CHARGED PION POLARIZABILITY (CPP)

PID STUDY

David Lawrence , Malachi Schram, Nikhil Kalra

Jefferson Lab, VA, USA

Jefferson Lab

U.S. DEPARTMENT OF ENERGY | Office of Science

JSA

Old data vs new data comparison

(3-GeV DATA) – 10th JAN

10,000 pi- and 10,000 mu- particle gun events.

- /home/davidl/work3/2021.10.20.CPP_hdgeant4/muminus/muminus.root
- /home/davidl/work3/2021.10.20.CPP_hdgeant4/piminus/piminus.root

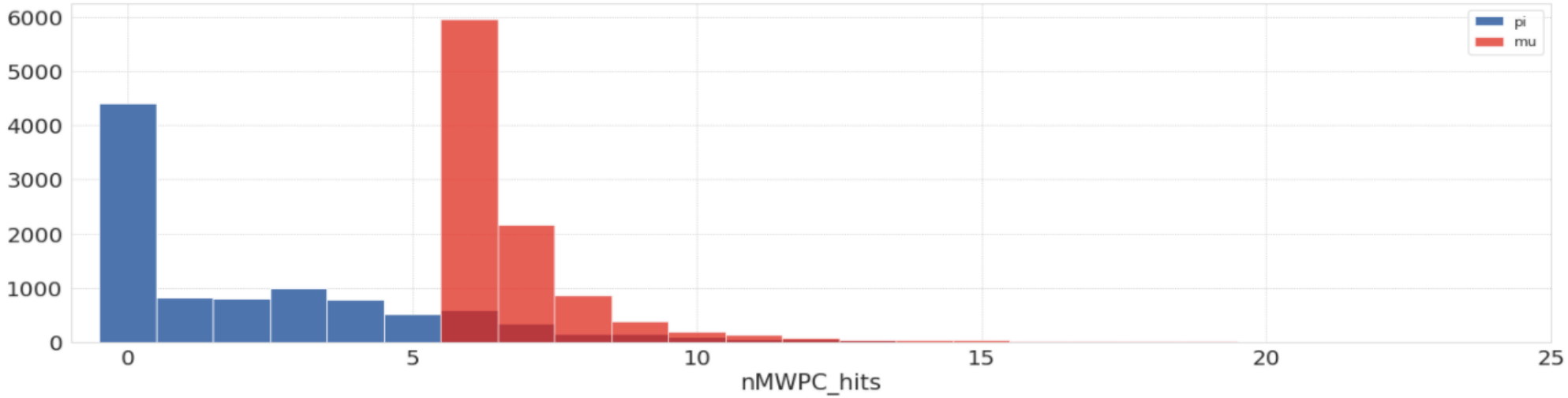
VS

(E_gamma ~=6-GeV Data) – 19th JAN

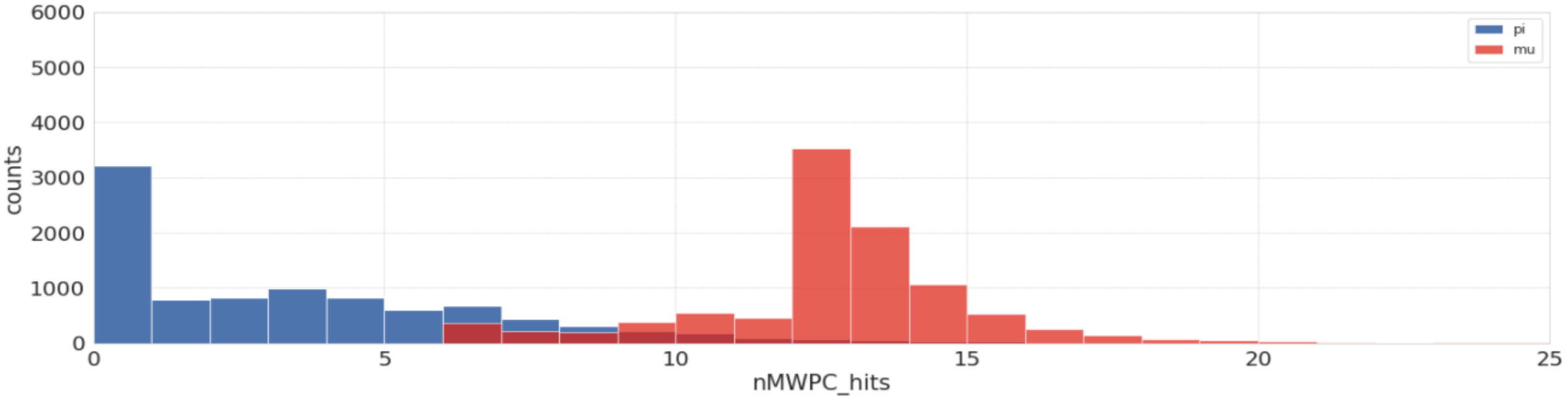
10,000 pi- and 10,000 mu- 2 particle events from physics generator.

