Acceptance Study for SciBooNE Charged-Current Coherent Pion Production Technical Note Rough Draft

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Abstract

We showed that the SciBooNE guys tried to mess physics up by cutting out all of their CC-Coh Pion events from their data that was actually there! Duh.

Do we need an abstract?

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 and linked: SciBooNE-MC and the corresponding ROOT files used in the simulation can be downloaded from here (insert dropbox/Google Drive Link here)

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 steps the macros should be run in and the expected plots that each macro produces.

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 understand why SciBooNE did not observe charged-current coherent pion production at low neutrino energy.

2 Samples

Five different samples were used in this study, three samples for ν-mode and two samples in $\bar{\nu}$-mode.[1] Table 2 summarizes these samples. Details on these samples can be found in 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	x.x.x	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 nuances of detector simulation in this acceptance model, and detail the assumptions made in order to result in the accurate classification 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.

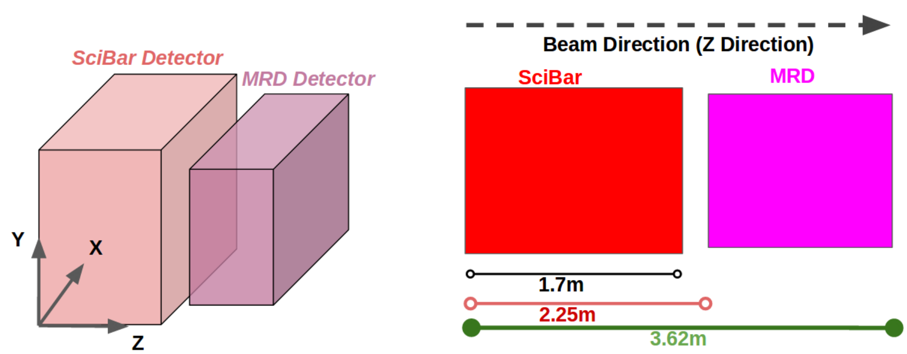

Figure 3.1: Representation of the SciBooNE detector and the coordinate frame we use in this study

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 in the 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.

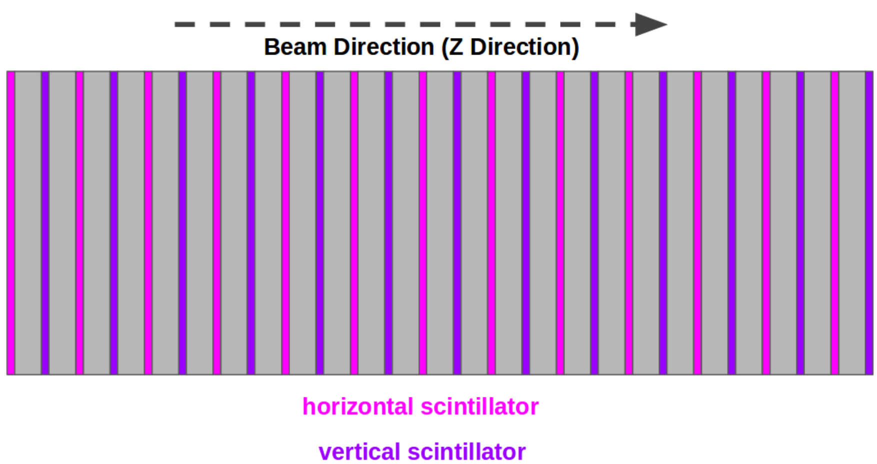

Figure 3.1.2: Depiction of the Muon Range Detector (MRD) which consists of alternating layers of horizontal scintillator (shown in pink) steel slabs (shown in grey) and vertical scintillator (shown in purple)

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.

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.

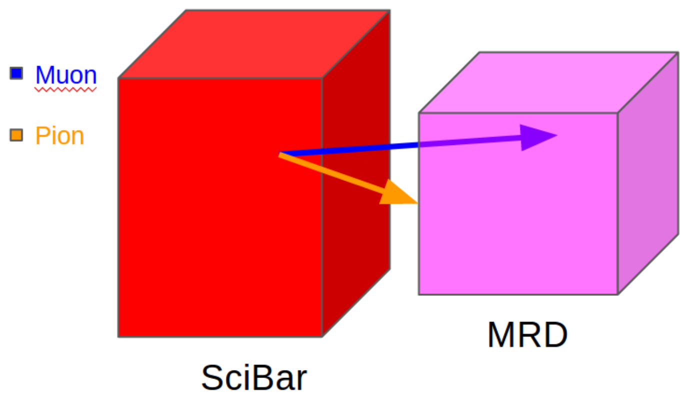

Figure 4.1: Depiction of an event that was classified as "Stopped."

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 kinematics to have exited out the back face of the MRD without stopping. An illustration of such an event is given in Figure 4.2.

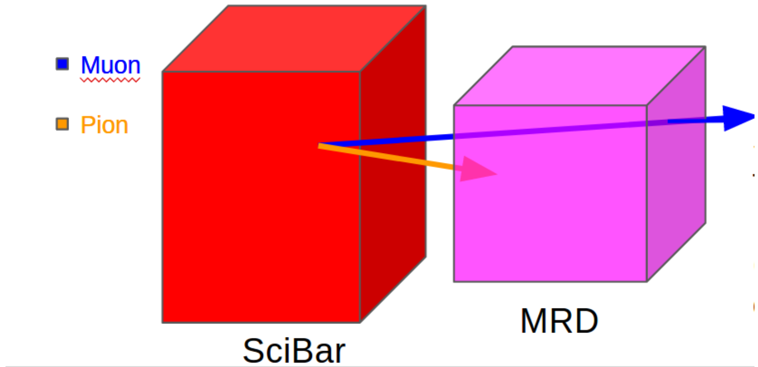

Figure 4.2: Depiction of an event that was classified as “out-the-back”.

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.

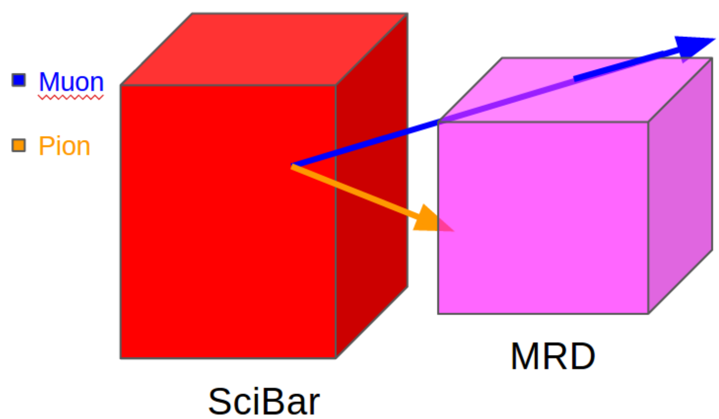

Figure 4.3: Depiction of an event that was classified as "Out-Side."

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 a CC-Inclusive event, and those that met the conditions of classification as Charged-Current Coherent Pion Production events. The plots in the two subsections below show our results.

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 previous simulation studies which were done. Table 5.1 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 vx.x.x 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: Event reduction table for a sample of ν-mode CC-Inclusive events simulated in the SciBooNE geometry.

Figure 5.1 shows the momentum and angular 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 vx.x.x Rein-Sehgal). The distributions have been normalized to the same area and show no strong differences between them.

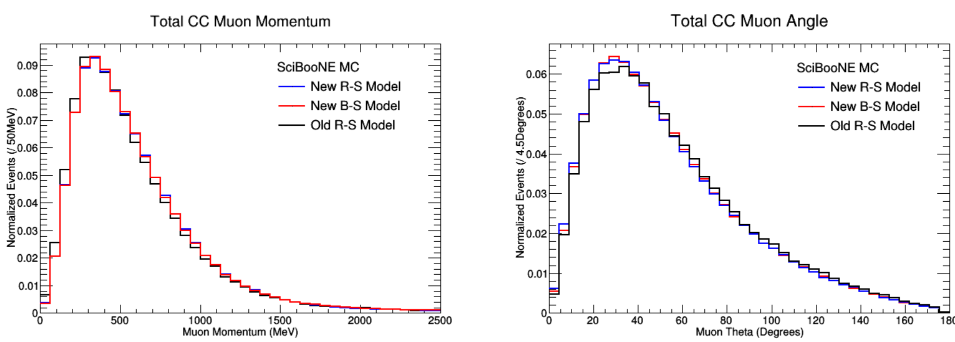

Figure 5.1: Muon Momentum (left) and Muon Angle (right) for ν-mode CC-Inclusive interactions for all three models included in this study. These samples kinematics are, unsurprisingly, very similar for the sample of CC-Inclusive

Figure 5.1 represents the one-dimensional efficiency for selecting ν-mode CC-Inclusive events for this study compared to results derived from Hirade's thesis (need proper reference) 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.

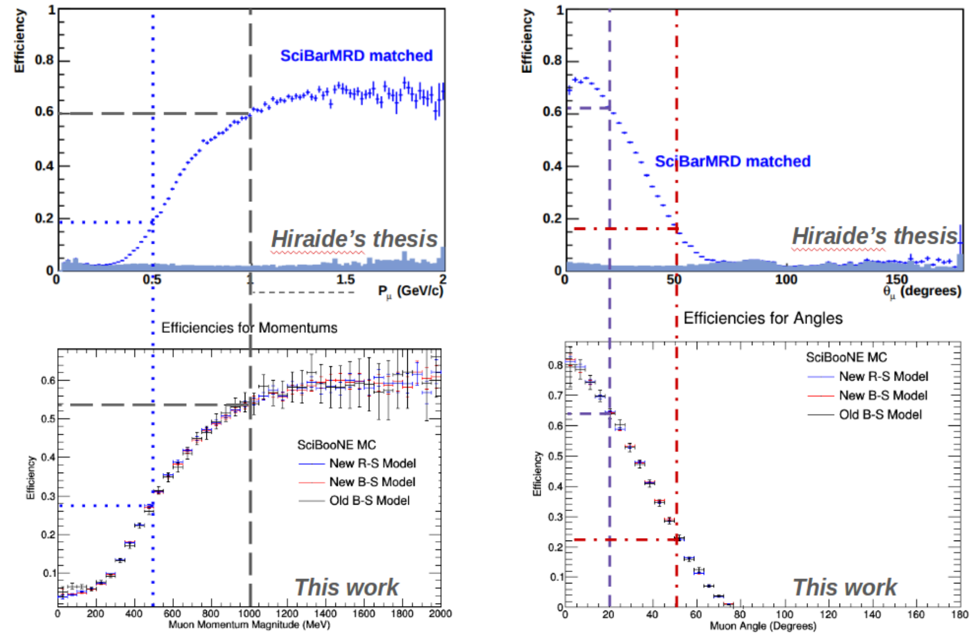

Figure 5.1: One-dimension efficiency plots for the ν-mode CC-Inclusive sample.

Figure 5.1 shows the two-dimensional efficiency for selecting ν-mode CC-Inclusive events for this study compared to results derived from Morgan's reference sample (need more words here about this....see email)

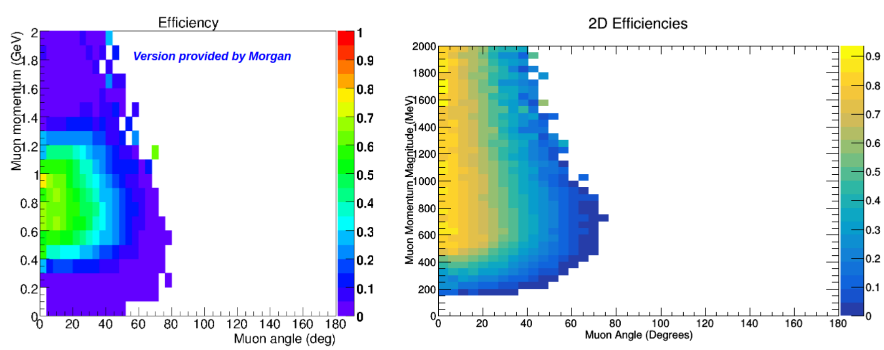

Figure 5.1: Two-dimensional efficiency plots for the ν-mode Rein-Sehgal CC-Inclusive sample.

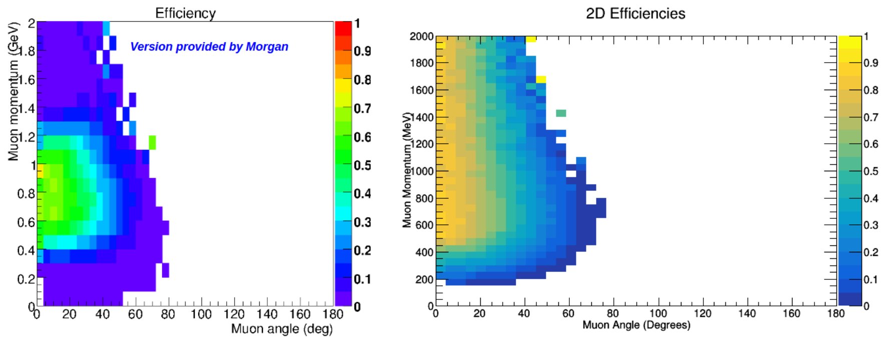

Figure 5.1: Two-dimensional efficiency plots for the ν-mode Berger-Sehgal CC-Inclusive sample.

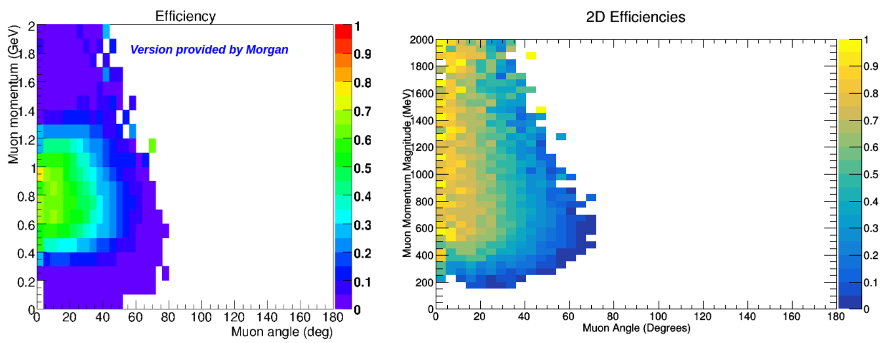

Figure 5.1: Two-dimensional efficiency plots for the ν-mode Old Rein-Sehgal CC-Inclusive sample.

Similar to before, Table 5.1 goes through the event selection criteria for selecting a sample of CC-Inclusive events from the neutrino 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: Event reduction table for a sample of $\bar{\nu}$-mode CC-Inclusive evnets simulated in the SciBooNE geometry.

Figure 5.1 shows the momentum and angular distribution for the sample of $\bar{\nu}$-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 vx.x.x Rein-Sehgal). The distributions have been normalized to the same area and show no strong differences between them.

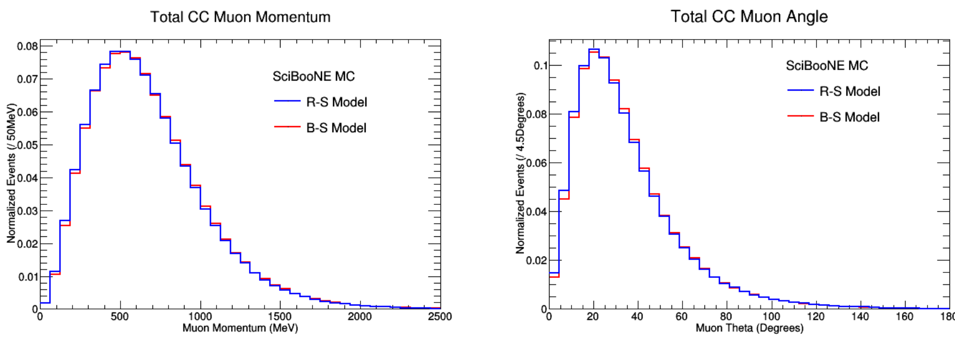

Figure 5.1: Muon Momentum (left) and Muon Angle (right) for $\bar{\nu}$-mode CC-Inclusive interactions for all three models included in this study. These samples kinematics are, unsurprisingly, very similar for the sample of CC-Inclusive

Figure 5.1 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).

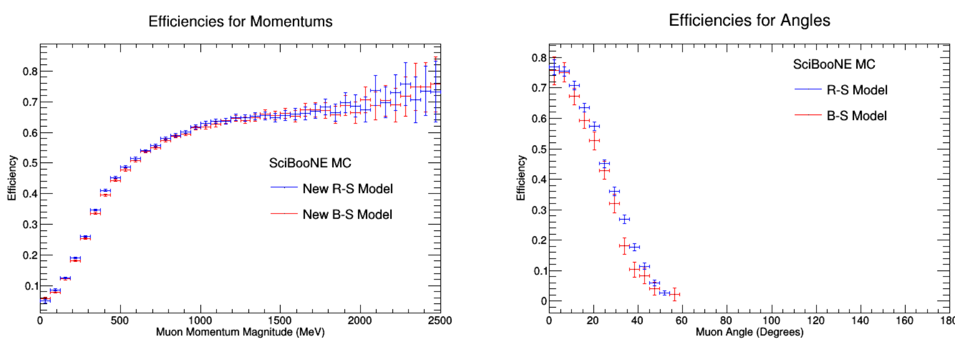

Figure 5.1: One-dimension efficiency plots for the $\bar{\nu}$-mode CC-Inclusive sample. Muon's Momentums is on the right and the Muon's Angles is on the left.

Figure 5.1 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)

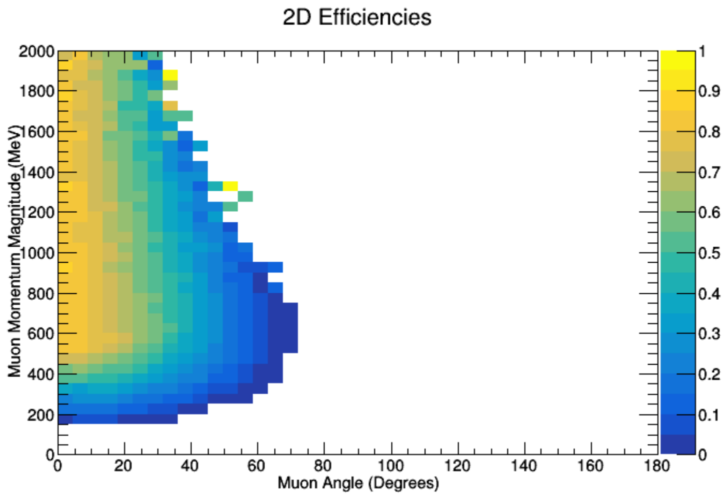

Figure 5.1: Two-dimensional efficiency plot for the $\bar{\nu}$-mode Rein-Sehgal CC-Inclusive sample.

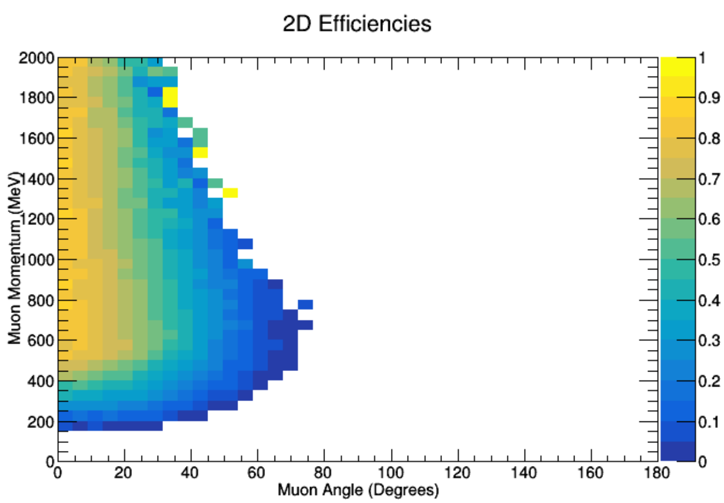

Figure 5.1: Two-dimensional efficiency plot for the $\bar{\nu}$-mode Berger-Sehgal CC-Inclusive sample.

Below are the tables that correspond to the five 2D Efficiency CC-Inclusive histograms that are above.

Table 1: 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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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 NM 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	0.834532	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	0.803922	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	0.74026	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	0.704342	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	0.660068	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	0.57636	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	0.498278	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	0.432253	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	0.373851	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	0.264297	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	0.144772	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	0.10119	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	0.0571429	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	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	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	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 2: 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	450-500	500-550
0-4.5 Deg	0	0	0	0	0.157895	0.325	0.422222	0.490566	0.615385	0.728571	0.895522
4.5-9 Deg	0	0	0	0.0625	0.176471	0.235849	0.396694	0.478261	0.581731	0.773279	0.811448
9-13.5 Deg	0	0	0	0.09375	0.156716	0.223529	0.362963	0.463343	0.5725	0.701245	0.78089
13.5-18 Deg	0	0	0	0.0382166	0.131222	0.260736	0.330233	0.448833	0.566116	0.634994	0.727545
18-22.5 Deg	0	0	0	0.039604	0.0973451	0.228145	0.318462	0.419903	0.517013	0.582547	0.656707
22.5-27 Deg	0	0	0	0.0264026	0.0930736	0.197461	0.321879	0.381265	0.447548	0.521715	0.578365
27-31.5 Deg	0	0	0	0.00486618	0.0857143	0.152859	0.25358	0.312166	0.395361	0.466491	0.496522
31.5-36 Deg	0	0	0	0.00754717	0.0815217	0.142292	0.218271	0.283494	0.333753	0.381784	0.436444
36-40.5 Deg	0	0	0	0	0.032538	0.0817963	0.170164	0.233583	0.275212	0.327416	0.366159
40.5-45 Deg	0	0	0	0	0.0139147	0.0678972	0.129657	0.192308	0.224483	0.252462	0.30273
45-49.5 Deg	0	0	0	0	0.00251467	0.0392938	0.0940285	0.141328	0.181437	0.212241	0.24064
49.5-54 Deg	0	0	0	0	0	0.0110121	0.0531873	0.0958814	0.126534	0.148936	0.169353
54-58.5 Deg	0	0	0	0	0	0.000456204	0.0199623	0.0552683	0.0810965	0.102659	0.119633
58.5-63 Deg	0	0	0	0	0	0	0.000714286	0.0128637	0.0467906	0.0568421	0.0634228
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00745573	0.0242928	0.0364188
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.000740466	0.00470367
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

New NM B-S	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
0-4.5 Deg	0.807692	0.880435	0.864865	0.843373	0.833333	0.858333	0.833333	0.826087	0.814815	0.778846	0.8	0.813725	0.829268
4.5-9 Deg	0.817109	0.806366	0.801402	0.814286	0.809211	0.804211	0.755448	0.822709	0.792657	0.804255	0.824945	0.804494	0.814536
9-13.5 Deg	0.798354	0.801724	0.794569	0.782796	0.780287	0.765235	0.773496	0.756598	0.759384	0.766798	0.776286	0.733735	0.717208
13.5-18 Deg	0.736387	0.720152	0.749489	0.762791	0.732403	0.711937	0.704908	0.702804	0.683544	0.703634	0.7086	0.706101	0.683544
18-22.5 Deg	0.692351	0.687027	0.677215	0.689404	0.661647	0.651855	0.661634	0.65554	0.634515	0.653195	0.635392	0.641326	0.620074
22.5-27 Deg	0.637657	0.629688	0.615445	0.637963	0.622396	0.604258	0.581746	0.570899	0.569778	0.571276	0.570789	0.557559	0.528678
27-31.5 Deg	0.564516	0.564264	0.554788	0.551891	0.55257	0.548276	0.521099	0.517559	0.518553	0.515256	0.490654	0.476651	0.444332
31.5-36 Deg	0.472969	0.488325	0.492462	0.479326	0.494505	0.47549	0.45864	0.461108	0.451835	0.42583	0.411765	0.437118	0.397764
36-40.5 Deg	0.387514	0.419254	0.425045	0.403834	0.392764	0.396559	0.400812	0.369942	0.368859	0.345339	0.357923	0.325411	0.296117
40.5-45 Deg	0.319185	0.342679	0.345987	0.330502	0.331052	0.323815	0.305906	0.312284	0.313023	0.294294	0.264706	0.272981	0.214286
45-49.5 Deg	0.244851	0.261486	0.269272	0.268868	0.255423	0.239971	0.254059	0.219613	0.205285	0.236769	0.215859	0.180723	0.158879
49.5-54 Deg	0.187424	0.203203	0.19403	0.204905	0.197958	0.161453	0.159744	0.142512	0.151292	0.132184	0.133858	0.0869565	0.097561
54-58.5 Deg	0.118058	0.129529	0.135933	0.125182	0.118211	0.109568	0.118863	0.117073	0.108844	0.0617284	0.0851064	0.0344828	0.0909091
58.5-63 Deg	0.0796216	0.0780856	0.0909091	0.0960929	0.0849558	0.0780781	0.103825	0.0458716	0	0.0333333	0	0	0
63-67.5 Deg	0.0436258	0.0367232	0.039666	0.0363636	0.0426136	0.0162162	0.0357143	0.0227273	0.0416667	0.0714286	0.166667	0	0
67.5-72 Deg	0.0114213	0.0195072	0.0166667	0.0120482	0	0	0.03125	0	0	0	0	0	0
72-76.5 Deg	0	0	0.00280899	0.00649351	0.0123457	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

New NM B-S	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	0.84375	0.78022	0.783133	0.898734	0.85	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	0.784504	0.774295	0.813665	0.792994	0.764706	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	0.731677	0.730769	0.708861	0.728296	0.755835	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	0.700457	0.681775	0.68321	0.68171	0.669251	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	0.60516	0.579566	0.597895	0.612863	0.599419	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	0.526667	0.524138	0.529101	0.509404	0.499093	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	0.474736	0.456456	0.431408	0.465169	0.451791	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	0.406551	0.405963	0.389205	0.33564	0.381395	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	0.300654	0.38785	0.366279	0.328	0.348624	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	0.233918	0.189474	0.197368	0.231884	0.222222	0.157895	0.2	0.0526316	0.428571	0.0588235	0.166667	0.166667	0.25	0	0	1
45-49.5 Deg	0.169014	0.0588235	0.0833333	0.166667	0.136364	0.25	0.0714286	0.333333	0.2	1	0	0	0	0	0	0
49.5-54 Deg	0.0769231	0.0909091	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0.111111	0	0	0.5	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
63-67.5 Deg	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
72-76.5 Deg	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

Table 3: 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	500-550	550-600	600-650
0-4.5 Deg	0	0	0	0	0.333333	0.5	0.5	0.8	0.857143	0.5	0.666667	1	0.857143
4.5-9 Deg	0	0	0	0	0	0.25	0.285714	0.470588	0.466667	0.608696	0.904762	0.9	0.65
9-13.5 Deg	0	0	0	0	0.0769231	0.181818	0.285714	0.451613	0.625	0.642857	0.765957	0.721519	0.813953
13.5-18 Deg	0	0	0	0.0714286	0.15	0.290323	0.365854	0.509091	0.621622	0.630952	0.682692	0.773109	0.722222
18-22.5 Deg	0	0	0	0.0571429	0.0689655	0.184211	0.242424	0.505155	0.474227	0.56	0.647482	0.656442	0.609929
22.5-27 Deg	0	0	0	0.0416667	0.04	0.247059	0.280488	0.346154	0.518797	0.465969	0.602679	0.631818	0.658291
27-31.5 Deg	0	0	0	0.0217391	0.0615385	0.1375	0.16	0.296296	0.390863	0.466981	0.520492	0.59761	0.522727
31.5-36 Deg	0	0	0	0.0816327	0.097561	0.07	0.244444	0.290503	0.384259	0.364407	0.435252	0.453925	0.540881
36-40.5 Deg	0	0	0	0	0.04	0.133333	0.155172	0.235577	0.282609	0.296296	0.37785	0.377049	0.41195
40.5-45 Deg	0	0	0	0	0	0.0869565	0.15122	0.161017	0.256228	0.271875	0.289894	0.306818	0.291545
45-49.5 Deg	0	0	0	0	0	0.0434783	0.0843882	0.141176	0.163462	0.159322	0.242331	0.231003	0.263699
49.5-54 Deg	0	0	0	0	0	0.0108696	0.0636364	0.0816327	0.160819	0.133144	0.170588	0.169381	0.212996
54-58.5 Deg	0	0	0	0	0	0	0.023622	0.0238095	0.0320513	0.107463	0.107595	0.110701	0.105991
58.5-63 Deg	0	0	0	0	0	0	0	0.0129032	0.0397554	0.0555556	0.0724638	0.0979592	0.0942408
63-67.5 Deg	0	0	0	0	0	0	0	0	0.0056338	0.0241379	0.0125523	0.0380952	0.04
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00338983	0	0.0212766	0.010989
72-76.5 Deg	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

