We report on the successful demonstration of selective acceleration of deuterium ions by target-normal sheath acceleration (TNSA) using the Vulcan PW laser at Rutherford Appleton Laboratory. TNSA ion beams are typically dominated by \( \text{H}^+ \), \( \text{C}^+ \), and \( \text{O}^+ \) ions due to hydrocarbon surface contaminants. Deuterium ions are accelerated by covering these contaminants with a microns thick layer of heavy water vapor, frozen onto a cryogenic target. The signal from a shot (200 J, 700 fs, > 10^{20} \text{ W/cm}^2, 1053\text{nm}) that produced an ion beam with >0.99 deuterium-ion-to-proton ratio and peak energy 14 MeV/nucleon is shown below. The bright yellow parabolic line, labeled \( \text{D}^+ \), is the deuterium signal; below it is the faint proton signal, labeled \( \text{H}^+ \). Within the range of our detectors (0-8.5°) we find laser-to-deuterium-ion conversion efficiency of 4.3% above 0.7 MeV/nucleon while a conservative estimate of the total beam gives a conversion efficiency of 9.4%.