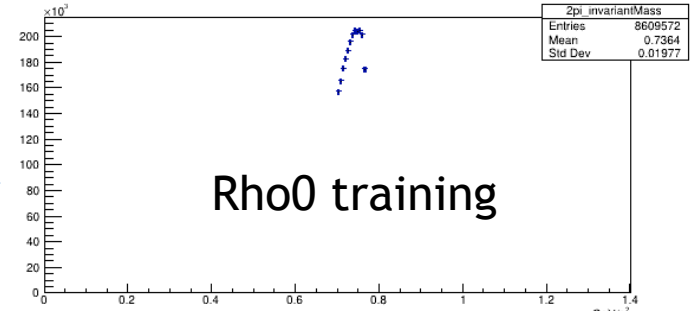
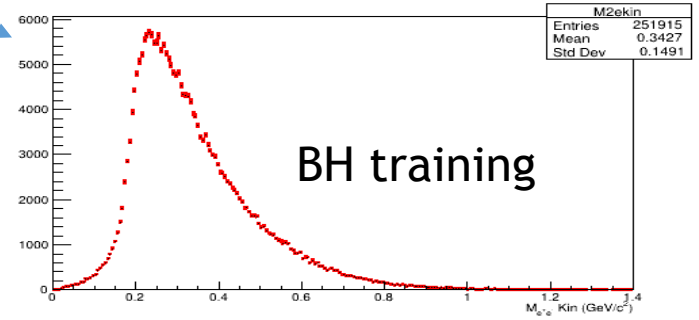
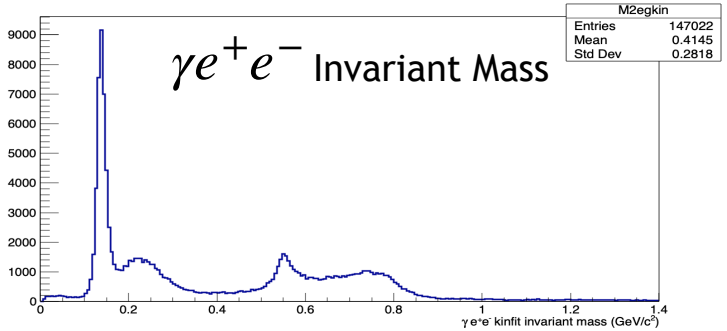
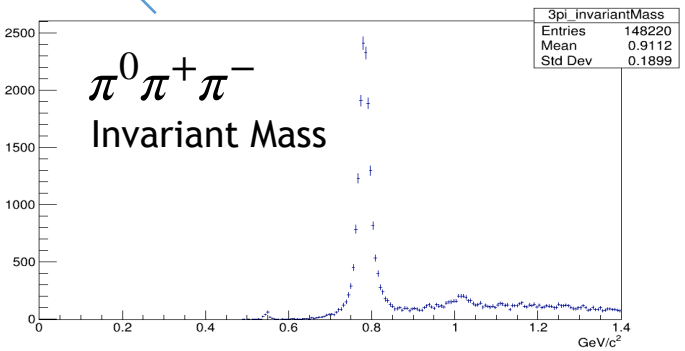
MVA for Electron/Pion Separation

- 2 Multi-layer perceptron neural nets—one for e-/π- separation, one for e+/π+.
- Train on rho0 pions (700 MeV < W < 770 MeV) and simulated Bethe-Heitler electron pairs
- Use $\pi^0 \rightarrow \gamma e^+ e^-$ and $\omega(782) \rightarrow \pi^0 \pi^+ \pi^-$ reactions as a way to test performance of the neural nets.



