Progress Update

Trevor Towstego
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Changing “nue CC1pi” Definition

- Mike suggested changing definition of “nue CC1pi” in purity calculations to refer to visible particles rather than neut mode
- Tried changing definition to require 1 pi+/- and 1 lepton
  - pion required to have momentum greater than Cherenkov threshold + 20 MeV

```
for (int i=0; i<npar; i++){
  if (Ipvc[i]==idpip && Ichvc[i]==1 && pmomv[i]>ctpip) npip+=1;
  if (Ipvc[i]==idpim && Ichvc[i]==1 && pmomv[i]>ctpim) npim+=1;
  if (Ipvc[i]==idpi0 && Ichvc[i]==1 && pmomv[i]>ctpi0) npi0+=1;
  if (Ipvc[i]==12 || Ipvc[i]==-12 || Ipvc[i]==14 || Ipvc[i]==-14) nlep+=1;
  if (Ichvc[i]==1) nvis+=1;
}

if (intmode<30 && ((npip==1 && npim==0 && npi0==0 && nlep==1) || (npip==0 && npim==1 && npi0==0 && nlep==1))) mode_out=1; // CC1pi
else if (intmode==1) mode_out=2; // CCQE
else if (intmode<30) mode_out=3; // CCother
else if (intmode>=30) mode_out=4; // NC
```

Baseline Comparison

2Repi

	by neut mode			by visible particles		
cut	**nue CC1pi**	**Other**	**Purity**	**nue CC1pi**	**Other**	**Purity**
FCFV	19.07	638.71	0.03	10.30	647.48	0.02
2 rings	5.03	156.23	0.03	4.11	157.14	0.03
epi-like	3.33	13.41	0.20	3.06	13.68	0.18
0 decay e	1.09	5.55	0.16	1.02	5.63	0.15

2Repi1de

	by neut mode			by visible particles		
cut	**nue CC1pi**	**Other**	**Purity**	**nue CC1pi**	**Other**	**Purity**
FCFV	19.07	638.71	0.03	10.30	647.48	0.02
2 rings	5.03	156.23	0.03	4.11	157.14	0.03
epi-like	3.33	13.41	0.20	3.06	13.68	0.18
1 decay e	2.19	5.42	0.29	1.95	5.66	0.26

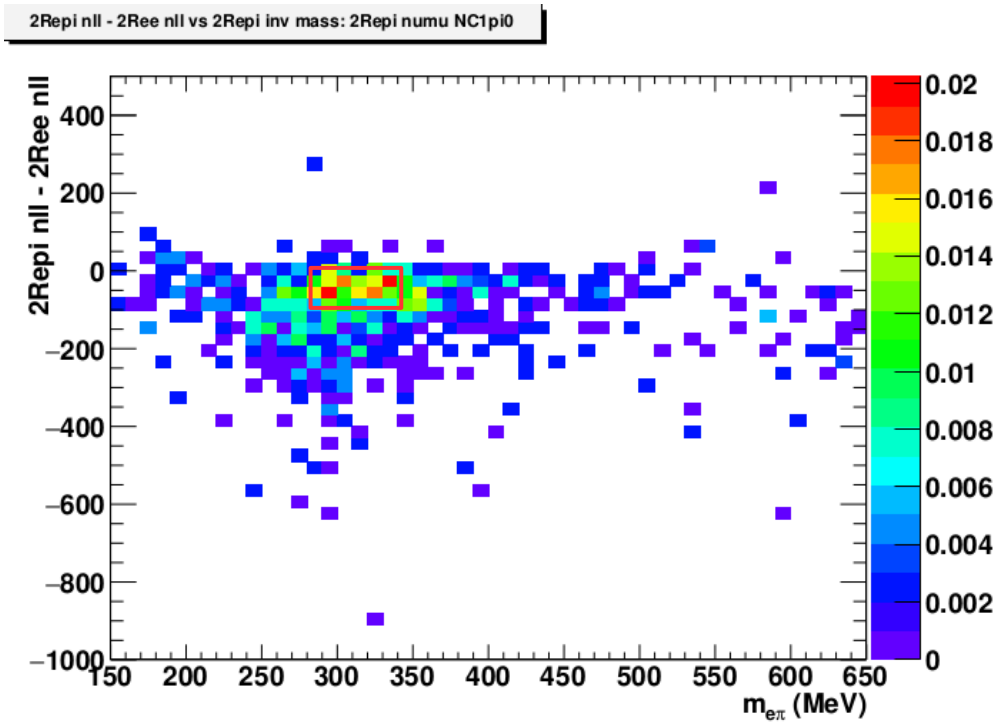
Purity and efficiency seem to actually be worse using the visible particles rather than neut mode.

