MEASUREMENT OF THE POINTING STABILITY OF THE DIFFERENT OPTICAL LASERS AT FLASH

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Abstract

In this report we want to give an impression of the laser manners , the imaging steps with programming and using different kind of laser sources in an experimental arrangement. The aim is also observing the spatial variations of the laser pulses.

1.Introduction

In order to observe movement behaviour of lasers in the laser hatch ,I wrote a fitting program to fit a Gaussian function by mathlab. I used two measurement methods.

2.Methods

Laser beams are sent to the experimental hall.There the spatial jitter was measured with two methods; profile measurements in the near field and measurements in the far field.The farfield measurement gives the angular varition of the laser.The measurements were made using a CCD camera.The Profile measurement gives significant information about characteristical shape of the laser. The ***far field*** measurement set up is shown in Fig.1 and Fig.2.

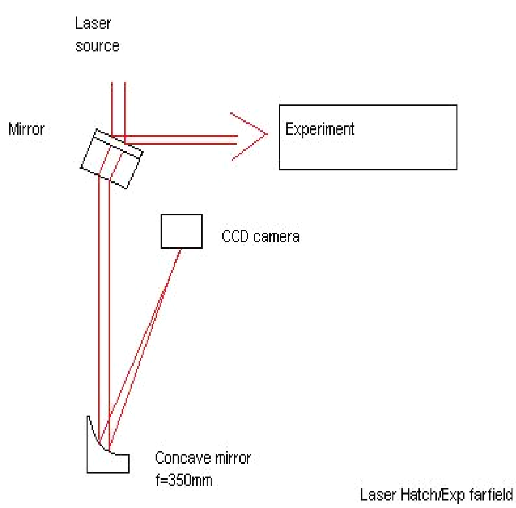

Fig. 1 Far field measurement set up.

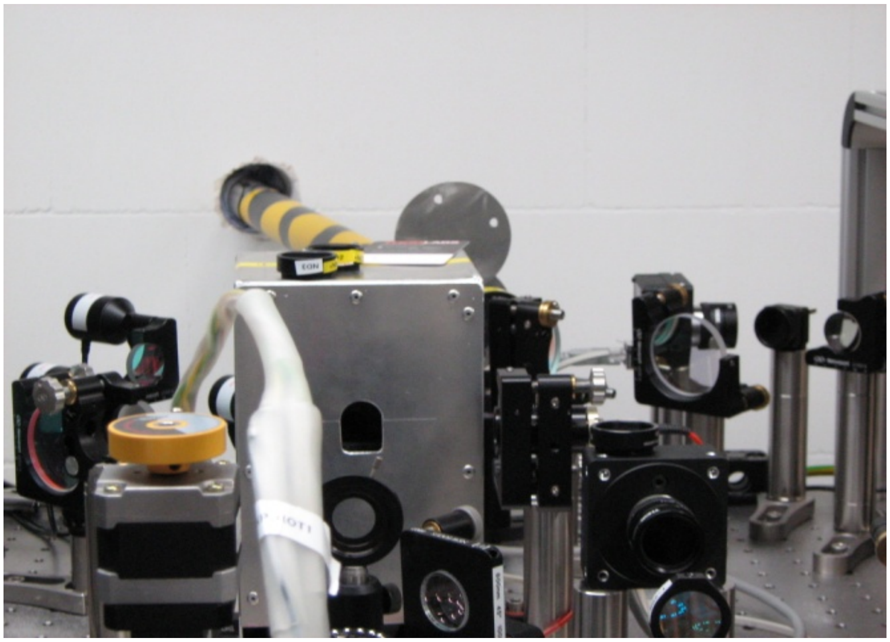

Fig. 2 Far field set up.

The far field measurement set-up includes a concave mirror which has focal length of 350mm.It was used for the *alignment* laser farfield measurement which was taken at BL2 in the experimental hall.A CCD camera was placed at the focus position of the mirror.A focal length of 500mm was used for *Titanium sapphire* laser inside the laser hutch.

