

eeDAP Registration Accuracy Evaluation

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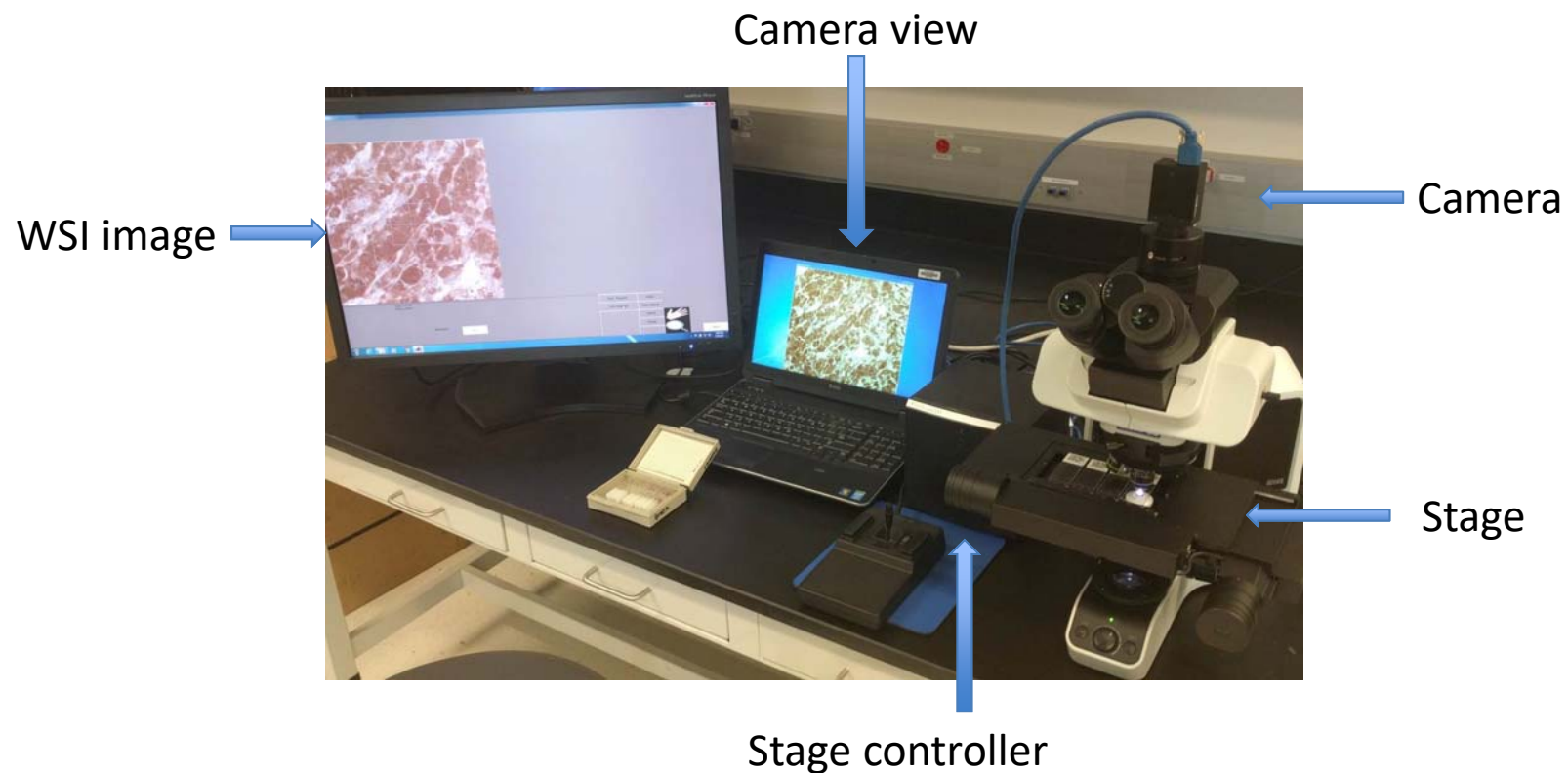
Outline

- eeDAP Introduction
- Registration Study Purpose
- Methods
- Results
- Conclusion and Discussion
- Future Plans

eeDAP

evaluation environment for Digital and Analog Pathology

- Control the microscope stage so that a user can read the same tissue/cell from WSI and glass slide.

