RATEN ICN PITEŞTI
INSTITUTUL DE CERCETĂRI NUCLEARE

RATEN ICN Infrastructure for R&D and E&T in nuclear energy

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Background

RA TEN
REGIA AUTONOMĂ
TEHNOLOGII pentru ENERGIA NUCLEARĂ

Technologies for Nuclear Energies State Owned Company (RATEN) is a strategic organization, providing scientific and technical support for the nuclear power activities in Romania.

RA TEN ICN PITEŞTI
INSTITUTUL DE CERCETĂRI NUCLEARE

The Institute for Nuclear Research is conducting activities, including research, development and training, contributing to the maintenance of a high level of nuclear safety for power plants and research reactor

CITON

CITON's main activity is dedicated to Design and Engineering works for Nuclear Projects and to Research and Development studies associated with the implementation of the National Nuclear Program.

RATEN ICN

- RATEN ICN is a scientific and technical organization with a relative recent history participating in the technological development of nuclear fuel in the design, construction and testing of some dedicated equipment to Cernavoda Nuclear Power Plant Unit 1 commissioned in 1996 and Unit 2 commissioned in 2007, participation in commissioning activity, testing large equipment (Fueling machine) and now contributing to the high level of nuclear safety of power plants. The last time highly appreciated services are contracted concerning post irradiation examination of spent fuel used in NPP Cernavoda.

RATEN ICN objectives

Development of scientific and technological support for the National Nuclear Energy Program:

- safe and competitive operation of Units 1 and 2 of Cernavoda NPP,
- construction of new nuclear power plants,
- promotion of advanced generation IV reactors and implementation of ALFRED Demonstrator in Romania,
- safe storage of nuclear spent fuel and radioactive waste management,
- operation and development of the infrastructure to sustain the R&D Programs, education and training, transfer of knowledge, international cooperation.

RATEN ICN organizational structure (R&D departments)

- Reactor Physics, Nuclear Fuel Performance and Nuclear Safety Dept.;
- TRIGA Reactor Dept.;
- Nuclear Materials and Corrosion Dept.;
- Out of Pile Testing Dept.;
- Radioactive Waste Treatment Plant;
- Electronics Dept.;
- Post-Irradiation Examination Laboratory;
- Surface Analysis Laboratory;
- Testing and Reliability Laboratory;
- Radiation Protection, Environment Protection and Civil Protection Laboratory;

RATEN ICN organizational structure (support departments)

- Metrology and IT Laboratory;
- Technical Quality Control Laboratory;
- Design Dept.;
- Nuclear Prototypes Workshop;
- Quality Management Dept.;
- Utilities Production and Distribution Dept.;
- Mechanics, Maintenance, Repairs Dept.;
- Support services (Programs, Contracts; Foreign Relations, Technology Transfer, Protocol; Administrative; HR; Financial, Accounting; Supply, Marketing; Investments, Patrimony; Emergency Situations, Prevention and Protection; Legal; Transports; Medical; Physical Protection; Safeguards; Protection of Classified Information).

RATEN ICN Main Facilities

- **Dual Core TRIGA Research Reactor (14 MW-SSR, ACPR);**
- **Post Irradiation Examination Laboratory (PIEL);**
- **Radioactive Waste Treatment Plant;**
- **Material Testing and Nuclear Fuel Fabrication Laboratories;**
- **Out-of-Pile Testing Laboratories;**
- **Radiation Protection, Environment Protection and Civil Protection Laboratory;**
- **Training center and related training facilities.**

Dual core TRIGA Research Reactor (14MW-SSR, ACPR)

TRIGA SSR - 14 MW and TRIGA ACPR RESEARCH REACTORS are unique facilities at national levels used for irradiating nuclear fuel, structural materials intended for nuclear power plants, obtaining radioisotopes for industry and medicine, neutron diffractometry, nuclear methods developments applicable to archeology, geology, medicine and environmental protection.

