VIBRATION MEASUREMENTS ON THE MAX II BEAM

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Abstract

Vibration measurements have been done several times during the commissioning of MAX-II. Almost from the moment of first stored beam until today. Vibration spectra from a number of these measurements are presented. It is worth noting that the vibration level is generally remarkably low and the possible reasons for this is discussed.

1 INTRODUCTION

MAX II is a 1.5 GeV third generation synchrotron radiation storage ring situated in Lund Sweden [1]. It is a ring with tenfold symmetry and space for eight insertion devices. Great effort was taken at the design of the ring to minimise vibration sources. Vibrations with an amplitude greater than 0.1 of σ of the transverse beamsize would deteriorate the good quality of the photon beam from the undulators.

2 METHODS

To measure vibrations of the electron beam, the emitted synchrotron radiation is used. It is recorded by a position sensitive detector placed at the diagnostic beamline [2]. The detector is a Wallmark plate position sensitive detector [3]. The detector signal is analysed with an oscilloscope with FFT function.

3 CALIBRATION

To find the sensitivity limit of the method a forced vibration with known amplitude was introduced to the beam. The beam was oscillated in the vertical direction with the frequencies 5, 40 and 400 Hz. The beam was given a kick that created a maximum beam deviation of 1, 5 and 50 μm using 0.01, 0.05 and 0.5 A p-p of coil current respectively in a coil with 18 turns on a 180 mm long laminated iron yoke.

The method of measuring vibrations with a Wallmark plate was found to be good for vibrations with an amplitude down to 2 μm, corresponding to 0.02 σ. The absolute amplitude of the vibration is measured with the bpm-monitors Fig. 1. the excitation took place near BPM #29 and the detection point was between BPM #1 and 2. In Fig. 1. and Fig. 2. the beam was excited with a DC signal with amplitude corresponding to the used AC levels.

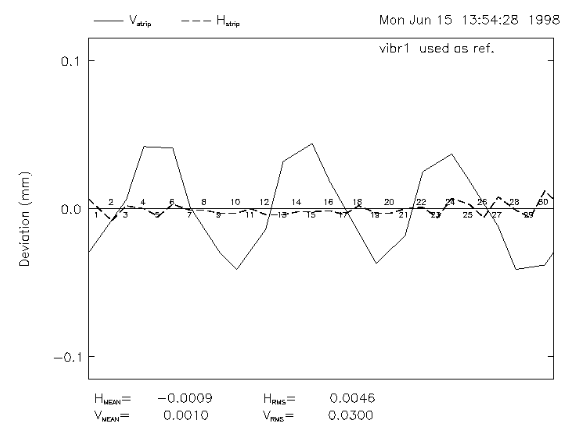

Figure 1: Closed orbit with 50 μm DC beam excitation.

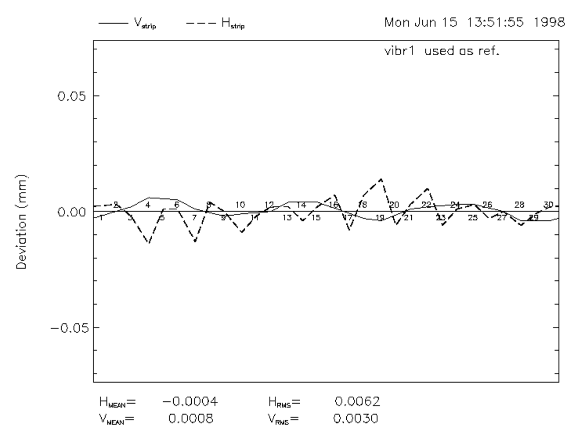

Figure 2: Closed orbit with 5 μm DC beam excitation.

Fig. 3. shows the detector response from an excitation of 40 Hz and 0.5 Amp. The 40 Hz peak is clearly visible in the lower track at the cursor. Fig. 4. shows the 40 Hz excitation at a much lower level. The sensitivity limit e.g. when the signal is drowned in noise corresponds to an excitation level of about 2 μm p-p. It was determined that no reduction of the beam excitation amplitude could be seen over the frequency range up to at least 400 Hz.

