SciBooNE Charged-Current Coherent Pion Production Acceptance Study Technical Note

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1 Introduction

This document is intended to serve as a reference for the acceptance study performed for the SciBooNE charged current coherent pion production (CC-Coh $\pi^{+/-}$) re-analysis, as well as provide documentation of the code used in this study (in the event anything needs to be revisited in the future). The code resides in the github repository labeled as and linked here: SciBooNE-MC. The corresponding ROOT files that were used in this acceptance study can be downloaded from here: SciBooNE-MC-ROOTFiles.

The paper is structured such that Section 2 outlines Monte Carlo samples used in this study, Section 3 describes the SciBooNE detector as it was simulated in this study, Section 4 describes the various event samples that were used to both validate and generate the acceptance studies for the CC-Coh $\pi^{+/-}$ sample. Section 5 gives a high level summary of the results including the event-reduction tables as well as the CC-Coh $\pi^{+/-}$ acceptance results.

The appendix is left to explain how the code is run and the details of the scripts within. The appendix also details the order in which the macros should be run in, and the important plots that each macro produces that play a role in making the plots shown in Section 5 (the Results section).

1.1 Goal of the Re-Analysis

The goal of the re-analysis is to examine the acceptance modeling for the SciBooNE results in the presence of modern neutrino generators and updated models in order to hopefully shed light on why SciBooNE did not observe charged-current coherent pion production at low neutrino energy.

This study is intended to examine the effects of the acceptance modeling for a sample of coherent pion interactions inside the SciBooNE detector and compare what these would have been for various coherent pion production models. We utilize a simple, but robust, simulation of the SciBooNE detector and the NEUT neutrino generator to select and classify these neutrino events.

2 Samples

Five different samples were used in this study, three samples were generated in neutrino mode (ν-mode) and two samples in antineutrino mode ($\bar{\nu}$-mode.)[1] Table 2 summarizes these samples. Details on these samples can be found in the Appendix.

[1] All of these samples were generated by Callum Wilkinson (Thanks, Callum!)

Summary of Samples

Mode	NEUT version	Pion-Model	Number of simulated events
ν	5.3.6	Rein-Sehgal	1,000,000
ν	5.3.6	Berger-Sehgal	1,000,000
ν	5.0.1	Rein-Sehgal	100,000
$\bar{\nu}$	5.3.6	Rein-Sehgal	1,000,000
$\bar{\nu}$	5.3.6	Berger-Sehgal	1,000,000

Table 2: Summary of the samples used to build the acceptance model for this study.

3 Detector Simulation

This section is intended to detail the detector simulation done in this acceptance model, and to describe the assumptions made in order to accomplish accurate classifications of simulated events as charged-current coherent pion production.

3.1 The Detector

For the purposes of this acceptance study, the SciBooNE experiment is composed of two sub-detectors. The first (and the more upstream) of the sub-detectors, is the Scintillator Bar Tracker (SciBar) which was originally conceived and constructed to function as the near detector for the K2K experiment. The second (and more downstream) of the sub-detectors, is the Muon Range Detector (MRD), which is the detector designed and constructed specifically for SciBooNE for measuring the momentum of muons produced from charged-current neutrino interactions up to 1.2 GeV/c by using the observed range of the trajectory of the muon. The coordinante system used throughout this study, and illustrated in Figure 3.1, puts the origin in the lower corner of the SciBar detector, has z along the beam direction, y opposite to gravity, and x to beam left.

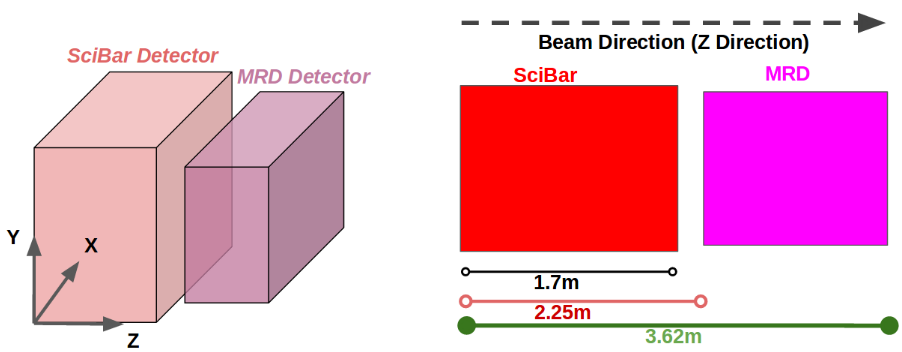

Figure 3.1: Representation of the SciBooNE detector and the coordinate frame we use in this study

3.1.1 The Scintillator Bar Tracker (SciBar)

The Scintillator Bar Tracker (SciBar) sub-detector is a scintillator detector which was used to identify neutrino interactions within SciBooNE. The dimensions of the SciBar detector used in this simulation are $0 < x < 3.0$ m, $0 < y < 3.0$ m, and $0 < z < 1.7$ m. This simulation models the scintillator materials as having a constant energy deposition per unit length (dE/dx) for both muons and pions of 2.04 MeV/cm based on previous SciBooNE analyses and on mean values for typical particle momentum listed in the particle data group (PDG).

3.1.2 The Muon Range Detector (MRD)

The Muon Range Detector (MRD), depicted in Figure 3.1.2, is located 0.55 m downstream of SciBar in the z-direction, and is a composition of two sets of thirteen alternating slabs of steel-scintillator layers, where the scintillator layers alternate between being horizontally oriented or vertically oriented, in the xy-plane. The steel layers have a z-direction thickness of 5.08 cm and the scintillator layers have a z-direction thickness of 0.6 cm. Combining all the layers of the different alternating materials results in 26 scintillator layers that "sandwich" twenty five steel layers in-between and gives a total z-direction dimension of being 1.37m. The xy-plane is modeled as a square again (as was the case with SciBar, too) with dimensions in the x-direction and the y-direction of 2.6 m. The energy deposition per unit length (dE/dx) of a muon penetrating the scintillator layers is assumed to be a constant 2.04 MeV/cm while the energy deposition for the muon in the steel layers is assumed to be a greater value of 11.43 MeV/cm. Both values are typical for muons at the energy range produced in SciBooNE and taken from the PDG.

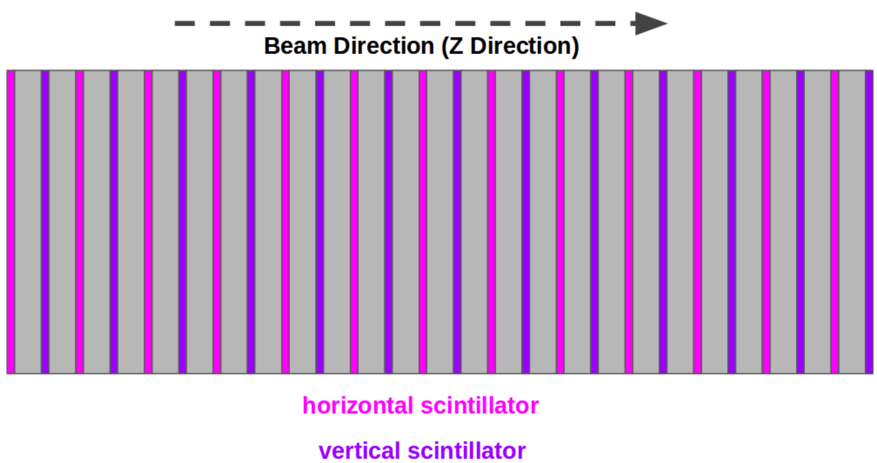

Figure 3.1.2: Depiction of the Muon Range Detector (MRD) which consists of alternating layers of horizontal scintillator (shown in pink) steel slabs (shown in grey) and vertical scintillator (shown in purple)

4 Event Selection

Two main samples are used in this study to generate the acceptance tables. The first is a charged current inclusive (CC-Inclusive) sample which requires a muon was created in the neutrino interaction and this muon intersects the MRD. This sample is described in Section 5.1 and is used to validate the building of the acceptance model by comparing it to previous SciBooNE analyses.

The second sample is the charged current coherent pion (CC-Coh $\pi^{+/-}$) sample which requires a muon and charged pion are created in the neutrino interaction exclusively (e.g. no other final state particles in the event). This sample is described in Section 5.2.

Both of these samples are selected using NEUT MC-truth flags which ensure we are treating pure samples which are classified by the neutrino generator as belonging to the appropriate sample.

Whether or not the event identified by our selection makes it into the final sample used in the acceptance study depends on the behavior of the muon with respect to the MRD. A muon which enters the MRD from a neutrino interaction will either come to stop in the MRD, exit out the back of the MRD (assuming it's momentum is great enough), or exit out the side of the MRD. In the next sections we explain this classification further.

4.1 Muon Stops within the MRD ("Stopped")

The requirement to classify a neutrino interaction as a "stopped" event requires the muon from the interaction to have reached the MRD, penetrated at least three layers of steel (giving activity in three layers of scintillator), and to then deposit all of its remaining energy prior to reaching a boundary of the MRD. An illustration of a CC-Coh $\pi^{+/-}$ event which would be classified as "stopped" is shown in Figure 4.1.

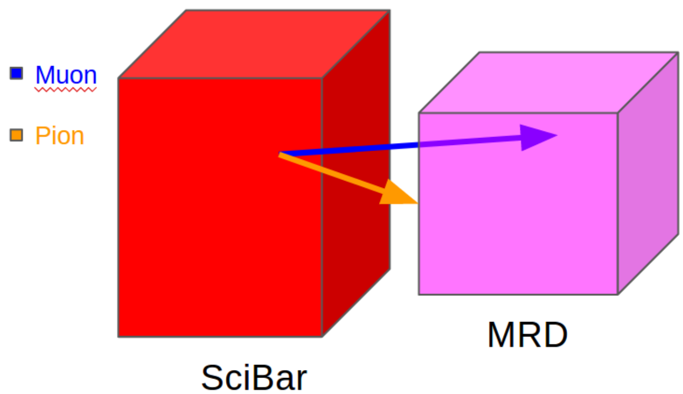

Figure 4.1: Depiction of an event that was classified as "Stopped."

These events allow for complete reconstruction of the muon's momentum based on the number of layers which the muon penetrated and the muons incident angle.

4.2 Muon exits out the back of the MRD ("Out-the-back")

The classification of a neutrino interaction as "out-the-back" requires that the muon from the interaction to have reached the MRD and to have had sufficient energy to have exited out the back face of the MRD without stopping. An illustration of such an event is given in Figure 4.2.

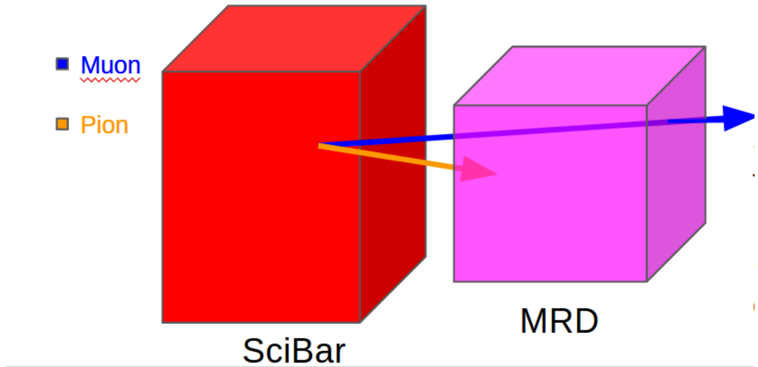

Figure 4.2: Depiction of an event that was classified as “out-the-back”.

The exact momentum of muons which pass completely through the MRD could not be made in reconstruction, so these events were classified as having the minimum energy required to penetrate all the steel and scintillator layers of the MRD.

4.3 Muon exits out the side of the MRD (“Out-the-side”)

The classification of a neutrino interaction as “out-the-side” requires that the muon from the interaction reached the MRD, penetrated at least three layers of steel, and then to have exited out the side of the active volume of the MRD (excluding the very back face). Events which are classified as “out-the-side” are excluded from this study because no accurate reconstruction of the muons momentum can be made when the muon exits out the side of the MRD. An illustration of such an excluded event which exits out the side of the MRD is given in Figure 4.3.

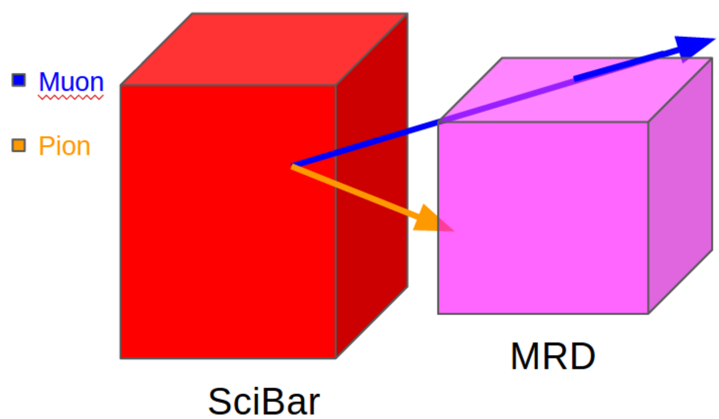

Figure 4.3: Depiction of an event that was classified as "Out-Side."

5 Results

The results of this acceptance study can be broken down into two different classification schemes of events. Those that met the conditions to qualify as CC-Inclusive events, and those that met the conditions of classification as Charged-Current Coherent Pion events. The former is used to validate the acceptance modeling and detector simulation to reasonably reproduce previously published CC-Inclusive studies from SciBooNE, while the latter is used for the reanalysis.

5.1 Charged-Current Inclusive Events

Here we define the charged current inclusive sample (CC-Inclusive) which we use to validate our acceptance model against previously performed simulation studies.

5.1.1 ν-mode Charged-Current Inclusive Events

Table 5.1.1 goes through the event selection criteria for selecting a sample of CC-Inclusive events from the neutrino mode (ν-mode) Monte Carlo.

ν-mode CC-Inclusive Event Reduction

Events Selection	NEUT v5.3.6 Rein-Sehgal	NEUT v5.3.6 Berger-Sehgal	NEUT v5.0.1 Rein-Sehgal
Total Sample	1,000,000	1,000,000	100,000
CC-Inclusive Interaction (μ + n-other particles in SciBar)	725,730	727,278	69,363
Muon enters the MRD	263,698	262,608	24,250
Muon enters the MRD and penetrates $\geq$ 3 layers of steel	231,089	230,054	21,001
"Stopped"-Events	177,406	175,799	16,062
"Out-the-back"-Events	15,389	15,952	1,421
"Out-the-side"-Events	38,294	38,303	3,518
Good CC-Inclusive Events	**192,795**	**191,751**	**17,483**

Table 5.1.1: Event reduction table for a sample of ν-mode CC-Inclusive events simulated in the SciBooNE geometry.

Figure 5.1.1 shows the momentum and angular (θ) distribution for the sample of ν-mode CC-Inclusive events passing all our requirements for all three models considered in this study (NEUT v5.3.6 Rein-Sehgal, NEUT v5.3.6 Berger-Sehgal, NEUT v5.0.1 Rein-Sehgal). The distributions have been normalized to the same area and show no strong differences between them.

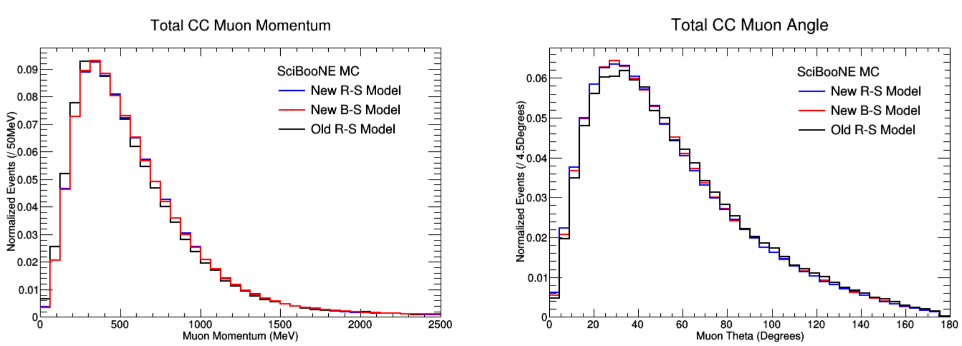

Figure 5.1.1: Muon Momentum (left) and Muon Angle (right) for ν-mode CC-Inclusive interactions for all three models included in this study. These samples kinematics are, unsurprisingly, very similar for the sample of CC-Inclusive

Figure 5.1.1 represents the one-dimensional efficiency for selecting ν-mode CC-Inclusive events for this study using all three different models compared to results derived from Hiraide's thesis [2] using the full SciBooNE Monte Carlo simulation. A few reference points are illustrated using dashed lines to guide the readers eye. A few perecent difference is seen, but overall agreement between the two simulations hold.

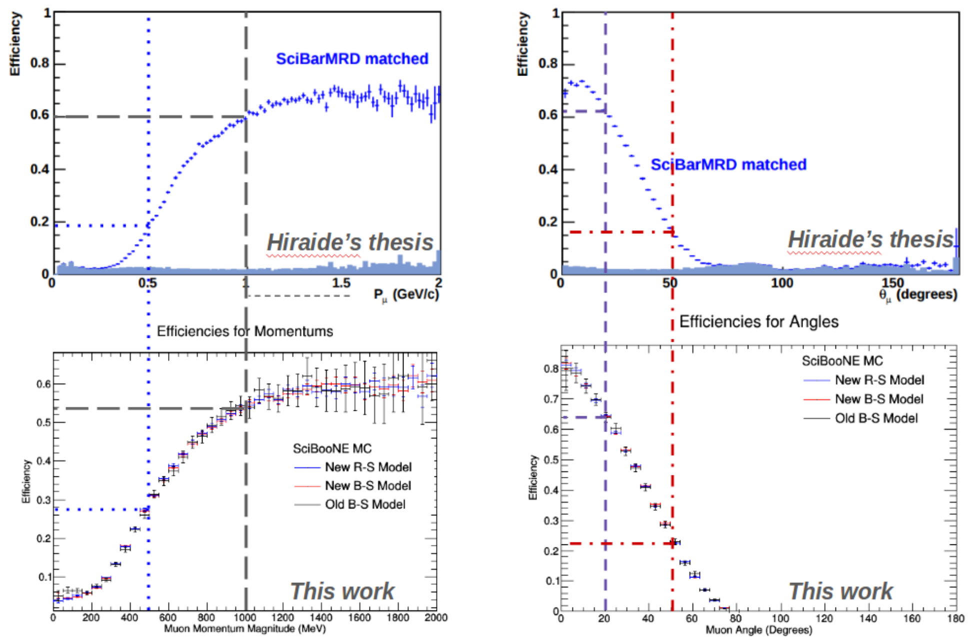

Figure 5.1.1: One-dimension efficiency plots for the ν-mode CC-Inclusive sample.

Figure 5.1.2 shows the two-dimensional efficiency for selecting ν-mode CC-Inclusive events. The left hand side is a reference plot provided by Morgan and the right hand side is for the Rein-Sehgal MC used in this study.

Below are the two dimensional efficiency plots for the CC Inclusive events in ν mode. The tables that correspond to the plots can be found in the Efficiency Tables section.

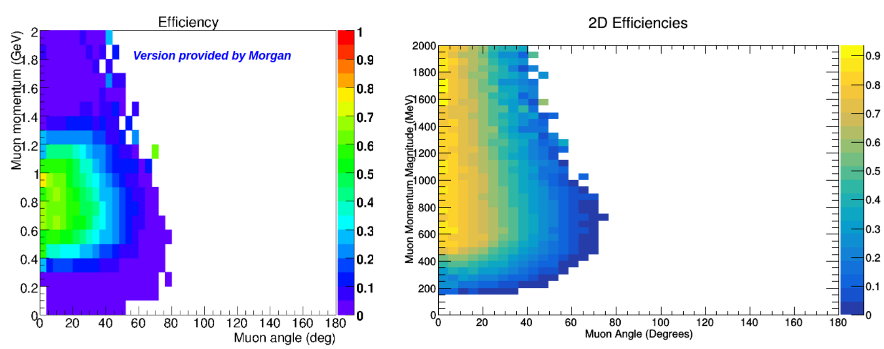

Figure 5.1.2: Two-dimensional efficiency plots for the ν-mode Rein-Sehgal CC-Inclusive sample.

[2] Hiraide's thesis can be found here: http://www-he.scphys.kyoto-u.ac.jp/theses/doctor/hiraide_dt.pdf

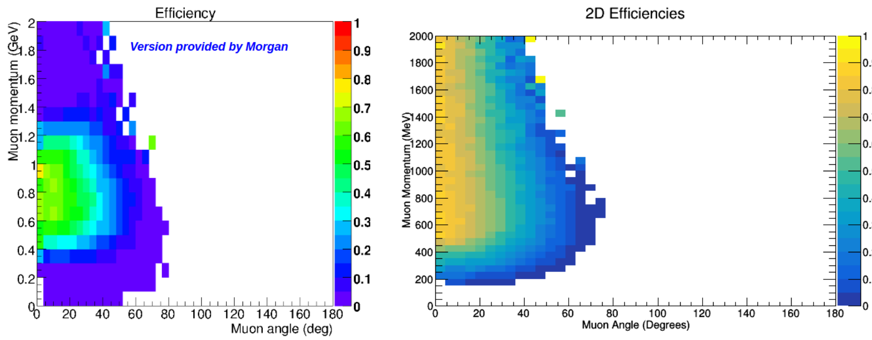

Figure 5.1.2: Two-dimensional efficiency plots for the ν-mode Berger-Sehgal CC-Inclusive sample.

