DUNE Flux – Correlation Studies

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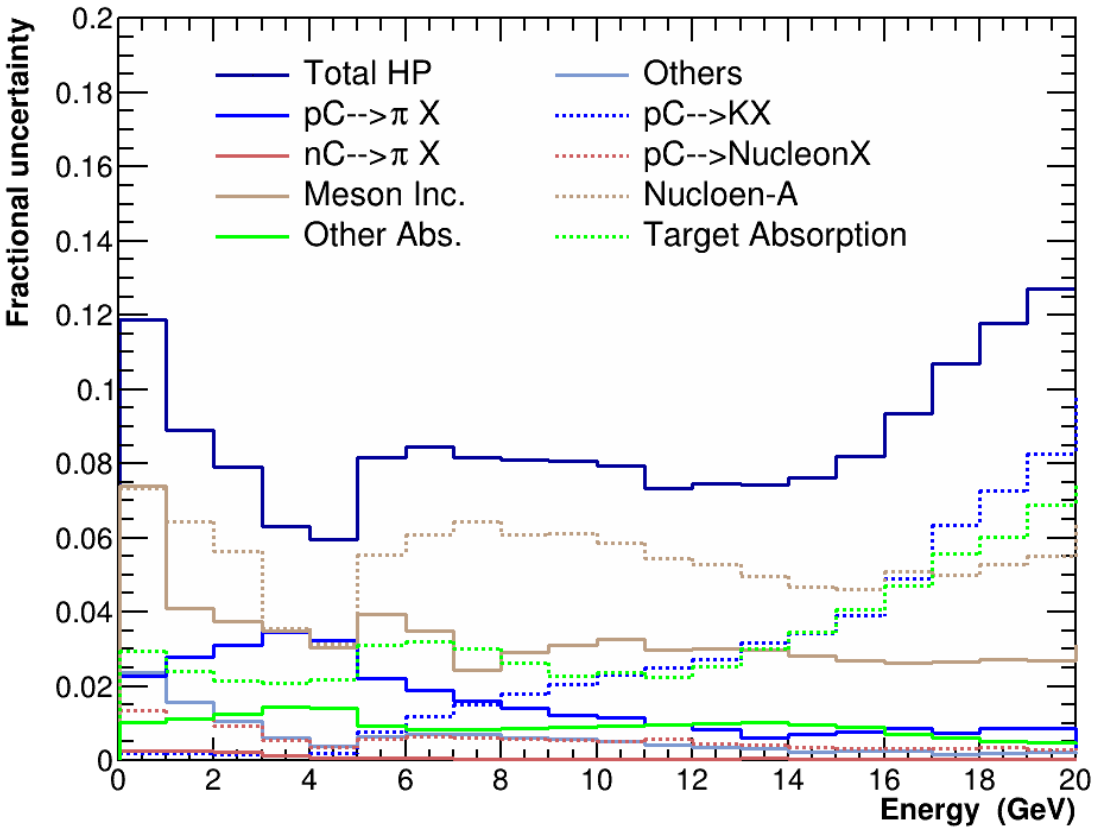
Fractional Uncertainty



Interactions covered by external data

- pC -> π X
- pC -> K X
- pC-> Nucleon X

There was no information from the external data related to bin to bin correlations. Thus bin-to-bin correlations are assumed to be 100 % .

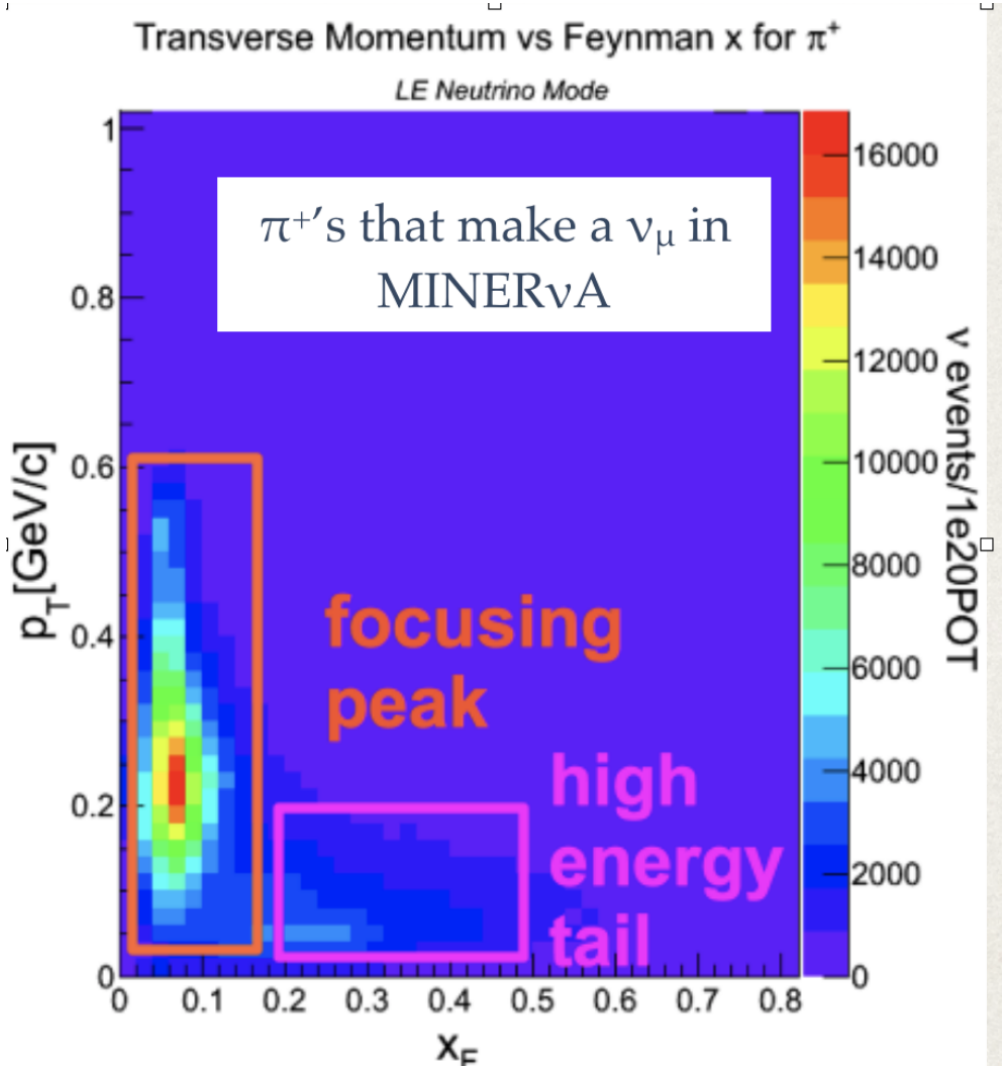
Fermilab

How it is done in PPFX ? – Previous SLIDE

The correlation and other data are kept in a plain database file in following ways :

- The parameter file contains the input data from results of studies to make interpolations and correlations between bins.
- For uncorrelated data, the central value and its uncertainty are provided as single values or a list of values.
- Correlated data requires a list of central values per bin, a list of statistical errors and a covariance matrix of the systematic errors.
- However, for these interactions : pC -> π X , pC -> K X, pC-> Nucleon X the elements of cov matrix becomes very large. Due to the many values it becomes impossible to process.
  - So in order to introduce correlations a trick is made where 100% correlation is to use the same random shift value per universe for all bins of a dataset.

NA61 phase space



- Split this into finer bins.
- Map the NA61 phase space onto the neutrino energy phase space.

Splitting up the phase space

This is the binning scheme taken into account for thin target pc->pi interactions, and respective plots for fractional uncertainties and correlations matrices are made.

Bin 1 : 0.02 < xf <= 0.2 and 0.025 < Pt <= 0.15 GeV/c
Bin 2 : 0.02 < xf <= 0.2 and 0.15 < Pt <= 0.3 GeV/c
Bin 3 : 0.02 < xf <= 0.2 and 0.3 < Pt <= 0.6 GeV/c

Focusing region

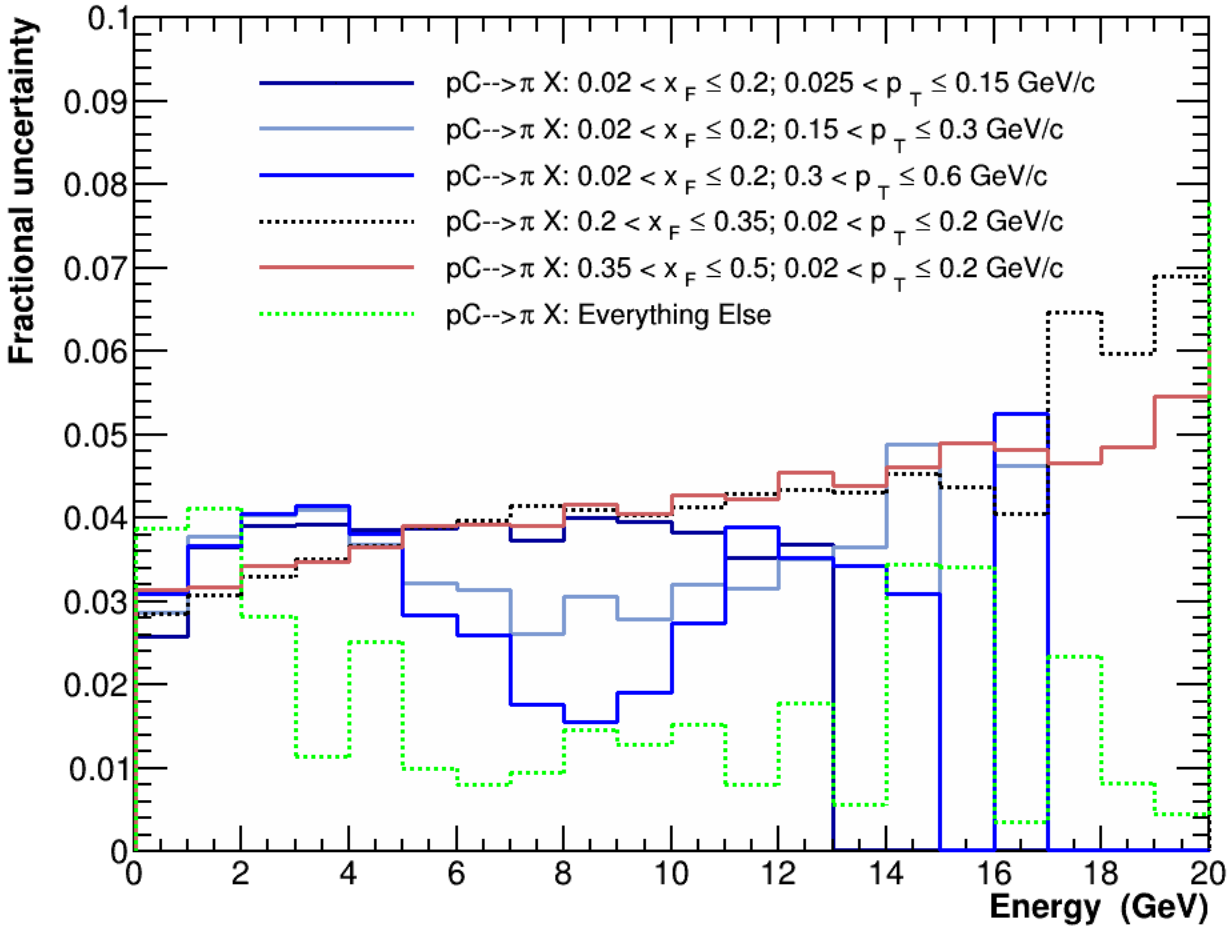
Bin 4 : 0.2 < xf <= 0.35 and 0.02 < Pt <= 0.2 GeV/c
Bin 5 : 0.35 < xf <= 0.5 and 0.02 < Pt <= 0.2 GeV/c

high energy tail

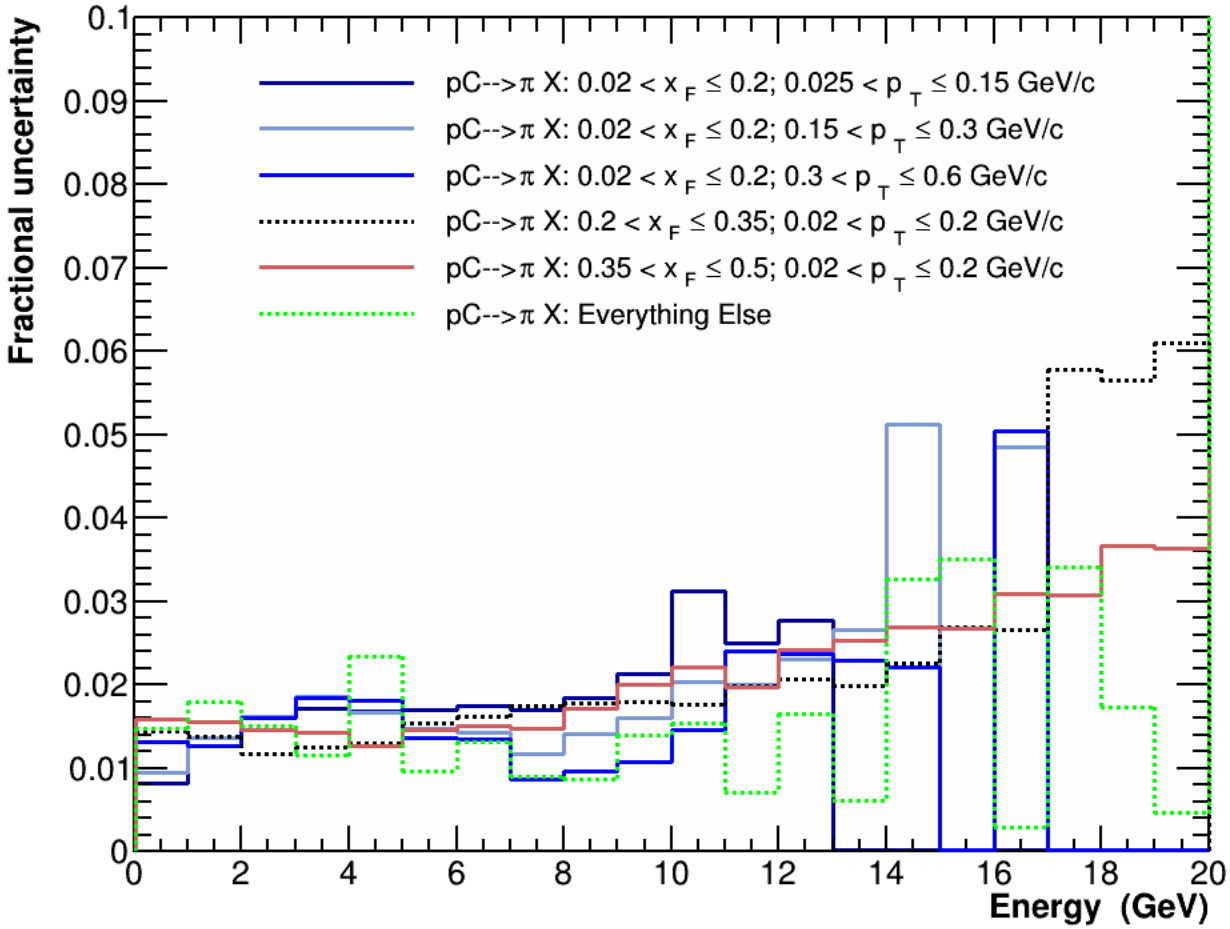
Bin 6: Everything else

Fractional Uncertainties

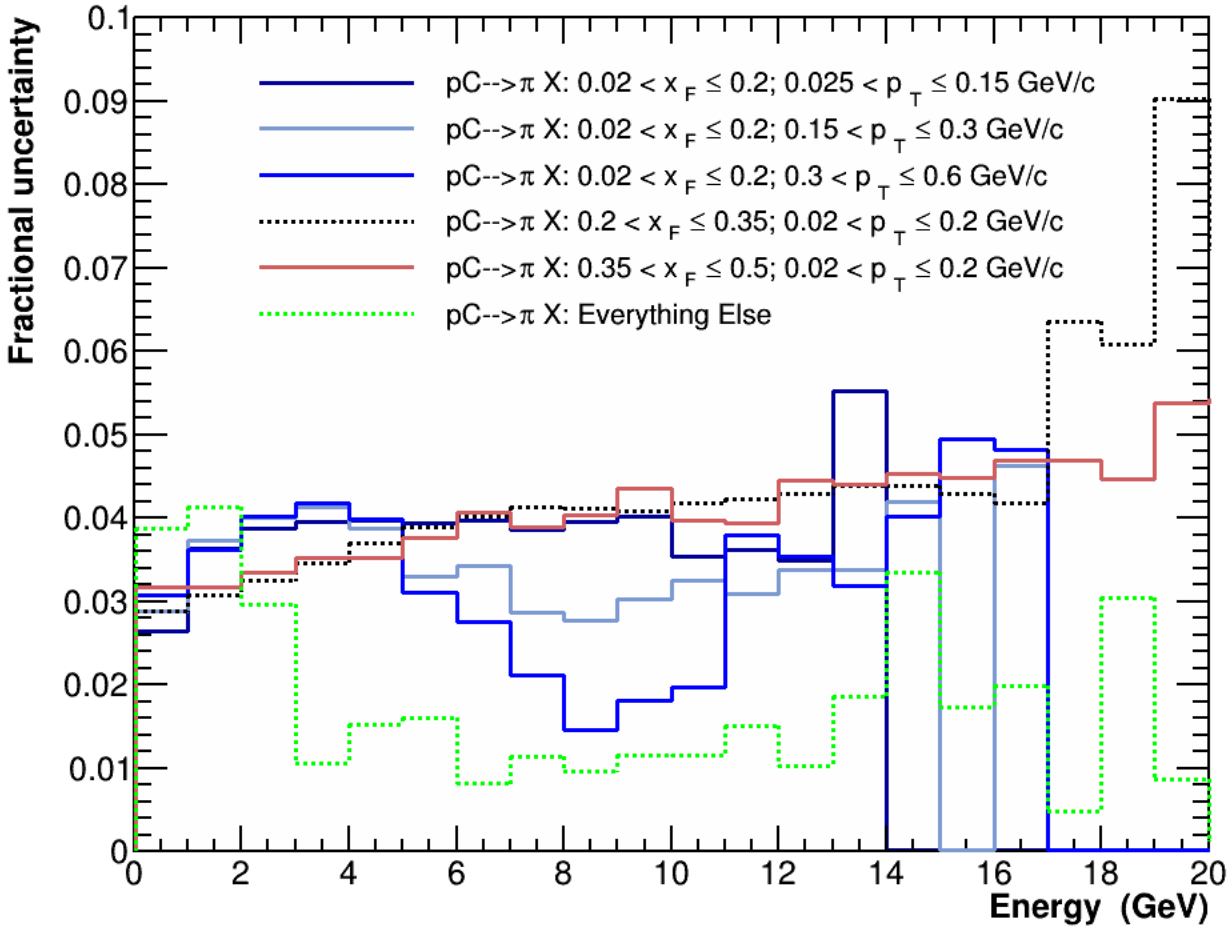
Default Case – (numu) near detector :



