Dissemination of optical carrier, RF and 1 PPS signals over London-Birmingham optical fibre link

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NPL disseminates ultra stable and accurate frequency reference signals in both the optical and radio frequency (RF) domains as well as time synchronisation signals with picosecond level precision to the University of Birmingham over a newly established optical fibre link, supported by the UK National Quantum Technologies Programme. The link will be used extensively for the purposes of optical clock comparisons and the provision of reference signals for an ultra-high resolution radar array system. A simplified diagram for the signal distribution can be found in Fig. 1.

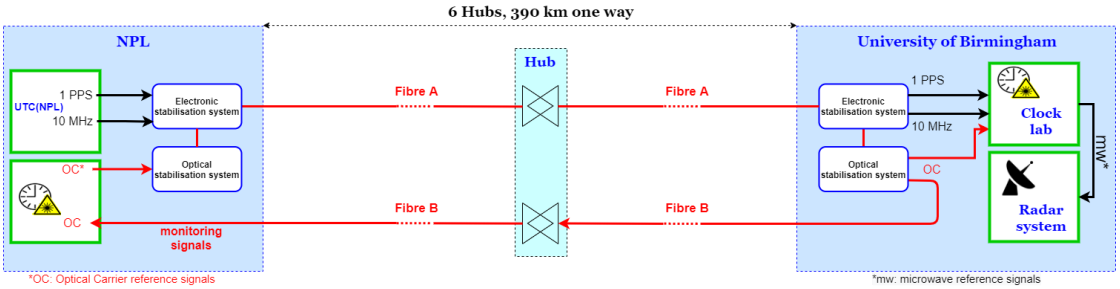

Fig. 1: A simplified diagram for 10 MHz RF, 1 PPS and optical carrier reference signal distribution from NPL to the University of Birmingham.

All metrological reference signals are disseminated to the users through a single dark fibre and amplification chain, based on the dense wavelength-division multiplexing (DWDM) technique (see Fig. 2). The multiplexer boxes along the link have been designed in such a way that they can be used in conjunction with other NPL optical signals, such as NPLTime® services and environmental monitoring. Additional channels have been reserved for the ongoing implementation of White Rabbit link, L band optical carrier dissemination and other experiments. To minimise the link noise, the gains of the bi-directional amplifiers along the link have been optimised[1], and wavelength selective isolators were installed to limit the backscattered signals.

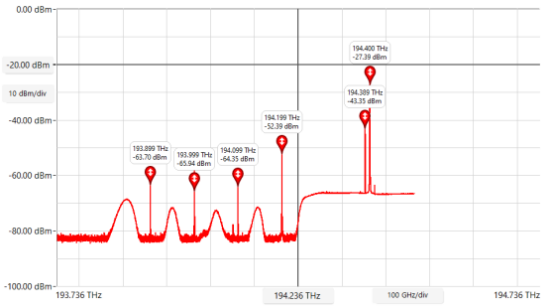

Fig. 2: An example of combining different metrological signals using different DWDM channels.

The link stability is monitored continuously at NPL through a round-trip link, for which the frequency stability for the optical carrier reference is below 10^{-19}@10^4 s and around 10^{-16}@10^4 s for the 10 MHz RF distribution. The link time stability for 1 PPS signal distribution stays below 3 ps after 10 s averaging.

[1] L. Sliwczynski, P. Krehlik, K. Salwik, "Modeling and Optimization of Bidirectional Fiber-Optic Links for Time and Frequency Transfer", IEEE Transactions on UFFC, vol. 66, No. 3, 2019.