THE ALLEN TELESCOPE ARRAY

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ABSTRACT

The Allen Telescope Array (ATA) will be a large collecting area radio telescope whose novel characteristics will be a wide field of view, continuous frequency coverage from 0.5–11.2 GHz, multi-beam capability, and built-in provision for RFI mitigation. Its scientific motivation includes deep SETI searches, wide-area HI surveys, monitoring of pulsars, and searches for unknown populations of transient and variable sources. The ATA is being built by a collaboration of the SETI Institute and the Radio Astronomy Laboratory at UC Berkeley.

MOTIVATION

The Allen Telescope Array (formerly known as the One-Hectare Telescope [1]) has been funded to enable two key endeavors. First, it will be home to a continuous SETI program. With sensitivity comparable to other large telescopes, and the inherent speed that comes with a large field of view, it will survey 100,000 stars, a factor of 100 more than existing targeted searches. The multi-beam and multi-frequency capabilities of the instrument will allow further monitoring of the stars that will be in any field of view during other observing programs. Second, the ATA will be a powerful tool for a wide variety of general astronomical studies. The wide field of view, unique for an instrument of the ATA's sensitivity at these frequencies, will allow deep wide-area surveys of Galactic and extragalactic HI, and of the polarized Galactic continuum. A companion survey to the Sloan Digital Sky Survey will detect all normal galaxies over 25% of the northern sky out to $z\sim0.2$. The wide field of view and instantaneous frequency coverage will also enable sensitive searches for transient and variable sources during any other observing program. Further planned studies include pulsar monitoring; mapping of the decrement in the cosmic background radiation seen toward galaxy clusters; and observations of HI absorption toward quasars at redshifts up to $z=2$.

SYSTEM DESCRIPTION

The ATA (Fig. 1) will consist of approximately 350 dishes of diameter 6.1 m, providing a 2.5-degree field of view at 1.4 GHz. The dishes will be an offset Gregorian configuration, to minimize antenna blockage and ground spillover. They will be illuminated by novel dual-polarization log-periodic feeds of very wide bandwidth, and followed by 12-K cryogenically cooled low noise amplifiers operating from 0.5–11.2 GHz. Beneath the feed a metal shroud will deflect ground spillover onto the sky; a radome will protect the feed from the weather. The entire RF band will be transported to a central laboratory on optic fiber; this enables simultaneous use at multiple frequencies and facilitates future upgrading when back-end processing becomes less expensive. At the central laboratory an up/down converter will produce four 100-MHz independently tunable outputs for each polarization from each antenna. Finally, phased array beams are made from digitized, delay-tracked data.

With its four independently tunable outputs, each with four phased-array beams, the ATA will be able to accommodate a variety of simultaneous back-end processing units. Those currently under design include a SETI spectrometer with six hundred million channels, a 1024-channel full-Stokes correlator with bandwidth at least 100 MHz, and a pulsar processor. A limited correlator will be available at first light to facilitate calibration. The back-ends share a design philosophy that emphasizes replaceable and re-programmable hardware to preserve investments in software to the degree possible. A variety of RFI mitigation techniques will be used to facilitate observations with each of these back-ends both within and outside allocated radio astronomy bands [2].

The site of the ATA is to be the Hat Creek Radio Observatory in northern California, the present location of the BIMA millimeter interferometer. Very low RFI levels and existing infrastructure make this site an attractive choice (the BIMA array is expected to move to a new location in 2005). The dishes will be distributed pseudo-randomly according to the site constraints in an area of 1 km in extent (Fig. 2). The antenna configuration has been optimized to achieve a near-Gaussian beamshape (FWHM) of about 78″ (natural weighting), near sidelobes below 1%, and far sidelobes of order 1/350. This configuration will allow superb imaging and minimize the effect of RFI.

