

HOW TO - Inject a laser beam into a fiber

1. Place two mirrors before two iris in the optical axis. (Figure 1)
2. Choose the right lens to inject the laser into the fiber. This injecting lens should have at least the NA of the fiber, but it is recommended to use a lens that has a higher NA than the fiber to make sure the fiber's NA is completely filled.
3. Place the injecting lens in a tunable lens mount.
4. Place the injecting lens and the fiber after the second iris in the optical axis. (Figure 1)

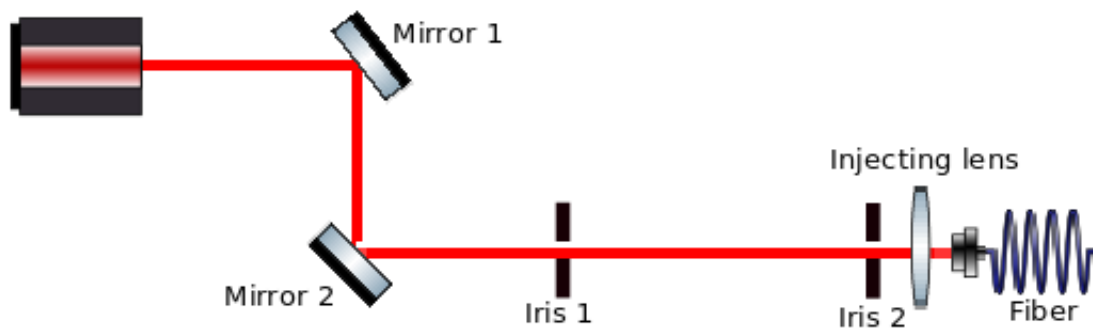


Figure 1 : Setup of mirrors and iris in the optical axis. The injecting lens is placed just before the fiber and after the second iris.

5. Walk the beam with the two mirrors to align the laser beam in the middle of both iris. Make sure the beam at the exit of the laser and after the injecting lens is always as straight as possible. <https://www.edmundoptics.com/resources/video/tutorials/how-to-align-a-laser-system/>
6. Place the first lens (L1) in a tunable lens mount.

7. Add the L1 in the optical axis. This lens should be at the same distance than its focal length from the injecting lens. (Figure 2)

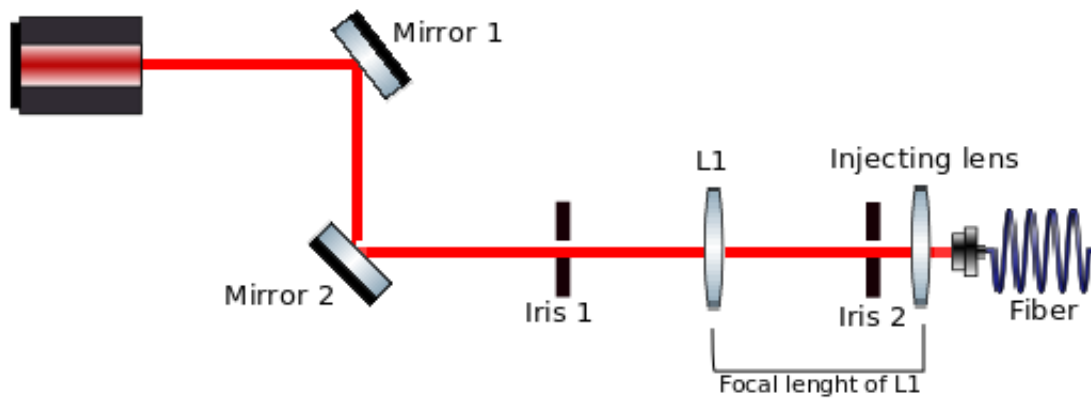


Figure 2 : Setup with L1.