Old NM R-S	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
0-4.5 Deg	0.7	0.777778	0.875	0.909091	0.777778	1	0.769231	0.8	0.777778	1	0.75	0.75	1
4.5-9 Deg	0.8	0.74359	0.877551	0.65	0.782609	0.792453	0.810811	0.866667	0.807692	0.815789	0.8	0.74359	0.861111
9-13.5 Deg	0.734177	0.732558	0.77907	0.744681	0.865979	0.746988	0.76087	0.747253	0.851064	0.776316	0.683544	0.791045	0.686567
13.5-18 Deg	0.739726	0.70229	0.719178	0.711656	0.753425	0.726115	0.735099	0.70068	0.688889	0.705357	0.688679	0.711538	0.705882
18-22.5 Deg	0.648936	0.705069	0.695187	0.643216	0.673267	0.651961	0.616505	0.639535	0.641176	0.666667	0.635593	0.59375	0.59375
22.5-27 Deg	0.668224	0.632959	0.659574	0.617647	0.593458	0.614213	0.654054	0.529801	0.594937	0.503817	0.591398	0.653465	0.52
27-31.5 Deg	0.544061	0.550781	0.516981	0.592437	0.524887	0.513228	0.49359	0.531034	0.475	0.521008	0.465116	0.406593	0.517857
31.5-36 Deg	0.461017	0.456311	0.462838	0.493878	0.474654	0.45	0.416667	0.470588	0.465909	0.454545	0.376812	0.436364	0.348837
36-40.5 Deg	0.424749	0.422222	0.376518	0.409692	0.394737	0.407407	0.360825	0.317308	0.397436	0.267857	0.272727	0.285714	0.380952
40.5-45 Deg	0.340557	0.366534	0.316742	0.337423	0.28777	0.29661	0.257576	0.140351	0.318182	0.307692	0.208333	0.357143	0.25
45-49.5 Deg	0.285156	0.27907	0.270115	0.273973	0.259259	0.347222	0.285714	0.28	0.217391	0.111111	0.1	0.0833333	0.166667
49.5-54 Deg	0.220588	0.220238	0.15942	0.142857	0.122807	0.236364	0.129032	0.0714286	0.1	0.142857	0	0	0
54-58.5 Deg	0.138728	0.186992	0.13253	0.176471	0.131579	0	0.357143	0.1	0	0	0	0	0.333333
58.5-63 Deg	0.0787402	0.0487805	0.0754717	0.15625	0.0416667	0	0.125	0	0	0	0	0	0
63-67.5 Deg	0.0869565	0	0.0689655	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0.0222222	0	0	0.111111	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
76.5-81 Deg	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
85.5-90 Deg	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
94.5-99 Deg	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
103.5-108 Deg	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
112.5-117 Deg	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
121.5-126 Deg	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
130.5-135 Deg	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
139.5-144 Deg	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
148.5-153 Deg	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
157.5-162 Deg	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
166.5-171 Deg	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
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0

Old NM R-S	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	0.6	0.833333	1	0.833333	0.909091	0.75	0.666667	1	0	0.666667	0	0.8	1	1
4.5-9 Deg	0.923077	0.825	0.875	0.833333	0.761905	0.85	0.8	0.823529	0.652174	0.923077	0.857143	0.882353	0.533333	0.85
9-13.5 Deg	0.862069	0.706897	0.660377	0.755556	0.688889	0.604651	0.933333	0.638298	0.714286	0.826087	0.958333	0.842105	0.777778	0.708333
13.5-18 Deg	0.670588	0.694444	0.68	0.677966	0.586957	0.653846	0.612245	0.65625	0.68	0.7	0.625	0.76	0.75	0.565217
18-22.5 Deg	0.6	0.652174	0.625	0.708333	0.568182	0.634146	0.461538	0.423077	0.625	0.47619	0.47619	0.76	0.611111	0.722222
22.5-27 Deg	0.578947	0.413793	0.568966	0.377778	0.666667	0.5	0.444444	0.473684	0.458333	0.647059	0.615385	0.45	0.4	0.333333
27-31.5 Deg	0.490566	0.487179	0.444444	0.347826	0.380952	0.4	0.384615	0.454545	0.1	0.333333	0.375	0.625	0.2	0.25
31.5-36 Deg	0.541667	0.238095	0.4	0.266667	0.3125	0.533333	0.352941	0.4	0.571429	0.222222	0.166667	0	0.666667	0.5
36-40.5 Deg	0.176471	0.2	0.117647	0.166667	0.333333	0.333333	0.5	0.285714	0.5	0	0	0	0	0
40.5-45 Deg	0.375	0.25	0.2	0	0	0	0.5	0	0	0	0	1	0	0
45-49.5 Deg	0.25	0	0.333333	1	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
54-58.5 Deg	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
63-67.5 Deg	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
72-76.5 Deg	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

Table 4: 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	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	0.037037	0.173913	0.225352	0.398693	0.510204	0.585034	0.741325	0.812332	0.808989	0.820399	0.80597	0.846154	0.826087	0.834821	0.846791	0.849776	0.814732	0.811494	0.835	0.820728	0.821212	0.820946	0.829352	0.86385	0.785124	0.834906	0.820896	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	0	0	0.0538922	0.179487	0.264881	0.351406	0.522654	0.611905	0.722011	0.822749	0.806912	0.812763	0.807565	0.807477	0.80314	0.805654	0.802672	0.816404	0.79961	0.808895	0.780172	0.79495	0.806396	0.799636	0.809524	0.799766	0.790123	0.793201	0.770154	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	0	0	0.0881226	0.175824	0.272864	0.369565	0.47927	0.562628	0.680187	0.778963	0.784609	0.775579	0.77094	0.780604	0.772247	0.778919	0.774887	0.769928	0.777286	0.764215	0.756151	0.769636	0.756423	0.745802	0.736299	0.725795	0.729068	0.731919	0.712513	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	0	0	0.0502959	0.162912	0.264642	0.372408	0.45271	0.529918	0.642998	0.714241	0.754711	0.746173	0.739165	0.72958	0.736591	0.712291	0.723065	0.699029	0.705178	0.708415	0.69735	0.68934	0.693381	0.700468	0.682373	0.673329	0.680972	0.660094	0.631818	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	0	0	0.0477273	0.135068	0.240964	0.32415	0.42098	0.500719	0.578125	0.669713	0.700024	0.693197	0.686785	0.675302	0.676973	0.671911	0.662691	0.649262	0.656827	0.646345	0.649693	0.62265	0.628975	0.613897	0.596406	0.591174	0.582904	0.568153	0.597598	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	0	0	0.0256881	0.127932	0.186722	0.284972	0.381885	0.46546	0.511835	0.587483	0.641457	0.609761	0.630852	0.616002	0.610015	0.585767	0.589724	0.588134	0.57303	0.583082	0.5553	0.564074	0.557719	0.53367	0.554507	0.527886	0.535211	0.501099	0.488432	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	0	0	0.0135747	0.0779102	0.157462	0.237522	0.318072	0.385341	0.455377	0.527993	0.566528	0.573181	0.550737	0.538564	0.550457	0.533736	0.525933	0.509007	0.512922	0.498878	0.50292	0.473382	0.487885	0.490838	0.454704	0.467192	0.428571	0.405405	0.464286	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	0	0	0.00265957	0.0702447	0.140581	0.21821	0.292653	0.342622	0.394628	0.429609	0.48047	0.502938	0.499068	0.49538	0.462372	0.47797	0.465828	0.428421	0.439291	0.425238	0.420697	0.393846	0.374753	0.375394	0.398374	0.379121	0.342857	0.27907	0.290323	0.282051	0.592593	0.333333	0.533333	0.75	0	0.6	1	0	0
36-40.5 Deg	0	0	0	0	0.0358187	0.107342	0.168067	0.222502	0.294331	0.333169	0.361301	0.382382	0.418154	0.431897	0.40234	0.403238	0.388569	0.407134	0.374224	0.366126	0.347445	0.358079	0.315942	0.337449	0.296512	0.306931	0.295082	0.265625	0.192308	0.2	0.142857	0.166667	0	0.5	0	0	0	0	0	0
40.5-45 Deg	0	0	0	0	0.0164051	0.0757272	0.131076	0.200825	0.226708	0.268313	0.30581	0.320273	0.346117	0.33394	0.333774	0.343066	0.307036	0.329013	0.279793	0.27593	0.311653	0.287736	0.211538	0.186275	0.203125	0.222222	0.111111	0.272727	0.2	0	0.333333	0	0	0	0	0	0	0	0	0
45-49.5 Deg	0	0	0	0	0	0.0478888	0.099454	0.13113	0.177444	0.212046	0.222903	0.250172	0.254128	0.270336	0.280552	0.252766	0.235294	0.240708	0.214834	0.218107	0.251908	0.234043	0.2	0.307692	0.235294	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0	0	0	0	0	0.0114405	0.0658882	0.103003	0.127891	0.149639	0.172282	0.178556	0.193367	0.190678	0.185291	0.18963	0.175556	0.136364	0.150327	0.116279	0.125	0.181818	0.0833333	0	0.5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0.000554017	0.0170428	0.0537772	0.0883421	0.116889	0.122696	0.124613	0.143336	0.139043	0.133106	0.130564	0.121076	0.105263	0.0547945	0.114286	0.157895	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0.0010015	0.020202	0.0406544	0.0526316	0.0724161	0.0817391	0.077907	0.0850662	0.0868263	0.0772947	0.0462963	0.0454545	0.0555556	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	0.00108167	0.00447928	0.0226148	0.0374384	0.0423729	0.0439122	0.0482759	0.0424242	0.025	0.125	0	0.125	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	0.00515464	0.0103093	0.0144928	0.00714286	0.0289855	0	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 5: 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
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
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
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
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
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
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
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
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
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
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
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
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
54-58.5 Deg	0	0	0	0	0	0	0.0210526	0.052506	0.080695	0.104636	0.120419	0.128324	0.143609
58.5-63 Deg	0	0	0	0	0	0	0	0.0150616	0.0392791	0.0594262	0.0719951	0.0804312	0.088785
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00795003	0.0215545	0.0325901	0.0497512	0.0446927
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00182983	0.00373599	0.00414938	0.0170648
72-76.5 Deg	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

New ANM B-S	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
0-4.5 Deg	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
4.5-9 Deg	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
9-13.5 Deg	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
13.5-18 Deg	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
18-22.5 Deg	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
22.5-27 Deg	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
27-31.5 Deg	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
31.5-36 Deg	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
36-40.5 Deg	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
40.5-45 Deg	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
45-49.5 Deg	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
49.5-54 Deg	0.203367	0.176355	0.210306	0.188017	0.202572	0.150943	0.148936	0.145455	0.130435	0.142857	0	0	0
54-58.5 Deg	0.149563	0.12426	0.149296	0.141667	0.115044	0.149254	0.285714	0	0.0769231	0	0	0	0
58.5-63 Deg	0.0819367	0.0946372	0.0851064	0.0535714	0.0888889	0.125	0	0	0	0	0	0	0
63-67.5 Deg	0.0397554	0.0674847	0.0933333	0.0952381	0.047619	0	0	0	0	0	0	0	0
67.5-72 Deg	0.00552486	0.0136986	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0.0266667	0	0.0833333	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

New ANM B-S	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	0.819005	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	0.791063	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	0.720774	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	0.689633	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	0.586435	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	0.548585	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	0.4447	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	0.429348	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	0.338983	0.410256	0.242424	0.157895	0.25	0.166667	0	0.5	0	0	0	0	0	0
40.5-45 Deg	0.210526	0.111111	0.285714	0	1	0.5	0.5	0	0	0	0	0	0	0
45-49.5 Deg	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	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	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
63-67.5 Deg	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
72-76.5 Deg	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

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. Table 5.2 goes through the event selection criteria for selecting a sample of CC-Coh $\pi^{+/-}$ events from the neutrino mode (ν-mode) Monte Carlo.

ν-mode CC-Coherent Pion Event Reduction

Events Selection	NEUT v5.3.6 Rein-Sehgal	NEUT v5.3.6 Berger-Sehgal	NEUT vx.x.x 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 6: Event reduction table for a sample of ν-mode Charged Current Coherent Pion events simulated in the SciBooNE geometry.

The NewANMBergerSehgal.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:

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

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

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:

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

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

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°.

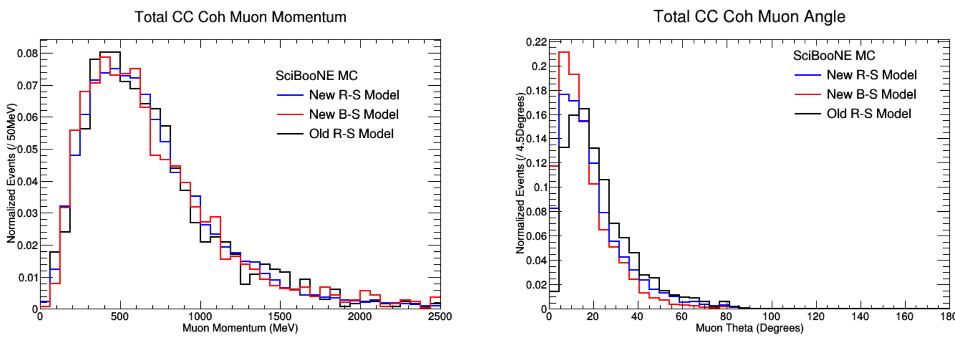

Figure 1: "Total" Muon Momentum (left) and "Total" Muon Angle (right) for ν-mode CC-Coh $\pi^{+/-}$ interactions for all three models included in this study. The "Total" classification means that all CC-Coh $\pi^{+/-}$ events are included in these histograms.

Here will be the plots for CC-Coh Pion with the good momentum efficiencies and the angle efficiencies!

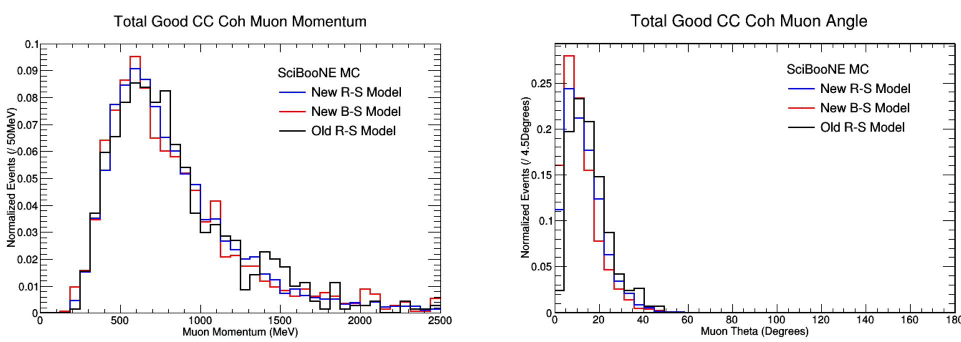

Figure 2: "Good" Muon Momentum (left) and "Good" Muon Angle (right) for ν-mode CC-Coh $\pi^{+/-}$ interactions for all three models included in this study. The "Good" classification means that only the stopped and not-stopped CC-Coh $\pi^{+/-}$ events are included for these histograms.

Now from here on will be the rest of the results for CC-Coh Events (so this will be the $|t|$ and Q^2 plots with the explanations for what they are!!). You might also want to make a figure that depicts what the $\theta_{particle}$'s are... think about it.

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:

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

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 $|t|$:

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

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

ν-Mode $|t|$ and Q^2 plots are below:

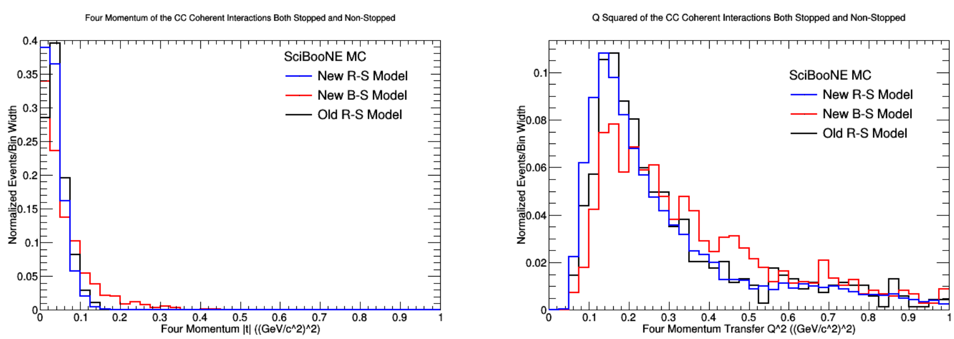

Figure 3: The $|t|$ Good Momentum Transfer (left) and Q^2 Good Momentum Transfer (right) for ν-mode CC-Coh $\pi^{+/-}$ interactions for the three models included in this study. The Good classification means that this includes both the stopped and the not-stopped classifications of the CC-Coh $\pi^{+/-}$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

Similar to before, Table 5.2 goes through the event selection criteria for selecting a sample of CC-Coh $\pi^{+/-}$ events from the neutrino mode ($\bar{\nu}$-mode) Monte Carlo.

Here will go the plots for CC-Coh Events for ANM both the momentums and the angles for total events.

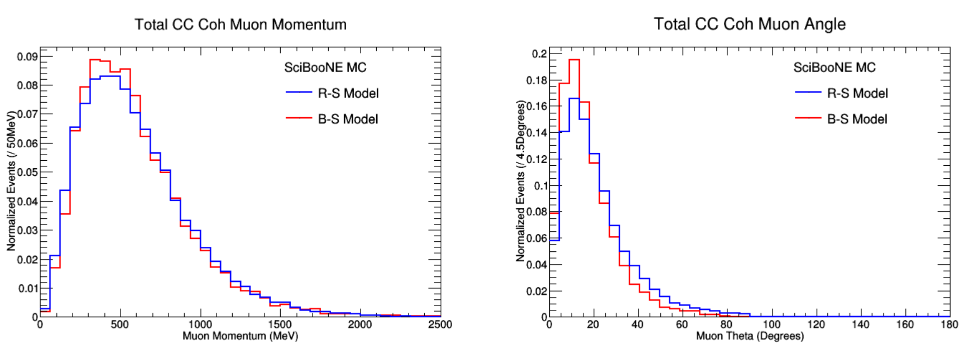

Figure 4: "Total" Muon Momentum (left) and "Total" Muon Angle (right) for ν-mode CC-Coh $\pi^{+/-}$ interactions for all three models included in this study. The "Total" classification means that all CC-Coh $\pi^{+/-}$ events are included in these histograms.

$\bar{\nu}$-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 7: Event reduction table for a sample of $\bar{\nu}$-mode Charged Current Coherent Pion events simulated in the SciBooNE geometry.

Here will go the plots for CC-Coh Events for ANM both the momentums and the angles for good events.

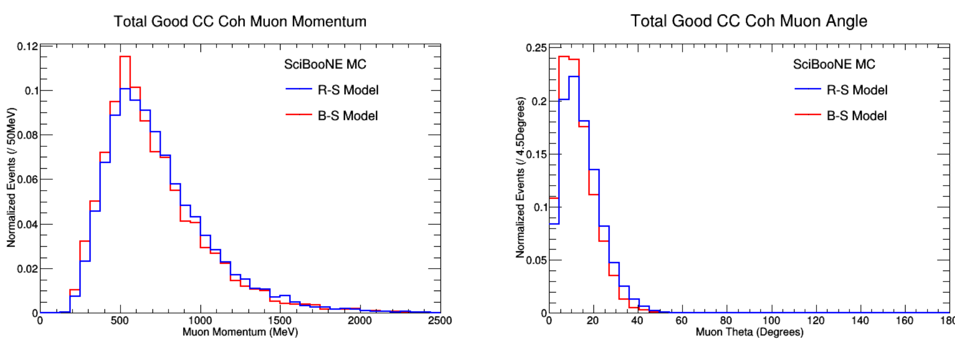

Figure 5: "Good" Muon Momentum (left) and "Good" Muon Angle (right) for $\bar{\nu}$-mode CC-Coh $\pi^{+/-}$ interactions for both of the models included in this study. The "Good" classification means that only the stopped and not-stopped CC-Coh $\pi^{+/-}$ events are included in these histograms.

Here should be a description of the different t and q plots!

$\bar{\nu}$-Mode $|t|$ and Q^2 plots are below:

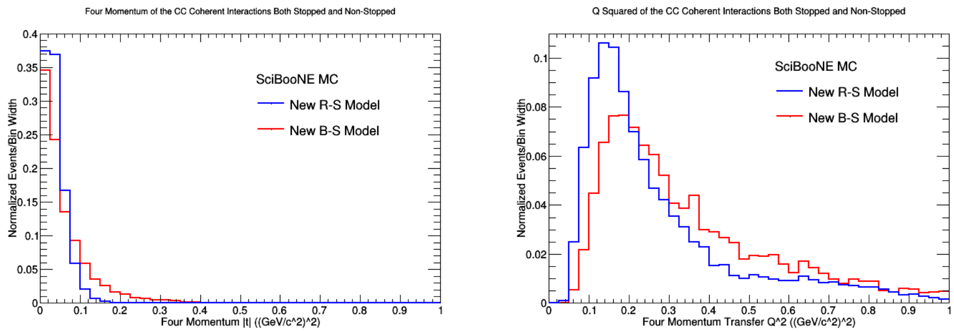

Figure 6: The $|t|$ Good Momentum Transfer (left) and Q^2 Good Momentum Transfer (right) for $\bar{\nu}$-mode CC-Coh $\pi^{+/-}$ interactions for both of the models included in this study. The Good classification means that this includes both the stopped and the not-stopped classifications of the CC-Coh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

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 (put link to sample here).

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 (put link to sample here).

A.3 ν-Mode Rein-Sehgal NEUTvx.x.x

A sample of 100,000 ν interactions were simulated using the NEUT generator (vx.x.x, 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 correspond to the file labeled

`SciBooNE_numu_coh_OLDNEUT_RooTrack.root`

found at the following link (put link to sample here).

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 correspond to the file labeled

`SciBooNE_numubar_coh_RooTrack.root`

found at the following link (put link to sample here).

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 correspond to the file labeled

`SciBooNE_numubar_coh_RooTrack_NEW.root`

found at the following link (put link to sample here).

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 (need to put a reference) showed in his thesis. This was done by... etc.

```
Put in the code for how we made the vertex distributions of the interactions.
```

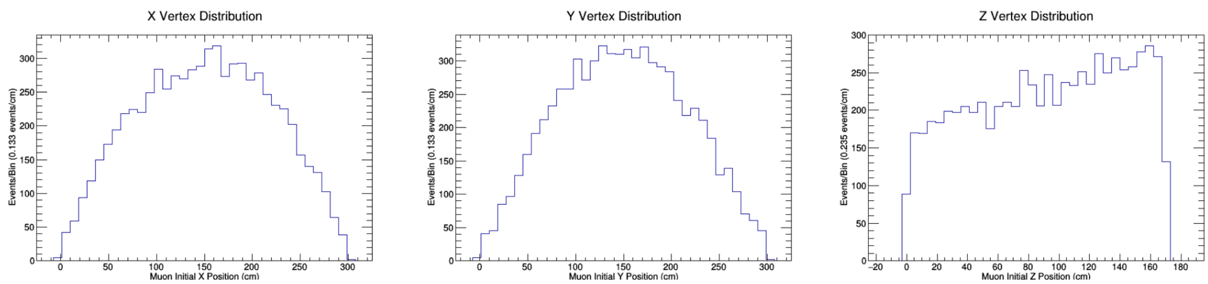

Figure 7: Vertex distributions of the events in the new Rein-Sehgal sample.

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.

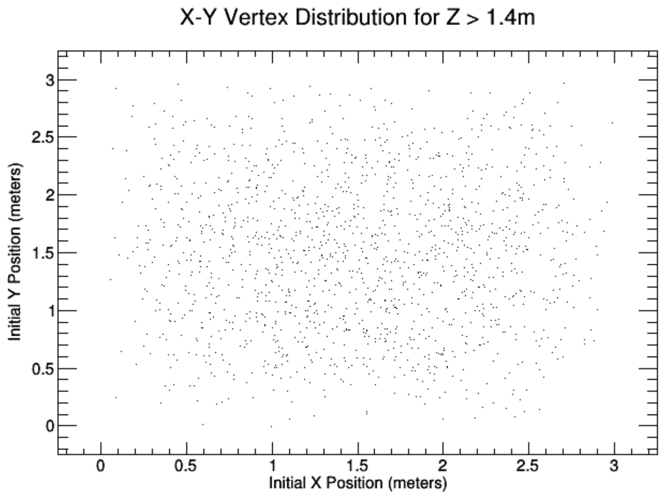

Figure 8: New ν-Mode Rein-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

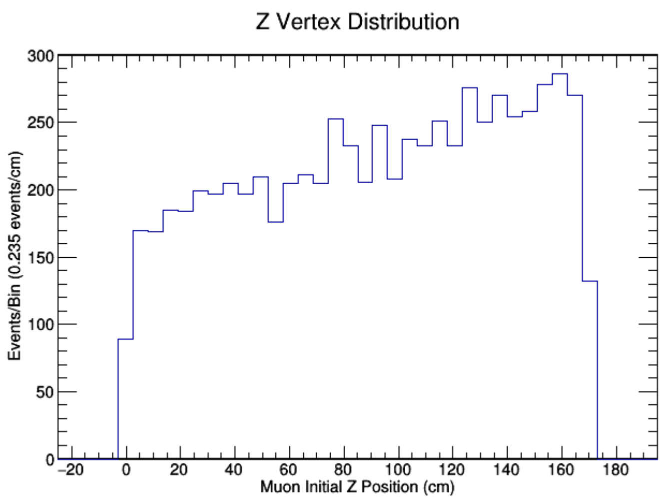

Figure 9: New ν-Mode Rein-Sehgal Z vertex distributions for the interactions.

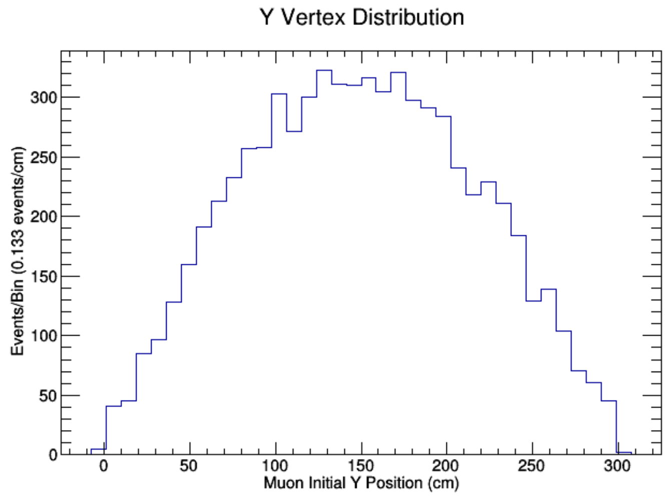

Figure 10: New ν-Mode Rein-Sehgal Y vertex distributions for the interactions.

