SUPPLEMENTARY INFORMATION

On-chip phonon-magnon reservoir for neuromorphic computing

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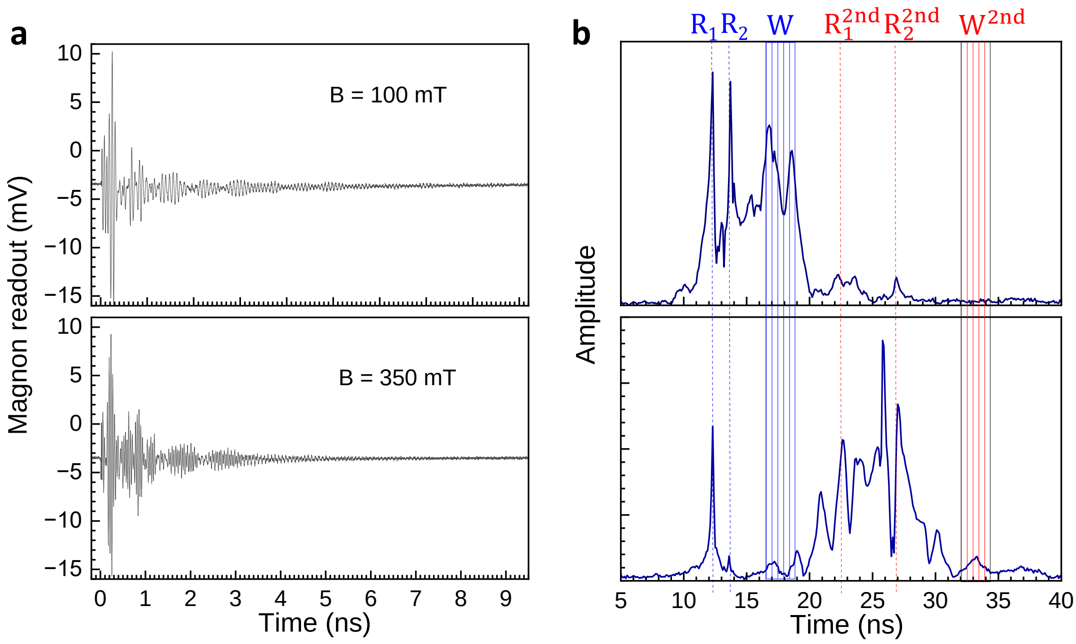
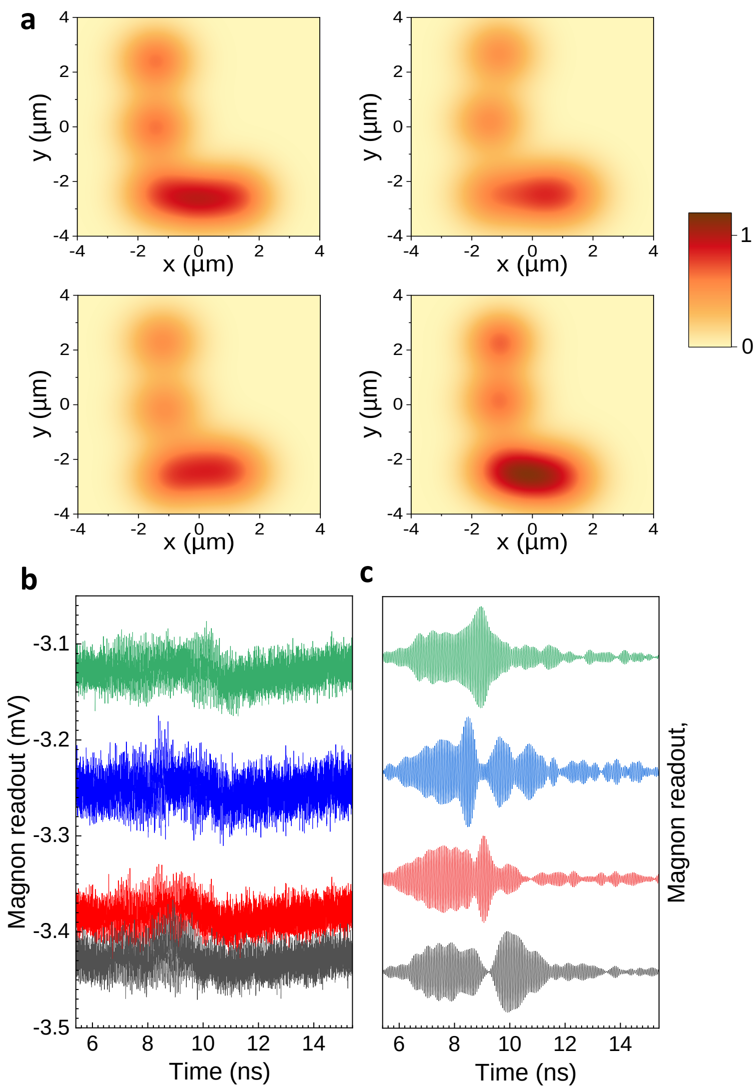


