Physics 343 Lecture # 9:
final thoughts on telescopes, interferometry, and deconvolution

This week's schedule

Monday – Wednesday: on call office hours for lab # 4

+ Baker in Serin W309 for sections C & D

+ Wu in ARC 216 for sections A, B, E, F, & G

You are strongly encouraged to take advantage of this (part II of analysis benefits from discussion).

Monday + Thursday: regular office hours

Lab # 4 due next Monday. If you have questions, please ask in office hours or by email!

Still waiting for responses from one person (and seeking an extra graduate student driver) for 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)

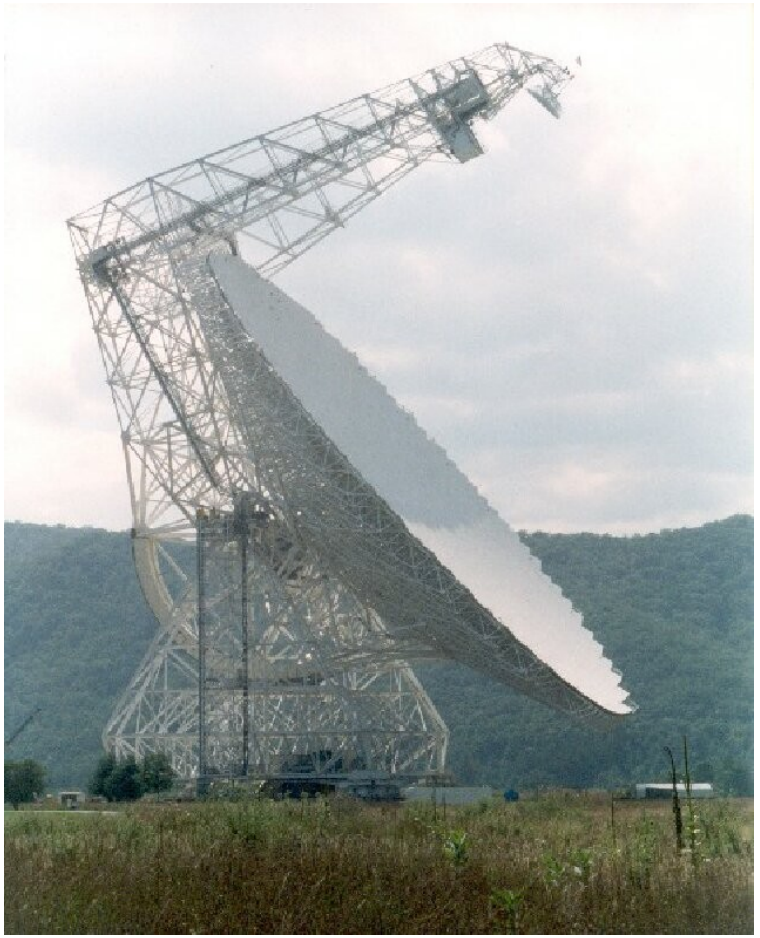
Answer: collecting area (for short-wavelength observations).

