

# Introduction and Motivation

- Dry-cask storage containers are the only form of long-term storage in the U.S.
- The amount of shielding required to reduce dose rates causes difficulties for x-ray and neutron imaging.
- Cosmic-ray muons are a natural source of highly energetic and highly penetrating particles.
- Imaging techniques can be tested on barrel set up before new cask data is collected.



MMT supermodules placed on opposite sides of the Westinghouse MC-10 Fuel Cask at INL [Poulson, 2019].

# **Mission Relevance**

Muon Imaging techniques can be used to prevent nuclear weapons proliferation by

- Maintaining continuity of knowledge of spent fuel in dry-cask storage
  - Identify if nuclear material has been removed from storage containers



# **Plenoptic Muon Imaging of Various Test Setups**

Dominic Lioce\*, Jesus Valencia\* University of New Mexico Adam Hecht, hecht@unm.edu Consortium for Monitoring, Technology, and Verification (MTV)



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- This work utilizes the Mini-Muon Tracker, developed by Los Alamos National Laboratory's Threat Reduction Team. Consists of two drift tube arrays (supermodules), placed on either side of object of interest Each array is made up of alternating stacks of drift tubes, allows for muon tracking in three-dimensions. For muons that interact with both supermodules, position and trajectory information is stored for each array. Position and trajectory data from both supermodules used
  - for reconstruction.







imaging methods at x = 103 cm (barrel handle). This work was funded in-part by the Consortium for Monitoring, Technology, and Verification under Department of Energy National Nuclear Security Administration award number DE-NA0003920

- - This technology was previously used to image the UNM reactor. Muon imaging has been utilized at the Fukushima Daiichi site.

# Conclusion

- Plenoptic imaging (using depth information) has been applied to barrel images to increase clarity of imaged objects. Cask imaging and verification in the future can aid non-proliferation efforts.
- Finalize Geant4 simulations of MC-10 cask Continue mock-up measurements at LANL





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### MTV Impact

- What is the impact of the MTV on your development?
  - MTV Fellow Jesus Valencia is supported by this work
- Personnel transitions: Plans for future relationship with national labs
  - Collaborating with Matthew Durham and Daniel Poulson from LANL to perform measurements at LANL.
- Technology transitions

#### **Next Steps**

