

Optofluid Cannulas Implantation and Fluid Injection

User Manual

Version 1.0.0

Contents

1	Optofluid Cannulas (OFC) Overview1.1OsFC - Single-shot Fluid Injection Cannulas1.2OmFC - Multiple Fluid Injections Cannulas1.3iOFC - Optofluid Cannula with interchangeable injectors1.4DiOFC - Dual Optofluid Cannulas with Interchangeable Injectors	3 4 5 6 7
2	Opto Fluid Cannulas receptacle implantation2.1OFC preparation2.2Implantation site preparation2.3Cannula Implantation	8 8 9
3	Opto Fluid Cannulas Usage3.1OFC care before/between experiments3.2Injection tube/micro-injector loading3.3Fluid injection3.4Optical probing	10 10 10 11 12
4	Support4.1Maintenance4.2Warranty4.3Disposition4.4Contact us	13 13 13 13 13

Optofluid Cannulas (OFC) Overview

Opto-fluid cannulas (OFC) allows easy access to the brain for liquids and light by hybridization of fiber-optic and fluid delivery cannulas. Designed for chronic implantation, they remove the need for frequent cannula replacement. This greatly decreases the risk of infection and ensures the spatial accuracy of fluid delivery and optical illumination to the brain region of interest. These factors allow consistent results in behavioral and longitudinal studies, even over long periods of time.

OFC are most often used in experiments that require the delivery of a fluid solution (such as a solution containing viruses or pharmacological agents) alongside illumination of the region of interest. When an **Opsin** (such as Channelrhodopsin) is expressed in the region of interest, the light-sensitive ion channels can be activated by outside illumination. OFC allow illumination weeks later when the opsins are properly expressed. OFC can also be used for fiber photometry recording, measuring activity induced fluorescence of all neurons expressing a calcium indicator in the region of interest. This can be done with various pharmacological agents, allowing real-time measurement of the effect of these agents on nervous tissue.

Several models of opto-fluid cannulas are offered for single and multiple injections or with interchangeable injections (Fig. 1.1). The lengths of the optical fiber, the injector and the injector guiding tube are customized to reach targeted regions of interest. Two main sections are found on these cannulas:

- The implantable **Protrusion** guides light and/or fluids deep into the brain.
- The **Receptacle** is secured on the head of the subject, connecting the cannula to sources of light and/or fluid.



Figure 1.1: The different OFC models (Left to right): DiOFC_S, DiOFC_L, iOFC-ZF, iOFC-M3, OmFC-ZF, OmFC-M3, and OsFC

1.1 OsFC - Single-shot Fluid Injection Cannulas

The *Single-shot Fluid Injection Cannulas (OsFC)* is designed for optical delivery/detection with a single fluid delivery. An optical **SM3 connector** (Fig. 1.2) connects to the optical fiber patch-cord and allows optical input. A 25-gauge **Stainless inlet** on the side (Fig. 1.2) is used for fluid input when connected to a polyethylene tube. The outputs are brought together in the **Protrusion** with a polyimide tube.

- The OsFC is designed to be **loaded with liquid before implantation**. Fluid delivery is performed once the cannula has been implanted.
- It is not recommended to perform a second injection as the passage can become clogged after first use.
- When delivering a virus-containing solution, it is important to remember that the solution stays in the tubing during the implantation process. This requires quick implantation of the cannula to avoid reducing infectivity due to exposure of the virus to room temperature.



Figure 1.2: Single-shot Fluid Injection Cannulas (OsFC) overview

1.2 OmFC - Multiple Fluid Injections Cannulas

The *Multiple Fluid Injections Cannulas (OmFC)* is designed for optical delivery/detection with the possibility of multiple fluid deliveries. An optical **SM3** or **ZF connector** (Fig.1.3) connects to the optical fiber patch-cord and allows optical input. A **Guiding tube** (Fig.1.3) allows the insertion of a *Fluid Micro-injector (FI-OmFC)* (Fig.1.3) that can be loaded with a single fluid.

- The **Guiding tube** is kept free of debris using an **Injector plug** which comes pre-installed on the cannula. Insert this plug during implantation and whenever the *FI-OmFC* is not in use to avoid clogging the guiding tube. When in place, the plug is 100 μ m longer than the guiding tube protrusion.
- The *FI-OmFC* can be reused multiple times on the same animal if properly cleaned and sterilized. We recommend only using lint-free wipes in combination with isopropanol or a similar cleanser.
- The *FI-OmFC* can be loaded separately from the cannula, and does not require loading during implantation. The stainless inlet on the fluid micro-injector is used to connect a syringe or a liquid delivery system using polyethylene tubing.



