Background studies

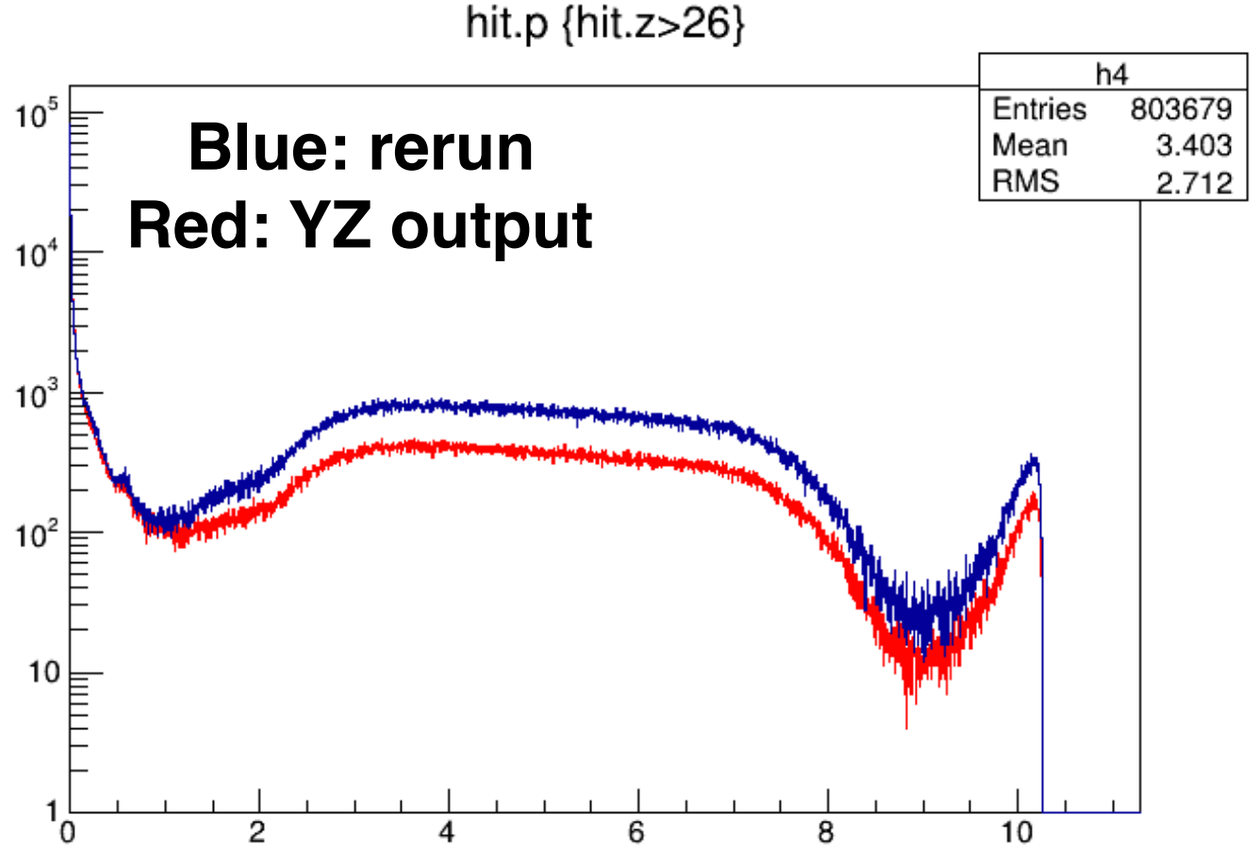
Ciprian Gal UVa

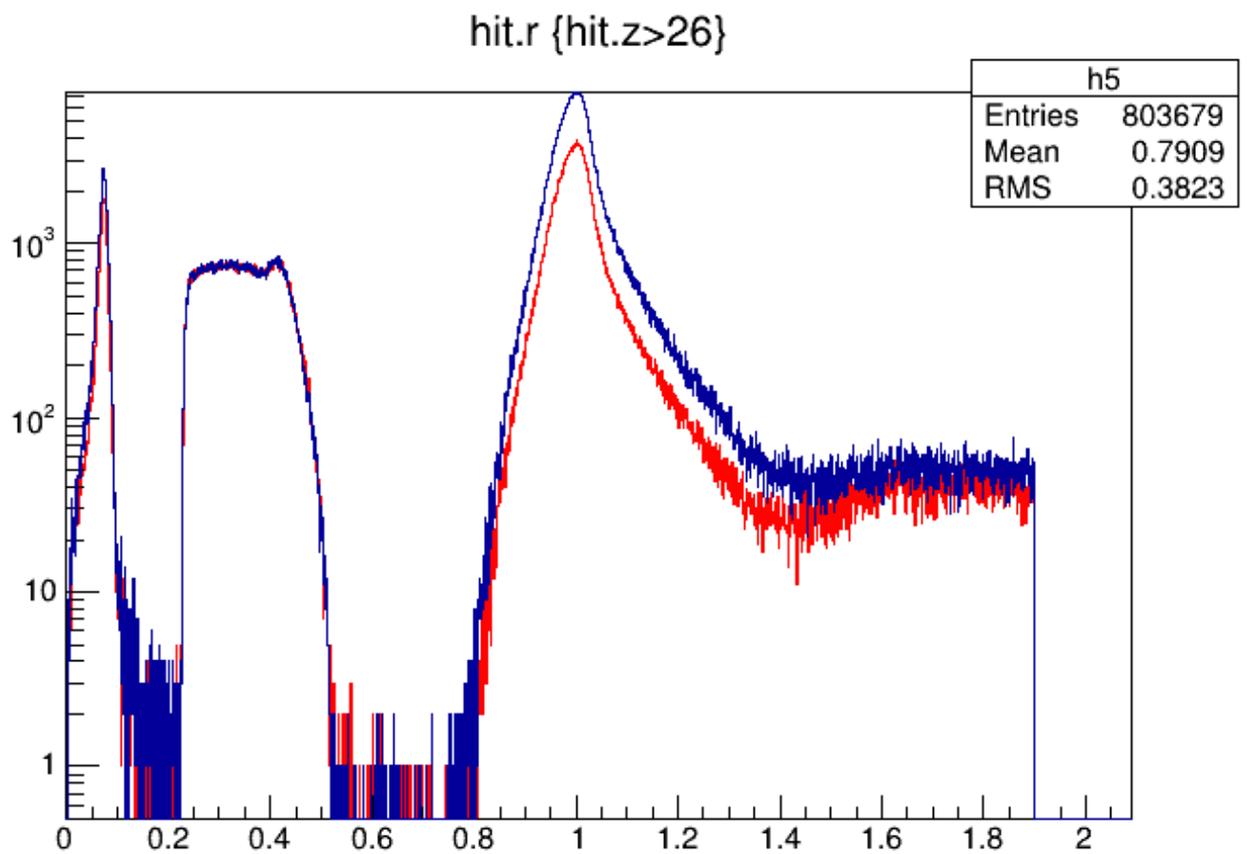
Simulation differences

A measured [ppb]	Am YZ	(YZ-CG)/YZ
-219.55	-282.10	0.22
-280.03	-278.20	-0.01
-57.84	-50.92	-0.14
-477.69	-411.90	-0.16
-216.08	-203.70	-0.06
-86.16	-68.49	-0.26
-287.05	-281.70	-0.02
-182.42	-174.00	-0.05
-61.80	-59.58	-0.04
-145.80	-115.80	-0.26
-102.33	-86.81	-0.18
-37.05	-32.68	-0.13
-35.69	-30.54	-0.17
-33.18	-33.76	0.02
-34.47	-33.61	-0.03
-13.84	-16.10	0.14
-13.40	-13.24	-0.01
-11.49	-10.22	-0.12

- After the changes made by Yuxiang I rerun the simulation and I got at most 26% difference between our results
- I decided to investigate further and got the tarball from Yuxiang with the exact code he ran (he also gave me a root file with a moller simulation with 1e6 events)
- As far as I can tell there are no differences for the Moller, ep-Elastic and ep-Inelastic processes on top of what is on the master branch
    - the only difference that remains the G4 version running the code (he ran G4.9.6p3 while I ran G4.10.2.2)

