Femtosecond laser dissection of neurons in *C. elegans*

Samuel Chung

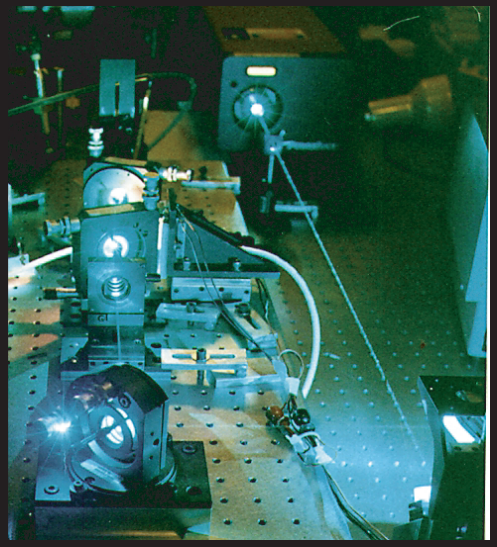
14 June 2005

Harvard University

Historical Background

Mazur Group

Femtosecond laser physics



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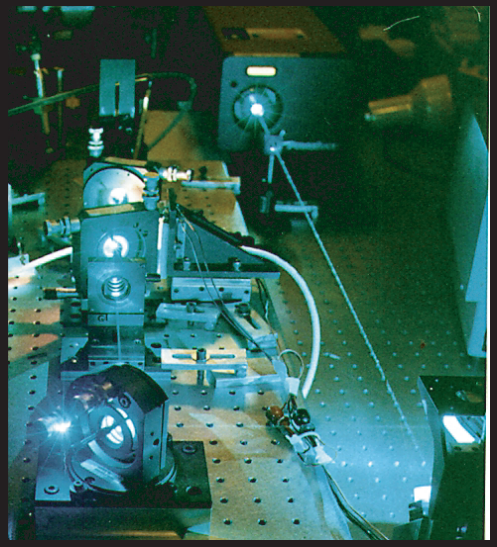


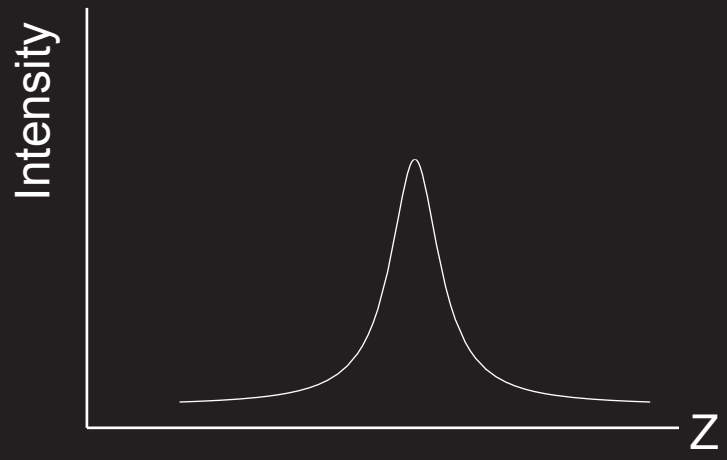
Samuel Group

C. elegans neurobiology

Worm image from J. Berger and R. Sommer, Max-Planck Institute for Developmental Biology

