IMPLEMENTING DIGITAL PATHOLOGY AT CHUM

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DISCLOSURE

Medical advisor on the Quebec provincial digital pathology committee

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LEARNING OBJECTIVES

1. Discuss the requirements for a successful implementation of digital pathology for primary diagnosis at CHUM

2. Summarize the gains and limitations of digital pathology

3. Identify future perspectives of digital pathology for clinical use

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PRESENTATION PLAN

- CHUM: Background
- CHUM Digital Pathology project
- Lessons learned
- Vision for the future

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WHO WE ARE

- Central lab of our Optilab-Montréal CHUM hub : 8 labs (academic and community hospital centers = 25% of provincial pathology activities). CHUM = 50% of the hub
- CHUM: 22 pathologists, 7 pathologist-assistants, 112 employees (48 lab technicians), +/- 20 residents, administrators, 1 medical biology specialist
- CHUM : 35K surgicals, 80K biopsies, ~ 5K consultations, ~ 400 autopsies, ~850K histology slides / y (approx. 2000 / d), 75K cytology slides

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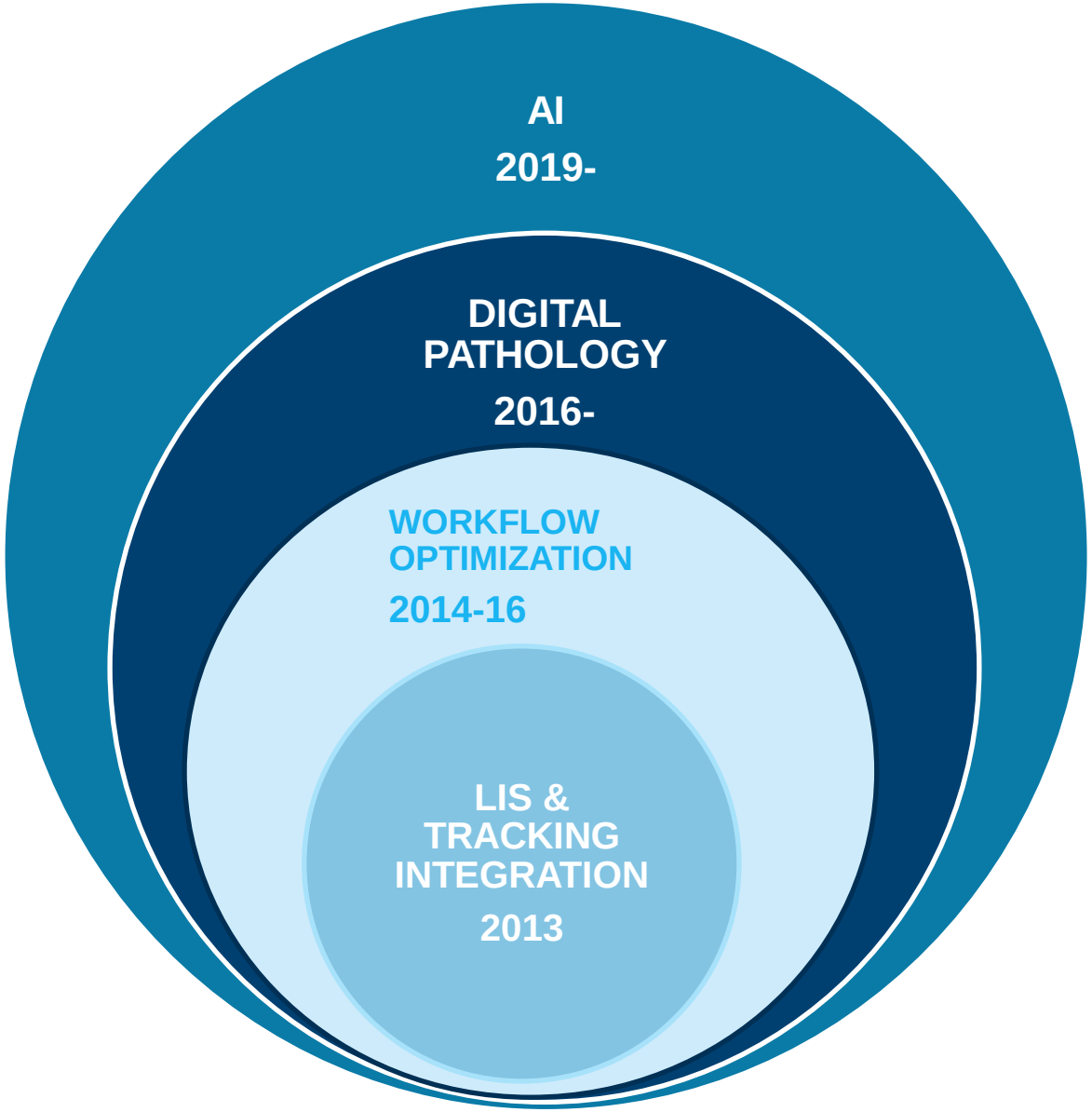
WHY: MODERNIZING PATHOLOGY

CHALLENGES

- Increased number and complexity of analyses
- Shortage of medical technologists
- Shortage of pathologists
- Manual processes
- Reorganisation of Quebec health care system and subsequent creation of Optilab hubs
- Designation of central labs and specialised testing



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DIGITAL PATHOLOGY: IMPLEMENTATION CALENDER

2012	Budget for one scanner	
2013	Integration LIS – Tracking system	
2014 – 2016	Optimisation of lab workflow	
2016-2019	Acquisition, validation, connection IMS-scanners (2)-LIS	2017: merger with Optilab hub 2017-18: relocation of CHUM
Jan 2019	FSISSS research funding, beginning of implementation Remote working	
Oct 2019	Introduction of first IA app as research project	
2020-22	Acquisition of additional scanners (+5) and storage (COVID funding – Quebec provincial project)	March 2020: COVID-19 pandemic
2020	Remote access for the first non-CHUM pathologist	
Dec 2022	100 % digital	

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CHANGE MANAGEMENT AT ALL LEVELS

- **Organizational or Transformational Change:** change management projects that are large in terms of scale and scope. These change transformations are often dramatic, such as altering the organizational hierarchy, launching a new product, or undergoing digital transformation.
- **Adaptive or Gradual Change:** These change projects are smaller is scope, and are smaller changes to products, processes, strategies, and workflows. Adaptive change projects include implementing new software tools, hiring a new team member to solve an existing challenge, or updating a work-from-home policy.
- **Individual Change Management:** These change projects help an individual to manage change to help them grow in their role and/or achieve specific goals. This could include learning a new skill.

https://whatfix.com/change-management/

CHANGE MANAGEMENT PLAN

1. Create a change proposal: argument for why the change needs to happen. Document the benefits, impact, and reason for the change.

2. Identify change leaders: vocal supporters of the change, usually senior-level management and other influential leaders. Be sure to mix a variety of roles on this change team.

3. Create a change management communications plan: how you will communicate every aspect of the change to the people affected by it.

4.Set goals and measures for the change: how you track the success (or failure) of various aspects of your change initiative. Create a plan to analyze the change after it goes into effect with measures tied to business goals and outcomes. Make these visible to everyone in the organization to evangelize the project.