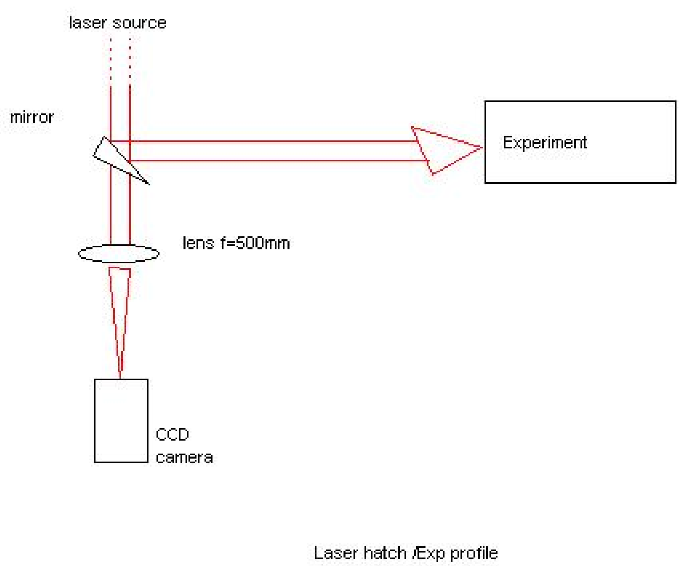

Fig. 3 Profile in near field set up

3.Using Laser Sources

In this experiment, three different laser sources were used.
The first one was an *alignment laser* and the other one was a titanium sapphire laser. The alignment laser is a semiconductor laser where an electrical current is converted directly into laser radiation. It has a wavelength of 635 nm and an output power of 1mW. Special thing with this alignment laser is that the light is coupled into an optical fiber. The other end of the fibre is the alignment laser source. Then, that is special laser fiber : “Single- mode fiber” having 5µm diameter . The output of Single- mode fiber generates a Gaussian beam profile.
The Titanium Sapphire laser consists of an oscillator and an amplifier. It’s used for producing very short pulses with 100 fs pulse duration. The amplifier is used to increase the intensity of the laser. An important property of a Titanium sapphire laser is that it's wavelength can be changed from 780nm to 820nm.The last laser sources was *Hydra focus* vacuum chamber is a amplifier system delivering25mjoules in100 femtosecond. which formed as three parts called sead laser,amplifier and booster.Sead laser produces weak laser pulses and send to amplifier region and after weak pulses amplified here sent to booster part where strong pulses formed.Hydra focus is a amplifier system delivering25mjoules in100 femtosecond.

4.Using Simulation

The programming presented in this work was done with Matlab, a software of Mathwork company. With this program the investigations of Gaussian function for fitting fluctuations of laser beam was done. A Gaussian function for one dimension is given as

$$Z = A\, e^{\left(-\left(\frac{x-x0}{a}\right)^{2}\right)} + c \qquad (1)$$

The results of programming are presented in beam postions and angular jitter movements figures.
In the laser hutch and in the experimental hall, I measured different sort of lasers and took thousands of laser images by CCD camera in order to observe and compare the stability of these lasers. Only by using the matlab program it was possible to automatically fit all images in a short time. Additionally it can be used for the calculation of the jitter movement of the laser beams.

5.Measurements and Results

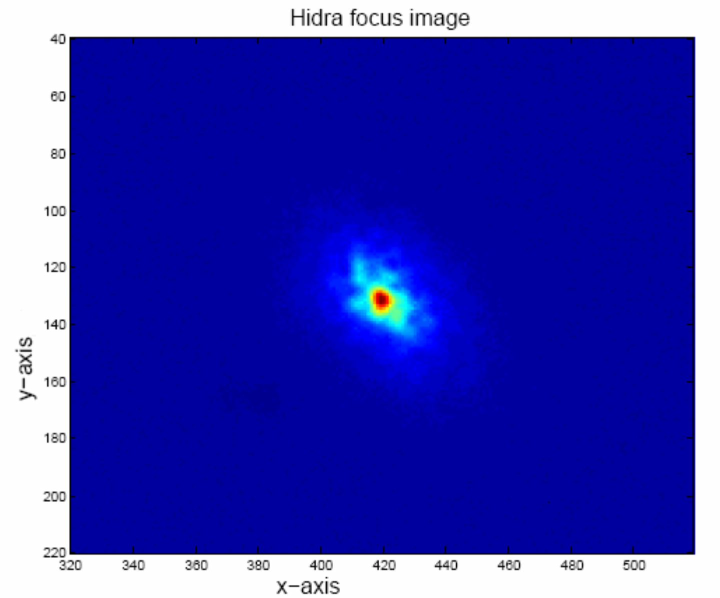

Fig.5 Hidra focus chamber Image taken at scattering screen in the experimental chamber

