Progress Update

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UofT Neutrino/DM Meeting
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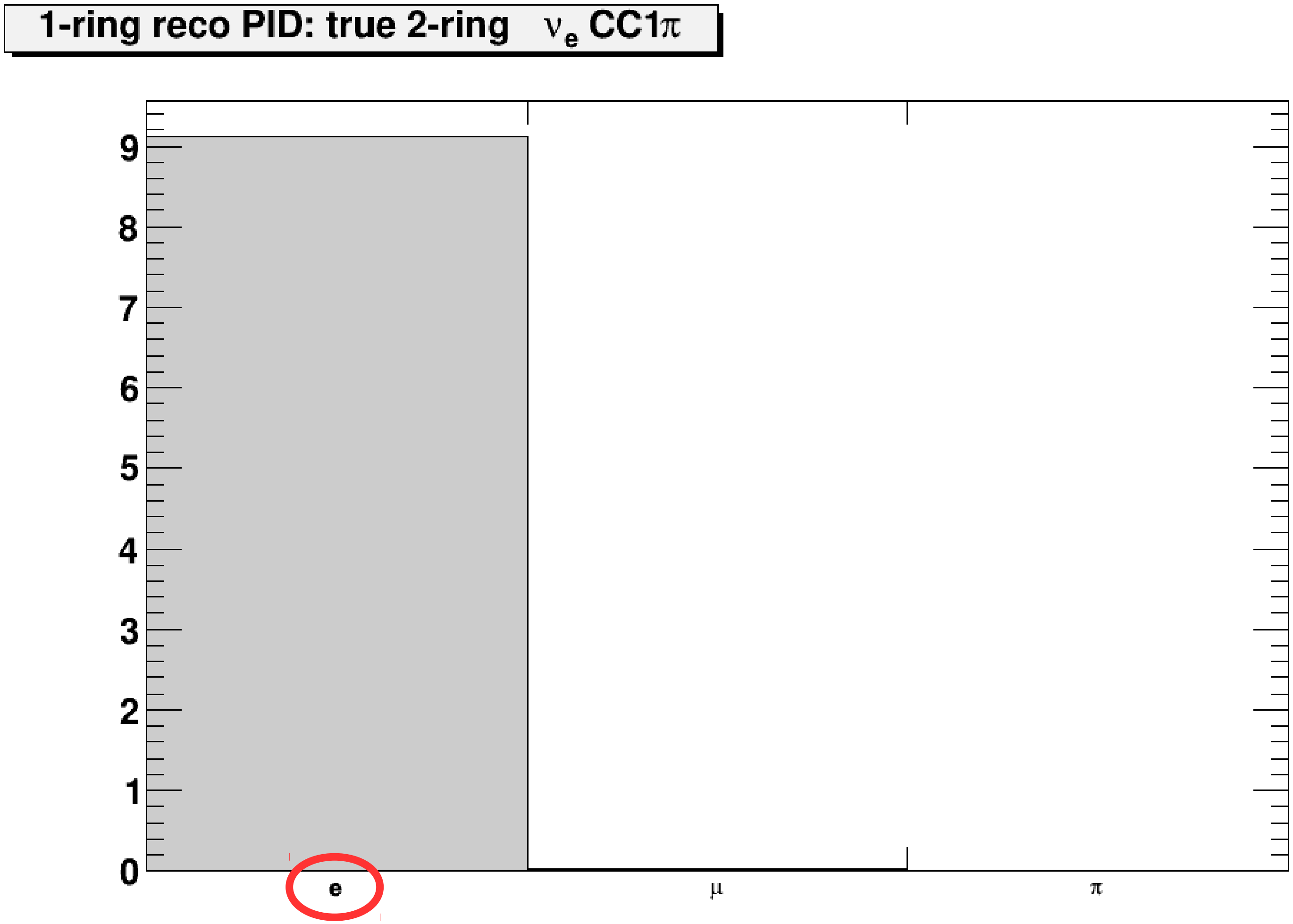
What are 2-ring ν_e CC1π events being reconstructed as?



