ENEEP Member: The Czech Technical University in Prague

Synthesis of implementation workflow and conditions for novel activities

February 2024

Contents

The implementation of any experiment (experimental activity) at the VR-1 Reactor follows the requirements of the Czech Atomic Act No. 263/2016 Coll. and regulations of national regulatory body. Operational procedures and reactor data management systems (DMS, Bugzilla) split all experimental activities into two groups: standard and non-standard.

Standard experiments (standard experimental activities) are defined as experiments which are routinely carried out at the reactor for a period of at least one year. Standard experiments are well defined, analysed from 3S perspective (safety, security, safeguards), and well described in relevant reactor documentation or in textbooks for students. Anyone who wishes to carry out standard experiments should follow standardised procedures on how to carry out standard experiments.

Experiments (experimental activities) which do not fulfil the above definition of standard experiments (standard experimental activities) are considered as non-standard experiments (non-standard experimental activity). In order to obtain permission to carry out non-standard experiments (non-standard experimental activities) an evaluation procedure is carried out which ensures safe and secure performance of non-standard experiments. The evaluation procedure which is applied for all users (researchers for research activities and students for both educational and research activities) which do not belong to the VR-1 reactor team is described in the following subsection. The procedure for carrying out non-standard experiments by VR-1 reactor teams are different and non-relevant for the purpose of this document.

1. Experiment management system

The top level of the experiment management system represents the Head of the Department of Nuclear Reactors together with the Reactor manager. The second level is an experiment guarantor (scientist/researcher), who is chosen from a selection of experiment guarantors who are experts in the field of the proposed experiment. The third level is the scientific advisory committee (SAC).

The management of the reactor (Head of Department of Nuclear Reactors and the Reactor manager), make decisions on assigning reactor operation time to the applicants and chooses the experiment guarantor in consultation with the scientific advisory committee. One of roles of the SAC is to advise on the planning, preparation and evaluation of particular experiments. The SAC consists of experts from CTU and independent experts from outside CTU. The SAC consists of researchers and experts from the reactor, the university, outside university and from abroad. The SAC

has five members and prepares statements and comments to the experiments proposals. After SAC approval of the experiment proposal, the reactor management selects an experiment guarantor. The experiment guarantor cooperates with applicants and the reactor operating organization.

After commissioning the VR-2 reactor the same experiment management system will be expanding from the VR-1 reactor to the VR-2 reactor. The VR-1 experiment management and its relation to the reactor management is shown in Figure 1.

