Education and Training at Research Reactors: Sharing the Experiences from Europe with Asia and Africa

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Outline

- Introduction
- IAEA and education and training at research reactors
- IAEA activities in Africa
- IAEA activities in Asia
- Conclusions

Introduction

Reactor status	Number of reactors	Number of countries
Teaching / training	178	54
Neutron activation analysis	128	54
Radioisotope production	100	45
Material Irradiation	86	30
Neutron radiography	74	41
Neutron scattering	52	34
Transmutation - silicon doping	30	19
Geochronology	27	23
Transmutation - gems coloration	21	12
Boron neutron capture therapy	19	13
Innovative Energy Research	13	9
Nuclear Data Provision	2	2
Other applications	139	38

source: IAEA RRDB 25.10. 2015 - RRs operational, temporary shutdown, under construction and planned

Introduction

- Education and training at research reactor
  - *What* is it possible to teach at research reactors?
  - *To whom* is dedicated education and training at research reactors?
  - *Which* types of research reactors are suitable for education and training?
  - *How* to provide education and training at reactor?
  - *How* much money costs education and training at reactor?
  - *How* much money can be earn form education and training at reactor?
  - ...

Introduction

- What is it possible to teach at research reactors?
- Various types of educational experiments or hands-on experiences
- Two principal fields of interest:
  - Reactor itself as complex nuclear installation
    - Typical reactor experiments - such control rod calibration, reactivity measurement, study of reactor kinetics,...
    - Hands-on experiences - such radiation protection, emergency preparedness, I&C, reactor maintenance, reactor operation,...
  - Reactor as source of radiation - neutrons, gamma,...
    - NAA, neutron imaging, neutron diffraction, nuclear data provision, radioisotope production,...

IAEA and education and training at RRs

- Education and training at research reactors has long tradition in Europe - Austria, Czech Republic, Finland France, Germany, Hungary, Italy, Slovenia, ...
- Nuclear educational at research reactors has been for several decades regular part of educational processes in Europe
- Several European research reactors have bilateral agreement of collaboration in nuclear education and training with research reactors in Africa and Asia
- But most of the collaborations are carried out under various IAEA activities and projects

IAEA and education and training at RRs

- IAEA activities related to education and training at research reactors using European experiences:
  - Dedicated IAEA questionnaire - use of research reactors for education and training
  - Reactor coalitions
  - EERRI courses
  - Assistance in building up national or regional educational and training courses
  - Internet reactor laboratory
- Financial and personal support through IAEA national & regional projects and grants or PUI funds

IAEA and education and training at RRs

- Dedicated IAEA questionnaire developed in collaboration between IAEA Department of Nuclear Sciences and Applications and external experts
- IAEA questionnaire based on EERRI reactor coalition matrix and EERRI experience
- Questionnaire is used in:
  - EERRI, AFRA (CARRN), ARASIA countries
  - MRRN (in simplified form)
  - APEC countries (together with more detailed E&T questionnaire)

IAEA and education and training at RRs

- The main aim is to get a general and not to much detailed - but complex overview about current regional status in nuclear education and training - both capabilities and needs in order to improve (or to motivate for) regional collaboration
- IAEA questionnaire is divided into 4 parts:
  - Country overview (capabilities / needs)
  - Education – theory (capabilities / needs)
  - Education – experiments (capabilities / needs)
  - Detailed information about reactor experiments (current or future status and needs)

IAEA and education and training at RRs

- Group fellowship training program - EERRI course
- 6 week training course organised by EERRI
- 1 RR in Austria, 3 RRs in Czech Republic, 2 RRs in Hungary and 1 RR in Slovenia
- The first 11 EERRI courses (2009-2015):
  - 85 participants from 30 countries - Australia, Azerbaijan, Brazil, Colombia, Chile, Democratic Republic of Congo, Egypt, Estonia, Ghana, Iraq, Jamaica, Jordan, Lebanon, Libya, Malaysia, Mexico, Myanmar, Nigeria, Oman, Pakistan, Philippines, Saudi Arabia, South Africa, Sudan, Syria, Tanzania, Tunisia, United Arab Emirates, Vietnam and Yemen

