QUESTAR SIMULATOR

Spartan IR Camera for the SOAR Telescope

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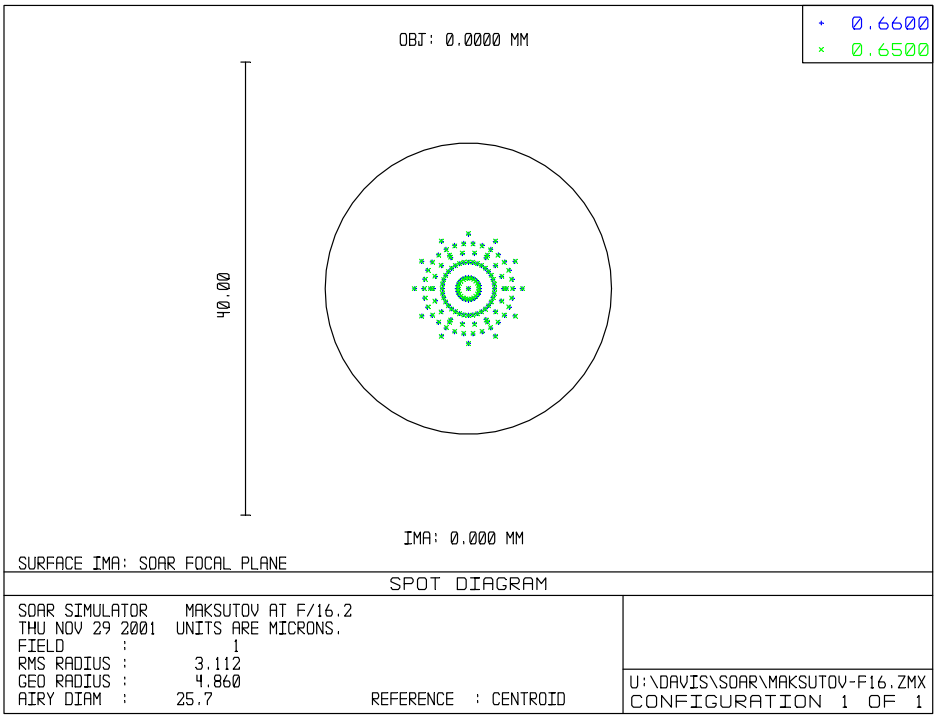
This document is an analysis of the Questar-based telescope simulator proposed by Tom Ingerson (private communication, 2001). This simulator is designed to mount to the telescope ISB and produce a diffraction limited f/16 beam (Figure 1). This document discusses the initial design and modifications necessary to make this design meet our simulator requirements.