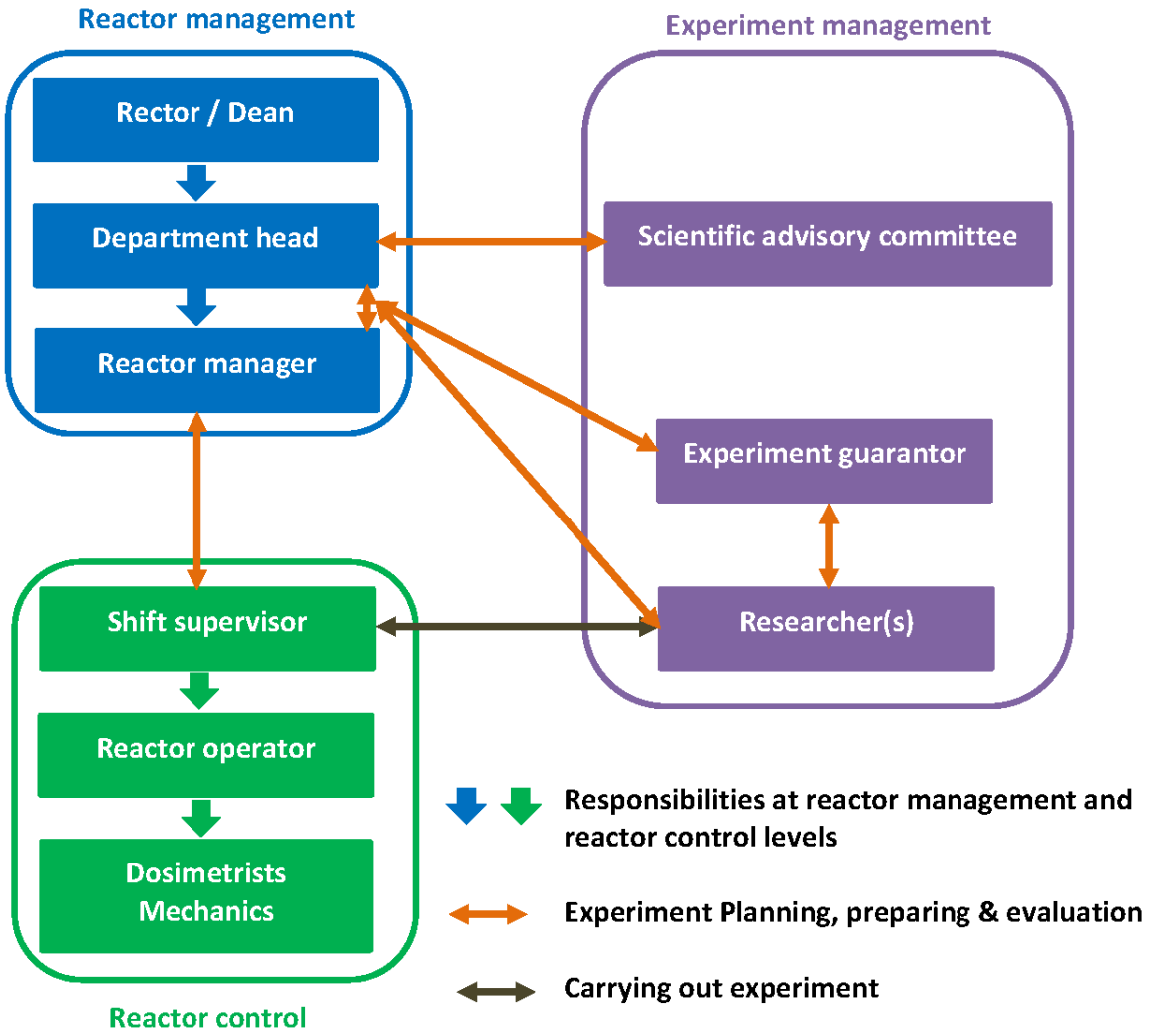


Figure 1: The VR-1 experiment management and its relation to the reactor management.

2. Application for non-standard experiment

All external users should apply for access to carry out non-standard experiment in compliance with the conditions described below. These conditions are the same for access for researchers and students who are applying for access for research experiments or for access for educational experiments.

Conditions for access to the VR-1 Nuclear Experimental Hub requires clearly short descriptions of the planned experiment at the reactor. Upon request of a reactor operator, the applicant has to document why, how, and for which purpose he/she wishes to utilise the reactor, to enable the reactor personnel to check whether the planned research, development or innovation activities are in accordance with the principles of peaceful utilisation of nuclear energy; whether they are not in conflict with Czech legislation and international conventions which the Czech Republic has to follow in the fields of Safeguards and Additional Protocol (IAEA and Euratom).

The VR-1 Nuclear Experimental Hub is a cluster of experimental nuclear facilities and nuclear laboratories wherein the centre of the hub is the VR-1 reactor and which consists of nine parts:

1. training reactor VR-1,
2. subcritical reactor VR-2,
3. internal reactor laboratory,
4. neutron activation analysis laboratory,
5. neutron interactions laboratory,
6. nuclear security laboratory,
7. radiation protection laboratory,
8. reactor I&C laboratory,
9. external neutron sources and neutron detectors

The VR-1 Nuclear Experimental Hub is operated by the CTU through the Department of Nuclear Reactors and the Department of Dosimetry and Application of Ionizing Radiation as its organisational units. The hub is systematically building step by step during the last decade in order to maximise utilisation synergies between various parts of the hub and to optimise the operational cost of the hub. Commissioning of the VR-2 reactor will finish completing the hub. All experimental instrumentation of the hub is available to domestic and foreign users through access.

Access to the VR-1 Nuclear Experimental Hub means ”the opportunity to carry out research, development and innovation activities at the premises of the VR-1 Nuclear Experimental Hub utilizing the VR-1 reactor and the VR-2 reactor and, its experimental and data processing equipment, adjacent laboratories, professional and technical support for such activities from the reactor staff in the fields of safe operation of nuclear installations, theoretical and experimental reactor and neutron physics, nuclear safety, and nuclear fuel cycle.“

The access is intended for individuals or organisations from the Czech Republic, within the European research area as well as outside the European Research area. The access allows also carrying out students' experimental works, especially, in the frame of their doctoral, master and bachelor theses as well as students' research projects.

