Virtual Microscopy in Routine Pathology

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What do we need?

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Talk at a Glance

- Advantages of VM
- Problems with introduction in routine paathology
- Solutions
  - Speed
  - Handling
  - PLIS Integration
  - Imaging
- Conclusions

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Advantages of Virtual Microscopy

User Viewer Slide Server Slide Scanner

- No glass archive, no glass transportation
- Microscopic diagnostic anytime anywhere
- Parallel viewing of different stainings, positions
- Viewing and handling parallel at different locations
- Image analysis just in time
- Annotations are simple to handled

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Pathologist Look on Virtual Microscopy

- No necessity to use VM now
- Image quality is better in conventional microscopes
- Introduction of VM must have positive financial effects
- Navigation of WSI is not efficient and slow
- Storage is needed and expansive
- Added value is not visible
- Legal problems – allowed for routine use?

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Storage requirement, Scanning time

- 1 day, 400 cases, 10 slides per case 4 TB
- 1 month 88 TB
- 1 year 1056 TB
- Charité radiology department /month 1,8 TB

- 3000 biopsies (1,5 cm^2) 4500 minutes
- 1000 surgical sllides (4 cm^2) 6000 minutes
- Total time for scanning (Hmamatsu) 10500 minutes

175 hours

7 Scanner work 24 hours

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SPEED up using Diagnostic Path

- Pathologists analyse between 2 and 30 ‰ of a WSI for diagnostic purposes

- For second opinion in breast cancer between 2 and 9 ‰ of the WSI area have been measured
  (measured on T.Konsult of the Berufsverband Deutscher Pathologen e.V)

- The diagnostic paths depend on the material, the kind of diagnostic (first, second opinion) and the complexity of the diagnostic problem

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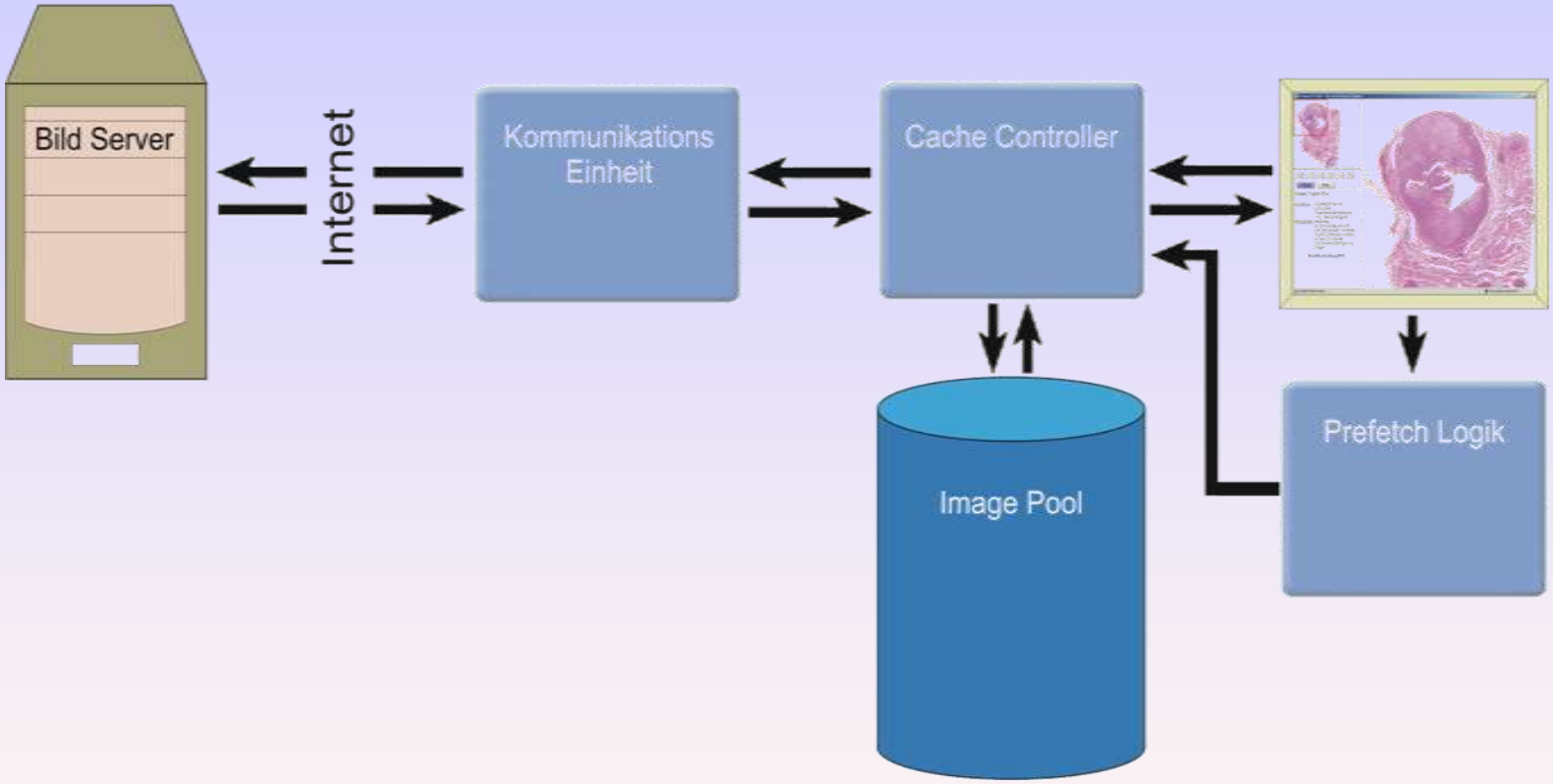
Caching and Prefetching



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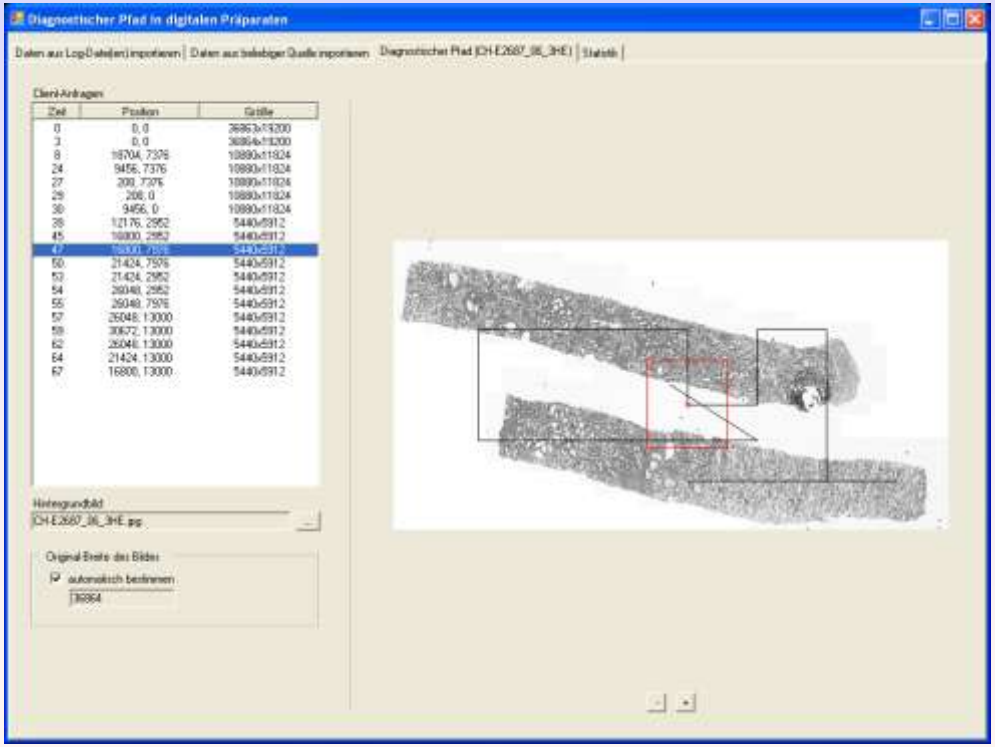
Prefetching

