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Upgrade concept for TOFTOF in the 21st Century

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As a cold time-of-flight spectrometer TOFTOF's impacts are felt across scientific areas including: biophysics, materials science; fundamental hard and soft condensed matter physics, chemistry and biology. Here we will discuss our idea for an upgraded TOFTOF. The upgrade addresses both the competitiveness of the instrument around existing scientific areas and aspires to address new questions/areas stemming from all the grand challenges for the MLZ and its user community. Specifically we seek to enhance the sample area, angular resolution and number of neutrons analysed by increasing the flux at the sample, decreasing background signal and increasing solid angle and angular resolution. Particular areas of scientific focus may be:

• The perspective on hydrogen dynamics, and the accompanying molecular dynamics, from TOFTOF on biological or soft matter material such as proteins, peptides, lipids and polymers is important for, e.g. gels, new drug release systems, polymer blends, liquids in confinement or organic solar cells. In health and the life-sciences dynamics are proving an important step forward from the structural view enabled by crystallography in understanding function.

• Neutron spectroscopy provides insight around molecular mobility in energy storage. Such as novel anode or cathode materials, electrolytes and the study of ion mobility in batteries under in-operando conditions may provide for improved electrochemical storage. Studies of hydrogen mobility and binding characteristics in solid-state hydrogen storage material characterise both chemisorption and physisorption. The perspective may enable efficient, sustainable and cheap catalysts in fuel.

• For materials science, the possibility to probe low-lying excitations (e.g. the phonon density of states) and measurements of diffusion coefficients will help to improve the understanding and development of novel materials.

• The study of quantum spin liquid and quantum spin ice phenomena in low dimensional and/or frustrated materials reveals rich physics and new concepts emerging from the quantum behaviour of many interacting particles.

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