Introduction to Digital Pathology

Scottish Association of Histotechnology
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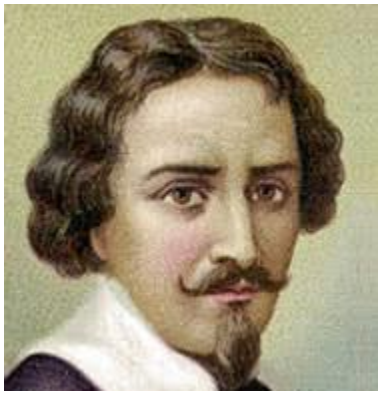
National Lead for Digital Pathology

History of the Light Microscope

- First compound light microscope was probably invented by Dutch spectacle makers Zacharias and Hans Jansen in the 1590's.
- Up to 30x magnification



Early Microscopes

- Anton van Leeuvenhoek (Dutch) made significant improvements (simpler design but higher quality lenses) in the mid 17th century.
- Up to 270x Magnification
- Described the first micro-organisms

Further developments

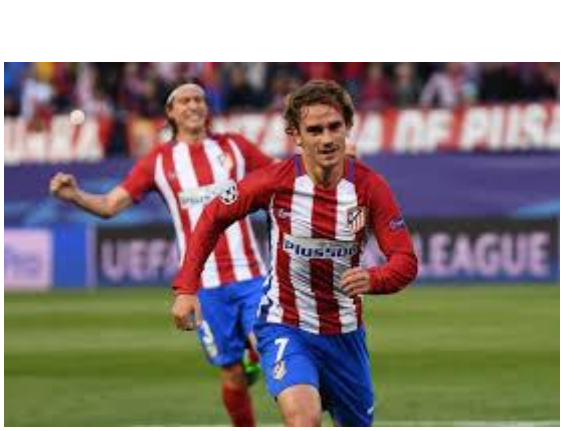
- Robert Hooke (UK) made design changes and used his microscope to good effect describing the first cells in his book, Micrographica of 1665.

Up to date

Radiology Changes

Comparison

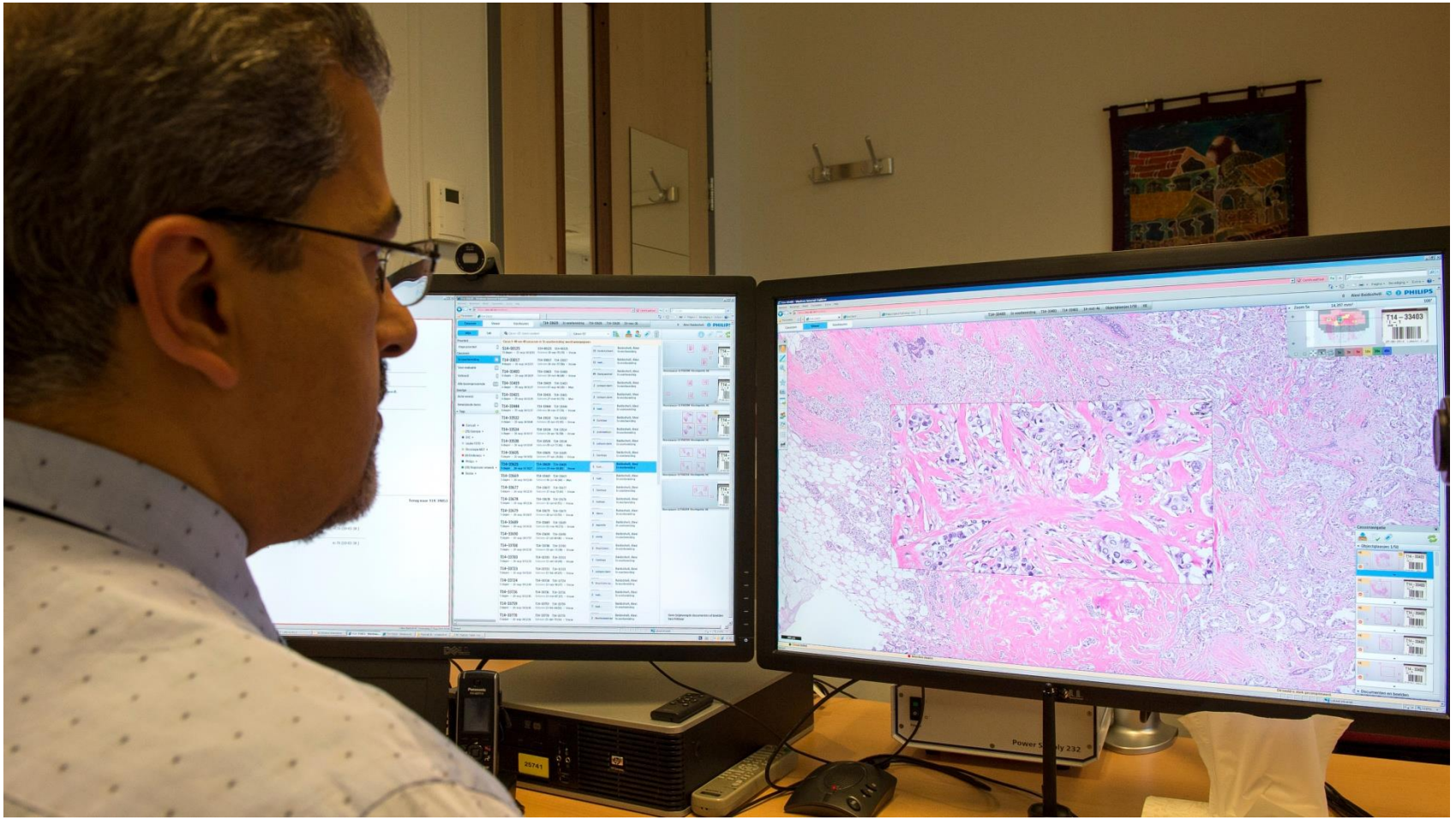
No more!



