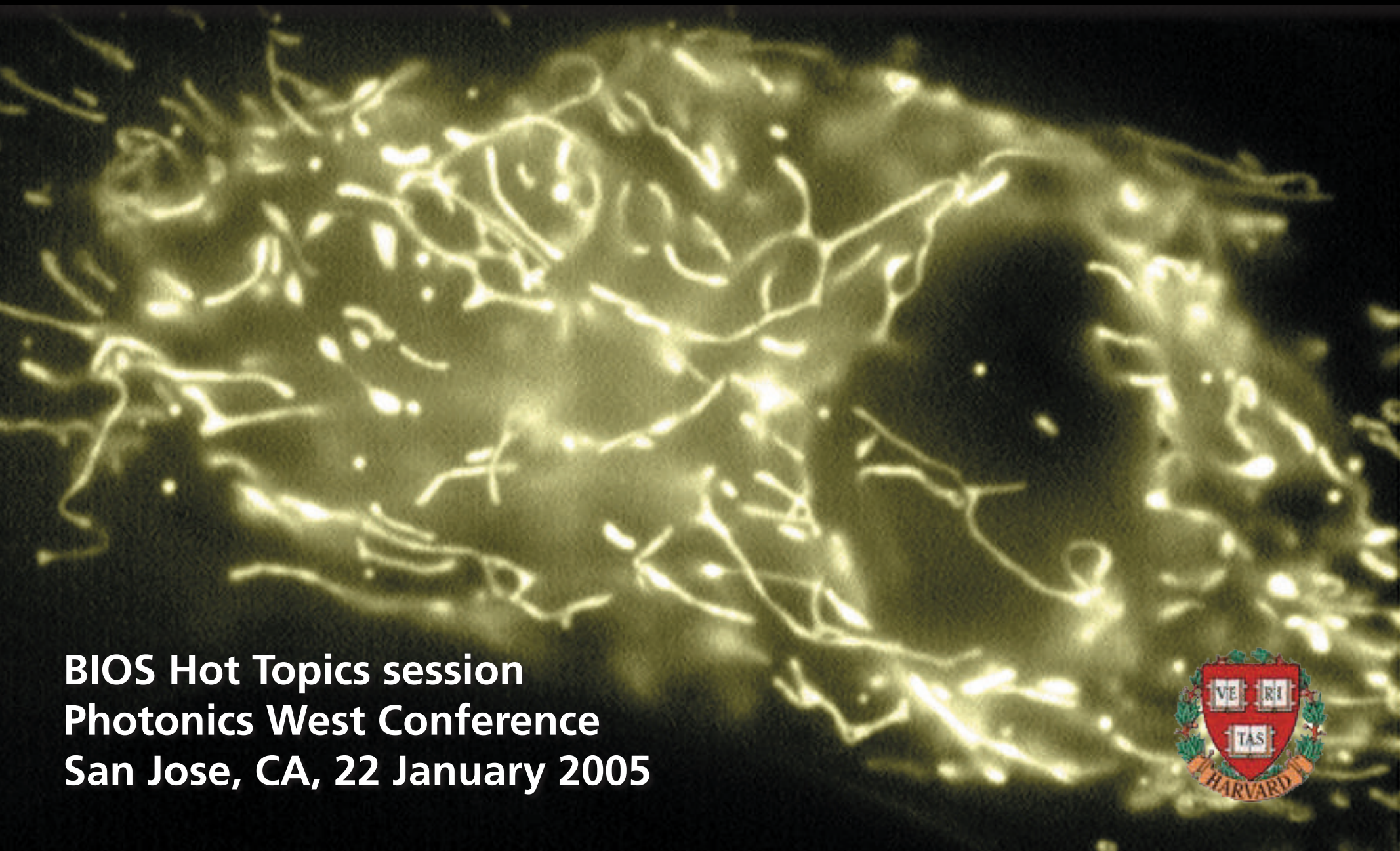


# Cellular microsurgery using ultrashort laser pulses



**BIOS Hot Topics session  
Photonics West Conference  
San Jose, CA, 22 January 2005**

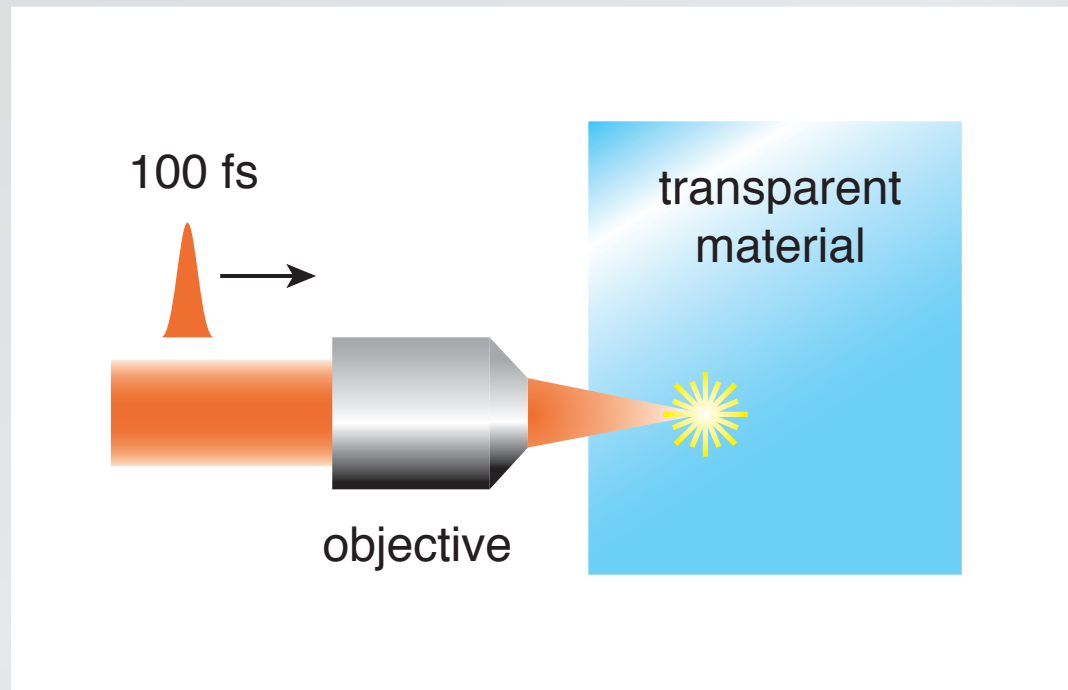


# **My message**

**can use light for micromanipulation**

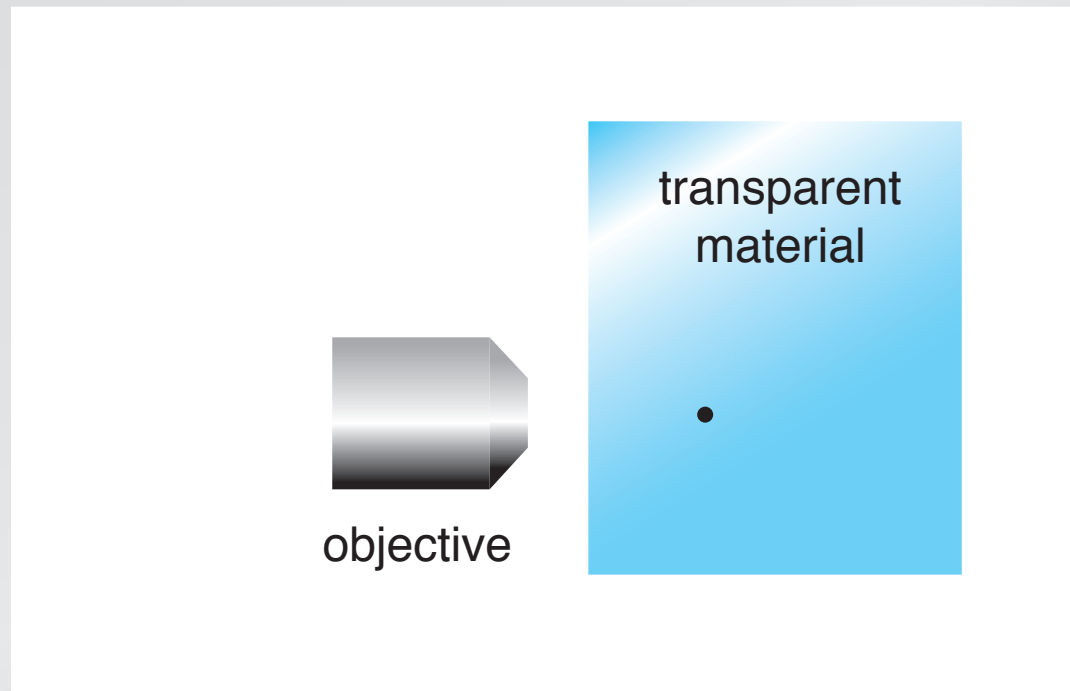
# Femtosecond micromachining

focus laser beam inside sample



# Femtosecond micromachining

causes microscopic damage at focus



# Femtosecond micromachining

Points to keep in mind:

- only nanojoules required!
- nanoscale ablation
- no collateral damage

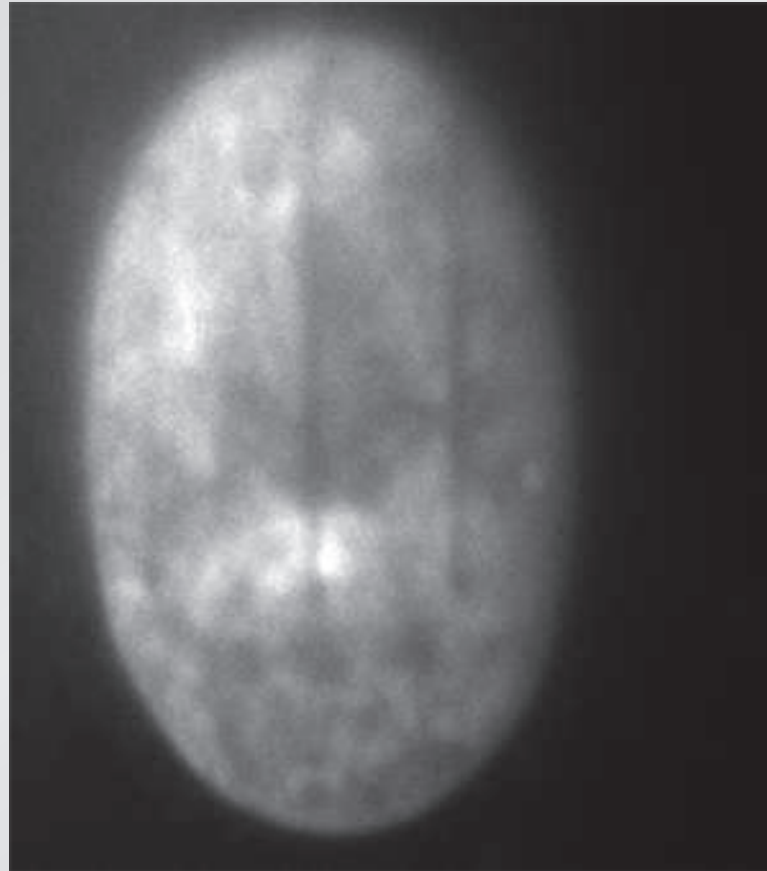


# Subcellular nanosurgery

**Q: photodegeneration, structural changes, or ablation?**

# Subcellular nanosurgery

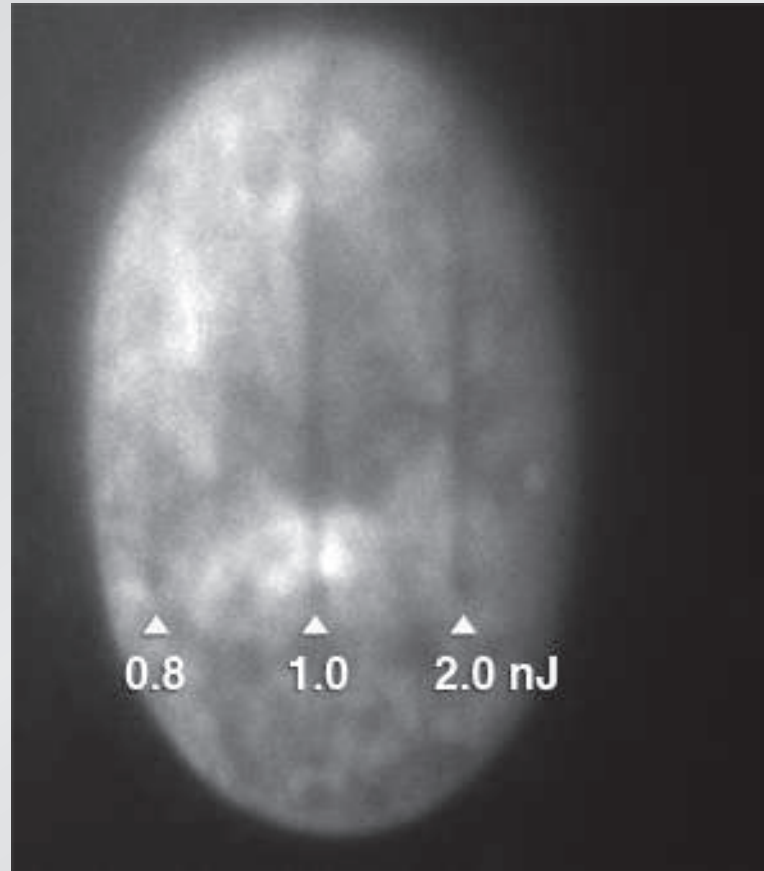
cuts in nucleus of fixed endothelial cell



fluorescence microscopy

# Subcellular nanosurgery

cuts in nucleus of fixed endothelial cell

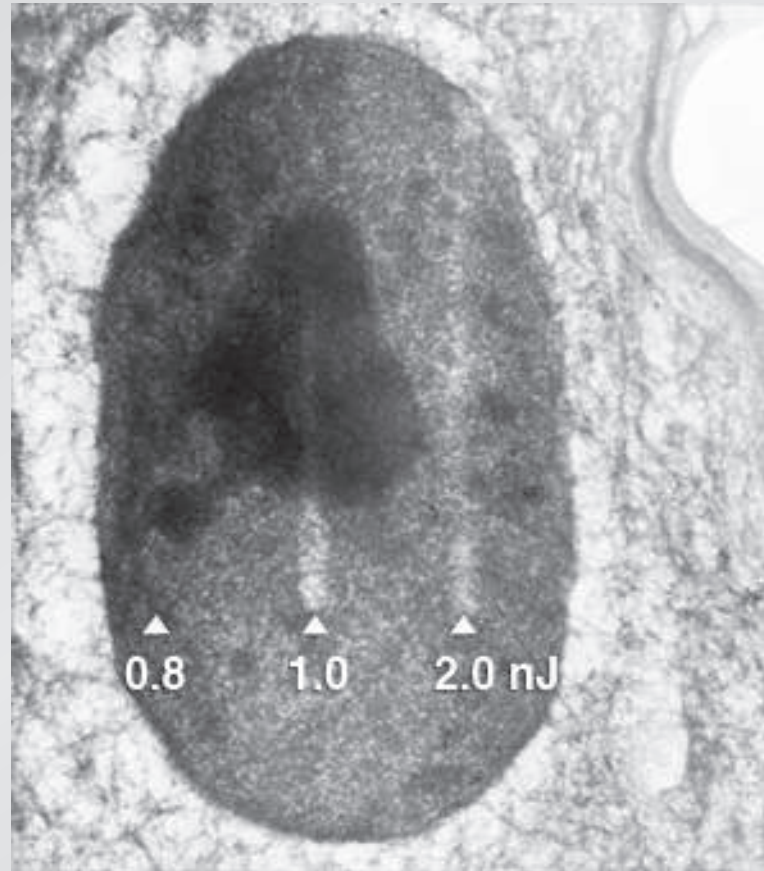


fluorescence microscopy



# Subcellular nanosurgery

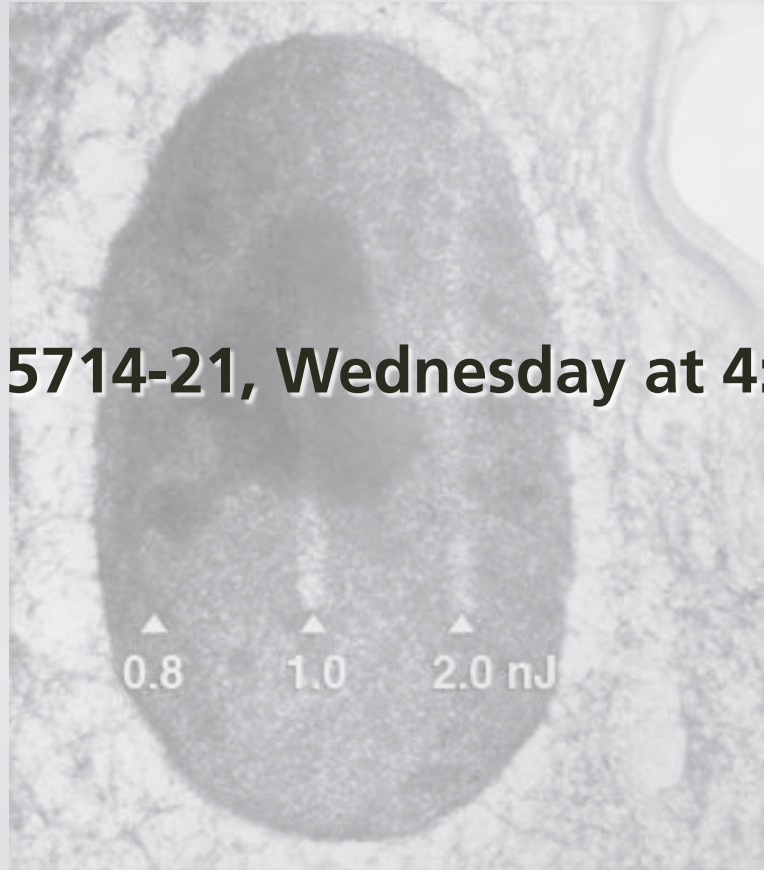
cuts in nucleus of fixed endothelial cell