8. Check if the addition of the L1 in the optical axis affects the laser beam alignment. If the laser beam is not going in the middle of the second iris by adding the L1, adjust its angle with its tunable lens mount.
9. Place the second lens (L2) in a tunable lens mount.
10. Add the L2 in the optical axis. This lens should be at the same distance than the sum of the focal length of L1 and L2 from L1. (Figure 3)

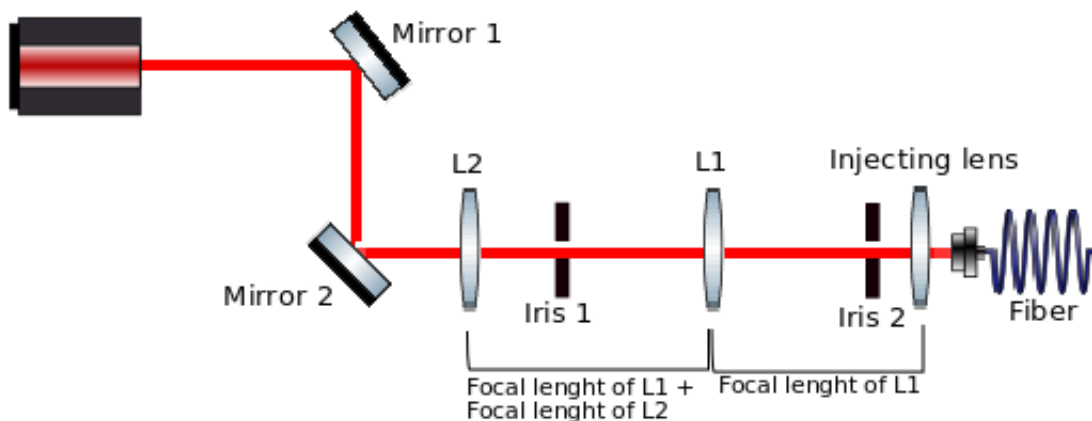


Figure 3 : Setup with L2.

11. Check if the addition of the L2 in the optical axis affects the laser beam alignment. If the laser beam is not going in the middle of the first iris by adding the L2, adjust its angle with the tunable lens mount.
12. The beam should not change its size with the distance after the L1. Make sure this is the case by looking at the beam size with a little piece of paper. If it's not, it means the lenses are not perfectly placed. Move the L2 to make sure the beam is well aligned as shown in figure 4.



Figure 4 : Rays' path with the addition of L1 and L2 in the optical path.

13. Place a power-meter at the other end of the fiber.
14. By adjusting the injecting lens with its tunable lens mount and moving horizontally the fiber to place it further or closer to the injecting lens, make sure the power at the end of the fiber is maximal. *The position where the power is maximal at the end of the fiber is not the optimal position for injection, but it helps finding the right spot.*
15. To verify if the fiber is well placed after the injecting lens for injection, place a sheet of paper at the other end of the fiber. (Figure 5)

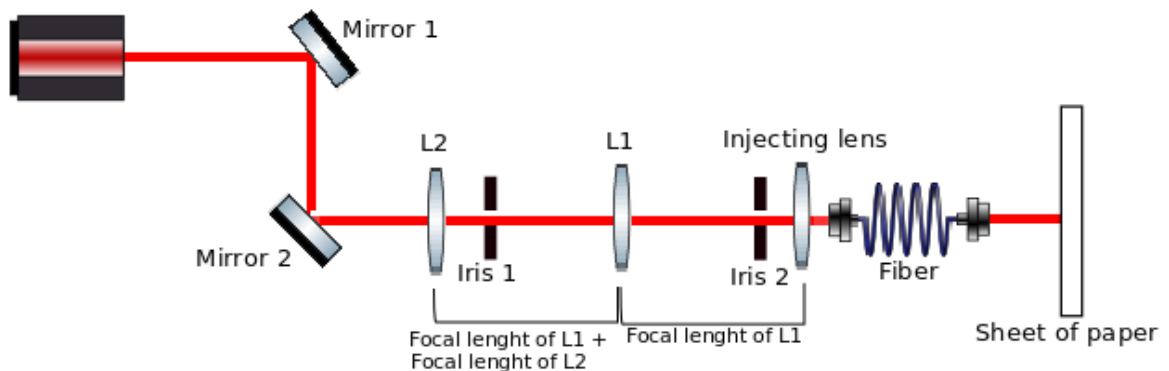


Figure 5 : Setup with the sheet of paper at the end of the fiber.

