MIT NSE Ph.D. Qualifying Exam:
Reactor Physics Oral Question, May, 2015

The US DOE is developing a new rectangular lattice, light-water-cooled, graphite-moderated reactor (LWCGMR) that uses standard Zr-clad UO_2 (5% enriched in U^{235}) fuel.

DOE is simultaneously developing a new set of core physics tools to compare the new reactor design with conventional LWRs. **DOE wants to use 3D deterministic multi-group neutron transport for core simulations. Your task is to develop a suite of analysis tools that will enable accurate core physics analysis** – regardless of the DOE designers' selection of pin/assembly dimensions and arrangements, fuel-to-coolant ratio, etc.

Gross LWCGMR Characteristics:

1. What impact will the graphite have on the reactor size?
2. In what ways will the LWCGMR neutron spectra differ from that of an LWR?
3. For the same burnup, how will the Pu^{239} inventory differ between LWCGMR and LWR fuel?

Cross Section Generation Methods:
DOE expects to generate multi-group cross sections using characteristic 2D lattices (e.g., single assemblies) as depicted schematically in the attached figures.

4. How will the LWCGMR lattice complexity affect the accuracy and choice of sub-group or equivalence-theory resonance self-shielding models for the lattice physics code?

3D Core Transport Methods:

5. What are some of the advantages and disadvantages of various **homogenized-pin-cell** or **explicit pin/clad/coolant** methods for solving the 3D transport equation?