

Experimental Facilities for Nuclear Education and Training

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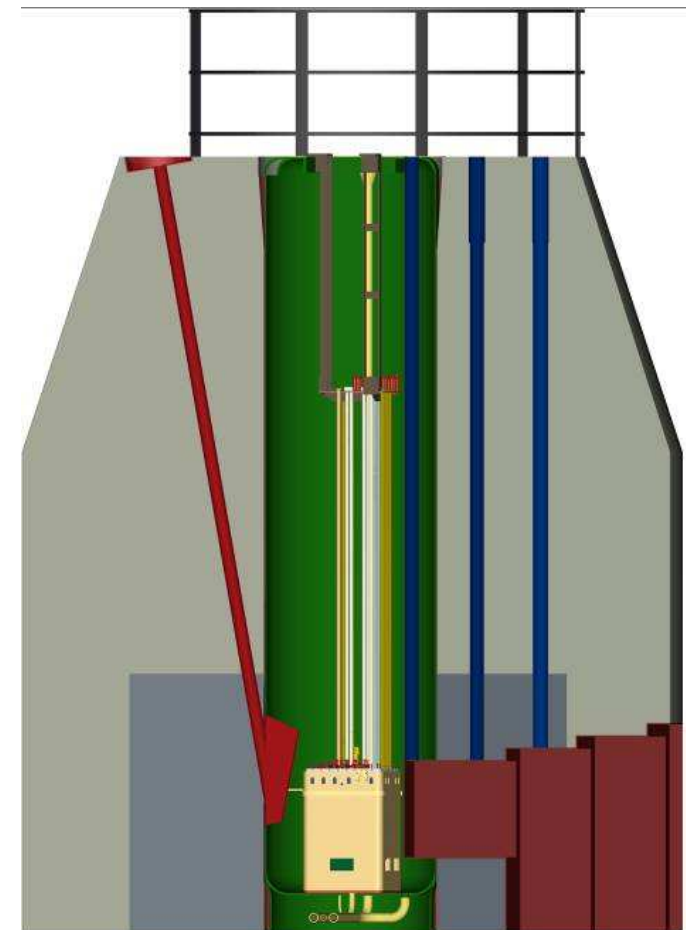
www.reak.bme.hu

International Conference on Human Resource Development for
Introducing and Expanding Nuclear Power Programmes

14-18 March 2010, Abu Dhabi, United Arab Emirates

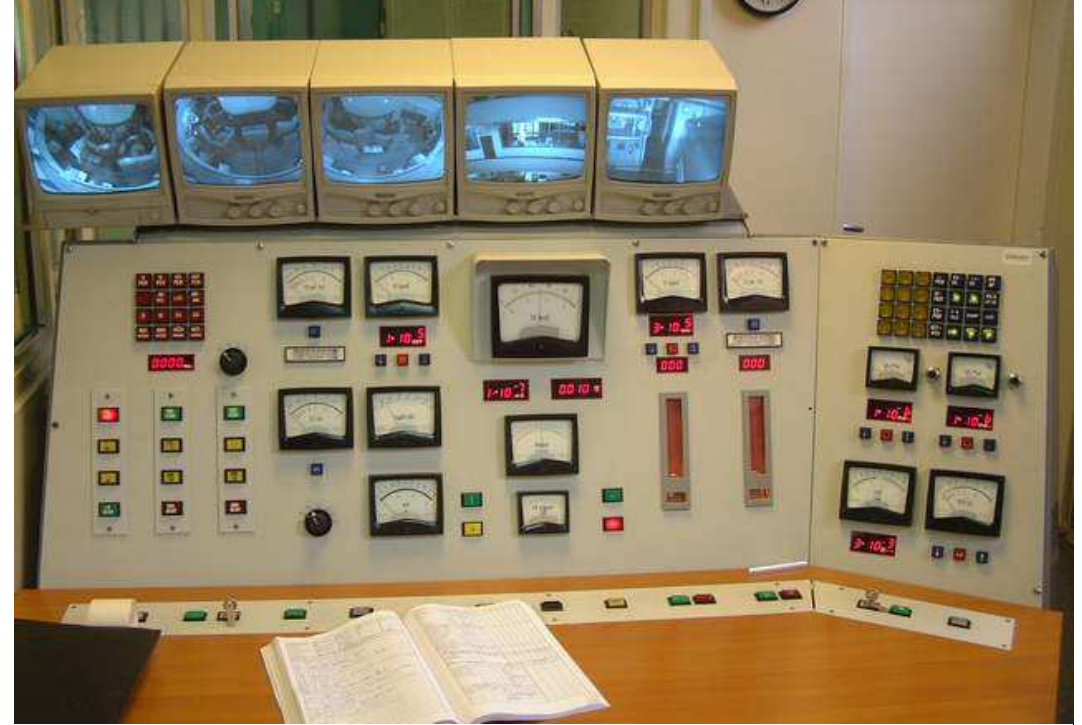
Training reactor, Hungary

- Location: Campus of the Budapest University of Technology and Economics (BME)
- Reactor type: pool-type reactor (Hungarian design)
- First criticality: 1971.
- Nominal Power: 100 kW
- Moderator and coolant: light water
- Horizontal and vertical irradiation channels
- Pneumatic dispatch system for the transfer of the samples into the core