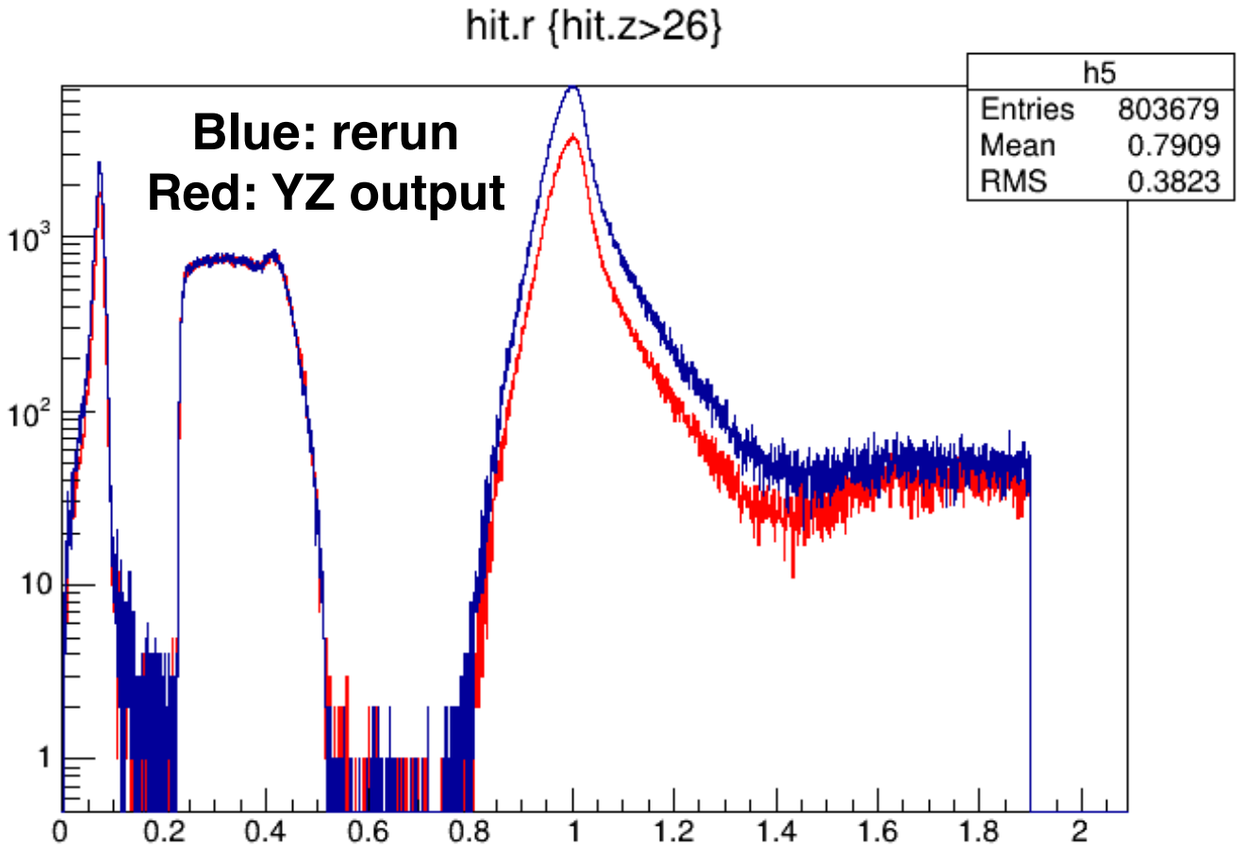
Simulation differences

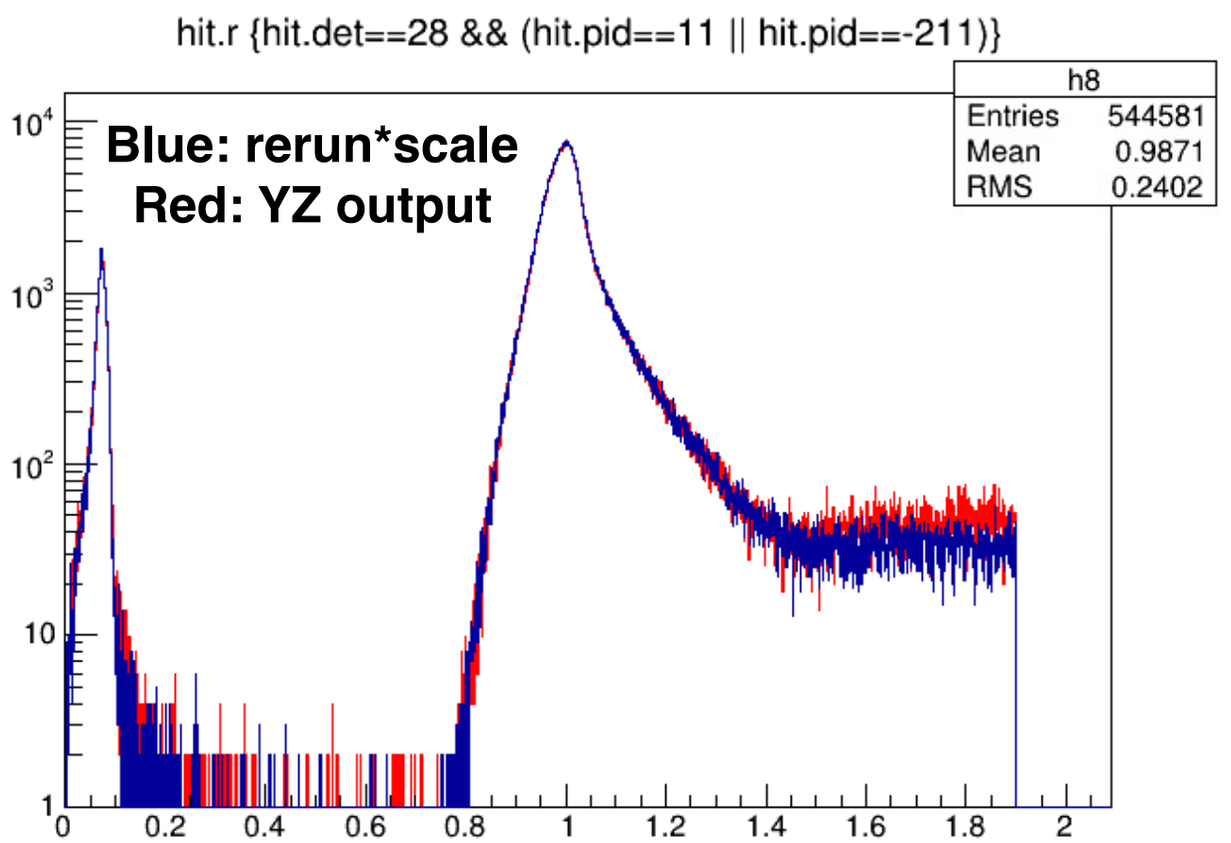




- The analysis makes a single cut (z>26 cm)
  - in addition to the r and phi cuts to attribute events to specific detectors
- For 1e6 events this cuts provides ~800k hits for his simulation output but when I rerun his code base I get ~1.3M

