Photon Science Exploitation of ALICE in Biomedical Science

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and

ALICE team

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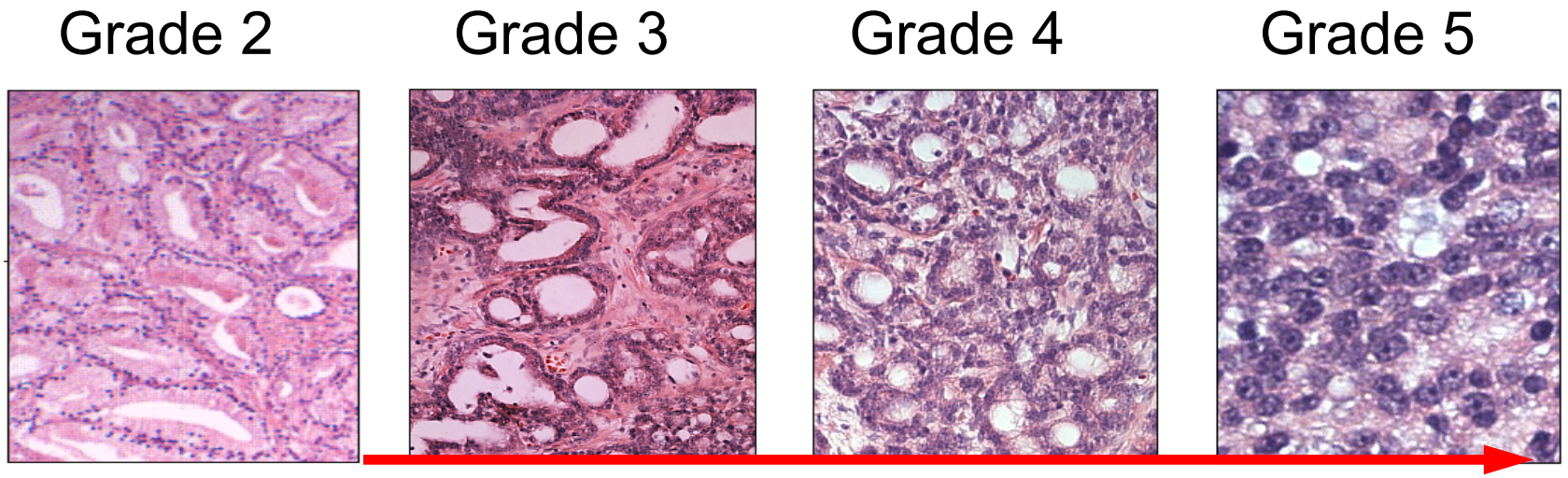
University of Liverpool
Manchester 1824 The University of Manchester
Consiglio Nazionale delle Ricerche
Lancaster University
Cardiff University

The Gleason Grading System Conventional pathology – biopsy samples



Increasing tumour aggressiveness

Lattouf *et al** *BJU Int* 2002; **90**:694–699.

390 patients, 15 pathologists resulted in:
38.2% of tumours being undergraded
32.6% overgraded.
29.2% assigned an identical grade

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Conclusion

The results presented here from oral tumour sections and on cultured cervical cells demonstrate the capability of IR microspectroscopy, combined with multivariate data analysis, to detect subtle chemical differences between cell types within a tumour. Growth factor dependent changes in the DNA and protein IR absorption have been shown in cultured cells, with evidence for down regulation of the EGF signalling mechanism at higher growth factor concentrations. In particular, the ability of synchrotron IR microscopy to make such measurements at the single cell level has been shown. These results further advance the potential for IR microspectroscopy to be of benefit in screening for cancer.

Tobin et al, Faraday Discuss, 126 (2004)

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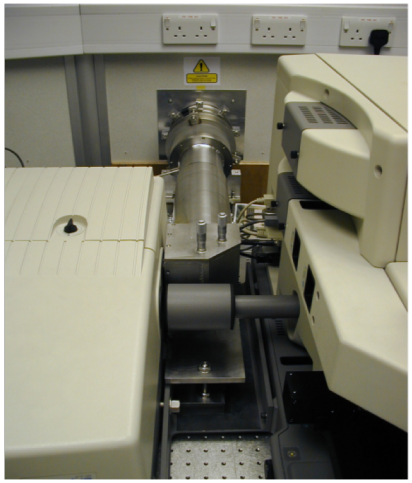
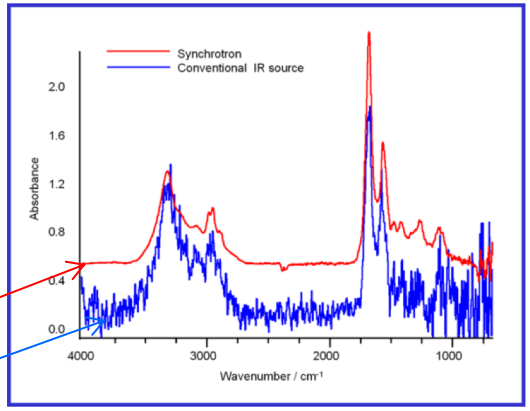
Synchrotron IR Microscopy





Commercial ir microscope, external SR source

Commercial ir microscope, internal thermal source
Same area sample / acquisition time

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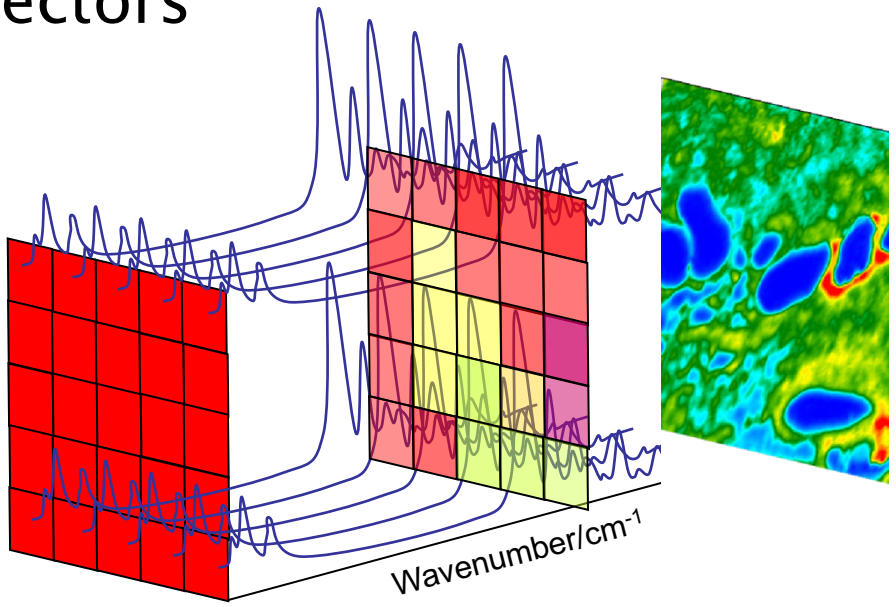
Rapid Sample Throughput

Focal Plane Array MCT Detectors

Using an array detector the image of the sample is focussed onto a array of MCT detectors so that spectra from each point on the sample can be obtained simultaneously.



This is much quicker for infrared spectral imaging.

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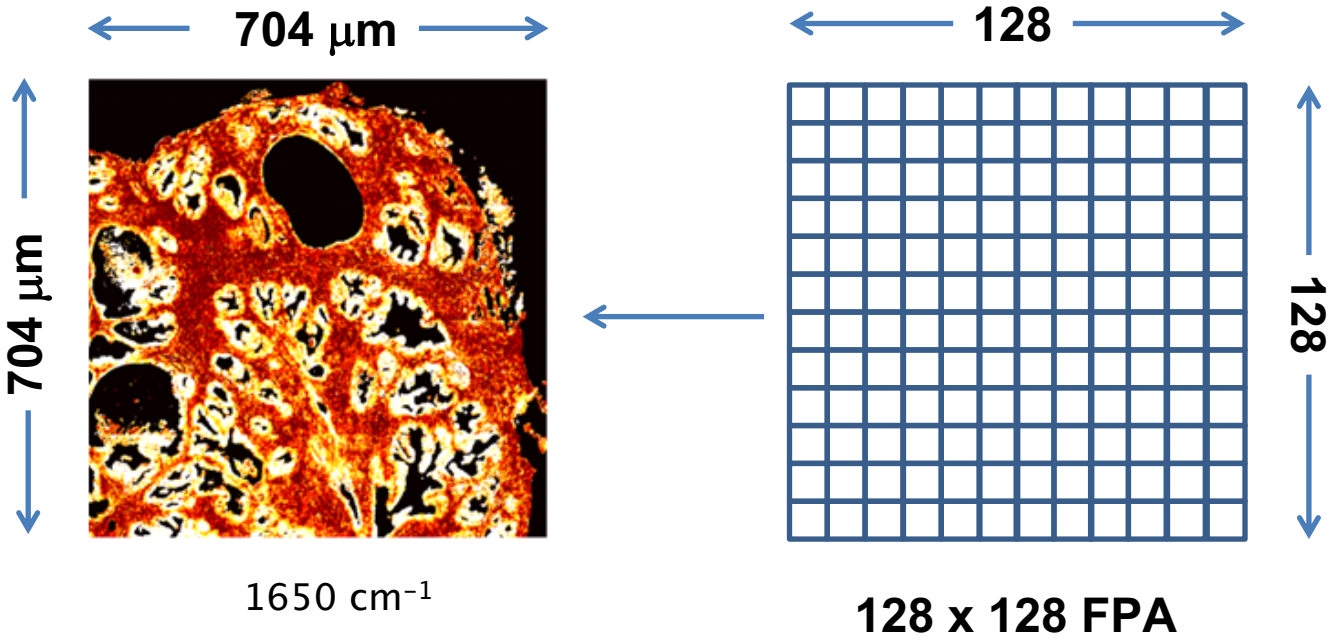
Rapid Sample Throughput



Simultaneous collection of 16384 spectra !