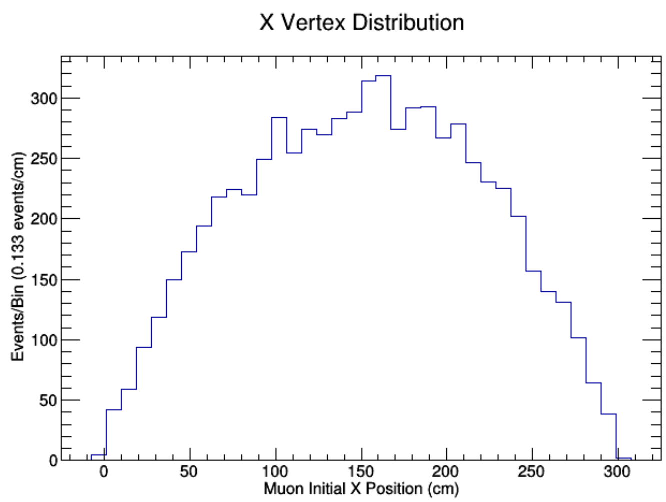

Figure 11: New ν-Mode Rein-Sehgal X vertex distributions for the interactions.

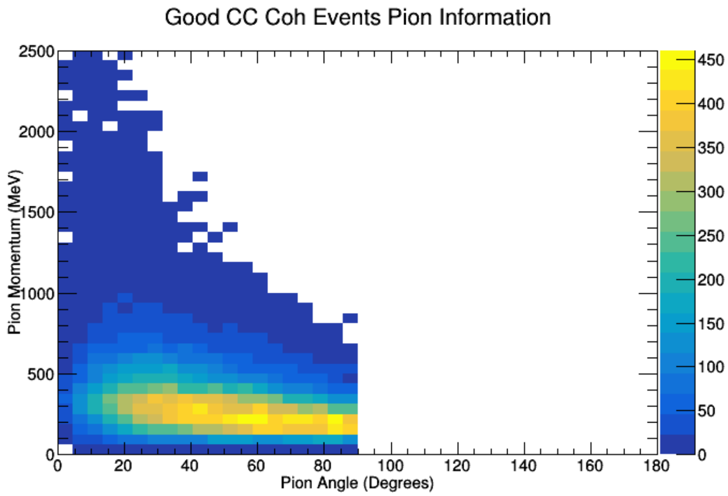

Figure 12: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

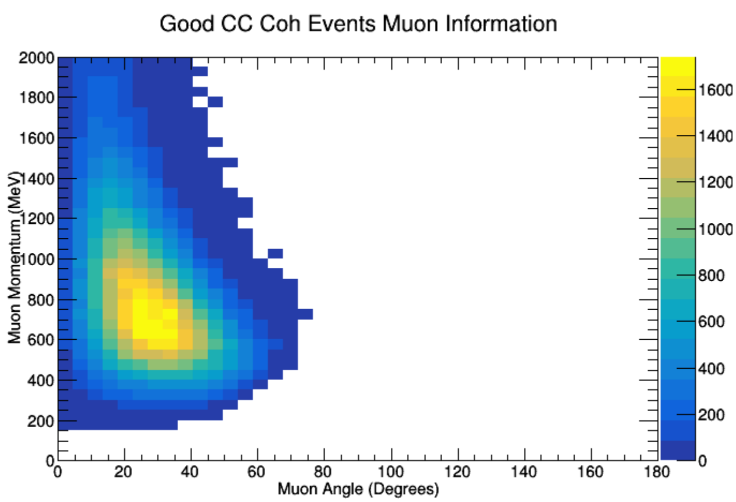

Figure 13: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".

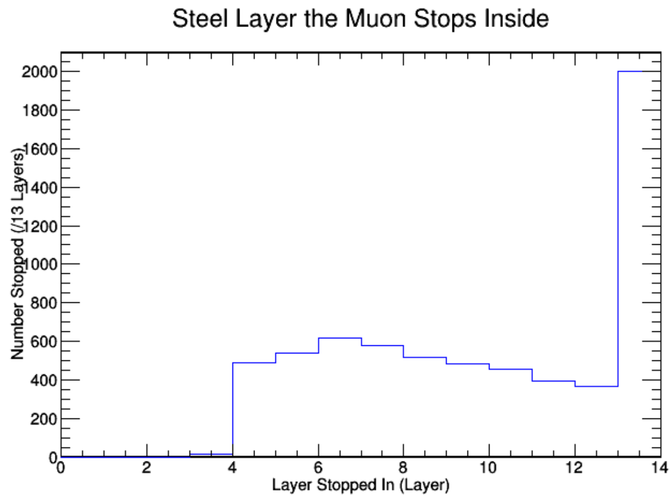

Figure 14: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

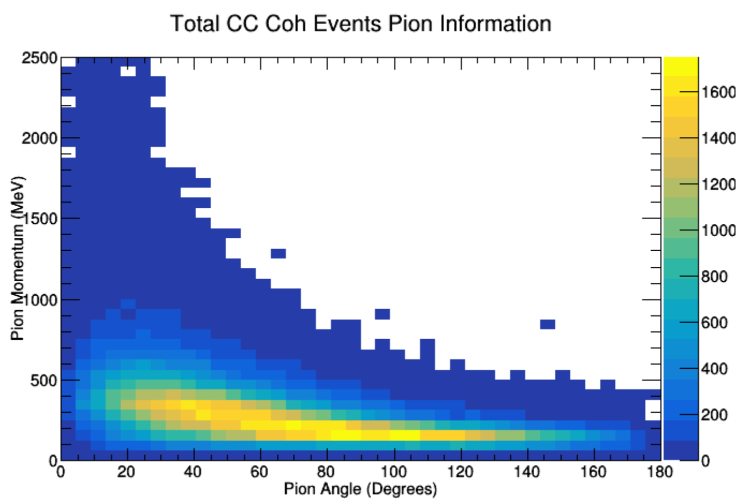

Figure 15: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

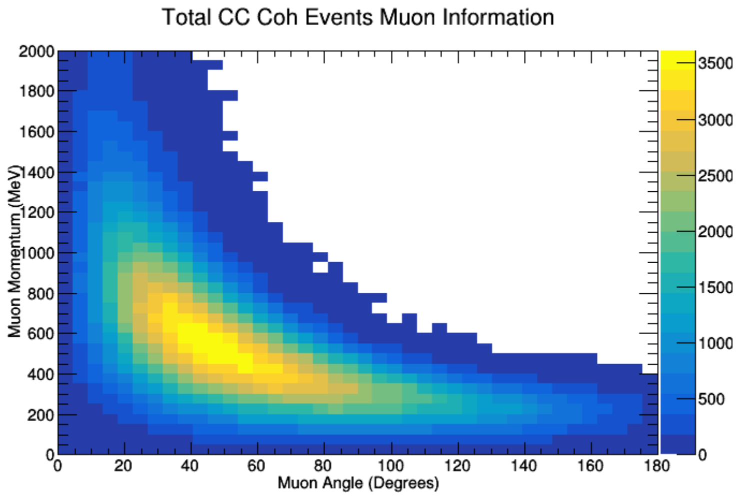

Figure 16: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

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).

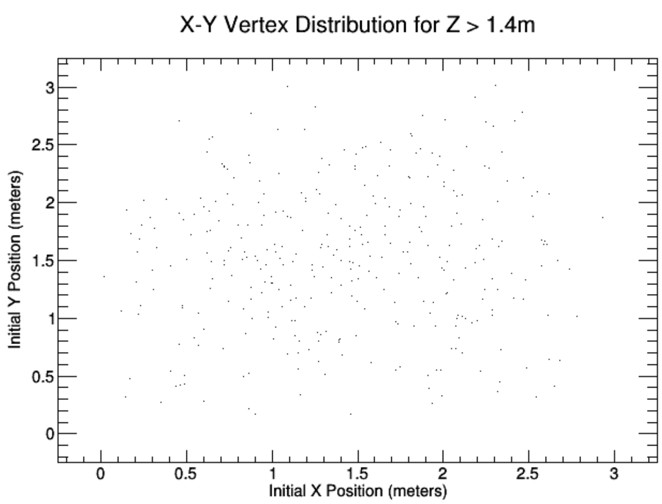

Figure 17: New ν-Mode Berger-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

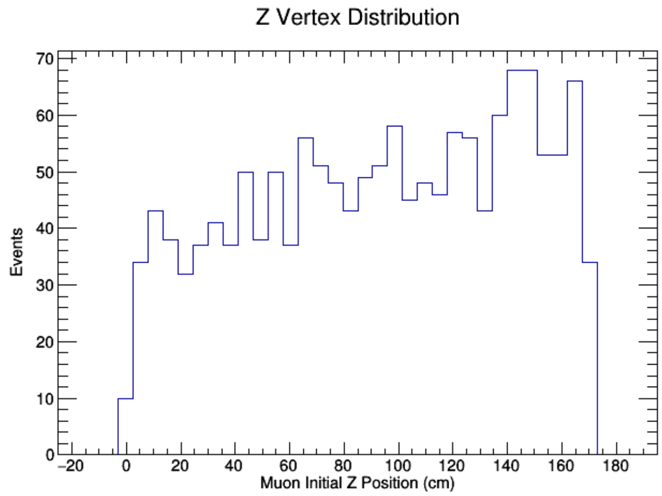

Figure 18: New ν-Mode Berger-Sehgal Z vertex distributions for the interactions.

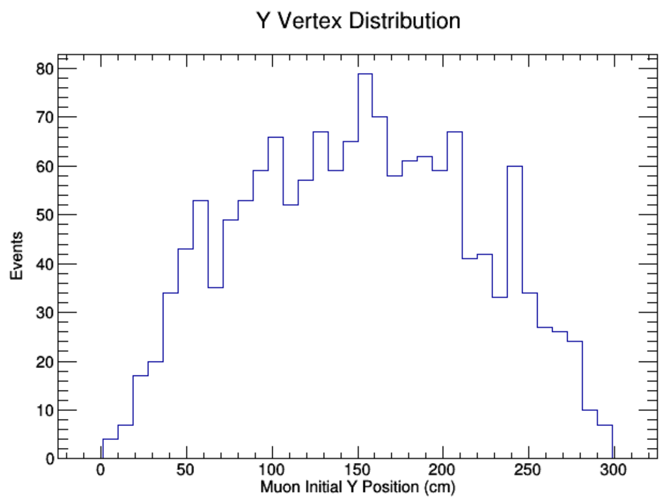

Figure 19: New ν-Mode Berger-Sehgal Y vertex distributions for the interactions.

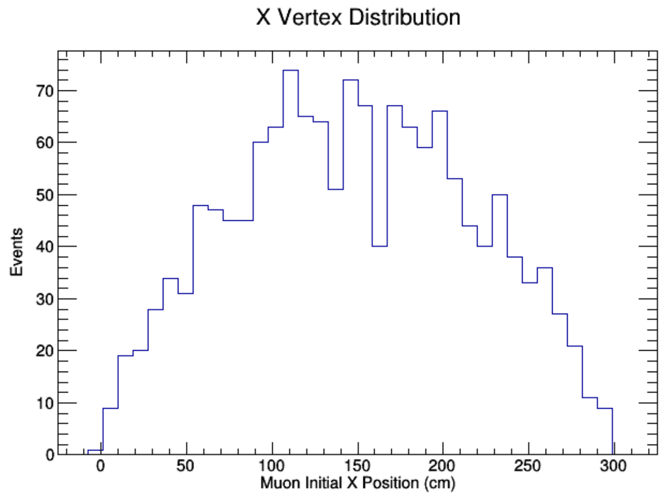

Figure 20: New ν-Mode Berger-Sehgal X vertex distributions for the interactions.

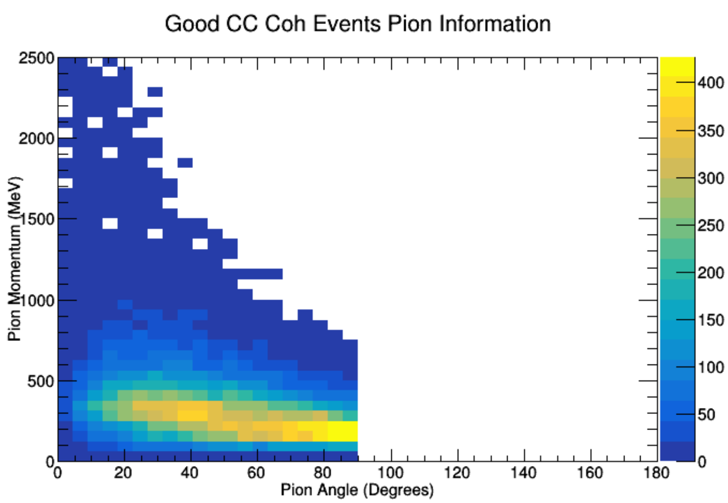

Figure 21: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

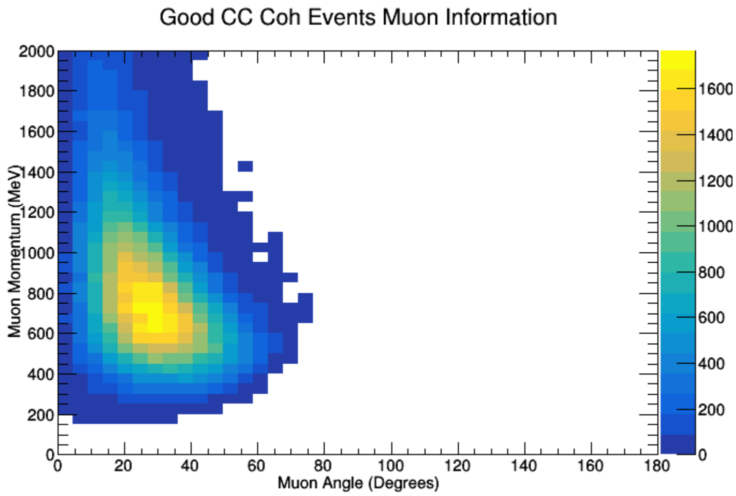

Figure 22: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".!

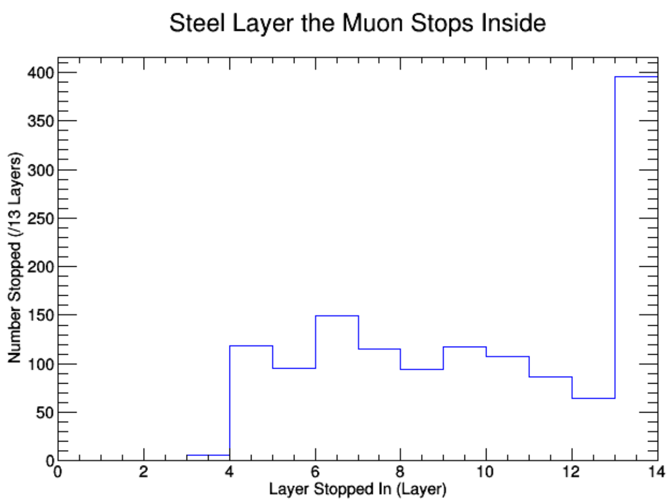

Figure 23: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

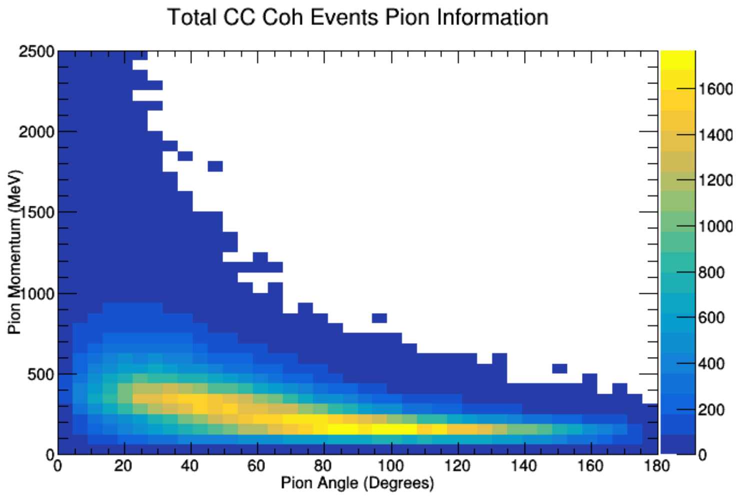

Figure 24: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

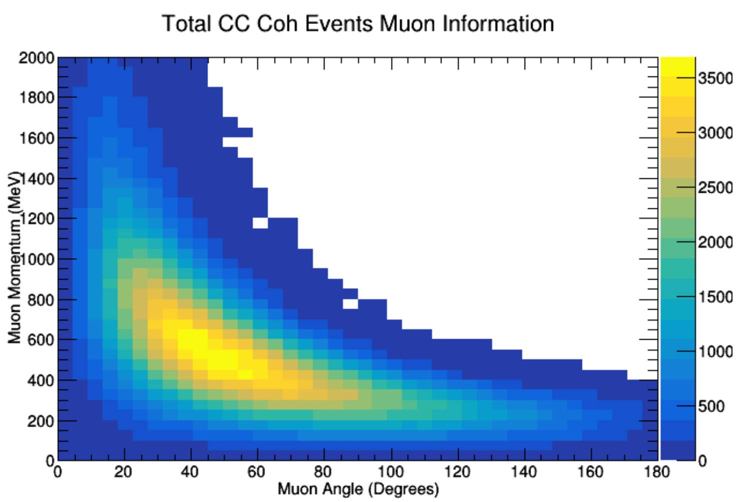

Figure 25: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

The NewNMBergerSehgal.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:

$$|\vec{p}_\mu| = \sqrt{P_{\mu_x}^2 + P_{\mu_y}^2 + P_{\mu_z}^2} \tag{17}$$

$$|\vec{p}_\pi| = \sqrt{P_{\pi_x}^2 + P_{\pi_y}^2 + P_{\pi_z}^2} \tag{18}$$

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:

$$\theta_\mu = tan^{-1}(\sqrt{P_{\mu_x}^2 + P_{\mu_y}^2}/P_{\mu_z}) \tag{19}$$

$$\theta_\pi = tan^{-1}(\sqrt{P_{\pi_x}^2 + P_{\pi_y}^2}/P_{\pi_z}) \tag{20}$$

The angles are reported in units of °, 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:

$$Q^2 = |(P_{\nu_\mu} - P_\mu)^2| \tag{21}$$

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

$$Q^2 = |(P_{\nu_{\mu,x}} - P_{\mu_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E})^2| \tag{22}$$

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:

$$|t| = |(Q - P_\pi)^2| = |(P_{\nu_\mu} - P_\mu - P_\pi)^2| \tag{23}$$

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

$$|t| = |(P_{\nu_{\mu,x}} - P_{\mu_x} - P_{\pi_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y} - P_{\pi_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z} - P_{\pi_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E} - P_{\pi_E})^2| \tag{24}$$

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

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).

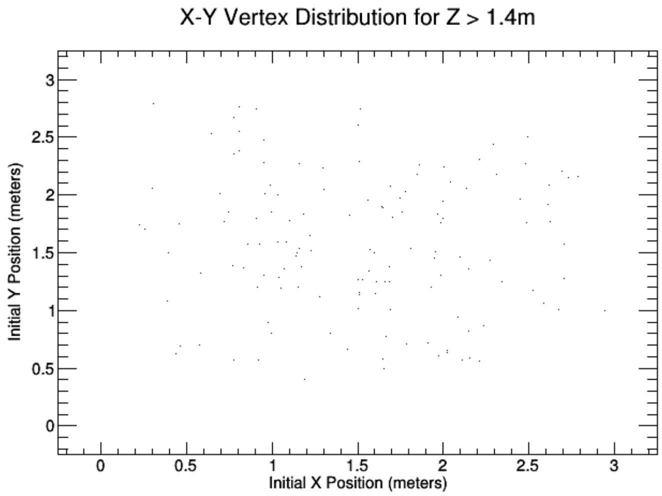

Figure 26: Old ν-Mode Rein-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

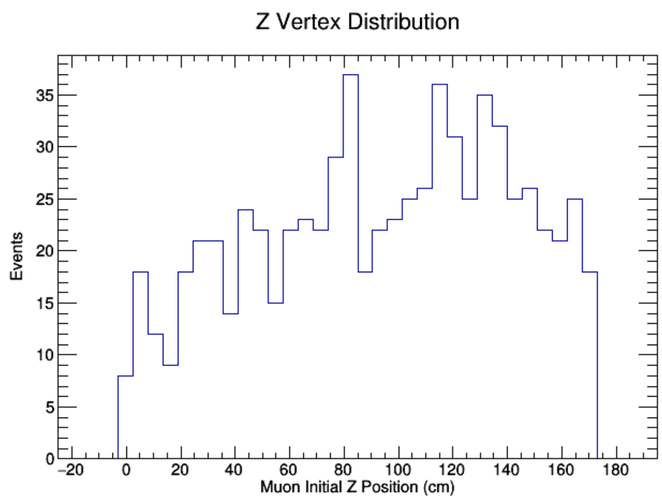

Figure 27: Old ν-Mode Rein-Sehgal Z vertex distributions for the interactions.

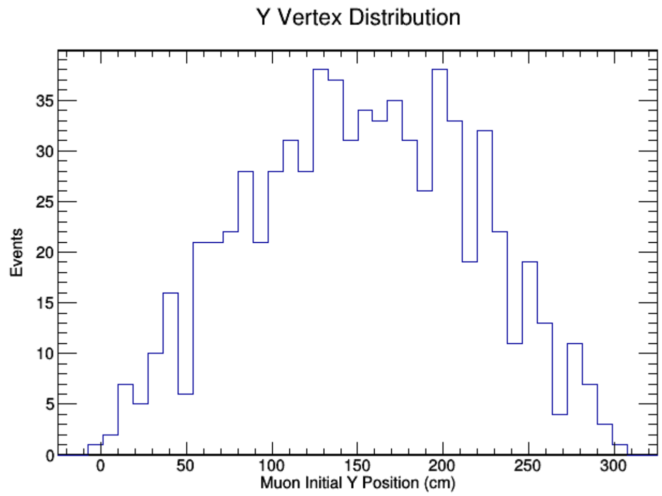

Figure 28: Old ν-Mode Rein-Sehgal Y vertex distributions for the interactions.

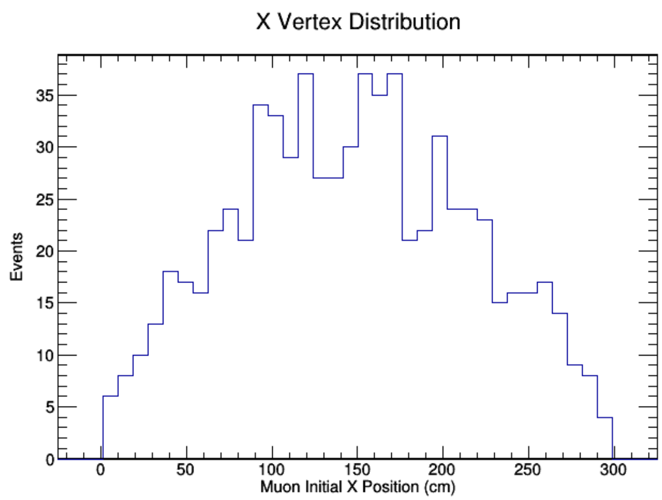

Figure 29: Old ν-Mode Rein-Sehgal X vertex distributions for the interactions.

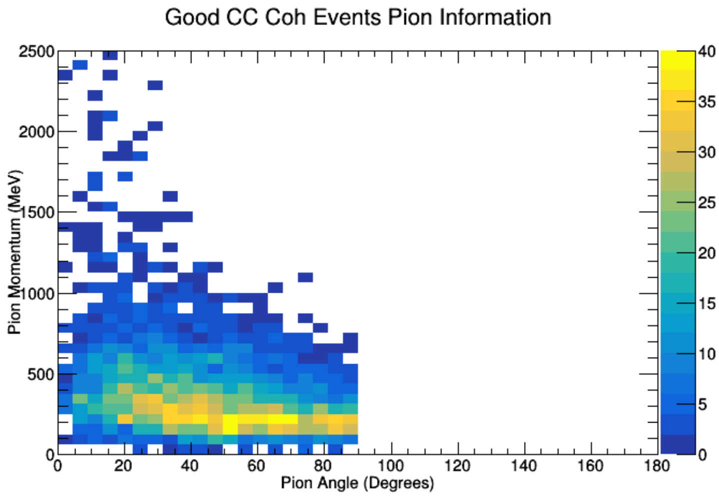

Figure 30: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

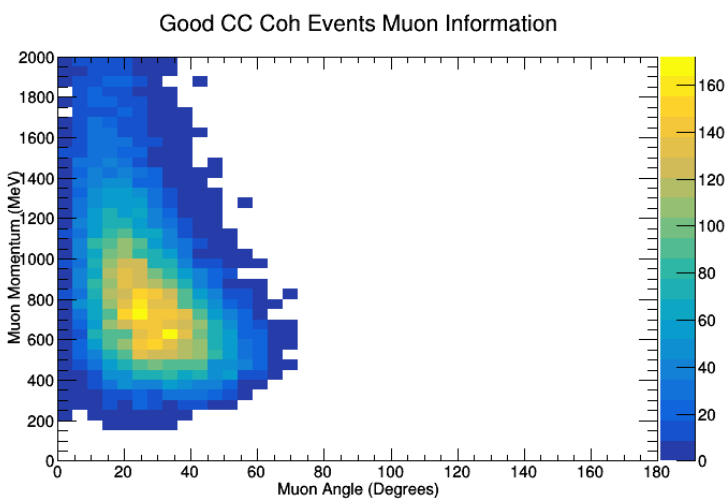

Figure 31: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".

