# BEAM STABILITY IN MAX-II

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## *Abstract*

The beam position stability in the MAX-II storage ring have been investigated. The influence of the mechanical girder and vacuum system designs are discussed. The BPM systems performance on the observed stability is discussed as well as the importance of a reliable BPM system. Results from measurements performed with the QSBPM [4] system on the MAX-II storage ring is presented as well as design features and improvements to enhance the beam stability.


## 1. INTRODUCTION

The beam position stability in MAX-II has been investigated regarding long term drifts and vibrations.

## 2. LONG TERM POSITION STABILITY

The conditions at the start of the measurement were 70mA stored current at full energy 1.5 GeV, and a machine where the main dipoles and the RF had been shutdown for three hours due to fault. The measured results can be seen in figs. 1 and 2. The jump in beam position has not been explained, but is believed to be the result of a stick-slip action somewhere in the machine where the vacuum system and the quadrupole magnets are in contact mechanically. However, the machine is designed to have the vacuum chamber floating freely from the magnets [1].

### *2.1 Correcting the drift*

Figs. 3 and 4 shows that the beam position drift can be corrected by applying a correction algorithm at regular intervals. the interval chosen in this experiment was 15 minutes and the conditions were similar to the non corrected beam position experiment. However, the initial current was only 40mA. The only uncorrected movement in the H direction is due to the zero-th order term which is controlled by the accelerating frequency which was not changed during this experiment. This means that the beam position can be within 0.1$\sigma$ of the beamsize.

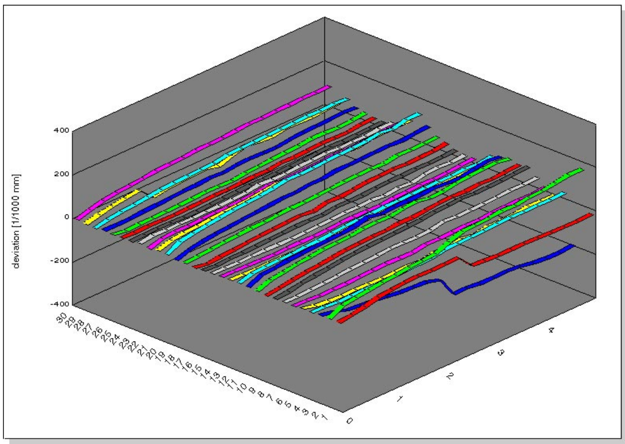


Fig. 2. Vertical beam position movement in MAX-II over several hours.

### *2.2 BPM system influence*

Of course the BPM system must be stable enough to be able to detect this kind of movements. At this stage we assume that the BPM heads are fixed in position as well as the quadrupole magnets.

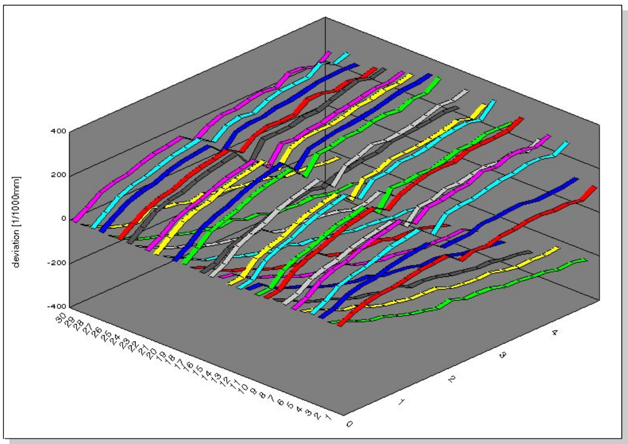


Fig. 1. Horizontal beam position movement in MAX-II over several hours.

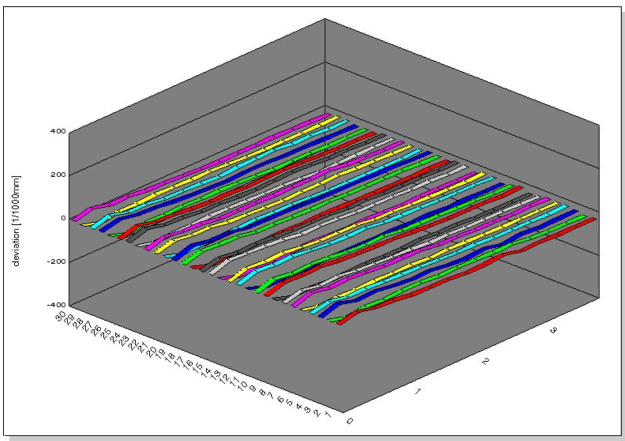


Fig. 3. Horizontal beam position movement in MAX-II measured and then corrected every 15 min. over several hours.