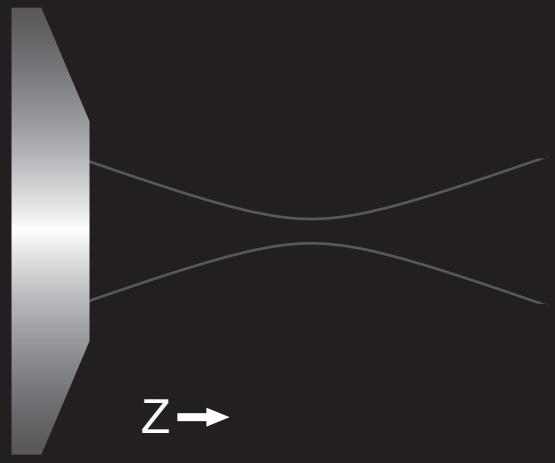
Nonlinear Absorption

Threshold intensity



Intensity equation

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



Nonlinear Absorption

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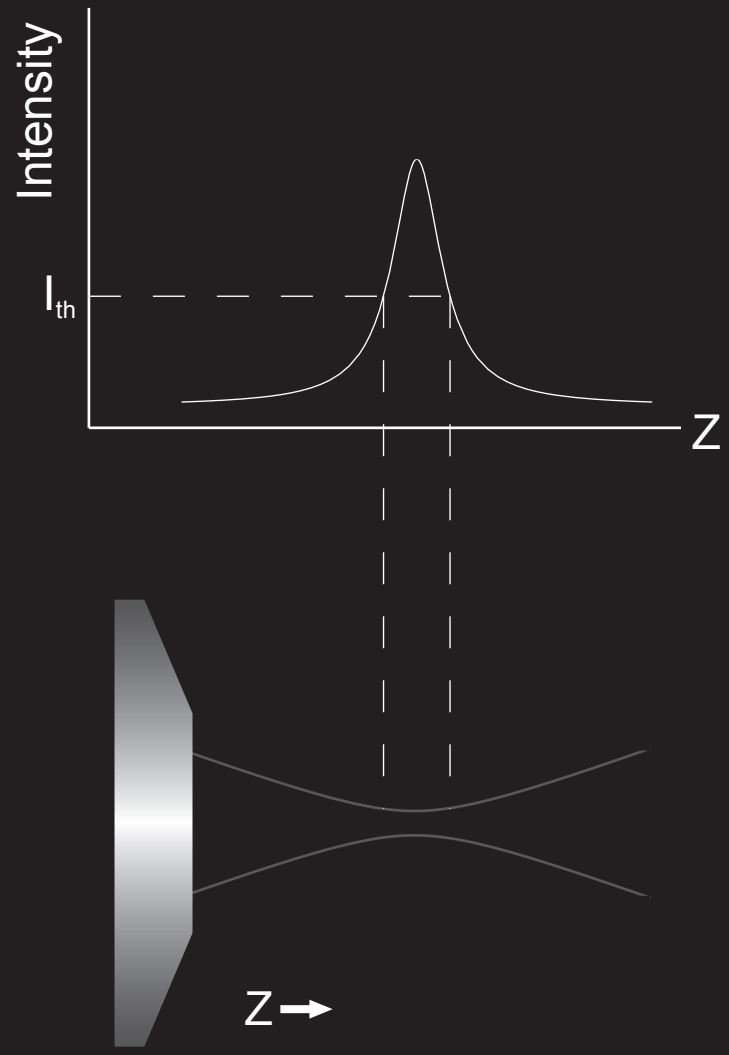

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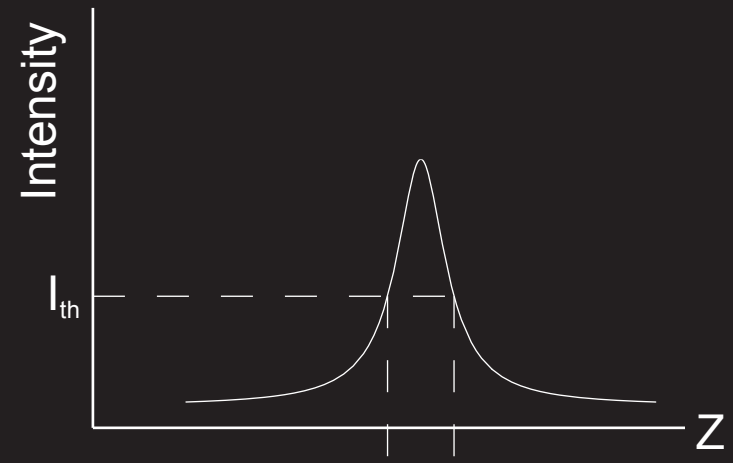

