Microspectroscopie et imagerie vibrationnelles : des outils photoniques d'intérêt en biologie et dans le domaine biomédical

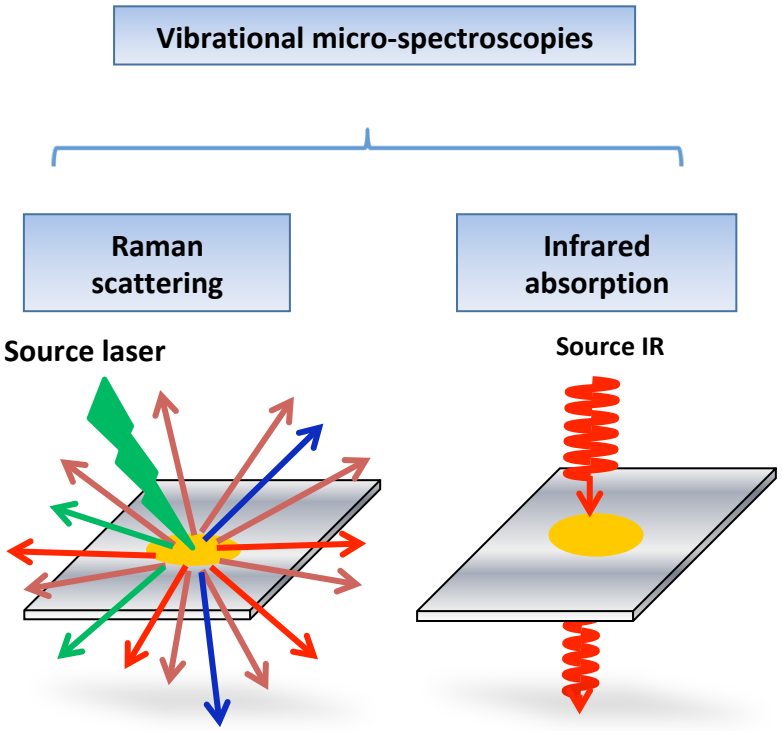
Valérie Untereiner

BioSpecT (BioSpectroscopie Translationnelle), EA 7506

Plate-forme d'Imagerie Cellulaire et Tissulaire (PICT)

