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Test Mass Temperature Field and Laser Aberration Modeling in Advanced LIGO[1] JOSHUA RAMETTE, Hillsdale Coll, MARIE KASPRZACK, GABRIELA GONZALEZ, Louisiana State University, AIDAN BROOKS, California Institute of Technology, CARL BLAIR, University of Western Australia, SHIVARAJ KANDHASAMY, University of Mississippi, HAOYU WANG, University of Birmingham, LIGO COLLABORATION — Advanced LIGO uses high laser power in the main interferometer arm cavities to achieve design sensitivity. A small part of this power is absorbed in the interferometer cavity mirrors where it creates thermal lenses. Actuation by "ring heaters," additional heater elements aimed to reduce the temperature gradients in the mirrors, minimizes aberrations in the main laser beam due to thermal lensing. We derive the first analytical model of the temperature field contribution in the mirrors generated by an ideal ring heater (Ramette et al. 2016). In addition, we simulate the test mass temperature field using finite element analysis software and find agreement with the prediction of our ring heater analytical model and existing models for self-heating of the test mass by the main laser beam. From our ring heater temperature field models, we then express the resulting optical aberration contribution in the main laser and compare to Hartmann wavefront sensor measurements of the aberration. Used in conjunction with wavefront measurements, our model provides a more complete understanding of the thermal state of the cavity mirrors and will allow a more efficient use of the ring heaters in Advanced LIGO.

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