Optimal pre-fetching corresponds to pathologists way through the WSI



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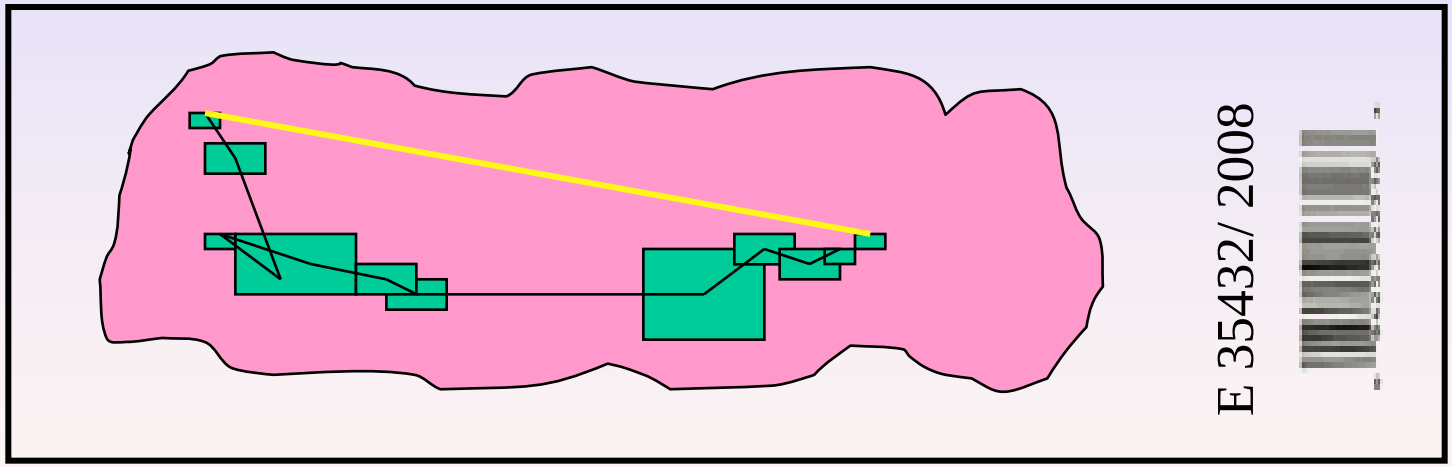
Linearity

Euclidean distance between the starting and the end point divided by the length of the way between these points

Linearity lies between
0 – fuzzy
1 – all points in one line



Material

In total 257 diagnostic paths from 131 WSI have been extracted and analysed.

Glass slides were scanned with three scanners (Olympus .Slide, Zeiss Mirax, Hamamatsu Nanozoomer).

On average a diagnostic path consists of 16 image requests and takes 189 seconds between first and last image request.

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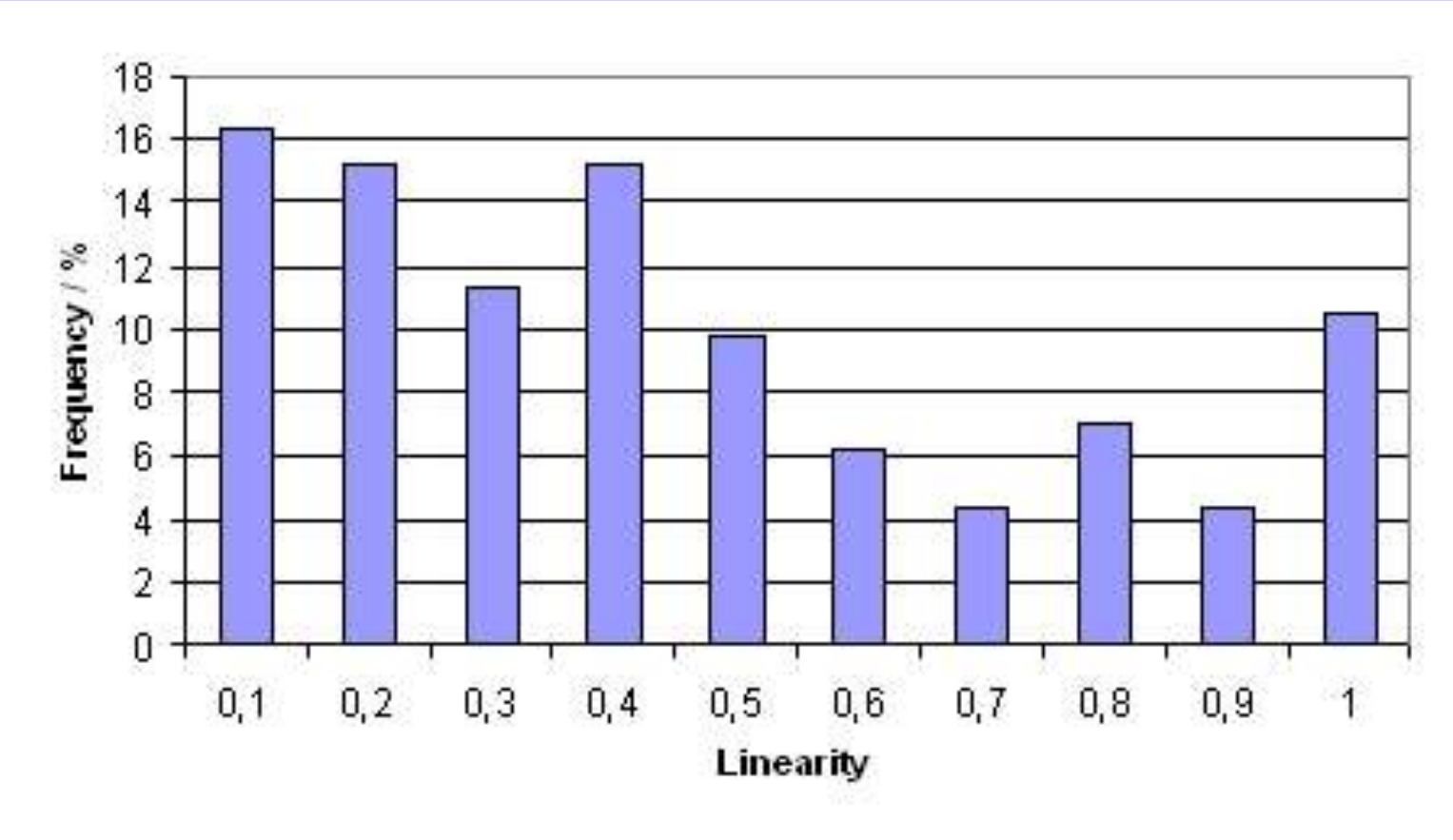
Frequency of Linearity



