CORTEX

Core monitoring techniques and experimental validation and demonstration

2nd Cortex Validation Workshop

CORTEX – The AKR-2 in the Cortex project

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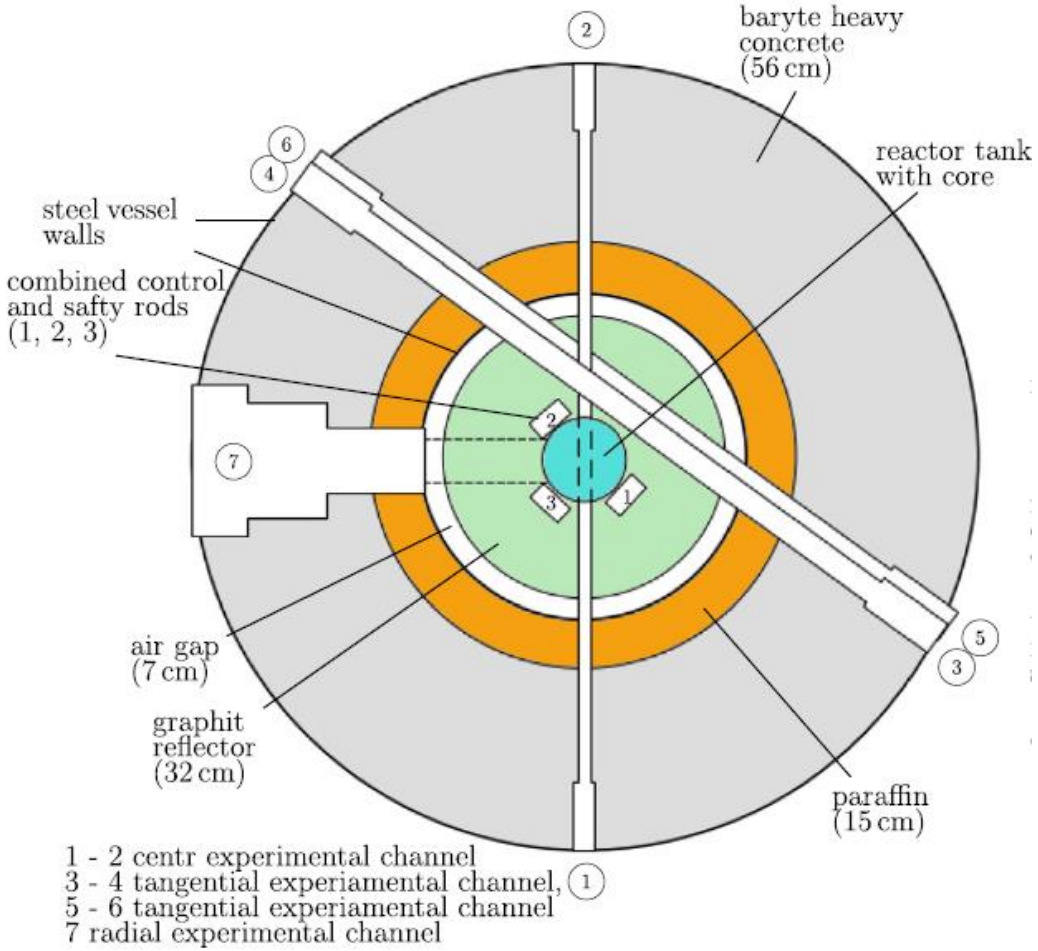
AKR-2

- Description of AKR-2
- Detector setup of the third measurement campaign
- Description of the noise source

The education and training reactor AKR-2

- is a thermal, homogeneous zero power reactor, moderated by polyethylene
- was completely upgraded in 2005
- is equipped with a state-of-the-art digital I&C control system Teleperm XS
- is designed for education in reactor physics, nuclear engineering and radiation protection/dosimetry



(a) Horizontal section at the core level. The horizontal section extends through the horizontal line of symmetry of channel 7, shown by the vertical section on the right (b).

AKR

Diameter:	250 cm
Height:	350 cm
Total Mass:	30 t

Fuel Elements

Diameter:	25 cm
Height:	27 cm
Thickness of fuel plate:	2 to 23 mm
Material:	Uranoxid + Polyethylene
Enrichment:	19.8% U-235

Reflector

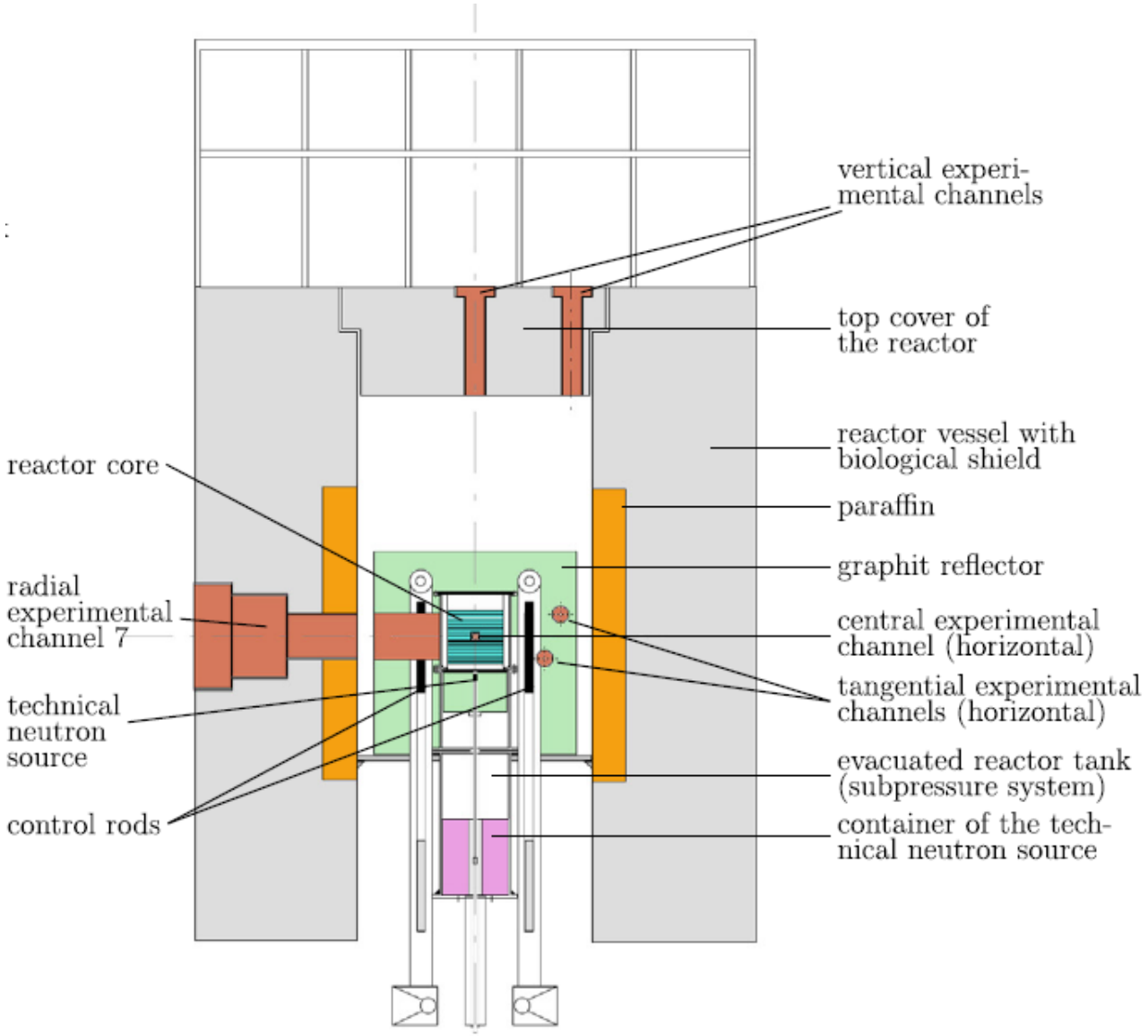
Material:	high purity graphite
Thickness:	32 cm

Neutron Source

Am-Be:	$2.2 \cdot 10^6$ Neutrons n/s

Control

	3 absorber rods
Material:	Cadmium
Reactivity:	0.38 $



(b) Vertical section at the core level.

