UNIVERSITY OF TORONTO

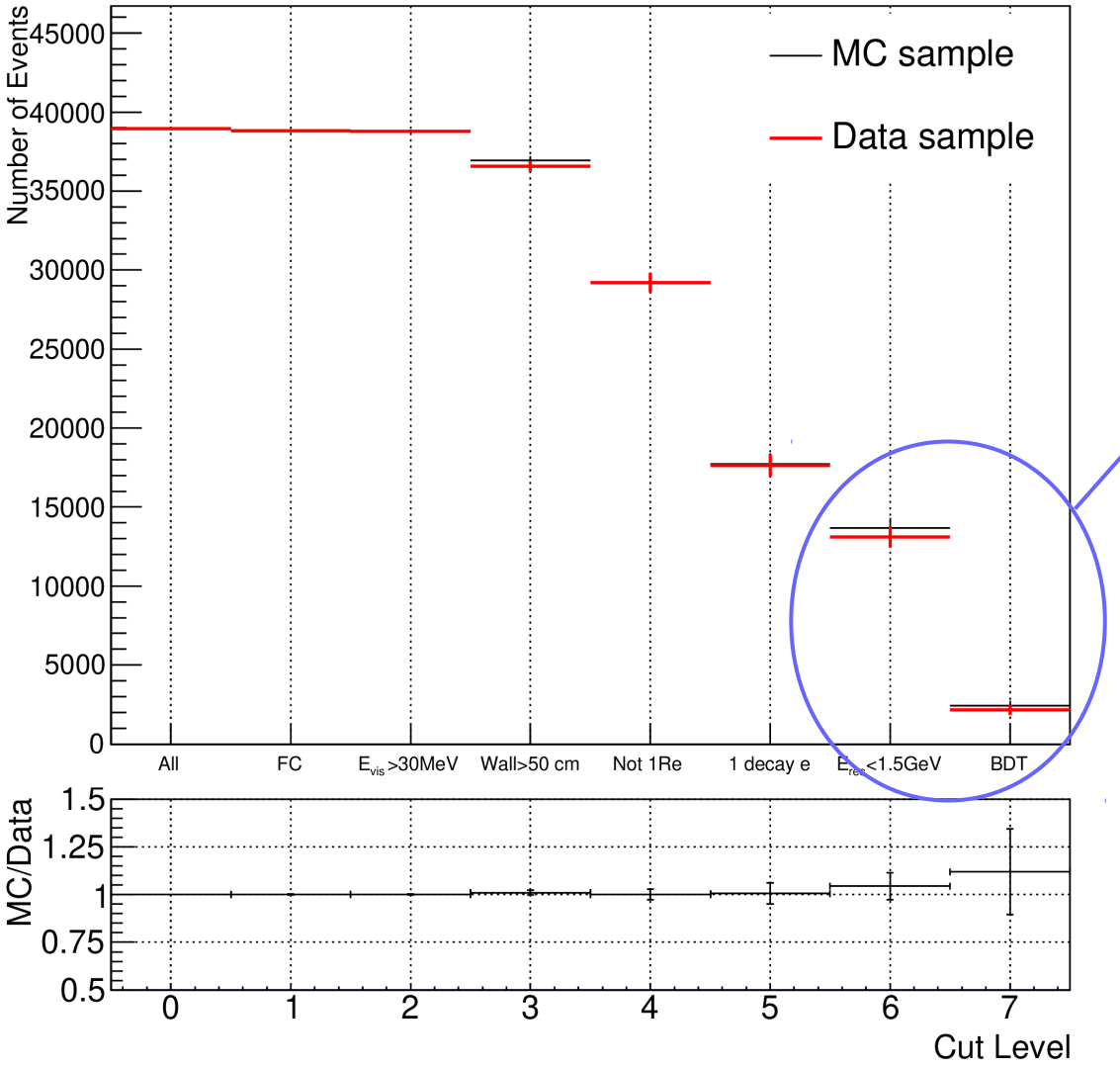
ν_e CCQE/CC1π^+ Selection Studies

Trevor Towstego

ν_e CCQE/CC1π^+ Meeting

July 10, 2019

Reminder: Hybrid Sample Efficiency Loss at BDT Cut



Greater efficiency loss than expected

Reminder: Efficiency Discrepancy of BDT Cut

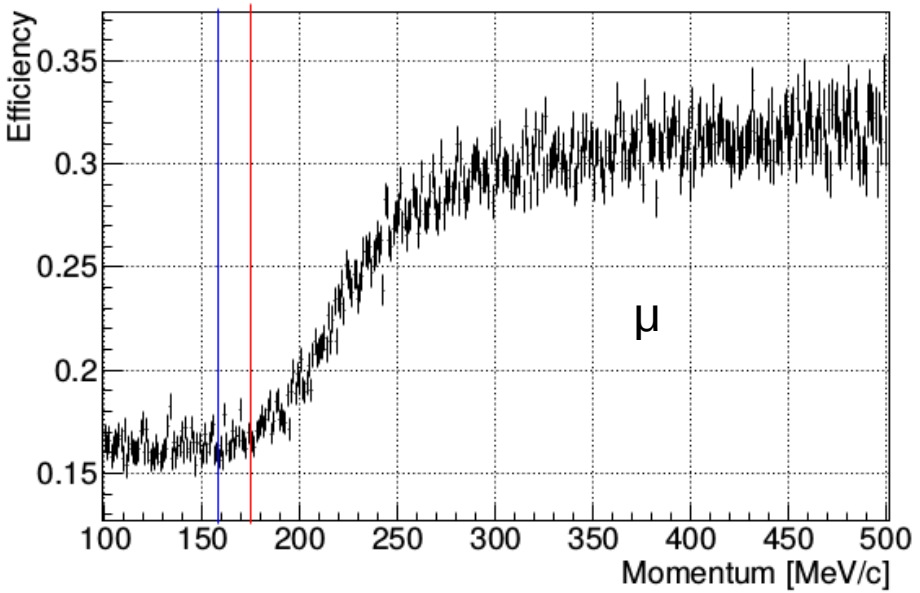
Sample:	Hybrid Sample	Oscillated T2K MC	Weight=1 T2K MC
BDT Cut Efficiency:	0.18	0.60	0.28

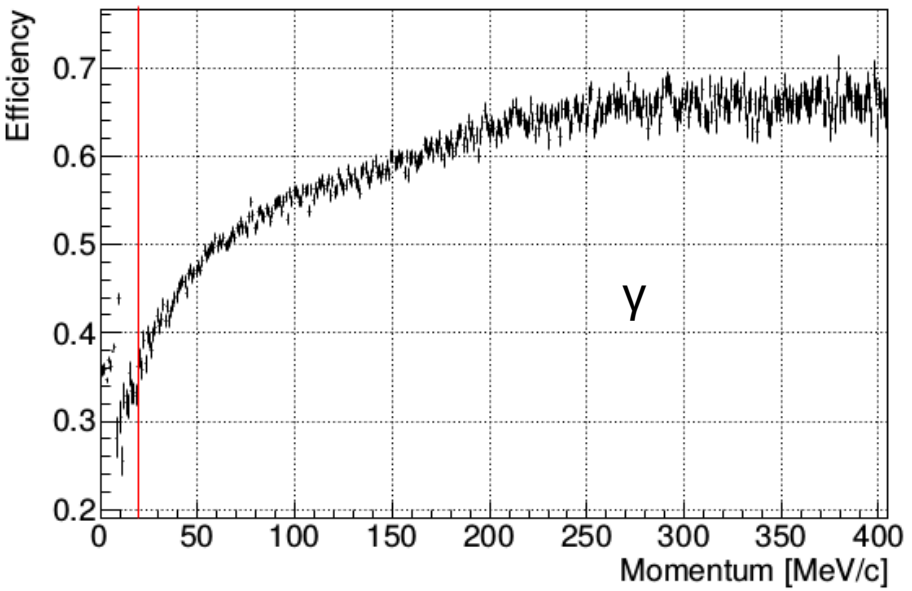
- Checked efficiency of BDT cut when T2K MC event weights are all set to 1, since hybrid sample events all have a weight of 1
  - Most of the discrepancy in efficiency is accounted for, but not all
- Possible reasons for remaining discrepancy:
  - Some statistical variation would be expected
  - $\bar{\nu}_e \rightarrow \bar{\nu}_e$ and $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$ T2K-SK MC files are not used in hybrid sample construction
  - **Different 1e1π^+ definitions used in hybrid sample construction vs. BDT evaluation**
    - Want change these definitions to be consistent to see if remaining discrepancy is accounted for
    - Began looking closely at how these definitions differ, and had some questions – some questions still remain after discussing with both the hybrid pion group and with T2K-SK

