The LIGO Science Education Center and its partnership

J. Giaime, D. Shoemaker, W. Katzman, representing:

The Laser Interferometer Gravitational-wave Observatory

Funded by the National Science Foundation, jointly operated by Caltech & MIT, with over 850 scientists from 50+ institutions participating through the LIGO Scientific Collaboration (LSC).

The LIGO SEC partnership in Louisiana

LIGO, Southern University, the San Francisco Exploratorium, the Louisiana Board of Regents and the Baton Rouge Area Foundation.

…with contributions from M. Cavaglià and D. Ingram.

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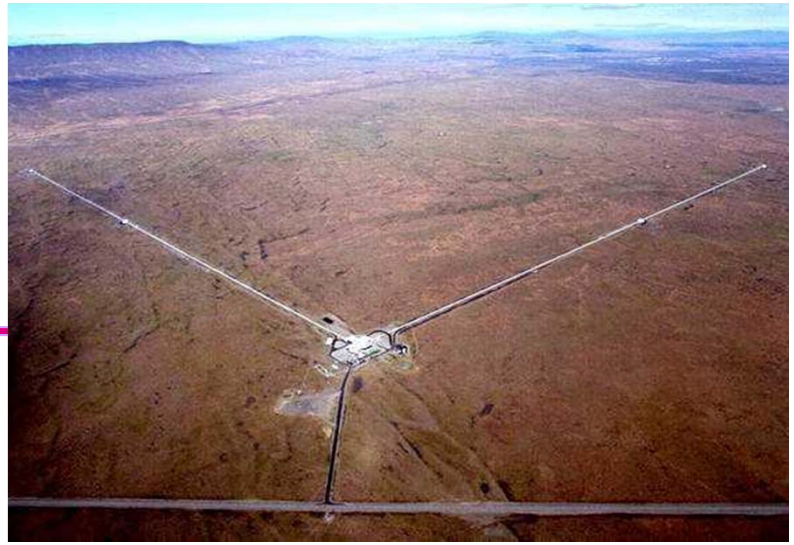
LIGO Outreach Objectives



- Improving science literacy in the general population
- Increasing participation in science, especially among under-represented and under-served groups
- Helping to reduce existing disparities in the access to educational resources
- Advocating the intellectual and social / socio-economic benefits of careers in science
- Providing and coordinating resources for the design and delivery of outreach and education activities by others within the collaboration
- Improving understanding by the citizenry of frontier science and large scientific projects
- Inspiring future generations of scientists and engineers

LIGO Outreach Efforts – Centered at Observatories

LIGO Livingston activities

LIGO Livingston Outreach

- LIGO Livingston Observatory
  - Standard tours – consisting of the Control Room and/or the facility grounds.
  - Customized ('VIP') tours – visiting other areas of the Observatory such as clean areas, and having a closer look at the vacuum system.
  - Scientists, graduate students and technicians interact with the public during:
    - Tours through the control room – seeing scientists at work
    - Open Public Days
    - Informal talks with teachers
    - VIP tours

LIGO Livingston
Science Education Center

The front of the SEC with the Wave-Wall

- 5000 Square foot exhibition hall filled with over 50 professional exhibits. Developed in conjunction with the Exploratorium (San Francisco).
- 1 Fully-equipped classroom (32 students)
- 1 State-of-the-art Auditorium
- Lobby area with interferometer display elements
- Three full time staff; supplemented by one Postdoc

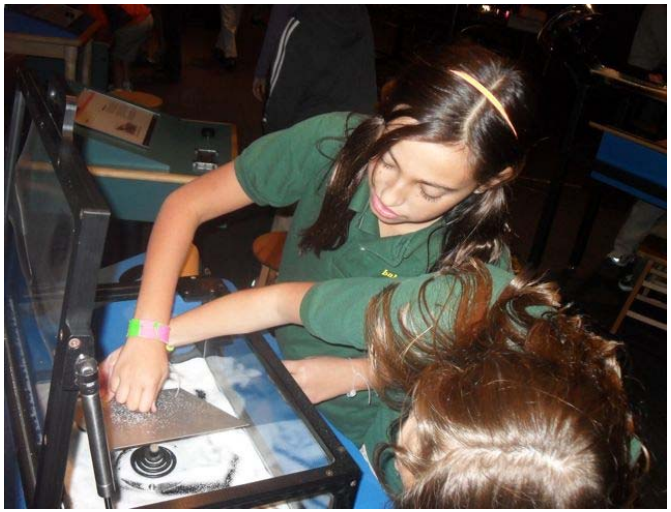
LIGO Livingston
Science Education Center
Partnerships

