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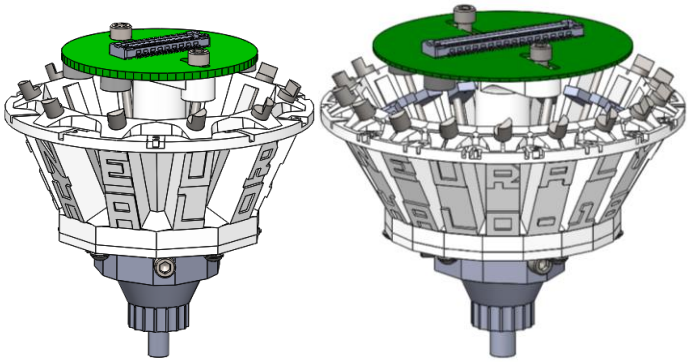

Halo-10/Halo-18 Microdrive

User's Manual

Microdrive used for manually driving tetrodes for electrophysiology recordings

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Table of Contents

List of Figures and Tables

1 Document Overview

This document describes the specifications and features of the Halo-28, Halo-18, and Halo-10 Microdrive. It also explains how to assemble the Microdrive, use it during normal operation, and Microdrive recycling procedures. There is a glossary at the end of the document.

2 Halo-18 Microdrive Overview

The Halo-18 Microdrive allows up to 16 tetrodes to be inserted into a freely moving animal. Two additional insertion shuttles can be used to insert fiber optics or reference electrodes.

Features:

- 18 independent drivable shuttles: 16 tetrodes, 2 for fiber or reference
- 11 mm insertion depth
- Customizable exit pattern
- M1 x .250mm half-moon head drive screw.
- Re-usable drive components (up to three uses)
- Internal grounding screw pass through
- 9.6 grams

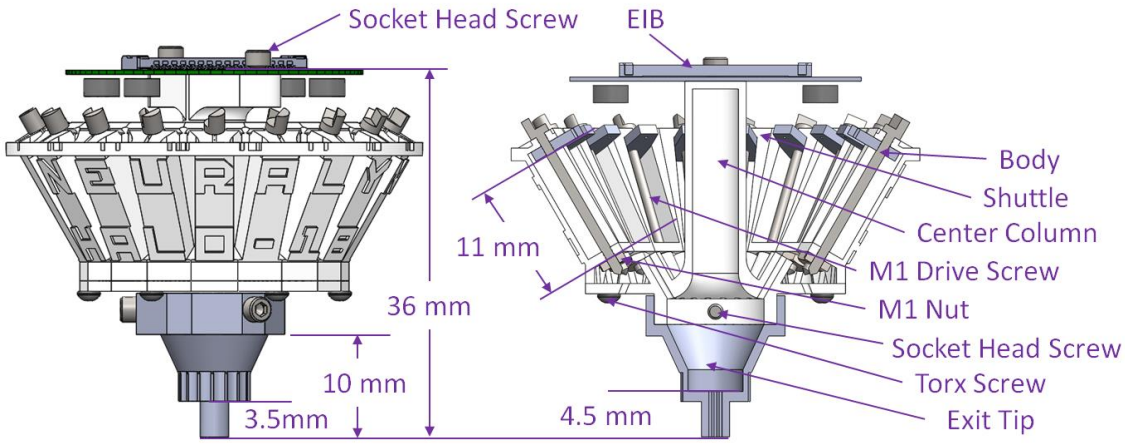


Figure 2-1 Halo-18 Microdrive Diagram

What's included with the Halo-18 Microdrive?

2.1 Body

- Referencing for each shuttle
- 18 shuttle paths
- 3 use life
- 2.5 grams

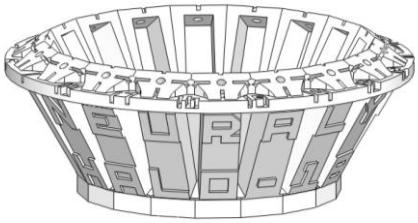


Figure 2-2 Body

2.2 Center Column

- 18 pass through locations
- Exit Tip mounting locations
- EIB mounting locations
- Body mounting locations
- 3 use life
- 1.1 grams

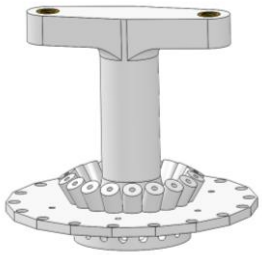


Figure 2-3 Center Column

2.3 Exit Tip

- Precision machined Ultem
- Selected from Neuralynx Exit Tip Configuration Guide
- Customizable tips - contact sales@neuralynx.com to order
- Geometry for enhanced dental cement bonding
- 1 use life
- 0.5 grams

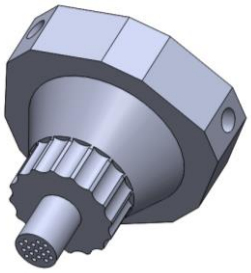


Figure 2-4 Exit Tip

2.4 Shuttle

- 3 use life
- 0.02 grams

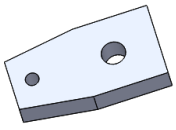


Figure 2-5 Shuttle

2.5 Included Hardware

- 20 X M1 Drive screw
- 20 X M1 Nut
- 7 X self-threading Torx Screw
- 6 X 1/8” 0-80 Socket Head Screws

2.6 Recommended Supplies (not included)

- tetrodes
- 5 minute epoxy
- Scotch-Weld DP-270
- Loctite 290
- EIB pins
- EIB
- Kwik-Cast / Kwik-sil
- Dental Cement
- X-ACTO blade
- Polymicro tubing (O.D. – .0064” I.D. – .0038”)
- Polyimide tubing 0.008”

2.7 Recommended Additional Products

Neuralynx provides additional products to support the assembly and use of the Halo-18 Microdrive and enhance multichannel electrophysiological research.

