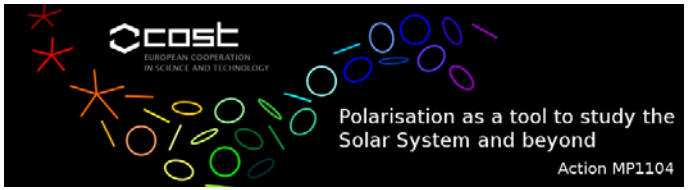
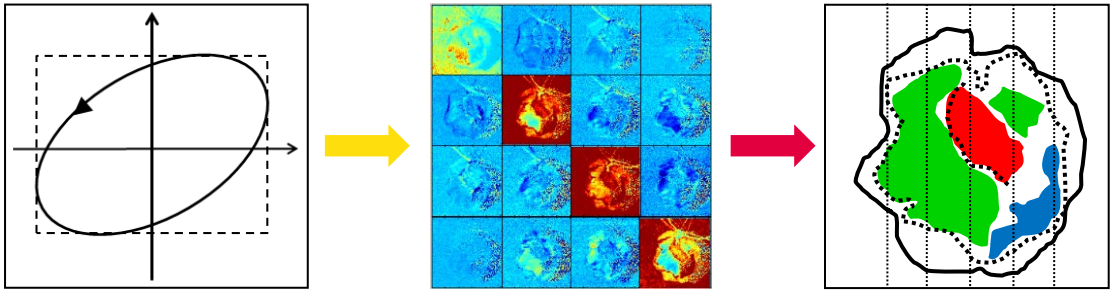
Polarimetric Imaging for Uterine Cervical Cancer Diagnosis

March 25th – Lorentz Center - Leiden





Antonello de Martino – Angelo Pierangelo – Tatiana Novikova

Presenter : Enric Garcia-Caurel

To Set the stage….

Why Cervical Cancer

- 2nd women cancer (after breast) by mortality, 275,000 deaths/yr essentially in developing and emerging countries
- **Screening** + **Disease Management Procedures** implemented in **developed** countries are very efficient but still perfectible (80 % decrease in mortality)
- Situation is very different in emerging countries
- Cervix is **accessible for direct (non endoscopic) imaging** and **good physical model**.
- We met *highly competent* and *motivated* gynecologists

Our Goals

- To develop an optical diagnostic tool to be used in real life
- To make good science on real life objects and bring a solution to human issues

Polarimetric Imaging

- Can be added to virtually any optical system at *affordable cost*
- Should be easily *accepted by practitioners*

Outline

The Uterine Cervix

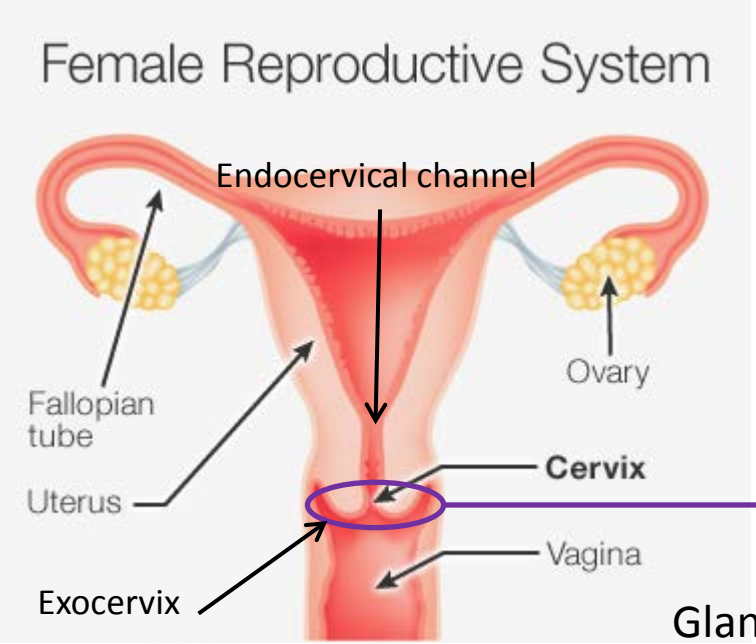
- Outline of anatomy and physiology
- Cancer onset and evolution
- Current screening and disease management

Polarimetric imaging

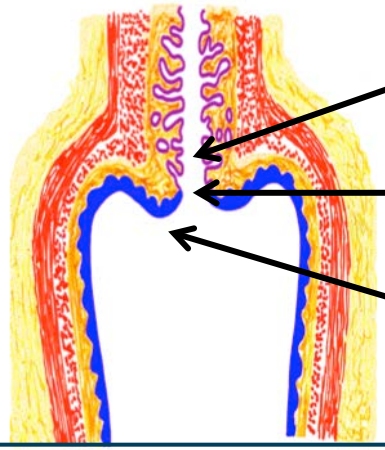
- Orthogonal State Contrast (OSC) imaging *in-vivo*
- Full Mueller imaging *ex-vivo*

Conclusion and Outlook

Anatomy and Physiology – Outline



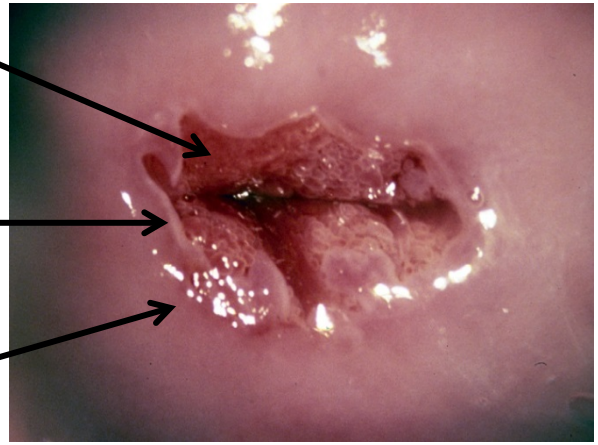
Uterine Cervix



Glandular Epithelium (endometrium)

