

# ***Next generation STEM preparation through LIGO science education at Southern University\****

**Stephen C. McGuire, PhD**  
**Professor of Physics**

**Luria S. Young, PhD, Professor**  
**Doctoral Program in Science and Mathematics Education (SMED)**

Southern University and A&M College  
Baton Rouge, Louisiana 70813

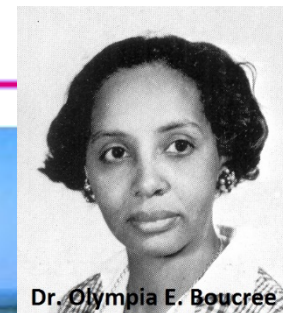
*-- Invited talk presented at the 2016 Winter Meeting of the American Association of Physics Teachers  
January 11, 2016, Hyatt Regency Hotel, New Orleans, LA*

***\*Work supported by NSF Grants No(s). PHY-0101177, PHY-0701652, PHY- 0355471, PHY-0917543 and Board of Regents Grant No. 05-231SUBR-CMSS.***

AAPT Winter Meeting January 11, 2016

- **Laser Interferometer Gravitational-wave Observatory (LIGO)**
- **Southern University's Role in LIGO**
  - **Materials Science**
  - Teacher Education and Science Literacy**
- **Current Work**
- **Summary and Future Activities**

# “The Michoud Field Trip” (personal reflection; circa 1961-63)



Dr. Olympia E. Boucree



Photo courtesy of NASA.



NASA announced the selection of the Michoud site on September 7, 1961. The Saturn IB and Saturn V first stages were manufactured at Michoud. By December 13, 1963 the production of the first Chrysler-built Saturn I and the presentation of the booster to NASA was completed.

**NASA Michoud Facility  
Michoud, Louisiana; a suburb of  
New Orleans**



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# SUBR-LIGO "Beginnings"

## American Association of Physics Teachers ANNOUNCER

December 1997

Vol. 27, No. 4



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### AAPT's 1998 Winter Meeting

HYATT Regency New Orleans, LA

January 3-8, 1998



#### Session AH

##### Plenary Session on LIGO—Catching Gravitational Waves

**Sponsor:** Committee on Graduate Education

**Day:** Monday, Jan. 5

**Time:** 11:30 a.m.-12:30 p.m.

**President:** James E. Parks, Univ. of Tennessee, 401 Nielson Physics Bldg., Knoxville, TN 37996-1200; 423-974-8952

##### AH1 11:30 a.m. LIGO—Catching Gravitational Waves

**Invited—Mark Coles, Caltech., The LIGO Project, Mail Code 18-34, Pasadena, CA 91125;**  
[coles@gsparc.ligo.caltech.edu](mailto:coles@gsparc.ligo.caltech.edu)

LIGO, the "Laser Interferometer Gravitational-wave Observatory," is the most ambitious project to detect gravitational radiation ever attempted. Observatories near Baton Rouge, Louisiana, and Richland, Washington, are now being built by a Caltech/MIT partnership to attempt this feat. Gravitational waves, predicted by Einstein as part of the general theory of relativity, promise an entirely new way to view the heavens that may revolutionize our understanding of the universe, providing new insights on phenomena such as the dynamics of black holes. The fantastically weak effects of gravitational radiation will be detected by using a device called a laser interferometer, which uses light to measure the distances between mirrors suspended 4 km apart in a high vacuum with an uncertainty of less than the diameter of a proton. The motivation for LIGO, an overview of how it works, and a status update on this exciting project will be presented.

