Geometry of Parabolic Reflectors

Abdus Salam ICTP, February 2004

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for Research and Training in
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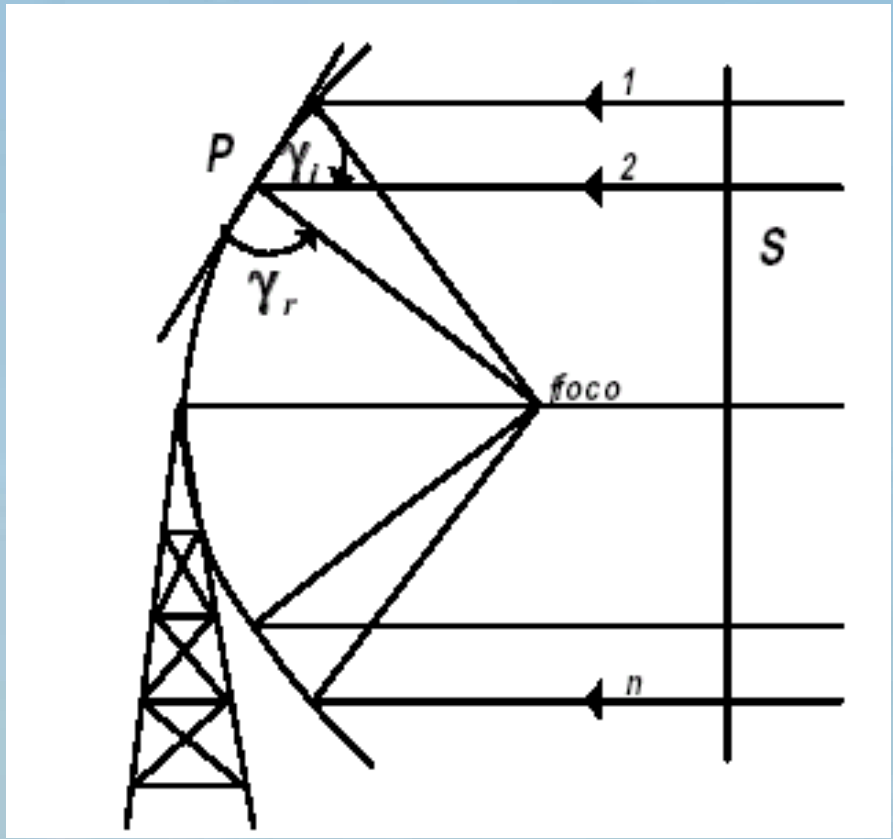
Geometry of parabolic reflectors

The main property of the parabolic reflector is that the incoming rays will be reflected through the focus ***f*** and will reach the surface ***S*** after having traversed the same distance and will therefore be in phase.



The basic property of a perfect parabolic reflector is that it converts a spherical wave irradiating from a point source placed at the focus into a plane wave. Conversely, all the energy received by the dish from a distant source is reflected to a single point at the focus of the dish. The position of the focus, or focal length, is given by:

$$f = \frac{D^2}{16 \times c}$$

where D is the dish diameter and c is the depth of the parabola at its center.

The size of the dish is the most important factor since it determines the maximum gain that can be achieved at the given frequency and the resulting beamwidth. The gain and beamwidth obtained are given by:

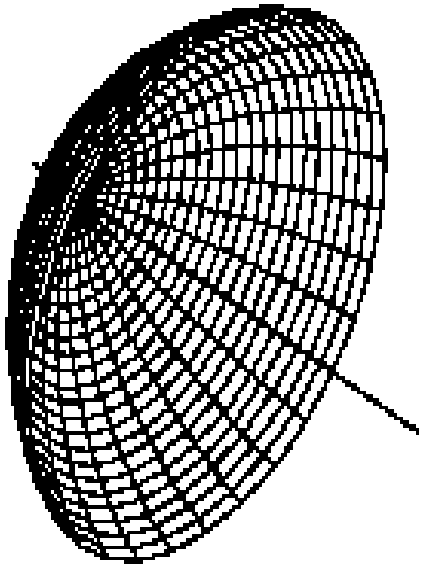
$$G = \frac{(\pi \times D)^2}{\lambda^2} \times n$$