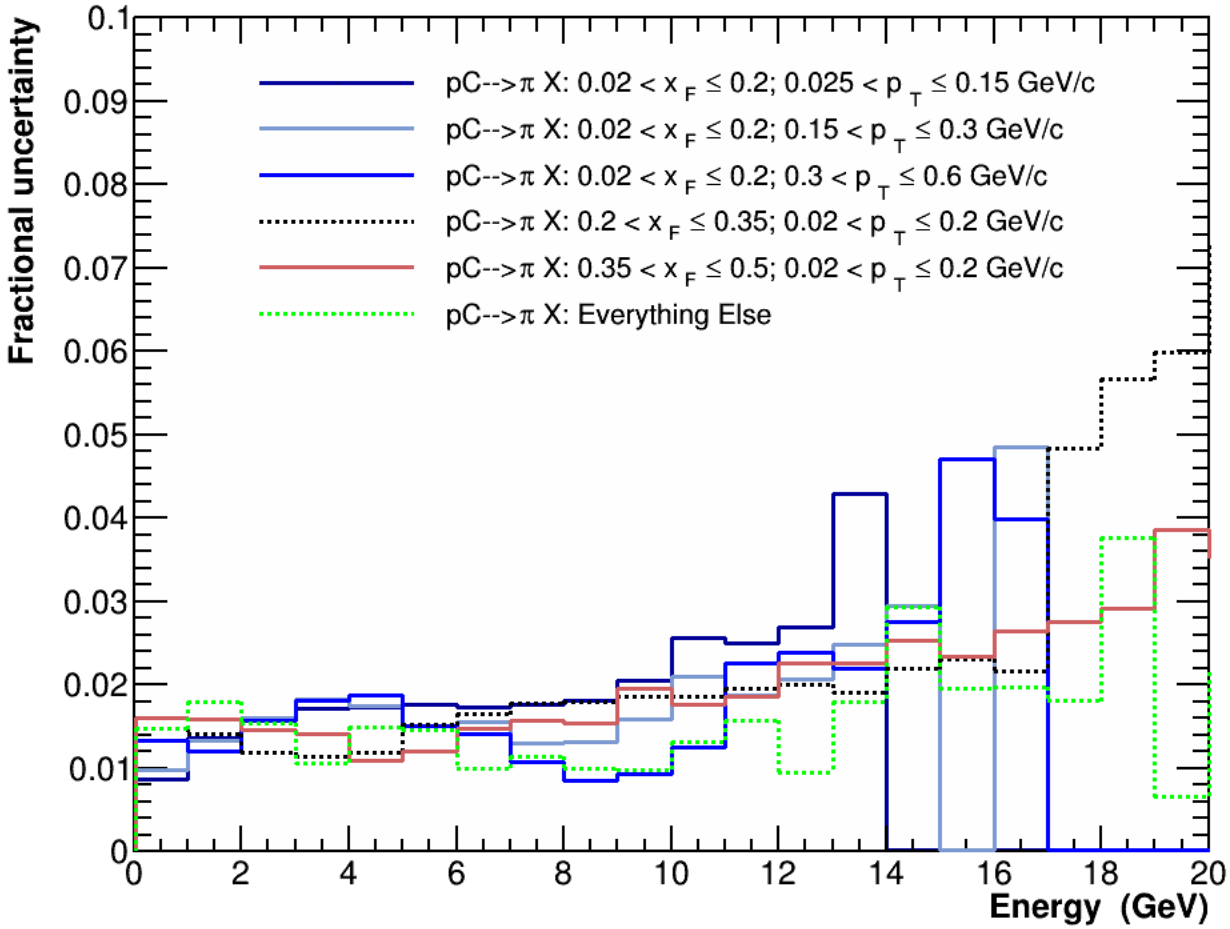
Uncorrelated Case – (numu) near detector :



Default Case – (numu) Far detector :



Uncorrelated Case – (numu) Far detector :



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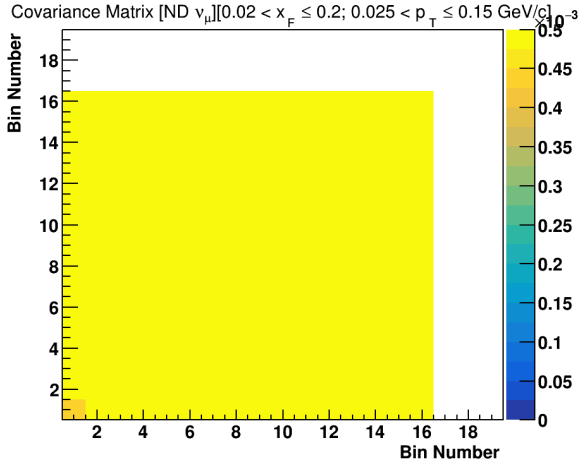
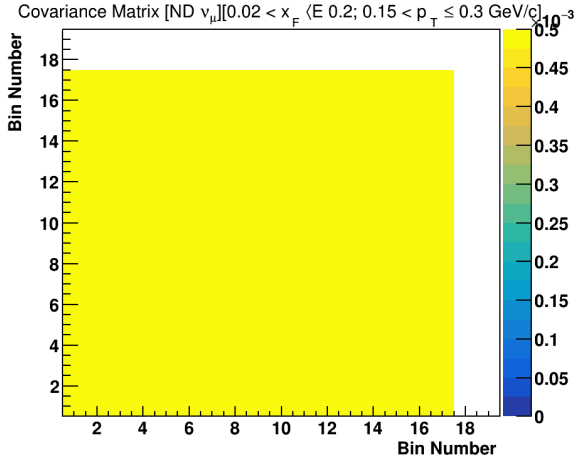
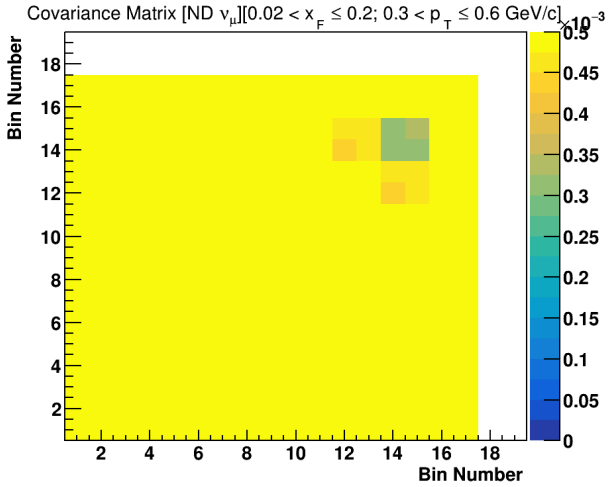
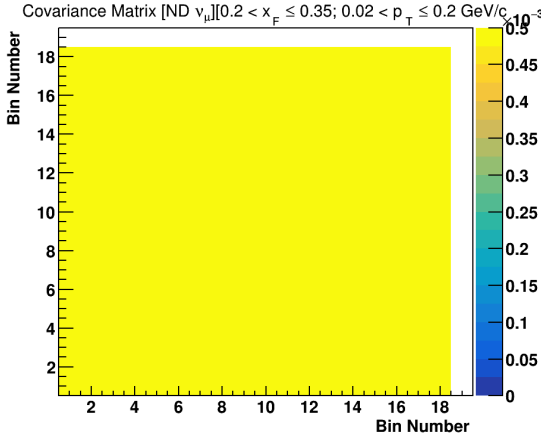
Covariances

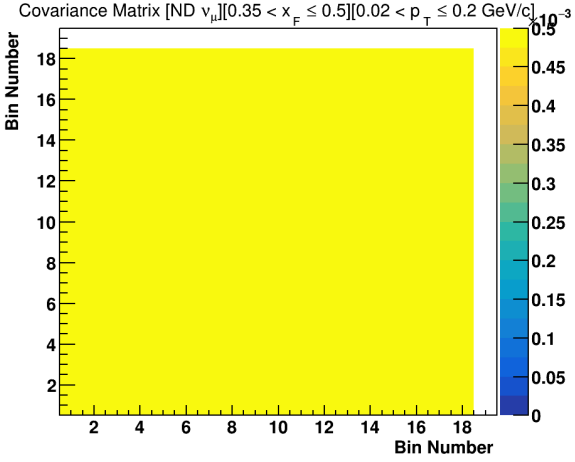
Default Case – (numu) near detector :

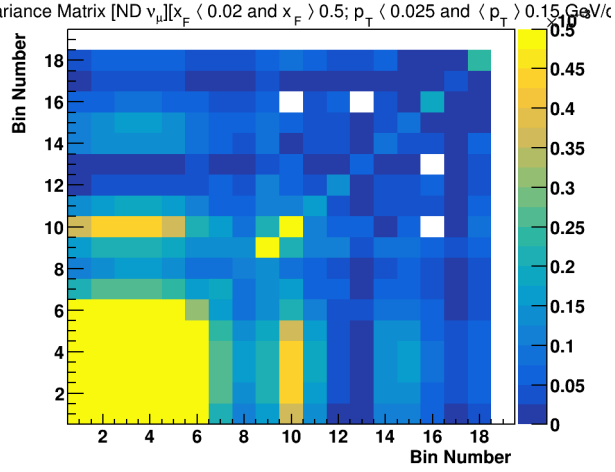












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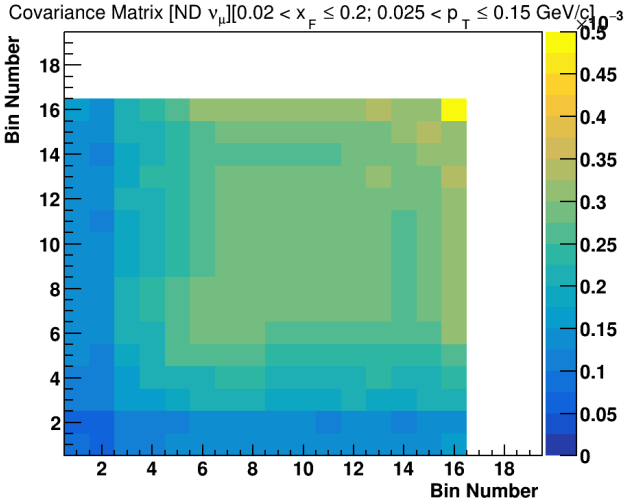
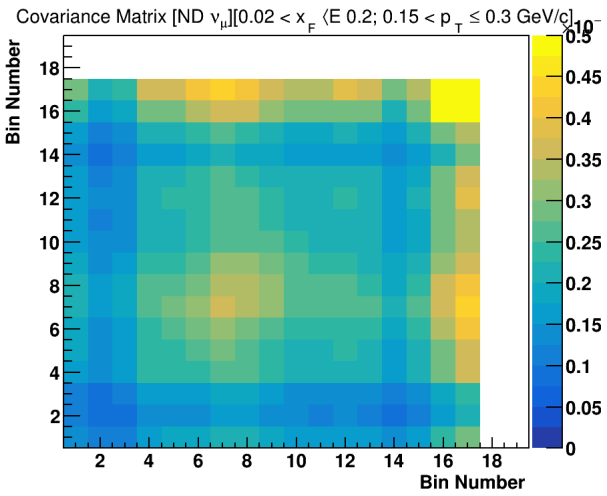
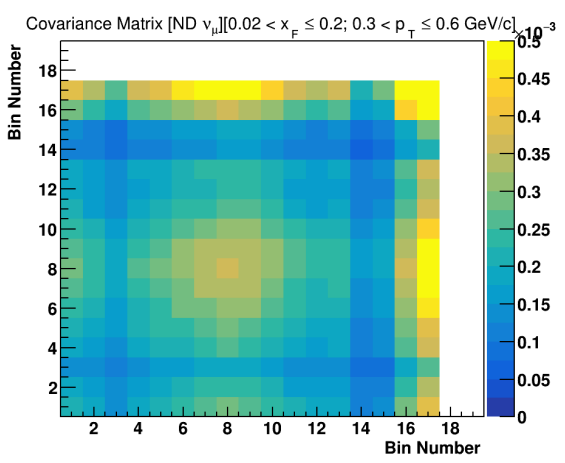
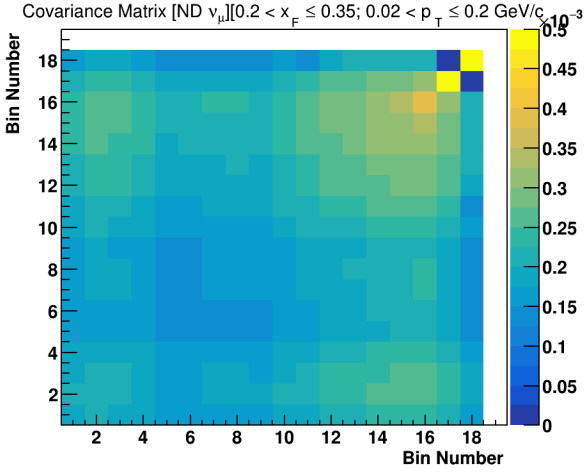
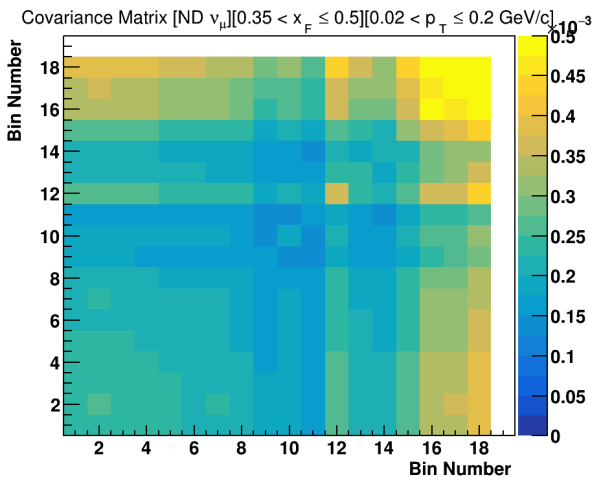
Uncorrelated Case – (numu) near detector :

