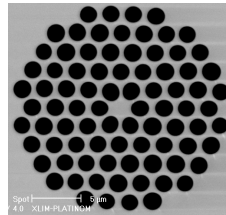
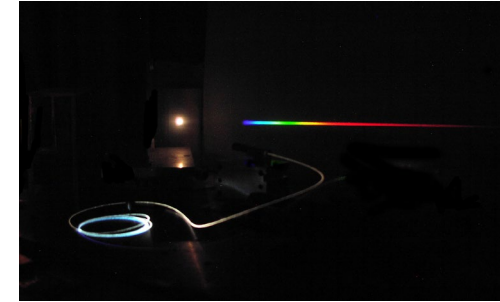
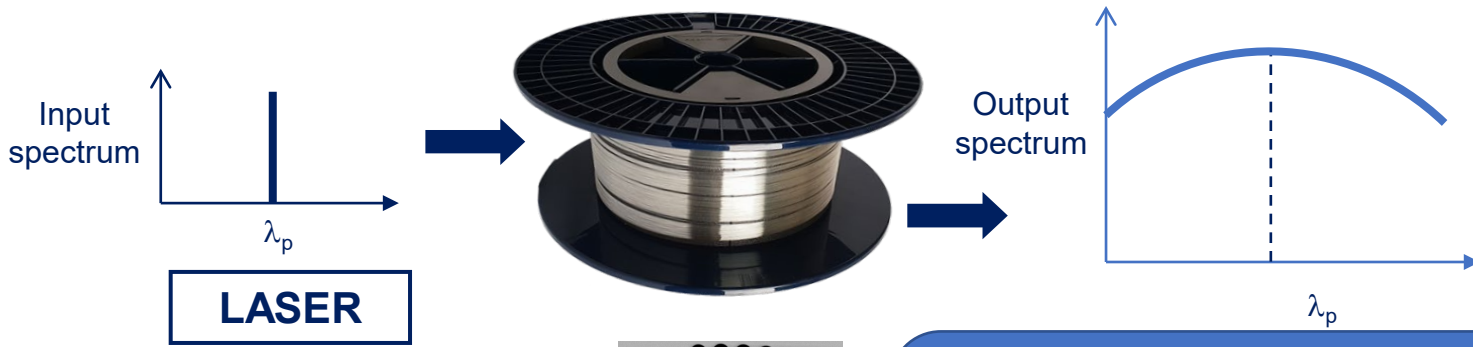


