

NA61 incident pion data interpolation



Nilay Bostan (Ulowa)

For PPFX group meeting

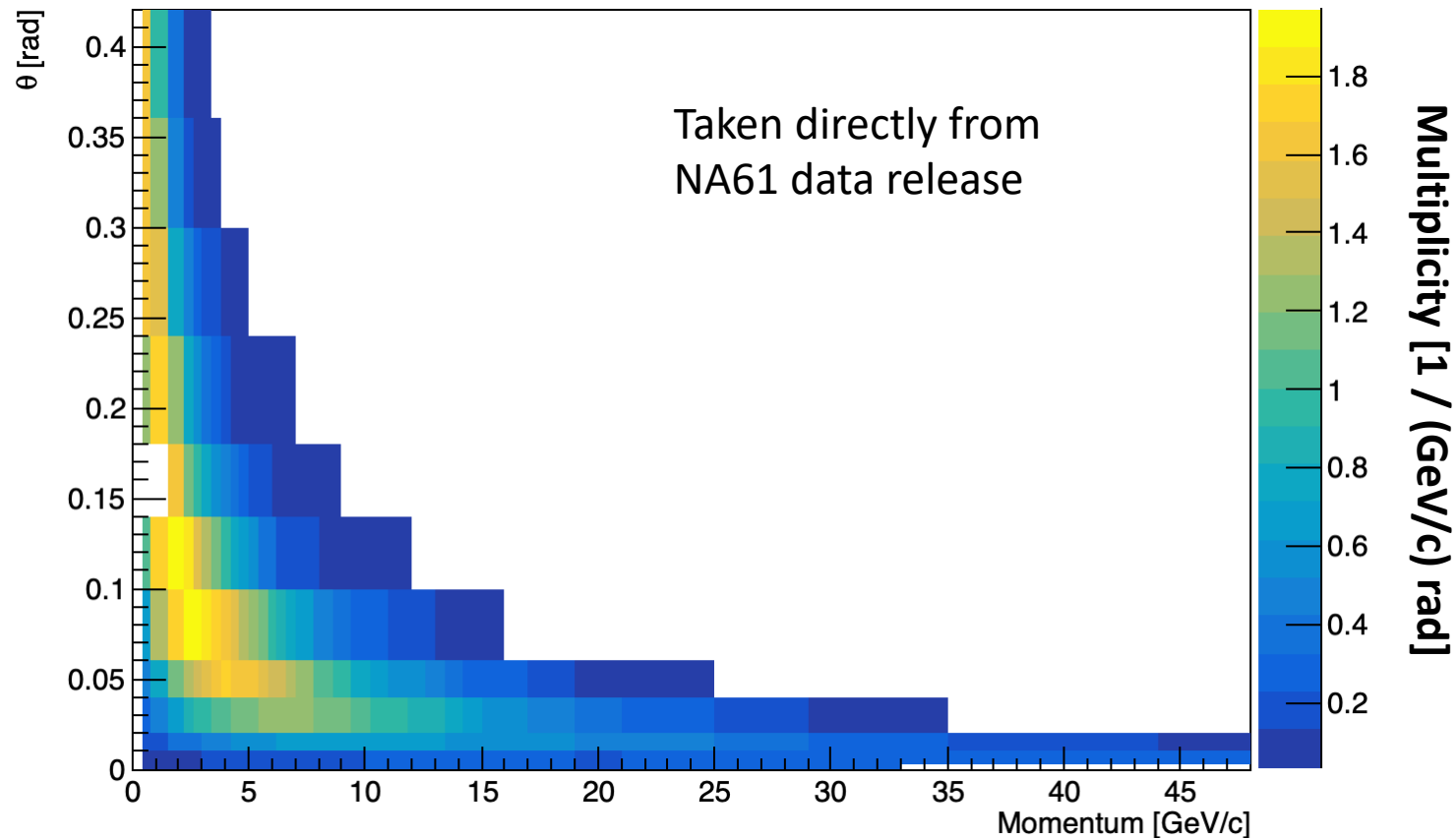
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Introduction

- We are exploring different ways to treat the NA61 $\pi^+C \rightarrow \pi^+X$ @ 60 GeV data and using as a correction into the PPFX code.
- In this presentation, I show an interpolation of the NA61 data in each shift created using the multi-universe technique.
- The first objective is to show this update is present the procedure.
- We are treated the NA61 statistical and systematic uncertainties independently. Some assumptions were made for the systematics that we can improve:
 - We use the systematic “Up” as gaussian distributed around the central value.
 - We assume 50% bin-to-bin- correlation.

