THAI SYNCHROTRON NATIONAL LAB

MEDSI CHICAGO 2020

Design of Magnet Girder System for Siam Photon Source II

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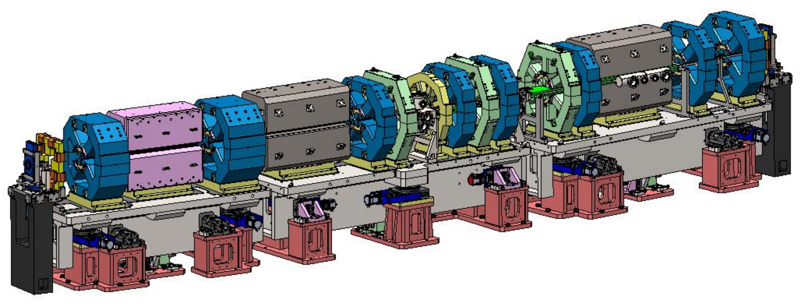
Abstract

- For the new Siam Photon Source II (SPS-II) a storage ring was designed with a circumference of 327.502 m. It consists of 14 DTBA cells, where each cell requires 6 girders.
- We developed a magnet girder system which uses wedgemounts for the precision alignment based on a 3-2-1 alignment method.
- Regarding a low girder deformation and to gain a high mechanical natural frequency, FEM simulations were carried out.
- On this poster simulation results are presented as well as the design of the girder, pedestal and its wedgemount based alignment system.

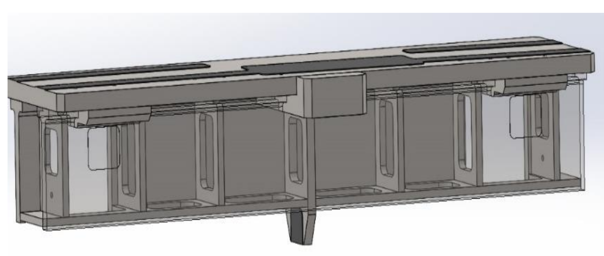
General Information

- There are three in length different girders per half-DTBA cell
- The girders are 2240 mm, 2750 mm and 2870 mm long. All of them have a width of 750 mm. The beam height was set to 1.2 meters.
- Each girder including magnets and pedestals has a weight between 7 to 8 t.



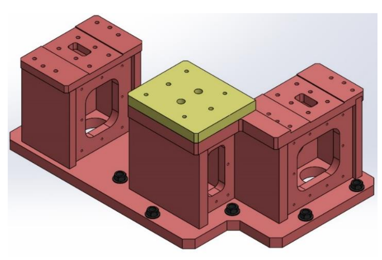
Girder Design

- Girder with a box-type structure with a thick top plate and seven internal enforcement ribs.
- The top plate requires high precision surfaces for the magnets. These surfaces will be machined with a flatness of 30 µm.
- 3x 80mm thick support beams transversally welded to girder top plate provide a basis for three vertical support points.



Pedestals

- There are 3 pedestals to support the girder.
- It is planned to install a damping layer (e.g. epoxy concrete) between concrete floor and pedestal base plate to improve the vibration stability.
- Pedestals can be filled with concrete for better damping.
- Pedestals also accommodate the adjustment components for horizontal girder alignment.

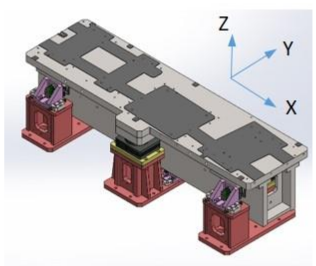


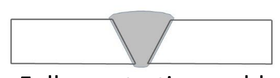
Material

- For girder and pedestals structural steel S355JR (or A572 Grade 50) will be used (good strength, durability and weld ability). The structures are being put together by full penetration welding (where it is possible).

Coordinate System

- The survey coordinate system is used.
- Z for vertical direction
- X and Y for horizontal direction

