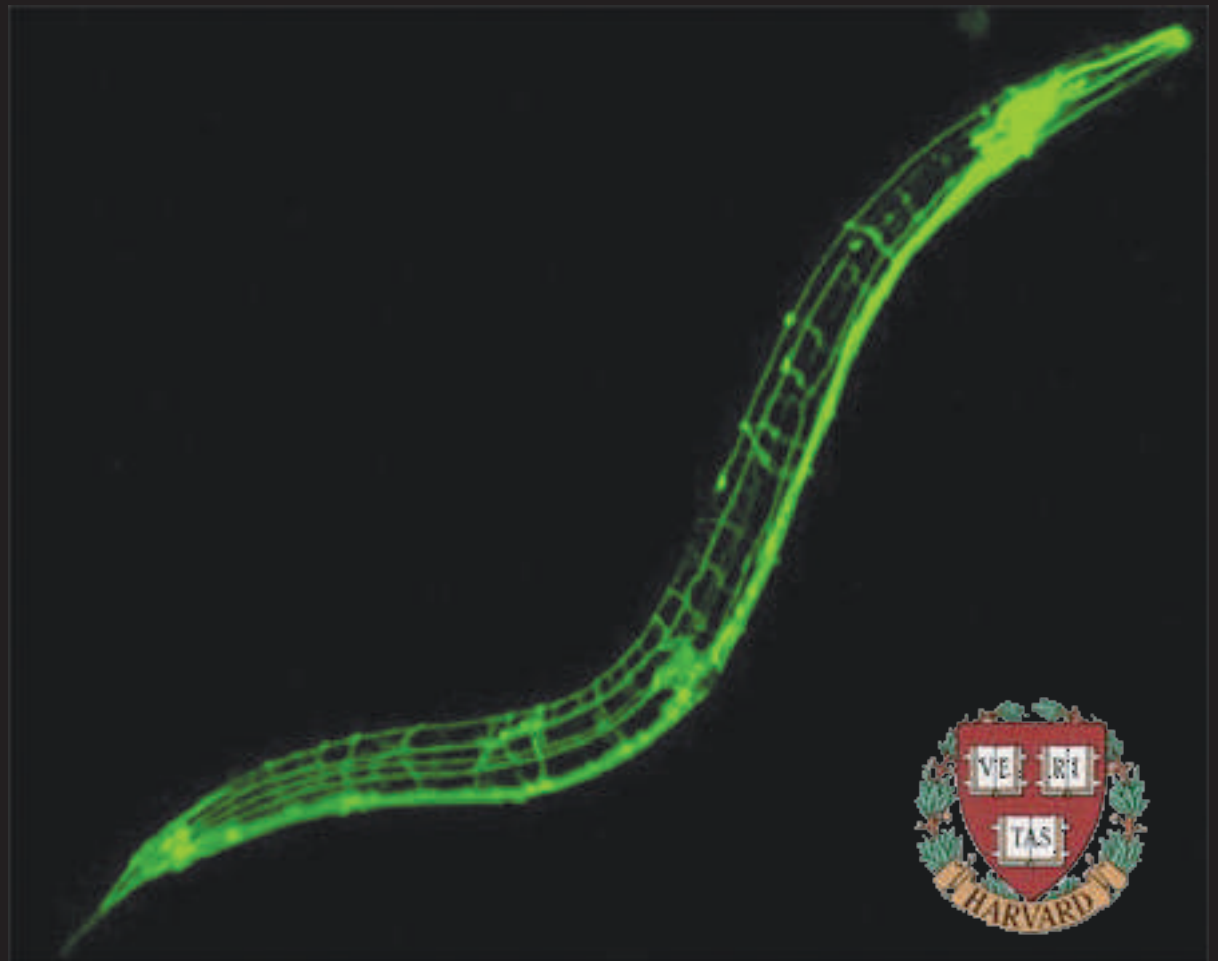


Applications of femtosecond laser ablation for nanoneurosurgery in *C. elegans*

Samuel Chung
Eric Mazur

Damon Clark, Chris Gabel
Aravinthan Samuel

BiOS at Photonics West
20 January 2007



"Model" organism
simple animal
similarities to higher organisms



"Model" organism
simple animal
similarities to higher organisms

transparent in visible
transparent in near infrared



"Model" organism

- simple animal
- similarities to higher organisms

- transparent in visible
- transparent in near infrared

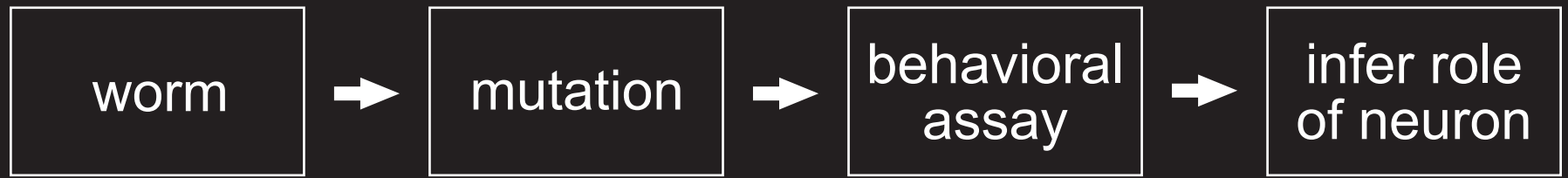
Nervous system

- composed of 302 neurons
- invariant wiring diagram
- encodes the worm's standard behavior



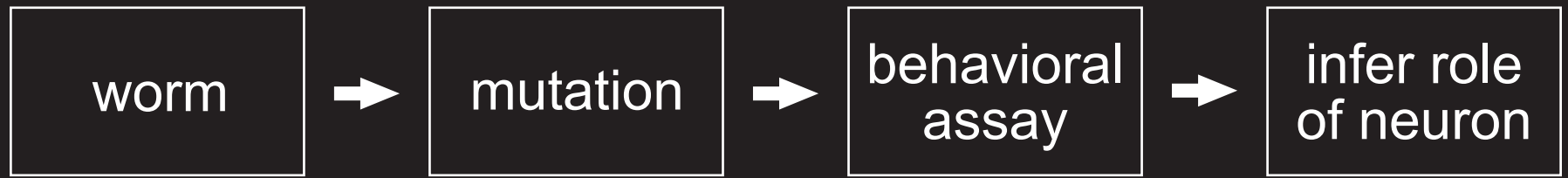
Mapping behavior to neurons

conventional method:

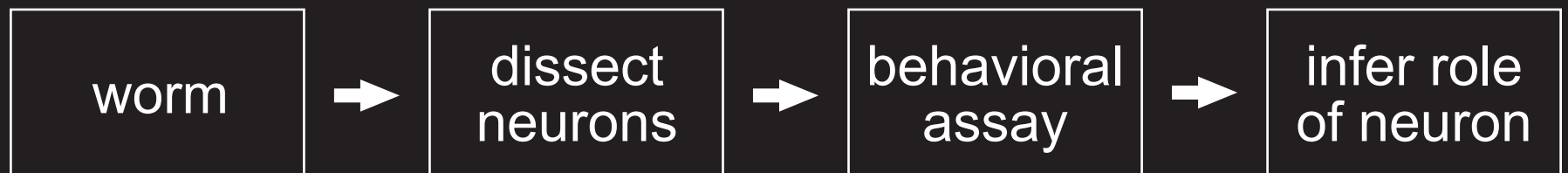


Mapping behavior to neurons

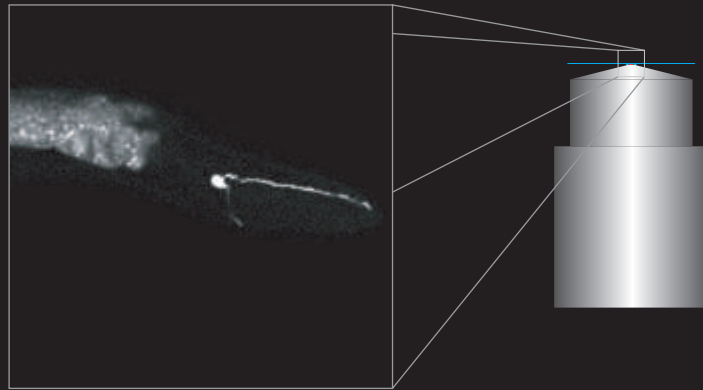
conventional method:



femtosecond laser dissection:



Laboratory setup



microscope
objective

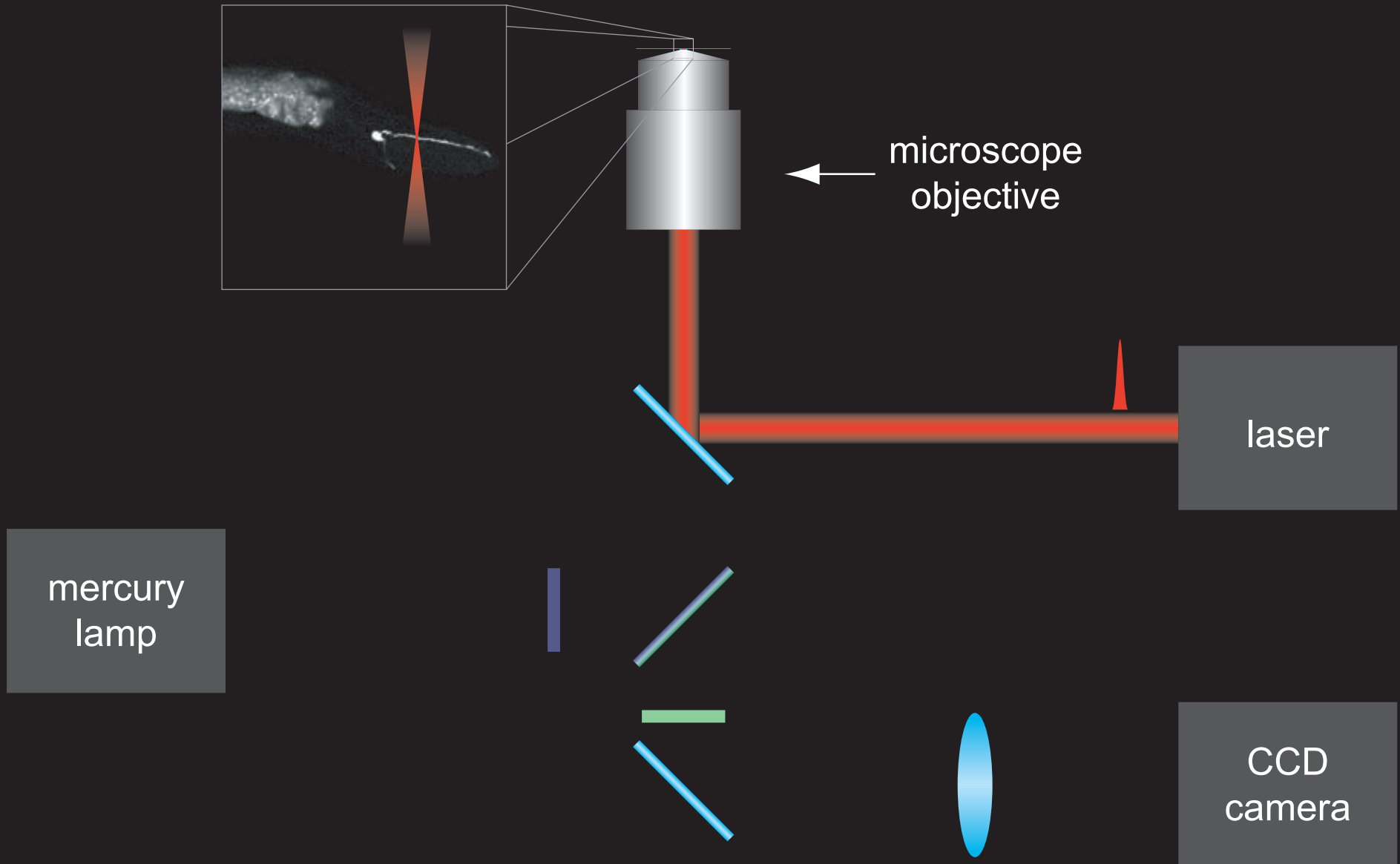
mercury
lamp

laser

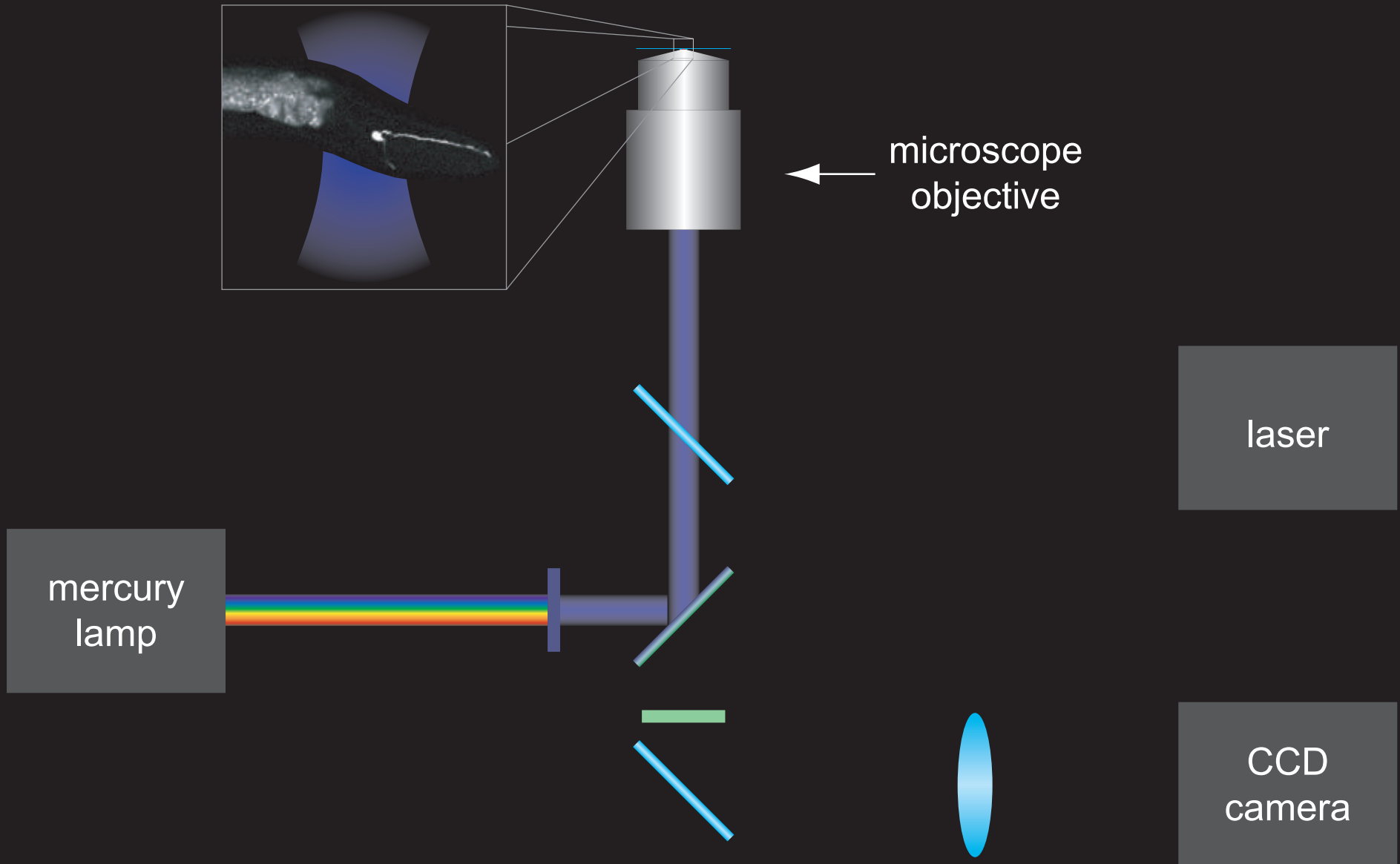
CCD
camera



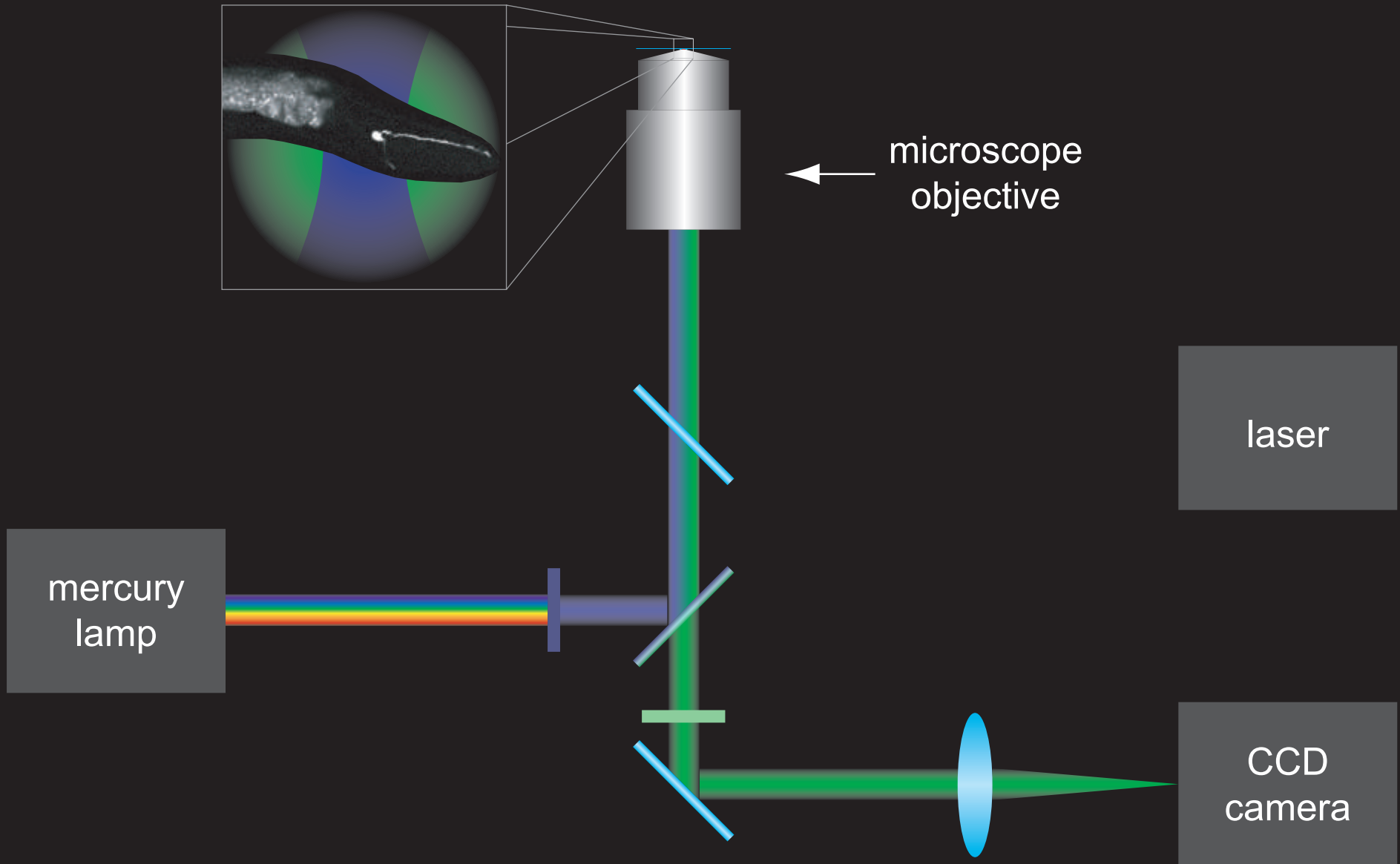
Laboratory setup