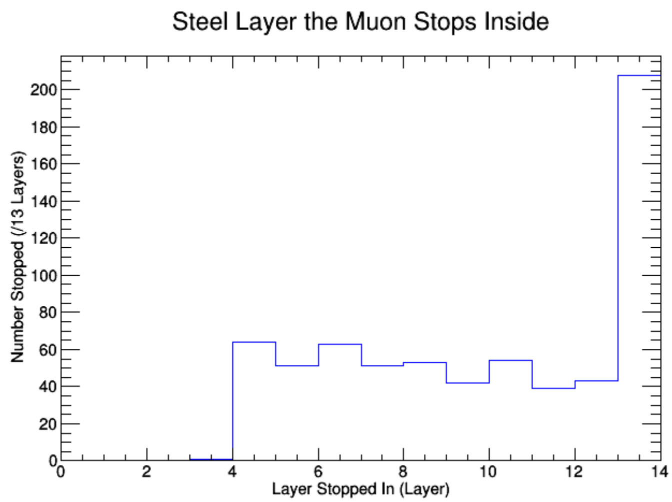

Figure 32: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

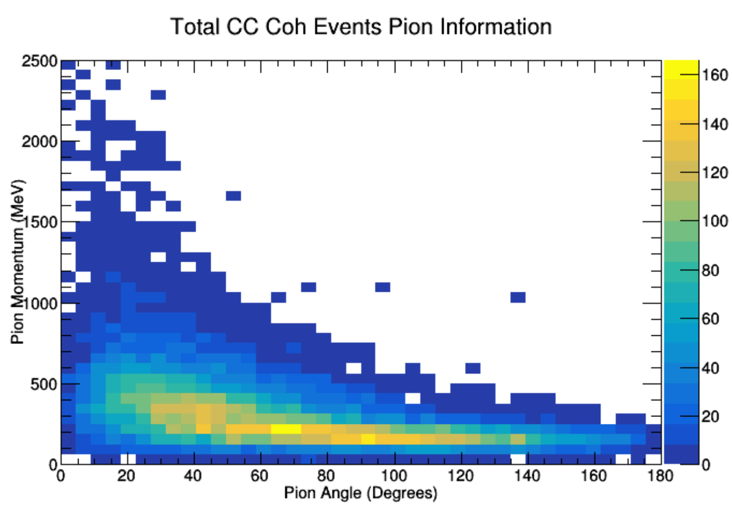

Figure 33: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

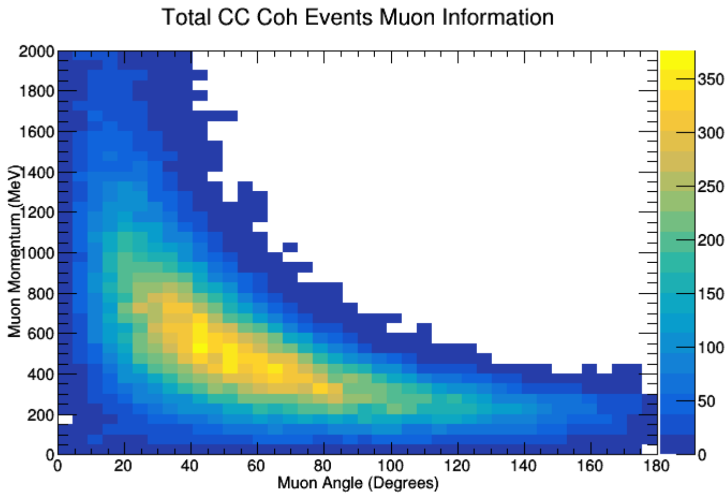

Figure 34: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

The OldNMReinSehgal.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:

$$|\vec{p}_{\mu}| = \sqrt{P_{\mu_x}^2 + P_{\mu_y}^2 + P_{\mu_z}^2} \tag{25}$$

$$|\vec{p}_{\pi}| = \sqrt{P_{\pi_x}^2 + P_{\pi_y}^2 + P_{\pi_z}^2} \tag{26}$$

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:

$$\theta_{\mu} = tan^{-1}(\sqrt{P_{\mu_x}^2 + P_{\mu_y}^2}/P_{\mu_z}) \tag{27}$$

$$\theta_{\pi} = tan^{-1}(\sqrt{P_{\pi_x}^2 + P_{\pi_y}^2}/P_{\pi_z}) \tag{28}$$

The angles are reported in units of °, 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:

$$Q^2 = |(P_{\nu_{\mu}} - P_{\mu})^2| \tag{29}$$

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

$$Q^2 = |(P_{\nu_{\mu,x}} - P_{\mu_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E})^2| \tag{30}$$

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:

$$|t| = |(Q - P_\pi)^2| = |(P_{\nu_\mu} - P_\mu - P_\pi)^2| \tag{31}$$

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

$$|t| = |(P_{\nu_{\mu,x}} - P_{\mu_x} - P_{\pi_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y} - P_{\pi_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z} - P_{\pi_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E} - P_{\pi_E})^2| \tag{32}$$

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

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).

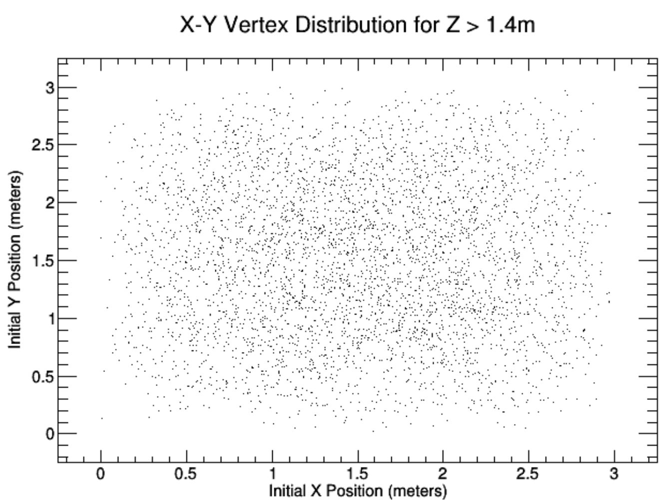

Figure 35: New $\bar{\nu}$-Mode Rein-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

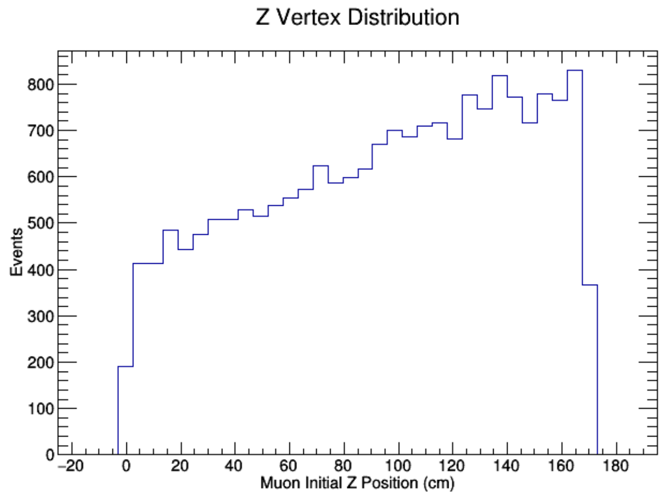

Figure 36: New $\bar{\nu}$-Mode Rein-Sehgal Z vertex distributions for the interactions.

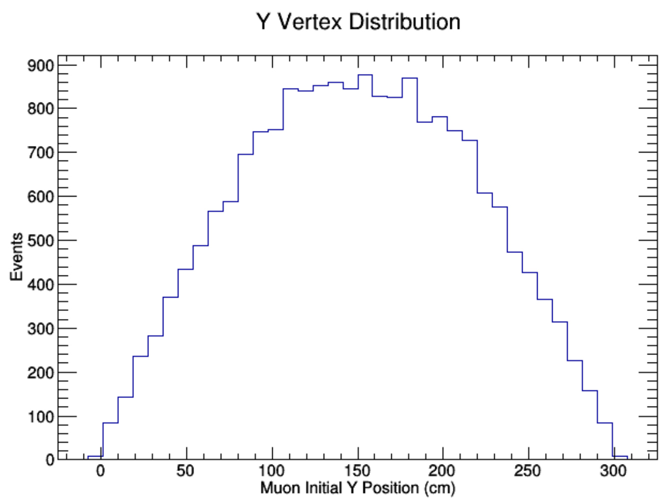

Figure 37: New $\bar{\nu}$-Mode Rein-Sehgal Y vertex distributions for the interactions.

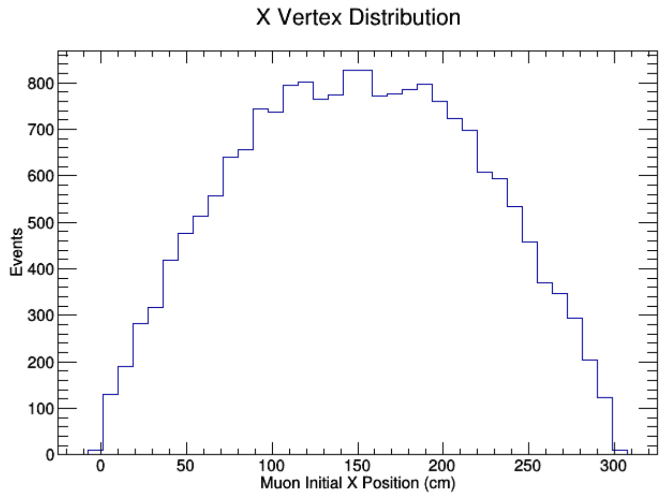

Figure 38: New $\bar{\nu}$-Mode Rein-Sehgal X vertex distributions for the interactions.

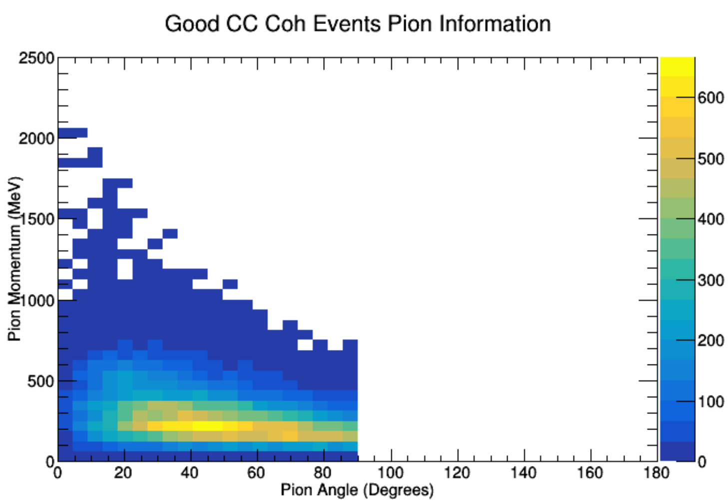

Figure 39: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

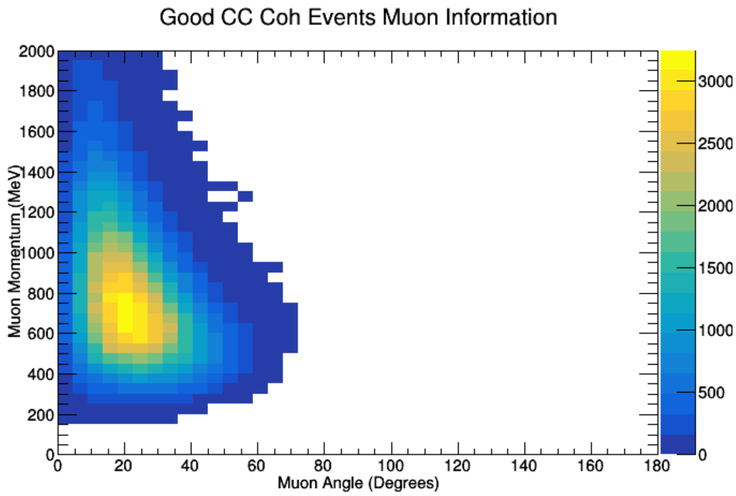

Figure 40: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".

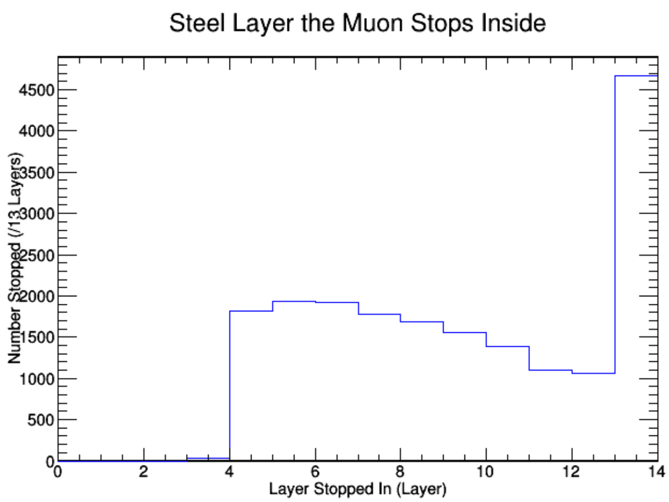

Figure 41: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

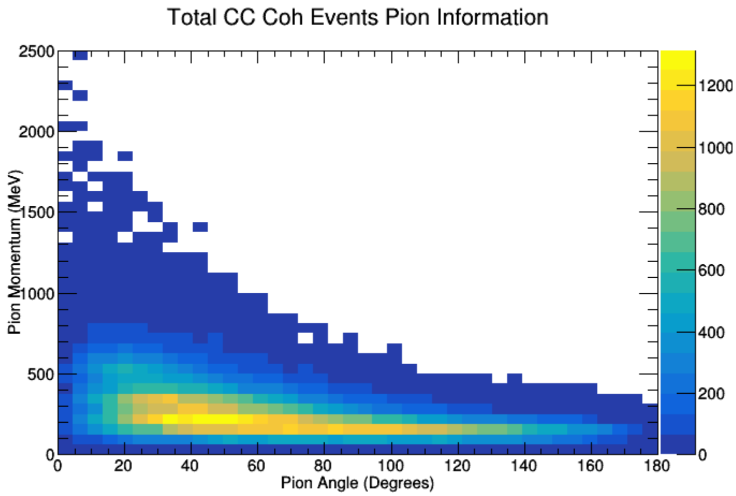

Figure 42: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

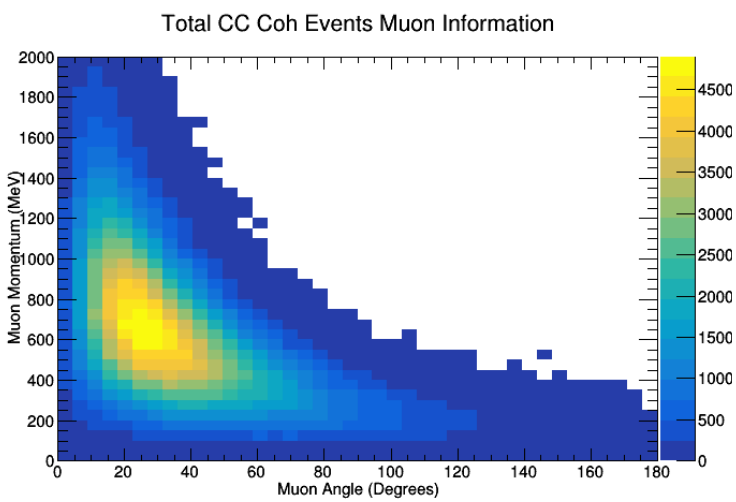

Figure 43: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

The NewANMReinSehgal.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:

$$|\vec{p}_\mu| = \sqrt{P_{\mu_x}^2 + P_{\mu_y}^2 + P_{\mu_z}^2} \tag{33}$$

$$|\vec{p}_\pi| = \sqrt{P_{\pi_x}^2 + P_{\pi_y}^2 + P_{\pi_z}^2} \tag{34}$$

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:

$$\theta_\mu = tan^{-1}(\sqrt{P_{\mu_x}^2 + P_{\mu_y}^2}/P_{\mu_z}) \tag{35}$$

$$\theta_\pi = tan^{-1}(\sqrt{P_{\pi_x}^2 + P_{\pi_y}^2}/P_{\pi_z}) \tag{36}$$

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:

$$Q^2 = |(P_{\nu_\mu} - P_\mu)^2| \tag{37}$$

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

$$Q^2 = |(P_{\nu_{\mu,x}} - P_{\mu_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E})^2| \tag{38}$$

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:

$$|t| = |(Q - P_\pi)^2| = |(P_{\nu_\mu} - P_\mu - P_\pi)^2| \tag{39}$$

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

$$|t| = |(P_{\nu_{\mu,x}} - P_{\mu_x} - P_{\pi_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y} - P_{\pi_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z} - P_{\pi_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E} - P_{\pi_E})^2| \tag{40}$$

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

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).

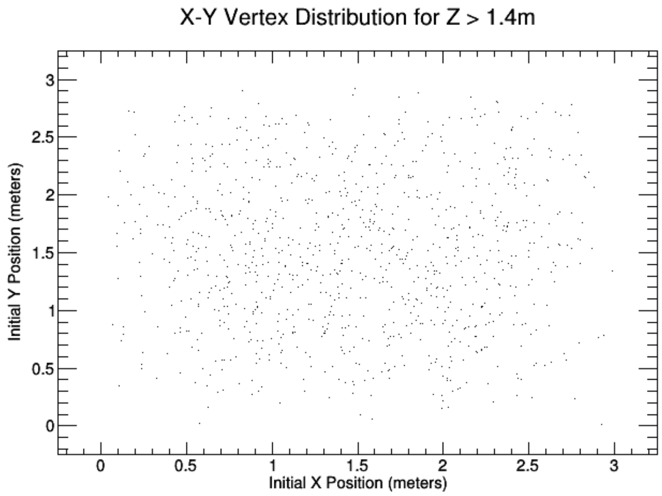

Figure 44: New $\bar{\nu}$-Mode Berger-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

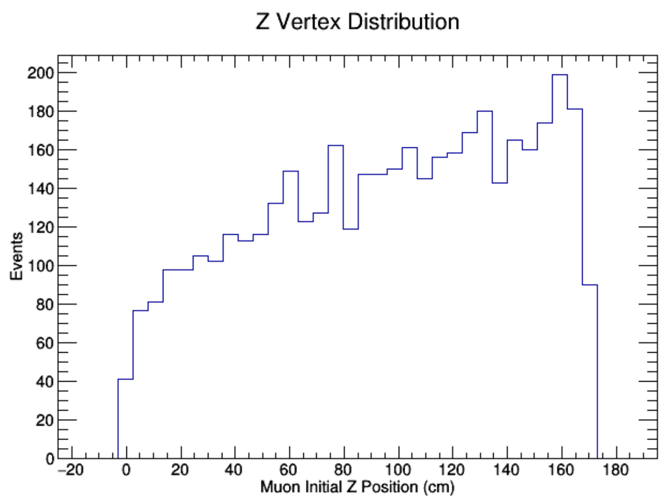

Figure 45: New $\bar{\nu}$-Mode Berger-Sehgal Z vertex distributions for the interactions.

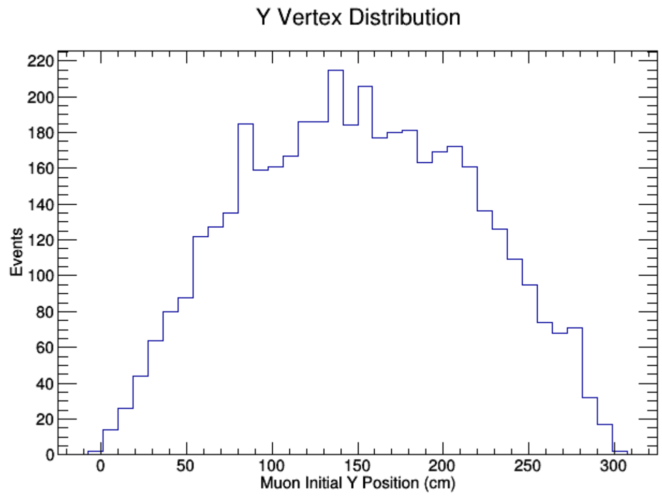

Figure 46: New $\bar{\nu}$-Mode Berger-Sehgal Y vertex distributions for the interactions.

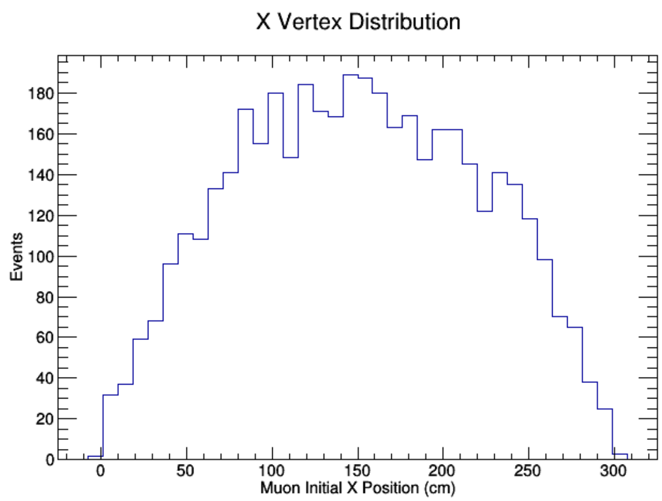

Figure 47: New $\bar{\nu}$-Mode Berger-Sehgal X vertex distributions for the interactions.

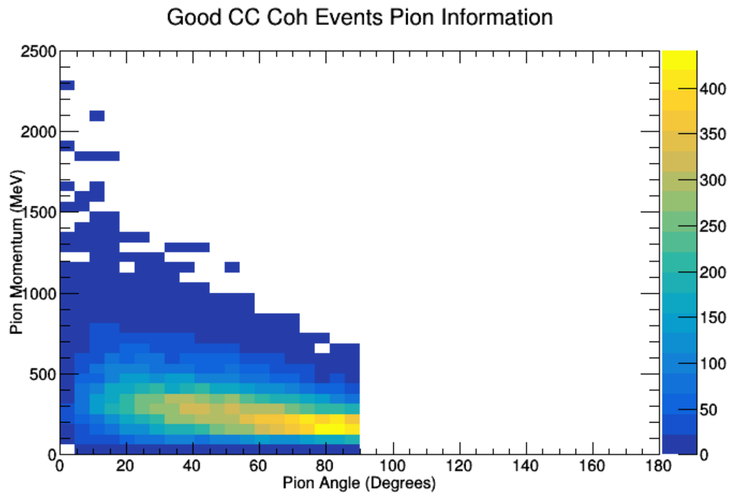

Figure 48: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

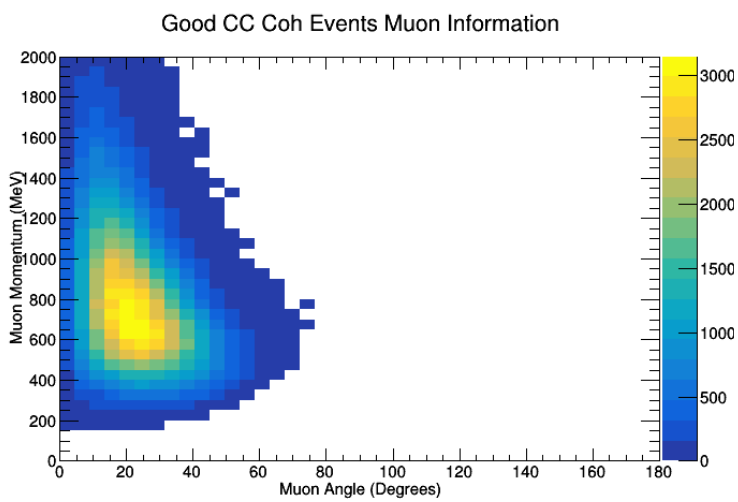

Figure 49: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".

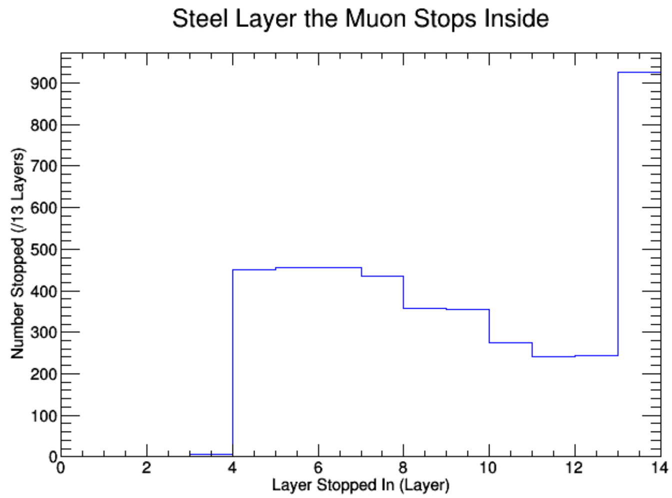

Figure 50: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

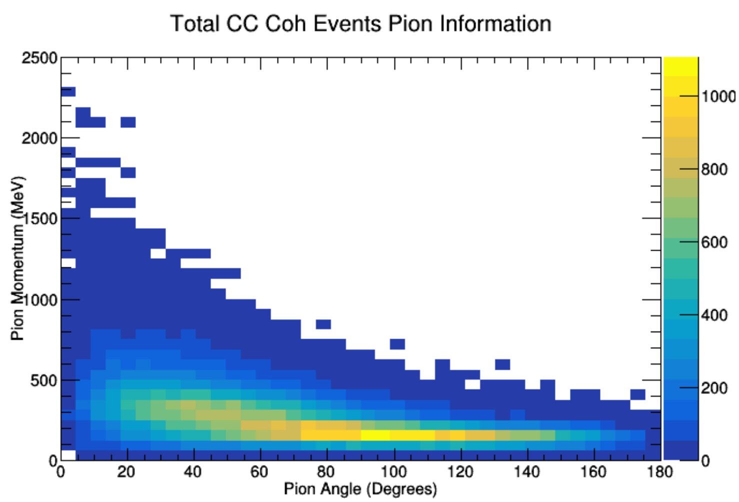

Figure 51: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

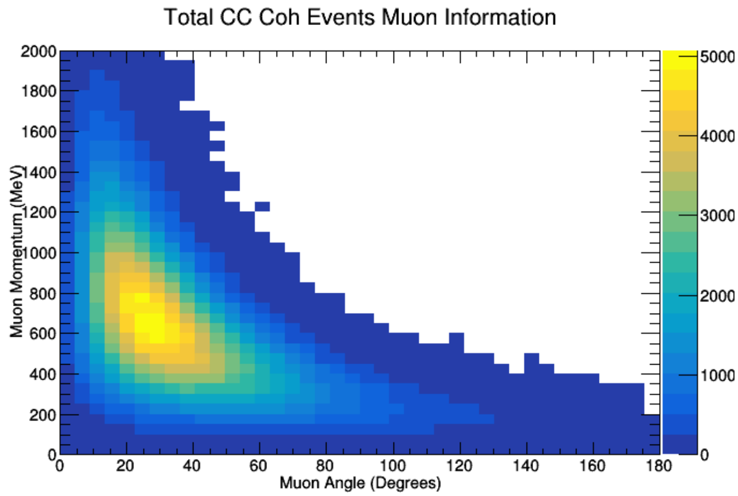

Figure 52: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

The NewANMBergerSehgal.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:

$$|\vec{p}_{\mu}| = \sqrt{P_{\mu_x}^2 + P_{\mu_y}^2 + P_{\mu_z}^2} \tag{41}$$

$$|\vec{p}_{\pi}| = \sqrt{P_{\pi_x}^2 + P_{\pi_y}^2 + P_{\pi_z}^2} \tag{42}$$

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:

$$\theta_{\mu} = tan^{-1}(\sqrt{P_{\mu_x}^2 + P_{\mu_y}^2}/P_{\mu_z}) \tag{43}$$

$$\theta_{\pi} = tan^{-1}(\sqrt{P_{\pi_x}^2 + P_{\pi_y}^2}/P_{\pi_z}) \tag{44}$$

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:

$$Q^2 = |(P_{\nu_{\mu}} - P_{\mu})^2| \tag{45}$$

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

$$Q^2 = |(P_{\nu_{\mu,x}} - P_{\mu_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E})^2| \tag{46}$$

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:

$$|t| = |(Q - P_\pi)^2| = |(P_{\nu_\mu} - P_\mu - P_\pi)^2| \tag{47}$$

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

$$|t| = |(P_{\nu_{\mu,x}} - P_{\mu_x} - P_{\pi_x})^2 + (P_{\nu_{\mu,y}} - P_{\mu_y} - P_{\pi_y})^2 + (P_{\nu_{\mu,z}} - P_{\mu_z} - P_{\pi_z})^2 + (P_{\nu_{\mu,E}} - P_{\mu_E} - P_{\pi_E})^2| \tag{48}$$