5. Create a change management training plan: outline how training will be administered.

https://whatfix.com/change-management/

IMPLEMENTATION PHASES

- Pilot: January to July 2019, 3 pathologists (our champions). Premise: time saving at the slide assembly bench of 2,5 FTEs/d, for pathologists: ↓ TaT 10-15 %
- Deployment CHUM August 2019-Fall 2022, 19/20 surgical pathologists (- 1 retiring and 2 cytopathologists), all residents
- Expansion to the hub: 2023

➢ Implementation team: project leader, project manager, lab manager, digital pathology plateform manager, lead technician

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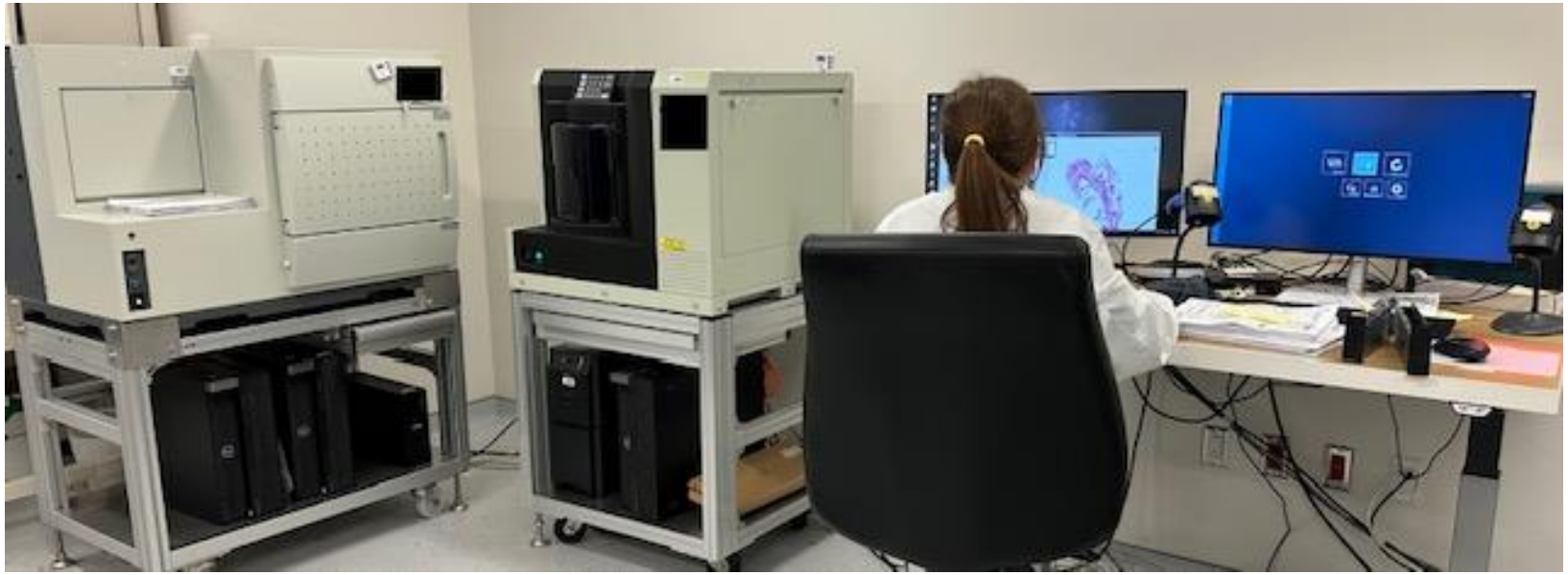
LAB REORGANIZATION

Room for scanners, with easy access to their rears for maintenance and repair, on stable ground, clean environment. In close proximity to the histology lab and a computer desk. Racks to hold slide trays before and after scanning.



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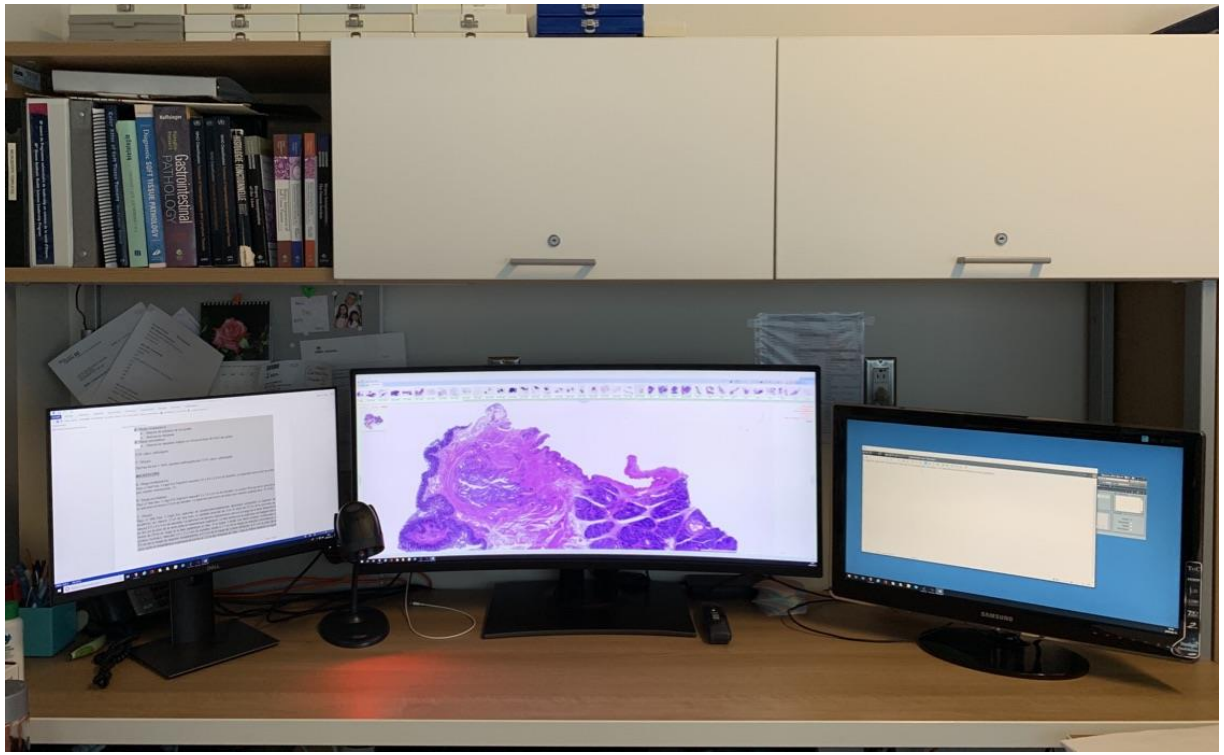
PATHOLOGIST'S OFFICE REORGANIZATION



VALIDATION PERIOD

Digital images were reviewed with correspondant glass slides for 1) biopsies, 2) surgicals, 3) TAT deteriorated during an ajustment period then improved