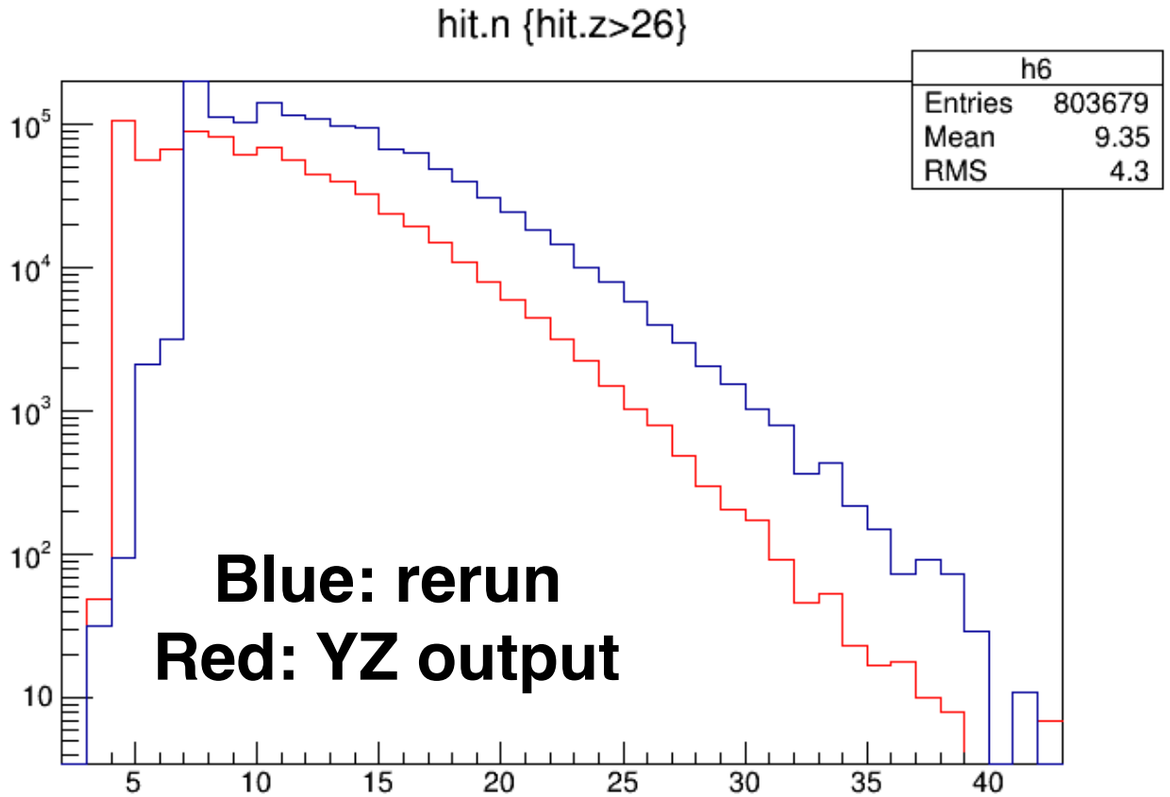
Simulation differences

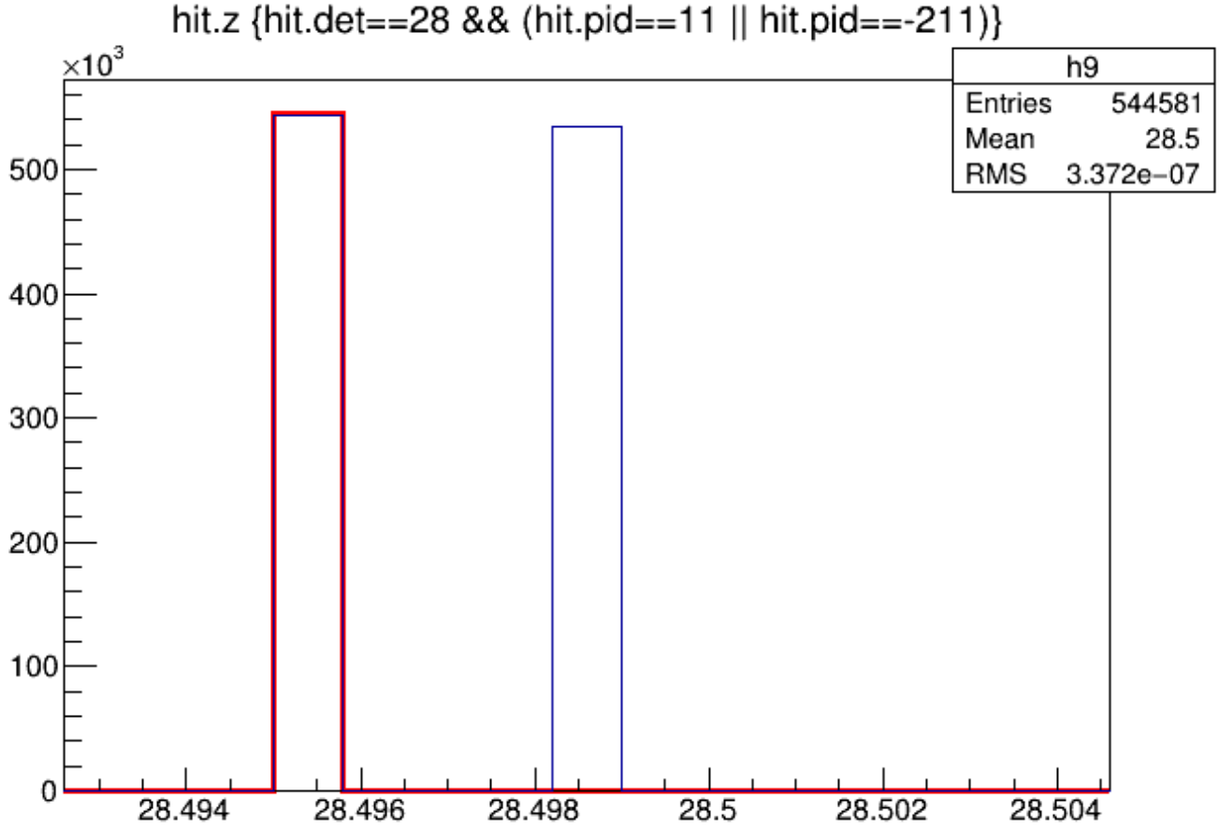




- Cutting on electrons and pions produces ~544k hits from his output and ~1.08M hits from rerun
    - the events between 0.2 and 0.5 were photon hits and were not actually taken into account in his analysis (there were radial and phi cuts)
- Scaling down my simulation (to look at the shape) to match the integrals shows that we mostly get the same radial distribution (they may be some difference in the tail)

Simulation differences





- If we look at the number of hits per event we can see that the rerun has a significantly larger number of hits

- If we look at the z position of the hits we can find the problem

    - it seems that G4.9.6 only produced a single hit per thin detector (the vacuum detector in the simulation has 0.05mm) however G4.10.X produces a hit at the entrance of the detector but also at the exit

- The hope was that the double counting (and slight change in the solid angle coverage of the front/back) would bring the results in line with what Yuxiang had