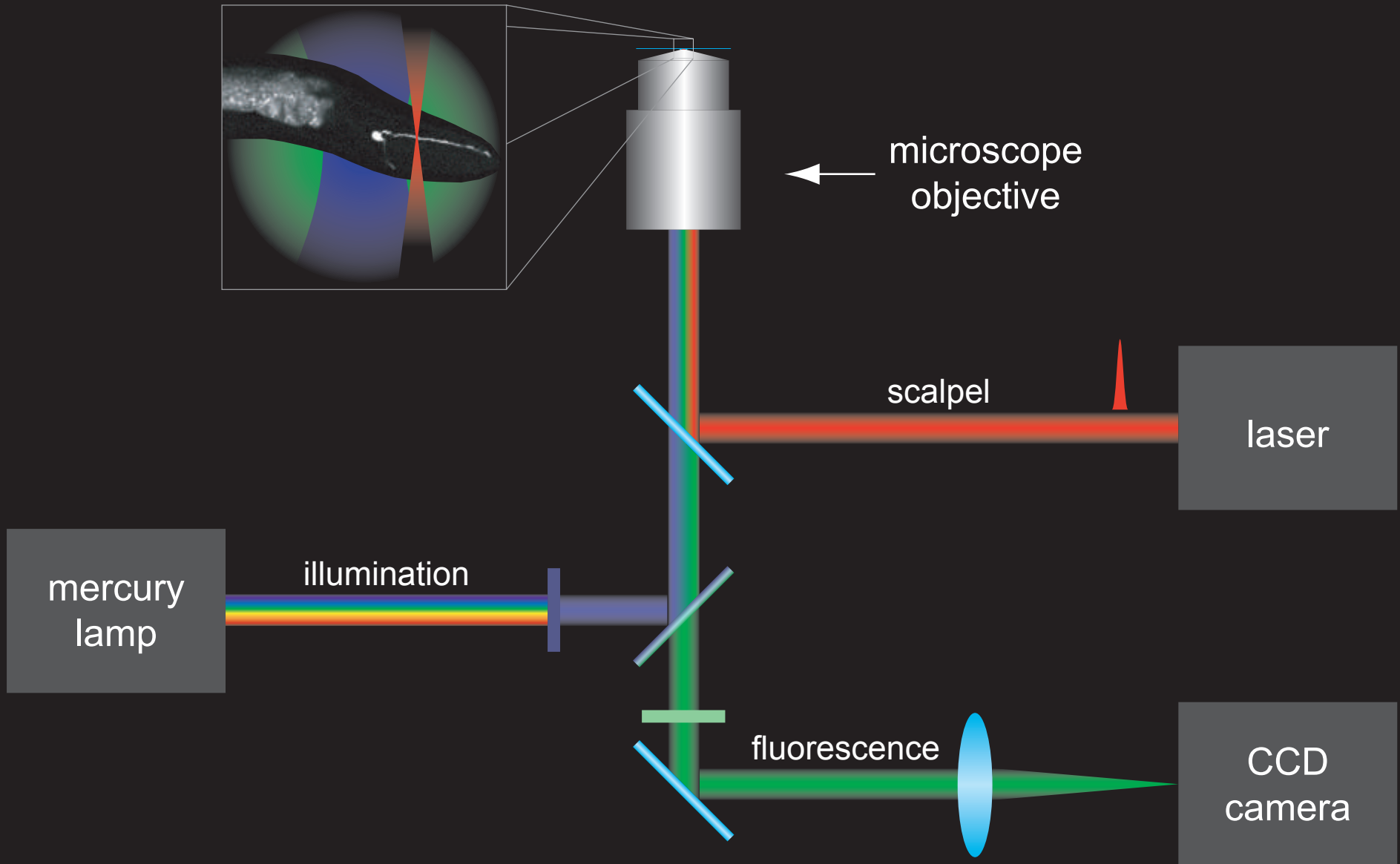
Laboratory setup



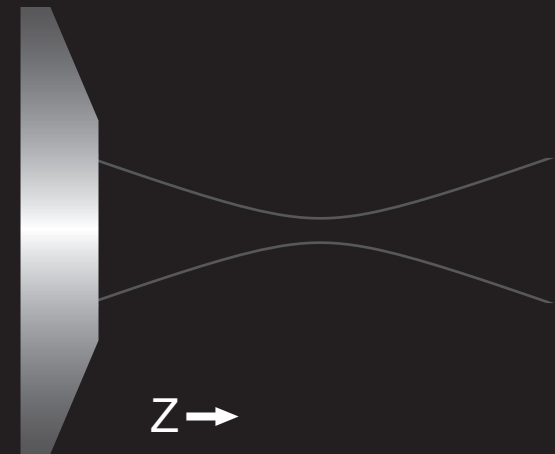
Laboratory setup



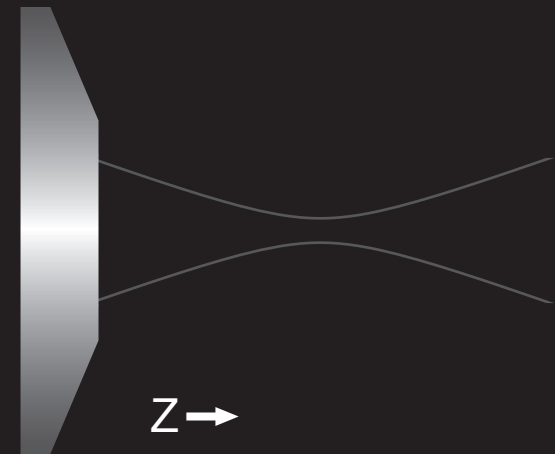
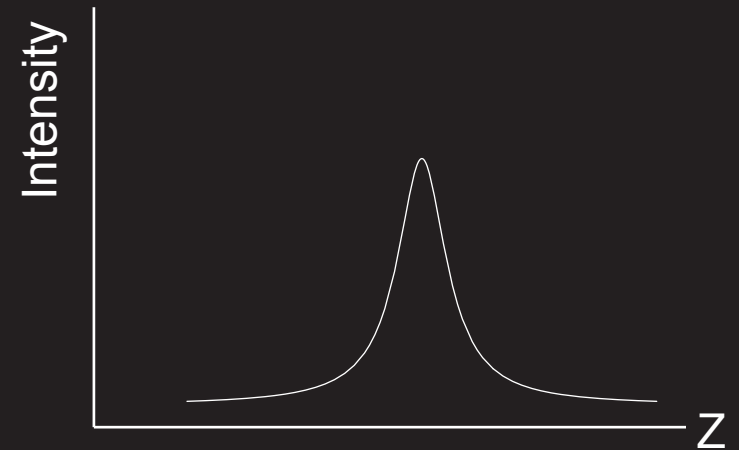
Laboratory setup



