

# Fluorescence Spectral Characteristics of Fiber Optic Imaging Bundles

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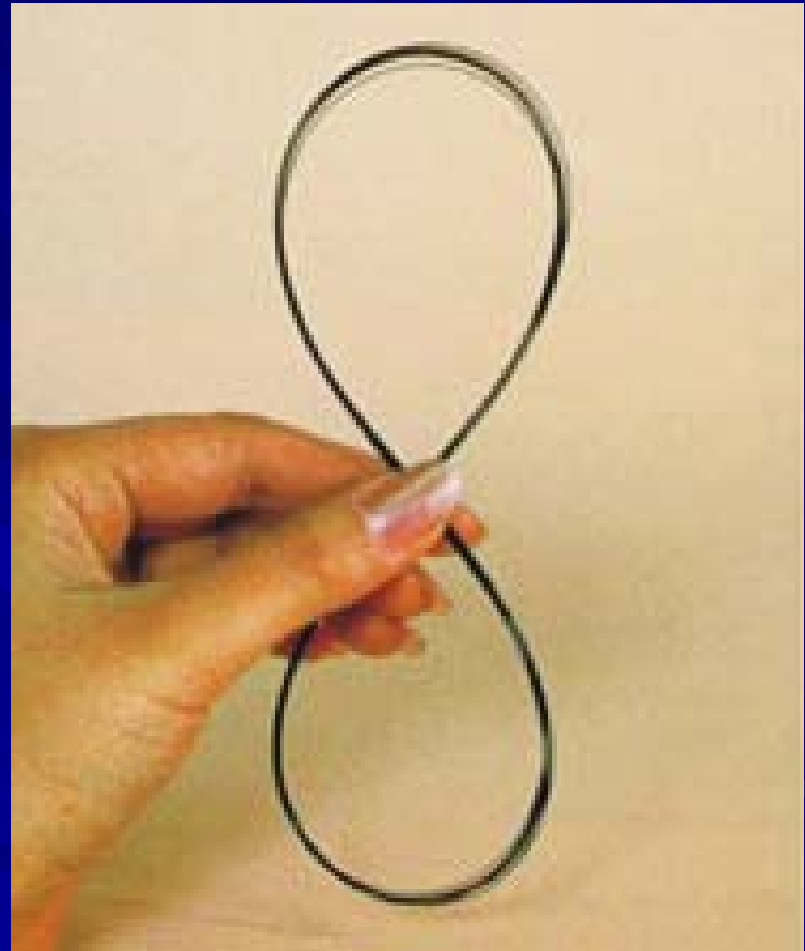
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# Outline

- Why fiber bundles?
- Current uses of fiber optic imaging bundles
- Autofluorescence of these bundles really is an issue
- Testing setup
- Fiber fluorescence
- Conclusions

# Why Coherent Fiber Bundles?

- Point to point image relays
- Flexible
- Variable lengths
- Used for remote imaging applications



