Attachment Number A to the Memorandum of Understanding (LIGO-M000234-00-M) between the Inter-University Centre for Astronomy and Astrophysics (IUCAA) and the Laser Interferometer Gravitational Wave Observatory (LIGO) Laboratory February 15, 2003

This Attachment A to the Memorandum of Understanding LIGO-M0000234-00-M covers the role of the Inter-University Centre for Astronomy and Astrophysics (IUCAA) as a Member of the LIGO Scientific Collaboration (LSC) and a member of the LIGO I Development Group (L1DG). The period of performance for the activities in this Attachment is from February 15, 2003 to August 15, 2003. This period may be modified by agreement to a revision of this Attachment.

1. LIGO Scientific Collaboration - The LIGO Scientific Collaboration (Collaboration) is organized as a separate organization from the LIGO Laboratory. It includes scientists from the LIGO Laboratory, and those from collaborating institutions, and has its own leadership and governance. The Collaboration will ensure equal scientific opportunity for individual participants and institutions. It will organize the research, publications, and all other scientific activities. The Collaboration will report to the Laboratory 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 semi-annual reports to the Directorate and its PAC.

2. Charter Membership - An initial period for formation of the Charter group of institutions in the LIGO Scientific Collaboration commenced on March 1, 1997 and ended following the first full meeting of the Collaboration at which the Collaboration Council assumed its role.

   Following the charter period, proposals will be evaluated and approved, as appropriate, through the Collaboration Council. An MOU with the LIGO Laboratory, including Attachments defining specific work, will be required for any participating institutions.

3. This document is an agreement between the Inter-University Centre for Astronomy and Astrophysics (IUCAA) and the LIGO Laboratory concerning the activities of IUCAA as a Collaborating Institution in the LIGO Scientific Collaboration (LSC) and in the LIGO I Development Group (L1DG), and as indicated in Items No. 8 and 9.

4. LIGO I Development Group - The LIGO I Development Group is the scientific collaboration for implementing and exploiting the initial LIGO detector and physics through the initial science data run. Only groups who establish a specific Attachment approved by the LIGO Labo-

ratory, which defines a sufficient contribution and participation in LIGO I development, implementation or data analysis will be part of this initial LIGO data run and science. Participation in future data runs and science that follow LIGO I will be possible for other groups, with guidelines to be determined by the LIGO Scientific Collaboration. It is anticipated that LIGO I data will only be made available through formal collaboration within the LIGO I Development Group during the first two years following its collection.

The general guideline for institutional membership in the LIGO I Development Group is that the contribution per collaborator of any new group to the design, construction, and implementation of the initial LIGO detector and to the first data run be comparable to that of the LIGO Laboratory scientists.

5. Report of Progress - IUCAA will provide a status report on its activities in support of LIGO every six months. The report will consist of: a) a summary status on research by topic as indicated in Item No. 9 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, b) updated List of Collaborators, and c) a plan of activities for the succeeding six-monthly period. The report will be due one month before the close of the period of performance under the Attachment in question.

6. Term of Membership - The Membership will be renewed every six months upon evidence of satisfactory performance of agreed upon duties.

   The coordinates of IUCAA members are included in the Attachment Z to the Memorandum of Understanding LIGO-M000234-00-M.

7. Intellectual Property Rights - The rights to intellectual property developed under this Attachment will be subject to the National Science Foundation Grant Policy as indicated in Section 730, Intellectual Property.

8. LAL Software Conventions - It is necessary that any delivered code conforms to the LAL style as laid out in the LAL specification T990030. This includes: 1) coding style, headers, etc.; 2) use of function calls, etc.; 3) organization of software in the directory structures indicated in the document; 4) inclusion of test codes and validation tests to enable users to verify successful installation of implementation; and 5) documentation and users manuals (html or pdf) to enable users to understand and adopt code.

9. During the period February 15, 2003 to August 15, 2003, IUCAA Gravitational Wave Data Analysis group will focus on the following two tasks:

   LIGO I Data Analysis

   a) Extended Hierarchical Search Methods for Inspiraling Compact Binaries

   The Mohanty-Dhurandhar approach of using a coarse grid of templates in the first stage and following up the search with a fine grid of templates is being improved by also decimating in time. The decimation in time is used in the first stage along with the coarse grid for triggering

the second stage. The algorithm and the code for the placement of templates in the first stage of the hierarchy can be run on a standalone machine. Efforts are being made to run the code in the LDAS environment. LAL routines were used for the fine search in the second stage. Preliminary results of Monte-Carlo simulations show multiple crossings. The multiplicity problem proves to be a bottle-neck for the hierarchical scheme and every effort will be made to surmount it. Also efforts are in progress to speed up the template placement algorithm so that it can adapt to frequent changes in the psd as is the case with real data. The goal is to use the algorithm on real data – namely S2 data.

b) Network Analysis

The IUCAA group and Sam Finn's group at Penn State will analyze the problem of searching for inspirals in data from a network of detectors. The first goal is to improve the efficiency of the search in one detector with help of interpolation techniques – sample the likelihood function at fewer points than what is currently done and reconstruct the full likelihood function by interpolation.

10. During the period February 15, 2003 to August 15, 2003, the LIGO Laboratory will provide, as requested and necessary, LIGO data of relevance to the research in Item No.

11. The research effort pursuant to this Attachment A will be coordinated by Sanjeev Dhurandhar and Albert Lazzarini on behalf of the IUCAA and the LIGO Laboratory, respectively.

12. 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. 9, as indicated below.

    a) Accommodations for IUCAA investigators while on LIGO research assignment at Caltech.

    b) Funding for visits at Caltech, on the part of IUCAA investigators, as agreed.

    Note:

    With the goal of subsidizing LIGO funds for the IUCAA/LIGO collaboration, a joint project funded by DST of India and NSF of the US is in progress. The PIs of the project are Albert Lazzarini from LIGO Laboratory and Sanjeev Dhurandhar from IUCAA. Sam Finn, Director, Center for Gravitational Wave Physics (CGWP) at Penn State is the Co-PI. Finn has agreed to fund visits of the Indian researchers to CGWP from the CGWP funds allocated for international collaboration.

Approved:

Barry Barish
LIGO Laboratory Director
26 Nov 03
Date

S. V. Dhurandhar
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IUCAA Principal Investigator
15th December 2003
Date

Albert Lazzarini
LIGO Laboratory Data and Computing
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15 NOV 2003
Date