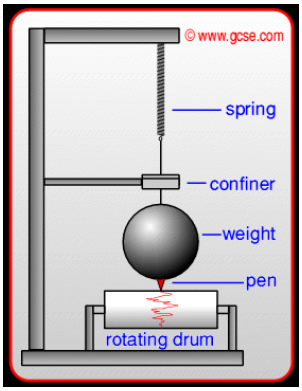
Using LIGO's e-Lab as a Stepping Stone to Research -
Advanced version – paired with the "whatever" time trend issue in Excel

LIGO e-Lab
Build Your Own Research Project Using Professional Science Data

Background: LIGO has many different environmental sensors positioned around and in the interferometer. They include a weather station, seismometers, tilt meters and magnetometers. The focus of this activity will be on the seismometers at LIGO, specifically the seismometer in the LVEA. The seismometer records vibrations of the Earth in three directions: N-S (labeled _X_ direction), E-W (labeled _Y_ direction), and Up-Down (labeled _Z_ direction). In the older generation of seismometers, these vibrations are measured as a moving of the ground (i.e. the rotating drum) relative to the weight in the seismometer. See picture at right.[1] Click on the picture for more information. Modern seismometers measure a change in voltage due to the movement of a coil attached to the ground. This coil wraps around a suspended magnet. See the pictures below. The unit of this velocity is given as micrometers/second. The data from the seismometer is later segregated into various frequency bands – one of which is crucial to this investigation. The unit for frequency is the hertz where one hertz is one cycle or vibration per second. For example, if you pat your head twice every second, you would say the frequency of patting is 2 hertz. The different frequencies of Earth's vibrations are divided into several different bands in order to aid the scientists working on the interferometer. One of these bands is called the microseism. This is the frequency band of 0.1 – 0.3 Hz and reveals Earth's motions quite accurately.



Seismometer w/cover removed

Seismometer w/magnetic mass removed

Seismometer w/magnetic mass & cover removed

LIGO is one of the most precise and sensitive measuring instruments on the planet. This activity will investigate that sensitivity. We will need to gather data from two sources (Bluestone at LIGO's e-Lab portal and the NOAA's National Data Buoy Center).

To get us started, consider this problem statement or question to answer:

Question: What is the relationship between the microseism at LIGO and wave height in the eastern Pacific?

Prediction: State whether or not you think a relationship exists & explain your reasoning.

Next

Procedure:

1. We access LIGO's seismometer data through the I2U2 Home **e-Labs** link. Click **e-Labs** and go. We are going to use LIGO's seismometer data to test your hypothesis.

2. Open up Firefox or IE 8 or older. The next click sequence is **e-Lab List** >> LIGO e-Lab. Pause here and read the LIGO overview.

3. Click on: **Student Home**

4. Next click sequence is: Username: (from your teacher), and Password: (from your teacher)

5. Here is where the data acquisition and analysis occurs. Onscreen tutorial can be accessed at any time.

6. Click on the Data link and then the Bluestone link.

7. At right is a Screen shot of the dashboard you will interact with.

8. Play around with this – take note of the ? as they help a lot.

9. In the Data Selection Section, leave the default settings as is EXCEPT:

a) **Change**: under Sensor change to the frequency band of 0.1 – 0.3 Hz on the SEISX channel – this is the microseism.

b) **Change**: under Station change to LVEA.

10. After inputting your Starting date & Ending date, your plots will be generated.

11. You can use the Zoom tool and Log Scale to enhance your viewing experience.

12. Once you have the time frame and Y –axis scale desired, you can: a) Save your Plot, b) View your Plot as a PNG Image, c) Copy your Plot, and d) Export your Data as a text file. We will deal with the text file in the *Excel Instructions for Time Aligning* …document.

13. Title your Word document - *Using LIGO's e-Lab as a tool –Advanced version*, your name, your period, and date. .

14. Copy and Paste the PNG image into your Word document below your question, etc.

15. Name the Word document file and save the Word document according to your teacher's directions.

16. It is NOAA buoy time! To get to the National Data Buoy Center click  on:

17. Select a buoy off the coast of Washington or N. Oregon from the map. Record its parameters.

18. Select the "View History" link if available. If this link is not available, choose another buoy.

19. Choose the year that matches your microseism window under the **Standard meteorological data** heading

20. Choose Method Two by Right clicking and Save Target As onto your Desktop.

The text files saved to your desk top need to be opened & analyzed in Excel. Directions are on a separate handout.

You should end up with a Word document that has the following:

a) Title, name(s), period, & problem statement.
b) One jpeg – on half a page - of your microseism plot.
c) A half page screen shot of the top of the work sheet that has the raw LIGO data.
d) A half page screen shot of the top of the work sheet that has the raw NOAA data.
e) A half page screen shot of the top of the work sheet containing DATE & TIME, rms & wave height
f) Full page XY dual axes scatter plot that is complete.
g) Write a short (2 – 3 sentences) conclusion which includes citing your data and results to support your conclusion.
h) Within the conclusion, generate one question for further investigation & a hypothesis related to this question.

Save your Word document as per teacher instructions.

References:

1. GCSE Physics – Seismometers - http://www.gcse.com/waves/seismometers.htm
2. USGS's Earthquake Archive - http://earthquake.usgs.gov/eqcenter/eqinthenews
3. I2U2's eLab: - http://www18.i2u2.org/
4. NOAA's National Data Buoy Center - http://www.ndbc.noaa.gov