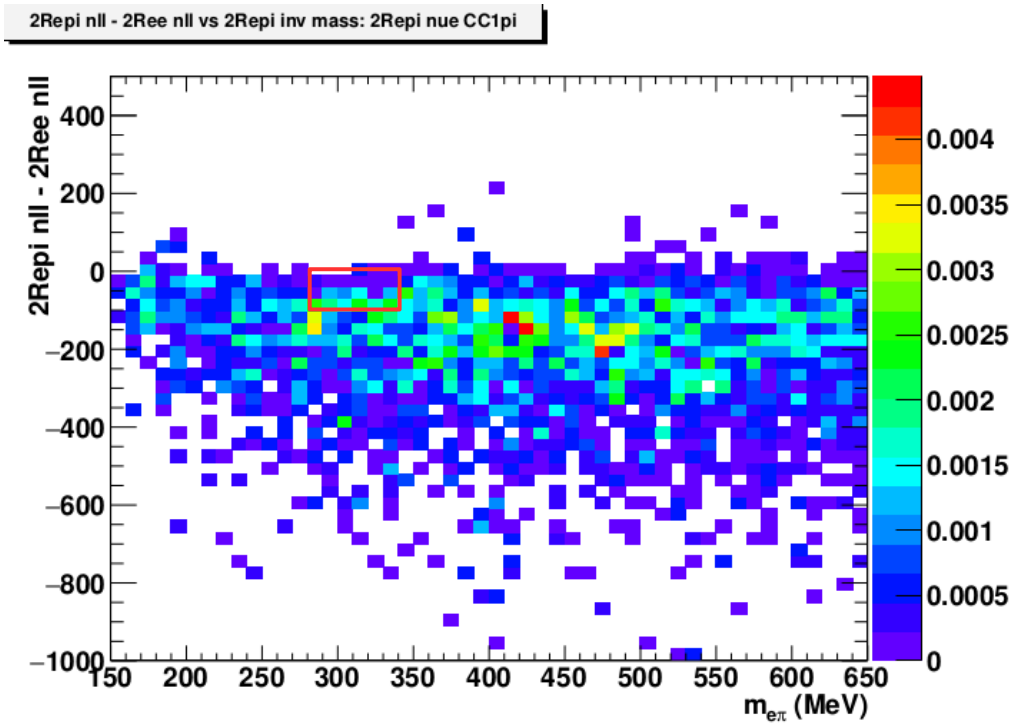
Revisiting numu NC1pi0 background

- Mike suggested checking to see if cut using e-e invariant mass would be better than using e-pi invariant mass

