

LIGO Science Education Center (LIGO SEC II)  
External Evaluation Progress Report  
Inverness Research Inc.  
October, 2011

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I. INTRODUCTION

This annual progress report outlines work and findings of Inverness Research’s external evaluation of the LIGO Science Education Center and its partnerships. It also presents some new and ongoing challenges for the program. Our primary evaluative roles at this stage in the project are (1) to provide formative feedback to the project leadership, focusing on the reach and impacts on various audiences of the LIGO SEC programs; and (2) to serve a “critical friend” role<sup>1</sup>, monitoring project activities, talking with project participants, partners and leaders, and providing a third party, external perspective on the LIGO SEC model.

Through surveys, site visits and interviews, we have gathered multiple points of view on the work of LIGO SEC. We have surveyed teachers, talked with project leadership and staff, interviewed LIGO partners and stakeholders, and observed several student groups at two facilities – LIGO SEC and SUBR. These multiple points of view inform this report, and we think shed light on this program “model” of connecting the LIGO experiment and the LIGO Science Education Center with regional and state science education improvement efforts. These multiple points of view also raise some new and some continuing questions for us about the project.

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<sup>1</sup>A critical friend can be defined as a trusted person who asks provocative questions, provides data to be examined through another lens, and offers critiques of a person’s work as a friend. A critical friend takes the time to fully understand the context of the work presented and the outcomes that the person or group is working toward. The friend is an advocate for the success of that work. (Nuttall in Heller, 1988; Costa and Kallick, 1993)

## II. EVALUATION TASKS

Evaluation tasks during this reporting period for LIGO SEC II included:

(1) Two site visits – one site visit in March 2010 and one in April 2011 (LIGO Science Education Center, Southern University at Baton Rouge, Baton Rouge Foundation, and Board of Regents in Baton Rouge). At these site visits we interviewed project leadership and staff/representatives, and observed school and student groups in the facilities (at LIGO SEC and SUBR).

(2) Developed and administered online LIGO Teacher Participant Survey (March-April, 2011).

(3) Interviewed stakeholders - development of interview protocol and interviewed a small number of “stakeholders” (regional and statewide science education/PD leaders). PLEASE NOTE: This process is still underway due to the fact that our first few interviews did not yield the kind of information we had hoped for. The interview protocol developed was based on testing an evaluation framework for LIGO SEC based on the concept of LIGO serving as an infrastructure for the region and state (see attachment 2). After the first several interviews, we determined this framework was not resonating well enough with interviewees. Until we generate a more appropriate framework, we have postponed completing the interviews.

(4) Interviewed Dr. Lisa Szechter (twice) – Fall 2010 and during site visit in 2011.

(5) Drafted a conceptual framework for the evaluation - vetted framework using a visual representation to prompt discussions with Project leadership during spring 2011 site visit and during stakeholder interviews.

(6) Generated annual progress report

The following sections will report on key findings and highlights from the teacher survey, site visits and interviews. Based on these findings and highlights, our own perspectives from work with LIGO SEC (since its inception), and based on evaluating other cutting-edge science research centers with structured efforts to interface with and impact public education, we raise challenges and questions along the way. We look forward to talking with Project leadership about these challenges and questions.

### III. LIGO REACH AND IMPACT

#### **A. Teacher Participant Survey Results**

Surveys contribute to our understanding of the effectiveness and reach of LIGO SEC, gauge the degree of integration of its various programs, and document the ways in which and extent to which LIGO is contributing to broader improvement efforts in the region. Over the course of our evaluation of LIGO SEC II, we will target different survey audiences. This year Inverness Research surveyed teacher participants of LIGO programs. We wanted a broad sense of teachers' experiences with LIGO, their assessment of the quality and value of their experiences, their assessment of the potential of LIGO and any feedback they have.

In this section we summarize the survey process, present some key results and findings from the survey, and end with questions and challenges this data raised for us. (For the survey instrument, see Attachment A.

##### *Survey Process*

LIGO SEC and its professional development partners provided Inverness Research with contact information for 176 teacher participants from this and previous years records. These contacts represent teachers/educators who have participated in professional development through LIGO SEC and/or its partners' PD programs (MISE, Ripple, etc.), visited the LIGO SEC during a public event, and/or had taken one or more of their classes to LIGO SEC. These educators were invited by email to participate in an online survey focused on the quality and impacts of the LIGO programs with which they had participated. The survey was available to teachers for four weeks.

