Vibration Simulations for SESAME Girder Magnets Assembly

Maher M. Shehab
SESAME Light Source, P.O. Box 7, Allan 19252, Jordan

Abstract

SESAM is a 3GeV, 3rd Generation Synchrotron Light Source currently under construction at area Allan 20 km from Amman the capital of Jordan. One of the major players on beam stability is the girder magnet system vibration stability. This paper describes the progress in the design and analysis of SESAME girder magnets system. As the girder design is still in the R&D phase several girder system solutions existed at modern light sources as ANKA and ALBA analyzed for SESAME case. What shown in this paper is the static modal & PSD analysis for the different studied scenarios.

1. Introduction

SESAME main ring consists of 16 Dipole, 32 F-quadrupoles with magnetic length of 30cm, 32 D-quadrupoles, 32 F-sextupoles and 32 F-sextapules with magnetic length of 10cm, the beam height for SESAME has been chanced recently from 1.2m to 1.4m to meet the beam height requirements of the denoted insertion devices, the girder system design has passed through many modifications to cope with the new requirements.

2. Girder System Design Proposals

Two major girder design proposal have studied. The first one consists of two types, one for the dipole magnet and the other for the multipoles. in SESAME lattice design, two sextuples (focus & defocus) and two Quadruples (focus & defocus) is symmetrically distributed about one dipole for this reason only two types of girders needed, this design proposal exactly emulates the ANKA girder system design in which three struts are placed in the horizontal plane one on the direction of the beam and two in a right angle with the beam direction in addition to three vertical jacks as shown in figure1.

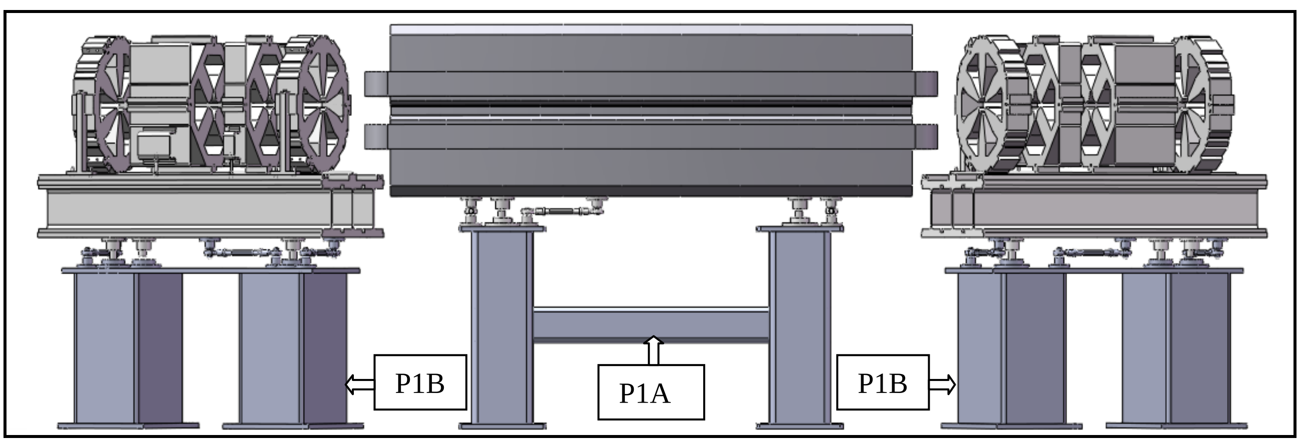

Figure 1: First Proposal of SESAME Girder System(P1 types A & B).

The second proposal is a single girder carrying the dipole magnet, four Quadrapules & four Sextapules . This configuration adapts ALBA girder system design. The configuration of this girder consists of three pedestals carrying the magnets pad. The pedestals occupied with two vertical jacks each, three adjustment struts are attached to the pad and pedestals, and the freedom on the horizontal plane is constrained by fixation.