TEM image

# Subcellular nanosurgery

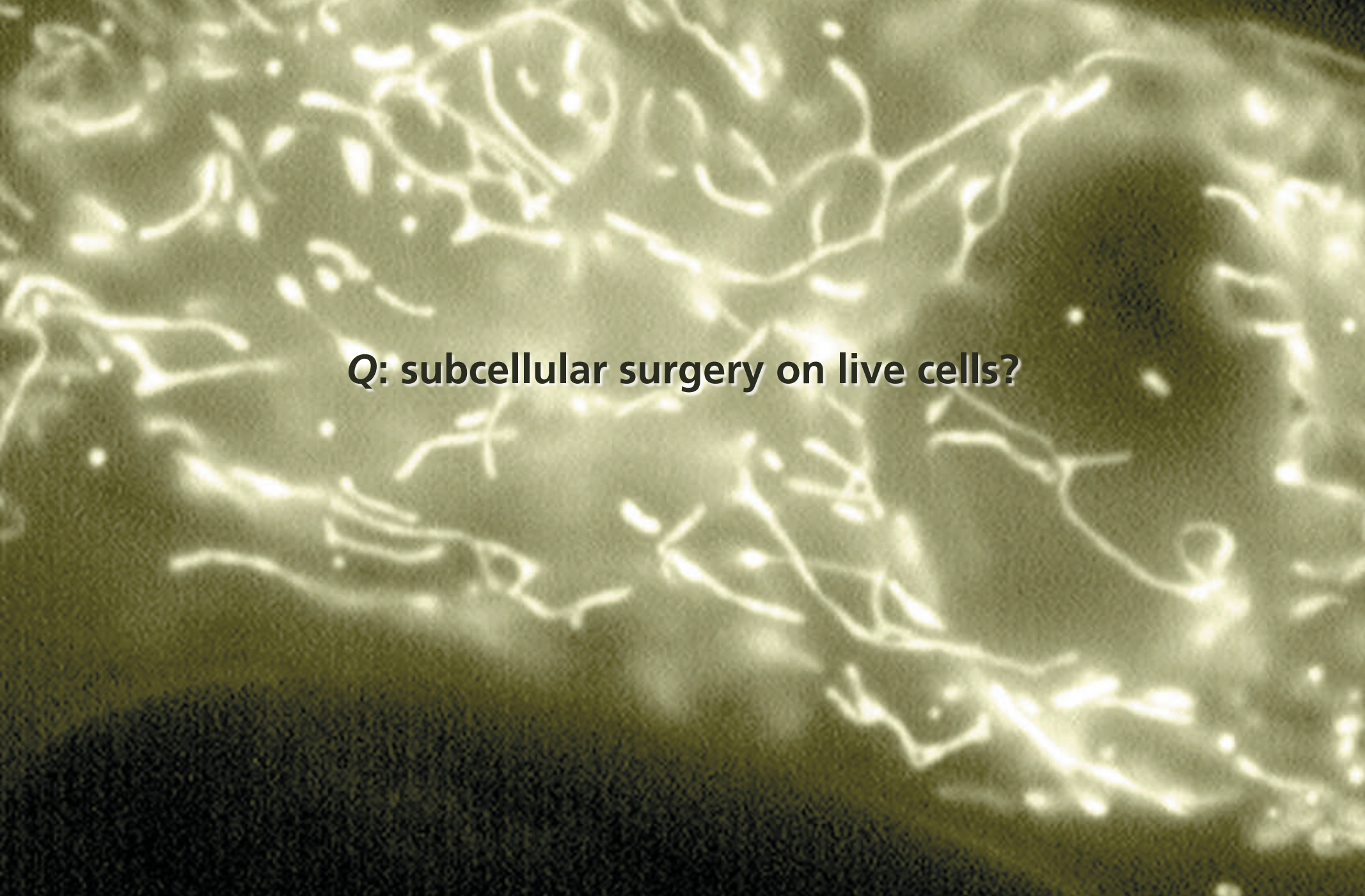
Talk 5714-21, Wednesday at 4:45 pm





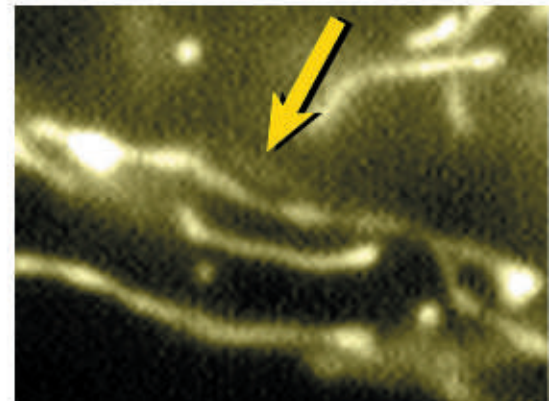
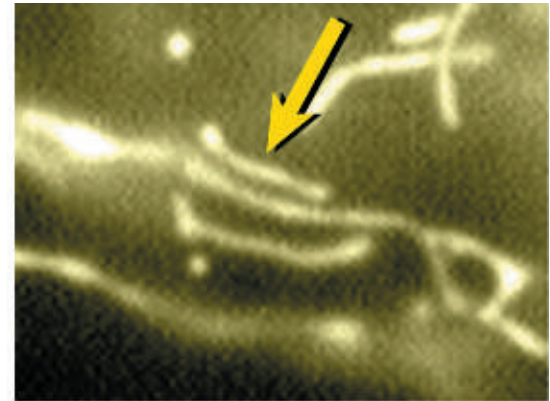
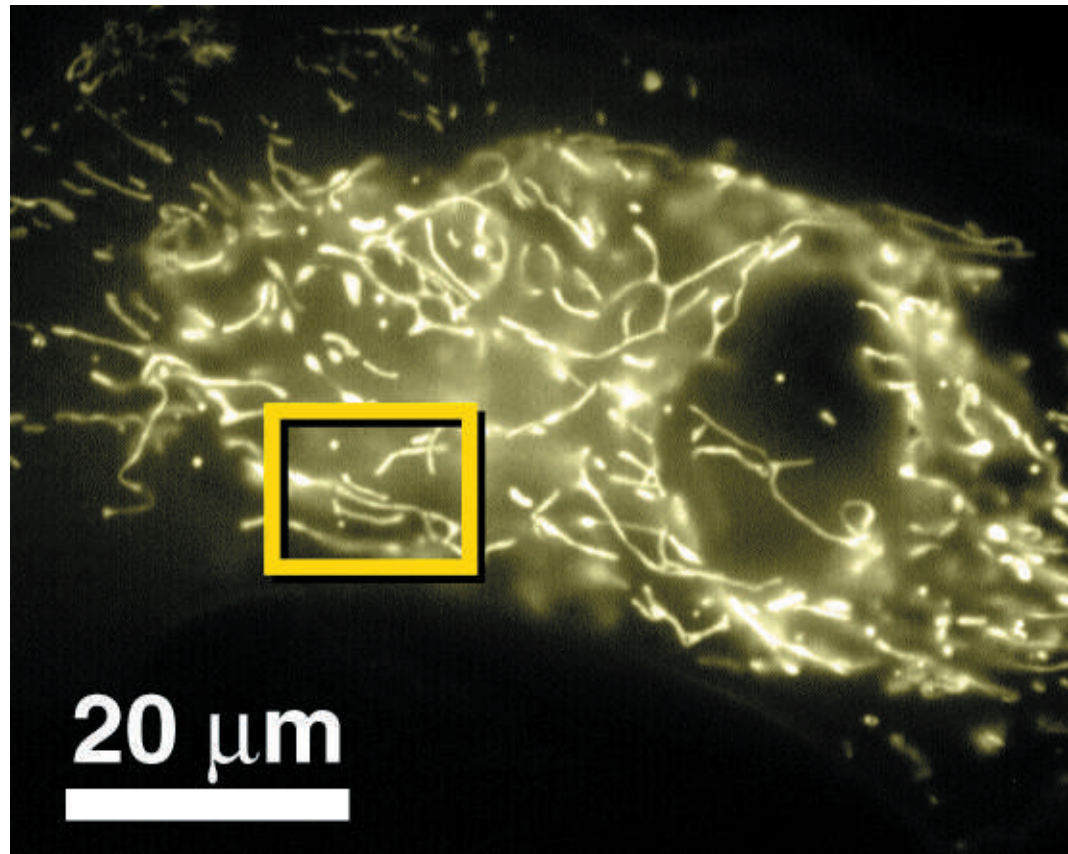
# Subcellular nanosurgery

**Q: subcellular surgery on live cells?**





# Subcellular nanosurgery

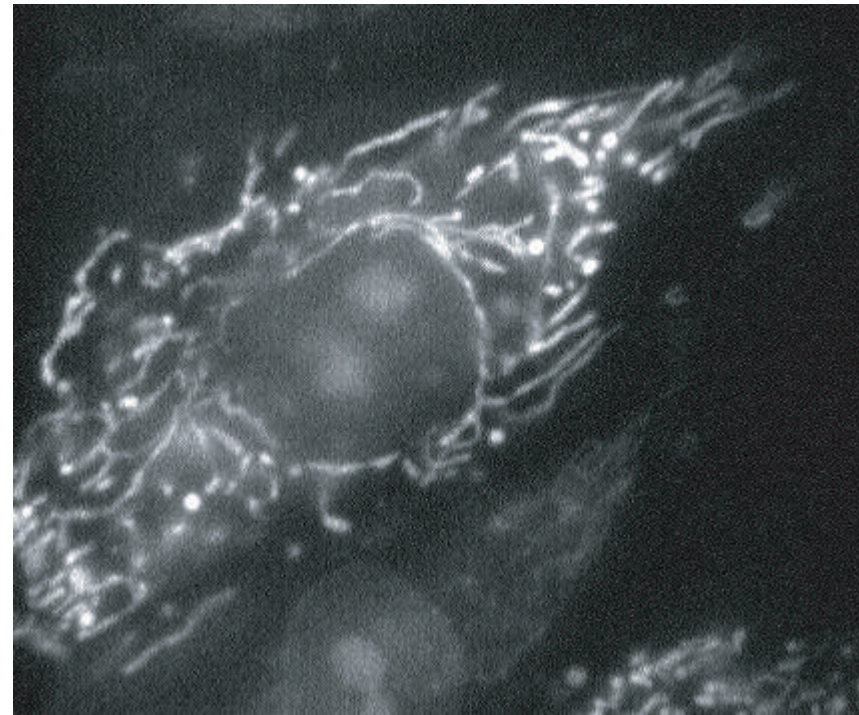
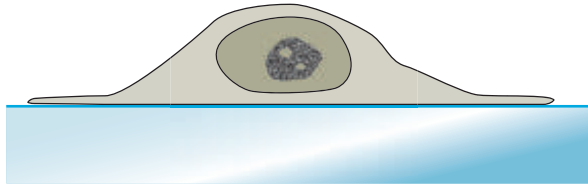






