IAF EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations - IAF EARTH OBSERVATION SYMPOSIUM (IP)

Author: Mr. KUNAL GUPTA
Birla Institute of Technology and Science(BITS), India, f20190823@pilani.bits-pilani.ac.in

Mr. Mridul Saxena
Birla Institute of Technology and Science(BITS), India, mridulsaxena2001@gmail.com
Mr. Vasu Swaroop
Birla Institute of Technology and Science(BITS), India, f20190656@pilani.bits-pilani.ac.in
Ms. Ishika Kadam
Birla Institute of Technology and Science(BITS), India, f20200964@pilani.bits-pilani.ac.in
Mr. Sathwik Gundala
Birla Institute of Technology and Science(BITS), India, sathwikgundala5@gmail.com

# THERMO-OPTICAL ANALYSIS OF CAMERA LENS SYSTEMS TO AVOID DEFOCUSING

**Abstract**

Cameras are widely used as imaging payloads by satellites. As the temperature changes with change in altitude and orbital positions, and with the lenses and the lens casing being of different materials, differential thermal expansion occurs despite both being exposed to the same temperature conditions. This leads to a change in the position of the lenses with respect to each other, causing a total focal length change of the lens system. Changes in focal length can lead to out-of-focus and blurry images which can be disastrous for any imaging satellite mission. Analysis of the change in focal length with different lens casing materials is important to determine which material offers the least focal length shift. By lens casing ruggedization, the desired material could be incorporated. This paper highlights thermo-optical software simulations to analyze the defocus with different lens casings, select the material with the least defocus and avoid fatal imaging errors. The basic idea behind the thermo-optical analysis is to consider a lens system, with a known focal length. Then subject this system to thermal loading and again calculate the focal length. Noting the difference in the two values would give the change in the focal length of the system after experiencing thermal loading. The overall simulation was segregated into thermal simulation which was performed using ANSYS and optical simulation which was performed using COMSOL Multiphysics. For optical simulation, a few lens models were first considered, the focal length values of which were known theoretically by the lens formula. The software's results were then compared with these theoretical values to find out the percentage errors. For thermal simulation, the thermal model was created, and the mesh was refined until the results converged to values with differences in the third decimal place. Temperature loads were applied in a transient profile along with the required constraints. These deformed lenses were again loaded in COMSOL and the new focal lengths were noted. A net error of 1-2% was observed in the focal length output from COMSOL (before applying thermal load). This is because COMSOL didn't take the optical center of the lens where the lens maker formula assumes. The difference in focal length for different casing materials is presented in this paper. This analysis proves effective in determining lens casing materials with the least defocus and will help in avoiding imaging errors when the satellite goes into space.