Lecture overview

- What hypothesis to test in the fly?
- Quantitative data collection
- Visual physiology conventions (“Methods”)

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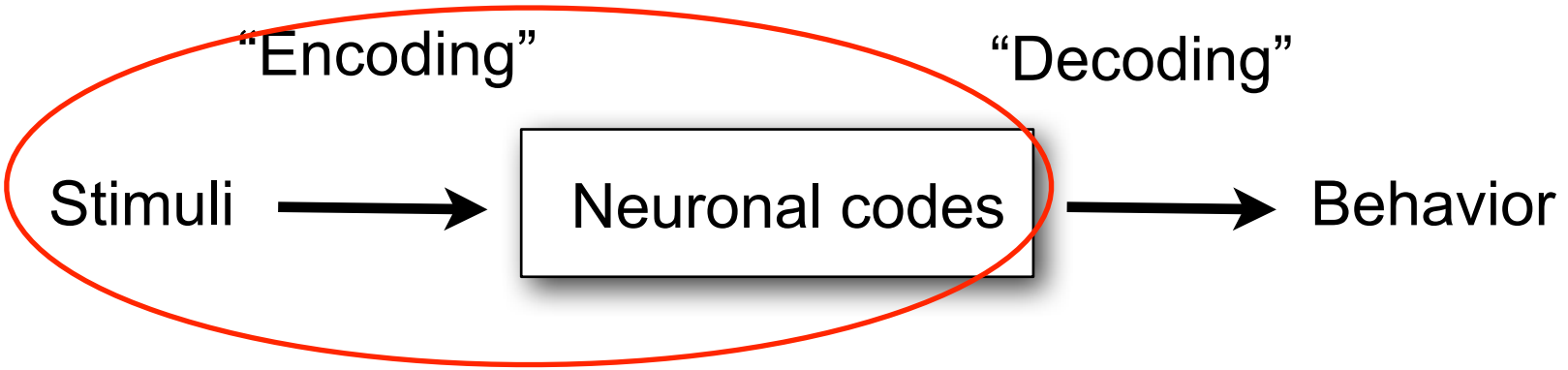


General situation in vision encoding studies:

Independent variable: pattern of photons

Dependent variable: pattern of spikes from one or more neurons

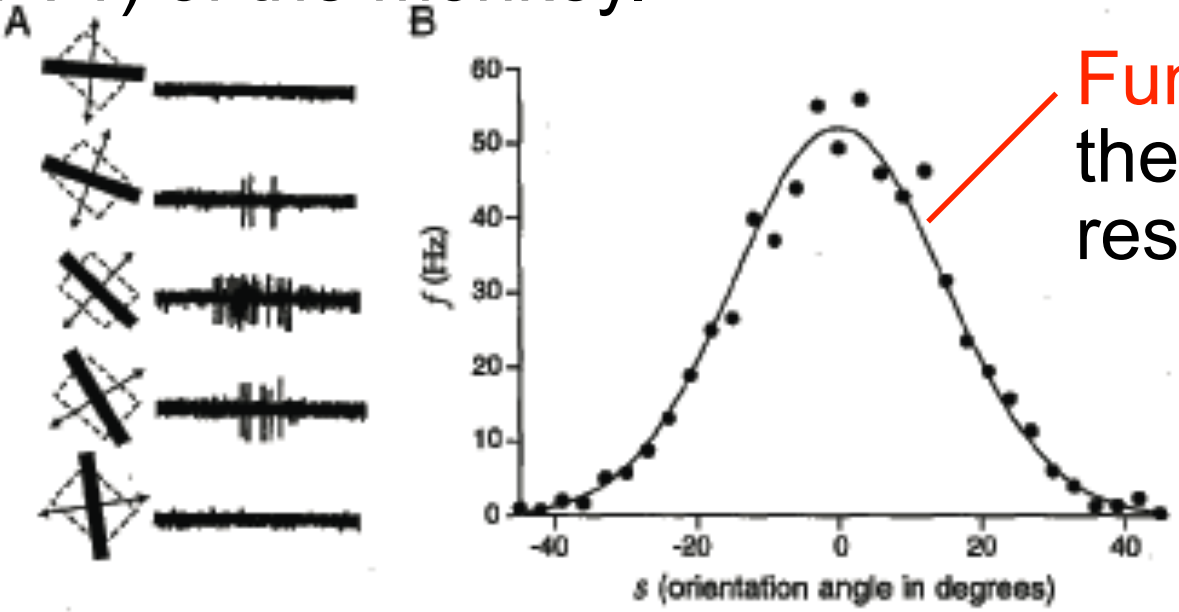
A specific case (e.g. for H1 in the fly):

Independent variable: direction of a moving grating

Dependent variable: spike rate during each the presentation of each grating

spikes per unit time (spikes/sec)

Example of quantitative neurophysiology: orientation tuning a neuron in primary visual cortex (area V1) of the monkey.



Function fit to the average responses

Figu … ey.
A ba … es.
The … are
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indic … ght
bar f… as
a fun… ng
the function 1.14 with parameters $r_{max} = 52.14$ Hz, $s_{max} = 0°$, and $\sigma_f = 14.73°$. (A adapted from Wandell, 1995, based on an original figure from Hubel and Wiesel, 1968; B data points from Henry et al., 1974).)

One of our overarching goals is to teach you how these kind of plots are produced.

You will do all the steps yourself!

Overall goal of the fly labs: the basics of carrying out a complete, quantitative neurophysiology experiment.

