New Folder Name Changes in fast P2T Mirror Design for the PSL

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CALIFORNIA INSTITUTE OF TECHNOLOGY

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Subject: Changes in fast PZT mirror design for the PSL

1. Background

Recently, it was realized, both at Caltech and at MIT, that the current version of the Spectra Physics laser (model 2080) is not operating well with the flat high reflector used for the fast PZT mirror (FPZTM). We found it difficult to force the laser into single frequency, single mode operation, unless the intracavity diaphragm was closed to an unreasonably small value, which in turn resulted in reduced output power, about 3.5 W at full 66 A current instead of the required 5 W. The experts from Spectra Physics recommended the use of a convex mirror with 11 m curvature as the remedy of choice. Since the standard size mirror made by the laser manufacturer is to large to be used in the FPZTM assembly, Spectra Physics offered to provide us with an evaluation sample, generated with size as specified by us. The opportunity thus arose to build the FPZTM with a thinner mirror than the traditional version, which was expected to result in a device with the first resonance higher than the current 220 kHz, with obvious advantages to the PSL frequency control system.

2. Changes in FPZTM Design

The changes in FPZTM design, and the resulting improvement in mirror performance, are summarized in Table 1 and in Figure 1. Constrained layer damping was adopted following a suggestion by Frederic Cleva (Orsay, France), who had successfully used it for FPZTM damping, and after the concept was clarified by consultation with Mike Gamble.

3. Laser Performance

- With the new, convex mirror, the laser output was 5.2 W maximum, single frequency, single mode, at 66 A discharge current.
- To obtain maximum output power, the intracavity aperture had to be kept fully open.
- It was easy to force single mode, single frequency operation, by following the standard etalon adjustment procedure, described in the manual that comes with the etalon.

FPZTM characteristic	Traditional design	Modified design
Mirror figure	Flat	Convex, R=11 m
Mirror size	ϕ7.75 mm, 4 mm thick	ϕ6 mm, 2.5 mm thick
PZT disk size	ϕ9.25 mm, 1.25 mm thick	ϕ9.25 mm, 0.5 mm thick
Damping material	Apiezon-Q loaded with lead powder	Perkin-Elmer Vac-seal epoxy
Damping method	Embedding	Constrained layer
First resonance	220 kHz, Q=7	350 kHz, Q=4
PZT capacitance	1 nF	1.8 nF

Table 1: Comparison between traditional and modified FPZTM designs

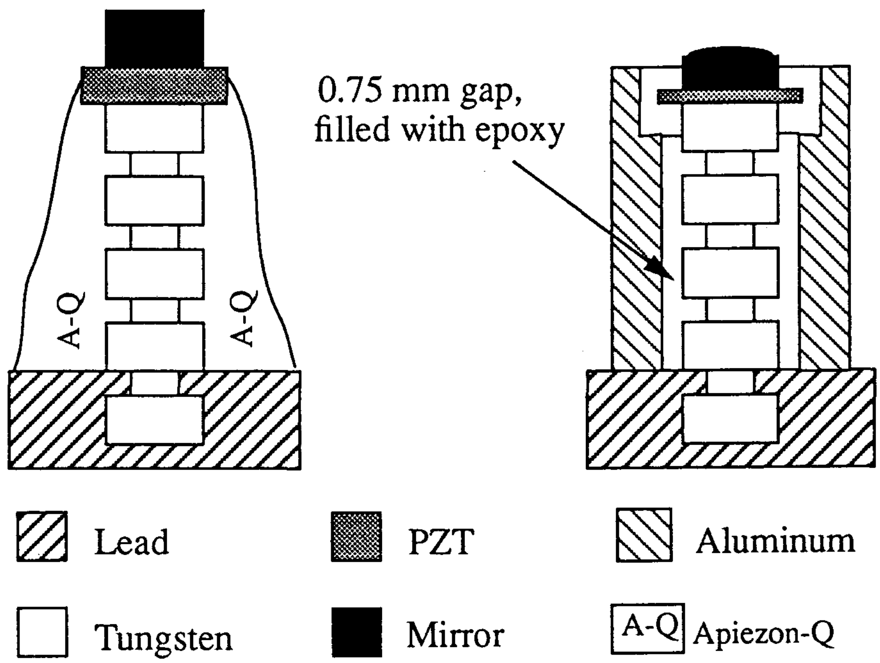

Fig. 1. Comparison between traditional (left) and modified (right) FPZTM designs

4. Conclusions

- The laser output has increased slightly above the required 5 W level as a result of using a convex high reflector.
- The high reflector curvature, 11 m, is not optimized for the length of the laser resonator, 2.14 m, which is ~15% longer than in the original Spectra Physics design. The suboptimal nature of the geometry is indicated by the fact that the intracavity aperture has to be kept fully open for maximum output.
- The modified FPZTM design is superior to the traditional one, as the first resonance is higher in frequency and its Q is lower.
- The PZT driver in the PSL frequency control electronics will have to be slightly modified to accommodate the increased capacitance of the modified FPZTM.

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