Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II)

- Overview -

Outline

1. Location
2. The Reactor
3. Neutron Sources
4. Applications

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Campus of TUM in Garching near Munich

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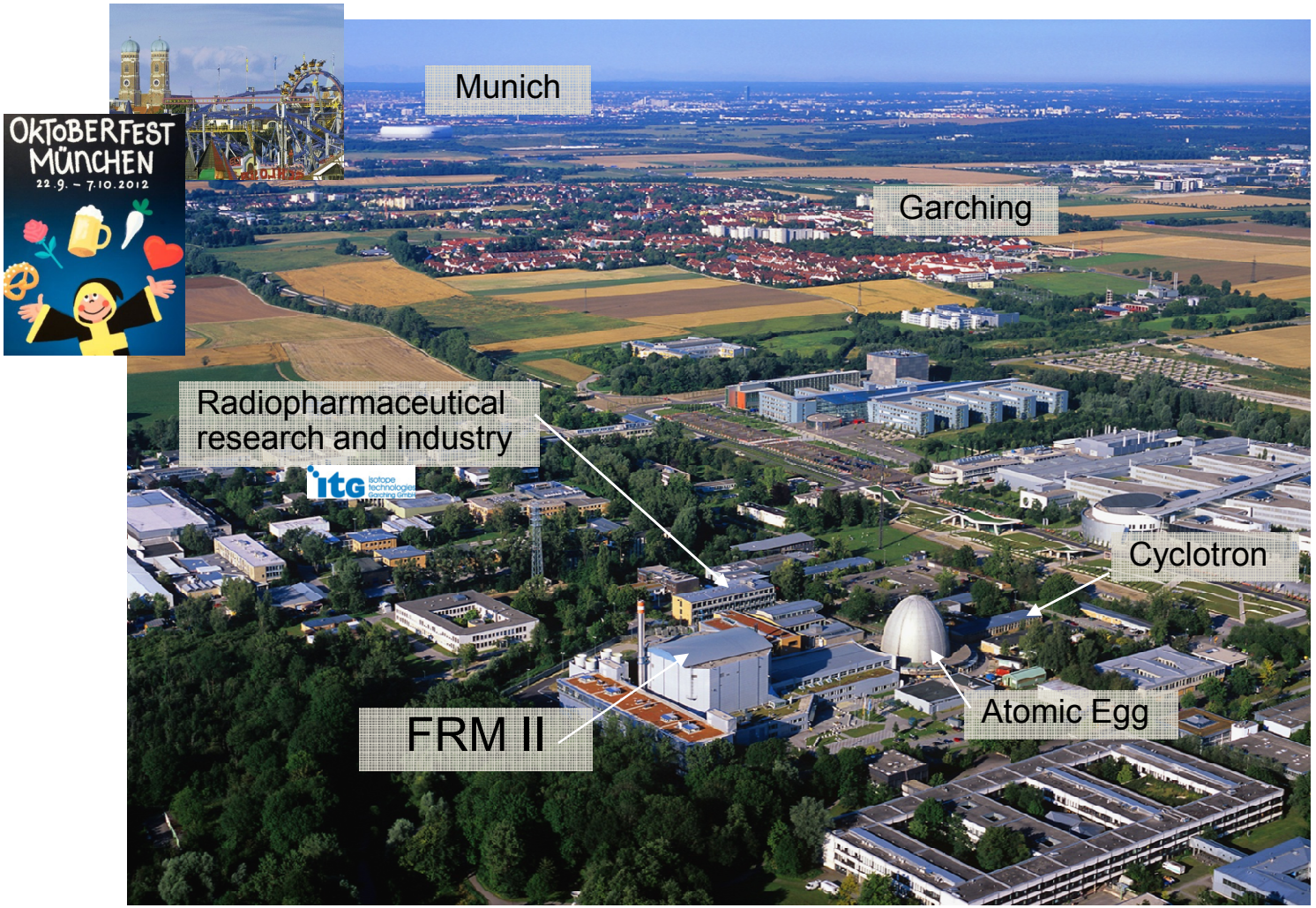

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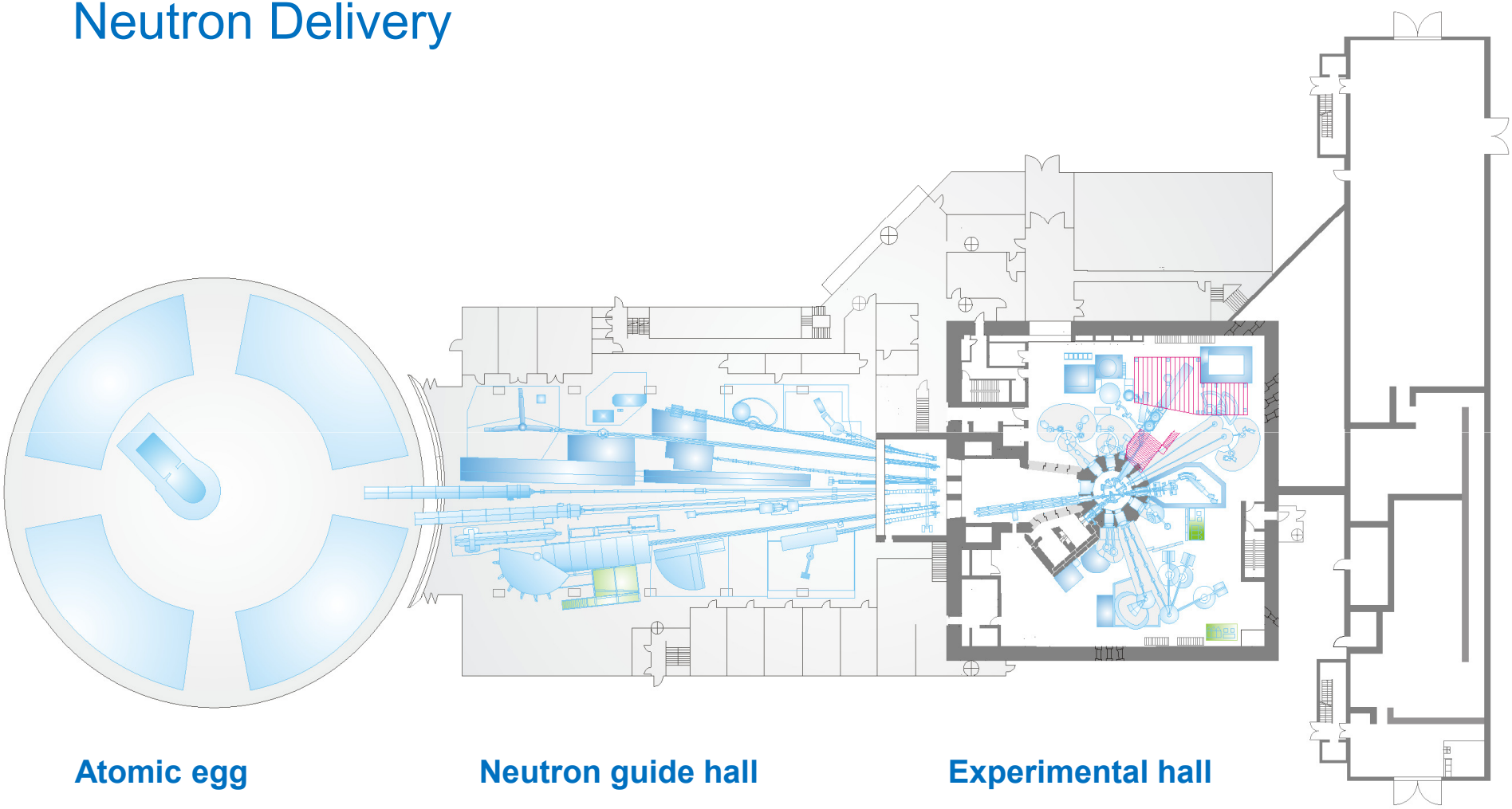
Neutron Delivery

