

Appendix B

Alignment procedure

For interference to occur, beams issuing from the two arms of the interferometer must be perfectly spatially overlapped from the beamsplitter to the detector. This spatial overlap has to be maintained on the complete course of the translation stage, that is about 135 cm. This implies to correctly align the interferometer. The goal of this appendix is to introduce the most efficient alignment procedure we have found up to now. A schematic of the optical layout is given in Figure B.1. The different optical elements that appear on it have already been introduced in section 2.1.1.

Diaphragms were designed and fabricated especially for the alignment of the interferometer. A photograph of one of these diaphragms is shown in Figure B.2a. They consist of a metallic base that is fixed on the optical bench and of a plastic part. The plastic part can be easily inserted on the base or removed from it. There are five apertures on the plastic element that allow to check the path followed by the laser beams. Light is either injected in aperture 1 or aperture 2. It is then reflected by one of the two corner cubes and passes back through aperture 5 or aperture 4. If the beam passes through the central aperture (aperture 3), it is reflected on the apex of the corner cube and returns back through aperture 3. Another diaphragm system was designed for the carriage. It is depicted in Figure B.2b. It consists in a circular plastic disk with an aperture at its center. To ensure that light correctly passes through the different apertures of these two diaphragm systems, intensity of the light that passes through the different apertures is maximized. This task is performed with the help of a power meter.

To allow for a tight control on the directions of the He:Ne and the supercontinuum laser beams, two sets of adjustable mirrors were used. They are both depicted in Figure B.3.

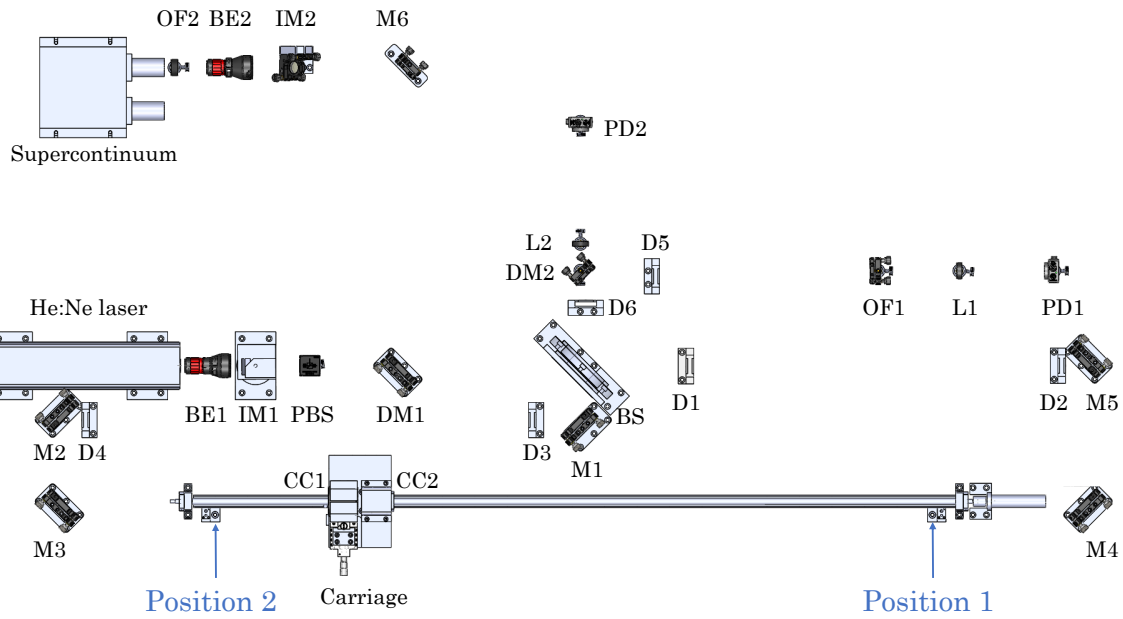


Figure B.1: Schematic of the optical bench. BE stands for beam expander, BS for beamsplitter, CC for corner cube, D for diaphragm, DM for Dichroic mirror, IM for Injection Mirrors, L for lens, M for Mirror, OF for optical filter, PBS for polarized beamsplitter and PD for photodetector. Assembly performed on SOLIDWORKS by Daniel Dedouaire.