Data central value

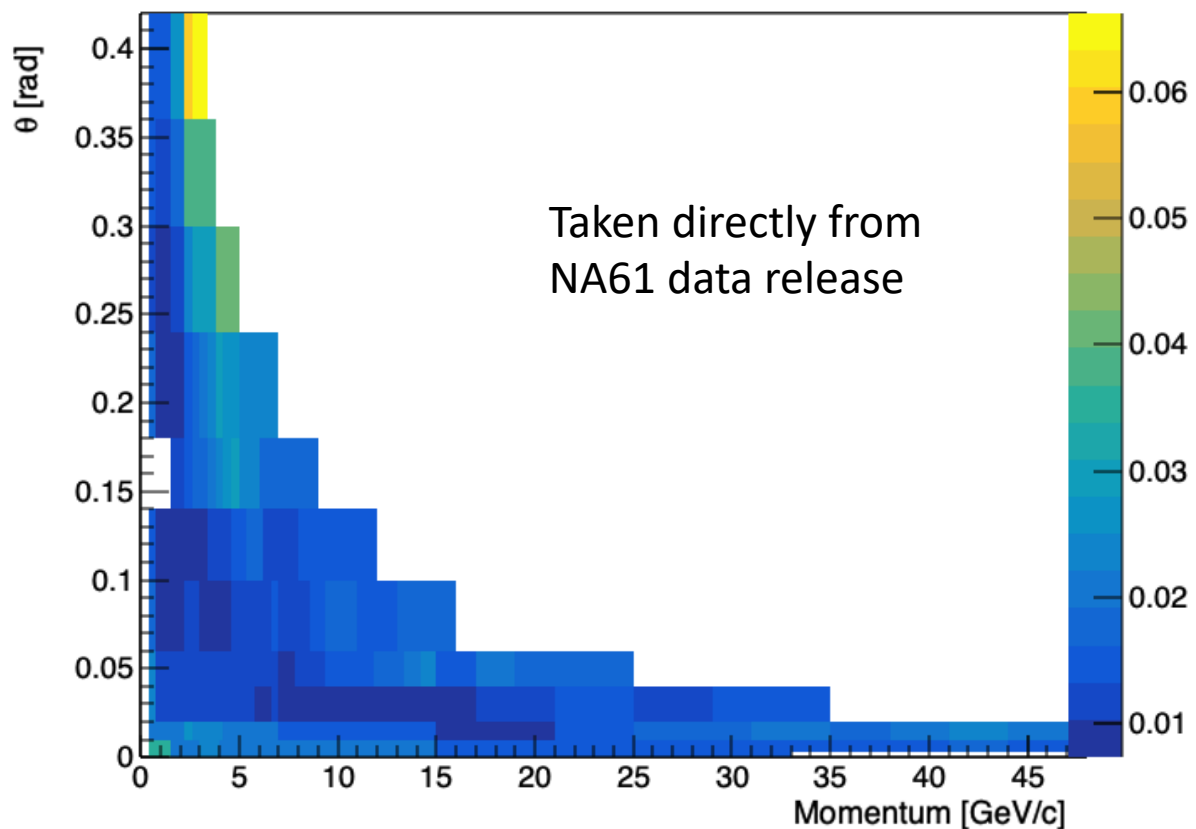
- The central value comes in TH2Poly bins of (θ, P) . For instance, for the same momentum bin we can have different θ ranges:



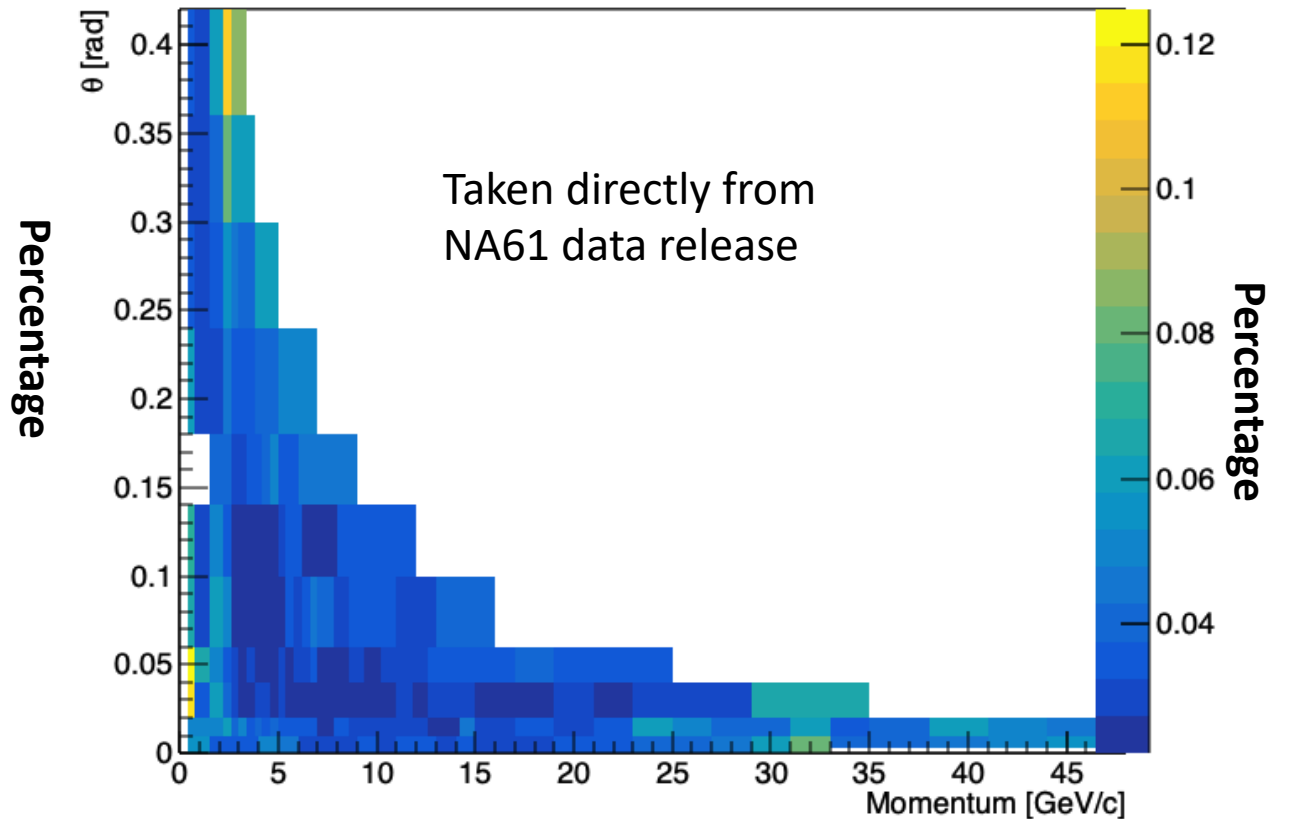
Data uncertainties

- Uncertainties are shown below:
 - Statistical uncertainty (left)
 - Total uncertainty “Up” (Systematics Up and statistical added in quadrature)

Statistical Uncertainty



Total Uncertainty Up



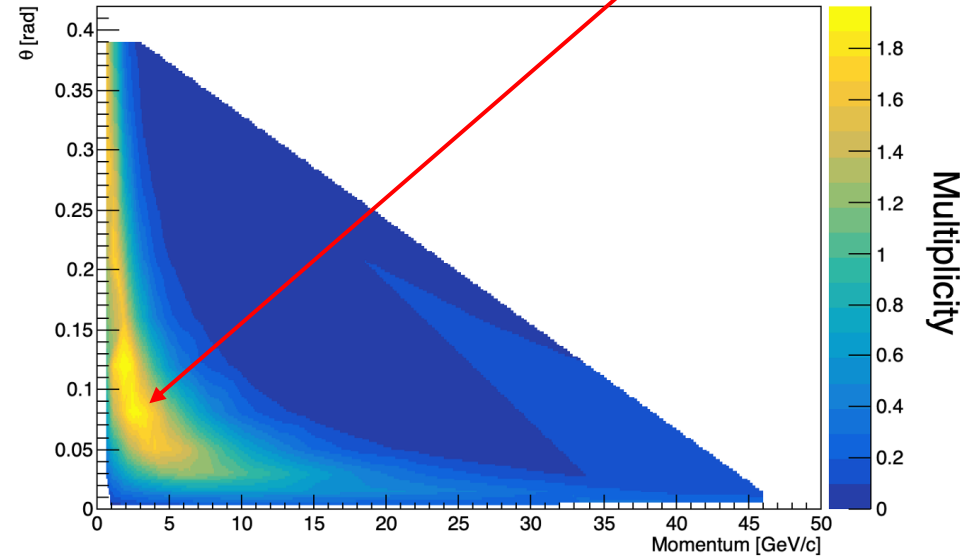
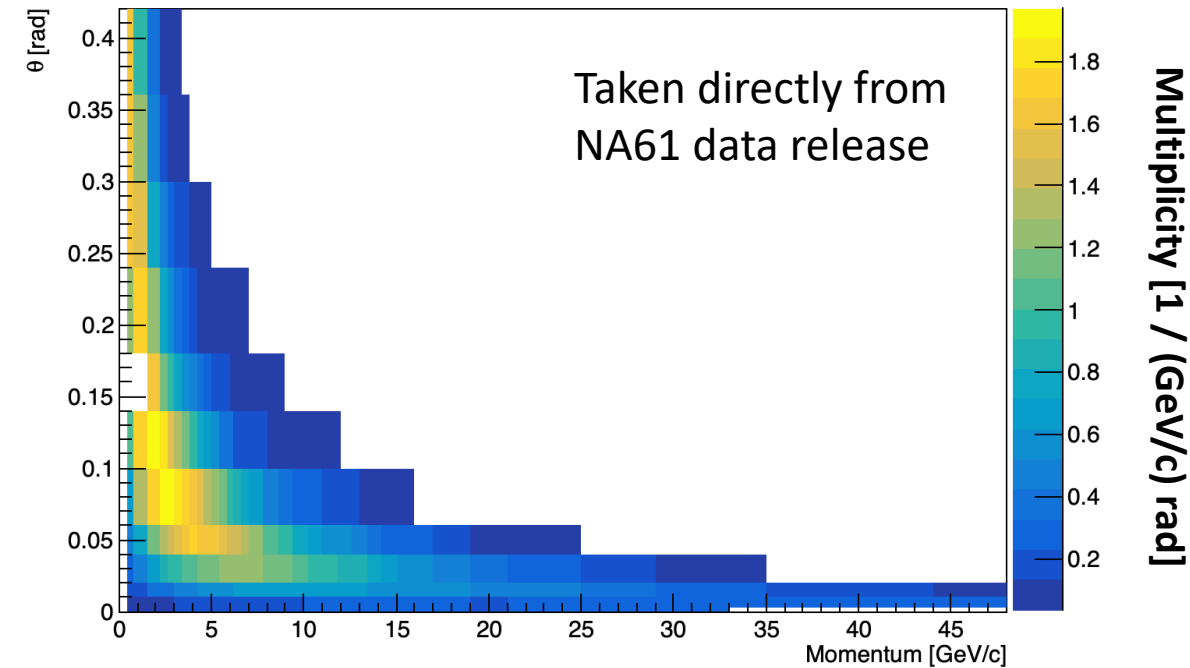
Procedure

- We consider the data values (central value or the shift generated inside the uncertainties) as (θ, P) data points (we use TGraph2D).
- We interpolate with fine binning (we use a TH2D):
 - Momentum: 0.1 GeV bin size in $[0, 50]$ GeV/c.
 - Angle: 2 mrad in $[0, 420]$ mrad.