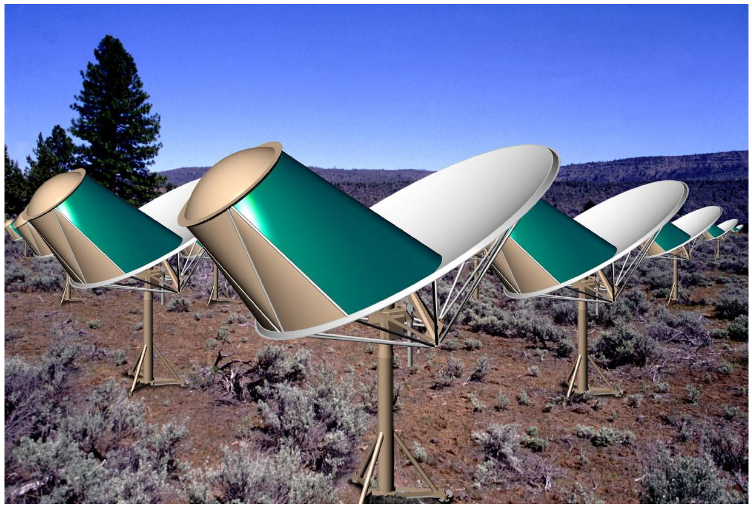

Fig. 1. Artist's impression of the ATA at Hat Creek Radio Observatory

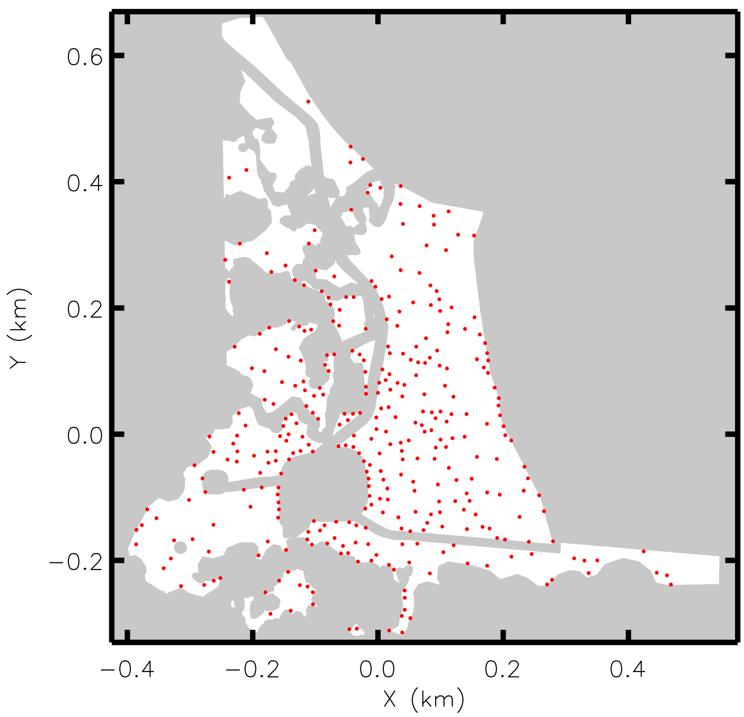

Fig. 2. The proposed ATA antenna configuration

CURRENT STATUS

The first ATA primary reflector meeting the surface specification (1.25 mm rms) was manufactured in May 2002. Further optimization continues. After acceptance testing at a site close to Berkeley, this reflector will be followed by several more over the next few months, which will form the Production Test Array (PTA) at Hat Creek. Prototype versions of the other system components are nearing completion, and the PTA is expected to be operational with a minimum of three antennas by the fourth quarter of 2002. Construction of the full array is expected to begin in 2003 and be complete by the end of 2005, with first light from the partial array in early 2004. In parallel, a prototyping array (using off-the-shelf hardware) has been built to allow the early development of RFI mitigation techniques and telescope monitor and control software [3]. As a natural prototype itself of large-N antenna technologies, the ATA will also enhance the development of the next generation instrument, the Square Kilometer Array.

REFERENCES

[1] W. J. Welch and J. W. Dreher, “The One-Hectare Telescope,” *Proc. SPIE*, vol. 4015, pp. 8–18, 2000.

[2] G. C. Bower, “A Radio Frequency Interference Mitigation Strategy for the Allen Telescope Array,” these proceedings.

[3] D. R. DeBoer, J. W. Dreher, and W. J. Welch, “The Rapid Prototype Array for the One Hectare Telescope,” *USNC/URSI National Radio Science Meeting*, p. 240, 2000.