- Fully supported by the **National Science Foundation**
- The Exploratorium
- Southern University, Baton Rouge
- LaSIP / La GEAR UP
  (Louisiana Dept. of Education)
- Baton Rouge Area Foundation (BRAF)
- Tulane University
- 5 Local school systems

LIGO Livingston Science Education Center

Partnerships – Exploratorium

- The Exploratorium
  - » Partners in developing 5000 Square foot exhibition hall filled with over 50 professional interactive science center quality exhibits.
  - » Provides training for SEC staff in informal educational methods
  - » “ExNet partnership” loans the SEC 10-12 new exhibits that rotate each year.



LIGO Livingston Science Education Center
Partnerships - SUBR

- Southern University of Baton Rouge
  - » Provides Docents to help facilitate experiences at the Science Education Center.
  - » Docents are undergraduates who major in Science, Technology, Engineering, Mathematics (STEM) or Education fields.
  - » Docents are trained by LIGO SEC staff to
    - – Better understand underlying science concepts
    - – Learn how to facilitate visitor interactions
    - – Better understand the research done at LIGO
  - » Docents receive financial aid (similar to a work-study) for their services.
  - » Docents represent a step in the pathway to being a scientist and serve as role models to students from underrepresented groups in the STEM fields
  - » 17 docents in training

LIGO Livingston Science Education Center

Partnerships – LaSIP / La GEAR UP

- LaSIP / La GEAR UP funds teacher training programs. (Louisiana Systemic Initiative Program / Gaining Early Awareness and Readiness for Undergrad Programs)

- Programs train Middle & High school teachers in science & science methods
  - » Teachers are primarily from disadvantaged regions
  - » Teachers use interactive exhibits, or inexpensive miniature exhibits (known as 'snacks'), to illustrate science concepts & increase learning.

LIGO Livingston Science Education Center
Partnerships – BRAF

- Baton Rouge Area Foundation (BRAF) manages grant funds from the NSF and uses these funds to support:
  - » The partnership with the Exploratorium
  - » Supporting educational research through Tulane University
  - » Supporting 5 school systems for longitudinal contact with LIGO-SEC:
    - – Two school systems that concentrate efforts on 9th grade science teachers and students for a prolonged duration
    - – Three school systems where we follow one class of students from 5th grade through 9th grade – providing the students with field trips and each of their teachers with professional development.

LIGO Livingston
Science Education Center
Partnerships – Tulane

Dr. Lisa Szechter uses LIGO Science Education Center to conduct research on the way people learn in Informal Environments

- Results showed correlations between personal interest in science and actions at a particular exhibit
- Results show that participation in inquiry activities resulted in:
  - Students asking more questions in the exhibit hall
  - Students making more observations
  - Parents using more science terms
  - Parents making more predictions

LIGO Livingston
Science Education Center
Teacher Professional Development

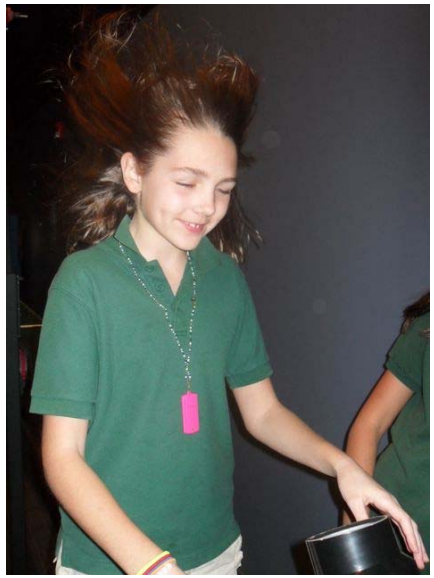
- Emphasize science inquiry
- Include tours of the site
- Utilize related LIGO science concepts such as waves, etc.
- Utilize science interactive exhibits that can be built inexpensively (< $20) that often mirror exhibits within the SEC.
- Partners – LaTech and SUBR conduct long-term teacher PD that includes one or more visits to LIGO SEC for tours and training.
- Provide PD as part of Math & Science Partnership programs.
- 5 school systems participate through the BRAF NSF grant