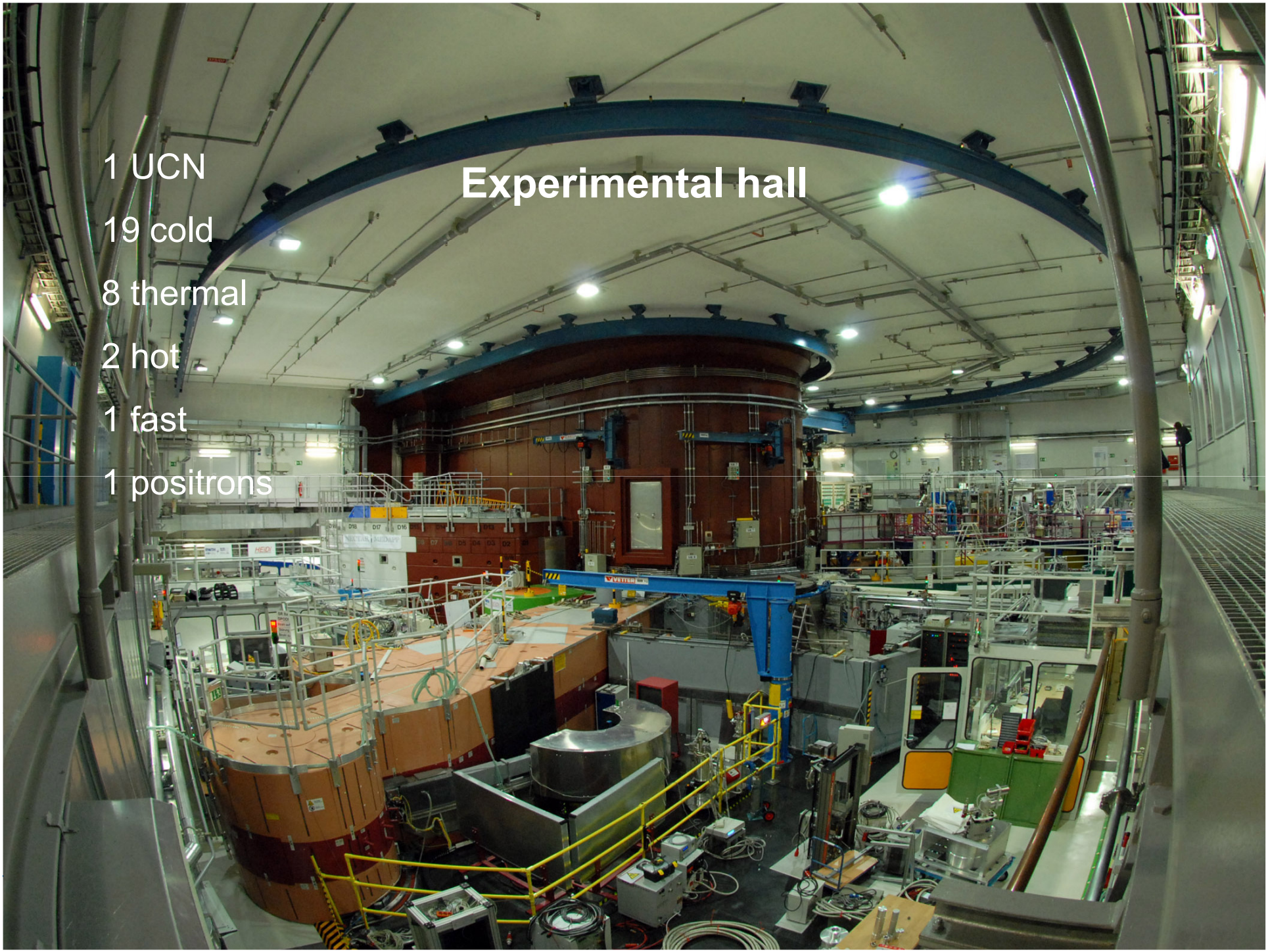


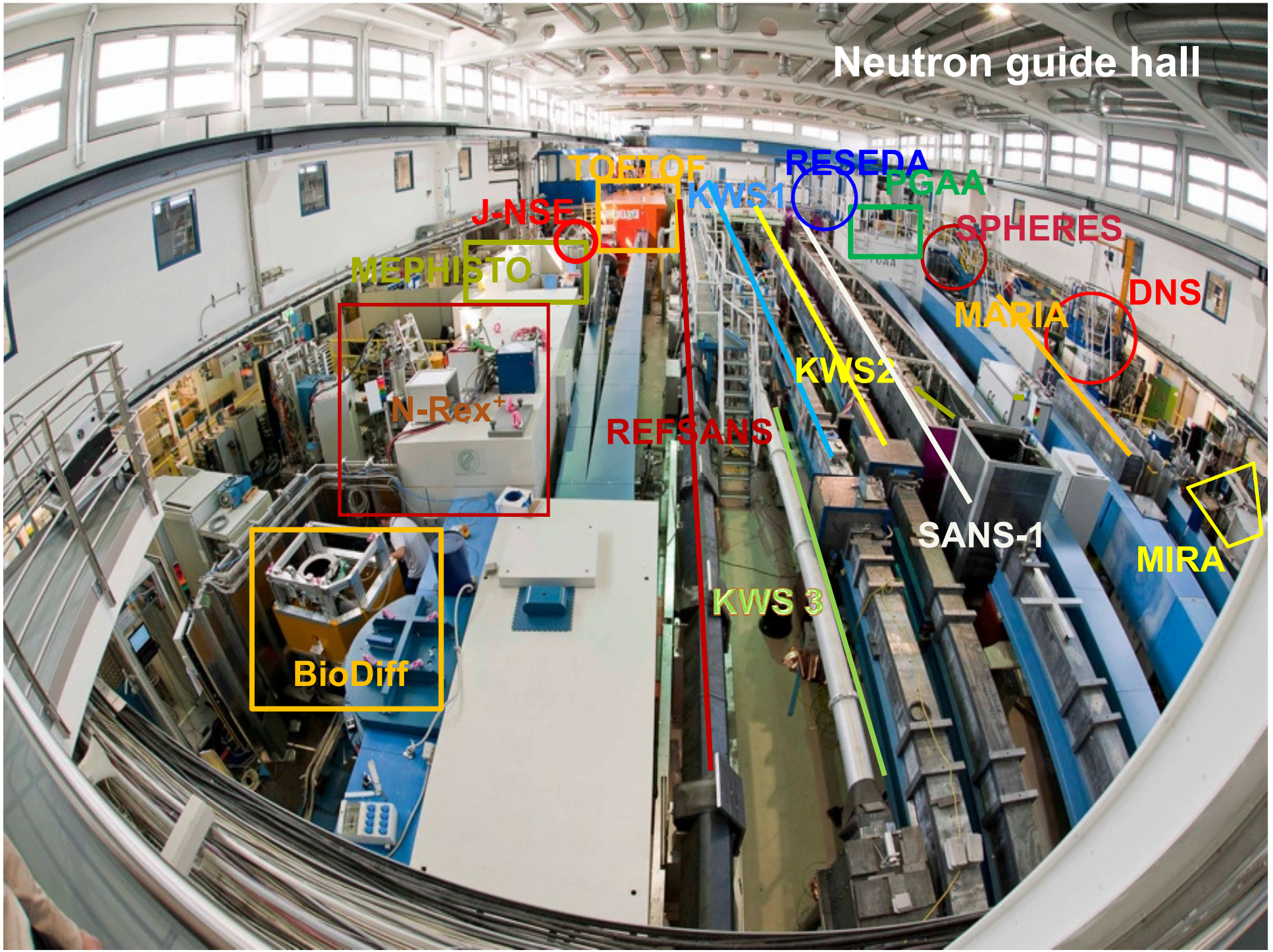
Atomic egg

Neutron guide hall

Experimental hall

New experimental Hall - under construction


Experimental hall
1 UCN
19 cold
8 thermal
2 hot
1 fast
1 positrons


Neutron guide hall
TOFTOF
RESEDA
PGAA
KWS1
J-NSE
SPHERES
MEPHISTO
DNS
MARIA
KWS2
N-Rex+
REFSANS
SANS-1
MIRA
KWS 3
BioDiff

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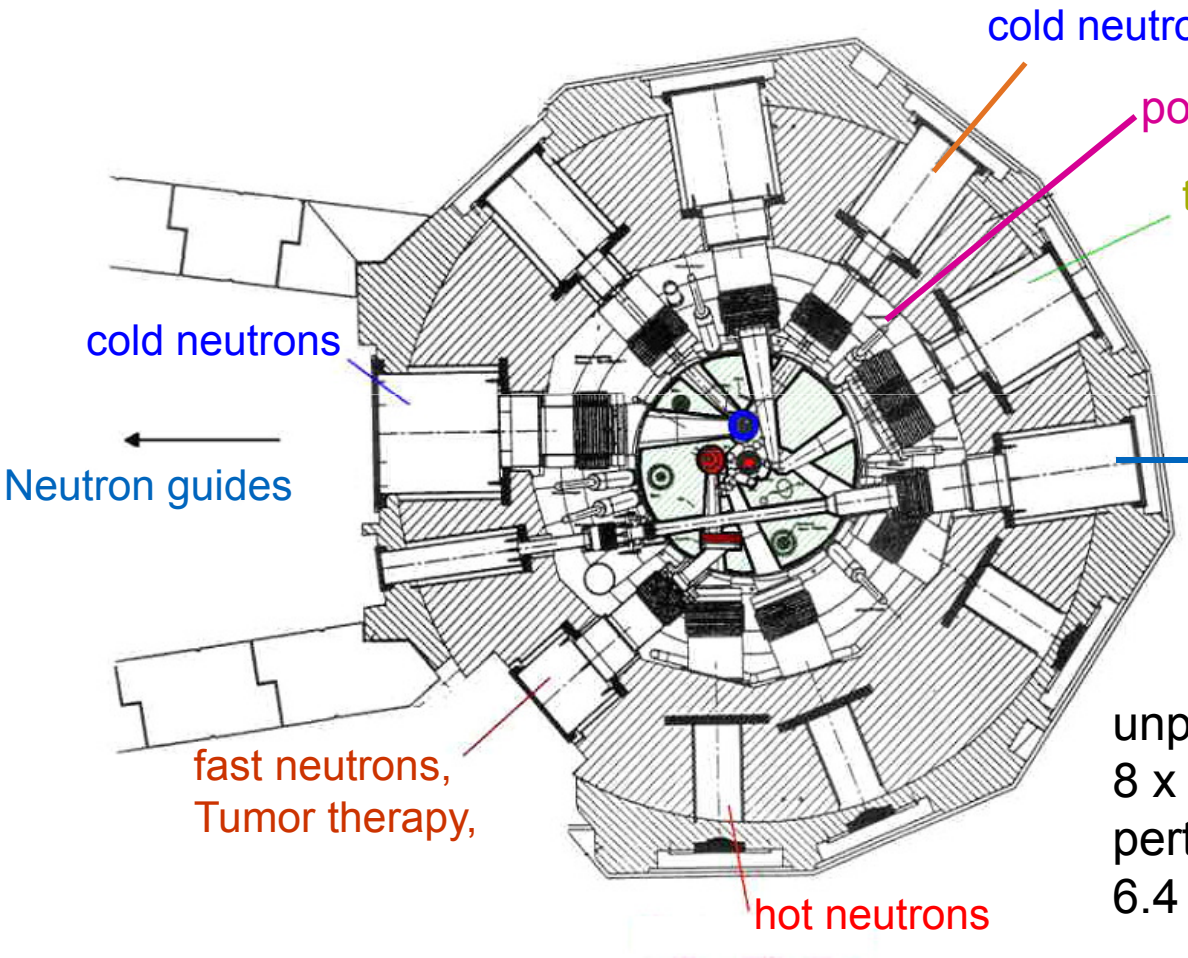
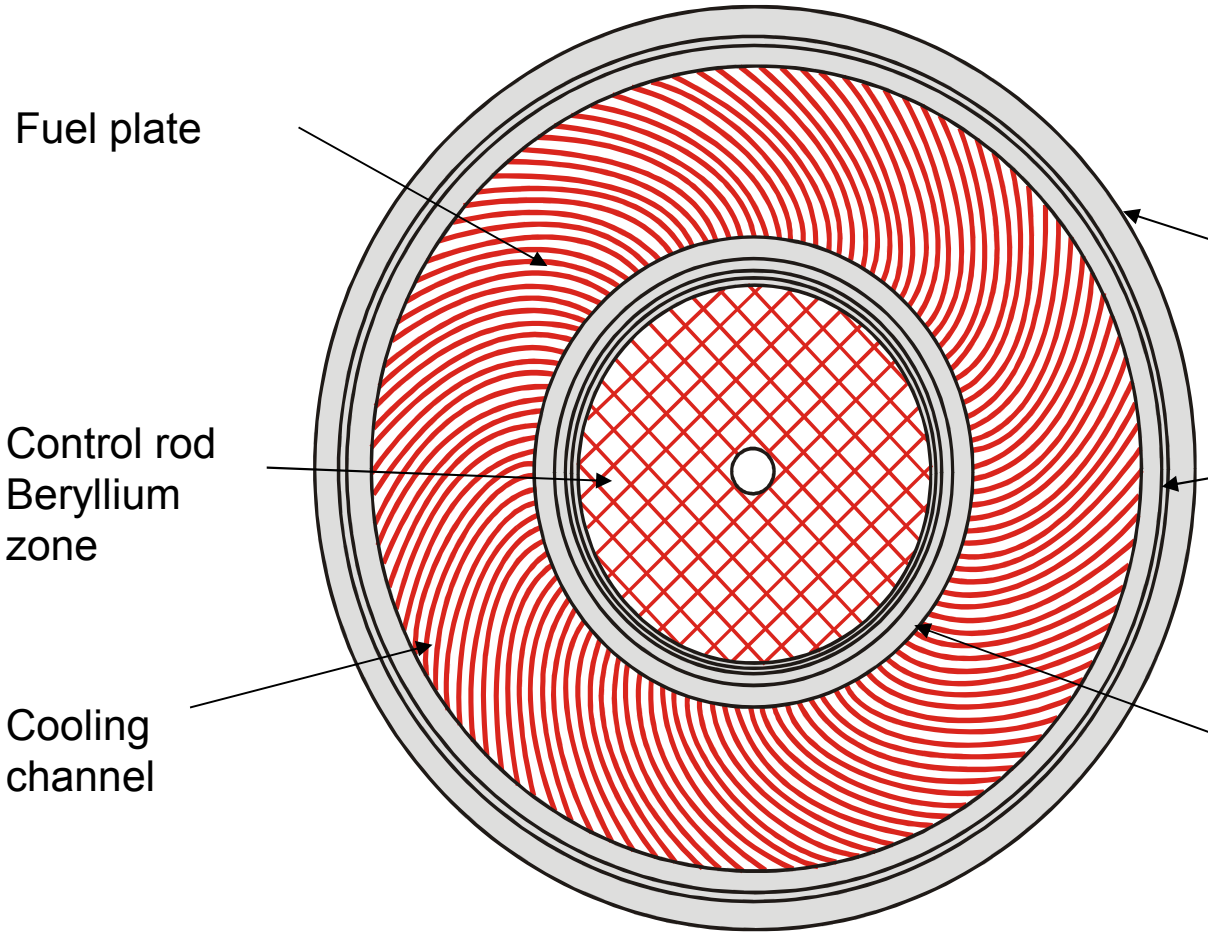
Neutrons of Different Wave Length



unperturbed thermal flux:
8×10^{14} n/cm^2/s
perturbed thermal flux:
6.4×10^{14} n/cm^2/s

