Role of small research reactors in education and training in radiological protection

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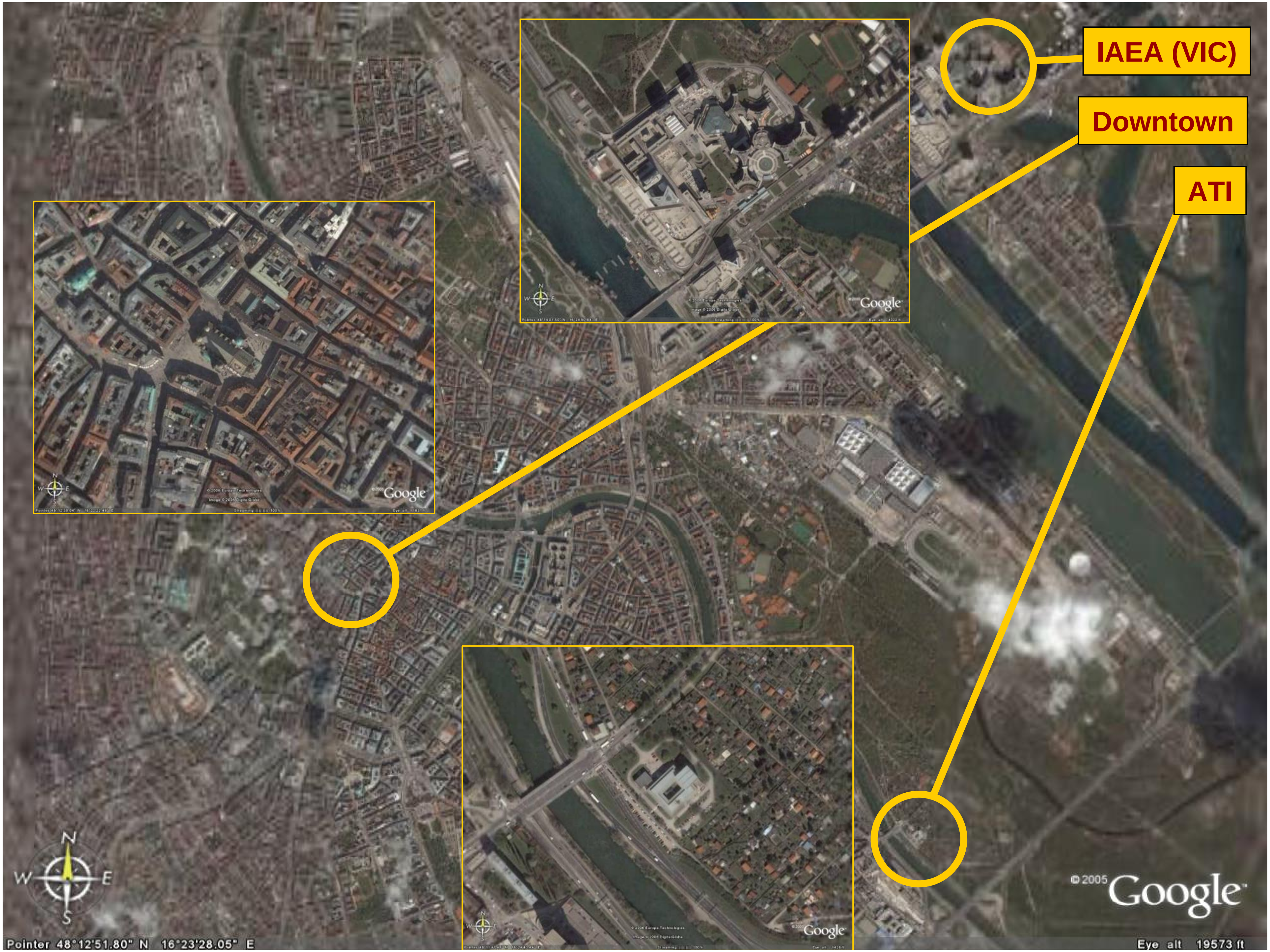
Topics

- Overview of the research reactors
  - ATI
  - ITN
  - NTI
  - VR-1
- Overview of education and training activities
- Specific advantages of research reactors
- Conclusions

