MCNP Training Modules for Safeguards Practitioners

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Problem Statement

- Monte Carlo N-Particle (MCNP) software is a vital tool for international safeguards

- No training modules exist specifically for international safeguards applications nor do any existing training modules address the complete set of specific needs of safeguards practitioners

Proposed Solution and Approach

- Training modules, suitable for virtual and in-person delivery, were developed to fill this gap

- Utilized existing content created for other MCNP training courses as the foundation for the course materials

- Added safeguards-specific content

- Replaced exercises with safeguards-relevant examples

Overview of Units

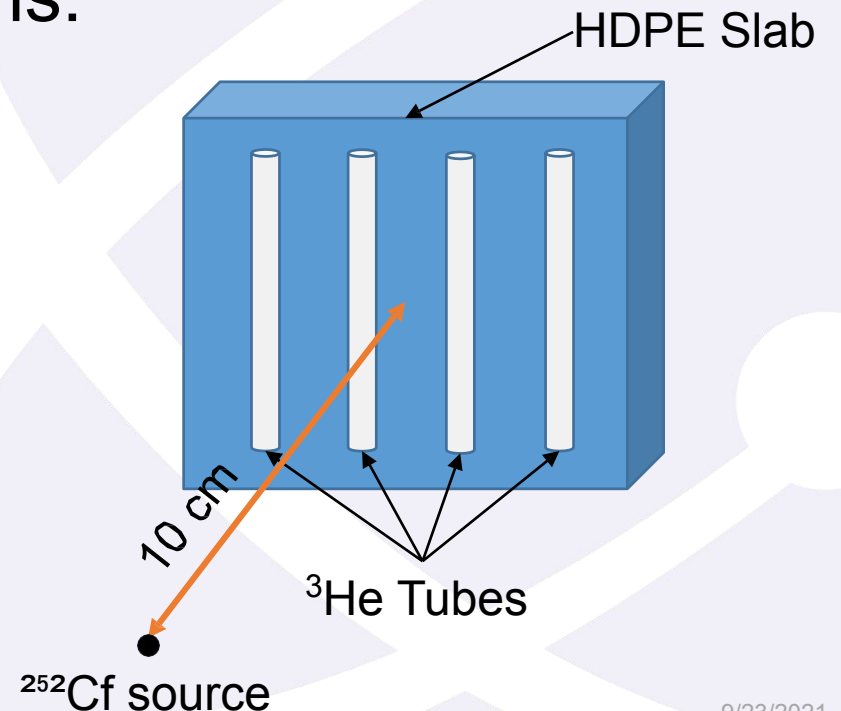| Unit 1: MCNP Basics for International Safeguards	Unit 2: Advanced Topics in MCNP for International Safeguards

• Cohesive set of modules to cover basic MCNP material with a focus on building neutron detectors
  – Geometry
  – Common material definitions
  – Fixed source definitions
  – Capture tallies
 	
• Approximately 1 week in length
	• Mix-and-match modules to cater to the audience
	  – Burn-up simulations
	  – MCNPTools & PTRAC
	  – Gamma detectors
	  – Principles of benchmarking
	• Approximately 1 week in length with the option to add individual modules to the basic course as time permits

Unit 1: MCNP Basics for International Safeguards

- Geared towards intermediate MCNP users

- Examples focus on international safeguards applications

- Modules include:
  - Introduction to MCNP
  - MCNP Basics Overview for International Safeguards
  - Advanced Geometry Concepts
  - Fixed Source Definitions
  - Capture Tallies, Print Tables, and Output Files
  - Capstone: NDA System Optimization

Capstone: NDA System Optimization Exercise

- Apply knowledge from entire course to optimize NDA system as a class

- Parameters to consider and how to optimize them using a basic neutron detector and fixed source definitions:
  - HDPE density & thickness
  - Response to different neutron sources
  - Effects of source encapsulation
  - Coincidence counting

HDPE Slab

^{3}He Tubes

10 cm

^{252}Cf source

Unit 2: Advanced Topics in MCNP for International Safeguards

- Gamma detectors

- Burn-up simulations

- SOURCES-4C

- ISC

- MCNPTools/PTRAC for Safeguards

- Principles of benchmarking

Summary of Project Outcomes

- Content created for an MCNP course for safeguards practitioners
- Established collaboration between safeguards practitioners and MCNP developers
- Proposal for internal funding to hold a pilot course for safeguards researchers in NEN division
- Funding from NA-241 to hold a course in FY22 for safeguards researchers

Project Summary

- Description: Develop MCNP training modules, suitable for virtual and in-person delivery, for safeguards practitioners using existing course content

- Outcome: MCNP training modules were created specifically for safeguards practitioners

- PI: Alexis C. Trahan

- Budget: $38.5k

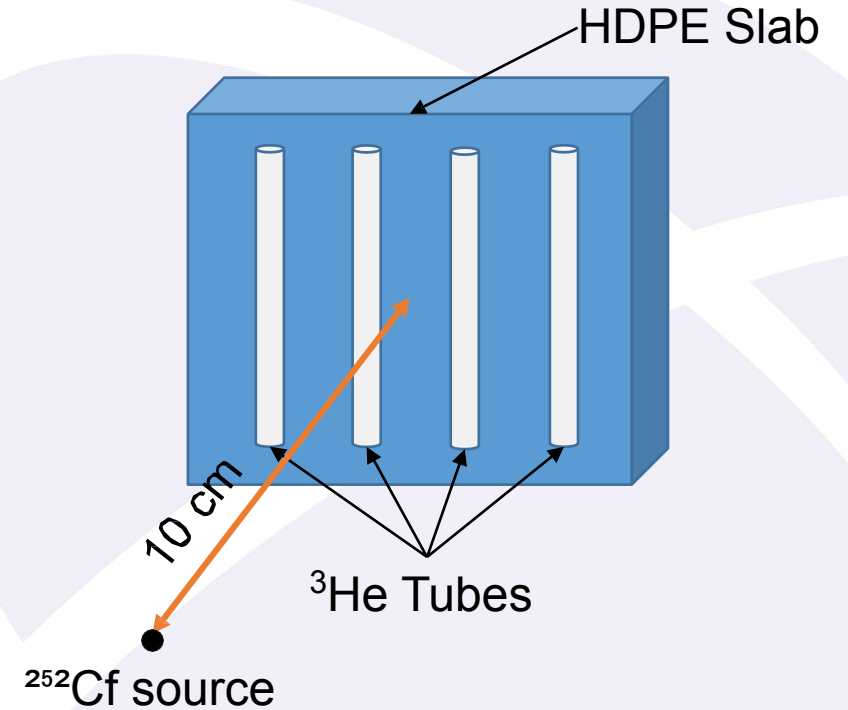- ISTI Focus: Computer and Computational Science, Training

Fig. 1. A basic neutron detector consisting of an HDPE slab and four 3He tubes with a 252Cf source positioned 10 cm from the centerline of the detector.

Acknowledgments

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