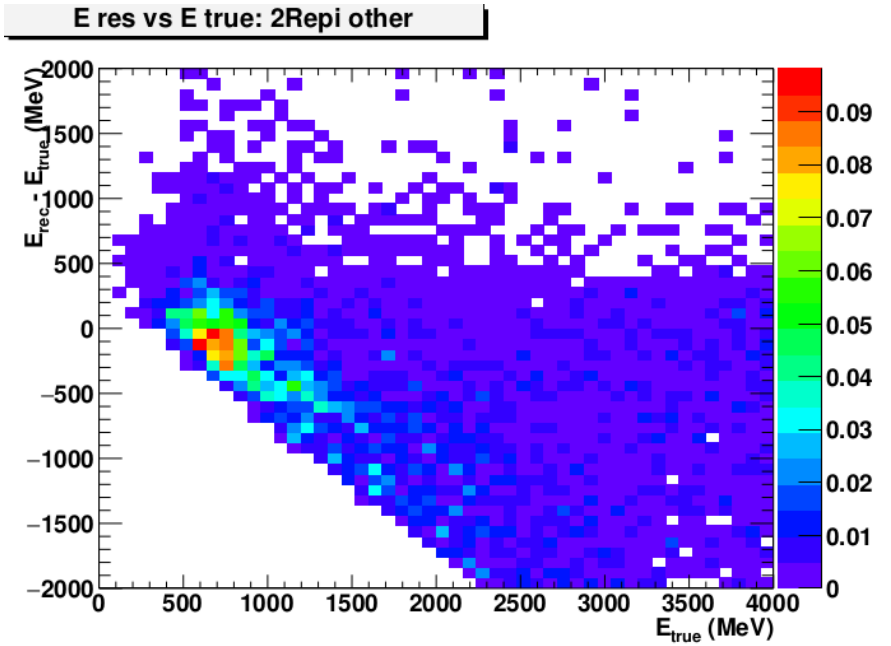
Energy Resolution

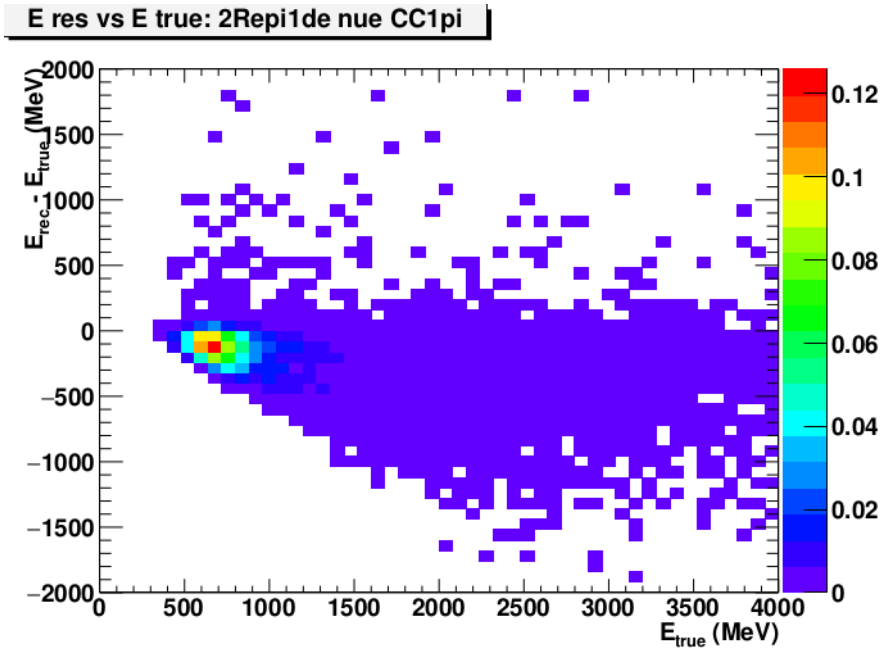


