# Photodisruption in biological samples using femtosecond laser pulses

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Photonic West
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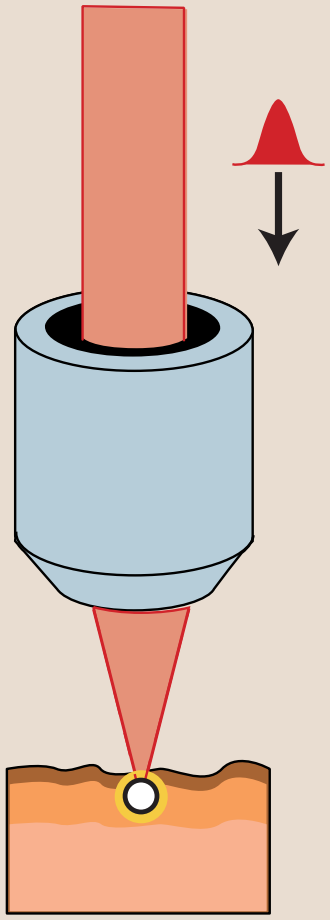
Harvard University
Department of Physics

# Outline

- Introduction
  - General method
  - Dynamics of photodisruption
- Results and discusion
  - Turbid tissue photodisruption
  - Subcellular micromachining
- Applications

# *Introduction*



**Photodisruption:** removal of tissue by ablation or vaporization

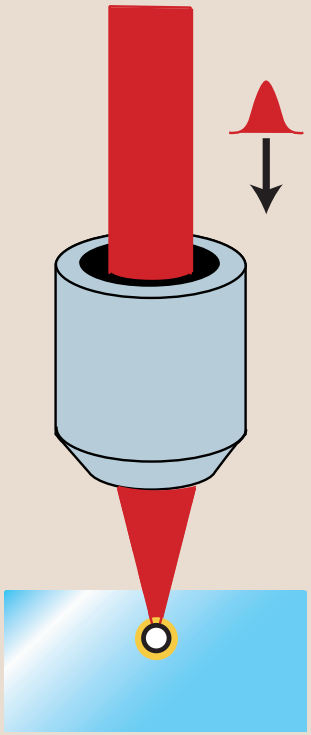
focus ultrashort pulse on tissue

high laser intensity at focus

ionization by nonlinear mechanisms

microscopic damage

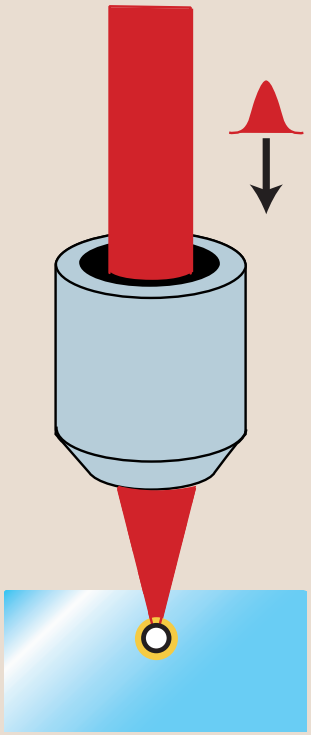
# Introduction



# Introduction

Nonlinear
Absorption

Plasma formation



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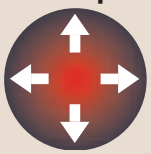

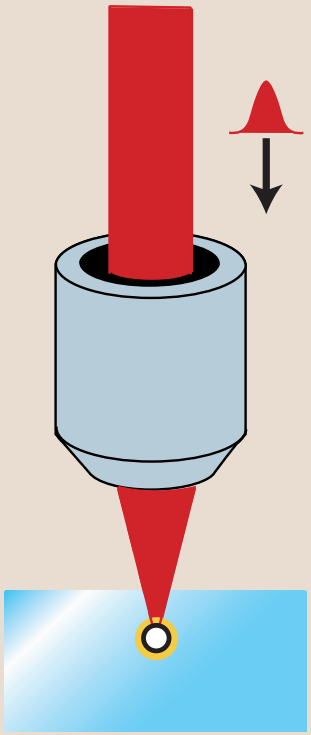

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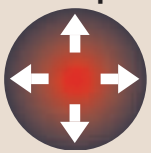
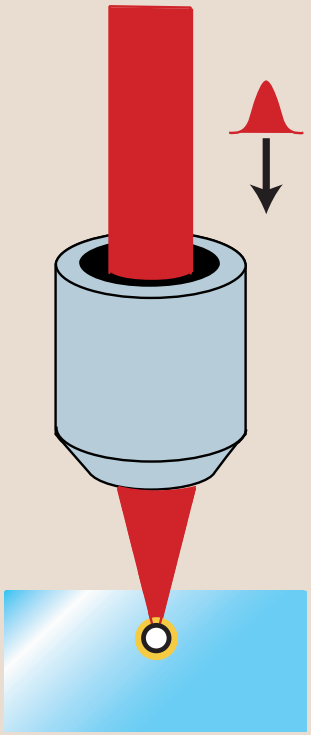
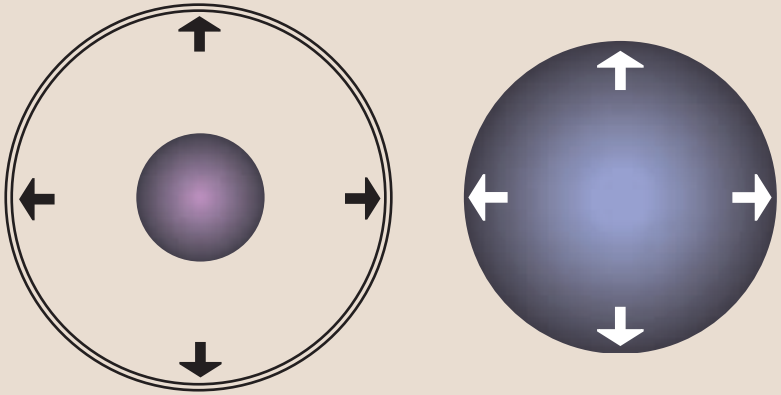


Mechanical effects





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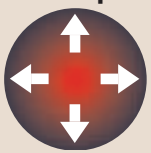
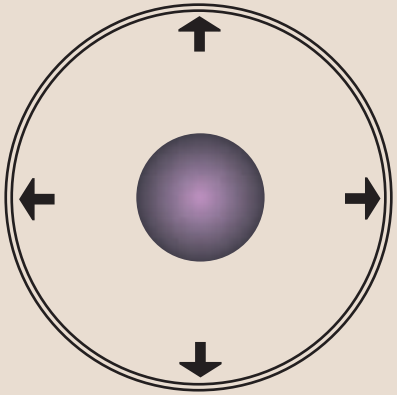
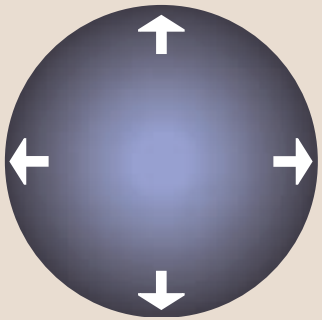
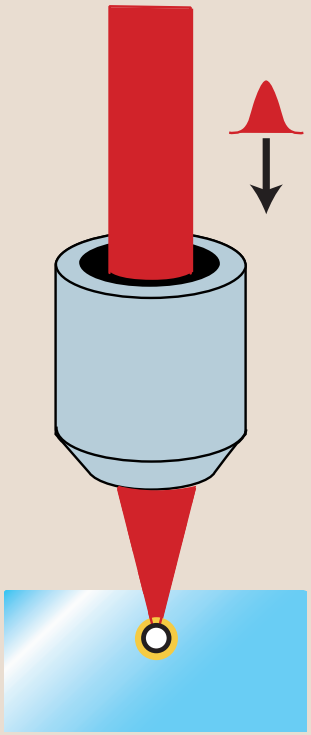