Figure 1.3: Multiple Fluid Injections Cannulas (OmFC) overview

1.3 iOFC - Optofluid Cannula with interchangeable injectors

The Optofluid Cannula with interchangeable injectors (iOFC) is the smallest and lightest OFC due to it's single **Guiding tube**. The **Guiding tube** (Fig.1.4) is used with interchangeable Optical injector for Optofluid Cannula with interchangeable injectors (FI-iOFC) and Fluid Injector for Optofluid Cannula with interchangeable injectors (OI-iOFC). These injectors are secured to the cannula using an SM3 or ZF receptacle.

- The **Guiding tube** is kept free of debris using an **Injector plug** which comes pre-installed on the cannula. Insert this plug during implantation and whenever a **Micro-injector** is not in use to avoid clogging the guiding tube.
- The *FI-iOFC* can be reused multiple times on the same animal if properly cleaned and sterilized. We recommend only using lint-free wipes in combination with isopropanol or a similar cleanser.
- The *FI-iOFC* can be loaded separately from the cannula, and does not require loading during implantation. The stainless inlet on the fluid micro-injector is used to connect a syringe or a liquid delivery system using polyethy-lene tubing.



• The OI-iOFC connects to a patch-cord using a **ZF** connection.

Figure 1.4: Optofluid Cannula with interchangeable injectors (iOFC) overview

1.4 DiOFC - Dual Optofluid Cannulas with Interchangeable Injectors

The precise pitch of the Dual Optofluid Cannulas with Interchangeable Injectors (DiOFC) guarantees an optimal bilateral implantation where both light and fluid injection can be used. The interchangeable configuration saves space and weight and can be used with multiple lengths of optical and fluid injector. The guiding tube (Fig.1.4) is used with interchangeable Fluid Injector for Dual Optofluid Cannula with interchangeable injectors (FI-DiOFC) and Optical Injector for Dual Optofluid Cannula with Interchangeable Injectors (OI-DiOFC). These injectors are secured to the cannula using an ZF receptacle.

- The **Guiding tubes** are kept free of debris using an **Injector plug** which comes pre-installed on the cannula. Insert this plug during implantation and whenever a **Micro-injector** is not in use to avoid clogging the guiding tube.
- The Guiding tubes have a minimum pitch (center to center distance) equal to the tube outer diameter.
- The *FI-DiOFC* can be reused multiple times on the same animal if properly cleaned and sterilized. We recommend only using lint-free wipes in combination with isopropanol or a similar cleanser.
- The *FI-DiOFC* can be loaded separately from the cannula, and does not require loading during implantation. The stainless inlet on the fluid micro-injector is used to connect a syringe or a liquid delivery system using polyethylene tubing.
- The OI-DiOFC connects to a patch-cord using a ZF connection.



Figure 1.5: Dual Optofluid Cannulas with Interchangeable Injectors (DiOFC) overview

Opto Fluid Cannulas receptacle implantation

As all OFC share basic design elements, implantation is very similar for each type of cannula. The following section describes the implantation process, followed by general usage guidelines. All OFC are delivered with **Protective caps** and **Injector plugs** to protect the **Protrusion**. Handle the cannula with care, as both the cannula and injectors are fragile.

2.1 OFC preparation

1. Install the cannula in the appropriate holder:

- Screw onto the OsFC an SM3 Receptacle Adapter (FCA-SM3) that is compatible with your Stereotaxic Cannula Holder (SCH). Secure the assembly in the SCH, then integrate it onto the stereotaxic apparatus.
- The OmFC is installed into the OmFC Cannula Holder (SCH-OmFC). The **Injector plug** must be left in place during installation and implantation. The plug must not be removed, as otherwise the **Guiding tube** could become clogged during implantation.
- The *iOFC* is installed into the SCH_1.25, where it is held by the connection of the *Injector plug*. The plug must not be removed, as otherwise the **Guiding tube** could become clogged during implantation.
- 2. Install the appropriate holder on a stereotaxic apparatus. In most cases, this involves a *Stereotaxic Cannula Holder*. The holder is required to accurately position the cannula for implantation.
 - The OmFC stereotaxic cannula holder (SCH_OmFC) must be installed into an in-line adapter (SIA) to be integrated on a stereotaxic apparatus.
- 3. Once the cannula is in place, the setup can be prepared for implantation.
 - If using an OsFC, the injection tube must be filled PRIOR to implantation. See section 3.2 for details on filling the injection tubing.