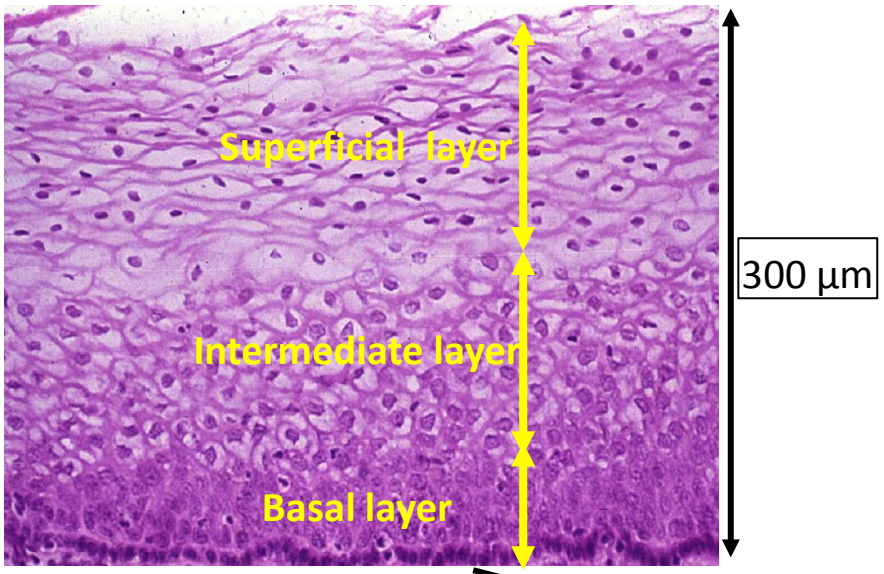
Junction zone

Malphighian epithelium



Microscopic Structure of Epithelia

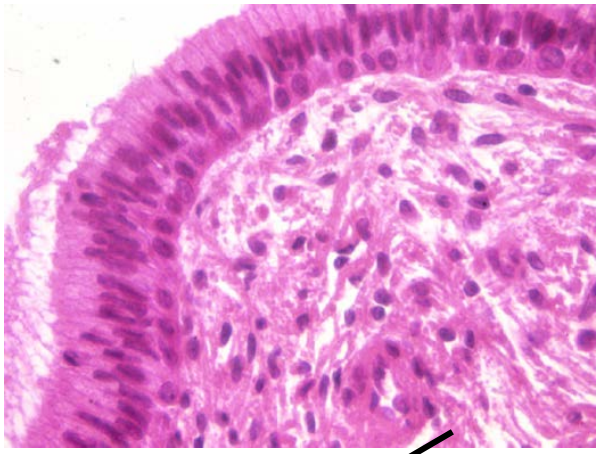
Mature Malpighian epithelium

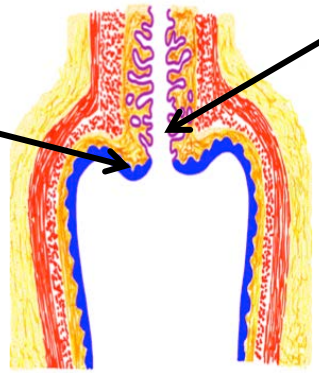


Glandular epithelium

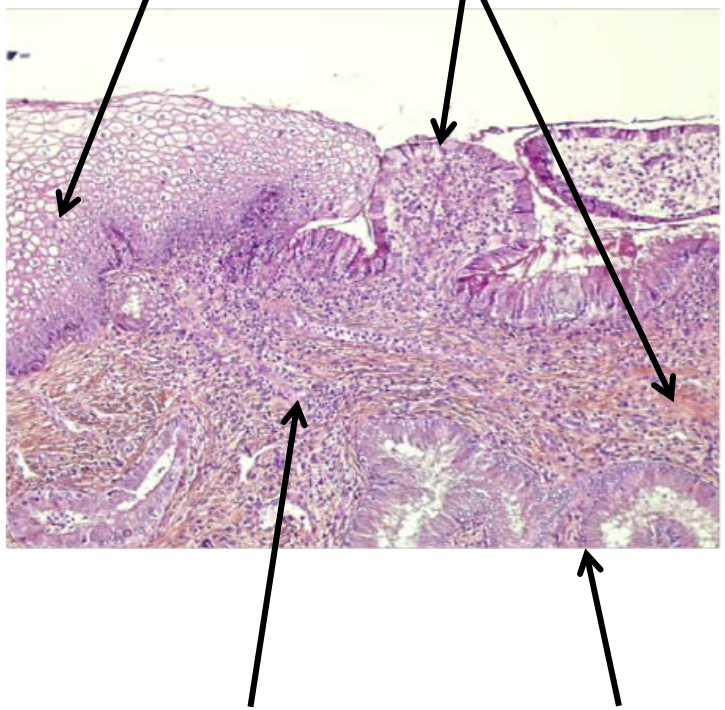
(endometrium)

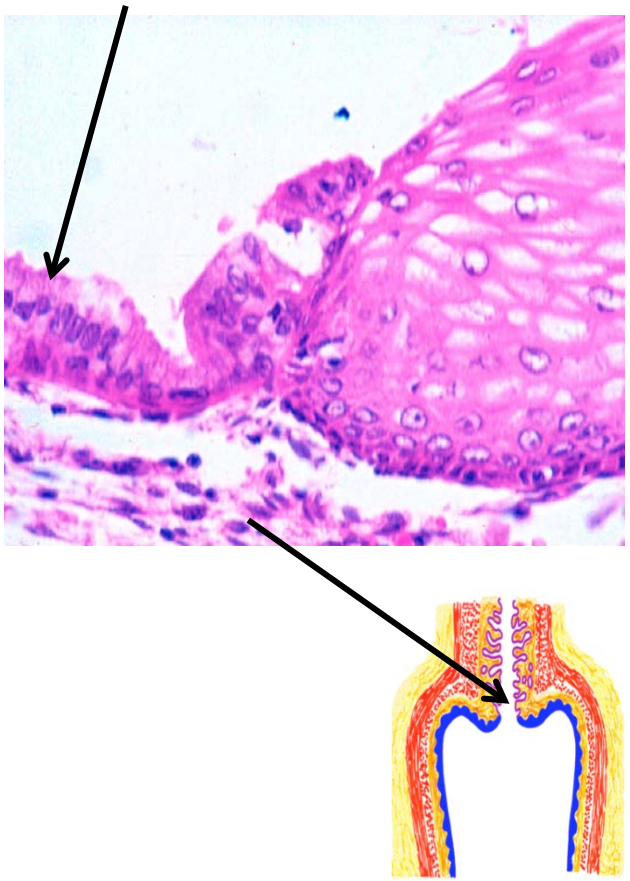
One or two cell layers (tens of µm)





Structure of the Junction Zone

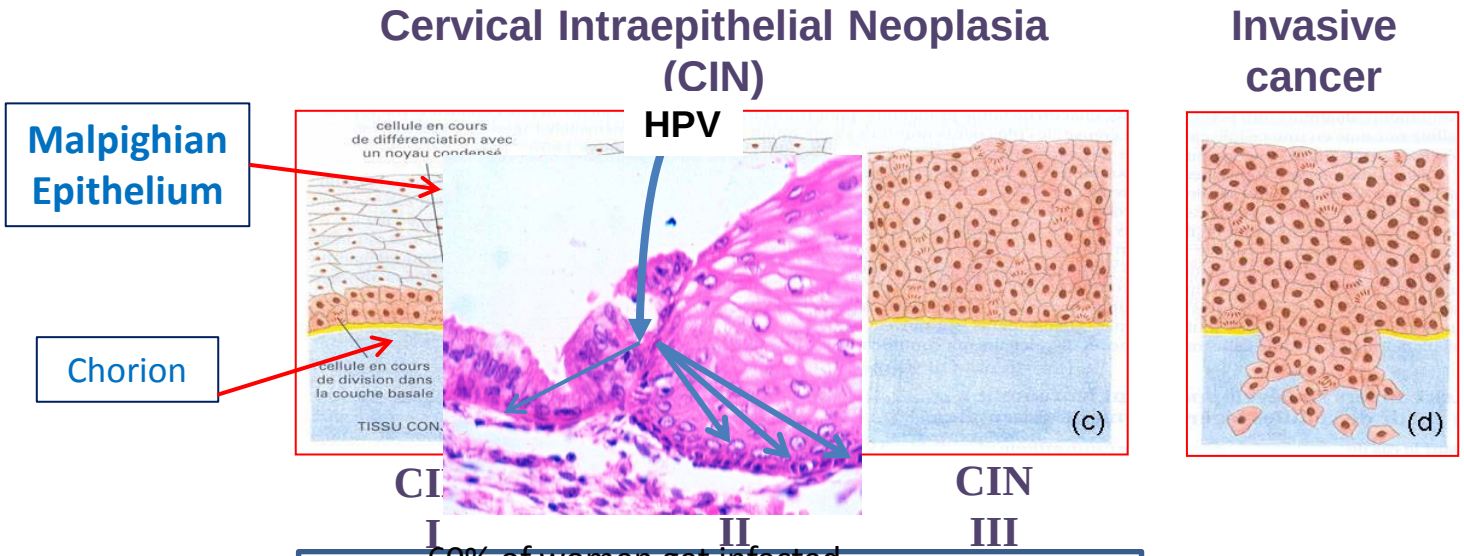




Cancer Onset and Development

Infection by Human Papilloma Virus.