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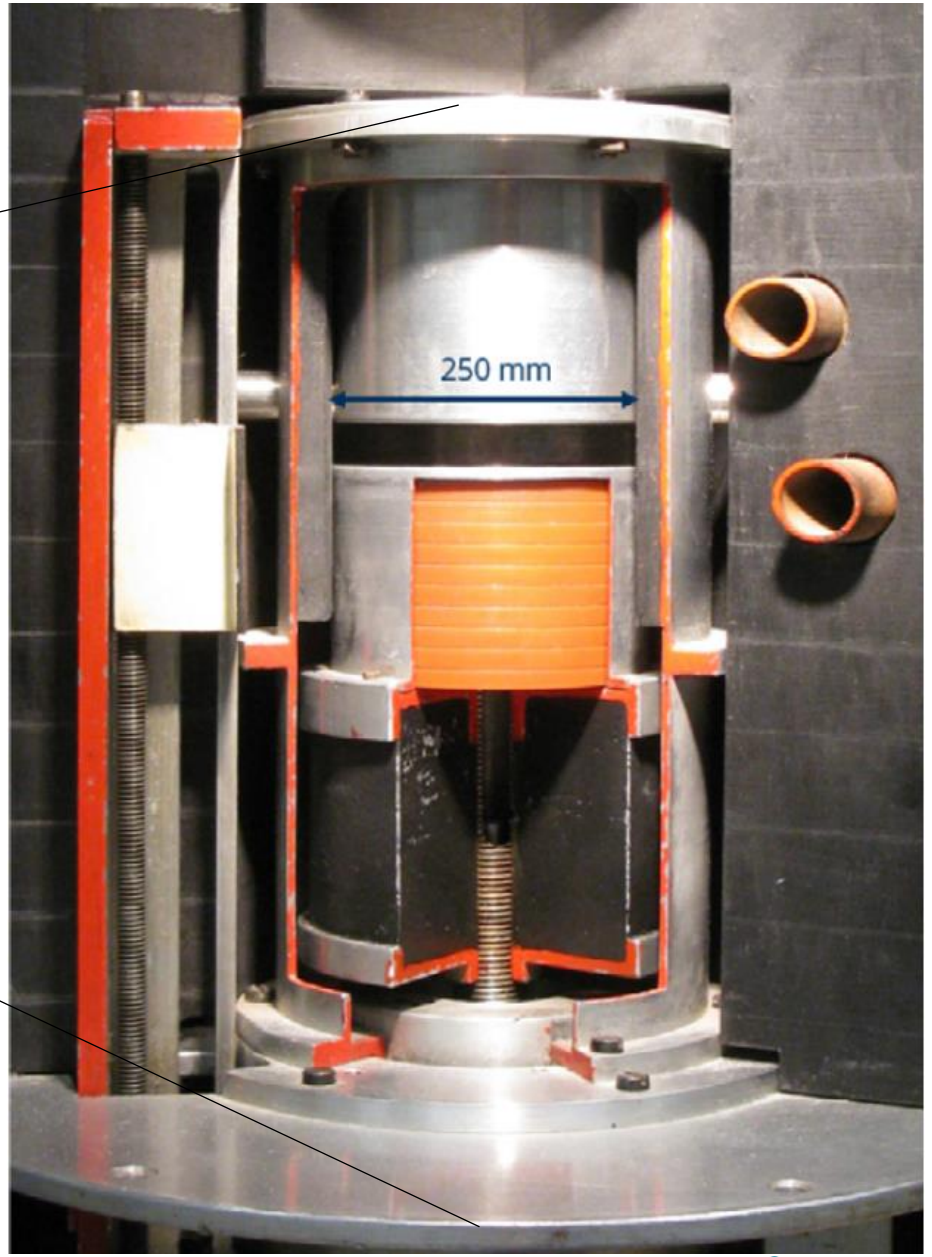
