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Colour and the Leeds virtual pathology project, 2003-2013

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May 2013

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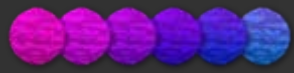
Summary

I. There is variability in colour in pathology imaging
II. Its important (I think)?
III. What can we do about it?



Leeds digital pathology project

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- Scanning since 2003
- 4 x Aperio scanners
  - 2AT – 380 slides at a time
  - 2 CS – 5 slides at a time
- Scan 2000 - 5000 slides per month for teaching, education and research
- 180,000 slides scanned
- 100 Terabytes of image data

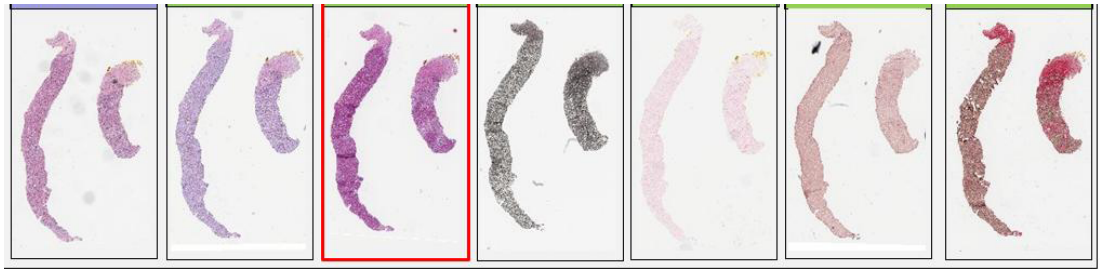
All available online, free at

www.virtualpathology.leeds.ac.uk

- EQA
- Slide library (5,000 cases)
- Undergraduate teaching
- Postgraduate teaching
- FRCPath examinations
- Clinical trials

My perspective

- I'm a practicing pathologist in the NHS
- I chose liver pathology as a subspeciality partly *because I like the colours*



- I run a digital pathology research project - colour was an issue in several of our projects over last 10 years
  - 3D pathology
  - Image analysis
  - High efficiency digital pathology workstation – the Leeds virtual microscope

Summary

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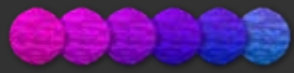

3D histopathology with virtual slides: From sections to scans

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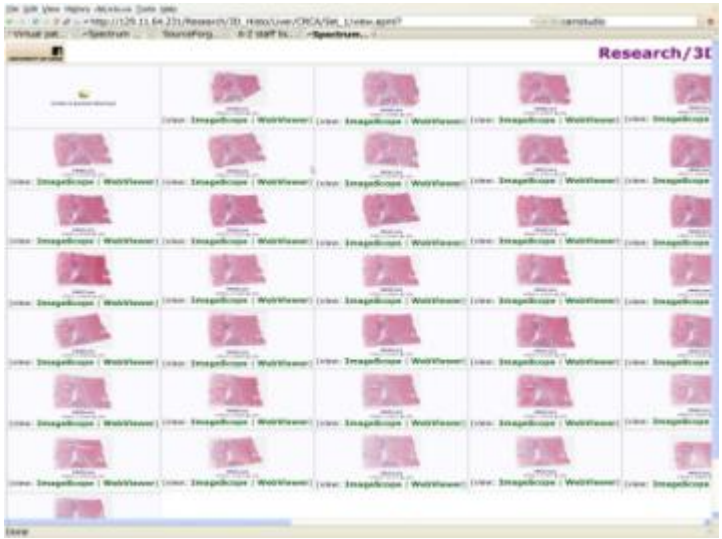