- /home/davidl/work3/2022.01.16.CPP_hdgeant4/Elton_sim/muons.root
- /home/davidl/work3/2022.01.16.CPP_hdgeant4/Elton_sim/pions.root
- /work/halld/home/elton/gen_2pi_primakoff_signal_jan2022/hddm/gen_2pi_primakoff_jan2022_071728_010_geant4_smeared.hddm
- /work/halld/home/elton/gen_BH_dec2021/hddm/dec2021_071729_000_geant4_smeared.hddm

n_MWPC hits



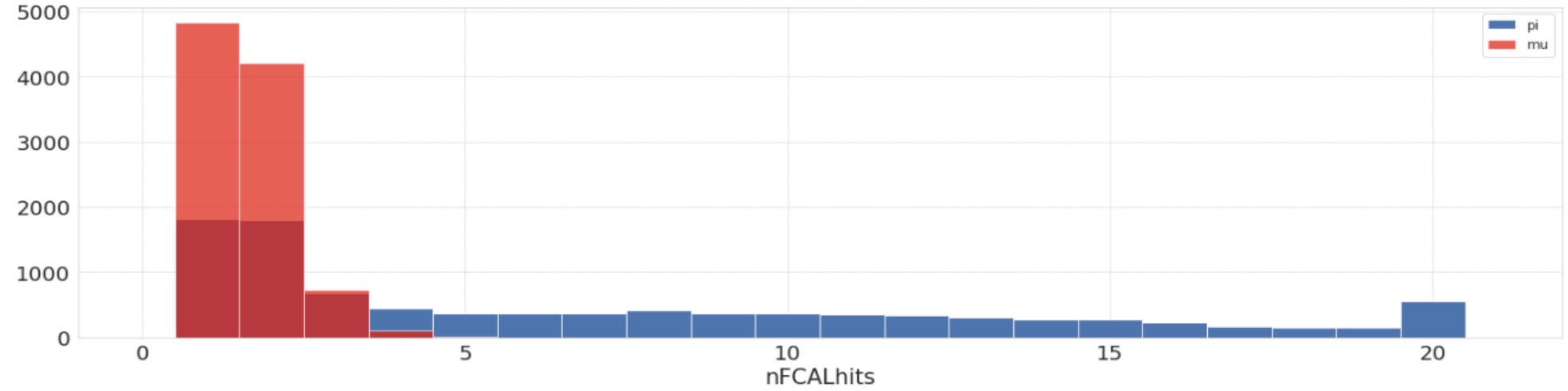
