Workshop summary on practical concerns

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The purpose of this session was to provide an opportunity to discuss topics of practical concern in the operation and design of spallation sources. There were five presentations: each addressing a different subject.

Mike Howe (LANL) described, in detail, measurements of dose rates in Experimental Room 1 at LANSCE. The basic difficulty of high dose rates in ER1 when beam is lost in the adjacent proton channel had been mentioned in a previous session at the meeting. This presentation described the detailed investigations to quantify the problem and, thus, enable a practical solution to be developed in providing safe access to the area.

This was, in essence, a shielding experiment that had our two main features of general interest. The health-physics aspects establishes two things: the scale of the hazard in sufficient detail to enable decisions to be made on the control of access to the area; and dosimetry that provides safe working conditions. Standard personal dosimeters were exposed during the experiment to assess how effectively they measured the dose. The neutron spectrum was found to have a very large component of high-energy neutrons and, as a result, the TLD badges, which are insensitive in the high-energy regime, gave a poor measurement of the dose. For this reason a second type of badge using NTA film, which has a better high energy response, is used in addition to the TLD badge when personnel enter ER1. The second feature concerns the measurements themselves, both the techniques and the results. The source was well known—100 mA of 800-MeV protons incident of a copper beam stop—and the shield is a 5-ft.-thick concrete wall. The neutron spectrum, and dose rate, were measured using a variety of detectors and unfolding codes. The experimental data were in good agreement with shielding calculations.

The measurement of dose rates in a pulsed fast neutron field has always been a technical challenge. Mike Howe described a new instrument that has been developed from the "Albatross" detector. The principle of operation is unchanged. Polyethylene is used to moderate the neutrons. A Geiger tube wrapped in silver foil detects the gammas from both thermal neutron capture in silver and the external radiation field. A second Geiger tube wrapped in tin foil detects just the external gammas. Subtracting the two gives the neutron field. The main development has been in the electronics to give a faster response, which allows the instrument to be used in a trip system. It is now fully developed, commercially available, and is a significant advance in dosimetry for pulsed sources.

Recent ISIS target failures, discussed elsewhere at this conference, have highlighted the need to have accurate alignment of a high-intensity beam on a target. The very high prompt radiation levels limit the possible beam-position detectors that can be placed near a target. Alan Carne (RAL) described the approach used at ISIS to monitor the position of the beam as it enters the target. Eight thermocouples are mounted on thermally isolated stainless-steel plates and are positioned symmetrically around the theoretical beam axis, four on a circle of diameter 75 mm and four on a diameter of 85 mm in the tails of the beam. Beam misalignment is then detected as a temperature difference between opposite thermocouples. These data can then be used in graphic displays, to generate warning messages to the operations staff and, if required, trip the accelerator. The principle is to be developed further in future targets by installing a similar arrangement of thermocouples in a special plate about halfway along the target. It is hoped that the external beam-halo monitor and the new internal diagnostic plate will provide a substantial improvement in beam-position monitoring and control, which is vital to improve the lifetime of the targets. It was clear from the discussion that followed the problem of monitoring a high-intensity proton beam near a target is one of common interest and one that presents a serious, and continuing, technical challenge.

Radiation damage is a concern of great importance to high-power spallation sources, particularly for the design of targets and proton-beam windows. Very little information is available to quantify the damage processes in the radiation field around a spallation target, and extrapolation from reactor experiments is subject to quite basic uncertainties. Irradiation testing on crucial components will become an increasing part of the design process. Walt Sommer (LANL) described the irradiation test facilities at the LAMPF beam stop. The LAMPF proton current of 0.8 mA at an energy of 800 MeV makes this facility ideally suited for studies of spallation sources. In fact, experiments were carried out for the SNQ project and are planned to study proton-beam window design for the SINQ facility. Both proton and neutron irradiations can be performed, and there is great flexibility in the physical arrangement and environment of the irradiation samples. Irradiations at elevated temperatures (650°C in the proton capsule and 850°C in the neutron capsule) can be accommodated. A tensile test rig is available that is capable of simulating cyclic stress problems. The general arrangement of the irradiation volumes allows the user great freedom to design equipment to provide special sample conditions. This is an excellent international user facility with peer review for experiments. The use of the protons is parasitic, which eases scheduling problems and reduces the cost of an experiment. Users are responsible for any new experimental equipment required for the sample environment.

The use of equipment at cryogenic temperatures is a common feature of neutron scattering facilities. This includes the sample environments as well as the cold moderators operated or planned at all sources. Moderators present particular problems in that, as well the cryogenic temperatures of the sources (< 100 K), the moderator fluids are also potentially explosive. This combination imposes severe constraints on the designers to ensure the systems are safe to install, commission, operate, and maintain. That the moderators themselves also become radioactive adds further to the design problems. Ken Williamson (LANL) reviewed the safety aspects of designing and operating cryogenic systems. The basic considerations underpinning the design of cryogenic systems and the principal hazards were discussed in detail. Some of the common causes of operational problems were discussed such as inadequate pressure relief and insufficient attention to cool-down stresses. There was a discussion of the administrative and technical systems at the different laboratories for dealing with operational safety matters, which also have an important influence on design.

The topics and the discussion at this session were concerned with quite basic practical problems of operating and designing spallation sources. ICANS presents a unique forum for such discussions and I believe all those present found the session most useful and informative.