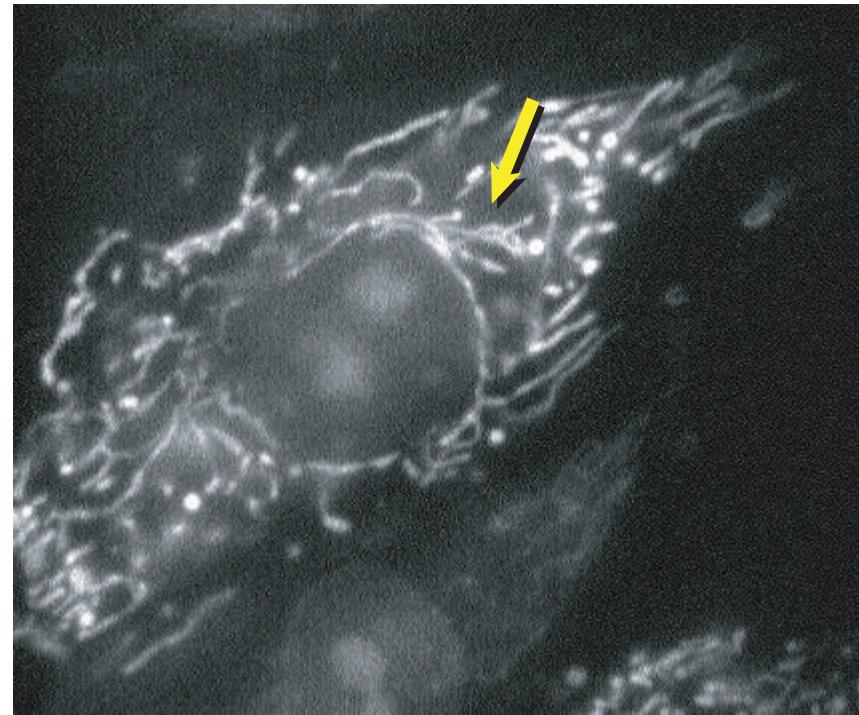
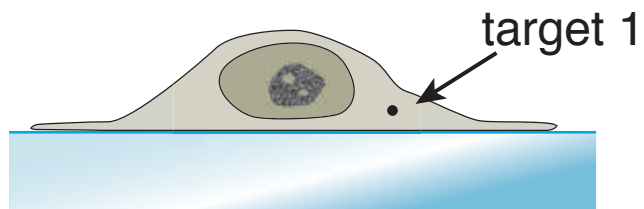
# Subcellular nanosurgery

## ethyldium bromide test



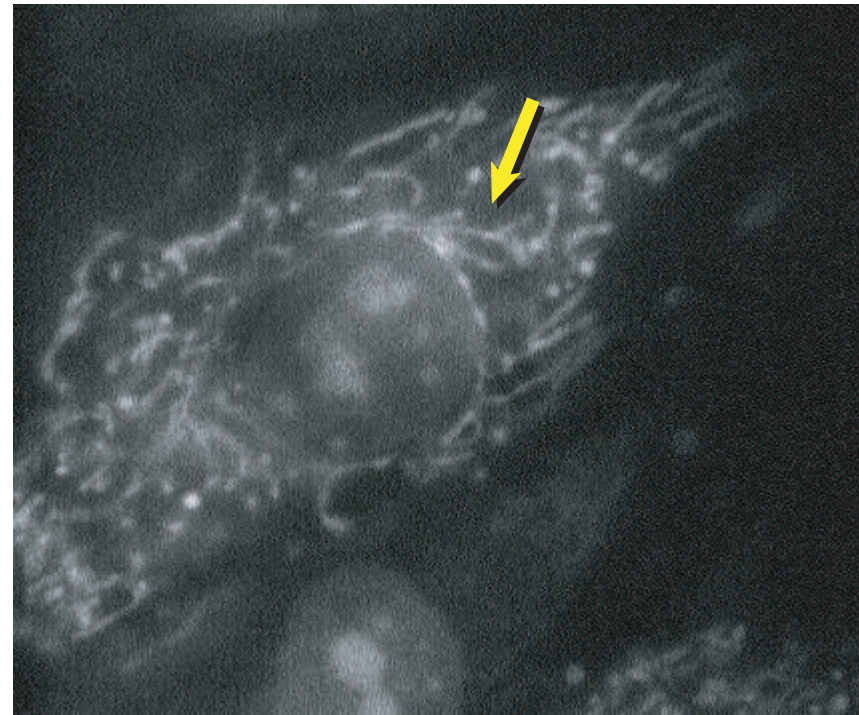
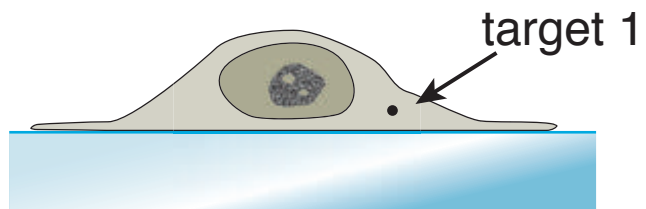
# Subcellular nanosurgery

## ethydium bromide test



# Subcellular nanosurgery

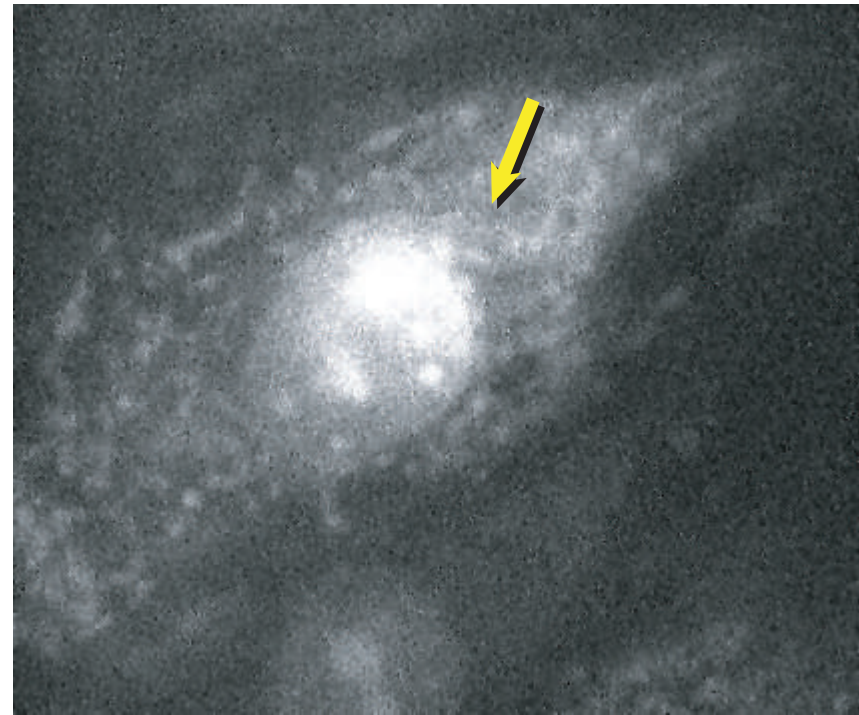
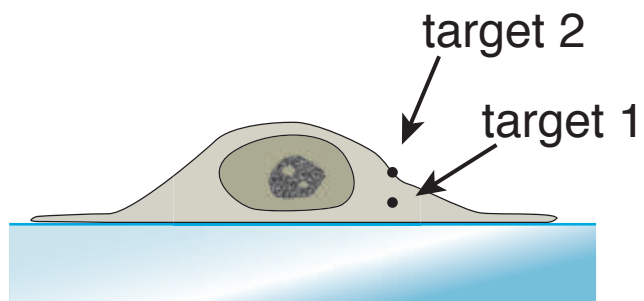
## ethydium bromide test





