

What is s-SNOM?

- AFM-based instrument
- Vis/IR/THz Reflection
- High spatial resolution (~30 nm)
- Surface sensitive (~10 nm)
- Hyperspectral mapping

How s-SNOM works?

01

02

Pick a Frequency!

3D mapping (tomography)

03

04

Nanoscale Spectroscopy

References:

- [1] A. Cvitkovic, N. Oelcie, and R. Hillenbrand, "Analytical model for quantitative prediction of material contrasts in scattering-type near-field optical microscopy," *Opt. Express* 15, 8550-8565 (2007).
- [2] Bagavath, C., Nasi, L. & Kumar, J. Investigations on the structural and optical properties of sphere-shaped indium nitride (InN). *Appl. Phys. A* 123, 287 (2017).
- [3] Majed Khan, M.A., Khan, W., Ahmed, M. et al. Crystallite structural, electrical and luminescent characteristics of thin films of In₂O₃ nanocubes synthesized by spray pyrolysis. *Electron. Mater.* Lett. 9, 53-57 (2013).
- [4] Govyadinov, A., Mastel, S., Golmar, F., Chuvilin, A., Carney, P. and Hillenbrand, R., 2014. Recovery of Permittivity and Depth from Near-Field Data as a Step toward Infrared Nanotomography. *ACS Nano*, 8(7), pp.6911-6921.
- [5] Benedikt Hauer, Andreas P. Engelhardt, and Thomas Taubner, "Quasi-analytical model for scattering infrared near-field microscopy on layered systems," *Express* 20, 13173-13188 (2012)

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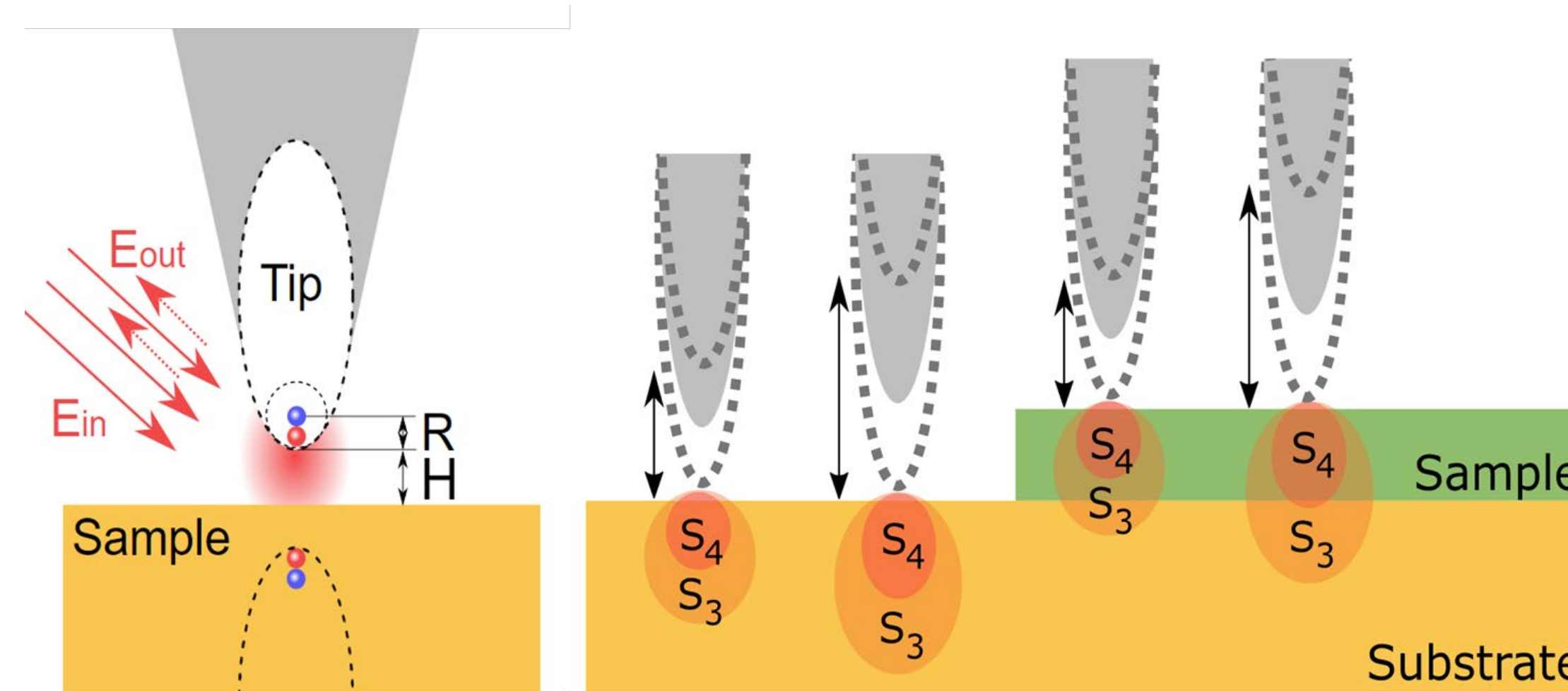
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There are access schemes for researchers and SMEs available!