##### *Response Rate*

Of the 176 survey invitees, 58 responded – a 33% response rate. Not all questions were answered by all 58 respondents; 56 respondents completed the survey.

##### *Survey participants*

79% of the respondents are from public schools that are not charter, 5% are from public charter schools, and the remaining were from private or home-schooling teaching contexts, or do not teach K-12 students directly .

35% are from middle schools and 33% are high from high school. There were also a number of elementary teachers in the sample, (21%). Most teach 6<sup>th</sup> grade (36%) with 9<sup>th</sup> and 7<sup>th</sup> grades being the next most frequently grade level. Additionally, over half of the respondents teach physical science (middle or high school), about a fifth teach elementary school. No respondents teach high school earth science and 5 respondents teach middle school earth science.

Over half of the respondents indicated that they engage in leadership<sup>2</sup> at their grade levels and in their science departments. A fifth of the respondents also indicated they are leaders in their districts and/or engage in leadership in science organizations or other professional groups.

### *Geographic Reach*

100% of the survey respondents are from Louisiana coming from roughly one-quarter of the Louisiana parishes, with the majority of respondents coming from the closest parishes, St. Tammany, Tangipahoa and Livingston.

### *LIGO Engagement*

90% of survey respondents had participated in one or more LIGO SEC teacher professional development event, and they indicated a range of venues/programs through which they attended. Most attended within the last year or two

Over half of the respondents have taken their students to visit the LIGO SEC facility.

### *Students*

Respondents (N = 29) who took students to LIGO for a field trip indicated bringing over 2500 students (over half of the teachers had come to LIGO more than once). Teachers who answered a question about SES status of students reported approximately a quarter are from low SES, a fifth from medium SES, none from high SES and over half reported mixed SES. (The “n” for responses to these questions is quite low, so we are reporting these statistics just as information.)

### *Quality of the LIGO programs*

Nearly all of the respondents (92%) rated the quality of the professional development events as either good (17%) or excellent (75%). 98% of respondents indicated they would recommend LIGO SEC PD events to other teachers, and 96% indicated they would definitely be interested in attending LIGO SEC pd events in the future.

Of those that brought classes to LIGO SEC for a field trip, 96% indicated they would definitely recommend LIGO SEC field trips to other teachers. Of those that responded, ¾ indicated they used LIGO SEC supports in preparing for the field trip, and 95% indicated the quality of the field trip was good or excellent. Most prevalent deterrents to bringing classes to LIGO SEC included distance, transportation and cost, with 20% respondents indicating there are no deterrents.

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<sup>2</sup> Leadership was defined in the survey as helping select instructional materials, serving on science committees, coaching colleagues, sponsoring a student science club, etc.)

## *Contributions to Teachers Knowledge and Teaching*

Prior to attending LIGO PD or bringing their students to a field trip 42% of the respondents indicated they had very limited or limited knowledge about LIGO-related science (waves, resonance, gravity, etc.), 20% had some knowledge, and 26% indicate they had considerable or great knowledge. At the time they took the survey, 2% indicated they understood LIGO SEC concepts to a small extent, 26% felt they some degree of understanding, and 71% felt they understood LIGO-related concept to a considerable or great extent.

About half of the respondents indicated they incorporated what they learned at LIGO SEC into their classrooms and provided specific examples in their comments.

In terms of the relative importance of LIGO SEC as an influence on their teaching, 43% of respondents indicated LIGO SEC is about as important as other influences on their science teaching, and 53% indicated it is more or much more important than other influences on their science teaching.

A majority of respondents (72%) indicated they would like to learn more about how to teach LIGO science with classroom-based activities, and 65% are interested in learning more about inquiry-based teaching. 40+ percent are interested in learning more about research experiences for students and teachers, and the same for how to develop a partnership between LIGO SEC and their classroom/school. Respondent comments indicated more interest in learning more about the LIGO experiment itself.

## *Teacher Comments*

We reviewed and analyzed the teachers' comments from the survey. Following are some points and perspectives that emerged for us.

