

nmi3



Budapest Neutron Centre

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NMI3-FP7-II Kick-off Meeting
March 12-13 2012, Grenoble, France

KFKI history



KFKI: **K**özponti **F**izikai **K**utató **I**ntézet = (Central Research Institute for Physics) was founded in 1950 and became the largest research center in during four decades.

From 1 January, 1992, KFKI was divided into five academic institutes and a number of enterprises

From 1 January, 2012, BNC: Consortium of 2 Centers

KFKI campus houses five research institutes of the Hungarian Academy of Sciences in Budapest, Hungary:



KFKI Research
Institute for Particle
and Nuclear Physics



Research Institute for
Technical Physics and
Materials Sciences



Research Institute for
Solid State Physics
and Optics



KFKI Atomic Energy
Research Institute

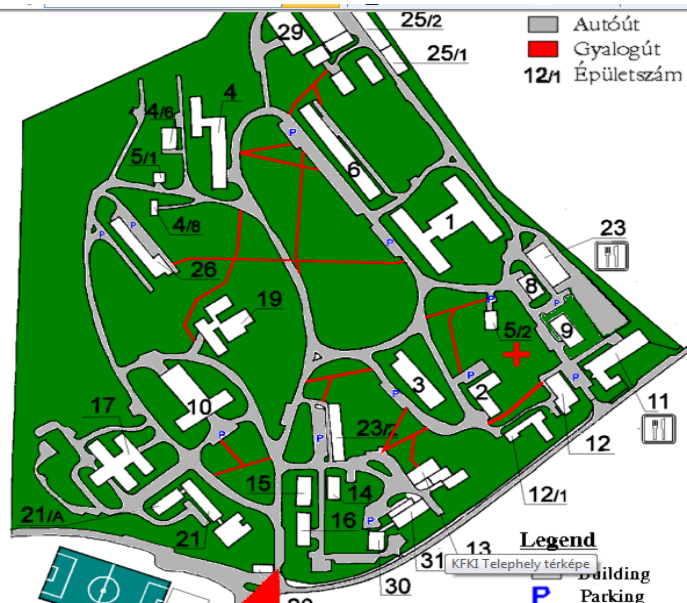


Institute of Isotopes

Wigner Res. Centre for Physics

Centre for Energy Research

Moreover, the KFKI Campus hosts over 20 spin-off companies



User offices at Bldg. 10 and 16

Guest house

Budapest Research Reactor



Became critical in 1959 - Thermal power: 2 MW
1st Upgrade in 1967 - Thermal power: 5 MW
2nd Upgrade (full scale reconstruction) from
1986 ... to 1990
Physical start-up: 1992
Operation licence: 25 November 1993
Thermal power: 10 MW

