Whole Slide Imaging/ Digital Pathology

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Whole Slide Imaging/ Digital Pathology

Historical Perspective

Advantages

Obstacles

Experience from our Demonstration Project

Disclosures

No financial relationship with any digital pathology company including Philips.

Member of the team evaluating the Philips Image Management System as part of a demonstration project with Sonora Quest Laboratories and Banner Health System.

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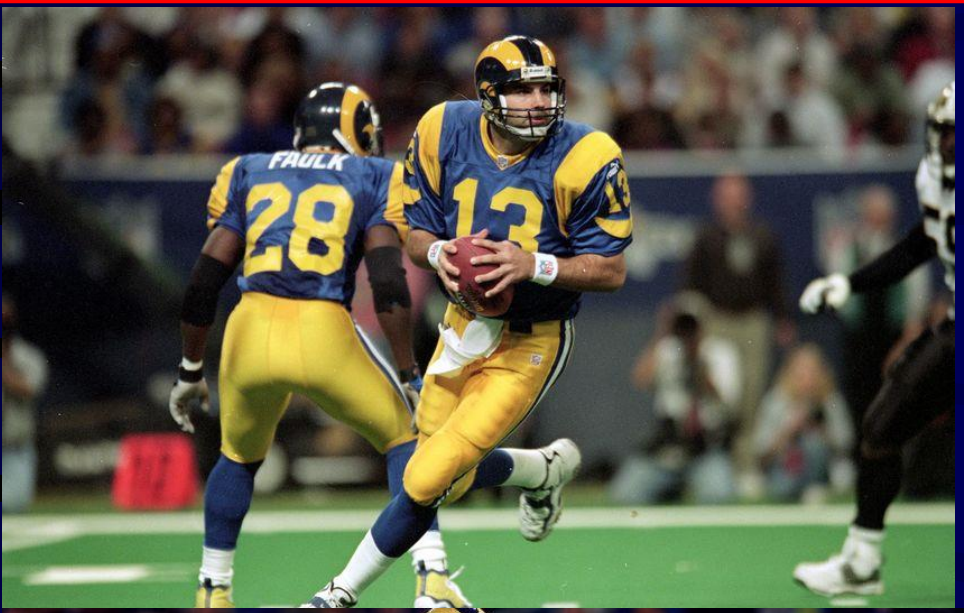
The RAMS ARE BACK!



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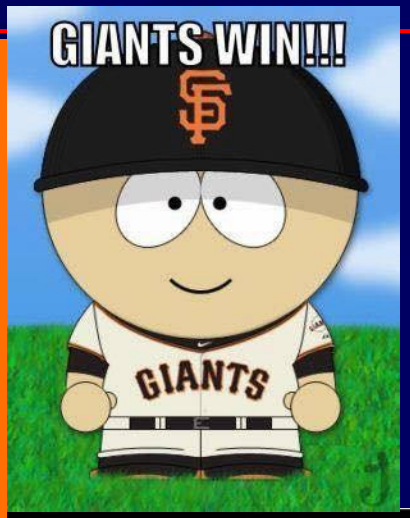
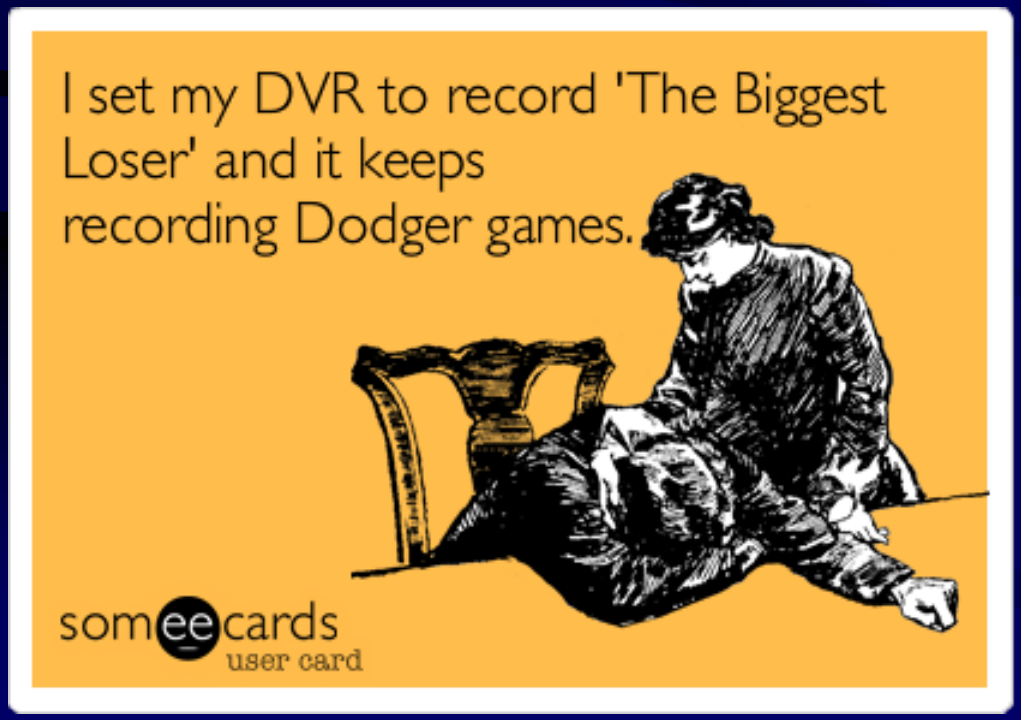
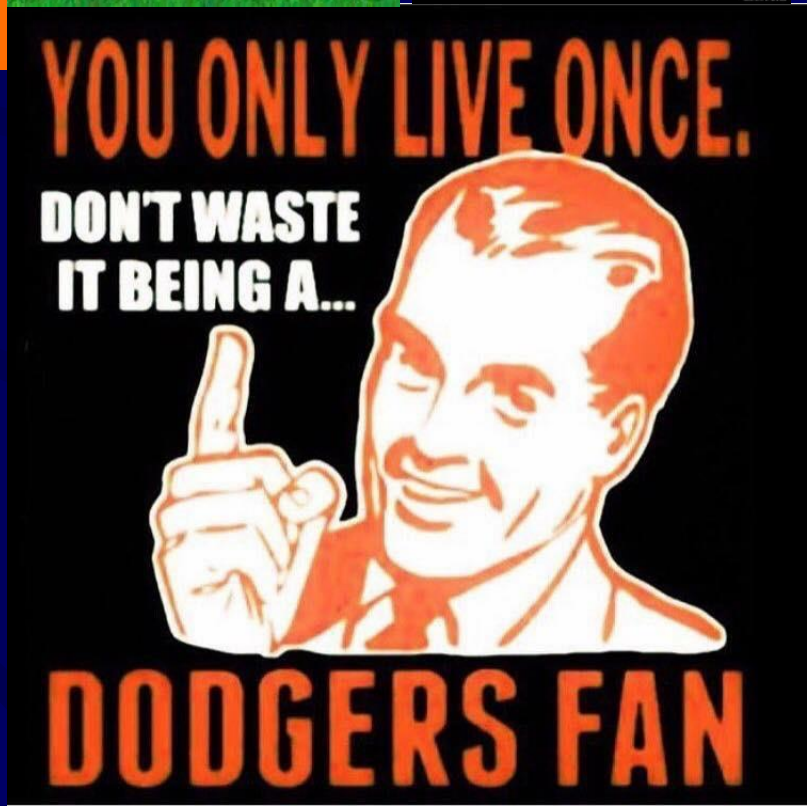
And for you Dodger Fans!





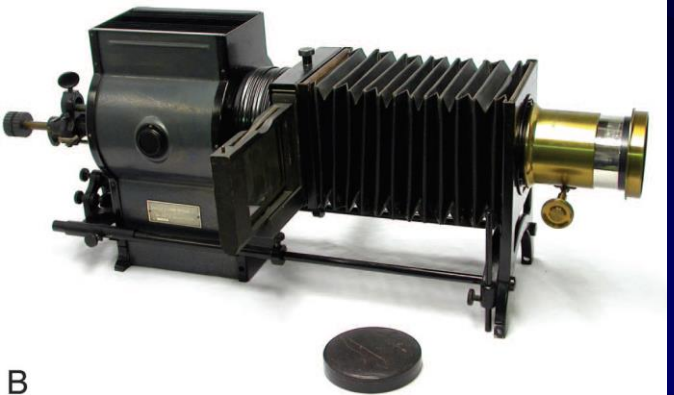


Objectives

- Review the historical time line/ evolution of digital pathology.
- Describe the advantages of whole slide imaging.
- What are the key elements/ obstacles for implementation.
- Knowledge gained from Philips-Banner-SQL Demonstration Project.

100 year span

Leitz Lantern Slide Camera, circa 1910



Bausch and Lomb Lantern Slide Projector, circa 1908

Morrison and Gardner:Arch Pathol Lab Med. 2015;139:1558

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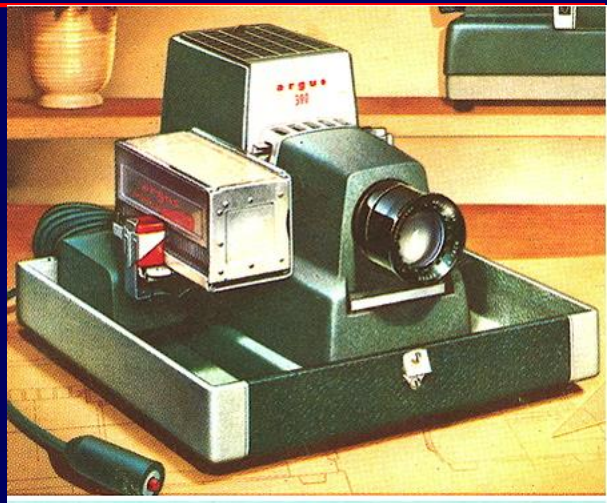
Enter the 1930-1960s

1935

1956



1961

1945

Figure

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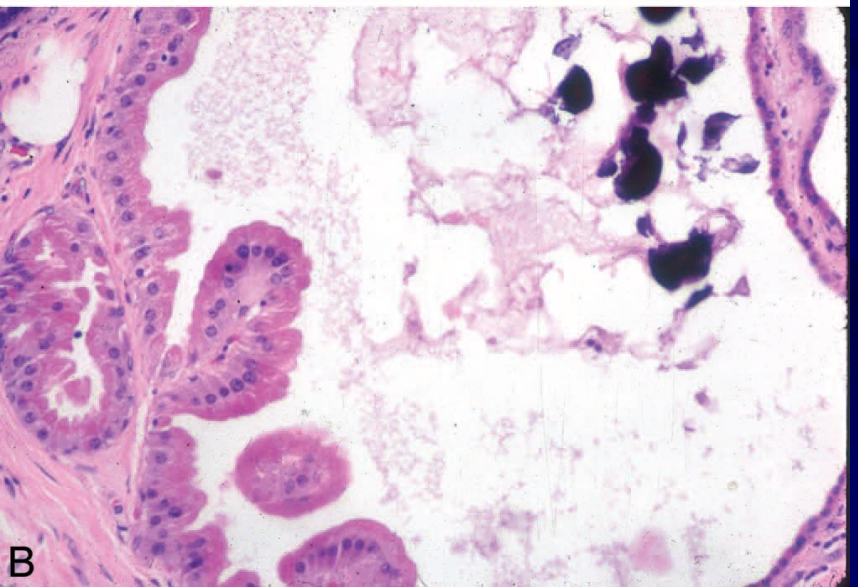
Enter the 1950-60s

Enter the 1980's

A


B

Morrison and Gardner:Arch Pathol Lab Med. 2015;139:1558

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Enter the late 1990's

Enter the 21 century

MICROSCOPE WITH DIGITAL CAMERA	WHOLE SLIDE SCANNERS	ROBOTIC MICROSCOPES	IMAGE ANALYSIS SYSTEMS
	 	 	

Thrall, M, et al. J Pathol Inform 2011, 2:51

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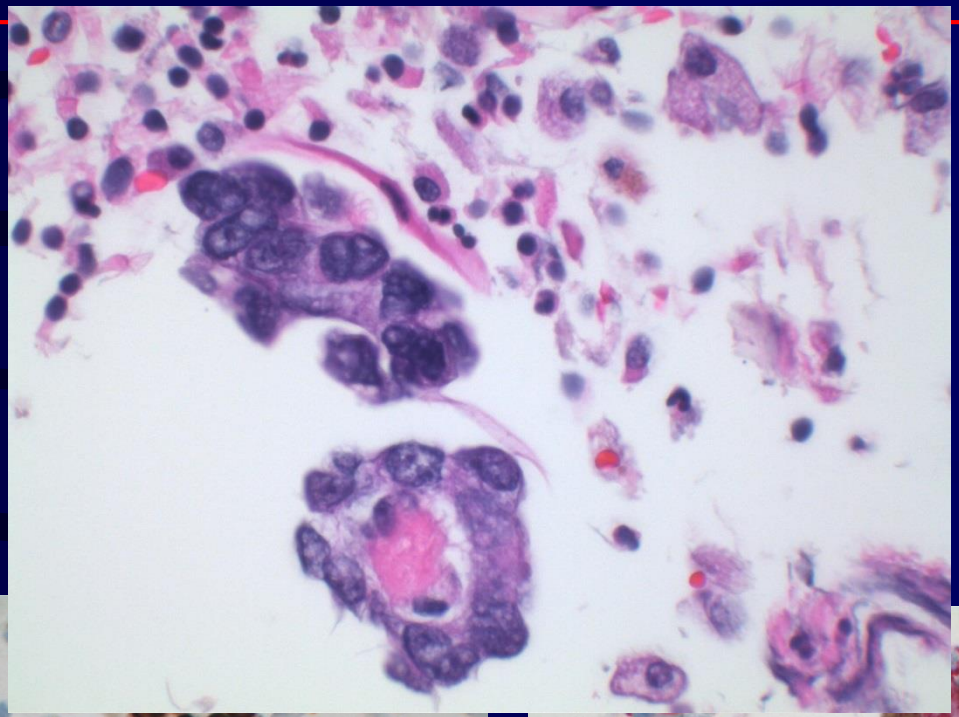
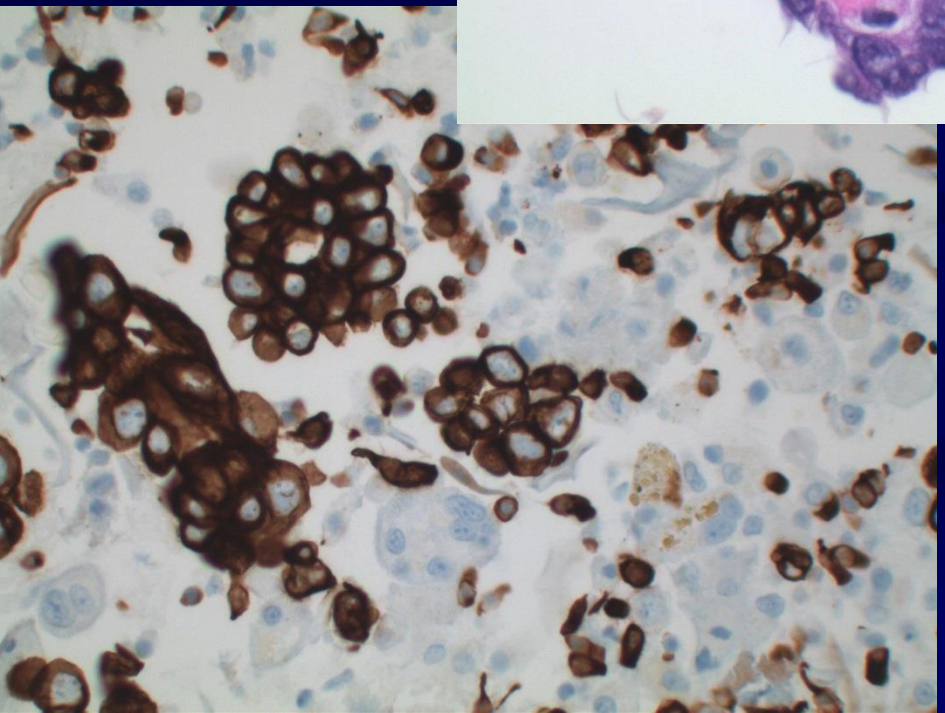
Patient A BAL fluid

spot digital camera

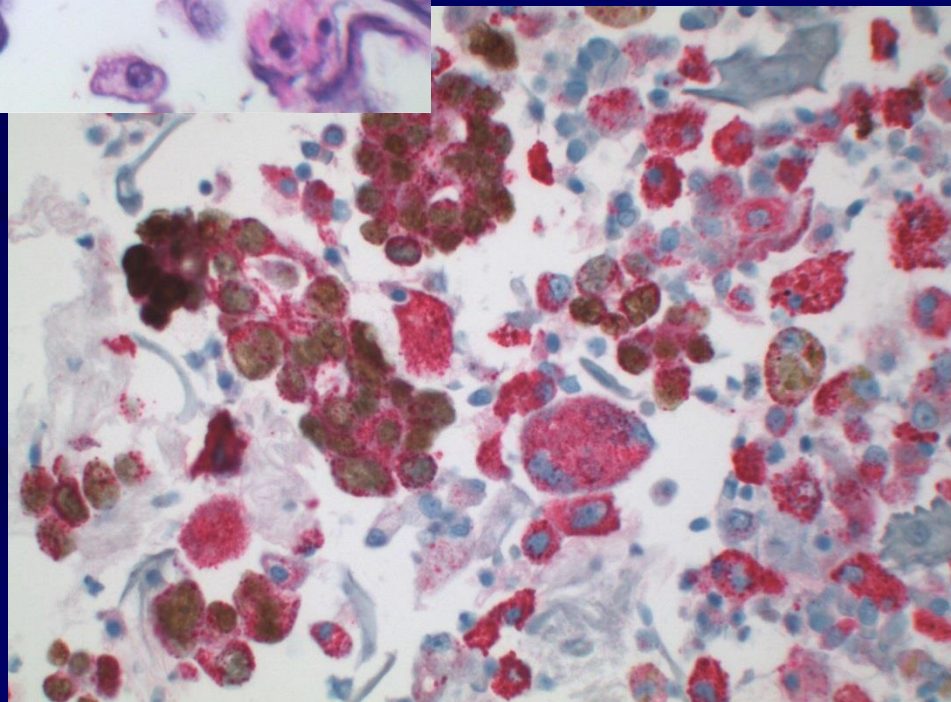


Proof of Lung origin

CK7



TTF-1/ Napsin




RAMS
FOOTBALL
CLUB


OUTDOOR

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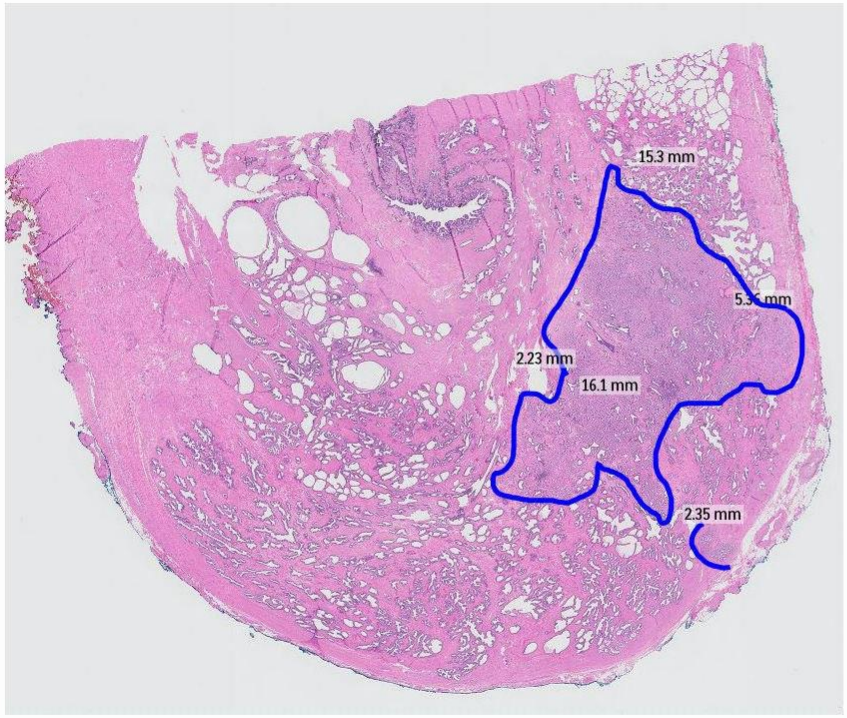
Zoom 1x



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Advantages to Whole Slide Imaging

Rapid availability of scanned images to the pathologist.

Eliminate courier time and ↓ cost for labs with multiple remote sites.

Evaluation of multiple slides and regions simultaneously.

Rapid and easy measurement: depth of invasion, area, cell size.

Telepathology: Frozen sections, internal and external consults

Image analysis and application of deep learning tools.

