BOONE_Memo
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Anti-neutrino Data Events

Heather Ray[1]

1 Introduction

Anti-neutrino data in runs 13200 - 13702 and runs 14200 - 14612 has been reprocessed using the following data quality requirements :

- beam event type : beam_event_type
- latency : all_pass_latency
- irm calibration : standardconfig
- rwm analysis : standardconfig
- dq beamline : standardconfig
- dq merge performance : standardconfig
- dq horn performance : standardconfig
- dq POT : horn_antinu_full
- dq stats : standardconfig

Three AF packages use horn current in the data quality cuts : CalibrateIRM, DQ_HornPerformance, and DQ_ProtonsOnTarget. The first two packages take the absolute value of the horn current, and thus *should* accommodate either horn current without a change to the rcp and code. The dq POT package has a separate rcp for anti-neutrino running, which has been used.

The runs processed have been separated into 11 different chunks, with roughly equal POT to start in each chunk. Two chunks are before the March shutdown, 9 are after. Table 1 lists the run ranges, dates of running, POT to start, total triggers left after data quality, and the ratio of triggers passing data quality to POT for each of these chunks. The POT count comes from a script created by Chris Green, that accesses the output from the above AF packages found in the .out files of each run. The script outputs a table of run number, POT in each run, and the percent of triggers lost to each of the dq cuts. At the end it prints a summary of the total POT and percent of triggers lost for a given run range. Table 2 lists the percent of triggers lost to each of the dq cuts for these 11 chunks of runs. It isn't expected that the ratio of triggers to POT will be flat as a function of time - there may have been periods of time where the horn wasn't running at full current, for example.

Chunk	Runs	Dates	POT (10^{12})	Trig	Trig/10^{12} POT
1	13200 - 13579	01/22 - 02/08	8345729.4603	2.0566e+06	0.246425
2	13580 - 13702	02/08 - 03/07	7030705.1610	2.12504e+06	0.302251
3	14200 - 14229	07/17 - 07/25	8304095.3965	2.1155e+06	0.254754
4	14230 - 14299	07/25 - 08/14	8065169.4658	2.23506e+06	0.277125
5	14300 - 14329	08/14 - 08/20	8638146.2816	2.05384e+06	0.237764
6	14330 - 14349	08/21 - 08/25	8783084.0313	1.72676e+06	0.196601
7	14350 - 14374	08/26 - 08/31	7878899.9833	1.87158e+06	0.237543
8	14375 - 14399	09/01 - 09/07	8451980.2393	1.93947e+06	0.229469
9	14400 - 14449	09/08 - 09/21	8701334.2249	2.0546e+06	0.236125
10	14450 - 14539	09/22 - 10/09	8806433.6124	2.30854e+06	0.262142
11	14540 - 14612	10/10 - 11/01	8232819.5824	2.1701e+06	0.263591

Table 1: POT and triggers to start after data quality for each of the chunks of runs processed. The last column is the triggers to start per 10^{12} POT.

Chunk	Runs	Latency	TA	HC	BP	IRM	Total Passed
1	13200 - 13579	0.02	0.02	0.27			99.70
2	13580 - 13702	0.02	2.29	0.21	0.01		97.48
3	14200 - 14229	0.15		0.01	0.43	0.01	99.40
4	14230 - 14299	0.16			0.02		99.82
5	14300 - 14329	0.13			0.02		99.85
6	14330 - 14349	0.13					99.86
7	14350 - 14374	0.12		1.45			98.43
8	14375 - 14399	0.13		0.01		0.01	99.85
9	14400 - 14449	0.13		0.96	0.03	0.01	98.88
10	14450 - 14539	0.13		0.02	0.04	0.01	99.81
11	14540 - 14612	0.14		0.04	0.09	0.01	99.73

Table 2: Percent of triggers lost to each of the data quality cuts. (only shown are cuts which reduced the number of triggers) TA = Torroid Agreement, HC = Horn Current, BP = BPM FOM2, IRM = IRM tdiff. The last column is the total percent of triggers passing the dq cuts.

There are several strange warnings found when running this script. These runs are still used in the POT summary and subsequent plots :

- **WARNING** In run 0013661, 1181 != 1185!
- **WARNING** In run 0014491, 23786 != 23788!

[1]hray@fnal.gov

- **WARNING** In run 0014571, 39698 != 39699!
- **WARNING** In run 0014594, 46511 != 46588!

2 Physics Selections

Seven sets of physics cuts were applied to these samples : LouisII, Haijun, Michel, CCQE, CCPiP, StNCpi0, and NC2. Descriptions of cuts used for these samples may be found elsewhere. [1] Table 3 lists the number of events left for each cut set for each chunk of data. Figure 1 plots the events left / POT for each chunk of data for each of the sets of cuts. The errors are found by assuming an error on the number of events passing the cuts only ($\sqrt{N}$). The POT measurement is assumed to carry no error.

