A High-Performance Reflector Antenna Appropriate for High-Volume Production

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The cost of an antenna element is a key parameter in maximizing the performance per cost ratio of an array. Most current radio telescope array antennas were not designed for high-volume production but generally "only" for performance since typically the production numbers were not large enough to (a) justify the additional design effort and (b) qualify for discount production in terms of amortized tooling costs and quantity purchase. The Allen Telescope Array (ATA) was one of the first radio telescope antenna arrays to be designed for high-volume antenna production.

The ATA antenna was a rim-supported single-shell antenna structure using a single piece aluminum reflector appropriate for a 6-meter offset reflector antenna. Costing models for very large arrays indicate a larger antenna diameter is likely preferred and additional design work was warranted. Developments at the Canadian Herzberg Institute Astrophysics (HIA) Dominion Radio Astronomy Observatory (DRAO) Composite Applications for Radio Telescopes (CART) program showed that single-shell composite structures could be made to larger size and with improved thermal performance over an aluminum shell. HIA, with support from an NSF technology development grant for the mount design, funded continued research to culminate in the manufacture of one such antenna, termed Dish Verification Antenna-1 (DVA-1). The SKA Project Office (Manchester, UK) also provided support as part of the dish verification program.

DVA-1 is a clear aperture offset shaped offset Gregorian antenna with excellent dimensional stability (over wind, temperature and gravity), which leads to high-dynamic range performance. Since it is unblocked, the sub-reflector and focal area may be very large to allow low frequency performance and a great deal of flexibility in feed packages. DVA-1 has a projected aperture of 15 meters and a 4-meter sub-reflector. The feed arm is mounted on the high-side to keep the pedestal low and costs down. The mount has three large welded sections, which all may be shipped in standard shipping containers and then assembled in the field. The pieces are as light as possible to reduce construction, shipping and lifetime costs. The antenna is passively very stable and the azimuth and elevation encoders are tightly coupled to the optical axis, such that a pointing model can compensate for most effects. Residual errors will be compensated by a tilt-meter assembly incorporated into the pedestal. In this paper we present the expected performance and plans to verify them on the DVA-1.