Single particle



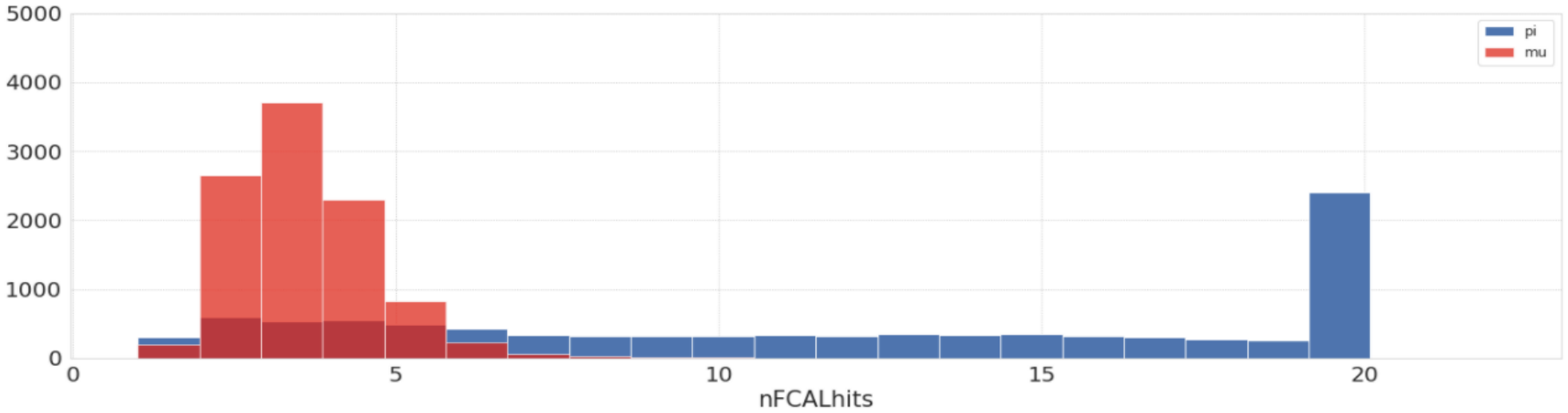
2 - particle

Jefferson Lab

n_fcal hits

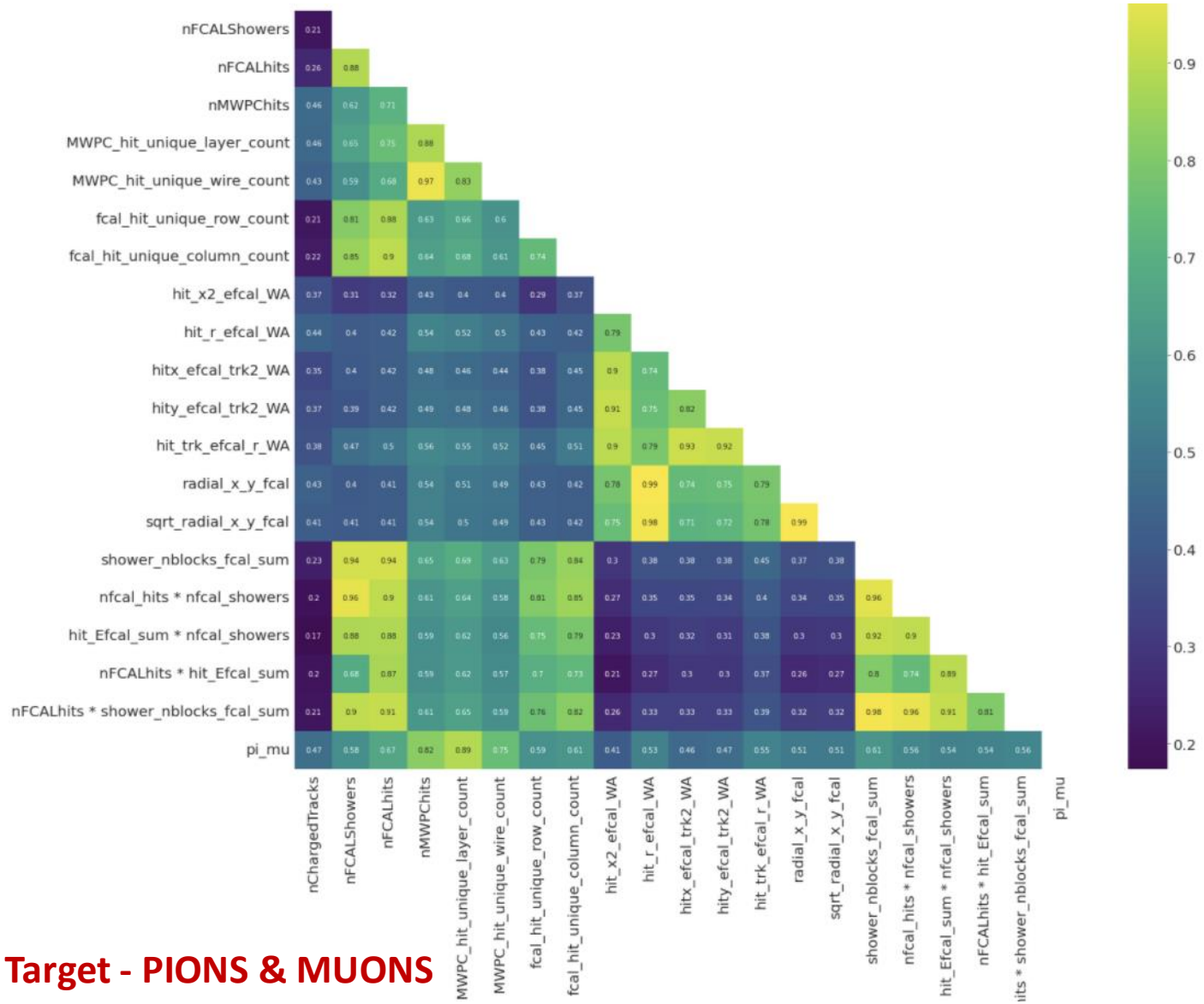


Single particle



2 - particle

New data with new calculated features



Target - PIONS & MUONS

CORRELATION PLOT

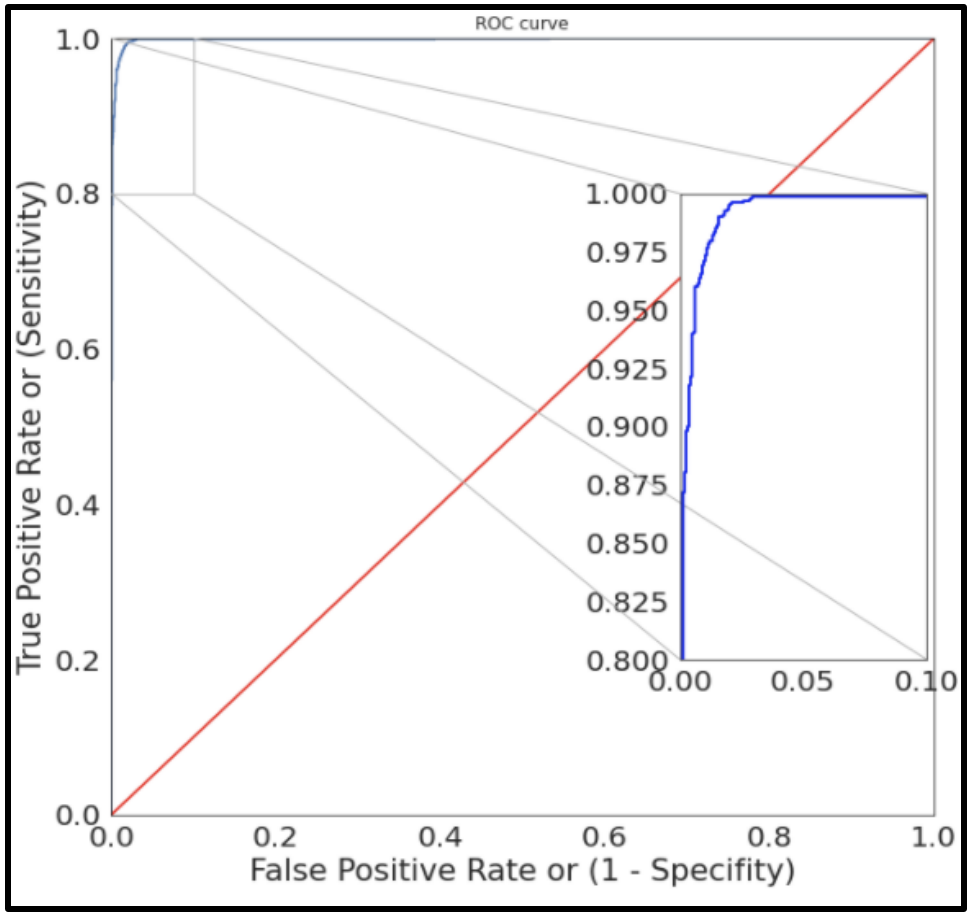
Steps to calculate correlation

- **Step 1**: Find the mean of **x**, and the mean of **y**
- **Step 2**: Subtract the mean of x from every x value (call them "**a**"), and subtract the mean of y from every y value (call them "**b**")
- **Step 3**: Calculate: **ab**, $\mathbf{a^2}$ and $\mathbf{b^2}$ for every value
- **Step 4**: Sum up **ab**, sum up $\mathbf{a^2}$ and sum up $\mathbf{b^2}$
- **Step 5**: Divide the sum of ab by the square root of [(sum of a^2) × (sum of b^2)]

