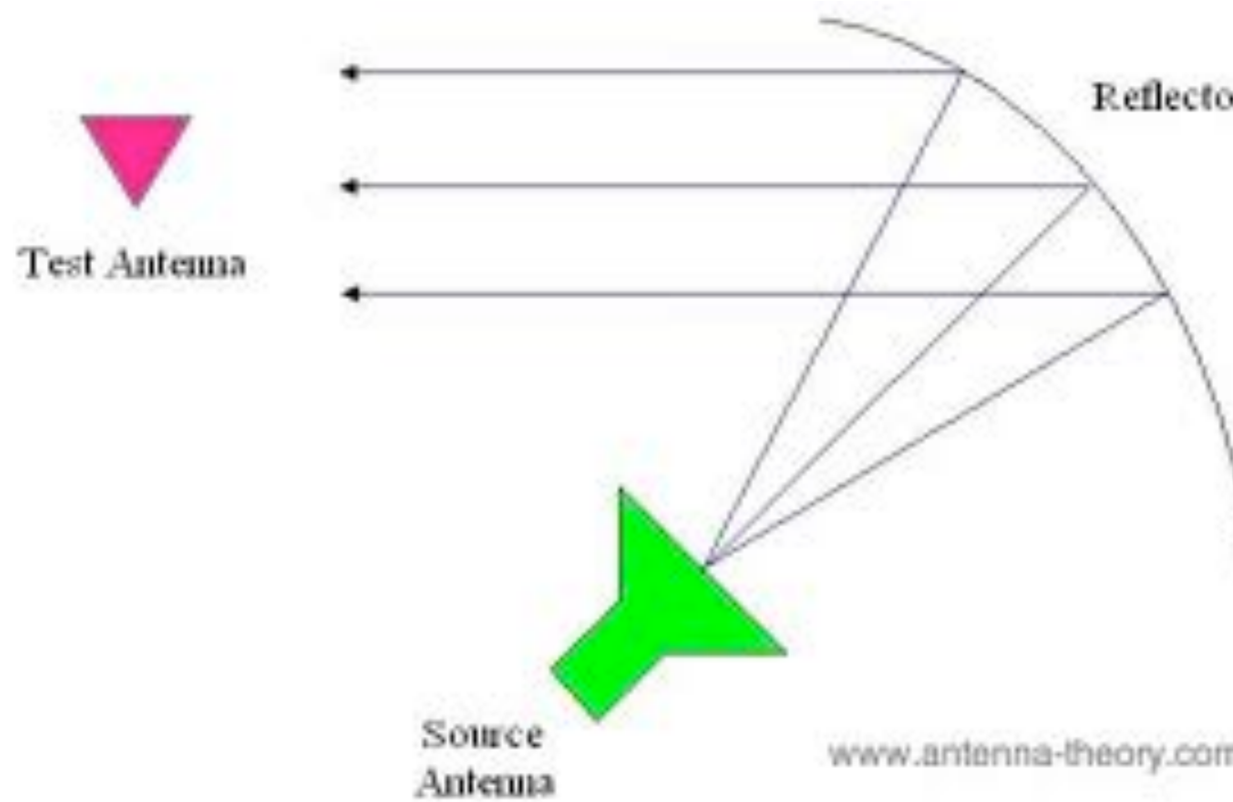
Parabolic Dish Antenna Masterclass

Amy

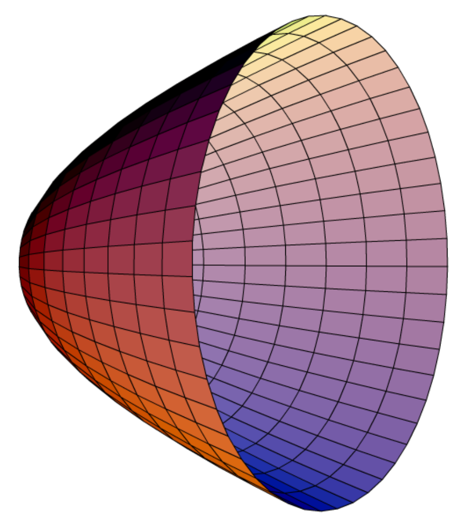
12/5/13

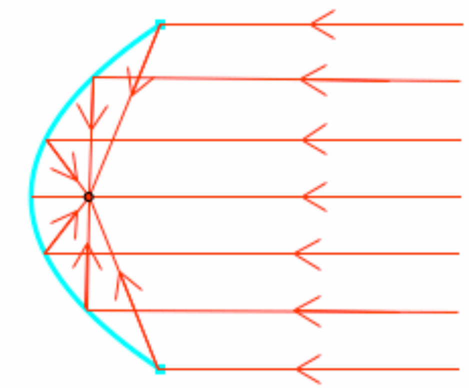
ULDB (NASA)