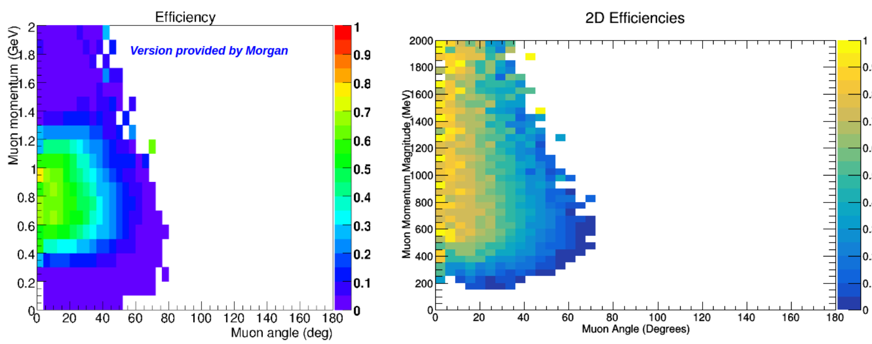

Figure 5.1.1: Two-dimensional efficiency plots for the ν-mode Old Rein-Sehgal CC-Inclusive sample.

5.1.2 $\bar{\nu}$-mode Charged-Current Inclusive Events

Similar to before, Table 5.1.2 goes through the event selection criteria for selecting a sample of CC-Inclusive events from the antineutrino mode ($\bar{\nu}$-mode) Monte Carlo.

$\bar{\nu}$-mode CC-Inclusive Event Reduction

Events Selection	NEUT v5.3.6 Rein-Sehgal	NEUT v5.3.6 Berger-Sehgal
Total Sample	1,000,000	1,000,000
CC-Inclusive Interaction (μ + n-other particles in SciBar)	699,239	704,327
Muon enters the MRD	380,362	380,869
Muon enters the MRD and penetrates $\geq$ 3 layers of steel	336,373	337,979
"Stopped"-Events	288,289	288,206
"Out-the-back"-Events	7,608	7,857
"Out-the-side"-Events	40,476	41,916
Good CC-Inclusive Events	**295,897**	**296,063**

Table 5.1.2: Event reduction table for a sample of $\bar{\nu}$-mode CC-Inclusive evnets simulated in the SciBooNE geometry.

Figure 5.1.1 shows the momentum and angular distribution for the sample of $\bar{\nu}$-mode CC-Inclusive events passing all our requirements for both models considered in this study (NEUT v5.3.6 Rein-Sehgal, and NEUT v5.3.6 Berger-Sehgal). The distributions have been normalized to the same area and show no strong differences between them.

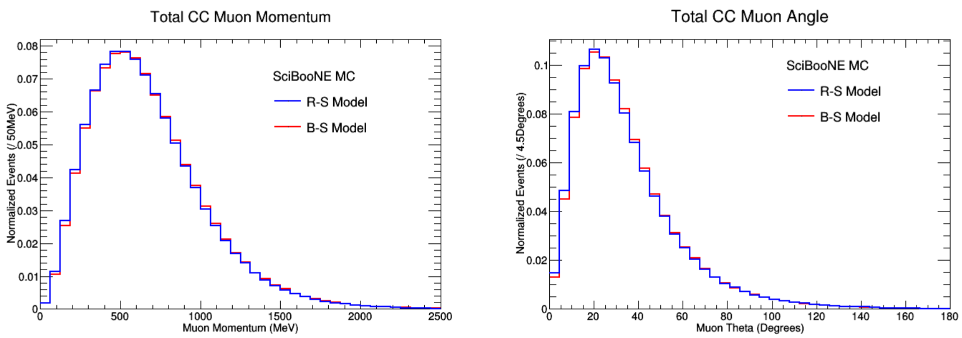

Figure 5.1.2: Muon Momentum (left) and Muon Angle (right) for $\bar{\nu}$-mode CC-Inclusive interactions for all three models included in this study. These samples kinematics are, unsurprisingly, very similar for the sample of CC-Inclusive

Figure 5.1.2 represents the one-dimensional efficiency for selecting $\bar{\nu}$-mode CC-Inclusive events for this study. No similar reference sample exists to be compared directly against, however we note that the shape and magnitude of the acceptance is nearly unchanged between $\bar{\nu}$ and ν-mode samples (as expected).

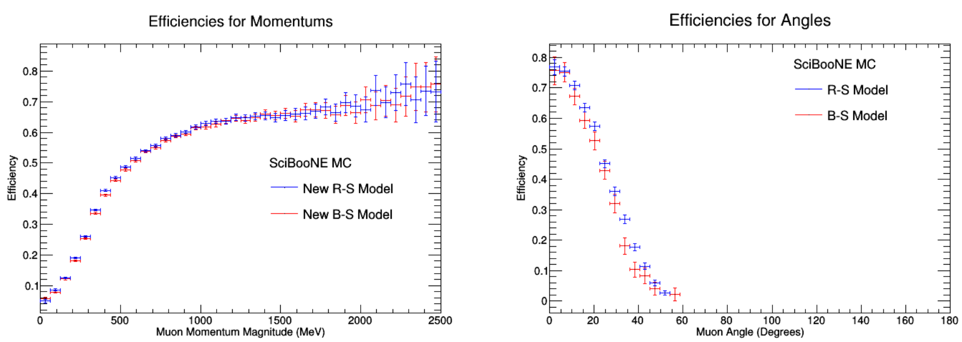

Figure 5.1.2: One-dimension efficiency plots for the $\bar{\nu}$-mode CC-Inclusive sample. Muon's Momentums is on the right and the Muon's Angles is on the left.

Figure 5.1.2 shows the two-dimensional efficiency for selecting $\bar{\nu}$-mode CC-Inclusive events for this study compared to results derived from Morgan's reference sample (need more words here about this....see email)

Below are the two dimensional efficiency plots for the CC Inclusive events in $\bar{\nu}$ mode. The tables that correspond to the plots can be found in the Efficiency Tables section.

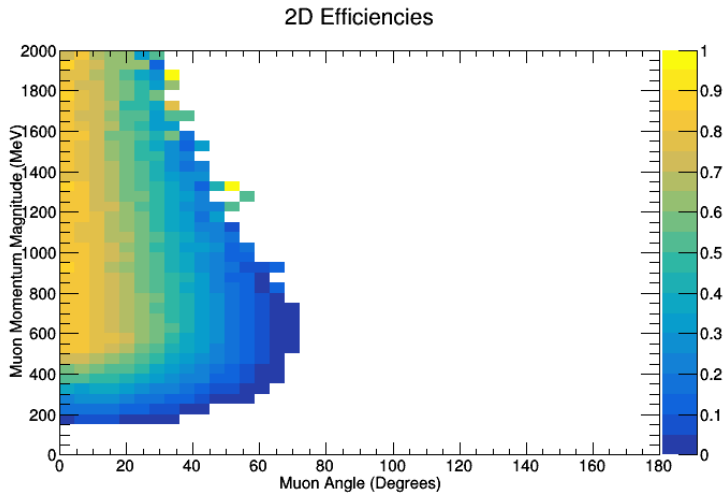

Figure 5.1.2: Two-dimensional efficiency plot for the $\bar{\nu}$-mode Rein-Sehgal CC-Inclusive sample.

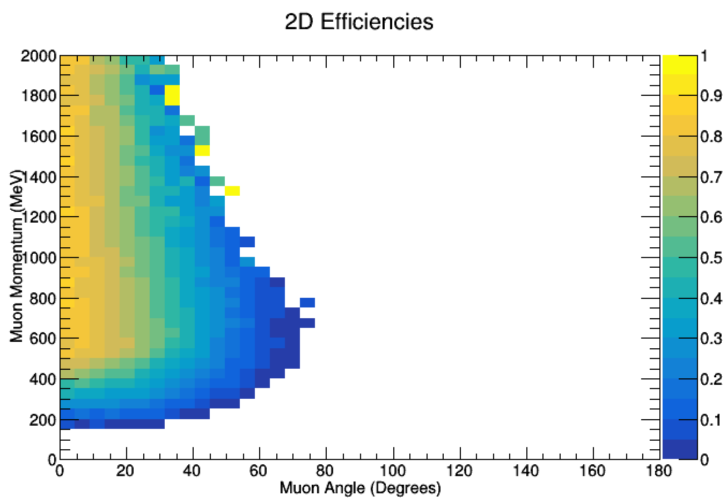

Figure 5.1.2: Two-dimensional efficiency plot for the $\bar{\nu}$-mode Berger-Sehgal CC-Inclusive sample.

5.2 Charged-Current Coherent Pion Production Events

Here we define the Charged-Current Coherent Pion Production sample (CC-Coh $\pi^{+/-}$) which we use to validate our acceptance model against previous simulation studies which were done.

5.2.1 ν-mode Charged-Current Coherent Pion Events

Table 5.2.1 goes through the event selection criteria for selecting a sample of CC-Coh $\pi^{+/-}$ events from the neutrino mode (ν-mode) Monte Carlo.

The first quantity that is calculated for the different events is the momentum of both the muon and the pion, which are both found from the equations:

ν-mode CC-Coherent Pion Event Reduction

Events Selection	NEUT v5.3.6 Rein-Sehgal	NEUT v5.3.6 Berger-Sehgal	NEUT v5.0.1 Rein-Sehgal
Total Sample	1,000,000	1,000,000	100,000
CC-Coherent Pion Interaction ($\mu + \pi + \varnothing$ in SciBar)	12,186	2,576	1,320
Both muon and pion are forward going	8,535	1,845	884
Muon enters the MRD and penetrates ≥ 3 layers of steel	7,407	1,592	767
"Stopped"-Events	6,448	1,350	669
"Out-the-back"-Events	530	150	56
"Out-the-side"-Events	429	92	42
Good Coherent Pion Events	**6,978**	**1,500**	**725**

Table 1: Event reduction table for a sample of ν-mode Charged Current Coherent Pion events simulated in the SciBooNE geometry.

$$|\vec{p}_\mu| = \sqrt{P_{\mu_x}^2 + P_{\mu_y}^2 + P_{\mu_z}^2} \tag{1}$$

$$|\vec{p}_\pi| = \sqrt{P_{\pi_x}^2 + P_{\pi_y}^2 + P_{\pi_z}^2} \tag{2}$$

where $|\vec{p}_\mu|$ represents the magnitude of the momentum for the corresponding particle, and P_{μ_x} represents the component of the four momentum for the corresponding particle. The momentum is reported in units of MeV/c.

The next quantity calculated is the angle from the beam-direction for both the muon and the pion, which are labeled as either θ_μ, or θ_π, respectively. The angle from the beam-direction is the same as the angle from the z-direction, and this angle is known as the azimuthal angle. The calculation of the azimuthal angle is slightly more involved than the simple calculation used for finding the magnitude of the momentum of the two particles, and is calculated using the equations:

$$\theta_\mu = tan^{-1}\left(\frac{\sqrt{P_{\mu_x}^2 + P_{\mu_y}^2}}{P_{\mu_z}}\right) \tag{3}$$

$$\theta_\pi = tan^{-1}\left(\frac{\sqrt{P_{\pi_x}^2 + P_{\pi_y}^2}}{P_{\pi_z}}\right) \tag{4}$$

The angles are reported in units of $^\circ$, and should run from 0° to 180°. In the case of charged-current coherent pion production, the angle should never be larger than 90°.

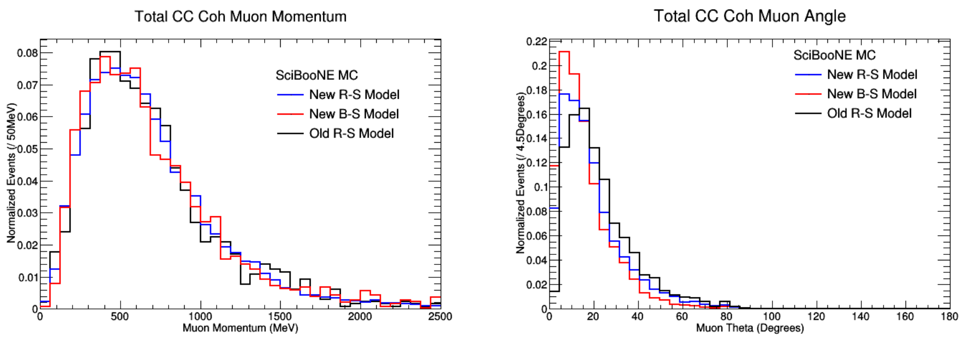

Figure 1: Muon Momentum for all of the muons of the events that made it to the MRD and penetrated at least three layers (left) and Muon Angle for the muons of the events that made it to the MRD and penetrated at least three layers (right) for ν-mode CC-Coh $\pi^{+/-}$ interactions for all three models included in this study. The "Total" classification means that all CC-Coh $\pi^{+/-}$ events are included in these histograms.

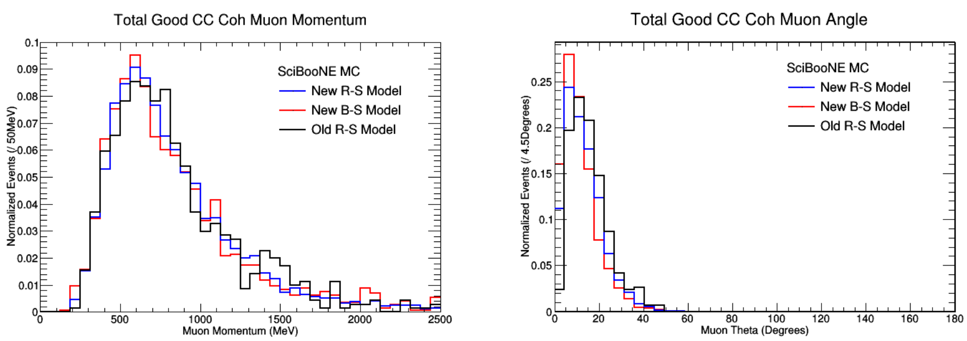

Figure 2: Muon Momentum of both the "stopped" and "not-stopped" samples (left) and Muon Angle of both the "stopped" and "not-stopped" samples (right) for ν-mode CC-Coh $\pi^{+/-}$ interactions for all three models included in this study. The "Good" classification means that only the stopped and not-stopped CC-Coh $\pi^{+/-}$ events are included for these histograms.

The last two quantities that are calculated are the two different types of four-momentum transfers specific to this interaction, which are Q^2 and $|t|$. The Q^2 corresponds to the four-momentum transfer from the neutrino and muon to the nucleus and pion, and is calculated using the equation:

$$Q^2 = |(P_{\nu_\mu} - P_\mu)^2| \tag{5}$$

This equation is the four-momentum notational form. The code follows the equation below in order to compute Q^2:

$$Q^2 = |(P_{\nu_{\mu,x}} - P_{\mu_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E})^2| \tag{6}$$

Q^2 is reported in units of $(MeV/c)^2$.

The $|t|$ corresponds to the four-momentum transfer from the neutrino, muon, and pion to the nucleus, and is calculated using the equation:

$$|t| = |(Q - P_\pi)^2| = |(P_{\nu_\mu} - P_\mu - P_\pi)^2| \tag{7}$$

This equation is the four-momentum notational form. The code follows the equation below in order to compute $|t|$:

$$|t| = |(P_{\nu_{\mu,x}} - P_{\mu_x} - P_{\pi_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y} - P_{\pi_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z} - P_{\pi_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E} - P_{\pi_E})^2| \quad (8)$$

$|t|$ is reported in units of $(MeV/c)^2$.

ν-Mode $|t|$ and Q^2 plots are below:

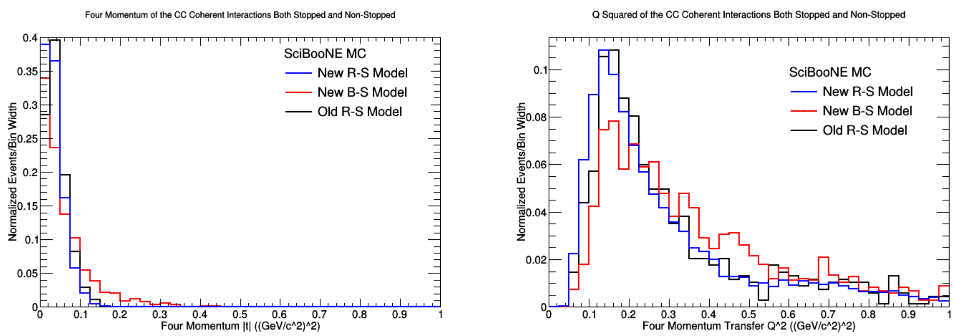

Figure 3: The $|t|$ Momentum Transfer for the "stopped" and "not-stopped" events (left) and Q^2 Momentum Transfer for the "stopped" and "not-stopped" events (right) for ν-mode CC-Coh $\pi^{+/-}$ interactions for the three models included in this study.

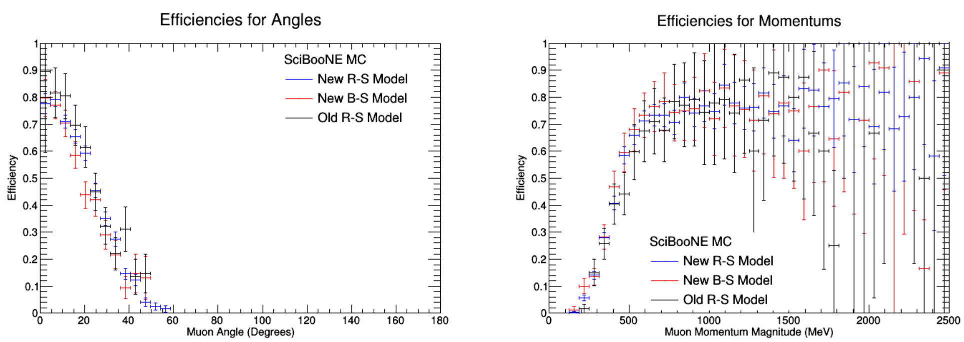

Figure 5.2.1: These two plots are the one dimensional efficiency plots that make the two dimensional efficiency plots that follow. The left plot is the muon angle efficiency plot and the right is the muon momentum efficiency plot for ν mode.

Below are the two dimensional efficiency plots for the CC Coherent Pion events in ν mode. The tables that correspond to the plots can be found in the Efficiency Tables section.

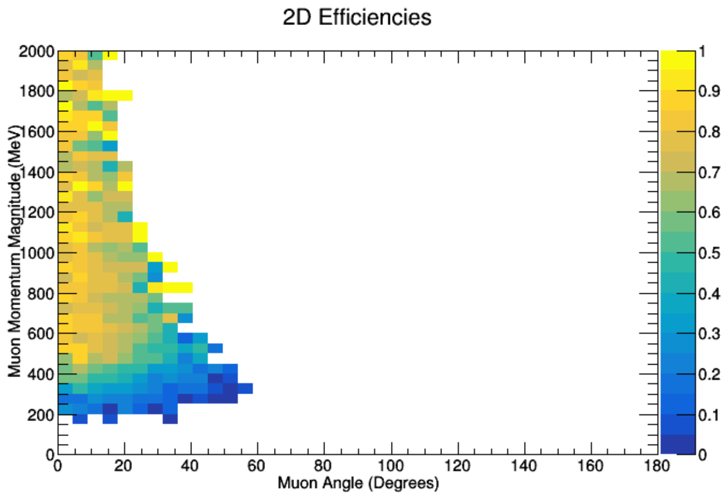

Figure 5.2.1: Two-dimensional efficiency plot for the new NEUT ν-mode Rein-Sehgal CC-Coherent sample.

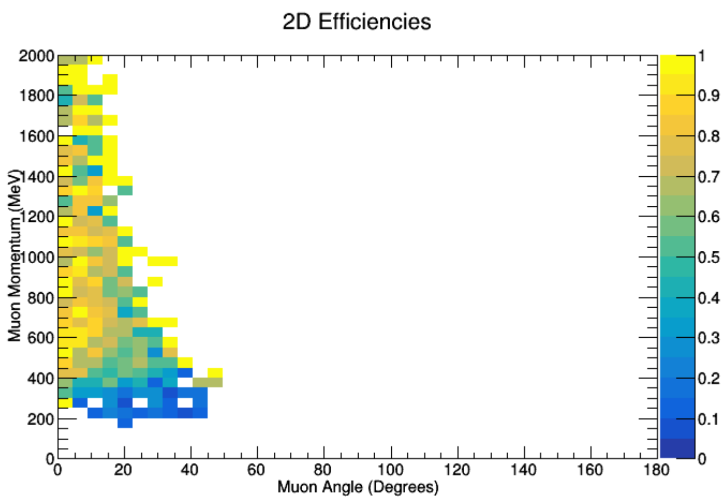

Figure 5.2.1: Two-dimensional efficiency plot for the new NEUT ν-mode Berger-Sehgal CC-Coherent sample.

