Nuclear Temperature and Moving Source Analysis

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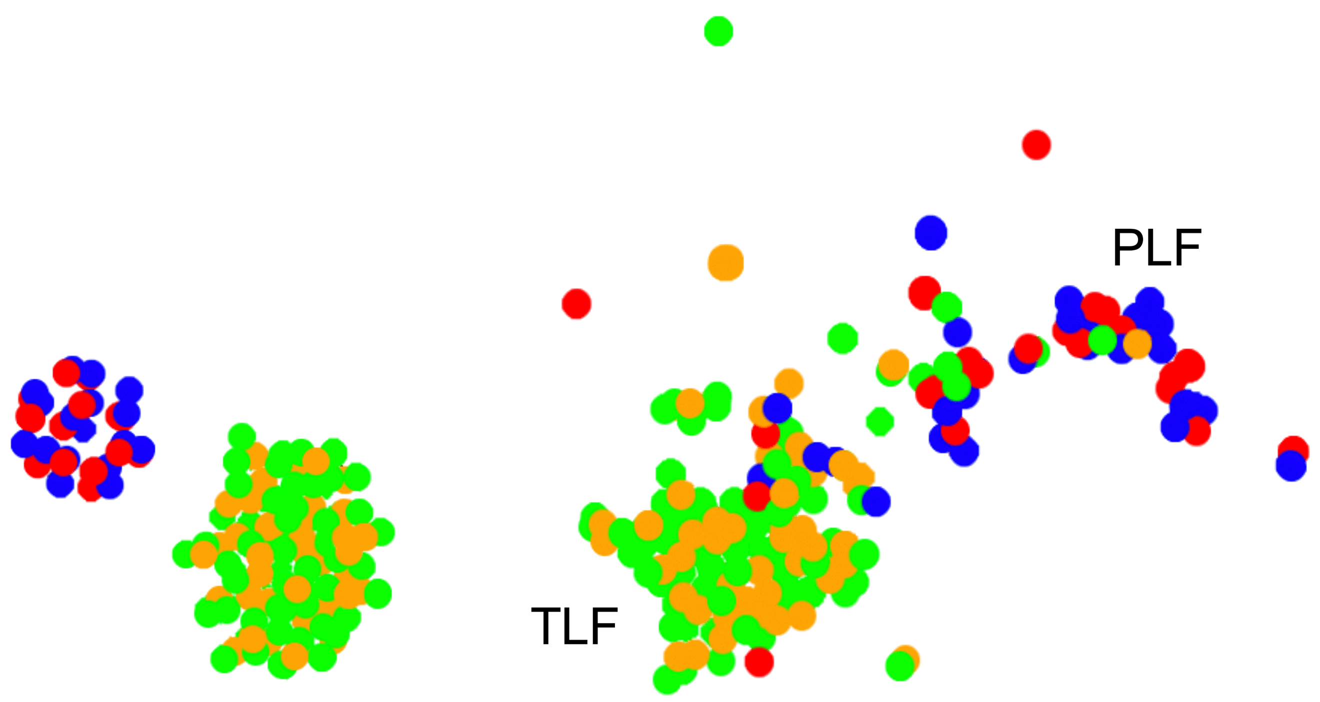
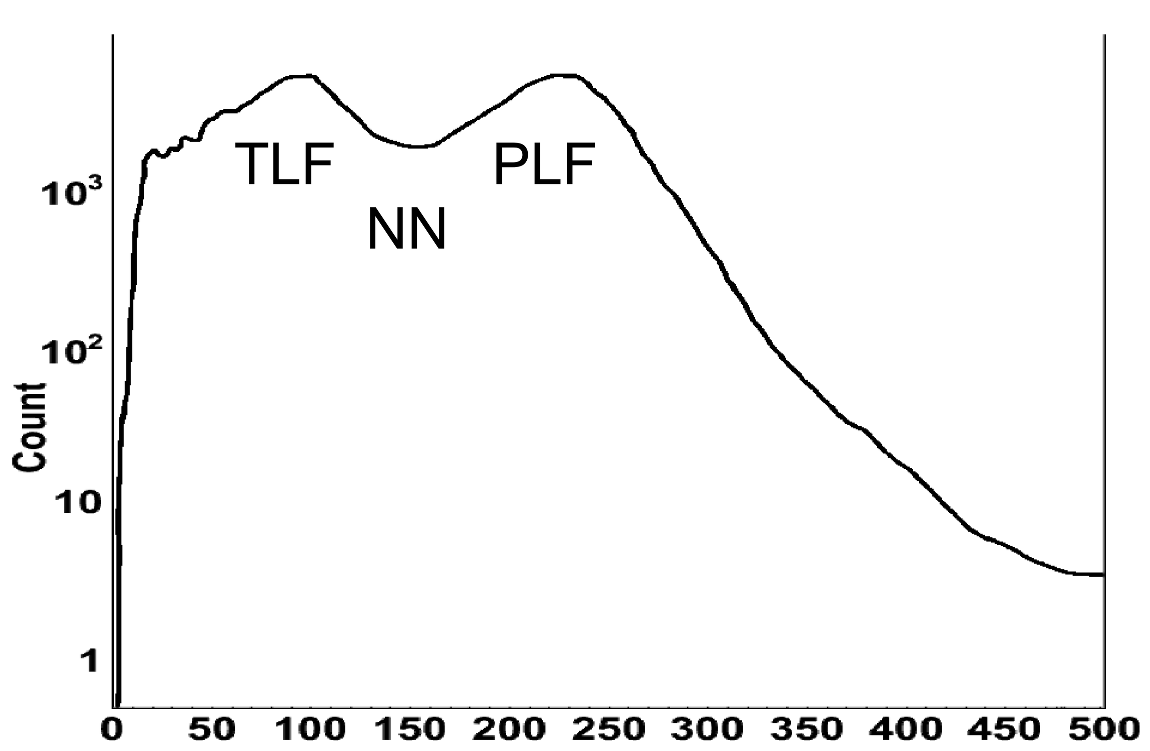
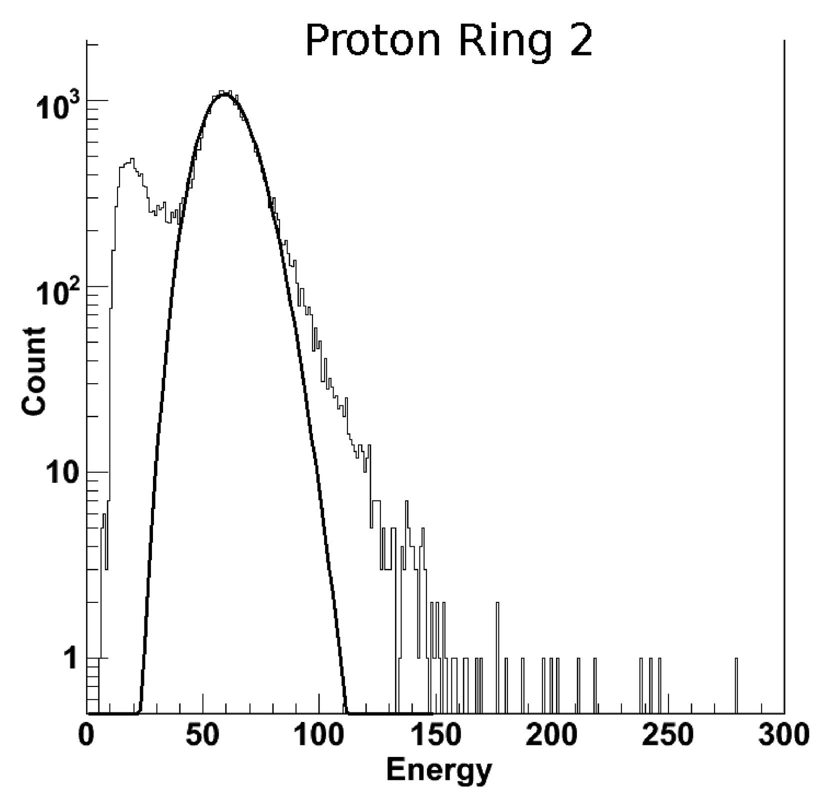