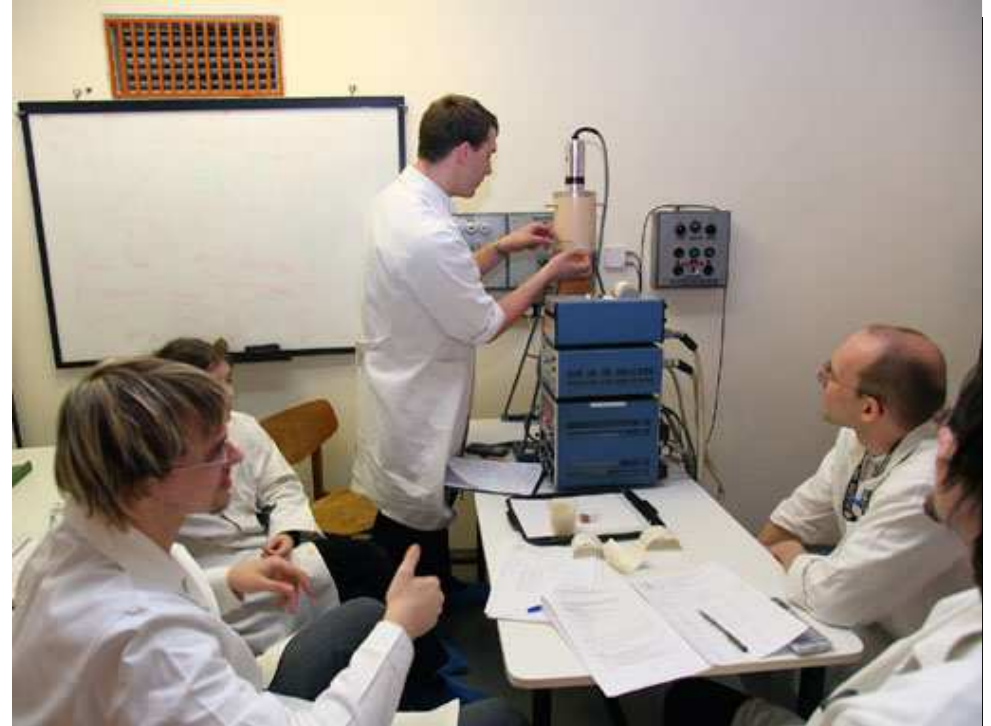
Education at Training Reactor, Hungary

- Main fields of courses:
 - reactor physics,
 - thermal hydraulics,
 - nuclear safety,
 - radiation protection,
 - nuclear measurements and instrumentation,
 - radiochemistry,
 - nuclear power plants
 - nuclear fuel cycle
- Beside the classroom lectures focus on small group experimental work



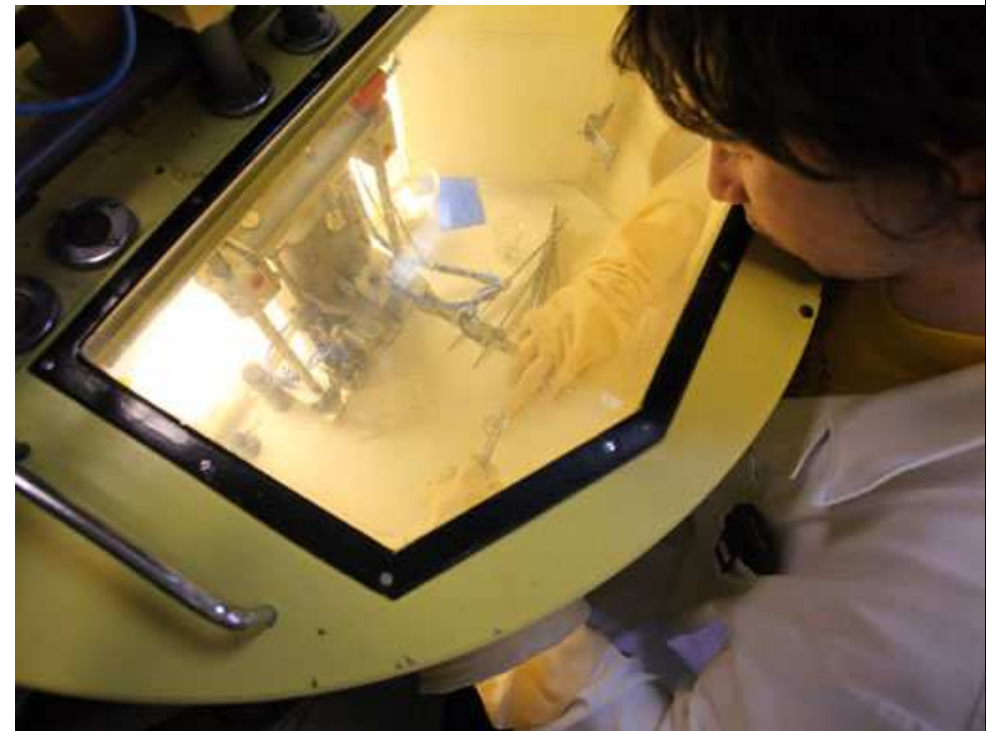
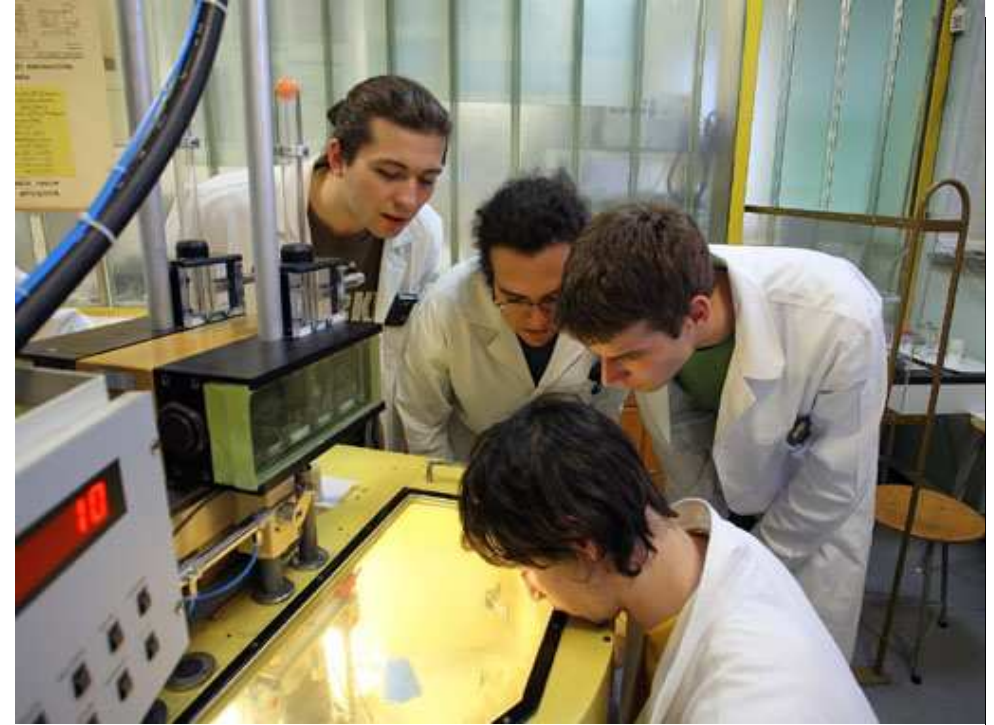
Education at Training Reactor, Hungary

- Levels of courses:
 - BSc, MSc, PhD
 - Post-graduate courses
- Specialties:
 - Engineering-physicist
 - Physics BSc and MSc with nuclear specialization
 - Energy Engineering (power engineering BSc and MSc with nuclear specialization)
 - Very active PhD school
- Measurement exercises for other universities and faculties of BME



Typical measurement exercises at Training Reactor, Hungary

- Neutron activation analysis
- Determination of thermal neutron flux in the reactor core using neutron activation analysis
- Investigation of delayed neutron parameters, determining of uranium concentration in samples