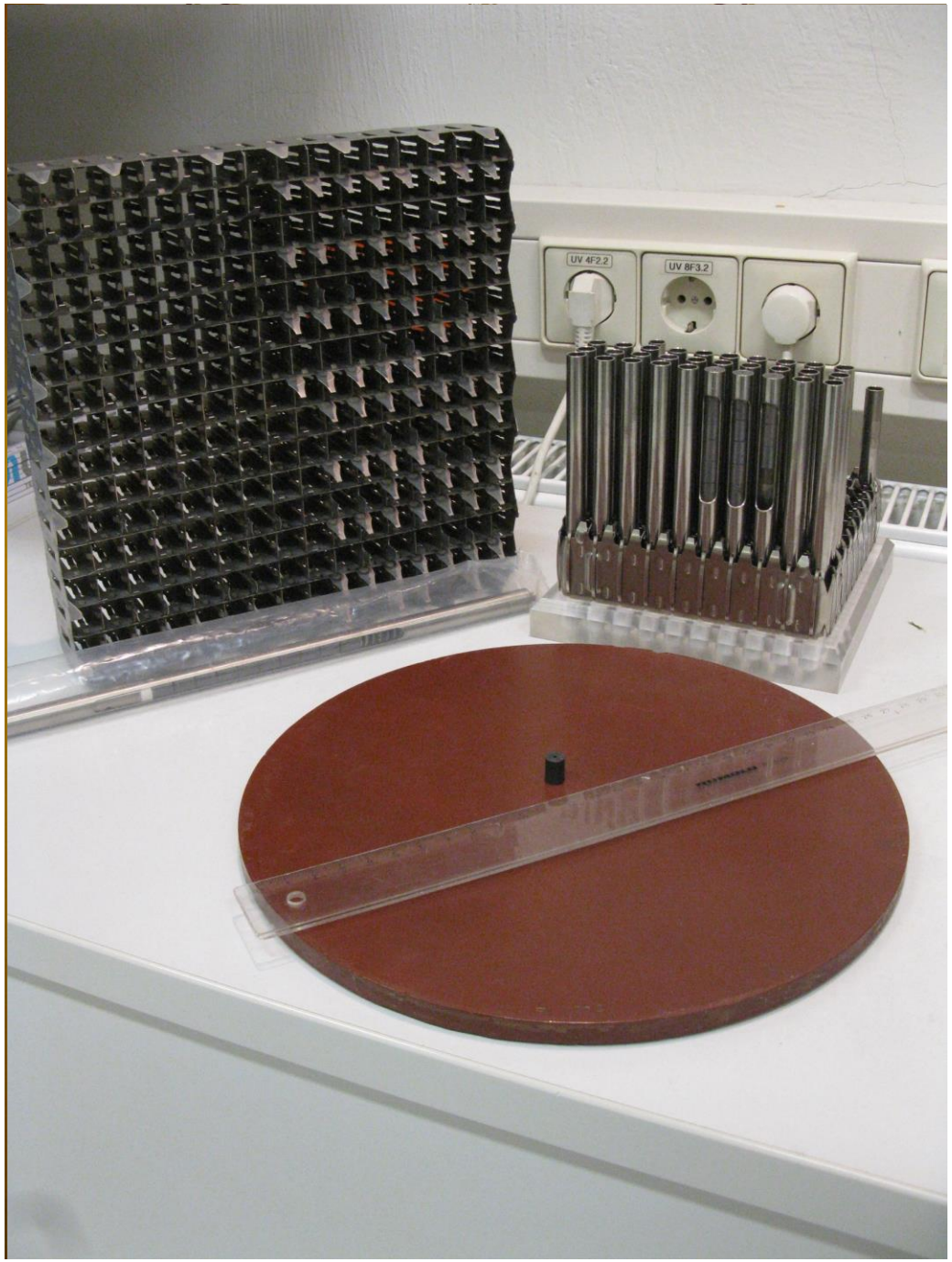
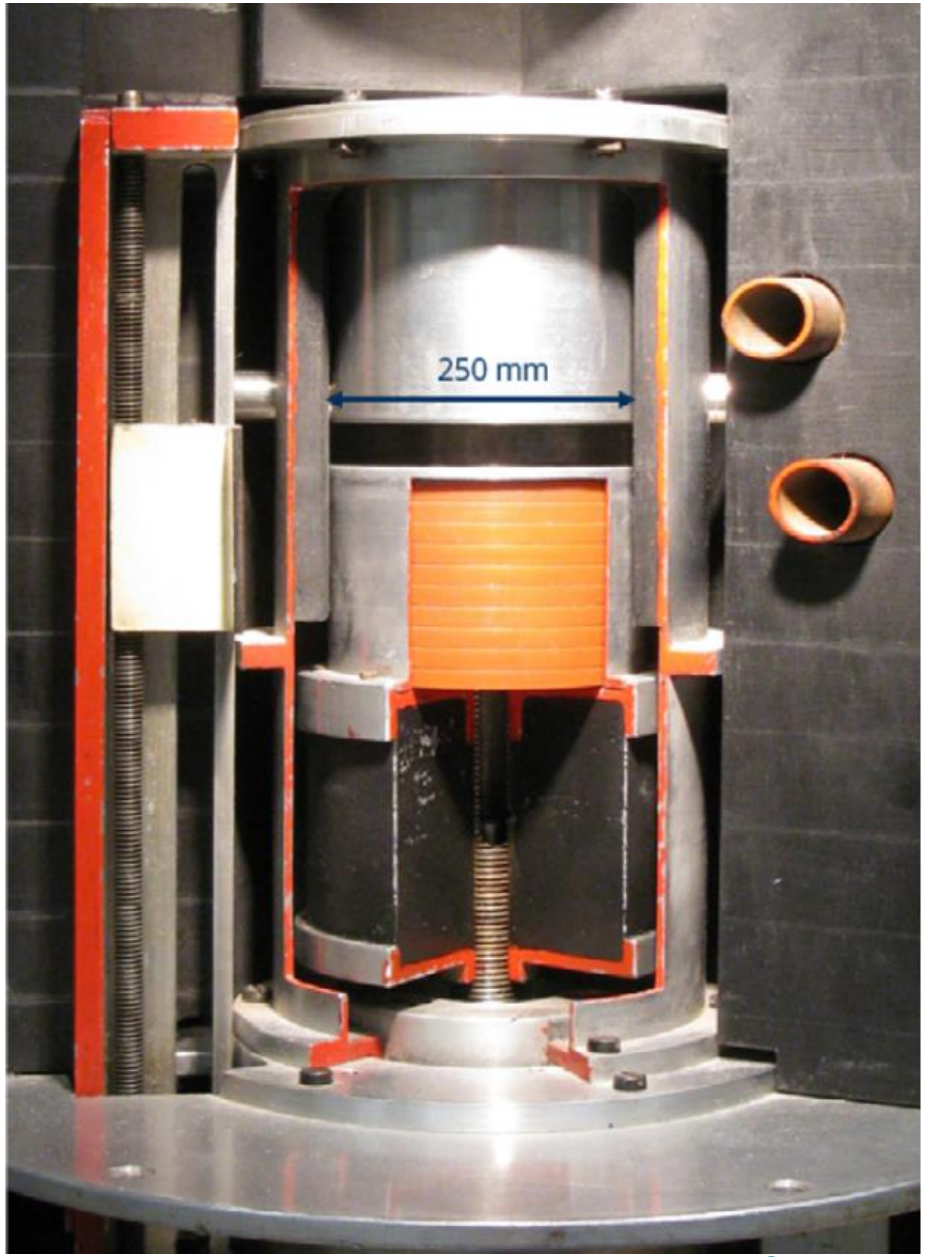
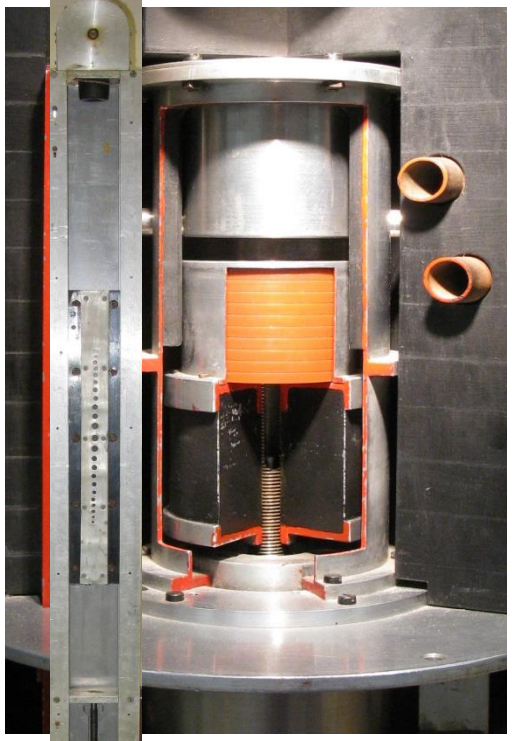

