Making an RGB Hologram

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Background

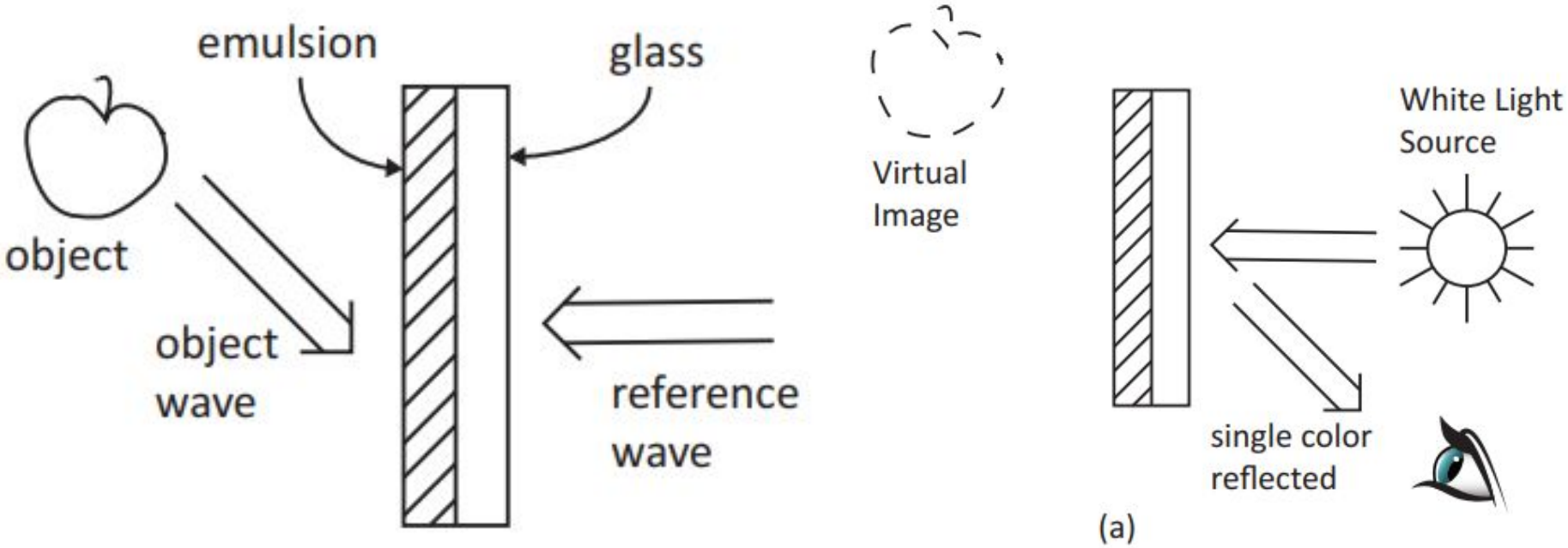
Holography - from 2D to 3D imaging systems

Capturing phase information via. Analog wavefront reconstruction

As the recording media is exposed under undisturbed circumstances, the contrast between the object and reference wavefronts allows us to store interference patterns

Since the changes in atomic structure of the emulsion during exposure are permanent, these interference patterns can then be read back out using any concentrated illumination, producing the illusion of a multidimensional image