It seems that the interpolation is smooth in our region of interest

Central value

Interpolated data

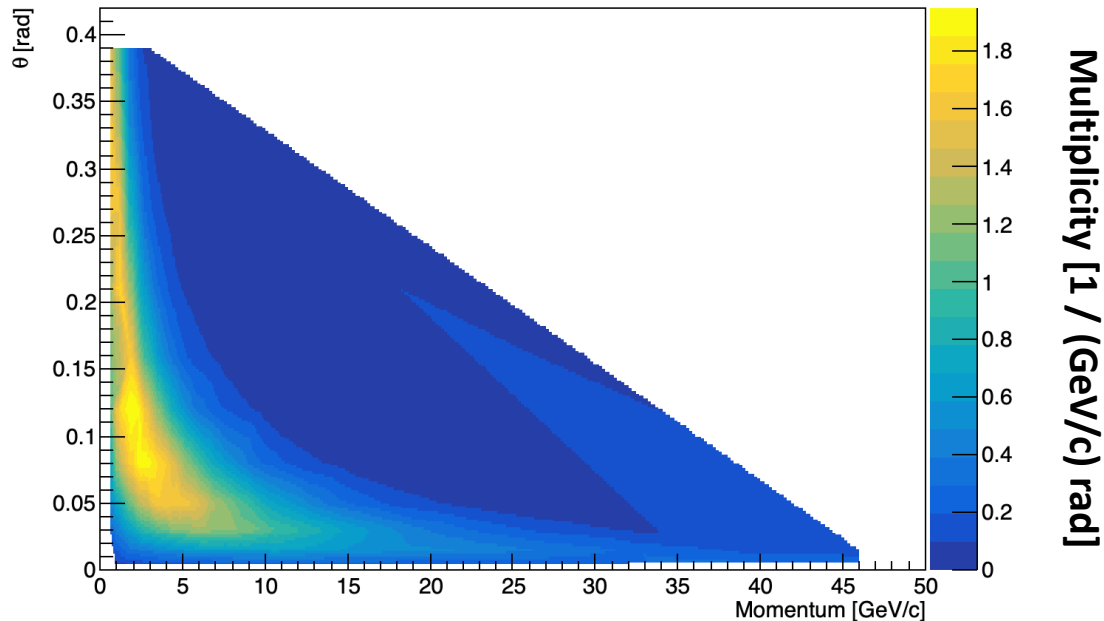


We are still looking how to handle the out of coverage interpolation...

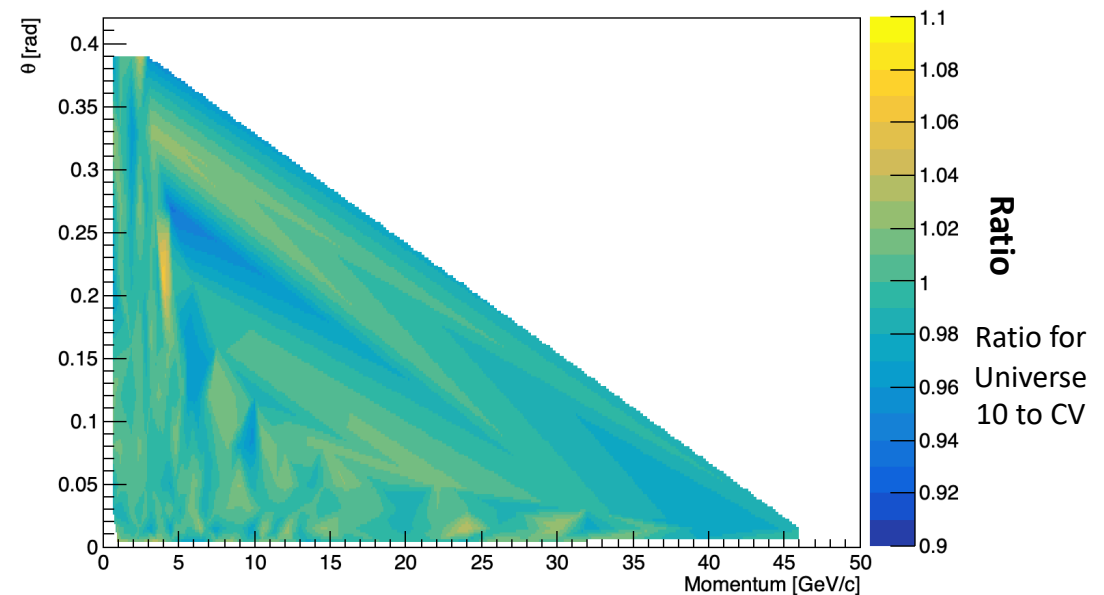
Statistical uncertainties

- We are treated the NA61 statistical and systematic uncertainties independently.
- Random shifts in uncorrelated bins, gaussian distributed and using the statistical uncertainty, are generated creating new data in 5000 universes in total. We interpolate in each universe.
- For instance, for the new data in universe 10:

New CV in universe 10



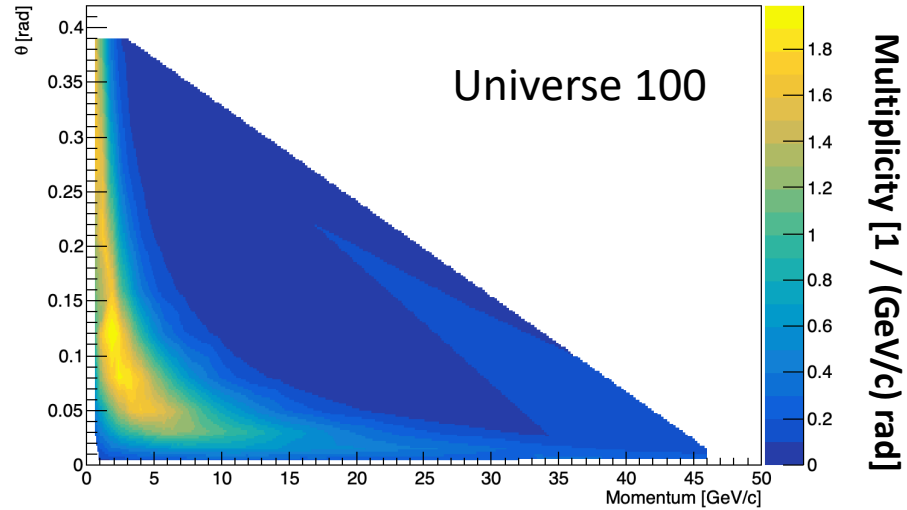
Ratio of the new CV over the nominal



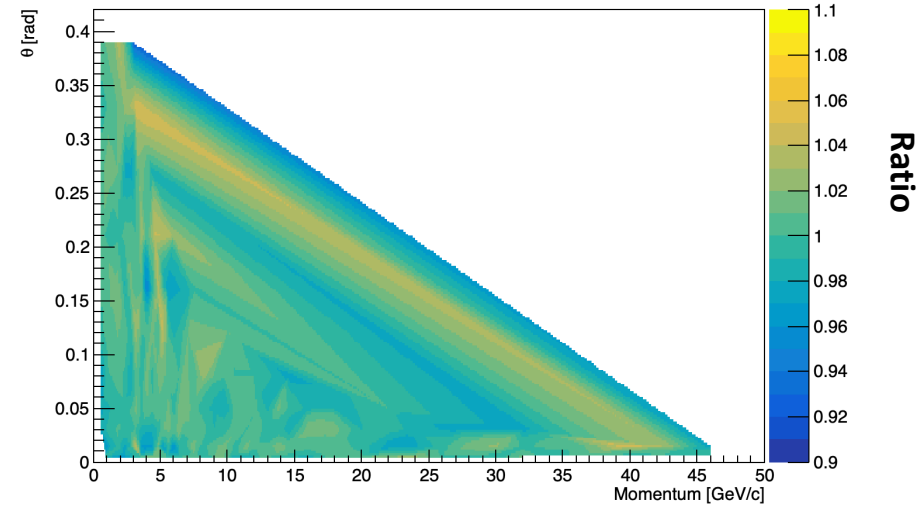
Statistical uncertainties

- Other examples:

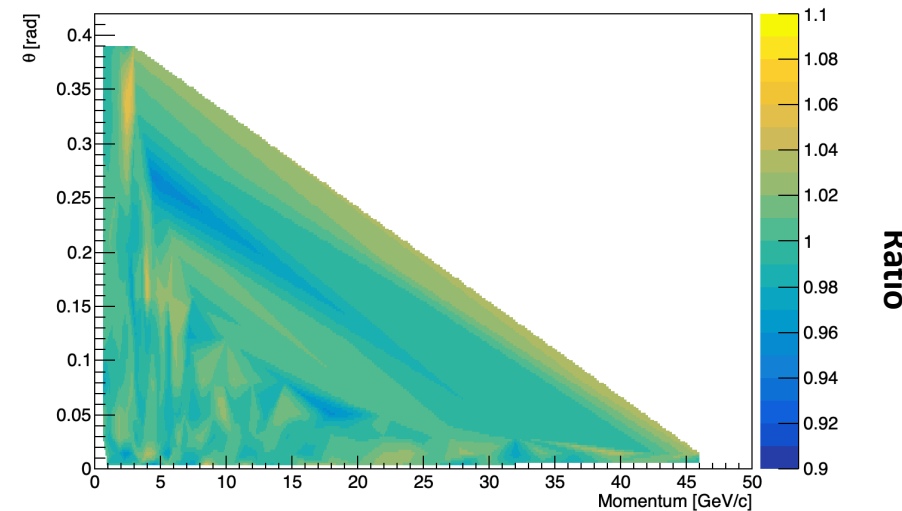
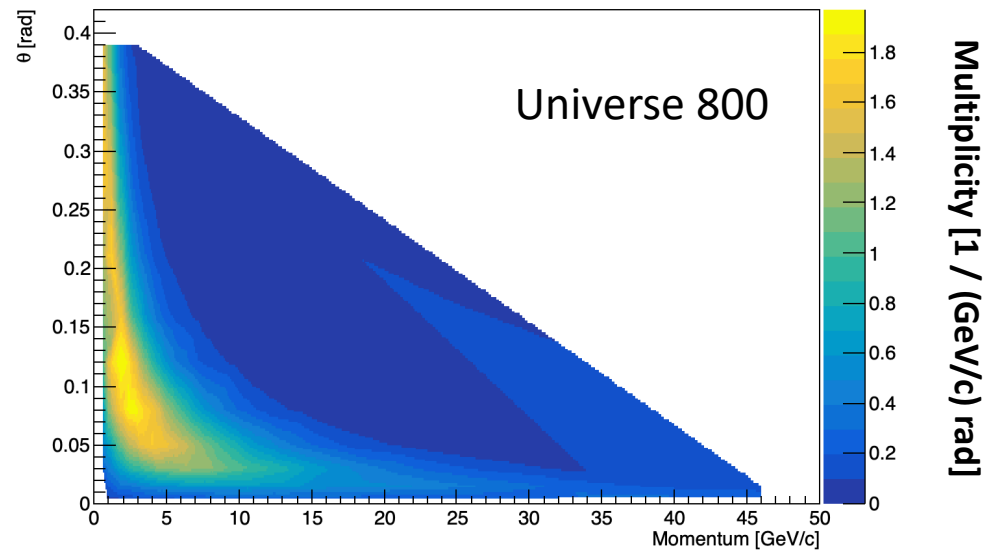
New CV