# Uses of Imaging Bundles

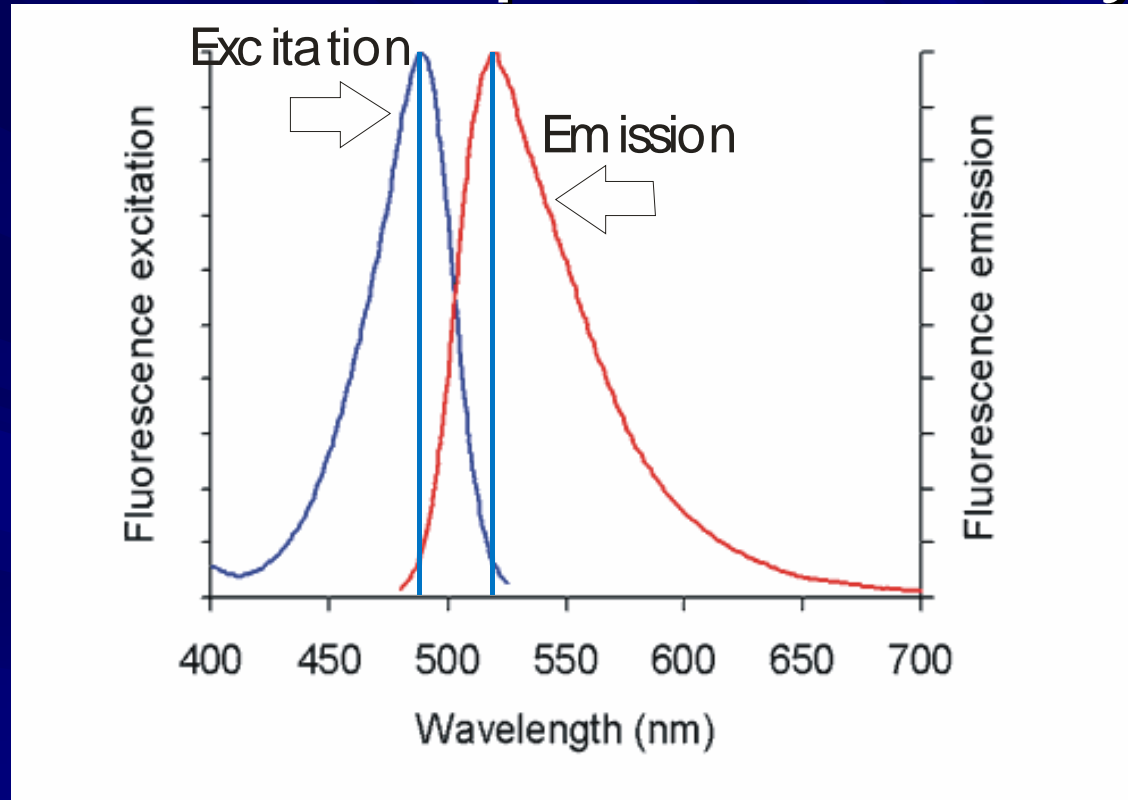
- Endoscopy
- Non-rigid image guides
- Two photon microscopy
- Confocal microscopy

# Limitations of Coherent Bundles

- Resolution of fibers limited by fiber size and spacing
- Crosstalk between fibers
- Losses high outside of visible region
- Autofluorescence from fibers can obscure optical signals