The CTU as host institution of the VR-1 Nuclear Experimental Hub providing access with strict application of non-discrimination and equal opportunities policy which gives equal chances to access the reactor for all applicants.

The applicant has to apply for access sufficiently in advance (at least one month ahead). At the same time the application requirements on reactor operation, on experimental and data processing equipment, laboratories and the proposal of experiment realisation deadline have to be submitted.

Upon request of the VR-1 Nuclear Experimental Hub, the applicant has to document why, how, and for which purpose he/she wishes to utilize the reactor, to enable the reactor personnel to check whether the planned research, development and innovation activities are in accordance with the principles of peaceful utilisation of nuclear energy; whether they are not in conflict with Czech legislation and international conventions which the Czech Republic has to follow in the fields of Safeguards and Additional Protocol (IAEA and Euratom). In case these requirements are not fulfilled, access to the reactor will be denied.

Prior to the beginning of research, development and innovation activities, an agreement has to be made between the reactor operator and the applicant on the ways of presenting the outcomes and on the intellectual property rights of the outcomes. The agreement on the intellectual property rights will define the type, amount and demands of research, development and innovation activities and share of user's and reactor operator on results. The agreement is made individually with each reactor user.

The applicant for access has to fill the application for access to large research infrastructure. The signed application should be sent to the administrative office of the Department of Nuclear Reactors, at the Faculty of Nuclear Sciences and Physical Engineering, at the Czech Technical University in Prague, V Holešovičkách 2, 180 00 Praha 8, or a scanned copy can be sent by e-mail lubomir.sklenka@fjfi.cvut.cz and in cc to jan.rataj@fjfi.cvut.cz. Unsigned or incomplete applications will not be processed.

The application for access will be discussed by the head of the Department of Nuclear Reactors and the head of the reactor operation in consultation with the scientific advisory committee. After being recommended by the head of the department, the application will be directed to a designated reactor employee – an experiment guarantor.

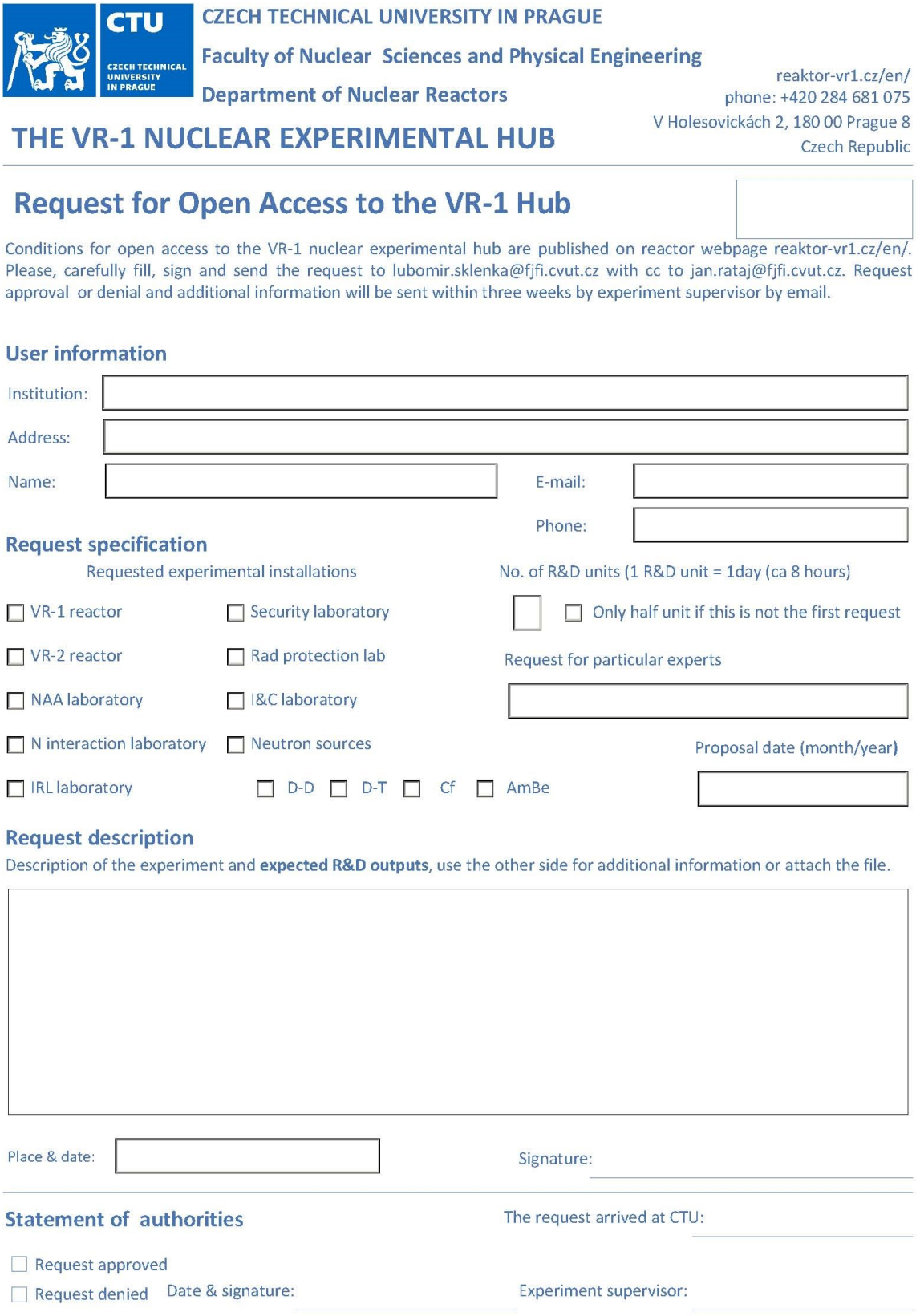
Notification of application acceptance or refusal, allocation of date and duration of access will be given within 14 days from the date of receiving of application. The approval of access takes into consideration the applicant's proposal; however, the reactor operator has the right to assign the range and duration of the access according to his best deliberation.