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

A.12 NMCombinedPlots.C

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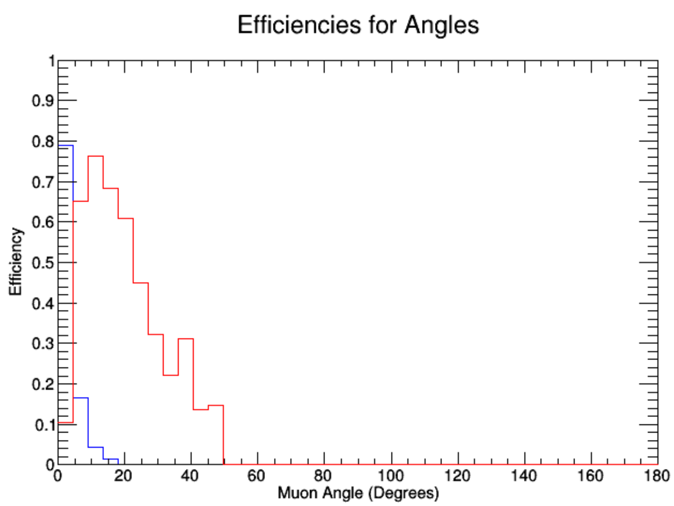

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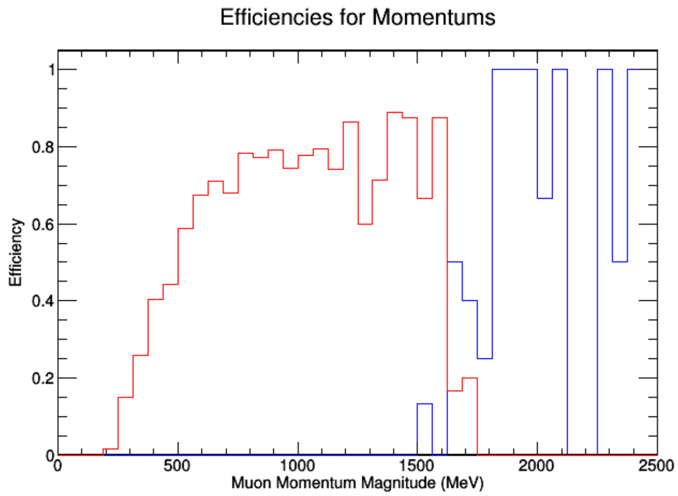

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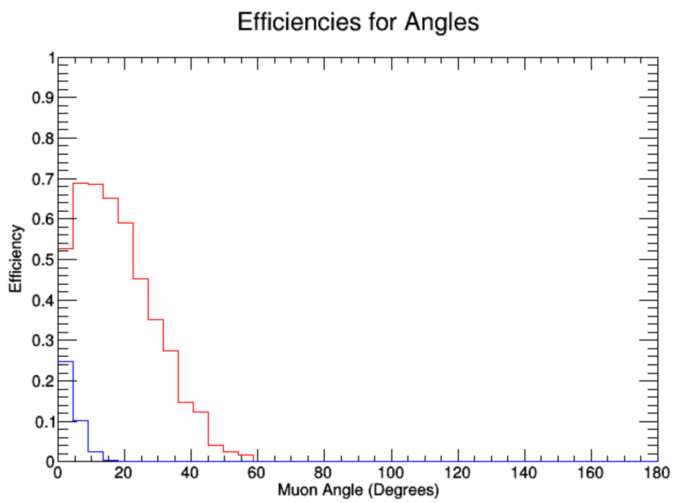

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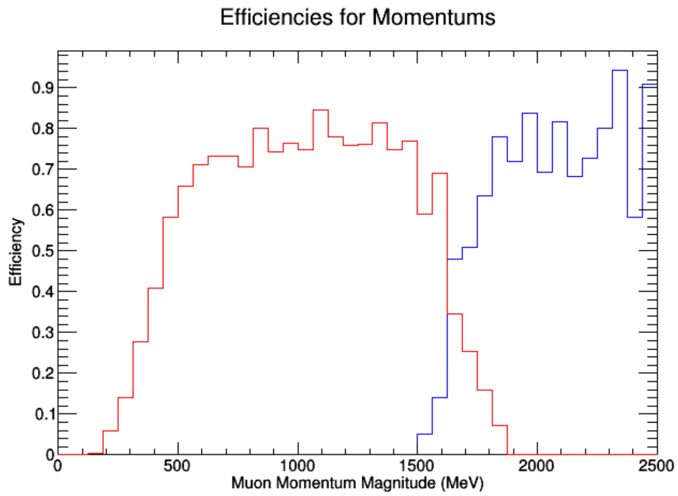

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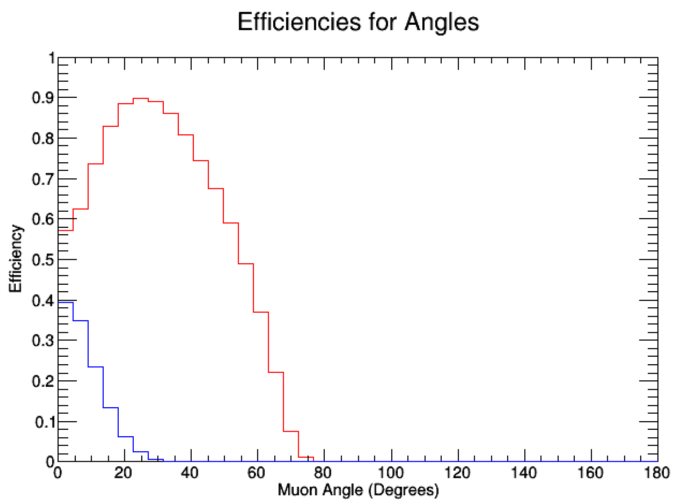

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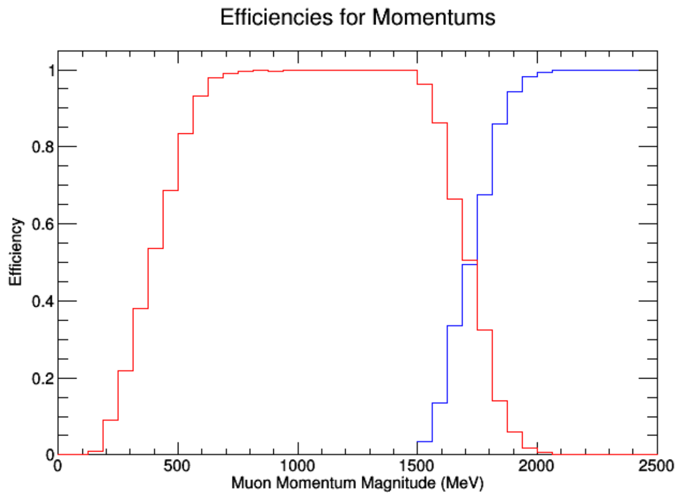

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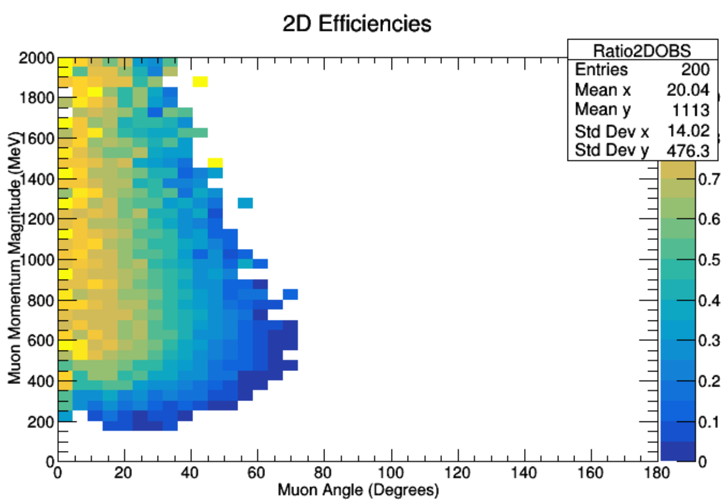

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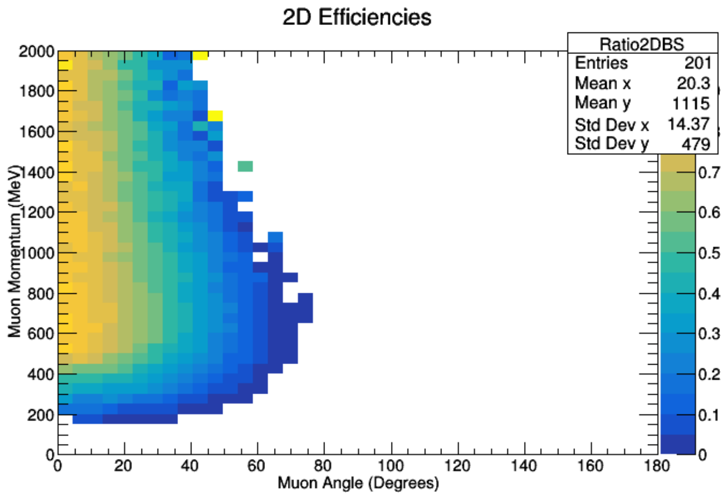

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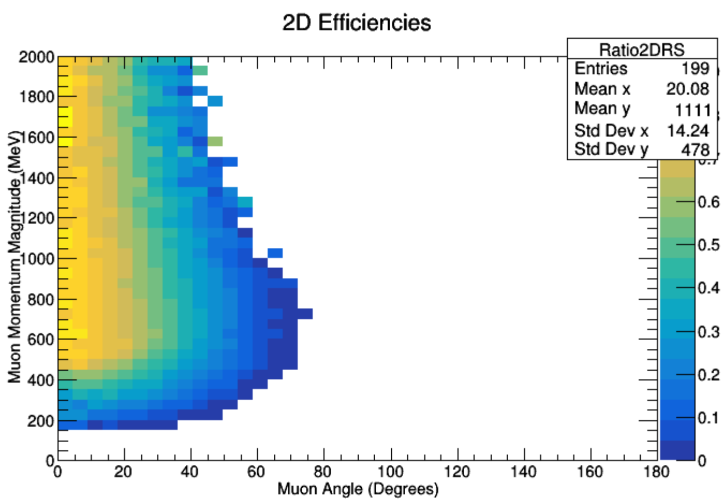

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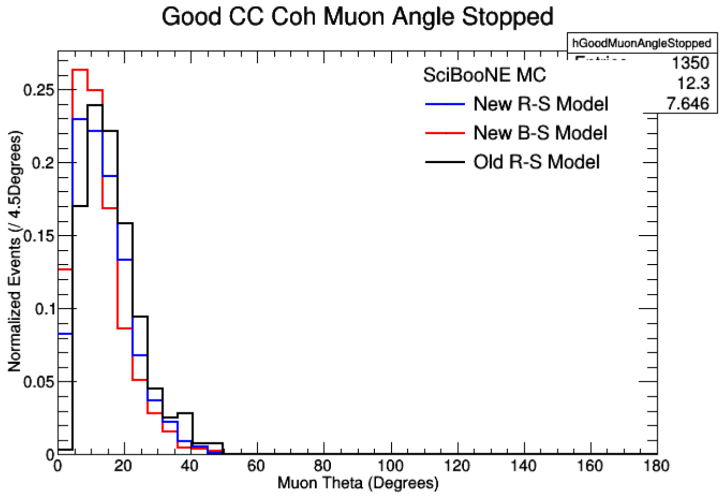

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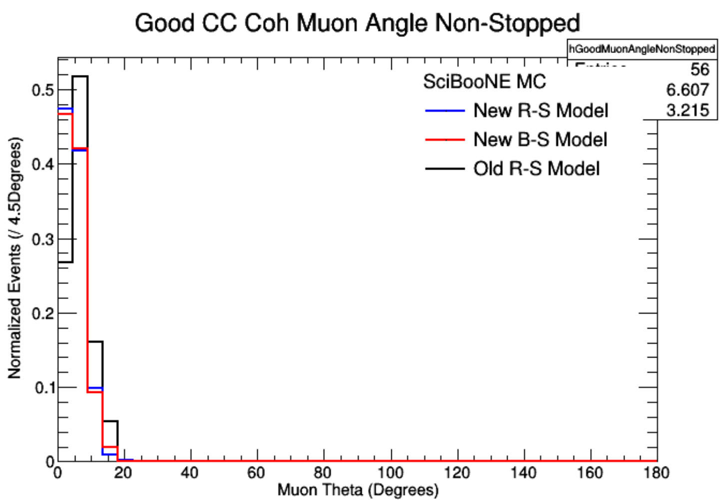

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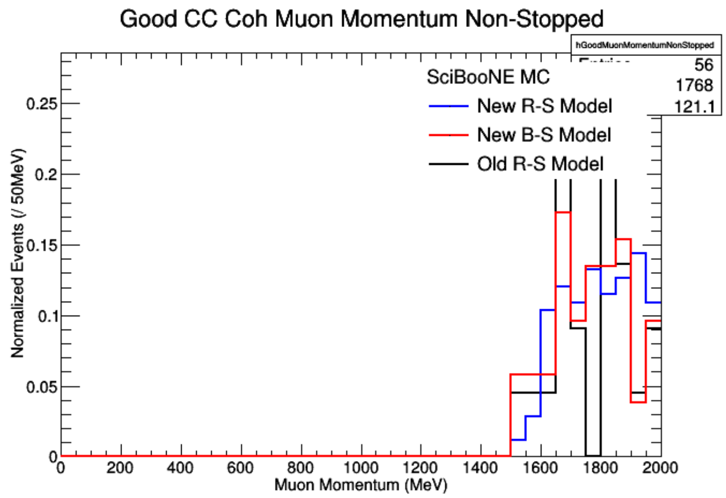

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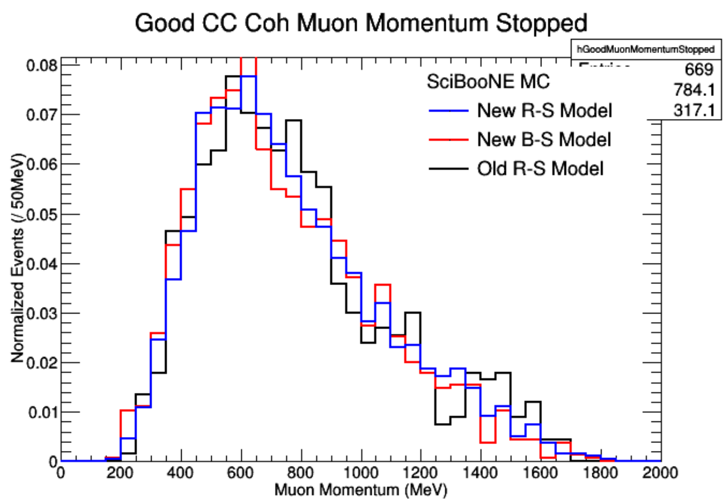

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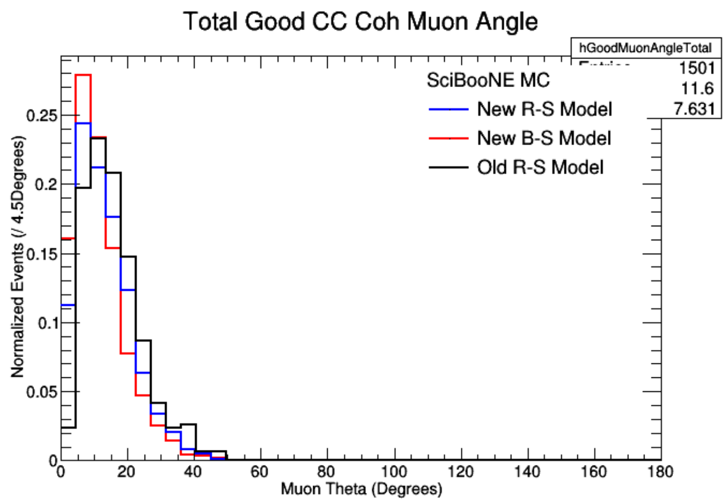

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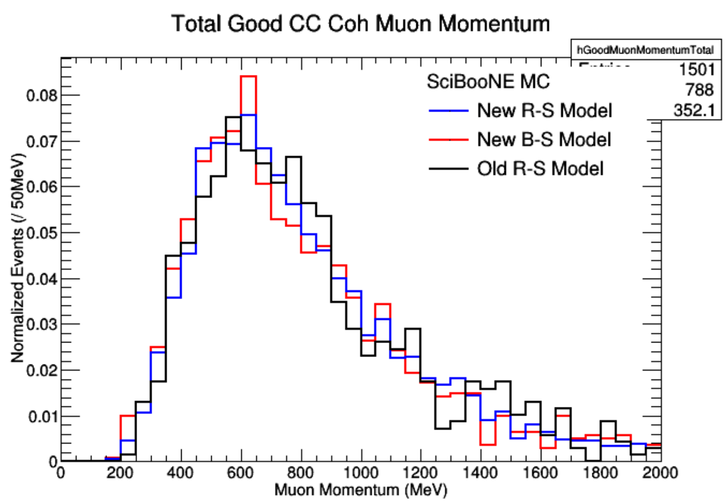

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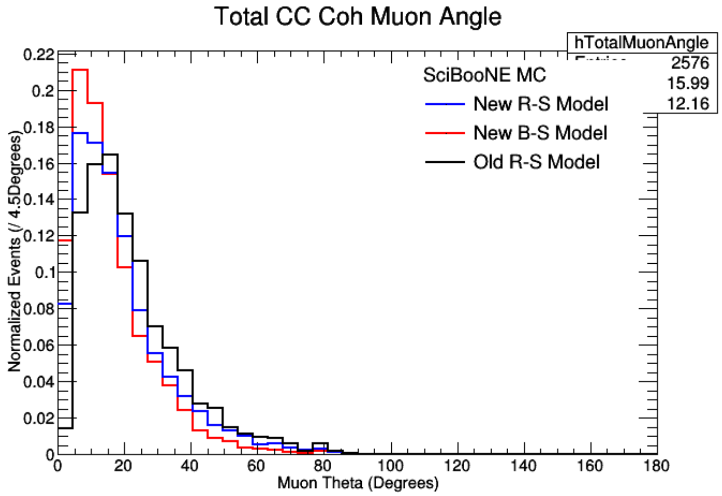

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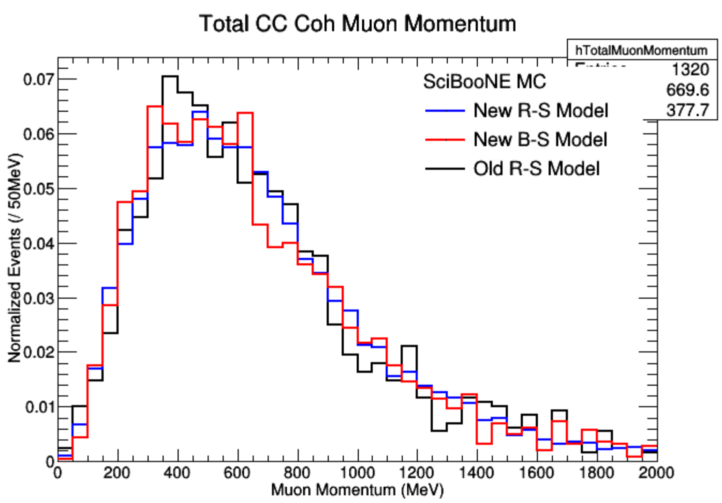

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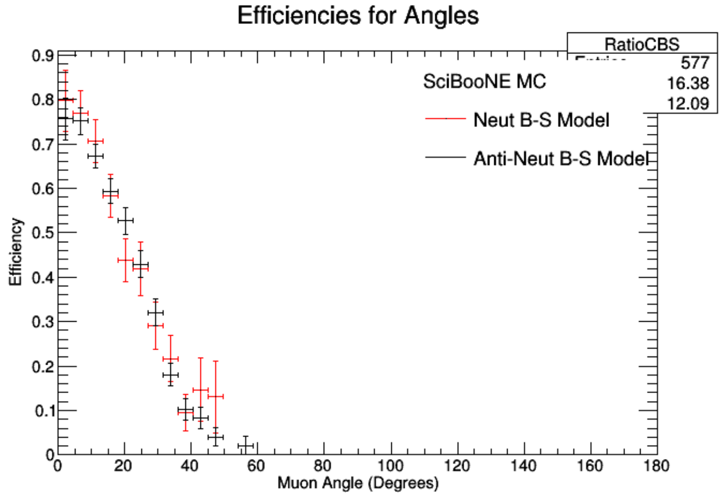

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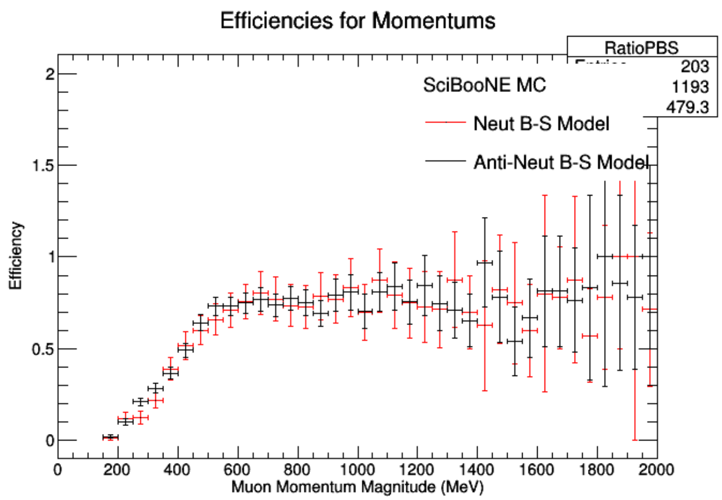

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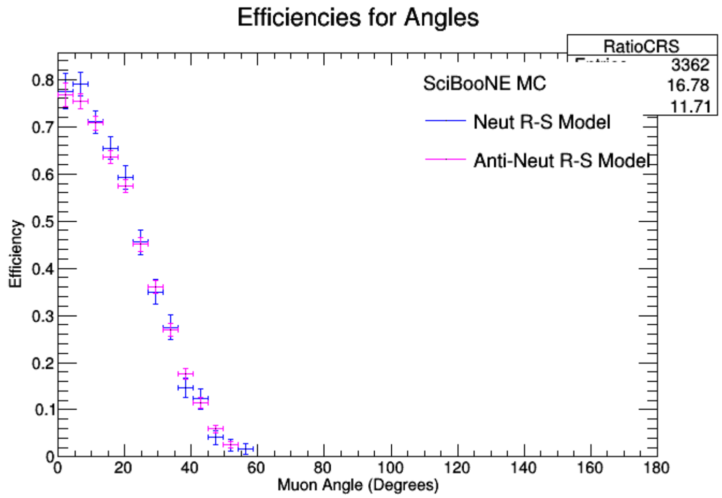

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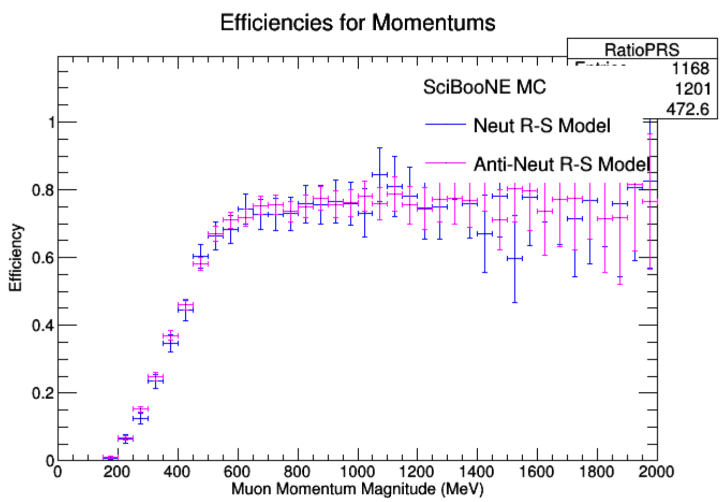

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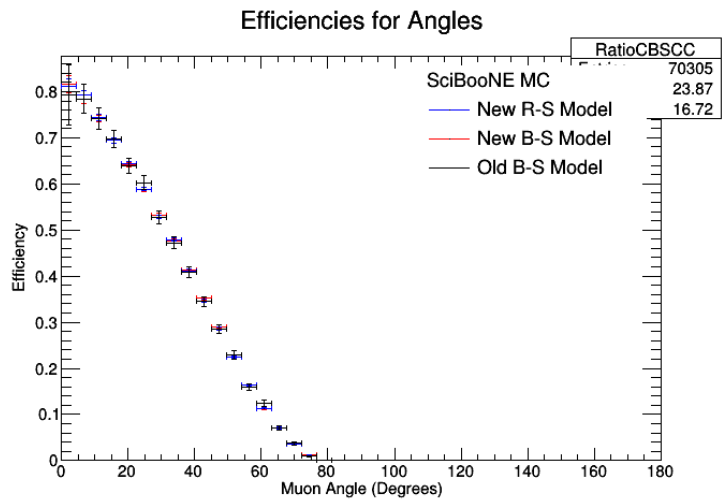

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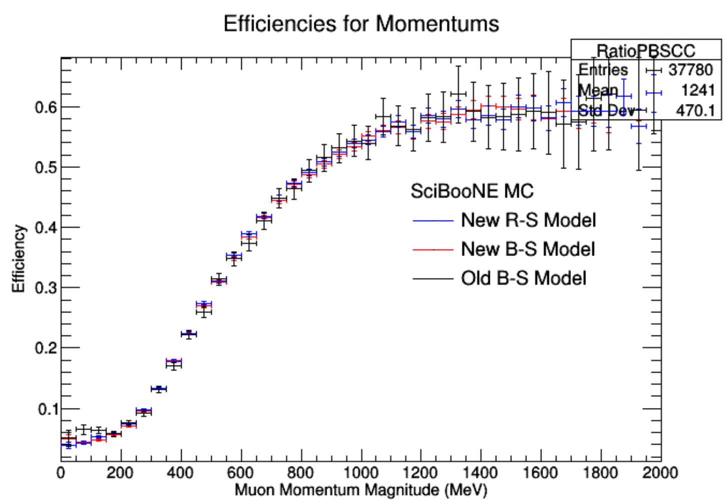

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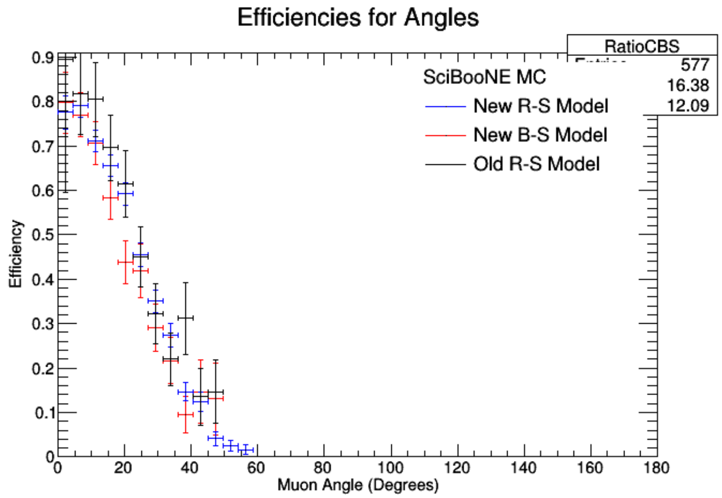

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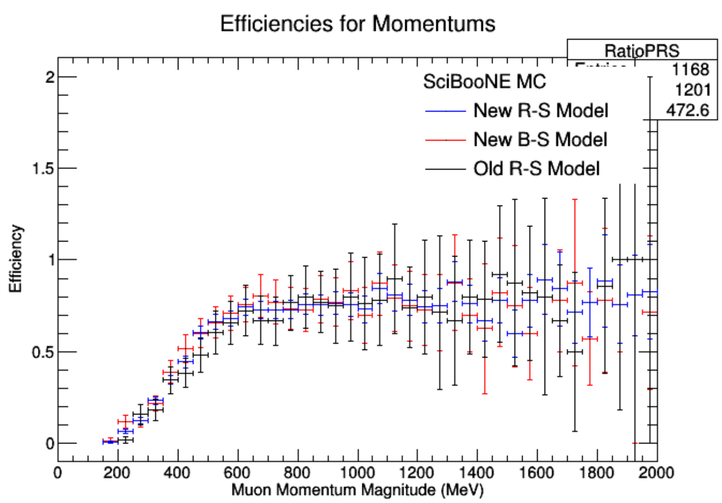