LIGO Livingston
Science Education Center
The Tour Experience

- **Pre-control Room Tour**
  - » Visitors are introduced to a cut-away of a turbo-molecular vacuum and shown a full scale mirror suspension to make the connection to the actual mirrors that will be seen through IR cameras in the control room.
- **Control Room Tour**
  - » Visitors then visit the LIGO control room where staff are currently working; led by SEC staff or a LIGO scientist.
  - » The need for a control room is explained, the positions that staff the control room are explained and a live video tour of the site is given.
  - » Wall projections and monitor displays of data and real-time views of the Interferometer are explained.
- **External Tour**
  - » These occur depending on weather and time frames. External tours make use of an overpass bridge, or occasionally (for smaller groups) a building-top view, in order to see the beam tubes, and other elements.
- **Visitors are encouraged to ask questions and interact!**

LIGO, Livingston
Science Education Center
School Field Trips

- **When students visit the SEC**, they get the opportunity to explore the science of waves and gravity through inquiry based activities and exhibits as well as see science at work.
  - » All activities and experiences are tailored to address points in the Louisiana Grade Level Expectations.
- **Programs are targeted to middle school students**.
  - » Programs are also offered to elementary, secondary and post-secondary students.



LIGO, Livingston
Science Education Center
School Field Trips

- **Tours**
  - » Groups are provided tours according to size, etc.
- **Classroom Activities** are provided when requested
  - » Hands-on, staff member facilitated inquiry activities
  - » Most focus on light and wave properties (e.g. interference, refraction, etc); other topics also exist (gravity)
- **Exhibit Hall Exploration**
  - » Time is allotted for free exploration of the hands-on exhibits in the SEC.
  - » Students are given four “rules” for their experience: interact with the exhibits, learn something, share something, and have fun.
  - » A short exhibit demo is performed by a staff member not only to teach a targeted concept, but to show students that there are multiple ways to use the exhibits.

LIGO, Livingston
Science Education Center
School Field Trips

- Pre-visit materials are mailed to teachers prior to the field trip.
  - » Includes the opportunity to view a ~20 min. documentary, *Einstein's Messengers*, to introduce students to the science of LIGO.
- When students arrive on site, they are briefly introduced to LIGO, and Gravitational Waves
- Students typically view the Making Waves video
- Docents who are closer to the students age are used to help students realize that they too can participate in science

LIGO, Livingston
Science Education Center
Public Tours

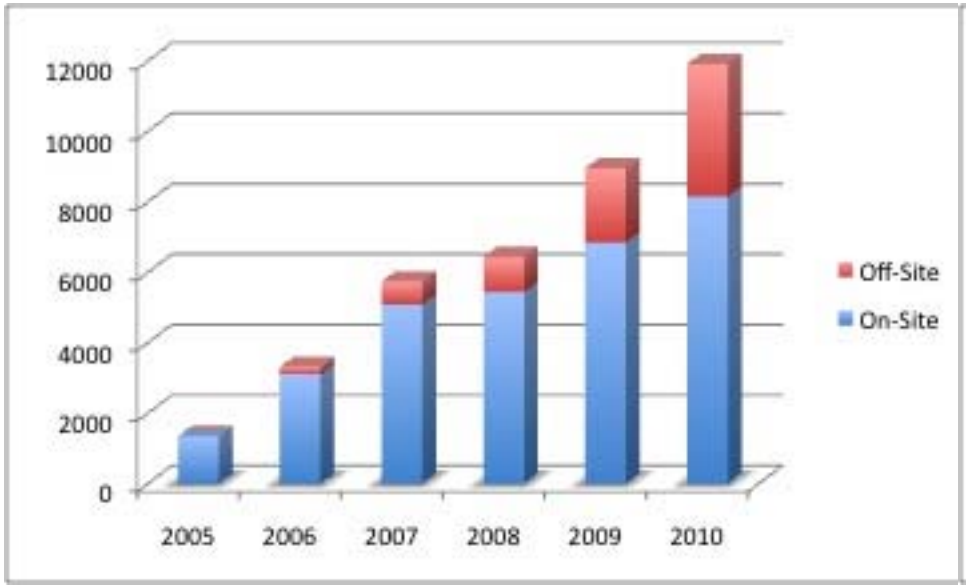
- The public is generally encouraged to visit during monthly ‘Science Saturdays’
- Special requests for other tours (larger groups, or inability to make it out on Saturdays) are accommodated as possible.
- The public is greeted and given a brief introduction to LIGO and gravitational waves.
- A gravitational wave video is watched (either the 8 minute Making Waves video (for Science Saturdays), or the 20 minute Einstein’s Messenger video.
- Tours of the site are given followed by time for free exploration in the exhibit hall.

