Abstract

The aim of the thesis is to study loss mechanism of stored electron beam during beam current decay and identify the limiting factor in measured beam lifetime in Indus-2 storage ring.

The beam loss in an electron storage ring is due to interaction of electron beam with gas atoms and electron-electron interaction within a beam bunch. Beam experiments which were conducted to separate the contribution of vacuum lifetime and Touschek lifetime from the measured beam lifetime are presented in the thesis. The contribution was separated by storing uniform current in all 291 available RF buckets and storing same amount of current in two-third RF buckets keeping the remaining one third RF buckets empty.

Analytical expressions for the shape factors for rectangular and elliptical shape of vacuum chamber as a function of longitudinal position along the circumference of storage ring are presented. These expressions are very useful to estimate the beam lifetime due to elastic scattering of electrons with the nuclei of residual gas atoms in realistic conditions like non uniform vacuum pressure in storage ring.

The aperture available for beam motion in vertical and horizontal plane was measured using movable beam scrapers which are installed in Indus-2 in one of the long straight sections. From these aperture studies, vacuum lifetime due to elastic scattering of electrons with the nuclei of residual gas atoms was estimated. The measured value of vertical aperture 4.1 mm was found to be less as compared to the theoretical estimated value which is ~6 mm. It was corrected by minimizing the closed orbit distortion in vertical plane, so by increase in vertical aperture, ~40% increase in beam lifetime was observed with stored current 100 mA at beam energy 2.5 GeV. The same amount of enhancement in beam lifetime was also observed with stored current 150 mA at beam energy 2.5 GeV.

Beam experiments were conducted by storing higher beam current in single RF bucket out of 291 RF buckets to find the effect of higher electron density in a bunch on beam lifetime at 550 MeV and 2.5 GeV beam energy.

A simulation study of the effect of RF phase modulation on longitudinal parameters for enhancement of Touschek lifetime in Indus-2 is also presented.
LIST OF PUBLICATIONS ARISING FROM THE THESIS

Journals:


Conferences:

1. “Beam lifetime studies in Indus-2 electron storage ring”, Pradeep Kumar, Riyasat Husain, A.D. Ghodke and Gurnam Singh, in proceedings of InPAC-2006 held at BARC/TIFR. (Paper selected for poster presentation prize)