The access means access to use the VR-1 reactor, its standard experimental and data processing equipment, adjacent laboratories, professional and technical support under the supervision of the reactor staff.

If additional costs are generated by the user, the reactor operator can require the payment of such costs by the user. The user has to be notified about this fact in advance, before the beginning of the research activities.

The user has to respect the rules of access into the reactor hall and adjacent laboratories, observe all rules and principles of nuclear safety, radiation protection, physical protection and occupational safety.

The user has to provide all required personal data necessary for the entrance into the control area at least 3 workdays before the beginning of their activities at the reactor. The personal data should be delivered to the experiment guarantor.



CZECH TECHNICAL UNIVERSITY IN PRAGUE
Faculty of Nuclear Sciences and Physical Engineering
Department of Nuclear Reactors

reaktor-vr1.cz/en/
phone: +420 284 681 075
V Holesovickách 2, 180 00 Prague 8
Czech Republic

THE VR-1 NUCLEAR EXPERIMENTAL HUB

Request for Open Access to the VR-1 Hub

Conditions for open access to the VR-1 nuclear experimental hub are published on reactor webpage reaktor-vr1.cz/en/. Please, carefully fill, sign and send the request to lubomir.sklenka@fjfi.cvut.cz with cc to jan.rataj@fjfi.cvut.cz. Request approval or denial and additional information will be sent within three weeks by experiment supervisor by email.

User information

Institution:
Address:
Name:
E-mail:
Phone:

Request specification

Requested experimental installations

VR-1 reactor
VR-2 reactor
NAA laboratory
N interaction laboratory
IRL laboratory
Security laboratory
Rad protection lab
I&C laboratory
Neutron sources
D-D D-T Cf AmBe

No. of R&D units (1 R&D unit = 1day (ca 8 hours)
Only half unit if this is not the first request

Request for particular experts

Proposal date (month/year)

Request description

Description of the experiment and **expected R&D outputs**, use the other side for additional information or attach the file.

Place & date:
Signature:

Statement of authorities

The request arrived at CTU:

Request approved
Request denied
Date & signature:
Experiment supervisor:

Figure 2: Request for access to the VR-1 Nuclear Experimental Hub (new form for 2022).