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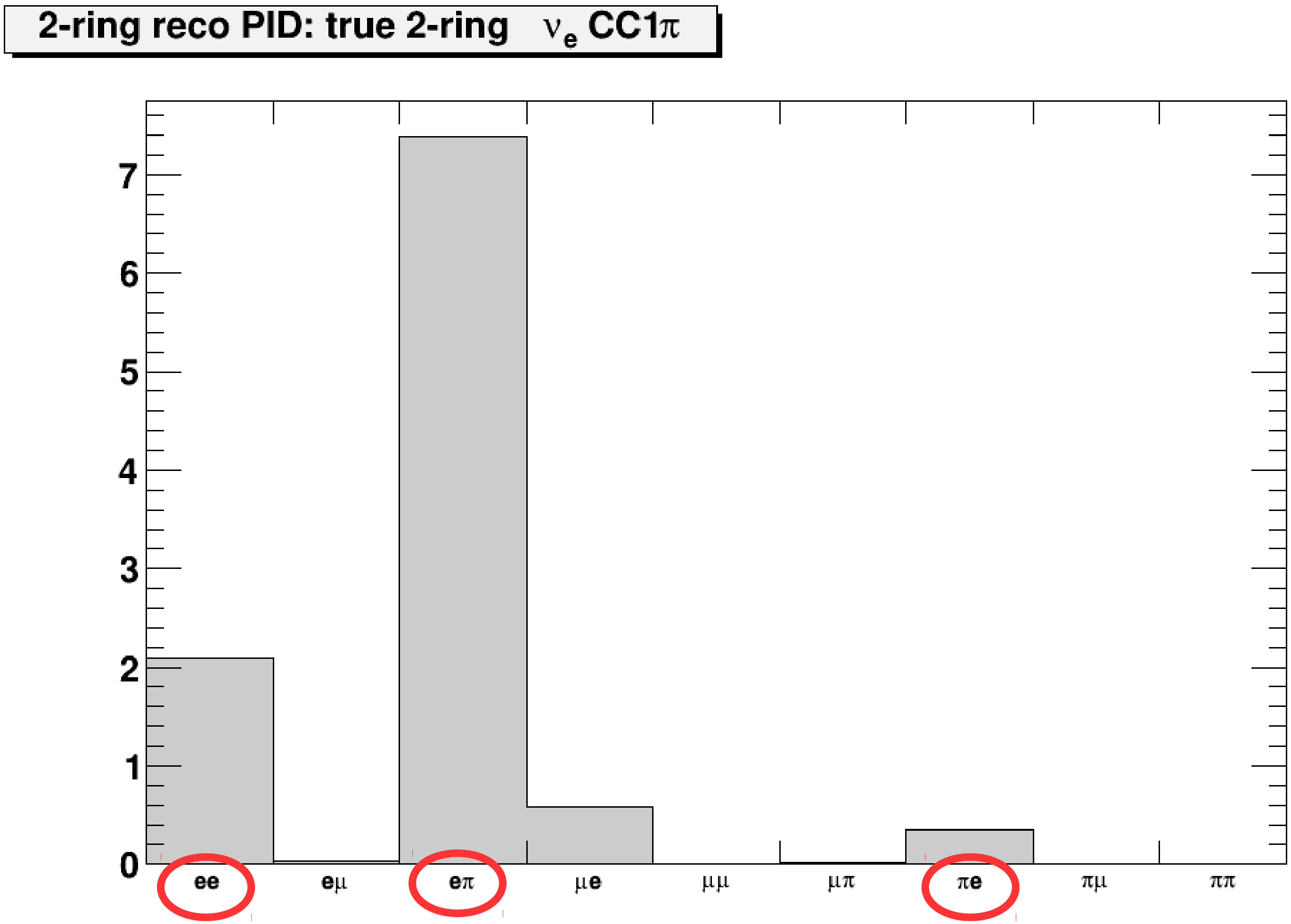
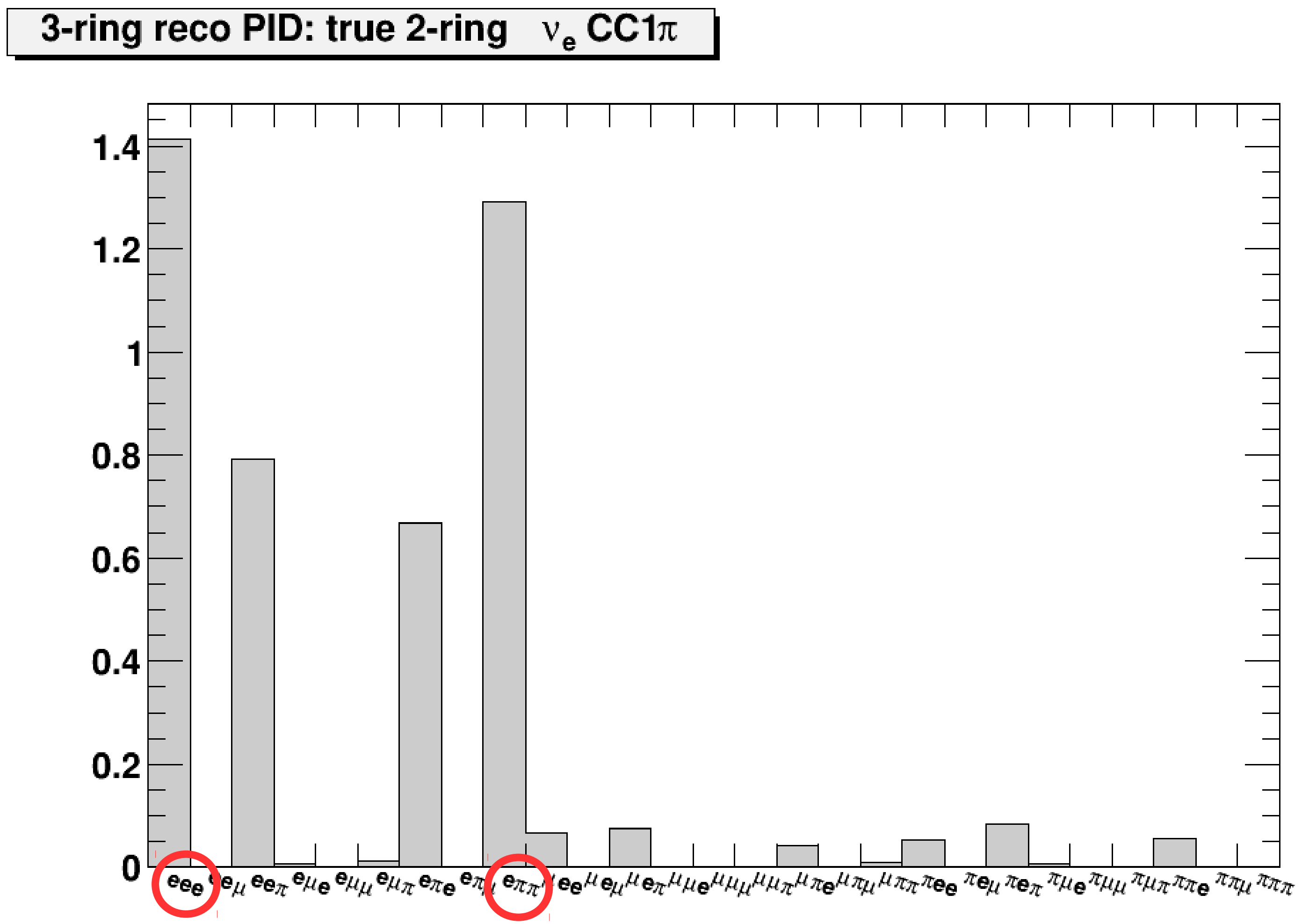