Reflection Hologram



RGB Hologram Motivation

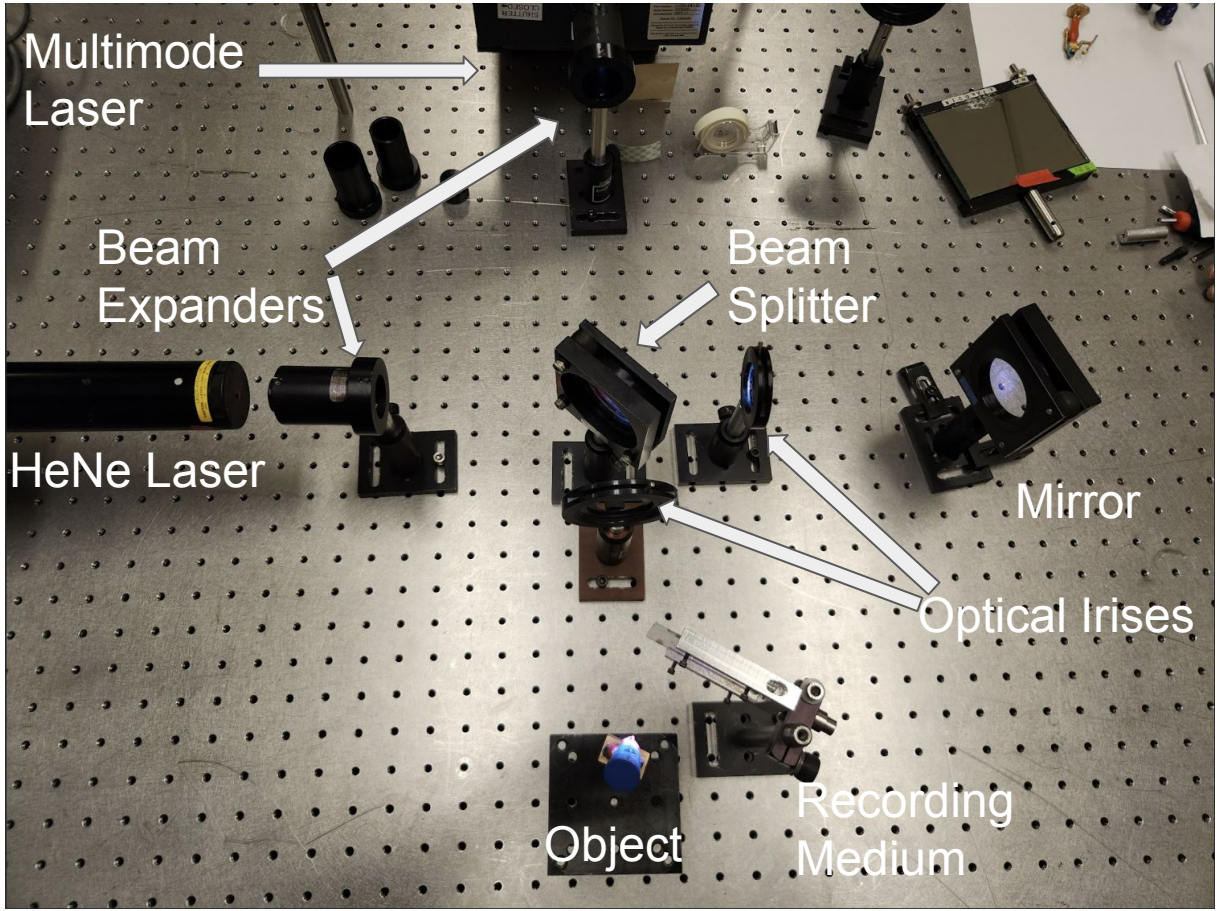
Writing with one laser = monochromatic hologram (not necessarily the color of object)

Can we preserve object's color in a hologram by writing with multiple lasers?

Potential uses:

- Enhanced medical imaging
- Enhanced visual data storage

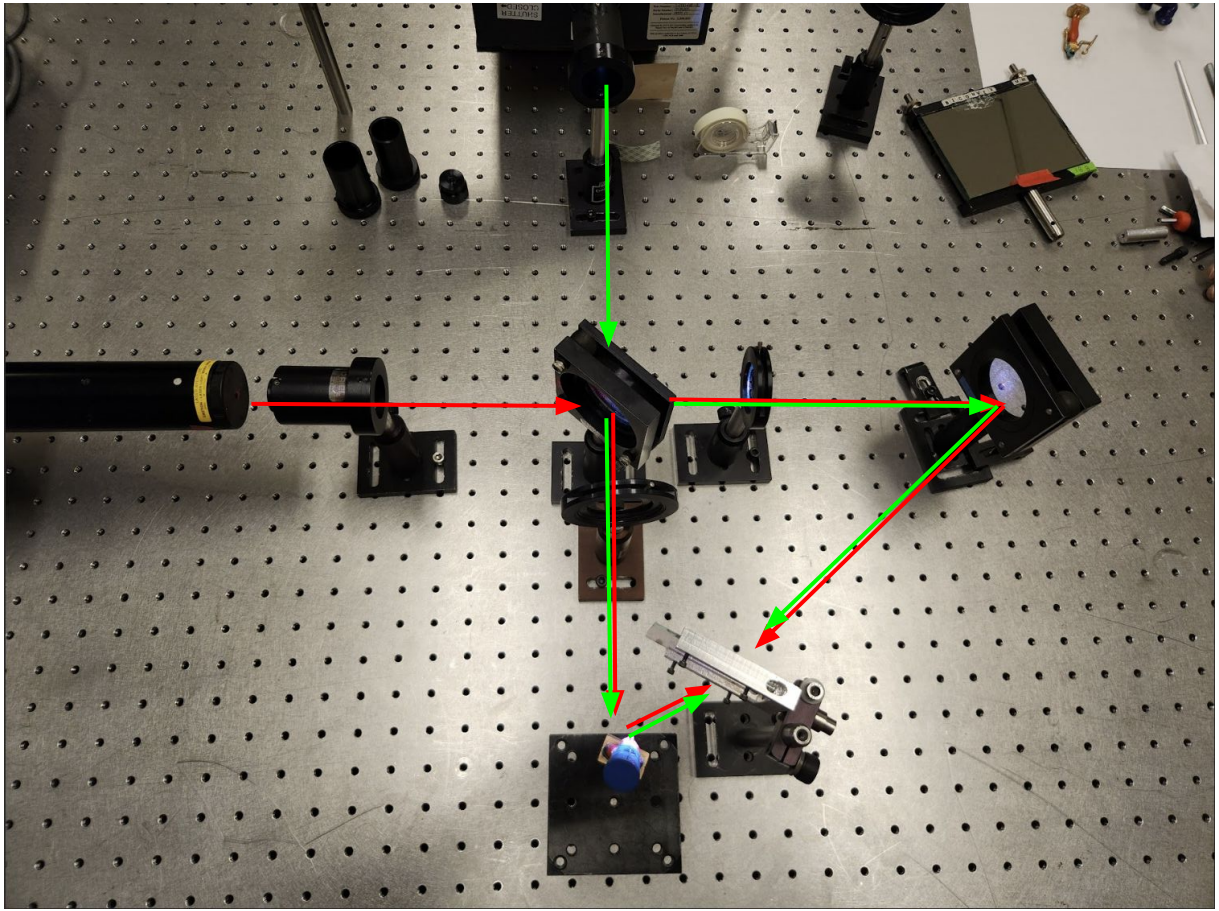
Setup


Multimode Laser
Beam Expanders
Beam Splitter
HeNe Laser
Mirror
Optical Irises
Object
Recording Medium

Procedure

Experiment 1

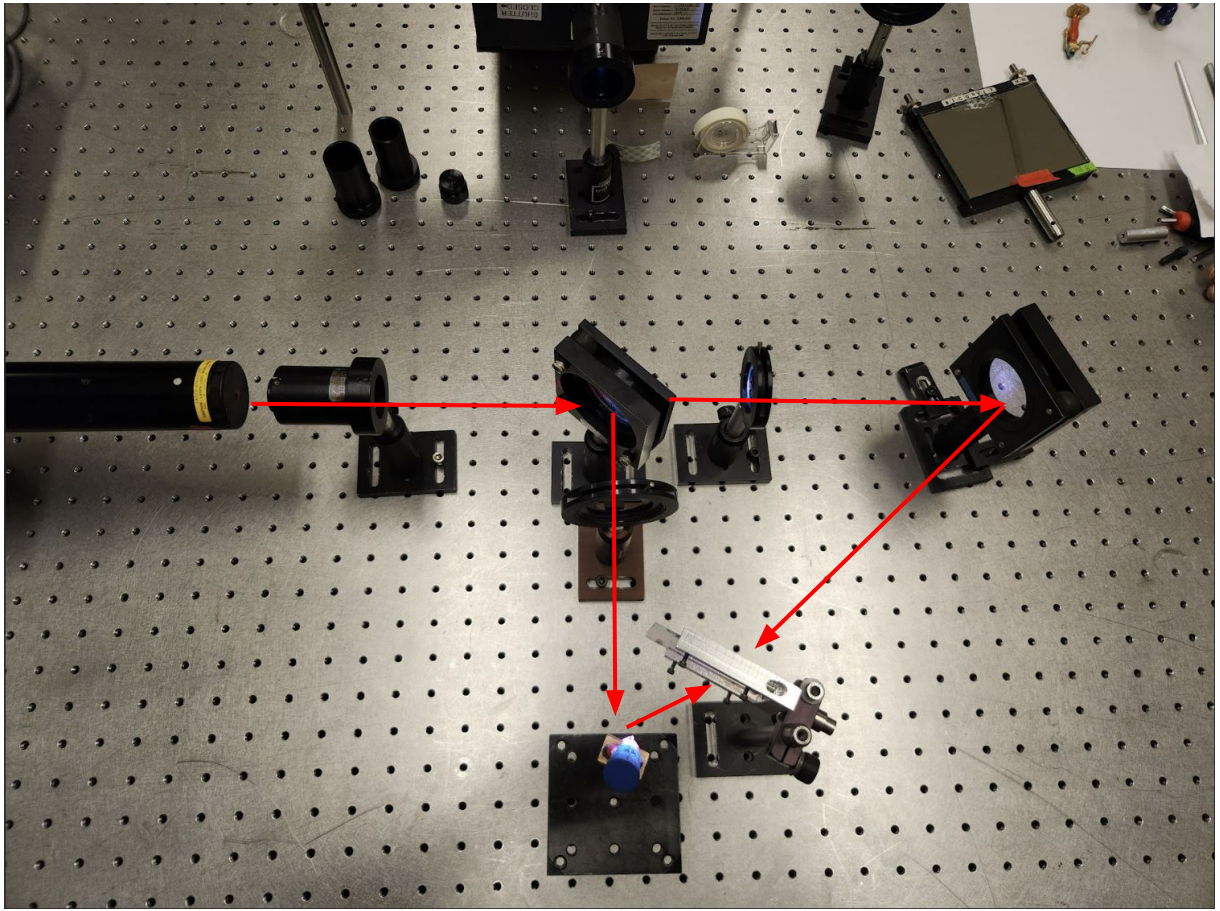
HeNe laser and Argon laser write simultaneously