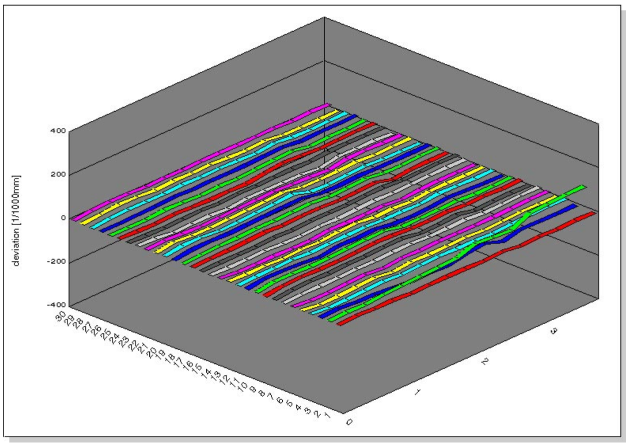


Fig. 4. Vertical beam position movement in MAX-II measured and then corrected every 15 min. over several hours.

## 3. VIBRATION ANALYSIS

The vibrations in the MAX-II beam has been measured by looking at the visible synchrotron radiation from a dipole magnet. The detector used is a position sensitive Wallmark plate [2]. It has a frequency response from DC to 50kHz, and a resolution of 2 µm.

### *3.1 Is the vibrations from the setup or from the beam?*

An investigation to determine the detector setups vibrations was done. Fig. 5 shows the vibration spectrum taken using a light bulb and a pinhole as the light source. The detector was mounted on the same stand and on the same place used for the measurements on MAX-II. The only detectable frequency is the mains frequency 50 Hz. Then the vibration spectrum of the beamline components being excited by gentle knocking is shown in fig. 6. It can clearly be seen by comparing figs.8 and 9 with fig. 6 that few of

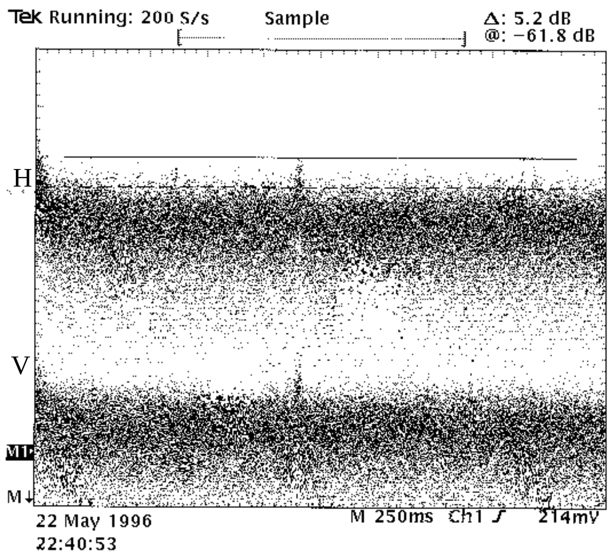


Fig. 5. Vibration spectrum of the test setup looking at a light bulb.

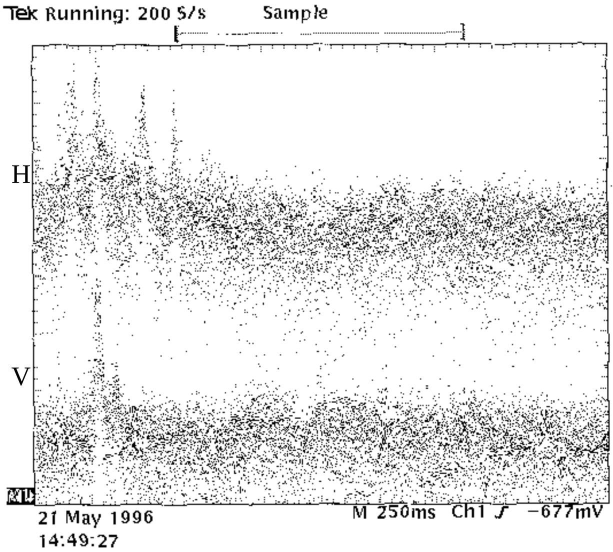


Fig. 6. Vibration spectrum of the testsetup looking at MAX-II and exciting the eigenfrequencies of the setup.

the frequencies in the vibration spectrum of the beam corresponds to the eigen frequencies of the beamline [3].