EPIC Online technology meeting on white lasers and supercontinuum generation

Guillaume HUSS

LEUKOS
— Make a bright future

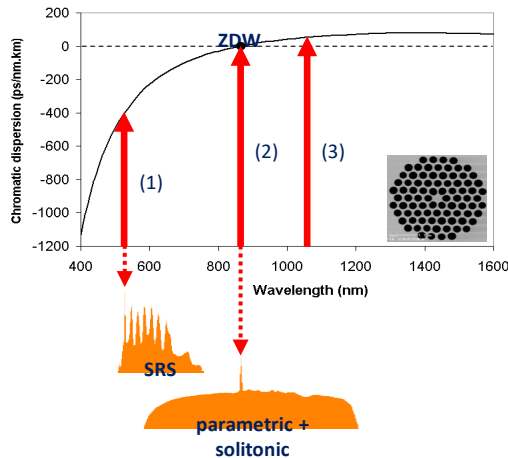
Supercontinuum generation



→ SC generation = very wide broadening of the incident wave spectrum

→ Spectral broadening due to the combination of many nonlinear effects

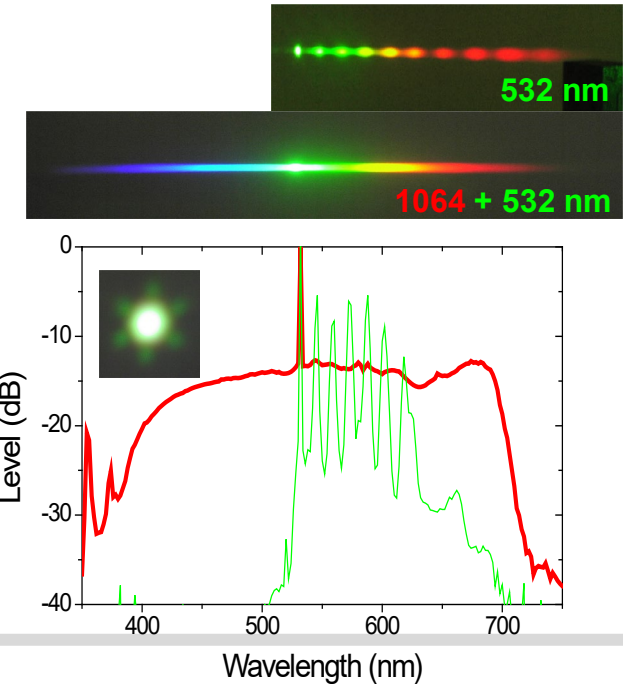
Importance of dispersion regime at λ_p



(1) Discrete generation of longer wavelengths

(2) Homogeneous spectral broadening on both sides of the pump

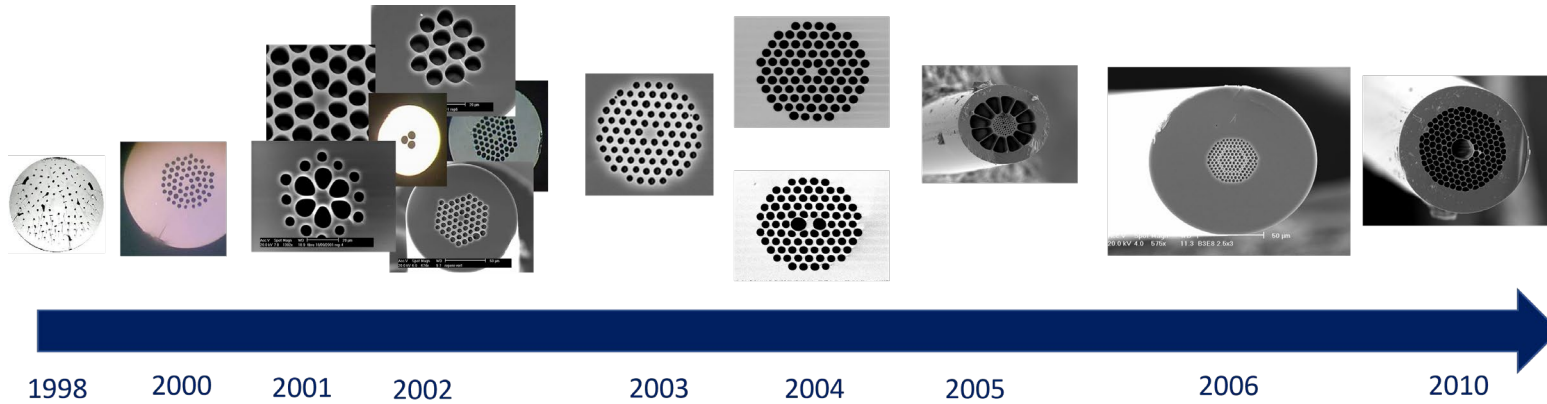
(3) + (1) = dual-wavelength pumping



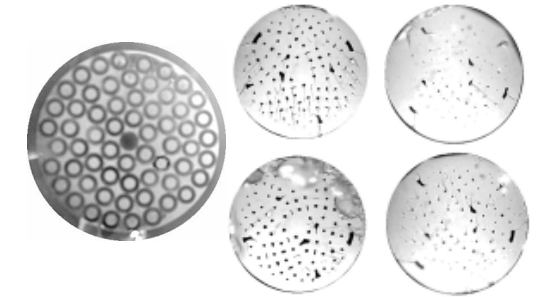
One key component : the non-linear fiber

Photonic crystal fiber

- First PCF: Pr. Russel , university of Bath , 1996
- First PCF in Limoges : 1998 (IRCOM)