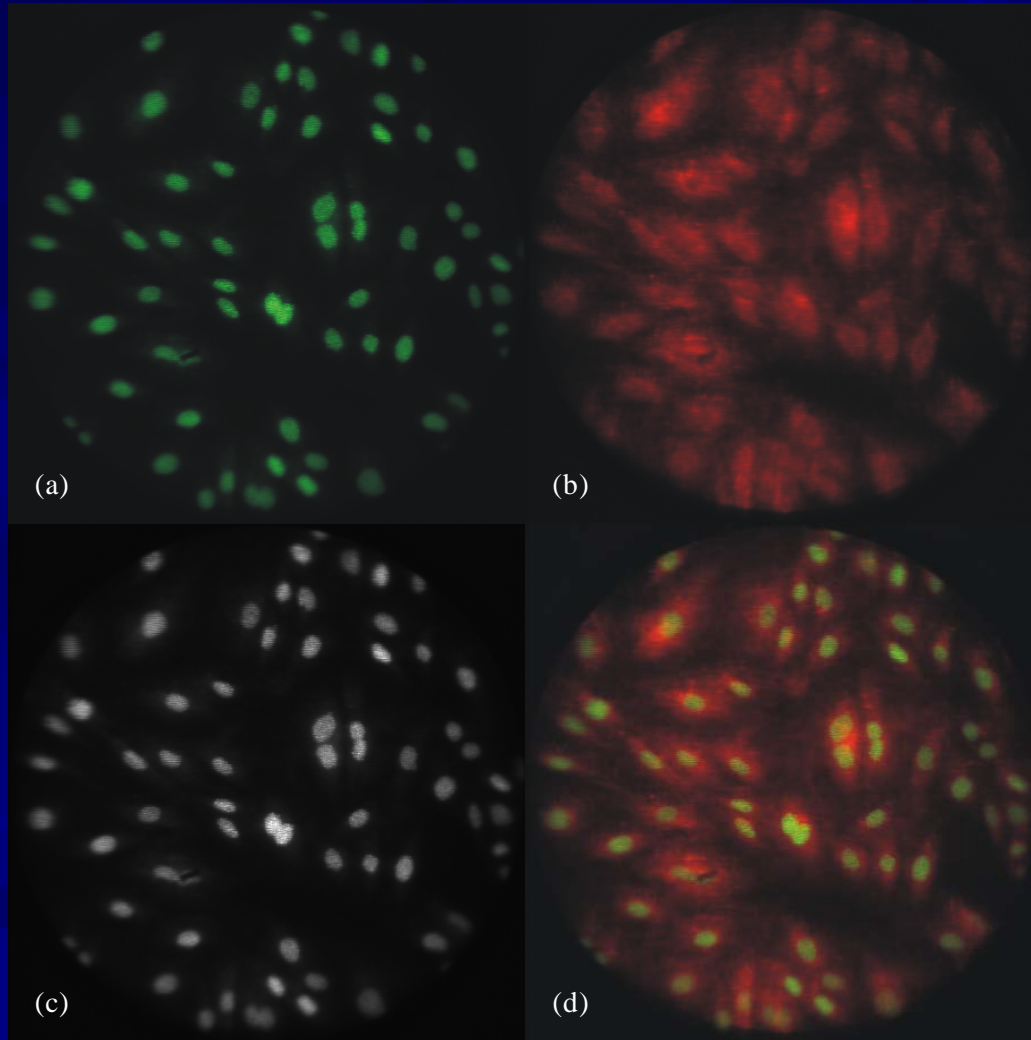


# Fluorescence Spectrum of Syto 16



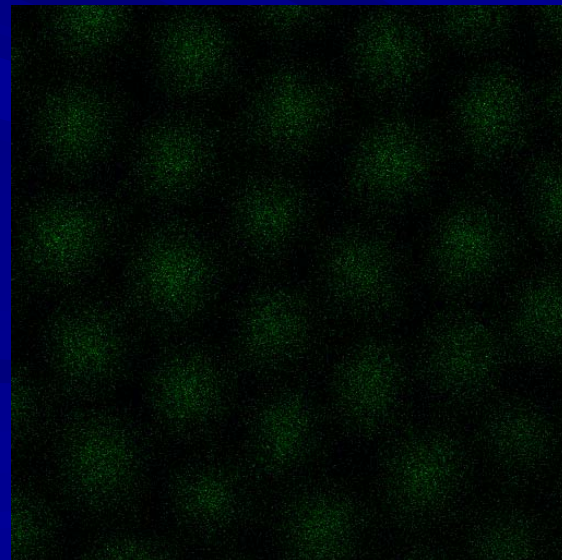
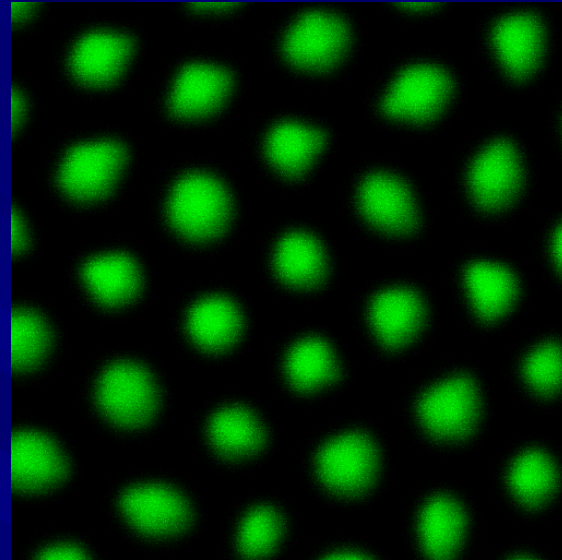
- Excitation peak is at 488 nm
- Emission peak is at 518 nm

# Multispectral Images



# Autofluorescence of Fiber Cores

- Top image:
  - 488 nm excitation
  - 515 nm emission, 30 nm bandpass
- Bottom image:
  - 488 nm excitation
  - 515 nm longpass emission filter (to dichroic cut off)