2.2 Implantation site preparation

- 1. Determine the stereotaxic coordinates for implantation.
- 2. *Optional*: Using a micro-drill, drill holes to allow the placement of skull screws around the craniotomy site. These help anchor the dental cement that holds the cannula in place.
- 3. Optional: Place the supporting screws in the prepared holes around the craniotomy site.
- 4. Perform the craniotomy above the targeted stereotaxic coordinates using a micro-drill. The craniotomy must be about **1.5 x** larger than the guiding tube diameter. Use table 2.1 to identify the cannula footprint.
 - When using a DiOFC, the craniotomy must accommodate both guiding tubes.

Table 2.1: Cannula Footprint; The white space represents the guiding tube, the cross the guiding tube center, and the beige shape the cannula receptacle



2.3 Cannula Implantation

- 1. Bring the cannula installed in the stereotaxic apparatus above the animal.
- 2. Slowly lower the cannula into the craniotomy until you reach the desired depth of the region of interest. Note that a slow speed is necessary to allow good tissue penetration.
- 3. Spread fast-drying bio-compatible glue between the receptacle and the skull.
 - If the receptacle is very close to bone, capillary action will ensure a liquid strong-adherence glue spreads underneath the receptacle.
 - If the receptacle is not very close to bone, use a gel glue to fill the gap.
 - Optional: Placing glue around the skull screws can increase their stability.
- 4. When the glue has dried, secure the cannula to the skull using dental cement on the base of the receptacle (and screws if some were installed).
 - If gel glue was used, it is important to place cement on it, from the cannula to the skull, to stabilize the system.
 - The dental cement should not come into contact with tissues, muscles, skin or fur, as this could drastically reduce the adhesion of the cannula. Note that several layers of cement may be needed to maximize the solidity of implant fixation.
- 5. Once the cement is dry, detach the implant from the stereotaxic cannula holder.
- 6. Replace the Injector Plug and Protective Cap to protect the Protrusion.

Opto Fluid Cannulas Usage

The following section details the usage of the various OFC and their injector. As a reminder, **Handle the cannulas and injectors with care; optical fibers and tubing are fragile and can easily be broken.**

3.1 OFC care before/between experiments

Before starting an experiment or between different experimental sessions (especially when starting or being spaced by several days or weeks post-surgical implantation, we recommend taking care of the implant on a regular or even daily basis, to avoid the accumulation of any secretions or particles that could prevent the injector plug from any damaging during its removal.

- 1. Using a sterile saline solution and a lint-free tissue paper, clean the top of the injector plug and Protective cap
- 2. Gently remove the protective cap
- 3. Gently turn clockwise and counterclock wise, the injector plug several times. In addition, a small portion of the injector plug may also be repeatedly be removed/inserted. No resistance should be encountered during this process.
- 4. In case of a resistance of the injector plug in the implant, apply again some sterile solution at the top pf the plug using either a lint-free wipe or a coton swab, and allow the liquid to enter the implant by capilarity.
- 5. Repeat the two last step until resistance of the injector plug in the implant is no longer experienced.
- 6. Replace the protective cap.

3.2 Injection tube/micro-injector loading

- 1. Connect the fluid injector stainless inlet (fluid input) to the polyethylene tubing (Fig. 3.1).
- 2. Connect the opposite end of the tubing to a gas-tight syringe or other fluid delivery system.
- 3. Fill the injection tubing with a volume equal to the required volume and the dead volume. The dead volume of each fluid injector can be found in table 3.1.
 - The injector should be filled until a small droplet appears at the tip.
- 4. Using a saline solution and a light-duty tissue paper clean the injector tip before placing it in the guiding tube.
 - It is important to collect any drop that leave the injector, to ensure no fluid clogs the guiding tube or soils the optical fiber.
 - The OsFC does not use a guiding tube. The protrusion itself should be cleaned before implantation.