Teachers are most interested in support with implementing lessons addressing LIGO science in their classrooms, and learning how to implement inquiry science teaching. Many teachers have attempted to incorporate what they learned at a LIGO SEC professional development in their classroom teaching. Examples include:

*I use the information about the LIGO exhibits as examples of waves and the purpose of science inquiry that scientist are using everyday (like LIGO) that may seem un-important to most but is an important step to new discoveries.*

*The sound waves, using the same bottles of different amounts, the laser, the Guitar o-Scope, the Laser light effects, standing waves, slinky, and liquid Nitrogen experiment*

*I was able to construct a wave generator that I have used in my classroom as a demonstration to help students with their understanding of waves.*

*Einstein's Messenger is our introduction to the concepts in this unit. We also have some models that we built in a workshop we can use that are similar to the equipment at LIGO.*

*I used the resonance activity "Palm Pipes" to show the relationship between waves and length of pvc pipe. My algebra class graphed this equation and used two points to show the exponential equation in the form of  $Y=AB^x$ .*

Respondents rated professional development experiences very highly in quality, usefulness, and contribution to their teaching. Sample comments include:

*I got to see experiments and models that I could do with my future students that are both inexpensive and easy. I really enjoyed the professional development because it opened my eyes to how interesting and fun it was to learn about the topics and participate in the demonstration hall as a teacher, and how rewarding it could be for my students.*

*This is the only training I've ever attended that was focused completely on my subject matter. There was not a whole lot of educational theory. There was 'hard' science instruction and learning.*

*The professionals that assist at LIGO help teachers understand the concepts they introduce in such a way that grabs one's attention and develops true understanding*

#### *Our Interpretation of the Survey Results: Key Ideas and Questions*

Following are ideas and questions we noted as we analyzed the teacher survey data. They raise both positive and challenging questions in our minds.

- The LIGO PD program is clearly highly regarded among its participants. In addition to high quality experiences and usefulness of the materials, teachers also reported strong learning gains in LIGO-related science concepts (waves, resonance, gravity). The success to date of LIGO professional development and the positive responses of teachers suggests that efforts should be made to expand the program's reach across the region and state and provide advanced or deeper leadership opportunities for teachers who have participated previously.
- Teachers each had a different way of incorporating LIGO activities in their classrooms. The program and teachers could benefit from some kind of process that enables them to share what they are doing with one another and the LIGO SEC staff (for example, teachers could more effectively share their lesson ideas through a website or listserv). Helping teachers incorporate LIGO science activities and incorporating more inquiry experiences could be an area of need that LIGO SEC is well-positioned to make a contribution.
- Respondents rated field trips and field trip support quite favorably. However, they also noted that there are significant barriers to coming to LIGO SEC for a field trip (notably distance and cost). We are also aware that there are limits to the number

of visits that can be made to the site, due to the sensitivity of the instrument, as well as staff and facility capacity. Developing the outreach programs – that is, programs that LIGO staff and scientists take out to schools – could help mitigate some of these limitations. This way, students who cannot come to LIGO can at least experience some of the kinds of activities available on a field trip. There may also be opportunities here for online or other multimedia approaches to the LIGO SEC experience.

Overall ratings and comments about the quality and value of LIGO SEC, and its role as a regional resource for science teaching while quite positive, are not outstanding. This suggests that there is room for improvement and imagining additional ways to reach and work with teachers and students across the region and state.

### **B. A regional and statewide support for science education improvement**

The two LIGO site visits we made during 2010 and 2011 followed a similar agenda. William Katzman carefully responded to calendars and travel schedules, our purposes for the site visits, and collaborated with his staff and partners to organize a filled agenda with opportunities to talk one-on-one and in small groups with many key players, as well as observe a few school groups.

We had opportunities to talk in some depth with project leadership and staff from LIGO SEC and Southern University. We also made a visit to BRAF and met with the program officer there in 2010, and had an opportunity to hold a structured interview with two representatives from the Board of Regents in Baton Rouge in 2011. These site visits served to (a) get us up to speed on the goals and work for the second phase of LIGO SEC funding, (b) meet new partners and staff at the Center and partnering institutions, (c) inform our own thinking about the conceptual framework for our evaluation, (d) prompt our thinking and ideas about the model of LIGO SEC as a world-class science research center attempting to serve the region and state as a resource for science education improvement.

We summarize below our observations and impressions from the site visits to LIGO SEC and Southern University at Baton Rouge (SUBR).