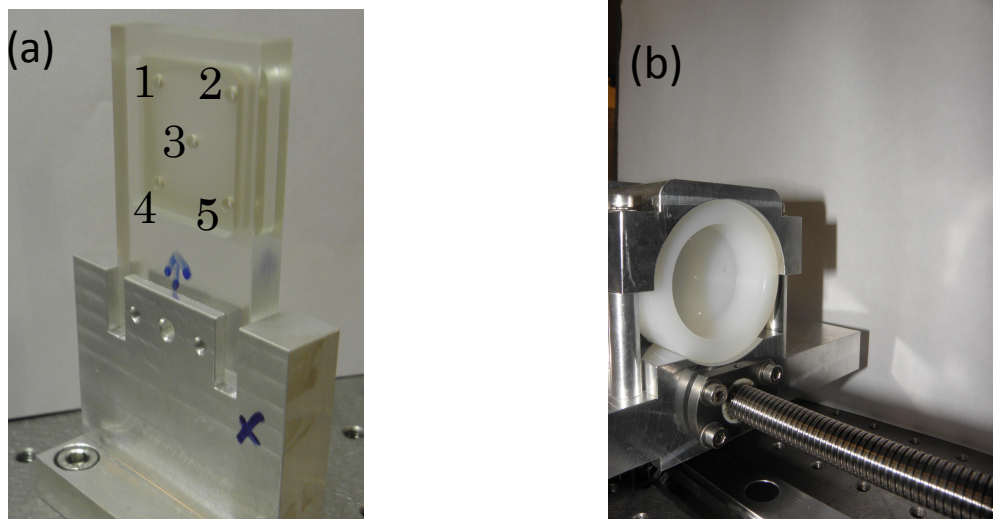


Figure B.2: Photographs of the two diaphragm systems used to align the interferometer. (a) Static diaphragm system. The metallic base is fixed on the optical bench while the plastic part can be easily removed. 5 circular apertures allow to control the path followed by light. If the laser beam passes through aperture 1(2), its reflection passes through aperture 5(4). If the beam passes through aperture 3, it is reflected on the apex of the corner cube and returns back through aperture 3. (b) Mobile diaphragm system. The diaphragm replaces the corner cubes on the carriage during the alignment procedure.

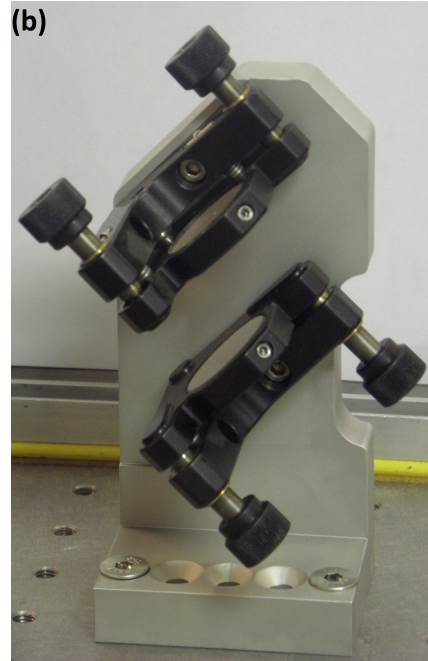
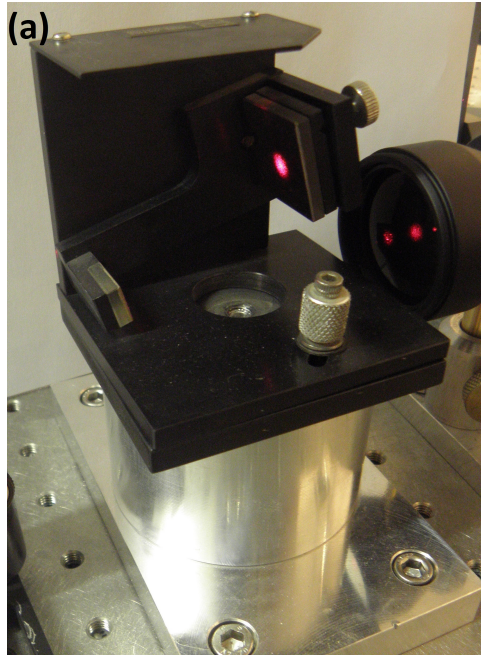


Figure B.3: Photographs of the two sets of adjustable mirrors that allow for a tight control on the laser beam direction at the output of (a) the He:Ne laser and (b) the supercontinuum.

Alignment is performed in a ten-step procedure that is described below. All the adjustable optics are labelled and numbered to facilitate the comprehension of the procedure. These labels are made explicit in Figure B.1.