Mechanical effects

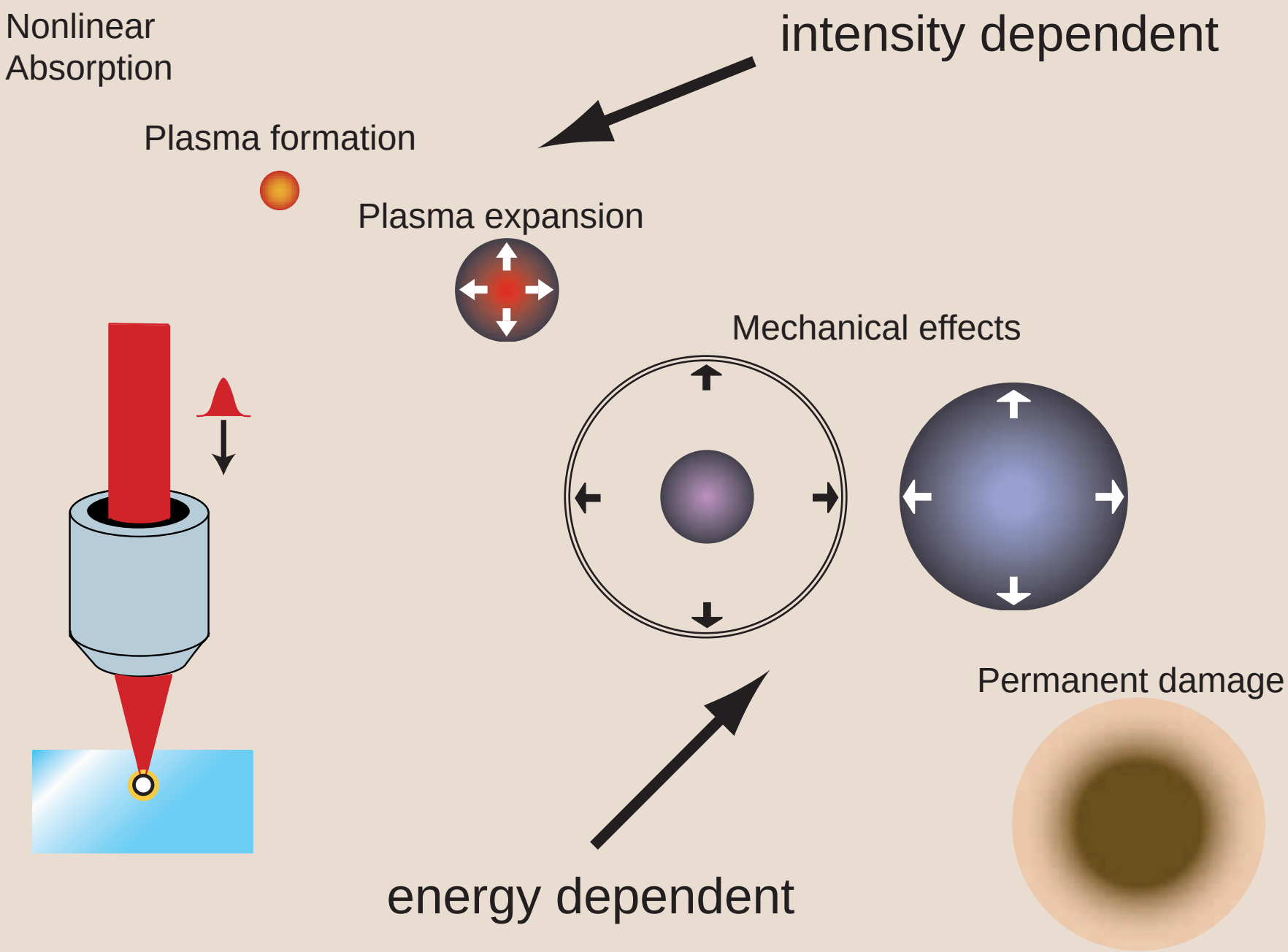




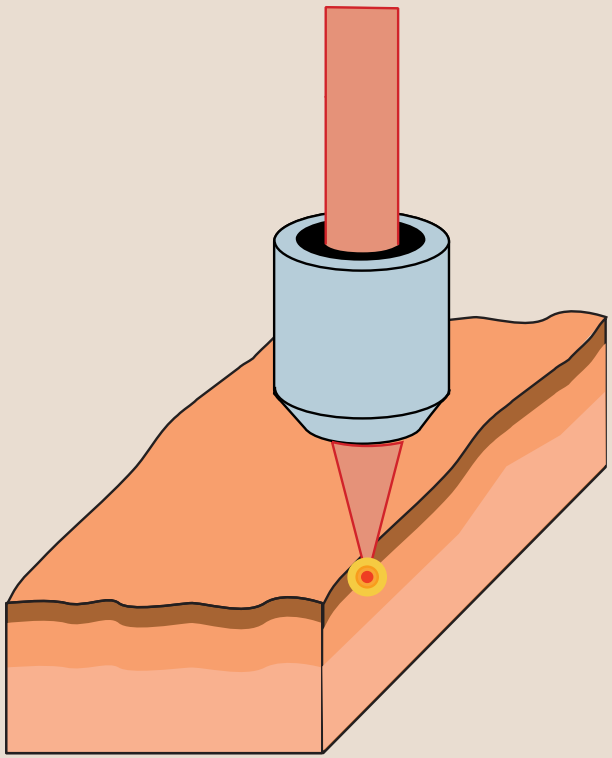


Permanent damage

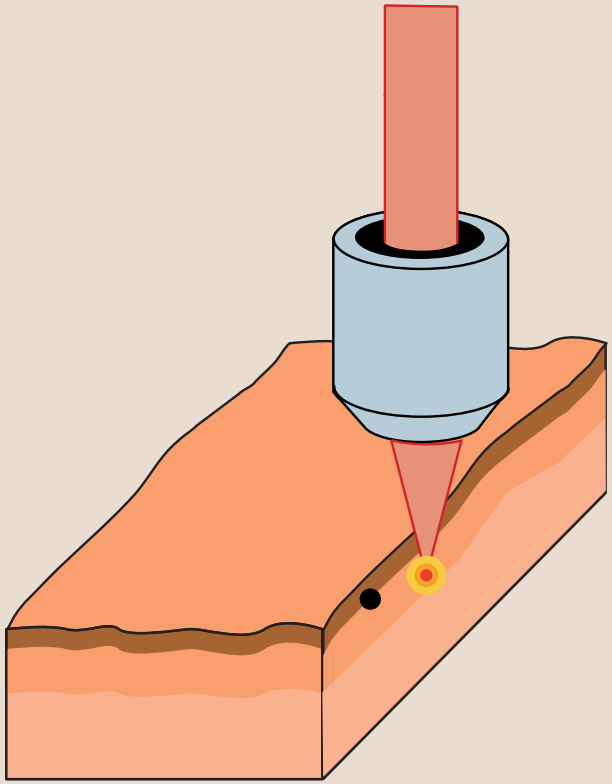
# Introduction



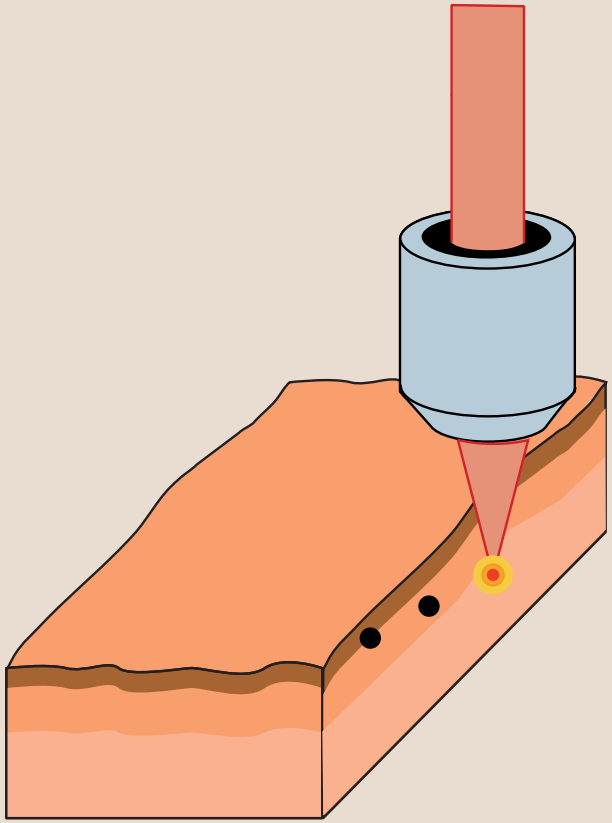
# Subsurface microstructure

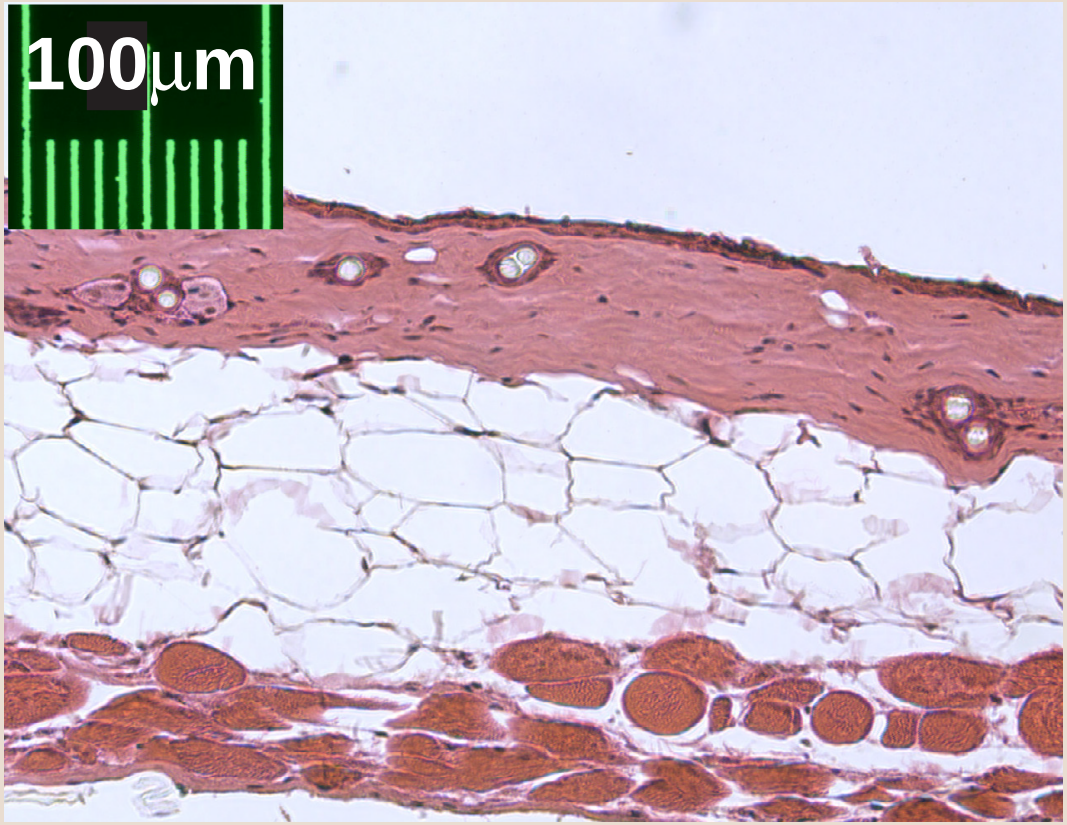