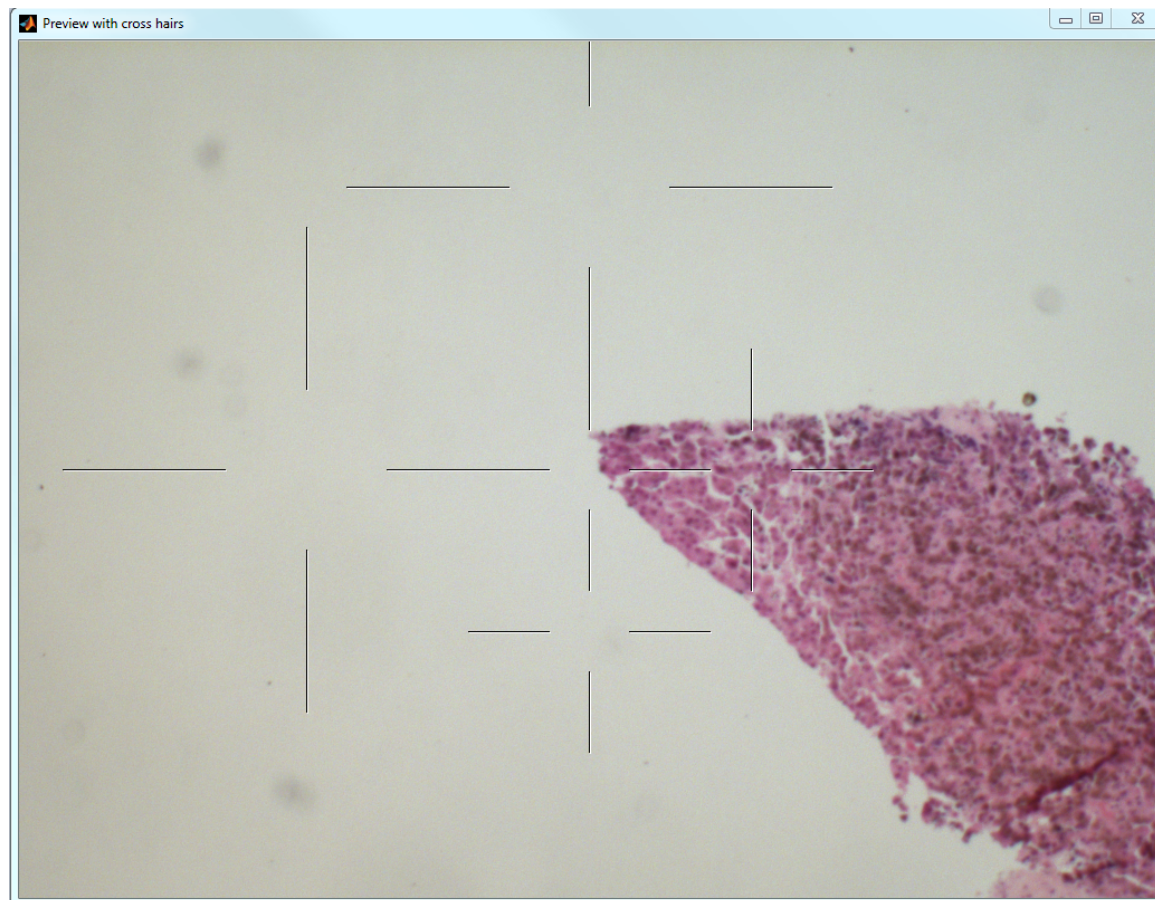




eeDAP Introduction

- Global Registration
 - Before reader starts
 - Requires 3 local registrations
 - Learn WSI-microscope relationship
- Local **RE**-registration
 - As reader is working
 - Possible for each FOV
 - Overcomes small errors from stage movement
- All registrations are based on cross correlation.

Global Registration



Camera image/eyepiece view

Global Registration

The screenshot shows the 'Slide Registration' software interface. On the left, there are several control panels and buttons. On the right, there is a main image area showing a large purple histological slide with a small 'camera ROI' box. An inset window titled 'Registration Position 1' shows a side-by-side comparison of the camera image (orange background) and the WSI (purple background).

- 1** Take camera images and stage positions: Points to the 'Take Stage Coordinates (Camera Coordinates)' panel with buttons 'Take Stage Position 1', 'Take Stage Position 2', and 'Take Stage Position 3'.
- 2** Take WSI positions: Points to the 'Take WSI Coordinates (Mouse-Click)' panel with buttons 'Take WSI Position 1', 'Take WSI Position 2', and 'Take WSI Position 3'.
- 3** Show camera image: Points to the 'Video' button.
- 4** Abort experiment: Points to the 'Abort' button.
- 5** Use last time experiment result: Points to the 'Load last calibration' button.
- 6** Redo registration: Points to the 'Refine Registration' button.
- 7** Skip high resolution registration: Points to the 'Finished Registration' button.
- 8** Show the stage and WSI position: Points to the 'WSI Position 1' and 'Stage Position 1' input fields.
- 9** thumb WSI: Points to the 'Registration Position 1' inset window.

Local RE-Registration

Task 2 of 5
QText_select_region

ROI: not set
WSI: not set

X coordinate: not set
Y coordinate: not set

Best_Register
Fast_Register

Video
Hide Reticle
Reset
Pause

Back
Abort

1 WSI
2 Task Panel
3 Control Panel
4 Best Register
5 Fast Register
6 Next button
7 Video button
8 Hide Reticle
9 Reset button
10 Pause button
11 Resume button
12 Back Button
13 Abort Button



Local RE-Registration

For each FOV ...

- **Automatic:**
 - When the microscope arrives at the task ROI, eeDAP will do Automatic Registration.
 - Use center patch of camera image.
 - Focus may not be good.
- **Fast:**
 - If the Automatic Registration fails, study administrator can focus microscope and do *Fast Registration*.
 - Use center patch of camera image.
- **Best:**
 - If the *Fast Registration* fails, study administrator can do the **Best Registration** (Use entire camera image).
- **Manual:**
 - Study administrator can use joystick
 - Visually register camera image and WSI

