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Testing Frozen-Spin Hydrogen-Deuteride Targets with Electron Beam

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The relaxation times of protons and deuterons in a frozen-spin hydrogen-deuteride (***HD***) target are more than 1 year under the normal experimental conditions (***T*** ~ 0.1 K and ***B*** ~ 1 T). These targets have been used successfully for photoproduction experiments both at **CLAS** in Jefferson Lab (**JLab**) and at **LEGS** in Brookhaven Lab. In order to explore its performance under electron beams, a series of polarization measurements with 9.7 MeV and sub-nanoAmp electron beam currents were conducted at the newly commissioned *Upgraded Injector Test Facility* (**UITF**) at **JLab**. Since the deposited energy on a target is almost independent of beam energy, the **UITF** beam can be used to simulate the GeV level performance. During the ***eHD*** tests, the 2 frozen-spin targets, with initial proton-polarizations of 40% and 34%, were used in an in-beam dilution refrigerator which held the ***HD*** target at ~0.1 K and ~ 1 T, and proton polarizations were tracked with a field swept **NMR** polarimeter while exposed to beams under varying conditions of current, dose, beam duty factor and temperature. At a fixed accumulated dose, the spin-relaxation rates drop with current, suggesting depolarization by the charge cloud of the beam. After an accumulated dose of ~2 μC/cm2, beam-off spin-relaxation rates drop from their super long initial values to the order of weeks (with beam-on **T1** values typically an order of magnitude shorter), reflecting a buildup of paramagnetic charge centers within the ***HD*** lattice. The accumulated polarization loss was approximately proportional to dose in both targets, dropping to *1/e* of their initial values after ~6 μC/cm2. Thermal equilibrium polarizations of targets not in the frozen-spin state (with intentionally short **T1**) have been used to deduce the ***in situ*** temperature of solid ***HD*** while under electron bombardment. A model for depolarization by beam-associated paramagnetic impurities largely accounts for the data, and suggests that improvements in heat removal could lead to significant increases in the in-beam **T1**.

Category

Polarized Targets

Primary authors: Dr WEI, Xiangdong (Jefferson Lab); Mr DEZERN, Gary (Jefferson Lab); Dr HANRETTY, Charles (Jefferson Lab); Dr SANDORFI, Andrew (Jefferson Lab); Dr KAGEYA, Tsuneo (Jefferson Lab); Dr LOWRY, Michael (Jefferson Lab); Dr O'CONNELL, Thomas (University of Connecticut); Dr WEI, Kevin (University of Connecticut); Dr BRUKER, Max (Jefferson Lab); Prof. JOO, Kyungseon (University of Connecticut); Dr GRAMES, Joe (Jefferson Lab); Dr MCCAUGHAN, Mike (Jefferson Lab); Dr POELKER, Matthew (Jefferson Lab); Dr SULEIMAN, Riad (Jefferson Lab); Dr WANG, Yan (Jefferson Lab); Prof. A. D'ANGELO, Annalisa (INFN-Roma Tor Vegata); Dr BARION, Luca (INFN, Ferrara, Italy); Dr CONTALBRIGO, Marco (INFN, Ferrara, Italy); Dr MALAGUTI, Roberto (INFN, Ferrara, Italy)

Presenter: Dr WEI, Xiangdong (Jefferson Lab)

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