# The FRM-II Hot and Cold Neutron Source

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The new research reactor FRM-II of the Technical University of Munich is equipped with a cold and a hot neutron source. These secondary sources shift the thermal neutron energy spectrum in the $D_2O$ moderator to lower and higher energies, respectively providing a broad range for neutron velocities for many different experiments.

The cold neutron source (cns) is a liquid deuterium source. The liquid deuterium (about 2,4 kg) is kept at the boiling point at full reactor power, and the thermal neutrons are moderated to lower energies. The liquid is cooled down to 25 K by a helium refrigerator, which has a max. cooling power of about 6 kWatt.

The hot neutron source (hns) consists of a graphite block (200 mm ∅, 300 mm high) and is thermally insulated with carbon fiber. The graphite block is heated by gamma radiation of the reactor core and increase the energy of thermal neutrons. The temperature inside the graphite block is measured by a purpose-built noise thermometer adapted to the extreme harsh environment conditions (temperature and nuclear radiation).

In the year 2003 and in early 2004 the cold and hot neutron source were installed and successfully tested. Both sources were ready for the nuclear commissioning of the research reactor FRM-II, which started at March 2$^{nd}$ with the first criticality.
From March 2004 to October 2004, the cold and hot neutron source were tested together with the FRM-II reactor at different nuclear power steps (0 – 20 MWatt).

During commissioning the control logic of the cns-refrigerator was optimized to follow every power transients of the FRM-II reactor (power changes and fast shut down).
The hot neutron source were heated up to 2050 °C at 20 MW reactor power, which corresponds to the theoretical calculations for the temperature profile.

The performance of the cold and hot neutron production was determined by measurements at the corresponding external neutron beams.