The information in Figure 1 is difficult to interpret. Figure 2 fits a straight line through the cut efficiencies for all points, both before and after shutdown. Figure 3 fits the line through only the post-shutdown data. In all cases but the NC2 events the slope of the fit line is ≈halved when you ignore the pre-shutdown data. By eye the LouisII, Haijun, Michel, and CCQE cut efficiencies appear to have a slightly oscillatory cut efficiency as a function of time (these samples have a high CCQE composition). The chisq/NDF for the straight line fit (using all data points) indicates that these points really don't fall on a line; the chisq/NDF varies from about 4 to 8. The other physics samples have a chisq/NDF of around 1. Table 4 lists the sigma deviation from 0 for the slope and the chisq/NDF of the straight line fit for the different samples using the fit to all data and the fit to post-shutdown data only. This table also shows the percent change between the all data fit and the post-shutdown data fit, for the slope deviation from 0 and the chisq/NDF. Using only the post-shutdown data all samples are ≈consistent with a straight line (based on the chisq/NDF of the straight line fit) except for the LouisII and CCQE samples.

Dividing the data into 11 chunks results in larger statistical error bars on the events / POT plots. A second study takes the 11 chunks of data and combines them into 4 chunks : 1 for all of the pre-shutdown data, and 3 for the post-shutdown data (chunks 3 - 5 combined, chunks 6 - 8 combined, chunks 9 - 11 combined). Figures 4, 5, and 6 show the event rates per 10^{12} POT for the 7 different box cuts using these combined data points. Figure 5 fits a straight line through all data points; Figure 6 fits a line through only the post-shutdown data points. Table 5 lists the sigma deviation from 0 for the slope and the chisq/NDF of the fits using these combined data points. This information should be compared to that found in Table 4, which uses a smaller division of data in time.

Grouping the data into larger bins in time results in a more drastic deviation of the points from a straight line fit when fitting to all data - the chisq/NDF now ranges from ≈ 4 to 18. The post-shutdown data shows better agreement with a straight line fit (where the slope is 2-3σ from 0), again except in the NC2 box, which shows a rather drastic dip in the event rate / POT for the middle chunk of data.

3 Overlay Plots

The 46 fundamental variables were examined for these 7 sets of physics cuts. Two different sets of plots were made. The first set plots has the overlay shapes of all 11 chunks of data, for shapes normalized to equal areas of 1. These plots appear to show fluctuations in the distributions for things like number of tank hits and energy for the CCPiP box. However, these plots are highly statistics limited. The second set of plots combines the 11 chunks of data into 4 total : 1 for the pre-shutdown data and 3 for the post-shutdown data. Fluctuations are still present in the CCPiP shapes as a function of time, but within 1-2 sigma of each other.

Plots are found on : AntiNuData_fundVars_overlay_absnorm.ps, AntiNuData_fundVars_overlay_absnorm_comb.ps. Filenames with “comb” in them are the second set of plots which combines the 11 chunks of data into 4 shapes.

The rosetta stone of shape color is as follows :

- First set of plots
  - chunk 1 = red, chunk 2 = light green, chunk 3 = dark blue, chunk 4 = yellow, chunk 5 = magenta, chunk 6 = light blue, chunk 7 = dark green, chunk 8 = blue, chunk 9 = really light grey, chunk 10 = light grey, chunk 11 = dark grey
- Second set of plots
  - Pre-shutdown (chunks 1 and 2) = red, chunks 3 - 5 combined = dark blue, chunks 6 - 8 combined = light blue, chunks 9 - 11 combined = periwinkle

File AntiNuData_fundVars_overlay_absnorm_comb.ps is part of the second set of plots, for the combined data. In this file the histogram shapes are all normalized to have an area of 1. The following is a list of pages and boxes which seem to show some migration in shape (aka detector response) as a function of time :

- pg 2 : total tank chg, CCPiP box (pale blue)
- pg 3 : ave tank time, CCPiP box (pale blue)
- pg 4 : number of tank hits, CCPiP box (pale blue)
- pg 8 : stancu full z, CCPiP box (pale blue and periwinkle lines show the z distribution changed from being slightly forward peaked to slightly backward peaked (pale blue) to more forward peaked (periwinkle))
- pg 14 : stancu full muon E, CCPiP box (pale blue)
- pg 20 : stancu real R, CCPiP box (pale blue)
- pg 22 : stancu flux muon E, CCPiP box (pale blue)

- pg 24 : stancu flux scintillation light, CCPiP (pale blue)
- pg 26 : calibrate energy electron E, CCPiP (pale blue)

Note that almost all of the deviations in shape come from the light blue histogram, representing data taken between August 21st and September 7th, 2006. In 8 of the 9 above plots the shape returns to normal for the post-September 7th data. These deviations are only a few sigma from the other shapes. In the shapes that do agree the agreement is fairly spot on, so these 9 really stand out to the eye, but again the statistical significance of the change in shape is small.

