

TIME CHANGES OF VERTICAL PROFILE OF NEUTRON FLUENCE RATE IN LVR-15 REACTOR

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ABSTRACT

The LVR-15 reactor is a light water research type reactor, which is situated, in Nuclear Research Institute, Rez near Prague. The reactor is used as a multipurpose facility. For some experiments and material productions, e.g. for homogeneity of silicon resistance in production of radiation doped silicon, the time changes of vertical profile of neutron fluence rate are particularly important. The assembly used for silicon irradiation has two self-powered neutron detectors installed in a vertical irradiation channel in LVR-15 reactor. Vertical profile of thermal neutron fluence rate was automatically scanned during reactor operation. The results of measurements made in 2002 and 2003 with these detectors are presented. A set of vertical profile measurements was made during two 21-days reactor cycles. During the cycle the vertical profile slightly changes both in the position of its maximum and in the shape. The time dependences of the position of profile maximum and the profile width at half maximum during the cycle are given.

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1. INTRODUCTION

The LVR-15 reactor is a light water research type reactor, which is situated, in Nuclear Research Institute, Rez near Prague. At present IRT-2M fuel of Russian production with enrichment of 36% is used. In the reactor core there are usually from 28 to 31 fuel elements with the total mass about 5 kg of ^{235}U . Reactor is cooled by demineralized water. The maximum thermal power is 10 MW and the reactor is operated on a 21-days irradiation cycle, with 8 to 10 cycles per year.

The reactor is used as a multipurpose facility and its main use is in the following areas: material research carried out at reactor loops and rigs, production of radiation doped silicon, production of radioisotopes for the radio pharmaceuticals and technical radiation sources, irradiation devices for special irradiation, pneumatic rabbit for activation analysis, development of boron neutron capture therapy at the thermal column channel and neutron physics research (e.g. neutron diffraction for different purposes) at reactor horizontal channels.

For some experiments and material productions, e.g. for homogeneity of silicon resistance in production of radiation doped silicon, the time changes of vertical profile of thermal neutron fluence rate are particularly important. For the measurement of this changes the two self-powered neutron detectors installed in a vertical irradiation channel in LVR-15 reactor are used.

2. DESCRIPTION OF THE EXPERIMENTAL WORK

The typical reactor core configuration (from February 2003) - the horizontal section of the reactor core - can be seen in Fig. 1. The pitch of fuel elements of a square section arranged into a rectangular lattice is 7.15 x 7.15 cm. Water gap between every two fuel units for cooling is 0.45 cm. The core (B2 - G7) is usually surrounded by Be reflector units placed in the row No.8 and rows No.9-10 are filled with water.

