Operation of the MAX II Insertion Devices

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ABSTRACT

The MAX II storage ring [1], which is just in the end phase of commissioning, is today equipped with three permanent magnet insertion devices; two undulators and one multipolewiggler, and one superconduting wiggler is under installation.

The three installed devices are bound to be in operation when the storage ring is fully commissioned later this year. Initial tests have been done to evaluate the influence on the storage ring of the devices, and to give some directions on restrictions, if any, for the use of the devices. The synchrotron light from the devices has not been possible to examine at this stage.

1 INTRODUCTION

The MAX II storage ring is a 1.5 GeV third generation synchrotron radiation source. It is injected at 0.5 GeV from the MAX I storage ring. MAX II is 90 m in circumference with a 10 period lattice able to carry 8 insertion devices of around 2.5 m each. Apart from the devices discussed here one superconducting wiggler is close to installation and a third undulator is under construction.

All tests referred below have been run at full energy (1.5 GeV) and with currents ranging from 12 down to 8 mA.

2 THE INSERTION DEVICES

The full technical description is reviewed in the neighboring poster/paper *Technical description of the MAX II undulators* [2]. In table 1 an overview of the most important data is given.

The devices are installed onto the MAX II storage ring since a couple of months. They are connected onto a common computer control net managing also the two devices already in operation on MAX I.

	U311*)	U511	MPW711
K_{max}	4.56	2.74	29.3
Period length (mm)	66	52	174
# of poles	77	99	27
Gap_{min}	22	22	22

Table 1. Technical specifications

*) The three digit number refers to the beamport number at MAX II.

One important feature here is that the devices are equipped with ”preprogrammed” correction coils which can compensate the remaining field integral through the device as a function of the gap.. At injection the insertion devices should be opened to ”full gap” and after ramping to full energy, closed down to the operation point.

3 CLOSED ORBIT DISTURBANCE

Measurement of the changes in closed orbit were made under poor conditions, which dominates the results. The two undulators (U311 and U511) gave maximum closed orbit deviations of up to 0.5 and 0.8 mm respectively. The multipole wiggler (MPW) gave a closed orbit deviation up to 1.6 mm, but at minimum gap the deviation was reduced to below 0.8 mm. The device is designed to operate almost uniquely on the smallest gap, and the larger errors at other gaps will not pose a problem.

By operating the three devices at the same time the overall closed orbit error rose to 1.2 mm (see fig. 1) with the MPW at minimum gap and 1.5 mm at slightly larger gaps.

The primary cause of the rather poor results is that the electron beam orbit without insertion devices was not well centered in the machine. Awaiting the completion of the orbit correction system a rough test on improving the beam position gave much better results. We thus believe that in a fully corrected machine the values quoted above will decrease by at least 80 %.

The Multipole wiggler will still move the closed orbit by a few 1/10 mm, but the ordinary correction system of the machine will be able to handle this.

The changes from the undulators will be small. Nothing indicates that we would need any additional correction system for the undulators while doing small gap movements. Weather the ordinary correction system have to be used at different operation patterns (undulators in or out of use) is still an open question.

Further the correcting currents in the devices can be optimized, mainly by trial and error. The systems are similar to the insertion devices in MAX I, and the experience from them is that this method is very effective.

4 TUNING BY THE INSERTION DEVICES

All three devices focus the electron beam. By a completely corrected electron beam position the focusing can be minimized, which was not the case. None of the measured changes in betatron frequency is alarming though.

Theoretical calculations of the effects of the insertion devices shows only slightly smaller changes. It can thus be assumed that despite the rather large closed orbit deviations we are still operating within fairly good fields.

The necessary changes in quadrupole currents needed to retune the machine are below 0.5%.

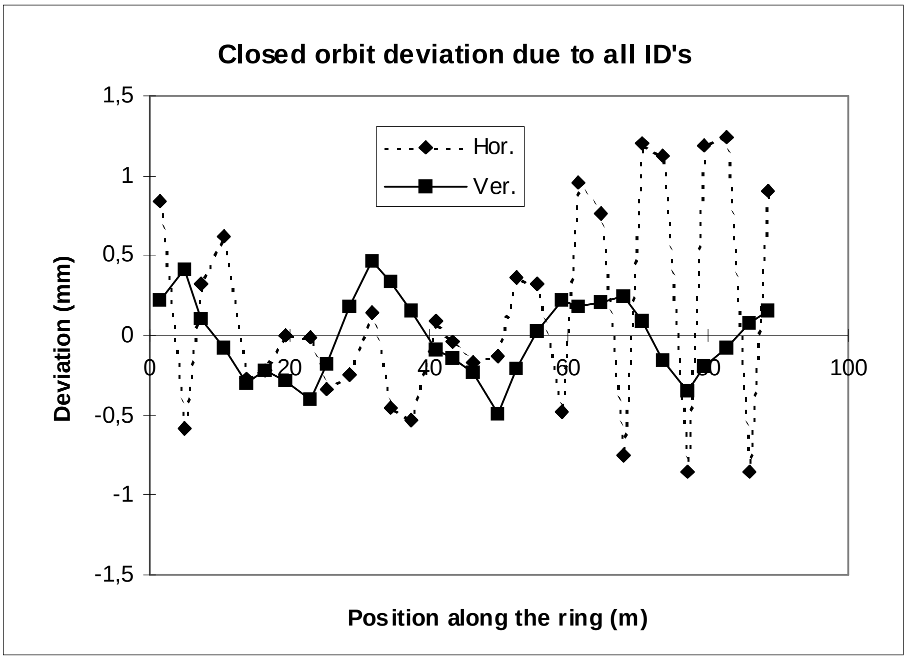

Figure 1. Closed orbit deviation with all ID’s closed.

5 LIFETIME

The lifetime of the machine was measured with all three devices closed, only the MPW closed and with none closed. The dominating effect here is the need for a well corrected electron orbit, as in some circumstances the insertion devices improved the beam lifetime.

6 CONCLUSIONS

All three insertion devices behave well. The effects induced by the two undulators are, as can be expected, small, while the MPW is not completely negligible. The

	Measured		Calculated	
Closed device	$\Delta\nu_h$*10^{-3}	$\Delta\nu_v$*10^{-3}	$\Delta\nu_h$*10^{-3}	$\Delta\nu_v$*10^{-3}
U311	0	6.0	0	4.7
U511	1.5	4.5	0	3.1
MPW	-7.5	31.5	0	26.4
U311+U511+MPW	-6	40.5	0	34.2

Table 2. Tune shifts

MPW will probably carry the restriction to operate only at minimum gap, or not at all. No retuning of the machine should be necessary due to the undulators.

The injection into the storage ring was effected by putting the three device in place. (Excessive runs with the undulators redrawn from the ring has been done over a long period). This will not pose any problem in real life.

The closed orbit changes are rather large which to a large extent is an effect of the badly corrected closed orbit before closing the insertion devices. The main effect though, is given by the MPW at gaps slightly larger than minimum gap. This is very well in accordance with the design criteria.

With the experience of insertion devices on MAX I we fell confident that by using the same methods, the insertion device operation in MAX II will, after full commissioning, be straight forward with negligible effects.

REFERENCES

[1] The new 1.5 GeV storage ring for synchrotron radiation: MAX II, Å. Andersson et al. Rev. Sci. Instrum., Vol. 66, No. 2 (1995) 1850

[2] Technical description of the MAX II undulators, G. LeBlanc et al. (these proceedings)