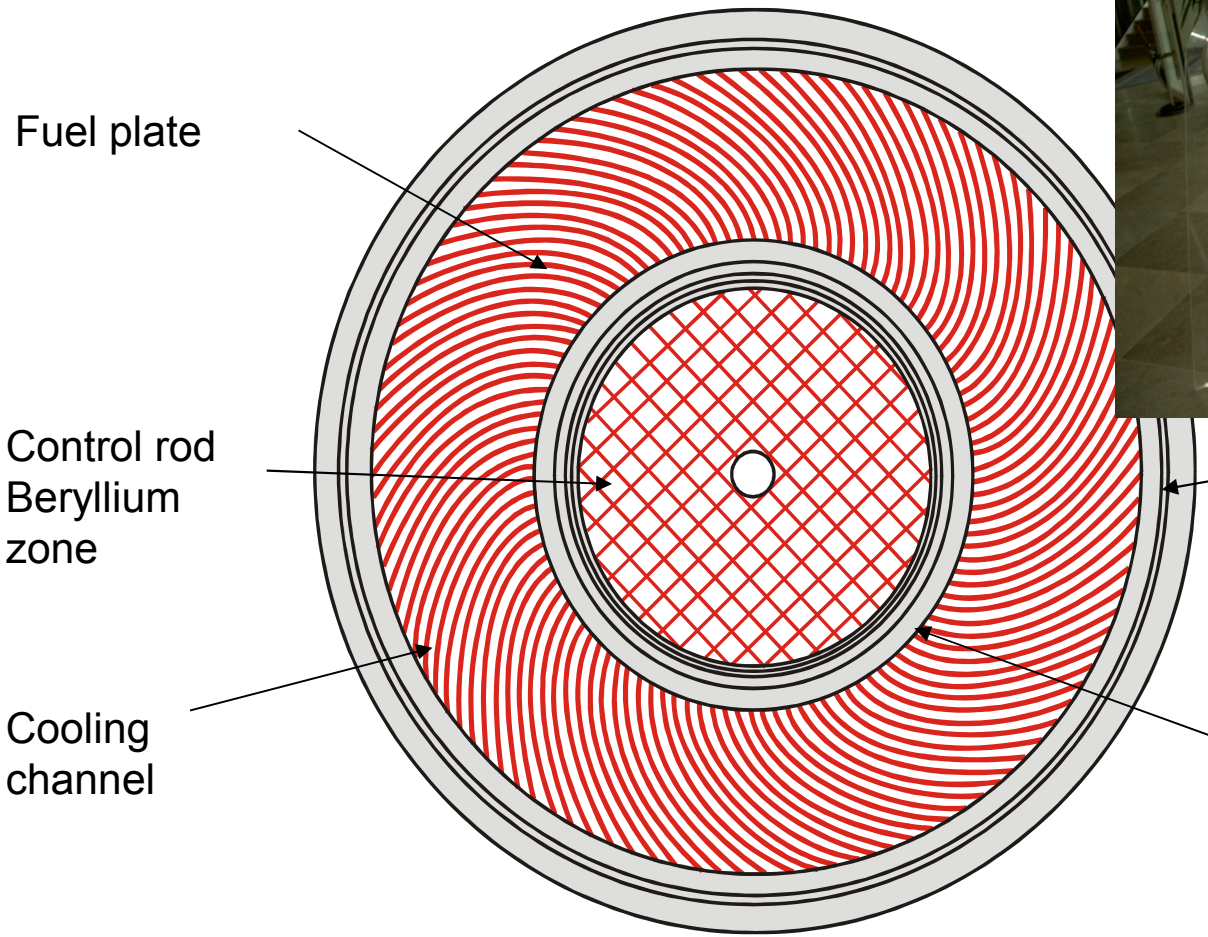
Compact Core



7,5 kg ^{235}Uranium

Cycle length: 60 d

Compact Core

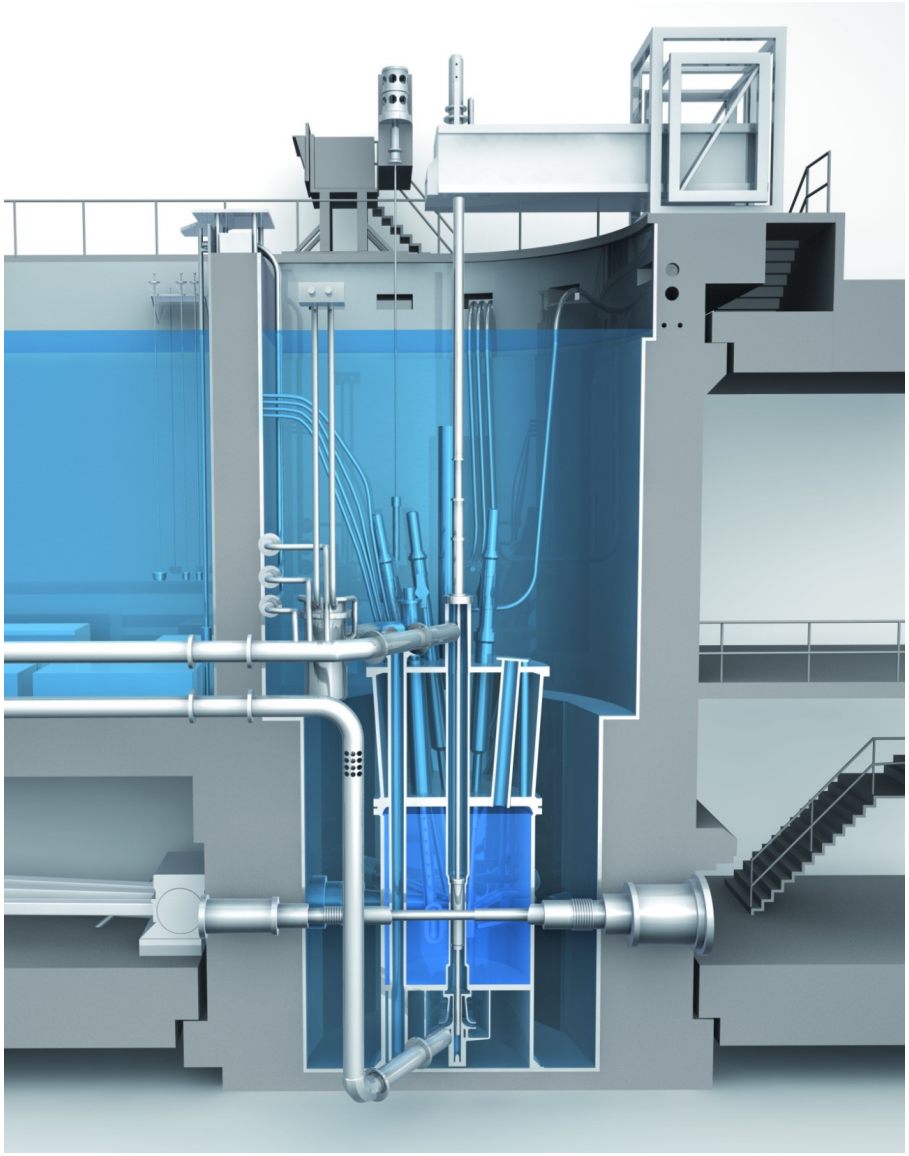


7,5 kg ^{235}Uranium

Cycle length: 60 d

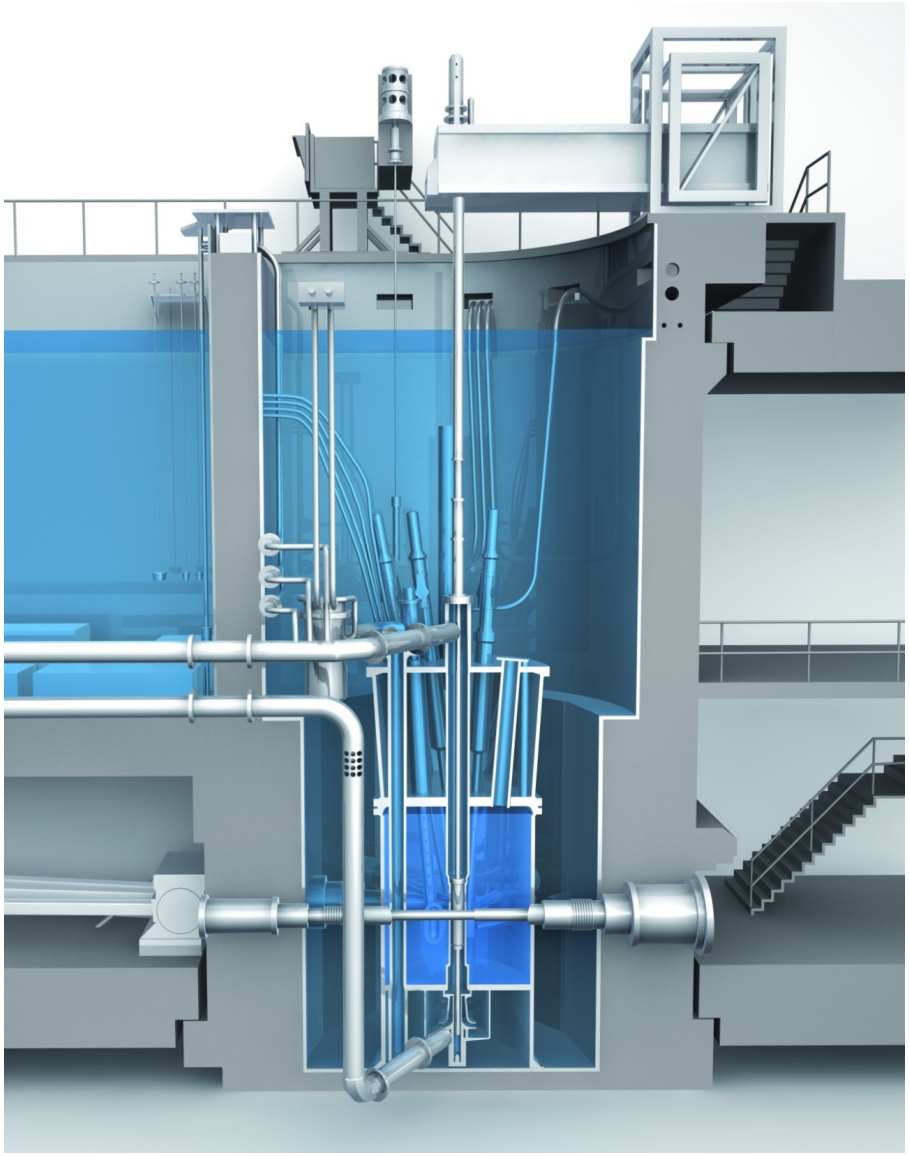
Neutron Research Source Heinz Maier-Leibnitz (FRM II)

