Progress Update

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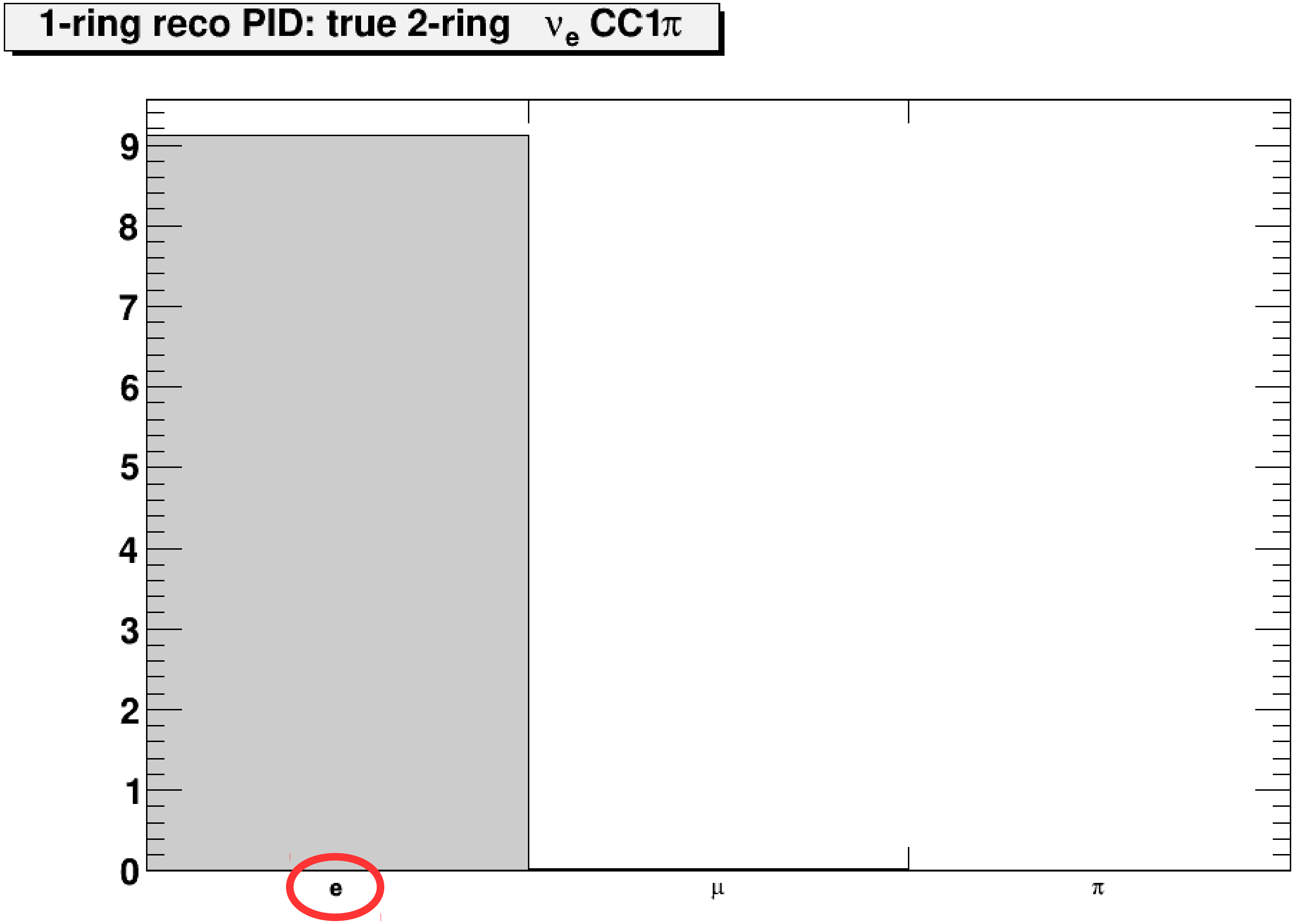
UofT Neutrino/DM Meeting
June 21, 2018

