



**Attachment OPS to the
Memorandum of Understanding LIGO-M050315-00
between the Hobart & William Smith Colleges LIGO Group (HWSLG)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
For The Period
August 15, 2008 - August 14, 2009**

This Attachment OPS to the Memorandum of Understanding LIGO-M050315-00 defines the role of the Hobart & William Smith Colleges LIGO Group (HWSLG) as a Member of the LIGO Scientific Collaboration (LSC) in the areas of detector commissioning, detector characterization, and operations support in the initial LIGO interferometers. The period of performance for the activities in this Attachment is from August 15, 2008 - August 14, 2009.

1. Collaboration

Together, the LIGO Laboratory and the LIGO Scientific Collaboration (LSC) are responsible for implementing and exploiting the initial LIGO detector through its science data runs. LSC groups are encouraged to contribute to the commissioning, characterization, and operation of the LIGO detectors, as members of working groups established by the LIGO Laboratory and the LSC.

2. Participation

During the period August 15, 2008 - August 14, 2009, the members of HWSLG will participate in the initial LIGO detector research program in the following areas:

a. Detector Commissioning

Not Applicable

b. Detector Characterization

The PI will maintain the code archive for the bicoherence monitors and will advise any LSC member who wishes to further develop these monitors. After the Enhanced LIGO Suspension Thermal Noise experiments have been completed, the PI may have the opportunity to update and develop these monitors. The coating and substrate thermal noise experiments will remain my research of greatest priority, but I would like to begin performing some detector characterization work once more.

c. Detector Operations

The PI is pleased to continue to serve his share of science monitor shifts and any other proportioned obligations necessary to keep the detectors operating well during the upgrade and operation of Enhanced LIGO.

d. Other Contributions

Not Applicable

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 HWSLG group members while on LIGO research assignment at any LIGO Laboratory site.

Not Applicable

- b. Access to LIGO data through established LSC channels in support of this work.

The PI will need access to online and stored LIGO data in order to test the bicoherence monitors and to monitor for up-conversion noise,

4. Coordination and Reporting

HWSLG will perform research within the structures established by the LIGO Laboratory and the LSC where appropriate.

In particular, with reference to activities described above:

2a will be carried out in coordination with the LIGO Laboratory Commissioning Leader.

2b will be carried out within the Detector Characterization Working Group of the LSC.

2c will be carried out in coordination with the LHO or LLO Site Head.

This includes 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.

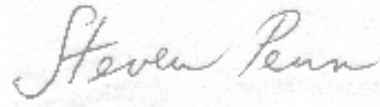
This Attachment will be updated at least annually with a plan of activities for the succeeding one-year period. These documents will be due one month before the close of the period of performance under this Attachment.

5. Computer Code

All computer code delivered to the LSC under this Attachment must be developed in consultation with the LSC Data Analysis Software Working Group (DASWG) and archived, documented and reviewed as determined by that group.

Signature Pending Approval

Jay Marx
LIGO Laboratory Director



Steven Penn
Principal Investigator(s)
HWSLG



David Reitze
LSC Spokesperson



**Attachment OPT to the
Memorandum of Understanding LIGO-M050315-00
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For The Period
August 15, 2008 - August 14, 2009**

This Attachment OPT to the Memorandum of Understanding LIGO-M050315-00 defines the role of the Hobart & William Smith Colleges LIGO Group (HWSLG) as a Member of the LIGO Scientific Collaboration (LSC), and a member of the Optics Development Group (LDG). The period of performance for the activities in this Attachment is from August 15, 2008 - August 14, 2009.

1. Collaboration

The Optics Development Group (ODG) is the scientific collaboration for defining and developing instruments in optics for use in advanced subsystems for the initial LIGO interferometers, or in entirely new advanced interferometers.

MOU Attachment OPT defines the roles and responsibilities of groups in this development group.

2. Participation

During the period August 15, 2008 - August 14, 2009, the members of HWSLG will participate in ODG in the following areas:

a. Optics Characterization

Fused Silica Mechanical Loss in the Low Frequency, Large V/S Regime

The repaired large cantilever sample is expected to be received from Heraeus by October. The PI will measure the loss in this sample and will prepare a paper on the results. This experiment provides a direct measurement of the anticipated mechanical loss for the Advanced LIGO test mass substrates. It also is a significant test of our model for the loss in fused silica.

The PI will measure the mechanical loss in 6 mm diameter fibers of Corning 7980. This measurement provides a direct comparison with the very high Q samples measured in Heraeus Suprasil. This experiment should indicate if the choice of Corning 7980 for the end test masses is acceptable.

