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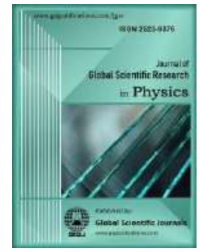

Laser Beam Measurement in Nd Glass Rod by the CCD Camera

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A R T I C L E I N F O

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A B S T R A C T

In the research study the quality factor of the (M2) laser beam in a laser glass rod and the thermal effects of xenon light on the beam shape and laser intensity. Also studying the behavior of the laser rod as a thermal lens formed inside the laser rod.

1. Introduction

This glass rod has many characteristics that distinguish it from other host crystals used in solid-state lasers, as it is distinguished by its ability to insulate, it can be deformed in uniformly high concentrations, and it can be manufactured in different and large sizes [1]. One of the properties of glass is that it has poor thermal conductivity compared to other crystalline materials. This factor leads to thermally induced double refraction and optical distortions in the laser rod when using high frequencies, which leads to the appearance of thermally induced lens effects[2].

The emission lines of the ions used as doping materials in the glass crystal are wide, so that short pulses of light can be obtained. They also allow a large portion of the energy to be stored in the amplifying medium for the same linear amplification factor[3].

Laser systems (Nd-Glass) are considered an important means of generating high laser frequencies used in studying plasma and nuclear fusion programs, as the power ranges from several kilowatts to much more than that, and because of this high energy level, the electrical energy entering is also high and leads to increased

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heat. In the glass rod by approximately 71%, this temperature level leads to thermal stress and serious optical distortions in the output laser beam through the generation of thermal lensing and double refraction effects [4].

We mention the most important sources for heating the rod in an ideal way, as the source used for pumping has emission beams that match the absorption beams of the laser rod, so a xenon lamp is used [5].

There are multiple absorption processes that heat the rod (Nd:Glass) without participating in the level pumping process ($F_{3/2}$) of the nydium atom (Nd).

We mention some of these sources[6]:

1- Absorption of ultraviolet rays by the host material (glass) if a lamp beam (Uv) of wavelength (λ<400𝓜m) is transmitted by an ion (Nd) where (Uv) is not filtered out.

2- Absorption of a beam (IR) of wavelength (λ > 1.4 𝓜m) by an ion (Nd) where ($I_{9/2} \rightarrow I_{15/2}$, $I_{13/2}$)

3- Absorption by impurity atoms that do not transfer their energy to (Nd) ions, and impurities such as (OH) are flipped to the ($F_{3/2}$) level in (Nd) [7].

4- Use a sodium or xenon source. Signal distortion: The optical signal propagated through the laser amplifier is distorted as a result of a number of physical processes that are divided into: spatial distortion and temporal distortion [8].

2. Parts of the System

The system consists of a He-Ne laser, which has a wavelength (λ=632.8nm), a glass rod (Nd:Glass), dimensions (Φ=4mm,10cm), and a refractive index (n=1.531), an electric oven with a controller, a temperature sensor, and a lens with a variable medium.

Figure (1): show Parts of the system

As we observe during heating, the glass rod is isolated inside the convection oven using a thermal insulator, and the process of measuring the temperature is carried out by placing the head of the thermocouple and attaching it to the outer surface of the glass rod.

3. Result and Discussion

We have assembled a CCD camera-based system that is capable of measuring laser beam quality on a single-shot pulsed basis. The system has been tested by using a He–Ne laser beam with added spatial distortion.

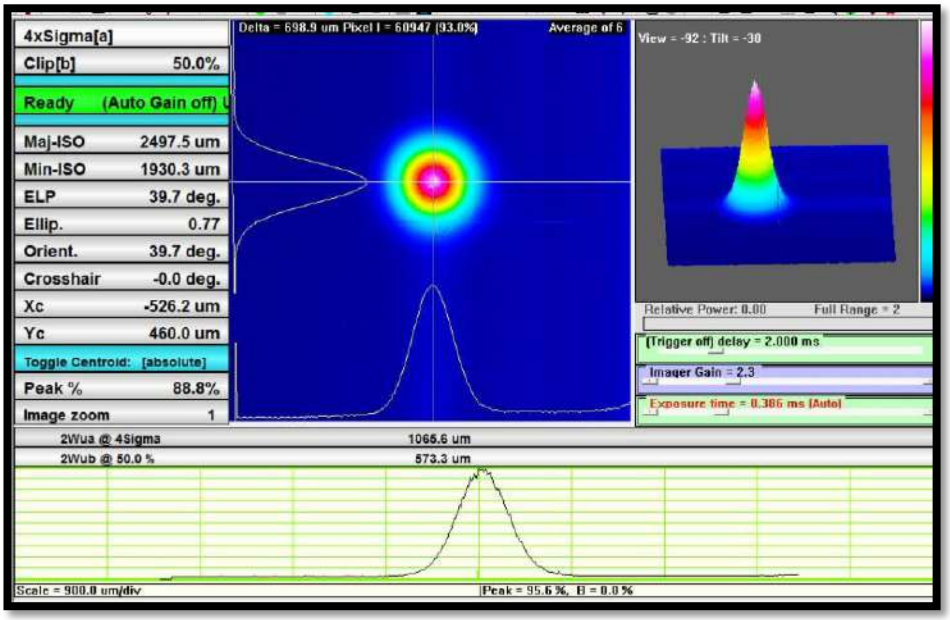


Figure (2): Gaussian pulse without dispersion.