$nll_{2Re\pi} - nll_{2Ree}$ vs. $m_{e\pi}$

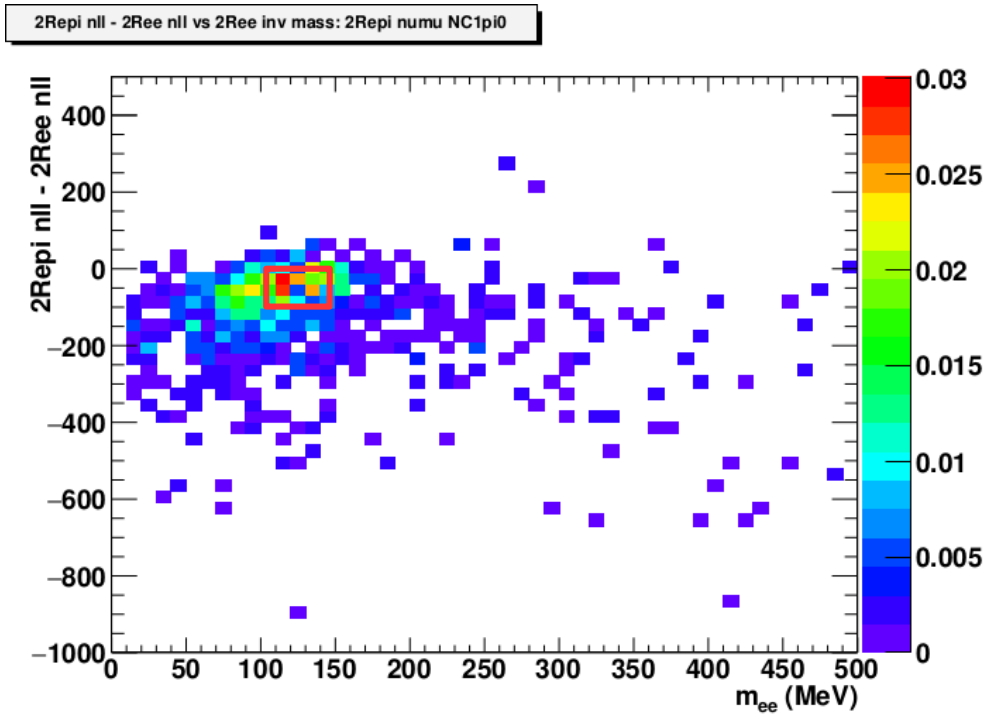
$m_{e\pi}<280$ || $m_{e\pi}>340$ || $nll_{2Re\pi}-nll_{2Ree}<-100$ || $nll_{2Re\pi}-nll_{2Ree}>0$