Pathology

Radiology

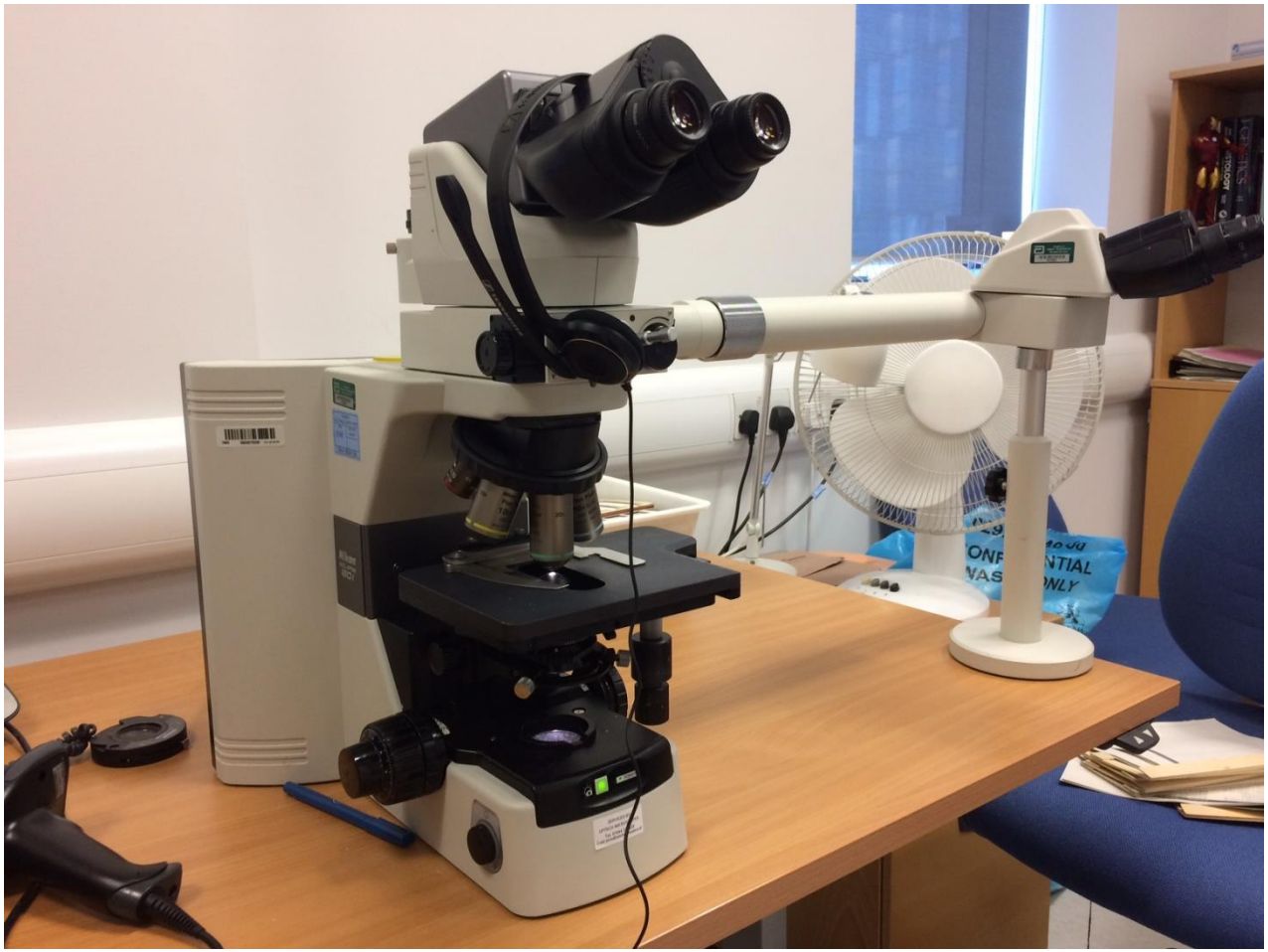
The future?



Pathology vs Radiology

- Why has it taken pathology so long to catch up with radiology?
  - Smaller market
  - Need for rapid turnaround
  - Digital pathology is an additional step
  - Magnification leading to vast data size
    - Technology now only able to cope with data size and transfer rates

Magnification

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Aberdeen
SCOTLAND
Fort William
Arbroath
Dundee
Perth
St Andrews
Oban
Loch Lomond & The Trossachs National Park
M90
M80
Edinburgh
Glasgow
Paisley
M77
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Ayr
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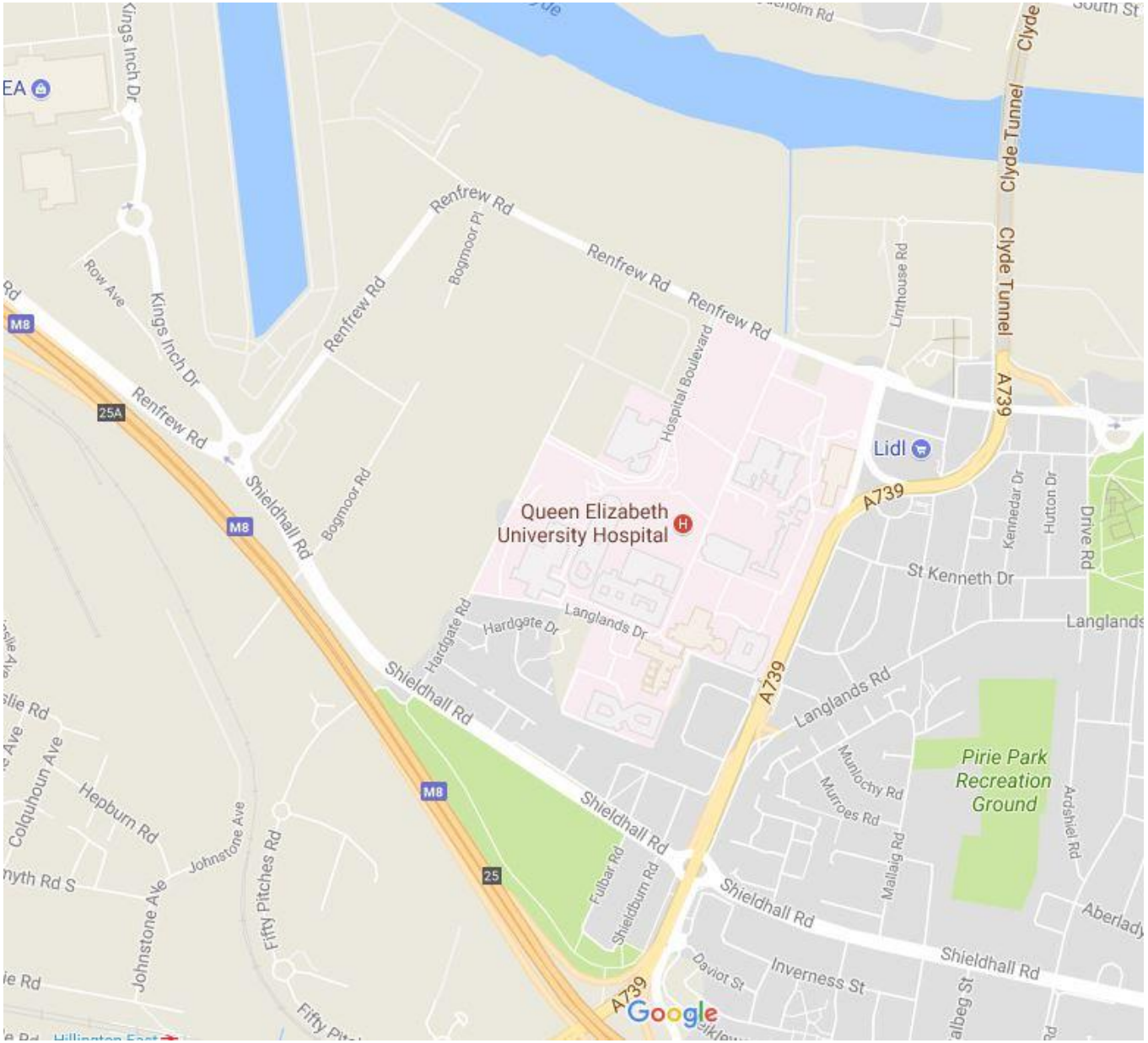
Queen Elizabeth University Hospital
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Hospital Boulevard
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Langlands Dr
St Kenneth Dr
Langlands Rd
Hepburn Rd
Johnstone Ave
Fifty Pitches Rd
Inverness St
Google

