Radon Daughter Plate-out

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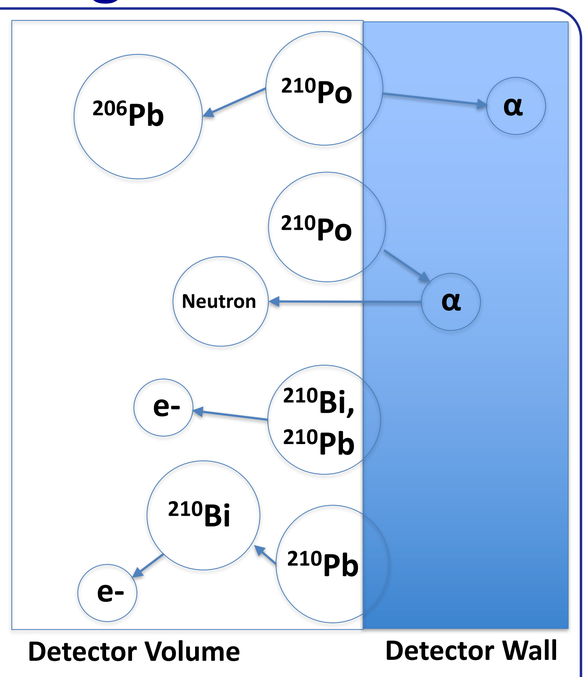
Radiopure materials for detector components in rare event searches may be contaminated after manufacture with long-lived ^{210}Po, produced by the decay of atmospheric radon. We show that the rate of radon daughter plate-out onto Teflon can be orders of magnitude larger than the rate onto other materials, but this high plate-out rate may be reduced through proximity of the Teflon to other materials.

Importance of Radon Daughter Plate-out

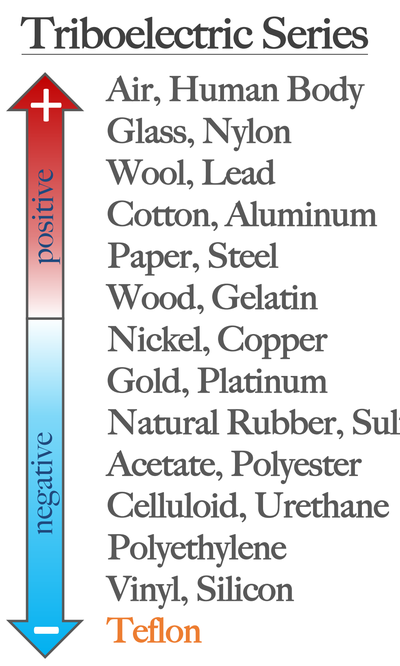
Radon progeny deposited onto sensitive components will cause backgrounds

- lead nuclei from ^{210}Po decay
- ^{210}Pb, ^{210}Bi betas
- neutrons produced by alpha-n reactions from ^{210}Po
- "naked" ^{210}Bi betas if the bismuth nuclei leave the surface and enter the detector bulk (eg xenon)



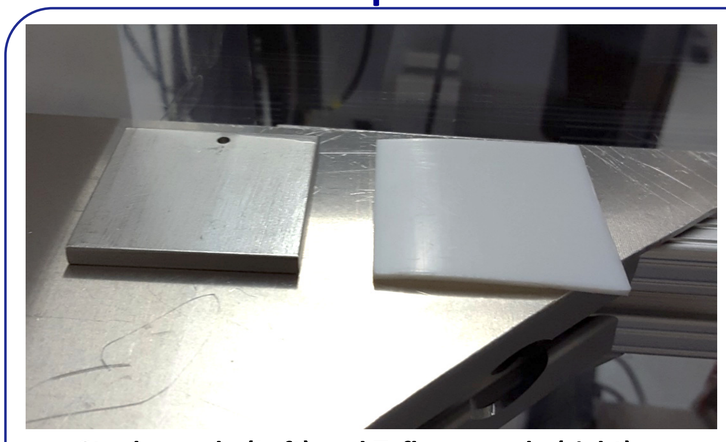
- Understanding the variation of radon daughter plate-out in a realistic setting is important for planning detector assembly.