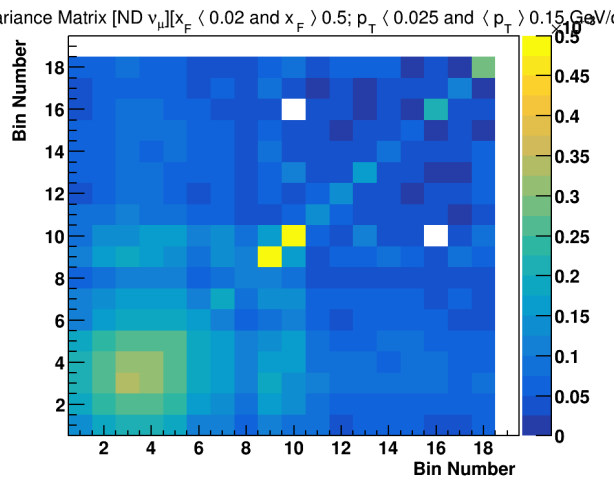






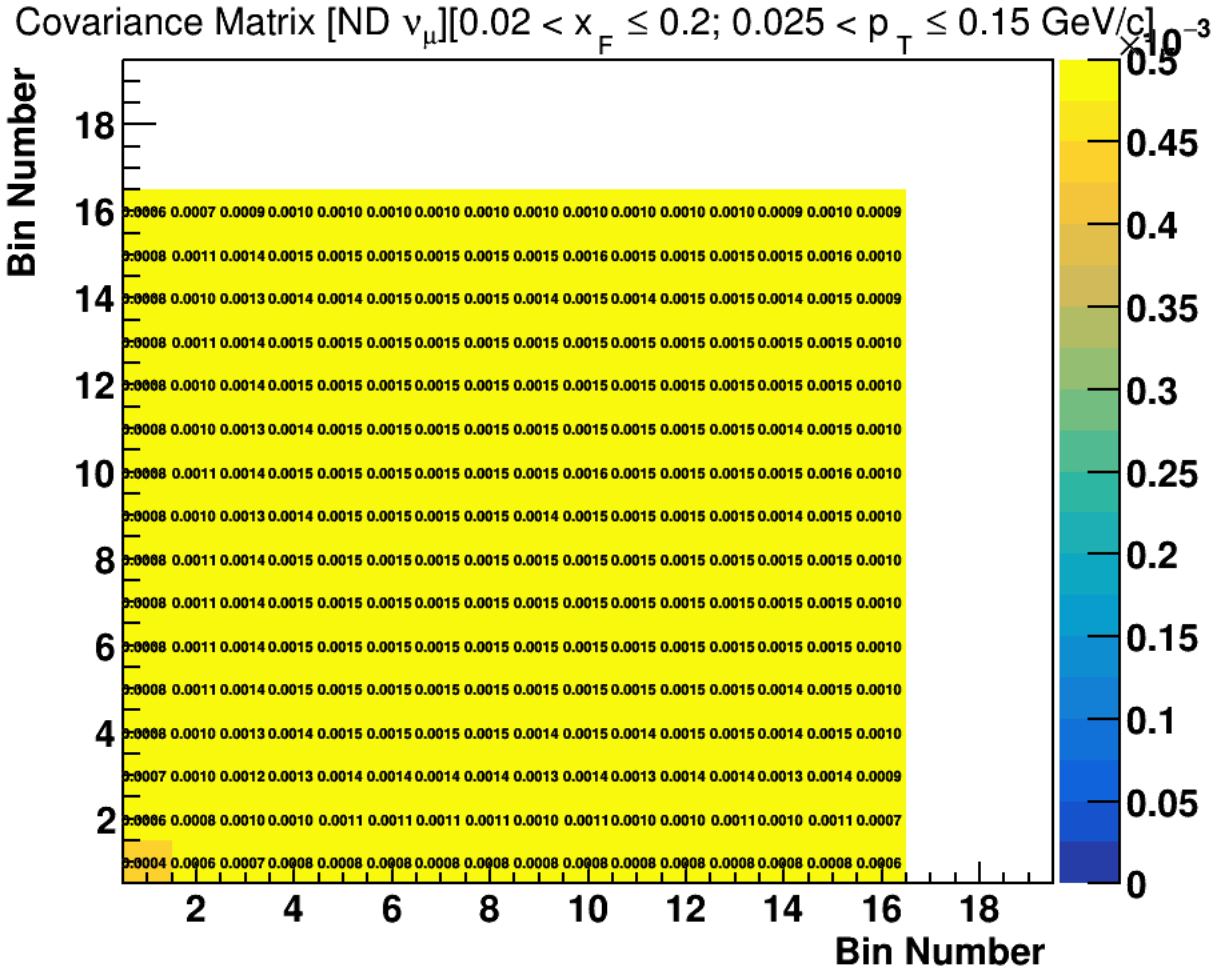






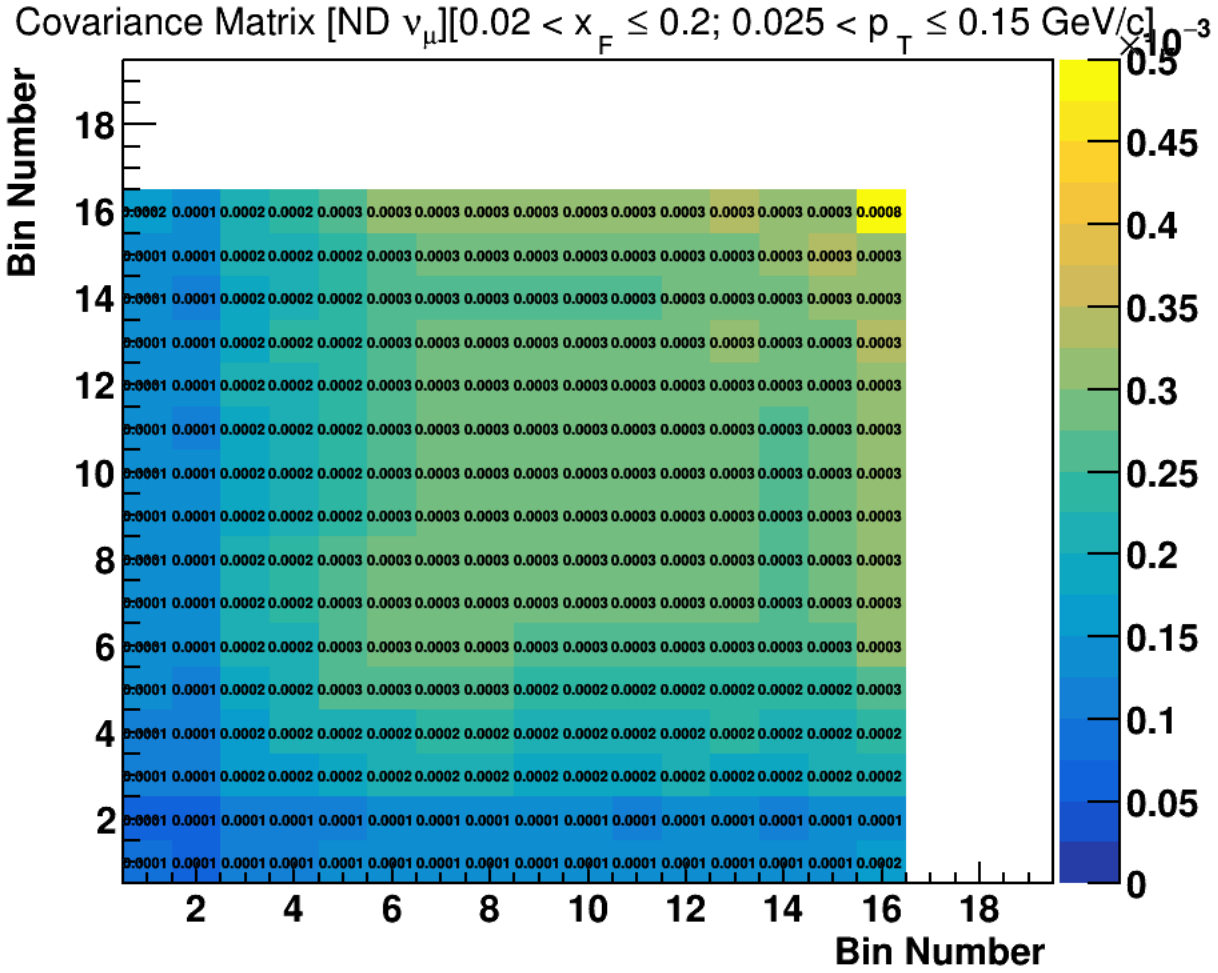
Fermilab

Default – Bin 1



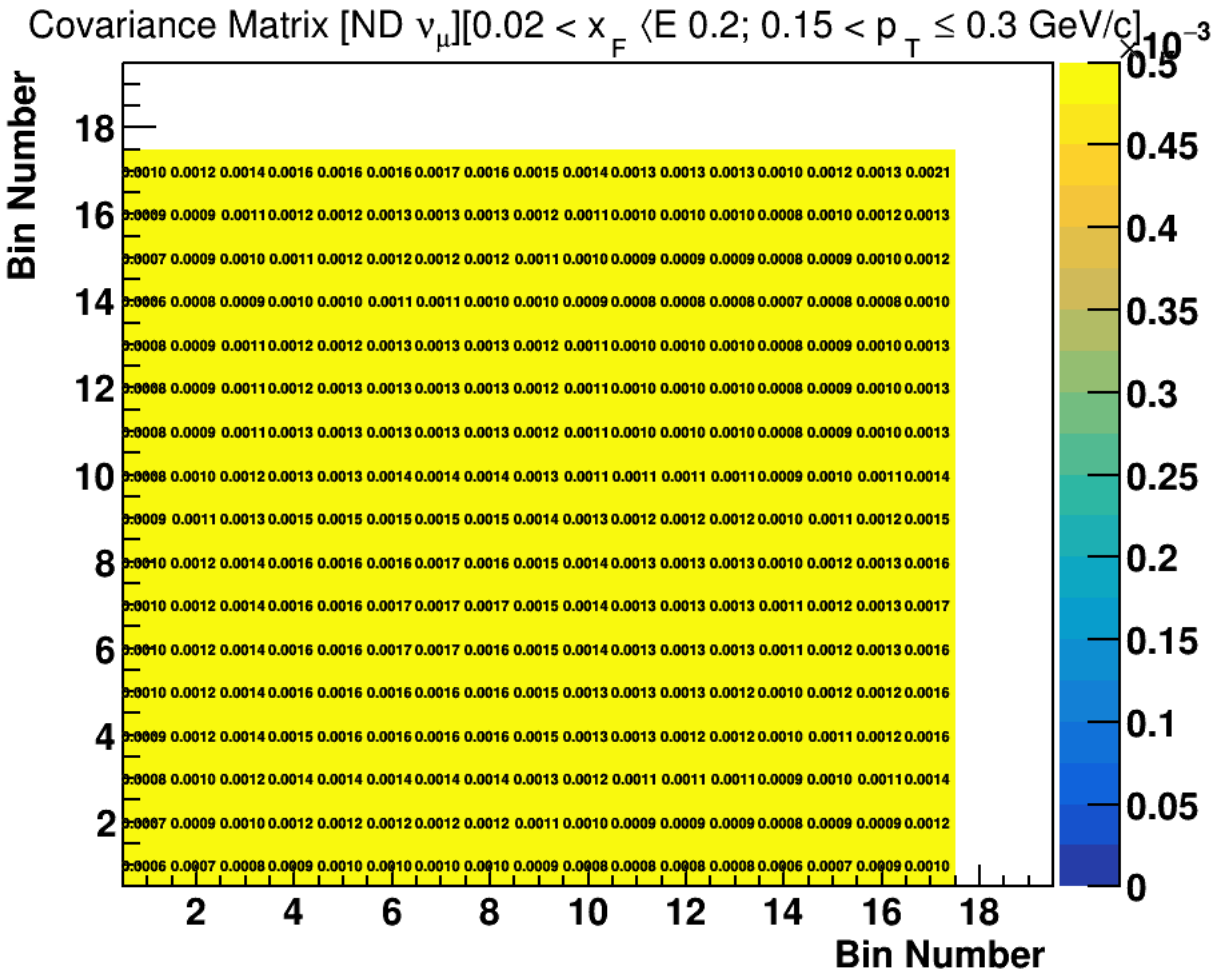
Fermilab

Uncorrelated – Bin 1



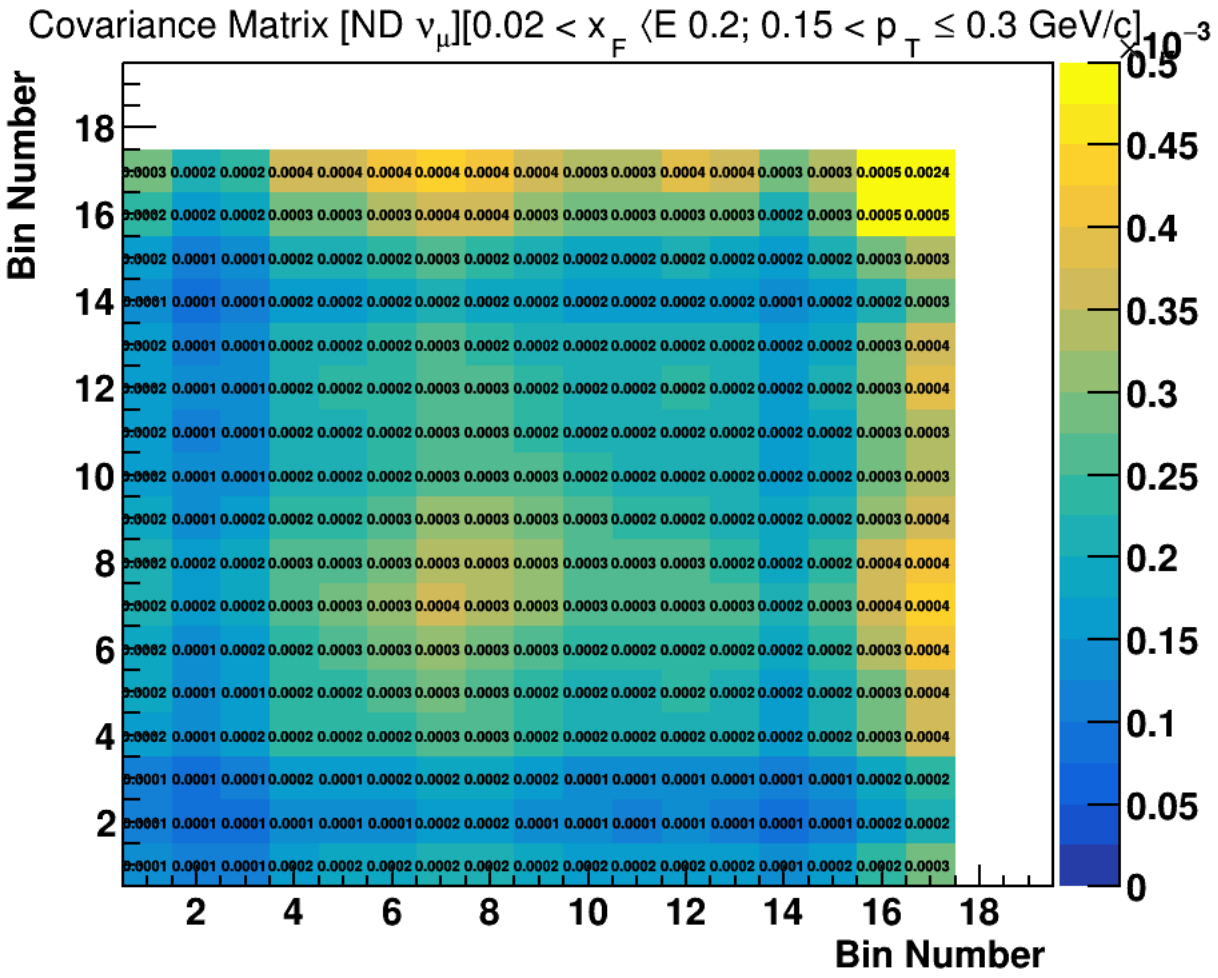
Fermilab

Default – Bin 2



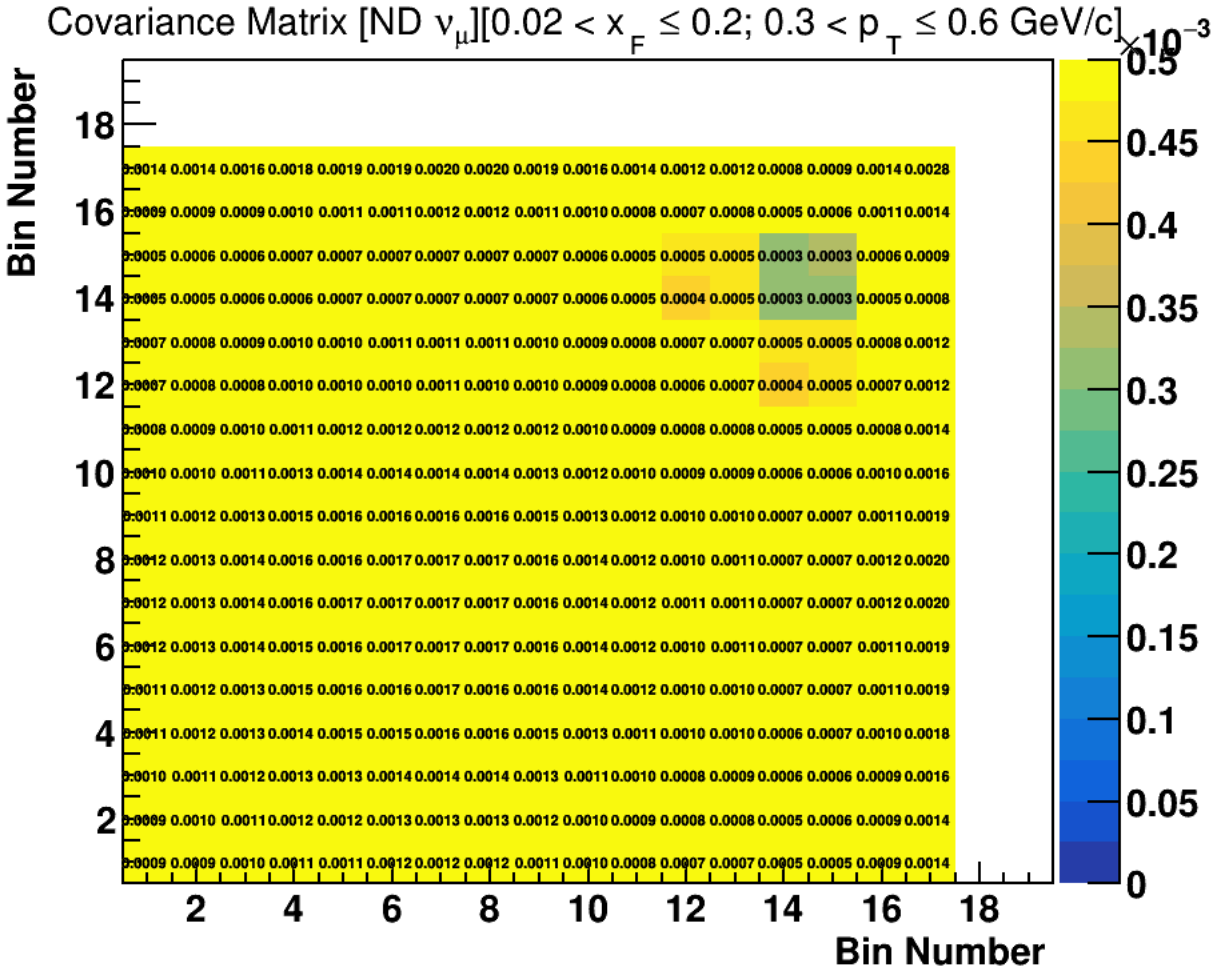
Fermilab

Uncorrelated – Bin 2



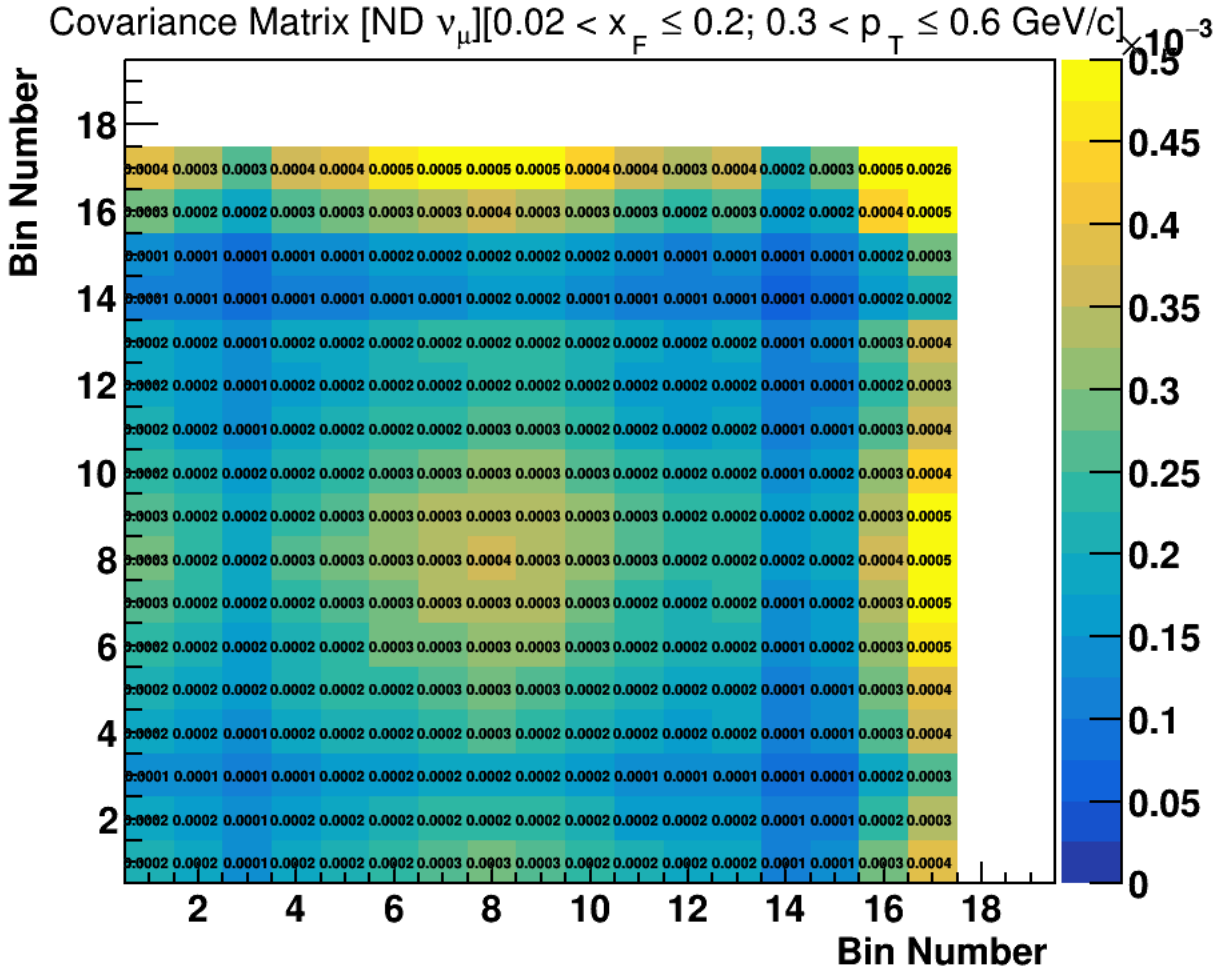
Fermilab

Default – Bin 3



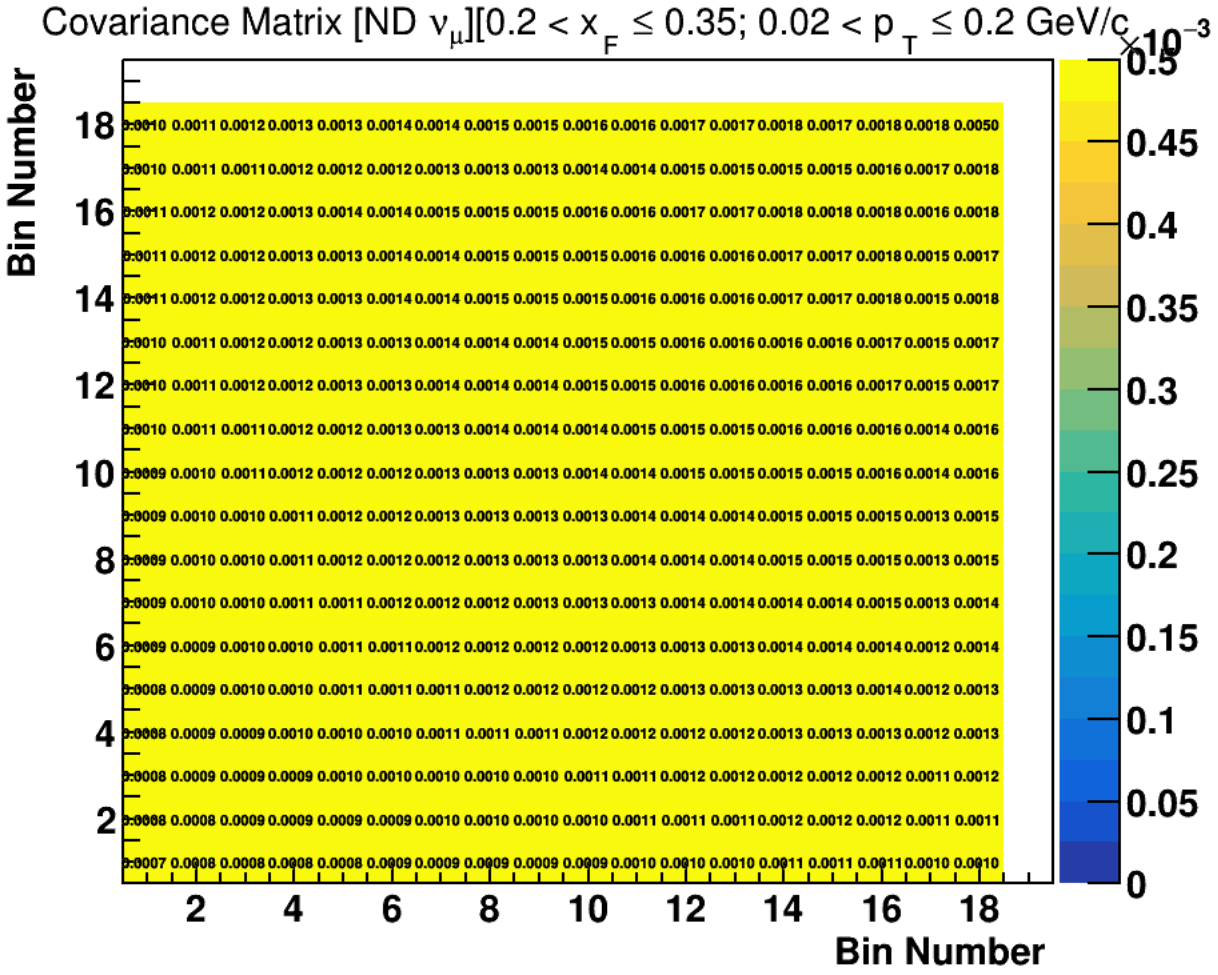
Fermilab

Uncorrelated – Bin 3