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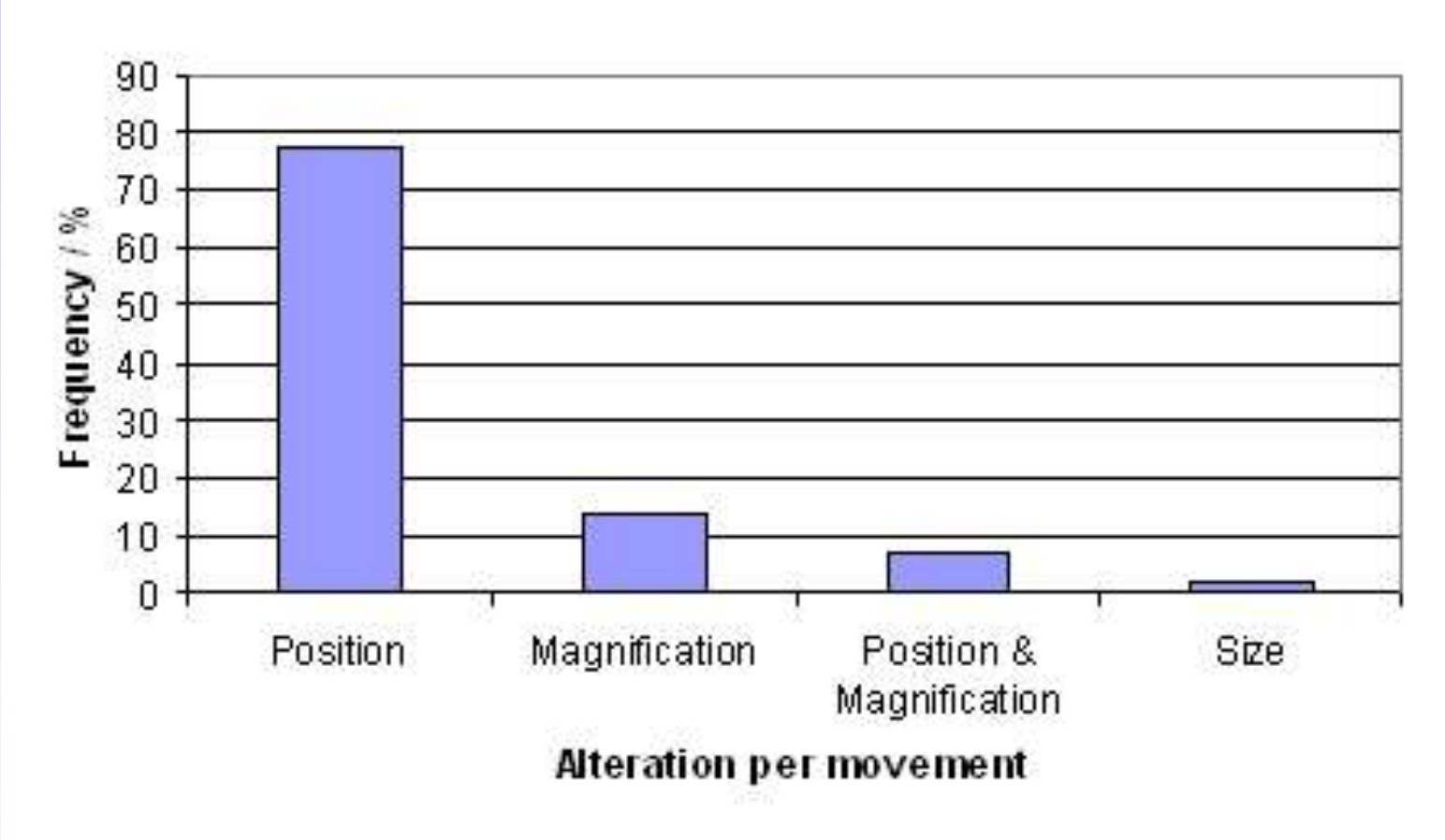
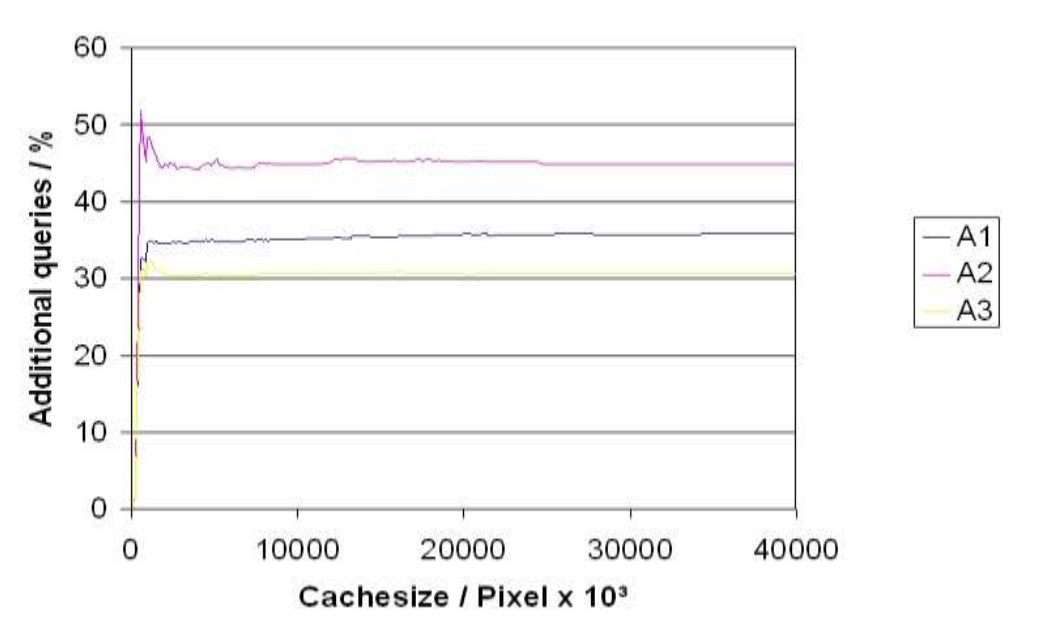
Frequency of Alterations per Movement



Additional Queries for Algorithms A1, A2, A3



Optimal algorithm for second opinion in breast cancer is A3.

Up to two three times faster.