250 mm


UV 4F2.2
UV 8F3.2


250 mm

Design of control rods



Cd is used as absorber

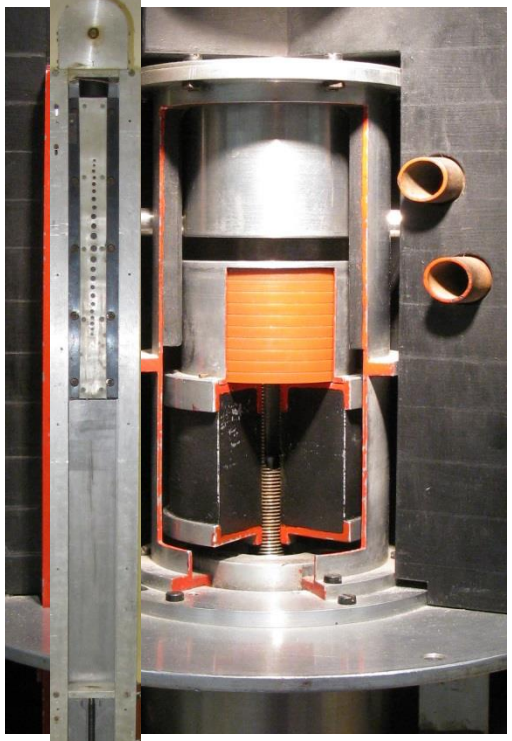
Holding magnet is fixed on spindle

Holding magnet coupled with counterweight

Counterweight

Motor with absolute encoder

Design of control rods



Holding magnet decoupled

Cd is used as absorber

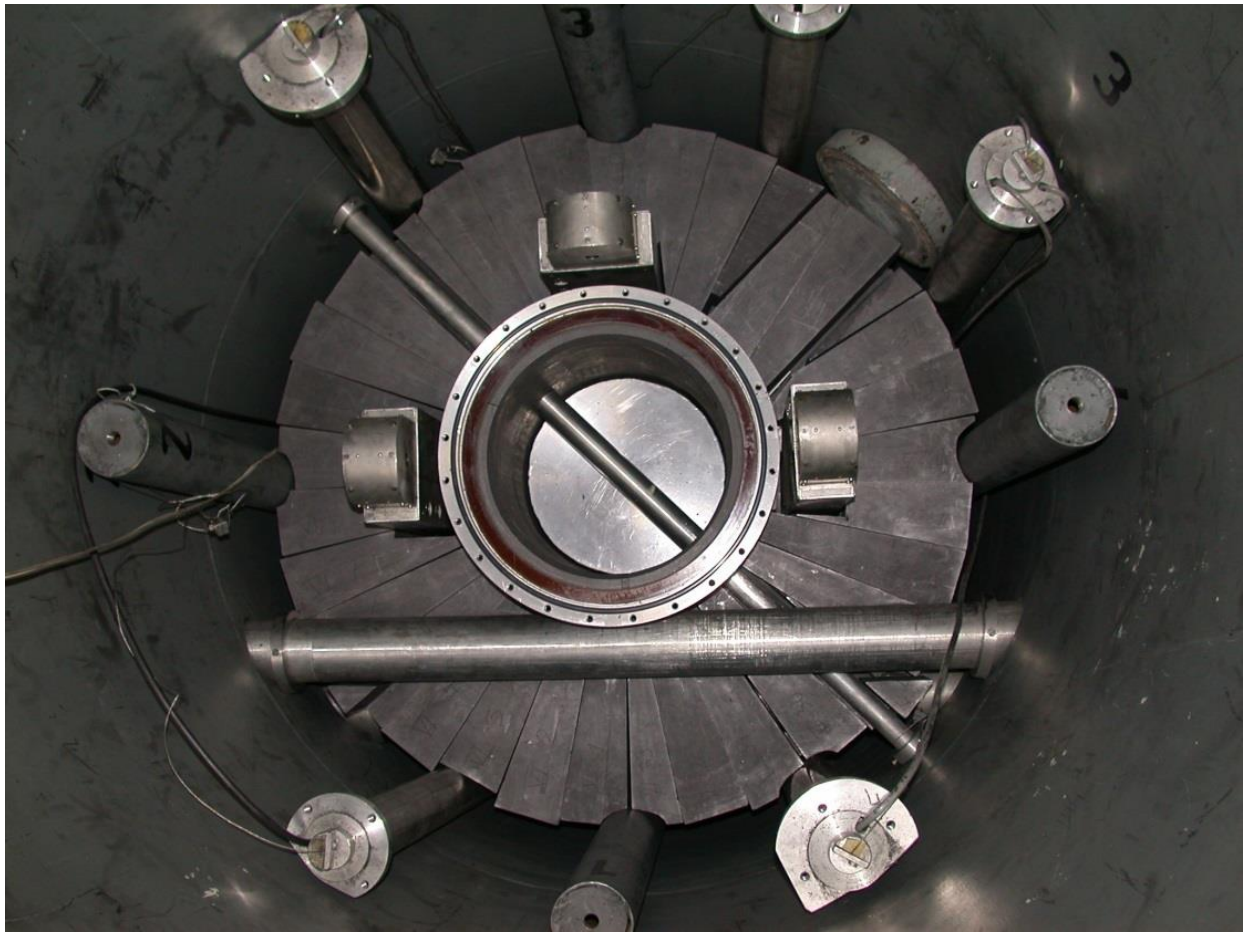
Holding magnet is fixed on spindle

Counterweight

Motor with absolute encoder

Upper core section

Core, reflector, rods, channels, detectors



Some further characteristics of AKR-2

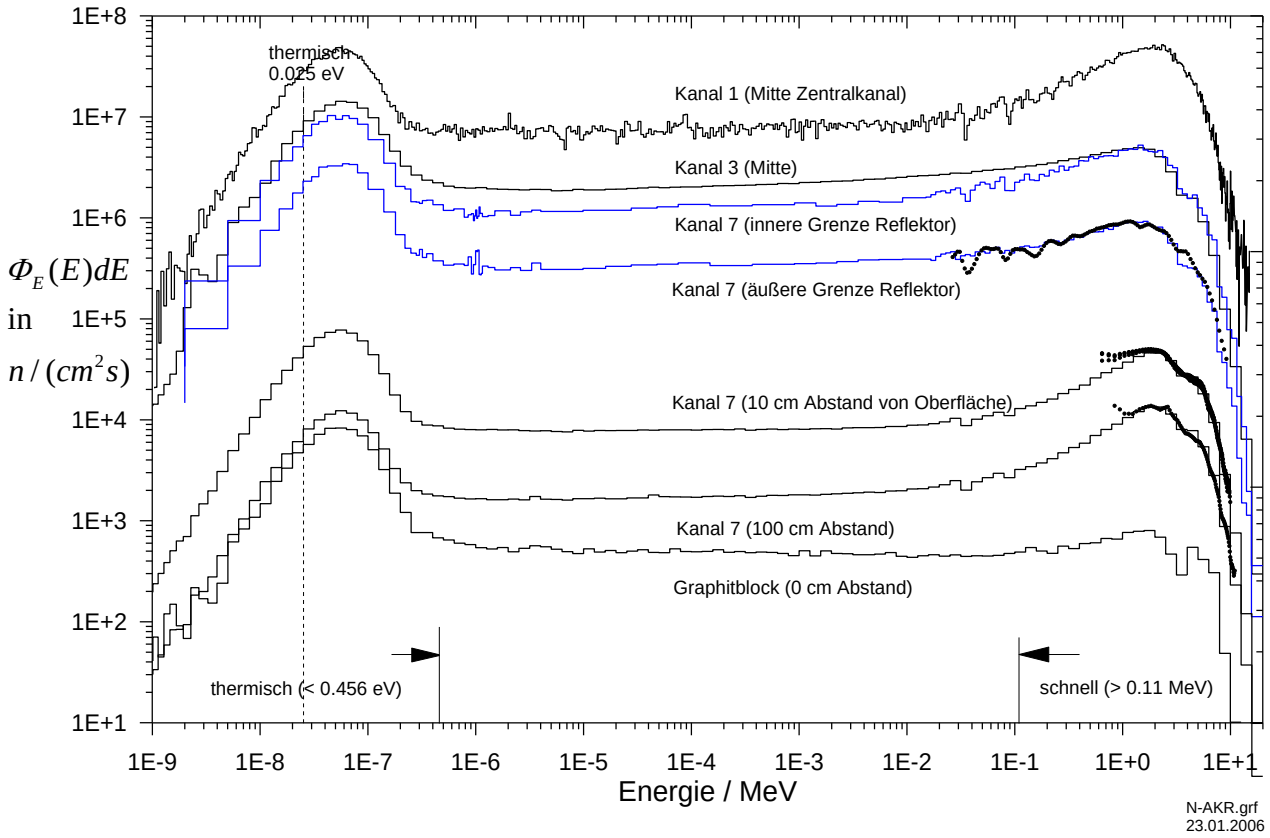
- Critical mass is about 796 g U-235 (enrichment 19,8 % U-235)