Google Maps and Digital Pathology

- Zoom and pan technology developed for google maps underpins digital pathology.
- Whole slide image data is huge but data streamed in routine viewing is only a fraction (about 5%).
- For example you don’t download a map of the world to find your way with Google maps.

Data Comparisons

Radiology PACS

- 60 MB Uncompressed per study
- 1MB compressed
- In 10 years, just reached 1 PB (1000 TB)

Digital Pathology

- 650MB per slide
- 4 GB per request
- In 7 years, anticipating at least 5 PB
- Won’t reach steady state until 10-15 years

- Overall, data requirements are about 10 x higher.

Drivers for Digitisation

- Currently NHS Scotland manages 2 million glass slides per year
- Digitisation has been shown to improve efficiency – up to 12%
- Security and accessibility of archive
- Enables innovative models of working
  - Cross boundary work sharing
  - Working off site (other hot site or home)
  - Improved ergonomics
- Possibility of computer image analytics

Health Portfolio

Mission

Governance

Programmes

Latest News

Health Portfolio

The Health Portfolio considers a 'Best for Scotland' approach for some of the functions within Laboratories, Clinical Engineering, Pharmacy Aseptic Dispensing, Public Health and Radiology.

You can find out more about this in the Programmes section.

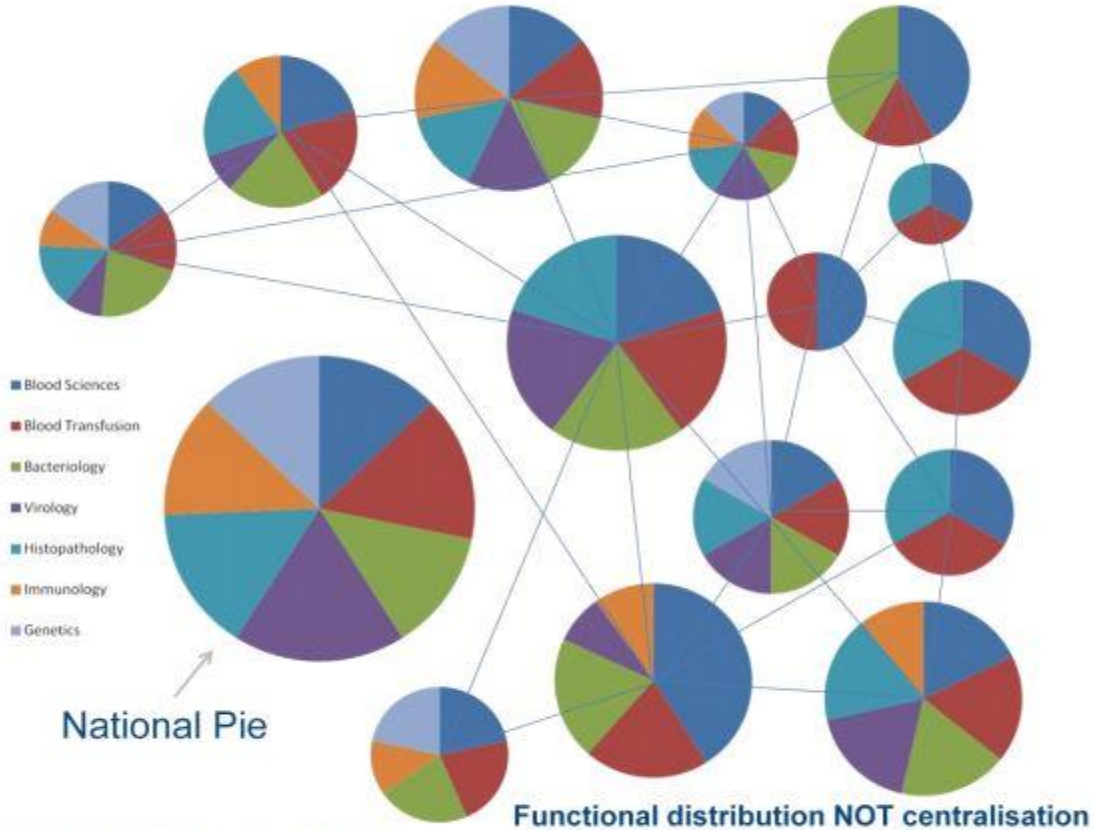


Figure 3: Distributed Service Model

The DSM enables delivery of the right testing repertoire in the right place at the right time to enable optimal patient care locally and nationally. There is a notional workload of varying degrees of complexity and volume described as the "national pie" in the figure 3. The DSM will deliver

