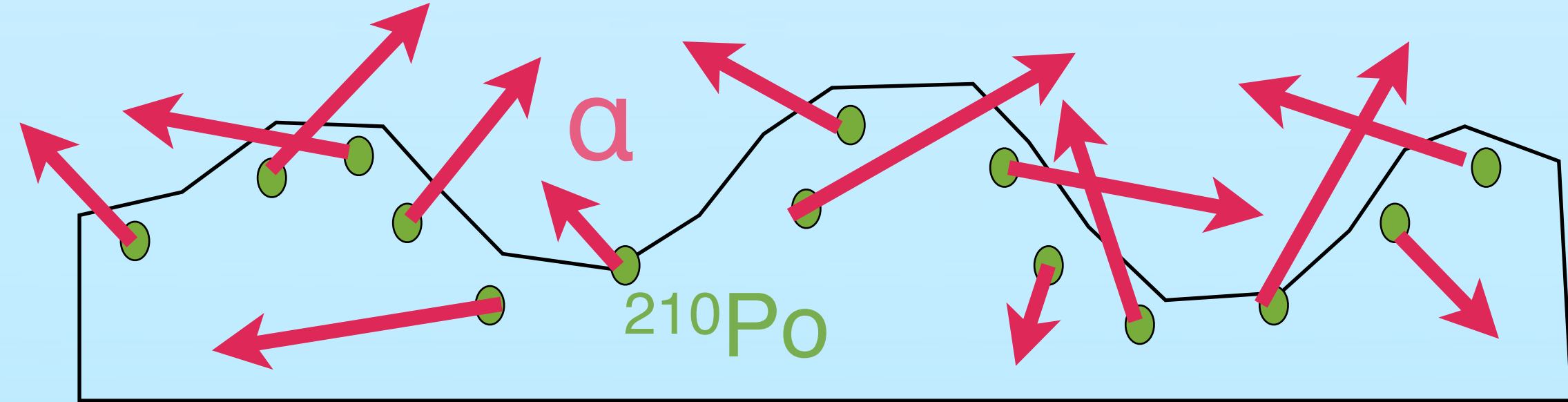


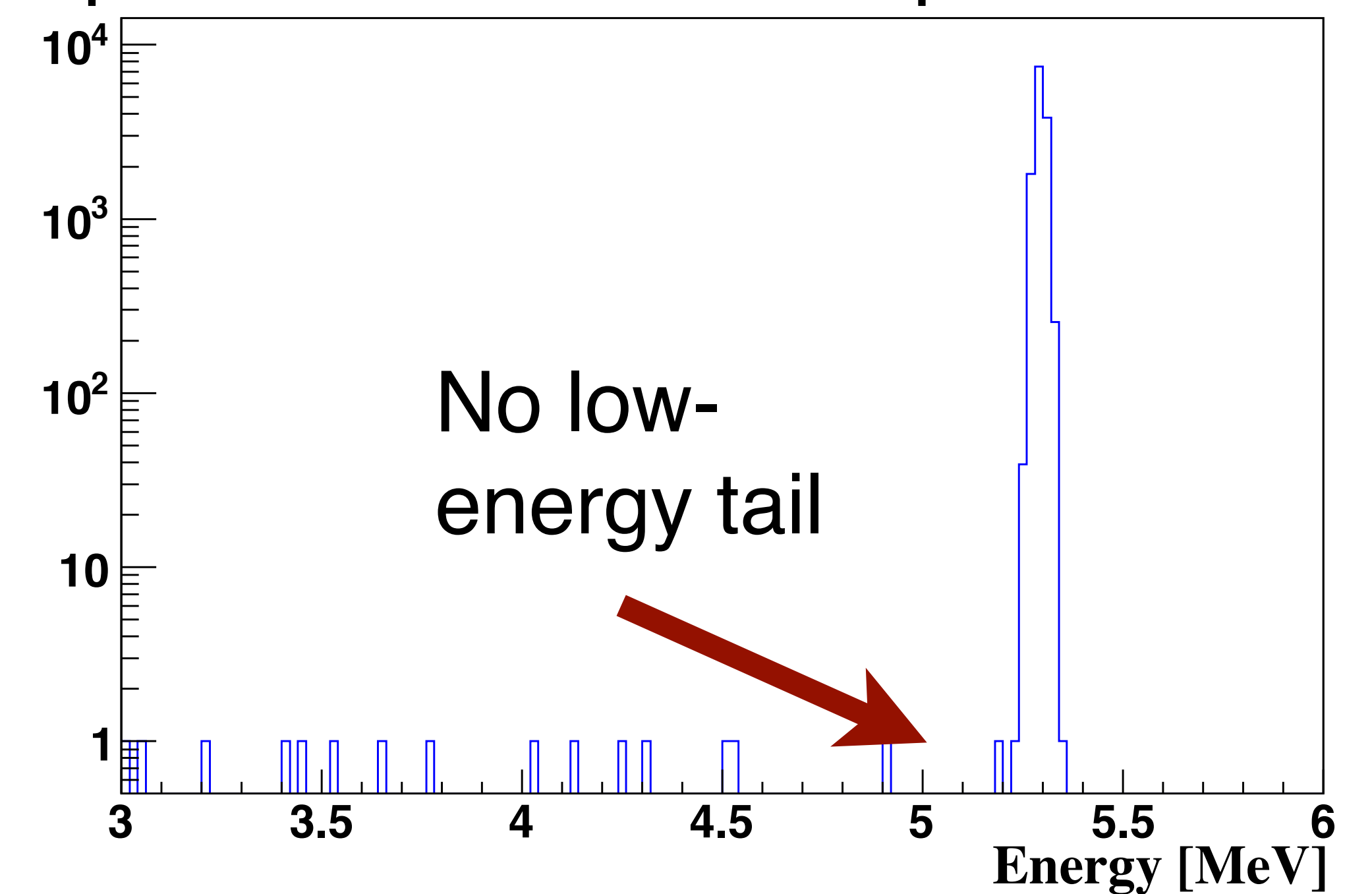
Motivation:

- Ultra-low background underground experiments are susceptible to surface backgrounds from radon exposure.
- The energetic alpha particles could mask the signal of neutrinoless double-beta decay.
- The nuclear recoil from the decay of ^{210}Po could mimic the expected signal of a WIMP.
- Exposure to radon leaves behind a depth distribution of progeny primarily through adsorption, nuclear recoil implantation, and diffusion.
- The surface roughness (texture) changes the effective depth through which a ^{210}Po decay product travels



- We examine radon-exposed samples with a variety of surface roughnesses

Simulated ^{210}Po decay from a smooth surface
no implantation - external alpha detection

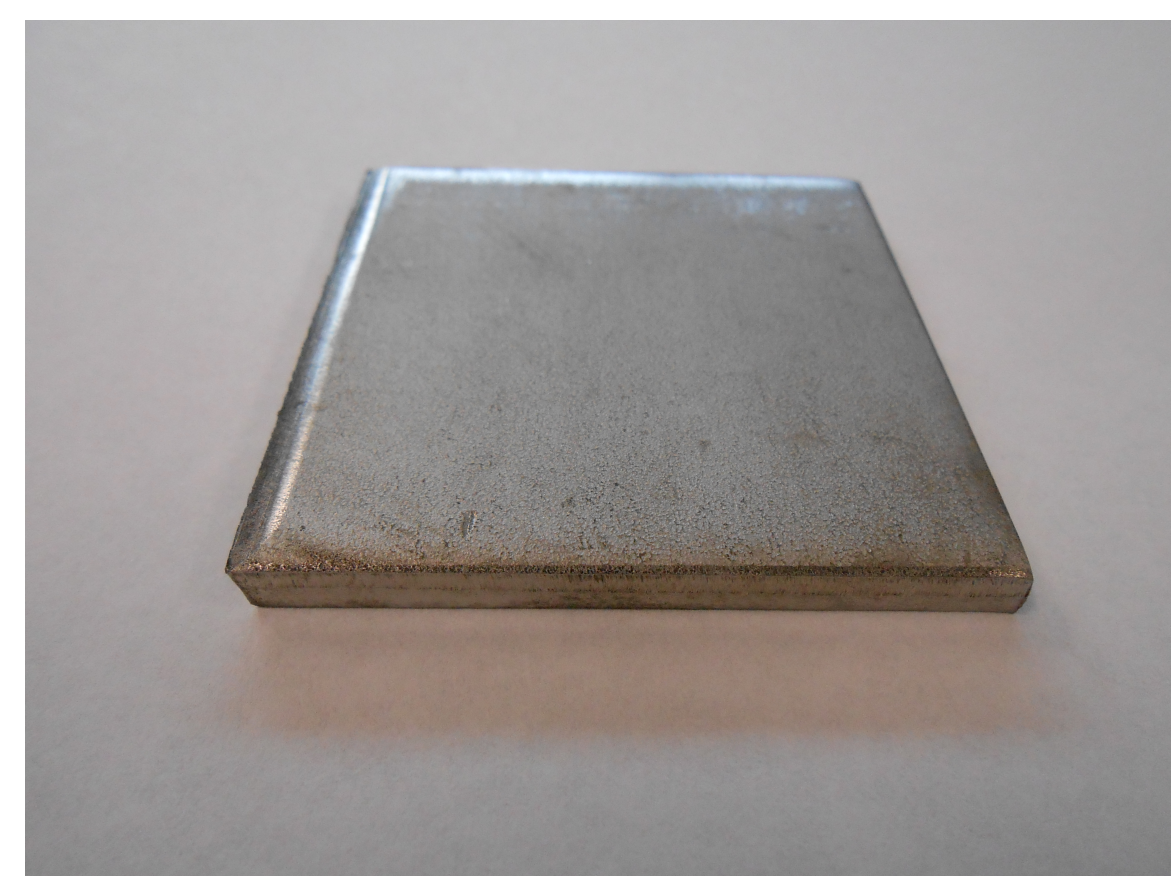


Experiment:

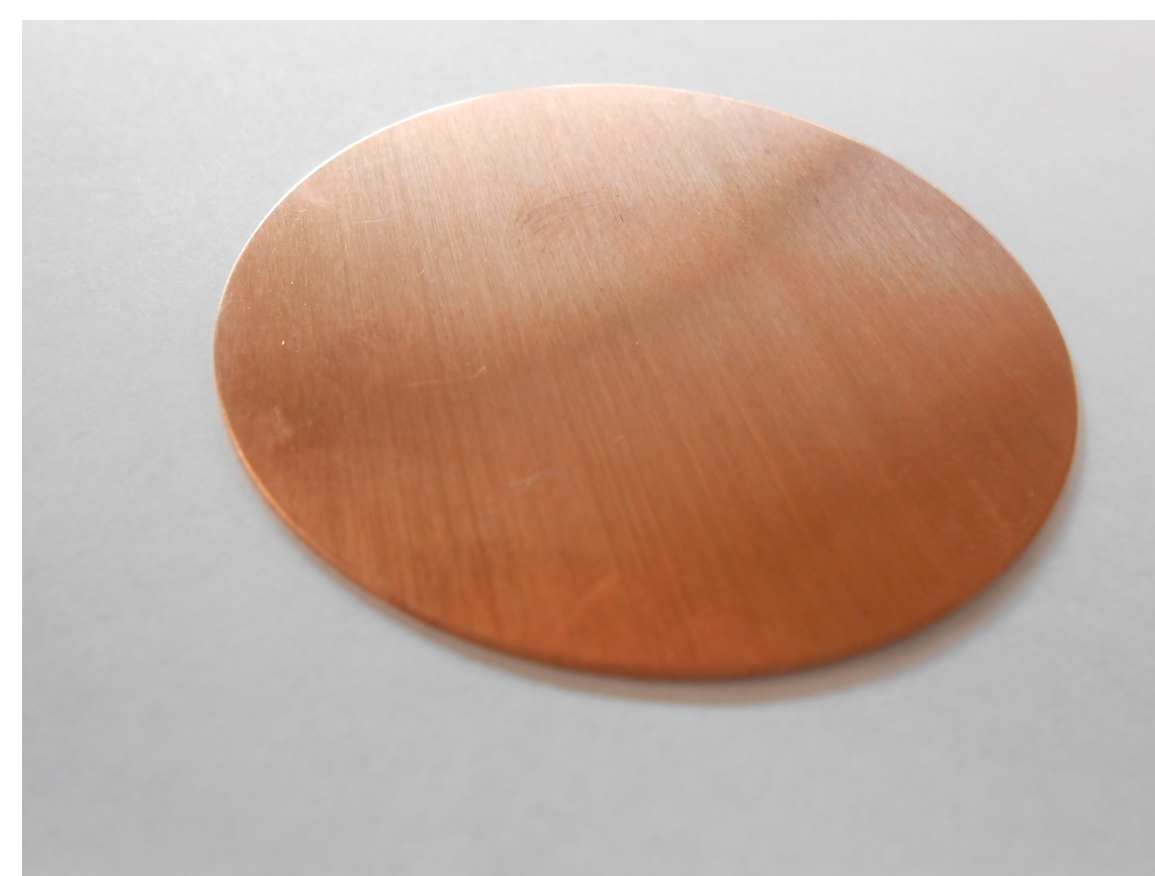
- Expose samples to radon ($\sim 5 \times 10^6 \text{ Bq m}^{-3} \text{ day}^{-1}$)
- Measure roughness (R) with Atomic Force Microscope
- Count ^{210}Po on an Ortec ULTRA-AS alpha detector

Results:

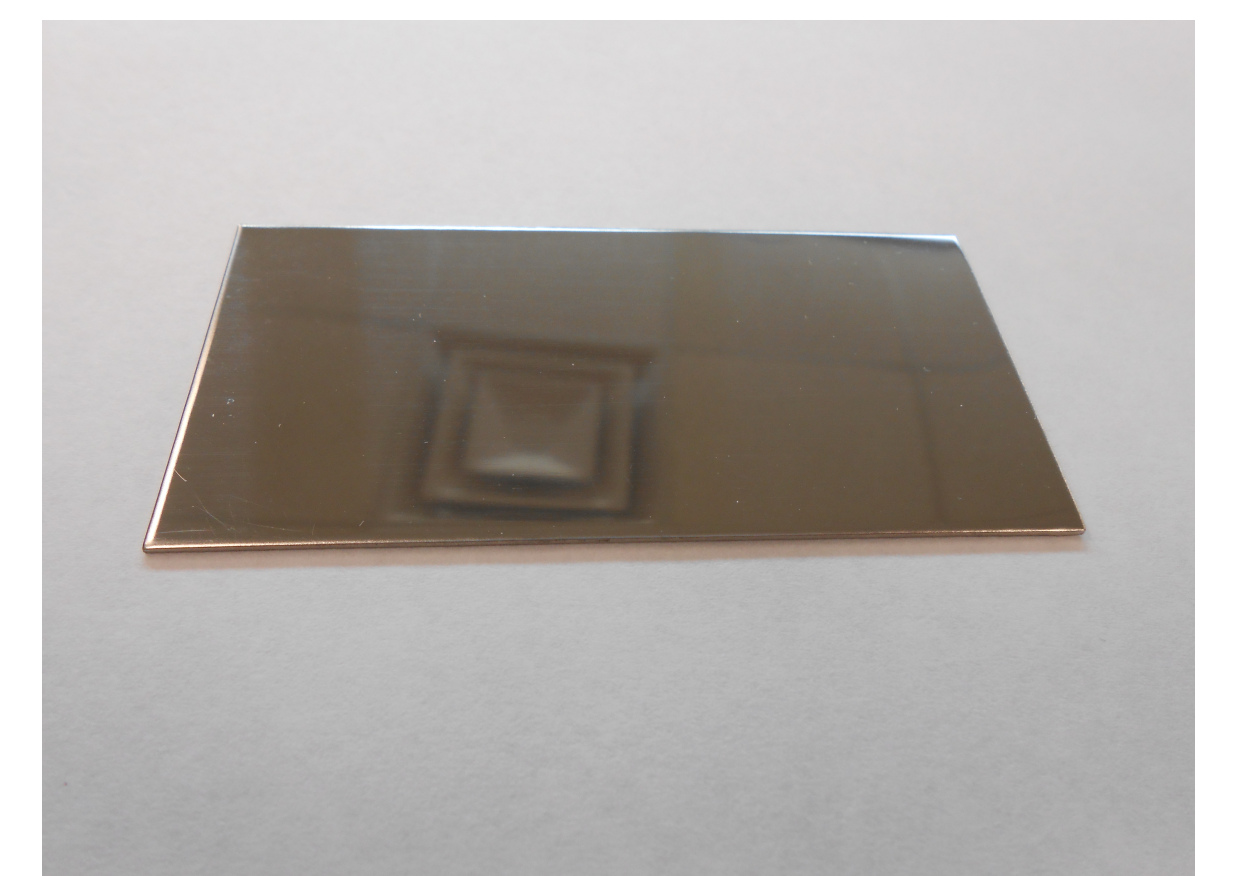
Samples



Stainless Steel
Mill Finish

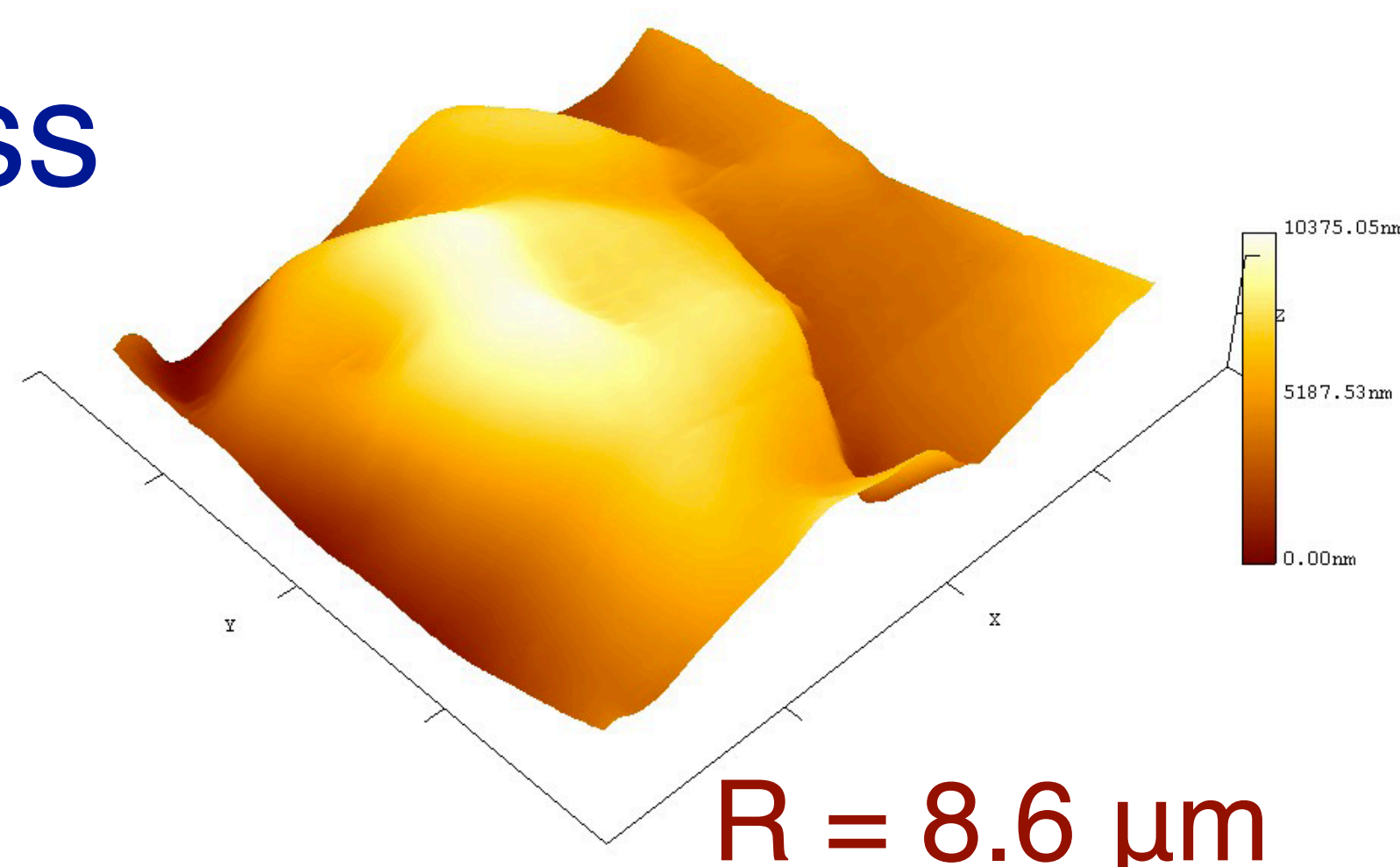