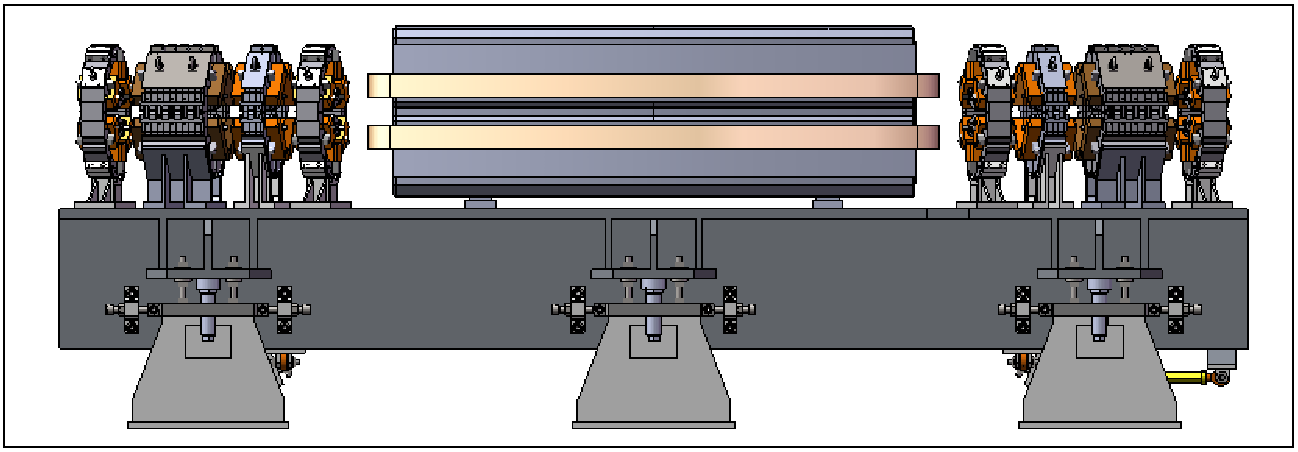

Figure 2: Second Proposal of SESAME Girder System (P2C2)

2. Static, Modal & PSD Analyses

2.1. Static Analysis

as a first step in the design and analysis, Static analysis has been performed for the different design proposals to assess the structural integrity of the different proposed designs, for the second proposal (ALBA type) we made the study for the two cases one for the girder supported by two pedestals (P2C1) and the second with three pedestals (P2C2), through all the performed analysis the mass of the vacuum chambers have been distributed on the magnets , the contact condition between all contact bodies has been considered as bonded , the following table surmises the static deformations for the different studied scenarios

Table 1: Static Deformation

Girder Type	Static Deformation
P1A	20 µm
P1B	15 µm
P2C1	34 µm
P2C2	29 µm

2.2. Modal Analysis

Modal analysis has been performed for the different design scenarios. for the ANKA type girder the first eign frequency for the dipole girder (P1A) was 19.9Hz while the first eign frequency for the multipole girder (P1B) was 25Hz. in comparison with the second proposal which has the first natural frequency 41.6Hz for the first case (P2C1) and 44 Hz for the second case (P2C2) a significant improvement has been utilized . table 2 shows the first natural frequency the shape of the mode for the different types of girders.

Table 1: First Natural Frequency

Girder	Frequency	Shape
P1A	19.9 Hz	Bending About Beam direction
P1B	25	Bending About Beam direction
P2C1	41.6	Bending About Beam direction
P2C2	44	Bending About Beam direction

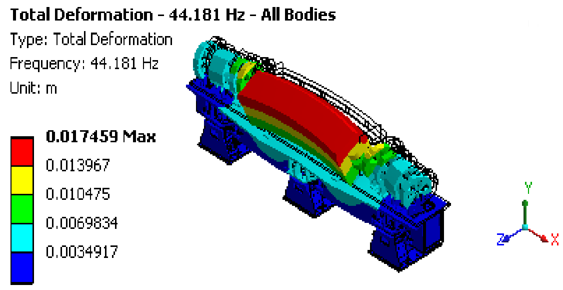

Figure 3: First Mode Shape for P2C2 Configuration.