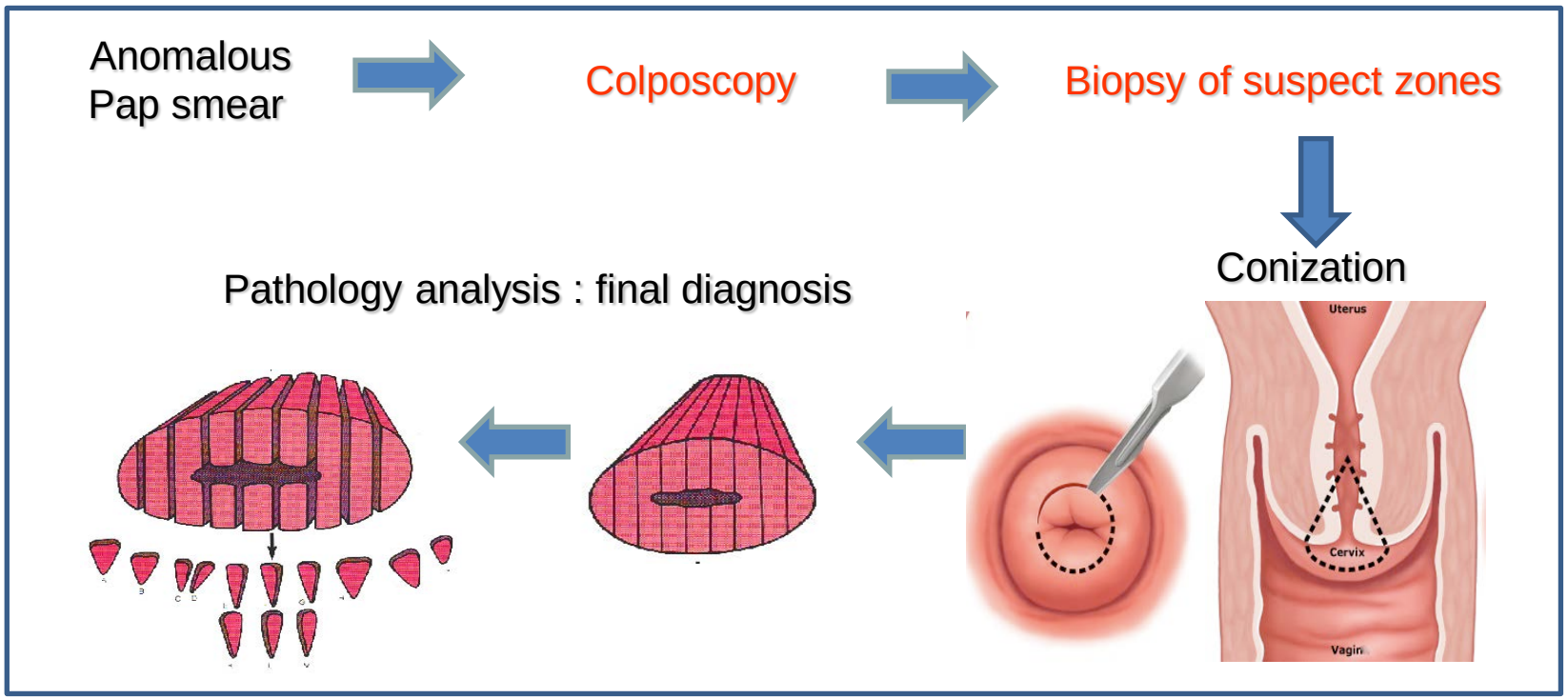
Common virus eliminated by the immune system



- Very slow evolution (5 to 10 years from infection to invasive cancer)
- Easily cured by simple surgery (conisation)

Screening is very effective but not perfect (reduction of mortality by 70-80%)

Cervical Cancer Management in Developed Countries



Colposcopy: Precancerous (CIN2+) lesions are very difficult to visualize. Results are very operator dependent.

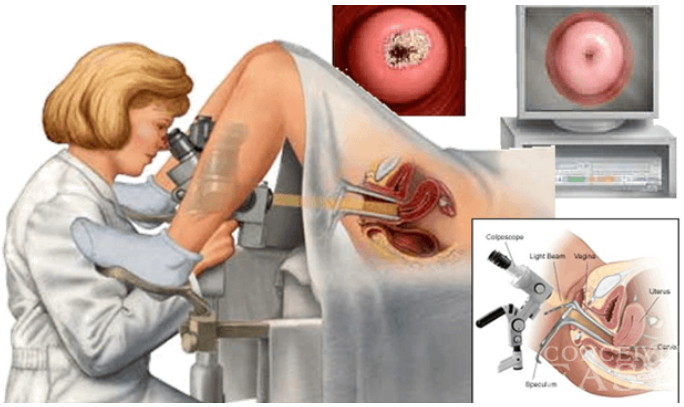
Conization : the surgical margins are poorly defined

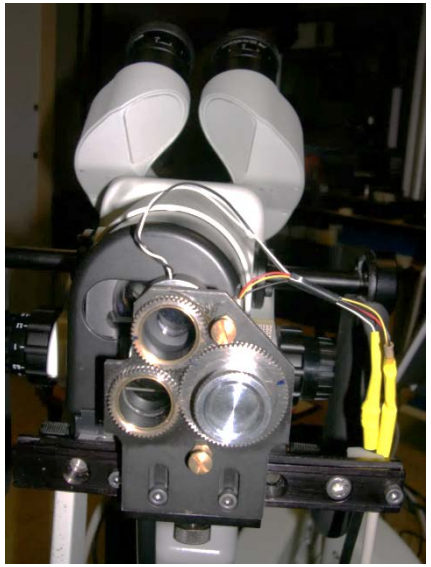
Systematic Pap smear cannot be implemented in developing countries. Currently no alternative is available to reduce the death toll (275 000 per year worldwide)

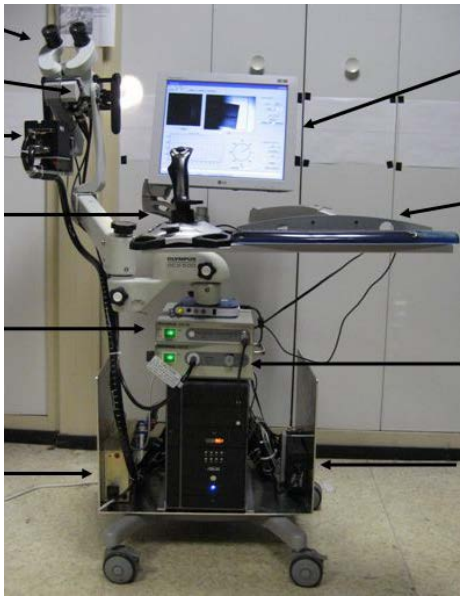
Polarimetry Experiments

I - Orthogonal State Contrast (OSC)

