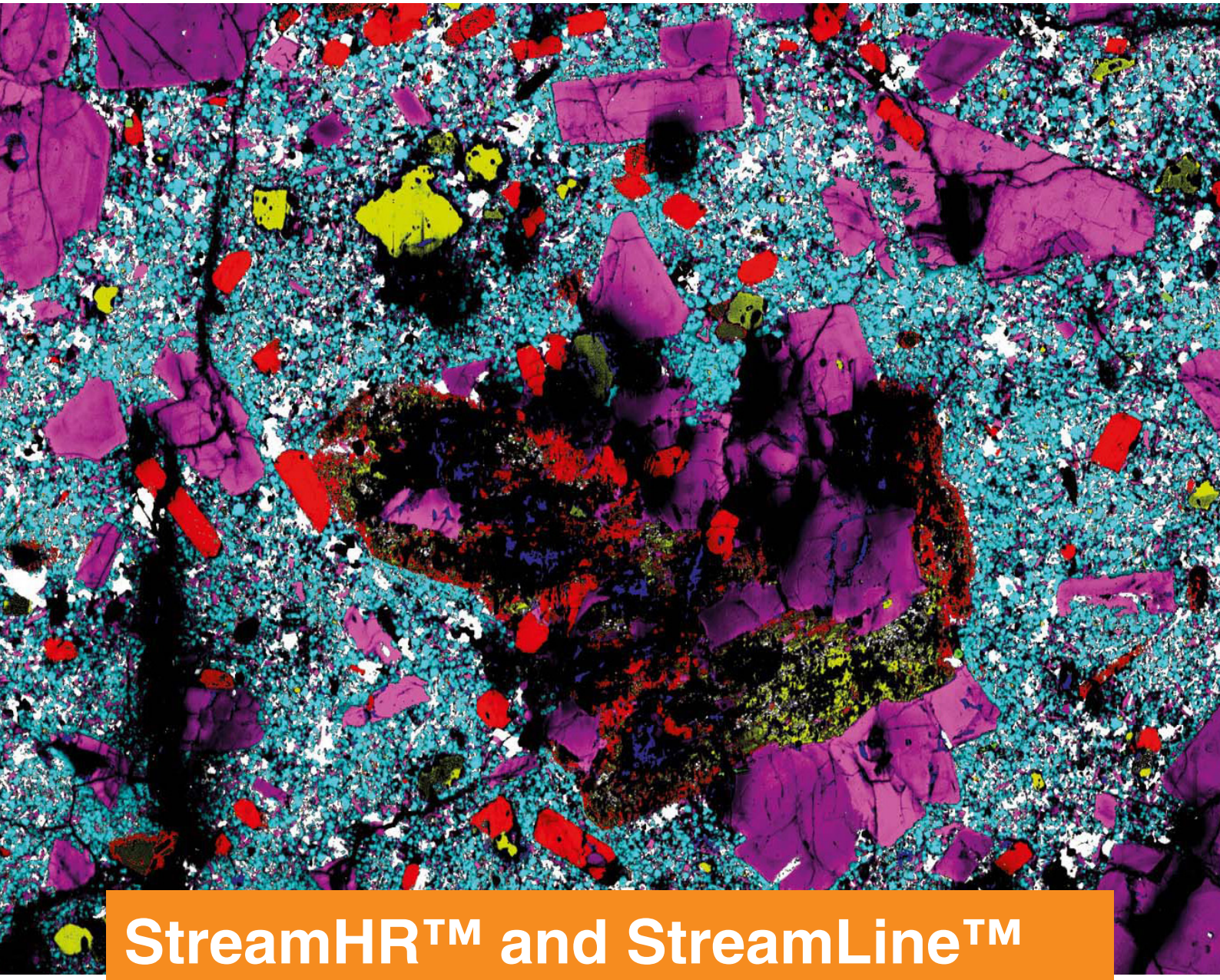
RENISHAW
apply innovation™



StreamHR™ and StreamLine™ imaging technology

Get chemical images faster

With Renishaw's StreamHR™ and StreamLine™ imaging technology, you can perform high-speed Raman or photoluminescence (PL) imaging to characterise your samples.