Radon Progeny Plate-out onto Teflon

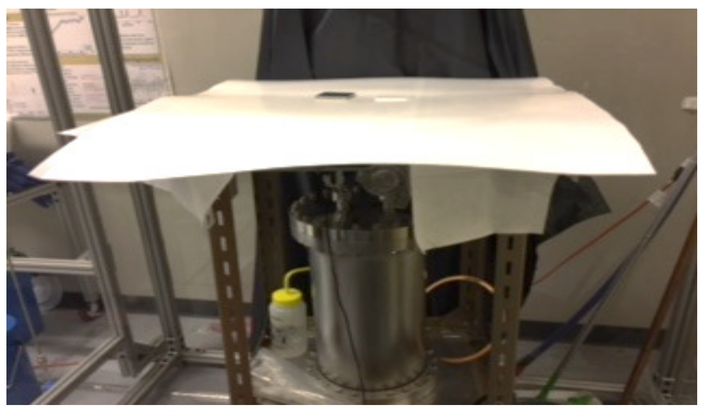


- Teflon has the largest surface area inside the LZ detector so understanding radon plate-out for this material is crucial for the LZ experiment
- Teflon tends to carry negative static charge
- The radon progeny tend to be positively charged (about 88% of the time)
- Thus we expect more radon daughters to plate-out onto Teflon than onto other materials

Experiment Procedure



Steel sample (Left) and Teflon sample (right)



Steel and Teflon samples on 97cm x 57cm Teflon Sheet

AlphaDuo Vacuum Chamber

- Place steel and Teflon samples in a Class 2000 cleanroom that recirculates air at 400 cfm
- Leave samples out for about 3 hours to allow the ^{214}Po to reach equilibrium
- Transfer samples to the alpha counter
  - only 1-2 minutes delay before counting begins
- Measure the quick radon daughters ^{218}Po and ^{214}Po using the Ortec AlphaDuo Counter
  - background ~1 count per run
  - test near acrylic wall vs in room center

