ing module (idQuantique ID100). The delay is scanned while recording the count rate. The resulting autocorrelation function (Fig. 5) shows the modelocked laser pulses have a sech^2 shape with a FWHM of 5.0 ps while the diode laser pulses have roughly gaussian shape with FWHM of 20.7 ps.

We then perform a cross-correlation measurement by sending the output of each laser on a different input mode of the PBS. Again, blue light is only generated if pulses from both lasers arrive at the same time. Jitter between the arrival times will show up as a broadening of the cross-correlation function, with total width equal to $\tau_{cc} = \sqrt{\tau_1^2 + \tau_2^2 + \tau_{sync}^2}$ where $\tau_{cc}, \tau_1, \tau_2$ and τ_{sync} are the pulse lengths FWHM for the cross-correlation function, first laser pulse shape, second laser pulse shape and the synchronization jitter distribution's FWHM respectively. We measure τ_{cc}=27.6 ps, for a resulting τ_{sync}=18 ps.

Electrical impulses are impractical over long distances, as jitter increases with losses in the cable. A more versatile method is to use a media converter to send an optical synchronization signal over large distances. We have built such a converter, shown in Fig. 6. The output signal from the InGaAs high-speed photodetector is first amplified by 7 dB before being converted to an ECL signal. Adding the amplifier alone does not add measurable jitter. This signal triggers a standard telecom laser (Bookham) which sends corresponding pulses through a fiber, which are then detected by another InGaAs high-

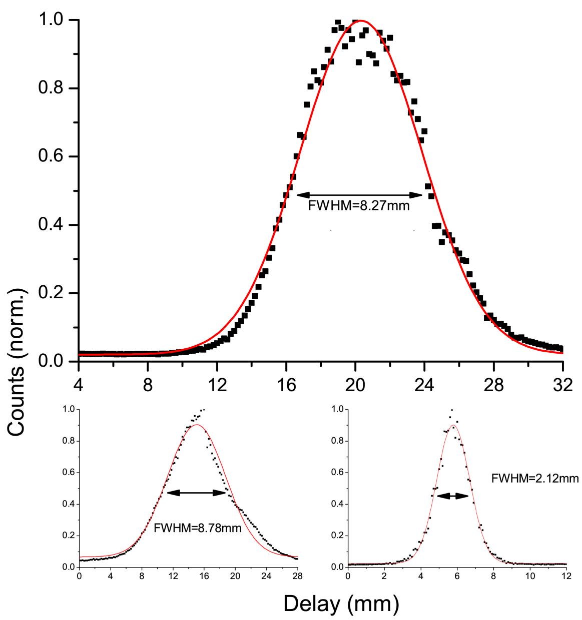

FIG. 5: Results of the cross- and auto-correlation measurements. *top*: Crosscorrelation with a gaussian fit FWHM=8.27 mm, or 27.6 ps. *bottom-left*: Autocorrelation of the diode laser based source, corresponds to a pulse length of 20.7 ps per pulse. *bottom-right*: Autocorrelation of the modelocked source, corresponds to a pulse length of 5.0 ps per pulse.

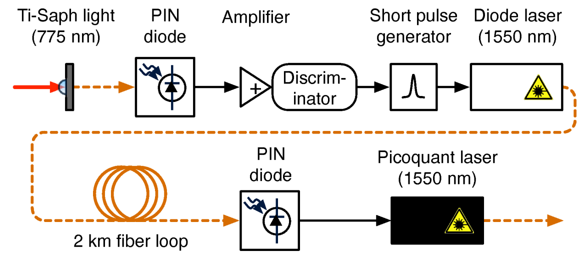

FIG. 6: Media Converter layout.

speed photodetector. The output from this diode is then used to trigger the diode laser. Cross-correlations measurements were performed with fiber lengths of 50 cm and 2.2 km (Fig. 7). The widths of the cross-correlation were 34.6 ps irrespective of the fiber length, for a jitter induced by the media converter of 21 ps and a total jitter for the full synchronization line of 27 ps.

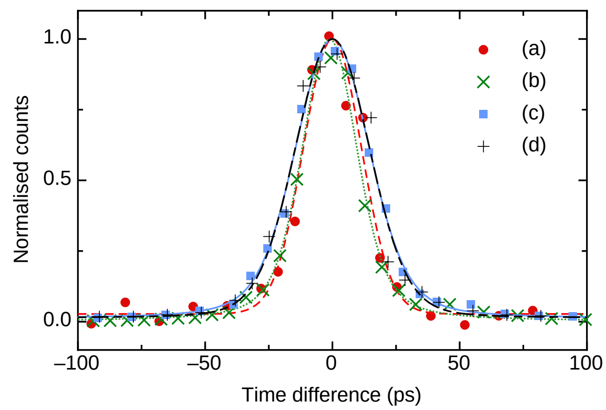

FIG. 7: Cross-correlation function using different synchronization systems. (a) Direct photodetector signal. (b) Amplified photodetector signal. (c) Media Converter with 50 cm fiber. (d) Media Converter with 2.2 km fiber.

With longer fibers, higher jitter can be caused by a lower signal-to-noise ratio on the InGaAs photodetector due to losses. Such additional jitter is shown in Fig. 8 as measured directly on a 6 GHz oscilloscope through the electric signal jitter using an optical variable attenuator. The exact values can depend strongly on both the pulse shape and the quality of the photodetector in the media converter.

In the field, the jitter will also be increased by path length fluctuations. Studies have shown that, over the course of a day, we can expect a fluctuation on the order of 10^{-5} for commercially installed underground fiber [21], i.e. cm-length fluctuations for every km of fiber. For example, if we want to see fluctuations of less than the pulse length of the diode laser, we could only tolerate 0.4 km. For larger distances, active fibre length stabi-