Both imaging methods save time by scanning the excitation laser over the sample, while continuously streaming spectral data from the CCD detector. This gives you Raman or PL images in the shortest possible time.

Most samples are not homogeneous; you need to know the size and distribution of their components to understand them fully. Raman spectral imaging can be used to show the 2D and 3D spatial distribution of chemical species within a sample. You can also use Raman imaging to determine the structural variation in a material, such as crystallinity, compressive/tensile stress or number of layers.

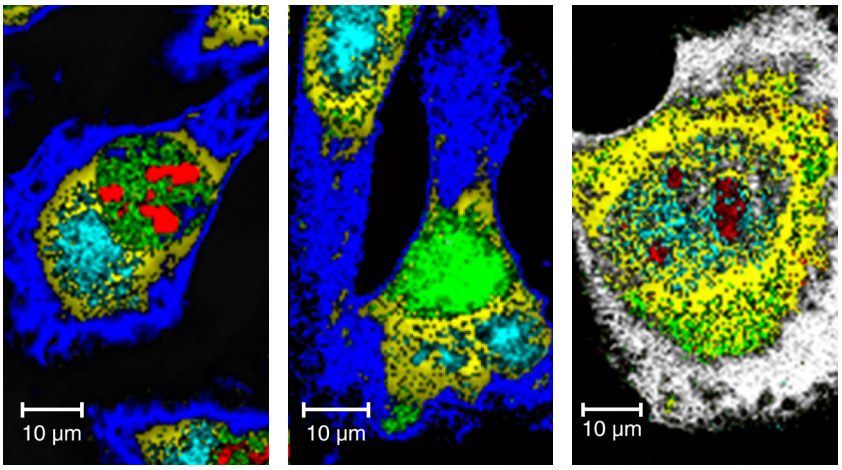
www.renishaw.com/raman

#renishawraman

Renishaw's fast imaging technology can obtain artefact-free chemical images from large sample areas. The analysed area is not limited to the field of view of the microscope objective, but by the total travel of the microscope stage. If your Raman instrument is configured with a Renishaw MS30 high speed encoded stage, the analysis region can be as big as 112 mm × 76 mm.

With StreamHR or StreamLine technologies, LiveTrack™ focus-tracking technology can automatically maintain focus on rough and uneven sample surfaces. You can also automate the Raman image collection over multiple sample areas using queuing or batch measurements.

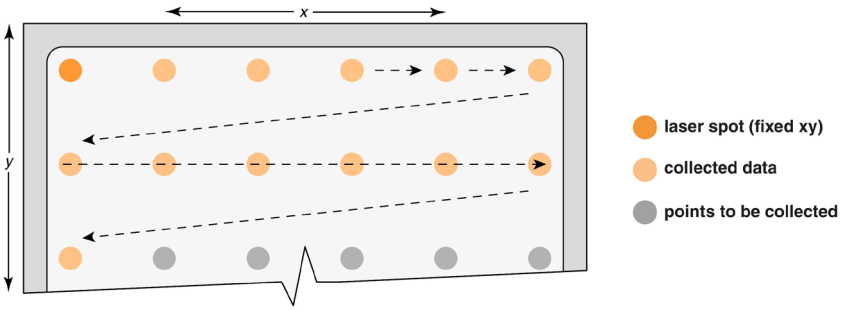
StreamLine imaging and LiveTrack focus-tracking technologies were used to produce a topographic Raman image of an ammonite fossil. This sample is large and has an extremely complex surface topography, making measurement impossible for most other Raman systems. Variations in Raman band positions from iron sulfide indicate regions of higher compressive stress (red) and higher tensile stress (blue).