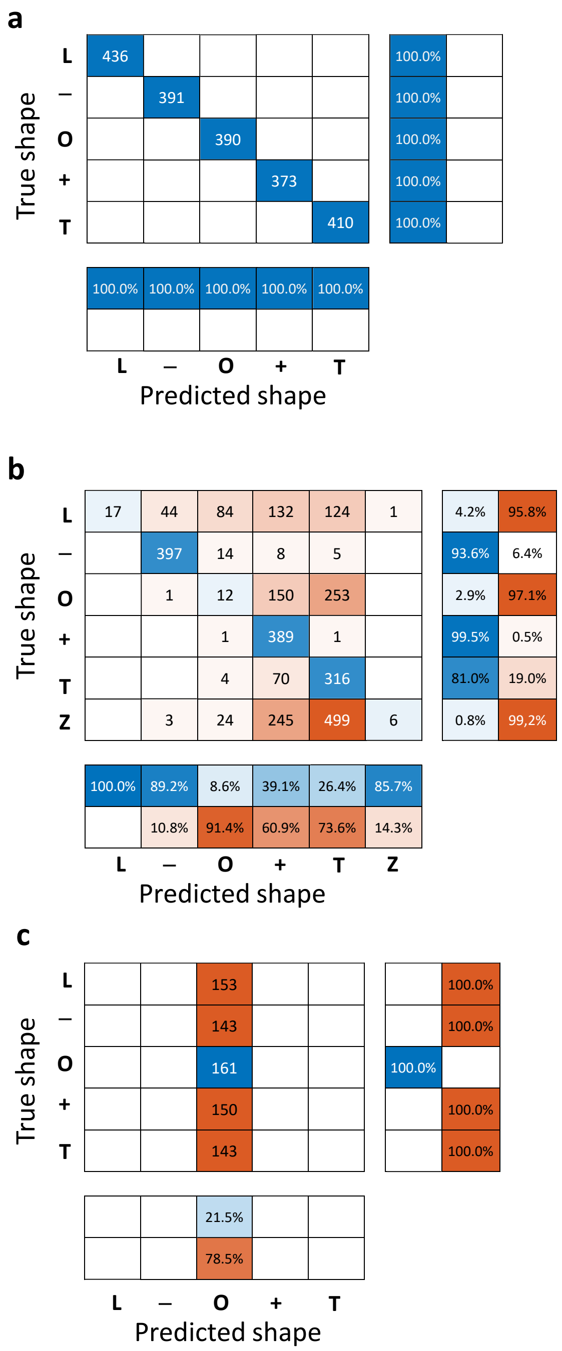
Supplementary Figure 1. **Optically generated phonon and magnon modes**

Magnon readout signals measured at the spatial overlap of the input and readout laser spots at two strengths of the external magnetic field (**a**) and their fast Fourier transforms (FFT) (**b**). The signals are shown as measured without filtering. The initially generated magnon-phonon wavepacket consists of the first and second order surface phonon modes, R1 (Rayleigh wave) and R2 (Sezawa wave), and the guided modes (W-band) [1], which calculated frequencies are indicated by the blue (first order) and red (second order) dashed lines and patterned rectangular, respectively. The input laser pulse also generates a broad wavepacket of magnon modes [2,3], which form a broad peak in the FFT spectrum. At the 20-µm working distance between the input and readout spots only the contribution of the first-order W-modes remain resolved in the readout signal. However, other modes, which are hidden in the readout noise support the recognition of the visual shapes.



Supplementary Figure 2. **Random visual shapes and readout signals**

a Numerically simulated spatial distribution of the input laser intensity for the symbol ‘L’ obtained by positioning the input laser spots with a randomized error in the range of ±100 nm. **b** Four random readout signals for the symbol ‘L’: **b** - as measured; **c** - filtered by a 15-20 GHz bandpass filter.



Supplementary Figure 3. **Confusion matrices for the filtered signals.**

a. Confusion matrix for unfiltered signals when the symbol 'Z' is excluded from consideration. In this case the ANN demonstrates recognition with 100% accuracy. **b.** Confusion matrix for the signals passed through the band stop (15-20 GHz) filter. In this case the ANN mistakes in 59% cases. Some recognition is still possible due to contribution of the surface (R1 and R2) and low-frequency bulk phonon modes. **c.** Confusion matrix for the signals passed through the band stop (0- 20 GHz) filter, which makes the recognition impossible. The absence of any values for the symbols in the confusion matrix implies divergence in data processing by ANN

References

[1] Yaremkevich, D. D. Et al., Protected Long-Distance Guiding of Hypersound Underneath a Nanocorrugated Surface. *ACS Nano* **15** 4802-4810 (2021).

[2] Salasysuk A. S. et al., Generation of a localized microwave magnetic field by coherent phonons in a ferromagnetic nanograting, *Phys. Rev. B* **97**, 060404(R) (2018).

[3] Scherbakov A. V. et al., Optical excitation of single- and multi-mode magnetization precession in Galfenol nanolayers", *Phys. Rev. Appl*. **11**, 031003 (2019).