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Long-range mutual synchronization of spin Hall nano-oscillators.

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We present the first experimental demonstration of mutual synchronization of up to nine nano-constriction based spin Hall nano-oscillators (SHNOs) [1]. The mutual synchronization is observed both as a strong increase in the power and coherence of the electrically measured microwave signal. The mutual synchronization is also optically probed using scanning micro-focused Brillouin light scattering microscopy (μ -BLS), providing the first direct imaging of synchronized nano-magnetic oscillators. Through tailoring of the region connecting two SHNOs, we are able to extend the synchronization range to 4 μ m. Given the design flexibility of nano-constriction SHNOs [2], and the very long synchronization range, we argue that our results open up many research and application opportunities where coherent phase locking is believed to be advantageous, e.g. for energy efficient spin wave computing on the nanoscale. [1] A. A. Awad, P. Dürrenfeld, A. Houshang, M. Dvornik, E. Iacocca, R. K. Dumas, and J. Åkerman, Nature Physics, 10.1038/nphys3927 (2016). [2] V. E. Demidov, S. Urazhdin, A. Zholud, A. V. Sadovnikov, and S. O. Demokritov, Appl. Phys. Lett. 105, 172410 (2014)