What are 2-ring ν_e CC1π events being reconstructed as?



Expanding the 2Reπ selection

- Looked at likelihood ratios of 2Reπ, 2Rπe, 1Re, 2Ree, 3Reee, and 3Reππ
  - only for events passing their respective event selection
    - i.e. only plot 2Ree likelihoods for events where fqmrpid[0][*] corresponds to a 2Ree fit
  - For some samples, only the 0de or the 1de case was considered
    - depending on the potential efficiency and the initial purity
- Looked at each selection separately, and tried to develop rejection requirements to isolate true 1e1π events

Baseline (2Reπ + 2Rπe)

- All event numbers shown have the following cuts applied:
  - FCFV
  - eπ cut (the cut being evaluated and modified)
  - 0/1 decay e
  - $E_{rec} < 1.5$ GeV
    - Based on either 2Reπ or 2Rπe reconstruction (whichever has lower index in MR fitter)

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.652	1.41	3.50	28.8%	9.06%	46.03%	31.55%
1de	1.145	3.51	2.27	60.7%	22.49%		

Note: efficiency is calculated with the denominator equal to the total number of true $1e1\pi^{+/-}$ events in FCFV with $E_\nu < 1.5$ GeV and with 1 or 2 sub-events (summed together)

2Reπ only

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.675	1.27	2.51	33.6%	8.16%	54.49%	29.47%
1de	1.205	3.32	1.33	71.5%	21.31%		

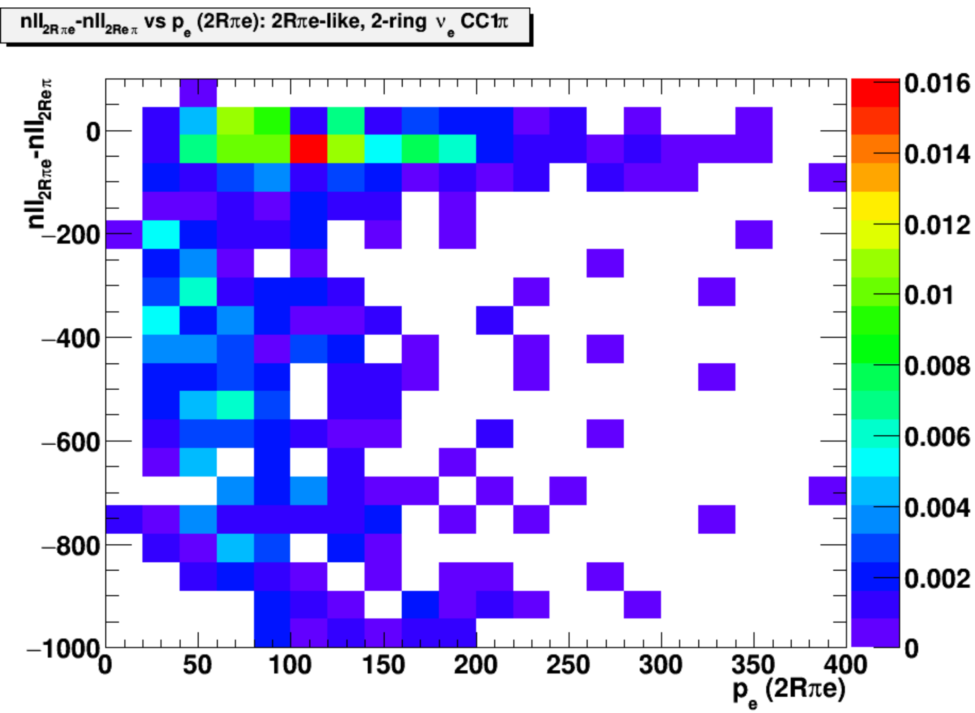
2Rπe only

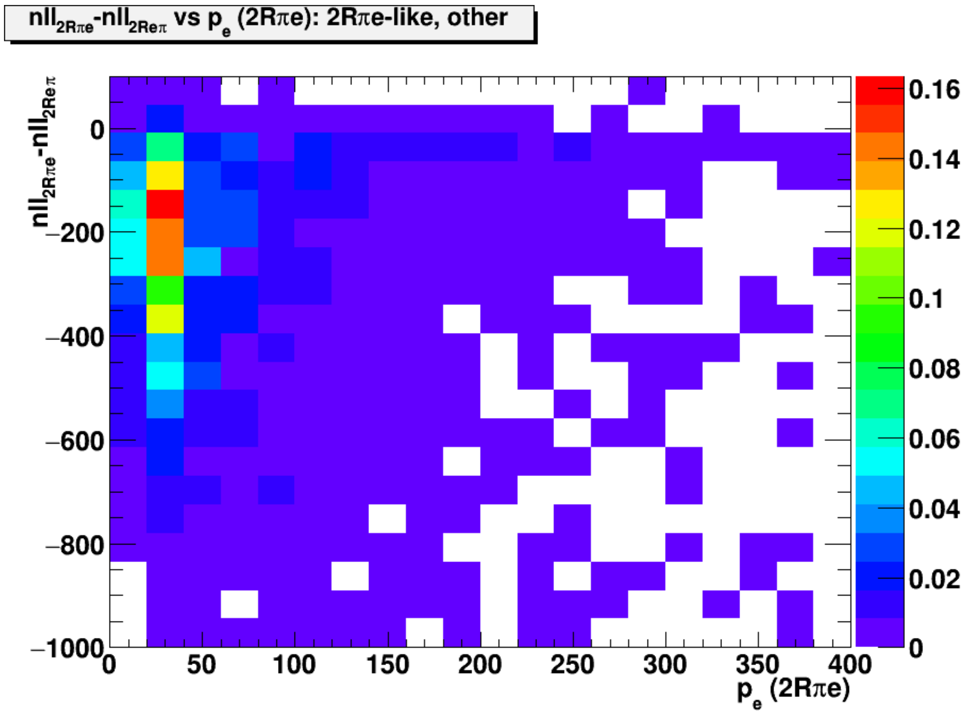
	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.125	0.14	0.99	12.4%	0.90%	14.35%	2.07%
1de	0.144	0.18	0.94	16.3%	1.18%		

```
fqmrmom[0][1] > 40.
```