#### Sessions—Tuesday, Jan. 6

##### CI3 11:00 a.m. Nuclear Physics Concepts for Non-Specialist Undergraduates

*Stephen McGuire, Cornell Univ., 238 T Bard/Materials Science and Engineering, Ithaca, NY 14853;*  
*607-255-0159; [scm2@cornell.edu](mailto:scm2@cornell.edu)*

*Donald Holcomb and David D. Clark, Cornell Univ.*

Nuclear physics concepts such as nuclear reactions, nuclear energy levels, characteristic gamma rays, radioactive decay and half-life, and pair production play a role in a rather broad range of applications. Examples include commercial energy production, medical diagnosis and treatment, radioisotopic power sources for space travel, the authentication of artwork, forensics, mineral assay, etc. Over the past several years we have developed a neutron activation laboratory exercise that reinforces the learning of these concepts as part of an introductory, calculus-based general physics course enrolling students majoring primarily in chemistry, biology, and pre-medicine. The accessibility of the subject matter afforded by the lab experiment has encouraged us to consider a more extended use of nuclear phenomena and applications in the introductory course. We examine how this might be achieved, for example, as a natural extension of the discussion of energy, its transformation, and its conservation.

1998 Winter Meeting



## The LIGO Laboratory Charter (2002 - 2006)

October, 2001,

LIGO-M010213-01-M

# *Science Education Program*

As a national facility based upon an exciting scientific research mission, LIGO can provide a focus for educational programs in science. **A Science Education Program will reach beyond the traditional university role of educating undergraduate and graduate students to reaching K-12 grade level students. The managers of the Caltech, MIT, Hanford and Livingston groups will develop and lead programs in educational outreach to the general public, in on-site educational programs at the Observatory sites, as well as the university campuses, and in supporting program development consistent with other NSF educational initiatives.**

# Possible Layout of Proposed Educational Outreach Center at LLO



**April 14, 1999**

**Classical science concepts: oscillations, waves, wave propagation, resonance, lasers, light, interference, Newtonian gravity.**



# LIGO Science Education Center Partnership

*“Using Exhibit-Based Teaching and Learning to Enhance Science Literacy”*

## MISSION

- To develop a Center at the LIGO Livingston Observatory (LLO) equipped with hands-on exhibits in LIGO-related science.
- To integrate the LLO Center, its exhibits and activities, into pre-service and in-service education at Southern University Baton Rouge (SUBR).

## Report of the NCATE re-accreditation visit to Southern University – Baton Rouge College of Education; Spring, 2004:

“All of the Unit’s PDS sites as well as the Southern University Laboratory School are targeted beneficiaries of the College serving as the lead Southern University Baton Rouge collaborator in a National Science Foundation funded 5-year project with the California Institute of Technology, the San Francisco Exploratorium, and the LA GEAR UP program of the Louisiana Board of Regents. The project leverages the content and pedagogical courses of the physical science curricula for middle and high school teacher candidates, and proposes to enrich the content of elementary teachers with classical physical science concepts that are fundamental to the Laser Interferometer Gravitational-Wave Observatory (LIGO).”





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# LIGO SEC Funding Awarded!!!

## \$5 million grant to finance LIGO education center

By **BOB ANDERSON**  
Florida parishes bureau

LIVINGSTON — The Laser Interferometer Gravitational Wave Observatory will receive a \$5 million grant to establish an Educational Outreach Center, officials said Tuesday.

The educational center at LIGO, in the piney woods of north-central Livingston Parish, will offer "hands-on exhibits" for students "from kindergarten to post-retirement," said Joe Giaime, an LSU professor and chief scientist at the site.

In addition to reaching a broad audience of students, the center will provide in-service science opportunities to teachers, according to Stephen McGuire, chairman of the Southern University physics department.

"By focusing our efforts on students and teachers, we position ourselves to significantly improve the level of science literacy throughout future generations," McGuire said.

McGuire has been involved in research of sapphires for possible use in the next improvement of optics at LIGO.

The center will be built with a grant from the National Science Foundation, which funded construction of LIGO.

The education center will bring together an alliance that includes research scientists from LIGO, California Institute of Technology and Massachusetts Institute of Technology.

Educators from Southern University, the Exploratorium of San Francisco and the Louisiana Systemic Initiatives, headed by the Louisiana Board of Regents and the Board of

□ See LIGO, Page 2B

## LIGO

CONTINUED FROM PAGE 1B

Elementary and Secondary Education, will participate, said Deborah Williams-Hedges of Caltech.