Colposcopy

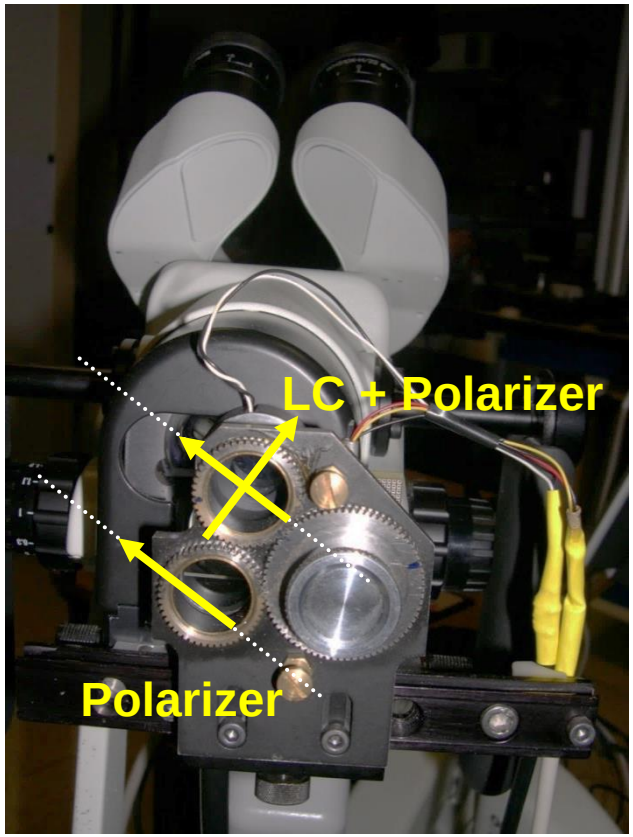




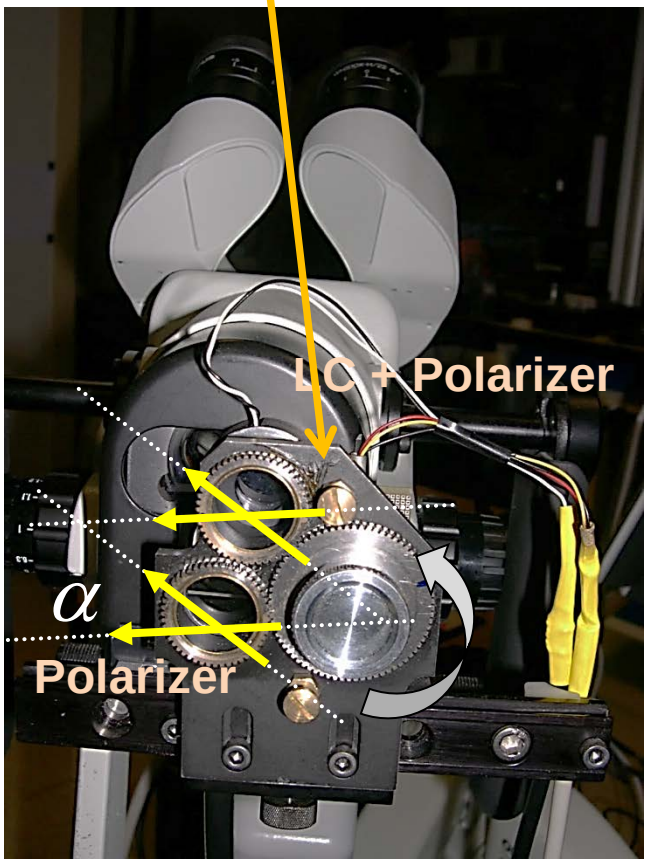


Orthogonal States Contrast

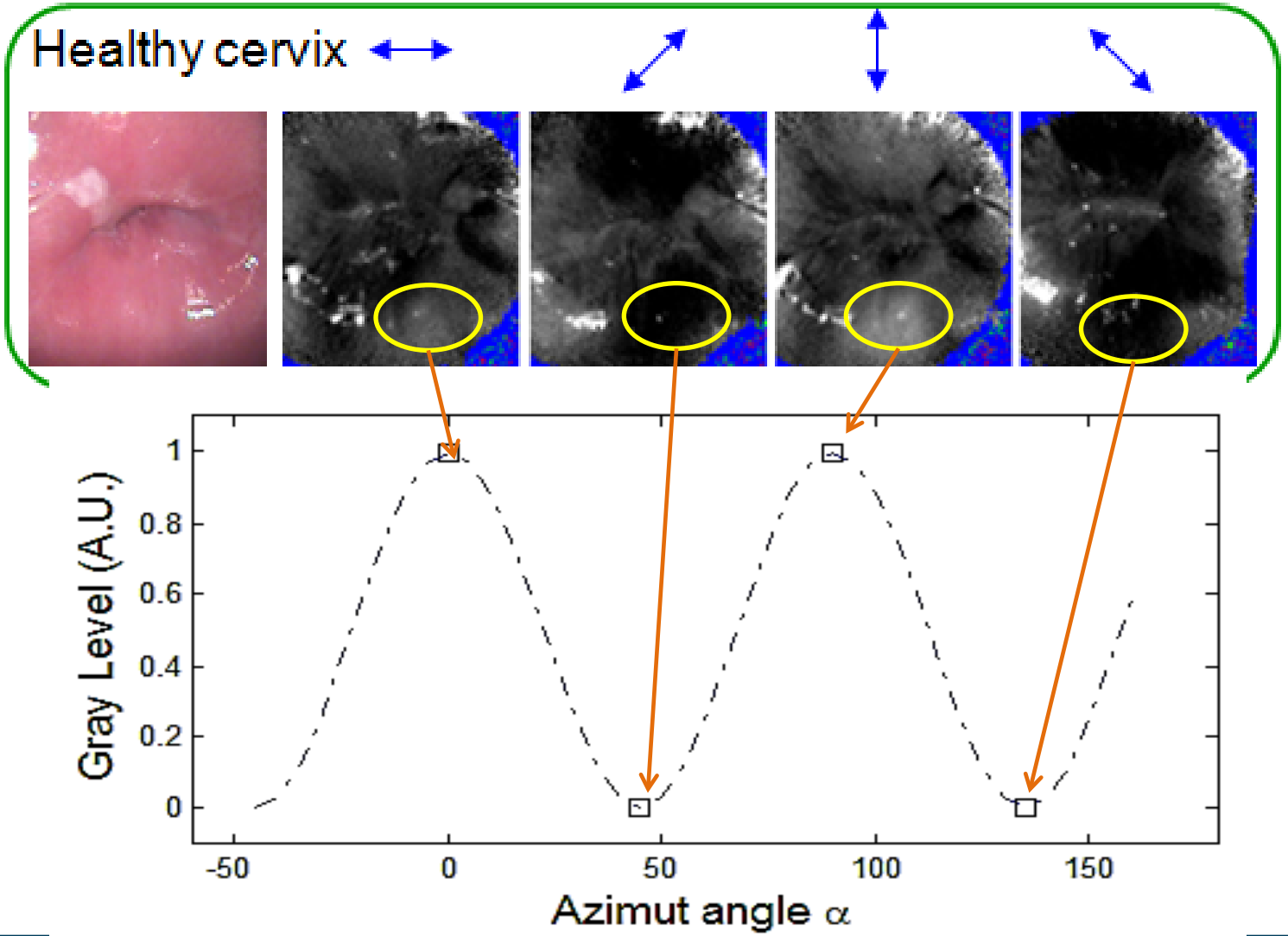
$$I_{OSC}(\alpha) = \frac{I_{//} - I_{\perp}}{I_{//} + I_{\perp}}$$