- thermal power 20 MW
- 1 compact fuel assembly, 8,1 kg HEU
- swimming pool reactor, 700 m^3 H_2O, pressure less, T ~ 35°C
- D_2O moderator
- 11 external neutron beams, neutron guides
- 32 beam instruments
- several irradiation systems
- access solely by scientific merit
- overbooking by factor 2
- users 60% Germany, 40% international
- ~ 1000 scientist/y



FRM II, a safe nuclear facility

- 4 barriers to retain radioactivity
- prepared for earth quakes, primary
- circuit decoupled from external seismic shaking
- full protection against any airplane crash, 1.80m thick containment
- prepared for 10,000-year flooding
- after scram no active cooling necessary



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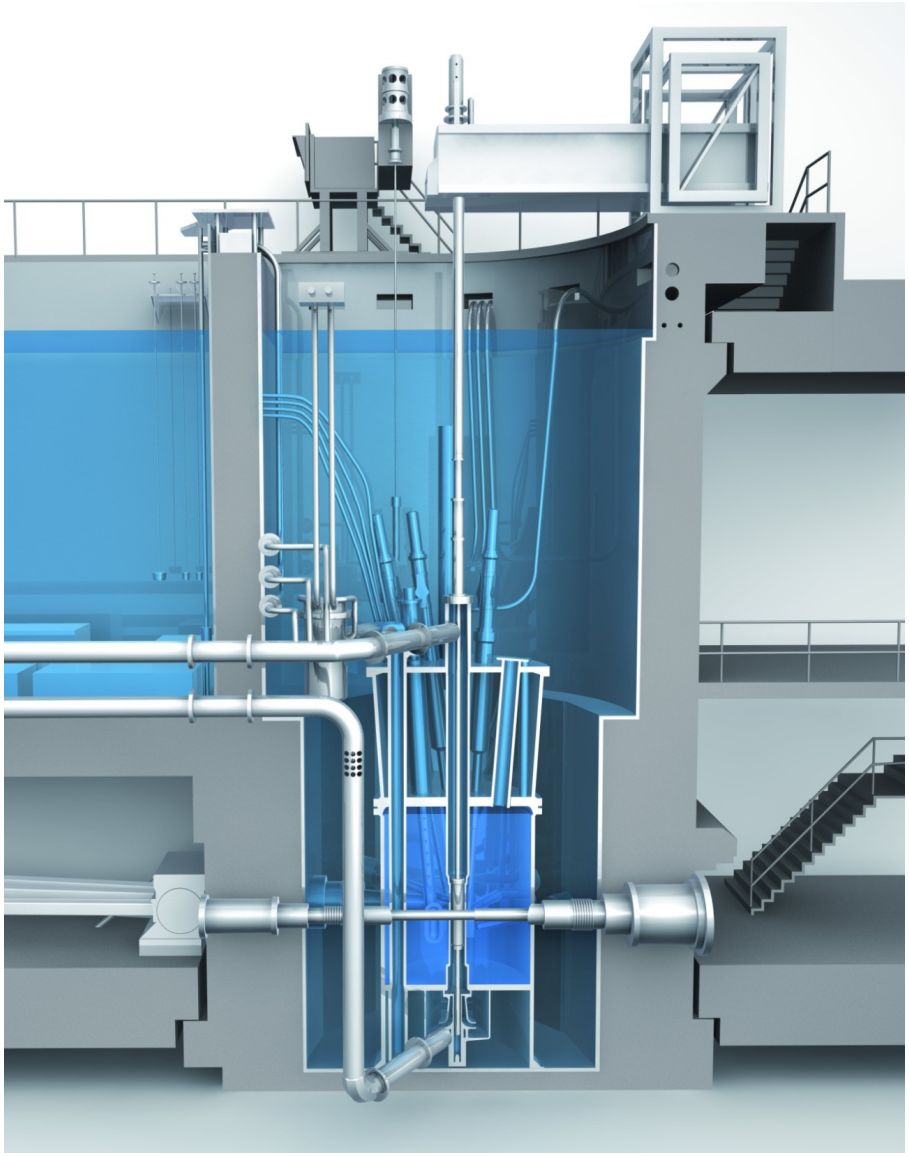
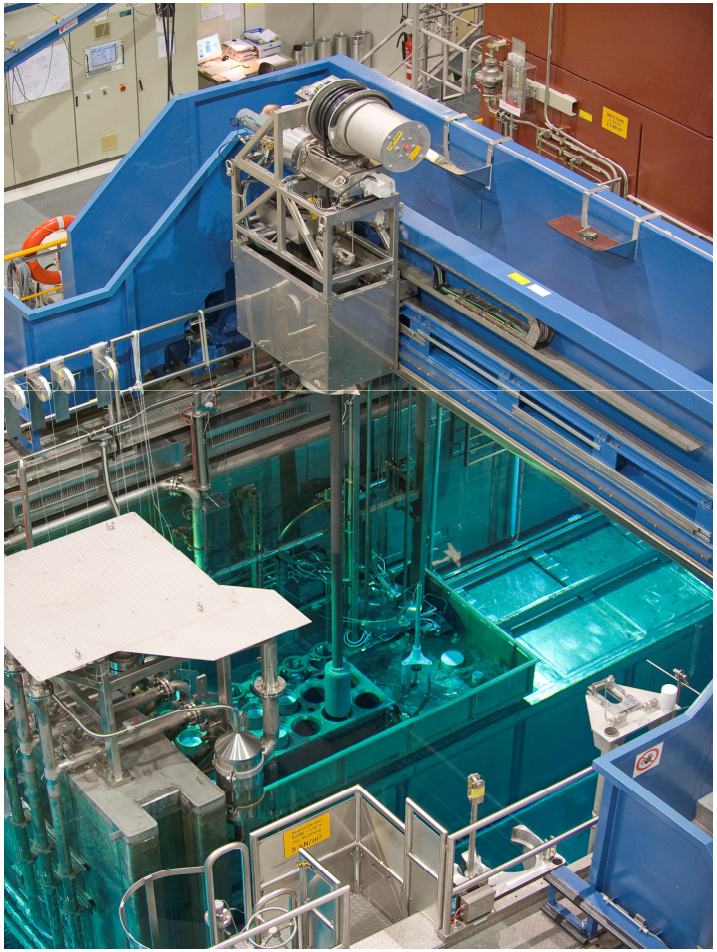
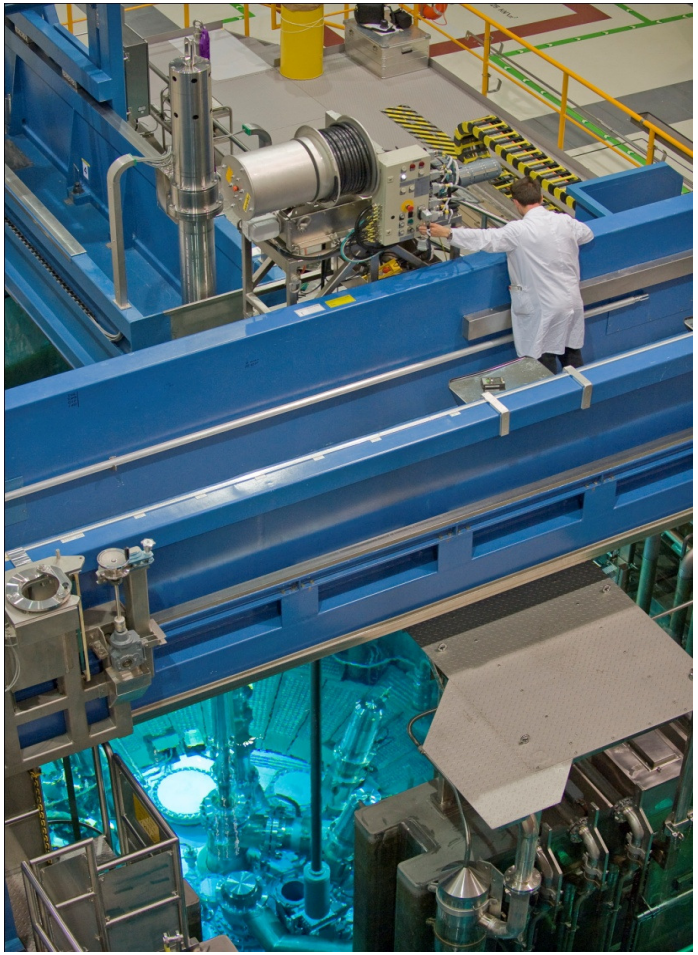
Irradiation Facilities

- 2 x 3 standard rabbit irradiation system
- capsule irradiation system
- Silicon doping
- Mo-99
- external beam of fast neutrons
- ϕ_{therm} = 2.3 10^{14} – 10^{13} n/cm^{2}s
- ϕ_{therm}/ ϕ_{fast}= 10^2 - 10^5