Optimized Annealing for Advanced LIGO Test Masses

We will make repairs on the vacuum annealing oven, which is required for the larger samples in this experiment. We will begin measurements of these annealing samples when the machining of the suspension system has been completed. Given the academic timetable, those measurements should begin in late August.

b. Other Contributions

Not Applicable

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 HWSLG group members while on LIGO research assignment at any LIGO Laboratory site.

Not Applicable

b. Access to LIGO data through established LSC channels in support of this work.

Not Applicable

4. Coordination and Reporting

HWSLG will perform 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.

This includes 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.

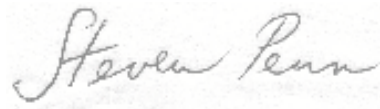
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5. Computer Code

All computer code delivered to the LSC under this Attachment must be developed in consultation with the LSC Data Analysis Software Working Group (DASWG) and archived, documented and reviewed as determined by that group.

Signature Pending Approval

Jay Marx
LIGO Laboratory Director



Steven Penn
Principal Investigator(s)
HWSLG



David Reitze
LSC Spokesperson



**Attachment OUT to the
Memorandum of Understanding LIGO-M050315-00
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and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
For The Period
August 15, 2008 - August 14, 2009**

This Attachment OUT to the Memorandum of Understanding LIGO-M050315-00 defines the role of the Hobart & William Smith Colleges LIGO Group (HWSLG) 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, 2008 - August 14, 2009.

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.

This MOU Attachments defines the role and responsibilities of groups in this development group.

2. Participation

During the period August 15, 2008 - August 14, 2009, the members of HWSLG will participate in in LDG in the following areas:

a. Educational Materials Developed

The PI will complete the development of the video hallway display in the HWS Physics building. This display includes two videos on LIGO and links to the LIGO website. The PI will also supervise a student who is construction a hallway display of an interactive interferometer, to teach the public about LIGO.

b. Other Contributions

Not Applicable

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 HWSLG group members while on LIGO research assignment at any LIGO Laboratory site.

Not Applicable

- b. Access to LIGO data through established LSC channels in support of this work.

Not Applicable

4. Coordination and Reporting

HWSLG will perform 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 with the LIGO Observatories Educational and Outreach Leaders.

This includes 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.

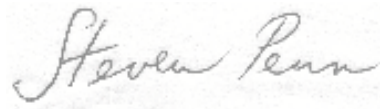
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5. Computer Code

All computer code delivered to the LSC under this Attachment must be developed in consultation with the LSC Data Analysis Software Working Group (DASWG) and archived, documented and reviewed as determined by that group.

Signature Pending Approval

Jay Marx
LIGO Laboratory Director



Steven Penn
Principal Investigator(s)
HWSLG



David Reitze
LSC Spokesperson



**Attachment SUS to the
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between the Hobart & William Smith Colleges LIGO Group (HWSLG)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
For The Period
August 15, 2008 - August 14, 2009**

This Attachment SUS to the Memorandum of Understanding LIGO-M050315-00 defines the role of the Hobart & William Smith Colleges LIGO Group (HWSLG) as a Member of the LIGO Scientific Collaboration (LSC), and a member of the Isolation/Suspension/Thermal Noise Development Group (ISTNDG). The period of performance for the activities in this Attachment is from August 15, 2008 - August 14, 2009.

1. Collaboration

The Isolation/Suspension/Thermal Noise Development Group (ISTNDG) is the scientific collaboration for defining and developing instruments in optics for use in advanced subsystems for the initial LIGO interferometers or in entirely new advanced interferometers. MOU Attachment SUS defines the roles and responsibilities of workgroups in this development group.

2. Participation

During the period August 15, 2008 - August 14, 2009, the members of HWSLG will participate in ISTNDG in the following areas:

a. Coating Losses

Coating Thermal Noise

The HWSLG will complete measurements on the mechanical loss in silica coatings as a function of annealing temperature and coating thickness. This data should isolate the excess loss arising in silica from the coating process. Preliminary measurements indicate that the excess loss arises mostly from the residual stress due to the coating process.

Southern University has the capability to use X-ray scattering to measure the bond angle distribution in the coatings and in an uncoated surface. That data would allow the PI to test if the coating loss and the surface loss resulted predominantly from the distortion of these bonds at the surface.

These bond angle distribution measurements would also be an important check on the accuracy of Prof. Hai Ping Chen's model of fused silica. If this theoretical model is able match the measured characteristics of silica, then ideally a similar theoretical approach could be used to model tantala. A theoretical understanding of the tantala coating could be the most efficient means to determine how to reduce its mechanical loss.

