

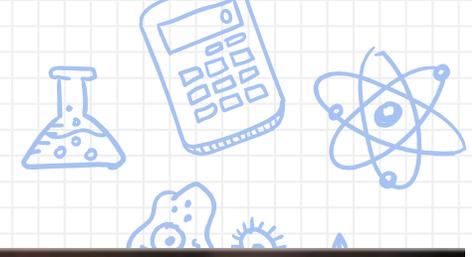
# EE16A Lab: APS 3 -- LAST LAB!

GSI: Sei

Lab Assistants: Cam, Ed, Ry

**Do not sit at stations 6, 7, 12, 20**





## Announcements!

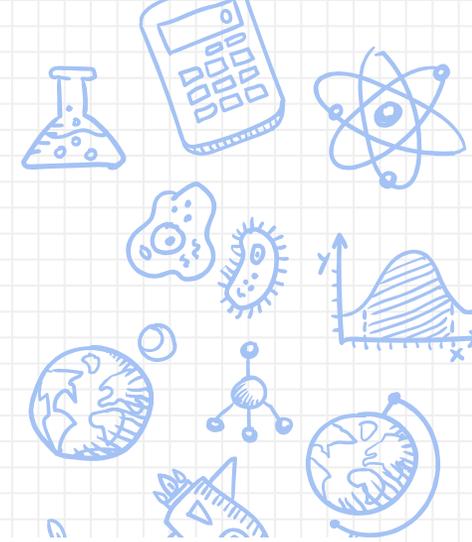
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- ✘ This is the **last lab!!!**
- ✘ Lab grades are updated
- ✘ Email me if there's an issue
- ✘ **GOOD LUCK ON YOUR EXAMS**



Caption: When you need to test your touchscreen



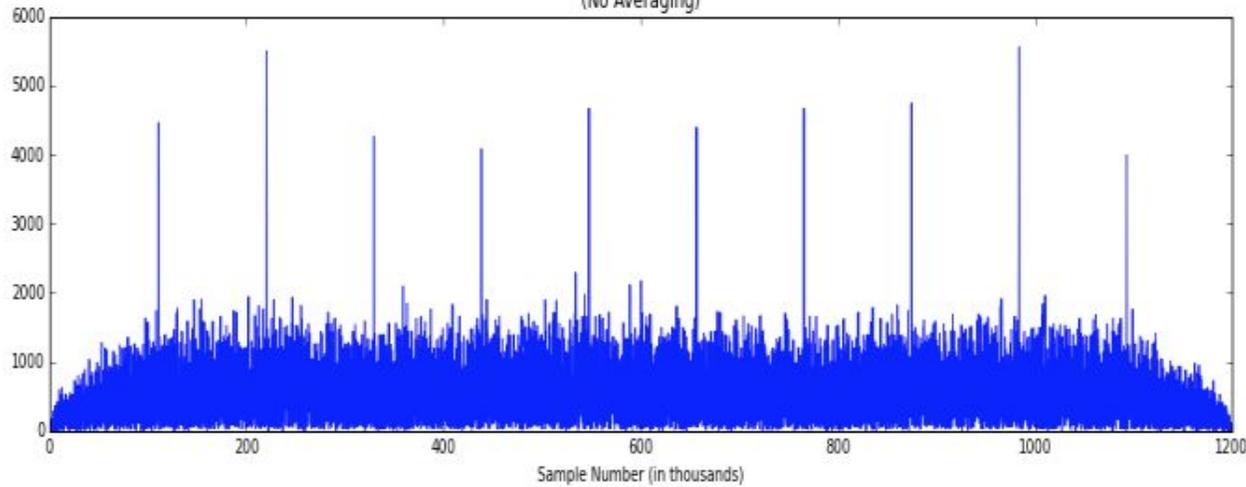


## Previously...

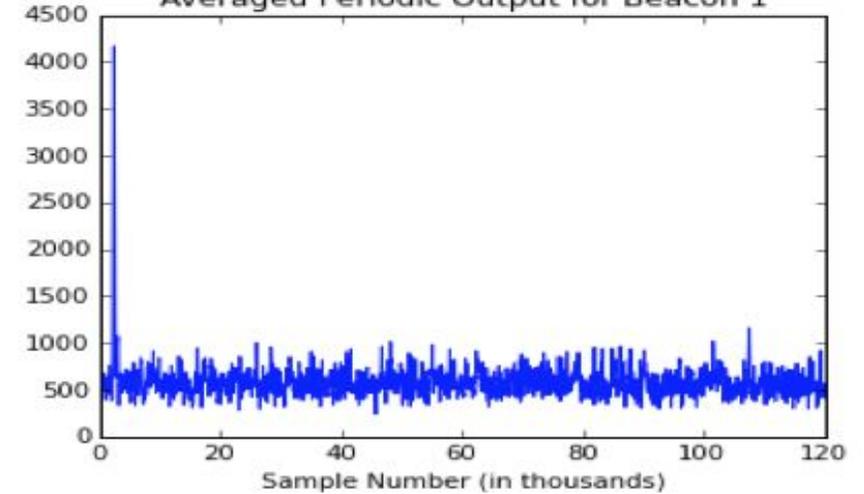
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- ✗ Averaging Function
  - ✗ Reduced noise, higher accuracy in determining peaks

