New insulators and mechanical supports to prevent arcing in CMFX

Ismail Aadan, Dr. Carlos Romero-Talamás

[1] University of Maryland, College Park, 20740 [2] University of Maryland Baltimore County, Arbutus, 21250

Abstract

The Centrifugal Mirror Fusion Experiment (CMFX) vacuum chamber experiences electric arcing when enough deuterium becomes trapped on surfaces behind the insulator. The effects of arcing on the plasma include lowering the insulating voltage and damage to the limiter electrodes. To minimize the migration of gas behind the insulator, a new insulator design is being implemented. Another improvement to CMFX by this design is the use of machinable ceramic (Macor) for the supports which will provide an electrically neutral material that will provide additional insulation and prevent electric shorting to the ends of the chamber.

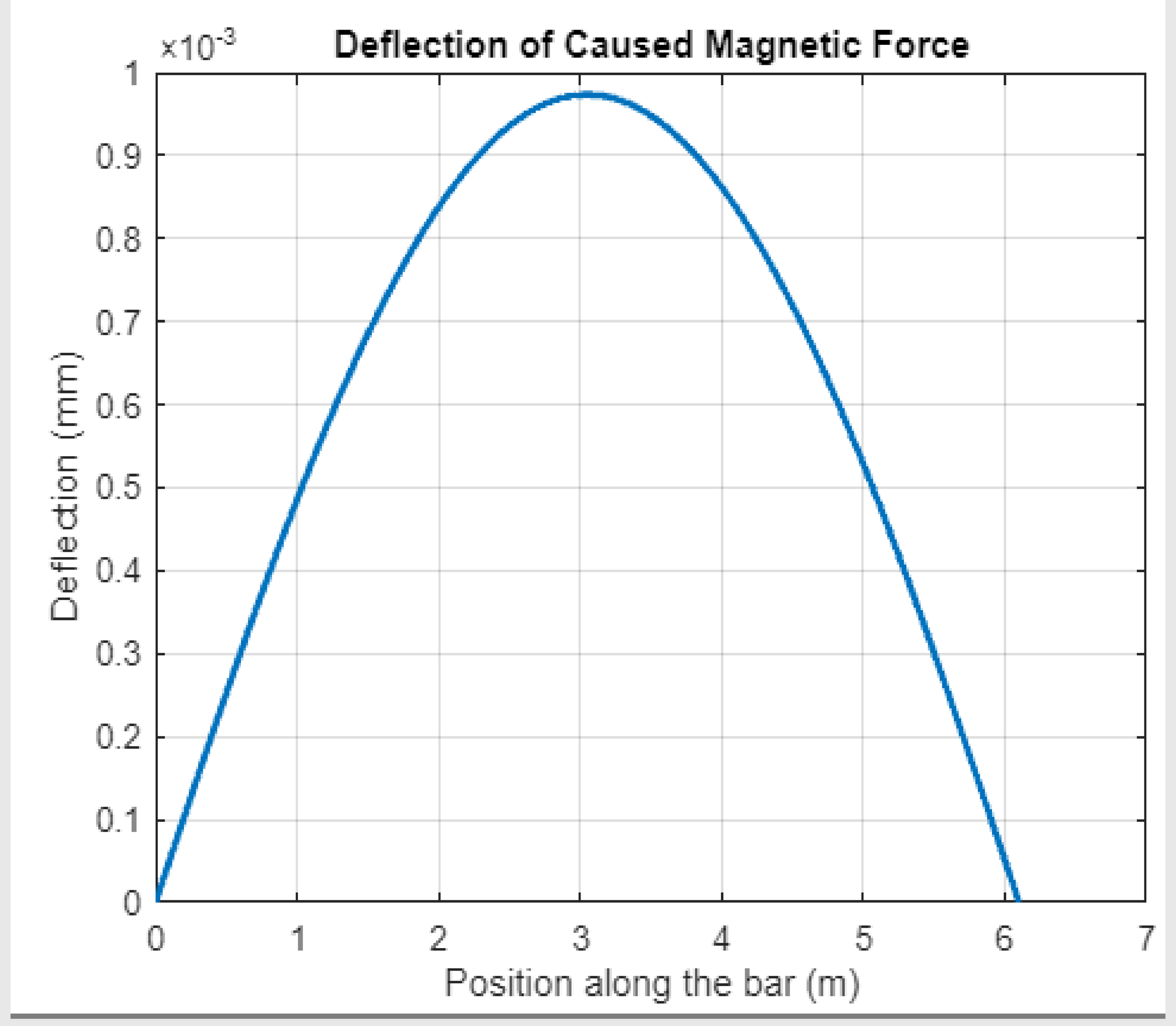
Intro

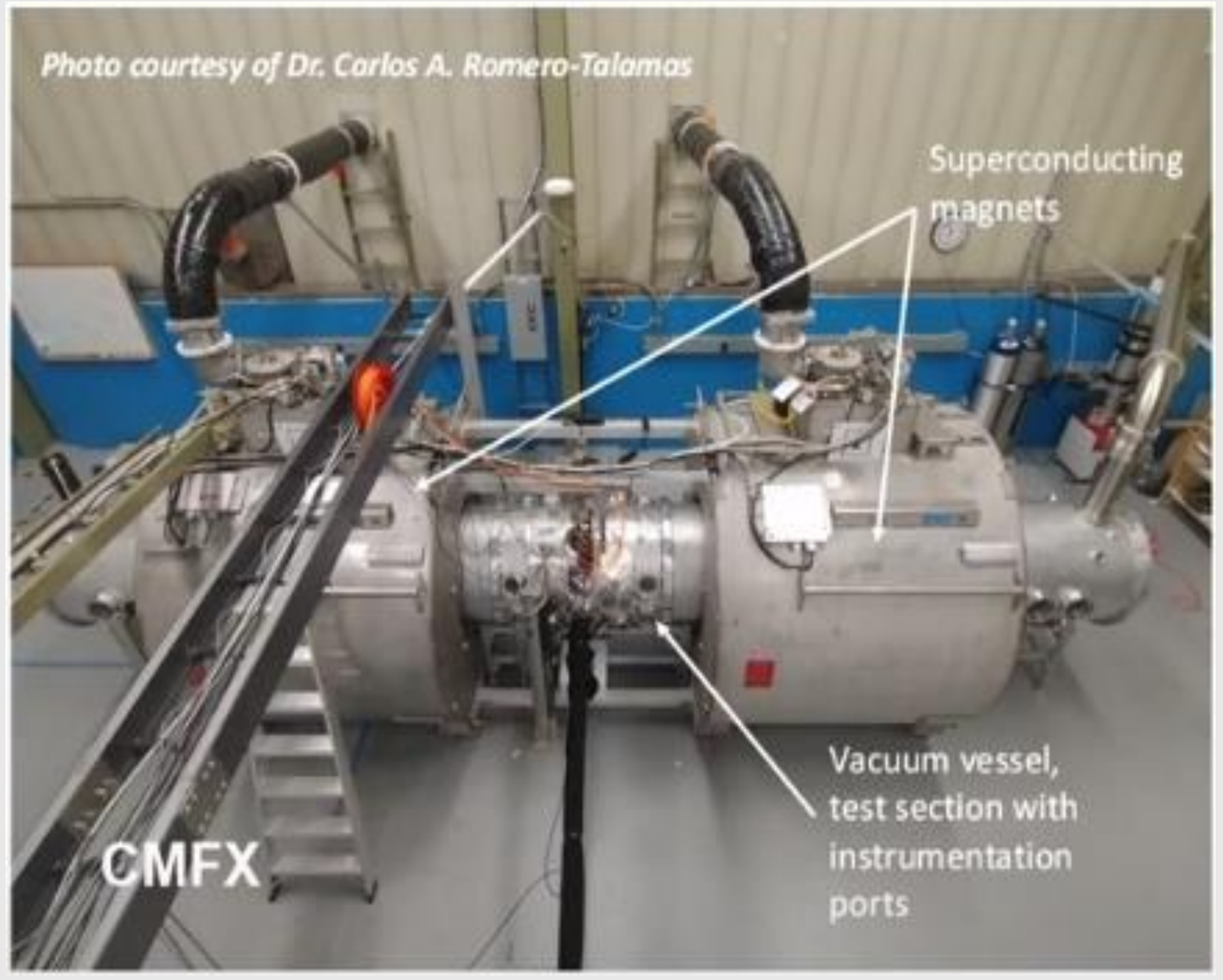
The Centrifugal Mirror Fusion experiment (CMFX) aims to decrease plasma arcing via design changes to the support structures for the actuator subassembly as well as to measure magnetic pressure that is deflecting the central electrode by 1 cm. The goal is to prevent the discharge of electric current between components inside the plasma chamber. The new shape of the supports is rounder to prevent blockages and gas build up in ridges and sharp surfaces. The primary methods of analysis for the magnetic pressure came via use of the superposition formula to find deflection of the electrode as well as utilizing the dependent magnetic field equation to find the distributed magnetic load on the electrode.

