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DESIGN OF SUPPORT FOR BPM DISPLACEMENT MEASUREMENT SYSTEM FOR HALF AND CONNECTION*

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Abstract

The beam orbit stability is an important parameter to measure the stability of the synchrotron radiation source. As for the fourth-generation storage ring, the emittance and beam size continue to decrease and higher requirements are being put forward for beam orbit stability. A set of offline BPM (beam position monitor) displacement measurement system with high stability was built. However, considering the adverse effect of the INVAR36 on magnetic field and the drift of the displacement data, we added carbon fiber to the new support for BPM displacement measurement probes. Besides we realized the function of real-time reading BPM displacement data through EPICS. This article mainly introduces the support design and EPICS connection of the BPM displacement measurement system.

INTRODUCTION

The Hefei Advanced Light Facility (HALF), a fourth-generation diffraction-limited storage ring, has completed pre-research. For the fourth-generation storage ring, ultra-high beam orbit stability is essential. The beam orbit stability is generally required to be less than 10% of the beam size, and near the insert device, it's usually required to be less than 5% of the beam size. For HALF, the minimum beam size in the horizontal and vertical directions is 5 μm and 2 μm, which means the vibration amplitude of the beam orbit should be less than 500nm in the horizontal direction and 200nm in the vertical direction. In order to meet the stability of beam orbit, a high-precision, a high-precision displacement measurement system and a high stable support for the high-precision probe are needed. The vibration amplitude of the support is also expected to be less than 50 nm and 20nm in the horizontal and vertical directions.

DESIGN

The Relationship between amplification factor and eigen-frequency is shown in Fig. 1. A higher ω_n will get a smaller support vibration amplitude.

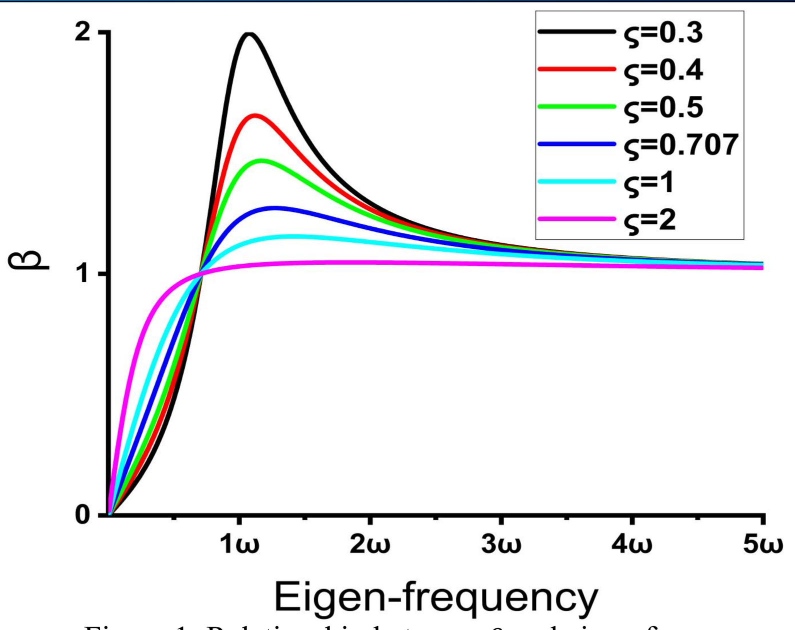

Figure 1: Relationship between β and eigen-frequency

According to the design requirements of the fixed method, the materials, the size, the eigen-frequency, and the difficulty of processing. The final model after FEA and optimization is shown in Fig. 2. The simulation results of the first longitudinal and horizontal eigen-frequency are $f_{1z} = 606.81\ Hz, f_{1x} = 791.78\ Hz$

