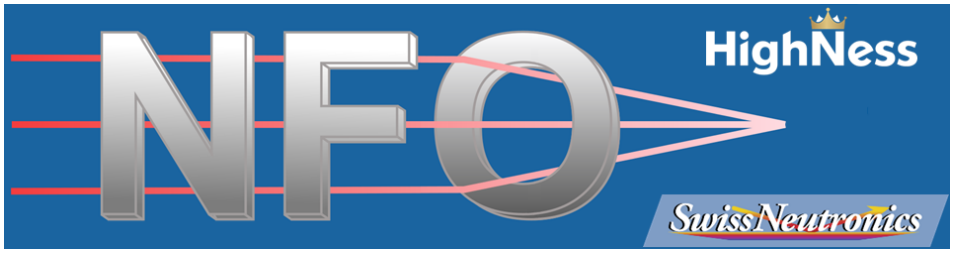

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Towards a Novel Focusing SANS at the MIT Nuclear Reactor for Materials, Energy, and Biology Research

Thursday, 2 March 2023 16:30 (30 minutes)

We propose to build a SANS diffractometer at the MIT Nuclear Reactor (MITR). SANS is a very popular technique for studies of materials with characteristic length scales in the range of 10 - 1000 nm. Unfortunately, all six US SANS diffractometers at national neutron research facilities (at Oak Ridge National Lab and NIST) are severely oversubscribed and require months of waiting time. The beamtime competition will become much worse in the next five years with planned (and possibly unplanned) long outages at both Oak Ridge and NIST facilities, thus crippling projects and making it nearly impossible for graduate students to substantially include SANS methods in their thesis research. Therefore, there is a pressing need for increased SANS capacity.

The 6 MW MITR has been in service since 1958 and has a long and proud tradition of carrying out education and research in the areas of fission engineering, materials, neutron physics, etc. Currently, a primarily neutron-irradiation facility with small confinement building a no cold source, MITR is not ideally suited for hosting SANS. However, there is an opportunity to build a novel SANS instrument at the MITR. Our detailed ray-tracing work points out that the best option is focusing SANS, which is much shorter and faster than traditional SANS. It will use neutron Wolter mirrors developed at MIT. If successful, it will be the first-of-its-kind instrument, potentially leading the way for more compact SANS facilities. Detailed estimates showed the achievable resolution of $Q_{min} \approx 4\times10^{-3-1}$ and the flux on the sample of $2\times10^{4}\mathrm{n/cm^{2}/s}$. This resolution will enable studies of structures with length scales below about 150 nm with typical measurement times of several hours. While this is longer than at national neutron research facilities at ORNL or NIST, such longer measurements are preferable to months of waiting for the beamtime at ORNL or NIST or giving up on critical information that requires SANS.

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