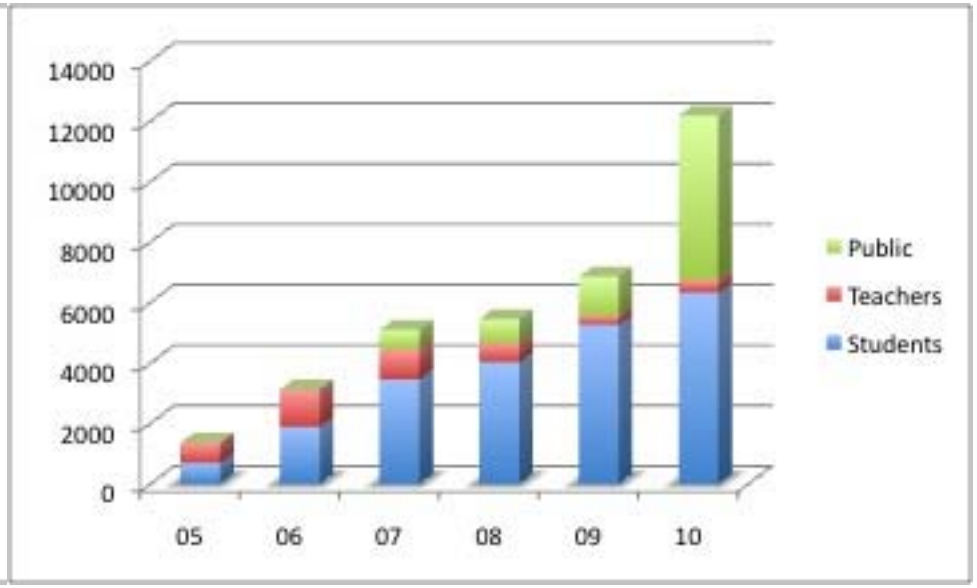
LIGO, Livingston
Science Education Center
Science Saturdays

- Open for people to drop in any time from 1PM - 5 PM on 3rd Saturday of each month
- Have activities that concentrate on a different topic each month to encourage repeat visitation
- Tours occur several times throughout the afternoon
- Tours are preceded by the 8 minute Making Waves video
- The 20 minute Einstein's Messengers video is available for viewing at specific times throughout the afternoon
- Special presentations are sometimes given on the monthly topic

LIGO, Livingston
Science Education Center
Trends

- **Demand is growing**:





- Outreach in each area expands each year – except for the teacher PDs. We believe this to be due to a combination of factors including market saturation, and the winding down of Math Science Partnership programs. Recently teacher PDs started growing again.
- In the past year Science Saturday (public) attendance increased from an average of 50 to an average of 250 per day.

LIGO Hanford activities

LIGO Hanford Outreach
Audiences

School field trips

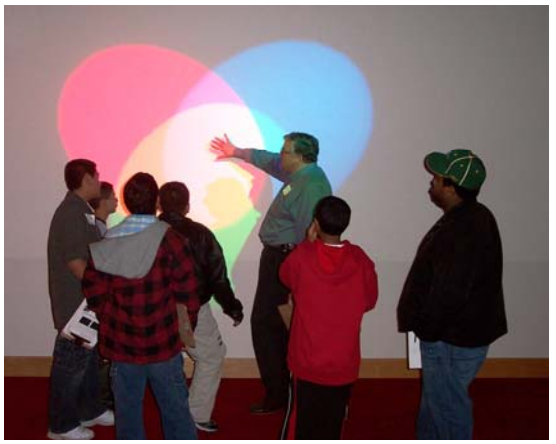
Special interest programs
(Cub Scout astronomy pin)

Public astronomy events

Off-site activities

The construction of Advanced LIGO adds a new dimension to a LIGO visitor experience

LIGO Hanford Outreach
Exhibits



15 permanent exhibits add hands-on flavor to on-site events

LIGO Hanford exhibits and field trip activities are correlated to Washington State science instructional standards.