Typical measurement exercises at Training Reactor, Hungary

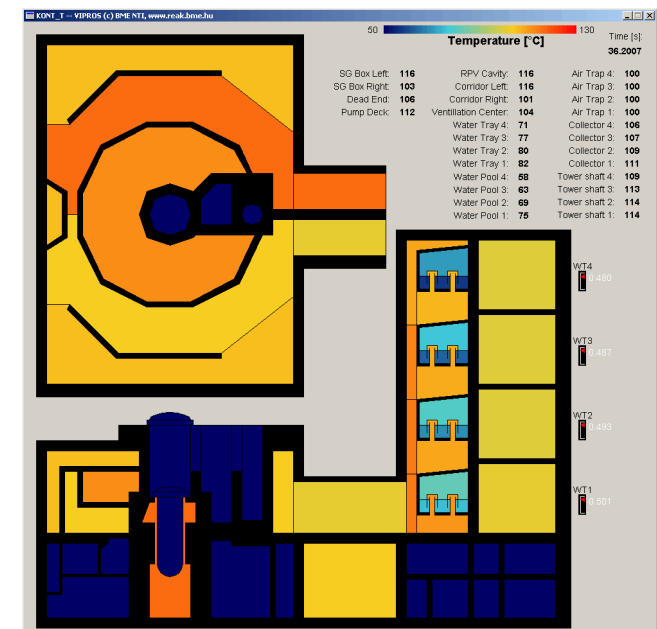
- Reactor operation exercise
- Measurement of the void coefficient and the control rod reactivity worth
- Measurement of thermal neutron diffusion length in graphite
- Criticality experiment
- Measurement of gamma- and neutron dose rate, radiation protection measurements



Post graduate course in reactor engineering at Training Reactor, Hungary

Continuing Education in Reactor Physics and Reactor Technology

- Applied Mathematics I, II, III
- Reactor Physics I,II,III,IV
- Reactor Technology I,II
- Radiation Protection and Dosimetry
- Environmental Protection
- Nuclear Measuring Techniques I, II
- Thermohydraulics I, II
- Nuclear Power Plants I, II
- Operation of Nuclear Reactors
- Control Technology I,II
- Electrical Devices and Grids
- Energy Systems
- Laboratory Practices I, II, III, IV, V, VI

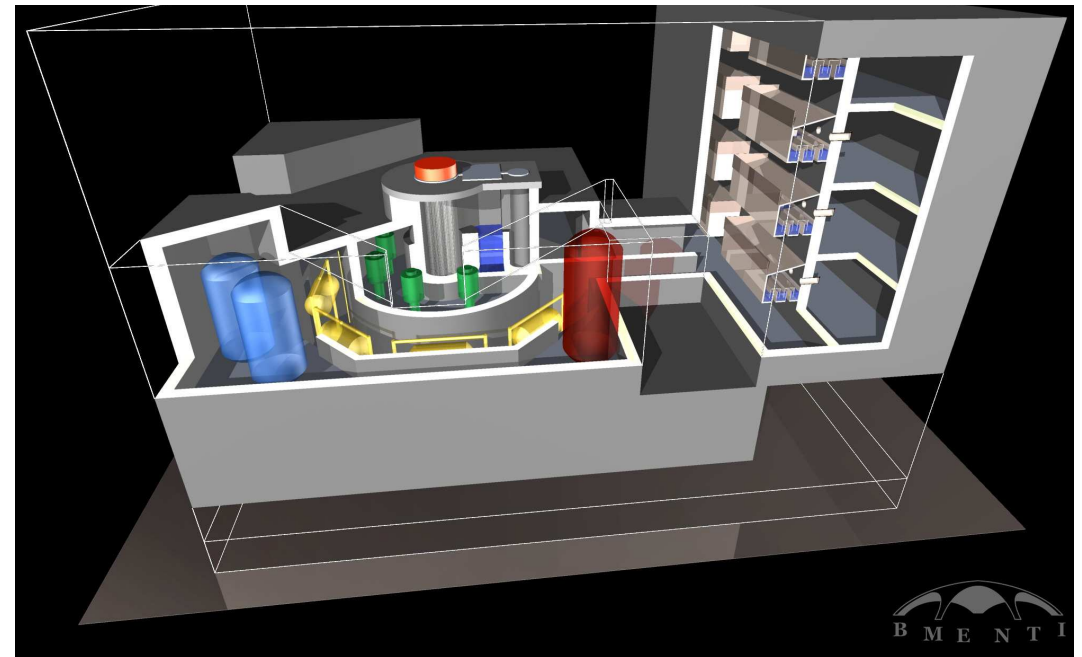
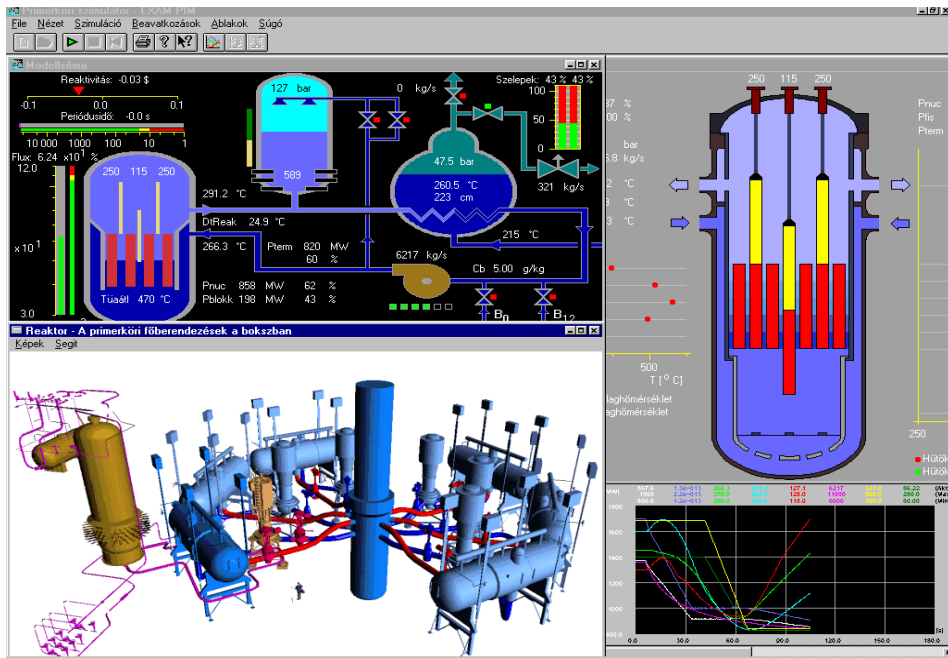


International education at Training Reactor, Hungary

- Slovak Technical University
Bratislava
- Czech Technical University Prague
- Technical University Vienna (Austria)
- The University of Rennes INSA
(France)
- Delft University (The Netherlands)
- École de Mines de Nantes (France)
- International Atomic Energy Agency
(IAEA)
- KTH Stockholm (Sweden)
- International Wigner course on
experimental reactor physics:
cooperation with TU Vienna, TU
Prag, TU Bratislava in the frame of
ENEN
- IAEA - EERRI course

