Utilization of Egyptian Research Reactor and modes of collaboration

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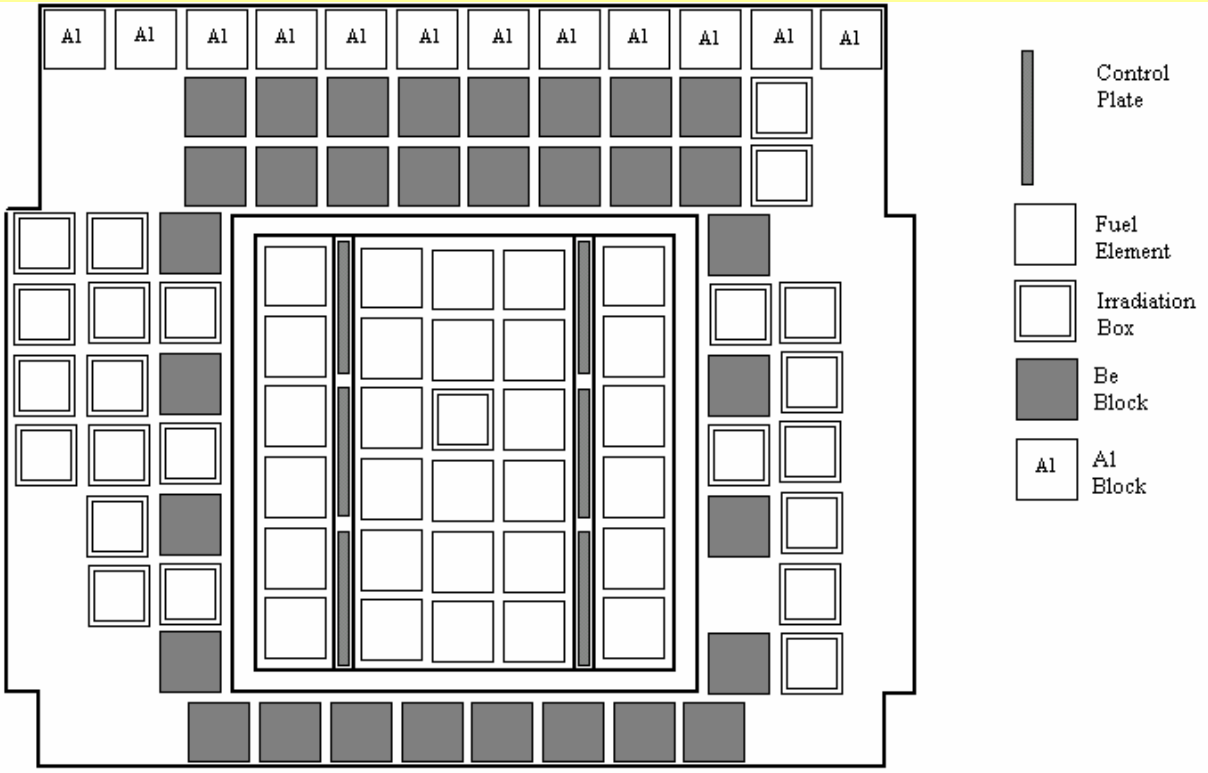
ETRR-2 Description

- ETRR-2 is a Material Testing Reactor (MTR), open pool type, 22 MW Power, of variable core arrangement, cooled and moderated by light water , with Be blocks reflectors.
- The reactor went critical for the first time in 1997. The reactor utilization phase started in 2004.
- **The main aspect on the ETRR-2 design is its flexible irradiation positions and potential for modification to harmonize with the requirements of the utilization.**
- Free access of reactor personnel and experimentalists during reactor operation at full power.