Jefferson Lab

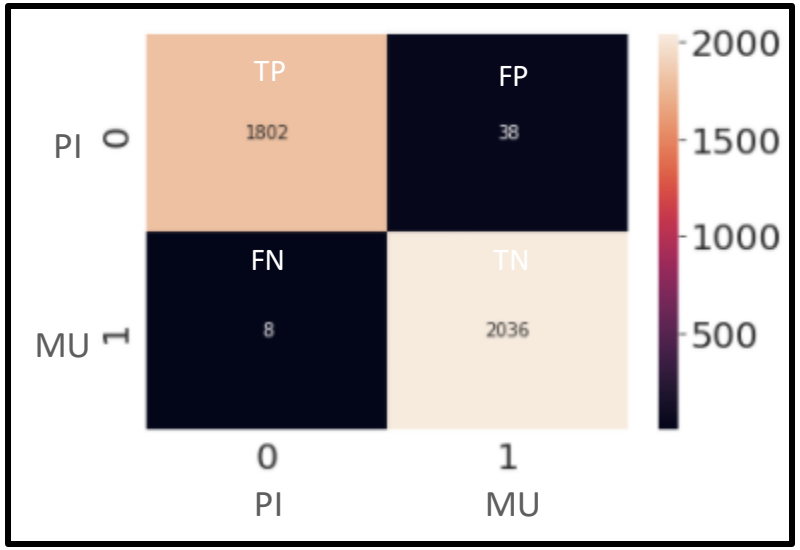
Model matrix all events

Roc curve



Classification report

	classification_ report			
	precision	recall	f1-score	support
0.0	0.98	0.99	0.99	1887
1.0	0.99	0.98	0.99	1997
accuracy			0.99	3884
macro avg	0.99	0.99	0.99	3884
weighted avg	0.99	0.99	0.99	3884



Confusion_Matrix

Jefferson Lab

Data with pions and muons hitting on 5,6 layers only

PION's

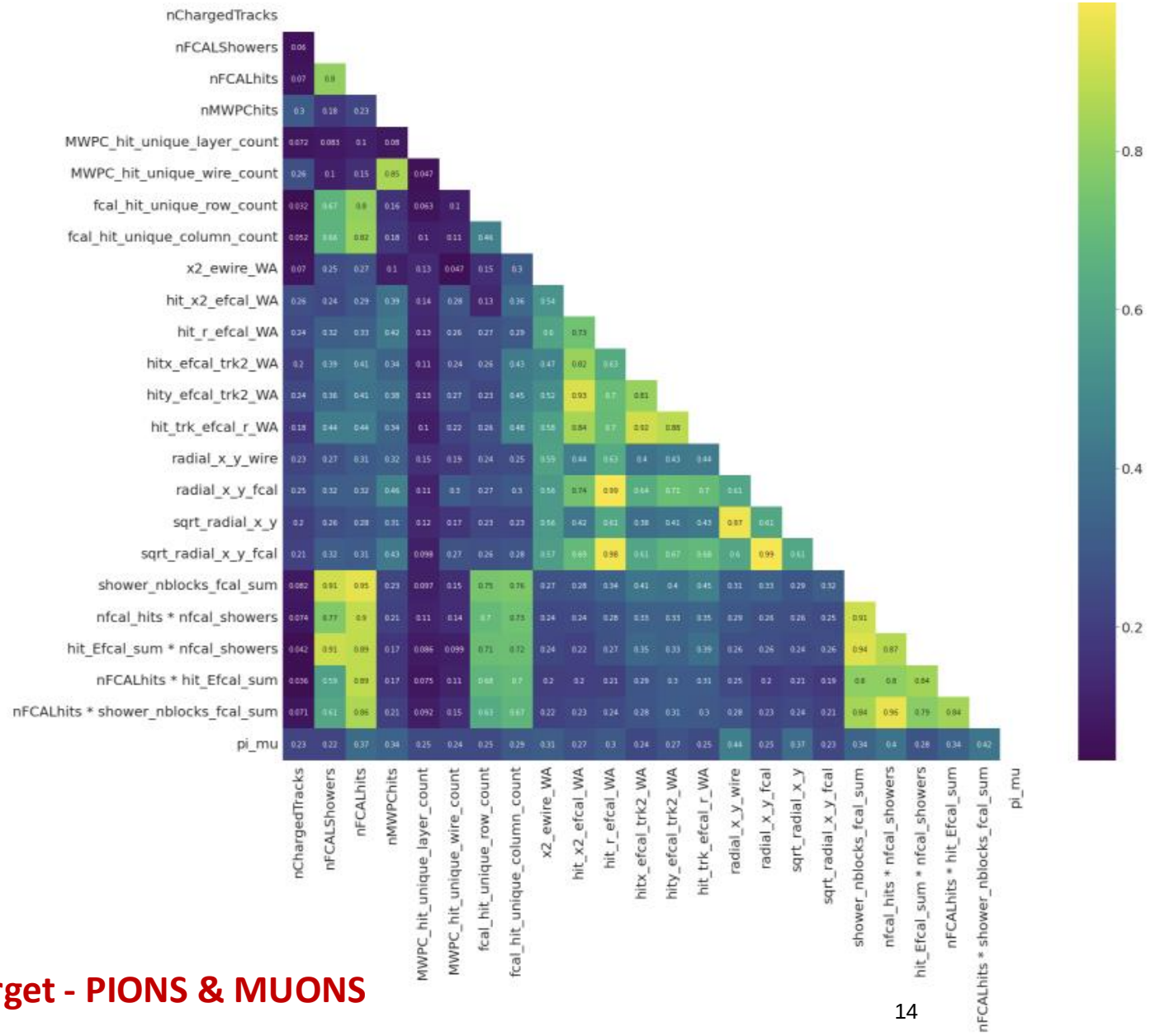
MWPC layers	Layers hits
0	3215
3	2015
2	1751
1	1485
4	544
6	385
5	29