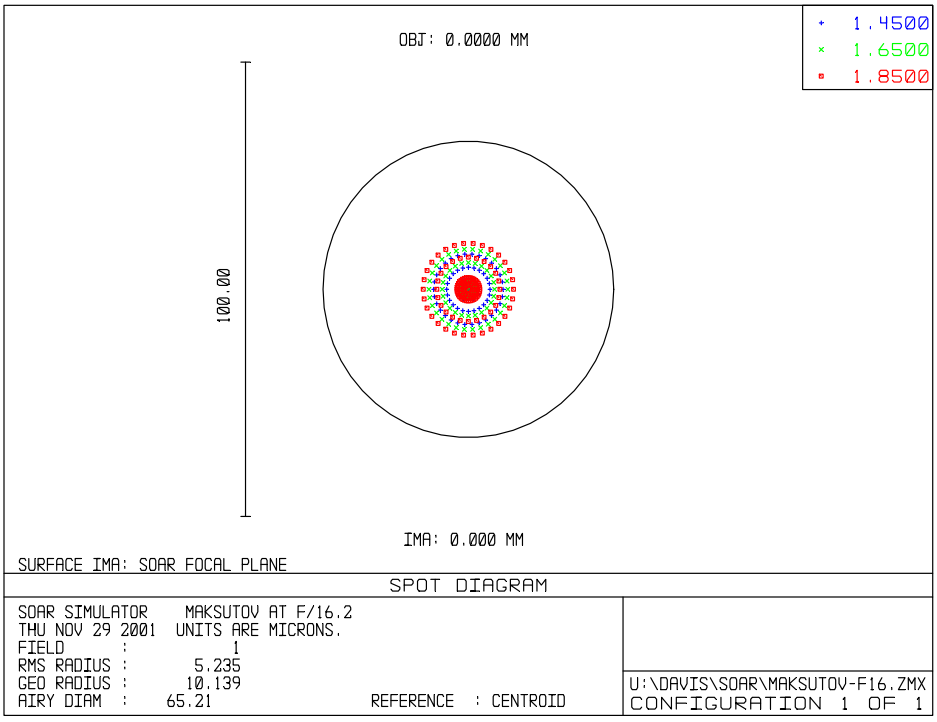
1 Concept

The centerpiece of this simulator design is a QM-1 long focus microscope. The simulator consists of a light source attached to the QM-1. The QM-1 produces an f/16.2 beam. The focal length is determined by a focusing lens, with ranges of 560 to 1500 mm possible. This simulator will be mounted to an x-y stage to provide images over the 160 * 160 mm square SOAR field. This simulator is achromatic over the range 400-2200 nm.

This simulator may also be used to view the image plane of the camera. A light source may be placed at the image plane of the camera. The light then passes through the camera and the simulator optics. A TV camera may be attached to the eyepiece of the Questar to view the light from the image plane (www.questar-corp.com/qm1.htm). This configuration may also be used to test the quality of the optics.

Figure 1 – Spot diagram of QM-1 simulator at 660 nm (top) and H-band (bottom). Each image is scaled by the Airy disk





2 Concerns

This design meets most of the telescope simulator requirements as given in the document "Design Requirements for the SOAR Beam Replicator" (Davis, 2001). The following section discusses the areas in which modifications are necessary to make the simulator meet our requirements.

2.1 Must bolt to camera

The camera must bolt to our telescope simulator just like the camera bolts to the telescope. The unmodified Questar design instead bolts to the telescope side of the ISB. The solution is to make a new mounting frame so that the simulator will bolt directly to the camera. This frame must extend the length of the simulator by 750 mm to make up for the difference between mounting to the ISB and the camera.

2.2 Focus position must be known to 0.03 mm

Our telescope simulator must have the ability to reproduce its focus position to 0.03 mm. It is currently unknown whether or not the focus knob on the QM-1 can meet this specification. A solution is to replace the existing knob with a 6-inch diameter knob with a Vernier scale. Such a knob would give the focus a reproducibility of 0.006 mm.

2.3 Transverse position must be adjustable to 0.004 mm

Our telescope simulator must have the ability to adjust the transverse position of its images to 0.004 mm. This position is necessary to measure the encircled energy of the images produced by the simulator and camera. However, another way to measure the encircled energy is to place a light source at the image plane of the camera. Then, the telescope simulator will produce images that can be read by a detector placed at the eyepiece. This configuration would allow a magnifying lens to be used to enlarge the images produced by the camera and simulator. This enlargement simplifies the encircled energy measurement and eliminates the need for fine adjustments.

3 Requirements Met By The QM-1 Simulator

3.1 Produces diffraction limited f/16 beam

The QM-1 is designed to produce a diffraction limited f/16 beam.

3.2 Produces images in visible and near IR wavelengths

The QM-1 produces achromatic images from 400-2500 nm.

3.3 Produces on- and off-axis fields

The QM-1 will be mounted on a stage with a 160*160mm field of motion.

3.4 Has a variable focus

The QM-1 has a focus-adjusting knob.

3.5 Pupil size and position

Our telescope simulator must replicate the position of the telescope pupil for at least one field point. With no modification, the QM-1 replicates the position of the telescope pupil for the center of the field.

4 Conclusion

The QM-1 telescope simulator design meets our specifications with a few minor alterations. This design will require much less effort than the earlier refractive SOBeR design. The design also has the advantage that it is achromatic over our desired wavelengths. Therefore, this simulator design should be used for our project.