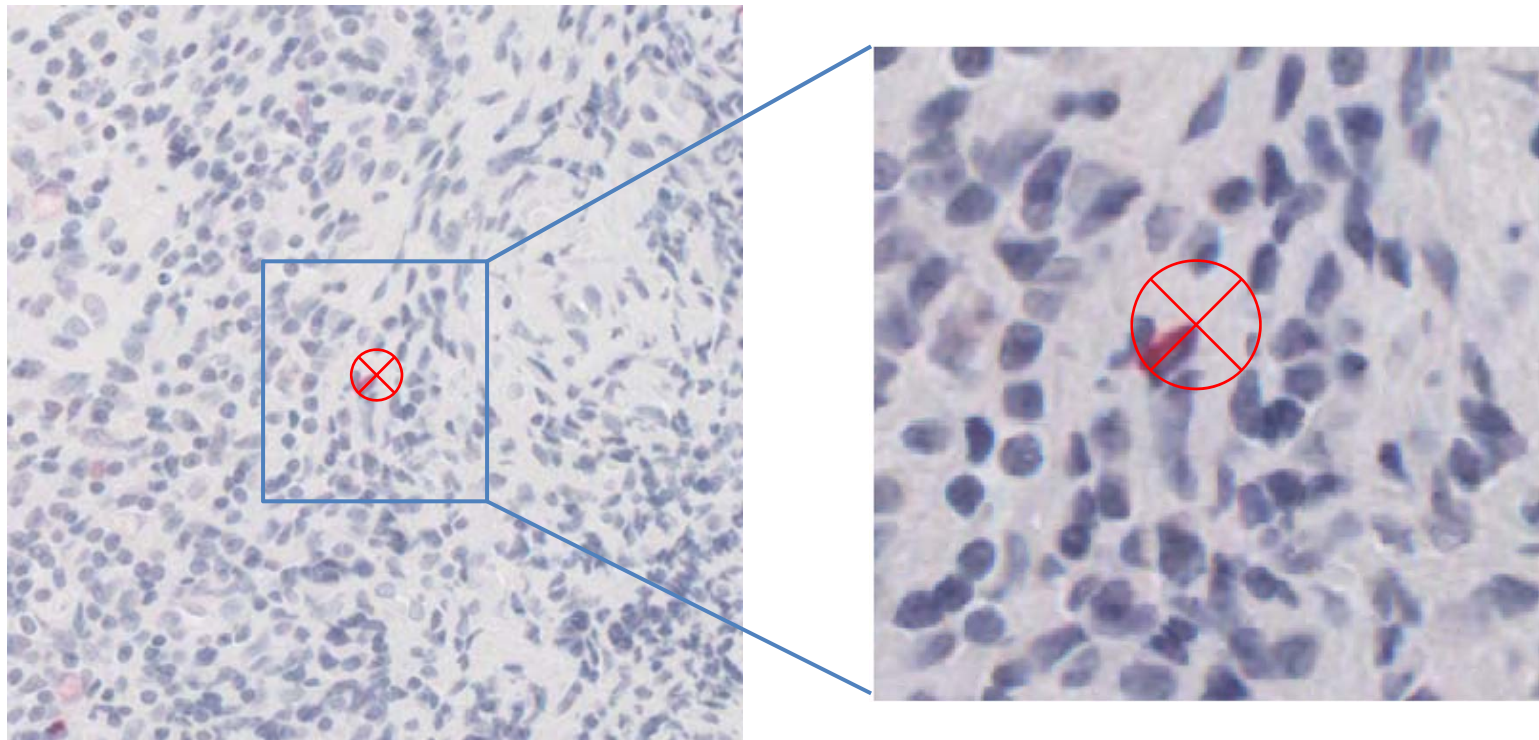
Registration Accuracy Study




- Objective: Evaluate the registration accuracy of eeDAP using real tissue.
- What is the registration error (distance) for each FOV?
- Does registration accuracy depend on tissue?

Study Methods

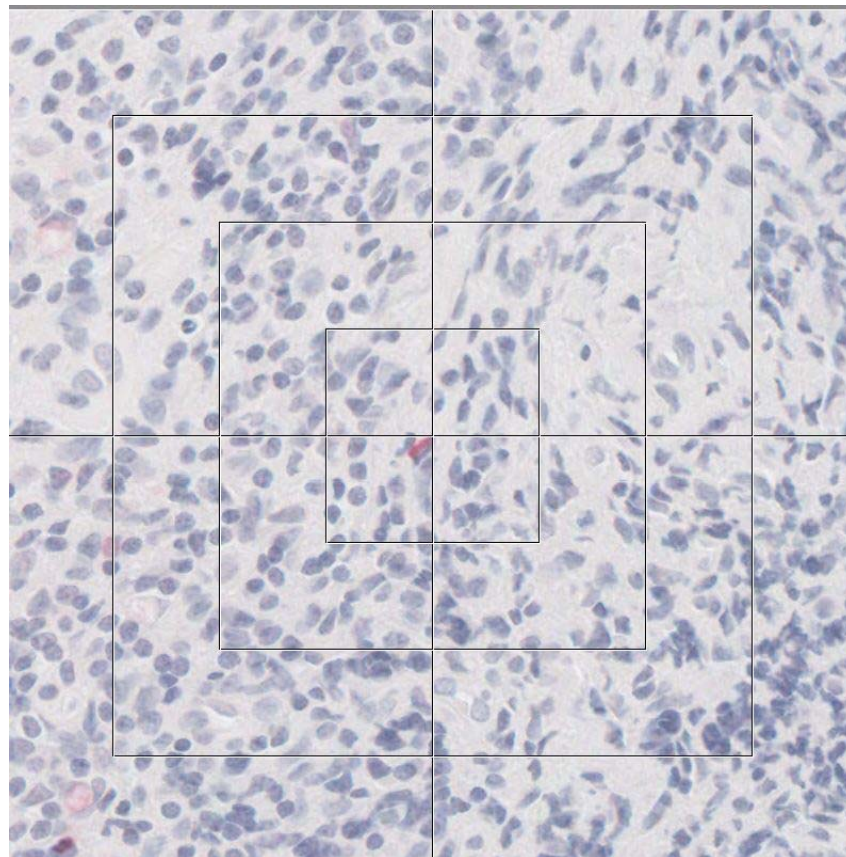
1. The center of each FOV should be a small target: a corner of cell or tiny structure.