# Subcellular nanosurgery

## ethyidium bromide test





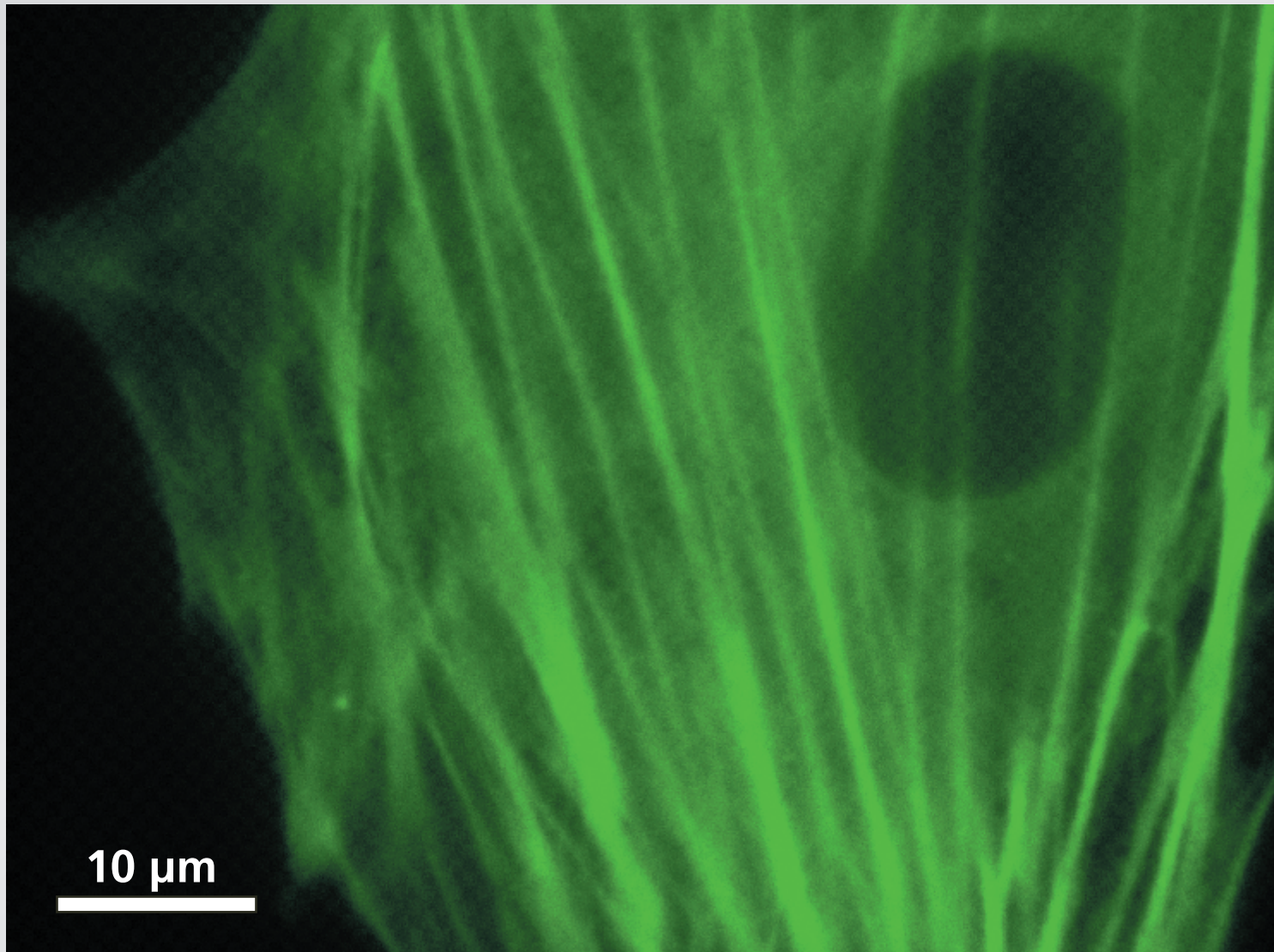
# Subcellular nanosurgery

**Q: can we probe the dynamics of the cytoskeleton?**



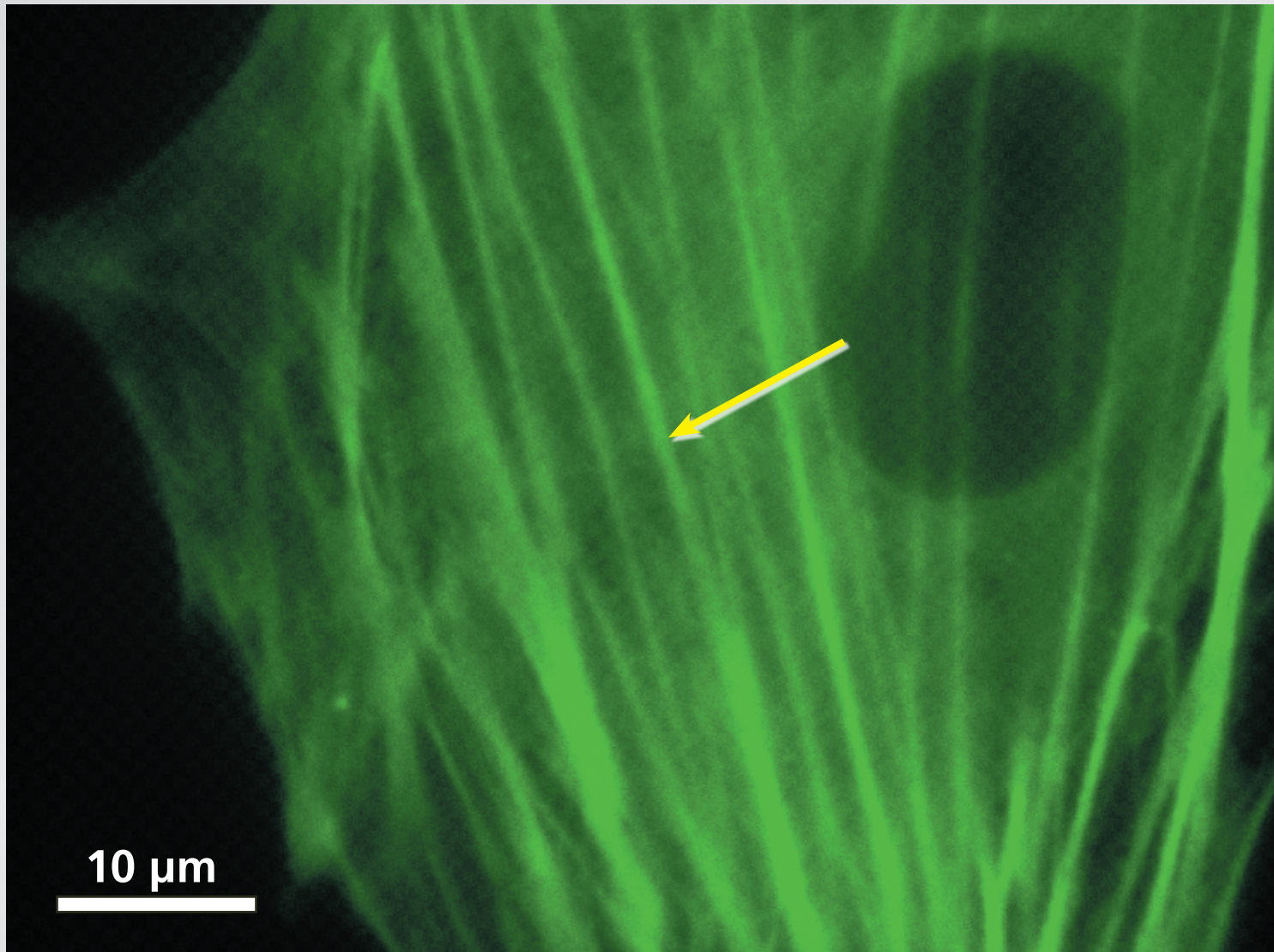
# Subcellular nanosurgery

actin fiber network of a live cell



# Subcellular nanosurgery

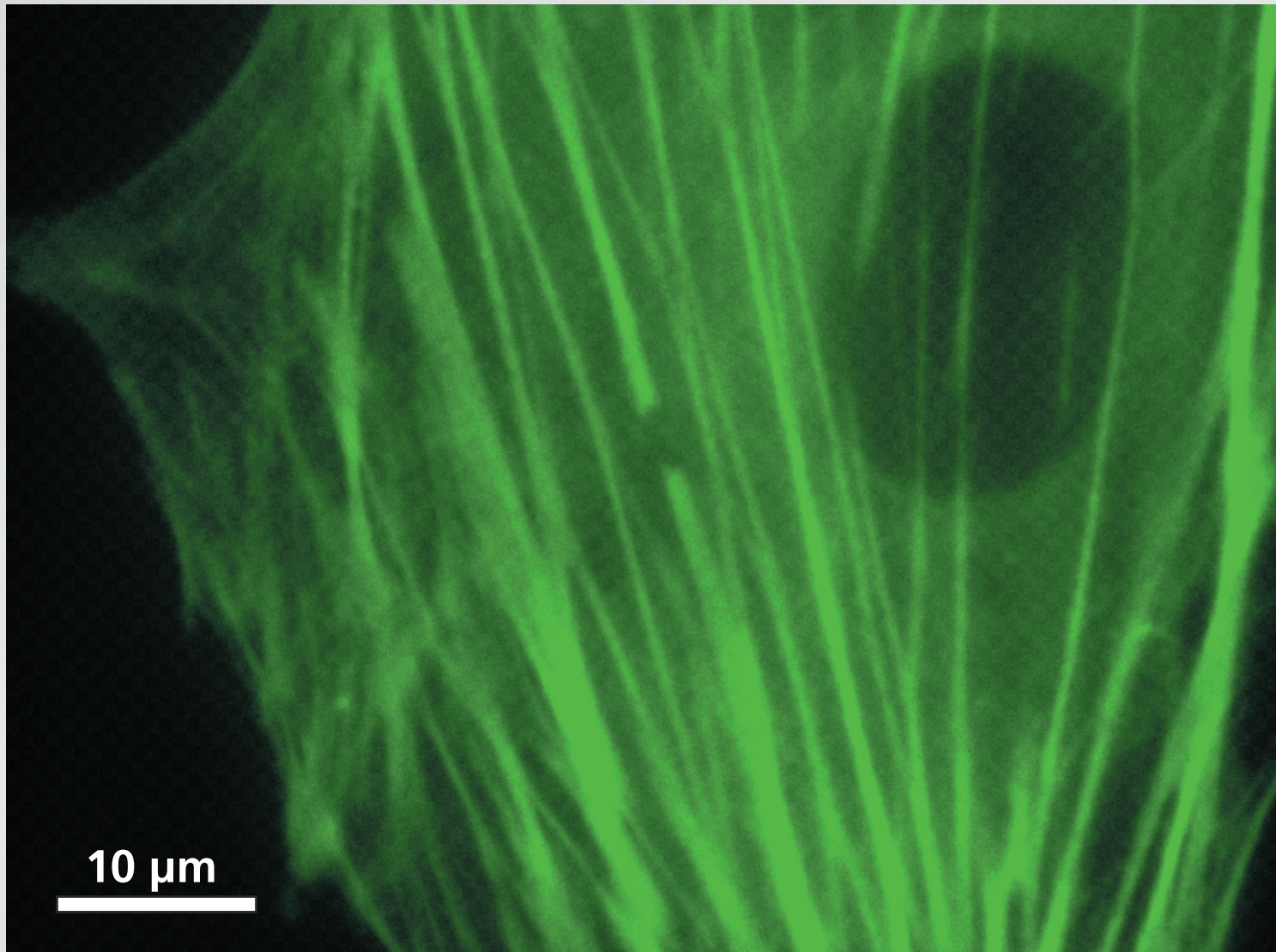
cut a single fiber bundle





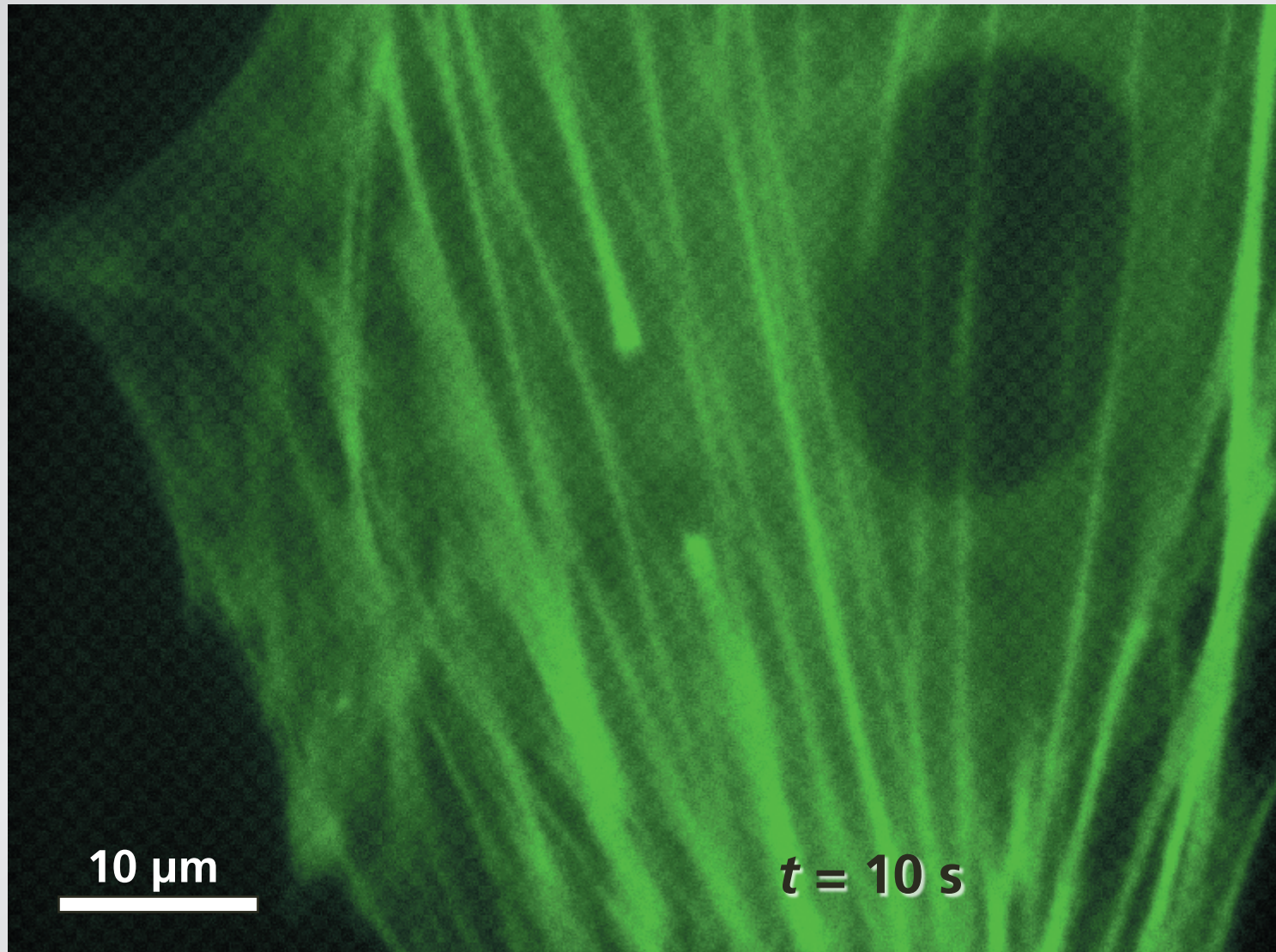
# Subcellular nanosurgery

cut a single fiber bundle



# Subcellular nanosurgery

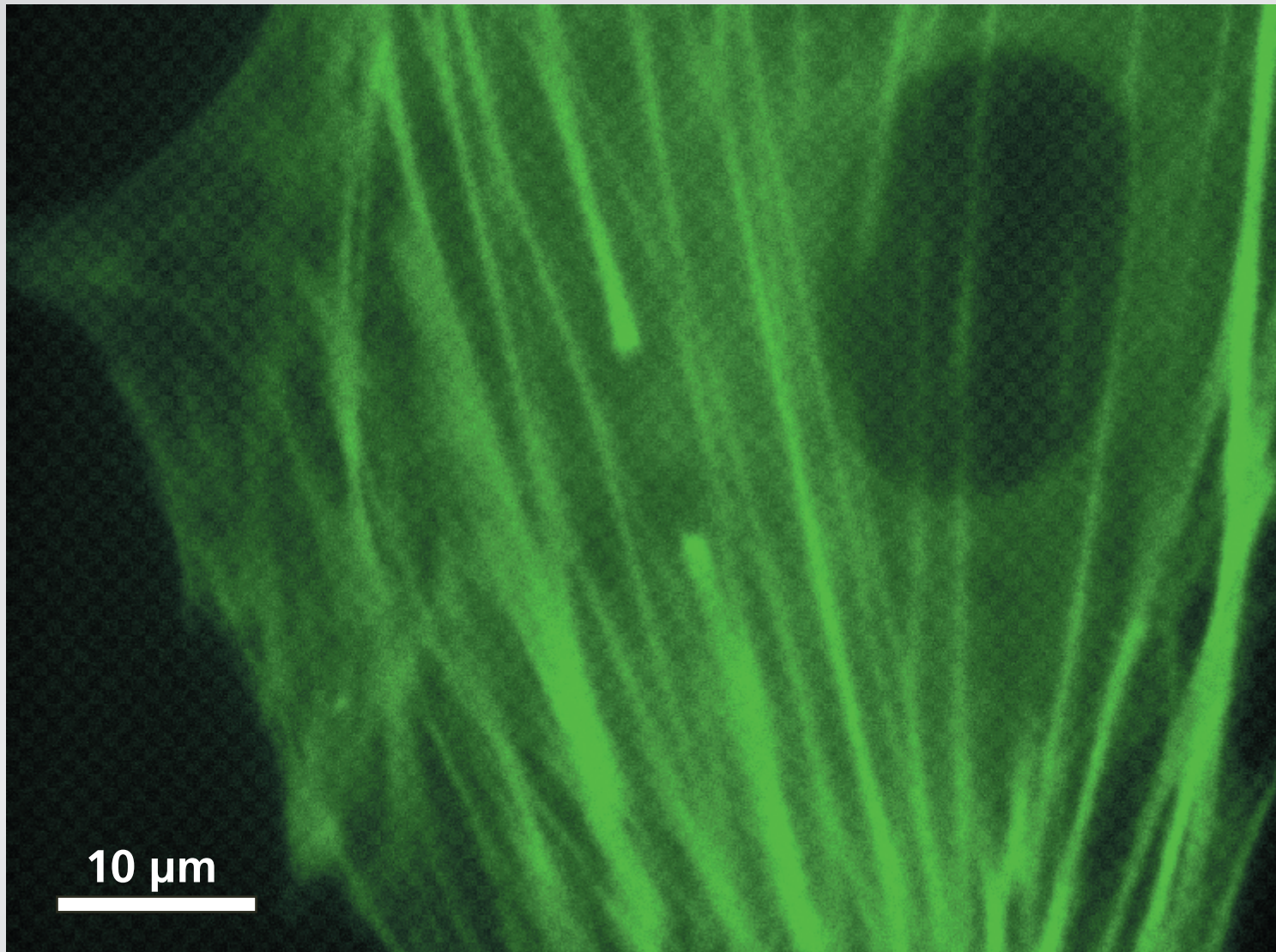
