Proximity Effect on Projectile Fragmentation

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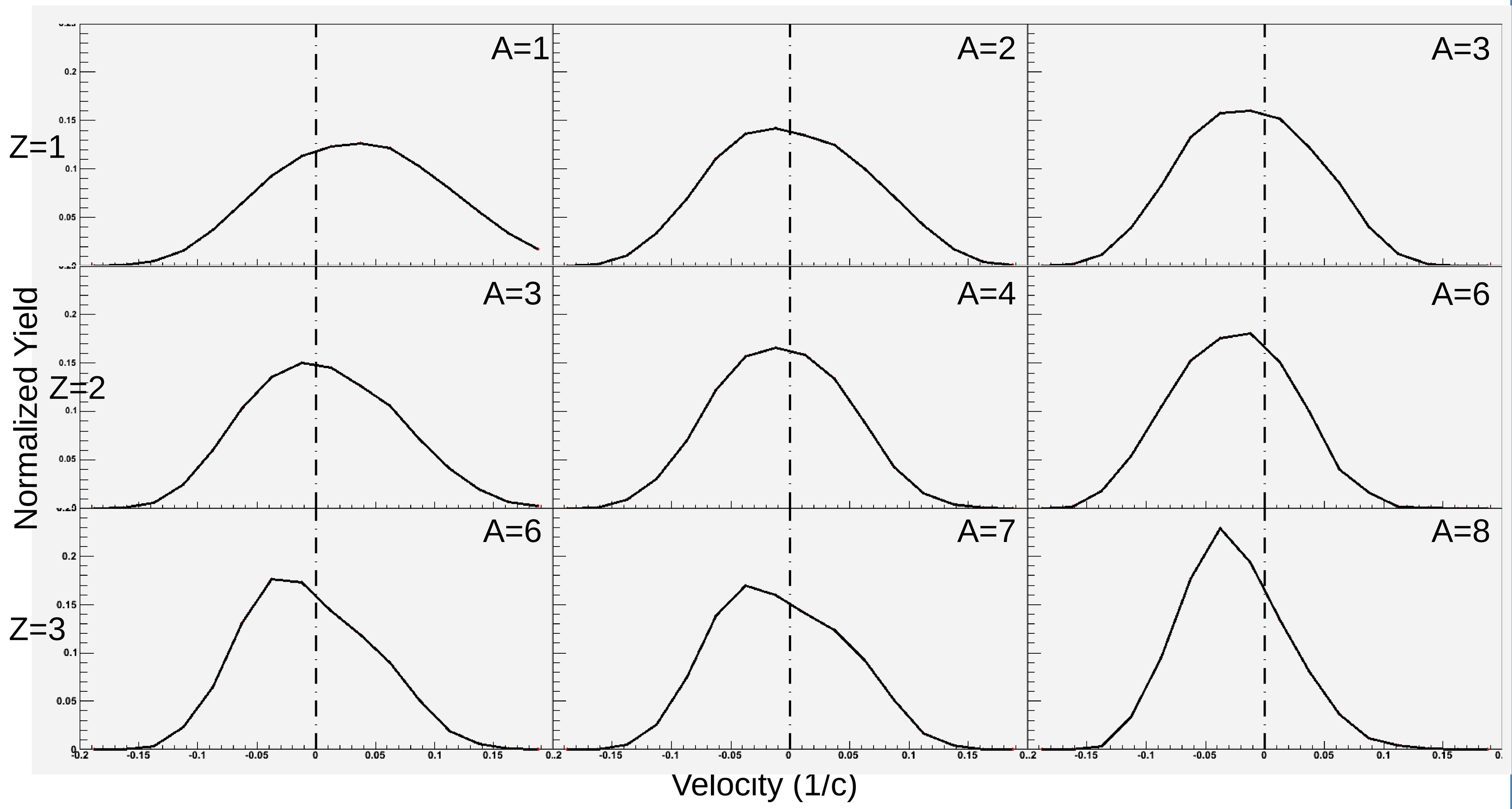
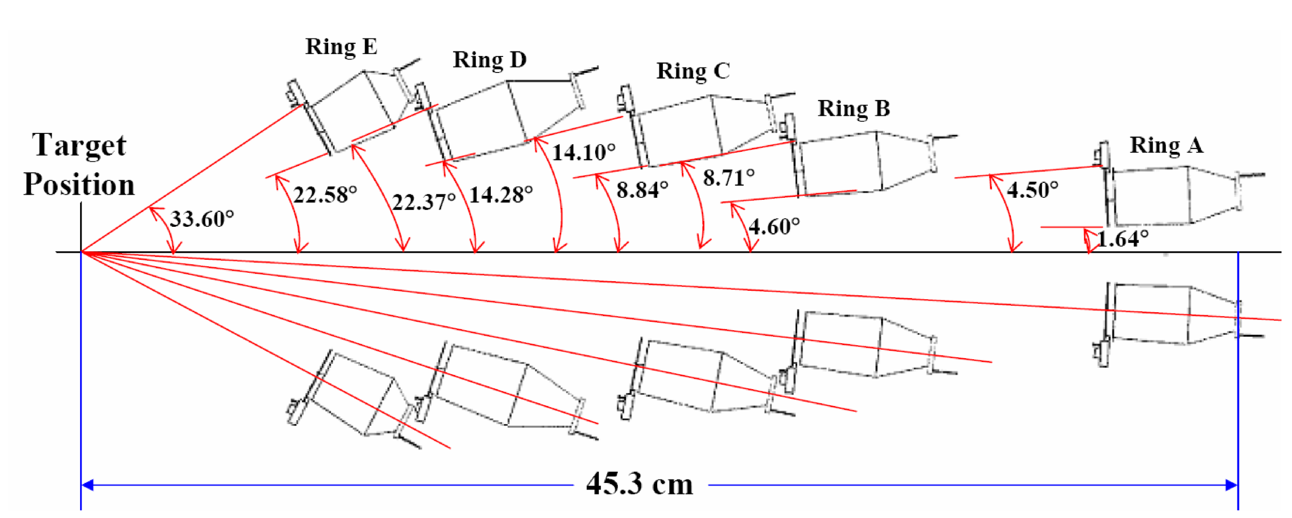
Motivation