Procurement

- Procurement Assisted by National Services Scotland
- Project Management and Clinical Leadership from GGC
- Two stage procurement
- Two site Pilot with NHS Lothian
- Implementation current (scanners/servers installed – workstations pending)

Funding

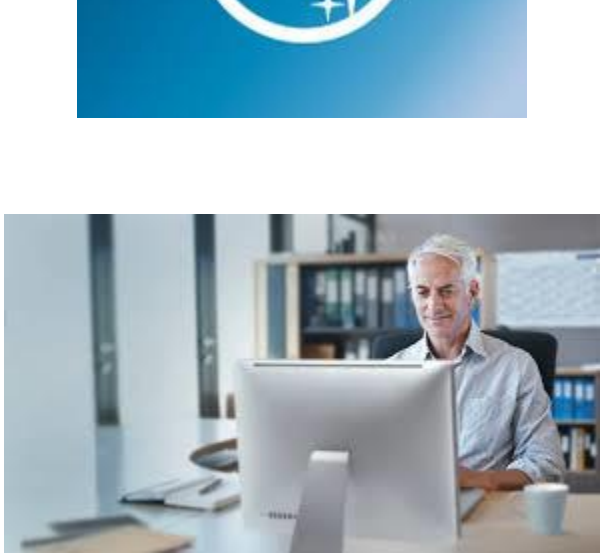
- Pilot funded through Cancer money and supported by shared services.
- Need to build business case for national funding.

Cost model

- National contract
  - Managed service contract
  - National data store
  - Board call off contract
  - Catalogue pricing
  - Model designed to enable smaller boards to come on board in a cost effective manner

Where are we now?

- Philips are the chosen supplier.
- Based in the Netherlands
- Strong presence in radiology PACS and leader in digital pathology.