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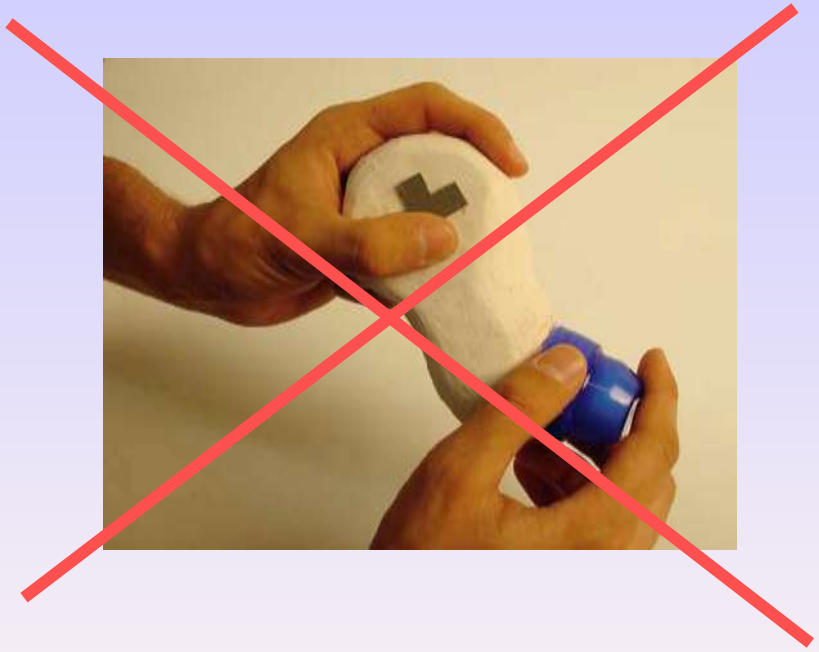
HANDLING Optimize Man Machine Interface

- Simple
- Intuitive
- Fast
- One hand tool
- Does not tire pathologists
- Usable for left and right hand



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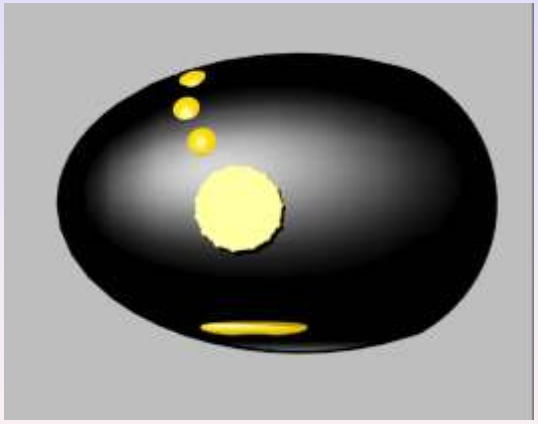
VM Navigation



Results of disign studies by students, Uni Magdeburg

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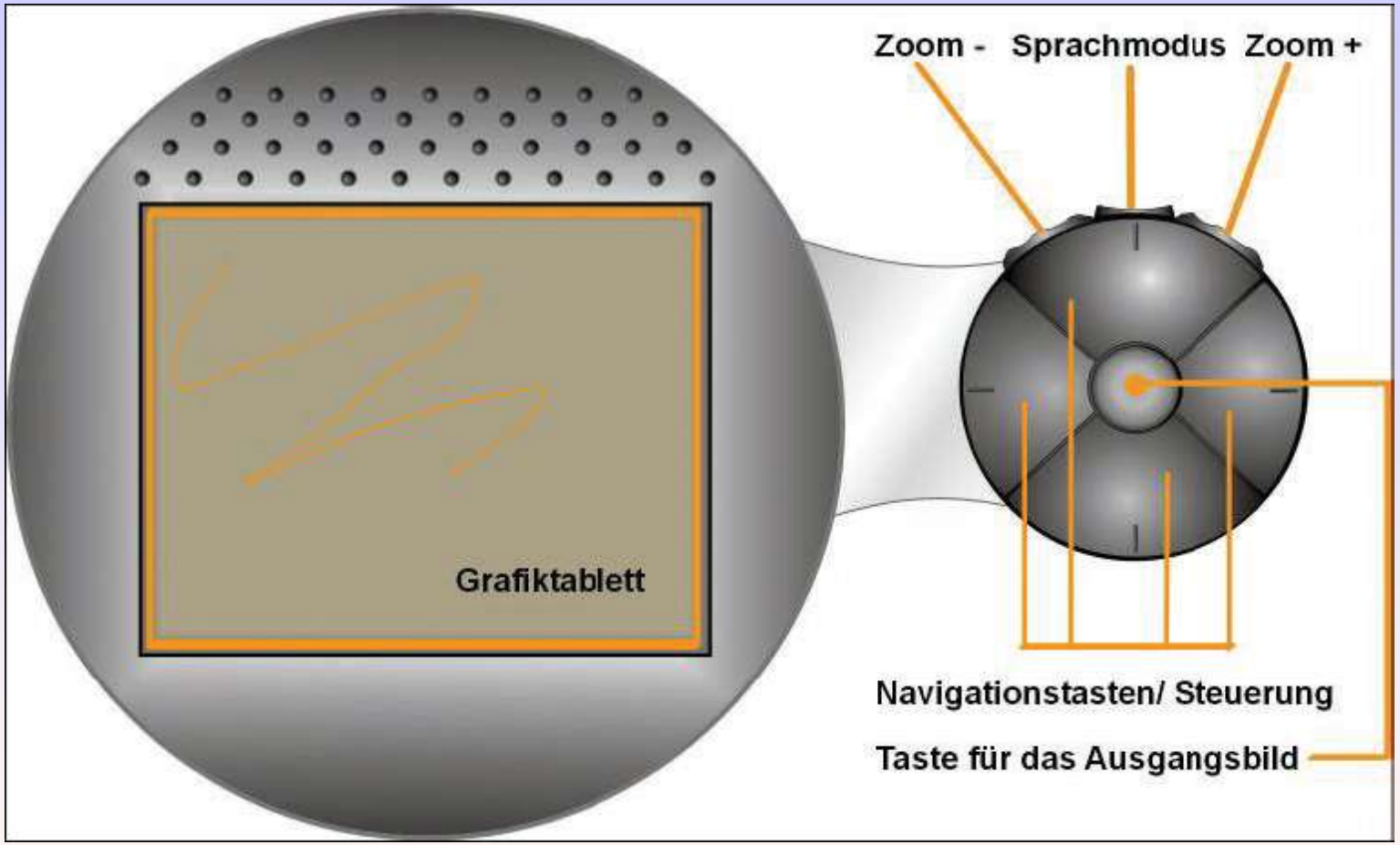
VM Navigation



VM Commercial Navigation Tools

Space Navigator

Space Pilot

Space Explorer

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INSTITUT FÜR PATHOLOGIE
RUDOLF-VIRCHOW-HAUS

VMscope
Beyond the scope of microscopy

EFFICIENCY – Integration to PIS

- Simple
- Intuitive
- Faster than conventional work
- Imaging integrated
- Case and slide have own IDs

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Pathology Network

Macroscope

Slide Scanner

Diagnostic PC

Local Area Network (LAN)