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



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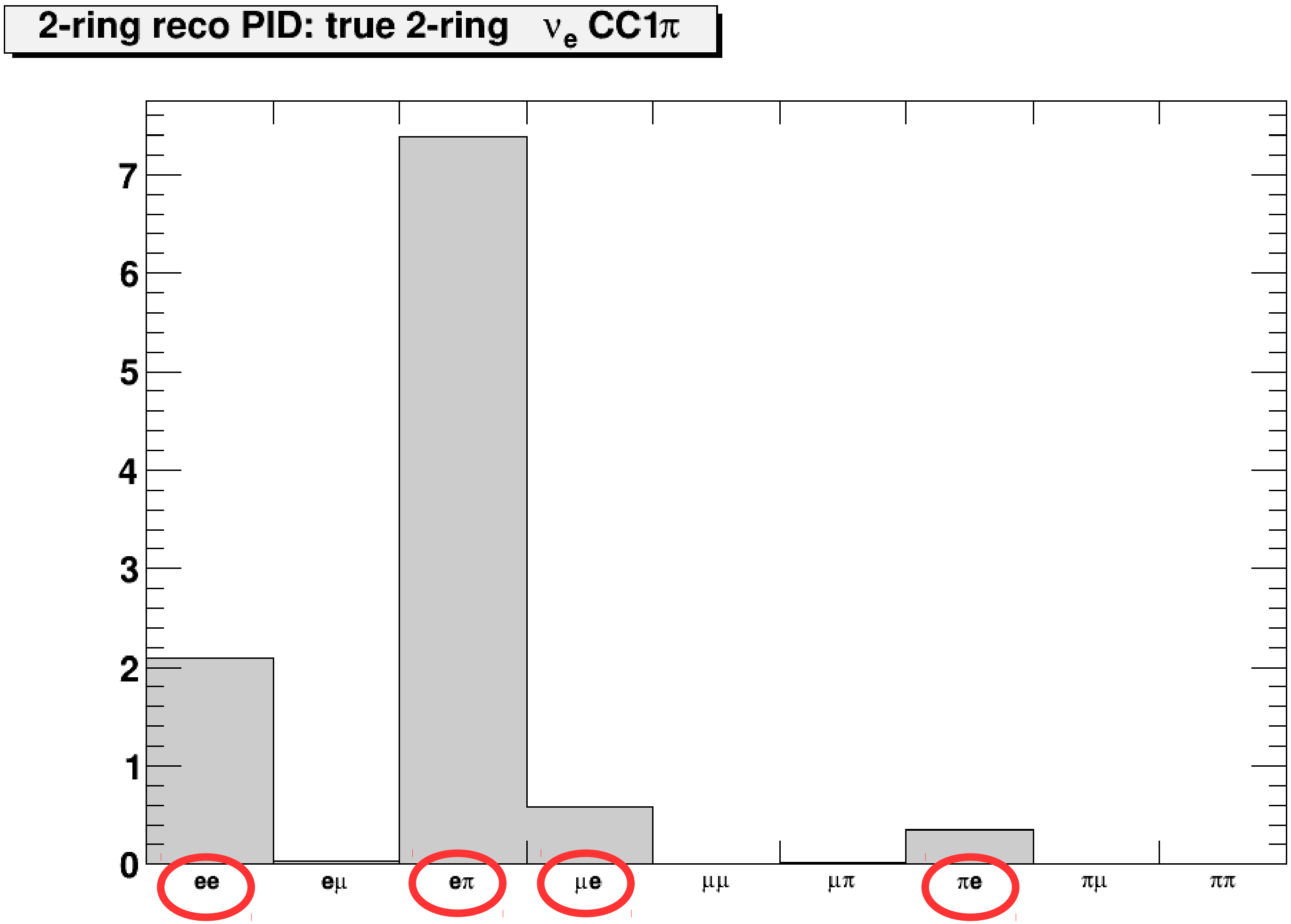

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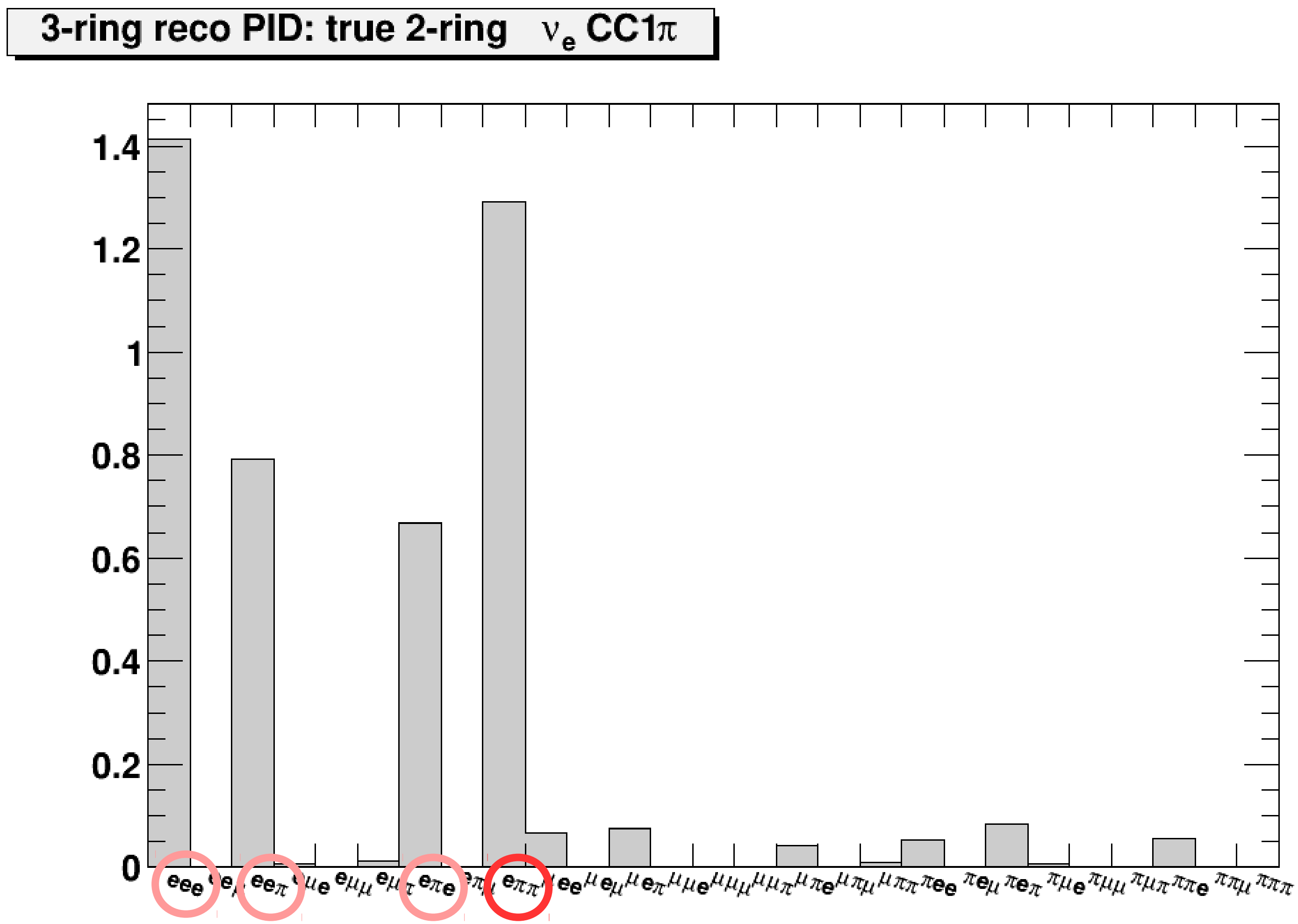