Dual core TRIGA Research Reactor (14MW-SSR, ACPR)

The project of TRIGA research reactor built in a Nuclear Technology Institute was a multipurpose project with the following goals:

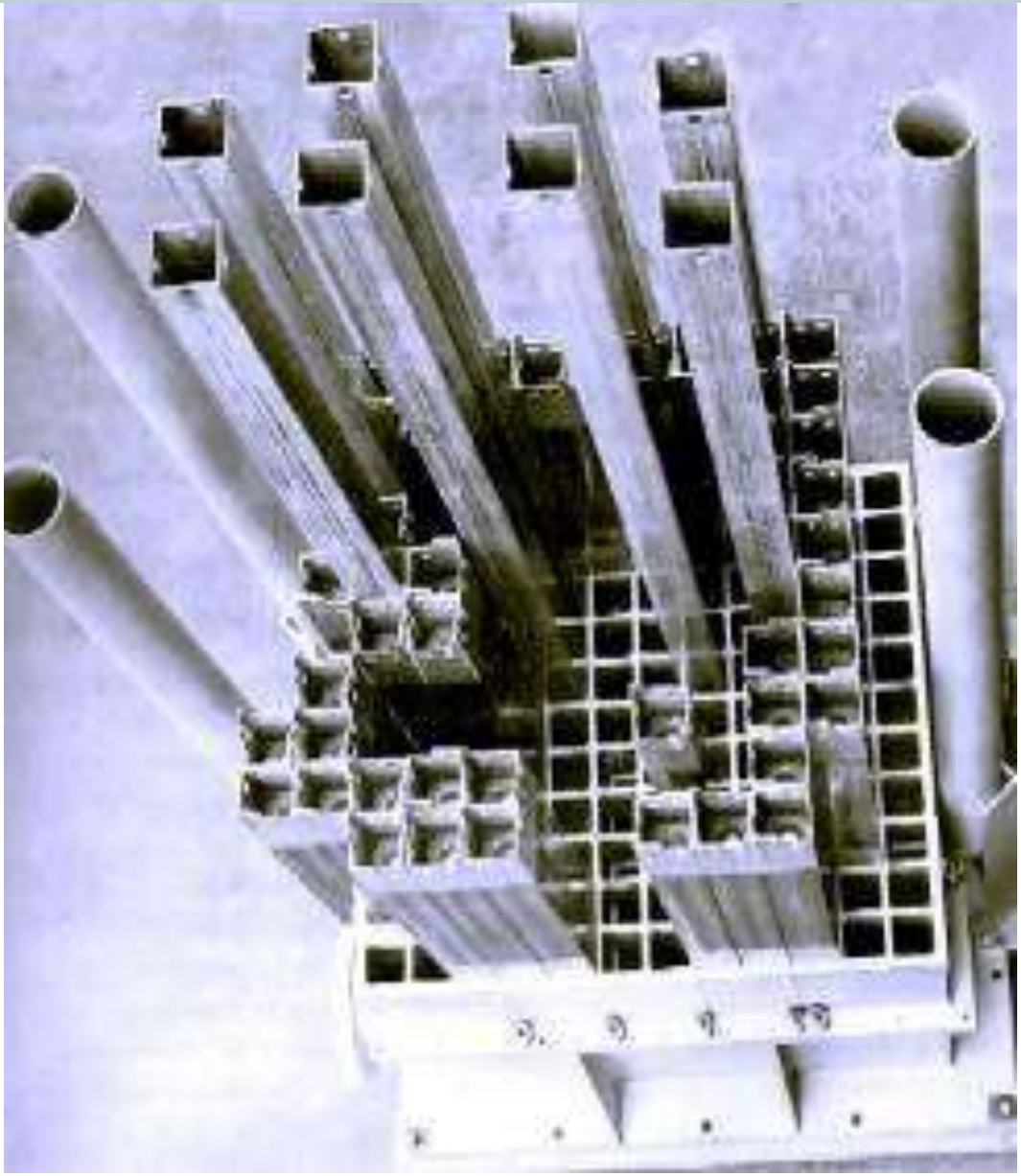
- **to sustain testing and qualification of materials and nuclear fuel for Cernavoda power plant;**
- **to enhance the radioisotope production and utilization for industry and medicine;**
- **to ensure a specialized research infrastructure for education and training for human resources for nuclear energy.**

Dual core TRIGA Research Reactor (14MW-SSR, ACPR)

The utilization of the reactor was oriented towards irradiation and testing of experimental fuel rods and assemblies, followed by post-irradiation examination, in order to gather data for the characterization of the Romanian technology of fuel for power plant qualification and determination of the limits in the utilization in steady-state (normal) condition of operation, anticipated transients and accident conditions, producing a large amount of data for the specific computer codes library.