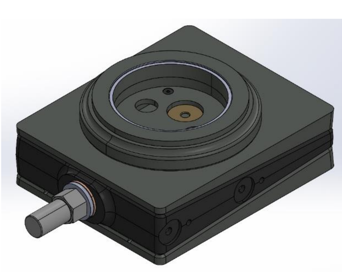


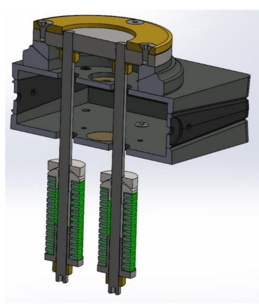


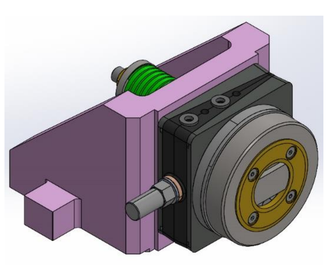
Full penetration weld

Adjustment System

- 6 wedgemounts manufactured by AirLoc AG will be used.
- For the Z-direction wedgemount model 414-KSKC was chosen since it was already successfully installed and used (with motorization) at ESRF [1]. (Range +/-9 mm)
- For the Y-direction wedgemount 2130-KSKCV with modifications to allow motorization will be used. (Range +/- 6 mm)
- The X-direction will be adjusted manually with wedgemount model 2012-KSKCV. (Range +/- 6 mm)
- All adjustment components are equipped with oil-free sliding washers which contact the girder.
- All wedgemounts are equipped with spherical seats.
- Coil springs are used to induce a pre-load between wedgemount and oil-free washer (resp. its housing).

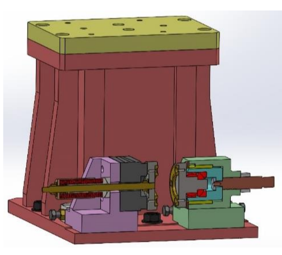


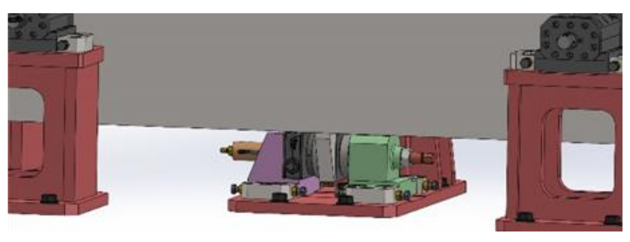




Manual X-Adjustment

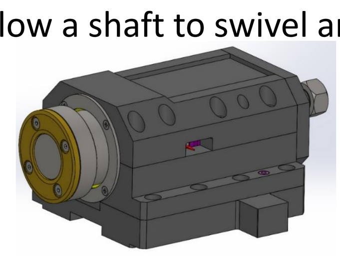
- The adjustment components for X-direction were placed on the base plate of the center pedestal and they contact the girder in its center.
- All components for the horizontal (X and Y) adjustment can be pre-adjusted by push-push screws with a range of +/- 12.5 mm.

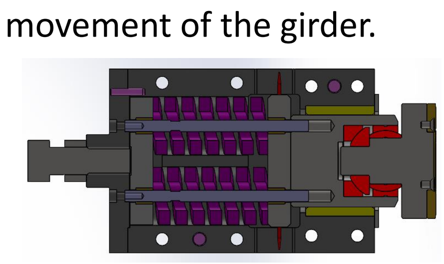




Push-Back Spring

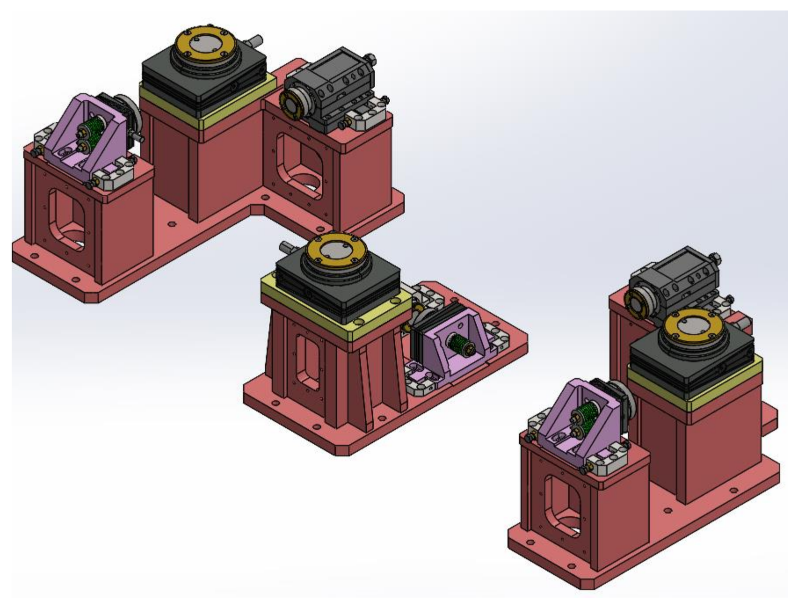
- A wedgemount can push the girder only in one direction – a push-back mechanism has to be used opposing to each wedgemount.
- Inside the push back spring assembly are two strong coil springs with a maximal load of 18.4 kN each and max. deflection of 13 mm.
- Springs are pushing against a cylinder equipped with a set of radial spherical and thrust spherical plain bearings. The bearings allow a shaft to swivel and thereby follow the movement of the girder.