PLIS

PACS

Intranet

HIS/EPR

Internet

Telepathology Consultation Centre

Case DB

Reference Cases

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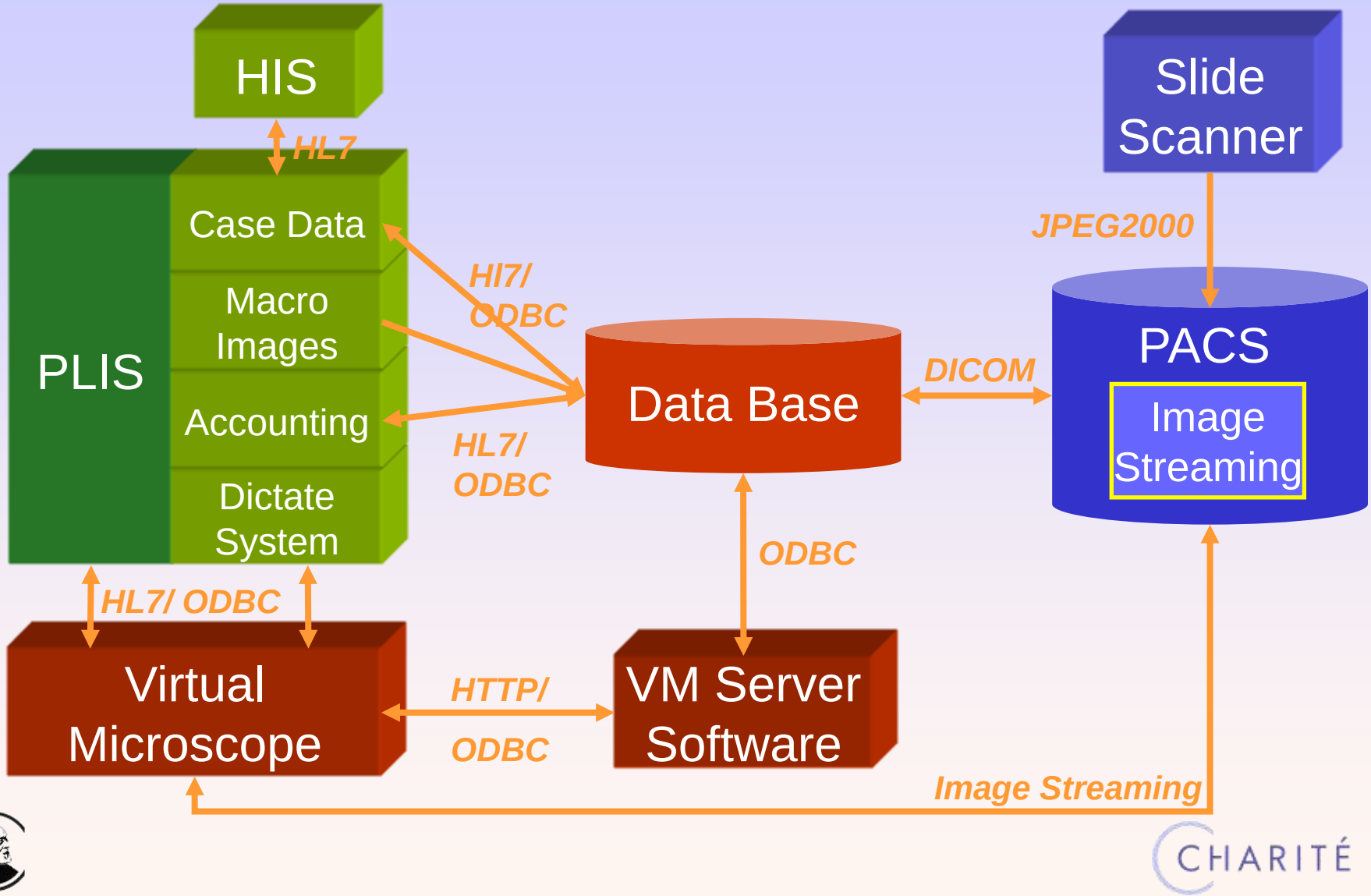
Integration into Pathology Information System



