Focus Hard

Offset Cassegrain Antenna

Bob KB1QV

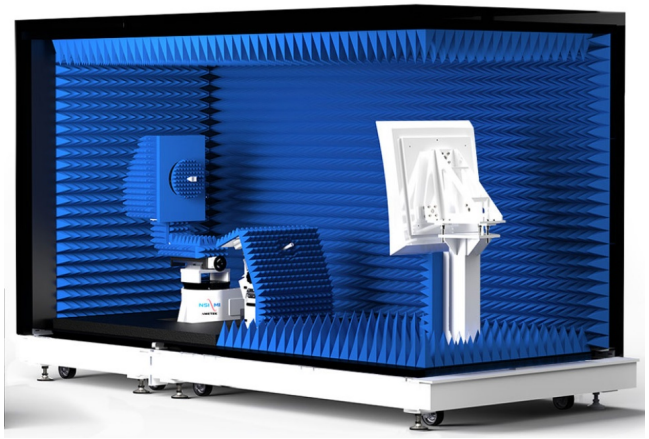
49th Eastern VHF/UHF/Microwave Conference

25 April 2026

Contents

Antenna

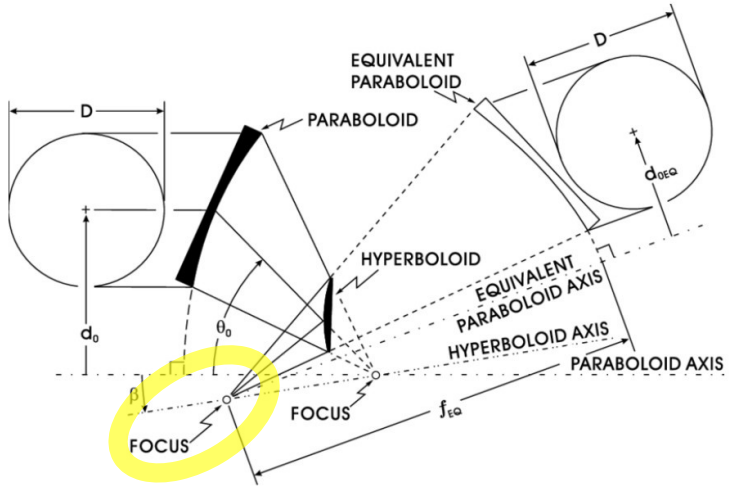
- Offset Cassegrain design
  - Parabolic main reflector
  - Hyperbolic sub reflector
- Compact antenna range application
- Used for automotive radar testing
  - 24GHz and 77GHz
- Obtained surplus
  - Don’t ask.



https://www.nsi-mi.com/system-solutions/far-field-systems/compact-range-systems/portable-compact-range-measurement-systems/portable-compact-range-measurement-system-18-05

Purpose

- Purpose
  - Find the focal point of the system
  - Verify system alignment
  - Determine desired placement and orientation for antenna feed
  - Once fully completed, use the system for microwave communications and radio astronomy



3: The equivalent paraboloid of the offset Cassegrain system

Challenges

- The original feed and mounting hardware are not available
- The design location is not known
- There are alignment adjustments on both the main reflector and sub reflector
- Positional geometry is likely very sensitive
- The reflector surfaces are a matte off-white finish
- The system was not originally intended to be used as an antenna

Techniques

- Several methods will be tried to find the focus point of the system
- Each will hopefully yield a best location
- The locations will be averaged and weighed to make a final determination for the feed location
- All techniques use wave phenomena that utilize the broadband nature of reflector surfaces
- The various methods attempted are listed below:

1) Mathematical techniques

- Equations determined for the primary surfaces
- E.M. Simulations considered

2) Optical, white light

- Small mirrors distributed on surfaces
- Projected from the focus to distant flat surface