2.7.1 Halo-18 Assembly Kit

- Assembly Jig
- 2.5mm Hex Driver
- T3 Torx Wrench
- 0.05” Allen Wrench
- Stereotaxic Mount (see 2.7.2)
- Halo Microdrive Turn tool (see 2.7.3)

Figure 2-6 Halo-18 Assembly Jig

2.7.2 Halo-18 Stereotaxic Mount

- 0.310” Stereotaxic rod attachment

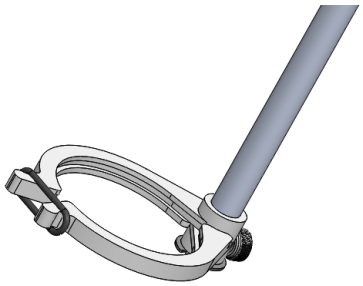


Figure 2-7 Halo-18 Stereotaxic Mount

2.7.3 Halo Microdrive Turn tool

- Locks onto M1 Drive screw.
- 16 indexed increments

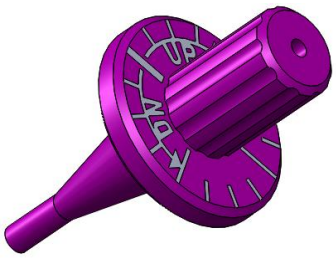


Figure 2-8 Halo Microdrive Turn tool

2.7.4 Halo-18 Protective Cap

- Infinite life
- Magnetic connection to EIB for easy installation and removal
- Omnetics option available
- Safe animal storage
- 1.6 - 2.2 grams

Figure 2-9 Halo-18 Protective Cap

3 Halo-10 Microdrive Overview

The Halo-10 Microdrive allows up to 8 tetrodes to be inserted into a freely moving animal. Two additional insertion shuttles can be used to insert fiber optics or reference electrodes.

Features:

- 10 independent drivable shuttles: 8 tetrode, 2 for fiber or reference
- 11 mm insertion depth
- Customizable exit pattern
- M1 x .250mm half-moon head drive screw.
- Re-usable drive components (up to three uses)
- Internal grounding screw pass through
- 6 grams

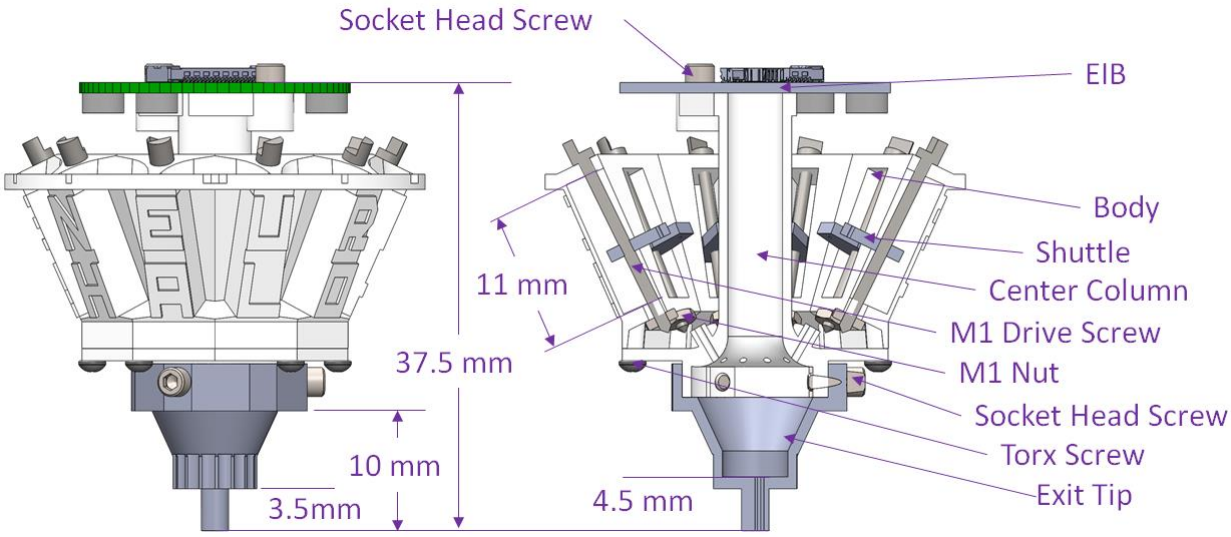


Figure 3-1 Halo-10 Microdrive Diagram

What's included with the Halo-10 Microdrive?

3.1 2 X Body

- Referencing for each shuttle
- 10 shuttle paths
- 2 use life
- 1.8 grams

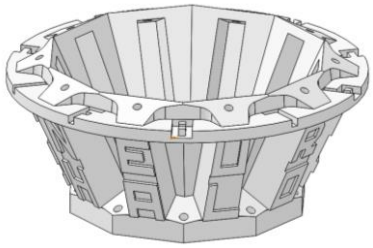


Figure 3-2 Body

3.2 Center Column

- 10 pass through locations
- Exit Tip mounting locations
- EIB mounting locations
- Body mounting locations
- 3 use life
- 1.0 grams

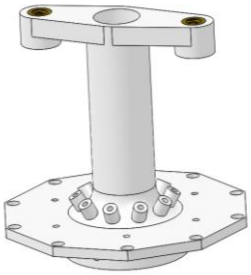


Figure 3-3 Center Column

3.3 Exit Tip

- Precision machined Ultem
- Selected from Neuralynx Exit Tip Configuration Guide
- Customizable tips - contact sales@neuralynx.com to order
- Geometry for enhanced dental cement bonding
- 1 use life
- 0.5 grams

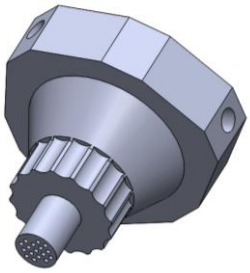


Figure 3-4 Exit Tip

3.4 Shuttle

- 3 use life
- 0.02 grams

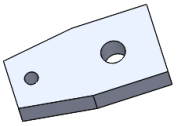


Figure 3-5 Shuttle

3.5 Included Hardware

- 10 X M1 Drive screw
- 10 X M1 Nut
- 6 X self-threading Torx Screw
- 6 X 1/8” 0-80 Socket Head Screws
- 3 x 1/4” 0-80 Socket Head Screws
- EIB-36 Standoff Adapter

3.6 Recommended Supplies (not included)

- tetrodes
- 5 minute epoxy
- Scotch-Weld DP-270
- Loctite 290
- EIB pins
- EIB
- Kwik-Cast / Kwik-sil
- Dental Cement
- X-ACTO blade
- Polymicro tubing (O.D. – .0064” I.D. – .0038”)
- Polyimide tubing 0.008”

3.7 Recommended Additional Products

Neuralynx provides additional products to support the assembly and use of the Halo-18 Microdrive and enhance multichannel electrophysiological research.

