

Proposed Power Handling and Reflectivity Tests of Mode Cleaner Mirrors

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Abstract

On Tuesday, 15 November, members of the Caltech science team assembled with R. Vogt to discuss various possible mirror configurations for future mode cleaner cavities. R. Drever proposed tests intended to establish the power limitations of cavities assembled from mirrors currently held in Caltech's stock; with some enhancements from other members of the team a test plan was agreed to and a tentative schedule was established. These are outlined for future reference.

R. Drever has proposed some small-scale experiments intended to deal with ongoing uncertainties about power-handling capability in mode cleaning cavities. Among the unresolved issues we hope to address are the following:

1. How does power-handling capability depend on mode cleaner length and mirror curvature?
2. Is it possible to build a mode cleaner able to transmit the full output power of one of our I-100 lasers using mirrors we have in stock?
3. Should any change to the current plan of introducing the existing 1-meter, 1,000 ppm transmission mode cleaner into vacuum be considered within the period allocated to that project?
4. What design is most promising for future generations of mode cleaner?

quantity	radius	T_{nom}	T_{meas}
10	50 cm	1000	1000-2000
2	50 cm	3000	4000(?)
6	15 m	1000	1000
2	15 m	3000	4000

Table 1: One-inch diameter mode cleaner mirrors in group's stock as of 11/17/88. Measured transmissions are in all cases approximate and in some cases questionable.

The following plan was developed to try and answer these questions as completely as possible in the minimum time. First, as the 40 meter vacuum system is being reconfigured for the introduction of the mode cleaner (scheduled to begin on 21 November) we will begin to set up equipment to evaluate the various mirrors we have in stock. The tests will involve setting up fixed-mirror, evacuated cavities in CES lab and locking to each of them with one of the I-100 lasers. Standard adjustable mirror mounts with vacuum-compatible motor drives will be used to save time; suspension and seismic isolation issues will be investigated separately, perhaps concurrently, in Bridge laboratory.

The mirrors to be tested include some having 50 cm radius and some having 15 meter radius. These mirrors have been in our stock for some time but have never been reliably tested to determine true transmission and losses; their nominal characteristics are summarized in Table 1. These figures will be obtained in standard cavity ringdown and throughput measurements.

To measure the 15-meter radius mirrors, a long vacuum system will be assembled in the CES lab using components of the 10-meter system currently at Bridge lab. To minimize interference between this work and ongoing work on the 40-meter system, the test station will be assembled in the hall along the Louie arm of the interferometer and light will be sent to the test station by temporary deflection mirrors.

In addition to the standard mirror-quality measurements, the laser will be run up to high power with each test configuration to try and determine

its limiting output power. Although no explicit experiments have been designed, we will look very carefully for signs of mirror degradation as a function of circulating power (and, if possible, vacuum quality) in the course of these tests.

Since the current mode cleaner is not performing well, there is strong motivation to reassemble the vacuum system with a direct compatible replacement. This will require the testing of 50 cm mirrors to be performed as early as possible. If no satisfactory 50 cm mirrors are found, the current mode cleaner will be installed as planned. If good mirrors are found a "twin" one-meter mode cleaner will be constructed and installed in place of the current one, providing this does not entail excessive delays. Tests on the 15 meter mirrors will commence after this decision, again to minimize delay of the installation.

To avoid diverting resources from our main projects the test program will be monitored and reported on at each Science Group (Monday) meeting. The tests will be terminated if insufficient progress is shown. At present we do not expect these measurements to extend past 12 December, 1988.