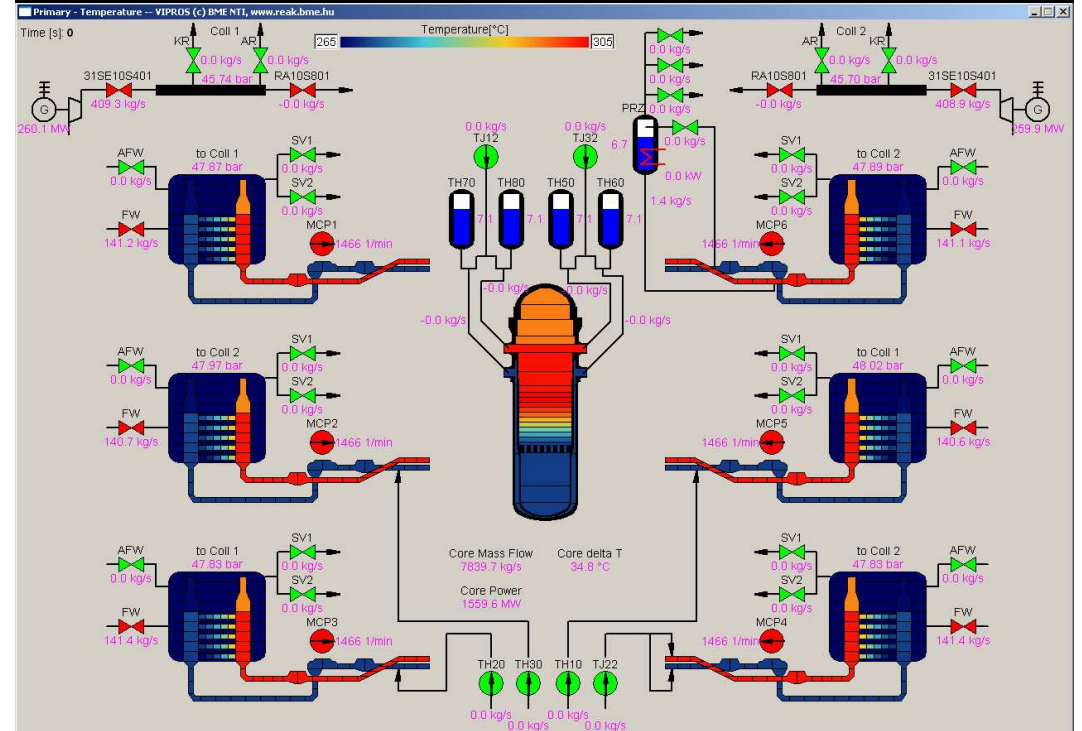
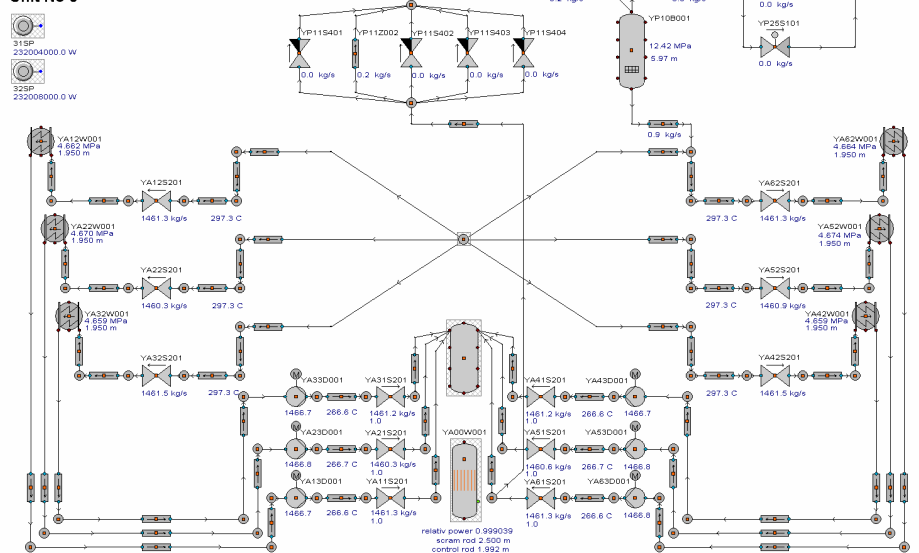