3.7.1 Halo-10 Assembly Kit

- Assembly Jig
- 2.5mm Hex Driver
- T3 Torx Wrench
- 0.05” Allen Wrench
- Stereotaxic Mount (see 2.7.2)
- Halo Microdrive Turn tool (see 2.7.3)

Figure 3-6 Halo-10 Assembly Jig

3.7.2 Halo-10 Stereotaxic Mount

- 0.310” Stereotaxic rod attachment

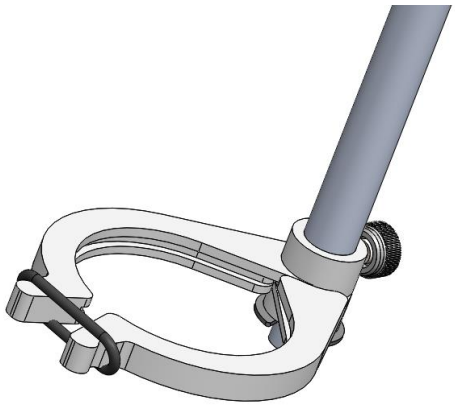


Figure 3-7 Halo-10 Stereotaxic Mount

3.7.3 Halo Microdrive Turn tool

- Locks onto M1 Drive screw.
- 16 indexed increments

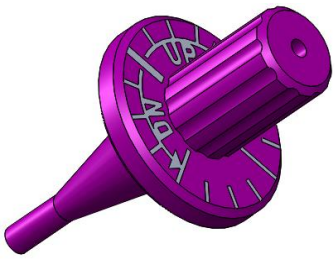


Figure 3-8 Halo Microdrive Turn tool

3.7.4 Halo-10 Protective Cap

- Infinite life
- Magnetic connection to EIB for easy installation and removal
- Omnetics option available
- Safe animal storage
- 2 grams

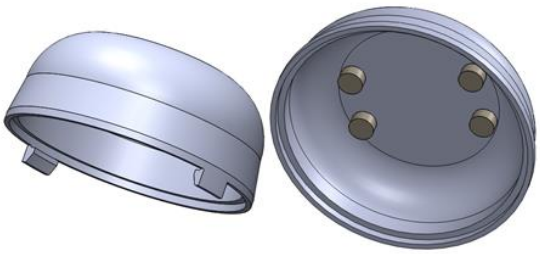


Figure 3-9 Halo-10 Omnetics and QuickClip Protective Cap

4 Assembling Drive

The following instructions will guide the user through the assembly of the Halo Microdrive. This process will the same for all three drives mentioned in this manual. Special considerations for each drive will be identified in the appropriate section.

4.1 Mounting Shuttles onto the Body

To mount the shuttles into the drive body first remove shuttles from their sleeve by cutting the sprue with an X-ACTO blade. Ensure that the sprue is entirely removed otherwise the shuttle will not seat properly into the Drive Body. If the Shuttle appears to be rough, polish it will fine grit sand paper. Next, insert a shuttle into a drive channel of the body. Press the shuttles down the channel until they sit flat on the bottom of the channel. Using the turn tool, thread an M1 Drive screw through the top pass-through hole on the Body, tap it through the shuttle, and then thread it through the base pass-through hole on the drive. The Drive screw will form threads as it passes through the shuttle which will require an increased torque. This is represented (image A). If the Drive Screw is not threaded concentric to the shuttle, remove the shuttle and try again. Repeat this process for the total number of shuttles necessary. Move the shuttles until they are approximately half way up their total travel.

Next, screw an M1 Nut onto the tip of each of the M1 Drive screw protruding from the bottom of the Body until snug against the Body. Be very particular while mounting the nut: if too loose against the Body, the Microdrive will have excessive hysteresis when changing drive directions; if too tight the Microdrive will have excessive friction which may result in the nut loosening over time (image B.) The provided hex driver should be used to start the nut on the screw. After starting the nut, it should be secured to the base until it is finger tight.

After all the nuts are mounted, apply a drop of Loctite to junction between each screw and its nut. The Loctite should wick into the threads. Allow Loctite to cure for at least an hour. Using an X-ACTO blade helps deliver the Loctite to the nut without spilling onto the drive body. If Loctite spills onto the body, clean up with a lint free cloth as quickly as possible (image C.)

After the Loctite has had time to cure, test each shuttle’s mechanics by moving the shuttle all the way up and all the way down. Finish by moving all shuttles to the top of their travel.

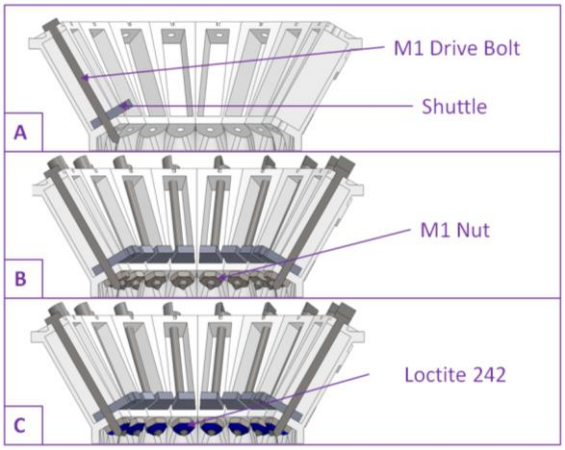


Figure 4-1 Shuttle Mounting

4.2 Alignment Guide

The purpose of this Alignment Guide is to ensure four things:

1) The connector on the EIB is orthogonal to the line of sight of the research animal
2) The referencing on the drive body lines up with the referencing on the EIB
3) There is no binding between the Polymicro tubing in the exit tip
4) Establish a reference guide.

First, plan where the Exit Tip will be located on the subject. Next, align the Center Column so the EIB - Center Column Adapter is parallel to the line of sight of the subject. This will ensure the QuickClip® EIB will align orthogonal to the line of sight of the subject. Finally align the Drive Body to the EIB so the shuttle references match the reference on the EIB. Mark these locations for future use.

Figure 4-2 Alignment Guide

To use the Exit Tip Alignment and Reference Guide, draw a line from each shuttle to a corresponding exit hole on the Exit Tip. Next, number each shuttle blank with the corresponding number on the assembled drive body. The Alignment and Reference guide can be found on the Exit Tip Configuration document as well as dimensions of through hole placements.