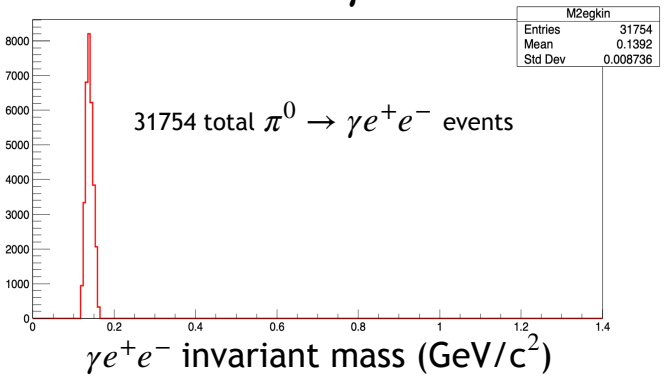




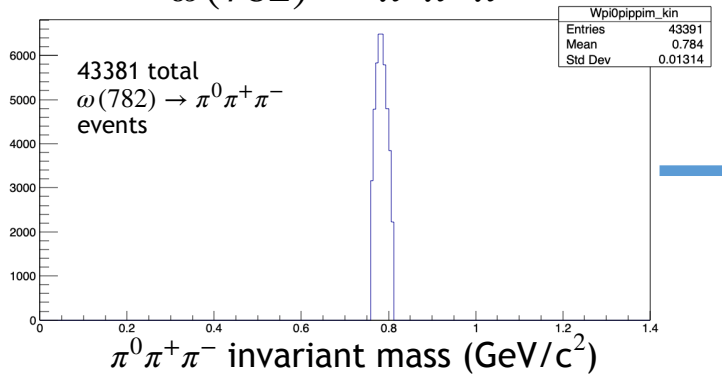


1: Get neural net response for e+e- from π0 and π+π- events from omega

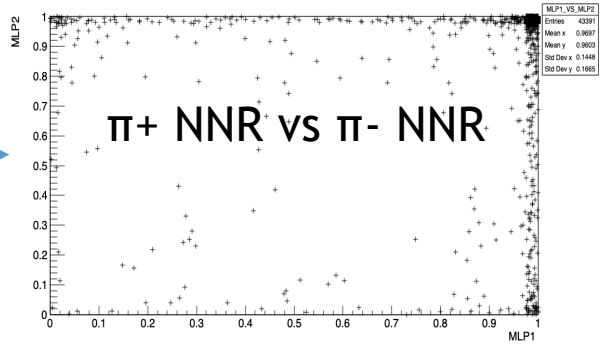
$\pi^0 \to \gamma e^+e^-$



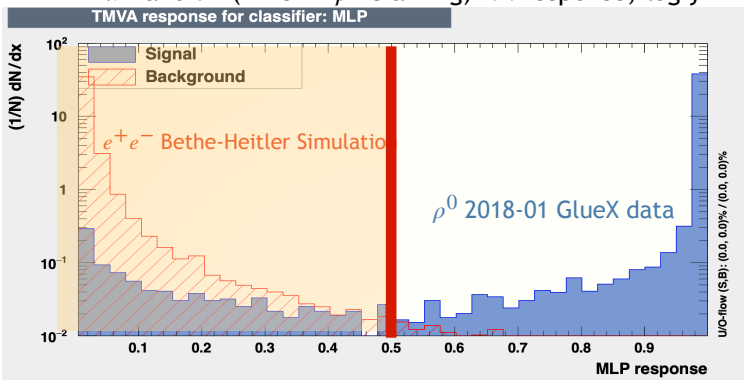
$\omega(782) \to \pi^0\pi^+\pi^-$



$\omega(782) \to \pi^0\pi^+\pi^-$

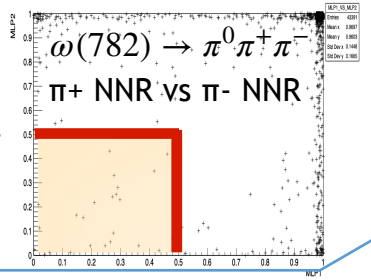


π^- and e^- (BH sim/ρ^0 training) NN response, log y



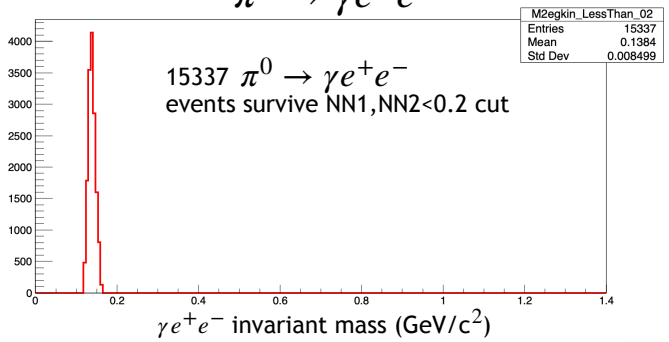
2. Pick a neural net response to be the integral boundary. Integrate all events to the left of that "cut point")

**since we're applying the same NNR cut to *both* tracks, it's really integrating within the square below:

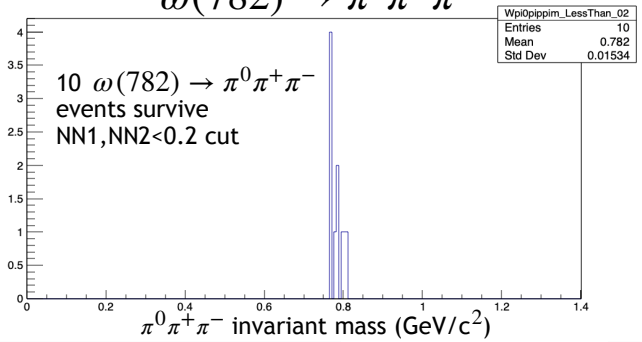


3. Record how many events of each type get integrated for the cut point. Repeat steps 2 and 3 with a new cut point.

$\pi^0 \to \gamma e^+e^-$



$\omega(782) \to \pi^0\pi^+\pi^-$

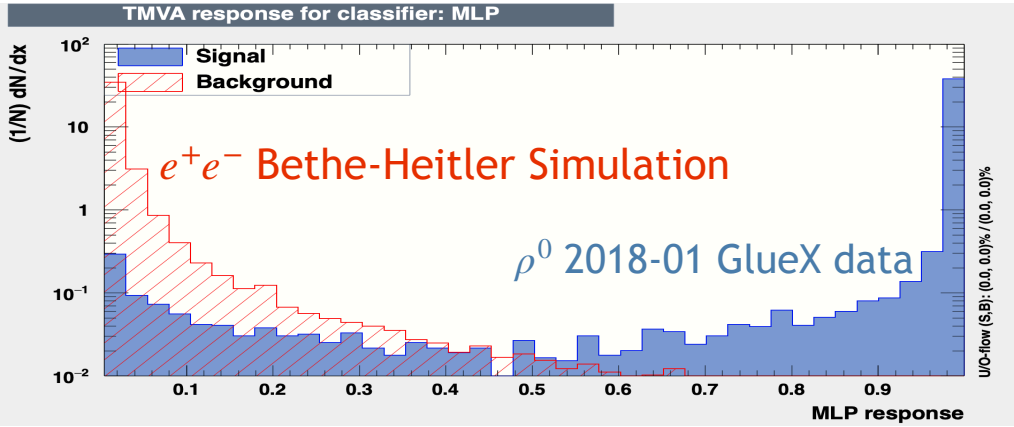


NN<	omega->Pion Efficency	pi0->Electron Efficiency	Pions survived	e+e- survived
0.01	0.01613237768	20.81627511	7	6610
0.02	0.02304625383	48.29942684	10	15337
0.03	0.02996012998	64.04232538	13	20336
0.04	0.03226475536	72.84121685	14	23130
0.05	0.03456938075	78.32713989	15	24872
0.06	0.03917863151	82.0904453	17	26067
0.07	0.03917863151	84.9278831	17	26968
0.08	0.03917863151	87.09768848	17	27657

