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Development of a new system for Nb_3Sn thin film deposition on 1.3 GHz cavities

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Nb_3Sn in the form of thin film on copper is one of the most promising routes in the field of superconducting radio-frequency accelerating cavities for future colliders. At INFN –Legnaro National Laboratories, thin films of Nb_3Sn have been successfully deposited on small copper samples via DC magnetron sputtering the process enabled the production of films with critical temperature > 17 K, at deposition temperatures of 600 ℃ - 650 ℃ and with the implementation of a Nb buffer layer of 30 um thickness. The design and development of a dedicated system to scale this deposition recipe from small samples to a full-size 1.3 GHz copper cavity are presented in this work. The main challenges involve both the high substrate temperatures—requiring careful thermal management and mechanical design—and the need to ensure uniform thin film deposition over a large and curved internal surface. Since a planar magnetron is employed, a rotational motion must be maintained during the process, achieved in this case by rotating the cavity itself. The system's core features include substrate heating using four infrared lamps, the insertion of a custom planar magnetron inside the cavity, and a ferrofluidic rotation mechanism compatible with ultra-high vacuum conditions. To this day, the system has been successfully built and tested.

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Footnotes

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