Supporting Information for:

Single-ion induced surface modifications on hydrogen-covered Si(001) surfaces – significant difference between slow highly charged and swift heavy ions

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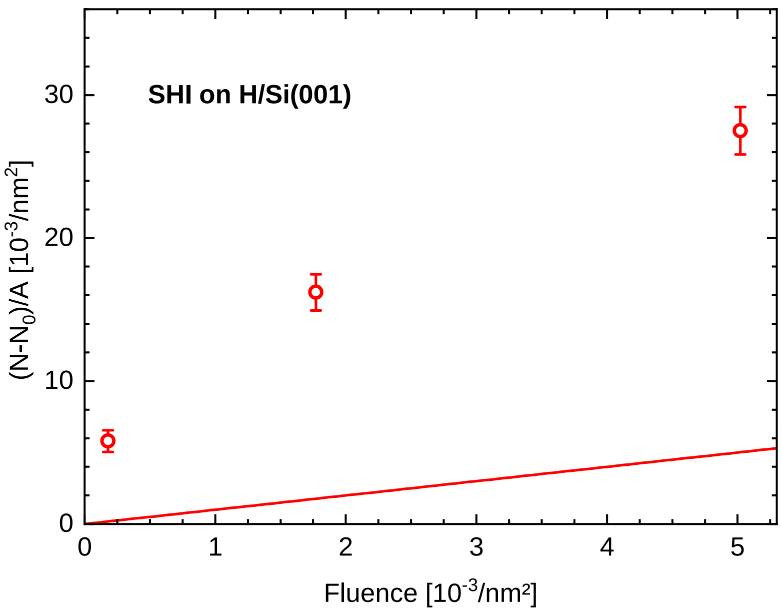

Figure S1: Number of bright features N per area A measured after SHI irradiation. The values have been corrected for the number of bright features, N_0, observed prior to irradiation on each of the samples separately. Experimental data for three different values of applied fluence (open symbols) are compared to a linear dependence of the features on the fluence when we assume an efficiency of 1 feature per ion (red line).

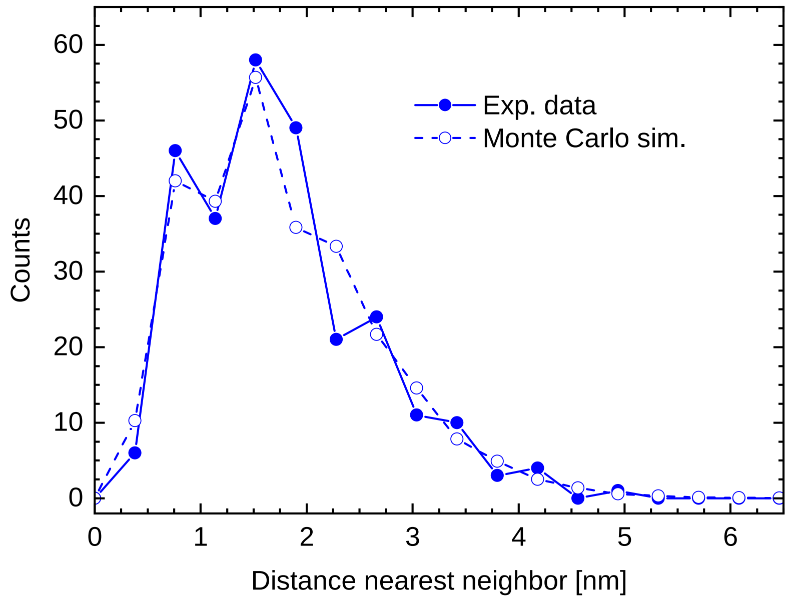

Figure S2: Distribution of next neighbor distances of single bright features on H/Si(001) as observed experimentally for the highest fluence applied ($5 \cdot 10^{11}\,\mathrm{cm}^{-2}$, filled blue data points). In comparison, the results of a Monte Carlo simulation on an area of $3000\,\mathrm{nm}^2$ is shown (open dots). Both sets of data agree well with each other; the observed peaks are associated with the discrete distances of the features on the H/Si(001) surface.

