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Modeling & Simulation of Geologic Repository Spent Fuel Canisters

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Group Members & Sponsors

Group Members

- Bellamie Curyea
- Savanah Scott
- Andrew Prince
- Daniel Espinoza

Group Sponsors

- Dr. Camille Palmer - OSU
- Jacob Benz – PNNL
- Halianne McGee- Hilbert - PNNL

Background

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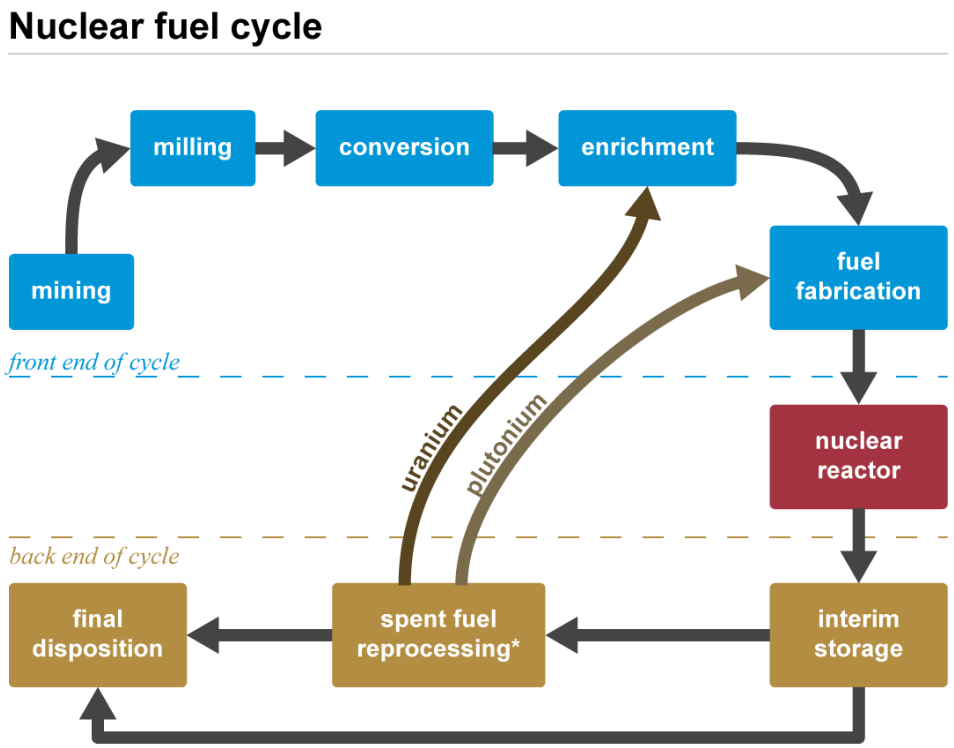
Key Terms

- Deep Geologic Repository
- Spent Fuel
- KBS-3
- Scintillator
- Photomultiplier
- Continuity of Knowledge (CoK)
- MCNP

Nuclear Fuel Cycle



**Spent fuel reprocessing* is omitted from the cycle in most countries, including the United States.

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Problem Statement

- Design a multi-component system capable of safeguarding spent fuel held within geologic repositories that will operate at an autonomous level.
- Address the deep penetration shielding issue by running MCNP to test the ability of the proposed system to detect radiation through some backfill media.