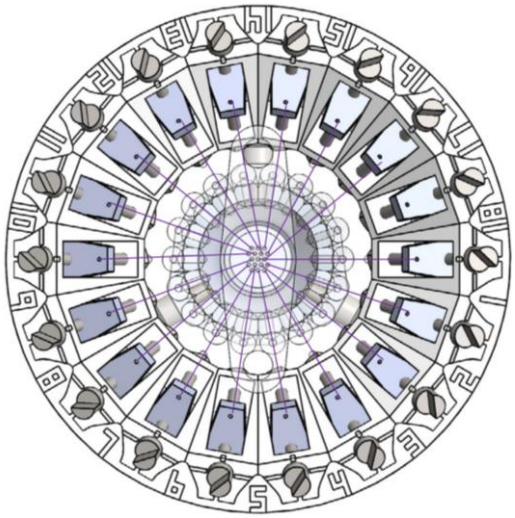


Figure 4-3 Exit Tip Alignment and Reference Guide

4.3 Inserting Polyimide Tubing

This drive utilizes a system of telescoping Polymicro and polyimide tubing to reinforce, guide, and protect tetrodes as they are driven. First polyimide tubing is inserted into the Microdrive and fixed at the exit tip of the Microdrive. Then, Polymicro tubing is telescoped into the polyimide tubing and fixed to the extension shuttles. Finally, tetrodes will be threaded through the Polymicro tubing. The Final configuration of Polymicro, Polyimide, and tetrodes are illustrated below Figure 4-4.

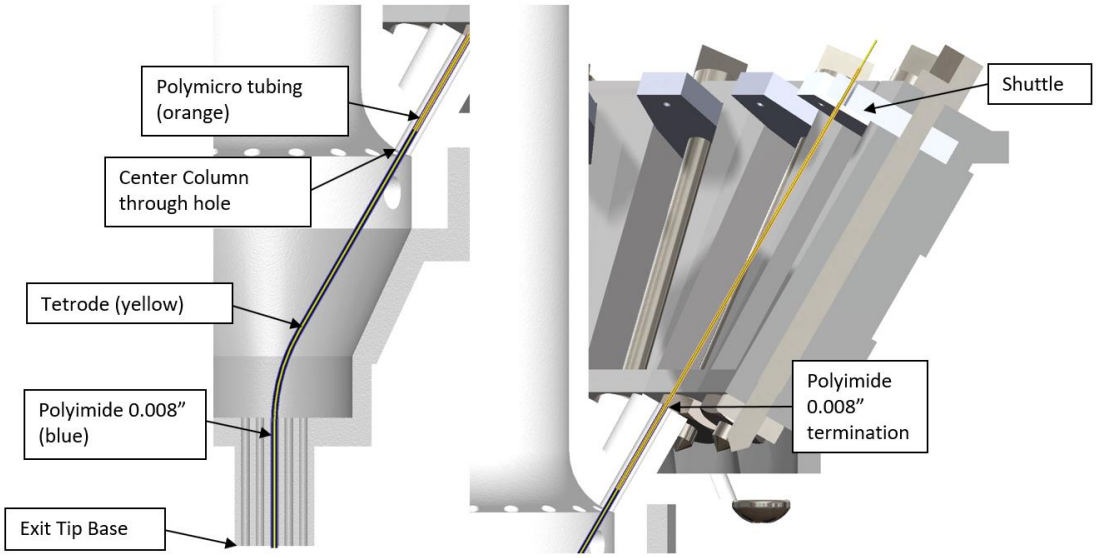


Figure 4-4 Overview of telescoping Polyimide Polymicro tubing

Prior to assembling the Microdrive, prep the Polyimide tubing by cutting sections of ~2.4" using a sharp X-acto knife. Prep the Polymicro Tubing by cleaving the necessary number of strands to a length of ~1.5". Each 12" length of 0.008" Polyimide tubing should produce 5 prepped strands.

First, mount the Center Column to the base of the Body using six Self-Tapping Torx Screws in a radial pattern Figure 4-5 corresponding to the alignment designated from previous section Figure 4-2. For the Halo-10 only five Torx screws should be used and for the Halo-28 seven Torx screws should be used. Use the T3 Torx Wrench provided with the Assembly kit to fasten the Torx Screws. Carefully turn the Wrench by the shaft of the wrench until you feel the Torx head seat to the center column. Do not turn the wrench by the 90 degree bend because you run the risk of over torqueing the bolt and stripping the through hole on the body greatly reducing the strength of the drive.

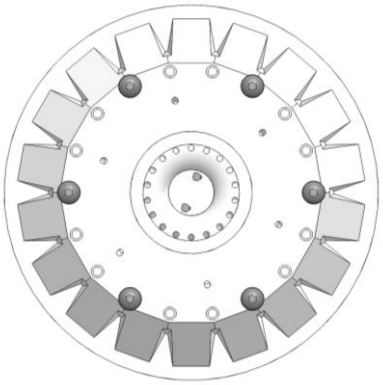


Figure 4-5 Mounted Center Column to Body

Next, using the Assembly Jig, hold the Exit Tip 1-1.5” from the base of the assembled Body Figure 4-6. Insert a strand of polyimide tubing into the through holes of the exit tip and then through the Center Column. Ensure the through hole on the exit tip corresponds to the shuttle specified the Alignment Guide Figure 4-3. Leave slack on both ends of the drive to allow the drive to be shifted around without pulling out the tubing. Repeat this process for the rest of the exit holes.

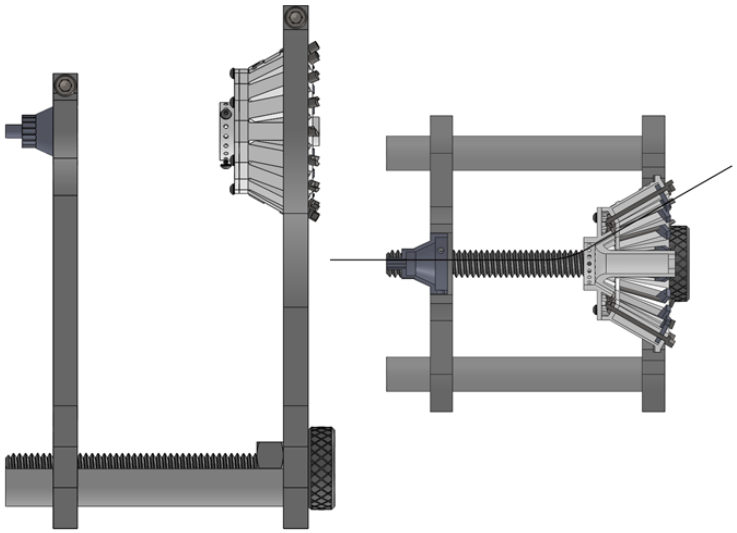


Figure 4-6 Loading Polymicro

After all shuttles have been loaded, partially fill the exit tip with DP-270. Do not fill past shelf used as stop on Center Column. This will cause the two pieces to be bound together

and eliminate the reusability of the Center Column. Angle the exit tip so the tip faces down to prevent the fluid epoxy from spilling. While the epoxy is still wet, move the Exit Tip towards the Center Column by turning the knurled head on the Assembly Jig. This will allow the polyimide to make its proper bend without kinking. While bringing the Exit Tip to the Center Column, adjust the Polyimide tubing's position by pulling on either end to ensure that it exits just above the through holes on the Center Column.

