The Purpose of a Multipurpose Reactor

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My background in RR

- Reactor Manager (RM) of the Argentinean reactors RA-6 and RA-8.
- Staff Trainer and Commissioning RM of the Algerian NUR and Egyptian ETRR-2 reactors.
- Design Team Member, power ramping-up Commissioning Manager and Advisor of the Operation Team of the Australian OPAL reactor.
- INVAP Project Manager for DIPR, RMB, RA10, MIPF, Pallas.
- Manager of INVAP RR and Associated Facilities Section.

The Operating Organizations dilemma

- Attractiveness of a Business Plan based on multiple “products”.
- Availability of stakeholders and investors.
- Better public acceptance.
- Possibility to develop user communities.

But…

- Increased initial and operational costs.
- Greater complexity.
- Licensing risks

Options for New Projects

- IAEA initiatives (such as ICERR).
- A small project (≈50 M USD) to develop skills.
- A proven licensed reactor (TRIGA experience) flexible enough to accommodate different applications.
- A larger project but including a limited number of features.
- MPR based on strategic plans developed by mature organizations (ANSTO, CNEN, CNEA, etc.).
- Others (such as single purpose facility / retrofitting of existing facilities)

Single purpose reactor

- Critical and subcritical assemblies
- Homogeneous reactors
- Energy production
- Water desalinization
- Non-civilian purposes

Retrofitting existing facilities

- Some designs allow for modifications to accommodate new applications.
- New applications compete with others.
- Late implementations are not efficient
  - On-service samples loading / withdraw
  - Doses are not “ALARA”
  - Production rates & performance far from optimum
  - Required performance obtained sometimes at the expense of stand by units.

Examples of late modifications

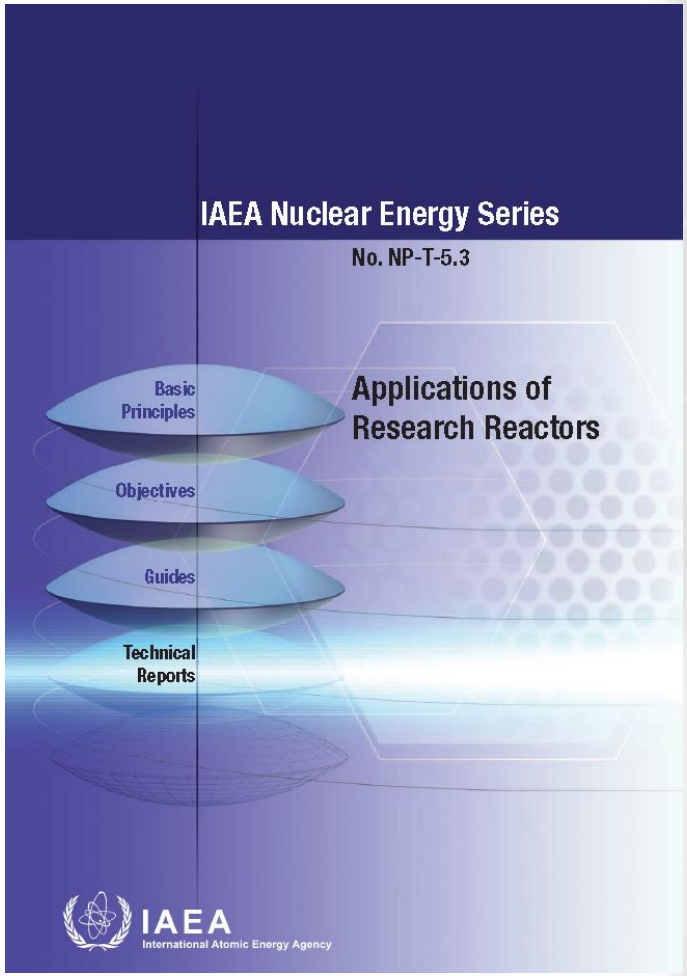
- RA-6 thermal column
  - Original setup: two graphite sections (1st inside the pool / 2nd in the reactor block)
  - First modification: enlarging the irradiation volume in the reactor block section
  - Second modification: replacing 1st section by a filter and collimator / install a filter and beam conditioner shaper in the 2nd section
  - Outcome: a BNCT facility
- Modifications driven by molybdenum production

Applications and Facilities

- Facilities may accommodate different Applications. Examples are:
  - Pneumatic rabbit
    - Radioisotope production
    - NAA
  - Beams
    - Dry neutron radiography
    - SANS
- Applications require specific support equipment in addition to those implemented in the Facility.