OsFC 110 nL+8 nL per mm of protrusio FI_OmFC 175 nL+8 nL per mm of protrusio FI_iOFC 115 nL+8 nL per mm of protrusio FL DiOFC-S 175 nL+8 nL per mm of protrusio	INJECTOR	DEAD VOLUME
FI_OmFC175 nL+8 nL per mm of protrusioFI_iOFC115 nL+8 nL per mm of protrusioFI_DiOFC-S175 nL+8 nL per mm of protrusio	OsFC	110 nL+8 nL per mm of protrusion
FI_iOFC 115 nL+8 nL per mm of protrusic FI_DiOFC-S 175 nL+8 nL per mm of protrusic	FI_OmFC	175 nL+8 nL per mm of protrusion
FL DiOFC-S 175 nL+8 nL per mm of protrusio	FI_iOFC	115 nL+8 nL per mm of protrusion
	FI_DiOFC-S	175 nL+8 nL per mm of protrusion
FI_DiOFC-L 110 nL+8 nL per mm of protrusio	FI_DiOFC-L	110 nL+8 nL per mm of protrusion

Table 3.1: Fluid Injector Dead Volume



Figure 3.1: OmFC Fluid Injector

3.3 Fluid injection

- 1. If performing the injection immediatley after cannula implantation, verify that the dental cement is completely dry before starting the injection.
- 2. Remove the plug from the guiding tube (Fig. 3.2, left panel).
- 3. Install the pre-loaded fluid injector (Fig. 3.2, middle panel).
 - For the OsFC, it is the cannula itself that is pre-loaded. Thus, there is no plug to remove or injector to place.
 - For the iOFC, the injector is screwed onto the SM3 connector.
- 4. Slowly inject the fluid at a controlled speed. Leave the injector in place while the fluid is diffusing within the tissue (Fig. 3.2, right panel).
- 5. Once the injection is complete and after waiting a few minutes for liquid diffusion in the tissue, slowly remove the injector
- 6. Replace the plug.



Figure 3.2: OmFC Fluid Injection

3.4 Optical probing

- 1. Prepare the optical injector.
 - For the OsFC and OmFC, the optical injector is integrated into the cannula, and no additional action is required
 - For the *iOFC* and *DiOFC*, the optical injector is separated from the cannula. The optical injector is inserted into the guiding tube. If an **SM3 receptacle** is used, the injector must be screwed tightly.
- 2. Clean the tip of the injector as well as the tip of the patch-cord with a lint-free wipe and isopropanol
- 3. Connect the fiber-optic patch-cord to the injector.
 - For the OsFC and the OmFC-M3, an **M3 connector patch-cord** is used. The connector must be screwed in tightly to ensure a stable connection.
 - For the *iOFC* and *OmFC-ZF*, a **Zirconia Ferrule connector** patch-cord is used. The two ferrules are linked using a Zirconia Mating Sleeve.
 - For the *DiOFC*, a **Zirconia Ferrule connector** patch-cord is used. The *OI-DiOFC* has an integrated sleeve, into which the patch-cord ferrule is inserted.
- 4. Activate the illumination system and perform the experiment.
- 5. Once the experiment is complete, detach the patch-cord. The subject can move freely with the cannula on its head between experiments.



Figure 3.3: OmFC Optical Injector

Support

4.1 Maintenance

The product does not require any maintenance. Do not open the enclosure. Contact Doric Lenses for return instructions if the unit does not work properly and needs to be repaired.

4.2 Warranty

This product is under warranty for a period of 12 months. Contact Doric Lenses for return instructions. This warranty will not be applicable if the unit is damaged or needs to be repaired as a result of improper use or operation outside the conditions stated in this manual. For more information, see our Website.

4.3 Disposition



Figure 4.1: WEEE directive logo

According with the directive 2012/19/EU of the European Parliament and the Council of the European Union regarding Waste Electrical and Electronic Equipment (WEEE), when the product will reach its end-of-life phase, it must not be disposed with regular waste. Make sure to dispose of it with regards of your local regulations. For more information about how and where to dispose of the product, please contact Doric Lenses.

4.4 Contact us

For any questions or comments, do not hesitate to contact us by:

Phone 1-418-877-5600

Email sales@doriclenses.com



© 2024 DORIC LENSES INC

357 rue Franquet - Quebec, (Quebec) G1P 4N7, Canada Phone: 1-418-877-5600 - Fax: 1-418-877-1008 www.doriclenses.com