DESIGN OF A LARGE APERTURE SUBMILLIMETER TELESCOPE

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The combination of new developments in focal plane bolometer arrays, access to very dry sites and a large aperture submillimeter telescope will dramatically expand our window into the submillimeter universe. Current state-of-the-art arrays have ~100 pixels and we can expect significantly larger arrays in the near future. In addition it is anticipated that the modest heterodyne receiver arrays currently available at millimeter wavelengths will progress into the submillimeter band and the number of pixels will crease significantly. Measurements from the Atacama desert and nearby peaks in Chile indicate that the 350 μm window is available much of the time and observations can even be made out to 200 μm in the best weather. Building telescopes that fully exploits these capabilities will require significant advances over existing radio telescope designs.

A design concept is being developed by Cornell and Caltech for a 25 m diameter telescope that has high aperture efficiency and good pointing at 350 μm and can operate at wavelengths as short as 200 μm. This will require offset pointing and tracking accuracies better than 0.3 arcsec and a net effective surface error of less than 13 microns. Another requirement not often encountered in radio telescopes is a large field of view to match the large focal arrays. This will require relatively large secondary and subsequent optical elements. These mirrors could be as large as 4 m in diameter to accommodate the large optical throughput for the bolometer arrays. A chopping secondary may not be practical and it is preferable to have the ability to scan the telescope rapidly and smoothly to overcome the low frequency noise common in bolometer systems. The telescope will be inside a dome with a shuttered opening to minimize the effects of wind and solar illumination. This telescope will bridge the gap between traditional radio telescopes and large optical telescopes and will require advanced techniques from both fields to meet the demanding requirements.

The primary surface presents a particularly difficult challenge. The individual panels should have RMS surface errors in the range of 4 to 6 microns. Several panel fabrication technologies are being studied, including CFRP, replicated electroformed Nickel, and traditional machined Aluminum. Important design considerations are the size and configuration of the panels and their adjusters. The surface will be actively adjusted to compensate for gravity induced deformations and thermal gradients. It will be necessary to continuously measure the surface for closed loop control of the adjusters. Several surface measuring techniques are being investigated for this system. The secondary and subsequent optical elements will also be very challenging because of their large size and required high accuracy.

The use of an active surface alleviates many of the design problems associated with building a stiff homologous mount and backing support structure for the panels but the bearings and drive systems will require advances beyond traditional radio telescope techniques. Use of hydrostatic bearings and direct drives similar to those used on optical telescopes are being investigated for use in this telescope.