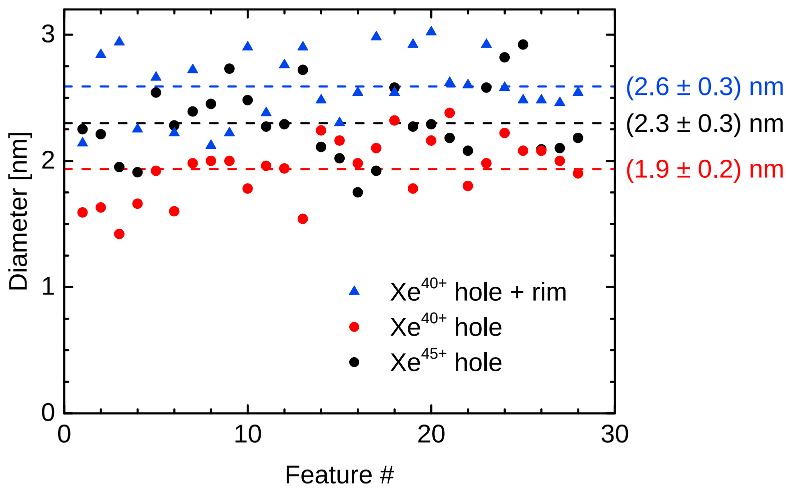

Figure S3: Measured diameters of detected features after impact of highly charged xenon ions (Xe^{45+}; Xe^{40+}). Holes produced by Xe^{45+} ions are well-defined and show a diameter of about 2.3 ± 0.3 nm (black circles). With 1.9 ± 0.2 nm, holes produced by the impact of Xe^{40+} ions are smaller (red circles). In the latter case, disordered material was resolved on the rim of the holes. Feature diameters for Xe^{40+} impacts including the rim are shown by blue triangles.

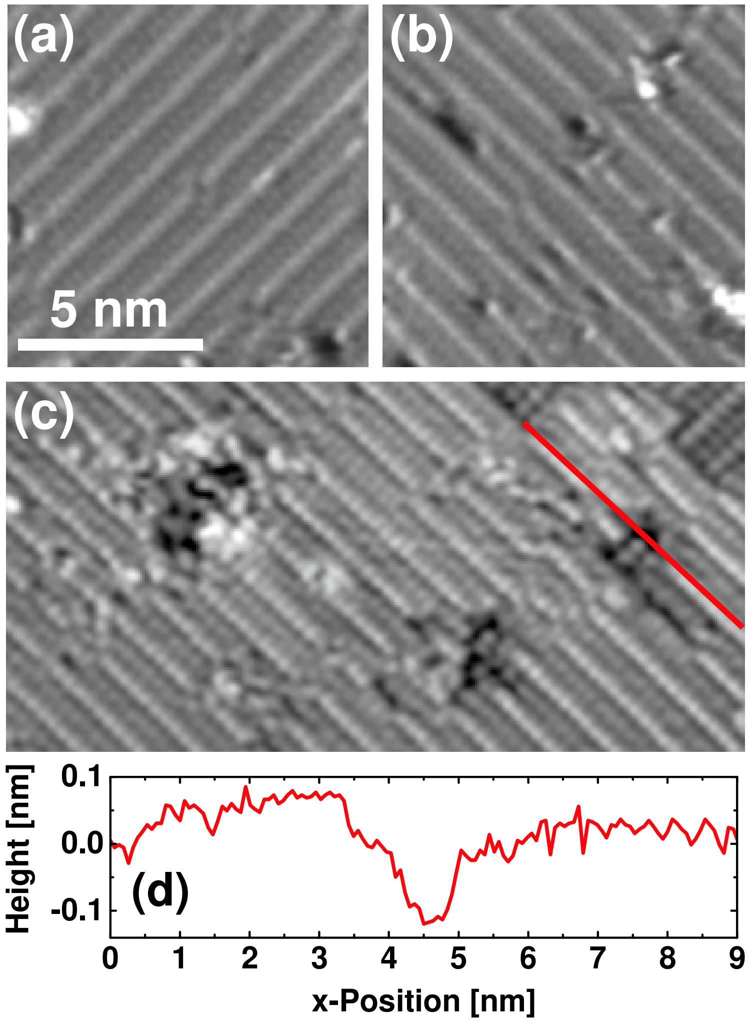

Figure S4: Filled state STM images ($U_t = -2$ V; $I_t = 0.5$ nA) of a 3×1 hydrogen-terminated Si(001) surface before and after irradiation with $^{129}Xe^{40+}$ ions ($E_{pot} = 38.5$ keV; $E_{kin} = 225$ keV). **(a)** Before irradiation, the H/Si(001) surface shows few small dark and bright features. **(b)** After irradiation, a slight increase of small dark and bright features is observed in areas outside of the ion beam spot. **(c)** In the area irradiated with Xe^{40+} ions, features extending over several dimer rows are observed. The red line indicates a line scan through the impact area; the corresponding height profile is shown in **(d)**. The feature in the upper left corner of **(c)** is attributed to two single ion impacts close to each other.

