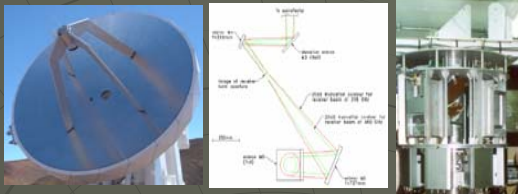


MIRROR ALIGNMENT USING DUAL BEAM LASER

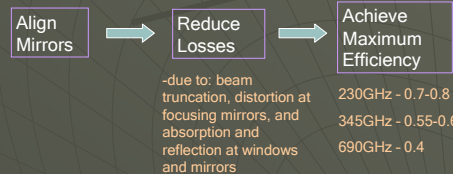
Vinya Agluba, Smithsonian Astrophysical Observatory, Submillimeter Array, Hilo, HI

SMA Optics Layout



A 6-meter diameter paraboloidal primary reflector is combined with a 350 mm diameter hyperboloidal sub reflector. Mirrors M3 through M6 form a beam waveguide which directs the beam from the antenna vertically downward into the receiver optics assembly.

The goal of this project is to assemble a portable setup that would align the sub reflector and the beam waveguide mirrors.



Methods



To align the mirrors, a dual beam laser is used. Because there are visible red beams at each end of the laser that are aligned to each other, it is feasible to place this laser between mirrors M4 and M5 since there is a lot of space for the laser and a focal point is located. The mount for the laser is kinematic, it can be adjusted by its x-y-z axis and angle.

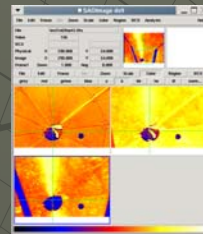


Mirror M4 is an ellipsoidal mirror. If the laser beam strikes this mirror, the beam would disperse. So, an aperture stop is placed after M4 to block the dispersion and still have a fine beam going to the sub reflector.

Acknowledgments:

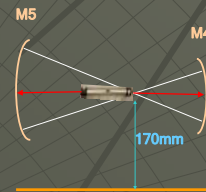
- Rob Christensen, Research Supervisor
- SMA Staff
- Sarah Anderson, Malika Bell and Lisa Hunter, Center for Adaptive Optics
- University of Hawaii - Manoa

Since it would be hard for us to look for the laser beam propagated on the sub reflector, a video camera is installed on the vertex of the reflector.



The DS9 program is used to measure the amount of displacement of the laser beam on the sub reflector from the center as the antenna moves from different elevation.

First Trial



One end of the dual laser is placed right on the focal point of mirror M4, which is 170mm high from the 4-5-6 plate to assure that the laser beam passes this critical point.



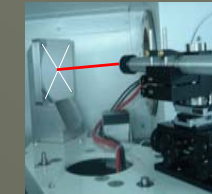
Antenna elevation: 20°



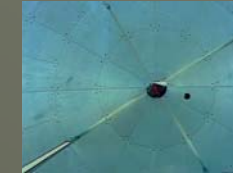
Antenna elevation: 70°

Looking on the sub reflector, the laser beam is off the center and as the elevation of the antenna changes, it moved by 1-3 pixels. The laser beam on the sub reflector is still dispersed even though an aperture stop is already placed because the mirror M3 is too dusty that it had contributed to the dispersion of the laser beam.

Second Trial



Instead of positioning the laser 170mm high from the 4-5-6 plate, the laser is placed such that the laser beam strikes the center of mirrors M4 and M6. Crosshairs are placed across the mirrors to show the center of the mirrors.



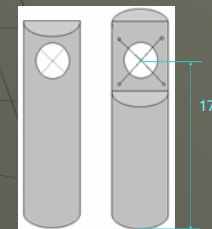
Antenna elevation: 15°



Antenna elevation: 85°

Looking again at the sub reflector, the laser beam is off the center at an antenna elevation of 15°. But as the antenna elevation increases, the laser beam disappears as shown in the picture above with an elevation of 85°. This proves that the laser beam does not pass through the focal point (the laser beam was higher than 170mm) and thus, beam truncation could have occurred.

Conclusion



170mm

A portable setup is built to align the mirrors of the Submillimeter Array optics. It must be noted that the laser beam should pass through the focal point of mirror M4 so there would be no beam truncation that would occur. To assure the 170mm height, targets like shown on the picture on the left could be placed on both ends of the laser and one target is positioned right where the focal point is located.

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