3D histopathology with virtual slides

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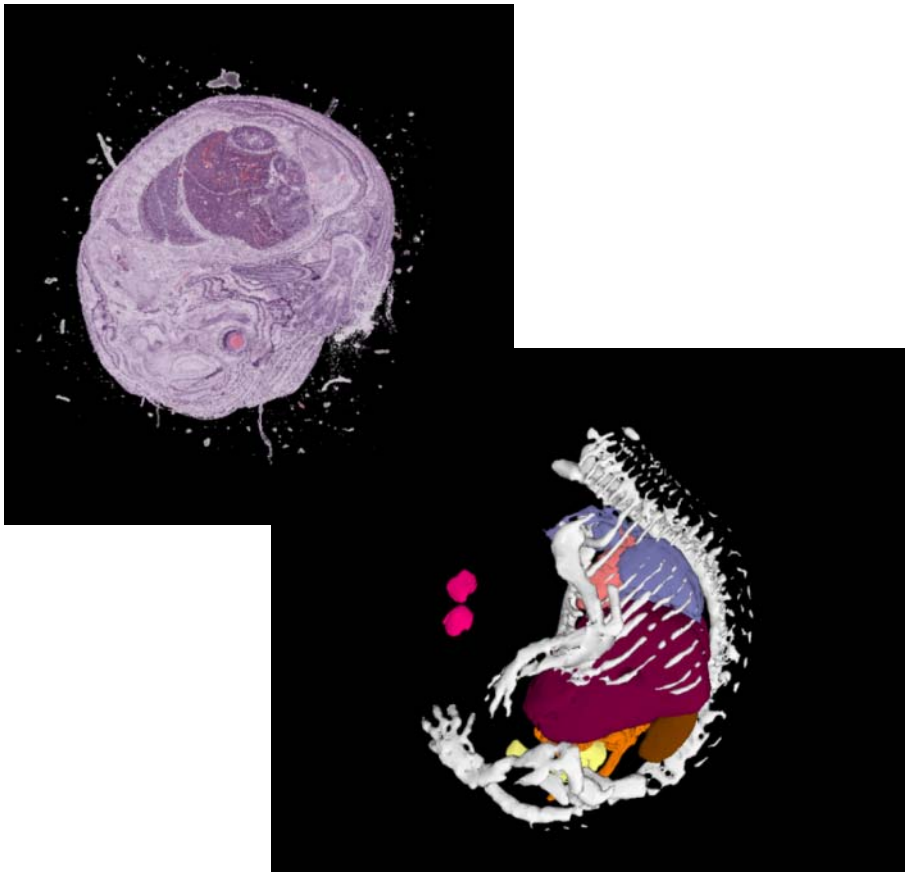
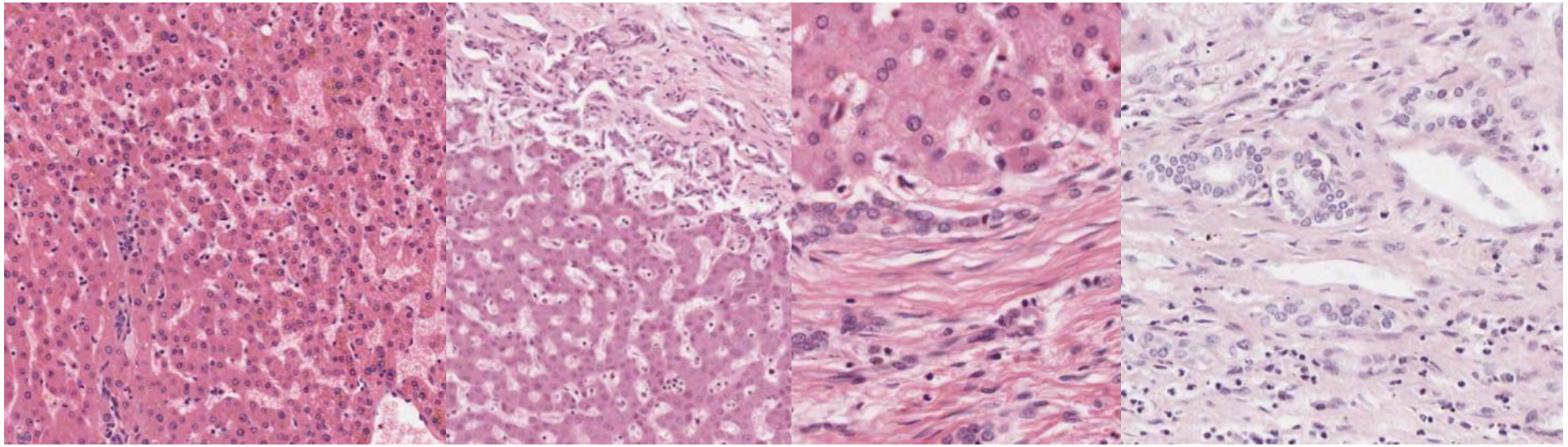


Nicholas Roberts,* Derek Magee,† Yi Song,† Keeran Brabazon,† Mike Shires,* Doreen Crellin,* Nicolas M. Orsi,* Richard Quirke,* Philip Quirke,* and Darren Treanor*‡, **Toward Routine Use of 3D Histopathology as a Research Tool** , *Am J Pathol, May 2012*

Colour variability in 3D pathology



Same day
+ Same tissue sample
+ Same stain
+ Same pre-sectioning protocol
+ Same technician
+ Same microtome