- Design visual stimuli to test a hypothesis — MATLAB proj 2 Design lab
- Setup a prep to record from relevant neurons — FLY wet lab 1
- A hypothesis about the relationship between visual stimuli and a neuronal response — FLY wet lab 2
- Collect digital data during that presentation — FLY wet lab 2
- Isolate individual spikes in that data — MATLAB proj 1
- Analyze the relationship between spike responses and visual stimuli — MATLAB proj 3 Data analysis lab
- Document your findings — Lab Report 2

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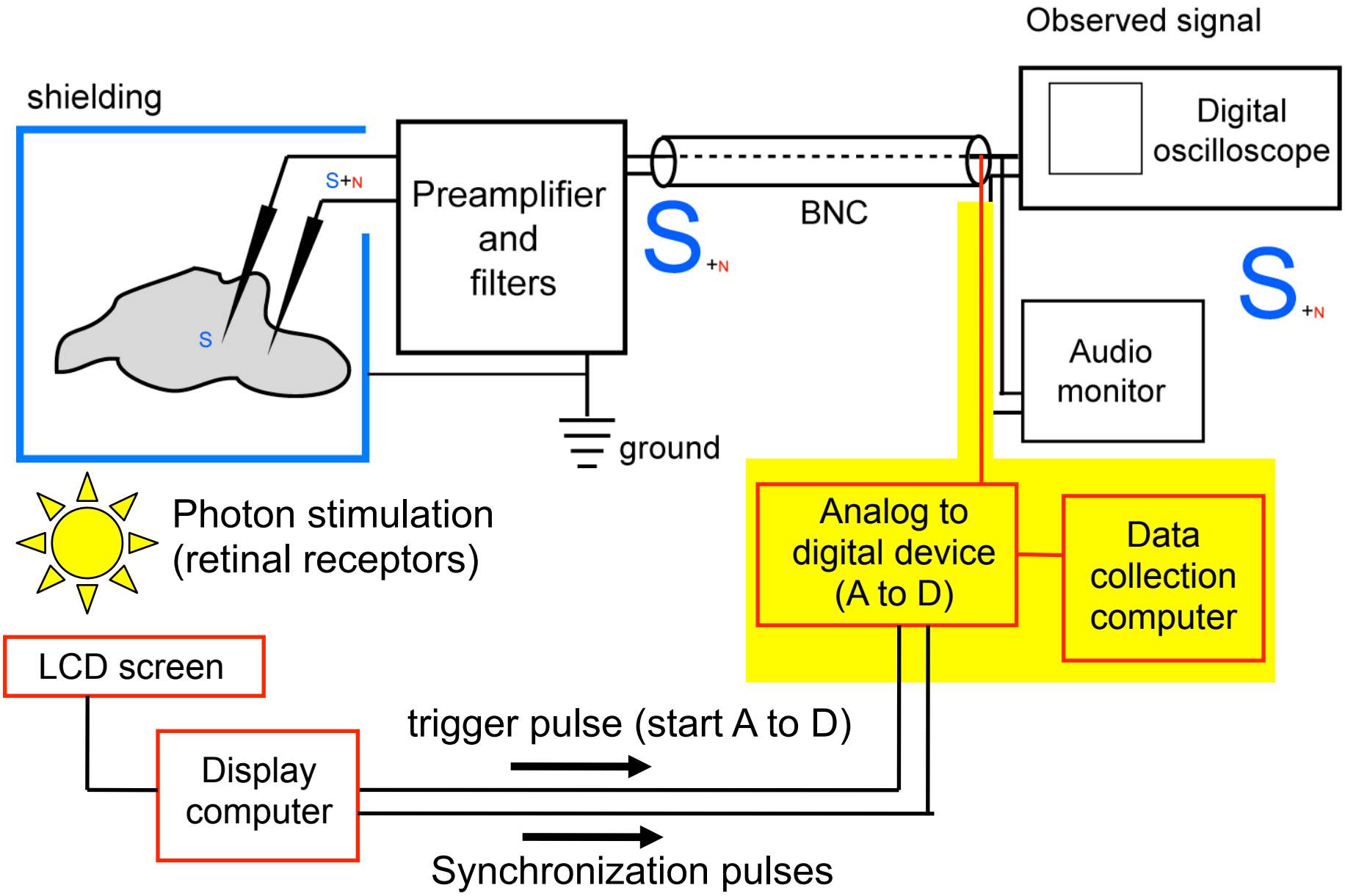
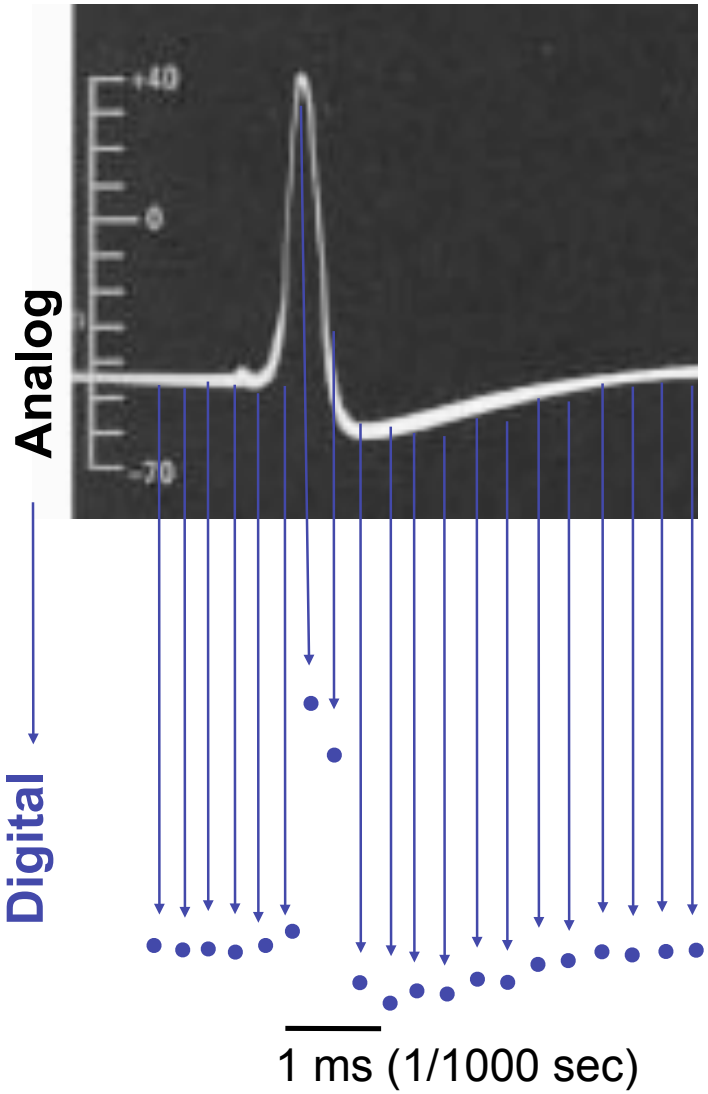
Basic electrophysiological setup