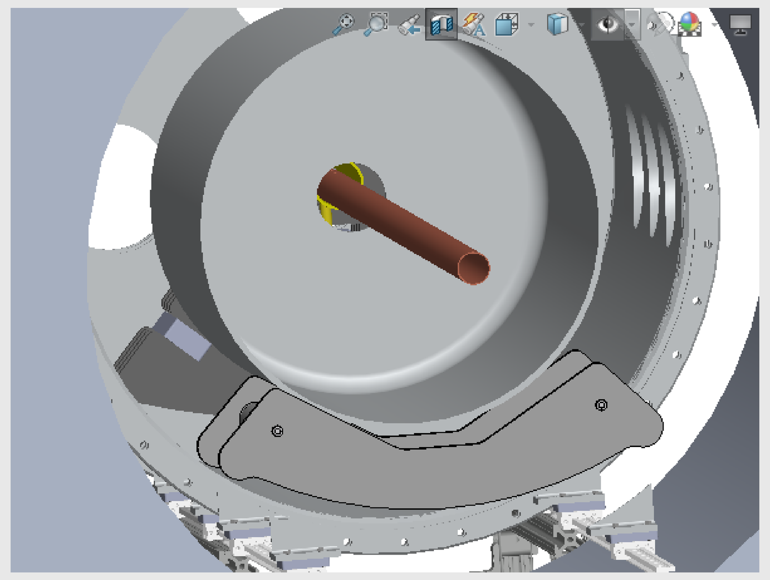
Methods

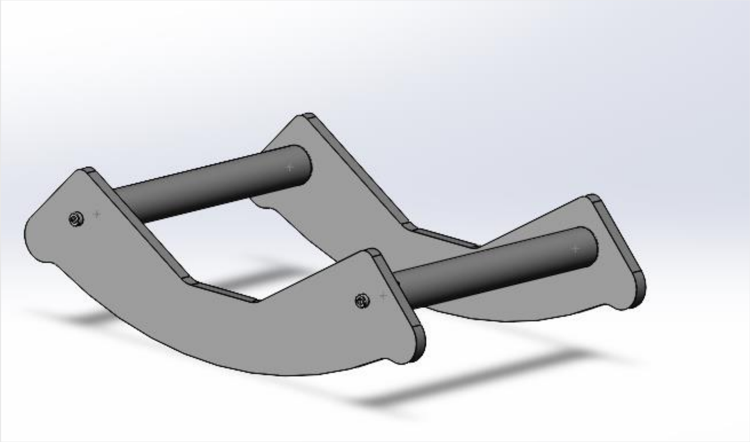
The purpose of the actuator supports new[design includes vented holes in the connector bars that result in allowing trapped gas to flow out seamlessly. This will improve power density on the plasma-facing side, and a simplified mounting structure fabricated out of a machinable ceramic (Macor). Additionally, the supports of the new design improve on the previous one by eliminating gaps in the center electrode supports and fasteners that would also cause arcing behind the main insulator. Details of the new support design are presented. MATLAB and SolidWorks was used to model the beam and the deflection caused by the magnetic field inside the plasma chamber.