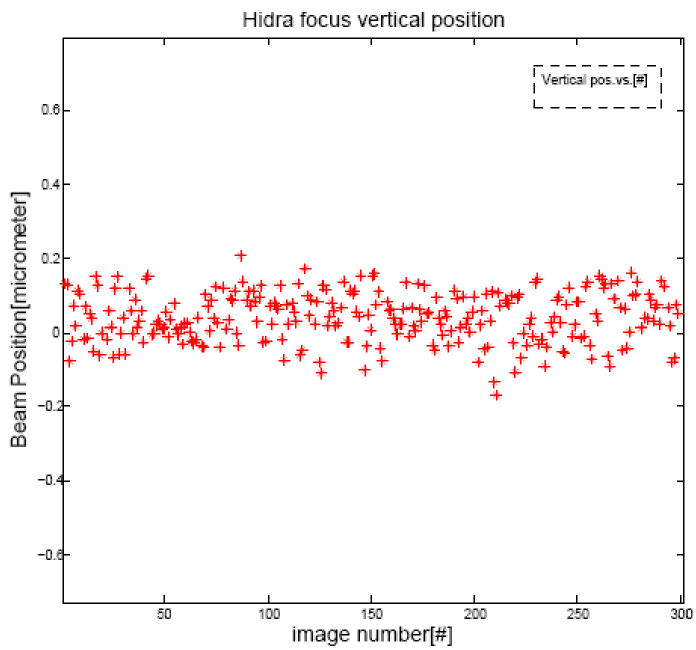

Fig.6 Result of fittng ,Jitter of the Hidra focus vertical position

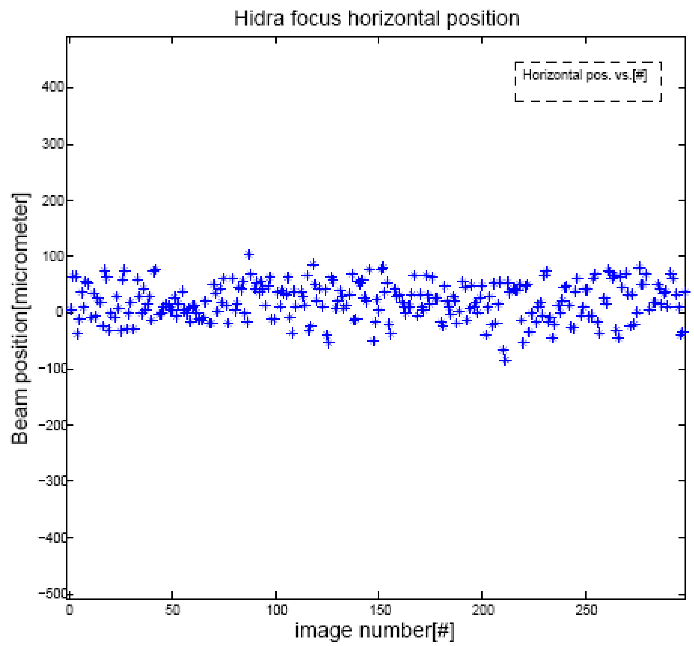

Fig.7 Jitter of the Hidra focus horizontal position

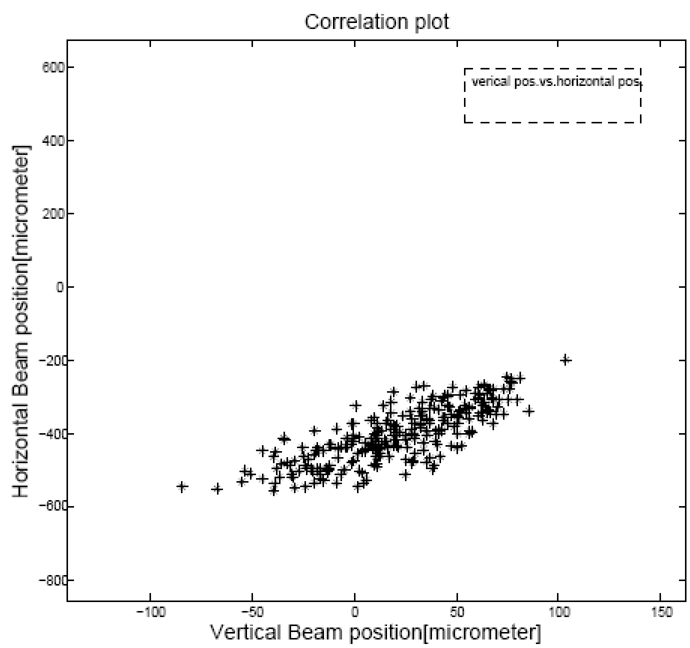

Fig.8 Correlation of Vertical and Horizontal jitter for Hidra focus

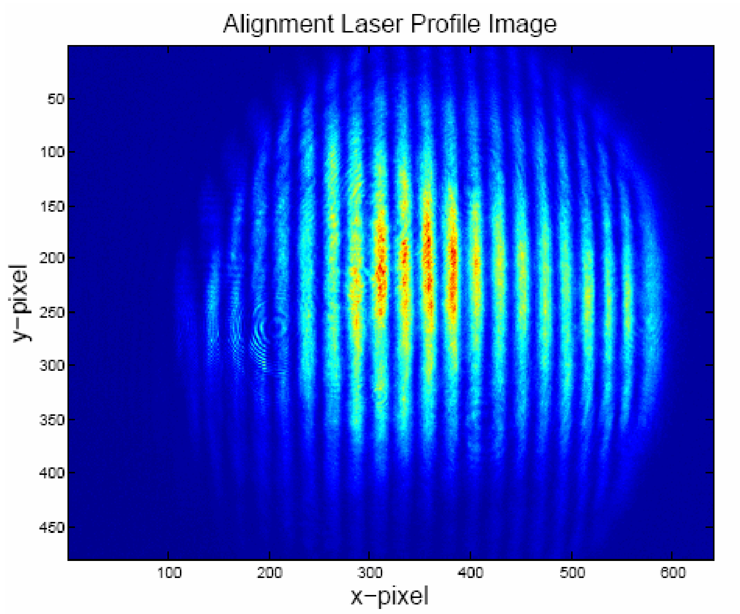

fig.9 Alignment Laser Profile measurement Image interference due to front and back side reflecting