They provide knowledge of LIGO science, experience in developing exhibits, expertise in exhibit-based teaching, connections to teacher development and access to public schools statewide, she said.

The five-year project includes creation of a series of 38 interactive exhibits demonstrating physical science principles related to LIGO science.

The center will be built on the LIGO site, but the design hasn't been completed, Giaime said Tuesday.

LIGO was created to detect gravitational radiation.

The observatory provides scientists an opportunity to prove Albert Einstein's theory that cosmic cataclysms can produce ripples in the fabric of space and time.

The Educational Outreach Center will tell the public the story that motivates this scientific endeavor, using exhibits and materials that reinforce public understanding of basic scientific principles.



FLORIDA  
PARISHES

It will help people understand how they can easily explore fundamental science concepts, said Stan Whitcomb, LIGO's deputy director.

"People who visit the center will learn how these concepts relate to and lead to cutting-edge scientific research endeavors," he said.

"The center will help us reach and inspire educators ... who are teaching the nation's future scientists and engineers."

People in the community have already showed a lot of interest in the

observatory's activities, said Mike Zucker, director of the LIGO Livingston Observatory.

"LIGO-related resources will ultimately reach and serve an extensive population of lifelong learners" as a result of the educational center, Zucker said.

LIGO has completed three science runs. The results of the last two runs haven't been published yet, Giaime said.

The Livingston facility is undergoing an additional seismic isolation upgrade, the LSU scientist said.

"Because of the economic activity of the area, our ground noise is greater than (Livingston's sister site) in Hanford," he said.

"The detectors still have a ways to go" in reaching the needed sensitivity, he said.

"The potential payoffs are magnificent," said LIGO Director Barry Barish, who is also the Linde Professor of Physics at Caltech.

"Messenger gravitational waves may reveal secrets central to many questions of great interest to astrophysicists," he said.

Those secrets include "coalescence of binary neutron stars, the collision of black holes, and the remnant gravitational wave signals from the early universe," Barish said.

A principal feature of the project is the partnering of LIGO with Southern University's College of Education and College of Sciences to develop programs that will enhance the preparation of science teachers and contribute to the professional development of in-service teachers, Williams-Hedges said.

The program should have "long-term and broad consequences," Louisiana Board of Regents' Kerry Davidson said.

"We are pleased to see this unique partnership develop among research scientists, museum educators, formal educators, and networks of local educators from the Livingston region," National Science Foundation Program Director Beverly Berger said.

"Together, they will make connections between science, the research at LIGO, and the surrounding community."

Wednesday, June 9, 2004

The Advocate  
Baton Rouge, La.



# SUBR-LIGO EDUCATIONAL OUTREACH TEAM

**Luria S. Young, PhD, Professor and Project Principal Investigator  
Doctoral Program in Science and Mathematics Education (SMED)**

**Stephen C. McGuire, PhD, Professor of Physics  
Principal Investigator - LIGO Scientific Collaboration**

**Verjanis Peoples, PhD, Dean,  
College of Education, Arts, and Humanities**

**Moustapha Diack, PhD, Professor  
Doctoral Program in Science and Mathematics Education (SMED)**

**Bobbie Remble Shujaa, Program Coordinator  
Modeling Inquiry-based Science Education (MISE) Program; Math Dept.**

**Kenneth R. Ford, PhD - SUBR-LIGO Inquiry Hall/Laboratory Manager  
Adjunct Assistant Professor - Department of Mathematics, Physics and SMED**



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# LIGO Science Education Center (SEC)