Baseline (2Reπ + 2Rπe)

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

	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de	0.652	1.41	3.50	28.8%	9.06%	0.637	46.03%	31.55%
1de	1.145	3.51	2.27	60.7%	22.49%	1.459		

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

Last Week

baseline

	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de	0.652	1.41	3.50	28.8%	9.06%	0.637	46.03%	31.55%
1de	1.145	3.51	2.27	60.7%	22.49%	1.459		

2Reπ + 2Rπe + 1Re + 2Ree + 3Reππ

	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de	0.698	1.46	3.07	32.3%	9.38%	0.686	44.45%	43.11%
1de	1.543	5.26	5.34	49.6%	33.72%	1.616		

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

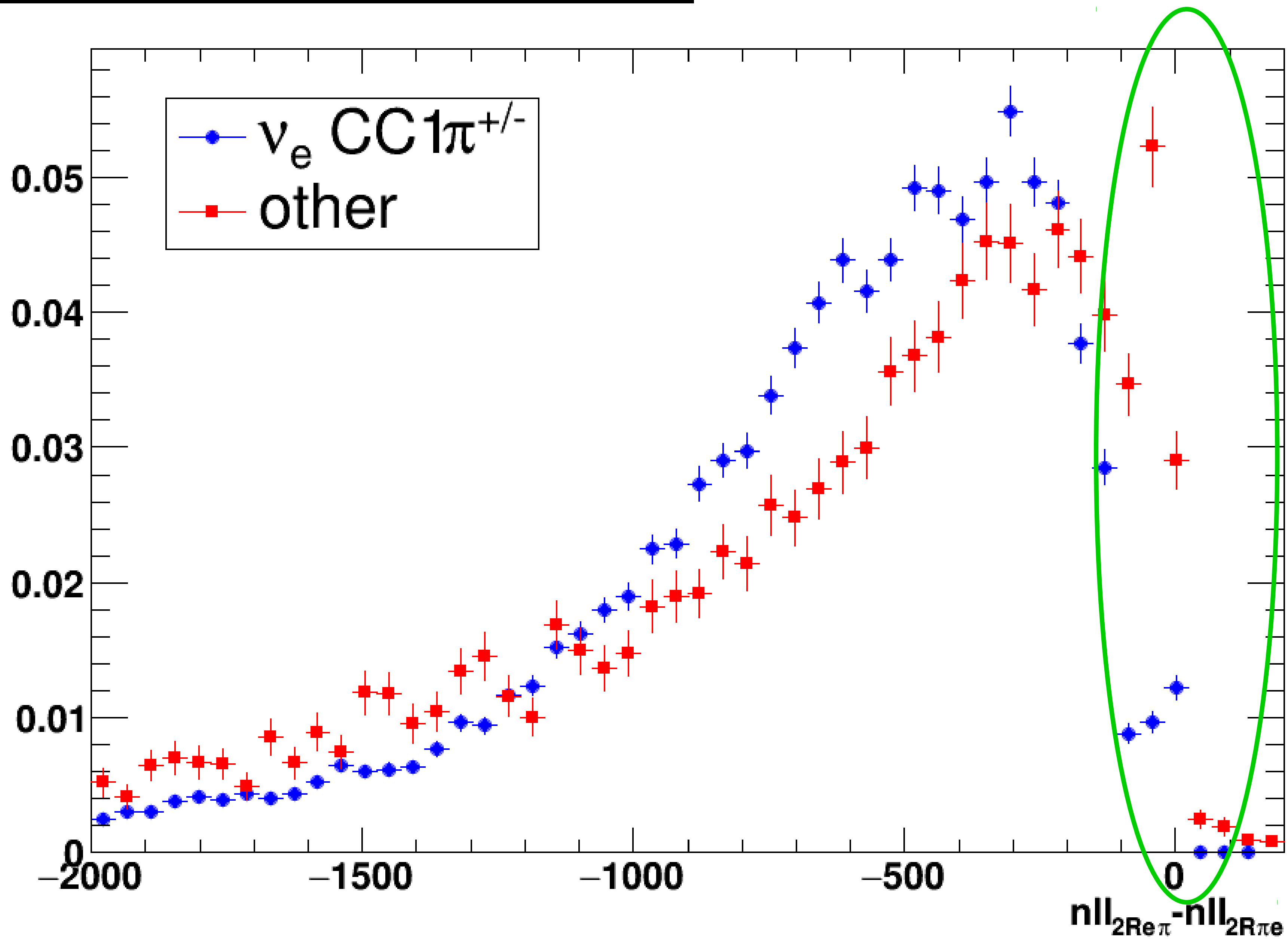
2Reπ only

	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de	0.675	1.27	2.51	33.6%	8.16%	0.654	54.49%	29.47%
1de	1.205	3.32	1.33	71.5%	21.31%	1.541		

```
( fqnse==2 ) || ( fqnse==1 && nll2repi-nll2rpie < -100. )
```

	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de	0.629	1.23	2.16	36.2%	7.85%	0.666	56.64%	29.17%
1de	1.205	3.32	1.33	71.5%	21.31%	1.541		

