Preface

The following is a brief outline of the coverage of each chapter in this thesis.

In Chap. 1, a brief description of the ESRF facility and its upgrade program is given.

In Chap. 2, the Touschek lifetime derivation from the Møller scattering differential cross section is presented. The effects of spin polarization in the Touschek lifetime are also treated.

In Chap. 3, the measurements of some parameters relevant to the Touschek lifetime, done for the ESRF storage ring, are reported. The RF voltage calibration factor between the readout value and the real voltage applied to the cavity is measured from the synchrotron tune and the synchronous phase measurements. A bunch lengthening with current model, derived from measurements, is presented. The momentum acceptance computation using a 6-D particle tracking code is described. The model includes the synchrotron oscillations, the synchrotron radiation and the physical apertures.

In Chap. 4, the lifetime measurements are described: the vacuum lifetime that must be measured before all the Touschek lifetime measurements; the effect of spin polarization on the Touschek lifetime and the spin polarization time; the Touschek lifetime versus the RF voltage; the Touschek lifetime versus the horizontal scraper position.

In Chap. 5, the optimization of the sextupole setting is described: the multi-objective generic algorithm used is described, and the results of the optimization and the measurements are reported.

In Chaps. 6 and 7, the Touschek lifetime model, described in previous chapters, is used to study the Touschek lifetime of the low emittance ESRF upgrade lattice. The bunch length model and the emittance growth due to intrabeam scattering are used to predict the Touschek lifetime of the new lattice for different modes.

In the first appendix, an overview of beam physics in an electron storage ring is given. In the first section, the single particle dynamics without synchrotron radiation is treated. In the second section, the effects of synchrotron radiation on the single particle dynamics are reported. In the third section two current dependent

effects related to the beam lifetime are treated: the bunch lengthening effect due to the longitudinal wakefield and the intrabeam scattering.

In the second appendix, a `matlab` code developed during the thesis work and used to simulate spin depolarization with a kicker is described.

In the third appendix, two possible momentum compaction factor measurements are presented.

In the fourth appendix, the effect of synchrotron motion on the dynamic aperture computation is described.

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