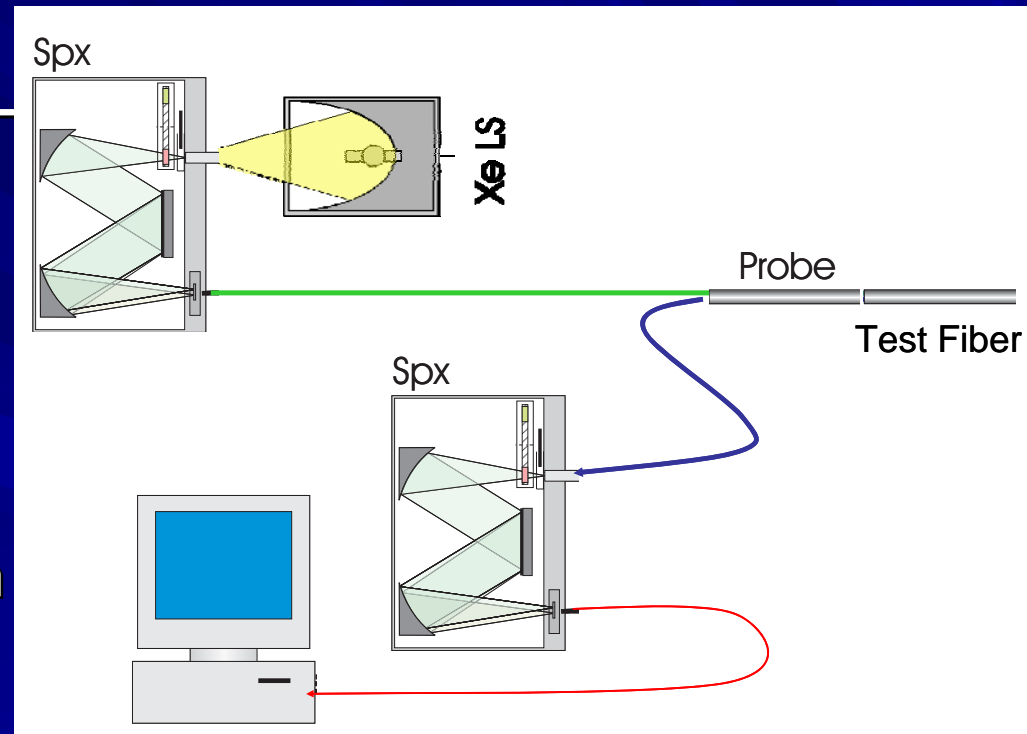


# Fibers Used

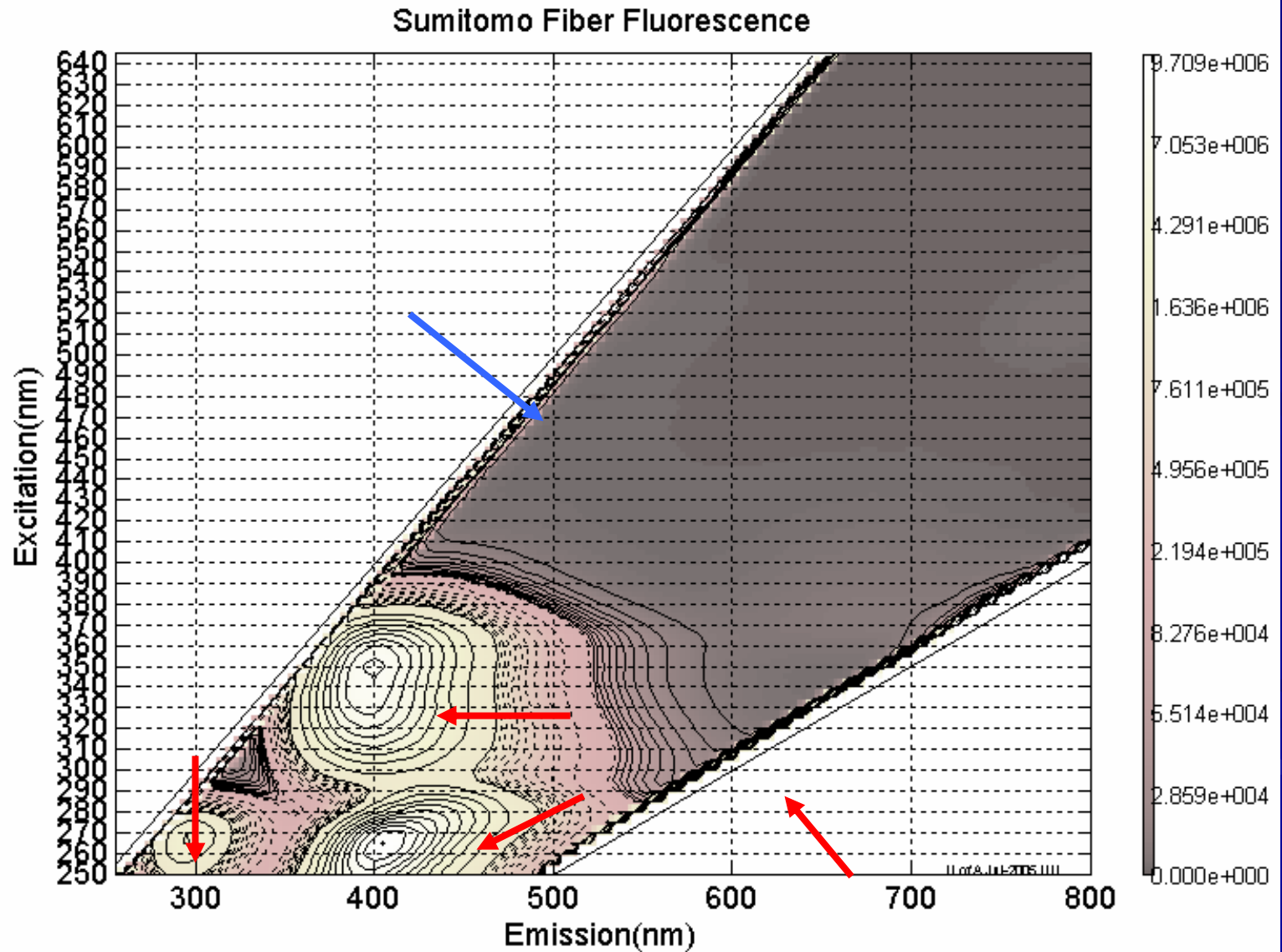
- Sumitomo IGN-08/30
- Fujikura FIGH-30-850N
- Both bundles have 30k imaging fibers
  - 2  $\mu\text{m}$  diameter
  - 3  $\mu\text{m}$  center to center spacing
- ~720  $\mu\text{m}$  active area
- ~1 mm in total diameter
- Germanium doped silica cores