Intensity equation

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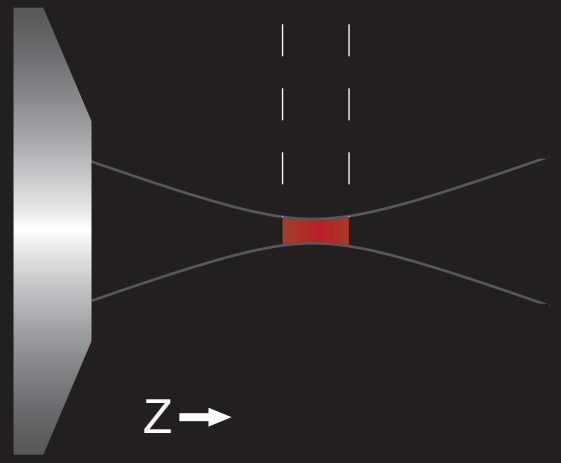
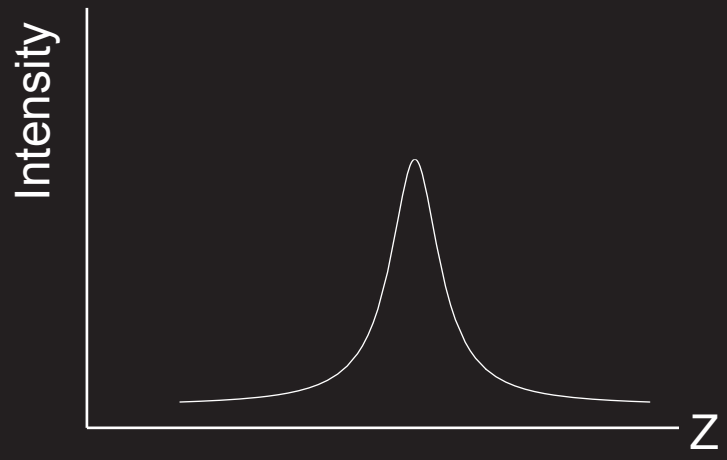
Localized absorption near focus



Nonlinear Absorption

Threshold intensity



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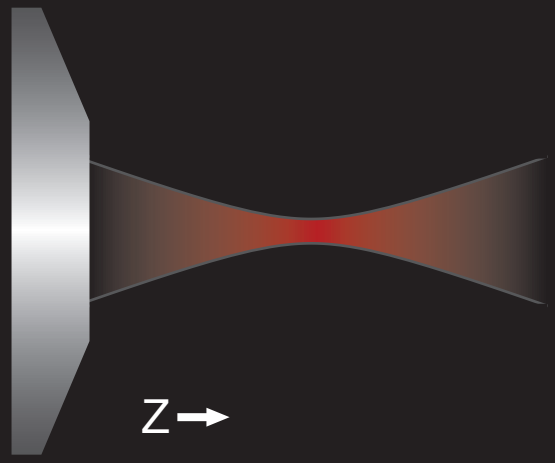
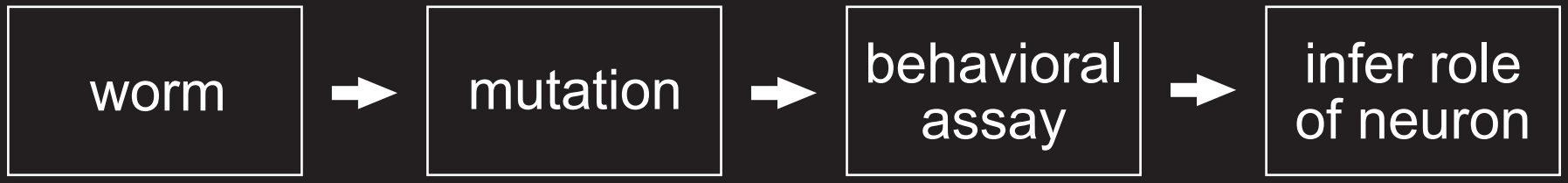


Biology Background

Mapping behavior to neurons

conventional method:



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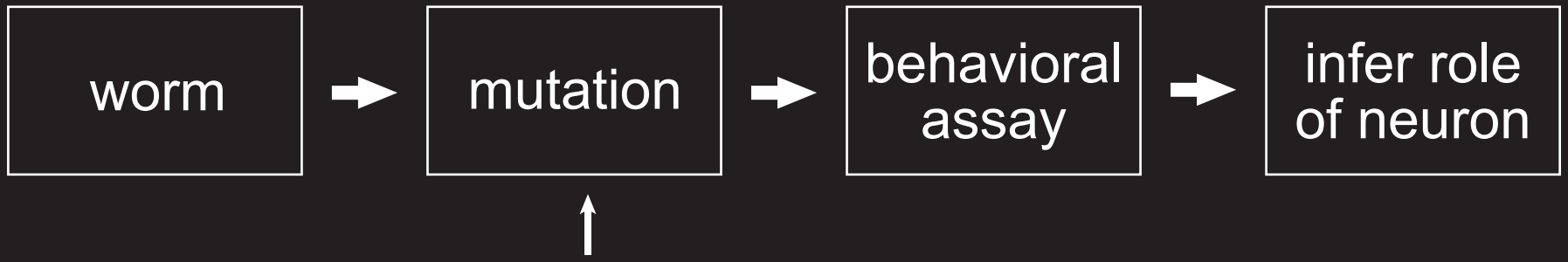