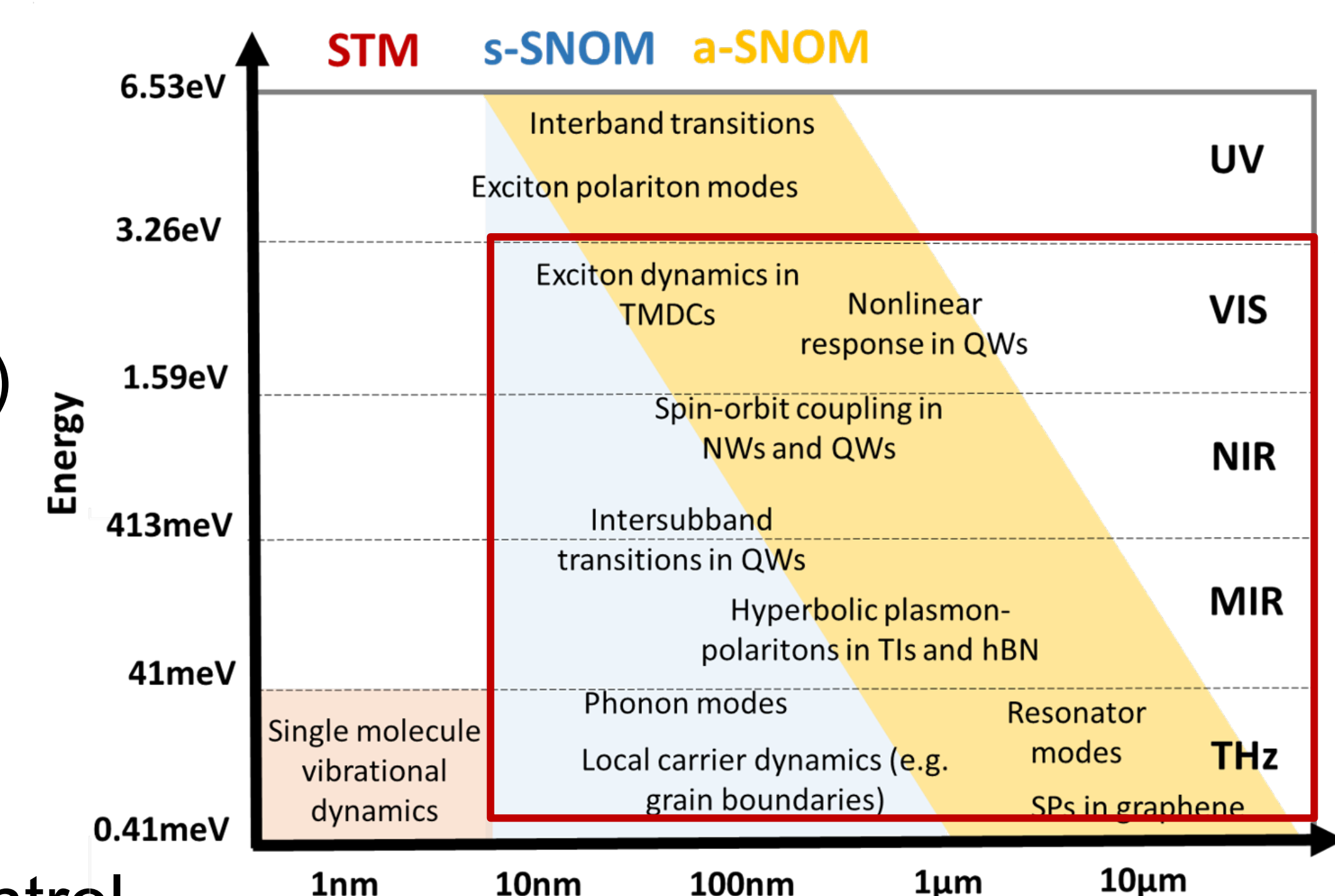
01 s-SNOM brief introduction



- Light coupled to apex of an AFM tip
- Strong field confinement at tip apex that overcomes diffraction limit
- Spatial resolution is on the order of the radius of curvature of the tip (~30 nm)
- Scattered light contains near-field signal and local sample information
- Probing depth varied by changing tapping amplitude or using a different demodulation order of near-field signal [1]

02 Operation modes:

- Visible range (532 nm, 685 nm)
- NIR range (780 nm, 1064 nm, 1550 nm)
- MIR range (5 – 15 μ m, 20 – 60 THz)
- Terahertz range (0.1 – 4 THz)
- Cryogenic operation (< 10 K)
- Transmission mode and polarisation control