# Subsurface microstrucure



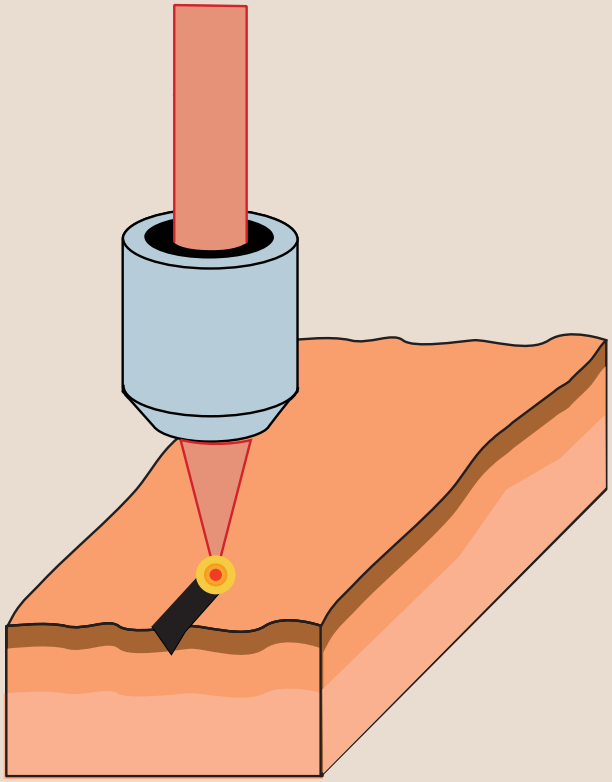
# *Subsurface microstructure*



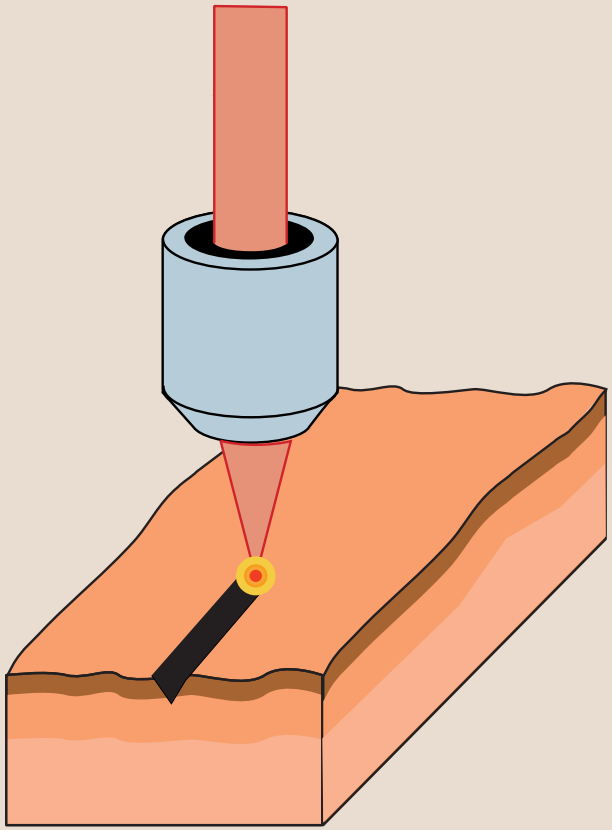



100fs, 20μJ, single pulse

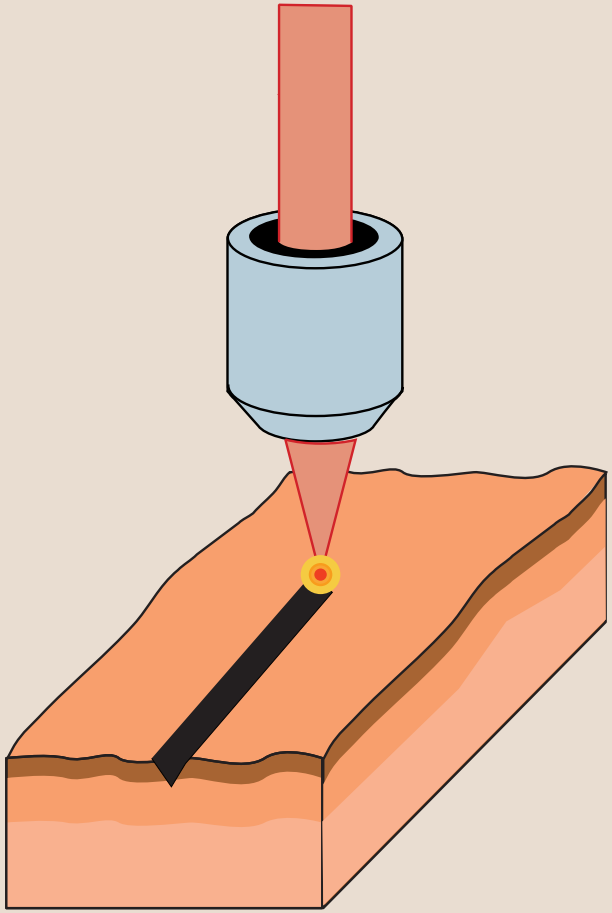
# Precise incision



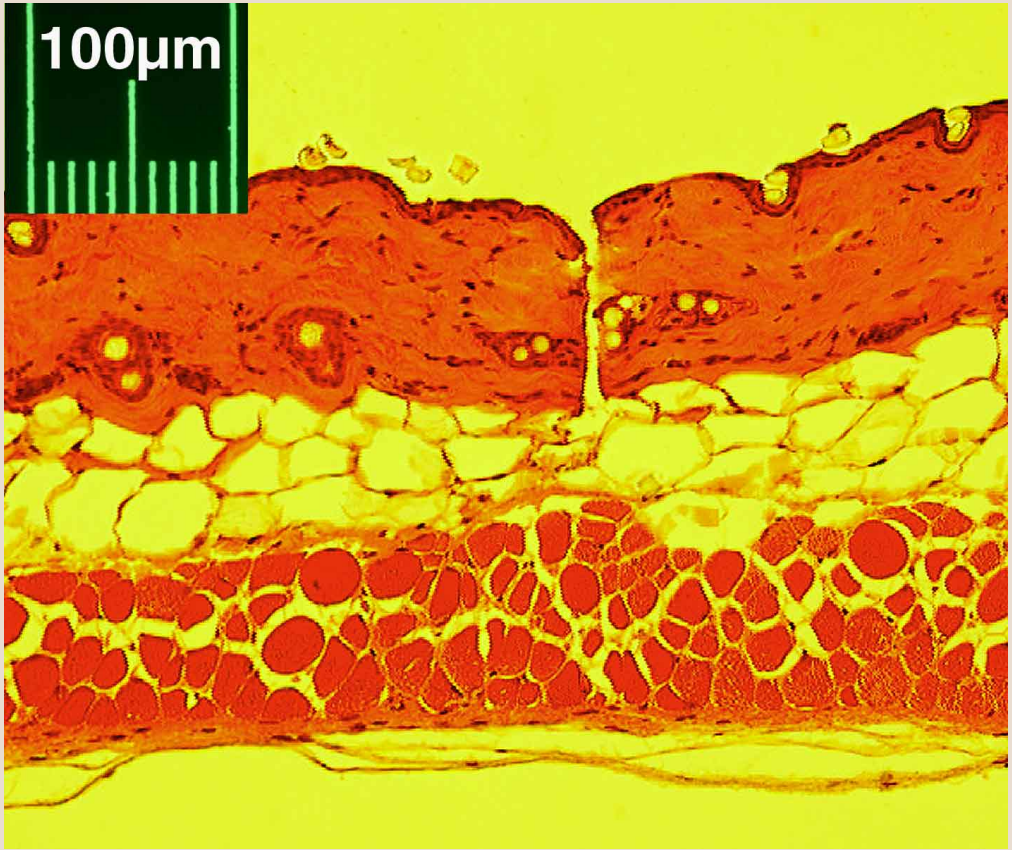
# Precise incision



# *Precise incision*

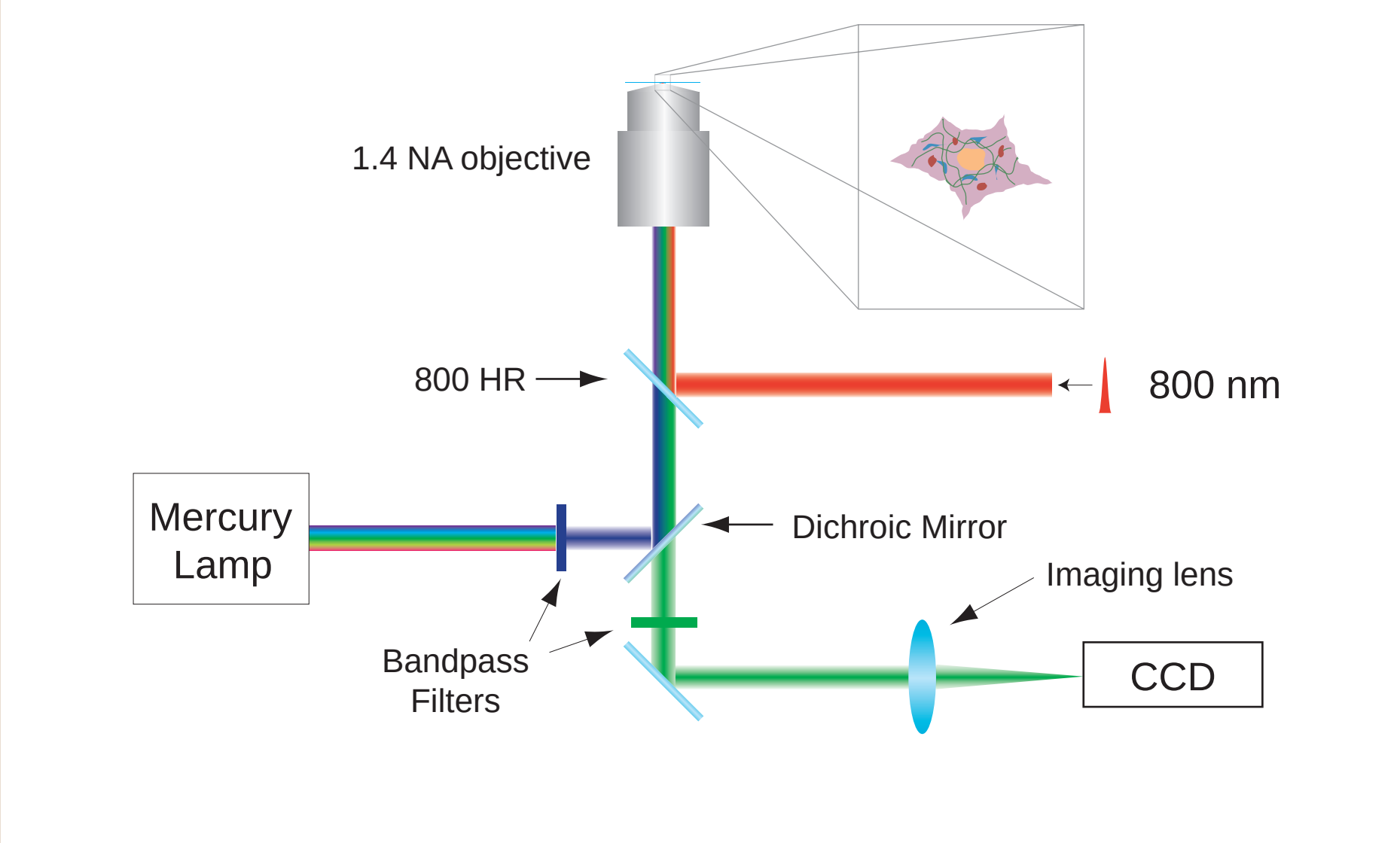