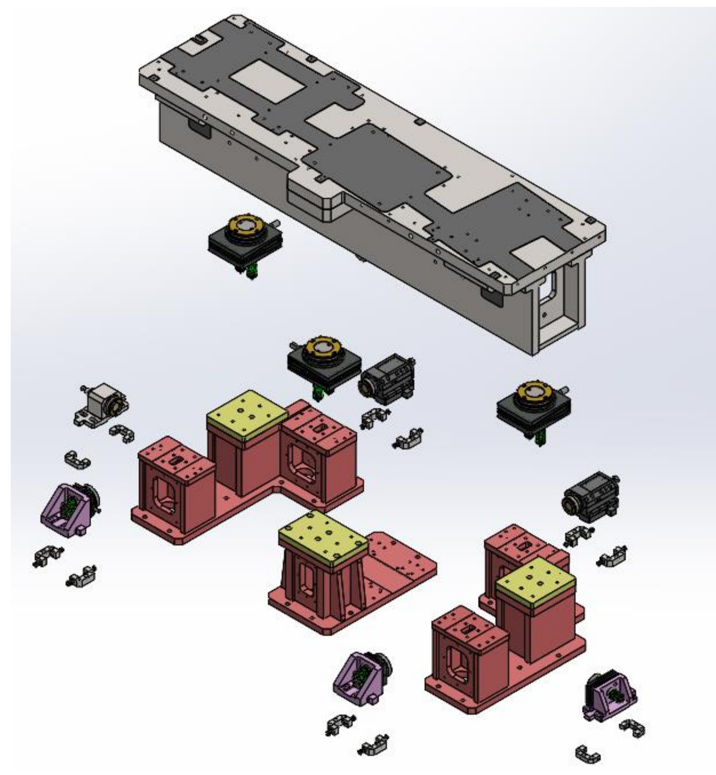




Girder System Assembly

- Welded box-type girder structure
- 2 outer and 1 center pedestal (welded structure)
- 3 wedgemounts for Z-alignment
- 2 wedgemounts for Y-alignment (with opposing push-back spring)
- 1 wedgemount for X-alignment (with opposing push-push screw)



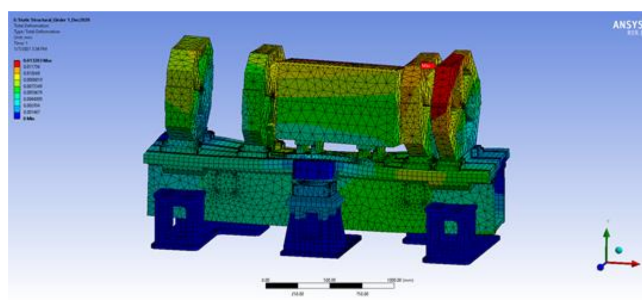


Simulation

- The simulation software ANSYS was used to optimize the girder geometry regarding an as low as possible girder deformation and a high first natural frequency.
- A simplified CAD model of each girder with magnets was used for the simulations. The design goal was a total deformation of less than 20 µm and a frequency for the 1st mode of higher than 35 Hz.
- The girder design was step by step improved by changing geometry parameters such as varying the thickness of all used steel plates as well as the length of the girder flanks or the width of the girder box.
- The results of the structural analysis were used further to perform the modal analysis.

Simulation Results – structural

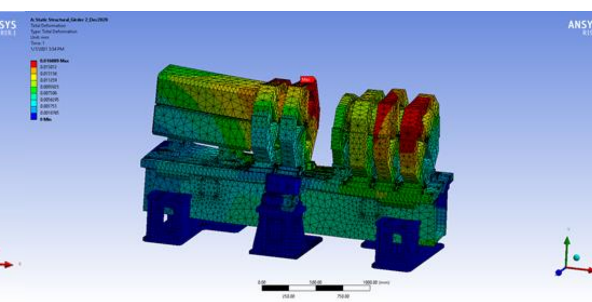
Girder 01



Total Deformation:
0.013mm at magnet top
0.010mm at girder top plate

Joint probe at support points:
21.6KN (Pedestal 1)
21KN (Pedestal 2)
21KN (center)

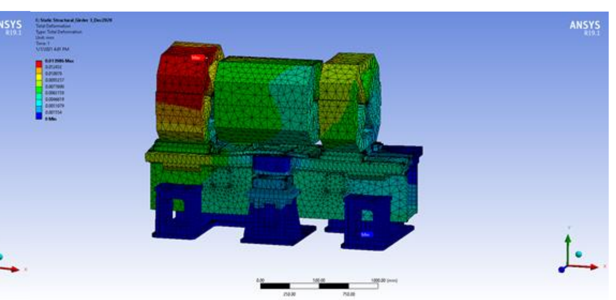
Girder 02



Total Deformation:
0.017mm at magnet top
0.012mm at girder top plate

Joint probe at support points:
26KN (Pedestal 1)
24.4KN (Pedestal 2)
14.5KN (center)

