Investigation of the affect of a Coulomb force on velocity distributions in multifragmentation

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The relationship between the N/Z of the fragmenting source and the nature of its subsequent fragmentation was studied in the reaction of ^{32}S with ^{112}Sn at 45 MeV/nucleon. Isotopically resolved LCP and IMF were measured with the Forward Array Using Silicon Technology (FAUST) [1]. The velocity distribution of ^{7}Li was observed to be asymmetric and backward peaked in the frame of the moving QP [2].

The velocity of the QP frame was determined by the velocity of the reconstructed QP, which consisted of all detected fragments in a given event. We observed a clear shift in the peak of the velocity distributions of the emitted Light Charged Particles (LCPs) towards the QT as the particles of a given Z become more neutron-rich, as shown left to right across a row in Figure 1. The magnitude of the shift decreases with increasing mass of the fragments. Some dependence of the positions of the peaks of these distributions on the distance between the QP and QT was proposed due to the Coulomb interaction. Previous work has utilized average velocities to probe the time between collision of the projectile and target and the break-up of the QP [3].
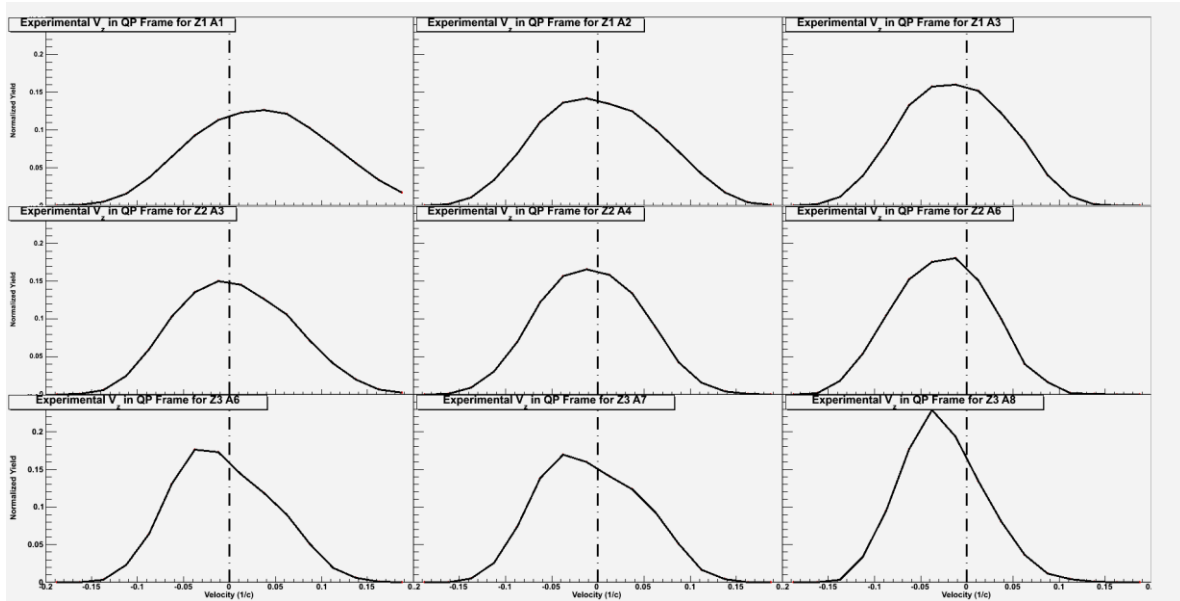

FIG. 1. Experimental velocity distributions of emitted fragments in the QP direction, in the QP frame (indicated by the dashed line).

In order to investigate the velocity distributions of the emitted fragments and their possible relationship to timing, DIT/SMM code for the system was run for different distances between the QP and the QT at the time of breakup. The Deep-Inelastic Transfer (DIT) creates an excited QP.[4]The Statistical