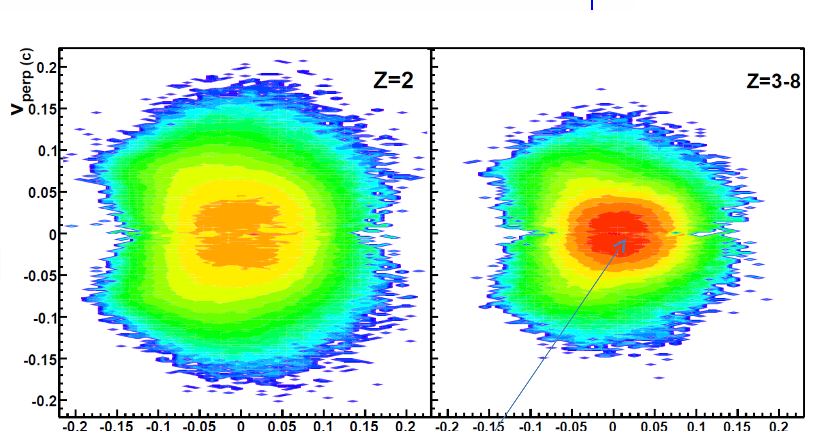
In a recent study of the reaction of ^{32}S with ^{112}Sn, the velocity distribution of ^{7}Li in the frame of the moving QP was seen to be asymmetric and backward peaked. *[Thesis, S. Soisson, 2010]* Velocity distributions of the Light Charged Particles (LCPs) show distinct trends. We observed a clear backward (towards the QT) shift in the data as the particles become more neutron-rich. Some dependence of these distributions on the distance between the QP and QT was expected, due to the Coulomb interaction. In order to investigate this behavior, DIT/SMM code for the system was run, for different distances between the QP and the QT at the time of breakup.

Experimental Details

Data for the ^{32}S on ^{112}Sn at 45 MeV/A system was taken at the TAMU Cyclotron Institute with the Forward Array Using Silicon Technology (FAUST). The experiment was performed by S. Soisson in 2005.



