CHARA TECHNICAL REPORT

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Another Array Option on Mt. Wilson

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1. INTRODUCTION

In this report, we briefly examine the effect on $U-V$ plane coverage by fixing the locations of the three outer array telescopes, but allowing selected locations for the remaining two telescopes. These new locations need not be along any of the three 'lines'.

(*Editor's Note: Although a decision regarding telescope placement has been made, we include this report at this time (October 97) for completeness.*)

2. SEARCHING FOR MR. GOODARRAY

The Mt. Wilson site has been successfully used for interferometry since 1919 and has been chosen as the site for the CHARA Array. In two previous reports (TR11 and TR14) we have discussed an array that located the five Array telescopes along three 'arms', located roughly 120 degrees apart, but altered to conform to the mountain's terrain. In this report, we consider an alternative siting, with the three outer telescopes fixed in the same locations, but with more flexibility for the two inner telescopes.

To begin with, we outlined a number of areas for telescope locations on the Mt. Wilson site, taking care to consider the topography and existing buildings. We next digitized representative points in these regions, separated by $\sim$10 m intervals. This process resulted in some 45 trial areas for the remaining two telescope locations. We then did a brute-force search in UV coverage of all 45*44/2= 990 possible locations for the two inner telescopes for a star with a declination of 20 degrees.

Figure 1 shows a preliminary "optimum" array location for the telescopes, based on this search procedure. (The final location of the telescopes will depend upon detailed surveying of local terrain for feasibility.) As can be seen in this figure the optimum telescope locations no longer fall along the three 'arms', but the telescopes do tend to fall along three sides of a large triangle. (Note that in this figure the location of the existing (since 1917!) 100-inch (2.54-m) Hooker telescope is denoted by a large square.)

Figure 2 shows the $U-V$ plane coverage with this optimum five-telescope (3+2) Mt. Wilson array compared to the best five-telescope array with three lines, as in TR11. Note that the

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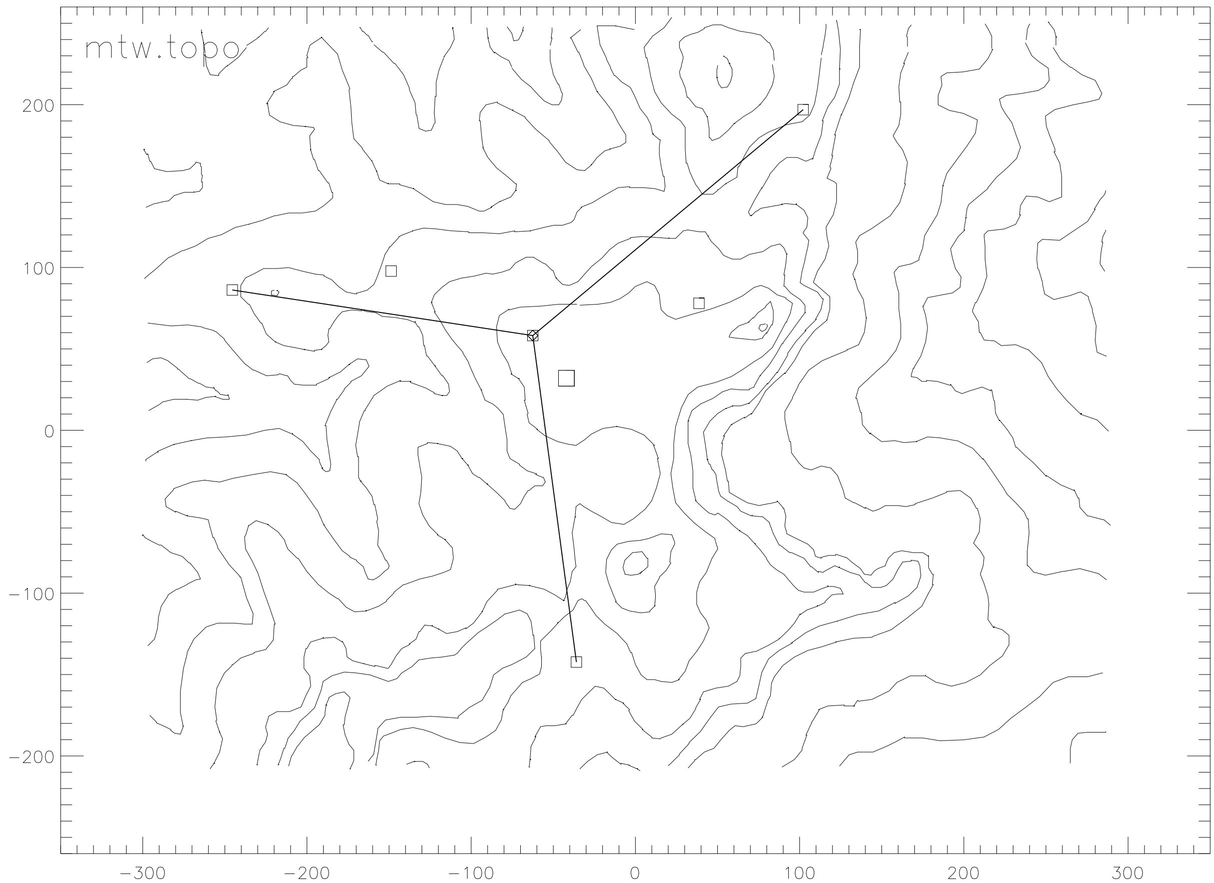