Results

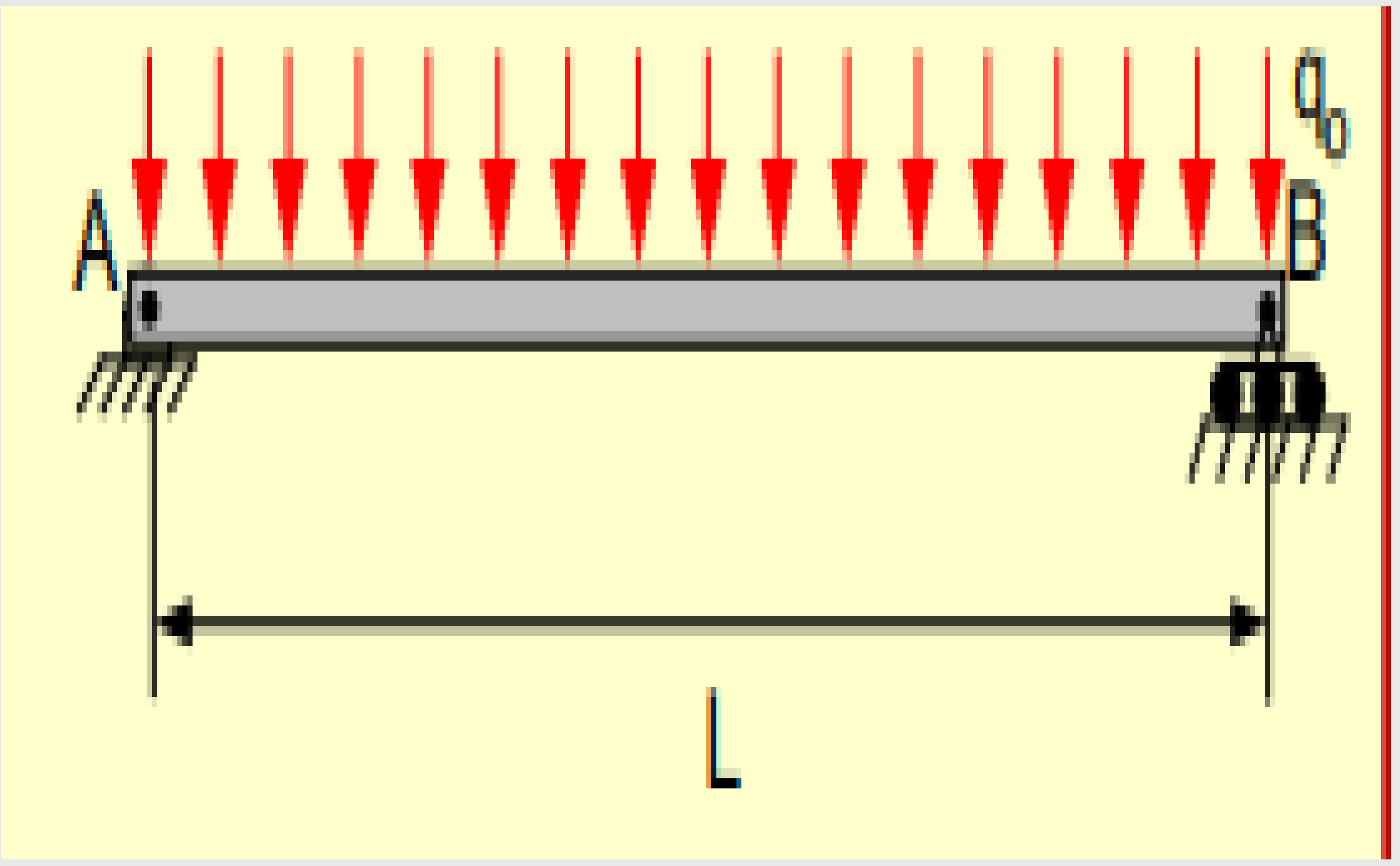








Distributed Load on Electrode



Theory

Acknowledgements

Work supported by ARPA-E Grant No. DE-AR0001270, and by NASA Grant No. 80NSSC20M0049 as part of the Maryland Space Grant Consortium program

Starting with the deflection Equation

δ=5qL^4/(384*E*I) m

Q = Distributed load of the Magnetic field (Pressure multiplied by distance)

Moment of Inertia of the Bar N/m

I=bh^3* 1/12 m^4

b = 6.1 m

h = 2.25 cm

E = Young's Modulus for Stainless Steel 200 Gpa

Radial Field Formula for Magnetic forces

Radial Field = B/r^(3/2)

B is the magnetic field

r is the radius of the B field

r = 3.81 cm

Find The Pressure

Magnetic Pressure magnitude

Pressure =B^2/2μ0

B = 0.34 Tesla or 3400 Gauss

μ0 is the Permeability of free space

μ0 =4*π*10^-7 H/M