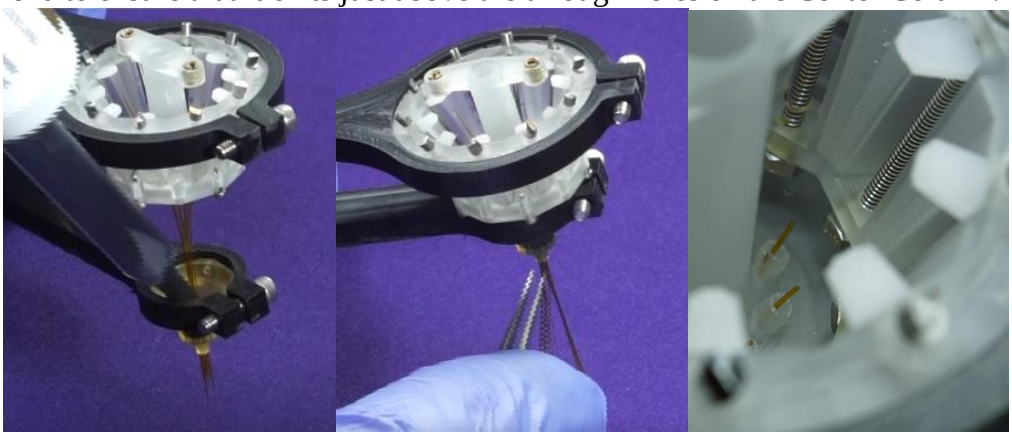


Figure 4-7 Applying DP-270, advancing Exit tip to Center Column and position Polyimide tubing

Finger pressure may be necessary to fully seat the Exit Tip to the center column.

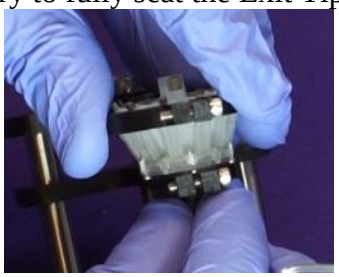


Figure 4-8 Securing Exit tip to Center Column

After seating the Exit Tip to the center column, release the jig section holding the exit tip and retract it to its full distance. This will be used to balance the drive vertically while the epoxy cures (24 hours).

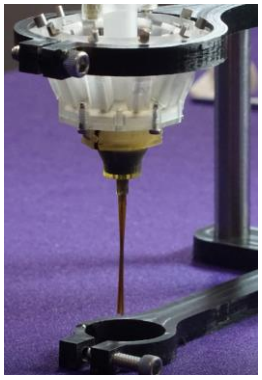


Figure 4-9 Position of Microdrive and Assembly Jig for curing epoxy

After the glue has cured, Fix the exit tip in place using three of the 1/8" 0-80 Socket Head screws. The screws will thread into the exit tip and seat into through holes on center

column. Next, trim the polyimide tubing flush to the end of the exit tip using a sharp X-acto knife.

Figure 4-10 Fixing Exit Tip and Trimming Polyimide tubing

Thread prepped lengths of Polymicro tubing through the polyimide tubing and through the shuttles.

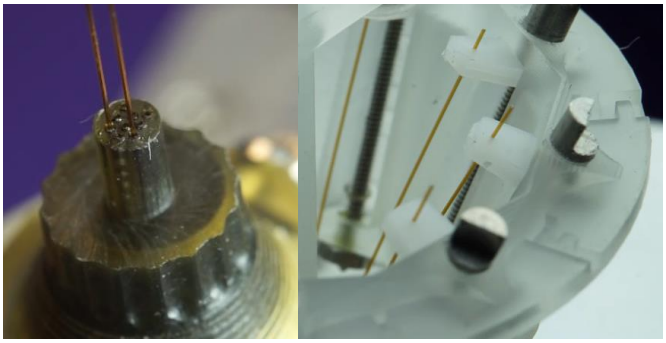


Figure 4-11 Inserting Polymicro tubing into Microdrive

Extend the shuttles down to their lowest position. Press the Polymicro tubing until it is flush to the base of the exit tip. Fix the Polymicro tubing to shuttle using 5 minute epoxy and let cure (20 minutes).

Figure 4-12 Positioning Shuttles and Polymicro tubing to be secured with epoxy

Retract the shuttles to their highest position. Trim the excess Polymicro to desired height.

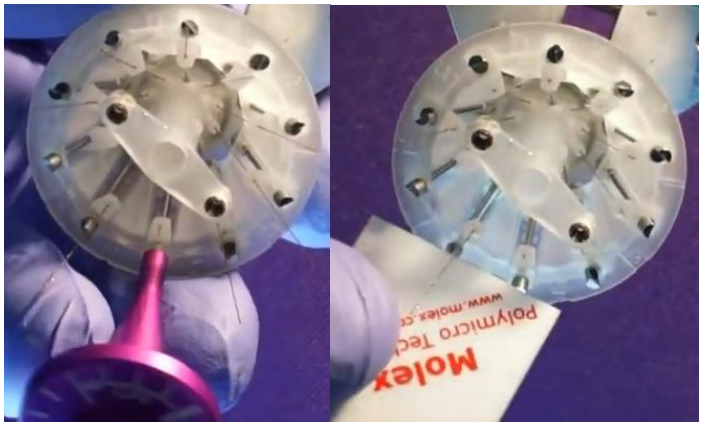


Figure 4-13 Positioning Shuttles at top of travel and trimming excess Polymicro tubing

Mount the EIB so the tetrode locations match up as closely as possible to numbered shuttle positions on the drive body. The mechanics of the Microdrive are now assembled and ready for loading tetrodes.

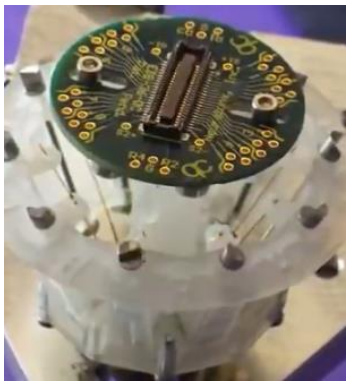


Figure 4-14 Mounting EIB on top of Microdrive

For more detail on the construction of the Halo Microdrive view the Halo-10 Microdrive Assembly video on the Neuralynx website.

4.4 Ground Wire Pass Through

Six holes located at the base of the Center Column can be used as pass throughs for grounding wires or EMG. Wires crimped into 23G cannula can be inserted into the 30G cannula and work as a connector.