Ratio of the new CV over the nominal



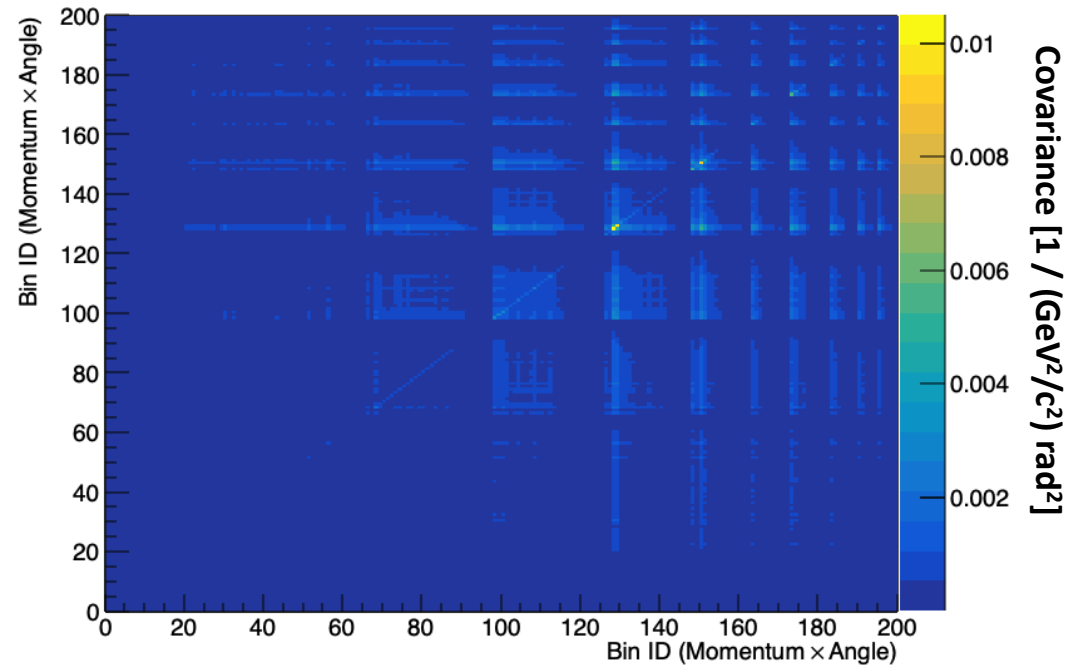
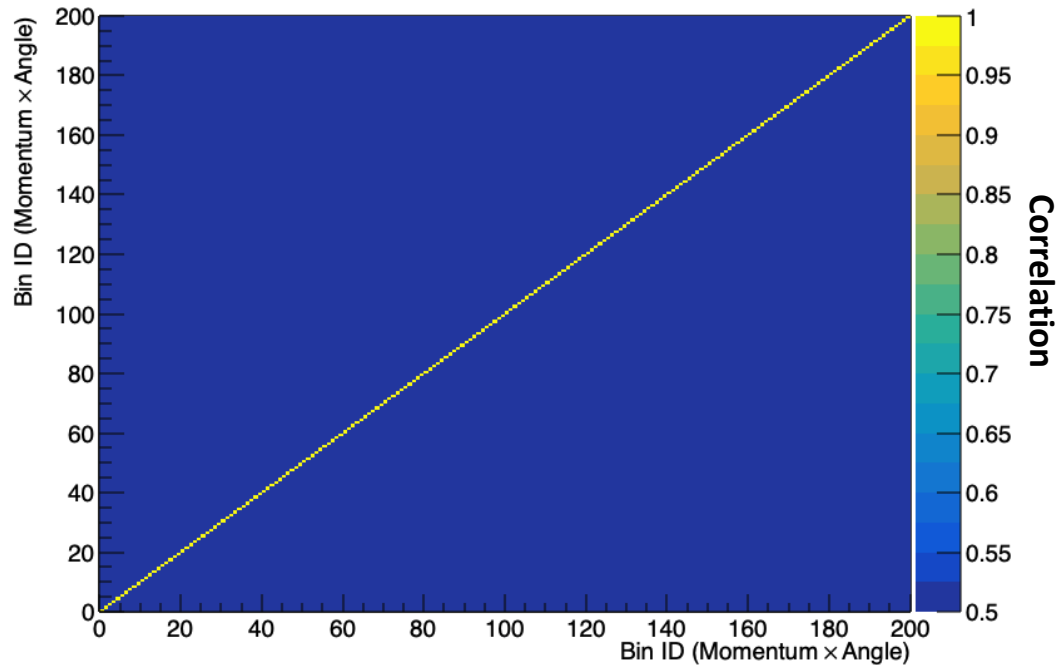
Ratio for
Universe 100
to CV



