

# Spin Wave Imaging

## Using the Confocal Brillouin/Raman Microscope Nanofinder®

Surface and Volume Magnon Characterization with Sub-Micrometer Spatial Resolution

### What is new?

Magnonic (or spin wave based) devices have a high potential for novel computational devices.

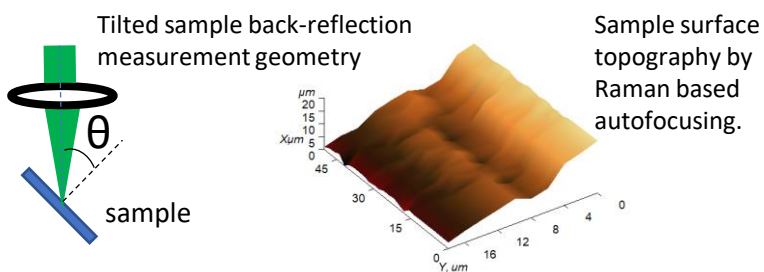
Spin wave location and propagation can be visualized with high spatial resolution by confocal Brillouin spectroscopy, operating in back-reflection geometry.

Detection of spin waves spectra from tilted samples allows the easier identification of surface magnons signals (Damon-Eshbach waves) based on their Stokes / anti-Stokes asymmetry, which depends on the orientation of the magnetic field.

Phonon and magnon signals can be readily distinguished by the polarization of the Brillouin-scattered light.

### Tilted sample measurement geometry for surface magnons detection

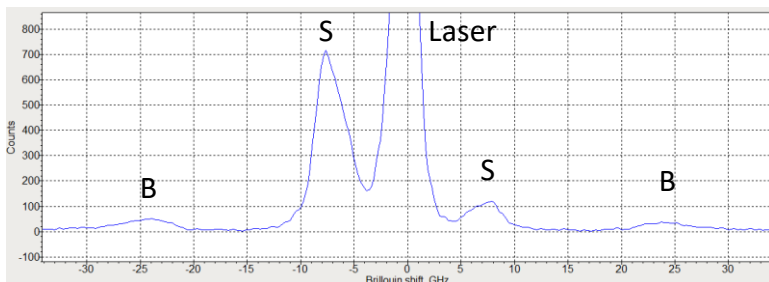
In the tilted sample back-reflection measurement geometry shown below, microscopic observation of the samples surface is complicated, precluding accurate focusing of the laser beam on the sample plane. Taking advantage of the Raman detection channel of the Nanofinder® confocal Brillouin/Raman system permits exact laser beam auto-focusing using a piezo XYZ scanner. XY-mapping along the tilted sample surface is possible with plane tilt correction, surface triangulation or/and autofocusing in every mapping point.



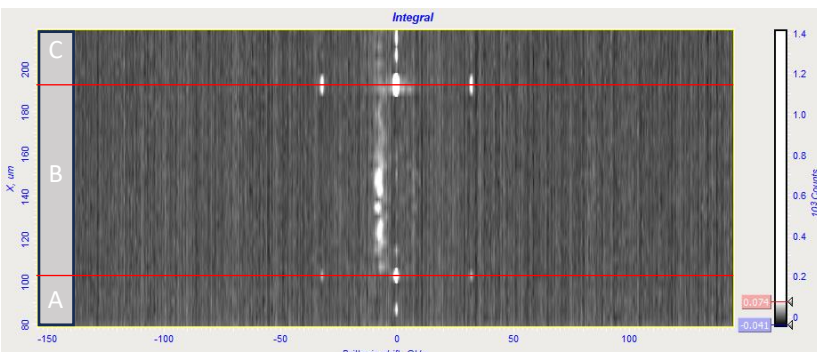
### Magnon Spectra and Spatial Mapping

Sample:  $\text{Fe}_3\text{Si}$  film on Si substrate, (courtesy of Nakamura Yoshiaki Laboratory, Osaka University)

Measurements were conducted in the absence of an external magnetic field using only sample magnetization.

