The Flexible Taper Transitions for an In-Vacuum Undulator

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Abstract

In a joint project between SPring-8 and PSI, an in-vacuum undulator U24 was installed in the SLS storage ring during 2001. In this frame, cooled flexible taper transitions were developed to provide a smooth transition between the vertical aperture of the adjacent fixed taper sections and the vertical gap of the undulator, thus minimizing any impedance discontinuity. After a numeric optimization of the shape of the tapers, these were manufactured via electro-discharge machining (EDM) from a Be-Cu sheet. Subsequent fatigue tests, as well as the operational experience so far, have proven the validity of the adopted concept.

In a further development step, two in-vacuum undulators covering an energy range 5-18 keV and with a gap range of 4-40 mm are currently being designed. These will require an upgrade of the flexible tapers allowing a longitudinal degree of freedom based on a parallel spring translator mechanism. In this way the danger of incurring into buckling due to a bake-out-induced differential thermal expansion of the vacuum chamber with respect to the in-vacuum beams supporting the magnet arrays will be minimized.

In this work the results on a nonlinear finite element optimization of the resulting flexible taper assembly will be presented, together with the set-up being developed for the in-vacuum fatigue tests of the whole structure. Depending on the outcome of the experimental assessment, the same concept could then be adopted also for a scraper device.

Keywords: in-vacuum undulator, flexible taper, finite element analysis, fatigue tests

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