Procedure

Experiment 2

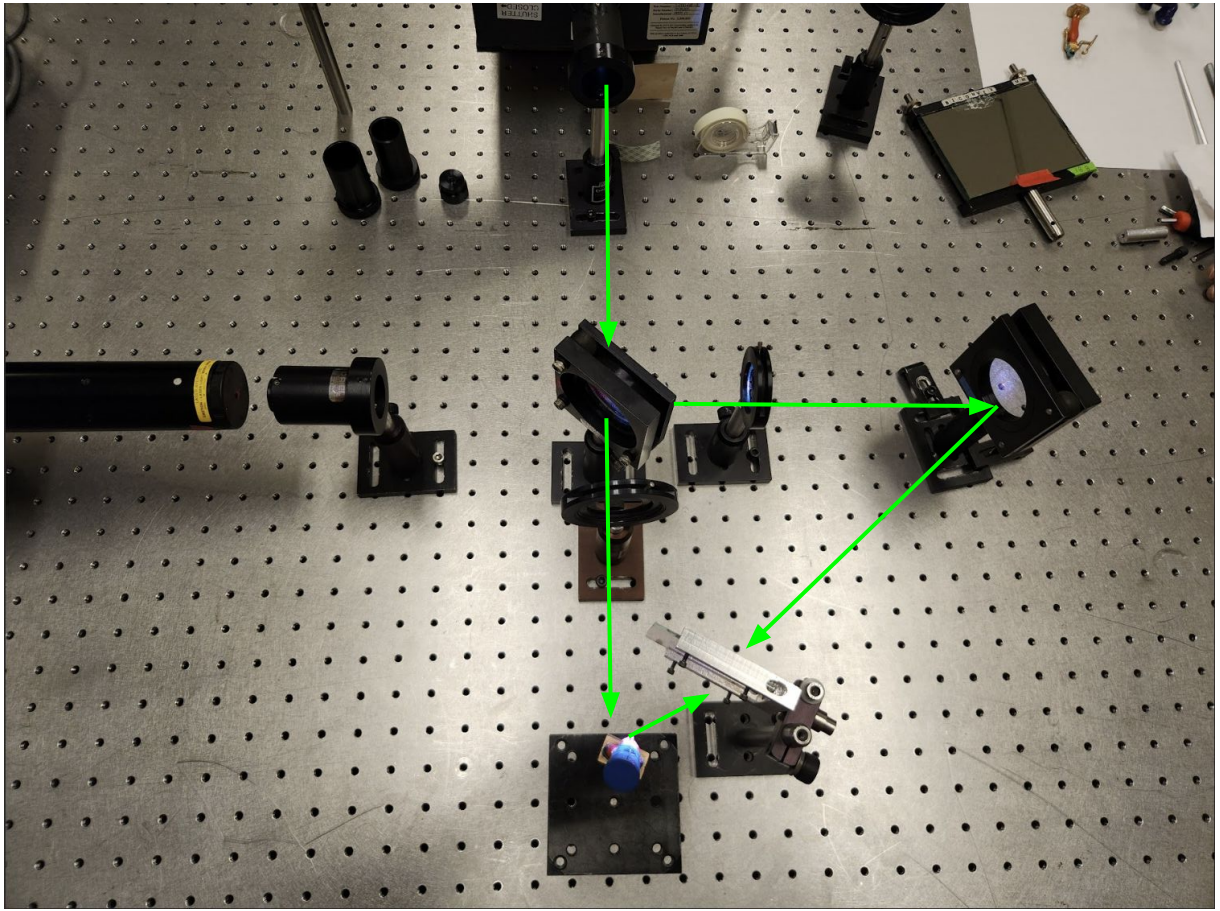
HeNe laser and Argon laser write separately



