(Astro)Physics 343 Lecture # 9:
telescopes; interferometry

This week's schedule

Monday – Wednesday: ad hoc office hours for lab # 4
(Baker for all sections)

Monday + Thursday: regular office hours

Lab # 4 due next Monday.

Labs # 2 and 3 are coming (slowly... sorry).

Still waiting for responses from three people re trip.

Why do we need telescopes?

If a simple dipole antenna can detect radio waves...

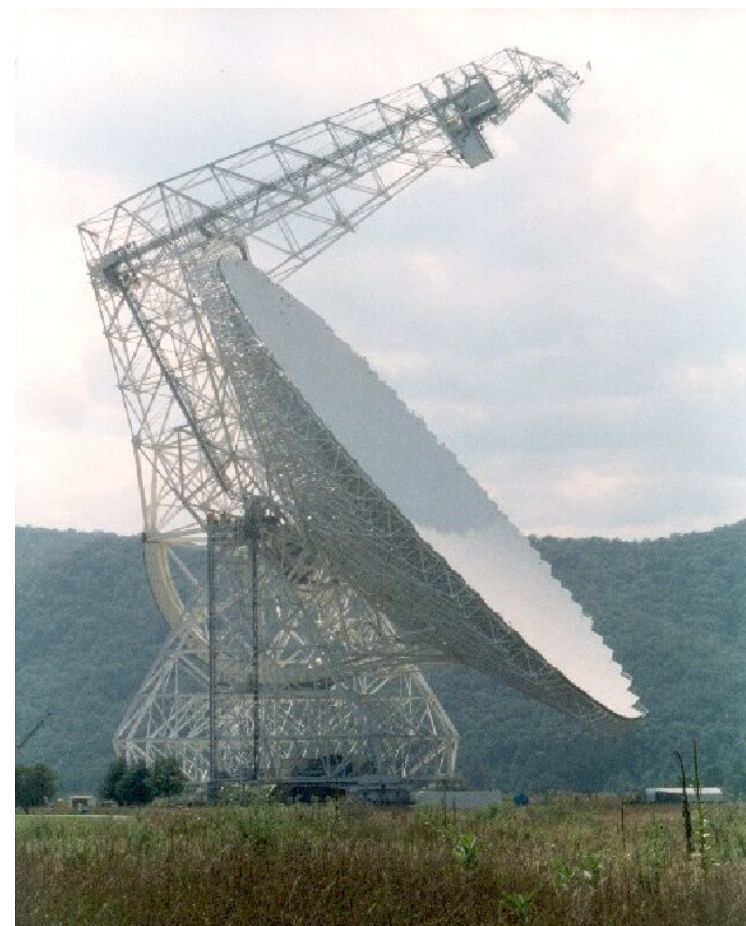
long-wavelength development array at VLA site (test bed for larger array with λ=0.3-30m)

Answer: collecting area (for short-wavelength observations).

Telescopes collect and focus power onto a smaller (e.g., feed horn or dipole) antenna.

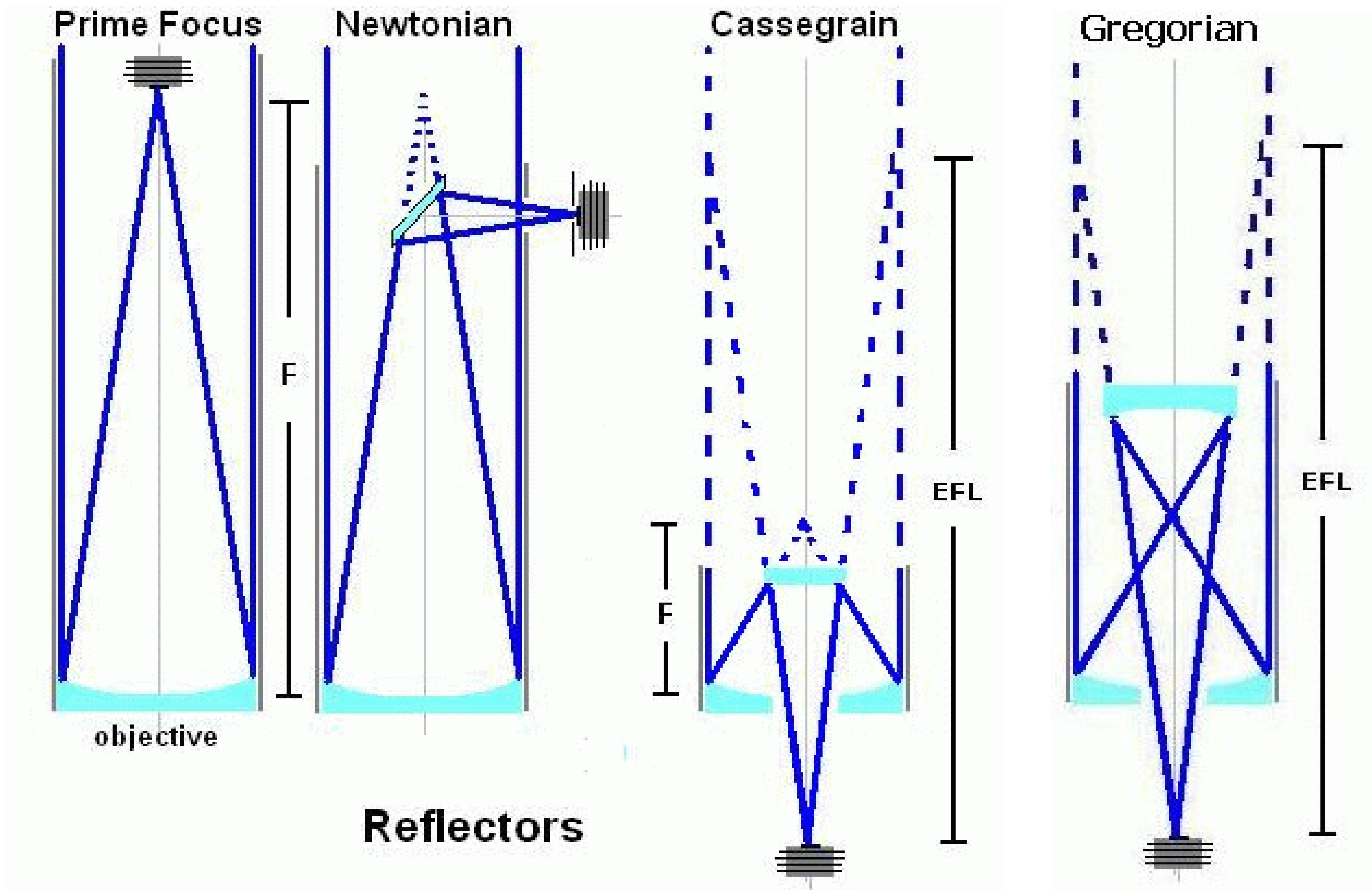
Telescope designs: feed horn vs. paraboloid