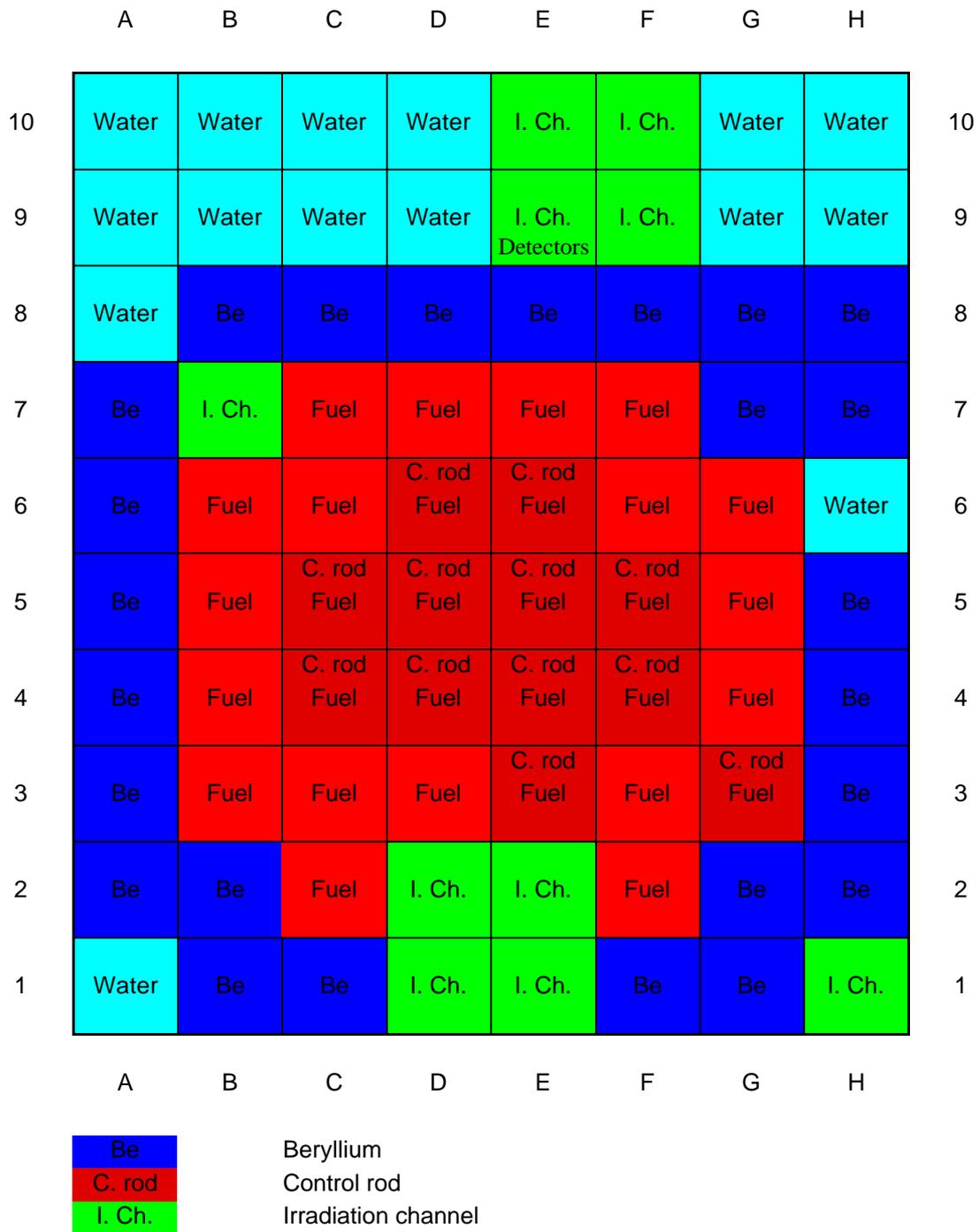


Figure 1. LVR-15 reactor core, February 2003

The Irradiation assembly for production of radiation doped silicon is placed in channels E9 to F10. The assembly was equipped with two self-powered neutron detectors installed in a vertical irradiation channel E9 in LVR-15 reactor. The detectors are based on Rh 103 emitter and they have a vertical range of 500 mm. Then vertical profile of thermal neutron fluence rate can be automatically scanned during reactor operation.

3. RESULTS

The measurements with two self-powered neutron detectors were performed during two reactor cycles in April/May 2002 (2002 cycle) and February 2003 (2003 cycle). The range of 500 mm was measured with either 20 mm or 25 mm step and time interval between two consequent measurements was usually 5 min. The current through the detector was measured, as it is proportional to the thermal neutron fluence rate.

In the Figure 2 there is an example of measured vertical profile. The position of 0 cm corresponds to the bottom of the core.