Biology Background

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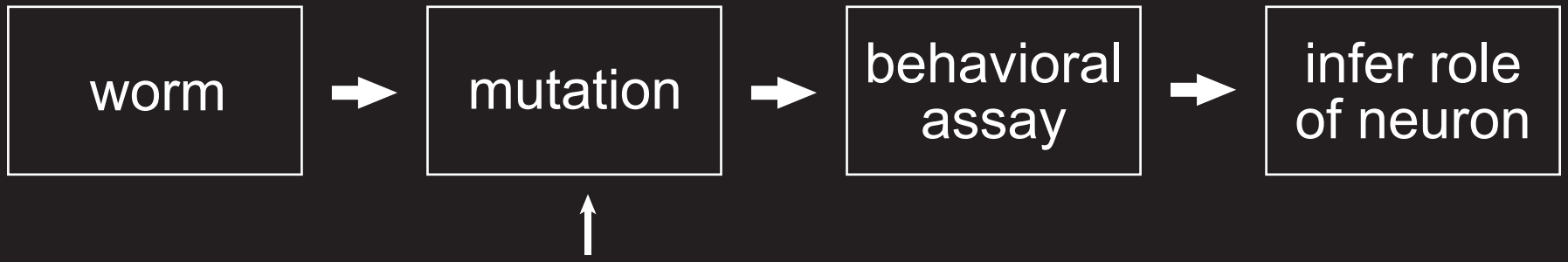
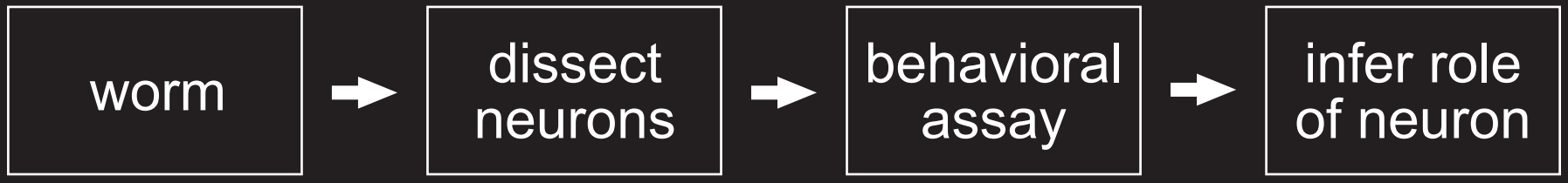
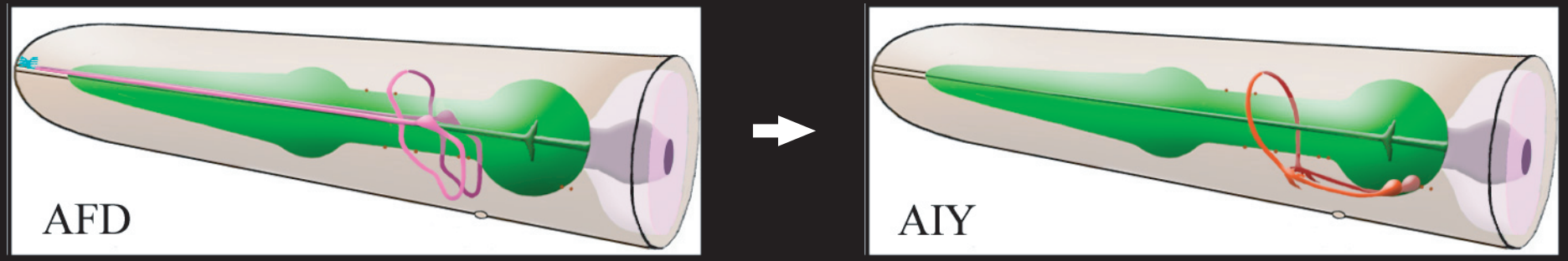


femtosecond laser dissection:



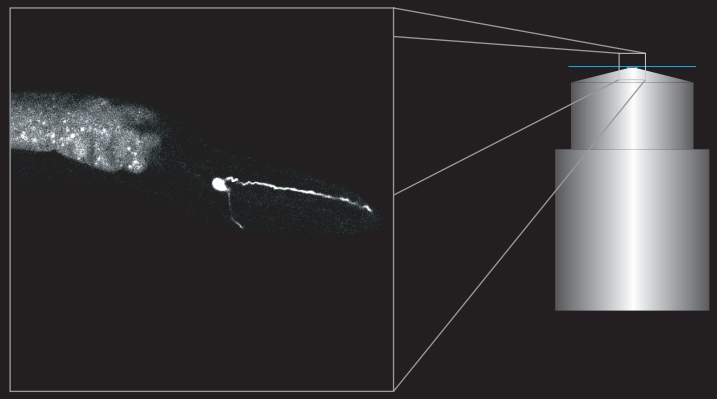
Biology Background

Neurons involved in thermotaxis



Images from Wormatlas

Laboratory Setup



1.4 NA objective

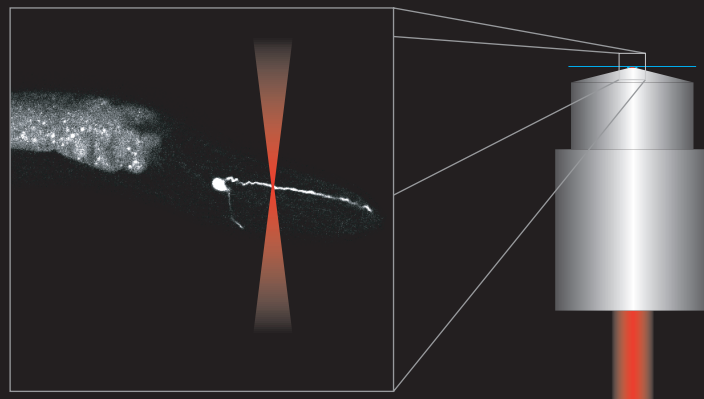
wavelength: 800 nm
pulse duration: 100 fs
repetition rate: 1 kHz

