ADMIR

MIRSTAIN

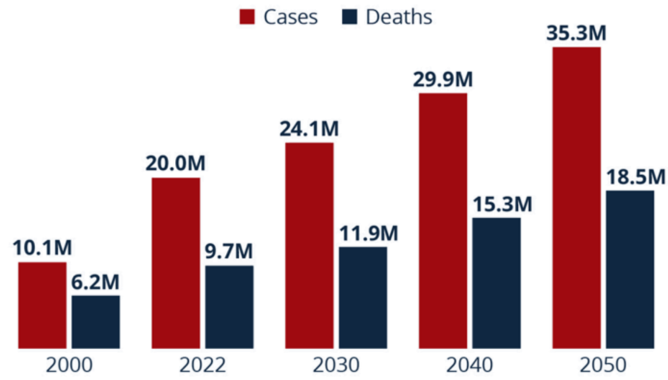
Infrared Morpho-Spectral Imaging platform for Label-Free Optical Tissue Staining

Increase the patient survival rate : Precise and accurate diagnosis & prognosis

Context

Cancer is a multifaceted and patient-specific disease, with incidence increasing by 20% over the past 8 years. Its treatment depends on highly precise diagnostics that are critical to patient survival. In 95% of cases, diagnosis relies on anatomic pathology a key medical field which focuses on tissues and cells analysis.

As a central part of modern medicine, pathologists are facing growing pressure to accelerate diagnostic workflows while improving clinical accuracy. ADMIR addresses both challenges through a high-throughput infrared imaging platform and Generative Deep Learning-based image analysis.



International Agency for research on cancer

Standard workflow

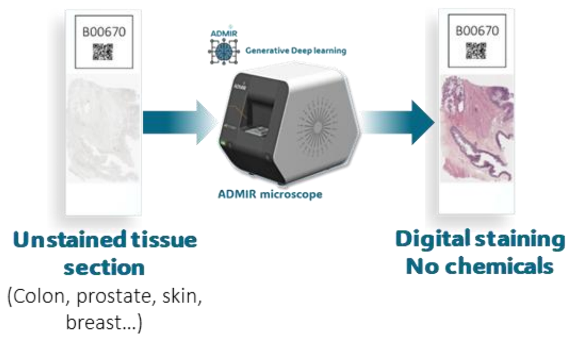
The diagnostic process typically follows several steps:

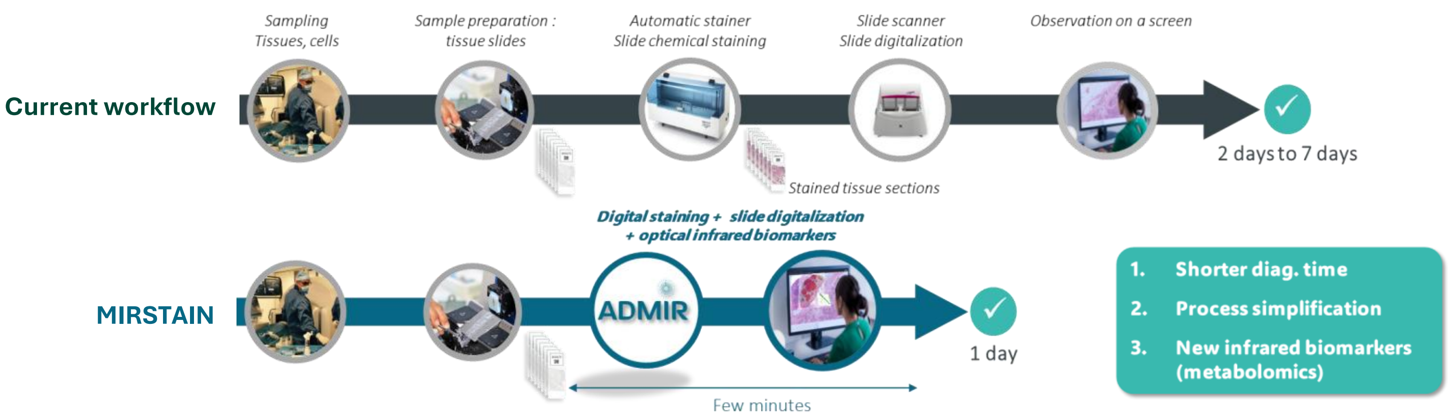
1. Tissue collection through biopsy or surgery.
2. Tissue processing, where samples are preserved in a fixative to maintain structure.
3. Dehydration and embedding, using alcohol and paraffin to prepare solid blocks.
4. Sectioning and mounting, where thin slices (3–5 micrometers) are cut and placed on microscopy slides.
5. Staining, usually by hematoxylin and Eosin (H&E), which highlight cell and tissue structures.