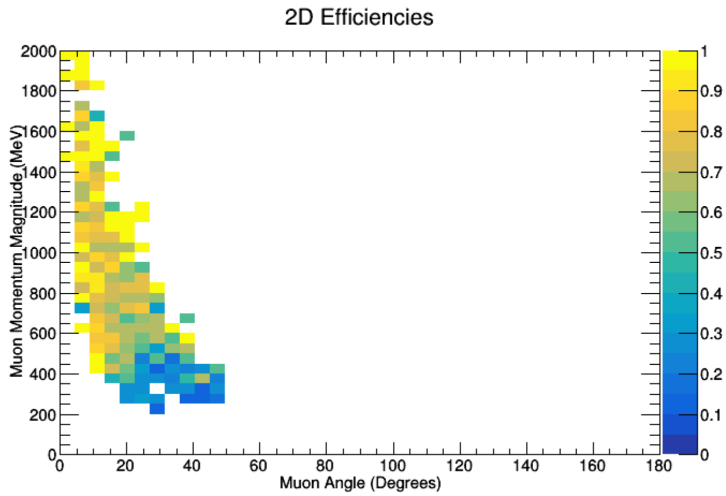

Figure 5.2.1: Two-dimensional efficiency plot for the old NEUT ν-mode Rein-Sehgal CC-Coherent sample.

5.2.2 $\bar{\nu}$-mode Charged-Current Coherent Pion Events

Similar to before, Table 5.2.2 goes through the event selection criteria for selecting a sample of CC-Coh $\pi^{+/-}$ events from the anti-neutrino mode ($\bar{\nu}$-mode) Monte Carlo.

$\bar{\nu}$-mode CC-Coherent Pion Event Reduction

Events Selection	NEUT v5.3.6 Rein-Sehgal	NEUT v5.3.6 Berger-Sehgal
Total Sample	1,000,000	1,000,000
CC-Coherent Pion Interaction ($\mu + \pi + \varnothing$ in SciBar)	36,669	7,790
Both muon and pion are forward going	24,675	5,477
Muon enters the MRD and penetrates $\geq$ 3 layers of steel	20,445	4,517
"Stopped"-Events "Out-the-back"-Events "Out-the-side"-Events	18,935 372 1,138	4,203 82 232
Good Coherent Pion Events	**19,307**	**4,285**

Table 2: Event reduction table for a sample of $\bar{\nu}$-mode Charged Current Coherent Pion events simulated in the SciBooNE geometry.

Below are the plots for CC-Coh $\pi^{+/-}$ Events for $\bar{\nu}$-mode. The layout of the rest will be very similar to ν-mode, and the equations used previously are the same equations used for the plots below.

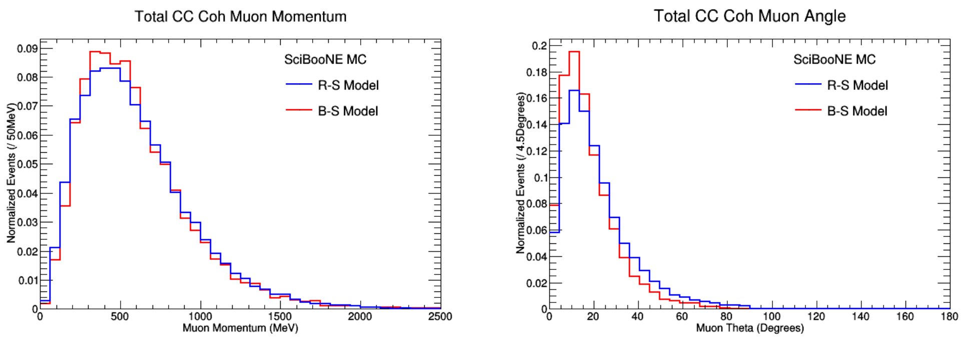

Figure 4: Muon Momentum (left) and Muon Angle (right) for ν-mode CC-Coh $\pi^{+/-}$ interactions for all three models included in this study.

The structure of the plots in Figure 5.2.2: very closely resembles the plots for the ν-mode above, and the rest of the plots in this section have that same characteristic.

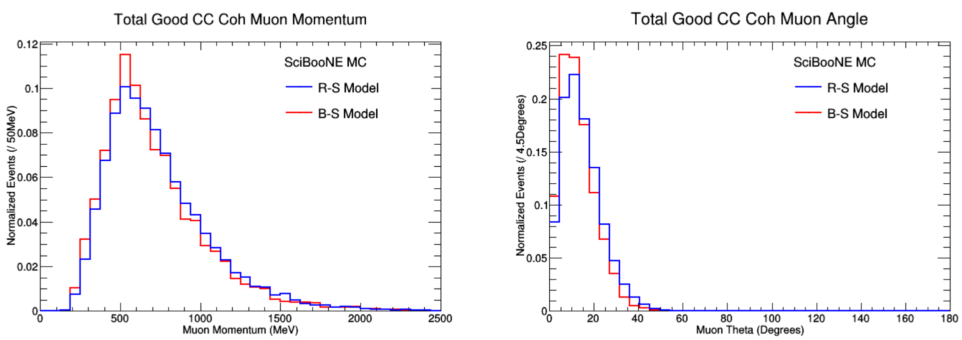

Figure 5: Muon Momentum (left) and Muon Angle (right) for $\bar{\nu}$-mode CC-Coh $\pi^{+/-}$ interactions for both the "stopped" and "not-stopped" samples of events.

$\bar{\nu}$-mode $|t|$ and Q^2 plots are below. They also have the same overall shape as the plots for ν-mode above.

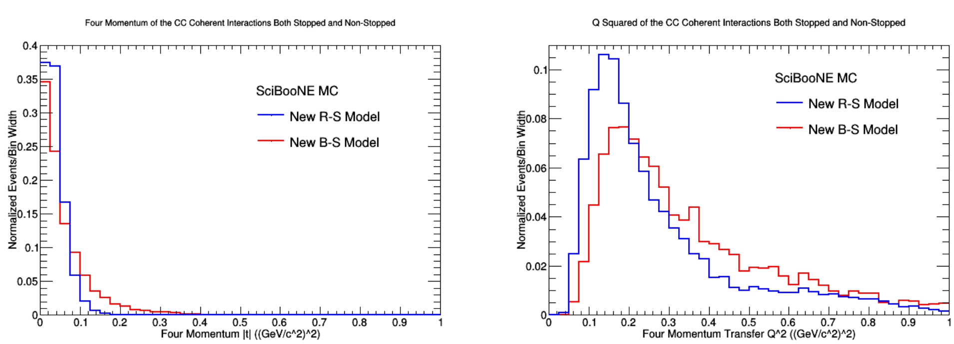

Figure 6: The $|t|$ Momentum Transfer (left) and Q^2 Momentum Transfer (right) for $\bar{\nu}$-mode CC-Coh $\pi^{+/-}$ interactions for both of the models included in this study which are the "stopped" and "not-stopped" events.

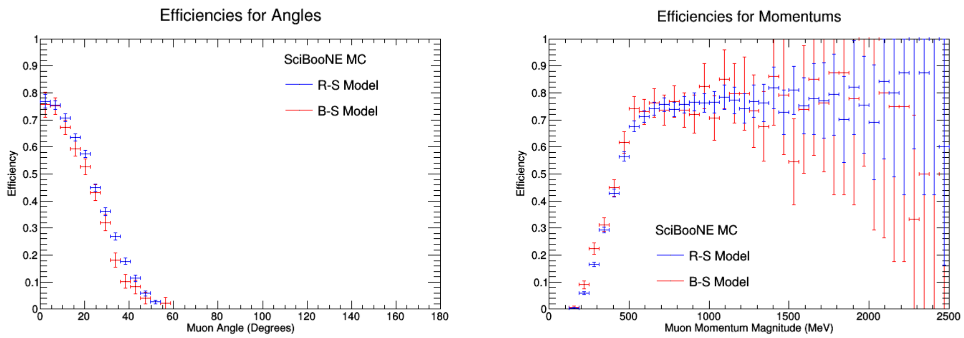

Figure 5.2.2: These two plots are the one dimensional efficiency plots that make the two dimensional efficiency plots that follow. The left plot is the muon angle efficiency plot and the right is the muon momentum efficiency plot for $\bar{\nu}$ mode.

Below are the two dimensional efficiency plots for the CC Coherent Pion events in $\bar{\nu}$ mode. The tables that correspond to the plots can be found in the Efficiency Tables section.

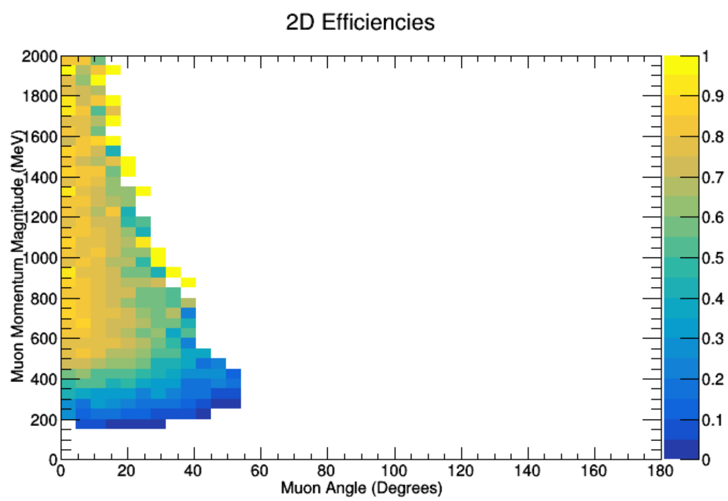

Figure 5.2.2: Two-dimensional efficiency plot for the new NEUT $\bar{\nu}$-mode Rein-Sehgal CC-Coherent sample.

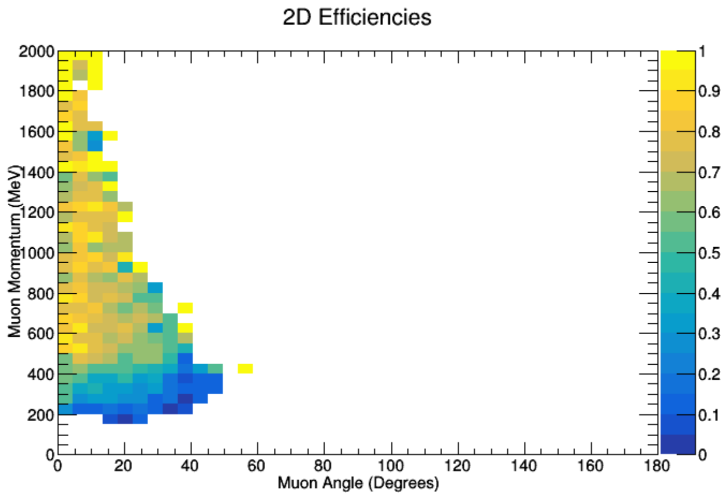

Figure 5.2.2: Two-dimensional efficiency plot for the new NEUT $\bar{\nu}$-mode Berger-Sehgal CC-Coherent sample.

A Appendix: Sample Details

Appendix on samples

A.1 ν-Mode Rein-Sehgal NEUTv5.3.6

A sample of 1,000,000 ν interactions were simulated using the NEUT generator (v5.3.6) and the Rein-Sehgal model for coherent pion production. This sample correspond to the file labeled

`SciBooNE_numu_coh_RooTrack.root`

found at the following link (SciBooNE-MC-ROOTFiles).

A.2 ν-Mode Berger-Sehgal NEUTv5.3.6

A sample of 1,000,000 ν interactions were simulated using the NEUT generator (v5.3.6) and the Berger-Sehgal model for coherent pion production. This sample correspond to the file labeled

`SciBooNE_numu_coh_RooTrack_NEW.root`

found at the following link (SciBooNE-MC-ROOTFiles).

A.3 ν-Mode Rein-Sehgal NEUTv5.0.1

A sample of 100,000 ν interactions were simulated using the NEUT generator (v5.0.1, believed to be the version used by the SciBooNE collaboration in the original publication) and the corresponding older Rein-Sehgal model for coherent pion production. This sample corresponds to the file labeled

`SciBooNE_numu_coh_OLDNEUT_RooTrack.root`

found at the following link (SciBooNE-MC-ROOTFiles).

A.4 $\bar{\nu}$-Mode Rein-Sehgal NEUTv5.3.6

A sample of 1,000,000 $\bar{\nu}$ interactions were simulated using the NEUT generator (v5.3.6) and the Rein-Sehgal model for coherent pion production. This sample corresponds to the file labeled

`SciBooNE_numubar_coh_RooTrack.root`

found at the following link (SciBooNE-MC-ROOTFiles).

A.5 $\bar{\nu}$-Mode Berger-Sehgal NEUTv5.3.6

A sample of 1,000,000 $\bar{\nu}$ interactions were simulated using the NEUT generator (v5.3.6) and the Berger-Sehgal model for coherent pion production. This sample corresponds to the file labeled

`SciBooNE_numubar_coh_RooTrack_NEW.root`

found at the following link (SciBooNE-MC-ROOTFiles).

A.6 Vertex Distributions

The events were all given a random initial point that was generated with the goal that the vertex distributions of this simulation would closely match the vertex distributions that Hiraide [3] showed in his thesis. This was done by... etc.

```
TRandom3 *randX = new TRandom3();
TRandom3 *randY = new TRandom3();
TRandom3 *flat = new TRandom3();
randX->SetSeed(jentry/2);
randY->SetSeed(jentry*jentry);
flat->SetSeed(jentry*jentry*jentry);
double Xpos = randX->Gaus(1.5,1.3);
while (Xpos<0 || Xpos>3.0) { Xpos = randX->Gaus(1.5,1.3); }
double Ypos = randY->Gaus(1.5,1.05);
while (Ypos<0 || Ypos>3.0) { Ypos = randY->Gaus(1.5,1.05); }
double Zpos = flat->Uniform(0,1.7);
```

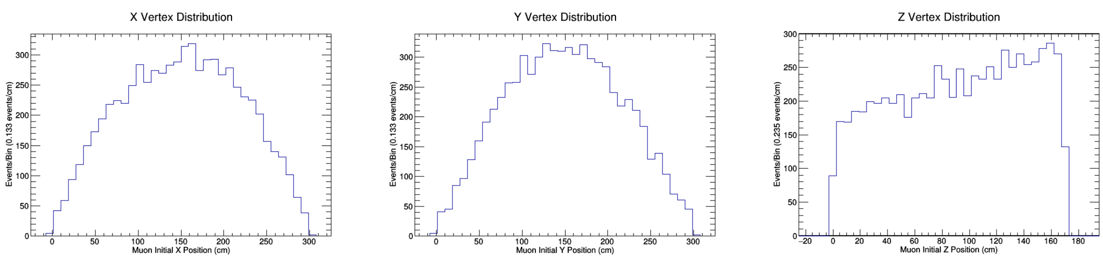

Figure 7: Vertex distributions of the events in the new Rein-Sehgal sample in ν-mode.

A.7 NewNMReinSehgal.C

This file is the macro that corresponds to the "NewNMReinSehgal.h" file, which connects with this file: "SciBooNE_numu_coh_RooTrack.root". This file performs the main analysis for this generated sample, and then organizes the information into many different histograms. The histograms are then written to a file titled "totalmuoninfoRS.root" inside the "ROOTFILES" directory. The "ROOTFILES" directory is included in the SciBooNE-MC repository (it is absolutely pertinent that this directory be located where the macro files are located due to how the calls of the combined data macros reference the now saved histograms). When this macro is run (which can take a while), it also plots a few different histograms. The histograms that are plotted are the ones shown in the figures below with descriptions included with the corresponding figures. The order that the histograms appear in this paper is the same order they will be shown when this macro is run in root.

[3] Hiraide's thesis can be found here: http://www-he.scphys.kyoto-u.ac.jp/theses/doctor/hiraide_dt.pdf

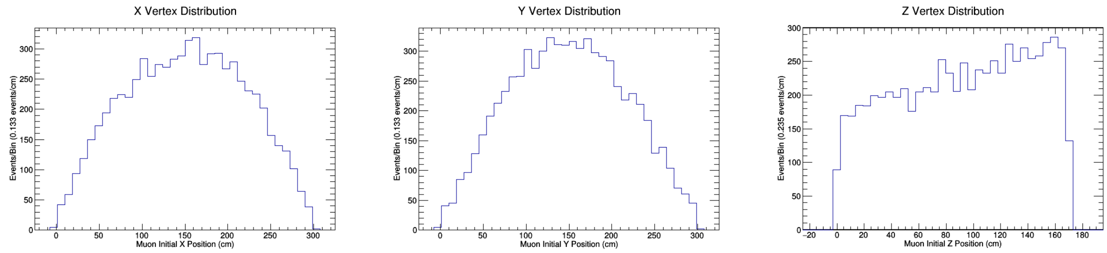

Figure 8: Vertex distributions of the events in the new Rein-Sehgal sample in ν-mode.

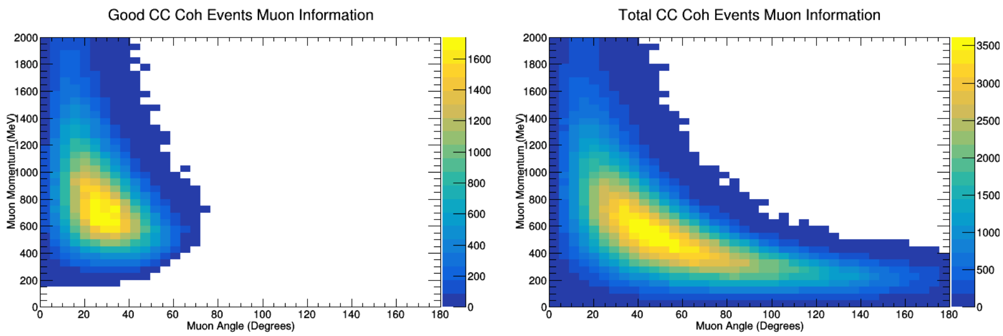

Figure 9: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Inclusive events in the new Rein-Sehgal sample in ν mode. The left only contains events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Inclusive.

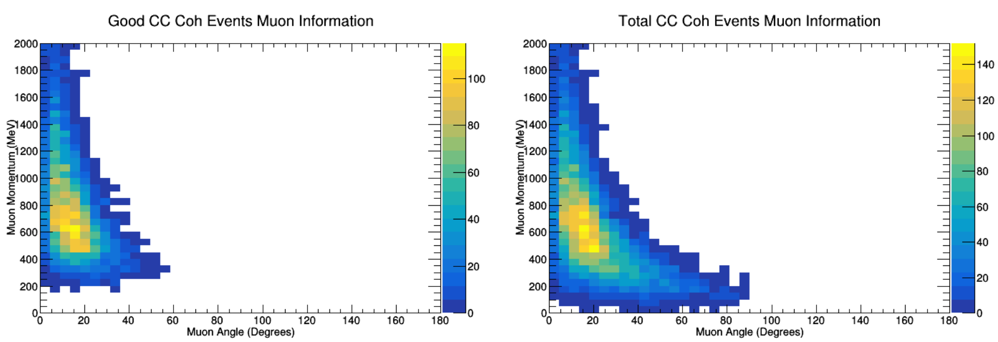

Figure 10: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Coherent Pion events in the new Rein-Sehgal sample in ν mode. The left only contains events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Coherent Pion.

The NewNMReinSehgal.C macro also calculates many different quantities for the generated simulation of the events and saves the information in histograms that are later called upon through the plotting macros (which are after all of the analysis macros). The first quantity that is calculated for the different vertexes is the momentum of both the muon and the pion, which are both calculated using the equations:

$$|\vec{p}_\mu| = \sqrt{P_{\mu_x}^2 + P_{\mu_y}^2 + P_{\mu_z}^2} \tag{9}$$

$$|\vec{p}_\pi| = \sqrt{P_{\pi_x}^2 + P_{\pi_y}^2 + P_{\pi_z}^2} \tag{10}$$

The momentum is reported in units of MeV/c.

The next quantity that is calculated in the macro is the angle from the beam-direction for both the muon and the pion, which are labeled as either θ_μ, or θ_π, respectively. The angle from the beam-direction is the same as the angle from the z-direction, and this angle is known as the azimuthal angle. The calculation of the azimuthal angle is slightly more involved than the simple calculation used for finding the magnitude of the momentum of the two particles, and is calculated using the equations:

$$\theta_\mu = tan^{-1}(\sqrt{P_{\mu_x}^2 + P_{\mu_y}^2}/P_{\mu_z}) \tag{11}$$

$$\theta_\pi = tan^{-1}(\sqrt{P_{\pi_x}^2 + P_{\pi_y}^2}/P_{\pi_z}) \tag{12}$$

The angles are reported in units of $^\circ$, and should run from 0° to 180°. In the case of Charged-Current Coherent Pion Production, the angle should never be larger than 90°.