Copper

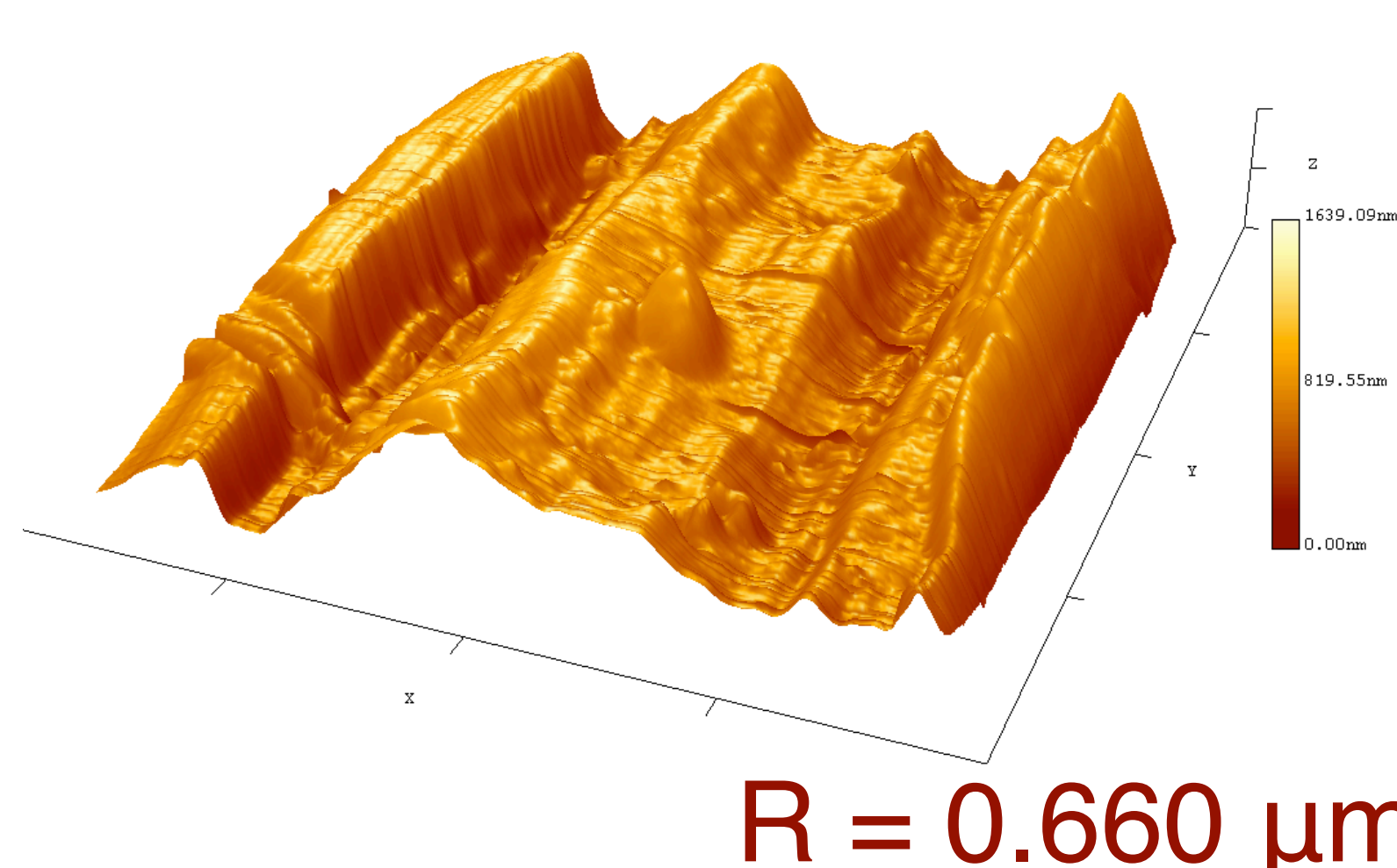


Stainless Steel
#8 (Mirror) Finish