Fiducial mark :  points out center feature.

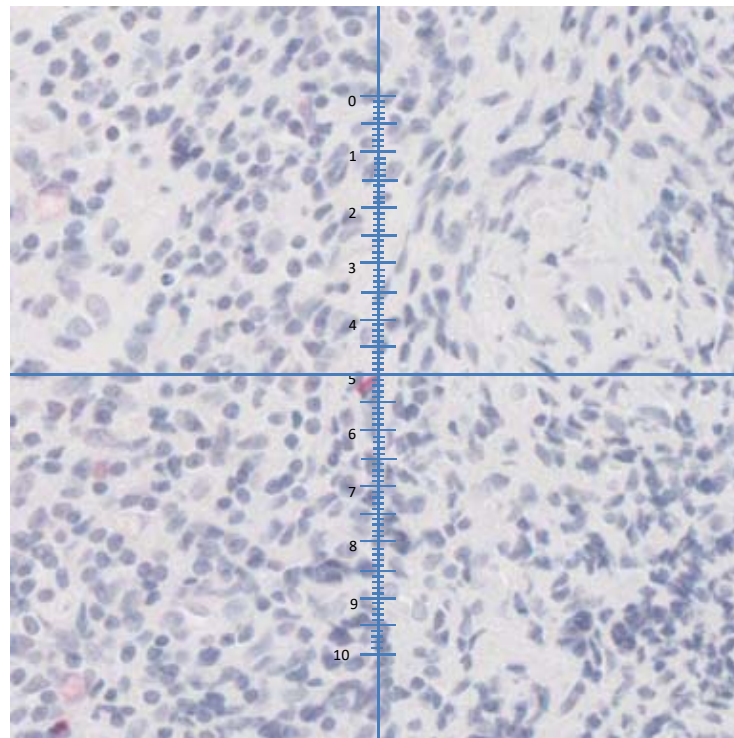
Study Methods

2. In WSI, use virtual reticle to identify the target.

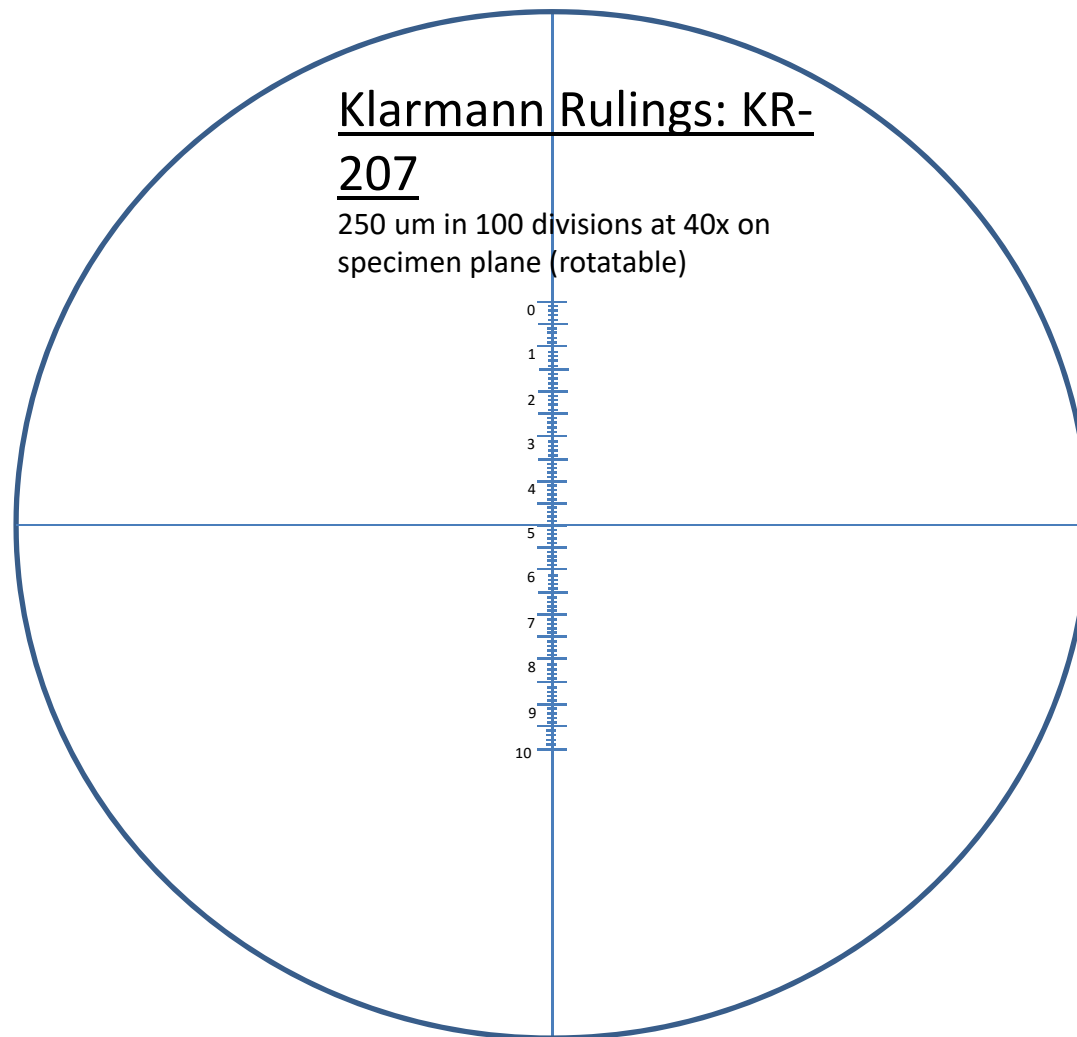


Study methods