14 MW TRIGA Research Reactor

The design of core incorporates features which ensure maintainability, testability and inspectability for the lifetime of reactor. Fuel rods are manufactured from a hydrated metallic alloy of Uranium, Zirconium and Erbium, cladded in Incoloy 800 tubes. Fuel assemblies contains 25 fuel rods assembled in a 5 x 5 square lattice. The fuel assembly is provided with top and down cast Aluminum alloys fittings. The top fitting allows the handling of assembly and control the water flow. The fuel assembly and core elements are placed into lower reactor gird with a lattice pitch of 90 mm.



Flux spectrum values

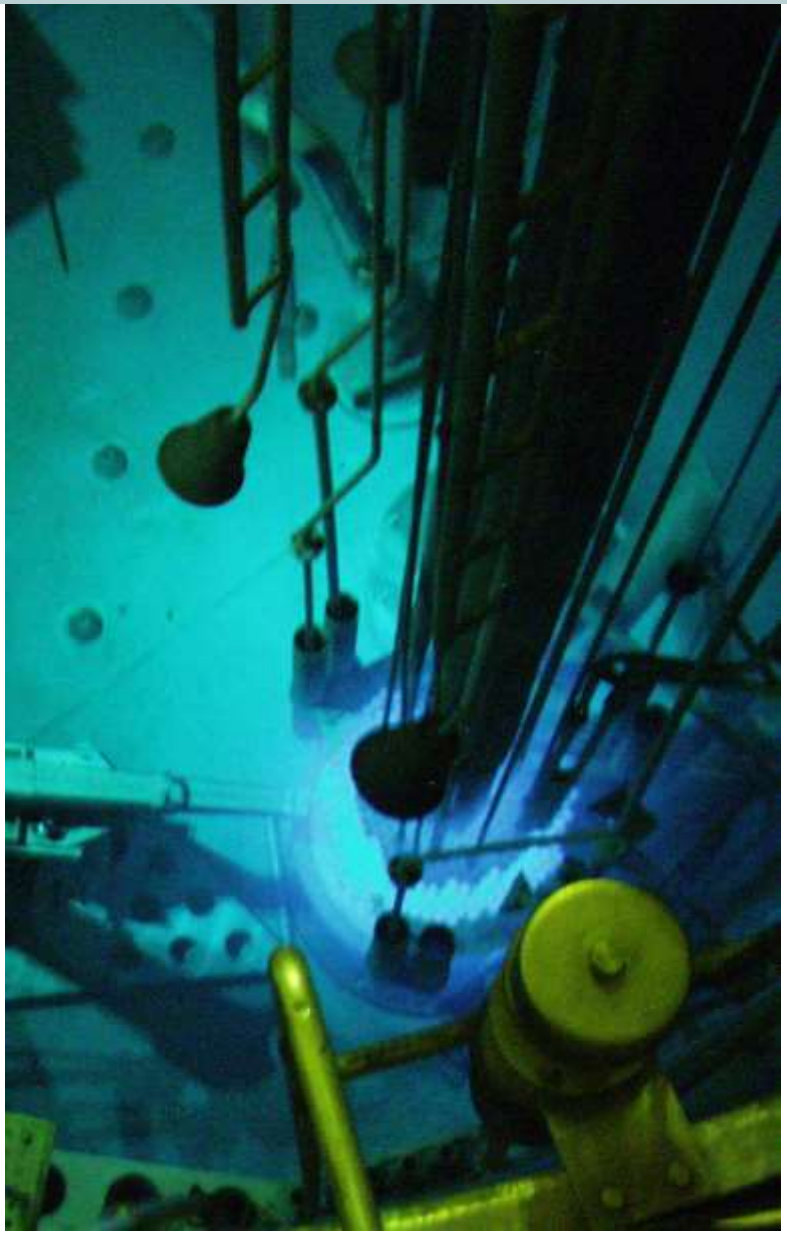
Neutron energy range (MeV)	Neutron flux (n/cm^2*s)	Average energy (MeV)
10^{-10}- 18	4.22×10^{14}	0.41
10^{-10}- 5.5×10^{-7}	2.63×10^{14}	
5.5×10^{-7}- 1.0	1.34×10^{14}	
1.0 - 18	6.89×10^{13}	2.46

data measured with all irradiation position (vertical channels) filled with water i.e. non-perturbed flux