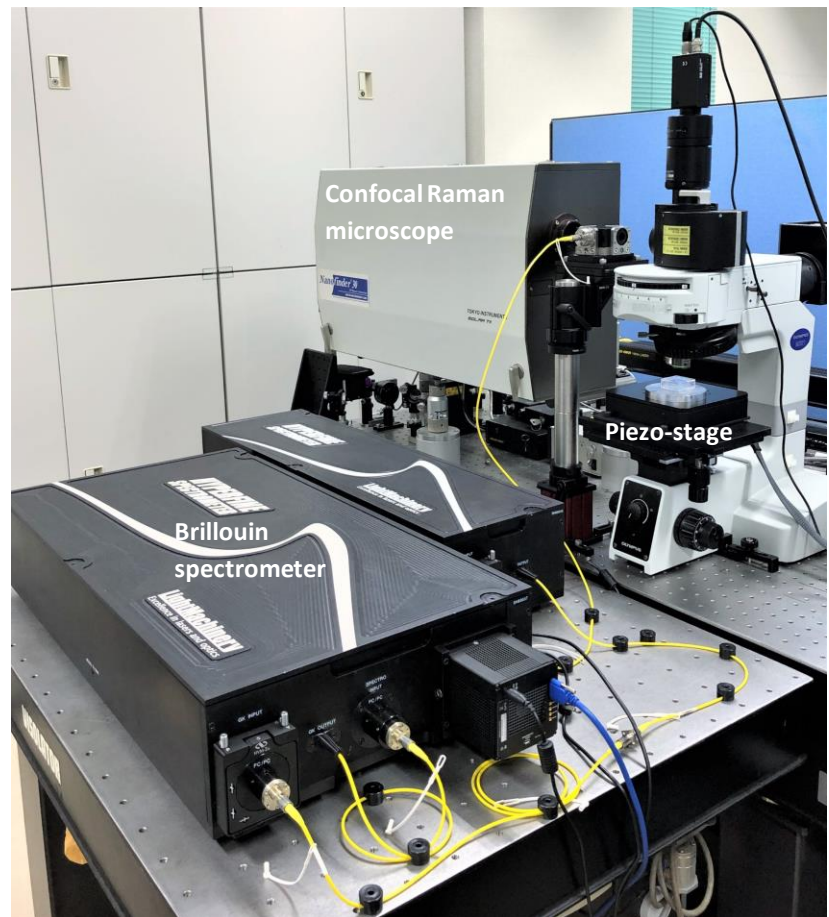


Surface S and bulk B magnon Brillouin peaks.



Magnon spectra recorded along the sample surface (A, B, C are different areas on the sample surface). Surface magnon signals are mainly detected in area B and have a strong anti-Stokes spectral component. This indicates an area with the same orientation of magnetization.

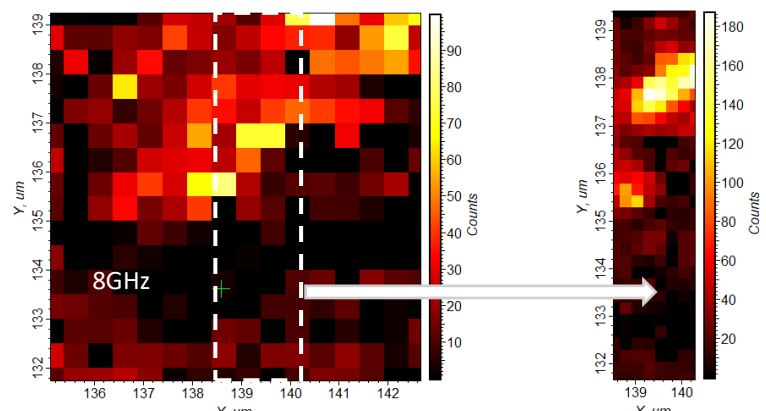
### System and Components



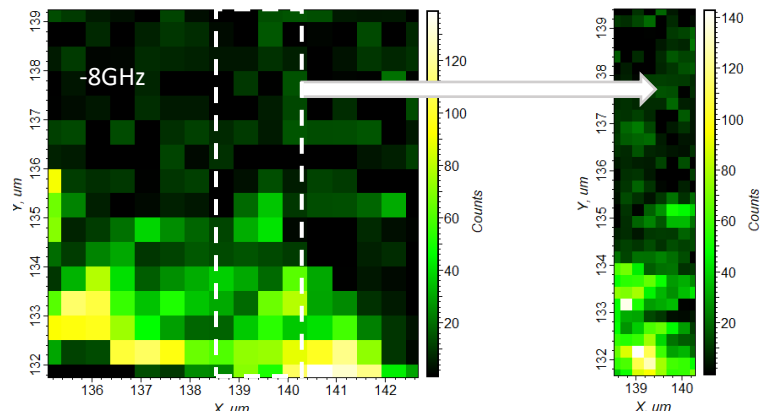
Confocal Brillouin/Raman imaging system Nanofinder® 30A (Tokyo Instruments, Japan)

### Surface Magnon Distribution 2D-images, same sample area

Surface magnon peak intensity at ~ 8 GHz



Surface magnon peak intensity at ~ -8 GHz



Mapping step 500 nm  
16X16 points

Mapping step 250 nm  
8X32 points

Surface magnon peaks intensities images show locations of magnetic clusters with different orientation of local magnetic field.