Ratio for
Universe 800
to CV

Systematic uncertainties

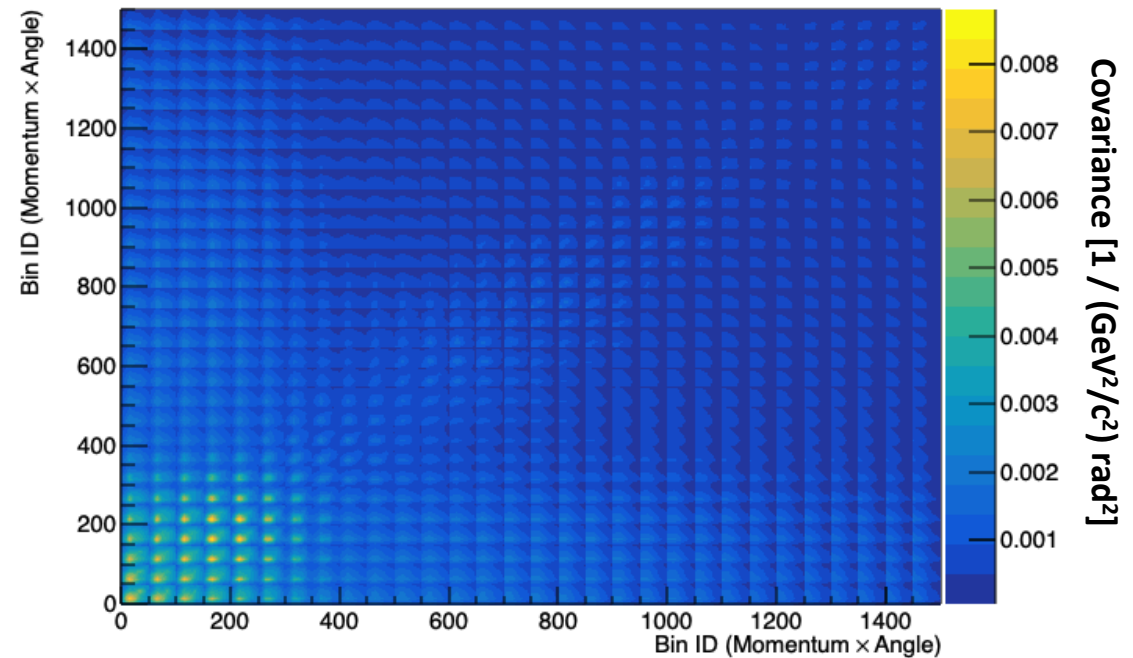
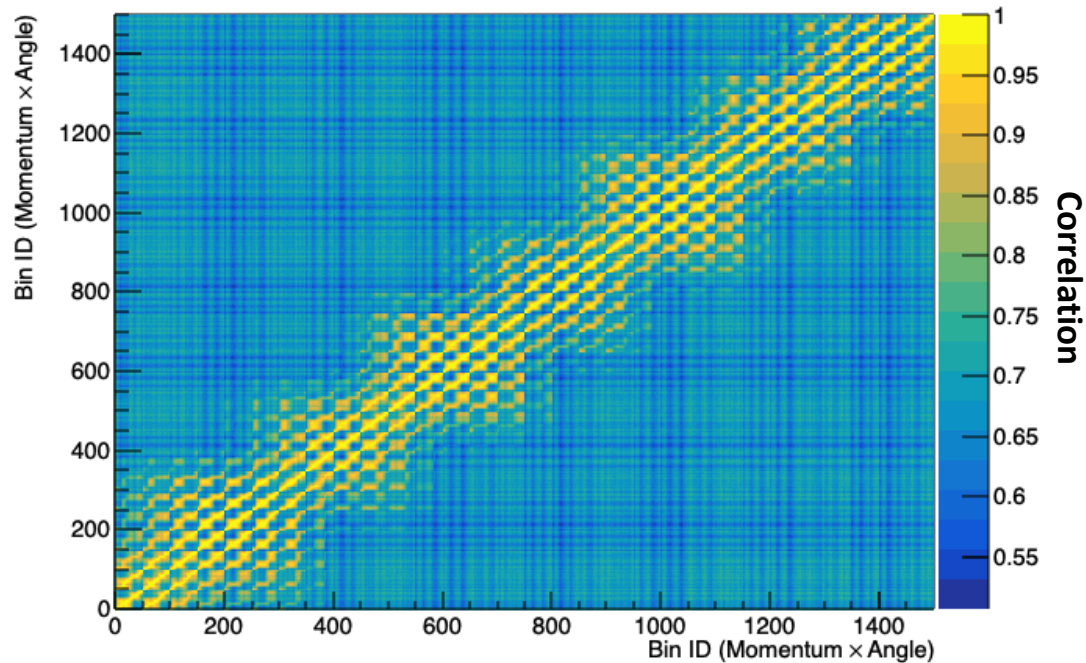
- The bin-to-bin correlation is not published by NA61. The data release split in systematics coming from different sources.
- We use +50% correlation across all bins as a first attempt (we want to have the infrastructure when we have better values).