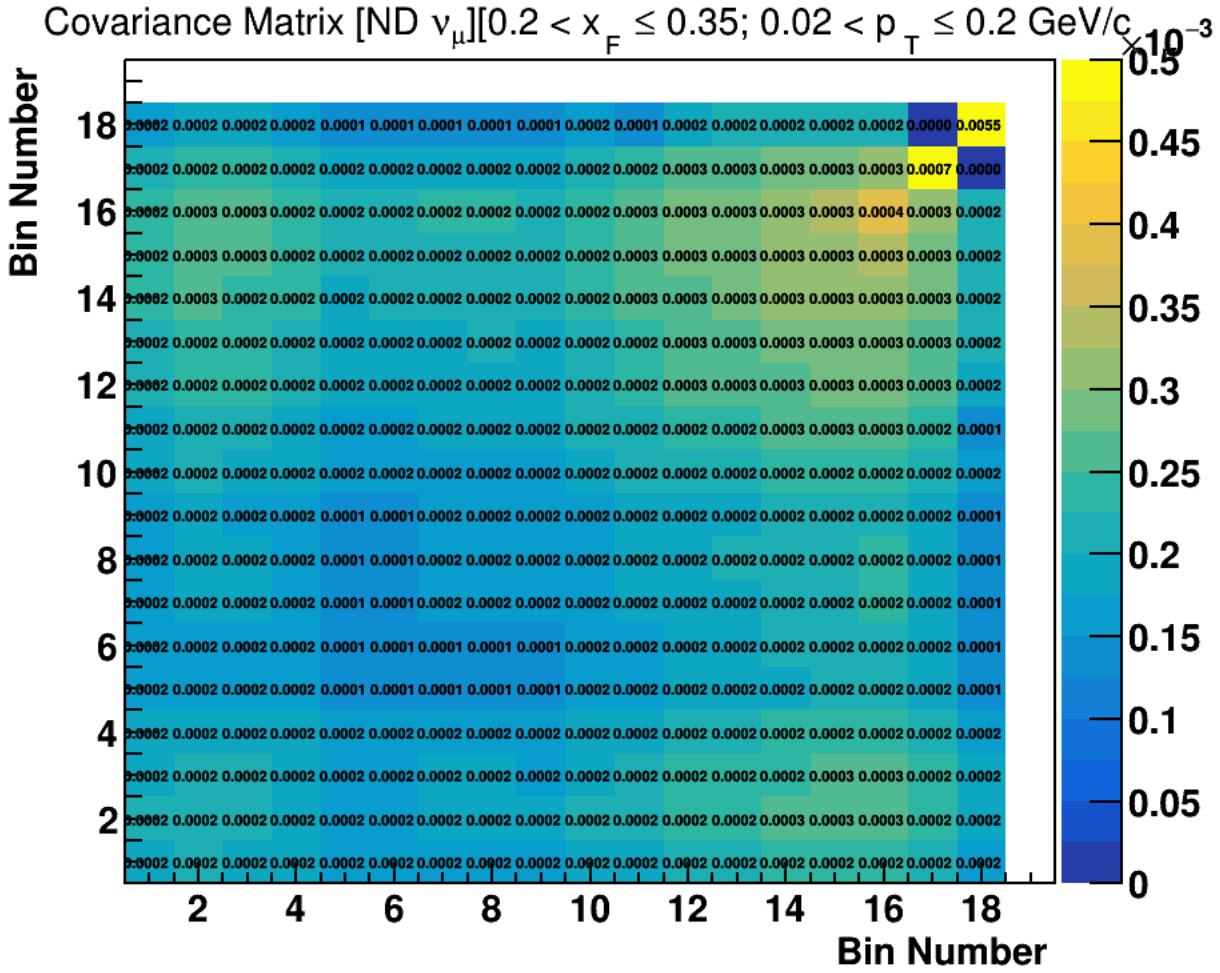
Fermilab

Default – Bin 4



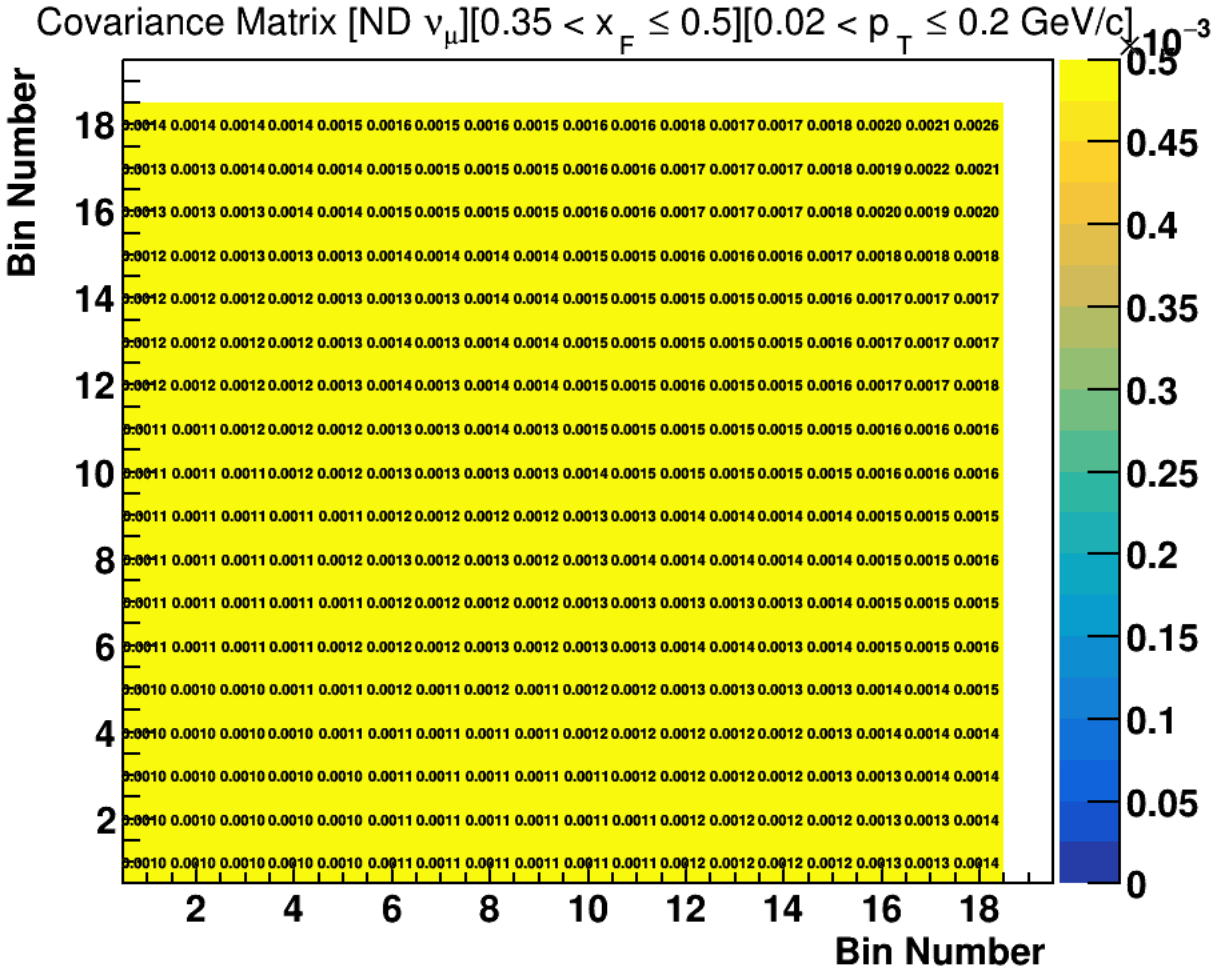
Fermilab

Uncorrelated – Bin 4



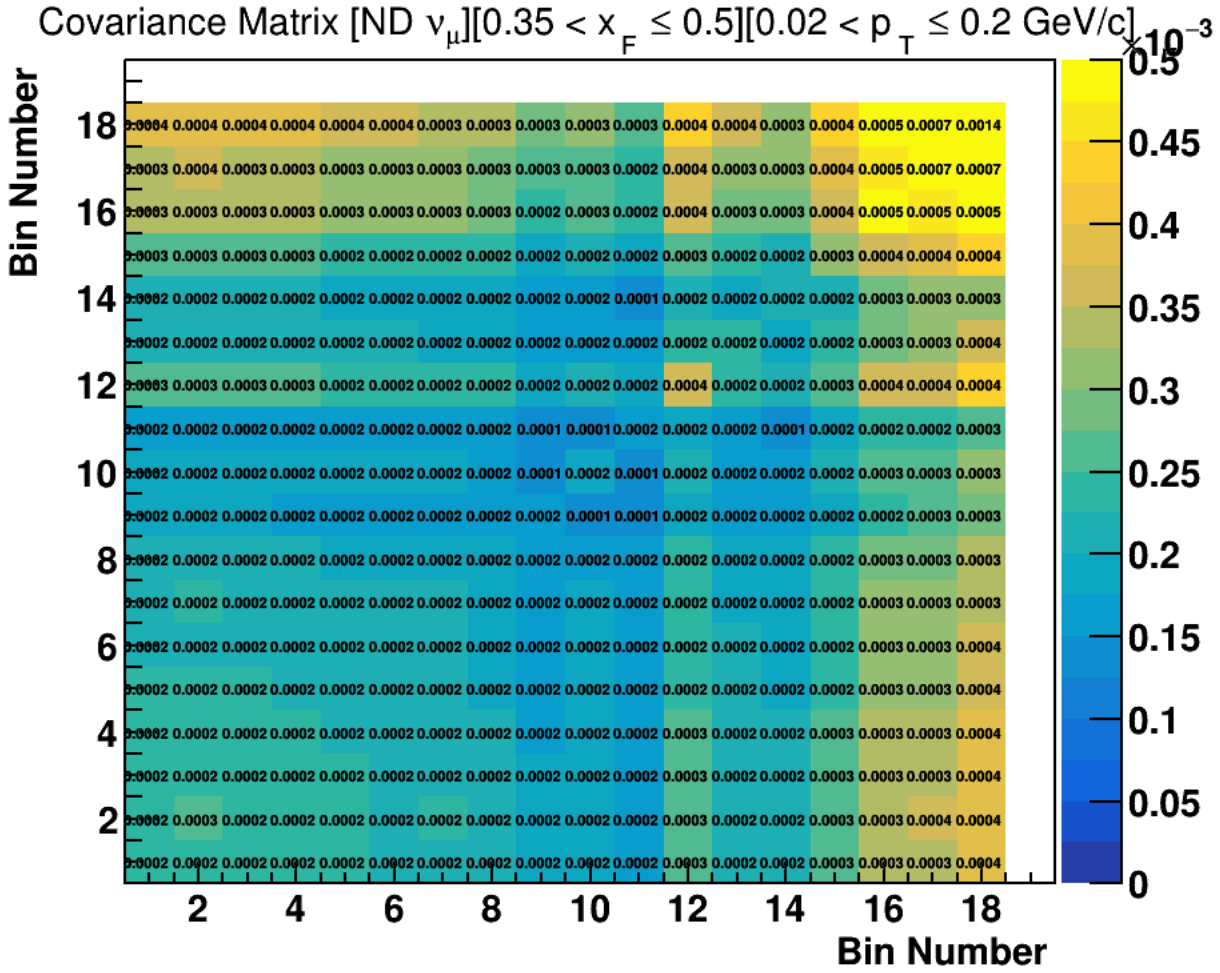
Fermilab

Default – Bin 5

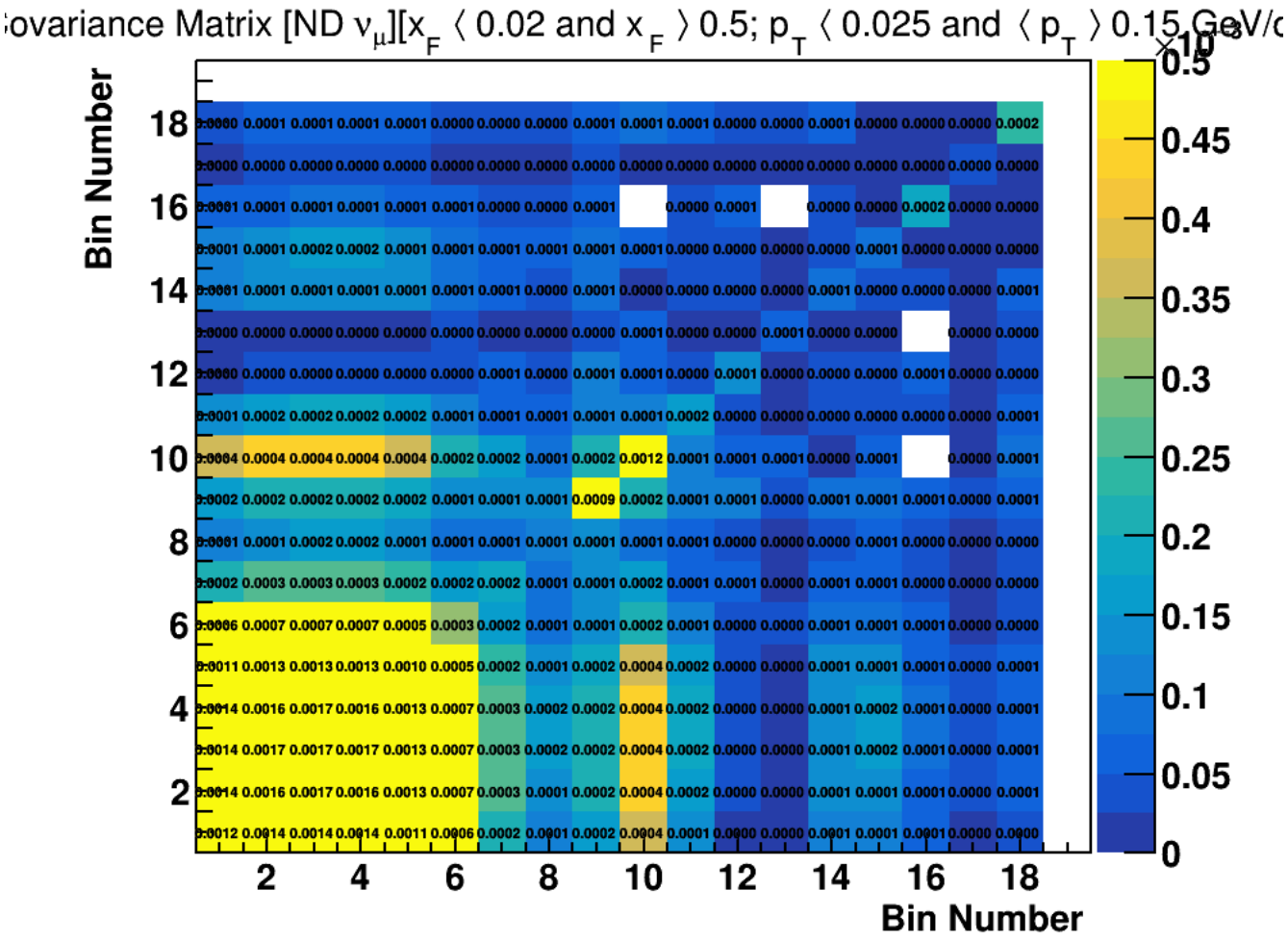


Fermilab

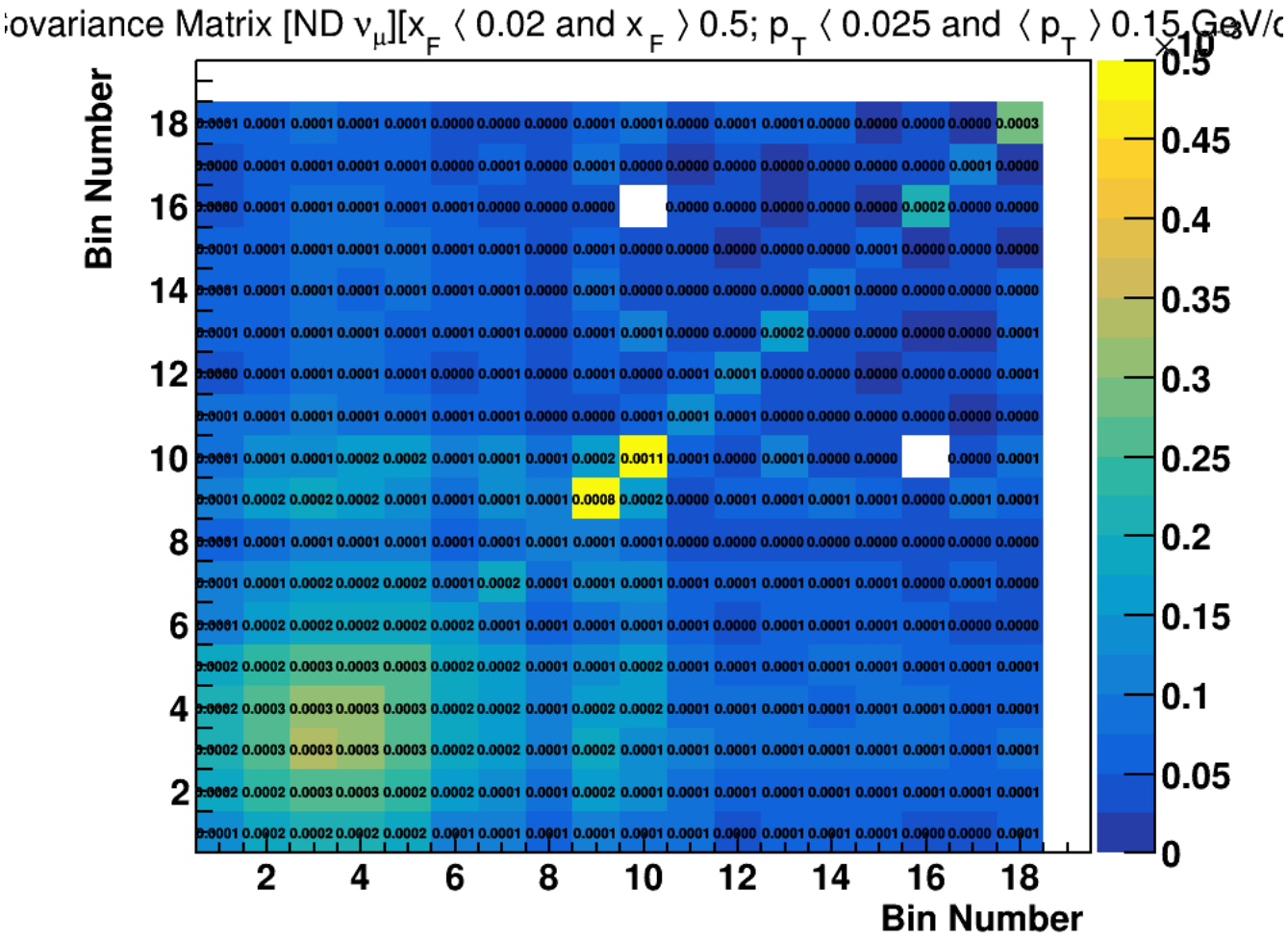
Uncorrelated – Bin 5



Default – Bin 6



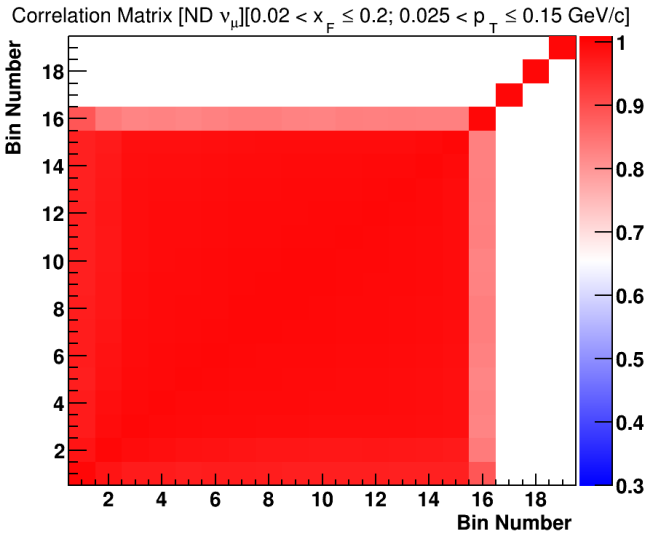
Uncorrelated – Bin 6

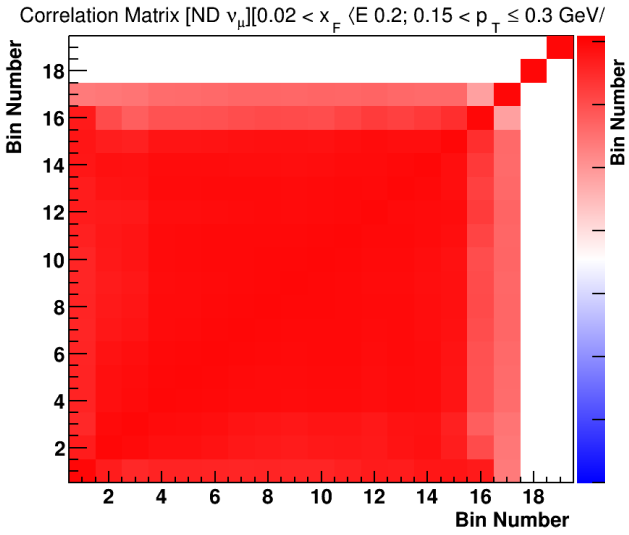


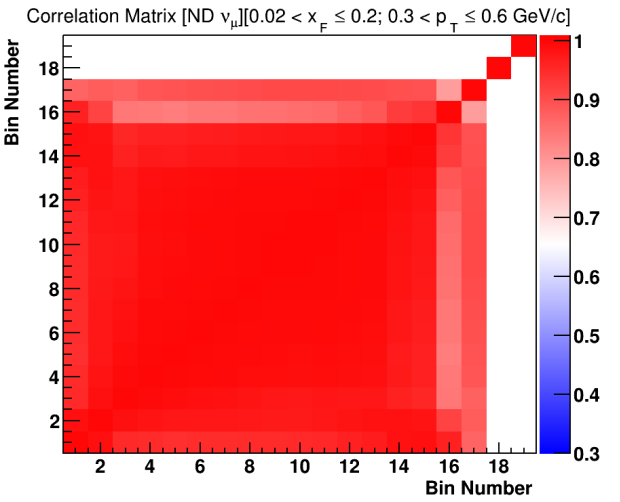
Correlations

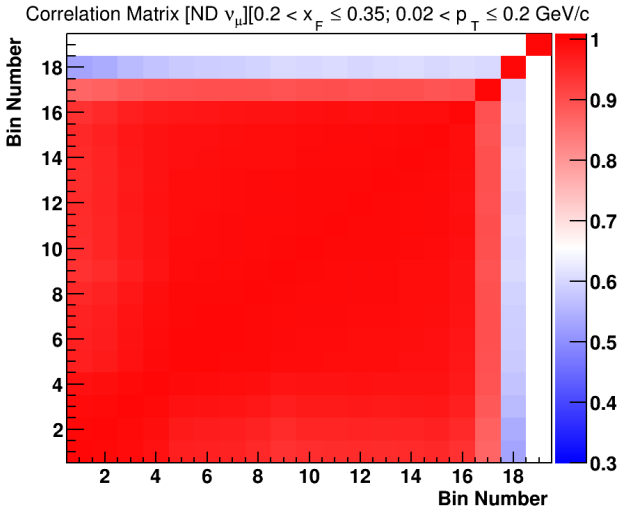