Figure 77

A.13 NMPionPlotting.C

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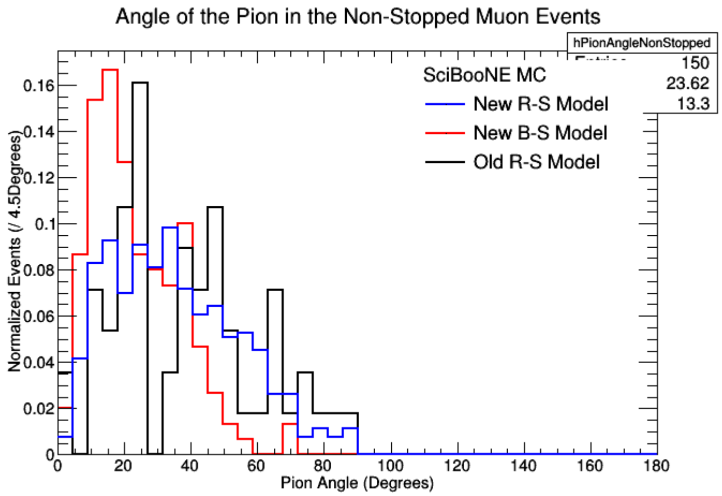

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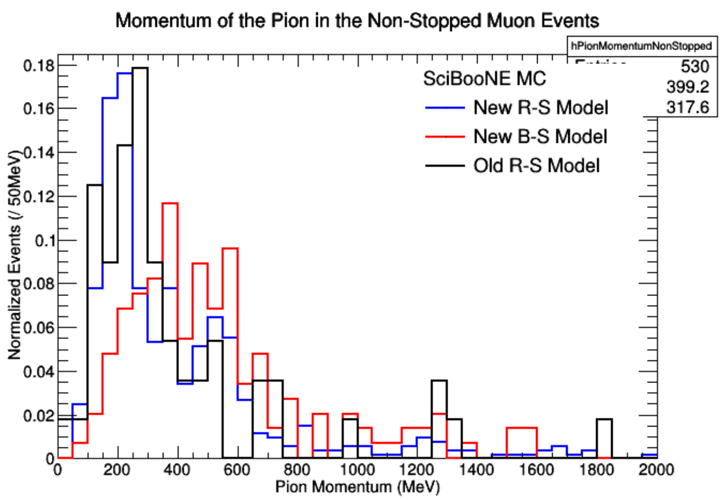

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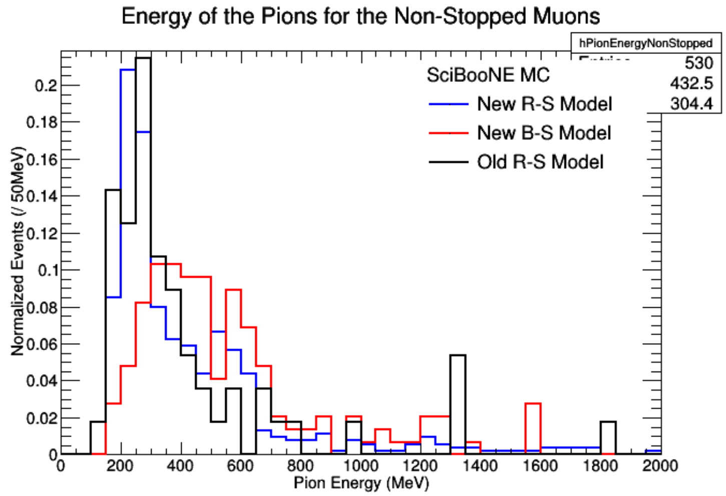

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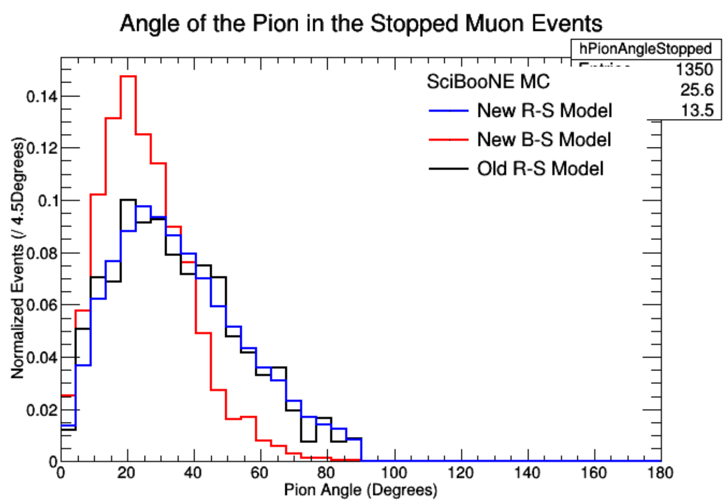

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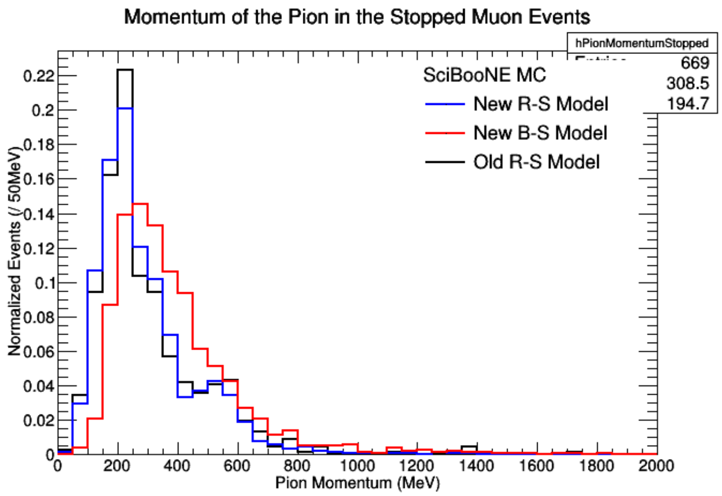

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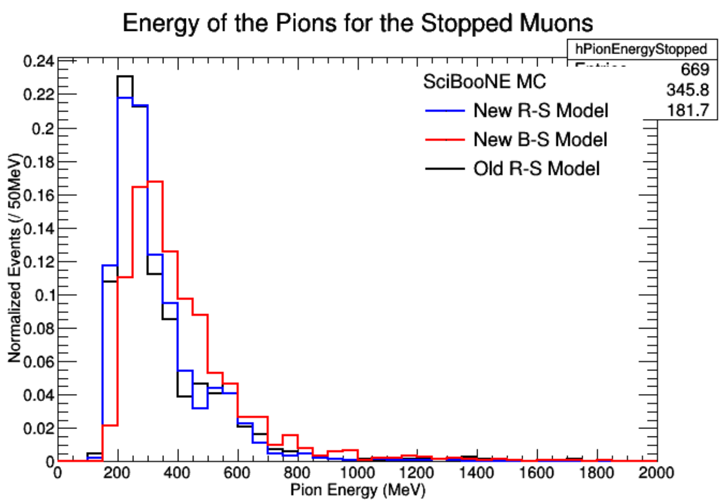

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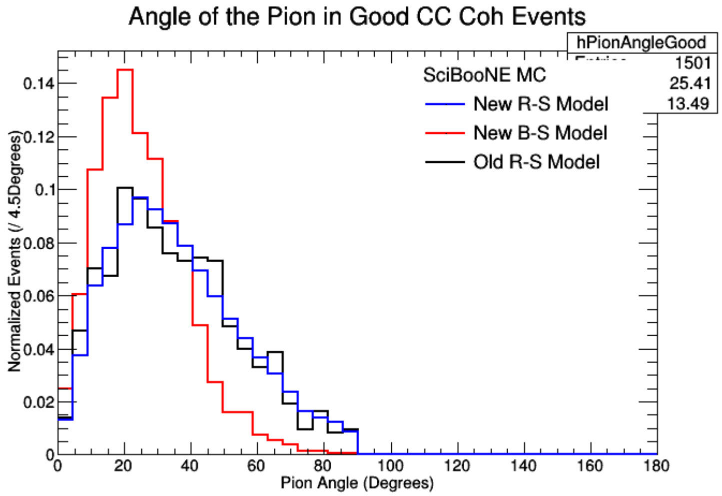

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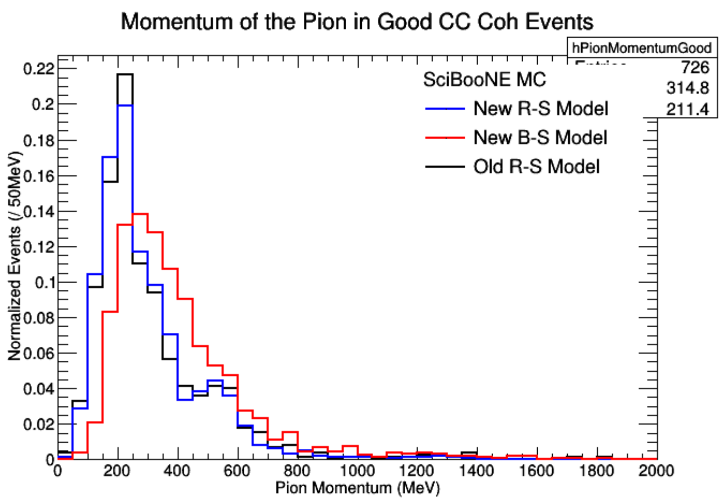

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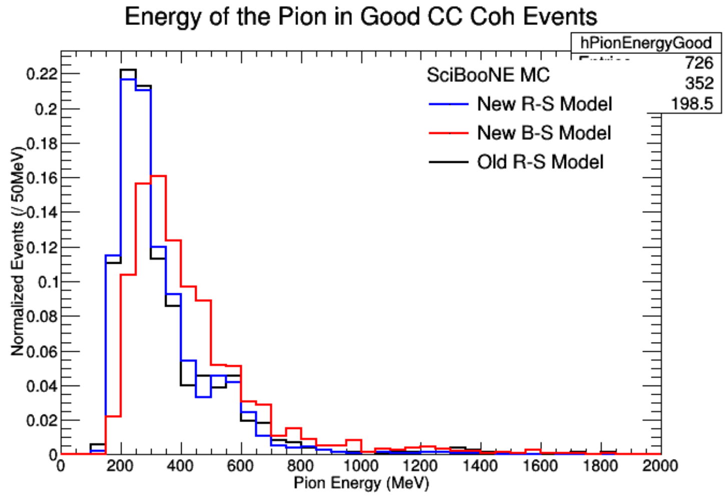

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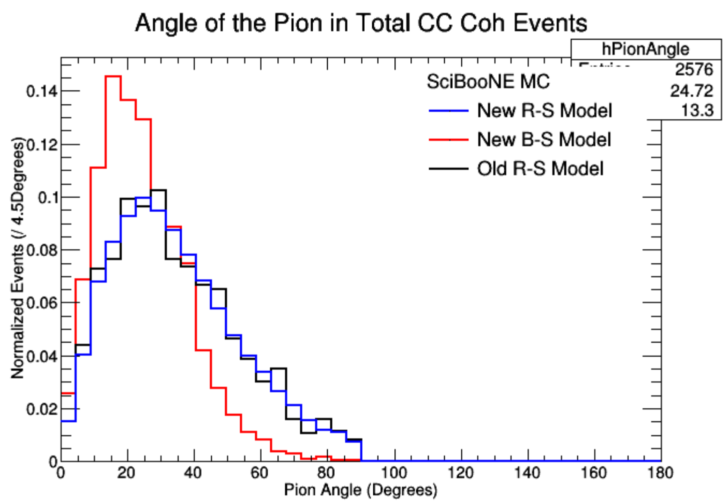

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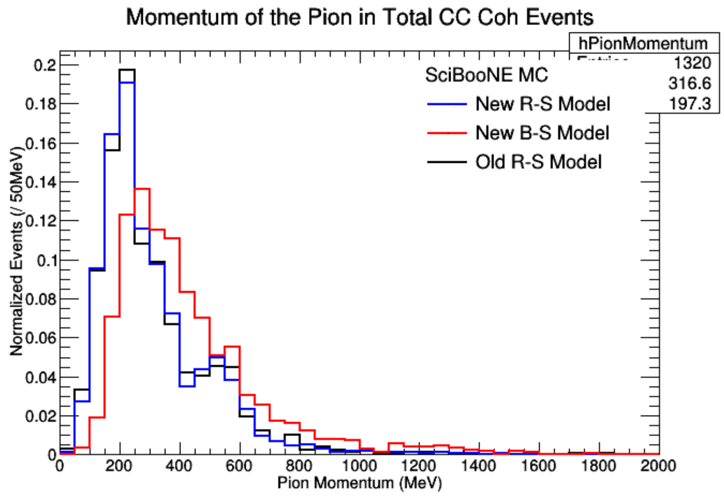

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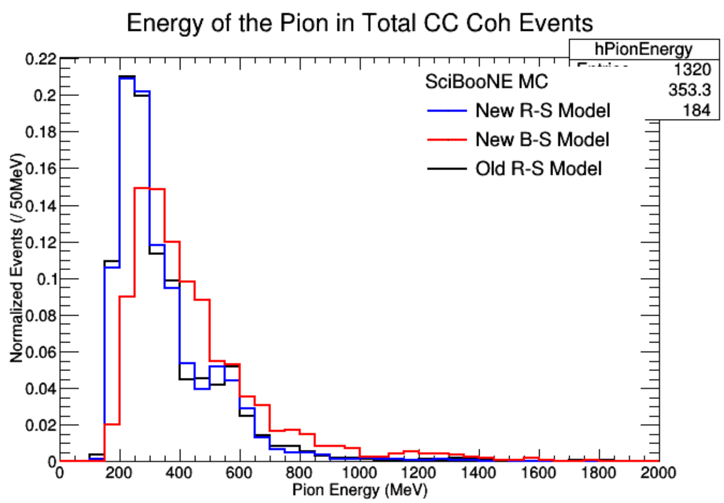

Figure 89

A.14 NMFourSquaredPlotting.C

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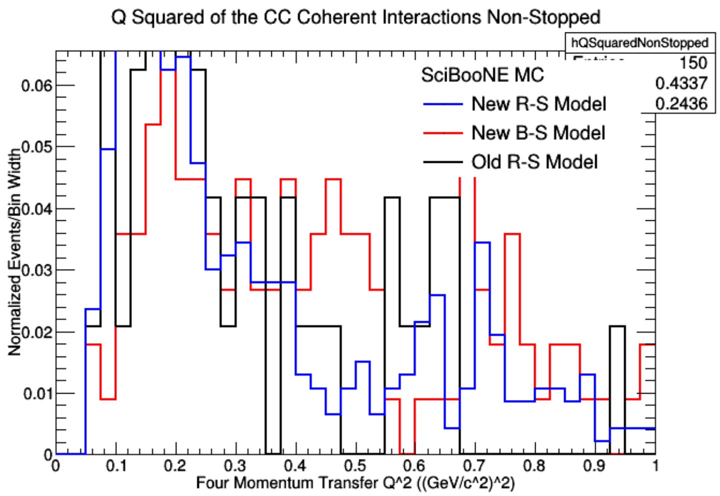

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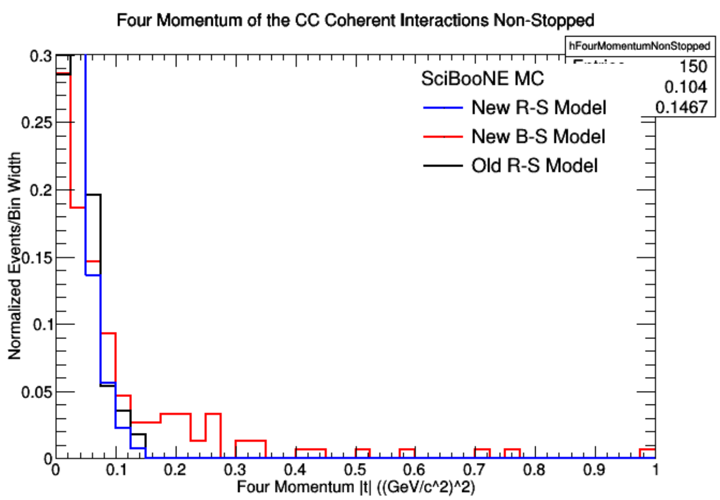

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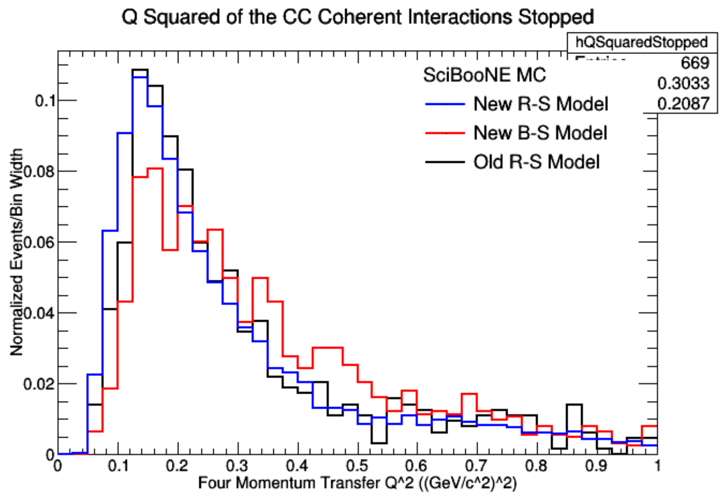

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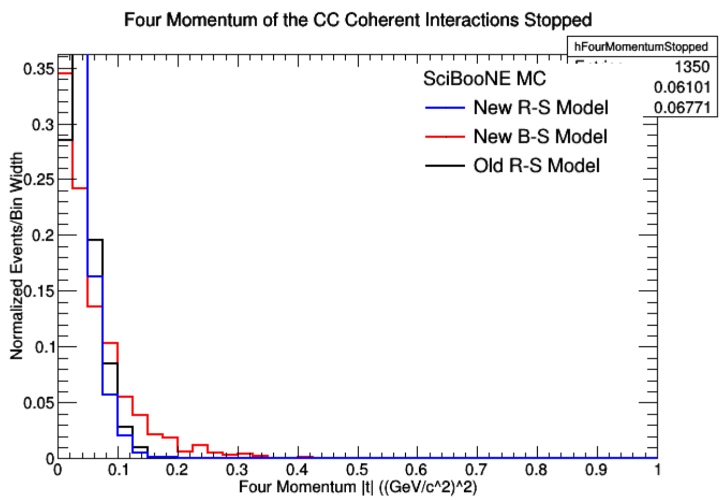

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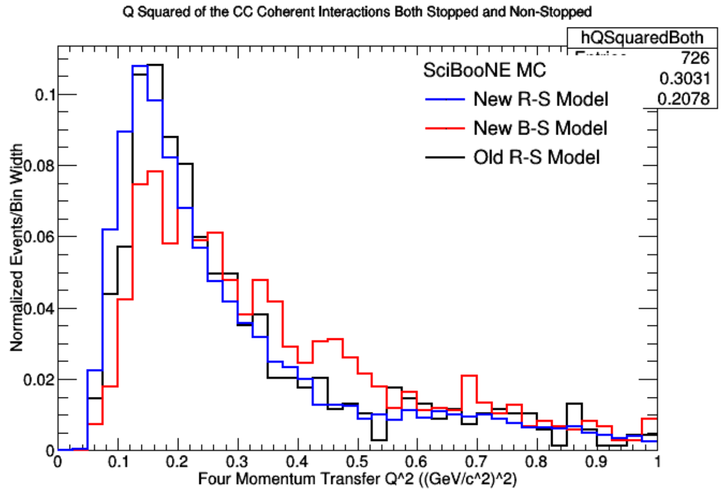

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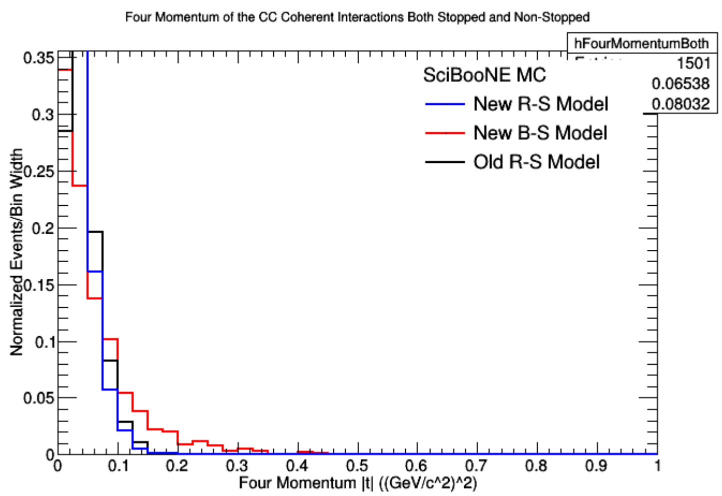

Figure 95

A.15 ANMCombinedPlots.C

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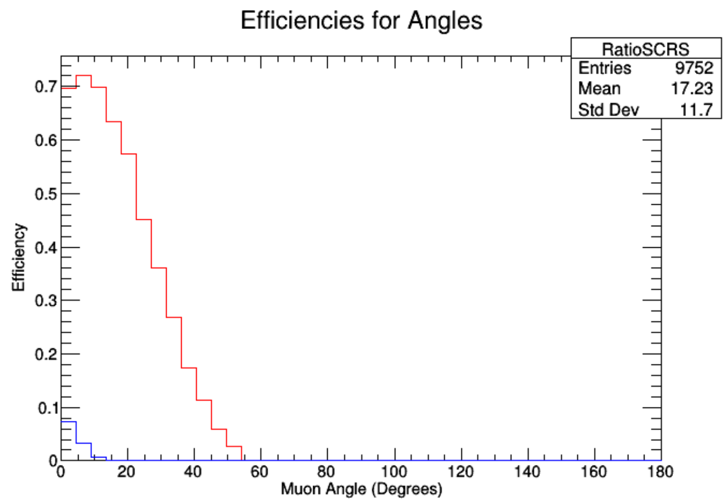

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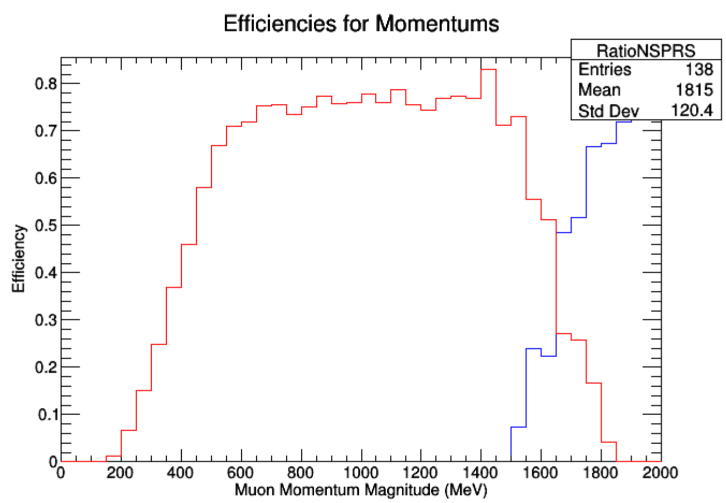

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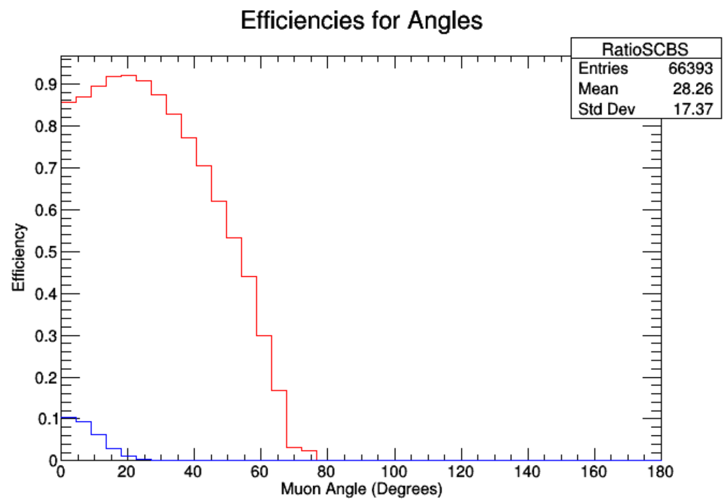

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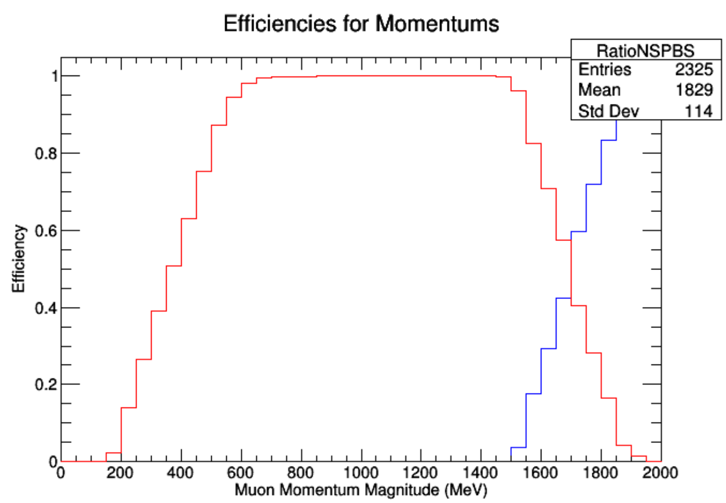

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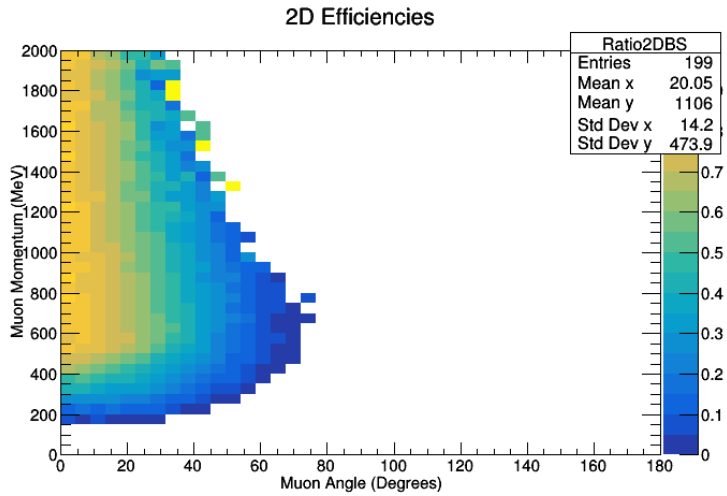

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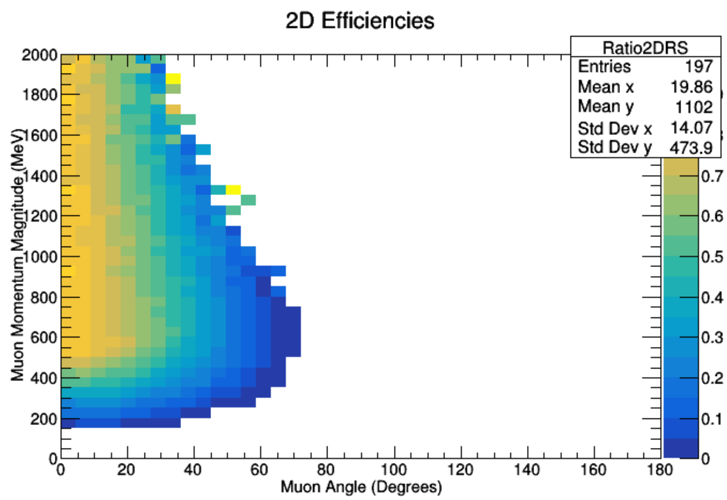

