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Summary on the session:

New Concepts in Target–Reflector–Moderator Systems

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The two sessions held under this general topic started out with an interesting presentation by S. Sidorkin on the progress and concept of the neutron target station of the Moscow Meson Factory (MMF) in Troitsk. The 100 Hz, 1 GeV linac designed for a proton current of 1 mA time average is nearing completion and acceleration has been successful up to an energy of 200 MeV. The linac will be equipped with a versatile stretcher–compressor ring which will allow a multitude of different operating modes of the neutron targets. Two targets are embedded in a common shielding block, one of them designed for short pulse operation, the other one for high average flux intensity modulated operation. The first target will be equipped with an H_2O ambient and an H_2 cold moderator whereas the second target will reside in a big D_2O tank and have a large D_2–cold moderator associated to it. The facility will also include an irradiation position in the target block upstream of the neutron targets which can be used for isotopes production and materials testing. Operation is expected to start in 1992 with full performance in 1994.

In the second contribution, Ian Thorson gave his views on the question whether one could simultaneously satisfy users who want pulsed neutrons and those for whom integral flux is what counts. He reminded us that, depending on the moderator material one uses, the spatial distribution of the slowing–down neutrons and that of the thermalized neutrons may either be quite similar, like in H_2O or differ considerably in low absorption moderators like D_2O or Be. A very extended spatial distribution of slowing down neutrons is obtained in the heavier materials such as Pb or Ni. His point is that, even at thermal energies there is always a more or less large component of slowing–down neutrons which are just entering the thermal regime and hence are more concentrated in space and time than those which are in thermal equilibrium with the moderator. His conclusion is that, if the primary fast neutron source has a sufficiently short pulse structure, one can indeed satisfy both, pulsed and integrated flux demands, if one is prepared to use additional momentum space shaping devices in the beam where necessary.

The presentation by Noburo Watanabe on the target–moderator–reflector concept for KENS–II was another proof of his total dedication to overall performance. Using the results which Dr. Kyanagi had presented in the session on cold moderators, KENS–II will have vertical injection from underneath (like SINQ) into a system of split targets (as developed for LANSCE), one of which is decoupled from its moderators whereas the other one is coupled (similar to the situation at MMF). A very clever pulse delivery management between the two targets and the muon facility will complement an optimized geometry and instrument allocation to squeeze out another order of magnitude in performance over what would be obtained from a conventional arrangement with the same proton beam power.

This set the stage for Mike Holding's discussion of the experience at RAL with the clad uranium target under the operating conditions of a medium power proton beam. To date, five uranium targets have been exhausted at ISIS with a varying number of pulses and total μA–hours. So far, no clear picture of the lifetime limiting key component has evolved, but also manufacturing

processes have not been exactly identical for the targets used so far. RAL is now on the way to go about this very systematically. One thing, which seems to be an important message to all of us who want to use materials under high load conditions is, that we will have to acquaint ourselves with the concepts of quality assurance.

In all following talks, even if not explicitly stated, quality assurance could somehow be sensed as being of prime importance. This became obvious, when Gary Russell introduced his LANSCE–repair programme by saying that the leak that had developed in their hydrogen moderator was probably due to a certain lack of care in the manufacturing. Now, as usual, Gary wants to take advantage of the fact that they have to go through all the trouble of removing the heavy binding magnet and top shield to fix also a few other problems they have encountered. One of them is the so called "target shine": If the beam channel walls outside the bulk shield can see parts of the target's surface, then one has to deal with direct high energy neutron radiation in that area. This may require a lot of bulky shielding. Gary hopes to cure this problem by opening up the gap between the two halfs of his split target, which he finds will not have a serious effect on the intensity from the flux trap moderators but could help the background radiation.

Most of the rest of the session covered by this summary was devoted to the liquid material target development at PSI. Yasushi Takeda gave an impressive account on his progress in the experimental investigation of the flow configuration in naturally circulating liquid lead–bismuth. Thanks to his work we now have a quite good idea on how the flow develops at the onset of heat input and what its distribution in the target is.

These investigations are complemented by a variety of other experiments, tests and calculations on which Martin Dubs reported. From this work we can now conclude that under standard operating conditions and in certain fault conditions which have to be considered, a liquid lead–bismuth target and its beam entrance window are feasible. The goal has not quite been reached yet, but the way to go can be seen. Nevertheless, it is felt to be prudent to develop a solid target in parallel to the liquid one, even if this is not a concept on which one would hope to build and go much further. Preliminary calculations indicate that there will be a range of operating parameters in terms of ball diameter and coolant flow velocity for a lead–shot pebble bed target, which can tolerate fault conditions resulting in a beam current density up to ten times higher than anticipated under standard operating conditions.

In any case, as we move towards higher and higher beam power, radioactivity not only on the target will become more and more of a problem. In that sense, Dr. Tonaka's presentations on his remote handling provisions in the new PS–experimental hall at KEK helped to round off the overall picture. It was impressive to see what can be done in terms of shortening necessary access times for removal of components from a radioactive environment if sufficient thought is given to the problem ahead of time. This is probably the price we all have to pay if we want to move towards higher source strength.

Barring details, the session made it very clear that quality assurance and early attention to handling and maintenance problems will be the key to a satisfactory performance of high power targets.