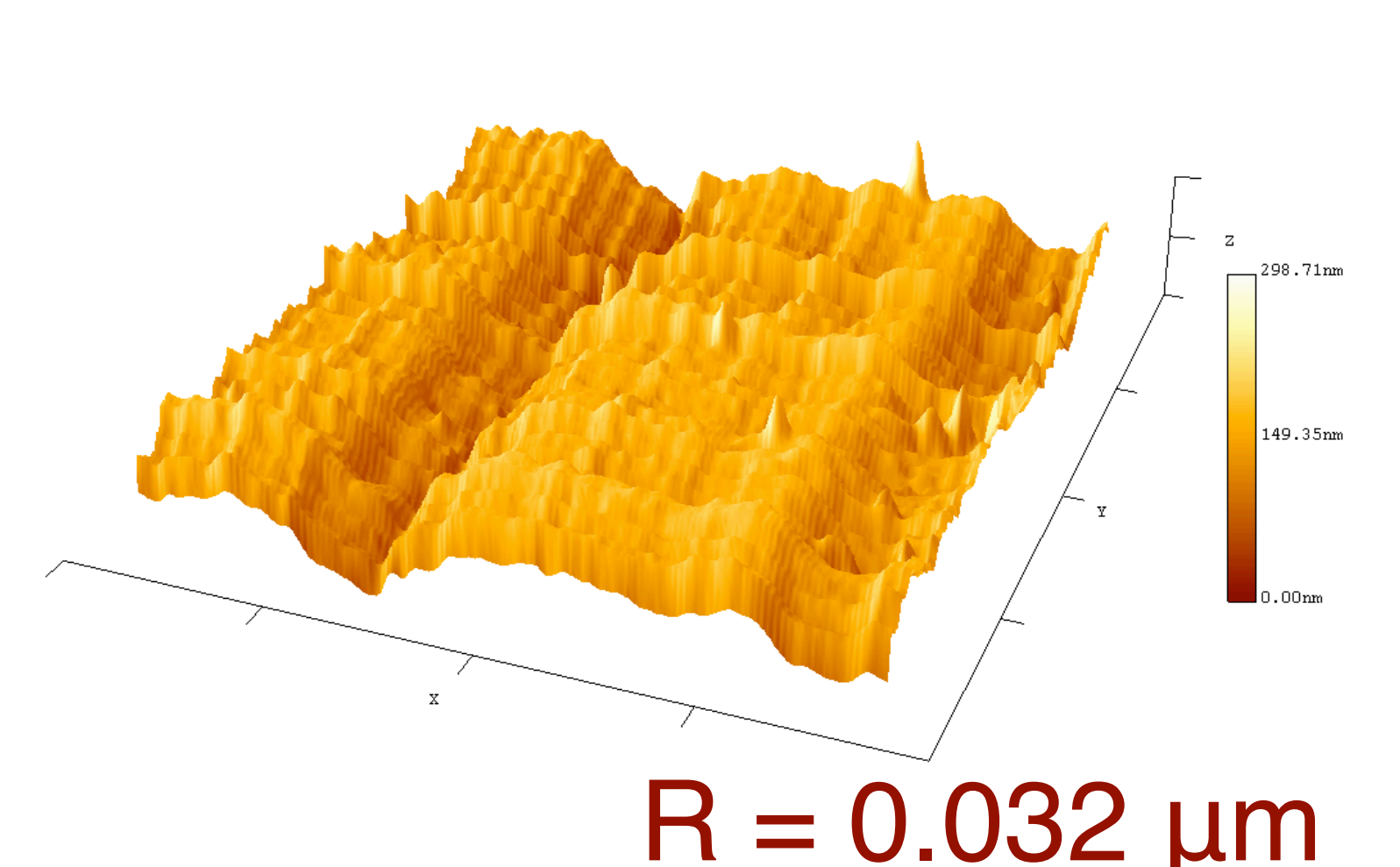
Roughness



$R = 8.6 \mu\text{m}$

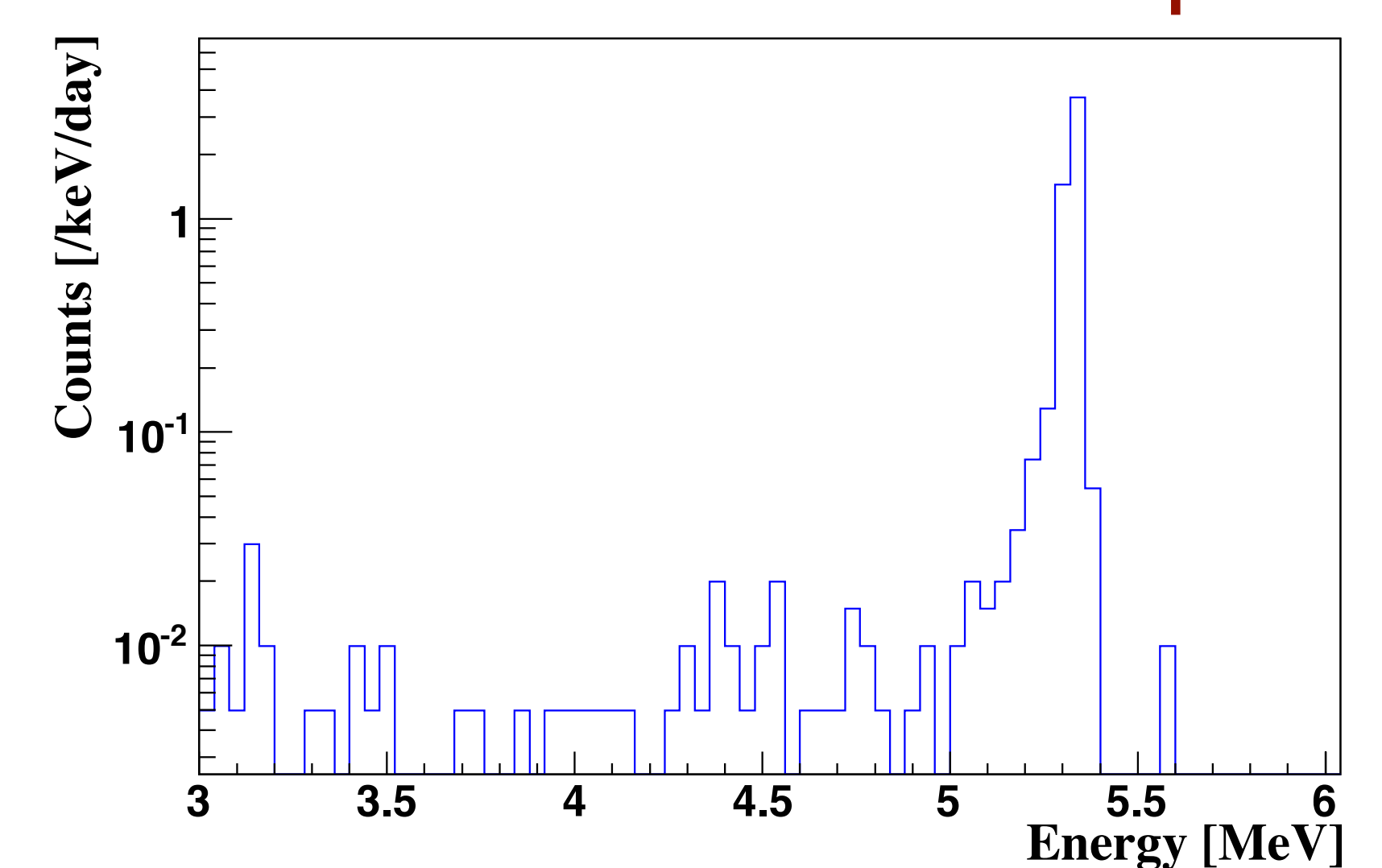