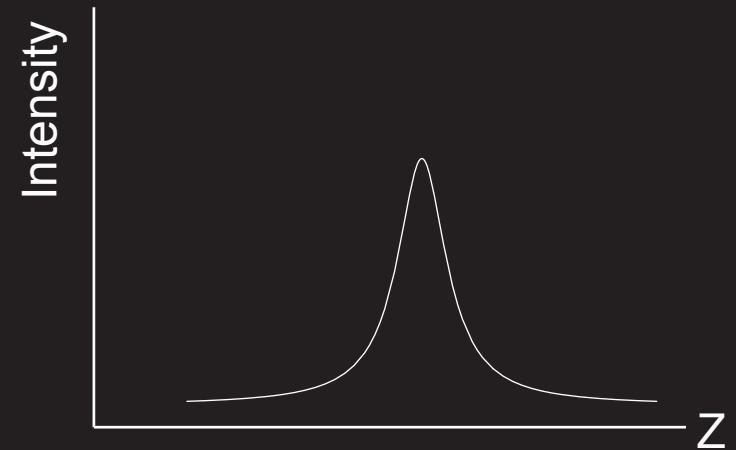
Surgery without incision



Surgery without incision

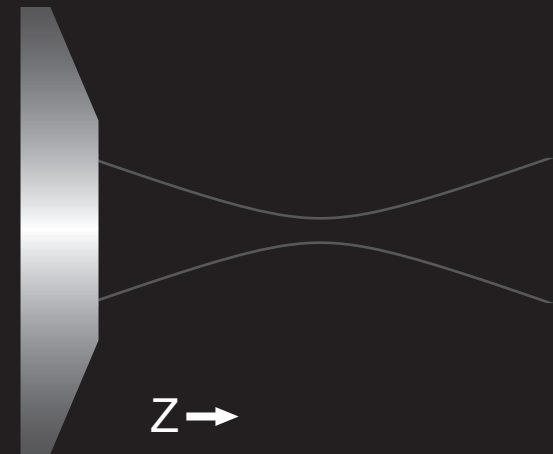


Surgery without incision

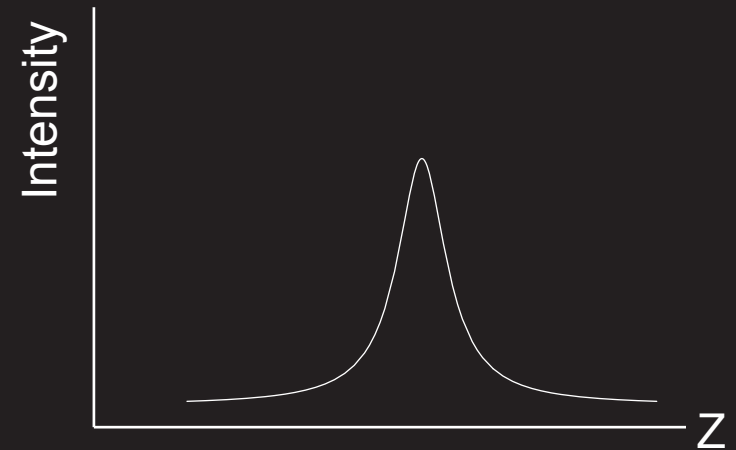


intensity equation

$$I \cong \frac{E}{A \tau}$$

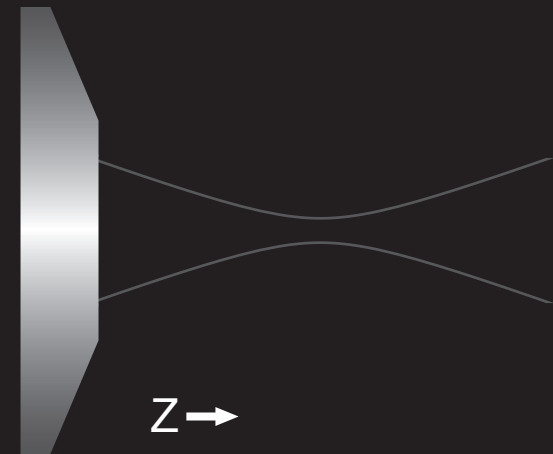


Surgery without incision



intensity equation

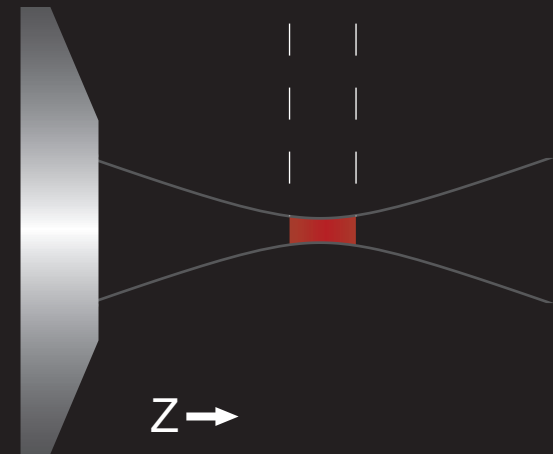
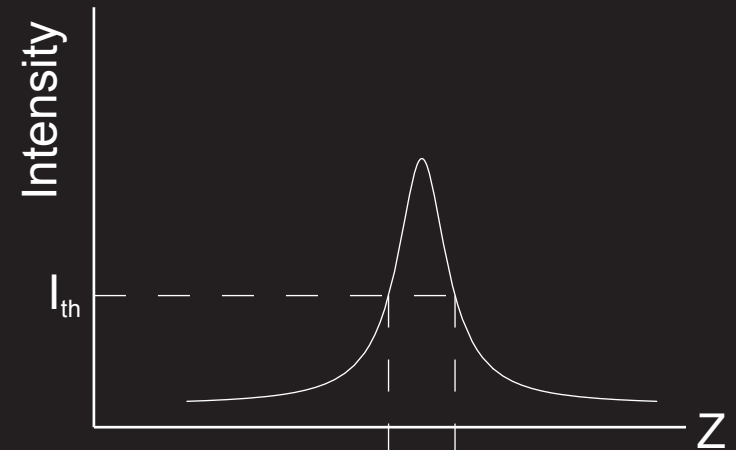
$$I \cong \frac{E}{A \tau} > I_{th}$$