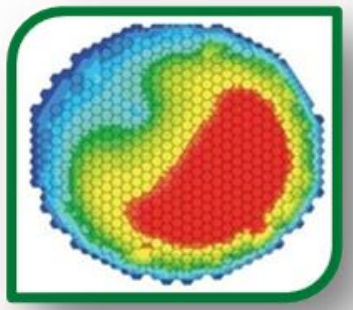
Applications as per IAEA

- Education and Training
- Neutron Activation Analysis
- Radioisotope Production
- Transmutation Effects:
  - Silicon Transmutation Doping
  - Gamma Irradiation
  - Gemstone coloration
- Neutron Imaging
- Neutron Beam Application
- Boron Neutron Capture Therapy
- Instrument testing and calibration
- Loops for testing



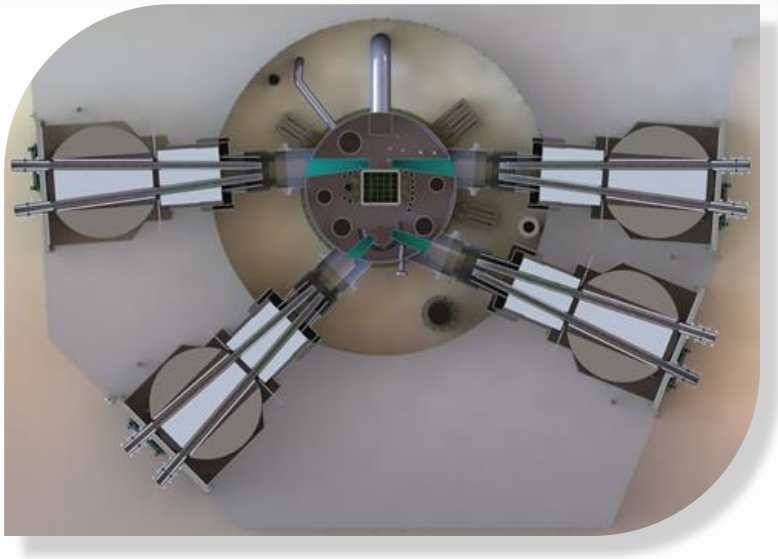
Selection of Facilities

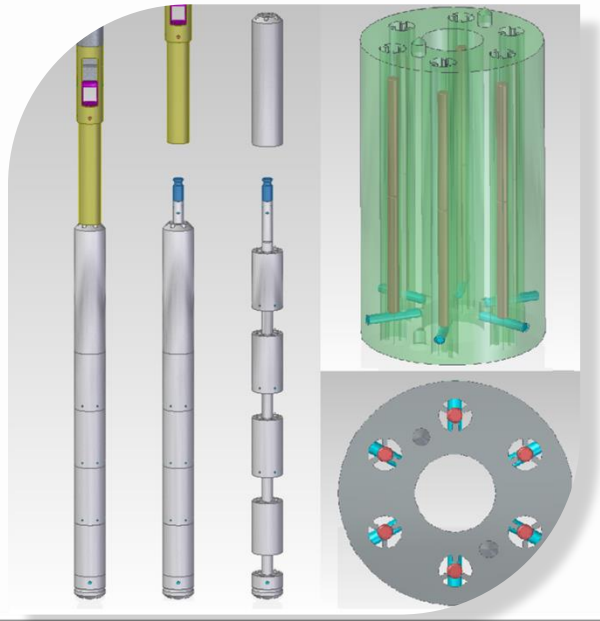
- Characterization of the Facility:
  - Volume
  - Neutron Fluxes
  - Neutron Spectra
  - Support Services
  - Impact on design and costs
- Competence between facilities:
  - Allowable perturbations
  - Requirements on the reactor status



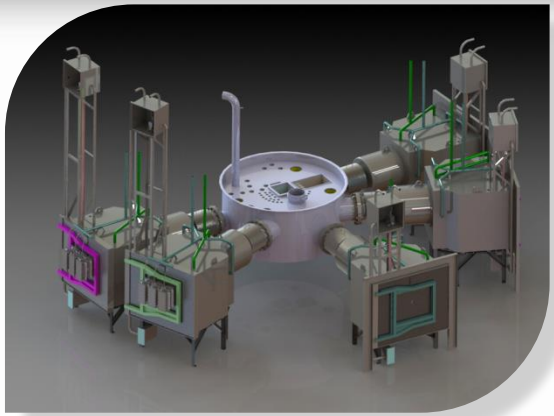
Analysis of some Facilities

- Facilities
  - Beams
  - Irradiation Positions:
    - In-core
    - Out-of-core
    - Bulk
    - Short residence time
  - Irradiation loops
  - Radioisotope production positions
- Analysis on:
  - Equipment
  - Impact





