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The SINQ Solid State Target: Lessons learned from a Recent Target Failure and the Experience Gained from an Improved Target Design

The continuous wave spallation source, SINQ, has been in operation for 28 years. The proton beam power was gradually increased over the past decades, up to nearly 1.0 MW. The D2O-cooled Pb/Zr-based 'cannelloni'-type solid state targets have proven to be very reliable, and underwent several design improvements over time in order to maximize the neutron yield. The strategy to use solid state targets, which are periodically replaced every two years, appeared to be highly successful, yielding in a 96% annual availability of the facility averaged over the past 20 years.

However, in 2016 an unexpected failure of target #11 occurred, forcing us to replace it thereafter. The premature end of the target was caused by extensive damage of many target rods and large amounts of molten lead blocking the cooling paths between the rods, as revealed by PIE. It should be emphasized that during the incident, all inventory was contained safely inside the target, the primary cooling loop and its filters. No radioactivity was released from SINQ.

Thereafter, the design of the SINQ target was significantly altered. In addition, the capabilities to accurately monitor the proton beam position on the target and the temperatures within the target were enhanced. The newly designed target has been in operation successfully since 2018.

We also introduced some sample rods with different Pb filling in the most thermally stressed area of the target and exposed them to the proton beam for two years. Afterwards, we performed tomography of the highly radioactive rods. The tomographic dataset reveals a strong re-distribution of the lead filling inside the irradiated Zircaloy tube.

This presentation will give an overview of the improved target design since the last target failure, including an elaborate temperature survey system in the hottest target region. We also present some results of the tomography of the re-distributed lead in one of the sample rods coming from this region.

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