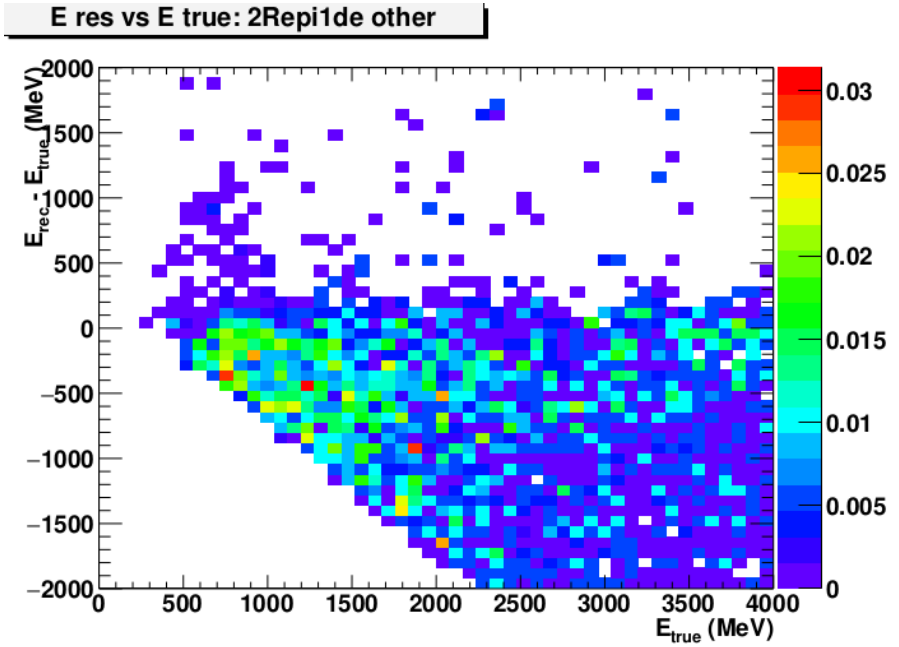


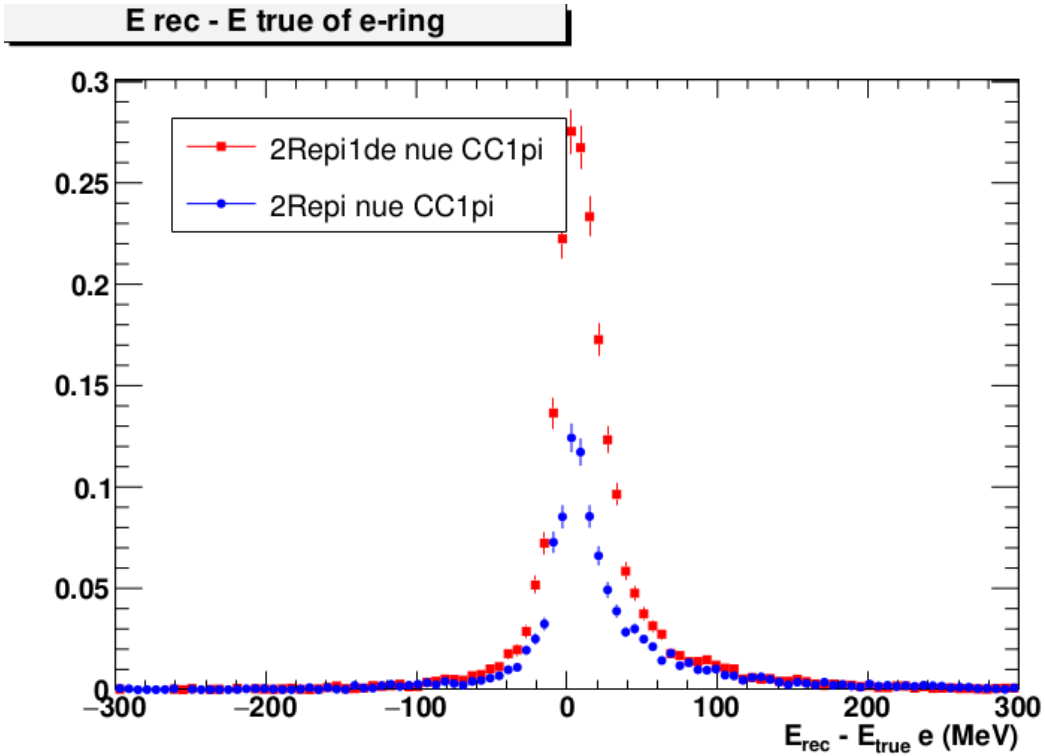
Missing energy?