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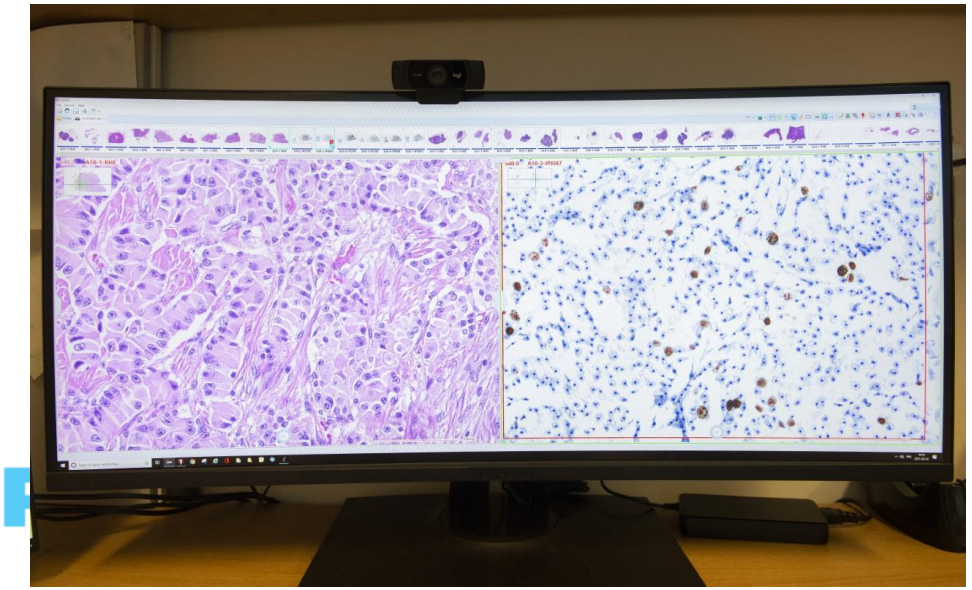
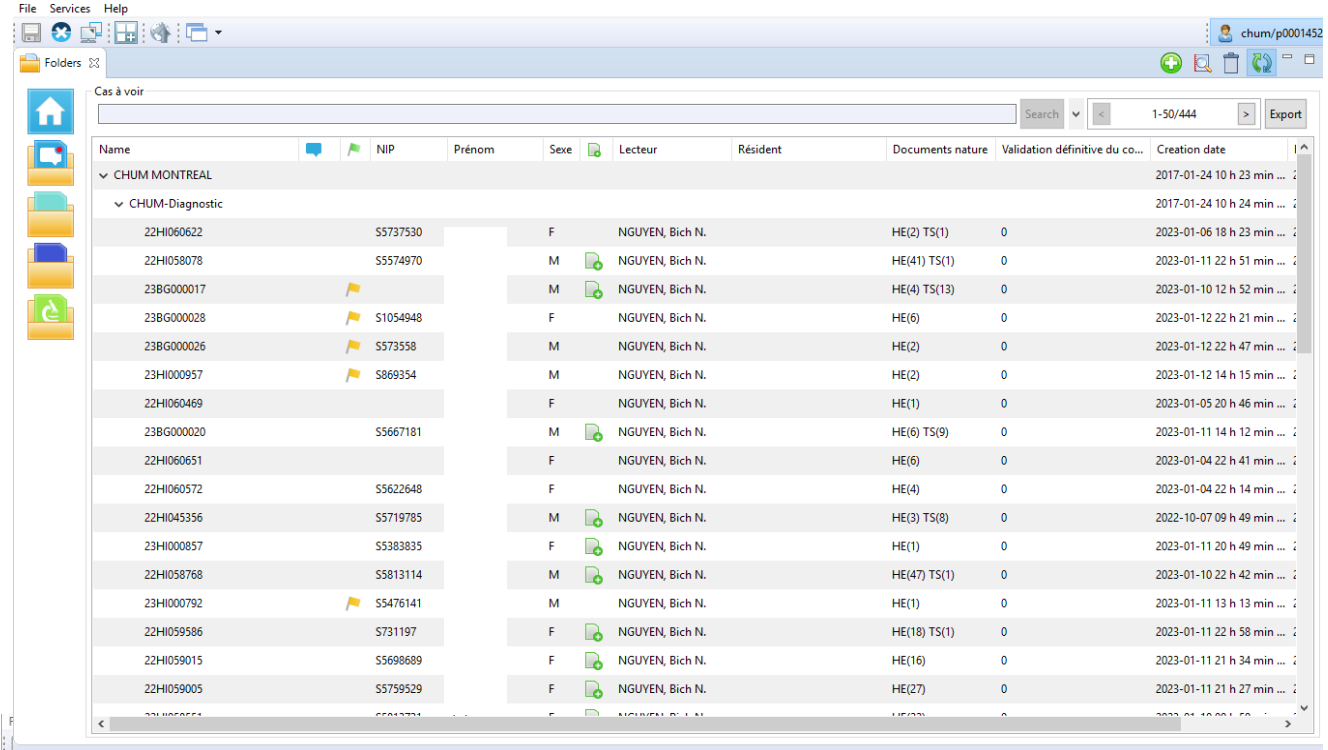
Design of the label and bar code: interfe-rence with the sanning process

« Racking and un-racking» time: to be accounted for when planning the number of scanners needed

Scanning protocols for different tissue types





IMS

- Integration with most scanner types
- User friendly viewer
- Management system with reliable work lists, QC modules
- Ability to integrate several AI apps and triage
- Modules for slide collections, research, external access/consults
- Technical support from vendor

HOW

PLANNING

- CHANGE MANAGEMENT

EQUIPMENT: HARDWARE, IMS

- TRAINING OF PERSONNEL AND PATHOLOGISTS
- VALIDATION PROCESS

MESURE OF CHANGE

- COMMUNICATION
- FEEDBACK

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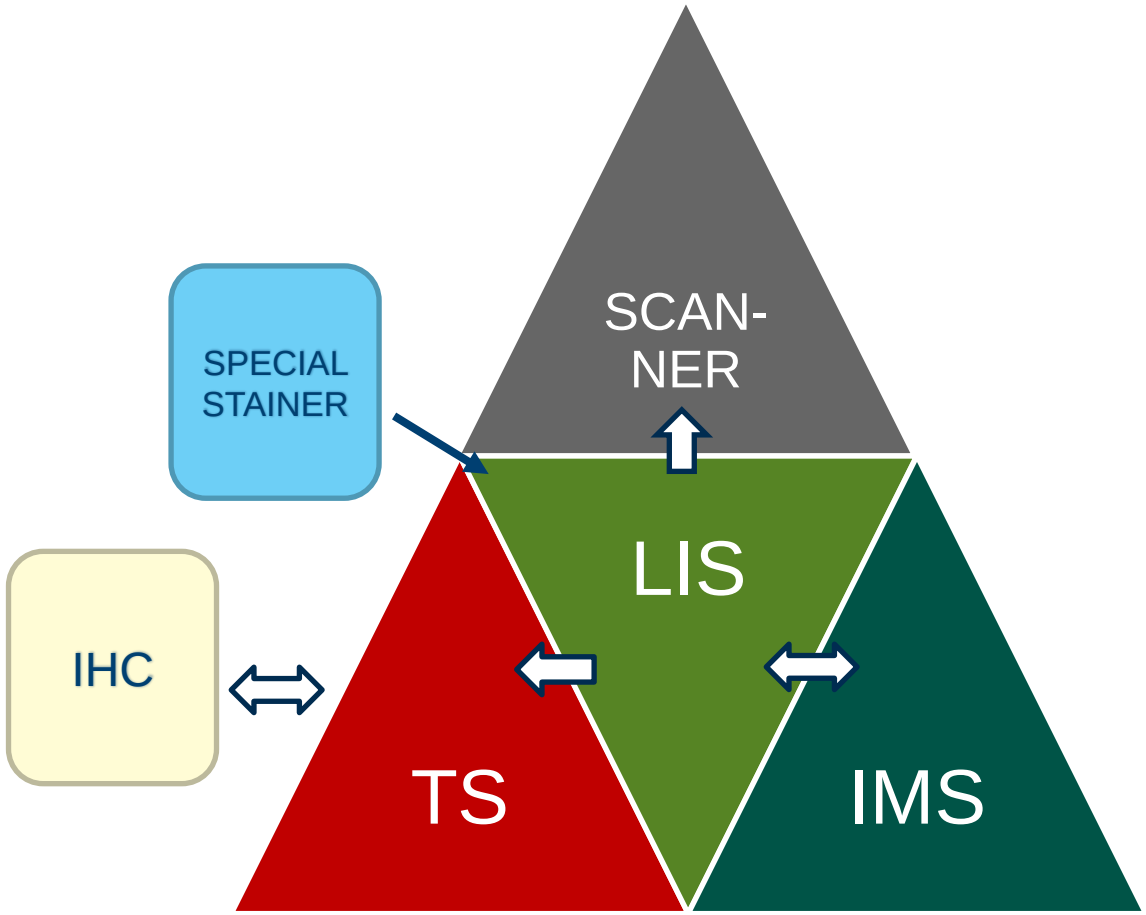
Connectivity and interoperability

- LIS is central in our lab workflow, provides patient details, to scanners and IMS, pathologist reporting
- TS essential for remote working in a paperless environment
- IMS manages worklists with infos received from LIS
- Scanners read our 2D QR codes
- Inability to get all vendors to work together for bidirectional integrations