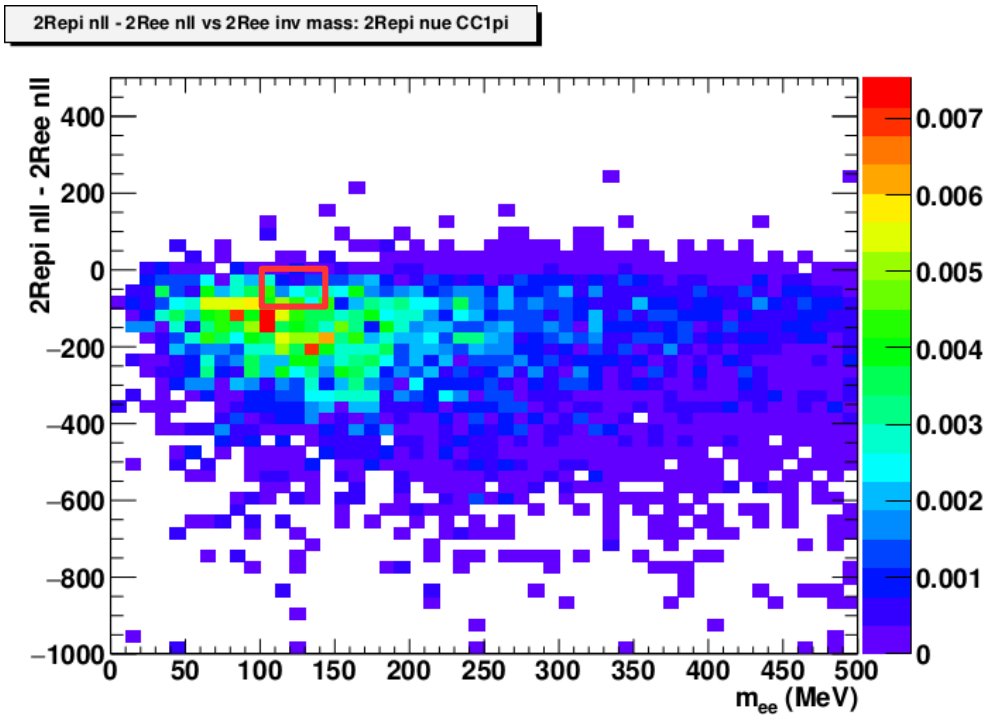




$nll_{2Re\pi} - nll_{2Ree}$ vs. m_{ee}

m_ee<105 || m_ee>150 || 2repi_nll-2ree_nll<-100 || 2repi_nll-2ree_nll>0





Cut Comparison

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	baseline	1.48	1.00	0.88	3.17	0.11	0.88	5.76	0.13	0.342
	E_{rec} < 1.5 GeV	0.28	0.41	0.79	2.45	0.08	0.79	3.22	0.20	0.392
	$\|p_e-p_\pi\|$ < 800 MeV	0.28	0.41	0.78	2.37	0.08	0.78	3.14	0.20	0.395
	$m_{e\pi}$ > 240 MeV || $nll_{2Re\pi}-nll_{1R\mu}$ < -700	0.25	0.40	0.72	1.87	0.06	0.72	2.58	0.22	0.398
	$m_{e\pi}$<280 || $m_{e\pi}$>340 || $nll_{2Re\pi}-nll_{2Ree}$<-100 || $nll_{2Re\pi}-nll_{2Ree}$>0	**0.24**	**0.40**	**0.70**	**1.54**	**0.05**	**0.70**	**2.22**	**0.24**	**0.410**

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	baseline	1.48	1.00	0.88	3.17	0.11	0.88	5.76	0.13	0.342
	E_{rec} < 1.5 GeV	0.28	0.41	0.79	2.45	0.08	0.79	3.22	0.20	0.392
	$\|p_e-p_\pi\|$ < 800 MeV	0.28	0.41	0.78	2.37	0.08	0.78	3.14	0.20	0.395
	$m_{e\pi}$ > 240 MeV || $nll_{2Re\pi}-nll_{1R\mu}$ < -700	0.25	0.40	0.72	1.87	0.06	0.72	2.58	0.22	0.398
	m_{ee}<105 || m_{ee}>150 || $nll_{2Re\pi}-nll_{2Ree}$<-100 || $nll_{2Re\pi}-nll_{2Ree}$>0	**0.23**	**0.39**	**0.68**	**1.51**	**0.04**	**0.68**	**2.17**	**0.24**	**0.403**

2Repi Breakdown: m_epi

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
baseline	0.02	0.02	0.03	0.01	0.03	0.37	0.48	1.08	0.44	0.80
E_{rec} < 1.5 GeV	0.01	0.02	0.02	0.01	0.03	0.28	0.37	0.88	0.17	0.75
$\|p_e-p_\pi\|$ < 800 MeV	0.01	0.01	0.02	0.01	0.03	0.26	0.35	0.88	0.16	0.73
$m_{e\pi}$ > 240 MeV || $nll_{2Re\pi}$-$nll_{1R\mu}$ < -700	0.01	0.01	0.02	0.01	0.01	0.17	0.23	0.85	0.15	0.46
$m_{e\pi}$<280 || $m_{e\pi}$>340 || $nll_{2Re\pi}$-nll_{2Ree}<-100 || $nll_{2Re\pi}$-nll_{2Ree}>0	**0.01**	**0.01**	**0.02**	**0.00**	**0.01**	**0.17**	**0.21**	**0.62**	**0.14**	**0.39**

cut	nue CC1pi	nue CCQE	nue CCother	numu CC1pi	numu CCQE	numu CCother	nue CC1pi	Other	Purity
baseline	1.09	0.49	0.30	0.11	0.07	1.29	1.09	5.55	0.16
E_{rec} < 1.5 GeV	0.71	0.34	0.14	0.09	0.06	0.14	0.71	3.30	0.18
$\|p_e-p_\pi\|$ < 800 MeV	0.71	0.34	0.14	0.09	0.06	0.14	0.71	3.21	0.18
$m_{e\pi}$ > 240 MeV || $nll_{2Re\pi}$-$nll_{1R\mu}$ < -700	0.69	0.31	0.13	0.08	0.04	0.13	0.69	2.62	0.21
$m_{e\pi}$<280 || $m_{e\pi}$>340 || $nll_{2Re\pi}$-nll_{2Ree}<-100 || $nll_{2Re\pi}$-nll_{2Ree}>0	**0.67**	**0.30**	**0.13**	**0.07**	**0.04**	**0.13**	**0.67**	**2.25**	**0.23**

