

## // AFFORDABLE COMPACT ACCELERATOR-DRIVEN NEUTRON SOURCE

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### BACKGROUND

Neutrons are valuable probes to investigate the structure and dynamics of condensed matter, to determine element composition of various items and to perform imaging of engineering materials and processes. We offer an affordable compact accelerator-based neutron source (CANS) that produces neutrons by the nuclear capture reaction between a low energy proton beam and light elements as beryllium or lithium. Depending on the power of the accelerator and the number of target stations and instruments such a source can be compared to small reactor or spallation-based neutron sources. The CANS can be built at reasonable low cost with low maintenance efforts and without nuclear licensing procedure as small accelerator facility for science and industry.

Main features of this CANS can be summarized as follows:

- The CANS consists of a low power proton accelerator (commercial tandetron). The proton beam is hitting a target of beryllium or lithium releasing neutrons which are moderated by thermal or cold (cryogenic) moderators. The moderated neutron beams are transferred by neutron guides and neutron optical devices to corresponding instruments.

Basic parameters of the CANS developed at Forschungszentrum Jülich are:

- 5 MeV electrostatic tandem accelerator producing a pulsed proton beam of 10 MeV at 1 mA peak current and an average power of 400 W
- Beryllium target with peak neutron yield of  $\sim 10^{13} \text{ s}^{-1}$
- Cold and thermal moderators with biological shielding
- Up to 6 neutron channels for serving various instruments as e.g. imaging station, reflectometer, small angle neutron scattering diffractometer, neutron powder diffractometer, prompt gamma neutron activation analysis.
- The costs for the accelerator, target station, neutron moderators and a basic set of instruments are approximately 10 M EUR.

Forschungszentrum provides the technical design and support for the construction of CANS with all relevant components as ion source and accelerator (commercial tandetron), target assembly, moderators, source performance and

### DEVELOPMENT STATUS

Demonstration model

### CATEGORIES

//Materials science and engineering //Surface engineering

customized instrumentation. This CANS allows one to exploit a versatile neutron source with high potential for basic investigations using neutrons in science, education and industry.

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## PROBLEM

Many applications using neutrons are limited by the intensity of the neutron flux and therefore any new generation of neutron source has boosted the development of new instrumentation and applications. With the construction of the ESS (European Spallation Source), the European neutron user community is looking forward to the brightest neutron source worldwide. At the same time there is an ongoing concentration of neutron science to only a few neutron facilities. These “bright lighthouses” serve the needs of a limited number of experienced researchers, but the smaller or medium flux sources used for method development, user recruitment, education, proof-of-principle experiments or bare capacity are vanishing. In addition, the limited possibility to access neutrons offered at nuclear research reactors or accelerator driven spallation sources, which are costly to build and to operate, also presents a severe drawback in using neutrons.

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## SOLUTION

To offer neutrons accessible more easily for science, training, and industrial use is a challenge. The concept of a CANS is a new approach to tackle this challenge with the aim to bring neutrons to the users on demand and in a cost effective way. Such a facility can be operated within the staff constraints of a university or an industrial R&D laboratory and makes neutron scattering accessible beyond existing large-scale neutron facilities.

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## SCOPE OF APPLICATION

Neutron scattering and analytics are important tools to study the properties and chemical composition of various samples and items in all areas of science and technology, e.g. physics, chemistry, biophysics, material science, geology, cultural heritage and medicine. The CANS developed at Forschungszentrum Jülich enables the efficient access to neutrons and thus opens up the opportunity to use neutrons at universities or industry at local or regional level.