NPP simulators at Training Reactor, Hungary



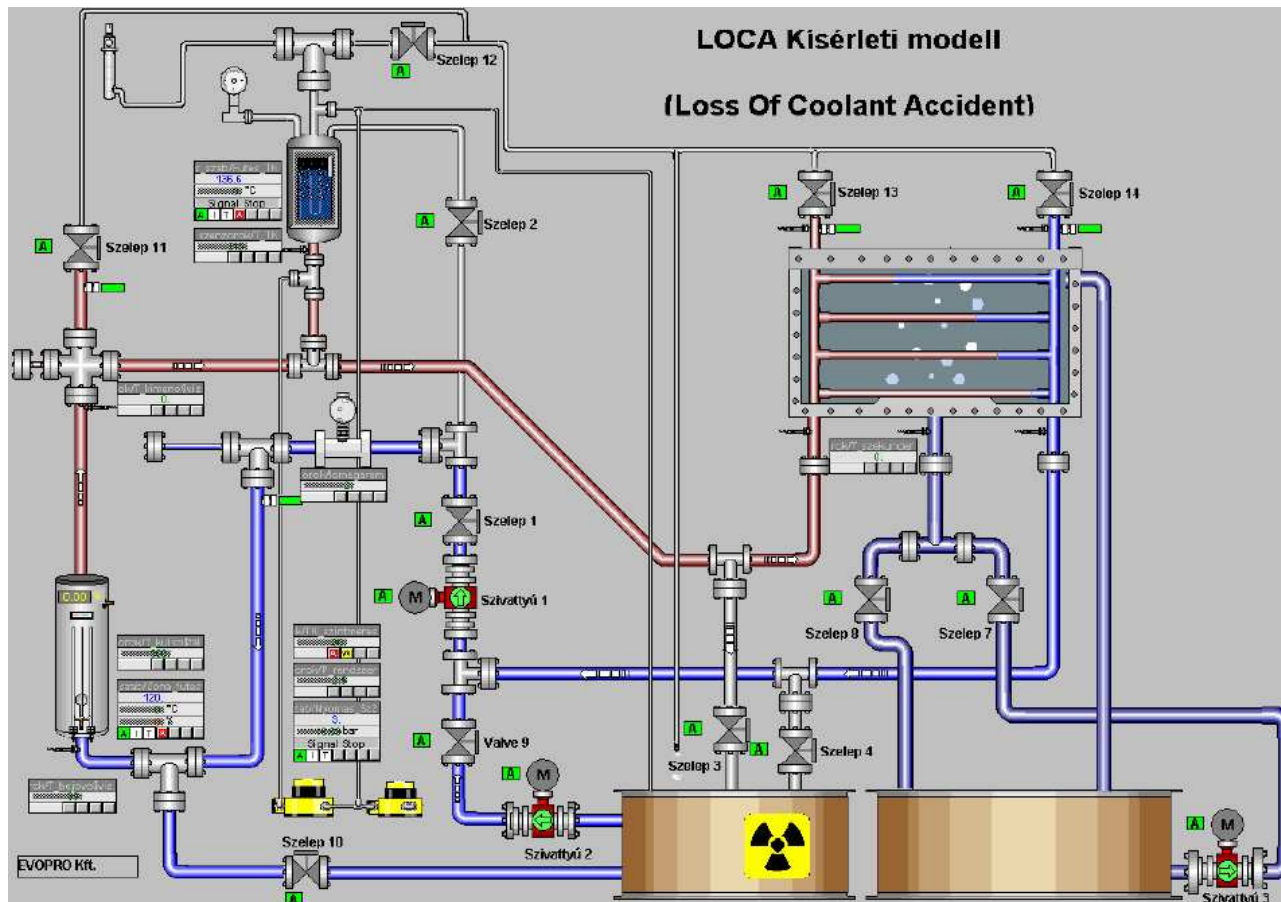
Primary loops

Paks NPP Unit No 3



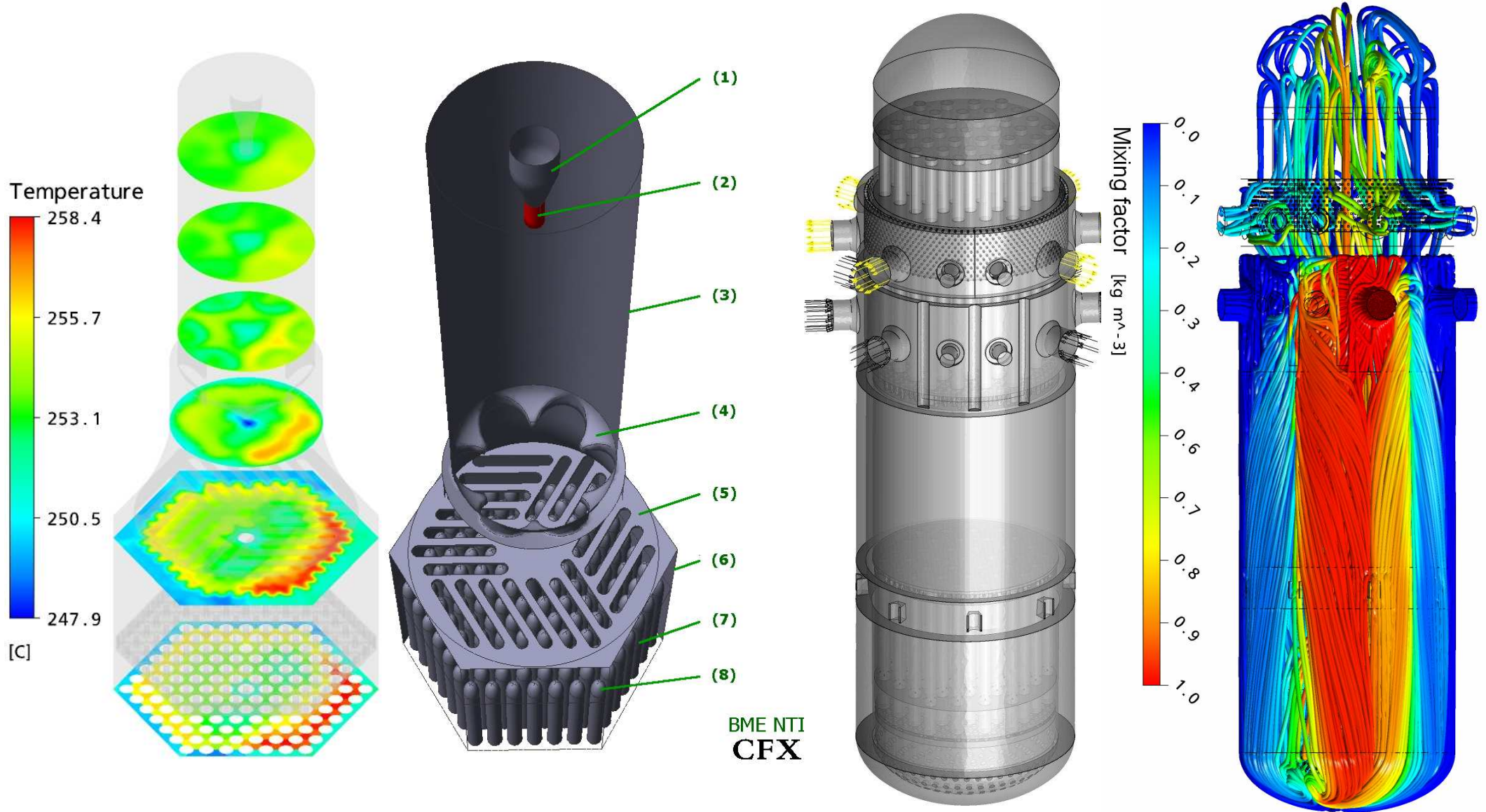
TRATEL – TRAnsparent Thermal-hydraulics TESt Loop

to demonstrate the behaviour of the
coolant in a PWR primary circuit
during normal operation and LOCAs.