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

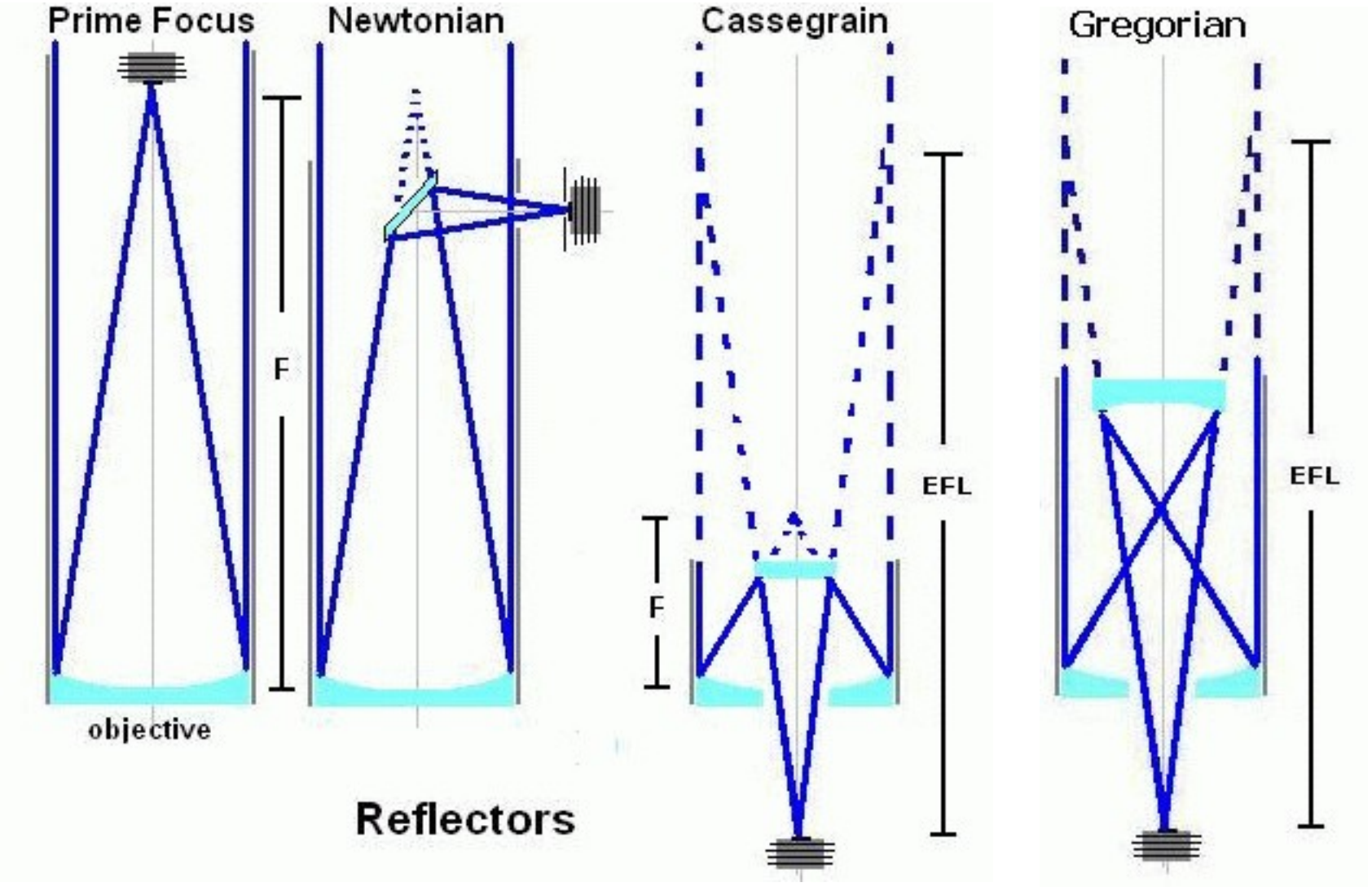
Telescope designs: feed horn vs. paraboloid

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

paraboloid antennas: good for collecting area, calibration tricky



Telescope designs: location of foci

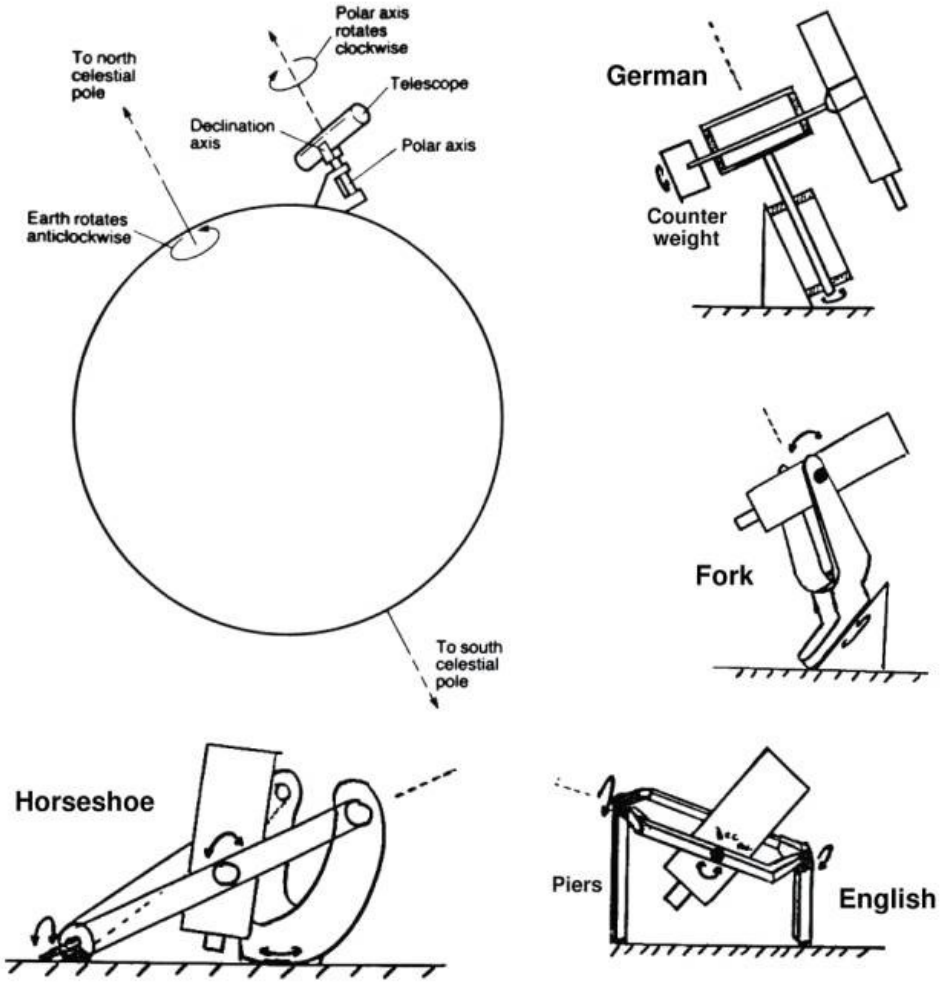


Borrowed from J. Oliver.