2Repi Breakdown: m_ee

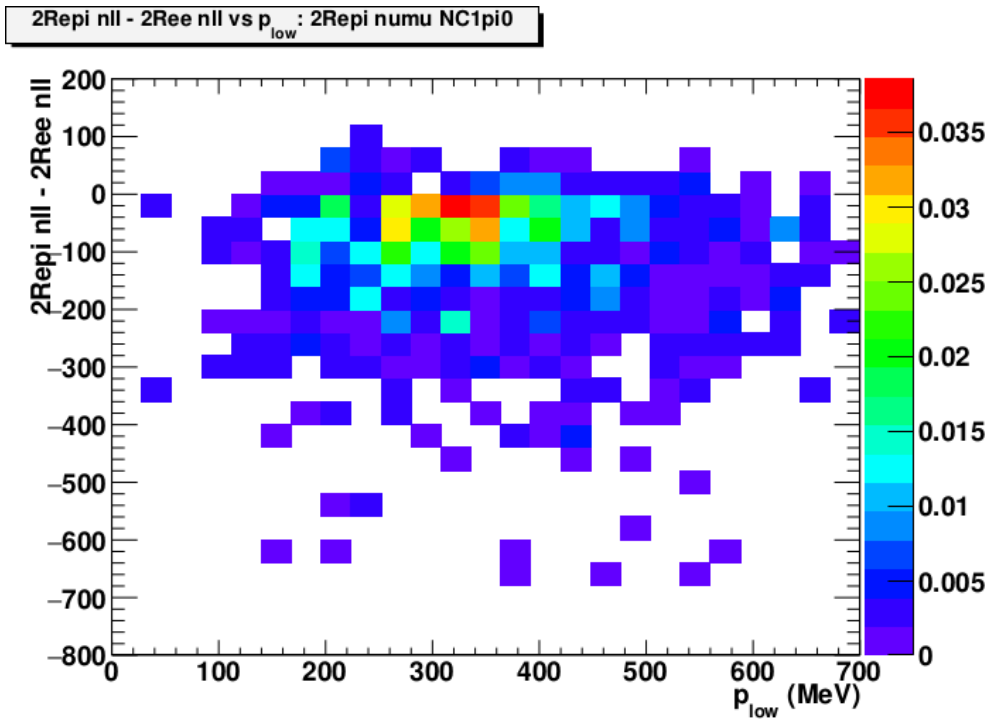
cut	nue NC 1pi+	nue NC 1pi-	nue NC 1pi0	nue NC Npi	nue NC 0pi	numu NC 1pi+	numu NC 1pi-	numu NC 1pi0	numu NC Npi	numu NC 0pi
baseline	0.02	0.02	0.03	0.01	0.03	0.37	0.48	1.08	0.44	0.80
E_{rec} < 1.5 GeV	0.01	0.02	0.02	0.01	0.03	0.28	0.37	0.88	0.17	0.75
$\|p_e-p_\pi\|$ < 800 MeV	0.01	0.01	0.02	0.01	0.03	0.26	0.35	0.88	0.16	0.73
$m_{e\pi}$ > 240 MeV || $nll_{2Re\pi}-nll_{1R\mu}$ < -700	0.01	0.01	0.02	0.01	0.01	0.17	0.23	0.85	0.15	0.46
$m_{e\pi}$<280 || $m_{e\pi}$>340 || $nll_{2Re\pi}-nll_{2Ree}$<-100 || $nll_{2Re\pi}-nll_{2Ree}$>0	**0.01**	**0.01**	**0.01**	**0.00**	**0.01**	**0.16**	**0.21**	**0.61**	**0.14**	**0.39**