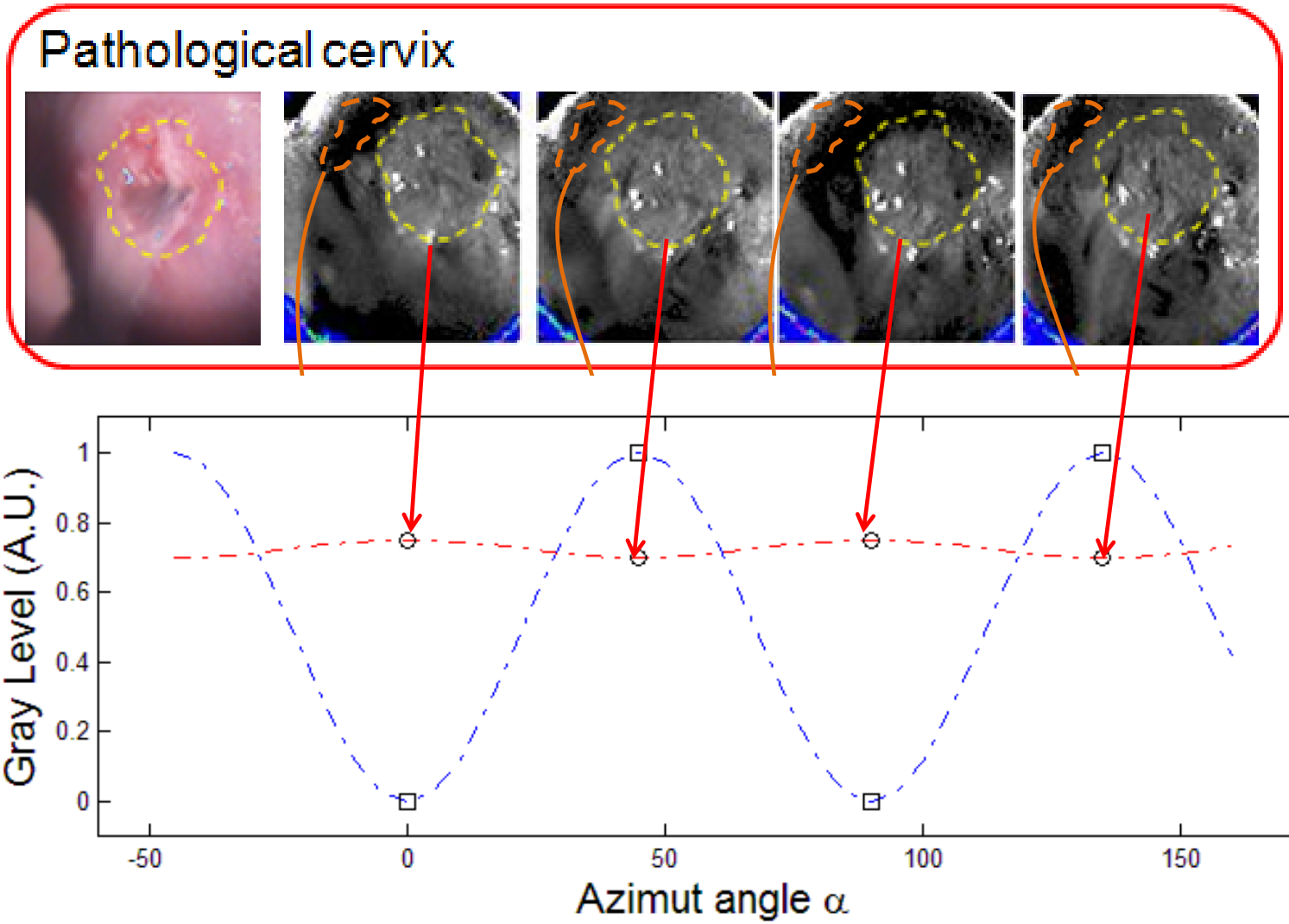
$$I_{OSC}(\alpha) = \frac{I_{//} - I_{\perp}}{I_{//} + I_{\perp}}$$



Colposcopy Azimuth



Colposcopy

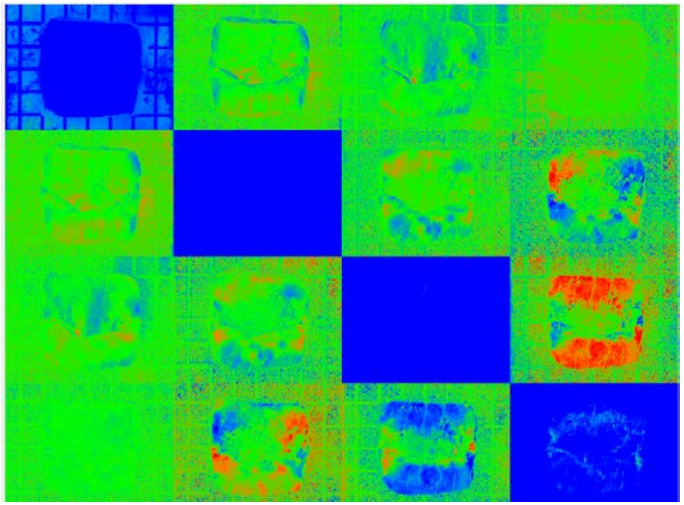


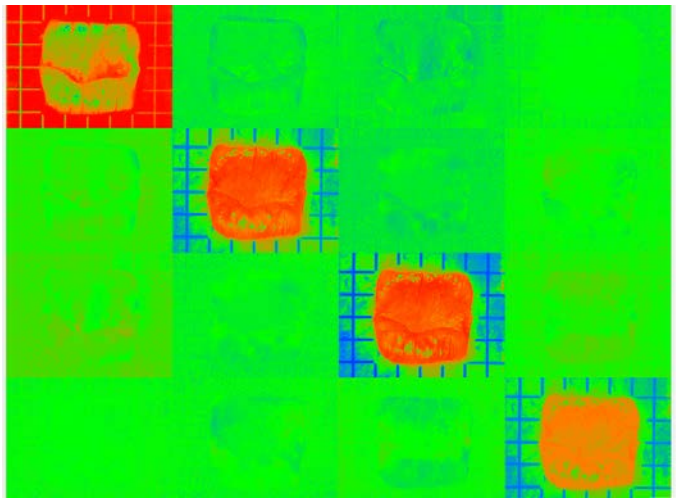
Polarimetry Experiments

II – Mueller Images on ex-vivo tissues

Description de la polarimétrie

Application ex-vivo : Tissu biologique (conisation)