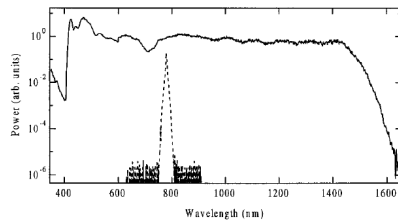
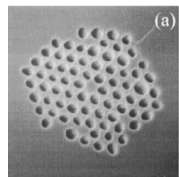
IRCOM drawing tower



First IRCOM PCF - 1998

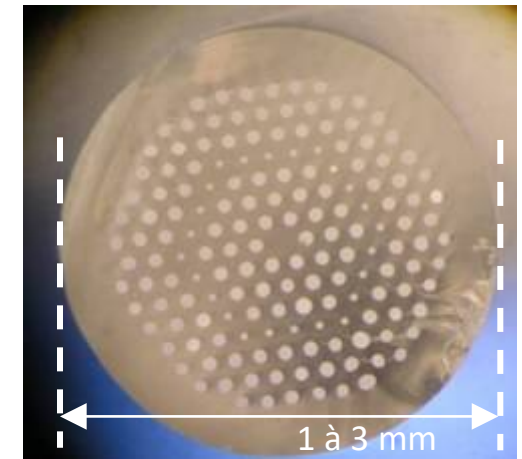
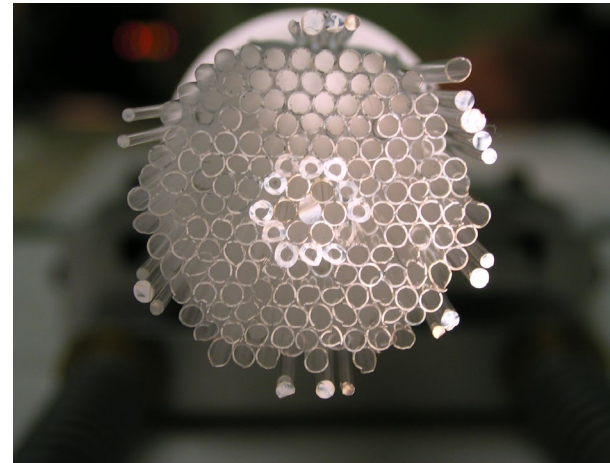
- **Visible continuum generation in air-silica microstructure optical fibers with anomalous dispersion at 800 nm**

Ranka et al., *Optics Letters* Vol. 25, *Issue 1*, pp. 25-27, 2000



$\lambda=800$ nm
100 fs

PCF fabrication : « stack and draw »

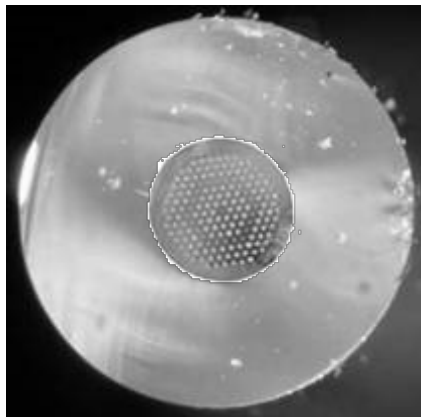


Tube
 $\Phi_{\text{ext}} = 5\text{-}35\text{ mm}$,
Thickness: 0.5 to 10 mm,
 $L = 1\text{ m}$

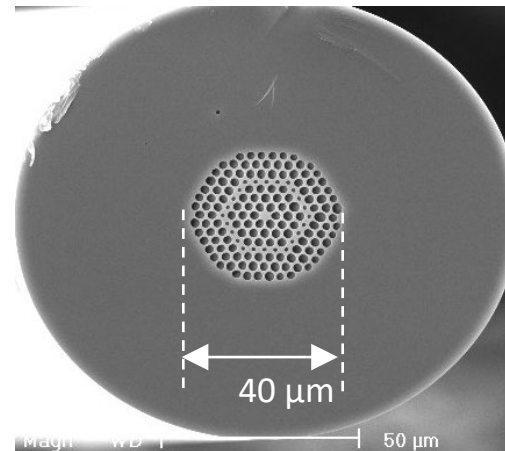
Capillaries
 $\Phi_{\text{ext}} = 0.5\text{-}6\text{ mm}$,
Thickness min : 70 μm ,
 $L = 1\text{ m}$