$$BW = \frac{70\lambda}{D}$$

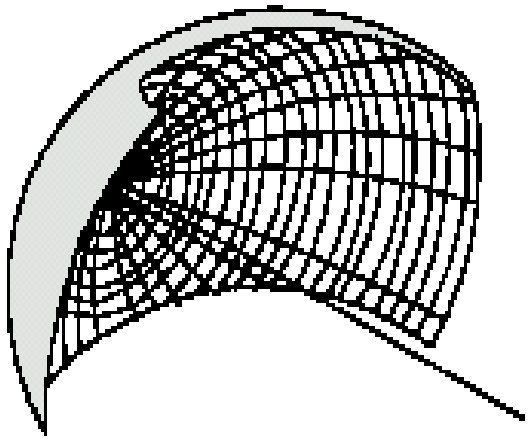
where D is the dish diameter and n is the efficiency. The efficiency is determined mainly by the effectiveness of illumination of the dish by the feed, but also by other factors. Each time the diameter of a dish is doubled, the gain is four times, or 6 dB, greater. If both stations double the size of their dishes, signal strength can be increased of 12 dB, a very substantial gain. An efficiency of 50% can be assumed when hand-building the antenna.

The ratio f/D (focal length/diameter of the dish) is the fundamental factor governing the design of the feed for a dish. The ratio is directly related to the beamwidth of the feed necessary to illuminate the dish effectively. Two dishes of the same diameter but different focal lengths require different design of feed if both are to be illuminated efficiently. The value of 0.25 corresponds to the common focal-plane dish in which the focus is in the same plane as the rim of the dish.