$nll_{2Re\pi}$-$nll_{2R\pi e}$: 2Reπ-like

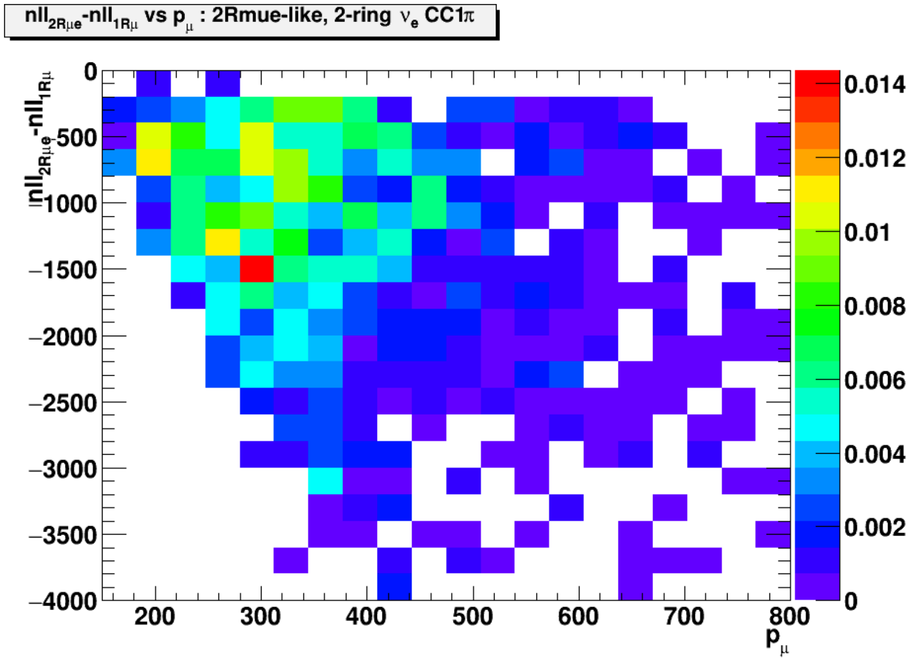


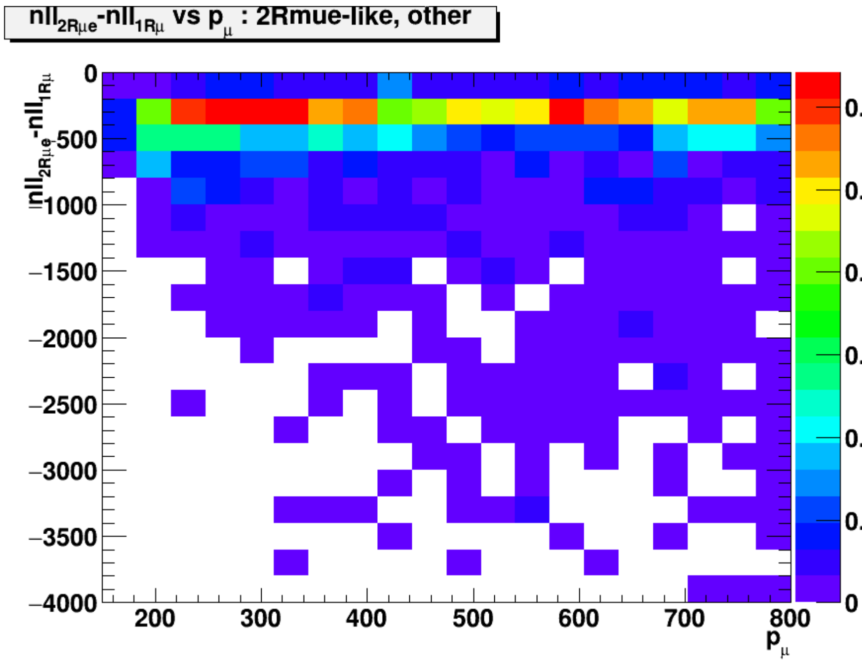
2Rμe only

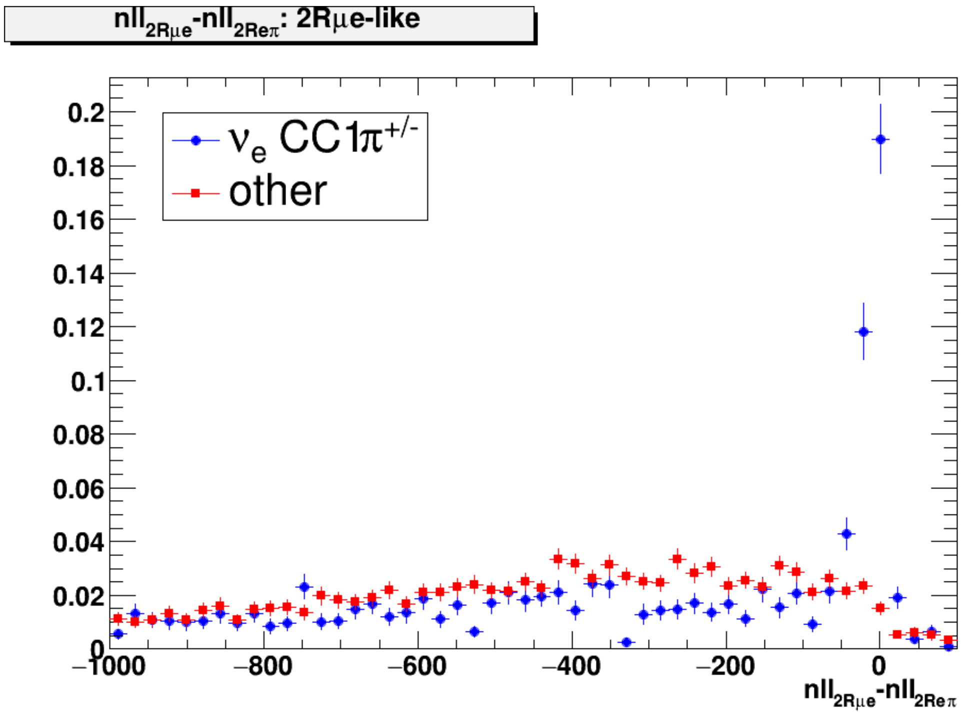
	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de	0.092	0.12	2.56	4.5%	0.78%	0.074	7.51%	3.43%
1de	0.170	0.41	4.03	9.3%	2.65%	0.196		

```
fqnse==2 &&
( fqmrmom[0][0] < 200. || nll2rmue-nll1rmu < -500. ) &&
( nll2rmue-nll2repi > -100. )
```

