

**Memorandum of Understanding (LIGO-M050310-00-M)**  
**between the**  
**Department of Physics of Southern University and A&M College**  
**Baton Rouge, LA Campus (SUBR)**  
**and the**  
**Laser Interferometer Gravitational Wave Observatory (LIGO)**  
**August 15, 2005**

The purpose of this Memorandum of Understanding (MOU) is to establish and define a collaborative relationship between the Department of Physics of Southern University and A&M College Group (SUBR) and the Laser Interferometer Gravitational-Wave Observatory (LIGO). Both parties to this agreement share the broad goals of developing the instruments and techniques for detecting and studying gravitational waves, and subsequently using them as an astrophysical probe. Under this MOU, the SUBR Physics Group will be a member group of the LIGO Scientific Collaboration.

1. The Department of Physics of Southern University and A&M College Group (SUBR) consists of Professor Stephen C. McGuire, who will serve as Principal Investigator for research in LIGO, and additional physics faculty members Edward E. Doomes, Assistant Professor, Mr. Rutherford McNair, Instructor, and Mrs. Ineatha Ruffin, Instructor. The focus of the research done by the SUBR Physics Group under this agreement will be the characterization of the chemical content and structure of LIGO test mass multilayer mirror coatings and substrates. The goal is to help understand potential sources of 1064 nm absorption in the coatings and substrates. An additional area of work is the emphasis of classical LIGO science concepts in our introductory physics courses through the use of exhibit-based inquiry.
2. LIGO comprises two parts: the LIGO Laboratory and the LIGO Scientific Collaboration. These two entities report to the LIGO Directorate, consisting of the LIGO Director, the LIGO Scientific Collaboration Spokesperson, and the LIGO Laboratory Deputy Director. The design and construction of the LIGO Observatories were carried out by California Institute of Technology (Caltech) and the Massachusetts Institute of Technology (MIT) under a Cooperative Agreement between the National Science Foundation (NSF) and Caltech. The LIGO Oversight Committee supervises the realization of LIGO.

A. The LIGO Laboratory is responsible for the operation of the LIGO

Observatories, the development and implementation of future detector systems, and participates in all aspects of the research with the LIGO detectors. LIGO is a system of three interferometric Fabry-Perot antennas, two of them 4 kilometers long and the third one 2 kilometers long, aimed at the simultaneous detection of gravitational waves in the frequency range 40-6000 Hz. LIGO Observatories are located in Hanford, Washington and in Livingston Parish, Louisiana (USA) and began observations in the year 2002. The LIGO Laboratory is funded through a Cooperative Agreement between the National Science Foundation and Caltech, with the portion of the LIGO Laboratory at MIT funded through a subcontract from Caltech.

- B. The LIGO Scientific Collaboration (LSC) is organized as a separate entity from the LIGO Laboratory. It includes scientists from the LIGO Laboratory, and those from collaborating institutions, and has its own governance and leadership (which includes the LSC Spokesperson as a member of the LIGO Directorate). The Collaboration ensures equal scientific opportunity for individual participants and institutions. It organizes the research, publications, and all other scientific activities. The Collaboration reports to the LIGO Directorate for final approval of its research program, technical work, observational physics publications, and talks announcing new observations and physics results. This will be done through regular reports to the Directorate and its Program Advisory Committee. The organization of the LSC and its governance are defined in its Charter.
3. As a member group of the LSC, the SUBR Physics Group will participate in the governance of the LSC and in setting its policies and procedures, as defined in the LSC charter. Similarly, it agrees to abide by the policies and procedures adopted by the LSC and posted on its website (<http://www.ligo.org/policies.html>), concerning publication, data access, software standards, and so on.
  4. Membership in more than one collaboration active in the same area of research may present complications. Members of the LSC contemplating joining other gravitational wave collaborations or participating in data analysis efforts with collaborations outside a framework established by the LSC should inform and consult with LSC and the LIGO Laboratory to ensure that no conflicts of interest exist.
  5. The LSC is the primary advocate of interferometric gravitational wave research in the U.S. To function effectively in this role, it needs to be informed in advance about major new initiatives. The SUBR Physics Group agrees to inform the LSC of any major new proposals related to LIGO to be submitted to the NSF, and to consult with the LSC concerning the best approach to support the overall LIGO program. The final decision about the scope of any such proposal shall remain the prerogative of the SUBR Physics Group.
  6. LSC Service Functions - Participation in the LSC brings with it responsibility for service functions to support the overall effort in achieving high detector sensitivity

and high data quality. In particular, each LSC group is expected to assist in the staffing of scientific monitoring shifts during organized data runs. The staffing of these shifts is notable for both its importance and the travel burden it places on scientists. This burden makes an equitable shift allocation mechanism necessary.

