The effects of source definition on the quality of Isoscaling

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The effects of varying source definition used in Isoscaling analyses have been studied. Isoscaling is the observed trend seen by taking the yield ratio of a specific nuclei between two sources, differing in isospin concentration (I=(N-Z)/A), and plotting this yield ratio for many different fragments as a function of either the N or Z value of the fragment. The resulting scaling should follow the form given in Eq. (1) [1]:

$$R_{21}(N,Z) = \frac{Y_2(N,Z)}{Y_1(N,Z)} = C * \exp^{(N\alpha + Z\beta)} \qquad (1)$$

The α parameter value extracted from this equation can be used in various other analyses including calculations of the symmetry energy coefficient and transport studies [1,2]. The experimental data used in this analysis comes from the reactions of ^{78,86}Kr beams on ^{58,64}Ni targets at 35 MeV/u collected using the NIMROD-ISiS array [3].

Previous isoscaling work was done by comparing the fragment yields between two different systems. In the work by Wuenschel *et. al.* [1], this was replaced by looking at the yield ratio between two quasi-projectile (QP) sources that differed in N/Z content. This was done by taking two QPs selected from specific bins in the QP N/Z distribution as seen in red on Fig. 1. This improved source definition led to an improved quality of isoscaling.

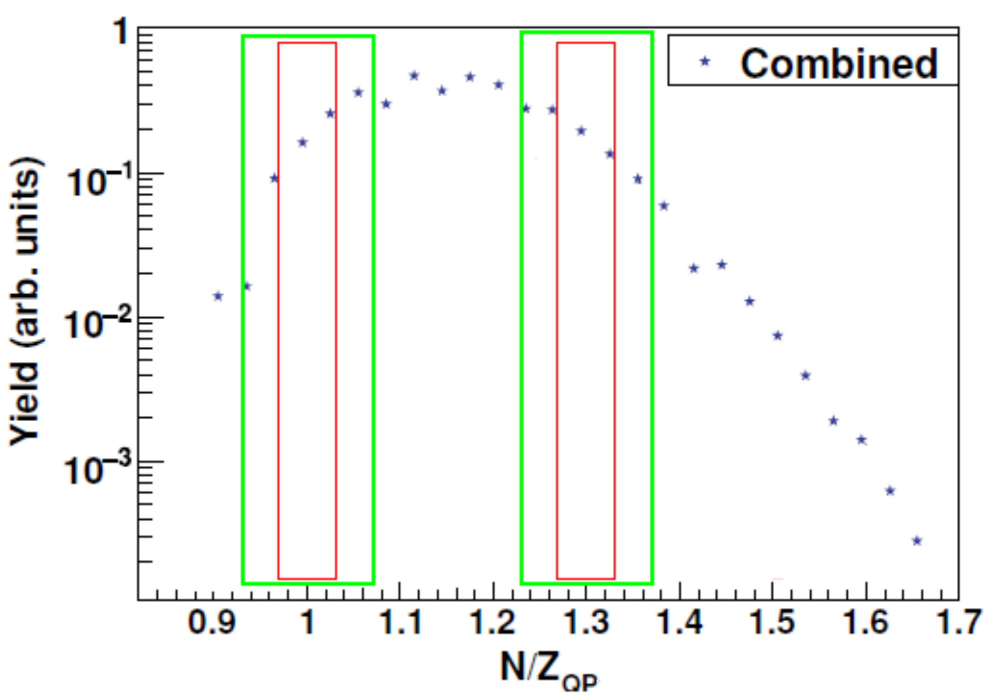

FIG. 1. N/Z distribution of quasi-projectiles. Red and green boxes correspond to bins of different width in N/Z for specifically selected sources for use in isoscaling.

This idea was expanded by varying the widths of the N/Z bins used to determine the QPs for the yield ratio. An example of the expanded N/Z bin can be seen in green in Fig. 1. By comparing the quality of the isoscaling as a function of bin width, it was hoped that some optimal binning value could be found that would generate the best isoscaling.

