LIGO GHS

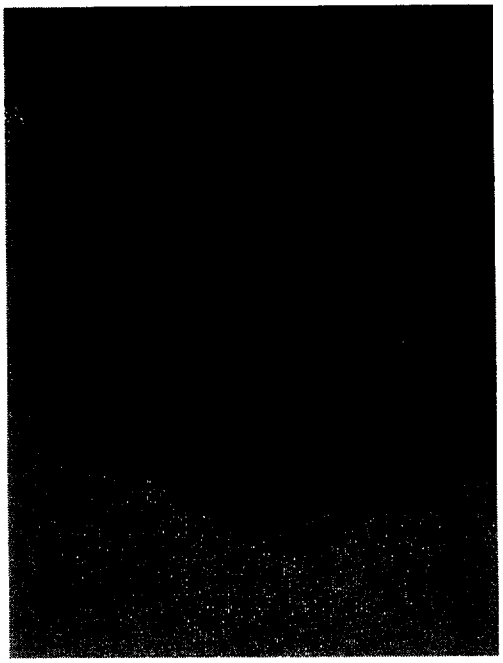
An Adventure In High School Physics

The Fourth Annual

Student Science and Engineering Exposition

Presented by Gladstone High School in Partnership with the Laser Interferometer Gravitational-wave Observatory

May 27, 2003



LIGO-G030271-00-W

Student Science and Engineering Exhibition
Gladstone High School
May 27, 2003

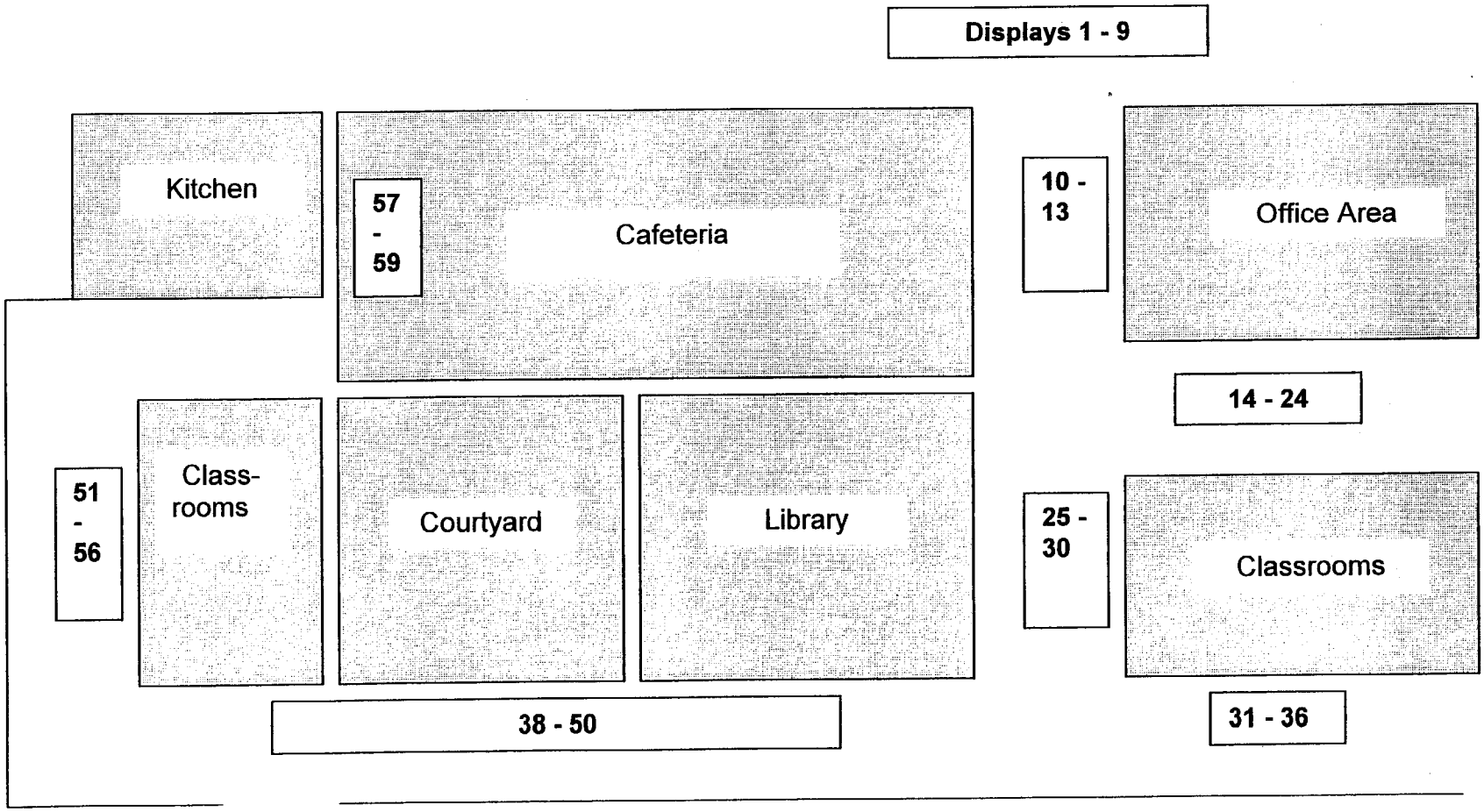
Welcome	Lincoln Jones Superintendent Bob Stewart Dale Ingram
Introduction of Student Displays	Lincoln Jones