*“Using Exhibit-Based Teaching and Learning to Enhance Science Literacy”*



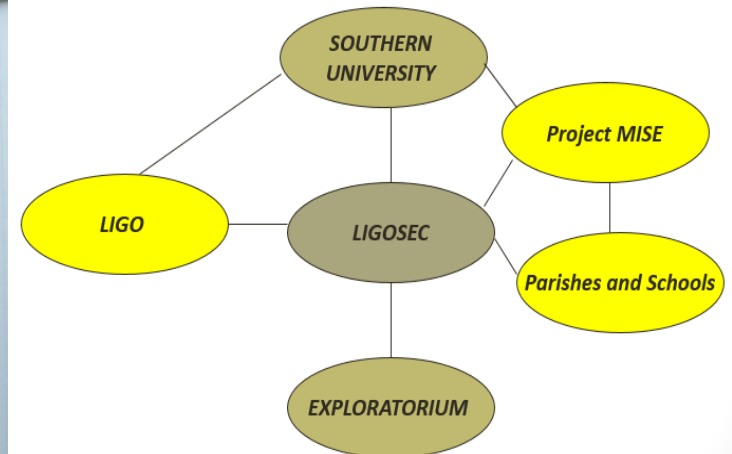
# Joint SUBR Faculty Meetings



**SUBR Joint Fall Faculty Convocations**

**LIGO Livingston Observatory**

*KEY PARTNERSHIPS = Win-Win Arrangements* \*



**College of Education, Arts  
and Humanities**

**Department of Mathematics,  
Physics and SMED**

\* *Inverness Research* Summary Evaluation Report, M. St. John, J. Helms, P. Castori, L. Stokes 2015.

# Exhibit training workshops





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# Pre- and In-service teacher preparation and docent training



LIGO Van



Student Docents



Student Docents



Family Open House



SUBR Inquiry Workshop



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# Current On-campus SUBR-LIGO Inquiry Hall, Room 202 Stewart Hall



Fall 2007, Exploratorium Visit  
S. McGuire, B. Remble and K. Ford



3-station Light Island



Seismograph



Spectra



Phase Pendulum



Coupled pendulums  
"with feet"



Gravity Well



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## Exhibit/Course Concept Mapping Example:

### 3-station Light Island



Department of Physics

Physics Course Enhancement  
LIGO Concept Mapping

Concept: →	Oscillations	Waves	Wave Propagation	Interference	Resonance	Lasers	Light	Newtonian Gravity
Course ↓								
Earth Science 201			Light Island	Light Island		Light Island	Light Island	
Earth Science 202			Light Island	Light Island		Light Island	Light Island	
Elements of Physics 141			Light Island	Light Island				
Elements of Physics 142			Light Island	Light Island		Light Island	Light Island	
General Physics 221			Light Island	Light Island				
General Physics 222			Light Island	Light Island		Light Island	Light Island	