Analysis output

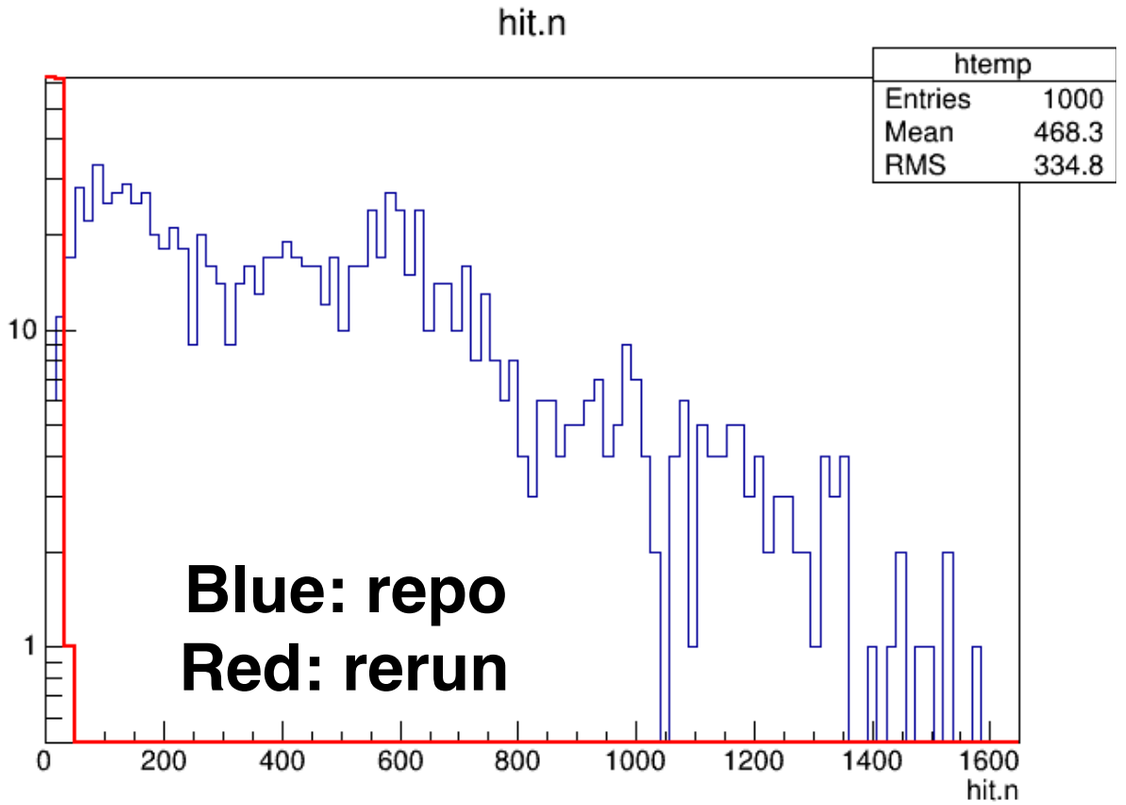
without proper cuts					with proper cuts			
Am CG	Am YZ	(YZ-CG)/YZ	ring	sector	Am CG	Am YZ	(YZ-CG)/YZ	YZ-CG
-219.55	-282.10	22.17%	1	0	-212.93	-282.10	24.52%	-69.166
-280.03	-278.20	-0.66%	1	1	not enough stat	-278.20	100.00%	-278.2
-57.84	-50.92	-13.60%	1	2	-60.07	-50.92	-17.97%	9.1489
-477.69	-411.90	-15.97%	2	0	-431.67	-411.90	-4.80%	19.767
-216.08	-203.70	-6.08%	2	1	-231.17	-203.70	-13.49%	27.472
-86.16	-68.49	-25.81%	2	2	-81.08	-68.49	-18.38%	12.5902
-287.05	-281.70	-1.90%	3	0	-279.55	-281.70	0.76%	-2.148
-182.42	-174.00	-4.84%	3	1	-191.66	-174.00	-10.15%	17.655
-61.80	-59.58	-3.72%	3	2	-67.14	-59.58	-12.68%	7.5572
-145.80	-115.80	-25.90%	4	0	-132.43	-115.80	-14.36%	16.633
-102.33	-86.81	-17.88%	4	1	-97.41	-86.81	-12.21%	10.5996
-37.05	-32.68	-13.37%	4	2	-35.06	-32.68	-7.29%	2.3808
-35.69	-30.54	-16.88%	5	0	-31.03	-30.54	-1.59%	0.4857
-33.18	-33.76	1.71%	5	1	-33.70	-33.76	0.19%	-0.0647
-34.47	-33.61	-2.55%	5	2	-34.30	-33.61	-2.06%	0.6916
-13.84	-16.10	14.05%	6	0	-16.50	-16.10	-2.48%	0.3996
-13.40	-13.24	-1.20%	6	1	-14.51	-13.24	-9.58%	1.2686
-11.49	-10.22	-12.44%	6	2	-11.34	-10.22	-10.93%	1.1166

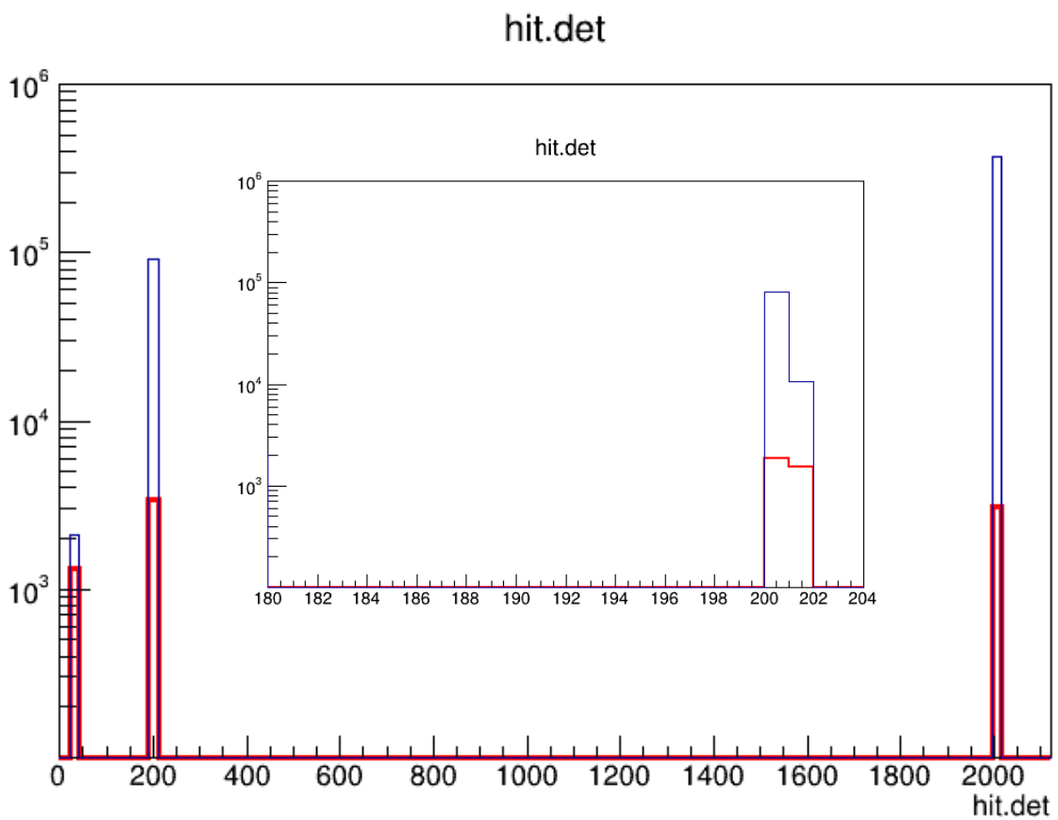
- Doing the comparison again with the proper cuts we have decreased the disagreement in some of the higher statistics rings (4,5,6) while some get a bit worse (3,2)

