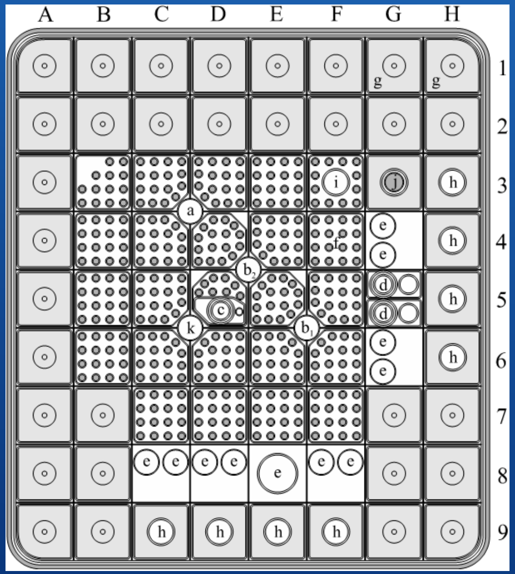
Critical experiment

BME Training Reactor, Exercise BME-05

Main topic: Reactor Physics / Subritical, critical and supercritical reactor

Keywords: criticality, subcritical system, 1/N method, doubling time, neutron detector

Purpose: In this experiment, one of the safest approach-to-critical techniques for nuclear reactors (1/N method) is studied. The aim is to show that a subcritical assembly can be brought into a critical state by careful modification of the effective multiplication factor. The required change in the height of the control rod, which is used to reach criticality, must be planned after measuring the stabilized neutron count rate in each step. At the end of the experiment, the reactor is brought to a slightly supercritical state and the excess reactivity of the core is determined using the doubling time method.



Level of exercise:	☐ Basic	☒ Advanced	☒ Complex
Level of education:	☐ BSc	☒ MSc	☐ PhD

What you will learn:

The students learn how to approach the critical state of a nuclear reactor in a safe manner. They learn the 1/N technique, along with the factors that might influence its safety. The importance of precise measurements and careful planning is emphasized.

Important information:

- Minimal size of student group: 2
- Maximal size of student group: 6
- Overall duration of the experiment (in wall clock hours): 4

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Possibility to perform experiment on demand: ☒ Yes ☐ No
Frequency of occurrence: 10-12 times per year
Examination modalities: short test before measurement, experiment report after
Teaching languages: English, Hungarian

Pre-knowledge required: Fundamentals of reactor physics and neutron detection

Instruments required for exercise:

- Reactor instrumentation
- Gas filled neutron detector with electronics

Execution:

- The critical condition of the reactor core is approached by gradually increasing the reactivity of the system, by withdrawing the control rods from the core.
- The neutron detector (BF_3 or ^3He counter) is located in the first channel of the irradiation tunnel of the reactor in the centerline of the core.
- The neutron count rate is measured and recorded in each step after the steady state condition has been reached. The inverse of the count rate is then plot on a diagram as a function of the manual rod position, and linear extrapolation is performed to the 1/N = 0 line to estimate the critical rod position

Limitations:
None