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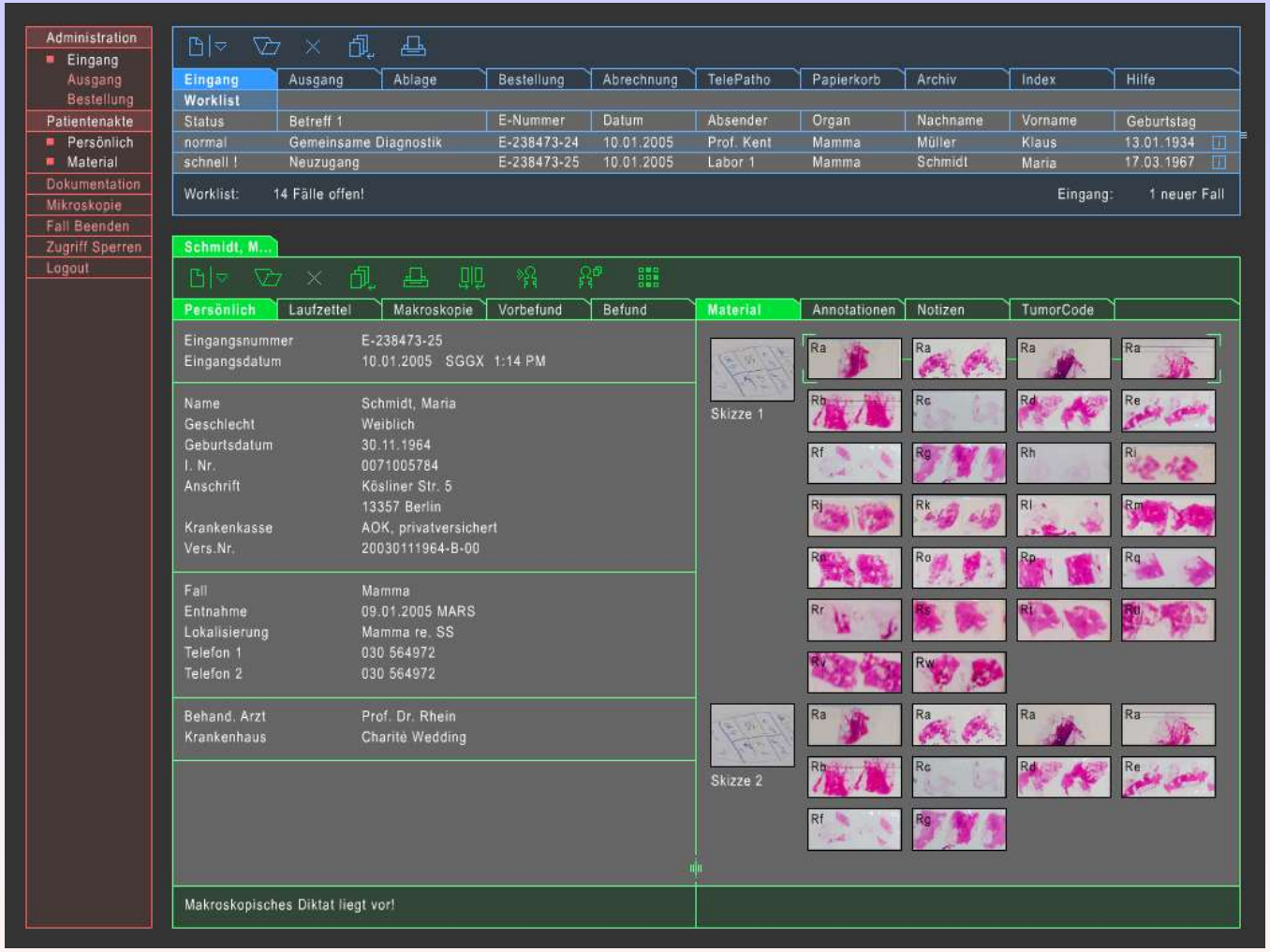
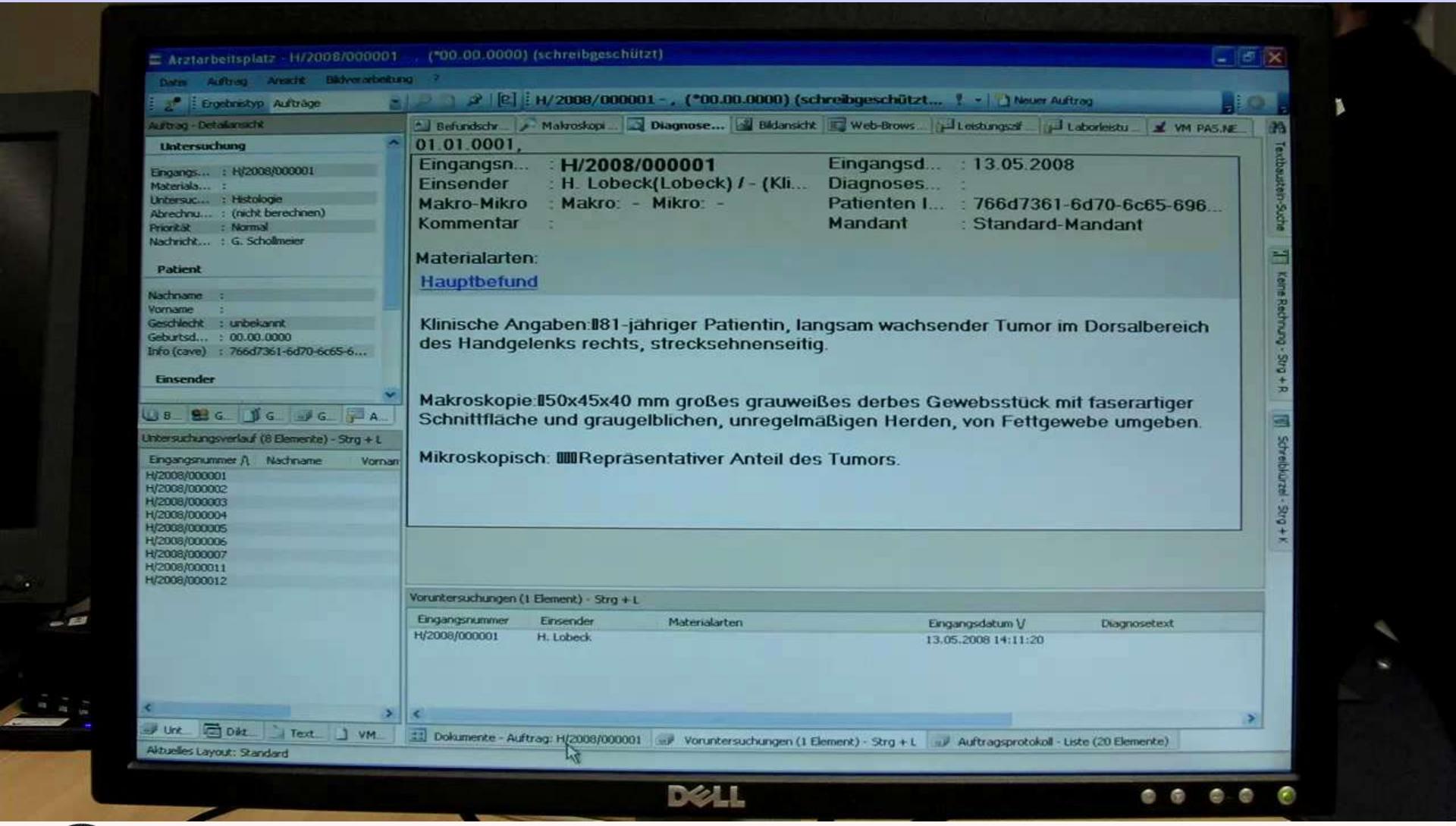
Routine Pathology – Design Study



Medical Workstation - All Information in One View

Routine Pathology – Support in Diagnostic (PAS)



BETTER than in conventional microscopy : Imaging

- Mesurement
- Biopsy stacks
- Parallel viewing of different stainings
- Ploidy analysis
- Case search and comparison
- .....

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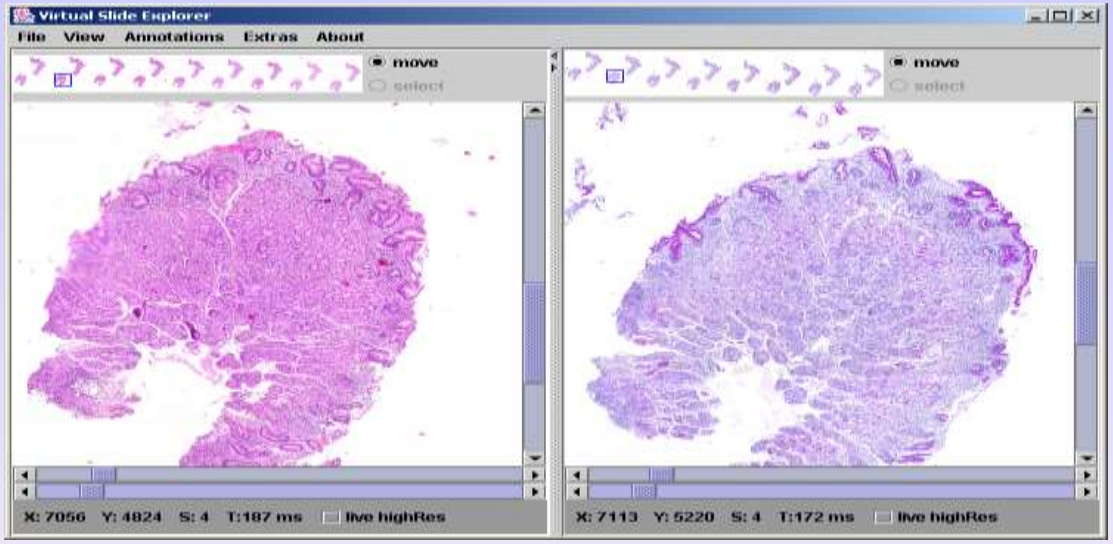
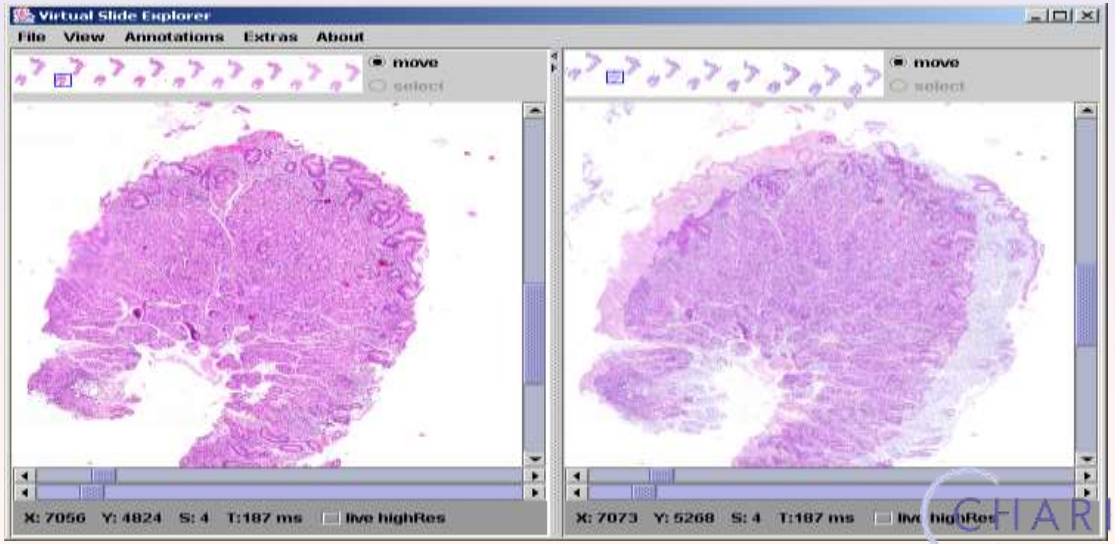
Routine Pathology – Support in Diagnostic