Université de Reims Champagne-Ardenne

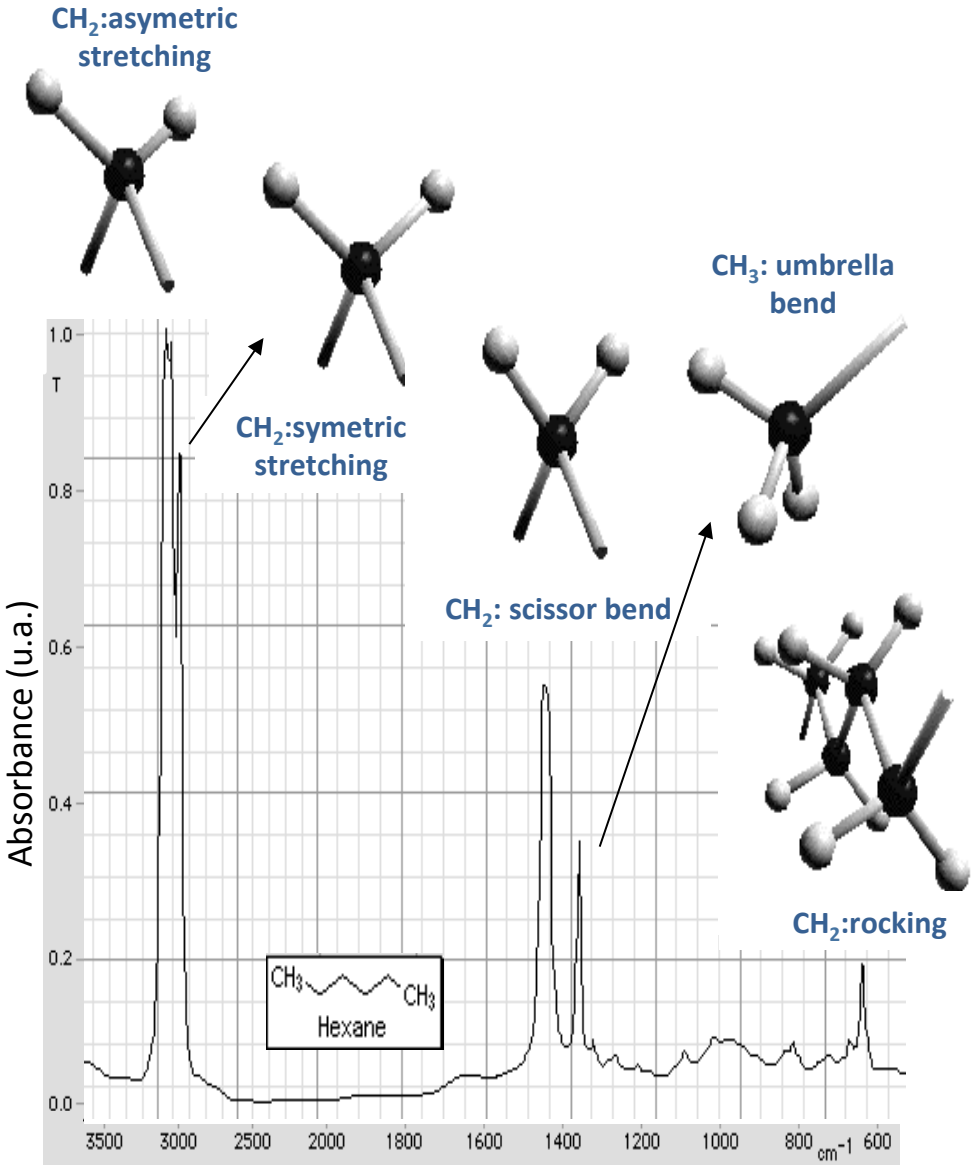
Interest of vibrational biospectroscopy



Non destructive light/matter interaction

Label-free

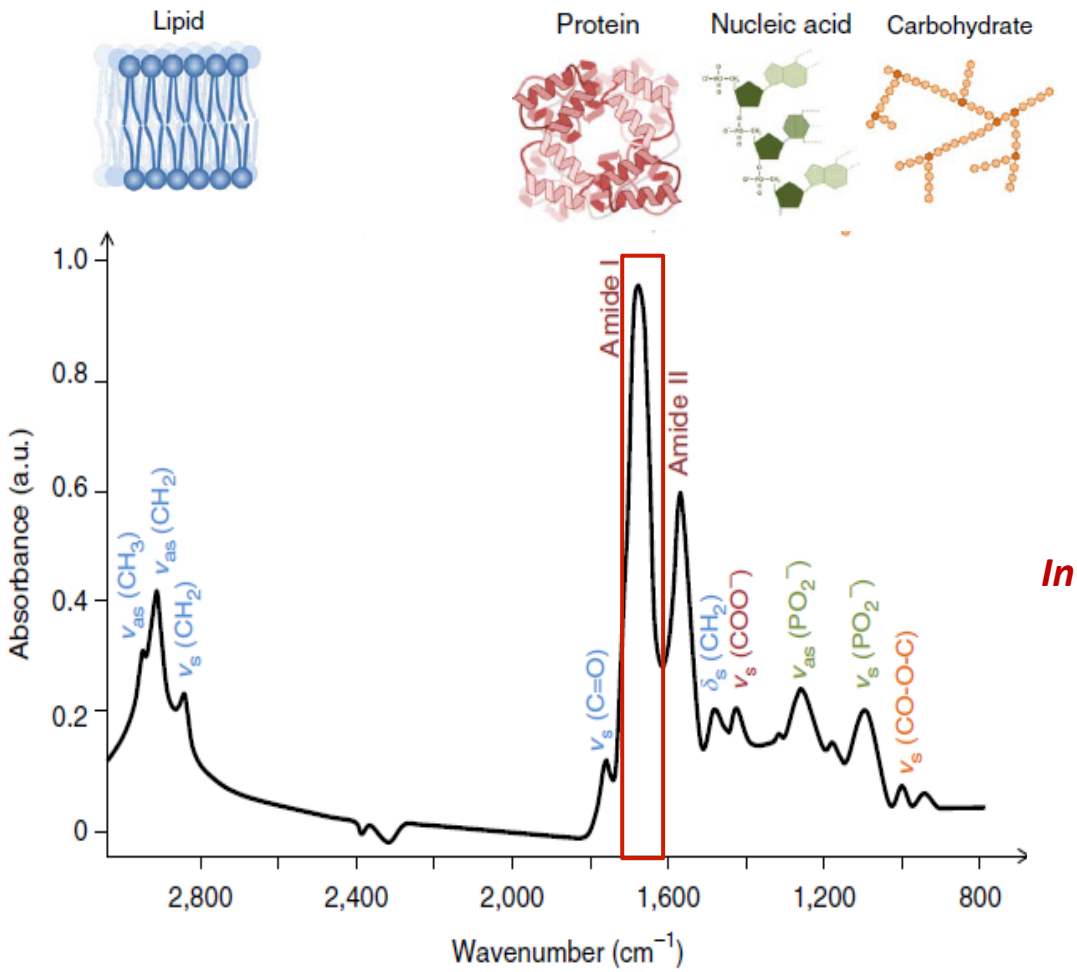
Micrometer resolution



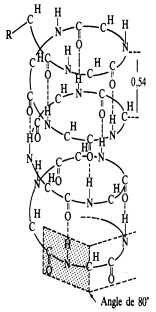
Wavenumber (∝ Frequency ∝ Energy) (cm^{-1})

Interest of vibrational biospectroscopy

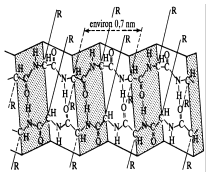
IR spectrum of a biological sample



Secondary structure of proteins



1656 cm^{-1}



1669 cm^{-1}

1665 cm^{-1}

***In situ* analysis of the chemical bonds, without altering the integrity of the sample**

High molecular and structural specificity

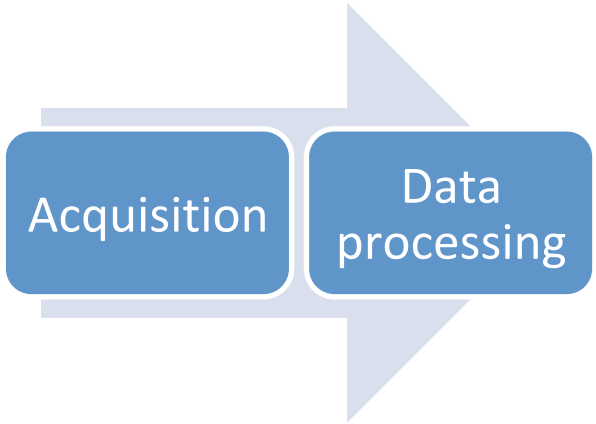
Our core expertise: vibrational spectroscopy for biological applications and biomedical translation

Vibrational spectrum = Molecular signature of the sample in a specific physiological or pathophysiological state