ETRR-2 Description

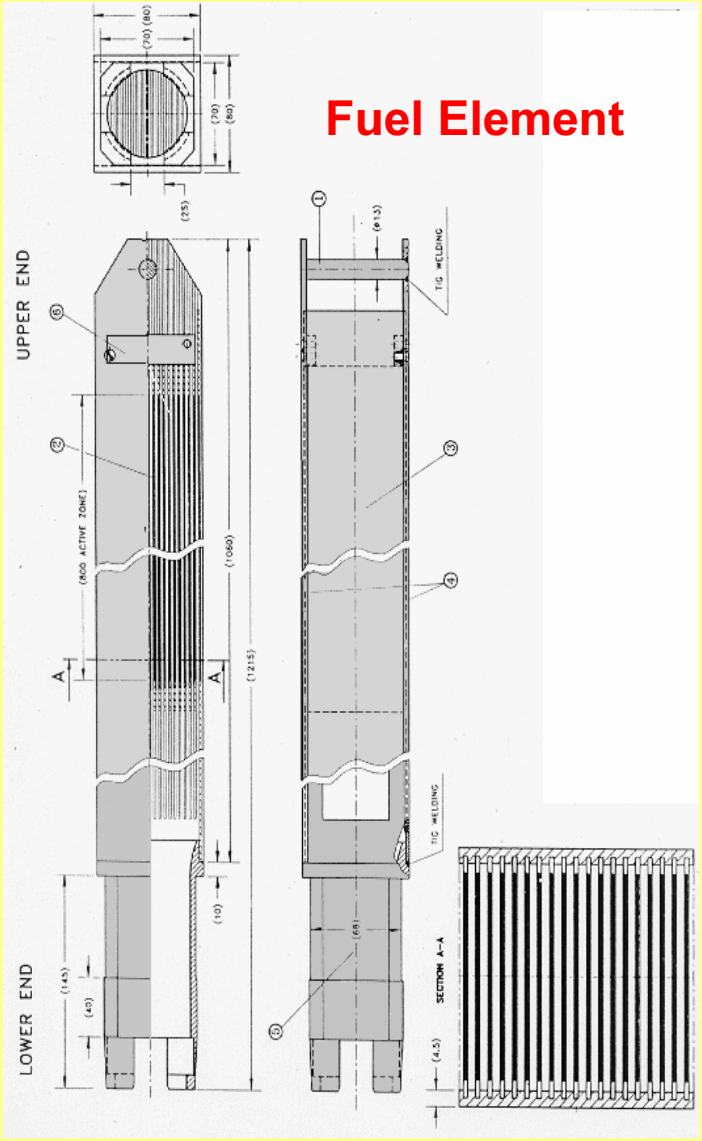
- Reactor core is a rectangular arrangement of up to 30 Fuel Element and the irradiation grid is variable arrangement of Be, irradiation boxes , AL blocks, or plugs. An example of core and irradiation grid arrangement is shown below.