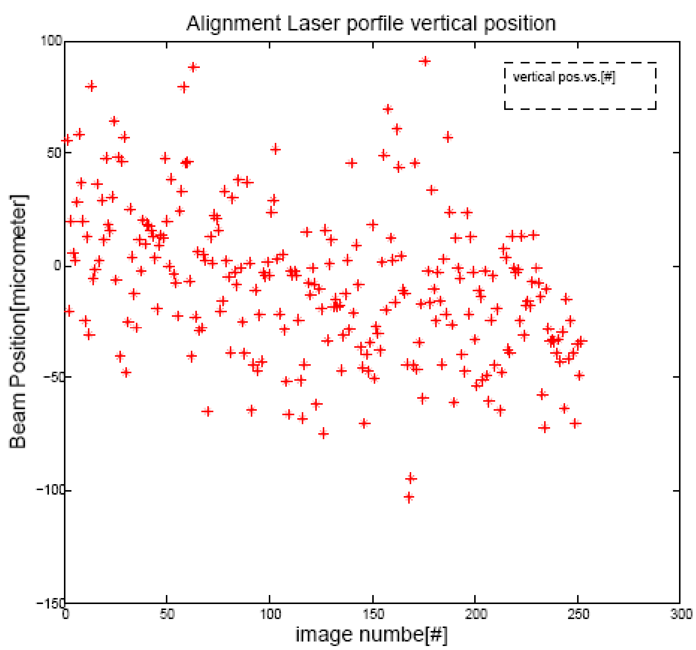

Fig.10 Result of fitting ,Jitter of the Alignment laser vertical position

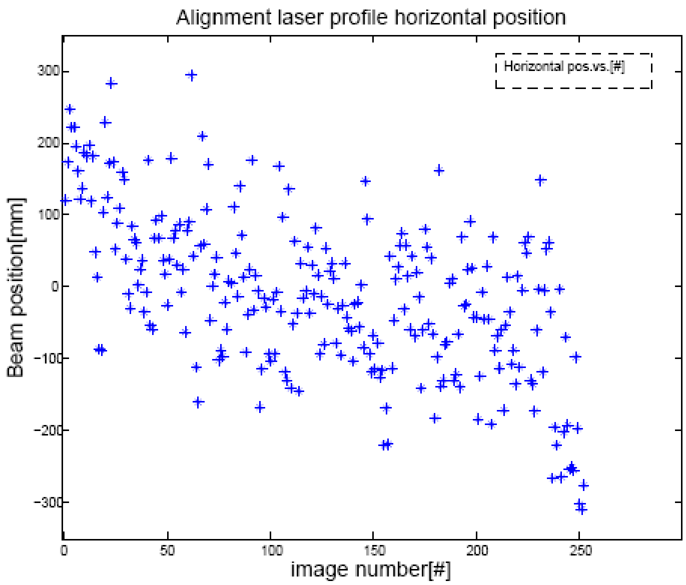

Fig.11 Jitter of the Alignment Laser Horizontal position

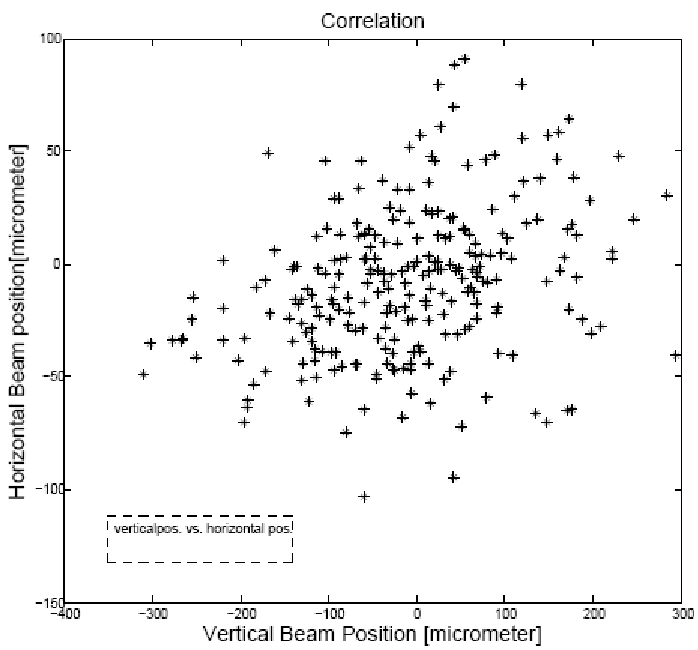

Fig.12 Correlation of Vertical and Horizontal jitter Alignment laser

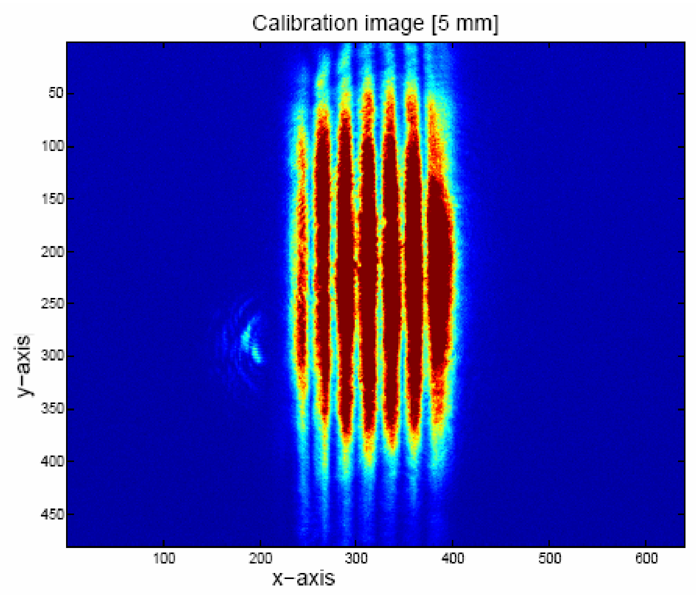

Fig.13 Alignment laser Horizontal calibration Image)

Calibration scale of Alignment laser image horizontal distance was 5 mm and 156 pixel.

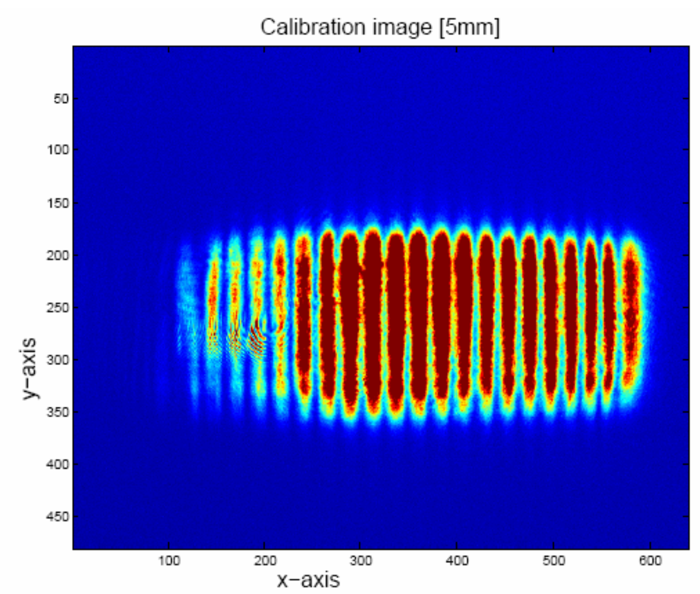

Fig.14 Alignment Laser vertical calibration Image

Calibration scale of Alignment laser image Vertical distance was 5 mm and 135 pixel.