FIGURE 1. Mt. Wilson site with new optimum 5-telescope (3+2) configuration

overall coverage is qualitatively better in the $U-V$ plot. In particular, the two large 'holes' (to NW or SE) have been eliminated. On the weighted coverage scale used in previous Tech Memos, the $U-V$ coverage improves from 0.559 to 0.593, a 6.1% improvement. This method essentially counted the number of UV squares that were "covered" on a coarse grid with squares of 35.4 m size. (On a four times finer grid of 8.85 m squares, the coverage improved from 0.1447 to 0.1509, a 4.3% improvement.)

Another way of looking at the improvement in $U-V$ coverage, also used in TR11 and TR14, was to consider the effect on the reconstructed image of an object, in this case a resolved binary star, patterned after the star 29 CMa. The reconstruction algorithm in this case is interpolation in the complex visibility plane.

Figure 3 shows that a qualitative improvement in the recovered image quality occurs with the 3+2 telescope case.

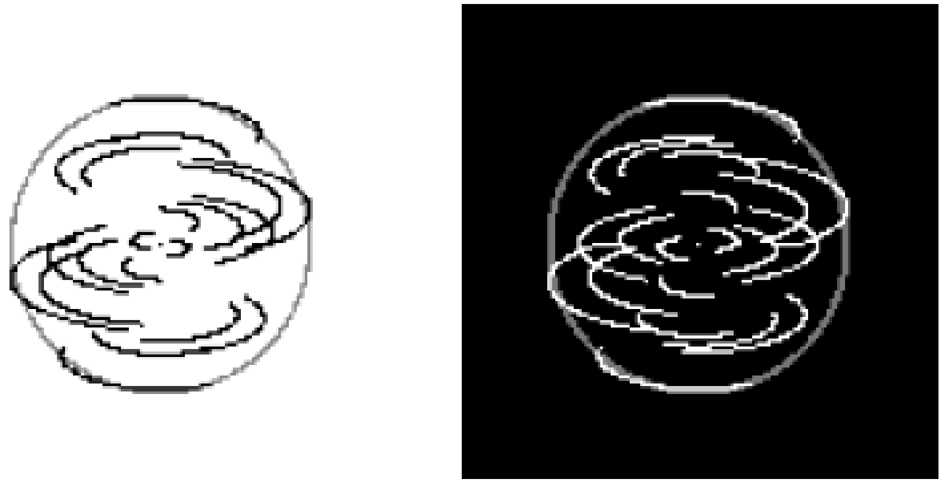

FIGURE 2. Left: UV coverage with optimum '3 arm' 5-telescope configuration. Right: UV coverage with best 3+2 configuration. The outer circle represents a 354 m separation, as in the original CHARA Y.

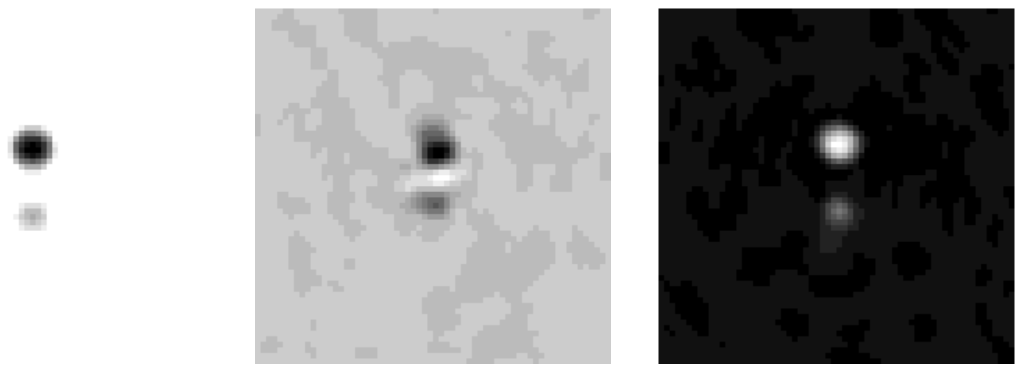

FIGURE 3. Left: Resolved binary image. Center: Image with 5-telescope Array, Right: Image with 3+2 Array configuration.

3. CONCLUSIONS

The amount of $U-V$ coverage only goes up modestly in our standard counting grid with the more flexible layout, but the recovered image quality for the 29 CMa model improved significantly. This shows that it is not only the extent of $U-V$ coverage that counts, but also the location. In particular, large regions with no coverage will lead to troublesome sidelobes in the image reconstruction process. The cost of this improvement is still undetermined, but it will involve directing the light from the inner telescopes toward then along two of the standard lines, by essentially lengthening the 'anti-polarization' legs in the appropriate directions. There will have to be roughly 100 m more tubing, as well as a large beam-directing mirror in each of the two 'broken' vacuum tubes.