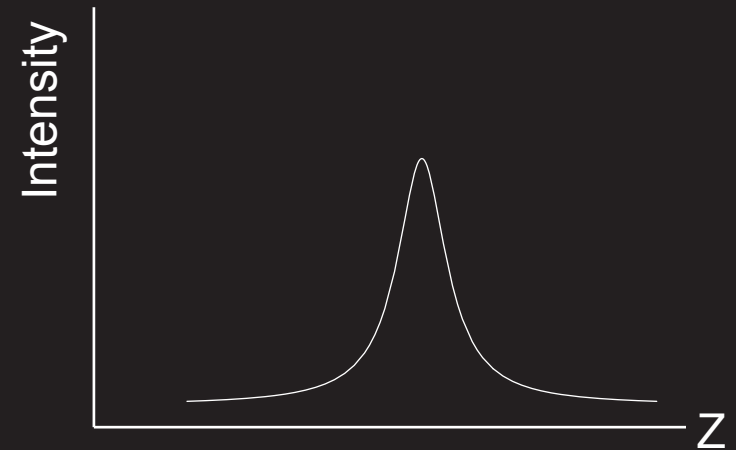
Surgery without incision

intensity equation

$$I \cong \frac{E}{A \tau} > I_{th}$$

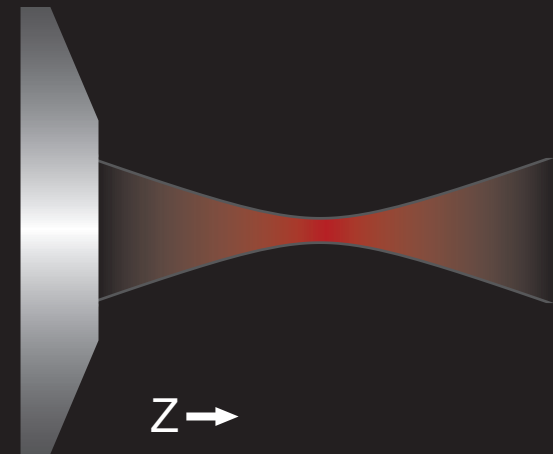


Surgery without incision

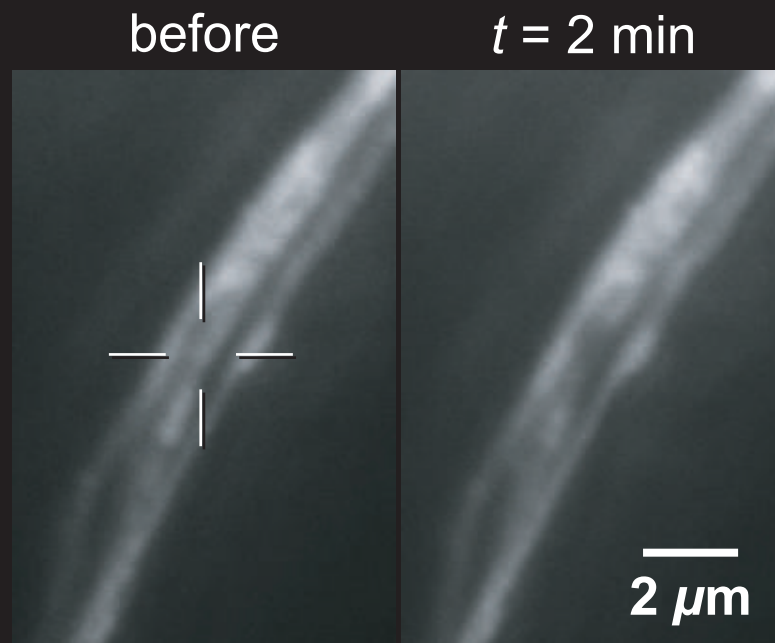


intensity equation

$$I \cong \frac{E}{A \tau} > I_{th}$$

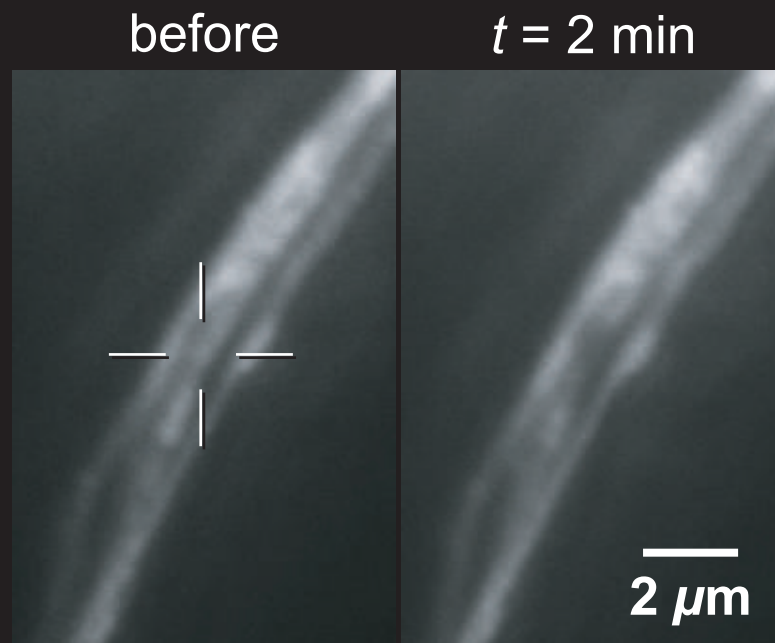


Resolution of dissection



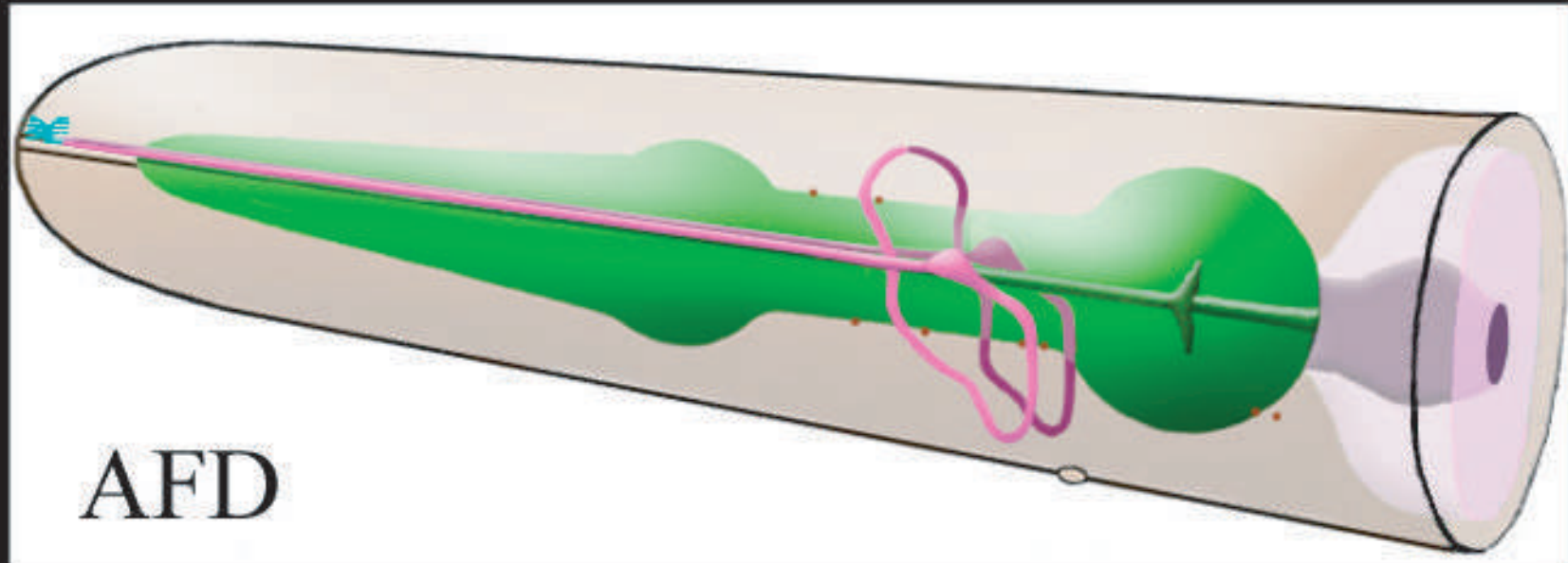
3.2 nJ pulses

Resolution of dissection



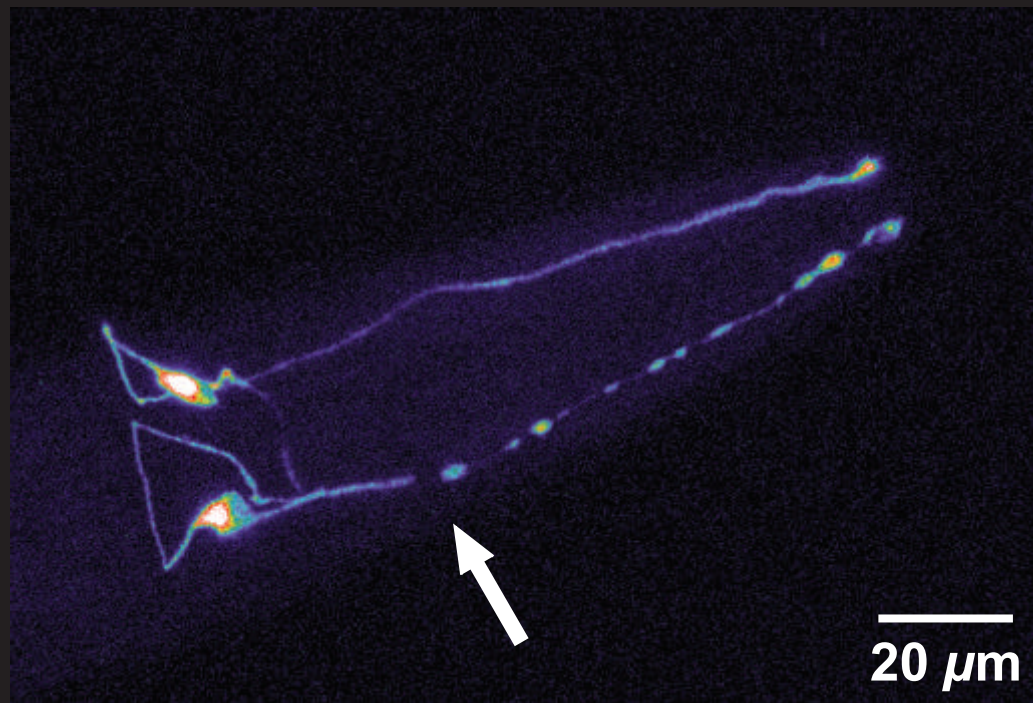
resolution
< $1 \mu\text{m}$

3.2 nJ pulses



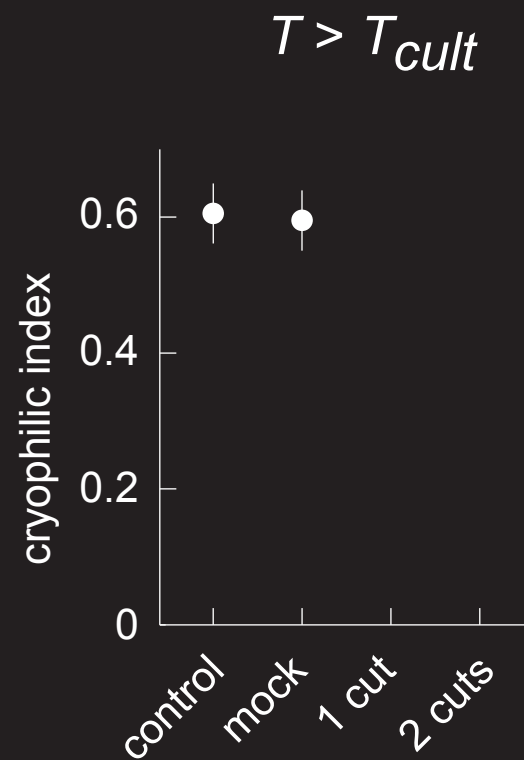
Where does the AFD sense temperature?