LIGO Hanford Outreach
Teacher Professional Development

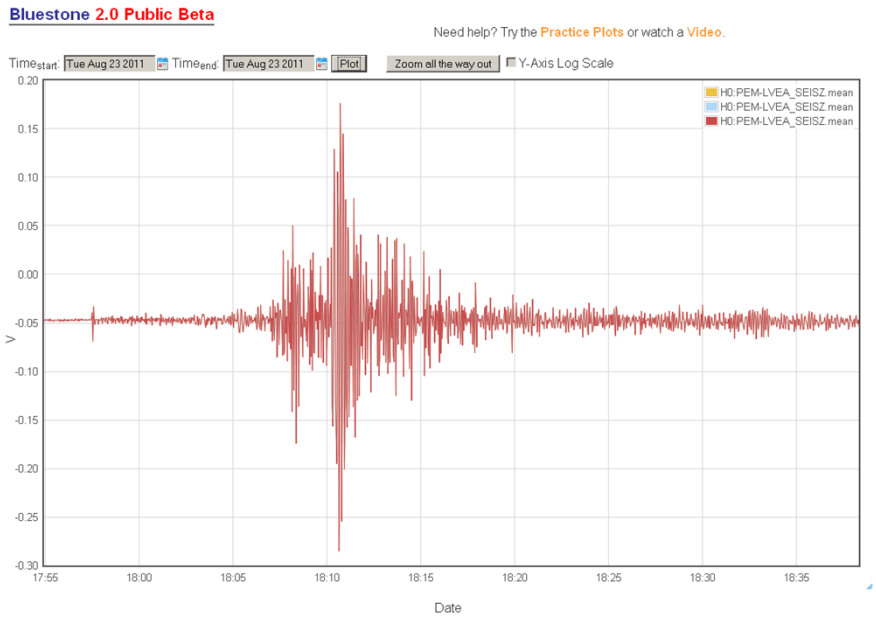
~35 teachers participated in the 2011 MSP Summer Academy at LHO. The MSP focuses on improving teachers' understanding of the nature of scientific inquiry.

Teacher training:

LIGO Hanford has collaborated on the Southeast WA Math and Science Partnership (MSP) program since 2007.

MSP partners include K-12 local school districts as well as Community Colleges

LIGO - I2U2 Collaboration



The August 23, 2011 Virginia earthquake as seen on a LIGO Hanford seismometer via the I2U2 Web interface

- NSF-funded effort to provide large-project data sets to students and teachers for science research
- The LIGO e-Lab is now in the third year of a three-year cycle of field testing
- The e-Lab includes a full suite of paperless server-side features such as pre- and post-tests, an online student logbook and tools for generating online interactive posters.
- Recruiting teachers for training and classroom implementation is the biggest challenge going forward.

LIGO Lab Outreach
Numbers

	Livingston	Hanford	Total
On-Site Contacts	8209	3500	11,709
Off-Site Contacts	3760	7500	11,260
Total Contacts	11,969	11,000	22,969
Teacher Training (PD)	382	175	557
# of events	201	225	426
Papers/Presentations	13	2	15

LIGO Scientific Collaboration Education and Outreach

- Collaboration focused on LIGO instruments and data
- 850 persons, 50+ institutions, mostly in US but also Europe, Asia, Australia, the Americas
- Many institutions have their own education and outreach programs
- All also contribute to, and draw from, the LSC-developed and coordinated activities
- Central coordination, web presence, Collaboration meeting sessions, ‘credit’ earned in Collaboration for Outreach

M. Cavaglià

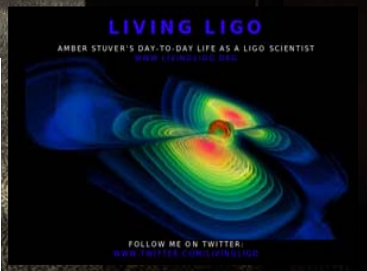
LIGO Scientific Collaboration activities