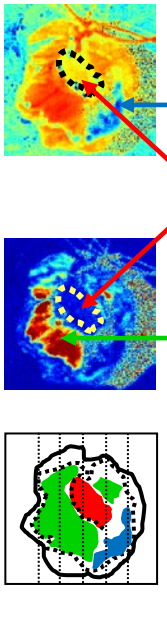




Depolarization

Retardation

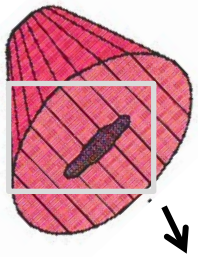
Anatomopathologist Cartograph



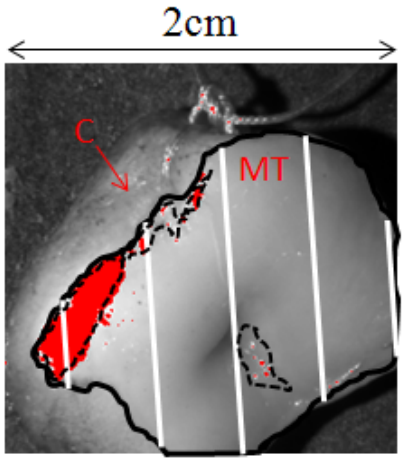
Ex-vivo Mueller Images – Healthy sample

Lu Chipman decomposition

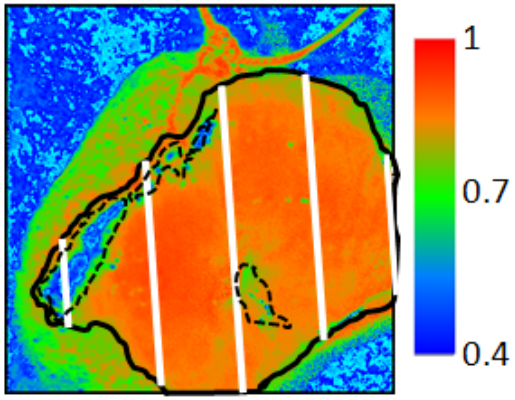
Δ : depolarization, R : retardation, α : orientation of slow axis

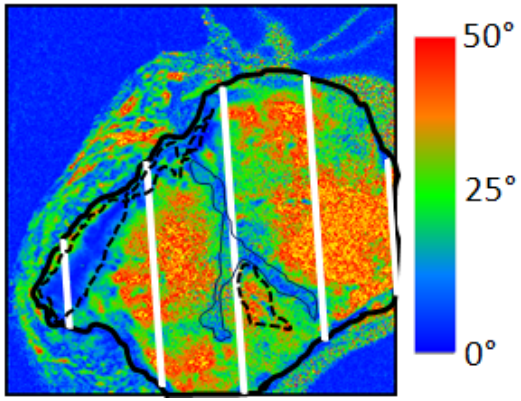


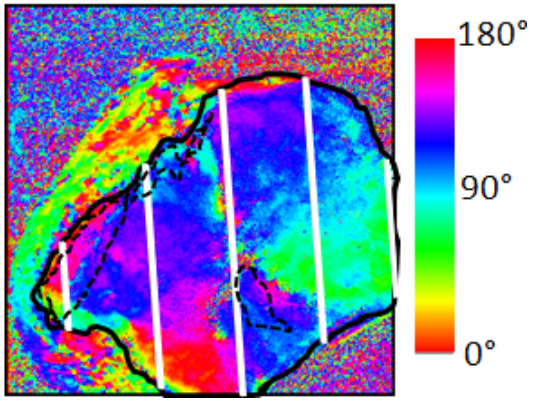
Observation direction



Healthy



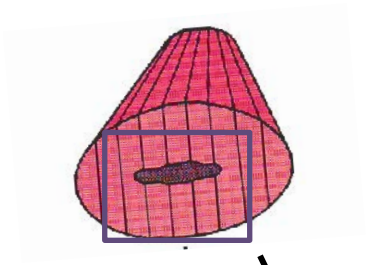




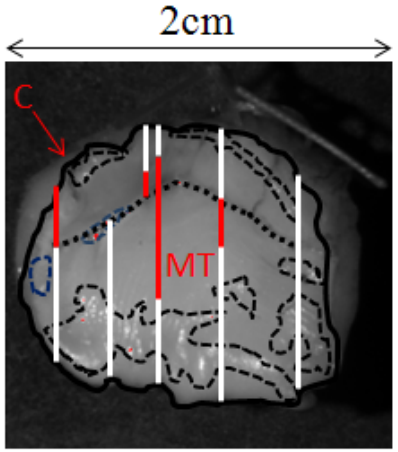
Ex-vivo Mueller Images – Healthy sample + CIN1

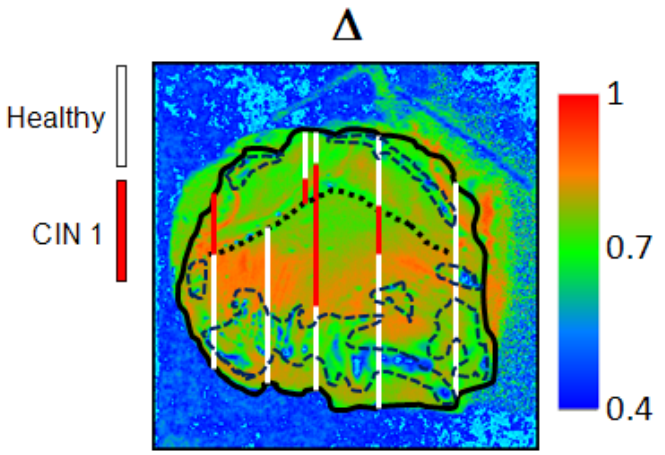
Lu Chipman decomposition

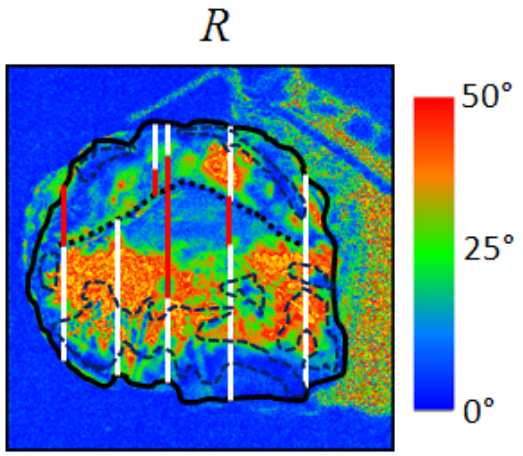
Δ : depolarization, R : retardation, α : orientation of slow axis