We must have some way of saving the voltage signal so that we can find the spikes (action potentials) later



A single action potential

Analog to digital device (A to D)

Number of samples taken every second:

1000 (1 kHz sampling)

2000 (2 kHz sampling)

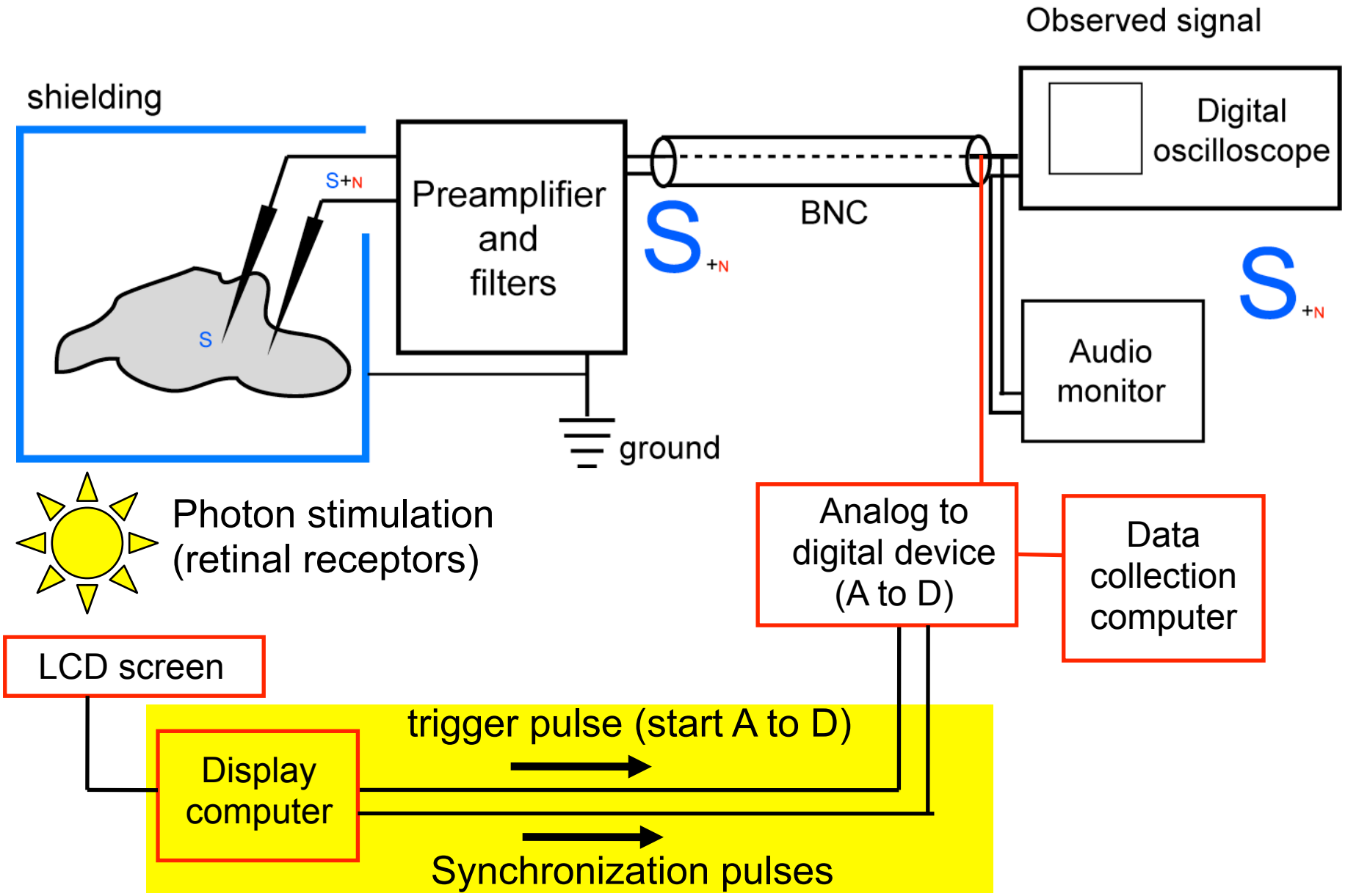
4000 (4 kHz sampling)

What sampling rate is optimal?