Each pixel 5.5x 5.5 micron and is an entire IR spectrum

High throughput collection of large areas of tissue

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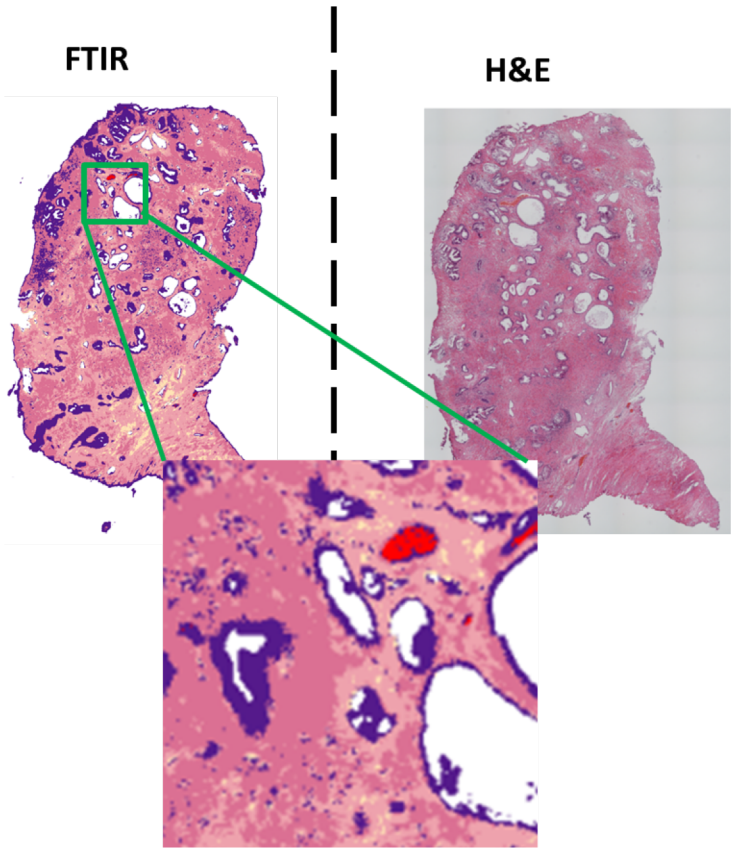
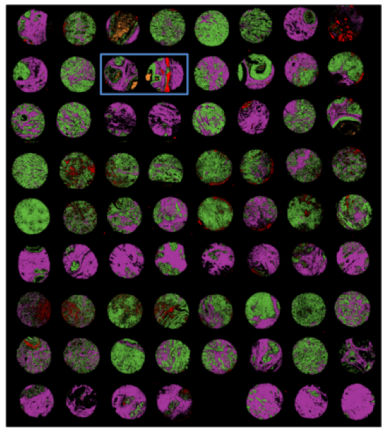
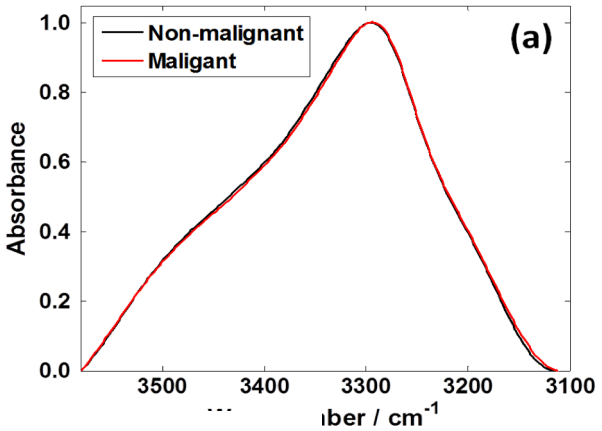
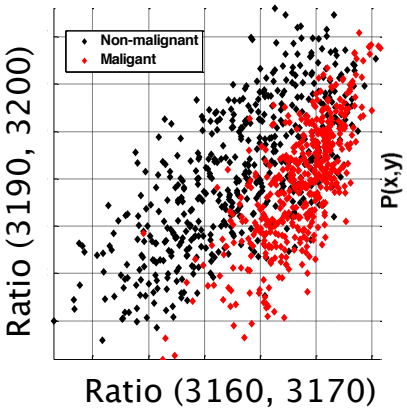
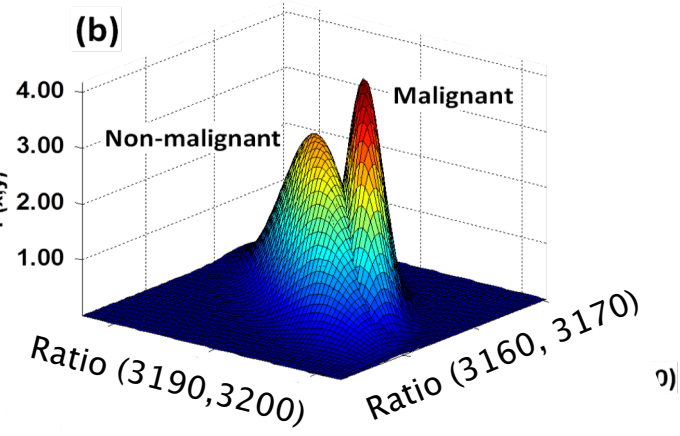
Rapid Sample Throughput











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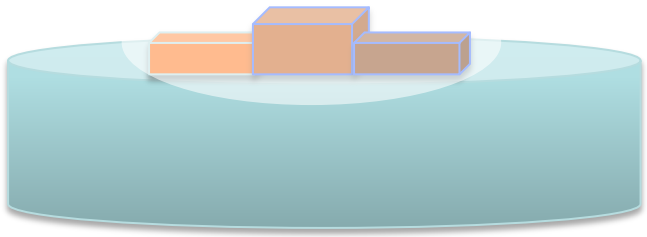
Improving Spatial Resolution
Breaking through Diffraction Limit: sub-micron imaging



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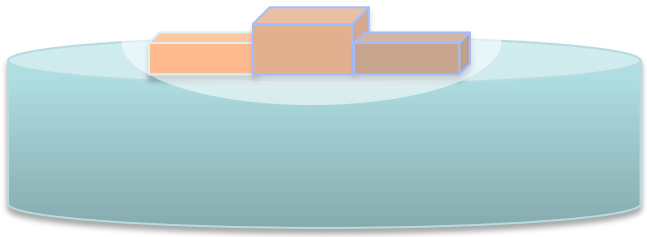

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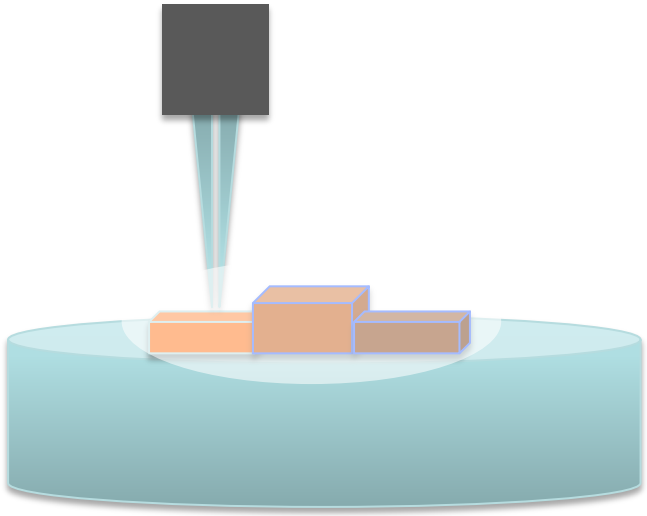

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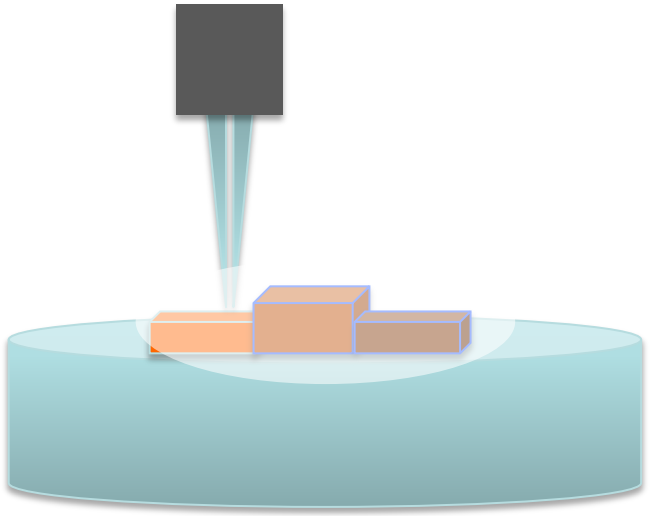

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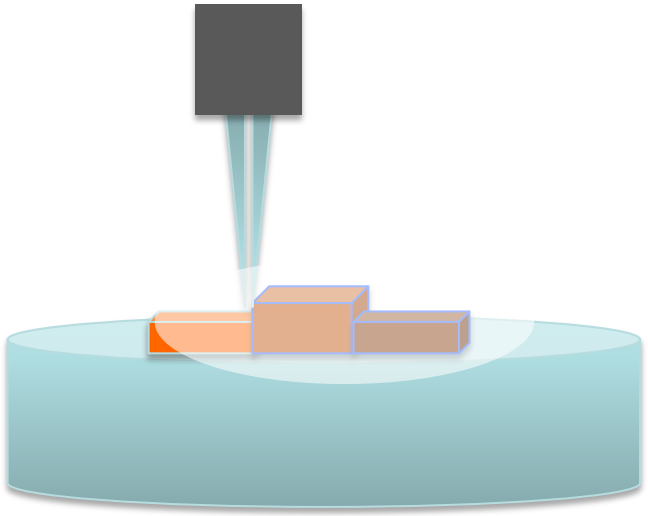

