

Development of an Enclosure for Cryogenic Dark Matter Detectors excluding Electromagnetic Radiation

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Abstract

The goal of this project was to develop a platform capable of supporting multiple families of dark matter detectors, that was capable of greatly improving the amount of photon pollution blocked by the enclosure as well as reaching cryogenic temperatures of 4 millikelvin. To accomplish this, copper was formed in such a way to thermodynamically assist in the cooling of the structure, while sealing in such a way that most of the noise would be attenuated by the enclosure.

Introduction

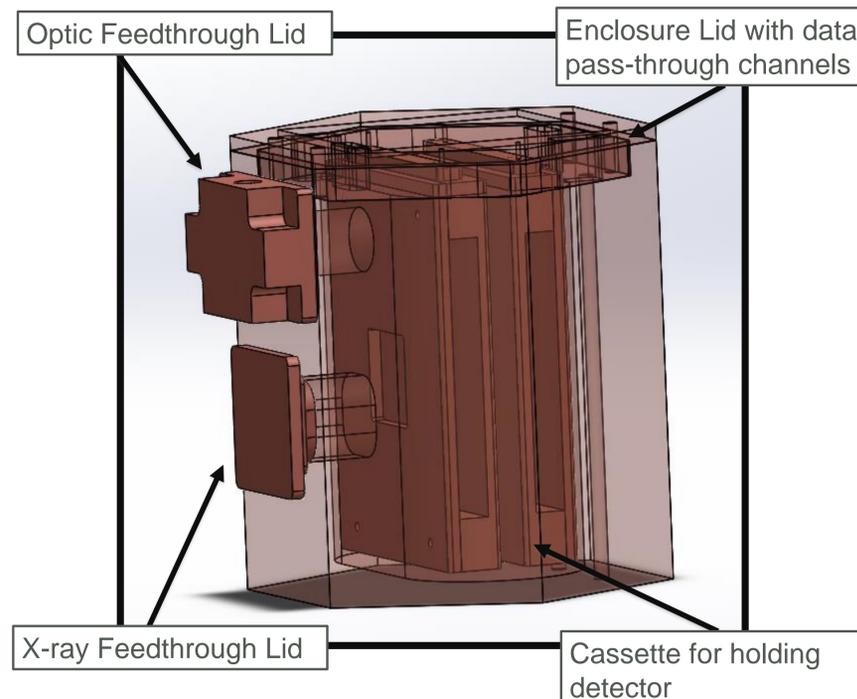
Fermilab's search for dark matter as a weakly interacting massive particle leads to a strong desire for a product that can shield an ultra sensitive detector from various noise sources. Additionally, these ultra sensitive detectors can only operate at cryogenic temperatures, and as a result the enclosure needs to not only shield the detector from external sources of noise, such as standard light, but also be able to withstand a transition from room temperature to 4 millikelvin



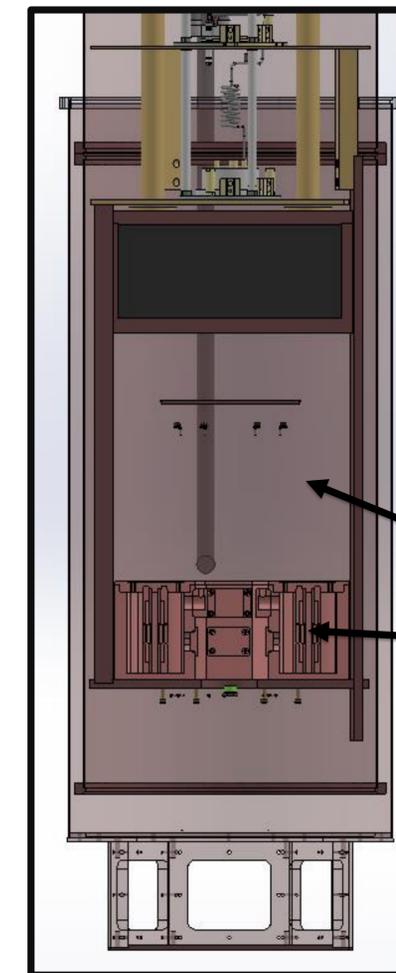
Methods and Materials

High purity copper was found to be the best material for the enclosure, as it has the perfect blend of signal attenuation, specific heat, and thermal contraction rates. Additionally, Copper emits relatively little radiation at cryogenic temperatures, removing another source of noise. The enclosure can be seated to the optical table in Fermilab's NEXUS fridge to cool to cryogenic temperature and has a cassette design to snugly fit the detector crystal.

Results



Discussion and Conclusion



The successes or failings of the design will be proved once the manufacturing and testing is complete. Regardless of the completeness of the project as far as reaching all outlined goals there has been much progress made.

NEXUS Fridge 4mK chamber

Detector Enclosures

The current iteration of the design eliminates many of the problems in previous models and improves on many of the desired features.

Acknowledgements

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