TRIGA ACPR main characteristics

Reactor vessel	4,5 m (width), 9 m (length), 10 m (depth), open pool
Fuel	Metal alloy 12% U-ZrH weight
Enrichment	19.75% U235 weight
Reactor power	
Steady state	500 kW maximum power
Pulsed	20.000 MW maximum power Minimum period: 1.2 ms

Thermal neutron flux	1.0×10^{14} n/cm^{-2}·s^{-1}
Fast neutron flux	1.0×10^{13} n/cm^{-2}·s^{-1}



IRRADIATION DEVICES AT THE ICN-RR, PITESTI, ROMANIA

Specification	Reactor	Irradiation device
Normal conditions	14 MW SSR	Capsule C1: on-line fission gas sweep analysis Capsule C2: fuel internal clad pressure evolution and central temperature Capsule C7: corrosion under irradiation Capsule C9: load follow-up Loop A: overpower
Transient conditions	14 MW SSR	Capsule C2 and loop A ramp tests
Accident conditions	ACPR	Capsule C6: (RIA simulation)
Future plans in terms of accident conditions	14 MW SSR	Modified capsule C2: for LOCA type accident, using fresh and irradiated fuel Modified loop A: to simulate LOCA at PWR's
	ACPR	Design a new irradiation device to allow testing of pre-irradiated fuel in RIA conditions, Designed and build a Pb-Bi capsule for MAXSSIMA project
Material irradiation	14 MW SSR	Capsule C5: for structural materials Loop A: pressure tube material

Post Irradiation Examination Laboratory - PIEL

The facilities of the laboratory allow the testing, handling and examination of the nuclear fuel and the structural materials used in nuclear power plants.

Methods implemented and used for post-irradiation examination:

- visual examination and photography
- high precision dimensional measurements
- axial gamma scanning and tomographic reconstruction of fission product distribution in the cross section of fuel rod,
- eddy current defect testing
- oxide layer thickness measurement, **(nondestructive tests)**

(destructive tests)

- fuel cladding puncture and fission gas analysis by mass spectrometry,
- metallography and ceramography by optical and scanning electron microscopy
- mechanical testing on samples of fuel cladding
- radiochemistry followed by mass spectrometry (ICP-MS, TIMS), gamma spectrometry, alpha spectrometry and high-pressure liquid chromatography.

Radioactive Waste Treatment Plant

Collecting, treating and conditioning of the radioactive waste resulted from the TRIGA reactors, the Nuclear Fuel Factory (FCN), Post-Irradiation Examination Laboratory (LEPI) and other nuclear installations within ICN and in the country, but also developing and implementing new equipment and technologies.

