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

Jonathan Asaadi*[1] and Zachary Williams†[1]

[1]Department of Physics, The University of Texas at Arlington

April 21, 2017

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

The goal of this document is to provide a reference for the acceptance study performed for the SciBooNE charged current coherent pion ($CC - Coh\pi^{+/-}$) re-analysis as well as provide documentation to the code used in this study (in the event anything needs to be revisited in the future).

The code currently lives in this github repository labeled 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 table as well as the CC-Coh-π acceptance results.

Sections **??** - **??** provide supporting plots which are used to generate the acceptance tables found in Section **??**.

The appendix is left to explain how the code is run and the details of the scripts within.

1.1 Goal

The goal of the reanalysis 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. The purpose of this acceptance study is to blah blah blah... (coming back to this later...)

2 Samples

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

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

3 Simulation

This section is intended to detail the nuances of this acceptance model, and to detail what assumptions are made in the acceptance modeling to result in accurate classifications of 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 [reference]. 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.

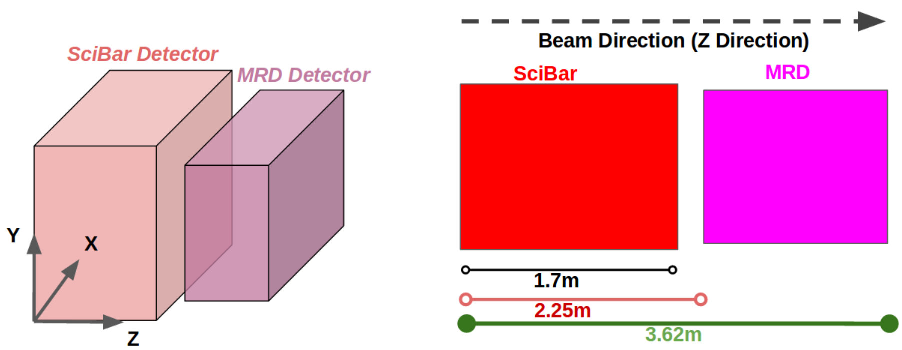


Figure 1: Representation of the SciBooNE detector and the coordinate frame we use in this study

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

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 teh SciBar detector used in this simulation are $0 < x < 3.0$ m , $0 < y < 3.0$ m $0 < z < 1.7$ 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 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 these values are typical for muons at the energy range produced in SciBooNE and taken from the PDG

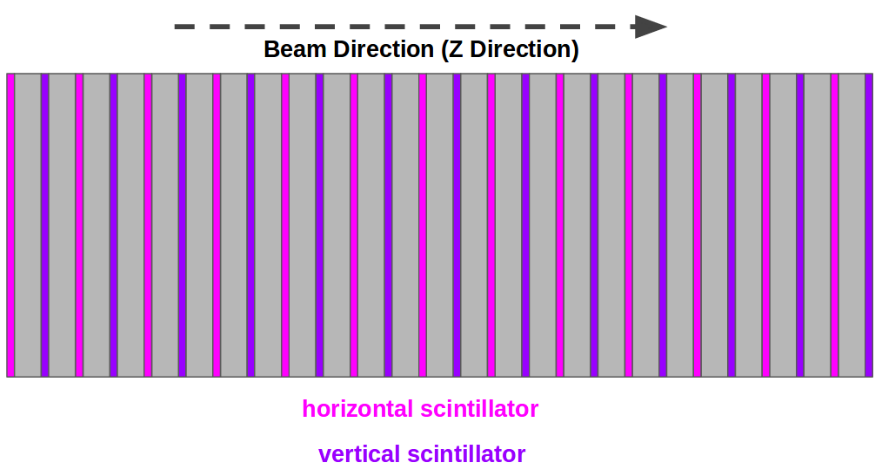


Figure 2: Depiction of the Muon Range Detector (MRB) which consists of alternating layers of horizontal scintillator (shown in pink) steel slabs (showin in grey) and vertical scintillator (shown in purple)

4 Event Selection

Two main samples are used in this study to generate an 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.

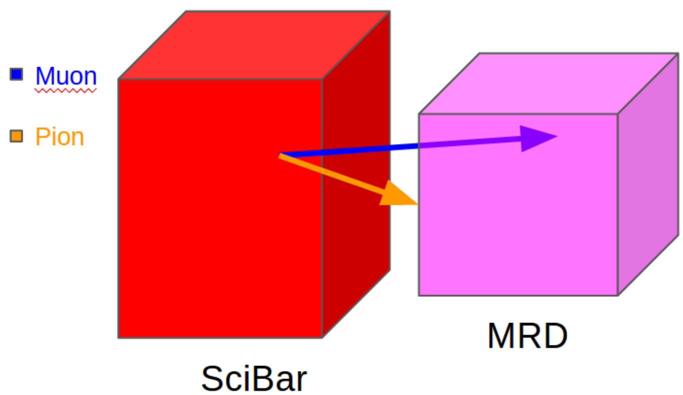


Figure 3: Depiction of an event that was classified as "Stopped."

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.

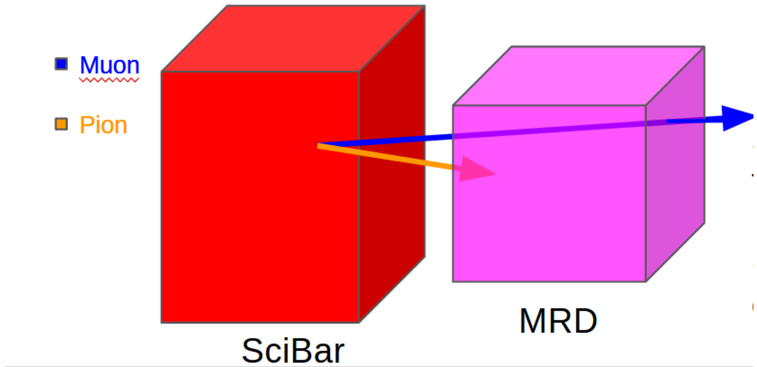


Figure 4: Depiction of an event that was classified as “out-the-back”.

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 to have reached the MRD, penetrated at least three layers of steel, but to have then 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 .

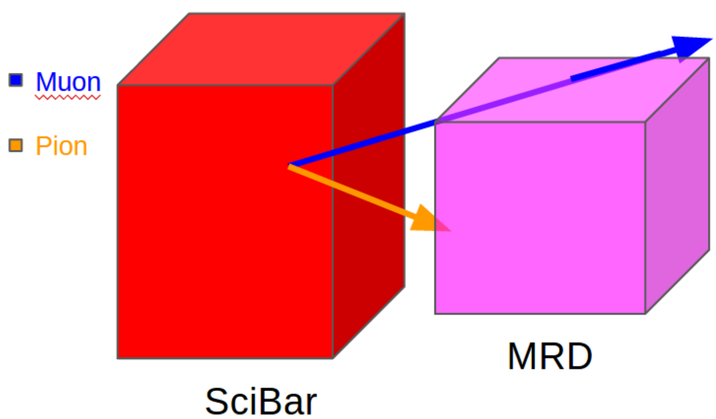


Figure 5: Depiction of an event that was classified as "Out-Side."

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 2 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 ≥ 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 2: Event reduction table for a sample of ν-mode CC-Inclusive evnets 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.

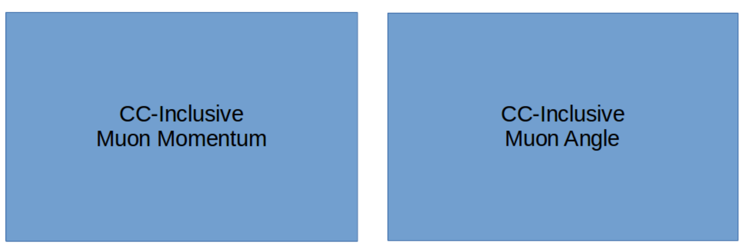


Figure 6: Muon Momentum (left) and Muon Angle (right) for ν-mode CC-Inclusive interactions for all three models included in this study. These samples kinematics are, unsurprisingly, very similar for the sample of CC-Inclusive

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.

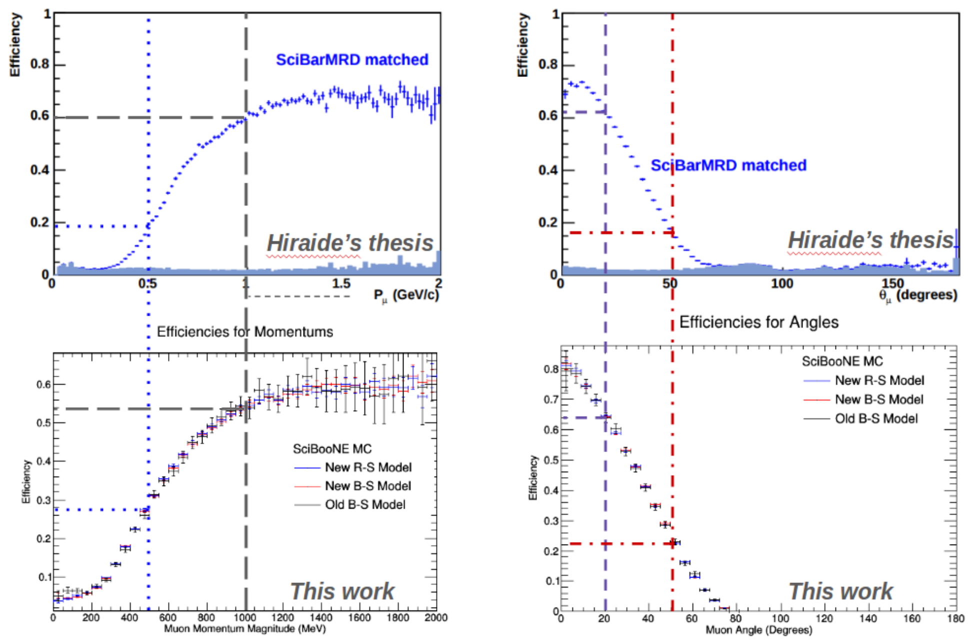


Figure 7: One-dimension efficiency plots for the ν-mode CC-Inclusive sample.

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)

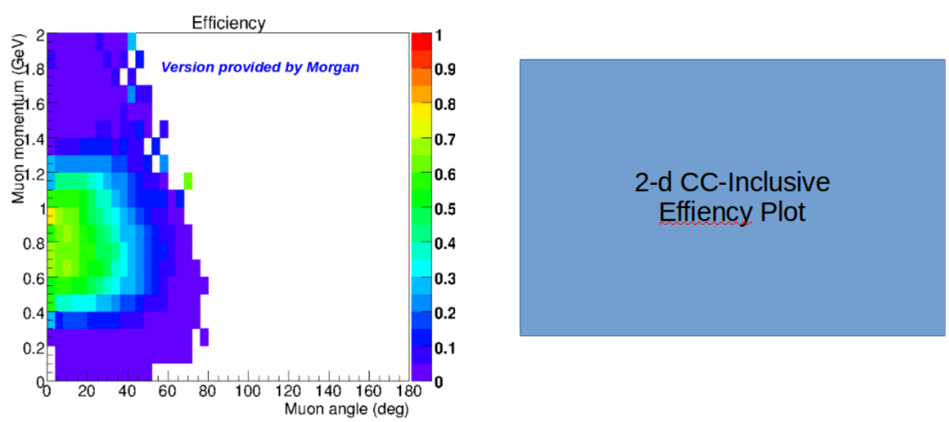


Figure 8: Two-dimensional efficiency plots for the ν-mode CC-Inclusive sample.

Similar to before, Table 3 goes through the event selection criteria for selecting a sample of CC-Inclusive events from the neutrino mode ($\bar{\nu}$-mode) Monte Carlo.

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

$\bar{\nu}$-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 3: Event reduction table for a sample of $\bar{\nu}$-mode CC-Inclusive evnets simulated in the SciBooNE geometry.

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.

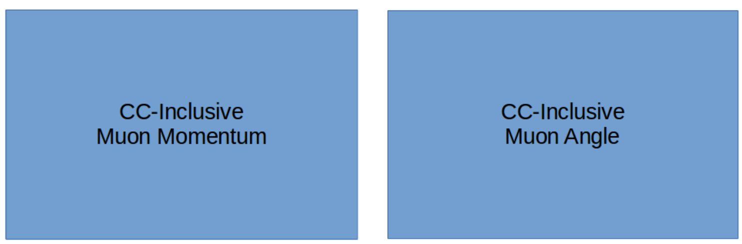
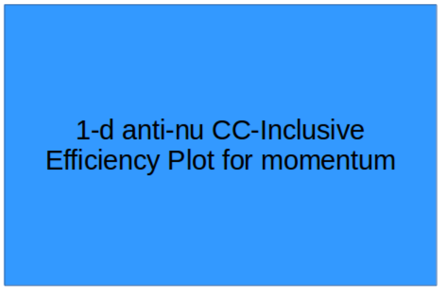


Figure 9: Muon Momentum (left) and Muon Angle (right) for $\bar{\nu}$-mode CC-Inclusive interactions for all three models included in this study. These samples kinematics are, unsurprisingly, very similar for the sample of CC-Inclusive

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).



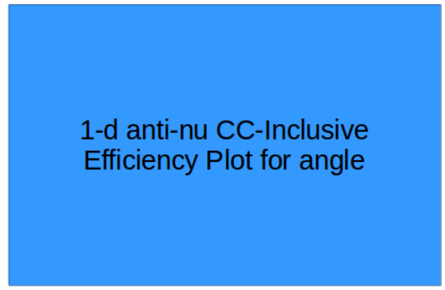


Figure 10: One-dimension efficiency plots for the $\bar{\nu}$-mode CC-Inclusive sample.

5.2 Charged-Current Coherent Pion Production Events

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 $\geq$ 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 4: Event reduction table for a sample of ν-mode Charged Current Coherent Pion events simulated in the SciBooNE geometry.

(Again, you show the momentum and angle spectrum. You show the 1-d efficiencies and you have the 2-d efficiency plots AND A TABLE WHICH LISTS THEM (this is the biggest piece that is missing and I was expecting to see), here you also include the q2 and |t| distributions and their definitions.)

$\bar{\nu}$-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	18,935	4,203
"Out-the-back"-Events	372	82
"Out-the-side"-Events	1,138	232
Good Coherent Pion Events	**19,307**	**4,285**

Table 5: Event reduction table for a sample of $\bar{\nu}$-mode Charged Current Coherent Pion events simulated in the SciBooNE geometry.

Table 6: 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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00645756	0.018006	0.0306081	0.0433498	0.053756	0.044898
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00228571	0.0041686	0.0121873	0.017341	0.020155
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

New NM R-S	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	0.773438	0.875	0.796748	0.798611	0.870504	0.819549	0.834532	0.852174	0.88785	0.762712	0.807692	0.802198	0.811321
4.5-9 Deg	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
9-13.5 Deg	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
13.5-18 Deg	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
18-22.5 Deg	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
22.5-27 Deg	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
27-31.5 Deg	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
31.5-36 Deg	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
36-40.5 Deg	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
40.5-45 Deg	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
45-49.5 Deg	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
49.5-54 Deg	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
54-58.5 Deg	0.135764	0.133188	0.12807	0.106557	0.122172	0.0814815	0.0571429	0.1	0.0322581	0	0.1	0.333333	0
58.5-63 Deg	0.0845225	0.0654045	0.074184	0.0883721	0.0841121	0.0405405	0	0	0	0	0	0	0
63-67.5 Deg	0.0724638	0.044586	0.0347222	0.0641026	0.0243902	0	0.136364	0	0	0	0	0	0
67.5-72 Deg	0.0234114	0.0121212	0.0131579	0.075	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0.00540541	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 R-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	0.835443	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	0.774026	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	0.721683	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	0.661465	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	0.600991	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	0.566828	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	0.389868	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	0.307116	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	0.182432	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	0.147059	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	0.148148	0.117647	0.0769231	0	0.6	0	0	0	0.25	0	0	0	0
49.5-54 Deg	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	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 7: 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
0-4.5 Deg	0	0	0	0	0.157895	0.325	0.422222	0.490566	0.615385	0.728571
4.5-9 Deg	0	0	0	0.0625	0.176471	0.235849	0.396694	0.478261	0.581731	0.773279
9-13.5 Deg	0	0	0	0.09375	0.156716	0.223529	0.362963	0.463343	0.5725	0.701245
13.5-18 Deg	0	0	0	0.0382166	0.131222	0.260736	0.330233	0.448833	0.566116	0.634994
18-22.5 Deg	0	0	0	0.039604	0.0973451	0.228145	0.318462	0.419903	0.517013	0.582547
22.5-27 Deg	0	0	0	0.0264026	0.0930736	0.197461	0.321879	0.381265	0.447548	0.521715
27-31.5 Deg	0	0	0	0.00486618	0.0857143	0.152859	0.25358	0.312166	0.395361	0.466491
31.5-36 Deg	0	0	0	0.00754717	0.0815217	0.142292	0.218271	0.283494	0.333753	0.381784
36-40.5 Deg	0	0	0	0	0.032538	0.0817963	0.170164	0.233583	0.275212	0.327416
40.5-45 Deg	0	0	0	0	0.0139147	0.0678972	0.129657	0.192308	0.224483	0.252462
45-49.5 Deg	0	0	0	0	0.00251467	0.0392938	0.0940285	0.141328	0.181437	0.212241
49.5-54 Deg	0	0	0	0	0	0.0110121	0.0531873	0.0958814	0.126534	0.148936
54-58.5 Deg	0	0	0	0	0	0.000456204	0.0199623	0.0552683	0.0810965	0.102659
58.5-63 Deg	0	0	0	0	0	0	0.000714286	0.0128637	0.0467906	0.0568421
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00745573	0.0242928
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.000740466
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

New NM B-S	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000
0-4.5 Deg	0.895522	0.807692	0.880435	0.864865	0.843373	0.833333	0.858333	0.833333	0.826087	0.814815
4.5-9 Deg	0.811448	0.817109	0.806366	0.801402	0.814286	0.809211	0.804211	0.755448	0.822709	0.792657
9-13.5 Deg	0.78089	0.798354	0.801724	0.794569	0.782796	0.780287	0.765235	0.773496	0.756598	0.759384
13.5-18 Deg	0.727545	0.736387	0.720152	0.749489	0.762791	0.732403	0.711937	0.704908	0.702804	0.683544
18-22.5 Deg	0.656707	0.692351	0.687027	0.677215	0.689404	0.661647	0.651855	0.661634	0.65554	0.634515
22.5-27 Deg	0.578365	0.637657	0.629688	0.615445	0.637963	0.622396	0.604258	0.581746	0.570899	0.569778
27-31.5 Deg	0.496522	0.564516	0.564264	0.554788	0.551891	0.55257	0.548276	0.521099	0.517559	0.518553
31.5-36 Deg	0.436444	0.472969	0.488325	0.492462	0.479326	0.494505	0.47549	0.45864	0.461108	0.451835
36-40.5 Deg	0.366159	0.387514	0.419254	0.425045	0.403834	0.392764	0.396559	0.400812	0.369942	0.368859
40.5-45 Deg	0.30273	0.319185	0.342679	0.345987	0.330502	0.331052	0.323815	0.305906	0.312284	0.313023
45-49.5 Deg	0.24064	0.244851	0.261486	0.269272	0.268868	0.255423	0.239971	0.254059	0.219613	0.205285
49.5-54 Deg	0.169353	0.187424	0.203203	0.19403	0.204905	0.197958	0.161453	0.159744	0.142512	0.151292
54-58.5 Deg	0.119633	0.118058	0.129529	0.135933	0.125182	0.118211	0.109568	0.118863	0.117073	0.108844
58.5-63 Deg	0.0634228	0.0796216	0.0780856	0.0909091	0.0960929	0.0849558	0.0780781	0.103825	0.0458716	0
63-67.5 Deg	0.0364188	0.0436258	0.0367232	0.039666	0.0363636	0.0426136	0.0162162	0.0357143	0.0227273	0.0416667
67.5-72 Deg	0.00470367	0.0114213	0.0195072	0.0166667	0.0120482	0	0	0.03125	0	0
72-76.5 Deg	0	0	0	0.00280899	0.00649351	0.0123457	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

New NM B-S	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500
0-4.5 Deg	0.778846	0.8	0.813725	0.829268	0.84375	0.78022	0.783133	0.898734	0.85	0.825397
4.5-9 Deg	0.804255	0.824945	0.804494	0.814536	0.784504	0.774295	0.813665	0.792994	0.764706	0.790036
9-13.5 Deg	0.766798	0.776286	0.733735	0.717208	0.731677	0.730769	0.708861	0.728296	0.755835	0.75089
13.5-18 Deg	0.703634	0.7086	0.706101	0.683544	0.700457	0.681775	0.68321	0.68171	0.669251	0.644678
18-22.5 Deg	0.653195	0.635392	0.641326	0.620074	0.60516	0.579566	0.597895	0.612863	0.599419	0.5856
22.5-27 Deg	0.571276	0.570789	0.557559	0.528678	0.526667	0.524138	0.529101	0.509404	0.499093	0.539326
27-31.5 Deg	0.515256	0.490654	0.476651	0.444332	0.474736	0.456456	0.431408	0.465169	0.451791	0.405145
31.5-36 Deg	0.42583	0.411765	0.437118	0.397764	0.406551	0.405963	0.389205	0.33564	0.381395	0.393333
36-40.5 Deg	0.345339	0.357923	0.325411	0.296117	0.300654	0.38785	0.366279	0.328	0.348624	0.204819
40.5-45 Deg	0.294294	0.264706	0.272981	0.214286	0.233918	0.189474	0.197368	0.231884	0.222222	0.157895
45-49.5 Deg	0.236769	0.215859	0.180723	0.158879	0.169014	0.0588235	0.0833333	0.166667	0.136364	0.25
49.5-54 Deg	0.132184	0.133858	0.0869565	0.097561	0.0769231	0.0909091	0	0	0	0
54-58.5 Deg	0.0617284	0.0851064	0.0344828	0.0909091	0	0.111111	0	0	0.5	0
58.5-63 Deg	0.0333333	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0.0714286	0.166667	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 NM 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	0.873016	0.767442	0.779661	0.847826	0.836735	0.809524	0.861111	0.794872	0.944444	0.833333
4.5-9 Deg	0.793651	0.741784	0.728643	0.759657	0.734884	0.770053	0.780749	0.761905	0.791908	0.794521
9-13.5 Deg	0.708249	0.717833	0.664251	0.747423	0.700581	0.688679	0.681967	0.69338	0.745763	0.685039
13.5-18 Deg	0.668863	0.66548	0.643629	0.637168	0.643038	0.62973	0.607973	0.666667	0.621212	0.622711
18-22.5 Deg	0.590654	0.587156	0.558376	0.564607	0.52568	0.568093	0.52549	0.575342	0.497696	0.557471
22.5-27 Deg	0.484043	0.5	0.535354	0.441767	0.436681	0.482587	0.40113	0.496599	0.461538	0.454545
27-31.5 Deg	0.433735	0.416667	0.362245	0.333333	0.411765	0.283951	0.402439	0.363636	0.285714	0.396825
31.5-36 Deg	0.277372	0.293103	0.308642	0.246753	0.34375	0.181818	0.108108	0.25	0.258065	0.137931
36-40.5 Deg	0.232143	0.186047	0.181818	0.214286	0.285714	0.214286	0.333333	0.166667	0.285714	0.181818
40.5-45 Deg	0.2	0.0526316	0.428571	0.0588235	0.166667	0.166667	0.25	0	0	1
45-49.5 Deg	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
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 8: 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	650-700	700-750	750-800	800-850	850-900	900-950	950-1000
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	0.7	0.777778	0.875	0.909091	0.777778	1	0.769231
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	0.8	0.74359	0.877551	0.65	0.782609	0.792453	0.810811
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	0.734177	0.732558	0.77907	0.744681	0.865979	0.746988	0.76087
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	0.739726	0.70229	0.719178	0.711656	0.753425	0.726115	0.735099
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	0.648936	0.705069	0.695187	0.643216	0.673267	0.651961	0.616505
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	0.668224	0.632959	0.659574	0.617647	0.593458	0.614213	0.654054
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	0.544061	0.550781	0.516981	0.592437	0.524887	0.513228	0.49359
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	0.461017	0.456311	0.462838	0.493878	0.474654	0.45	0.416667
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	0.424749	0.422222	0.376518	0.409692	0.394737	0.407407	0.360825
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	0.340557	0.366534	0.316742	0.337423	0.28777	0.29661	0.257576
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	0.285156	0.27907	0.270115	0.273973	0.259259	0.347222	0.285714
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	0.220588	0.220238	0.15942	0.142857	0.122807	0.236364	0.129032
54-58.5 Deg	0	0	0	0	0	0	0.023622	0.0238095	0.0320513	0.107463	0.107595	0.110701	0.105991	0.138728	0.186992	0.13253	0.176471	0.131579	0	0.357143
58.5-63 Deg	0	0	0	0	0	0	0	0.0129032	0.0397554	0.0555556	0.0724638	0.0979592	0.0942408	0.0787402	0.0487805	0.0754717	0.15625	0.0416667	0	0.125
63-67.5 Deg	0	0	0	0	0	0	0	0	0.0056338	0.0241379	0.0125523	0.0380952	0.04	0.0869565	0	0.0689655	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00338983	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	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