References

[1] www-boone.fnal.gov/memos/TenBox_v2.ps 3

Chunk	Runs	LII	Haij	Mich	QE	PiP	Pi0	NC2
1	13200 - 13579	305	260	556	939	58	104	184
2	13580 - 13702	263	227	497	845	51	78	193
3	14200 - 14229	263	219	417	681	43	69	165
4	14230 - 14299	246	192	462	734	46	72	152
5	14300 - 14329	239	197	419	777	40	81	171
6	14330 - 14349	195	167	411	667	30	67	133
7	14350 - 14374	253	214	440	721	41	78	159
8	14375 - 14399	210	184	429	656	30	74	128
9	14400 - 14449	214	180	408	676	38	70	169
10	14450 - 14539	218	188	410	669	34	64	180
11	14540 - 14612	230	191	350	637	21	68	159

Table 3: Number of events left after event selection cuts for each of the chunks of data, for the 7 physics samples.

Sample	All Data		Post-Shutdown			
	slope σ from 0	chi2/NDF	slope σ from 0	% change	chi2/NDF	% change
LouisII	5.62	3.96	2.34	-58.4%	3.54	-10.6%
Haijun	4.85	3.46	1.53	-68.5%	2.46	-28.9%
Michel	7.82	4.65	3.28	-58.1%	2.48	-46.7%
CCQE	9.86	8.66	3.48	-64.7%	3.37	-61.1%
CCPiP	5.04	1.17	3.12	-38.1%	1.14	-2.6%
StNCpi0	2.97	1.15	0.91	-69.4%	0.66	-42.6%
NC2	2.45	3.86	0.18	-92.7%	2.53	-34.5%

Table 4: Slope sigma deviation from 0 and chisq/NDF for the fit of a line to the data for all data points (left side of table), and for only post-shutdown data (right side of table). The percent change is defined as (1 - (new value / old value)).

Sample	All Data		Post-Shutdown	
	slope σ from 0	chi2/NDF	slope σ from 0	chi2/NDF
LouisII	6.06	3.89	2.77	1.64
Haijun	5.29	4.70	1.91	0.20
Michel	8.21	9.37	3.40	1.81
CCQE	10.9	17.8	4.17	0.18
CCPiP	4.60	1.25	2.56	0.54
StNCpi0	3.36	1.82	1.29	0.25
NC2	2.83	9.65	0.19	8.00

Table 5: Slope sigma deviation from 0 and chisq/NDF for the fit of a line to the data for all data points (left side of table), and for only post-shutdown data (right side of table). The percent change is defined as (1 - (new value / old value)). Values shown here are for the data which has been binned more widely in time (1 point for pre-shutdown data, 3 for post).