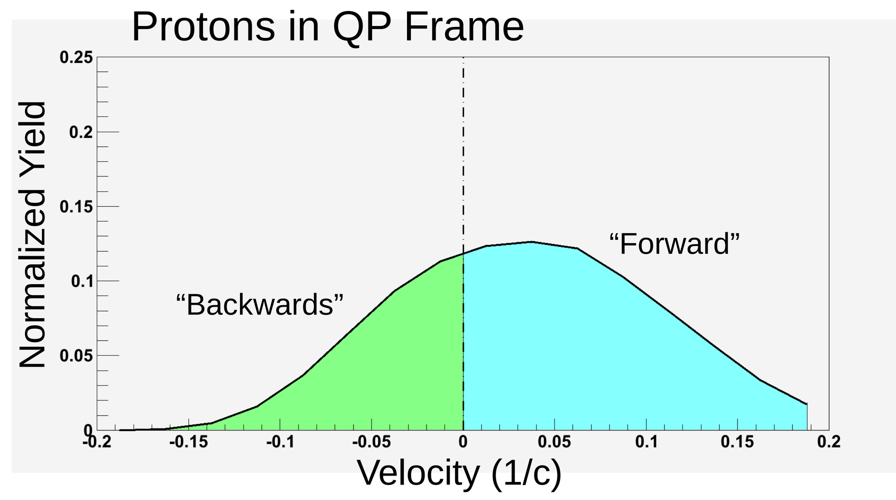
The velocity of the QP Frame is determined by the velocity of the reconstructed QP, which consists of al detected fragments in a given event.



Velocity of the QP Frame

[Thesis, S. Soisson, 2010]

DIT/SMM Simulations



The Forward/Backward ratio is relates the number of particles emitted forward to those emitted backward in the QP frame. Errors are based on counting statistics.