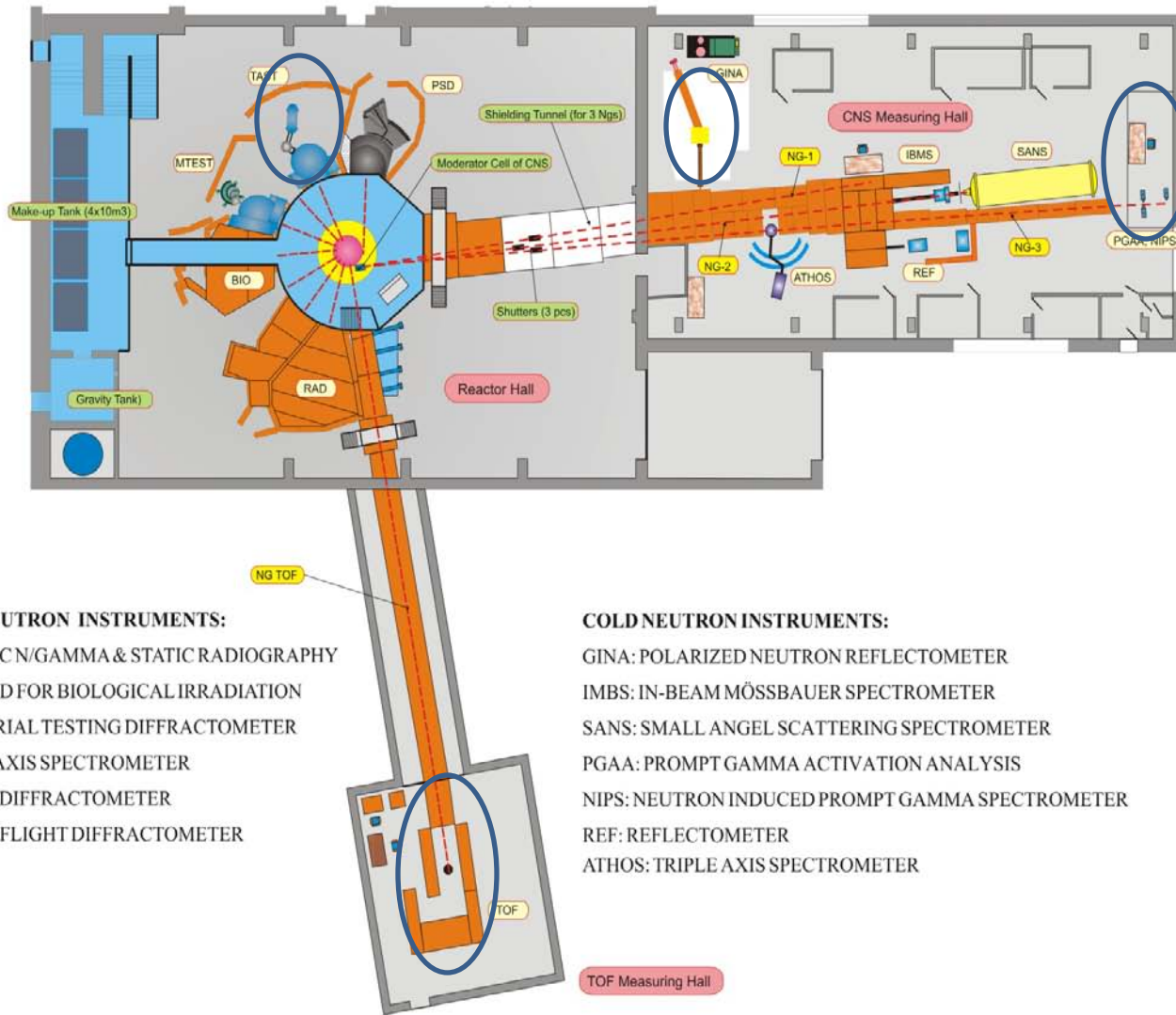
Tank-type reactor, moderated
and cooled by light water
Thermal neutron flux:
 $2.5 \cdot 10^{14}$ n/cm²s
Fast neutron flux:
 $1 \cdot 10^{14}$ n/cm²s



Future Prospect Reactor upgrade

- Transition to LEU (20%), increase of power (12-15 MW)
- Cold source modernization, guide system upgrade
- Improvement of the infrastructure
- Instrumentation development
- Instrument upgrade by replacement/improvement
- Sample environment
- Operation until 2023

12 Beam Instruments



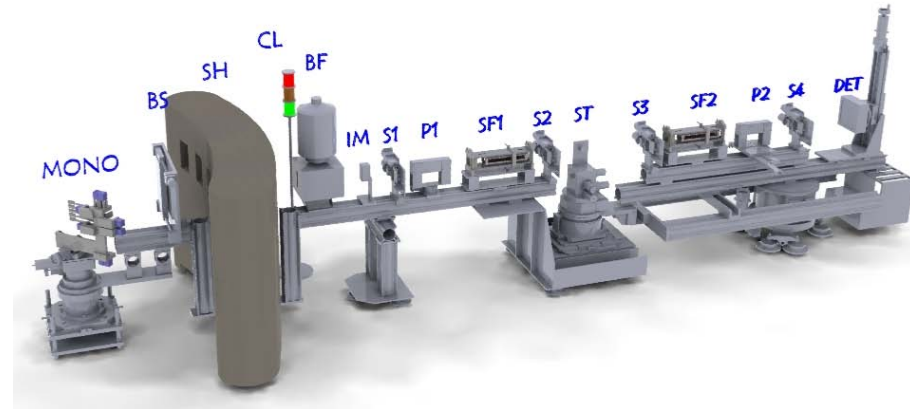
THERMAL NEUTRON INSTRUMENTS:

- RAD: DYNAMIC N/GAMMA & STATIC RADIOGRAPHY
- BIO: PORT USED FOR BIOLOGICAL IRRADIATION
- MTEST: MATERIAL TESTING DIFFRACTOMETER
- TAST: TRIPLE AXIS SPECTROMETER
- PSD: POWDER DIFFRACTOMETER
- TOF: TIME-OF-FLIGHT DIFFRACTOMETER

COLD NEUTRON INSTRUMENTS:

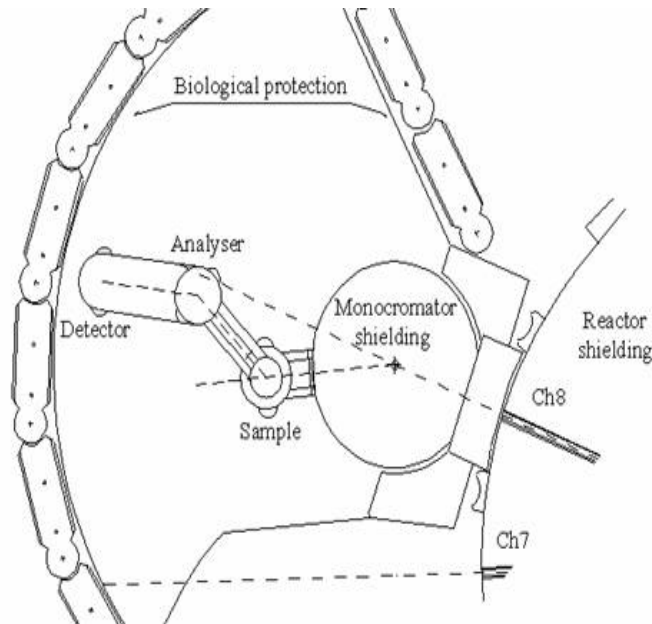
- GINA: POLARIZED NEUTRON REFLECTOMETER
- IMBS: IN-BEAM MÖSSBAUER SPECTROMETER
- SANS: SMALL ANGLE SCATTERING SPECTROMETER
- PGAA: PROMPT GAMMA ACTIVATION ANALYSIS
- NIPS: NEUTRON INDUCED PROMPT GAMMA SPECTROMETER
- REF: REFLECTOMETER
- ATHOS: TRIPLE AXIS SPECTROMETER

GINA-Polarized Neutron Reflectometer



- Optimized for magnetic multilayer studies**
- Vertical sample geometry**
- Wide range of scattering angle**
- Variable monochromatic wavelength**
- Full polarization analysis**
- Magnetic sample environment**
- Adjustable temperature range**
- Equipped with 2D detector for off specular studies**
- Also available for soft matter studies**

TAST – Thermal Three Axis Spectrometer



- Monochromator : Cu 200 (double focusing)
- Analyser : PG 002 (horizontally focusing)
- Detector: ^3He single tube
- Flux at specimen at 1 \AA : $2 \times 10^6 \text{ n/cm}^2/\text{sec}$
- Momentum transfer : $0.2 - 10 \text{ \AA}^{-1}$
- Energy transfer : $1 - 60 \text{ meV}$
- Sample environment: CCR ($T_{\text{min}}=10\text{K}$)

Medium flux, medium resolution

Possible use of the spectrometer

- Phonon, magnon measurements at medium energies
- PDOS measurements
- Molecular excitations
- Measurement of weak elastic signals (EDS ...)