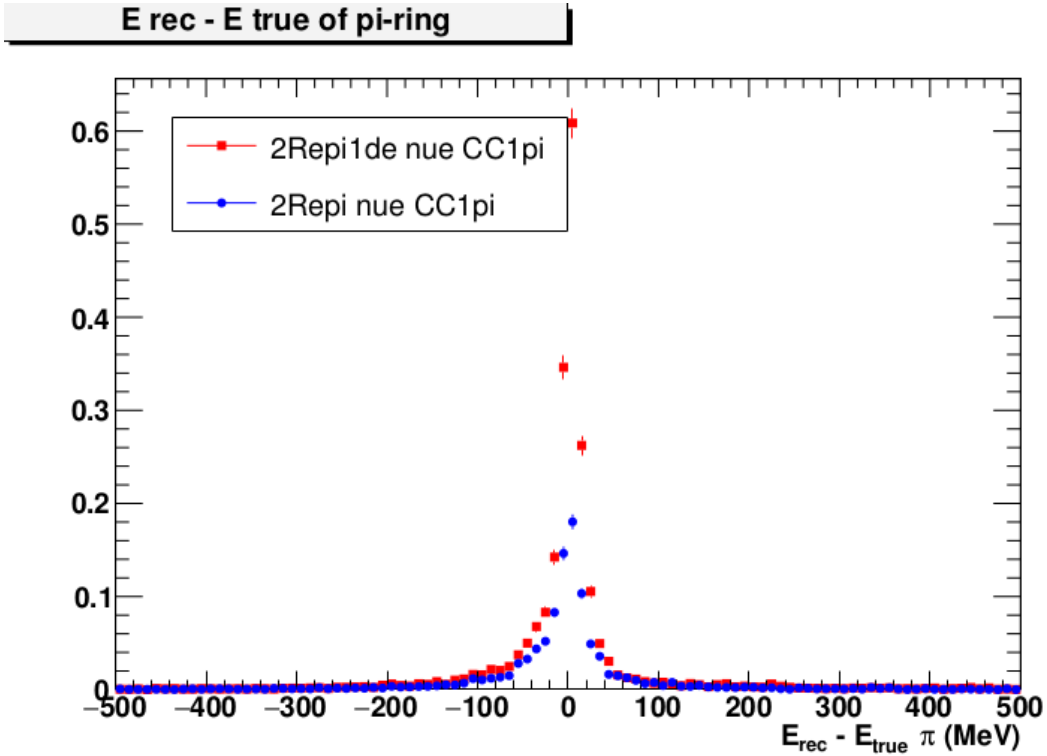

E res vs E true: 2Repi nue CC1pi
$E_{rec.} - E_{true}$ (MeV)
E_{true} (MeV)


E res vs E true: 2Repi other
$E_{rec.} - E_{true}$ (MeV)
E_{true} (MeV)


E res vs E true: 2Repi1de nue CC1pi
$E_{rec.} - E_{true}$ (MeV)
E_{true} (MeV)


E res vs E true: 2Repi1de other
$E_{rec.} - E_{true}$ (MeV)
E_{true} (MeV)





- No clear source of missing energy
- pions identified using VCWORK block

```
if (int_mode==1 && (Is2repi_exp || Is2repi1de_exp)){ // if true CC1pi event, determine energy resolution of e and pi rings (if they pass in 2Repi or 2Repi1de selections)
  Erese = sqrt(0.511*0.511 + fqmrmom[0][iering]*fqmrmom[0][iering]) - sqrt(0.511*0.511 + 1000000.*pnu[2]*pnu[2]);
  for (int i=0; i<Npvc; i++){
    if (abs(Ipvc[i])==PIDarr[ipip] && Ichvc[i]==1){
      Erespi = sqrt(139.57*139.57 + fqmrmom[0][ipiring]*fqmrmom[0][ipiring]) - sqrt(139.57*139.57 + Abspvc[i]*Abspvc[i]);
      ispi = true;
      break;
    }
  }

}
```

