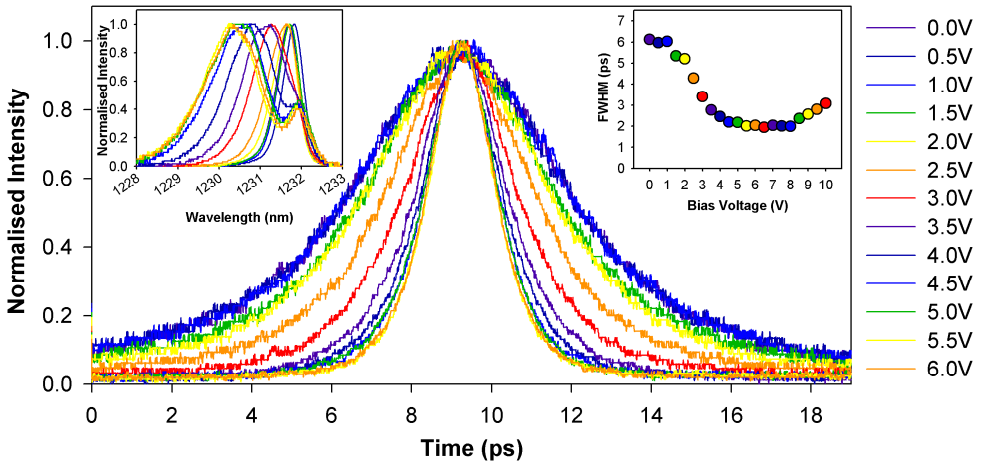

Fig. 6. Main plot: temporal profiles of picosecond pulses measured by intensity autocorrelation under reverse bias levels from 0 V to 6 V. Top left: spectra of pulses corresponding to those in the main plot. Top right: plot showing the evolution of the pulse duration with reverse bias levels up to 10 V.

As the intracavity dispersion was optimized for femtosecond-pulse operation at 1260nm it is proposed that at 1231 nm the soliton mode-locking model no longer applies and pulsing is instead controlled by a form of the fast saturable absorber mechanism. In this regime the pulse duration depends upon the modulation depth of the absorber [16], which is being tuned via the QCSE on application of a reverse bias, thereby explaining the observation of pulse- duration tuning. For the femtosecond pulses obtained in these assessments, it is proposed that the absorber is operating in the soliton regime where pulse formation is affected by a wider range of factors [17] that includes crucially the dispersion present within the system. The degree to which pulse durations can be controlled through electronic adjustment of the SESAM whilst operating in this regime is the subject of ongoing study but our work has shown clearly that the SESAM can be switched successfully between a picosecond operation in the fast saturable absorber regime and a femtosecond operation in the soliton regime.

4. Conclusion

We have demonstrated switching between continuous wave, picosecond and femtosecond operating regimes for a Cr^{4+}:forsterite laser, by exploiting the quantum-confined Stark effect in an electrically contacted GaInNAs SESAM. Additionally, we have demonstrated a continuous tunability of mode-locked pulses in the picosecond regime by a factor of 3.2. Further investigations will include testing the switching capabilities of QCSE SESAMs with alternative absorber designs that enhance the Stark effect and we will investigate more comprehensively the range of pulse durations that can be switched. Using these techniques we believe that it will be possible to develop lasers that exhibit rapid and reliable regime switching with a welcome reduction in their overall complexity.

Acknowledgments

The authors acknowledge the assistance of Dr David Massoubre for his help in wire-bonding the QCSE SESAM and funding from the Engineering and Physical Sciences Research Council (Grants: EP/E064450/1 and EP/E06440X/1.)