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High power beam dump drum for FRIB primary beam: challenge and solutions

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The Facility for Rare Isotope Beams (FRIB) at Michigan State University in East Lansing is building a heavy ion accelerator to produce rare isotopes by the fragmentation method. The linac will accelerate primary ion beams from Oxygen to Uranium to energies above 200 MeV/u with a beam power of up to 400 kW. For the rare isotope production, the in-flight technique and fragment separation is used. Only a fraction of the primary beam will be converted into rare isotopes and 300 kW of unreacted primary beam power needs to be absorbed in the beam dump.
The concept of the beam dump for FRIB is based on a rotating thin-wall drum filled with water. The drum is made of Ti-6Al-4V alloy and had an outer wall thickness of 0.5 mm. Flowing water is used to both cool the wall and to stop the beam inside the drum. The high power and the use of heavy ions leads to high power densities in the materials used. Effective water cooling is required to dissipate the power deposited in the wall, which for the heaviest 238U beam can reach up to 70 kW. Extensive thermal, mechanical and fluid flow analysis have been performed, taking into account the beam power deposited in the water and the drum wall. To validate the simulations, a thermal and mechanical test with a beam dump ¼-scaled mockup with a high energy electron beam was performed at the Budker Institute of Nuclear Physics in Novosibirsk.

The results of tests, simulations and material studies will be discussed in this paper.

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