Material Testing Department and Nuclear Fuel Fabrication Laboratories

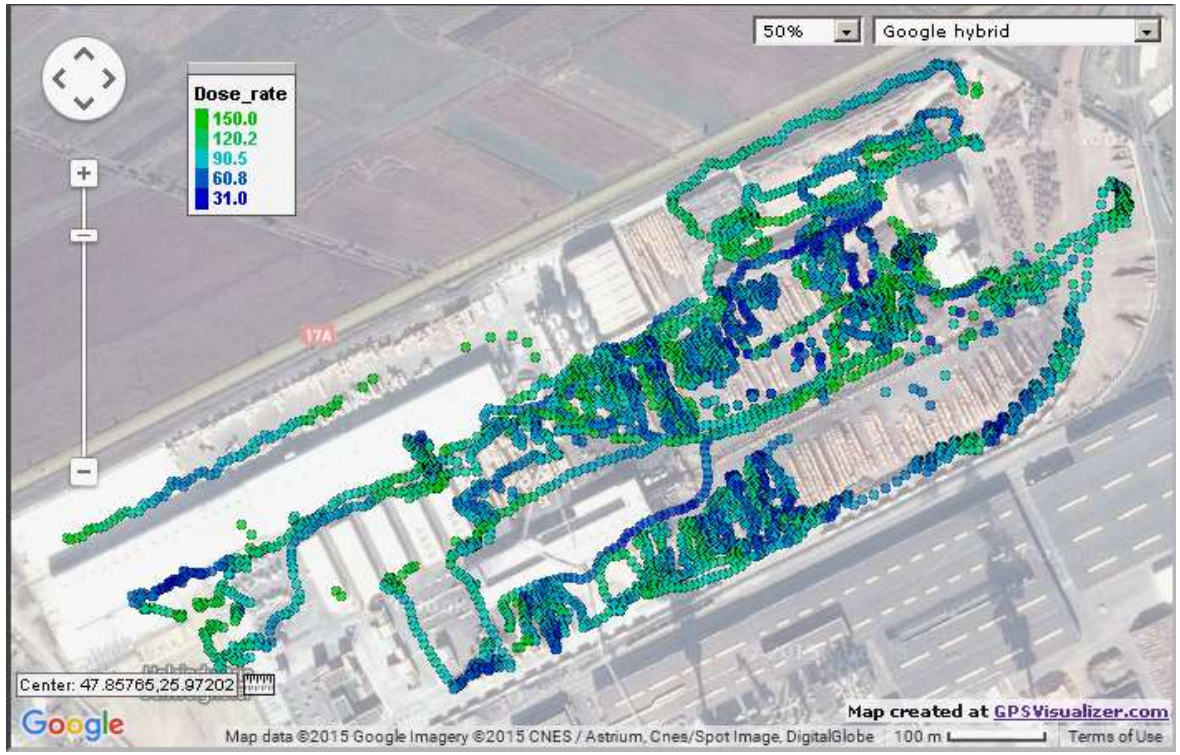
- technologies for obtaining UO_2 powders;
- technologies for obtaining sintered UO_2 pellets with controlled microstructure;
- Developing materials for extreme conditions - pressure, temperature and high neutron fluxes;
- Investigation of corrosion mechanisms located in structural components from various nuclear facilities and industrial facilities;
- Investigation of the release mechanisms, transport and deposition ones of corrosion products and the dependence of the physical-mechanical properties and corrosion resistance of materials, but also the physical-chemical properties of the transport fluid;
- Evaluation of corrosion mechanisms and corrosion products in the primary coolant circuit of research reactors;
- Studies and experiments of microbiological corrosion in nuclear installations;
- Analysis of corrosion on equipment and on corroded equipment in nuclear facilities;
- Testing under corrosion in order to identify the causes and establishing the measures for diminishing/preventing corrosion phenomena;
- Corrosion experiments for Generation IV nuclear applications materials.

Out-of-Pile Testing Laboratories

- Equipment design and development for nuclear installations;
- Development of theoretical models and computer codes;
- Design, manufacturing and testing equipment and special devices for nuclear installations;
- Analysis of experimental data;

Radiation Protection Laboratory

- **Characterization of materials resulted from authorized nuclear activities, for clearance or classification as radioactive waste;**
- **Radiological survey and assessment for characterization of radioactively contaminated sites.**
- **Development of radiation detection methods to be used in radiation protection, environment radioactivity monitoring and nuclear or radiological emergency response activities.**



R&D Main Outcomes

- studies and researches in the field of materials and nuclear fuels, reactor physics, nuclear safety, equipment, instrumentation and control for nuclear applications;
- technologies for characterization, treatment and conditioning of radioactive waste;
- methods for radiation measuring for environmental and radiation protection applications; radiological consequences estimation and technical support for emergency planning;
- Development of the scientific research infrastructure
- Development of human resource in the research area by training of young people.