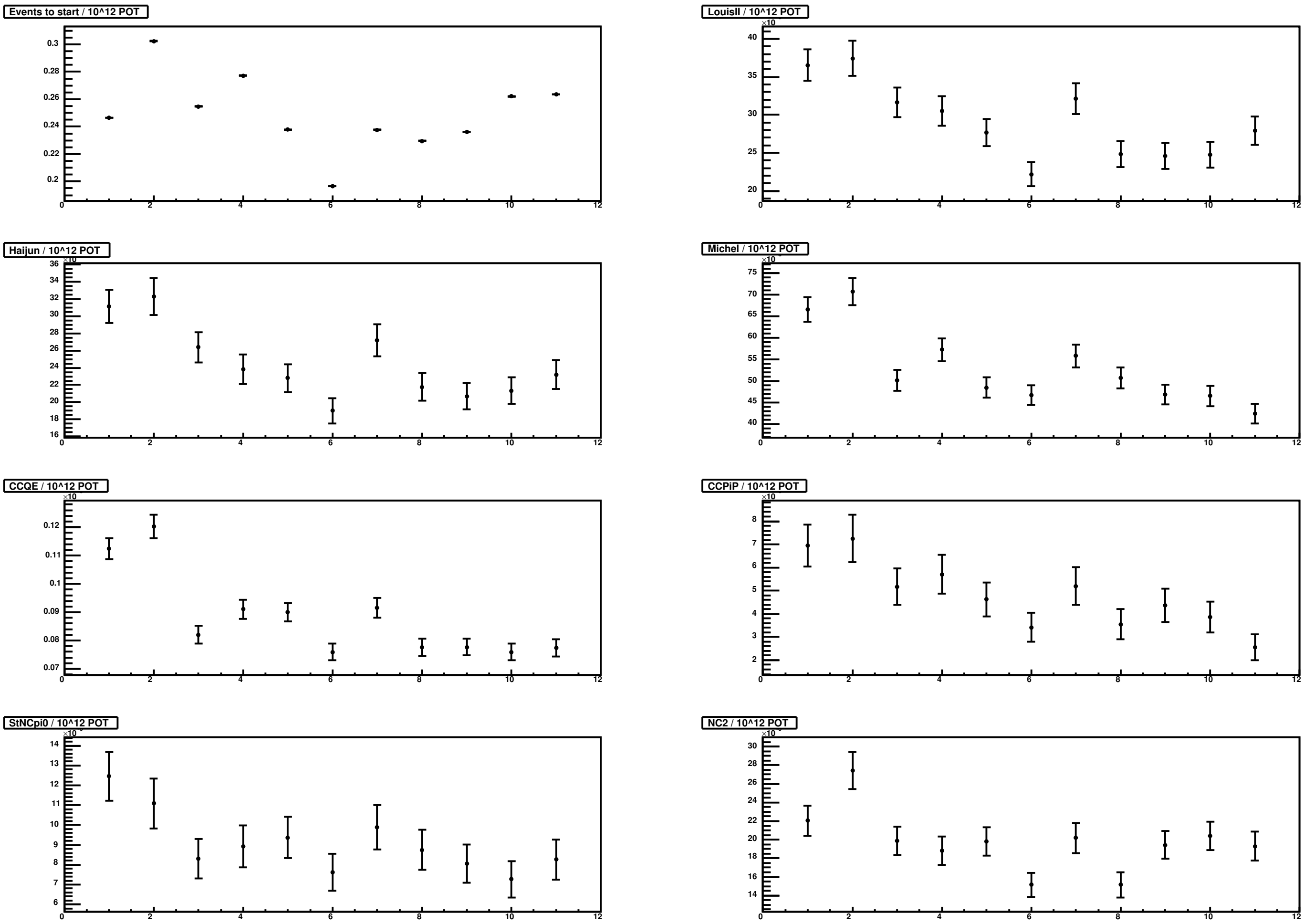

Figure 1: Plots of beam triggers / POT to start (top left) and cut efficiency (events left / POT) for each of the 7 physics cuts applied. The first two points on each graph are from before shutdown data. Plots are : LouisII (1st row, right), Haijun (2nd row, left), Michel (2nd row, right), CCQE (3rd row, left), CCPiP (3rd row, right), StNCpi0 (4th row, left), NC2 (4th row, right).