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.156	0.12	0.45	21.9%	0.80%	28.20%	1.87%
1de	0.204	0.17	0.30	35.9%	1.07%		

```
fqmrmom[0][1] > 40.
```





1Re only

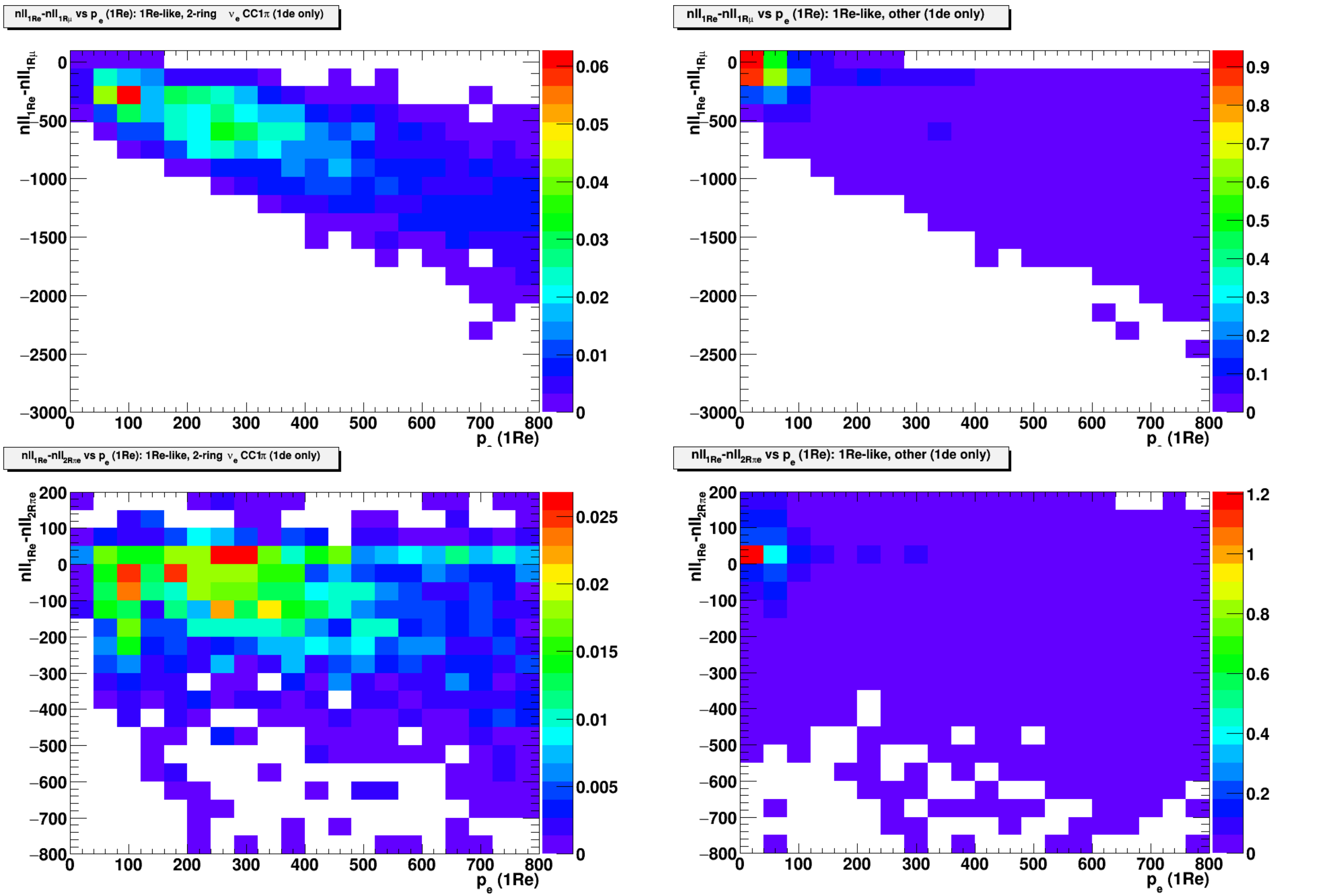
	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	1.399	0.67	24.50	2.7%	4.30%	6.38%	13.54%
1de	0.726	1.44	6.48	18.2%	9.25%		

```
fqnse==2 &&
fq1rmom[0][1] > 40. &&
( nll1re-nll1rmu < -200. || fq1rmom[0][1] > 80. ) &&
( nll1re-nll2rpie < -50. || fq1rmom[0][1] > 80. )
```