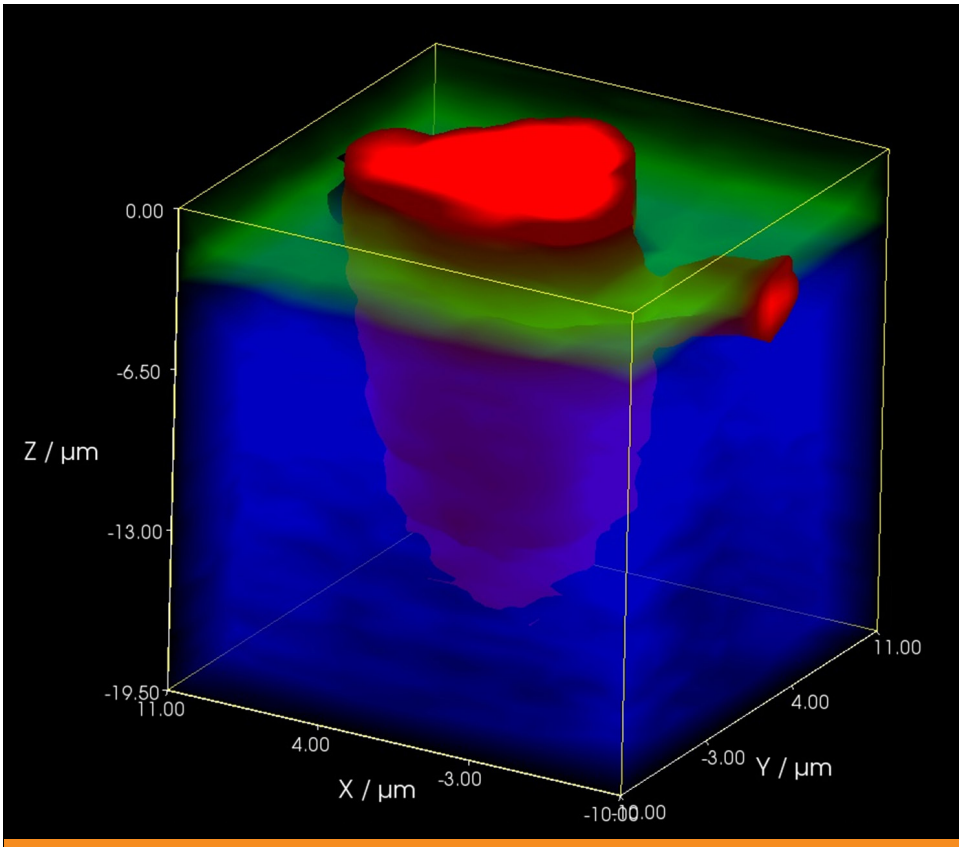
Raman images showing the size and distribution of organelles and biomolecules, in normal and abnormal cells using StreamHR technology. Left to right: normal, autophagic and apoptotic MG-63 cells.

StreamHR™ imaging technology for the highest spatial resolution

If your samples contain features smaller than 1 µm, you might need the highest spatial resolution to reveal them. With StreamHR technology, a diffraction-limited laser spot is scanned across the sample using small step sizes, down to 50 nm. This can produce highly detailed chemical and structural information as 1D profiles, 2D areas or 3D volumes with diffraction limited spatial resolution (<300 nm using 532 nm excitation).