laser

mercury lamp

CCD camera

Laboratory Setup



1.4 NA objective

wavelength: 800 nm
pulse duration: 100 fs
repetition rate: 1 kHz

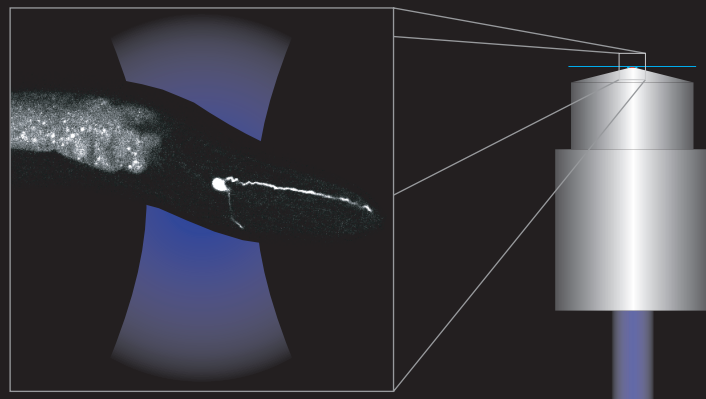
800 nm high reflector

laser

mercury lamp

CCD camera

Laboratory Setup



1.4 NA objective

wavelength: 800 nm
pulse duration: 100 fs
repetition rate: 1 kHz

laser

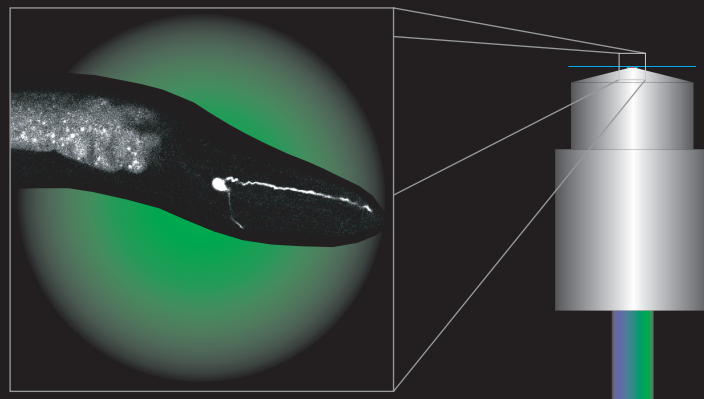
mercury lamp

dichroic mirror

bandpass filters

CCD camera

Laboratory Setup



1.4 NA objective

wavelength: 800 nm
pulse duration: 100 fs
repetition rate: 1 kHz

laser

mercury lamp