Multifragmentation Model (SMM) simulates the multifragmentation of this excited QP.[5] The unfiltered DIT/SMM data was mostly Gaussian in shape. The peaks of the velocity distributions of emitted fragments in the beam direction in the QP frame were shifted towards the QT (negative in the QP frame) at close proximity, but shifted forward with increasing distance between the QP and QT ("proximity"), as shown in figure 2.
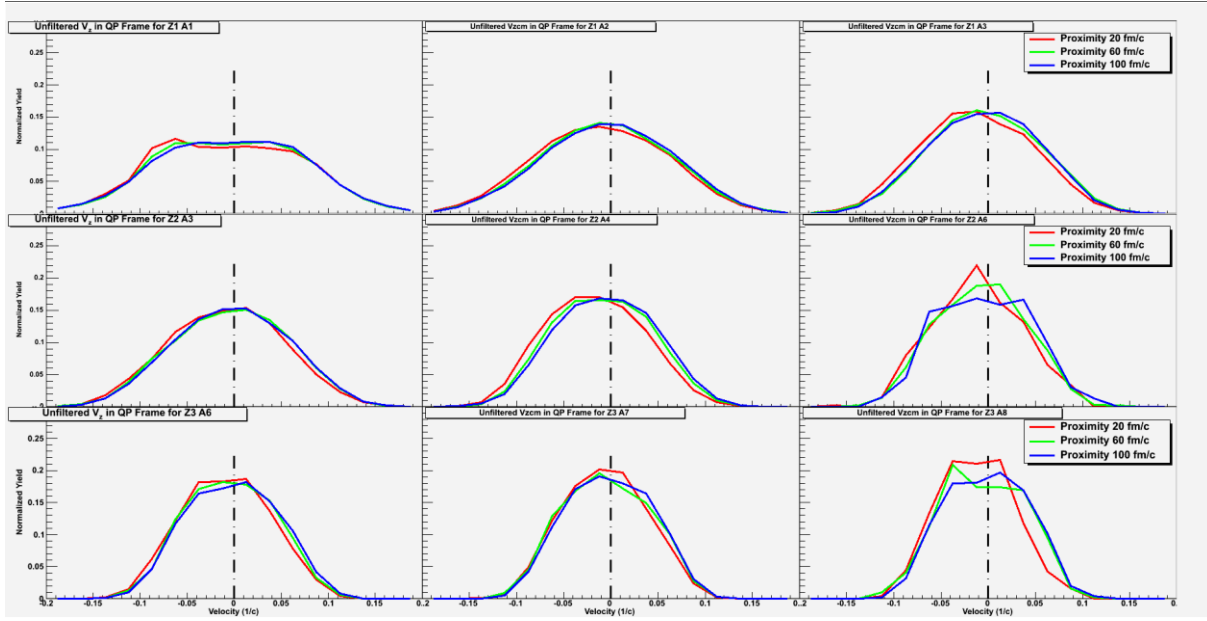

FIG. 2. Velocity distributions of emitted fragments in the QP direction, in the QP frame (indicated by the dashed line), generated from DIT/SMM.

The proximity effect was seen most clearly in the alpha particle distribution. The left panel of figure 3 shows the gradual shifting of the mode of the velocity of the alpha particles towards the velocity of the QP frame as the proximity increases. The FAUST software filter takes into account the geometry and energy thresholds of the apparatus. It results in a shift of the alpha velocity distribution in the beam direction of the QP frame to be more centered around zero, and obfuscated the shift in velocity distribution between the different proximities between the QP and QT. The distribution also narrowed after the application of the filter, as the right panel in figure 3 demonstrates. This shift is likely related to the omission of back-emitted particles from the QP frame.

The proximity of the QP to the QT at the time of breakup in SMM does affect the distribution of fragments in the QP frame. However, the effect is diminished when the experimental filter is applied. None of the proximity options shown scaled to the shapes of the originally observed distributions of ^{7}Li and other LCPs from the experimental data. Investigation of the source of the asymmetric velocity distributions of fragments is ongoing.
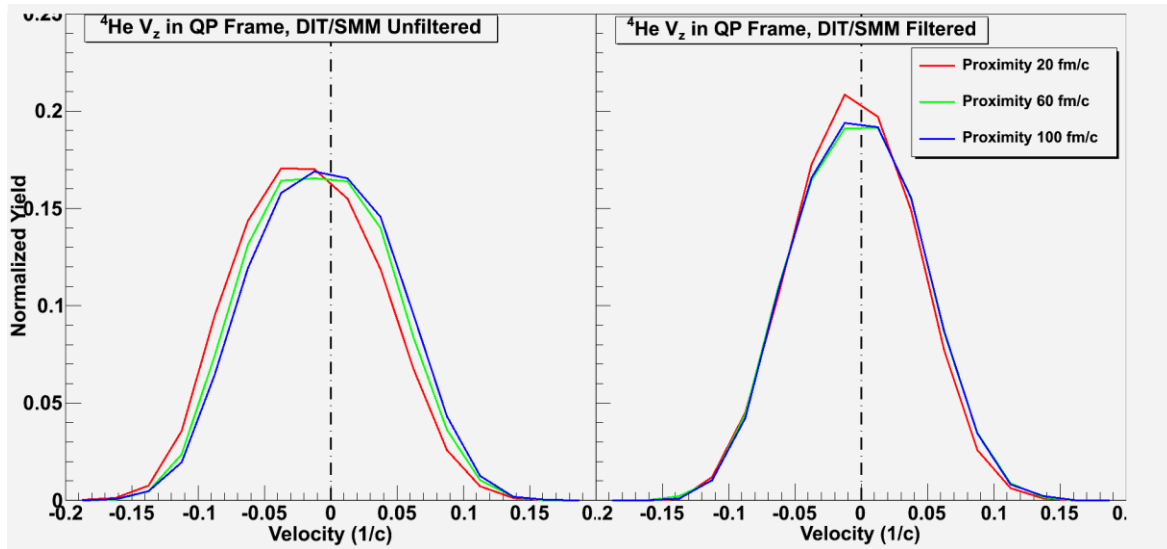
FIG. 3. The effect of the FAUST filter on the velocity distribution of alpha particles in the QP direction, in the QP frame. The "Proximity" in the legend refers to the distance in time between the QT and QP at the time of the break-up of the QP.

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