***Ex vivo* and *in vivo* samples**

Cell, tissue, biofluid

Live, frozen or fixed



Detection and characterization of physiological or pathological conditions

Identification of spectroscopic biomarkers

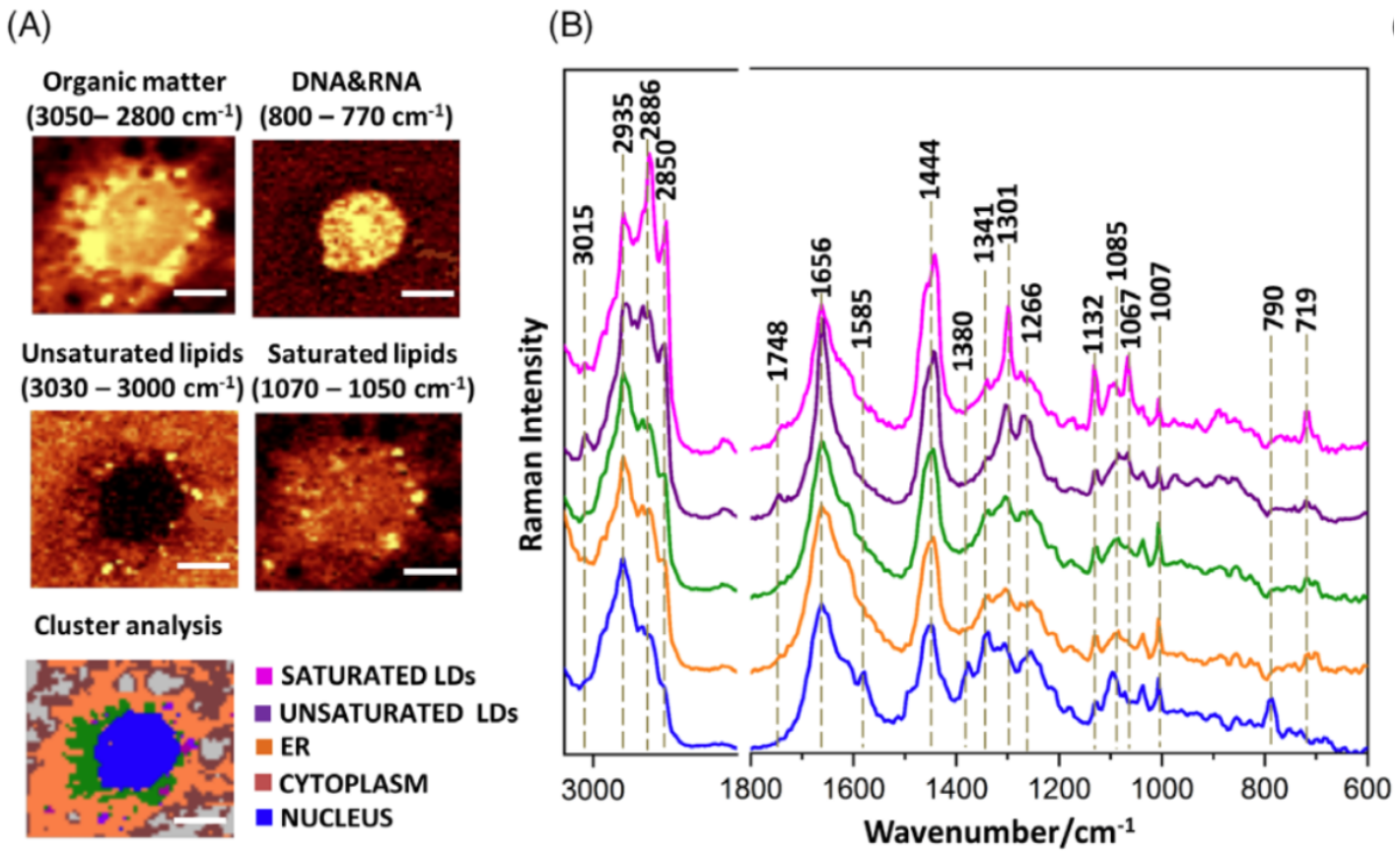
Discriminant vibrations independent of the biological variability using multivariate statistical data processing