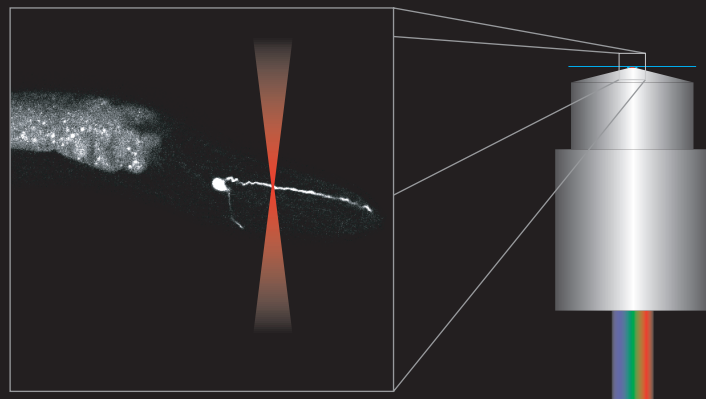
dichroic mirror

imaging lens

bandpass filters

CCD camera

Laboratory Setup



1.4 NA objective

wavelength: 800 nm
pulse duration: 100 fs
repetition rate: 1 kHz

scalpel

laser

mercury lamp

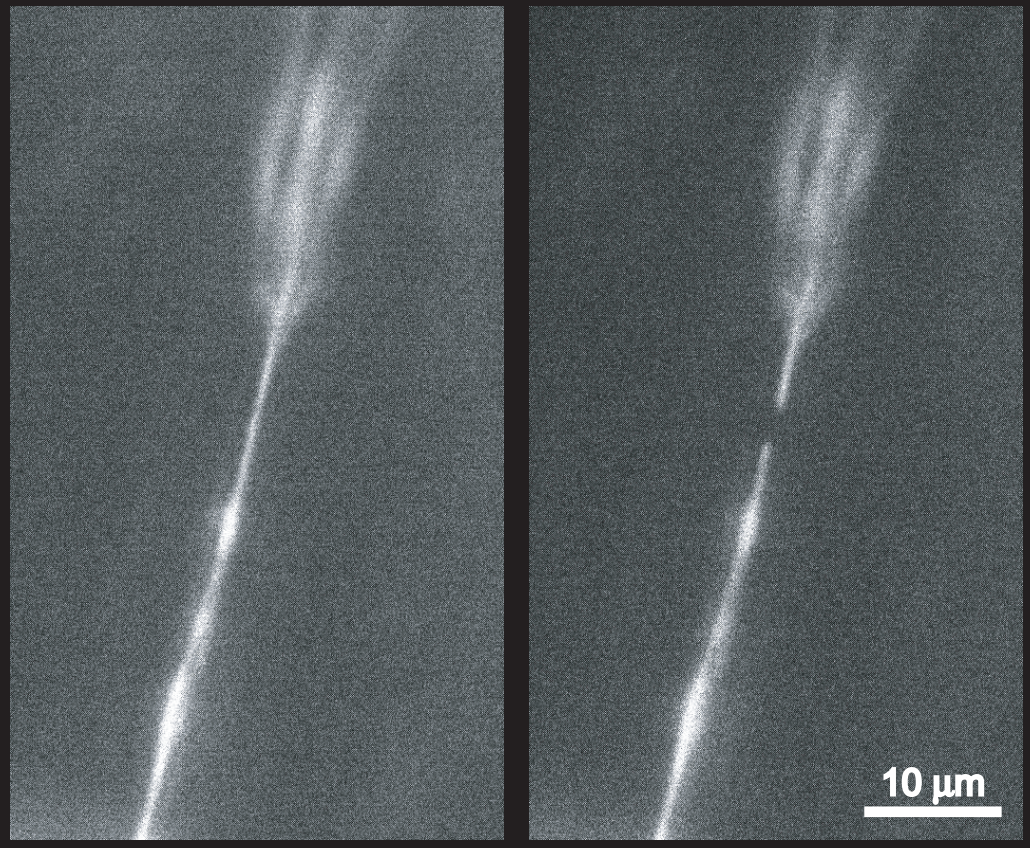
illumination

fluorescence

CCD camera

Fluorescent Images

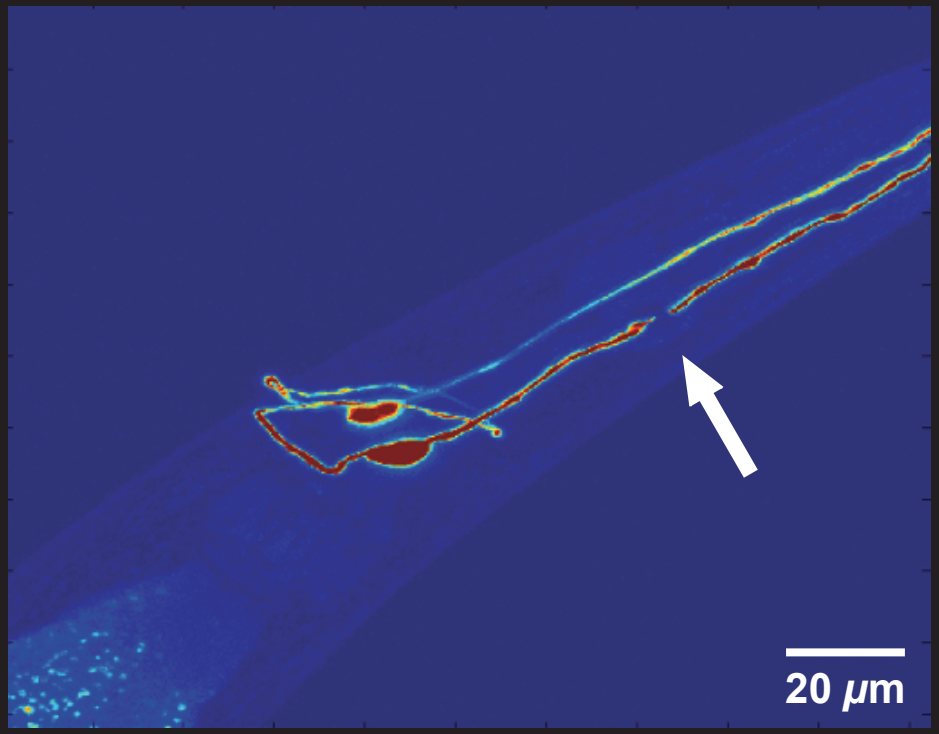
Clean cut of worm neuron from high-energy pulses



14 nJ pulses

Fluorescent Images

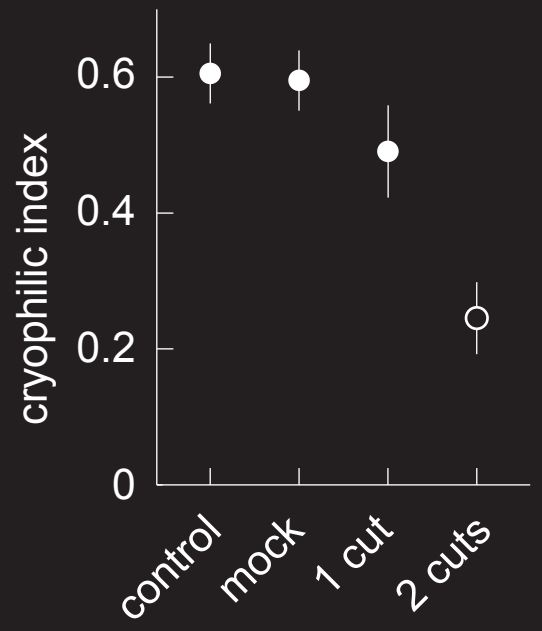
Confocal microscope image of neurons
one day after surgery