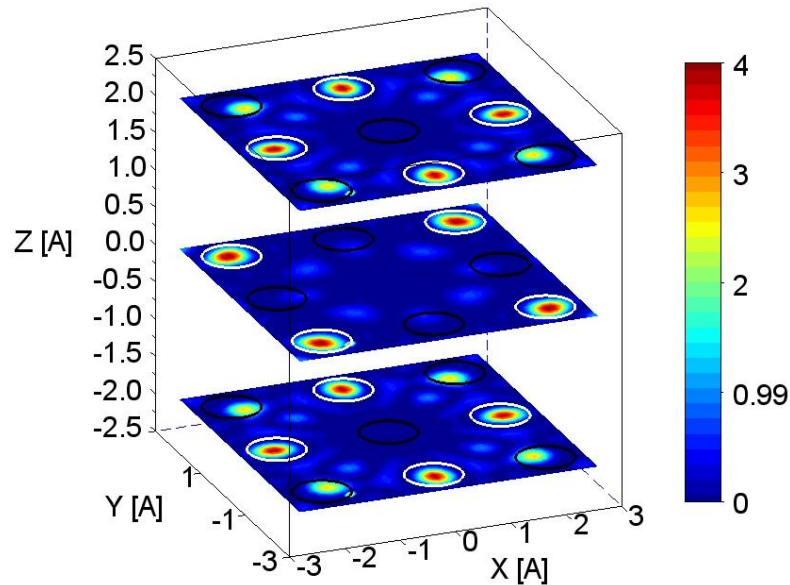
HOLOGRAPHIC OPTION AT TAST



2D PSD (200 X 200 mm²)

BGO scintillator detector

Eulerian cradle



Position of H (white circles) and Pd (black circles) in PdH single crystal

Possible use of neutron holography

Determination of the position of different atoms in the unit cell:

- Neutron absorber nuclei

(Gamma-conversion neutron holography)

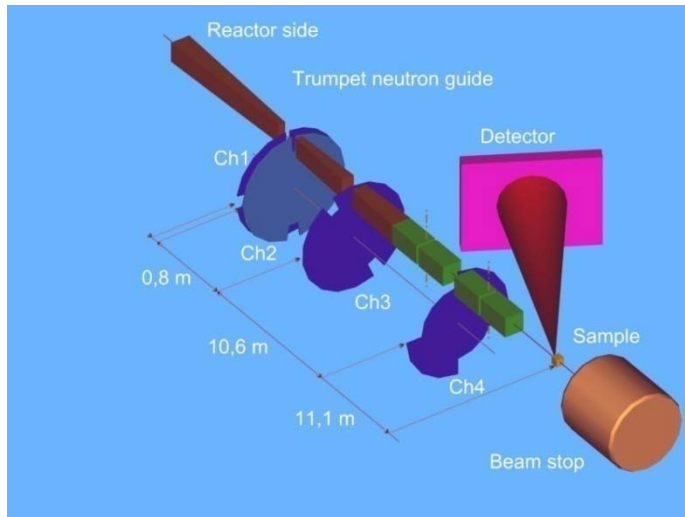
- H (proton)

(Incoherent neutron holography)

Single crystal sample is needed.

d = 0.5 – 1 cm

High resolution time-of-flight diffractometer (TOF)



Total flight path	L=25 m
Bandwidth $\Delta\lambda$	0.4 nm (50 Hz) to 0.1 nm (200 Hz)
Resolution $\Delta d/d$	1×10^{-3} at $\lambda=0.1$ nm (200 Hz)
Neutron guide cross section	$25 \times 100 \text{ mm}^2$
At Chopper 1 & 2	$10 \times 100 \text{ mm}^2$
Coating	Supermirror NiTi, m=2
Curvature	None
Space between of disk 1 & 2	27 mm
Chopper disk outer diameter	700 mm
inner diameter	500 mm
Material	Carbon fibre epoxy
Coating	Gd_2O_3
Max. speed for 1 and 2	12 000 rpm
Max. speed for 3 and 4	6 000 rpm
Detector size (planned)	$1000 \times 800 \text{ mm}^2$
Detector angle	160° - 170°



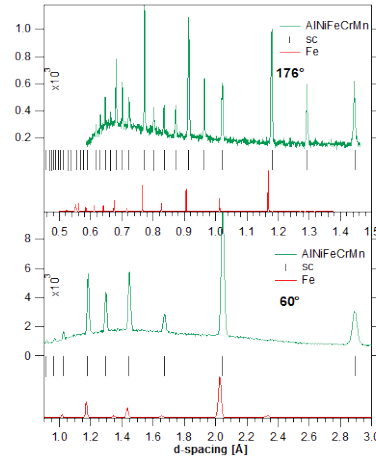
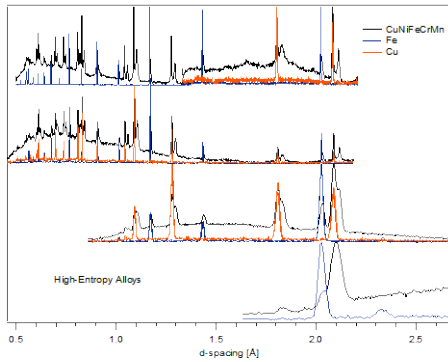
- High resolution (up to $1,5 \times 10^{-3} \text{ \AA}$)
- Variable resolution and wavelength band
- Event list data acquisition