= Different colour

Colour normalisation used in 3D pathology

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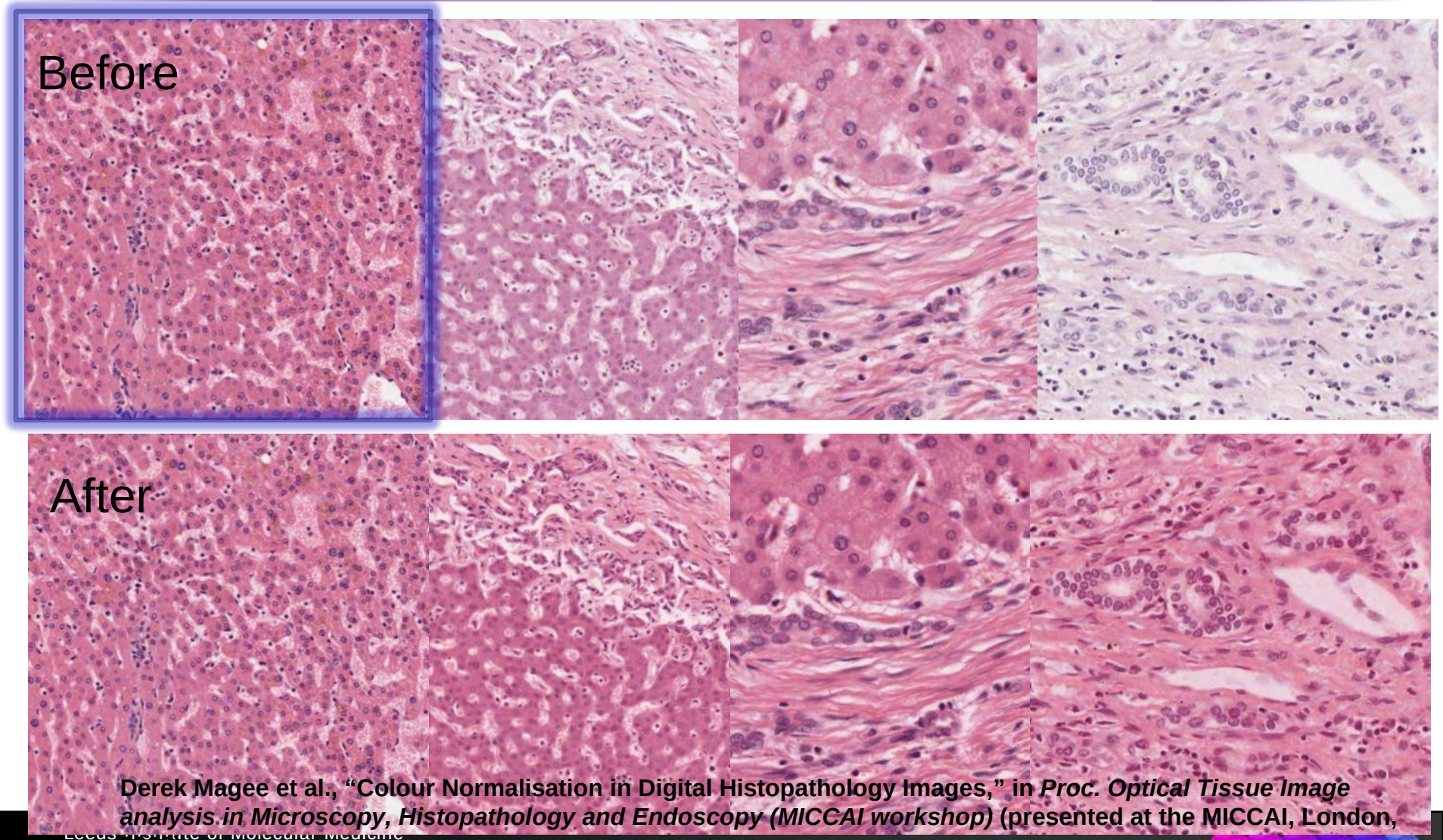
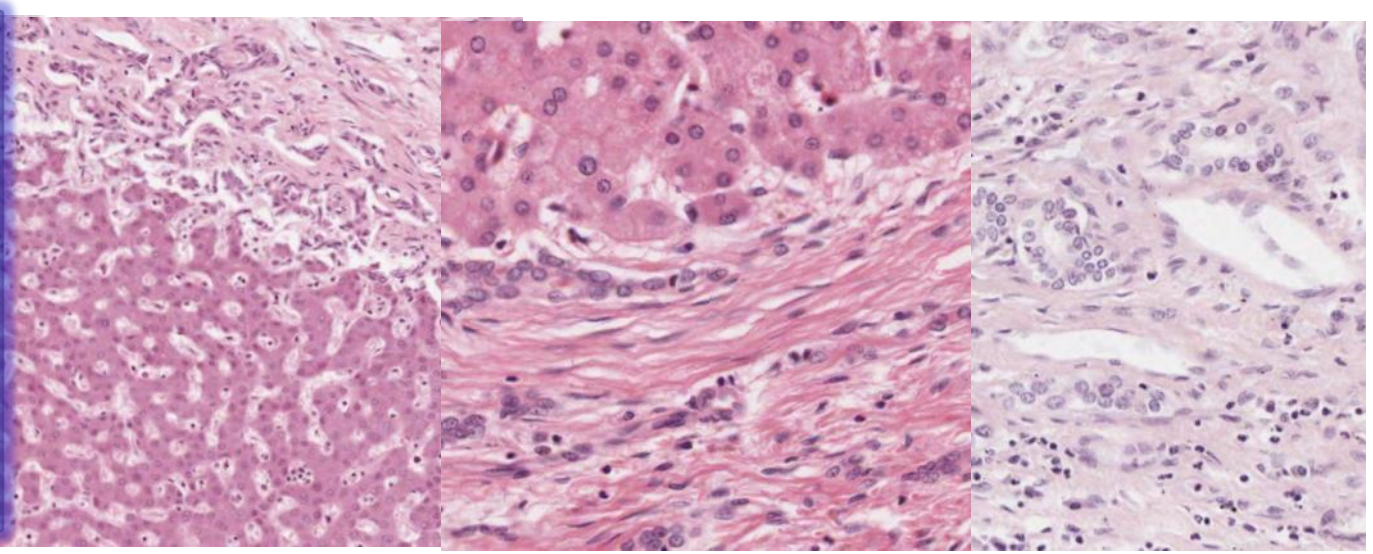