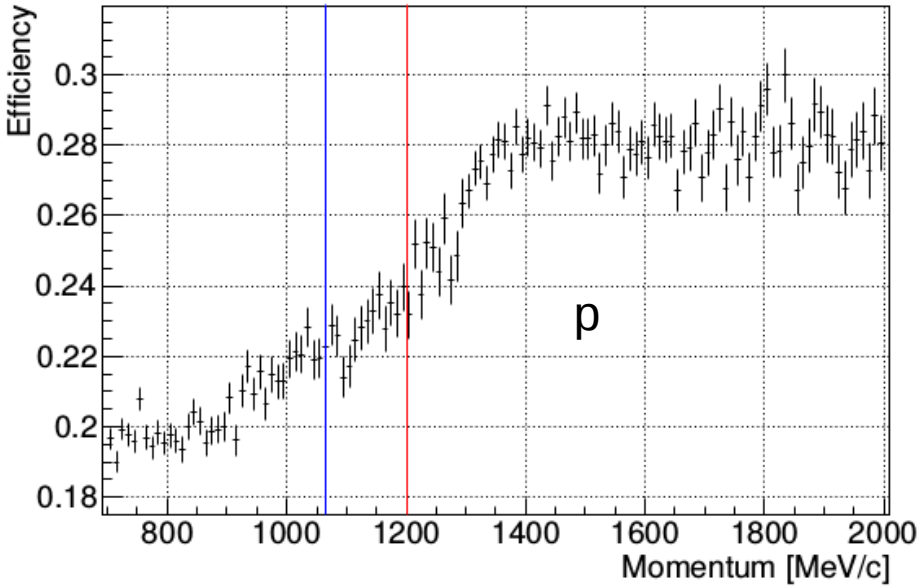
1e1π^+ Events: Particle Thresholds

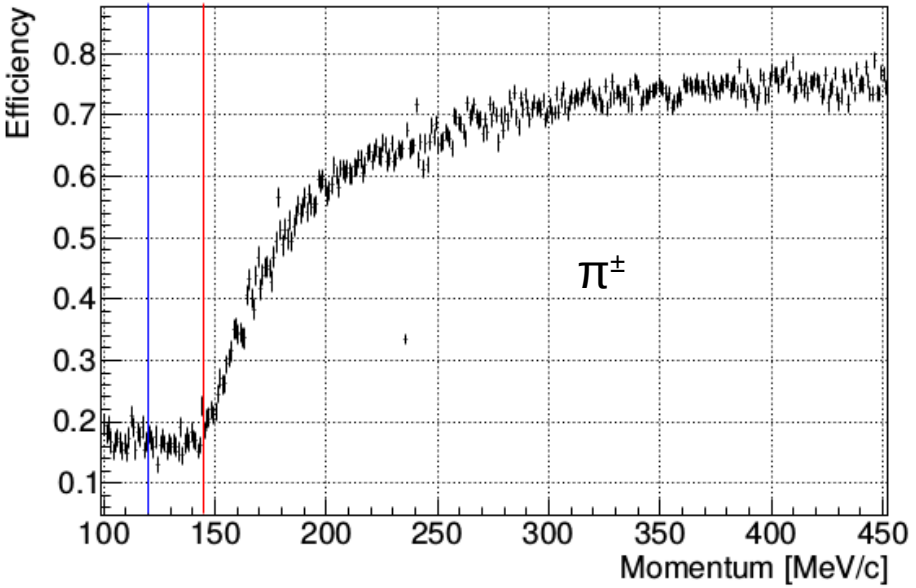
- I have been using a visible threshold for charged particles of $p_{Cherenkov}$ + 30 MeV/c in my own studies
- Yoshida-san determined her thresholds by looking at fiTQun's ring detection efficiency – these were implemented into her hybrid sample construction (and therefore inherited by my hybrid sample construction)
  - Note that the threshold momentum for muons used in the hybrid sample is set to 200 MeV/c to be consistent with the 30 MeV E_{vis} cut used when selecting for atmospheric μ-like events
  - For the ν_e CC1π^+ hybrid sample , I should change this threshold to 145 MeV/c, and change the electron threshold to 30 MeV/c
- I would like to change the thresholds I use to be the same as Yoshida-san's (both for the hybrid sample construction and my own studies)
  - I think it would be good to keep things consistent, and these thresholds seem to be well-motivated