Examples of dishes

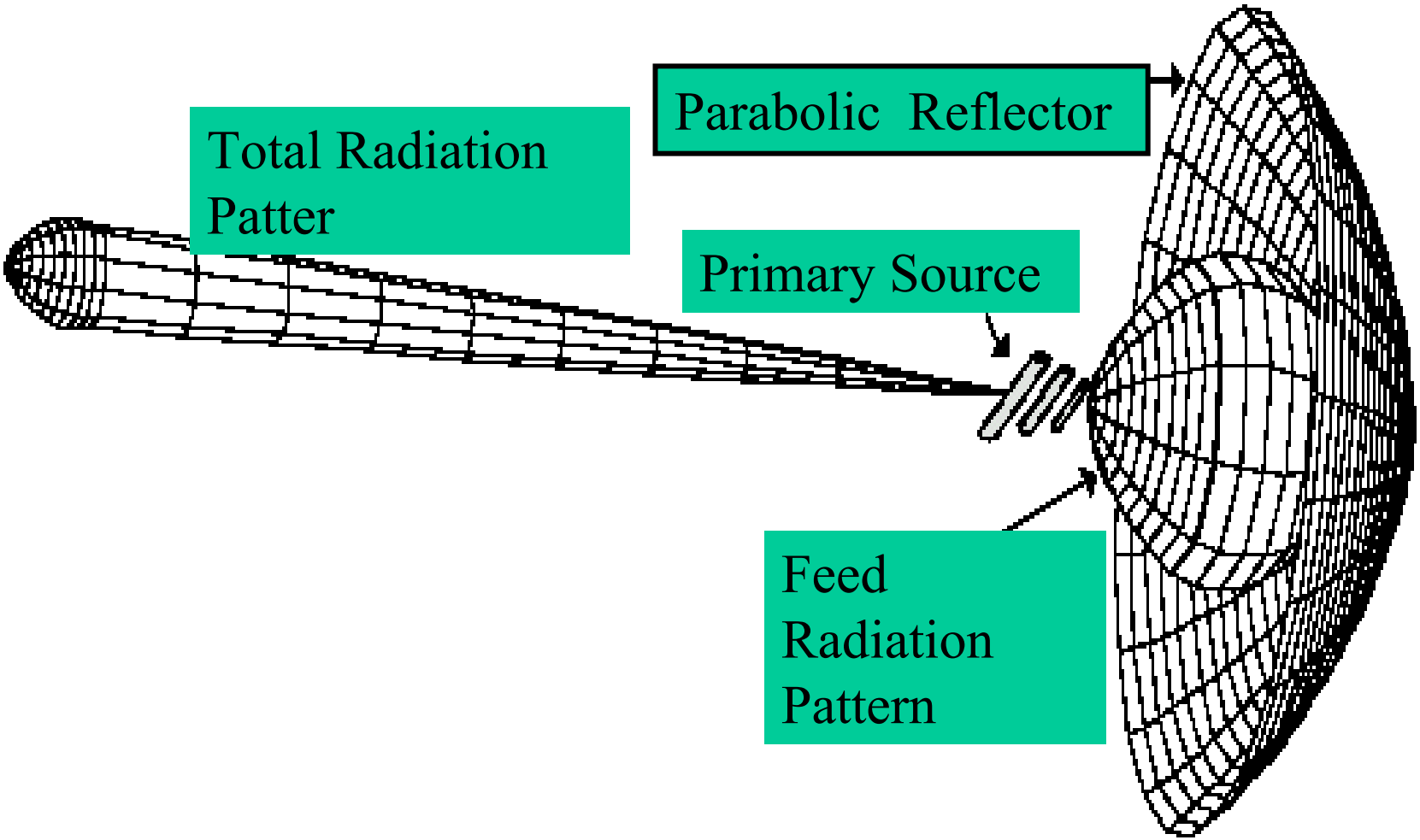


Parabolic Dish



Truncated Parabolic Dish

Parabolic Cylinder


Total Radiation Patter
Parabolic Reflector
Primary Source
Feed Radiation Pattern

Dish Illumination

- The illumination of the dish is crucial to the performance
- We should illuminate as much as the reflecting surface as possible as well as avoiding spillover
- The best results are obtained with a tapered illuminator that will progressively diminish the illumination of the edges thus reducing sidelobes and spillover
- Another critical parameter is the position of the feed with respect to the reflector

