

# FINDING A FOCUS OF A RADIO TELESCOPE (OFFSET FED PARABOLIC DISH ANTENNAS)



## Introduction

- An offset-feed dish antenna has a reflector which is a section of a normal parabolic reflector.
- An offset-feed dish antenna strategically utilizes a parabolic reflector section that excludes the dish's central region, thereby mitigating feed blockage by the feed antenna and support structure.

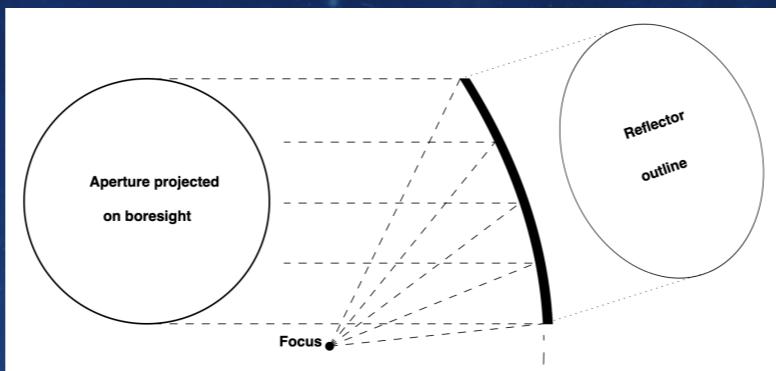
## Motivation

- The offset-feed configuration provides a notable advantage in satellite reception scenarios.
- By positioning the feed horn skyward, away from the warm earth, spillover noise from ground sources is significantly reduced. This design minimizes losses in efficiency. The offset dish offers higher gain, G, since the efficiency is higher, plus reduced noise temperature, T, so both terms in the G/T ratio are improved.
- Accurately determining the focus of a tilted parabola is crucial for optimizing signal reception.



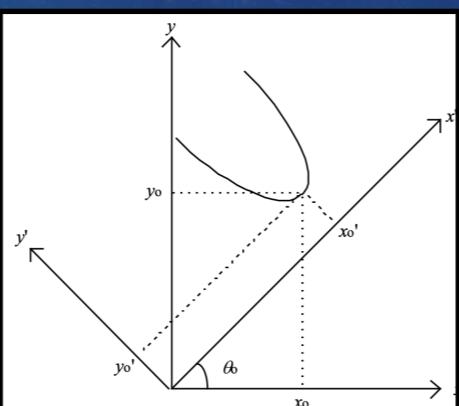
Suhani Surana, Dr. Dan Marrone

## Proposed Parabola Structure



Geometry of Offset Parabolic Dish Antenna

### Parabolic curves in any orientation - Mathematical Result



$$(y' - y'_0) = p(x' - x'_0)^2$$

Final Concluding Equation,  $y =$

$$\frac{1}{2A} \sec \theta \left( \sqrt{4A^2 \cot^2 \theta + 4A \cot^3 \theta + 4A y' \cos^2 \theta + 4A x' \cos \theta + 4A(x_1 + x \cos \theta) \cos \theta + \cot^4 \theta} + 2A \cot \theta + \cot^2 \theta \right)$$

Where,  $A = 1/4f$ , This equation yields us the mathematical value of  $y$  after applying the 2D Rotation Matrix

## Making Measurements

- Tools such as Combination Squared, Surface Plate, Vernier Calipers, Rulers were used to make the initial measurements starting with a point by the manufacturer.
- The major and minor axis and the coordinates were defined and the measurements were recorded precisely.



## Improved Offset Reflector Calculations Using Computational Techniques

- Through Python's SciPy library, we optimized parabolic curve fitting to experimental data from radio telescope measurements.
- Leveraging curve\_fit and chi-squared analysis, we achieved precise parameter optimization thus, deriving optimized values for  $x_0$ ,  $y_0$ ,  $f$ , and tilt angle, with a standard deviation of  $\sigma \approx 0.1155$ .

## Practical Verification

- Utilized rotation matrix equations to calculate the coordinates of the focus of a tilted parabola, integrating parameters such as tilt angle, vertex coordinates, and focal length.
- Verified the computational findings through experimental validation, employing a signal receptor attached to the parabolic surface to confirm the focus coordinates in the natural coordinate system.

## Conclusion

Focal length = 34.73563 inches  
 Focal Length Coordinates - 19.25 inches, 4.4 inches  
 $x_0, y_0 = 18.4136$  inches, 2.91855 inches  
**Tilt angle = 29.844°**  
 To aim an offset dish on the horizon with the feed below the dish, the reflector must be tilted forward — 29.844° from horizontal for the Multicom dish.