Vibrational spectroscopy for biological applications and biomedical translation

Raman spectral analysis on liver cells

Infrared spectral analysis on colon tissue

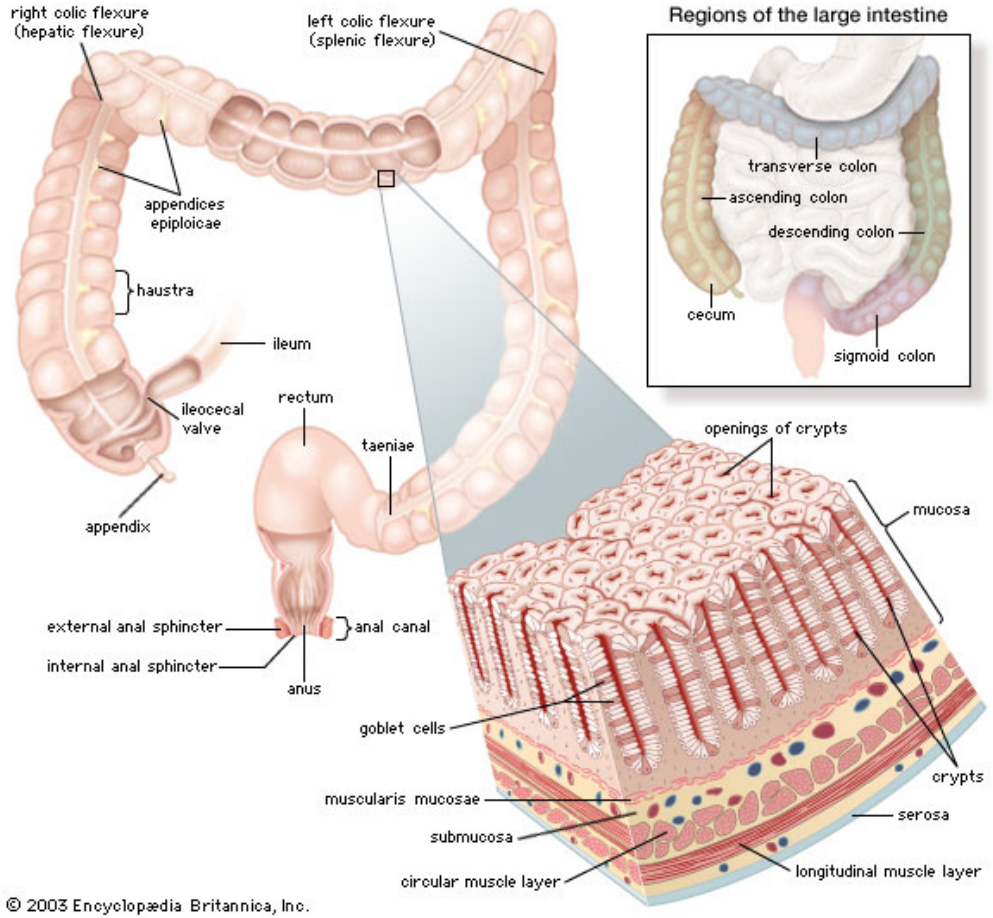
Raman imaging of a single liver sinusoidal endothelial cell (LSEC)



Szafraniec E *et al.* , 2019

Colon anatomy and histology

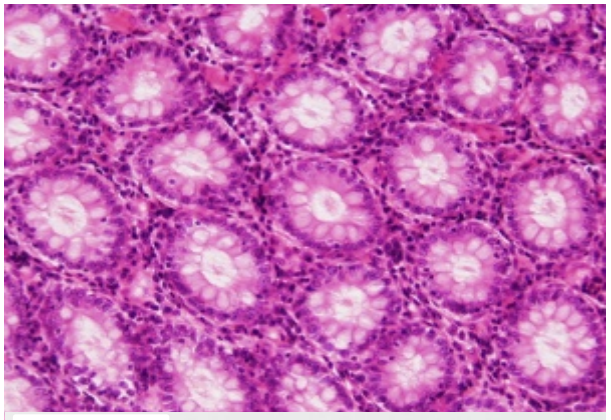
- Colon - last part of the digestive system
- Cecum, colon, rectum and anal canal - large intestine



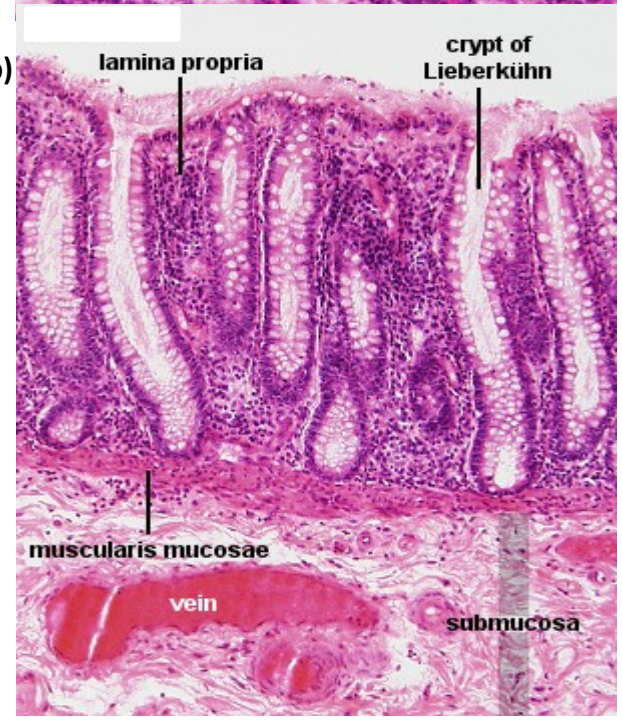
HE stained sections (non-tumoral)

(a) Transverse (b) Longitudinal

(a)



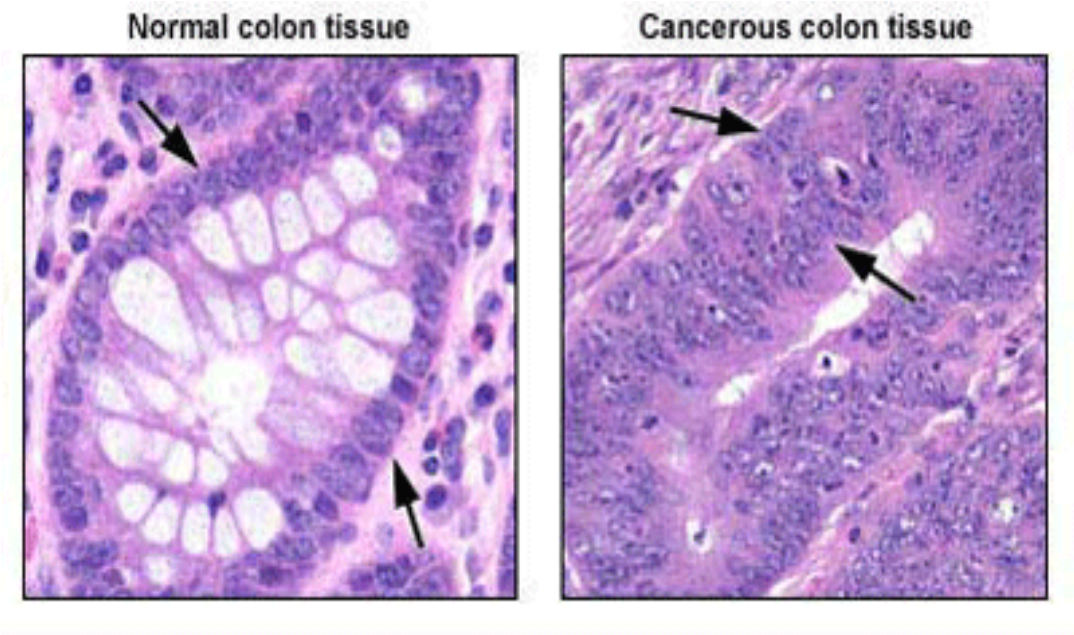
(b)