- I think at this point I have done all I can think of to track down these differences

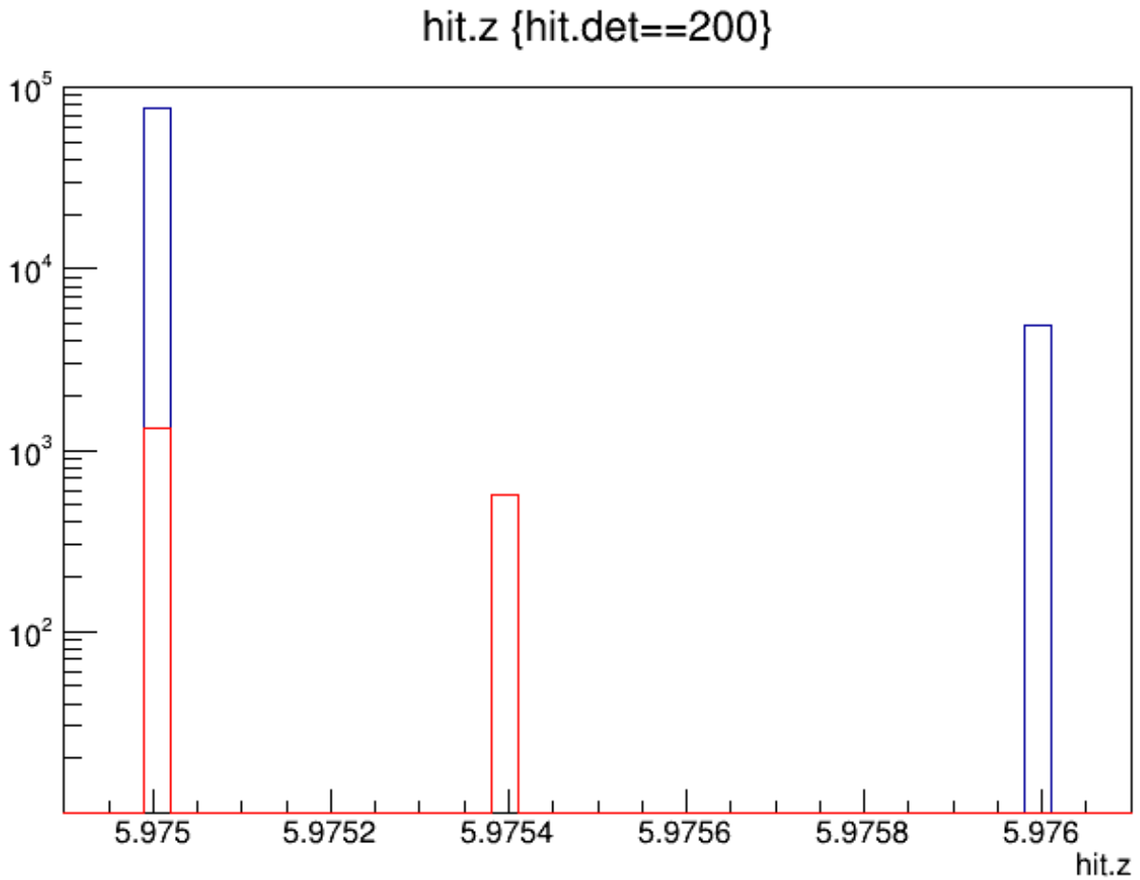
  - Both the ep-Elastic and ep-Inelastic had 1e7 events while the moller had 1e6 (will run 1e7 to make sure this is not due to stats)