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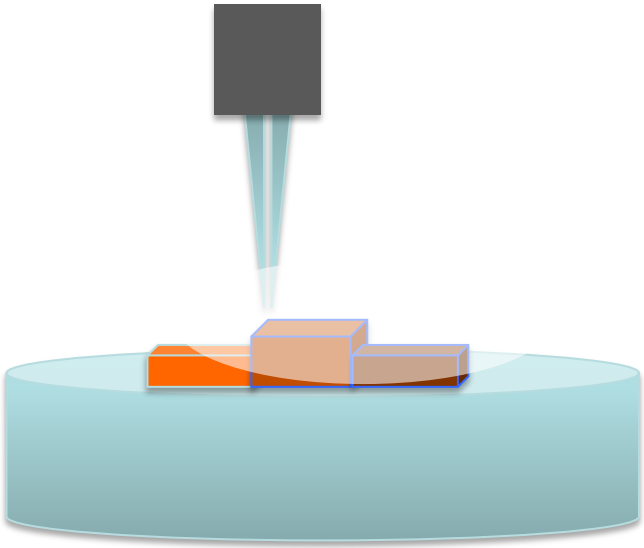

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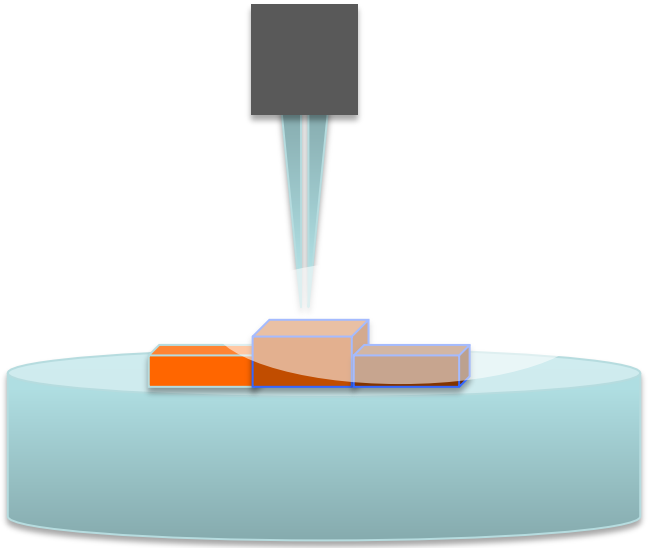

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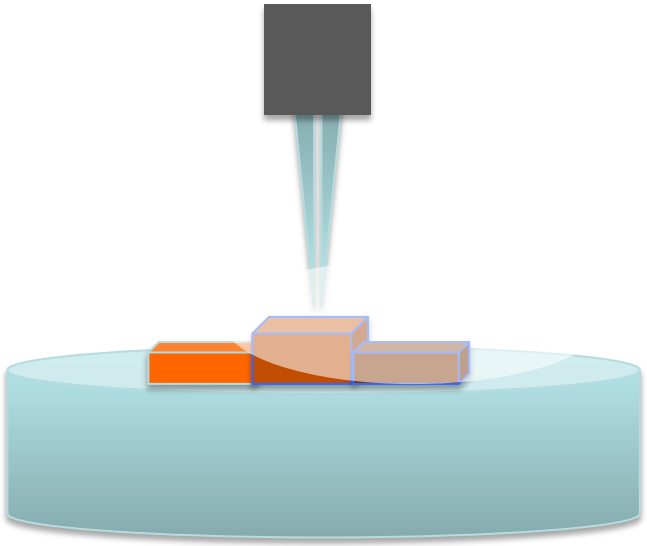

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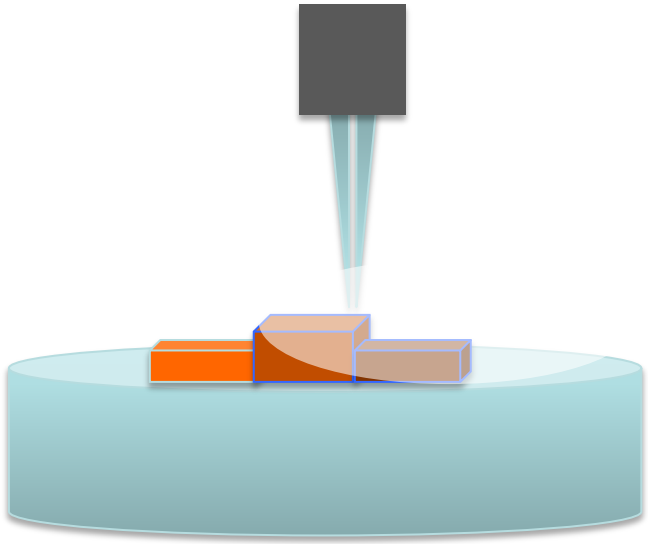

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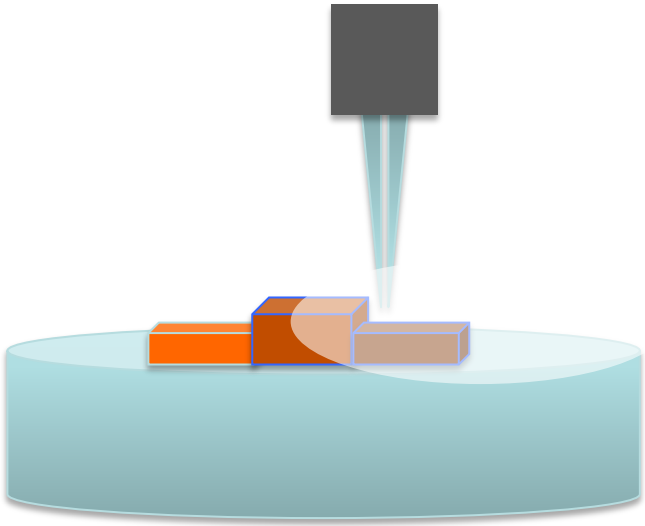

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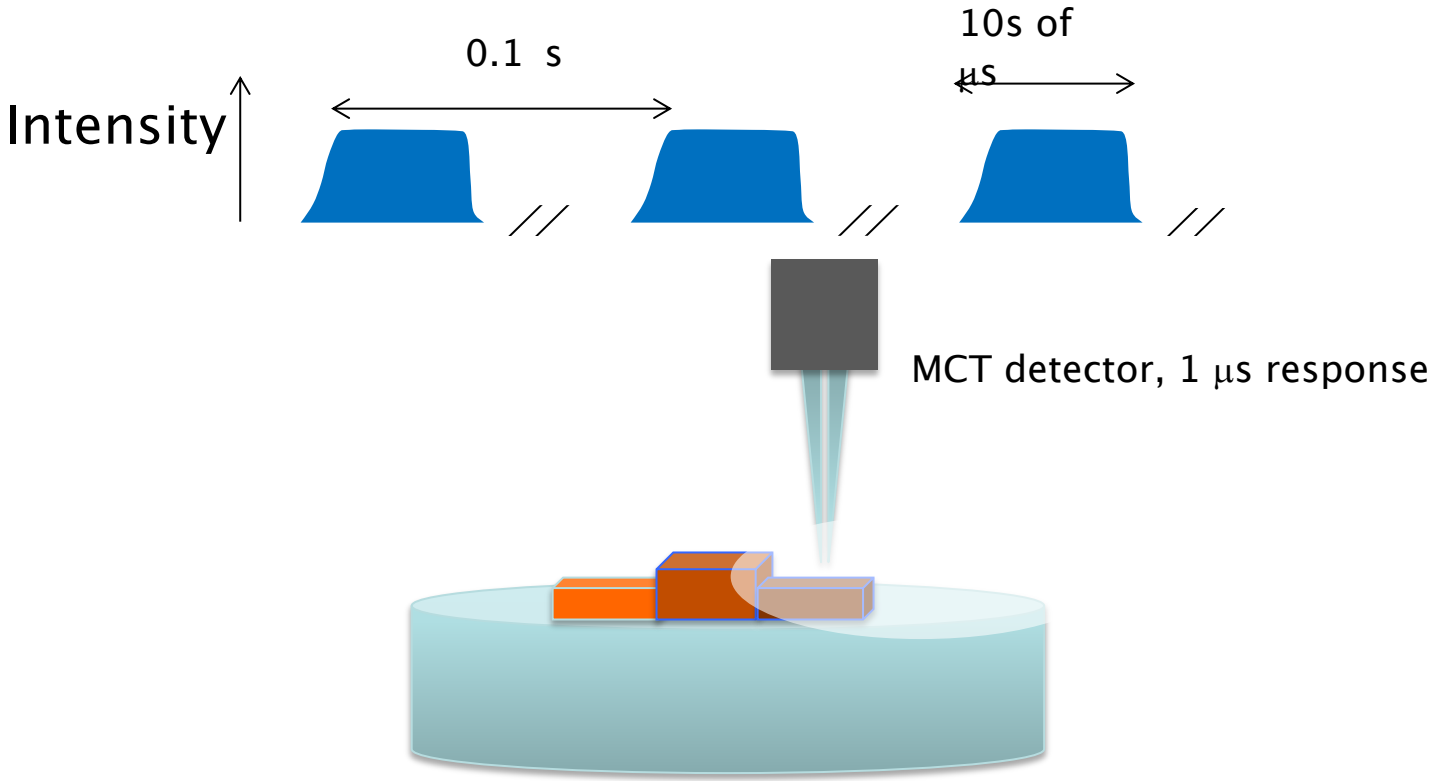