Design Considerations

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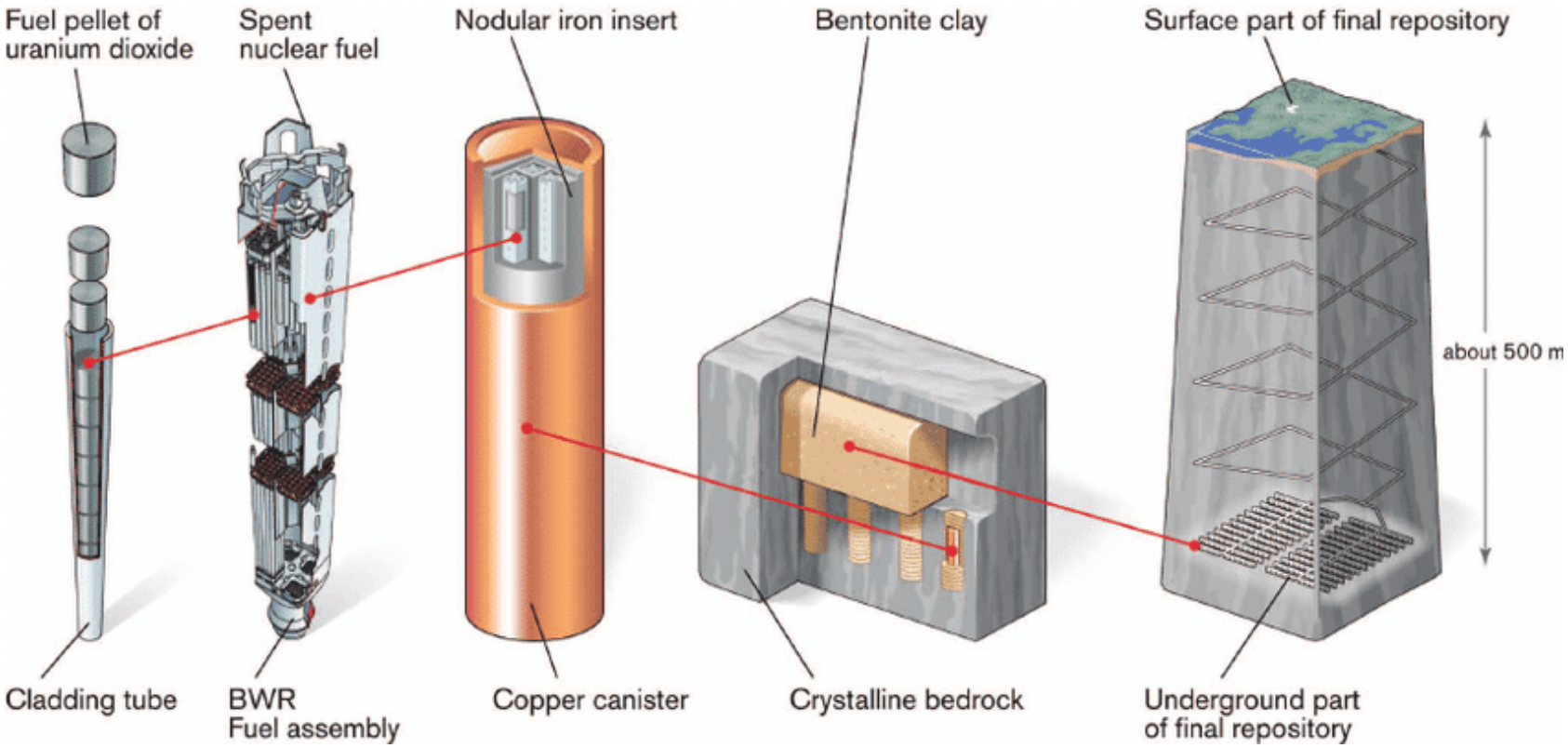
Design Challenges

- The design must be:
  - Environmentally Sturdy
  - Resistant Malicious Tampering
  - Easy Implementation
  - Cost Effective

KBS-3


Fuel pellet of uranium dioxide
Spent nuclear fuel
Nodular iron insert
Bentonite clay
Surface part of final repository
about 500 m
Cladding tube
BWR Fuel assembly
Copper canister
Crystalline bedrock
Underground part of final repository

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Design Components

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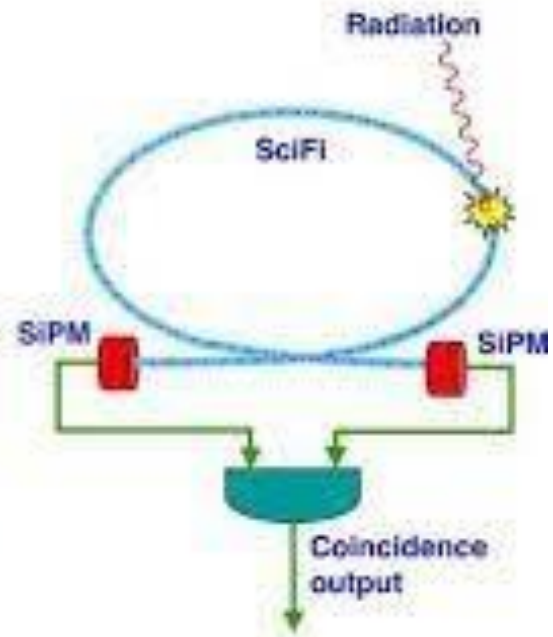
Detector Mesh for Nuclear Repositories (DMNR)