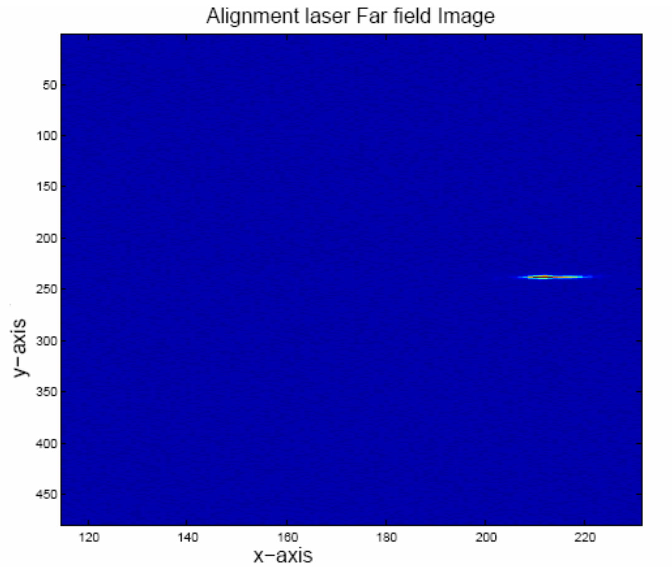

Fig.14 Alignment laser far field Image one spot on left

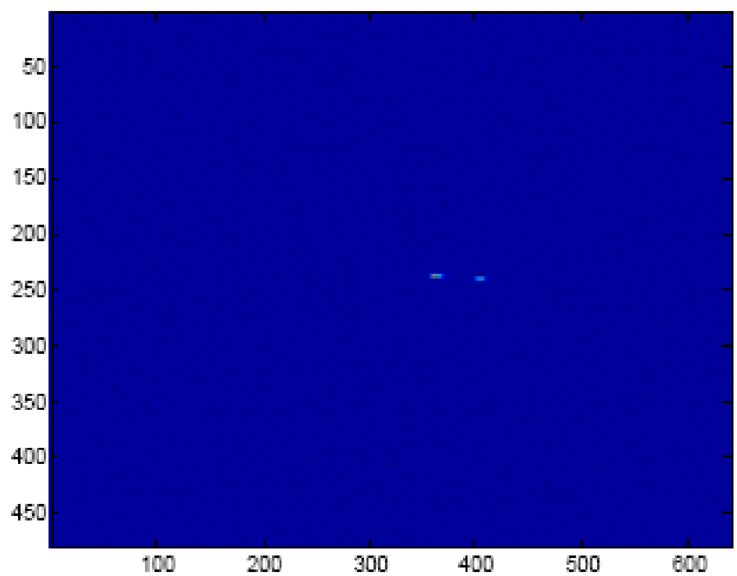

Fig.15 Alignment laser far field image double spot

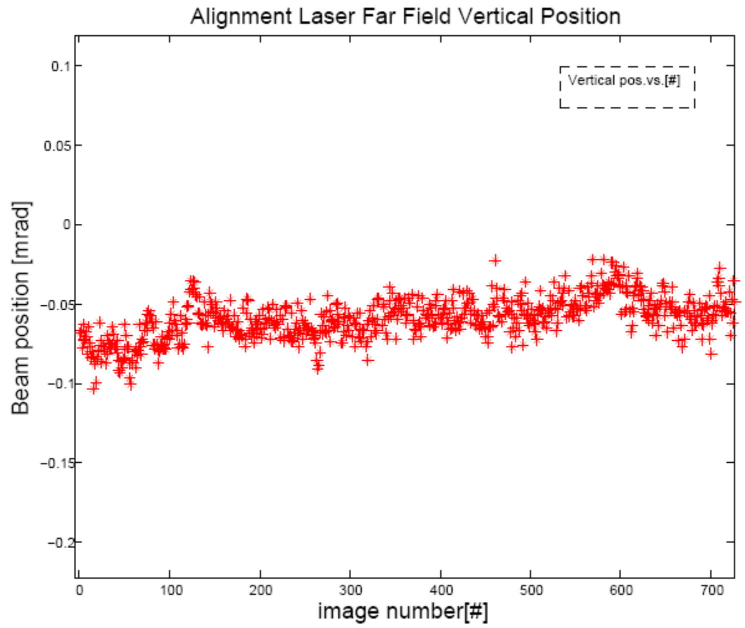

Fig. 16 Vertical angular jitter of the Alignment laser

Alignment laser far field vertical position graph,The angular jitter movement has created about -0.1 mrad .