Procedure

Experiment 2

HeNe laser and Argon laser write separately



Procedure

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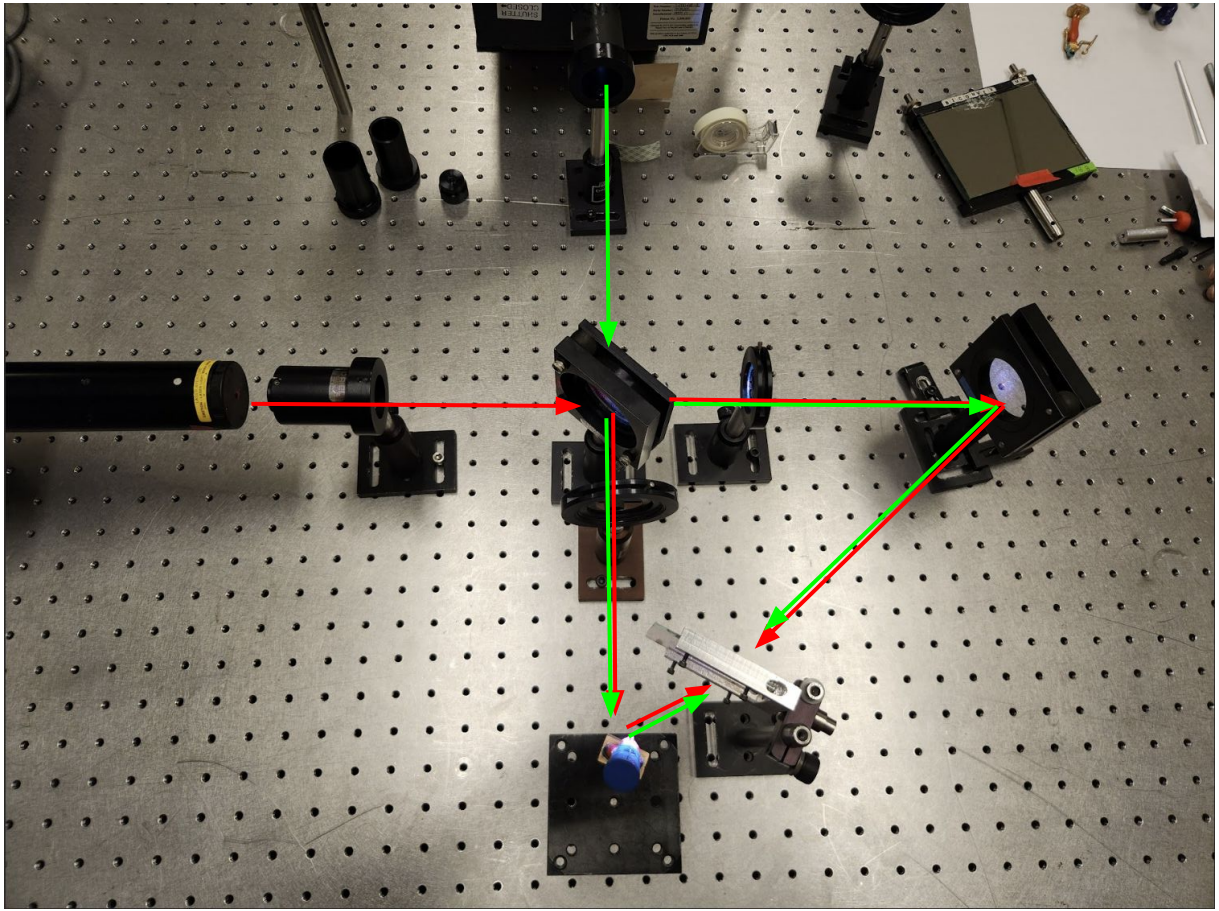
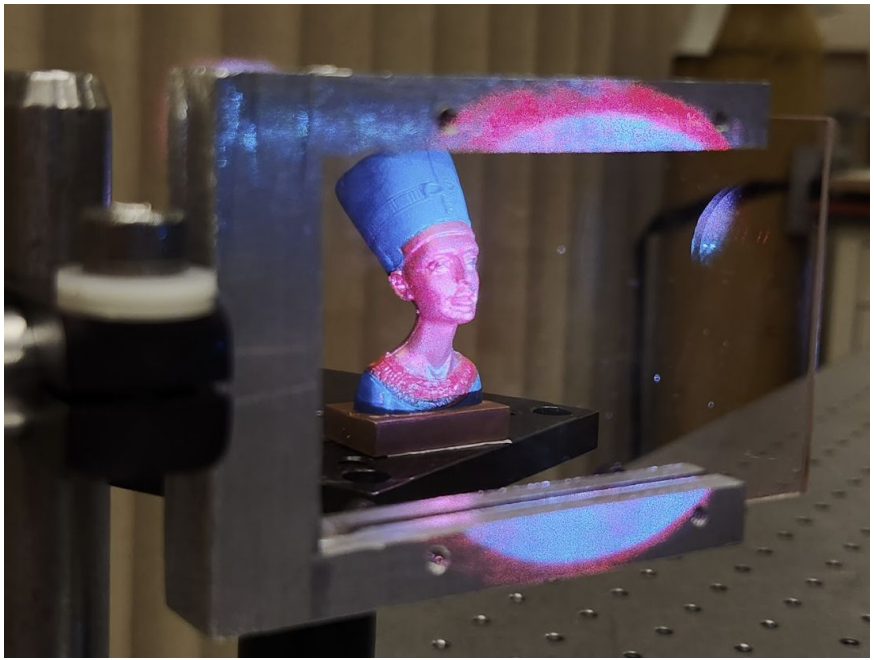