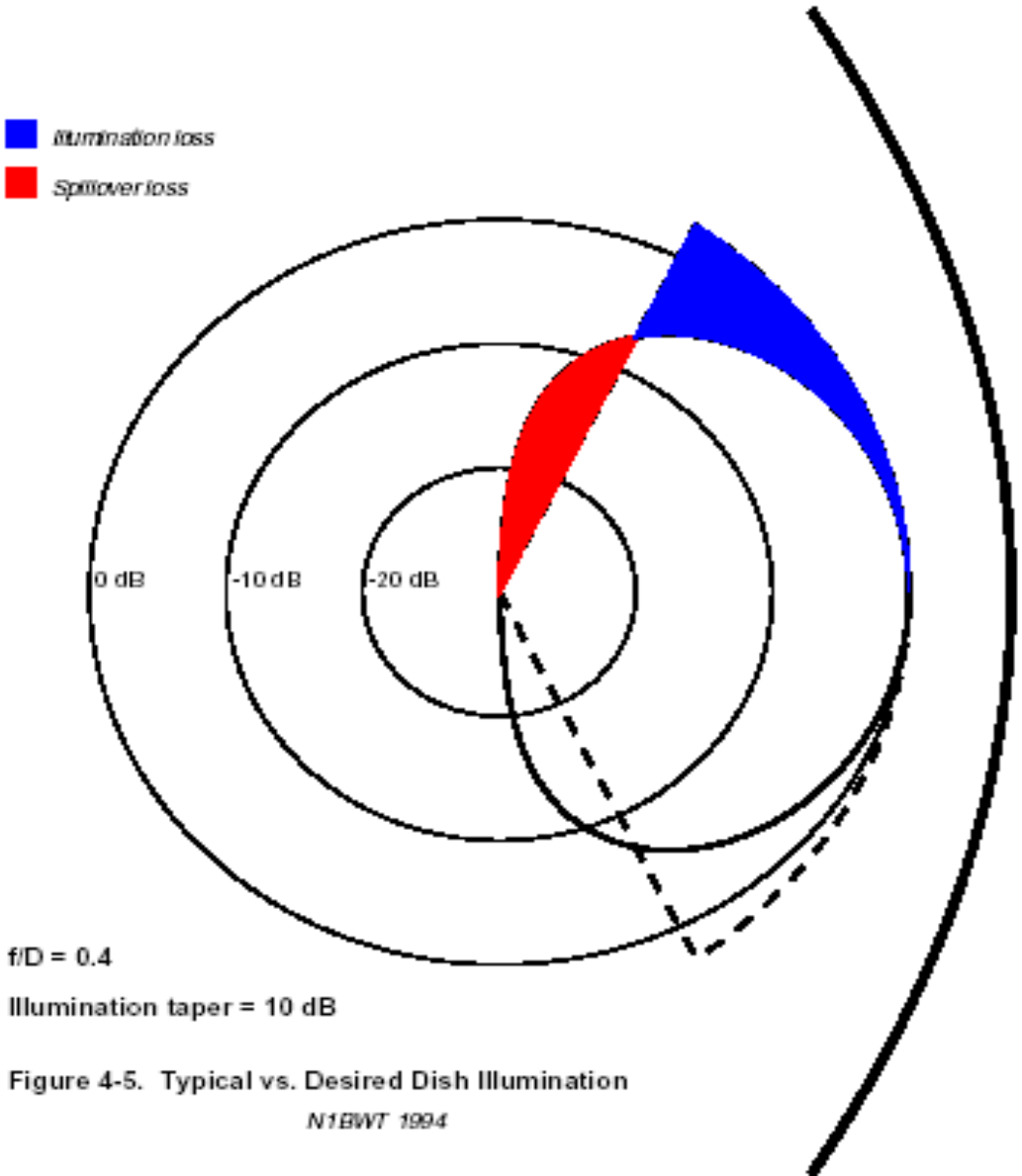


Figure 4-5. Typical vs. Desired Dish Illumination

N1BWT 1994

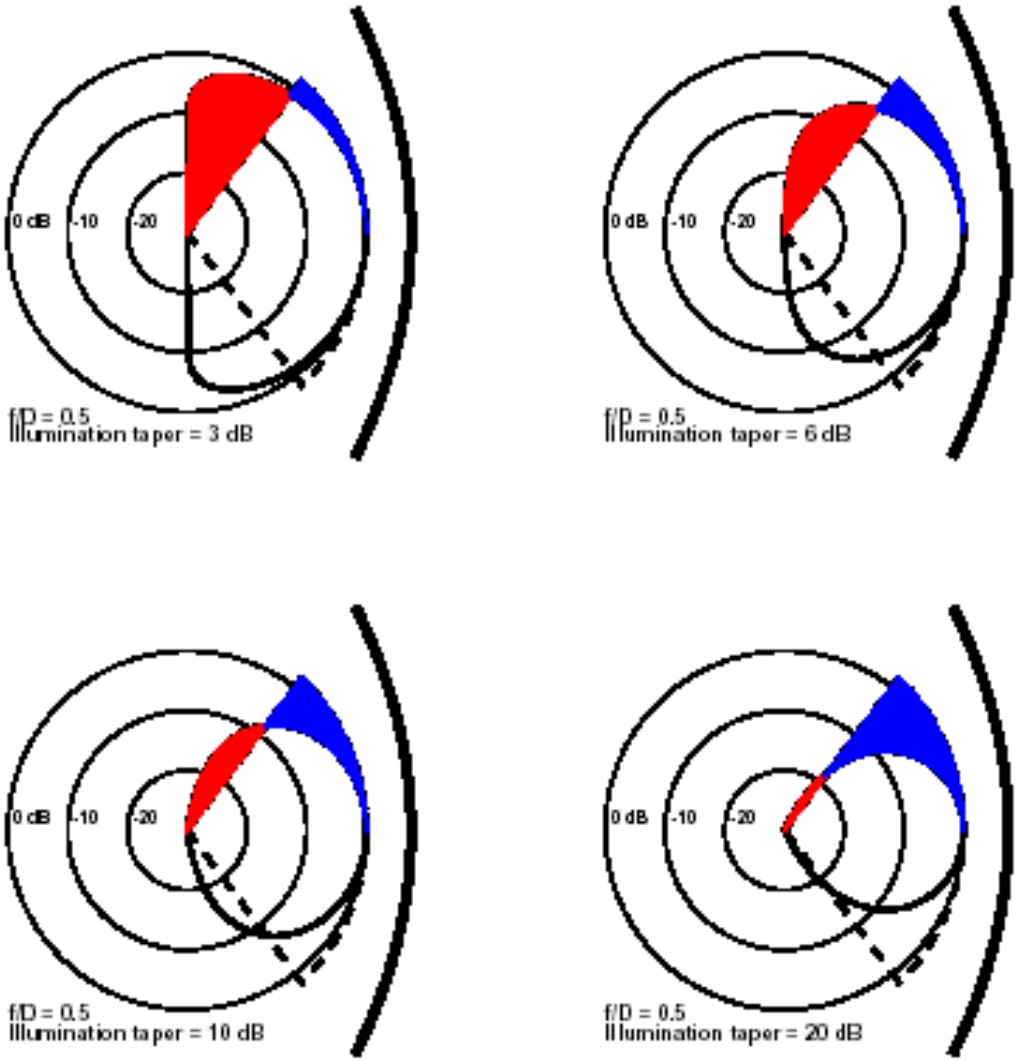