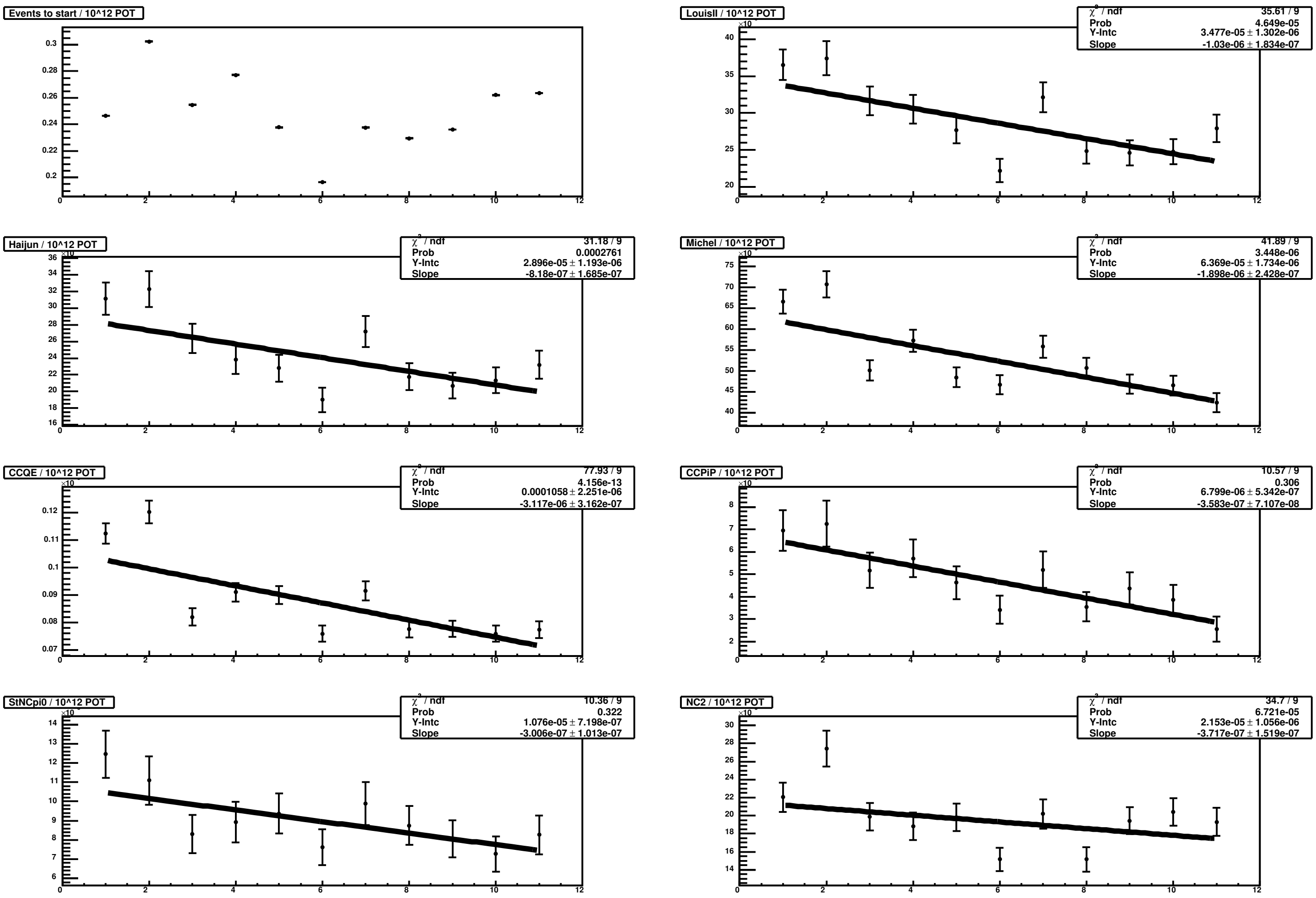

Figure 2: Plots of beam triggers / POT to start (top left) and cut efficiency (events left / POT) for each of the 7 physics cuts applied. The first two points on each graph are from before shutdown data. A straight line has been fit through all points. Fit parameters are printed on the plots. Plots are : LouisII (1st row, right), Haijun (2nd row, left), Michel (2nd row, right), CCQE (3rd row, left), CCPiP (3rd row, right), StNCpi0 (4th row, left), NC2 (4th row, right).