Forward/Backward Ratio for No Proximity

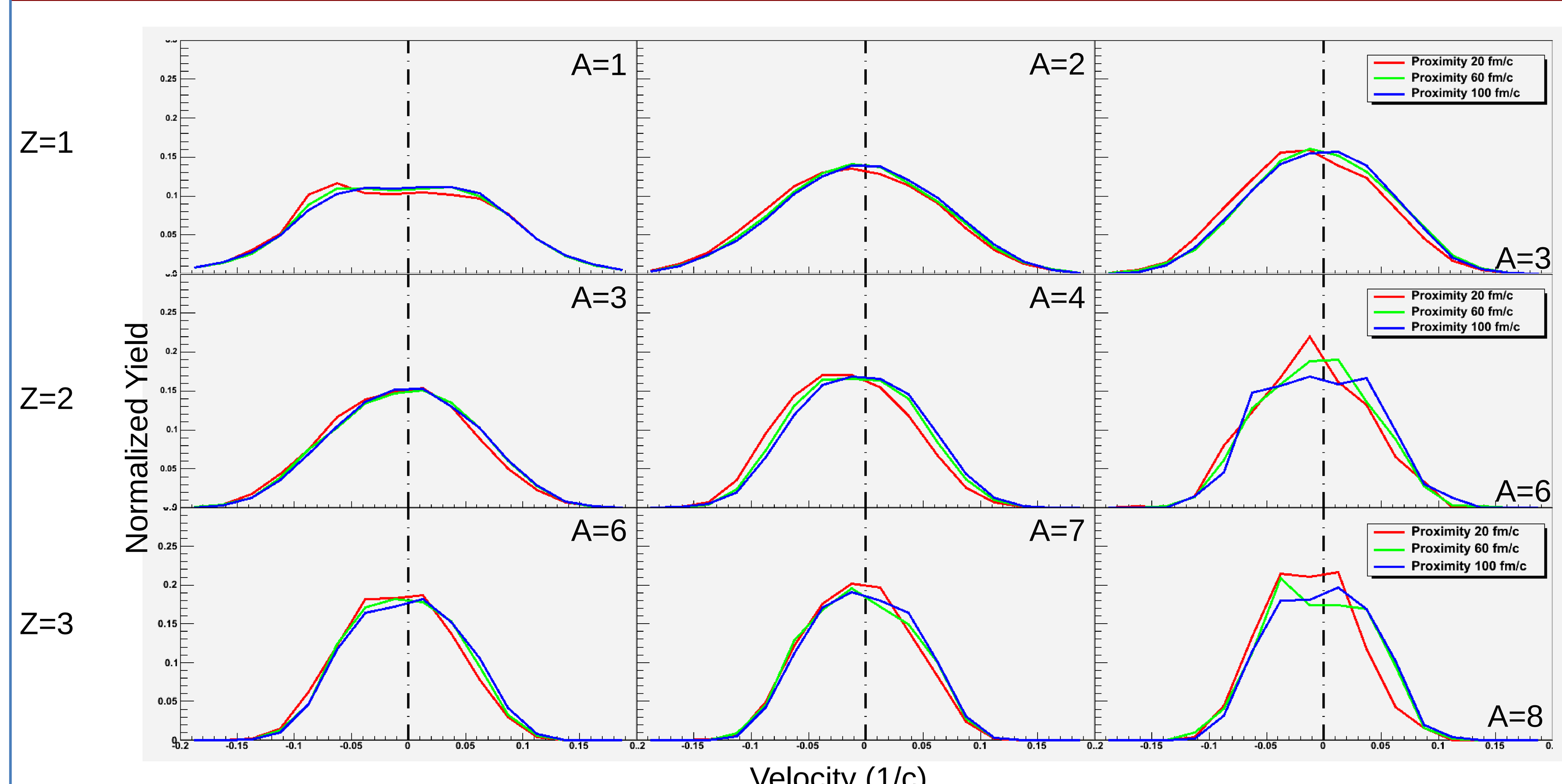
Isotope	Experimental Data	No Filter	Filter
^{1}H	2.37±.01	1.11±.01	1.71±.04
^{2}H	1.27±.01	1.26±.01	1.27±.05
^{3}H	0.977±.012	1.318±.024	1.16±.08
^{3}He	1.40±.02	1.28±.02	1.41±.07
^{4}He	1.098±.003	1.29±.01	1.32±.03
^{6}He	0.71±.02	1.38±.10	1.42±.36
^{6}Li	1.05±.02	1.33±.03	1.33±.09
^{7}Li	1.03±.01	1.36±.04	1.33±.01
^{8}Li	0.63±.02	1.21±.09	0.78±.18
^{7}Be	1.47±.03	1.36±.04	1.29±.09
^{9}Be	0.10±.02	1.40±.06	1.32±.15
^{10}Be	0.95±.03	1.30±.10	1.71±.47
^{10}B	1.40±.03	1.37±.04	1.43±.10
^{11}B	1.28±.02	1.43±.04	1.41±.10
^{12}B	1.05±.05	1.16±.13	1.47±.49
^{11}C	2.21±.06	1.40±.06	1.47±.13
^{12}C	2.20±.03	1.46±.04	1.55±.09
^{13}C	1.97±.04	1.47±.07	1.45±.15

•DIT: Deep-Inelastic Transfer: Creates an excited QP *[L. Tassen-Got and C. Stephan, Nucl. Phys. A524, 121 (1991).]*

•SMM:Statistical Multifragmentation Model: Simulates the multifragmentation of the excited QP . *[A. Botvina et al., Nucl. Phys. A 475, 663 (1987).]*

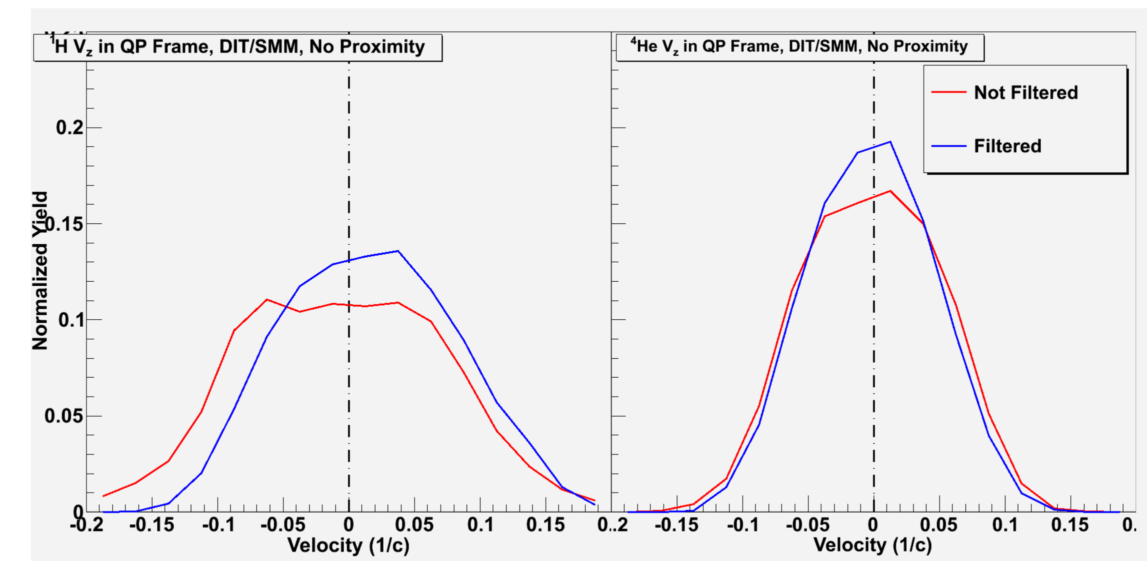
•The Experimental data shows that neutron-poor (blue text) isotopes are more forward-emitted than to neutron-rich (orange) isotopes. The amplitude of this change decreases with increasing mass of the fragments.