Department of Physics

Interactive Exhibit  
Professional Development Activity Mapping

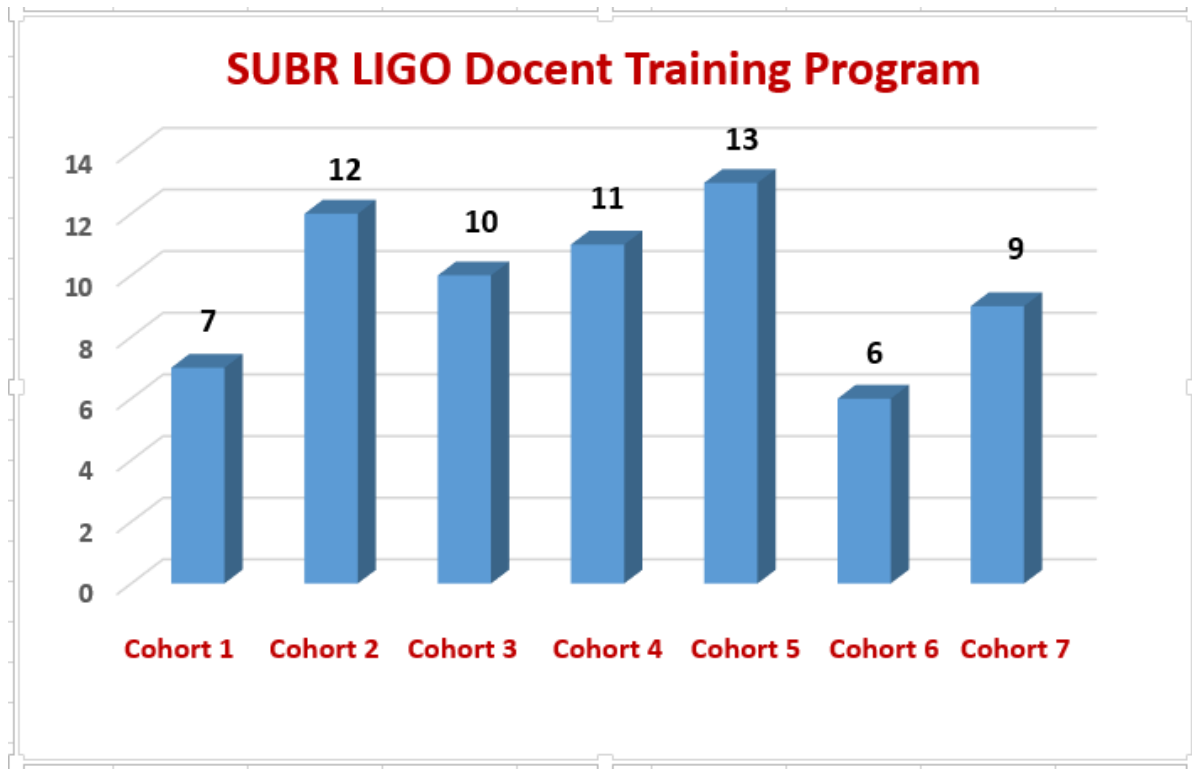
Professional Development	Area/Activity: →	Pre-Service Course Content	In-Service Workshops	Sound Perception	Visual Perception
Exhibit ↓					
Gravity Well		X	X		
Light Island		X	X		
Seismograph		X	X		
Spectra		X	X		
Coupled Pendulums		X	X		