Two Integration Sweeps:

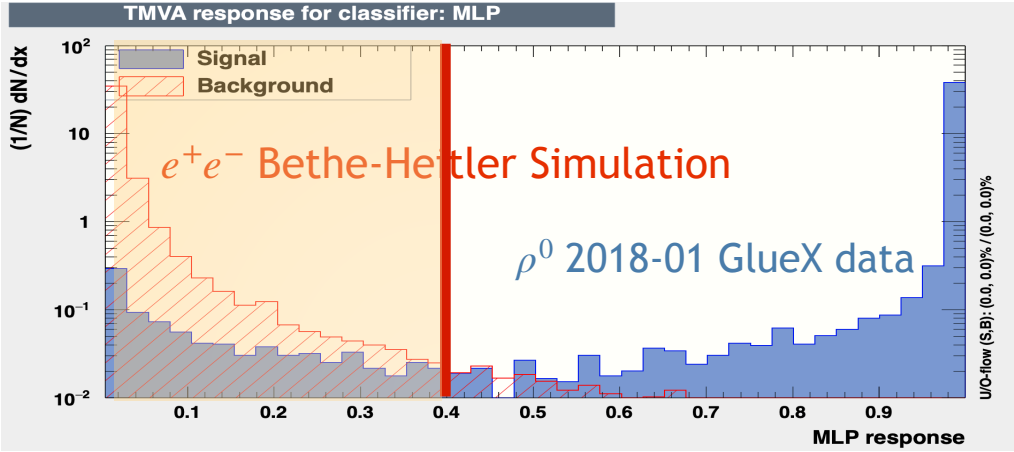
π^- and e^- (BH sim/ρ^0 training) NN response, log y

**On this slide I'm showing the NN response for a single track from the training of the NN. This is only for building intuition on what regions will accept/reject pions and electrons. The actual NN response plots of the events I'm integrating are on subsequent slides.



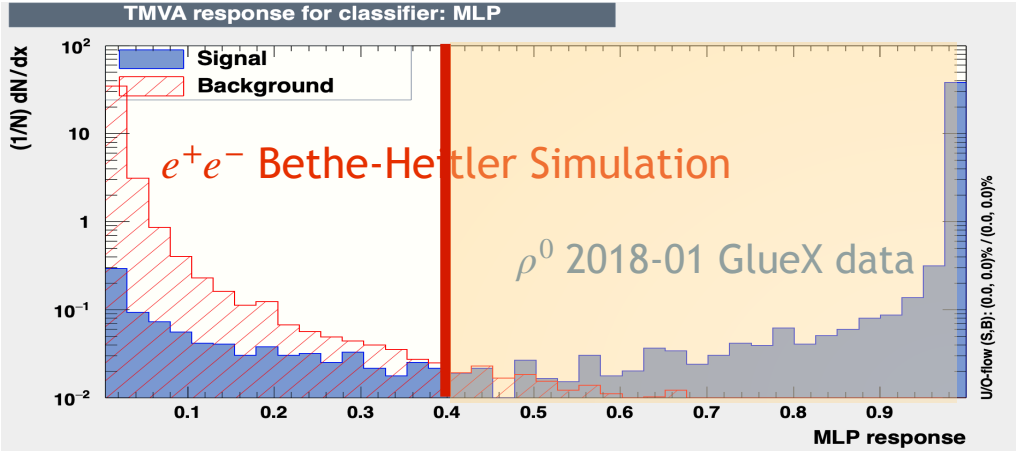
1. 'Less than' sweep: select e, reject π