gap widens with time





# Subcellular nanosurgery

dynamics provides information on *in vivo* mechanics





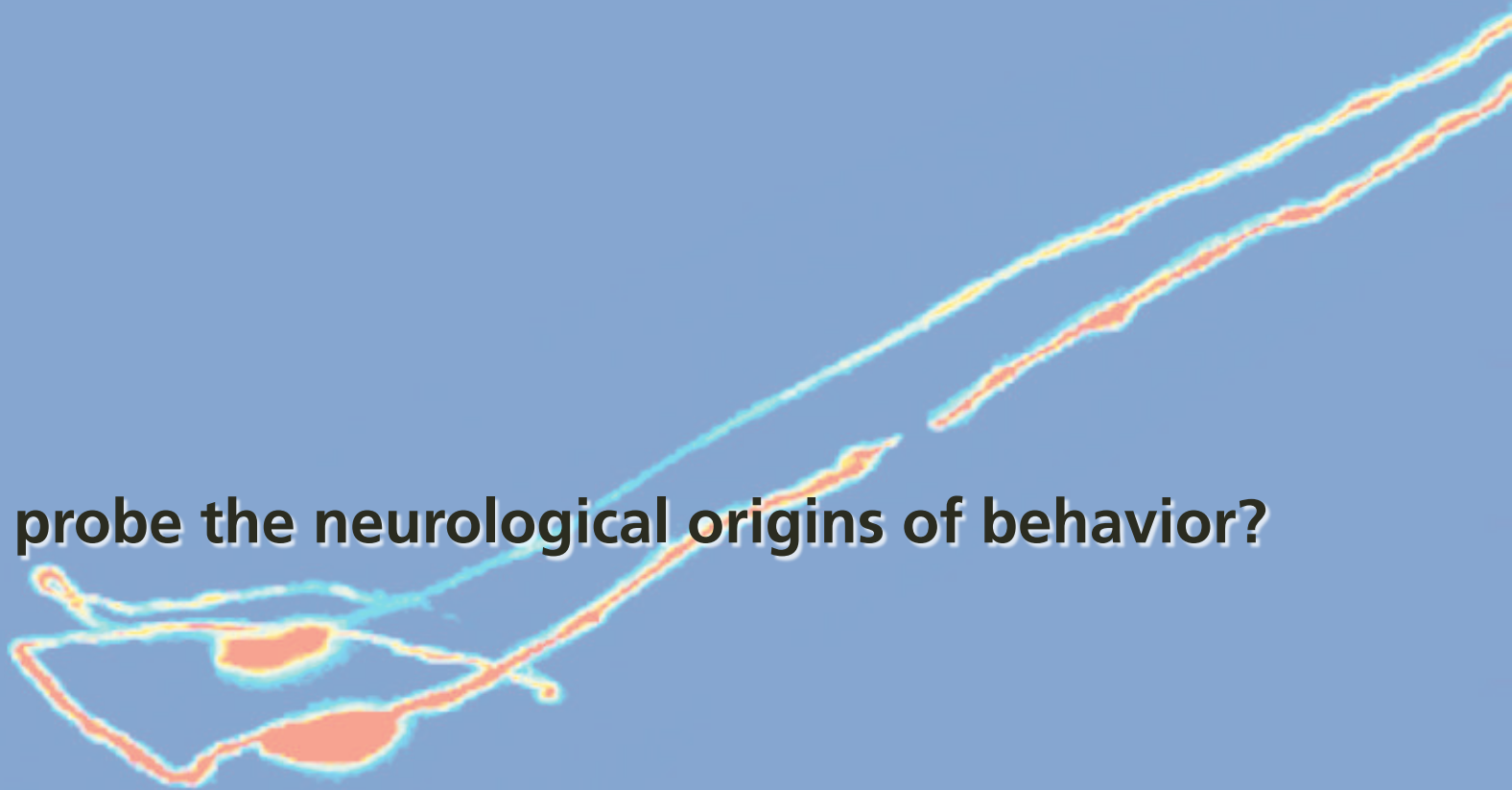
# Subcellular nanosurgery

A fluorescence microscopy image showing a cell with numerous bright green, elongated, and somewhat parallel structures, likely representing microtubules or actin filaments, against a dark background. The structures are distributed throughout the cell, with some appearing more concentrated in certain areas.

