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## Introduction

Electro Static Drive (ESD) is used to actuate the mirrors of the interferometer along longitudinal degree of freedom.

The longitudinal force from ESD balances the horizontal component of gravitation.

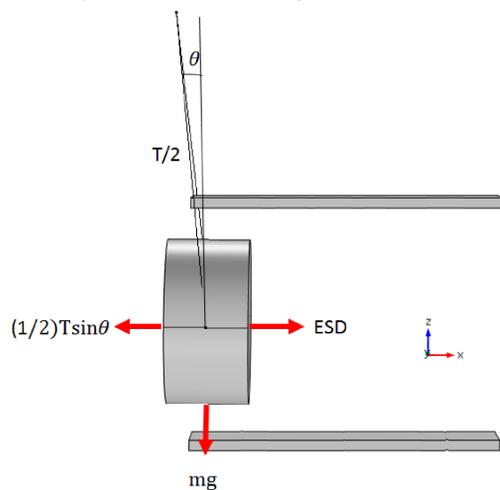


Figure 1. Forces on the mirror

## Computational Method

The force acting on the mirror is calculated using electrostatics module of COMSOL multiphysics<sup>®</sup> employing Maxwell stress tensor with  $n$  being unit normal vector of surface area  $A$ .

$$F = T \cdot n \, dA$$

$$T = \epsilon_0 \begin{bmatrix} E_x^2 - E^2/2 & E_x E_y & E_x E_z \\ E_x E_y & E_y^2 - E^2/2 & E_y E_z \\ E_x E_z & E_y E_z & E_z^2 - E^2/2 \end{bmatrix}$$

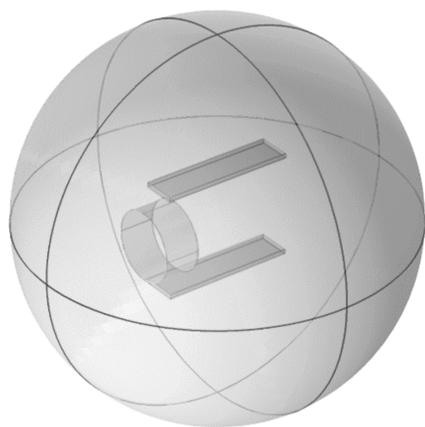


Figure 2. Air volume boundary of the ESD

Parameter	Value
Plate dimensions	90 x 23 x 3 mm
Separation	70 mm
Voltage	700 V
Mirror diameter	4.90 cm
Mirror thickness	2.45 cm
Mirror mass	100 g
Mirror dielectric	$3.79 \epsilon_0$

## Results

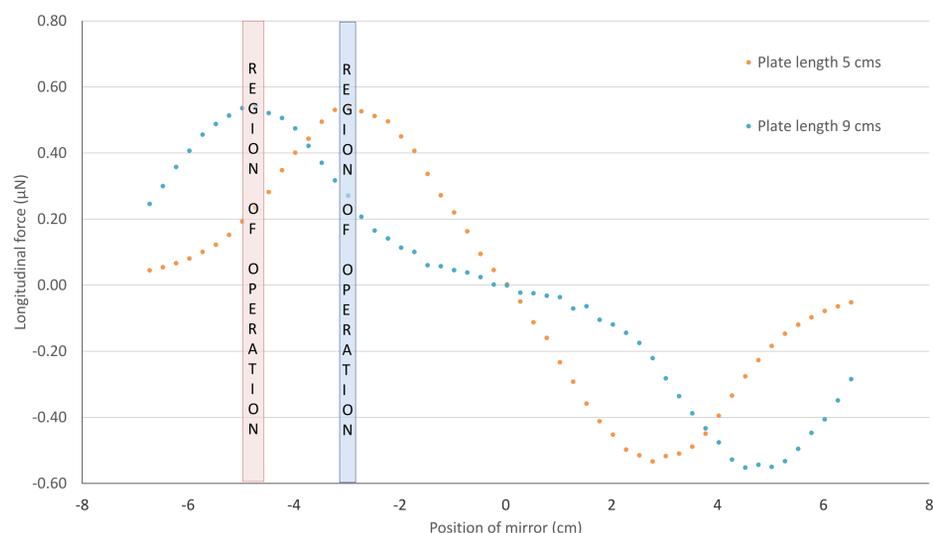


Figure 3. Longitudinal force versus position of mirror for 700 V voltage and 7 cm separation between plates

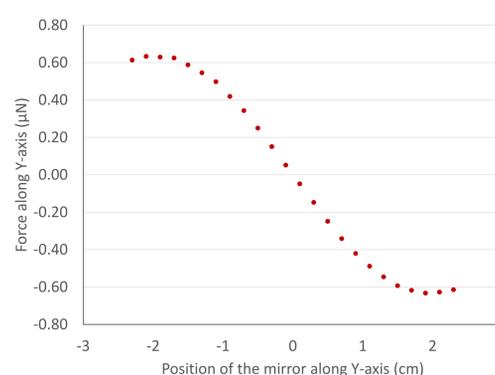


Figure 4. Force versus position of mirror along Y-axis

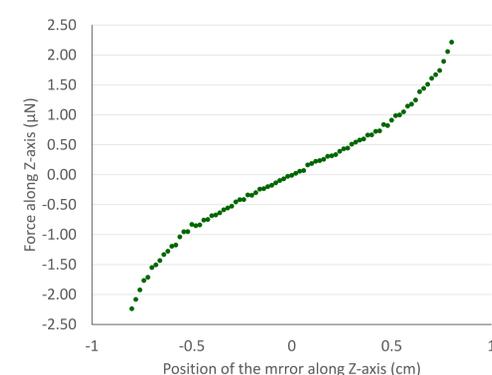


Figure 5. Force versus position of mirror along Z-axis

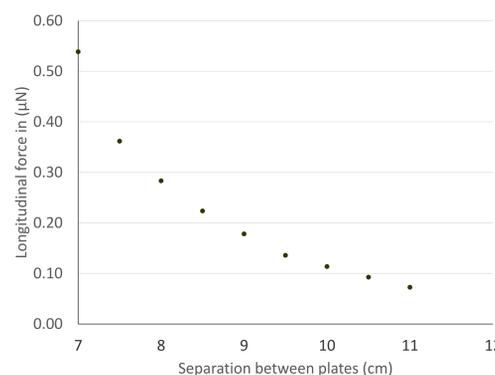


Figure 6. Force versus separation between plates

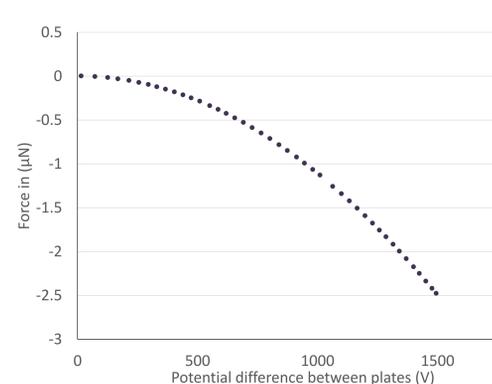


Figure 7. Force versus voltage applied

## Conclusion

The maximum force acting on the mirror is 0.54  $\mu\text{N}$  at 700 V. The force magnitude can be improved by increasing voltage and diminishing the separation between plates.

The force along X, Y-axis acts towards the center of the plates and in Z direction towards the plates to which the mass is closer.

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