Equipment for Beams

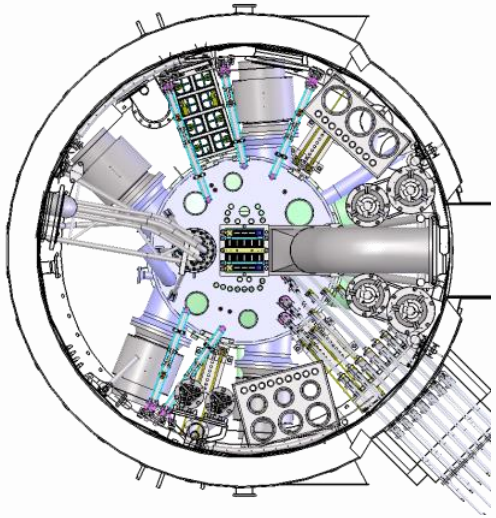


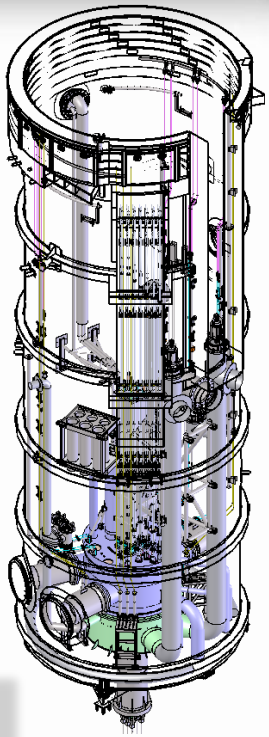
- Shutters
- Filters
- Neutron guides
- Cold, Thermal and Hot Neutron Sources

- In-pile cooling
- Shields
- Pool leak prevention and detection
- Positioning and lifting equipment for instruments

Impact of Beams

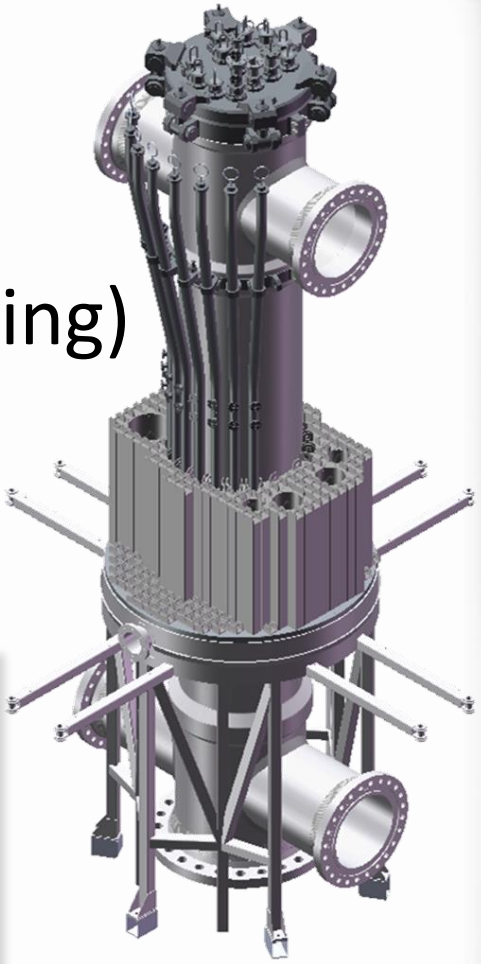
- Beams:
  - Core height:
    - Pool position
    - Confinement height
  - Site layout:
    - Beam Halls for Instruments
    - Future expansions
  - Facility layout:
    - Space for experiments
    - Circulations