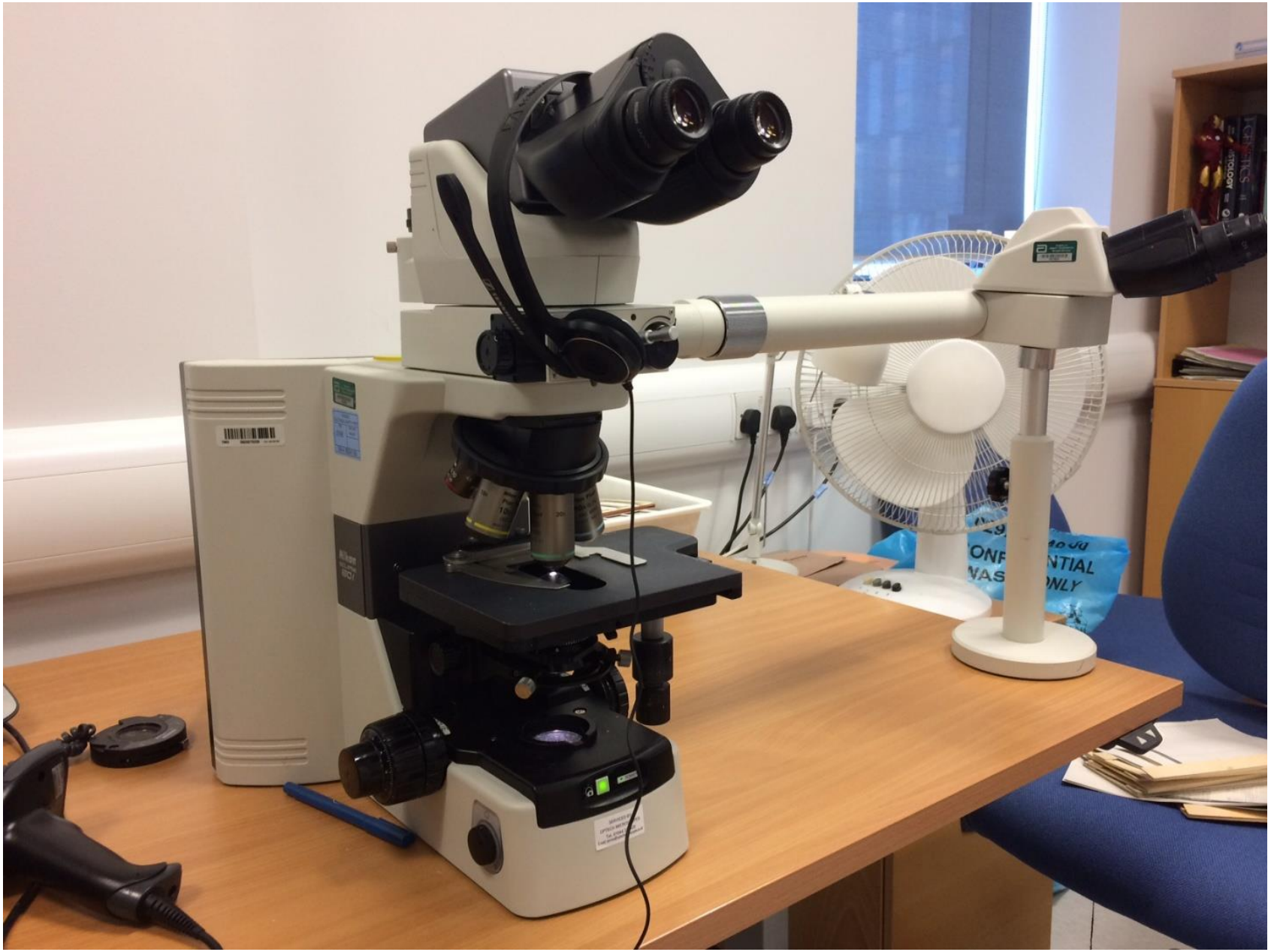
Process of digital pathology

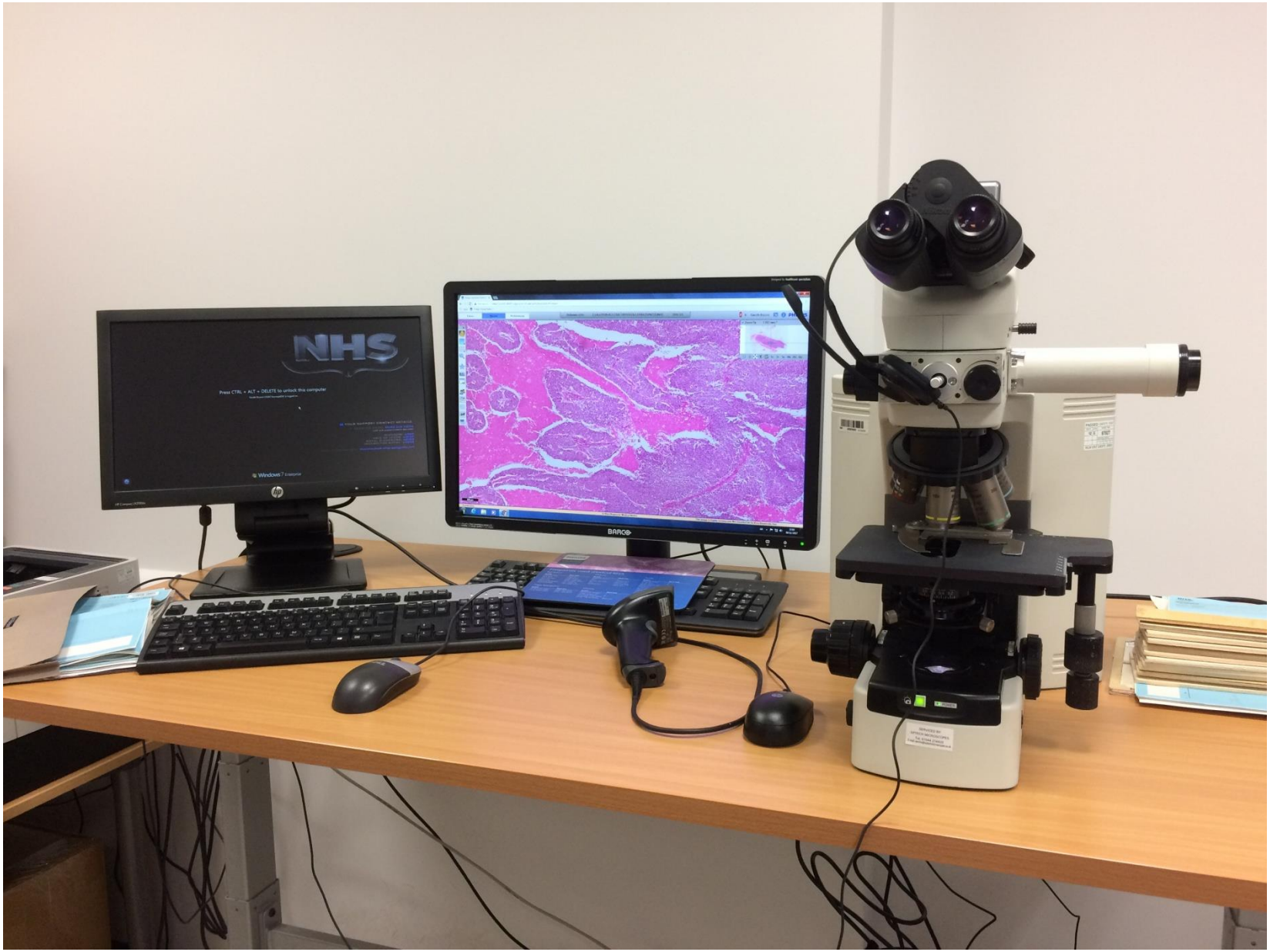
Philips UFS

- Highly automated
- Capacity of 300 slides (GGC 2500 slides/day)
- Prioritisation protocols
- Approximately 1 min scan time
- 5 scanners in GGC
- Over £150000

Workstation

- Powerful PC (similar to PACS)
- Two 24 inch Barco HD monitors (about 2.5 megappixels)
- Integrated workflow including LIS and Clinical Sytems
- Working towards a national reporting system
- About £3000




NHS
Press CTRL + ALT + DELETE to unlock this computer
Windows 7 Enterprise
BARCO

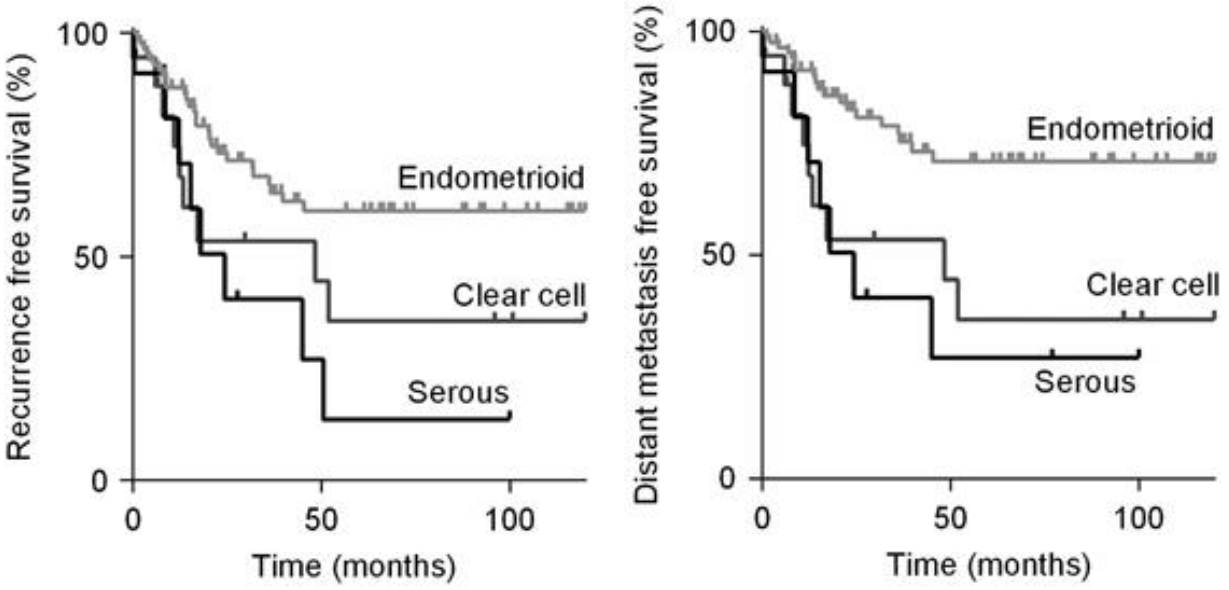
What will Digital Pathology Deliver?