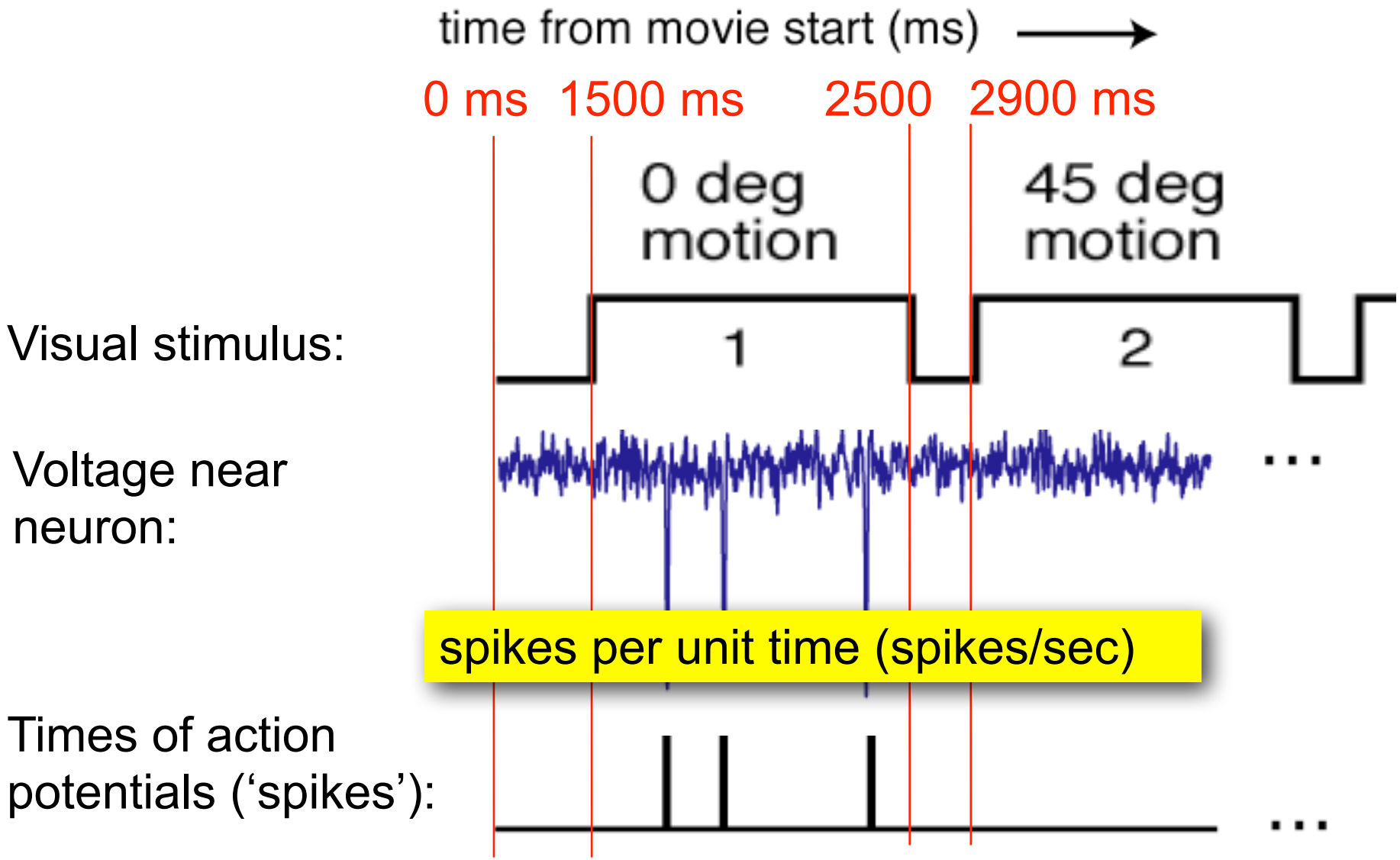
Are there downsides to sampling faster?

**Sample at 2x the highest frequency in the signal to get a perfect reproduction of the signal (= "Nyquist sampling rate").*

