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RESEARCH OF BELLOW SHIELD STRUCTURE APPLIED TO BPM

X.J. Nie*, L. Kang, R. Liu, S.K. Tian
Institute of High Energy Physics (IHEP) Accelerator Center, Dongguan, China
J.X. Chen, H.Y. He, L. Liu, C.J. Ning, A.X. Wang,
G.Y. Wang, J.B. Yu, Y.J. Yu, J.S. Zhang, D.H. Zhu
Institute of High Energy Physics (IHEP CSNS) China Spallation Neutron Source, Dongguan, China

Abstract

The design of shield structure for bellow is an important content for the research of beam position monitor (BPM). The bellow shield structure consists of contact fingers and spring fingers. Several alternative schemes for bellow shield were achieved based on BPM detailed structure. The optimal scheme was achieved by the impedance simulation analysis with CST. The dimension of the contact finger was decided based on the length of BPM with the stress condition. The C-type string was manufactured, and the spring force was measured as well.

INSTRUCTIONS

Beam position monitor (BPM) is an important diagnostic equipment of beam position. It is widely applied on accelerator. Normally, four electrodes are applied to get the beam signal and the beam position is calculated by the signal contrast. To decrease the effect of near equipment to BPM, the bellows are applied to the two ends of BPM [1, 2]. But they will lead to a discontinuous surface inside the vacuum chamber and thus the impedance will increase accordingly. So, it is necessary to design the shield structure to reduce the impedance of the bellows.

DESIGN OF BELLOW SHIELD STRUCTURE FOR BPM

The shielding principle is stated as the following. Some mental wires or strips are used to contact the two ends of the bellows to form a smooth transition. This can eliminate the cavity structure inside the vacuum chamber, decrease the impedance and the HOM leakage [3, 4].

Design of Shield Plan

According to some related references and the overall structure of BPM, several alternative shielding structures were achieved as Fig. 1. Model 1 was the C type shielding structure in which the C type string was used to press the contact fingers. Model 2 was the double fingers in which the contact fingers touch the vacuum chamber and spring fingers pressed on them. Model 3 had a simple structure which just had contact fingers to touch a cone-shaped sleeve. An insert block was used in model 4 to touch the spring finger, which could get a small step with big gaps. Model 5 had a net type shield structure to touch the vacuum chamber.

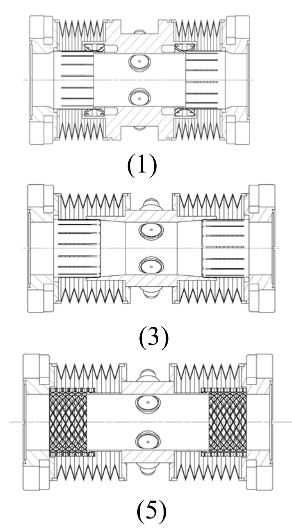

Figure 1: Shield plans of BPM bellow.

To understand the impedance characteristic for above shield structures, the simulation of impedance was done for them. The result showed as Figs. 2 and 3.

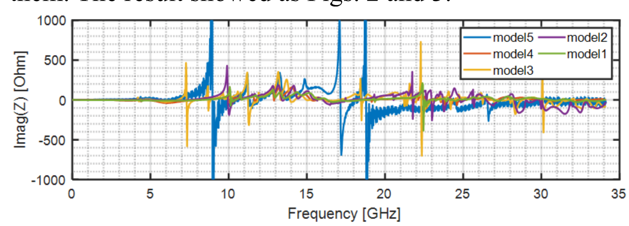

Figure 2: Imaginary part of impedance for the shield structures.

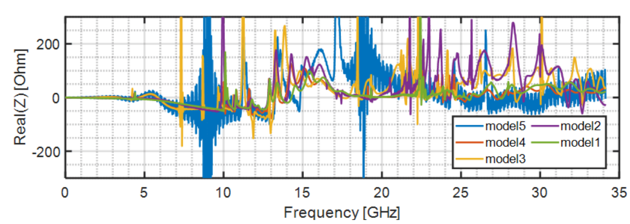

Figure 3: Real part of impedance for the shield structures.

It seemed that model 1 had the best impedance characteristic. So, the further study was focused on it. The main structure of the final shield plan showed as Fig. 4.