The audience is invited to view the displays that are located according to the map on the following page. Please feel free to discuss the projects with the students. Following the viewing time we will meet again in the cafeteria for several presentations

Introduction of Presentations	Lincoln Jones
Closing Remarks	LIGO Hanford Head Dr. Fred Raab

Display Guide

The display numbers on the map below match the numbers that accompany the descriptions on the following pages of the program.



Student Project Displays

Spectroscopy

3 Amanda Buffington — Visible Absorption Intensity vs. Color Type

Does a visible spectrometer give similar absorbance values for similar concentrations of different colors? This is an important question for understanding the long-term calibration of the instrument.

4 Jaime Junell — A Spectroscopic Study of Turbidity

Milk provides a useful medium for spectroscopically measuring the Tyndall effect. How linear is the relationship between the concentration of particulate and the amount of light the mixture transmits?

5 Christy Courtain — Approximating Particle Size in Curdling Milk

Dynamic processes such as curdling can be studied with light transmission. Uniform materials such as baking sprinkles can serve as a model for the rather complex environment of acidified milk.

6 Shannon Finney
7 David Tuttle — Quantifying Aqueous Fe(II)

A visible spectrometer should help us measure Fe(II) in solution if we make a set of appropriate standards. Complications arise from the interconversion between Fe(II) and Fe(III), a process that appears to be pH dependent.

8 Luke Durkee — Electrical and Spectroscopic Behavior of LED's

The voltages across various light-emitting diodes appear to increase at lower temperatures, suggesting that electrical resistance is increasing. Spectral lines remain the same as the LED's temperature changes.

9 Alex Streeter — Absorption Spectroscopy with Cardboard & Duct Tape

A diffraction grating on a cardboard box can serve as a good spectroscope if the entrance slit is very thin and very regular. A video camera can capture the spectral emissions of various sources.

Structural Analysis

10 Michael Price
11 Justin Moore — POV-RAY Software for Molecular Modeling

POV-RAY is a free drawing program. Once one learns how to input coordinates, structural chemical models are possible. We have used crystallographic data from the Web to model simple materials.

12 Shad Downey — Determining Crystal Structures through Diffraction
13 Colin Sakewitz

Crystallography yields geometric data about crystalline materials. Solving a crystal structure first requires that sets of parallel planes in the crystal be identified. Atomic positions can then be determined from the intensities of the diffraction events in the data.

Physical Chemistry

14 Greg Oleksak — The Kinetics of Peroxide Decomposition

Pour peroxide on a cut and the peroxide will fizz. Those wishing to study this system might prefer to use potatoes instead – the fizz is the same but your flesh stays intact. Concentration of the potato slurry in distilled water is one experimental variable we can study.

15 Jeff Gale — Hot Metal Surfaces as Catalysts
16 Bryan Lietzke

The oxidation of ammonia by atmospheric O_2 is slow at room conditions but proceeds quickly on a hot copper wire. The heat released by the oxidation keeps the wire glowing hot for long periods of time.