« primary » preform
Assembly of 100's of capillaries

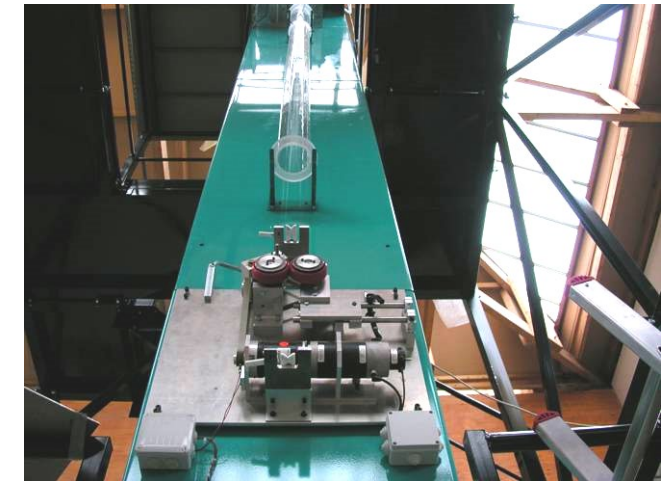
Microstructured cane
 $\Phi_{\text{ext}} = 1\text{ to }3\text{ mm}$,
 $L = 1\text{ m}$



« secondary preform »
 $\Phi_{\text{ext}} = 5\text{ to }12\text{ mm}$,
 $L = 1\text{ m}$



Microstructured fiber



Properties

- A white laser is combining properties of a lamp (spectral broadening) and a laser (spatially coherent)



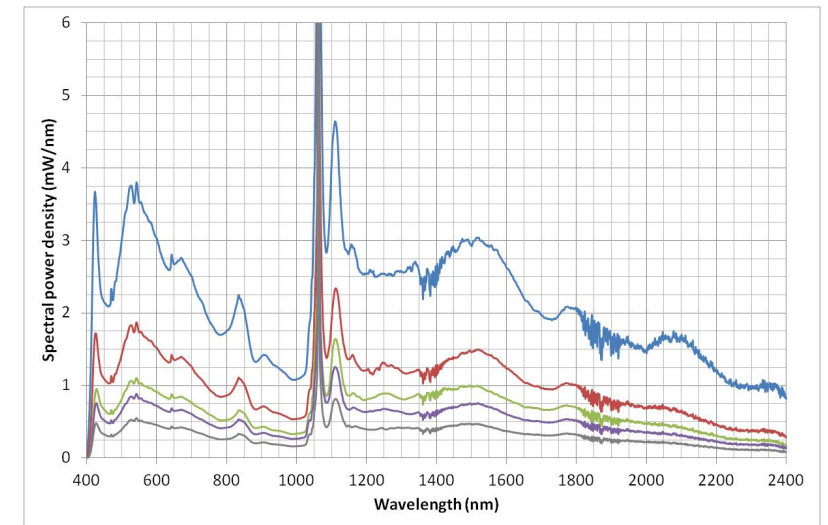
- Laser source emitting on a spectral range covering UV to mid-IR (>10 μ m)