MUON's

MWPC layers	Layers hits
6	9980
4	4
5	3
1	2
3	2
0	1

- Pions are mostly hitting on 0,1,2,3,4 and most of them are not reaching to the last 2 layers as shown in the table below.
- Muons are reaching all the way to 6th layer
- Cut data to keep only events hitting 5th or 6th layers. Did data balancing for Pion's.

Data with pions and muons hitting on 5,6 layers only



CORRELATION PLOT

Steps to calculate correlation

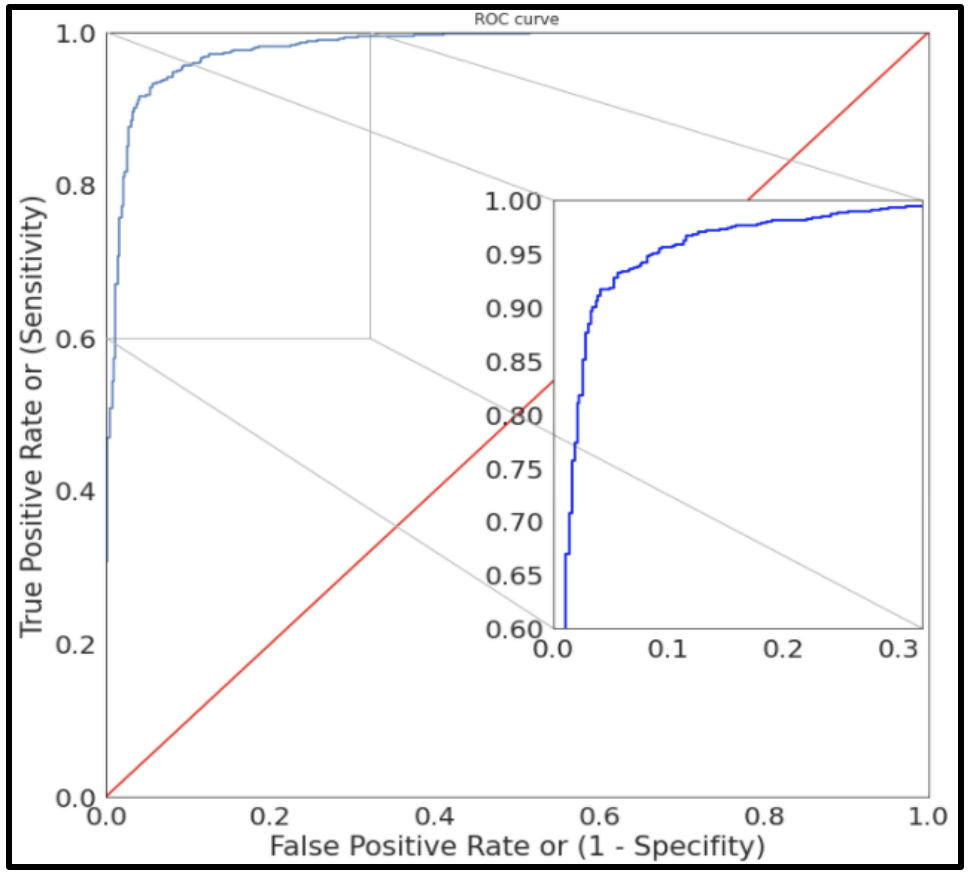
- **Step 1**: Find the mean of **x**, and the mean of **y**
- **Step 2**: Subtract the mean of x from every x value (call them "**a**"), and subtract the mean of y from every y value (call them "**b**")
- **Step 3**: Calculate: **ab**, **a²** and **b²** for every value
- **Step 4**: Sum up **ab**, sum up **a²** and sum up **b²**
- **Step 5**: Divide the sum of ab by the square root of [(sum of a^2) × (sum of b^2)]