Finally the Coating Group has issued a white paper to several coating vendors requesting feedback about their measurement capabilities that might help in either lowering the coating loss or in determining the fundamental loss mechanism in the coating materials. The direction of our future experiments will be strongly influenced by the responses we receive. In any case, the HWSLG will remain a main contributor to this research.

b. Suspension Design for Advanced LIGO

Not Applicable

c. Other Contributions

Suspension Thermal Noise for Enhanced LIGO and/or Advanced LIGO

The PI will complete the tests of the ribbon test mass suspension. The sapphire prism standoffs should be finished by 1 August. The PI aims to have a complete set of measurements using the HWS test apparatus by mid-September. If these results appear promising, the PI would like the MIT group to test this design on the Pathfinder optic suspension. If these results demonstrate a significant reduction in thermal noise, the PI will propose an upgrade to the Enhanced LIGO suspensions.

If this design successfully reduces the thermal noise for Large Optic Suspensions, then we will propose that the design be considered for possible application to the HAM small and large triple suspensions for Advanced LIGO as a future replacement for the baseline wire suspensions.

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 HWSLG group members while on LIGO research assignment at any LIGO Laboratory site.

We require continued support from the LIGO Lab for our coating research. This support would include the purchase of substrates and coatings for our coating research and the allocation of lab personnel to help support and coordinate these efforts.

b. Access to LIGO data through established LSC channels in support of this work.

Not Applicable

4. Coordination and Reporting

HWSLG will perform 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 Isolation/Suspension/Thermal Noise Development Group of the LSC.

This includes 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.

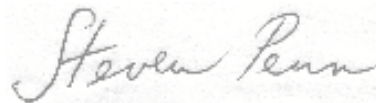
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5. Computer Code

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Signature Pending Approval

Jay Marx
LIGO Laboratory Director



Steven Penn
Principal Investigator(s)
HWSLG



David Reitze
LSC Spokesperson



**Attachment Z to the
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(HWSLG)
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For The Period
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This Attachment Z to the Memorandum of Understanding LIGO-M050315-00 lists the members of Hobart and William Smith Colleges LIGO Group (HWSLG) participating in LIGO Scientific Collaboration (LSC) development group activities in support of the initial LIGO interferometers. The period of performance for these activities is from August 15, 2008 - August 14, 2009.

Faculty:

The Faculty category includes all "faculty rank" LSC members. This includes professorial appointments, research faculty appointments, teaching faculty appointments, lecturer and reader appointments, and similar appointments, and visiting appointments in all these categories.

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Forwarding: penn@hws.edu

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10 St. Clair Street

City: Geneva

State: NY

Postal Code: 14456

Country: USA

Technical Staff:

The Technical Staff category includes all non-PI LSC members with scientist, engineer, computer systems administrator or programmer, technician, and similar appointments, and visiting appointments in all these categories.

Postdoctoral Scholars:

Graduate Students:

Undergraduate Students:

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Phone:

Voice: 1 315 7813759

Fax:

Email:

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Forwarding: raghuvir.kasturi@hws.edu

Postal Address:

HWS Gravity Lab

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HWS Gravity Lab

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City: Geneva

State: NY

Postal Code: 14456

Country: USA

Administrative Staff:

The Administrative Staff category allows the listing of administrative aides and other staff members who perform essential support services in or for LSC member groups, but are not involved in the LIGO Scientific Collaborations engineering or scientific work. *Personnel who are involved in the LSC's scientific or engineering work, including computer system administration and programming, should be listed under other categories.* Personnel listed as Administrative Staff may be designated as a point of contact or proxy, but do not appear as authors on LSC publications, do not count toward a group's council delegate allocation, may not serve as council delegates, and do not increase a group's shift obligation.

FTE Commitment:

#	Name	Category	Member	Research	LIGO
1	Kasturi, Raghuvir	undergraduate	100%	20%	100%
2	Luongo, Christine	undergraduate	100%	20%	100%
3	Penn, Steven	faculty	100%	40%	100%
4	Scanlon, Matthew	undergraduate	100%	20%	100%
5	Stephens, Paul	undergraduate	100%	20%	100%
				Total FTE:	5.00

Roles:

Principal Investigators: Penn, Steven

Membership Point-Of-Contact: Penn, Steven

Group PIO/Press Coordinator: Penn, Steven

Proxies:

Author Eligible

Penn, Steven

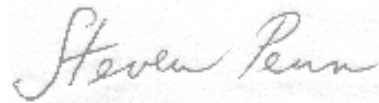
Council Delegates

Penn, Steven

Approvals:

Signature Pending Approval

Jay Marx
LIGO Laboratory Director



Steven Penn
Principal Investigator(s)
HWSLG

Signature Pending Approval

David Reitze
LSC Spokesperson