ETRR-2 Description

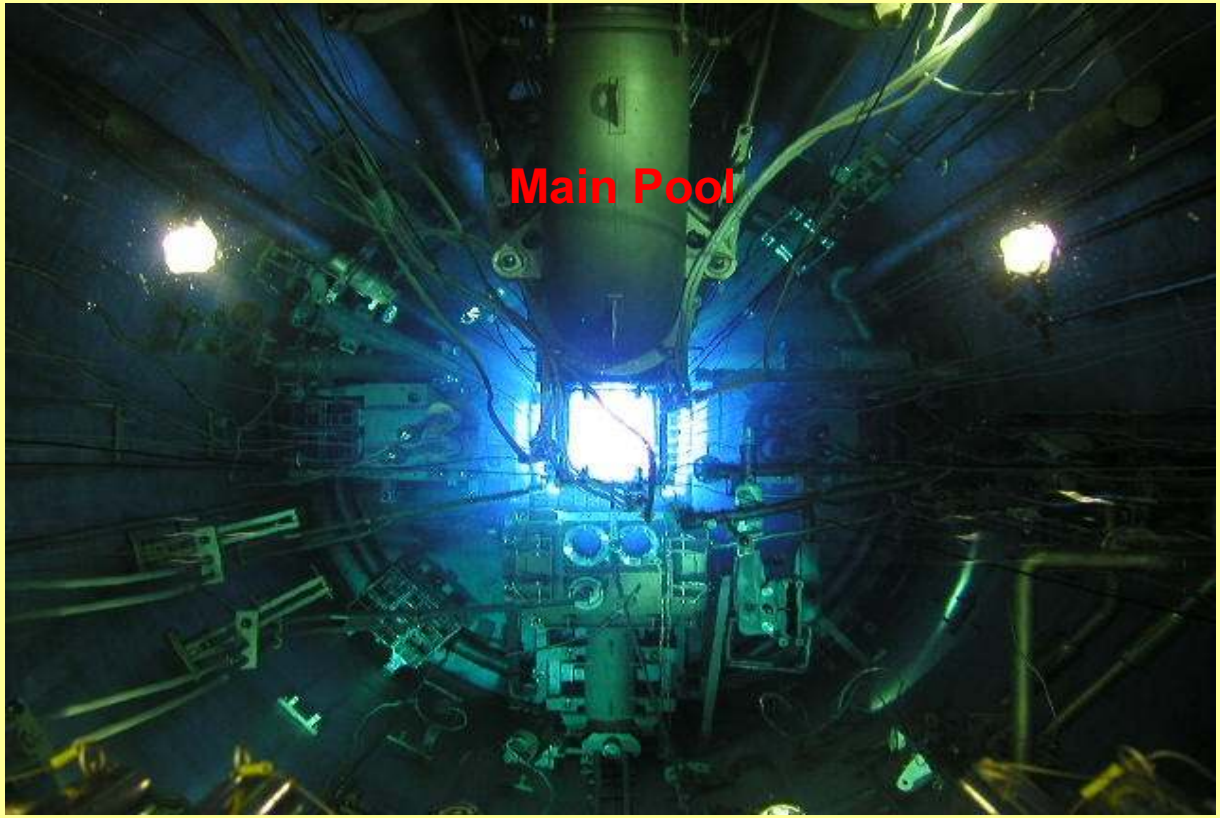
- **Fuel Element :**
- Reactor Fuel Element is MTR type with 19 fuel Plates, Low Enriched Uranium (19.75 % U^{235}), made of U_3O_8 dispersed in pure Al matrix;
- Fuel elements are Manufactured on site at the Fuel Manufacture Plant;
- Reactor is re-fueled with two fresh Fuel Elements every operation cycle.

- The reactor operation cycle up to 19 full power days for high neutron fluence irradiation.



ETRR-2 Description

- Reactor **Main Pool** houses the reactor internal components, irradiation facilities, and beam tubes and connected to an Auxiliary Pool for spent fuel and radioactive material storage.



Potential Capabilities

- Radioisotopes Production
- R & D in Physics and Engineering
- Neutron Activation Analysis (NAA)
- Semi-conductors production
- Material Testing
- Neutron Radiography
- Beam Tube Research and Applications
- Education and Training

Facilities Description

- Several experimental and production facilities are installed to meet the requirements of users for radioisotope (RI) production, Neutron Activation Analysis (NAA) applications, Neutron Transmutation Doping (NTD), neutron radiography experiments, and training of personnel. Reactor potential users are from research institutes, universities, industrial and medical organizations.

