Assessing the Performance of the STAR Forward Calorimeter System

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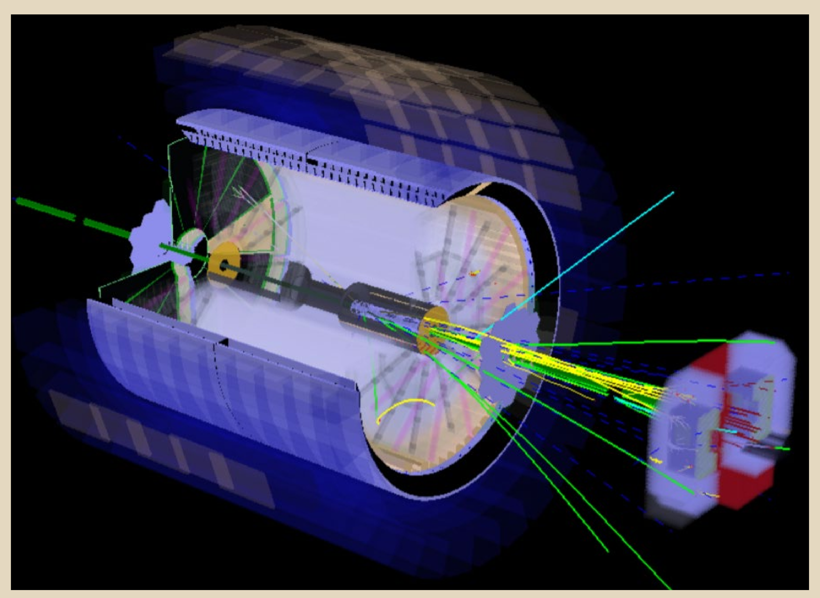
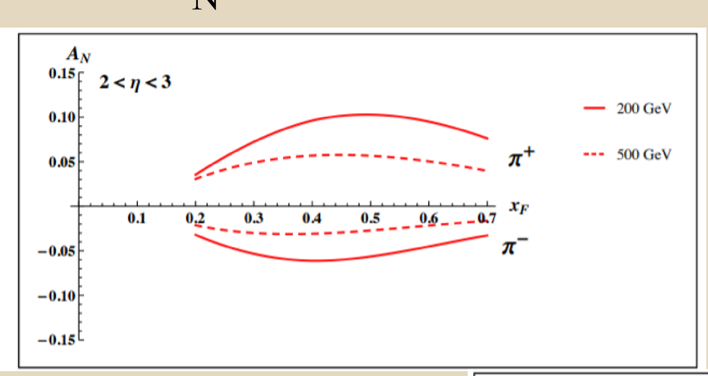
The STAR Experiment

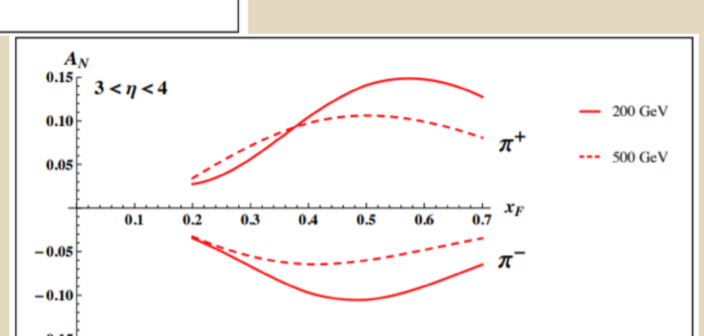
The STAR Experiment at RHIC focusses on studying nuclear matter and nuclear structure through the collisions of heavy ions and spin-polarized protons. One region of interest are effects due the transverse momentum structure of partons in the proton and their rapidity / x dependence on, specifically how the Collins effect changes for different kinematic regions. This is accomplished by the large rapidity coverage of the STAR detector. But the forward rapidity region has been not well covered until recently.



STAR Forward Upgrade

The purpose of the STAR forward upgrade is to cover a rapidity region on 2.8 to 4. to access high and low-x partons. Below we show the latest prediction for the transvers single spin asymmetries for π+ and π- at forward rapidities and different √s. Measuring these asymmetries could finally explain the underlying science of the large SSA A_N for π^0s at forward rapitities.