Testing some cuts

- Tried out a set of cuts based on looking at histograms (FHC, NH, dcp=0)

2Repi
FCFV
2 rings
epi-like
0 decay e
|p_e-p_pi| < 1000 MeV
280MeV<m_epi<350MeV && -150<2repi_nll-2ree_nll<0

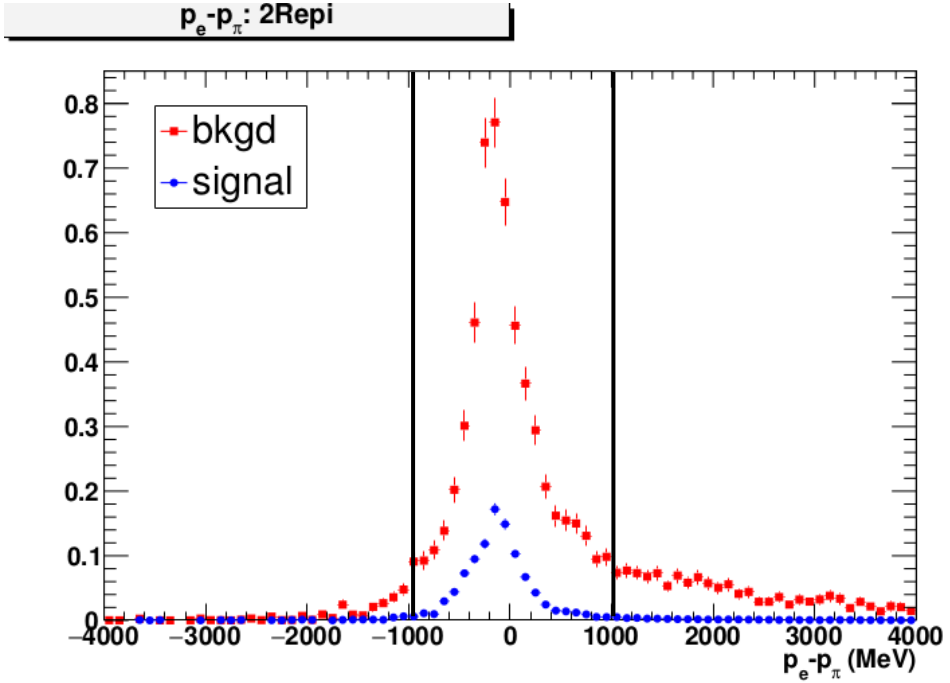
2Repi1de
FCFV
2 rings
epi-like
1 decay e
|p_e-p_pi| < 1000 MeV
d2se < 200cm