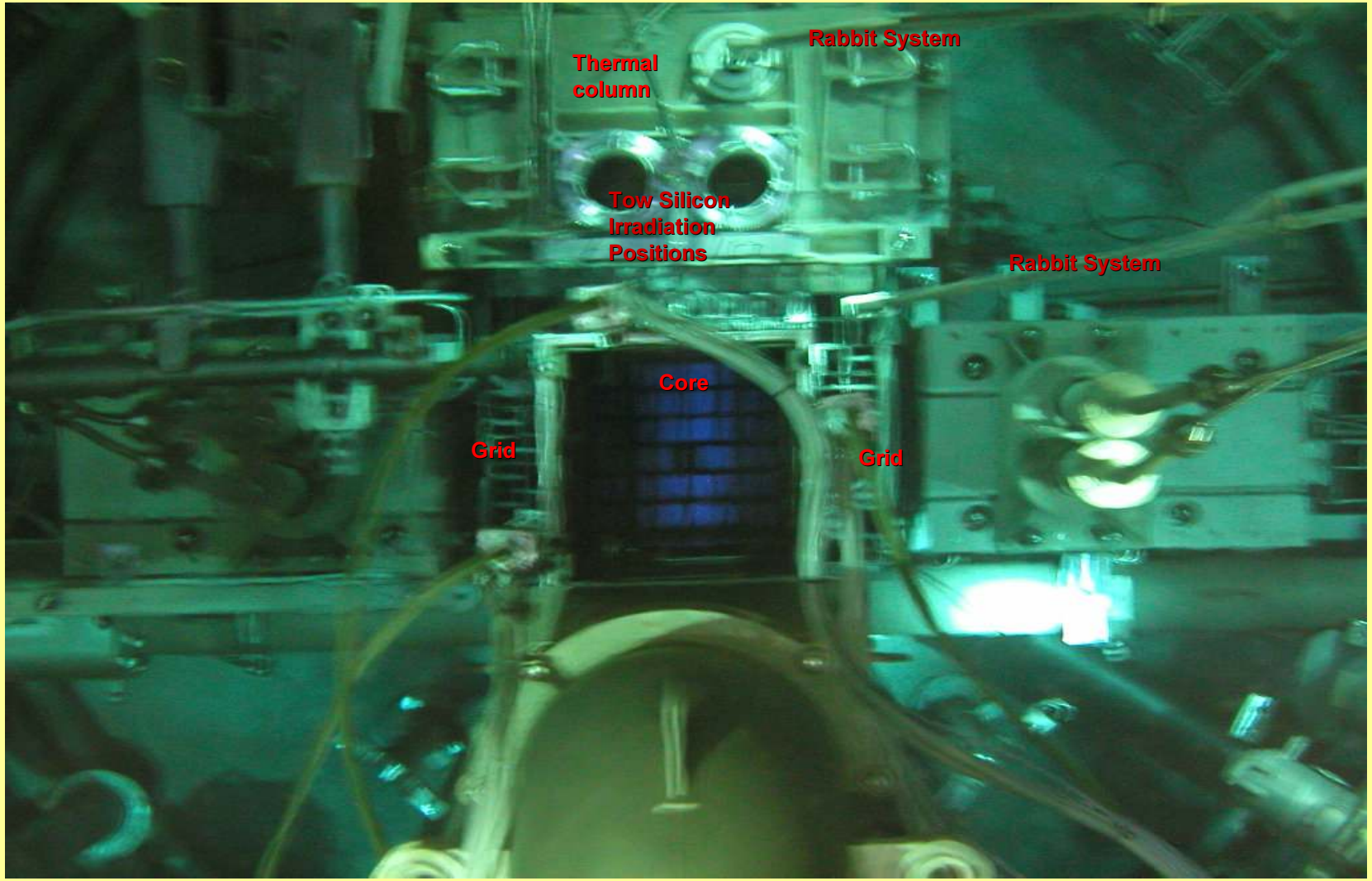
- **Irradiation facilities:**

- Irradiation positions in core and irradiation grid sample irradiation and RI production;
- Two positions for fast irradiation system for NAA;
- Two positions in Thermal Column for NTD.

- **Neutron Beam tubes :**

- Two radial beam tubes and under water beam tube;
- Thermal Column; - Tangential beam tube.