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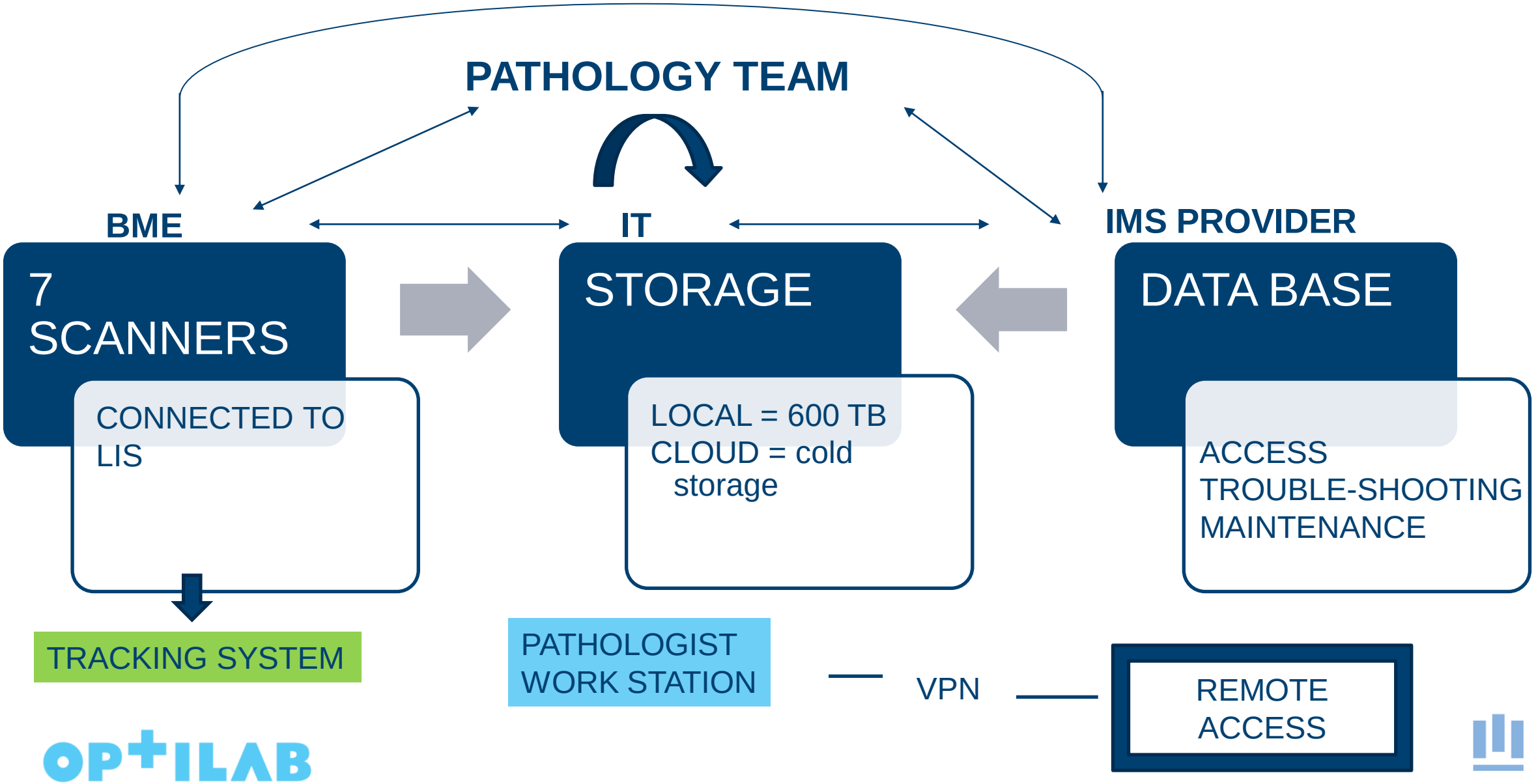
Collaboration



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CHALLENGES

- Significant investment required
  - Acquisition of equipment and software, compatibility with lab's LIS, tracking system
  - Time investments: training time for employees and pathologists, troubleshooting
- Storage space
- Bandwidth issues
- Technical support
- Change management

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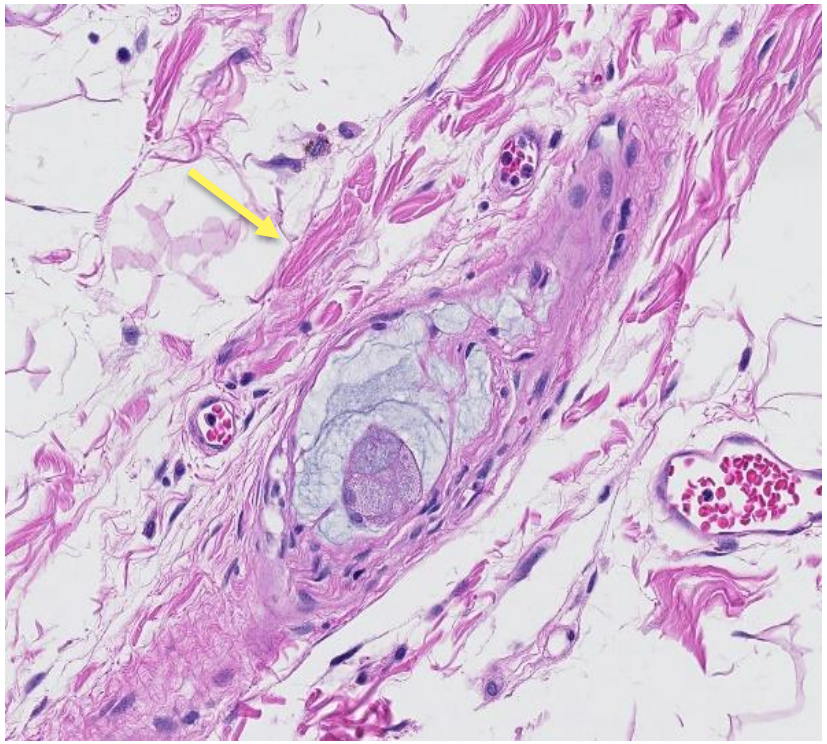
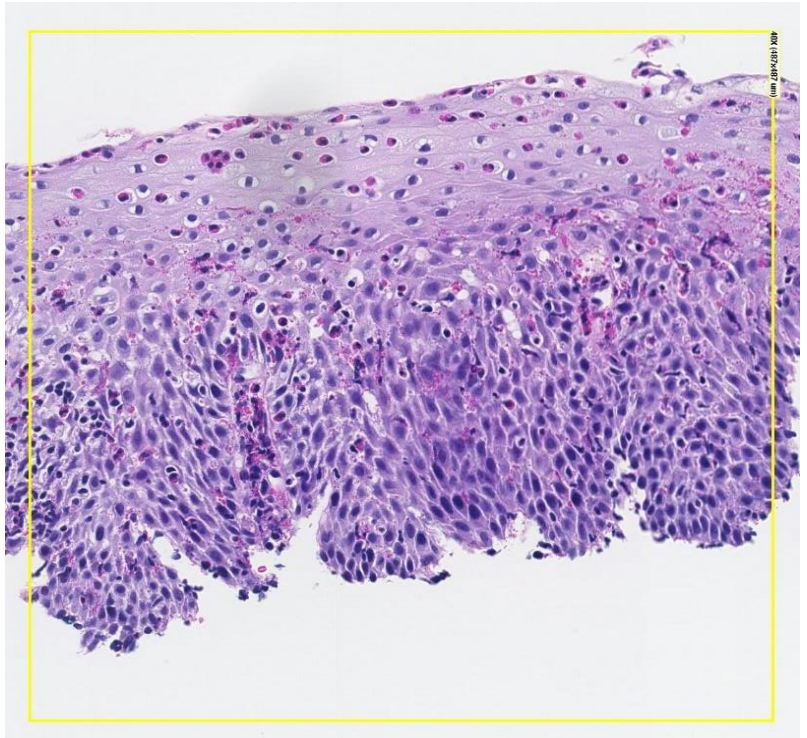
Enhanced pathologist's experience

- Digital tools : mesures, annotations, count, unconventional magnification, digital pictures, visualized areas on slides, synchronized comparison of slides, remote consults
- Better management of worklists, case assembly and prioritization of cases
- Clinico-pathological rounds, remote teaching and working





