WIDE FIELD OPTICAL DESIGN FOR SCUBA-2

Duncan, W. D.[1], Atad, E.[2], Peacock, T[2]
, Harris, J.[2], Holland, W. S.[2], Audley, M. D.[2]
[1]NIST, 325 Broadway, Boulder, CO 80305, USA
[2]UKATC, Royal Observatory, Blackford Hill, Edinburgh, EH9 3HJ, UK

We outline the design approach for the SCUBA-2 optical design and suggest it as a practical method for designing other wide-field instruments in the mm to few THz range. The field of view of the James Clerk Maxwell is 600mm in diameter at the Cassegrain focus. An optical system is required to image this focal plane onto the detector arrays which are operated at 100 mK and are manufactured at the 3" Si wafer size scale. In addition, the SCUBA-2 instrument is too large and heavy to consider co-rotating it with both axes of the telescope. It will be located at the Naysmyth focus which inevitably leads to a complex optical system. To avoid dielectric losses an all reflecting design is used. This means that the system is all off-axis. Simple calculations show that the Strehl ratio of the relay optics has to be very high to avoid increasing the losses associated with the telescope surface. This high performance must be established across the field of view by the optics and maintained as the telescope changes elevation. It is also highly desirable to have low field distortion to greatly simplify image construction. The optical design has to to have a good image of the telescope aperture close to the array in order to limit the field of view of the pixels and control stray light. The optical design must also predict the detailed surface shape of the mirrors for manufacture and using time reverse diffraction calculations predict the field at each mirror and stop so they can be sized correctly. The large number of optical elements requires that the surface accuracy of each element must be 1 micron rms to avoid significant throughput losses due to surface scattering. The SCUBA-2 optical system consists of 10 off-axis mirrors of general aspheric shape with some mirrors being greater than 1 m sq. This level of optical design and ability to manufacure such mirrors has only become possible in the last few years using commercial codes and 5-axis machining and polishing.

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1. (a)
William Duncan
NIST
325 Broadway
Boulder, CO
80305 USA
wduncan@boulder.nist.gov

(b) 303 497 3811

(c)

2. J - Radio Astronomy

3. (a)

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