

# CALIFORNIA INSTITUTE OF TECHNOLOGY

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LIGO PROJECT  
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February 12, 1991

Dr. Paul A. Vanden Bout, Director  
National Radio Astronomy Observatory  
Edgemont Road  
Charlottesville, VA 22903-2475

Dear Sir:

Your letter regarding the LIGO Site Solicitation Announcement has been received. We are enclosing an updated list of questions raised by others, together with our responses, which may be useful in preparing your proposal. In accordance with the Announcement, these questions and answers are being furnished to all parties who, like you, have expressed interest.

Thank you for your interest.

Sincerely,



William E. Althouse  
Chief Engineer, LIGO Project

WEA/ca

Enclosure

**LASER INTERFEROMETER  
GRAVITATIONAL-WAVE OBSERVATORY  
(LIGO)  
Site Solicitation Announcement**

**ANSWERS TO QUESTIONS  
February 12, 1991**

*Erratum:* under **Site Requirements**, Item 7, the sentence in parentheses should read "... equipment consumes a negligible amount of ~~matter~~ *water* ..."

1. **Is there a stated or unstated preference for a site on the West Coast and one on the East Coast? Could a site in the state of XX meet the scientific criteria for distance between two U.S. sites?**

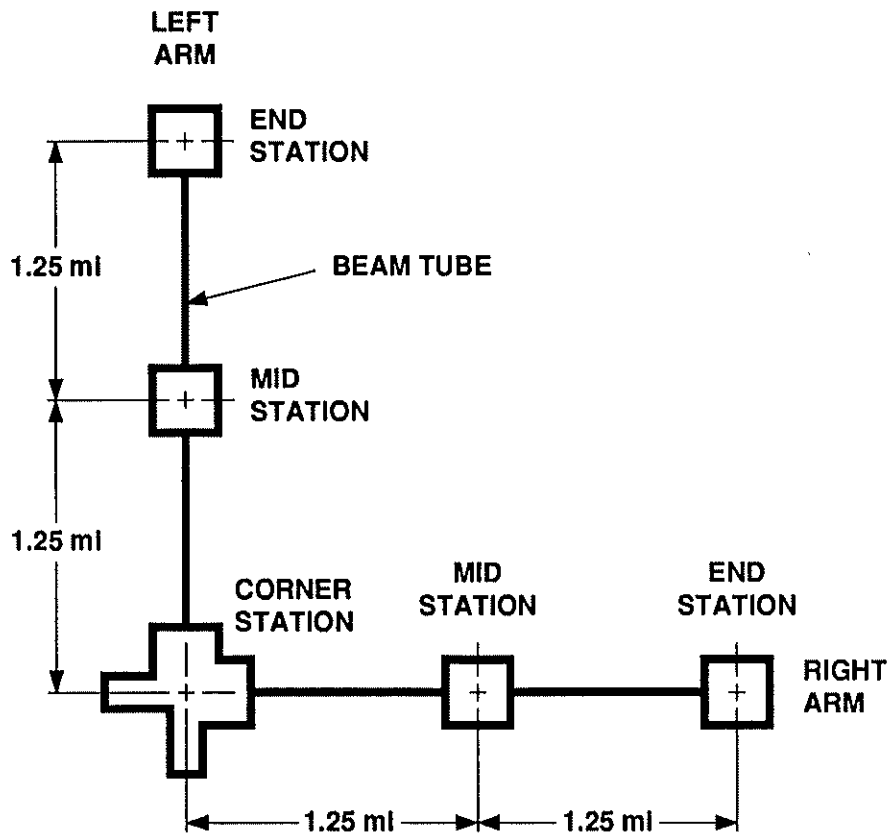
There is no preference for coastal locations. There is a strong preference (but not an absolute requirement) to have two sites separated by 1,500 to 3,000 miles. This preference appears to create a natural disadvantage for sites near the center of the U.S. However, a pair of sites which includes a Midwestern site of superior quality would likely rank higher than a pair of poor coastal sites.

2. **Will the results of LIGO be more accurate with increased distance between sites (i.e., is 3,000 mi. separation better than 1,500 mi.)?**

Sorry, but there is no simple answer. Some measurement parameters improve as separation increases, others get worse. In addition, there are other geometrical parameters, such as direction of the line connecting two sites and the locations relative to a European site, which are important. Each site-pair will have to be evaluated individually.