**100fs, 20μJ**

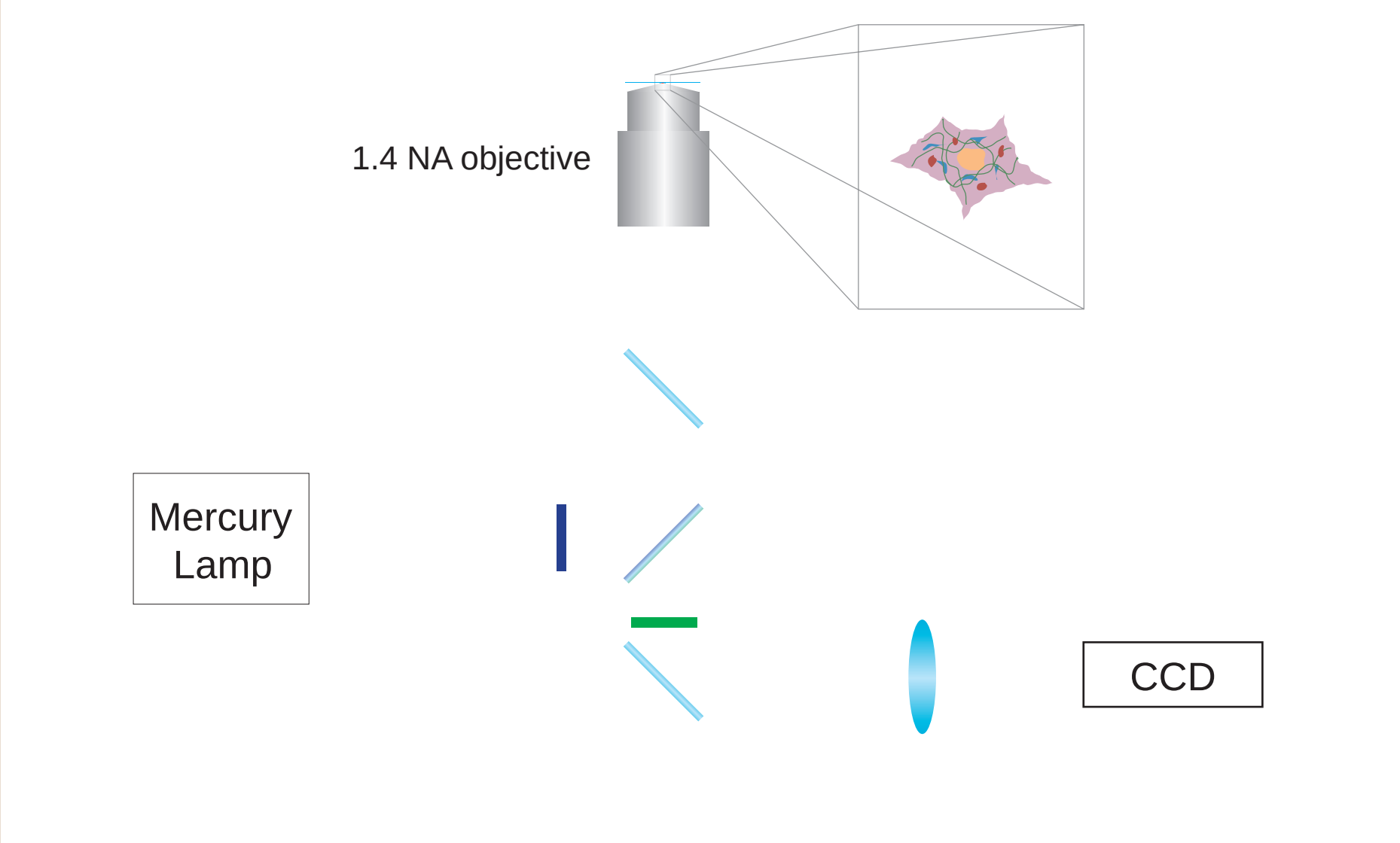



3 passes
at 0, 100μm, and 200μm

# Microscope


1.4 NA objective
800 HR
800 nm
Mercury Lamp
Dichroic Mirror
Imaging lens
Bandpass Filters
CCD

# Microscope



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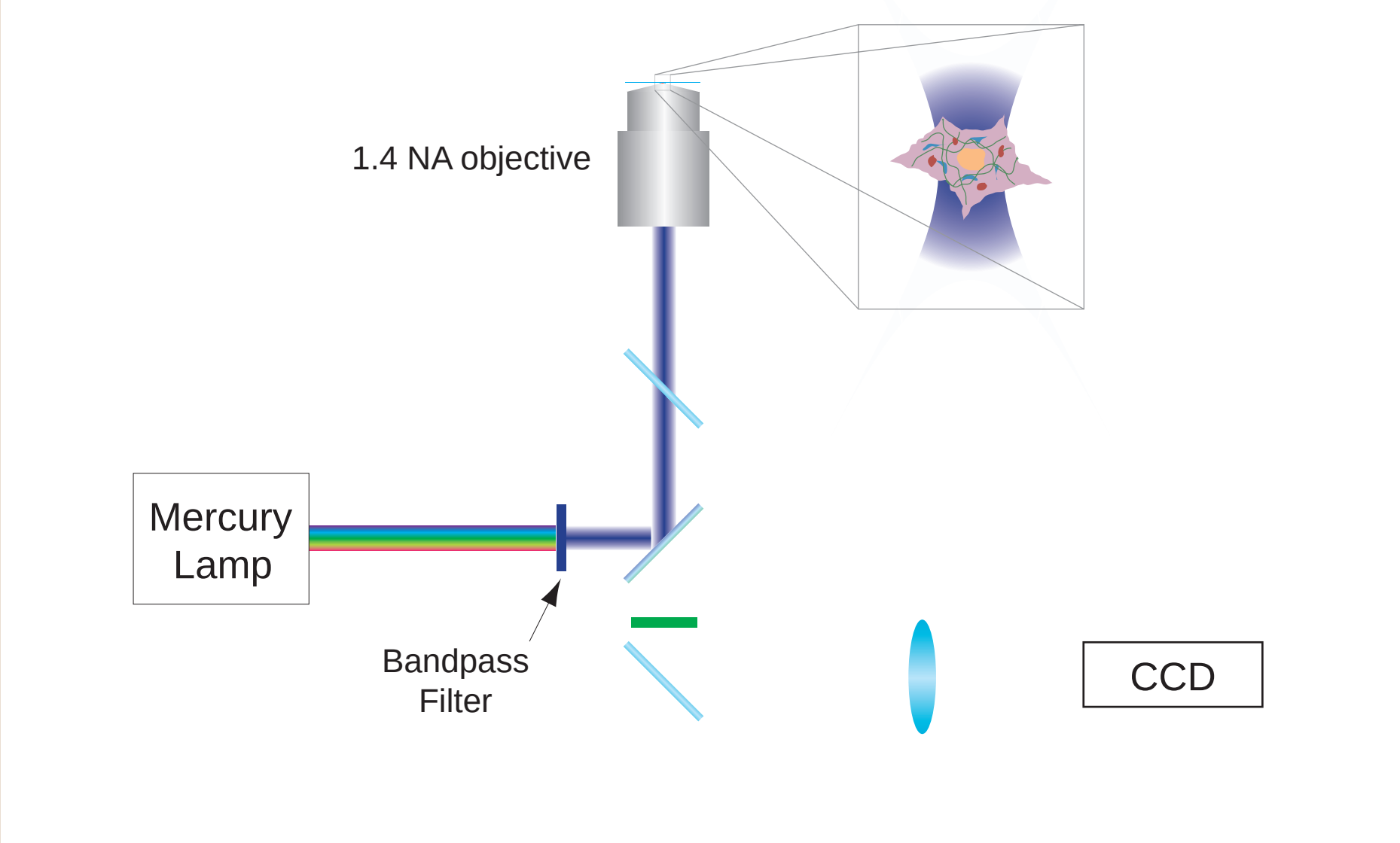