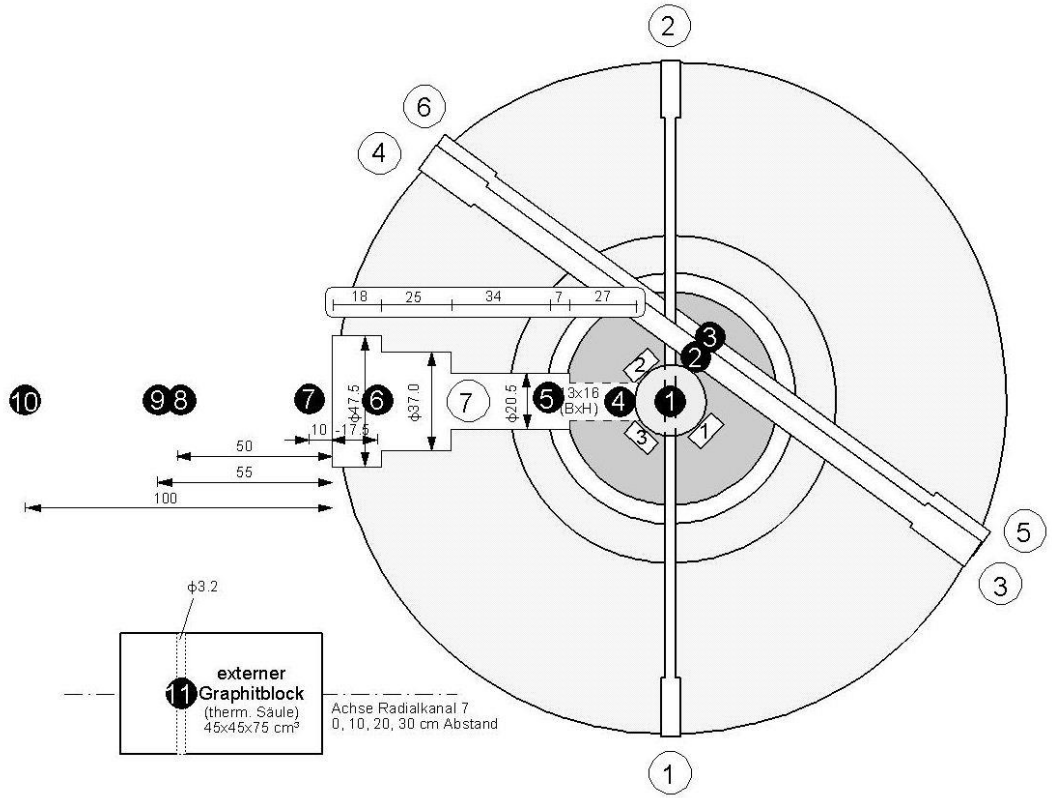
- Excess reactivity is limited → $\Delta k/k$ = 0,3 %
- ⇨ strong absorber cannot be used
- ⇨ prompt supercritical state is physically excluded

- Power effects such as burnup, temperature effects due to operation and Xenon poisening are negligible

- Power excursion is self-limited due to negative fuel-moderator coefficient
- ⇨ - 3 cent/K
- ⇨ temperature of the fuel plates cannot reach the melting point

Some further characteristics of AKR-2





Absolute neutron energy spectrum (2 Watt, MCNP und experiments)

Thermal neutron flux density (core center, 1): $\Phi_{th,max} = 2.7 \cdot 10^7 \ n/\left(cm^2 \cdot s\right)$

Cortex noise sources

Noise sources

Two noise sources are considered for AKR-2:

Absorber of variable strength

Inserts a localized perturbation in the reactor

Vibrating absorber

Models a vibrating perturbation in the reactor

Both can be operated seperatly or at once during experiments to provide validation data for different frequencies and/or locations of the perturbation

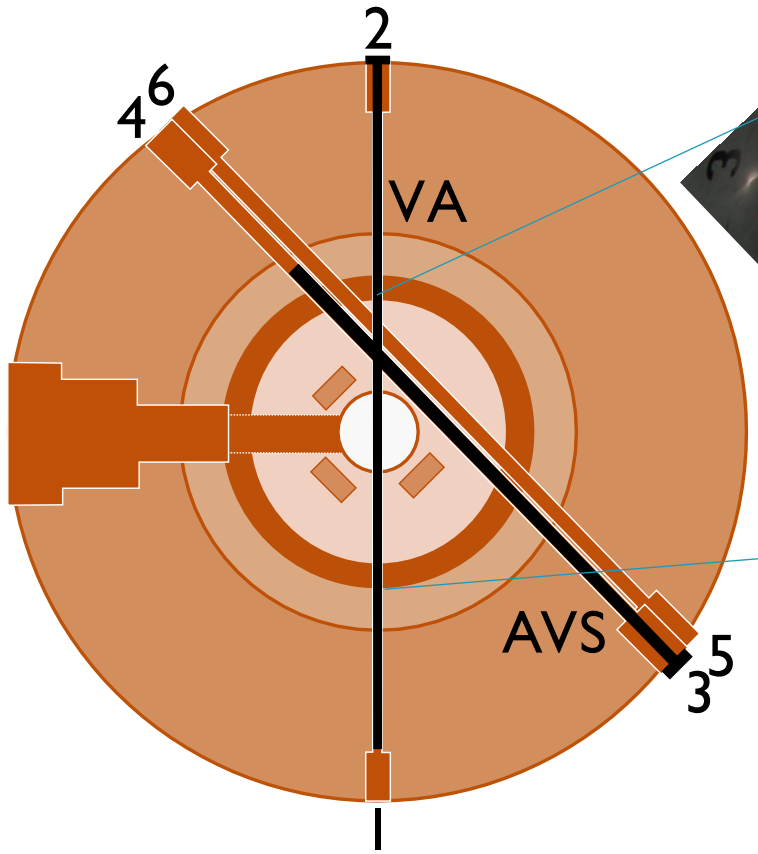
Location of the AKR-2 perturbation devices