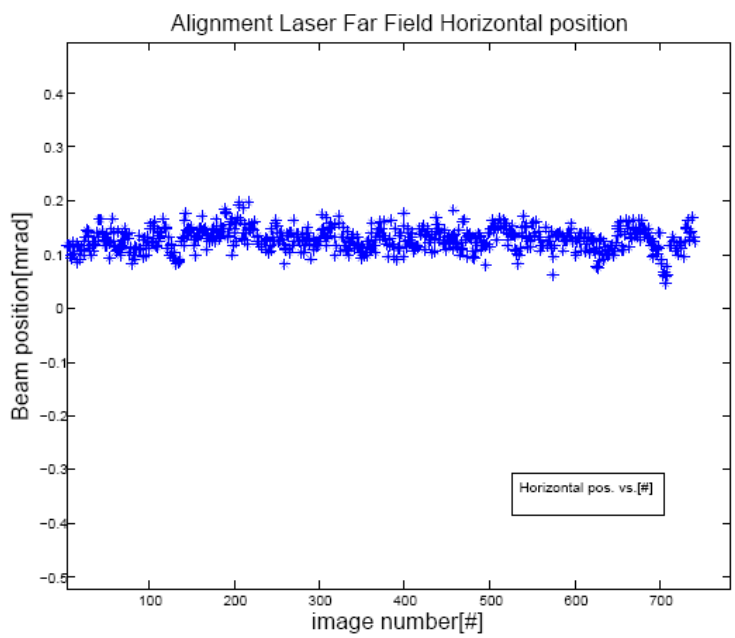

Fig.17 Horizontal angular jitter of the Alignment laser

Alignment laser far field horizontal position graph,The angular jitter movement has created between 0.1mrad.

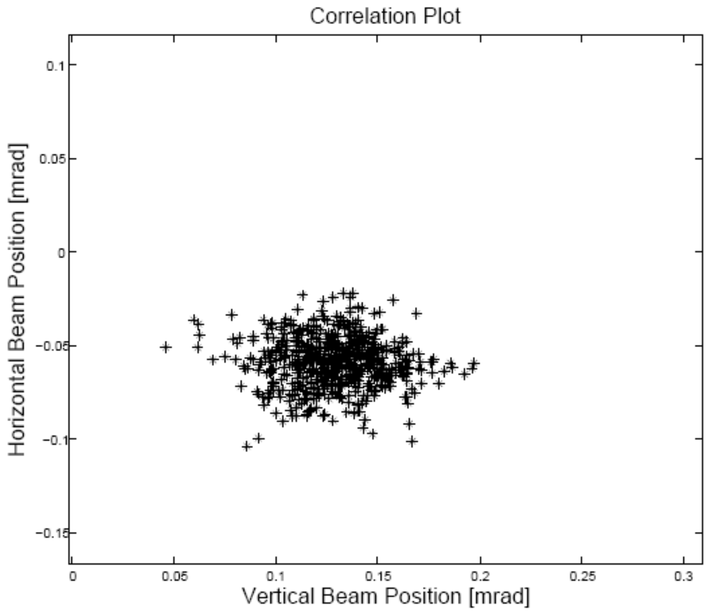

Fig.18 Correlation between horizontal and vertical angular jitter of the Alignment laser

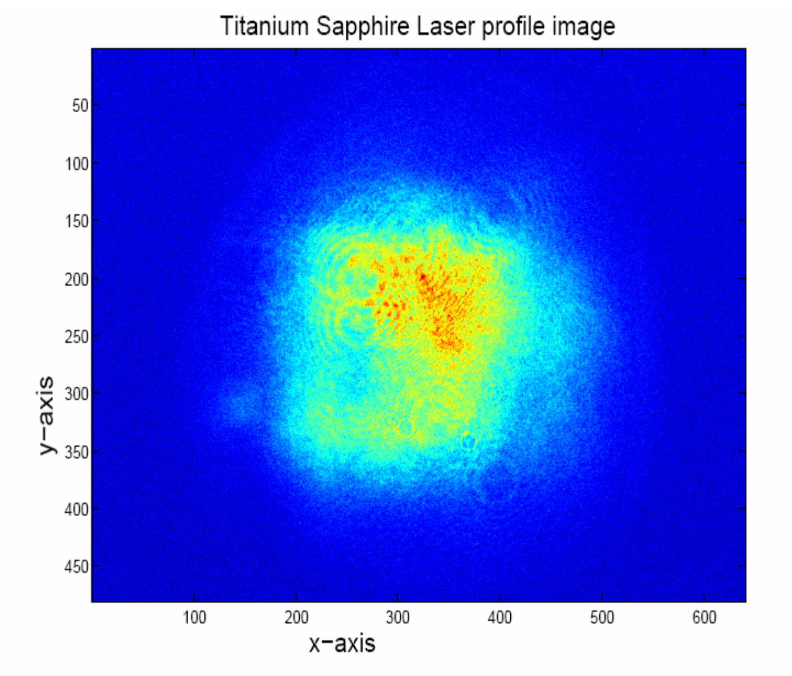

Fig.19 Titanium Sapphire laser iimage

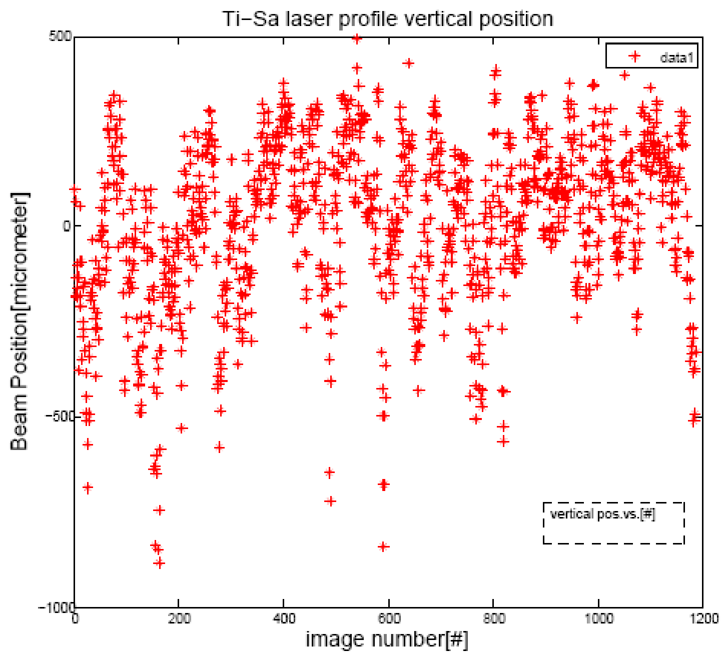

Fig.20 Jitter of the Titanium Sapphire laser vertical position

Titanium Spphire laser profile vertical position graph,The jitter movement has propogated about -500 micrometer and +500micrometer.