Silicon Doping Facility

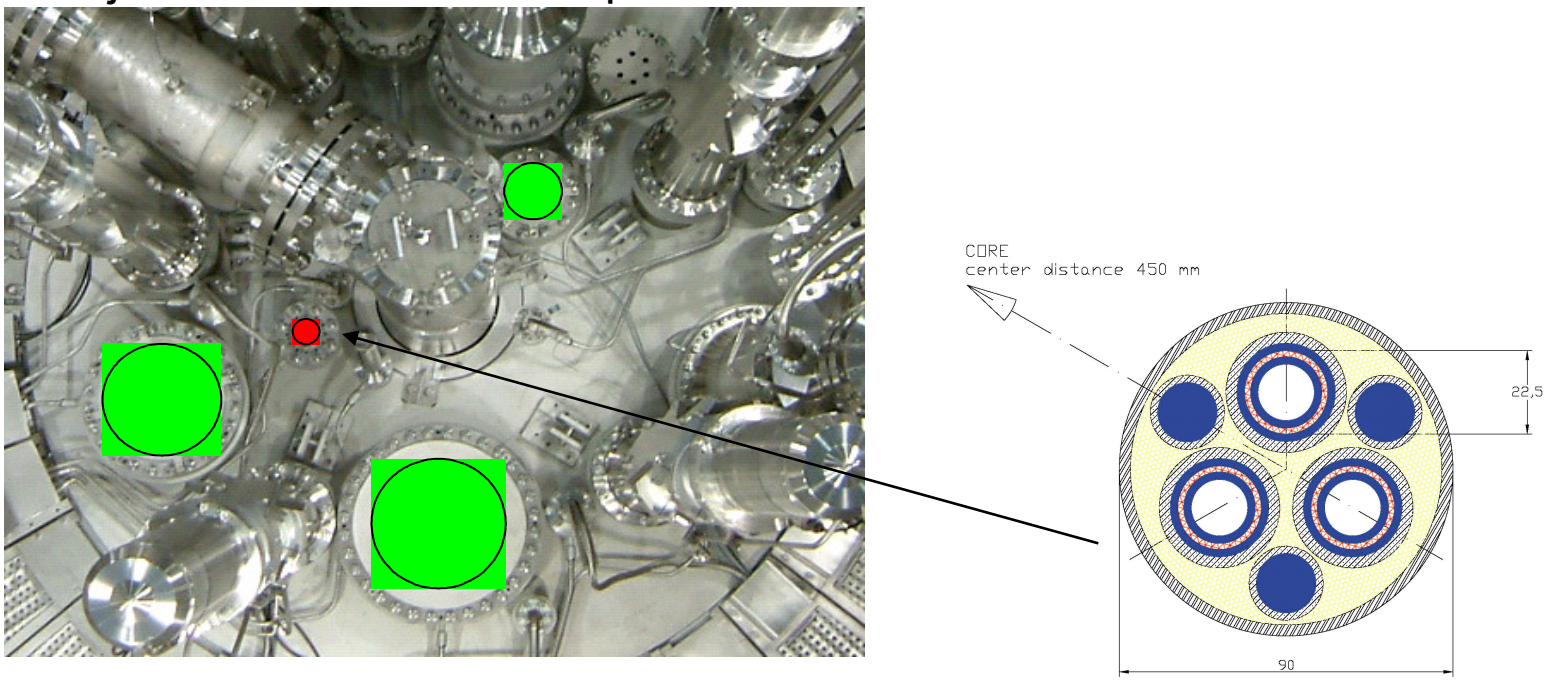




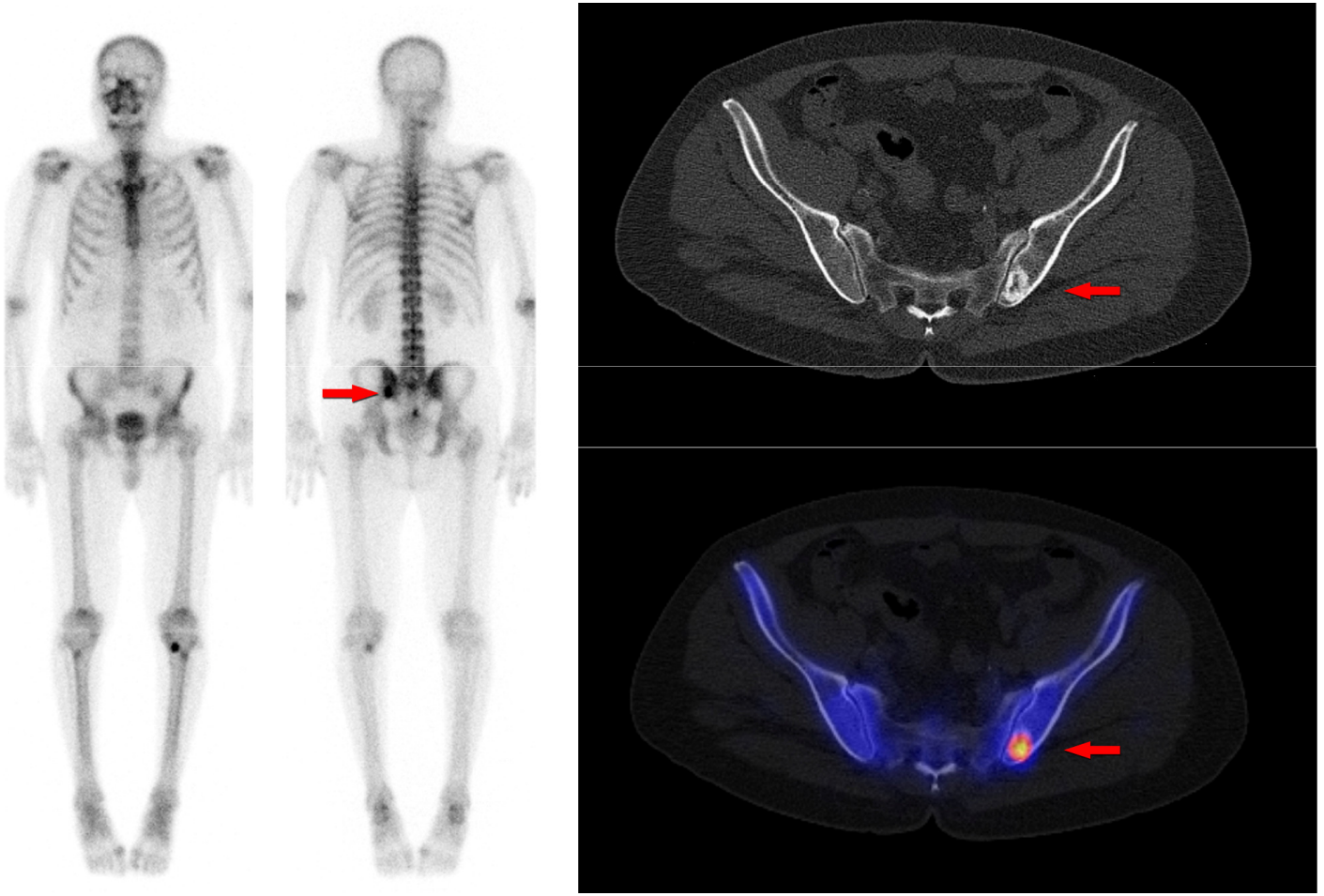
Silicon Doping

Production of Mo-99 at FRM II

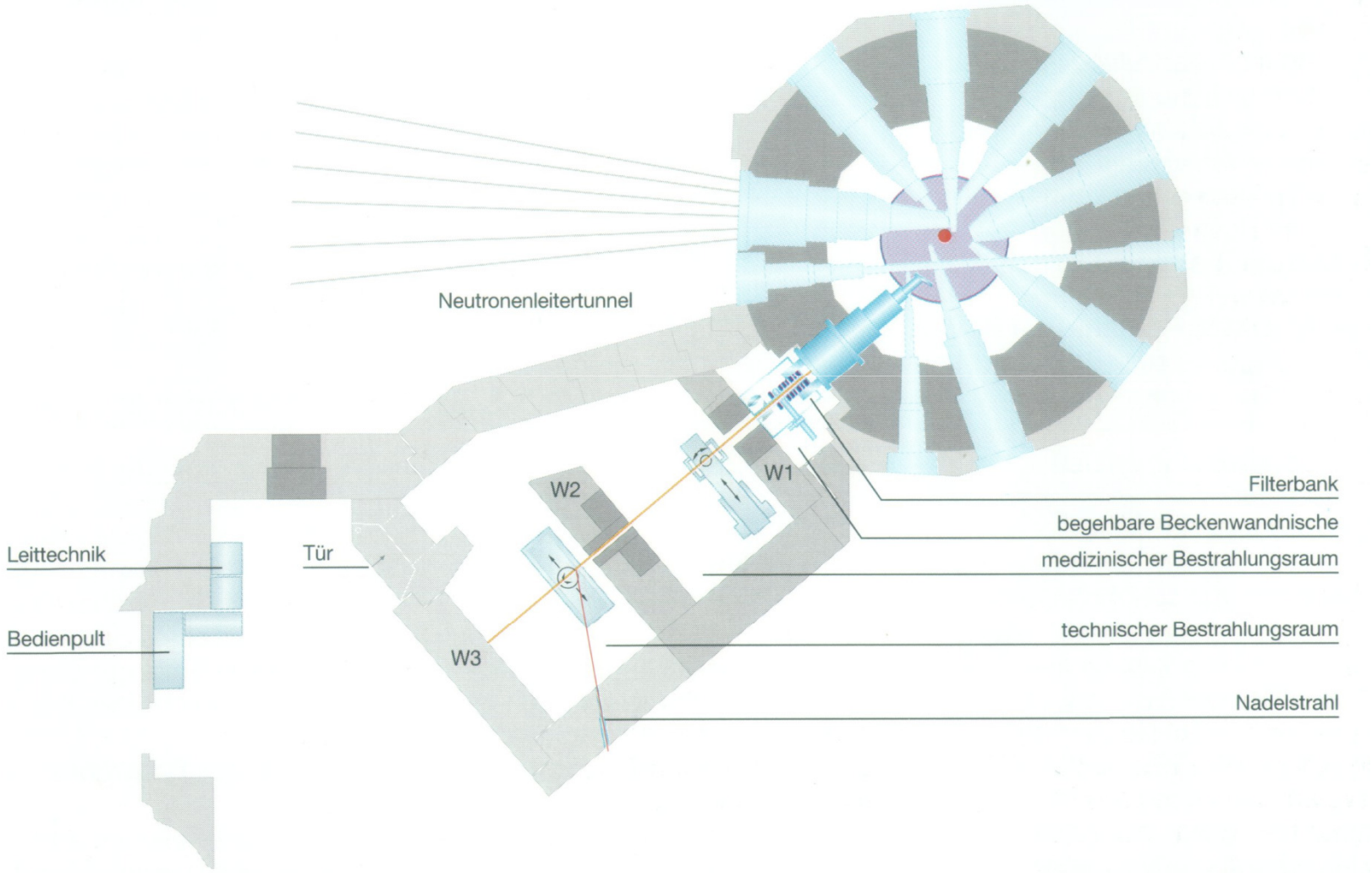
- Production of Molybdene-99 at FRM II technically feasible
- Quantity produced at Garching may cover up to 50% of annual European demand – 17,000 Ci/week ~ 3 000 6-days Ci/week
- Financial frame work: **5.4 Million Euro**
- Project start in 2009 – first production end 2014