Real time consultation and collaboration

Evans, et al. Arch Pathol Lab Med—Vol 141, July 2017

Considerations in Implementation

Barriers to the Adoption of Whole Slide Imaging for Clinical Use

Cost: hardware, software, information technology support/ infrastructure and maintenance

Pathologist perception of inferior performance compared to microscopy

Lack of standards and/or best practice guidelines

Evans, et al. Arch Pathol Lab Med—Vol 141, July 2017

Considerations in Implementation (2)

Barriers to the Adoption of Whole Slide Imaging for Clinical Use

Regulatory issues: lack of US FDA approval
(prior to late 2017)

Medicolegal liability, licensure, and credentialing issues

Absence of defined professional billing codes or business models

Evans, et al. Arch Pathol Lab Med—Vol 141, July 2017

Considerations: Implementing WSI for Diagnosis

- Cost: hardware, software, information technology support/ infrastructure and maintenance
- Pathologist perception of inferior performance compared to light microscopy
- Lack of standards and/or best practice guidelines
- Regulatory issues: lack of US Food and Drug Administration approval in the United States
- Medicolegal liability, licensure, and credentialing issues
- Absence of defined professional billing codes or business models

Evans, et al. Arch Pathol Lab Med—Vol 141, July 2017

Considerations: Implementing WSI for Diagnosis

Applications of WSI in patient care: where to start and how to assemble an implementation team: all slides; IHC, sp. stains etc.

Strategy for selecting a WSI scanner

Resources required to operate and maintain a clinical digital pathology program

Validation of the system to be used

Strategies to encourage adoption of WSI by pathologists

What to expect after going live, based on the experience of early adopters

Evans, et al. Arch Pathol Lab Med—Vol 141, July 2017

Considerations: Implementing WSI for Diagnosis

- Applications of WSI in patient care: where to start and how to assemble an implementation team
- Strategy for selecting a WSI scanner
- Resources required to operate and maintain a clinical digital pathology program
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- What to expect after going live, based on the experience of early adopters

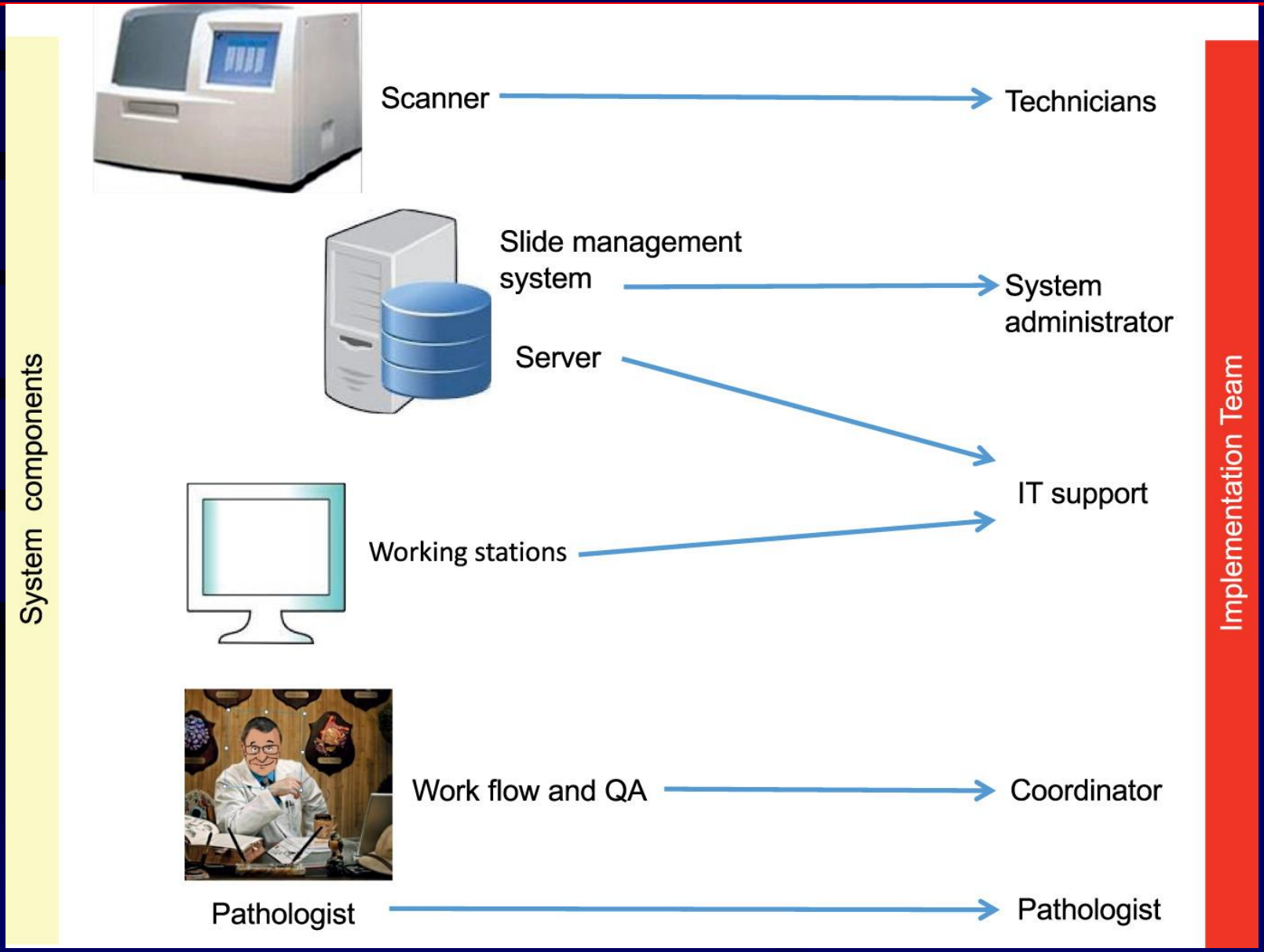
Evans, et al. Arch Pathol Lab Med—Vol 141, July 2017

Pathologist Discomfort with WSI

- Lack of training or experience with the technology
- Time required to review cases by WSI such that confident diagnoses are rendered
- Fundamental mechanical and ergonomic differences between WSI and light microscopy
- Concern that WSI will introduce unfamiliar digital artifacts over and above those generated by routine histologic processing
- Lack of US Food and Drug Administration approval to use WSI for primary diagnosis in the United States

Evans, et al. Arch Pathol Lab Med—Vol 141, July 2017

Considerations: Implementing WSI for Diagnosis



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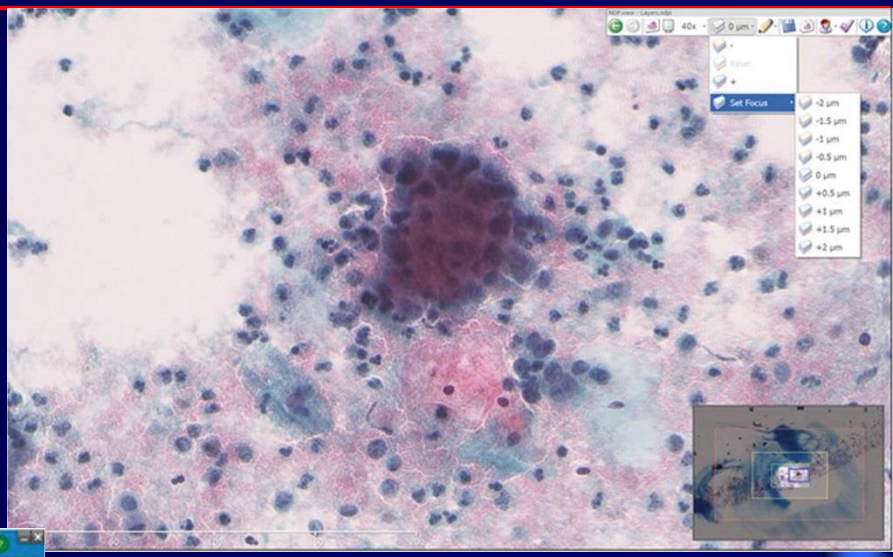
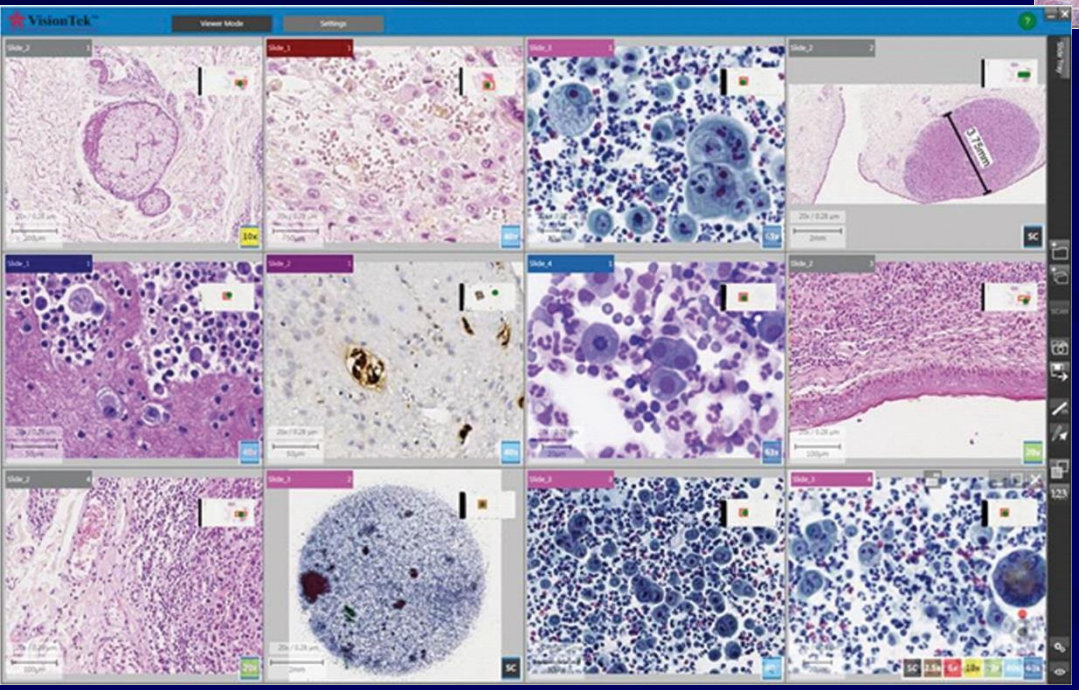
Applications: WSI





Aperio- upper left:
View up to 4 slides

Hamatsu: upper right
Cytology

Vision Tek-Sakura
Multiple slides- modalities

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Whole Slide Imaging Philips Study

14 month randomized, blinded study using cases intended for routine surgical pathology diagnosis.

1992 cases read across 4 institutions and 16 pathologists

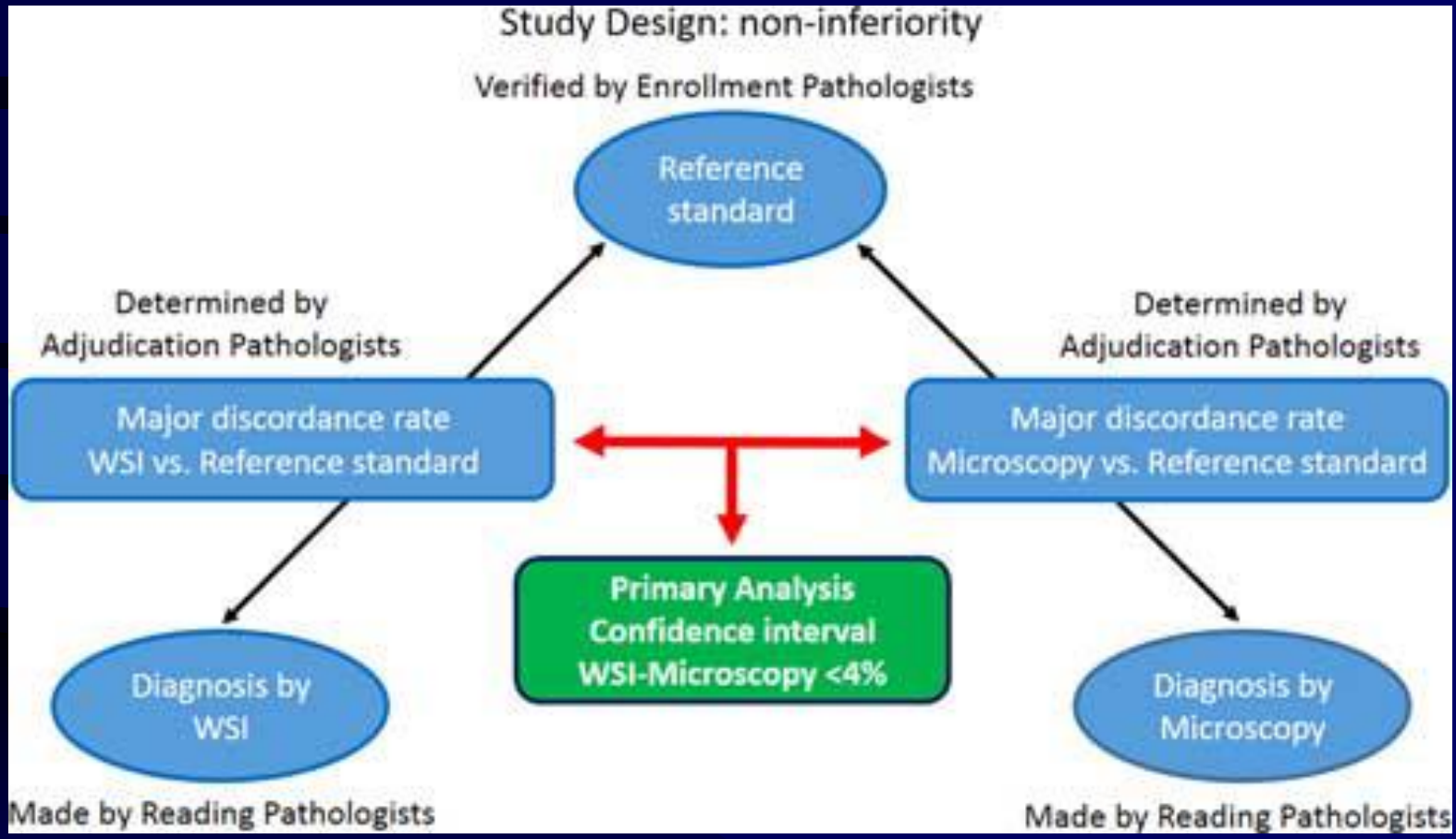
Philips Intellisite Pathology Solution: 15,292 reads

4 week washout period before re-read using alternative method (digital vs microscopy and vice versa)

73% of slides were HE, 27% IHC and histochemical test slides.

Am J Surg Pathol Volume 42, Number 1, January 2018

Whole Slide Imaging Philips Study



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Whole Slide Imaging Philips Study

Digital slides were read in batches of 20.

Mean read time: microscopy: 74 seconds; digital: 84 sec

94% slides scanned adequately on first scan; 98.5% by 2 scans. Maximum # scans utilized was 5.

Reference standard: Original sign out Dx by microscopy.

Major discrepancy rate with ref. standard: 4.6% by microscopy and 4.9% by WSI.

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Whole Slide Imaging Philips Study (2)

Differences by Organ System:

<1% WSI discordance > microscopy: Stomach, skin, brain, colorectal and prostate.

>1% WSI discordance: GYN (1.2), bladder (1.3), neopl. Kid (1.5); endocrine (1.8%)

<1% microscopy discord > WSI: Breast, respiratory, LN's

>1% microscopy discord > WSI: liver/biliary, salivary, perianal

No difference: peritoneal, appendix, gallballder, soft tissue

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Philips- Demonstrtion Project

7 week evaluation of the Philips Intellesite Scanner and Image Management System (IMS): Sonorq Quest Labs; Banner Health

Scanned IHC, recut and special stain slides in first 4 weeks and then added selected up front HE slides

2 Pathologists at independent sites reading their own cases in parallel with glass slides, in no particular order, though usually digital slides first.

Not intended as a validation of the system or individual pathologists

Slides scanned at the central SQL location into server on site.

IMS system application installed on each pathologist's current workstation and their current monitor was used.

The FDA approved workstation was intended for use but could not be installed in time for each pathologist. Available for demonstration, training and additional exploration at the central location, as time allowed.

As of 4/2/18, number of cases and slides imaged and read per pathologist: 450 cases/ 1575 slides.

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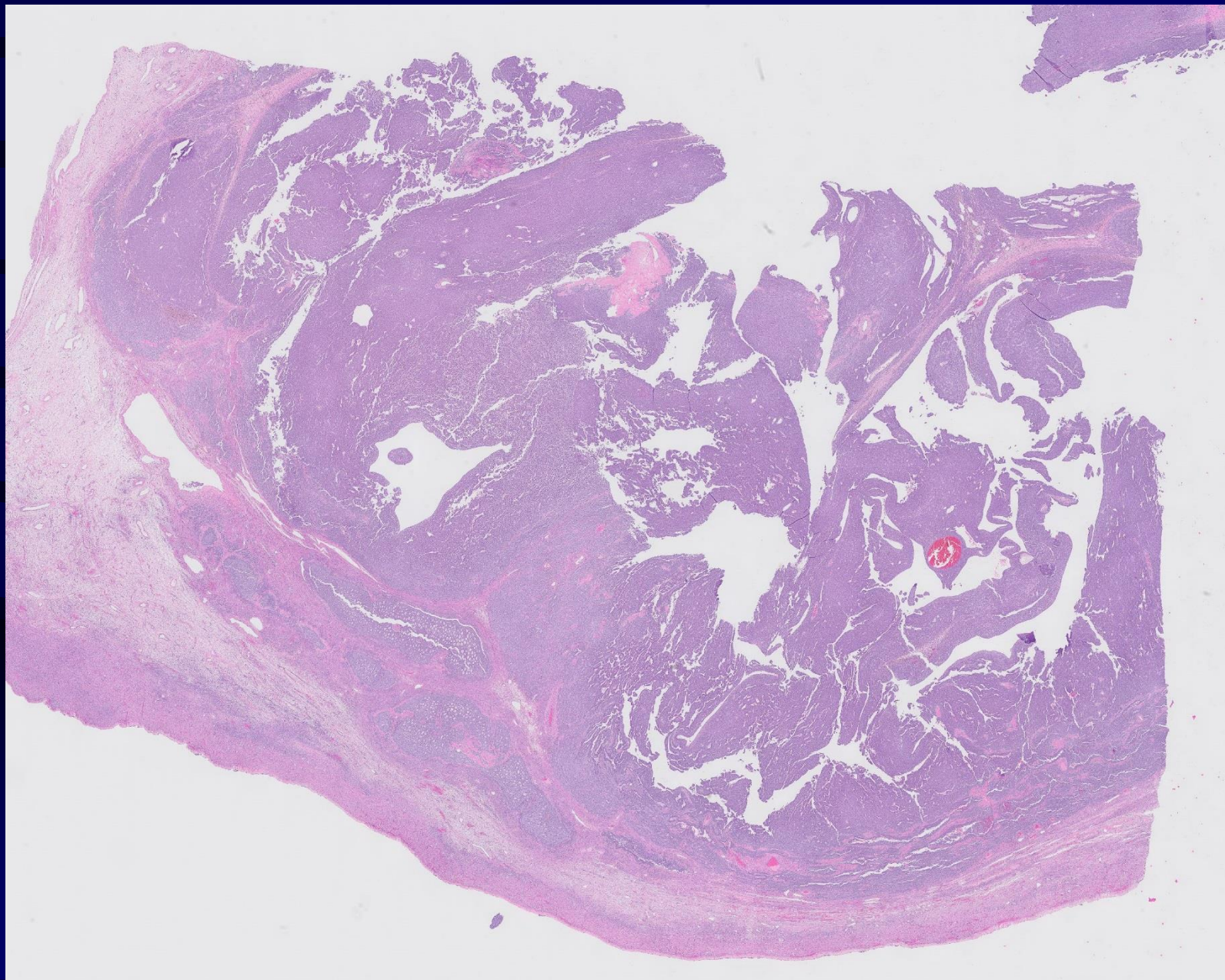
38 yo: abnl vaginal bleeding and ovarian mass