- Spatially single mode on the whole spectrum



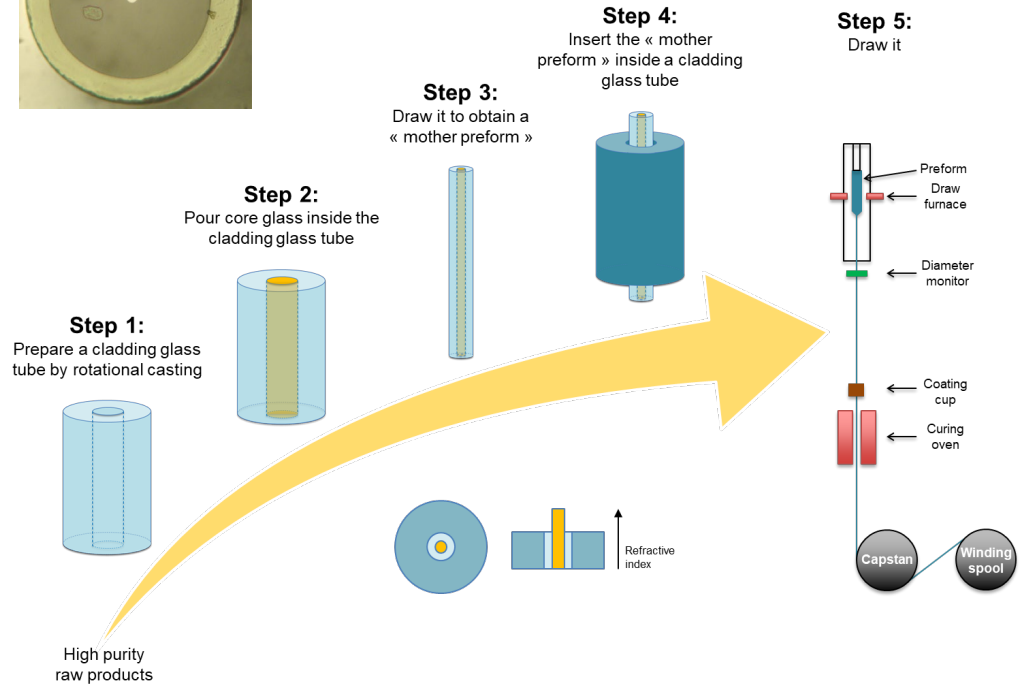
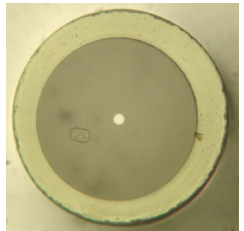
- High power spectral densities

- Fiber laser

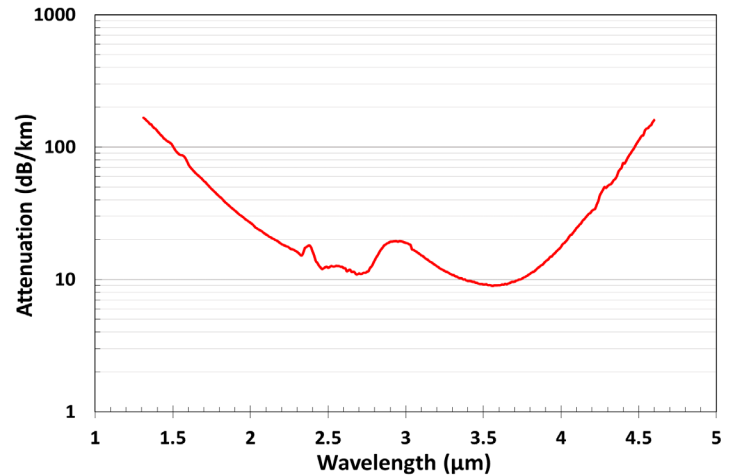


Extending wavelengths to Mid-IR

- New material: Zblan, Indium, Chalcogenide fibers
- Collaboration with the pioneer company in fluoride glasses