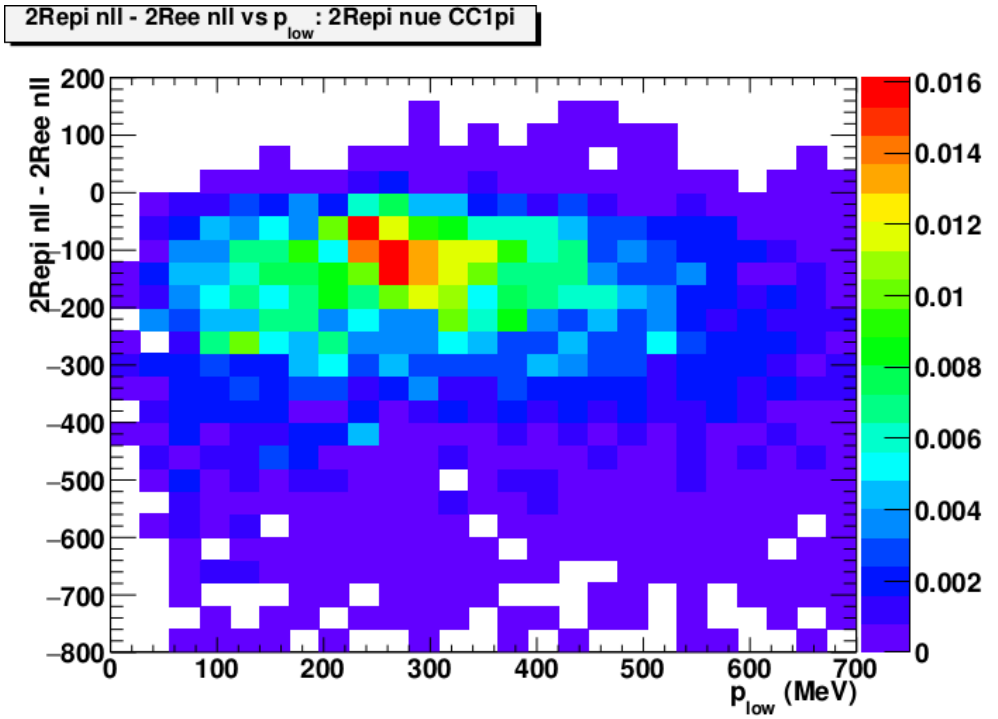
cut	nue CC1pi	nue CCQE	nue CCother	numu CC1pi	numu CCQE	numu CCother	nue CC1pi	Other	Purity
baseline	1.09	0.49	0.30	0.11	0.07	1.29	1.09	5.55	0.16
E_{rec} < 1.5 GeV	0.71	0.34	0.14	0.09	0.06	0.14	0.71	3.30	0.18
$\|p_e-p_\pi\|$ < 800 MeV	0.71	0.34	0.14	0.09	0.06	0.14	0.71	3.21	0.18
$m_{e\pi}$ > 240 MeV || $nll_{2Re\pi}-nll_{1R\mu}$ < -700	0.69	0.31	0.13	0.08	0.04	0.13	0.69	2.62	0.21
m_{ee}<105 || m_{ee}>150 || $nll_{2Re\pi}-nll_{2Ree}$<-100 || $nll_{2Re\pi}-nll_{2Ree}$>0	**0.65**	**0.29**	**0.12**	**0.07**	**0.04**	**0.12**	**0.65**	**2.20**	**0.23**