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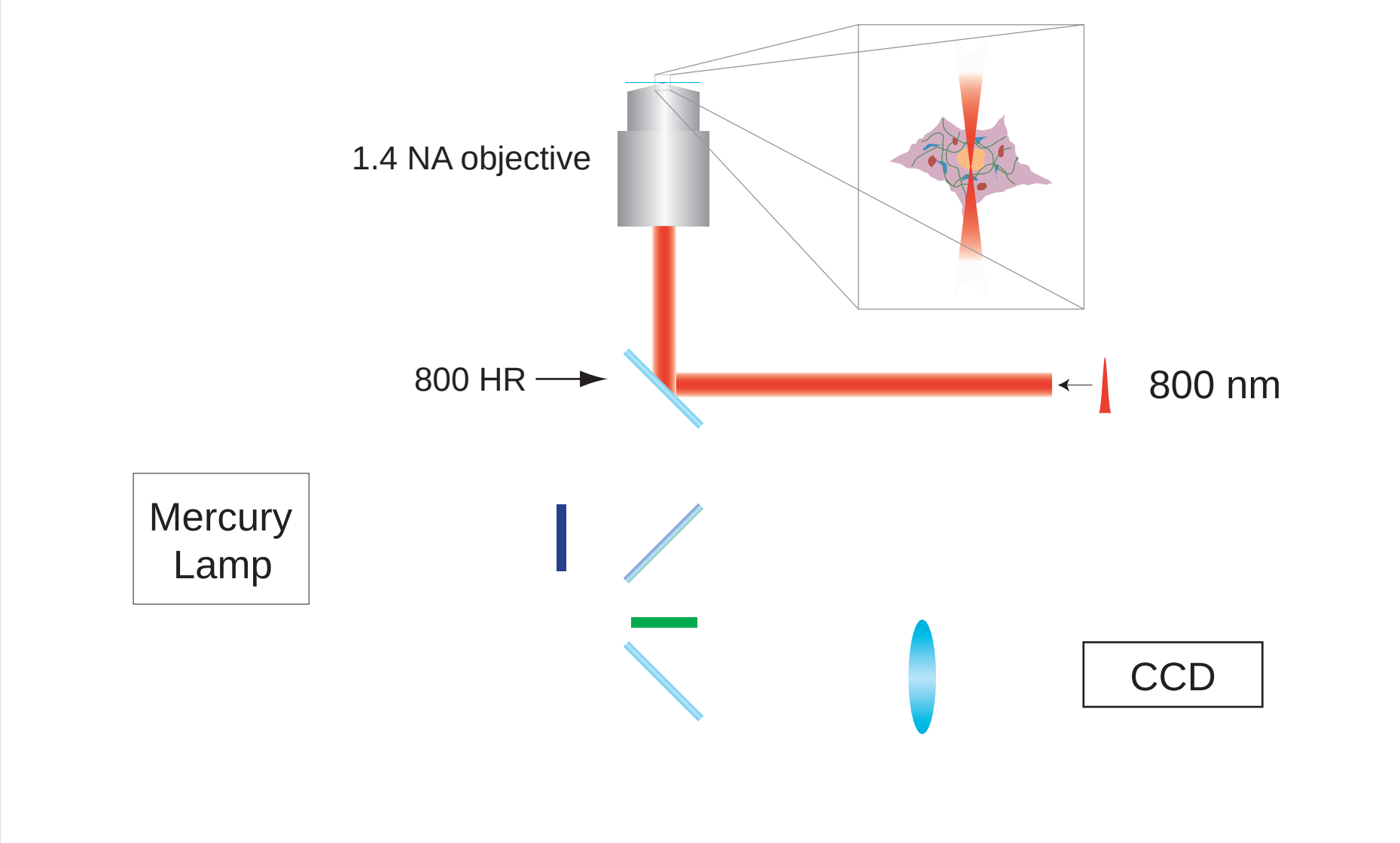

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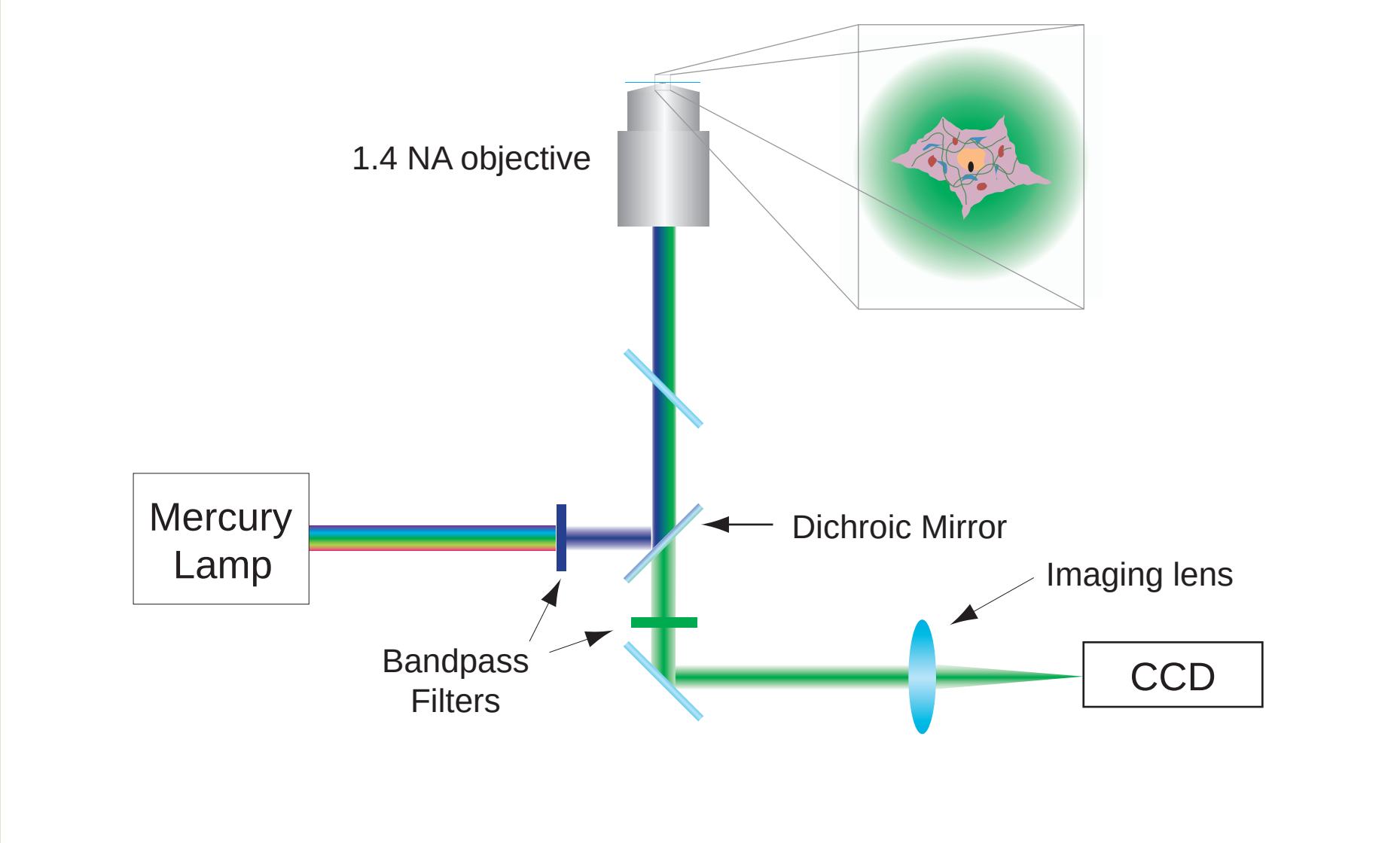
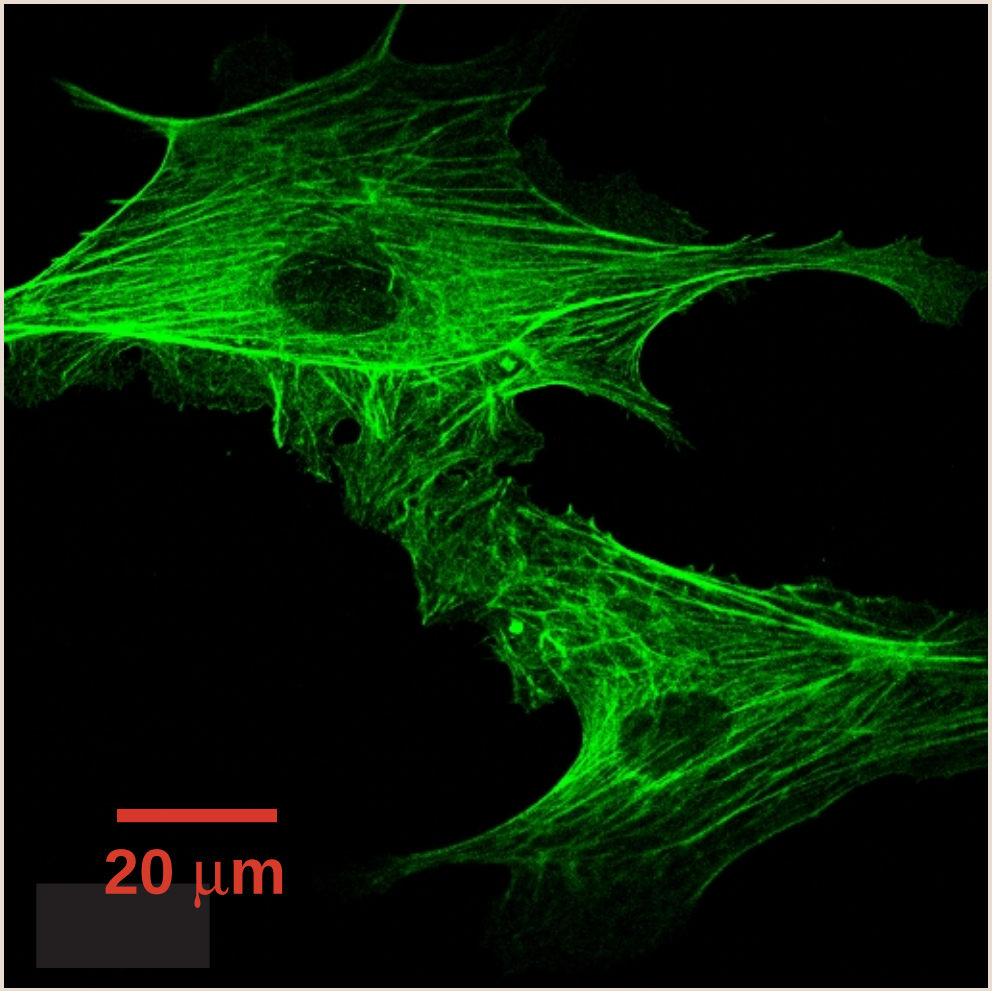