Basic electrophysiological setup

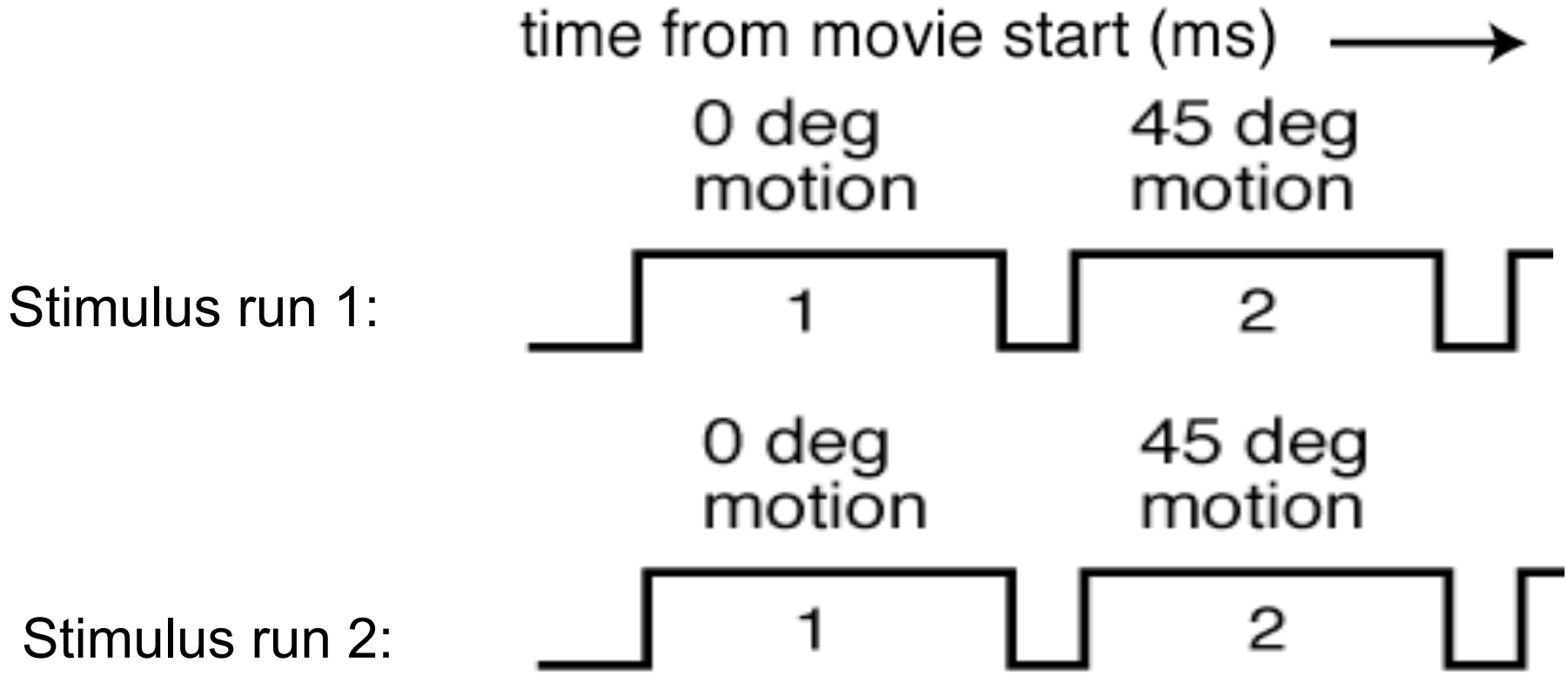


We must have some way of aligning (synchronizing) the visual stimulus with the recorded voltage

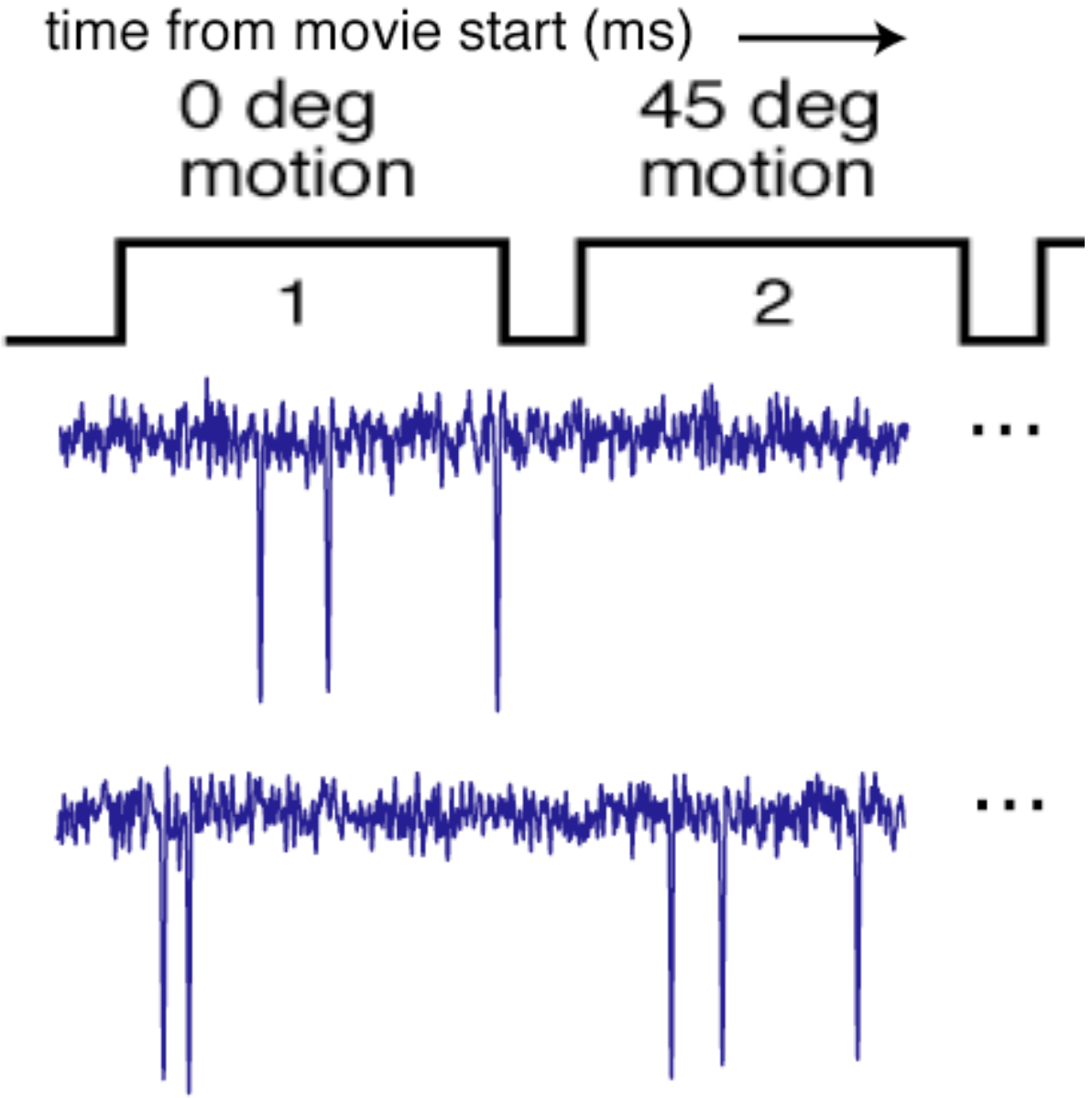


First steps to quantitative physiology (science):

- Ability to accurately repeat conditions.
- Control of variables -- only change one thing at a time!