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de						30.06%	8.89%
1de	0.882	1.39	3.23	30.1%	8.89%		

Note: 1Re-like events that pass 1Re and 1Re1de selections are not included in this 1Re sample

```
fqnse==2 &&
fq1rmom[0][1] > 40. &&
( nll1re-nll1rmu < -200. || fq1rmom[0][1] > 80. ) &&
( nll1re-nll2rpie < -50. || fq1rmom[0][1] > 80. )
```



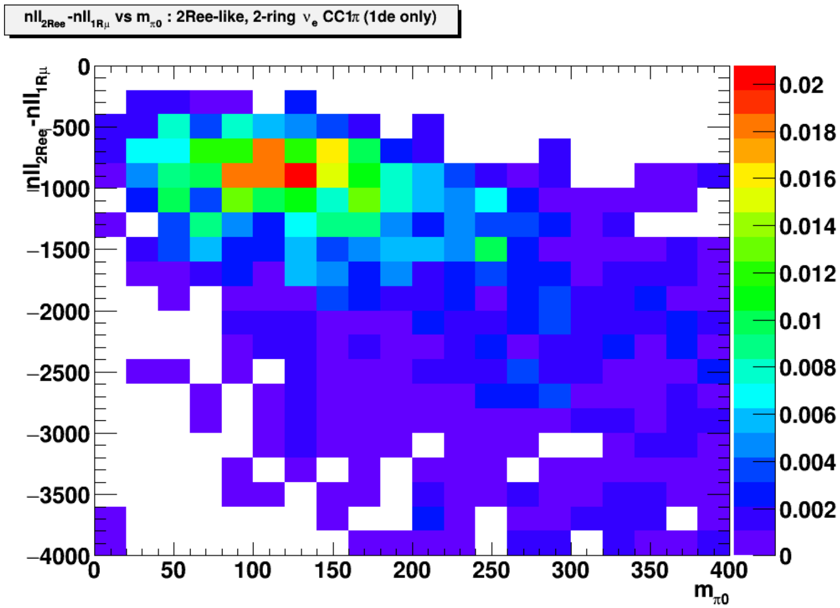
2Ree only

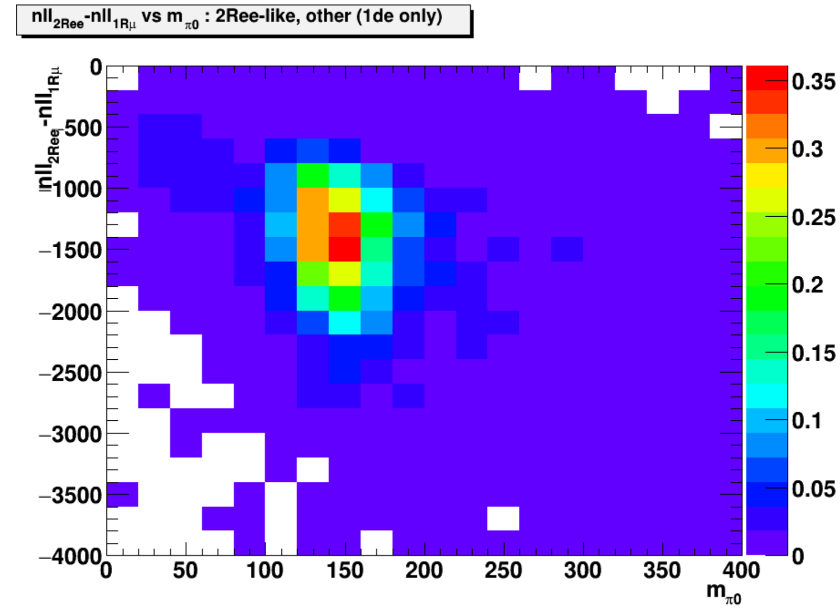
	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.365	0.41	64.16	0.6%	2.65%	1.37%	6.23%
1de	0.246	0.56	5.93	8.6%	3.59%		

