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Outcome of the Post-Irradiation Examination of the baseline design prototype target and Nb-cladding R&D for the Beam Dump Facility (BDF) at CERN

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The Beam Dump Facility (BDF) and the SHiP experiment [1] have been selected to investigate hidden sector physics at CERN's ECN3 experimental cavern starting in 2030. To produce feebly interacting particles via a fixed target impacted by 400 GeV protons from CERN's Super Proton Synchrotron (SPS), the design of this target must safely absorb up to 356 kW of beam power [2]. With the initiation of the High-Intensity ECN3 (HI-ECN3) project's Technical Design phase, multiple concepts for the BDF high-power target are being explored, alongside essential material R&D. This new phase builds on the significant insights gained in recent years, particularly during the Comprehensive Design Phase, which included the development of a baseline design, construction and irradiation testing of a prototype, and subsequent post-irradiation examination (PIE) along with R&D on niobium alloys for cladding.

The baseline design comprises a water-cooled eighteen molybdenum-based alloy TZM and pure W cylinders, cladded with Tantalum-2.5W alloy [3]. A prototype was constructed and irradiated at CERN in 2017 [4-5]. A post irradiation examination (PIE) has then been carried out to evaluate and characterize the resilience of the target core materials and Ta-based cladding [6].

Concerns regarding high decay heat from the cladding, particularly under a Loss-of-Coolant Accident (LOCA) scenario, prompted a feasibility study for niobium-based cladding materials. Pure Nb, Nb1Zr, and Nb10Hf1Ti were downselected, leading to the production of prototype cladded capsules via Hot Isostatic Pressing (HIP) and their subsequent thermo-mechanical characterization [7].

In this contribution, the HI-ECN3 project and Targetry developments are introduced, particularly a new He-cooled W concept for the Target. It details the outcomes and key conclusions from the post-irradiation examination of the baseline prototype target, as well as the findings from the R&D on niobium-based cladding.

[1] https://cds.cern.ch/record/2704147
[2] https://doi.org/10.23731/CYRM-2020-002
[3] https://doi.org/10.1103/PhysRevAccelBeams.22.113001
[4] https://doi.org/10.1103/PhysRevAccelBeams.22.123001
[5] https://doi.org/10.18429/JACoW-IPAC2021-WEPAB365
[6] https://doi.org/10.1002/mdp2.101
[7] https://doi.org/10.18429/JACoW-IPAC2023-THPM017

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