The Union for Compact Accelerator-driven Neutron Sources (UCANS)

UCANS9

March 28th-31st, 2022

RIKEN, Japan

Online Conference

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RIKEN Accelerator-driven compact Neutron Sources

HBS High Power Density Neutron Target - Design and Experimental Tests

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In recent years, the interest in low energy compact accelerator-driven neutron sources (CANS) has increased worldwide. The focus of this interest is shifting more and more from small university based CANS to powerful high flux CANS that have the potential to replace current reactor based neutron sources and possible alternatives to spallation sources.

Within the framework of the Jülich High Brilliance Neutron Source (HBS) project, a high flux accelerator based neutron source is developed. One of the key components as well as the main power-limiting factor is the target that releases neutrons from the impinging protons via nuclear reactions. Since the neutron yield of nuclear reactions is quite small, this is compensated with a high proton current. However, the high proton current leads to a strong heat release inside the target. At the same time the target has to be very compact to allow the subsequent extraction of a neutron beam with a high brilliance. Overall, this leads to unique requirements of the HBS target given by a 70 MeV pulsed proton beam with a peak current of 100 mA and an average thermal power release of 100 kW inside the target with a surface area of 100 cm^2.

A solid tantalum target prototype with an innovative micro channel water cooling structure was developed, manufactured, and successfully tested to match these requirements. Known problems from low energy targets like blistering, limited heat dissipation and high thermomechanical stresses have been consequently minimized during the development. Feedback from the production process helped to eliminate known weak points of the prototype. The coolant erosion resistance of the micro channel structure was demonstrated in a six-week endurance experiment, to exclude possible concerns on this. Furthermore, the target was successfully high heat flux tested at ~1 kW/cm^2 in the electron beam facility JUDITH 2 and with these measurements the design simulations of the target could be validated. The specifics of the HBS target concept as well as the results of the experimental heat load and erosion tests will be presented.