Once stained, **pathologists** examine the slides under a microscope to assess tissue architecture and detect abnormalities like inflammation, necrosis, atypical cells, or tumor invasion. H&E is used in about 95% of initial cancer diagnoses. When more detail is needed, **additional tests** are performed. These may include **special stains** (e.g., PAS for carbohydrates, Trichrome for collagen), or **Immunohistochemistry (IHC)**, which uses antibodies to detect specific proteins, aiding in disease classification and biomarker identification. If necessary, **molecular tests** like PCR or DNA/RNA sequencing may be used to refine the diagnosis.

MIRSTAIN

The ADMIR scanner, MIRSTAIN, produces digital H&E whole slide images (WSIs) without using any chemicals — no reagents or physical staining required. The operator simply loads unstained tissue slides, and MIRSTAIN generates the corresponding stained image.





Workflow – faster, smarter, cheaper

The MIRSTAIN scanner creates digitally stained whole slide images from translucent, unstained slides—eliminating the need for chemical stains or reagents. This results in:

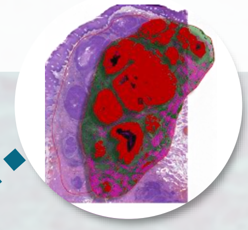
- No staining time
- 30% lower lab costs
- 30% less water
- 50% fewer chemicals used

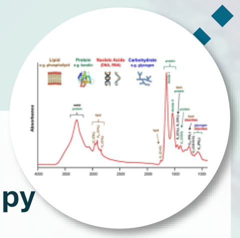
H&E staining – stable, precise, reliable

Mitoses appear via infrared contrast linked to DNA. Nucleus and membrane details are clearly visible and remain consistent across slides thanks to the fully digital staining process.

Special digital staining & tissue segmentation

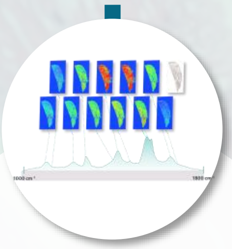
MIRSTAIN produces whole slide images in the infrared range. These optical data are relevant of several biomarkers, enabling semantic tissue segmentation and virtual staining. They may also be used to map biochemical features to help identify specific diseases, such as amylose.





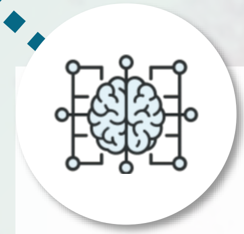
Infrared spectroscopy

The infrared scanner incorporates sixteen discrete quantum cascade lasers (QCLs), each tuned to emit at wavelengths corresponding to the rovibrational transitions of chemical bonds present in essential biomolecular classes, including nucleic acids (DNA, RNA), proteins, carbohydrates...
The corresponding absorptions allow to fully characterize a tissue.