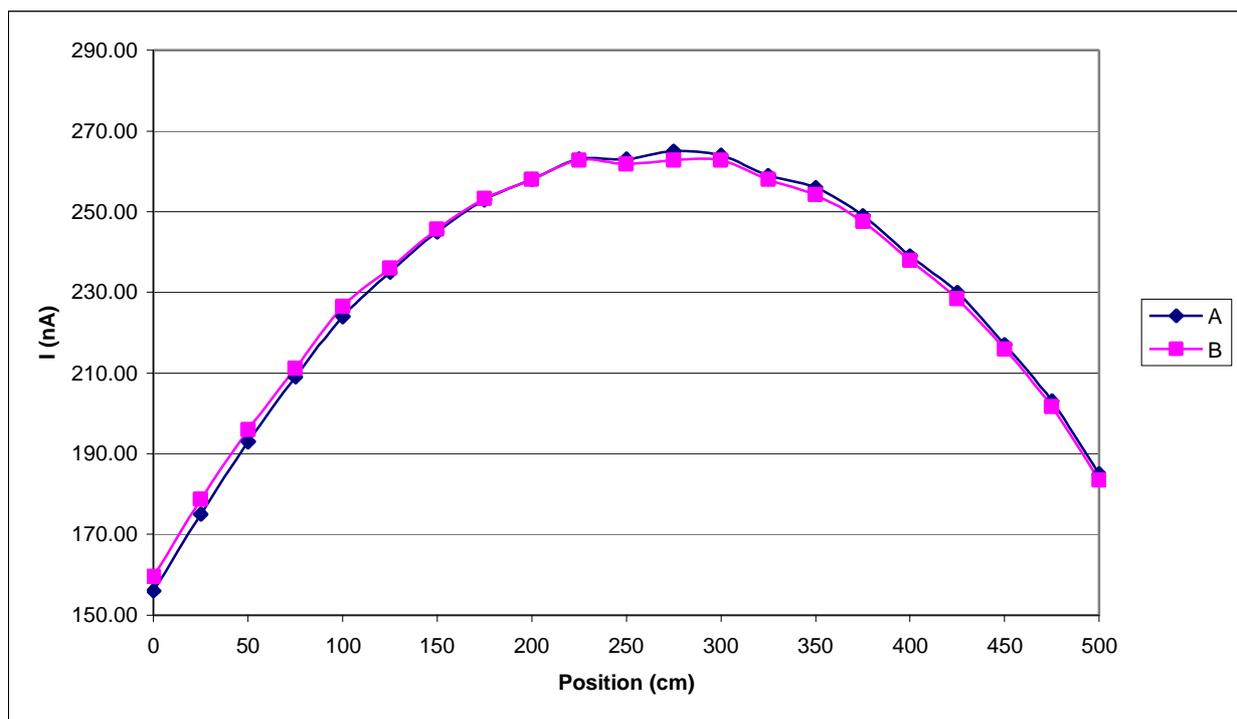


Fig. 2. Example of the measured profile with two detectors A and B started at 24.4.2002 19:13

Each of these individual profile curves was fitted with parabola and the mean value of the current was calculated. The position of profile maximum and the profile width at half maximum (FWHM) were also evaluated and their time variation was of interest. In the Figures 3 and 4 the time dependences of the position of the profile maximum are given for 2002 cycle and 2003 cycle respectively and the time changes of the profile width at half maximum are presented in the Figures 5, 6 respectively.