Figure 4-6. Dish Illumination with Various Illumination Tapers

N1BWT 1994

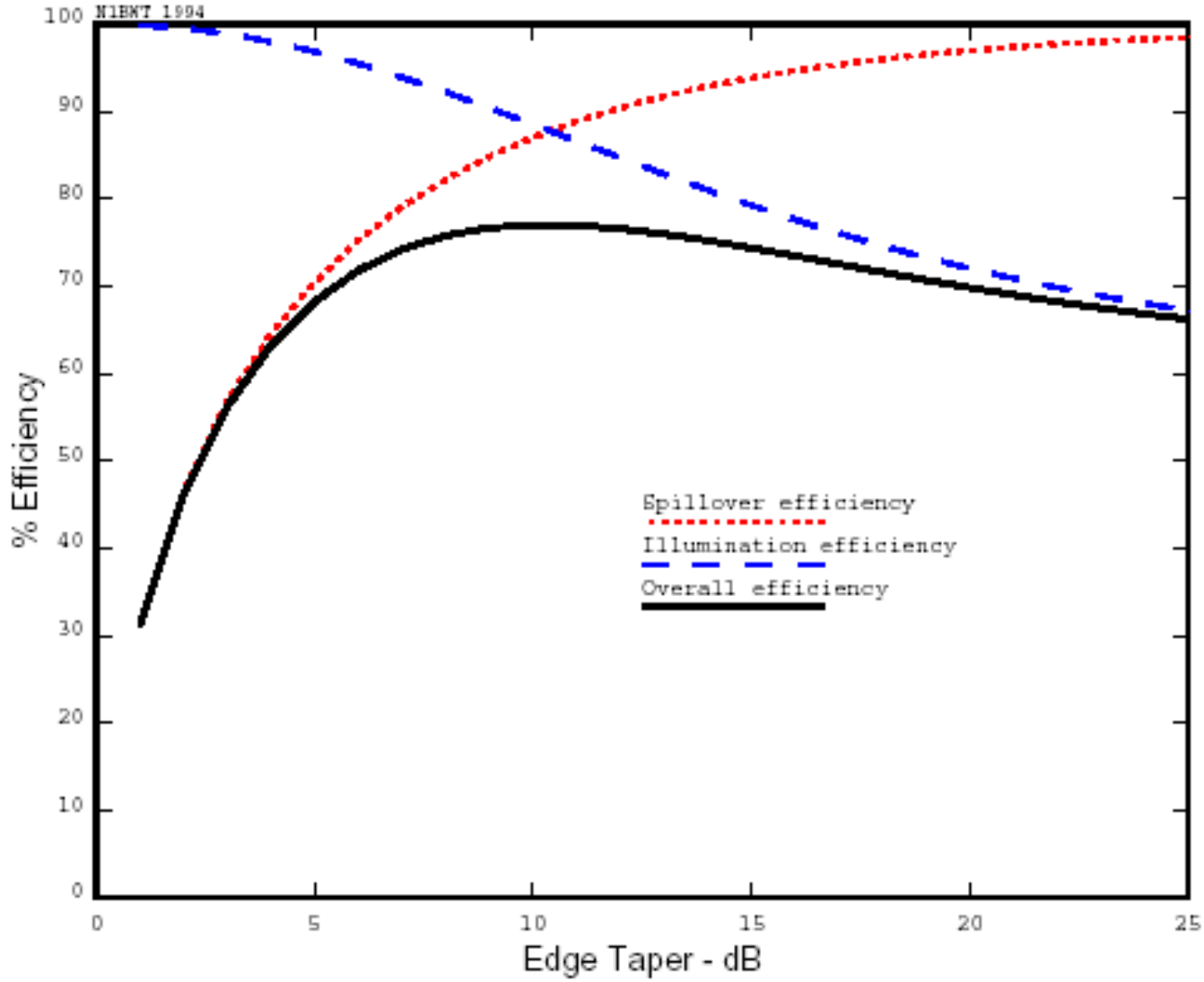


Figure 4-7. Efficiency