1.4 NA objective
Mercury Lamp
Dichroic Mirror
Imaging lens
Bandpass Filters
CCD

# Single cell



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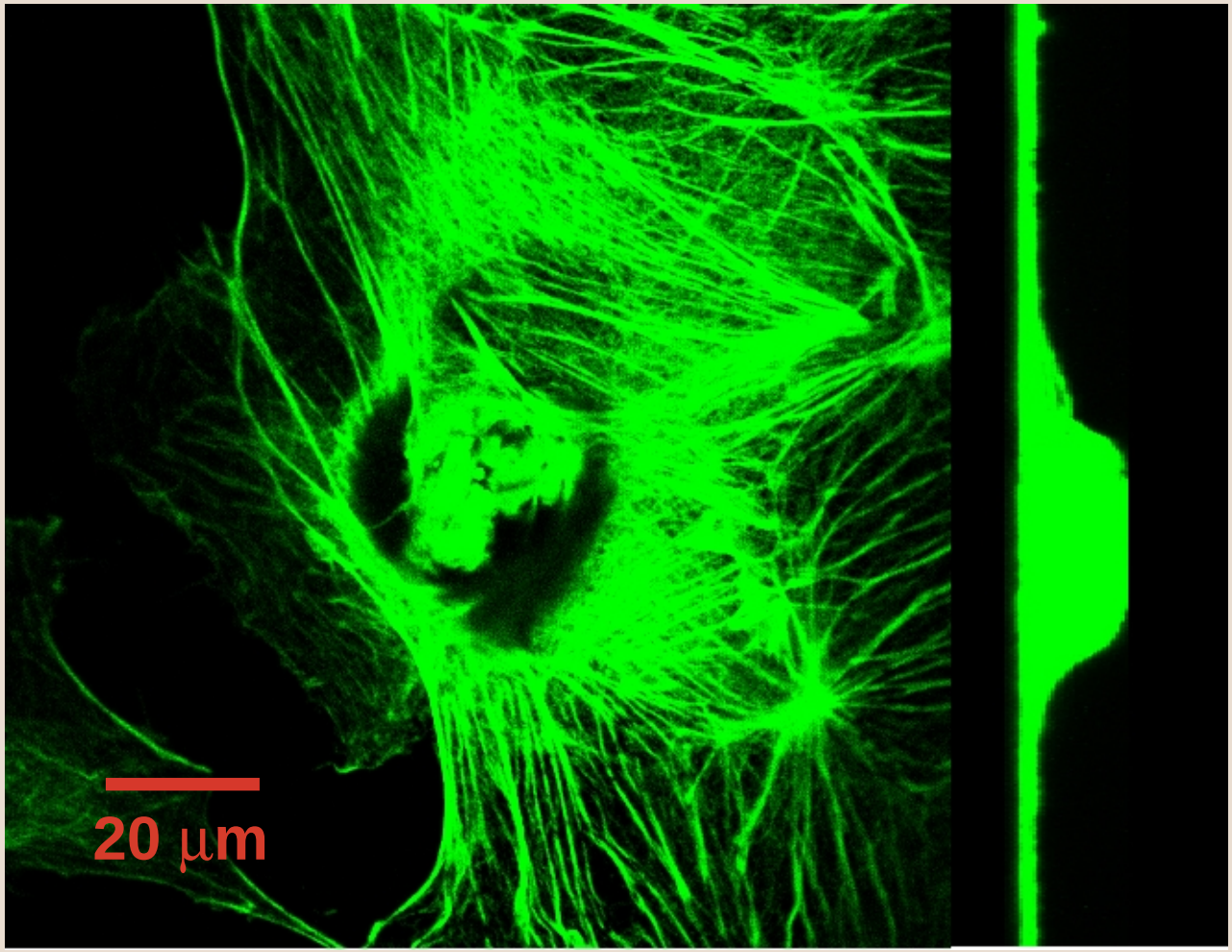
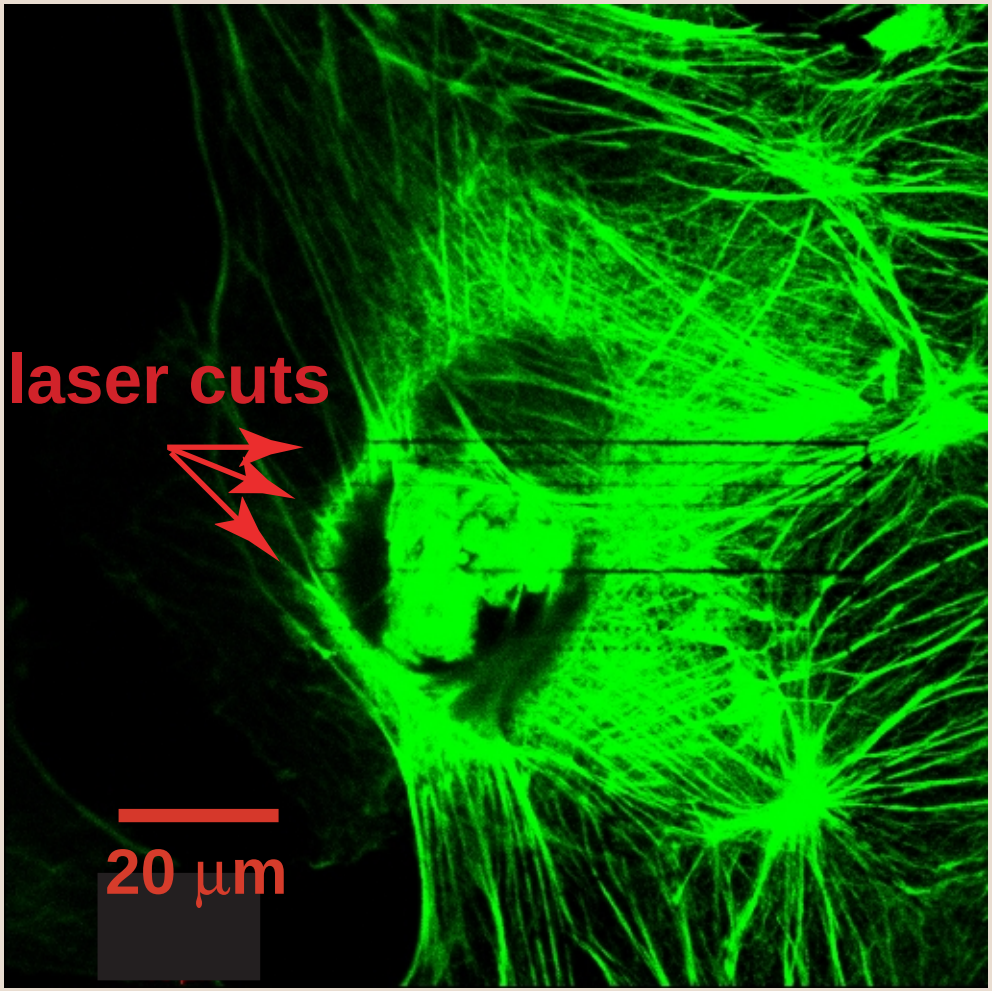
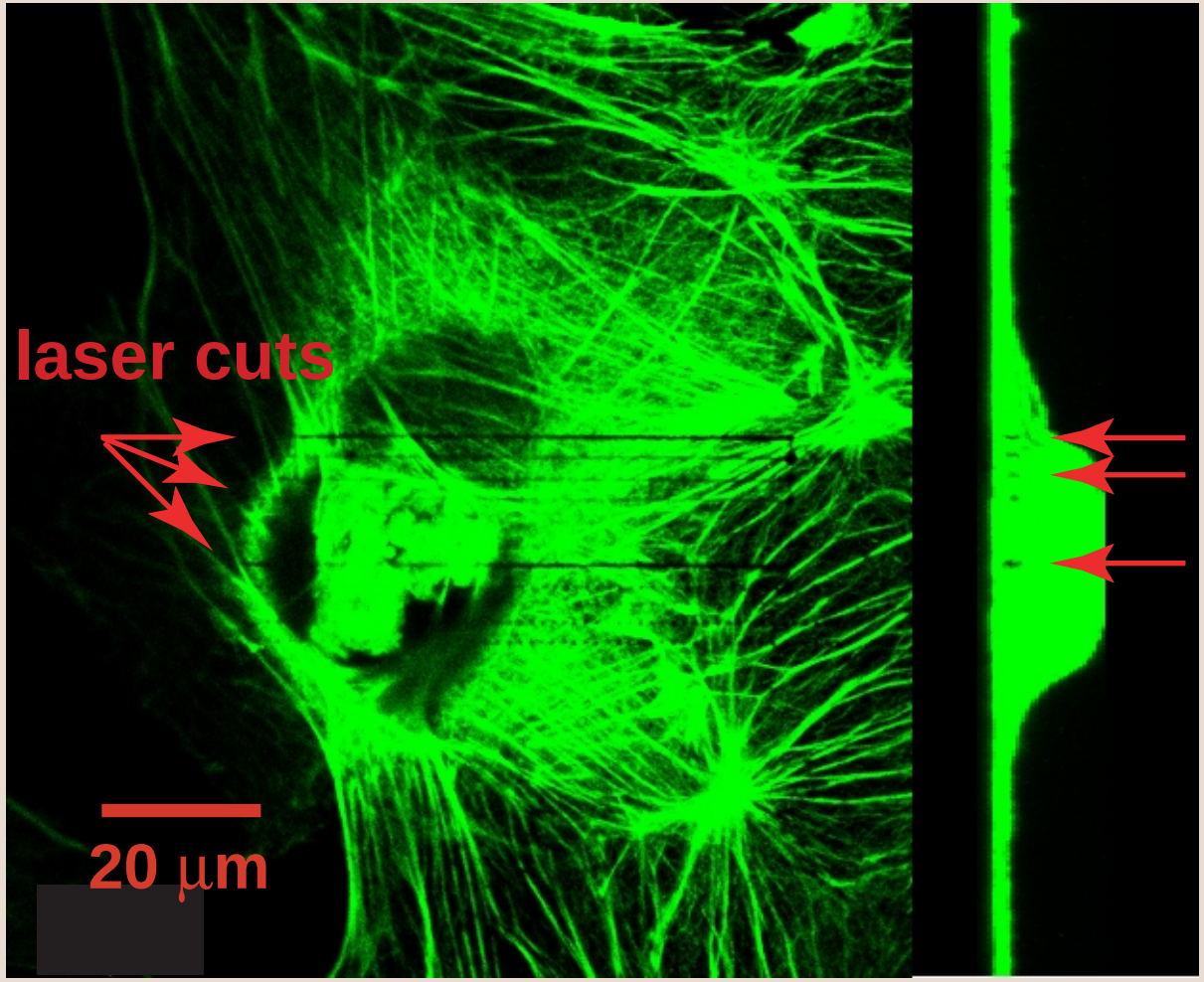