Bimodal imaging system

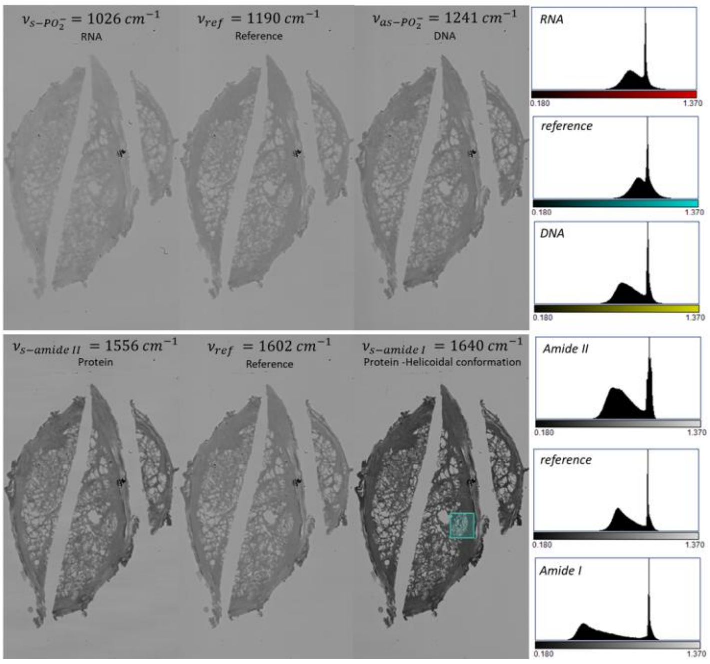
We developed a bimodal imaging platform that combines infrared lens-free optics, with conventional brightfield visible-light microscopy. This combination preserve the subcellular spatial resolution of conventional microscopy, while adding the spectral data of an infrared stack.



Generative Deep learning

A deep learning model processes features from both brightfield and infrared image stacks. It integrates morphological and spectral information to enable digital H&E staining. Infrared modality provides spectral information, acting as a reference palette, while the brightfield image serves as the structural template that the model can colorize accordingly.

Staining Without Stains: Infrared Microscopy Meets Subcellular Resolution



Infrared spectroscopic platform

Infrared (IR) microscopy is increasingly used in tissue imaging, especially in surgical pathology, for label-free, chemical and molecular analysis. Developments based on Fourier Transform IR microscopes have already demonstrated their ability to image tissues. This approach has long been limited by the low-power of available infrared light sources, which made IR microscopes extremely slow for imaging tasks. Today, several optical systems solve this issue by combining tunable quantum cascade lasers (QCLs) with uncooled IR. These new systems increase acquisition speed and are now compatible with tissue imaging. Still, they remain limited by the low spatial resolution of infrared imagers

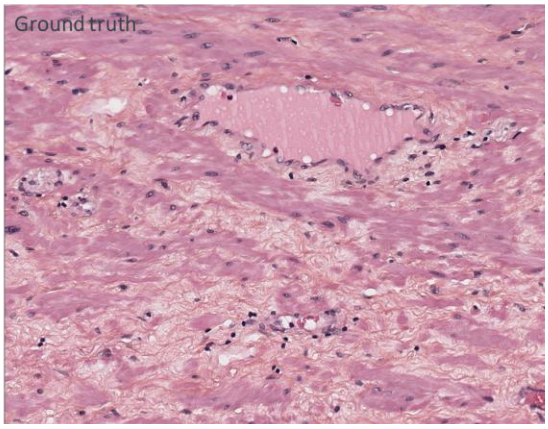
- Tissue segmentation
- Low spatial resolution (few microns)

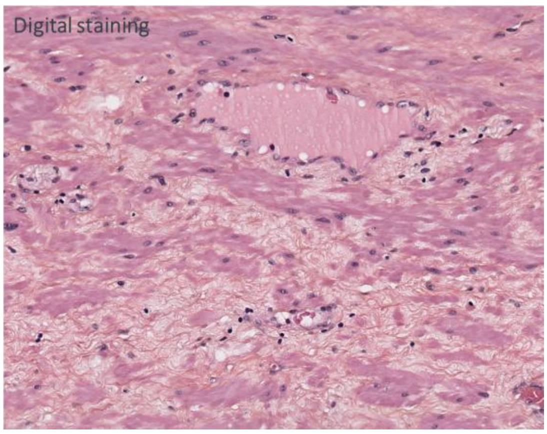
MIRSTAIN bimodal platform

ADMIR developed a novel bimodal platform that combines infrared spectral imaging, with conventional visible-light microscopy techniques. This combination enables:

- **Sub-cellular resolution**
- **Tissue segmentation** according to their spectral and morphological fingerprints
- **Digital staining,** infered by our deep learning model from the infrared and visible fingerprints