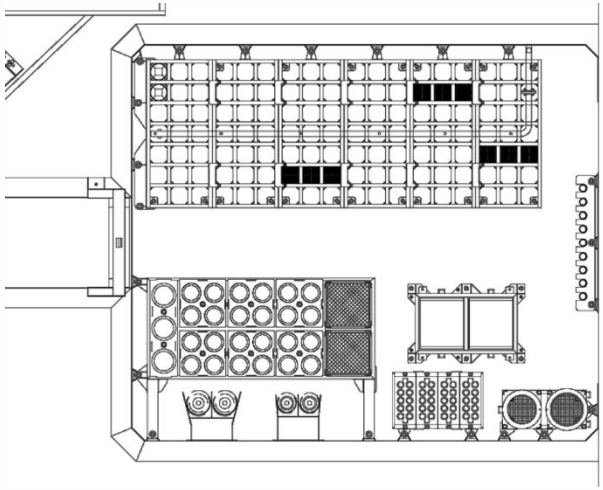
Equipment for Irradiation Positions

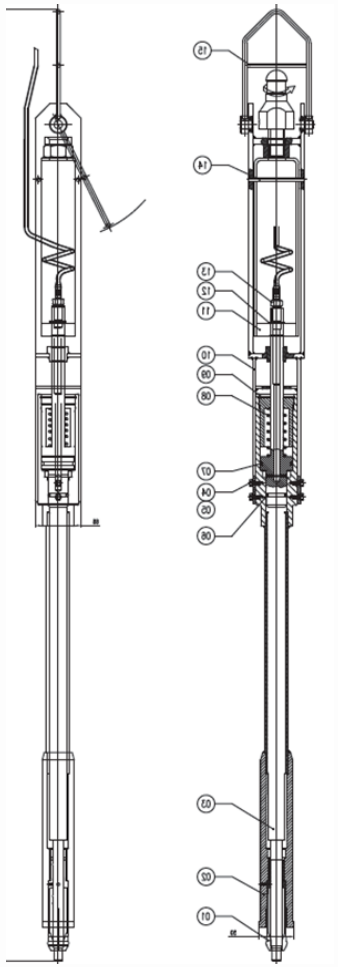
- Cooling
- Flux flatteners
- Underwater instrumentation (cabling)
- Special detection systems (e.g. delayed neutrons detectors)
- Locking devices
- Lifting equipment
- Special toolkit



Impact of Irradiation Positions

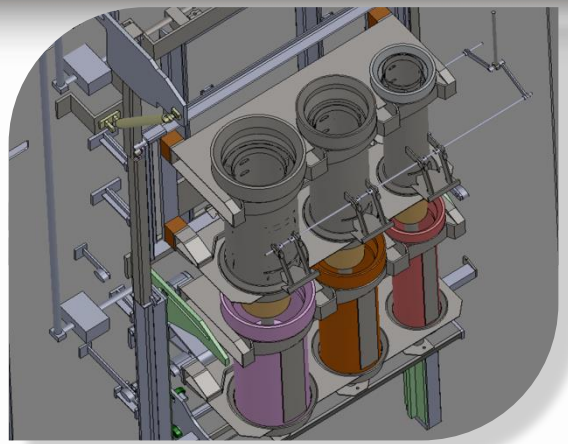
- Space and devices for rigs assembly / disassembly.
- Waste storage.
- Hot workshop.
- Remote operation tools.

