BWA-CAM
Application Note

2/18/2014

Uneven Distribution of Region of Interest (ROI) Spots: What is wrong?

The BWA-CAM is included in Haas Laser Technologies **Laser Beam Analyzer System.** This application note covers beam profiling and M squared measurement as it relates to Region of Interests (ROI).

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UNEVEN DISTRIBUTION OF REGION OF INTERESTS (ROI): WHAT IS WRONG?

The basic principle of the BWA-CAM is based upon a small laser cavity emulating a Fabry-Perot etalon with high finesse. The cavity is tilted at a small angle: nominally about 4 degrees so that as the focused beam enters the cavity it walks up the cavity and with each round trip in the cavity a small percentage of light passes through and is directed to the pixilated sensor. Of course each walk up the cavity causes a spatial time delay and therefore creates the individual ROIs (Region of Interest).

Figure 1 shows an example of a BWA-CAM image where the ROIs are not evenly spaced. The first ROI is on the left and as the spots progress to the right the spacing increases a little bit between each consecutive spot where the last two spots are significantly further spaced then the first two spots in the image by more than a factor of 2.

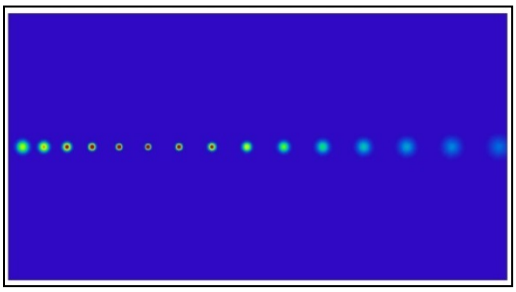
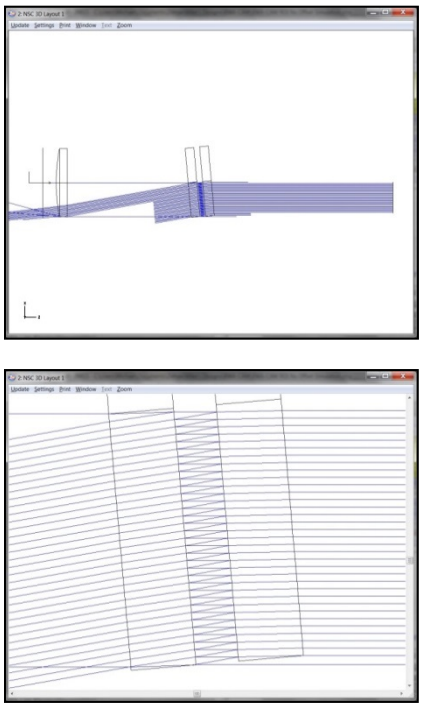


Figure 1: Uneven spacing of ROIs

What causes this odd behavior and how does it affect the M-square measurement? Fortunately it is nothing to be too alarmed about and the impact on the measurement is within the error of uncertainty for the basic camera measurement of +/- 2%.

In order for a laser cavity to work and produce amplified light both the mirrors in the cavity must be perfectly aligned. Although the BWA-CAM is not a laser, the two mirrors do need to be perfectly aligned in the axis the beam walks up the cavity.

Figures 2a & 2b show a basic optical layout of a BWA-CAM and a zoom image of the Fabry-Perot cavity and how the beam walks up the cavity with each round trip.



Figures 2a & 2b: BWA-CAM Optical Layout Showing Single On-Axis Ray and Zoom of the Fabry-Perot Cavity

The two images show a single, on-axis ray. One can see that the spacing of each round trip is consistent throughout the walk of the beam up the cavity.

This configuration leads to Figure 3 where all the ROIs are evenly spaced from the first spot to the last. This is the result of the Fabry-Perot cavity being perfectly aligned.

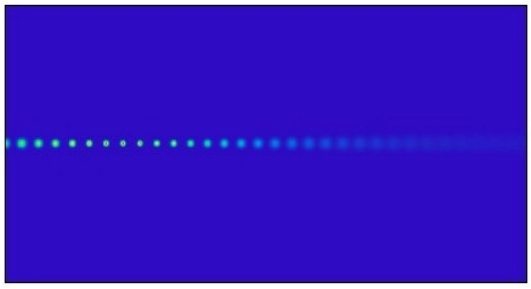
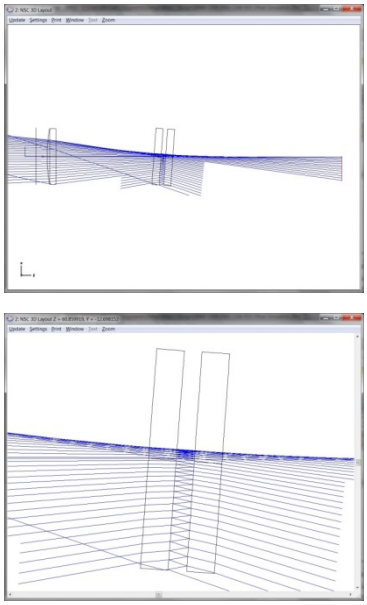


Figure 3: Evenly spaced ROIs

In contrast, Figures 4a & 4b show the BWA-CAM layout where the ROIs are not evenly spaced. The first two spots are close together but as each round trip in the cavity leads to greater and greater spacing. In this example, the spacing between the etalons is about 2.1mm which is the same as in Figures 2a & 2b. However there is a slight angle between the two optics of 0.3 degrees.

It is this small angle difference that is causing the variation in distance between spots. The nominal angle of incidence for each mirror interaction is 4 degrees but with one mirror tilted an additional 0.3 degrees this causes the angle to change with each round trip. The first beam strikes the optic at 4.3 deg angle of incidence (AOI), the second would then be 4.6 degrees, the third 4.9 degrees and so on up to the last spot. If we had 20 ROIs, the last would strike the optic at a 10 degree AOI.

If we have a difference for each spot of 0.3 deg which adds on each round trip, what would then be the influence on the M-square measurement? The path length for the first round trip is 4.214mm and at the 20th spot the path length is 4.265mm. This makes the difference between the 1st and 20th spot of 51 microns. As the correct path should be 4.2mm, the difference is 65um and represents a change of about 1.55%. As the uncertainty in the camera measurement is +/- 2% this number is within the uncertainty. Using 20 ROIs would not normally be done and therefore the actual error would be less.



Figures 4a & 4b: BWA-CAM Layout with Uneven ROI Spacing and Zoom of the FP cavity

This phenomenon occurs when the mirrors are over adjusted past the nominal alignment. For a given angle of the FP optics, the beam walks a certain direction. It would be possible for the user to align the beam on the wrong side of the camera and cause the spots to position in the opposite direction and this is the source of the non-equal spacing. It is therefore important that the first spot is on the correct starting position of the camera sensor and that the subsequent spots space in the correct direction.

For additional information, contact a Haas Laser Technology sales representative **(973) 598-1150** or visit our website www.haaslti.com

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