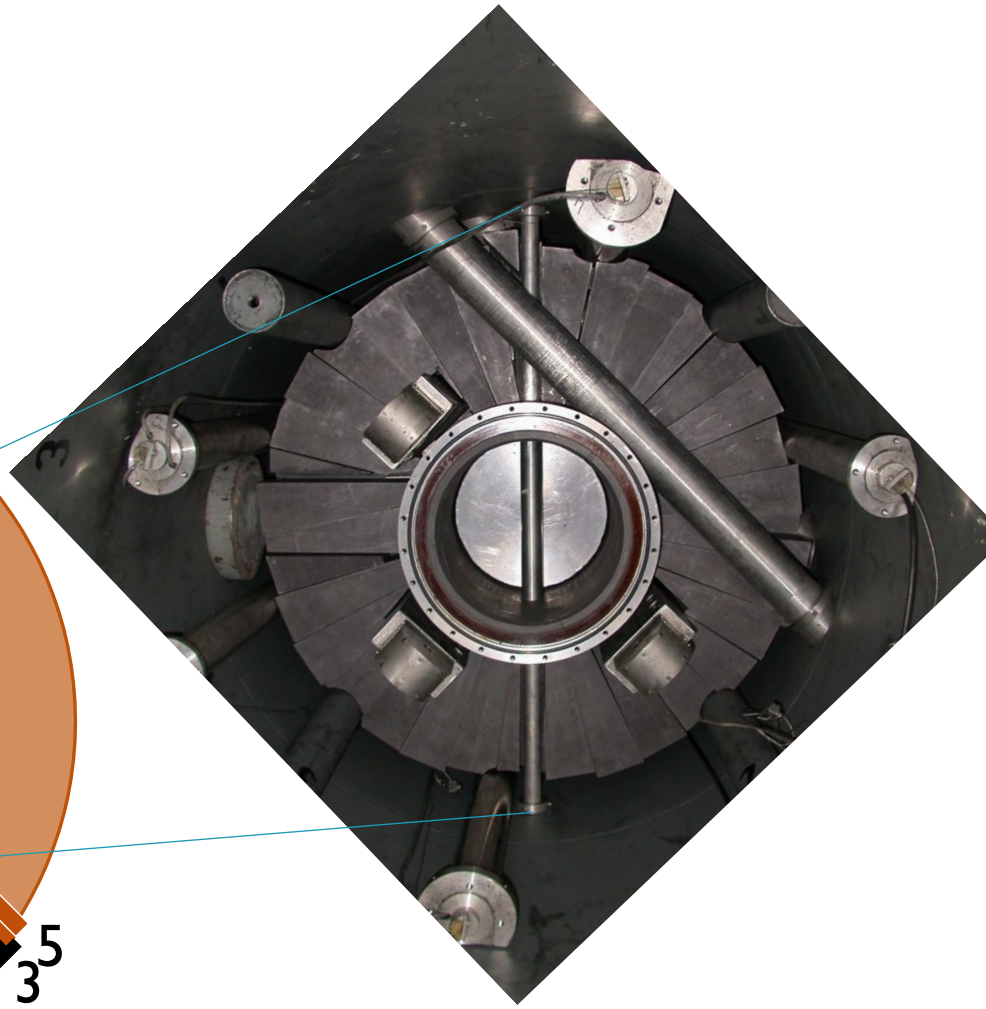
Vibrating absorber (VA)

Inserted into the central channel 1-2

Absorber of variable strength (AVS)

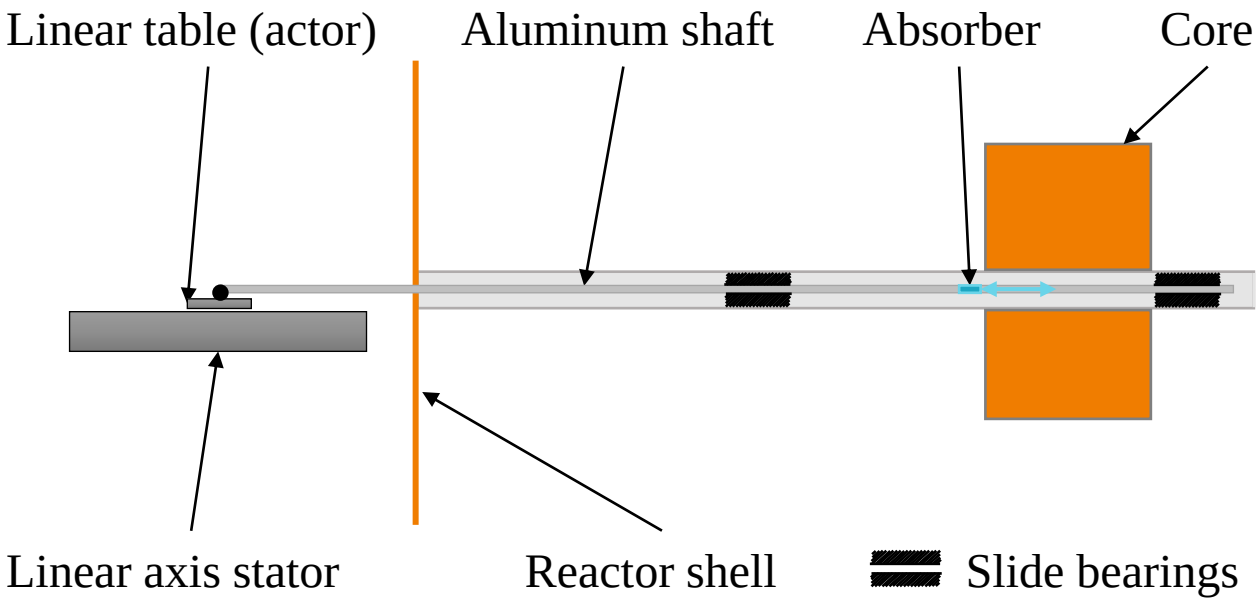
Inserted into one of the tangential channels 3-4 or 5-6



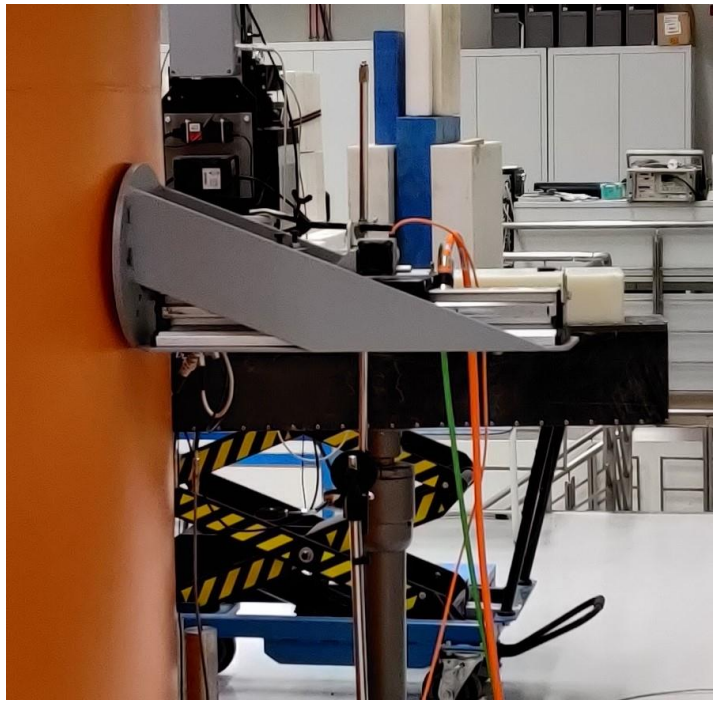


Location of AKR-2 perturbation devices

Vibrating absorber (current setup)