Cancer Diagnosis: Szintigraphy of Metastasis



MEDical APPlication **MEDAPP**



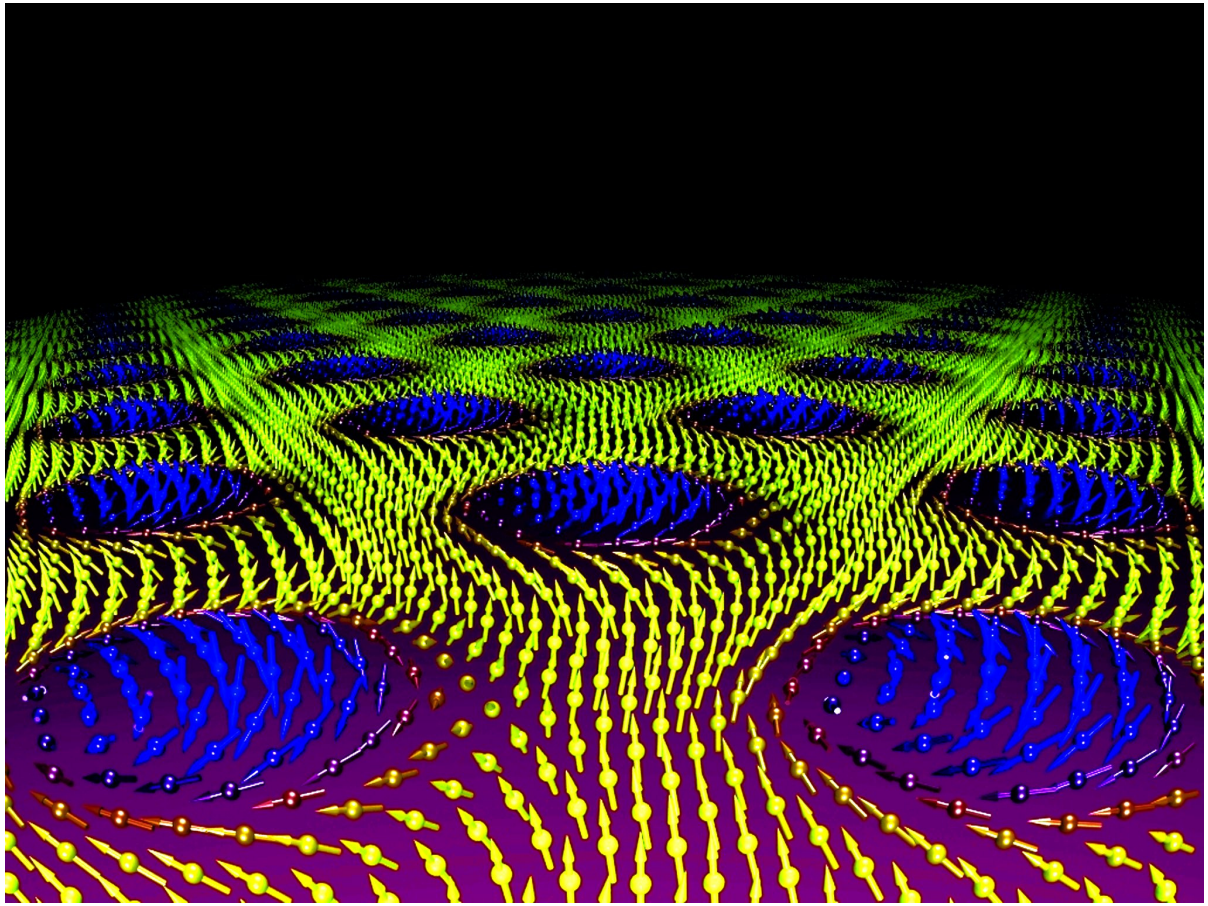
Hadron Therapy
High Energy Cancer Care Therapy with Neutrons

Innovative 3-axis Spectrometer at FRM II

Inosov et al., Nature Physics 6:178 - 181 2010
Keller, Buchner, Keimer MPI-Stuttgart

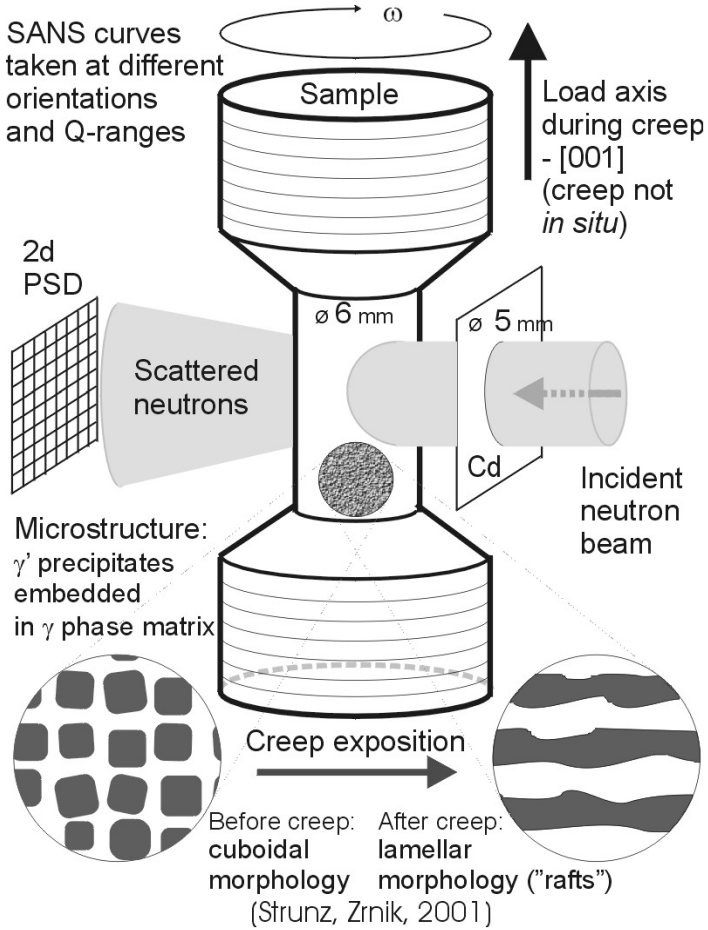
Max-Planck-Institut für Festkörperforschung

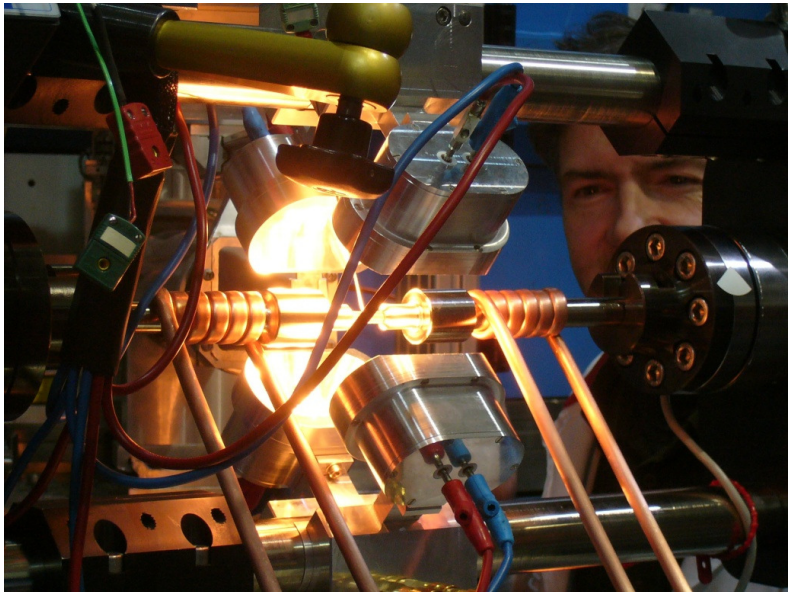
Skyrmion Lattice in MnSi
New kind of magnetic ordering on a mesocopic scale

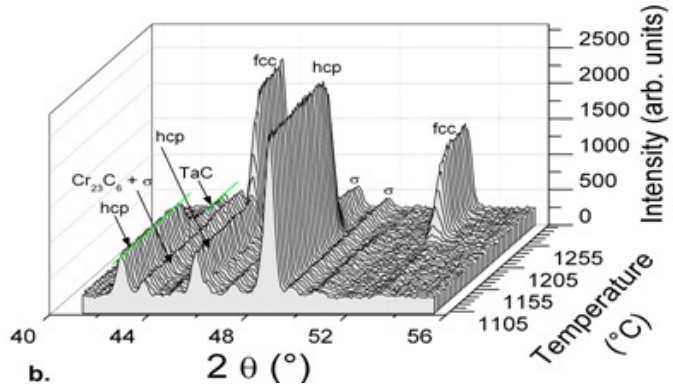


S. Mühlbauer, B. Binz, F. Jonietz, C. Pfleiderer, A. Rosch, A. Neugebauer, R. Georgii, P. Böni:
Skyrmion Lattice in a Chiral Magnet, Science **323** (2009), pp. 915-919