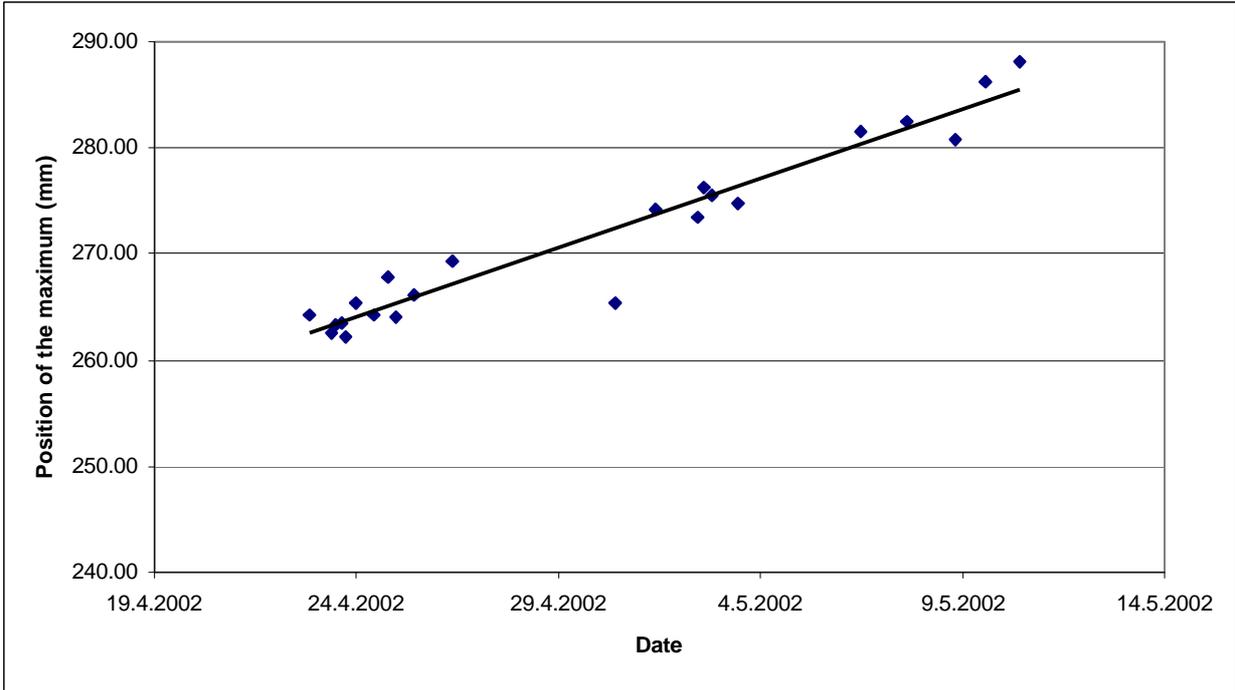


Fig. 3. Time dependence of the position of the profile maximum for 2002 cycle

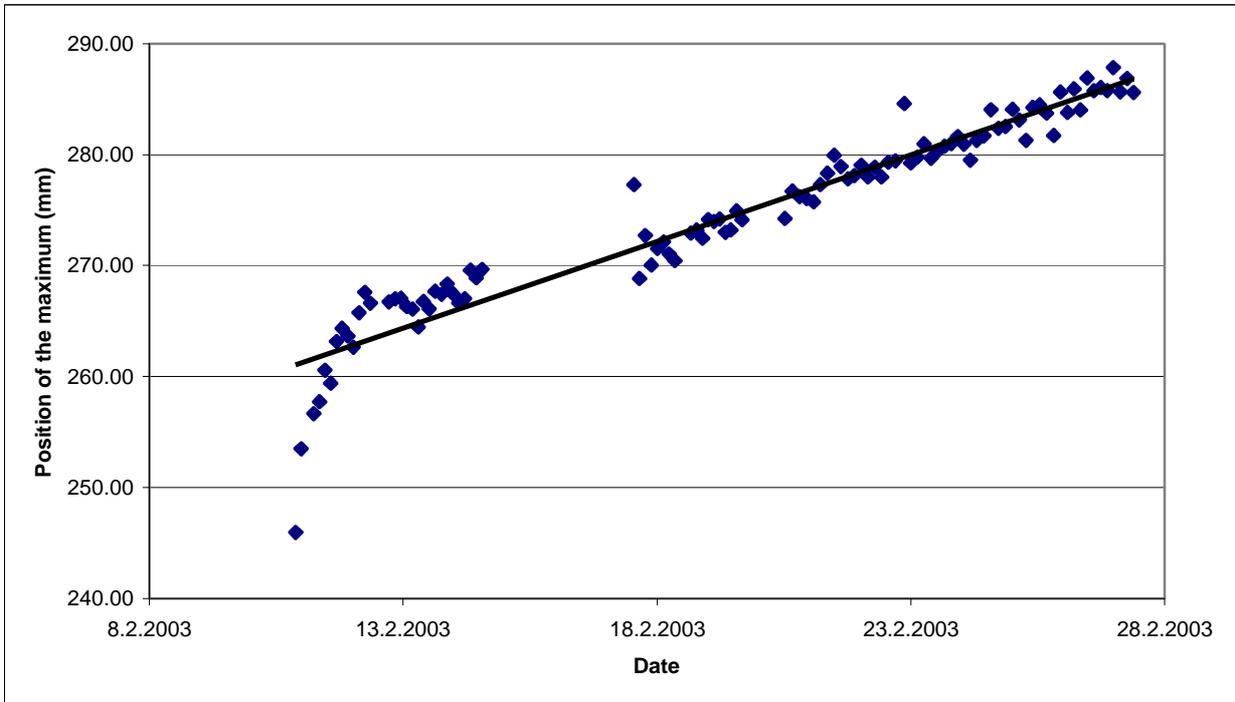


Fig. 4. Time dependence of the position of the profile maximum for 2003 cycle

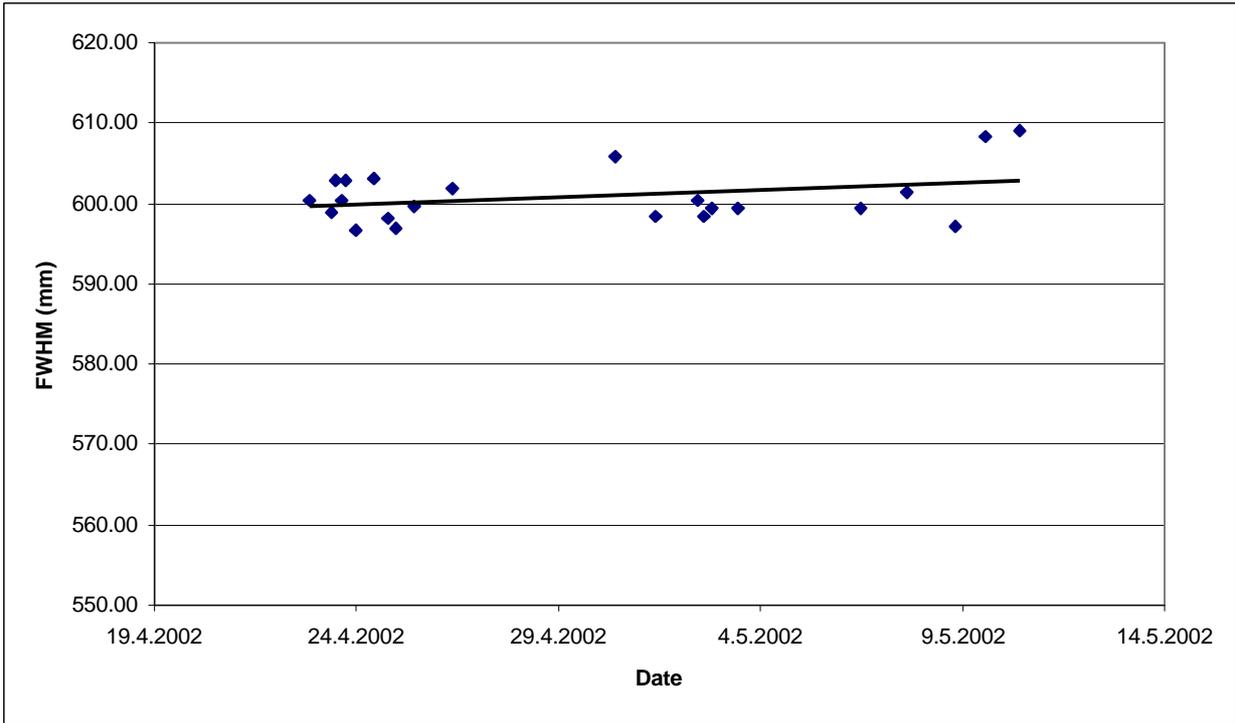


Fig. 5. Time dependence of the profile width at half maximum for 2002 cycle

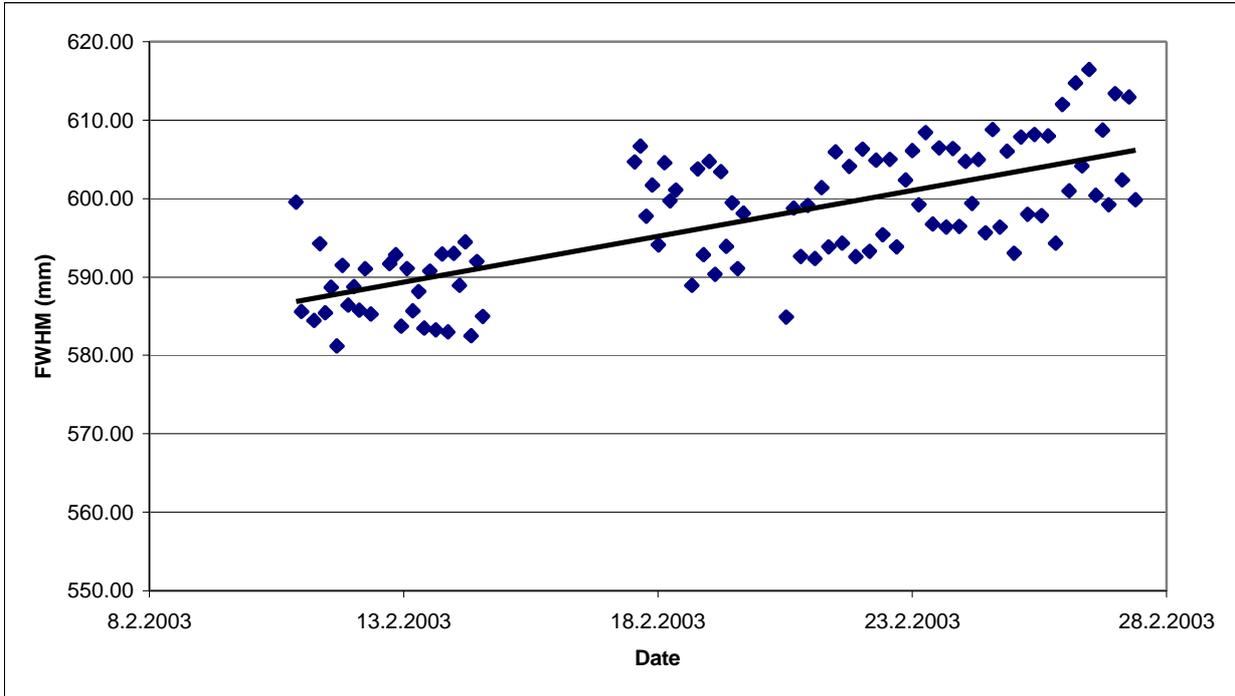


Fig. 6. Time dependence of the profile width at half maximum for 2003

4. CONCLUSION

The measurements of vertical profile of thermal neutron fluence rate with two self-powered neutron detectors installed in a vertical irradiation channel in LVR-15 reactor are presented. A set of vertical profile measurements was made during two 21-days reactor cycles. During the cycle the vertical profile slightly changes both in the position of its maximum and in the shape. The shift of the maximum about 1.5 mm per day was determined. This shift corresponds with control rod movement during the cycle. On the other hand, only small changes in the FWHM of vertical profile were determined which is very important for homogeneity of the radiation field of the irradiated sample. During the cycle the width at half maximum increased with average value about 1 mm per day.