Girder 03

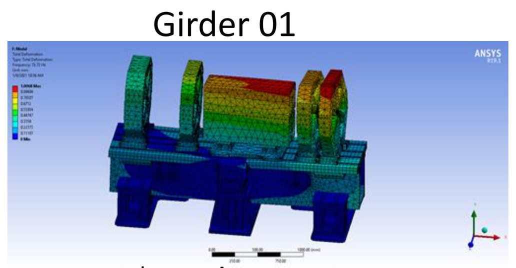


Total Deformation:
0.014mm at magnet top
0.009mm at girder top plate

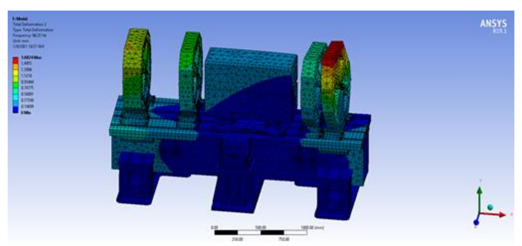
Joint probe at support points:
25KN (Pedestal 1)
17.2KN (Pedestal 2)
21.8KN (center)

Simulation Results – modal

Girder 01

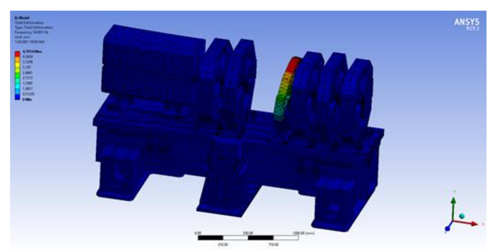


1st mode 72.7 Hz

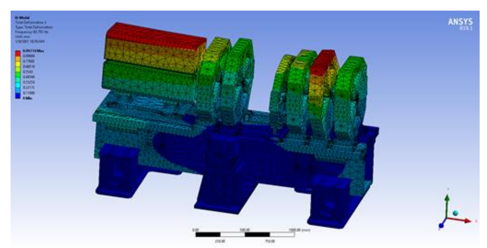


2nd mode 86.4 Hz

Girder 02

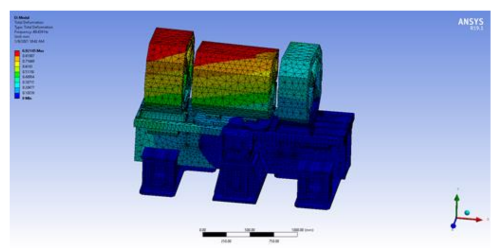


1st mode 54.9 Hz

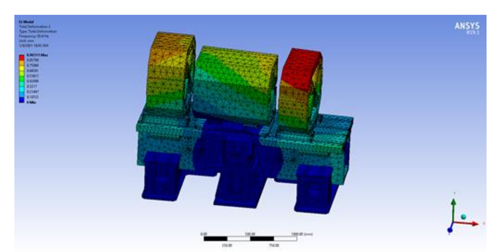


2nd mode 63.8 Hz

Girder 03



1st mode 69.4 Hz



2nd mode 83.6 Hz

	Girder 01	Girder 02	Girder 03
Mode	Frequency [Hz]	Frequency [Hz]	Frequency [Hz]
1	72.7	54.9	69.4
2	86.4	63.8	83.6
3	94.8	67.3	100.4
4	107.7	70.6	116.9
5	110.4	72.3	136.7
6	112.7	83.4	146.6

- The frequencies for all three girders are above the design frequency of 35 Hz.
- Frequencies higher than 70 Hz especially due to short girder length of less than 3 m.
- Frequencies for girder 02 are lower due to a thin and tall structure of an octupole magnet.

Conclusion

A magnet girder system for the new SPS-II synchrotron with DTBA cell structure was developed. Three girders of different lengths were designed which share the same type of pedestals and adjustment components. It is explained how all components are designed and how the alignment system using wedgemount works. FEM simulation was used to investigate the deformation and vibration behavior of the girder system under full magnet load. The results of the simulations are presented.

Acknowledgement

The author would like to thank Prof. J. R. Chen (NSRRC, Taiwan) and F. Cianciosi (ESRF, France) for their useful suggestions and good collaboration. Furthermore, the author would like to thank the SLRI 3GeV team for their support and help with the girder project.

References

[1] *Filippo Cianciosi, Lin Zhang, Thierry Brochard, et. al., The Girders System for the new ESRF storage ring, 11/09/2016, MEDSI 2016, Barcelona*

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