Research at Training Reactor, Hungary

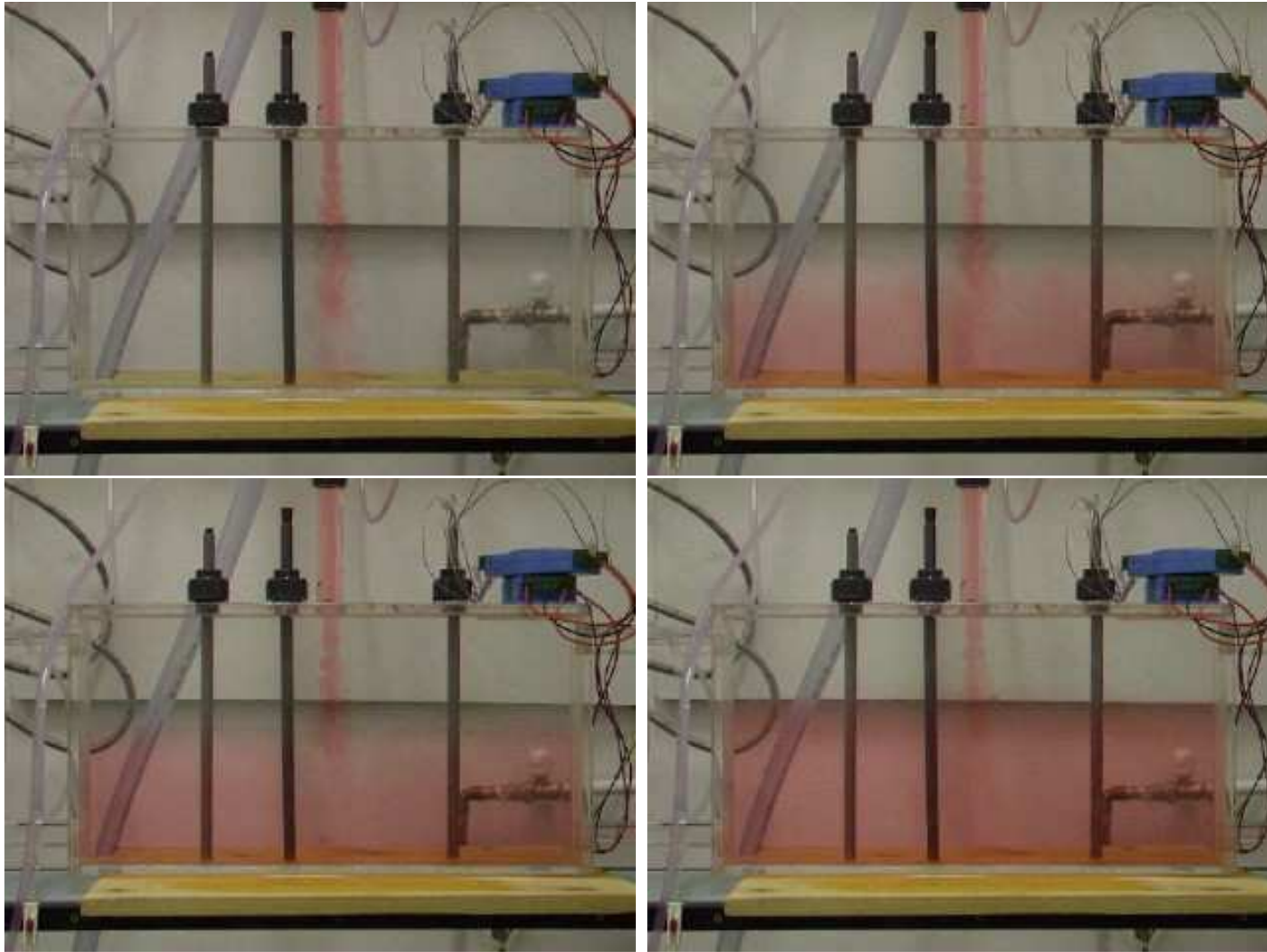
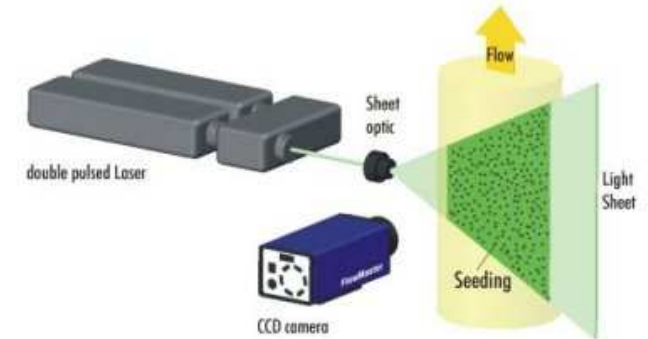
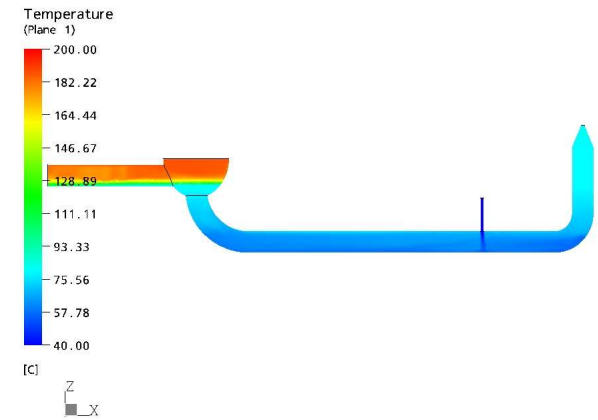
Thermal hydraulics, CFD



Research at Training Reactor, Hungary

Thermal hydraulics – thermal stratification

Experimental and numerical investigation of thermal stratification and cold plume mixing



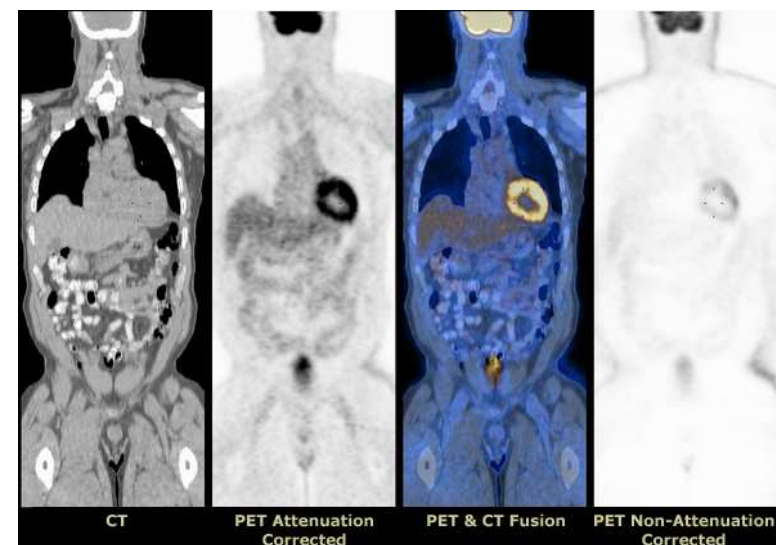
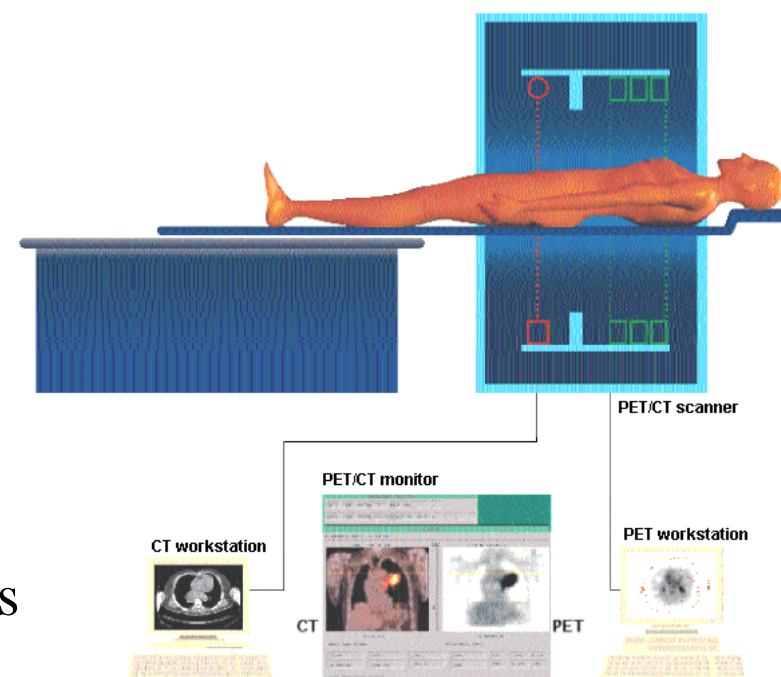
eGMC – USB based GM-counter for education (Training Reactor, Hungary)