# Measurement System

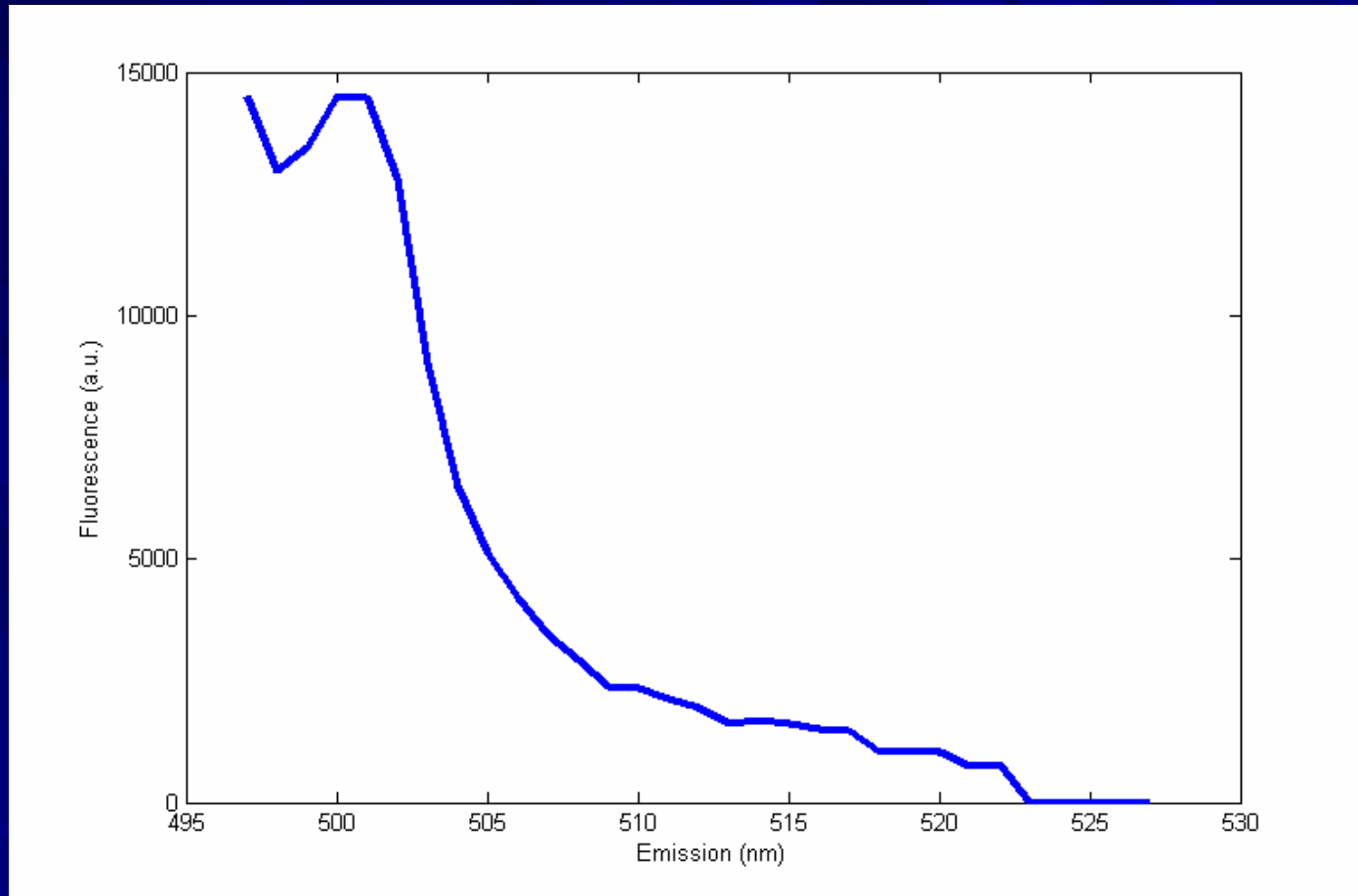
- Double grating excitation emission fluorometer with PMT
- Delivered through a quartz fiber
- Variable parameters:
  - Excitation and Emission Wavelength
  - Excitation Bandwidth
  - Emission Bandwidth
  - Integration Time