Particle	$p_{Cherenkov}$ + 30 MeV/c	fiTQun Ring Detection Efficiency	Hybrid Sample Construction
γ	30.0 MeV/c	20 MeV/c	20 MeV/c
e	30.6 MeV/c	10 MeV/c	10 MeV/c
μ	150.5 MeV/c	145 MeV/c	200 MeV/c
$\pi^{\pm}$	189.2 MeV/c	175 MeV/c	175 MeV/c
$K^{\pm}$	593.0 MeV/c		
p	1100.0 MeV/c	1200 MeV/c	1200 MeV/c
other			p/E > 0.75188









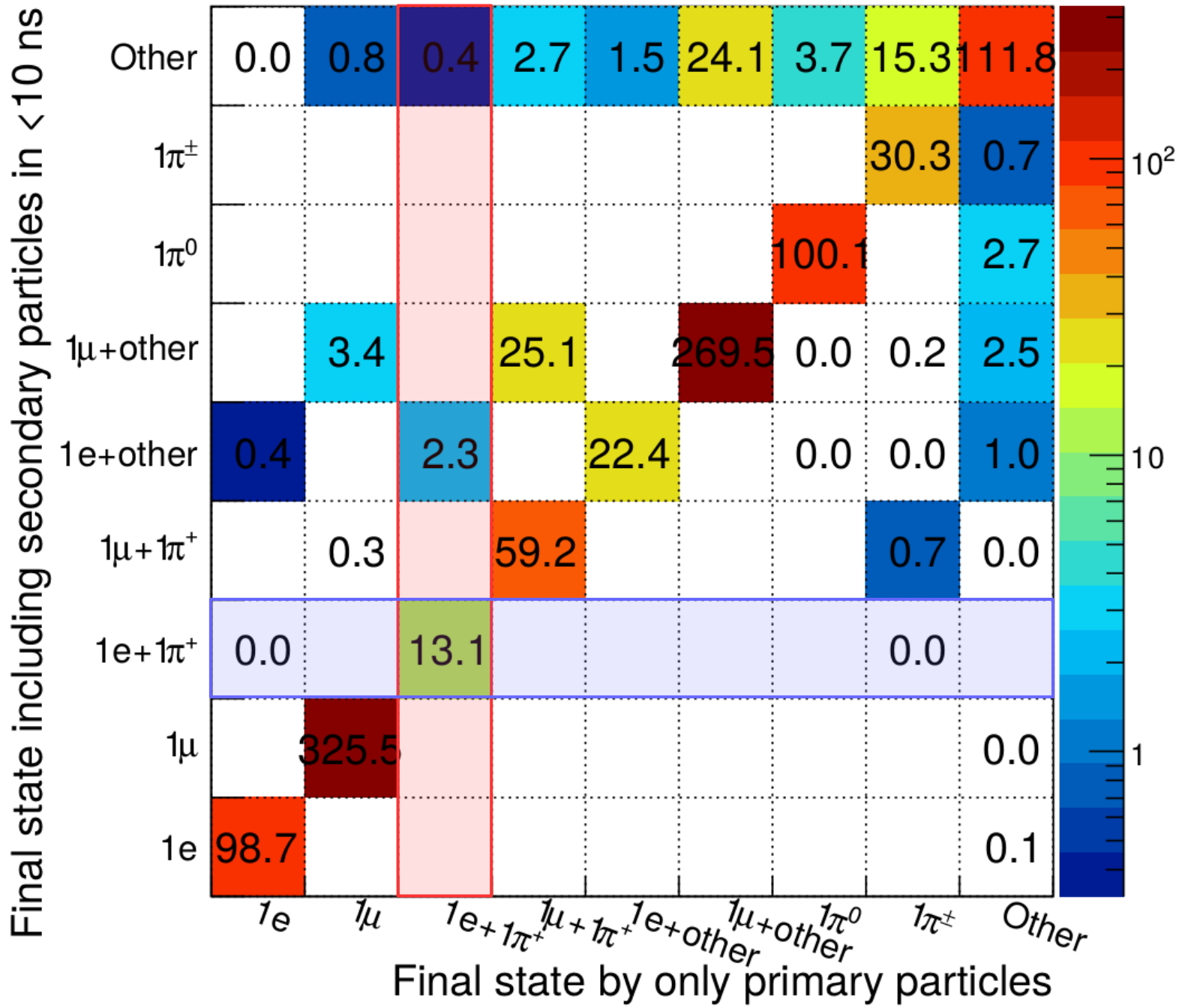
Note: the threshold for electrons (10 MeV/c) comes from the minimum momentum considered when tuning fiTQun likelihood functions