	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de							37.5%	0.97%
1de	0.204	0.15	0.25	37.5%	0.97%	0.238		


nll2Rμe-nll1Rμ vs pμ : 2Rmue-like, 2-ring νe CC1π
nll2Rμe-nll1Rμ
pμ


nll2Rμe-nll1Rμ vs pμ : 2Rmue-like, other
nll2Rμe-nll1Rμ
pμ


nll2Rμe-nll2Reπ: 2Rμe-like
νe CC1π+/-
other
nll2Rμe-nll2Reπ

Improved eπ-like Cut

baseline

	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de	0.652	1.41	3.50	28.8%	9.06%	0.637	46.03%	31.55%
1de	1.145	3.51	2.27	60.7%	22.49%	1.459		

Last Week: 2Reπ + 2Rπe + 1Re + 2Ree + 3Reππ

	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de	0.698	1.46	3.07	32.3%	9.38%	0.686	44.45%	43.11%
1de	1.543	5.26	5.34	49.6%	33.72%	1.616		

This Week: 2Reπ + 2Rπe + 1Re + 2Ree + 3Reππ + 2Rμe

	osc. ν_e CC FOM	true 1e1π	other	purity	eff.	1e1π FOM	net purity	net eff.
0de	0.660	1.41	2.62	34.9%	9.04%	0.702	45.37%	43.73%
1de	1.553	5.41	5.59	49.2%	34.69%	1.632		

Efficiency: 31.5% → 43.1% → 43.7%
Purity: 46.0% → 44.4% → 45.4%

Using BDTs: Attempt 1

- Create input sample for TMVA using the following cuts:
  - FCFV
  - possible 2Repi
    - 0 de: i2repi==0 || i2rpie==0 || i3repipi==0
    - 1 de: (i1re==0 && !ls1re && !ls1re1de) || i2ree==0 || i2repi==0 || i2rpie==0 || i2rmue==0 || i3repipi==0
  - 1/2 sub-events
    - separate samples
- Use 1R and 2R likelihood ratios as BDT variables:
  - nll1re-nll1rmu
  - nll1re-nll2repi
  - nll1re-nll2rpie
  - nll1re-nll2ree
  - nll1rmu-nll2repi
  - nll1rmu-nll2rpie
  - nll1rmu-nll2ree
  - nll2repi-nll2rpie
  - nll2repi-nll2ree
  - nll2rpie-nll2ree
- 2Rμe and 3R likelihoods were not used because only some events contain information for those fits