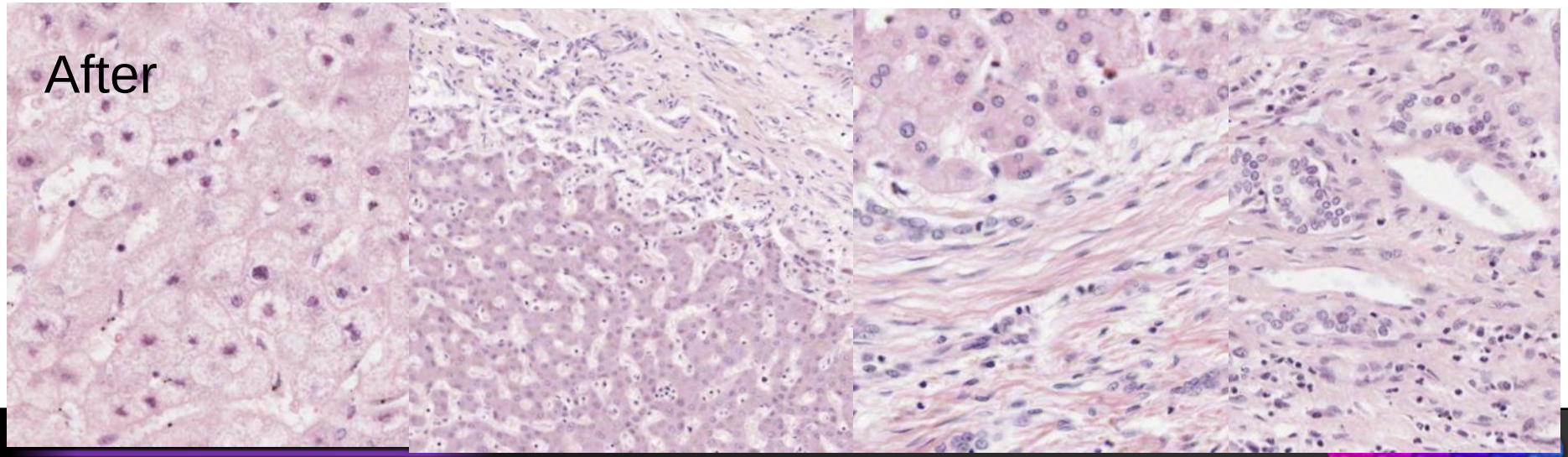
Derek Magee et al., "Colour Normalisation in Digital Histopathology Images," in *Proc. Optical Tissue Image analysis in Microscopy, Histopathology and Endoscopy (MICCAI workshop)* (presented at the MICCAI, London, 2009).

And again…

Before

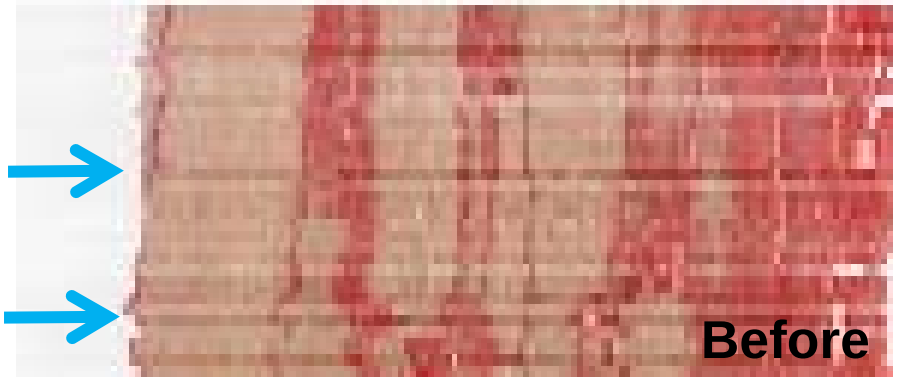


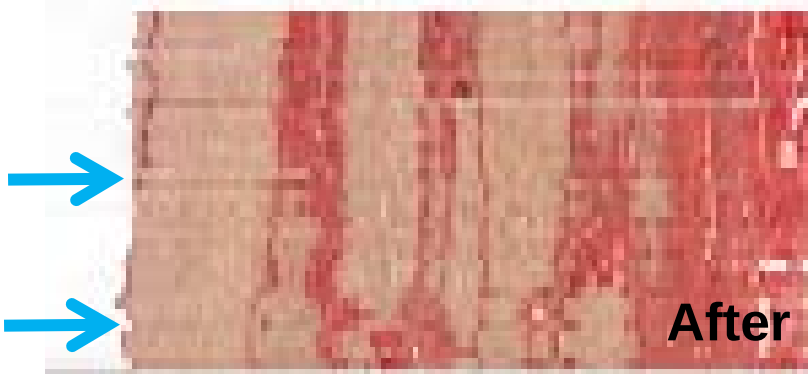
After

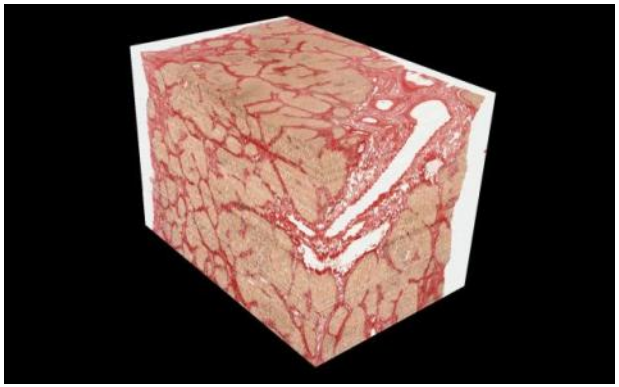


Colour correction makes a better volume

- Correct variability in staining and section thickness.