Strain Measurements with Neutrons at High Temperatures

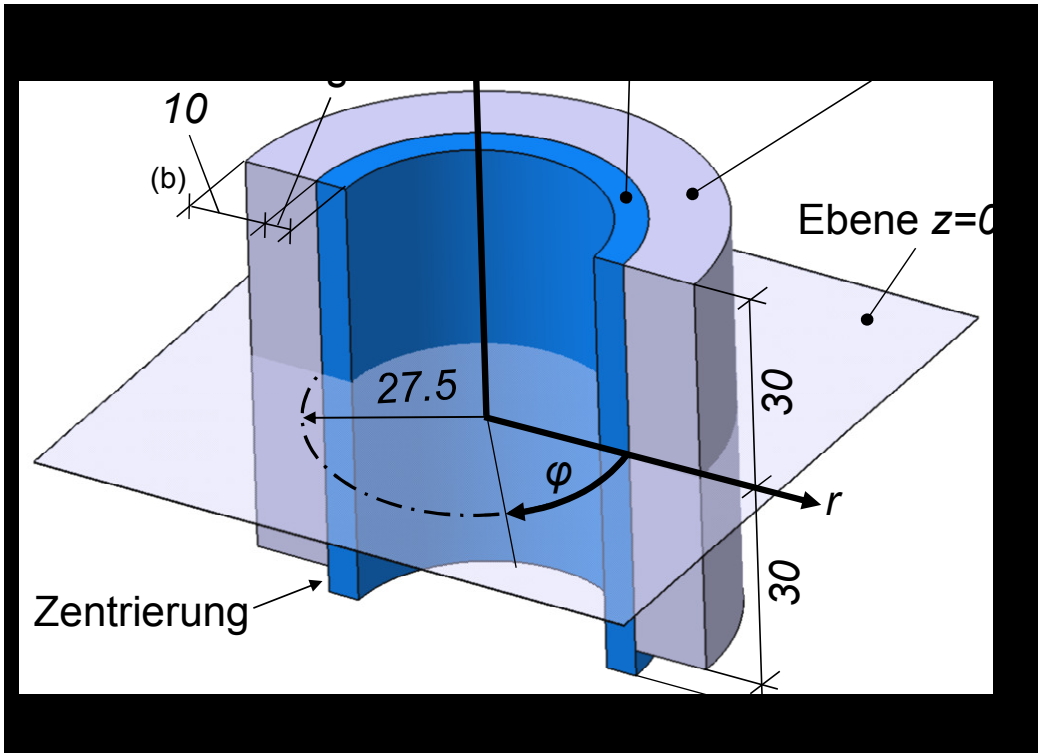


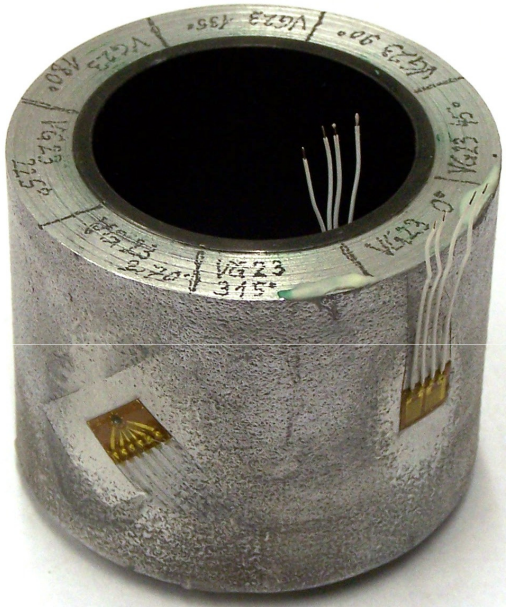




Ralph Gilles
Elbio Calzada

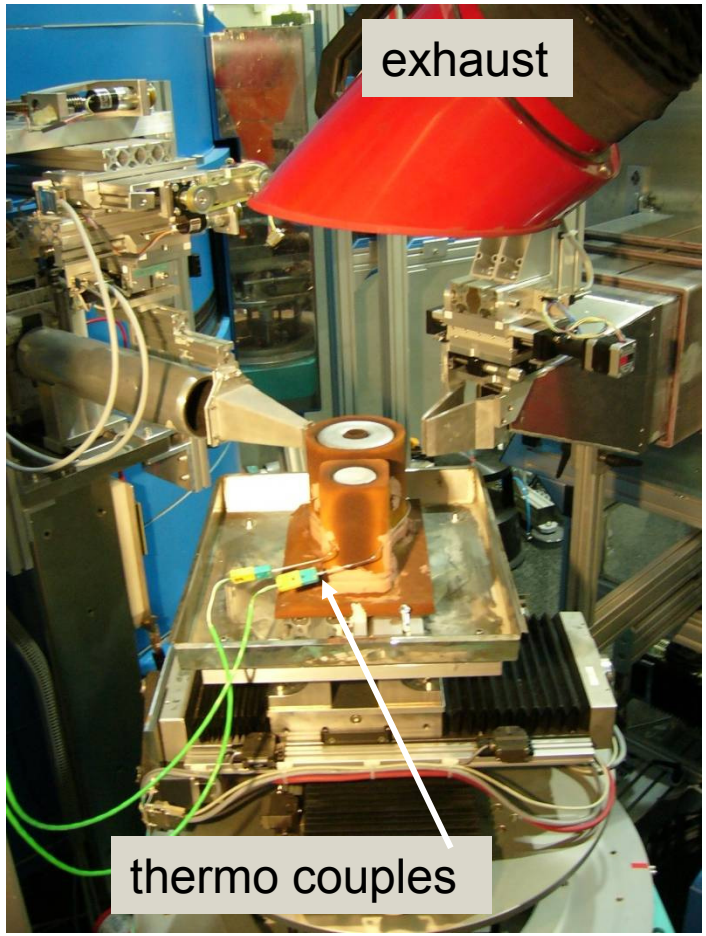
Model Cast Body of a Cylinder Liner

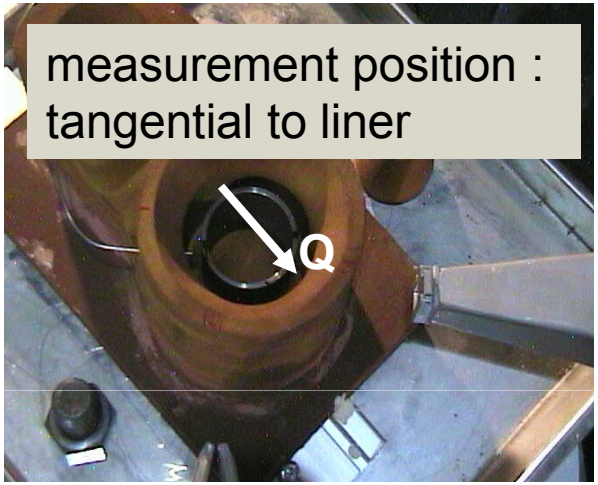


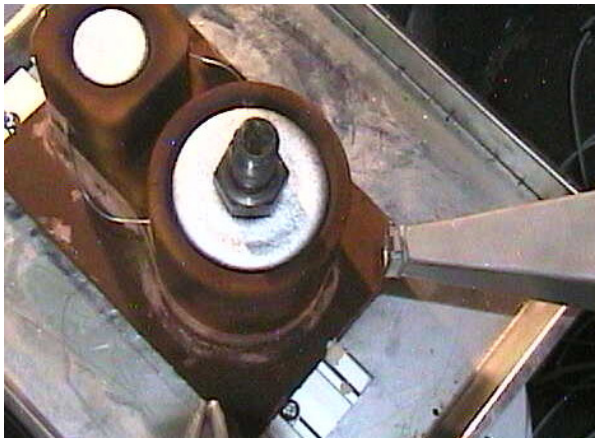


U. Wasmuth utg, M. Hofmann FRM II

In-situ Strain Measurement at a Cylinder Liner







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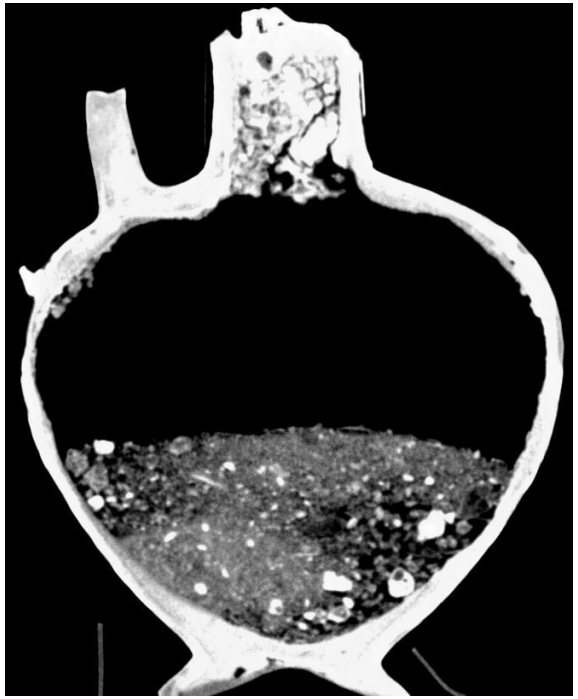
Sealed Roman Vase/Amphora, presumed empty

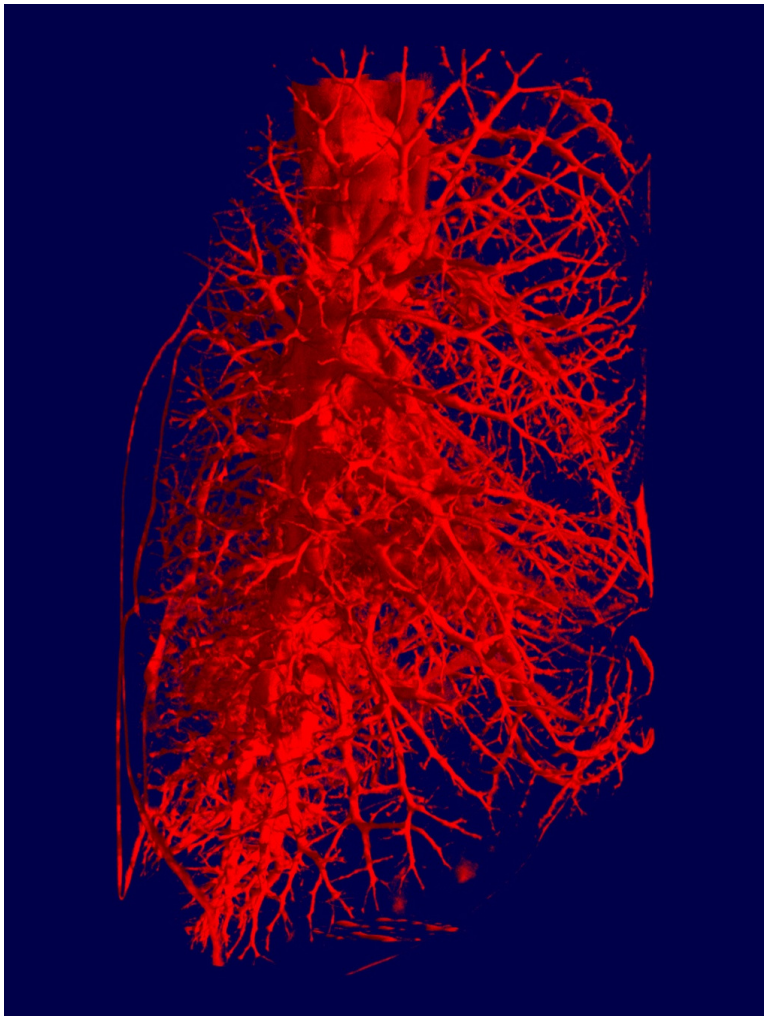
Neutron Tomography Reveals Plant Seeds



Neutron Radiography of a Rat Lung 2D

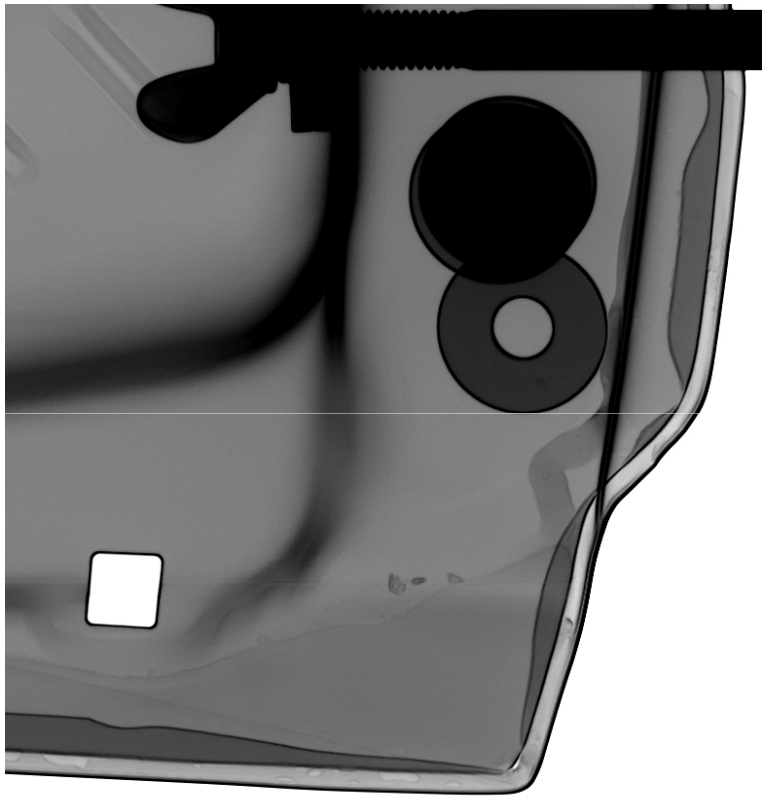
Schillinger (FRM II), Metzge (MW – TUM), Runck, Stahl (Uni-Klinik Freiburg)