3. On microscope, use reticle in eyepiece
 - Rotatable ruler
 - Measure distance: target to center (human)



Reticle Choice



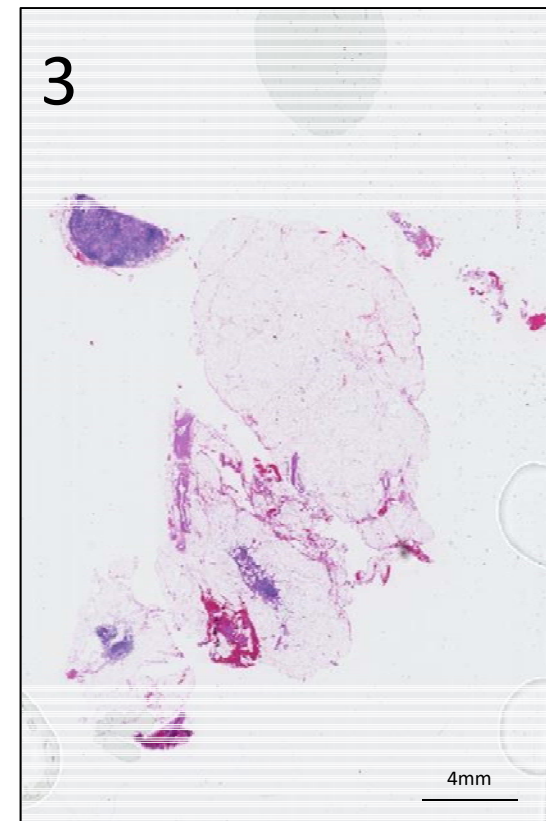
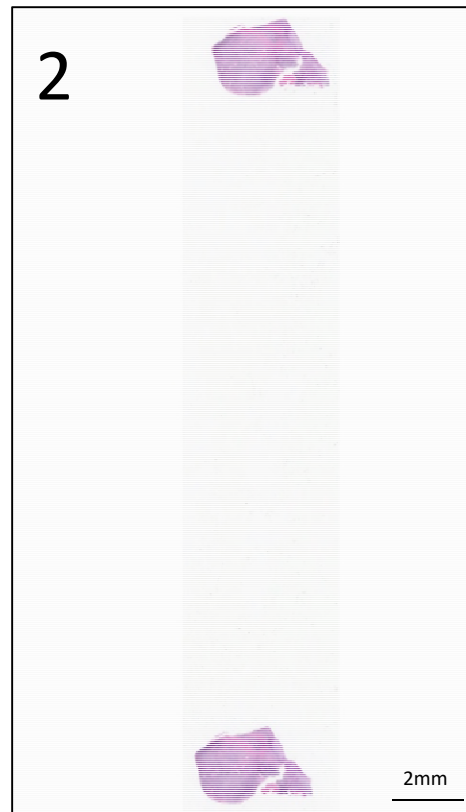
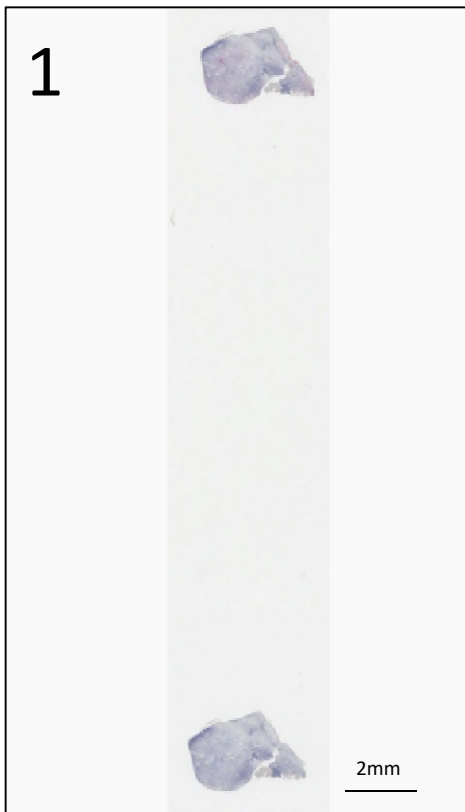


