ABSTRACT

The NEPAL project was a new opening for the SAFIR2014 programme by Aalto University. In the project, we had three main themes:

1. **Accurate burnup calculations** that aim at finding rare but potentially problematic nuclei like strong absorbers or other reactor-physically important nuclei. Additionally, it is important to know accurate concentrations of nuclei that are important for spent fuel disposal or nuclear safeguards.

2. **Behavior of nuclear fuel in a quasi-stationary situation.** Traditionally, the characteristics of fuel pellets are described on the basis of empirical data. Reliable modeling outside of the normal operating parameter range necessitates thorough understanding of the phenomena and their modeling in a mesoscopic scale. We developed a novel mesoscopic model of the thermal creep failure of fuel pellets.

3. **Coupling of the temperature distribution in a fuel pellet to neutronics.** Cross sections in neutronics depend on temperature, so a more accurate model of temperature distribution reduces errors in reactor core calculations. (This theme was continued at VTT from 2012 onwards, so it has been omitted from this poster.)

**THEME: ACCURATE BURNUP CALCULATIONS**

Monte Carlo burnup calculations combine sequential steady state neutronics and depletion calculations with a coupling scheme. On each step, the scheme uses one or more neutronics solutions and possible preliminary depletion calculations to predict representative step average values for quantities.

We have developed new higher order neutronics-depletion coupling schemes. These methods are based on using data from the previous step to form higher order predictions about the future development of the cross sections and flux.

**THEME: MESOSCOPIC MODELING OF FUEL PELLETS**

We are developing a computational model for simulating the microstructural evolution of nuclear fuel. The model includes damage accumulation from thermal creep deformation and from fission gas build-up within the pellet. Damage accumulation is linked with increasing porosity of the fuel, as microcracks and gas bubbles are formed. Diffusion of fission gases is simulated from the viewpoint of percolation theory; gas flows through interconnected pores, and can only reach the surface of the pellet through continuous pore pathways.

**DELIVERABLES**

These:


Papers and reports:

5. Isotalo, A.E., Comparison of Neutronics-Depletion Coupling Scheme for Burnup Calculations. Accepted for publication in Nuclear Science and Engineering, 2014.