416 x 416 µm
= 173 µm^2 =
40X field

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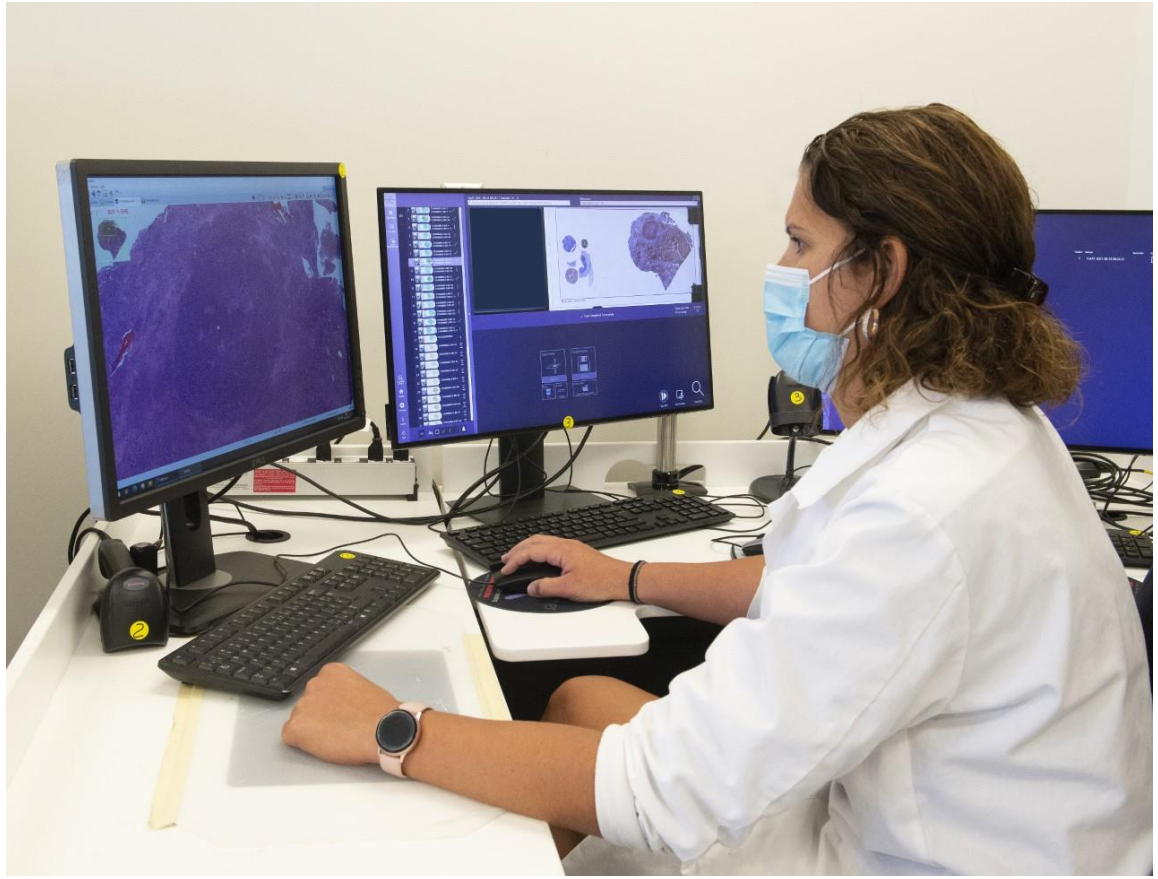
Satisfaction at work for technologists and lab managers



- Creation of a new bench for lab technologists : learning scanning protocoles, QA
- Transformation of the medical technologist profession

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OTHER ADVANTAGES

- **Education**: slide collections, web-based educational programs for pathology residents, CME for practicing pathologists.
- **Minimal physical space** required for storage.
- **Research**: no more need to recut precious tissue blocks, development of AI

Zarella MD et al. A practical guide to whole slide Imaging. A white paper from the Digital Pathology Association. Arch Pathol Lab med Vol 143, Feb 2019

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GAIN IN EFFICIENCY (2021)

TASKS	IN CHARGE	PRE-IMPLEMENTATION INDICATORS	POST-IMPLEMENTATION INDICATORS
Slide distribution	Lab technicians	23 h	- 23h
Slide examination to reporting	**Pathologists**	**Turnaround time** **Productivity (slide load)** **Case assembly** **Slide handling**	**- 18 % (b) / - 25 % (s)** **+ 17%** - 0.5h x 19 = - 9.5 h/d - 9 sec/slide x 2000 = - 5 h; TOTAL 14.5 h
Slide archival and retrieval	Lab clerk	14 days in average	6 days
Physical case assembly and delivery for consultations and transferts	Lab clerk	3 days in avarage	1 day
IHC QA programs	Technologists Coordonnators	3 h	2.5 h

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TOTAL TIME SAVING: 37,5 H

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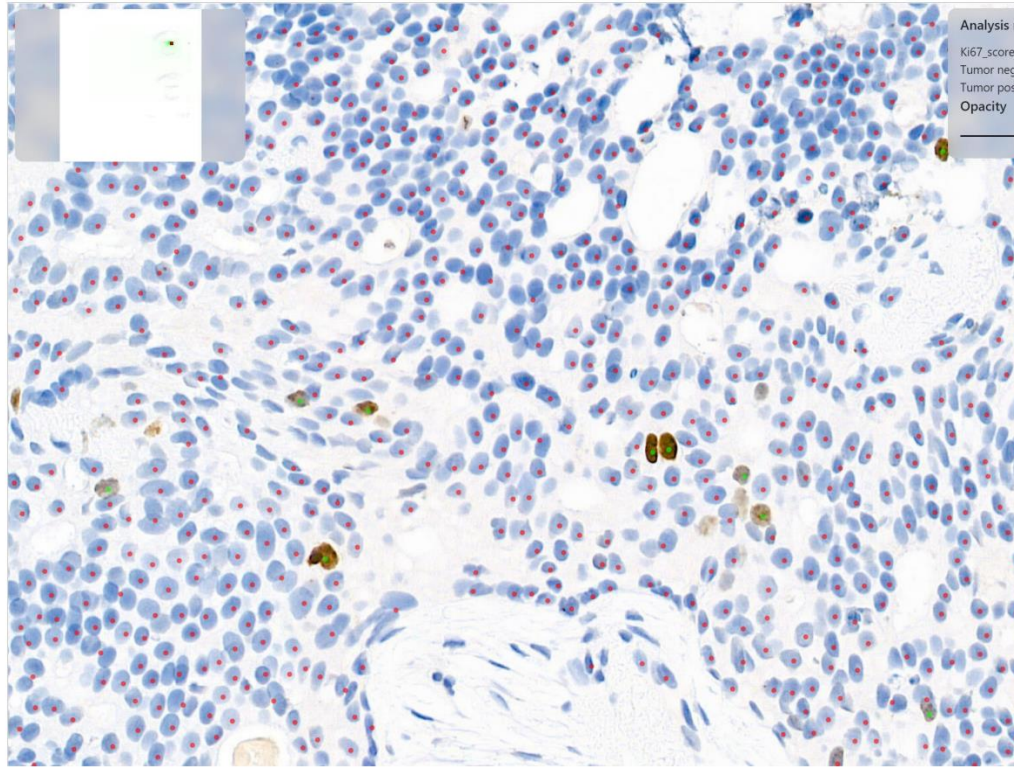
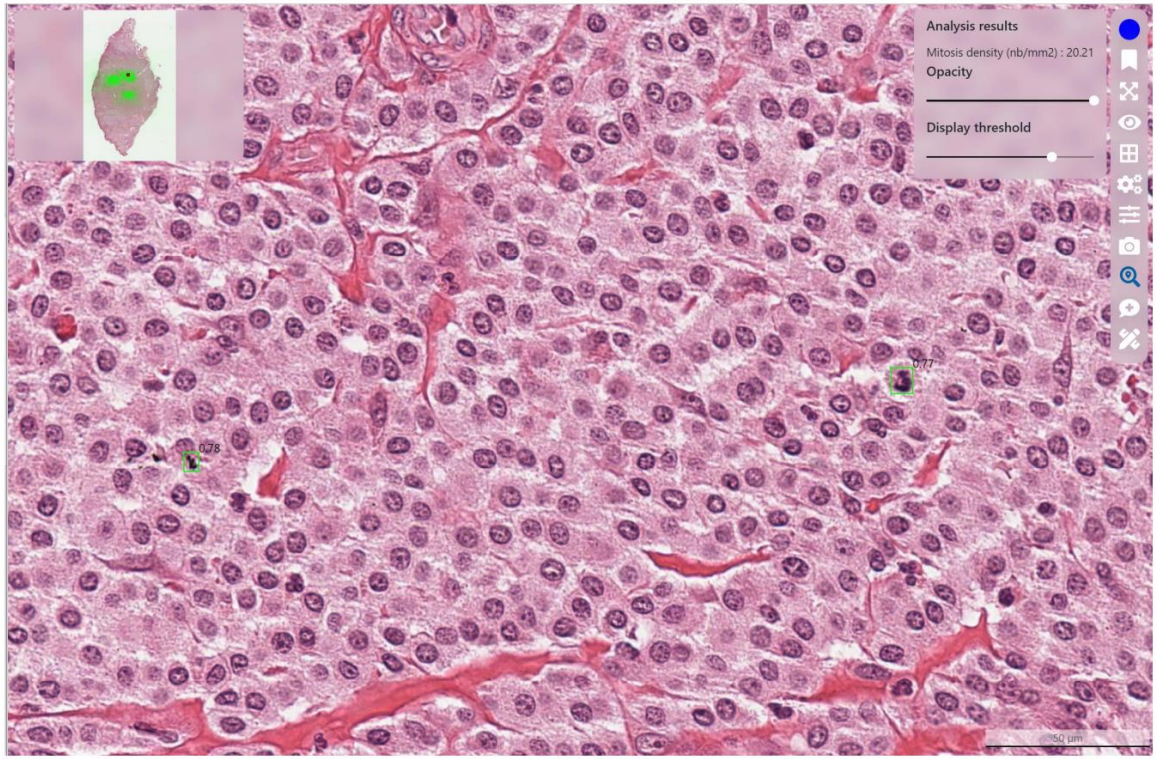
AI: TOPIC OF THE HOUR

