Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Experimental loophole-free Bell inequality violation using electron spins separated by 1.3 km B HENSEN, H BERNIEN, A E DRÉAU, A REISERER, N KALB, M S BLOK, J RUITENBERG, R F L VERMEULEN, R N SCHOUTEN, QuTech Kavli Inst. of Nanoscience, Delft Univ. of Tech. The Netherlands, C ABELLÁN, W AMAYA, V PRUNERI, M W MITCHELL, ICFO-Institut de Ciencies Fotoniques, The Barcelona Inst. of Sc. and Tech., Spain, M MARKHAM, D J TWITCHEN, Element Six Innovation, Didcot, Oxfordshire, UK, D ELKOUS, S WEHNER, QuTech, Delft Univ. of Tech., The Netherlands, T H TAMINIAU, R HANSON, QuTech Kavli Inst. of Nanoscience, Delft Univ. of Tech. The Netherlands — 50 years ago[1], John Bell proved that no theory of nature that obeys locality and realism can reproduce all the predictions of quantum theory. Numerous Bell inequality tests have been reported, however, all experiments reported so far required additional assumptions to obtain a contradiction with local realism, resulting in loopholes. Here we will present[2] a Bell experiment that is free of any such additional assumption. We use an event-ready scheme that enables the generation of robust entanglement between distant electron spins. Efficient spin read-out avoids the fair-sampling assumption, while the use of fast random-basis selection and spin read-out combined with a spatial separation of 1.3 km ensure the required locality conditions. We performed 245 trials that tested the CHSH–Bell inequality $S \leq 2$ and found $S = 2.42 + -0.20$. A null-hypothesis test yields a probability of $P \leq 0.039$ that a local-realist model for space-like separated sites could produce data with a violation at least as large as we observe, even when allowing for memory in the devices. [1] J.S. Bell, Physics 1, 195-200, (1964) [2] Hensen et al. Nature 526, 682 (2015)

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Date submitted: 05 Nov 2015 Electronic form version 1.4