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Title:

Evolving design criteria for very large aperture space based telescopes and their influence on the need for intergrated tools in the optimization process.

Short Abstract:

NASAís Advanced Mirror Technology Development program is maturing technology to design and build future space telescopes, including tools to speed up the design process. These tools have been used to conduct trade studies for 4 meter and 8 meter monolithic primaries, complete with support systems. This paper reports some early trade studies for typical specification requirements such as lowest mirror bending frequency and suspension system lowest frequency. The results use representative allowable values for each mirror material and construction method and generic material properties. These studies lead to some interesting relationships between feasible designs and the realities of building these mirrors.

Long Abstarct:

NASAís Advanced Mirror Technology Development (AMTD) program has been developing the means to design and build the future generations of space based telescopes. With the nearing completion of the James Webb Space Telescope (JWST), the astrophysics community is already starting to define the requirements for follow on observatories. The restrictions of available launch vehicles and the possibilities of planned future vehicles have fueled the competition between monolithic primaries (with better optical quality) and segmented primaries (with larger apertures, but with diffraction, costs and figure control issues). Regardless of the current shroud sizes and lift capacities, these competing architectures share the need for rapid design tools. As part of the AMTD program a number of tools have been developed and tested to speed up the design process. Starting with the Arnold Mirror Modeler (which creates Finite Element Models (FEM) for structural analysis) and now also feeds these models into thermal stability analyses. They share common file formats and interchangeable results. During the development of the program, numerous trade studies were created for 4 meter and 8 meter monolithic primaries, complete with support systems. Evaluation of these results has led to a better understanding of how the specification drives the results. This paper will show some of the early trade studies for typical specification requirements such as lowest mirror bending frequency and suspension system lowest frequency. The results use representative allowable stress values for each mirror substrate material and construction method and generic material properties. These studies lead to some interesting relationships between feasible

designs and the realities of actually trying to build these mirrors. Much of the traditional specifications were developed for much smaller systems, where the mass and volume of the primary where a small portion of the overall satellite. JWST shows us that as the aperture grows, the primary takes up the majority of the mass and volume and the established rules need to be adjusted. For example, a small change in lowest frequency requirement can change the cost by millions of dollars.

The paper uses numerous trade studies created during the software development phase of the Arnold Mirror Modeler to illustrate the influences of system specifications on the design space. The future telescopes will require better performance, stability and documented feasibility to meet the hurdles of todayís budget and schedules realities. AMTD is developing the tools, but the basic system planning mentality also has to adopt to the requirements of these very large and complex physical structures.