Confocal microscope image of AFD neurons
two hours after surgery

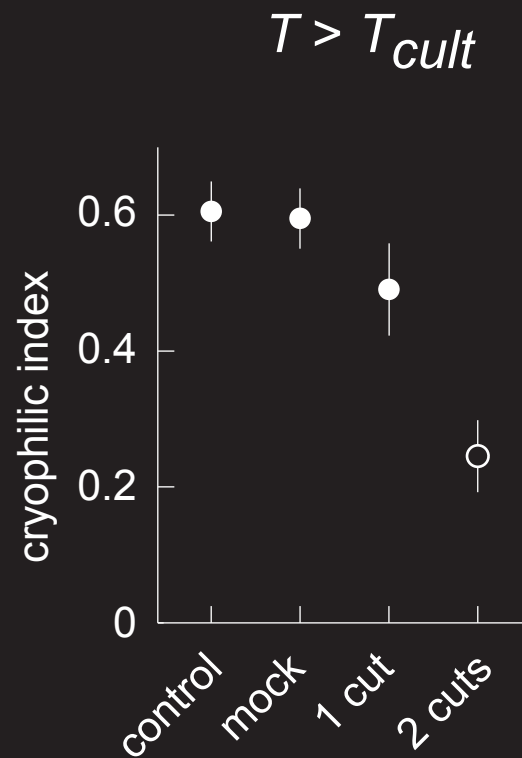


3.2 nJ pulses

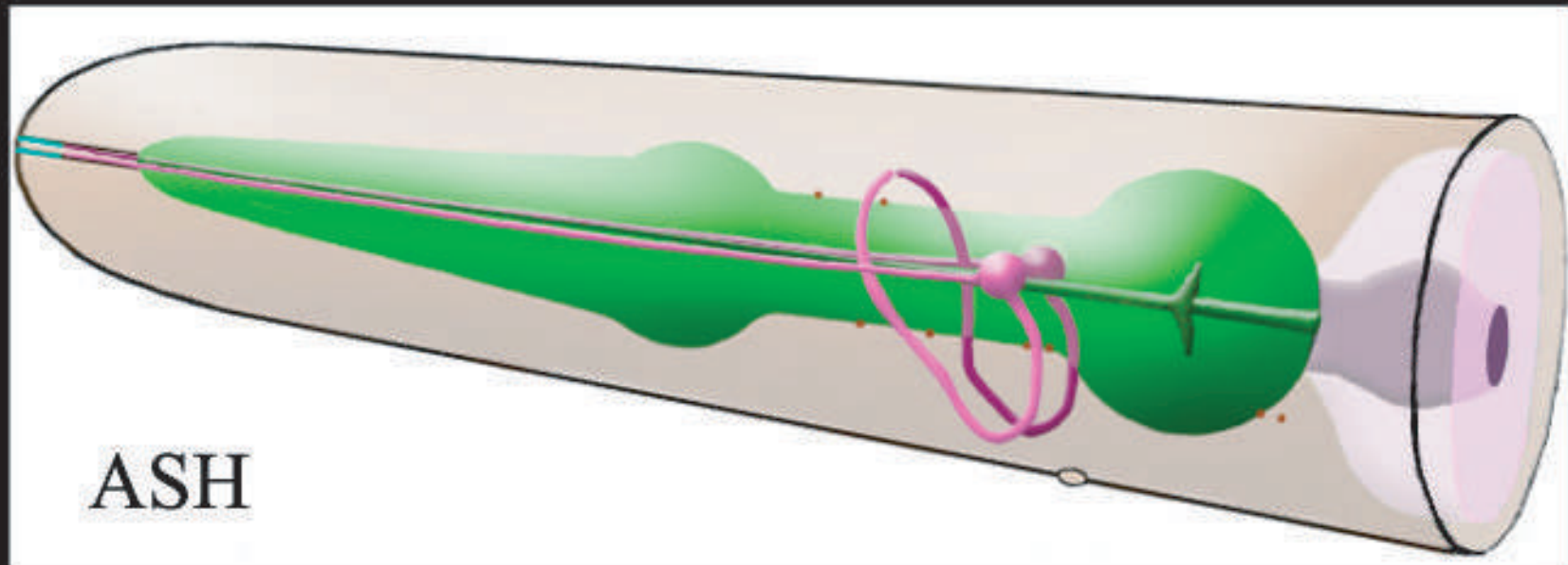
Behavioral assay



Behavioral assay



active
cryophilic drive
above T_{cult}
switched off

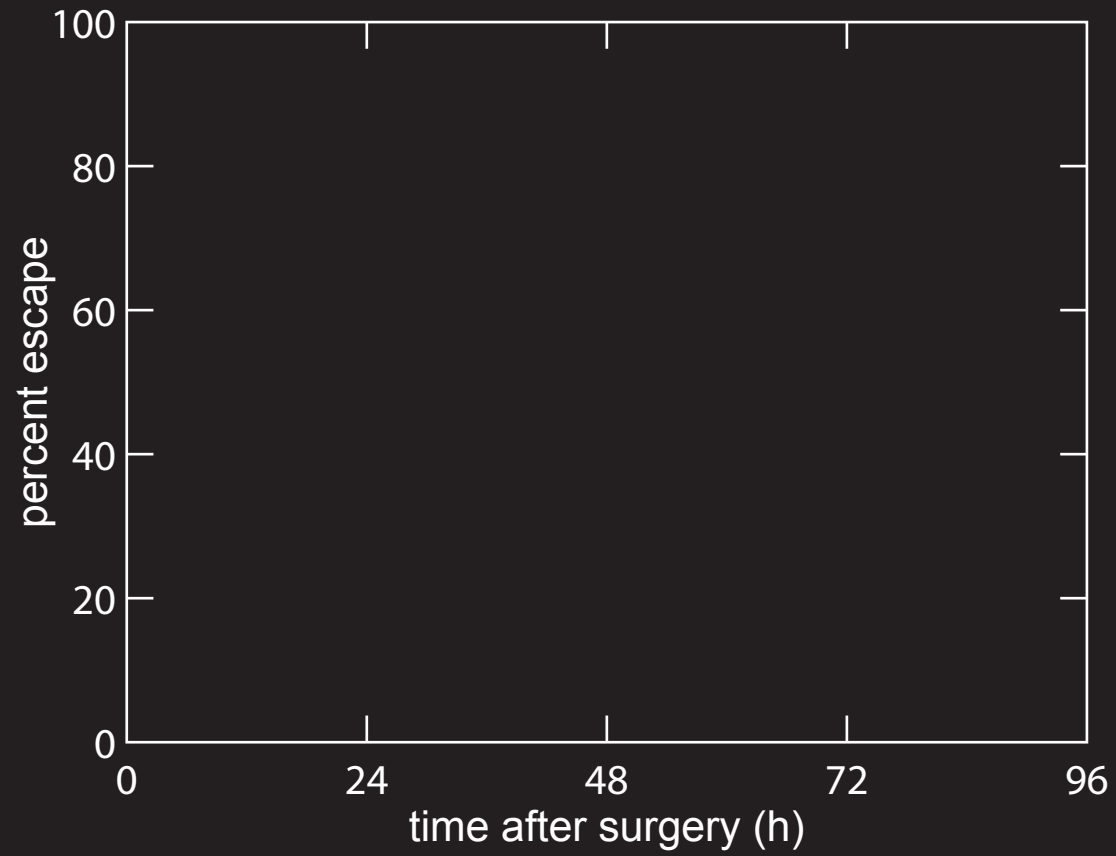


Can the ASH regenerate its dendrite?