Simulation differences

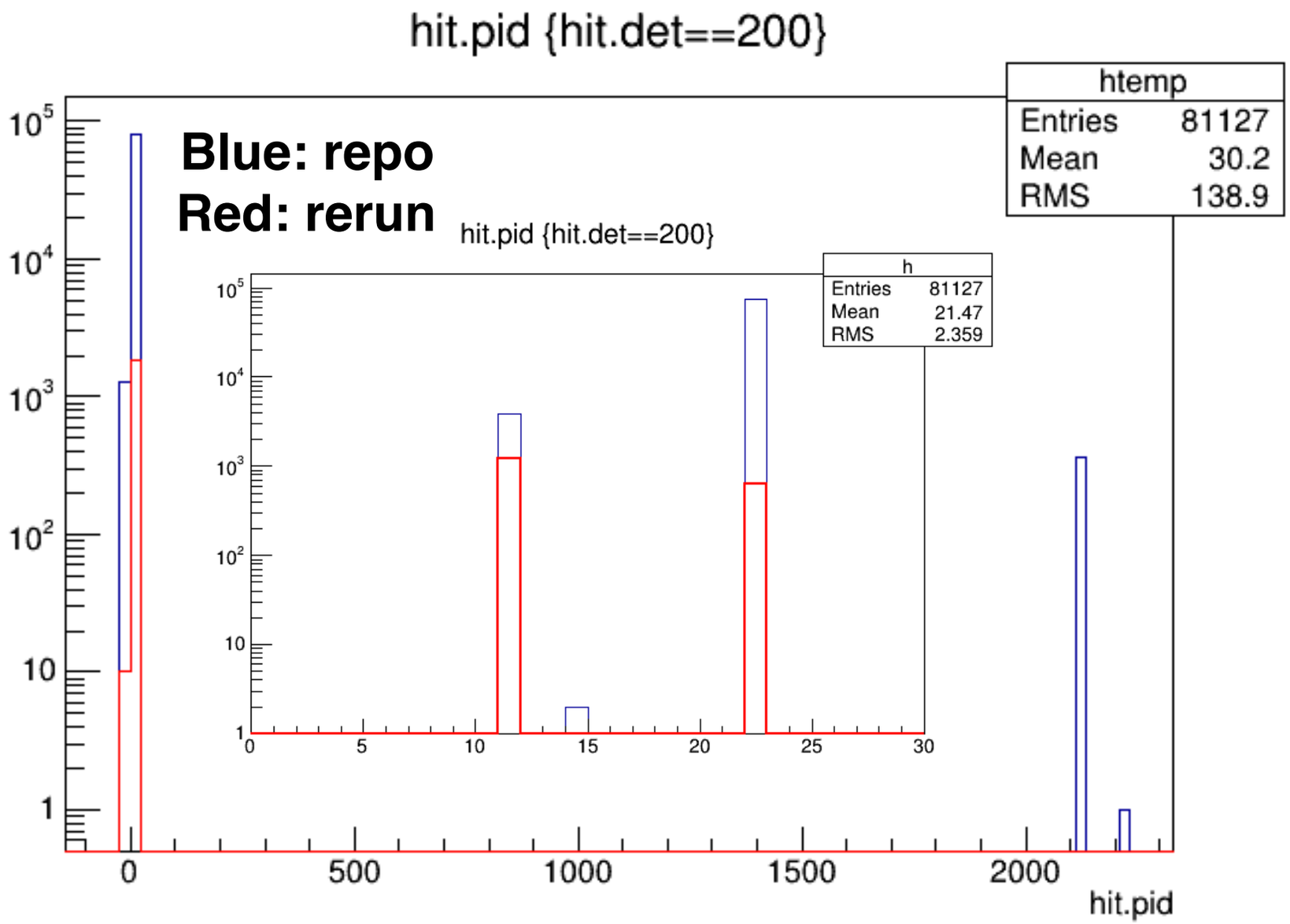




- Comparing the repo codebase (jeffersonLab/remoll) with the one Yuxiang provided to me (and I re-run) for 1000 events show some odd behavior
- The number of hits per event is significantly increased while the number of detectors seems to be the same (the output file size and simulation time grows significantly too)
- The repo codebase seems to register significantly larger number of hits (even accounting for the double counting)
  - also looks like the z thickness of the detectors changed (from 0.0004 to 0.001)!?