Source: Blue Histology, Univ. of Western Australia

Colorectal cancer

- Loss of functional control in the normal cells lining the colon or rectum



HE stained

(Source: cancerinformaiton.org.uk)

Current screening and diagnostic methods

- **Screening methods:** Fecal occult blood test (FOBT), colonoscopy and sigmoidoscopy, etc

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Diagnosis confirmation: HISTOPATHOLOGY

Present need: Newer classification methods providing biomolecular information from cells and tissues complementary to histopathology

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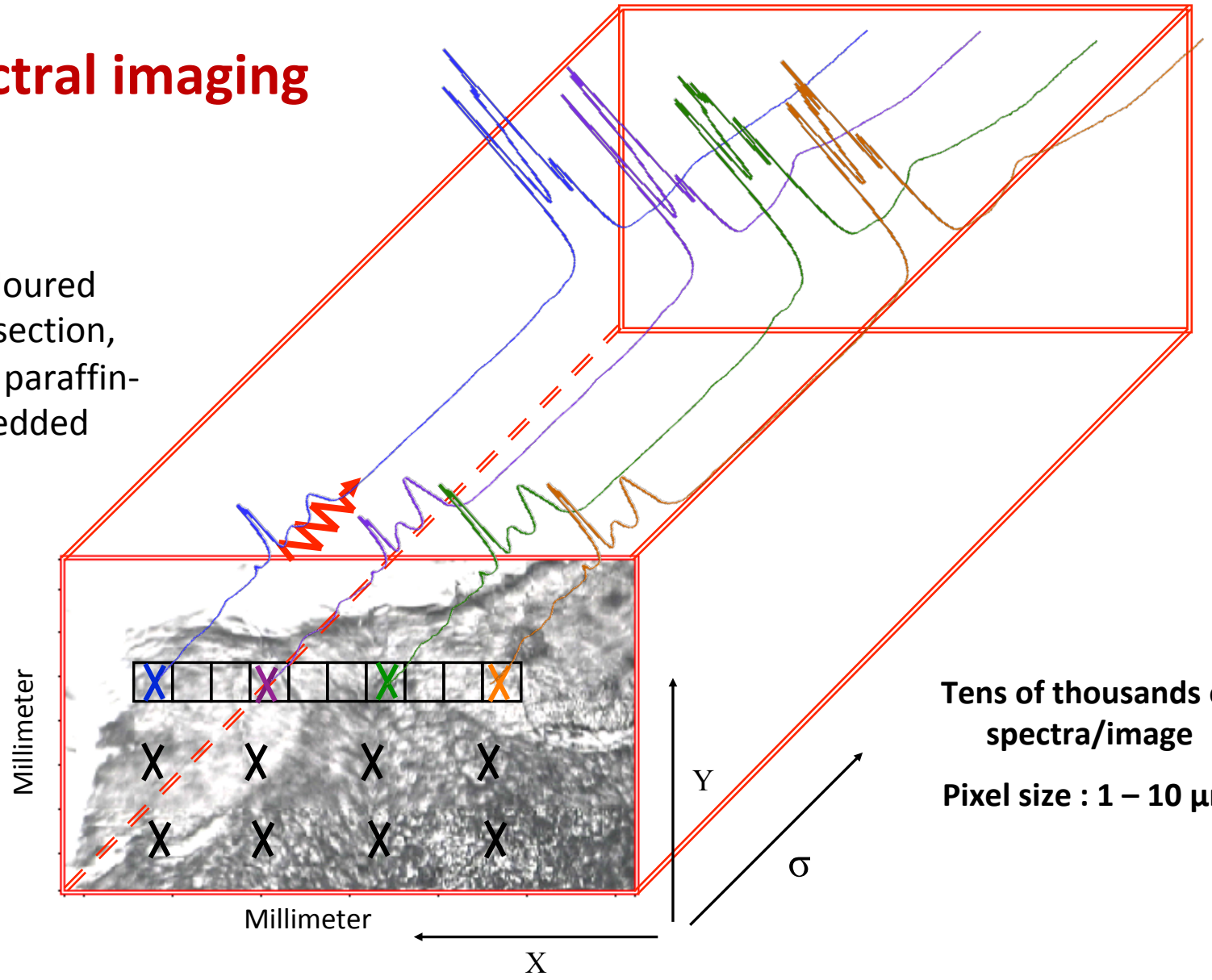
Automated approaches for rapid diagnosis