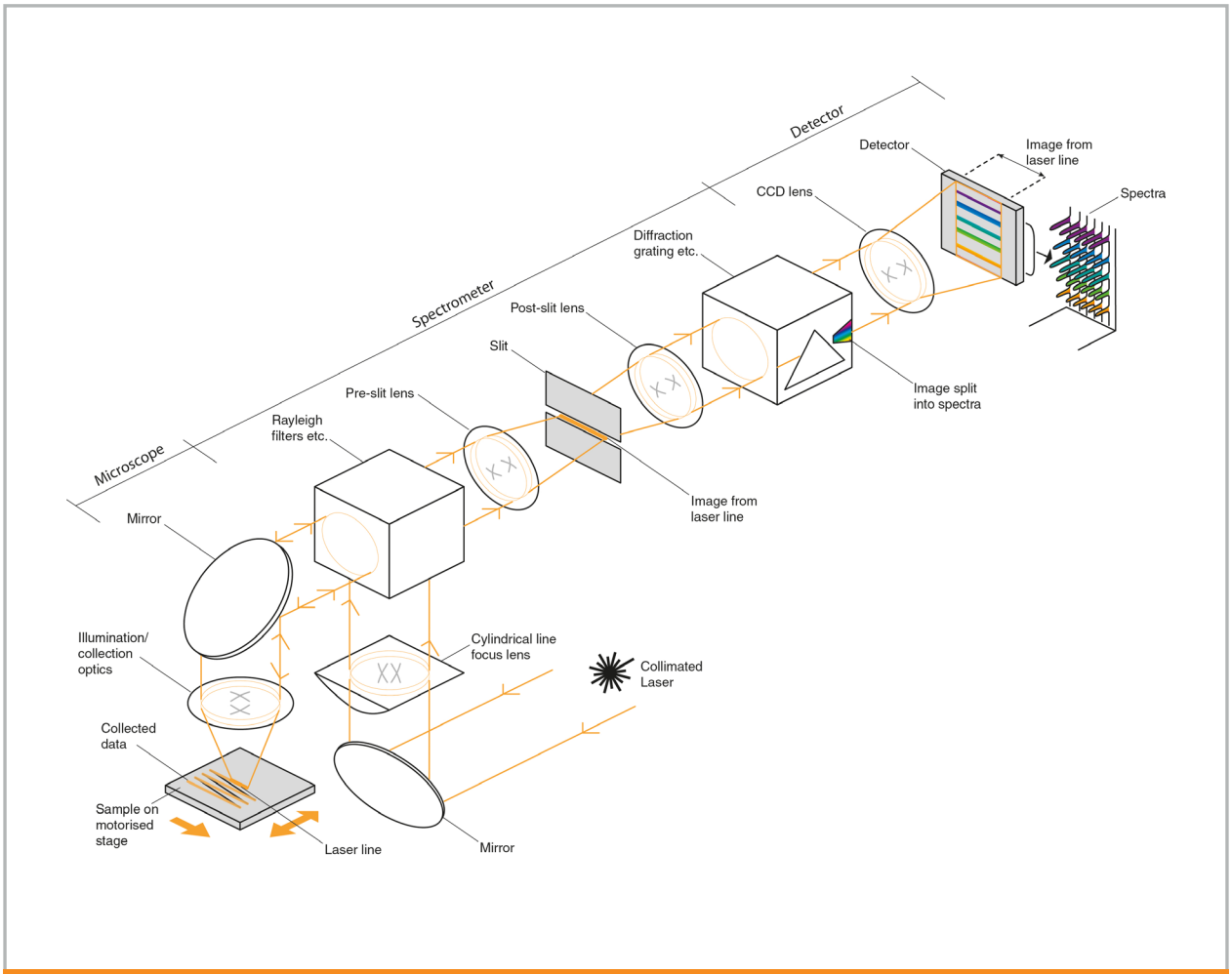
Schematic diagram of data collection using StreamHR technology. The sample is moved under the excitation laser spot while continuously streaming spectral data from the CCD detector. The step size between rows can be as low as 50 nm so that no information is missed.



StreamHR technology was used to produce a 3D volume repetition image of a 3C-SiC core inclusion, showing: 3C-SiC inclusion (red); 4H-SiC epilayer (green); 4H-SiC substrate (blue). Sample courtesy of Prof. Noboru Ohtani, Kwansei Gakuin University, Japan.

StreamLine™ imaging technology for fast and non-destructive analysis

Streamline technology rapidly generates chemical images of very large sample areas. With the StreamLine method, a laser line is used to excite molecular vibrations within a sample. This spreads the laser power over a larger area. Minimising the laser power density helps to prevent laser-induced sample damage, compared to an intense laser spot. You can therefore use higher total powers (20 to 40 times higher) without damaging light-sensitive materials including catalysts, pharmaceutical formulations, forensic materials (including inks) and biological specimens. This massively shortens Raman imaging measurement times.