Irradiation Facilities



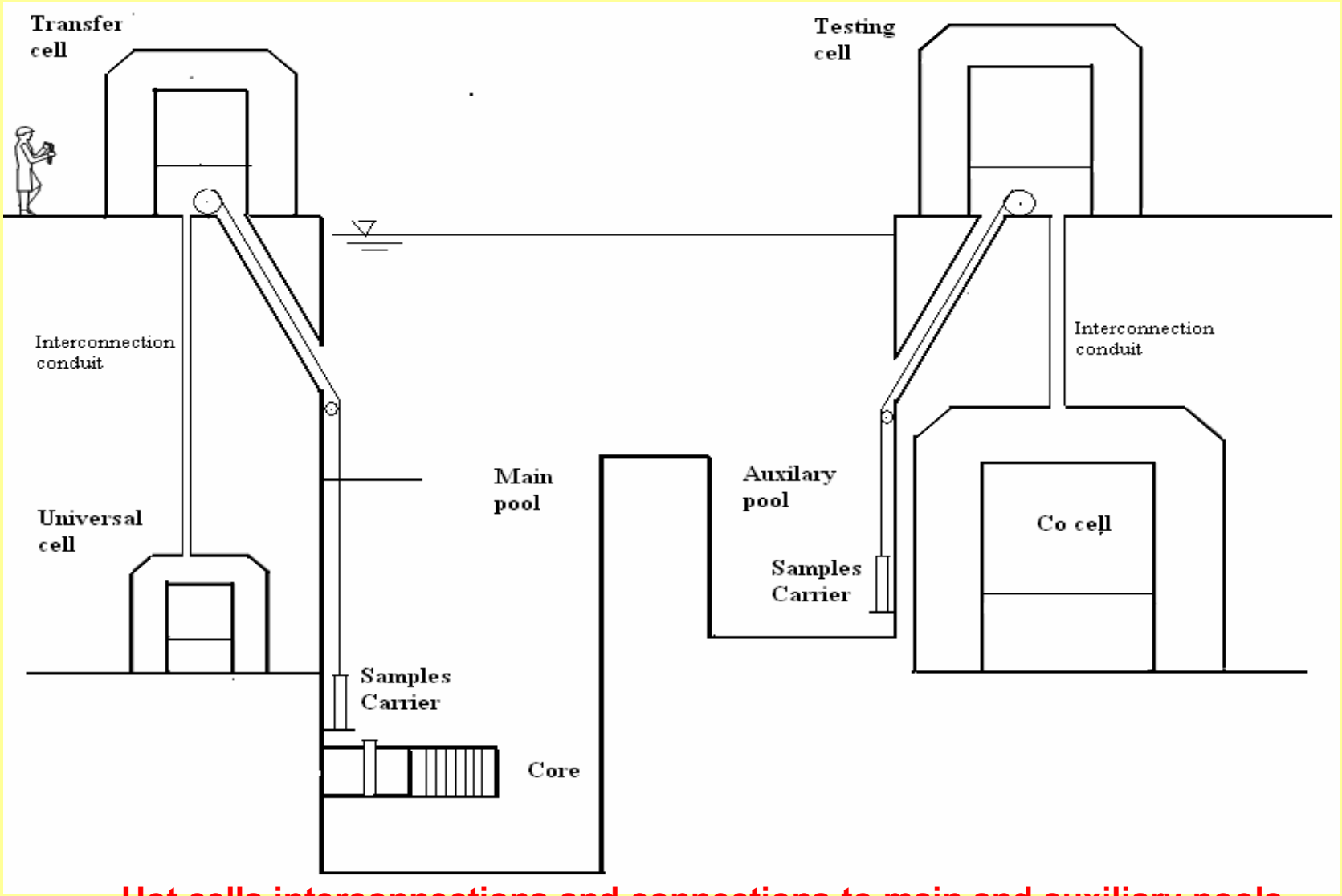
Irradiation Facilities

- **Sample irradiation and isotope production:**

- **irradiation positions** at the irradiation grid are 22 positions for sample irradiation for Research and Development and for isotopes production. Irradiation positions closed to core have maximum thermal flux up to $2.7 \times 10^{14} n/cm^2.sec$ and maximum fast flux $2.2 \times 10^{14} n/cm^2.sec$;
- Hot cells are installed for samples and radioisotopes (I-131, I-125, Cr-51, Ir-192) manipulation. **Transfer Cell** is for Sample/Isotope movement to/from core and send to **Universal Cell** for can opening and visual inspection and Sample/Isotope loading into shielded containers to RI Production Facilities;

- **Core center position** is dedicated for Co^{60} production for medical and industrial application. 50,000 Ci can be produced per year;
- **Co-60 Hot cell** is installed for Co-60 engineering processing and sealed source production.