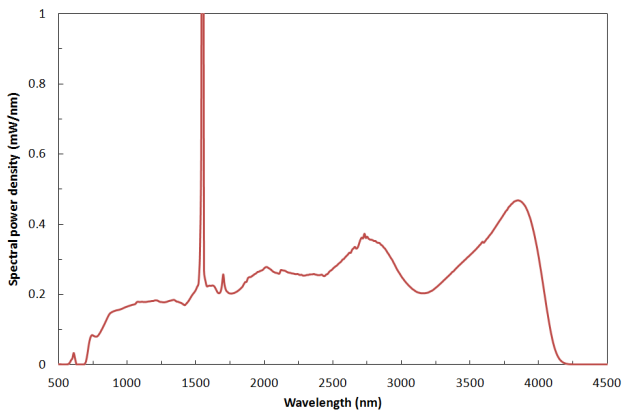
Fiber attenuation



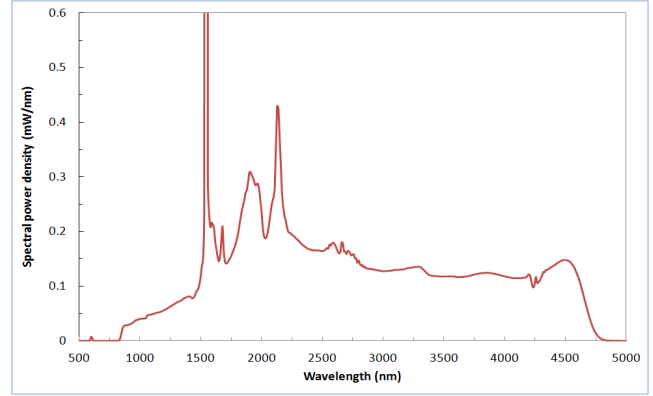
LOW LOSSES:
9dB/km low enough for large lengths requirements

Extending wavelengths to Mid-IR

➔ High reliability, long lifetime (>20000h)



- ZBLAN
- >4.1 μm
- >1 W

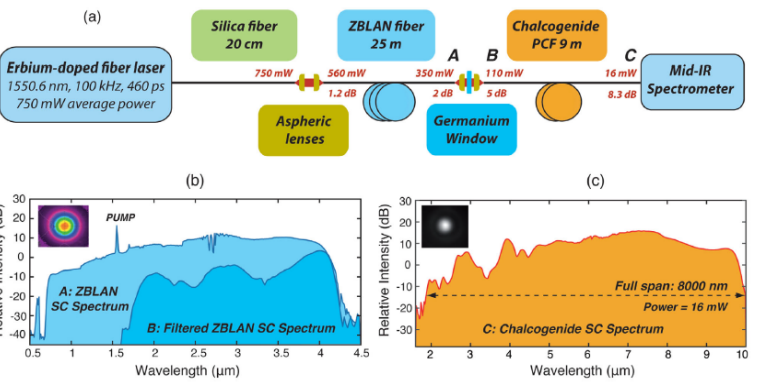


- Indium
- >4.8 μm
- >0,6 W

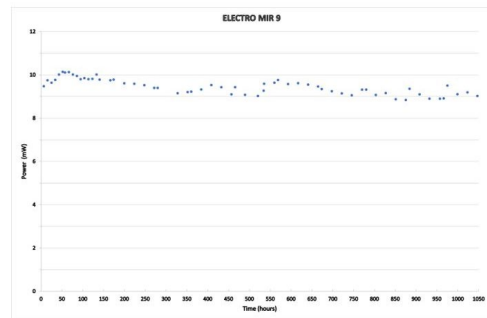
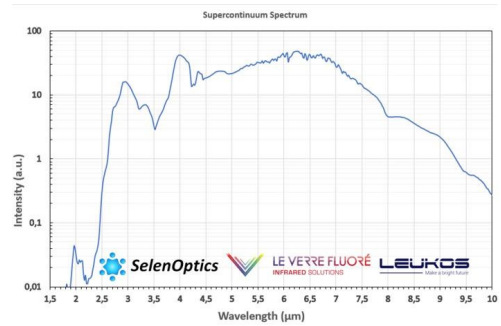