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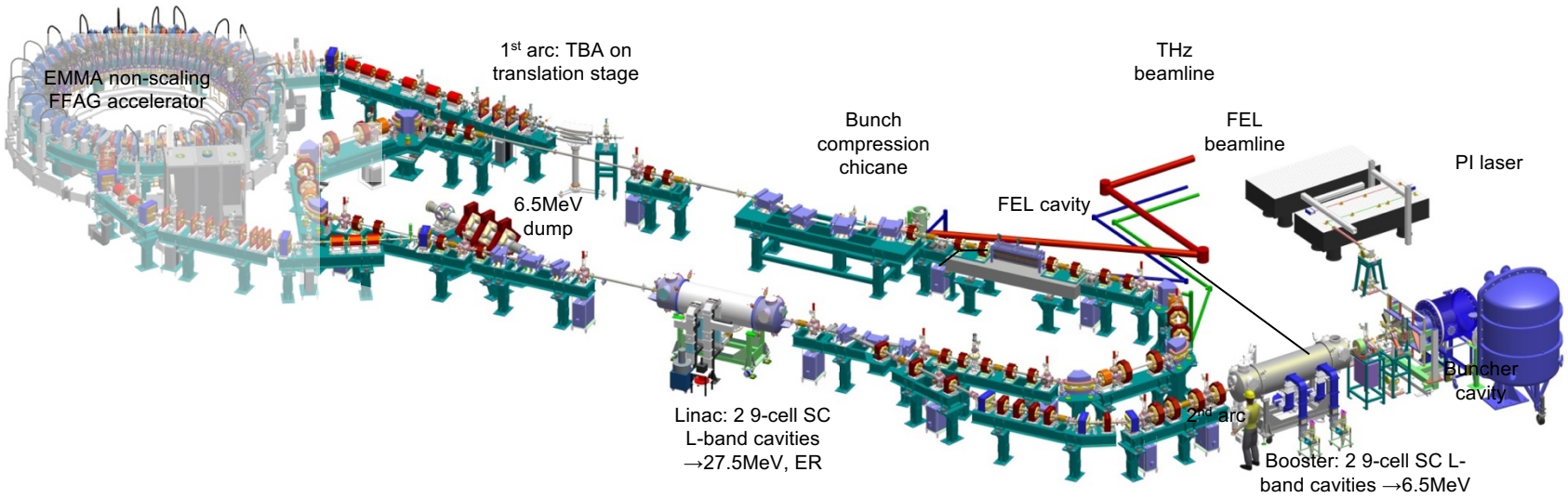
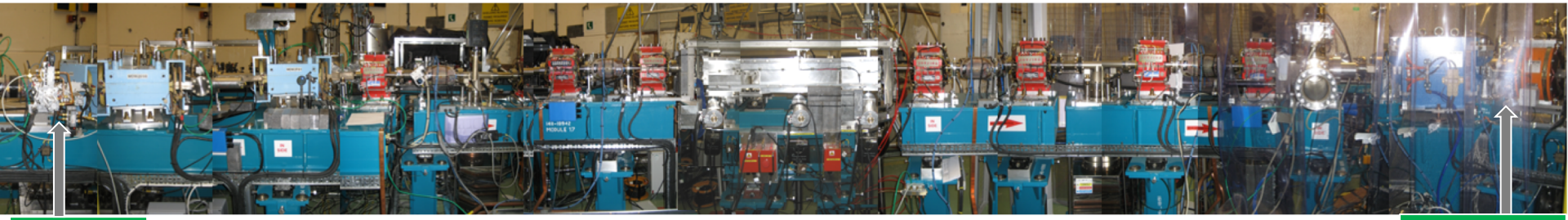
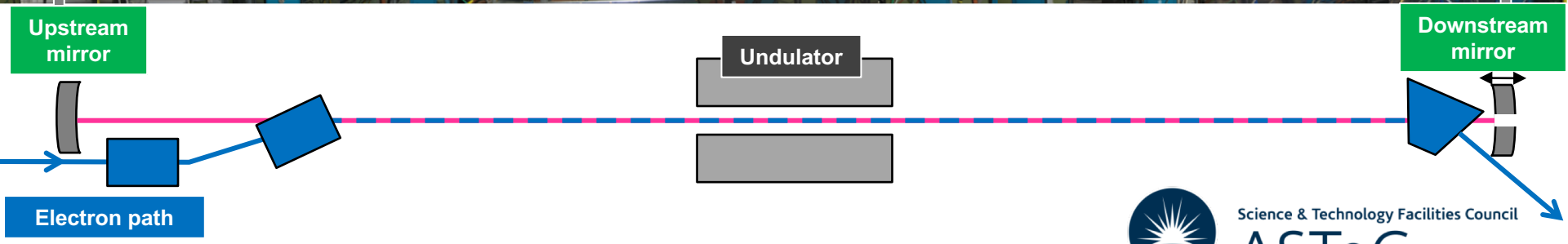
ALICE: "Accelerators and Lasers in Combined Experiments"







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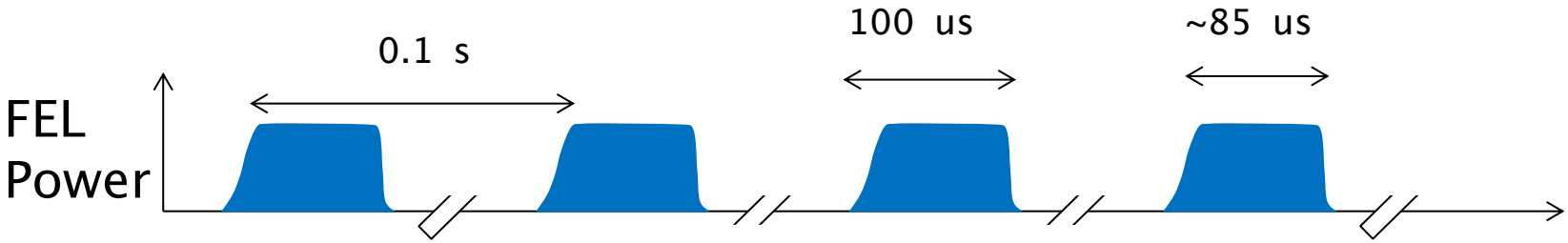

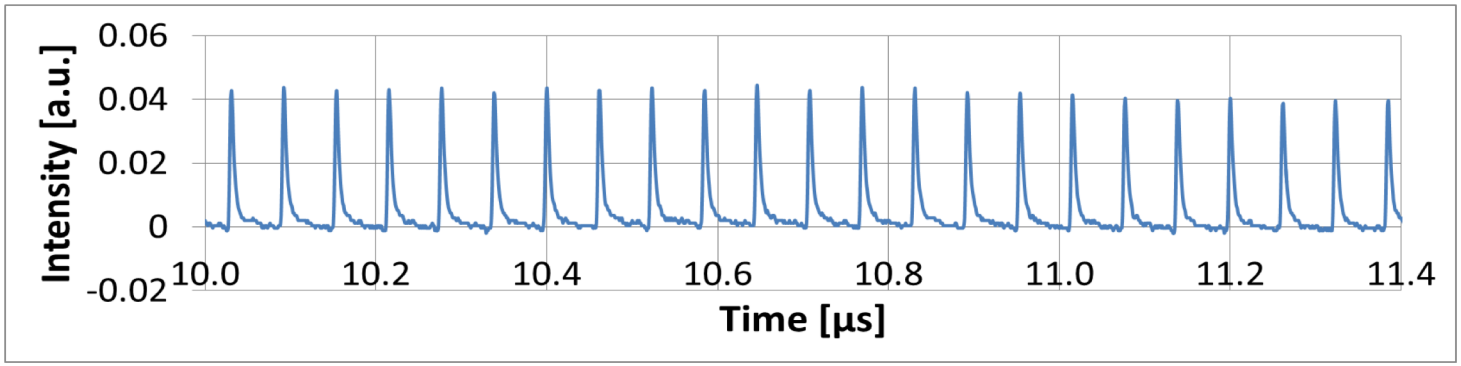

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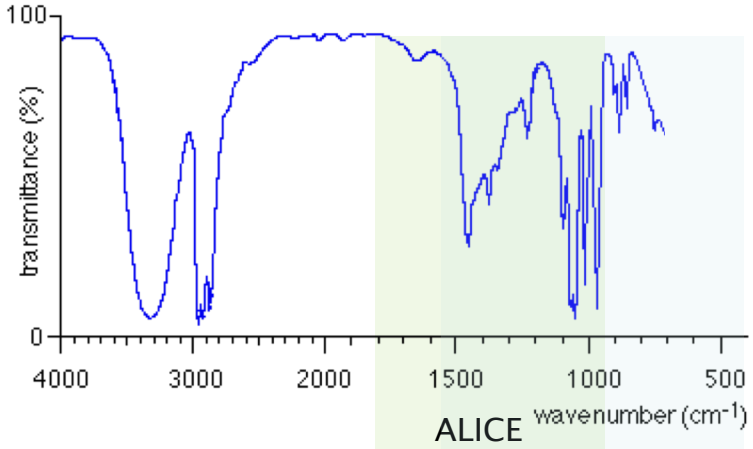
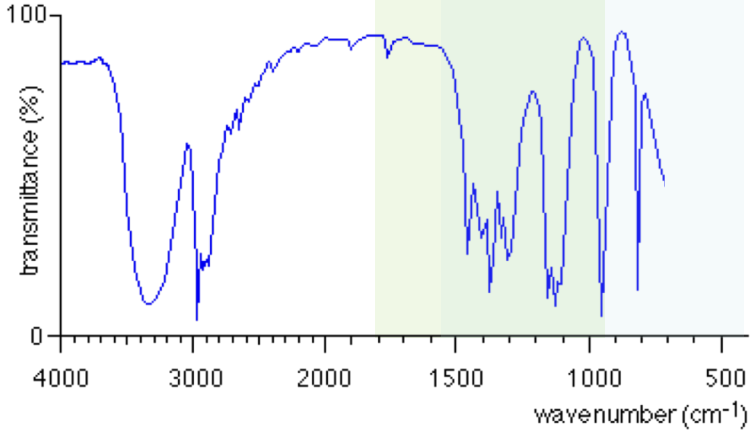
infra-red spectrum of propan-1-ol, $CH_3CH_2CH_2OH$



ALICE

infra-red spectrum of propan-2-ol, CH_3CHCH_3 (OH)