3. My copy of the announcement did not contain any drawings. The enclosed drawing is my interpretation of the words in the announcement. Is it correct?

We cannot certify the accuracy of drawings produced by others. The following figure illustrates the layout of the LIGO (not to scale):



4. The announcement does not specify land size for the buildings. What is the minimum acreage you require for each of the five buildings?

We have no minimum land area requirements. The land offered must be sufficiently large to accommodate the Site Requirements listed in the announcement.

5. Would it be acceptable if land were leased to, rather than title delivered to, LIGO?

Yes. Proposed leases must be for a minimum duration of 25 years.

6. Would it be acceptable to deliver clear title to the land for the buildings, and secure a right-of-way for the arms of the LIGO?

This and similar legal questions can be answered only in the context of a complete proposal. All serious proposals will receive full review, including legal review.

7. **Would the presence of cattle, which might rub up against the concrete arms of the LIGO, be a problem?**

We do not know the vibration spectra created by cattle, so we cannot know in advance if they would be a problem. However, with the possible exception of a stampede, we would expect that the presence of LIGO would be more disruptive to the ranching activities (because of the long barricade) than the cattle would be to LIGO. Any fencing required would be a cost item to be considered.

8. **The announcement indicates the minimum electricity required to handle the LIGO. What is the maximum electrical power LIGO would require?**

The site announcement specifies a minimum power *capacity* of 1 MW delivered to the site. This is intended to cover our current best estimate for maximum LIGO power *consumption*.

9. **No requirement for natural gas is given in the announcement. Can it be assumed that no natural gas is required and the buildings will be heated and cooled electrically?**

Heating and cooling would be provided by the most economical means available at a given site. Thus there is no specific requirement for natural gas because it may not be economical at some sites.

10. **The Fact Sheet furnished to our Governor noted that sites "... should be far enough from urban development to ensure that they are seismically and acoustically quiet ..."**  
**Do you have any specifications on how quiet the site must be? How far away must the site be from a public highway that has light use?**

Our vibration specifications cannot be easily stated in absolute, site-independent terms, and there is no unique minimum distance to potential noise sources. Quieter sites are strongly preferred, but more remote sites may incur higher construction costs or make it difficult to recruit resident staff.

11. **Can you elaborate on the Site Selection Criteria, Science Impact, references to relative alignment of sites?**

LIGO sensitivity does not depend on absolute orientation of a facility, but does depend on the relative orientation between two or more facilities. We intend to compute sensitivity for each pair formed from the pool of proposed sites. It should be clear that if a proposed site can accommodate more than one orientation, it would be in a proposer's best interest to identify such alternatives in the proposal. Alternatives can be considered in our evaluation process only if the proposal offers the land needed to accommodate them.

12. **The Site Selection Criteria mentions angle between arms. What is the tolerance on the 90° opening angle?**

We strongly prefer exactly 90°. The engineering and construction of buildings and equipment will become significantly more costly for angles other than 90°.

**13. Can you give us some indication of the shape and orientation of the buildings relative to the layout?**

Our engineering concepts are preliminary, and no detailed engineering has been done. We would not like the site to place strong design constraints on the placement of equipment.

**14. What will be the annual operating budget of each LIGO facility?**

We have indicated expected on-site employment of 10–20 people. Beyond salaries and facility maintenance, our major operating expense would be electrical power, which we have estimated to be  $\lesssim 1$  MW (continuous).

**15. What role do you envision for nearby universities? Will you offer public tours or museum facilities? What about educational opportunities for local secondary and college students?**

While we recognize the desirability of good relations with the local community, our early efforts will be strongly concentrated on getting LIGO operational. It will be quite natural, in time, to develop close ties to nearby communities and universities; these will evolve as the mutual benefits become apparent.

**16. We are thinking of proposing a below-ground alignment in order to be compatible with current land use. How will the cost effects on LIGO structures be treated?**

**The Site Solicitation Announcement states that site preparation costs borne by the LIGO Project may not exceed \$2.5M. Is this a firm requirement?**

We cannot prejudge the competitiveness of proposals which have not been submitted. The Site Solicitation Announcement describes a surface facility built upon a continuous, flat, (nearly) level, 2.5 mile x 2.5 mile, L-shaped base. All costs required to make a site compatible with this description are treated as site preparation costs, and will be competitively evaluated, understanding that the NSF-approved construction proposal contains only \$2.5M for site preparation.