### *Southern University at Baton Rouge (SUBR)*

From these site visits we observed a growing place and independence of Southern University's efforts to deepen and institutionalize LIGO approaches within their own programming. Existing in a classroom space within the College of Education, and staffed by a doctoral student in science education, Southern University now has a flow of campus classes and community groups who take advantage of the smaller, "satellite" version of the LIGO SEC exhibit hall. The facility serves a range of purposes. From demonstrating mathematical and statistical concepts for campus math and physics courses, to modeling lessons about wave structures and functions for pre-service and inservice teachers (Projects MISE), to illuminating concepts about light for a local church pastor, this on-campus facility is a strong example of how the LIGO SEC experience and approach can take root and have educational impacts at satellite sites. Southern is also supporting additional graduate students who are using the LIGO program as a venue for their science education research. Southern University is dedicated to the LIGO model and takes their own initiative to drive (literally<sup>3</sup> and figuratively) the program on their campus.

SUBR also continues to host a docent training program which prepares SUBR students to serve as docents at the LIGO SEC facility for school groups and Saturday events. Up to 80 students have participated in this program. Over the course of 10 training sessions, docents learn about the LIGO experiment, how to facilitate learning at the LIGO SEC exhibits, and how to interact with the public and school groups.

In addition, SUBR has sent 20 docents to the NSTA conference and 7 to the NCTM conference. Several of them are now considering teaching as a career – 30 are now or have been Noyce Scholars.

On site visits in prior years we have interviewed docents and reported on our findings elsewhere to LIGO SEC. While it may have had a slow start, the docent program is now in full swing and a very efficient and effective program. It is, we believe, a shining example of leveraging partner assets to the benefit of the program.

Project MISE, the professional development program funded in part through Louisiana Board of Regents funds, and administered in partnership between LIGO SEC and SUBR, has to date served over 180 teachers. They report that there are more applicants than they can accommodate. In an effort to create community among all past and present MISE participants, SUBR and LIGO SEC cohost an annual "share-a-thon" where teachers share their ideas for teaching LIGO science concepts and are presented with new ideas from LIGO and SUBR.

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<sup>3</sup> Because of commuting and travel challenges of the SUBR docents to LIGO SEC, Southern secured funds to purchase a van for that specific purpose, thus eliminating the transportation challenges and stresses experienced by their students.



## *LIGO SEC*

At LIGO SEC we observed, on the part of the staff, a sense of confidence in the LIGO SEC leadership, a willingness to begin forging new alliances (e.g. the grant with the public television company), and the intention to remain focused, realistic, but open to new and different ways of offering services and supports that are uniquely LIGO. We learned that William Katzman is now part of the Education and Public Outreach group – along with three other LIGO Livingston scientists - that has self-assembled from the LSC (LIGO Scientific Collaboration). We anticipate that there will be both creative contributions and creative gains related to approaches, resources and methods for bringing LIGO science to public audiences from this working group.

We also learned that the longitudinal studies associated with the second phase of LIGO SEC are underway. One arm of this effort involves following students over time at a school district, and the other arm supports teachers over time at another school district. Our plans for the coming year or two includes interviewing teachers from both of these longitudinal study efforts, and observing actual classrooms where LIGO Science is being taught.

A significant challenge faced by LIGO SEC now has to do with capacity building - their own, their partners' and the classroom teachers with whom they work. Curriculum has been developed<sup>4</sup>, programs that target undergraduate education, teacher preservice and inservice, and the public have been developed and tested. Given the limits of the facility itself – including the parameters for the disturbances that can interfere with the LIGO experiment if there is too much activity in the vicinity, and the constant limits of resources and staffing – we think the time is ripe for LIGO SEC to carefully consider how to more strategically use its time, space, and resources to build the capacity it has to impact LA science education, and broaden its reach. Unless there is an explicit investment in new approaches and ideas to build capacity, the LIGO SEC may be inclined to continue doing what it has learned how to do well, but not grow or expand its reach and impact, or investigate the unique niche it can play in the development of new pedagogies related to abstract, emergent sciences.

An acknowledged priority, LIGO could invest more time and energy into proposal writing to leverage its track record for high quality professional development, curriculum, and effective partnerships. Teacher surveys indicated an interest in learning how to partner (schools/districts) with LIGO; stakeholders who have known LIGO for some years can still imagine the original vision of LIGO being a robust bridge between informal and formal education, building through LA universities and colleges viable ways to train new teachers, experienced teachers, and perhaps even new scientists.

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<sup>4</sup> We were very impressed with volume of curriculum work the MISE and Ripple projects have produced for their participants; curriculum that is grounded in the LIGO SEC materials and approaches.

Another area of potential growth not fully realized is to systematically and intentionally tap into and build the teacher leadership potential that exists within existing LIGO participants.