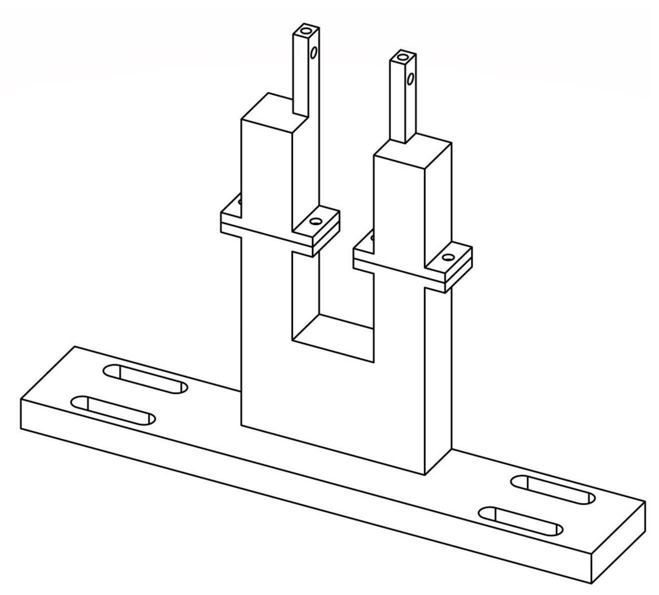

Figure 2: The model of the support

MEASUREMENT

Eigen-frequency by Hammer Method

Figure 3 is the horizontal and longitudinal frequency response of the constrained mode, which shows the first eigen-frequency in the longitudinal and horizontal directions are $f_{1z} = 252.9\ Hz$ and $f_{1x} = 470.7\ Hz$.

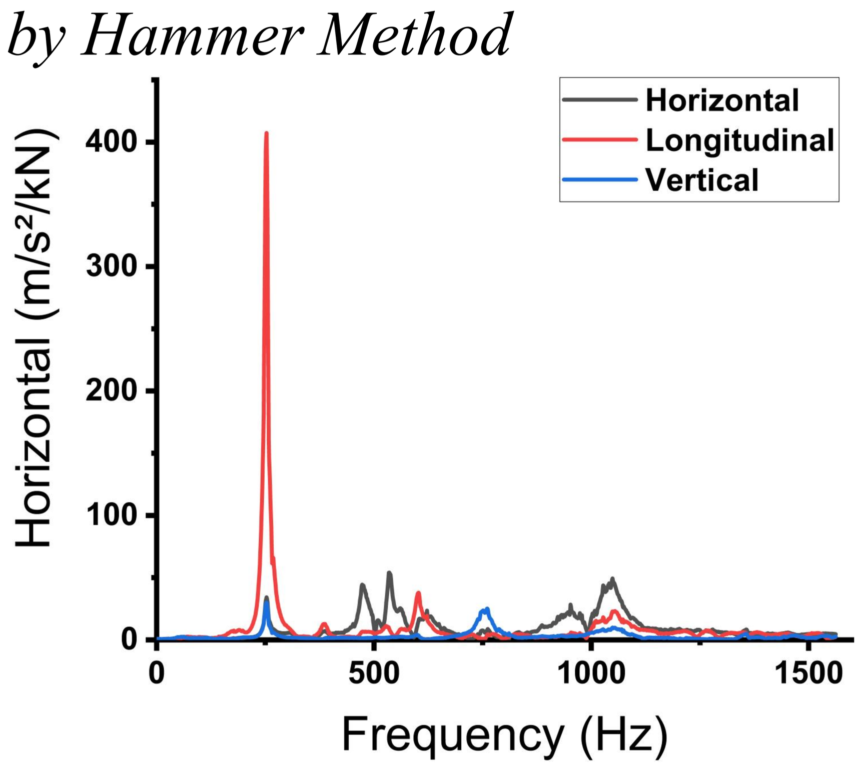

Figure 3: The frequency response of the constrained mode

MEASUREMENT

Vibration Measurement of the Support

The RMS vibration amplitude on the support and the platform are listed in the table.

Vibration amplitude RMS	Horizontal	Vertical
Top	13.09nm	13.56 nm
Platform	12.50 nm	13.16 nm
Target	50 nm	20nm
Amplification Factor	1.047	1.030

Measurement of the BPM Displacement

The displacement data from the two probes contains information about the BPM thermal expansion and the BPM movement.