Old 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	0.8	0.777778	1	0.75	0.75	1	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	0.866667	0.807692	0.815789	0.8	0.74359	0.861111	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	0.747253	0.851064	0.776316	0.683544	0.791045	0.686567	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	0.70068	0.688889	0.705357	0.688679	0.711538	0.705882	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	0.639535	0.641176	0.666667	0.635593	0.59375	0.59375	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	0.529801	0.594937	0.503817	0.591398	0.653465	0.52	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	0.531034	0.475	0.521008	0.465116	0.406593	0.517857	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	0.470588	0.465909	0.454545	0.376812	0.436364	0.348837	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	0.317308	0.397436	0.267857	0.272727	0.285714	0.380952	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	0.140351	0.318182	0.307692	0.208333	0.357143	0.25	0.375	0.25	0.2	0	0	0	0.5	0	0	0	0	1	0	0
45-49.5 Deg	0.28	0.217391	0.111111	0.1	0.0833333	0.166667	0.25	0	0.333333	1	0	0	0	0	0	0	0	0	0	0
49.5-54 Deg	0.0714286	0.1	0.142857	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0.1	0	0	0	0	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	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 9: 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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

New ANM R-S	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0.811494	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	0.808895	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	0.764215	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	0.708415	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	0.646345	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	0.583082	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	0.498878	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	0.425238	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	0.347445	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	0.311653	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	0.251908	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	0.125	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	0.157895	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	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10: Table for 2D Histogram for New ANM-Berger-Sehgal

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

ν-Mode $|t|$ and Q^2 plots are below:

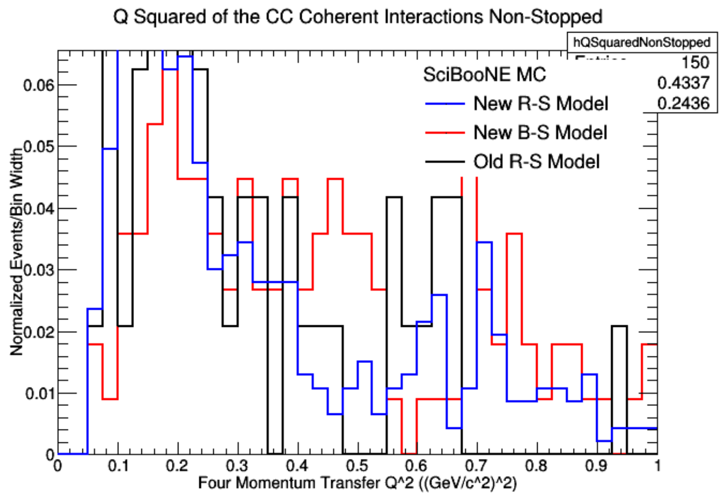


Figure 11:

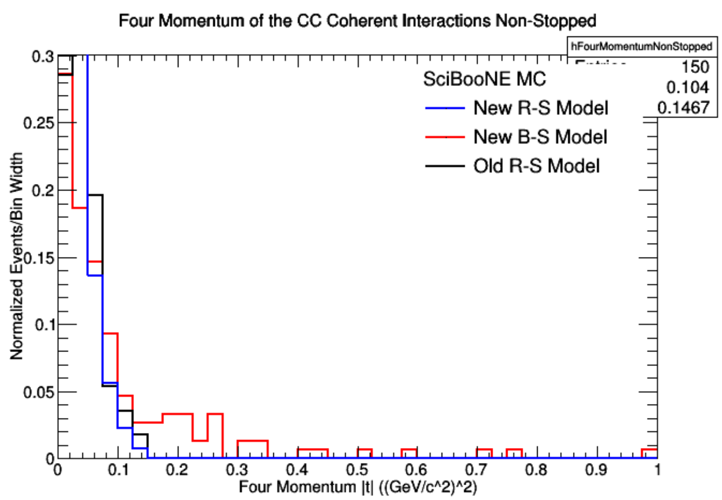


Figure 12:

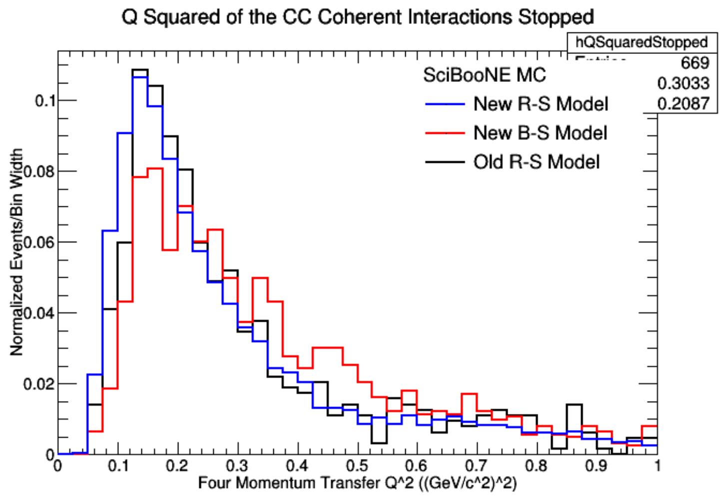


Figure 13:

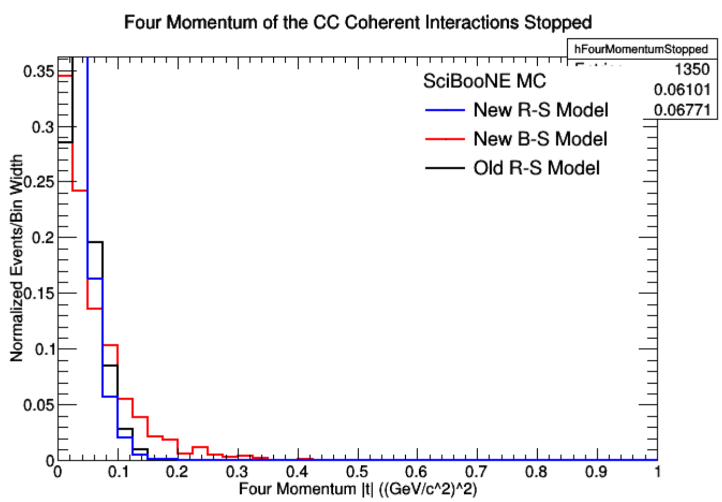


Figure 14:

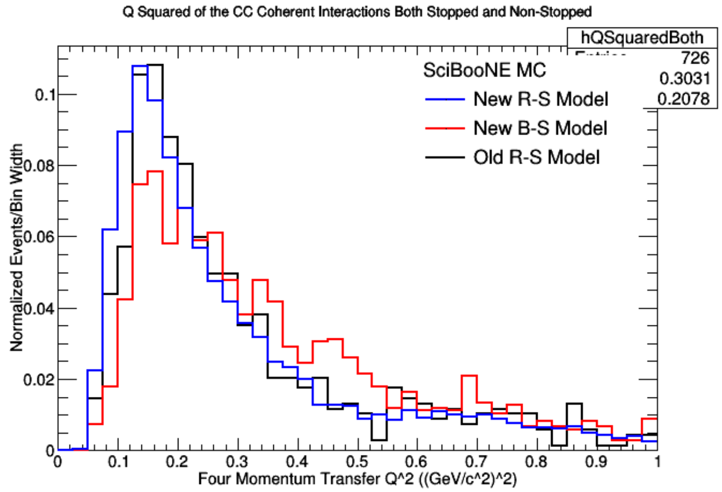


Figure 15:

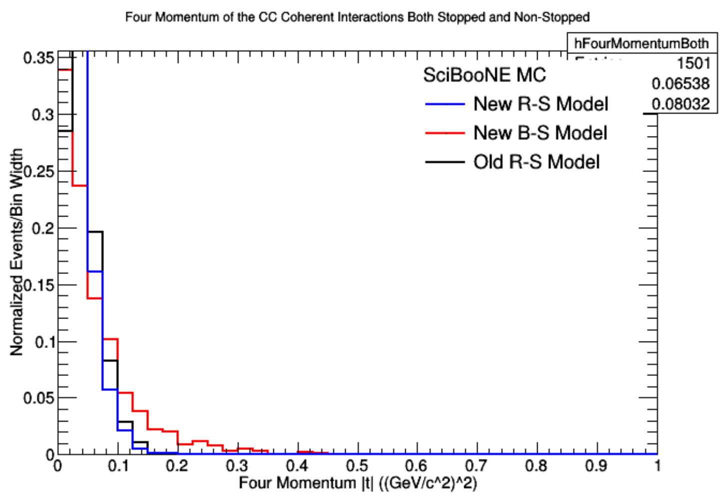


Figure 16:

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

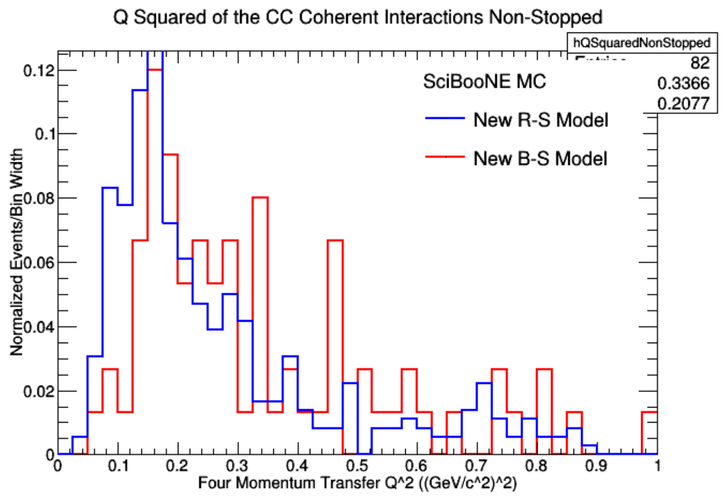


Figure 17:

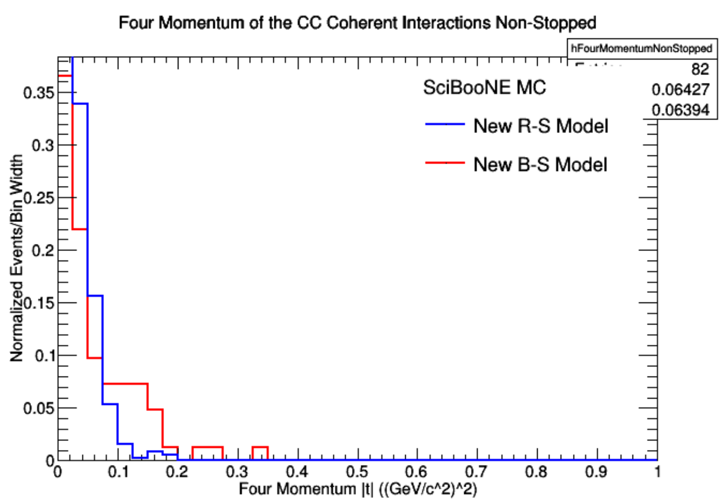


Figure 18:

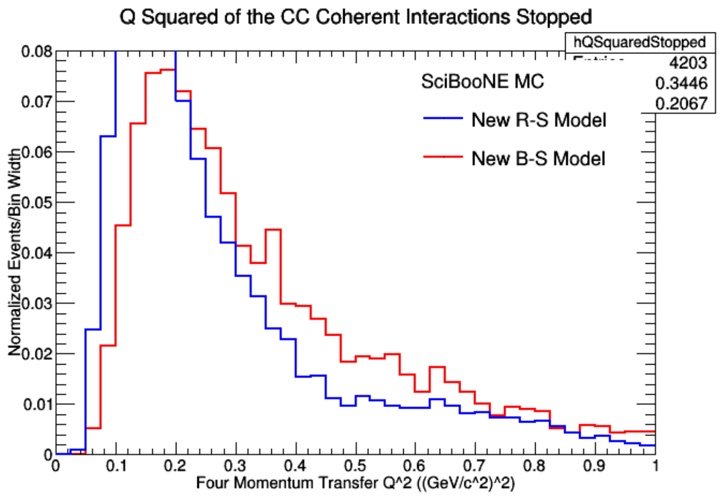


Figure 19:

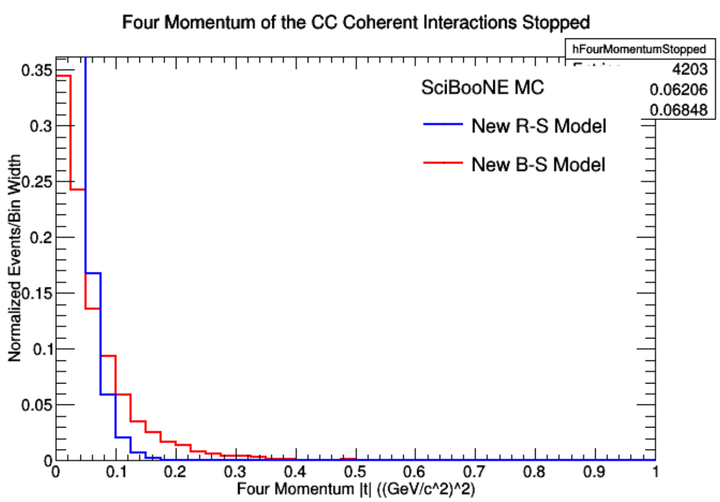


Figure 20:

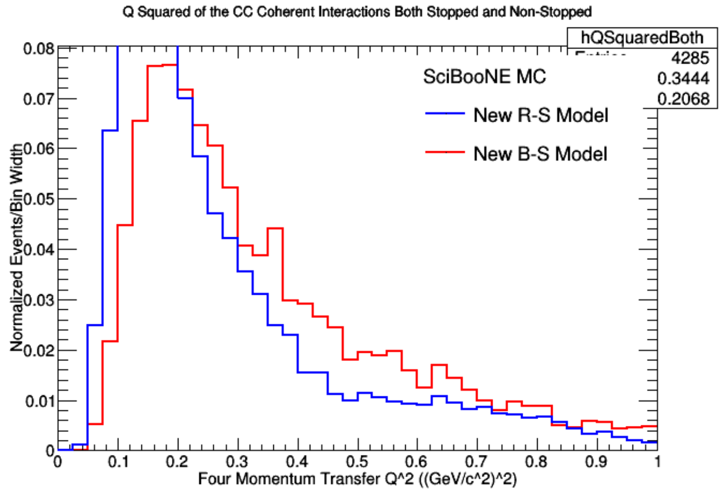


Figure 21:

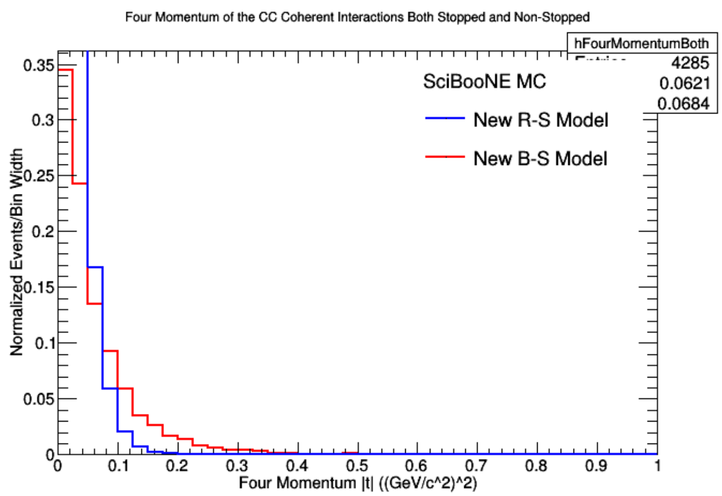


Figure 22:

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.

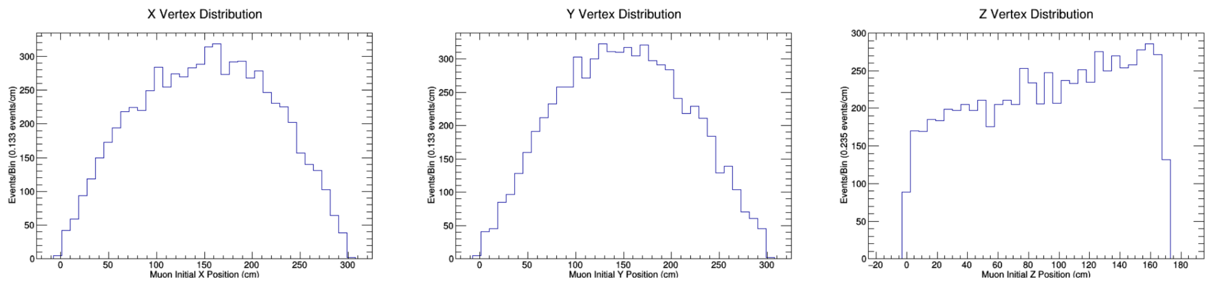


Figure 23: Vertex distributions of the events in the new Rein-Sehgal sample.

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.

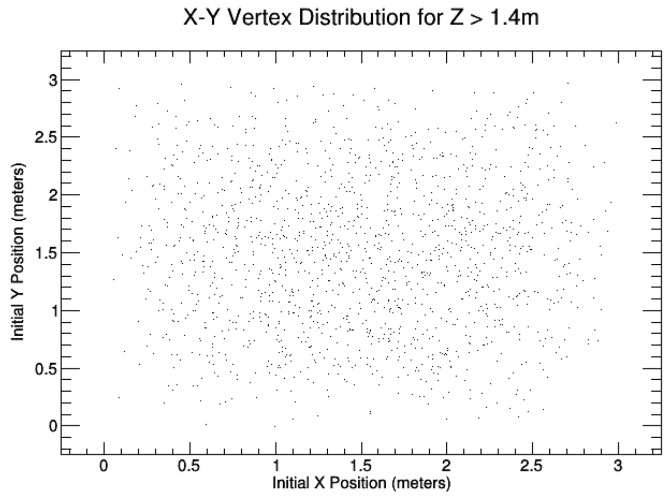


Figure 24: New ν-Mode Rein-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

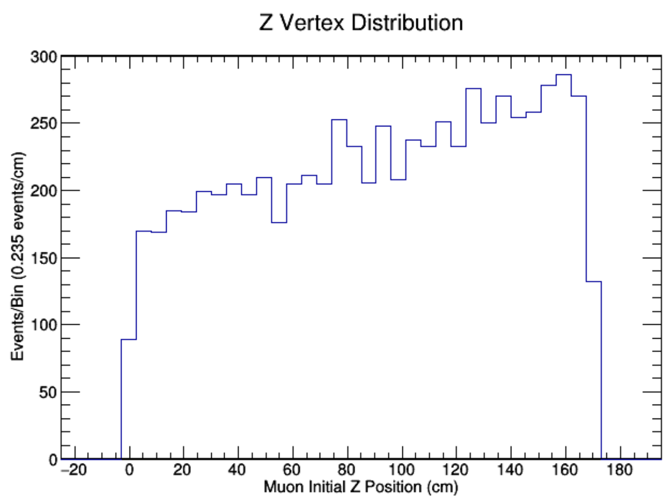


Figure 25: New ν-Mode Rein-Sehgal Z vertex distributions for the interactions.

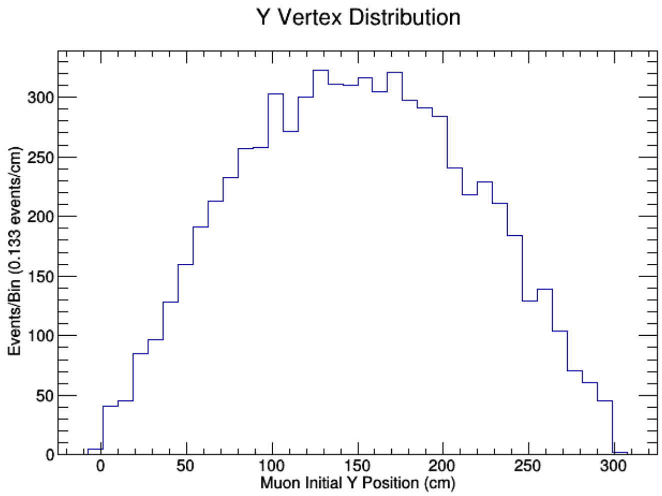


Figure 26: New ν-Mode Rein-Sehgal Y vertex distributions for the interactions.

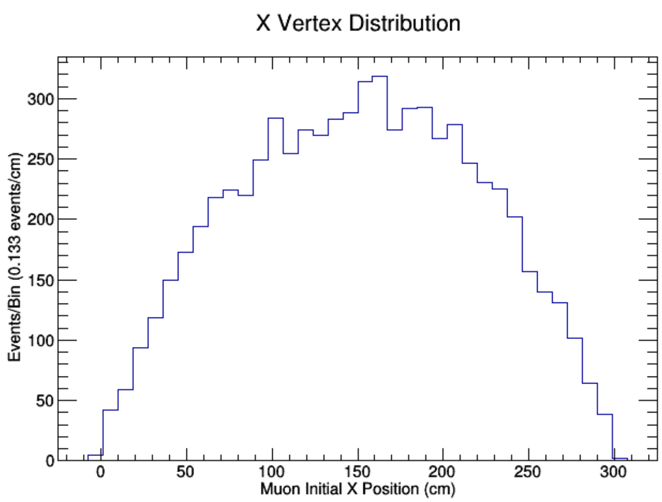


Figure 27: New ν-Mode Rein-Sehgal X vertex distributions for the interactions.

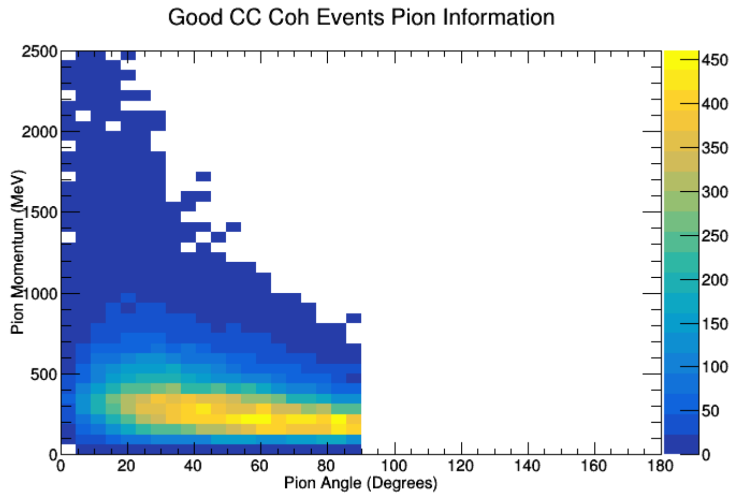


Figure 28: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

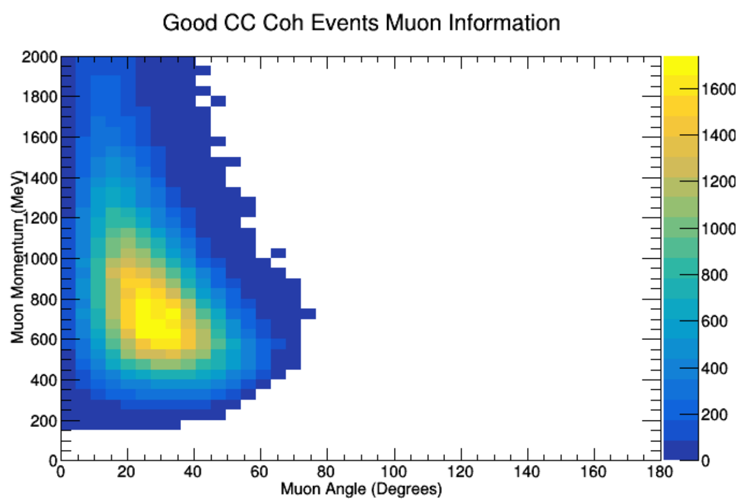


Figure 29: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".