Irradiation Facilities



Hot cells interconnections and connections to main and auxiliary pools

Irradiation Facilities

- **Material Testing Cell:**

- Material Testing Hot Cell is installed for Destructive Tests on irradiated samples (standard specimens).
- The cell is provided with Impact machine, Microhardness tester, and Tensile machine.
- Irradiated samples are transported under water from main pool to the auxiliary pool using operational tools.
- The Testing cell is connected to the Auxiliary pool , an irradiated samples carrier is used to transport irradiated samples from the Auxiliary pool to the testing cell

Irradiation Facilities

- **NAA lab:**

- ETRR-2 is equipped with two **Fast Pneumatic Transport Systems (Rabbit Systems):** One in reflector area position ($9x10^{13}$ $n/cm^2.sec$. The other being in Thermal Column position ($2x10^{11}$ $n/cm^2.sec$);

- **NAA** lab is provided with high efficiency detection systems for elemental analysis of irradiated samples. Environmental, geological, and biological samples could be analyzed for different applications at the NAA labs with the provided detection systems;

- The lab contributes to the reactor routine measurements of pools water samples, etc.

Irradiation Facilities

- **Silicon Doping at ETRR-2:**

- Two irradiation positions at thermal column for irradiation Ingots of 28 cm long and up to 5 Inches diameter;
- Thermal flux: 10^{13} n/cm^2/sec and Thermal-to-fast flux ratio: 67.7.
- Temperature during irradiation less than 80 ^{O}c;
- Axial resistively variation in the product: less than 5 %;
- Labs of post irradiation tests and measurements are also included.

Neutron Beam Tubes

- In ETRR-2, Neutron Radiography facility is Installed in front of a radial beam tube with proper shielding and samples handling mechanisms:
- Beam port flux about 3.0 x10^7 n/cm^2.sec;
- L= 3315 mm;
- D= 30 mm .

- Underwater neutron radiography system has been installed for radiography examination of irradiated samples.

- Thermal Column and connected shielded room are dedicated for BNCT application.

Future Prospects for Utilization

- Development of the existing facilities to increase the utilization and harmonize with the market requirements:
  - Upgrading of the NTD facilities;
  - Introduce irradiation facilities for Mo-99 production;
  - Installation of small angle neutron scattering (SANS) facility;
  - Development of the static neutron radiography to be real-time to allow for more applications.
- Accreditation for NAA Lab and implantation of K_0 method and Large Sample AA.
- Start production of radio isotopes (Cr-51, Ir-192, I-125).
- Continues training and re-training for manpower development to support longer time operation.
- Collaboration and exchange information and experience with regional countries.

Future Prospects for Utilization

- **Upgrading of the NTD facilities:**

- it is possible to introduce modifications to the existing silicon irradiation rig to irradiate six–inch diameter silicon ingots;

- The existing aluminum container (about 15 mm thick) in the irradiation rig is substituted with another one of appropriate thickness (3 mm) to accommodate six-inch diameter;

- A simple design of new aluminum container has been completed as well as manufacturing of one container;

- The new container can irradiate larger size and quantities of doped silicon than the existing five-inch container. Irradiation tests and commissioning are in progress;

- The outer positions in the irradiation grid could be mad available for irradiation of 8-inch ingots and more six-inch diameter. A simple irradiation is suggested to be adapted in ETRR-2.

Future Prospects for Utilization

- **Mo-99 Production:**

- Two in-core irradiation boxes will be dedicated for the irradiation for production of 1000 Ci/week of Mo-99;

- The in core irradiation has the advantage of no special cooling or irradiation loop is required;