# Fiber Fluorescence EEM



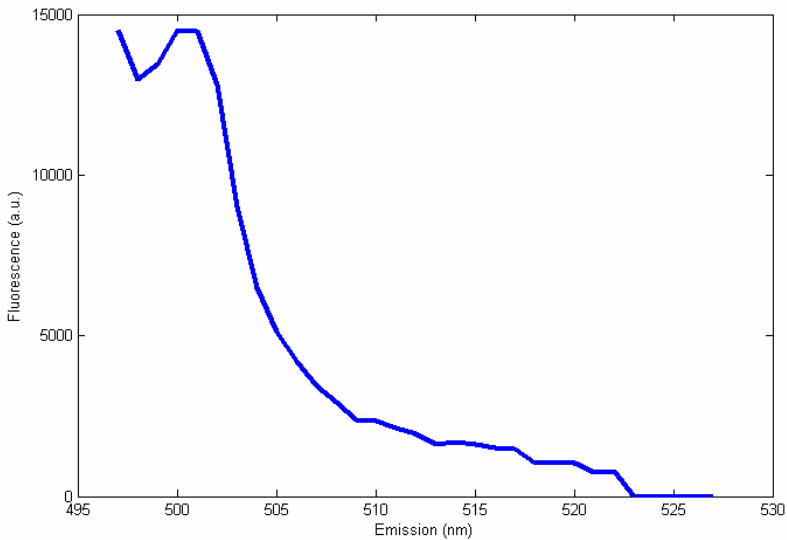
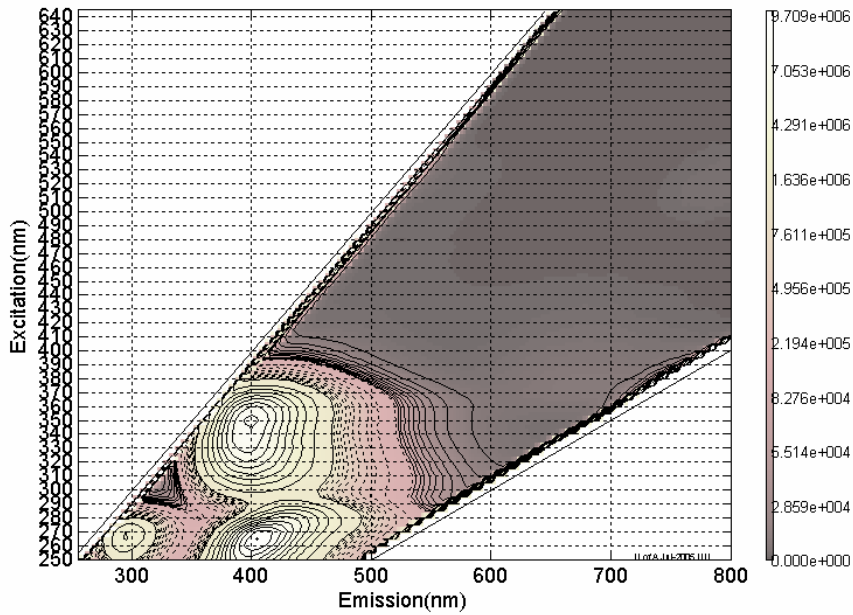
# Sumitomo Line Scan at 488 nm