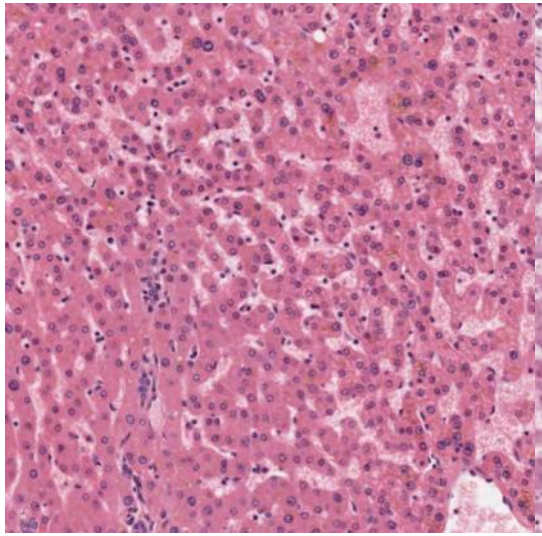
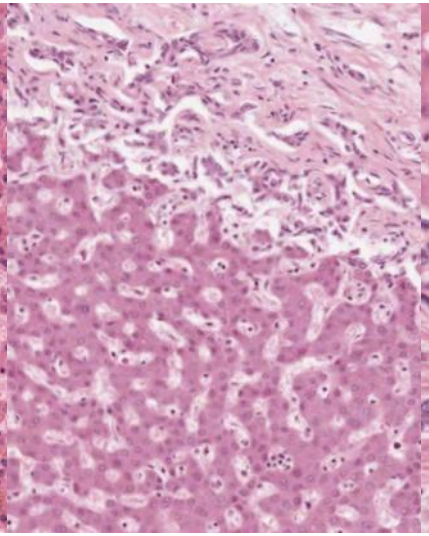
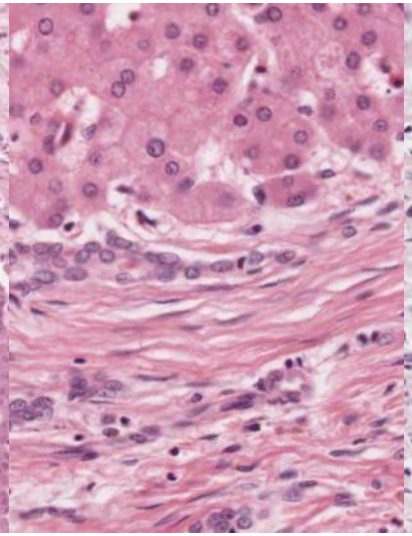
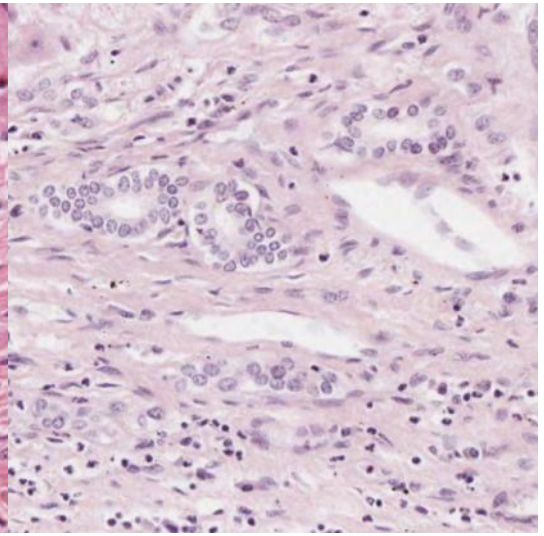






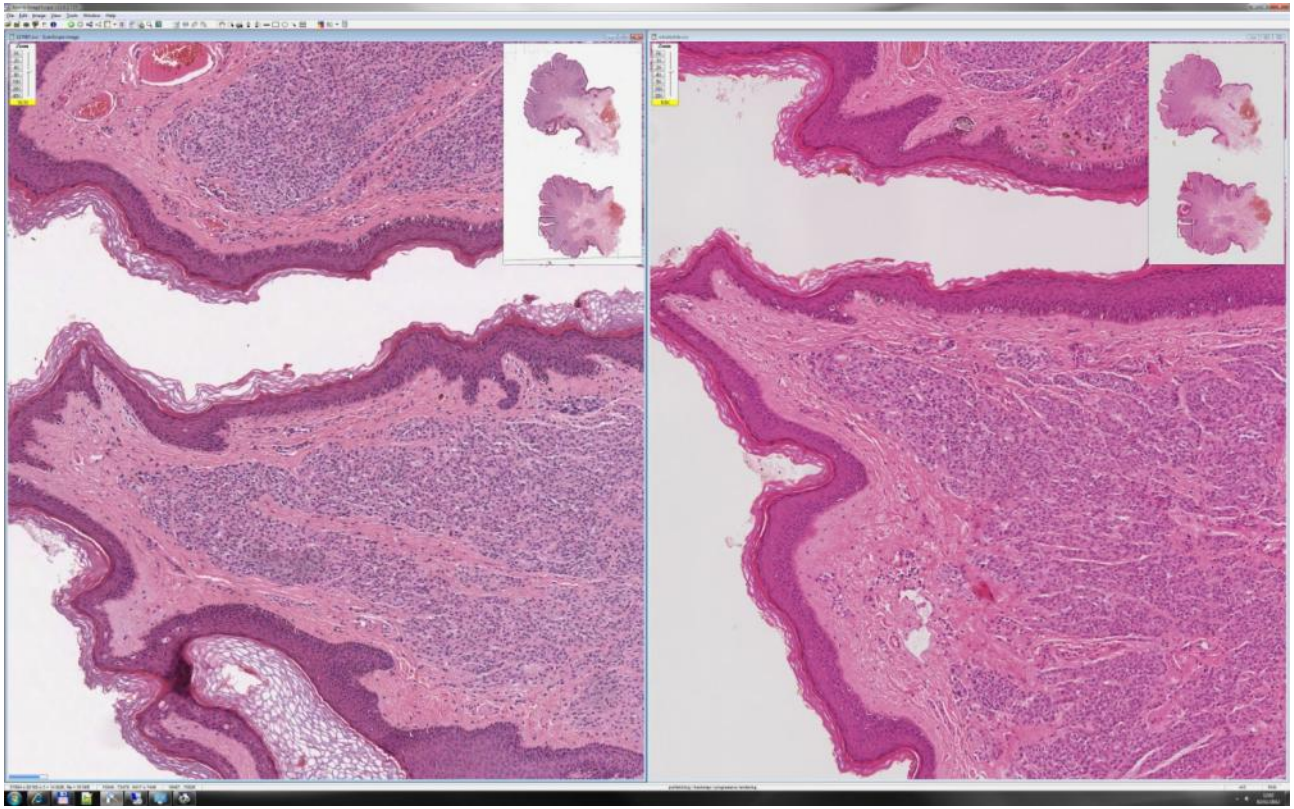
Magee D, Treanor D, Crellin D, Shires M, Smith K, Mohee K, et al. Colour Normalisation in Digital Histopathology Images. Proc. Optical Tissue Image analysis in Microscopy, Histopathology and Endoscopy (MICCAI workshop). London; 2009.