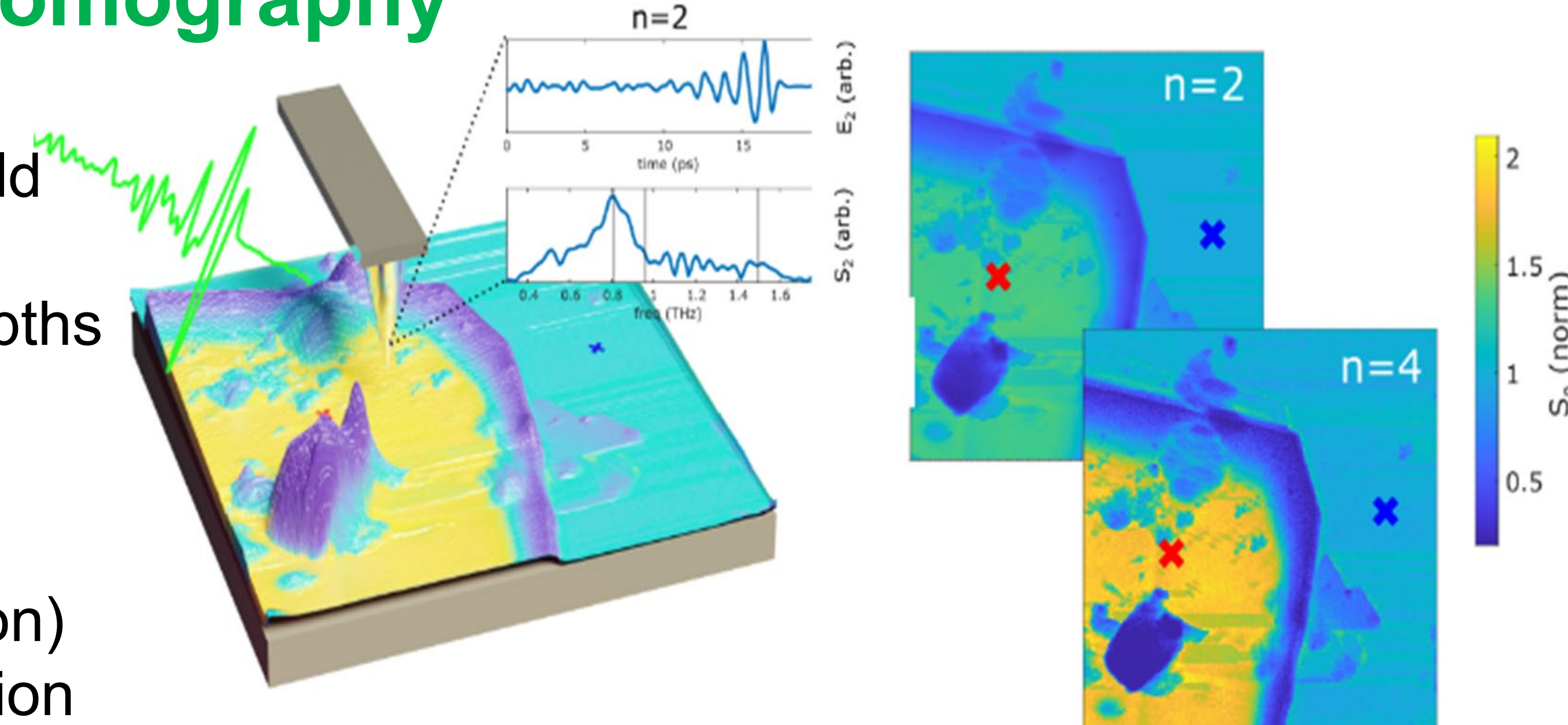


J Lloyd-Hughes et al, J. Phys.: Condens. Matter 33 353001 (2021)

Applications: direct mapping of near-fields in metamaterials; imaging of doped regions and defects, identification of surface passivation layers or surface properties, nanoscale mapping of conductivity and chemical composition; probing interface regions

03 3D mapping – nano-tomography

- Capability to perform 2D near-field imaging with < 30 nm spatial resolution at different probing depths
- Can investigate surface material properties (e.g. carrier mobility, conductivity, chemical composition) by looking at different demodulation orders or tapping amplitudes