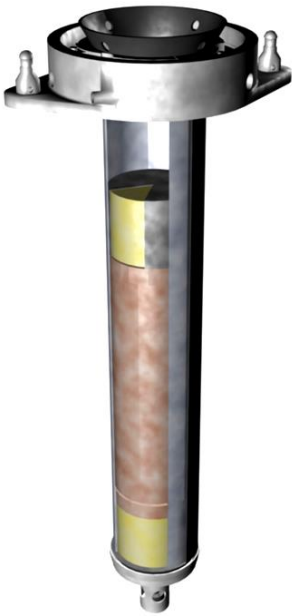


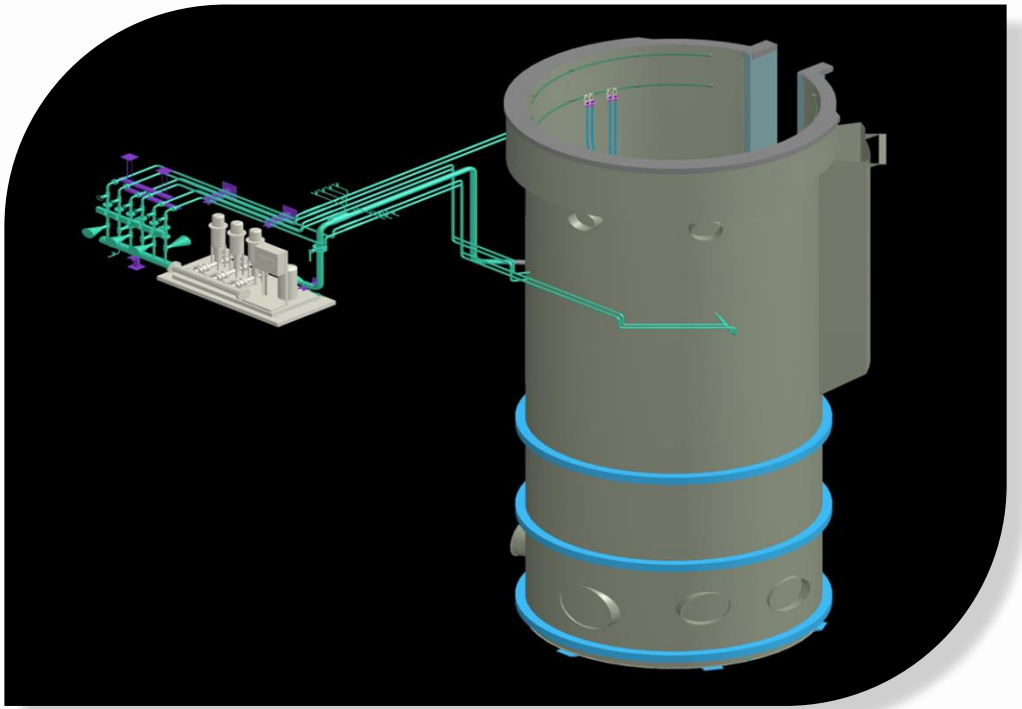


Special case of Silicon Doping

- Silicon doping
  - Rotation system
  - Assembly space
  - Large storage

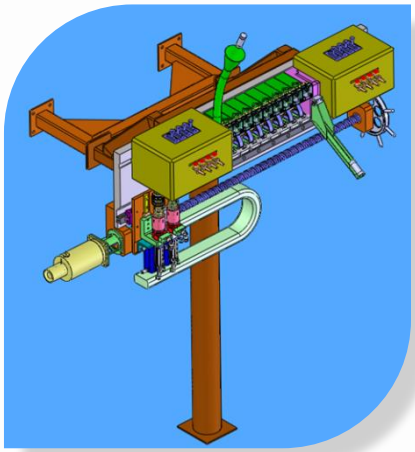


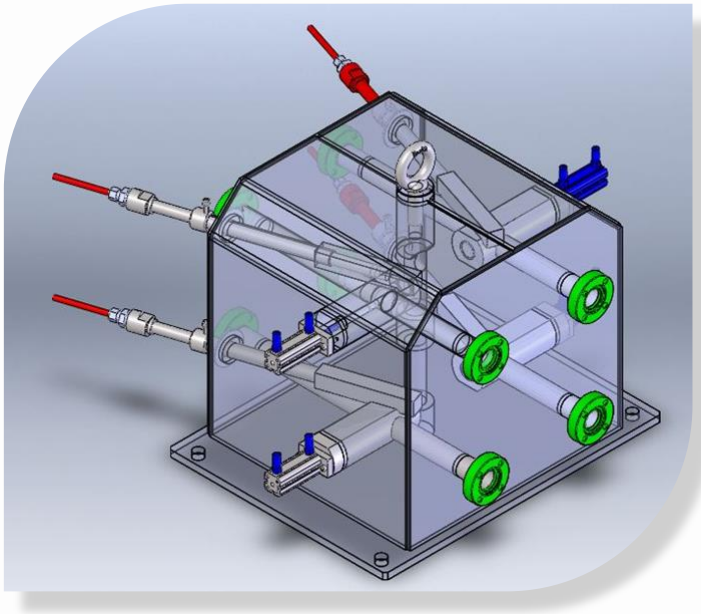




Equipment for Short Residence Time Irr. Pos.

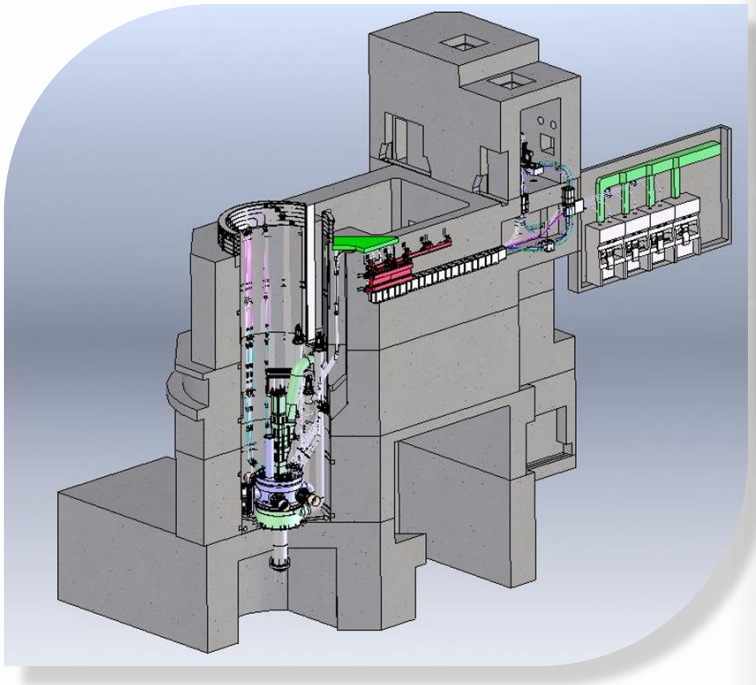
- Pneumatic triggering system
- Cooling system
- Rabbit cans
- Reception station
- Shielding
- Interlocking/measuring devices





Impact of Short Residence Time Irr. Pos.