# *Single cell*

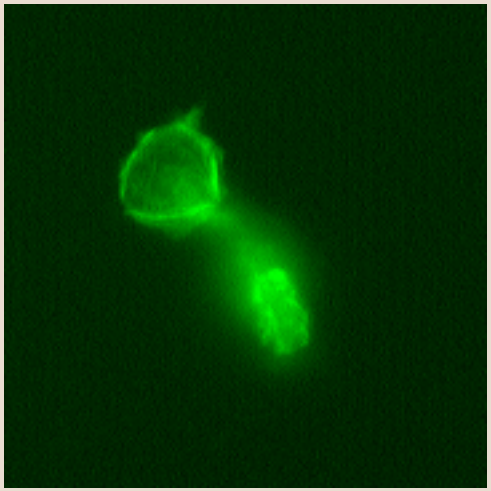



**contral slice of a photodisrupted cell**

# Single cell

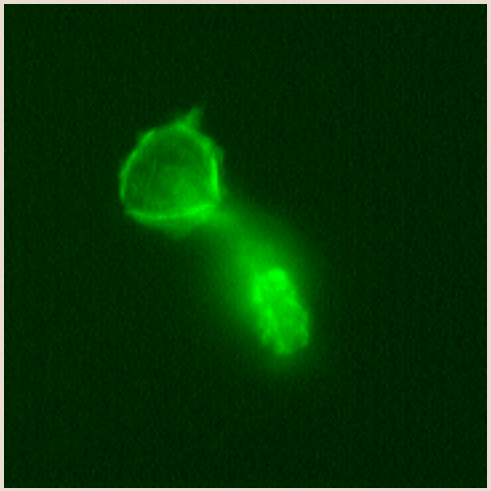


# *Single cell*

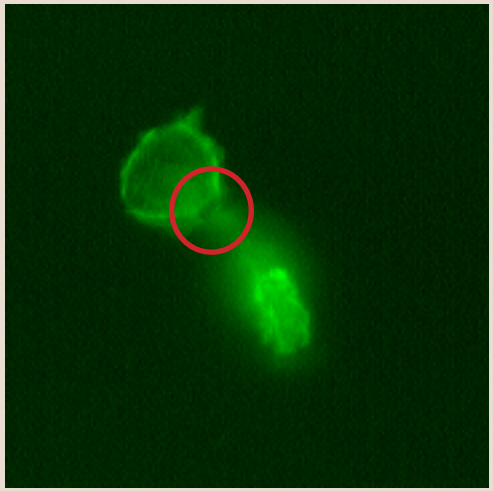


before laser irradiation

# *Single cell*

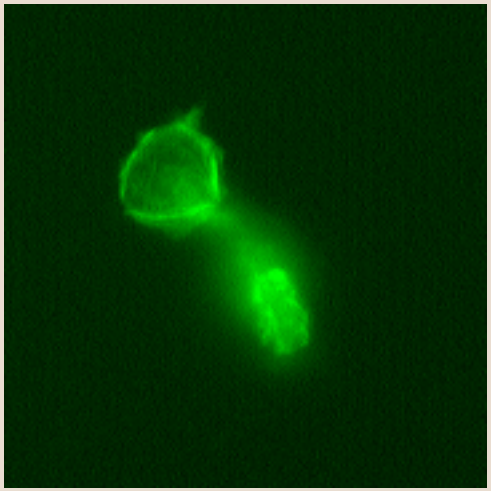


before laser irradiation

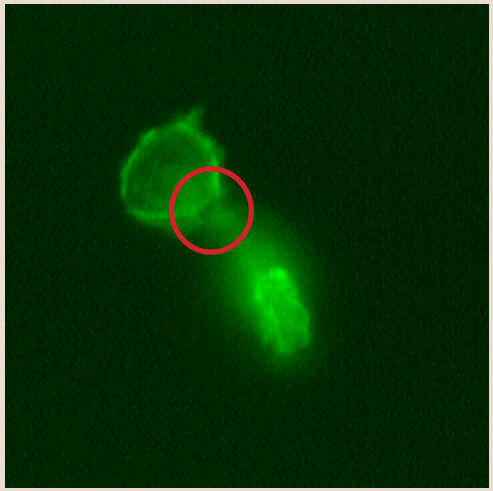


after 1 min.

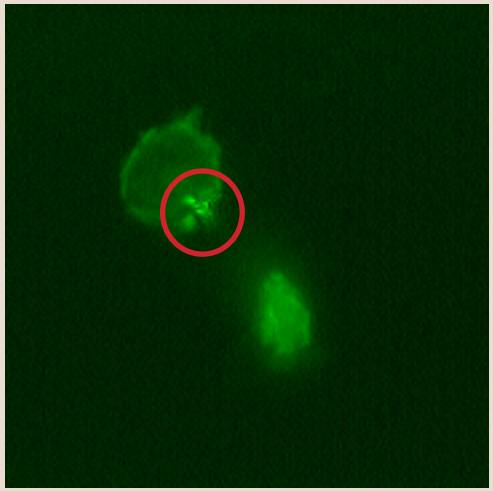
# *Single cell*



before laser irradiation

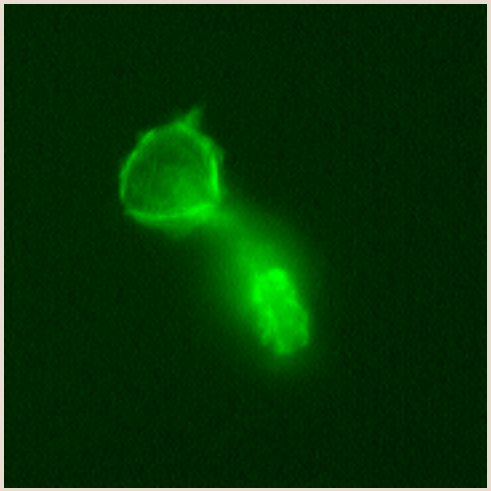


after 1 min.

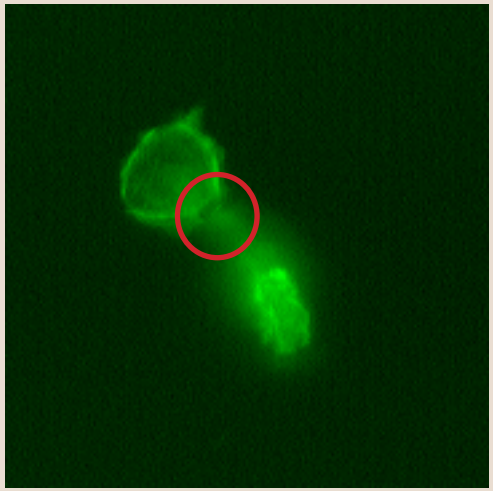


after 2 min.