A nominal guideline is that each LSC group should staff a fraction of the shifts comparable to its FTE fraction devoted to LSC activities. Stephen C. McGuire (SUBR Physics Group) will be responsible for interaction with the designated LSC Shift Organizer with respect to the ABC Group's Service Function commitments.

Groups making extensive contributions to the LSC in other service efforts that involve a substantial travel burden may request a reduction in their nominal share of shift staffing. Those efforts can include:

- Commissioning and instrument improvement
  - Participation in on-site detector characterization investigations
  - Development/operation of analysis software/hardware infrastructure and validation of analysis software that requires travel away from the home institution.
7. Each party to this agreement continues to be responsible for all support of its staff including travel costs associated with the activities under this agreement. Exceptional support of travel by the other institution may be allowed for travel requested by that institution.
  8. Attachments to this MOU will be prepared annually to define the specific activities and responsibilities of the SUBR Physics Group and to define any resources to be provided by the LIGO Laboratory to the SUBR Physics Group in support of those activities.
  9. The SUBR Physics Group will provide an annual status report on its activities in support of LIGO. The report will consist of a summary status on research by topic as indicated in the Attachments for that period including progress against the milestones if any, significant accomplishments such as new insights/discoveries or publications, issues of concern if any, and an indication of invested time by each member of the group. The report will be due one month before the close of the period of performance under the Attachments in question.
  10. The LSC will review the progress report against the Attachments from the previous year and assess the Attachments for the up-coming year annually, under its established procedure, and recommend acceptance or rejection of each Attachment by the LIGO Director and the LSC Spokesperson.
  11. A list of SUBR Physics Group members will be updated at least every **six months**. The SUBR Physics Group members and appropriate contact information will be provided in electronic form as Attachment Z to this Memorandum of Understanding. In cases where individuals who leave the group have had access to LIGO data and this access should be terminated, the SUBR Physics Group Principal Investigator is

responsible for timely notification to the Directorate and to the computing committee so access may be revoked.

12. The LIGO Laboratory is responsible for obtaining NSF approval of collaborative Memoranda of Understanding where required. All Memoranda of Understanding will be provided to NSF for their information.
13. The rights to intellectual property developed under this Attachment using LIGO Laboratory resources will be subject to the National Science Foundation Grant Policy as indicated in Section 730, Intellectual Property.
  - A. In the event a patentable invention is conceived or first actually reduced to practice during the work of a member(s) of the SUBR Physics Group at LIGO Laboratory facilities, he/she will:
    - i) make prompt disclosure of the invention to the Director of the LIGO Laboratory; and
    - ii) cooperate with LIGO Laboratory and supply all information and execute all papers including invention reports, records of invention, patent applications and powers of attorney, necessary and proper to fulfill the obligations of the LIGO Laboratory to the U.S. Government sponsor.
  - B. The ownership of inventions conceived solely by members of the SUBR Physics Group at LIGO facilities shall be owned by the Southern University and A&M College, although the LIGO Laboratory shall be granted a license to use such invention for noncommercial research purposes at LIGO facilities. Inventions that are conceived by both members of the SUBR Physics Group and LIGO Laboratory staff as part of the LIGO project shall be jointly owned and any income from commercial licensing shall be shared in proportion to the number of joint inventors from each institution.

In all other regards, the rights to intellectual property developed by members of the SUBR Physics Group under this Attachment will be in accordance with the policies of Southern University and A&M College.

14. This MOU supersedes the previous MOU between the LIGO Laboratory and the SUBR Physics group (LIGO-M000300-00-M) and its amendments and attachments. This MOU will remain in force until the parties mutually agree to terminate it, or until it is terminated in accordance with LSC procedures.

Approved:

---

Barry Barish  
LIGO Director

---

Stephen C. McGuire  
Principal Investigator  
SUBR Physics Group

---

Peter Saulson  
LSC Spokesperson

**Attachment OPT to the**  
**Memorandum of Understanding (LIGO-M050310-00-M)**  
**between the**  
**Department of Physics of Southern University and A&M College**  
**Baton Rouge, LA Campus (SUBR)**  
**and the**  
**Laser Interferometer Gravitational Wave Observatory (LIGO)**  
**August 15, 2005**

This Attachment OPT to the Memorandum of Understanding LIGO-M050310-00-M defines the role of the Department of Physics of Southern University and A&M College Group (SUBR) as a Member of the LIGO Scientific Collaboration (LSC) and a member of the Optics Development Group (ODG). The period of performance for the activities in this Attachment is from August 15, 2005 to August 15, 2006.