### *3.2 Amplitude of the measured vibrations*

The highest peak amplitude of measured vibration is 2.3µm at 17.5 Hz and the second highest are at 11.8 Hz and 1.4 µm. These amplitudes are well within the design requirements [1] of the MAX-II machine.
The frequencies probably originate from traffic noise on a nearby street. The early ground vibration measurements [1] showed peaks at 12 and 17 Hz with a steep roll off at higher frequencies as can be seen in fig. 7.

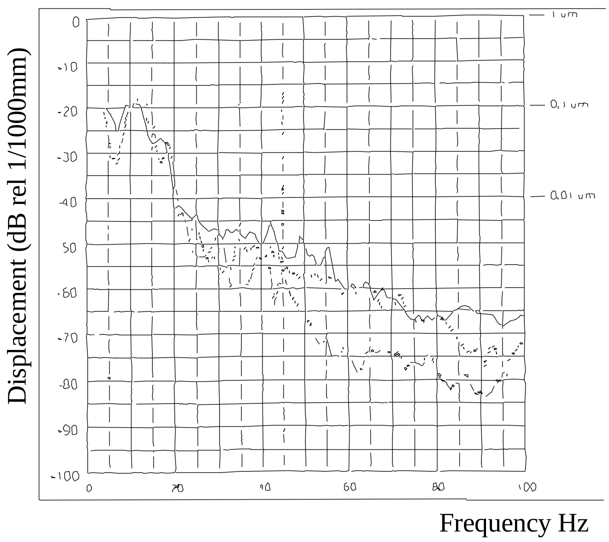


Fig. 7. Vibration spectrum of the ground under the MAX-II hall.

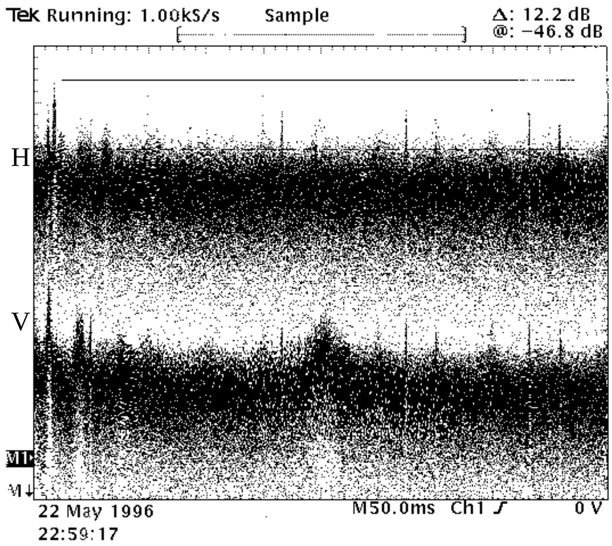


Fig. 8. Vibration spectrum of MAX II at 1.5 GeV.

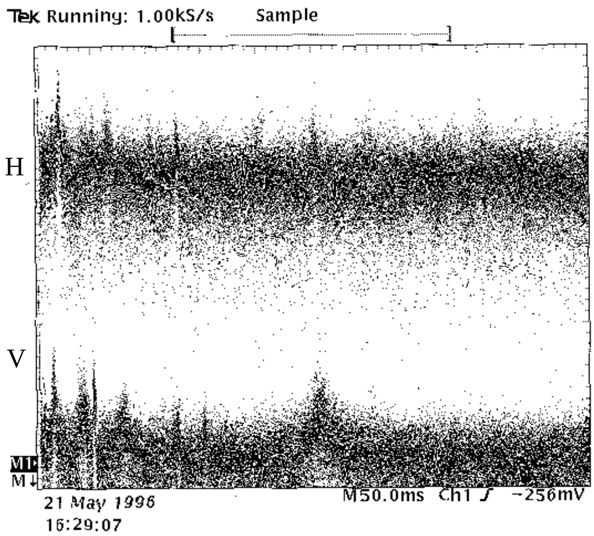


Fig. 9. Vibration spectrum of MAX II at 0.5 GeV.

## 4. CONCLUTIONS

The slow positional drift is as seen rather easy to control with the BPM system and might decrease over time since thermal equilibrium had not yet been reached in the accelerator tunnel when these measurements were done.

The vibration measurements confirm that the precautions taken regarding the effort to get a very stable floor in the MAX-II hall has succeeded. There is at this point no need to equip the MAX-II machine with any beam positional feedback system.

## 5. REFERENCES


[1] M. Eriksson et. al., Design report for the MAX II Ring, MAX publications
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[3] Å. Andersson, et. al., Beam profile measurements with visible synchrotron radiation light on MAX-II, these proceedings.

[4] P. Röjsel, Nucl. Instr. and Meth. A 343 (1994) 374-382. A beam position measurement system using quadrupole magnets magnetic centre as the position reference.