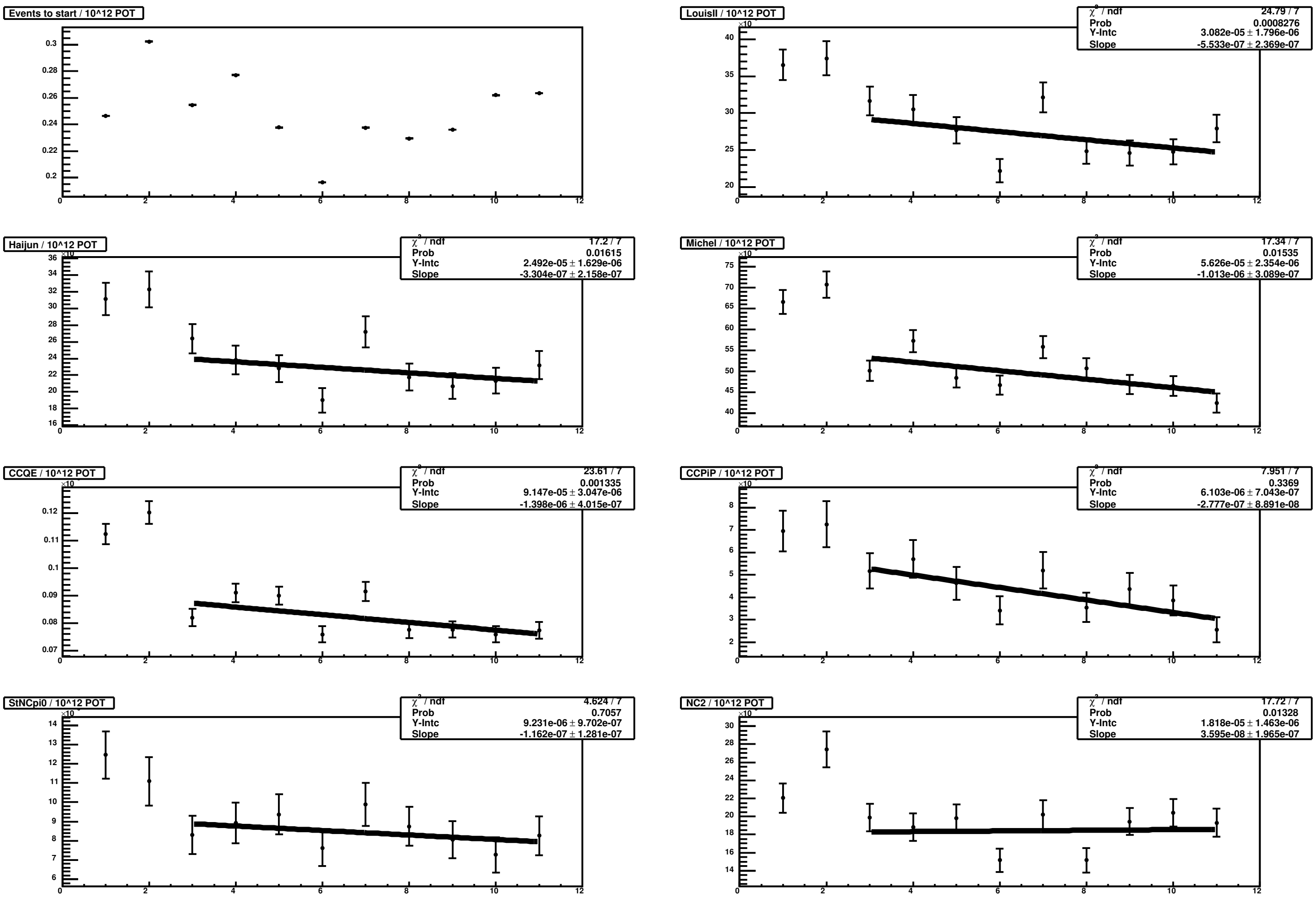

Figure 3: Plots of beam triggers / POT to start (top left) and cut efficiency (events left / POT) for each of the 7 physics cuts applied. The first two points on each graph are from before shutdown data. A straight line has been fit through the post-shutdown data only. Fit parameters are printed on the plots. Plots are : LouisII (1st row, right), Haijun (2nd row, left), Michel (2nd row, right), CCQE (3rd row, left), CCPiP (3rd row, right), StNCpi0 (4th row, left), NC2 (4th row, right).

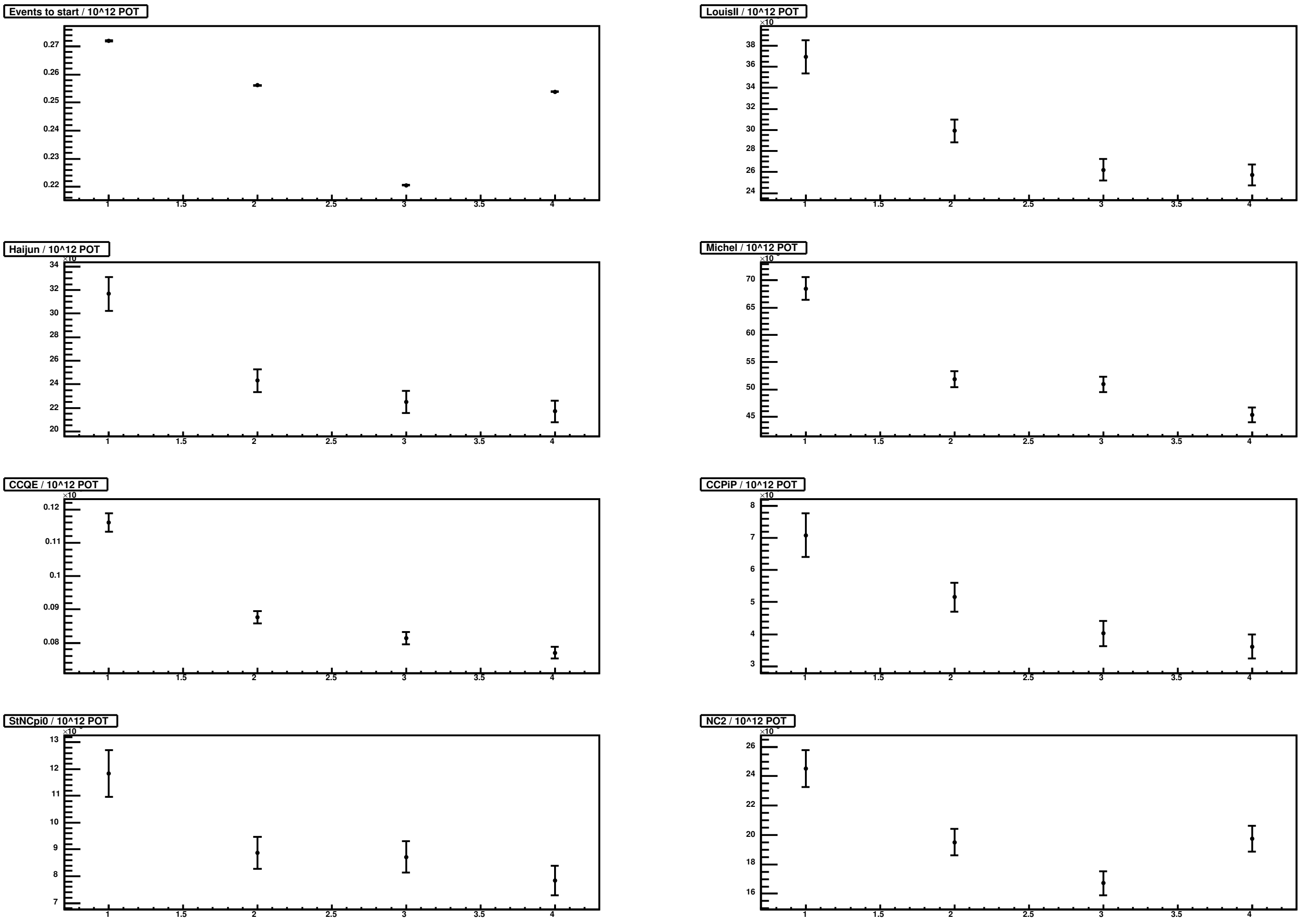

Figure 4: Plots of beam triggers / POT to start (top left) and cut efficiency (events left / POT) for each of the 7 physics cuts applied. Shown are the 11 chunks of data combined into 4 chunks : the first point is for all pre-shutdown data examined, the 2nd, 3rd, and 4th points are for post-shutdown data, combined as described in the text. Plots are : LouisII (1st row, right), Haijun (2nd row, left), Michel (2nd row, right), CCQE (3rd row, left), CCPiP (3rd row, right), StNCpi0 (4th row, left), NC2 (4th row, right).