1. Optics Development Group – The Optics Development Group (ODG) is the scientific collaboration for defining and developing improvements in optics for use in advanced subsystems for the initial LIGO interferometers or in entirely new advanced interferometers. MOU Attachments define the roles and responsibilities of groups in this development group.
2. During the period August 15, 2005 to August 15, 2006, the members of SUBR Physics Group will participate in ODG in the following areas:

*Test mass multilayer coatings characterization:* The SUBR Physics Group will investigate the chemical and micro structural characteristics of test mass multilayer coatings under consideration for use in advanced versions of the interferometer. The goal of this work is to help identify and understand potential sources of 1064 nm absorption in the coatings. In pursuing this goal we will take advantage of synchrotron radiation probes and data analysis systems available at the Center for Advanced Microstructures and Devices (CAMD) in Baton Rouge, LA. Appropriate experiment proposals for beam time will be submitted for evaluation by CAMD. Experiments will be designed and carried out by SUBR Physics Group personnel in collaboration with Dr. Roland Tittsworth, senior CAMD scientist at the Double Crystal Monochromator (DCM) Beamline. Initial studies will focus on the determination of the titania ( $\text{TiO}_2$ ) content within the Tantalum ( $\text{Ta}_2\text{O}_5$ ) layers of coatings recently provided to SUBR by Caltech. Techniques to be employed include (1) X-ray fluorescence (XRF) for chemical content determination, and (2) X-ray absorption near edge spectroscopy (XANES) for information on atomic valence state, three-dimensional geometry and coordination environment of the element under investigation, and (3) Extended X-ray absorption fluorescence spectroscopy (EXAFS) for information on coordination environment and nearest neighbor atom environment.

3. Resource Sharing: The LIGO Laboratory will contribute resources including allocation of appropriate scientific and engineering personnel, research facilities and funding in support of the effort in Item No. 2, as indicated below.
  - a) Research accommodations for the SUBR Physics group members while on LIGO research assignment at any LIGO Laboratory site,
  - b) Access to LIGO data through established LSC channels in support of this work.
  - c) Office and laboratory space previously made available at LLO for the LIGO-SUBR Advanced Optical Materials Laboratory and will be used in support of the activities described in item 2.
  
4. Coordination and Reporting – SUBR Physics Group will perform this research within the structures established by the LIGO Laboratory and the LSC where appropriate. In particular activities described in Item 2 will be carried out within the Optics Development Working Group of the LSC. Coordination will include keeping the Group leaders informed of activities and plans, reporting to the group at meetings and telecons, and through technical documents submitted to the LIGO Document Control Center.

In addition, an annual report will be submitted with the update to this Attachment, giving a summary status on research by topic as indicated in Item No. 2, including progress against the milestones if any, significant accomplishments such as new insights/discoveries or publications, issues of concern if any, and an indication of invested time. This Attachment will be updated at least annually with a plan of activities for the succeeding on-year period. These documents will be due one month before the close of the period of performance under this Attachment.

Approved:

---

Barry Barish  
LIGO Laboratory Director

---

Stephen C. McGuire  
Principal Investigator  
SUBR Physics Group

---

Peter Saulson  
LSC Spokesperson

---

David Reitze  
ODG Leader

**Attachment OUT to the**  
**Memorandum of Understanding (LIGO-M050300-00-M)**  
**between the**  
**Department of Physics of Southern University and A&M College**  
**Baton Rouge, LA Campus (SUBR)**  
**and the**  
**Laser Interferometer Gravitational Wave Observatory (LIGO)**  
**August 15, 2005**

This Attachment OUT to the Memorandum of Understanding LIGO-M050300-00-M defines the role of the Department of Physics of Southern University and A&M College Group (SUBR) as a Member of the LIGO Scientific Collaboration (LSC) in support of Education and Outreach to the broader community. The period of performance for the activities in this Attachment is from August 15, 2005 to August 15, 2006.