4.5 Loading and Prepping Tetrodes

There are many different techniques for making tetrodes. Our Tetrode Assembly Station Manual will guide you through some of those processed and is available online.
Prior to loading the drive, the tetrodes need to be prepped. This starts by separating the four wires Figure 4-15. First, cut the loop at the top. Pull the two sets of wires down gently until you feel a little resistance, and then give a sharp tug to both sides to keep them separated. Do the same with each set of two wires. If the ends aren't accessible at first, hold the wires a little below the end and twirl the ends between your fingers sharply

until the ends separate enough for you to grab them. Separate and tug to hold as below, using the tetrode tweezers if necessary. If the four wires are of different lengths, or the ends are curly, cut them down until they are all about the same length from the intersection point (where the polyimide coating has stuck them all together from the heat gun).

It's not critical that the tetrodes be any particular length, only that they are all close in length to each other. No single wire should be too long or short when fed into the Polymicro. Successful prepping will result with enough straight tetrodes at each end to push through the Polymicro and out the Exit Tip, and enough play to span the four separate holes for each wire of the tetrode in the Headstage.

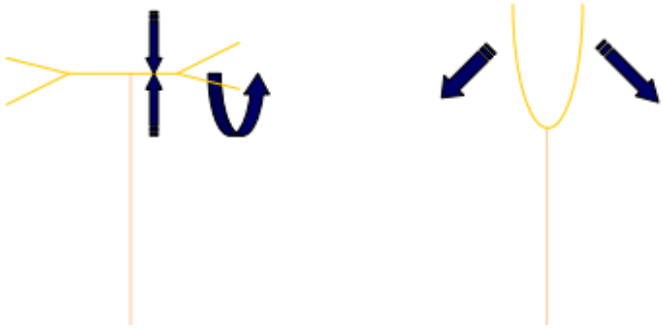


Figure 4-15 Tetrode Tip Separating

Next, thread the prepped tetrodes through the Polymicro tubing until they are flush with the base of the Exit Tip, ~3mm of tetrode extends past the end of the Polymicro. After the tetrodes have been inserted into the Polymicro, secure the tetrodes to the Polymicro using epoxy. If the tetrodes are planning on being plated, wait to secure them after the plating process. This will allow the tetrode to be replaced if any issue happens due to the plating.

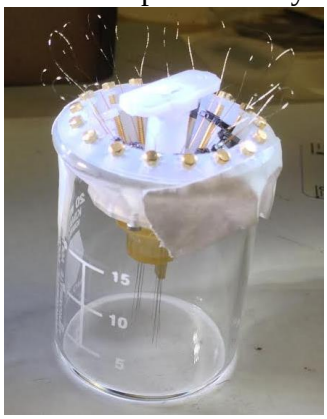


Figure 4-16 Inserted Tetrodes

4.6 Pinning Tetrodes

Lower all shuttles to the lowest possible position. For this step you will want to mount the lower portion of your drive in a stable holding device such as a small vise grip or back into the Assembly Jig. Each individual wire in the tetrode is going to be guided through a via on the EIB that corresponds to the correct pin out. This is going to be done by inserting the wire from the bottom of the EIB and then pinning it from the top.

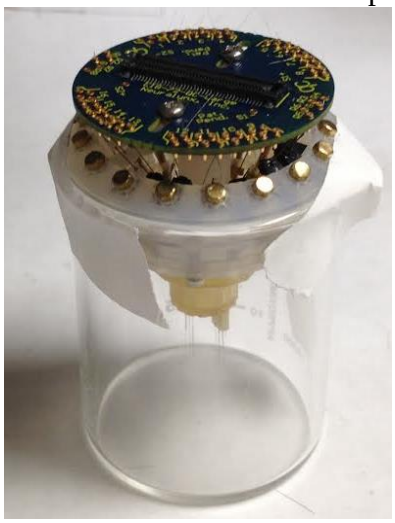


Figure 4-17 Pinned and Fully Assembled Microdrive

4.7 Halo-10 Instructions

To use the EIB-36 with the Halo-10 a Spacer must be used to allow access to the Tetrode pin Through Holes. Quarter inch 0-80 Socket head screws need to be used for the increased size.

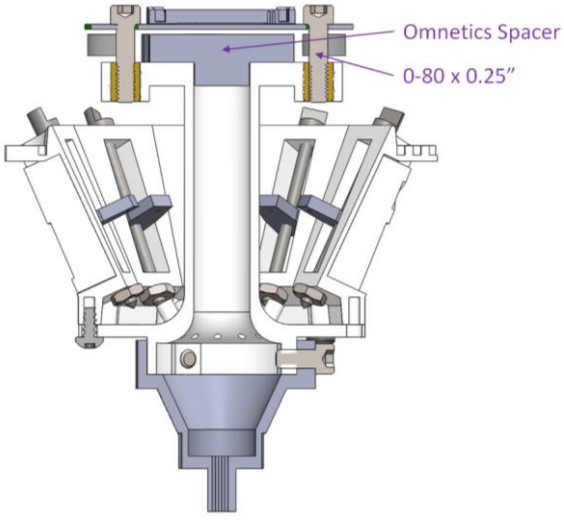


Figure 4-18 EIB-36 Mounted on Halo-10

5 Implanting the Microdrive

5.1 Stereotaxic Mount

A Stereotaxic Mount (purchased from Neuralynx) is used to hold the Microdrive during surgery. The Stereotaxic Mount holds the Microdrive by its outer lip. The lower lip retainer can be fixed to a 0.310" stereotaxic rod using a knurled thumb screw. The upper lip retainer can be fixed to the lower lip using a rubber gasket. After implant the Stereotaxic Mount can be removed by trimming the rubber gasket and then unscrewing the thumb screw locking the lower lip retainer.

