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HYMN –A novel unified toolbox for in-situ magnetic hyperthermia experiments using neutron scattering

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One of the most promising use cases of magnetic hyperthermia, is the use of magnetic nanoparticles (MNPs) for cancer therapy. In this treatment, MNPs are immersed into tumours and by heating with external magnetic fields, typically 100-900 kHz, destroy cancer cells. Since it is a clinical application the optimization of field parameters and in turn, the heating power, is crucial to maintain both safety and high efficiency. Safety dictates an upper limit of applied magnetic field exists. Hence, for successful application, the heating power needs to be improved by the optimization of MNPs structure. What is more, recent studies have shown a huge increase in magnetic heating by the excitation of transversal spin modes in MNPs, in low GHz range. An ideal tool for the characterization of such MNPs is small angle neutron scattering (SANS), with the extended functionality provided by the MIEZE technique. The aim of our ERUM-Pro HYMN project is to develop a novel, unified experimental and computational toolbox for in-situ magnetic hyperthermia experiments under clinical conditions, utilising the SANS and MIEZE-SANS technique, combined with nanomagnetic simulations. This will be achieved by the development of two custom-made setups for operation in the 100-450 kHz (up to 30 mT) as well as 0.5-4 GHz (up to 2 mT) range. We present first SANS results, where we used in-situ RF heating at 450 kHz to examine the dynamic structure formation of magnetite nanocubes with 12, 34 and 53 nm size.

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