16. By adjusting the injecting lens with its tunable lens mount, verify the laser beam is well injected into the fiber. When the laser beam touches the edge of the fiber, only modes from the sides are taken by the laser beam. This phenomenon can be seen on the sheet of paper by moving the injection. Place the injection at the position where the beam is sharpe on the edges with the tunable lens mount of the injecting lens. (Figure 6)

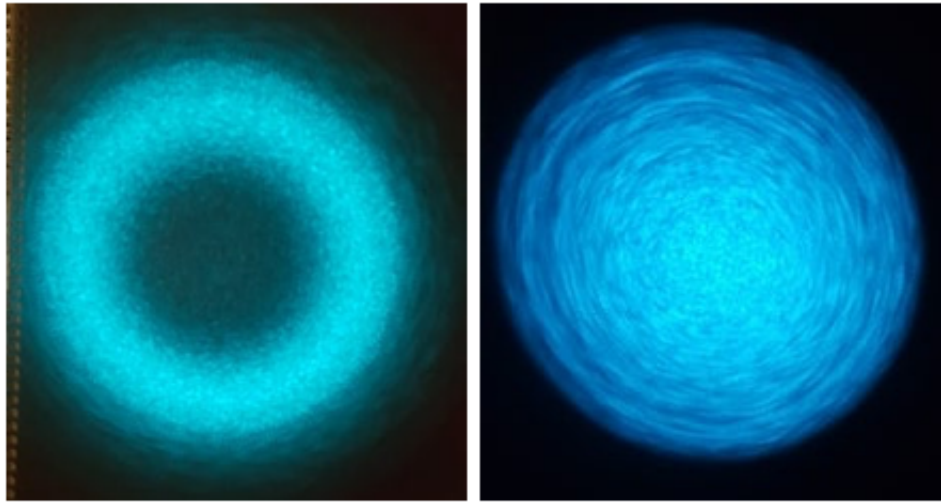


Figure 6 : Laser beam's pattern on the sheet of paper when the injecting lens aims the edge of the fiber (left) and when it goes right in the middle of the fiber (right).

17. The fiber should be placed at the position where the beam' size on the sheet of paper starts to not change. (Figure 7)

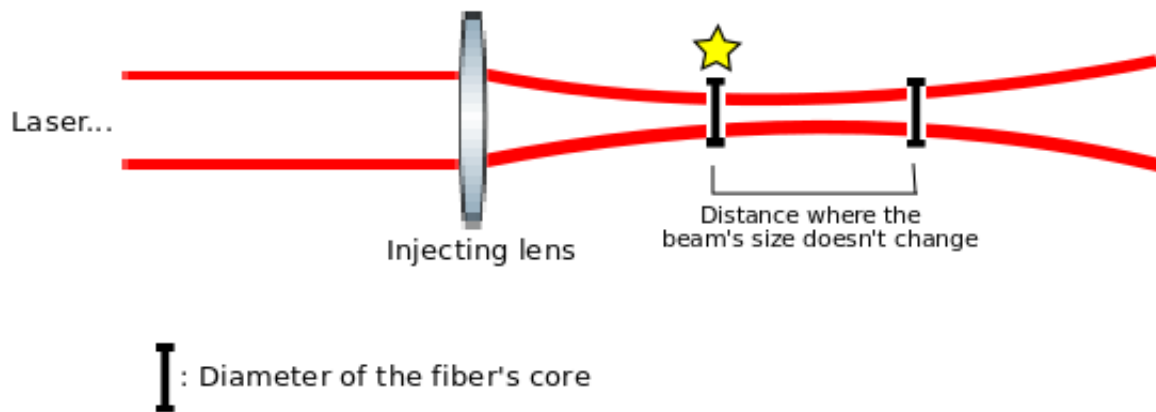


Figure 7 : Scheme of the rays' pattern after the injecting lens. The star shows the optimal position where the fiber should be placed for injection.