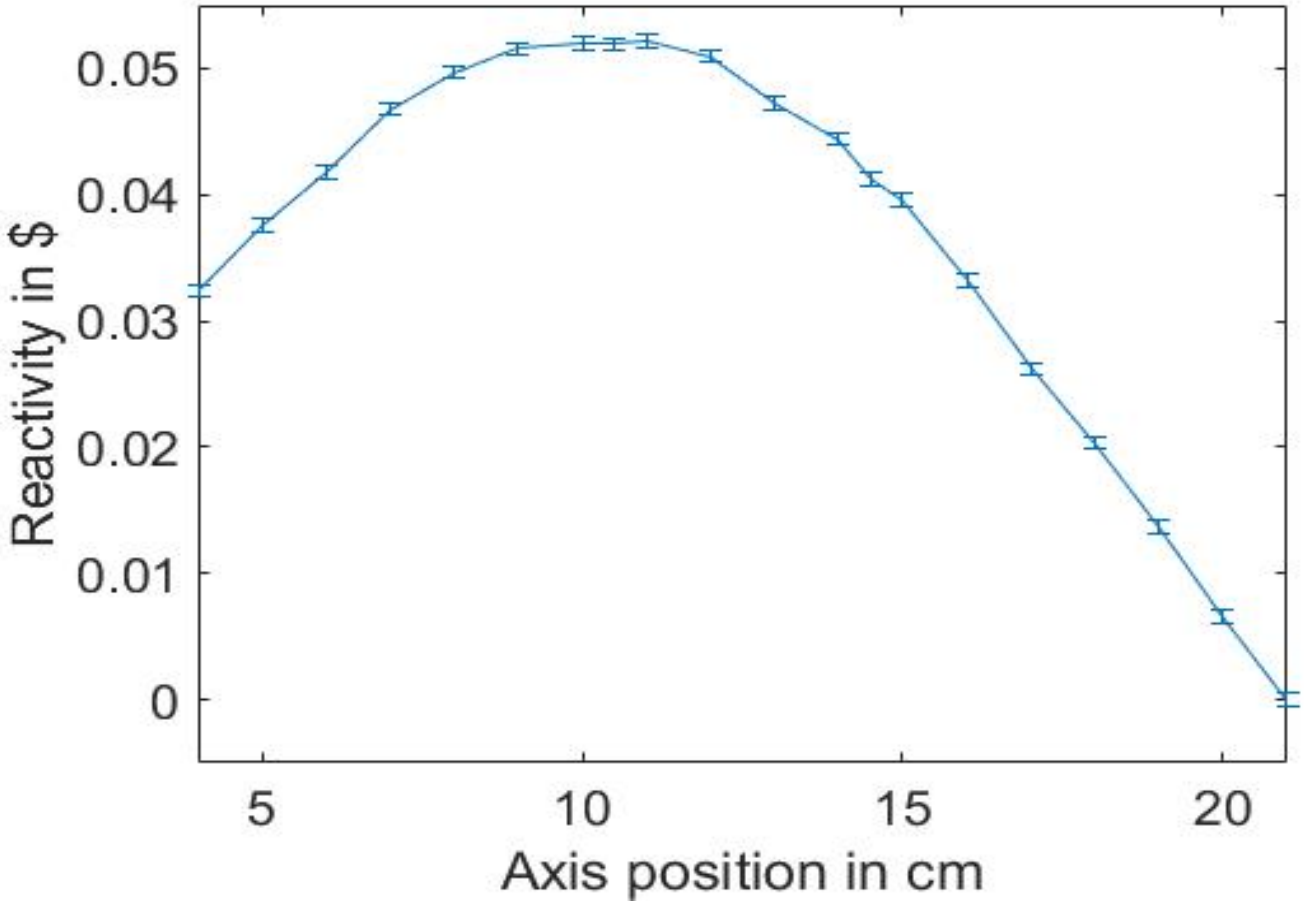
Schematic of the Vibrating absorber



Vibrating absorber mounted to opening 2

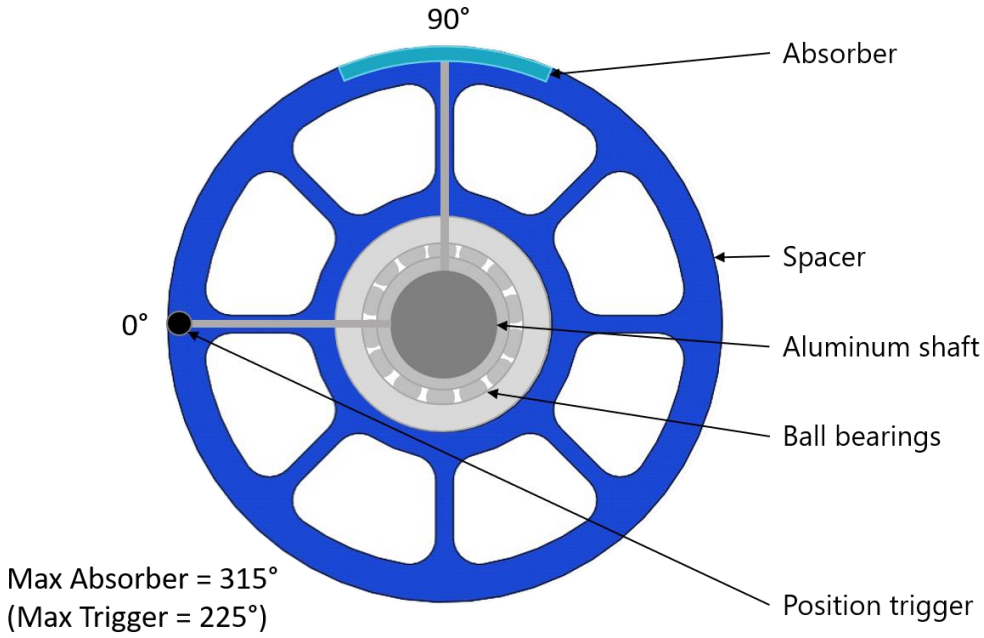
- Realized as a a set of indium foils moving in the experimental channel 1-2
- Driven by a linear motor axis with frequencies 0.01 Hz - 10 Hz

Vibrating absorber (current setup)

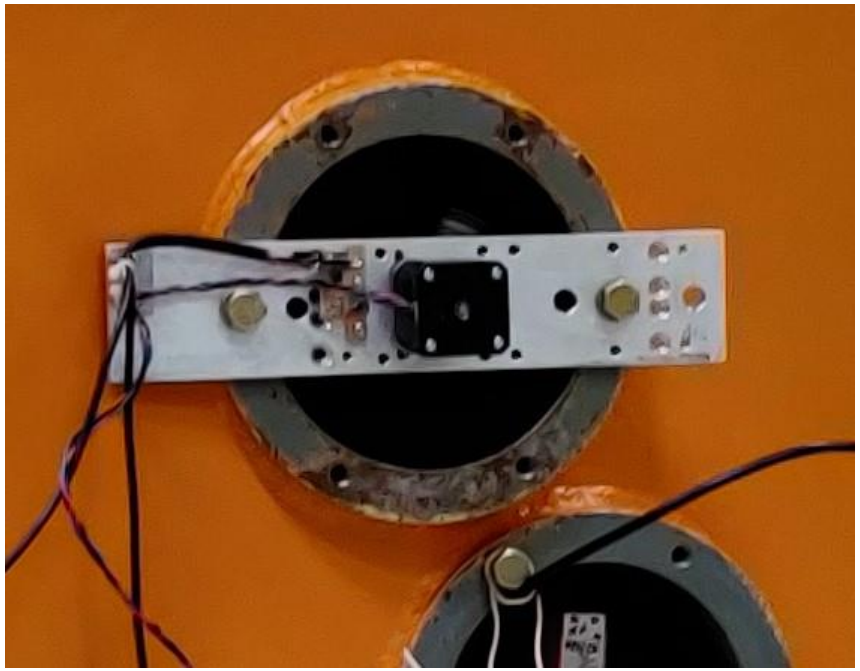


Measured reactivity of VA, center is at 10.5 cm

Absorber of variable strength (current setup)