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

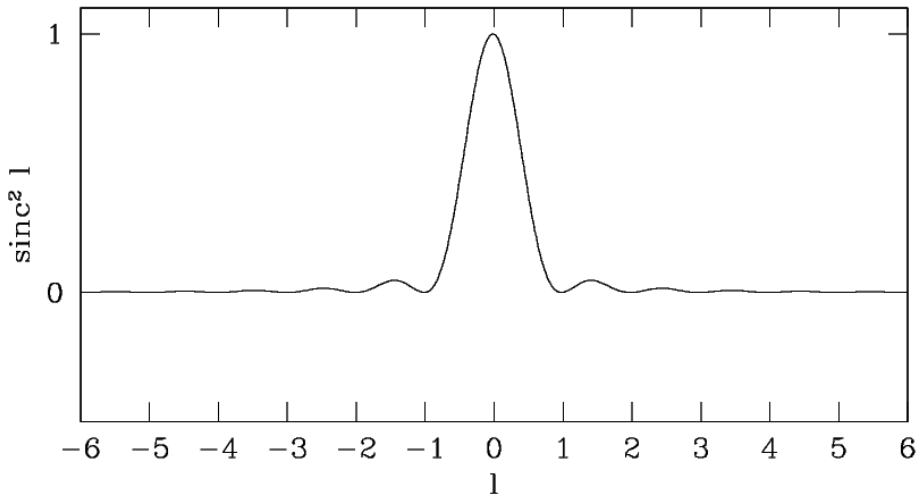
The last big scope with an equatorial mount

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

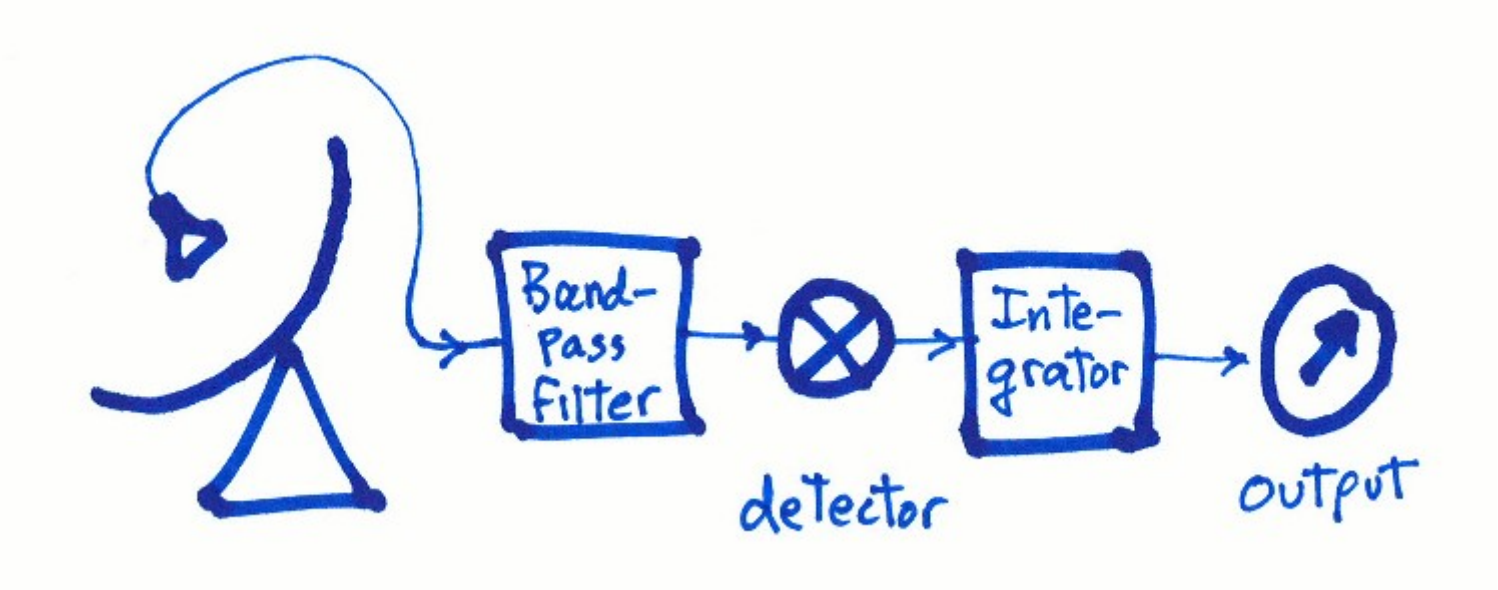
Steps in detection of radio emission with a radiometer:

(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