Same tissue, slightly different section/ stain

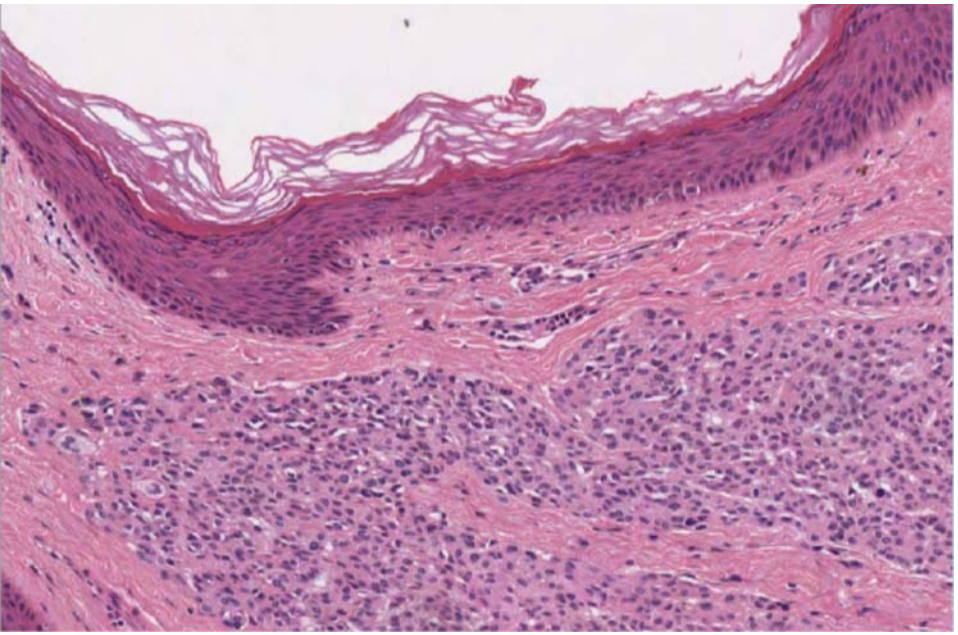
Pre-analytic treatment → **Section** → **Stain** → Scan → Transmit → Display

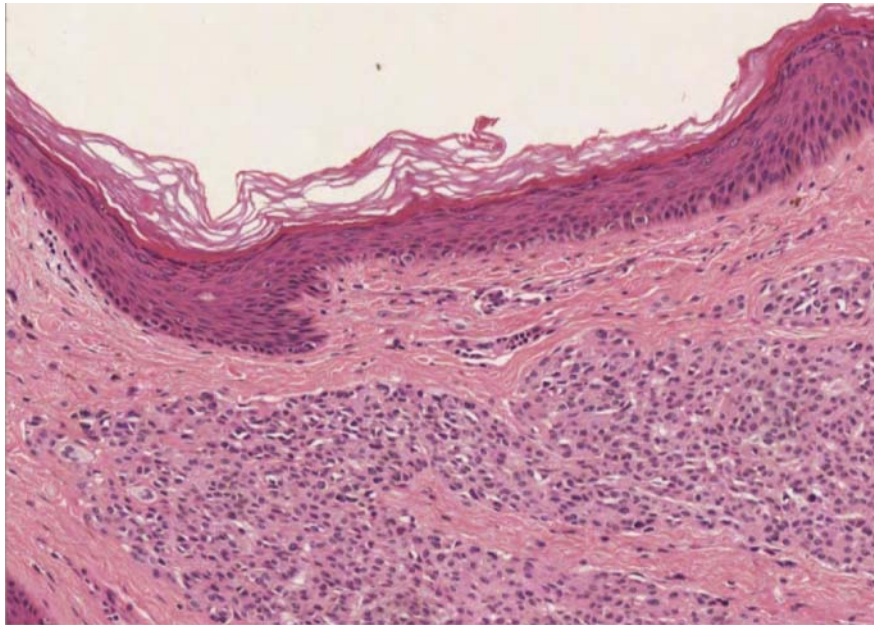
Same slide, different scanner



- Which is “best”?
  - i.e. Which do you *prefer*?

