MIT NSE Ph.D. Qualifying Exam:
Reactor Physics Oral Question, May 2016

As part of the TREAT reactor restart, analysts are studying various methods to model the reactor core and the many experiments proposed for the transient pulsed reactor.

Basic Reactor Physics:

1. If the reactor were precisely critical with all control rods fully withdrawn, what is your back-of-the-envelope estimate of k-infinity of the fuel blocks, knowing that the migration area for fission emission neutrons is 3500 cm^2 in pure graphite (1.60 g/cc)?
2. If one fuel block were to replace a graphite block at the **periphery** of the critical reactor core, what is your back-of-the-envelope estimate of the reactor k-effective?
3. If a fuel block were to replace the **central air channel** of the critical reactor, what is your back-of-the-envelope estimate of the reactor k-effective?

Homogenized Core Modeling and 2D Lattice Methods:

Analyzing the TREAT using multi-group diffusion theory with homogenized fuel/can/air blocks:

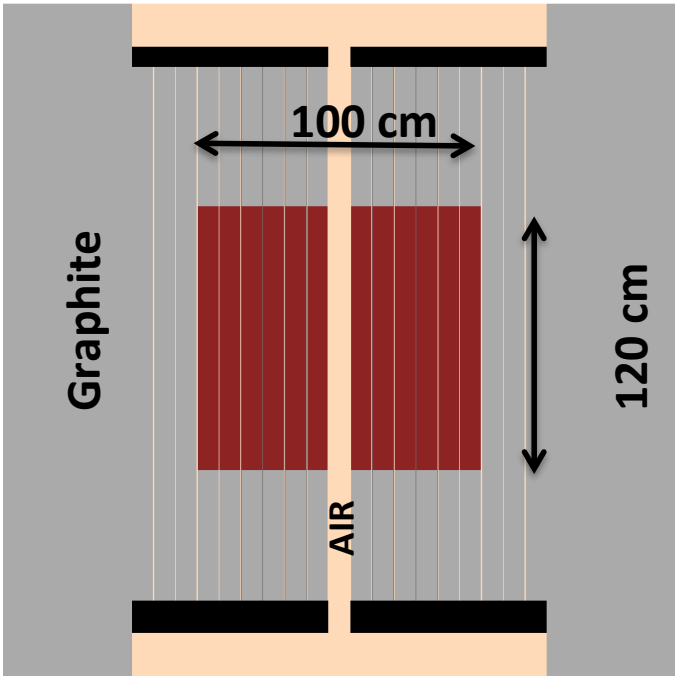
4. What spectrum would you use to generate lattice cross sections for fuel blocks and graphite reflector blocks?
5. How would you select the most appropriate energy group boundaries to capture reflector flux peaking effects?
6. How would you treat the air-gap axial neutron streaming impact on homogenized fuel block diffusion coefficients?
7. How would you account for the **93% enriched uranium metal particle's** 10-μm average grain size impact on thermal flux spatial self-shielding of the fuel/graphite mixture?

Transient Reactor Analysis:

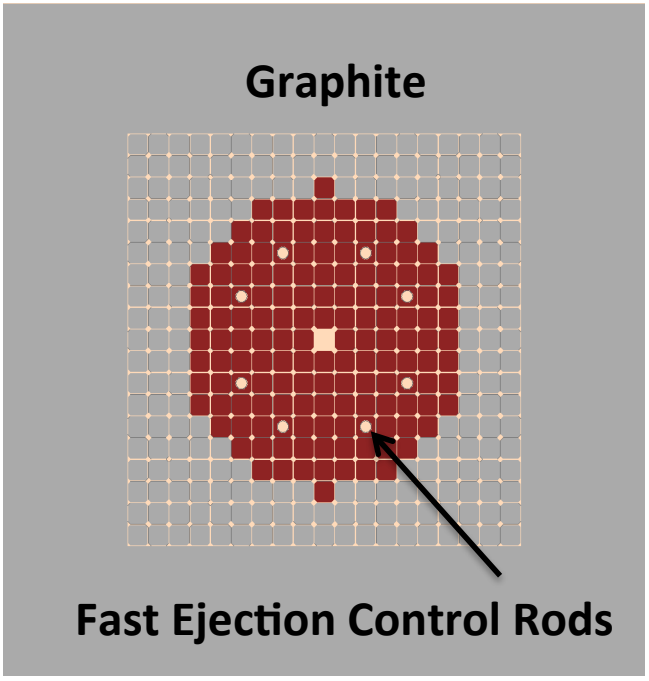
A 120 cm long fuel block (without axial reflectors) is suspended in the central air channel with its bottom located at the upper core/reflector interface, and the reactor is brought to exactly critical. The fuel block is then released and it falls by gravity (without friction) through both the core and lower reflector.

8. What is the time for the falling fuel block to be axially centered in the core?
9. Using first-order perturbation (FOP) theory, explain how you would estimate core reactivity vs. time as the fuel block falls.
10. If there were no reactivity feedback effects, what would be the approximate shape of the reactor power excursion?
11. What physical feedback effects might limit the reactor power excursion before the fuel block had fallen through the reactor core?

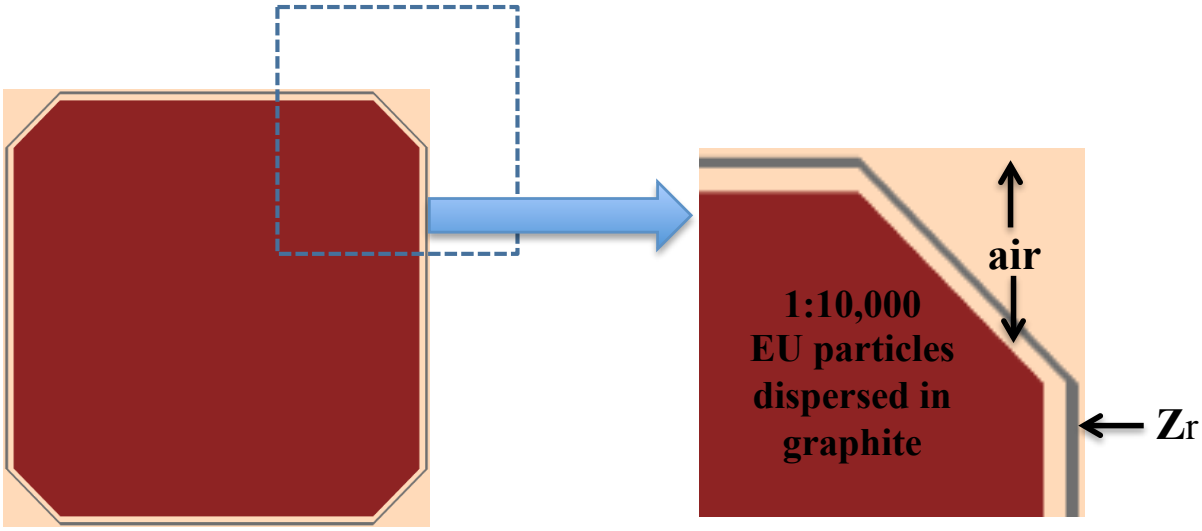
TREAT Pulsed Reactor



Vertical Slice



Horizontal Slice



Fuel Block

Neutron Cross Sections