#### *Plans for future site visits*

Our plans for future LIGO site visits include observing LIGO-related programs at the other partnering university (LA Tech) to learn how those sites may be following suit or modifying the LIGO model to serve their own campus and community purposes. We think visiting other sites will be important to study questions stakeholders have about the depth, breadth and growth of partnerships, reach and impact across the state. We would also like to observe a professional development session during the year that Bobbie Remble facilitates at Southern University or at a local school site. We think seeing LIGO translated in other kinds of settings will broaden our own perspectives on the “model,” its reach and impact, and will inform the project leadership.

### **C. A program with significant potential to lead/contribute to the development of pedagogies that bridge emergent science and engineering research with K-12 education through informal means**

LIGO SEC has an emerging track record with local and regional educators who know of the program, and who use what they learn and gain to improve their science teaching (primarily physical sciences), train pre-service, inservice and undergraduate students interested in science education/teaching. LIGO SEC also has an acknowledged niche within the statewide infrastructure for science education, as described, portrayed and included in state department and board of regents visioning, funding and publications.

However, Inverness has identified what we consider to be an extremely challenging, significant, and not yet realized opportunity for creating a science education center with parallel “cutting edge” approaches and pedagogies for educating public audiences about emergent sciences. Part of our perspective about this comes out of current work with other efforts to house a facility for improving science education at a site where cutting edge research is occurring<sup>5</sup>. Given the remarkable science and engineering endeavors at LIGO SEC, we consistently wonder, to what extent and in what ways does LIGO SEC actually tap into the experiment itself? Not just in terms of the science concepts related to and knowledge generated by the experiment, but in terms of the scientific “habits of mind<sup>6</sup>” associated with the onsite experiment itself and the motivation, inspiration and creative processes that drives the science and the scientists. Though hands-on inquiry approaches to teaching science are central to this kind of education, we have a sense there is something unique and important that LIGO SEC could contribute. NICE!

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<sup>5</sup> Inverness Research is currently working with the Homestake experiment in Montana, and has worked over time with NIH SEPA projects, and NSF STC Centers’ education and outreach efforts.

<sup>6</sup> AAAS Benchmarks for Scientific Literacy – Project 206, Chapter 12  
<http://www.project2061.org/publications/bsl/online/index.php?chapter=12>

Though the exhibit hall is brimming with rich, engaging Exploratorium-like exhibits that demonstrate physical science concepts (we counted some 44 exhibits), is the program seriously interested in teaching more about the actual experiment going on in at the facility? How do you make the science, engineering more accessible? We noticed one exhibit in the far corner about the experiment, but think that more explicit reference to how the curriculum, activities and exhibits relate to the experiment going on there is needed.

Also, where is the design and engineering aspect that relates to the LIGO II experiment in the programs? With LIGO II getting underway, and so much of the facility devoted to engineering, design, development, construction and the like, and with teachers indicating an interest in learning more about “inquiry” we think that the time is ripe to consider creative ways to highlight the amazing engineering feat happening there.

Finally, with respect to LIGO SEC’s work with teachers, how can the capacities of teachers who participate in professional development be built, tapped or amplified within their schools and communities to amplify the LIGO SEC effect?

Through its development of curriculum at LIGO SEC, MISE and Ripple we see significant potential for more extensive online, web-based supports and resources for teachers. A virtual LIGO experience has been part of the vision for LIGO from the beginning. What are some ways LIGO SEC could begin building a more robust and interactive web-based presence?

#### IV. SUMMARY

Individuals and institutions with whom LIGO SEC has worked have had positive and educative experiences. Curriculum, professional development and knowledgeable, welcoming program leadership and supports are all ranked very high. This is a strong foundation on which to build.

LIGO SEC has an education track record and is well-positioned to broaden its own impact and contributions. Building LIGO SEC’s own capacity for providing high quality professional development has become an expectation of the community. Building LIGO Livingston’s ability to design new pedagogies that bridge emergent and theoretical science and engineering research with public education offers much promise, and we think the facility and expertise is well-positioned to do so. This will take creative thinking and planning, resources and supports.

Because of its experience, and its role as a critical friend to the project, Inverness Research believes it can support and help catalyze the thinking and planning toward these ends. We look forward to talking with you soon about this report, supporting the visioning and planning process for amplifying the good work you have established and begun to do, and to the work ahead these next three years.