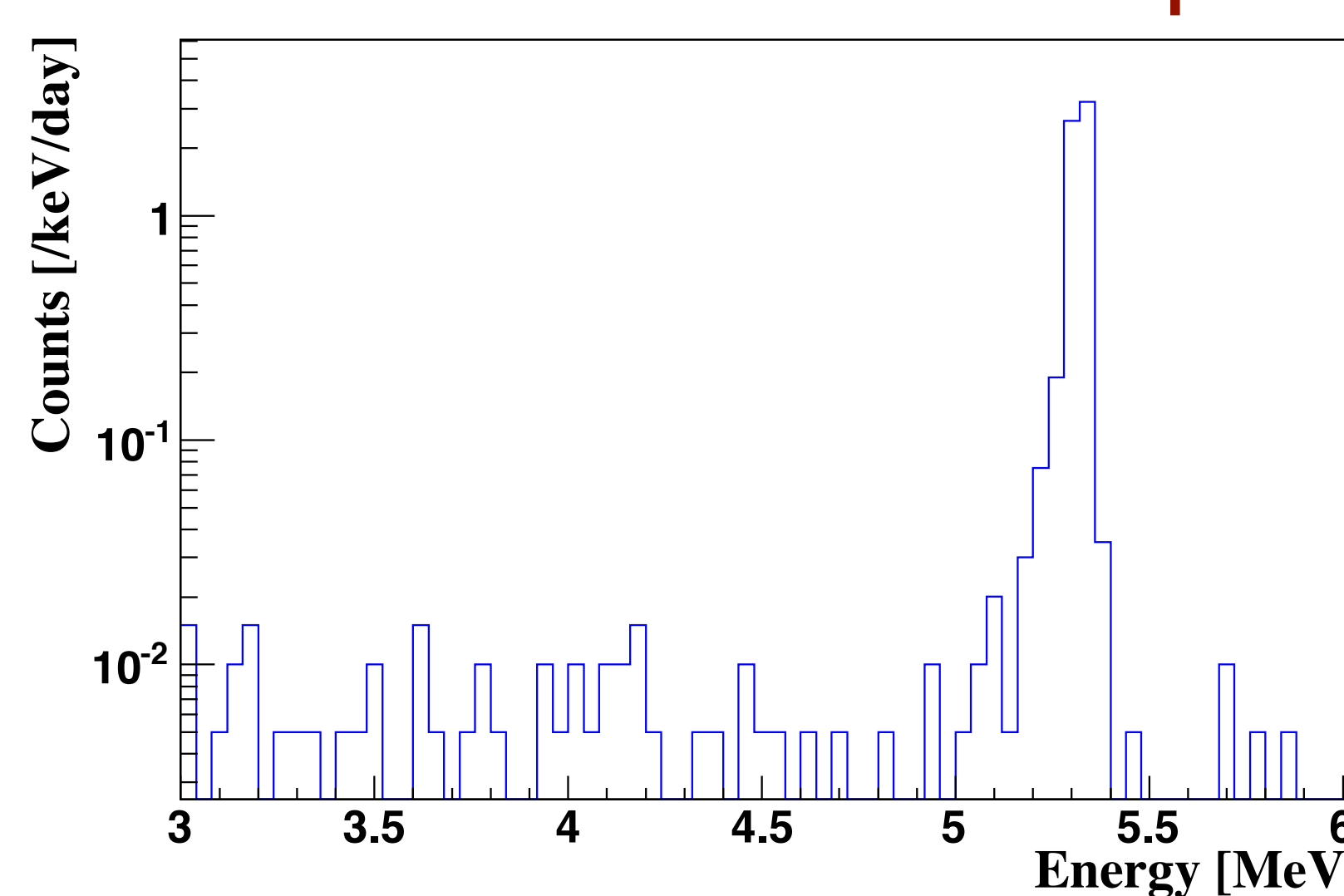
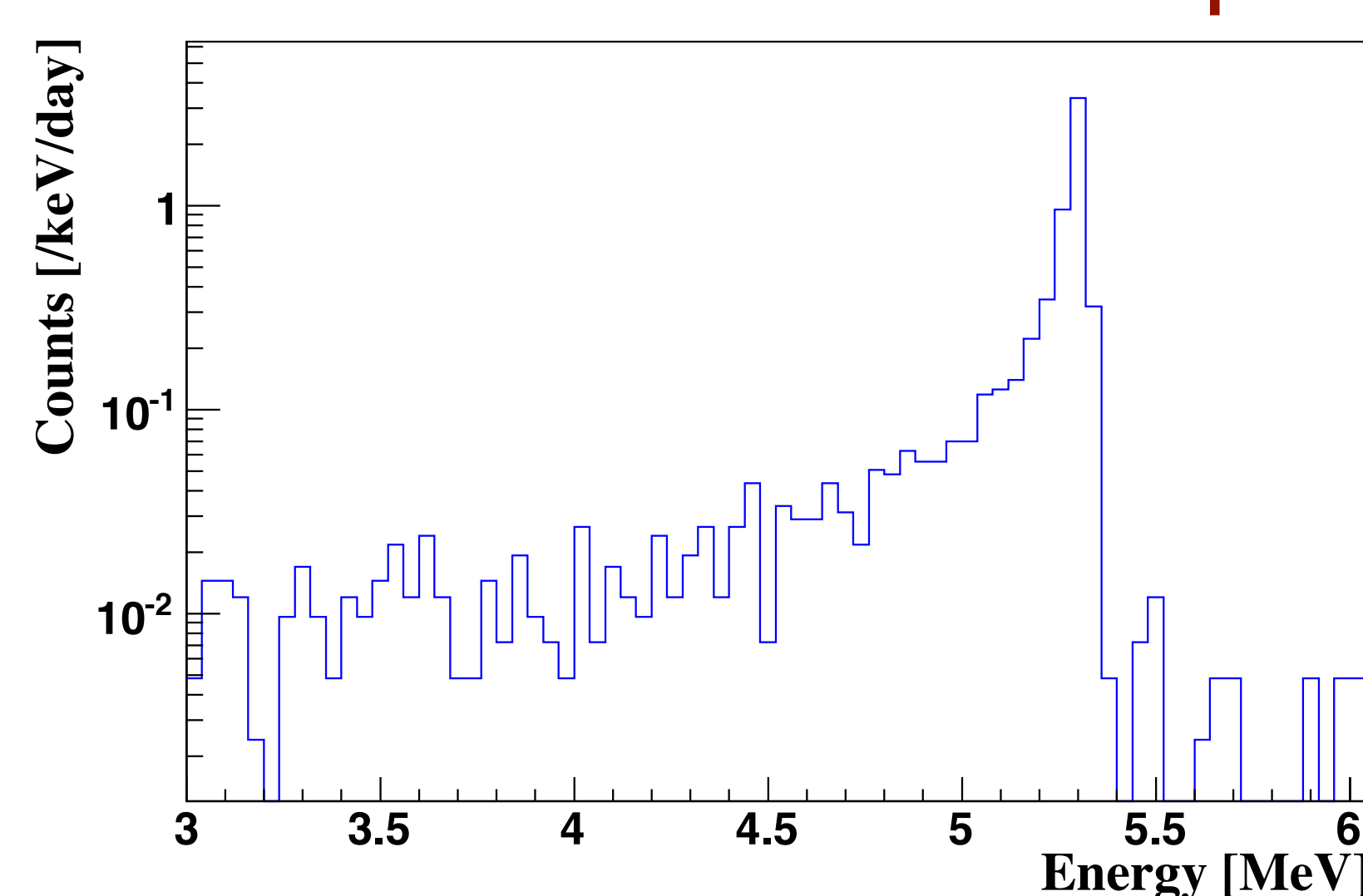