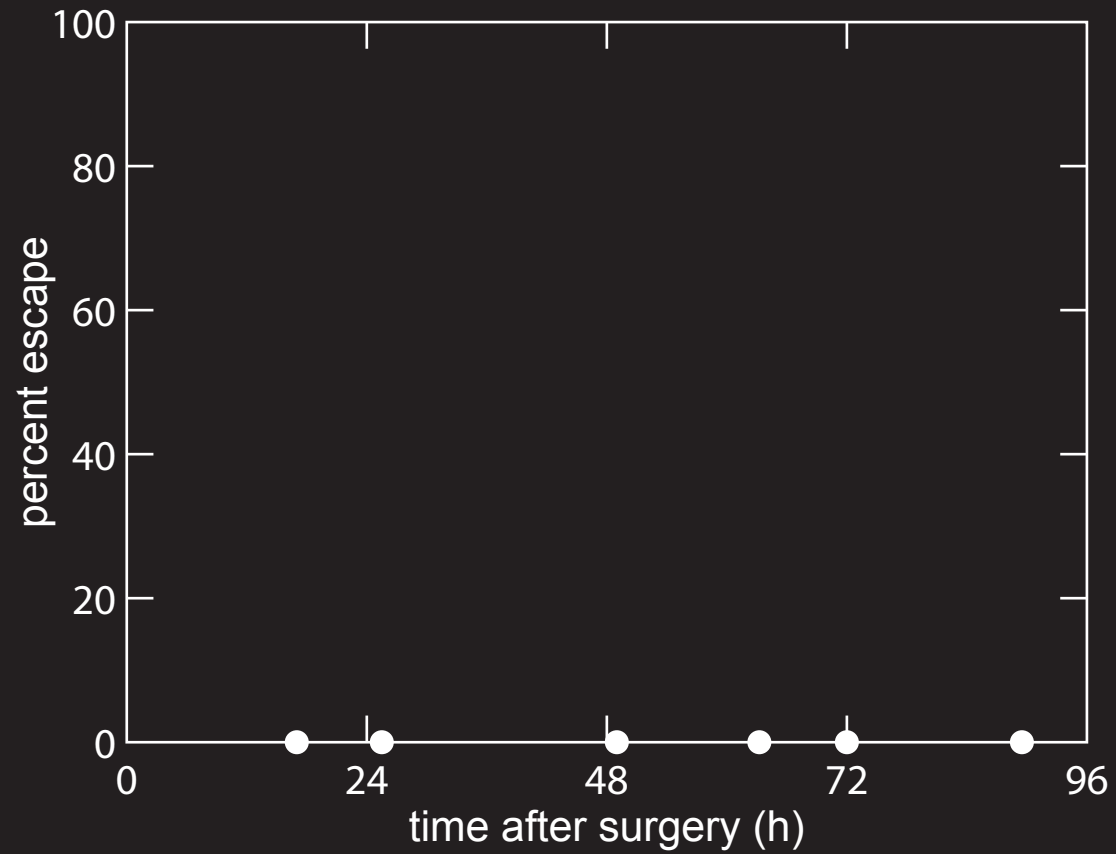


15 mm ring of glycerol dissolved into agarose

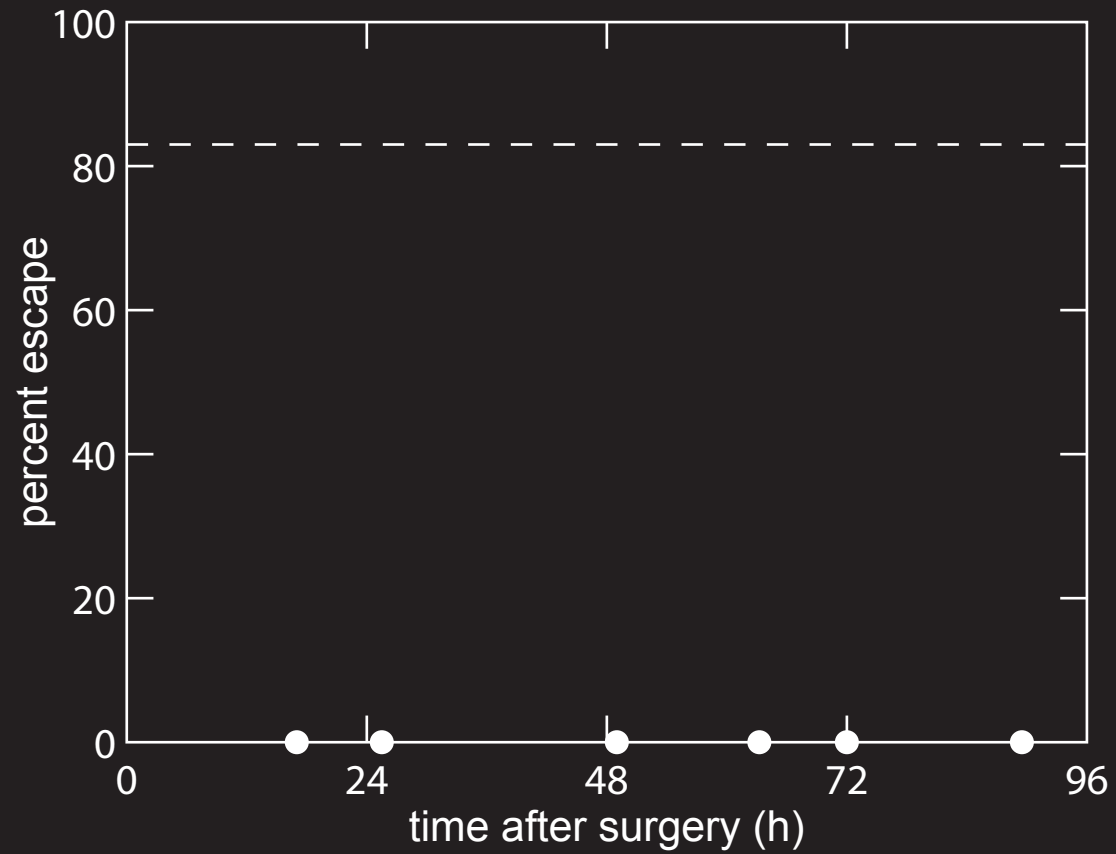
Applications



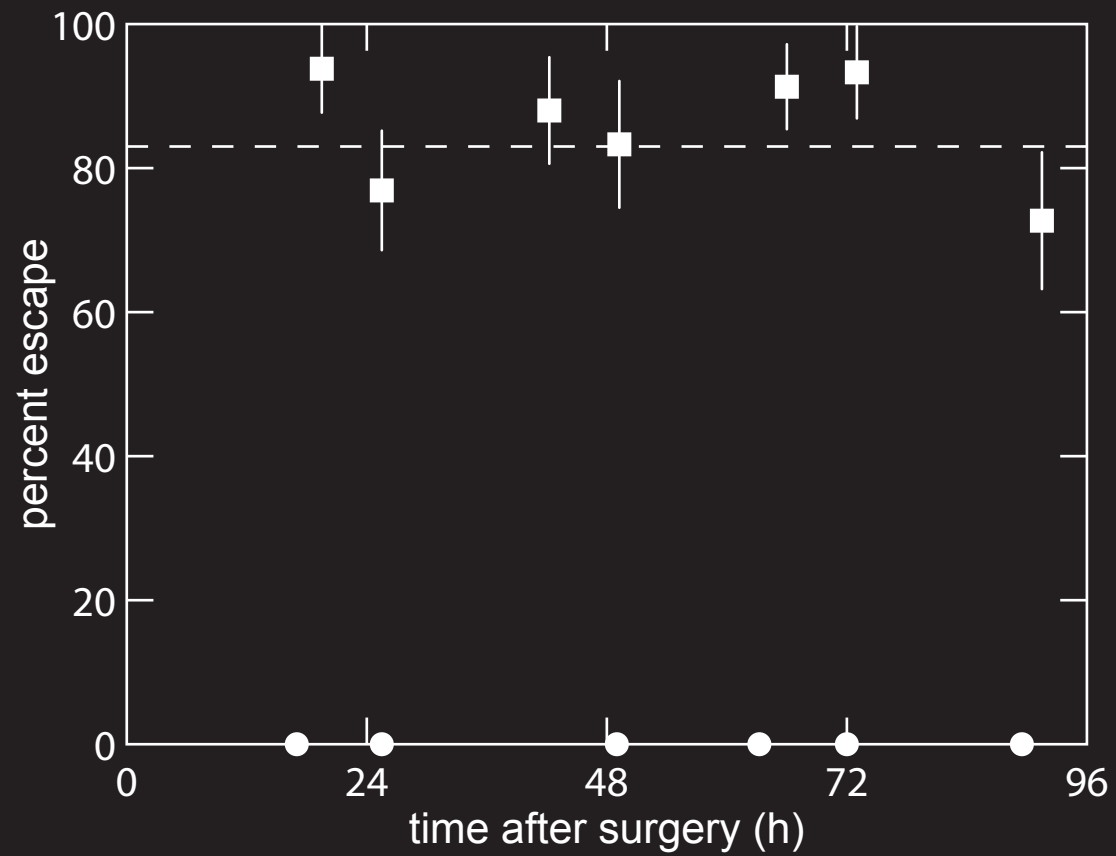
Applications



Applications



Applications



improving technique

handling worms

expediting surgeries

improving technique
handling worms
expediting surgeries

neuronal basis of behavior

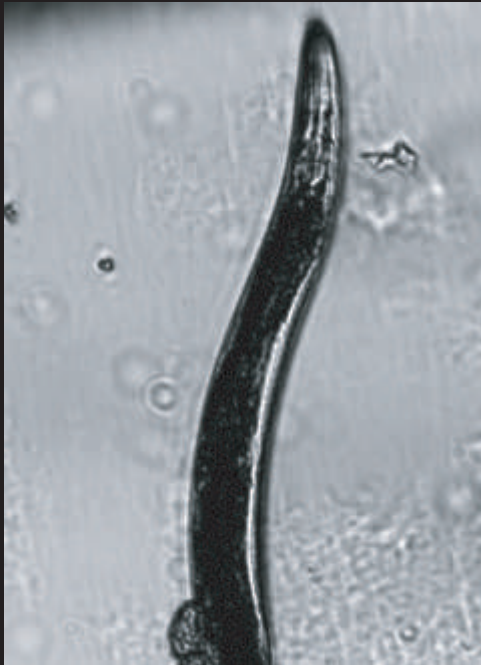
improving technique
handling worms
expediting surgeries

neuronal basis of behavior

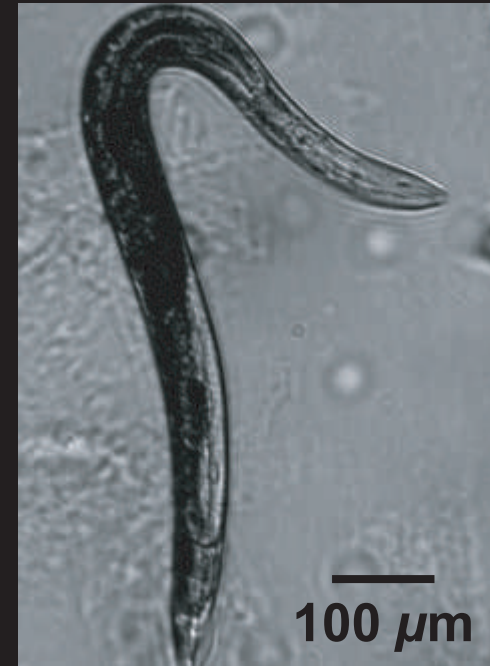