vs. Edge Taper for a Dish

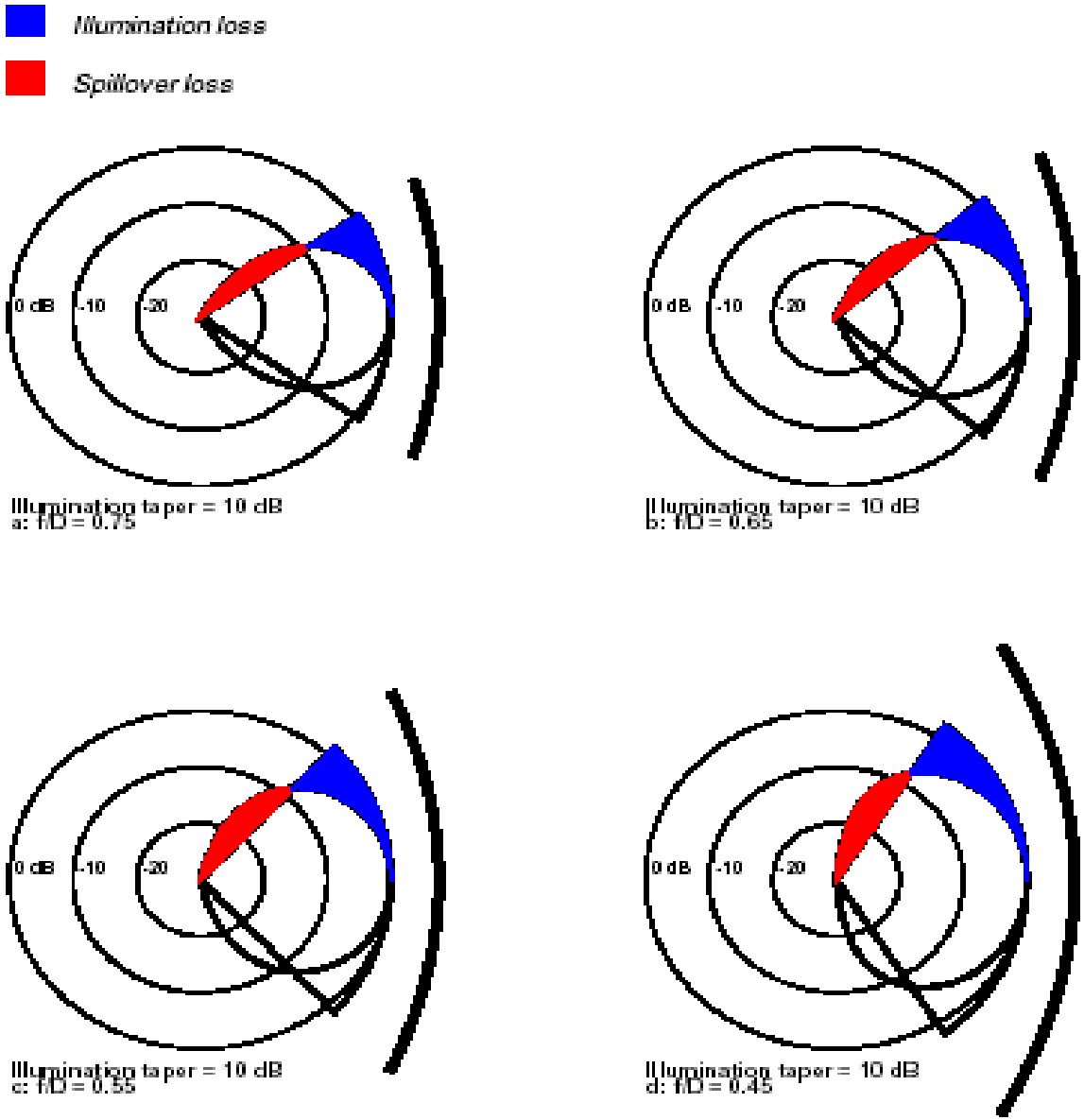


Figure 4-8. Dish Illumination for Various f/D Ratios

N1BWT 1994