$R = 0.660 \mu\text{m}$



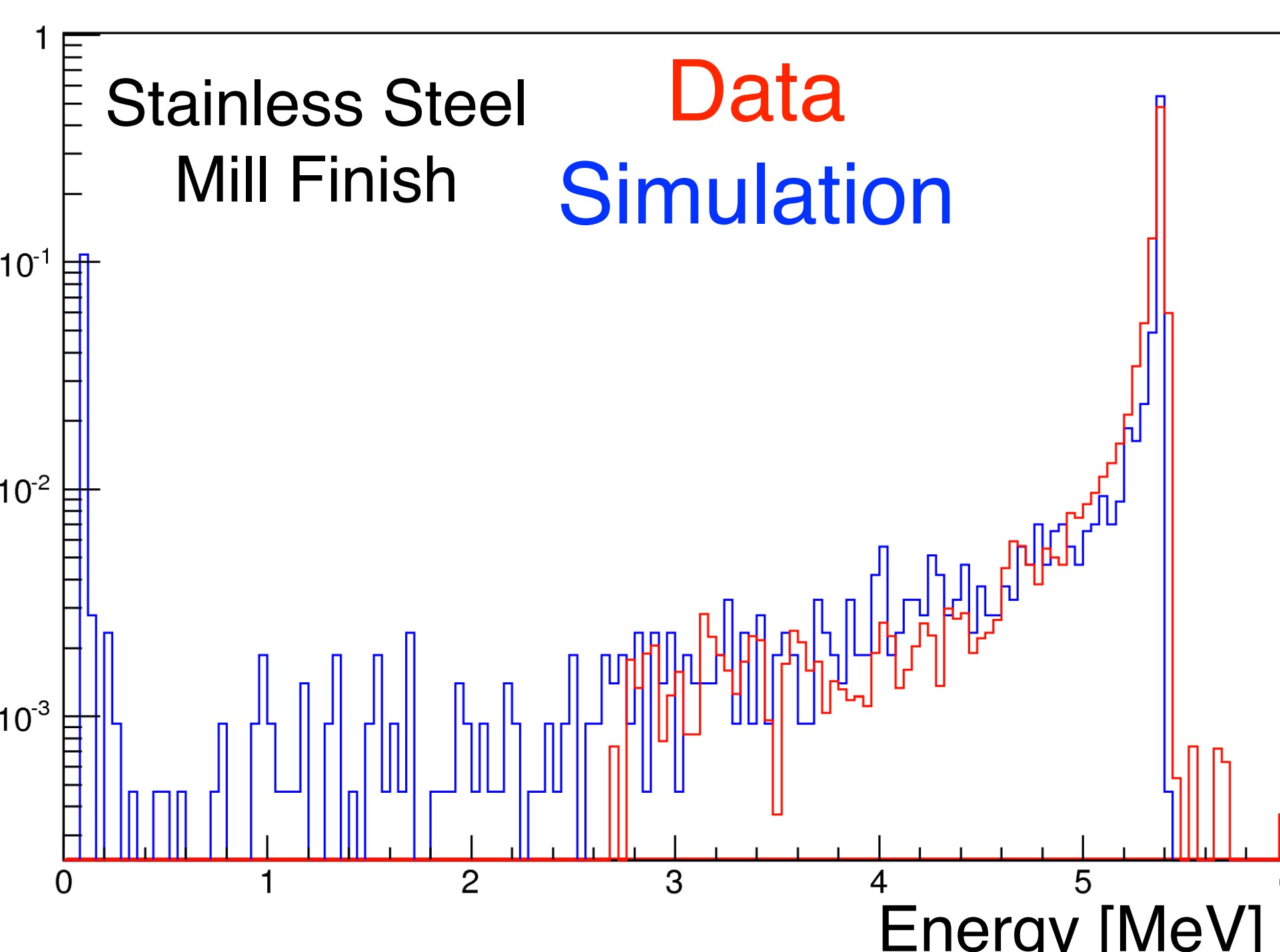
$R = 0.032 \mu\text{m}$

^{210}Po Spectrum



Model: Geant4 simulation

- ^{218}Po on surface; decay to ^{210}Pb for implantation depth (down to $0.1 \mu\text{m}$)
 - Using validated nuclear recoil range (SRIM)
- Extend depth to effectively model extra material from roughness (exponential down to R)
- simpler than including roughness in geometry
- Further extend depth for diffusion and bulk backgrounds



We gratefully acknowledge the support of the U.S. Department of Energy through Award Number DE-SC0005054.

Summary:

- A realistic radon progeny implantation depth and effective roughness correction is necessary to model the low energy tail from surface α decays
- Surface α decays from rough surfaces (even mill finish) can degrade to energies near a double-beta region of interest and low energy WIMP interactions