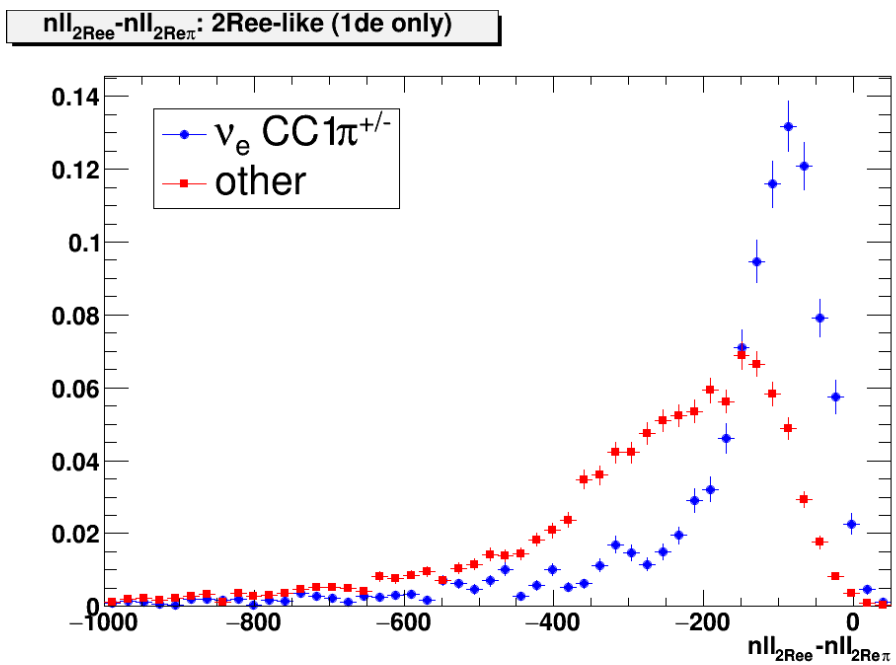
```
fqnse==2 &&
( nll2ree-nll1rmu > -1000. && fqpi0mass[0] < 140. ) &&
( nll2ree-nll2repi > -150. )
```

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de						29.60%	1.00%
1de	0.282	0.16	0.37	29.6%	1.00%		

```
fqnse==2 &&
( nll2ree-nll1rmu > -1000. && fqpi0mass[0] < 140. ) &&
( nll2ree-nll2repi > -150. )
```







3Reππ only

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.151	0.17	0.43	28.1%	1.08%	34.77%	3.81%
1de	0.282	0.43	0.68	38.4%	2.73%		

```
nll3repipi-nll2repi > -800.+fqmrmom[0][0]*1.60
```

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.134	0.07	0.11	37.6%	0.43%	56.60%	1.87%
1de	0.317	0.23	0.11	66.5%	1.45%		

3Reee only

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.715	0.42	6.29	6.3%	2.70%	5.52%	3.08%
1de	0.102	0.06	1.94	3.0%	0.38%		

Difficult to see any separation of signal and background in likelihood ratio plots!

Putting it all together

baseline

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.652	1.41	3.50	28.8%	9.06%	46.03%	31.55%
1de	1.145	3.51	2.27	60.7%	22.49%		

2Reπ + 2Rπe + 1Re + 2Ree + 3Reππ

	FOM	true 1e1π	other	purity	eff.	net purity	net eff.
0de	0.698	1.46	3.07	32.3%	9.38%	44.45%	43.11%
1de	1.543	5.26	5.34	49.6%	33.72%		

Efficiency improved from 31.5% → 43.1%
Purity decreased from 46.0% → 44.4%

Next Steps

- Investigate 2Rμe, 3Reeπ, and 3Reπe samples as well
- Starting to develop BDT framework