Contribution ID: **116** Type: **Contributed Focus Session Oral Presentation**

High Power Targets and Performance Optimization versus costs or How much shall one pay for a useful neutron?

Tuesday, 20 May 2014 16:20 (25 minutes)

The performance of a spallation neutron source depends on the underlying physics, its engineering and available technologies. However, the realization of a project and the operation of the facility will – in the real world - depend on the financial resources and political support. Funding will only be granted if appropriate sales arguments are given. A fashionable argument is to deliver a high power beam to the target to achieve high neutron fluxes, or better, higher power onto target than the other facilities. An increase of beam power will naturally result in higher neutron production rates of the spallation target. However, at the same time the higher beam power on a target system will impact its lifetime, complexity, downtimes and finally its costs (if its operation and the substitution of components are taken into account).
The second target station at ISIS impressively proved that the high power argument is not the only path to achieve high physics performance. The extensive use of simulations and smart engineering resulted in a high performing low power source which has set standards for future facilities.
Another criterion often used for the comparison of neutron sources is the neutron flux or brightness at the surface of a moderator. Important parts of the sources such as the neutron guide system and the shielding are completely disregarded if such a definition is used. If this criterion would be true ISIS TS2 could never perform well, if compared to existing MW sources. Likewise, using the flux of 'useful neutrons' at an instrument as a measure of performance could be misleading since it disregards background issues.
A fair performance comparison has to take into account all operation aspects, such as availability, background and neutron flux at the instruments sample position, appropriately weighted. With the availability of large computer resources it has become possible to consider all integral parts of a neutron source in simulations – from the target, to moderators, neutron guides, collimation systems and its appropriate shielding for background reduction at the instrument sample position. Hence performance studies of a source using several different figures of merit become possible.
At PSI the target development culminated in the operation of the liquid metal Lead Bismuth eutectic (LBE) target MEGAPIE. During its operation from August until December 2006 its advantage over the standard heavy water cooled target with respect to neutron production was clearly demonstrated, but at the same time also higher background was found. The higher overall costs for the liquid metal target with its ancillary systems together with its larger hazard potential and the lower lifetime finally lead to the decision to continue using the heavy water cooled Cannelloni targets. However, MEGAPIE triggered a re-design of the water cooled target and pushed its performance.
In this talk we will outline the high power target development strategy of PSI and emphasize the need of simulation strategies, encompassing the facilities from the proton beam down to the detectors of the neutron instruments, to achieve the maximum performance under the given physical and economical boundary conditions.

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Session Classification: Focus Session 1: Target Design Challenges

Track Classification: Target Design Challenges