IAEA and education and training at RRs

NUCLEAR TRAINING AWARDS 13. WINNER

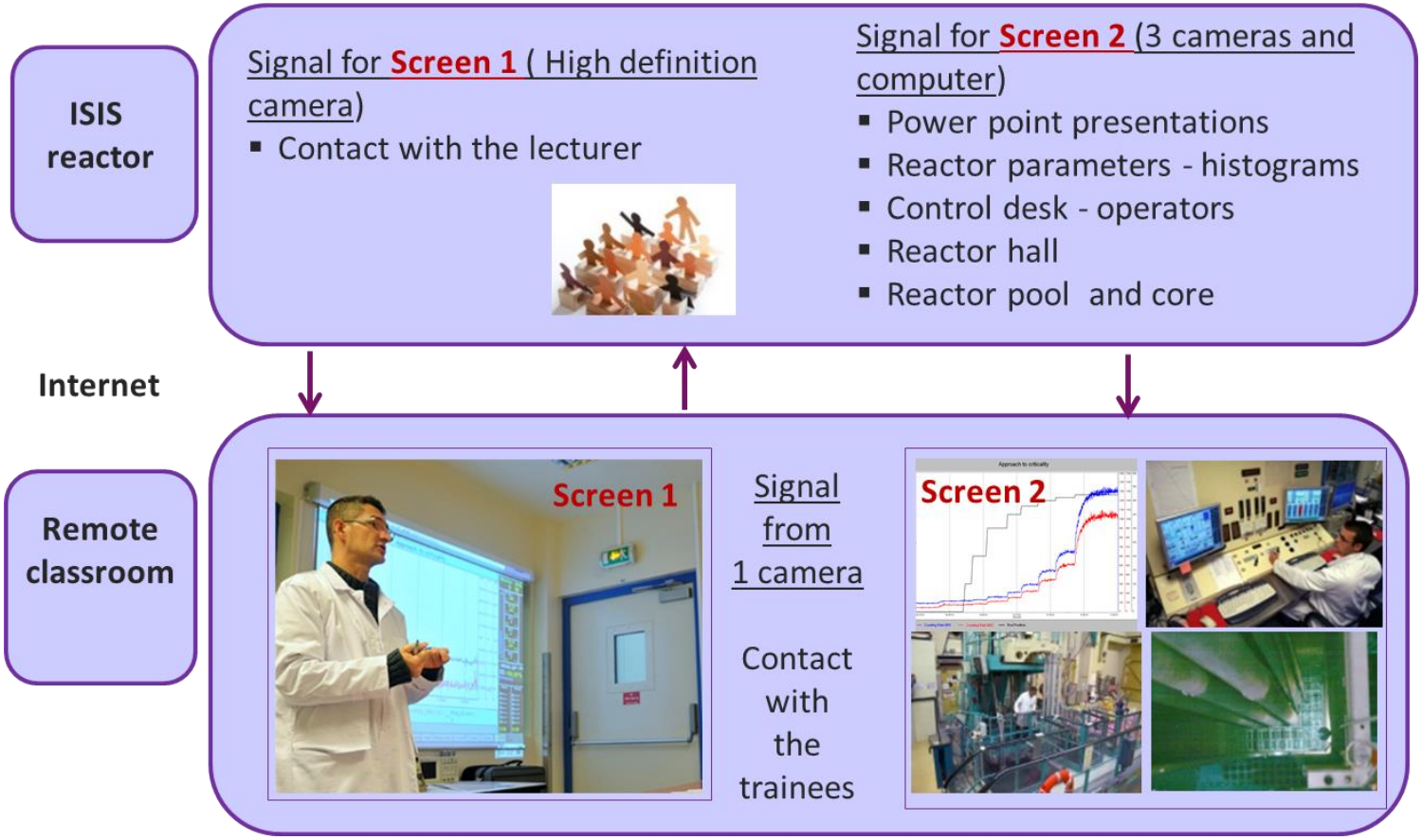
7. EERRI course at VR-1 reactor (2013)

IAEA and education and training at RRs

- Internet Reactor Laboratory project from IAEA
- Aims at providing virtual access to research reactor experiments connecting, through the internet, an operating research reactor in a country (host reactor) with universities classes in other countries (guest institutions).
- The IRL project is under implementation in Africa, Asia, Europe and Latin America.
- In Europe, the ISIS reactor at CEA Saclay (France) will broadcasts from 2016 “Core experiments” every year to Europe and Africa (Belarus, Lithuania, Tanzania, Tunisia, …)

IAEA and education and training at RRs

- The system implemented on the ISIS reactor



IAEA and education and training at RRs

- A workshop for professors from the guest institutions was organized in October 2015 at the ISIS host reactor with the objective to:
  - Train the guest instructors through practical Labs
  - Discuss technical and pedagogical aspects
  - Coordinate the broadcasting schedule for 2016