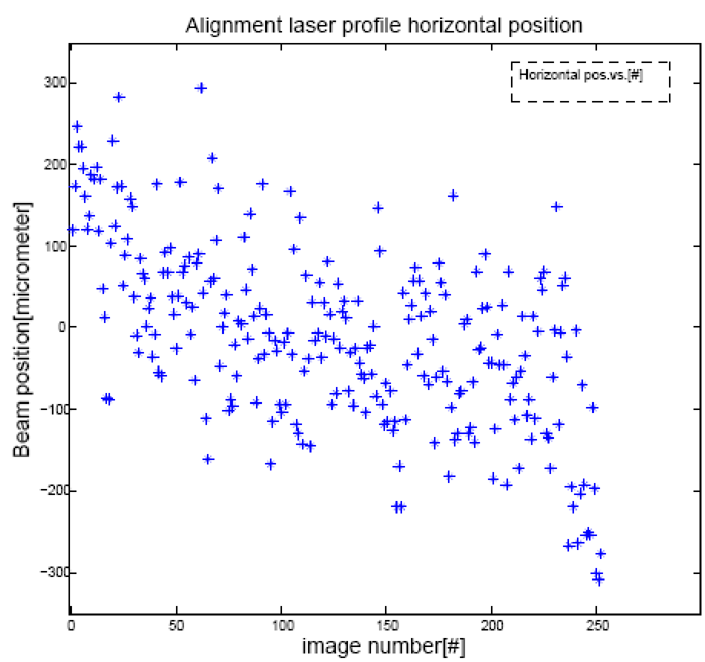

Fig.21 Jitter of the Titanium Sapphire horizontal position

Titanium Spphire laser profile horizontal position graph,The jitter movement is about -200 micrometer and +200micrometer.