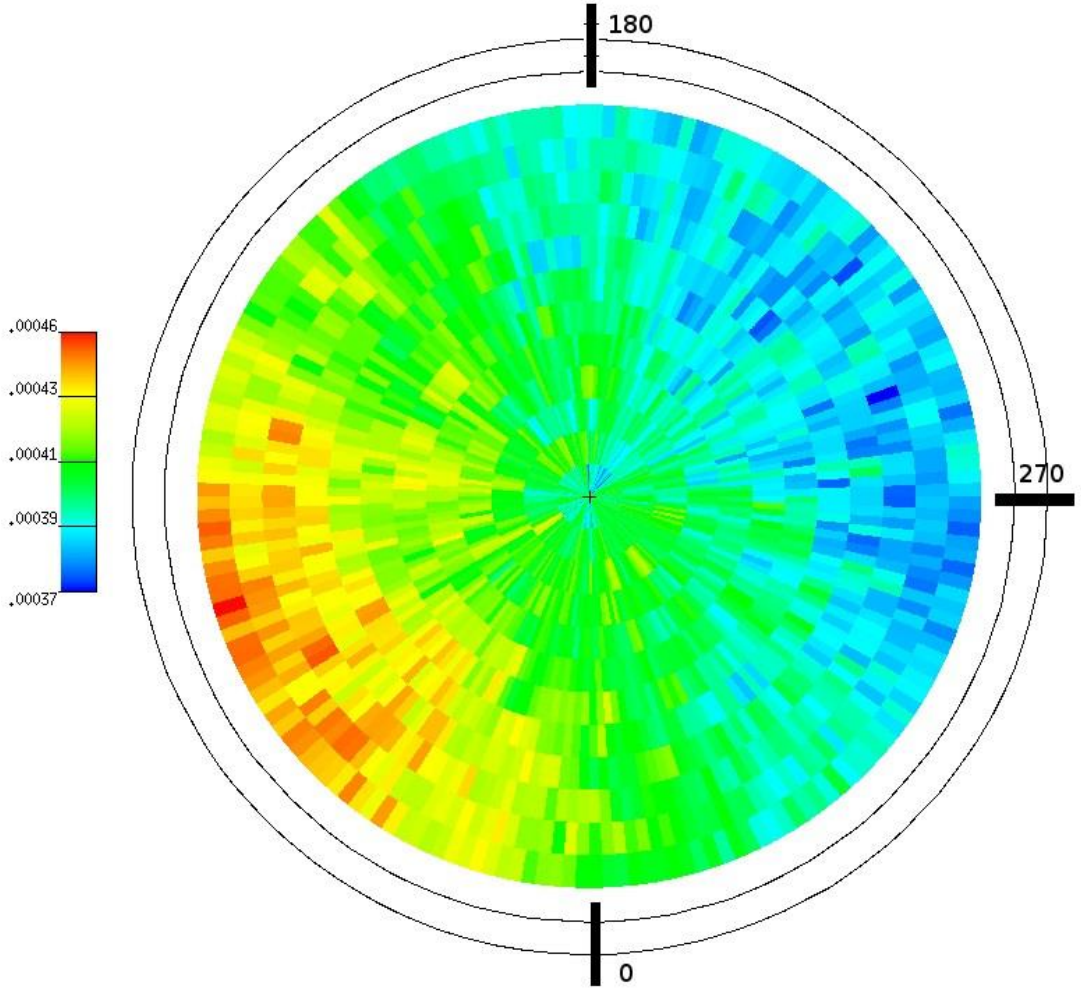
Schematic of absorber of variable strength



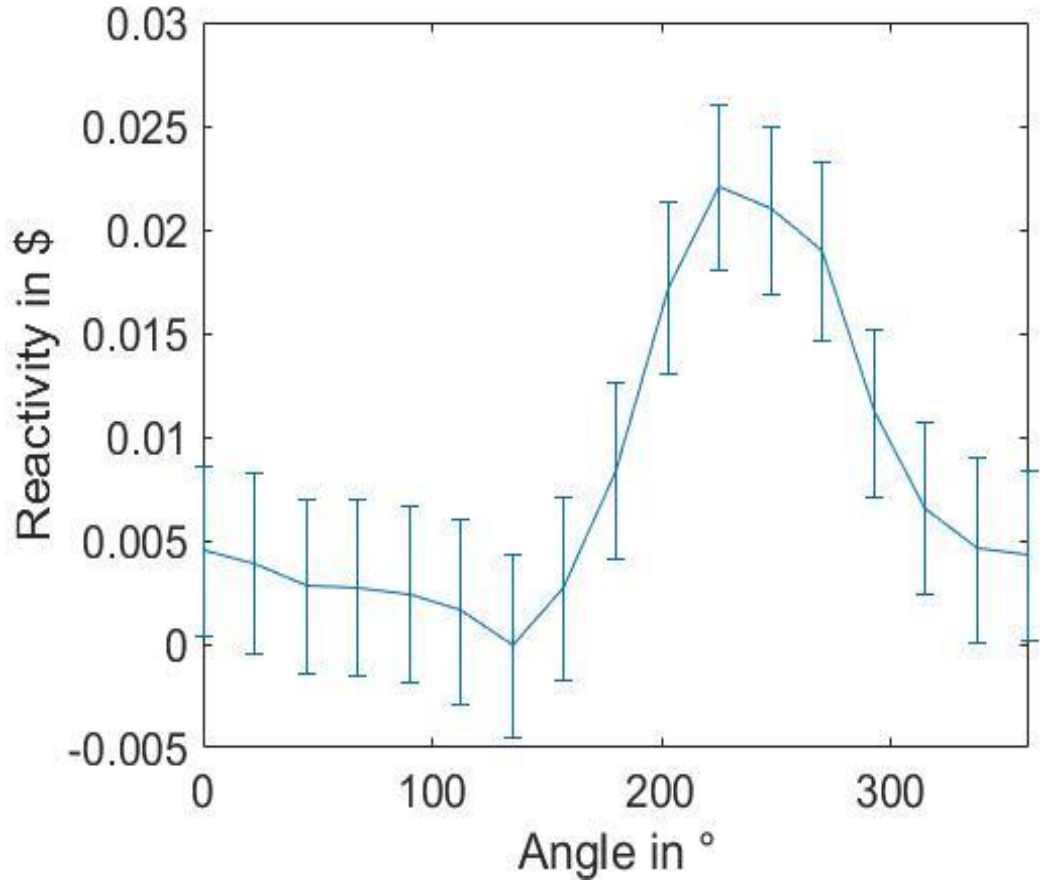
Absorber of variable strength mounted opening 3

- Realized as a cadmium sheet rotating in the experimental channel 3-4
- Driven by a stepper motor with frequencies 0.1 Hz - 15 Hz

Absorber of variable strength



MCNP simulations of the flux in the experimental channels



Measured reactivity of AVS in channel 3-4

Thank you!