Mechanical Design, Testing, and Simulation of Self-Aligning Gaussian Telescope and Test Stand for ITER LFS Reflectometer Diagnostic

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Motivation
- The Low Field Side Reflectometer diagnostic device will be used for ITER
  - Couple microwaves in and out across the vacuum windows
  - Movement of the vacuum vessel with respect to the waveguides
    - Thermal growth • slow movements
    - Vibrations/Disruptions • rapid movements

Background
This mechanism was begun, designed, and patented by Michael Gomez, Ali Zolfaghari, and Cara Bagley during the 2015 SULI program.

Self-Aligning Gaussian Telescope
- Apply Gaussian optics
  - One side of the waveguide remains fixed, the other side is free to move
  - Two identical, spherical mirrors
- Focal length
  - Link maintains a distance of 2*f between the mirrors
  - Distance from end of waveguide to mirror fixed at one focal length

Model
- Test Stand designed to hold waveguide and Self-Aligning Gaussian Telescope.
  - Simulate motions the mechanism will undergo at ITER
  - Original design altered to match set-up at General Atomics
    - Simplified to one waveguide and telescope mechanism

Analysis and Results
Simulations performed in ANSYS workbench. Refer to videos.

Rigid Body Dynamics
- Movement in the x- and z-directions to simulate thermal growth
- Final model will also allow movement in the y-direction
- Waveguide slides and rotates appropriately

Static Structural
- Yield strength of aluminum = 275 MPa
- Maximum stress on link = 122 MPa
- Factor of Safety = 2.2
- Motion in the correct directions
  - Tube slides in x-direction
  - Plate and clamp fixed

Future Work
- Assembly of the self-aligning scissors mechanism and stand
- The motions of the stand will be tested in order to simulate thermal expansion, thermal contractions, disruptions, and vibrations
  - Slow single- and multi-directional movement
  - Rapid multi-directional movement
  - Laser alignment
  - Natural frequency
- Send to General Atomics where the mechanism will undergo microwave testing
- Revise as necessary
- LFS Reflectometer diagnostic device ready to be used for ITER

Conclusions
- Based on the results from the simulations, the apparatus will function properly
- More progress required before the mechanism reaches the final destination of ITER

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References