Measurement data

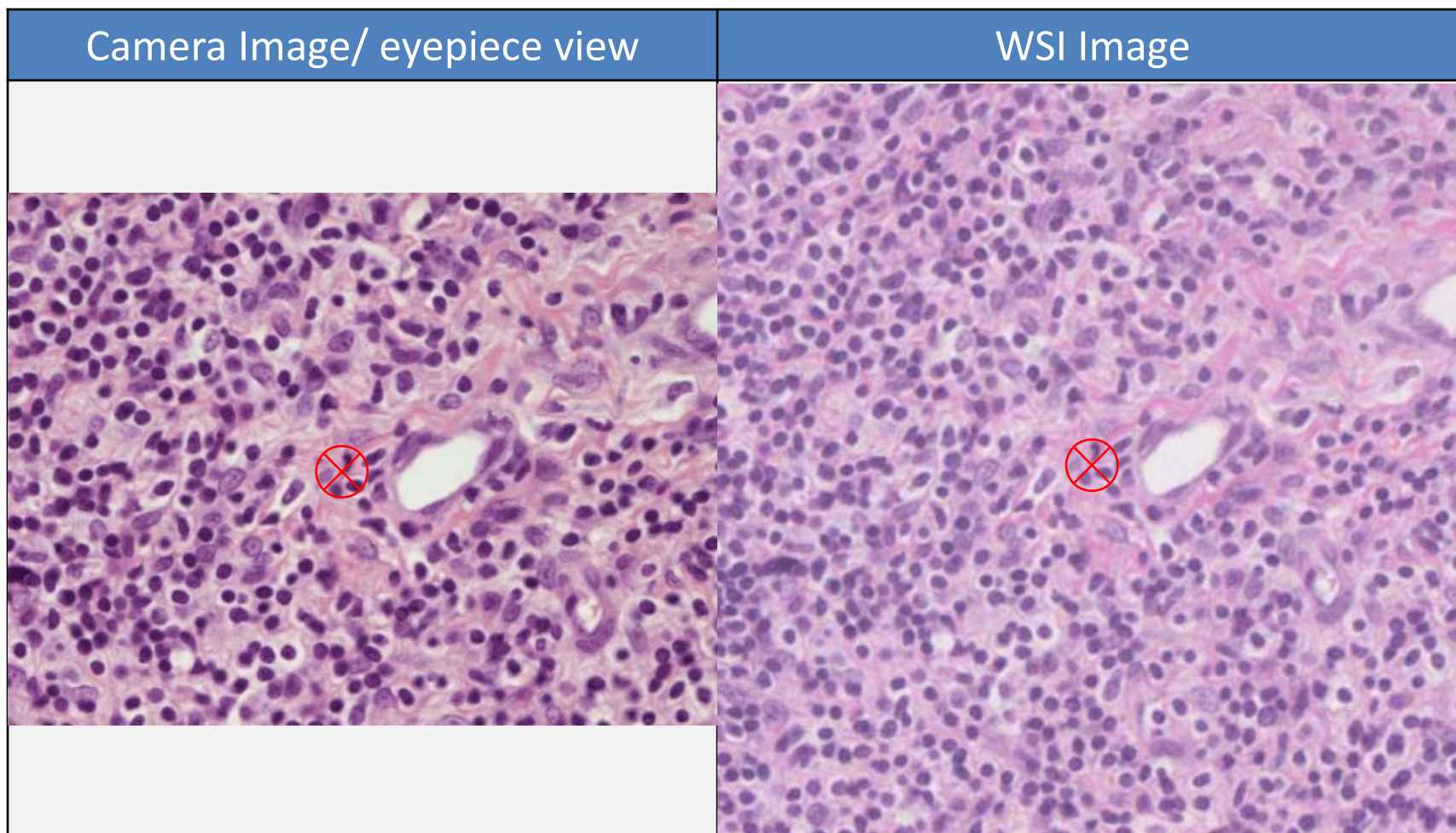
- **Automatic:**
 - Not part of this preliminary study.
- **Fast:**
 - 2 readers (one eeDAP expert, one novice) , 3 slides, 10 ROIs/slide.
- **Best:**
 - 1 reader (eeDAP expert), 3 slides , the same 10 ROIs/slide.
- **Manual:**
 - Not part of this preliminary study

Slide choice

1. Canine oral melanoma, phosphohistone H3 (pHH3) stain.
2. Canine oral melanoma, hematoxylin and eosin (H&E) stain.
3. Human lymph node, hematoxylin and eosin (H&E) stain.
(challenging case due to uneven tissue: out of focused scanned WSI)