Each small block corresponds to bins of energy with bin boundaries [0,0.5,1,1.5,2,2.5,3,3.5,4,4.5,5,5.5,6,7,8,12,16,20,40,100] GeV for all sign and all flavor of neutrinos.

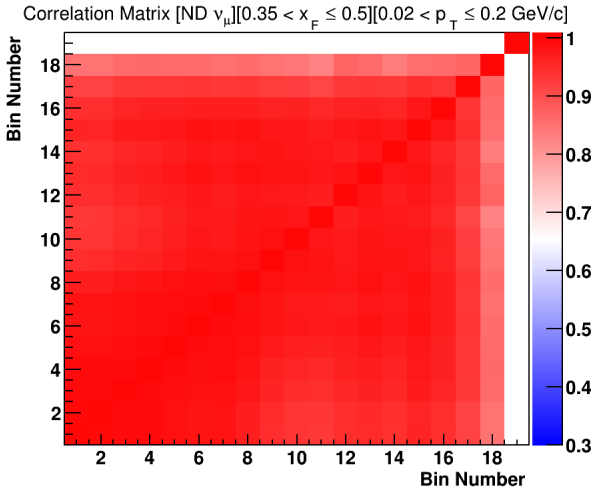
Default Case – (numu) near detector :

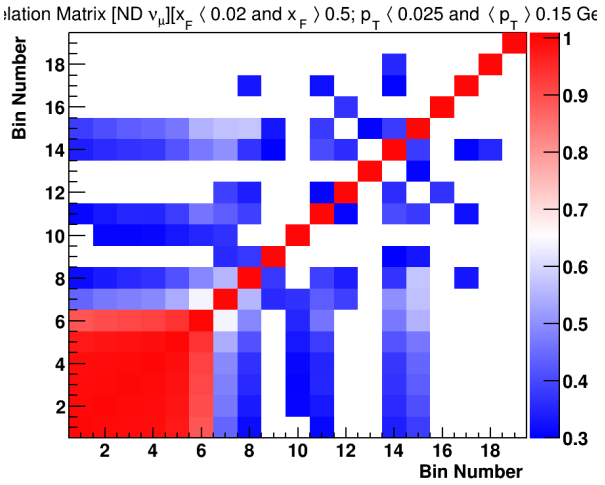






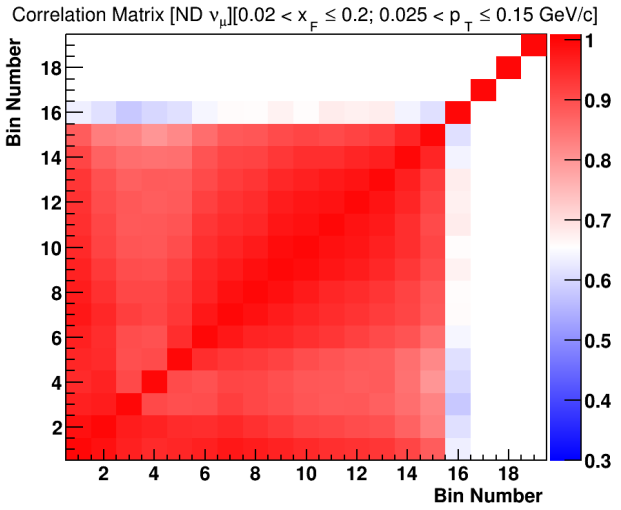


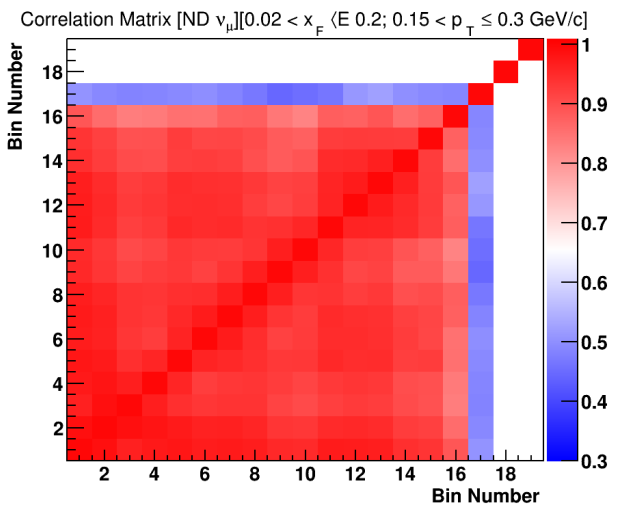


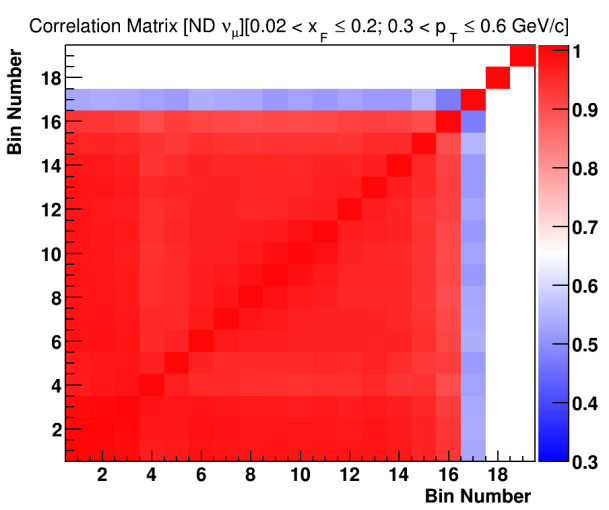


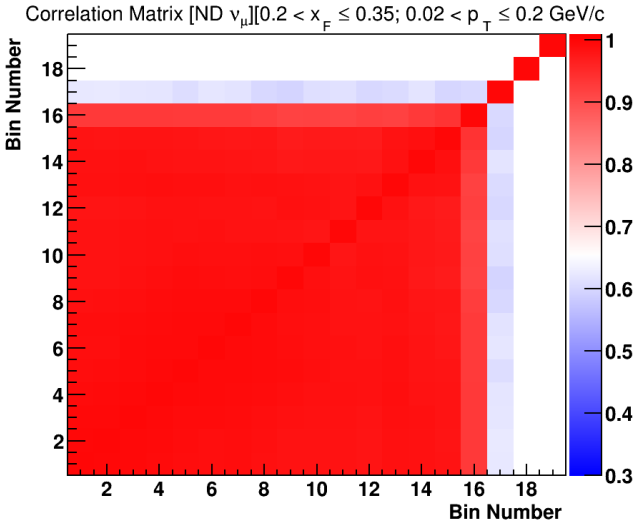
Fermilab

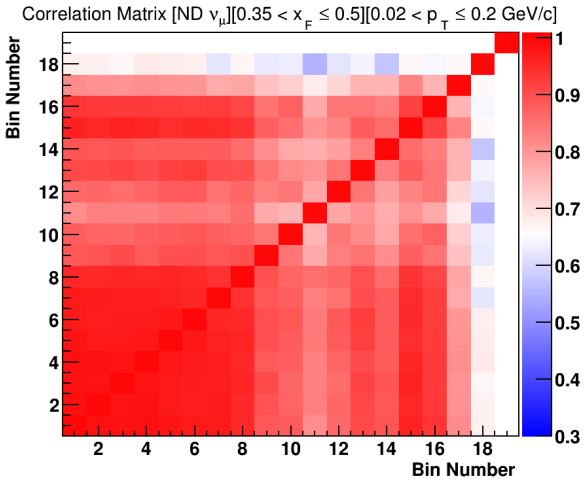
Uncorrelated Case – (numu) near detector :