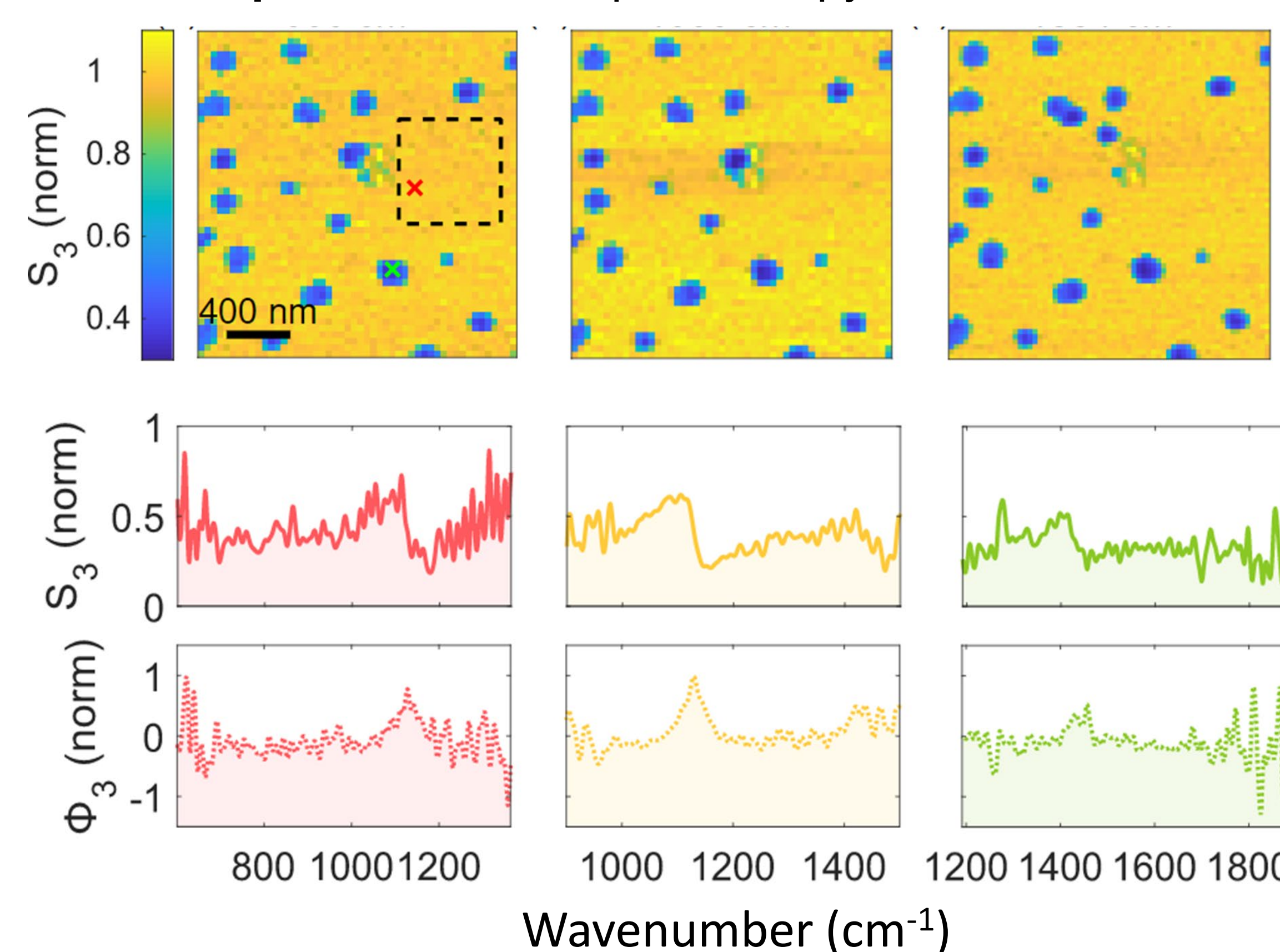


Measurements conducted by Xinyun Liu (Boland group), Manchester
Samples provided by Thorsten Hesjedal group, University of Oxford