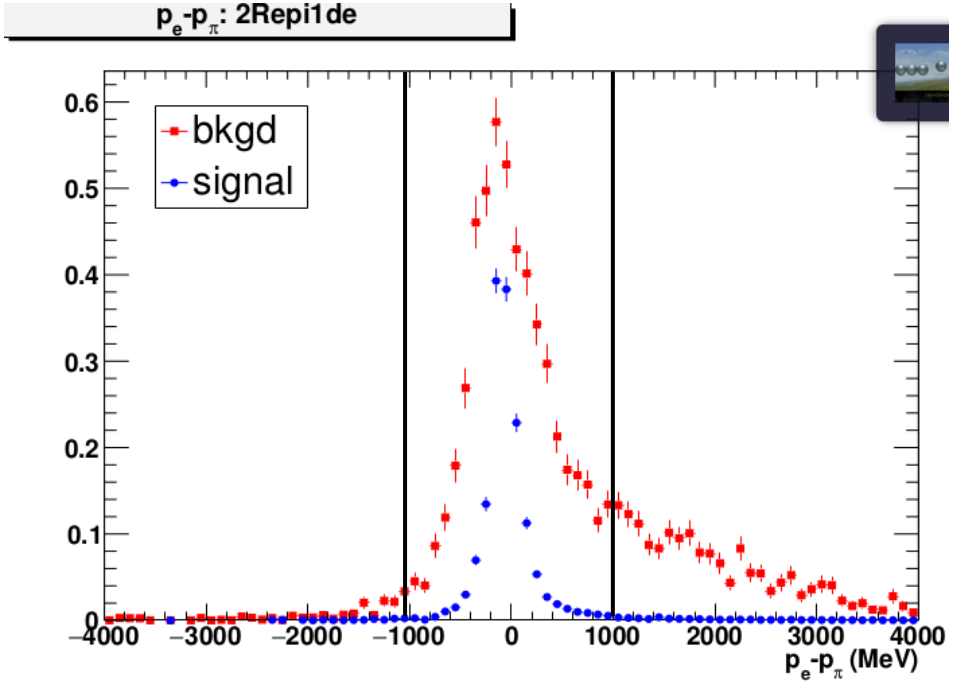
no p_e cut

new m_epi vs 2Repi_nll-2Ree_nll cut

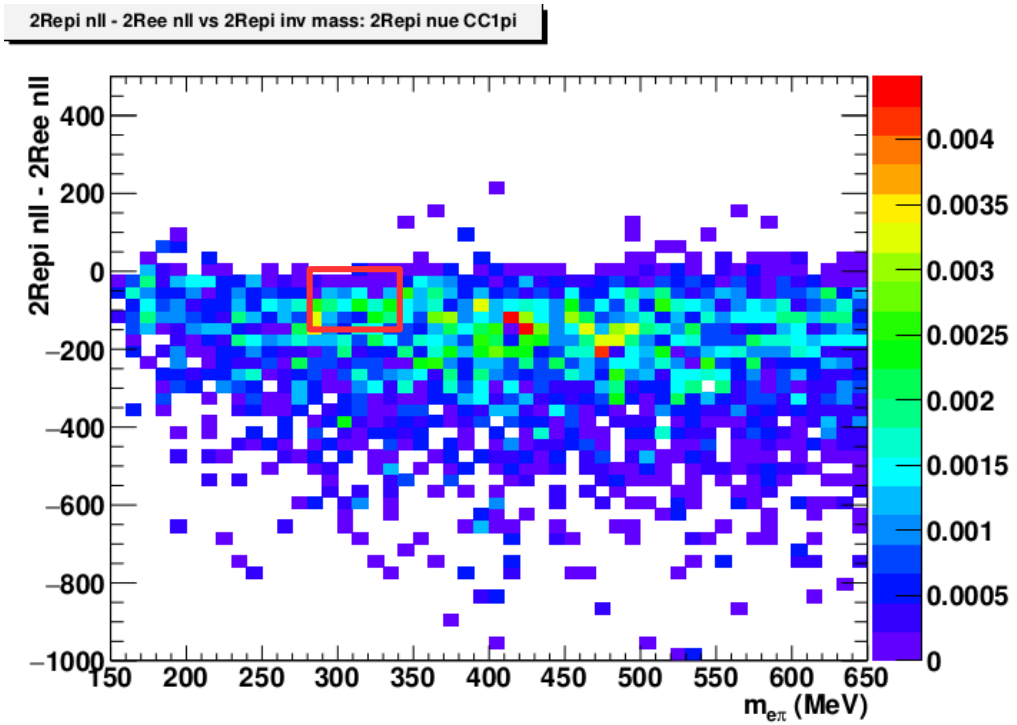
FCFV: evclass==1 && evis>30. && nhitac<16 && fqwall_2r>100.