RATEN ICN participation in the European Commission Projects (ongoing)

Project	Project Title	Period
MAXSIMA	Methodology, Analysis and experiments for the "Safety in MYRRHA Assessment"	2012–2018
CAST	Carbon 14 Source Term	2013–2018
CEBAMA	Cement based Materials, Properties, Evolution, Barrier Functions	2015–2019
FASTNET	FAST Nuclear Emergency Tools	
GEMMA	Generation in Materials Maturity	2017–2021
CHANCE	Characterization of Conditioned Nuclear Waste for its Safe Disposal in Europe	2017–2021
MEACTOS	Mitigating Environmentally Assisted Cracking through Optimisation of Surface Condition	2017–2021
TRANSAT	Transversal Actions for Tritium	2017–2021

E&T Internal Activities

- **RATEN ICN staff completed specific annual training programs on nuclear safety, radiation and environmental protection, quality management, environment, health and occupational safety**
- **The experimental facilities and the experience gained by the specialists in the institute ensure the active involvement of young people in national, European and international programs and projects.**
- **Internal training program for the initiation of new employees regarding the activity of the Institute.**

Collaboration and Agreements with Romanian Universities

- University from Pitesti: Faculty of Science (Physical Engineering, Nuclear Engineering Technology, Environment Engineering, Chemistry);
- University of Bucharest: Faculty of Physics, Faculty of Chemistry;
- University Politehnica of Bucharest: Power Engineering Faculty, Environment Engineering.

- 300 students from the final years completed internships at the institute;
- 200 master students and final year students completed laboratory classes at the institute;
- 130 students were tutored for their bachelor paper;
- 120 students were tutored for their dissertation papers.

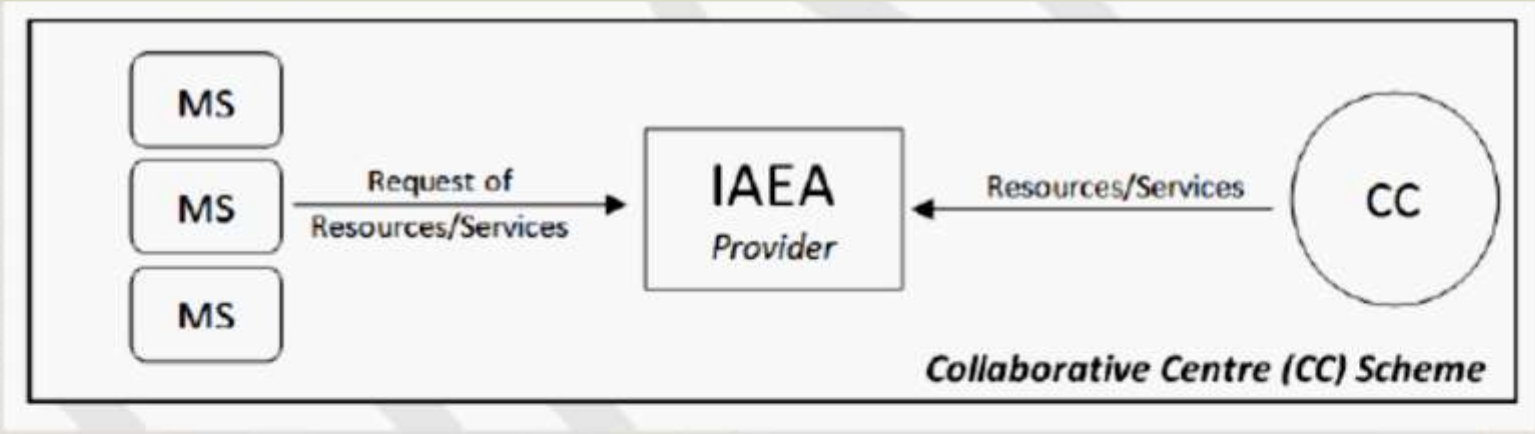
Cooperation between RATEN ICN and IAEA - Vienna