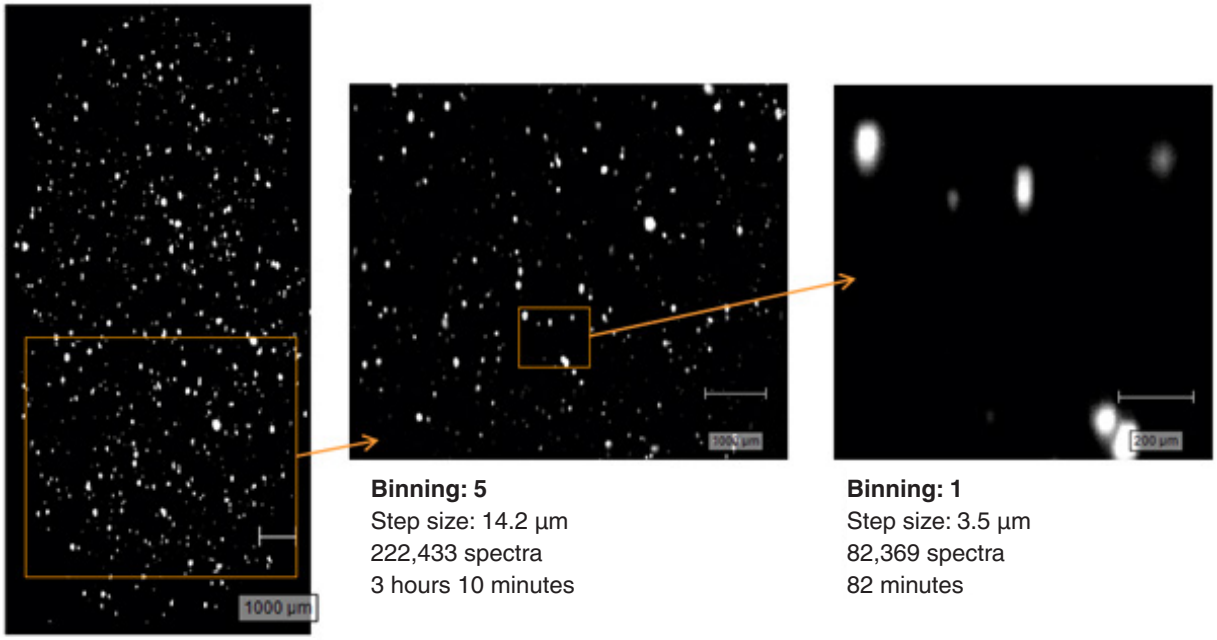
Schematic diagram showing the optical layout for StreamLine technology on the inVia™ confocal Raman microscope.

Excitation with a laser line produces a series of parallel spectra on the detector. StreamLine technology synchronises the sample motion on the MS30 stage with the movement of the signal on the detector. Each imaged point of the sample traverses the laser line once. The charge (signal) on the detector accumulates while it moves across the detector. Data is read off continuously from the detector during StreamLine Raman imaging. This rapidly generates a large, artefact-free chemical image of the sample.

StreamLine™ imaging technology goes faster with binning

StreamLine technology is ideal for quickly resolving domains or particles down to 1 µm in size. If you do not require the highest spatial resolution, you can choose to enhance the signal-to-noise ratio and boost imaging speed by binning. If binning is used, the spectral data from a specified number of rows on the CCD detector will be added together. This drastically reduces the required exposure time and the total data collection time.

StreamLine technology is a flexible method for fast Raman imaging. High-speed images can be collected at low spatial resolution to understand overall chemical distribution over a large sample area. Users can then 'zoom in' on regions of interest by collecting a high-resolution StreamLine technology or StreamHR image.



Binning: 10
Step size: 35.5 µm
106,009 spectra
3 hours 3 minutes

Binning: 5
Step size: 14.2 µm
222,433 spectra
3 hours 10 minutes

Binning: 1
Step size: 3.5 µm
82,369 spectra
82 minutes

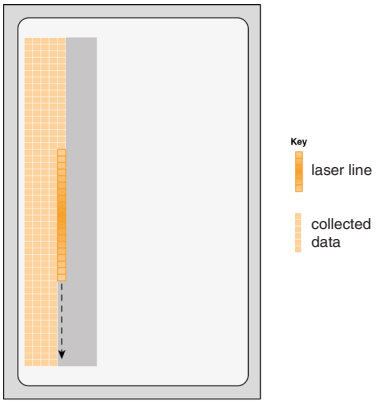
Binning was used with StreamLine technology to "zoom in" on selected API particles (shown in white) within a pharmaceutical tablet. Orange boxes indicate regions that were subsequently analysed at higher spatial resolution (i.e. less binning). All three Raman images were collected with a 20× objective, so the same depth was being sampled in Z for easily comparable data.