In order to quantify the improvement of quality, we took a simple relative error calculation on the isoscaling parameter α by dividing the error in the fit parameter by the parameter value and taking that as a percentage. The results can be seen in Fig. 2 where the relative error in a is plotted as a function of the width of the N/Z bins. We can see here that a clear trend is observed where some optimal region of bin width can be used to provide the best quality isoscaling.

Future work to be investigated includes determining the isoscaling quality as a function of Δ (where $\Delta=(Z/A)_1^2-(Z/A)_2^2$) as well as the effect that changing the position of the bins within the N/Z distribution has on the quality of the isoscaling.

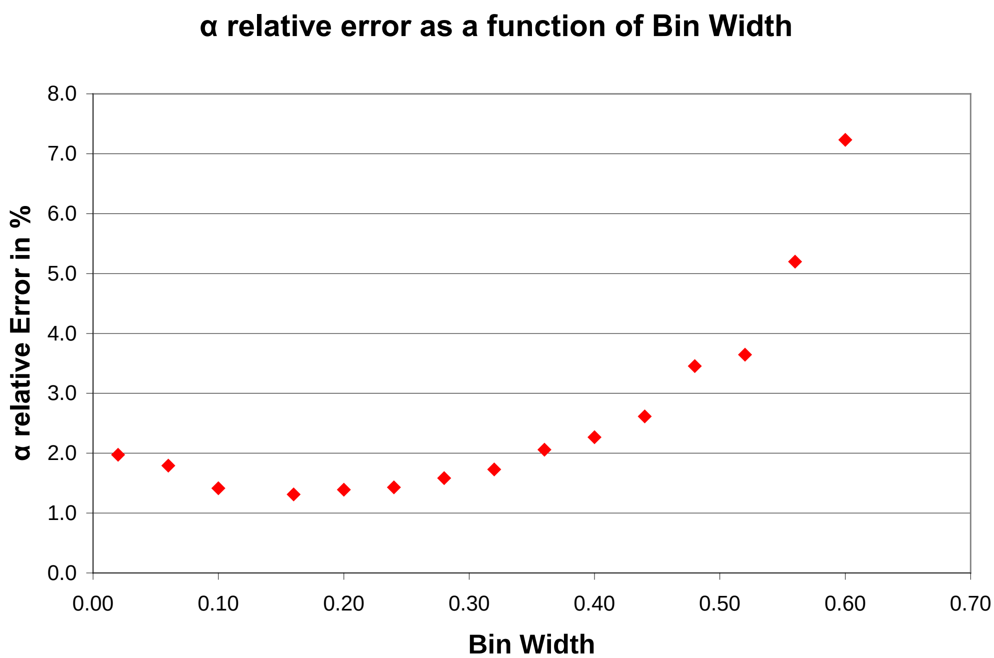

FIG. 2. Plot of the relative error in the isoscaling parameter α as a function of varying bin widths in the isoscaling analysis. A minimum region is observed between widths of 0.1 and 0.2 in N/Z suggesting that bin widths of these sizes should produce better quality isoscaling.

[1] S. Wuenschel, R. Dienhoffer, G.A. Souliotis, S. Galanopoulos, Z. Kohley, K. Hagel, D.V. Shetty, K. Huseman, L.W. May, S.N. Soisson, B.C. Stein, A.L. Caraley, and S.J. Yennello, Phys. Rev. C **79**, 1 (2009).

[2] M.B. Tsang, T.X. Liu, L. Shi, C.K. Gelbke, X.D. Liu, P. Danielewicz, W.G. Lynch, W.P. Tan, A. Wagner, H.S. Xu, W.A. Friedman, G. Verde, R.T. de Souza, V.E. Viola, R.J. Charity, L. Beaulieu, L.G. Sobotka, B. Davin, Y. Larochelle, T. Lefort, and R. Yanez, Phys. Rev. Lett. **92**, 1 (2004).