

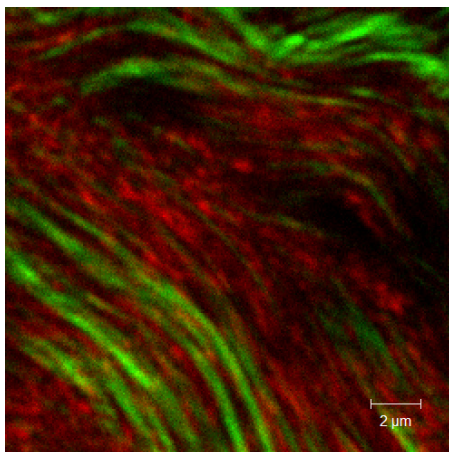
# The microstructural origin of second harmonic generation in collagen fibres (2012-2013)

*Faglærer: Associate professor Magnus Lilledahl ([magnus.lilledahl@ntnu.no](mailto:magnus.lilledahl@ntnu.no), D4-172)*

When intense light interacts with matter, nonlinear optical process can occur. These process are non-linear in the electric field and results in general in the production of photons with different wavelengths than the excitation photons. One such process is second harmonic generation (SHG) where two photons of the same wavelength are converted into one photon of twice the energy of the excitation photons. SHG only occurs in molecules that are non-centrosymmetric, and collagen, due to its helical structure, is such a molecule.

Non-linear properties have nice properties for microscopic imaging of biological samples, e.g. intrinsic three dimensional imaging and high penetration depth due to long excitation wavelengths. Second harmonic generation microscopy has therefore been used to image collagen fibres in a wide array of biological samples.

However, since second harmonic generation is a coherent process the radiation pattern is strongly dependent on the subresolution structure of the collagen fibres. In particular, the forward scattered and backward scattered signals are quite different as seen in the figure below, where the backward scattered signal is shown in red and the forward scattered signal is shown in green. A better understanding of these differences is necessary to develop SHG microscopy as a quantitative tool in biomedical imaging.



We wish to understand the ultrastructural origin of these differences. We propose to do this by imaging the same sample using second harmonic generation microscopy and transmission electron microscopy. The much higher resolution of transmission microscopy will allow us to understand what differences in the collagen structure gives rise to these differences.

## Project tasks

- Preparation of cartilage samples for nonlinear microscopy and electron microscopy
- Imaging of samples using nonlinear microscope
- Imaging of samples using transmission electron microscope
- Analysis and comparison of images to develop an electromagnetic model of observed radiation patterns of different collagen fibres.

The project is compatible with a project assignment, master thesis or both. Contact me by e-mail or come by my office if you want to discuss the project further.