Real-time Doppler-assisted tomography of microstructured fibers by side-scattering.

We introduce the concept of Doppler-assisted tomography (DAT) and show that it can be applied successfully to non-invasive imaging of the internal microstructure of a photonic crystal fiber. The fiber is spun at ~10 Hz around its axis and laterally illuminated with a laser beam. Monitoring the time-dependent Doppler shift of the light scattered by the hollow channels permits the azimuthal angle and radial position of individual channels to be measured. An inverse Radon transform is used to construct an image of the microstructure from the frequency-modulated scattered signal. We also show that DAT can image sub-wavelength features and monitor the structure along a tapered fiber, which is not possible using other techniques without cutting up the taper into several short pieces or filling it with index-matching oil. The non-destructive nature of DAT means that it could potentially be applied to image the fiber microstructure as it emerges from the drawing tower, or indeed to carry out tomography on any transparent microstructured cylindrical object.