The last two quantities that this analysis macro calculates are the two different types of four-momentum transfers specific to this interaction, which are Q^2 and $|t|$. The Q^2 corresponds to the four-momentum transfer from the neutrino and muon to the nucleus and pion, and is calculated using the equation:

$$Q^2 = |(P_{\nu_\mu} - P_\mu)^2| \tag{13}$$

This equation is the four-momentum notational form. The code follows the equation below in order to compute Q^2:

$$Q^2 = |(P_{\nu_{\mu,x}} - P_{\mu_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E})^2| \tag{14}$$

Q^2 is reported in units of $(MeV/c)^2$.

The $|t|$ corresponds to the four-momentum transfer from the neutrino, muon, and pion to the nucleus, and is calculated using the equation:

$$|t| = |(Q - P_\pi)^2| = |(P_{\nu_\mu} - P_\mu - P_\pi)^2| \tag{15}$$

This equation is the four-momentum notational form. The code follows the equation below in order to compute $|t|$:

$$|t| = |(P_{\nu_{\mu,x}} - P_{\mu_x} - P_{\pi_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y} - P_{\pi_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z} - P_{\pi_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E} - P_{\pi_E})^2| \tag{16}$$

$|t|$ is reported in units of $(MeV/c)^2$.

A.8 NewNMBergerSehgal.C

This file is the macro that corresponds to the "NewNMBergerSehgal.h" file, which connects with this file: "SciBooNE_numu_coh_RooTrack_NEW.root". This file performs the main analysis for this generated sample, and then organizes the information into many different histograms. The histograms are then written to a file titled "totalmuoninfoBS.root" inside the "ROOTFILES" directory. The "ROOTFILES" directory is included in the SciBooNE-MC repository (it is absolutely pertinent that this directory be located where the macro files are located due to how the calls of the combined data macros reference the now saved histograms).

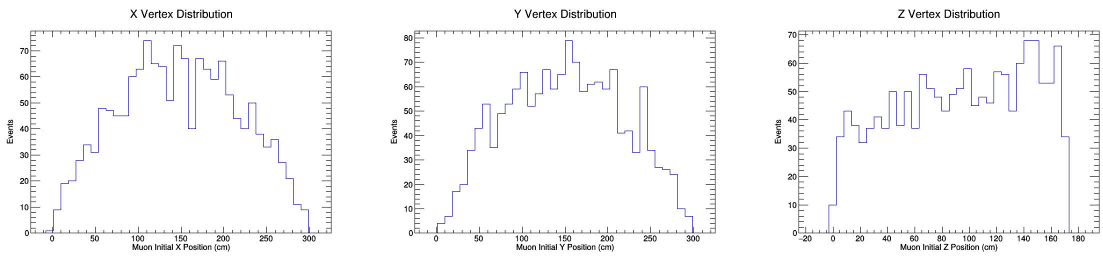

Figure 11: Vertex distributions of the events in the new Berger-Sehgal sample in ν-mode.

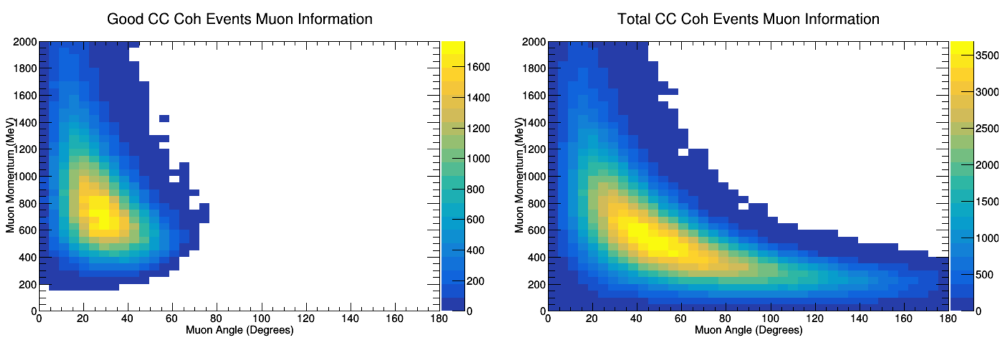

Figure 12: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Inclusive events in the new Berger-Sehgal sample in ν mode. The left only contains events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Inclusive.

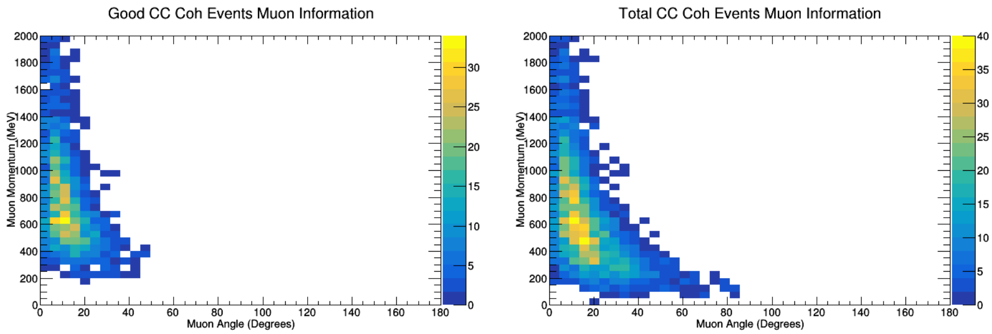

Figure 13: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Coherent Pion events in the new Berger-Sehgal sample in ν mode. The left only contains events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Coherent Pion.

A.9 OldNMReinSehgal.C

This file is the macro that corresponds to the "OldNMReinSehgal.h" file, which connects with this file: "SciBooNE_numu_coh_OLDNEUT_RooTrack.root". This file performs the main analysis for this generated sample, and then organizes the information into many different histograms. The histograms are then written to a file titled "totalmuoninfoOBS.root" inside the "ROOTFILES" directory. The "ROOTFILES" directory is included in the SciBooNE-MC repository (it is absolutely pertinent that this directory be located where the macro files are located due to how the calls of the combined data macros reference the now saved histograms).

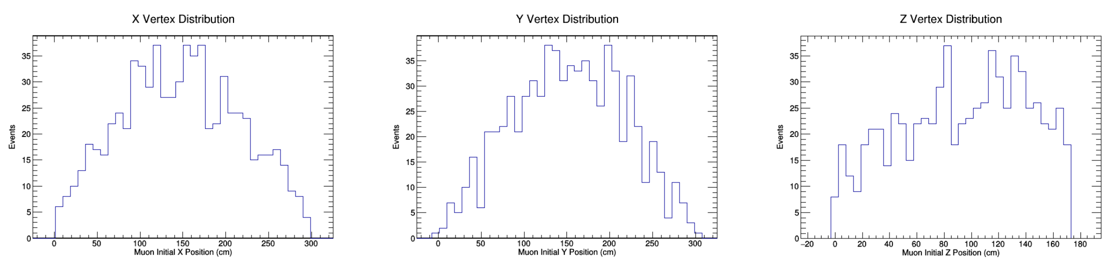

Figure 14: Vertex distributions of the events in the old Rein-Sehgal sample in ν-mode.

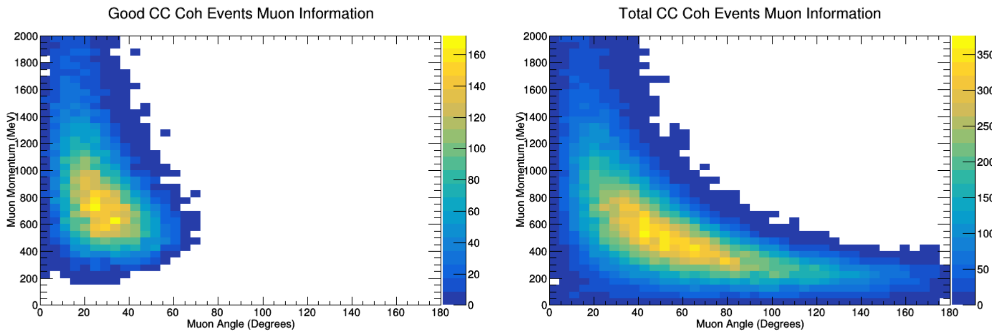

Figure 15: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Inclusive events in the old Rein-Sehgal sample in ν mode. The left only contains events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Inclusive.

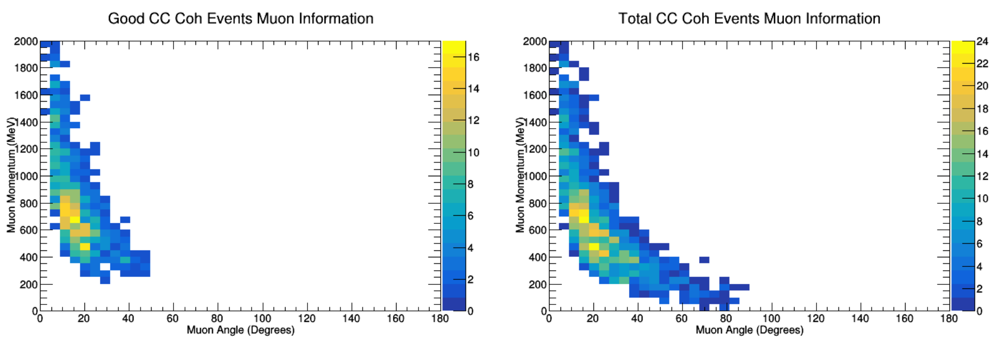

Figure 16: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Coherent Pion events in the old Rein-Sehgal sample in ν mode. The left only contains events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Coherent Pion.

A.10 NewANMReinSehgal.C

This file is the macro that corresponds to the "NewANMReinSehgal.h" file, which connects with this file: "SciBooNE_numubar_coh_RooTrack.root". This file performs the main analysis for this generated sample, and then organizes the information into many different histograms. The histograms are then written to a file titled "totalmuoninfoRSBar.root" inside the "ROOTFILES" directory. The "ROOTFILES" directory is included in the SciBooNE-MC repository (it is absolutely pertinent that this directory be located where the macro files are located due to how the calls of the combined data macros reference the now saved histograms).

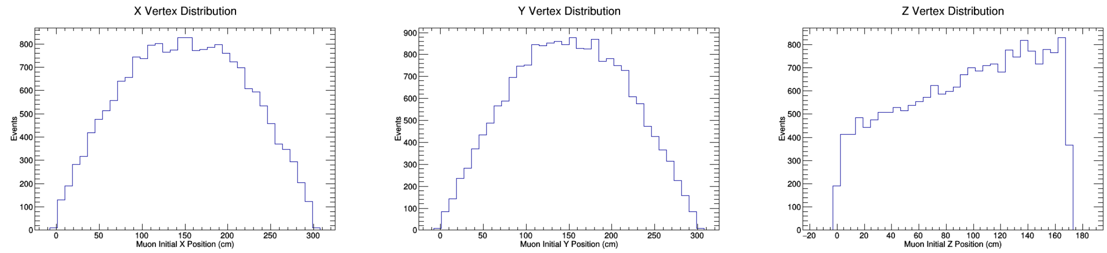

Figure 17: Vertex distributions of the events in the new Rein-Sehgal sample in $\bar{\nu}$-mode.

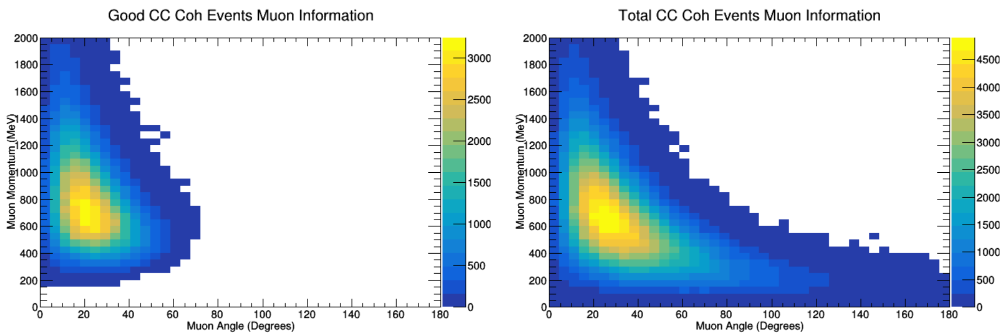

Figure 18: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Inclusive events in the new Rein-Sehgal sample in $\bar{\nu}$ mode. The left only contains events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Inclusive.

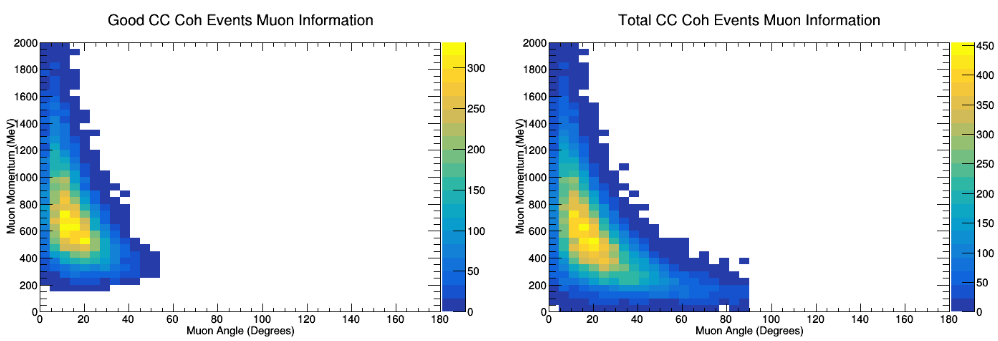

Figure 19: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Coherent Pion events in the new Rein-Sehgal sample in $\bar{\nu}$ mode. The left only contains events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Coherent Pion.

A.11 NewANMBergerSehgal.C

This file is the macro that corresponds to the "NewANMBergerSehgal.h" file, which connects with this file: "SciBooNE_numubar_coh_RooTrack_NEW.root". This file performs the main analysis for this generated sample, and then organizes the information into many different histograms. The histograms are then written to a file titled "totalmuoninfoBSBar.root" inside the

"ROOTFILES" directory. The "ROOTFILES" directory is included in the SciBooNE-MC repository (it is absolutely pertinent that this directory be located where the macro files are located due to how the calls of the combined data macros reference the now saved histograms).

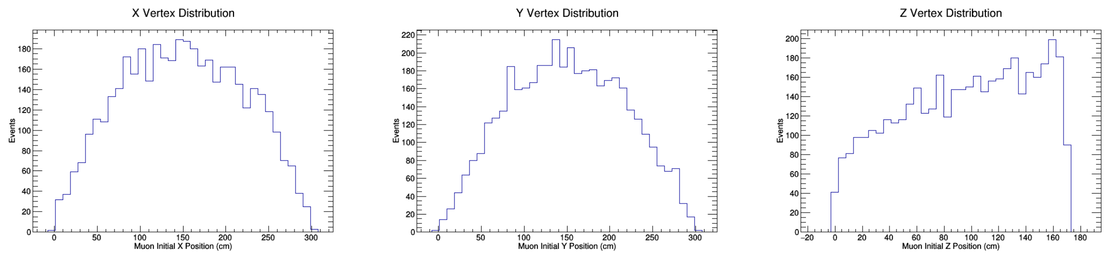

Figure 20: Vertex distributions of the events in the new Berger-Sehgal sample in $\bar{\nu}$-mode.

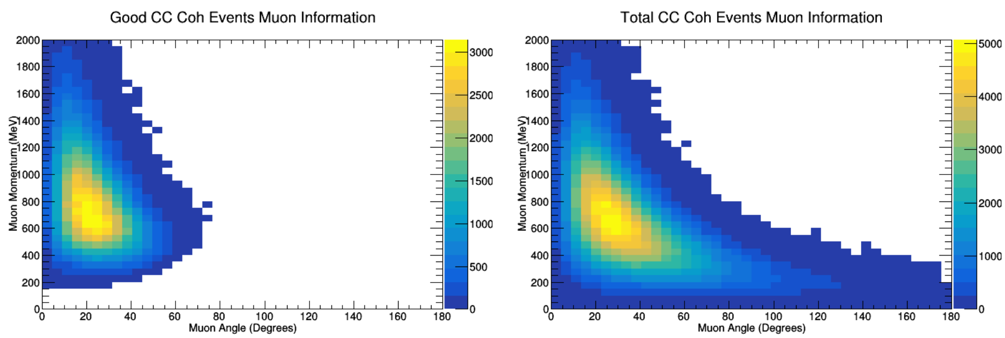

Figure 21: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Inclusive events in the new Berger-Sehgal sample in $\bar{\nu}$ mode. The left only contain events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Inclusive.

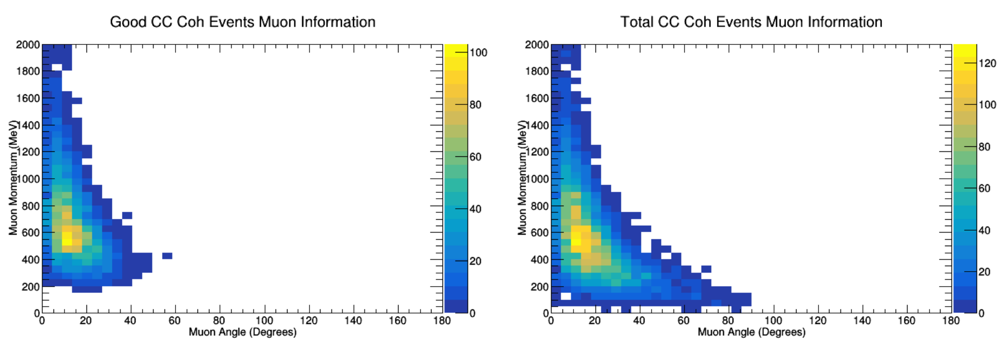

Figure 22: These are the two two dimensional histograms that when the left is divided by the right it returns the two dimensional efficiency histogram for the CC Coherent Pion events in the new Berger-Sehgal sample in $\bar{\nu}$ mode. The left only contain events that stopped or went out the back and penetrated the front face of the MRD. The right contains all of the events that were classified as CC Coherent Pion.

A.12 NMCombinedPlots.C

This is the file that performs the main plotting operations for the neutrino mode samples using the muon's information. All of the muon efficiency plots for neutrino mode are made with this file.

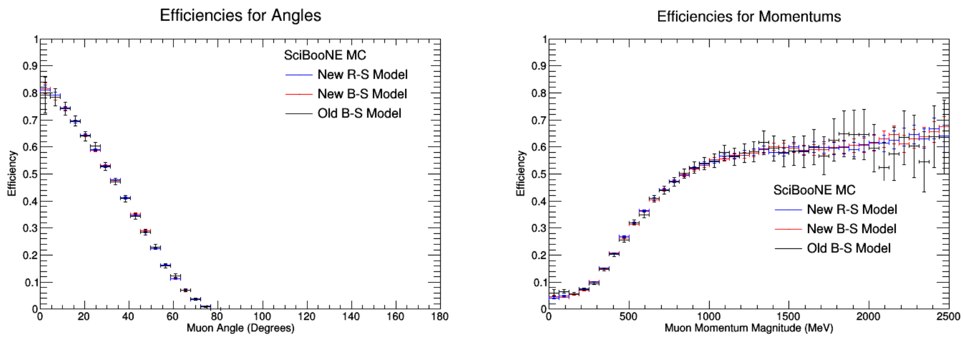

Figure 23: These are the ν mode one dimensional efficiency plots of the two dimensional CC Inclusive efficiency plots that are below. The left is the angle efficiency plot and the right is the momentum efficiency plot for the muon.

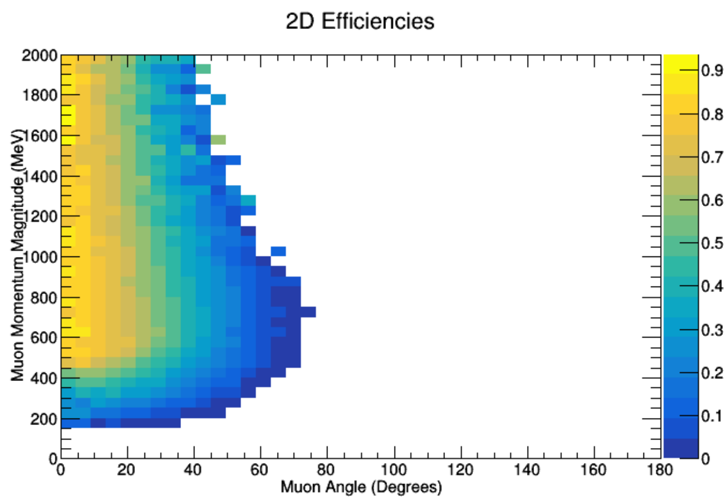

Figure 24: Two-dimensional efficiency plot for the new NEUT ν-mode Rein-Sehgal CC-Inclusive sample.