- 200 data we have for NA61 in total

Systematic uncertainties

- We apply the Cholesky decomposition to get the lower matrix triangle and multiply by the vector of shifts. We calculate 5000 universes.
- As a check I show the correlation and covariance matrix for a sub-area of the (θ, P) for the interpolated 5000 universes after interpolation:

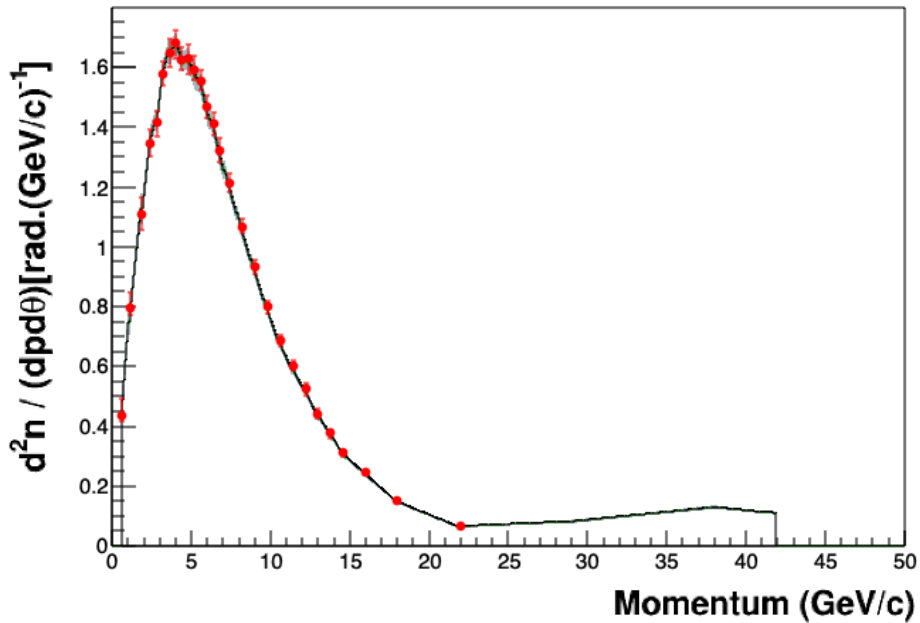


- 1500 interpolated bins: P in $[2, 5]$ GeV/c and θ in $[50, 150]$ mrad

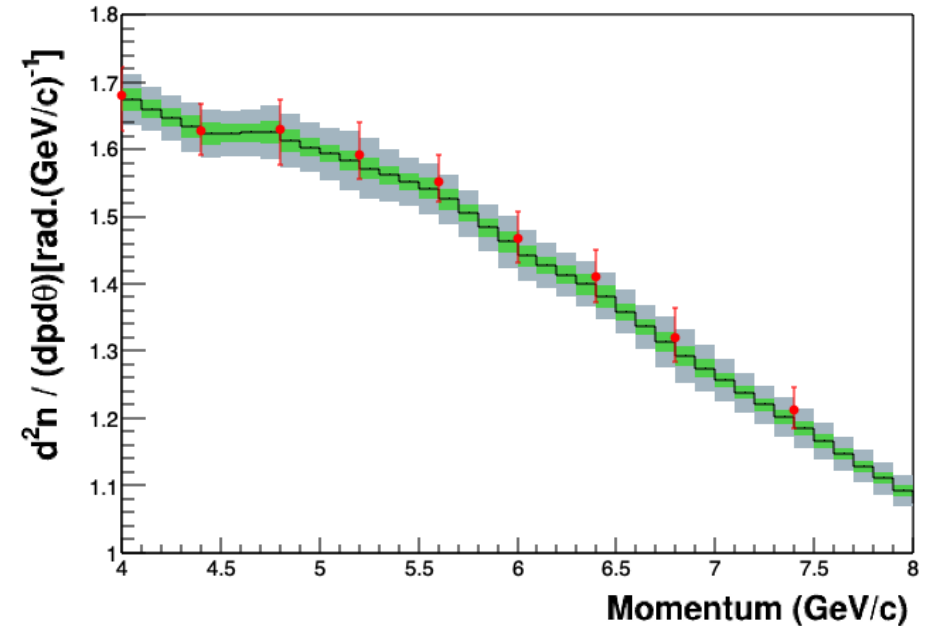
Data vs Interpolated data using only statistical uncertainties

NA61 (red) in [40,60] mrad. Error bars are total uncertainties.

Interpolated NA61: central value (black) in [50,52] mrad. Green bar statistical and gray bar the total (statistical and systematics added in quadrature)



Zooming in:



Conclusions

- This is my first attempt to interpolate NA61 data.
- To test the procedure: shifting the data distribution according to the statistical and systematical uncertainties (assuming for +50% bin-to-bin- correlation).
- I am going to understand some details about how the interpolation works and to understand the multi-universe technique.
- I am using some scripts which Leo Aliaga did for systematical and systematical uncertainties with multi-universe technique.
- I am presenting today these preliminary results to contribute a discussion about the procedure to use NA61 data.

Backup

Center of the bin

- This is just an exercise to see if the center of bin may scale well with the angle range (I am not using it in the interpolation):

