RECENT ACCELERATOR DEVELOPMENT AT MAXlab

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Abstract

The recent accelerator development and upgrading programme at MAXlab are presented. We are then focusing on the MAX II storage ring. The results from the operation of the 3rd harmonic Landau cavities, the beam position correcting system, vibration effects and the effect of the insertion devices on the beam are then discussed. The consequences of some non-conventional design solutions like a non-adjustable magnet positioning system, integrated sextupole/quadrupole magnets etc on the beam performance are also presented.

1 INTRODUCTION

At the last EPAC conference in 1996, the MAX II design was presented [1]. We will now report on the consequences of some of the non-conventional solutions like:

- Low-energy injection
- Fixed magnet-girder suspension
- Combined quadrupole/sextupole magnets
- Non-zero dispersion in the straight sections
- Passive 3rd harmonic Landau cavities

The main target specifications and the achieved performance are seen below:

Table 1: MAX II parameters

	Target spec	**Achieved**
Emax	1.5 GeV	1.5 GeV
I_{circ}	200 mA	260 mA
Hor em	8.8 nm rad	9 nmrad
Beam life-time at 10 % coupling	2 Ah	4 Ah
Min coupling	10 %	0.6 %
Energy spread	0.07 %	0.1 %
Uncorrected closed orbit deviation (RMS)	Hor 1.7 mm Vert 1.2 mm	Hor 1.1 mm Vert 1.2 mm
Corrected closed orbit deviation (RMS)	Hor 30 µm Vert 5 µm	Hor 3µm Vert 3 µm

2 LOW ENERGY INJECTION

The MAX II ring is injected via the MAX I ring at 500 MeV. The cycling rate of the MAX I ring is low, one cycle/minute. Injection takes typically 0.5-1 hours, which is acceptable since the MAX II ring only needs one fill per day. In case of problems, however, injection can be painfully slow since the low injector rep rate prolongs the diagnostic work.

At injection, the magnets in MAX II develop much less power than they do at full energy. This introduces some changes in magnet size, which has an influence on the beam positional drift after the ramping of MAX II. This effect and eventual remanence effects are however handled by the automatic beam positioning system discussed below.

3 BEAM LIFE-TIME

The losses of the stored beam are dominated by the Touschek effect and vacuum losses.

3.1 Vacuum losses

The MAX II vacuum chamber is mounted directly on the cell girders with no in situ baking means. In case of baking, the magnets, also mounted directly on the girders with no adjustment means, have to be taken off the girders. After commissioning, baking has been pretty rare and then only at a few cells. The system is now well conditioned and the beam vacuum losses are negligeable compared to the Touschek ones.

3.2 Touschek losses.

The target specification was 2 Ah beam life-time, which was met during commissioning. After the introduction of the passive Landau cavities [2], the increased bunch length resulted in a doubling of the beam life time to 4 Ah. This was a most important improvement since this reduces the injections to one per day.

4 MAGNET ALIGNMENT

As mentioned above, the magnets are positioned on machined disks welded on the girders with no adjustment means. This alignment method calls for tight mechanical tolerances of the magnets. The specified RMS alignment tolerance of 30 µm of the magnet centers was verified by a measurement of the closed orbit deviation with no correctors engaged.

The sextupole components needed for chromaticity correction were machined into the quadrupole magnet surfaces. For a fine-tuning of the chromaticity, additional windings on the quad backlegs are used. These corrections also induce a dipole component in the quads. Since these dipole fields are highly periodic, they are easily corrected for with the global correction system.

5 BEAM POSITIONING

The beam position is measured relative the BPMs which are rigidly bolted on the main girders. The BPMs are calibrated to the neighbouring magnet centers with the QSBPM method [3]. The transfer matrix between the magnet elements and the BPM readings is then used to globally correct the closed orbit. The reproducibility of the beam position measurements is estimated to 2 µm. The beam is now globally corrected each 5^{th} minute to compensate for slow drifts. The beam is then kept within some 3-5 µm relative the BPM heads.

6 ENERGY SPREAD

The MAX II ring was initially plagued by strong longitudinal multi-bunch instabilities. The energy spread was then a factor of 8 larger than the natural one which had the undesirable consequences of increasing the beam size in the non-zero dispersion straight sections used for the insertion devices and to widen the undulator harmonic peaks [4].

The Landau cavities mentioned above introduce sufficiently large non-linearities to the RF fields to damp the multi-bunch instabilities. The Landau cavities are now used in routine operation.

7 REFERENCES

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