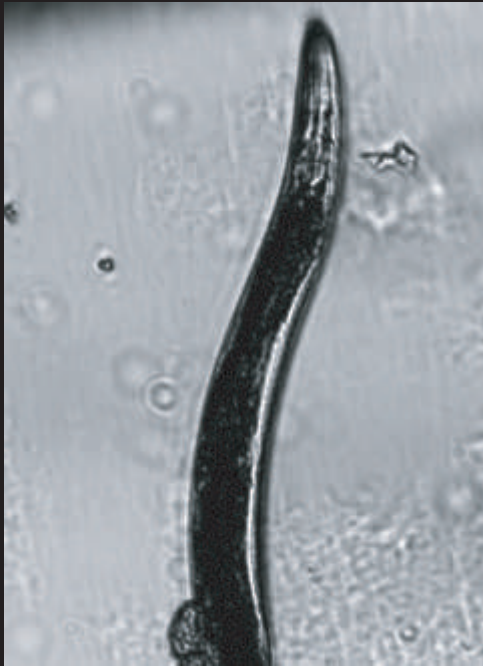
regeneration

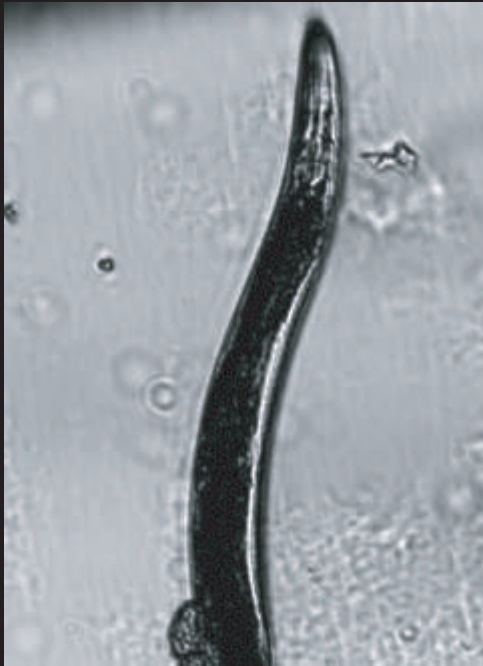
degeneration

Future work

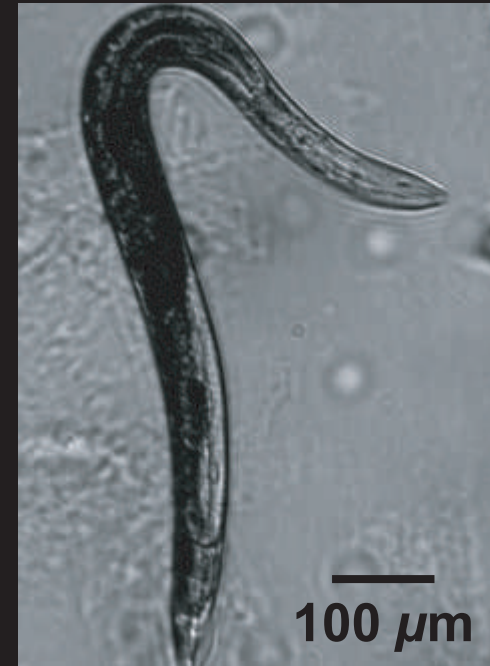


Future work





Normal phenotype



Thin-nose phenotype
post-surgery

<http://mazur-www.harvard.edu>

Acknowledgements

National Science Foundation

DMR-0213805

PHY-0555583



Acknowledgements

National Science Foundation

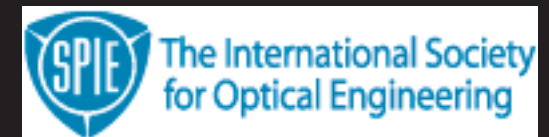
DMR-0213805

PHY-0555583



Travel Grants from:

SPIE



Newport Spectra-Physics



Harvard Graduate Student Council