- New USB based GM-counters for educational purposes
- 2 versions: with and without own LCD display
- Demonstrations software added



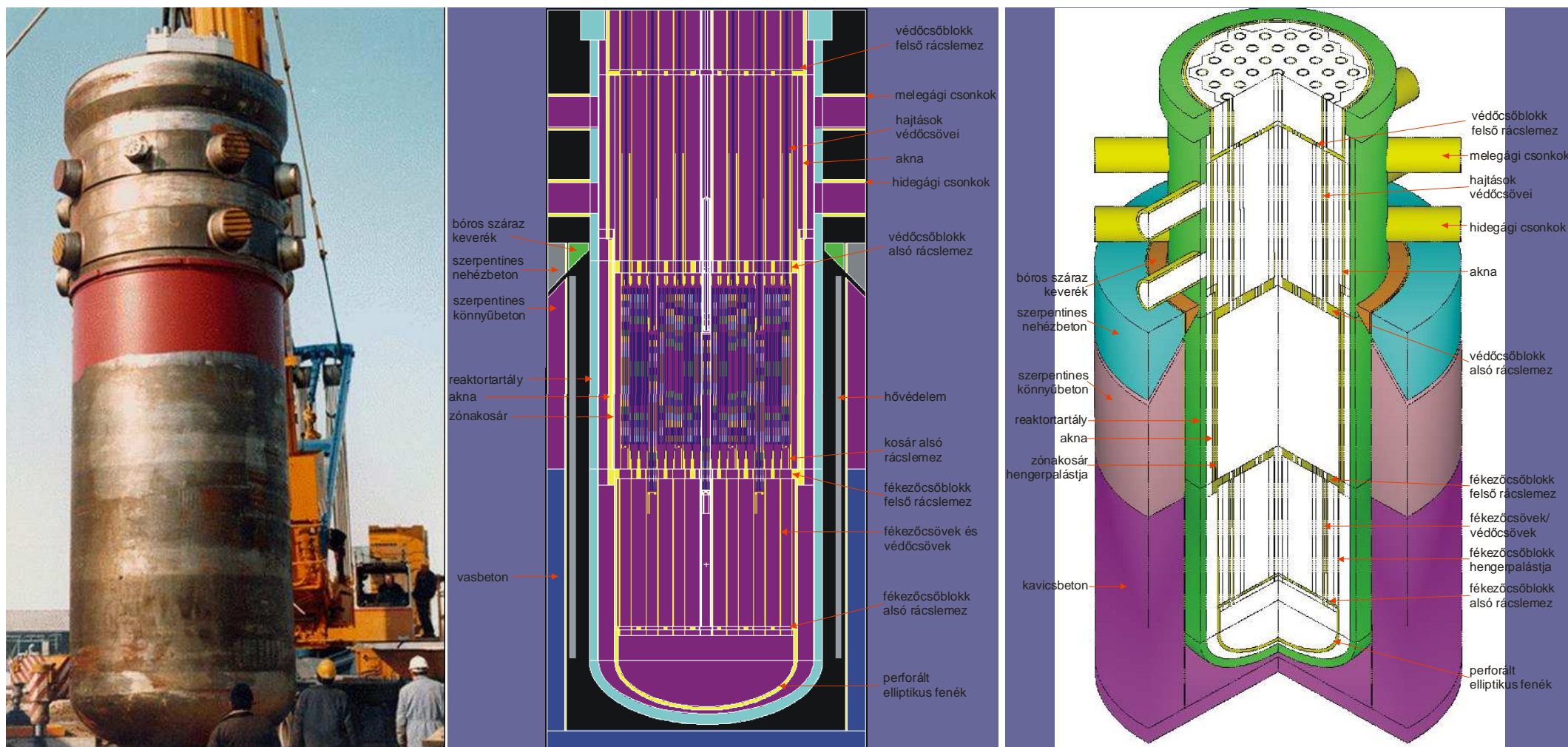
New education: medical physics

- In the frame of Physics MSc course a nuclear medical physics specialization is under preparation
- Goal is to train physicist for
 - hospital's radiotherapy centers
 - hospital's radio diagnostic centers
 - medical instrument and device R&D companies