Example voltage traces



Stimulus:

Voltage near neuron on run 1:

Voltage near neuron on run 2:

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Standard units of visual stimuli

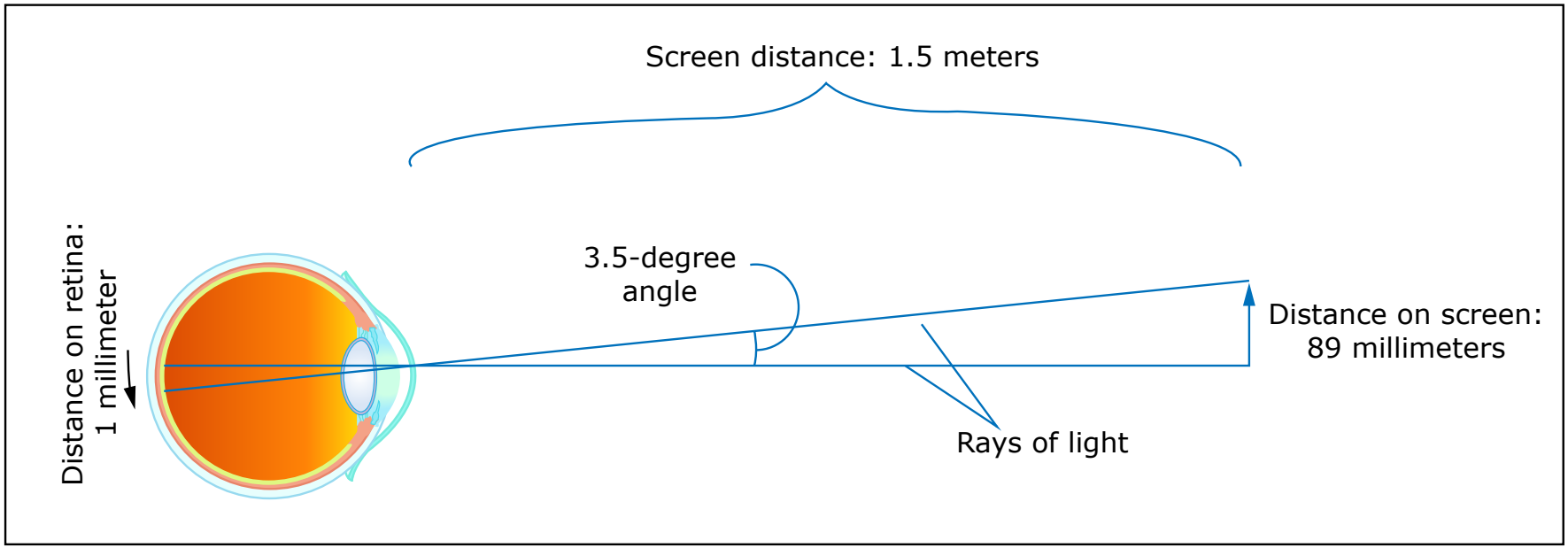


Image by MIT OpenCourseWare.