Exhibits

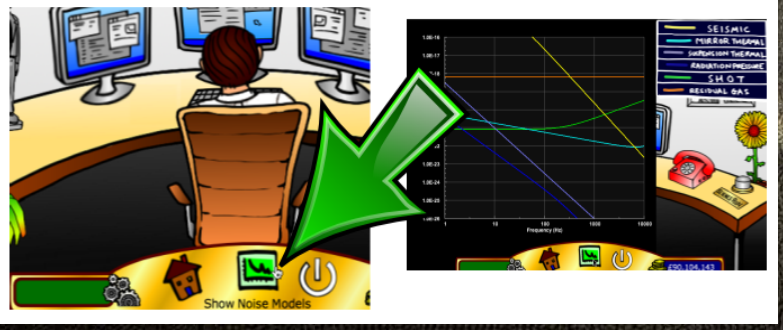
Science Fairs and Festivals

Web

Blogs



Games

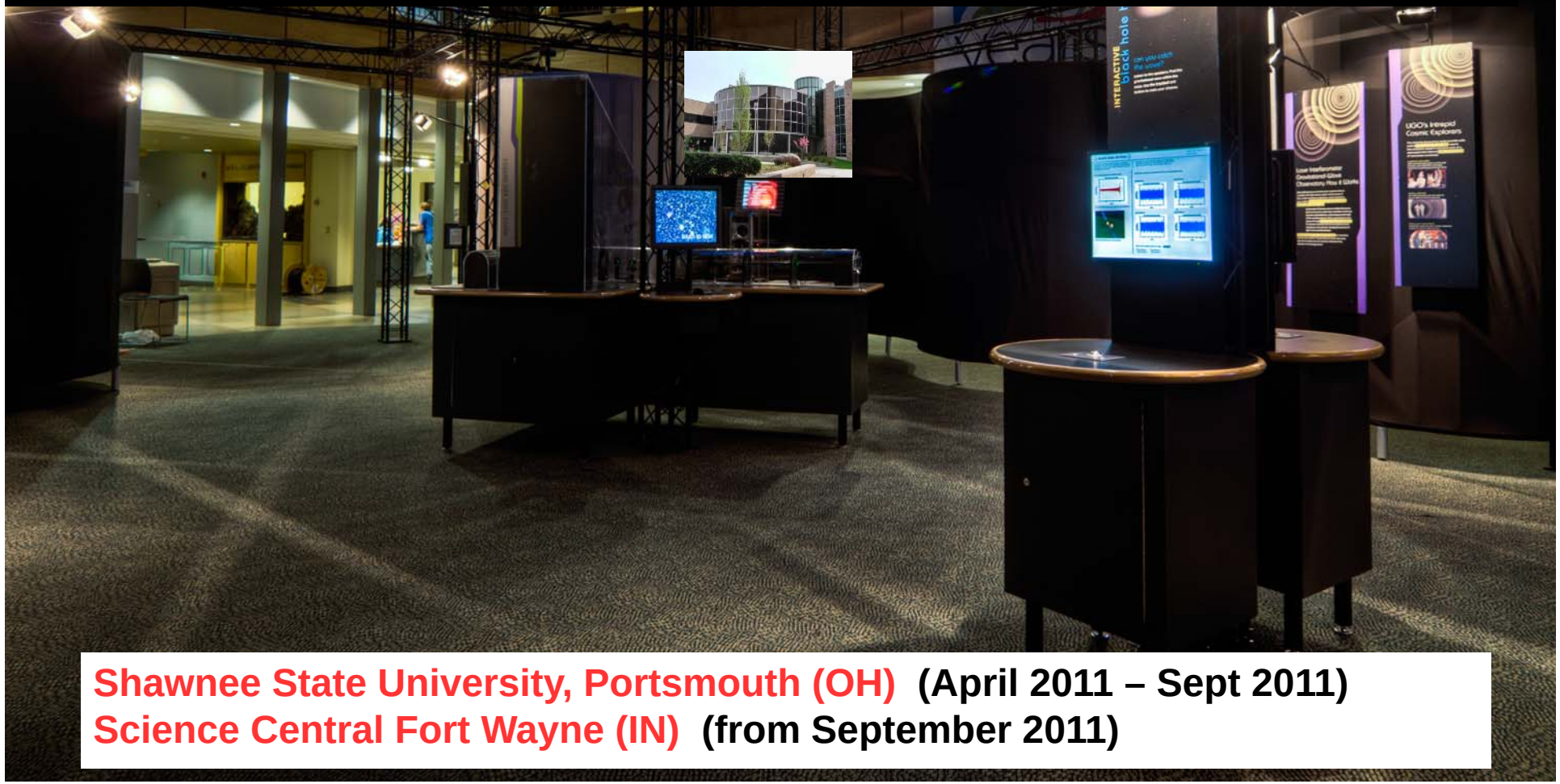


Student training

Astronomy's New Messengers

A LIGO Traveling Exhibit

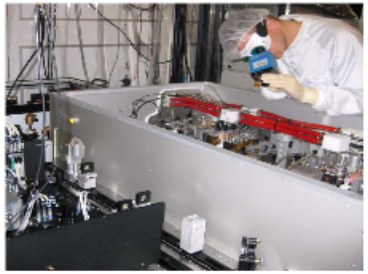
http://ligo.phy.olemiss.edu/LIGOexhibit



Shawnee State University, Portsmouth (OH) **(April 2011 – Sept 2011)**
Science Central Fort Wayne (IN) **(from September 2011)**