Paraboloid

- A dish antenna follows the shape of a paraboloid
  - The shape swept out by a parabola $y=ax^2$ rotated about the z axis





- This shape is chosen because a plane wave incident on a parabolic reflector focuses at a point
- Or in our case, a transmitter at the focal point aimed at the dish produces a plane wave

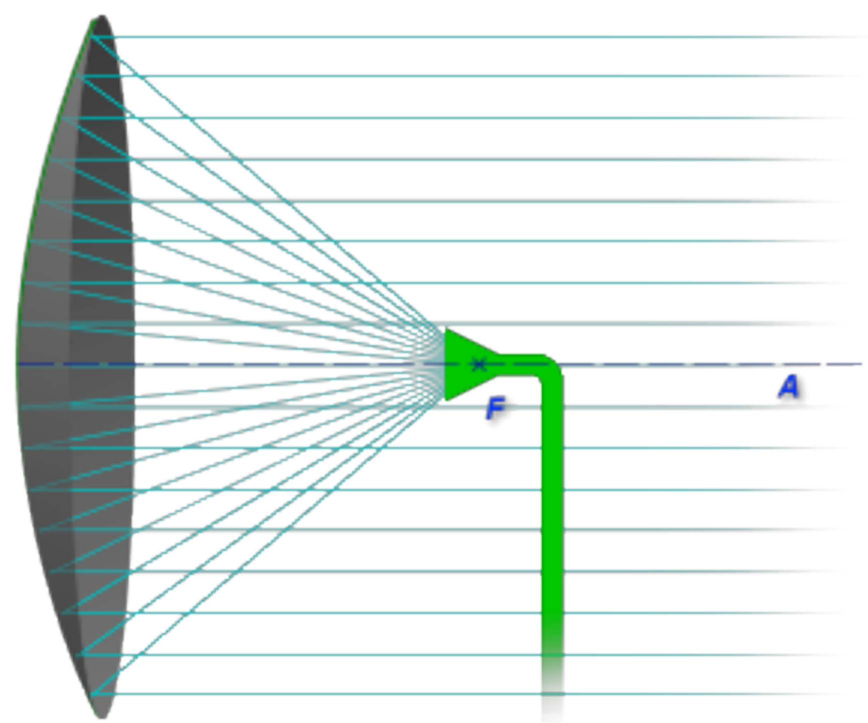
Dish Antenna

- A dish antenna is a paraboloid that has been sliced by a plane
- This center-feed dish antenna is probably a paraboloid that has been sliced by a plane perpendicular to the paraboloid’s axis of rotation

- Its “feed” sits at the focal point of the paraboloid, which sits along the paraboloid’s axis of rotation