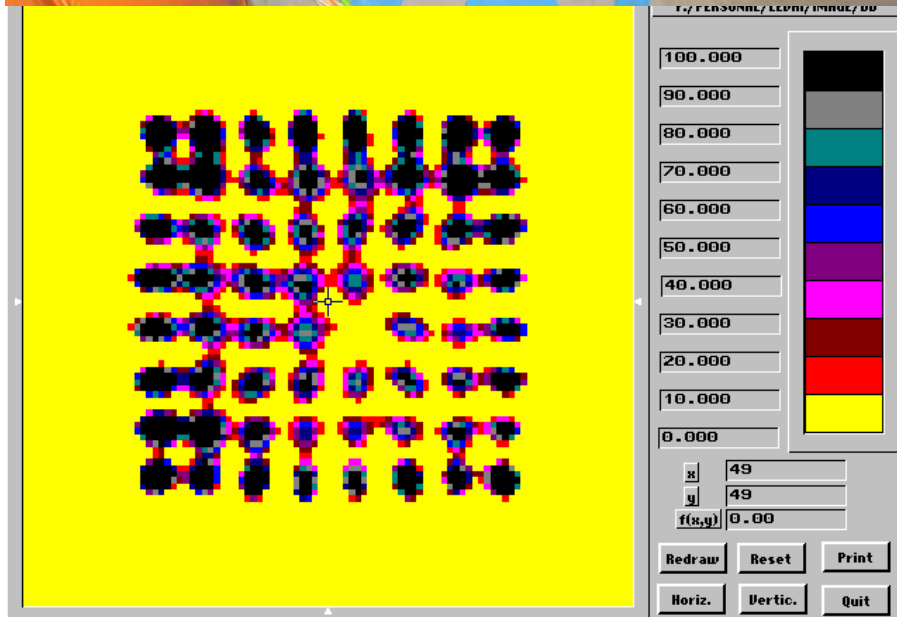
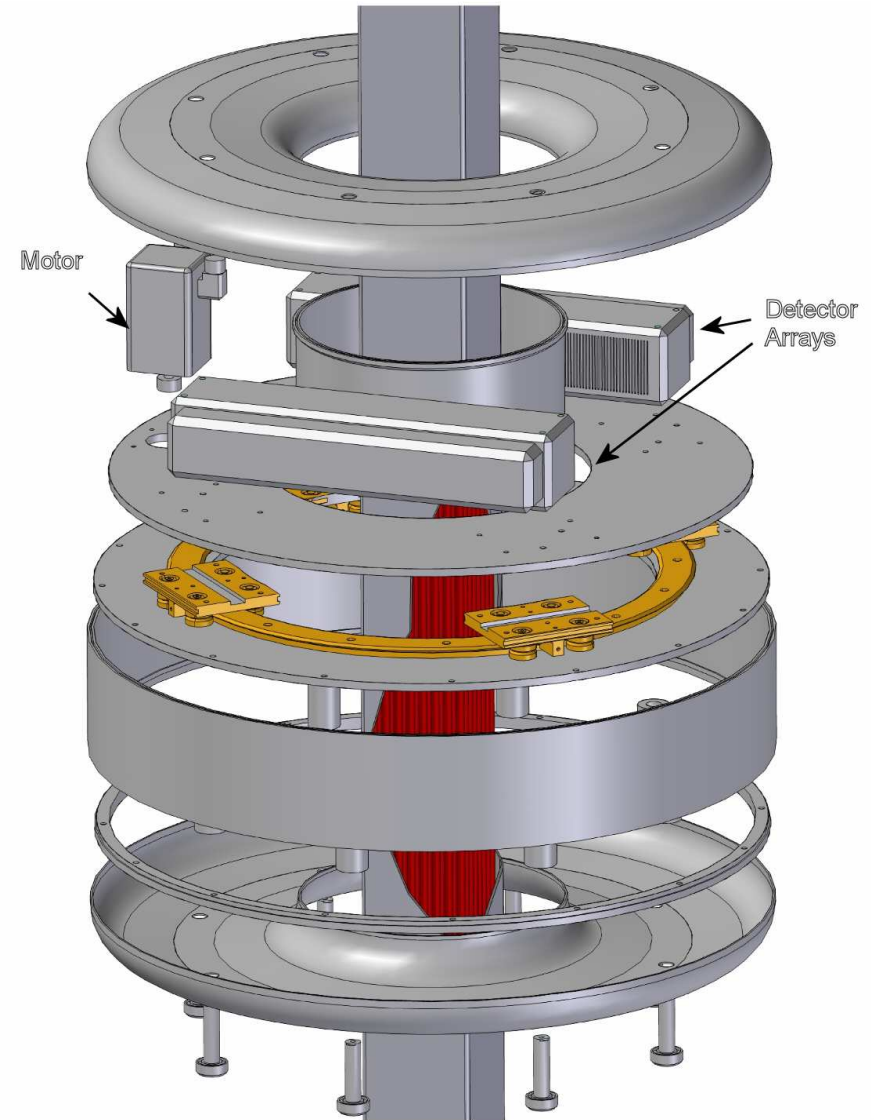
Research at Training Reactor, Hungary

Monte-Carlo Analysis



Research at Training Reactor, Hungary

PGET – Passive Gamma Emission Tomography



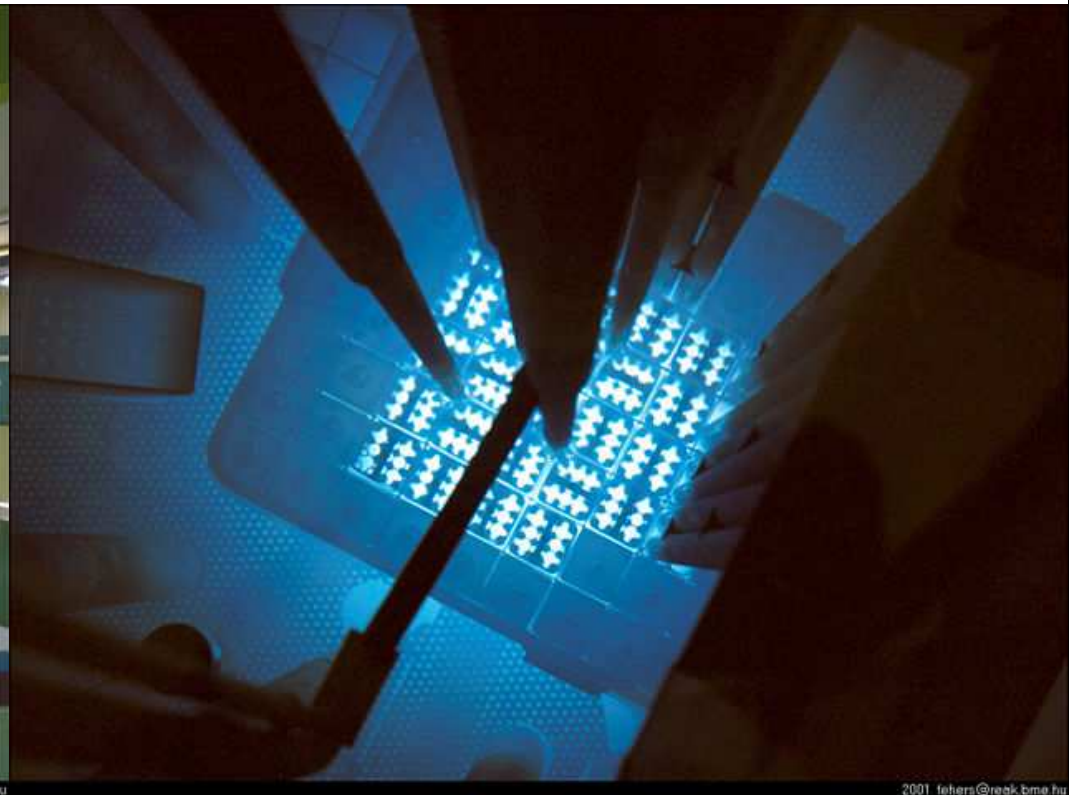
Research at Training Reactor, Hungary

XRF – X-Ray Fluorescence Analysis



Szaloki I, Osan J, Van Grieken RE, X-ray spectrometry, *Analytical Chemistry*, 78, 4069-4096, 2006.

The Training Reactor of TU Budapest, Hungary is open for other countries and universities, and also for post-graduate short courses for senior engineers



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