Spin wave nonlinearity in thin-film YIG magnonic waveguides

R. Leenders,[a] K. G. Fripp,[a] A. V. Shytov,[a] H. Tan,[b] A. Lutsenko,[b] S. van Dijken,[b] C. Dubs,[c] F. Heyroth,[d] G. Schmidt,[d] and V. V. Kruglyak[a]

a: University of Exeter, United Kingdom;

b: Aalto University, Finland;

c: INNOVENT e.V. Technologieentwicklung, Jena, Germany;

d: Martin-Luther-Universität Halle-Wittenberg, Halle, Germany.

We will present results of a detailed characterisation of magnonic waveguide structures for application in magnonic reservoir computing. The structures are formed by adding input and output antennas (microstrip or coplanar waveguide) on top of 177 nm thick YIG films epitaxially grown GGG substrates with (001) orientation. All-electrical spin wave spectroscopy measurements revealed that the coplanar waveguide antennas had a lower insertion loss, while microstrip antennas had a greater excitation bandwidth. A strong nonlinearity was observed at moderate excitation levels in cw regime, with the nonlinearity thresholds increasing consistently in the pulsed regime (Fig. 1). The results of the characterisation provide a solid reference for the next step in the project – using the magnonic waveguides within a magnonic active ring reservoir computing scheme.

The research leading to these results has received funding from the UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Grant No. 10039217) and from the Horizon Europe (HORIZON-CL4-2021-DIGITAL-EMERGING-01) under Grant Agreement No. 101070347. Yet, views and opinions expressed are those of the authors only and do not necessarily reflect those of the EU, and the EU cannot be held responsible for them.

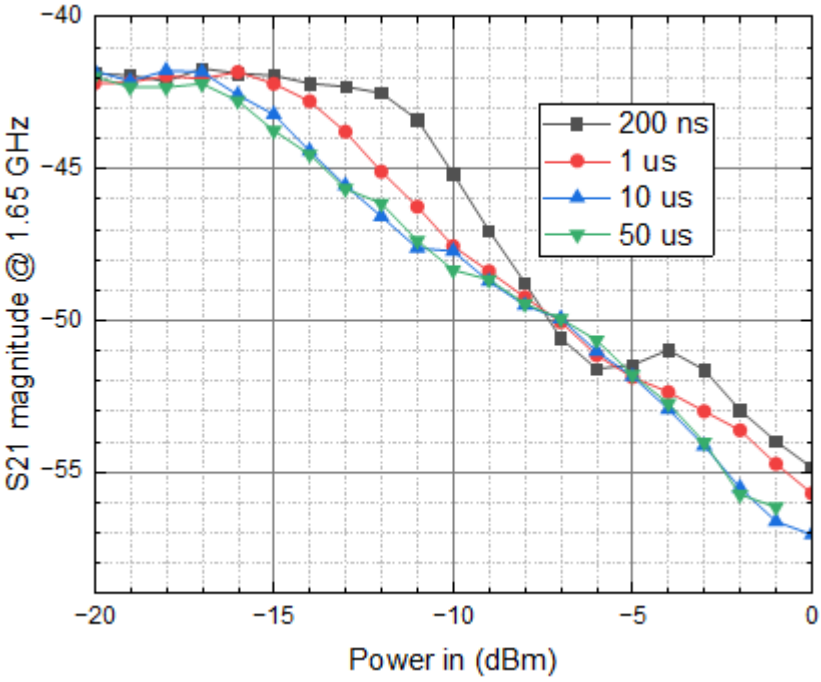

Fig. 1. The power dependence of the S21 parameter of a YIG magnonic waveguide with microstrip input and output antennas is shown for different durations of microwave pulses (bursts). The measurements are done in the Damon-Eshbach geometry with the bias field of 3 mT. The career frequency is 1.65 GHz.