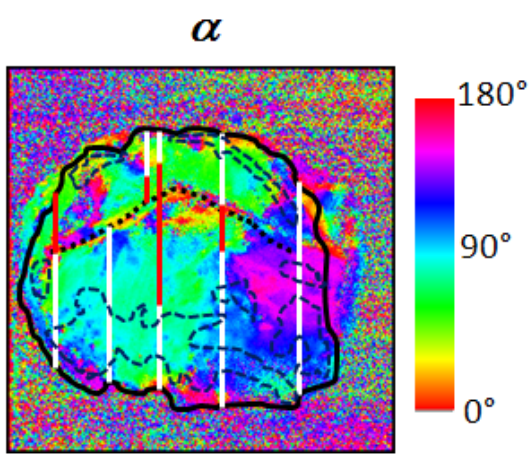


Observation direction



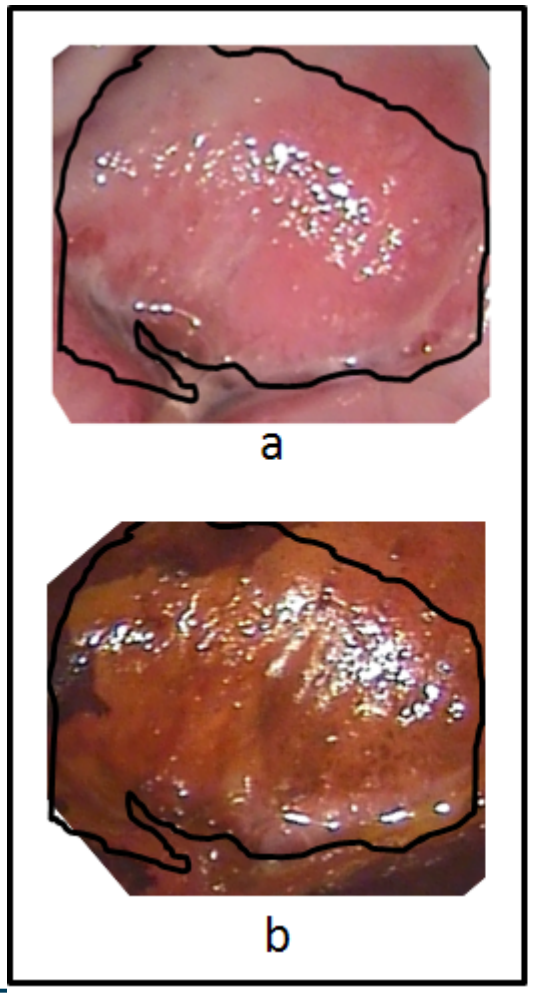




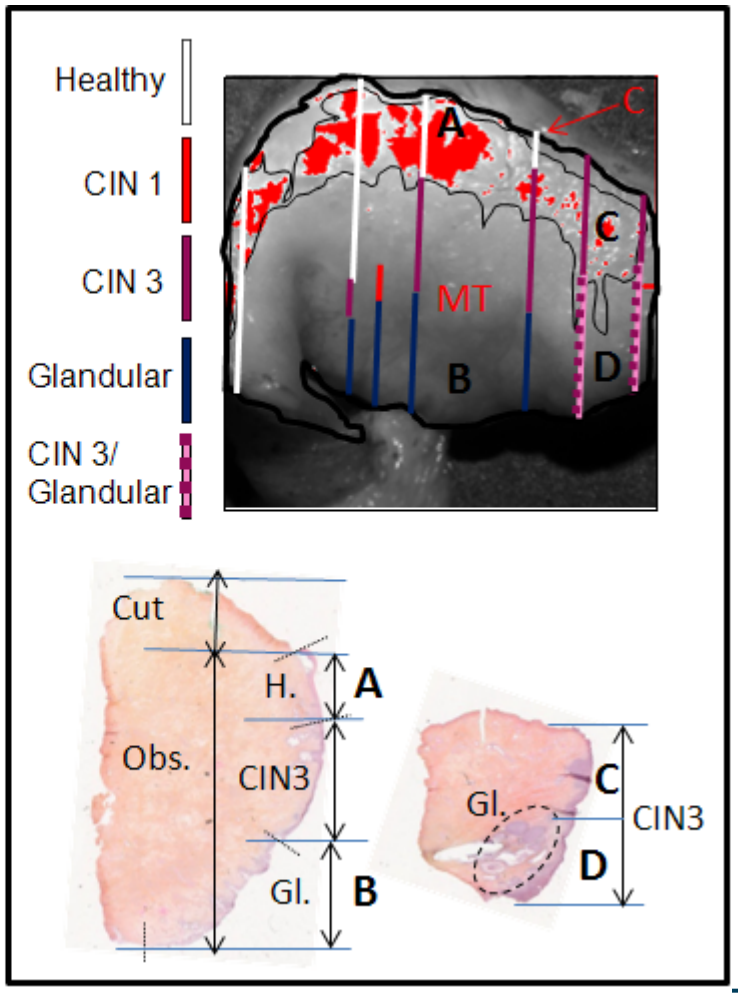


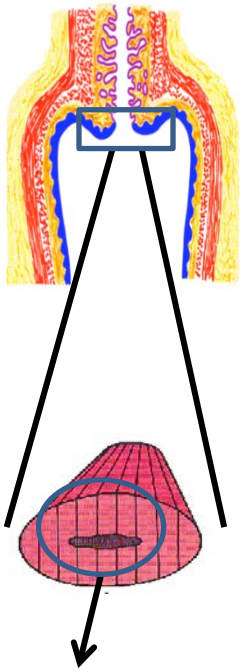
Ex-vivo Mueller Images – Healthy + CIN3 + Glandular