17 Michael Reynolds — A Comparative Study of Solution Conductivity's

A careful study of solution conductivity vs. both electrolyte concentration and temperature requires stringent control of many variables. A batch-testing device makes it possible to run a number of tests simultaneously. $CuSO_4$ solutions appear to carry more current than NaCl solutions at similar concentrations and temperatures.

18 Jessica Evers — Thermal Expansion of Metals
19 Sarah Parma

We have found that expansion experiments are difficult to execute. Samples must be large enough to yield a measurable change, but large samples are difficult to heat uniformly.

20 Lincoln Jones — Synthesis & Physical Properties of Alloys
21 Emily Bondietti

We have dissolved copper into both molten tin and molten zinc. Simple malleability tests seem to clearly show the hardening that occurs when the pure metal is adulterated.

Quantitative Analysis

22 Henry Thompson — Turbidity Relationships in Natural Water

Access to Clackamas River data has allowed me to examine relationships between turbidity and rainfall. Light transmission was one method of generating the turbidity values.

23 Melinda Scrivner Titration of Stomach Antacid Products

Do Rolaids (or the generic equivalent) really absorb forty-seven times their weight in excess stomach acid? Titration results suggest that this claim may not be unreasonable.

24 Vanessa White Calibrating a Thermocouple for Low Temperature Use

Thermocouples can go where thermometers fear to tread (such as a dry ice bath). Correct calibrations are essential when working with unusual temperatures, and limitations on the voltage response of our software appear to limit the temperature range we can measure.

Instrument Building

25 Jordan Lewis Gravimeter: A Long-Period Oscillator

I have used another student's Visual Basic torque calculator to analyze the opposing torques on my gravimeter. We are searching for a strategy to more closely balance the torques in order to slow the gravimeter down.

26 Lincoln Jones A Mobile Robot as a Remote Sensing Device

An integrated circuit called a "Basic Stamp" is the brain of our device. Getting the robot to move from software commands was our first success. Now we are trying to instruct the device to go to a distant location and capture data using on-board sensors.

27 Michael Hanson A Mobile Robot as a Surveillance Tool
28 David Wikander

A heavy payload required our robot to have powerful motors. The motor power must find its way to the wheels. All of this must be supervised by, in our case, a hand-held infrared signal emitter.

29 Chad Erwert Seismometer with Optical Sensors

One could make a pendulum seismometer in five minutes but the instrument's performance would corroborate the time spent. I have designed and built a much more professional device that relies on two laser diodes and accompanying sensors to record the activity of the mass.

30 Anthony Schoepflin An Improved Laser Mount for an Interferometer

Our student-built interferometers are very useful but suffer from poor laser control. Simple materials but an effective design have yielded laser mounts. Maintaining the laser in a fixed but adjustable position greatly increases the instrument's usefulness.

31 Ross Kenney Audio Output of Interference Patterns
32 Nick Pileggi

Very small vibrations can make interference patterns wiggle. When this activity occurs on the surface of a phototransistor, sound can be obtained if the fluctuating signal is amplified.

33 Glenn Burke Vibration Sensor

A two-piece sensor detects vibrations as long as one piece remains still relative to the other. An infrared LED and a matching phototransistor create the signal information.

34 Jesse Laur Vibration Isolation Stack

A set of masses and springs can remove certain vibration frequencies, creating a stationary surface for making sensitive measurements.

35 Joseph Katz-Wigmore Digital Interfaces for Analog Measuring Tools

I have been building and testing Apple IIe interfaces for several types of sensors. Students will use these systems for digital data collection in classroom experiments.

36 Alex O'Dell An Electric Field Meter

The probe of an electric field meter is a coil. A field will induce a current in the coil, which is then amplified and rectified. A panel meter displays the output signal.

Electronics

38 Josh Hall Light-Activated Alarm

An illuminated photocell triggers the delivery of power to a speaker.

39 Nick Mueller Telephone Tester

Plug this circuit into a household phone jack. An LED will turn on if your extension is off the hook

.

40 Brad Gibson Lie Detector

Sweat from an untruthful person completes a circuit that triggers an alarm. Parents might find this circuit helpful when asking about homework

.

41 Nick O'Halloran Timed Courtesy Light

A timer chip continues to power a lamp up to 15 seconds after shut-off.

