⑥ Holography Using Cheap Diode Lasers

If you ask most laser 'experts' about the possibility of using a laser pointer or inexpensive diode laser module for making holograms, the typical response will be to forget it – the coherence length is only a few mm and therefore inadequate. This apparently isn't the case. The coherence length for a typical laser pointer or diode laser module may actually be more like 200 mm (10 inches) – comparable to that of an HeNe laser and, with care, will remain stable for long enough to make an exposure. While it may be unreasonable to expect any old $8.95 laser pointer to produce the same quality results as a $500 HeNe laser, surprisingly good holograms can be obtained on a budget. And, it would appear, that in some cases, they can actually be superior.

While I don't know how to select a laser diode to guarantee an adequate coherence length, it certainly must be a single spatial (transverse) mode type which is usually the case for lower power diodes but those above 50 to 100 mW are generally multimode. So, forget about trying to using a 1 W laser diode of any wavelength for interferometry or holography. However, single spatial mode doesn't guarantee that longitudinal mode or has the needed stability for these applications. And, any particular diode may operate with the desired mode structure only over a range of current/output power and/or when maintained within a particular temperature range.

For for information on laser pointer holography, see:

- 3D Imagery (take the linke for "Laser Pointer Holography").
- Holoworld – Laser Pointer Holography – Detailed discussion of experiments and results with a variety of setups.

Also see the section: Holographic Information Resources.

(From: Frank DeFreitas (director@holoworld.com).)

I had my fingers crossed tighter than ever 35 mW of power for holography using a diode source. It worked!

The module used contained the Hitachi 35 mW, 658 nm diode, along with AR-coated anamorphic prisms (optional) and The measured optical output after collimating optics is 27 mW and total cost for putting the whole thing together was about $50 to $60.

This little baby exceeds the performance of any HeNe in its power range, including the $5,000 Spectra-Physics at 25

Those diodes are real little buggers once they're set up with an interferometer. Very strange behavior (at least strange after working with gas lasers for so many years) – and in a good way.

In any case, this baby is ROCK solid. The final test which put us over the top was so incredible that I thought there was something wrong with the set-up. I would tap on the table just to make sure. It's almost as if a fringe-locker was in place. Even with the best HeNe that I've had here (Spectra-Physics

124B Stabilite) there would ALWAYS be some "drift" or what I call "float". (Float is the feeling still -- it's not something that shows up very clearly to the eye. It's more of a "feeling" when testing). The fringes with the new diode are locked so tight it's almost like watching a still photograph.

As far as the coherence length is concerned, I measured (using a Science and Mechanics PhotoMeter placed in the fringes) out to 14 feet without any change. As you may know, this amount of coherence would require a rather expensive etalon on any lab laser. Up until this point, we were only capable of recording a few inches using diode lasers.

This diode created two very bright test holograms that exhibited depth all the way back with the object(s) (1. ocean coral, 2. angel statue with wings). For a special twist, I used an initial set-up for a 30 x 40 cm hologram and then just shot two 4 x 5s with the set-up as-is. Even though the size of the holograms are 4 x 5, they will give you an indication of what a 30 x 40 cm hologram would turn out like -- since your beam spread, exposure, etc. are calibrated for that size.

For a complete report, along with photos of the module, the holograms, the visible beam in my lab and a interesting size comparison to a Spectra-Physics 124B HeNe laser go to the Our Own 25 mW Laser Page. (There are also other reports preceeding this one which may be accessed at the Holoworld site.) D and S Lasers is a spinoff of Holoworld offering plans, a kit, as well as an assembled 25+ mW diode laser system with long coherence length suitable

As for using green laser pointers, realize different technology than laser diodes in red pointers. Green pointers are Diode Pumped Solid State (DPSS) frequency doubled lasers. To be useful for holography, a laser has to have a decent coherence length. For a short cavity laser like a that in a laser diode (a fraction of a mm) or green laser pointer (2 to 10 mm typical), this implies single longitudinal (and of course single transverse) mode operation. Some red diodes do this under some conditions (by controlling diode current and diode temperature). Depending on the specific configuration of the laser some may also operate single mode. Maybe. major modifications may be difficult. The **not** operate single mode but may do so at times depending on pump power and pump beam alignment. A discrete operate single mode up to a modest power level and then switch to multimode. Many or most green pointers are now quasi-CW and/or Q-switched which further complicates matters.

(From: Colin K. (colinholo@yahoo.com).)

Laser diodes do work. I would not say they most amateur holographers use. There needs frequency to single mode. If you only need reliable diode for $35 with a coherence length of more than 6 ft. I run one from two D-cell batteries and have made more than 30 holograms with it with no failures. As the red diodes increase in hard to get the line to stabilize. I have a TEC based laser with the Panasonic 50 mW diode and I have had much difficulty keeping it in a single mode. When I can the coherence length is quite long. More than 12 feet.

The 35 mW laser Frank sells from the Holoworld site (APC with Mitsubishi Diode) makes a good hologram most of the time but it will run in multiline mode at random times.

The best laser I have found in red is the Analog Technologies TLM-S1 Tunable Laser Module but it's not cheap (don't ask!). There is also a less expensive non-tunable about $800 very soon. I am hoping to test a sample with a 50 mW diode in a few days. The 25 mW has extremely long coherence lengths.

(From: Tony (kilm02nspm@clara.co.uk).)

I thought that laser diodes would be unsuitable for holography due to their supposedly very short coherence length until 1999, when I read of holograms being made using laser pointers. I didn't believe it, but thought it wouldn't hurt to try. I bought a laser pointer (the feedback regulation), broke it open and fixed the diode and board to an adjustable mount, powering it from 3 AA time, producing brighter holograms that were ever possible with my old 1 mW He-Ne. Having only a small table I've the long coherence lengths quoted by some but I have found reflections from objects at the back of the table, giving a coherence length (taking into account the path difference there must have been) of at least 50 cm. I tried a few pointers and found only the cheap no-regulator types with only a resistor and diode don't work. One thing to remember is they do need to warm up just like a gas laser so don't expect to click the power on and off still best to use a shutter. Set up an interferometer to check the warmup time as well as you table's stability. The simplest way (assuming you've already built a vibration damping table) to make a transmission hologram with a diode laser is: Remove the collimating lens from the pointer, this produces a 'stripe' of light which can be used instead of a beam expander. Screen off the edges of the stripe next to the laser until only your objects and reflector are illuminated. With the laser at the left centre for example, you would place your object below and your reflector for the reference beam above centre on the right. Arrange your plate at the bottom of the table, the fun part being to keep it out of the direct beam while facing the reflected light from your object and being fully illuminated by correct angle. You'll have to use some white card in the plate holder to try and balance the light from the object and reference beams. All this is much easier with more mirrors of course but for a zero-budget experiment it does work. You can make a partial reflector for the reference beam by painting a piece of 6 mm roughly control the intensity by moving it plate or film.