Phase Pendulum		X	X		
Vibrating String		X	X		
Ripple Tank		X	X		
Doppler Rocket		X	X		
Sound Tube		X	X		
Subjective Colors			X		X
Vacuum Tubes			X	X	
Inverse Ears			X	X	
Sound Bite			X	X	





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# SUBR LIGO Docent Training Program\*

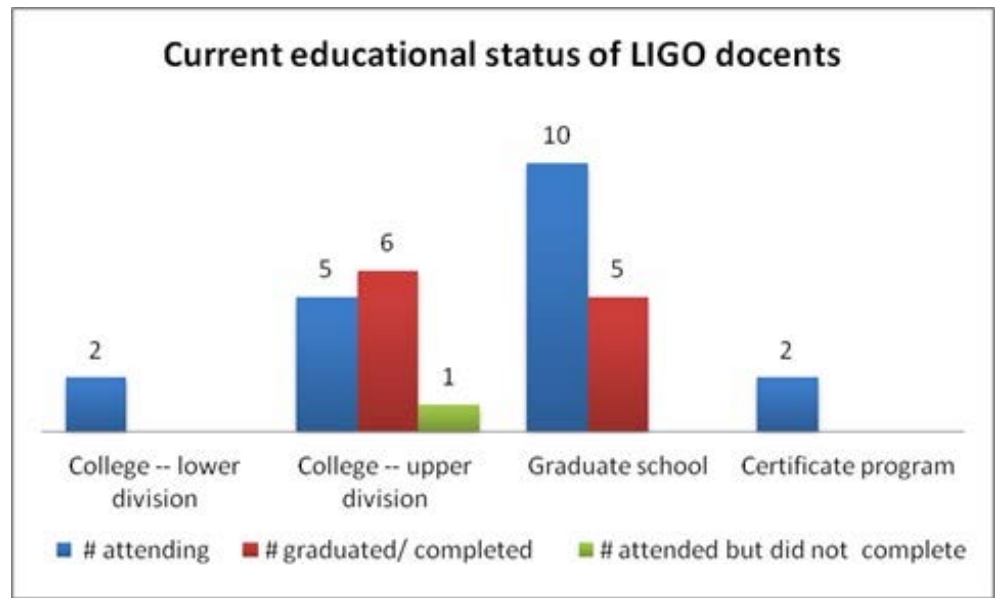
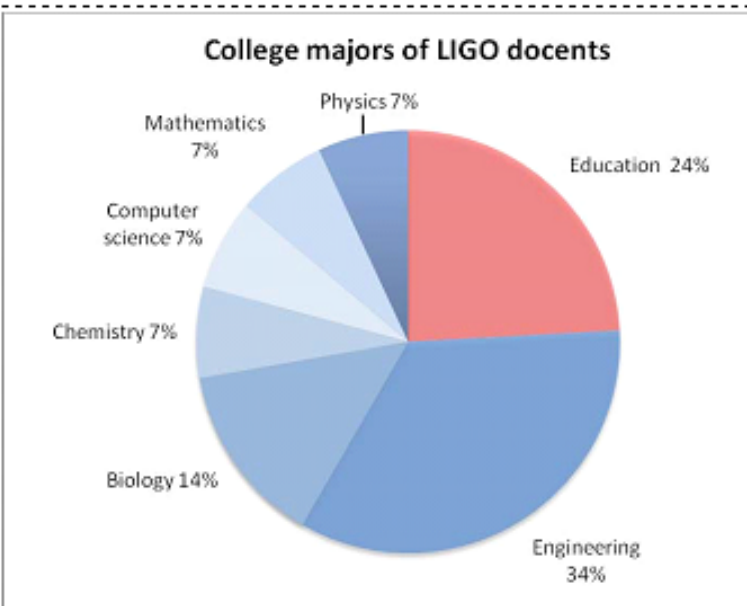