Simultaneous Viewing of Different Stains and Slices



Semi-Transparent Overlay of Different Stains and Slices



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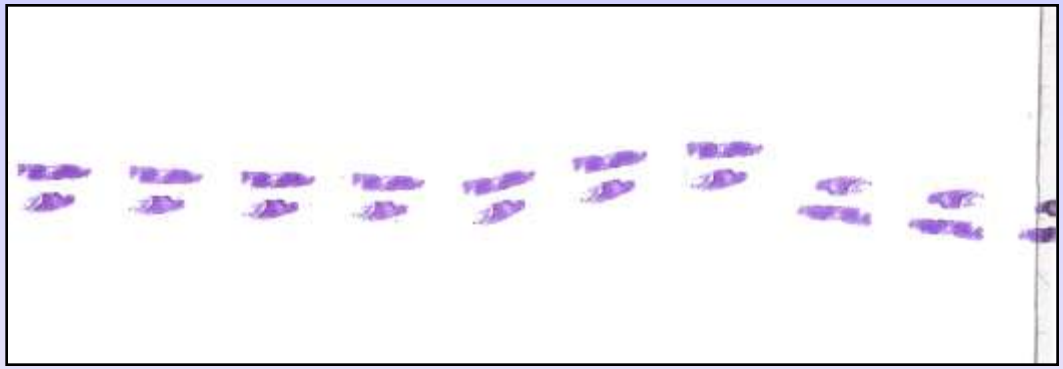
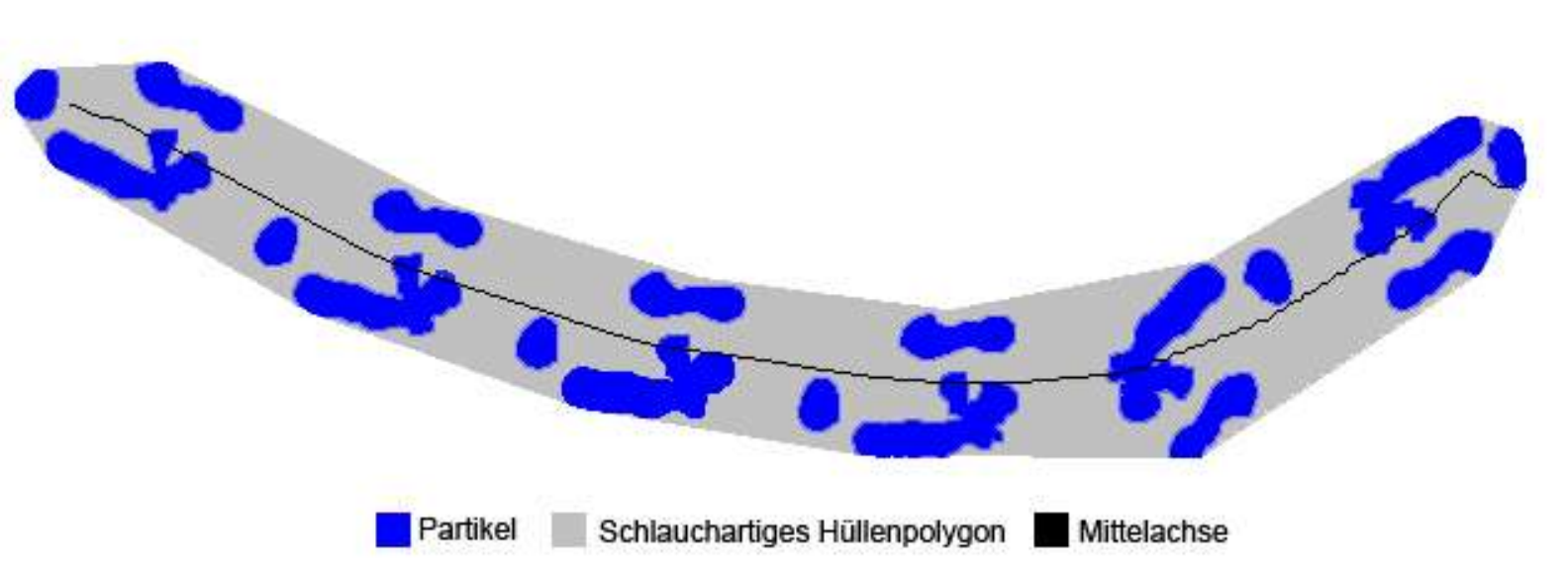
Typical Biopsy Stack



