amplitudes (owing to the relatively high sensitivity of the electro-optic detection scheme). The only fundamental limitation is provided by the pulse width of the sampling optical signal (about 100 fs in this case), which determines the measurement time resolution and therefore sets an upper limit to the carrier frequency of the measured waveform. Experimentally, the main challenge is to stabilize the carrier frequency and repetition rate of the mode-locked QCL with respect to the fibre laser's repetition rate, so that during the measurement the sampled signal accumulates coherently to produce large signal-to-noise ratios. In practice, this is achieved with three radiofrequency synthesizers sharing a common reference that, respectively, modulate the QCL at its cavity roundtrip frequency, stabilize the fibre laser's repetition rate and phase-lock the QCL carrier frequency to the nearest harmonic of the fibre laser's repetition rate (using fast servo electronics to control the QCL bias current).

The development and application of this technique in the work of Barbieri *et al.* allows for the unambiguous demonstration of QCL active mode-locking at terahertz wavelengths. The researchers observed decreasing temporal widths down to around 10 ps (resulting from the mutual phase-locking of an increasing number of longitudinal modes) as the radiofrequency modulation power was increased. Interestingly, comparing the spectra and waveforms of the measured signals also reveals that these pulses are transform limited; that is, their time–bandwidth products are as small as physically allowed. By comparison, in the case of interband diode lasers, mode-locked pulses typically exhibit significant frequency chirping, which increases their bandwidth for a fixed pulse width[5]. This phenomenon is a direct consequence of the coupling between gain modulation and refractive-index modulation that exists in interband lasers, which is ultimately related to the asymmetric shape of their gain spectra. Owing to their radically different light-emission mechanism, such coupling is generally absent in QCLs, a property that seems to directly manifest itself in these measurement results.

We expect that further insight into the fundamental dynamic properties of intersubband gain media will be enabled by future applications of the same technique on a variety of terahertz QCL structures. As already mentioned, early work in this area has been hindered by the lack of direct measurement techniques for the time-domain visualization of pulsed QCL waveforms. The new method of asynchronous coherent sampling demonstrated by Barbieri *et al.* provides just that, and therefore can be used to address fundamental questions such as the conditions under which QCLs can be stably mode-locked. For example, of particular interest is the relationship between non-radiative relaxation lifetimes, the cavity roundtrip time and stable pulse formation, which can now be directly investigated in terahertz devices based on different gain-medium designs. Finally, the development of compact, high-average-power sources of pulsed terahertz radiation based on actively mode-locked QCLs promises to have a strong technological impact in applications such as spectroscopy, sensing and imaging. ❐

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OPTICAL MANIPULATION

Tweezer app for iPad

Scientists in the UK have developed an application ('app') for Apple's iPad that allows the user to create and simultaneously control the three-dimensional positions of up to 11 independent optical traps by touch (*J. Opt.* **13,** 044002; 2011). The aptly named 'iTweezers' is the innovation of Richard Bowman and colleagues from the physics departments of the Universities of Glasgow and Bristol. Bowman told *Nature Photonics* that they soon hope to make the app available to download for free from the iTunes App Store. In the meantime, a copy can be requested directly from the authors (r.bowman@physics.gla.ac.uk). The app is designed to work with holographic optical tweezers that use a computer-controlled spatial light modulator to create and control multiple optical traps.

The app uses the iPad's screen to display the real-time video from the microscope of an optical tweezer and indicates the trap positions using circular markers. Manipulating the positions of the traps and their trapped particles is simple: a finger drag gesture moves a trapped particle in the *x*–*y* plane, whereas a pinch gesture outwards or inwards moves it up or down along the *z* axis. Traps can be created or removed by double-tapping the screen.

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"When we first got a iPad in the group, we were keen to see what could be done with it. We soon realized that it could be the perfect control platform for optical tweezers," explained Bowman. "The app will also work with the latest iPhone and iPod Touch."

The app works by using a WiFi connection to communicate the user's gestures to a desktop computer that uses LabVIEW software to control the trapping hardware.

A video showing the app in action can be seen on YouTube (www.youtube.com/watch?v=qgDMcP9e5G0), where it has already received over 15,000 views.

Bowman and colleagues have also developed an app called the iHologram, which allows the user to visualize the light fields used in optical trapping but does not offer any form of trap control.

The Glasgow–Bristol collaboration are now working on developing a more general toolkit app that will allow the iPad to control any scientific equipment that can receive commands through National Instrument's LabVIEW software.

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