Exported snapshots from the whole scanned slide



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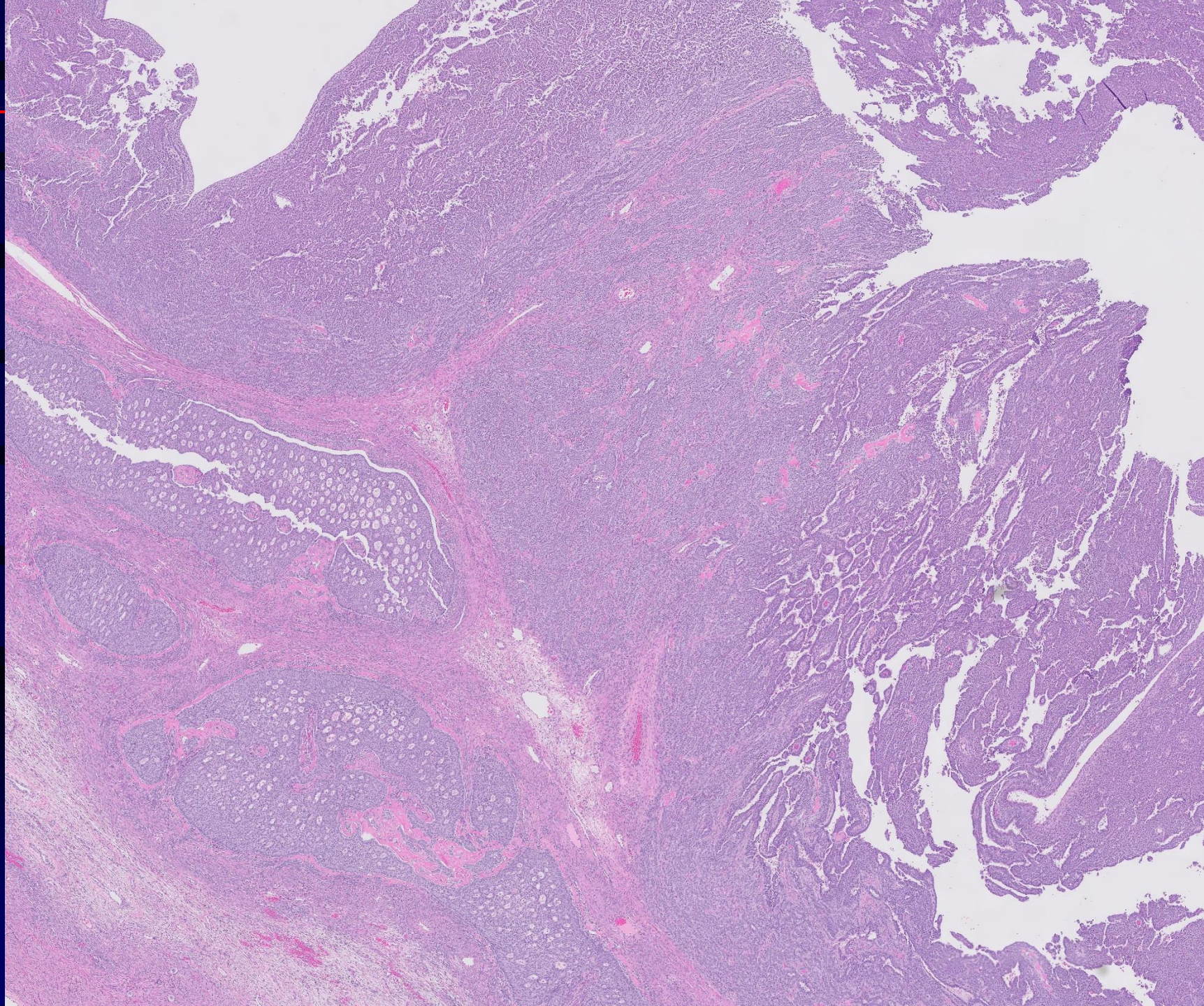

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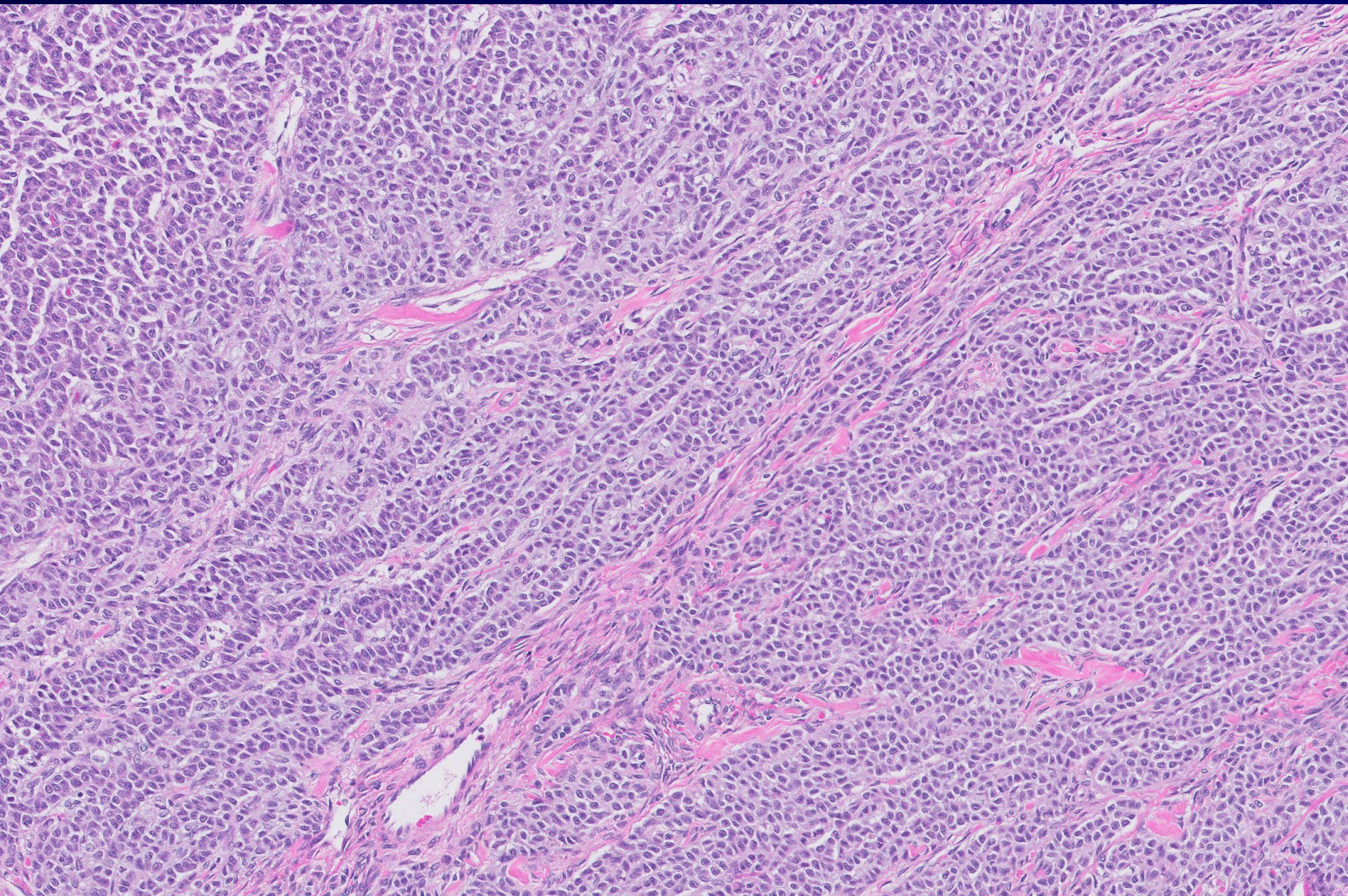

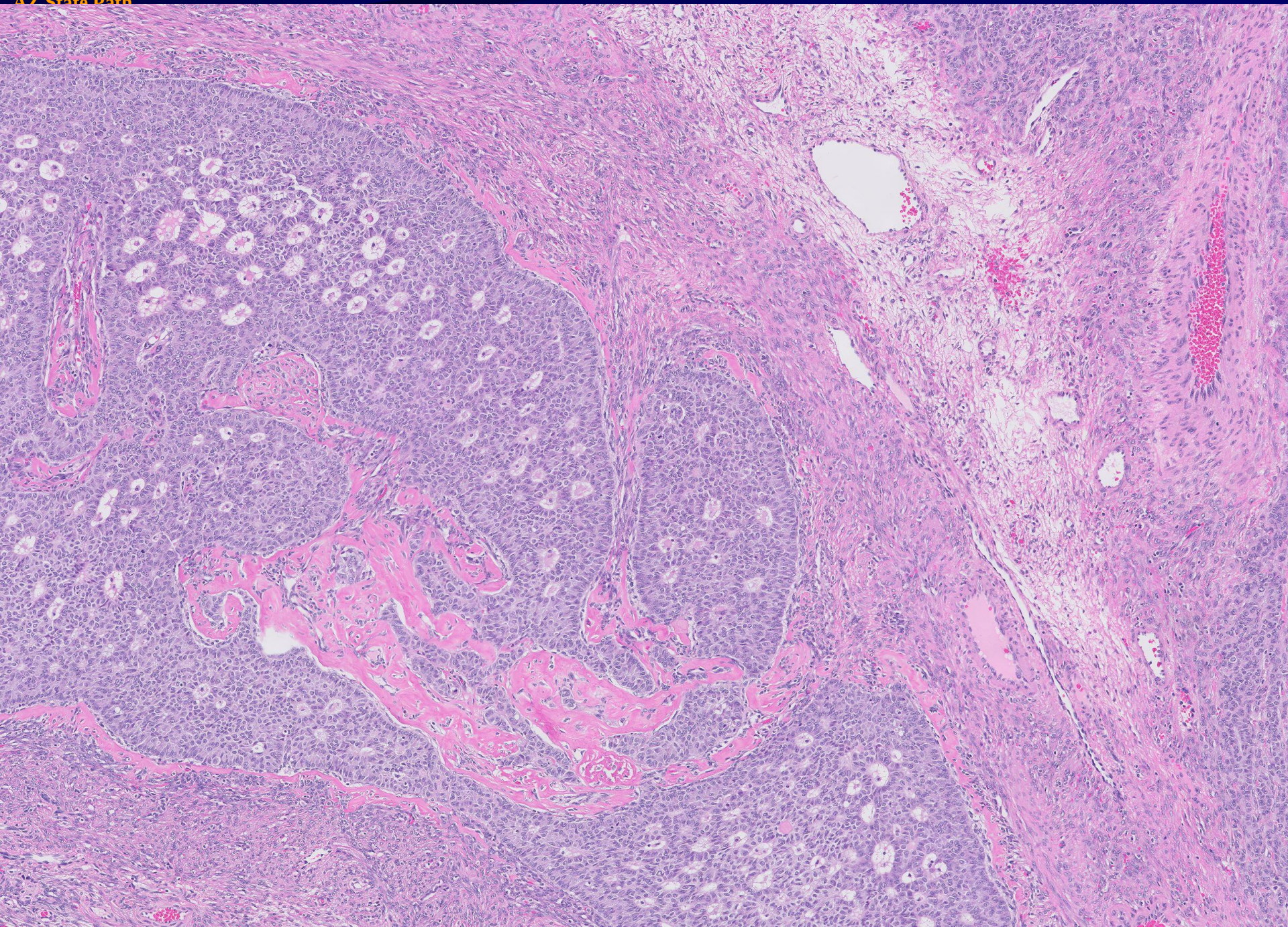

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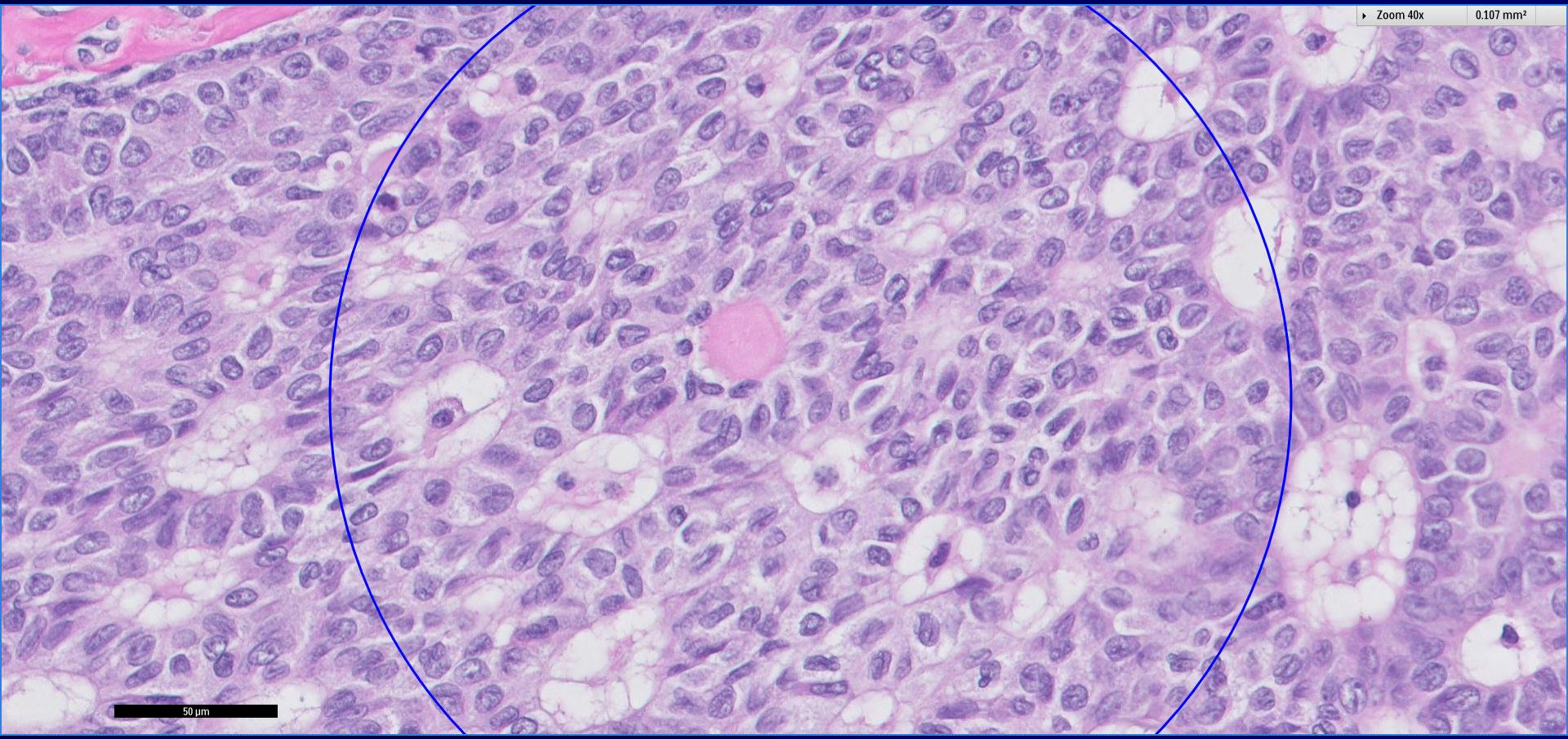

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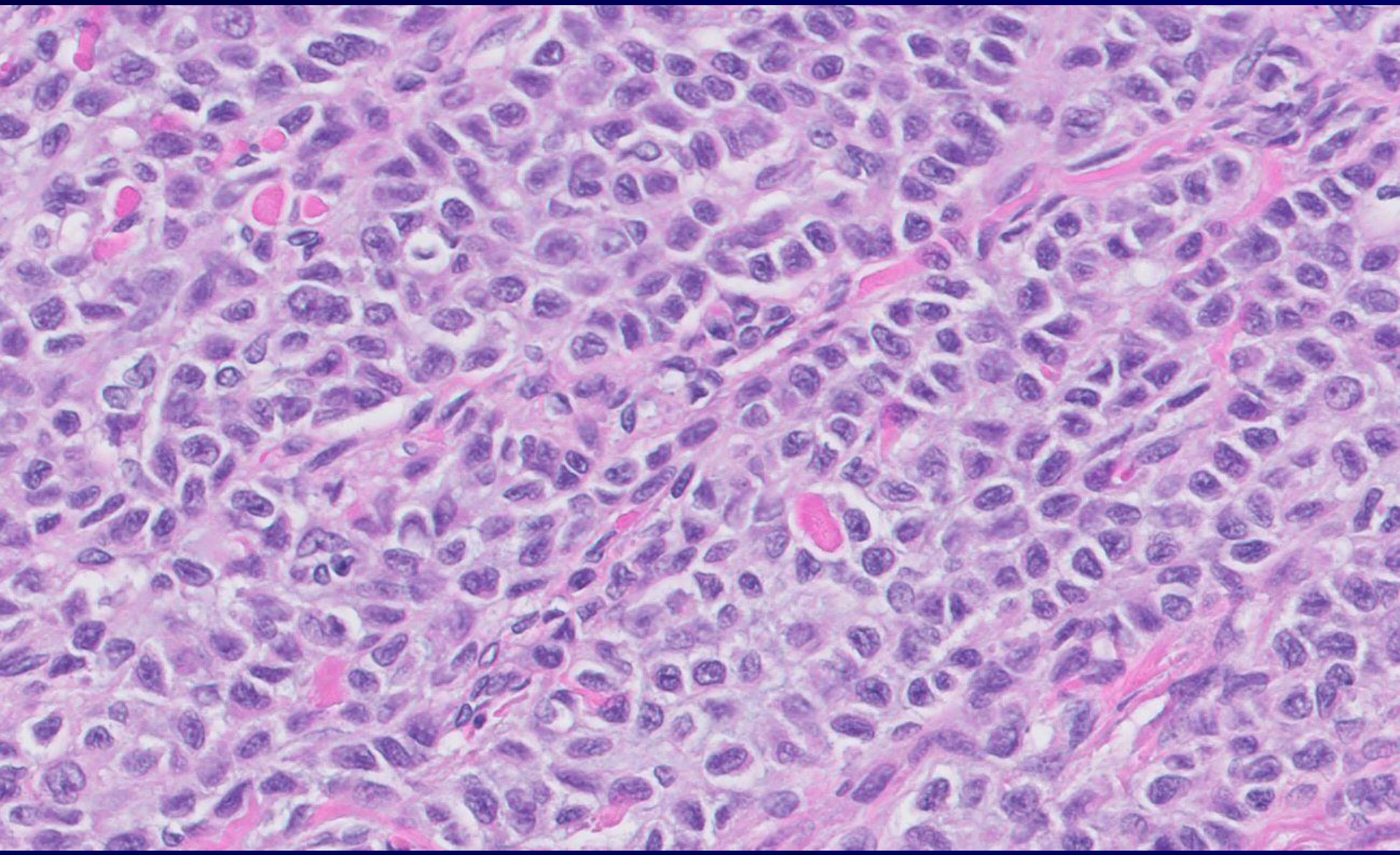

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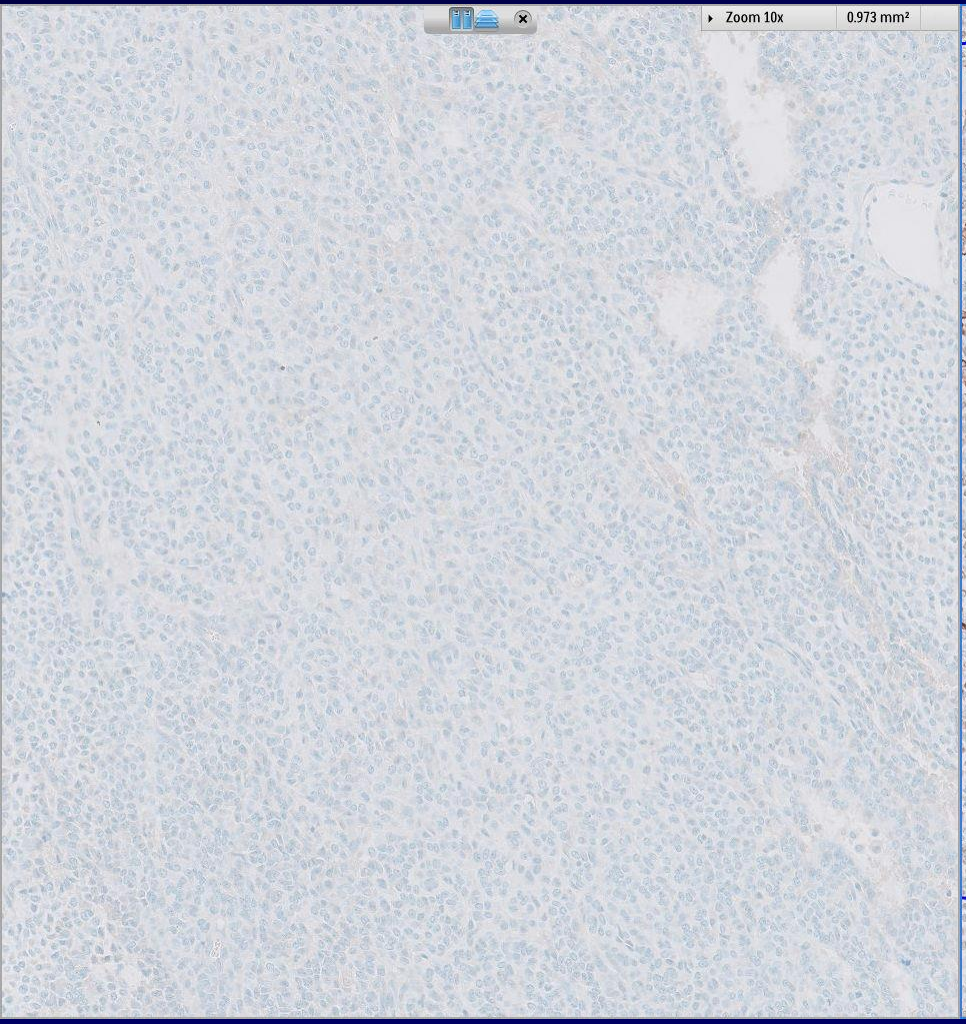
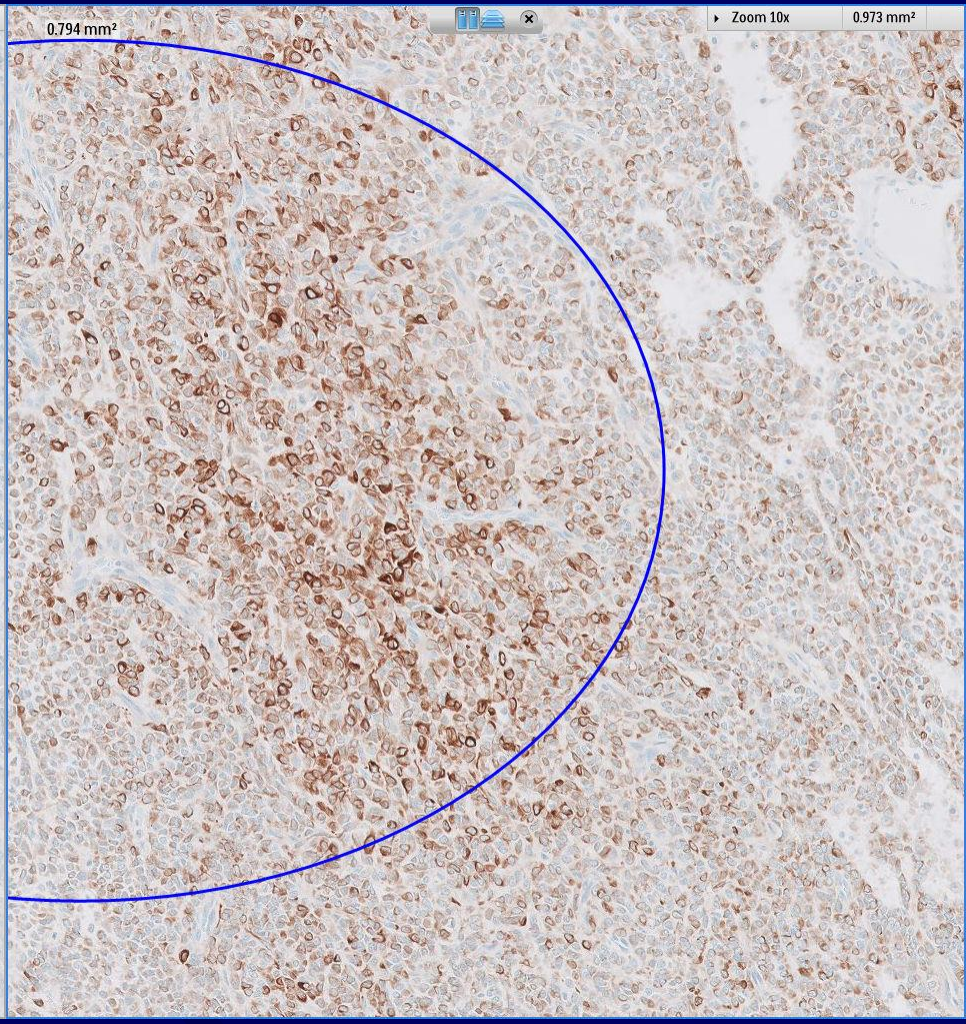
EMA