Application for Science

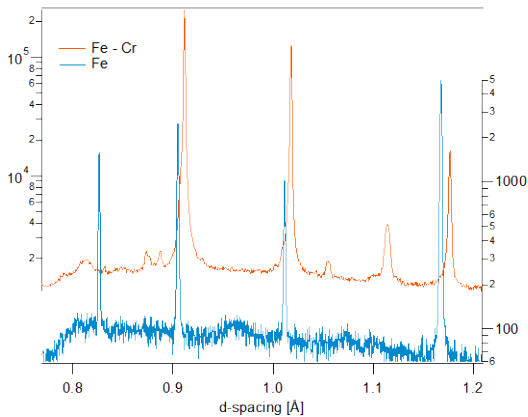


Metallurgy

High-entropy alloys

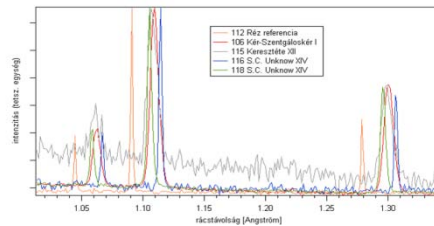


Fe-Cr system



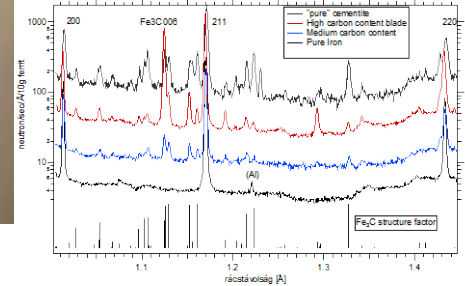
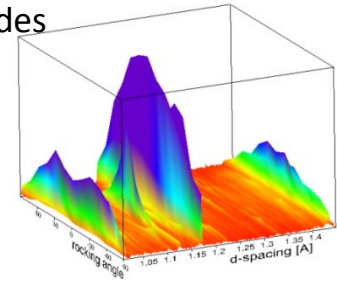
- Phase analysis
- Structure determination
- Texture and stress analysis