Precision/Stratified Medicine

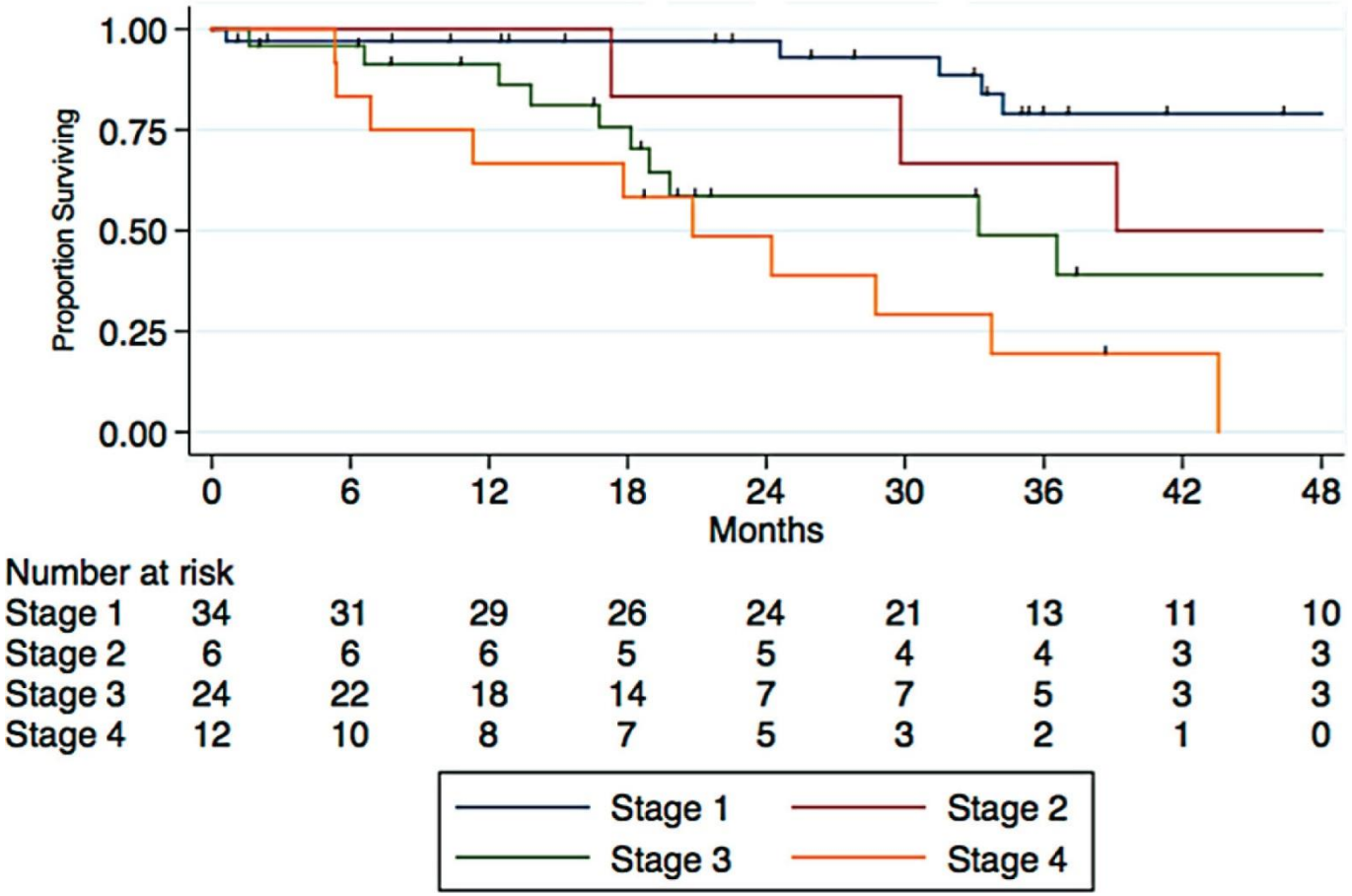
- Excitement about Molecular Pathology, tumour genetics cutting edge technology

- If only someone could come up with a technique that took the patients
  - Genetic susceptibility
  - Envirnonmental influences
  - Tumour genomics
  - Proteomics
  - Tumour microenvironment
- And display it in a way it can be quickly interpreted by an observer without massive computer power.