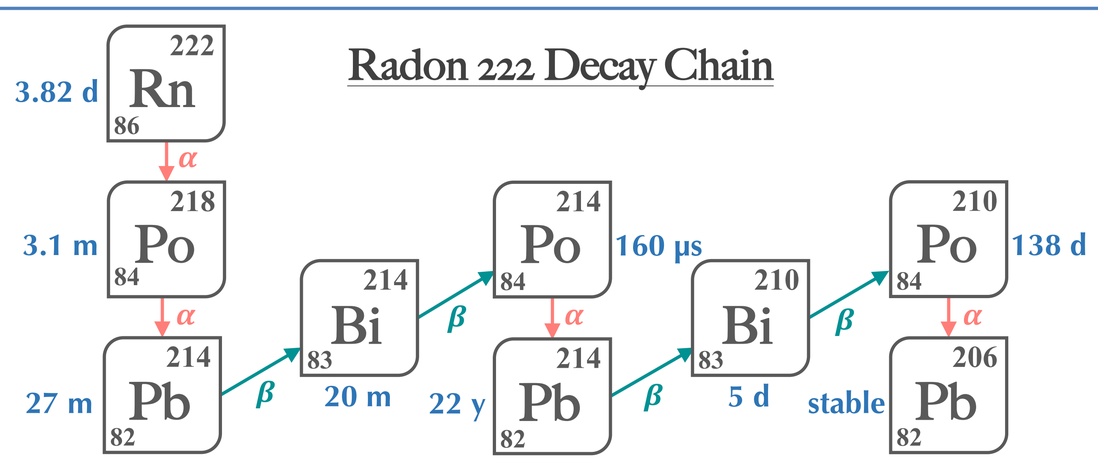
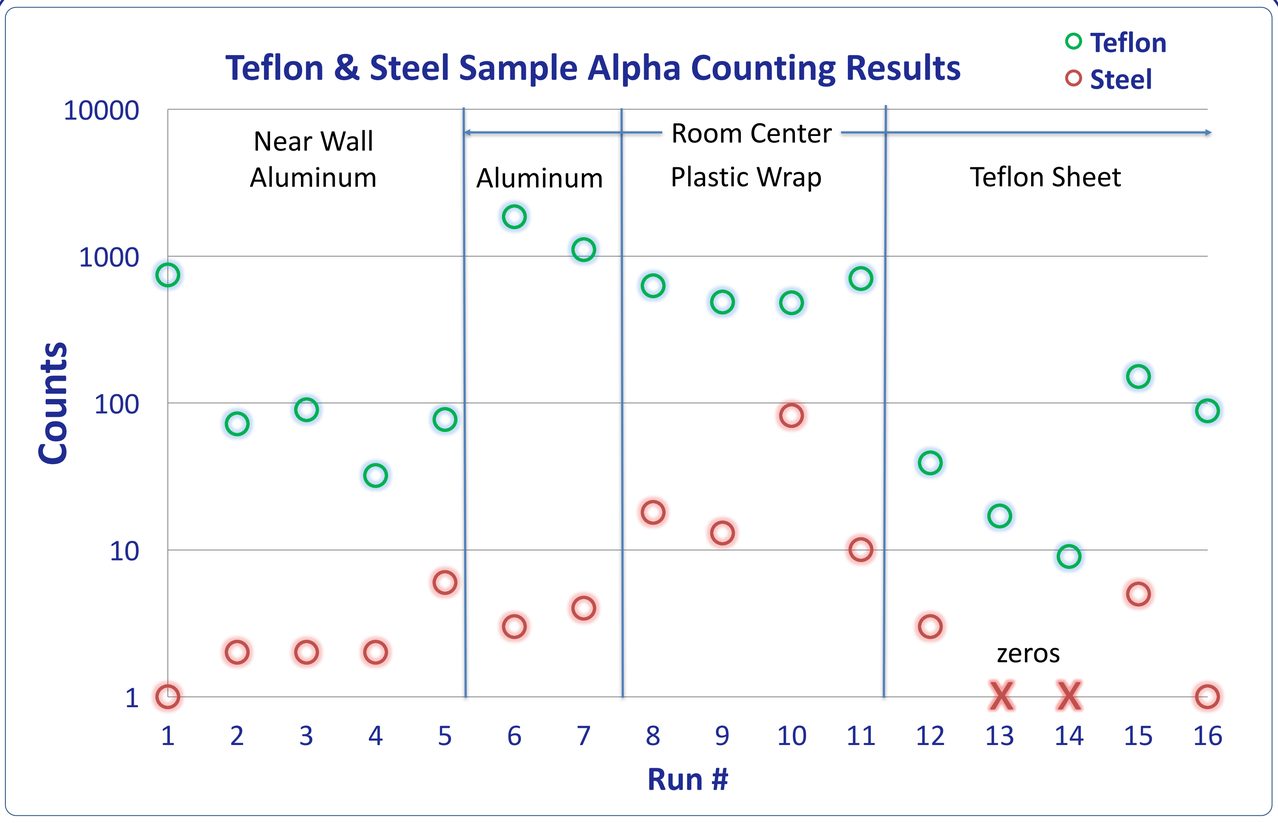


Plate-out onto Teflon vs. Steel



- Teflon and steel plate-out tests next to the wall yielded ~40x higher counts on the Teflon than steel
- Teflon at the center of the room had ~20x higher counts than the Teflon near the acrylic wall
- Plastic wrap reduced the counts on the Teflon by ~2x and increased counts on the steel sample
- The large Teflon sheet successfully diverted radon daughters from the small Teflon sample

Evaluation of Results & Future Work

- Teflon tends to attract radon daughters ~40-800x higher than other materials
  - Likely large variation based on geometry, air flow, and handling
  - Agrees with our expectation based on Teflon's position in the triboelectric series
- Teflon sheets may be useful to attract radon daughters away from sensitive materials
- Future tests will involve moving the large sheet around the cleanroom to find which location affects the sample the greatest
- Other methods to reduce radon plate-out such as using a high voltage wire will be attempted as well

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