Development of Very Short Period Undulators

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The energy of photons from undulators is inversely proportional to the period length of the undulator field and proportional to the square of the electron-beam energy. Hard x-ray radiation was usually generated with in-vacuum undulators with period lengths of several cm installed in electron storage rings with 6-8GeV energies[1, 2]. Construction of newer sources has recently been planned and partly realized in compact 3rd generation light sources with in-vacuum undulators of period lengths around 20mm [3]. This was preceded by the construction of three in-vacuum-type undulators at the Photon Factory (PF), High Energy Accelerator Research Organization, KEK. It proved that these short gap undulators were very useful as hard x-ray sources in the 2.5-GeV storage ring [4, 5].

As the next step, we have been exploring a method to fabricate very short period undulators. Here, “very short period” means periods one order-of-magnitude shorter than the ordinary period of several cm. We are developing a plate-type magnet some 100mm long with a period length of 4mm in the longitudinal direction. We selected 4-mm period since we can generate 12-keV radiation with the first harmonic of this undulator in the 2.5-GeV storage ring. The very short period undulators operate in a gap one order-of-magnitude shorter than that of ordinary undulators. Thus these undulators are very useful when they are combined with very low emittance storage rings and linacs.

A multi-pole magnetizing method was applied to magnetizing this plate: a periodic undulator field (of 4-mm period in this case) was generated by pulsed electro-magnets, and was transcribed into the plate. The magnetization procedure allows the undulator field to be obtained in a very short gap between the pair of opposing plates [6]. Here we report the magnetization method to obtain a very short period and present the test results. The spectrum calculation of the radiation from the measured undulator field compares well with that from an ideal magnetic field in the region of the fundamental radiation, and the radiation from 10 to 15keV was found to be useful for synchrotron radiation experiments in case of 2.5-GeV energy of the electron beam.

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