- A net of radiation detection that utilizes scintillating wires and photomultiplier tubes
- Would be wrapped around the canisters themselves



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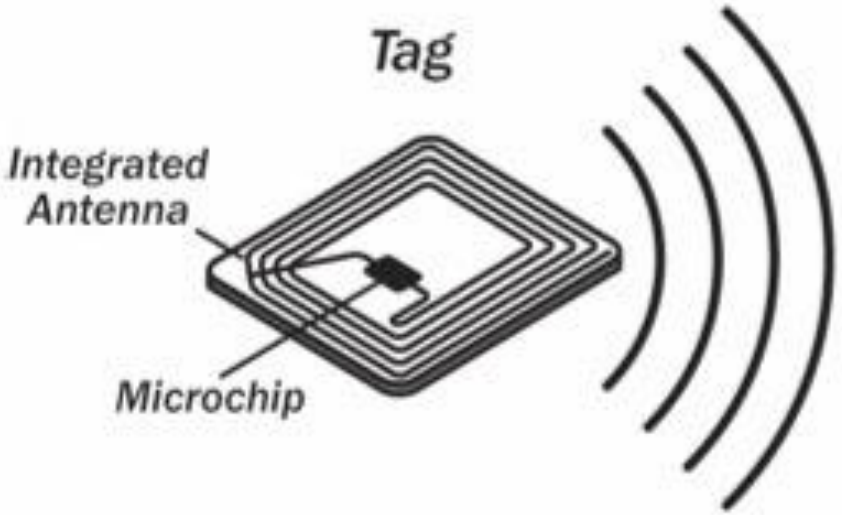
Radio-frequency Identification (RFID) Tags

- RFID tags embedded into each canister, with sensors throughout the travel route to the final deposition site



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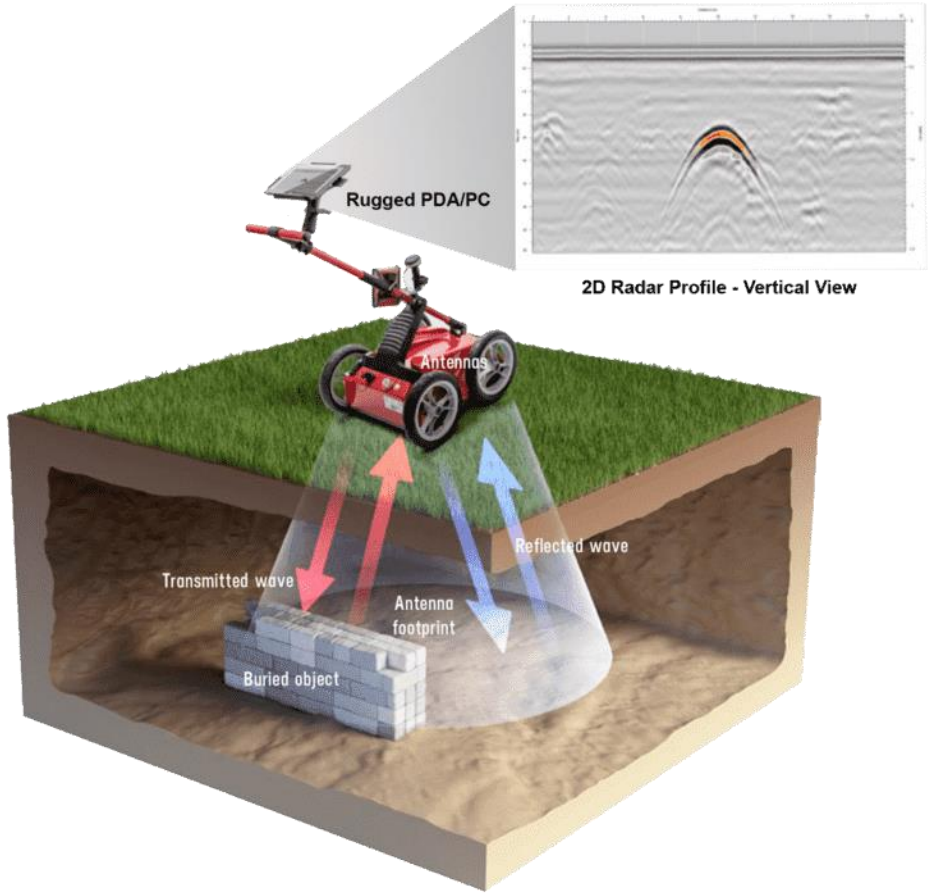
Ground Penetrating Radar (GPR)