Target - PIONS & MUONS

Jefferson Lab

Model matrix 5th, 6th layer hits only

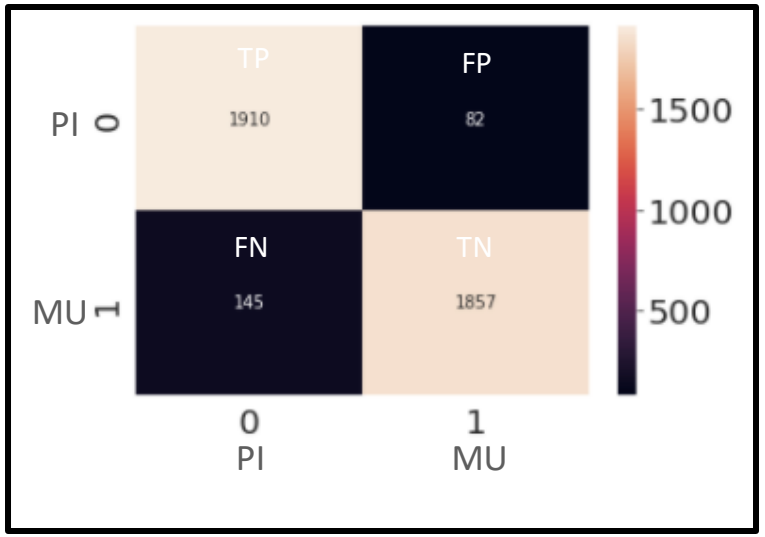
Roc curve



Classification report

classification_ report

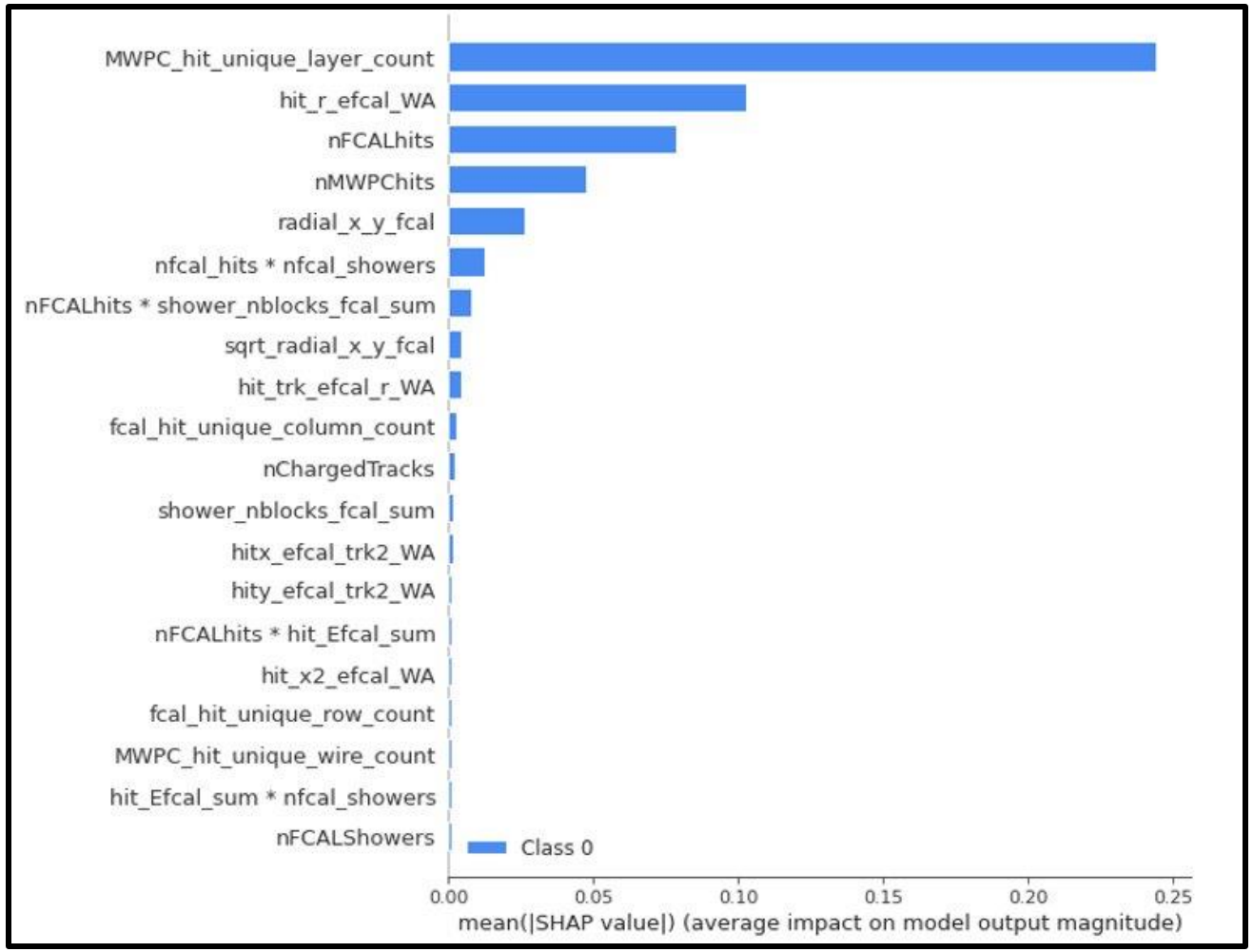
	precision	recall	f1-score	support
0.0	0.96	0.93	0.94	2055
