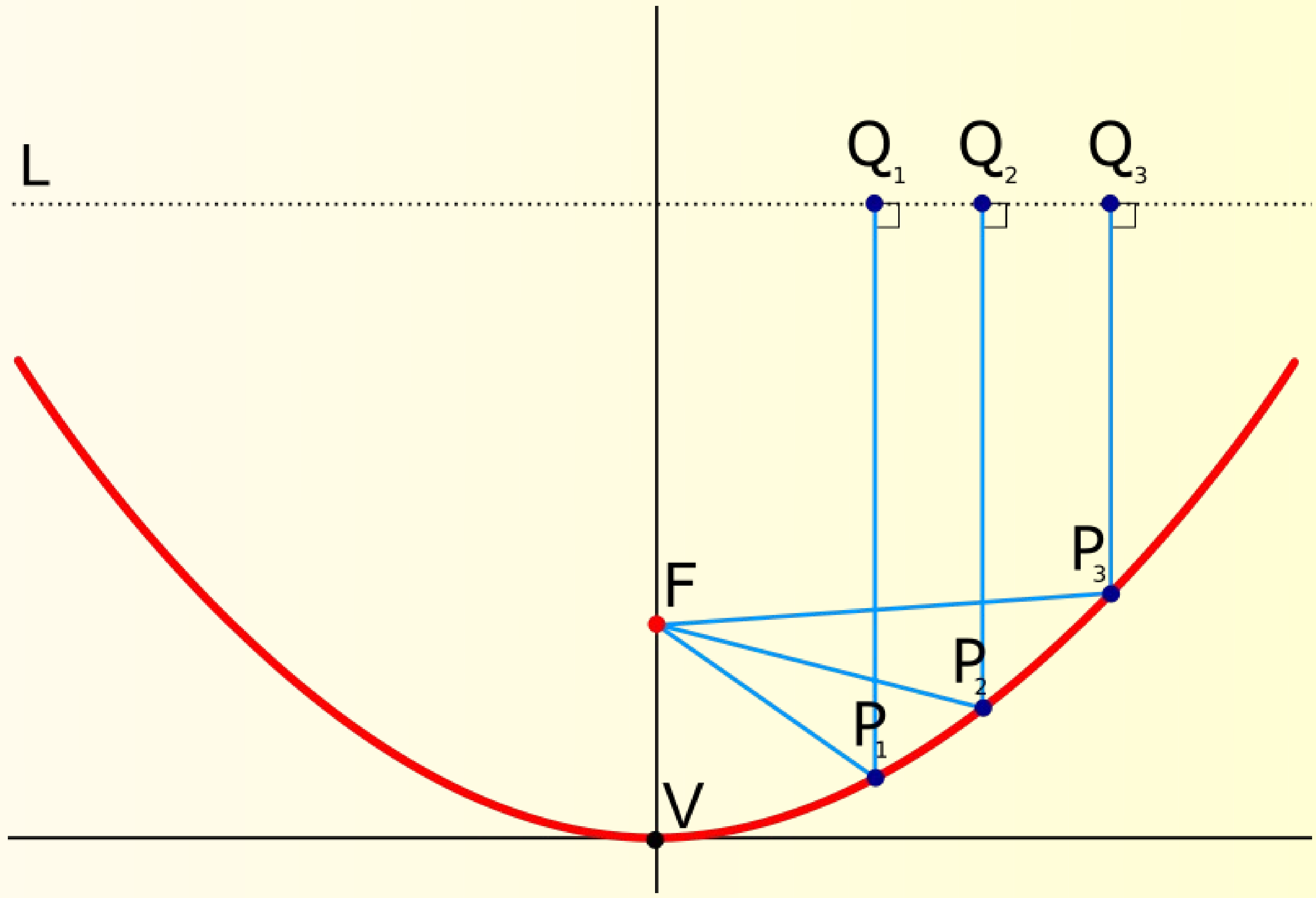
Reflector antennas

- Why? For a dipole $$A_e = \frac{\lambda^2}{4\pi}$$
- Great for long wavelength, terrible for short
- Use a reflector to collect more; a parabola is defined as a locus of points equidistant to a fixed point and a line
- So if we have a plane wave arriving a parabolic reflector will add all the waves arriving along its axis **in phase** at that point

