

Manipulator configuration for high precision adjustment of micro optical components

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Abstract

Mechanical manipulators for optical components are well known as a mean to compensate manufacturing tolerances and to optimize entire optical systems.

Mechanical manipulators are reasonable priced, compared to those with Piezo- drives or other motorized solutions.

Nevertheless, mechanical actuators provide high long term stability, structural stiffness and extreme resolution down to 100nm and less. The combination of lateral and rotational manipulators allow highly precise and stable adjustment, for instance of micro-optical components.

Herewith the capabilities of mechanical manipulators is shown by the example of an Assembly combining a micro lens array with a spatial filter.

1 Assembly requirements

A micro lens array of 1050x790 micro lenses has a pitch (x,y) of 42 μ m. The array has an over all size of 44x33 mm. It has to aligned a spatial filter, consisting of an array of pupil stops with a diameter of 4 μ m with respect to a micro lens array. Each micro lens has to be aligned with one stop with an accuracy of 0.3 μ m. Therefore a 0,1 μ m sensitivity of the alignment is required at least.

The assembly has to be made in situ. Thus strict design space limitations are to be observed.

2 Assembly design

The assembly consists of two main supports, one support containing the x-y adjustment, a second support contains the angular alignment. Both supports are joined by a clamping mechanism, allowing a pre alignment down to 5 μ m and very precise fixing of the pre alignment. It is of extreme importance to avoid deformation

and stress, fixing the adjustment supports after pre alignment and during fine alignment too.

The design has to ensure precise positioning during transport, assembly and operation. That means, it has to withstand shock load up to 15g and temperature fluctuation between 5°C and 40°C. But the most challenging environmental effect is the deposition of up to 5W Laser power during operation. That leads to a temperature difference in the adjustment supports themselves of about 2°C. For position stability of 0.1µm a specially optimized design is needed, otherwise the temperature gradient will cause misalignment.

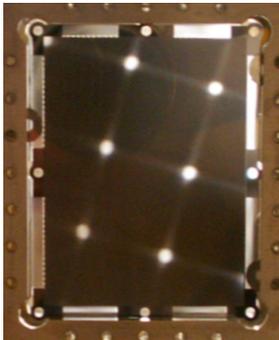


Figure 1: Microlens and spatial filter assembly, before starting alignment

2.1 X-Y Manipulation support

The X-Y Manipulation Support consists of two manually operated actuators. Each of them moving one direction, x or y. The design of the actuators and solid state hinges result in an independent movement of both directions. The sensitivity of the actuator allows adjustment down to 100nm, while the adjustment range is +/- 25µm

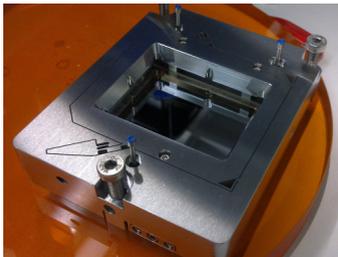


Figure 2: X-Y Manipulation Support

2.2 Angular Manipulation support

The angular manipulation support consists of an arrangement of solid state hinges, and only one manually operated Manipulator. The design ensures an operation which leads to a rotation of the micro lens array of +/- 3.5 angular minutes. The sensitivity of the support allows manual adjustment down to 0.4 angular minutes.

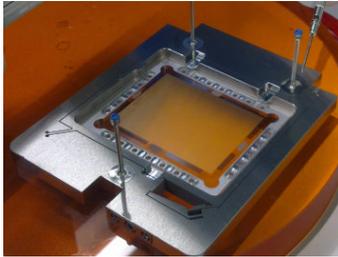


Figure 3: Angular manipulation support

3 Adjustment

Adjustment of the above mentioned accuracy is feasible only by highly sophisticated measurement tooling and evaluation software. The adjustment has to ensure maximum transition of the assembly, while the intensity homogeneity (spot to spot) has to be at the best and crosstalk at minimum.

Therefore a special camera tool was designed, using a 133 Mega pixel camera Sinar Evolution 75H modified by Jenoptik. The tailored evaluation software calculates intensity distribution and crosstalk. It calculates next adjustment steps and gives prognosis for prospective performance of the assembly.

Fine adjustment steps in deed, lead to the calculated effects so that this highly sophisticated alignment can be done in less than 1 hour.