

DANISH CANS Workshop November 2016

WG1: Low-Flux neutron scattering and pre-experiment sample testing for ESS

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The prospects of a Danish Compact Accelerator driven Neutron Sources (CANS) in terms of Danish neutron scattering activities is fascinating. However, there are of course a number of issues that must be addressed, before such a large research infrastructure should be initiated. In relation to neutron scattering experiments, a main concern is the possible signal-to-noise level, flux consideration and possible alternatives as for example additional beamlines at existing and upcoming sources (ESS).

The establishment of a CANS facility at Risø should in any case be considered as an integrated part of the Danish involvement in ESS, and related to the proposed *scientific light houses*, that are presently discussed in terms of funding and integration into Danish research environments.

DANISH CANS

A CANS facility at DTU/Risø should not only be established to make preliminary tests experiments, which are intended to be finalized at large international facilities. Such use of a CANS facility would be unacceptable expensive. Even with a low-flux source, the ambition should be to make true, world leading science. That is required to establish a user community with real impact.

The demand for a Danish CANS facility should be based solely on requirements from Danish users. There must be a group of dedicated scientists within the Danish universities, who will use the CANS facility as one of their primary research tools. Still, however, a success criterion will without doubt be that the facility can attract collaboration with European scientists.

It must be further possible to make measurements in reasonable time. As a goal, one may specify that two weeks of beam-time must be sufficient to acquire data that has sufficient quality to be published in international journals.

A Danish CANS facility would probably be most suited for low-resolution SANS experiments and Imaging experiments. The SANS experiments will likely focus on soft matter systems, which typically have or can be designed to have rather good neutron contrast, and which are available in relative large amounts and stable for many hours or days. Dedicated protein and related structural biophysics research will likely be very limited at a Danish CANS facility, due to the combined lack of high neutron flux and the amount of available and stable samples.

DESIGN REQUIREMENTS FOR A DANISH CANS

The design of CANS facilities are somewhat flexible. It is possible to optimize a CANS facility for rather specific applications, which makes the CANS prospects rather attractive. One may imagine a European or worldwide landscape of CANS facilities, which in combination meets requirements from

wide ranges of research needs. Such flexibility may, however, for a Danish CANS facility lead to some conflict between optimal source design for respectively isotope production and scattering experiments.

Based on experience from existing CANS facilities, it is judged that a pulsed source is probably the best choice if used for scattering and imaging purpose. This statement must, however, be investigated in detail, keeping in mind that today, the best SANS experiments are probably done at continuous sources, i.e. the reactor sources (ILL, NIST, ...). The requirement for a CANS facility to be used for scattering and imaging purpose is first of all low background, i.e. the signal-to-noise ration must be good, and guarantee high-quality data. The flux itself must be high enough to get publishable data in reasonable time, but with a low (and stable) background one can, to some extent, always prolong the data acquisition time.

A criterion for success will be that the facility itself have dedicated researchers using the facility for their in-house research. A science case may be required during the process of fund-raising and initial design, possibly a science case based on one of the ESS-lighthouse projects. Furthermore, the facility must provide technical support in terms of staff members to support users in instrumentation and data acquisition, and necessary infrastructure for handling of data, sample and sample environment.

OPPORTUNITIES FOR A DANISH CANS

A Danish CANS will be attractive for Danish users in terms of fast and easy access.

One may imagine that a Danish CANS can be a relative low-cost source for neutron scattering. Like the DR3 reactor at Risø, where one could argue that the cost for neutron scattering was only marginal, since the reactor was paid for other purpose. A similar situation could exist for a Danish CANS, if the facility would allow for isotope production. The marginal cost for neutron scattering would be reduced since health physics is already available at DTU Nutech at Risø.

A CANS facility in Denmark would not become a competition to the research otherwise performed at ESS or other international high-flux facilities. The possibilities at a Danish CANS would rather be complementary, extending the general use of neutron scattering for materials studies.

ALTERNATIVES TO CANS

One may think of various scenarios for establishing facilities for the neutron community, which would be as good, better or cheaper than a Danish CANS facility.

Europe has still a number of small national neutron sources, based on small research reactors. These facilities could provide easy and quick access if required and decided. But these facilities will likely all be closed within a relative short timeframe. They are therefore no real alternative for the neutron user-community. There may be other new sources coming up. A number of CANS projects exists in Europe. It is unknown, however, how the access to these sources will be in terms of external use for neutron scattering and imaging.

A real alternative could be a Danish “low-cost” multipurpose beamline at ESS, inspired by the Cassiopeia-facility that Denmark has established at the MAX II facility in Lund. At present, there is no opening for such national beamlines at ESS.

FUNDING:

To become a realistic project, it is foreseen that DTU must take the lead in the establishment and future running of the facility. The ministry of research and associated research infrastructure will likely not have the basis for such investment in the next many years. For the establishment of a Danish CANS, funding from Private Foundations is therefore required.

The running costs must initially be based solely on DTU funding, possibly with supplement from the isotope production.

RECOMMENDATION

It is recommended that two cases are studied:

- Linac - pulsed source
- Cyclotron - continuous source

These studies must include detail on costs and performances related to signal-to-noise ratio for two types of instruments, e.g. SANS and Imaging. As a guideline, neutron fluxes for a CANS that are similar to or exceed those of the existing facilities at PSI or Saclay would ensure that a Danish CANS would meet requirements for obtaining publishable data.

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