42 Curtis Eckert Touch-Activated Alarm

Breaking a trigger wire activates an audio alarm.

45 Nic Markle Lamp Dimmer

An adjustment mechanism automatically controls the voltage across a lamp.

46 Sean Terrill AC/DC Power Supply

This is a traditional low-voltage supply that uses a step-down transformer.

47 Tony Beach Water Sensor

Dissolved ions in water will complete a circuit that powers a small buzzer.

48 Chris Davis Digitally Sequenced Blinker

Two integrated circuits work in tandem to deliver voltage to a sequence of LED's.

49 Dain Edwards Melody Maker

This circuit controls output to a speaker to hopefully make music.

50 Nick Dunn Audio Siren

A timer IC controls the termination of voltage across a speaker

50a Andy Albrich Switching Power Supply

Here is another form of AC-DC power supply that changes the input voltage.

51 Leston Loomis Timed Blinker

A 555 timer IC can regulate the voltage pulses to an LED. The size of the capacitor in the circuit influences the blink rate.

52 Brian Hickerson Moisture Alarm

In dry conditions the transistor in this circuit receives no base current. Moisture completes a path to the base, turning on the transistor and sounding an alarm.

53 Cameron Trone RC Receiver

A radio frequency that resonates in the coil will activate a relay that in turn could switch on a garage door opener or other motor.

54 Adam Bickford Audio Siren Generator

Two timing chips work in tandem to deliver varying frequencies to a speaker.

55 Nathan Clements RC Transmitter

The reverse of (53), this circuit outputs RF from a coil and an antenna.

56 David Young Atmospheric Ion Detector

Similar to a moisture sensor in principle, this device measures field changes that occur as ions interact with the probe.

Software

57 Chris Larson Linux Servers & CGI Scripting

A CGI script is software that controls data entry on Web sites. Using a 'mini-Internet' between two computers, I can transmit information from one to the other using a CGI script.

58 Samantha Gotschall HTML Development for Student Research

Web pages are one of the main ways that we display GHS student research. A variety of HTML techniques are needed to create functional and attractive pages.

59 James Younglove Software Analysis of the Earth's Geomagnetism

Geomagnetism data is available on the Web but must be processed to be useful. One can use a variety of tricks to automate repetitive analysis tasks.

Presentations

Electronics

Paul Buchanan — Building In-house Capacity for Circuit Board Production

Solderless breadboards are useful for developing new circuits, but stable and reliable long-term performance requires a printed circuit board. I am developing a low-cost assembly process for custom boards that GHS students can use in future years.

Evan Geier — 'Virtual' Electronic Circuits

Do you need to build and test a circuit in a hurry? One option is to use circuit simulator software that lets you perform these tasks on a computer screen. We have simulated the activity of several RC filters.

Software

Zach Keesey — C++ Graphics I

Traditional C++ programs run in a 'terminal' – a plain screen that displays letters and numbers. An interest in incorporating graphics capabilities into a C++ program led me to use the OpenGL toolkit for graphics development.

Tobias Brockmann — C++ Graphics II

OpenGL functions can be used for data visualization if one can create an interface to the data. I will demonstrate a program that can read values from a file or generate values internally. The program then writes a scatter plot.

Randy Mackin — C++ Graphics III

Here is another example of a data interface and a plotting engine. This program reads a long file of wind direction data and plots these on a compass-like display. This will be a useful tool for future student research projects.

Leston Loomis — Java Development

Java is a language that provides much of the computing breadth of C or C++ but is also well suited for Web applications. I will demonstrate some basic Java techniques and applications.

Gregg Dowdy — Expanded Programming Tricks

Most programming projects at GHS involve data analysis but there are a number of other types of products that an emerging programmer can create. Here is a small sample.

Data Analysis

Tiffany Tomlinson
Rachel Shaw

Long Term Analysis of Ocean Tides

LIGO is interested in ocean tides because the tides cause local changes in gravity that affect the interferometers. Our Integrated Science I class studied several years of tide activity along the coasts of Oregon and Washington.

Bryan Herbert

MS Access as a Data Management Tool

We have a large archive of seismic data from LIGO Hanford's five seismometers. How does one manage tens of thousands of numbers? I have learned how to generate plots and statistics using a variety of database functions on this archive.