Same slide, different software





- Irfanview (L); Windows photo viewer (R)

Pre-analytic treatment | **Section** | **Stain** | Scan | Transmit | Display

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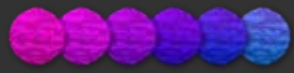
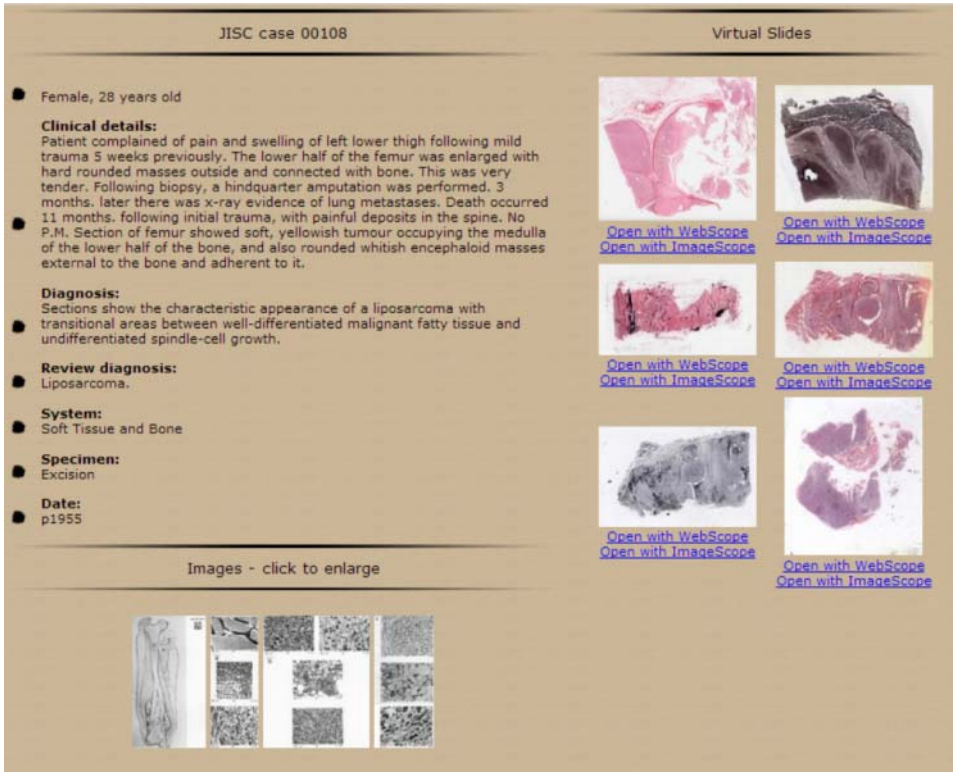
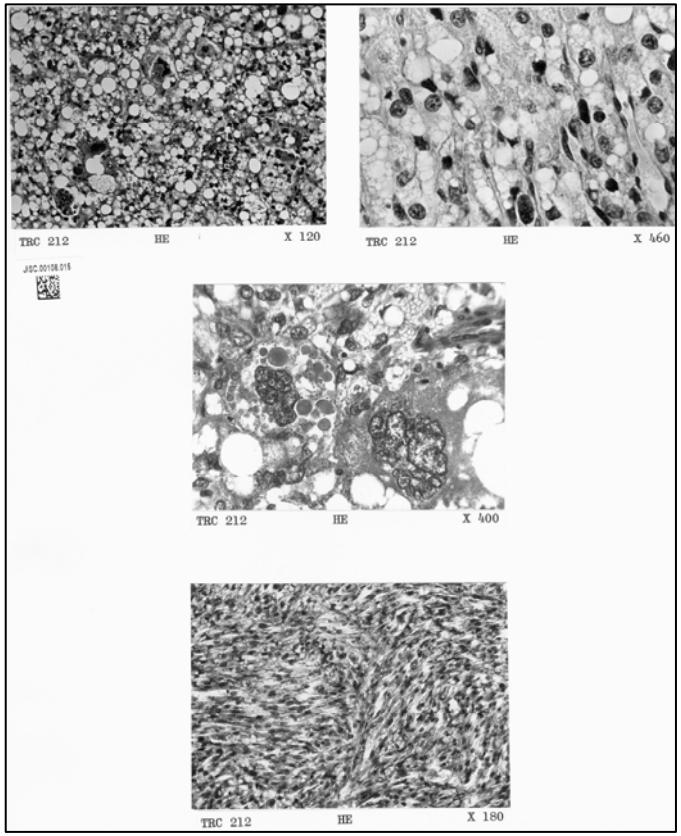


Is colour important to pathologists?