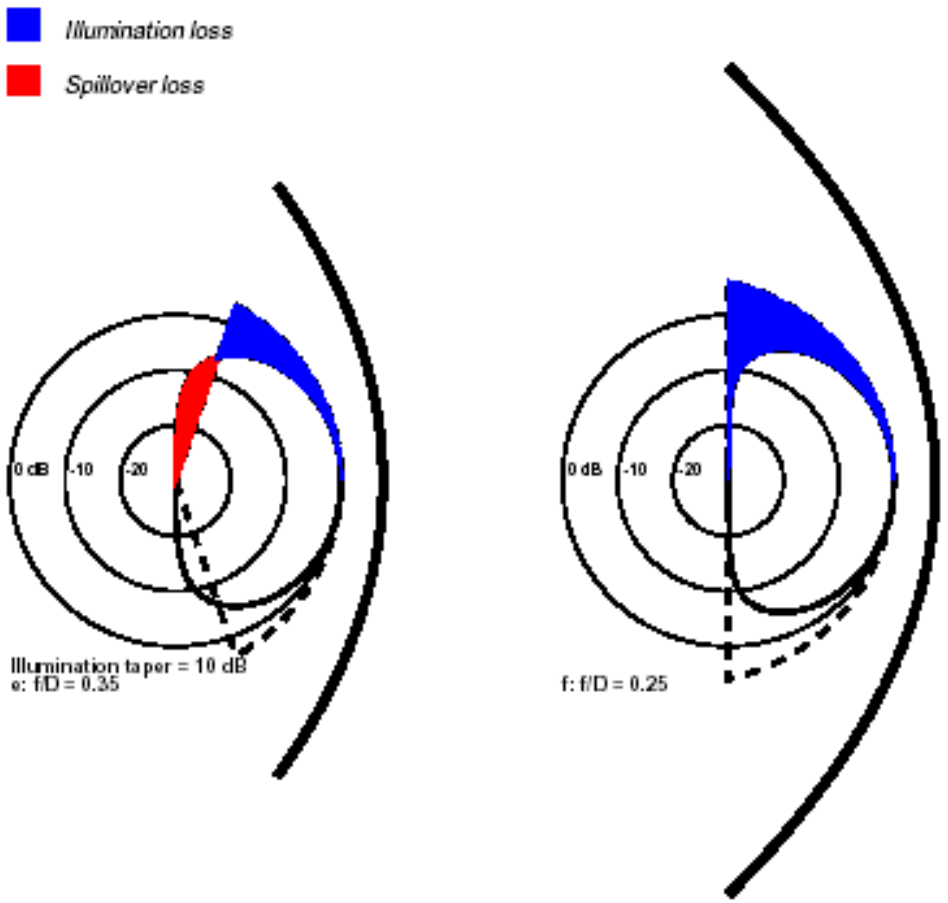
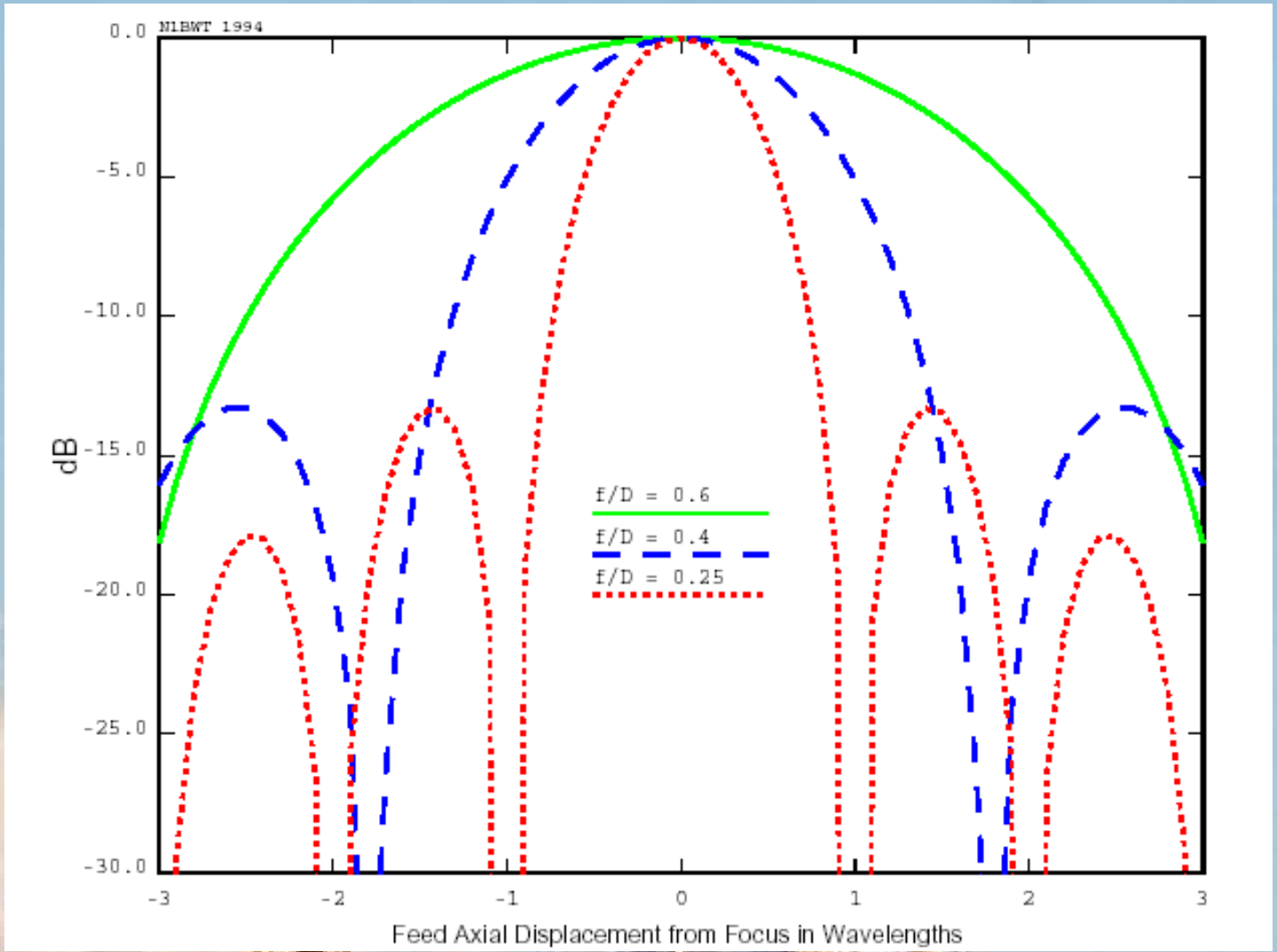


Figure 4-8 Cont. Dish Illumination for Various f/D Ratios

N1BWT 1994

Error in wavelength loss from focus displ.



Types of parabolic feeds

- Center Feed
- Offset Feed
- Cassegrain Feed

What Snows does to antennas..