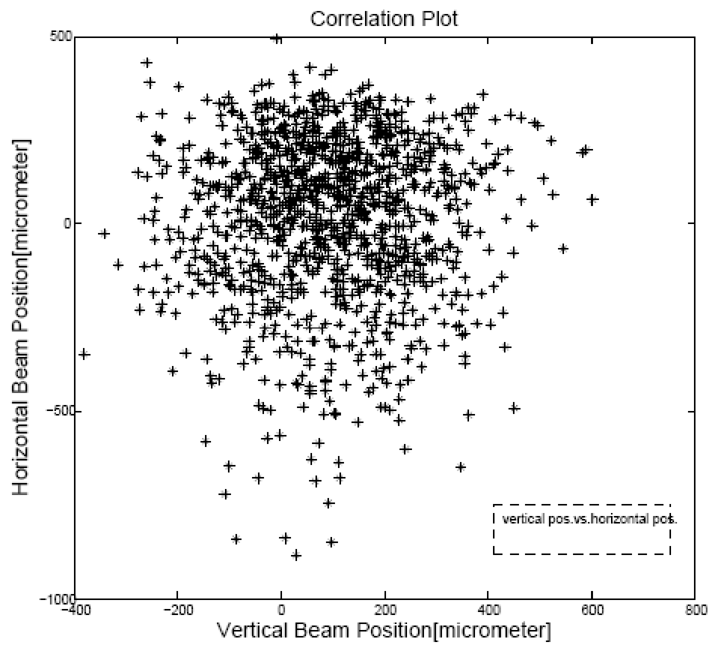

Fig.22 Correlation of Vertical and Horizontal for Titanium Sapphire laser

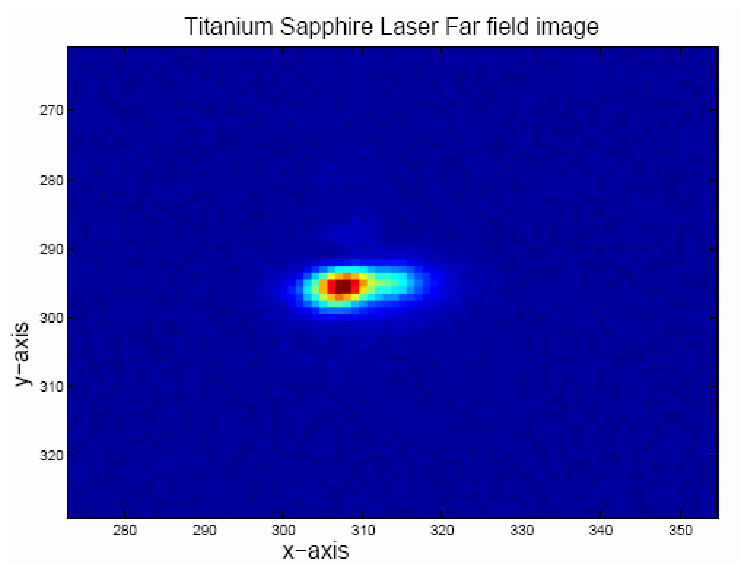

Fig.23 Ti-Sa Laser Image

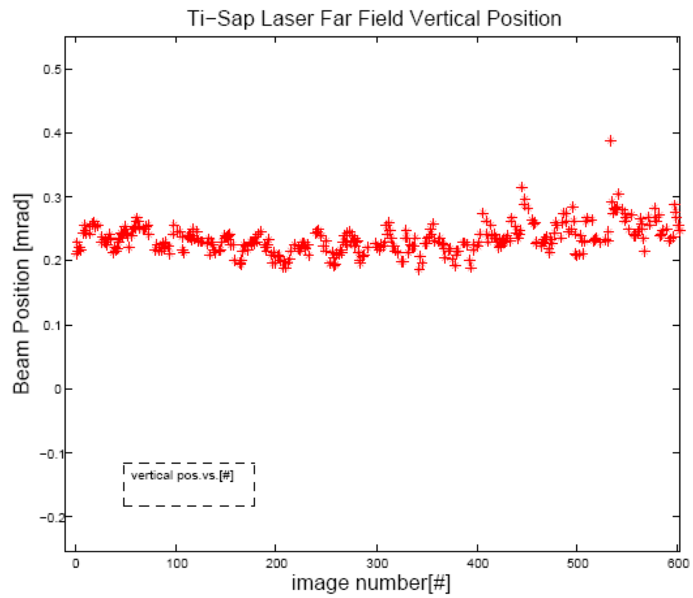

Fig.24 Vertical angular Jitter of the Titanium Sapphire laser

Titanium Spphire laser far field vertical position graph,The angular jitter movement has propogated between 0.2 mrad and 0.3mrad.

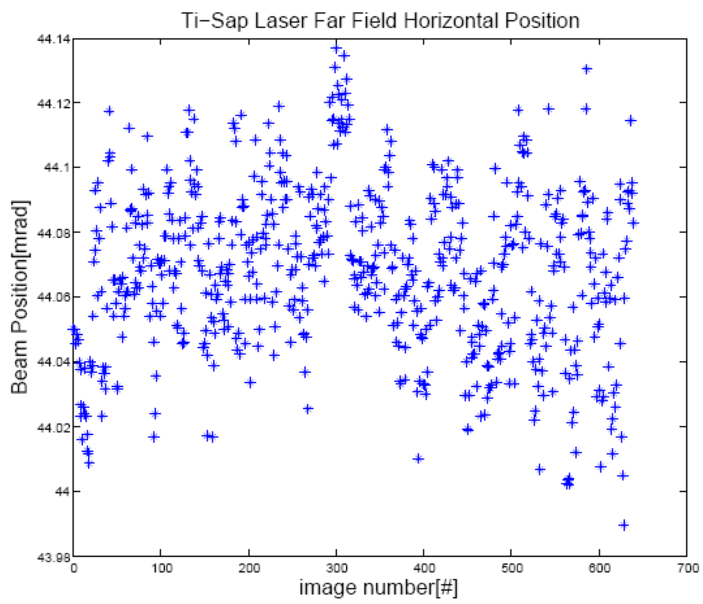

Fig.25 Horizontal angular Jitter of the Titanium Sapphire laser

Titanium Spphire laser far field horizontal position graph,The angular jitter movement is about 0.1 mrad .

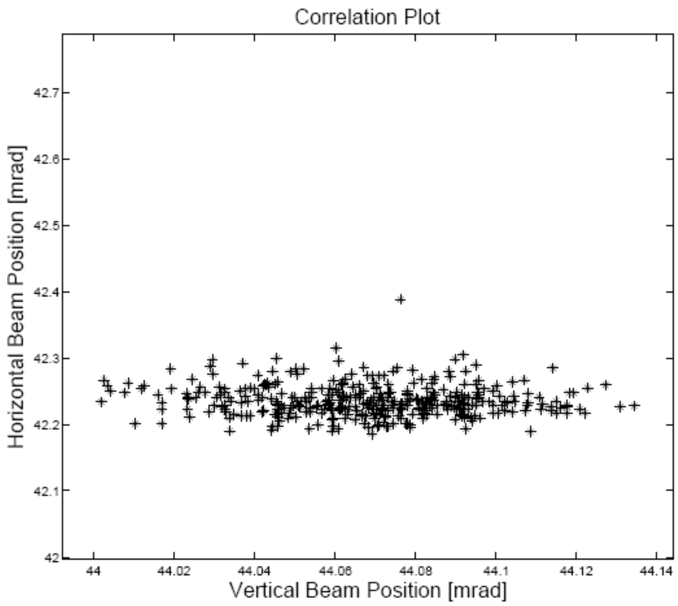

Fig.26 Correlation between horizontal and vertical angular jitter of the Titanium Sapphire laser.

Conclusion

Measurements; each image shows the spatial characteristical properties of the lasers.It is easy to notice that the differences between each others.Those differences depends on either intensity of laser or dust and dirt of the sensitive optical devices.For instance, the Alignment laser image has interefernce fringe patterns at profile measurements in the near field ,also it is easy to say the Alignment laser has very high intensity distribution in that colorful image *[Fig.9]*. Again the Alignment laser has interesting situation at far field measurements image [Fig.14].In this image had double spots laser light and I cropped it into one spot.We obtained ellittical shape of the alignment laser.The intensity is lower profile measurement in near field.

If there was double spots ,the script program would not run correctly to calculate the jitter movement.That is why we had to ignore one spot at right side.And the reason of generating double spots was mirror which was used at far field measurements in the experimental hall.Incident beam, was reflected on front side of mirror firstly and then was reflected on behind side the mirror. The Titanium Sapphire laser has also interesting image ,it is not hard to realize very small diffraction circles inside image.The reason of genenerating diffraction dust on the optical devices.

Results; there are several output sketch for jitter movement which are changing with respect to vertical and horizontal positions and with respect to measurement methods named profile in near fied and far field.The ideal case of jitter movement might be able to propogate very short distance and very small angle.

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