Cam5.2



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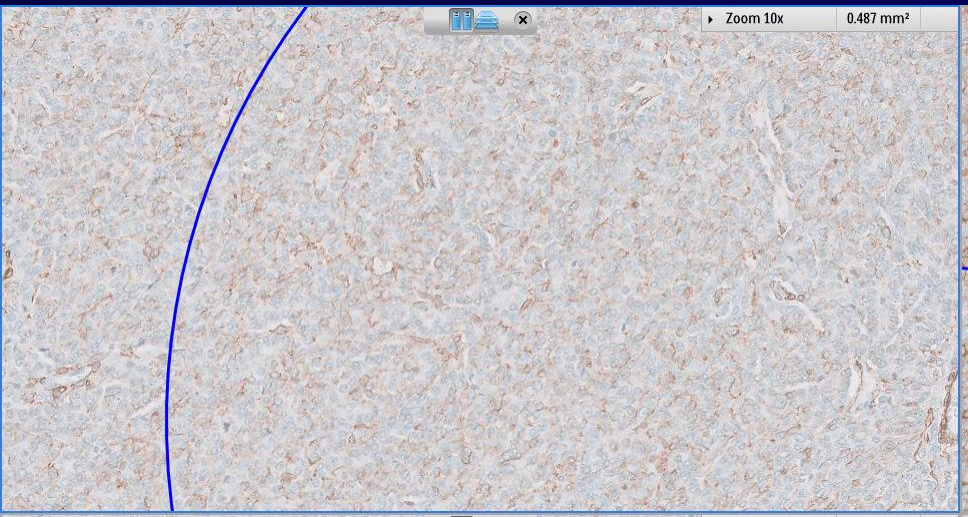
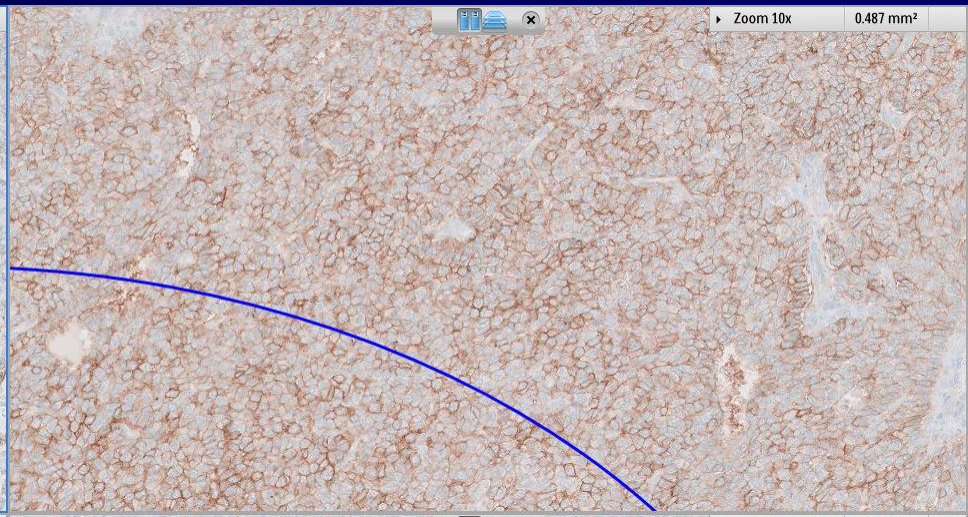
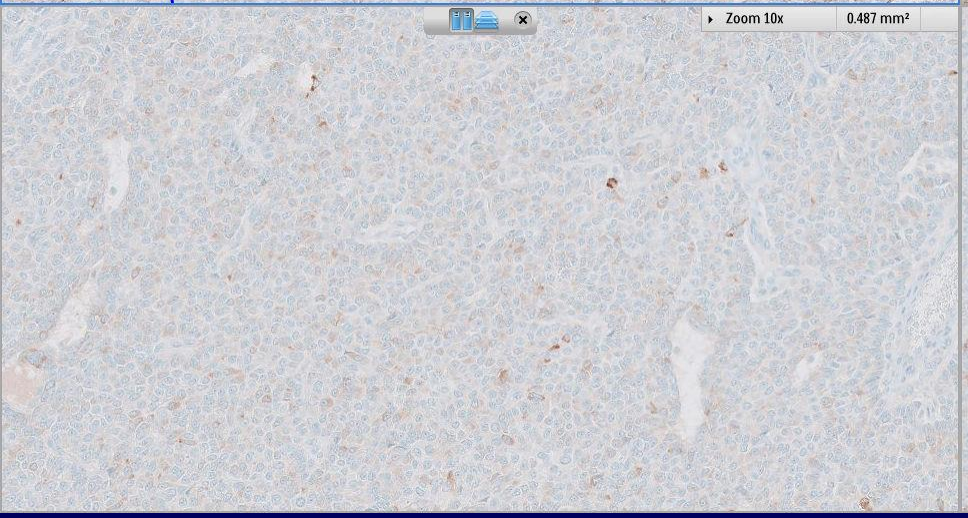
SMA



CD99



inhibin



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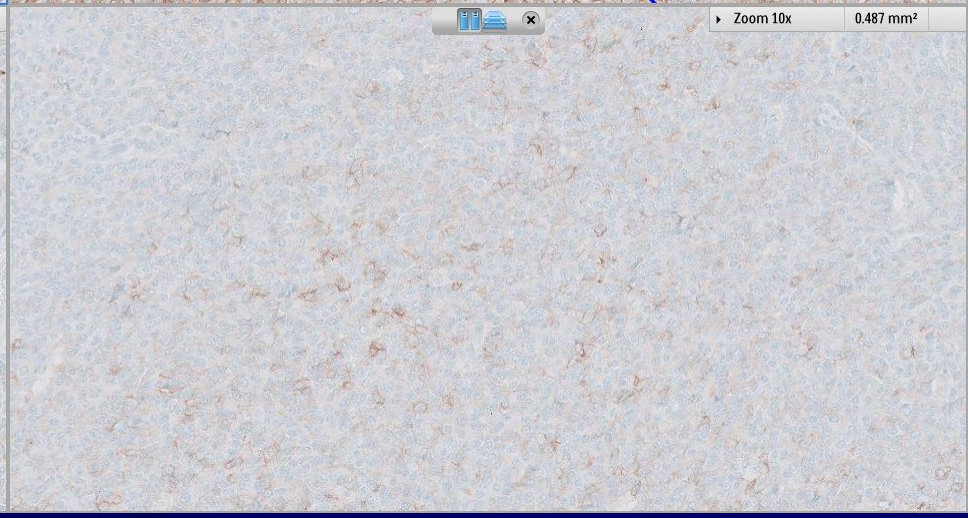

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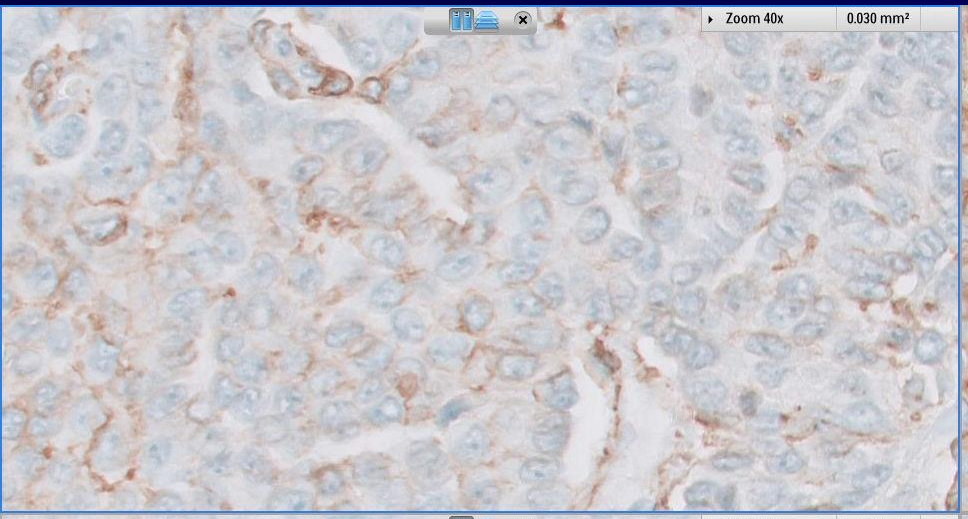
Granulosa cell tumor

SMA



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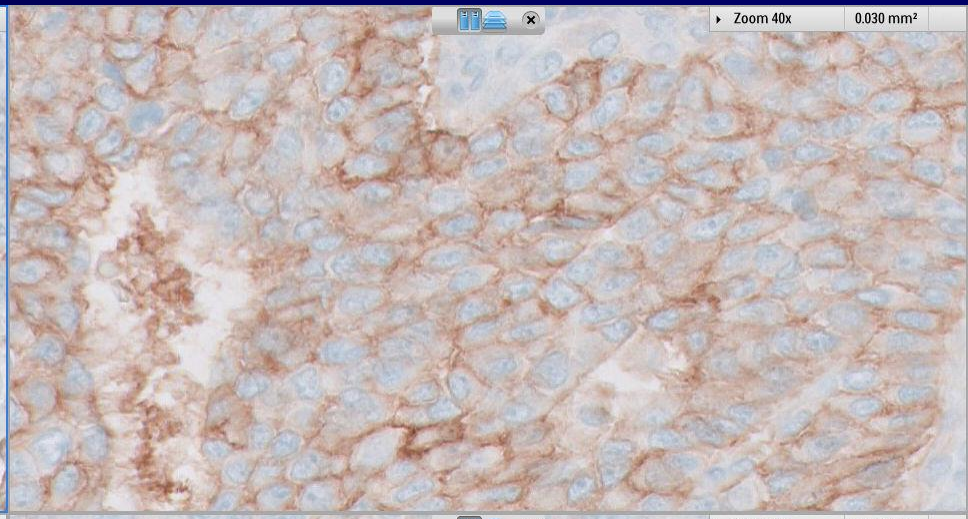

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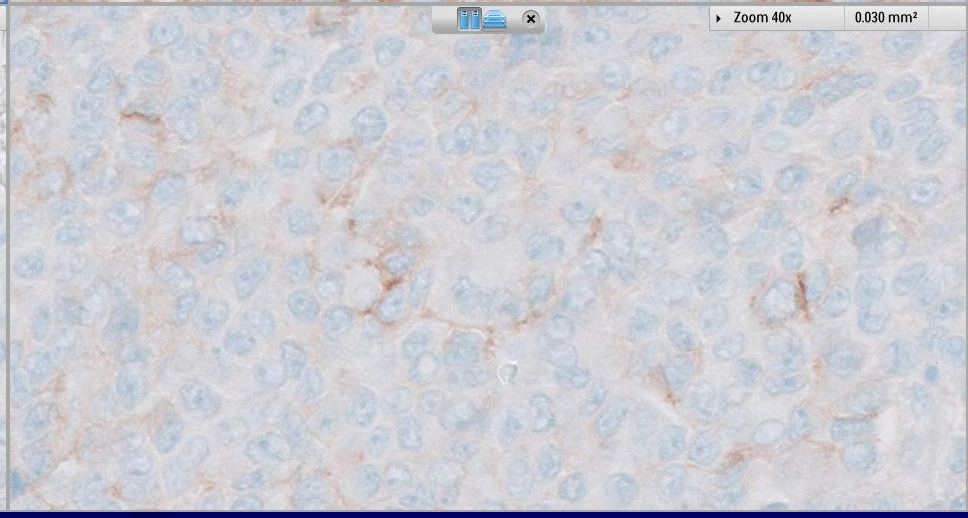

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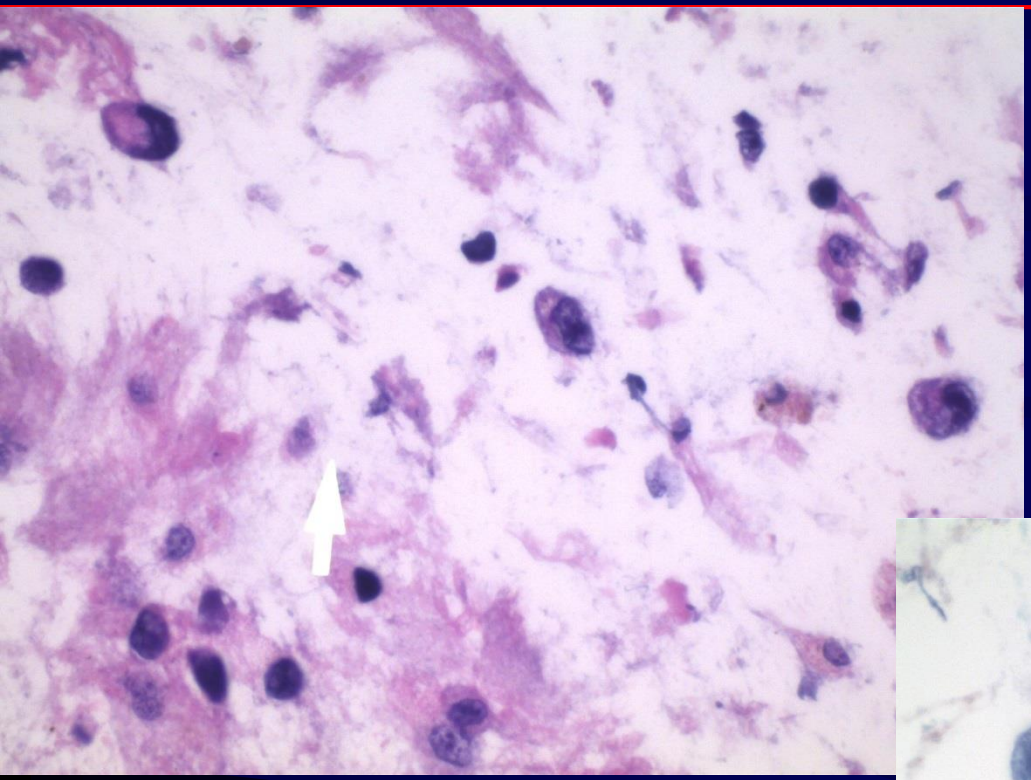
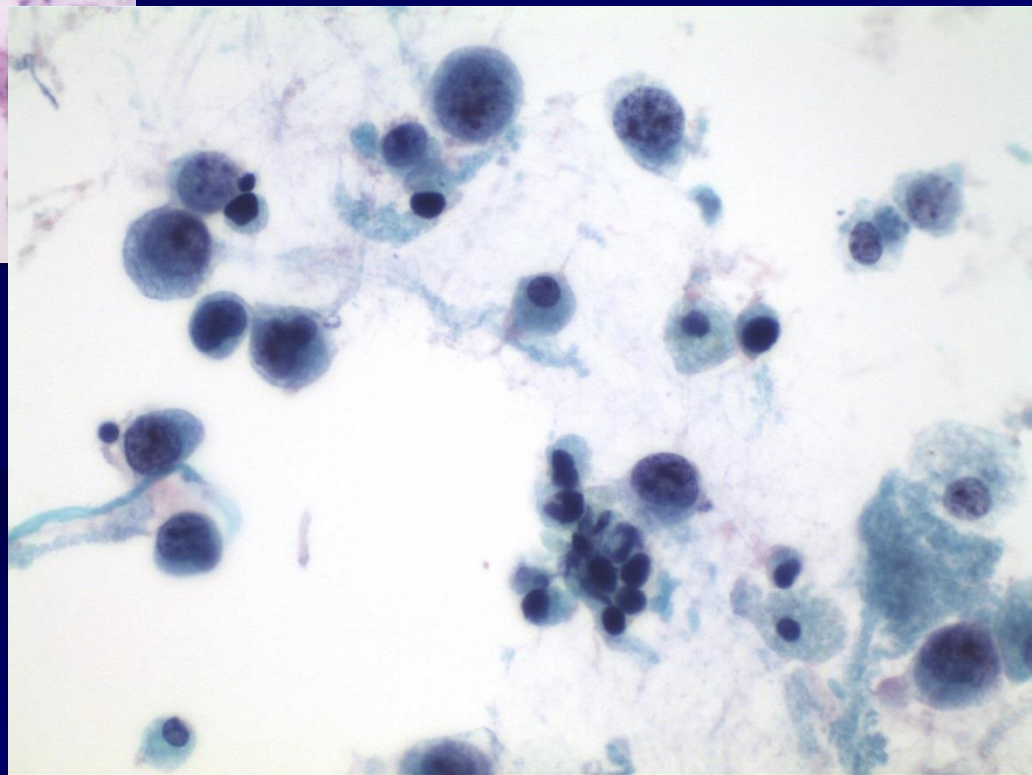
60 year old with pulmonary consolidaton- BAL





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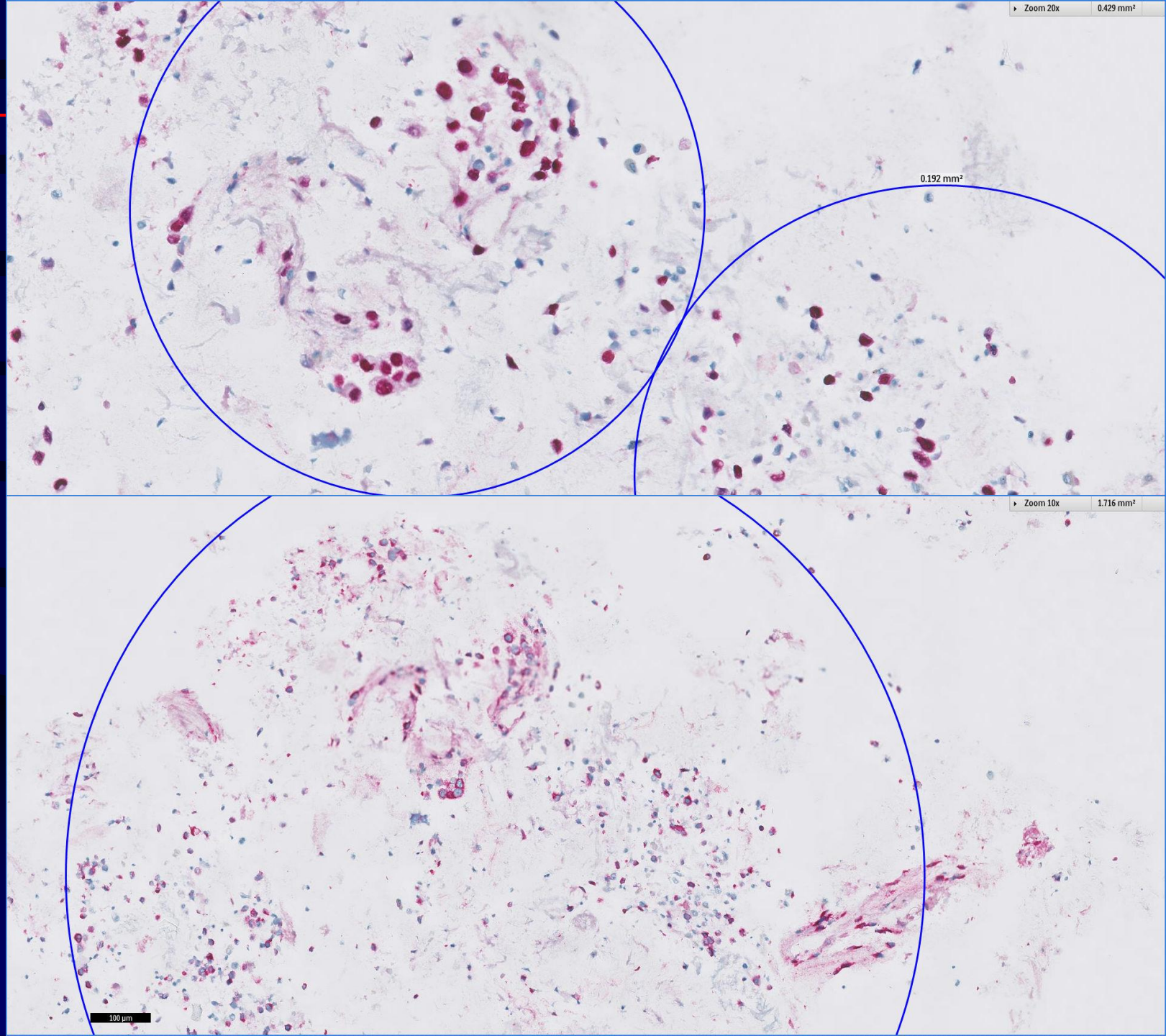
60 yo BAL SOX-10