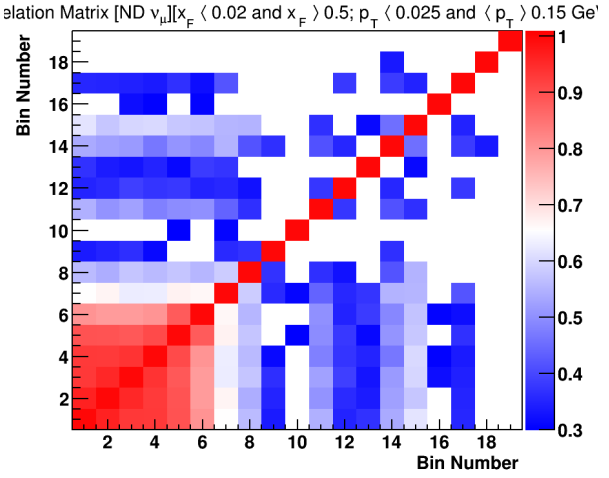






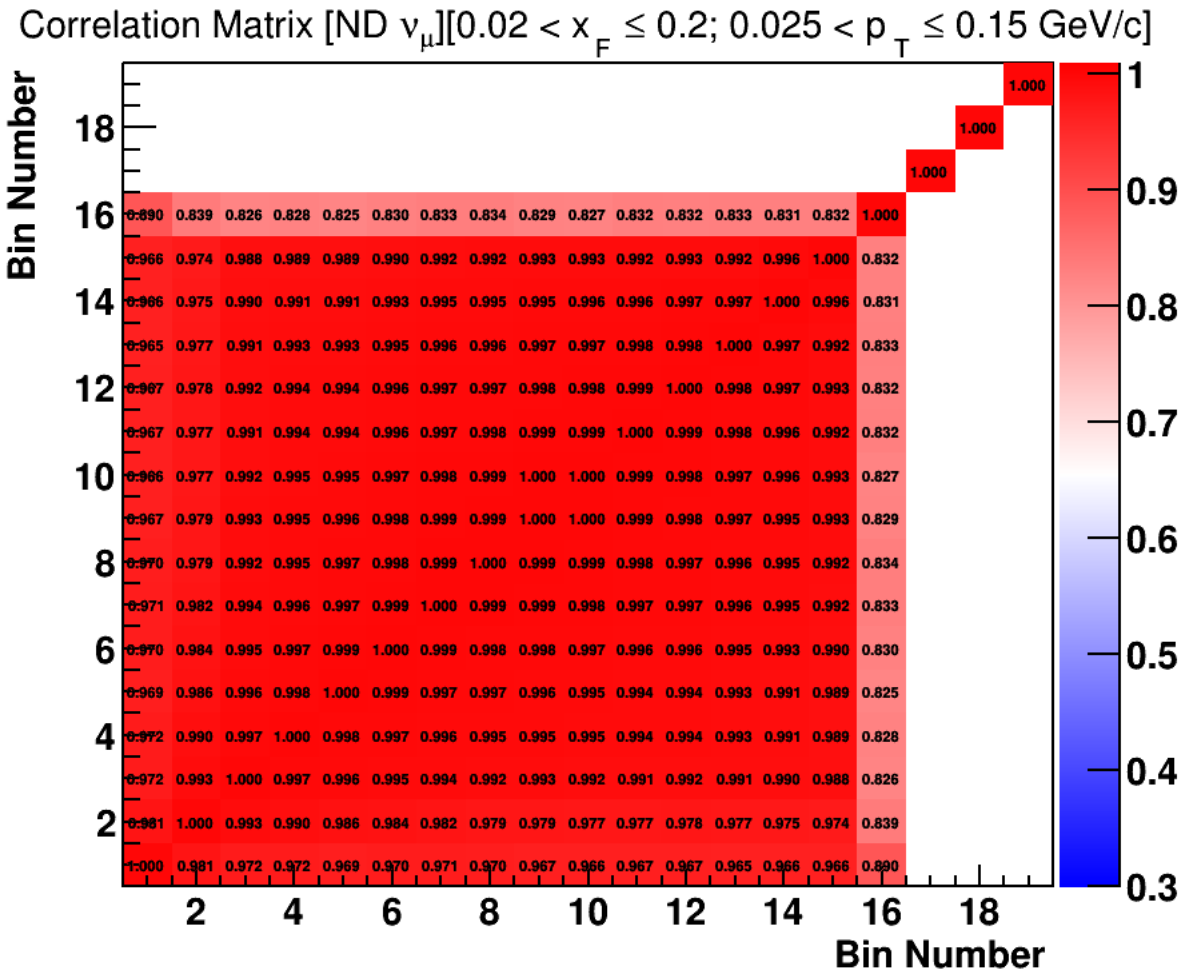




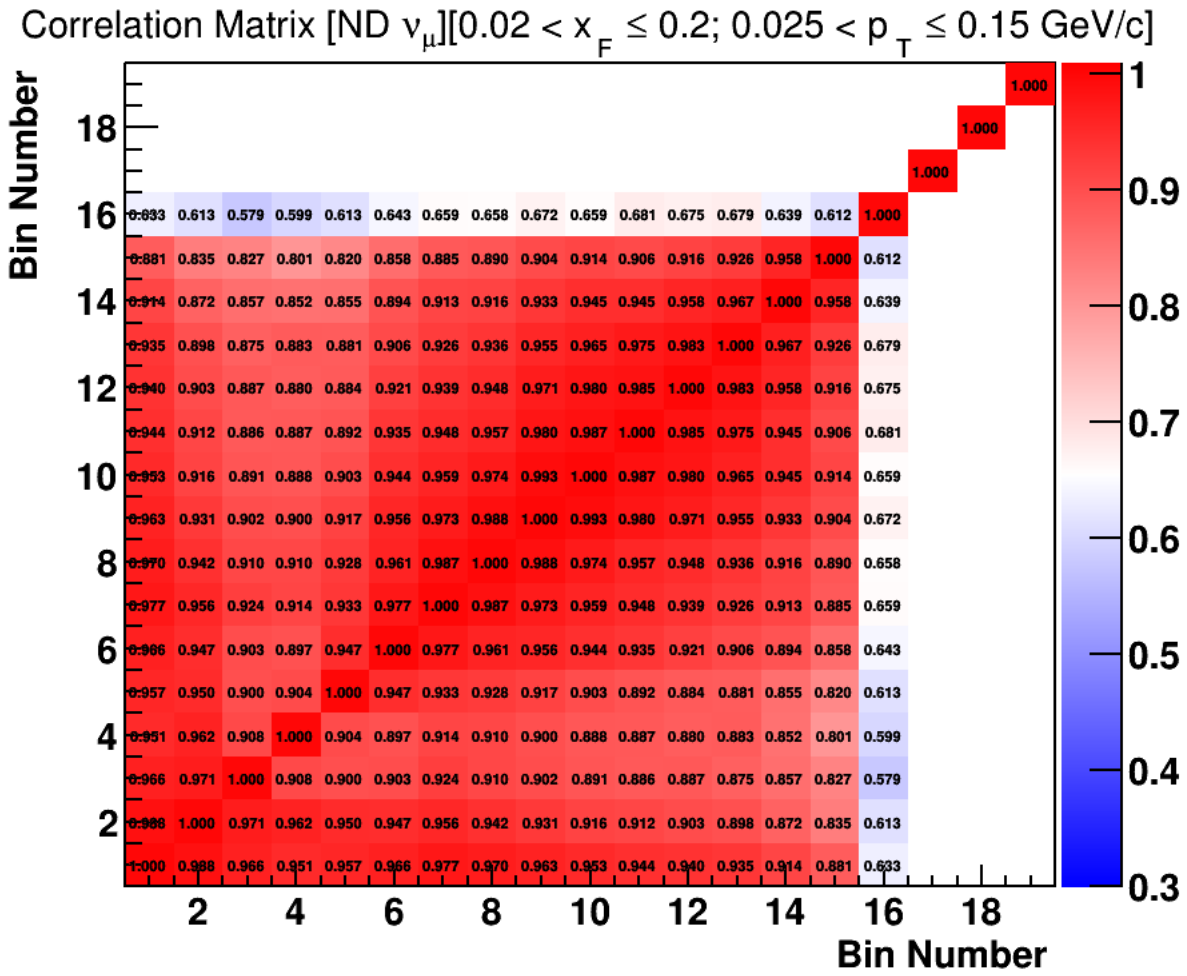


Fermilab

Default – Bin 1

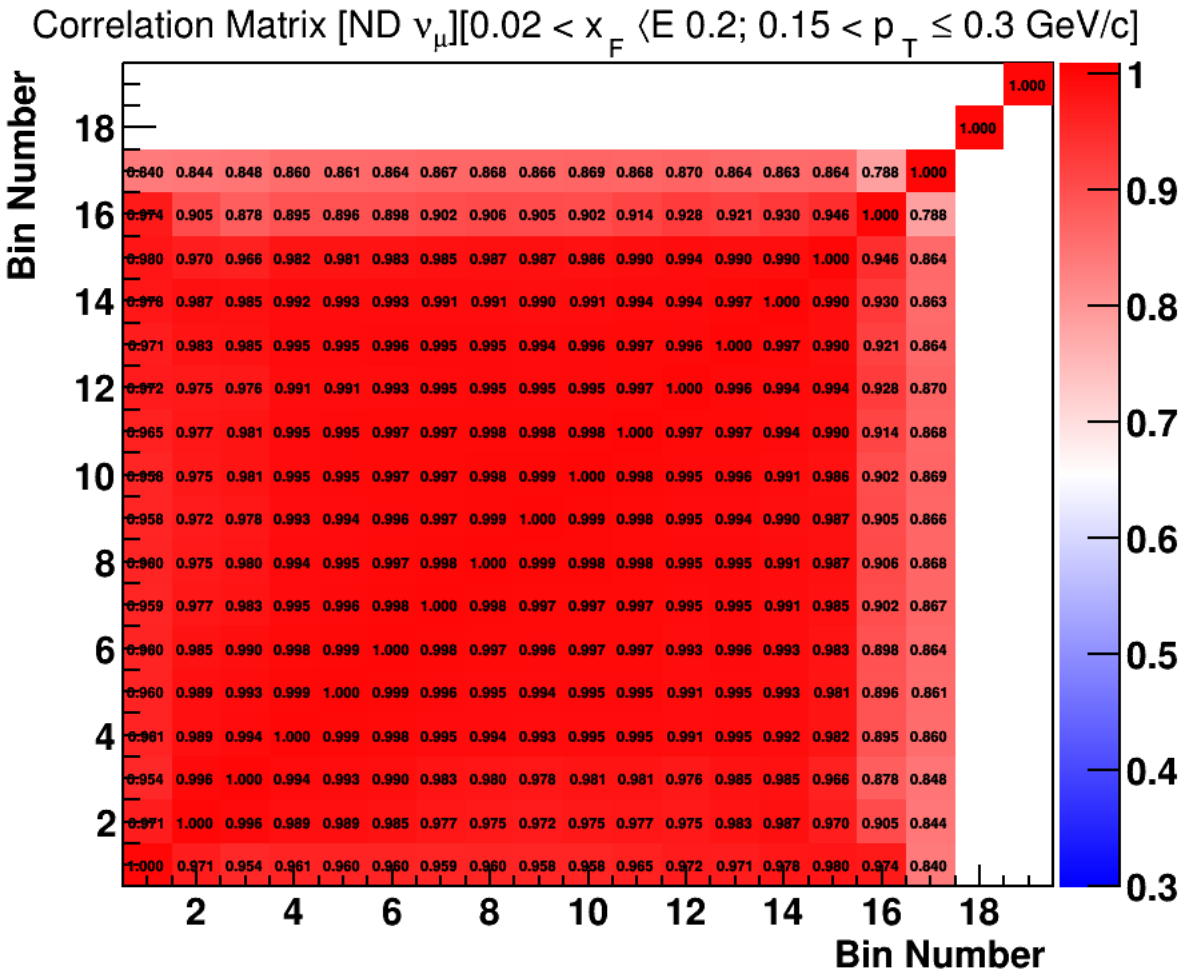


Uncorrelated – Bin 1

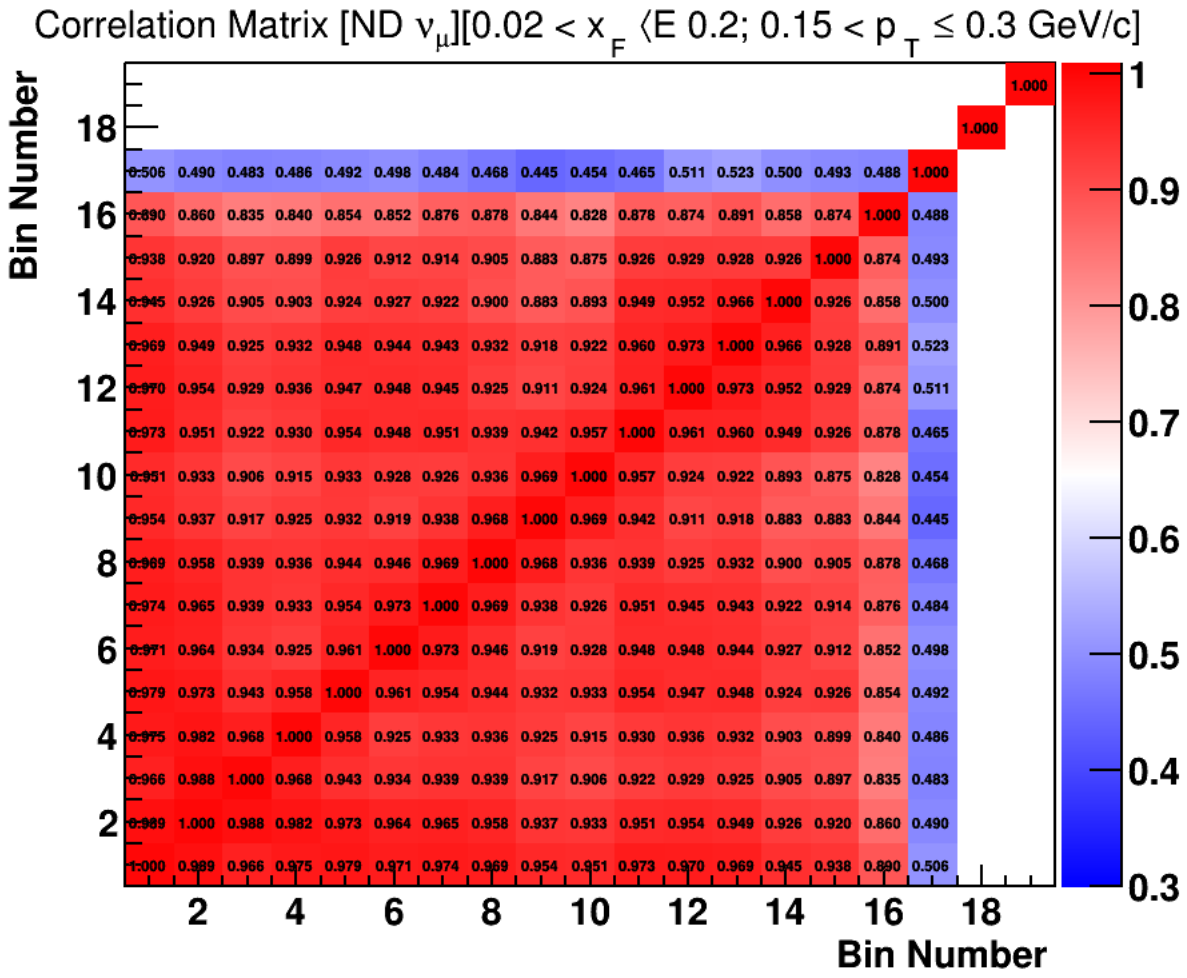


Fermilab

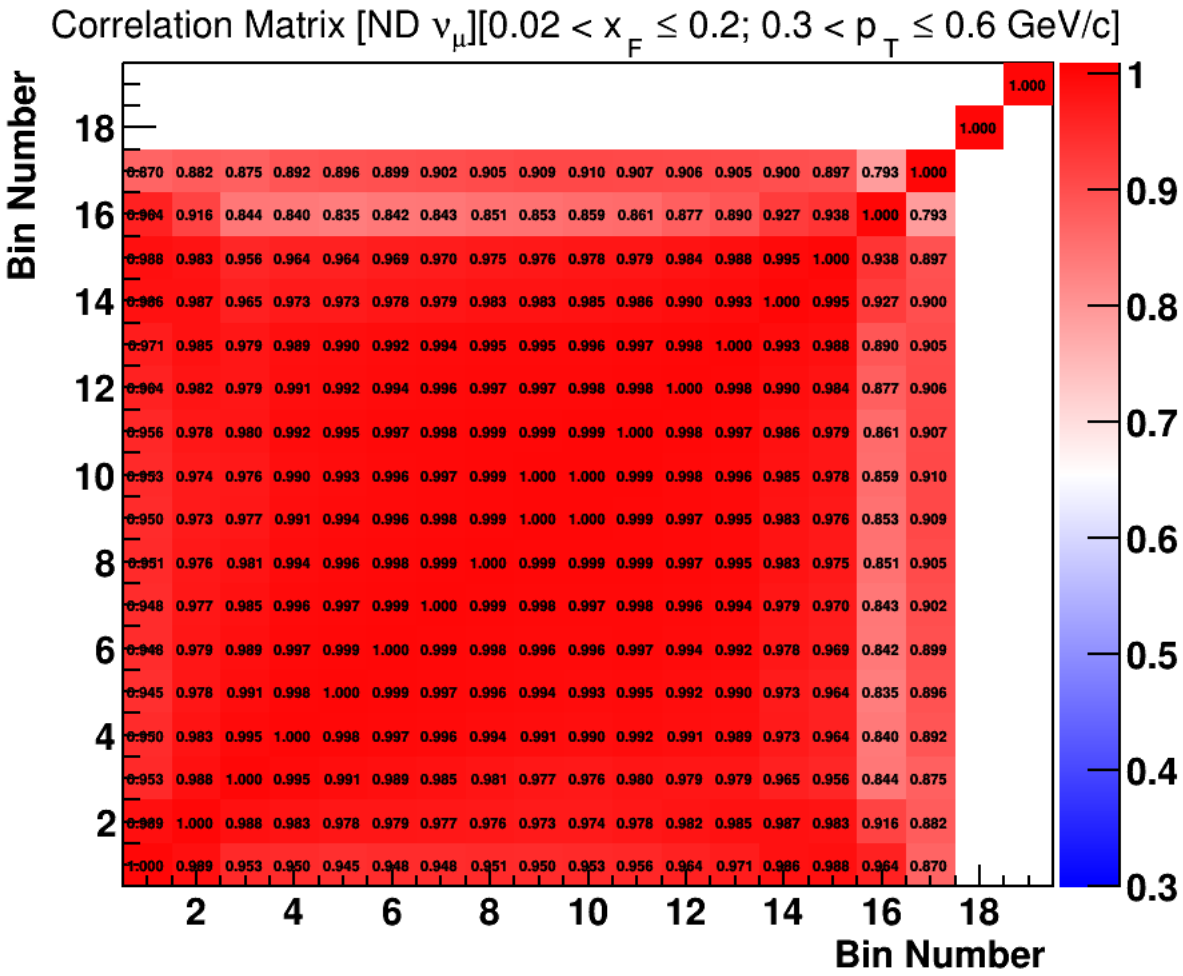
Default – Bin 2



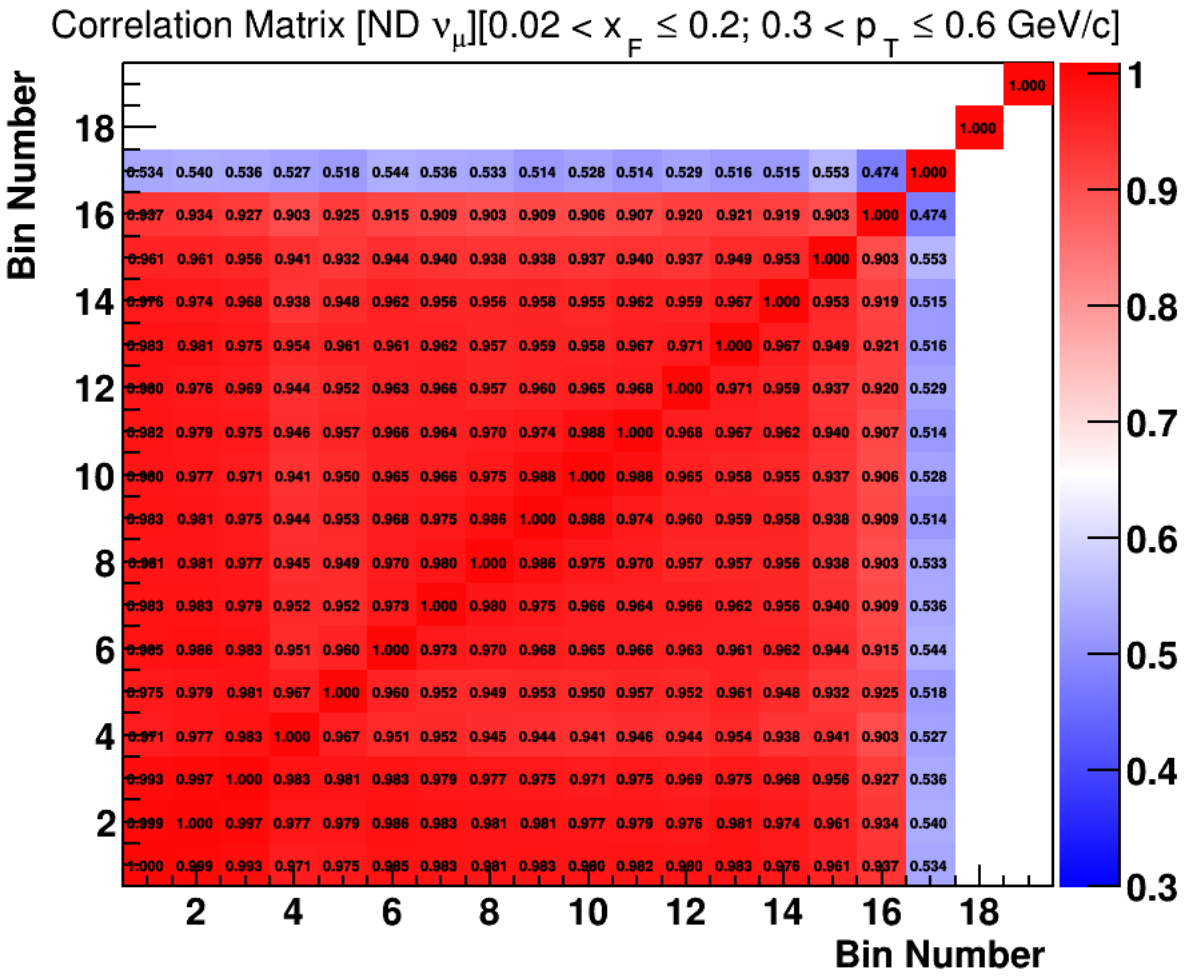
Uncorrelated – Bin 2



Default – Bin 3

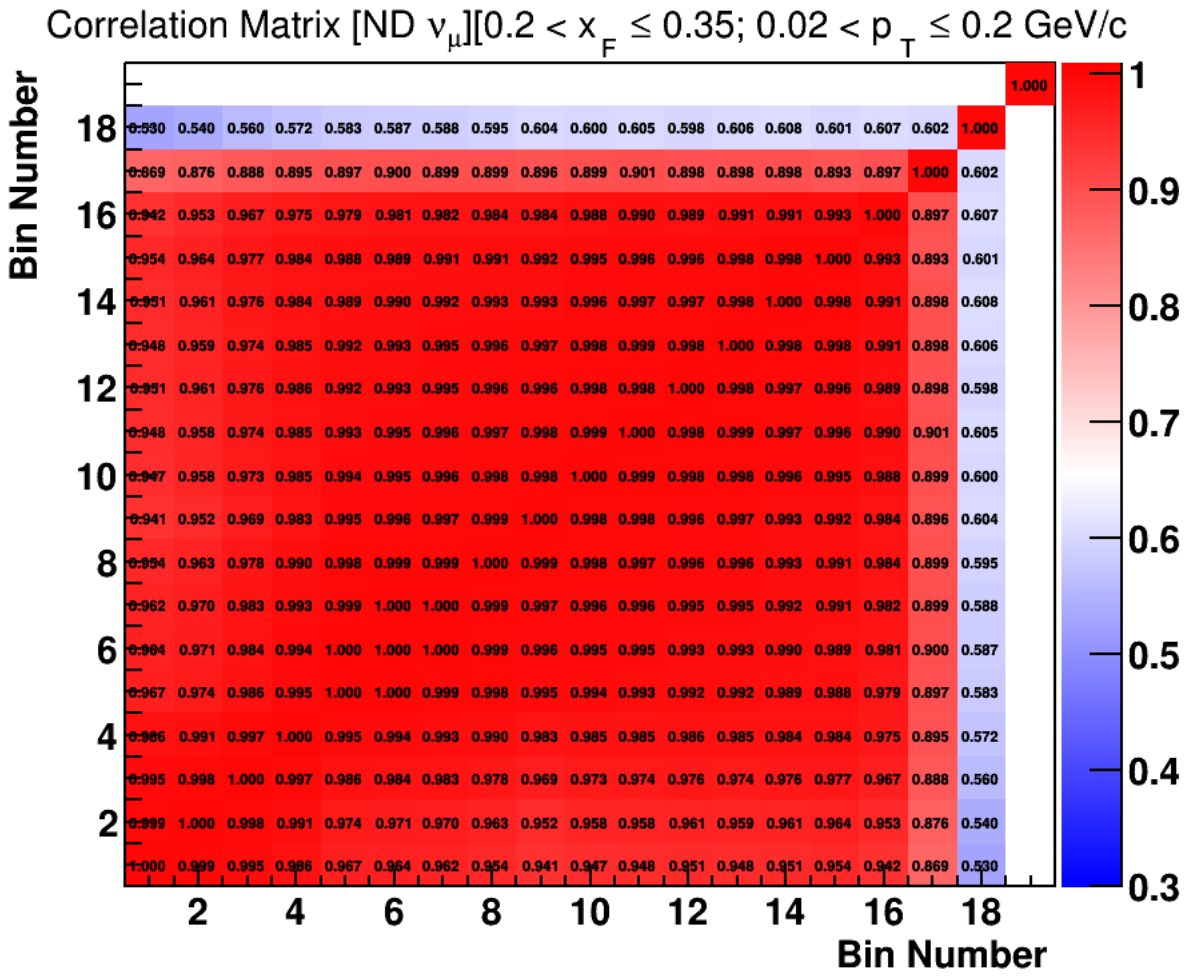


Uncorrelated – Bin 3



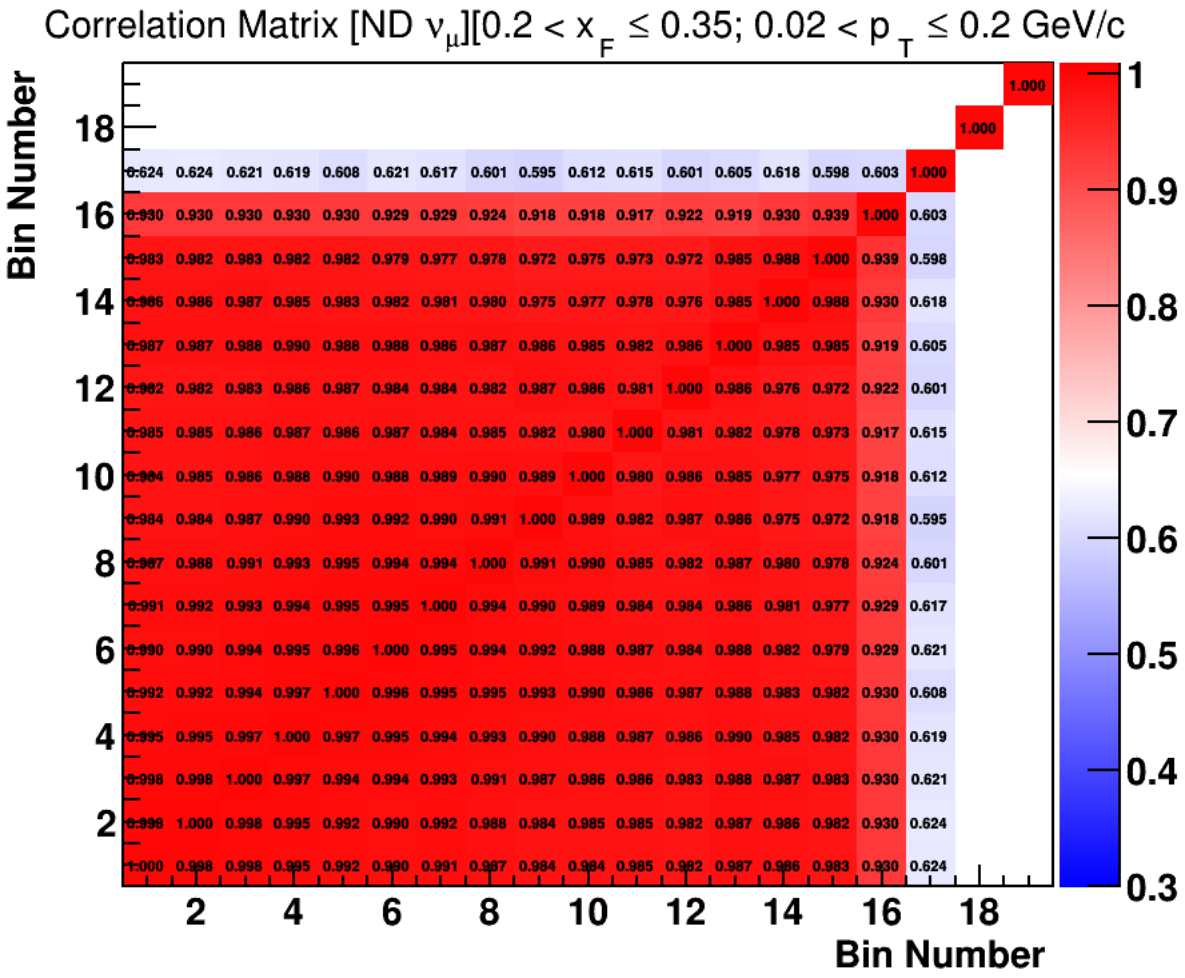
