Mechanical Tolerance Analysis of the Front-end Optics for the STEAMR Instrument

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***Abstract*—The optics of the STEAMR instrument is a complex system involving off-axis mirrors designed to achieve precise imaging of the 14 receiver channel beams from the far field to the corresponding feed horns. An initial optical design was generated by Swedish Space Corporation which laid the framework for the subsequent IAP design which further developed the optical system to meet the mission performance requirements.**

Although simulations of the optics presently show good results, little is known about the sensitivity to mechanical errors for the complete optics chain. This work encompasses a tolerance analysis limited to the front-end optics consisting of the six off-axis mirrors. With six degrees of freedom for each of the six component reflectors, the scale of the required mechanical tolerancing analysis is significant. The goal of this work is therefore to identify critical locations within the optics architecture that have the largest influence on performance, specifically in terms of the farfield beam patterns. To simplify the problem, all mirrors are assumed to have no surface error. The results of this analysis will be of key importance in the eventual manufacture and assembly of the final instrument.

The main software tool used for these simulations is the optical design and analysis package ZEMAX, which offers built-in routines for performing Monte-Carlo simulations specifically for tolerancing problems. Key attention is given to errors in focusing and pointing for the elevation direction, being that this is the most crucial direction for observation. The ZEMAX tolerance analysis tool will allow for time-efficient calculation of the overall tolerance tasks. The main performance critiera here will be based upon geometrical beam pointing. Following this, the worst case scenarios will be analysed in further detail with the physical optics software package GRASP.

To lessen the numerical calculation load, only two beams (corresponding to the highest and lowest elevation) are considered in the first iteration. Besides giving a figure of the sensitivity for all mirrors, it is also the aim of this work to translate the results into corresponding sensitivity numbers for the structure supporting the entire optical system.