

## **DISCLAIMER**

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## Highlights

### RaDIATE Collaboration Thermal shock studies

As next-generation accelerator target facilities (High Energy Physics, Spallation Sources, ...) become increasingly more powerful and intense, high power target systems face key technical challenges, such as radiation damage and thermal shock. Those ultimately degrade the performance and lifetime of targets and have been identified as the leading cross-cutting challenges of high-power target facilities. In order to operate reliable beam-intercepting devices in the framework of energy and intensity increase for next generation accelerators, the RaDIATE Collaboration (Radiation Damage In Accelerator Target Environment) [1], established in 2012 and managed by Fermilab, brings together existing expertise in nuclear material and accelerator targets from 20 international institutions, including CERN, to execute a coordinated strategy for high power targetry R&D.

In this context, several thermal shock studies were performed at CERN's HiRadMat (High-Radiation to Materials) facility, that took a key step towards improving our knowledge on target damage tolerance.

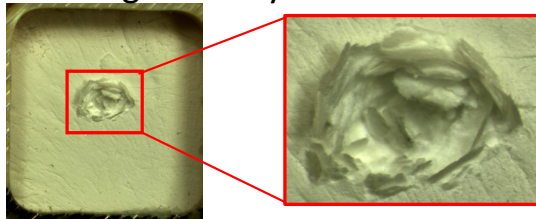
The first experiment HRMT-24, supported by EURCARD2 and completed in 2015, successfully validated the Johnson-Cook strength model developed at SwRI on beryllium S200FH (used for beam window material), providing a better confidence in simulating the thermal shock response of current and future S200FH beryllium components [2]. HRMT-43, supported by ARIES and completed in 2018, tested various materials (Be, C, SiC, Si, Ti and ceramic nanofiber). It was a first and unique test which included pre-irradiated specimens from high energy proton beam irradiation to identify thermal shock response differences between non-irradiated and previously irradiated materials. Real-time measurement of dynamic thermomechanical response of graphite helped to benchmark numerical simulations.

HRMT-60, significantly supported by EUROLABS was completed in 2022. We tested about 120 specimens with non-irradiated (C, Ti, Be, novel materials, SiC-SiC, W) and pre-irradiated materials (C, Ti, Be). Preliminary results shows that most of the specimen didn't present visible track of beam damage except for nanofiber specimen and Sigraflex (C) that was predicted through heat transfer simulations in nanofiber medias.

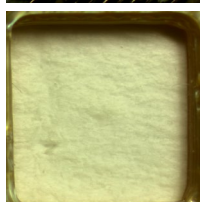
All samples have been sent to Pacific Northwest National Laboratory, USA, and Material Research Facility, Culham-UK, for further Post Irradiation Examination (PIE). The results will greatly improve our knowledge of thermal shock behavior in target materials and will guide for more robust design of next-generation accelerator target systems. All the results obtained during these 3 experiments benefit the different RaDIATE collaborators around the world.



High density nanofiber



Low density nanofiber



RaDIATE collaboration has been researching radiation effects on design properties but identifying damage tolerance limits of material will be very beneficial for future generation acceleration development. A future test at the HiRadMat facility, planned in 2025, is under discussion to investigate the dynamic fracture toughness limits of target materials under beam pulse loading environment.

[1] [www.radiate.fnal.gov](http://www.radiate.fnal.gov)

[2] K. Ammigan, S. Bidhar et al., PRAB 22, 044501 (2019)