3) Thermal / Infrared

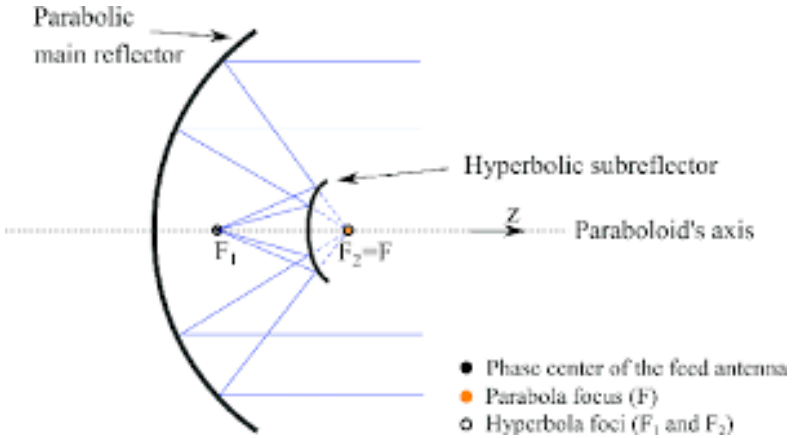
- Create a localized a heat sources at the focus point
- Use a thermal camera to see how the main dish is illuminated

4) Acoustic / Sound

- Put a planar sound source at a distance
- Focus a microphone at focus to find the maximum

5) Microwave

- Install a microwave source and coupled detector at the focus
- Have a larger reflector at distance

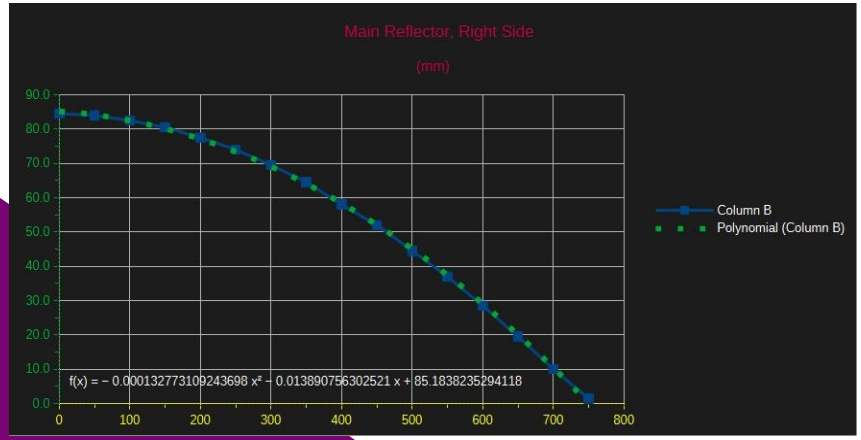


Mathematical

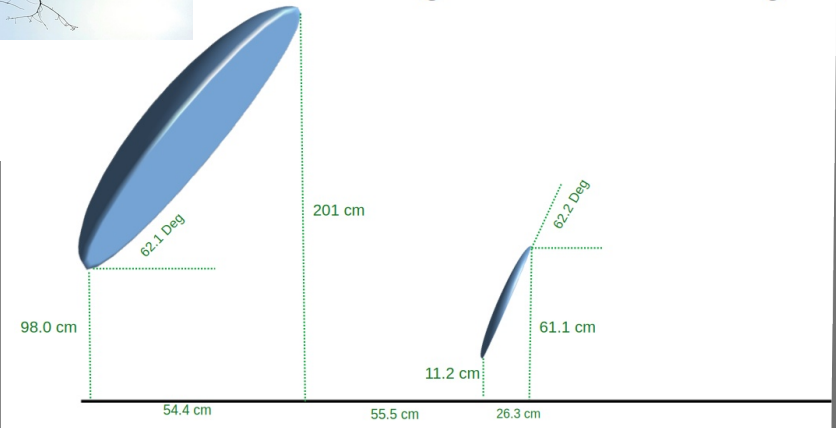
- Determine the profile of the surfaces
- The most important parameter is the vertical profile
  - It is assumed that the focus is symmetrical in azimuth and is on the center-line
- The parabola was measured in two axis mechanically
- The sub-reflector was laser scanned to make a surface model of the complex surface.
- The location of the of each reflector needed to be located relatively to each other
- Analysis was outsourced