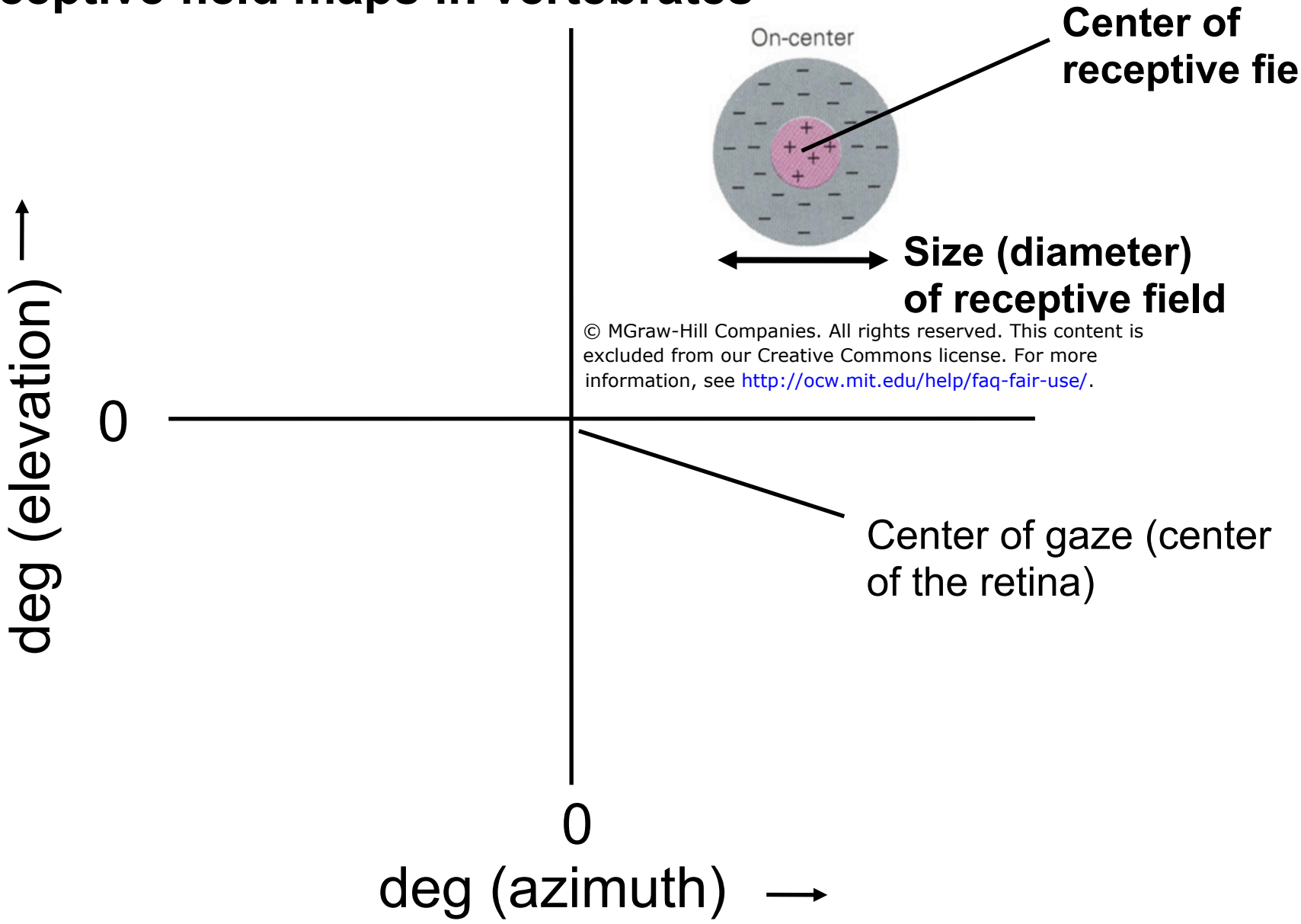
Stimulus size: degrees of visual angle (deg)

E.g. "The white square subtended approximately 4 deg x 4 deg of visual angle"

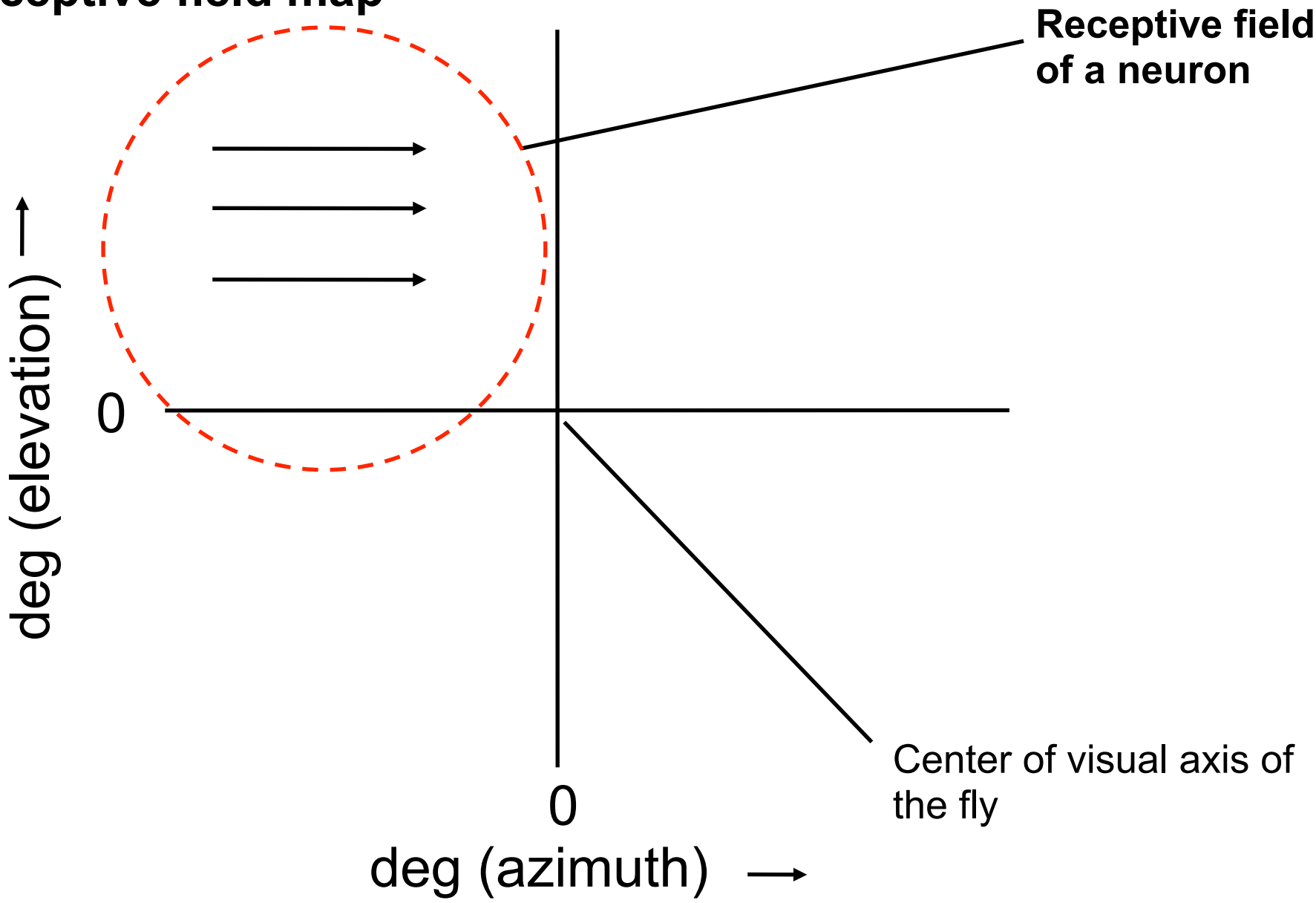
Speed of motion: degrees of visual angle covered per unit time (deg/sec)

E.g. "The white square was moved from left to right at a speed of 40 deg/s."