60 yo BAL Melan A



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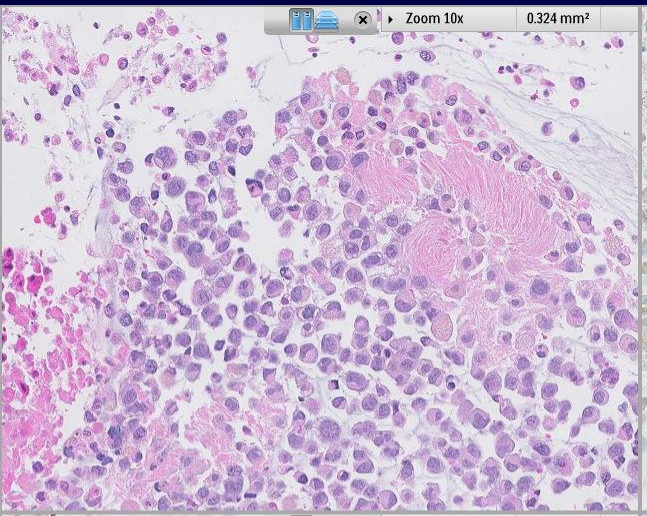
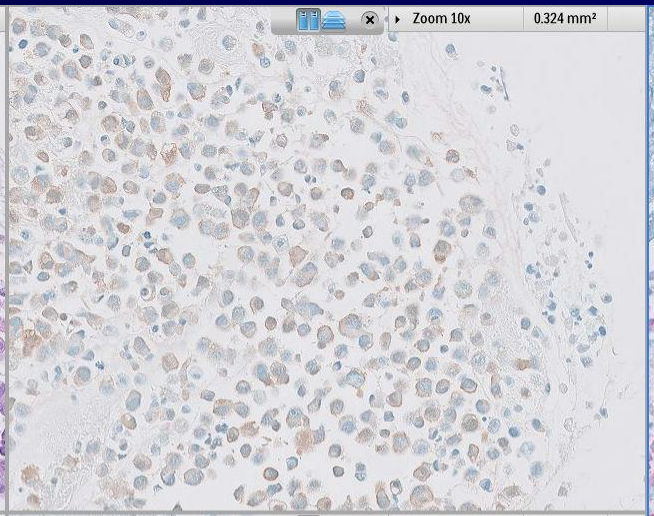
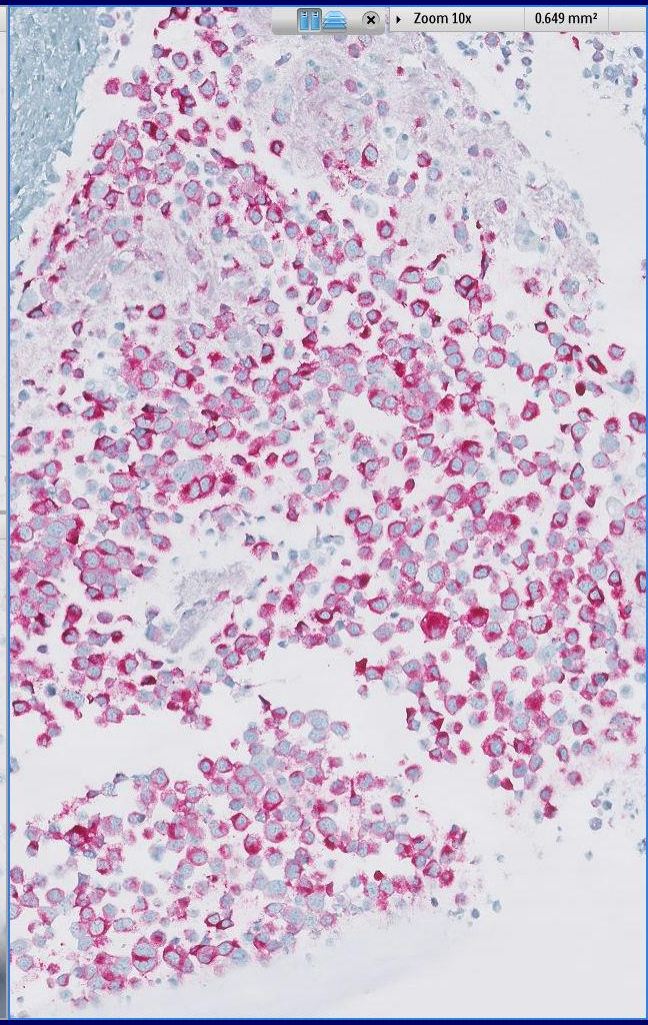
60 year old with pulmonary consolidaton- BAL

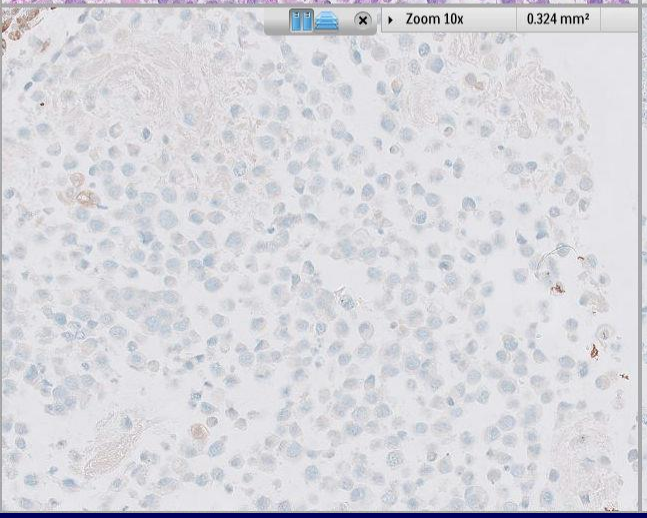
S-100

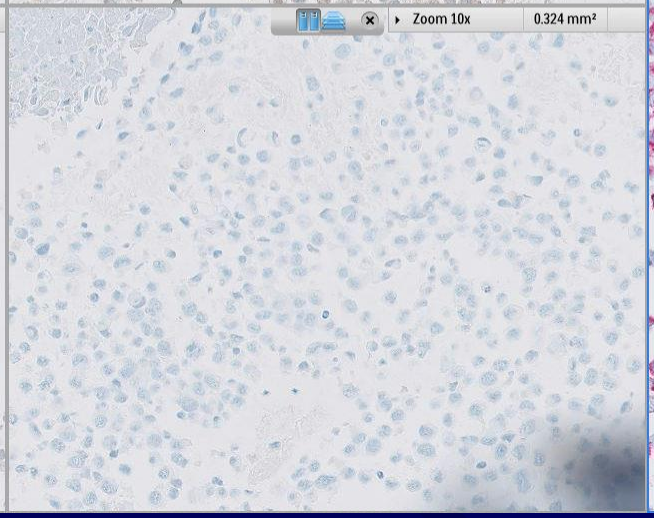
Melan A











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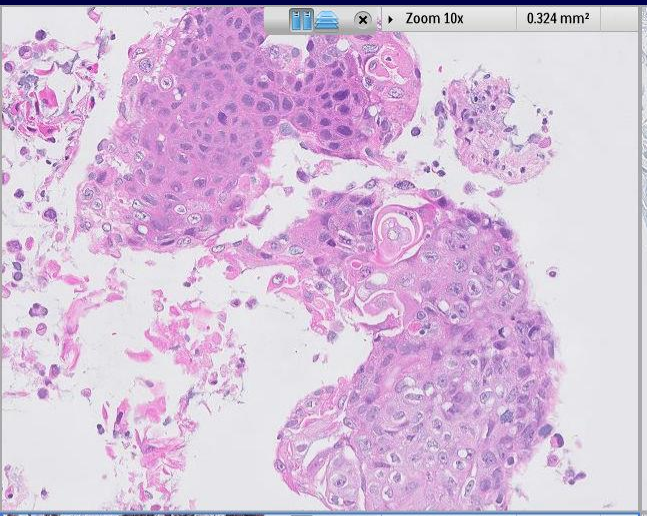
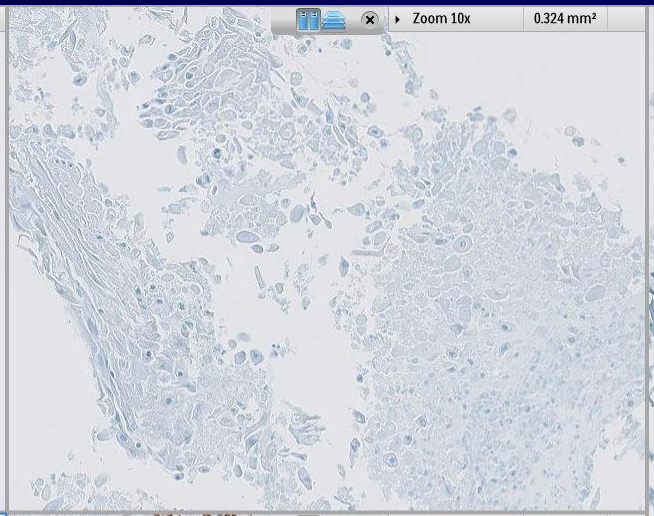
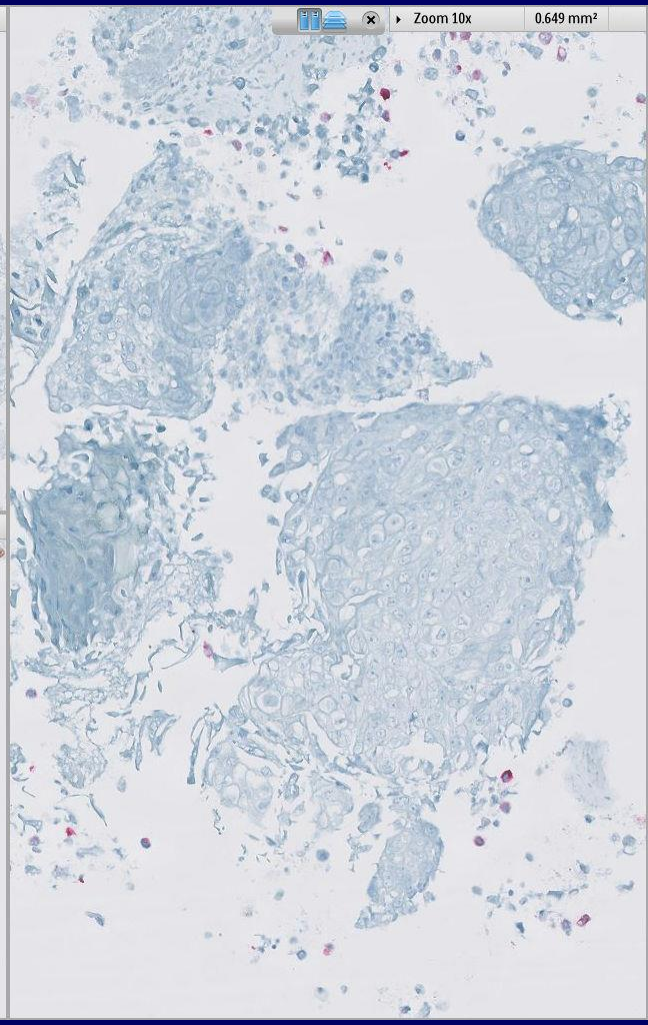
Metastatic Melanoma and SCCA- BAL

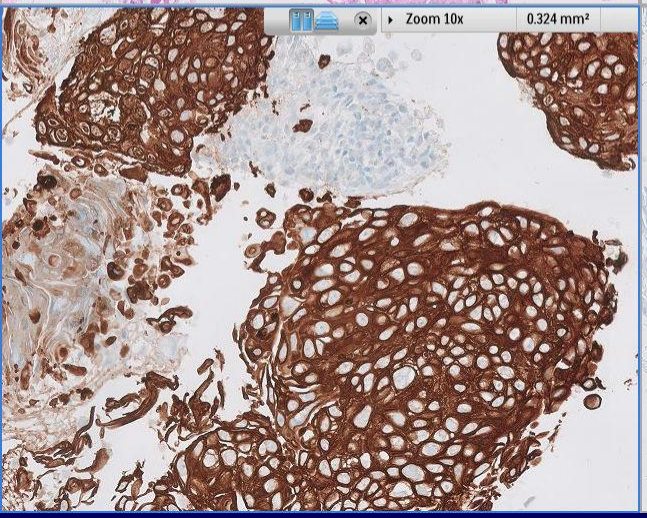
S-100

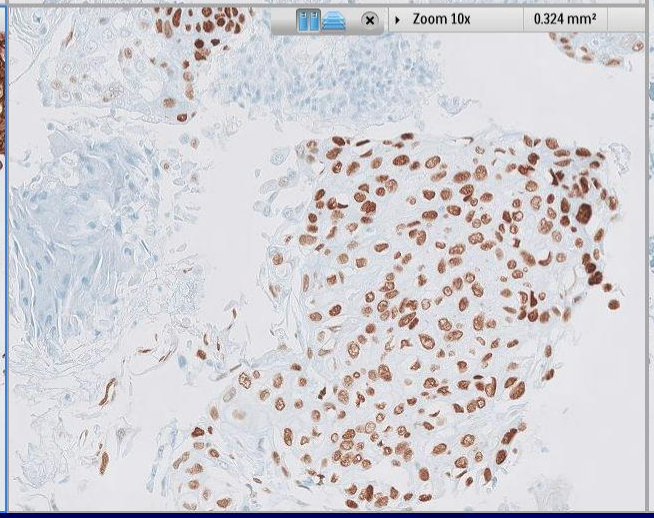
Melan A











CK 5/6

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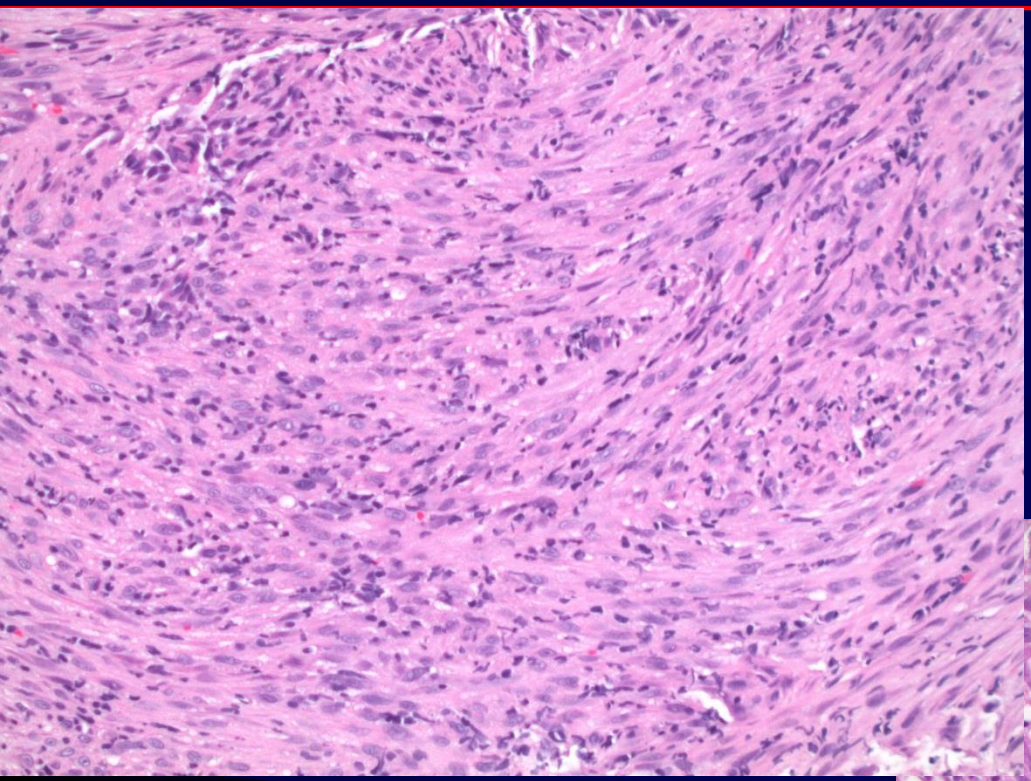
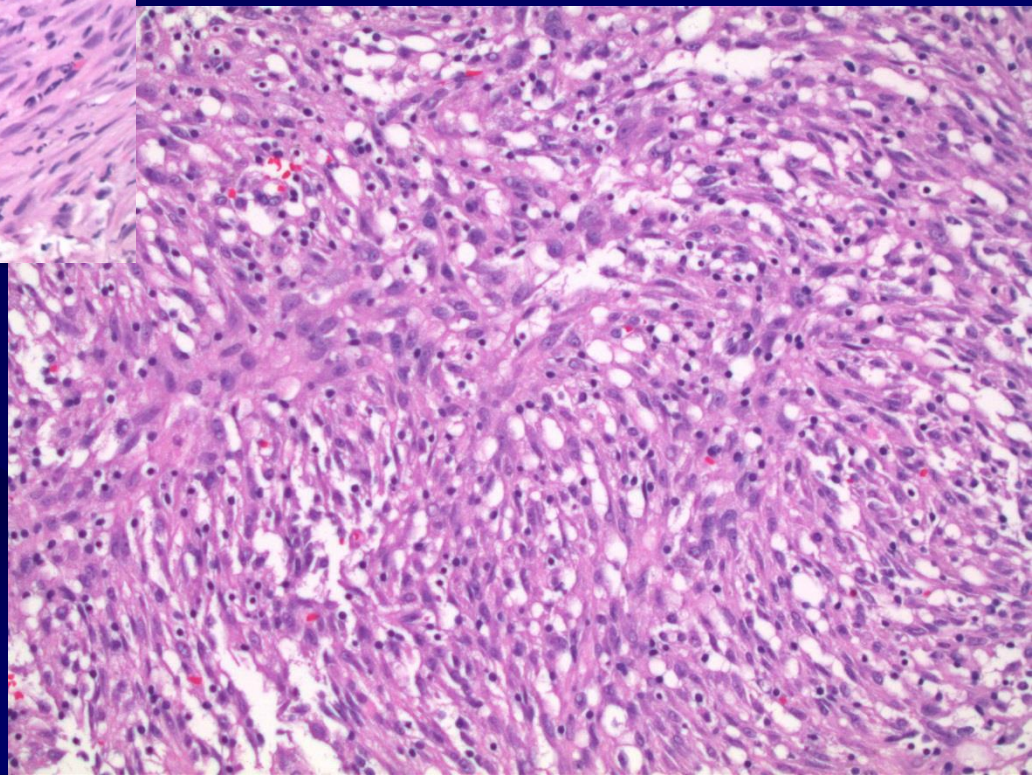
Inlfammatory myofibroblastic tumor