## Disciplines Represented

- Physics
- Mathematics
- Chemistry
- Biology
- Computer Science
- Education
- Mechanical Engineering
- Electrical Engineering
- Business
- Agriculture
- English

\*Southern University at Baton Rouge (SUBR), Annual Collaborative Report (Phase II, Year 5) September 30, 2014, L. Young and J. Meynsse.

# Docent Training Program: Distribution of Docent Majors\*

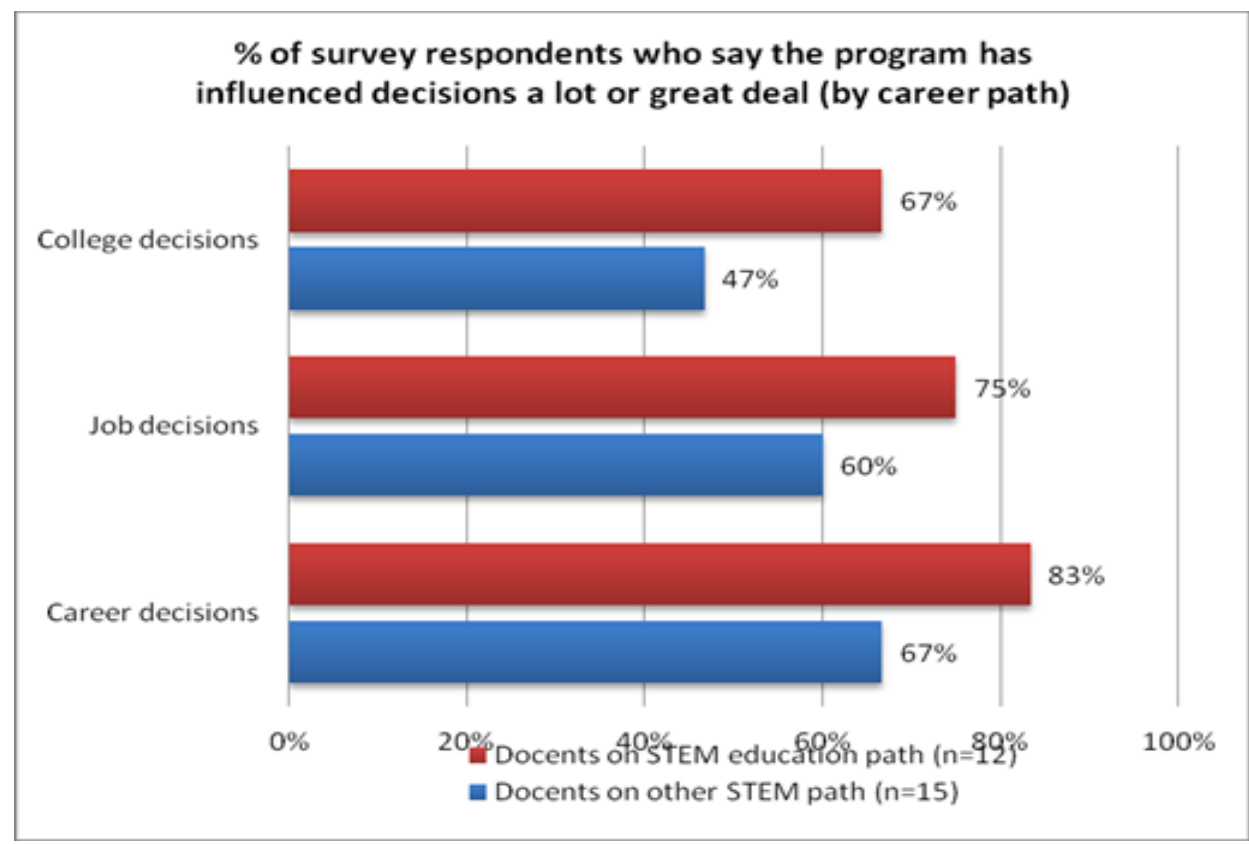


\*Southern University at Baton Rouge (SUBR), Annual Collaborative Report (Phase II, Year 5) September 30, 2014, L. Young and J. Meynsse.



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# Docent Training Program: Impacts on student career path decisions\*



\*Southern University at Baton Rouge (SUBR), Annual Collaborative Report (Phase II, Year 5) September 30, 2014, L. Young and J. Meynsse.



# Annual Docent Recognition Program

<u>Cohort 1</u>	
India Anderson	LaShunda Antoine
Deirdra Boley	Wesley Ray Edwards, Jr.
Ebba Gordon	Daniel Hart
Maude Johnson	Durrell Jones
Kevin Mason	William Parker
Quenton Richardson	Milton Smith
Penny Sterling	Calvin Tate
<u>Cohort 2</u>	
Ayokunle Adeyemi	Donnovan Betreace
Grenesha Brown	Amber Collins
Jevin Frank	T'Era Hartfield
Gerri Hull	Francesca Jones
Margaret Jones	Corey Loyd
Joshua Maxie	Meagan Pickney
Tallya Reaux	Yatora Remble
John Shu	Travis Thornton
Cory Vincent	
<u>Cohort 3</u>	
Zephra Bell	Tegra Chevalier
Mykel Delandro	Melvin Hollins
Victor McNeely	Charles Shropshire
Natishia Thanni	Tonyatta Wallace
Joseph Williams	Tyrslai Williams
<u>Cohort 4</u>	
Brandon Blunt	William Burrell
D'Nealian Butler	Jasmine Crockett
Jillian Crawley-Foster	Edward Jackson
Mary Johnson	Hernika McCoy
Jasmin Richardson	Denita Walker
Donavon Walker	



## SUBR LIGO Docent Recognition Ceremony Cohort 5

<u>Cohort 5</u>	
Mark Bryant	Corey Graham
Matthew Jones	John-Pierre Lafleur
Torrance Latham	Shira Madden
Thomas Massey	Stuart Moses
Daniel Nelson	Angelica Pierson
Aaron Thibodeaux	Micah Whitmore
Dakota Williams	