3. The VR-1 Nuclear Experimental Hub basic parameters and characteristics

The basic parameters and characteristics of the VR-1 Nuclear Experimental Hub including the VR-1 reactor are provided to users upon request. Due to various types of experiments (experimental activities) such as samples irradiation, reactor kinetics & dynamics experiments, security experiments, or recently neutron imaging experiments no unified set of basic parameters and characteristics is available for users. Also, various types of core configurations of the VR-1 reactor (usually new core configuration every 1-2 years) do not allow for the determination of basic parameters and characteristics in long-term horizon. That is why for each specific user's request a current set of basic technical parameters and characteristics is determined.

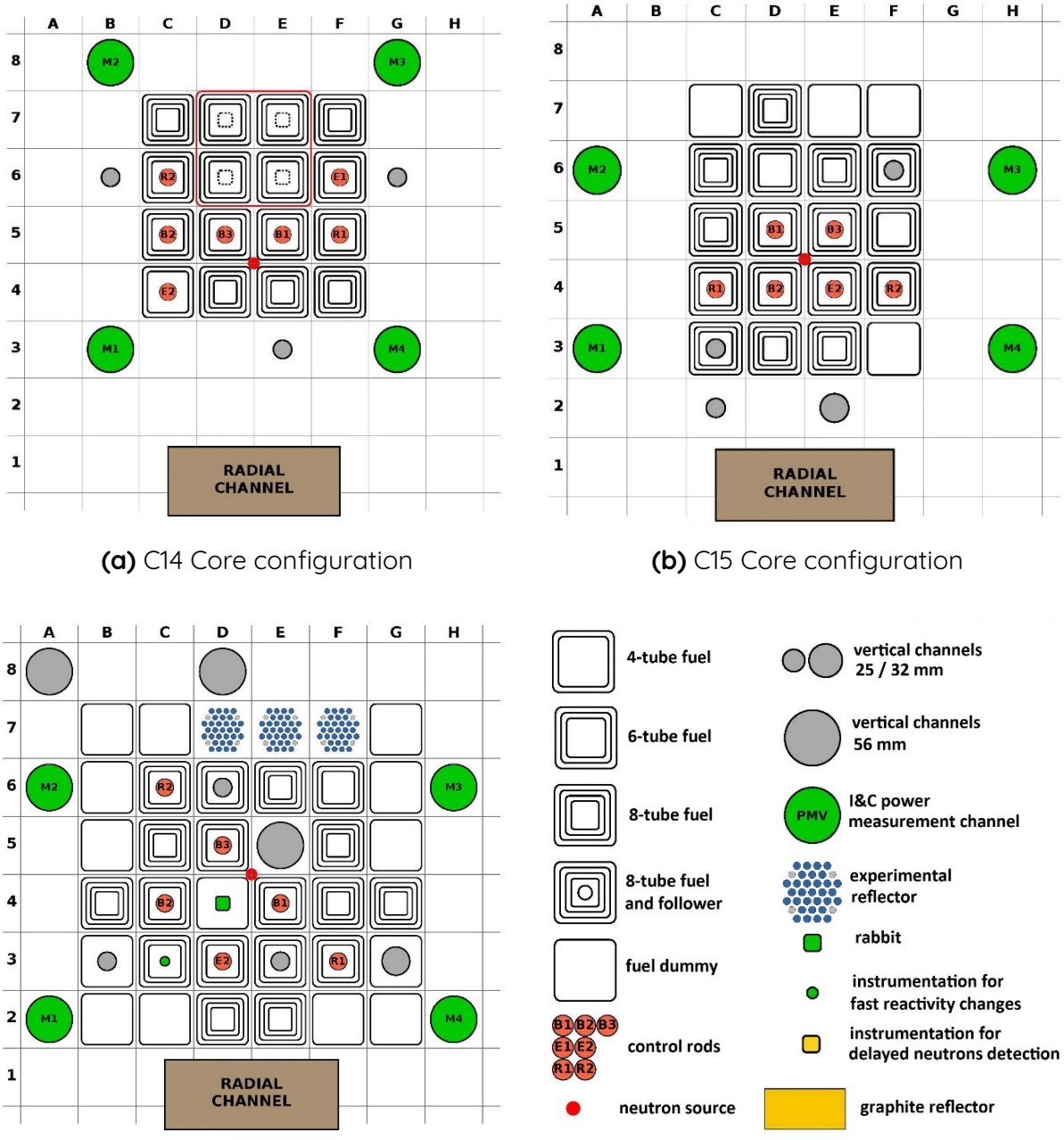
In Figure 3 are shown various core configuration of the VR-1 Reactor operated in 2015-2020. In Table 1 are shown selected indicative parameters of the VR-1 Reactor and in Fig. 4 is shown an example of relative neutron flux distribution at C16 core configuration. Emission rates of external neutron sources are shown in Table 2. Basic parameters and characteristics of the subcritical reactor VR-2 will be available after its commissioning in 2023.

