Center for Astrophysics

Harvard College Observatory
Smithsonian Astrophysical Observatory

TECHNICAL MEMORANDUM

September 10, 1990

To: Files Technical Memo #32

From: Paul Ho

Subject: Hawaii Site Plan

Baseline Length. The rationale for a minimum baseline of 500 m is the goal of subarcsecond imaging. At the longest SMA wavelength of 0.87 mm, a 500 m baseline would yield an angular resolution of 0.4". At the shortest SMA wavelength of 0.35 mm, this corresponds to an angular resolution of 0.2". It is useful to remember that 0.1" corresponds to a spatial resolution of 10 AU at a distance of 100 pc, or 5 pc at a distance of 5 Mpc. Subarcsecond imaging is crucial for the study of protostellar disks in nearby dark clouds, and in studying the nuclear regions of nearby galaxies. For protogalaxies or starbursts at cosmological distances that are redshifted into the submillimeter band, subarcsecond resolution will allow the disk of a galaxy to be resolved. Given that other submillimeter interferometers will not likely be built in the next decade, the SMA should try to provide an angular resolution similar to that available in the optical, which is better than 0.5" already from the ground. Preliminary atmospheric phase data indicate that 0.1" resolution will be possible on Mauna Kea. Hence the SMA should be designed such that the angular resolution is ultimately limited by the atmosphere rather than physical layout.

Angular Resolution versus Wavelength. For the next few years, until receiver technology improves at the shortest wavelength ranges of the SMA, the best continuum sensitivity for the SMA will be at 0.87 mm. For this reason, 500 m is absolutely necessary for work at 0.87 mm. It is useful to remember that the IRAM 30 m telescope at 0.87 mm, and the JCMT at 0.35 mm, will both have an angular resolution of 5". To make it worthwhile for all the agony of interferometry, the SMA should be at least a factor of 10 improvement in angular resolution over these instruments. Therefore, 500 m baseline is a minimum, and the possibility of expanding beyond 500 m is a strong endorsement in the site selection process. It is important also to remind ourselves and others that although we begin continuum studies at 0.87 mm, we intend to push to 0.35 mm. This is because of the fact that the spectral information between 0.87 mm and 0.35 mm will be extremely-important for determining radiation mechanisms and dust properties. For phenomena at 10-100 K, the SMA will provide the angular resolution to resolve the phenomena at the peak of their radiation spectrum.

Potential of Interferometry with CSO and JCMT. With regards to the possibility of operations up on Mauna Kea which include the CSO and JCMT, this should definitely be planned for. The collecting area of a 15 m (10 m) antenna is equivalent to 6.25 (2.78) times the collecing area of a 6 m telescope. Even at 0.5 times less efficiency, the JCMT and CSO are equivalent to 3 (1.4) more 6 m telescopes. In addition, 8 antennas are 1.9 times faster than 6 antennas operating as an interferometer. For a $30 M project, adding those telescopes are equivalent to about $27 M on first order. To take advantage of the larger telescopes, they should be located at the ends of one of the arms of the interferometer in order to increase sensitivity to small structures whose fluxes will be weaker, and to improve calibrations on long baselines. Because of their large enclosures, a central location for the larger telescopes is not as desirable since they would pose a physical limit to the shortest baseline that can be configured and would also result in increased shadowing effects. This argues that the central location of the SMA should be displaced about 500 m from the CSO and JCMT.

Array Configuration on Mauna Kea. The question arises as to the layout of the array on Mauna Kea. I refer to the MOU between Hawaii and SAO. In the letter from Hall to Shapiro, dated March 10, 1988, there were amendments made to the proposed MOU, specifically item (c). In part, this revision included the following specific language: "It is recognized also that part of the area shown in Exhibit A is currently not included in the Complex Development Plan (CDP) which has been approved by the State Board of Land and Natural Resources (BLNR) which leases the land to UH. BLNR approval must be received by UH for use of this area. **SAO** shall arrange for the preparation of the necessary documentation in coordination with UH, and UH shall support the SMA strongly within Hawaii." The area outlined in Exhibit A exceeds the boundaries of area C specifically to provide a NS extension of 700 m, and a EW extension of 500 m. This is to allow a maximum baseline of 500 m even for low declination sources such as the Galactic Center. This extension out of area C also allows the CSO and JCMT to be located on the longer legs of the array should joint operations as an interferometer becomes feasible in the future.