Ki67 Scoring



MITOSIS DETECTION & COUNT



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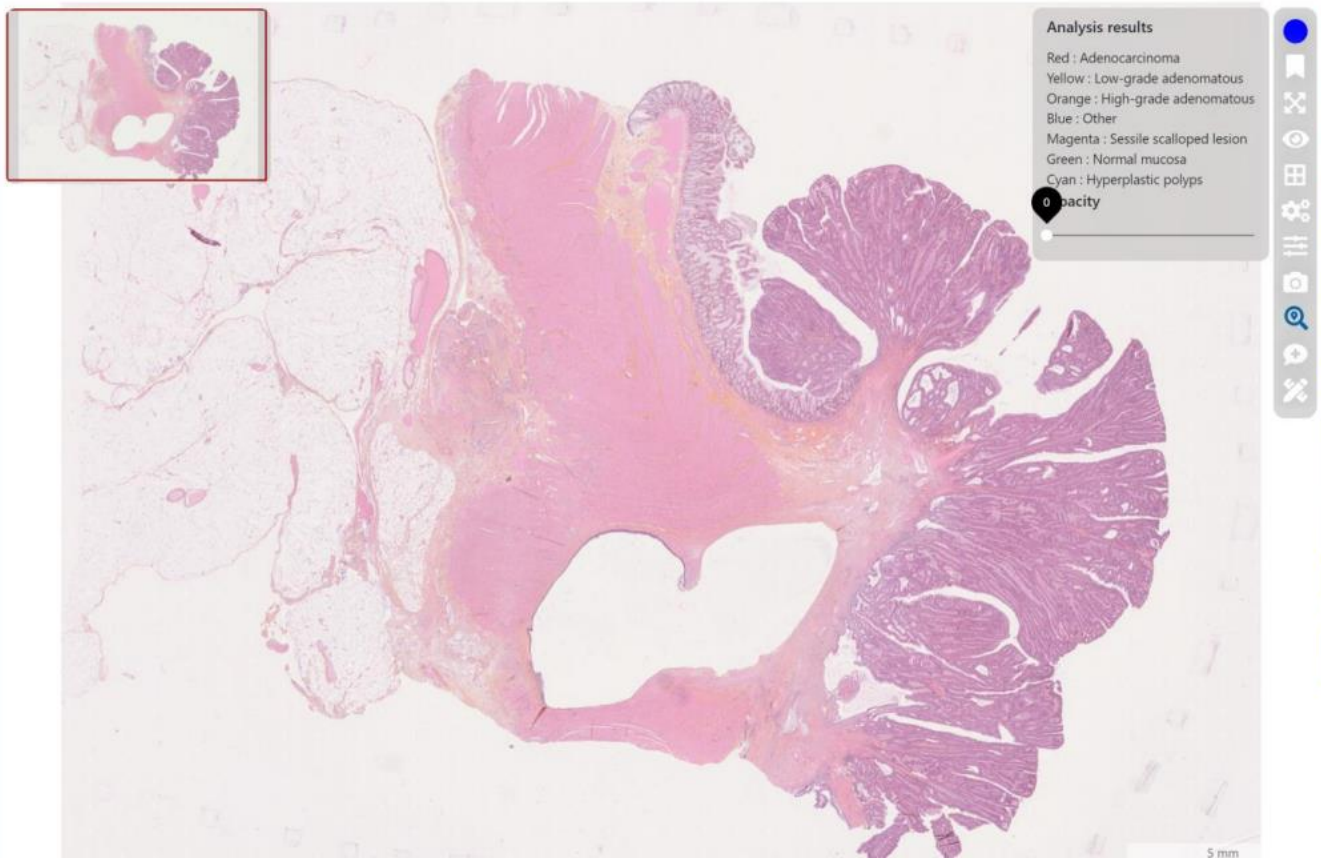
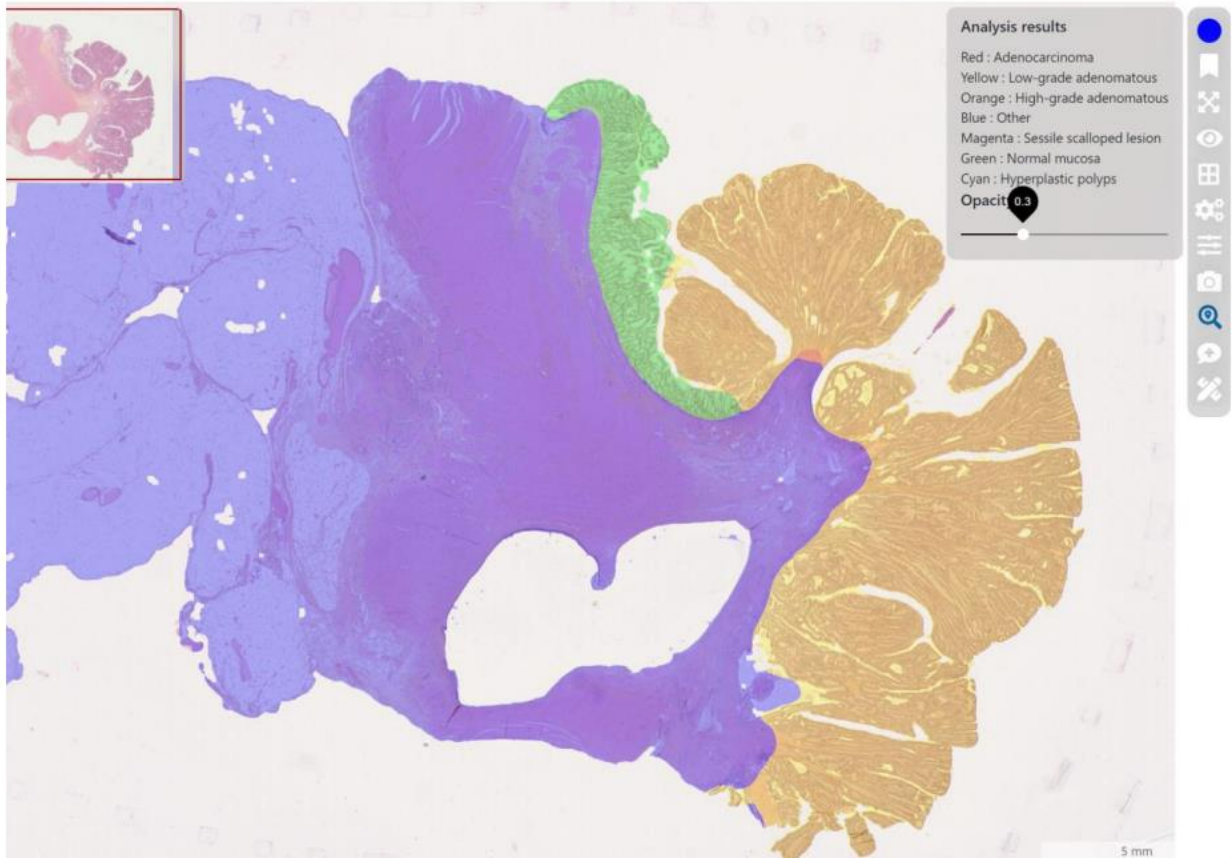
DIGESTIVE BIOPSIES TRIAGE