Table 1: Selected parameters of the VR-1 Reactor.

Reactor parameter	Value
Nominal power	100 W
Maximal power	500 W up to 700 hours/year
Thermal neutron flux in the core (maximal) at 100 W	$1.34 - 1.38 \cdot 10^9$ [cm^{-2}s^{-1}]
Fast neutron flux in the core (maximal) at 100 W	$2.91 - 4.04 \cdot 10^9$ [cm^{-2}s^{-1}]
Slow reactivity changes	up to $+0.40\ \beta_{eff}$
Fast reactivity changes	up to $+0.15\ \beta_{eff}$
Experimental vertical channels' diameter	$25/32/56$ mm
Water temperature change during experiments	ambient to 45°C
Radial channel (beam port) – diameter	$90/250$ mm
Tangential channel (beam port) – diameter	100 mm

Table 2: Emission rates of external neutron sources.

Neutron source	Emission rate [n/s]
D-D neutron generator	$\sim 7 \times 10^6$
D-T neutron generator	$\sim 1 \times 10^8$
Cf neutron source	$\sim 3.9 \times 10^7$
Am-Be neutron source	$\sim 1.9 \times 10^5$
Am-Be neutron source	$\sim 1.2 \times 10^7$



(a) C14 Core configuration

(b) C15 Core configuration

(c) C16 Core configuration

(d) Legend

Figure 3: Various core configuration of the VR-1 Reactor operated in 2015-2020.

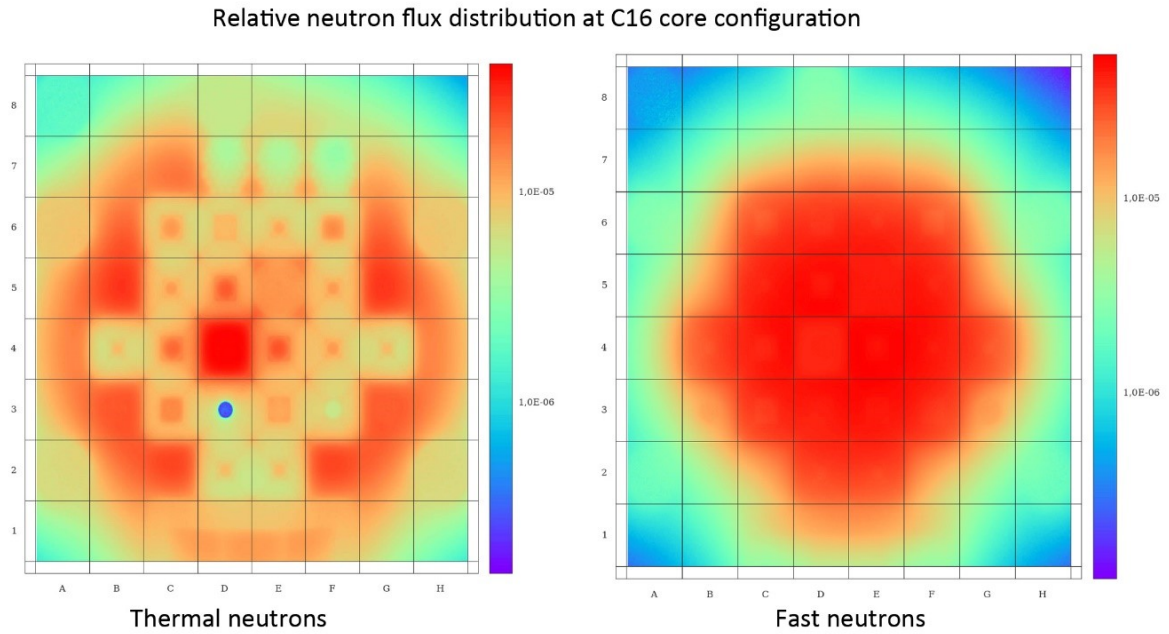


Figure 4: An example of relative neutron flux distribution at C16 core configuration.