PIP-II Warm Unit

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Abstract

The Warm Units are a vacuum manifold that joins the superconducting cryomodules of the PIP-II linear accelerator (linac). The primary function of the Warm Unit is to provide vacuum pumping for the cryomodules. They also provide the opportunity for beam characterization instrumentation to be installed periodically along the linac. The key design tasks were defining the interface to the cryomodules and designing a bellows restraint to use during the installation of the warm unit.

Introduction

The Warm Unit support structure needs to interface with the cryomodules to allow for proper alignment of the beamline between the cryomodules and the warm units. This will be done using a U-shaped bracket.
For the vacuum system of the warm unit to interface with the cryomodule a hydroformed bellows is used. These bellows are vulnerable to damage, especially during the warm unit installation, so a fixture to restrain and protect them had to be developed.


Figure 1

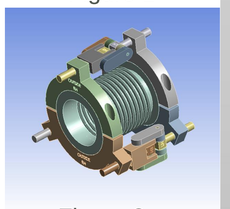
Figure 2

Methods and Materials

Special considerations
Bracket
- Proper load capacity
- Clearance between nearby features

Bellows Restraint
- Vacuum and particle free assembly safe materials
- Galling between like materials
- Enough strength to compress the bellows

Structural analysis was performed using Ansys Clearances were verified in the 3D model and through rapid prototyping. Materials where chosen that would not oxidize and produce rust. To prevent galling all parts that where in contact with each other are dissimilar materials.

Results

ANSYS structural analysis
- Warm Unit support structure and bellow restraint had negligible deformation shown in figures 3 and 4.
- The max stress concentration was well below the yield strength of the materials.

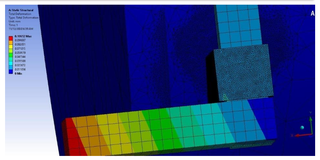
Figure 3

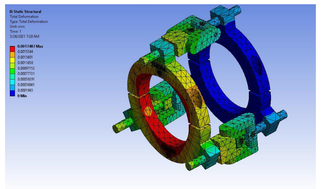
Figure 4

Results Continued

- The accelerator is sensitive to frequencies below 10Hz and at 30Hz.
- A modal analysis was performed on the entire warm unit figure 5
- The structure resonated at some critical frequencies
- Low profile gussets moved that mode away from the critical frequencies. Figures 6 and 7

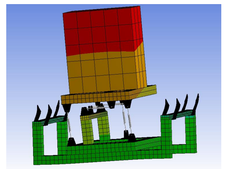
Figure 5

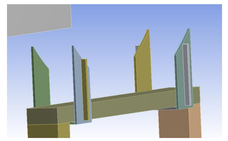
Figure 6

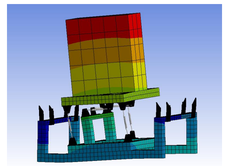
Figure 7

Conclusions

Through careful analysis and testing a support bracket and bellows restraint was designed to meet all the criteria that Fermilab provided.

Acknowledgements

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