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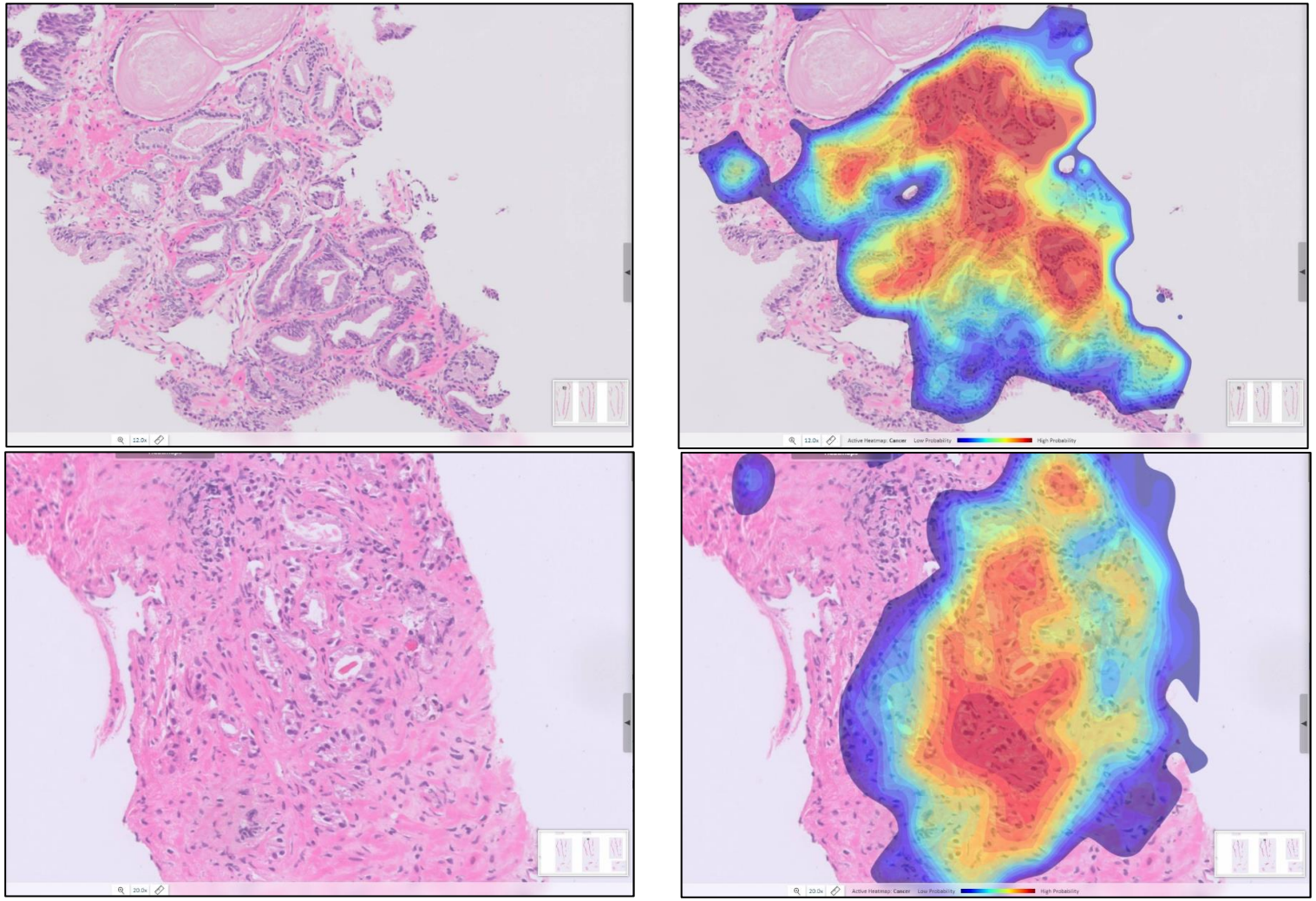
DETECTION OF CANCER (EX. PROSTATE BIOPSIES)



Alexi Baidoshvili, MD, PhD. Real Life Efficiency Gains using Digital and Computational Pathology: A Pathologist's Viewpoint. LABPON

paration (1) | Review (50) | Complete (2) | All (53) | Showing 20-30 of 50 | 1 | 2 | ... | 5

Case ID	Patient	DOB	Accession	Bench	Slides	Clinician	AI result
A03392 Updated	Abercrombie, John Male	Mar 6, 1953 68 years	Oct 16, 2020 2 days ago	Prostate Biopsy	16 slides 13 parts	F. Jefferson LMC	Cancer Benign 3+
S14-9988	Remy, Jake Male	Apr 23, 1950 71 years	Oct 16, 2020 2 days ago	Prostate Biopsy	19 slides 2 parts	F. Jefferson LMC	Cancer Undetermin..
C-ECTP0100 Updated	Johnsonsto, Hansel Male	Apr 17, 1975 45 years	Oct 16, 2020 2 days ago	Prostate Biopsy	12 slides 3 parts	F. Jefferson LMC	Cancer
C-ECTP0100	Lopez, Brad Male	Apr 17, 1975 45 years	Oct 16, 2020 2 days ago	Derm Biopsy	12 slides 3 parts	F. Jefferson LMC	Likely Malig..
C-ECTP0100 Pending	Smith, John Male	Apr 17, 1975 45 years	Oct 16, 2020 2 days ago	Prostate Biopsy	12 slides 3 parts	F. Jefferson LMC	Benign
C-ECTP0100 Pending	Mason, Paul Male	Apr 17, 1975 45 years	Oct 16, 2020 2 days ago	Prostate Biopsy	12 slides 3 parts	F. Jefferson LMC	Benign
C-ECTP0100	White, Jennifer Female	Apr 17, 1975 45 years	Oct 16, 2020 2 days ago	Breast Resection	12 slides 3 parts	F. Jefferson LMC	
C-ECTP0100 Pending	Price, Monique Female	Apr 17, 1975 45 years	Oct 16, 2020 2 days ago	Breast Resection	12 slides 3 parts	F. Jefferson LMC	
C-ECTP0100	Bradford, Cristina Female	Apr 17, 1975 45 years	Oct 16, 2020 2 days ago	Derm Biopsy	12 slides 3 parts	F. Jefferson LMC	Suspect Mel..
C-ECTP0100	Chapman, Marianne Female	Apr 17, 1975 45 years	Oct 16, 2020 2 days ago	Breast Resection	12 slides 3 parts	F. Jefferson LMC	

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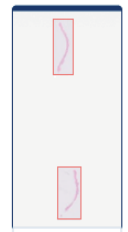
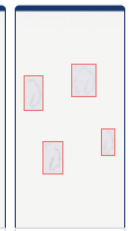
16 slides | 13 parts, 13 blocks

Part A | 1 slide
A1 | 1 slide

A03392-A1-1
H&E
Benign

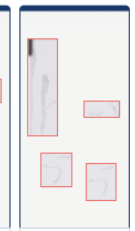
Part B | 1 slide
B1 | 1 slide

A03392-B1-1
H&E
Benign

Part C | 2 slides
C1 | 2 slides

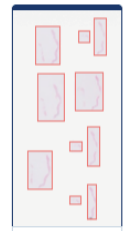
A03392-C1-1
H&E
Benign

A03392-C1-2
PR3x
IHC

Part D | 2 slides
D1 | 2 slides

A03392-D1-1
H&E
Benign

A03392-D1-2
PR3x
IHC

Part E | 1 slide
E1 | 1 slide

A03392-E1-1
H&E
Undeterm.

