

# MONTE CARLO NEUTRONIC SIMULATIONS FOR A NEW APPROACH TO PARAMETRIC INAA AND Mo-99 PRODUCTION FEASIBILITY AT MURR

Nickie Peters

Dr. J. David Robertson, Dissertation Supervisor

## ABSTRACT

A novel approach to parametric instrumental neutron activation analysis at MURR has been established. In particular, a detailed MCNP5 steady-state model of the MURR core was developed. The model, which was based on the most recent continuous-energy neutron data from the ENDF and JEFF neutron libraries, was used to compute the local continuous-energy neutron flux distribution. By coupling the computed flux spectrum to the energy-dependent  $(n, \gamma)$  cross-sections for a range of nuclides, their intrinsic reaction rates were predicted in irradiation channel ROW2. The model was initially benchmarked by measuring the intrinsic  $(n, \gamma)$  reaction rates for a set of mostly dilute single-element standards in ROW2.

Predictions of the intrinsic reaction rates for many nuclides, including those with high epithermal sensitivity and non- $1/v$  behavior, are within  $\pm 5\%$  of the measured values. Using predicted  $(n, \gamma)$  reaction-rates, trace-elemental concentrations were determined in NIST standard reference materials, bovine liver, obsidian and coal fly ash. The agreements with the certified concentrations were generally within  $\pm 5\%$ . The new methodology has produced better results for a greater number of elements than  $k_0$ . The model was also combined with MONTEBURNS and ORIGEN to test the feasibility of Mo-99 production at MURR from fissioning LEU. Results from a 5-gram low-enriched uranium target show predictions of Mo-99 end-of-irradiation yields are within 3% of the measured value. This dissertation entails a complete study of the MCNP5 model and the new neutron activation analysis method.