1. Education and Outreach – As a frontier physics effort, LIGO offers a unique opportunity to inspire interest in science among students and to educate the broader community. The LIGO Laboratory supports a broad program of education and outreach to take advantage of these opportunities. Activities to attract and educate visitors take place at both Observatories, as well as the development of educational materials for use there and elsewhere. The LIGO Laboratory is building a Science Education Center at the Livingston Observatory, and is participating with local partners to make it a vehicle for science education throughout the region. LSC groups are invited to participate in these activities, and to suggest others, with the goal of leveraging activities to make a greater impact. MOU Attachments define the roles and responsibilities of groups participating in these activities.
2. During the period August 15, 2005 to August 15, 2006, the members of the SUBR Physics Group will participate in Education and Outreach in the following areas:
  - a) *K-12 Educational Activities* – The SUBR Physics Group will participate in professional development workshops aimed at PK-12 teachers at various times throughout the above period. These workshops include, but are not limited to ten, (10) planned weekend workshops to be carried out as part of the , “Modeling Inquiry Science Education (MISE)” project at SUBR. Extensive use will be made of the LIGO Exploratorium exhibits housed at SUBR and LLO in this effort.
  - b) *Educational Material Development* – The SUBR Physics Group will conduct introductory physics course redesign activities leading to changes in course content, improved syllabi, and newly developed educational materials during the academic year.
3. Resource Sharing: The LIGO Laboratory will contribute resources including allocation of appropriate scientific and engineering personnel, research facilities and funding in support of

the effort in Item No. 2, as indicated below.

- a) Research accommodations for SUBR Physics group members while on LIGO assignment at any LIGO Laboratory site,
  - b) Access to LIGO data through established LSC channels in support of this work.
  - c) Access to the interactive exhibits and workshop space housed at the LIGO Livingston site.
4. Coordination and Reporting – The Department of Physics of Southern University and A&M College Group (SUBR) will perform this research within the structures established by the LIGO Laboratory and the LSC where appropriate. In particular activities described in Item 2 will be carried out in coordination with the LIGO Observatories Education and Outreach Leaders. Coordination will include keeping these leaders informed of activities and plans, reporting to them at meetings and telecons, and through technical documents submitted to the LIGO Document Control Center.

In addition, an annual report will be submitted with the update to this Attachment, giving a summary status on research by topic as indicated in Item No. 2, including progress against the milestones if any, significant accomplishments such as new insights/discoveries or publications, issues of concern if any, and an indication of invested time. This Attachment will be updated at least annually with a plan of activities for the succeeding on-year period. These documents will be due one month before the close of the period of performance under this Attachment.

Approved:

---

Barry Barish  
LIGO Laboratory Director

---

Stephen C. McGuire  
SUBR Physics Group Principal Investigator

---

Peter Saulson  
LSC Spokesperson

---

John Thacker  
LLO Education and Outreach Leader

**Attachment Number Z to the**  
**Memorandum of Understanding (M050310-00-M)**  
**between the**  
**Department of Physics of Southern University and A&M College**  
**Baton Rouge, LA Campus (SUBR)**  
**and the**  
**Laser Interferometer Gravitational Wave Observatory (LIGO) Laboratory**  
**August 15, 2005**

This Attachment to the Memorandum of Understanding LIGO-M050300-00-M lists the coordinates of the members of the Department of Physics of Southern University and A&M College (SUBR) who will participate in the LIGO Scientific Collaboration (LSC). The period of performance for activities in this Attachment is from August 15, 2005 to August 15, 2006. This period may be modified by agreement to a revision of this Attachment.

<b>Name</b>	<b>Address</b>	<b>E-Mail</b>	<b>Phone Nos.</b>	<b>Begin Date</b>	<b>End Date</b>
McGuire, Stephen C. Previous FTE: 100% Next Year FTE: 100 % <b>Authorship</b> Professor & Chair	Dept. of Physics Southern University P. O. Box 10445 Baton Rouge, LA 70813	smcguire1@ cox.net	225-771-4396	Aug. 15, 2005	Aug. 15, 2006
Doomes, Edward E. Previous FTE: 0% Next Year FTE: 100 % <b>Authorship</b> Assistant Professor	Dept. of Physics Southern University P. O. Box 10445 Baton Rouge, LA 70813	edoomes@gmail.com	225-771-3140	Aug. 15, 2005	Aug. 15, 2006
Rutherford B. McNair Previous FTE: 0% Next Year FTE: 15% <b>No Authorship</b> Instructor	Dept. of Physics Southern University P. O. Box 10445 Baton Rouge, LA 70813	rmcnair@ebrpss. k12.la.us	225-771-3140	Aug. 15, 2005	Aug. 15, 2006

Ineatha Ruffin Previous FTE: 0% Next Year FTE: 15% <b>No Authorship</b> Instructor	Dept. of Physics Southern University P. O. Box 10445 Baton Rouge, LA 70813	neatr1@cox.net	225-771-3140	Aug. 15, 2005	Aug. 15, 2006
--	---	----------------	--------------	---------------	---------------

Scientific Collaboration Council Delegate: **Stephen C. McGuire**

Approved:

---

Barry Barish  
LIGO Laboratory Director

---

Stephen C. McGuire  
SUBR Principal Investigator

---

Peter Saulson  
LSC Spokesperson