

NOVA Shield Analysis Notes

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1 Run 679

1.1 Analysis A

Analysis A was performed at an earlier time and is considered to be incomplete.

1.2 Analysis B

Raw data exhibits poor ^{210}Po - ^{218}Po resolution, yet barely has any low-energy noise. Gain Correction will be performed using ^{214}Po peak line. Upon first inspection, there do not appear to be any 'bad intervals' that need to be removed. Gain correction will be done with the guess function.

GC Settings: (G, 0, 189, 238);(1453, 7.7, 25, 5)

First GC shows very poor resolution, which was expected, and events do not neatly fall into ROI, but it appears that there will not be a better alternative .

Counts vs Energy shows very large number of 214/218 events, as well as large ROI 'bleed-over' the Po-218 rate will not be reliable for this run.

NLL Range for next run: (4,8)

Rate vs time indicates a Po-214 rate of 5.10 ± 0.26 mBq, which is likely a low estimate due to the amount of 'spill-over' from the Po-214 ROI. Po-214 indicates a χ^2/dof value of 12.25/15 and a p -value of 0.6602, which indicates that this model is likely a good fit to the data taken. However, there would be room for improvement if the resolution could be increased. Po-218 indicates a rate of 6.09 ± 0.29 mBq, but this is artificially high due to 'spill-over' from Po-210.

Po-210 Rate vs. Time indicates a rate of 78 cpd, which is consistent with other runs, indicating that there are likely no major systemic issues going on. However, there are 5 bins that are more than 1σ away from the mean, indicating that those bins should be looked at closer.

Remaining plots (Residuals, Expected vs Measured) did not exhibit any issues.

1.3 Analysis C

Analysis C will aim to refine the values of the emanation rates, as well as further investigate the Po-210 bins that are more than one σ from the mean rate. Analysis will be done by modifying the run settings file rather than running a manual run again.

New NLL Settings: (4.0, 8.0)

Rate vs Time plot now indicates a Po-214 rate of 5.09 ± 0.26 mBq, a χ^2/dof value of 12.26/15, and a p -value of 0.6589. This indicates a good fit to the data. The Po-218 ROI has too much 'spill-over' from Po-210 events to be considered reliable data.

^{222}Rn Emanation Rate for Run 679: 5.09 ± 0.26 mBq

2 Run 681

2.1 Analysis A

Run 678 exhibits extreme gain variation and may be unusable for analysis purposes. After meeting with Dr. Schnee, a decision was made to remove 50% of the data hours due to the hours not containing gain-correctable data.

Bad Intervals: [(0,5),(18,56),(92,153),(163,210)]

Gain Correction Settings: [(G, 0, 57, 900), (1453, 7.7, 35, 5)]

After gain correction, data is usable and beautiful.

Counts vs Time is indicative of great resolution and high Polonium decay rates.

NLL plots suggest a later setting of (4, 8)

Rate vs Time indicates a Po-214 Rate of 5.92 ± 0.45 mBq, and a Po-218 rate of 4.94 ± 0.44 mBq. These rates will be further refined in Analysis B. Po-210 Rate vs time indicates a rate of 96 cpd, which is a bit high, but likely still in the normal range for our emanation. The last bin varies more than $1/\text{sigma}$ from the mean, and this may indicate a need for further investigation.

Residuals and Expected vs Measured plots reflect findings in earlier plots.

2.2 Analysis B

Analysis B will aim to refine the values of the emanation rates, as well as further investigate the Po-210 bins that are more than one σ from the mean rate. Analysis will be done by modifying the run settings file rather than running a manual run again.

New NLL settings: (3.0, 8.0)

Rate vs Time Plot now indicates a Po-214 rate of 5.91 ± 0.45 mBq, a χ^2/dof value of 2.06/4 and a p -value of 0.7238. This indicates that the model is a good fit to the data. Po-218 exhibits a rate of 4.94 ± 0.44 mBq, a χ^2/dof value of 1.49/4, and a p -value of 0.8287, which indicates a slightly worse, albeit still good fit to the data. These rates combine to a weighted mean of 5.41 ± 0.48 mBq. Po-210 rate was similar to analysis A and raised no concerns.

Rn Emanation Rate for Run 681: 5.41 ± 0.48 mBq

3 Conclusions

399 data hours were taken, and 246 data hours were usable. Those data hours indicate a mean ^{222}Rn emanation rate of 5.16 ± 0.22 mBq.