

Comments on "Active Surface Adjustment to Nominal vs. Nearby Paraboloid".

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In his memo of Oct. 20, Larry advocates the use of a closed loop system to keep the surface of the main reflector adjusted to a fixed rather than a best-fit shape. The proposed design of such a closed loop system would set the surface by bringing the outputs of a series of sensors to zero, without having to measure the precise displacement of the surface at any time. I argue here that a system without surface measurement capability, either in the positioners or as an independent system, would be difficult to bring into adjustment.

In a system of the type considered in Larry's memo the position of the surface is sensed with respect to some desired position represented by an initial setting. Since there is no convenient physical reference for the desired paraboloid, it seems me that this idea would most likely be applicable to the measurement of one panel relative to its neighbor, as in the Keck telescope mirrors. Consider such a system and assume that some initial setting of the surface is chosen. The problem is that it is difficult to make any further adjustments to the chosen setting since this requires making mechanical offset adjustments of the sensors. One cannot simply apply electrical offsets to the outputs of the sensors since this would require that the sensors be calibrated position-measuring devices and therefore more sophisticated and accurate than the devices that Larry considers.

I envisage an acceptable closed loop system as one in which the positions of some hundreds of points on the surface are measured, and the surface is then adjusted to bring the readings into conformity with a set of values supplied by a computer. The reference values in the computer can be adjusted as required. When such a system is first operated we do not know how the individual measurement points lie with respect to the best-fit paraboloid, i.e. whether any given measurement point is on a bump or a hollow of the surface panels. Holography provides a way of calibrating such offsets and we would surely want to take advantage of it. (In a sense holography provides the ultimate measurement technique since it is a direct check of the receiving performance of the antenna.) For this reason I believe that the surface adjustment should be based on numerical position readings which are compared with a reference model in a computer. The closed loop operation with the sensors that Larry describes is a way of maintaining "an initial good alignment". But basically I don't believe that getting an initial good alignment is a well defined, one-time operation. Rather it is likely to require a number of steps with various procedures including holography at different declinations and wavelengths. In doing this it will be important to be able to modify the surface model through the computer as successive improvements are found. Even when we are fully satisfied that a satisfactory setting model has been found, it will be necessary to check and 'retune' it at intervals.

The question arises of whether it is necessary to have readouts on the positioners if there is also an independent, real-time surface measuring system. Readouts on the positioners would provide some desirable redundancy,

and, most importantly, would enable us to retain the ability to use an open loop system as a backup if the surface measurement system fails.

The question of whether to correct to a fixed or best-fit paraboloid has a big effect on the range of travel of the positioners, and thus on the speed with which they must work. If a greater range of travel is required, the positioners must be readjusted at smaller intervals in elevation as the telescope tracks. With the fixed paraboloid option there is thus likely to be much more wear on the positioners. Also, the magnitude of the errors that may be introduced by non-functioning positioners is directly limited by the range of travel. Thus the fixed-paraboloid mode places greater demands on the reliability of the positioners.

The fixed-paraboloid mode appears to minimize the amount of adjustment required for the position of the components at the prime focus. Larry also implies that it is easier to determine the correct position of the focus in this mode of operation. I would not have thought that this is very significant since if the computer model of the antenna is any good at all it ought to be able to predict the position of the focus. Even if the model is not accurate at the start of operation, calibration of pointing and focussing should indicate how to improve it. The problem of relating the actual surface, as indicated by position sensors, to the azimuth and elevation readouts of the telescope seems to be largely independent of which correction mode is chosen. If we go from the fixed paraboloid mode to the best-fit mode we exchange a larger range of operation of several hundred surface positioners for a larger range of operation of the three-coordinate prime focus adjustment, which, on an a-priori judgement, seems like a good thing to do. We need some numbers to show how big these ranges are, but at present I would think that the best-fit adjustment mode is the safer choice.