ATI

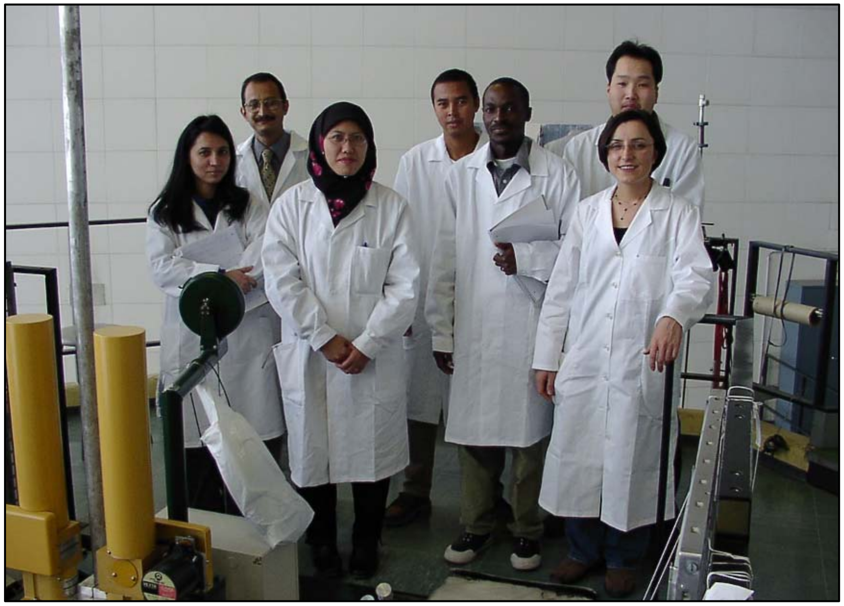
- The Atominstitut Vienna operates the last research reactor in Austria.
  - Triga Mark II, 250 kW.
  - First criticality in 1962.
  - Seibersdorf and Graz reactors decommissioned in the last decade.
- ATI reactor near the center of Vienna.
- Closest facility to the IAEA.


IAEA (VIC)
Downtown
ATI
© 2005 Google
Pointer 48°12'51.80" N 16°23'28.05" E
Eye alt 19573 ft


TRIGA Vienna
© 2006 Europa Technologies
Image © 2006 DigitalGlobe
©2006 Google™
Zeiger 48°11'47.85" N 16°24'44.02" E Höhe 158 m
Übertragung ||||||||| 100%
Sichthöhe 623 m

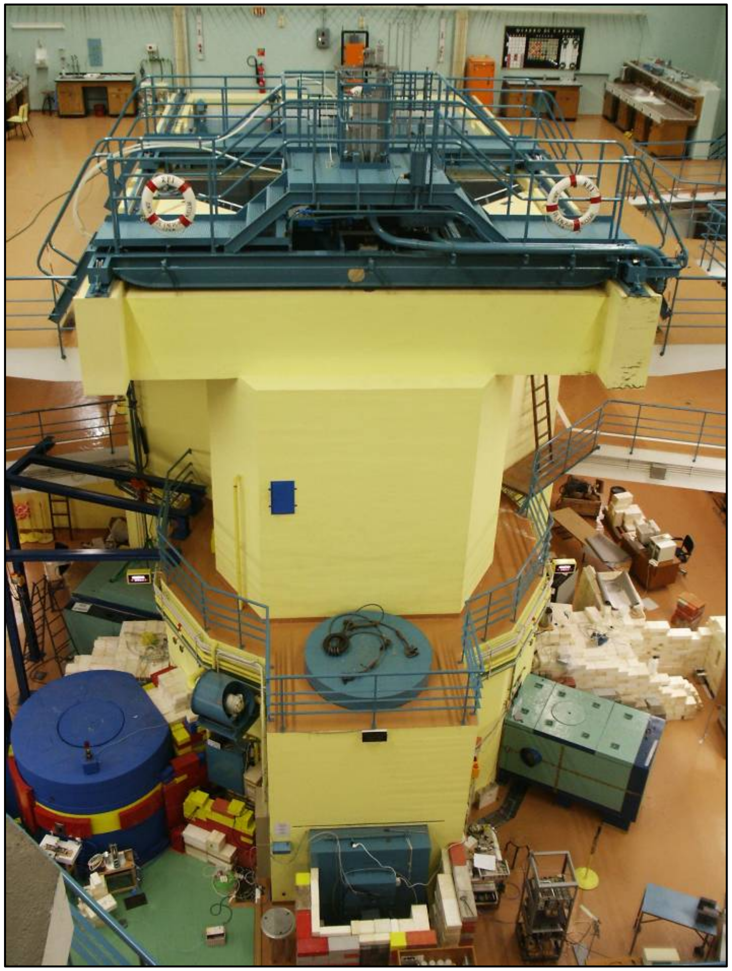
ATI

- Cooperation with IAEA and CTBTO:
  - Research projects, coordinated research programs (CRP) and supply of expert services.
- Regular training courses for the IAEA Safeguard Trainees
  - Since 1984 more than 100 trainees spent about 4 weeks of intensive practical training at the Atominstitut.
- Specialized practical courses carried out for institutions in other countries:
  - Germany, Czech Republic, Slovak Republic, United Kingdom.