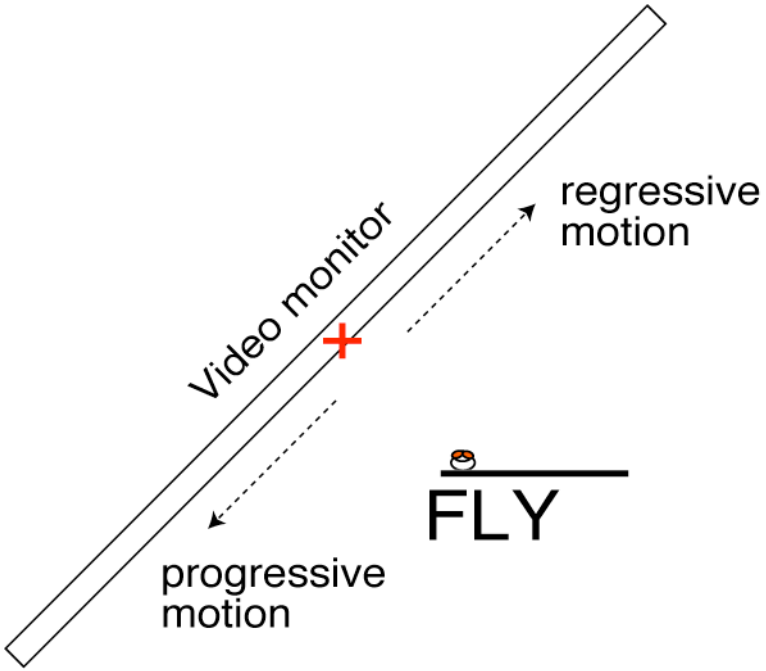
Standard units of visual stimuli: receptive field maps in vertebrates

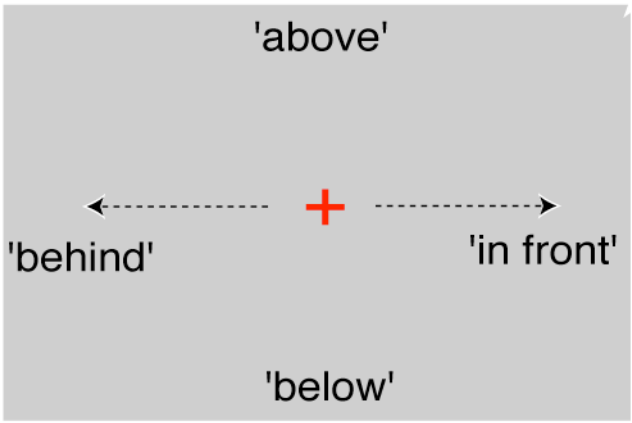


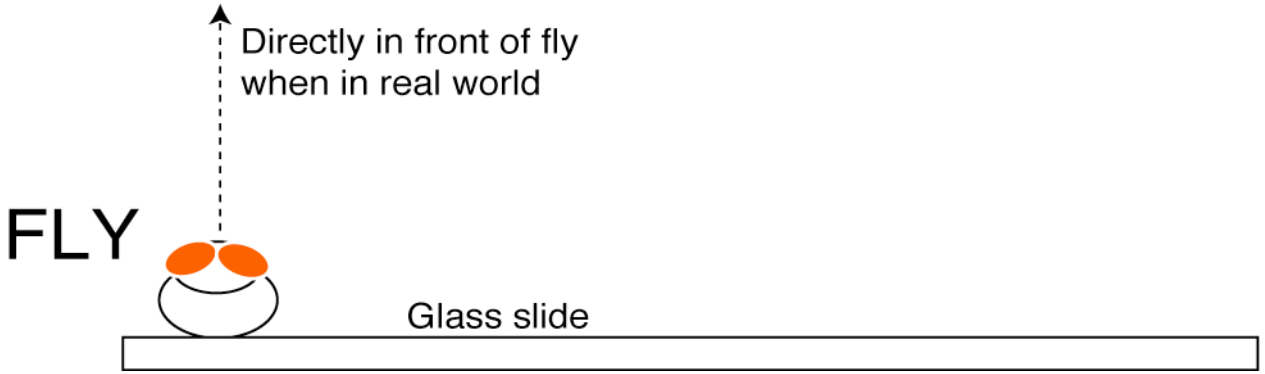
Standard units of visual stimuli: receptive field map



Fly visual field: state your conventions!







Things that should be in your movie:

1) First ~10 sec: test a large drifting grating in eight different directions around the clock. At least 500 ms between each of these stimulus conditions.

2) Stimulus conditions to test your main hypothesis.

Your group is responsible for keeping track of the times of the start and end of each stimulus condition in your movie.

9.17 Systems Neuroscience Lab

Spring 2013