ELECTRO MIR

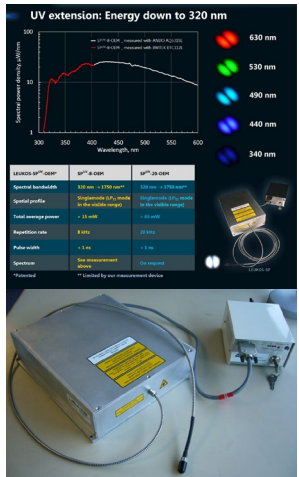
▪ Collaboration with



- ZBLAN + Chalcogenide
- >9.5 μm
- >1 W



LEUKOS products



100mW / 30kHz
350-2400nm

2kHz / jitter temp < 5ns
350-2400nm



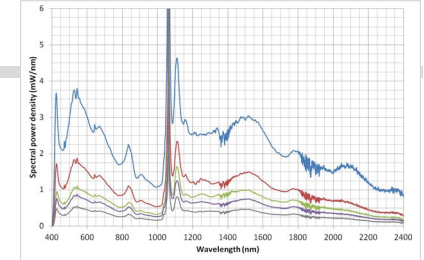
200mW / 30kHz
450-2400nm



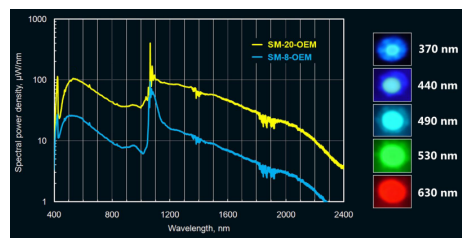
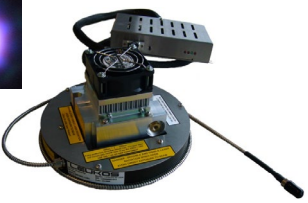
Adjustable pulse width
Adjustable repetition rate



6W / 1-80 MHz
400-2400nm



20mW / 8kHz
400-2400nm



Dual output laser
for CARS application



Mid-IR
supercontinuum
lasers

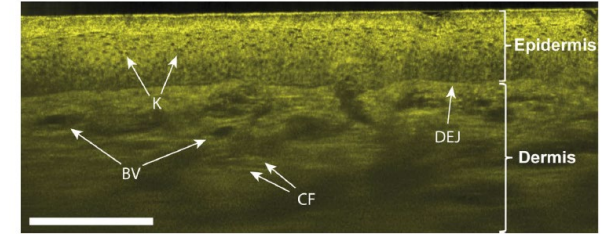


Supercontinuum
lasers for OEM
integration

Applications

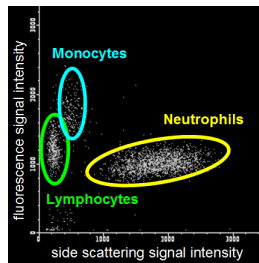
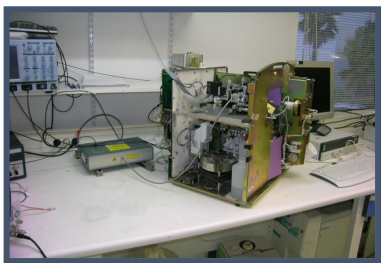


CONFOCAL MICROSCOPY



OCT

Fast in vivo
detection of skin
cancer



FLOW CYTOMETRY

IMAGING

Breast carcinoma
detection

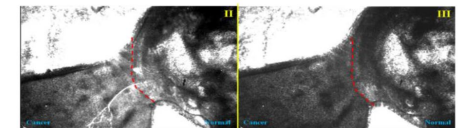
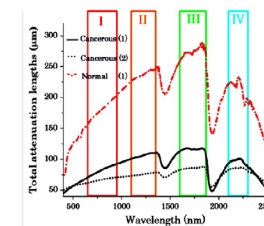
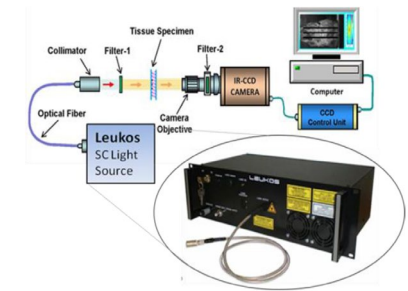


Figure 6: Images from malignant (left) and normal (right) breast tissues from patient n=2 (high grade tumor), using wavelengths at the second (II) and third (III) optical windows, with red dashes representing the demarcation line between normal and cancer.