Design of Optimized Cassegrain Antenna Systems

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The focal point of a parabolic dish is at a physically inconvenient location, and getting a signal to and from the feedhorn requires a significant amount of feedline. At the higher microwave frequencies, the feedline loss is significant, and intolerable above 10 GHz.

One compromise is to move the equipment to the feed location. This adds possible additional feed blockage, plus significant weight at the feed location – in most amateur mounting schemes, the additional weight further unbalances a poorly balanced system. Offset dishes can have the equipment placed out of the RF path with short feedline but are still often unbalanced.

A Cassegrain antenna system, with a subreflector to redirect the RF to the dish surface from a more conveniently placed feedhorn, can place the equipment at a location which is more convenient, both electrically and mechanically, without compromising dish performance. In the case of very deep dishes, the performance can be improved by fully illuminating the dish surface. However, the Cassegrain antenna only achieves good performance for large dishes, greater than perhaps 40 wavelengths in diameter – few amateurs have dishes large enough for lower frequencies.

For EME or radio astronomy, the Cassegrain antenna offers the additional advantage that the primary feed spillover is directed toward cold sky for improved **G/T**.

The Cassegrain subreflector, shaped to a hyperbolic curve, has been difficult to fabricate, so hams were limited by the availability of existing subreflectors, usually from surplus sources. The recent development of inexpensive, computer-driven, tabletop routers and 3D printers makes it possible to easily fabricate custom subreflectors and other shapes. In the USA, the Makerspace movement has made CNC machinery with more capability accessible to ordinary people.

A custom subreflector may be designed to place the feedhorn at a desired location for a given dish ***f*/D** and feedhorn; a high-performance feedhorn may be used with a deeper dish. Of course, there are tradeoffs to be considered. To enable the required calculations and easily consider tradeoffs, a **MATLAB** script was developed which calculates the subreflector size and hyperbola parameters for a chosen feed location, dish ***f*/D,** and feedhorn. Once a suitable combination is determined, the hyperbolic curve is output, either as an X-Y table or directly as G-code for a CNC machine or 3D printer. The **MATLAB** script is easily modified for different machinery. It will probably also run on the free **GNU Octave** interpreter.

Several examples for the higher microwave bands have been built and tested, with good measured performance. An EME system for 10 GHz is in development.