- Fast acquisition (~10 to 15 min/cm²)
- Subcellular spatial resolution (250 nm to 500nm)
- Reproducible digital staining
- Tissue segmentation

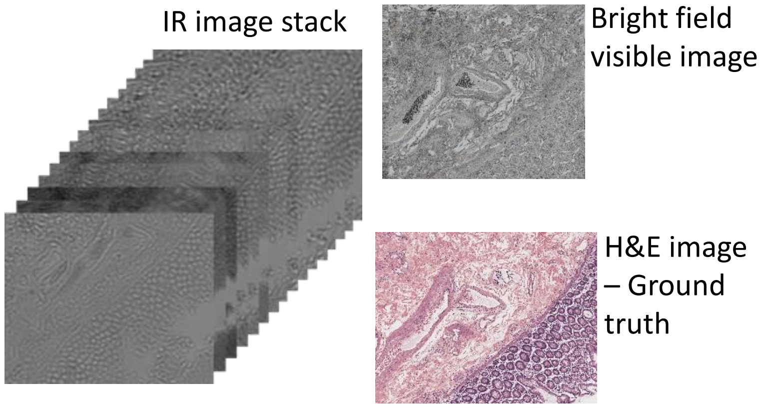


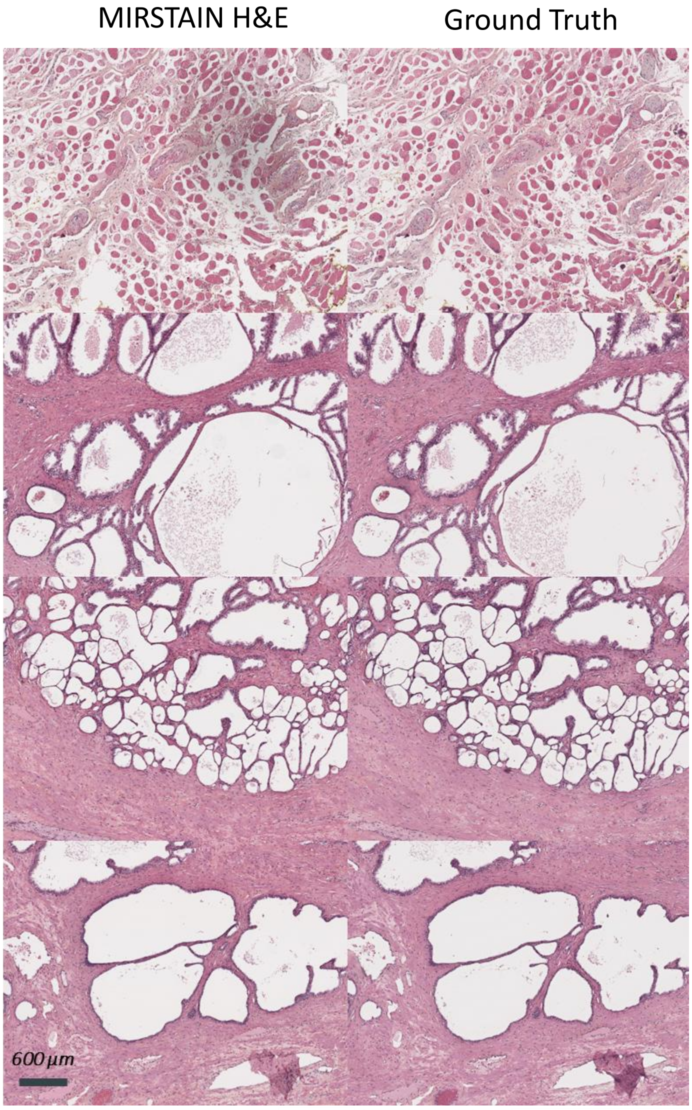


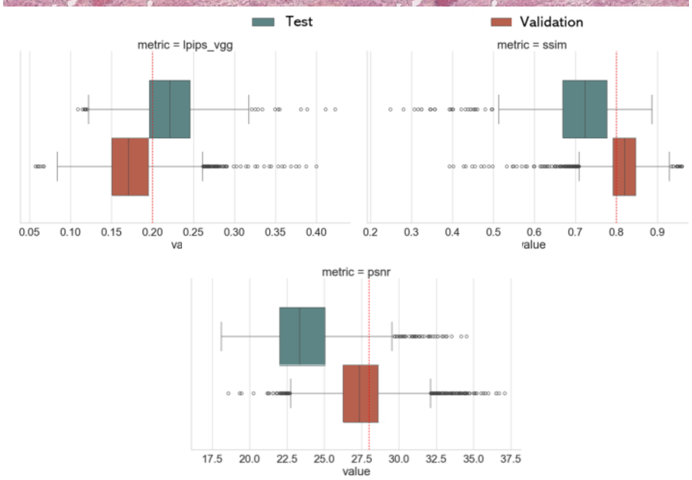
Preclinical validation

Image data set

28 whole slide images have been used to train and validate a deep learning model. This model is fed with two types of 256x256-pixels patches: infrared and brightfield unstained. Based on these images, it was trained to reproduce the corresponding H&E-stained tissue. The training dataset presented both healthy tissues, as well as adenocarcinoma.



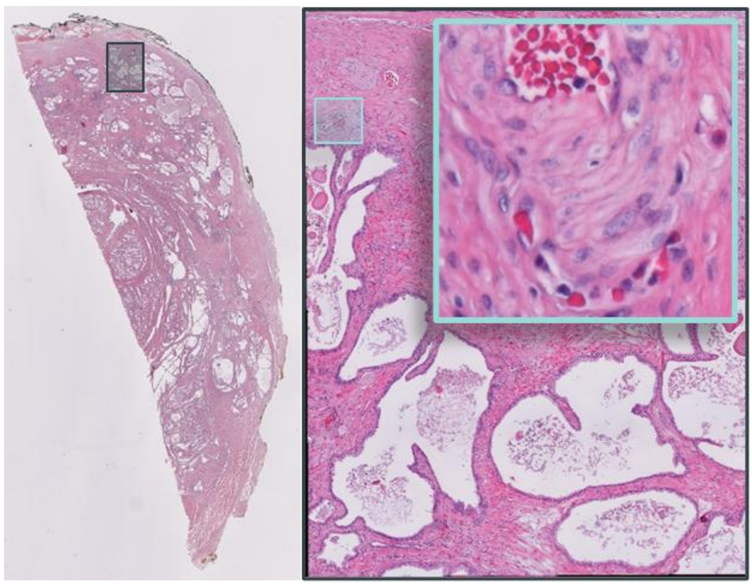




Digital staining versus ground truth

Multiple regions of interest (1000 × 1000 pixels) were inferred using the model. Qualitative comparison with the corresponding H&E-stained slides reveal that digitally stained images accurately replicate cytological features—such as capsules, alveoli, smooth muscle, capillaries, venules, and red blood cells. Color contrast, as well as nuclear, cytoplasmic, and extracellular details closely match traditional H&E.

Beyond the qualitative comparisons, three pixel-wise metrics have been computed for the test patches. We have considered the Peak Signal-to-Noise Ratio (PSNR), the Structural Similarity Index Measure (SSIM) and the Learned Perceptual Image Patch Similarity (LPIPS) metrics. PSNR >21 is satisfactory when compared to literature benchmarks. Ideally, SSIM ~0.8 is generally indicative of strong inference performance. LPIPS <0,1 is indicative of very good similarity. These quantitative metrics confirm the reliability and robustness of the MIRSTAIN approach.



ADMIR

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MIRSTAIN

MIRSTAIN is a breakthrough imaging solution powered by infrared spectroscopy. Designed for digital staining and advanced tissue analysis, it opens up a new era of possibilities for medical professionals.

1. Digital staining with subcellular detail
2. Infrared-Enhanced spectral signatures
3. Fast and simple
4. No chemicals for tissue staining

About ADMIR

Founded in 2022 as a CEA spin-off and winner of the 2022 i-Lab award, ADMIR is a pioneering startup at the crossroads of precision oncology, digital pathology, and AI-driven innovation.

7 R&D years

12 patents