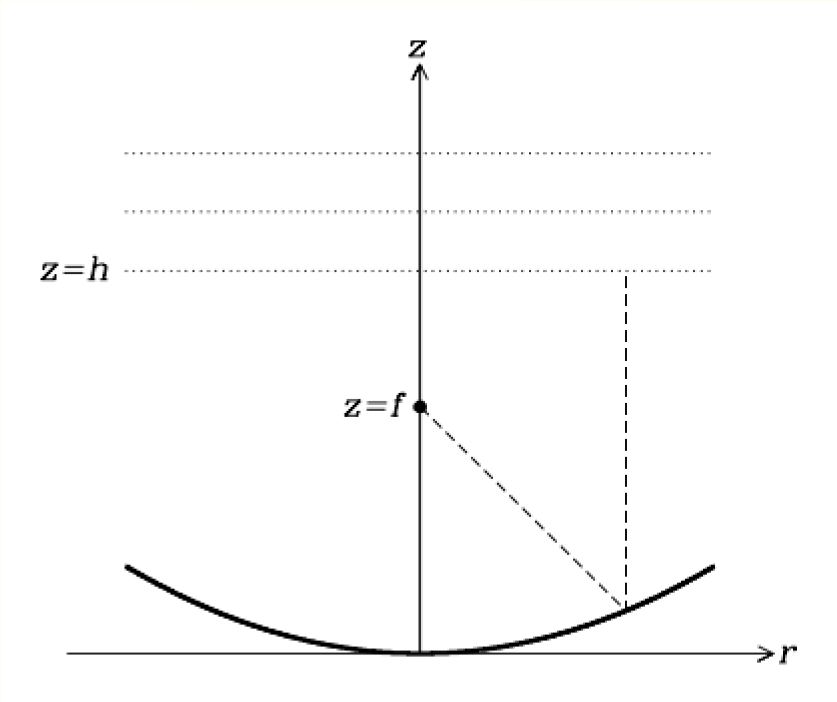
For an line normal to the axis

- to have focus $P_1+Q_1 = P_1+Q_2 = P_3+Q_3$



A diagram

- total path top focal point must not depend on radius (r)



In maths

- Consider the r=0 and an arbitrary r

$$f + h = \sqrt{(r^2 + (f - z)^2)} + h - z$$

if we remove h , add z to both sides and square this:

$$(f + z)^2 = r^2 + f^2 + z^2 - 2 f z$$

$$f^2 + z^2 + 2 f z = r^2 + f^2 + z^2 - 2 f z$$

$$z = \frac{r^2}{4f}$$

Which is in the form $y = a x^2$

Focal Ratio

- If the dish had a diameter D the focal ratio is f/D
- For large f/D the focal support legs get cumbersome
- For small f/D the field of view gets small
- A typical compromise is f/D about 0.4- 0.6
- There is a focal ellipsoid around focus where we have good focus

Advantages

- A_e can approximate (large) geometrical area

$$A = \pi D^2 / 4$$

- Does not depend on wavelength, so you can swap receivers
- Simpler than dipole arrays

Far Field

- To have the plane parallel wavefronts we assumed what is the minimum distance (R)?

Let Δ be the maximum departure from a plane wave. This occurs at the edge of the reflector. The far-field distance is defined by requiring that $\Delta < \lambda/16$

$$R^2 = (R - \Delta)^2 + \left(\frac{D}{2}\right)^2$$

with some assumptions

- approximations

$$D \gg \lambda \quad \text{(so diffraction is small)},$$

$$\Delta/2 \ll D^2/8\lambda$$

$$R \approx \frac{D^2}{8\Delta} = \frac{2D^2}{\lambda}$$

Examples

- a 100m dish at 1cm gives 2000km (must be outside low earth orbit)
- a 12m dish at 21cm gives 1.3km (not very far!)