StreamLine™ imaging technology with Slalom mode: Get complete sample coverage

If binning is used to enhance imaging speeds, Slalom mode can ensure that your data is gathered from the entire region of interest. This helps you to detect smaller features that you might otherwise miss, such as monolayer graphene on a large wafer, forensic contaminants, semiconductor defects or SERS nanoparticles. StreamLine technology's Slalom mode provides an effective solution to the problem of undersampling when using larger step sizes.

StreamLine technology's Slalom mode gives you the flexibility to produce images at the resolution and size you want, without changing objective lens. This enables you to make direct and accurate quantitative comparison between measurements.

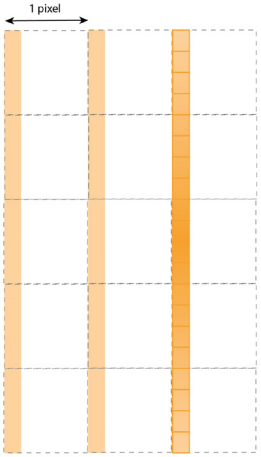
Raman images of an American dollar bill showing: black ink (white), green ink (green), unique paper fibres (yellow) and trace explosives (red). StreamLine technology was used in Slalom mode to ensure that the entire dollar bill was analysed and that trace explosive particles were not missed.



StreamLine technology for fast yet gentle Raman imaging

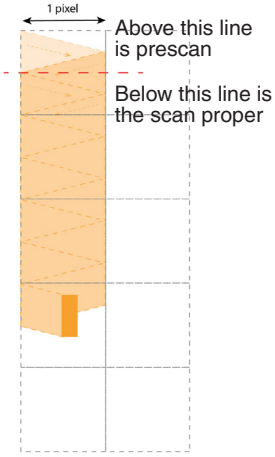
The laser line is scanned across the sample along the y-axis. Data is collected from multiple rows on the CCD detector simultaneously.

The step size in x is equal to the width of the laser line. Complete coverage is achieved, but not at the fastest speeds.



Undersampling without Slalom mode

If the step size in x is greater than the width of the laser line, some areas of the sample will not be analysed. In this illustration, data is collected from ~20% of the sample.



StreamLine technology with Slalom mode for fast and complete coverage

The zig-zag motion of the laser line enables a step size in x that is larger than the width of the laser line.

Data is collected from 100% of the sample at the fastest speeds.

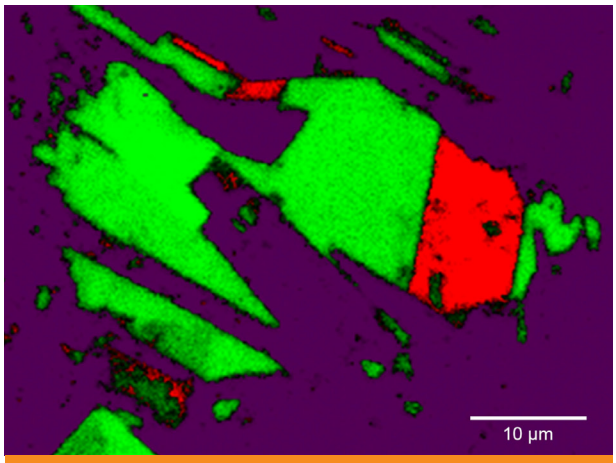
Go even faster in *Rapide* mode

If you require even faster Raman imaging, use StreamHR and StreamLine technologies in *Rapide* mode for that extra boost. The *Rapide* option uses a patented communication method between the sample stage and the CCD detector to achieve extreme speed.