Fingerprint



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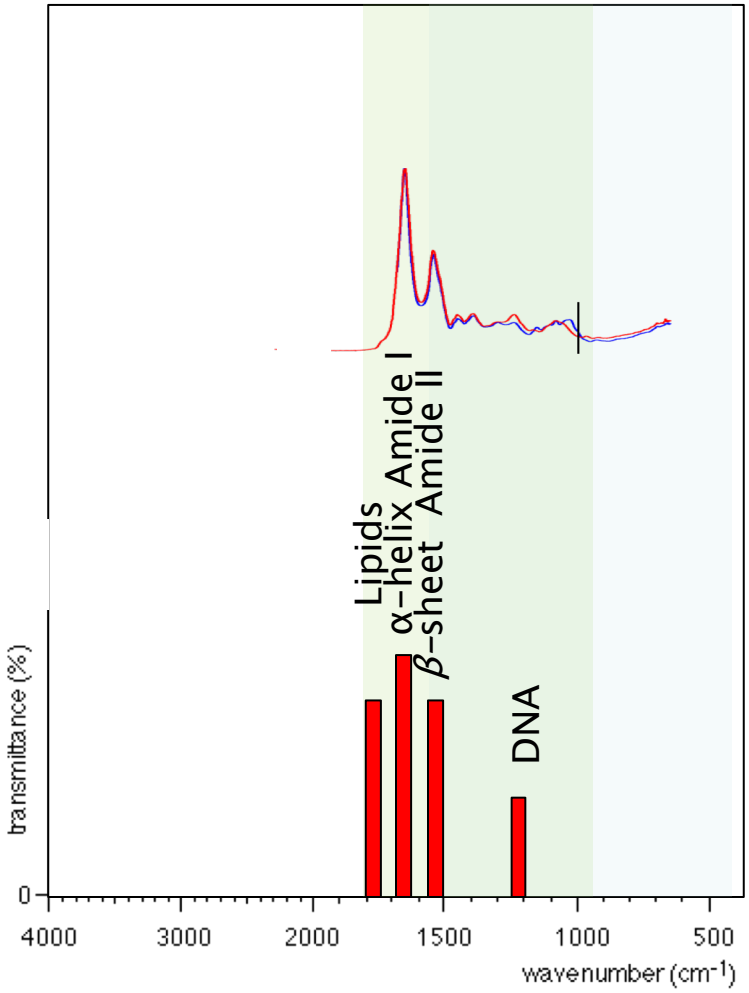

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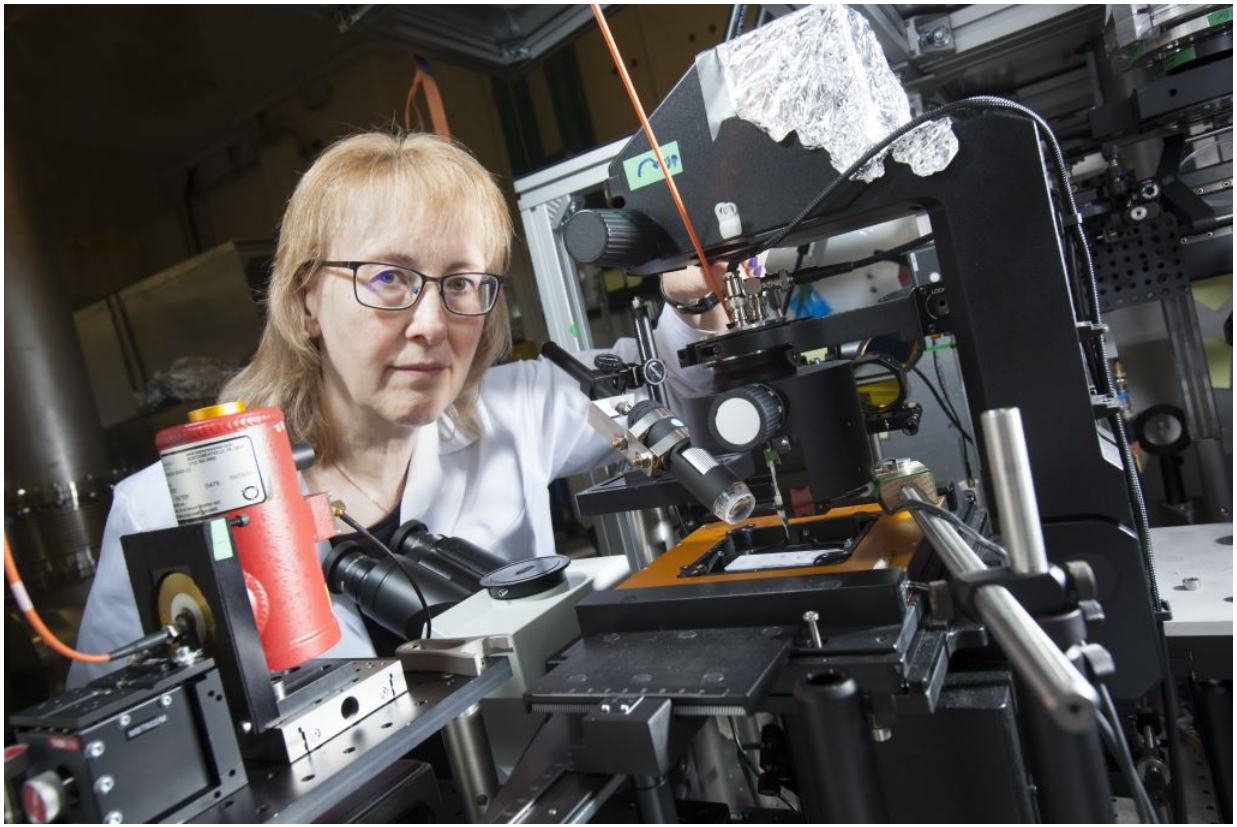

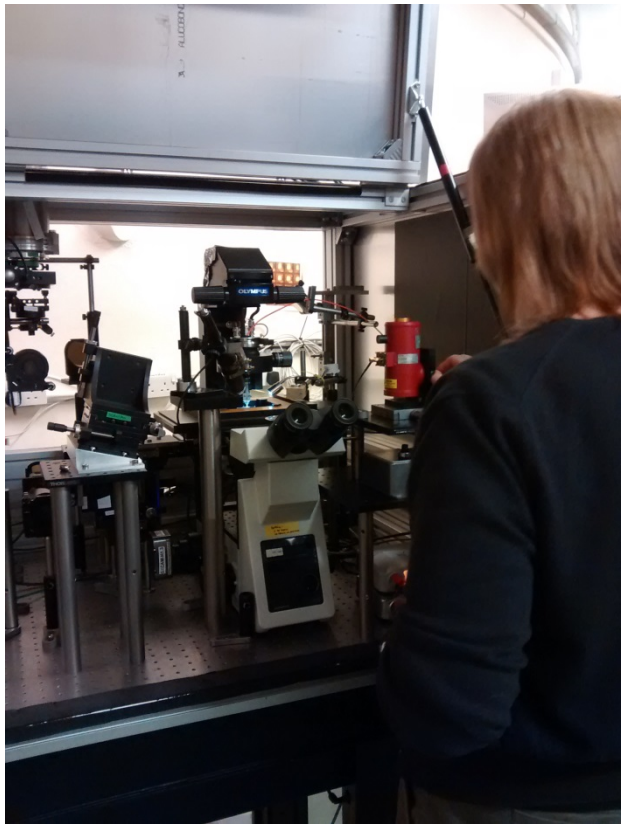

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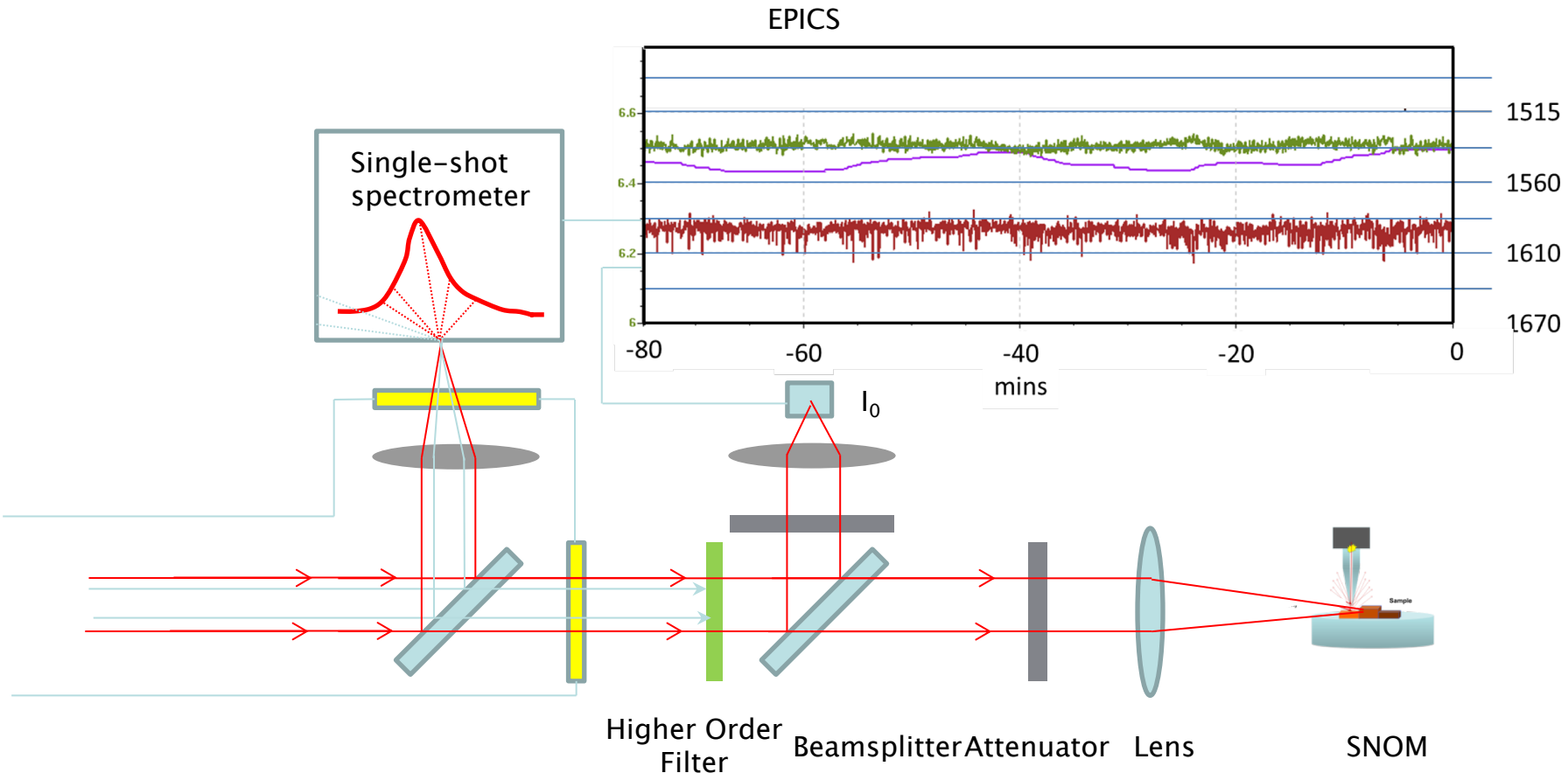