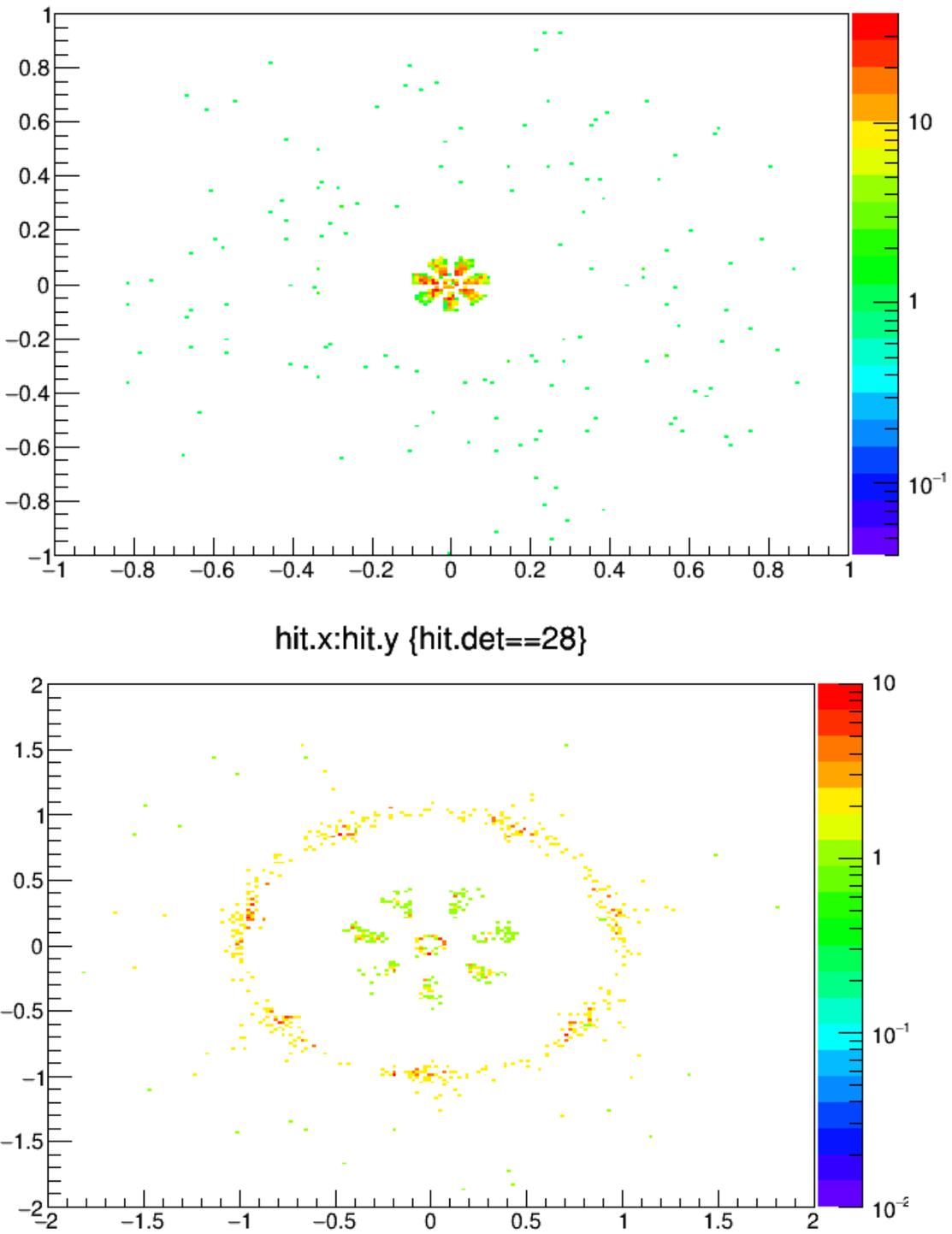
Simulation differences



- Looking at pid for these hits the only difference I can see is the larger number for the repo codebase

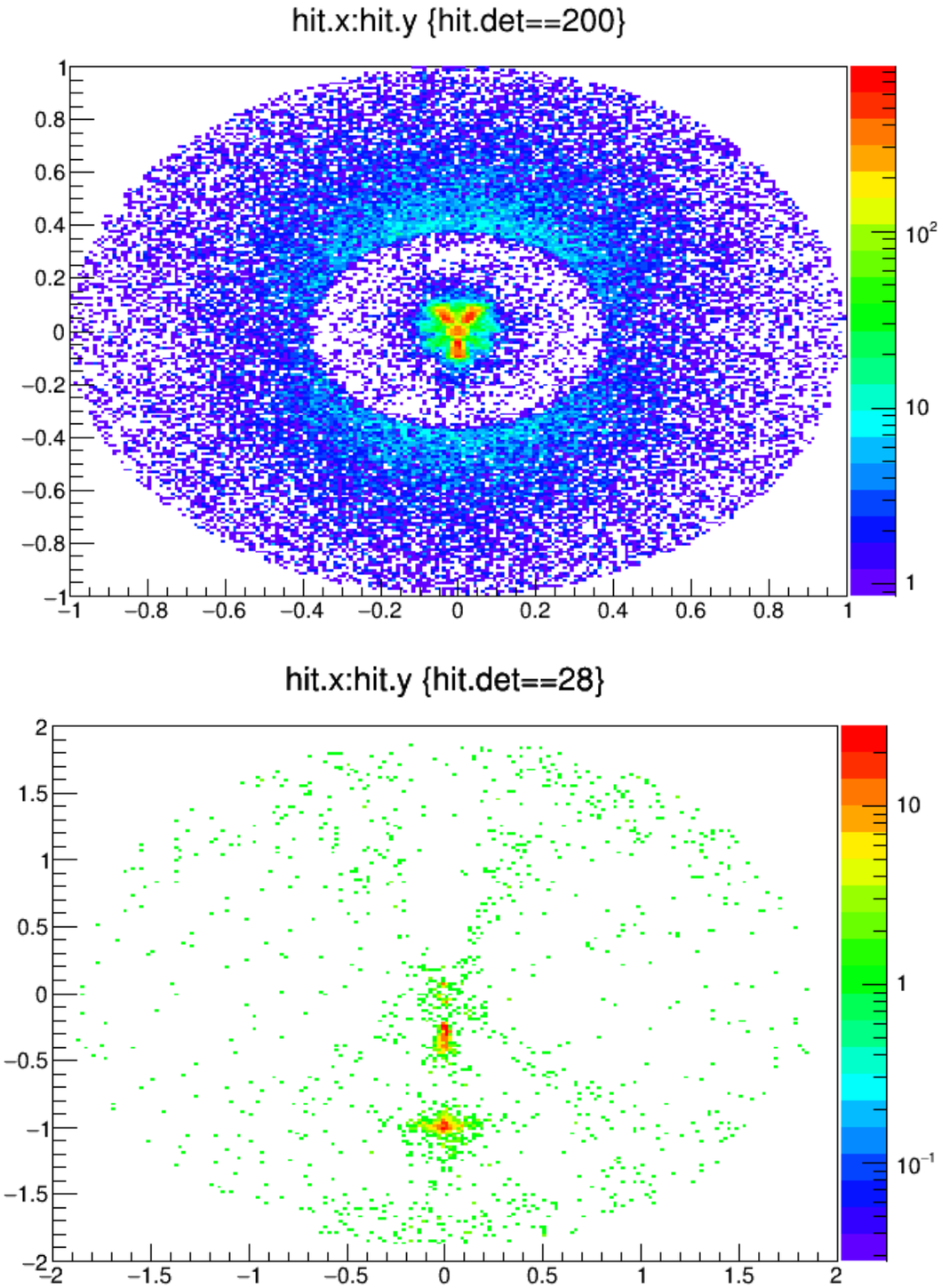
Simulation differences

Red: rerun



Blue: repo

***replacing the geometry with the one YZ had produces the same results**



Plan moving forward

- Yuxiang's original root macros can be found in my fork of remoll (https://github.com/cipriangal/remoll/tree/master/rootScripts/mollerBkgStudy)

- Have a branch where I am putting together a streamlined version with the appropriate cuts of Yuxiang's analysis (https://github.com/JeffersonLab/remoll/tree/bkgAna)

- Q: Should this analysis include the Al window? If so I need to do some cross checks for that too

- Plan is to have a version that works smoothly within a week or so and then go through with the target length study (will hand this off to a student at UVa) and I will focus on optimizing the detector acceptance