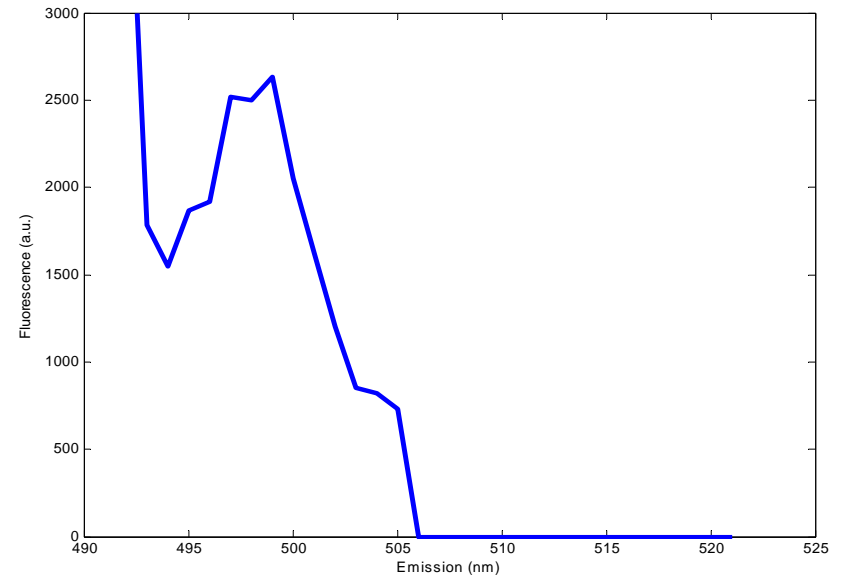
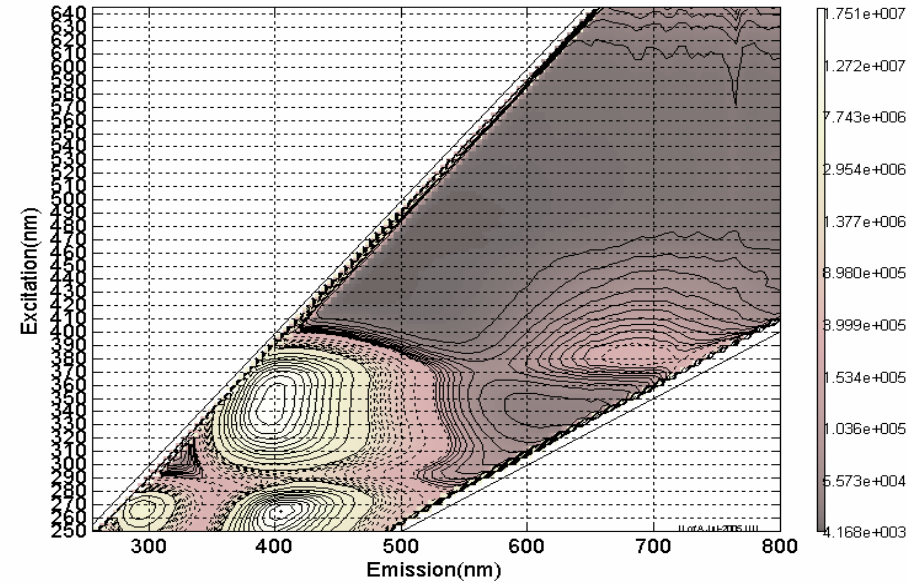
- 1 nm steps in emission detection, 1 nm excitation and emission bandwidths