π^- and e^- (BH sim/ρ^0 training) NN response, log y

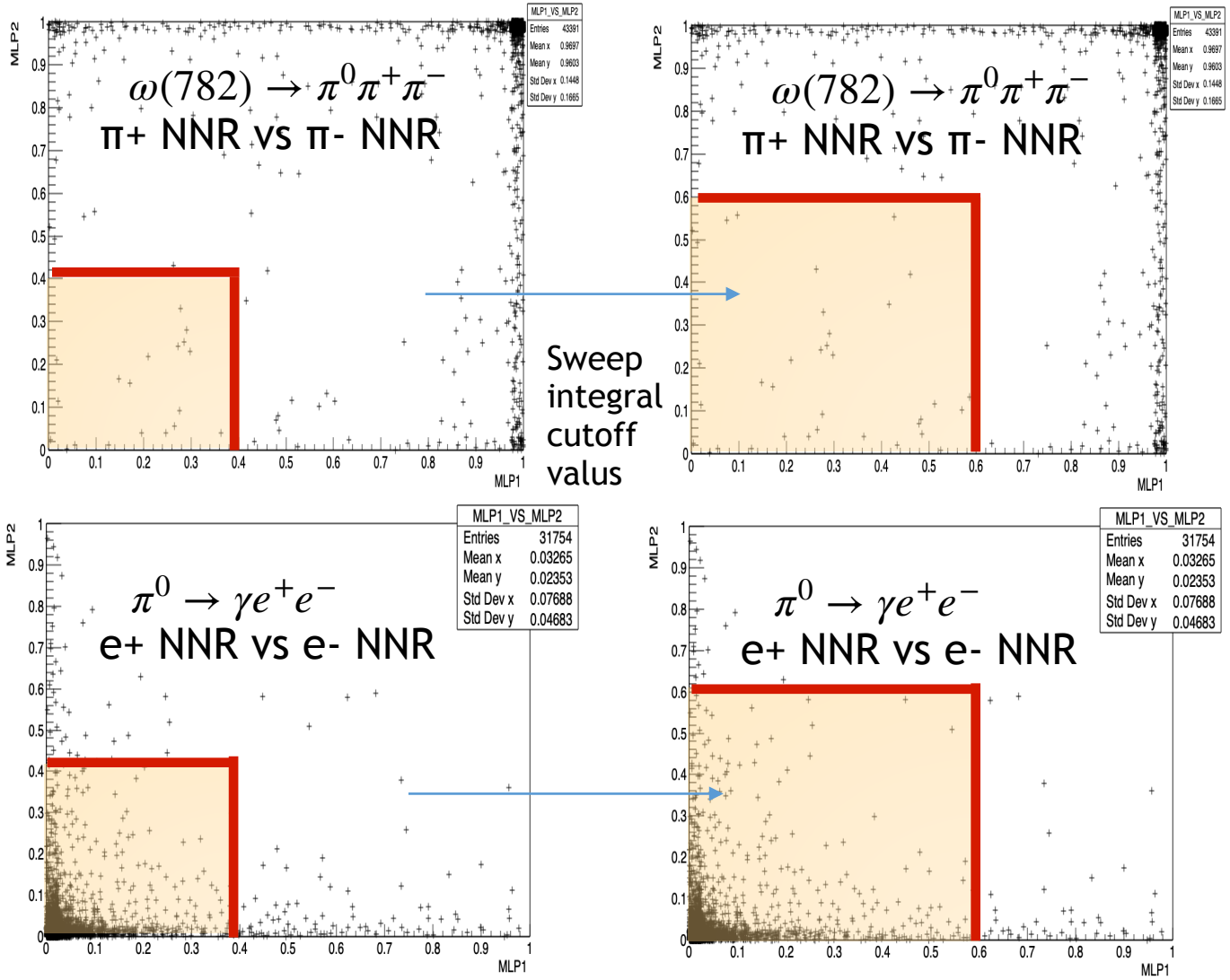


2. 'Greater than' sweep: select π, reject e

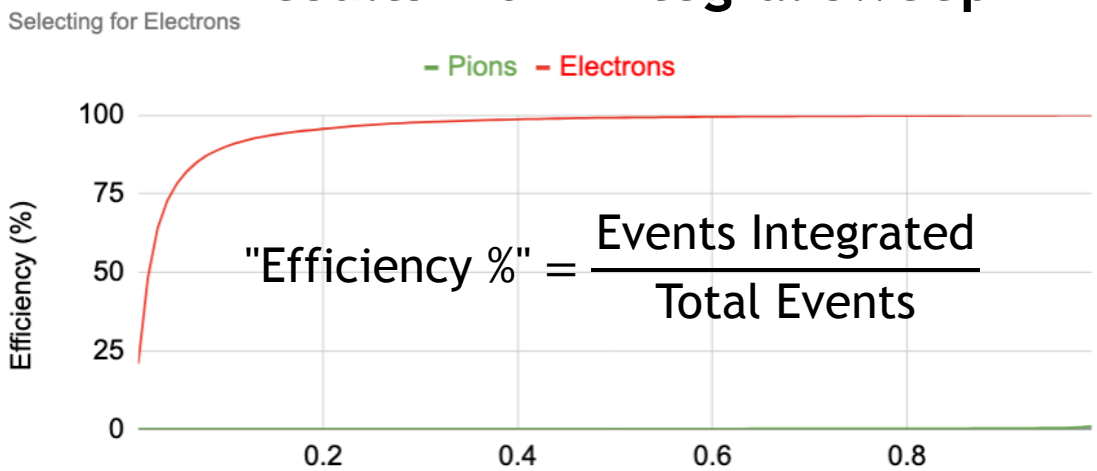
π^- and e^- (BH sim/ρ^0 training) NN response, log y