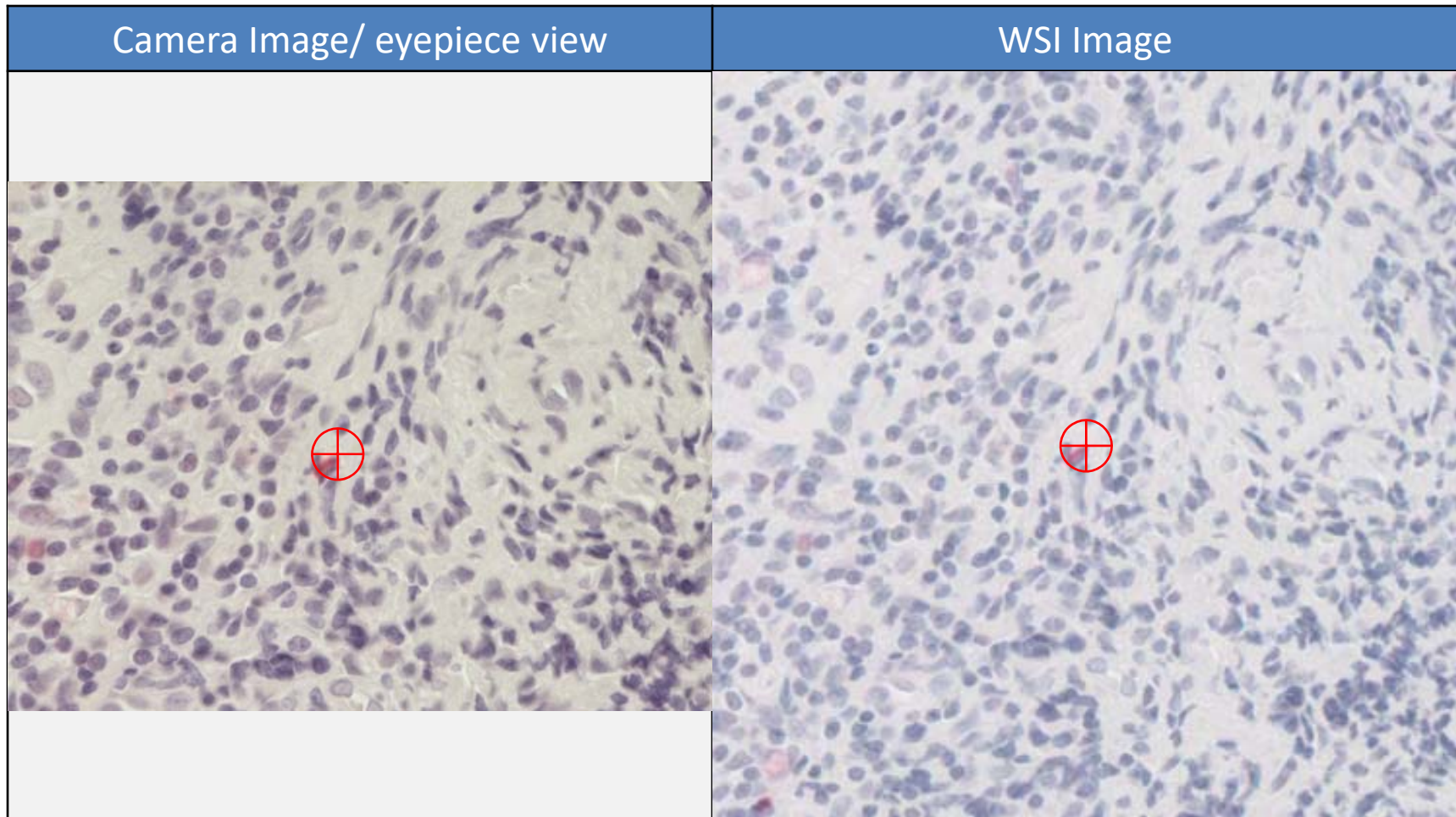
Fast Registration Success Case



Canine oral melanoma, H&E stain

Fiducial mark :  points out center feature.

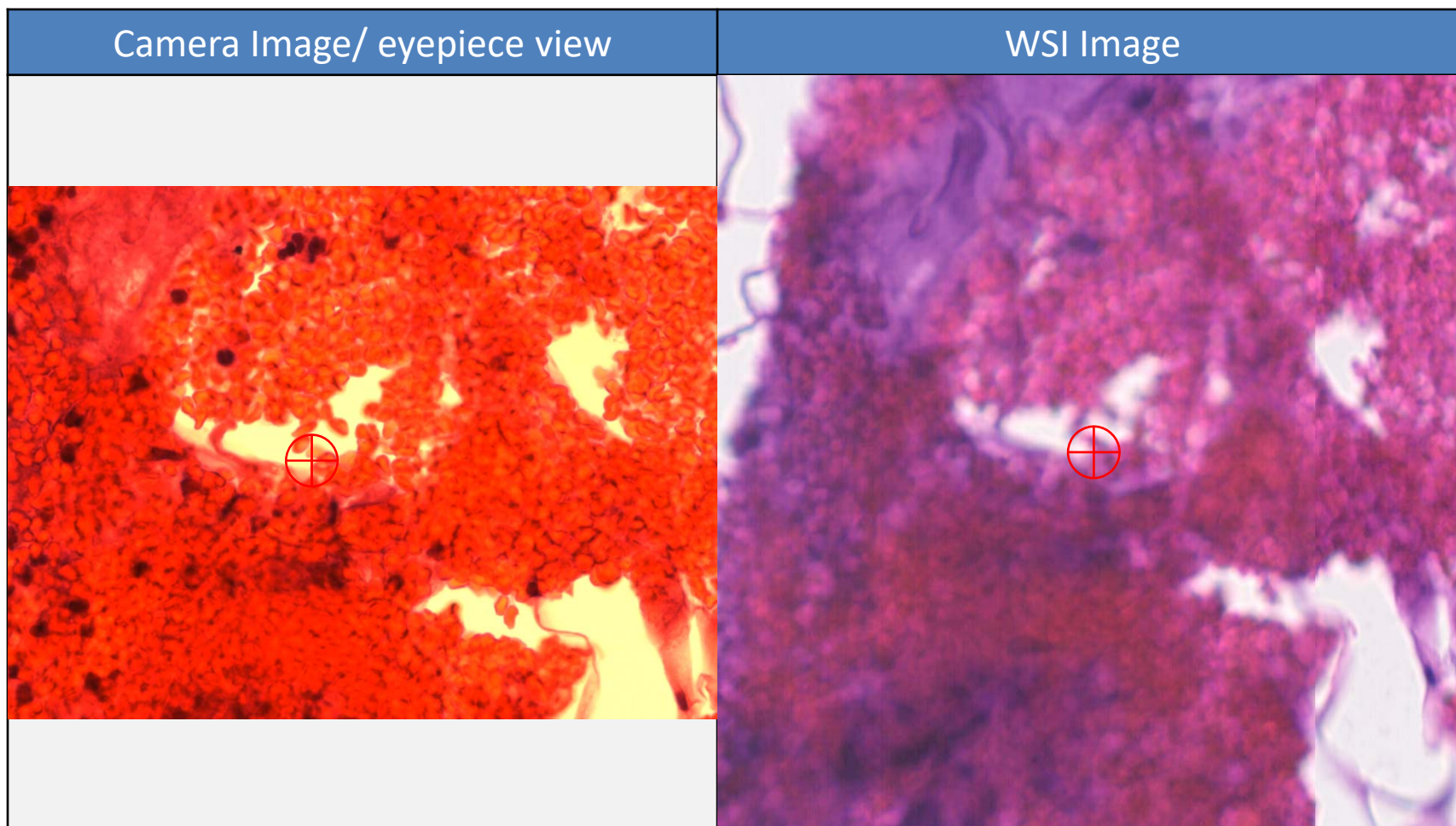
Fast Registration Success Case



Canine oral melanoma, pHH3 stain.

Fiducial mark :  points out center feature.

