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REPORT OF THE WORKSHOP ON SMALL-ANGLE AND REFLECTOMETRY INSTRUMENTS ON FUTURE SPALLATION SOURCES

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This workshop was well attended, with 16 people participating. Most were more involved with small-angle scattering rather than with reflectometry, with the result that most of the discussions emphasized the need for a variety of small-angle capabilities. Furthermore, the discussions frequently assumed the scenario that we were specifying requirements for the initial suite and add-on instruments for SNS. This led to rather conservative requests, with some consideration of practicalities. The consensus was that the initial instruments on one of the new high-power sources should take full advantage of the increased flux, but with minimal technological risk and with only modest improvements of the design specifications compared to current instruments.

GENERAL statements relevant to both Reflectometry and Small-Angle

1. Backgrounds must be kept low, so that the increased count rate will also be an improvement in the signal-to-noise ratio. The use of T_0 choppers was assumed to keep the high-energy pulse away from the sample and detector areas, and the T_0 choppers themselves will have to be heavily shielded. This in itself will preclude the use of "short" flight paths.

2. Detector R&D is essential. We will not be able to handle the anticipated count rates with the detectors we are now using. High speed, low noise, and time stamping are essential. Reflectometers should plan to use 2D position-sensitive detectors for off specular and in-plane scattering. Future designs will require higher resolution (1 mm) than is now being used.

3. Sample areas must be large enough to accommodate a large variety of environment and ancillary equipment. At a minimum, there should be a space of 1 m along the beam direction, a width of 2 m transverse to the beam, and free height from floor to ceiling. It must be possible to work in this area with the neighboring beams on (shutter closed). This requirement and the shielding push the moderator-to-sample distance to at least 10 m.

4. Pulse rate should be 10 Hz. "Conventional" instrument designs that use the entire wavelength band in each pulse require a low repetition rate. This is especially true for the length of instrument (15–20 m) dictated by shielding at the high-power sources. If the pulse rate is any faster, then choppers will have to be used to limit the wavelength band, and the beam power will *not* be fully used.

REFLECTOMETER

1. Minimum reflectivity down to 10^{-7} or better, essentially equal to the best current instruments, must be guaranteed. This requires low background.

2. Horizontal surface geometry is required for the first reflectometer. In addition to liquid interfaces at one or a few fixed angles, a solid sample can be tilted to access higher or lower angles. No one present was aware of any requirements or advantages of vertical surfaces. If the pulse rate is faster than 30 Hz or so, then a "reactor" style instrument with variable beam angle should be considered.

3. Scanning with programmable slits becomes practical at the higher flux rates of the new sources. This is most useful if the entire pattern is measured at once, hence wants low pulse repetition rate.

4. Off-specular and in-plane scattering should be included. These measurements also require that backgrounds be kept low.

5. Today's Clever Idea from Jack: When doing reflectometry at a reactor with variable incident angles, the collimation slits may be adjusted at each setting. At a pulsed source, that can be accomplished by using dynamic slits with actuators driven in synchronization with the pulse in a preprogrammed pattern to optimize at each wavelength.

SMALL-ANGLE SCATTERING

A "utility" machine with $Q_{min} = 0.001$ Å^{-1} should be specified as the first instrument. The majority of users can be served with this minimum Q. With a moderator-to-sample distance of 10 m, pinhole collimation can be used. The collimation should begin inside the bulk shield. (This may require some R&D on radiation damage. The engineering and shielding people must become involved in the project early.)

Wide Q range, $Q_{max} = 10$ Å^{-1}, should be available on the same machine, for simultaneous measurements of phenomena at different length scales. There was considerable discussion about this, and the conclusion was that this feature must be exploited to take full advantage of pulsed sources. In particular, measuring reaction kinetics requires that the entire Q range is determined in a single setting. Several problems must be considered. Low backgrounds are essential, and the method will work best for samples with low incoherent scattering. A moveable detector provides a selection of dynamic ranges (not the full range at once), but covers the situation of the interesting region falling between two detector banks. If wide-angle detector banks are used, the optimum sample geometry is cylindrical instead of flat samples. If the wavelength band is used to extend the Q range, then the sample thickness appropriate for short wavelengths produces too much multiple scattering at long wavelengths. Dynamic slits should be investigated here also.

VLQD. Very-Low-Q Diffractometers should be considered for the second tiers of instruments at the new sources. Perhaps because several in the group are involved with designing an instrument with an ellipsoidal mirror, or perhaps because that is the best idea now available for a VLQD, such an instrument was proposed (see article by Hjelm *et al.* in these proceedings). The time scale allows for the considerable R&D effort needed to learn how to fabricate the mirror.