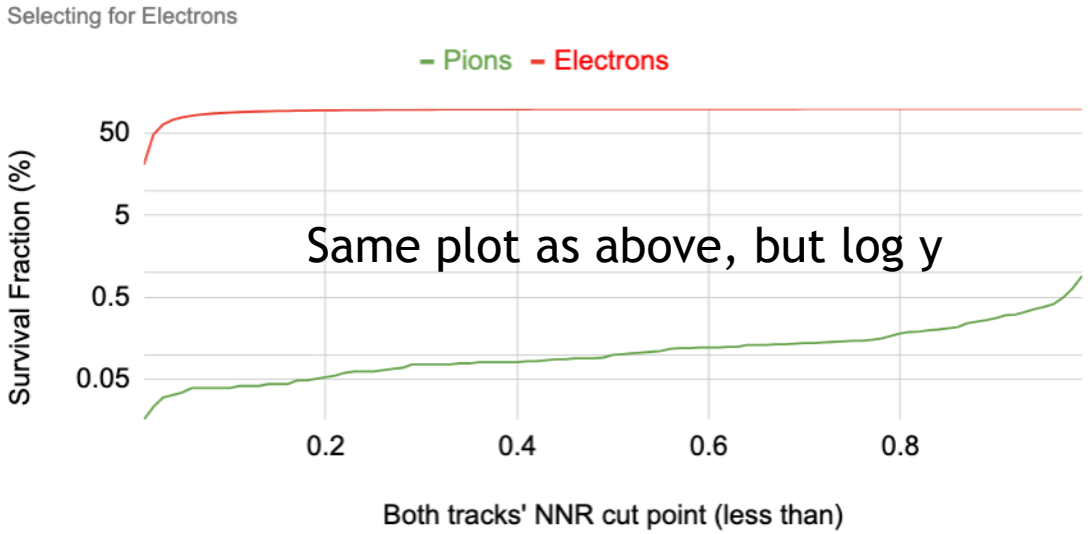


1. ‘Less than’ sweep: *select e, reject π*

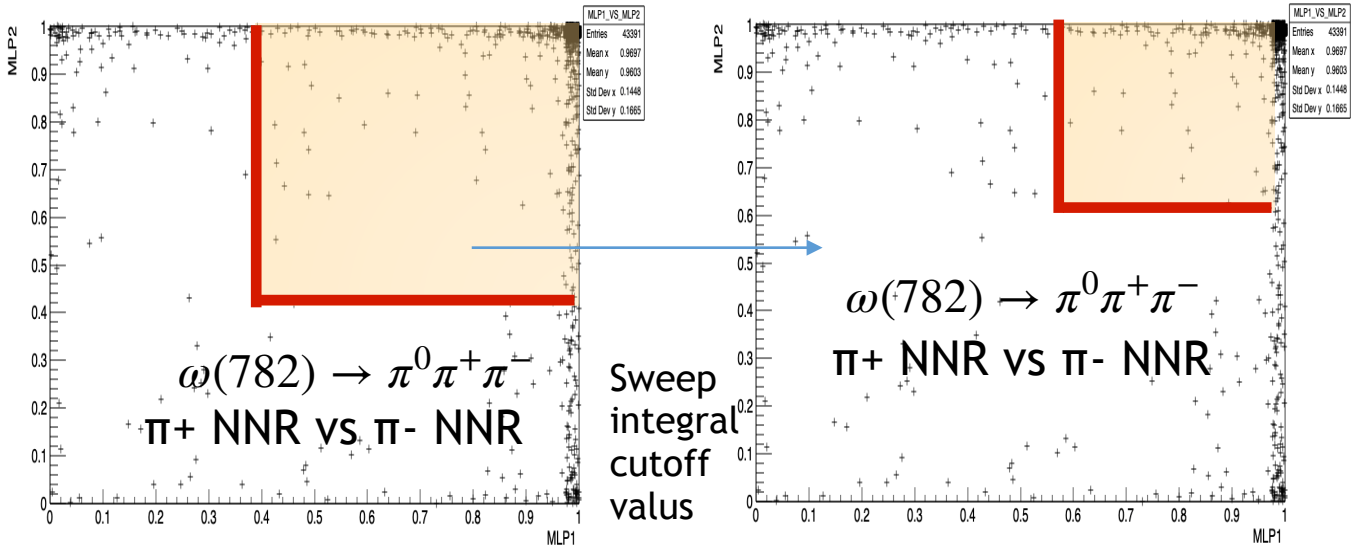


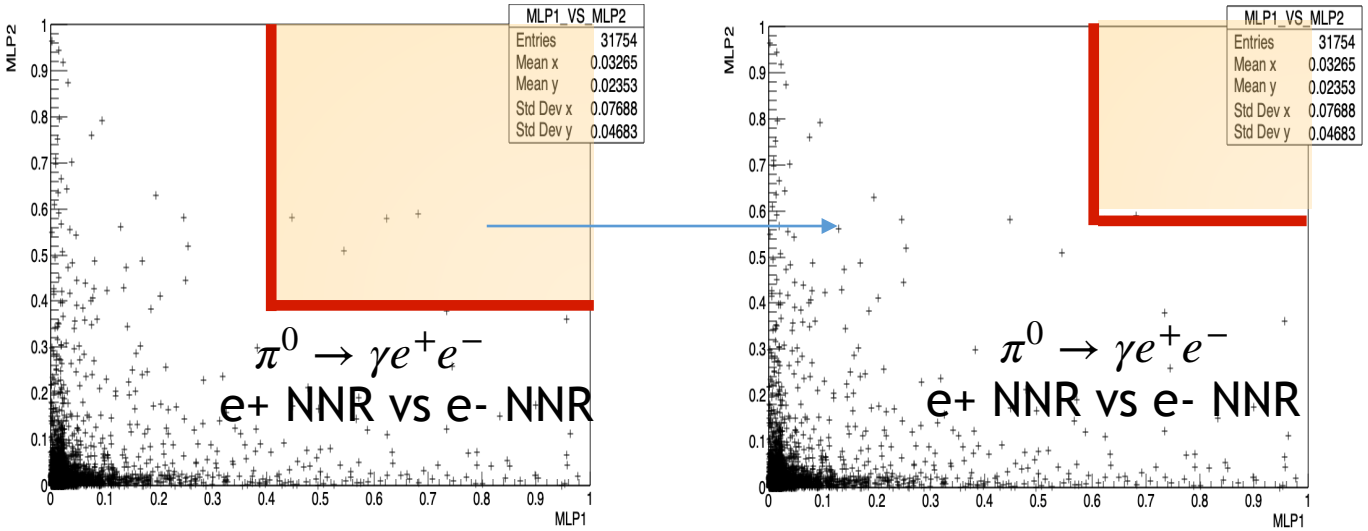
Results from integral sweep



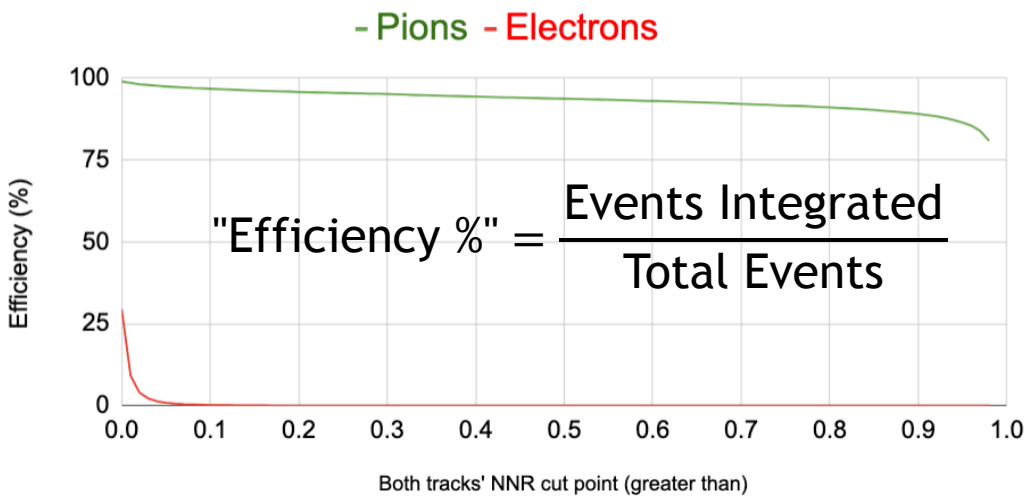


2. ‘Greater than’ sweep: *select π, reject e*

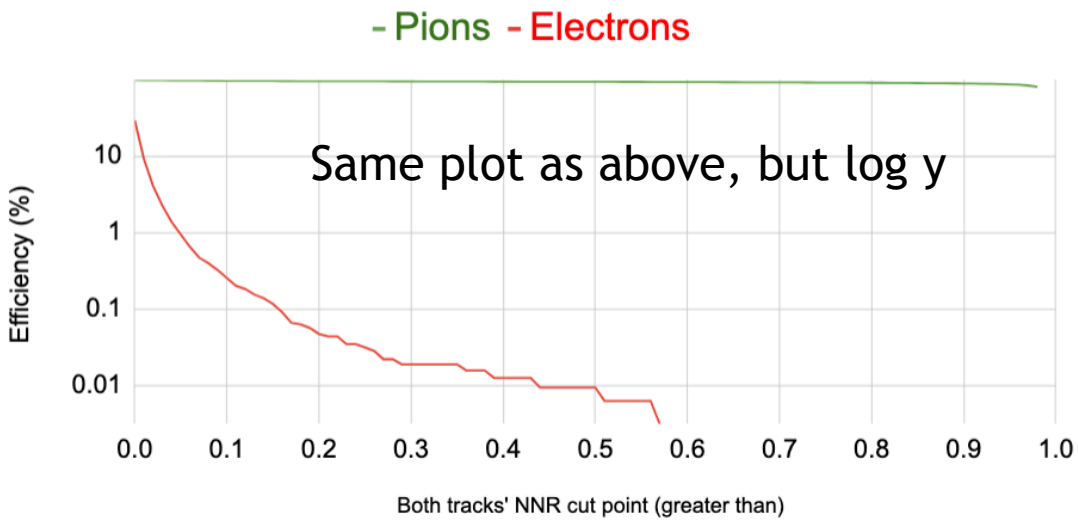