# Fiber Fluorescence EEM

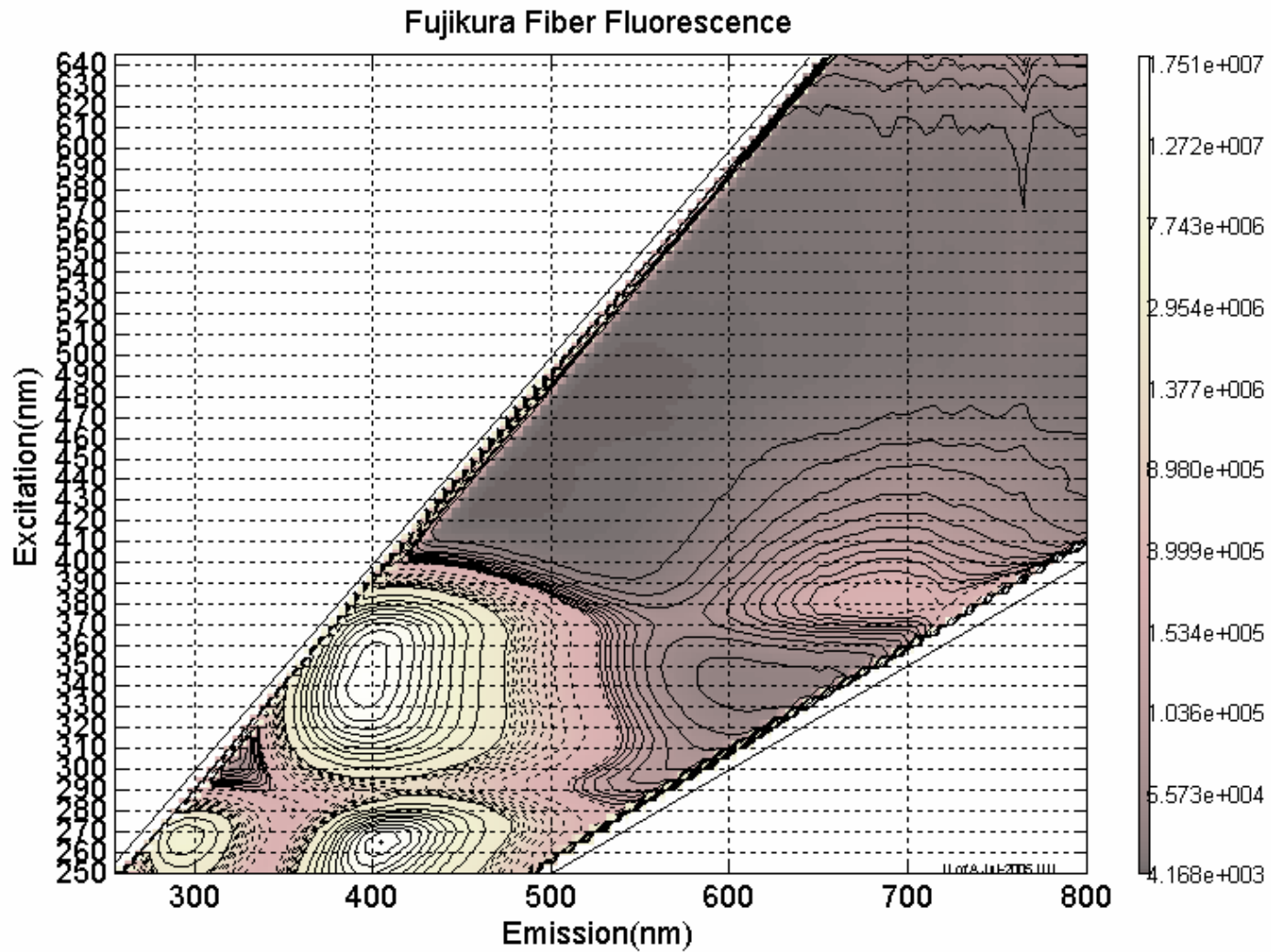
Sumitomo Fiber Fluorescence



Fujikura Fiber Fluorescence



# Fujikura Fiber Fluorescence Spectra



# Raman Scattering

$$\frac{\Delta \nu}{c} = \frac{1}{\lambda_{incident}} - \frac{1}{\lambda_{scattered}}$$

$$\approx \frac{\Delta \lambda}{\lambda^2} = 450 \text{ cm}^{-1}$$

- For 488 nm incident and 499 nm scattered peak

# Conclusions

- In UV there is significant autofluorescence due to material properties of the fibers
- Throughout visible region, fiber autofluorescence is close to excitation wavelength
- Appropriate filter and dye selection may be able to reduce fiber autofluorescence due to Raman scattering

# Acknowledgements

- Ned Kirkpatrick, Urs Utzinger, Art Gmitro
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