1. The He:Ne laser is injected parallel to the translation stage by ensuring that the beam passes through the central aperture of the two diaphragms D1 and D2. The set of adjustable mirrors IM1, located at the output of the He:Ne laser, is used to correct the trajectory of the laser beam.
2. The beamsplitter BS and the mirror M1 are adjusted. To do so, the two diaphragms D3 and D4 are utilized. The beamsplitter is tilted horizontally so that the laser beam passes through the central aperture of diaphragm D3. Mirror M1 is adjusted so that the light beam passes through the central aperture of diaphragm D4. The procedure is repeated until light perfectly passes through both apertures.
3. Mirrors M4 and M5 are adjusted by maximizing the intensity behind the mobile diaphragm system. Mirror M5 is adjusted when the carriage is located at position 1 while mirror M4 is adjusted when the carriage is located at the other extremity of the translation stage, that is position 2. The procedure is repeated until light perfectly passes through the mobile diaphragm at both positions 1 and 2. During this step, the arm with mirrors M2 and M3 is obstructed.
4. Mirrors M2 and M3 are adjusted in a similar way to mirrors M4 and M5. Mirror M3 is adjusted when the carriage is located at position 1 while M2 is adjusted when the carriage is located at position 2. The procedure is repeated until light perfectly passes through the mobile diaphragm at both positions 1 and 2. During this step, the arm with mirrors M4 and M5 is obstructed.
5. The interferometer is now aligned and the laser He:Ne is injected in aperture 1 instead of aperture 3 (see Figure B.2). The set of adjustable mirrors IM1 is adjusted using the two diaphragms D1 and D2 in a similar way to step 1. The mobile alignment system is

replaced by two corner cubes placed back-to-back on the carriage.

6. An estimate of the adjustment of the movable corner cube position is obtained by looking at the spatial fringe pattern projected, using a lens, on the wall at the balanced output of the interferometer after having removed all the diaphragms from their metallic base. If vertical lines are observed on the spot, like in Figure B.4a, the movable corner cube must be shifted horizontally until the vertical lines disappear. If the lines are horizontal, the movable corner cube must be shifted vertically. Figure B.4b shows the pattern that is observed when the relative positioning of the corner cubes is fine.
7. The dichroic mirror is placed at the balanced output. To ensure that light hits the dichroic mirror DM2 with a 45-degree angle, the beam has to pass through aperture 5 of diaphragm D5 after its reflection on the dichroic mirror DM2. The lens L1 and the photodetector PD1 are placed in such a way that the He:Ne laser beam passes through the center of the lens and hits the photodetector on the center of its active area.
8. A fine adjustment of the relative position of the corner cubes is obtained by maximizing the visibility of the He:Ne interference fringes measured with the photodetector PD1. During this stage, the carriage is in motion at a relatively low speed.
9. The supercontinuum laser is injected parallel to the translation stage. The set of adjustable mirrors IM2 is used to ensure that light hits mirror M6 at its center. Mirror M6 is adjusted so that light passes through the aperture 1 of diaphragm D1 while the dichroic mirror DM1 is adjusted by ensuring that light passes through aperture 1 of both diaphragms D2.
10. Lens L2 and photodetector PD2 are placed in such a way that the supercontinuum laser beam passes through the center of the lens and hits the photodetector on the center of its active area.

After having performed these ten steps, the interferometer is supposed to be correctly aligned. A measurement of the interferogram of the He:Ne laser on the complete translation stage is then made to ensure that the contrast is nearly constant for all the positions of the carriage.

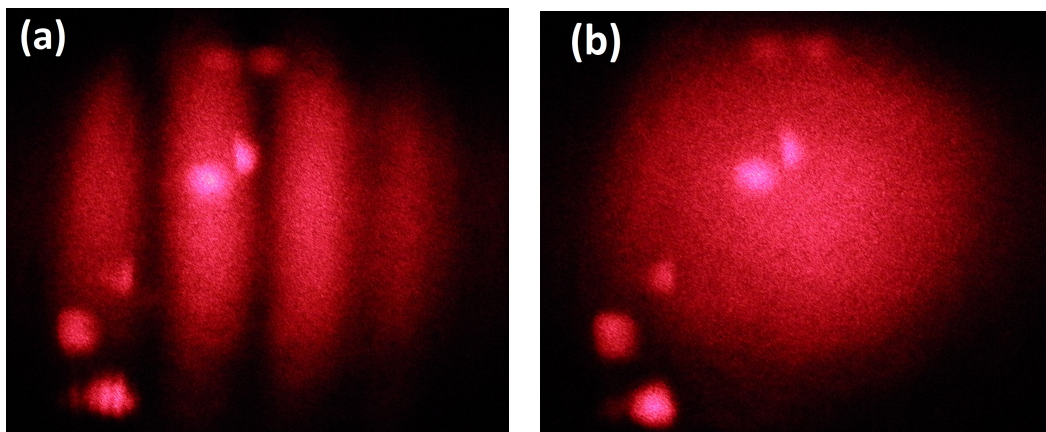


Figure B.4: Photographs of the spatial fringe pattern projected on the wall at the balanced output of the interferometer. (a) The relative position of the cube corners is mediocre, resulting in this characteristic fringe pattern. (b) The relative position of the cube corners is fine, resulting in the central Haidinger fringe pattern.