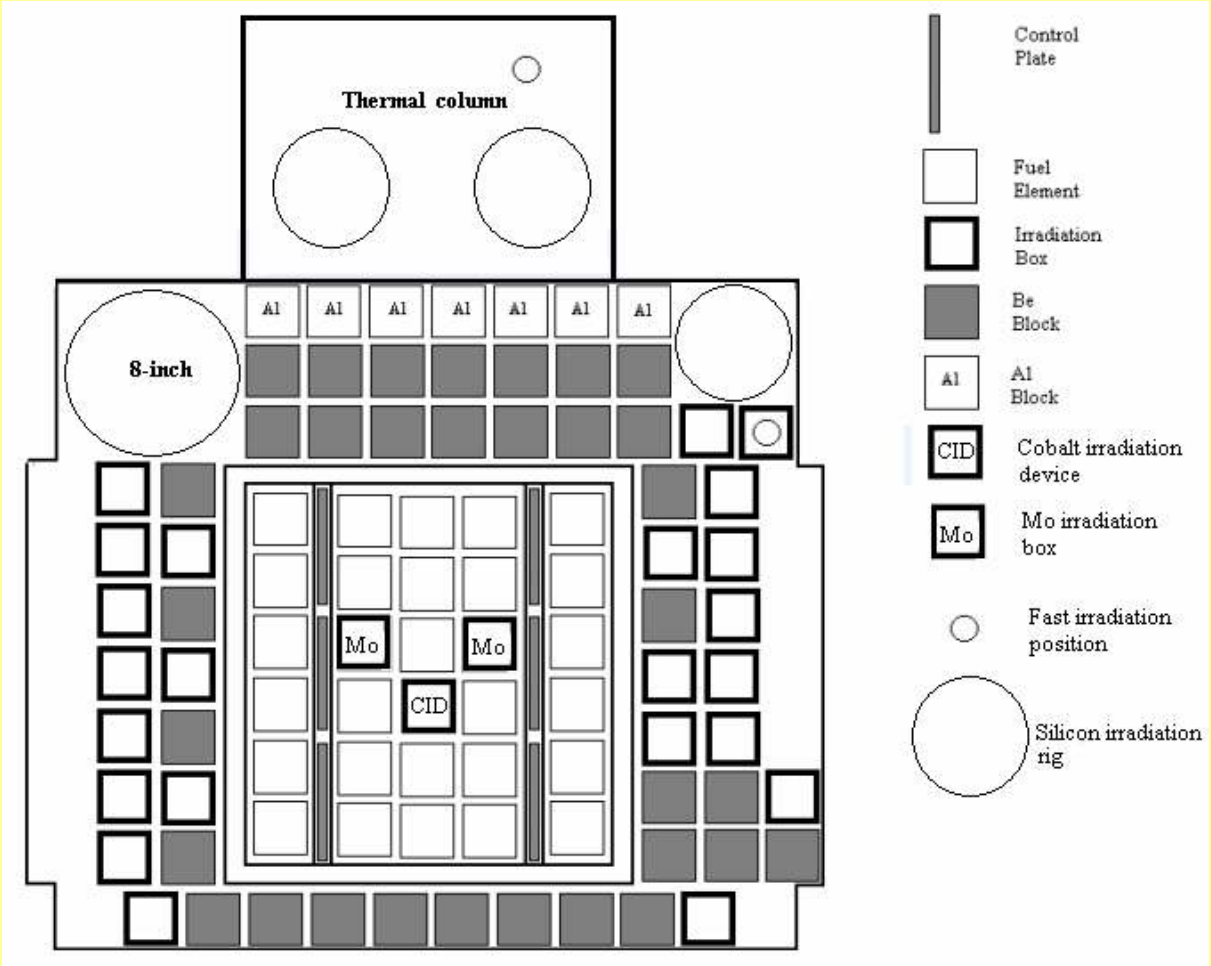
- The irradiation boxes will be loaded into or removed from the core while the reactor is shut down;

- Co-60 Hot cell will be adapted to be used for irradiated Mo-99 targets loading into shielded containers.

- **SANS installation at tangential beam port:**

  The conditions are optimal for installation of 2 or 3 scattering instruments. IAEA will support a first SANS (Small Angle neutron scattering) with intermediate level for applications in material science.

Future Prospects for Utilization



ETRR-2 irradiation facilities with modifications

Modes of collaboration

Modes of Collaboration with other Research Reactor institutes:

- Networking and bilateral co-operation;
- Technical cooperation projects;
- Conferences and forum;
- Meetings , training activates , workshops, expert mission and scientific visits;
- Experimental facilities sharing;
- Common research and scientific publications;
- Sharing in research projects.

Thank You