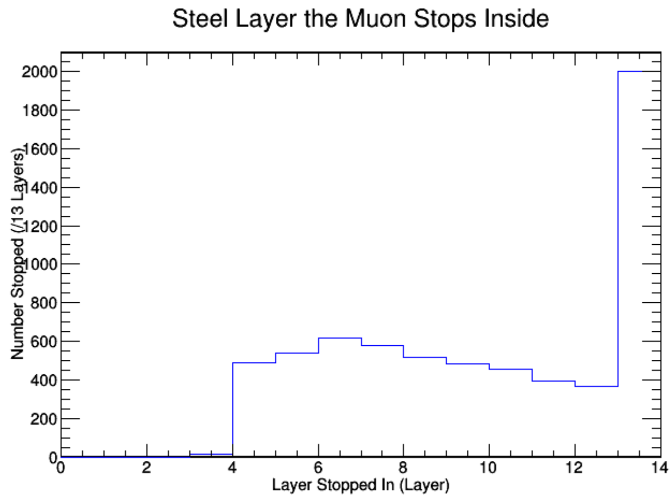


Figure 30: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

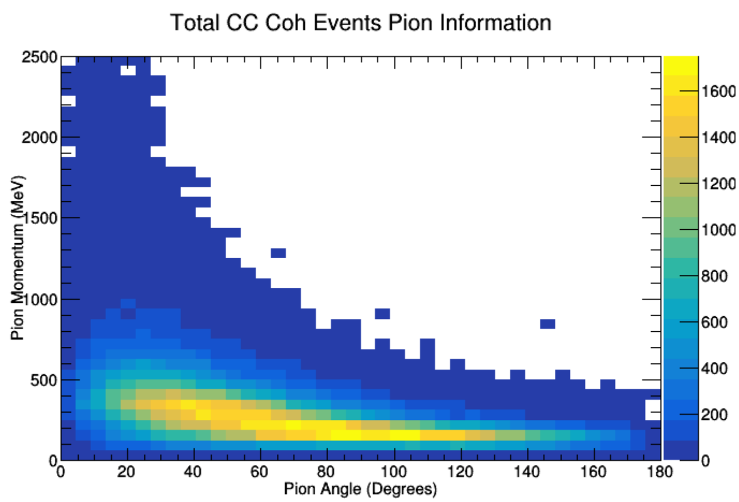


Figure 31: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

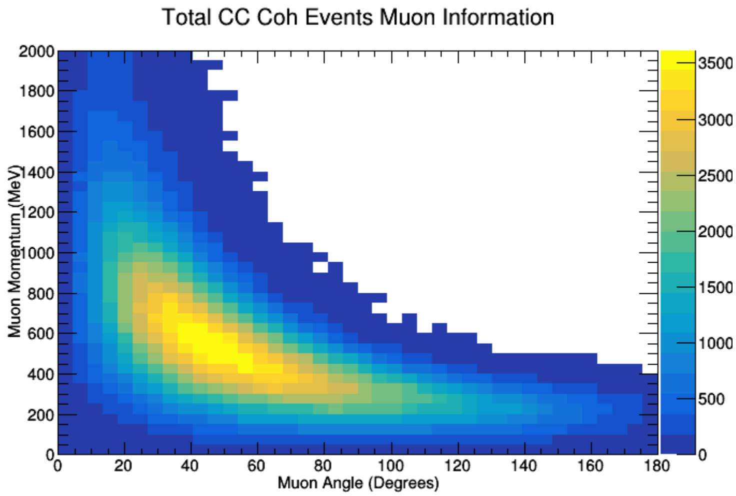


Figure 32: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

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:

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

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

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:

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

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

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°.

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 $(MeV/c)^2$.

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).

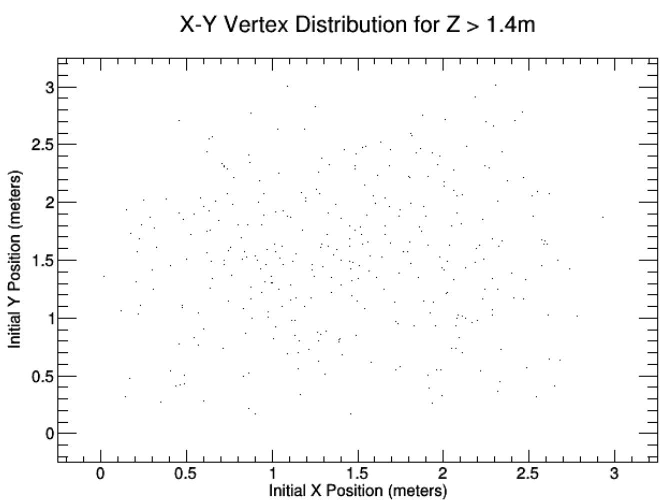


Figure 33: New ν-Mode Berger-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

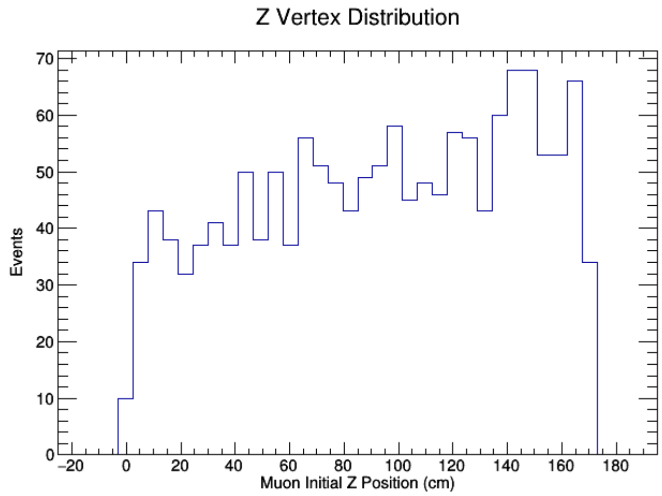


Figure 34: New ν-Mode Berger-Sehgal Z vertex distributions for the interactions.

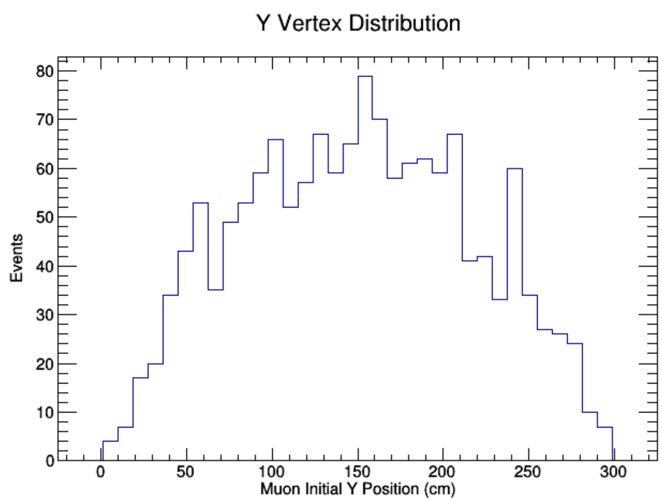


Figure 35: New ν-Mode Berger-Sehgal Y vertex distributions for the interactions.

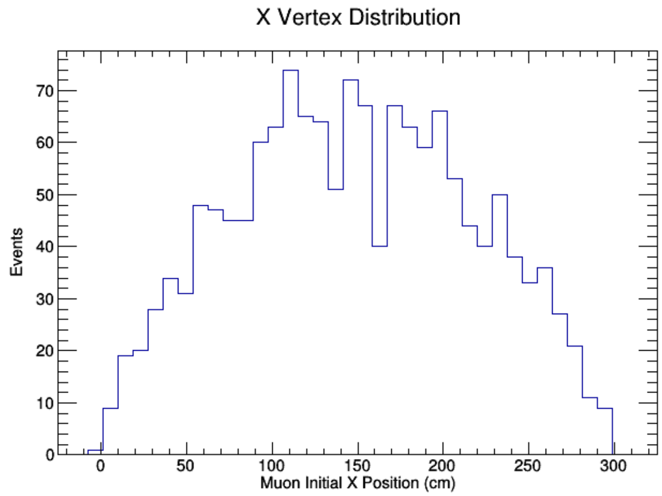


Figure 36: New ν-Mode Berger-Sehgal X vertex distributions for the interactions.

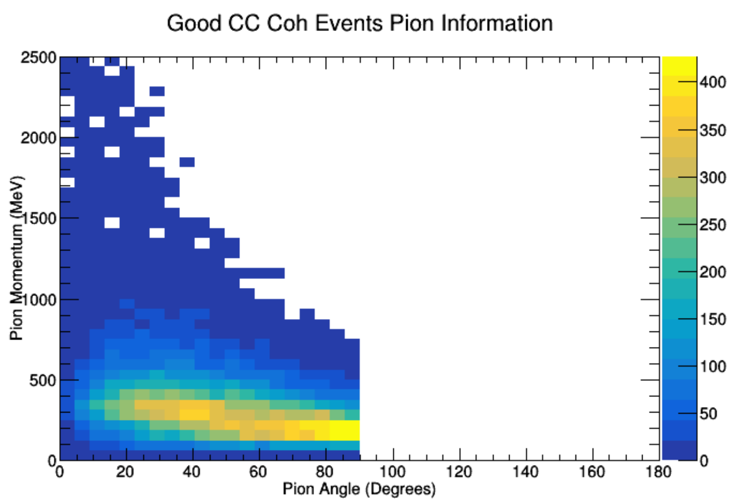


Figure 37: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

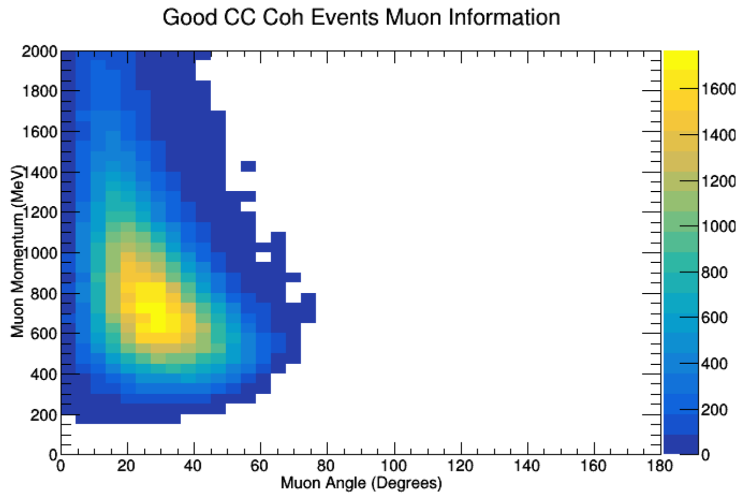


Figure 38: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".!

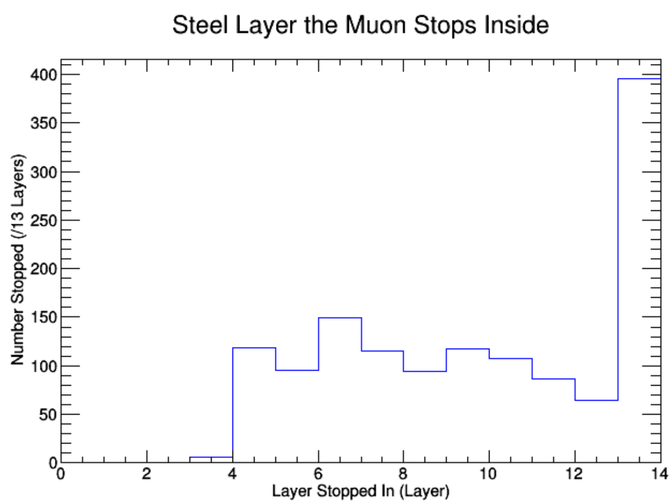


Figure 39: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

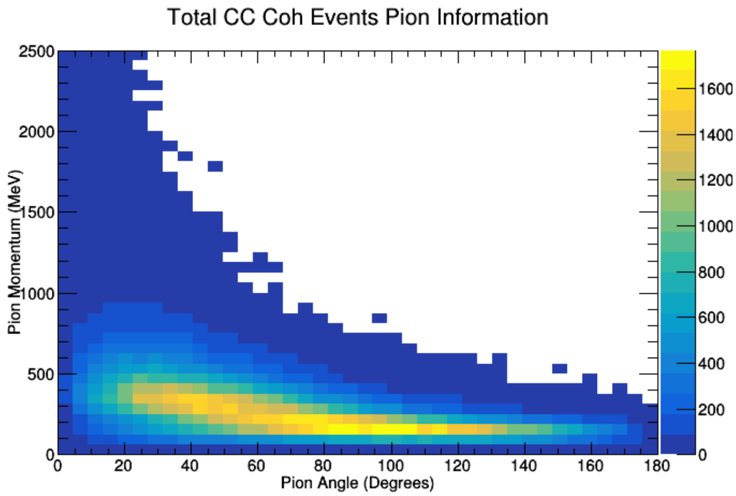


Figure 40: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

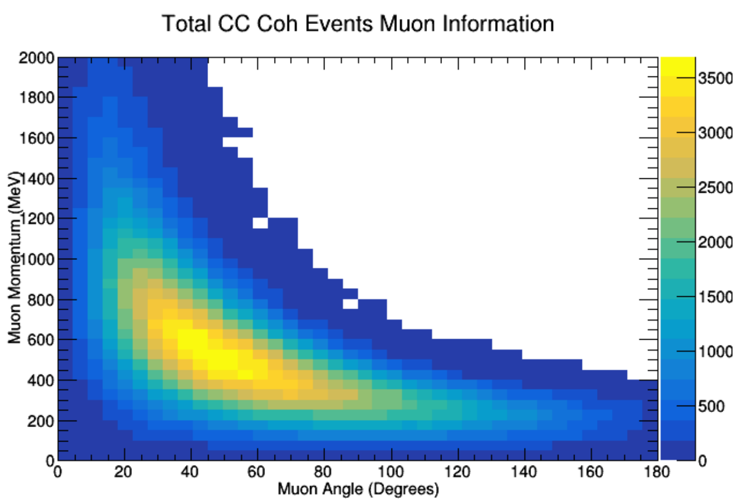


Figure 41: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

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:

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

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

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 °, 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.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).

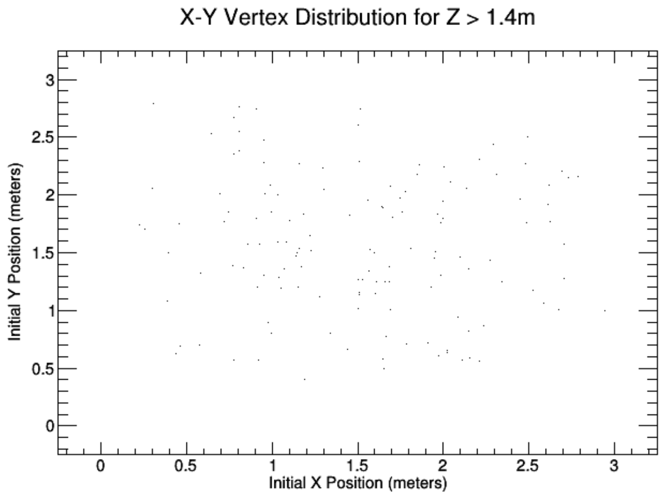


Figure 42: Old ν-Mode Rein-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

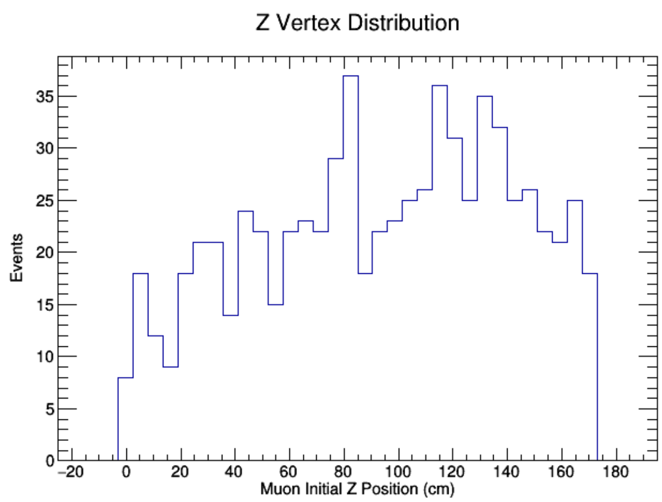


Figure 43: Old ν-Mode Rein-Sehgal Z vertex distributions for the interactions.

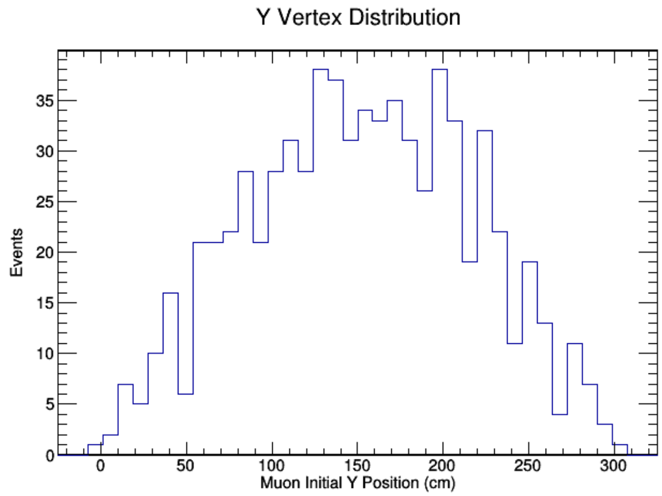


Figure 44: Old ν-Mode Rein-Sehgal Y vertex distributions for the interactions.

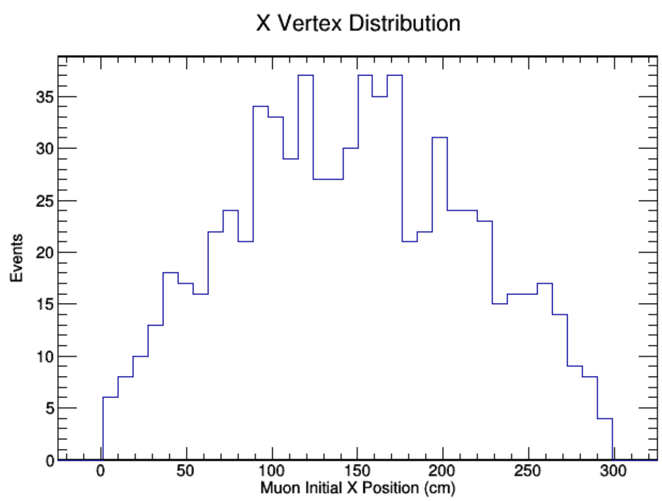


Figure 45: Old ν-Mode Rein-Sehgal X vertex distributions for the interactions.

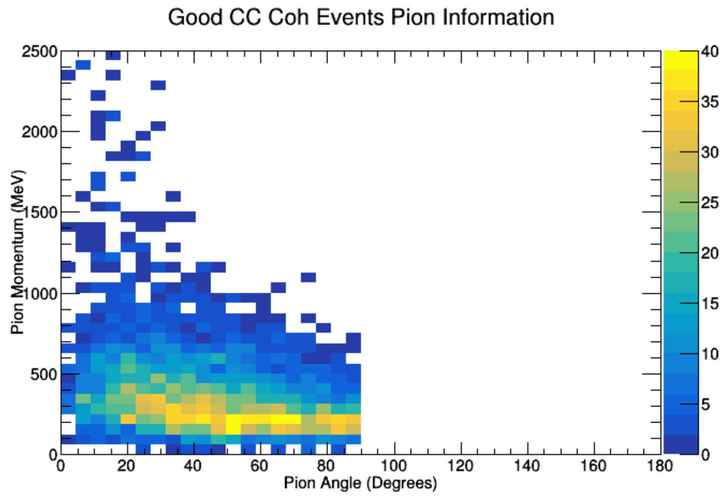


Figure 46: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

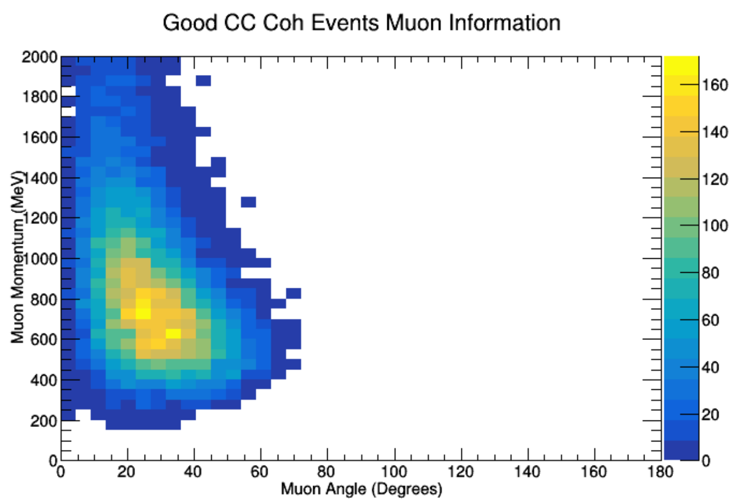


Figure 47: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".

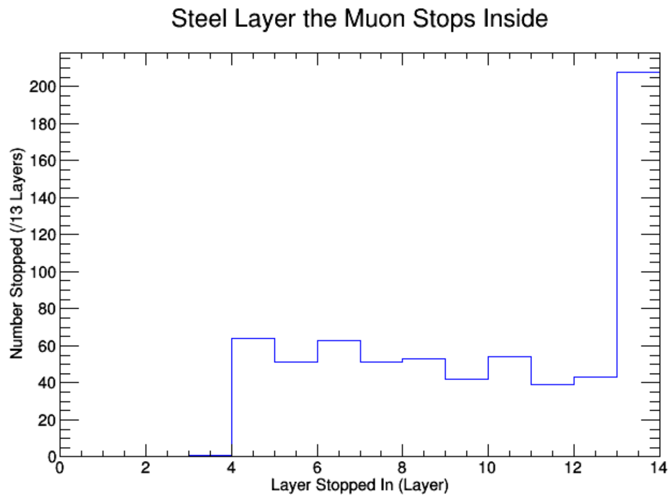


Figure 48: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

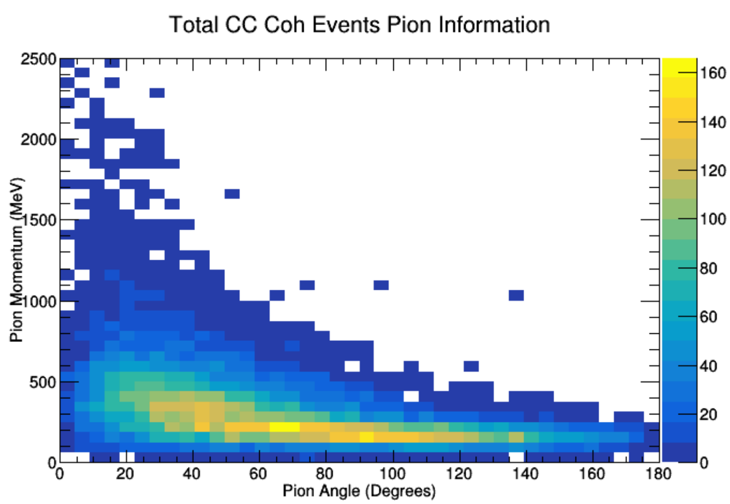


Figure 49: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

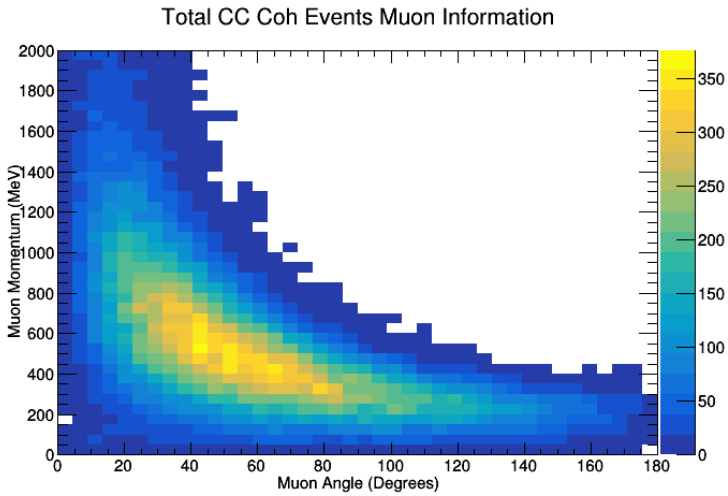


Figure 50: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

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:

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

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

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.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).

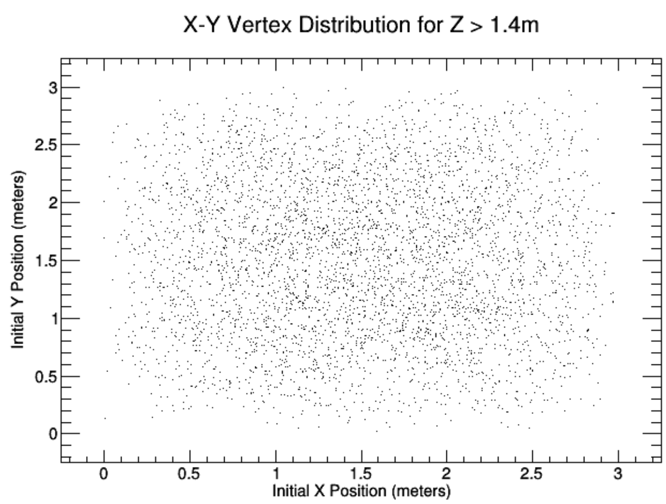


Figure 51: New $\bar{\nu}$-Mode Rein-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

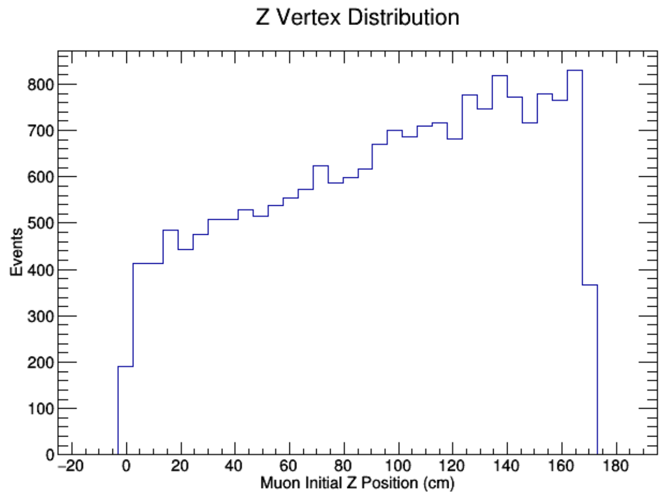


Figure 52: New $\bar{\nu}$-Mode Rein-Sehgal Z vertex distributions for the interactions.