Figure No. 2 It is a standard form for the laser pulse plateau and is Gaussian shaped, where (M^2) standard .

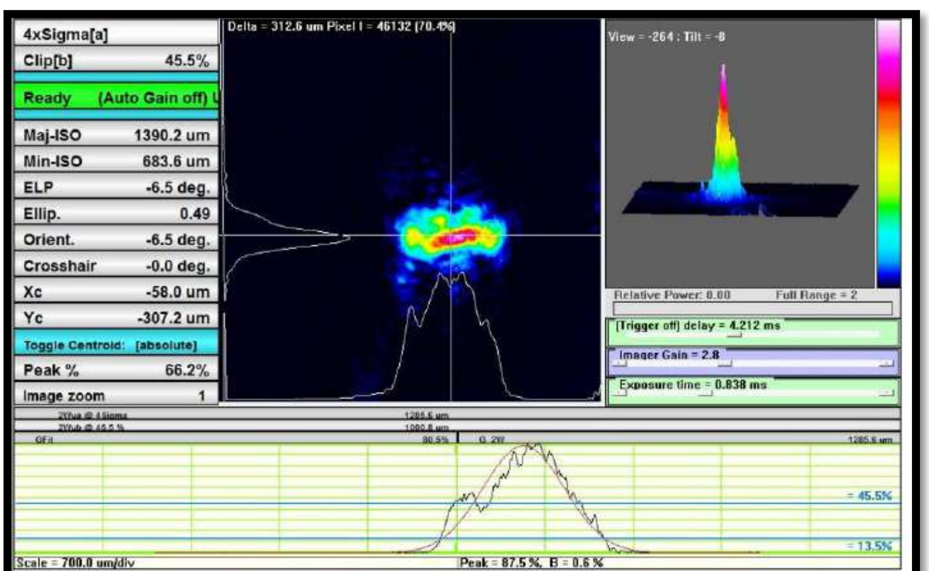


Figure (3): attenuation effect at 10 c°

Figure No. 3 We obtained this shape after ten minutes of heating (10) degrees Celsius, and we notice a distortion in the curve as a result of the scattering of laser light in the laser rod (Nd:Glass)

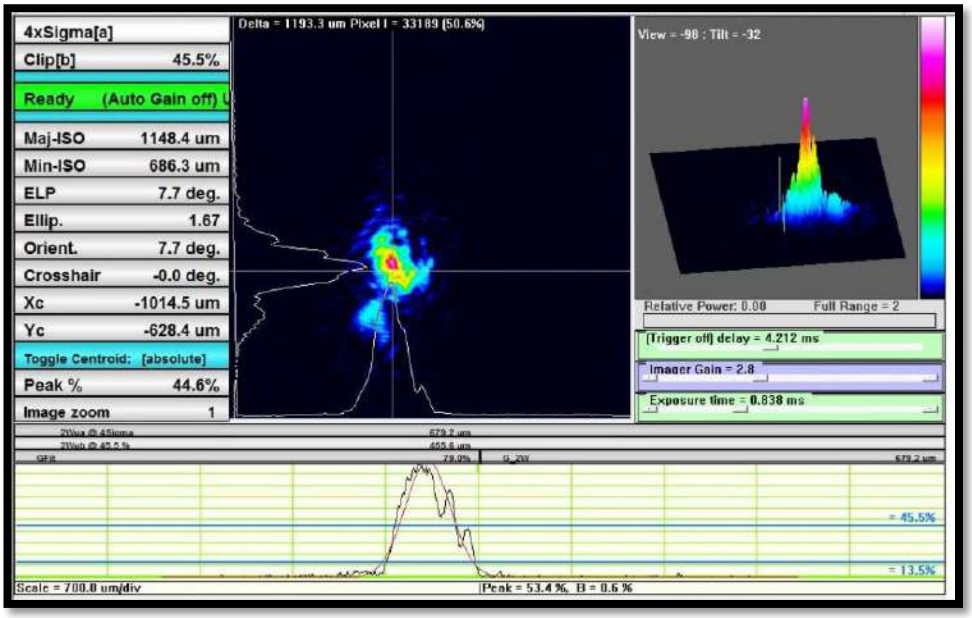


Figure (4): attenuation effect at 20 c°

Figure No. 4: Twenty minutes after the penis is exposed to laser rays, we notice an increase in the deformation of the curve (Gaussian), resulting from dispersion inside the penis.

