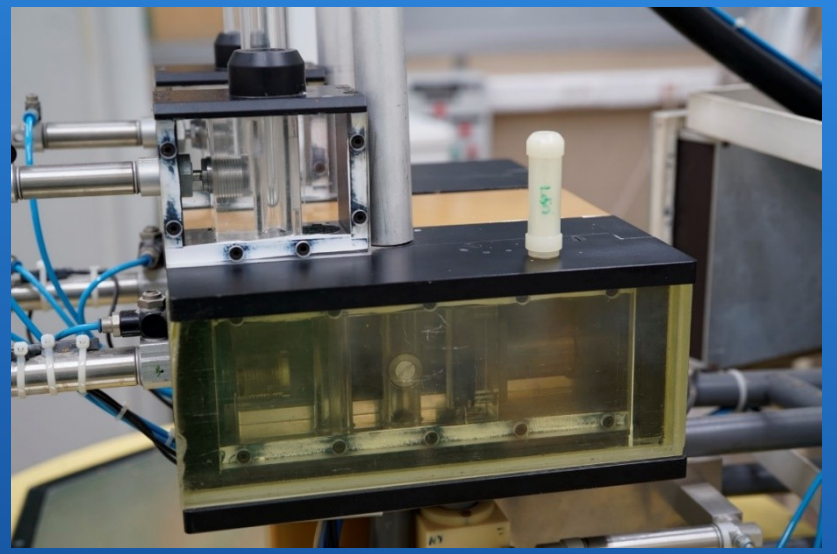
Determination of delayed neutron parameters and uranium content

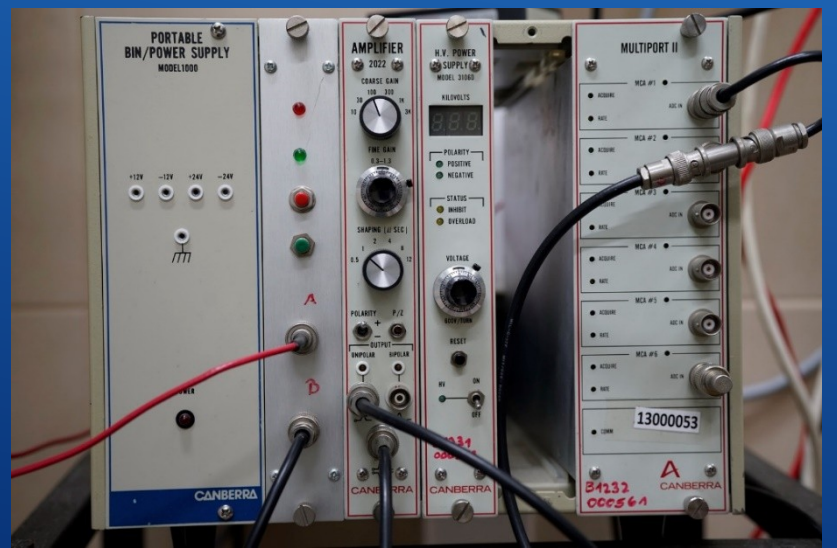
BME Training Reactor, Exercise BME-02

Main topic: Reactor Physics /Decay parameters of delayed neutron precursors

Keywords: neutron activation, thermal neutron flux, delayed neutrons, delayed neutron precursors, neutron detection, gas filled detector types

Purpose: The aim of this experiment is to familiarize the students with the production of delayed neutrons. During the exercise they learn that delayed neutrons are born from fission products; a group of fission products have the property that after negative beta decay they are able to emit a neutron; the emission time is determined by the half-life of the beta decay of the precursors, which can be categorized into six groups based on the corresponding half-lives; the uranium content of a sample can be measured based on the number of delayed neutrons emitted by a sample in a predefined time interval





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

What you will learn:
Students learn how to determine the delayed neutron parameters by activating a uranium sample in the reactor core and the application of this measurement to the determination of the uranium content of a sample.

Important information:
- Minimal size of student group: 2
- Maximal size of student group: 6
- Overall duration of the experiment (in wall clock hours): 3

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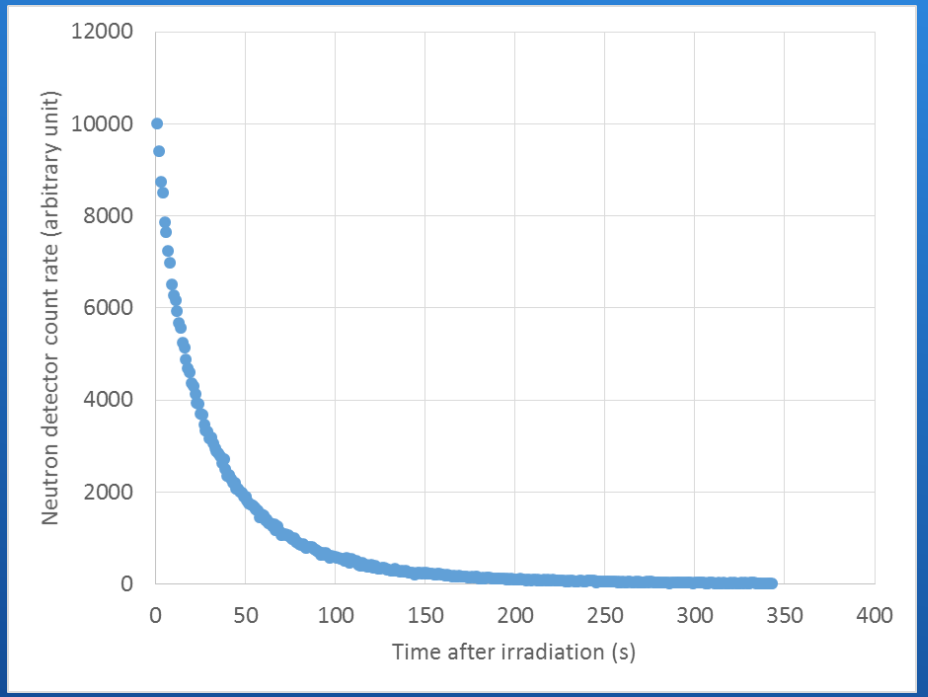
Possibility to perform experiment on demand: ☒ Yes ☐ No
Frequency of occurrence: 10-12 times per year
Examination modalities: short test before measurement, experiment report after
Teaching languages: English, Hungarian

Pre-knowledge required: Basics on nuclear and reactor physics, neutron detection.

Instruments required for exercise:

- Reactor and pneumatic sample transporting system;
- Uranium foil in small polyethylene container for the pneumatic transport system;
- Measuring vessel filled with moderator (paraffin);
- 6 neutron detectors (^{3}He);
- Computer with multichannel analyzer card (used in multiscale – time-analyzer mode).



Execution:

- A natural uranium foil is irradiated in the reactor core at 1 kW thermal power.
- After returning from the core, the foil is measured using 6 parallelly connected, 3He filled neutron detectors placed into a vessel filled with paraffin moderator.
- The “decay-curve” of the delayed neutron precursors is measured

Limitations:
None