Candidate method: infrared spectral imaging

Spectral imaging

Uncoloured tissue section, possibly paraffin-embedded



Tens of thousands of spectra/image

Pixel size : 1 – 10 µm

Data cube (X × Y × σ) → hyperspectral image

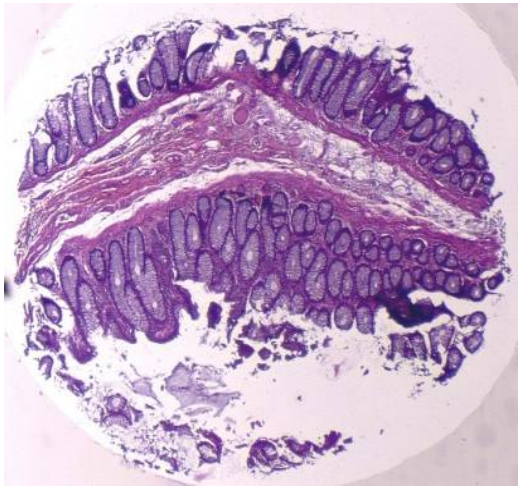
K-means clustering results of the IR spectral images using random pseudo-colors

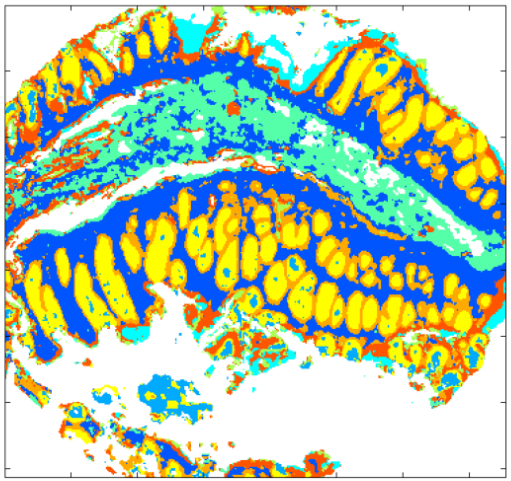
HPS stained tissue
(5X magnification)