1.0	0.93	0.96	0.94	1939
accuracy			0.94	3994
macro avg	0.94	0.94	0.94	3994
weighted avg	0.94	0.94	0.94	3994



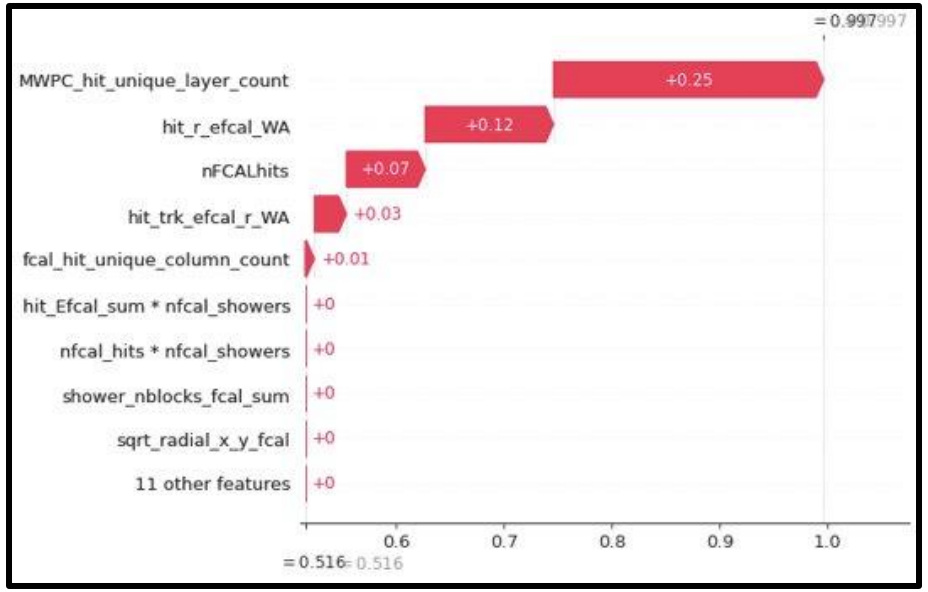
Confusion_Matrix

Jefferson Lab

Shaply library – "find best features for your model"



SUMMARY PLOT



WATERFALL PLOT

Jefferson Lab