

Heavy Ion Beam Acceleration in the KEK Digital Accelerator: Induction Acceleration from 200 keV to a few tens of MeV

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Since the last year beam commissioning in the KEK digital accelerator [1], which is the small scale induction synchrotron, has been carried out using He¹⁺ ion beam of a few tens of μA [2]. This paper discusses essential and crucial issues associated with induction acceleration of a low current ion beam from a low energy, such as injection error, relatively large closed orbit distortion (COD), and induction acceleration with predicted feedback. Injection errors are categorized into injection orbit mismatching and optics mismatching. The former is observed as a coherent betatron oscillation, which is corrected by adjusting two pairs of steering magnets. The COD, which is monitored at 5 positions along the ring, is corrected by 8 figure back leg coils of the main magnets [1].

Induction acceleration and barrier bucket trapping are controlled by a gate control system of the switching power driving the induction cells, which consists of the bunch monitor, FPGAs, and DSP. In acceleration in a rapid cycle synchrotron, acceleration timing is quite important. Unfortunately the gate control based on direct beam-feedback is not available because of a poor S/N ratio in the bunch monitor signal. So, the timing for acceleration pulse trigger is scheduled in advance in the FPGA. This is called a predicted control method [3]. We discuss in details how the trigger timing of acceleration/trapping voltage pulse is determined so as to well synchronized with magnet ramping. Observed beam motions are reproduced with a help of computer simulations. Then, the predicted control method will be justified.

[1]T. Iwashita et al., "KEK Digital Accelerator", PHY.Rev.ST-AB14, 071301-20 (2011)

[2]K. Takayama, in this conference.

[3]S. Harada, in Master Thesis (Tokyo City University) 2012.

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