Intensity variation = < 2% RMS

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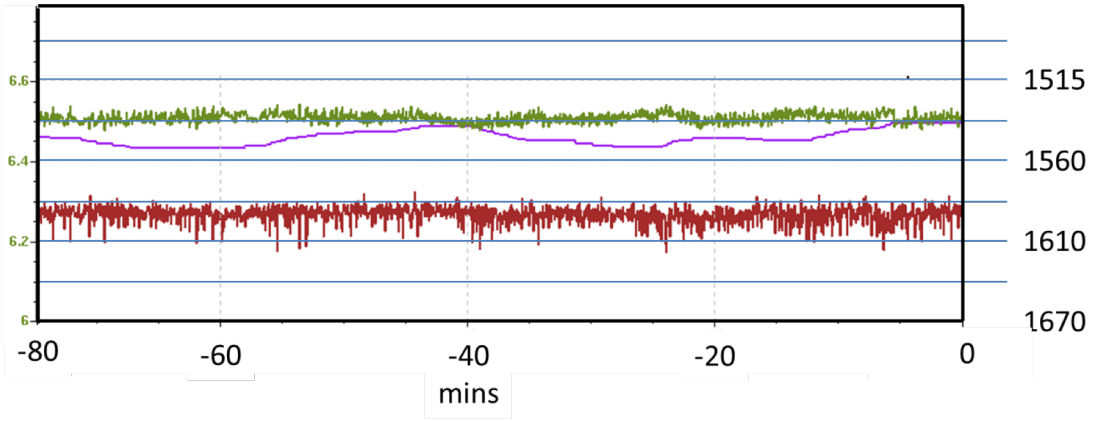
Stability Stability Stability

Wavenumber (Wavelength)

Undulator gap (Tweak)

Spectral width



Intensity variation = < 2% RMS

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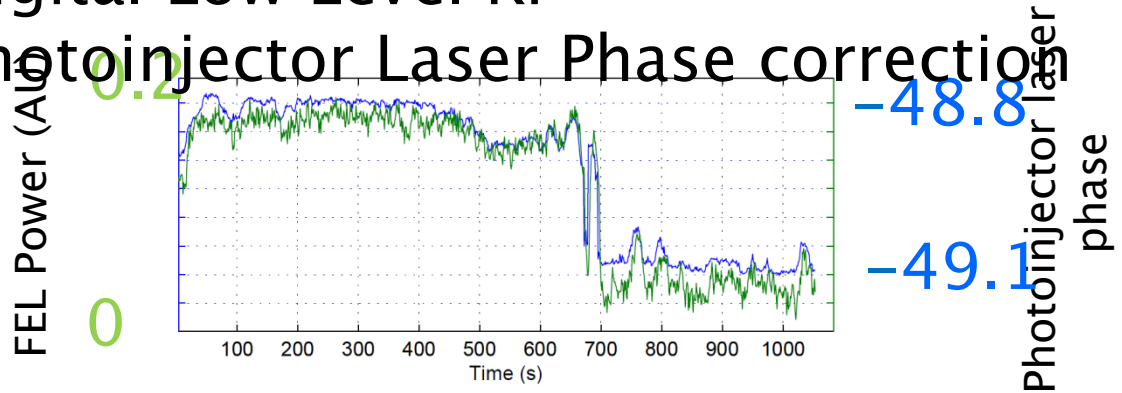
Stability Stability Stability

- Improving performance / reliability cryo system
- Digital Low Level RF
- Photoinjector Laser Phase correction



- Temperature feedback on cavity length +
- Tweaks from single shot spectroscopy
- 24 hour running

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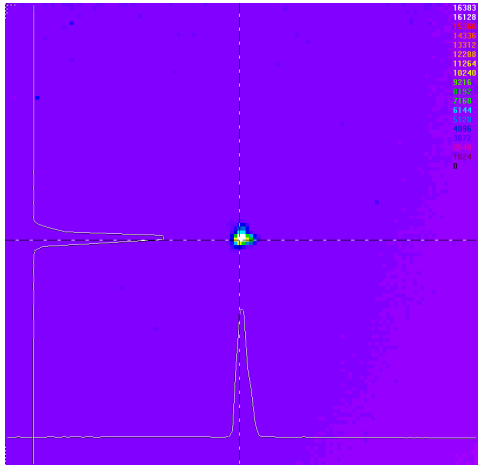
Stability



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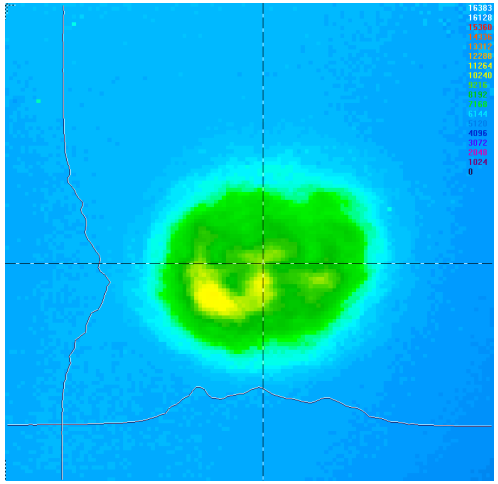

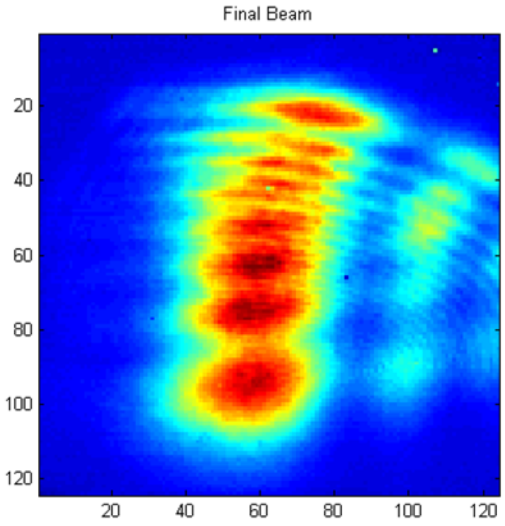

Stability

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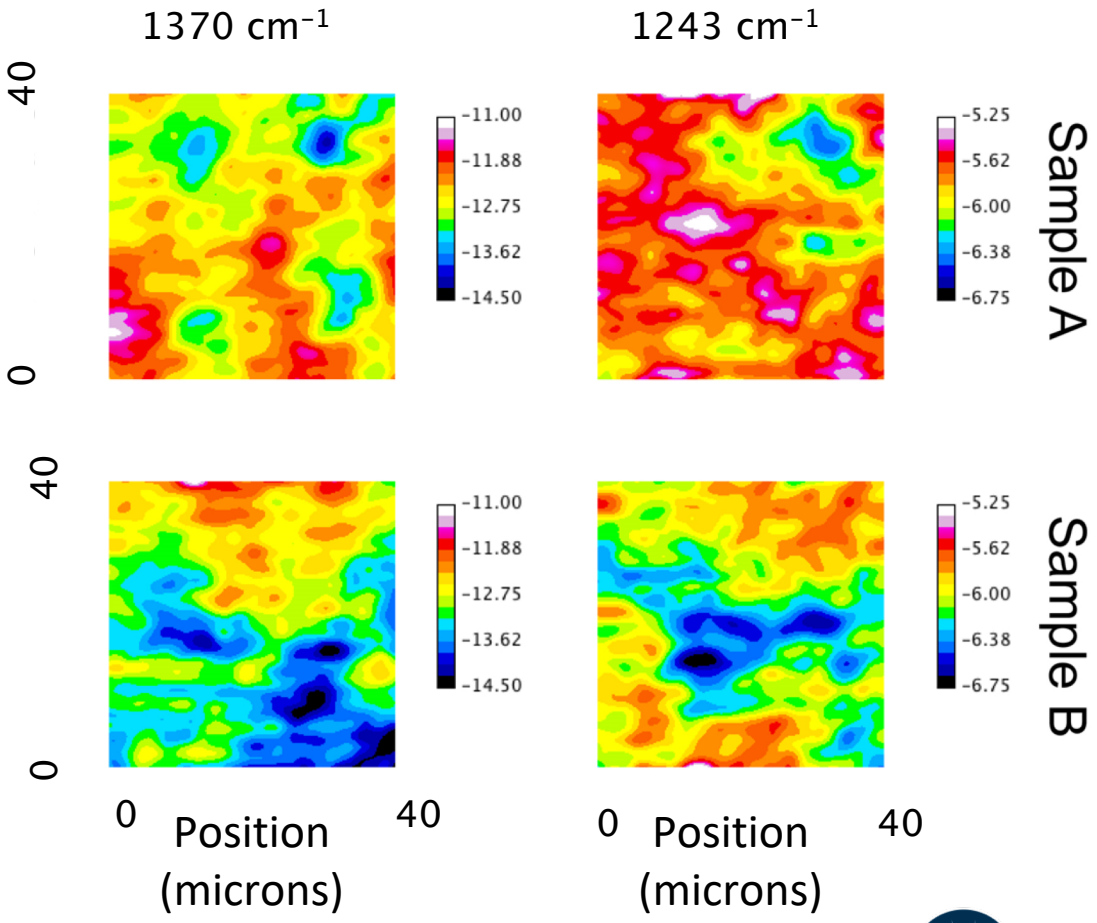
APPLIED PHYSICS LETTERS **102**, 053701 (2013)