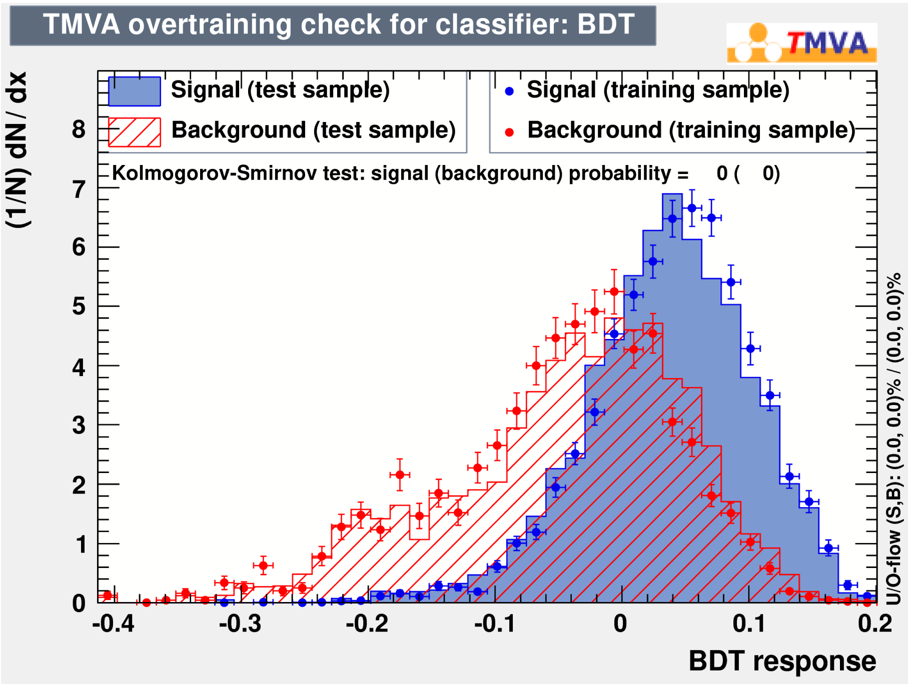
Using BDTs: Attempt 1

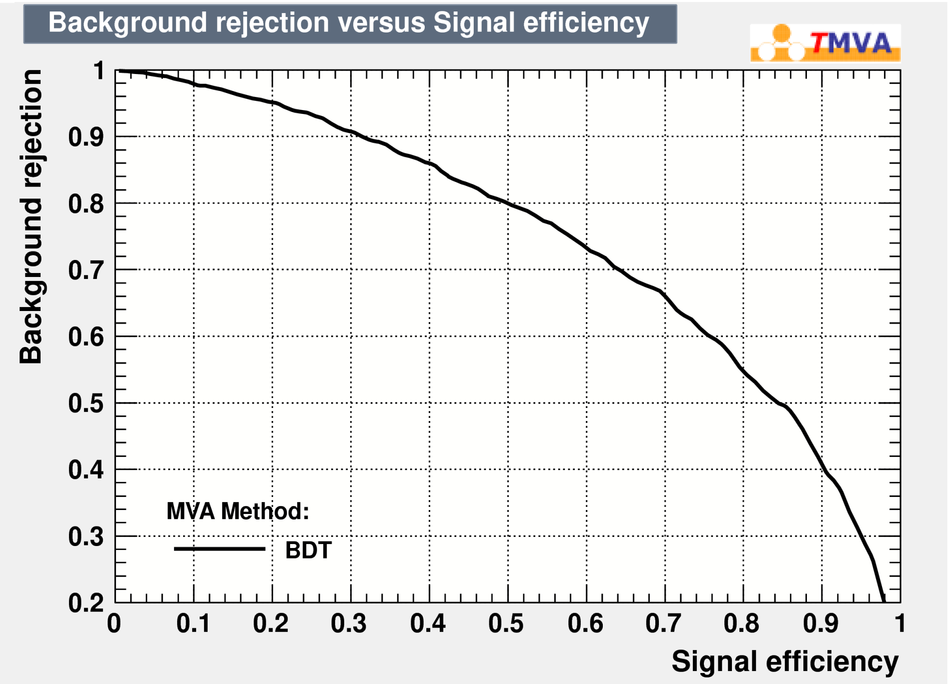
	New BL FOM	BDT 1 FOM
2Reπ	0.702	**0.956**
2Reπ1de	1.632	**2.028**

- NTrees = 850
- MaxDepth = 3

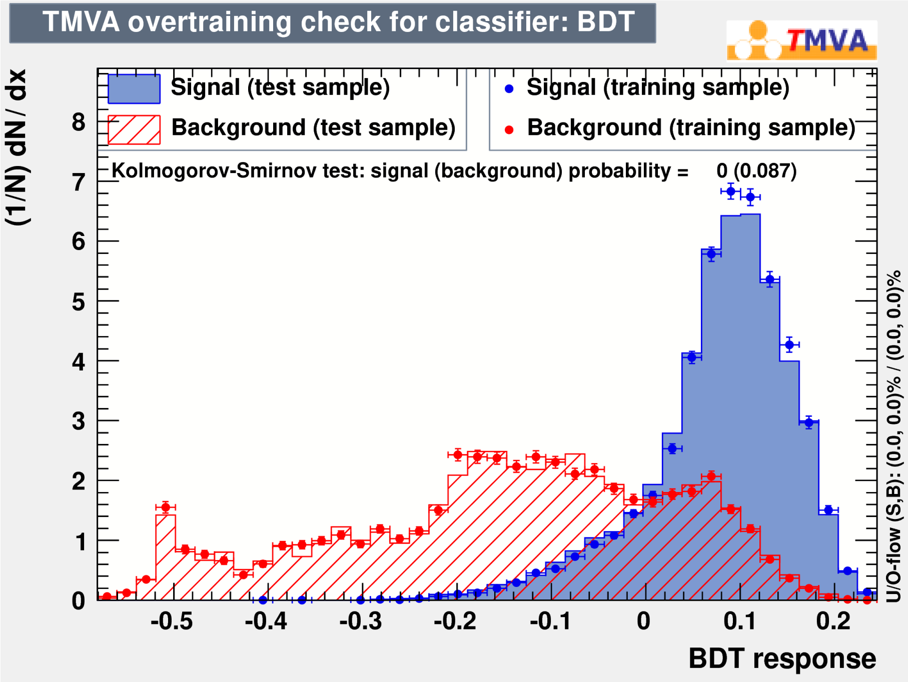
Note: FOM refers to true 1e1$\pi^{+/-}$ events as signal