ATOMINSTITUT

ITN



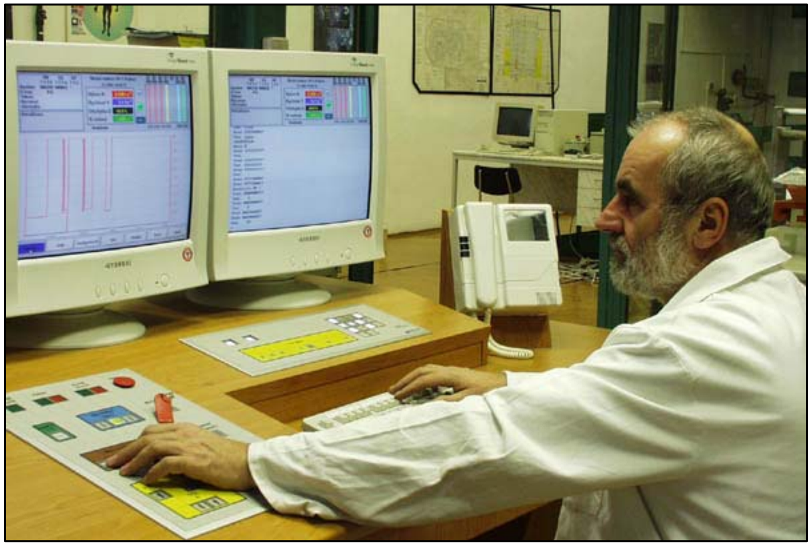
- The Nuclear and Technological Institute operates the Portuguese Research Reactor.
  - Pool type, 1 MW.
  - First criticality in 1961.
- Only research reactor in the Iberian Peninsula.

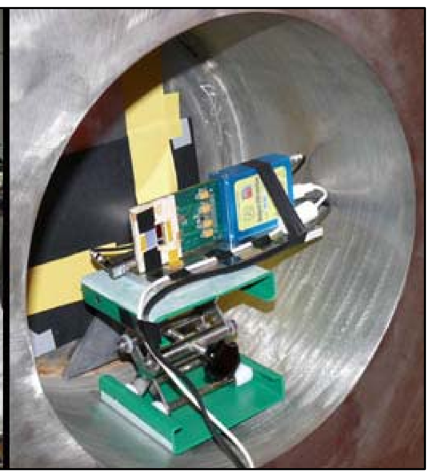
itn

NTI

- The Institute of Nuclear Techniques (NTI) is part of the Faculty of Natural Sciences of the Budapest University of Technology and Economics, Hungary.
- NTI operates a 100 kW pool-type reactor of Hungarian design since 1971.

VR-1





- The Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague operates the VR-1 “Sparrow” training reactor since December 1990.
- The VR-1 “Sparrow” is a pool-type reactor that operates normally at 1 kW.

Education and training activities

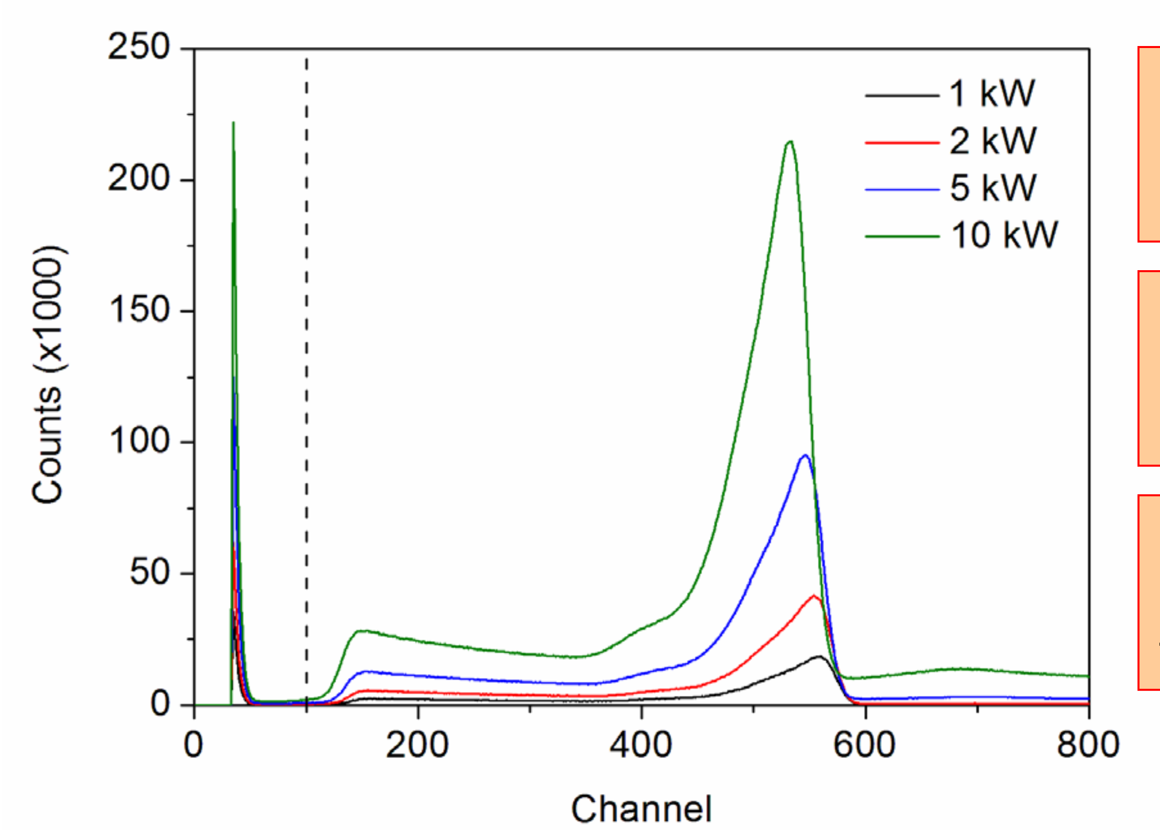
- The ATI, NTI and VR-1 are university reactors. The ITN reactor is not, but supports programs in several universities.
- The ATI and ITN reactors are in non-nuclear countries (Austria, Portugal).
  - Only chance for the public and students to visit an operating nuclear installation.
- All reactors support a broad range of education and training activities, based in nuclear physics and engineering, but radiological protection plays a significant role.

