Near-common path Fourier transformation interferometer

Imaging Fourier transform spectroscopy (IFTS) is a powerful method for biological hyperspectral analysis based on various imaging modalities such as fluorescence or Raman. Since the measurements are taken in Fourier space of the spectrum, it can also take advantage of compressed sensing strategies. IFTS has been readily implemented in high-throughput high-content microscope systems based on wide-field imaging. However, there are limitations in existing wide field IFTS designs. Non-common path approaches often lack phase stability degrading spectrum extraction accuracy. Alternatively, designs based on common-path Sagnac interferometer are stable but incompatible with high throughput imaging. Sagnac designs require exhaustive sequential scanning over large interferometric path delays making compressive strategic data acquisition impossible. In this project we designed a novel phase stable near-common-path interferometer (figure 1) enabling high throughput hyperspectral imaging based on strategic data acquisition. Figure 2 shows spectral measurements of a biological specimen using the proposed system. Our results suggest that this approach can improve throughput over many other wide-field spectral techniques by more than an order of magnitude without compromising phase stability.

![Fig 1. Schematic of the proposed new near common path interferometer system.](image)

![Fig 2. (A1) A mouse muscle tissue sample with regenerated cells some expressing mYFP (ex/em = 508/524 nm) and some with nuclei expressing hrGFP II (ex/em = 500/506 nm). (A2) Recovered spectra for two pixels marked in Fig. ‘A1’. (F) Recovered hyperspectral Images of sample in ‘A1’ at representative spectral bands. (B) Compressive peak emission wavelength measurements for a similar mouse muscle tissue sample with regenerated cells. Images are color coded with peak emission wavelength.](image)