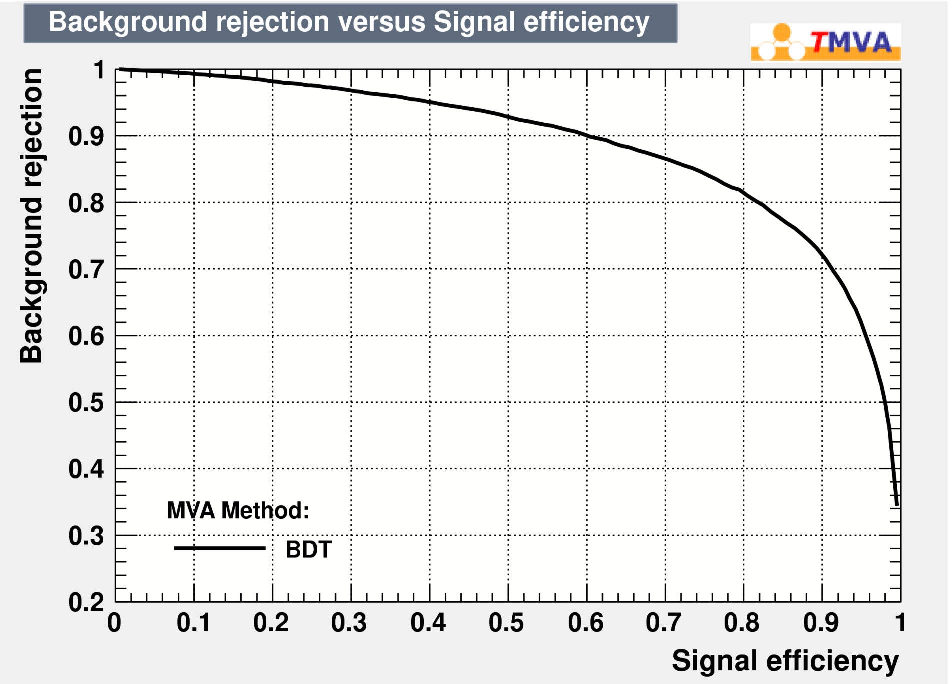
2Reπ





2Reπ1de





Using BDTs: Attempt 2

- Create input sample for TMVA using the following cuts:
  - FCFV
  - possible 2Repi
    - 0 de: i2repi==0 || i2rpie==0 || i3repipi==0
    - 1 de: (i1re==0 && !Is1re && !Is1re1de) || i2ree==0 || i2repi==0 || i2rpie==0 || i2rmue==0 || i3repipi==0
  - 1/2 sub-events
    - separate samples
- Use 1R and 2R likelihood ratios as BDT variables:
  - nll1re-nll1rmu
  - nll1re-nll2repi
  - nll1re-nll2rpie
  - nll1re-nll2ree
  - nll1rmu-nll2repi
  - nll1rmu-nll2rpie
  - nll1rmu-nll2ree
  - nll2repi-nll2rpie
  - nll2repi-nll2ree
  - nll2rpie-nll2ree
  - pe_1re
  - pmu_1rmu
  - pe_2repi
  - ppi_2repi
  - pe_2rpie
  - ppi_2rpie
  - pe1_2ree
  - pe2_2ree
- 2Rμe and 3R likelihoods were not used because only some events contain information for those fits

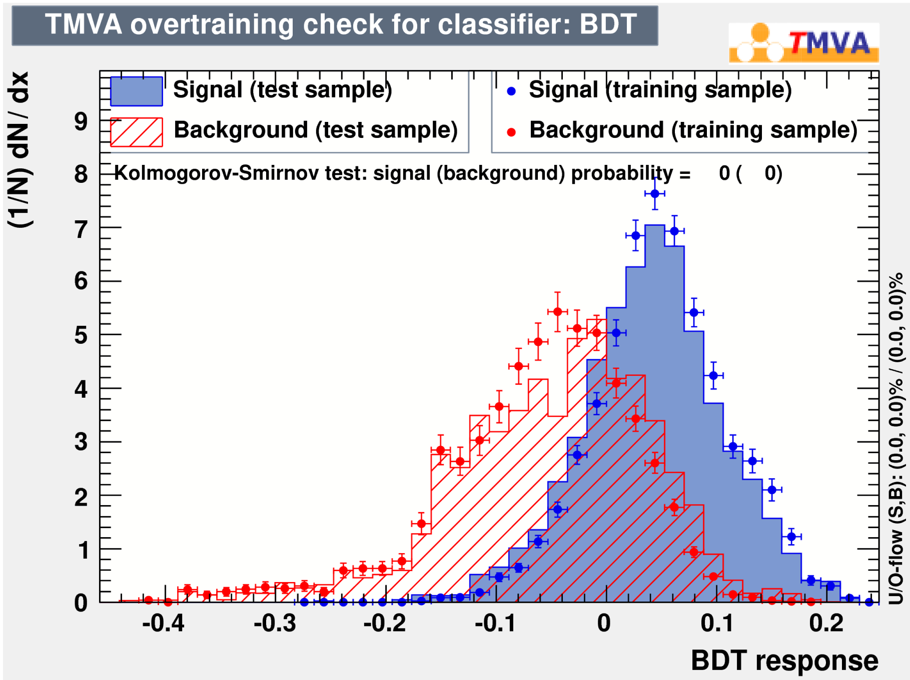
Using BDTs: Attempt 2

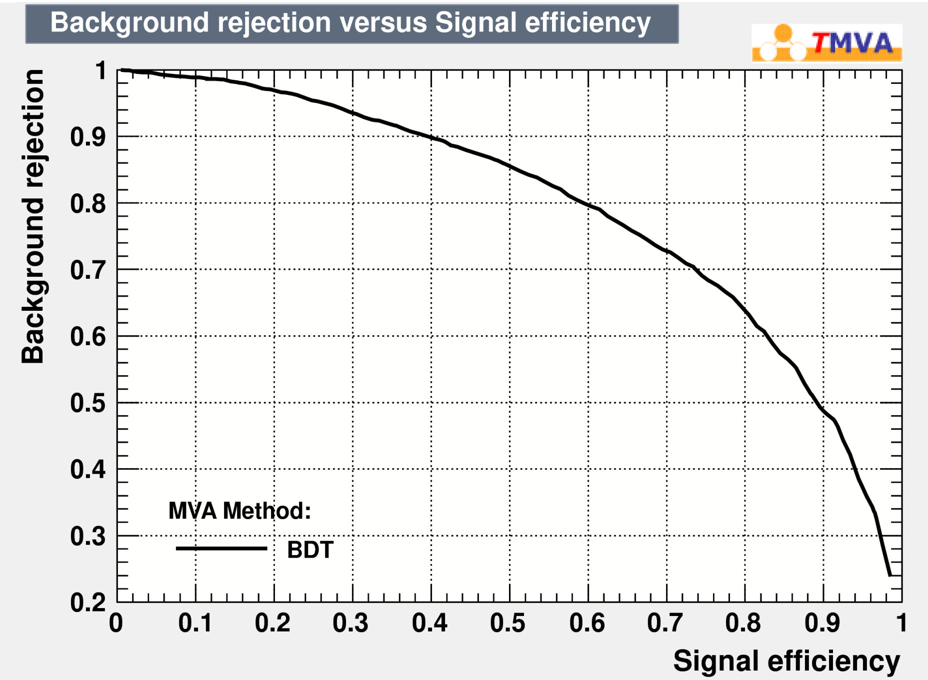
	New BL FOM	BDT 1 FOM	BDT 2 FOM
2Reπ	0.702	0.956	**1.004**
2Reπ1de	1.632	2.028	**2.146**