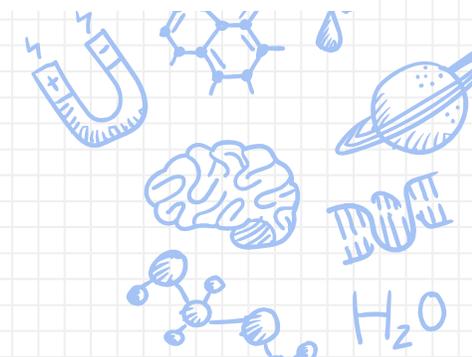
2.5 sec Recording of Beacon 1 After Separation  
(No Averaging)



Averaged Periodic Output for Beacon 1



- ✗ `Signal_to_distances(raw_signal, t0)`
  - ✗ We don't usually have  $t_0$  known





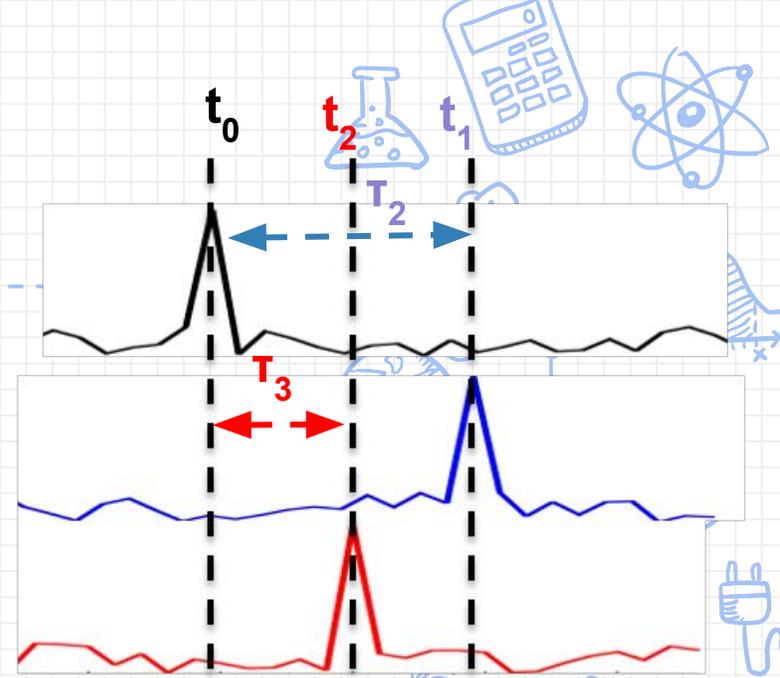
## Problem: We do not know $t_0$

✘ Only know time offsets:  $T_m = t_m - t_0$

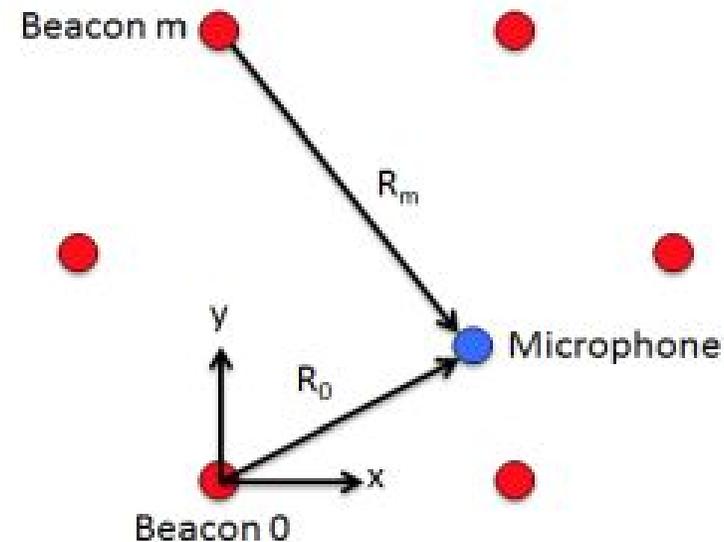
✘  $R_m = \sqrt{(x - x_m)^2 + (y - y_m)^2} = v_s t_m$

✘  $R_0 = \sqrt{(x)^2 + (y)^2} = v_s t_0$  (Beacon 0 is at origin)