- Reactivity insertion rate
- Tubing accessibility and shielding
- Decay stations
- Remote dose monitoring
- Waste management/ Reuse / Recycle
- Gas bottles



Equipment for Loops

- Underwater Positioning System
- Core components protections:
  - Smash
  - Jets / Explosions
  - Heat
  - Chemical
- Connections:
  - Instrumentation
  - (Reactor) Protection System
- Services:
  - Chilled water
  - Filtered vents
  - Industrial Gases

Impact of Loops

- Reactivity worth
- Underwater connections
- Space for assembly / disassembly
- Underwater storage / resting places
- Heavy equipment
- Shielded bunkers / glove boxes

Equipment for Radioisotope Production

- Hot cells for:
  - Assembly / disassembly
  - Conditioning
  - Processing
- Transfer equipment:
  - Hatches and access
  - Elevators
  - Containers
  - Transport systems
  - Monitoring

Impact of Radioisotope Production

- Contamination hazard
- Lifting of heavy loads
- Hot cell maintenance:
  - Tools and spares
  - Breathing air
  - Trained operators
- Decontamination and Storage of containers

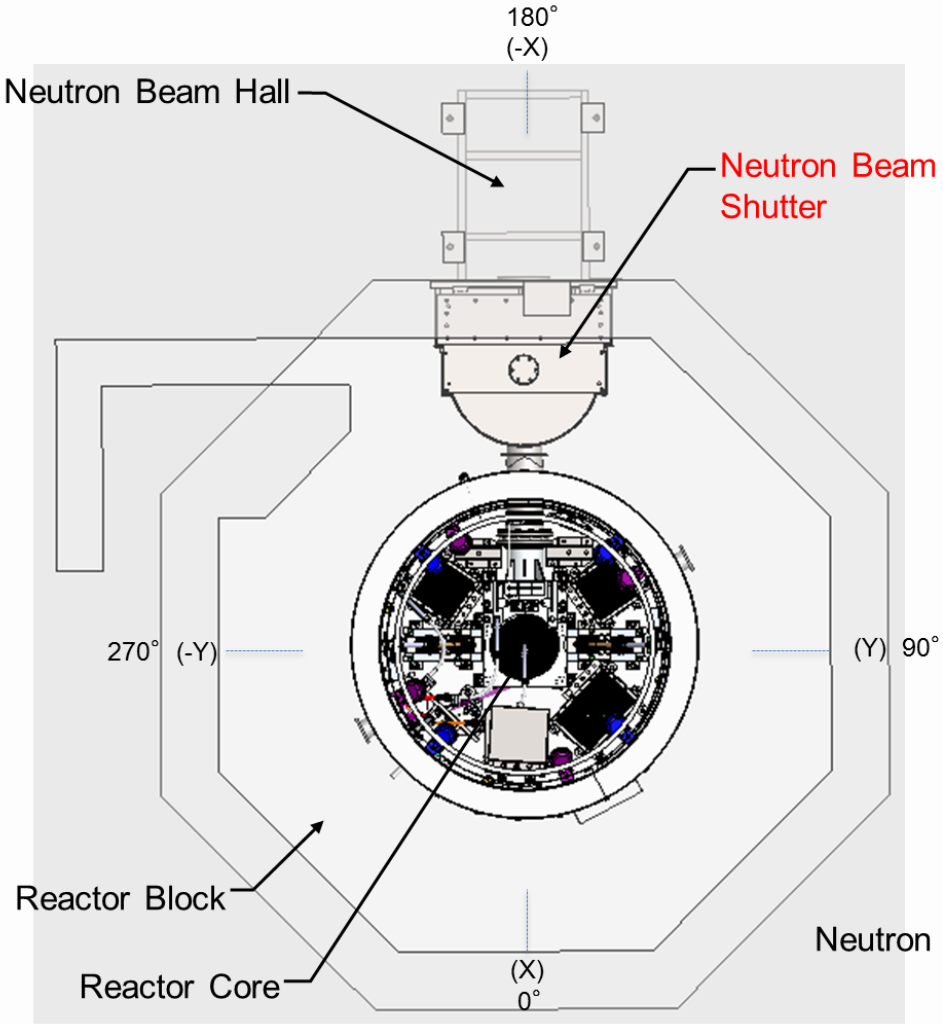
At the end of the day, how a MPR looks like?