- NTrees = 850
- MaxDepth = 3

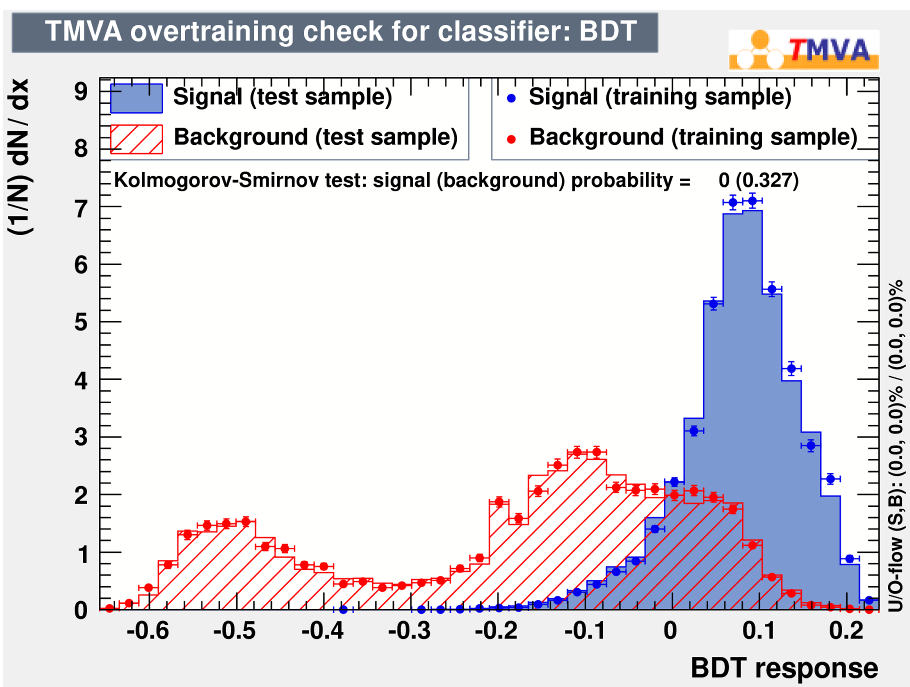
Note: FOM refers to true $1e1\pi^{+/-}$ events as signal

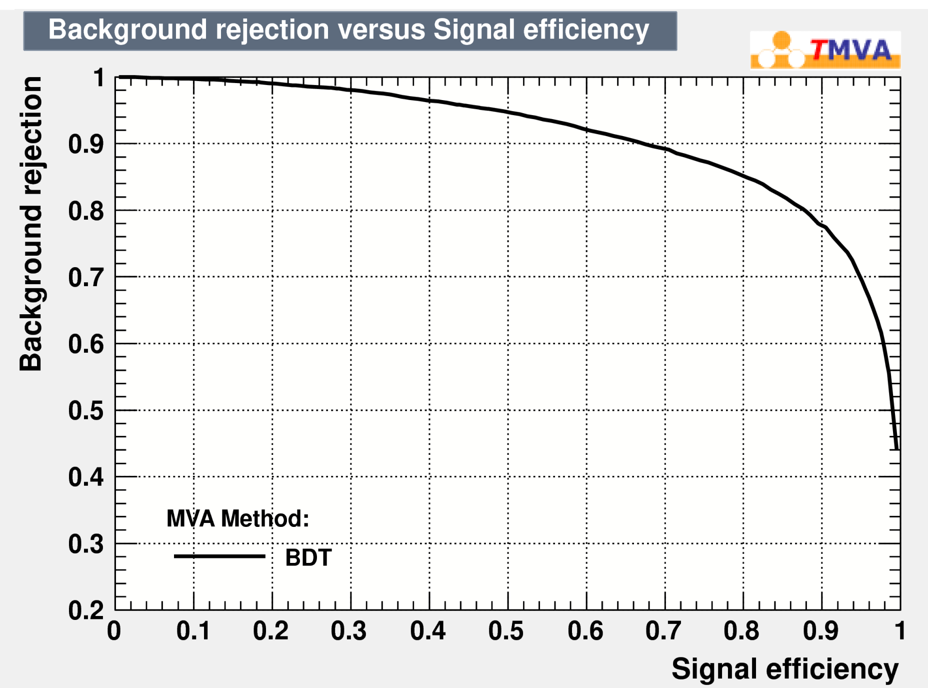
2Reπ





2Reπ1de





Thoughts

- Perhaps start looking at 4R reconstructions?
- Most events do not have 2Rμe and 3R fiTQun information
  - Yoshida-san just re-processed the T2K MC so that the root files now contain all multi-ring fiTQun information
    - Will copy them over to the neut cluster and start working with these files
- Still have some concerns about memory requirements
  - Above BDTs ran fine, but may be a concern when adding more variables, or including more events in the TMVA input samples