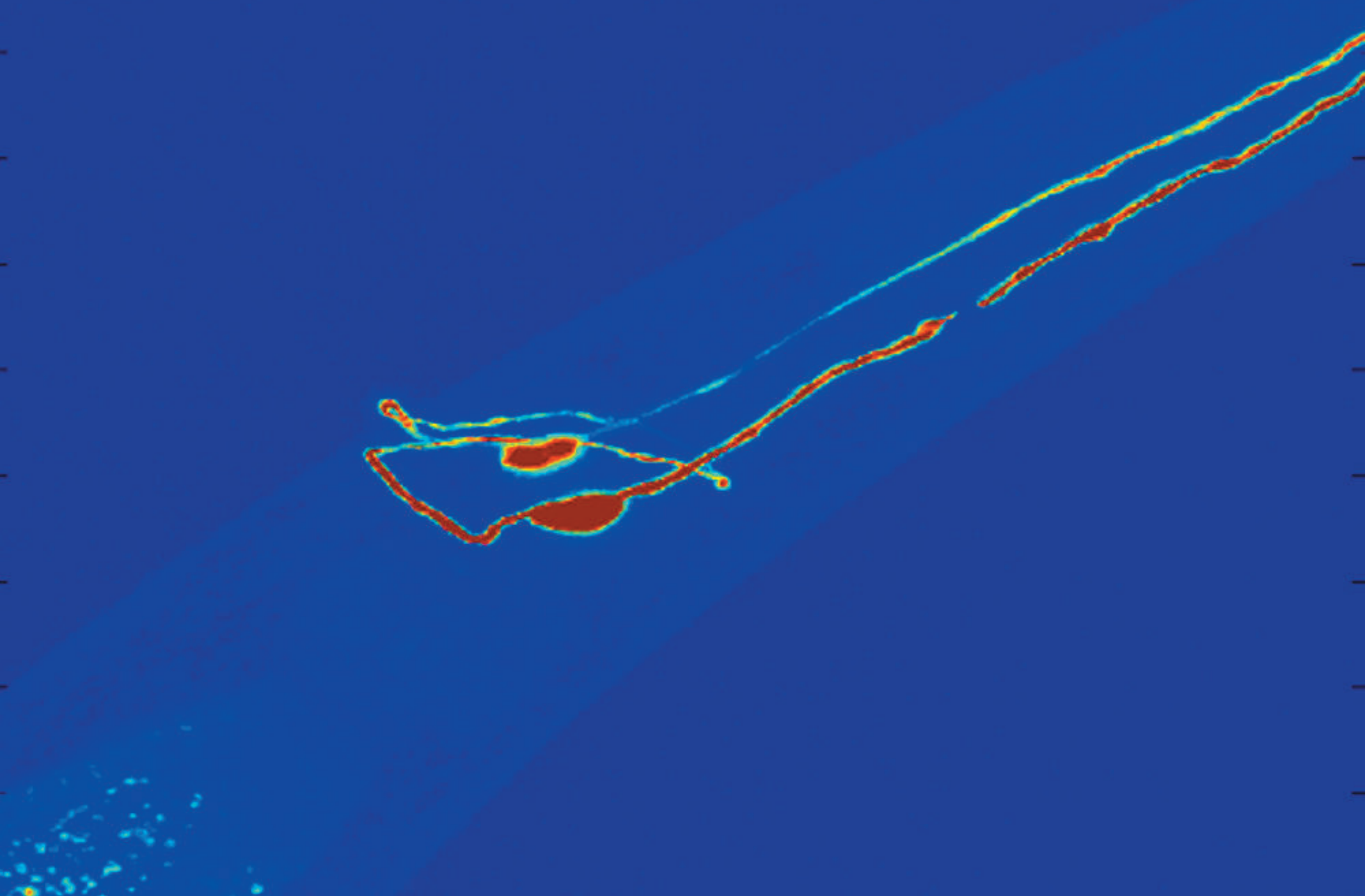
**Talk 5695-37, Tuesday at 4:40 pm**

# Nanoneurosurgery

**Q: can we probe the neurological origins of behavior?**

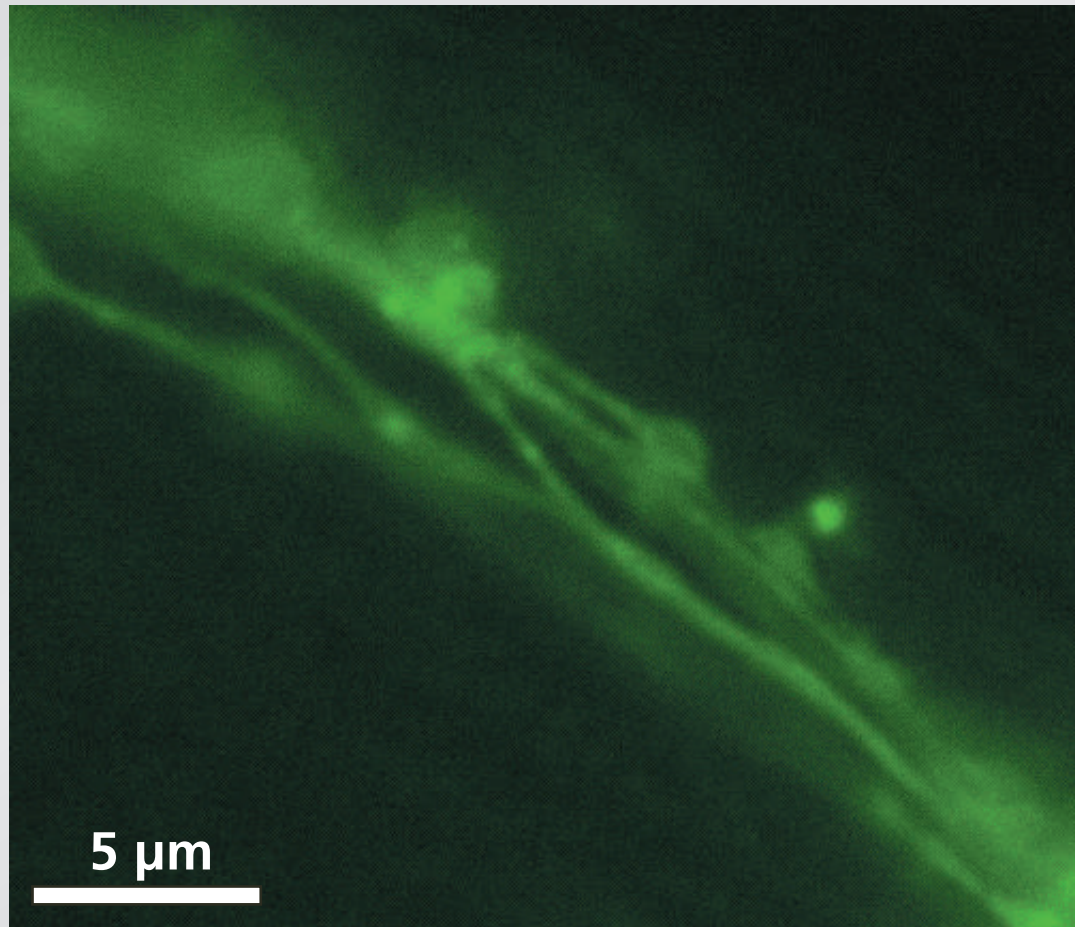


# Nanoneurosurgery



# Nanoneurosurgery

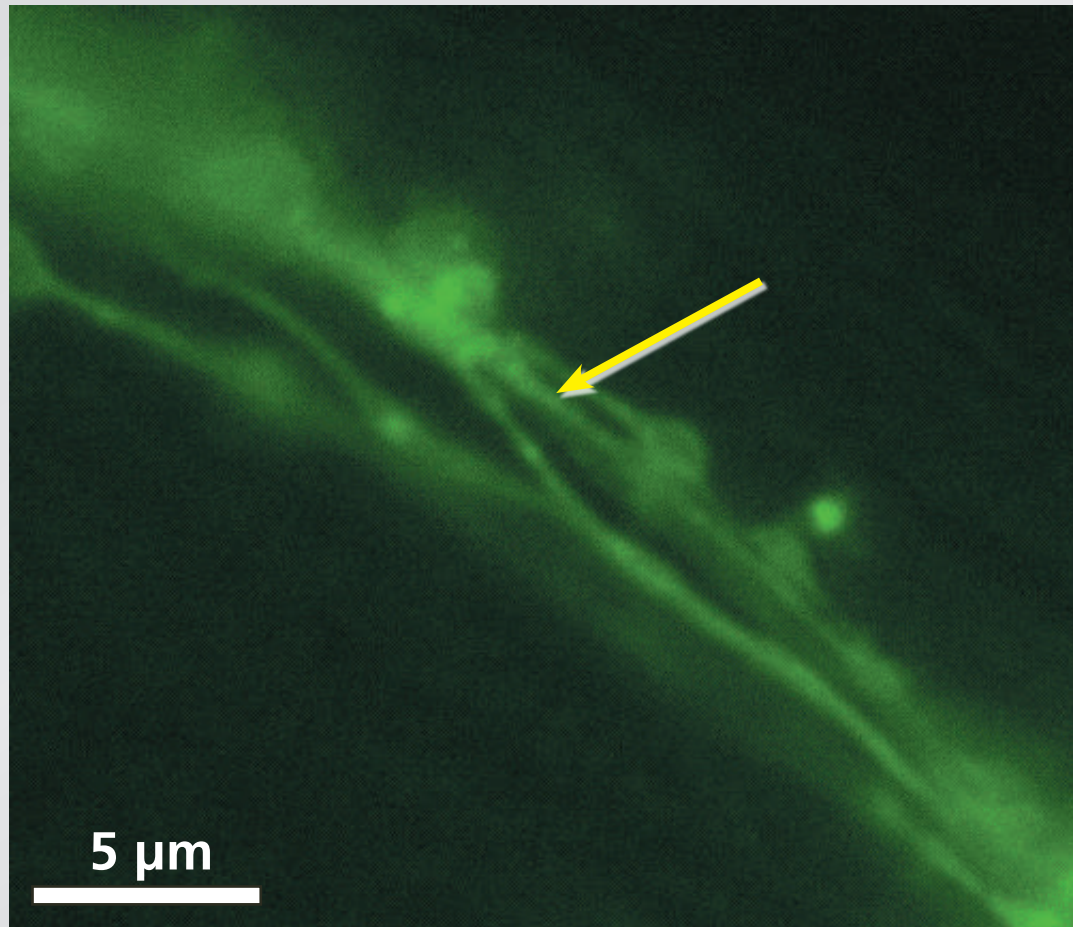
cut single dendrite in amphid bundle





# Nanoneurosurgery

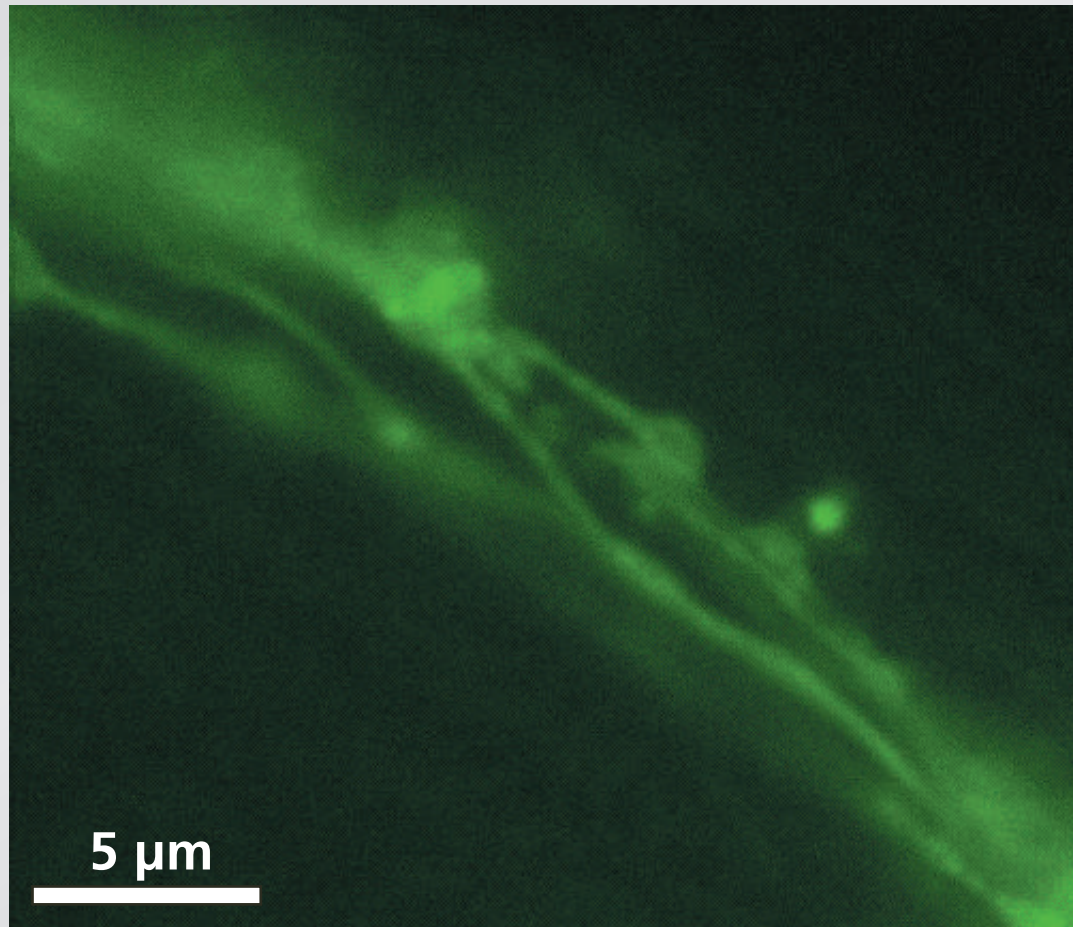
cut single dendrite in amphid bundle





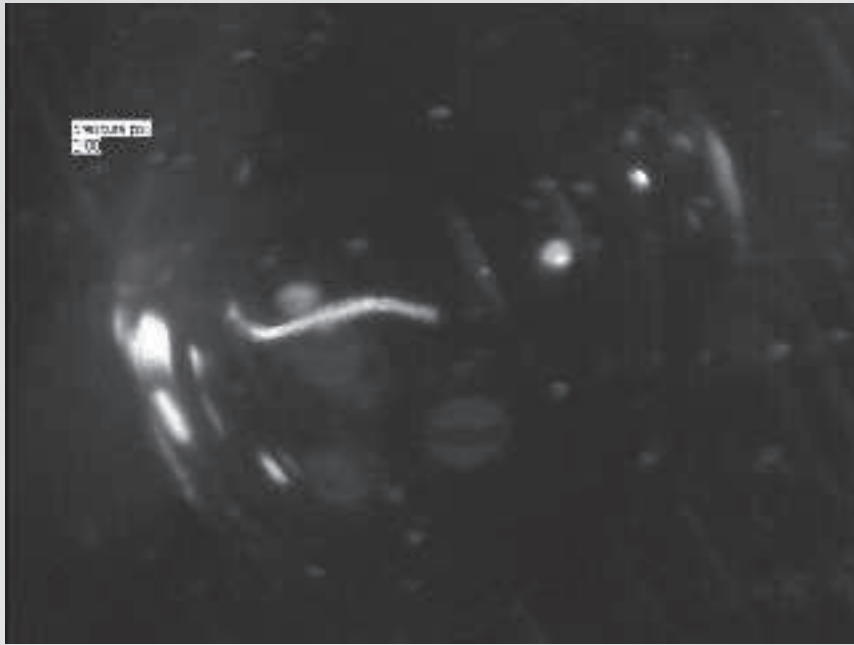
