Workshop summary on high power targets and target assembly developments

A. Carne
Rutherford-Appleton Laboratory
Chilton, Nr Didcot, Oxon
UNITED KINGDOM

There were four presentations in this session under the broad heading of High Power Targets and Target Assembly Developments.

The first paper was from Andrew Taylor (RAL) proposing upgrades to some of the ISIS moderators following several years' running experience and feedback from the instrument users. The ISIS target assembly was based on the best obtainable specification at the time, where 'best' in my book means optimum match between physics requirements and engineering realities, giving also good operational reliability and maintainability. Operating experience now suggests modifications to some moderators to give improvements mainly to pulse shape, resulting in improved resolution. These are, in descending order of priority but increasing order of technical difficulty :

i) Change poison depth in front H_2O moderator
ii) Modify reflector to open up to second face of H_2-moderator (CRISP)
iii) Change poison depth in CH_4 moderator (subject to agreement of HRPD, LAD, MARI, TEST).

The question was raised of using H_2 instead of CH_4 for the front cold moderator, iii) above. It was pointed out that with hydrogen densities of 0.06 in liquid CH_4 and 0.042 in liquid H_2, a better pulse shape and resolution were obtainable from liquid CH_4. We shall return to this point again.

The second paper was from Trevor Lucas (RAL/LANSCE) on a possible mixed solid CH_4-in-liquid H_2 moderator at 20K. This represents a fun challenge to cryogenics engineers and some first-shot thermodynamics calculations looked reasonable (e.g. 3 mm CH_4 pellets in liquid H_2, pellet centre temperature ~ 50K at ISIS-type energies). However there remain several tricky problems on pellet formation, the risk of clogging, the difficulty of pumping the "slurry" with a high density of CH_4, and the size of the operational device.

But just how good is this slurry neutronically? For example, if the pellet centres are at 50K and the liquid hydrogen at 25K, what is the spectral temperature of the mix? Even with 60% CH_4 in the mix (as in the thermodynamics example) the average hydrogen density is only about 25% greater than liquid hydrogen. At what percentage mix does the gain justify the engineering complexities? Is CH_4 soluble in H_2? Why not add Krypton to make the methane lattice bigger and "unfreeze" the rotational modes? Krypton is also in natural poison when used this way.

In the discussions on this topic there were two offers of help : the first in the best tradition of ICANS, where Gary Russell offered to model a CH_4/H_2 moderator to determine the neutron output spectrum as a function of the ratio of CH_4 to H_2; and the second with our new colleagues from reactor sources, where Colin West (ANS at ORNL) offered the use of a cryogenic test-bed for slurry moderator testing.

The third paper was from Noboru Watanabe (KEK) who reviewed the efficiency of accelerator based cold neutron sources, with the goal of achieving an efficiency comparable with the ILL cold source. Efficiency here is defined as

$$\int_\lambda \phi_c(\lambda)d\lambda/n_f$$

A fully decoupled high power moderator, like ISIS, has an efficiency ~ 6 x 10^{-5} compared with 3 x 10^{-4} for the ILL cold source. With such large differences accelerator based cold sources are not competitive, especially in the important area of SAS. How can accelerator based sources be improved?

One possibility to improve on the pulsed source performance would be to follow the intensity modulated source practice proposed at SNQ, i.e. to use a decoupled moderator and exploit both the bandwidth and time structure. KENS-II may have such a moderator, in addition to short pulse moderators, but its competitiveness depends crucially on the gain that might be achieved from exploiting the time structure. Ideally KENS-II would like an efficiency 10X that of ILL. There were, however, worries whether such a gain might be achievable.

Other features of an SAS instrument include :

resolution obtainable with a beamline about 30 m long; long tails to the neutron pulses might be removed by the use of phased choppers; the use of focusing guides is being considered. The performance of SAS instruments would benefit from a p.r.f. lower than 50 Hz: one case, at least, to support the contention raised at the Conference of the value of a very low (~ 1 Hz!) p.r.f.

The final paper was from Gary Russell (LANCSE) on the TMRS upgrade. The present LANCSE TMRS is an elegant flux trap target system with 4 moderators in "slab" geometry located between the upper and lower target tungsten blocks. It can be upgraded by opening up the upper reflector to add two more moderators and so provide perhaps four more beamlines into the new experimental hall.

There are several geometric possibilities for the two new moderators, beyond the initial thought of having them in wing configuration : the moderators could be in slab in the same plane as the upper target block, or they could be in slab and slightly above the upper target block to operate as flux trap moderator in a similar way to the present moderators. The suggestion was raised that the upper target block itself might be of slab type (as was proposed for the SNQ target) to improve the solid angle coupling to the moderators, especially in wing geometry. "Tuning" of the target lengths was done on the original assembly and clearly it would be worthwhile to do this again. LANSCE is fortunate to have such computing resources to make such studies!

To the question of what materials for the moderators, the first thoughts were for one water moderator and one liquid methane. The choice will depend on user demand. On ISIS we were fortunate to have at a quite early stage a clear specification of moderator types, canvassed from the user requirements. I offer the recommendation of a similar canvassing exercise for the LANSCE upgrade in order to clear the way for the necessary technical developments.

A good meeting, some interesting challenges and some good examples of collaboration within and beyond ICANS!