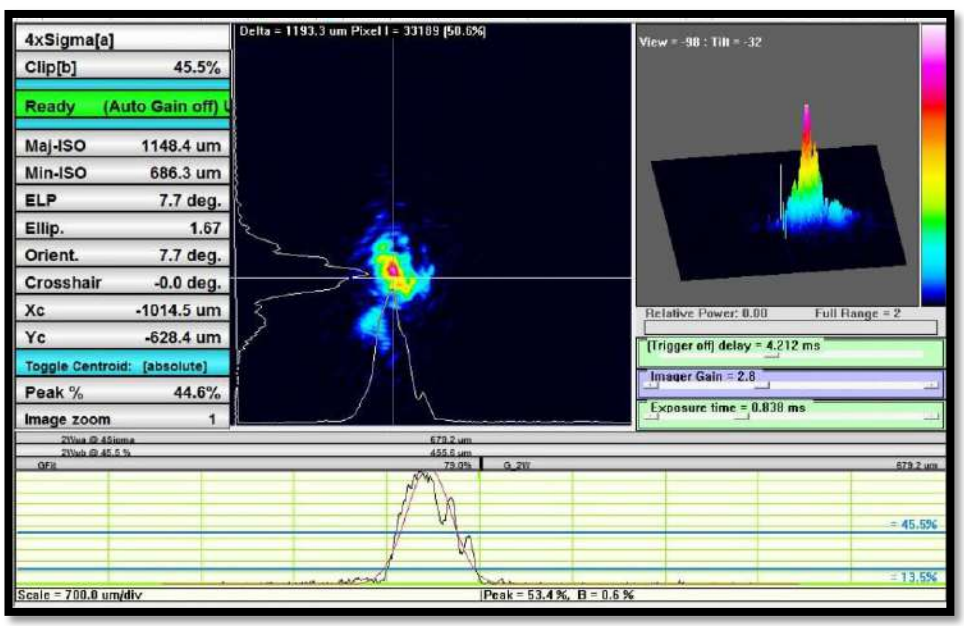
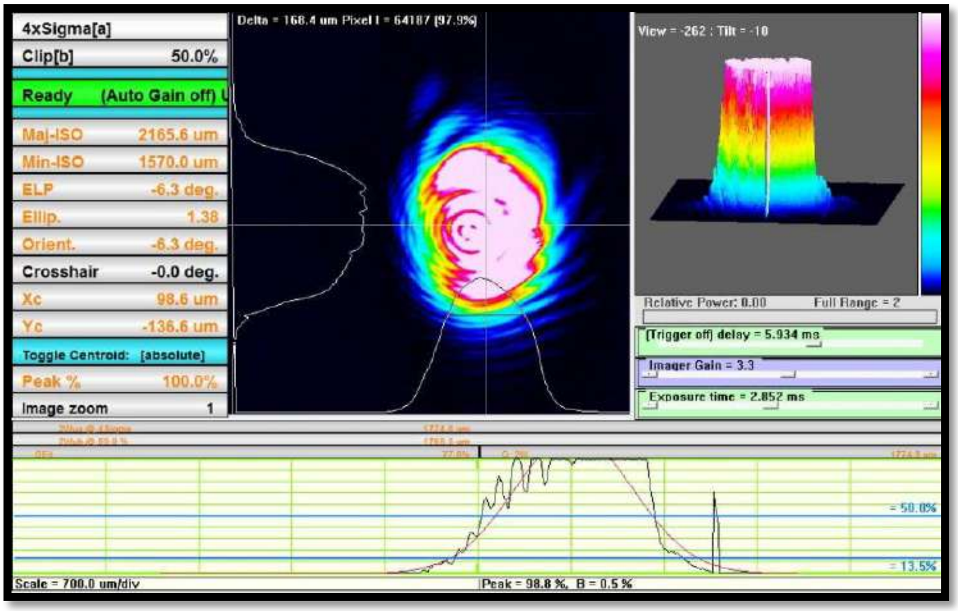


Figure (5): attenuation effect at (40 ,50 and 60) c°

Figure No. 5: After the rod is exposed to a light lamp (sodium) for thirty minutes, we notice an increase in distortion as a result of the increased dispersion of light inside the laser glass rod, and so on for the other temperatures, 40, 50, and 60. The higher the temperature, the closer the rod is to turning into a soft lens. We will discuss that later. From this, we notice, according to the equation ($\mu^2 = \frac{\pi w_\circ \theta^\circ}{\lambda}$), that the quality factor varies according to temperature, as the higher the temperature, the lower the quality factor (M^2) .[8]



In this measurement, a fast camera (CCD Camera) was used to record the interference fringes generated by the reflection of rays from the first and second faces of the laser rod, as the change in the emerging fringes indicates the generation of the thermal lens.

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