Neutron Tomography of a Rat Lung 3D



Schillinger (FRM II), Metzge (MW – TUM), Runck, Stahl (Uni-Klinik Freiburg)

Comparison X-Ray Radiography and Neutron Radiography

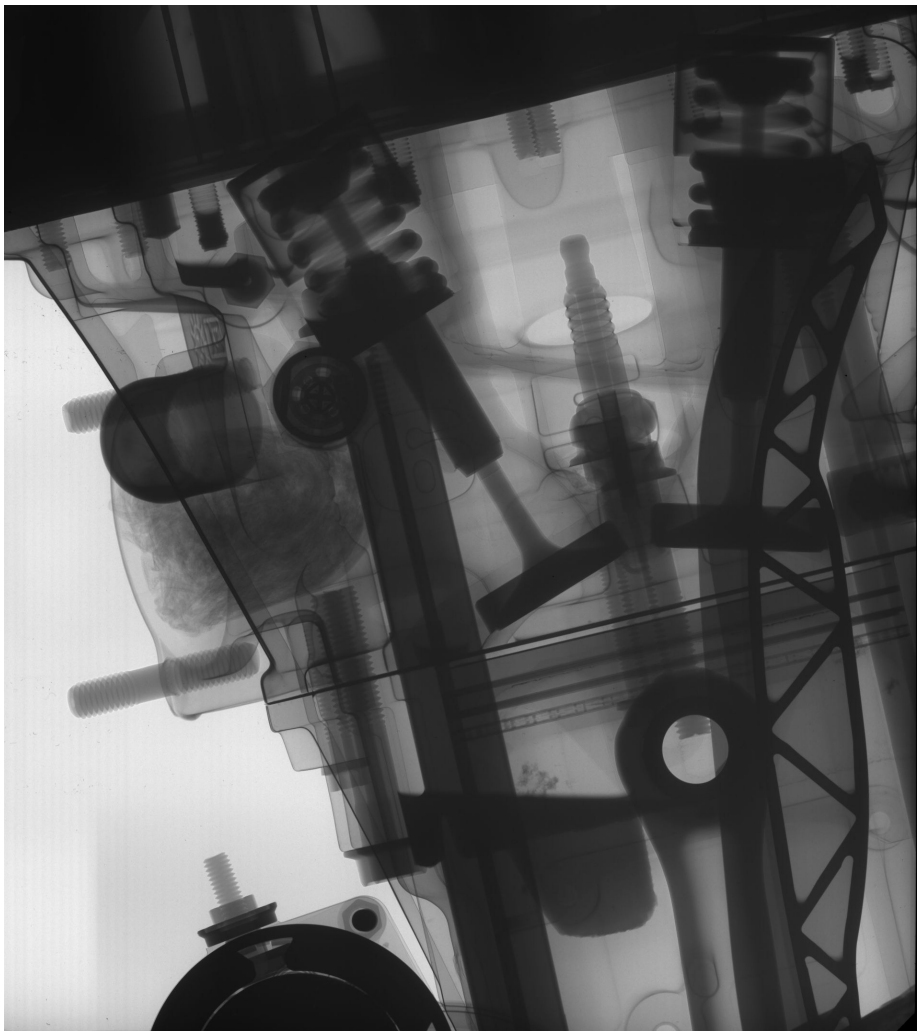


X-Ray Radiography

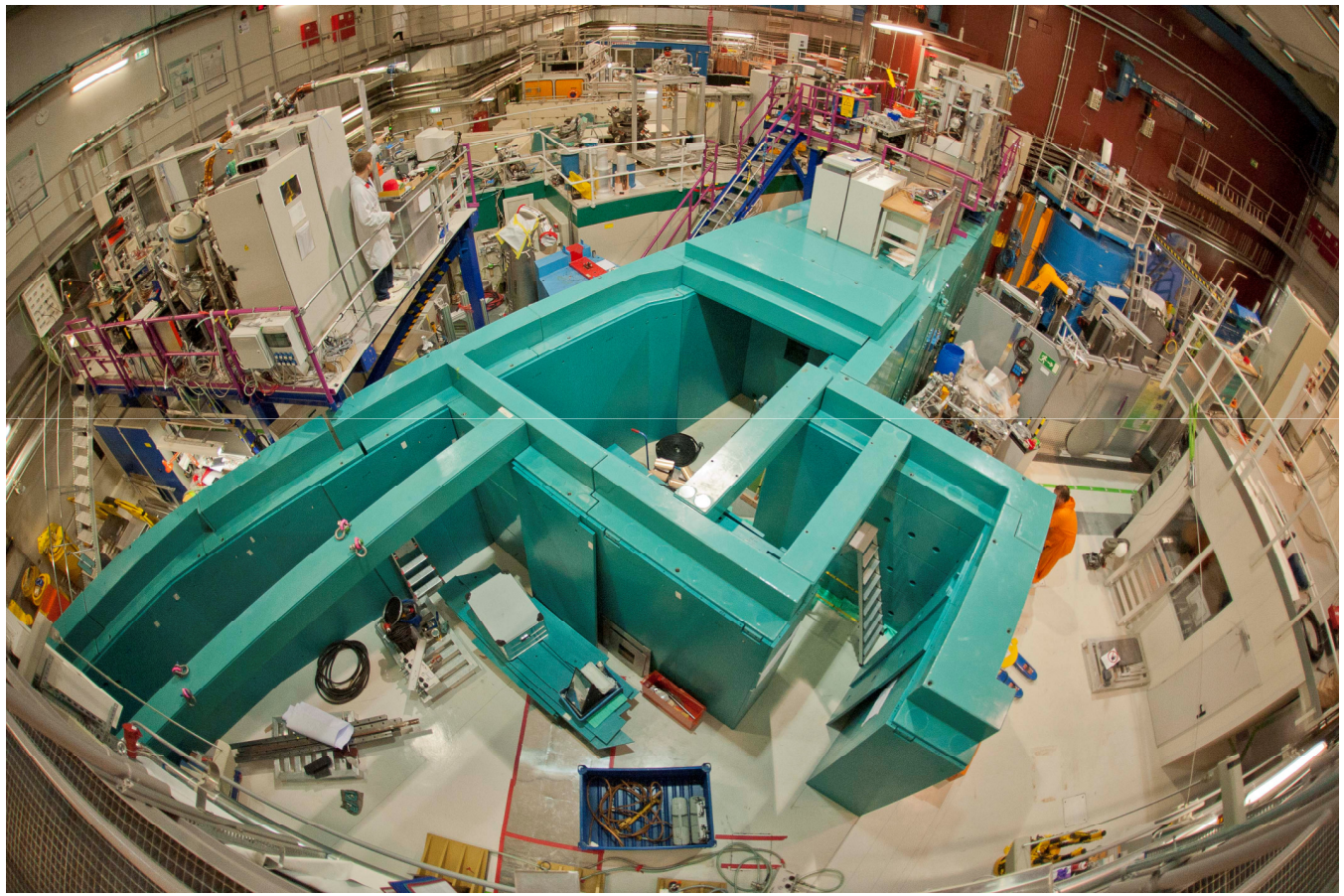
Neutron Radiography

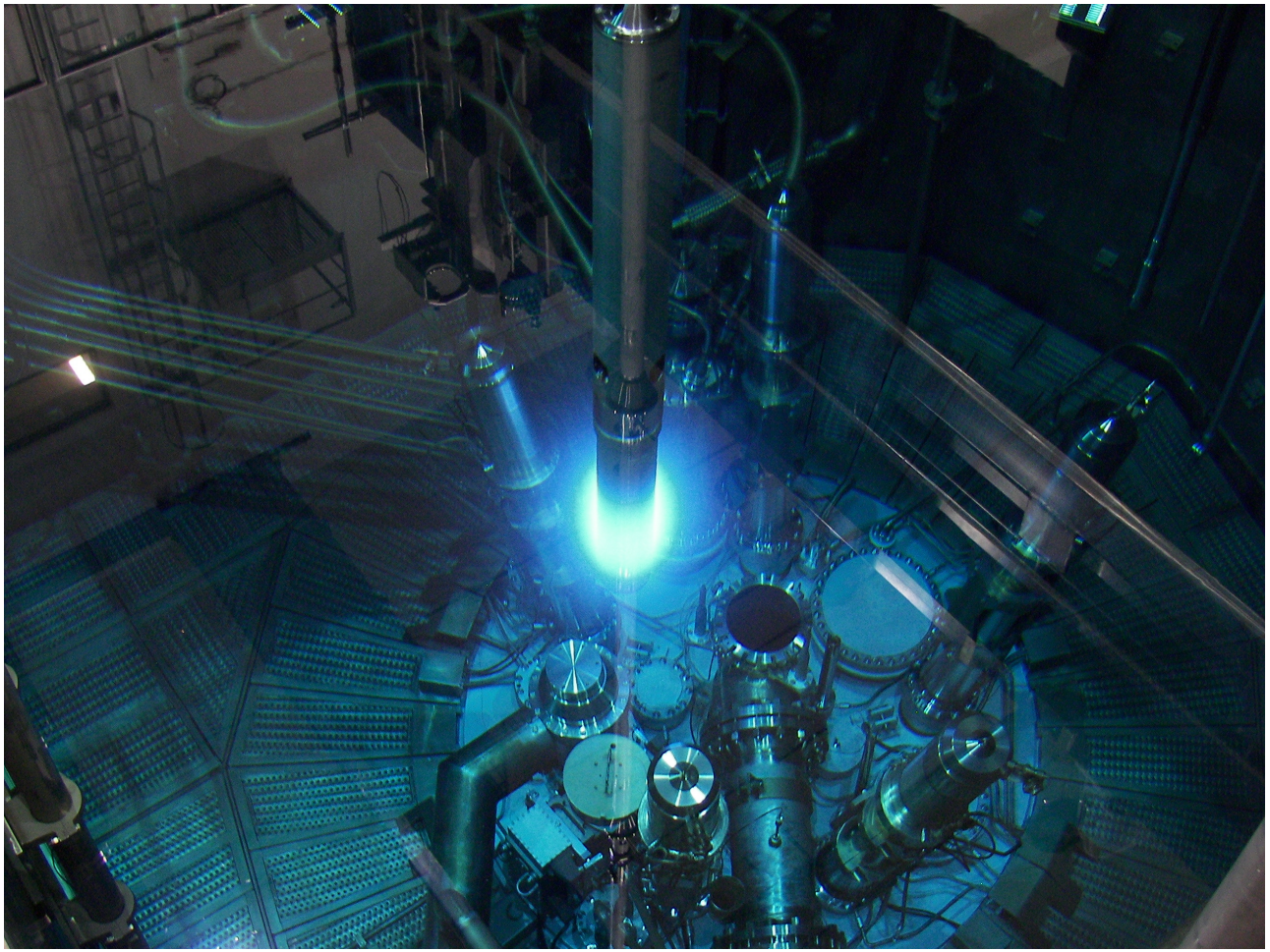
I. Wehmeyer (Ford), B. Schillinger, R. Gilles (FRM II)

One Cylinder Engine - High Resolution Radiography



New ANTARES Facility for Neutron Imaging





Light in the dark....