Near-field optical microscopy with an infra-red free electron laser applied to cancer diagnosis

Oesophageal Tissue



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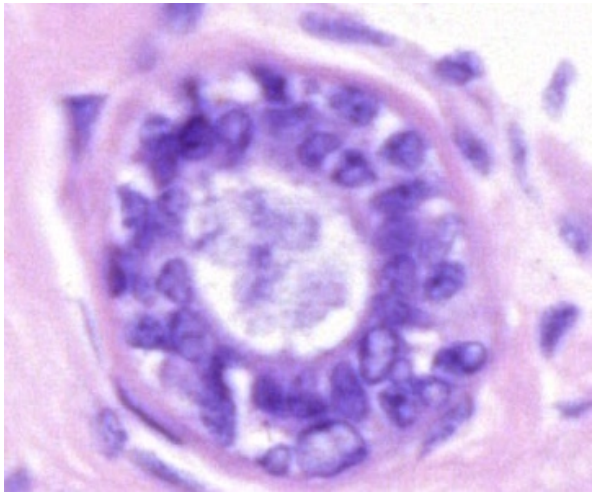
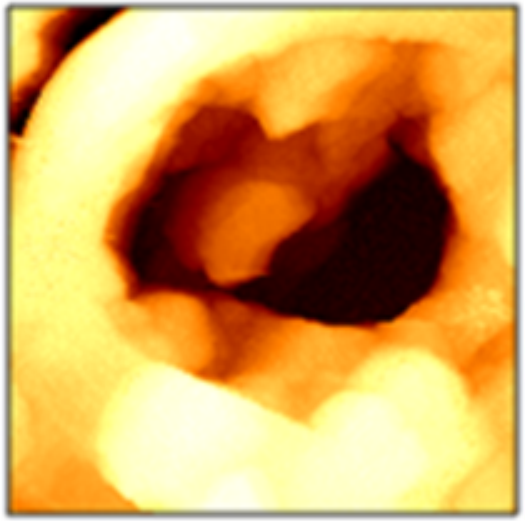
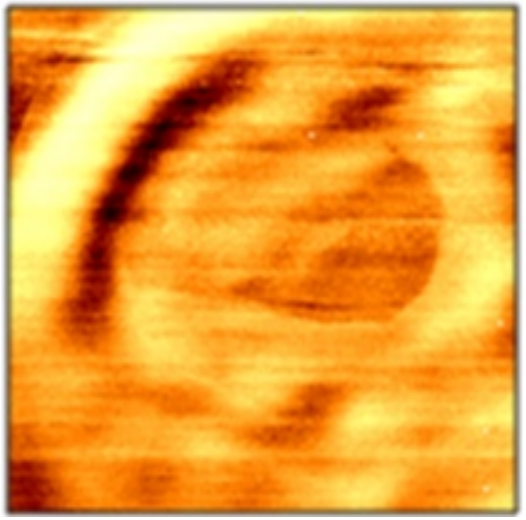
Normal Breast Tissue







1242 cm

Pathology

Topography SNOM

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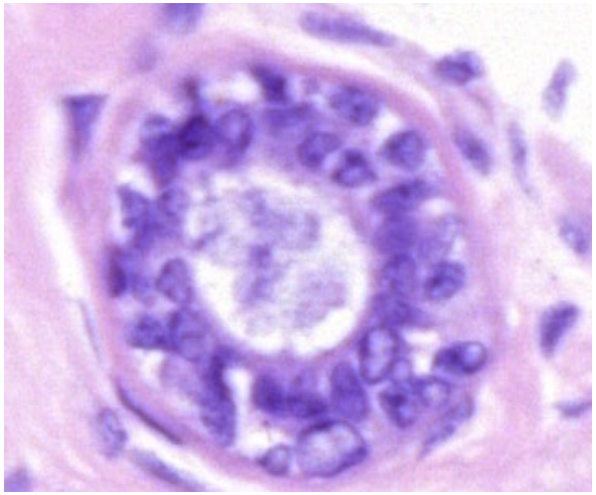
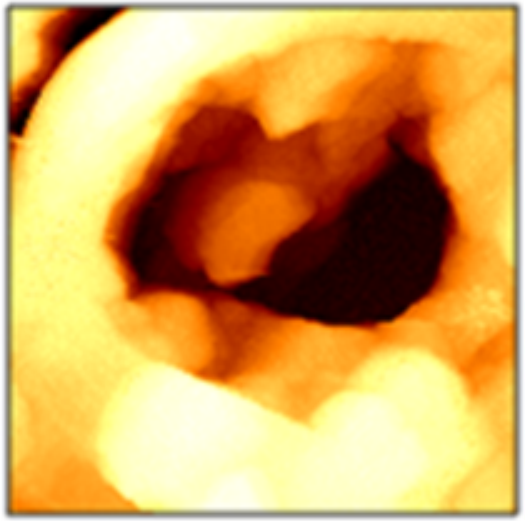
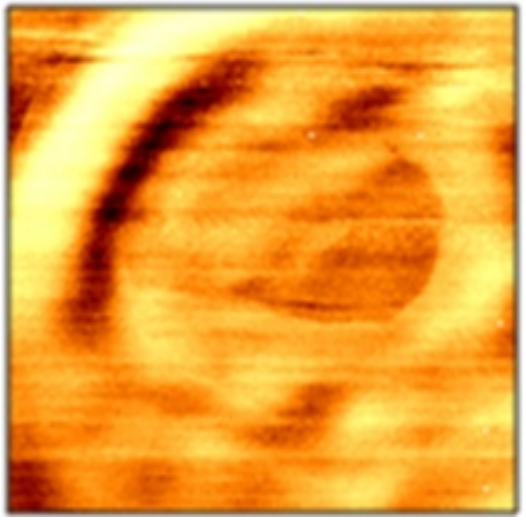
Normal Breast Tissue







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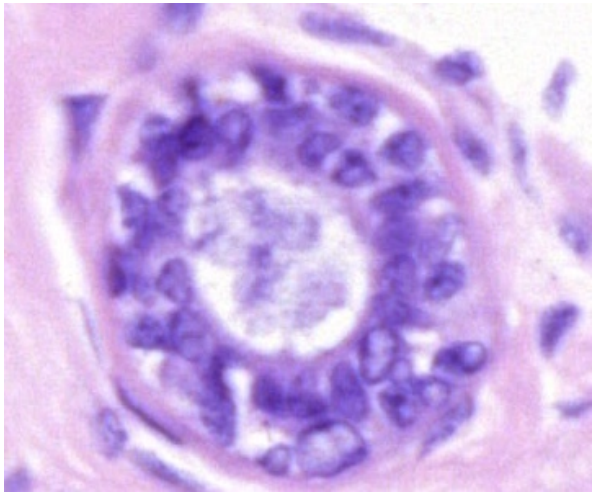

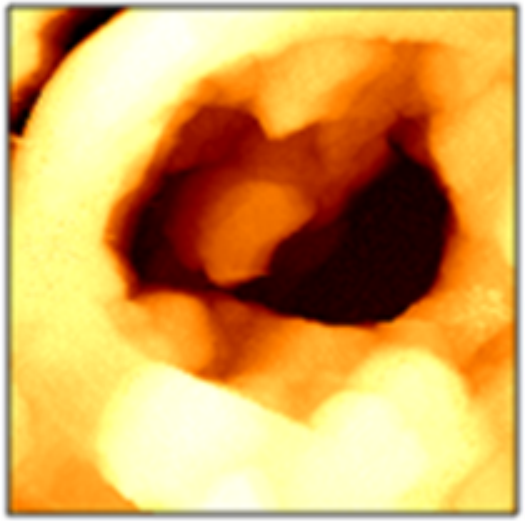

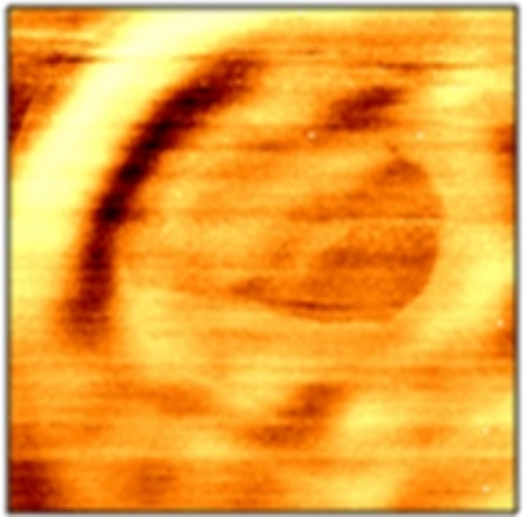

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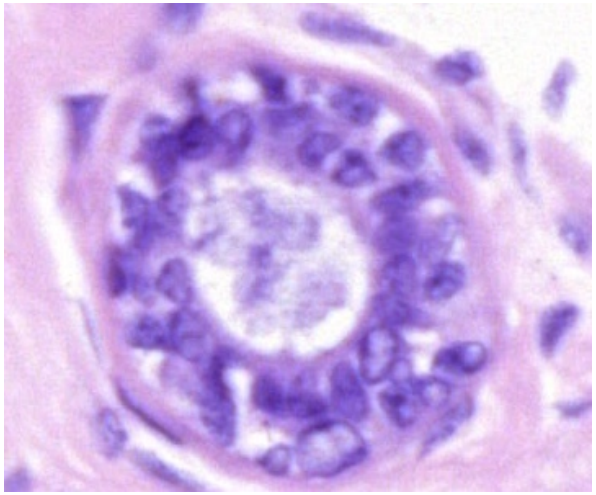