K-means clustered IR image

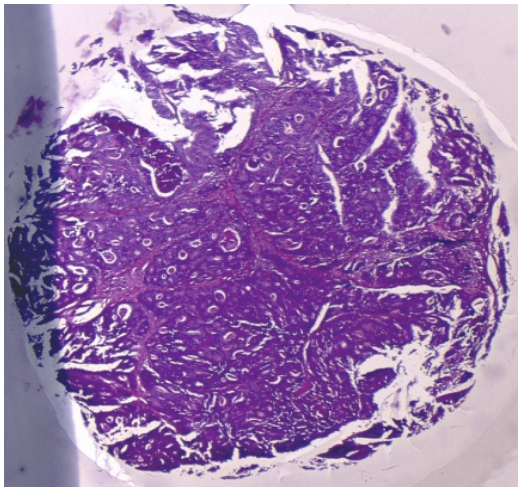
Histological attribution

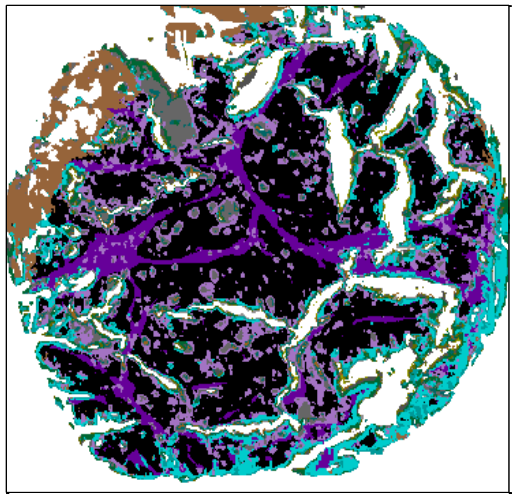
Non-tumoral tissue





Tumoral tissue





Annotation by an expert pathologist

Crypts (inner part)
Crypts (outer part)
Lamina propria
Submucosa

⇩

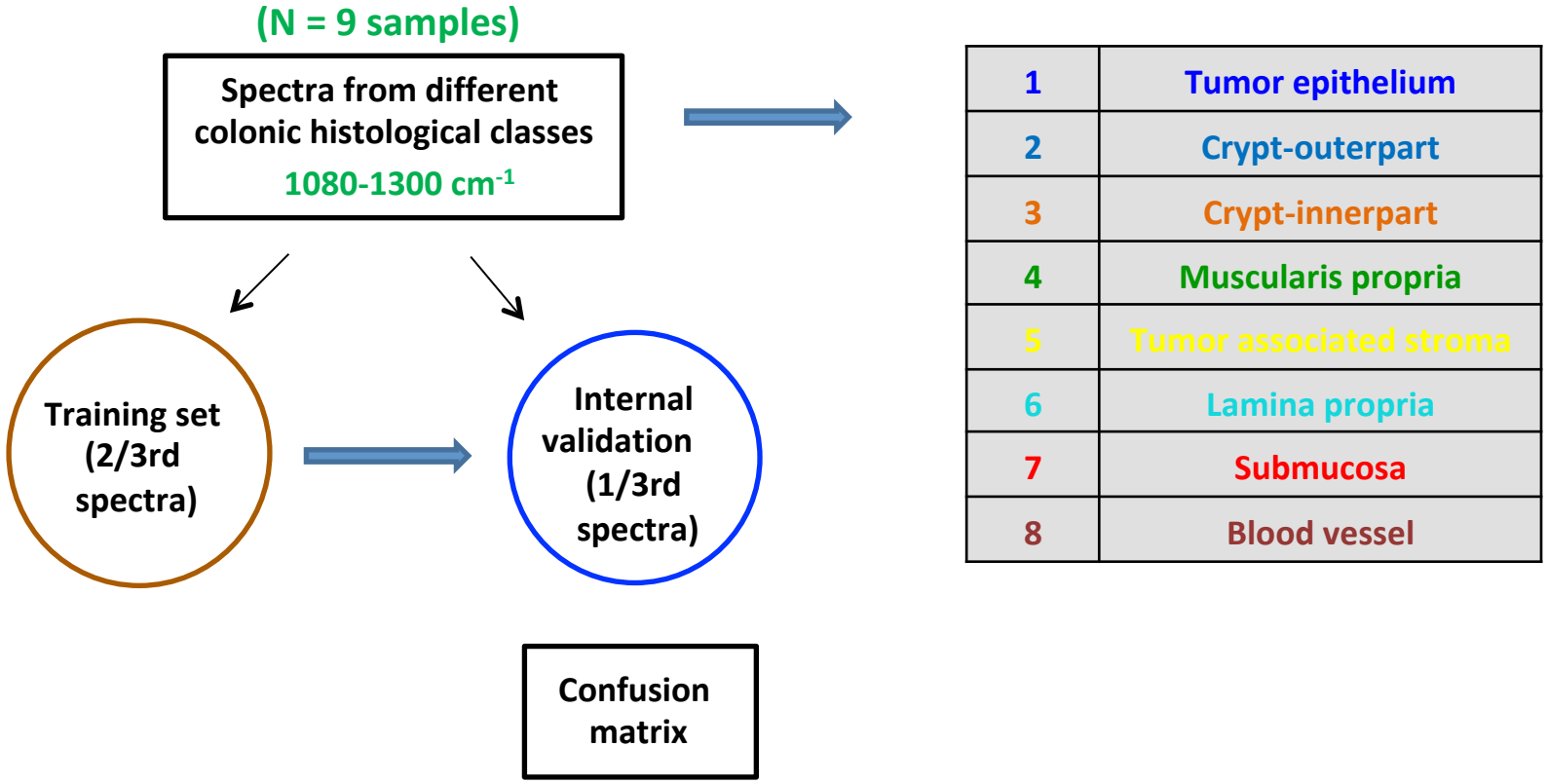
Library of spectral markers

⇧

Tumor
Tumor associated stroma

Others - not attributed to any histological class

Construction and application of the prediction model based on linear discriminant analysis

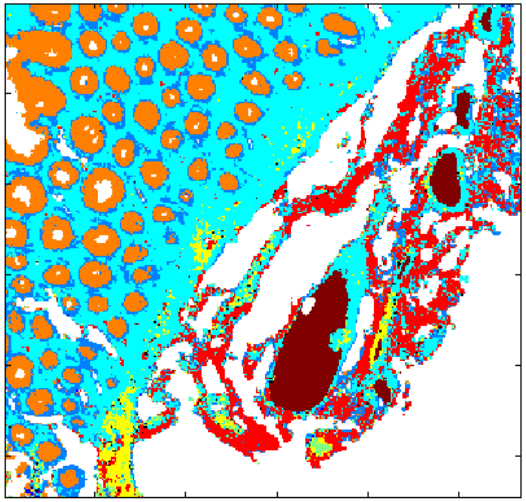


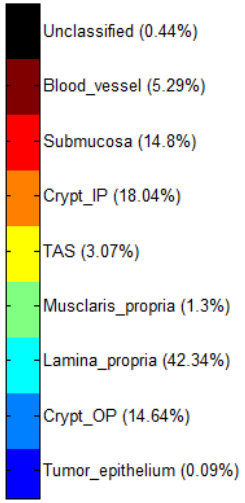
1	Tumor epithelium
2	Crypt-outerpart
3	Crypt-innerpart
4	Muscularis propria
5	Tumor associated stroma
6	Lamina propria
7	Submucosa
8	Blood vessel

EXTERNAL VALIDATION
Identification of unknown colonic tissues by spectral histopathology

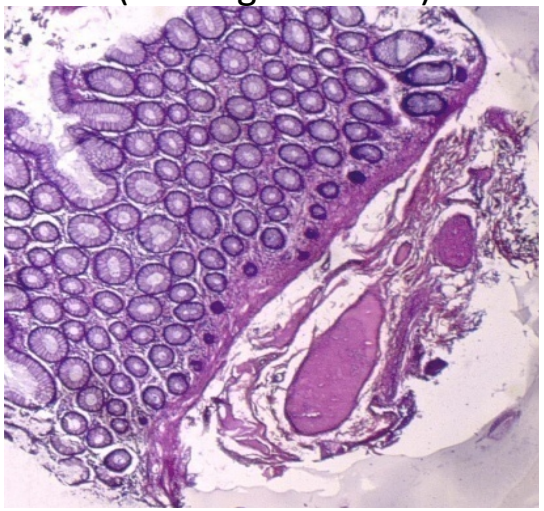
(No. of spectra tested: 3 620 287)

IR-LDA predicted image



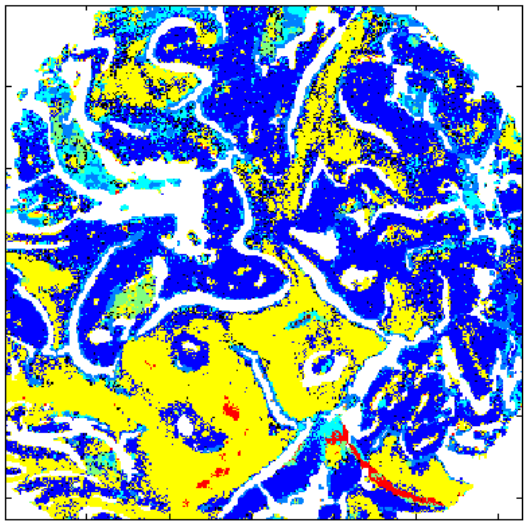


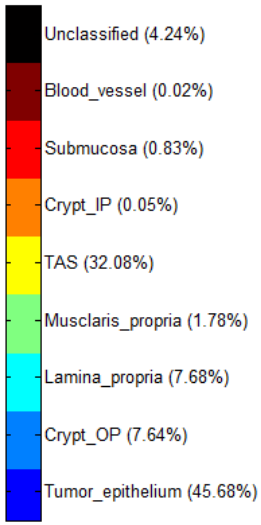
HPS stained colon tissue
(5X magnification)