Michelle McInnes

Microseisms and Ocean Waves

Our seismic archive contains information about microseisms at LIGO Hanford. I am studying the relationship between microseisms and ocean wave heights using MS Excel. Pacific Northwest and Alaska ocean buoys show wave height patterns that correlate with LIGO's microseisms.

Publication of Results

Stephanie Brown

Student Research Posters with Adobe Illustrator

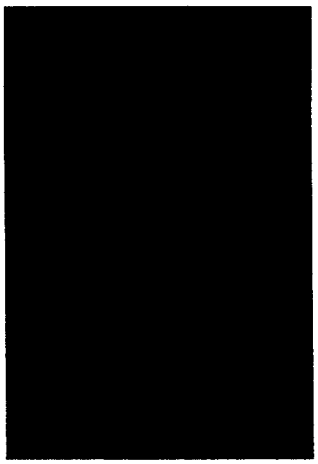
Posters are helpful for summarizing various themes of our research program. Illustrator is a powerful and complex tool for synthesizing text and graphics and for importing a variety of external objects such as photographs and plots.

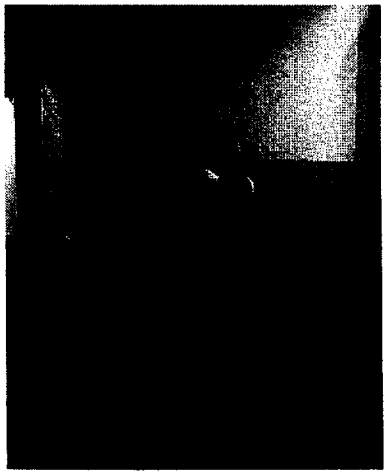
A Visit to LIGO Hanford

On Friday, April 25 nearly 30 students gathered at GHS at 6:00 AM for a 250-mile bus ride to the LIGO Hanford Observatory. Dr. Fred Raab and the LIGO staff gave us a thorough and close look at the art and science of gravitational wave detection. At the close of our stay, several GHS research students gave presentations of their work in LIGO's new auditorium.

Our particular thanks go to Dr. Raab, LIGO electronics engineer Richard McCarthy and facilities specialist Terry Martini. We also thank GHS parents Mrs. Webster and Mr. Courtain for a long day of chaperoning.

The trip was made possible through a gift from the O'Dell family to the Gladstone Education Foundation.





Acknowledgements

LIGO continues to support and encourage our research program at GHS through investments of time, expertise, encouragement and other aspects of mentorship. LIGO is operated by Caltech and MIT and is supported by the National Science Foundation (Cooperative Agreement PHY-0107417).

Financial support for our program this year has come from the Gladstone Education Foundation, the Clackamas County Technical Education Consortium and the GHS Moe Foundation (funded by proceeds from the High School student store, Moe's Corner).

The Gladstone School District Board of Directors, in concert with our administrative team, continues to encourage the development of research opportunities for students.

GHS building administrators Stu Evans, Bill Stewart and Ed Simmons continue to make events such as this evening possible in ways too numerous to count or describe.

Many GHS staff members graciously support the research work of these students. We owe particular thanks to Roy DeRousie, Karla Bennett, Barbara Benson, Debbie Poyser, Mary Cay Misely, Ellen Peck, Kyle Kivett and Steve Carrigg.

Joy Roman prepared tonight's refreshments and the GHS custodial staff has assisted with logistical preparations.

In addition to staff members at LIGO, we also benefit from the knowledge and encouragement of individuals outside of GHS. Our thanks go to Royace Aikin and Norm Anheier of the Pacific Northwest National Laboratory, Dr. Margret Geselbracht of Reed College and John and Jay Lewis of Goldwrench Automotive in Gladstone.

Lori Hughes of the Vancouver office of Miller Nash facilitated her firm's donation of three complete computers to the GHS Science Department. These machines will continue to meet our growing needs for computing resources.

Our student research program operates on grants and other funds that are outside of the District's budgeted revenues. If you or your employer would be interested in helping to support the research experiences of these and future GHS students, please contact Tammy Tracy of the Gladstone Education Foundation at 503-655-2777.