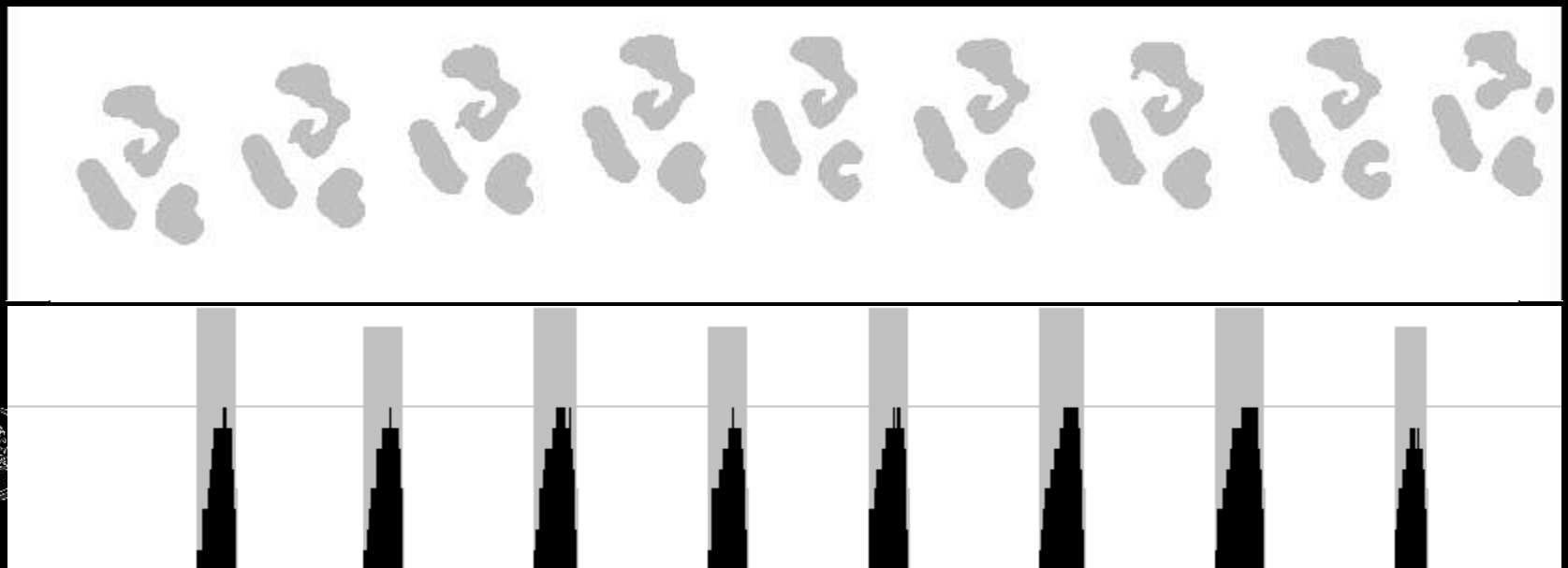
Rotation of biopsies

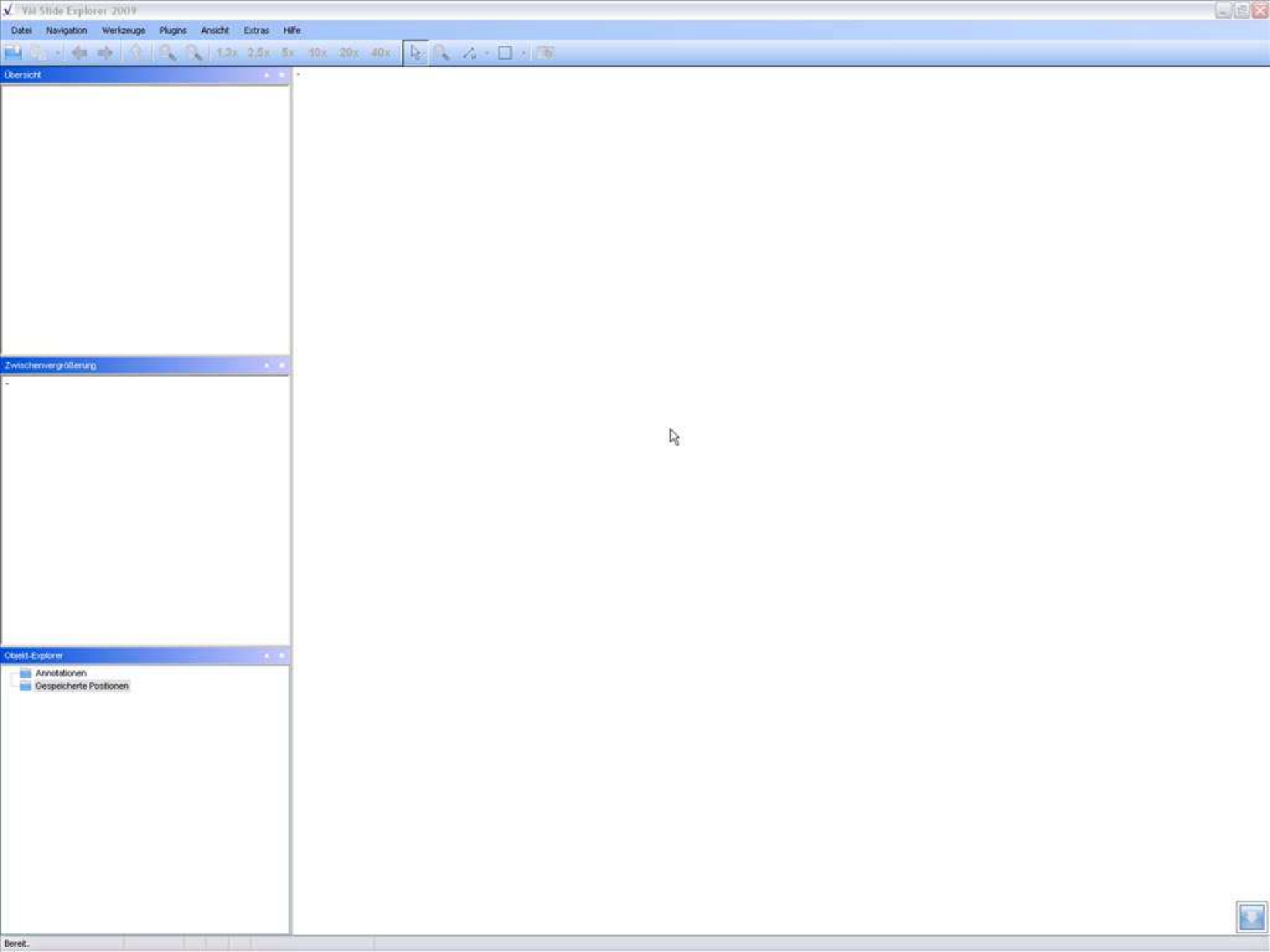
Variation of particle number in neigbouring planes

Determination of Rotation



Full-automatic analysis of serial histological sections
in context of estimating similar tissue artifacts on neighboured sections




Vil Slide Explorer 2019
Datei
Navigation
Werkzeuge
Plugins
Ansicht
Extras
Hilfe
1,3x
2,5x
5x
10x
20x
40x
Übersicht
Zwischenvergrößerung
Objekt-Explorer
Annotationen
Gespeicherte Positionen
Bereit.

Steps for imaging in routine

- Scanning
- Analysis of the total WSI
- Viewing in dependence of image analysis results
  (open at highest density of mitoses)
- Measurements in ROI (preprocessed)
  (- count number of mitoses within marked area
  - determine percentage of marked cells, ...)
- Case search and comparison

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Way of Introduction in Germany

- **VM in education**
- **VM in second opinion and decentral departments**
- **VM as tool for interdisciplinary tumour centres**
- **VM for routine marker quantification**
- **VM for smaller departments (e.g. Neuropathology)**
- **VM for whole university institutes**

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Conclusions

- **VM has a large potential in the near future**
- **Introduction will take years**
- **Process will run similar to digital radiology**
- **Largest advantages now for universities**
- **DRGs, certification of tumour centres, will promote process**

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Thank you!