Primary and Secondary Banks

- In the hybrid sample construction, both primary and secondary particle banks are looked through when selecting for CC1π^+-like events in the T2K-SK MC
  - This comes from Xiaoyue's final state definitions used in her atmospheric fit
- Discussed at T2K-SK meeting yesterday
  - Consensus seems to be that secondary stack shouldn't be included when constructing the hybrid sample
  - However, Yoshida-san suggested that we should keep the current final state definition (with the secondary stack) for the atmospheric fit
    - This means that we would need to come up with a different way of using the hybrid samples to constrain the systematics in the atmospheric fit

Primary Stack (VCWORK)	**Secondary Stack (CONVVECT)**

• Requires Ichvc[i]==1 (i.e. flagged "to chase")
• Ignore nucleus
• Ignore neutrons
	• Ignore particles produced with GEANT interaction code corresponding to:
	  • pair production
	  • Compton scattering
	  • photo-electric
	  • Bremsstrahlung
	  • below tracking threshold
	• Ignore nucleus
	• Ignore neutrons
	• Ignore events with generated time > 10 ns
	• Ignore particles with same ID as parent (i.e. scattered particles)
	• Ignore gammas with π^0 parent particle


Final state including secondary particles in <10 ns
Other
1π±
1π0
1μ+other
1e+other
1μ+1π+
1e+1π+
1μ
1e
0.0 0.8 0.4 2.7 1.5 24.1 3.7 15.3 111.8
30.3 0.7
100.1 2.7
3.4 25.1 269.5 0.0 0.2 2.5
0.4 2.3 22.4 0.0 0.0 1.0
0.3 59.2 0.7 0.0
0.0 13.1 0.0
325.5 0.0
98.7 0.1
1e 1μ 1e+1π+ 1μ+1π+ 1e+other 1μ+other 1π0 1π± Other
Final state by only primary particles
10²
10
1

Summary

- When investigating the efficiency discrepancy in the BDT cut, started looking closer at how final-state particles are defined in the hybrid sample construction vs. in my own studies
- There are two aspects to consider:
  - Visible particle thresholds: Will change my thresholds to be consistent with Yoshida-san's and with the hybrid sample construction
  - Primary/Secondary particles: Discussions still ongoing on how to deal with this