Geometry

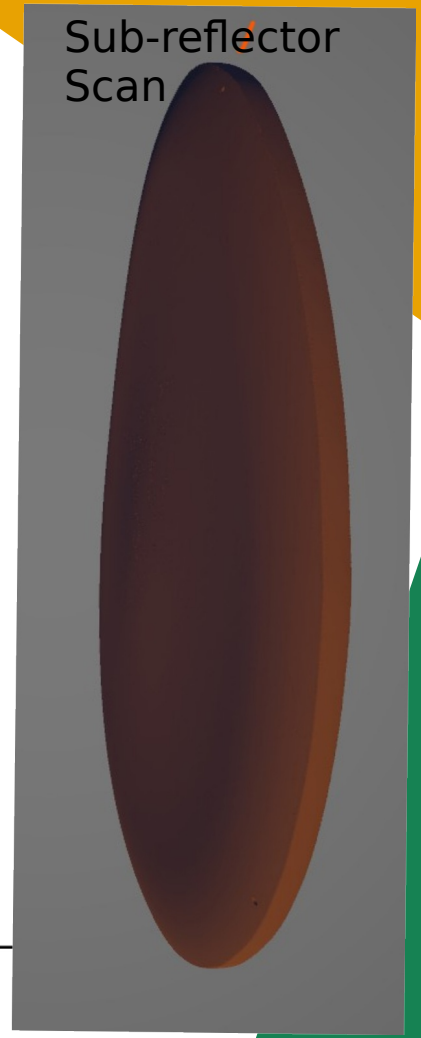
Parabola Measurements



Cassegrain Positioning



Sub-reflector Scan



Optical

- Strategically place mirrors on the antenna surfaces
  - Mirrors are attached with a thin layer of adhesive
- Use a bright white light source at the focus
- Project on to a flat white surface at night
- Move the source until an optimum is found
- Add or adjust location of flat mirrors as required
- Verify that first reflection from the sub-reflector mirrors properly illuminate mirrors on the main reflector
- It is more important that the vertical axis have the majority of mirrors.

Thermal

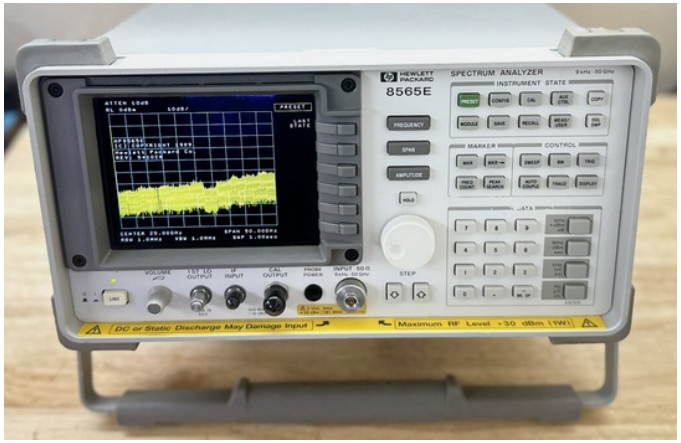
- Put an IR source at the focus point
  - This could be LED source or an actual heat source
- Hopefully the off-white surface of the surfaces will be reflective enough
  - If not, aluminum foil can be added to enhance reflectivity
- From a distance, observe the main reflector with the thermal camera
  - Verify that the camera is aligned on the system axis
- Move the source until an optimum is found
- Record images on USB C device.

Audio

- Crate a planar single audio tone at a distance
  - This can be accomplished with an audio driver and flat panel
- A small microphone is moved around in the focus are to find the maximum signal
- A signal generator is used as the source
- An oscilloscope is used as the receiver
- A audio frequency is chosen that falls within the bandwidth of the devices
  - Likely around 10-15 kHz.
- The RF frequency in GHz multiplied by 1.14 gives the acoustic frequency in kHz of equal wavelengths

Microwave

- A waveguide horn is put at the expected feed point
- A highly reflective target is placed at a distance on the system axis
- A frequency of 24 GHz will be used
- Equipment available include a signal source and spectrum analyzer
- A directional couple is used to measure the reflected energy from the distant target
  - Both a waveguide and a stripline coupler are available
- Move the feed horn until the highest amplitude is found
- This is a 2-way measurement. Radar like.
- This microwave measurement is most like how the antenna will be used in the field.



~~Results~~

- The results will be presented at the conference presentation
- The measurement work is being done in mid-April
  - Weather
  - Other timing constraints
- All the various techniques described will be attempted
- The following results will be shown
  - A photo or description of the measurement
  - A numerical location of where the optimum focus is located
- A suggestion as to what technique seemed “best” will be given

Other Views

Feed Perspective

Feed Mounting Region

Above Sub-reflector

Set-up Equipment Used

Laser Distance Measure

Digital and Bubble Level

Laser Level, Vertical and Horizontal