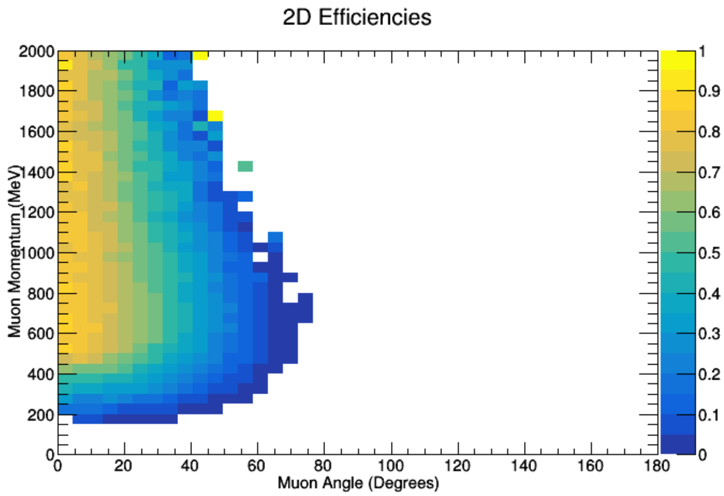

Figure 25: Two-dimensional efficiency plot for the new NEUT ν-mode Berger-Sehgal CC-Inclusive sample.

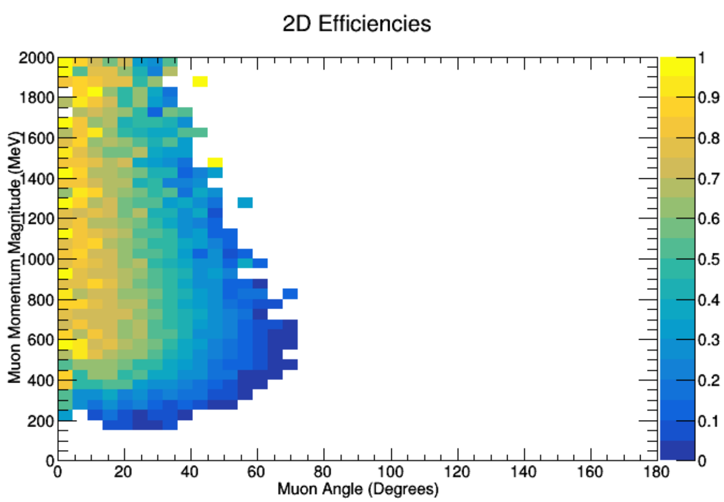

Figure 26: Two-dimensional efficiency plot for the old NEUT ν-mode Rein-Sehgal CC-Inclusive sample.

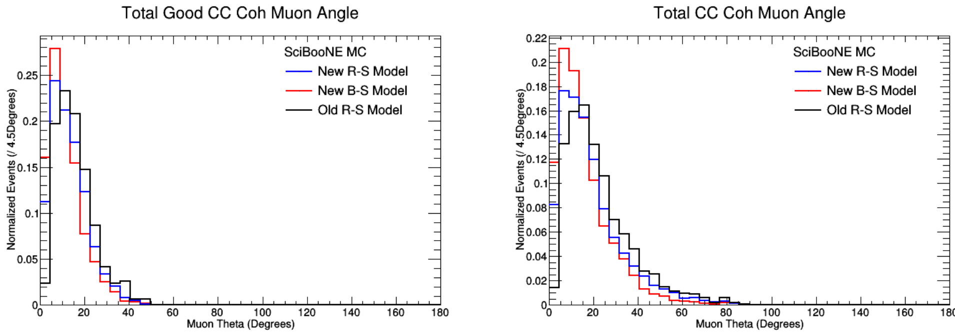

Figure 27: These are the two plots for muon angles in ν mode that are used to make the one dimensional efficiency plot for the angles in CC Coh Pion events. The left is the plot for the events that had a muon make it to the front face of the MRD and the muon either stopped or went out the back face. The right plot is the muon angles for all of the events that were classified as CC Coh Pion. The left divided by the right gives the efficiency plot for the muon angles in CC Coh Pion events.

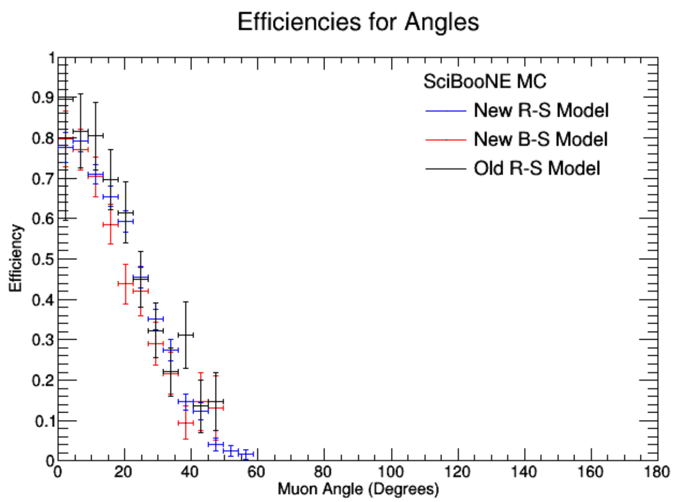

Figure 28: This is the one dimensional muon angles efficiency plot for the CC Coh Pion events from the ν mode samples.

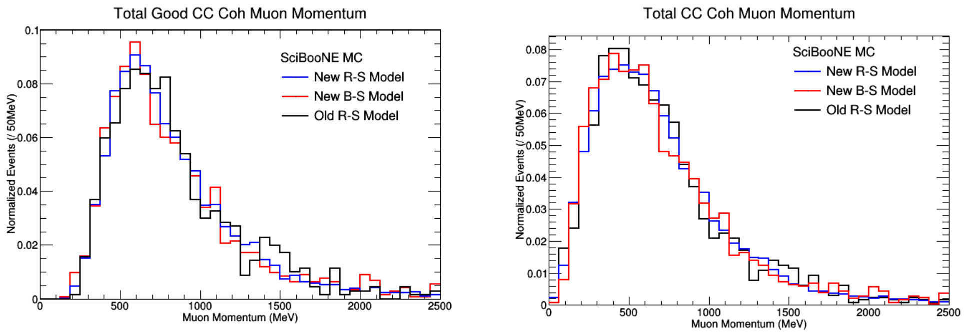

Figure 29: These are the two plots for muon momentums in ν mode that are used to make the one dimensional efficiency plot for the momentums in CC Coh Pion events. The left is the plot for the events that had a muon make it to the front face of the MRD and the muon either stopped or went out the back face. The right plot is the muon momentums for all of the events that were classified as CC Coh Pion. The left divided by the right gives the efficiency plot for the muon momentums in CC Coh Pion events.

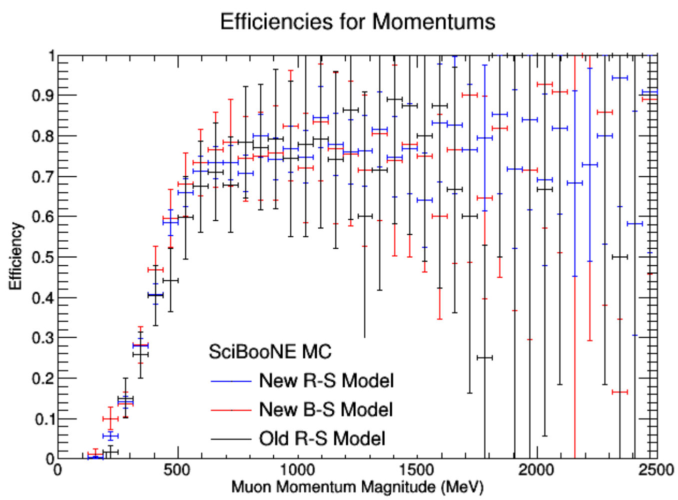

Figure 30: This is the one dimensional muon momentums efficiency plot for the CC Coh Pion events from the ν mode samples.

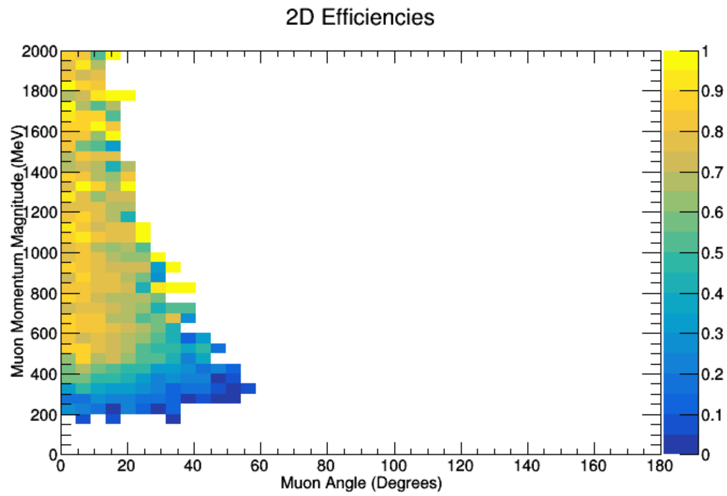

Figure 31: Two-dimensional efficiency plot for the new NEUT ν-mode Rein-Sehgal CC-Coherent sample.

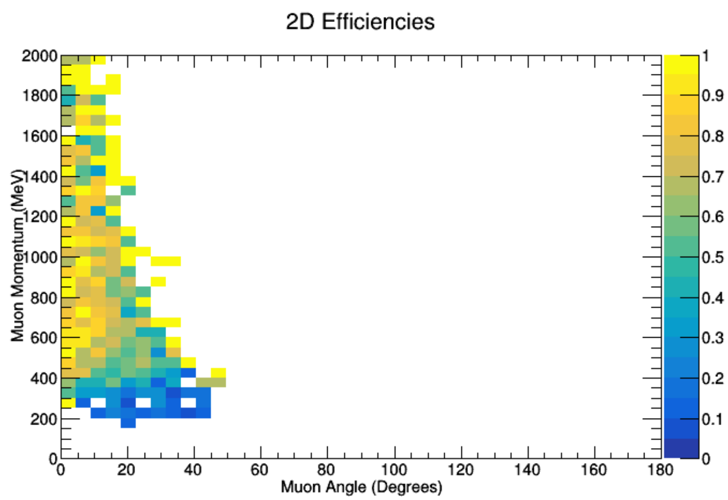

Figure 32: Two-dimensional efficiency plot for the new NEUT ν-mode Berger-Sehgal CC-Coherent sample.

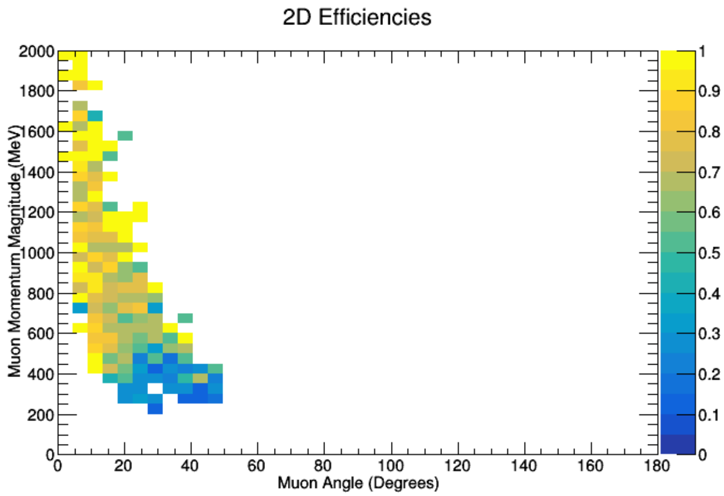

Figure 33: Two-dimensional efficiency plot for the old NEUT ν-mode Rein-Sehgal CC-Coherent sample.

A.13 NMPionPlotting.C

This is the file that performs the main plotting operations for the neutrino mode samples using the pion's information. All of the pion efficiency plots for neutrino mode are made with this file.

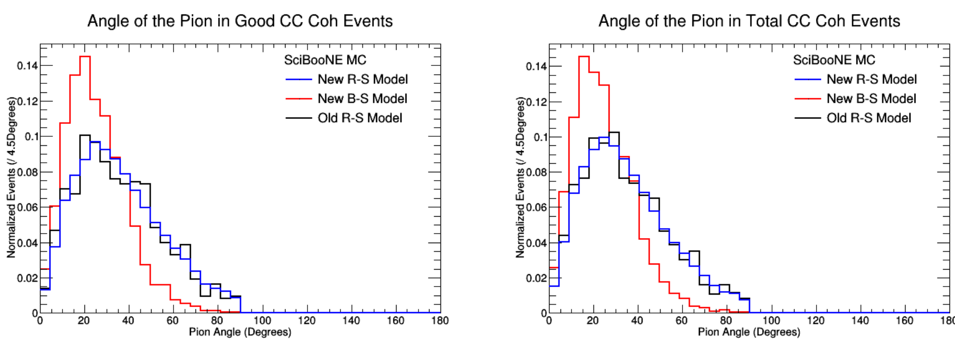

Figure 34: These are the angles of the pions in CC Coh Pion events in the ν mode samples. The left plot is the angles for the pions where the muon made it to the MRD and either stopped or went out the back face of the MRD. The right plot is the pion angles for all of the events that were classified as CC Coh Pion.

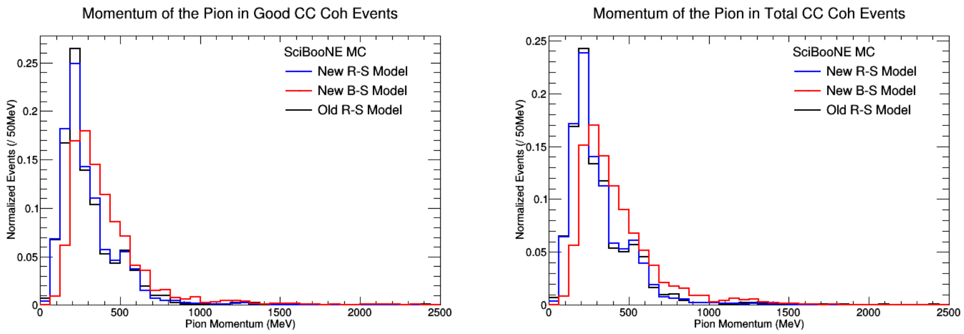

Figure 35: These are the momentums of the pions in CC Coh Pion events in the ν mode samples. The left plot is the angles for the pions where the muon made it to the MRD and either stopped or went out the back face of the MRD. The right plot is the pion momentums for all of the events that were classified as CC Coh Pion.

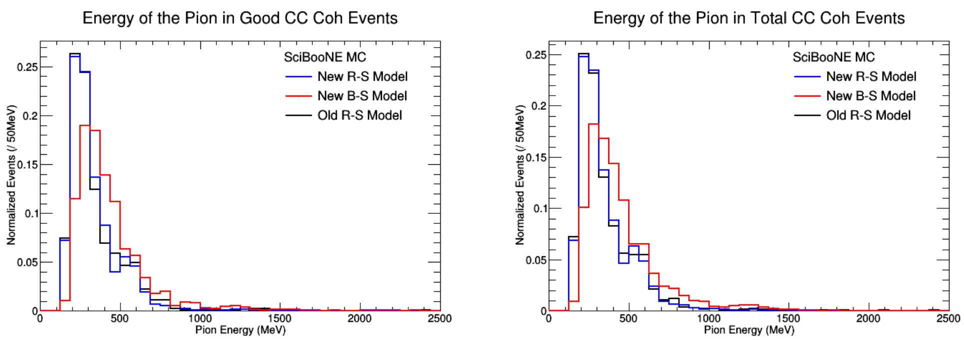

Figure 36: These are the energies of the pions in CC Coh Pion events in the ν mode samples. The left plot is the energies for the pions where the muon made it to the MRD and either stopped or went out the back face of the MRD. The right plot is the pion energies for all of the events that were classified as CC Coh Pion.

A.14 NMFourSquaredPlotting.C

All of the four-momentum transfer (both $|t|$ and Q^2) combined plots are made with this file for neutrino mode.

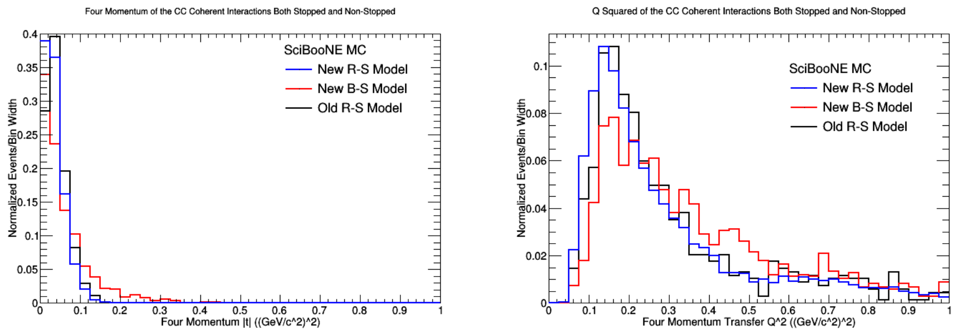

Figure 37: The $|t|$ Momentum Transfer for the "stopped" and "not-stopped" events (left) and Q^2 Momentum Transfer for the "stopped" and "not-stopped" events (right) for ν-mode CC-Coh $\pi^{+/-}$ interactions for the three models included in this study.

A.15 ANMCombinedPlots.C

This is the file that performs the main plotting operations for the anti-neutrino mode samples using the muon's information. All of the muon efficiency plots for anti-neutrino mode are made with this file.

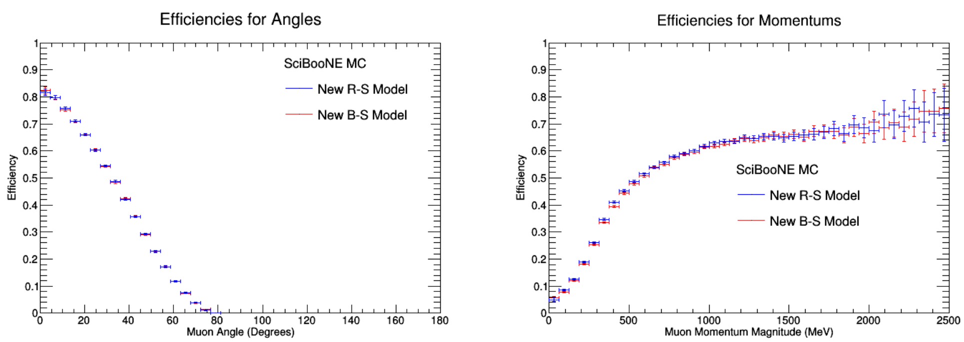

Figure 38: These are the $\bar{\nu}$ mode one dimensional efficiency plots of the two dimensional CC Inclusive efficiency plots that are below. The left is the angle efficiency plot and the right is the momentum efficiency plot for the muon.

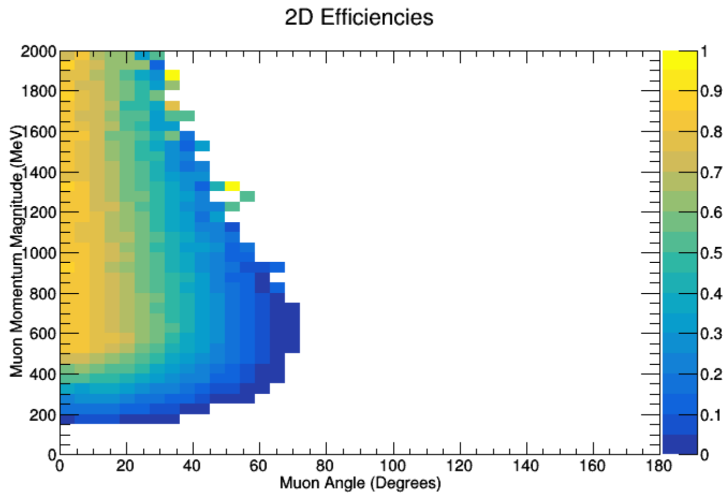

Figure 39: Two-dimensional efficiency plots for the $\bar{\nu}$-mode Rein-Sehgal CC-Inclusive sample.

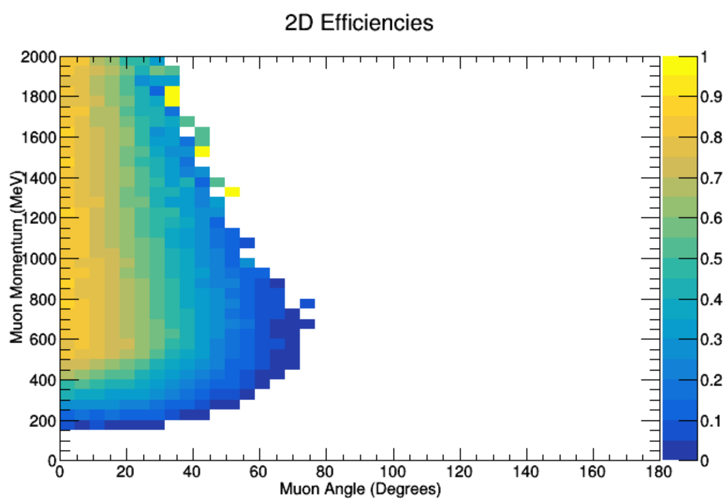

Figure 40: Two-dimensional efficiency plots for the $\bar{\nu}$-mode Berger-Sehgal CC-Inclusive sample.

