Identification of an isochronous operating mode for a passive electrostatic storage ring

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A race-track shaped electrostatic system capable of storing charged particles has been designed, built and tested using electrons [1]. The 'electron recycling spectrometer' (ERS) is composed of two 180° hemispherical deflector analyzers (HDAs) connected by two cylindrical lens stacks. The lens stacks consist of four 3-element electrostatic lenses; one before the entrance and exits of each HDA to accelerate/decelerate and control the electrons' trajectory [2].

Recently, regions of long term storage have been observed for asymmetric operating voltages (i.e. different pass energies applied to the two HDAs). The regions of storage are determined by varying the potentials of middle lens element (V2) in the four 3-element lenses. We examine the stored electrons for various pairs of V2 potentials over which a broad range of storage times are observed.

The nature of the orbits within the ERS has been investigated at different lens potentials by examining the electron 'bunch' peak width as a function of orbit number. The bunches in the ERS spread out over time due to (a) the different paths the electrons take around the ring, (b) the initial energy spread in the injected pulse, and (c) space charge effects within the bunch.

In normal operation, a ~35 ns wide (FWHM) bunch of electrons is injected into the ring. This pulse of electrons is then viewed every orbit as the beam is extracted from the system and the temporal width of the electrons as a function of orbit number (i.e. storage time) is determined. In Figure 1 the peak width evolution for two pairs of lens potentials are shown to have different behaviours. The rate of peak width change decreases dramatically when the V2 potentials are slightly (≤ 1V, or ~2% of V2) offset from those with the highest count rate. One observes narrow well defined peaks, providing evidence of isochronous behaviour of the electron beam. Identification of this mode of operation is advantageous if the system is to be used as, say, a mass spectrometer (e.g. [3, 4]) or a high energy resolution electron/positron source.

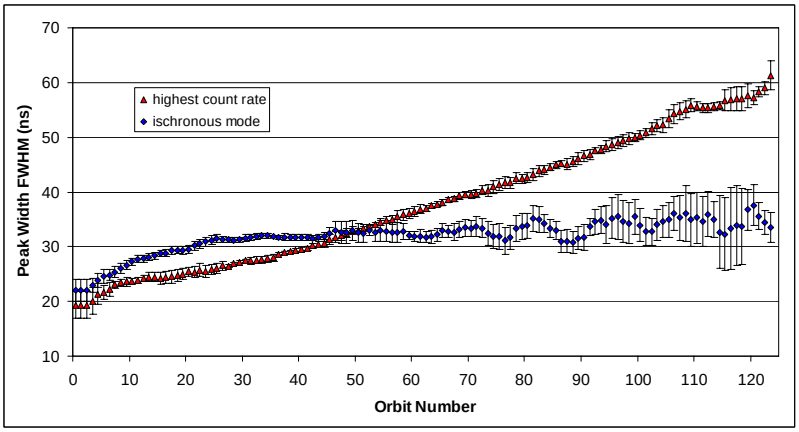

Figure 1. Plot of peak width variation for long term recycling (> 4000 ns).

References

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