14 nJ pulses

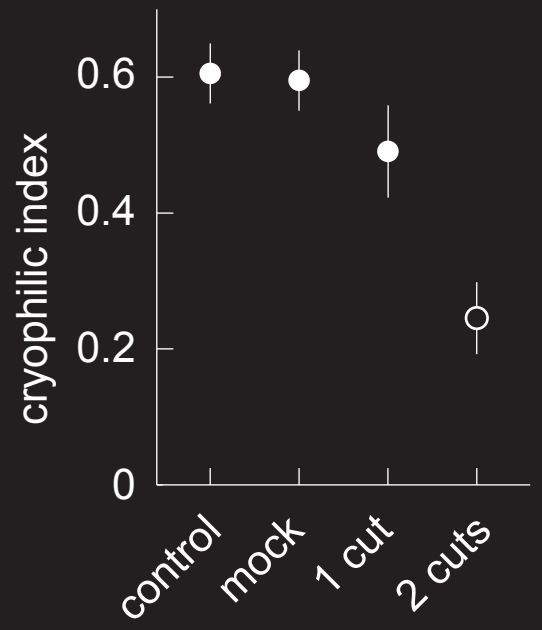
Behavioral assay

$T > T_{cult}$



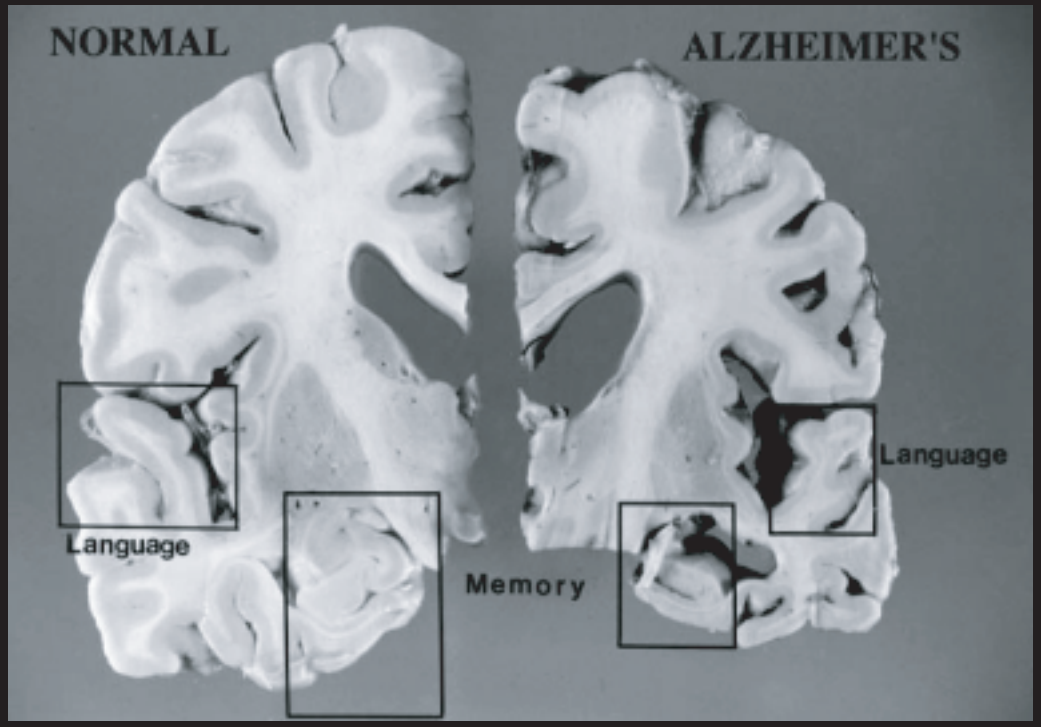
Behavioral assay

$T > T_{cult}$



active
cryophilic drive
above T_{cult}
switched off

Future Work



Neurodegeneration in *C. elegans*

Application to Alzheimer's and Parkinson's Diseases

Image courtesy of Ennaceur Lab, University of Sunderland, UK

Acknowledgements

Advisor: Eric Mazur

Collaborator: Aravi Samuel