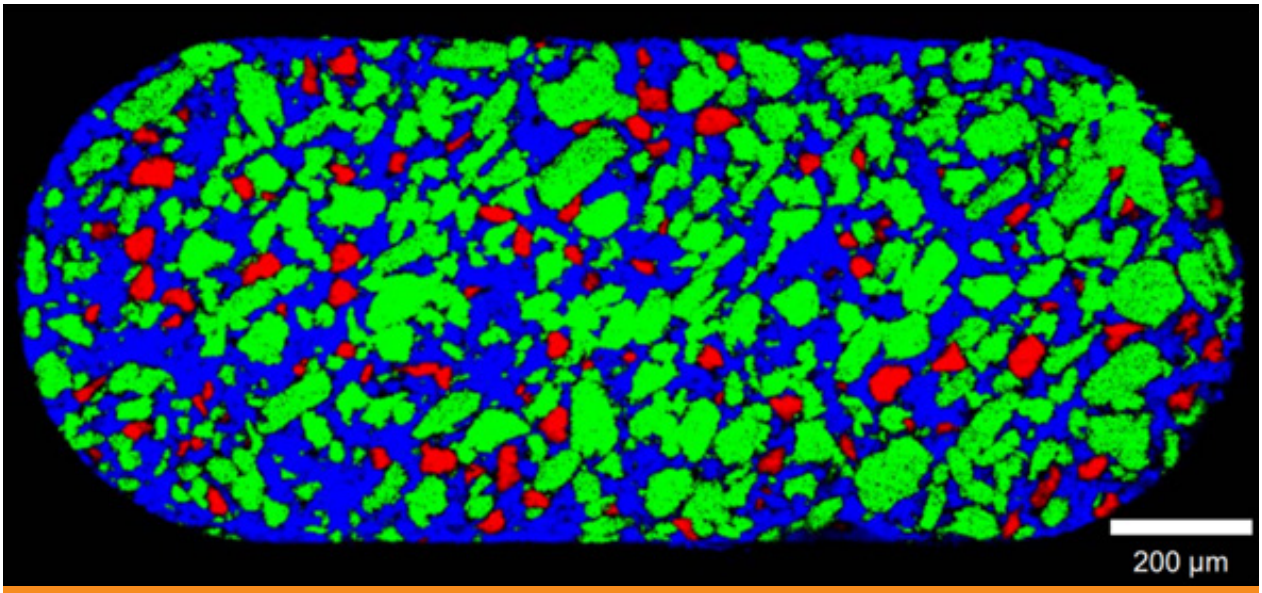
StreamHR™ Rapide imaging technology enables you to collect highly resolved Raman images at rates faster than 1,000 spectra per second.

StreamLine™ Rapide imaging technology can collect Raman images at even faster rates of 1,500 spectra per second. Your Renishaw inVia microscope can now analyse large areas faster than ever before.

You can also take advantage of the ultra-fast spectral readout of StreamHR *Rapide* technology to acquire data without moving the sample. This capability could be used for monitoring chemical reactions and processes down to microseconds.



Raman image of single-layer graphene (red) and multi-layered graphene (green) on a Si/SiO_2 substrate. 52,136 spectra were collected at a rate of 700 spectra per second using StreamHR *Rapide* imaging technology.



A Raman image taken with StreamLine *Rapide* imaging technology of a milled analgesic tablet containing over 1.3 million spectra was collected in 35 minutes. The imaged area is 18.2 mm × 8.1 mm. Colours indicate caffeine (red), aspirin (green) and paracetamol (blue).

RENISHAW
apply innovation™

When performance really matters, choose Renishaw

We launched our first Raman spectroscopy product in 1992, and have been continuously developing Raman instrumentation ever since. Decades of experience ensure that our products can be trusted to deliver the results you need. Our Raman systems are built with parts manufactured in-house. These are put through extensive and rigorous testing to ensure they are highly stable and reliable.

www.renishaw.com/raman

#renishawraman

+44 (0) 1453 524524 **raman@renishaw.com**

PN262(EN)-01-L