Subject	***ATI***	***RPI***	***NTI***	***VR-1***
Nuclear Energy: Introduction	X	X	X	X
Introduction to Nuclear Physics	X			
Nuclear Reactor Theory	X	X	X	X
Nuclear Thermal-Hydraulics			X	
Nuclear Materials			X	
Experimental Reactor Physics	X		X	X
Nuclear Fuel Cycle			X	X
Radiochemistry	X	X	X	
Operation and Control	X		X	X
Radiation Protection and Nuclear Measurements	X	X	X	X
Reliability and Safety				X
Waste Management and Decommissioning				
Nuclear Fusion				X
Advanced Courses	X			X

Specific advantages of research reactors

- Research reactors have unique characteristics that can be used as an advantage for education and training in radiological protection:
  - Intensity of the radiation fields depends on the reactor's power ("programmable" radiation source);
  - Simultaneous gamma and neutron fields;
  - Production of specific isotopes;
  - Pre-operational and operational surveys.

Specific advantages of research reactors



Signals due to gammas and neutrons have different amplitudes.

Linear response with increased signal intensity (reactor power).

Operation limit of detector (non-responsive to 10x signal).

Checking instrument's response (^{3}He tube) with increase in neutron flux and gamma dose rate.

Specific advantages of research reactors

- When using a beam port in a reactor, gamma radiation is normally present together with the neutrons. This is not necessarily a nuisance, as it allows to study:
  - Interference phenomena in active and passive detectors.
  - Properties of different materials as shield for gammas and neutrons – e.g. students will find that Pb will also attenuate neutrons.
  - Optimization of combined shielding, discussing the advantages and disadvantages of using first a material with higher efficiency for gammas or for neutrons.

Specific advantages of research reactors

- In practical courses it is important to be able to produce radioactive isotopes precisely tailored for particular experiments.
- By choice of appropriate samples:
  - chemical composition, mass, thermal neutron cross sections.
- By appropriate irradiation parameters:
  - irradiation time, neutron flux.
- Activity and dose rate of samples can easily be adapted to different radiation protection experiments.

Specific advantages of research reactors

- Average activity, average half-live:
  - Calculate/measure dose rates at certain distances from irradiated sample; explanation of terms like absorbed dose, KERMA, dose equivalent and effective dose.
- Low activity, short half-live:
  - Determination of half-lives.
- Average activity, long half-live:
  - Handling of unsealed radioactive materials.
- High activity, long half-live:
  - Handling of sealed radioactive materials.
- Average activity, short half-live:
  - Contamination and decontamination.

Specific advantages of research reactors

- Further steps are mostly a question of creativity and use of complementary techniques or procedures.
- Examples:
  - Experimental implementation of the PUREX process:
    - combination of safe handling of unsealed radioactive materials, nuclear chemistry and radiation protection.
  - Absorption of radionuclides in organic substances:
    - e.g. the transport of a radioactive marked fertilizer in plants.
  - Environmental monitoring:
    - Collect air, water, swipe samples; correlate with reactor power; compare with fixed monitoring in facility.

Conclusions

- Research reactors are versatile tools for education and training in radiological protection, presenting excellent opportunities to teach practical radiation protection.
- Any research reactor can in principle be used.
- Education and training can be better performed in low and medium power facilities, as it will not impact significantly normal operation for other users.