Supplementary Information

Because of the chemical similarities of group 2 and group 3 elements, additional extraction experiments were conducted for the separation of Sc-46 from $Ca(NO_3)_2$ and Y-90 from $Sr(NO_3)_2$ solutions. The radionuclides Ca-45, Sc-46, Sr-85, and Y-90 were produced by neutron irradiation of [^{44}Ca]CaO (Neonest AB, Sweden), Sc_2O_3 (ACROS ORGANICS; VWR, Amsterdam, the Netherlands), SrO, and Y_2O_3, respectively, at the Hoger Onderwijs Reactor (HOR) of the TU Delft | Reactor Institute (the Netherlands). [^{44}Ca]CaO and SrO were irradiated with a thermal neutron flux of $4.24 \cdot 10^{17}$ $s^{-1}m^{-2}$ for 10 days and 1 day, respectively. Sc_2O_3 was irradiated with a thermal neutron flux of $4.69 \cdot 10^{16}$ $s^{-1}m^{-2}$ for 5 hours, and Y_2O_3 was irradiated with a thermal neutron flux of $4.69 \cdot 10^{16}$ $s^{-1}m^{-2}$ for 3 hours. The irradiated [^{44}Ca]CaO and Sr were subsequently dissolved in dilute HNO_3, dried down, and redissolved in ultrapure water. Ca-45 and Y-90 were measured with a Liquid Scintillation Counter (tri-carb 2750TR/LL, Packard). Sc-46 and Sr-85 were measured directly with the Wallac Wizard2 3” 2480 Automatic Gamma Counter (Perkin Elmer).

The aqueous solutions used in the solvent extraction experiments were prepared by dissolution of different amounts of $Ca(NO_3)_2$ and $Sr(NO_3)_2$ (Merck Sigma, Zwijndrecht, the Netherlands) in ultrapure water and subsequent addition of above mentioned radiotracers. Both batch and microfluidic extraction were performed as described in the main manuscript. The results off all batch and microfluidic extration experiments are shown in Fig. S1. The batch extraction of Sc-46 from 1 M $Ca(NO_3)_2$ resulted in a very good separation, with over 99 % extraction of Sc-46 and below 1 % of Ca-45 co-extraction. However, results differed tremendously for the 1 mM and 1 µM $Ca(NO_3)_2$ solution. Here, the Ca co-extraction increased up to 80 %, while the Sc-46 extraction decreased to 70 %. Back-extraction of Sc-46 was unsuccessful into every tested HCl solution, and therefore no microfluidic back-extraction of Sc-46 was done. The extraction of Y-90 from $Sr(NO_3)_2$ yielded successful efficiencies of over 95 % for all three $Sr(NO_3)_2$ solutions while the Sr-89 co-extraction remained below 2 %. Back-extraction of Y-90 could be achieved with efficiencies over 99 % into HCl concentrations over 0.1 M HCl. Microfluidic extraction of 10 µM [^{46}Sc]Sc was achieved with maximum efficiencies as shown during batch extraction in 1.8 seconds of contact time. Microfluidic extraction of 100 µM [^{90}Y]Y resulted in efficiencies of 99 % in approximately 1 second of contact time from 1 µM $Sr(NO_3)_2$ and in around 0.3 seconds from 1 M $Sr(NO_3)_2$. Microfluidic back-extraction of Y-90 however was slower and resulted in around 90 % back-extraction efficiency into 4 M HCl within 1.2 seconds and only 60 % into 1 M HCl within 1.8 seconds of contact time.