Bronchial biopsy

Bronchial wash CB



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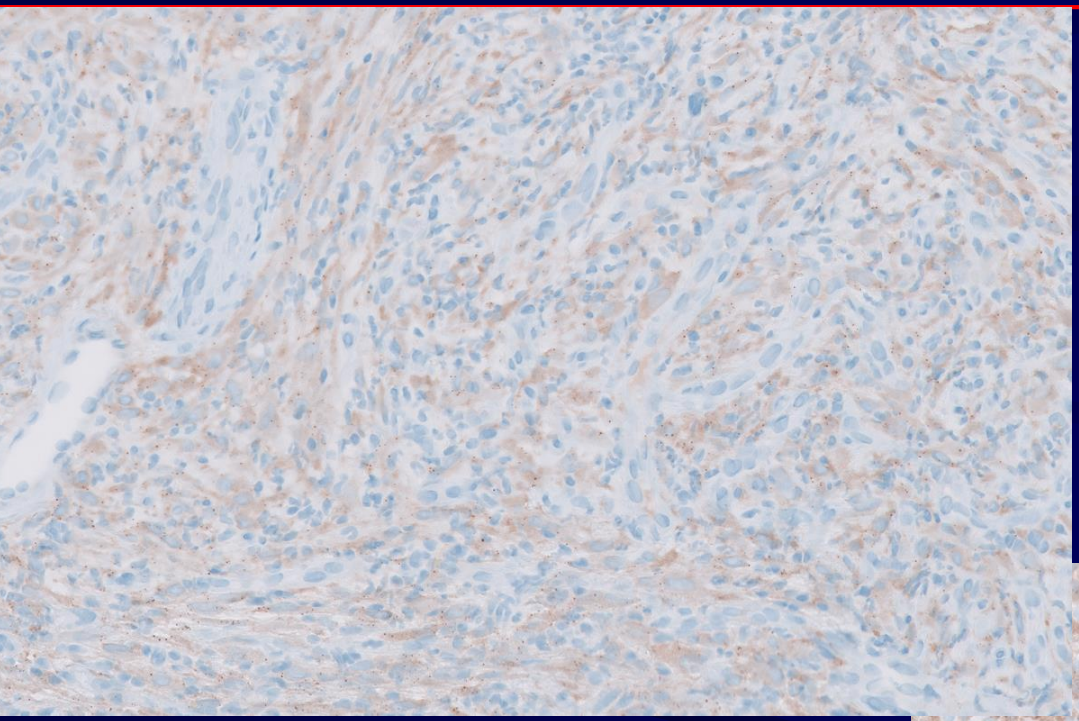
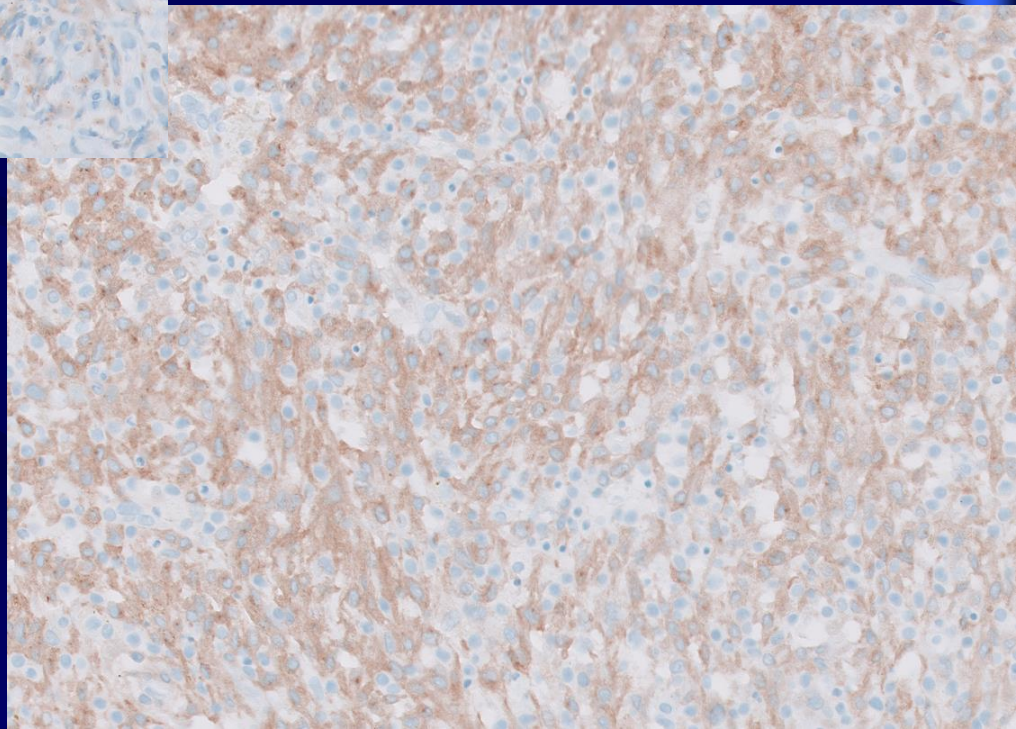
IMT: ALK IHC images exported



Bronchial biopsy

Bronchial wash CB



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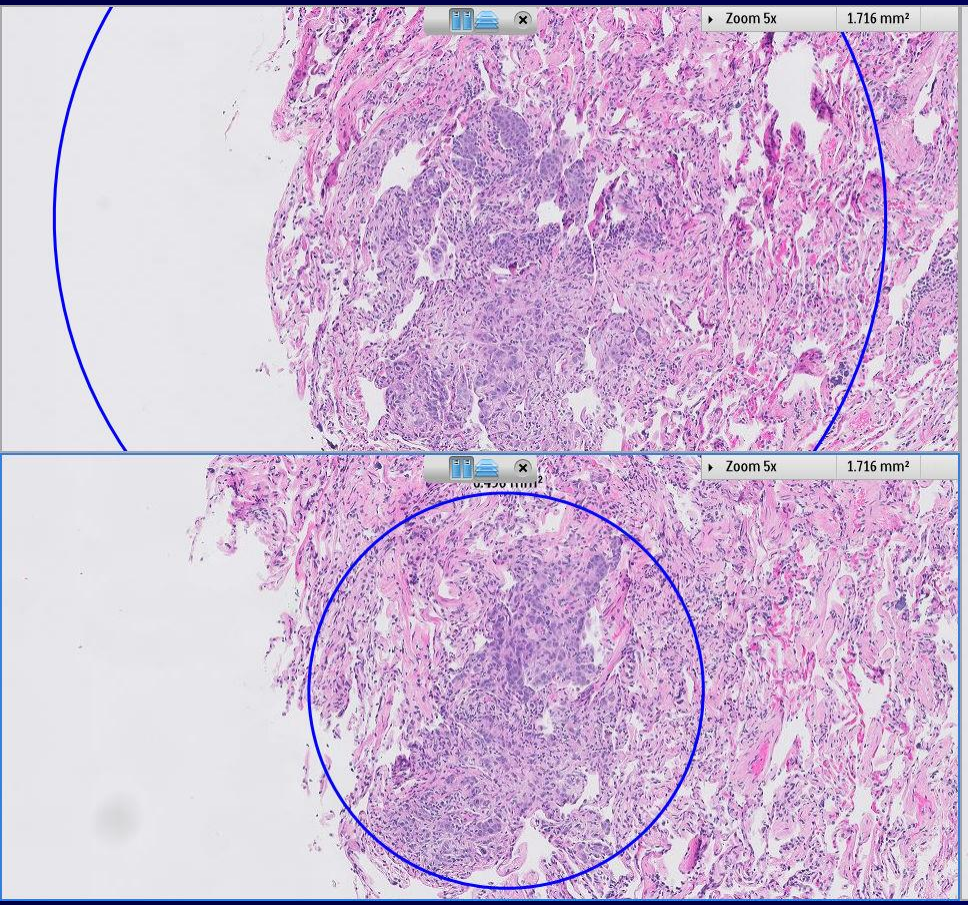
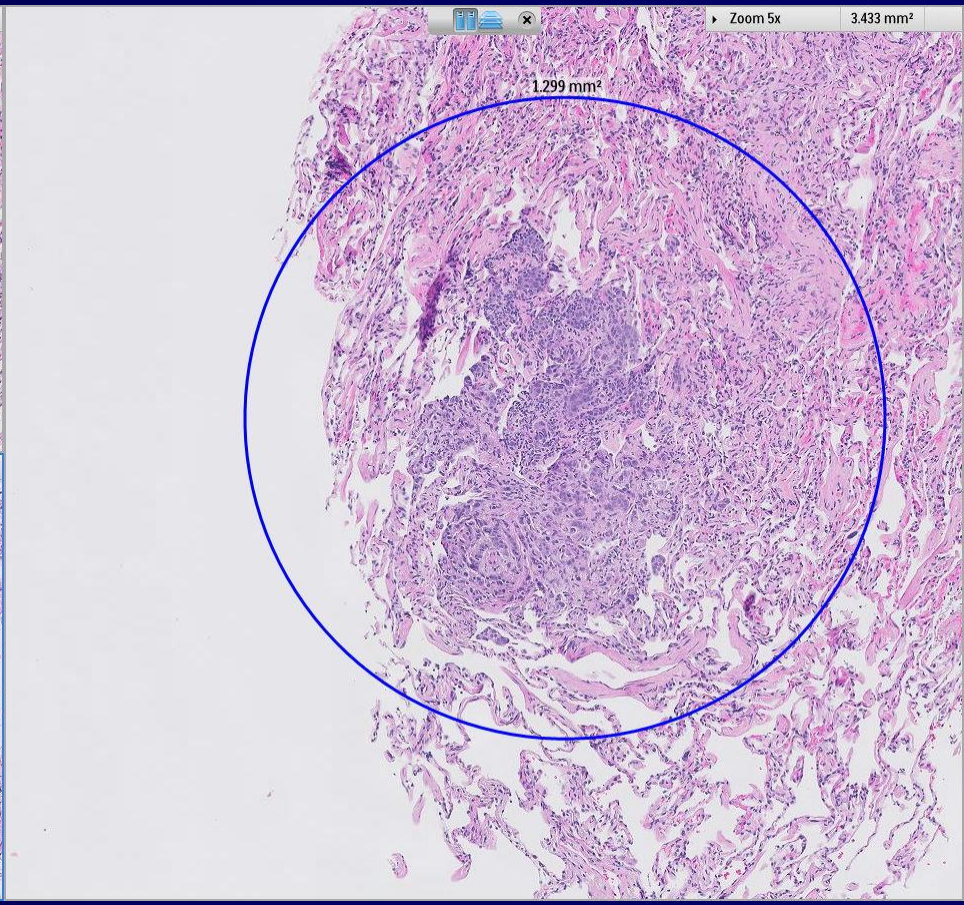
Comparing levels: images exported





Bronchial biopsy- metastatic breast carcinoma 5X

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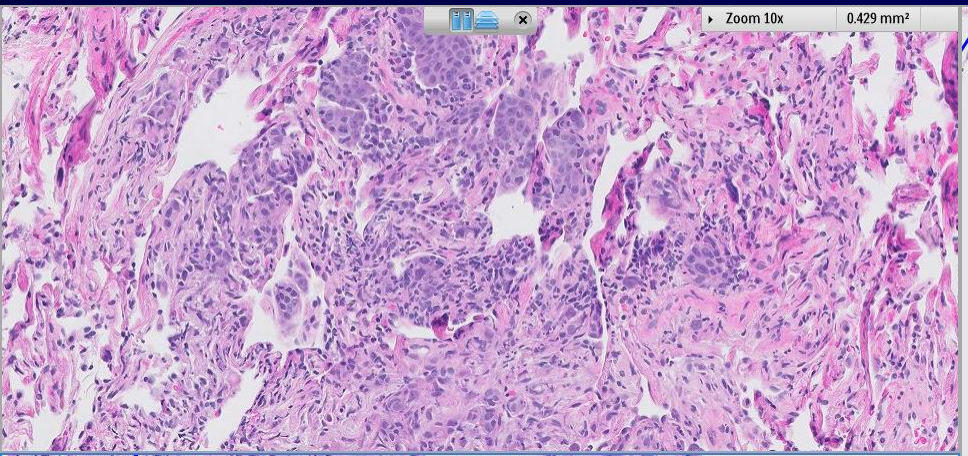
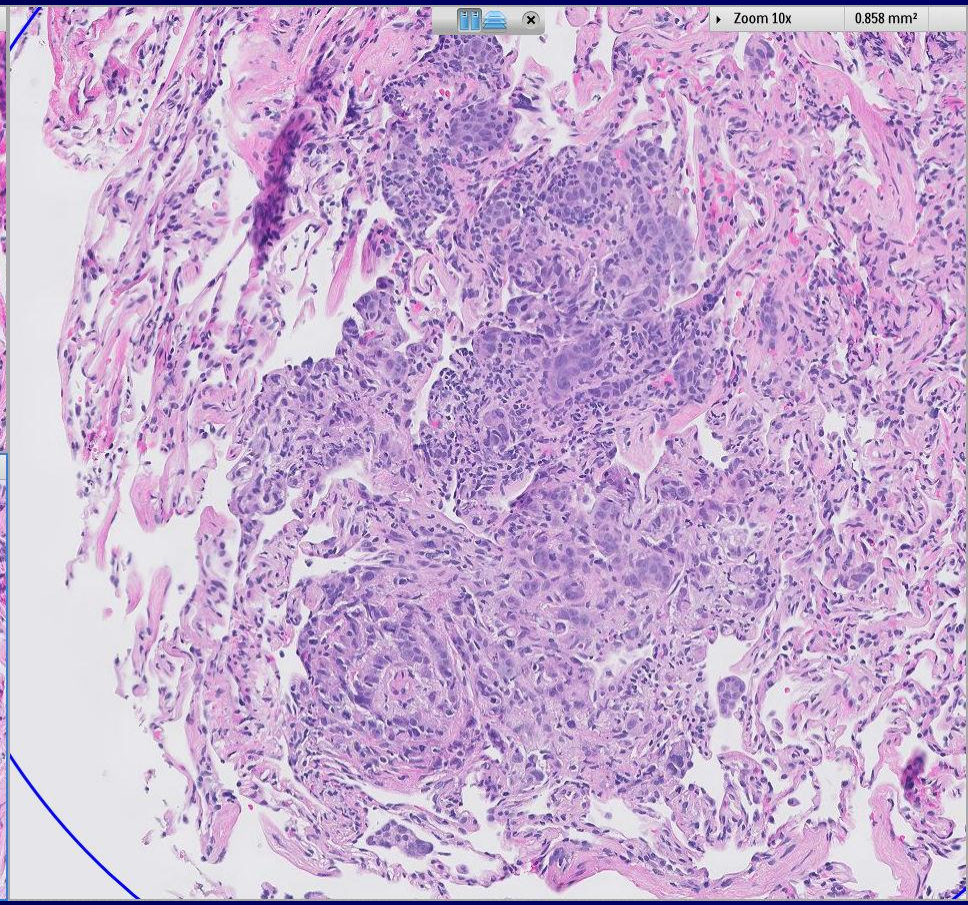
Comparing levels: images exported

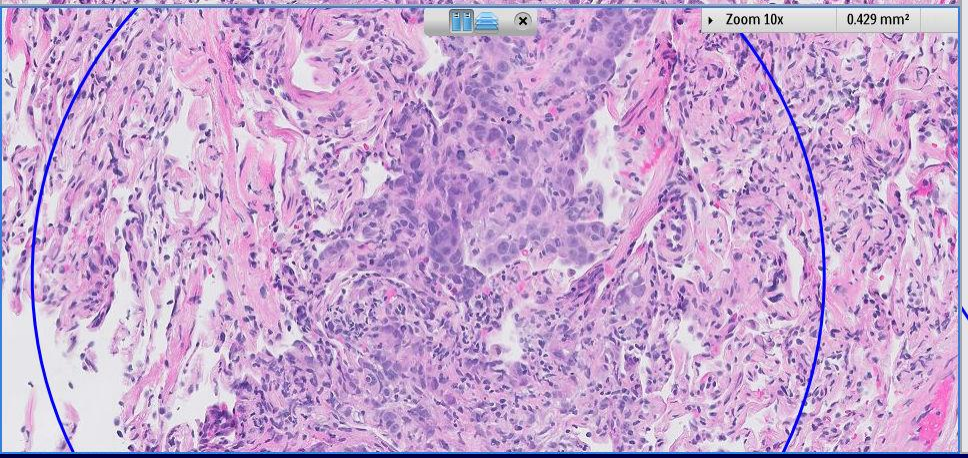
Level 1



Level 3



Level 2



Bronchial biopsy- metastatic breast carcinoma- 10X

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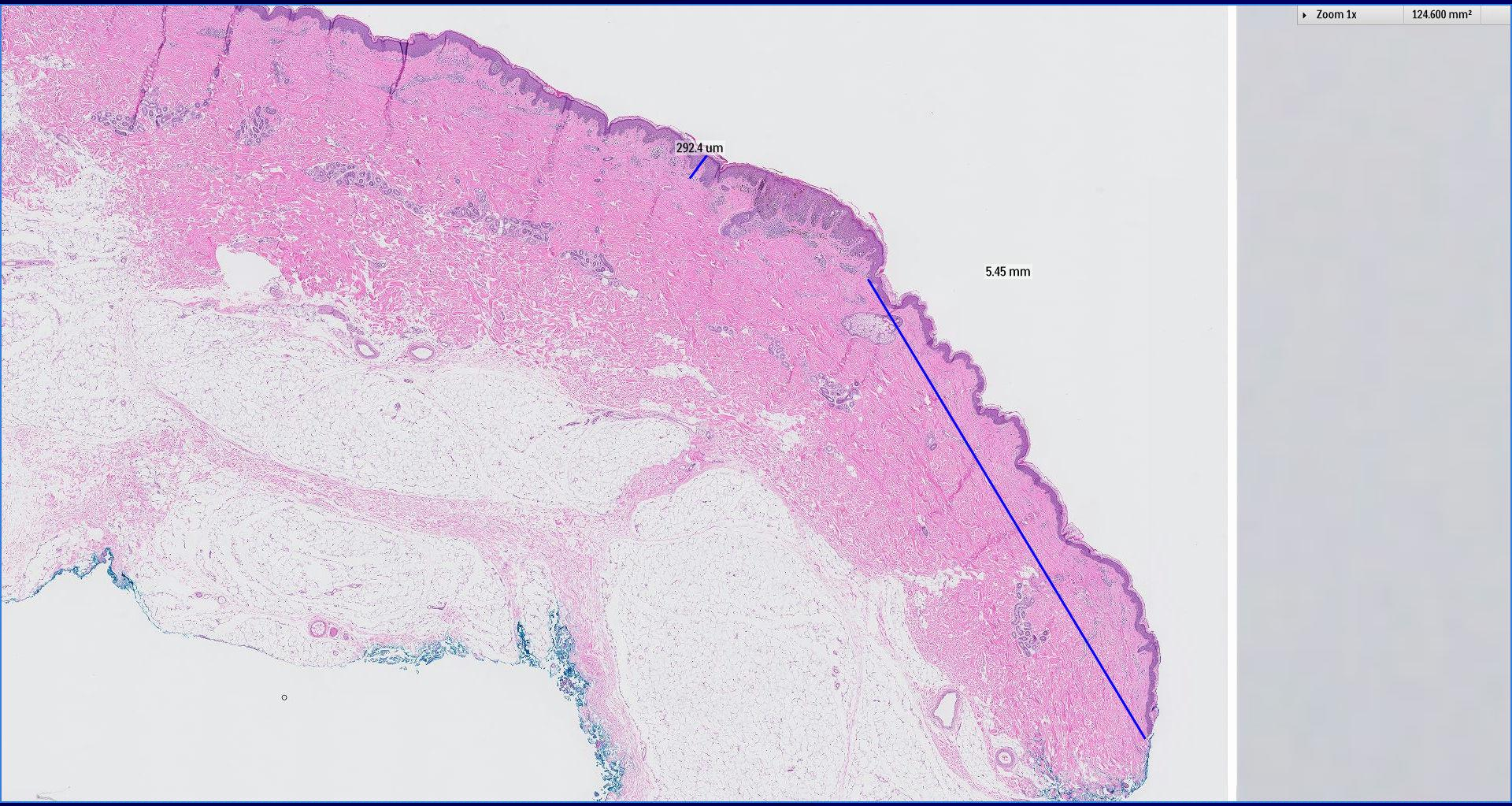
Measurements



5.45 mm lateral margin

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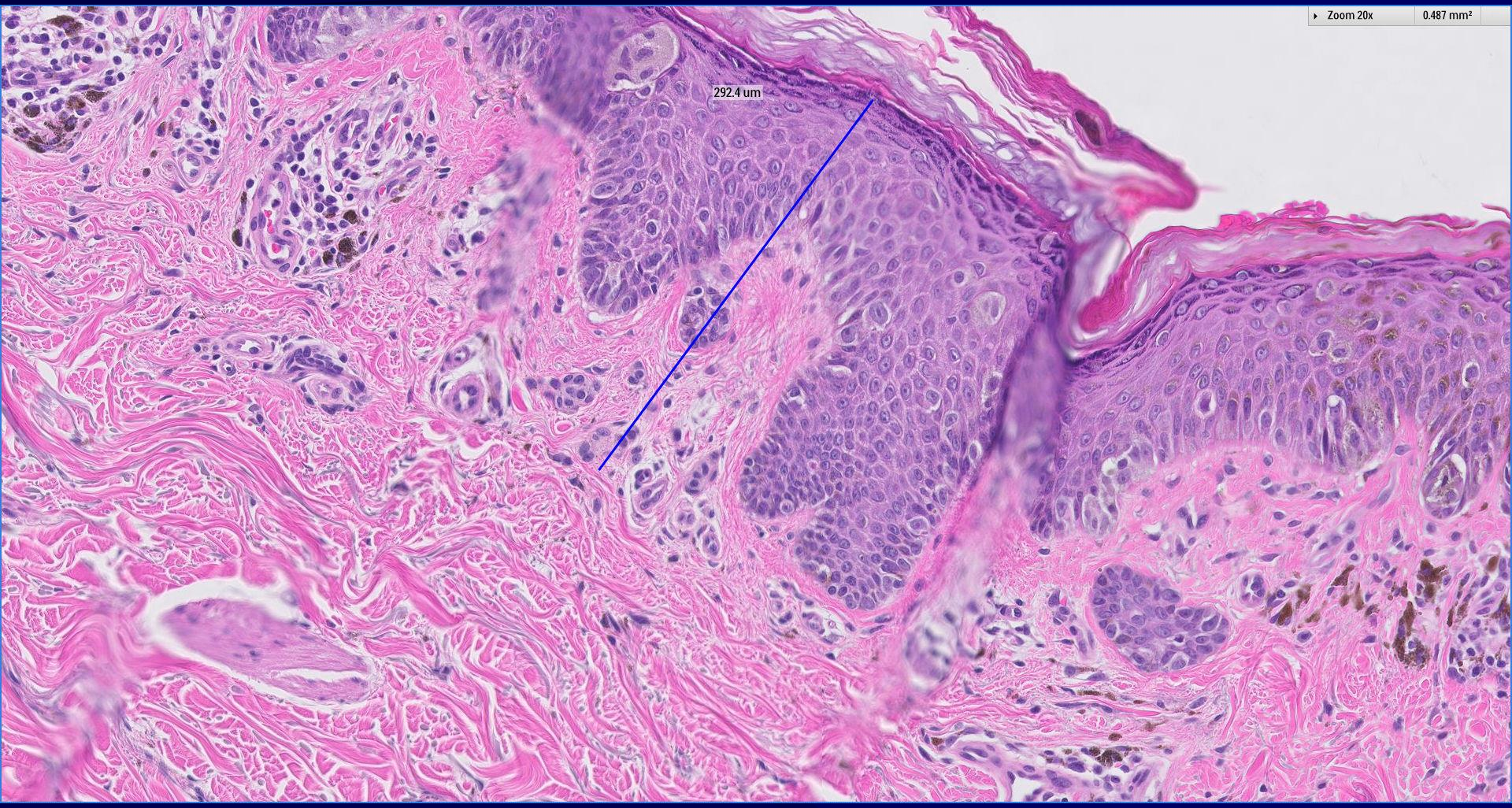
Measurements