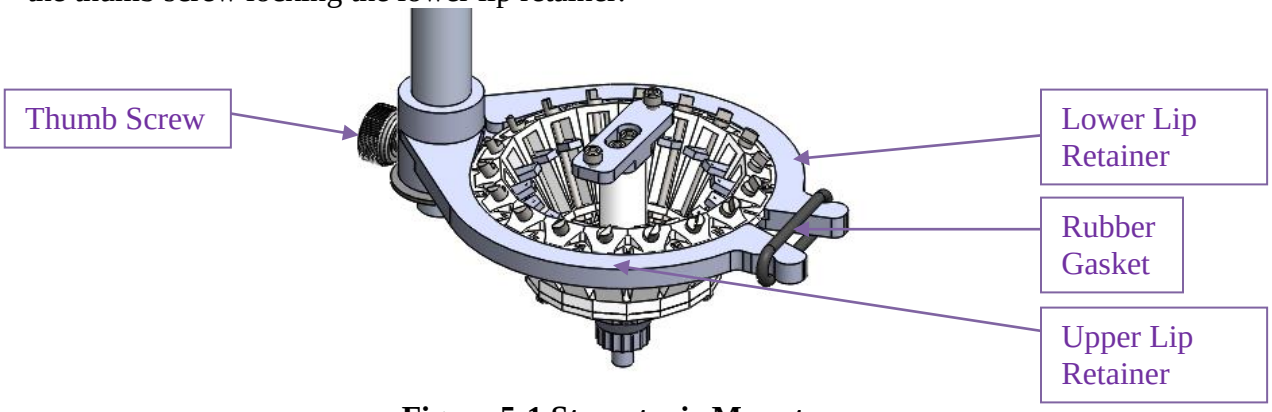


Figure 5-1 Stereotaxic Mount

5.2 Craniotomy

The Exit Tip is designed to be the least invasive as possible by minimizing craniotomy size. Kwik-sil is intended to seal the exposed area of the craniotomy and the Exit Tip which will then be affixed using Dental Cement. If the drive is intended to be re-used, the drive tip should not be sealed above the 00-51 x 3/32 TXP F/T PH P/T 48 – 2 S/S screws on the Exit Tip. It is recommended to affix bone screws for grounding in a location which will be covered by dental cement to protect the grounding wires from breaking.

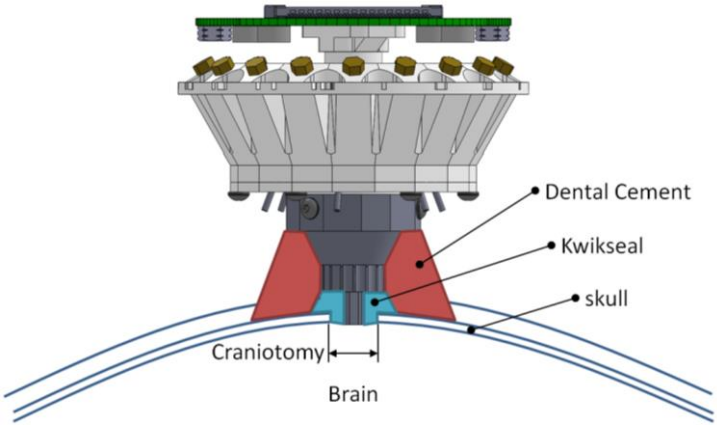


Figure 5-2 Craniotomy

6 Protective Cap

A Protective Cap can be purchased from Neuralynx and used to protect the Microdrive while not being used for recording. The Cap utilizes the QuickClip® aligning magnetics to aid in application to the drive. An Omnetics version is also available which has a higher profile to clear the increased height of the connectors and a clip mechanism which fastens to the outer lip of the drive body. Vetrap should be wound around the drive body and protective cap to ensure retention.