Problems with center-feed antennas

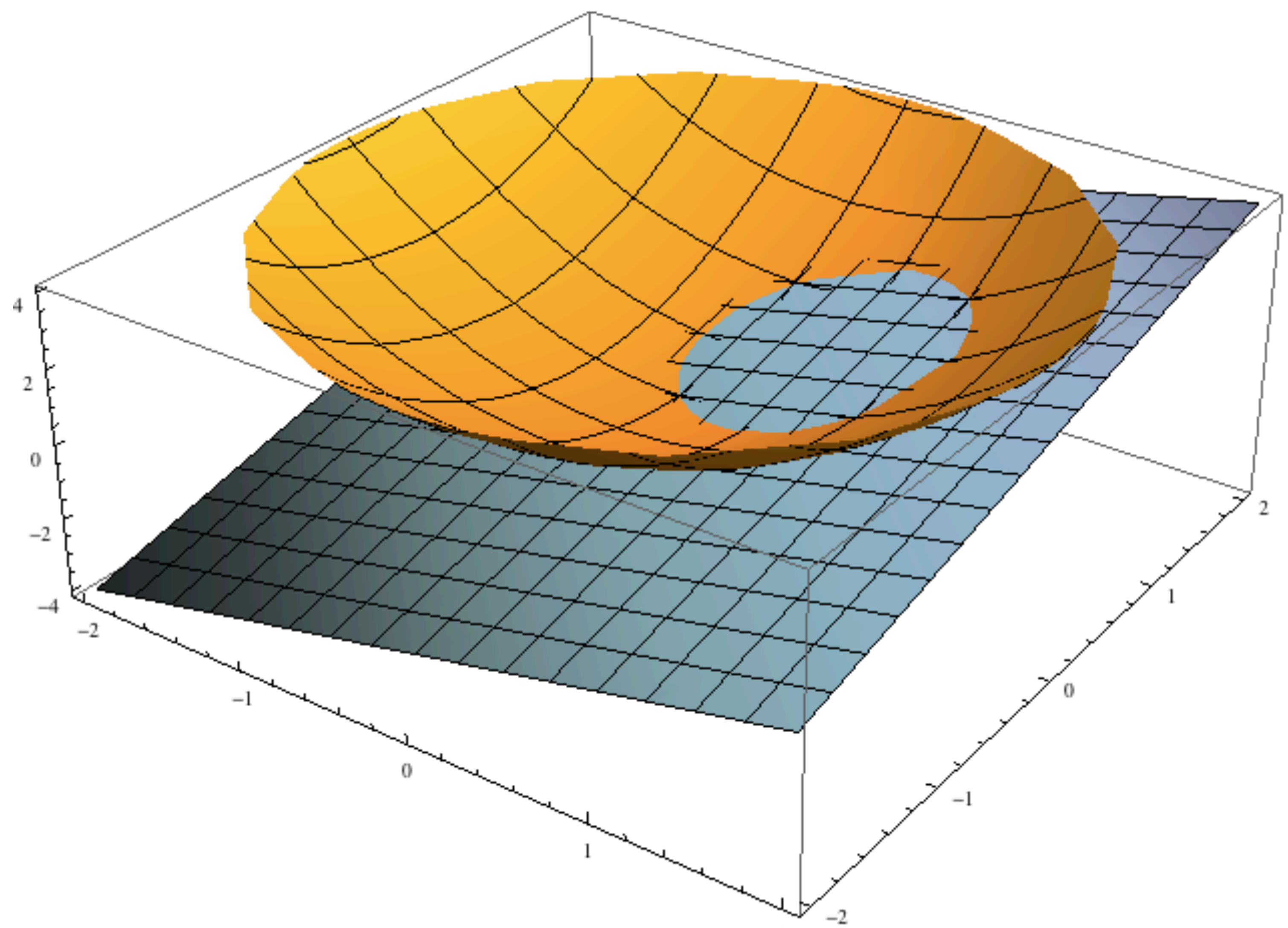
- There are a couple of issues with "center-feed" antennas
  - The feed is in the way!
  - The reflected wave can interact with the feed antenna which is supposed to be just transmitting
- So what do you do?



http://www.radartutorial.eu/06.antennas/an10.en.html

Offset feed antenna

- An offset feed antenna is also a paraboloid sliced by a plane but at an oblique angle:



- Turns out this is always an *ellipse*
- But if you are looking parallel to the axis of the paraboloid, it is a *circle*

Picture from: http://math.stackexchange.com/questions/149645/calculate-the-volume-of-a-zone

- In other words, its projection on the x-y plane is a *circle*

Intersection of paraboloid and plane projects to a circle on the x-y plane

Find the intersection between the plane and paraboloid:

$$z = x^2 + y^2 = 2ax + 2by$$

Or

$$\begin{aligned} x^2 - 2ax + y^2 - 2by &= 0 \\ (x^2 - 2ax + a^2) + (y^2 - 2by + b^2) &= a^2 + b^2 \\ (x-a)^2 + (y-b)^2 &= a^2 + b^2 \end{aligned}$$