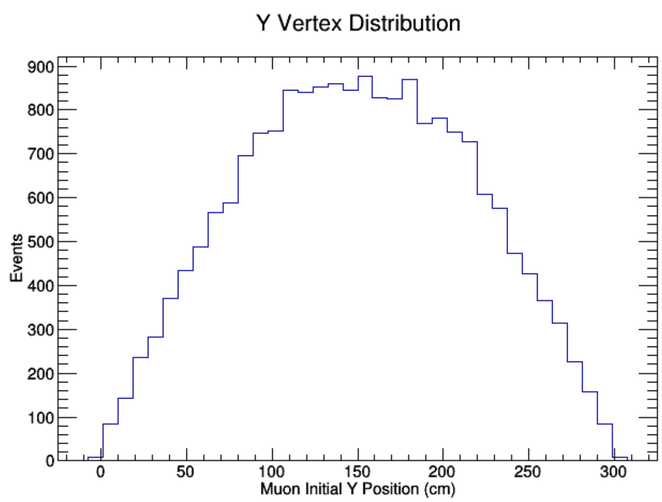


Figure 53: New $\bar{\nu}$-Mode Rein-Sehgal Y vertex distributions for the interactions.

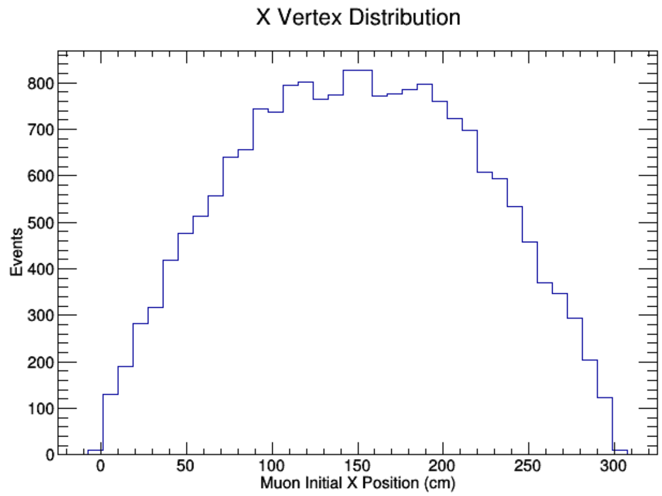


Figure 54: New $\bar{\nu}$-Mode Rein-Sehgal X vertex distributions for the interactions.

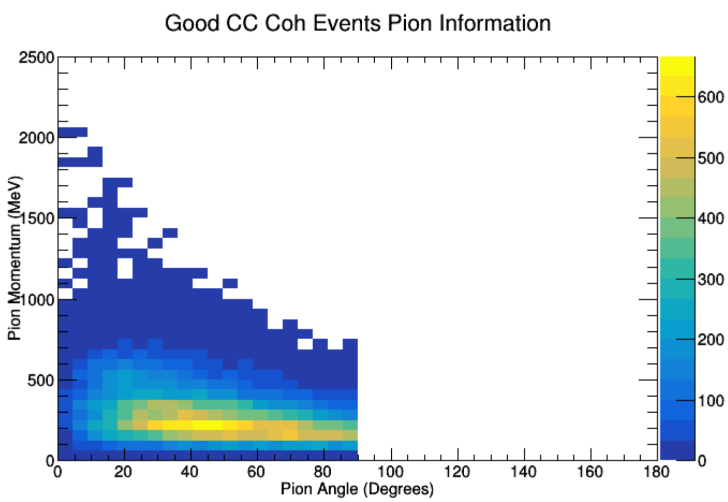


Figure 55: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

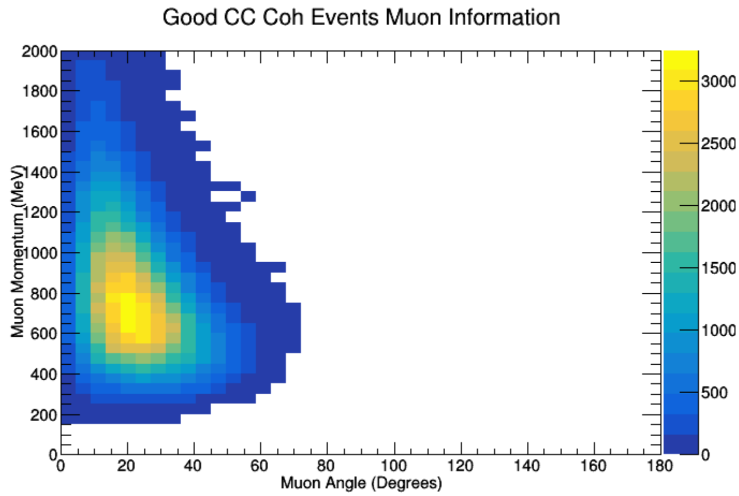


Figure 56: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".

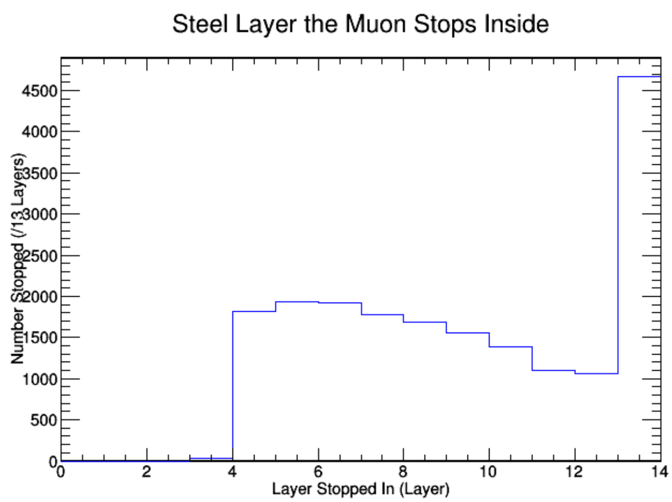


Figure 57: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

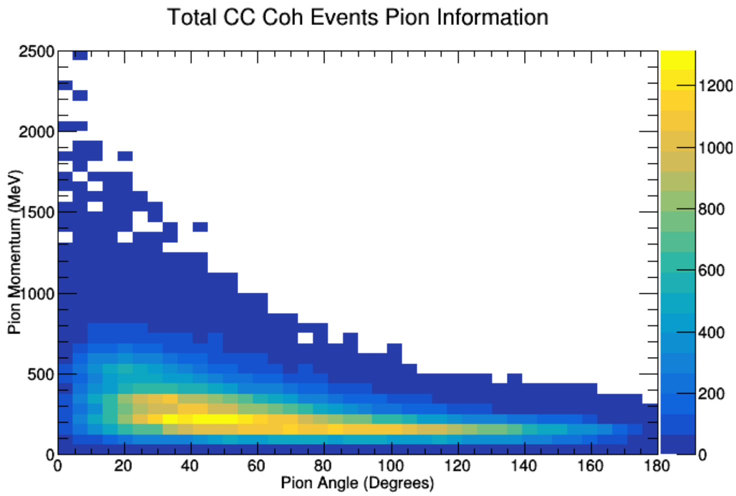


Figure 58: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

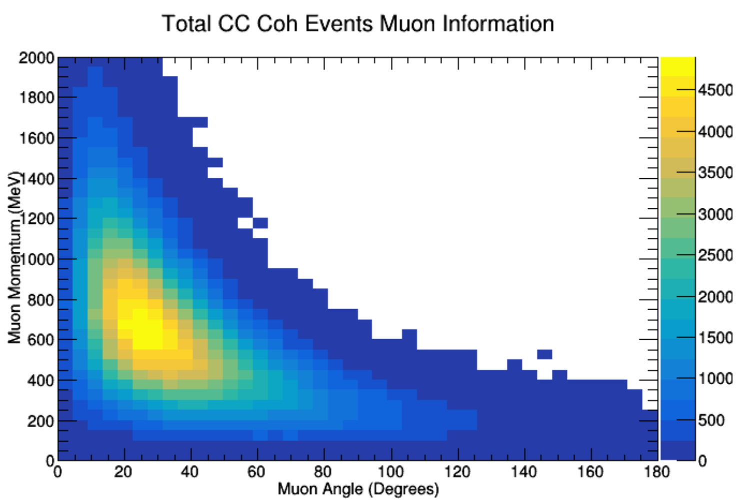


Figure 59: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

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:

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

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

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 $^\circ$, 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:

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

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.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).

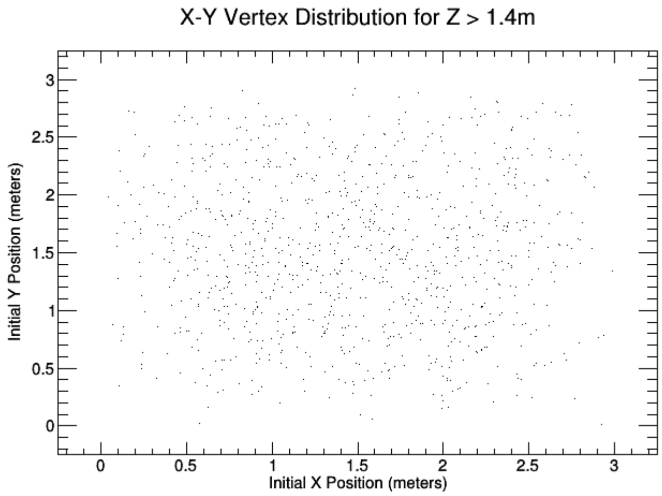


Figure 60: New $\bar{\nu}$-Mode Berger-Sehgal X-Y vertex distributions for muons that made it to the MRD and penetrated at least to the third layer of steel.

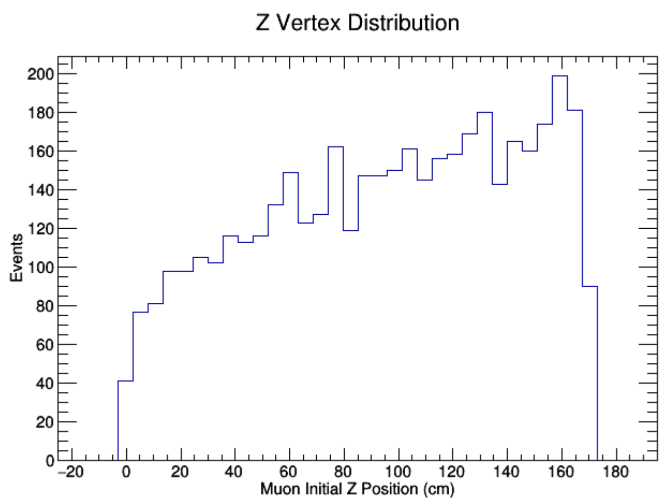


Figure 61: New $\bar{\nu}$-Mode Berger-Sehgal Z vertex distributions for the interactions.

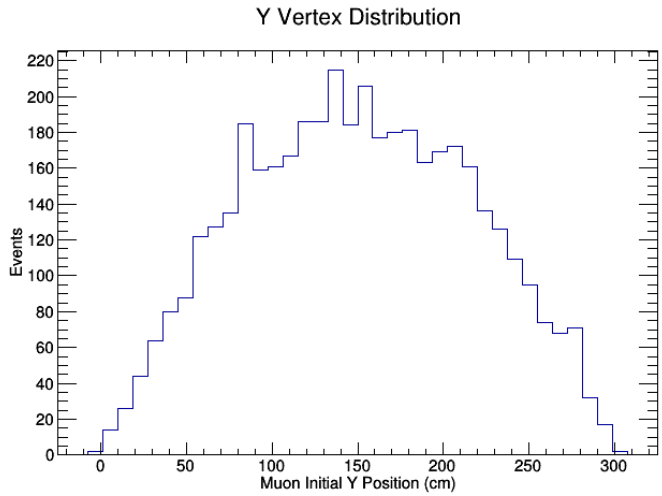


Figure 62: New $\bar{\nu}$-Mode Berger-Sehgal Y vertex distributions for the interactions.

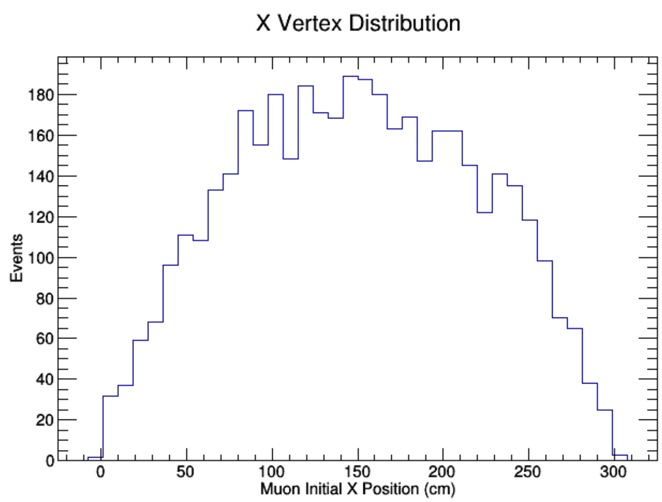


Figure 63: New $\bar{\nu}$-Mode Berger-Sehgal X vertex distributions for the interactions.

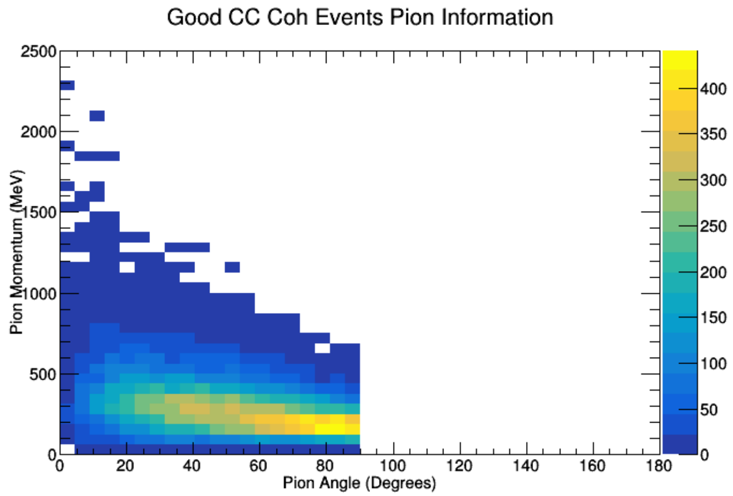


Figure 64: This is a 2D histogram for the momentum and angle of the pion in the CC Coh Pion events that met the qualification of being "good".

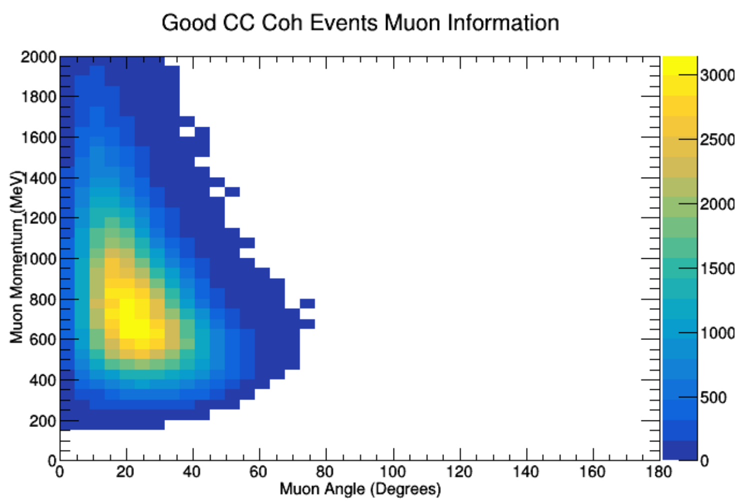


Figure 65: This is a 2D histogram for the momentum and angle of the muon in the CC Coh Pion events that met the qualification of being "good".

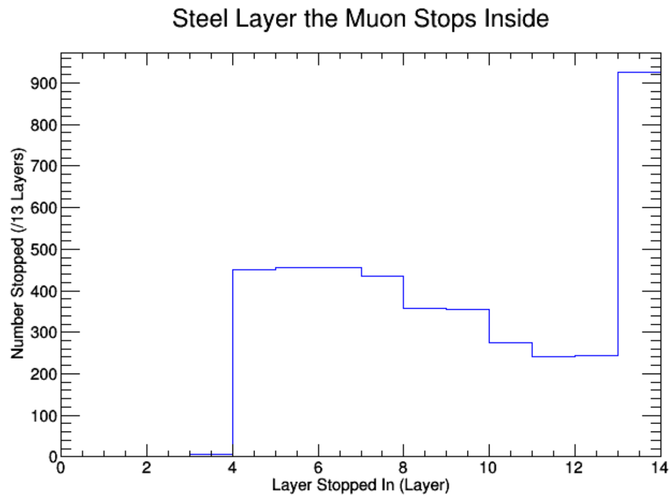


Figure 66: This histogram shows the amount of muons that embedded (or "Stopped") in a corresponding layer of steel in our simulation.

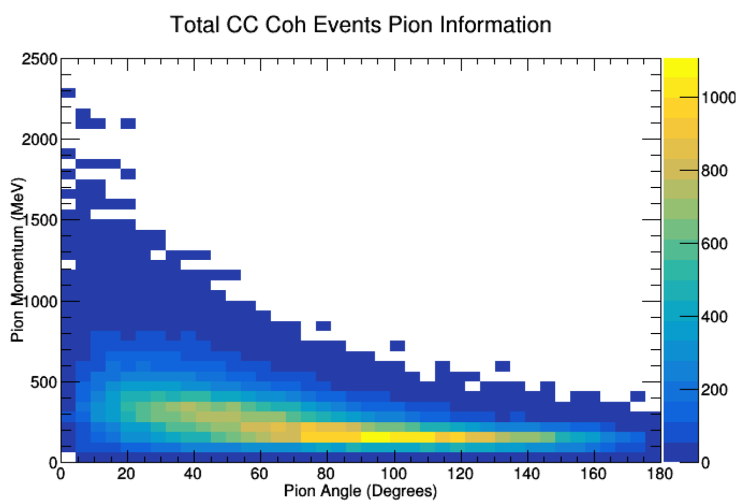


Figure 67: This is a 2D histogram for the momentum and angle of the pion in the total CC Coh Pion events.

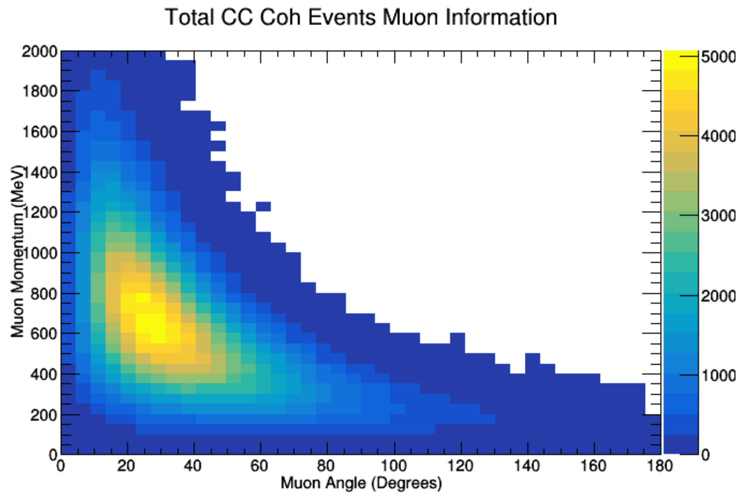


Figure 68: This is a 2D histogram for the momentum and angle of the muon in the total CC Coh Pion events.

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:

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

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

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 °, 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.12 NMCombinedPlots.C

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

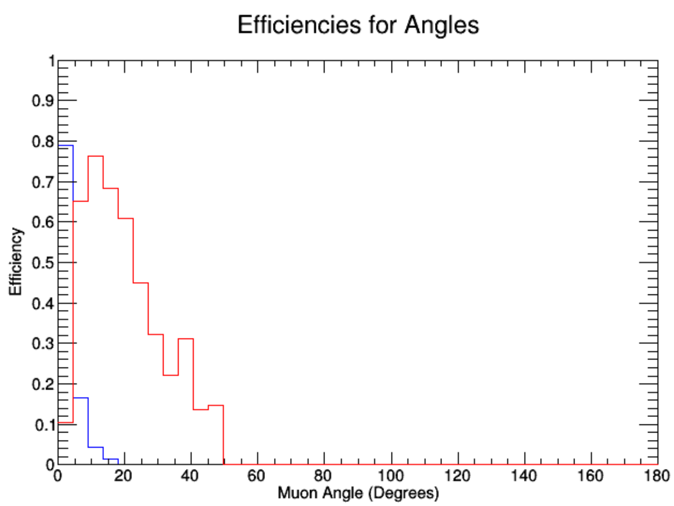


Figure 69:

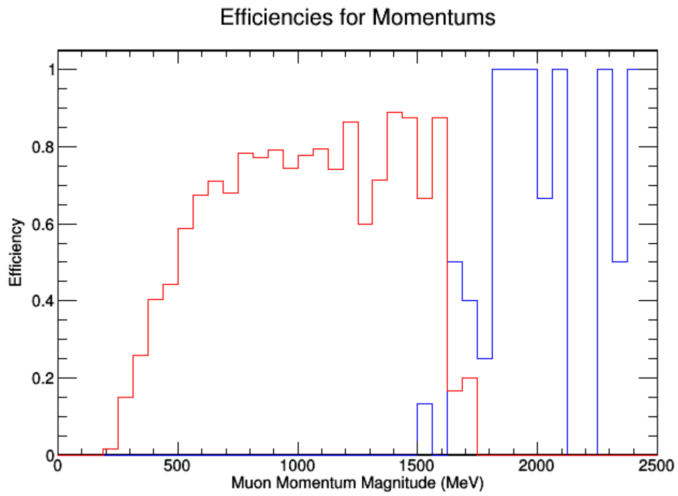


Figure 70:

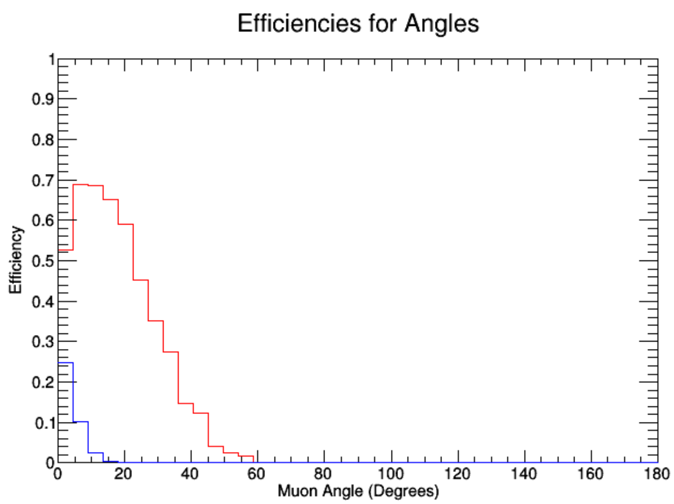


Figure 71:

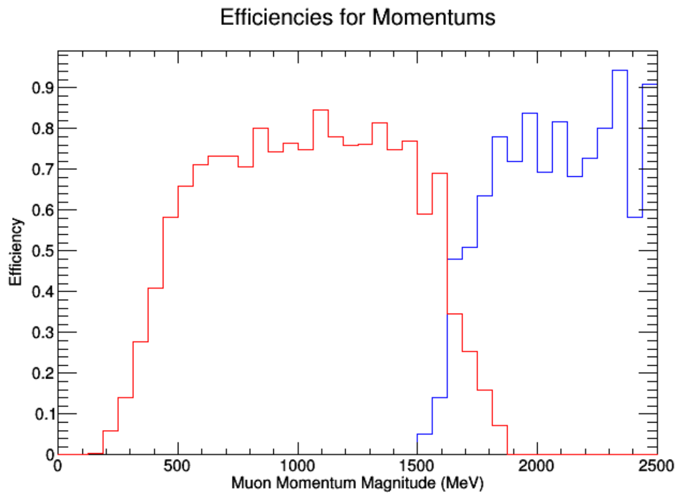


Figure 72:

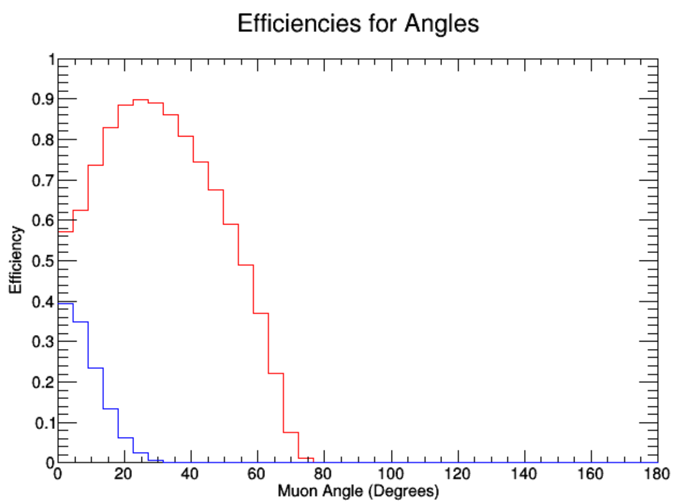


Figure 73:

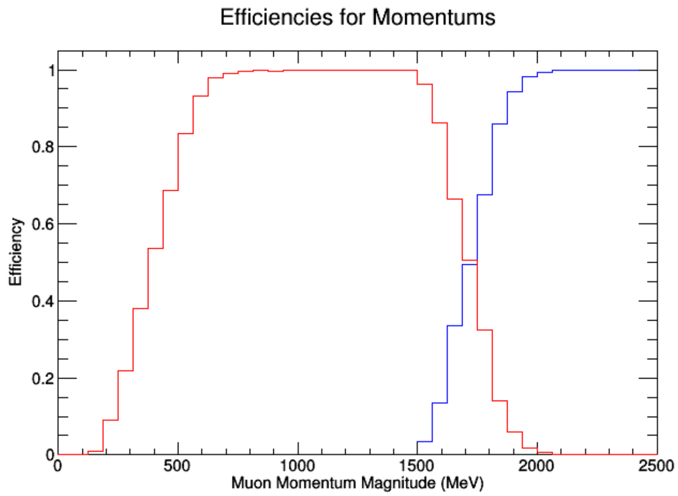


Figure 74:

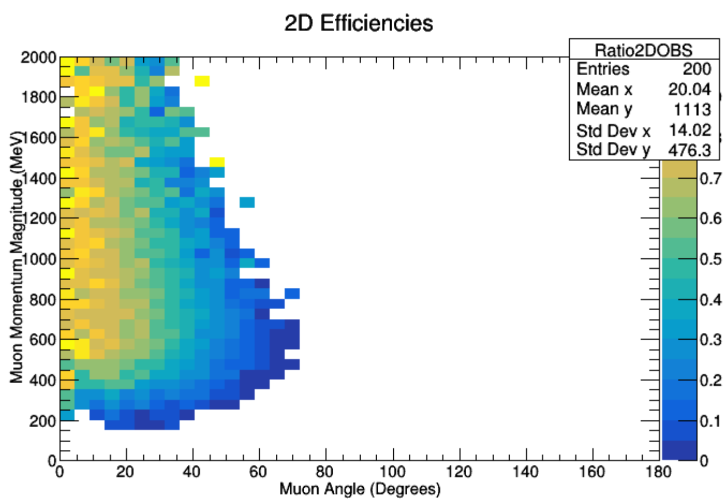


Figure 75:

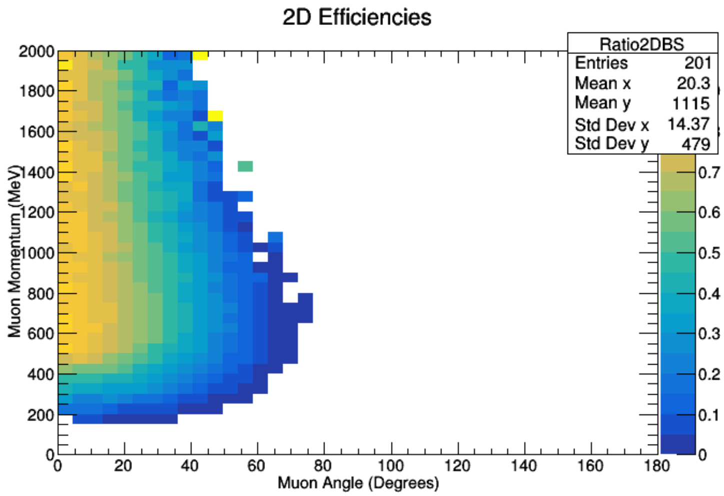


Figure 76:

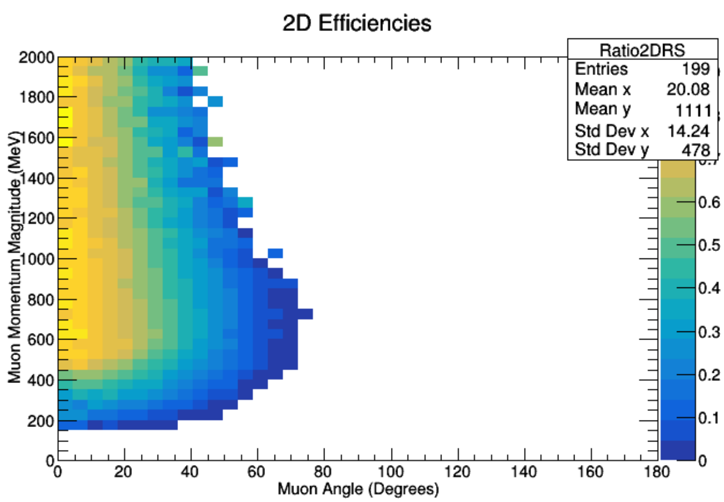


Figure 77:

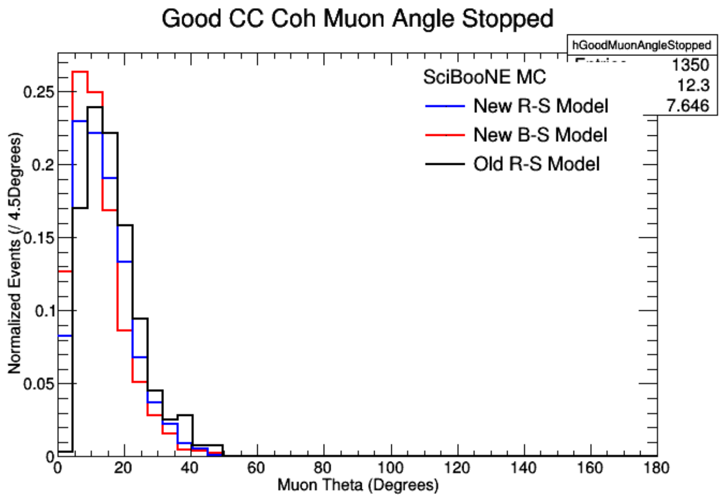


Figure 78:

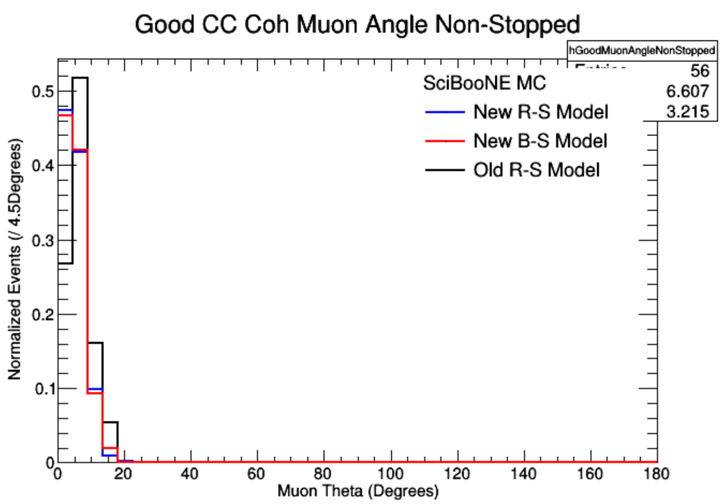


Figure 79:

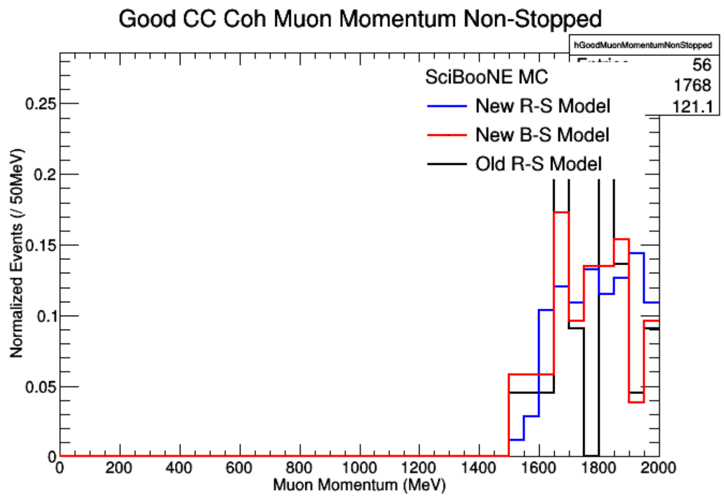


Figure 80:

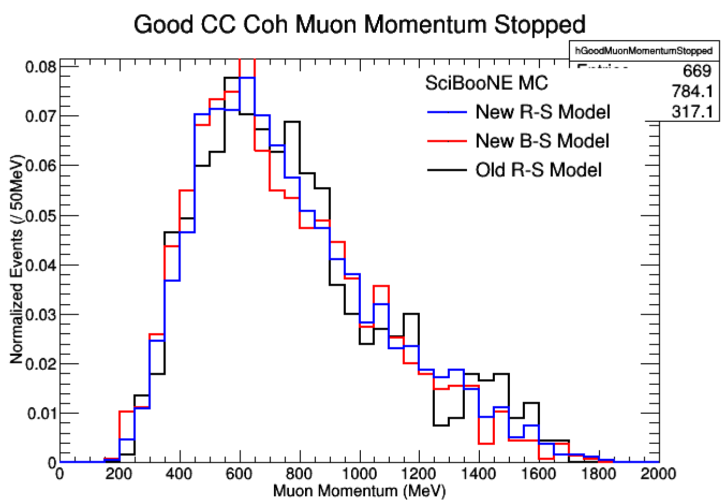


Figure 81:

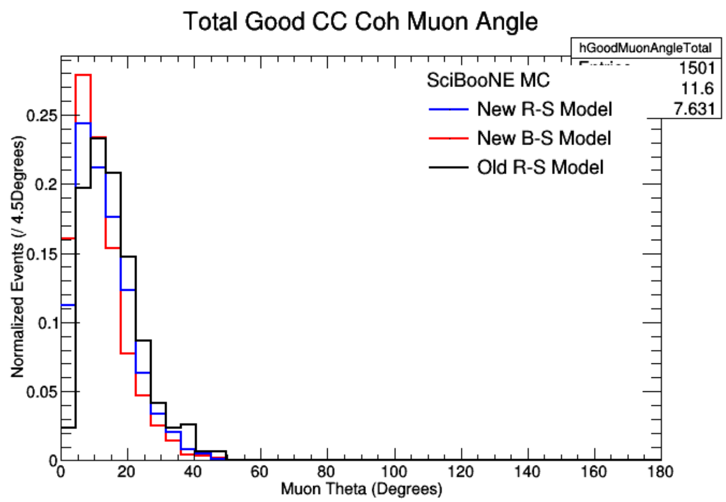


Figure 82:

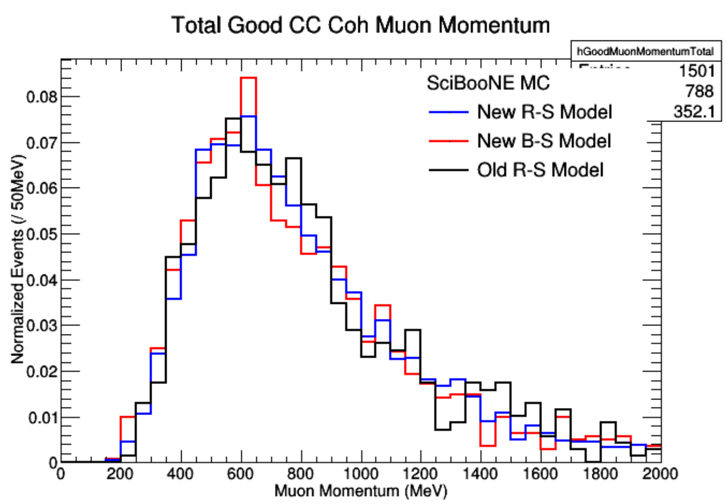


Figure 83:

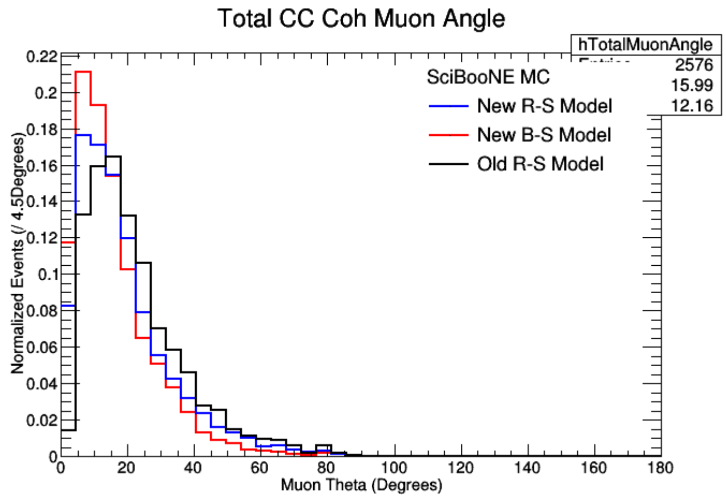


Figure 84:

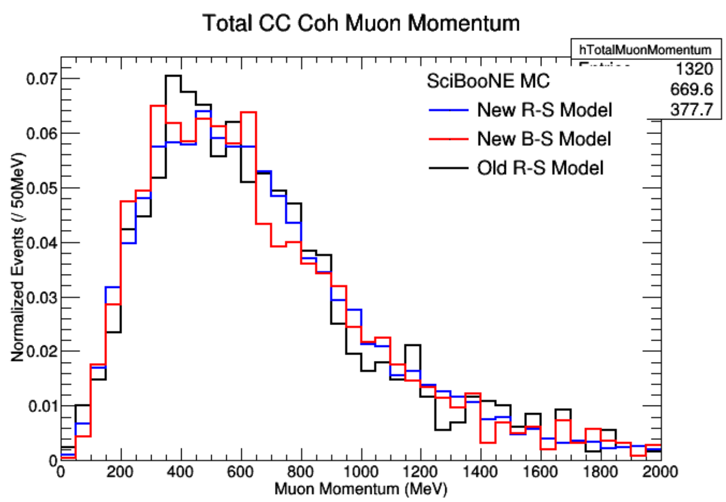


Figure 85:

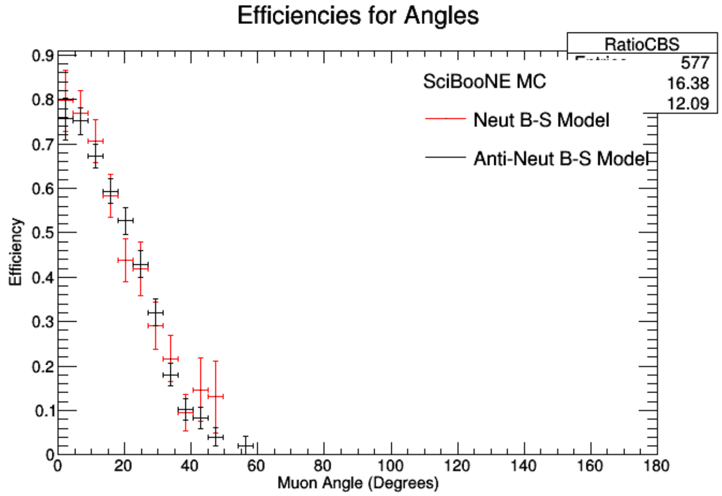


Figure 86:

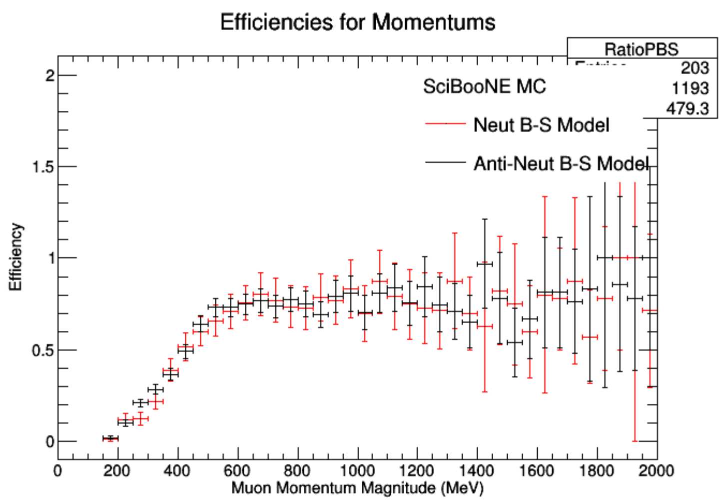


Figure 87:

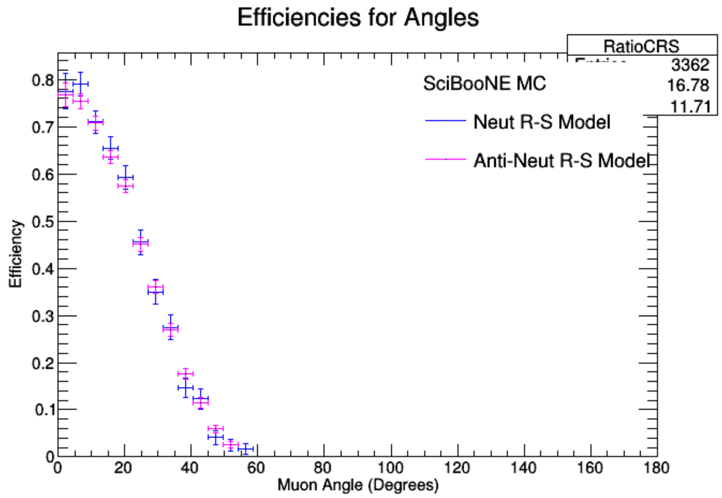


Figure 88:

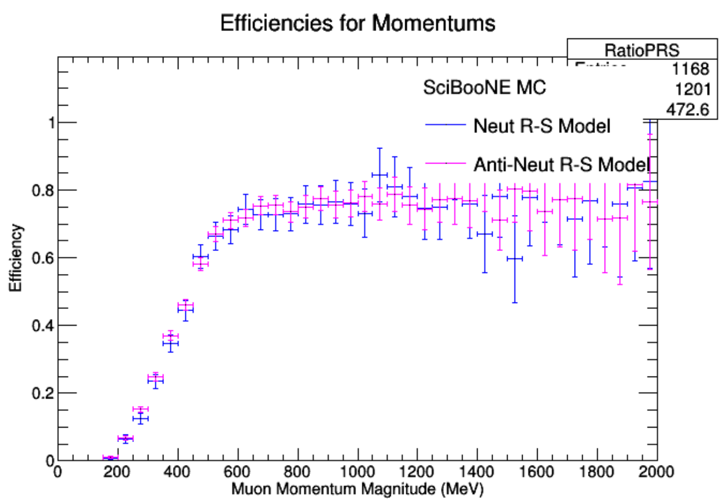


Figure 89:

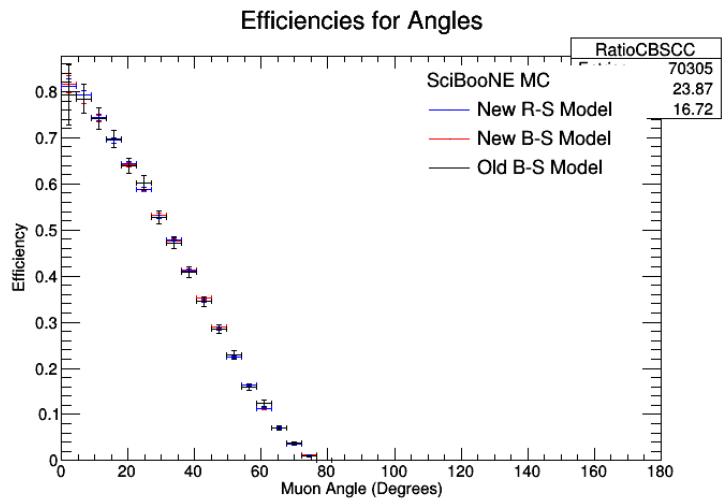


Figure 90:

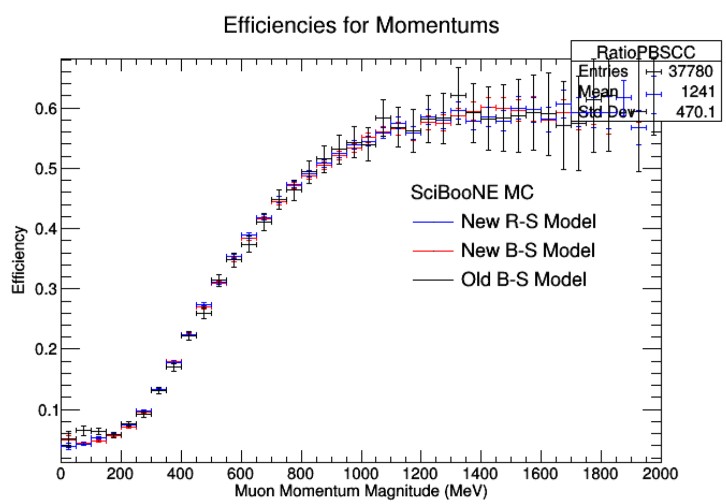


Figure 91:

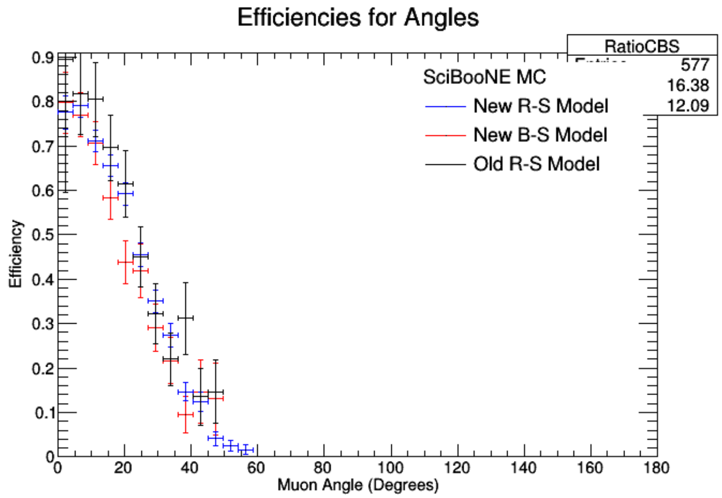


Figure 92:

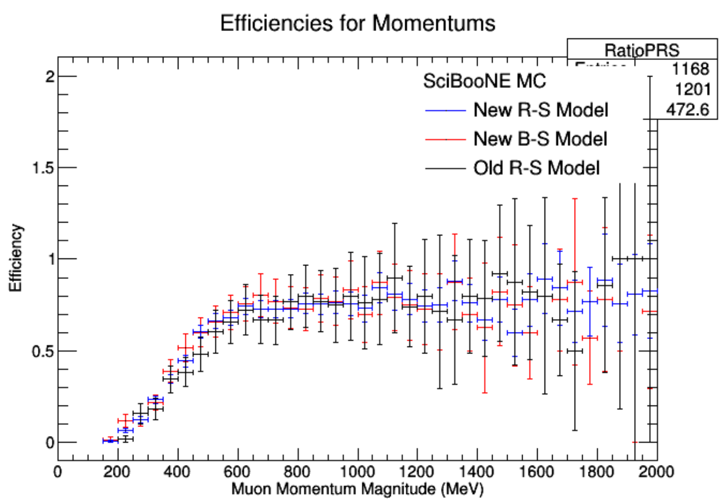


Figure 93:

A.13 NMPionPlotting.C

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

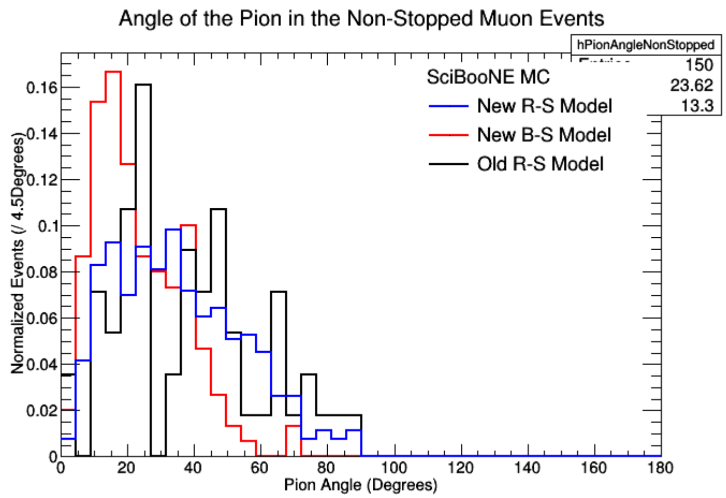


Figure 94:

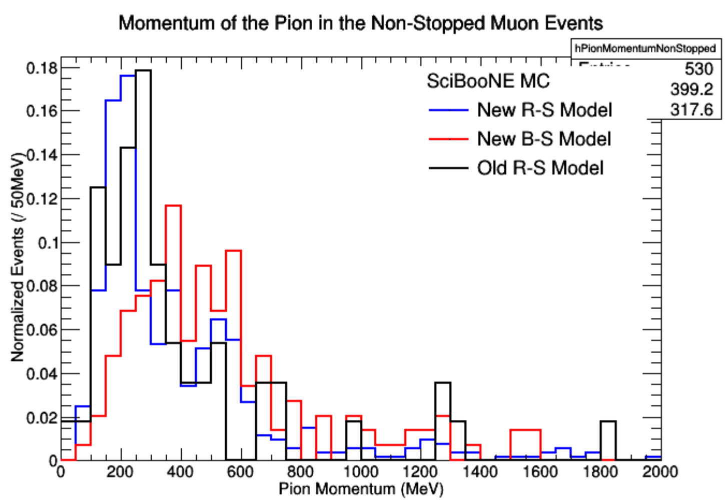


Figure 95:

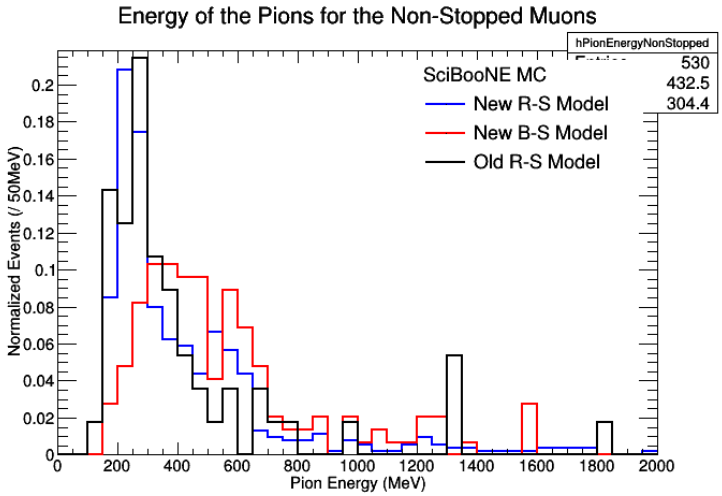


Figure 96:

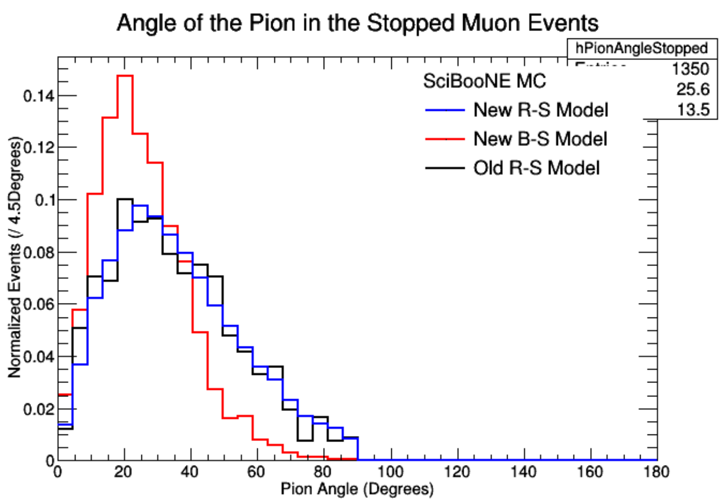


Figure 97:

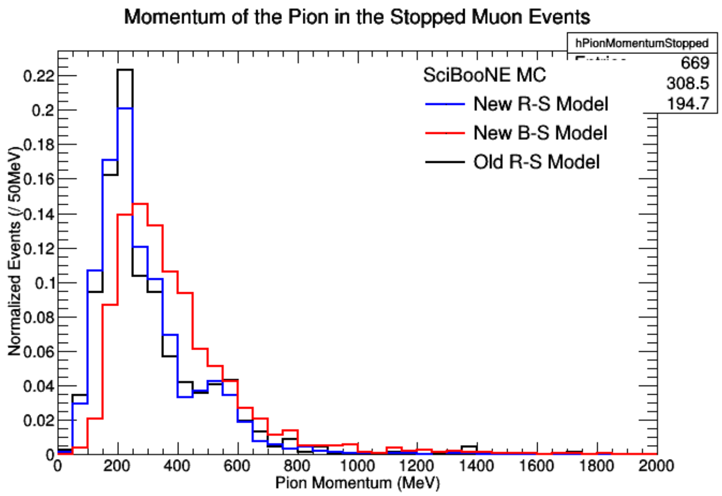


Figure 98:

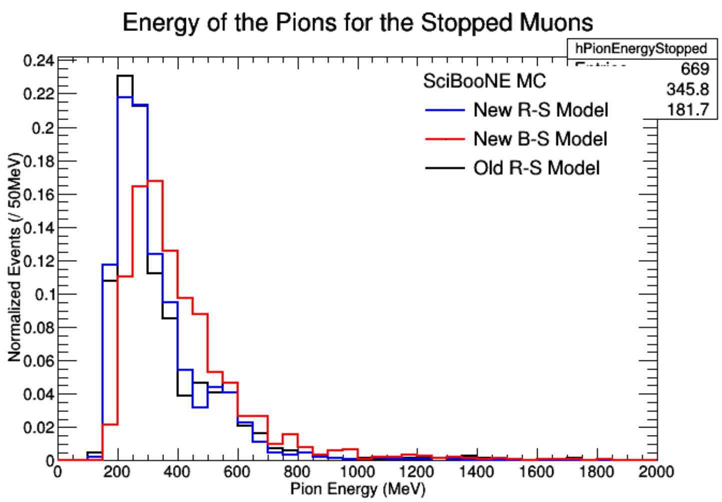


Figure 99:

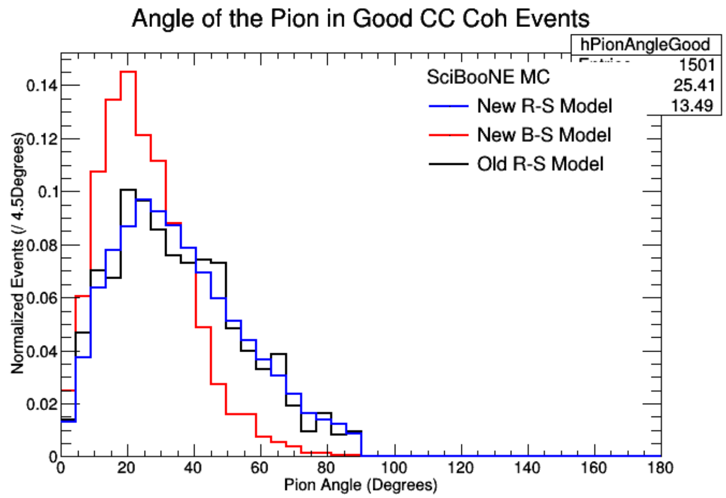


Figure 100:

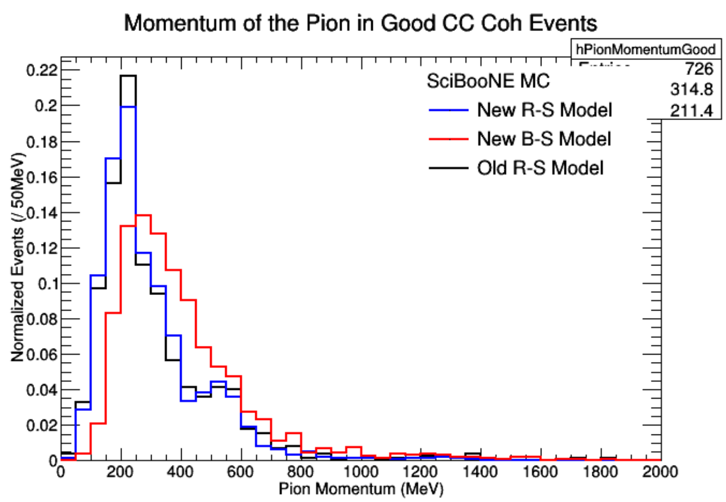


Figure 101:

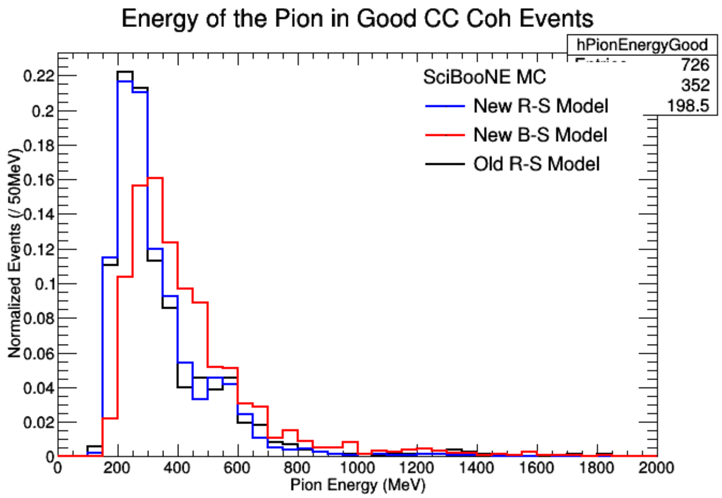


Figure 102:

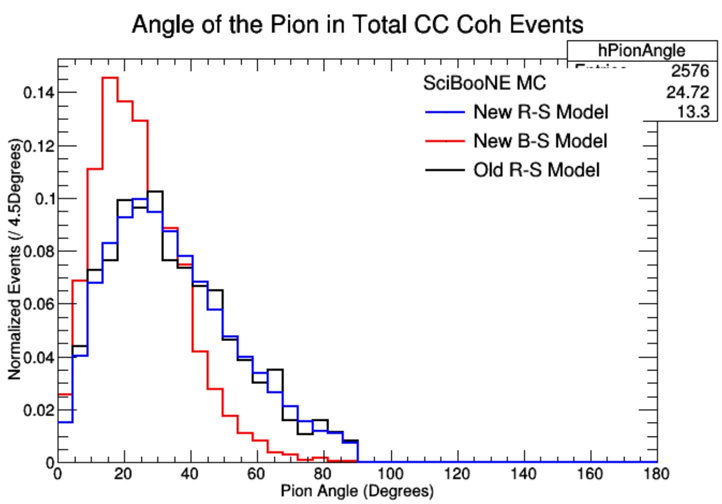


Figure 103:

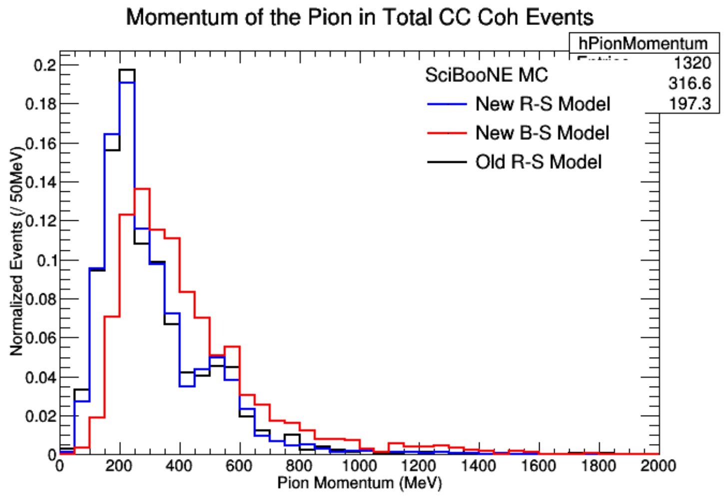


Figure 104:

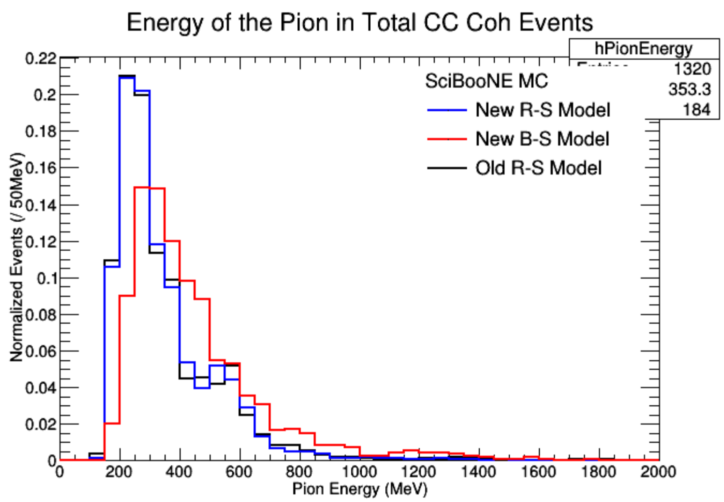


Figure 105:

A.14 NMFourSquaredPlotting.C

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

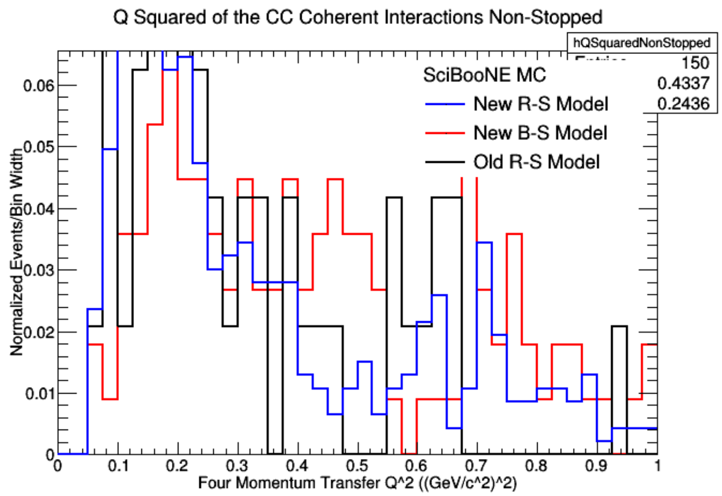


Figure 106:

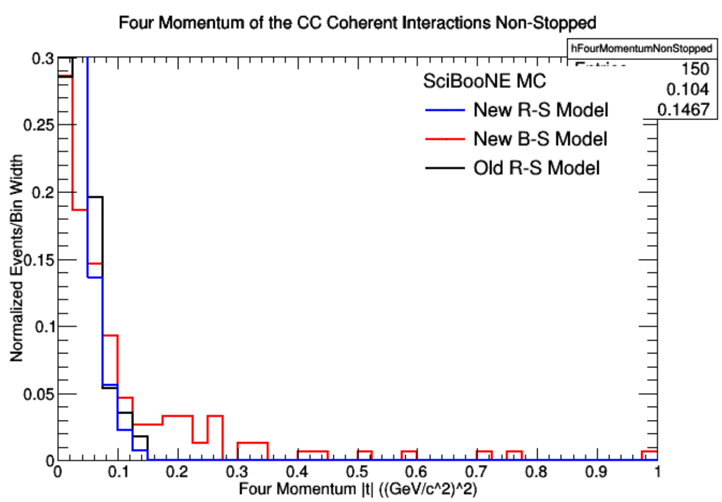


Figure 107:

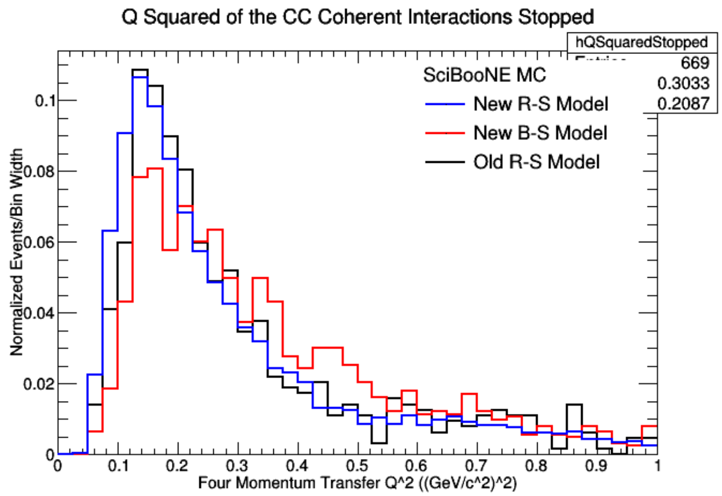


Figure 108:

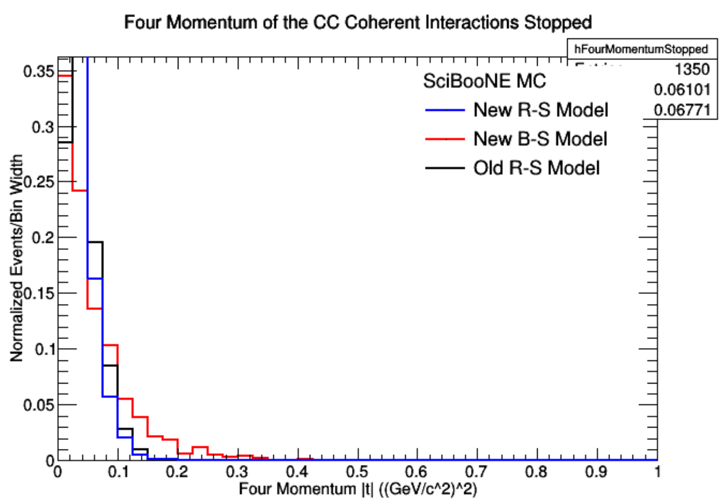


Figure 109:

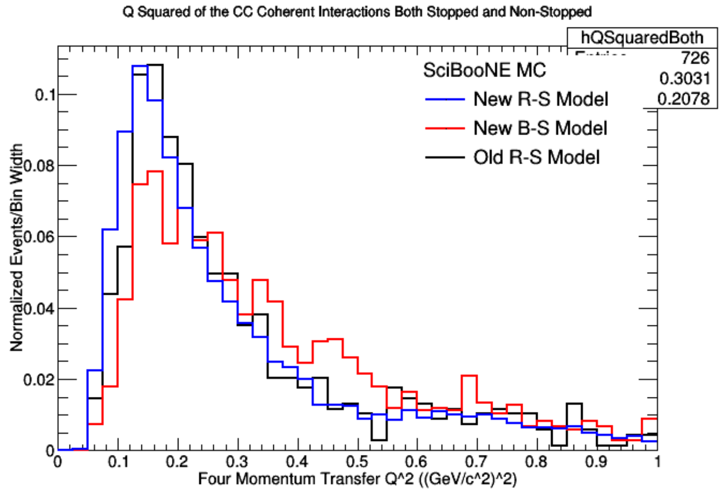


Figure 110:

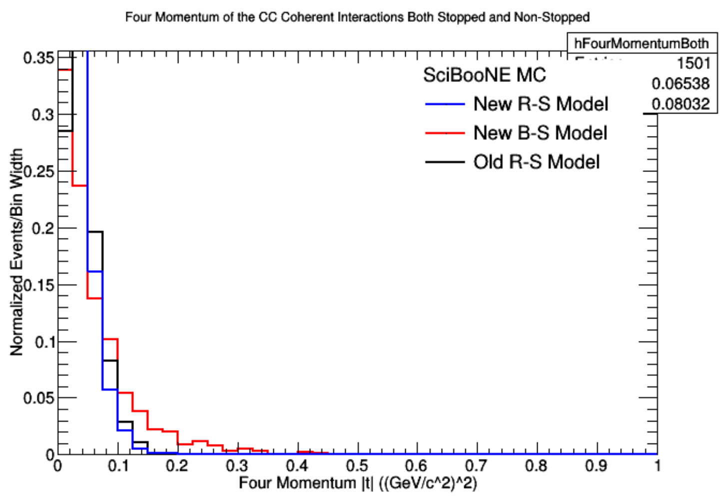


Figure 111:

A.15 ANMCombinedPlots.C

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

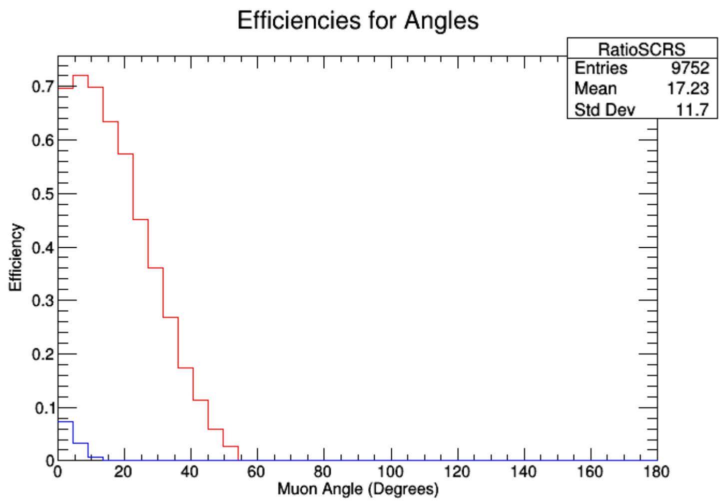


Figure 112:

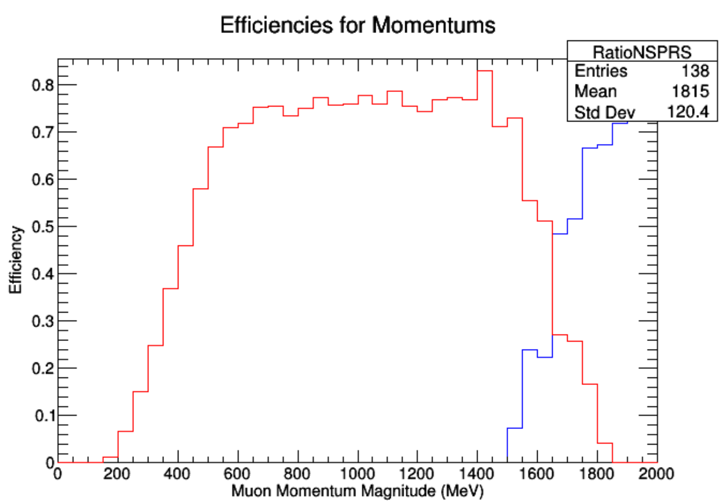


Figure 113:

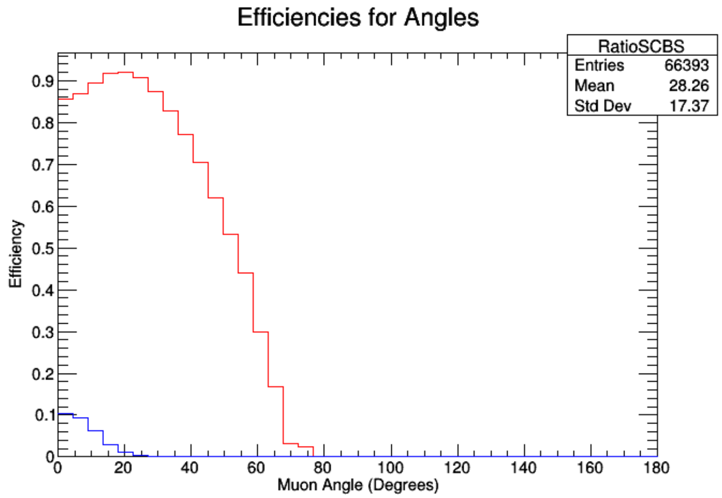


Figure 114:

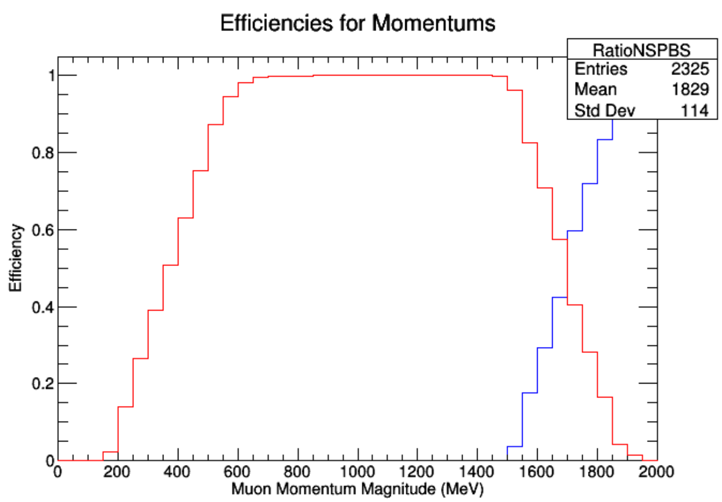


Figure 115:

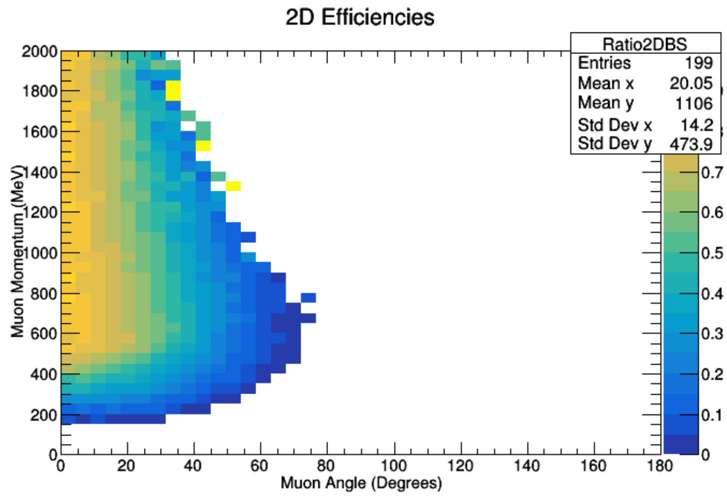


Figure 116:

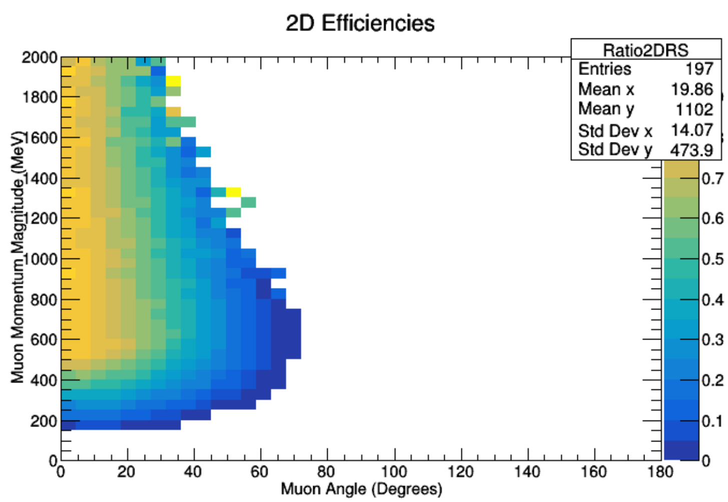


Figure 117:

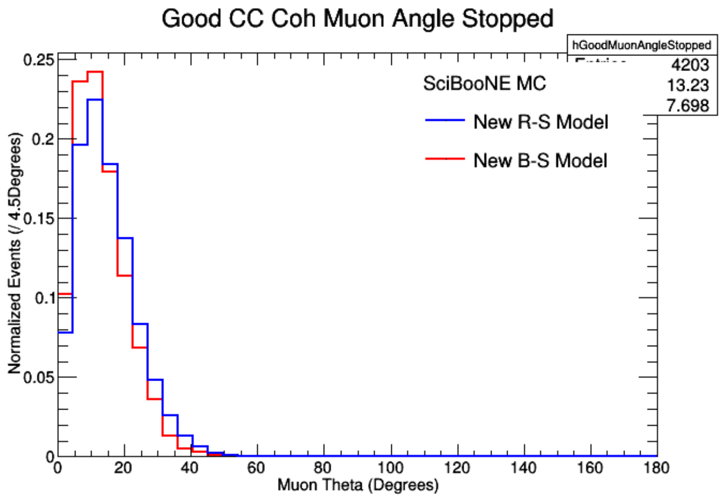


Figure 118:

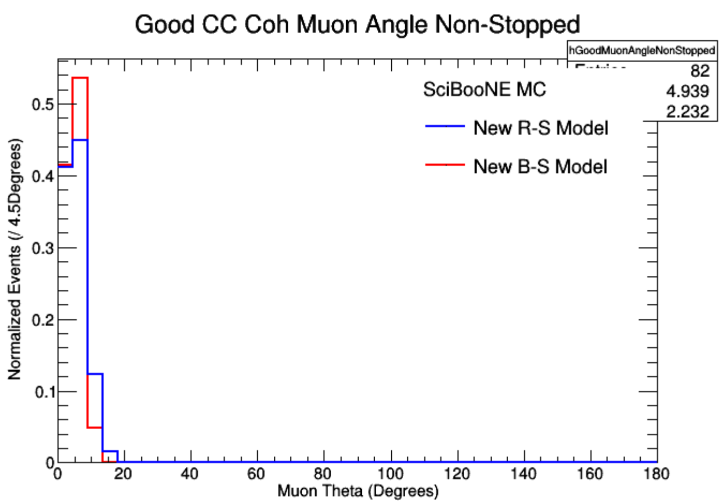


Figure 119:

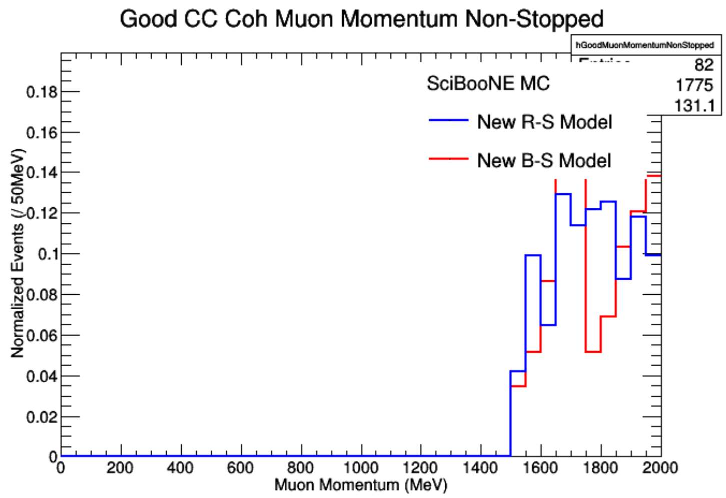


Figure 120:

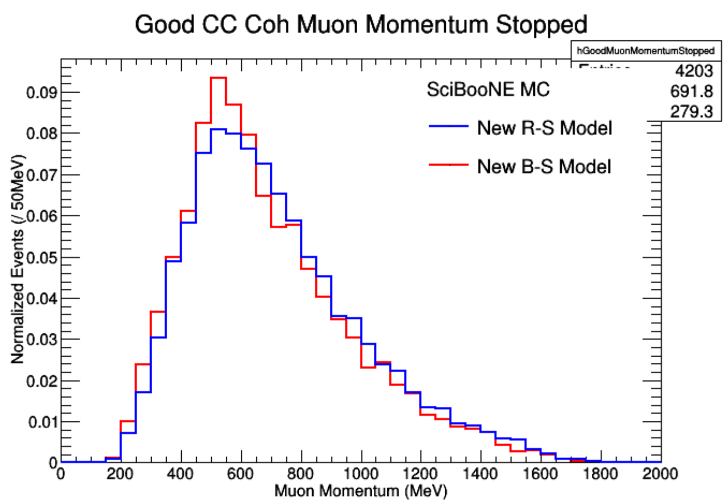


Figure 121:

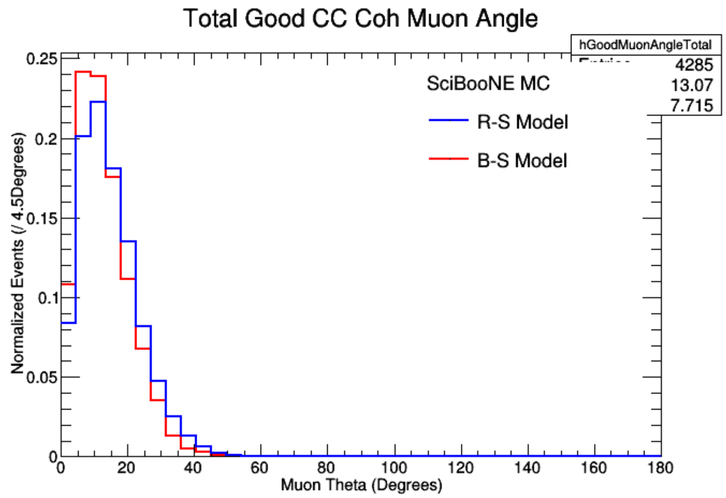


Figure 122:

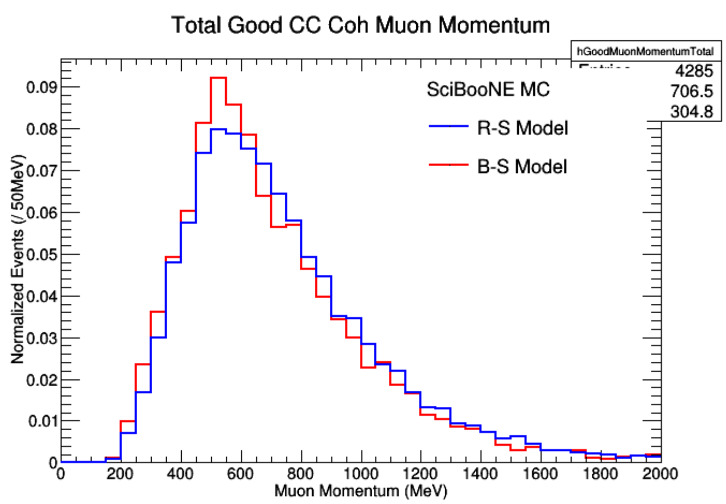


Figure 123:

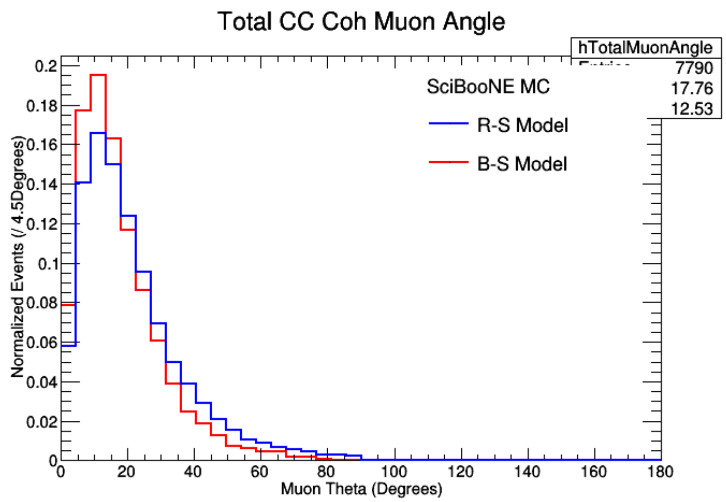


Figure 124:

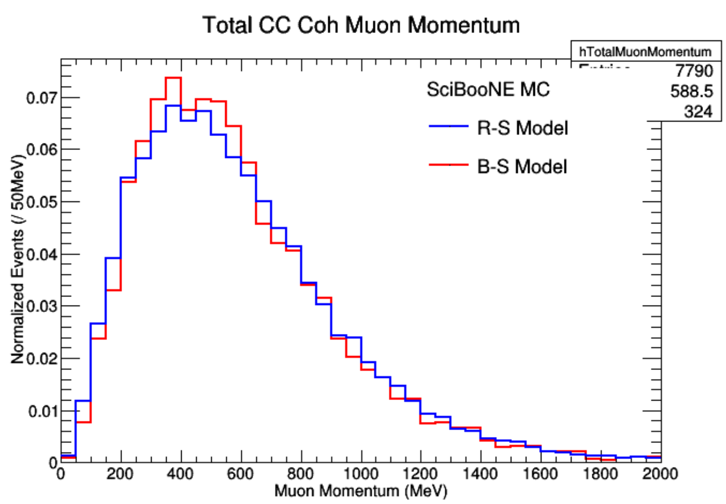


Figure 125:

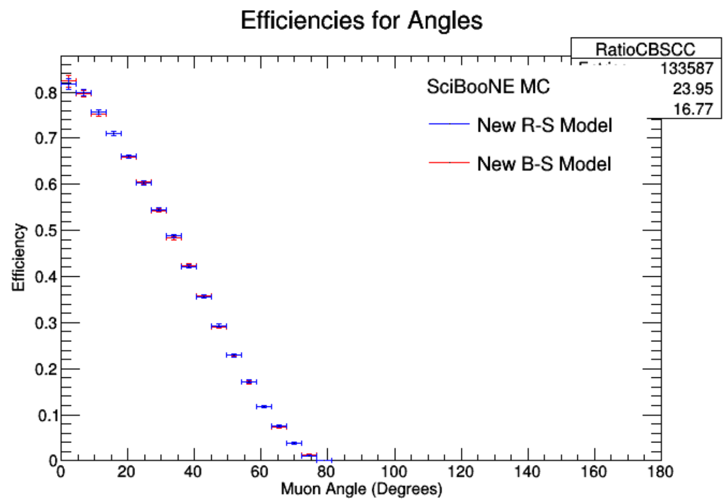


Figure 126:

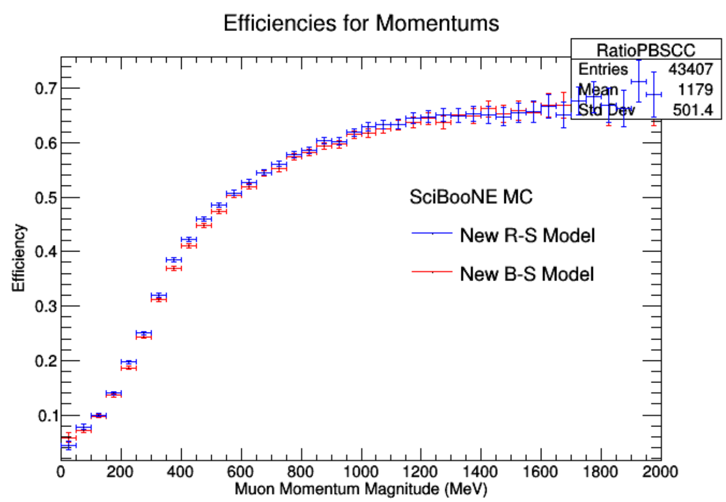


Figure 127:

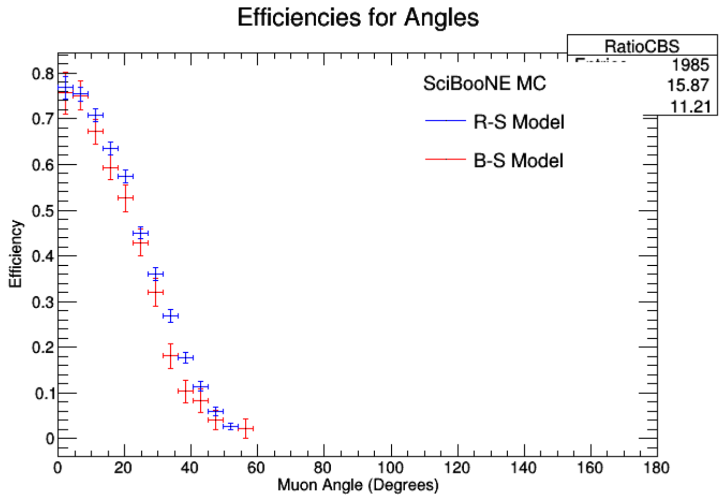


Figure 128:

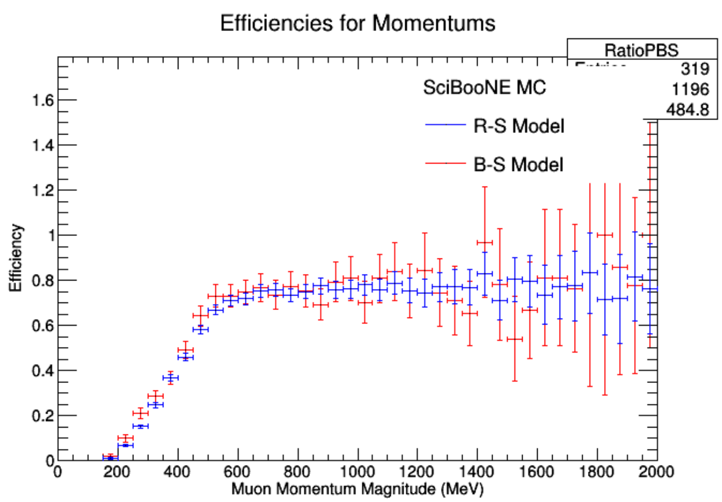


Figure 129:

A.16 ANMPionPlotting.C

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

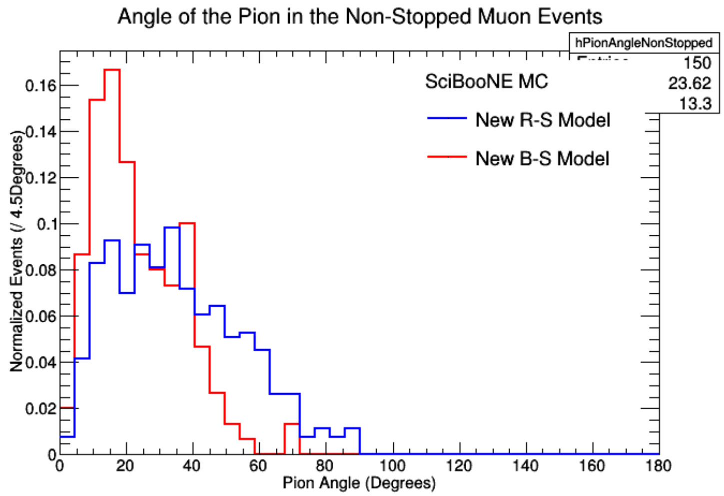


Figure 130:

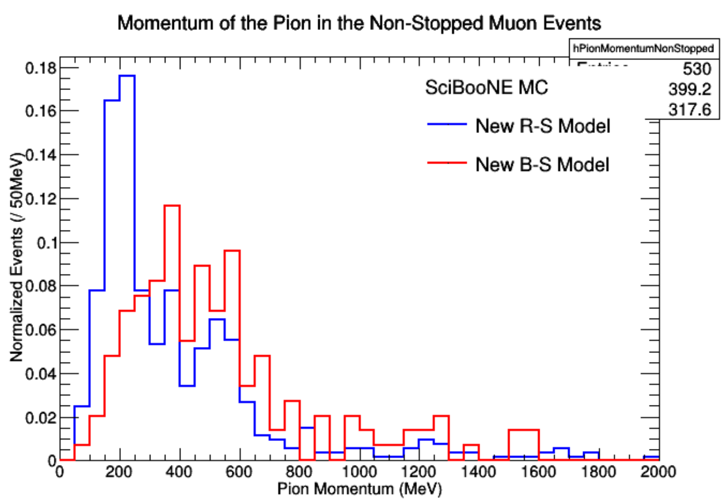


Figure 131:

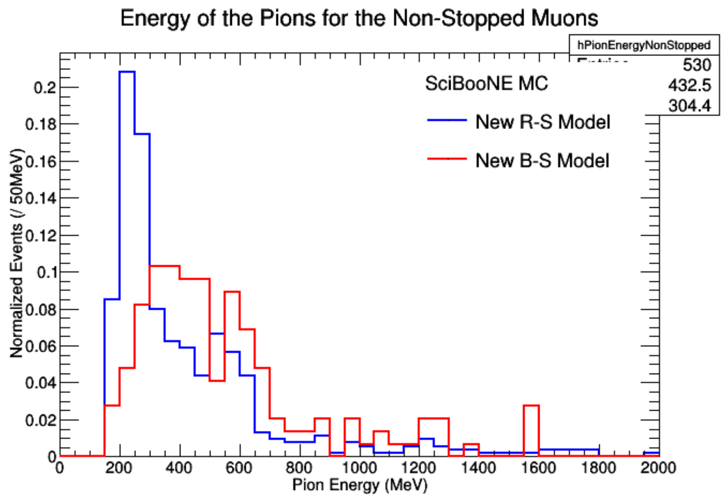


Figure 132:

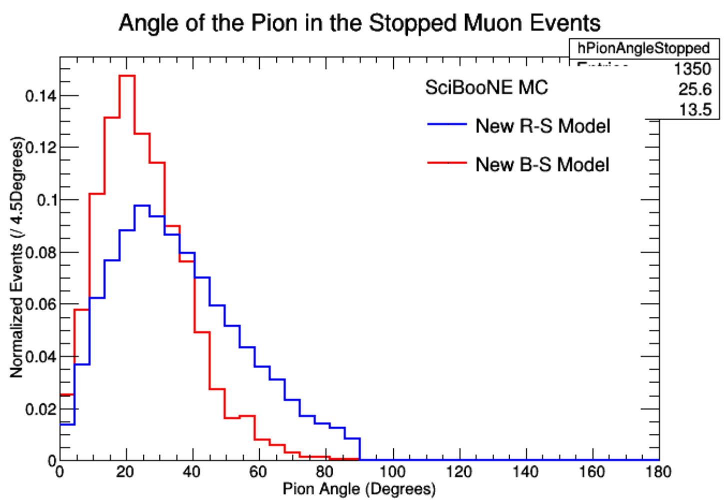


Figure 133:

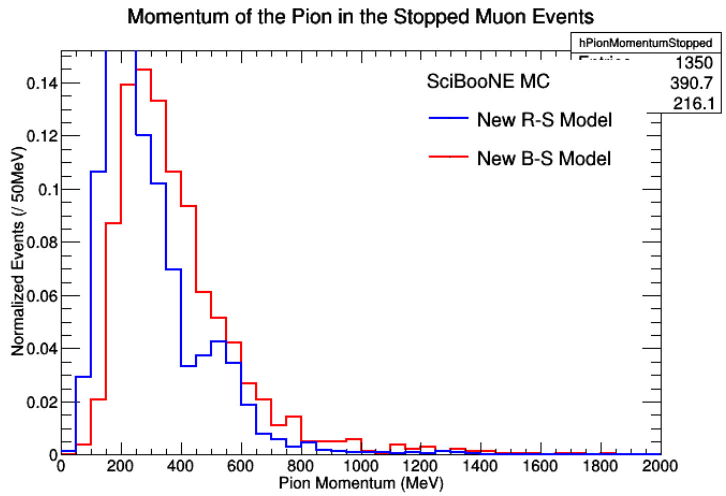


Figure 134:

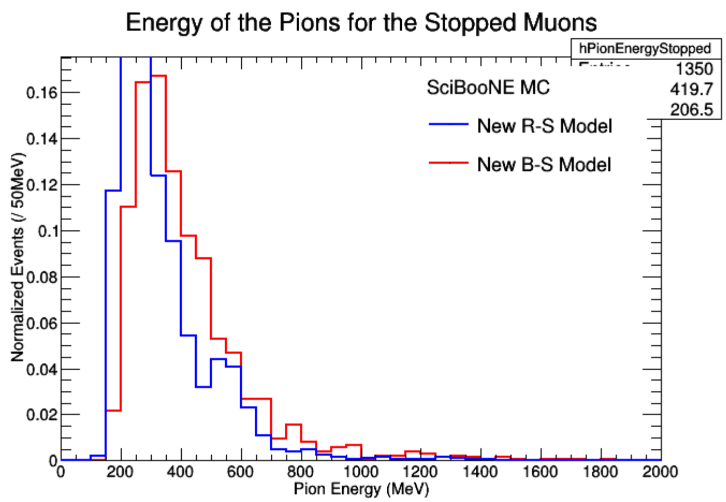


Figure 135:

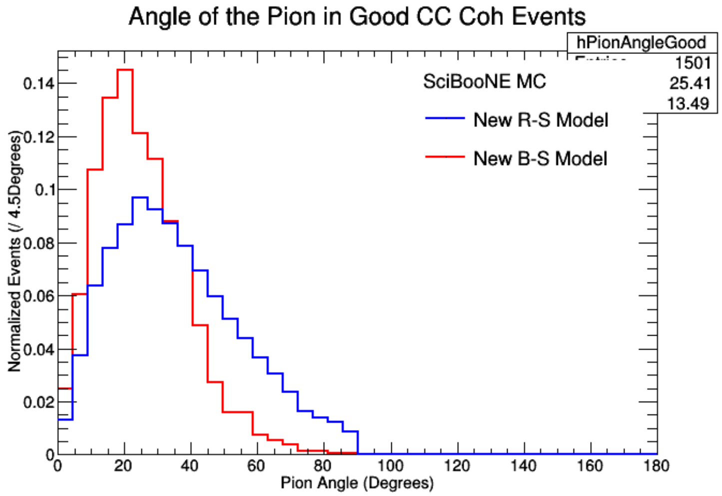


Figure 136:

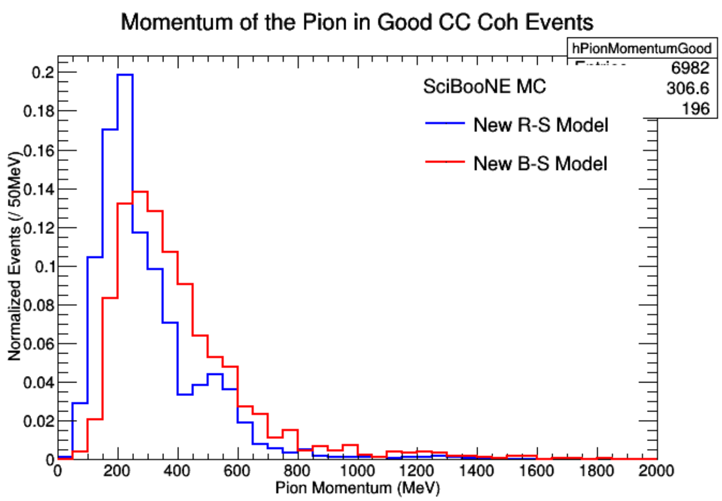


Figure 137:

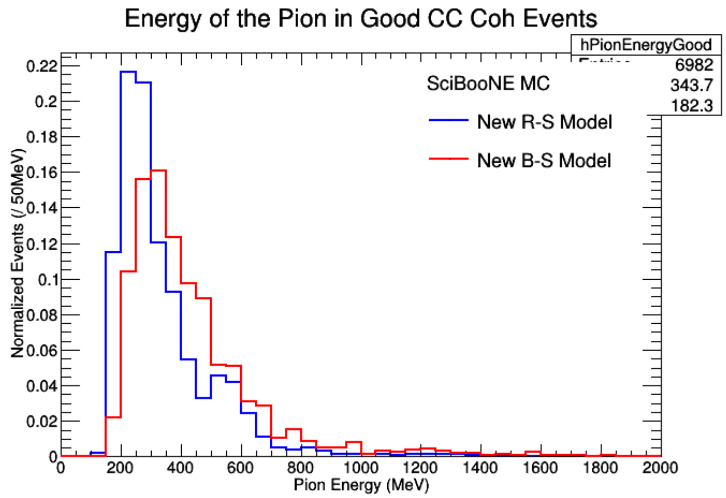


Figure 138:

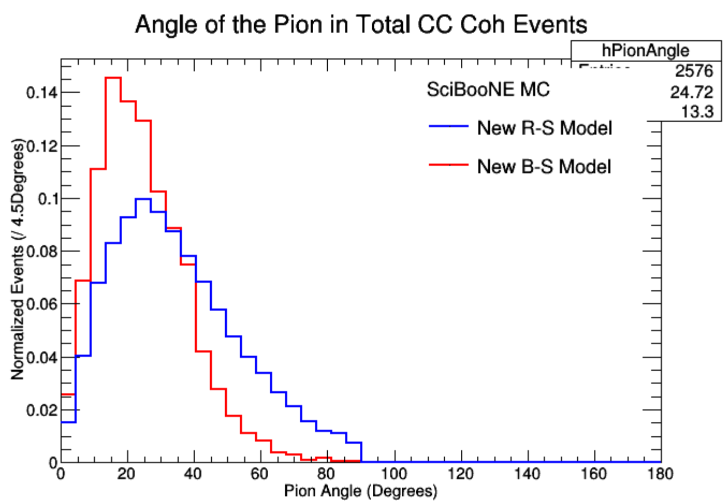


Figure 139:

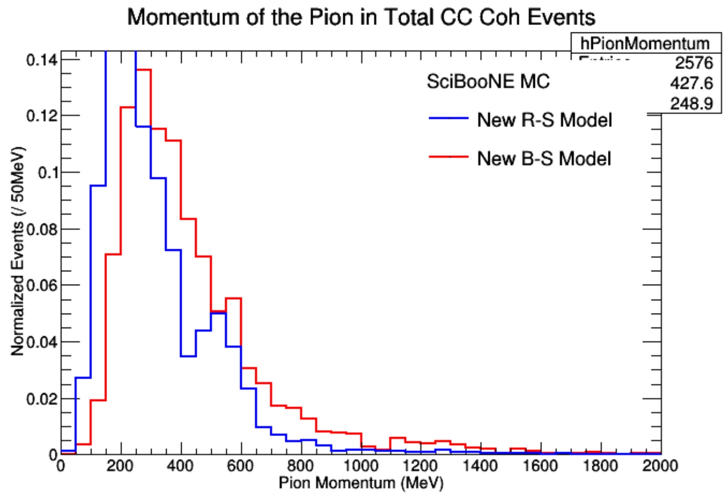


Figure 140:

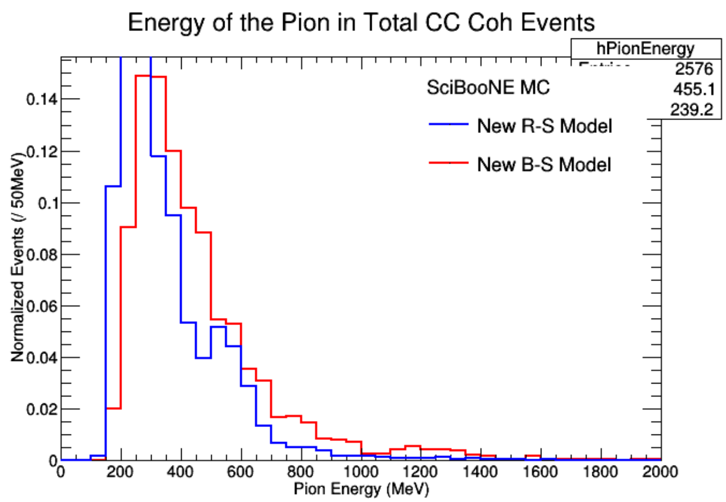


Figure 141:

A.17 ANMFourSquaredPlotting.C

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

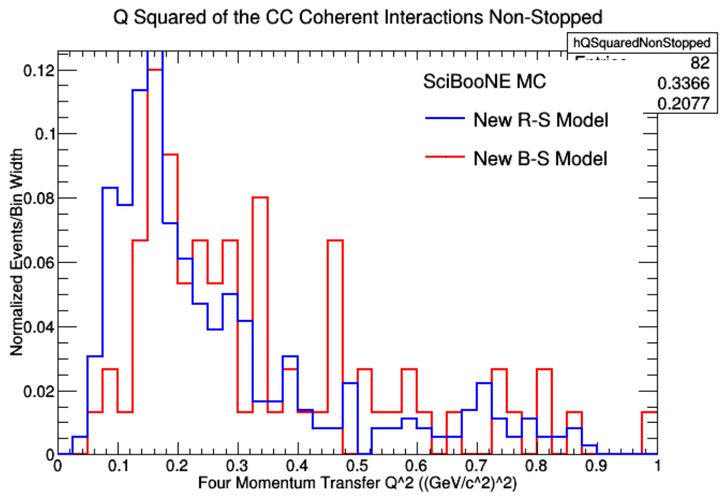


Figure 142:

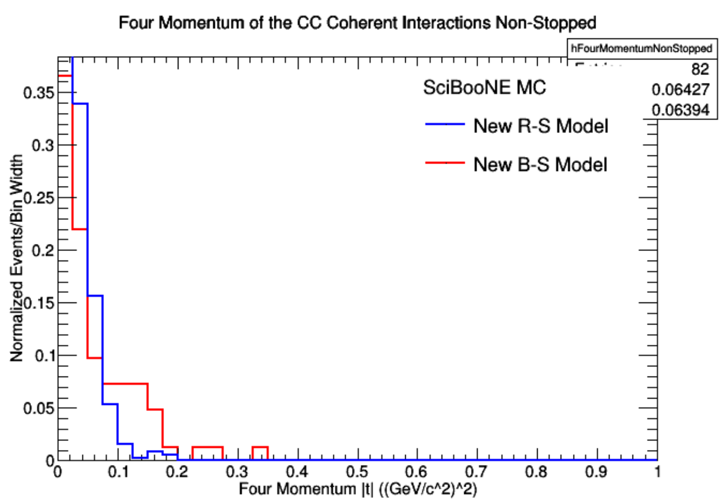


Figure 143:

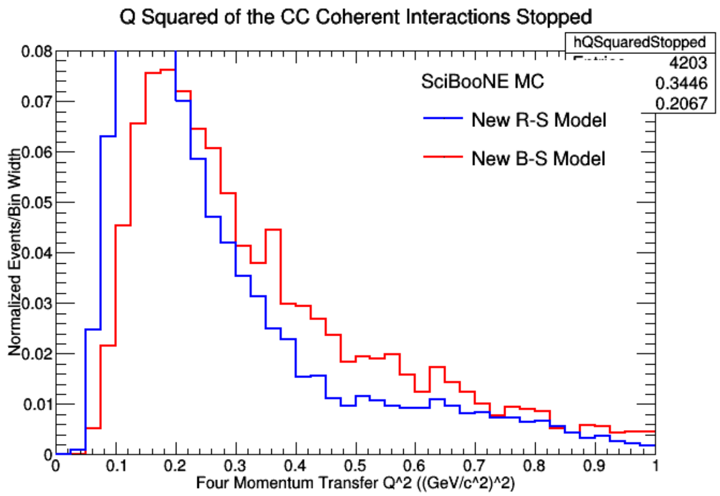


Figure 144:

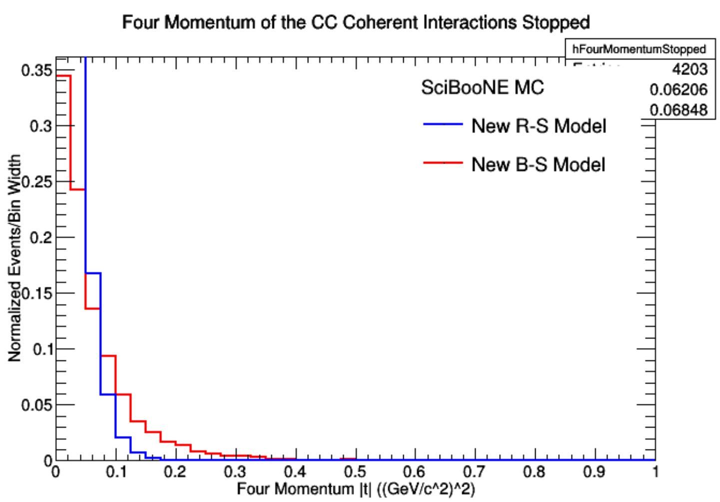


Figure 145:

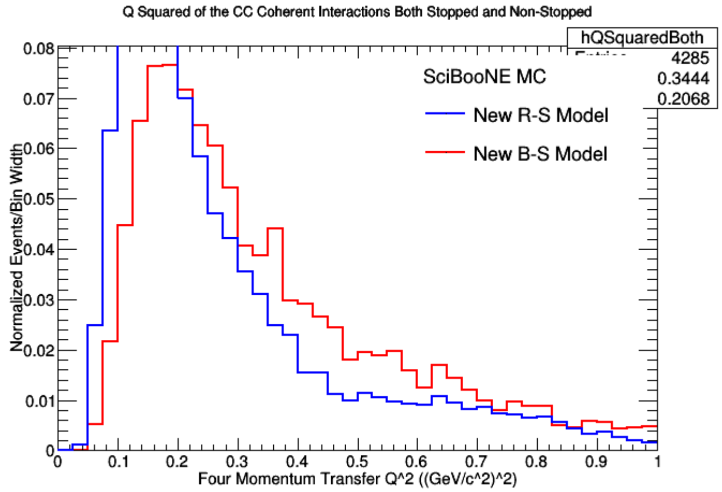


Figure 146:

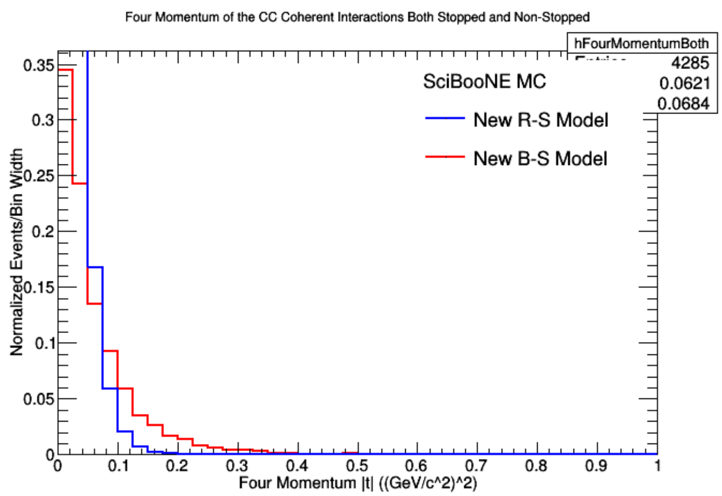


Figure 147:

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 11: 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
0-4.5 Deg	0	0	0	0.09375	0.259259	0.26087	0.317073	0.45	0.553846	0.716049
4.5-9 Deg	0	0	0	0.123457	0.244681	0.218182	0.40411	0.490291	0.568376	0.766102
9-13.5 Deg	0	0	0	0.0280374	0.150943	0.31	0.334426	0.479167	0.582	0.693122
13.5-18 Deg	0	0	0	0.0696203	0.164502	0.242902	0.389937	0.460102	0.524072	0.648363
18-22.5 Deg	0	0	0	0.0396825	0.134503	0.220374	0.320233	0.4	0.498252	0.56578
22.5-27 Deg	0	0	0	0.0341615	0.120614	0.20088	0.284783	0.356223	0.442424	0.513469
27-31.5 Deg	0	0	0	0.0128535	0.0852575	0.146399	0.240517	0.328982	0.381593	0.467435
31.5-36 Deg	0	0	0	0.00618557	0.047749	0.138308	0.215553	0.260465	0.322889	0.379459
36-40.5 Deg	0	0	0	0	0.0376749	0.104341	0.167825	0.228974	0.272658	0.326716
40.5-45 Deg	0	0	0	0	0.0185547	0.0617036	0.129648	0.175194	0.22549	0.249335
45-49.5 Deg	0	0	0	0	0.00241935	0.0461908	0.0861688	0.129907	0.177771	0.209127
49.5-54 Deg	0	0	0	0	0	0.0115123	0.0555327	0.102639	0.123702	0.161442
54-58.5 Deg	0	0	0	0	0	0	0.0248494	0.0445331	0.0810889	0.106105
58.5-63 Deg	0	0	0	0	0	0	0	0.0165922	0.0418139	0.0557781
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00645756	0.018006
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00228571
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

New NM 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	0.816092	0.828829	0.842975	0.845455	0.773438	0.875	0.796748	0.798611	0.870504	0.819549
4.5-9 Deg	0.824047	0.789617	0.844186	0.80404	0.828302	0.807771	0.816514	0.820841	0.809981	0.79823
9-13.5 Deg	0.795417	0.787402	0.784336	0.786013	0.779396	0.757746	0.77907	0.784038	0.763083	0.776828
13.5-18 Deg	0.73062	0.742788	0.7373	0.725131	0.707711	0.713192	0.708657	0.71437	0.713376	0.722747
18-22.5 Deg	0.666667	0.703245	0.681216	0.694102	0.67205	0.674541	0.661496	0.647185	0.673965	0.656648
22.5-27 Deg	0.590521	0.619898	0.653967	0.628604	0.61255	0.617109	0.601285	0.58894	0.579674	0.578595
27-31.5 Deg	0.496599	0.55869	0.57336	0.536199	0.537204	0.545332	0.542526	0.532462	0.524605	0.503756
31.5-36 Deg	0.44563	0.489885	0.50075	0.5	0.512734	0.486242	0.465472	0.455387	0.439182	0.459893
36-40.5 Deg	0.35271	0.399772	0.4	0.410602	0.420808	0.416728	0.404237	0.378892	0.371585	0.362308
40.5-45 Deg	0.297987	0.31442	0.331903	0.342802	0.33975	0.324022	0.312566	0.299735	0.293671	0.284258
45-49.5 Deg	0.220634	0.249649	0.260561	0.269592	0.273593	0.258347	0.252889	0.239492	0.238606	0.221135
49.5-54 Deg	0.165696	0.190045	0.182172	0.214009	0.188606	0.193939	0.207	0.177469	0.140187	0.124514
54-58.5 Deg	0.109863	0.131459	0.132259	0.121872	0.135764	0.133188	0.12807	0.106557	0.122172	0.0814815
58.5-63 Deg	0.0744786	0.0831667	0.0781828	0.0883686	0.0845225	0.0654045	0.074184	0.0883721	0.0841121	0.0405405
63-67.5 Deg	0.0306081	0.0433498	0.053756	0.044898	0.0724638	0.044586	0.0347222	0.0641026	0.0243902	0
67.5-72 Deg	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	0.00540541	0	0	0	0	0
76.5-81 Deg	0	0	0	0	0	0	0	0	0	0
81-85.5 Deg	0	0	0	0	0	0	0	0	0	0
85.5-90 Deg	0	0	0	0	0	0	0	0	0	0
90-94.5 Deg	0	0	0	0	0	0	0	0	0	0
94.5-99 Deg	0	0	0	0	0	0	0	0	0	0
99-103.5 Deg	0	0	0	0	0	0	0	0	0	0
103.5-108 Deg	0	0	0	0	0	0	0	0	0	0
108-112.5 Deg	0	0	0	0	0	0	0	0	0	0
112.5-117 Deg	0	0	0	0	0	0	0	0	0	0
117-121.5 Deg	0	0	0	0	0	0	0	0	0	0
121.5-126 Deg	0	0	0	0	0	0	0	0	0	0
126-130.5 Deg	0	0	0	0	0	0	0	0	0	0
130.5-135 Deg	0	0	0	0	0	0	0	0	0	0
135-139.5 Deg	0	0	0	0	0	0	0	0	0	0
139.5-144 Deg	0	0	0	0	0	0	0	0	0	0
144-148.5 Deg	0	0	0	0	0	0	0	0	0	0
148.5-153 Deg	0	0	0	0	0	0	0	0	0	0
153-157.5 Deg	0	0	0	0	0	0	0	0	0	0
157.5-162 Deg	0	0	0	0	0	0	0	0	0	0
162-166.5 Deg	0	0	0	0	0	0	0	0	0	0
166.5-171 Deg	0	0	0	0	0	0	0	0	0	0
171-175.5 Deg	0	0	0	0	0	0	0	0	0	0
175.5-180 Deg	0	0	0	0	0	0	0	0	0	0

New NM 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	0.834532	0.852174	0.88785	0.762712	0.807692	0.802198	0.811321	0.835443	0.753086	0.779412
4.5-9 Deg	0.803922	0.828974	0.800875	0.820276	0.789474	0.798982	0.801136	0.774026	0.79868	0.744186
9-13.5 Deg	0.74026	0.760633	0.746401	0.713326	0.746803	0.720867	0.735724	0.721683	0.72093	0.716946
13.5-18 Deg	0.704342	0.713103	0.697987	0.688694	0.708895	0.681319	0.674493	0.661465	0.680731	0.635036
18-22.5 Deg	0.660068	0.632723	0.652881	0.627978	0.634488	0.606524	0.599138	0.600991	0.58926	0.585284
22.5-27 Deg	0.57636	0.56538	0.564828	0.553719	0.550962	0.498274	0.550685	0.566828	0.500901	0.497826
27-31.5 Deg	0.498278	0.493626	0.481938	0.446392	0.463785	0.474016	0.465487	0.389868	0.438953	0.384615
31.5-36 Deg	0.432253	0.403556	0.432373	0.361111	0.379648	0.411483	0.370968	0.307116	0.361702	0.355191
36-40.5 Deg	0.373851	0.336748	0.352837	0.316279	0.293333	0.333333	0.282609	0.182432	0.261194	0.25
40.5-45 Deg	0.264297	0.2897	0.274247	0.191235	0.220238	0.204918	0.309524	0.147059	0.169014	0.30303
45-49.5 Deg	0.144772	0.168675	0.216867	0.15534	0.182927	0.113636	0.0645161	0.148148	0.117647	0.0769231
49.5-54 Deg	0.10119	0.178295	0.145161	0.0740741	0.08	0.142857	0.2	0	0	0.1
54-58.5 Deg	0.0571429	0.1	0.0322581	0	0.1	0.333333	0	0	0	0
58.5-63 Deg	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0.136364	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 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	0.783333	0.936508	0.8	0.921569	0.921569	0.77193	0.848485	0.861111	0.826087	0.823529
4.5-9 Deg	0.742424	0.784091	0.770642	0.790476	0.754717	0.774194	0.79375	0.813793	0.748387	0.785714
9-13.5 Deg	0.727468	0.697572	0.704835	0.730978	0.747774	0.70068	0.684982	0.73029	0.623853	0.713615
13.5-18 Deg	0.657848	0.664093	0.618938	0.648718	0.634561	0.598291	0.63871	0.638686	0.630252	0.614407
18-22.5 Deg	0.56654	0.562092	0.581633	0.546547	0.532051	0.582707	0.517647	0.569507	0.530055	0.5625
22.5-27 Deg	0.511166	0.513605	0.453674	0.539095	0.447761	0.428571	0.476821	0.462963	0.379032	0.435185
27-31.5 Deg	0.484375	0.360577	0.414634	0.34058	0.242991	0.416667	0.405941	0.333333	0.25974	0.403846
31.5-36 Deg	0.294118	0.293578	0.337349	0.328571	0.272727	0.34375	0.227273	0.290323	0.25	0.380952
36-40.5 Deg	0.430556	0.191489	0.127273	0.238095	0.2	0.25	0.0714286	0.25	0.1	0.333333
40.5-45 Deg	0.16	0.0909091	0.1875	0.1875	0.166667	0	0.2	0	0.5	0
45-49.5 Deg	0	0.6	0	0	0	0.25	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 NM-Berger-Sehgal

New NM B-S	0-50 MeV/c	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000
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	0.864865	0.843373	0.833333	0.858333	0.833333	0.826087	0.814815
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	0.801402	0.814286	0.809211	0.804211	0.755448	0.822709	0.792657
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	0.794569	0.782796	0.780287	0.765235	0.773496	0.756598	0.759384
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	0.749489	0.762791	0.732403	0.711937	0.704908	0.702804	0.683544
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	0.677215	0.689404	0.661647	0.651855	0.661634	0.65554	0.634515
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	0.615445	0.637963	0.622396	0.604258	0.581746	0.570899	0.569778
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	0.554788	0.551891	0.55257	0.548276	0.521099	0.517559	0.518553
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	0.492462	0.479326	0.494505	0.47549	0.45864	0.461108	0.451835
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	0.425045	0.403834	0.392764	0.396559	0.400812	0.369942	0.368859
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	0.345987	0.330502	0.331052	0.323815	0.305906	0.312284	0.313023
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	0.269272	0.268868	0.255423	0.239971	0.254059	0.219613	0.205285
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	0.19403	0.204905	0.197958	0.161453	0.159744	0.142512	0.151292
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	0.135933	0.125182	0.118211	0.109568	0.118863	0.117073	0.108844
58.5-63 Deg	0	0	0	0	0	0	0.000714286	0.0128637	0.0467906	0.0568421	0.0634228	0.0796216	0.0780856	0.0909091	0.0960929	0.0849558	0.0780781	0.103825	0.0458716	0
63-67.5 Deg	0	0	0	0	0	0	0	0	0.00745573	0.0242928	0.0364188	0.0436258	0.0367232	0.039666	0.0363636	0.0426136	0.0162162	0.0357143	0.0227273	0.0416667
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.000740466	0.00470367	0.0114213	0.0195072	0.0166667	0.0120482	0	0	0.03125	0	0
72-76.5 Deg	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00280899	0.00649351	0.0123457	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 B-S	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0.778846	0.8	0.813725	0.829268	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	0.804255	0.824945	0.804494	0.814536	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	0.766798	0.776286	0.733735	0.717208	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	0.703634	0.7086	0.706101	0.683544	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	0.653195	0.635392	0.641326	0.620074	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	0.571276	0.570789	0.557559	0.528678	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	0.515256	0.490654	0.476651	0.444332	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	0.42583	0.411765	0.437118	0.397764	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	0.345339	0.357923	0.325411	0.296117	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	0.294294	0.264706	0.272981	0.214286	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	0.236769	0.215859	0.180723	0.158879	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	0.132184	0.133858	0.0869565	0.097561	0.0769231	0.0909091	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0.0617284	0.0851064	0.0344828	0.0909091	0	0.111111	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0
58.5-63 Deg	0.0333333	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63-67.5 Deg	0.0714286	0.166667	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 13: 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	650-700	700-750	750-800	800-850	850-900	900-950	950-1000	1000-1050	1050-1100	1100-1150	1150-1200	1200-1250	1250-1300	1300-1350	1350-1400	1400-1450	1450-1500	1500-1550	1550-1600	1600-1650	1650-1700	1700-1750	1750-1800	1800-1850	1850-1900	1900-1950	1950-2000
0-4.5 Deg	0	0	0	0	0.333333	0.5	0.5	0.8	0.857143	0.5	0.666667	1	0.857143	0.7	0.777778	0.875	0.909091	0.777778	1	0.769231	0.8	0.777778	1	0.75	0.75	1	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	0	0	0	0	0.25	0.285714	0.470588	0.466667	0.608696	0.904762	0.9	0.65	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	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	0	0	0	0.0769231	0.181818	0.285714	0.451613	0.625	0.642857	0.765957	0.721519	0.813953	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	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	0	0	0.0714286	0.15	0.290323	0.365854	0.509091	0.621622	0.630952	0.682692	0.773109	0.722222	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	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	0	0	0.0571429	0.0689655	0.184211	0.242424	0.505155	0.474227	0.56	0.647482	0.656442	0.609929	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	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	0	0	0.0416667	0.04	0.247059	0.280488	0.346154	0.518797	0.465969	0.602679	0.631818	0.658291	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	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	0	0	0.0217391	0.0615385	0.1375	0.16	0.296296	0.390863	0.466981	0.520492	0.59761	0.522727	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	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	0	0	0.0816327	0.097561	0.07	0.244444	0.290503	0.384259	0.364407	0.435252	0.453925	0.540881	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	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	0	0	0	0.04	0.133333	0.155172	0.235577	0.282609	0.296296	0.37785	0.377049	0.41195	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	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	0	0	0	0	0.0869565	0.15122	0.161017	0.256228	0.271875	0.289894	0.306818	0.291545	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	0.375	0.25	0.2	0	0	0	0.5	0	0	0	0	1	0	0
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	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	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	0.0108696	0.0636364	0.0816327	0.160819	0.133144	0.170588	0.169381	0.212996	0.220588	0.220238	0.15942	0.142857	0.122807	0.236364	0.129032	0.0714286	0.1	0.142857	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54-58.5 Deg	0	0	0	0	0	0	0.023622	0.0238095	0.0320513	0.107463	0.107595	0.110701	0.105991	0.138728	0.186992	0.13253	0.176471	0.131579	0	0.357143	0.1	0	0	0	0	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	0.0129032	0.0397554	0.0555556	0.0724638	0.0979592	0.0942408	0.0787402	0.0487805	0.0754717	0.15625	0.0416667	0	0.125	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	0.0056338	0.0241379	0.0125523	0.0380952	0.04	0.0869565	0	0.0689655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67.5-72 Deg	0	0	0	0	0	0	0	0	0	0.00338983	0	0.0212766	0.010989	0.0222222	0	0	0.111111	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 14: Table for 2D Histogram for New ANM-Rein-Sehgal

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

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

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

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

Table 15: 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