HCAL and ECAL

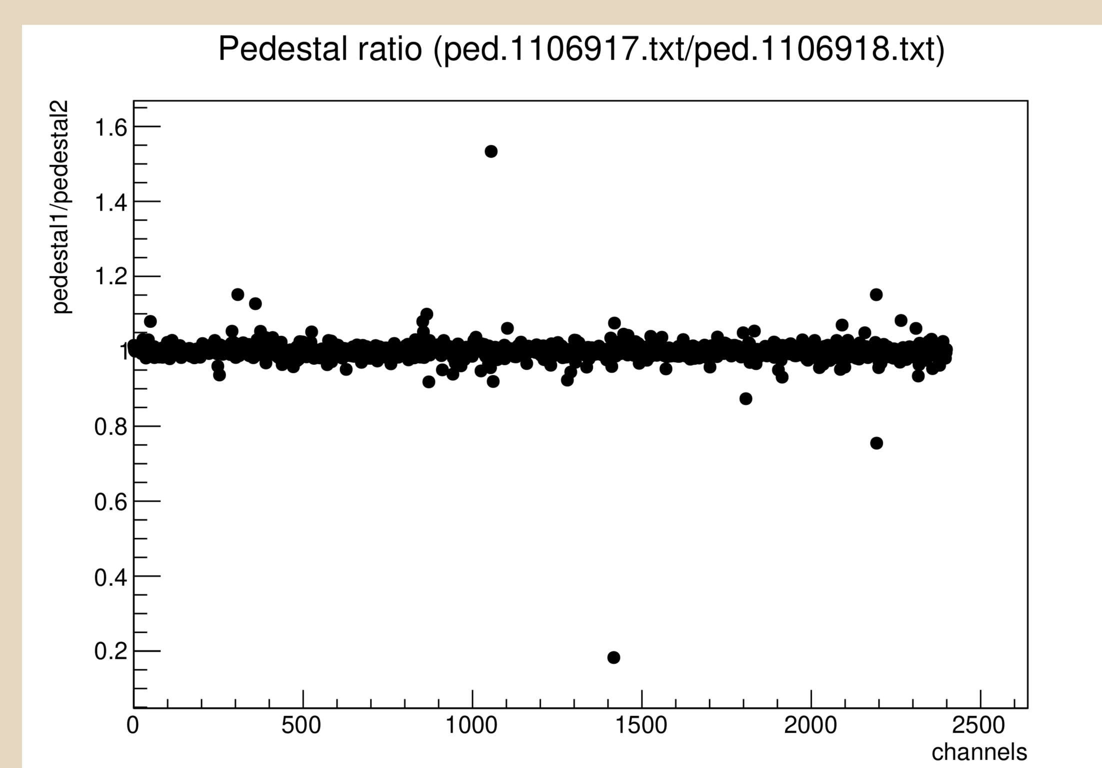
The two primary subsystems of the Forward Upgrade are the hadronic (left) and electromagnetic (right) calorimeters. Both can be pictured below, providing us with a more complete picture of the energies of particles in the forward region. To ensure we get high quality data for polarized pp run in 2022, we have been testing both very extensively over run-2021, examples are pedestals and the readout with the LED.

Analysis Code

For this analysis, we used a C++ ROOT analysis code. The method of implementation was to read in the files into a vector, and then iterate over that vector to produce graphs. The opening of all the files was done in TGraph. Since Tgraph has some built in parsing capabilities, we took our files and directly defined what each column of data would be (string, float, etc.) Since TGraph is capable of parsing data, this is perfectly fine for slow controls information, like the current.