- Unmanned GPR to check that the canisters remain where declared



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Weight Sensors

- Weight sensors placed below the canister to detect the removal of nuclear material from the spent fuel canisters

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Practical Work

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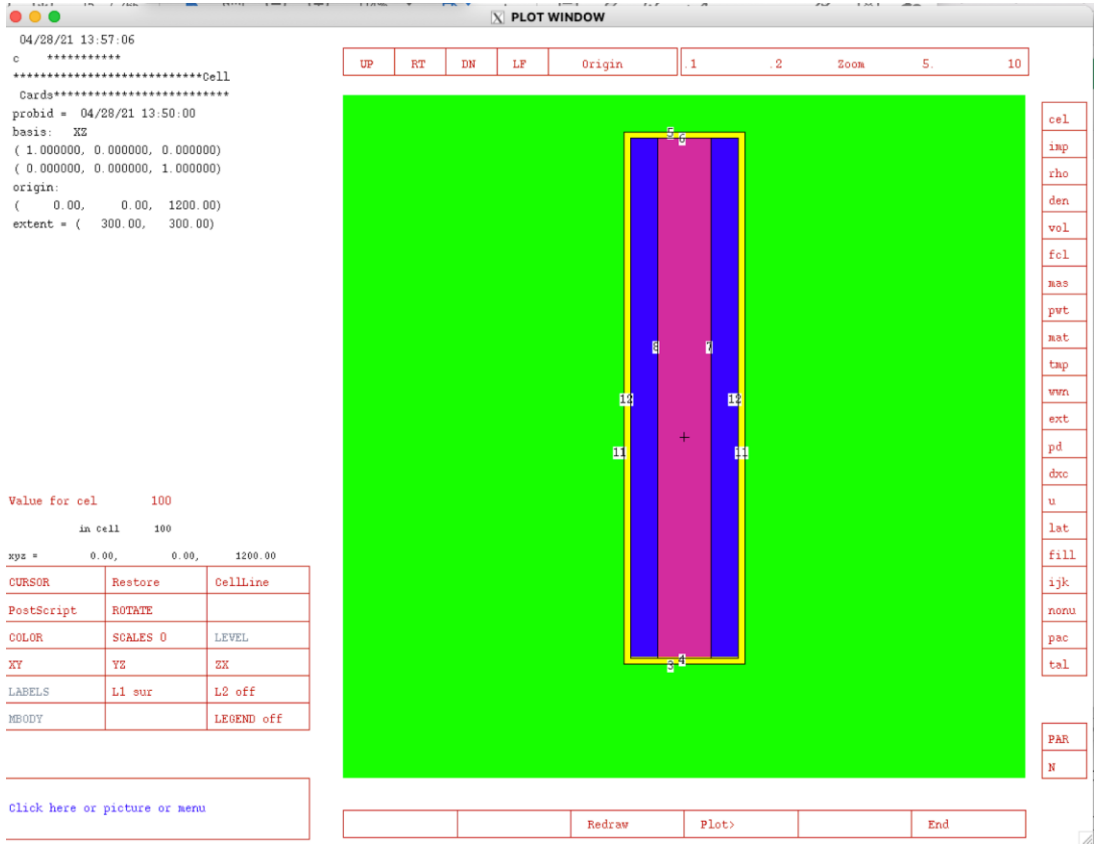
Simulation/ Modeling

- MCNP for neutron and gamma tracking.
- Use of SolidWorks to develop additional visual models



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Significance

- Aids in maintenance of the nuclear non-proliferation treaty
- Safeguarding of spent fuel
- Developing guidelines for the IAEA for newly developing repositories