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TARGET-MODERATOR-SYSTEM: TARGET CONCEPTS

D. Filges
Forschungszentrum Jülich GmbH, Institut für Kernphysik, D-52425 Jülich, Germany

There were nine presentations in this session under the broad heading of "Target-Moderator System: Target Concepts".

The first two papers were from G. Bauer (PSI) proposing Mercury (Hg) as a new challenge for liquid metal target material for pulsed spallation sources. The desirable properties for high power spallation target materials were summarized. Mercury looks good compared to Tantalum and Tungsten the discussed "standard" target materials. The nuclear physics-, material-, and chemical properties show clearly the advantage of Mercury. It was demonstrated that the material HT9 (low Ni content) is useful to maintain the strength for the target container up to 400 °C. A problem is the pressure and the resulting stress on the target container using liquid metal as target material for high power pulsed targets. A simple simulation model was used to calculate the time dependent stress level on the surface of the target container as a function of time. A solution to lower the stress levels by two orders of magnitude to tolerable levels by adding 3% He gas to the liquid Mercury was shown. The question was raised on potential cavitation and corrision problems, which should be studied immediately for the pressure and temperature in question.

The third paper was from J. Lettry (CERN) about development and operation experience on ISOLDE molten metal targets. The target materials were liquid Lanthanum, Tin and Lead in Tantalum target containers. The targets were driven with protons at 1 GeV energy with about 1.5 to 2.2 x 10^{13} protons per pulse at temperatures of 1250 °C, 750 °C and 830 °C respectively. After initial difficulties with the integrity of the containers at high pulse power the containers and the proton beam windows now are still operational after a dose of about 2 x 10^{18} protons.

The original pulse structure (2.4 μs pulse length) clearly caused pressure waves in the targets. However, after changing the extraction mode from the four rings of the CERN PS-Booster to a separation time of 500 μs (total effective pulse length 2ms) the target container of Tantalum showed no damage after this dose of 2.2 x 10^{18} protons.

The fourth paper given by J.H. Rosenfeld (Thermacore Inc.) reviewed the use of heat pipes for cooling Lead-Bismuth liquid metal targets for SINQ and ESS. The advantage of heat pipes is to transfer large amounts of heat with little temperature drop and the safety aspect. For SINQ 8 heat pipes and for ESS about 40 heat pipes are needed. A design for SINQ is about 80% complete and can be converted easily for ESS.

The fifth paper was from B. Guttek (KFA) reporting the studies on the ESS Tantalum target-moderator-reflector system as a stationary target with 4 moderators and 18 beam tubes. Different cooling concepts were studied. He cooling for 1 MW beam at 5 bar Helium pressure

and with 2 cooling circuits was studied. He cooling for 1 MW beam at 5 bar Helium pressure and for 2 MW at 10 bar Helium pressure seems to be feasible. At higher beam power (5 MW) H_20/D_20 cooling is demanded. The adaption of the Tantalum target dimensions to those of the ESS Mercury target was demonstrated.

The sixth paper was given by T. Broome (RAL) on the performance of ISIS targets and Methane moderators. The used Tantalum target gives no significant problem in operation. The main reason for removing the first Tantalum target was to make it available for material studies as part of the ESS studies. It is planned to dismantle this target and make detailed examinations of the condition of the tantalum. The Uranium targets used upto now failed by swelling and many of the target plates buckled. The discussion about Uranium target failure came to the conclusion that there is a growth of the Uranium grains during the proton irradiation, however, to start with smaller grains implies that this is not the dominant process leading to failure. It seems that the effect of Hydrogen in both Zircaloy and Uranium is to form hydrides and this causes embrittlement. The future use of Uranium targets at ISIS depends on establishing the detailed cause of failure. The Methane moderators still suffer from effects of irradiation which lead to the production of hydrogen gas and formation of solids in the moderator can. The minimum lifetime should be 500 mA/h. A development programm is underway concentrating on two main topics, the fluid regime in the moderator and the irradiation chemistry of the methane. There is some indication that the formation of the hydrocarbons which lead to the blockage could well be reduced by the addition of chemical agents. The chemistry is based of the recombination of free radicals in ethane-methane systems.

The seventh and eighth papers were from our Russian colleagues V.G. Miroshnichenko (INR) and S.F. Sidorkin (INR) proposing multiplying targets with Ga-cooling and concepts of Uranium targets for the Moscow meson factory. Concepts for Tungsten targets as an alternative were also diccussed. The multiplying target RIN-10 is designed as a fast critical assembly with uranium nitride fuel and liquid Ga-cooling having a $k_{eff} < 0.95$. The question was raised about the critically safety of those target systems and the licensing in Western Europe of a spallation facility using multiplying targets. A good overview about different possible Uranium alloys was given. Target characteristics for various fuel compositions (e.g. for W, U-233, U-235, Pu-239) are also studied. The performance of the RIN-10 neutron source compared to ESS was discussed. Fuel elements on the basis of U_3Si with natural Uranium and Tungsten and other main components for the RIN-10 facility have already been manufactured.

The final paper was from K. Ziegler (HMI) about FFAG-accelerator options for spallation sources. The status of the FFAG-evaluation and physics studies was reported. The main problem is the technical experience with a proton FFAG; an electron machine worked very well. In general a FFAG design looks very promising, however, there are still problems in the design with the injection and extraction scheme.

A good session, some interesting challenges with Mercury as target material for high power pulsed target systems beyond 1 MW beam power relating to safety, cooling and nuclear physics; great progress in the engineering of stationary 5 MW beam power target systems, but nevertheless there are open problems concerning damage, lifetime, stress waves and corrosion questions.