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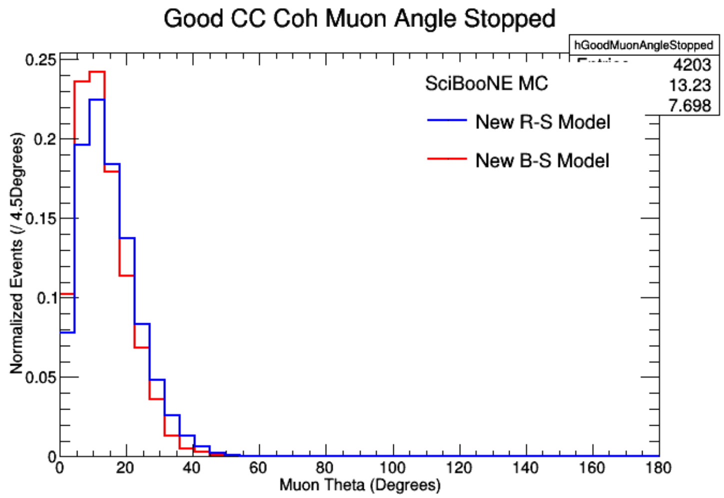

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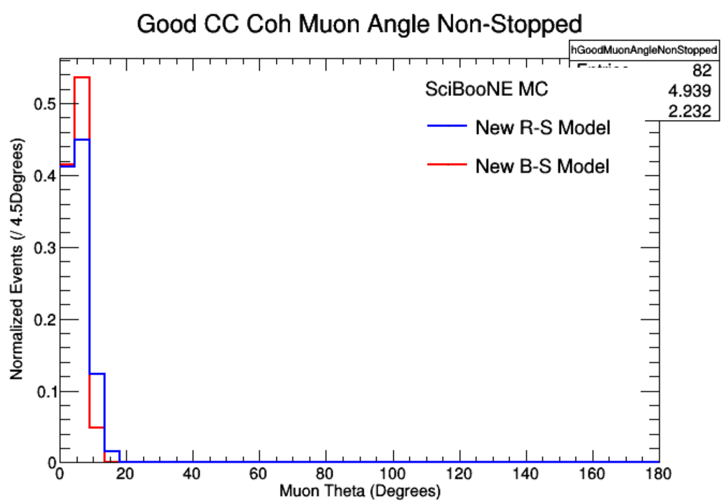

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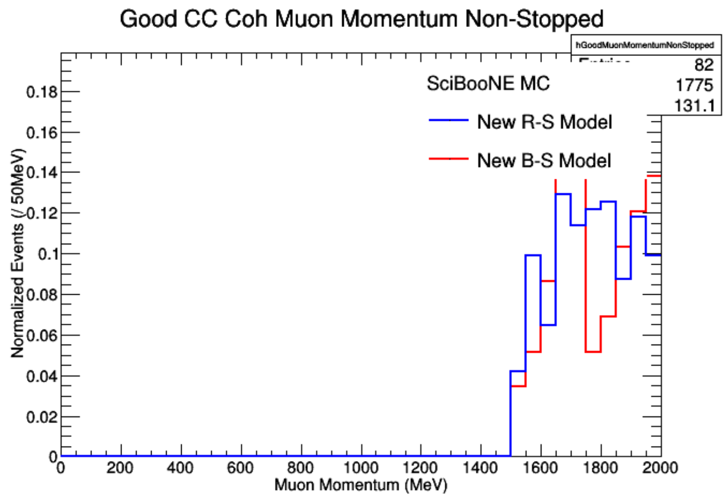

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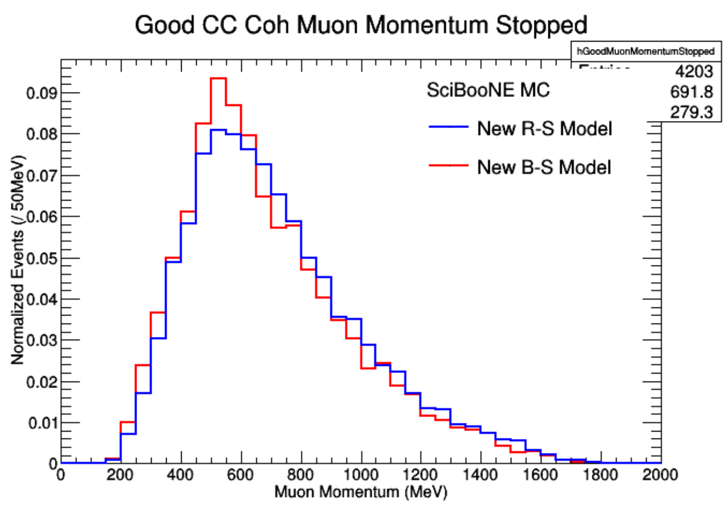

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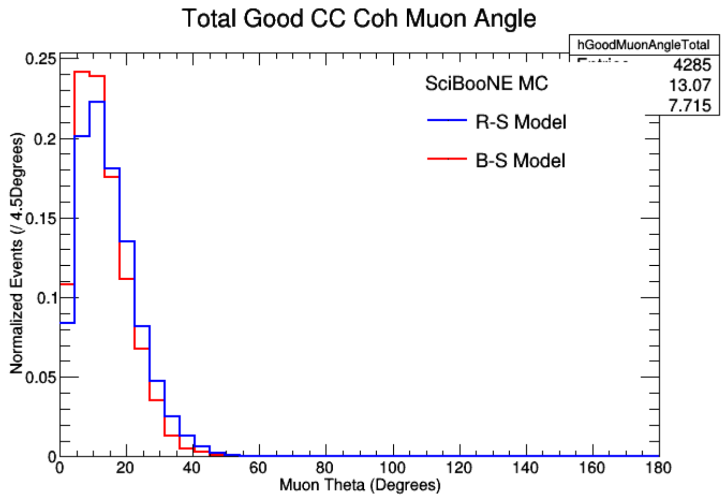

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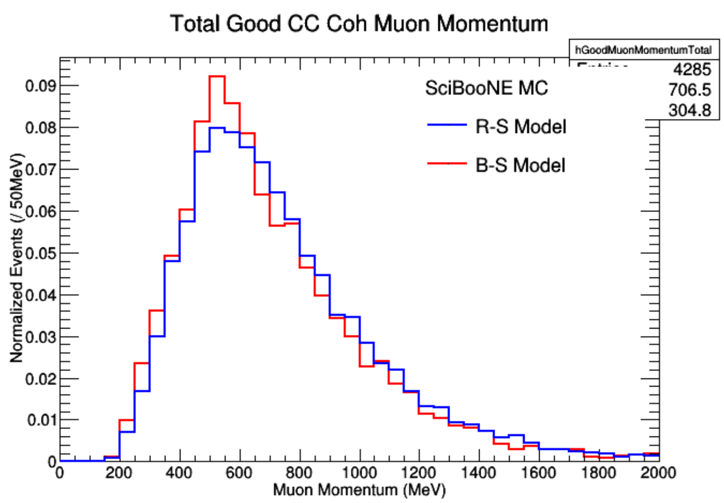

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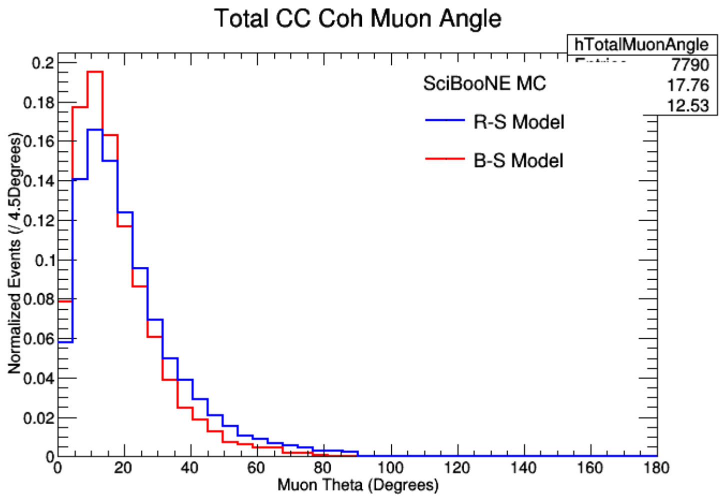

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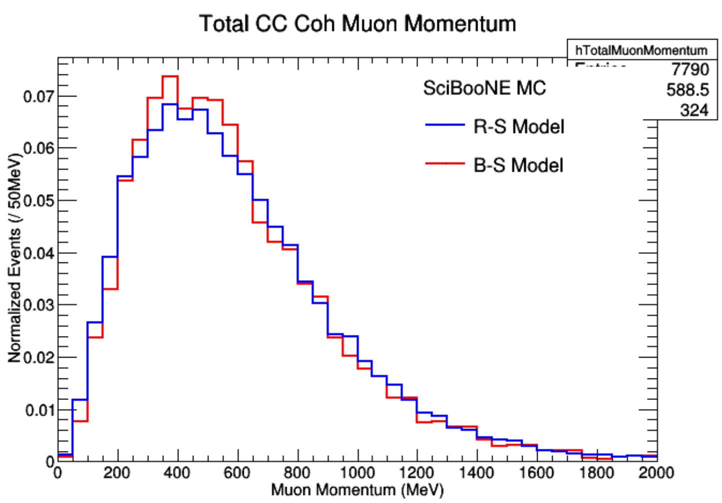

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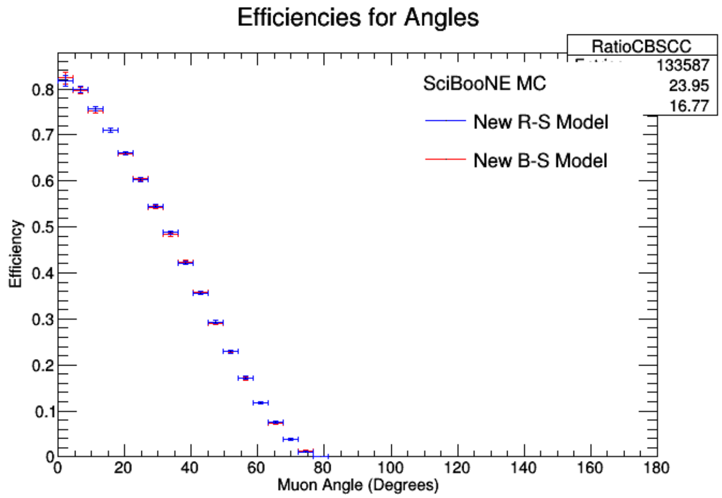

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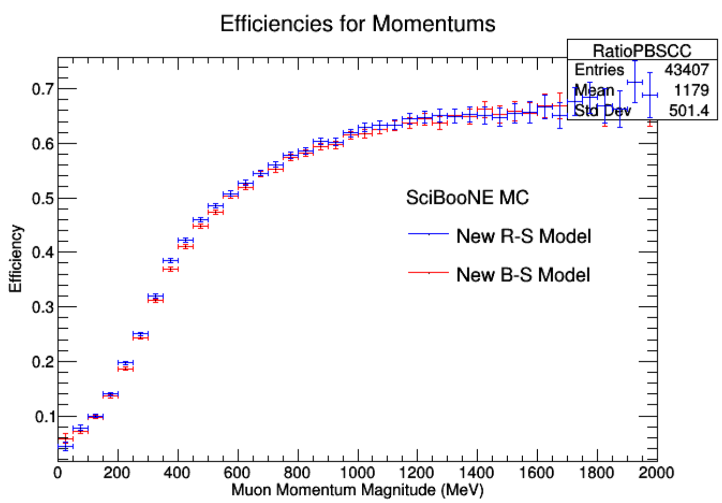

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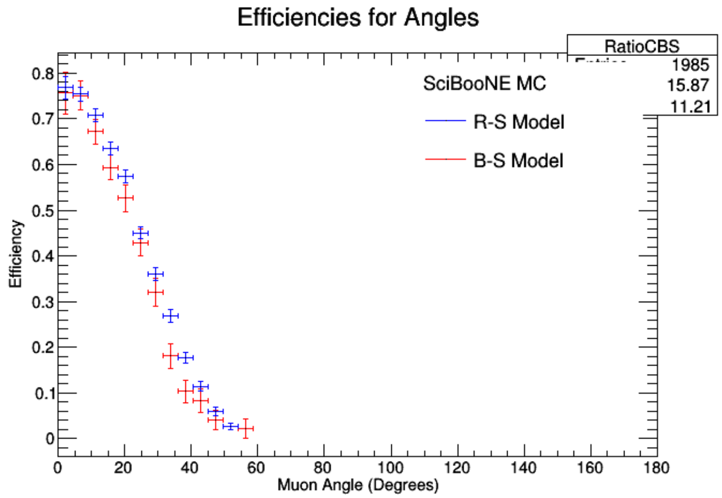

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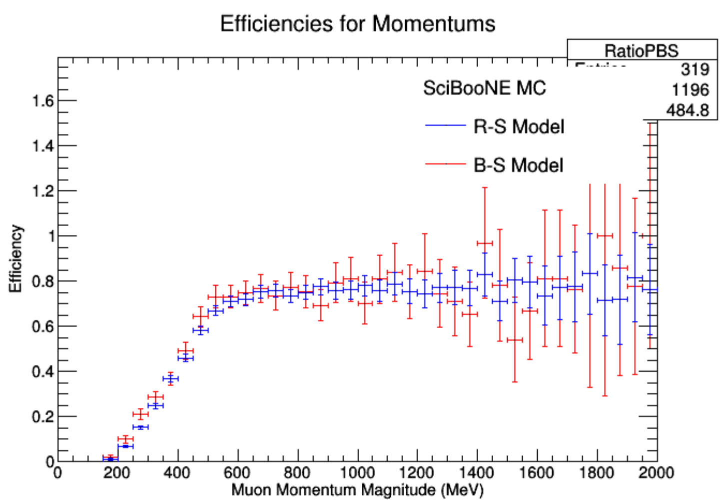

Figure 113

A.16 ANMPionPlotting.C

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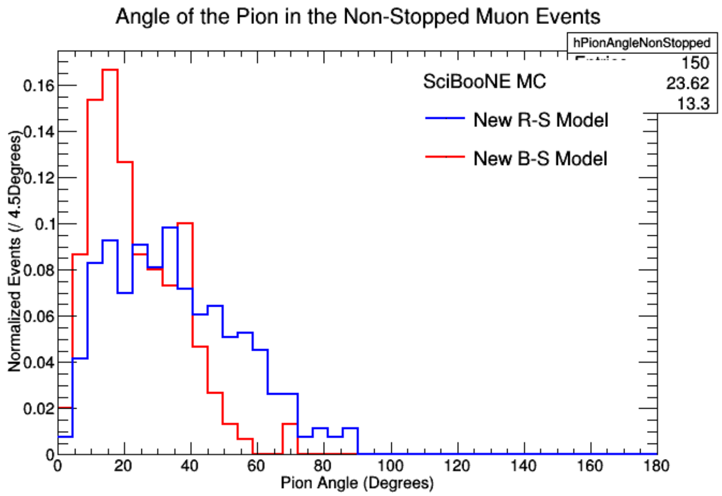

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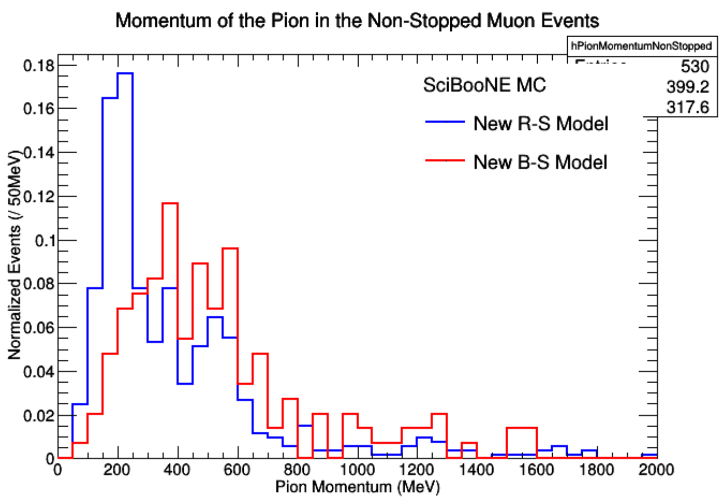

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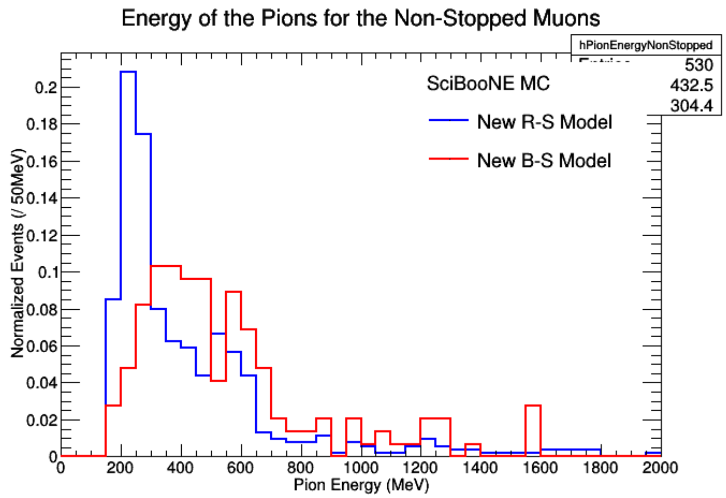

Figure 116

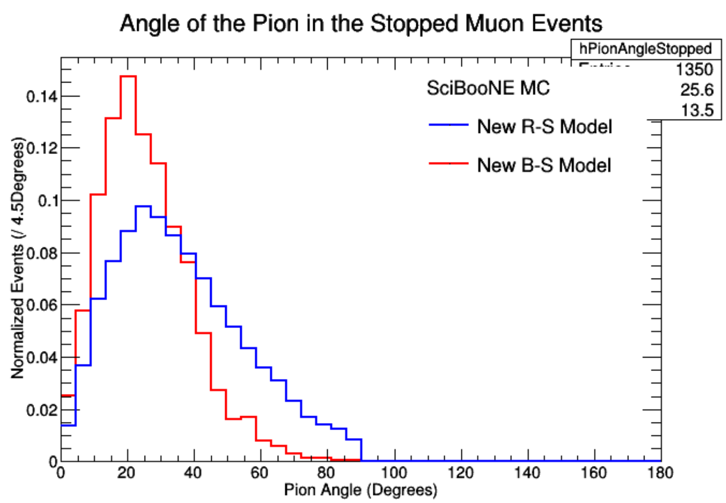

Figure 117

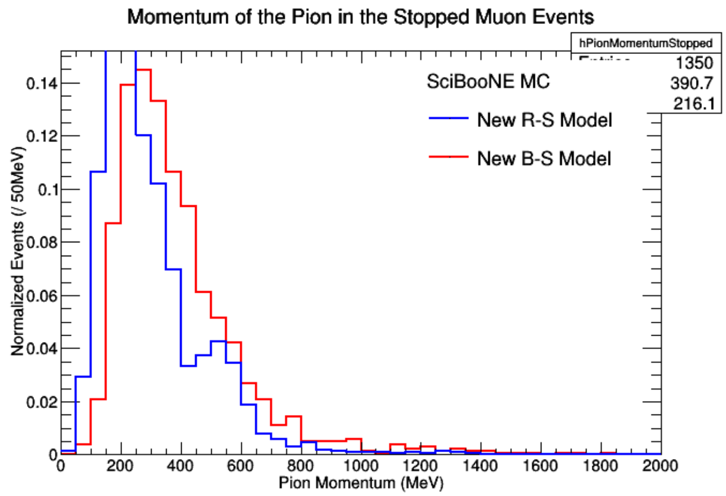

Figure 118

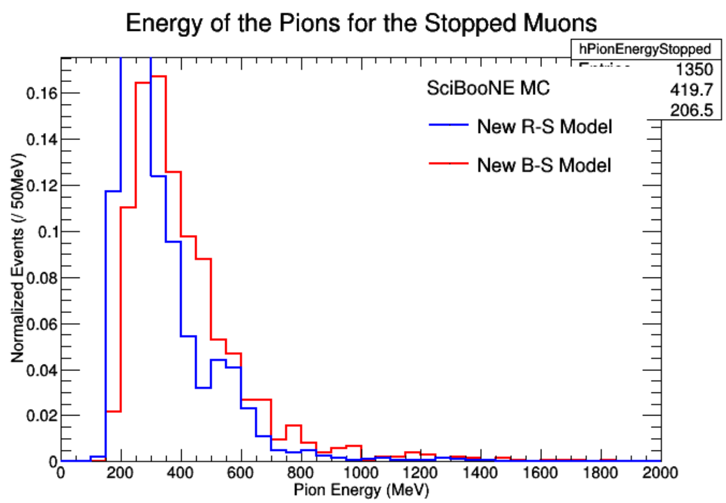

Figure 119

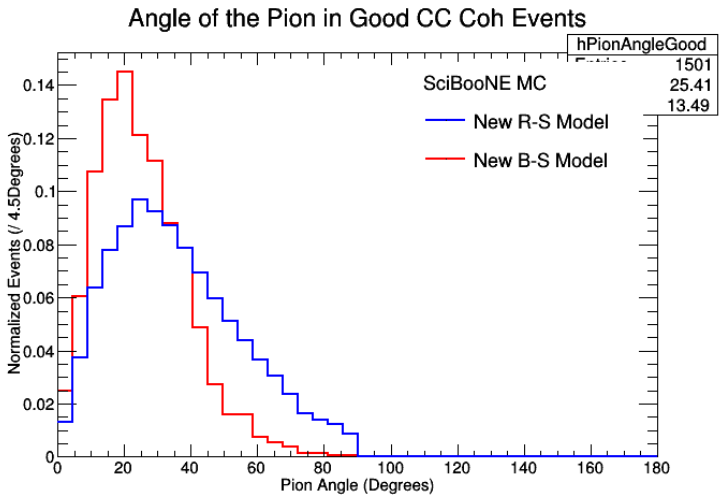

Figure 120

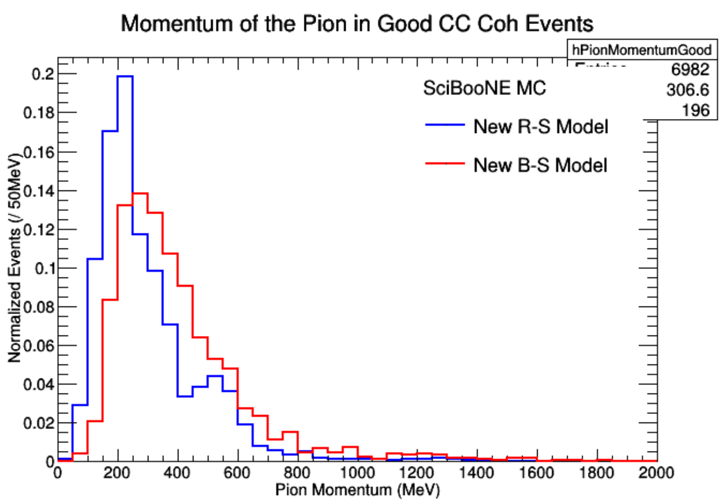

Figure 121

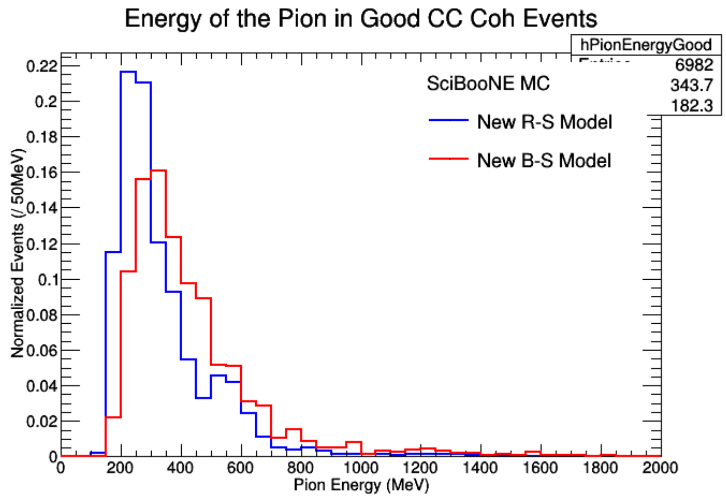

Figure 122

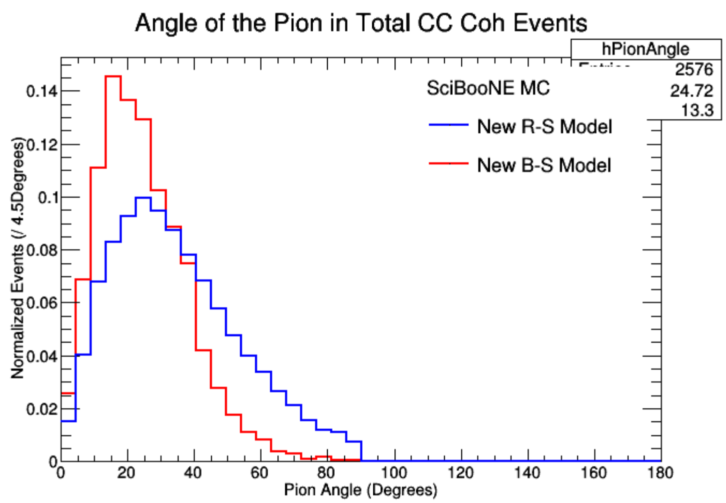

Figure 123

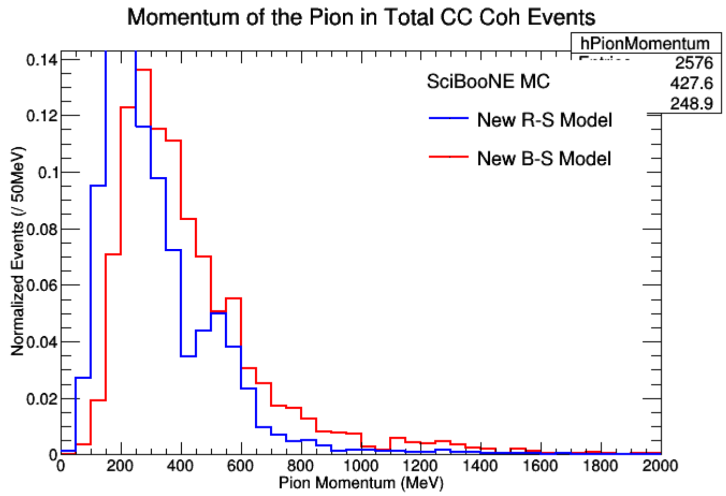

Figure 124

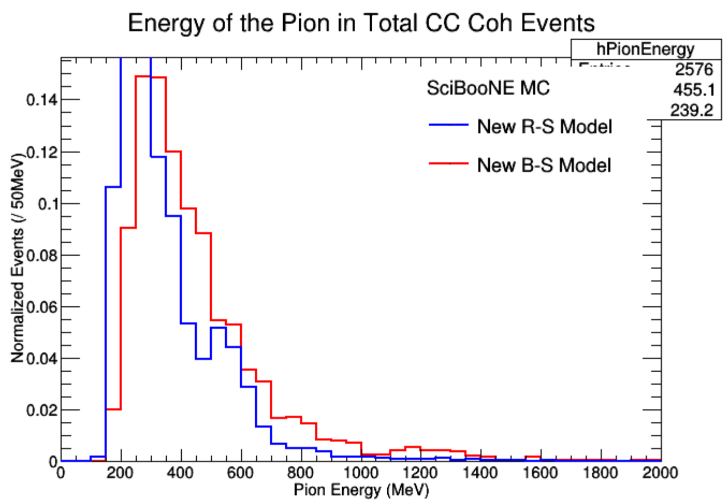

Figure 125

A.17 ANMFourSquaredPlotting.C

I need to come back and insert all of my images here.

