Palomar Beam Transfer Optics Transmission

A. Bouchez, v1: 7/27/06

1. Transmission of BTO optics in the Coudé lab

On 25 July, 2006, A. Moore and I mounted the 594 nm wavelength HeNe laser on the BTO optical bench, parallel to and immediately below the 660 nm fiber laser. The 594 nm beam was focused through a 25 μm pinhole and collimated with an F = 50.2 mm lens, forming a ~4 mm diameter beam which was then reflected off two fold mirrors onto the axis of the Chicago laser output beam. A polarizing beam-splitter cube was placed in the notch at the edge of the steel platform to reject all but horizontally polarized light before the beam reached the first BTO mirror (M1a).

The power measured with the Newport digital power meter at the input (just before M1a) and after each BTO optic up to the trolley are shown in Table 1. The input power appeared stable to ~5 μW over the ~3 minutes needed to complete the measurements in each run. Values marked in red are probably inaccurate due to higher than expected beam divergence, which caused the stimulus beam to overfill the sensor head. This also kept us from measuring the reflectance of the boresight mirror. Steps were taken to address the beam divergence on 26 July (see Section 2), but we ran out of time and were not able to repeat the experiment.

Location (after optic)	Power (mW)			Mean ratio to input	Mean trans.
	run 1	run 2	run 3		
Input	296	289	283	1.000	1.000
M1a	289	276		0.967	0.967
Beam-splitter cube	280	276		0.951	0.984
FSM	256	248	240	0.858	0.902
1/2 wave plate	250	249	236	0.847	0.988
Coude window			238	0.841	0.993
Trolley mirror			220	0.777	0.924
Q1 beam-splitter			219	0.774	0.995
Boresight mirror				N/A	N/A

Table 1: Power measured after each BTO optic up to the prime focus cage, and their implied transmission at 594 nm. Values marked in red are suspect due to overfilling of the sensor head.

Of the BTO optics measured, only M1a and the FSM have transmissions below 98%, which seems a reasonable threshold for concern. The apparently low reflectance of M1a (96.7%) may be simply due to the reflectivity of the multilayer dielectric coating of this optics being lower at 594 nm than at the design wavelength of 589 nm, though this needs to be verified. M1a is the only optic measured here with narrow-band dielectric coatings.

The majority of the loss in the Coudé lab segment of the BTO clearly occurs at the FSM, whose measured 90.2% reflectivity is roughly consistent with the value of 89.1% measured by C. Shelton on 5/17/06 using a 660 nm diode laser. This diamond-turned aluminum mirror should be replaced as soon as possible with a polished, high-reflectivity mirror.

2. The BTO 594nm stimulus breadboard

The higher than expected beam divergence mentioned above led me to redesign the stimulus on 26 July, 2006, using an F = 100.4 mm lens to allow greater beam expansion after the pinhole. The laser and optics were remounted on an 12"x18" breadboard, allowing the entire stimulus package to be carried to either the Coudé lab to repeat the experiment described in Section 1, or the LLT storage room to measure the transmission of the remaining BTO optics. The layout was therefore designed to be compact, and to allow easy reorientation of a linearly polarized output beam. An annotated photo of the 594 nm stimulus breadboard on is shown in Figure 1.

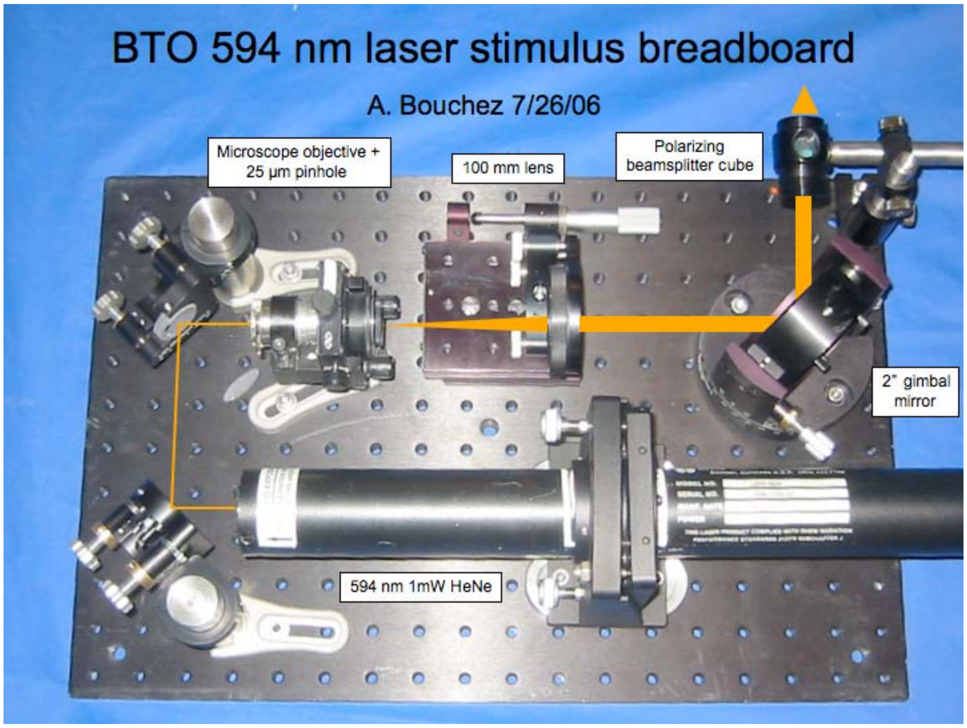

Figure 1: Annotated photo of the 594 nm laser stimulus breadboard. The final gimbal mirror directs an ~8 mm diameter collimated and linearly polarized beam in any direction. The output power is ~300 μW.

We attempted to measure the transmission of the LLT optics using the new breadboard on the afternoon on 26 July, but were hampered by rapid variability in the output laser power. While the unpolarized power exiting the laser appeared stable to a few percent, we observed large variations after the polarizing beam-splitter, implying that the polarization vector was wandering around. This effect was not observed the previous day, and may have been due to allowing insufficient time for the laser to warm up and stabilize (we waited ~1 hr).

At this point we ran out of time, and had to leave the experiment unfinished. I placed the breadboard in the AO cabinet, and plan to purchase parts to replace those scavenged from other projects so that we can retain it for future use. I will return to Palomar to complete the transmission measurements sometime before the September LGS engineering run.