# Nanoneurosurgery

cut single dendrite in amphid bundle



# Nanoneurosurgery

surgery results in quantifiable behavior changes



before



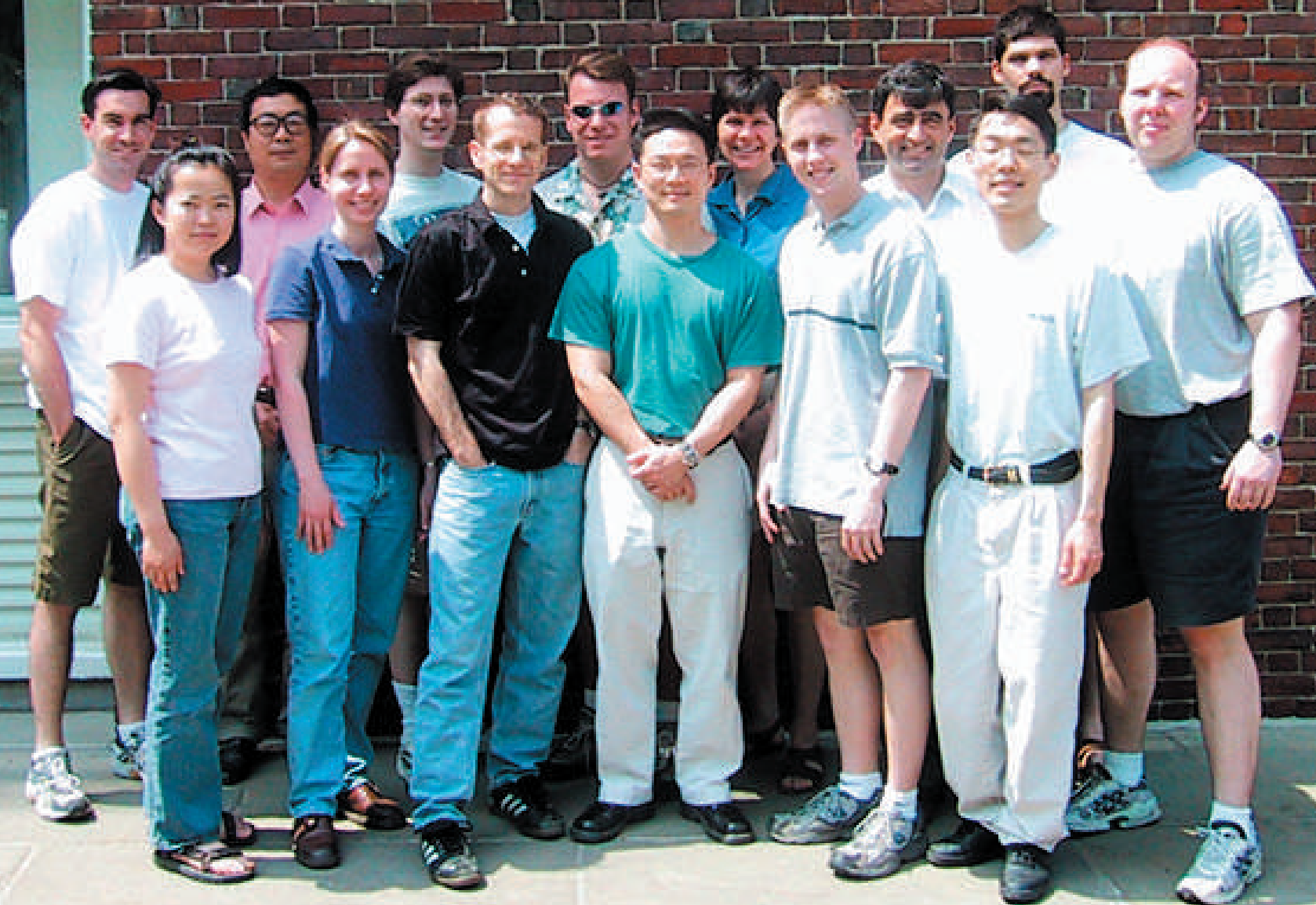
after

# Conclusion

**great tool for micromanipulating the machinery of life!**



CORDON MCKAY  
LABORATORY OF  
APPLIED SCIENCE



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**DARPA**

**National Science Foundation**

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