Internet broadcasts and web

Celebrate LaserFest, the 50-year anniversary of the invention of the laser! Bring cutting-edge laser technology into your classroom with an online LaserFest program featuring the laser science of LIGO, the Laser Interferometer Gravitational-wave Observatory.



Courtesy LZH

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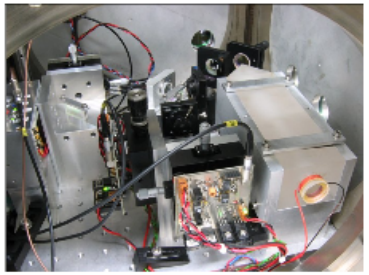

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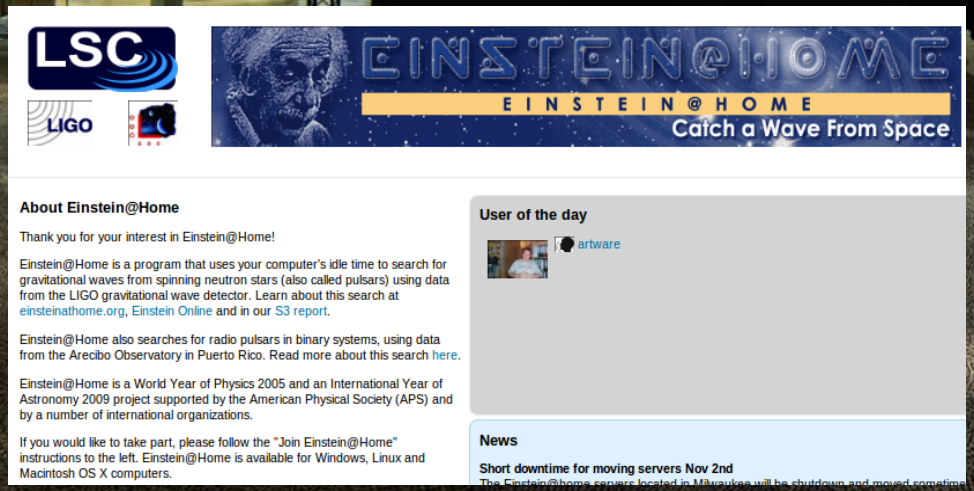

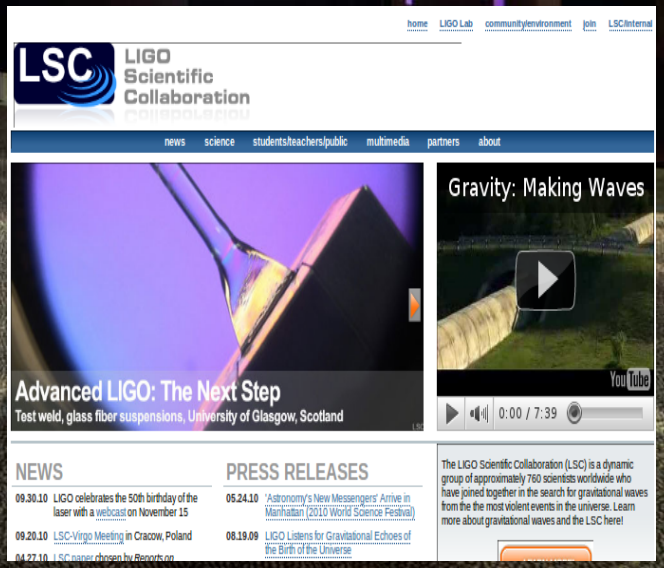

LIGO Outreach

- Robust program centered at the Observatories
  - » Happily geographically located in regions of under-served populations
- Science Education Center at Livingston our ‘star’ facility with production teaching of students and teachers
- Hanford also quite active; future potential for second Science Center
- LIGO Scientific Collaboration providing material and hosting activities, tuned to capabilities and local needs

A vital element of the LIGO mission