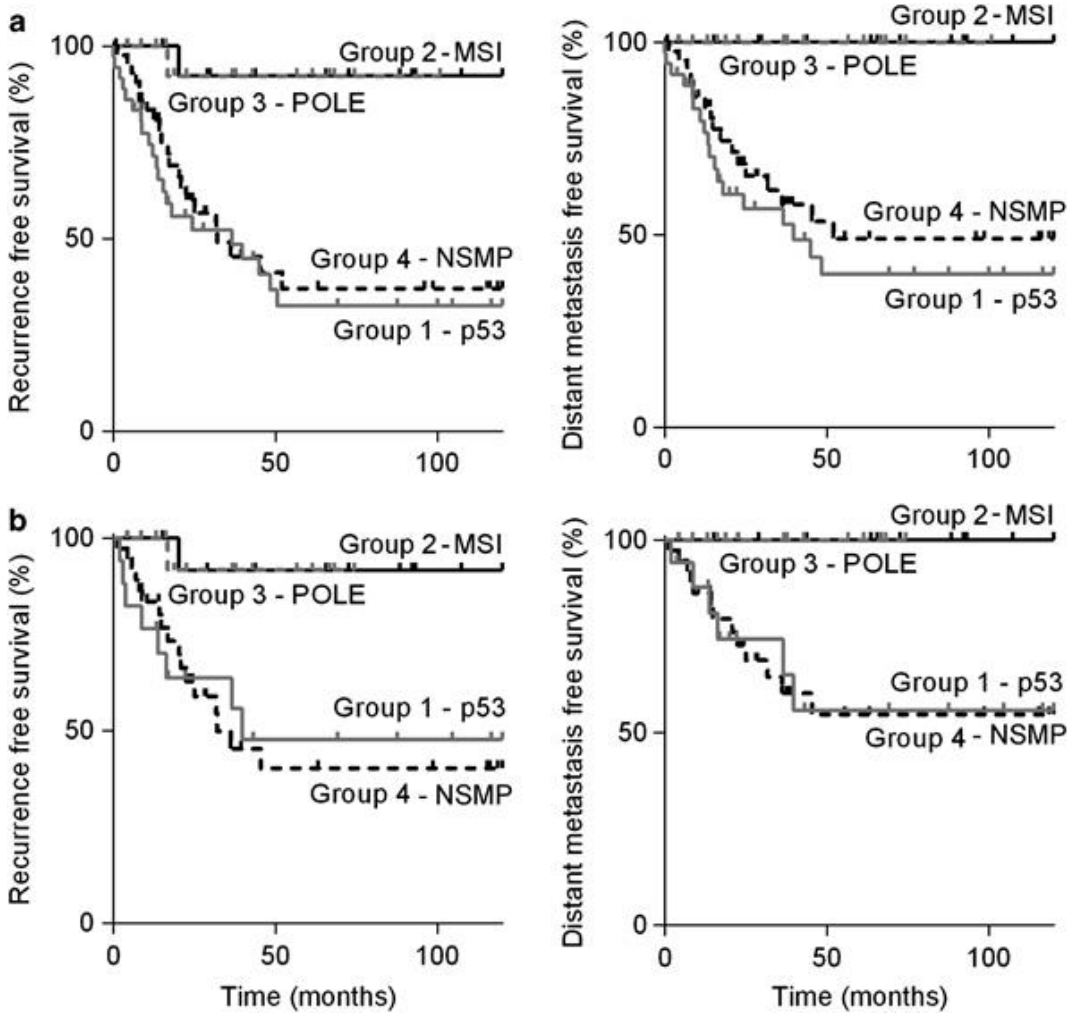
Endometrial Cancer Survival by type



Endometrial (Serous) carcinoma survival by stage



Addition of molecular results



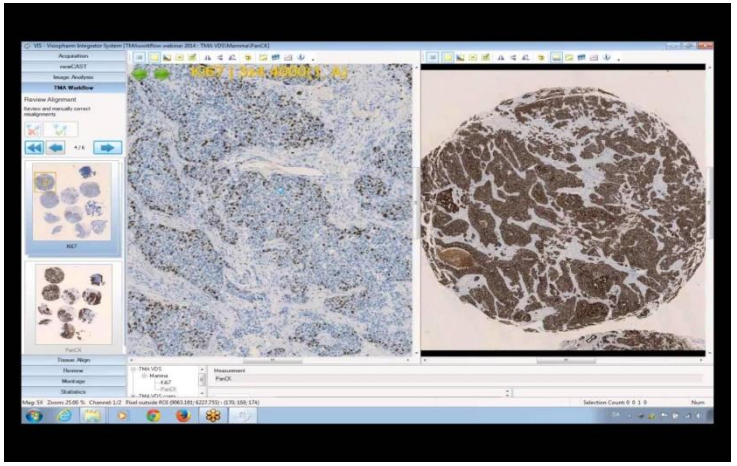
Addition of Computational Pathology

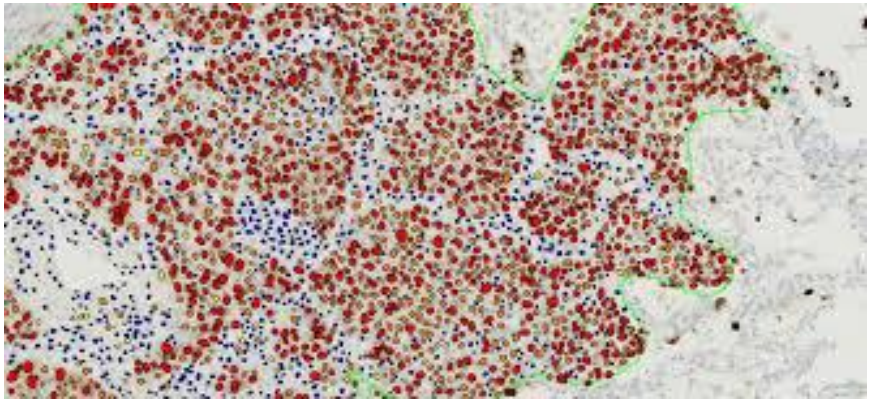
- Humans and computers have different skill sets
  - Humans – Pattern recognition and coping with minor variation.
  - Computers – Counting, measuring

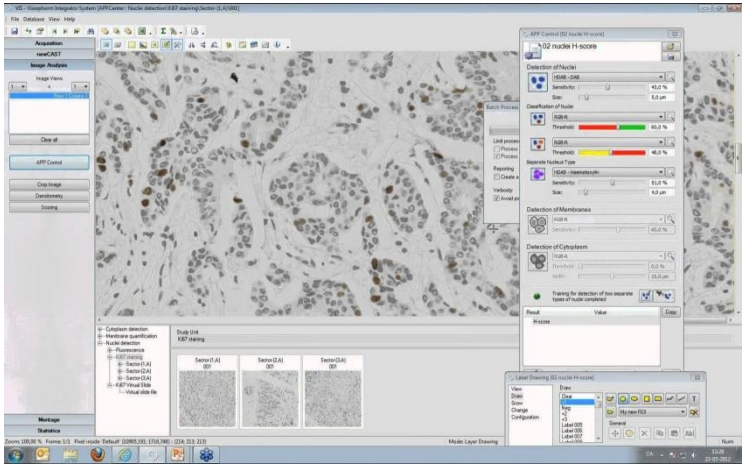
- Perhaps with computational pathology we will unlock further stratification based on image alone?