2.3 Spectrum Analysis

A random input load has been applied to the support structure model at its mounting points. This is to simulate the vibration transmitted into the structure from the environment. up to know we have not made any ground vibration measurements, vertical floor PSD measured at daresbury laboratory [2] has been considered, a flat PSD spectrum from 1 Hz to 120Hz of 1E-8 g^2/Hz has been applied , with a damping ration of 2%.

What shown in Figures.4,5 & 6 is the results of the finite element analysis for vertical deflection of each magnet in P2C2 girder proposal. the maximum vertical deflection was0.089µm corresponding to S1 magnet , figure 4shows the PSD response of Sextuple magnets while figures 5 and 6 shows the response of the quadruples and dipole respectively. where the magnets is ordered as S1,Q1,Q2,S2,Dipole,S3,Q3,Q4 and S4 from lift to right.

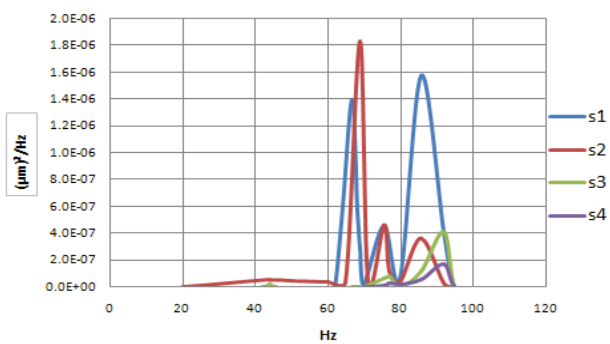

Fig.4. Vertical PSD Response Displacement For Sexta Magnets

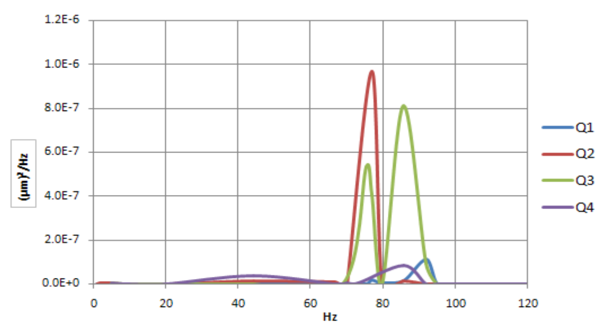

Fig.5. Vertical PSD Response Displacement For Sexta Magnets

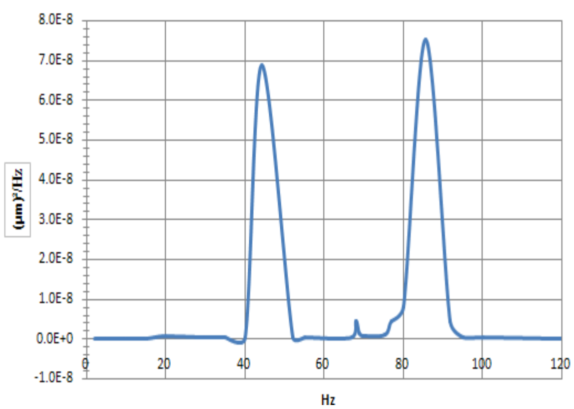

Fig.6. Vertical PSD Response Displacement For Dipole Magnet

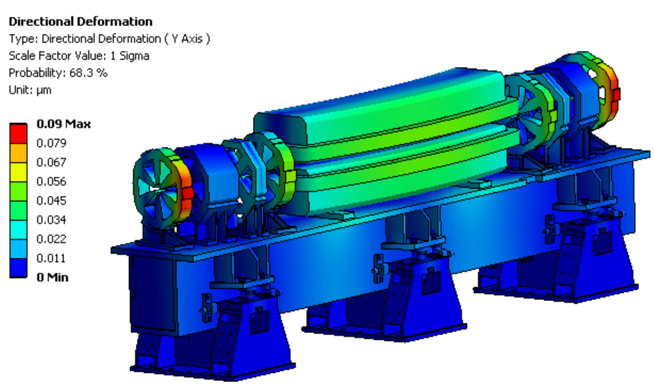

Fig.7. Girder Response To Flat PSD of 1E-8 g^2/Hz

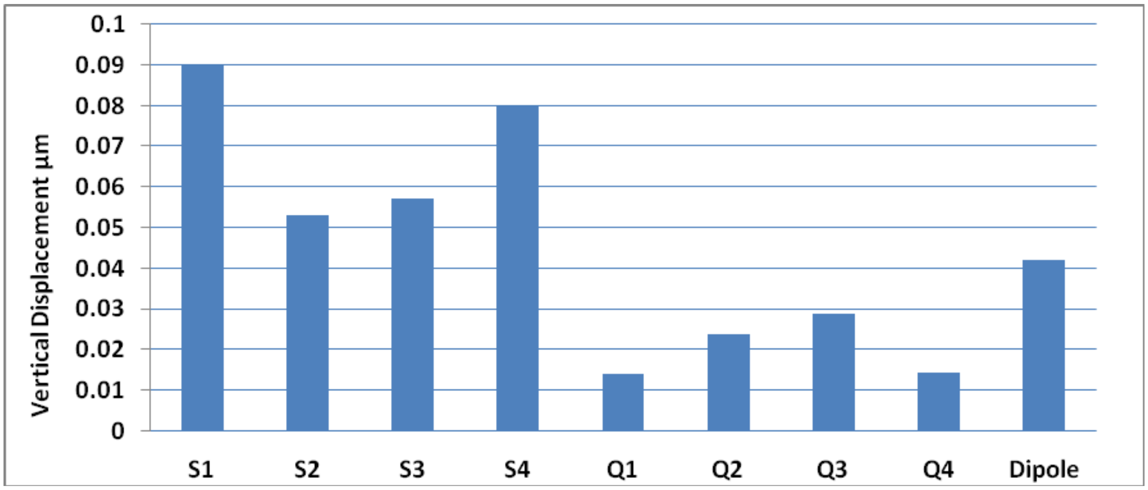

Figure 8: Vertical Displacement of Magnets Subjected to 1E-8 g^2/Hz PSD Base Excitation

3.Discussion And Conclusion