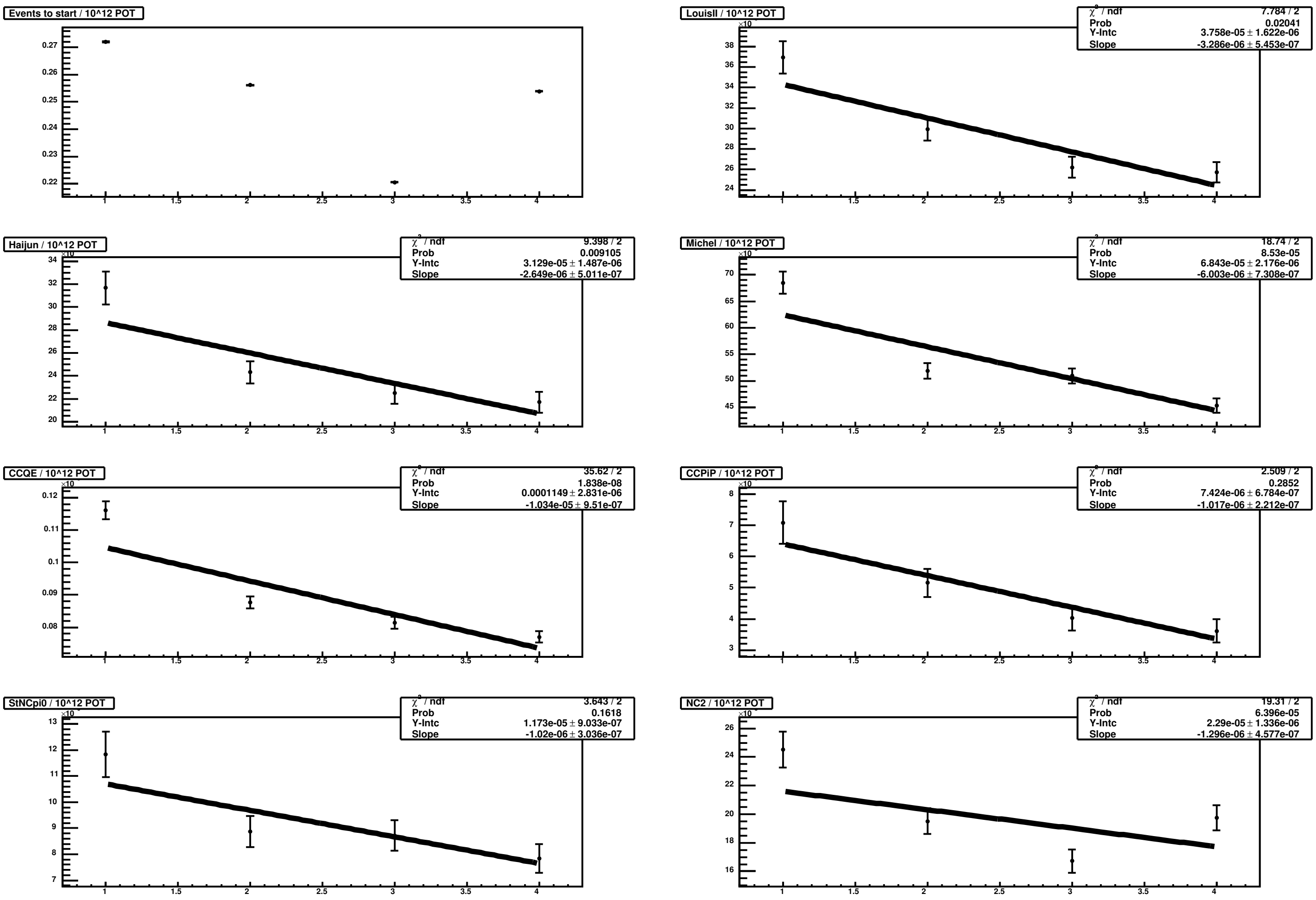

Figure 5: Plots of beam triggers / POT to start (top left) and cut efficiency (events left / POT) for each of the 7 physics cuts applied. Shown are the 11 chunks of data combined into 4 chunks : the first point is for all pre-shutdown data examined, the 2nd, 3rd, and 4th points are for post-shutdown data, combined as described in the text. A straight line has been fit through all points. Fit parameters are printed on the plots. Plots are : LouisII (1st row, right), Haijun (2nd row, left), Michel (2nd row, right), CCQE (3rd row, left), CCPiP (3rd row, right), StNCpi0 (4th row, left), NC2 (4th row, right).

