Supplement of

Developing a radiation field-based monitoring system for the transport and storage cask inventory during extended interim storage

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Developing a radiation-field-based monitoring system for the transport and storage cask inventory during extended interim storage

Motivation and Task

- Radiation-field outside CASTOR® V/19-cask at the cylinder surface (simulated with MCNP6.2)
- Spent nuclear fuel: medium burn-up of 56.7 GWd/tHM and 5 years cooling time
- Fuel distribution changes: axial redistribution at different fuel assembly positions

Gamma- and Neutron-Fields: Simulation

- Gamma-field shows only changes at outer fuel assembly
- Subsiduation more recognizable at lower energies

Cosmic Muons: Volume Reconstruction

Maximum Likelihood estimation:
  - Discretization of the object
  - Assume path through the object (PoCA or more likely path)
  - Calculate the muon path length for every muon and voxel “system matrix”
  - Solve the linear equation system with measured data
  - Full container simulation:
    - Simulation of cosmic muons with G4beamline
    - Measurement time = 12 h (5.3¹⁷ events)
    - MLEM-reconstruction with region clustering

Gamma- and Neutron-Fields: Measurement System

- Neutron-field shows changes at outer and inner fuel assembly
- Subsiduation more recognizable at lower energies

- Simulation with fuel relocation:
  - 9 cm vertical subsiduation → Vertical scattering density profile of central fuel assembly (normalized)

References

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Support safety during prolonged interim storage and elongation of approval