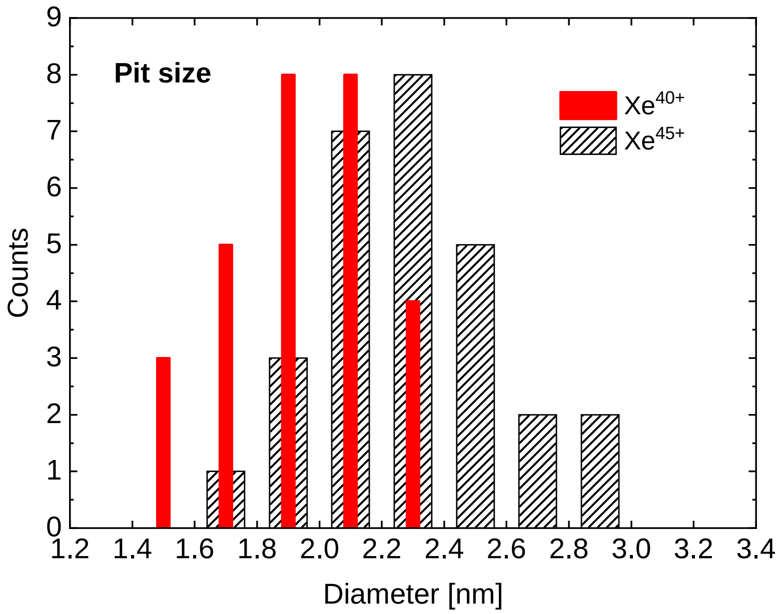

Figure S5: Distributions of pit diameters as measured after ion impact of Xe^{40+} (red) and Xe^{45+} ions (dashed in black). The distribution measured after impact of Xe^{45+} ions is clearly shifted to larger diameters.

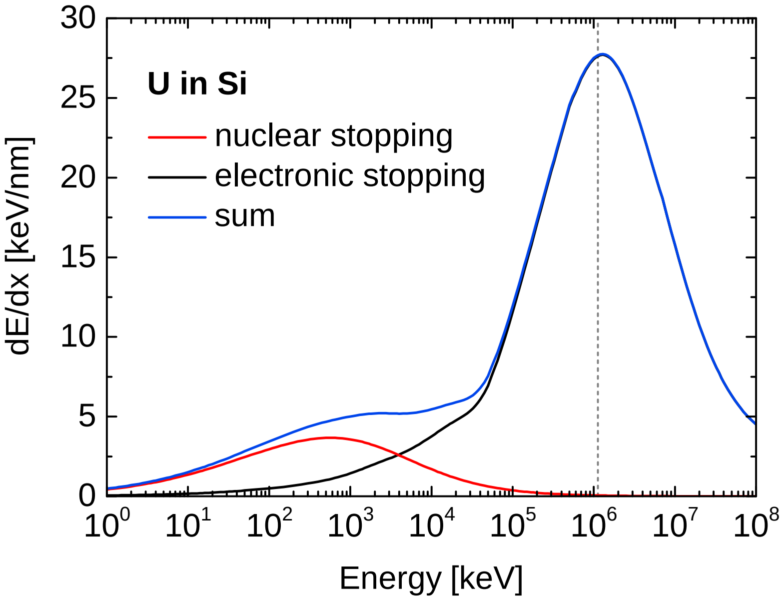

Figure S6: Stopping power dE/dx of ^{238}U in silicon. Representation of nuclear stopping power (red), electronic stopping power (black), and total stopping power (blue) as a function of the kinetic energy of the projectile (SRIM)[1]. The SRIM calculations take into account an equilibrium state of charge whereas the state of charge of the SHI employed in our experiment at UNILAC is lower than the equilibrium state of charge. The kinetic energy of the latter ones is indicated by the grey dotted line.

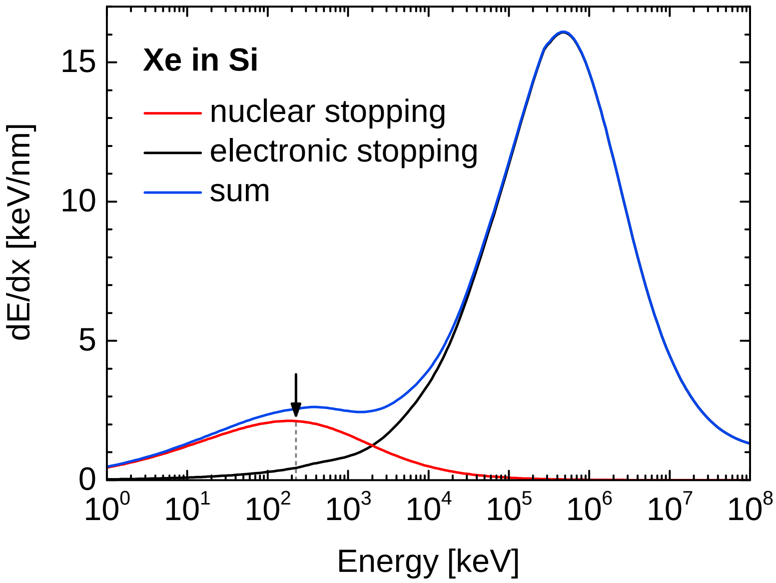

Figure S7: Stopping power dE/dx of ^{129}Xe in silicon. Representation of the nuclear stopping power (red), electronic stopping power (black), and total stopping power (blue) as a function of the kinetic energy of the projectile (SRIM)[1]. The SRIM calculations take into account an equilibrium state of charge whereas the state of charge of the HCI employed in our experiment is higher than the equilibrium state of charge. The kinetic energy of the latter ones is indicated by the arrow and the grey dotted line.

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[1] J. F. Ziegler, *Homepage SRIM-Code*, `http://www.srim.org/` (2006), [Online accessed 31-January-2018].