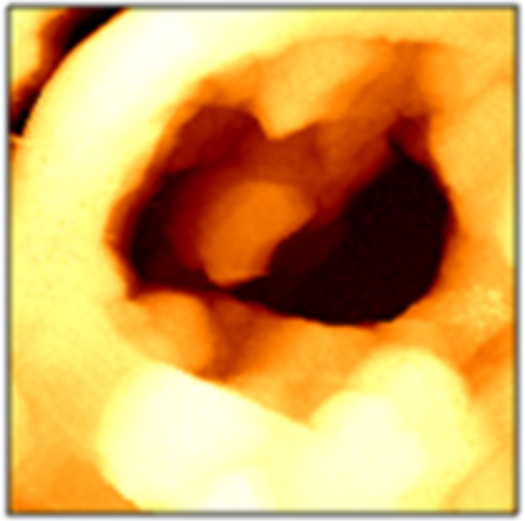

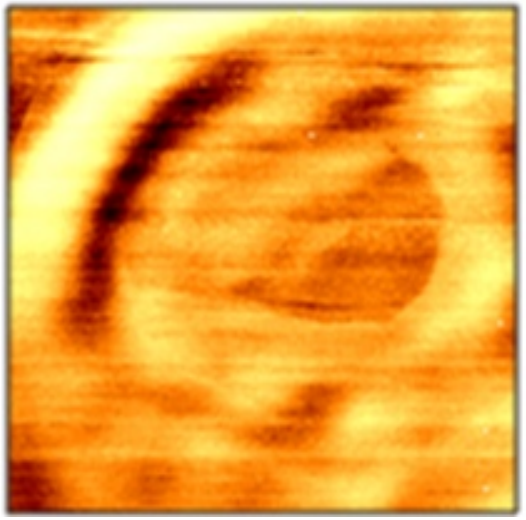

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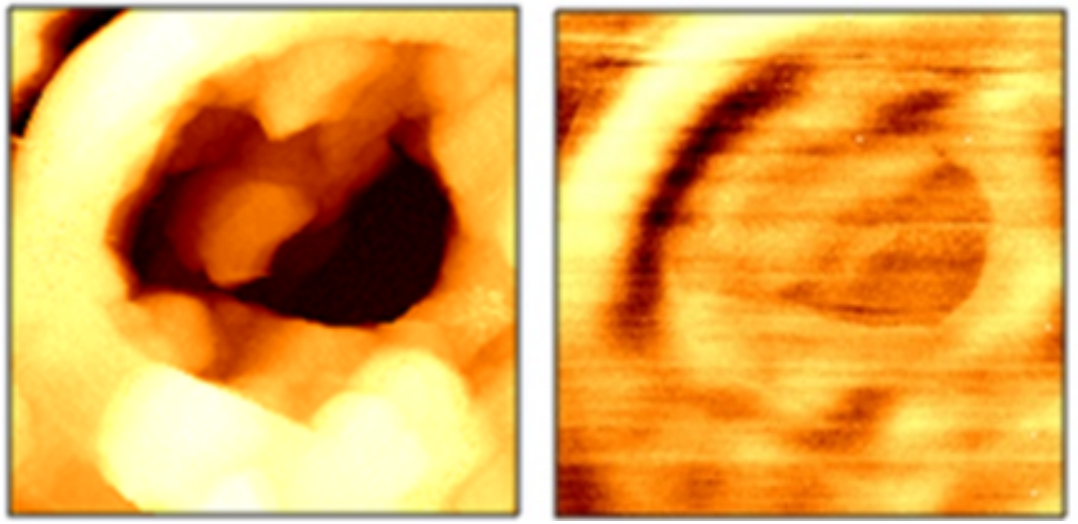
Normal Breast Tissue

Early signs of cancer occurs in basement layer of epithelium: myoepithelium



1242 cm

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Imaging organelles

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Organelle

From Wikipedia, the free encyclopedia

In cell biology, an **organelle** (/ɔːrgəˈnɛl/) is a specialized subunit within a cell that has a specific function. Individual organelles are usually separately enclosed within their own lipid bilayers.

/ə/ 'a' in 'about'

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Conclusion:

With a very stable FEL:

IR sub-diffraction imaging of tissue is indeed possible

Potential for:
Understanding cancer development
Drug targeting at sub-cellular level

2016

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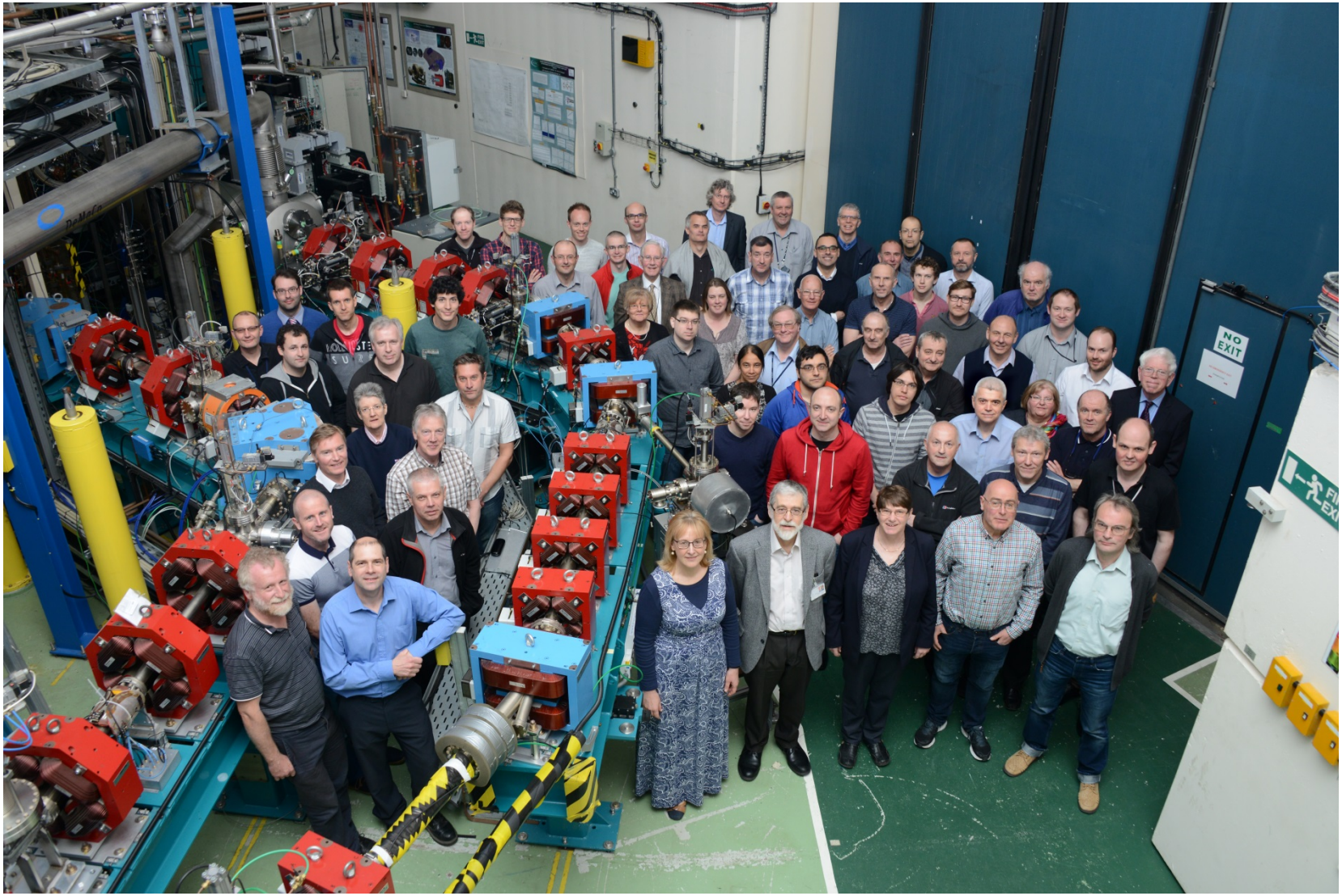

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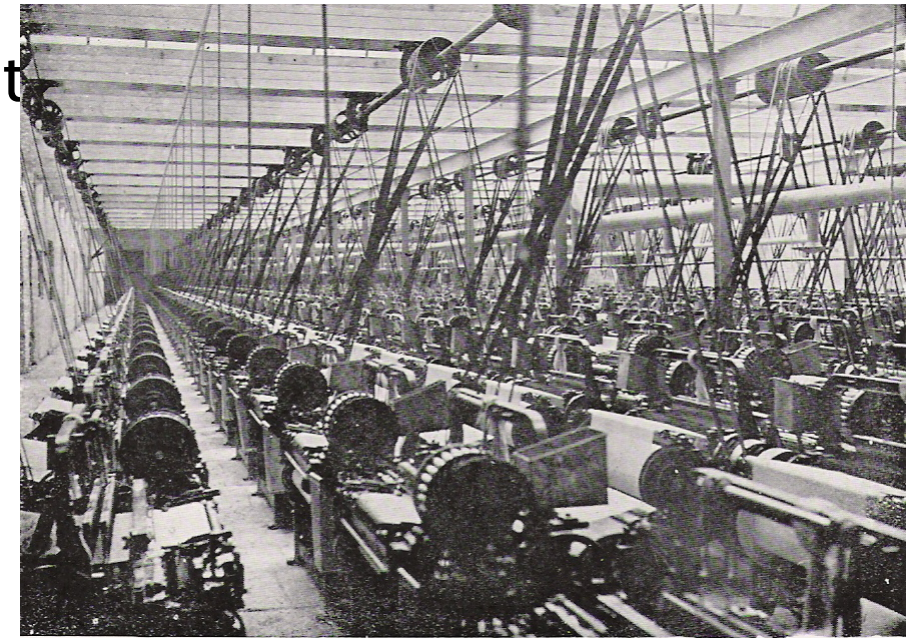
Where do we go from here?

Funding body EPSRC recognise need for UK IR FEL

ASTeC require turn key IR FEL requiring less specialist suppo

More user time for same cost

Look again at the merits of
NC IR FEL



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