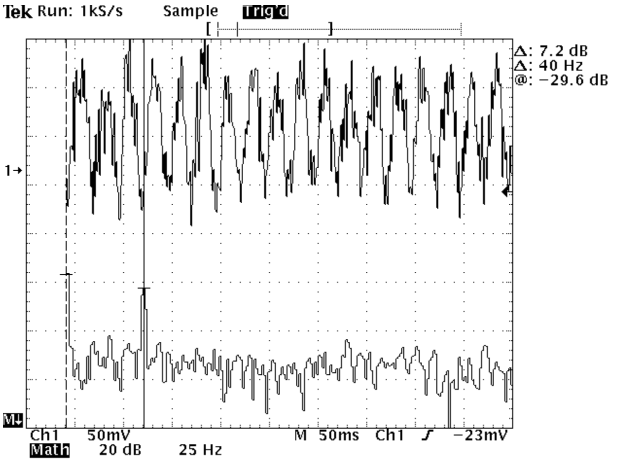

Figure 3: Detector signal from 40 Hz, 50 µm beam excitation, and corresponding FFT spectrum.

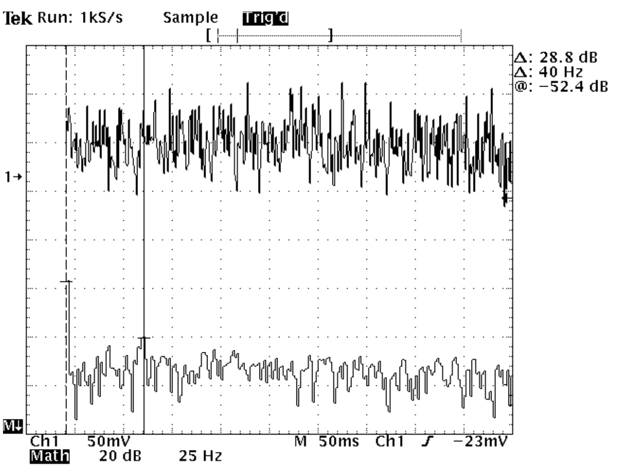

Figure 4: Detector signal from 40 Hz, 5 µm beam excitation, and corresponding FFT spectrum.

4 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 Wallmark plate PSD. The frequency response of the detector is from DC to 50 kHz, and with a resolution of 2 µm.

4.1 Are the vibrations from the measuring device or from the beam?

An investigation to determine the detector and measurement set-ups vibrations was done. Fig. 5. shows the vibration spectrum taken using a HeNe laser as the light source. The detector was mounted on the same stand and on the same place used for the measurements on MAX-II. There are no detectable vibrations seen.

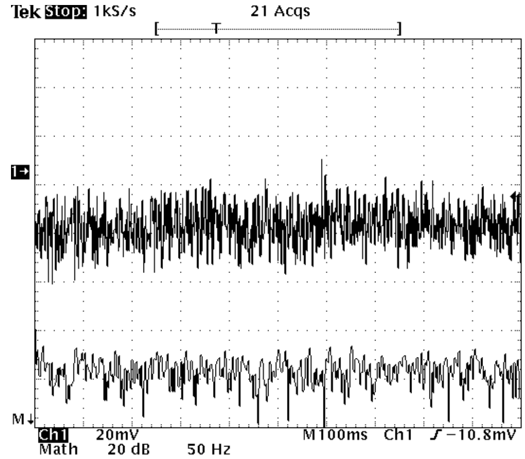

Figure 5: Detector signal using HeNe laser as light source, and corresponding FFT spectrum.