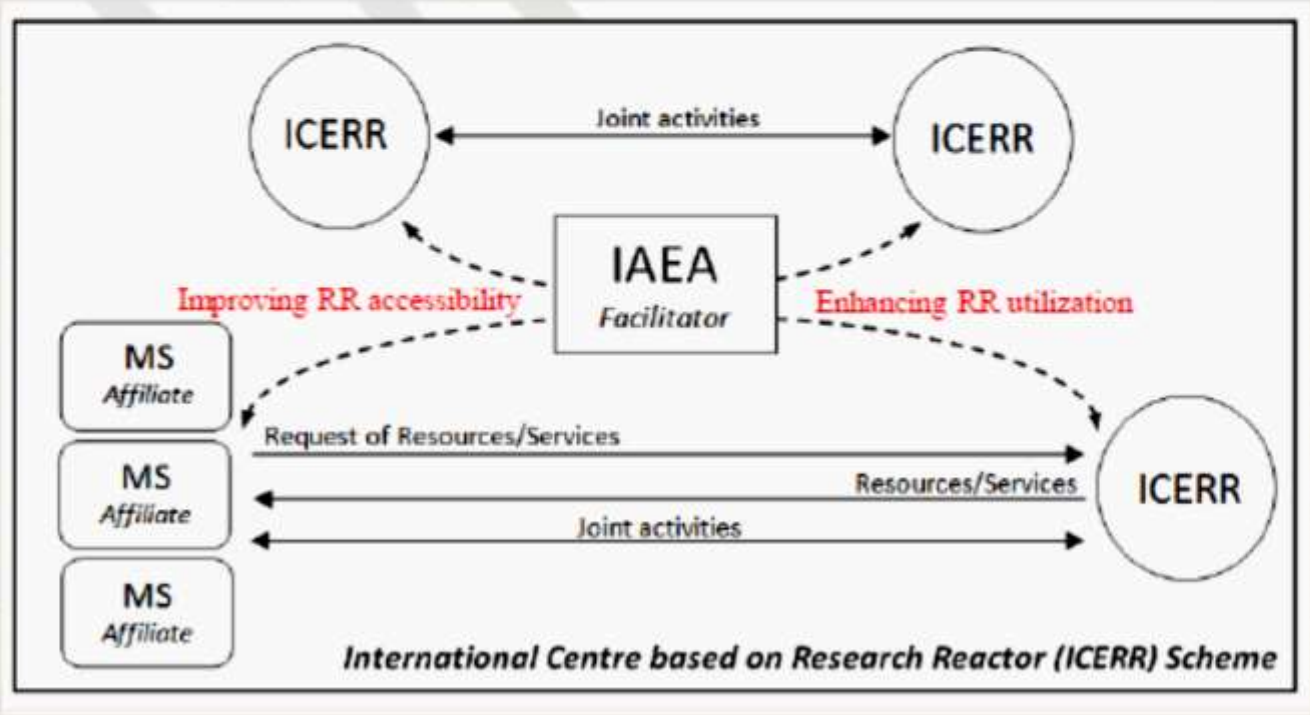
- Technical cooperation projects (TC);
- Coordinated research projects (CRP's);
- Regional projects;
- Experts missions;
- Consultative meetings;
- Conferences and IAEA courses;
- Fellowships trainings;
- Courses and workshops organization;
- IAEA networks membership (ALMERA, RANET).

IAEA
International Atomic Energy Agency
Atoms for Peace

On 15th September 2015, in Vienna, it was signed the Practical Arrangements (PA) between RATEN ICN and IAEA. Following this, on 21st April 2016 it was inaugurate the Training Centre, infrastructure that is part of this PA.

IAEA – initiative on ICERR





RATEN ICN REQUEST FOR DESIGNATION as IAEA - ICERR

- **May 2018, the request was sent by official channels**

Areas for the designation:

1. **providing access to the operating research reactor and ancillary facilities for Education & Training (E&T) and professional training;**
2. **Hosting of international / regional scientists / engineers / technicians for E&T and professional training.**
3. **R&D international joint projects**

Next steps:

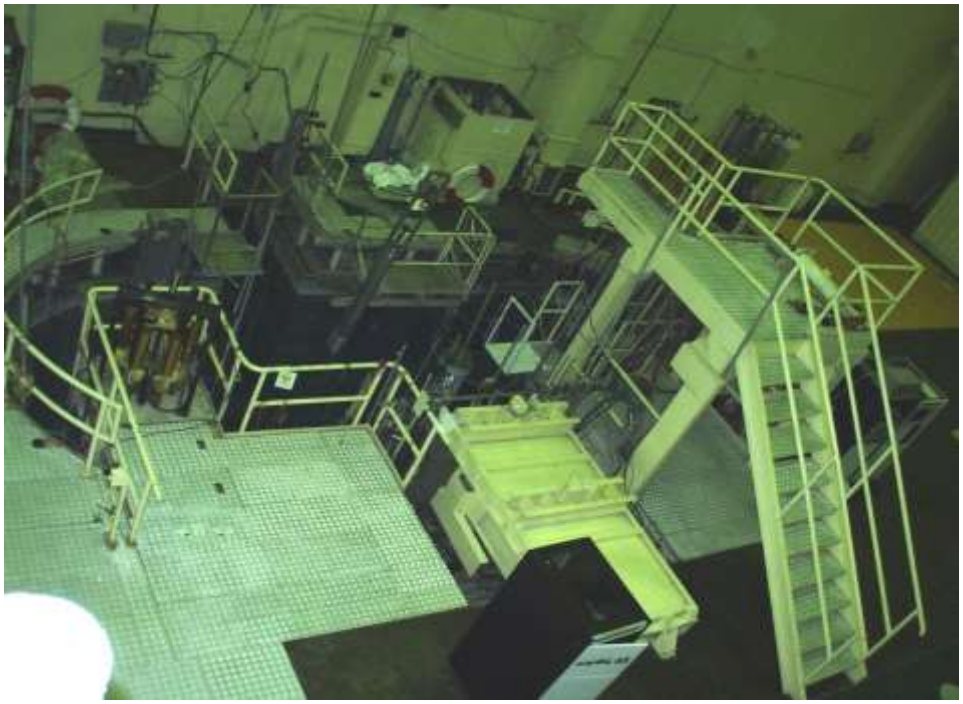
- **an audit procedure that should be performed by a committee of independent, international experts appointed by the IAEA;**
- **the IAEA recognition of the ICERR status based on the self-assessment and on positive feed-back of the independent expert audit.**

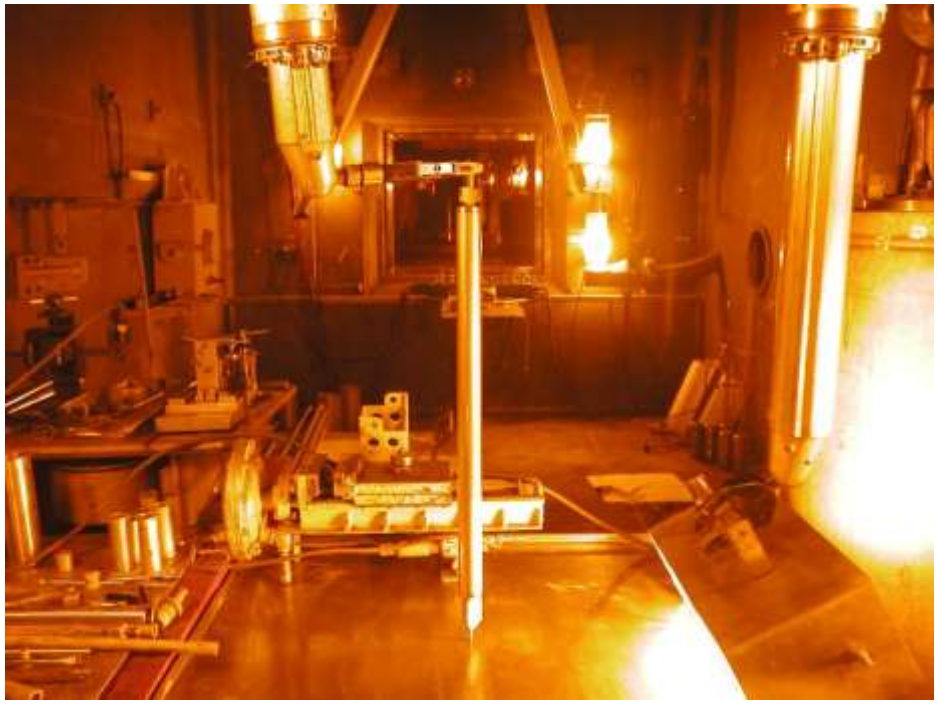
Conclusion

http://www.nuclear.ro/ro/infrastructura.php ; https://erris.gov.ro/-58

RATEN ICN infrastructure sustain the R&D Programs, education and training, international cooperation.

The Institute's research structure is harmonized with national and international nuclear research programs.





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Thank You!