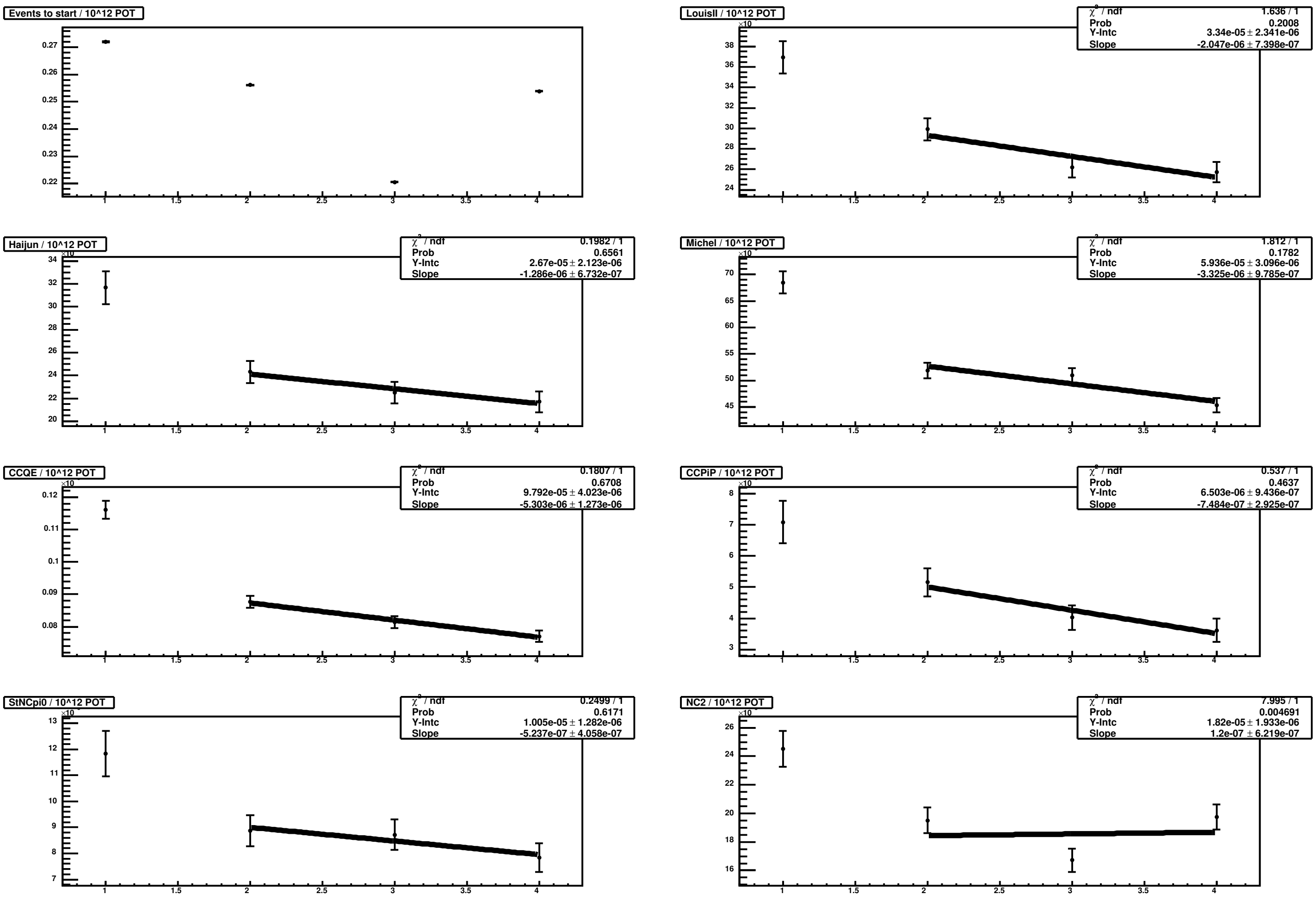

Figure 6: Plots of beam triggers / POT to start (top left) and cut efficiency (events left / POT) for each of the 7 physics cuts applied. Shown are the 11 chunks of data combined into 4 chunks : the first point is for all pre-shutdown data examined, the 2nd, 3rd, and 4th points are for post-shutdown data, combined as described in the text. A straight line has been fit through the post-shutdown data only. Fit parameters are printed on the plots. Plots are : LouisII (1st row, right), Haijun (2nd row, left), Michel (2nd row, right), CCQE (3rd row, left), CCPiP (3rd row, right), StNCpi0 (4th row, left), NC2 (4th row, right).