Plots vs. p_low

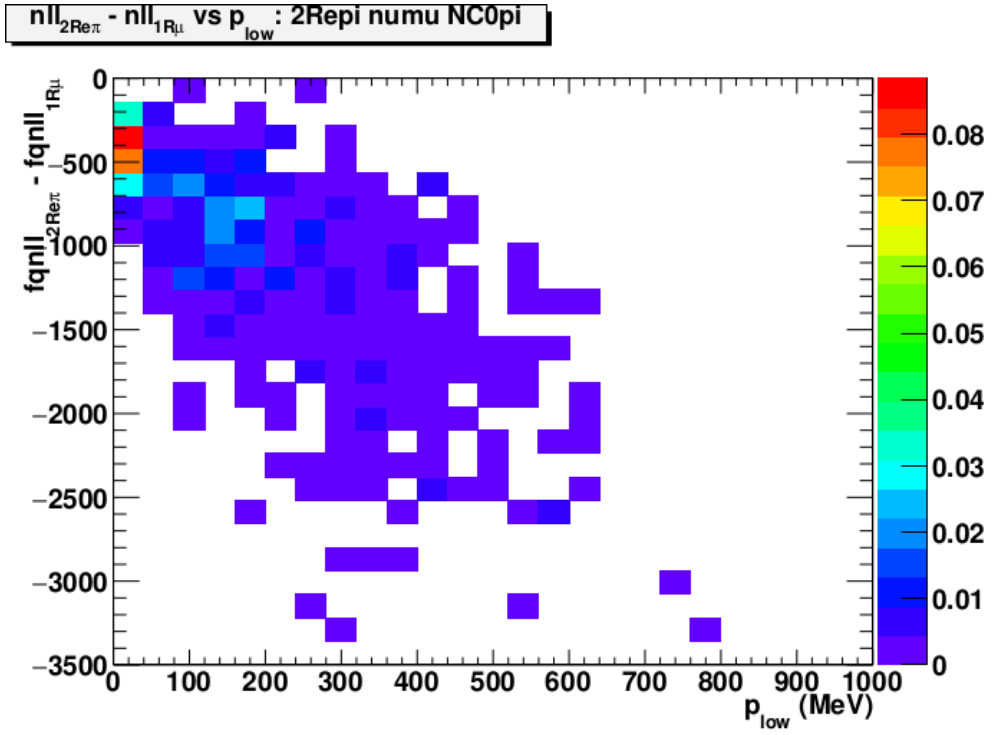
- Mike also suggested plotting likelihood ratios vs. momentum of lower-momentum ring for both numu NC1pi0 and numu NC0pi backgrounds

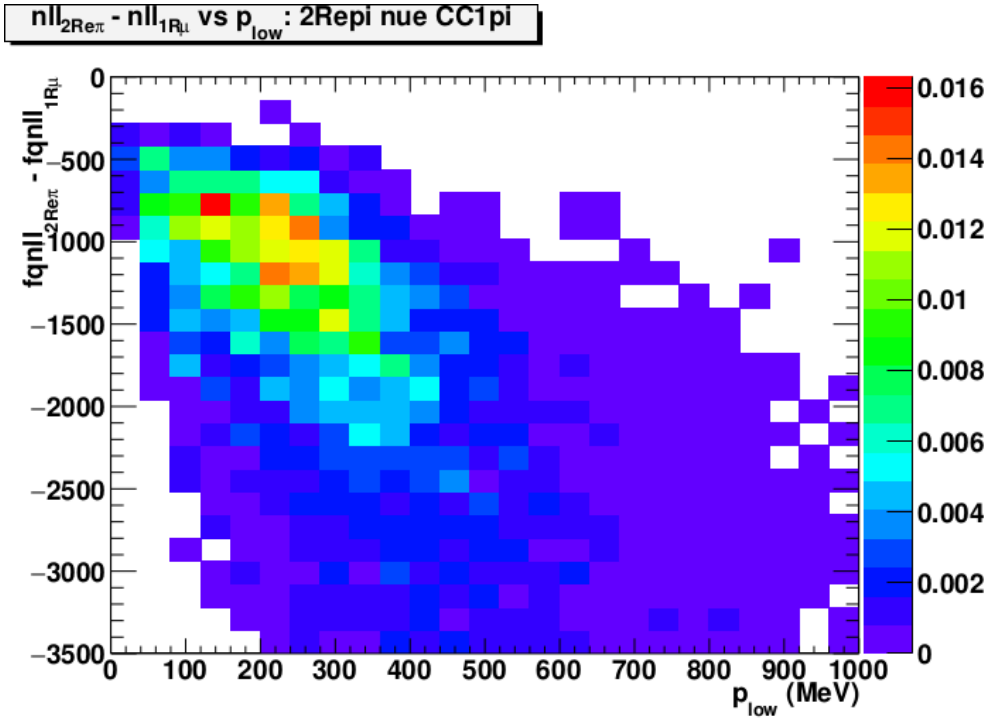
$nll_{2Re\pi} - nll_{2Ree}$ vs. p_{low}





$nll_{2Re\pi} - nll_{1R\mu}$ vs. p_{low}





Still to Do

- Investigate what likelihoods for MR fits look like before making 2Repi selection
  - i.e. is the default fiTQun MR cut appropriate?