The girder system for SESAME is still under development and analysis phase. what we did to now is experimenting the different existed girder systems designs in light sources similar to SESAME, the results shown in this paper shows the expected performance of those designs subjected to SESAME case.

For the deformations results the P2C2 proposal has shown the largest deflection value of 29 µm, but not far from the other proposals, for the modal analysis result it is clear that the first mode shape for the different proposals was bending around the beam direction, there was a noticeable improvement for the first natural frequencies in the second design proposal P2, specially the case of three pedestals support. in which the first natural frequency was 44 Hz. while in the first proposal the first natural frequency for the P1A type girder was 19Hz.

Applying the flat PSD excitation of 1E-8 g^2/Hz, revealed a maximum vertical displacement of 0.09 µm occurred at S1 magnet. for the quadruple magnets the maximum vertical displacement was 0.029 µm at Q3, while for the dipole it was 0.042 µm it is noted that the maximum response occurs around 65 Hz, 79 Hz and 85 Hz for the Sextuple magnets, and around 79Hz and 85Hz for the Quads , for the dipole magnet the maximum response occurs at 44 Hz and 85 Hz.

4.References

[1] L. Zhang, Vibration of Magnet Girder Assembly, EPAC96

[2] K. K. Leung, Dynamic response Analysis of The LBL Advanced Light Source Synchrotron Storage Ring, PAC93

[3] C.J. Nelson, PSD Spectrum Analysis, FEA Report for ATLAS End Cap Support Structure