0.2924 mm (292.4 um) depth

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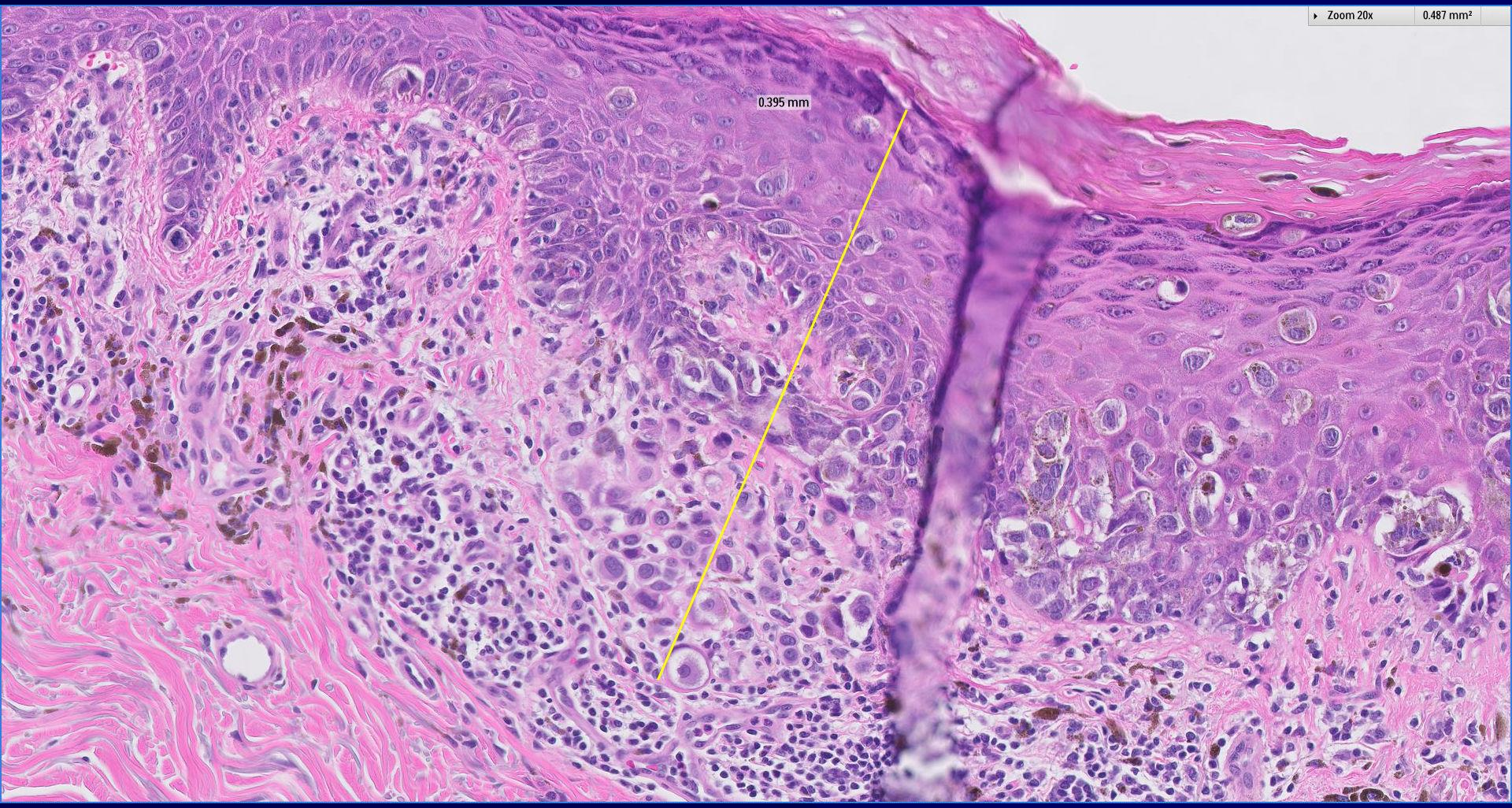
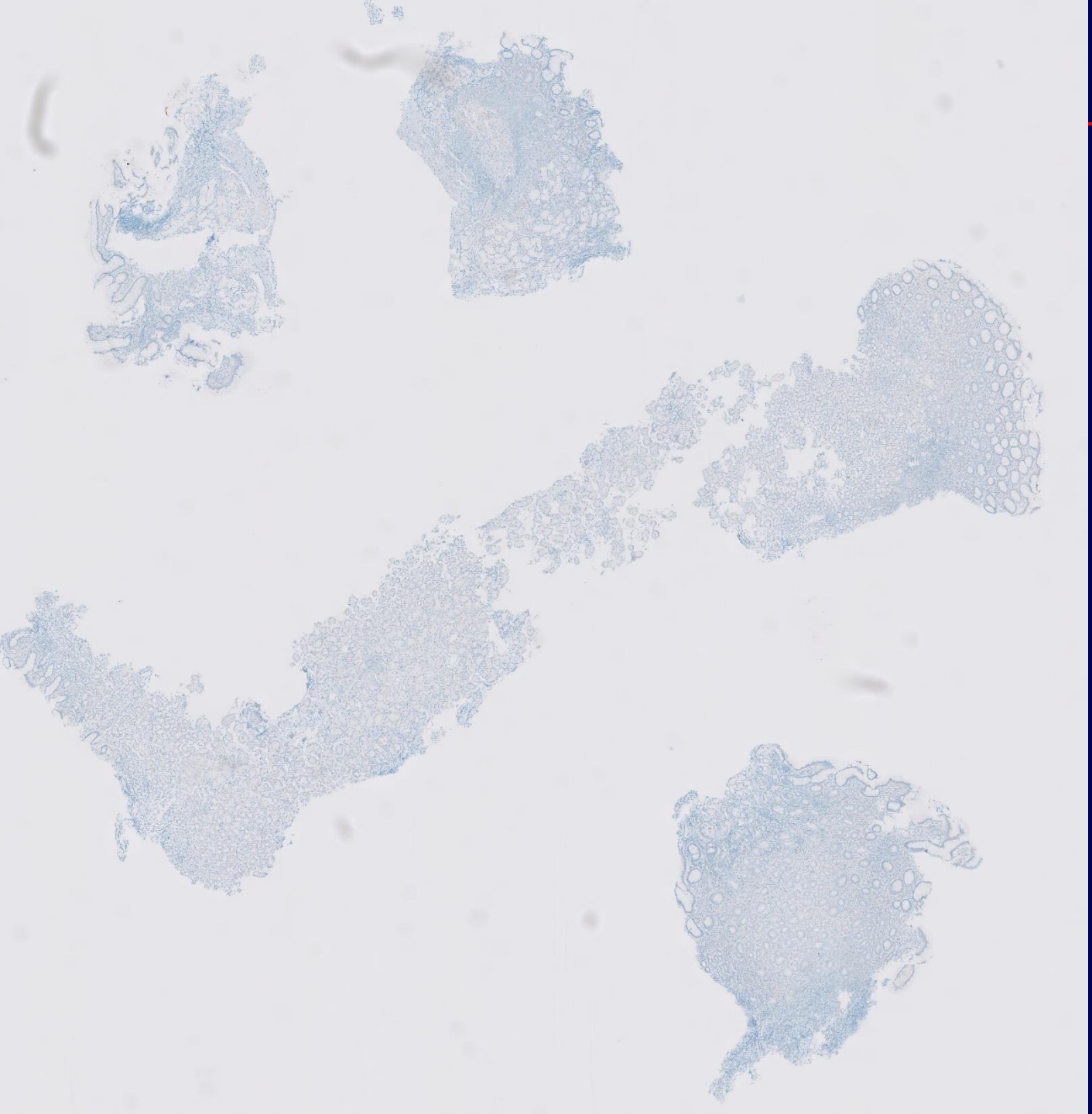
Measurements



0.395 mm depth



H. Pylori

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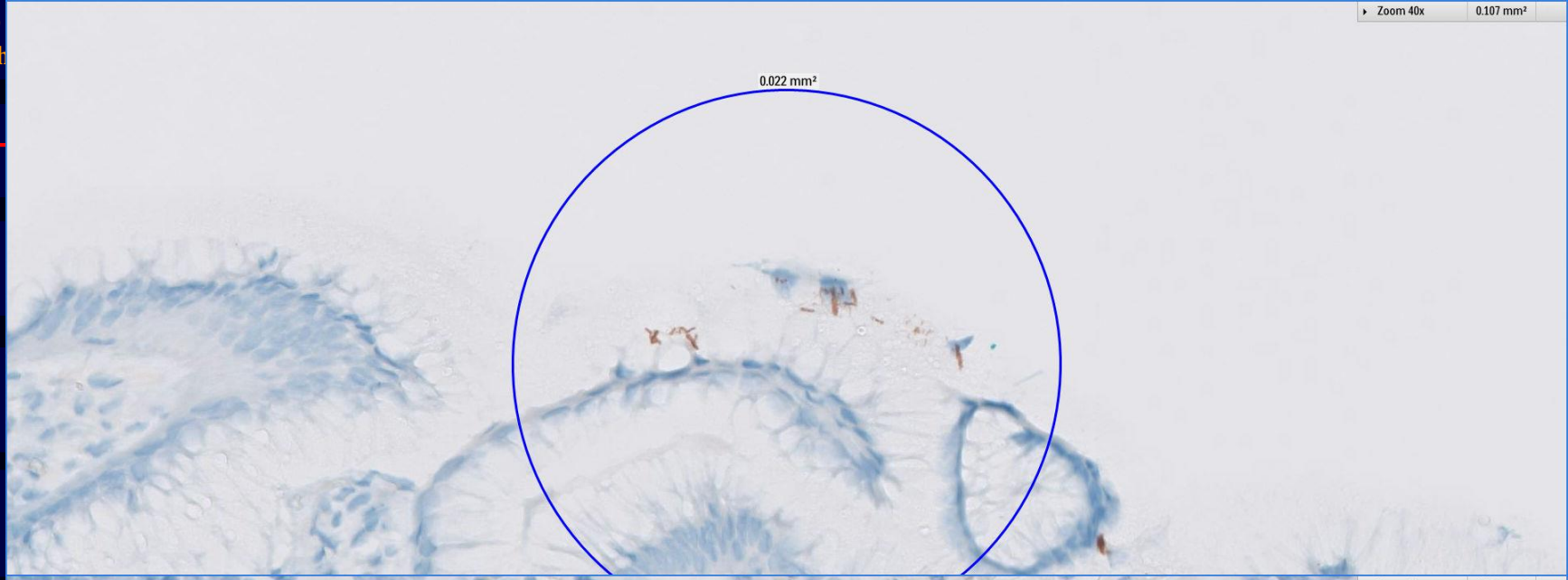
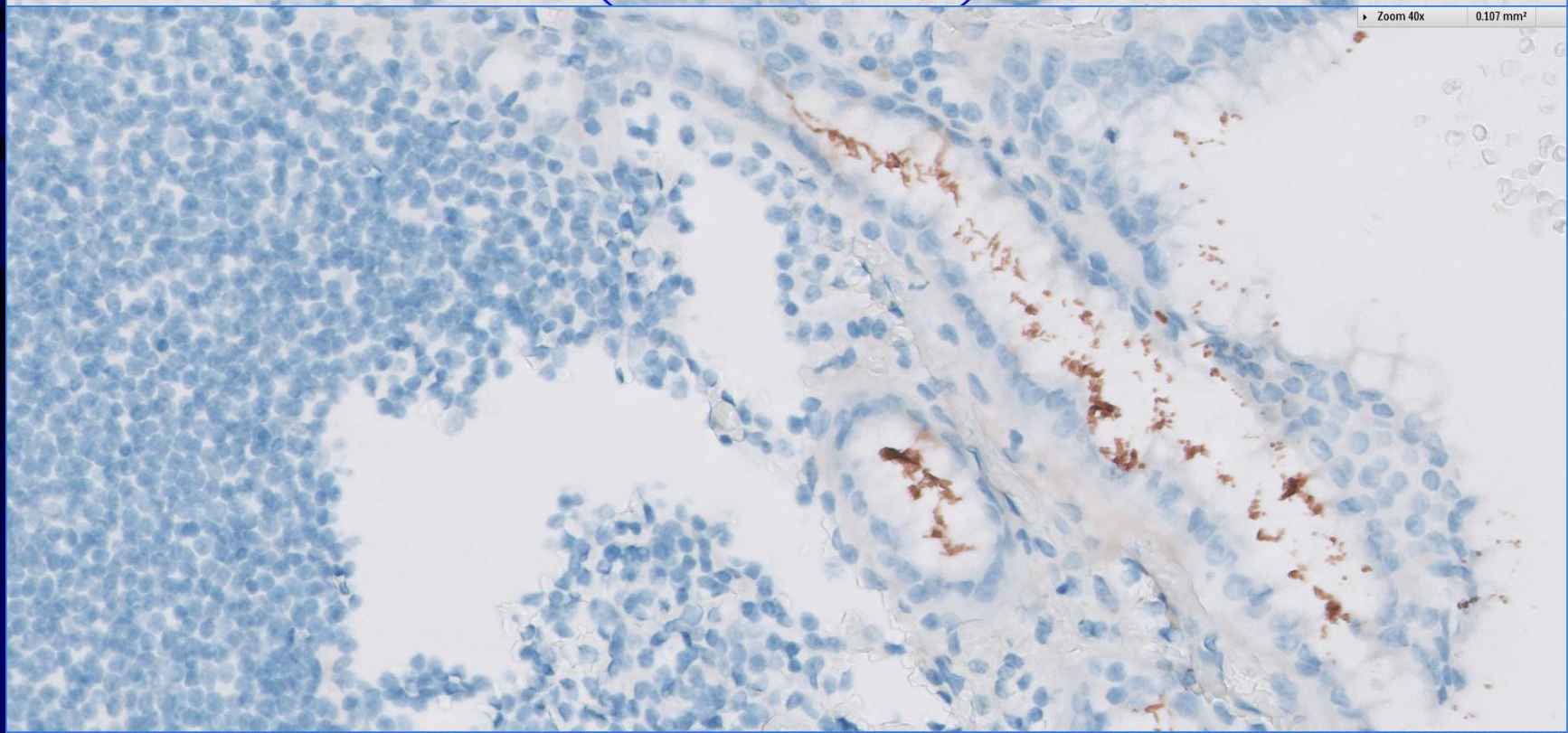
Hpy Pt.



Hpy cont



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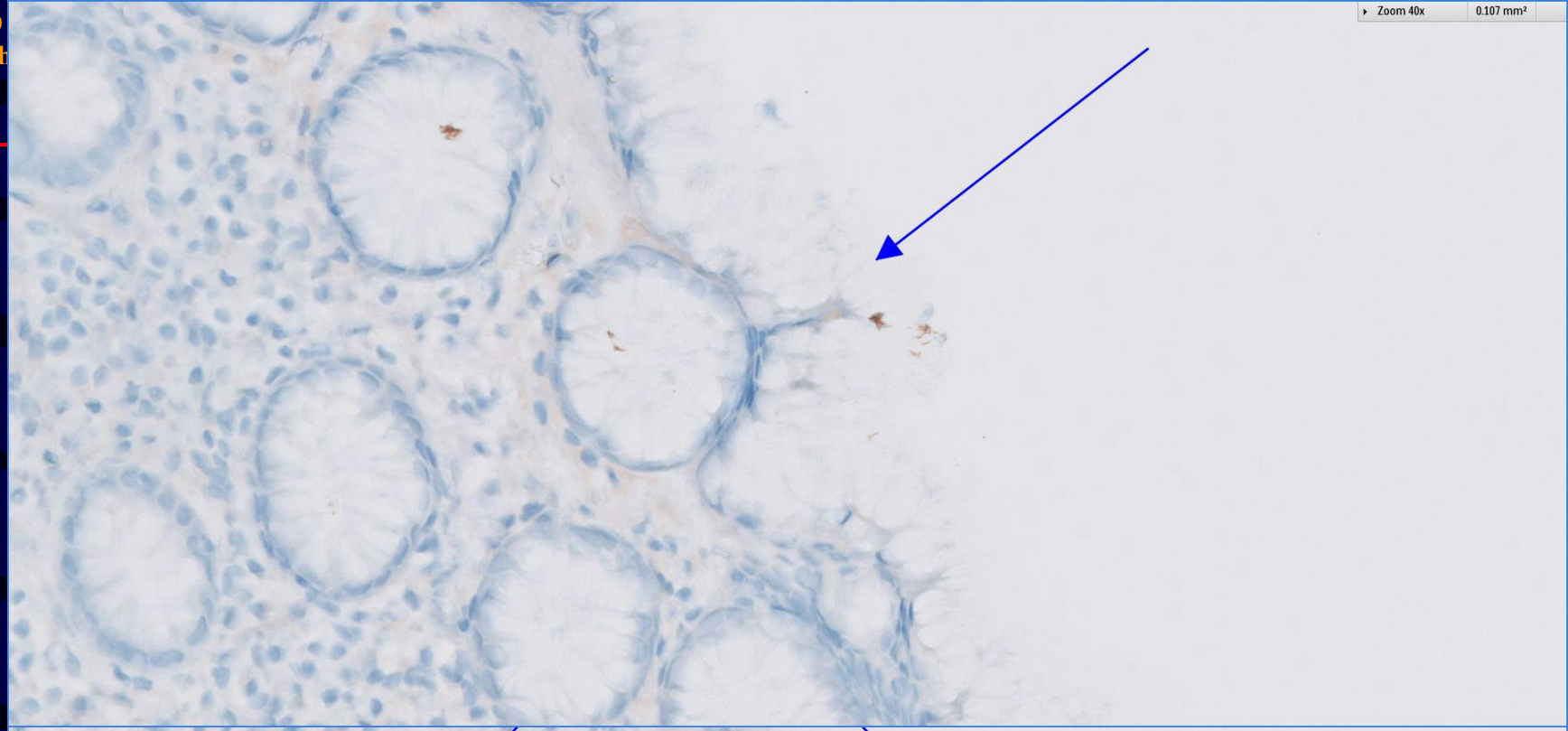
Hpy Pt.



Hpy Pt.