Bronze artefacts

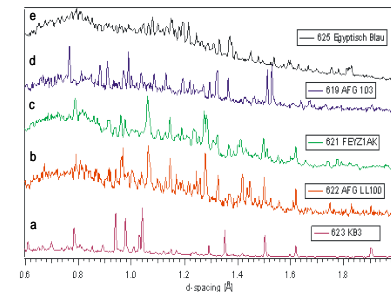


Archeometry

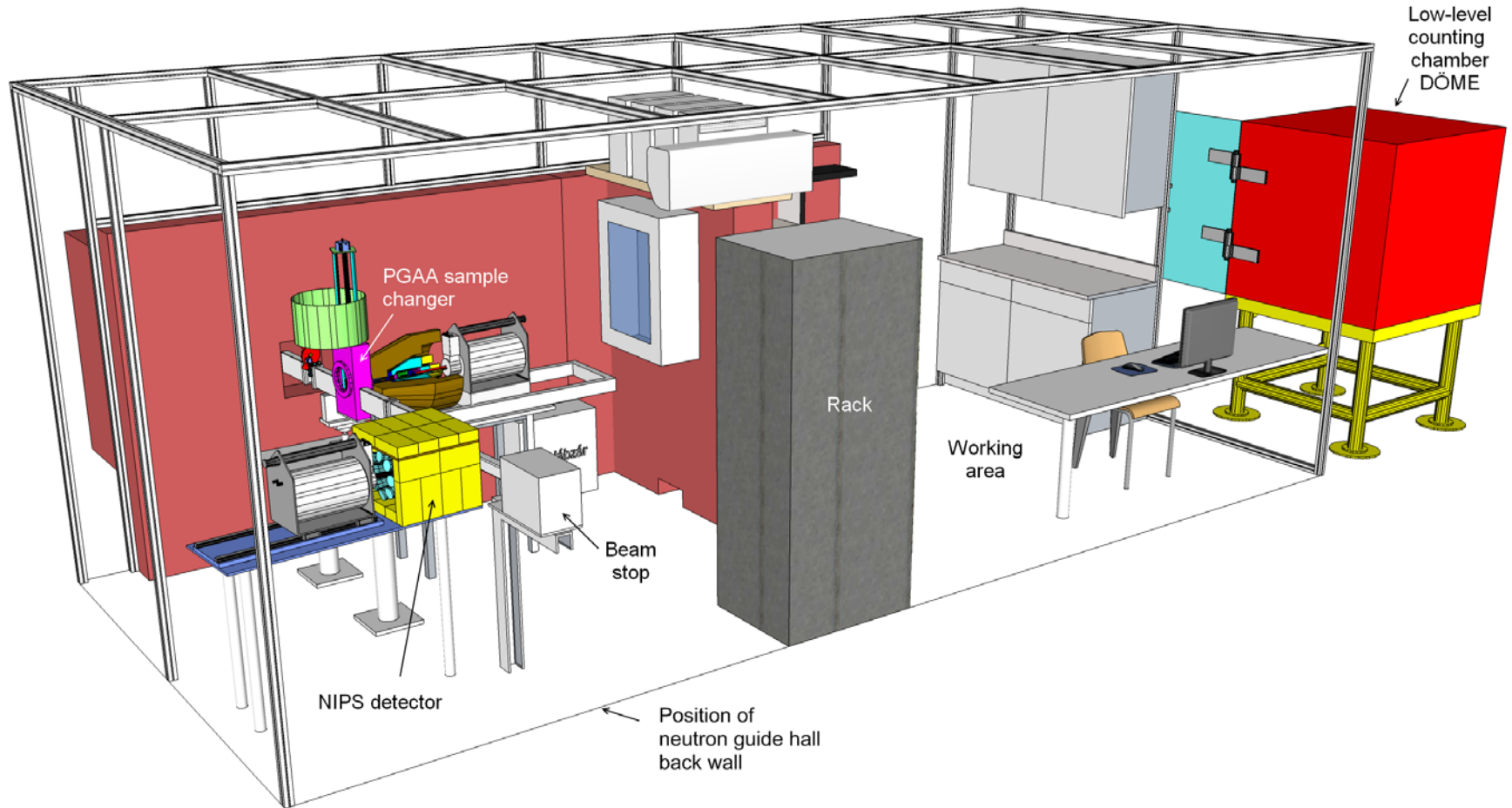
Carbon steel blades



Lapis lazuli



New layout of the prompt gamma activation analysis and neutron induced prompt gamma-ray spectroscopy (PGAA-NIPS)





PGAI (prompt-gamma activation imaging)

- collimating the neutron beam: *chord*
- + collimating the gamma detection: *isovolume*
- point-wise scanning: *2D/3D PGAA*
- resolution reached: *2 – 3 mm*
- very time consuming: *> days*

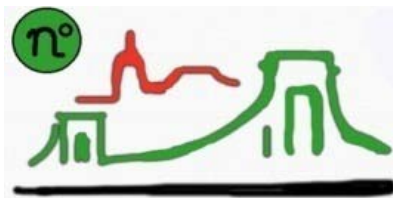
Neutron Radiography/Tomography

- fast: *sec – hours*
- small objects: *in the range of cm's*

Radiography/Tomography-driven PGAI

- visualize and locate the interesting regions first
- prompt- γ measurement only where it is needed
- can save substantial beam time
- **R&D: e.g. homogeneity investigations in NMI3 Imaging JRA**

nmi3



CETS 2012
Budapest



6th Central European Training School on Neutron Scattering
14 May - 19 May, 2012, Budapest, Hungary
Registration : 15 April 2012

In 2010



Welcome the scientists and visitors!



Thank you for your attention!