paraboloid antennas: good for collecting area, calibration tricky



feed horns: response can be calculated a priori! but size limited...

Telescope designs: location of foci



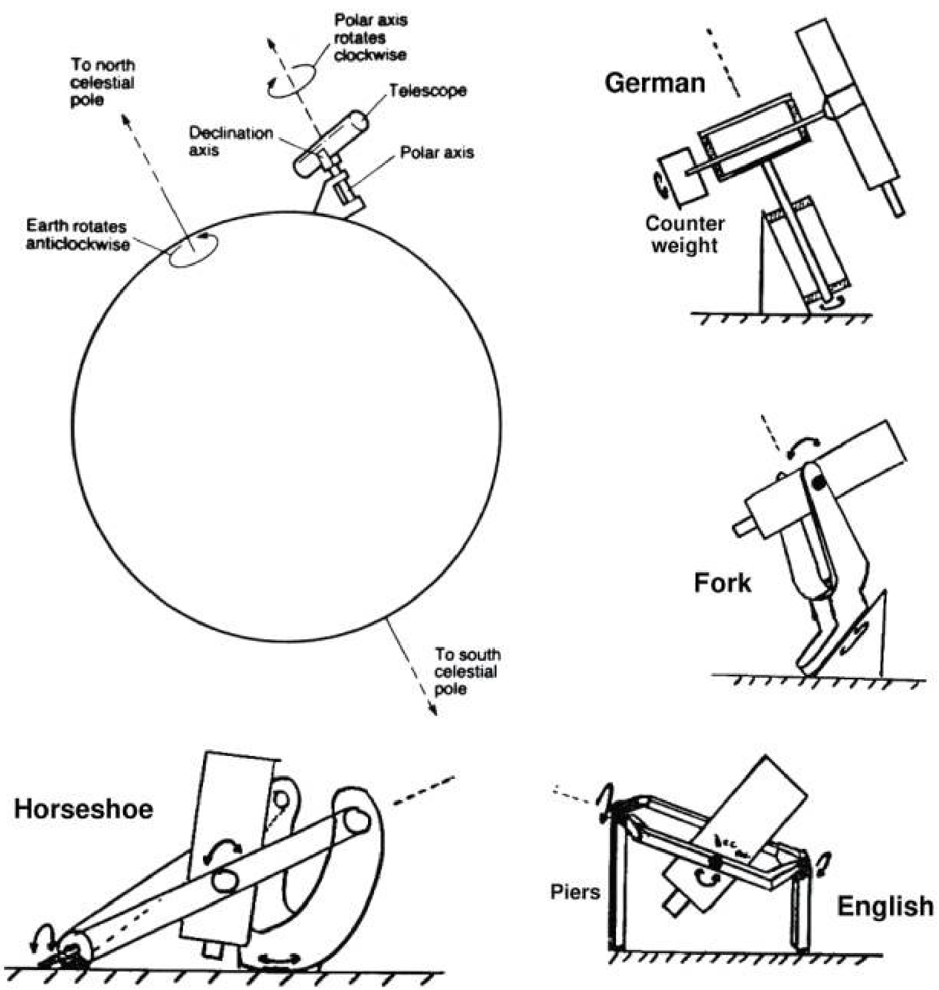
Borrowed from J. Oliver.

