DDF Annual Report

Title of Investigation:

Optical Design Tools for Rapid Concept Development

Principal Investigator:

Joseph M. Howard, 551

Initiation Year:

FY 2004

FY 2004 Authorized Funding:

$7k

Actual or Expected Expenditure of FY 2004 Funding:

Computers $4k; Software $2k; Hardware support items $1k

Status at End of FY 2004:

To be continued in FY 2005 with additional DDF FTEs (0.05).

Expected Completion Date:

September 2005

Purpose of Investigation:

To develop a set of easy to use tools for optical designers here at Goddard to aid in the optical design of astronomical instruments. This includes collating published analytical methods for automatic aberration correction of optical systems, providing new methods if necessary, and incorporating them into the macro language of optical design software for easy use. Additionally, the design tools will be used to perform global optimization to generate a database of starting designs for various classes of telescopes, relays and cameras.

FY 2004 Accomplishments: Funding for this DDF purchased OSLO optical design software, two Pentium computers, and supporting hardware to create the Global Optimization Optical Design Laboratory (GOODLab). Originally a two-processor machine was desired for this project, however two independent single processor machines proved more affordable and less risky. GOODLab is now established.

The first design tool generated from this project was for a three-mirror conic telescope design, referred to as a three-mirror-anastigmat (TMA). Based on the work by D. Korsch (Reflective Optics, Academic Press, 1991), this design form is readily described analytically so that it can be programmed for rapid evaluation and customization. The applicable equations were implemented in the macro language of OSLO, and a slider interface activated to give the user graphical control and real time feedback of the layout and performance of the system. Figure 1 illustrates the user interface of the TMA sliders, and Figure 2 illustrates the resulting output and lens layout that the user sees in real time. This tool was successfully implemented in the Optics branch by a coworker who used it for a design study of collector telescopes for a stellar interferometer.

Figure 1. Slider controls for three-mirror-anastigmat (TMA) design tool. The first four sliders (d1, d2, d3, r1) are the available lens parameters remaining as degrees of freedom to the designer, while the next two (f/# and EBR) are generally considered as specified by science requirements. The remaining controls provide additional assistance in layout and evaluation of the telescope.

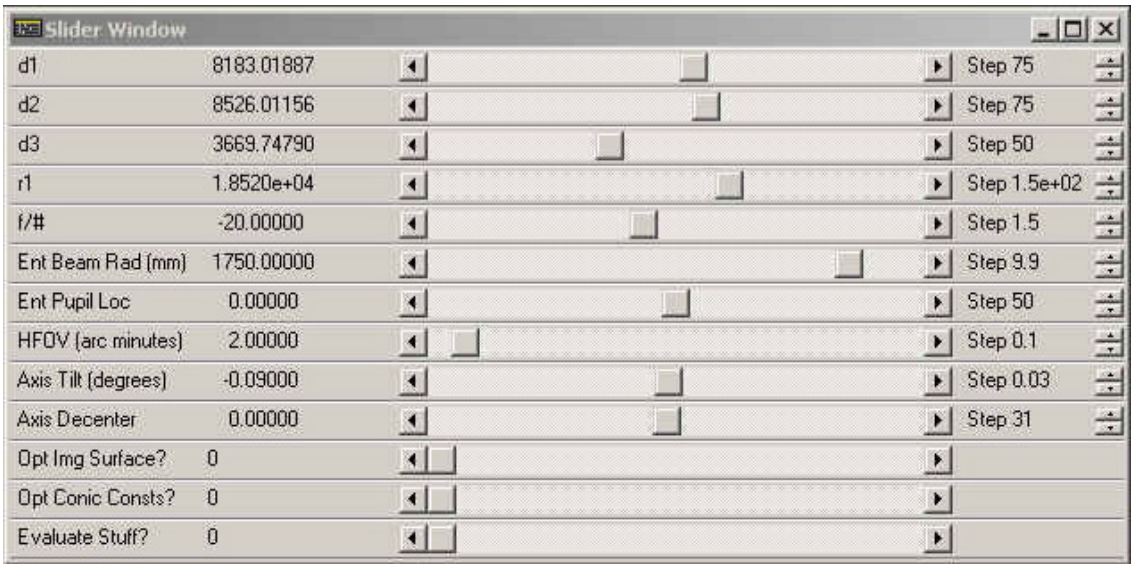
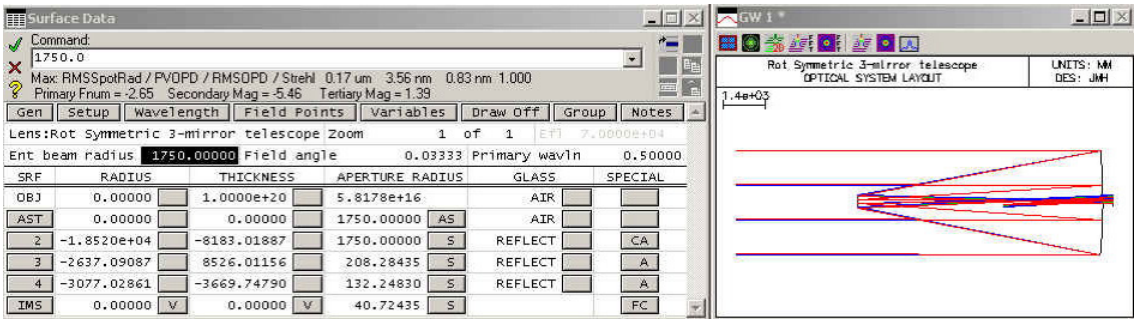


Figure 2. Outputs from TMA design tool. In the left window, system performance is displayed in text just below command line, next to the yellow question mark. The layout is automatically updated in the right window as sliders are operated.



Planned Future Work:

Additional tools for three-mirror relays are planned, as well as lengthy global searches using these tools with desirable first-order parameters. For example, several starting designs of relays will be located and saved with various f/# and magnification requirements. These systems will be saved in a database for quick retrieval during design studies, and the design tools will be made available to employees at GSFC.

Summary:

(1) Project's innovative features: real-time updating of lens parameters that are constrained to ensure a given set of image requirements.

(2) Potential payoff to Goddard/NASA: Rapid development of optical designs, leading to more efficient proposal efforts.

(3) The criteria for success: Multiple users of finished design tools.

(4) Technical risk factors that might have, or that in fact have, prevented achieving success: requiring the optical designer to use new software may hamper ease of use.