Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное образовательное учреждение высшего образования

«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»

Направление подготовки/профиль: 14.06.01 Ядерная, тепловая и возобновляемая энергетика и сопутствующие технологии, 2.4.9 Ядерные энергетические установки, включая проектирование, эксплуатацию и вывод из эксплуатации
Школа: Инженерная школа ядерных технологий
Отделение: Научно-образовательный центр международного ядерного образования и карьерного сопровождения иностранных студентов

Научно-квалификационная работа

Тема научно-квалификационной работы
Оптимизация эффективности и разрешения в альфа-спектрометрических измерениях с различной геометрией и материалом коллиматоров.

УДК 539.1.075:621.384.8

Аспирант

Группа	ФИО	Подпись	Дата
А9-43И	Амоах Питер Атта		

Руководителя профиля подготовки

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Директор ИЯТШ	Долматов О.Ю.	к.ф.- м.н., доцент		

Руководитель отделения

Должность	ФИО	Ученая степень, звание	Подпись	Дата
И.о. зав. каф. – руководитель НОЦ ЦМЯО на правах кафедры	Верхотурова В.В.	к.ист.н.		

Научный руководитель

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Директор ИЯТШ	Долматов О.Ю.	к.ф.- м.н., доцент		

Томск – 2023 г.

Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное образовательное учреждение
высшего образования

**«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

Field of training (specialty): 14.06.01 Nuclear, Thermal and Renewable Energy and Related Technologies, 2.4.9 Nuclear Power Plants: Design, Operation and Decommissioning
School: Nuclear Science & Engineering
Division: Research and Training Centre for International Nuclear Education and Career

Scientific qualification work

Title
Optimization of Efficiency and Resolution in Alpha Spectrometry Measurements with Varying Geometries and Material of Collimators.

UDC 539.1.075:621.384.8

PhD student

Group	Full name	Signature	Date
A9-43и	Peter Atta Amoah		

Programme Director

Job position	Full name	Academic degree, academic rank	Signature	Date
Director of Nuclear Science & Engineering School	Oleg Yu. Dolmatov	Candidate of Science, associate professor		

Research and Training Centre for International Nuclear Education and Career

Job position	Full name	Academic degree, academic rank	Signature	Date
Head of Research and Training Centre for International Nuclear Education and Career	Vera V. Verkhoturova	Candidate of Science, associate professor		

Scientific supervisor

Job position	Full name	Academic degree, academic rank	Signature	Date
Director of Nuclear Science & Engineering School	Oleg Yu. Dolmatov	Candidate of Science, associate professor		

Tomsk – 2023

Abstract

A study to analyse the optimization of counting efficiency and energy resolution in alpha spectrometry measurements with different collimator geometries has provided more insight with the output data obtained. Experimental and simulation analysis were undertaken with Isotropic ^{241}Am, ^{244}Cm, and ^{238}Pu sources to assess the mesh-hole collimator geometries with diameters of 2.5 mm, 4.0 mm, 5.0 mm, and 6.0 mm. Without the use of the collimator, efficiency values of 7.89±0.04 %, 27.2±0.23 %, and 27.0±0.12 % were obtained from ^{241}Am, ^{238}Pu, and ^{244}Cm respectively. The corresponding Full Width at Half Maximum (FWHM) data obtained for ^{241}Am, ^{238}Pu, and ^{244}Cm were 34.53±0.43 keV, 32.77±0.27 keV, and 30.68±0.10 keV respectively. With the application of the circular geometries, the resolution of Am-241 had increased by significant differences of 13.76 %, 10.60 %, and 13.99 % with the 2.5 mm, 4.0 mm and 5.0 mm collimators respectively. Whiles increments of 20.45 %, 10.47 %, and 7.81 %were obtained for Pu-238 with the 2.5 mm, 4.0 mm and 5.0 mm collimators respectively. Cm-244 produced fairly steady increments in resolution of 17.08 %, 19.20 %, and 20.99 % with the 2.5 mm, 4.0 mm and 5.0 mm collimators respectively. The application of the collimator significantly reduced the counting efficiency values, producing 1.03±0.01% (Am-241 at 2.5 mm), 2.05±0.01% (Pu-238 at 2.5 mm), and 2.71±0.01% (Cm-244 at 2.5 mm). With the application of the hexagonal mesh-hole collimator, the resolution of Am-241 increased by differences of 20.36 %, 14.94 %, and 13.61 % with the 2.5 mm, 4.0 mm and 5.0 mm collimators respectively, and 22.00 %, 19.16 %, and 17.67 % for Pu-238 from 2.5 mm, 4.0 mm, and 5.0 mm respectively. Whiles with Cm-244 increased differences of 13.36 %, 12.71 %, and 11.54 % were recorded for 2.5 mm, 4.0 mm, and 5.0 mm respectively. The triangular mesh-hole collimator was identified to be relatively more effective in enhancing energy resolution with 26.74 ± 3.19% improvement for Pu-238 and 16.82 ± 0.20 % for Am-241, compared to the enhancements of 24.55 ± 2.36% and 15.64 ± 0.40 % respectively with the hexagonal mesh-hole collimator. A significant compromise of 87.32% and 77.87% were evaluated as the maximum loss in efficiency with the triangular geometries and hexagonal geometries respectively. Though theoretically proven to be inadequate, the circular mesh-hole collimator has provided quite good results with the output data. It has been shown through this study that the triangular geometry can adequately replace the hexagonal geometry to deliver outstanding results as well. The energy resolution datasets of 22.68 keV and 24.78 keV with the use of the triangular and hexagonal mesh-hole collimators respectively are very encouraging, considering the 9.5 mm distance from the collimator to the detector.