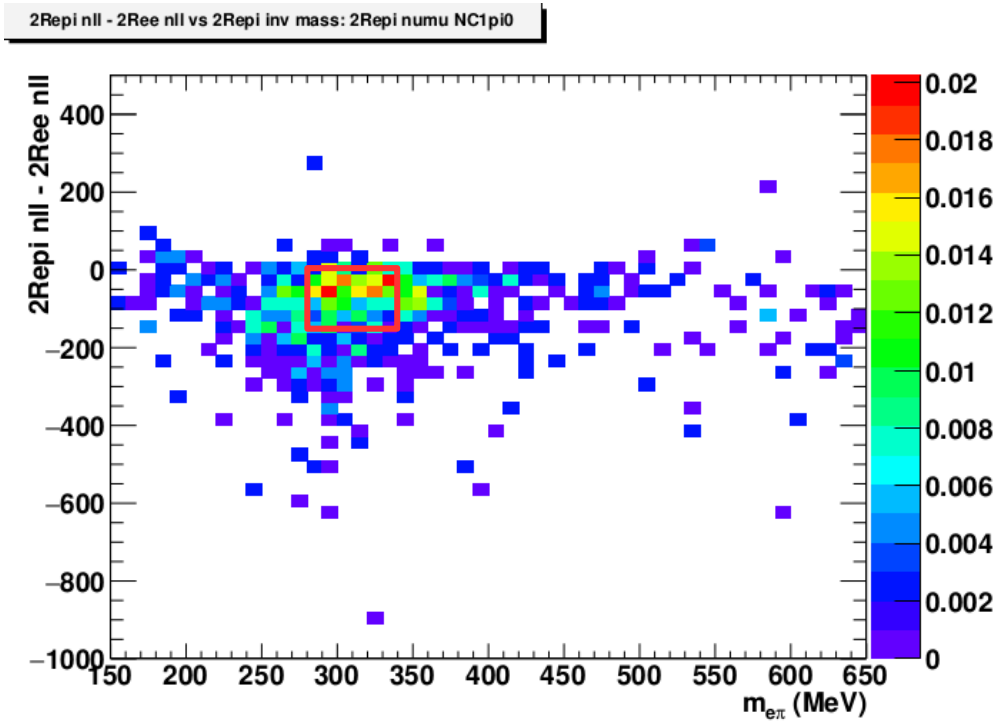
|p_e-p_pi| < 800MeV



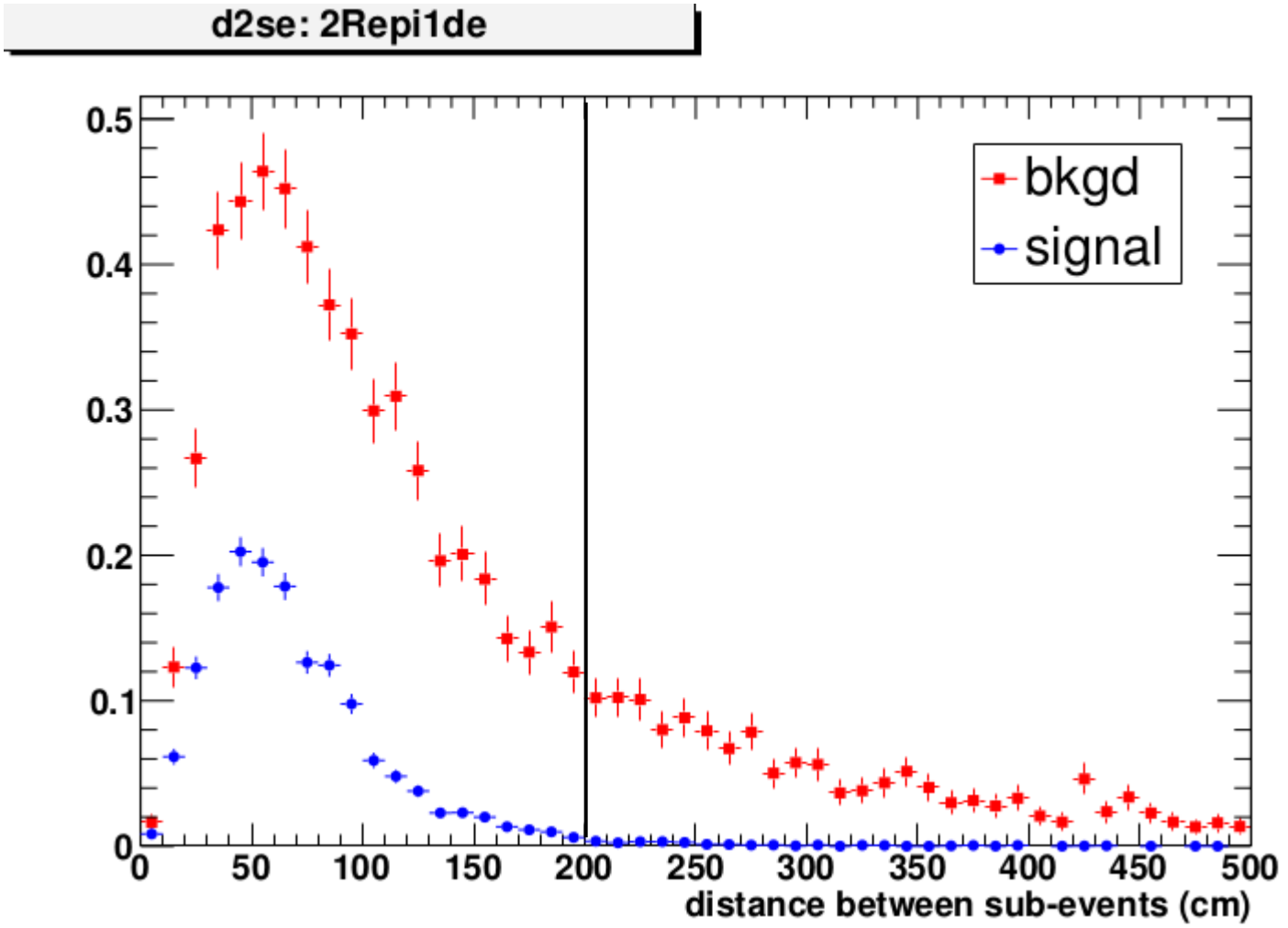


280MeV<m_epi<350MeV && -150<2repi_nll-2ree_nll<0





d2se < 200 cm


d2se: 2Repi1de
bkgd
signal
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
300
350
400
450
500
distance between sub-events (cm)

Final 2Repi FOM is same as last week

Sample	cut	numu/numub CC	intrinsic nue/nueb CC	osc nue/nueb CC	numu/numub NC	intrinsic nue/nueb NC	Signal	Bkgd	Purity	FOM
2Repi	FCFV	414.82	27.42	42.45	168.32	4.77	42.45	615.33	0.06	1.66
	2 rings	66.04	5.10	4.99	83.02	2.11	4.99	156.26	0.03	0.39
	epi-like	6.74	2.28	2.34	5.19	0.19	2.34	14.40	0.14	0.57
	0 decay e	1.48	1.00	0.88	3.17	0.11	0.88	5.76	0.13	0.34
	|p_e-p_pi| <1000MeV	0.82	0.62	0.84	2.92	0.10	0.84	4.47	0.16	0.37
	m_epi vs 2RepiInll-2ReenIl	**0.80**	**0.60**	**0.80**	**2.39**	**0.08**	**0.80**	**3.88**	**0.17**	**0.37**
2Repi1de	FCFV	414.82	27.42	42.45	168.32	4.77	42.45	615.33	0.06	1.66
	2 rings	66.04	5.10	4.99	83.02	2.11	4.99	156.26	0.03	0.39
	epi-like	6.74	2.28	2.34	5.19	0.19	2.34	14.40	0.14	0.57
	1 decay e	3.35	1.14	1.43	1.63	0.06	1.43	6.18	0.19	0.52
	|p_e-p_pi| <1000MeV	2.14	0.77	1.40	1.47	0.06	1.40	4.43	0.24	0.58
	d2se<200cm	**1.26**	**0.73**	**1.38**	**1.36**	**0.06**	**1.38**	**3.40**	**0.29**	**0.63**