04 Nanoscale spectroscopy

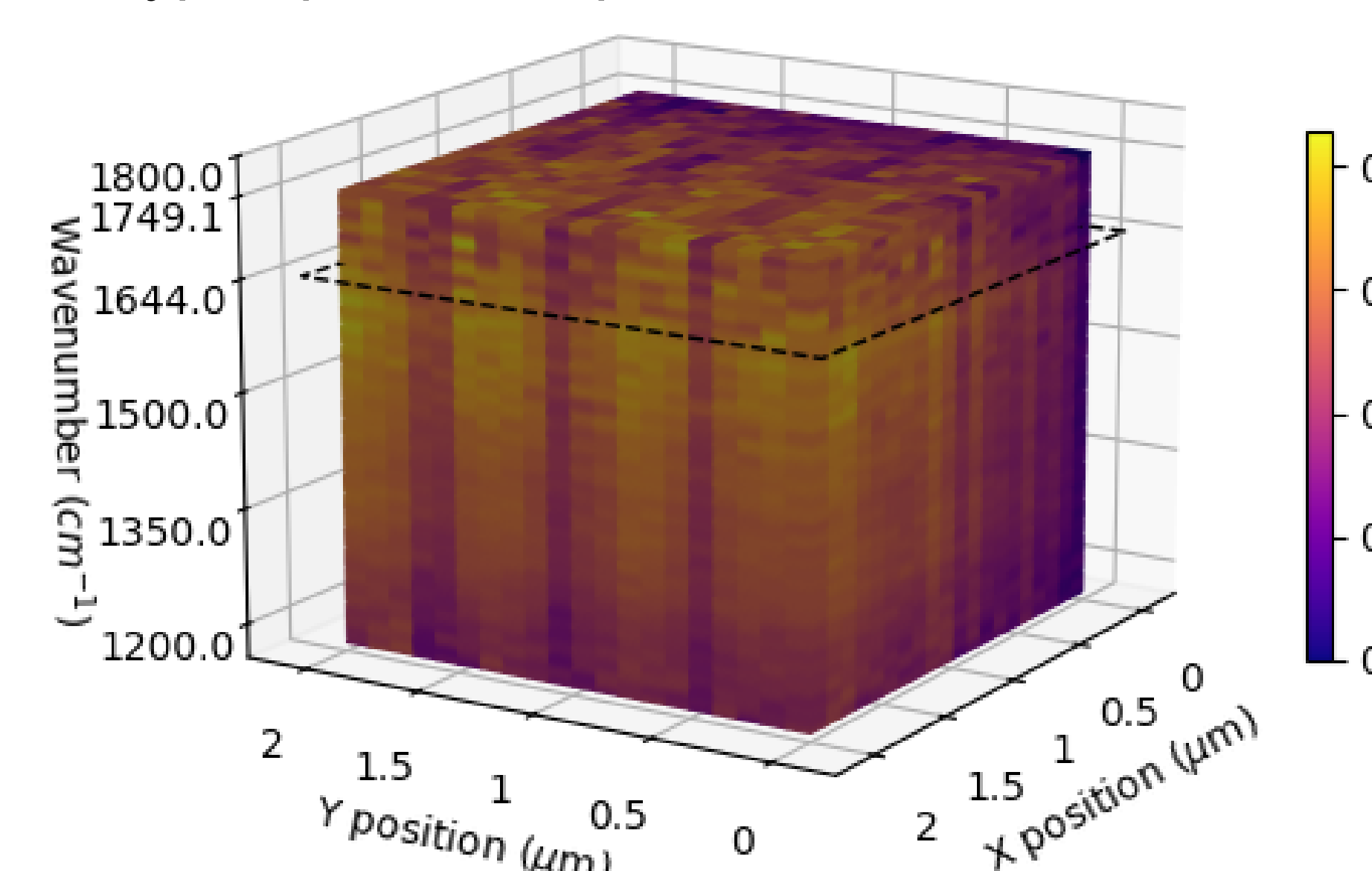
Hyperspectral mapping of scattered near-field amplitude & phase to identify spectral features (e.g. vibrational modes, doped regions)

Example: nano-FTIR spectroscopy on InN NPs



Measurements conducted by Xinyun Liu (Boland group), Manchester
Samples provided by Nazi Kherani's group, University of Toronto

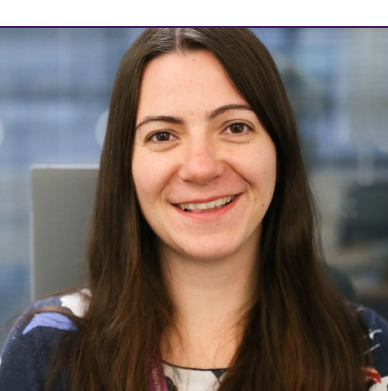
Example: hyperspectral map of TMDC nano-channels



Measurements conducted by Siv Sachin (Boland group), Manchester
Samples provided by Radha Boya's group, Manchester

Capability to perform nanoscale spectroscopy (e.g. nanoFTIR), enabling:

- measurement of individual NPs
- mapping of grain boundaries and interfaces, changes in chemical composition
- extraction of local dielectric function, carrier concentration, etc.



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