Writing Simultaneously



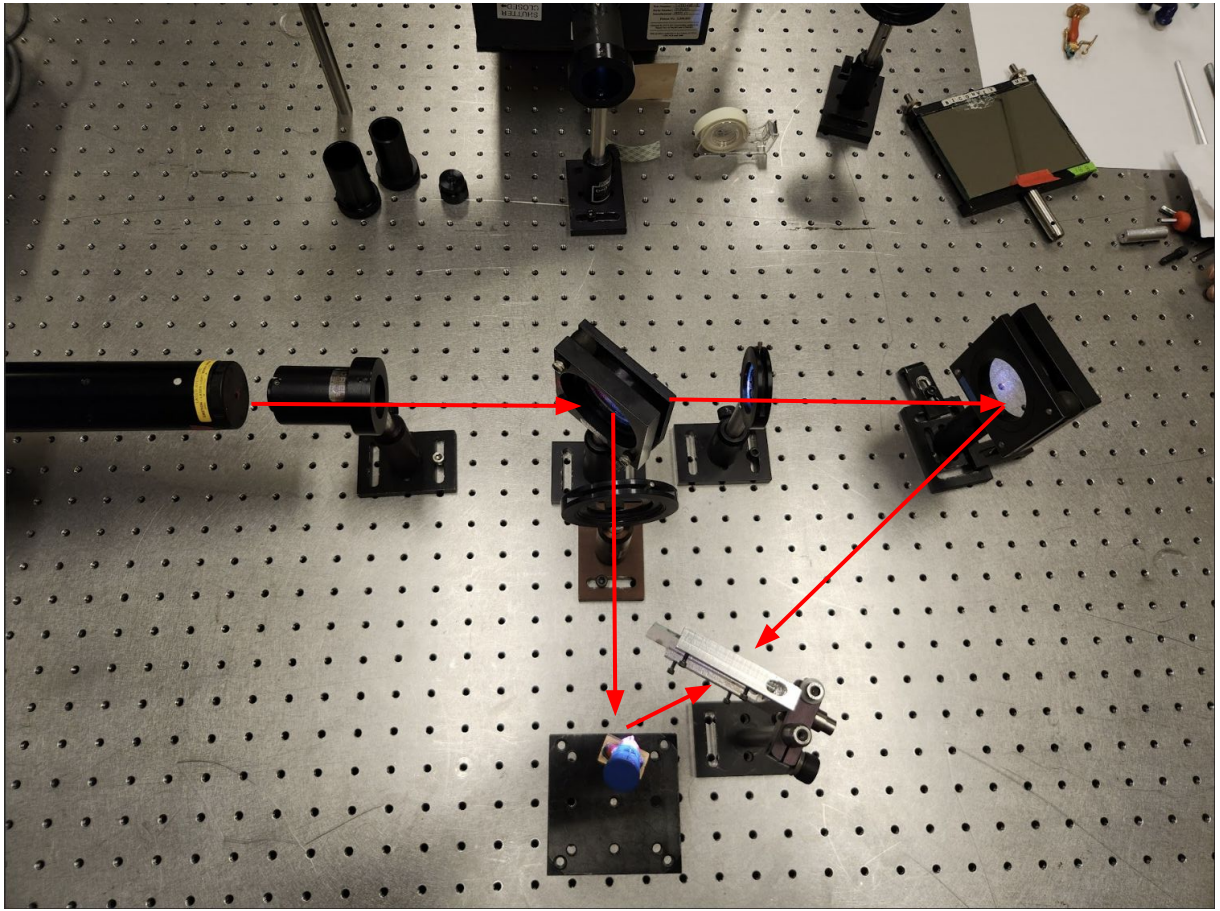
No hologram formed

Why?

Troubleshooting required

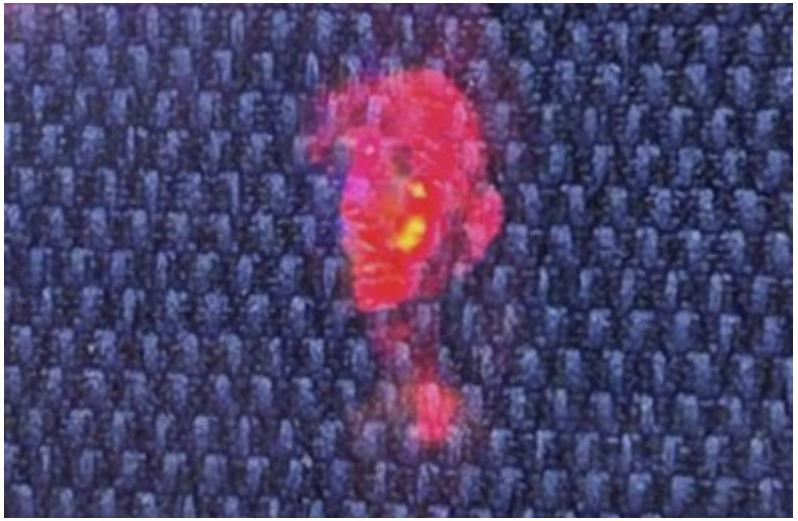
Troubleshooting

Writing with only red HeNe laser

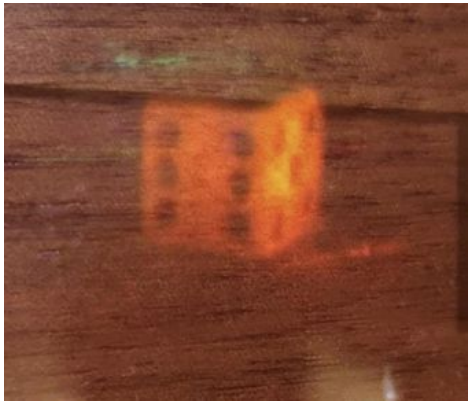


Results - Red

- HeNe Red Laser
  - High resolution hologram
  - Exposure time: 2 minutes
  - Guessed exposure time