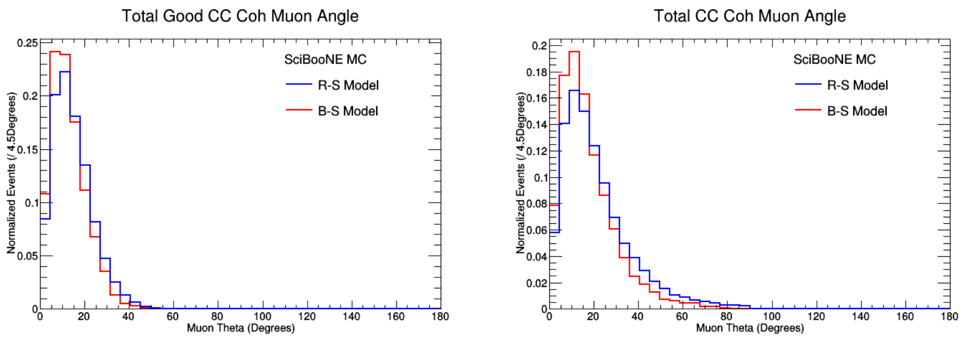

Figure 41: These are the two plots for muon angles in $\bar{\nu}$ mode that are used to make the one dimensional efficiency plot for the angles in CC Coh Pion events. The left is the plot for the events that had a muon make it to the front face of the MRD and the muon either stopped or went out the back face. The right plot is the muon angles for all of the events that were classified as CC Coh Pion. The left divided by the right gives the efficiency plot for the muon angles in CC Coh Pion events.

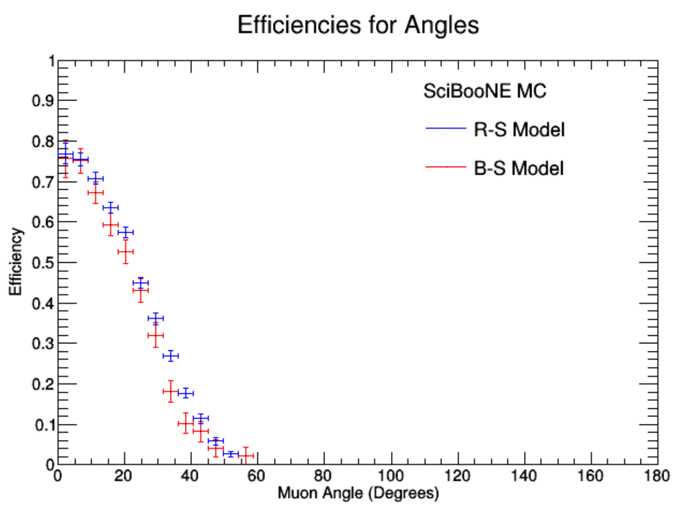

Figure 42: This is the one dimensional muon angles efficiency plot for the CC Coh Pion events from the $\bar{\nu}$ mode samples.

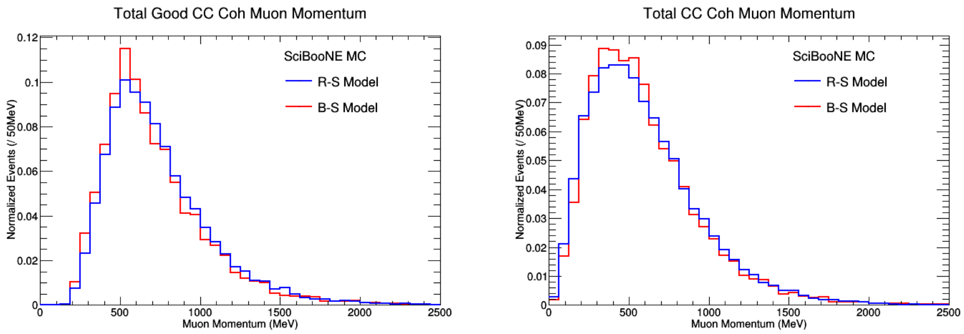

Figure 43: These are the two plots for muon momentums in $\bar{\nu}$ mode that are used to make the one dimensional efficiency plot for the momentums in CC Coh Pion events. The left is the plot for the events that had a muon make it to the front face of the MRD and the muon either stopped or went out the back face. The right plot is the muon momentums for all of the events that were classified as CC Coh Pion. The left divided by the right gives the efficiency plot for the muon momentums in CC Coh Pion events.

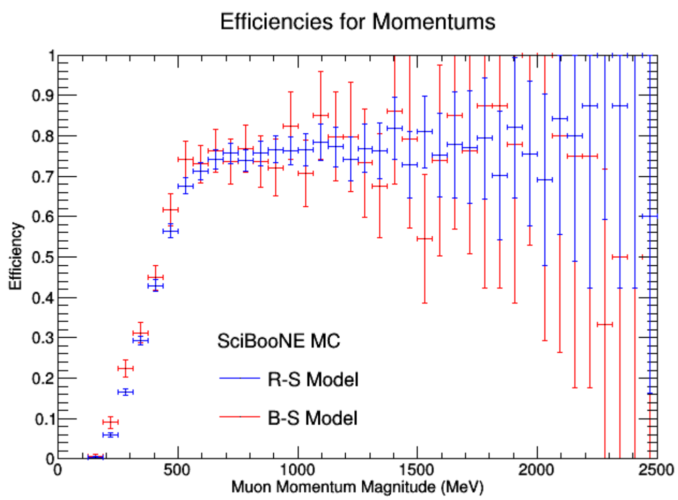

Figure 44: This is the one dimensional muon momentums efficiency plot for the CC Coh Pion events from the $\bar{\nu}$ mode samples.

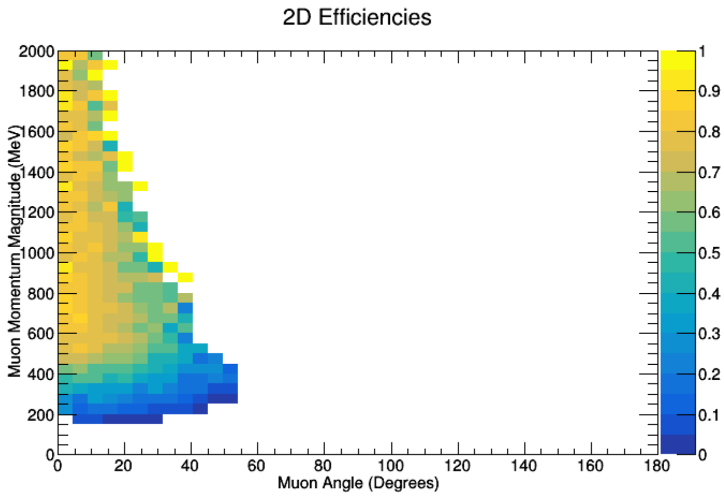

Figure 45: Two-dimensional efficiency plot for the new NEUT $\bar{\nu}$-mode Rein-Sehgal CC-Coherent sample.

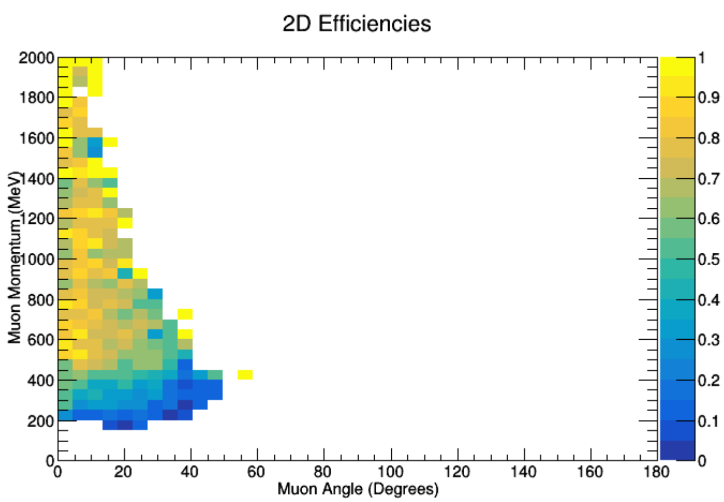

Figure 46: Two-dimensional efficiency plot for the new NEUT $\bar{\nu}$-mode Berger-Sehgal CC-Coherent sample.

A.16 ANMPionPlotting.C

This is the file that performs the main plotting operations for the anti-neutrino mode samples using the pion's information. All of the pion efficiency plots for anti-neutrino mode are made with this file.

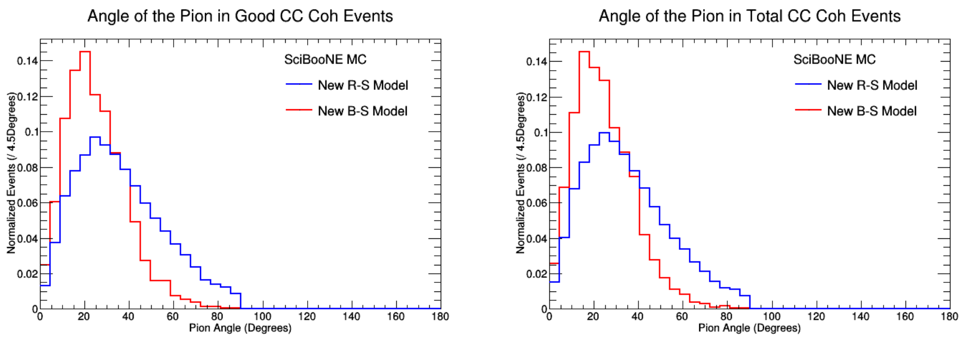

Figure 47: These are the angles of the pions in CC Coh Pion events in the $\bar{\nu}$ mode samples. The left plot is the angles for the pions where the muon made it to the MRD and either stopped or went out the back face of the MRD. The right plot is the pion angles for all of the events that were classified as CC Coh Pion.

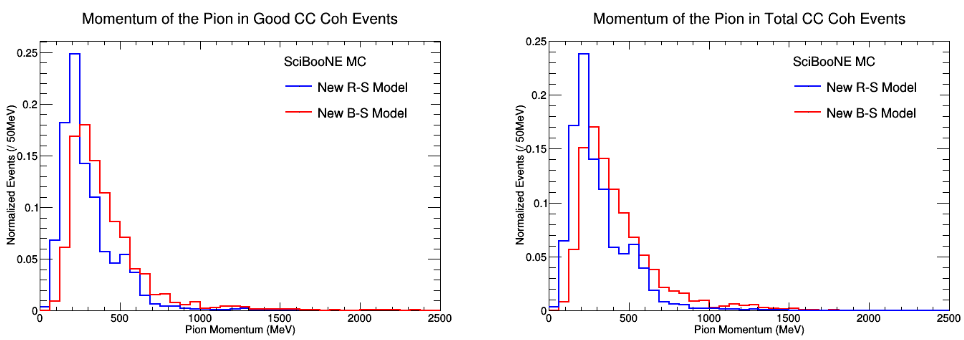

Figure 48: These are the momentums of the pions in CC Coh Pion events in the $\bar{\nu}$ mode samples. The left plot is the momentums for the pions where the muon made it to the MRD and either stopped or went out the back face of the MRD. The right plot is the pion momentums for all of the events that were classified as CC Coh Pion.

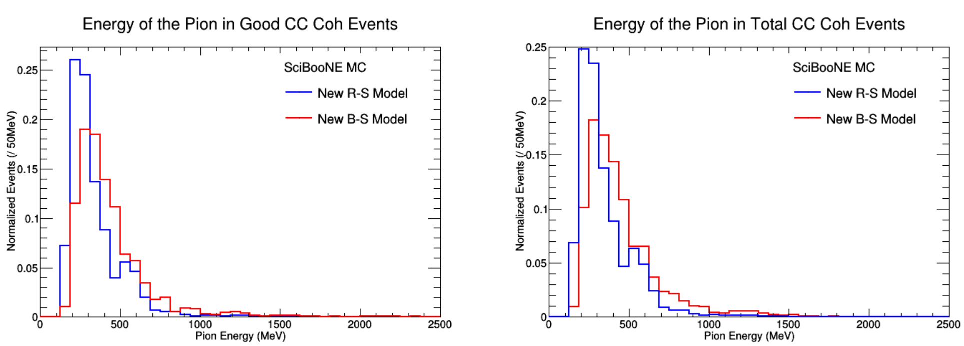

Figure 49: These are the energies of the pions in CC Coh Pion events in the $\bar{\nu}$ mode samples. The left plot is the energies for the pions where the muon made it to the MRD and either stopped or went out the back face of the MRD. The right plot is the pion energies for all of the events that were classified as CC Coh Pion.

A.17 ANMFourSquaredPlotting.C

All of the four-momentum transfer (both $|t|$ and Q^2) combined plots are made with this file for anti-neutrino mode.

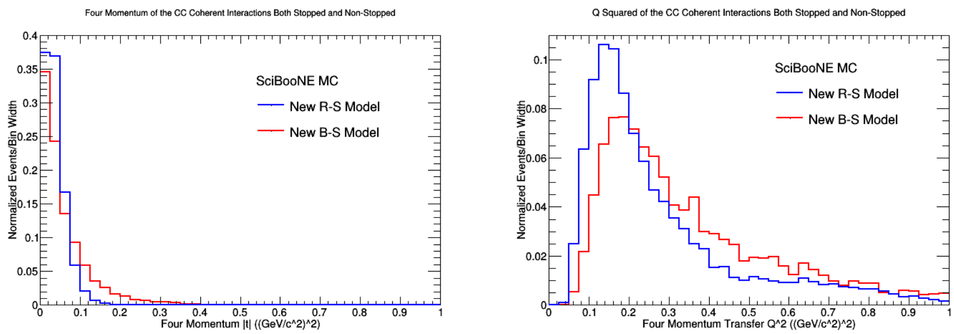

Figure 50: The $|t|$ Momentum Transfer (left) and Q^2 Momentum Transfer (right) for $\bar{\nu}$-mode CC-Coh $\pi^{+/-}$ interactions for both of the models included in this study which are the "stopped" and "not-stopped" events.

B Efficiency Tables

These are the corresponding tables to the 2D Efficiency plots for CC-Inclusive events.

Table 3: Table for 2D Histogram for New NM-Rein-Sehgal

New NM R-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0	0	0	0.09375	0.259259	0.26087	0.317073	0.45	0.553846	0.716049	0.816092	0.828829	0.842975	0.845455	0.773438	0.875	0.796748	0.798611	0.870504	0.819549	0.834532	0.852174	0.88785	0.762712	0.807692	0.802198	0.811321	0.835443	0.753086	0.779412	0.783333	0.936508	0.8	0.921569	0.921569	0.77193	0.848485	0.861111	0.826087	0.823529
4.5-9 Deg	0	0	0	0.123457	0.244681	0.218182	0.40411	0.490291	0.568376	0.766102	0.824047	0.789617	0.844186	0.80404	0.828302	0.807771	0.816514	0.820841	0.809981	0.79823	0.803922	0.828974	0.800875	0.820276	0.789474	0.798982	0.801136	0.774026	0.79868	0.744186	0.742424	0.784091	0.770642	0.790476	0.754717	0.774194	0.79375	0.813793	0.748387	0.785714
9-13.5 Deg	0	0	0	0.0280374	0.150943	0.31	0.334426	0.479167	0.582	0.693122	0.795417	0.787402	0.784336	0.786013	0.779396	0.757746	0.77907	0.784038	0.763083	0.776828	0.74026	0.760633	0.746401	0.713326	0.746803	0.720867	0.735724	0.721683	0.72093	0.716946	0.727468	0.697572	0.704835	0.730978	0.747774	0.70068	0.684982	0.73029	0.623853	0.713615
13.5-18 Deg	0	0	0	0.0696203	0.164502	0.242902	0.389937	0.460102	0.524072	0.648363	0.73062	0.742788	0.7373	0.725131	0.707711	0.713192	0.708657	0.71437	0.713376	0.722747	0.704342	0.713103	0.697987	0.688694	0.708895	0.681319	0.674493	0.661465	0.680731	0.635036	0.657848	0.664093	0.618938	0.648718	0.634561	0.598291	0.63871	0.638686	0.630252	0.614407
18-22.5 Deg	0	0	0	0.0396825	0.134503	0.220374	0.320233	0.4	0.498252	0.56578	0.666667	0.703245	0.681216	0.694102	0.67205	0.674541	0.661496	0.647185	0.673965	0.656648	0.660068	0.632723	0.652881	0.627978	0.634488	0.606524	0.599138	0.600991	0.58926	0.585284	0.56654	0.562092	0.581633	0.546547	0.532051	0.582707	0.517647	0.569507	0.530055	0.5625
22.5-27 Deg	0	0	0	0.0341615	0.120614	0.20088	0.284783	0.356223	0.442424	0.513469	0.590521	0.619898	0.653967	0.628604	0.61255	0.617109	0.601285	0.58894	0.579674	0.578595	0.57636	0.56538	0.564828	0.553719	0.550962	0.498274	0.550685	0.566828	0.500901	0.497826	0.511166	0.513605	0.453674	0.539095	0.447761	0.428571	0.476821	0.462963	0.379032	0.435185
27-31.5 Deg	0	0	0	0.0128535	0.0852575	0.146399	0.240517	0.328982	0.381593	0.467435	0.496599	0.55869	0.57336	0.536199	0.537204	0.545332	0.542526	0.532462	0.524605	0.503756	0.498278	0.493626	0.481938	0.446392	0.463785	0.474016	0.465487	0.389868	0.438953	0.384615	0.484375	0.360577	0.414634	0.34058	0.242991	0.416667	0.405941	0.333333	0.25974	0.403846
31.5-36 Deg	0	0	0	0.00618557	0.047749	0.138308	0.215553	0.260465	0.322889	0.379459	0.44563	0.489885	0.50075	0.5	0.512734	0.486242	0.465472	0.455387	0.439182	0.459893	0.432253	0.403556	0.432373	0.361111	0.379648	0.411483	0.370968	0.307116	0.361702	0.355191	0.294118	0.293578	0.337349	0.328571	0.272727	0.34375	0.227273	0.290323	0.25	0.380952
36-40.5 Deg	0	0	0	0	0.0376749	0.104341	0.167825	0.228974	0.272658	0.326716	0.35271	0.399772	0.4	0.410602	0.420808	0.416728	0.404237	0.378892	0.371585	0.362308	0.373851	0.336748	0.352837	0.316279	0.293333	0.333333	0.282609	0.182432	0.261194	0.25	0.430556	0.191489	0.127273	0.238095	0.2	0.25	0.0714286	0.25	0.1	0.333333
40.5-45 Deg	0	0	0	0	0.0185547	0.0617036	0.129648	0.175194	0.22549	0.249335	0.297987	0.31442	0.331903	0.342802	0.33975	0.324022	0.312566	0.299735	0.293671	0.284258	0.264297	0.2897	0.274247	0.191235	0.220238	0.204918	0.309524	0.147059	0.169014	0.30303	0.16	0.0909091	0.1875	0.1875	0.166667	0	0.2	0	0.5	0
45-49.5 Deg	0	0	0	0	0.00241935	0.0461908	0.0861688	0.129907	0.177771	0.209127	0.220634	0.249649	0.260561	0.269592	0.273593	0.258347	0.252889	0.239492	0.238606	0.221135	0.144772	0.168675	0.216867	0.15534	0.182927	0.113636	0.0645161	0.148148	0.117647	0.0769231	0	0.6	0	0	0	0.25	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0.0115123	0.0555327	0.102639	0.123702	0.161442	0.165696	0.190045	0.182172	0.214009	0.188606	0.193939	0.207	0.177469	0.140187	0.124514	0.10119	0.178295	0.145161	0.0740741	0.08	0.142857	0.2	0	0	0.1	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0.0248494	0.0445331	0.0810889	0.106105	0.109863	0.131459	0.132259	0.121872	0.135764	0.133188	0.12807	0.106557	0.122172	0.0814815	0.0571429	0.1	0.0322581	0	0.1	0.333333	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0.0165922	0.0418139	0.0557781	0.0744786	0.0831667	0.0781828	0.0883686	0.0845225	0.0654045	0.074184	0.0883721	0.0841121	0.0405405	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00645756	0.018006	0.0306081	0.0433498	0.053756	0.044898	0.0724638	0.044586	0.0347222	0.0641026	0.0243902	0	0.136364	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00228571	0.0041686	0.0121873	0.017341	0.020155	0.0234114	0.0121212	0.0131579	0.075	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00540541	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4: Table for 2D Histogram for New NM-Berger-Sehgal

New NM B-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450
0-4.5 Deg	0	0	0	0	0.157895	0.325	0.422222	0.490566	0.615385
4.5-9 Deg	0	0	0	0.0625	0.176471	0.235849	0.396694	0.478261	0.581731
9-13.5 Deg	0	0	0	0.09375	0.156716	0.223529	0.362963	0.463343	0.5725
13.5-18 Deg	0	0	0	0.0382166	0.131222	0.260736	0.330233	0.448833	0.566116
18-22.5 Deg	0	0	0	0.039604	0.0973451	0.228145	0.318462	0.419903	0.517013
22.5-27 Deg	0	0	0	0.0264026	0.0930736	0.197461	0.321879	0.381265	0.447548
27-31.5 Deg	0	0	0	0.00486618	0.0857143	0.152859	0.25358	0.312166	0.395361
31.5-36 Deg	0	0	0	0.00754717	0.0815217	0.142292	0.218271	0.283494	0.333753
36-40.5 Deg	0	0	0	0	0.032538	0.0817963	0.170164	0.233583	0.275212
40.5-45 Deg	0	0	0	0	0.0139147	0.0678972	0.129657	0.192308	0.224483
45-49.5 Deg	0	0	0	0	0.00251467	0.0392938	0.0940285	0.141328	0.181437
49.5-54 Deg	0	0	0	0	0	0.0110121	0.0531873	0.0958814	0.126534
54-58.5 Deg	0	0	0	0	0	0.000456204	0.0199623	0.0552683	0.0810965
58.5-63 Deg	0	0	0	0	0	0	0.000714286	0.0128637	0.0467906
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00745573
67.5-72 Deg	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0