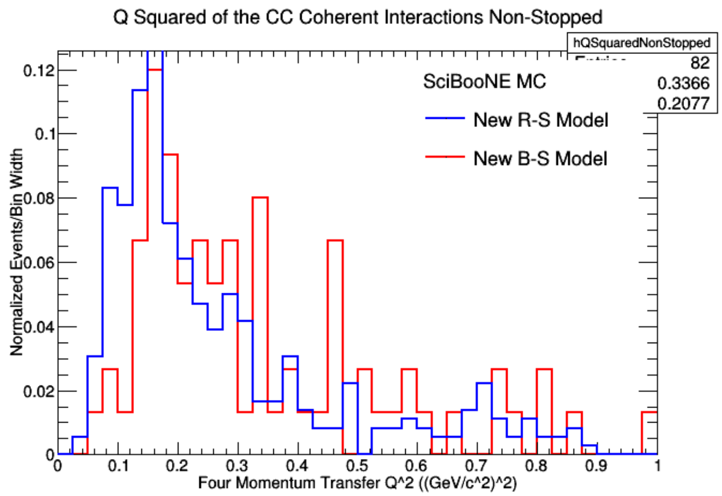

Figure 126

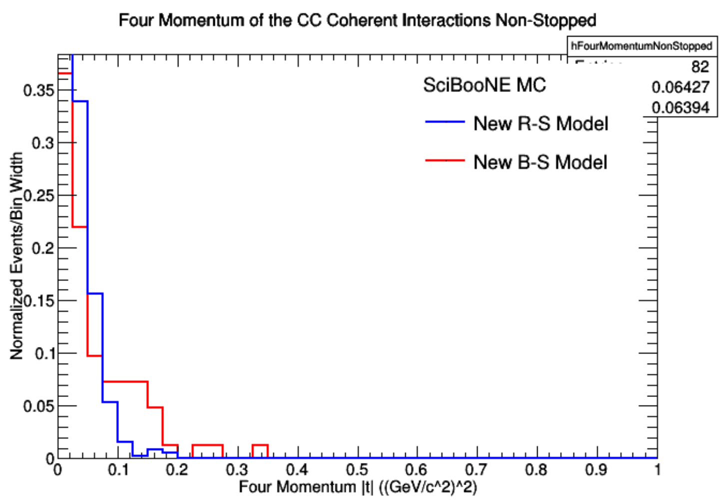

Figure 127

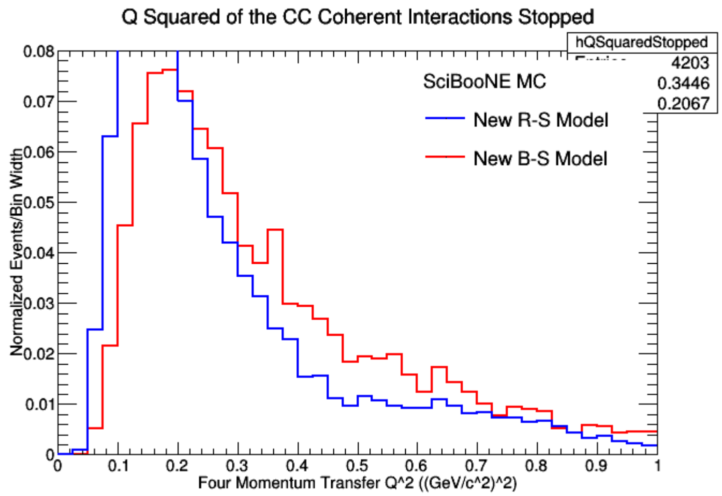

Figure 128

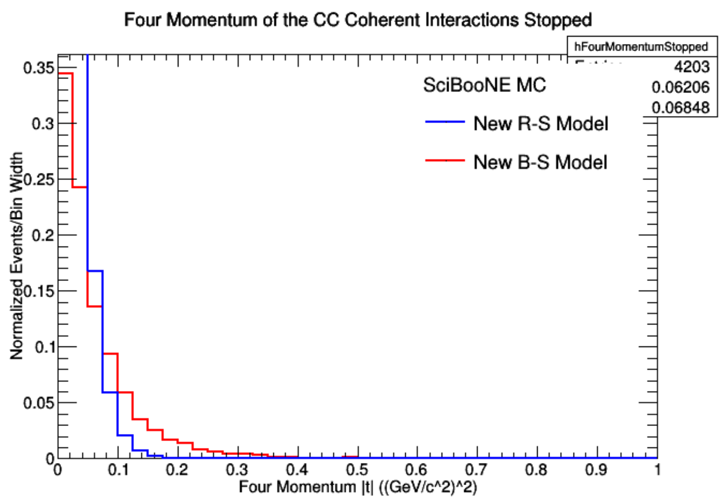

Figure 129

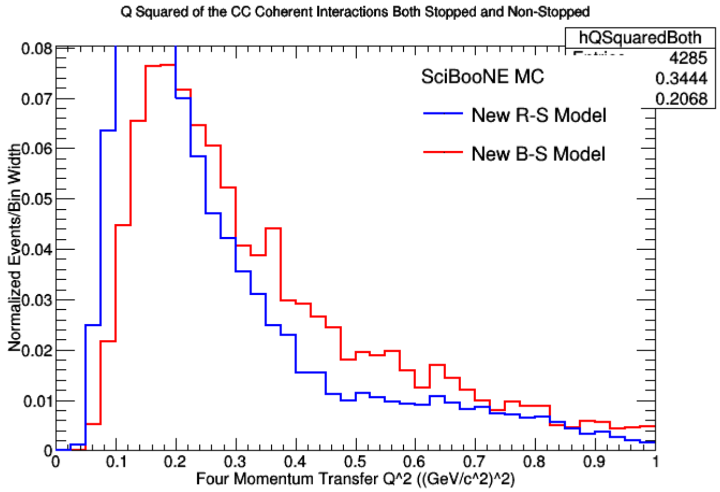

Figure 130

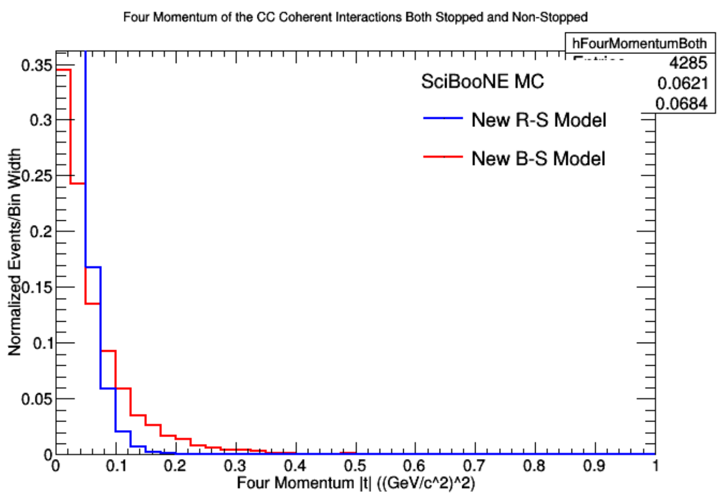

Figure 131

B Steps for Running the Code

The instructions on how to run the code and the order the files need to run in so that there are no resulting error messages, or other issues while running the code, are detailed in this section.

Step 1: This is the first step. (Run the NewNM macros and the NewANM macros and the OldNM macro.)

Step 2: This is the second step. (Run the combined plotting macros.)

Step 3: This is the third step. (Run the Pion Plotting macros.)

Step 4: Etc. (Run the FourSquaredMomentum macros.)

C Closing Remarks and Cautions

These are just a few cautionary suggestions for potential issues that might be encountered while trying to use this code. This will also be where and further closing remarks can be made.

D Acknowledgements

Thank everyone who helped, and thank everyone who gave their inputs into your acceptance study. YOU NEED TO GIVE A HUGE AND SPECIAL THANKS TO DR. ASAADI RIGHT HERE! (He has been suuuuuuuper patient...)

E Figures and Tables

E.1 List of Figures

There will eventually be a huge list of figures here.

E.2 List of Tables

There will eventually be the event reduction tables and 2D histogram tables here.

Table 8: 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 9: 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	450-500	500-550	550-600	600-650
0-4.5 Deg	0	0	0	0	0.157895	0.325	0.422222	0.490566	0.615385	0.728571	0.895522	0.807692	0.880435
4.5-9 Deg	0	0	0	0.0625	0.176471	0.235849	0.396694	0.478261	0.581731	0.773279	0.811448	0.817109	0.806366
9-13.5 Deg	0	0	0	0.09375	0.156716	0.223529	0.362963	0.463343	0.5725	0.701245	0.78089	0.798354	0.801724
13.5-18 Deg	0	0	0	0.0382166	0.131222	0.260736	0.330233	0.448833	0.566116	0.634994	0.727545	0.736387	0.720152
18-22.5 Deg	0	0	0	0.039604	0.0973451	0.228145	0.318462	0.419903	0.517013	0.582547	0.656707	0.692351	0.687027
22.5-27 Deg	0	0	0	0.0264026	0.0930736	0.197461	0.321879	0.381265	0.447548	0.521715	0.578365	0.637657	0.629688
27-31.5 Deg	0	0	0	0.00486618	0.0857143	0.152859	0.25358	0.312166	0.395361	0.466491	0.496522	0.564516	0.564264
31.5-36 Deg	0	0	0	0.00754717	0.0815217	0.142292	0.218271	0.283494	0.333753	0.381784	0.436444	0.472969	0.488325
36-40.5 Deg	0	0	0	0	0.032538	0.0817963	0.170164	0.233583	0.275212	0.327416	0.366159	0.387514	0.419254
40.5-45 Deg	0	0	0	0	0.0139147	0.0678972	0.129657	0.192308	0.224483	0.252462	0.30273	0.319185	0.342679
45-49.5 Deg	0	0	0	0	0.00251467	0.0392938	0.0940285	0.141328	0.181437	0.212241	0.24064	0.244851	0.261486
49.5-54 Deg	0	0	0	0	0	0.0110121	0.0531873	0.0958814	0.126534	0.148936	0.169353	0.187424	0.203203
54-58.5 Deg	0	0	0	0	0	0.000456204	0.0199623	0.0552683	0.0810965	0.102659	0.119633	0.118058	0.129529
58.5-63 Deg	0	0	0	0	0	0	0.000714286	0.0128637	0.0467906	0.0568421	0.0634228	0.0796216	0.0780856
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00745573	0.0242928	0.0364188	0.0436258	0.0367232
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.000740466	0.00470367	0.0114213	0.0195072
72-76.5 Deg	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

New NM B-S	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
0-4.5 Deg	0.864865	0.843373	0.833333	0.858333	0.833333	0.826087	0.814815	0.778846	0.8	0.813725	0.829268	0.84375	0.78022	0.783133
4.5-9 Deg	0.801402	0.814286	0.809211	0.804211	0.755448	0.822709	0.792657	0.804255	0.824945	0.804494	0.814536	0.784504	0.774295	0.813665
9-13.5 Deg	0.794569	0.782796	0.780287	0.765235	0.773496	0.756598	0.759384	0.766798	0.776286	0.733735	0.717208	0.731677	0.730769	0.708861
13.5-18 Deg	0.749489	0.762791	0.732403	0.711937	0.704908	0.702804	0.683544	0.703634	0.7086	0.706101	0.683544	0.700457	0.681775	0.68321
18-22.5 Deg	0.677215	0.689404	0.661647	0.651855	0.661634	0.65554	0.634515	0.653195	0.635392	0.641326	0.620074	0.60516	0.579566	0.597895
22.5-27 Deg	0.615445	0.637963	0.622396	0.604258	0.581746	0.570899	0.569778	0.571276	0.570789	0.557559	0.528678	0.526667	0.524138	0.529101
27-31.5 Deg	0.554788	0.551891	0.55257	0.548276	0.521099	0.517559	0.518553	0.515256	0.490654	0.476651	0.444332	0.474736	0.456456	0.431408
31.5-36 Deg	0.492462	0.479326	0.494505	0.47549	0.45864	0.461108	0.451835	0.42583	0.411765	0.437118	0.397764	0.406551	0.405963	0.389205
36-40.5 Deg	0.425045	0.403834	0.392764	0.396559	0.400812	0.369942	0.368859	0.345339	0.357923	0.325411	0.296117	0.300654	0.38785	0.366279
40.5-45 Deg	0.345987	0.330502	0.331052	0.323815	0.305906	0.312284	0.313023	0.294294	0.264706	0.272981	0.214286	0.233918	0.189474	0.197368
45-49.5 Deg	0.269272	0.268868	0.255423	0.239971	0.254059	0.219613	0.205285	0.236769	0.215859	0.180723	0.158879	0.169014	0.0588235	0.0833333
49.5-54 Deg	0.19403	0.204905	0.197958	0.161453	0.159744	0.142512	0.151292	0.132184	0.133858	0.0869565	0.097561	0.0769231	0.0909091	0
54-58.5 Deg	0.135933	0.125182	0.118211	0.109568	0.118863	0.117073	0.108844	0.0617284	0.0851064	0.0344828	0.0909091	0	0.111111	0
58.5-63 Deg	0.0909091	0.0960929	0.0849558	0.0780781	0.103825	0.0458716	0	0.0333333	0	0	0	0	0	0
63-67.5 Deg	0.039666	0.0363636	0.0426136	0.0162162	0.0357143	0.0227273	0.0416667	0.0714286	0.166667	0	0	0	0	0
67.5-72 Deg	0.0166667	0.0120482	0	0	0.03125	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0.00280899	0.00649351	0.0123457	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

New NM B-S	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	0.898734	0.85	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	0.792994	0.764706	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	0.728296	0.755835	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	0.68171	0.669251	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	0.612863	0.599419	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	0.509404	0.499093	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	0.465169	0.451791	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	0.33564	0.381395	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	0.328	0.348624	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	0.231884	0.222222	0.157895	0.2	0.0526316	0.428571	0.0588235	0.166667	0.166667	0.25	0	0	1
45-49.5 Deg	0.166667	0.136364	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	0	0
54-58.5 Deg	0	0.5	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
63-67.5 Deg	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
72-76.5 Deg	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
81-85.5 Deg	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
90-94.5 Deg	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
99-103.5 Deg	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
108-112.5 Deg	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
117-121.5 Deg	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
126-130.5 Deg	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
135-139.5 Deg	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
144-148.5 Deg	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
153-157.5 Deg	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
162-166.5 Deg	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
171-175.5 Deg	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

Table 10: 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 11: 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
0-4.5 Deg	0	0	0	0.037037	0.173913	0.225352	0.398693	0.510204	0.585034
4.5-9 Deg	0	0	0	0.0538922	0.179487	0.264881	0.351406	0.522654	0.611905
9-13.5 Deg	0	0	0	0.0881226	0.175824	0.272864	0.369565	0.47927	0.562628
13.5-18 Deg	0	0	0	0.0502959	0.162912	0.264642	0.372408	0.45271	0.529918
18-22.5 Deg	0	0	0	0.0477273	0.135068	0.240964	0.32415	0.42098	0.500719
22.5-27 Deg	0	0	0	0.0256881	0.127932	0.186722	0.284972	0.381885	0.46546
27-31.5 Deg	0	0	0	0.0135747	0.0779102	0.157462	0.237522	0.318072	0.385341
31.5-36 Deg	0	0	0	0.00265957	0.0702447	0.140581	0.21821	0.292653	0.342622
36-40.5 Deg	0	0	0	0	0.0358187	0.107342	0.168067	0.222502	0.294331
40.5-45 Deg	0	0	0	0	0.0164051	0.0757272	0.131076	0.200825	0.226708
45-49.5 Deg	0	0	0	0	0	0.0478888	0.099454	0.13113	0.177444
49.5-54 Deg	0	0	0	0	0	0.0114405	0.0658882	0.103003	0.127891
54-58.5 Deg	0	0	0	0	0	0.000554017	0.0170428	0.0537772	0.0883421
58.5-63 Deg	0	0	0	0	0	0	0.0010015	0.020202	0.0406544
63-67.5 Deg	0	0	0	0	0	0	0	0.00108167	0.00447928
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 ANM R-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	0.741325	0.812332	0.808989	0.820399	0.80597	0.846154	0.826087	0.834821	0.846791	0.849776
4.5-9 Deg	0.722011	0.822749	0.806912	0.812763	0.807565	0.807477	0.80314	0.805654	0.802672	0.816404
9-13.5 Deg	0.680187	0.778963	0.784609	0.775579	0.77094	0.780604	0.772247	0.778919	0.774887	0.769928
13.5-18 Deg	0.642998	0.714241	0.754711	0.746173	0.739165	0.72958	0.736591	0.712291	0.723065	0.699029
18-22.5 Deg	0.578125	0.669713	0.700024	0.693197	0.686785	0.675302	0.676973	0.671911	0.662691	0.649262
22.5-27 Deg	0.511835	0.587483	0.641457	0.609761	0.630852	0.616002	0.610015	0.585767	0.589724	0.588134
27-31.5 Deg	0.455377	0.527993	0.566528	0.573181	0.550737	0.538564	0.550457	0.533736	0.525933	0.509007
31.5-36 Deg	0.394628	0.429609	0.48047	0.502938	0.499068	0.49538	0.462372	0.47797	0.465828	0.428421
36-40.5 Deg	0.333169	0.361301	0.382382	0.418154	0.431897	0.40234	0.403238	0.388569	0.407134	0.374224
40.5-45 Deg	0.268313	0.30581	0.320273	0.346117	0.33394	0.333774	0.343066	0.307036	0.329013	0.279793
45-49.5 Deg	0.212046	0.222903	0.250172	0.254128	0.270336	0.280552	0.252766	0.235294	0.240708	0.214834
49.5-54 Deg	0.149639	0.172282	0.178556	0.193367	0.190678	0.185291	0.18963	0.175556	0.136364	0.150327
54-58.5 Deg	0.116889	0.122696	0.124613	0.143336	0.139043	0.133106	0.130564	0.121076	0.105263	0.0547945
58.5-63 Deg	0.0526316	0.0724161	0.0817391	0.077907	0.0850662	0.0868263	0.0772947	0.0462963	0.0454545	0.0555556
63-67.5 Deg	0.0226148	0.0374384	0.0423729	0.0439122	0.0482759	0.0424242	0.025	0.125	0	0.125
67.5-72 Deg	0	0.00515464	0.0103093	0.0144928	0.00714286	0.0289855	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	950-1000	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500
0-4.5 Deg	0.814732	0.811494	0.835	0.820728	0.821212	0.820946	0.829352	0.86385	0.785124	0.834906	0.820896
4.5-9 Deg	0.79961	0.808895	0.780172	0.79495	0.806396	0.799636	0.809524	0.799766	0.790123	0.793201	0.770154
9-13.5 Deg	0.777286	0.764215	0.756151	0.769636	0.756423	0.745802	0.736299	0.725795	0.729068	0.731919	0.712513
13.5-18 Deg	0.705178	0.708415	0.69735	0.68934	0.693381	0.700468	0.682373	0.673329	0.680972	0.660094	0.631818
18-22.5 Deg	0.656827	0.646345	0.649693	0.62265	0.628975	0.613897	0.596406	0.591174	0.582904	0.568153	0.597598
22.5-27 Deg	0.57303	0.583082	0.5553	0.564074	0.557719	0.53367	0.554507	0.527886	0.535211	0.501099	0.488432
27-31.5 Deg	0.512922	0.498878	0.50292	0.473382	0.487885	0.490838	0.454704	0.467192	0.428571	0.405405	0.464286
31.5-36 Deg	0.439291	0.425238	0.420697	0.393846	0.374753	0.375394	0.398374	0.379121	0.342857	0.27907	0.290323
36-40.5 Deg	0.366126	0.347445	0.358079	0.315942	0.337449	0.296512	0.306931	0.295082	0.265625	0.192308	0.2
40.5-45 Deg	0.27593	0.311653	0.287736	0.211538	0.186275	0.203125	0.222222	0.111111	0.272727	0.2	0
45-49.5 Deg	0.218107	0.251908	0.234043	0.2	0.307692	0.235294	0	0.4	0	0	0
49.5-54 Deg	0.116279	0.125	0.181818	0.0833333	0	0.5	0	1	0	0	0
54-58.5 Deg	0.114286	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	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

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 12: 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
0-4.5 Deg	0	0	0	0.0930233	0.144737	0.283186	0.421384	0.494898	0.668161	0.710247
4.5-9 Deg	0	0	0	0.0166667	0.165094	0.269231	0.4	0.541667	0.613402	0.732694
9-13.5 Deg	0	0	0	0.0700935	0.130919	0.271667	0.353012	0.480322	0.569575	0.68139
13.5-18 Deg	0	0	0	0.0401338	0.149742	0.265497	0.336059	0.414129	0.536284	0.638281
18-22.5 Deg	0	0	0	0.0277778	0.137174	0.23849	0.319925	0.423721	0.499227	0.57533
22.5-27 Deg	0	0	0	0.0196464	0.109134	0.204236	0.312057	0.385731	0.447873	0.516755
27-31.5 Deg	0	0	0	0.00315956	0.104046	0.165109	0.256264	0.322028	0.397871	0.445264
31.5-36 Deg	0	0	0	0	0.0525862	0.124857	0.206051	0.275698	0.333971	0.392423
36-40.5 Deg	0	0	0	0	0.0444774	0.105837	0.16809	0.234525	0.286885	0.327259
40.5-45 Deg	0	0	0	0	0.0210938	0.0689829	0.137208	0.172468	0.226261	0.272047
45-49.5 Deg	0	0	0	0	0	0.035913	0.0925481	0.127177	0.17693	0.21244
49.5-54 Deg	0	0	0	0	0	0.0115668	0.0516817	0.101349	0.118959	0.148848
54-58.5 Deg	0	0	0	0	0	0	0.0210526	0.052506	0.080695	0.104636
58.5-63 Deg	0	0	0	0	0	0	0	0.0150616	0.0392791	0.0594262
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00795003	0.0215545
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00182983
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 B-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	0.805861	0.796703	0.834184	0.844907	0.827907	0.866324	0.843458	0.855072	0.83208	0.813433
4.5-9 Deg	0.797824	0.812245	0.82494	0.814583	0.823051	0.812541	0.792568	0.781479	0.804378	0.794982
9-13.5 Deg	0.781754	0.795837	0.774114	0.785362	0.773578	0.781475	0.76586	0.762567	0.752009	0.761471
13.5-18 Deg	0.728386	0.717996	0.747335	0.748866	0.736466	0.7337	0.731489	0.723615	0.700111	0.714206
18-22.5 Deg	0.655519	0.701815	0.686171	0.689579	0.686069	0.673434	0.65566	0.6686	0.647105	0.657014
22.5-27 Deg	0.600138	0.645331	0.628718	0.629526	0.604035	0.609545	0.603815	0.602548	0.578702	0.597386
27-31.5 Deg	0.512134	0.574856	0.561587	0.558263	0.539545	0.545725	0.538095	0.525974	0.509479	0.506996
31.5-36 Deg	0.431607	0.47668	0.500539	0.496867	0.476983	0.479711	0.460797	0.455385	0.446729	0.424768
36-40.5 Deg	0.353491	0.400137	0.418747	0.422945	0.407023	0.396731	0.398879	0.392036	0.372638	0.364706
40.5-45 Deg	0.300615	0.316995	0.337145	0.348088	0.337621	0.320774	0.311813	0.293856	0.315938	0.294333
45-49.5 Deg	0.229012	0.236659	0.252955	0.271491	0.267346	0.259352	0.254042	0.228395	0.213368	0.222222
49.5-54 Deg	0.169149	0.194822	0.189664	0.203367	0.176355	0.210306	0.188017	0.202572	0.150943	0.148936
54-58.5 Deg	0.120419	0.128324	0.143609	0.149563	0.12426	0.149296	0.141667	0.115044	0.149254	0.285714
58.5-63 Deg	0.0719951	0.0804312	0.088785	0.0819367	0.0946372	0.0851064	0.0535714	0.0888889	0.125	0
63-67.5 Deg	0.0325901	0.0497512	0.0446927	0.0397554	0.0674847	0.0933333	0.0952381	0.047619	0	0
67.5-72 Deg	0.00373599	0.00414938	0.0170648	0.00552486	0.0136986	0	0	0	0	0
72-76.5 Deg	0	0	0	0.0266667	0	0.0833333	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 B-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	0.818653	0.841432	0.806366	0.833866	0.867133	0.840741	0.819005	0.813084	0.83	0.886667
4.5-9 Deg	0.805085	0.823664	0.813322	0.809233	0.801491	0.754923	0.791063	0.783712	0.79661	0.793729
9-13.5 Deg	0.748873	0.73664	0.739656	0.735498	0.72956	0.755391	0.720774	0.711163	0.74169	0.714434
13.5-18 Deg	0.71014	0.691088	0.695486	0.679018	0.673116	0.66913	0.689633	0.664591	0.685662	0.667735
18-22.5 Deg	0.636641	0.624197	0.638889	0.646891	0.628604	0.584667	0.586435	0.624873	0.603365	0.570149
22.5-27 Deg	0.569439	0.583187	0.543649	0.537295	0.536066	0.55848	0.548585	0.504687	0.518738	0.493639
27-31.5 Deg	0.501982	0.5	0.4943	0.457645	0.467143	0.448387	0.4447	0.485531	0.401487	0.407609
31.5-36 Deg	0.438768	0.394628	0.38565	0.408915	0.451791	0.342561	0.429348	0.30303	0.322917	0.333333
36-40.5 Deg	0.376984	0.347664	0.323529	0.355856	0.312849	0.325	0.338983	0.410256	0.242424	0.157895
40.5-45 Deg	0.257062	0.283262	0.26	0.298851	0.258065	0.228571	0.210526	0.111111	0.285714	0
45-49.5 Deg	0.229299	0.195652	0.196429	0.142857	0.285714	0.333333	0	0.5	0	0
49.5-54 Deg	0.145455	0.130435	0.142857	0	0	0	1	0	0	0
54-58.5 Deg	0	0.0769231	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

New ANM B-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	0.823129	0.825397	0.871795	0.825243	0.824074	0.797297	0.815789	0.774194	0.823529	0.809524
4.5-9 Deg	0.777403	0.774319	0.787879	0.784741	0.817629	0.771523	0.778723	0.776824	0.762376	0.821229
9-13.5 Deg	0.730546	0.70028	0.702786	0.692029	0.698795	0.727488	0.698895	0.694079	0.706827	0.663507
13.5-18 Deg	0.664188	0.656201	0.664884	0.654737	0.652068	0.615894	0.627737	0.628571	0.650888	0.613924
18-22.5 Deg	0.581722	0.600887	0.607558	0.583333	0.531915	0.573034	0.525641	0.527559	0.552632	0.487179
22.5-27 Deg	0.501502	0.469828	0.469945	0.477273	0.443299	0.445783	0.442623	0.297297	0.405405	0.482759
27-31.5 Deg	0.365517	0.330189	0.263889	0.446809	0.4	0.380952	0.136364	0.333333	0.555556	0.333333
31.5-36 Deg	0.285714	0.3	0.333333	0.352941	0.166667	1	1	0.333333	0.5	0
36-40.5 Deg	0.25	0.166667	0	0.5	0	0	0	0	0	0
40.5-45 Deg	1	0.5	0.5	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