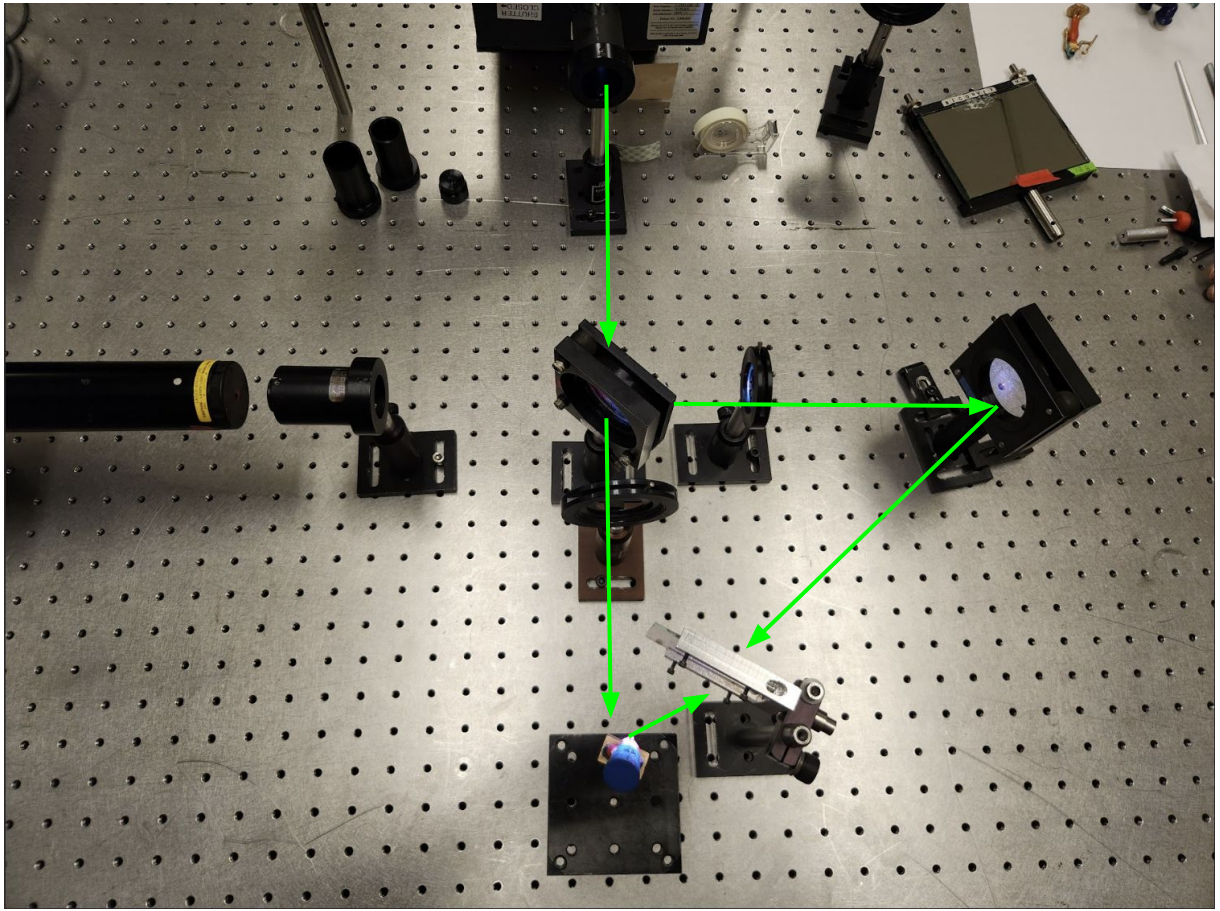


Individual Red Laser Test



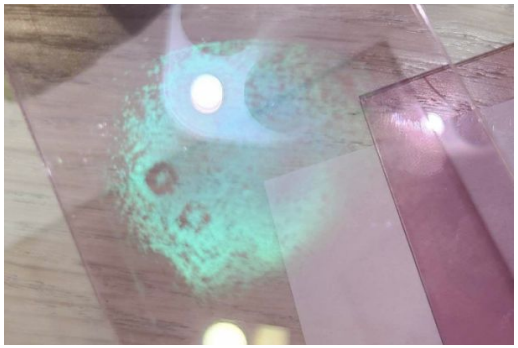
Troubleshooting

Writing with green laser only



Results - Green

- Argon Multimode Laser
  - Multimode worked
  - PROBLEM: cooling system → vibrations



