INL/MIS-22-68712-Revision-0

Calculating Radiation Damage (DPA) from Transmutation Products

September 2022

Micah D Gale, Sebastian Schunert, Angelica Mata Cruz, Olin W Calvin, Daniel J Vanwasshenova

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Calculating Radiation Damage (DPA) from Transmutation Products

PRESENTER:

Sebastian Schunert

BACKGROUND:

- Radiation damage changes materials
- Methods ignore changing compositions
- 20% of damage can be missed in some materials

METHODS

1. Use existing transmutation solvers
2. Tested with Greenwood Ni-59 work

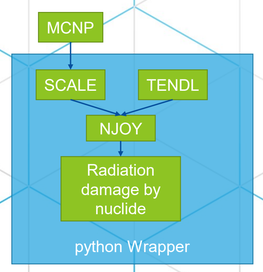
$$\frac{\partial \hat{E}}{\partial t} = \sum_{p=1}^{P}\left(\lambda_p \eta_p N_p(t) + N_p(t)\int_0^{\infty} \sigma_{D,p}(E)\phi(E,t)dE\right)$$

Introduced New Terms to Bateman System

$$\tilde{N} \equiv \left(N_1, \dots, N_I, \hat{E}\right)^T$$

$$\frac{\partial \tilde{N}}{\partial t} = \tilde{A}\tilde{N}$$

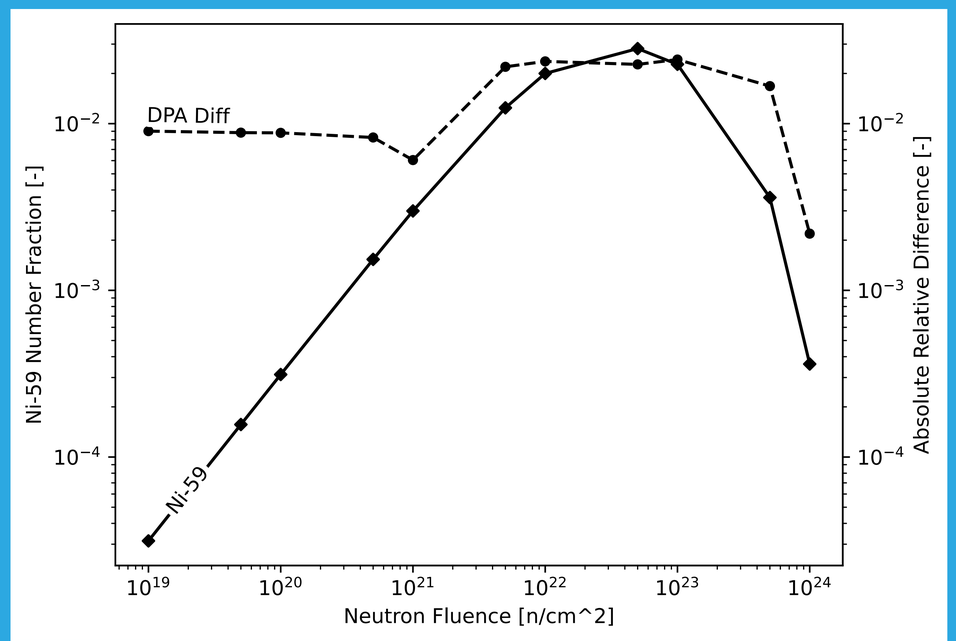
3. Systematically found sources of DPA
    1. See examples in plot


MCNP
SCALE
TENDL
NJOY
Radiation damage by nuclide
python Wrapper

4. Created *ab initio* models for damage from radioactive decay

Demonstrated that Existing Tools Can Easily & Accurately Calculate Radiation Damage.

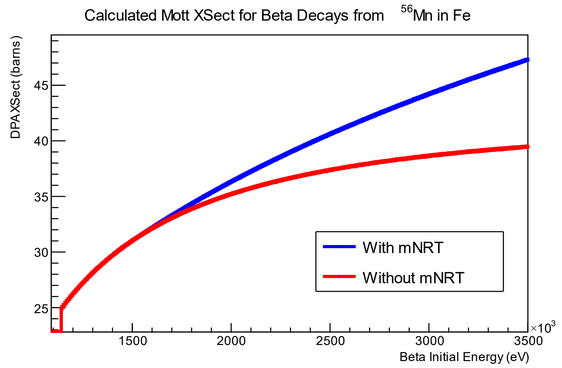
Demonstration performed in Griffin Transmutation Solver

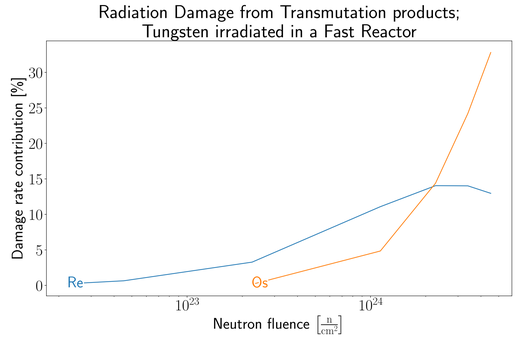


Difference in DPA in demonstration were due to rounding in benchmark article

Download the **full paper**

Additional Information





Publications

- M. Gale, O. Calvin, and S. Schunert, “Using Griffin’s Transmutation Solver to Calculate Radiation Damage,” PHYSOR. Pittsburgh, Pennsylvania, May 2022.
- M. Gale, O. Calvin, and S. Schunert. “Calculating Non-Nuclide Number Density Quantities of Interest in the Bateman Depletion Equations.” Nuclear Science and Engineering. Planned.
- M. Gale and A. Mata Cruz. “A Systematic Review of the Effect of Transmutation Products on Radiation Damage in Fission Reactors.” Journal of Nuclear Materials. Planned.
- D. van Wasshenova. “Investigation of Beta Decay Produced Damage with GEANT4.” Journal of Computational Physics. Planned.

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