Part F | 1 slide
F1 | 1 slide

A03392-F1-1
H&E
IQ issue

Part G | 1 slide
G1 | 1 slide

A03392-G1-1
H&E
Benign

Part H | 2 slides
H1 | 2 slides

A03392-H1-1
H&E
Benign

A03392-H1-2
PR3x
IHC

Part I | 1 slide
I1 | 1 slide

A03392-I1-1
H&E
Benign

Part J | 1 slide
I1 | 1 slide

A03392-J1-1
H&E
Benign

QUALITY CONTROL

QC AI

Identify quality issues in high throughput workflows prior to pathologist review.

Tissue Cut-Off

Missing / No Tissue

Pen marks, Air bubbles

Out of focus identification

Serial Section Alignment

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COMPUTATIONAL PATHOLOGY

- An approach to diagnosis that incorporates multiple sources of raw data (clinical electronic medical records, lab data including omics, imaging (radiology and pathology), extracts biologically and clinically relevant information from these data, uses mathematic models at the molecular, individual and populational levels to generate diagnostic interferences and predictions, presents this knowledge to customers through dynamic and integrated reports and interfaces, enabling physicians, patients, lab personnel and other health care stakeholders to make the best possible medical decisions
- DPA: the ‘omics’ or ‘big-data’ approach to pathology, where multiple sources of patient information including pathology image data and **meta-data** are combined to extract patterns and analyze features
- Subset of this field, encompassing CP applications related to whole slide imaging (WSI) and analysis

Louis DN *et al.* Computational pathology: an emerging definition. *Arch Pathol Lab Med* 2014; 138: 1133–1138

E Abels et al. Computational pathology definitions, best practices, and recommendations for regulatory guidance: a white paper from the Digital Pathology Association, J Pathol. 2019 Nov; 249(3): 286–294

COMPUTATIONAL PATHOLOGY

- Promises
  - Gain in efficiency: assists the pathologists in tedious and time-consuming tasks
  - Building clinical decision support tools to diagnose accurately and improve patient care
- Limitations
  - sensibility and specificity of IA apps still unacceptable for direct clinical use due to low quality and number of training sets
  - « black box phenomenon »
- Research in AI is limited by ethical and legal issues, regulation policy

M Cui, D Zhang. Artificial intelligence and computational pathology. Lab Investigation (2021) 101:412-422

AI Mukhamediev et al. Review of Artificial Intelligence and Machine Learning Technologies: Classification, Restrictions, Opportunities and Challenges. *Mathematics* **2022**, *10*(15), 2552; **https://doi.org/10.3390/math10152552**

THE NEXT STEP

- According to a recent survey from experts in the field of DP, IA would be routinely used within Anatomical Pathology (AP) laboratory and pathologist clinical workflow by 2030
- Our provincial project will ensure interoperability between platforms to facilitate interaction and collaboration between pathologists across multiple laboratories as well as exchanging data
- Healthcare institutions could be encouraged to pool anonymized patient data and make them publicly accessible, so that researchers around the world may cooperate to develop more accurate diagnostic algorithms
- At CHUM we are planning cloud storage to collect WSI for future research in AI
- We will join expertise with computer scientists to further advance AI development for clinical use

M Alvaro Berbis, DS McClintock, A Bychkow, and al. Computational pathology in 2030: a Delphi study forecasting the role of AI in pathology within the next decade. www.thelancet.com Vol 88 Feb, 2023.

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CONCLUSIONS

1. Requirements for a successful implementation of digital pathology for primary diagnosis: planning, selection of equipment, connectivity and interoperability, collaboration, change management

2. Gains : efficiency, use of AI, happy work environment: benefit patient care

   Limitations : cost, robustness, service provider, “black box”

3. Future perspectives of digital pathology for clinical use :

   Computational pathology

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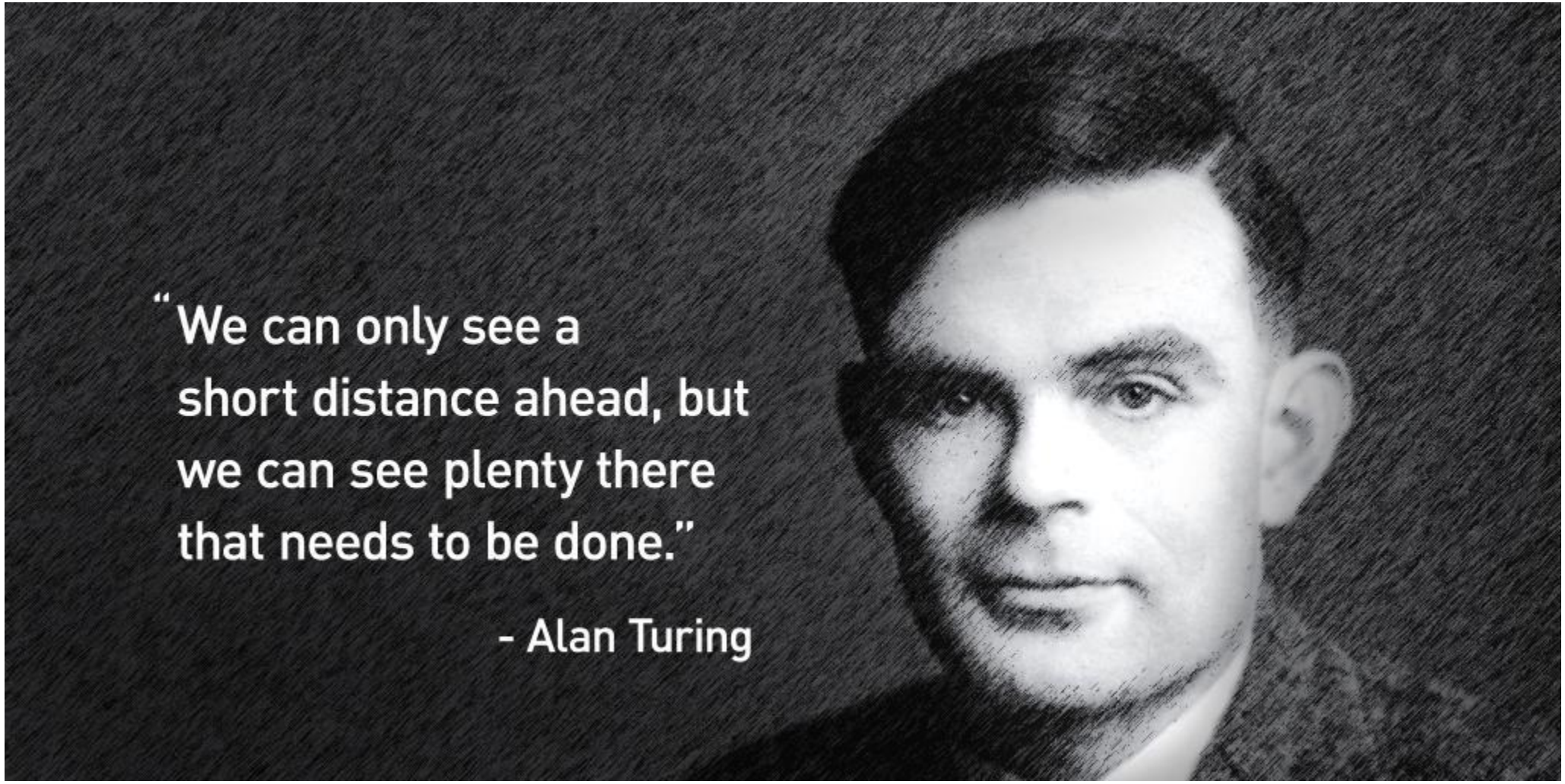

The Turing test : A computer would deserve to be called intelligent if it could deceive a human into believing that it was human

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