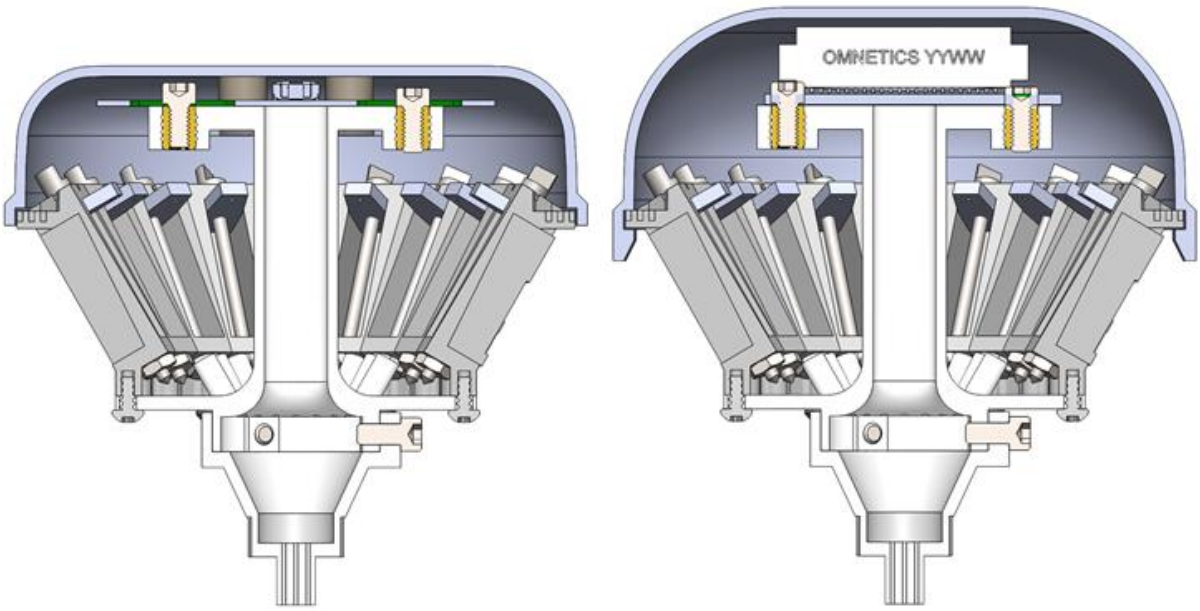


Figure 6-1 Halo-18 Microdrive QuickClip and Omnetics Protective Cap

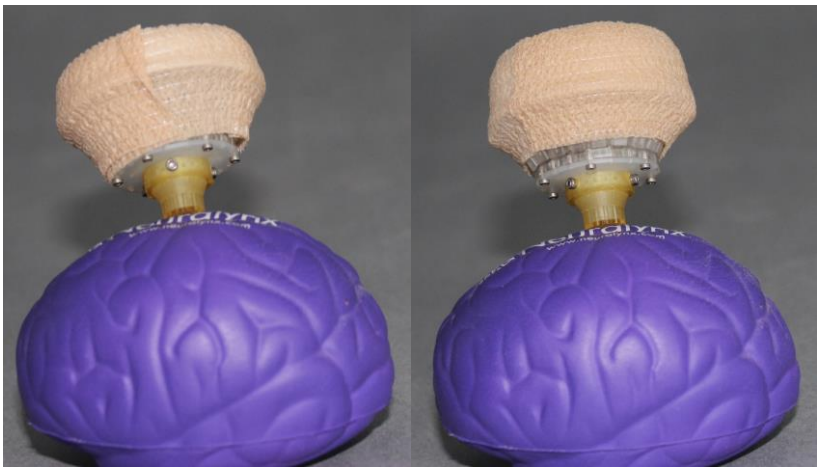
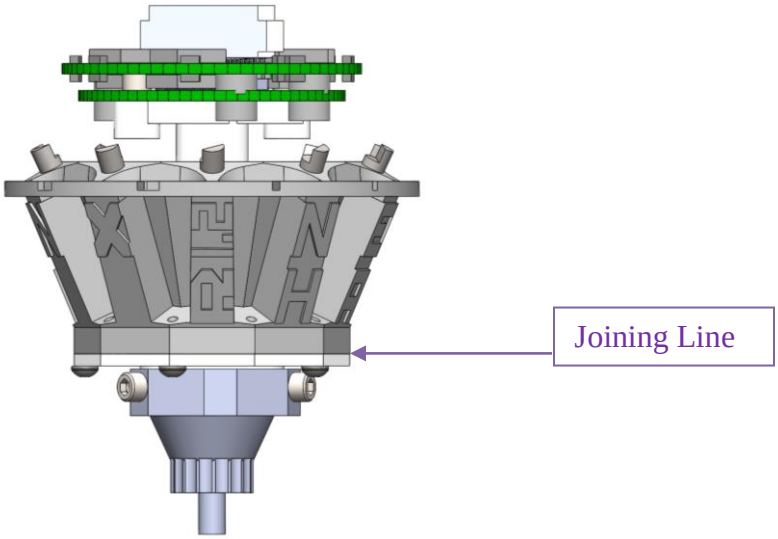


Figure 6-2 Vetrap Applied to Microdrive Protective Caps

7 Adding and Removing Headstage

When connecting and disconnecting Quick Clip style Headstage to the EIB Mounted on the Microdrive hold the drive from below the joining line of the Center Column and Body and follow the QuickClip connect and disconnect instructions located on the Neuralynx website. When connecting and disconnecting Omnetics style Headstages hold the drive from the same location and insert the connector in line with the pins into the corresponding sockets.



8 Recycling Microdrive

The Halo-18 Microdrive can be reused up to 3 times. To reuse the microdrive post implantation follow these steps:

- Remove the Center Column and Body from the Exit Tip. If dental cement was carefully attached during surgery, the Socket Head Screw on the exit Tip can be unthreaded and the assembled Body can be pulled off the animal.
- An Exit Tip may be cleaned by placing the Ultem piece in boiling water to soften the dental cement. Do not exceed 350^{o} F when cleaning Ultem piece.
- Remove the EIB from the Center Column by unthreading the Socket Head Screws. Trim the tetrode's wires attached to the EIB.
- Remove Center Column from the Body by removing the Torx Screws attached to the base of the Center Column.
- Remove the M1 nuts from the M1 Drive screw by breaking the Loctite bond and unthreading.
- Unthread the M1 Drive screw from the shuttles and remove both the delrin shuttle and the M1 Drive screw from the Body.
- Prep a bath of alcohol and soak the M1 nuts, M1 Drive screw, and delrin shuttles. The adhesive used to bond the polymicro and the tetrode wire should be soft enough to remove them from the shuttles. Clean the shuttles nuts and bolts post soaking.
- Microdrive should be ready to rebuild.

NOTE: Each time a self-tapping screw is threaded into a hole, that hole's structural integrity is sacrificed for a consecutive attachment. The Microdrive is designed with three different radial patterns allowing up to three builds of each component. Shuttles should be used until any hysteresis is noticed.

9 Custom Exit Tip

The Halo-18 Microdrive can be modified at the Exit Tip to accommodate a wide range of large scale electrophysiology studies. Contact Neuralynx sales for more information.

10 Optogenetics

The Exit Tip can be outfitted to accept optical fibers for optogenetic studies. This is accomplished by spanning a polyimide tube from the Center Column to the Exit Tip instead of a polymicro tube during the assembly of the Microdrive. After the Exit Tip is fastened to the Center Column, it will need to be trimmed so it sits flush with the base of the Exit Tip and the top of the Center Column pass through hole. Next, optical fiber is loaded into the corresponding shuttle and threaded through the polyimide tunnel. Some friction may occur between the sharp edge of the fiber tip and the polyimide tube. Prepare several fibers in case one breaks during the insertion. To enable the shuttle to accept the optic fiber ferrule the through hole on the shuttle should be increased to 1.25mm diameter. Press the ferrule through the enlarged hole until a small portion extends off the other side of the shuttle. Next, attach the sleeve to the ferrule about half way down the sleeve length. Finally encase the assembled shuttle, ferrule, and sleeve with epoxy to prevent it from slipping. Be careful when applying epoxy as it could bond the shuttle to the body block the patch cable from fully seating on the polished end of the ferrule.

Modifications necessary for this module include increasing the Exit Tip's pass through diameter to 0.5mm to accommodate polyimide with dimensions 0.0196" O.D. and 0.0135" I.D.

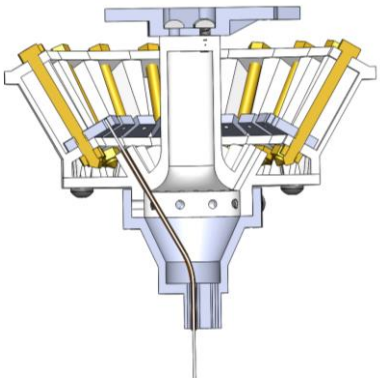


Figure 10-1 Optogenetic Integration

11 Glossary

EIB – Electrode Interface Board.
O.D. – Outer Diameter
I.D. – Inner Diameter
Polymicro tubing – Silica Capillary
Polyimide tubing – Polymer based tubing
Ultem – A biocompatible plastic
Cyanoacrylate – Super Glue
Tetrode – Four microwires twisted together for improved resolution in electrophysiological recordings
Pitch – The distance along the axis that is covered by one complete rotation

12 Vendor List

- McMaster-Carr
  - T3 torques drive
  - 00-51 x 3/32 TXP F/T PH P/T 48 – 2 S/S
  - Loctite 294
  - epoxy
  - X-ACTO blades

- Thor-labs
  - fiber

- Molex Electronic Solutions
  - polymicro tubing - TSP100170

- World Precision Instruments
  - Kwik-cast

- Amazon
  - Vetrap

13 Neuralynx Contact

To purchase Microdrive, Microdrive accessories, Microdrive replacement parts, or to learn more about the Halo-18 Microdrive contact Sales@Neuralynx.com. For assistance in construction or implementation of Halo-18 Microdrive contact support@neuralynx.com.