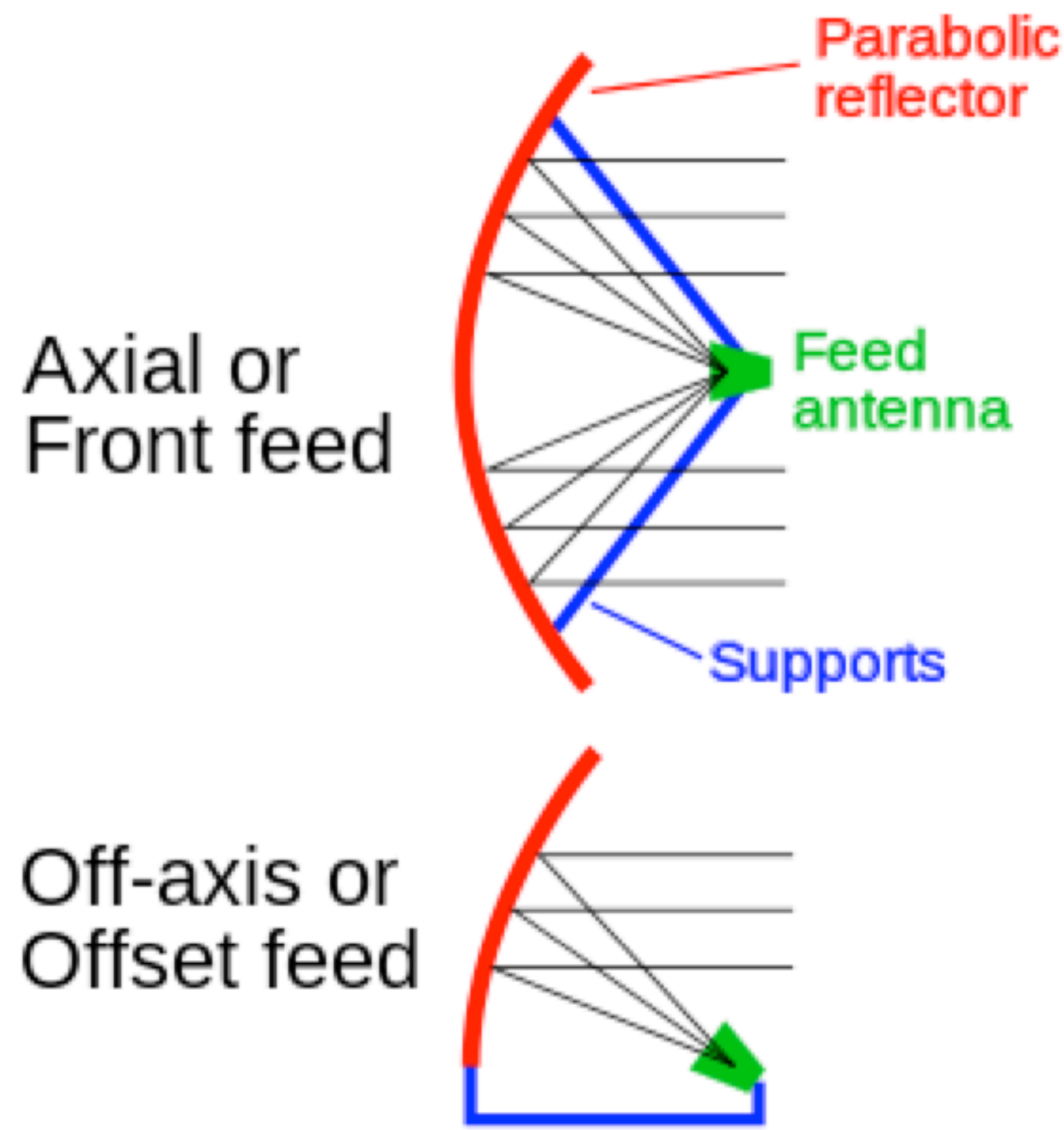
In the xy plane, this is a disk centered at (a, b) with $R = \sqrt{a^2 + b^2}$:

$$\mathcal{A} = \{(x, y) \in \mathbb{R}^2 : (x-a)^2 + (y-b)^2 \leq a^2 + b^2\}$$

http://math.stackexchange.com/questions/149645/calculate-the-volume-of-a-zone

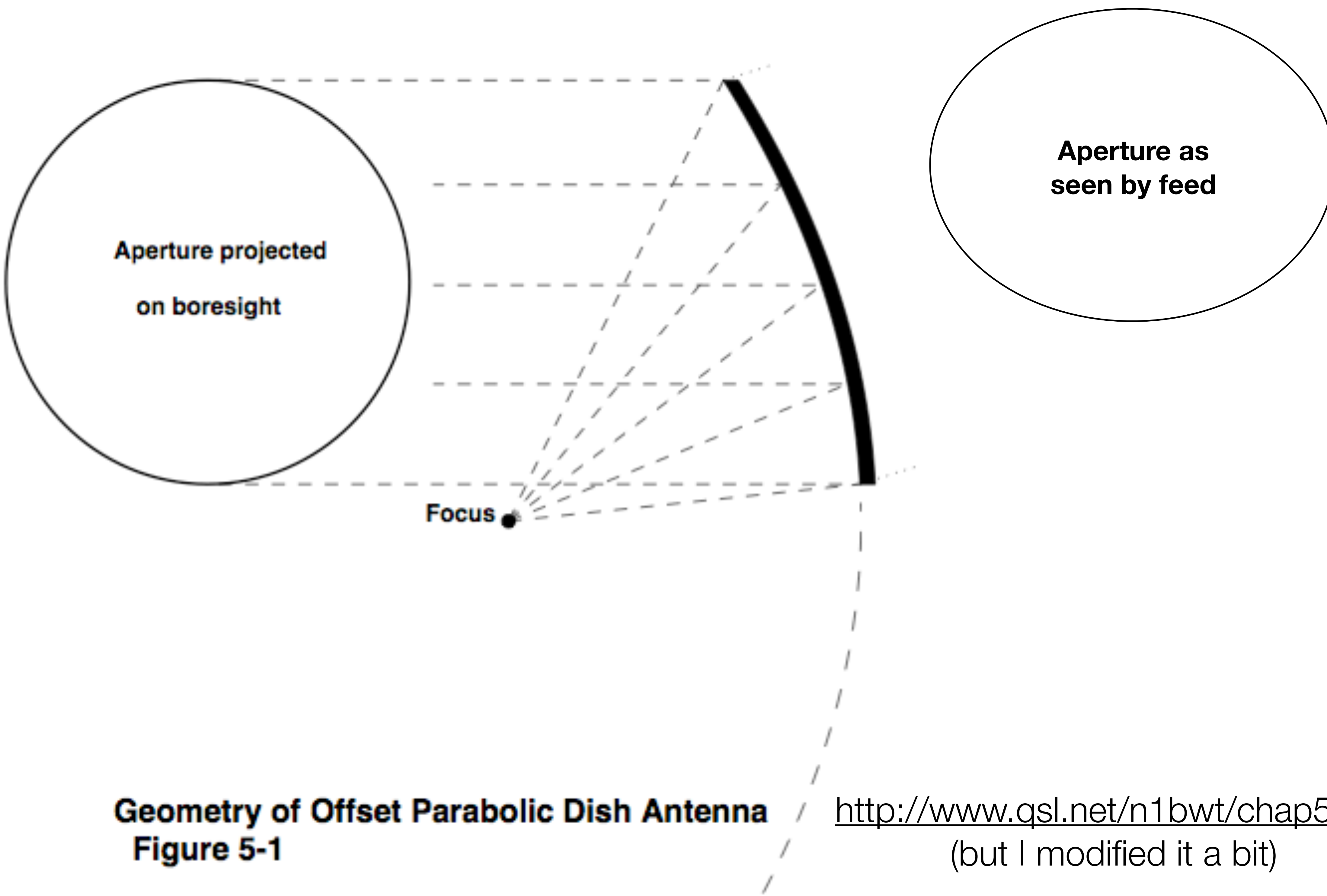
Offset feed

- Feed antenna still sits at focal point
- Reflector still follows paraboloid shape → produces a plane wave
- But now the feed antenna is out of the way



Thanks Wikipedia!