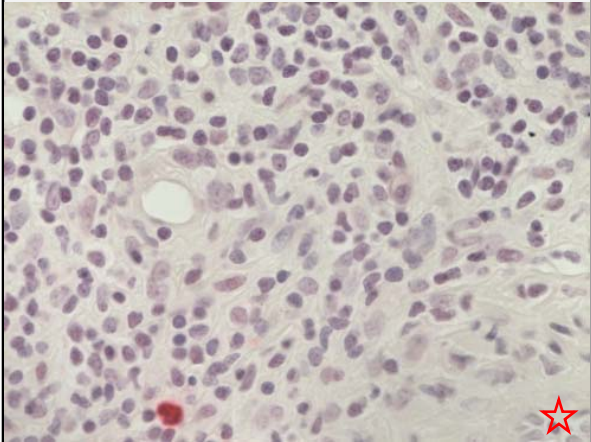
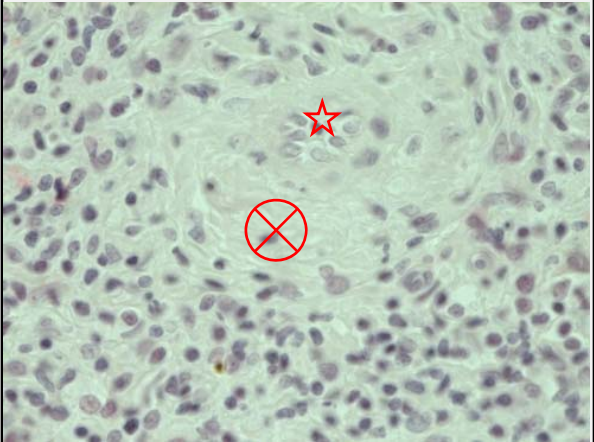
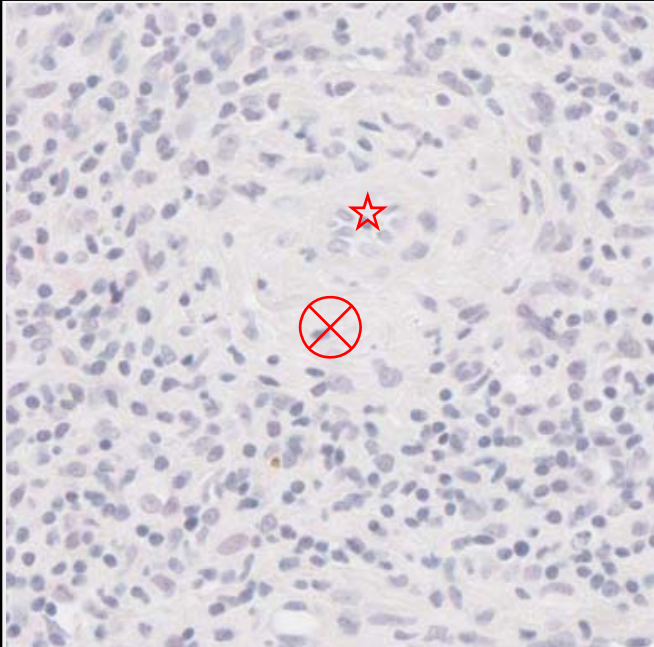
Fast Registration Success Case



Human lymph node, H&E stain

Fiducial mark :  points out center feature.

Best Registration Success Case

| Camera Image/eyepiece view Fast Registration | Camera Image/eyepiece view Best Registration | WSI Image |
|--|---|--|
|  |  |  |

Canine oral melanoma, pHH3 stain.

Fiducial mark :  points out center feature.

 : another landmark cell

Failed Case

| Camera Image/eyepiece view Fast Registration | Camera Image/eyepiece view Best Registration | WSI Image |
|---|--|--|
|  |  |  |

Human lymph node, H&E stain

Fiducial mark :  points out center feature.

: another landmark cell

Results: Reader 1



Fast registration

- 27 out of 30 FOV “Successes”
 - Successful registration: error less than 2.5 μm (first tick mark of ruler, diameter of cell in the study is about 8 μm).
- 3 out of 30 FOV “Failures”
 - When it fails, it fails badly: observed error large (between 100 and 150 μm).

Best registration

- Fix 2 out of 3 cases. The failed case error was 75 μm .

| | <i>Fast Registration</i> | Best Registration |
|----------------------------------|------------------------------|------------------------------|
| Canine H&E | 10 | 10 |
| Canine pHH3 | 9 | 10 |
| Human H&E (challenging slide) | 8 | 9 |

Results: Reader 2



- Independent global registration.
- Independent focus for Fast Registration.
- 100% matching results with first reader.



Conclusions and Discussion

- eeDAP registration was found to be accurate.
 - **Fast** registration was successful in 90% cases.
 - **Best** registration fixed mis-registration in 2 out of 3 failures.
 - When successful, error is less than 2.5um.
- Registration accuracy measurements by two readers matched 100%.
- Registration errors depend on content at center of FOV.
 - There are potentially problems when the content is low contrast, homogeneous, or sparse.
- Recommendation: Evaluate registration accuracy before starting study.
 - Be aware of problem FOVs and have a plan.
 - Replace problem FOVs (if possible).
- Manual registration is always possible.



Future Plans

- Evaluate registration accuracy of
 - Automatic registration, and
 - No automatic registration
(measure stage accuracy, global registration).
- Evaluate more stains & tissue types, more readers & sites.
 - Accuracy
- Improve methods



Thank You !

Welcome to visit our exhibit this week

eeDAP website <https://github.com/DIDSR/eeDAP>