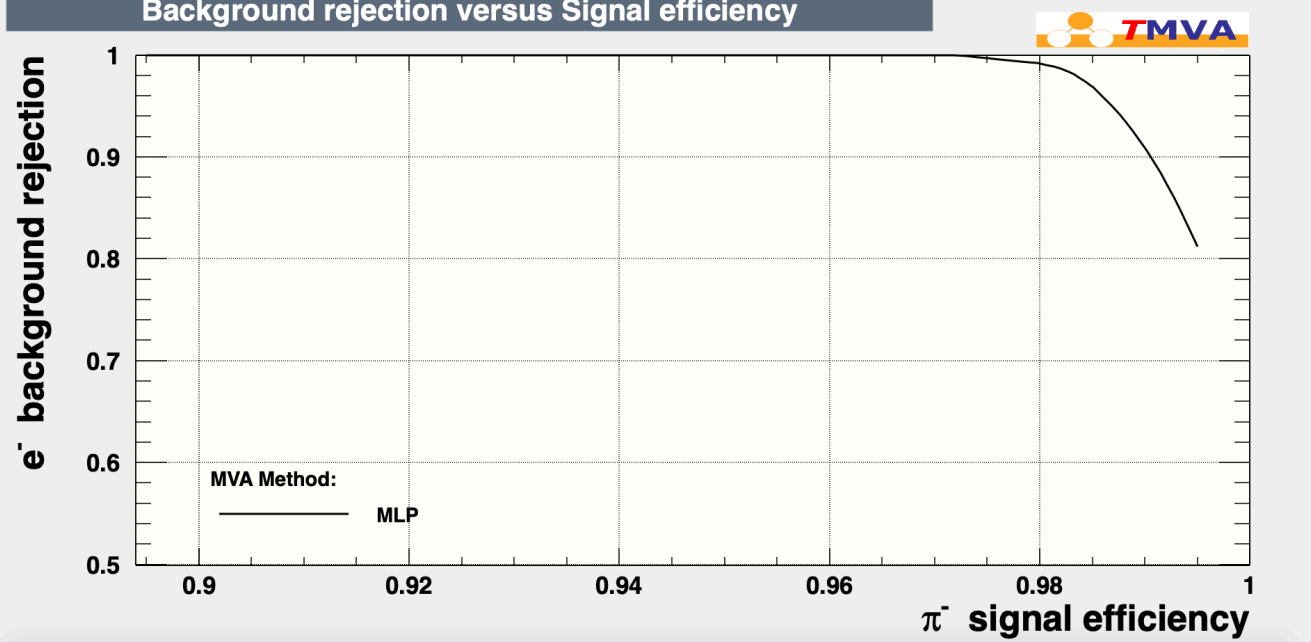


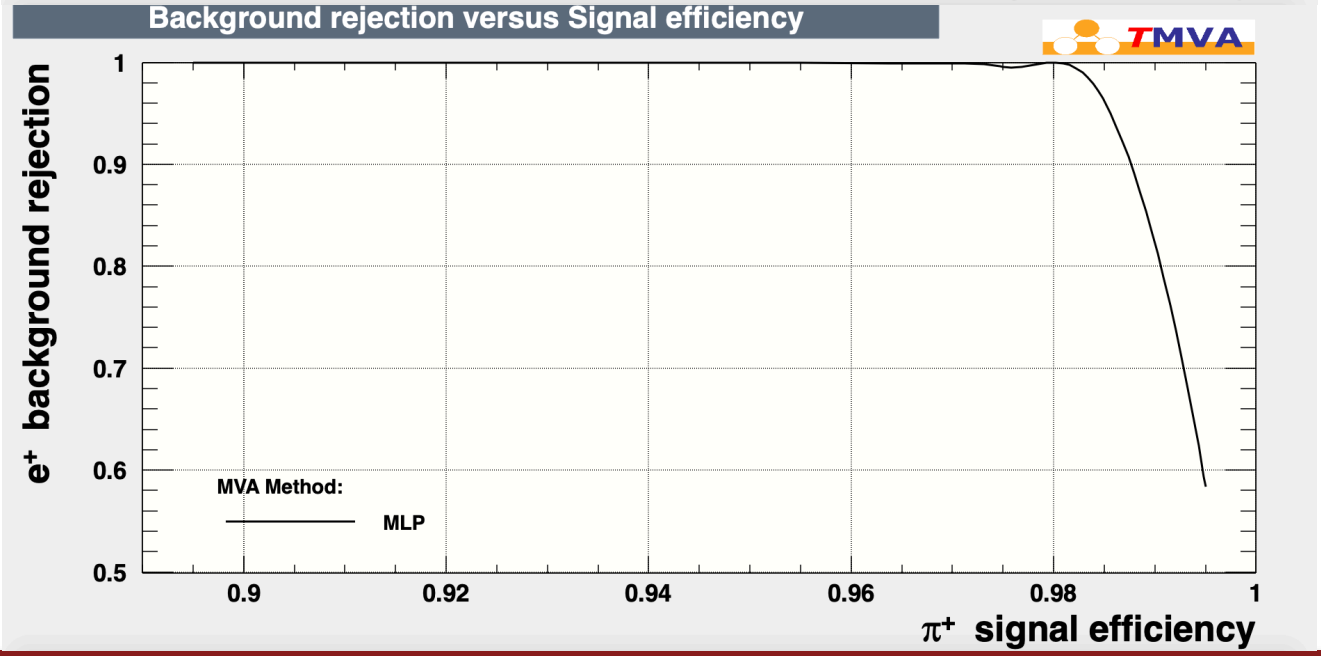
Results from integral sweep

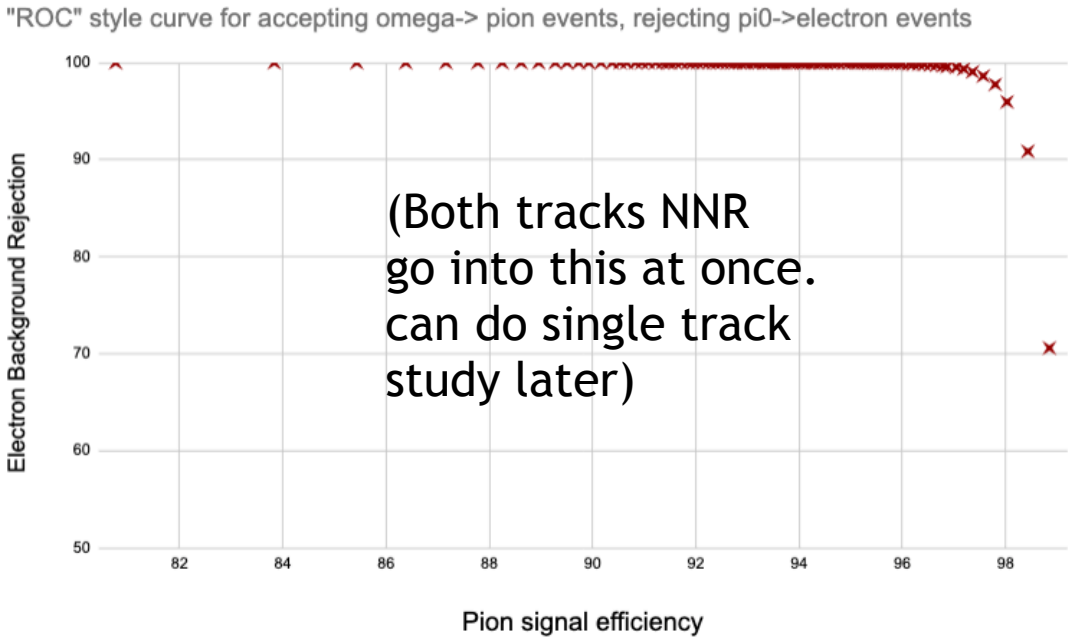


$$\text{"Efficiency \%"} = \frac{\text{Events Integrated}}{\text{Total Events}}$$



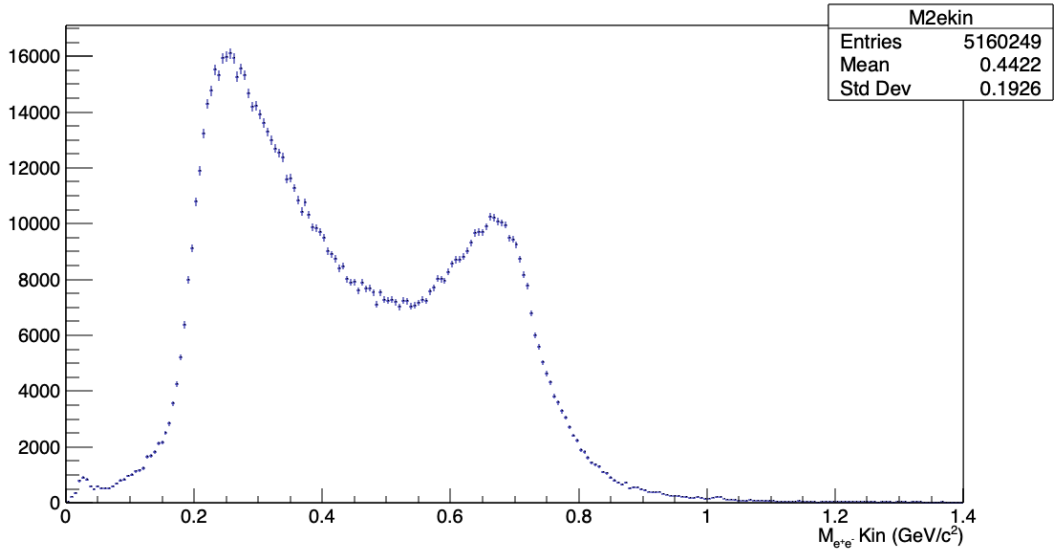