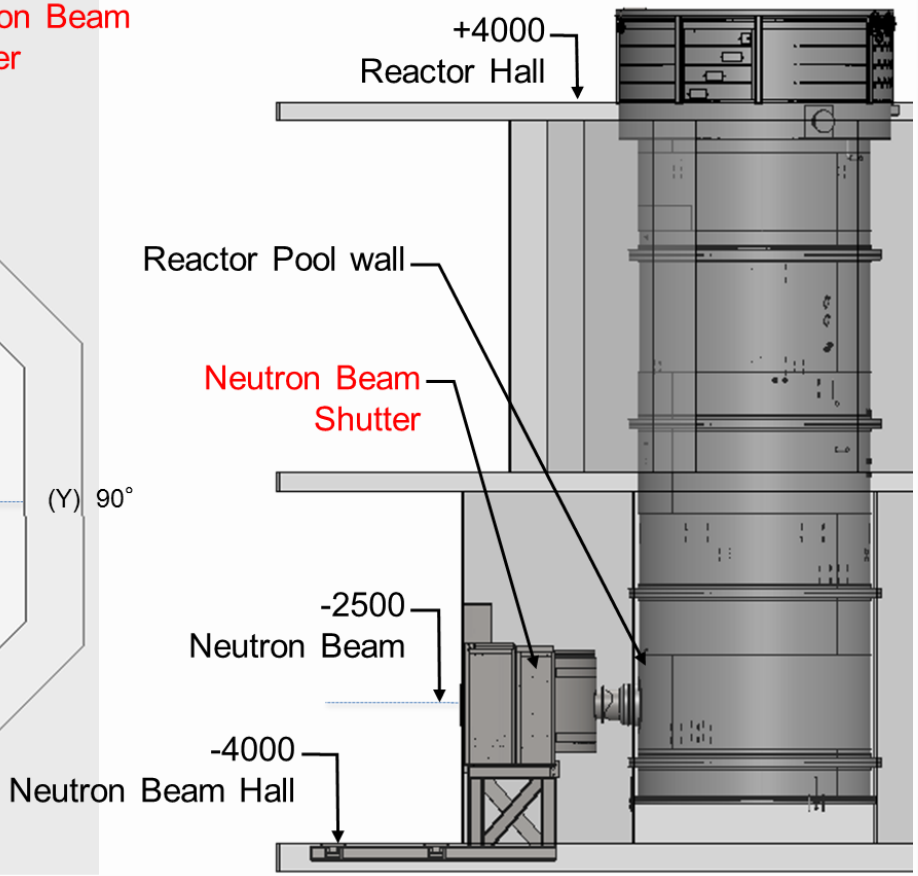
Which reactor is a MPR?