signal = oscillated nue/nueb CC

Sample	cut	nue NC 1pi+	nue NC 1pi-	nue NC 1pi0	nue NC Npi	nue NC 0pi	numu NC 1pi+	numu NC 1pi-	numu NC 1pi0	numu NC Npi	numu NC 0pi
2Repi	FCFV	0.61	0.49	1.34	0.83	1.51	18.96	14.91	50.38	26.47	57.60
	2 rings	0.17	0.14	0.83	0.15	0.81	5.02	3.79	34.72	4.25	35.23
	epi-like	0.04	0.03	0.03	0.03	0.05	0.96	0.74	1.22	1.04	1.23
	0 decay e	0.02	0.02	0.03	0.01	0.03	0.37	0.48	1.08	0.44	0.80
	|p_e-p_pi| <1000MeV	0.02	0.02	0.03	0.01	0.03	0.36	0.47	1.00	0.31	0.79
	m_epi vs 2RepinII-2ReenII	**0.01**	**0.02**	**0.02**	**0.01**	**0.02**	**0.35**	**0.44**	**0.64**	**0.29**	**0.68**
2Repi1de	FCFV	0.61	0.49	1.34	0.83	1.51	18.96	14.91	50.38	26.47	57.60
	2 rings	0.17	0.14	0.83	0.15	0.81	5.02	3.79	34.72	4.25	35.23
	epi-like	0.04	0.03	0.03	0.03	0.05	0.96	0.74	1.22	1.04	1.23
	1 decay e	0.02	0.01	0.00	0.02	0.02	0.50	0.19	0.13	0.44	0.37
	|p_e-p_pi| <1000MeV	0.02	0.01	0.00	0.01	0.02	0.49	0.18	0.09	0.35	0.36
	d2se<200cm	**0.02**	**0.01**	**0.00**	**0.01**	**0.02**	**0.46**	**0.16**	**0.09**	**0.32**	**0.33**

Sample	cut	nue CC1pi	nue CCQE	nue CCother	numu CC1pi	numu CCQE	numu CCother	Signal	Background	Purity
2Repi	FCFV	19.07	32.69	18.11	93.86	126.25	194.71	19.07	638.71	0.03
	2 rings	5.03	2.19	2.88	29.36	10.50	26.18	5.03	156.23	0.03
	epi-like	3.33	0.56	0.74	0.94	0.14	5.66	3.33	13.41	0.20
	0 decay e	1.09	0.49	0.30	0.11	0.07	1.29	1.09	5.55	0.16
	|p_e-p_pi|<1000MeV	0.86	0.40	0.20	0.11	0.07	0.64	0.86	4.45	0.16
	m_epi vs 2RepinII-2ReenII	**0.82**	**0.39**	**0.20**	**0.10**	**0.07**	**0.63**	**0.82**	**3.86**	**0.18**
2Repi1de	FCFV	19.07	32.69	18.11	93.86	126.25	194.71	19.07	638.71	0.03
	2 rings	5.03	2.19	2.88	29.36	10.50	26.18	5.03	156.23	0.03
	epi-like	3.33	0.56	0.74	0.94	0.14	5.66	3.33	13.41	0.20
	1 decay e	2.19	0.06	0.31	0.49	0.05	2.81	2.19	5.42	0.29
	|p_e-p_pi|<1000MeV	1.92	0.04	0.21	0.48	0.05	1.61	1.92	3.91	0.33
	d2se<200cm	**1.87**	**0.04**	**0.20**	**0.36**	**0.03**	**0.87**	**1.87**	**2.91**	**0.39**

Thoughts

- If we continue to isolate 2Repi backgrounds, perhaps we can slowly chip them away
- Moving towards grid search, need to:
  - parameterize cuts
    - need to decide on which cuts to investigate, define parameters, and decide their ranges using plots as guidance
  - Current cut candidates:
    - Don’t include wall (decide on fixed value for purpose of grid search)
    - d2se (2Repi1de only)
      - perhaps look at d2se plotted against other variables
    - p_e – p_pi (upper and lower bounds, separately for 2Repi and 2Repi1de selections)
    - m_epi vs some variable(s)
    - p_e cut