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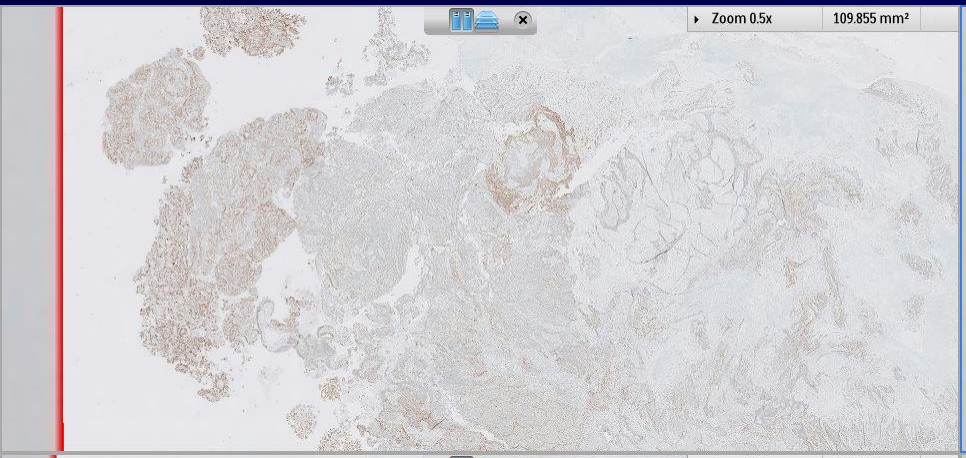
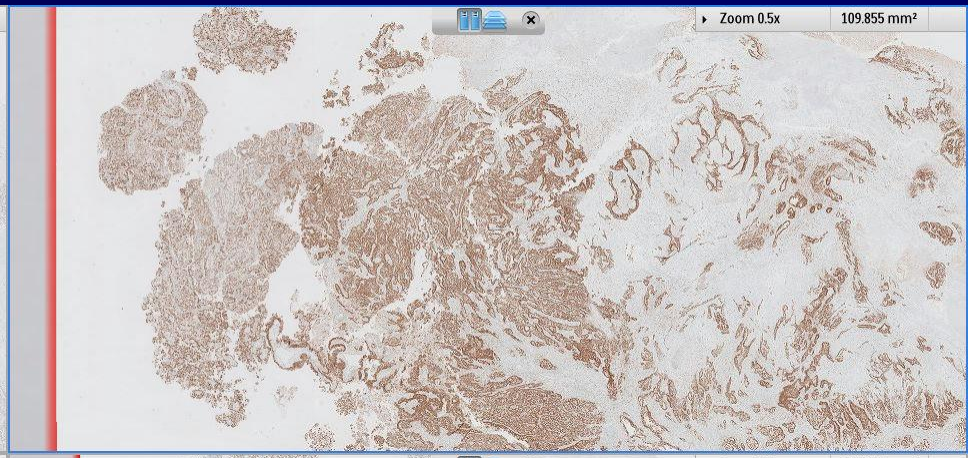
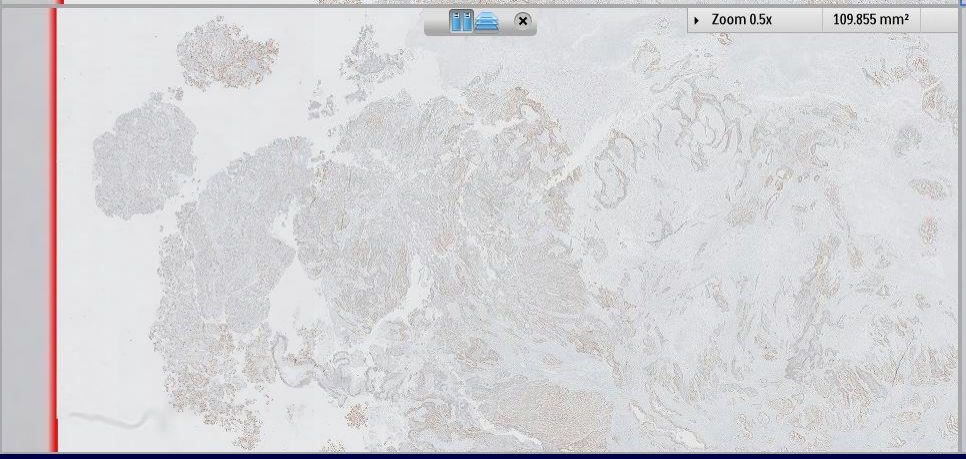
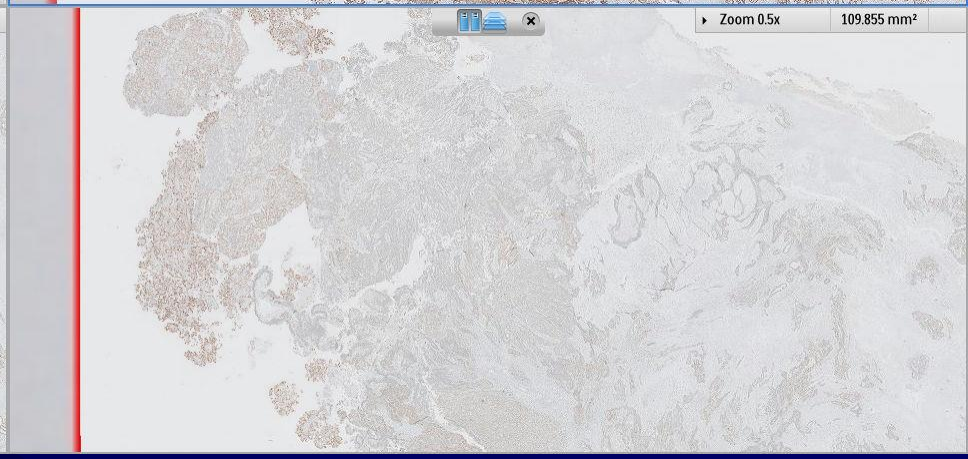
Endometrial CA MMR, 0.5X

MLH1 Aligned slides MSH6









MSH6 PMS2

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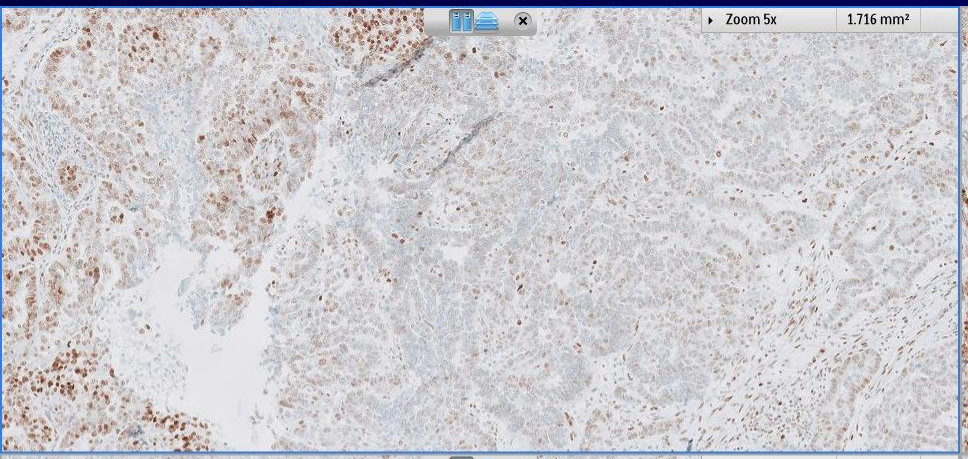
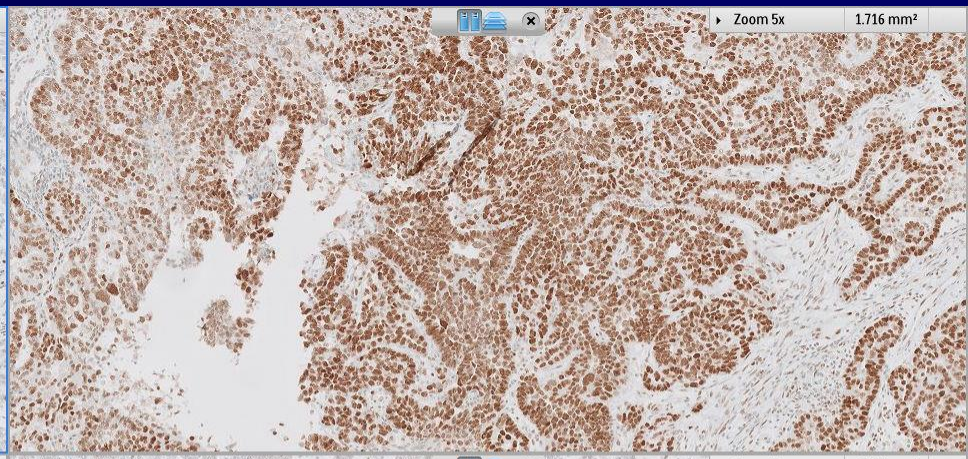
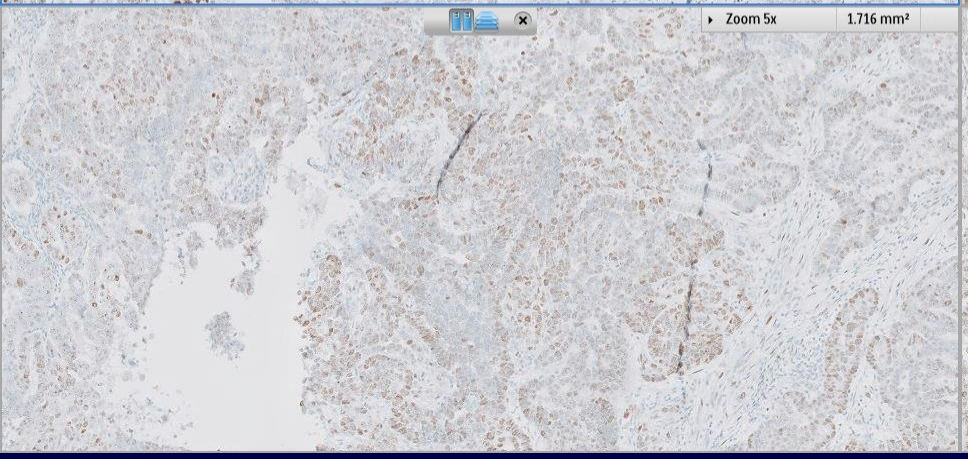
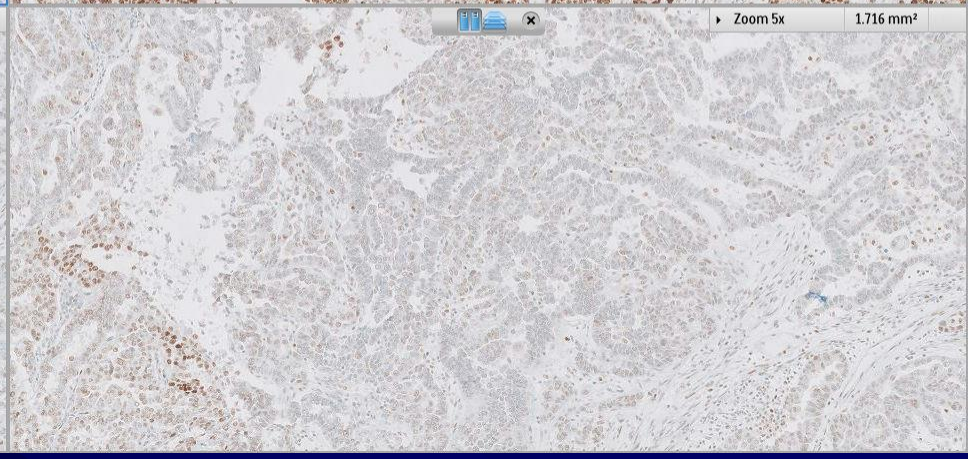
Endometrial CA MMR, 5X

MLH1 Aligned slides MSH6









MSH6 PMS2

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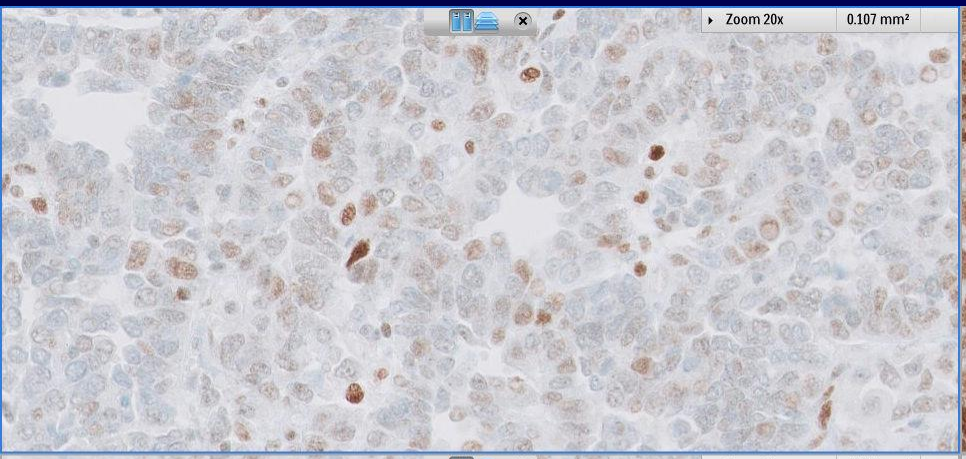
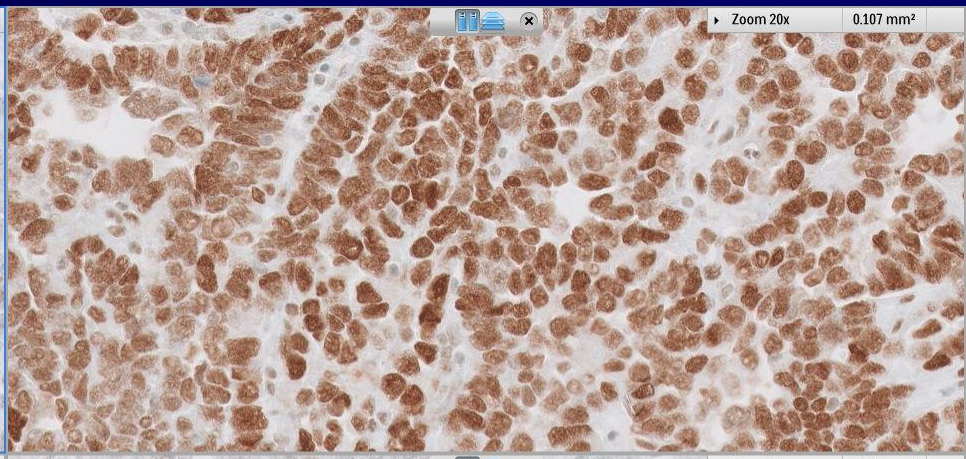
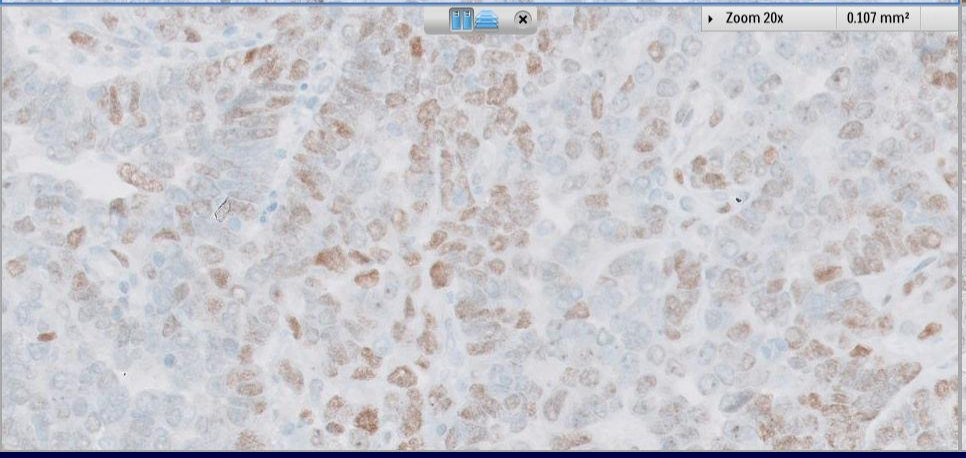
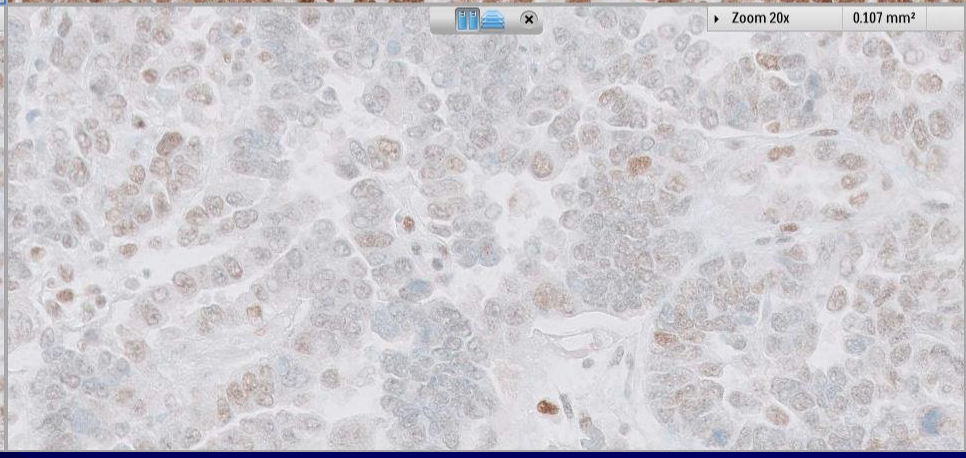
Endometrial CA MMR, 20X

MLH1 Aligned slides MSH6









MSH6 PMS2

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small fragments in focus

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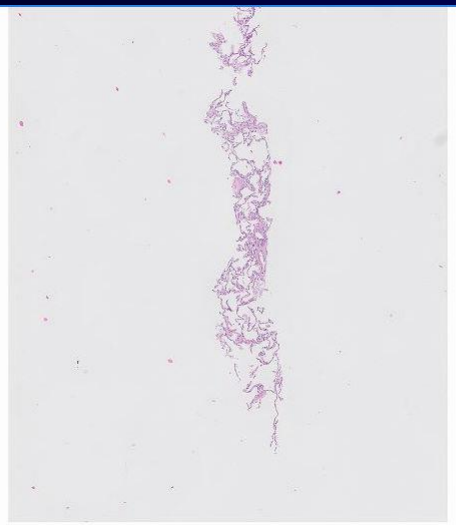
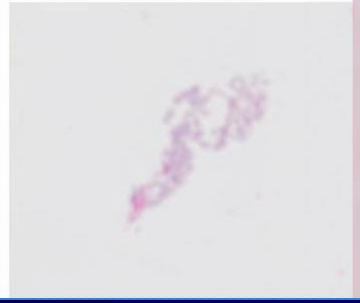
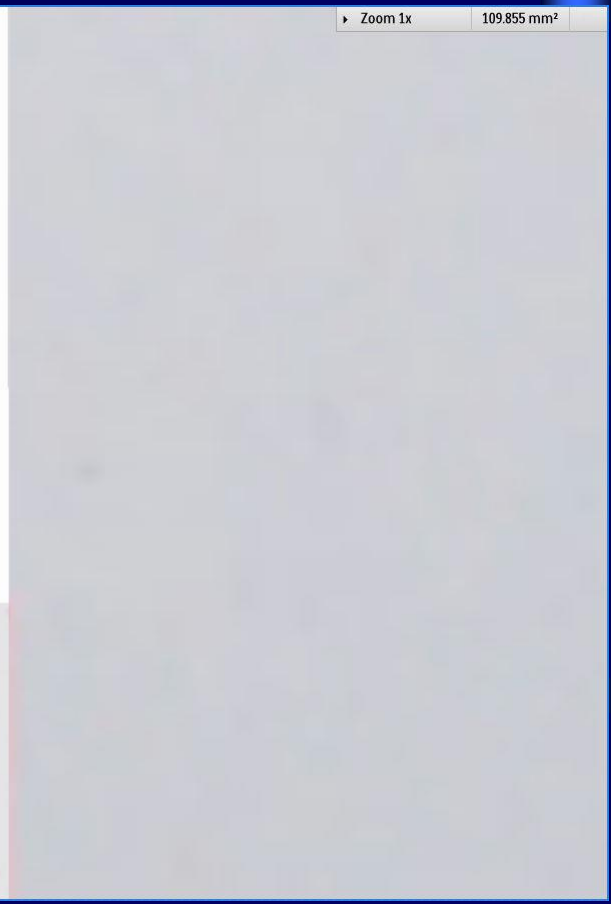
Next level small fragments out of focus







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Philips Demonstrtion Project: Take Aways

Selecting the appropriate implementation team is critical.

IT support is paramount: ensuring proper bandwidth and workstations and troubleshooting.

WSI is a powerful tool with equivalence to glass slide reading for diagnosis in routine surgical pathology. Cytology, frozen sections, hematopathology smears not yet FDA approved.

Some lag time and minimal image quality issues exist versus the optimized FDA approved workstation (not prohibitive for proof of concept in the project).

Rare out of focus issue with very small fragments of tissue.

Philips- Demonstrtion Project Team!

Project Manger: William Desalvo, SQL

SQL Management: Anthony Cerullo, Joseph Berryhill, Ida Male, Sandra Bambulas, Susan Schmidt

SQL Histology: Tamara Stahn, Dawn Stapley, Nelly Melendez Rosario and Steven Stubblefield.

SQL and Banner IT: Calley McCoy, Bart Mika, Khai Dao, Diane Blasko

Philips Corporation: Cynthia Marr, Steve Sorenson, Nora Mansoorian and Lisa Cuomo.

Banner Lab Managers: Gabrielle Siciliano (BTMC) and Denise Waltrip (BDMC)

Pathologists: Holly McDaniel (BDMC) and Richard Eisen (BTMC).

Whole Slide Imaging: References

Evans AJ, Salama ME, et al. Implementation of Whole Slide Imaging for Clinical Purposes: Issues to Consider From the Perspective of Early Adopters. Arch Pathol Lab Med. 2017;141:944–959.

Hedvat CV. Digital Microscopy. Past, Present, and Future. Arch Pathol Lab Med. 2010;134:1666–1670.

Mukhopadhyay S, Feldman MD, et al. Whole Slide Imaging Versus Microscopy for Primary Diagnosis in Surgical Pathology. A Multicenter Blinded Randomized Noninferiority Study of 1992 Cases (Pivotal Study). Am J Surg Pathol 2018;42:39–52.

Whole Slide Imaging: References (2)

Morrison AO and Gardner JM. Microscopic Image Photography Techniques of the Past, Present, and Future. Arch Pathol Lab Med. 2015;139:1558–1564.

Thrall M, Pantanowitz L and Khalbuss W. Telecytology: Clinical applications, current challenges, and future benefits. J Pathol Inform 2011, 2:51.

Bauer TW, Schonefeld L, et al. Validation of Whole Slide Imaging for Primary Diagnosis in Surgical Pathology. Arch Pathol Lab Med. 2013;137:518–524.

THE END