30 MW

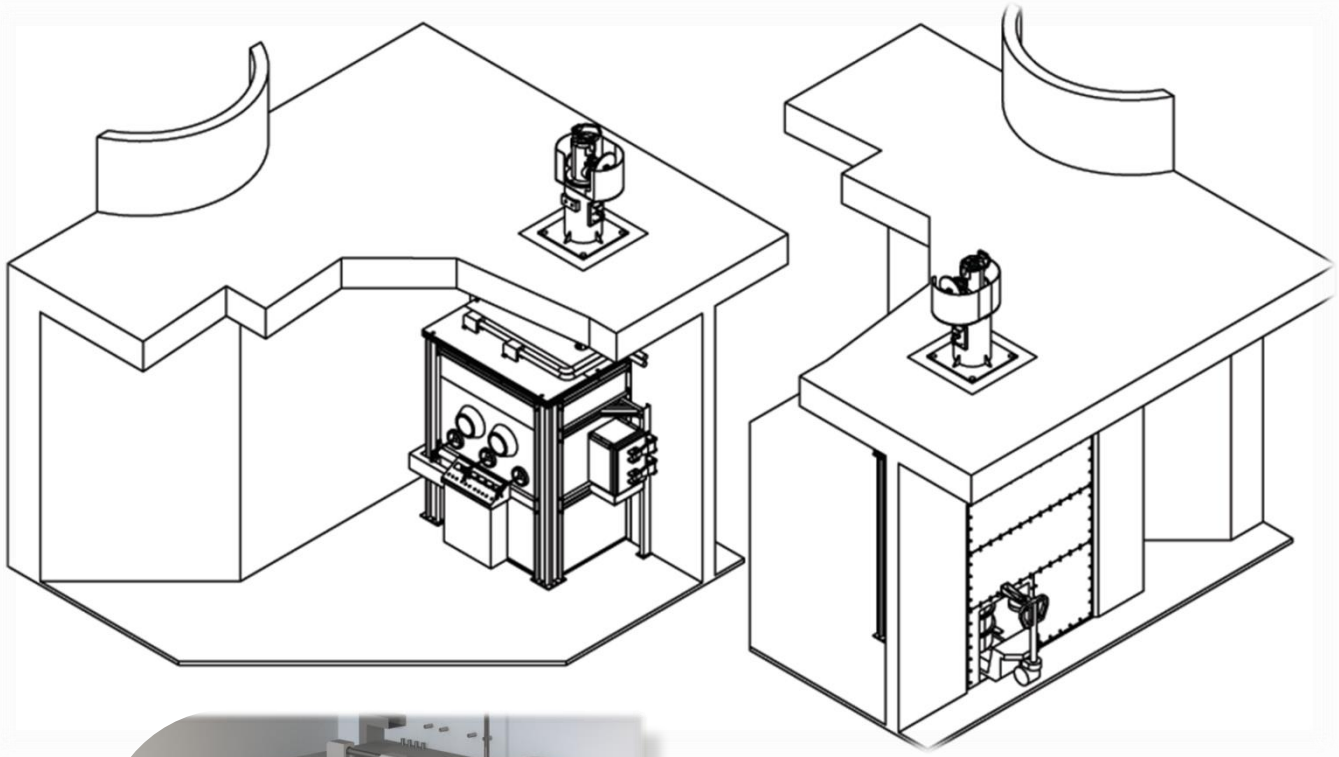
30 kW

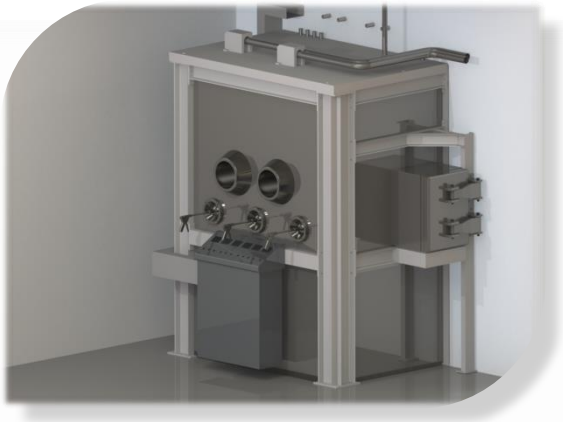
Neutron Beam

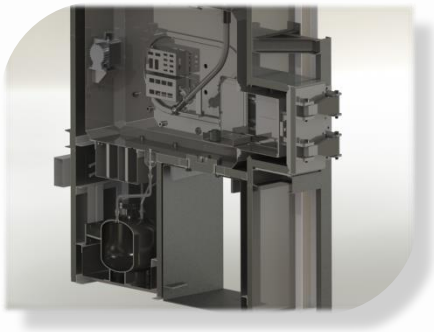




Radchem Hot Cell

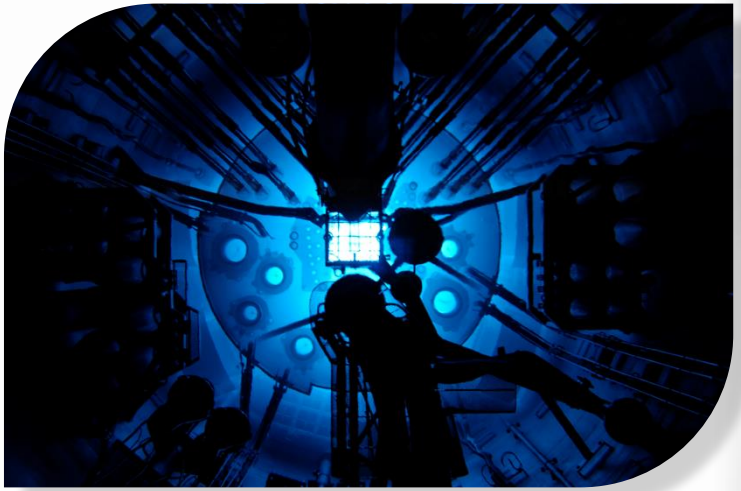






Conclusion

- A Multipurpose Reactor is a facility able to run several applications at the same time without noticeable interference between them.
- OPAL reactor is an outstanding example of Multipurpose Reactor:
  - 300 FPD per year
  - Products up to mid 2015:
    - 6496 irradiated U plates
    - 628 irradiated Te targets
    - 26000+ irradiated Si ingots
    - 500+ research papers
    - 10+ state of the art research instruments



Muito obrigado pela sua atenção