Image analysis

- Visiopharm CE-IVD
- Counting of ICC
- More accurate ER, PR, Ki67 and Her2

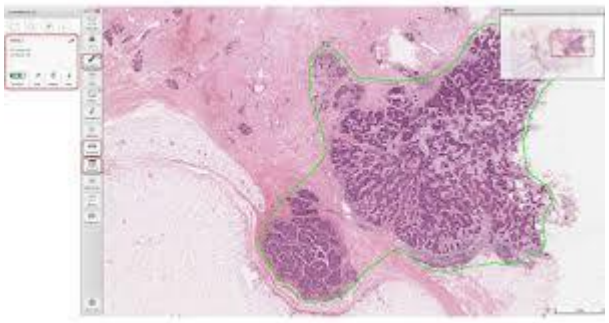






Path XL

- PathXL now part of the Philips group
- Use automated analysis to identify tumour
- Keen to partner through the Molecular Pathology Node



Big Data

- 2 million images a year across NHS Scotland
- Linked to molecular data and pathology reports
- Also clinical data/outcomes
- Amazing and valuable research and development resource for NHS Scotland
- Industry already wanting to partner

The future of histopathology

- Potential to build on our pilot and roll out Digital Pathology across NHS Scotland in a coordinated fashion
- Aim to be the first country in the world to be fully digitised
- Build on image analytics, leading to more precise diagnoses

What does this mean for the Pathology in Scotland?

Regional Working

- Digital Pathology is an enabler for a true distributed service model in pathology
- Functional teams working across multiple sites
- Realtime consultation or easy referral
- Seamless review of cases for MDT

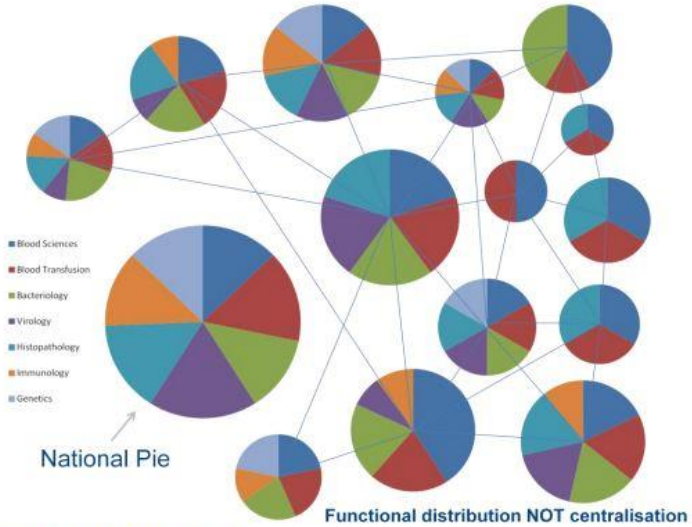
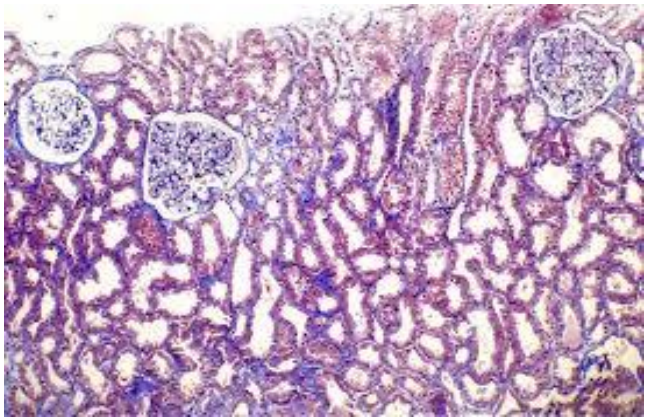
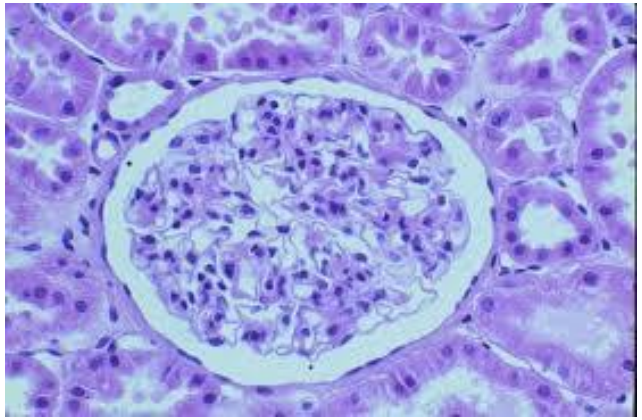


Figure 3: Distributed Service Model

National Working

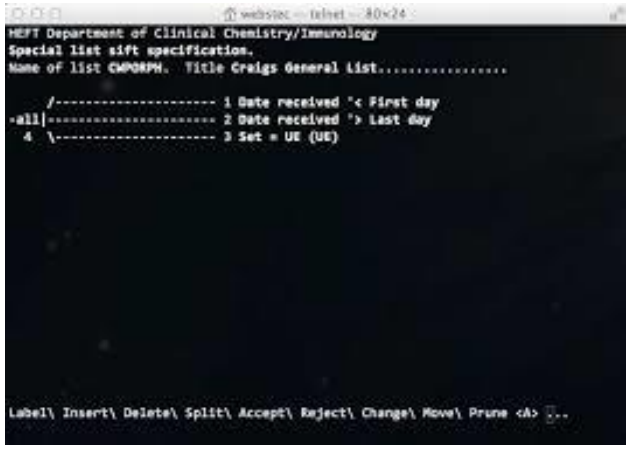
- Useful for small volume specialist areas
  - Renal/transplant pathology
  - Paediatric pathology
  - Neuropathology





Challenges

- Reporting cases across Board boundries
  - Governance issues
  - Data protection
  - IT security
  - Practicalities of multiple LIMS



Solutions

- Integrated reporting solution for digital pathology
- De-coupling reporting IT from laboratory IT, enabling a distributed model
- Enhanced reporting functionality compared with most current LIMS

Take home messages

1. Digital Pathology is here now!
2. (I believe) Digital Pathology is here to stay
3. True enabler
   - Digital microscope ☹
   - Digital workflow ☺
4. Great opportunity for NHS Scotland to be a world leader in digital pathology and associated R+D

Get involved!

- Arrange a visit to GGC or Lothian to experience the technology
- Possibility of expanding the pilot
- Help build the business case for national roll out
- Engage with service redesign to maximise the benefits of digital pathology


Thank you
Questions?
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