Testing a 20 cm Diameter Open Reflector *)

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Abstract:
An open reflector with plane mirrors has been designed and manufactured as a first step to test the joining technology. The measurements of the offset angles during and immediately after assembly demonstrated the required accuracy of 0.2 arc seconds. Following tests mounting the reflector in different orientations showed significant distortions by gravity as well as some long term drift. The tests have been performed mainly using the large collimator of the Solar Telescope "Einstein Tower Potsdam". The results show the necessity to upgrade the joining technology.

Description of the Reflector:
The reflector consists of a monolithic aluminium frame and 3 plane glass mirrors. The mirrors are independently connected to the frame. Adjacent mirrors are separated by approximately 2 mm. During assembly the mirror being joined is horizontal. This requires an inclined interferometer for real time control of the mirror orientation. The accuracy of the measurement of dihedral angles has been estimated and verified to be about 0.05". After polymerisation of the joints the dihedral angles were 0.32", 2.35"and 0.13", respectively, the distortion of the plane mirrors being negligible.

Far Field Measurement
For far field test we replaced the grating of the spectrograph at "Einstein Tower" by the reflector. The collimator lens made by Zeiss has 12m focal distance and 35cm diameter. A green diode pumped micro laser module was used as a light source and with the help of a beam splitter the far field appears directly on a CCD. The far field could be observed in 3 configurations:

- reflection by two of the mirrors only (direct determination of the dihedral angle offsets)
- symmetry axis of the reflector parallel to the optical axis of the collimator
- one of the reflector mirrors horizontal (same as during assembly)

The far field consisted in 3 well resolved spots in general. To compute the dihedral angle offsets requires the correct assignment of the far field spots to the six sectors of the reflector. This could be achieved by a priori knowledge and the results of the two-mirror configuration. Once assigned, the offset angles are obtained using a least square adjustment.

Interferometry**)
The results of the far field measurements have been confirmed using the 16 inch ZYGO of the Helmholtz Centre Berlin (BESSY II). Especially the signs of the offset angles are obtained by the phase shifting interferometer. This measurement could be done with the horizontal axis of the reflector only.

Results and Conclusion
Main result of the test is the observation of elastic changes as well as a drift of the angles due to the joining material. The order of magnitude of these changes is 1". Small elastic deformations of the frame have been observed by charging it with an extra weight. But this can be improved by a more stiff frame easily.
The next steps of development will be:

- testing new joining material with respect of deformation and stability
- introducing materials of high elastic modulus and high thermal conductivity for the frame and the mirrors
- manufacture a new triple mirror

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