Reply to the “Comment on: Testing the speed of ‘spooky action at a distance’ ”

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This is the reply to the comment arXiv:0810.4452 by Kofler, Ursin, Brukner, and Zeilinger.

Quantum correlations cannot be described by local common causes. This prediction of quantum theory, surprising as it might appear, has been widely confirmed by numerous experiments. In our Nature Letter [1] we considered this point as established and addressed another issue: the alternative assumption that quantum correlations are due to supra-luminal influences of a first event onto a second event. For this purpose we believe that it suffices to observe 2-photon interferences with a visibility high enough to potentially violate Bell’s inequality, as we reported (over 2 x 17.5 km). Simultaneously closing other loopholes, like the locality loophole as desired by Kofler and colleagues, would certainly be an interesting addition, as would be any Bell tests that simultaneously address several of the loopholes. Indeed, to rigorously exclude any common cause explanation of the observed quantum correlation one should, ideally, simultaneously close the locality and the detection loophole (and assume the existence of independent randomness and that quantum measurements are finished when detectors fire or at least when a mesoscopic mass has sufficiently moved as insured in our experiment, see our recent article [2]). This is a formidable task and any progress towards achieving it is most welcome. So far, however, all experiments have addressed at most one of these loopholes; ours is no exception.

Concerning the comment on the use of a Franson interferometer for testing quantum nonlocality, we stress that this is not a fundamental issue. In principle it suffices to replace the entrance beam splitters of each interferometer by a fast switch. In this way the non-interfering lateral peaks observed in the 2-photon interferogram would disappear. However, in practice such switches suffer due to losses of around 3 dB. Hence, with today’s technology it is much more convenient to replace the ideal switch by a passive coupler, as we did in our experiment in a way very similar to [3].

1. D. Salart et al., Nature 454, 861-864 (2008).
2. D. Salart et al., Phys. Rev. Lett. 100, 220404 (2008).
3. N. Gisin and H. Zbinden, Phys. Lett. A 264, 103 (1999).