Fermilab

Default – Bin 4



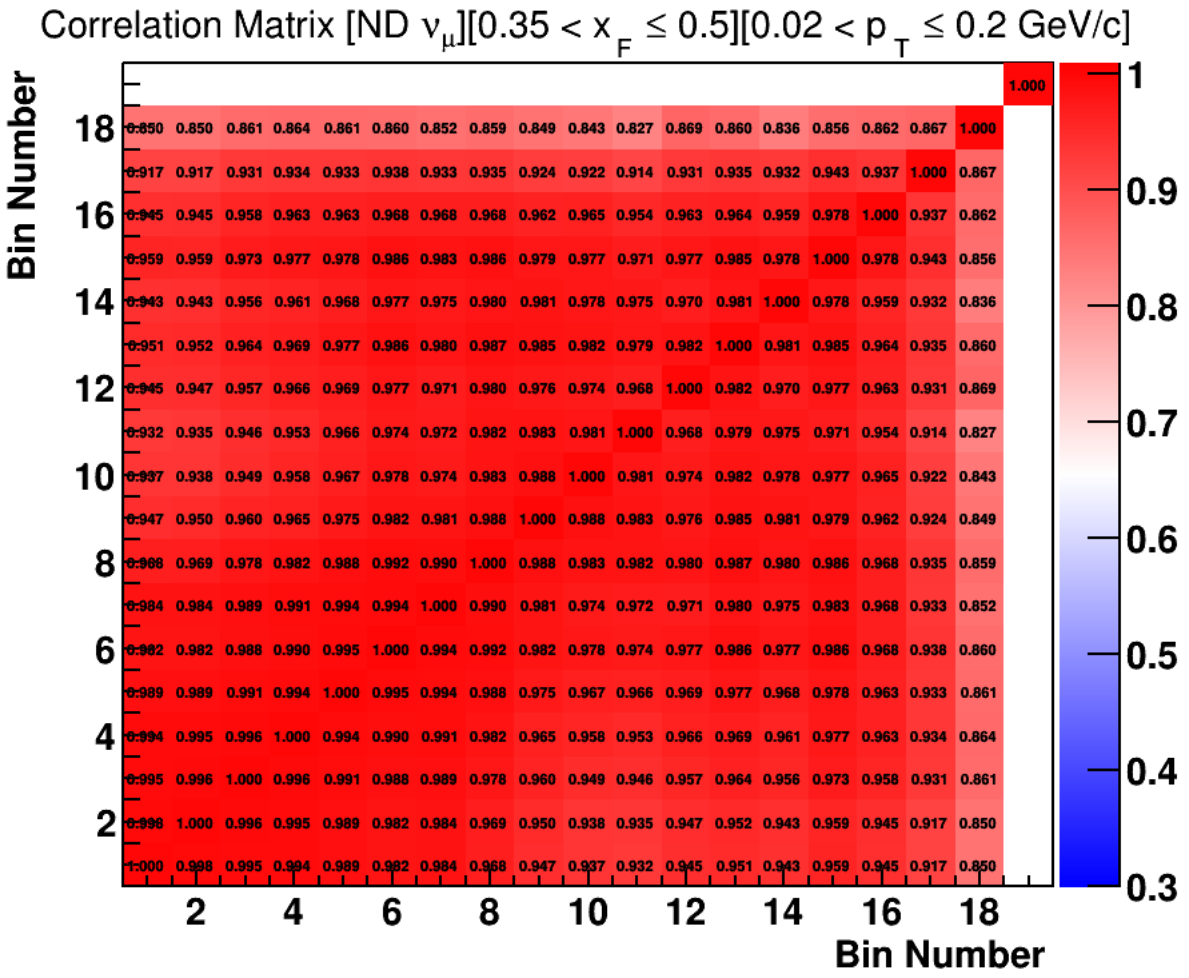
Fermilab

Uncorrelated – Bin 4



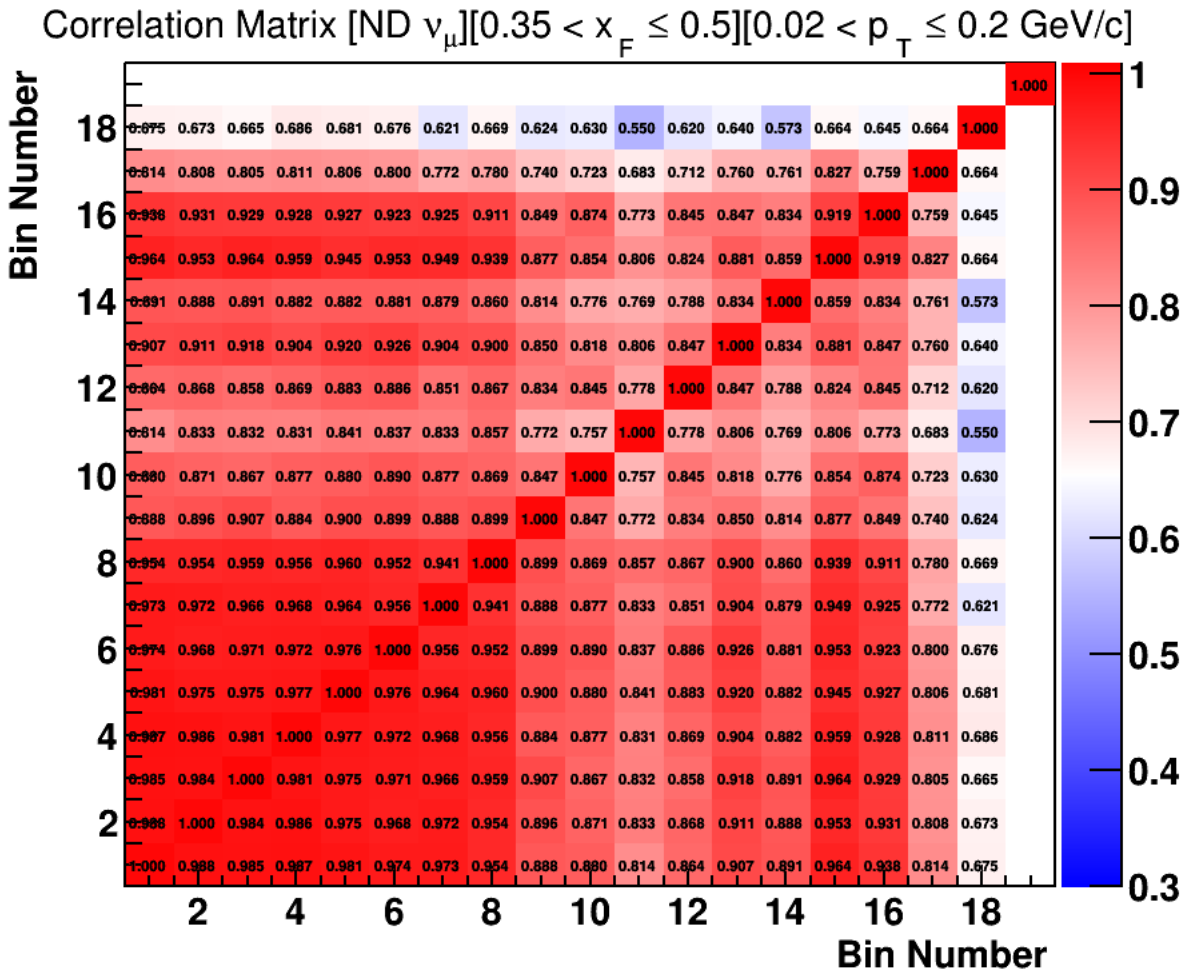
Fermilab

Default – Bin 5



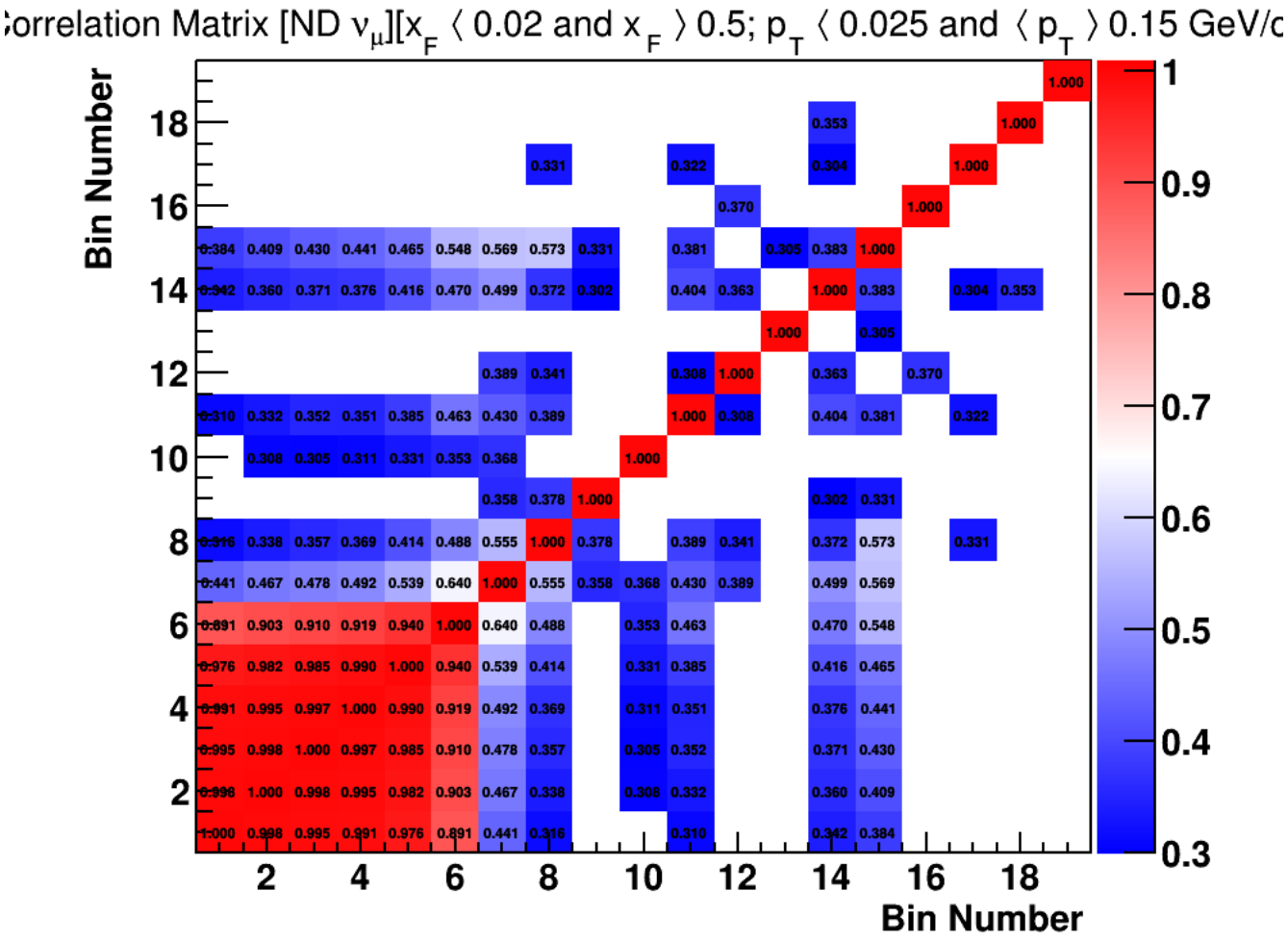
Fermilab

Uncorrelated – Bin 5



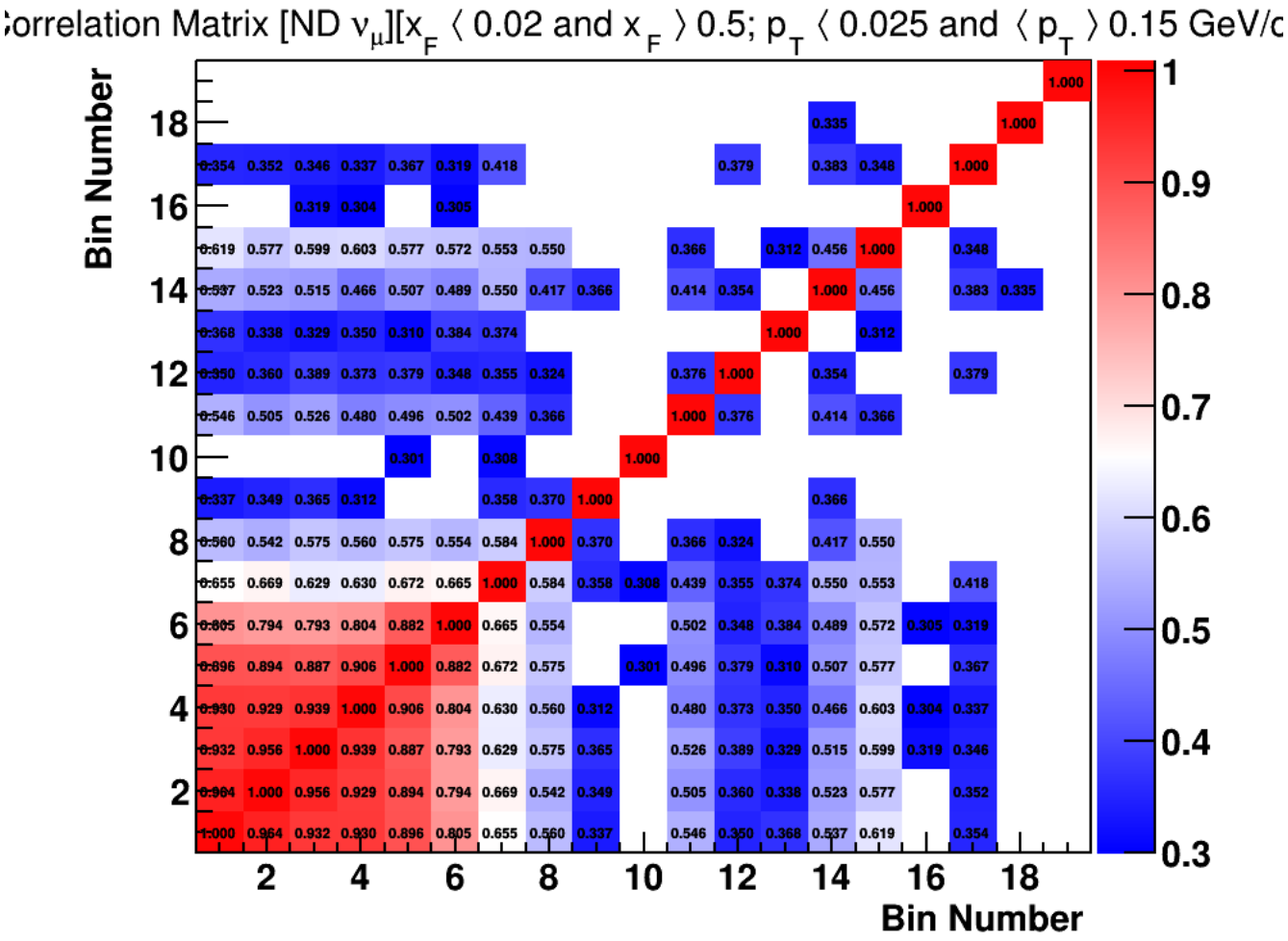
Fermilab

Default – Bin 6



Fermilab

Uncorrelated – Bin 6

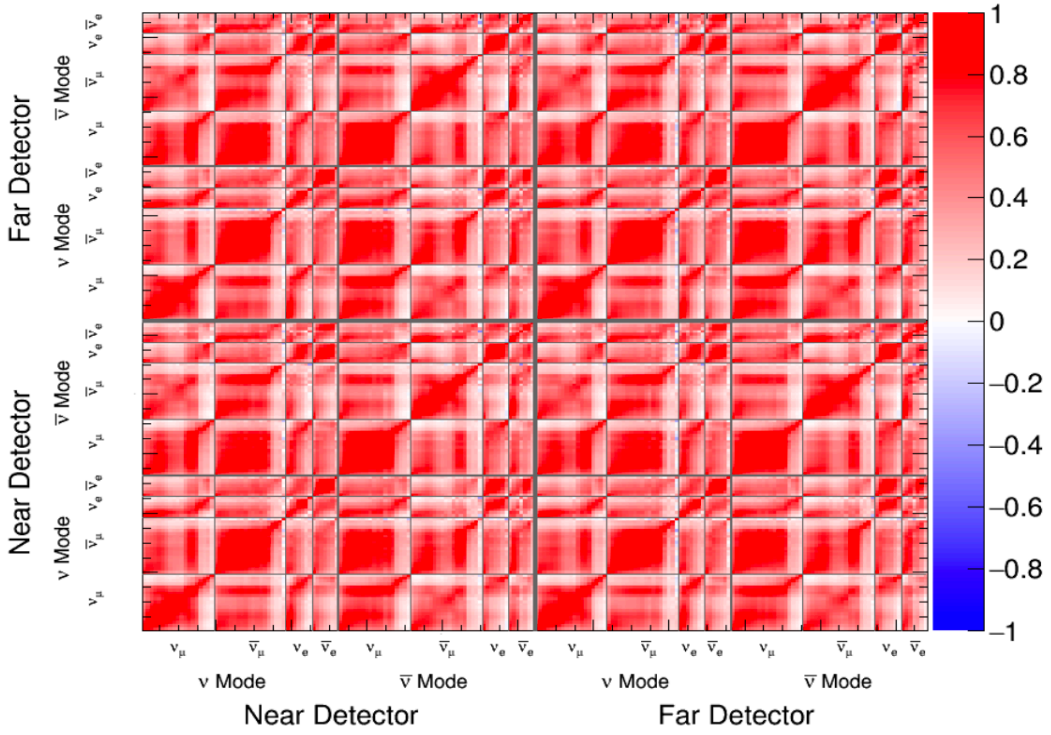


Fermilab

FAR Detector Results, antinu results I have them with me. Will update my talk later.

Correlations

