A System That Permits Micron Level Magnet Gap Control For an In-vacuum Undulator

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The X-25 Insertion device at the National Synchrotron Light Source is a newly installed 1M long, 18mm period, in-vacuum, Cryo-ready, Hybrid Undulator, Replacing a 1.5M long, 180mm period wiggler magnet that had operated for the past 15 years. This Undulator requires extremely tight straightness, taper and gap control tolerances of the order of a several microns. First order Gap control is performed using 4 external stepper motors with a linear encoder feedback system that positions each magnet girder to a mean reproducibility of 1 micron. The one meter magnet length required multiple structural feed-thoughts in the vacuum envelope to assure continuity between rigid external structural girders and the in-vacuum magnet girders. However, magnetic and mechanical measurements indicated that gap dependent non-linear magnetic forces, environmental temperature gradients, and operational conditions caused deflections of the in-vacuum magnet girders that exceeded specification. The external linear encoders could not measure these affects and correction by the primary gap control system would be ineffective. The Undulator was designed to be used either as a water cooled Mini Gap Undulator “MGU” operating at 20C or a Cryogenic Permanent Magnet Undulator “CPMU” operating at -120C. During testing as a CPMU direct measurements of the magnet gap differed by greater then 1mm with respect to the gap as inferred by the external linear encoders. These measurements indicated that relying exclusively on a conventional external linear encoder based control system is insufficient under extreme conditions and a direct means of gap measurement and a secondary means of gap control are necessary to maintain micron control of the magnet girders over the full range of environmental and operational conditions. A system was devised to provide a secondary means of gap control to permit correction over the regime of these tertiary effects for up to 100 microns of non linear gap control. This paper shall describe the secondary gap control system and how it may be used to optimize Undulator performance.

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