Workshop : At the Host reactor (control room)

Workshop : As at the Guest institution

IAEA and education & training in Africa

- IAEA activities for the enhancement of the utilization of African research reactors in nuclear education and training
  1. IAEA initiative in establishing CARRN
  2. Dedicated IAEA questionnaire - use of research reactors for education and training
  3. Regional workshop on enhanced use of research reactors for education and training purposes, Rabat, September 2013
  4. Regional training course on the safety of research reactors, Rabat, June 2014

IAEA and education & training in Africa

- CARRN - Central African Research Reactors Network
  - 11/2009 – Abuja, Nigeria - first ideas and discussions on establishing African Research Reactors Network
  - 07/2011 – Accra, Ghana - establishing of CARRN - Central African Research Reactors Network
  - Nine countries found CARRN - Algeria, D.R. of Congo, Ghana, Madagascar, Morocco, Niger, Nigeria, Sudan, and Zambia
  - Two fields of collaboration were selected - Education & training and Neutron activation analysis
  - Ghana - coordinator for education and training

IAEA and education & training in Africa

- Dedicated IAEA questionnaire - use of research reactors for education and training
  - Questionnaires discussion:
    - 07/2011 – Accra, Ghana
    - 05/2012 – Algiers, Algeria
    - 10/2012 – Cairo, Egypt (7th AFRA conference)
    - 09/2013 – Rabat, Morocco (Regional workshop)
    - 12/2014 – Algiers, Algeria (8th AFRA conference)
  - Questionnaires distribution:
    - 17 questionnaires were distributed
    - 12 countries sent back filled questionnaire (70 %)
    - 5 countries have not reply yet (30 %)

IAEA and education & training in Africa

- Education – experiments (capabilities / needs):
  - 31 subjects from 34 listed in questionnaire are part of regular national education system at Bc, Mgr. or PhD. level at minimum
    - in 1 country in AFRA countries, ca. 90 % from 31 subjects at 2 countries in AFRA, ca. 75 % from 31 subjects at 3 - 4 countries in AFRA
- Reactor – experiments (detailed description):
  - All 13 groups of experiments listed in questionnaire are groups of routine experiments at RR
    - in 1 RR in AFRA countries, ca. 85 % from all 13 groups at 2 – 3 RR in Africa, 1-3 experiments in each group

IAEA and education & training in Africa

Regional workshop on enhanced use of research reactors for education and training purposes

- Rabat, 23 - 27 September 2013
- 12 participants from 7 countries (Algeria, Egypt, Ghana, Libya, Nigeria, Sudan and Tunisia)
- Lecturers and instructors from host country with support of IAEA (1 IAEA staff & 2 experts from Europe)
- Four experiments were carried out during two days
- For the first time in Africa international trainees had chance to run research reactor during the practical hands-on training

IAEA and education & training in Africa

IAEA and education & training in Africa

Regional training course on the safety of research reactors

- Rabat, 2 - 12 June 2014
- 12 participants from 7 countries (DRC, Egypt, Ghana, Libya, Nigeria, South Africa and Sudan)
- lecturers and instructors from host country with support of IAEA (2 IAEA staff, 2 experts from Africa and 2 experts from Europe)
- 14 experiments were carried out during two weeks
  - Incl. Water management, Radiation protection in practice, Emergency preparedness in practice, Safety of experiments in practice, Participants running the reactor