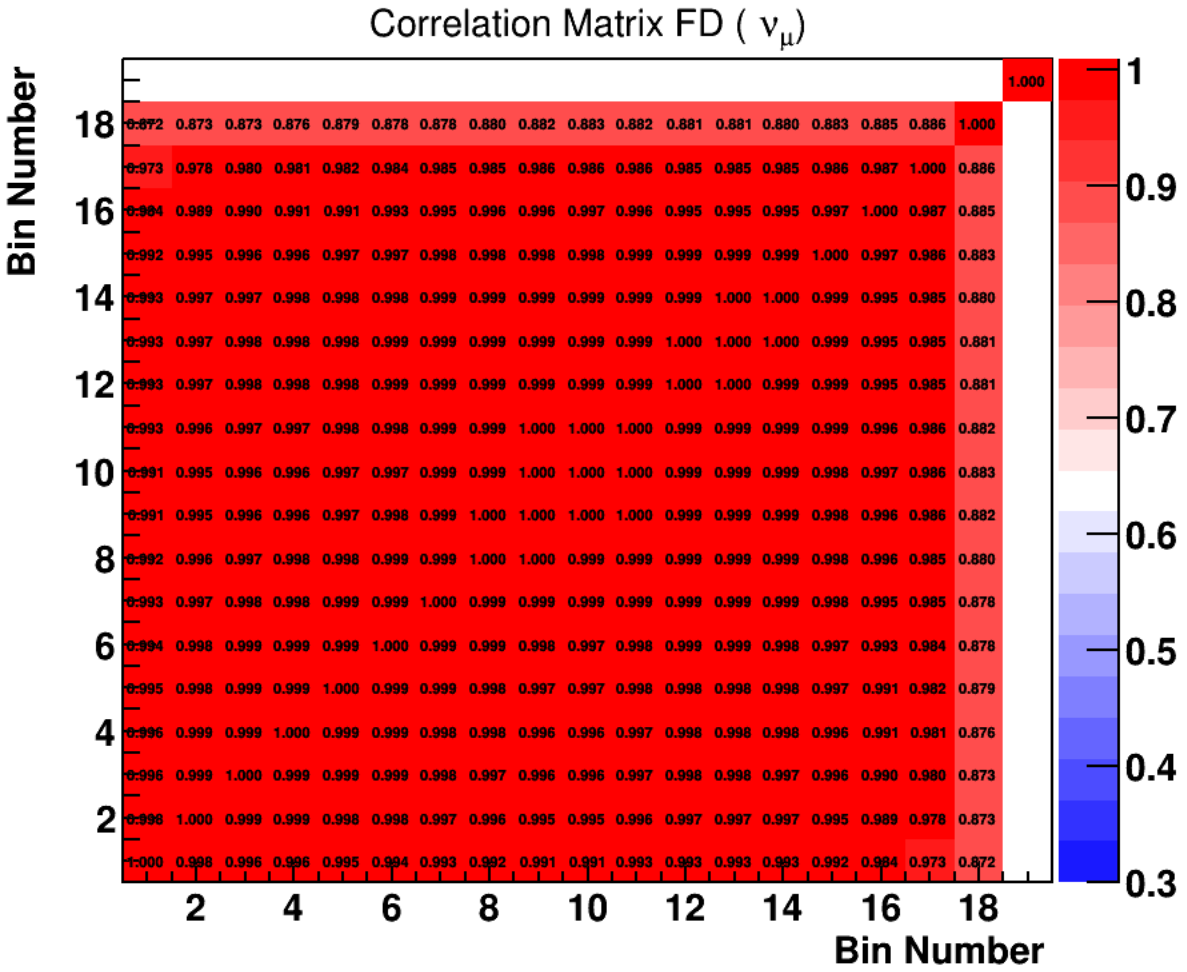
Correlation Matrix



Optimized

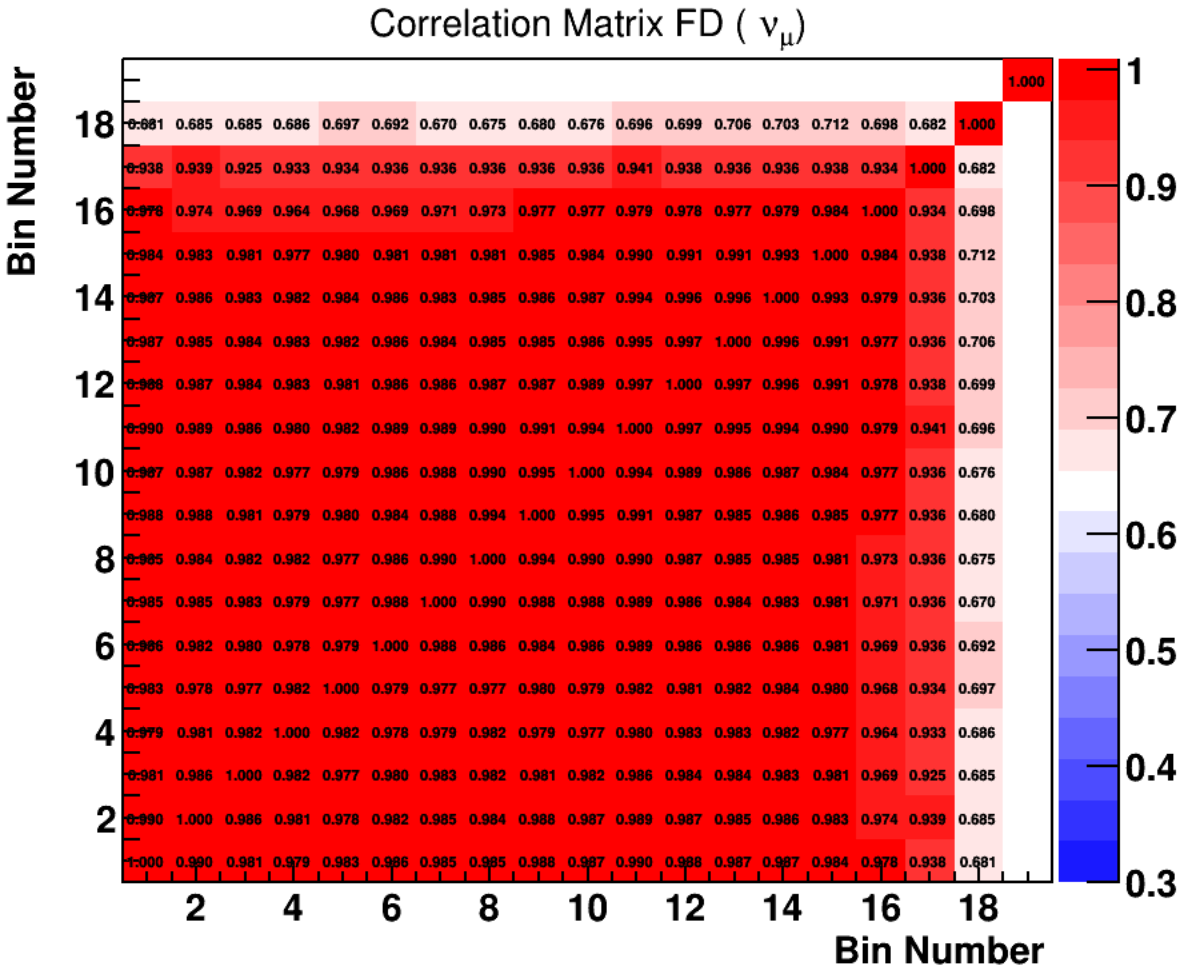
- Fluxes are **highly correlated** across most bins
- **Focusing regions and high energy bins** are the exceptions
- Depends strongly on **correlations of underlying datasets**; in many cases, we have to guess at these.

Correlation for numu far detector pc->Pi - Default



Fermilab

Correlation for numu far detector pc->Pi – No Corr



Correlations decreases, more significantly in the higher bin regions.