4.2 Amplitude of the measured vibrations

The highest peak to peak amplitude of a single measured vibration Fig. 8. is 5 µm at 38 Hz. These amplitudes are within 0.1 σ of the vertical beamsize. We can also see some other vibration frequencies at 18 Hz and 300 Hz. The origin of the 300 Hz is obvious, but the 18 Hz needs some explaining. Early ground vibration measurements showed a frequency response of the ground with peaks at 12 and 17 Hz and a steep roll off at higher frequencies [4]. Which concludes that the 18 Hz may come via the ground from the surroundings.

Fig. 6. shows a vibration spectra in the horizontal plane. We can see some of the multiples of power line frequencies which is all that is different from the vertical plane spectra.

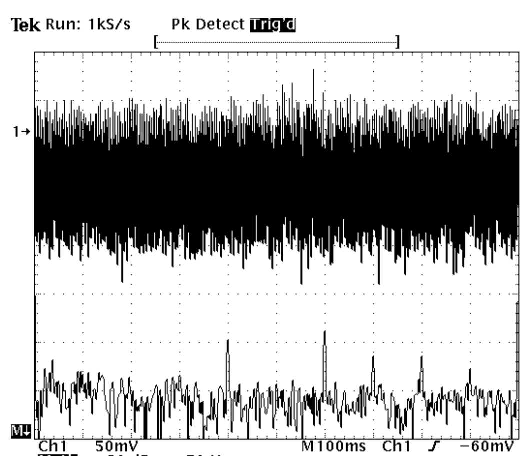

Figure 6: Example of beam vibrations in the horizontal plane, and corresponding FFT spectrum.

It can however be noted that the 38 Hz signal is gone in the horizontal spectrum. A typical vibration spectrum of the MAX-II beam varies from absolutely flat to what we can see in the figures in this paper which then represent more or less worst case vibrations over an hours measurements. This at the time when the measurements was done. Fig. 7. shows a worst case of vibrations found once during the vibration investigation.

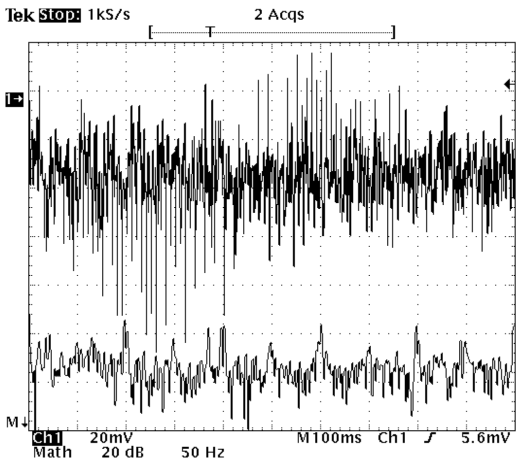

Figure 7: Example of worst case beam vibrations in the vertical plane, and corresponding FFT spectrum.

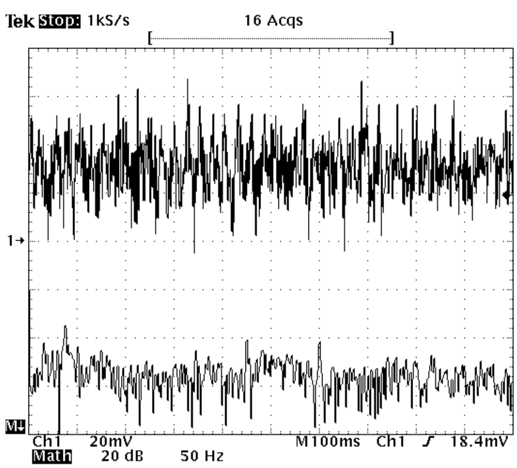

Figure 8: Example of beam vibrations in the vertical plane, and corresponding FFT spectrum.

5 CONCLUSIONS

There are no significant measurable vibrations in the MAX II beam. Some minor vibrations are however detected, mainly with the frequency of 48 Hz. These are probably due to the big cooling water pumps bolted to the roof of the accelerator tunnel.

REFERENCES

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