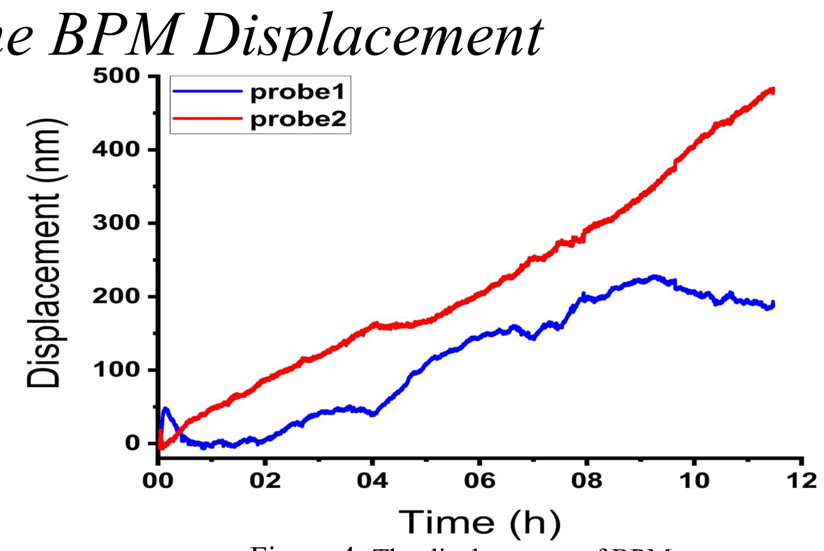

Figure 4: The displacement of BPM

EPICS CONNECTION

In order to correct the error of the beam position induced by the movement of the vacuum chamber and the BPM, it is necessary to upload the BPM displacement data to the EPICS system in real time.

IOC mainly consists of run-time database, device driver and sequencer. The run-time database consists of all kinds of records. The device driver can be divided into three layers: record support, driver support and device support. StreamDevice is used as device support, and Asyn is used as driver support. The EPICS support module for capaNCDT6200 on GitHub is used to transfer data to EPICS.

When the IOC is started, the BPM displacement data is read through the serial port, packaged into EPICS record and released to the local area network. The data can be obtained by accessing PV name through OPI.

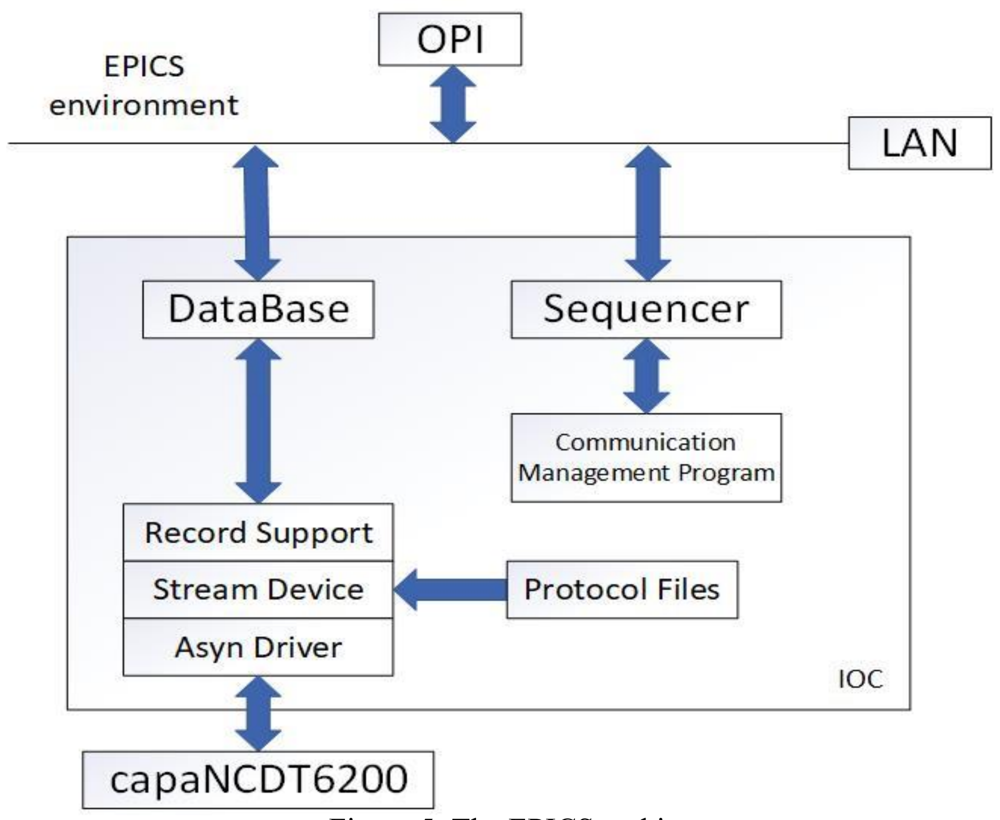

Figure 5: The EPICS architecture

CONCLUSION

The new support has a high first eigen-frequency in the horizontal and longitudinal directions of 252.9 Hz and 470.7 Hz. The horizontal and vertical RMS vibration amplitude of the support are 13.09 nm and 13.56 nm, which meet requirements for beam orbit stability. The new support realizes the function of measuring the displacement from both sides, which explains the reason for the drift of BPM displacement data. In addition, the data transfer between the BPM displacement measurement system and EPICS is also realized, which is necessary for further realization of BPM data correction.

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