✘  $R_m - R_0 = v_s (t_m - t_0) = v_s T_m$



CC of received signal and beacons





## Making it linear:

- ✗ Same trick: subtract first equation from others

$$v_s \tau_m = \frac{-2x_m x + x_m^2 - 2y_m y + y_m^2}{v_s \tau_m} - 2\sqrt{x^2 + y^2} \quad \text{Not linear :c}$$

$$v_s \tau_m - v_s \tau_1 = \left[ \frac{-2x_m x + x_m^2 - 2y_m y + y_m^2}{v_s \tau_m} - 2\sqrt{x^2 + y^2} \right] - \left[ \frac{-2x_1 x + x_1^2 - 2y_1 y + y_1^2}{v_s \tau_1} - 2\sqrt{x^2 + y^2} \right]$$

Linear!

simplify!  $m \neq 0, m \neq 1$

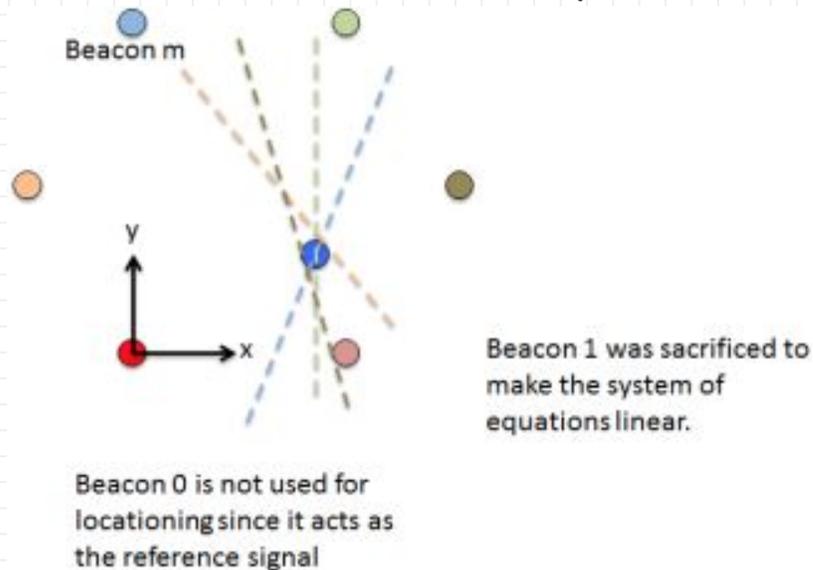
$$\left( \frac{2x_m}{v_s \tau_m} - \frac{2x_1}{v_s \tau_1} \right) x + \left( \frac{2y_m}{v_s \tau_m} - \frac{2y_1}{v_s \tau_1} \right) y = \left( \frac{x_m^2 + y_m^2}{v_s \tau_m} - \frac{x_1^2 + y_1^2}{v_s \tau_1} \right) - (v_s \tau_m - v_s \tau_1)$$

$$m \neq 0, m \neq 1$$

$$\left(\frac{2x_m}{v_s \tau_m} - \frac{2x_1}{v_s \tau_1}\right)x + \left(\frac{2y_m}{v_s \tau_m} - \frac{2y_1}{v_s \tau_1}\right)y = \left(\frac{x_m^2 + y_m^2}{v_s \tau_m} - \frac{x_1^2 + y_1^2}{v_s \tau_1}\right) - (v_s \tau_m - v_s \tau_1)$$

## Making it linear:

- ✗ After simplifying, we have  $n-2$  linear equations where  $n$  is the number of beacons to begin with
- ✗ Can do least-squares regardless of number of beacons
  - ✗ Best estimate of location if measurements are inconsistent
  - ✗ If there is no exact point of intersection bc of error or noise



$$Ax = b$$

$$A^T Ax = A^T b$$



## Important Notes

- ✗ **Copy and paste** your functions from APS2
- ✗ Watch your step! Be mindful of the cables.
- ✗ Avoid sitting at stations running the demos (6, 7, 12, 20)
- ✗ Be mindful of others when testing
  - ✗ Use the mute/unmute buttons on the soundcards
  - ✗ Do not block speakers with your body unless you're doing so on purpose (duck your head if necessary)
- ✗ Don't touch/fiddle the speaker
- ✗ Don't change the volume!
- ✗ Coordinates are in inches, not feet
- ✗ **Please fill out feedback! It's fun!!!**

**Check off:** [tinyurl.com/16a-lab-checkoff](https://tinyurl.com/16a-lab-checkoff)  
**Question Queue:** [tinyurl.com/lab108-q](https://tinyurl.com/lab108-q)  
**Presentation:** Check inst website!  
**Feedback:** [tinyurl.com/lab108-feedback](https://tinyurl.com/lab108-feedback)