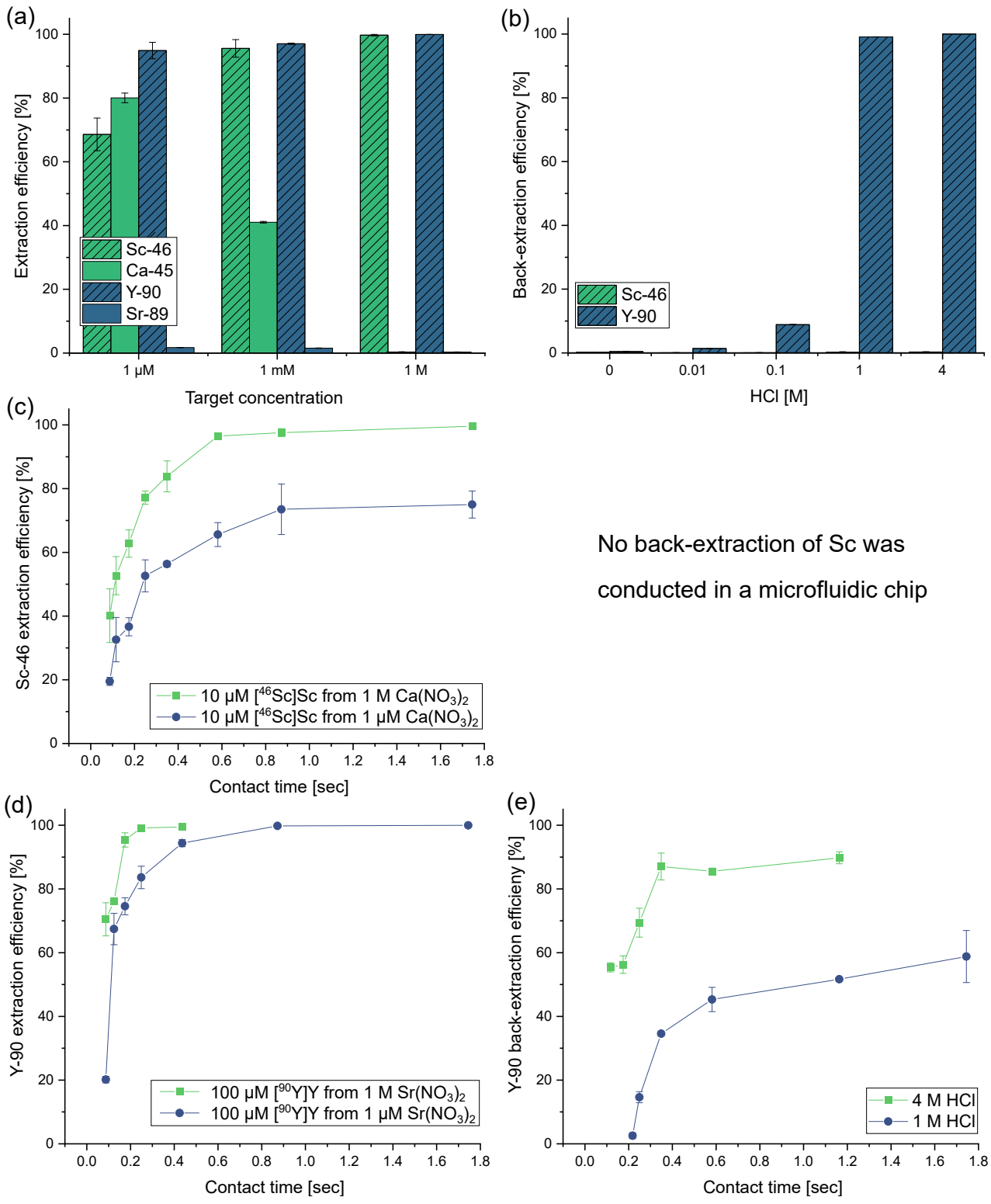

Figure S1. (a) Batch extraction of Ca-45, Sc-46, Sr-89, and Y-90 for varying target concentrations. (b) Batch back-extraction of Sc-46 and Y-90 for varying HCl concentrations. (c) Microfluidic extraction of Sc-46 from two different $Ca(NO_3)_2$ in MQ solutions for varying contact times. (d) Microfluidic extraction of Y-90 from two different $Sr(NO_3)_2$ in MQ solutions for varying contact times. (e) Microfluidic back-extraction of Y-90 into different HCl solutions for varying contact times. All experiments were done in triplicate and error bars represent the standard deviation of the mean.