* niexj@ihep.ac.cn

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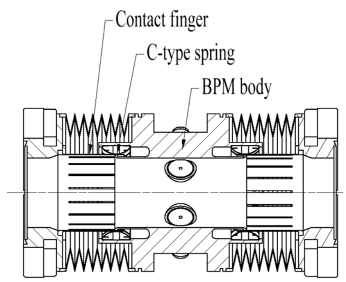


Figure 4: Final BPM bellow shield structure.

Design of Contact Fingers

Contact finger touches vacuum chamber directly. It's easy to make offset with the bellow when making vacuum connection. Simulative computation of stress was done for different length contact finger under 1mm offset. The result showed as Fig. 5, which illustrated that the longer contact finger would get better stress. Based on some related reference, beryllium Copper C17200 was selected to make contact finger, which had about 1000MPa yield limit [5]. Thus, the minimum length was set as 8mm according to the chart and BPM structure.

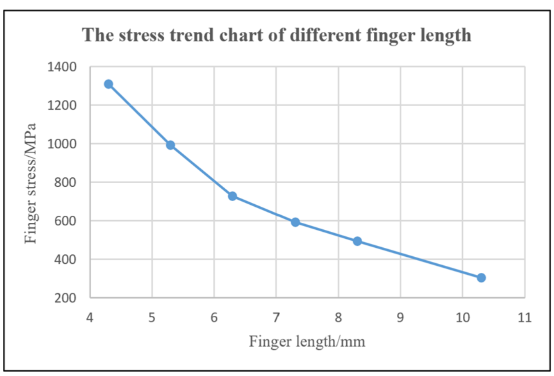


Figure 5: Stress trend chart of different finger length.

Meanwhile, the stress with different contact finger width was simulated. The result showed as Fig. 6. According to the chart, we can conclude that the narrower width of the contact finger can achieve better stress. But there are not significant difference among them. So, the final width of contact finger was set as 4mm.

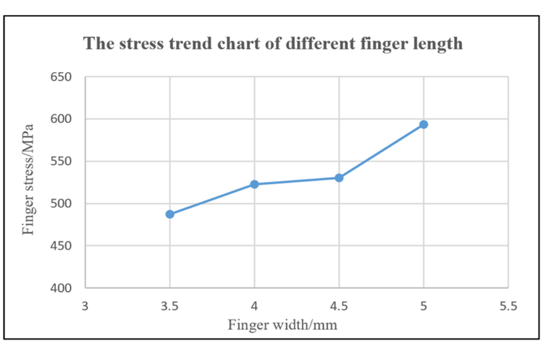
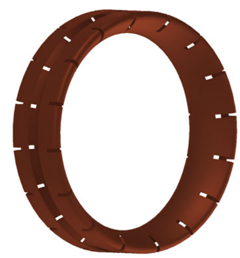


Figure 6: Stress trend chart of different finger width.

Analogized to shanghai synchrotron radiation facility (SSRF), the thickness of the contact finger was set as 0.2mm according to some references. And the gap between two fingers was set as 0.5mm [3].

Design and Trial Manufacture for C-Type Spring

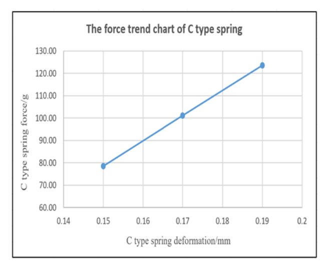
C-type spring was a critical component for the shield of BPM bellow, which presses on the contact fingers to keep them touching with the vacuum chamber. According to some references, when the elastic force reaches 125g, the contact fingers can touch the vacuum chamber well with flexible adjustment. The C-type model was designed based on BPM contact finger. Then the trial-manufacture and the measurement of elastic force were made to verify the technology and elastic force. The result showed that about 0.19mm deformation can obtain about 125g elastic force. Figure 7 showed the model and result.



(1) C-type spring model

(2) C-type spring sample

(3) Elastic force test



(4) Elastic force trend chart

Figure 7: C-type spring model and elastic force test.

SUMMARY

The shield plan of BPM bellow was decided by BPM structure and impedance characteristic. The structural dimensions of contact fingers such as the length and width were achieved by the stress trend chart. Finally, the C-type spring was manufactured by trial and the elastic force was measured accordingly.

ACKNOWLEDGEMENTS

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