### Order of Ceremony

#### Mistress of Ceremony

*Zephra Bell, SUBR LIGO Docent, Cohort 3*

#### Welcome

*Mary Johnson, SUBR LIGO Docent, Cohort 4*

#### Remarks

*Dr. Joseph Meynsse, PI, SUBR LIGO Project  
Dr. Joe Giaime, Observatory Head, LIGO Livingston*

#### Overview of Docent Training Program

*William Parker, SUBR LIGO Docent, Cohort 1*

#### Experiences of Docents

*Hernika McCoy, SUBR LIGO Docent, Cohort 4  
Donovan Walker, SUBR LIGO Docent, Cohort 4*

#### Recognition of Docents

*Kathy Holt, Senior Science Educator, LIGO SEC  
Bobbie Remble, Project MISE Site Coordinator*

#### Remarks & Closing

*William Katzman, Program Leader, LIGO SEC  
Dr. Stephen C. McGuire, Science Content Coordinator  
Dr. Luria Young, Science Educ. Specialist, SUBR LIGO Project*

*Special thanks to Southern University Faculty and Staff,  
and LIGO SEC, LaSIP, and Exploratorium Staff*

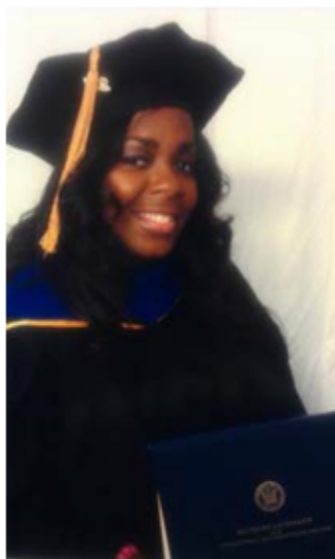
*Funded by the National Science Foundation  
PHY-0355471 and 0917543*



# Educational Research

(Examples of SMED Program graduates)

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Dr. Tonya Rose  
Summer 2011

“The Effects of Informal Science Learning on Middle School Students Science Attitudes”



Dr. Ken Ford  
Fall 2012

“Inquiry Learning: Students’ Perception of Light Wave Phenomena in an Informal Learning Environment”



Dr. Reco Knowles  
Spring 2012

“Investigating the Impact of Snacks on High School Students Science Learning and Science Self-Efficacy”



# SUBR-LIGO SEC Partnership Findings\*

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- Docent program (with SUBR) growing and becoming more integral to the work of LIGO SEC
- Teacher professional development through MISE is far reaching and increases number of regional/LA (and beyond) teachers and teacher leaders who are knowledgeable and skilled in teaching LIGO Science concepts
- Course re-design results in strengthening SUBR STEM programs and laboratory experiences – undergrad, teacher prep, and grad
- Promotes and offers a unique context to study formal and informal educational approaches grounded in “LIGO Science”

\**Inverness Research Summary Evaluation Report*, M. St. John, J. Helms, P. Castori, L. Stokes 2015.



# **Broadening Participation Going Forward**

**Phase III Funding:** \$2.5 M for 5 years ; NSF PHY-1506269

## **Goal:**

- Strengthen teacher candidate training and clinical faculty professional development focused on inquiry based teaching and learning, using exhibits and “snacks.”

## **Partners:**

- LIGO Livingston Observatory (Livingston, LA)
- SUBR's Departments of Education, Physics, Mathematics, and Science/Mathematics Education Doctoral (SMED) Program
- San Francisco Exploratorium
- Southern University at New Orleans (SUNO)
- CORE Element (Coordinator of PD in the NOLA area)
- University of Glasgow, Scotland



**For more information see.....**

## **The LSC White Paper on Education and Public Outreach (EPO)**

The LSC White Paper on Education and Public Outreach 2014-2015 - Public Document: [EPO LSC White Paper 2014-2015 Public Post-MoU-2014 v2](#)

<https://dcc.ligo.org/LIGO-T1400721/public>

**LIGO Web site:** <http://www.ligo.caltech.edu>

**LIGO Science Education Center:** <http://www.ligo-la.caltech.edu>



**Meanwhile, stay tuned ...**

*Thank You!!*