IAEA and education & training in Africa

IAEA and education & training in Asia

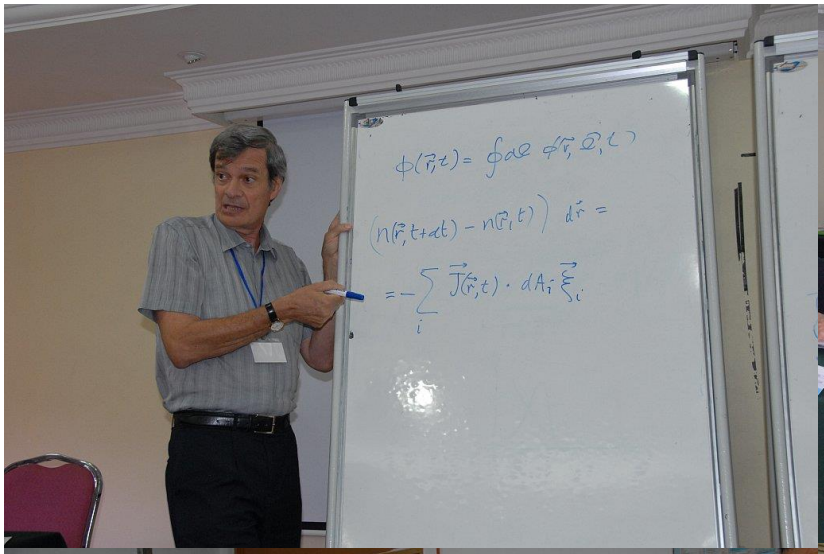
- Regional Workshop on Education and Training Practices with Research Reactors, 4 - 8 June 2012, Prague, Czech Republic
- The first contacts between representatives of European research reactors and research reactors in South - East Asia - Indonesia, Malaysia, Thailand, Vietnam
- All potential partners agreed that EERRI course can be inspiration for similar regional course in South-East Asia

IAEA and education & training in Asia

Training course on education and training to support nuclear power program in APEC economies

- Selangor, Malaysia, 19 - 30 August 2013
- 30 participants from Malaysia and Thailand
- Lecturers and instructors from host country with support of IAEA (4 experts from Europe and 1 experts from USA)
- Due to temporary shut-down of RTP reactor a few hand-on experiments including NAA were carried out

IAEA and education & training in Asia



Training course on education and training to support nuclear power program in APEC economies, Selangor, 2013

IAEA and education & training in Asia

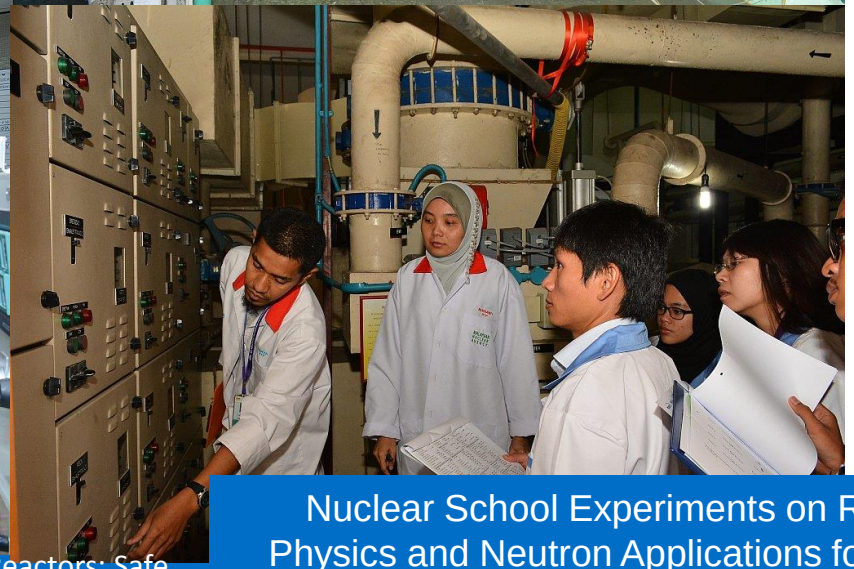
Nuclear School Experiments on Reactor Physics and Neutron Applications for Asia-Pacific Region

- Selangor, Malaysia & Jogyakarta, Indonesia
- 30 March - 10 April 2015
- 11 participants from 7 Asian countries (Bangladesh, Cambodia, Indonesia, Iraq, Malaysia, Thailand and Vietnam)
- Lecturers and instructors from host countries with support of IAEA (2 experts from Europe)
- In this course for the first time two research reactors from two countries were involved in South-East Asia

IAEA and education & training in Asia

Nuclear School Experiments on Reactor Physics and Neutron Applications for Asia-Pacific Region, Jogyakarta, Indonesia 2015

IAEA and education & training in Asia



Nuclear School Experiments on Reactor Physics and Neutron Applications for Asia-Pacific Region, Selangor, Malaysia 2015

Conclusions

- Since 2011, an extensive work has been carried under IAEA projects in order to develop the utilisation of research reactors for Education and Training in Africa and Asia.
- Starting from the experience of the EERRI coalition in Europe, an extensive overview of the status of the Education and Training at a regional level was carried out.
- It was followed by the development of regional courses based on the utilization of the research reactors with the assistance of the IAEA and IAEA experts.
- Sharing the experience and practices in the frame of the development of regional courses has proven to be very effective and will be further developed by the IAEA.