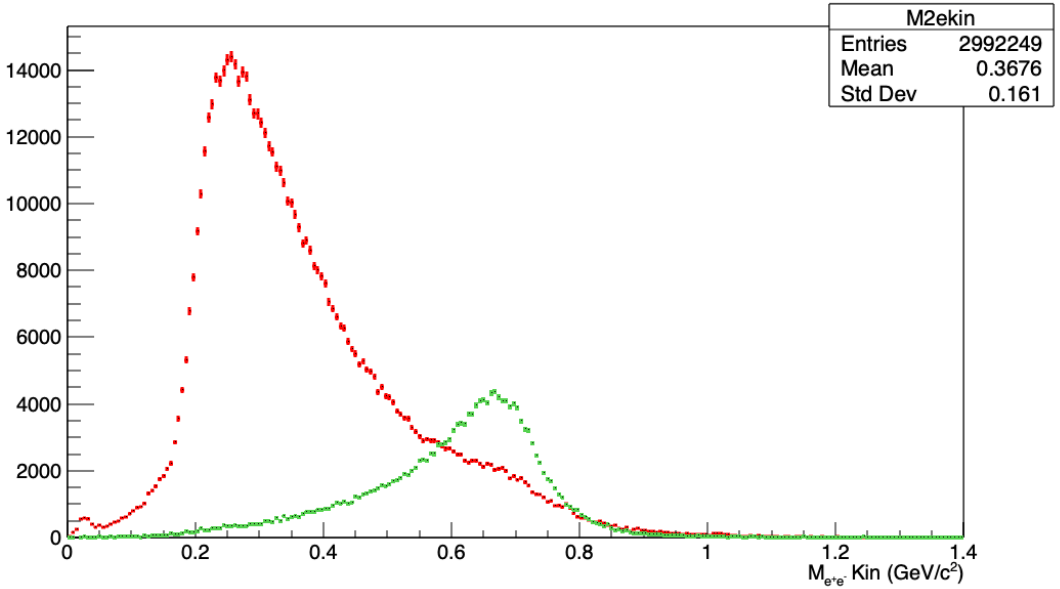




(Both tracks NNR go into this at once. can do single track study later)

Differences: Training ROC curves can get 100% background rejection efficiency at 97% signal efficiency,
whereas the double track data classification requires you to go down to 93%


M2ekin
Entries 5160249
Mean 0.4422
Std Dev 0.1926
16000
14000
12000
10000
8000
6000
4000
2000
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
$M_{e^+e^-}$ Kin (GeV/c^2)


M2ekin
Entries 2992249
Mean 0.3676
Std Dev 0.161
14000
12000
10000
8000
6000
4000
2000
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
$M_{e^+e^-}$ Kin (GeV/c^2)