Colposcopy



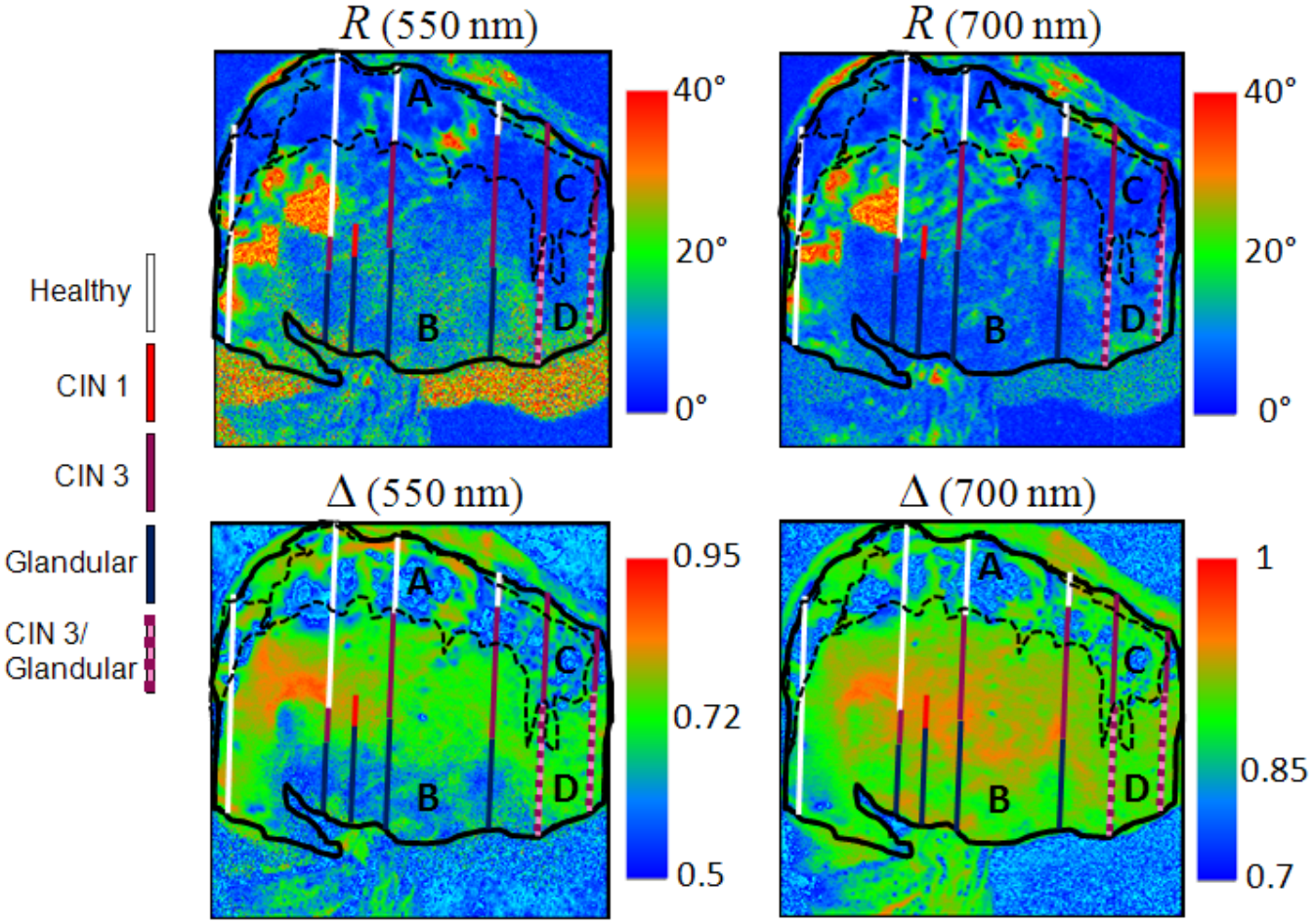
Pathology





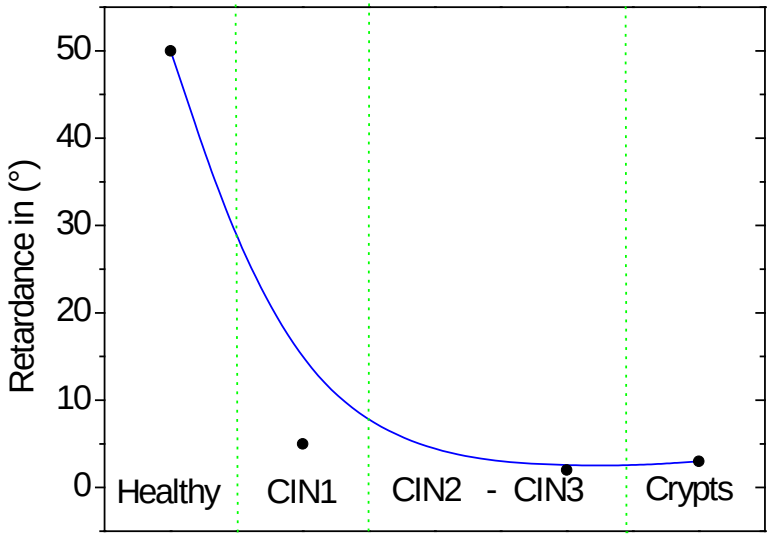
To observer

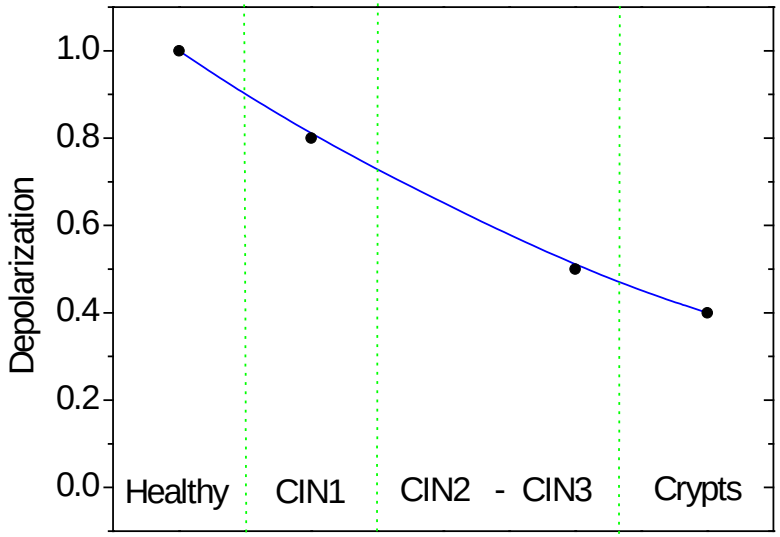
Ex-vivo Mueller Images – Healthy + CIN3 + Glandular



Summary of Observed Trends

- Healthy malpighian epithelium exhibits a specific birefringence
- Birefringence disappears already at stage CIN1. This birefringence is more specific than classical colposcopy.
- Depolarization « hierarchy » : glandular < CIN3 < CIN1 < healthy malpighian
- Multiwavelength imaging should be able to disentangle contributions from deep structures (crypts).





What comes next….

- Project « PAIR Gynéco » funded by the French Institute of Cancer (INCa)
  - Systematic study on 100 to 200 conizations, with learning and testing phases of image segmentation procedures (IMM & CHU de Bicêtre)
  - Assessment in vivo with a Mueller colposcope (CHU de Bicêtre)
  - Evaluation of polarimetry for the follow-up of radiochemotherapy for locally advanced cervical cancers (Institut Gustave Roussy)
- Polarimetric imaging of histological slides, modelling of polarized light scattering and, perhaps, understanding something about the observed contrasts

L'INSTITUT MUTUALISTE MONTSOURIS

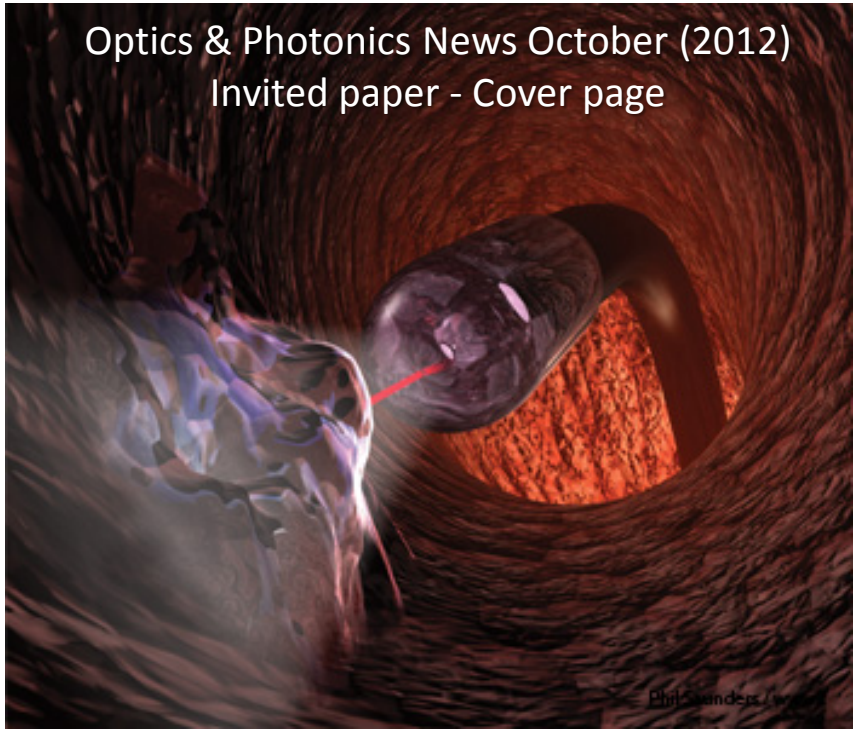
INSTITUT NATIONAL DU CANCER

ASSISTANCE PUBLIQUE HÔPITAUX DE PARIS

Thank you

Physicians - Medical Team

André Nazac – KB
Abdelali Benali – IMM
Pierre Validire – IMM
Henri Cohen – IMM



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