New NM B-S	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950
0-4.5 Deg	0.728571	0.895522	0.807692	0.880435	0.864865	0.843373	0.833333	0.858333	0.833333	0.826087
4.5-9 Deg	0.773279	0.811448	0.817109	0.806366	0.801402	0.814286	0.809211	0.804211	0.755448	0.822709
9-13.5 Deg	0.701245	0.78089	0.798354	0.801724	0.794569	0.782796	0.780287	0.765235	0.773496	0.756598
13.5-18 Deg	0.634994	0.727545	0.736387	0.720152	0.749489	0.762791	0.732403	0.711937	0.704908	0.702804
18-22.5 Deg	0.582547	0.656707	0.692351	0.687027	0.677215	0.689404	0.661647	0.651855	0.661634	0.65554
22.5-27 Deg	0.521715	0.578365	0.637657	0.629688	0.615445	0.637963	0.622396	0.604258	0.581746	0.570899
27-31.5 Deg	0.466491	0.496522	0.564516	0.564264	0.554788	0.551891	0.55257	0.548276	0.521099	0.517559
31.5-36 Deg	0.381784	0.436444	0.472969	0.488325	0.492462	0.479326	0.494505	0.47549	0.45864	0.461108
36-40.5 Deg	0.327416	0.366159	0.387514	0.419254	0.425045	0.403834	0.392764	0.396559	0.400812	0.369942
40.5-45 Deg	0.252462	0.30273	0.319185	0.342679	0.345987	0.330502	0.331052	0.323815	0.305906	0.312284
45-49.5 Deg	0.212241	0.24064	0.244851	0.261486	0.269272	0.268868	0.255423	0.239971	0.254059	0.219613
49.5-54 Deg	0.148936	0.169353	0.187424	0.203203	0.19403	0.204905	0.197958	0.161453	0.159744	0.142512
54-58.5 Deg	0.102659	0.119633	0.118058	0.129529	0.135933	0.125182	0.118211	0.109568	0.118863	0.117073
58.5-63 Deg	0.0568421	0.0634228	0.0796216	0.0780856	0.0909091	0.0960929	0.0849558	0.0780781	0.103825	0.0458716
63-67.5 Deg	0.0242928	0.0364188	0.0436258	0.0367232	0.039666	0.0363636	0.0426136	0.0162162	0.0357143	0.0227273
67.5-72 Deg	0.000740466	0.00470367	0.0114213	0.0195072	0.0166667	0.0120482	0	0	0.03125	0
72-76.5 Deg	0	0	0	0	0.00280899	0.00649351	0.0123457	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

New NM B-S	950-1000	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450
0-4.5 Deg	0.814815	0.778846	0.8	0.813725	0.829268	0.84375	0.78022	0.783133	0.898734	0.85
4.5-9 Deg	0.792657	0.804255	0.824945	0.804494	0.814536	0.784504	0.774295	0.813665	0.792994	0.764706
9-13.5 Deg	0.759384	0.766798	0.776286	0.733735	0.717208	0.731677	0.730769	0.708861	0.728296	0.755835
13.5-18 Deg	0.683544	0.703634	0.7086	0.706101	0.683544	0.700457	0.681775	0.68321	0.68171	0.669251
18-22.5 Deg	0.634515	0.653195	0.635392	0.641326	0.620074	0.60516	0.579566	0.597895	0.612863	0.599419
22.5-27 Deg	0.569778	0.571276	0.570789	0.557559	0.528678	0.526667	0.524138	0.529101	0.509404	0.499093
27-31.5 Deg	0.518553	0.515256	0.490654	0.476651	0.444332	0.474736	0.456456	0.431408	0.465169	0.451791
31.5-36 Deg	0.451835	0.42583	0.411765	0.437118	0.397764	0.406551	0.405963	0.389205	0.33564	0.381395
36-40.5 Deg	0.368859	0.345339	0.357923	0.325411	0.296117	0.300654	0.38785	0.366279	0.328	0.348624
40.5-45 Deg	0.313023	0.294294	0.264706	0.272981	0.214286	0.233918	0.189474	0.197368	0.231884	0.222222
45-49.5 Deg	0.205285	0.236769	0.215859	0.180723	0.158879	0.169014	0.0588235	0.0833333	0.166667	0.136364
49.5-54 Deg	0.151292	0.132184	0.133858	0.0869565	0.097561	0.0769231	0.0909091	0	0	0
54-58.5 Deg	0.108844	0.0617284	0.0851064	0.0344828	0.0909091	0	0.111111	0	0	0.5
58.5-63 Deg	0	0.0333333	0	0	0	0	0	0	0	0
63-67.5 Deg	0.0416667	0.0714286	0.166667	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

New NM B-S	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0.825397	0.873016	0.767442	0.779661	0.847826	0.836735	0.809524	0.861111	0.794872	0.944444	0.833333
4.5-9 Deg	0.790036	0.793651	0.741784	0.728643	0.759657	0.734884	0.770053	0.780749	0.761905	0.791908	0.794521
9-13.5 Deg	0.75089	0.708249	0.717833	0.664251	0.747423	0.700581	0.688679	0.681967	0.69338	0.745763	0.685039
13.5-18 Deg	0.644678	0.668863	0.66548	0.643629	0.637168	0.643038	0.62973	0.607973	0.666667	0.621212	0.622711
18-22.5 Deg	0.5856	0.590654	0.587156	0.558376	0.564607	0.52568	0.568093	0.52549	0.575342	0.497696	0.557471
22.5-27 Deg	0.539326	0.484043	0.5	0.535354	0.441767	0.436681	0.482587	0.40113	0.496599	0.461538	0.454545
27-31.5 Deg	0.405145	0.433735	0.416667	0.362245	0.333333	0.411765	0.283951	0.402439	0.363636	0.285714	0.396825
31.5-36 Deg	0.393333	0.277372	0.293103	0.308642	0.246753	0.34375	0.181818	0.108108	0.25	0.258065	0.137931
36-40.5 Deg	0.204819	0.232143	0.186047	0.181818	0.214286	0.285714	0.214286	0.333333	0.166667	0.285714	0.181818
40.5-45 Deg	0.157895	0.2	0.0526316	0.428571	0.0588235	0.166667	0.166667	0.25	0	0	1
45-49.5 Deg	0.25	0.0714286	0.333333	0.2	1	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0

Table 5: Table for 2D Histogram for Old NM-Rein-Sehgal

Old NM R-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500
0-4.5 Deg	0	0	0	0	0.333333	0.5	0.5	0.8	0.857143	0.5
4.5-9 Deg	0	0	0	0	0	0.25	0.285714	0.470588	0.466667	0.608696
9-13.5 Deg	0	0	0	0	0.0769231	0.181818	0.285714	0.451613	0.625	0.642857
13.5-18 Deg	0	0	0	0.0714286	0.15	0.290323	0.365854	0.509091	0.621622	0.630952
18-22.5 Deg	0	0	0	0.0571429	0.0689655	0.184211	0.242424	0.505155	0.474227	0.56
22.5-27 Deg	0	0	0	0.0416667	0.04	0.247059	0.280488	0.346154	0.518797	0.465969
27-31.5 Deg	0	0	0	0.0217391	0.0615385	0.1375	0.16	0.296296	0.390863	0.466981
31.5-36 Deg	0	0	0	0.0816327	0.097561	0.07	0.244444	0.290503	0.384259	0.364407
36-40.5 Deg	0	0	0	0	0.04	0.133333	0.155172	0.235577	0.282609	0.296296
40.5-45 Deg	0	0	0	0	0	0.0869565	0.15122	0.161017	0.256228	0.271875
45-49.5 Deg	0	0	0	0	0	0.0434783	0.0843882	0.141176	0.163462	0.159322
49.5-54 Deg	0	0	0	0	0	0.0108696	0.0636364	0.0816327	0.160819	0.133144
54-58.5 Deg	0	0	0	0	0	0	0.023622	0.0238095	0.0320513	0.107463
58.5-63 Deg	0	0	0	0	0	0	0	0.0129032	0.0397554	0.0555556
63-67.5 Deg	0	0	0	0	0	0	0	0	0.0056338	0.0241379
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00338983
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

Old NM R-S	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000
0-4.5 Deg	0.666667	1	0.857143	0.7	0.777778	0.875	0.909091	0.777778	1	0.769231
4.5-9 Deg	0.904762	0.9	0.65	0.8	0.74359	0.877551	0.65	0.782609	0.792453	0.810811
9-13.5 Deg	0.765957	0.721519	0.813953	0.734177	0.732558	0.77907	0.744681	0.865979	0.746988	0.76087
13.5-18 Deg	0.682692	0.773109	0.722222	0.739726	0.70229	0.719178	0.711656	0.753425	0.726115	0.735099
18-22.5 Deg	0.647482	0.656442	0.609929	0.648936	0.705069	0.695187	0.643216	0.673267	0.651961	0.616505
22.5-27 Deg	0.602679	0.631818	0.658291	0.668224	0.632959	0.659574	0.617647	0.593458	0.614213	0.654054
27-31.5 Deg	0.520492	0.59761	0.522727	0.544061	0.550781	0.516981	0.592437	0.524887	0.513228	0.49359
31.5-36 Deg	0.435252	0.453925	0.540881	0.461017	0.456311	0.462838	0.493878	0.474654	0.45	0.416667
36-40.5 Deg	0.37785	0.377049	0.41195	0.424749	0.422222	0.376518	0.409692	0.394737	0.407407	0.360825
40.5-45 Deg	0.289894	0.306818	0.291545	0.340557	0.366534	0.316742	0.337423	0.28777	0.29661	0.257576
45-49.5 Deg	0.242331	0.231003	0.263699	0.285156	0.27907	0.270115	0.273973	0.259259	0.347222	0.285714
49.5-54 Deg	0.170588	0.169381	0.212996	0.220588	0.220238	0.15942	0.142857	0.122807	0.236364	0.129032
54-58.5 Deg	0.107595	0.110701	0.105991	0.138728	0.186992	0.13253	0.176471	0.131579	0	0.357143
58.5-63 Deg	0.0724638	0.0979592	0.0942408	0.0787402	0.0487805	0.0754717	0.15625	0.0416667	0	0.125
63-67.5 Deg	0.0125523	0.0380952	0.04	0.0869565	0	0.0689655	0	0	0	0
67.5-72 Deg	0	0.0212766	0.010989	0.0222222	0	0	0.111111	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

Old NM R-S	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500
0-4.5 Deg	0.8	0.777778	1	0.75	0.75	1	0.6	0.833333	1	0.833333
4.5-9 Deg	0.866667	0.807692	0.815789	0.8	0.74359	0.861111	0.923077	0.825	0.875	0.833333
9-13.5 Deg	0.747253	0.851064	0.776316	0.683544	0.791045	0.686567	0.862069	0.706897	0.660377	0.755556
13.5-18 Deg	0.70068	0.688889	0.705357	0.688679	0.711538	0.705882	0.670588	0.694444	0.68	0.677966
18-22.5 Deg	0.639535	0.641176	0.666667	0.635593	0.59375	0.59375	0.6	0.652174	0.625	0.708333
22.5-27 Deg	0.529801	0.594937	0.503817	0.591398	0.653465	0.52	0.578947	0.413793	0.568966	0.377778
27-31.5 Deg	0.531034	0.475	0.521008	0.465116	0.406593	0.517857	0.490566	0.487179	0.444444	0.347826
31.5-36 Deg	0.470588	0.465909	0.454545	0.376812	0.436364	0.348837	0.541667	0.238095	0.4	0.266667
36-40.5 Deg	0.317308	0.397436	0.267857	0.272727	0.285714	0.380952	0.176471	0.2	0.117647	0.166667
40.5-45 Deg	0.140351	0.318182	0.307692	0.208333	0.357143	0.25	0.375	0.25	0.2	0
45-49.5 Deg	0.28	0.217391	0.111111	0.1	0.0833333	0.166667	0.25	0	0.333333	1
49.5-54 Deg	0.0714286	0.1	0.142857	0	0	0	0	0	0	0
54-58.5 Deg	0.1	0	0	0	0	0.333333	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

Old NM R-S	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0.909091	0.75	0.666667	1	0	0.666667	0	0.8	1	1
4.5-9 Deg	0.761905	0.85	0.8	0.823529	0.652174	0.923077	0.857143	0.882353	0.533333	0.85
9-13.5 Deg	0.688889	0.604651	0.933333	0.638298	0.714286	0.826087	0.958333	0.842105	0.777778	0.708333
13.5-18 Deg	0.586957	0.653846	0.612245	0.65625	0.68	0.7	0.625	0.76	0.75	0.565217
18-22.5 Deg	0.568182	0.634146	0.461538	0.423077	0.625	0.47619	0.47619	0.76	0.611111	0.722222
22.5-27 Deg	0.666667	0.5	0.444444	0.473684	0.458333	0.647059	0.615385	0.45	0.4	0.333333
27-31.5 Deg	0.380952	0.4	0.384615	0.454545	0.1	0.333333	0.375	0.625	0.2	0.25
31.5-36 Deg	0.3125	0.533333	0.352941	0.4	0.571429	0.222222	0.166667	0	0.666667	0.5
36-40.5 Deg	0.333333	0.333333	0.5	0.285714	0.5	0	0	0	0	0
40.5-45 Deg	0	0	0.5	0	0	0	0	1	0	0
45-49.5 Deg	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

Table 6: Table for 2D Histogram for New ANM-Rein-Sehgal

New ANM R-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500
0-4.5 Deg	0	0	0	0.037037	0.173913	0.225352	0.398693	0.510204	0.585034	0.741325
4.5-9 Deg	0	0	0	0.0538922	0.179487	0.264881	0.351406	0.522654	0.611905	0.722011
9-13.5 Deg	0	0	0	0.0881226	0.175824	0.272864	0.369565	0.47927	0.562628	0.680187
13.5-18 Deg	0	0	0	0.0502959	0.162912	0.264642	0.372408	0.45271	0.529918	0.642998
18-22.5 Deg	0	0	0	0.0477273	0.135068	0.240964	0.32415	0.42098	0.500719	0.578125
22.5-27 Deg	0	0	0	0.0256881	0.127932	0.186722	0.284972	0.381885	0.46546	0.511835
27-31.5 Deg	0	0	0	0.0135747	0.0779102	0.157462	0.237522	0.318072	0.385341	0.455377
31.5-36 Deg	0	0	0	0.00265957	0.0702447	0.140581	0.21821	0.292653	0.342622	0.394628
36-40.5 Deg	0	0	0	0	0.0358187	0.107342	0.168067	0.222502	0.294331	0.333169
40.5-45 Deg	0	0	0	0	0.0164051	0.0757272	0.131076	0.200825	0.226708	0.268313
45-49.5 Deg	0	0	0	0	0	0.0478888	0.099454	0.13113	0.177444	0.212046
49.5-54 Deg	0	0	0	0	0	0.0114405	0.0658882	0.103003	0.127891	0.149639
54-58.5 Deg	0	0	0	0	0	0.000554017	0.0170428	0.0537772	0.0883421	0.116889
58.5-63 Deg	0	0	0	0	0	0	0.0010015	0.020202	0.0406544	0.0526316
63-67.5 Deg	0	0	0	0	0	0	0	0.00108167	0.00447928	0.0226148
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

New ANM R-S	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000
0-4.5 Deg	0.812332	0.808989	0.820399	0.80597	0.846154	0.826087	0.834821	0.846791	0.849776	0.814732
4.5-9 Deg	0.822749	0.806912	0.812763	0.807565	0.807477	0.80314	0.805654	0.802672	0.816404	0.79961
9-13.5 Deg	0.778963	0.784609	0.775579	0.77094	0.780604	0.772247	0.778919	0.774887	0.769928	0.777286
13.5-18 Deg	0.714241	0.754711	0.746173	0.739165	0.72958	0.736591	0.712291	0.723065	0.699029	0.705178
18-22.5 Deg	0.669713	0.700024	0.693197	0.686785	0.675302	0.676973	0.671911	0.662691	0.649262	0.656827
22.5-27 Deg	0.587483	0.641457	0.609761	0.630852	0.616002	0.610015	0.585767	0.589724	0.588134	0.57303
27-31.5 Deg	0.527993	0.566528	0.573181	0.550737	0.538564	0.550457	0.533736	0.525933	0.509007	0.512922
31.5-36 Deg	0.429609	0.48047	0.502938	0.499068	0.49538	0.462372	0.47797	0.465828	0.428421	0.439291
36-40.5 Deg	0.361301	0.382382	0.418154	0.431897	0.40234	0.403238	0.388569	0.407134	0.374224	0.366126
40.5-45 Deg	0.30581	0.320273	0.346117	0.33394	0.333774	0.343066	0.307036	0.329013	0.279793	0.27593
45-49.5 Deg	0.222903	0.250172	0.254128	0.270336	0.280552	0.252766	0.235294	0.240708	0.214834	0.218107
49.5-54 Deg	0.172282	0.178556	0.193367	0.190678	0.185291	0.18963	0.175556	0.136364	0.150327	0.116279
54-58.5 Deg	0.122696	0.124613	0.143336	0.139043	0.133106	0.130564	0.121076	0.105263	0.0547945	0.114286
58.5-63 Deg	0.0724161	0.0817391	0.077907	0.0850662	0.0868263	0.0772947	0.0462963	0.0454545	0.0555556	0
63-67.5 Deg	0.0374384	0.0423729	0.0439122	0.0482759	0.0424242	0.025	0.125	0	0.125	0
67.5-72 Deg	0.00515464	0.0103093	0.0144928	0.00714286	0.0289855	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

New ANM R-S	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500
0-4.5 Deg	0.811494	0.835	0.820728	0.821212	0.820946	0.829352	0.86385	0.785124	0.834906	0.820896
4.5-9 Deg	0.808895	0.780172	0.79495	0.806396	0.799636	0.809524	0.799766	0.790123	0.793201	0.770154
9-13.5 Deg	0.764215	0.756151	0.769636	0.756423	0.745802	0.736299	0.725795	0.729068	0.731919	0.712513
13.5-18 Deg	0.708415	0.69735	0.68934	0.693381	0.700468	0.682373	0.673329	0.680972	0.660094	0.631818
18-22.5 Deg	0.646345	0.649693	0.62265	0.628975	0.613897	0.596406	0.591174	0.582904	0.568153	0.597598
22.5-27 Deg	0.583082	0.5553	0.564074	0.557719	0.53367	0.554507	0.527886	0.535211	0.501099	0.488432
27-31.5 Deg	0.498878	0.50292	0.473382	0.487885	0.490838	0.454704	0.467192	0.428571	0.405405	0.464286
31.5-36 Deg	0.425238	0.420697	0.393846	0.374753	0.375394	0.398374	0.379121	0.342857	0.27907	0.290323
36-40.5 Deg	0.347445	0.358079	0.315942	0.337449	0.296512	0.306931	0.295082	0.265625	0.192308	0.2
40.5-45 Deg	0.311653	0.287736	0.211538	0.186275	0.203125	0.222222	0.111111	0.272727	0.2	0
45-49.5 Deg	0.251908	0.234043	0.2	0.307692	0.235294	0	0.4	0	0	0
49.5-54 Deg	0.125	0.181818	0.0833333	0	0.5	0	1	0	0	0
54-58.5 Deg	0.157895	0	0	0	0	0.5	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

New ANM R-S	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0.815642	0.802721	0.80315	0.8	0.836538	0.855556	0.808989	0.783784	0.884058	0.705882
4.5-9 Deg	0.790738	0.80036	0.792494	0.733146	0.794798	0.766323	0.734982	0.759091	0.770335	0.812155
9-13.5 Deg	0.703791	0.716617	0.724876	0.71537	0.701461	0.718579	0.711409	0.698052	0.719368	0.688776
13.5-18 Deg	0.63144	0.590237	0.677481	0.628692	0.681818	0.648734	0.609848	0.615385	0.643275	0.635714
18-22.5 Deg	0.59465	0.57381	0.533875	0.509091	0.476852	0.57377	0.569231	0.522523	0.635294	0.603175
22.5-27 Deg	0.481343	0.509091	0.469388	0.515385	0.494382	0.472222	0.490909	0.390244	0.647059	0.321429
27-31.5 Deg	0.381679	0.402062	0.346154	0.348837	0.358974	0.55	0.307692	0.25	0.125	0.5
31.5-36 Deg	0.282051	0.592593	0.333333	0.533333	0.75	0	0.6	1	0	0
36-40.5 Deg	0.142857	0.166667	0	0.5	0	0	0	0	0	0
40.5-45 Deg	0.333333	0	0	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