- UK MRC tumour reference collection @ Leeds, 1955





Leeds “Powerwall” project: as fast as a microscope

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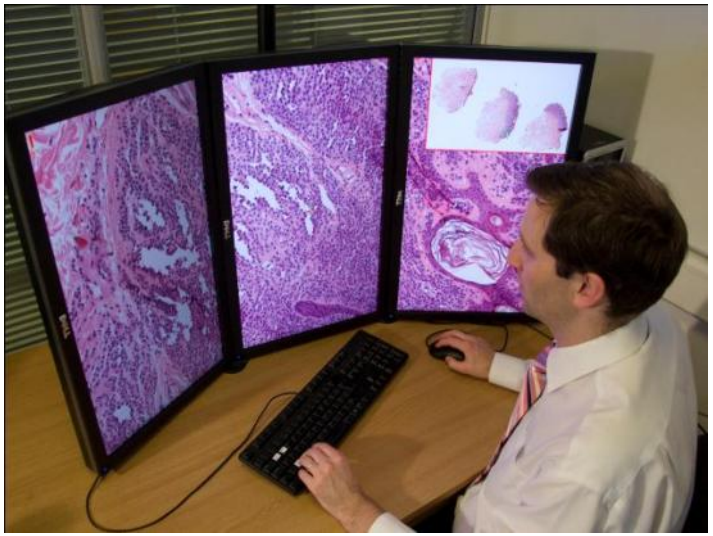
Leeds Powerwall

- Collaboration, teaching, discussion

Leeds virtual microscope v1

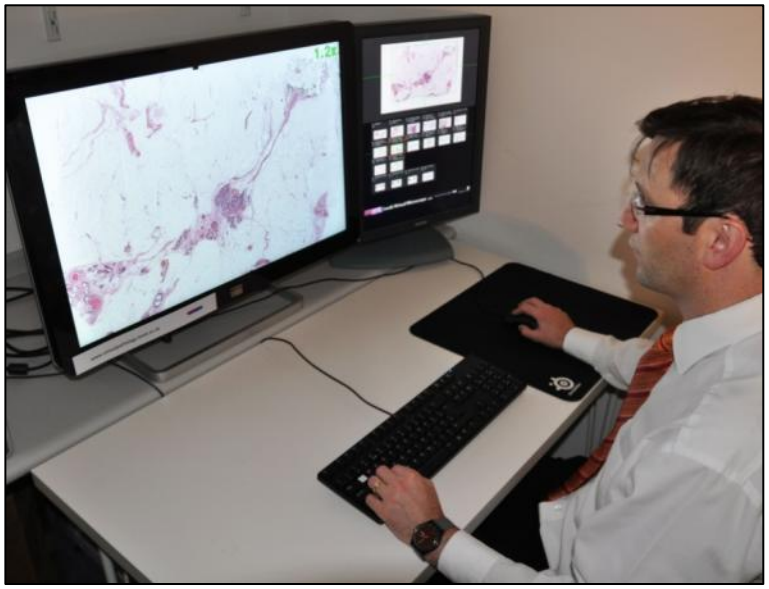


- Diagnosis (single user)

Off the shelf displays, minimal calibration, no colour calibration

Leeds virtual microscope v2

- Medical grade monitors
  - Barco Coronis 6MP plus Nio 3MP
  - Total 9 megapixels
  - Basic calibration only (not per-slide)
  - As fast as a microscope



Is colour important to pathologists in clinical practice?

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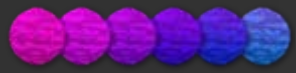
NO

- Effect of colour on diagnostic accuracy is **unknown**
  - But little research in the area
- **Huge variability** in microscope components and setup in laboratories seems to be tolerated by pathologists
- Small validation studies of digital pathology **don't mention colour** as a problem

YES

- Badly stained slides are hard to read, **can mislead you**
- Pathologists find stains from other labs harder (slower) to interpret
  - And get "**recuts**" in their own lab for referred cases
- It's important in radiology, printing, photography etc. So **surely** must be important in pathology



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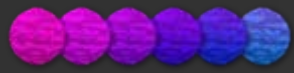
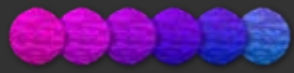
So…

- There is variability between laboratory processes, individual sections, scanners, and software
- We don't know what the effects of variability in colour are, if any,
- But at the very least unfamiliar colours slow our diagnoses, and *may* affect diagnostic accuracy
- We know that calibration of images is important in radiology and printing



What can we do about it?

- Minimum requirement
  - Different installations of the same virtual slide system from one manufacturer should be consistent
- Better still
  - All systems should reproduce the **same slide the same way**
- In an ideal world
  - Scanners should all replicate what we see down the scope
  - But we don't know if we need that, we don't know what's "good enough"



So what do you think?

Acknowledgements

Virtual Pathology in Pathology & Tumour Biology at Leeds Institute of Molecular Medicine
- Phil Quirke
- David Turner, Martin Waterhouse, Mike Hale, Alex Wright, Fraser Lewis, Hannah Dee, Gordon Hutchins
- Nick Roberts, Richard Quirke, Mike Shires, Doreen Crellin, Nick Roberts (technical work)

Image analysis & computer vision
- Alex Wright & Andrew Bennett &Yanong Zhu, Pathology and Tumour Biology Group, Leeds Institute of Molecular Medicine, University of Leeds
- Ladislav Gubic, Jim Swainston, James Bridges, BSc students, School of Computing, University of Leeds
- Andy Bulpitt, Derek Magee, Yi Song, Yu Zhou, School of Computing, University of Leeds

Visualisation & human computer interaction
- Roy Ruddle, Rhys Thomas, John Hodrien School of Computing
- Rebecca Randell, Leeds Institute of Molecular Medicine

Collaborators/ supporters
- Claudia Mello-Thoms, University of Pittsburgh
- David Brettle, Leeds Teaching Hospitals Trust
- Barco

Funding
- Pathological Society of Great Britain and Ireland
- Department of Health
- Yorkshire Cancer Research
- National Institute for Health Research
- EPSRC Innovation and Knowledge Centre at Leeds

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