OSEM Force Calculations

S. M. Aston, K. A. Strain, N. A. Robertson.

1 Introduction

During a discussion concerning ear positioning at the Glasgow Monolithic Workshop an action was raised to determine the OSEM force required to exert 1mrad pitch movement at the mirror [1]. We also investigate if this represents the "worst-case" OSEM requirement, which would enable us to proceed with the current OSEM electronics / actuation design. This brief technical notes aims to address both of these issues.

2 Background

The top mass incorporates Pitch Adjusters which enables the mechanical adjustment to move within the OSEM range. The worst case initial adjustment of the Pitch Adjuster is expected to be approximately 1 mrad (range ≈ 20mrad) [1]. It is therefore necessary to calculate the OSEM force required to achieve this 1mrad of movement.

To enable the force to be calculated, information regarding the "DC" response of the TM Quad suspension to OSEM forces, as well as information relating to the level-arms, is required.

3 Quad Model Results

The results obtained from the TM Quad model provided information about the angular responses to forces applied at the Top Stage (pitch, yaw and roll). The latest posted version of the model has been run "QUAD_April_04" and the following figures were kindly supplied by N. Robertson [2]:-

Top Stage Torques:-

- Pitch, 0.13 rad Nm^{-1}
- Yaw, 0.015 rad Nm^{-1}
- Roll, 0.0054 rad Nm^{-1}

4 Lever-Arms

The following notes on the Top Stage lever arms for the controls prototype were also supplied by N. Roberston [2]:-

- Pitch, 0.11 m (Single Coil)
- Yaw, 0.12 m (Two Coils)
- Roll, 0.16 m (Two Coils)

5 Results

Hence, we can now calculate the required OSEM force's as follows:-

Top Stage:-

- **Pitch**, 0.13 rad Nm^{-1} with worst case initial adjustment of ≈ 1 mrad [1]
  i.e. 7.7×10^{-3} Nm / 1 mrad
  ⇒ OSEM force required = 7.7×10^{-3} Nm / 0.11 m = **70 mN**

- **Yaw**, 0.015 rad Nm^{-1} with worst case initial adjustment of ≈ 0.2 mrad [1]
  i.e. 1.3×10^{-2} Nm / 0.2 mrad
  ⇒ OSEM force required = 1.3×10^{-2} Nm / 0.12 m / 2 coils = **56 mN**

- **Roll**, 0.0054 rad Nm^{-1} with worst case initial adjustment of ≈ 0.1 mrad [1]
  i.e. 1.85×10^{-2} Nm / 0.1 mrad
  ⇒ OSEM force required = 1.85×10^{-2} Nm / 0.16 m / 2 coils = **58 mN**

6 Conclusions

It can be seen from the results obtained that the pitch DOF represents the largest force required to be exerted by an OSEM at the top-stage and is equal to 70 mN.

7 References

[1] LIGO-T050010-00-K - Monolithic suspension workshop (Glasgow January 2005): Minutes & Actions.

[2] E-mail Correspondence with Norna Roberston, 15/02/2005.