Palomar Laser Diagnostics Requirements

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1. Introduction

Laser diagnostics for the Chicago Sum Frequency Laser (CSFL) have to date been located on the U. Chicago laser bench. However, moving the beam diagnostics from the laser bench to two location in the beam transfer optics system (BTO) would lead to the following benefits.

- Increased area available on the laser bench (eg. for a second 1.32 μm gain module).
- Laser power and beam diagnostics at the entrance to the laser launch telescope (LLT).
- Independent engineering of the laser and diagnostic systems.

This document defines the requirements of the laser diagnostic system in general, and instruments at two locations in particular: on the BTO polar axis bench in the Coude lab, and near the entrance to the laser launch telescope at the telescope prime focus (PF). At present it is written for a dual-beam system (589nm and 660nm, projected simultaneously), though this requirement may change.

2. Top-level requirements

2.1. Simultaneity with laser projection

All diagnostic instruments, with the exceptions of the spectrum analyzer and sky-viewing camera, shall operate simultaneously with projection of the laser on the sky.

2.2. Number of surfaces.

The number of surfaces in the direct beam to the sky shall be minimized.

3. Computer and interface requirements

3.1. Computer control

All diagnostic instruments shall be controlled by a local PC running linux. This will most likely be the "bto" computer for PF instruments, and the "laser" computer for Coude instruments.

3.2. Logging of diagnostics

All scalar diagnostics, with the exception of laser bandwidth, shall be logged at regular intervals to the AO database. Two-dimentional diagnostics such as near- and far-field images shall be analyzed in real time to produce scalar quantities (such as FWH and M^2), which can then be logged.

3.3. Remote viewing of diagnostics

All diagnostics, with the exception of laser bandwidth, shall be remotely viewed from a workstation in the control room. An interface providing graphical tools such as strip charts will allow simultaneous viewing of the following at a minimum:

- Coude power (W)
- Some measure of laser wavelength (Na cell flux, residual, ...)
- PF power (W)
- PF near-field FWHM (mm)
- PF M^2

4. Prime focus diagnostics

4.1. Tip/tilt

Measure fast tip and tilt of the 589 nm beam (or, if not available, the 660 nm beam) near the LLT FSM plane. This functionality is currently provided by the Q3 quad cell diode with a 3 mm thick RG630 colored glass filter.

4.2. Power

Measure the total power, in W, of the transmitted 589 nm beam.

4.3. Near-field camera

Measure the FWHM of the near-field 589 nm beam. It might be desirable for this camera to simultaneously image the 660 nm beam, allowing accurate co-alignment.

4.4. Far-field camera

Measure the FWHM of the far-field 589 nm beam.

4.5. Imaging the sky through the LLT

This is not strictly diagnostic of laser properties, the ability to image stars through the LLT is necessary for collimating the LLT and boresighting it to the Hale Telescope. This will not be operated simultaneously with laser projection, and may therefore require manual reconfiguration (mounting of the camera, or raising of a flip mirror). Two capabilities are necessary, which could require two distinct optical configurations:

- Wide field: >2 arcmin across.
- Fine platescale: < 0.2 arcsec/pixel.

4.6. Shutter

[NOT A REQUIREMENT] The provision of a shutter on the prime focus bench capable of absorbing the ~10W 589nm beam might considerable simplify BTO operations, allowing us to do away with the 660 nm probe beam.

5. Coude lab diagnostics bench

5.1. Power

Measure the total power, in W, of the transmitted 589 nm beam.

5.2. Near-field imaging

Measure the FWHM of the near-field 589 nm beam. It might be desirable for this camera to simultaneously image the 660 nm beam, allowing accurate co-alignment.

5.3. Far-field imaging

Measure the FWHM of the far-field 589 nm beam.

5.4. Wavelength

Some measure of the laser wavelength is necessary. Needs more though.

5.5. Bandwidth

A scanning etalon used to measure the laser bandwidth shall be included in the Coude diagnostics package, though it need not be operated simultaneously with projection on the sky. It

could therefore be fed using a flip mirror. Note that the spectrum analyzer currently used requires calibration with a HeNe (*every time?*), which may also need to be included in the design.

5.6. Polarization

[NOT A REQUIREMENT] We could consider including a second photodiode on the alternate beam of the polarizeing beamsplitter cube, thus measuring the degree of horizontral linear polarization by their ratio.

6. Shutter configuration

The shutter located at the output of the CSFL bench currently serves 3 distinct functions:

A. Shutoff of the beam to the sky (eg. aircraft, slewing)
B. Safeguard against damage to telescope/dome (eg. Q3 interlock activation)
C. Personnel safety within all zones, including exposed regions of Coude lab (manual activation)

Transferring the primary laser diagnostics to the BTO polar axis bench leads to the obvious problem that the beam diagnostics cannot be measured when the laser bench shutter is closed.

While adding significant complexity, we may want to consider a system with 3 shutters, which serve the above functions in a 1-to-1 fashion.

1. At the output of the PF diagnostics bench (function A)
2. At the ouput of the Coude lab (function B)
3. A the output of the laser bench (function C)

This needs more thought...