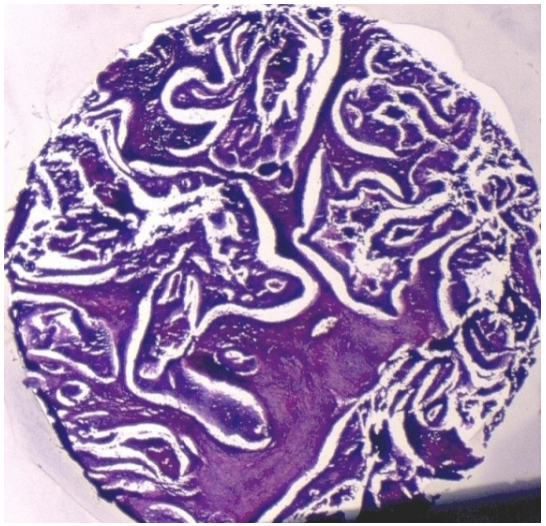


Final diagnosis

Non tumoral

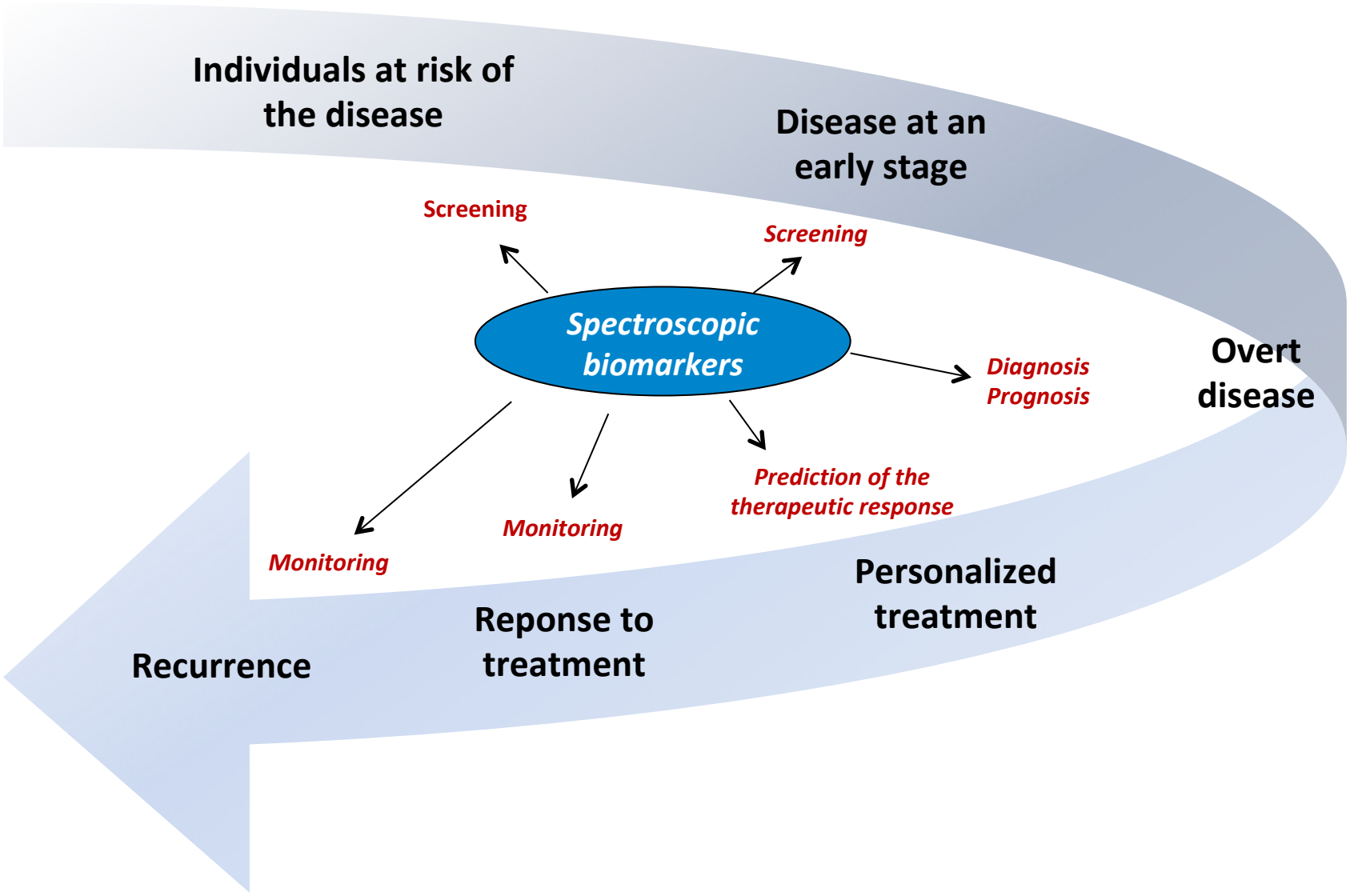






Adenocarcinoma

Translational development of vibrational spectroscopy



Equipe BioSpec*T* : BioSpectroscopie Translationn*elle*

P. I. C. T.
Plate-forme en Imagerie Cellulaire et Tissulaire

Plate-forme IBiSA
d'Imagerie Cellulaire et Tissulaire (PICT)