Recent superheavy element discoveries have benefitted from $^{48}\text{Ca}$ projectiles bombarding actinide targets. The possibilities for making new elements ($Z > 118$) in $^{48}\text{Ca}$ reactions have been exhausted and projectiles with higher $Z$ such as $^{45}\text{Sc}$, $^{50}\text{Ti}$, etc. must be used instead.

Cross sections have been measured for the $4n$ exit channel of the $^{45}\text{Sc} + \text{158, 160 Gd}$ reactions. These complement previous bombardments of the lanthanide targets $^{159}\text{Tb}$ and $^{162}\text{Dy}$ with $^{45}\text{Sc}$ projectiles [1]. These systems allow for the study of projectile/target effects and the effects of the relative neutron content in the compound system on the $4n$ cross sections. The evaporation residues (EVRs) were produced using beam from the K500 cyclotron. Unreacted beam and undesired reaction products were filtered using the spectrometer MARS [2]. The general experimental details are described in Ref. [3]. All data presented here are preliminary. The $4n$ and $p3n$ cross sections for the reactions of $^{45}\text{Sc} + \text{158, 160 Gd}$, $^{159}\text{Tb}$ are plotted in Fig. 1 and Fig. 2, respectively. For the $^{45}\text{Sc} + \text{159 Tb}$ reaction, the $p3n$ exit channel cross section is significantly larger than the $4n$ cross section. For the $^{45}\text{Sc} + \text{158, 160 Gd}$ reactions, sensitivity to the $p3n$ product is limited by small alpha branches (~1-3%).

**FIG. 1.** Cross sections for the $4n$ channels in the $^{45}\text{Sc} + \text{158, 160 Gd}$ (blue circles and black squares) and $^{45}\text{Sc} + \text{159 Tb}$ (purple diamonds) reactions.
These data were analyzed within a simple, three-step model of fusion evaporation reactions:

$$\sigma_{\text{EF}} = \sigma_{\text{capt}} P_{\text{CN}} W_{\text{surf}},$$

where the fusion cross sections, $\sigma_{\text{capt}}$, were calculated using the coupled-channel code CCFULL[4]; compound nucleus formation probabilities, $P_{\text{CN}}$, were estimated using the functional form of the Fusion-by Diffusion [5] approach that is presented in Ref. [6], and survival probabilities, $W_{\text{surf}}$, were calculated using the standard transition state theory approach presented in Ref. [7]. The calculation of survival cannot be reduced to the well-known Vandenbosch and Huizenga formula [8] due to the large contribution of proton emission from the compound nucleus. The survival probabilities are shown to be the main force in driving down the $4n$ cross sections in the $^{45}\text{Sc} + ^{159}\text{Tb}$ reaction. Calculations are still in progress and final results will be published in a future work.