Telescope designs: on or off axis?

100m Effelsberg telescope (Germany) + Green Bank Telescope (WV)

Telescope designs: mount?

alt-az: both axes to track sources



equatorial: one axis to track sources

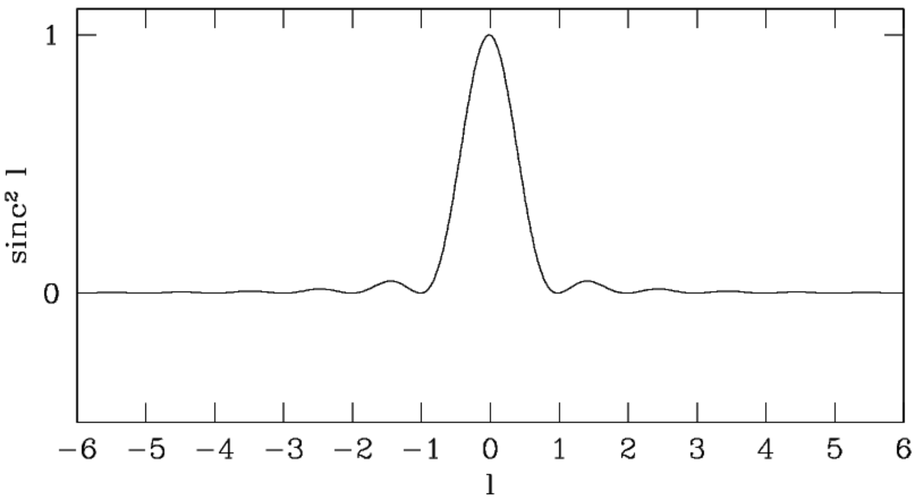
The last big scope with an equatorial mount

140 ft telescope at Green Bank:

(1) world's largest telescope with an equatorial mount

(2) contains world's largest ball bearing!

The (angular) resolution of a telescope



We know that the FWHM of the telescope's beam is proportional to λ/D.

By the Rayleigh criterion, this is also its resolving power: two point sources separated by the FWHM will sit on peak + first dip of response.

Radiometers

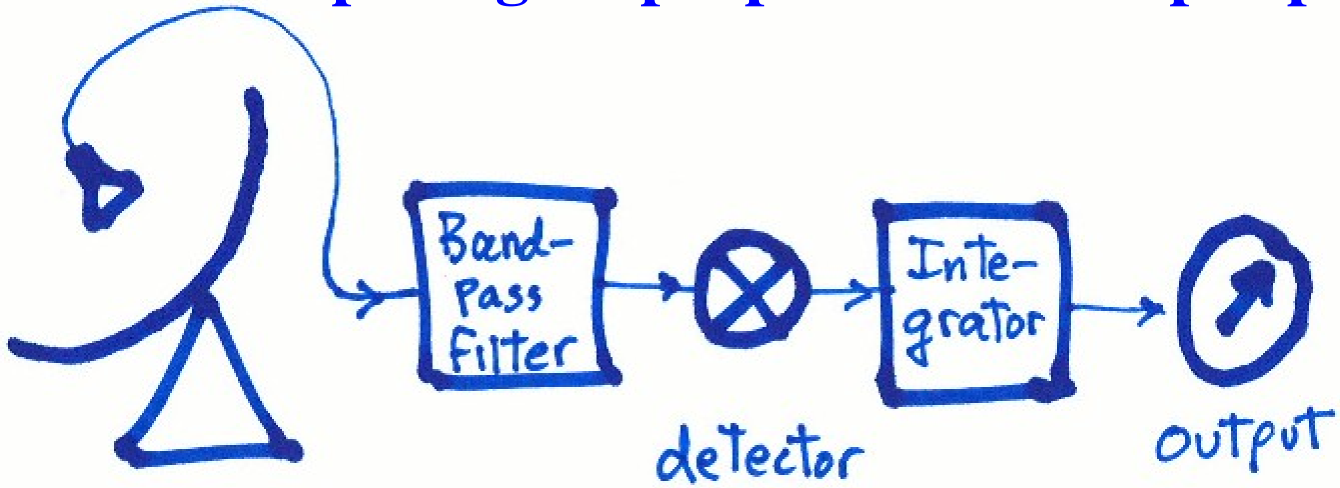
Steps in detection of radio emission with a radiometer:

(1) select a frequency bandpass

(2) multiply signal by itself

(3) integrate over some time interval

(4) record output signal proportional to input power



Borrowed from Condon & Ransom, ERA.

Sensitivity of an ideal radiometer

If system temperature is T_{sys}

... bandwidth is $\Delta\nu$

... integration time is Δt

then the sensitivity (1σ noise) will be

$$\Delta T = T_{sys} / \mathrm{sqrt}(\Delta\nu \, \Delta t)$$

i.e., goes down as sqrt(number of samples)!

Quiz