Elution of $^{68}Ge/^{68}Ga$ radionuclide generators in "reverse" mode

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Introduction: The $^{68}Ge/^{68}Ga$ radionuclide generator provides an excellent source of positron emitting ^{68}Ga for the routine synthesis and application of ^{68}Ga-labeled compounds using PET. The eluates show a breakthrough of ^{68}Ge of 10^{-3} to 10^{-2}%, increasing with time or usage frequency, and impurities such as stable Zn^{II} generated by the decay of ^{68}Ga, Ti^{IV} a constituent of the ^{68}Ge adsorption column material and Fe^{III} as a general impurity.
Recently the "reverse" mode of elution for the $^{44}Ti/^{44}Sc$ radionuclide generator was investigated [1]. Here we report the evaluation and comparative study of two different modes of elution for the $^{68}Ge/^{68}Ga$ generator.

Experimental: A commercial generator based on a TiO_2 phase adsorbing $^{68}Ge^{IV}$ was obtained from Cyclotron Co. Ltd. In the present study, a 300 MBq-device was used. The generator was washed with 10 ml 0.1 M HCl solution during one week in one direction ("direct elution"). In the following week, the generator was washed with 10 ml 0.1 M HCl solution the same way (direct elution before "reverse"). However, immediately after this primary elution of ^{68}Ga, the generator was washed with 10 ml of 0.1 N HCl in the opposite direction ("reverse elution").. Elution of the generator was carried out three times a day. Samples were collected in 15 ml plastic vials and measured for their ^{68}Ga and ^{68}Ge content. The absolute radioactivity of ^{68}Ga samples was accomplished in a dose calibrator M2316 (Messelektronik Dresden GmbH). The absolute radio-activity of ^{68}Ge samples was measured by γ-spectro-metry using a high-purity germanium (HPGe) detector three days after elution.

Results and Discussion: Figure 1 illustrates the yield of ^{68}Ga obtained from an increasing number of elutions of both elution modes. Figure 2 illustrates the breakthrough of ^{68}Ge observed in an increasing number of elutions of both elution modes.
The general yield of ^{68}Ga did not notably change from day to day and neither within the two weeks (Fig. 1). Expectedly, in the reverse elution the ^{68}Ga yield was always low, representing about 10% of the initially eluted ^{68}Ga.
Over a period of one week and 15 elution processes, the yield of ^{68}Ga in the direct elution and in the direct elution of the reverse mode did not significantly differ from each other.
The reverse elution washes ^{68}Ge, which is localized on the generator column close to its breakthrough, back to a higher and "safer" position on the TiO_2-matrix. This should reduce the breakthrough for the next elution. Over the 15 reverse elution processes, the ^{68}Ge-break-through in a direct elution (24 ± 4 %) following a reverse elution (16 ± 3 %) was thus reduced by 33 %.
On the other hand, there was an about ten times higher "breakthrough" of ^{68}Ge in the reverse elution, which indicates for a strong wash-off of the ^{68}Ge-loading at the top of the generator column. However, the use of the "reverse" fraction from previous elution for the next direct elution should recover most of this ^{68}Ge-loss as it has been shown for the $^{44}Ti/^{44}Sc$ generator by the work of Filosofov et al. [1]. Alternatively, a sufficient amount of adsorbent could be installed on top of the original generator column.

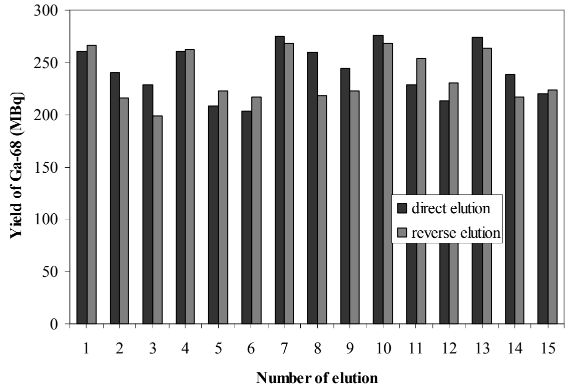

Fig.1. Yield of ^{68}Ga in the various elution modi.

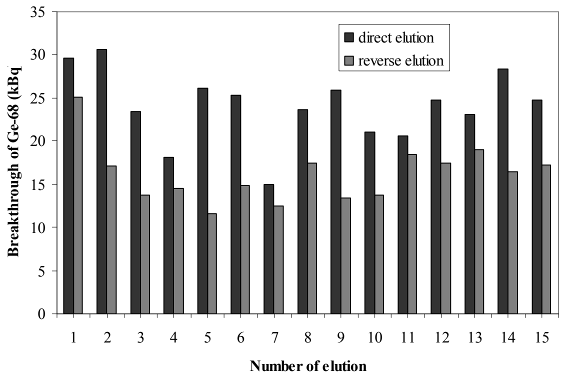

Fig. 2. Breakthrough of ^{68}Ge in "direct" and "reverse" elution mode.

Conclusions: In this study of 15 comparative elution processes, a benefit of reduced breakthrough in the "reverse" elution mode for the $^{68}Ge/^{68}Ga$ generator of 33 % could be observed.
An extended study over a longer period of time including more elution processes and a reuse of the reverse elution fraction should show a beneficial effect of the reverse mode of elution also for the $^{68}Ge/^{68}Ga$ generator.
In case of the $^{44}Ti/^{44}Sc$ generator an increased yield and an improved life-time of the generator has been shown over more than 50 elution processes. Furthermore, a reuse of the reverse elution fraction was applied.

References:

[1] D. V. Filosofov, N.S. Loktionova, F. Rösch, A $^{44}Ti/^{44}Sc$ radio-nuclide generator for potential application of ^{44}Sc-based PET-radio-pharmaceuticals; Radiochimica Acta 98, 149-156 (2010)