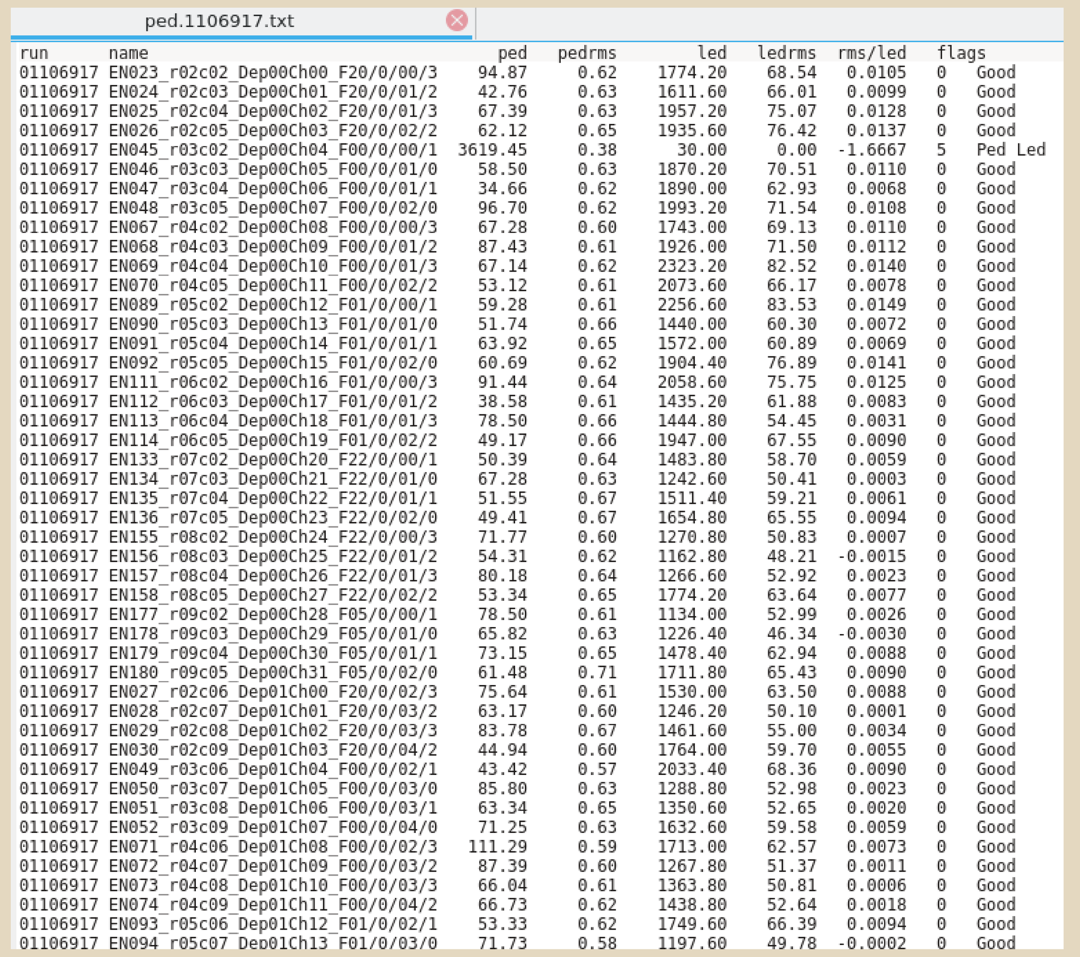
ROOT Analysis

To analyze the efficiency of the HCAL and ECAL systems, LED and Pedestal data were taken with the instruments during runs. This was done to ensure that the noise was staple across different runs, so that the measurements will be of high quality come the 2022 run of STAR. Here is a comparison between two runs, which is just a sample from the 157 graphs that were made. This run indicates that there was minimal differences between the pedestal across two runs. We can extrapolate from this information that there was not any noticeable damage due to radiation done to the new components in the Forward Calorimeter System during our 2021 run.



Next Steps

One of our next steps at STAR is to take this program and having the graphs be posted to the FCS monitor to have them regularly available, instead to have them existing locally, or only at the online cluster. Another plan moving forward is to make the program more efficient in how it organizes the data being taken and representing them, possibly by using a tree or tuple system instead of graphing directly through the TGraph. This would also probably be a more efficient for opening the data files. Below is an example of the files created