Table 7: Table for 2D Histogram for New ANM-Berger-Sehgal

New ANM B-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0	0	0	0.0930233	0.144737	0.283186	0.421384	0.494898	0.668161	0.710247	0.805861	0.796703	0.834184	0.844907	0.827907	0.866324	0.843458	0.855072	0.83208	0.813433	0.818653	0.841432	0.806366	0.833866	0.867133	0.840741	0.819005	0.813084	0.83	0.886667	0.823129	0.825397	0.871795	0.825243	0.824074	0.797297	0.815789	0.774194	0.823529	0.809524
4.5-9 Deg	0	0	0	0.0166667	0.165094	0.269231	0.4	0.541667	0.613402	0.732694	0.797824	0.812245	0.82494	0.814583	0.823051	0.812541	0.792568	0.781479	0.804378	0.794982	0.805085	0.823664	0.813322	0.809233	0.801491	0.754923	0.791063	0.783712	0.79661	0.793729	0.777403	0.774319	0.787879	0.784741	0.817629	0.771523	0.778723	0.776824	0.762376	0.821229
9-13.5 Deg	0	0	0	0.0700935	0.130919	0.271667	0.353012	0.480322	0.569575	0.68139	0.781754	0.795837	0.774114	0.785362	0.773578	0.781475	0.76586	0.762567	0.752009	0.761471	0.748873	0.73664	0.739656	0.735498	0.72956	0.755391	0.720774	0.711163	0.74169	0.714434	0.730546	0.70028	0.702786	0.692029	0.698795	0.727488	0.698895	0.694079	0.706827	0.663507
13.5-18 Deg	0	0	0	0.0401338	0.149742	0.265497	0.336059	0.414129	0.536284	0.638281	0.728386	0.717996	0.747335	0.748866	0.736466	0.7337	0.731489	0.723615	0.700111	0.714206	0.71014	0.691088	0.695486	0.679018	0.673116	0.66913	0.689633	0.664591	0.685662	0.667735	0.664188	0.656201	0.664884	0.654737	0.652068	0.615894	0.627737	0.628571	0.650888	0.613924
18-22.5 Deg	0	0	0	0.0277778	0.137174	0.23849	0.319925	0.423721	0.499227	0.57533	0.655519	0.701815	0.686171	0.689579	0.686069	0.673434	0.65566	0.6686	0.647105	0.657014	0.636641	0.624197	0.638889	0.646891	0.628604	0.584667	0.586435	0.624873	0.603365	0.570149	0.581722	0.600887	0.607558	0.583333	0.531915	0.573034	0.525641	0.527559	0.552632	0.487179
22.5-27 Deg	0	0	0	0.0196464	0.109134	0.204236	0.312057	0.385731	0.447873	0.516755	0.600138	0.645331	0.628718	0.629526	0.604035	0.609545	0.603815	0.602548	0.578702	0.597386	0.569439	0.583187	0.543649	0.537295	0.536066	0.55848	0.548585	0.504687	0.518738	0.493639	0.501502	0.469828	0.469945	0.477273	0.443299	0.445783	0.442623	0.297297	0.405405	0.482759
27-31.5 Deg	0	0	0	0.00315956	0.104046	0.165109	0.256264	0.322028	0.397871	0.445264	0.512134	0.574856	0.561587	0.558263	0.539545	0.545725	0.538095	0.525974	0.509479	0.506996	0.501982	0.5	0.4943	0.457645	0.467143	0.448387	0.4447	0.485531	0.401487	0.407609	0.365517	0.330189	0.263889	0.446809	0.4	0.380952	0.136364	0.333333	0.555556	0.333333
31.5-36 Deg	0	0	0	0	0.0525862	0.124857	0.206051	0.275698	0.333971	0.392423	0.431607	0.47668	0.500539	0.496867	0.476983	0.479711	0.460797	0.455385	0.446729	0.424768	0.438768	0.394628	0.38565	0.408915	0.451791	0.342561	0.429348	0.30303	0.322917	0.333333	0.285714	0.3	0.333333	0.352941	0.166667	1	1	0.333333	0.5	0
36-40.5 Deg	0	0	0	0	0.0444774	0.105837	0.16809	0.234525	0.286885	0.327259	0.353491	0.400137	0.418747	0.422945	0.407023	0.396731	0.398879	0.392036	0.372638	0.364706	0.376984	0.347664	0.323529	0.355856	0.312849	0.325	0.338983	0.410256	0.242424	0.157895	0.25	0.166667	0	0.5	0	0	0	0	0	0
40.5-45 Deg	0	0	0	0	0.0210938	0.0689829	0.137208	0.172468	0.226261	0.272047	0.300615	0.316995	0.337145	0.348088	0.337621	0.320774	0.311813	0.293856	0.315938	0.294333	0.257062	0.283262	0.26	0.298851	0.258065	0.228571	0.210526	0.111111	0.285714	0	1	0.5	0.5	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0.035913	0.0925481	0.127177	0.17693	0.21244	0.229012	0.236659	0.252955	0.271491	0.267346	0.259352	0.254042	0.228395	0.213368	0.222222	0.229299	0.195652	0.196429	0.142857	0.285714	0.333333	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0.0115668	0.0516817	0.101349	0.118959	0.148848	0.169149	0.194822	0.189664	0.203367	0.176355	0.210306	0.188017	0.202572	0.150943	0.148936	0.145455	0.130435	0.142857	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0.0210526	0.052506	0.080695	0.104636	0.120419	0.128324	0.143609	0.149563	0.12426	0.149296	0.141667	0.115044	0.149254	0.285714	0	0.0769231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0.0150616	0.0392791	0.0594262	0.0719951	0.0804312	0.088785	0.0819367	0.0946372	0.0851064	0.0535714	0.0888889	0.125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00795003	0.0215545	0.0325901	0.0497512	0.0446927	0.0397554	0.0674847	0.0933333	0.0952381	0.047619	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00182983	0.00373599	0.00414938	0.0170648	0.00552486	0.0136986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0266667	0	0.0833333	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

These are the corresponding tables to the 2D Efficiency plots for CC-Coherent Pion events.

Table 8: Table for 2D Histogram for New CC-Coh Pion NM-Rein-Sehgal

New NM R-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0	0	0	0	0.25	0.166667	0.3125	0.5625	0.571429	0.642857	0.88	0.814815	0.875	0.866667	0.744681	0.888889	0.806452	0.710526	0.891892	0.75	0.794118	0.870968	0.904762	0.8125	0.76	0.913043	0.785714	0.882353	0.666667	0.666667	0.846154	0.8	0.888889	0.9	1	0.692308	1	0.833333	0.785714	0.875
4.5-9 Deg	0	0	0	0.0769231	0.235294	0.15	0.48	0.590909	0.653061	0.854545	0.885714	0.717949	0.84375	0.827586	0.789474	0.836538	0.8	0.858824	0.833333	0.813725	0.822785	0.930556	0.848485	0.869565	0.770492	0.796875	0.961538	0.80303	0.71875	0.836735	0.565217	0.828571	0.869565	0.875	0.666667	0.714286	0.888889	0.714286	0.909091	0.833333
9-13.5 Deg	0	0	0	0	0.166667	0.290323	0.350877	0.452055	0.552083	0.693069	0.792453	0.794393	0.828125	0.830645	0.752	0.744	0.755102	0.780952	0.752688	0.786517	0.69697	0.813953	0.74	0.76	0.76087	0.6	0.891304	0.653846	0.666667	0.785714	0.529412	0.611111	1	0.875	0.5	0.9	0.8	0.777778	0.666667	0.5
13.5-18 Deg	0	0	0	0.0909091	0.047619	0.2	0.310345	0.494845	0.505376	0.711111	0.736	0.748252	0.756579	0.666667	0.717391	0.650794	0.774775	0.770833	0.706667	0.692308	0.641026	0.755556	0.783784	0.675676	0.653846	0.714286	0.666667	0.6	0.4	0.75	0.333333	1	0.8	0.5	0.666667	1	0	0	0	1
18-22.5 Deg	0	0	0	0	0.205882	0.214286	0.341772	0.4	0.481132	0.634483	0.674242	0.677966	0.704	0.699115	0.696078	0.694118	0.72	0.655172	0.731707	0.633333	0.653846	0.777778	0.777778	0.4	0.666667	0.714286	1	0.8	0.666667	0	0	0	0	0	0	1	0	0	0	0
22.5-27 Deg	0	0	0	0	0.142857	0.176471	0.258824	0.346154	0.465347	0.537037	0.516854	0.642105	0.690141	0.540984	0.633333	0.65625	0.4	0.588235	0.714286	0.6	0.5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27-31.5 Deg	0	0	0	0	0.0487805	0.166667	0.244186	0.2	0.323529	0.535211	0.483871	0.532258	0.55	0.588235	0.428571	0.555556	0.923077	0.25	0.333333	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31.5-36 Deg	0	0	0	0.0294118	0.115385	0.130435	0.147059	0.294118	0.322581	0.42	0.458333	0.407407	0.44	0.75	0.5	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36-40.5 Deg	0	0	0	0	0	0.0483871	0.190476	0.207547	0.292683	0.222222	0.368421	0.142857	0	0.25	0.5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.5-45 Deg	0	0	0	0	0	0.0588235	0.1875	0.209302	0.173913	0.352941	0.454545	0.333333	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0.0263158	0.0526316	0.0434783	0.230769	0	0.166667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0.0384615	0.0344828	0.0833333	0.125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9: Table for 2D Histogram for New CC-Coh Pion NM-Berger-Sehgal

New NM B-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0	0	0	0	0	1	0.5	0.625	0.777778	0.875	1	0.916667	0.923077	0.888889	0.833333	0.7	1	1	0.857143	0.666667	0.75	1	0.818182	1	0.666667	0.5	0.875	0.7	1	0.833333	0.75	1	0	0.666667	0.666667	0.4	0.5	1	1	0.666667
4.5-9 Deg	0	0	0	0	0	0.1	0.333333	0.4	0.764706	0.692308	0.692308	0.909091	0.935484	0.777778	1	0.8	0.714286	0.772727	0.9	0.956522	0.73913	0.913043	0.823529	0.705882	0.842105	0.818182	1	0.583333	0.5	0.666667	0.8	0.428571	1	0.875	1	0.714286	1	1	1	0.666667
9-13.5 Deg	0	0	0	0	0.125	0	0.3	0.4375	0.5	0.666667	0.8	0.666667	0.85	0.875	0.826087	0.771429	0.75	0.857143	0.681818	0.8	0.625	0.875	0.7	0.777778	0.333333	0.833333	0.875	0.833333	0.333333	1	0.5	0.5	1	0.666667	1	0.5	1	0	0	1
13.5-18 Deg	0	0	0	0	0.230769	0.25	0.26087	0.576923	0.466667	0.5	0.636364	0.735294	0.678571	0.727273	0.772727	0.736842	0.583333	0.5625	0.714286	0.714286	0.714286	0.833333	0.75	0.5	1	0.6	0	1	1	1	1	1	0	1	0	0	1	1	0	0
18-22.5 Deg	0	0	0	0.111111	0.181818	0.0769231	0.193548	0.307692	0.565217	0.566667	0.529412	0.55	0.666667	0.692308	0.363636	0.5	0.6	0.714286	0.5	1	1	0.5	1	0	0	0	0.5	1	0	0	0	0	0	0	0	0	0	0	0	0
22.5-27 Deg	0	0	0	0	0.133333	0	0.25	0.421053	0.538462	0.666667	0.619048	0.636364	0.416667	0.777778	0.5	1	0.5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27-31.5 Deg	0	0	0	0	0.181818	0.263158	0.285714	0.125	0.4	0.5	0.285714	0.5	0.444444	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31.5-36 Deg	0	0	0	0	0.142857	0.111111	0.0625	0.363636	0.333333	0.5	0.75	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36-40.5 Deg	0	0	0	0	0.0833333	0	0.181818	0	0.142857	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.5-45 Deg	0	0	0	0	0.111111	0.166667	0.166667	0.666667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0	0	0.666667	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10: Table for 2D Histogram for Old CC-Coh Pion NM-Rein-Sehgal

Old NM R-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1
4.5-9 Deg	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.333333	1	0.714286	0.9	1	0.727273	1	0.8	0.875	0.666667	0.875	0.666667	0.666667	0.875	0.9	1	0.75	1	0.666667	0.857143	0.666667	0	0.833333	1	1	1
9-13.5 Deg	0	0	0	0	0	0	0	0	1	1	0.875	0.8	0.866667	0.8125	0.714286	0.789474	0.928571	0.916667	0.7	0.888889	0.666667	0.75	0.8	0.7	0.75	1	0.8	0.75	0.666667	1	1	1	1	0.4	0	0	1	0	0	0
13.5-18 Deg	0	0	0	0	0	0	0	0.444444	0.727273	0.5625	0.785714	0.8125	0.6875	0.73913	0.636364	0.705882	0.733333	0.6875	0.875	0.75	0.666667	0.75	1	1	0.5	0	0	1	0	0.5	1	0	0	0	0	0	0	0	0	0
18-22.5 Deg	0	0	0	0	0	0.25	0.25	0.533333	0.5625	0.666667	0.615385	0.65	0.684211	0.5	0.777778	0.666667	0.75	0.6	0.6	1	0.666667	1	1	1	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0
22.5-27 Deg	0	0	0	0	0	0.3	0.25	0.272727	0.3	0.214286	0.545455	0.555556	0.666667	0.636364	0.8	0.666667	0.75	0.75	0.5	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27-31.5 Deg	0	0	0	0	0.111111	0.285714	0	0.25	0.111111	0.5	0.3125	0.666667	0.666667	0.666667	0.333333	0.6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31.5-36 Deg	0	0	0	0	0	0	0.25	0.214286	0.285714	0.166667	0.6	0.5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36-40.5 Deg	0	0	0	0	0	0.1	0.285714	0.466667	0.222222	0.5	0.666667	1	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.5-45 Deg	0	0	0	0	0	0.142857	0.125	0.666667	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0.166667	0.285714	0.2	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 11: Table for 2D Histogram for New CC-Coh Pion ANM-Rein-Sehgal

New ANM R-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000
0-4.5 Deg	0	0	0	0	0.259259	0.26	0.4	0.45	0.569231	0.719512	0.789474	0.77381	0.821053	0.801802	0.861111	0.877049	0.836957	0.865979	0.903614	0.797297
4.5-9 Deg	0	0	0	0.0851064	0.133333	0.163934	0.375	0.541667	0.615385	0.71028	0.8125	0.793233	0.837121	0.85034	0.833333	0.802632	0.807547	0.832636	0.79668	0.823529
9-13.5 Deg	0	0	0	0.0681818	0.157303	0.314961	0.319277	0.520325	0.512635	0.69774	0.798742	0.794937	0.78803	0.777778	0.779904	0.760933	0.77095	0.790274	0.791667	0.792115
13.5-18 Deg	0	0	0	0.030303	0.160714	0.285714	0.328829	0.437888	0.513966	0.638243	0.683962	0.764858	0.748869	0.743276	0.758523	0.732759	0.735192	0.742489	0.715054	0.664596
18-22.5 Deg	0	0	0	0.047619	0.137255	0.226601	0.338235	0.458101	0.541555	0.628641	0.696703	0.738342	0.695187	0.736677	0.709924	0.647059	0.703704	0.673611	0.555556	0.666667
22.5-27 Deg	0	0	0	0.0232558	0.130435	0.16087	0.239875	0.384615	0.457143	0.55615	0.610465	0.652632	0.577982	0.68254	0.641791	0.596639	0.553846	0.666667	0.576923	0.47619
27-31.5 Deg	0	0	0	0.0103093	0.0578035	0.163636	0.299639	0.320988	0.402778	0.444444	0.527273	0.559322	0.61194	0.567568	0.57971	0.575	0.56	0.7	0.428571	1
31.5-36 Deg	0	0	0	0	0.0883721	0.165094	0.222222	0.303571	0.352381	0.426829	0.528926	0.484211	0.350877	0.583333	0.666667	0.545455	0.5	0	1	0
36-40.5 Deg	0	0	0	0	0.0516432	0.135135	0.18593	0.198758	0.29927	0.395833	0.384615	0.232558	0.526316	0.444444	0.2	0.666667	0	1	0	0
40.5-45 Deg	0	0	0	0	0.0121212	0.0964467	0.187097	0.187919	0.293478	0.16	0.391304	0	0	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0.0434783	0.0746269	0.205479	0.25	0.2	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0.00952381	0.0684932	0.153846	0.142857	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

New ANM R-S	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0.810127	0.885714	0.841463	0.774194	0.815789	0.848485	0.909091	0.775	0.897436	0.821429	0.857143	0.735294	0.809524	0.75	0.928571	0.947368	0.761905	0.769231	1	0.818182
4.5-9 Deg	0.782178	0.751269	0.815642	0.808383	0.784314	0.805085	0.794118	0.808989	0.825581	0.701754	0.848485	0.807018	0.756098	0.785714	0.821429	0.727273	0.708333	0.625	0.666667	0.8125
9-13.5 Deg	0.827103	0.763736	0.79375	0.726562	0.652174	0.724138	0.739726	0.760563	0.818182	0.654545	0.735294	0.875	0.571429	0.684211	0.5	0.8	0.666667	1	0.833333	0.571429
13.5-18 Deg	0.744966	0.7	0.727273	0.711864	0.808511	0.682927	0.619048	0.631579	0.555556	0.75	0.4	1	0	1	0.75	1	0	0	1	0
18-22.5 Deg	0.604651	0.676471	0.6	0.454545	0.428571	0.6	0.6	0	1	1	0	0	0	0	0	0	0	0	0	0
22.5-27 Deg	0.636364	0.9	0.4	0.5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
27-31.5 Deg	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31.5-36 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36-40.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.5-45 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 12: Table for 2D Histogram for New CC-Coh Pion ANM-Berger-Sehgal

New ANM B-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000
0-4.5 Deg	0	0	0	0	0.285714	0.5	0.5	0.555556	0.578947	0.583333	0.884615	0.9	0.8	0.885714	0.783784	0.914286	0.794872	0.6	0.777778	0.769231
4.5-9 Deg	0	0	0	0	0.105263	0.285714	0.361702	0.525424	0.603175	0.780822	0.904762	0.752941	0.906667	0.804878	0.753247	0.864865	0.813333	0.763889	0.85	0.803922
9-13.5 Deg	0	0	0	0	0.137931	0.325581	0.421875	0.358974	0.515625	0.702703	0.79845	0.786885	0.743363	0.781609	0.80198	0.734694	0.731343	0.686047	0.767857	0.866667
13.5-18 Deg	0	0	0	0.05	0.159091	0.339286	0.345238	0.373626	0.520408	0.675676	0.73913	0.675926	0.709091	0.74026	0.694915	0.754717	0.729167	0.608696	0.8	0.72
18-22.5 Deg	0	0	0	0.0416667	0.146341	0.291667	0.315789	0.472527	0.5	0.5375	0.622449	0.735632	0.758065	0.666667	0.566667	0.722222	0.692308	0.761905	0.428571	0.9
22.5-27 Deg	0	0	0	0.12	0.156863	0.271186	0.261538	0.313953	0.4625	0.623377	0.629032	0.627907	0.675	0.73913	0.692308	0.5	0.6	0.666667	1	0
27-31.5 Deg	0	0	0	0	0.111111	0.148148	0.3	0.390625	0.411765	0.615385	0.62963	0.578947	0.3	0.666667	0.571429	0.5	0.333333	0	0	0
31.5-36 Deg	0	0	0	0	0.0454545	0.163934	0.16	0.195122	0.37931	0.461538	0.545455	0.5	0.5	0.5	0	0	0	0	0	0
36-40.5 Deg	0	0	0	0	0.097561	0.0333333	0.129032	0.0909091	0.181818	0.142857	0.4	0.666667	1	0	1	0	0	0	0	0
40.5-45 Deg	0	0	0	0	0	0.106383	0.142857	0.1	0.3	0	0	0	0	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0	0.142857	0.142857	0.5	0	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

New ANM B-S	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0.64	0.695652	0.904762	0.695652	0.846154	0.666667	0.642857	0.578947	1	0.777778	0.833333	1	1	0.857143	0.75	1	1	1	1	1
4.5-9 Deg	0.808511	0.869565	0.882353	0.771429	0.851852	0.793103	0.708333	0.75	0.947368	0.8	0.6	0.636364	0.75	0.777778	0.875	0.8	0	0.666667	0.714286	1
9-13.5 Deg	0.631579	0.903226	0.785714	0.772727	0.9	0.75	0.75	0.636364	1	1	0.25	0.333333	0.75	0	0	0	1	1	1	1
13.5-18 Deg	0.681818	0.7	0.727273	0.75	0.8	0.6	1	0.5	1	0	0	1	0	0	0	0	0	0	0	0
18-22.5 Deg	0.666667	0.666667	0	1	0.666667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.5-27 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27-31.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31.5-36 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36-40.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.5-45 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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