Offset feed antenna



Geometry of Offset Parabolic Dish Antenna
Figure 5-1

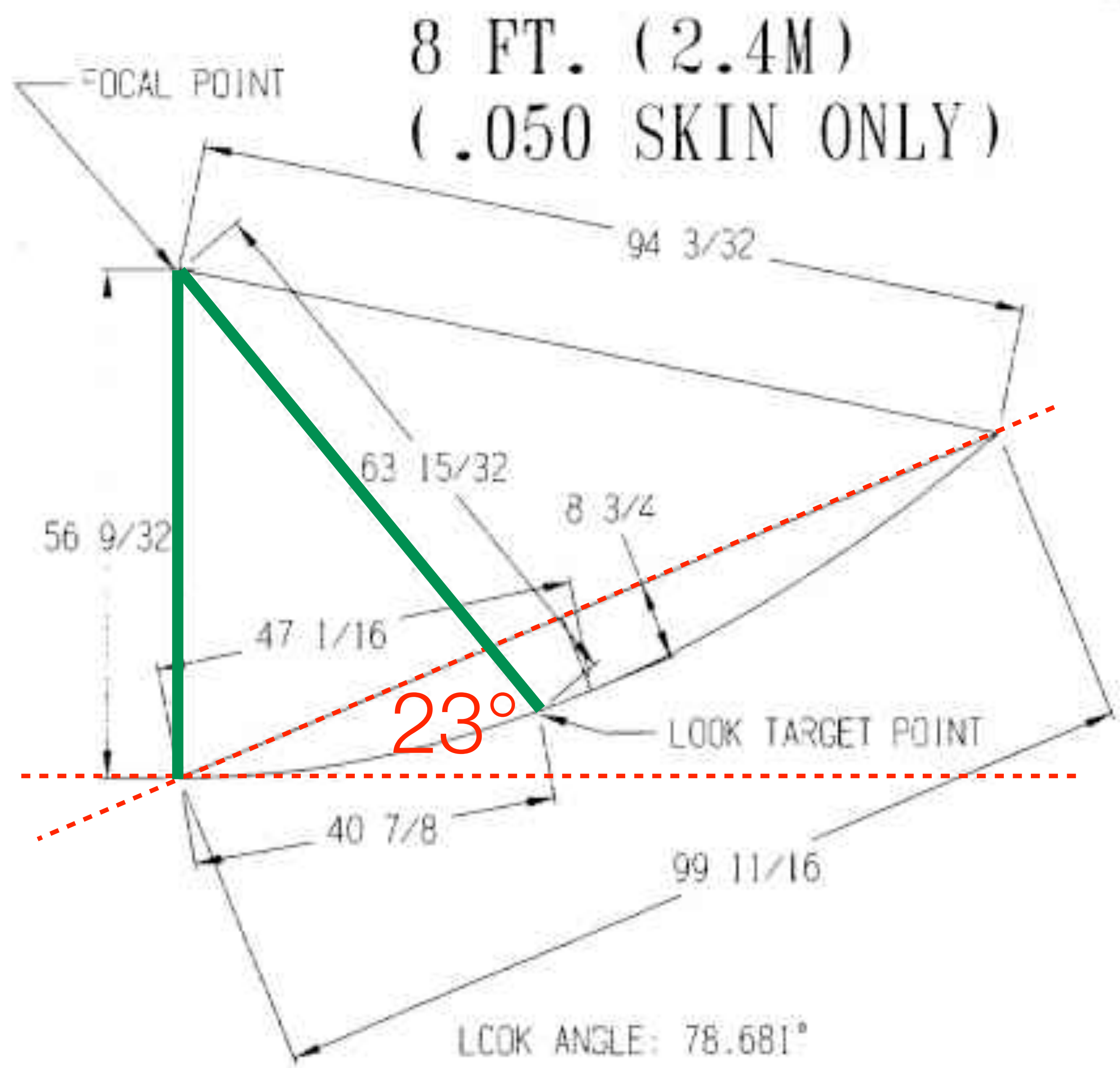
http://www.qsl.net/n1bwt/chap5.pdf
(but I modified it a bit)

Andersen Inc. dish that we will use

- Parabolic 2.4 m dish antenna with offset feed
- F/D = 0.610
- Bottom of the antenna is the vertex of the paraboloid
- Measured distance from vertex to feed is 146 cm = 2.4 m * 0.610
- Angle of offset 23°

Andersen Inc. Dish that we will use

- The feed does sit at the focal point
- Our plane wave will propagate vertically in this picture
- Green lines are the feed brackets
- So for a plane wave emitted horizontally, the lower bracket should be parallel with the ground



Drawing from Andersen Inc.

The Wallops hangar (from Frank)