ped.1106917.txt

run	name	ped	pedrms	led	ledrms	rms/led	flags	
01106917	EN023_r02c02_Dep00Ch00_F20/0/00/3	94.87	0.62	1774.20	68.54	0.0105	0	Good
01106917	EN024_r02c03_Dep00Ch01_F20/0/01/2	42.76	0.63	1611.60	66.01	0.0099	0	Good
01106917	EN025_r02c04_Dep00Ch02_F20/0/01/3	67.39	0.63	1957.20	75.07	0.0128	0	Good
01106917	EN026_r02c05_Dep00Ch03_F20/0/02/2	62.12	0.65	1935.60	76.42	0.0137	0	Good
01106917	EN045_r03c02_Dep00Ch04_F00/0/00/1	3619.45	0.38	30.00	0.00	-1.6667	5	Ped Led
01106917	EN046_r03c03_Dep00Ch05_F00/0/01/0	58.50	0.63	1870.20	70.51	0.0110	0	Good
01106917	EN047_r03c04_Dep00Ch06_F00/0/01/1	34.66	0.62	1890.00	62.93	0.0068	0	Good
01106917	EN048_r03c05_Dep00Ch07_F00/0/02/0	96.70	0.62	1993.20	71.54	0.0108	0	Good
01106917	EN067_r04c02_Dep00Ch08_F00/0/00/3	67.28	0.60	1743.00	69.13	0.0110	0	Good
01106917	EN068_r04c03_Dep00Ch09_F00/0/01/2	87.43	0.61	1926.00	71.50	0.0112	0	Good
01106917	EN069_r04c04_Dep00Ch10_F00/0/01/3	67.14	0.62	2323.20	82.52	0.0140	0	Good
01106917	EN070_r04c05_Dep00Ch11_F00/0/02/2	53.12	0.61	2073.60	66.17	0.0078	0	Good
01106917	EN089_r05c02_Dep00Ch12_F01/0/00/1	59.28	0.61	2256.60	83.53	0.0149	0	Good
01106917	EN090_r05c03_Dep00Ch13_F01/0/01/0	51.74	0.66	1440.00	60.30	0.0072	0	Good
01106917	EN091_r05c04_Dep00Ch14_F01/0/01/1	63.92	0.65	1572.00	60.89	0.0069	0	Good
01106917	EN092_r05c05_Dep00Ch15_F01/0/02/0	60.69	0.62	1904.40	76.89	0.0141	0	Good
01106917	EN111_r06c02_Dep00Ch16_F01/0/00/3	91.44	0.64	2058.60	75.75	0.0125	0	Good
01106917	EN112_r06c03_Dep00Ch17_F01/0/01/2	38.58	0.61	1435.20	61.88	0.0083	0	Good
01106917	EN113_r06c04_Dep00Ch18_F01/0/01/3	78.50	0.66	1444.80	54.45	0.0031	0	Good
01106917	EN114_r06c05_Dep00Ch19_F01/0/02/2	49.17	0.66	1947.00	67.55	0.0090	0	Good
01106917	EN133_r07c02_Dep00Ch20_F22/0/00/1	50.39	0.64	1483.80	58.70	0.0059	0	Good
01106917	EN134_r07c03_Dep00Ch21_F22/0/01/0	67.28	0.63	1242.60	50.41	0.0003	0	Good
01106917	EN135_r07c04_Dep00Ch22_F22/0/01/1	51.55	0.67	1511.40	59.21	0.0061	0	Good
01106917	EN136_r07c05_Dep00Ch23_F22/0/02/0	49.41	0.67	1654.80	65.55	0.0094	0	Good
01106917	EN155_r08c02_Dep00Ch24_F22/0/00/3	71.77	0.60	1270.80	50.83	0.0007	0	Good
01106917	EN156_r08c03_Dep00Ch25_F22/0/01/2	54.31	0.62	1162.80	48.21	-0.0015	0	Good
01106917	EN157_r08c04_Dep00Ch26_F22/0/01/3	80.18	0.64	1266.60	52.92	0.0023	0	Good
01106917	EN158_r08c05_Dep00Ch27_F22/0/02/2	53.34	0.65	1774.20	63.64	0.0077	0	Good
01106917	EN177_r09c02_Dep00Ch28_F05/0/00/1	78.50	0.61	1134.00	52.99	0.0026	0	Good
01106917	EN178_r09c03_Dep00Ch29_F05/0/01/0	65.82	0.63	1226.40	46.34	-0.0030	0	Good
01106917	EN179_r09c04_Dep00Ch30_F05/0/01/1	73.15	0.65	1478.40	62.94	0.0088	0	Good
01106917	EN180_r09c05_Dep00Ch31_F05/0/02/0	61.48	0.71	1711.80	65.43	0.0090	0	Good
01106917	EN027_r02c06_Dep01Ch00_F20/0/02/3	75.64	0.61	1530.00	63.50	0.0088	0	Good
01106917	EN028_r02c07_Dep01Ch01_F20/0/03/2	63.17	0.60	1246.20	50.10	0.0001	0	Good
01106917	EN029_r02c08_Dep01Ch02_F20/0/03/3	83.78	0.67	1461.60	55.00	0.0034	0	Good
01106917	EN030_r02c09_Dep01Ch03_F20/0/04/2	44.94	0.60	1764.00	59.70	0.0055	0	Good
01106917	EN049_r03c06_Dep01Ch04_F00/0/02/1	43.42	0.57	2033.40	68.36	0.0090	0	Good
01106917	EN050_r03c07_Dep01Ch05_F00/0/03/0	85.80	0.63	1288.80	52.98	0.0023	0	Good
01106917	EN051_r03c08_Dep01Ch06_F00/0/03/1	63.34	0.65	1350.60	52.65	0.0020	0	Good
01106917	EN052_r03c09_Dep01Ch07_F00/0/04/0	71.25	0.63	1632.60	59.58	0.0059	0	Good
01106917	EN071_r04c06_Dep01Ch08_F00/0/02/3	111.29	0.59	1713.00	62.57	0.0073	0	Good
01106917	EN072_r04c07_Dep01Ch09_F00/0/03/2	87.39	0.60	1267.80	51.37	0.0011	0	Good
01106917	EN073_r04c08_Dep01Ch10_F00/0/03/3	66.04	0.61	1363.80	50.81	0.0006	0	Good
01106917	EN074_r04c09_Dep01Ch11_F00/0/04/2	66.73	0.62	1438.80	52.64	0.0018	0	Good
01106917	EN093_r05c06_Dep01Ch12_F01/0/02/1	53.33	0.62	1749.60	66.39	0.0094	0	Good
01106917	EN094_r05c07_Dep01Ch13_F01/0/03/0	71.73	0.58	1197.60	49.78	-0.0002	0	Good

Conclusion

The calorimeter systems appears to not show any time dependence for the ratios for pedestal and LED data for different data, with a few outliers. This means that we should get excellent data come next year's run in 2022.

Acknowledgements

U.S. DEPARTMENT OF ENERGY
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BROOKHAVEN NATIONAL LABORATORY