PhD Thesis Defense

Nuclear Science and Engineering Program

Design, Construction, and Demonstration of a Neutron Beamline and a Neutron Imaging Facility at a Mark-I TRIGA Reactor

Aaron E. Craft

The fleet of research and training reactors is aging, and no new research reactors are planned in the United States. Thus, there is a need to expand the capabilities of existing reactors to meet users' needs. While many research reactors have beam port facilities, the original design of the United States Geological Survey TRIGA Reactor (GSTR) did not include beam ports. The MInes NEutron Radiography (MINER) facility developed by this thesis and installed at the GSTR provides new capabilities for both researchers and students at the Colorado School of Mines. The facility consists of a number of components, including a neutron beamline and beamstop, an optical table, an experimental enclosure and associated interlocks, a computer control system, a multi-channel plate imaging detector, and the associated electronics.

The neutron beam source location, determined through Monte Carlo modeling, provides the best mixture of high neutron flux, high thermal neutron content, and low gamma radiation content. An MCNP model of the neutron beam provides researchers with a tool for designing experiments before placing objects in the neutron beam. Experimental multi-foil activation results, compared to calculated multi-foil activation results, validate the model. The validated MCNP model predicts a neutron beamline flux of $2.2*10^6 \pm 6.4*10^5$ n/cm^2-s based on a source particle rate determined from the foil activation experiments when the reactor is operating at a power of 950 kW$_t$ with the beam shutter fully open. The average cadmium ratio of the beamline is 7.4, and the L/D of the neutron beam is ≈200±10.

Radiographs of a sensitivity indicator taken using both the digital detector and the transfer foil method provide one demonstration of the radiographic capabilities of the new facility. Calibration fuel pins manufactured using copper and stainless steel surrogate fuel pellets provide additional specimens for demonstration of the new facility and offer a comparison between digital and film radiography at the new facility. Comparison of the radiographs taken by the two methods reveals that the digital detector does not produce high quality images when compared to film radiography.

DATE: January 17
TIME: 1:00-3:00 PM
LOCATION: Hill Hall 300