Measurement and modeling of cosmic ray exposure for SuperCDMS dark matter detectors.


Introduction:
Dark matter is an unknown type of matter that composes roughly 27% of the observable universe.
The Super Cryogenic Dark Matter Search (SuperCDMS) aims to directly detect dark matter particle candidates called WIMPs.
Due to the high-sensitivity of the germanium detectors employed, shielding from cosmic rays is paramount.
Secondary cosmic ray exposure (specifically protons, neutrons and muons) to the above ground germanium detectors produces a β decay background that diminishes WIMP detection sensitivity.
In order to model this background radiation, location specific attenuation parameters need to be developed, which was the goal of this work.

Materials and Methods:
Located across the U.S and Canada; attenuation factors were needed for a total ten sites of experiment or detector fabrication.
Three main variables were of interest; elevation, position within earth’s geomagnetic field, and time of exposure in respect to the sun’s solar cycle.
Muon, proton, and neutron reference fluxes were obtained from a literature review.
Predicted cosmic ray fluxes were compared to CRY computer simulations.
Muon fluxes predicted at PNNL were compared to on site measured fluxes.
Different methods of calculating attenuation factors for altitude were compared.

Results:
For each of the ten locations, three attenuation factors were developed. These were applied to 3 independent particle fluxes resulting in 110 separate fluxes. CRY simulations as well as measured above/below ground muon rates at PNNL were used for cross-checking. Measured Counts = 2.20 counts/sec, CRY = 3.07 counts/sec. Predictedβ = 3.56 counts/sec. Predictedβ = 3.93 counts/sec.

Acknowledgments
This material is based upon work supported by the National Science Foundation through the Robert Noyce Teacher Scholarship Program under grant 1546150. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. The research was made possible by the California State University STEM Teacher Researcher Program in partnership with PNNL.