Unfiltered SMM Data

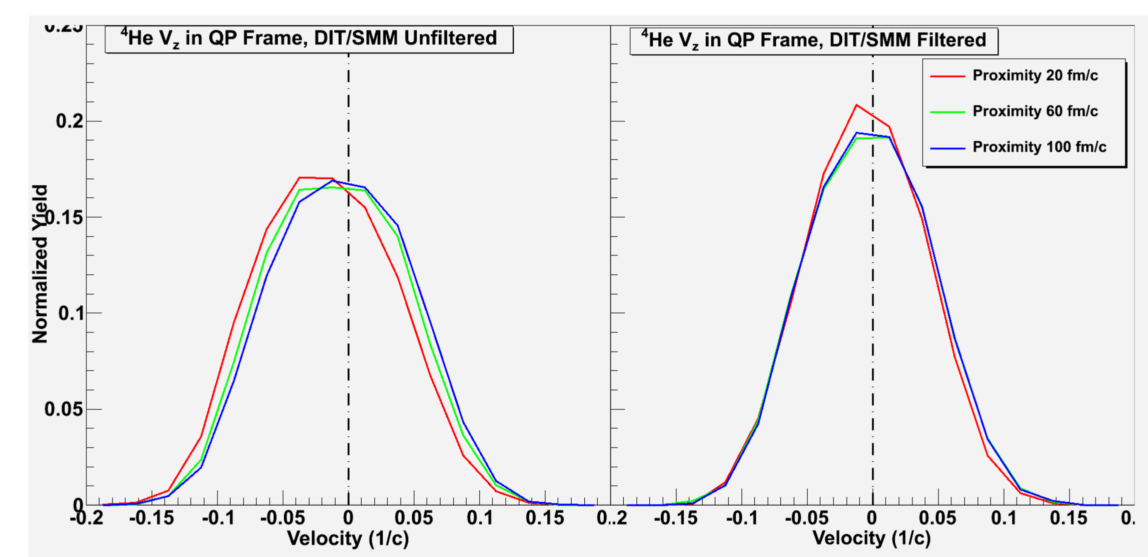


The unfiltered DIT/SMM data is mostly Gaussian in shape. The velocity distributions in the beam direction in the QP frame are back-shifted at close proximity, but shift forward with increasing distance between the QP and QT. The proximity effect can be seen most clearly in the alpha particle distribution.

Effect of FAUST Software Filter



The FAUST software filter applies geometry and energy threshold cuts to the particles. This shifts the proton and the alpha velocity distribution in the beam direction of the QP frame to be more centered around 0. The distribution also narrows after the application of the filter.



Before the filter is applied, an increase in distance between the QP and QT ("proximity" above) causes the protons to shift forwards more, and makes the distribution centered more about zero. The FAUST filter obfuscates the shift in velocity distribution between the different proximities between the QP and QT. The obvious shift of the distribution to be more centered at zero is likely related to the omission of back-emitted particles from the QP frame.

Conclusions

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 results of the calculation are filtered. None of the proximity options shown scale to the shapes of the originally observed distributions of ^{7}Li and other LCPs from the experimental data.

Acknowledgements

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