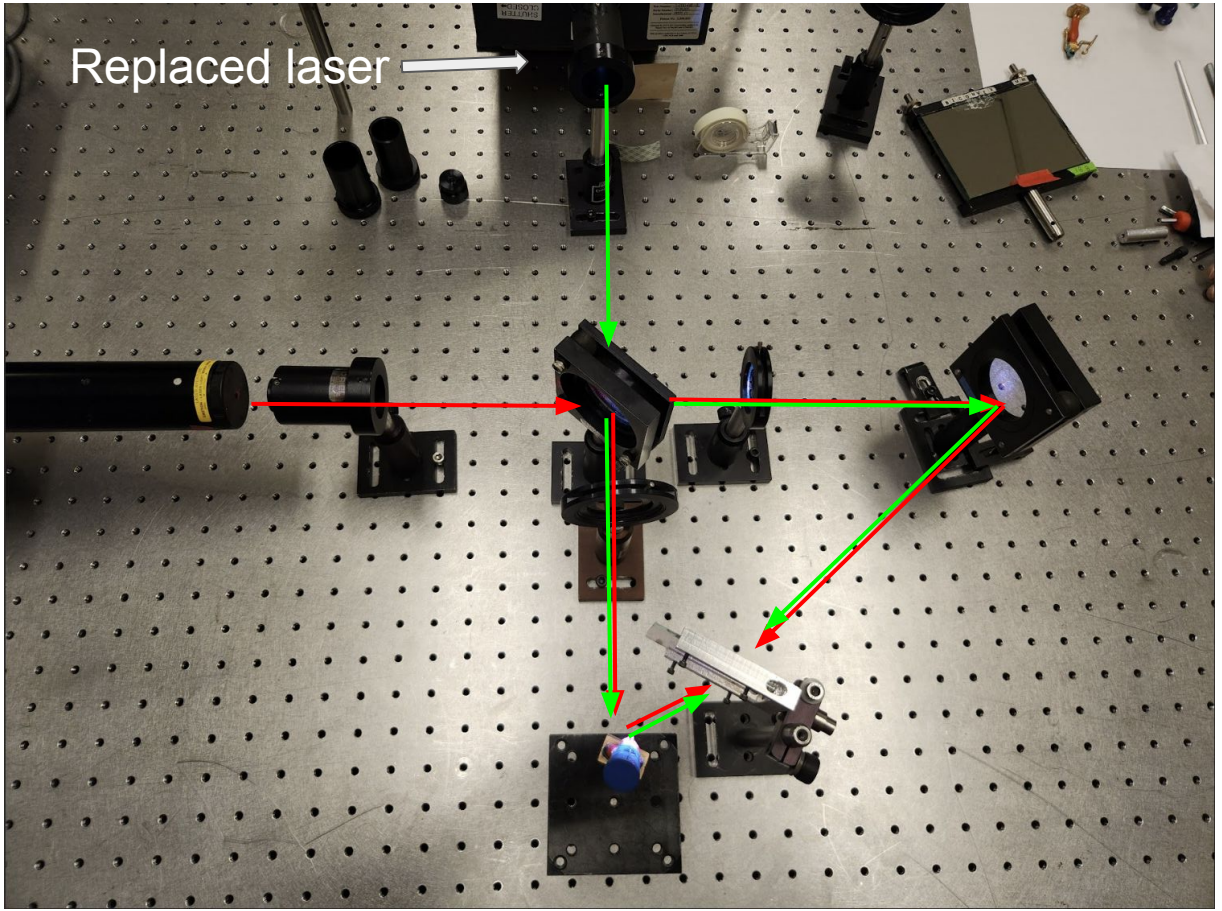
Multimode Laser Result

- Replacement Green Laser
  - Green only
  - Power not adjustable
  - Concerns with coherence length
  - Write time: 3 minutes

Replacement Laser Result

Repeating with New Laser

Replaced green laser with a smaller one - no vibrations



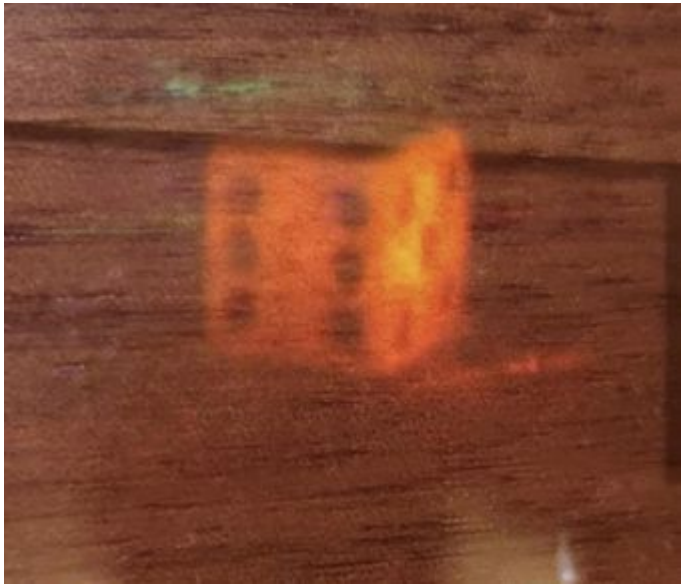
Results - Red and Green

Individual Exposures

Simultaneous Exposure

Conclusion: individual exposures better

Effect on Color



Red-only hologram

Red and green hologram

Notes on Equipment

- Manufacturer Notes on Emulsion Material
  - Lifetime: minimum 12 months
    - Unideal holograms from April 2023
  - Recommended exposure parameters
    - Blue - 80 mJ/cm2
    - Green - 30 mJ/cm2
    - Red - 20mJ/cm2
    - Guess exposure time
  - “Instant”
    - Developing phase - chemical baths
    - Potential tradeoff between quality and convenience
- Lasers
  - No online specs sheet – perhaps too old?
  - Can probably guess exposure time

Future Directions

Adding blue

- Put Argon on another table
- Still noisy

Optimize exposure time

- Ball-parked duration and power
- Fine tuning

Better write setup

- Larger write beams
- Object much closer to emulsion
- Optimize laser power