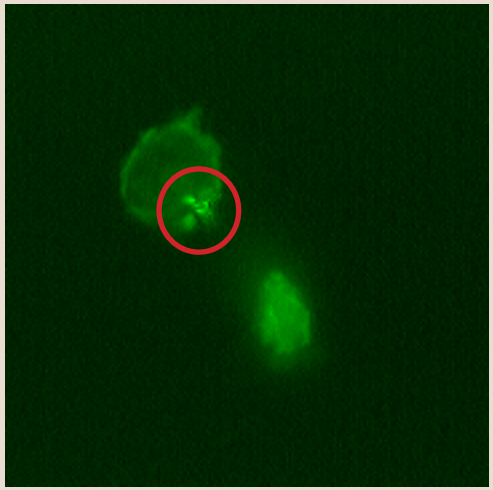
# *Single cell*



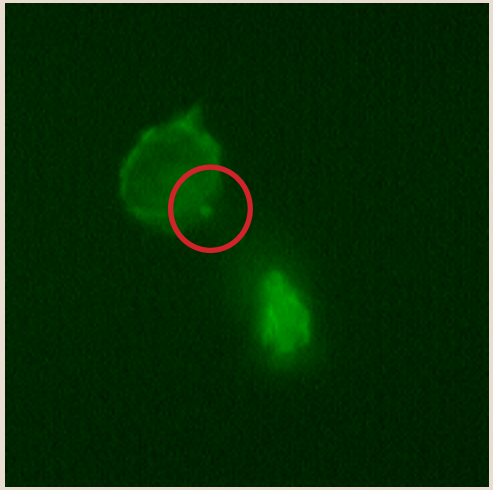
before laser irradiation



after 1 min.



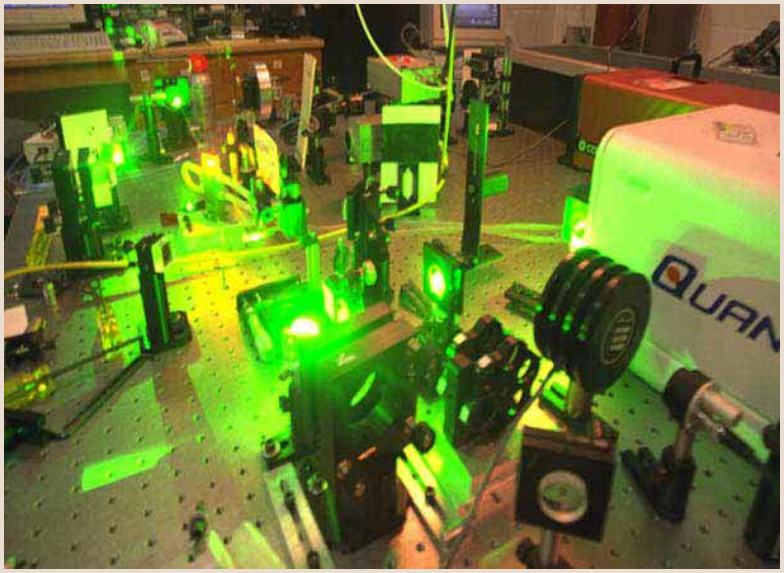
with 800nm light

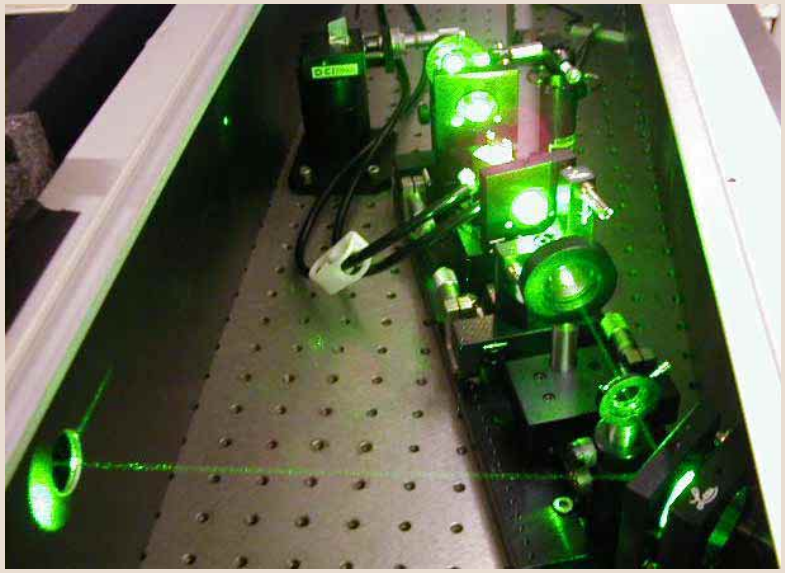


without 800nm light

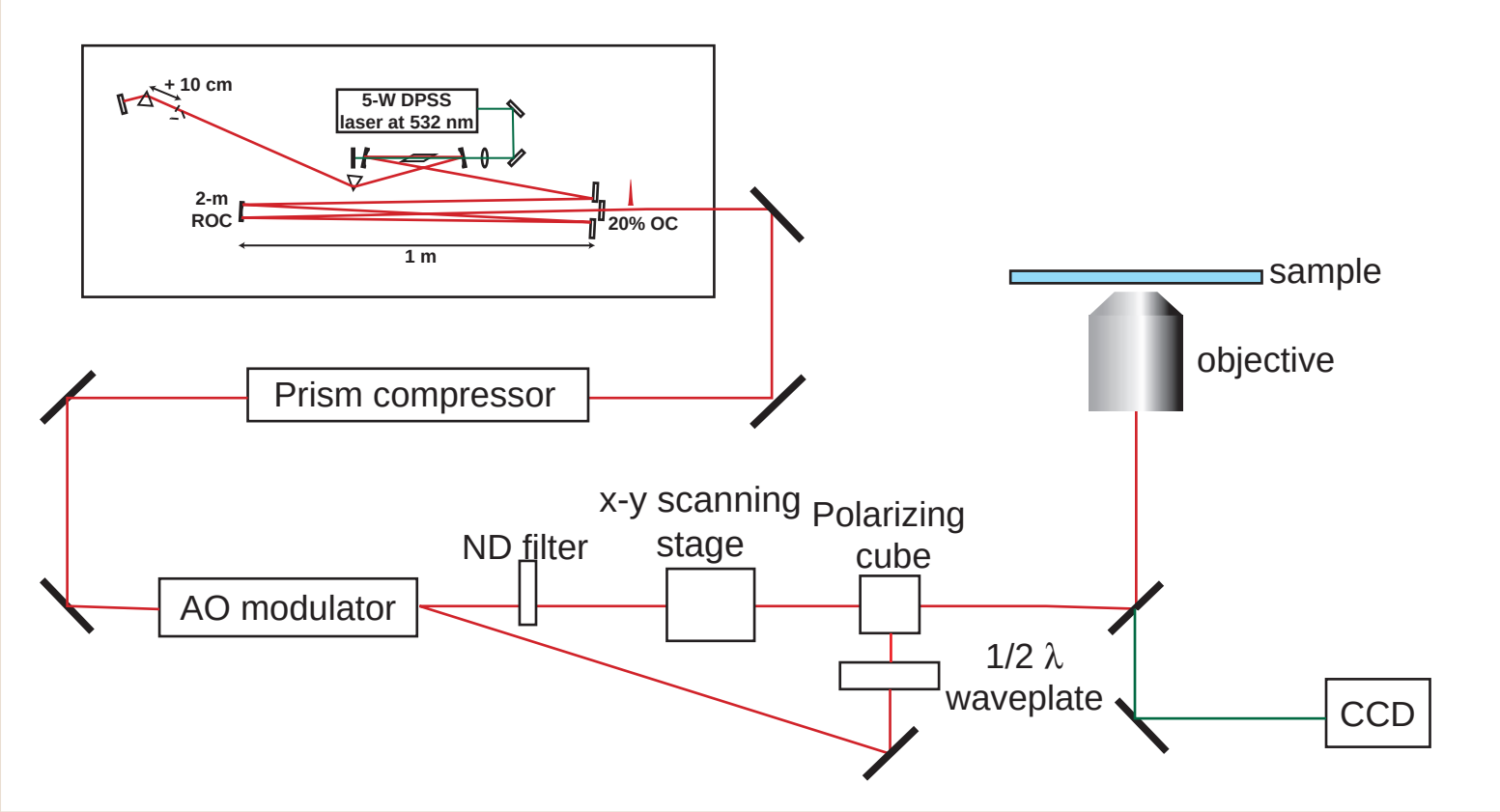
**why nanojoules?**

**non-amplified micromachining**

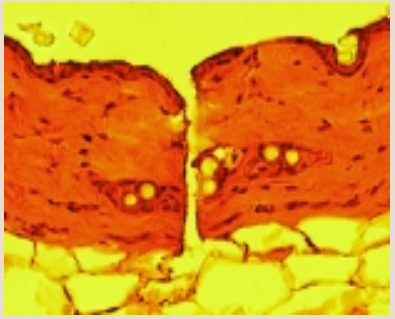




# Single cell

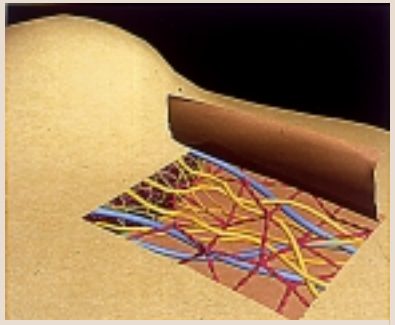

+ 10 cm
5-W DPSS
laser at 532 nm
2-m
ROC
20% OC
1 m
sample
objective
Prism compressor
x-y scanning
stage
Polarizing
cube
ND filter
AO modulator
1/2 λ
waveplate
CCD

# Applications



High precision laser scalpel

Transdermal drug delivery



Cytoskeleton integrity and function: mechanical signal transduction in cell

*Wang N, Butler JP, Ingber DE  Science 1993 Vol. 260*

# *Acknowledgements*

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**http://mazur-www.harvard.edu**