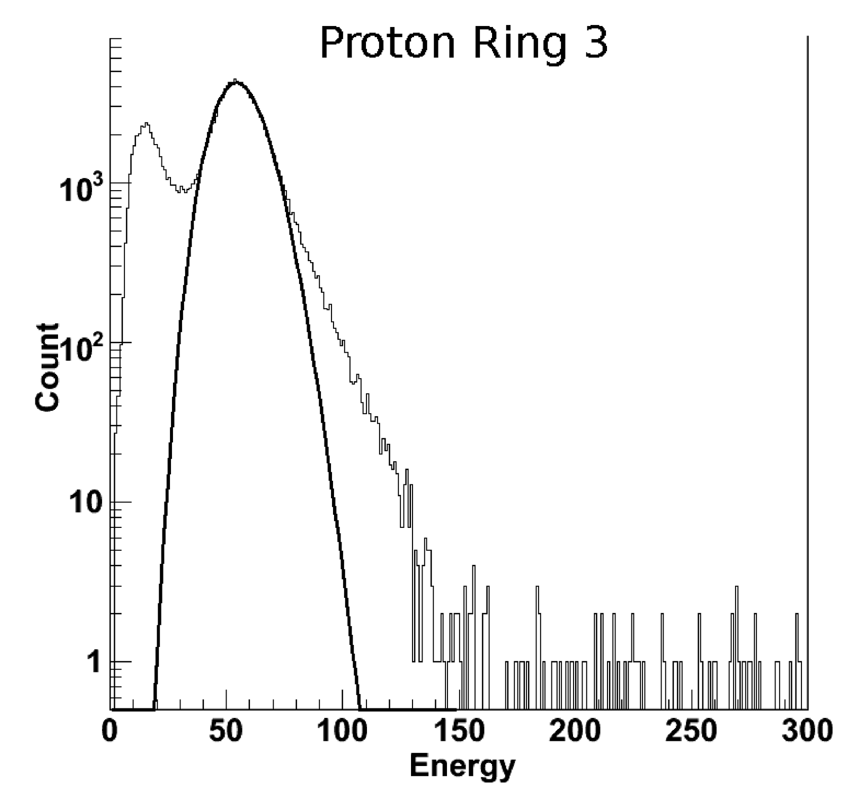
In a peripheral collision only a portion of the nuclei actually collide. This results in a large projectile like fragment (PLF), large target like fragment (TLF), and some nucleon-nucleon interaction (NN).

During the collision particles are emitted according to a Maxwell-Boltzmann distribution. This means the number of particles detected, at any particular angle and energy will be proportional to the reaction temperature and the velocity of the particle beam. The energy spectra also changes with the angle. The high energy PLF is most prominent in the forward angles, and the TLF is most prominent in the rear directions.



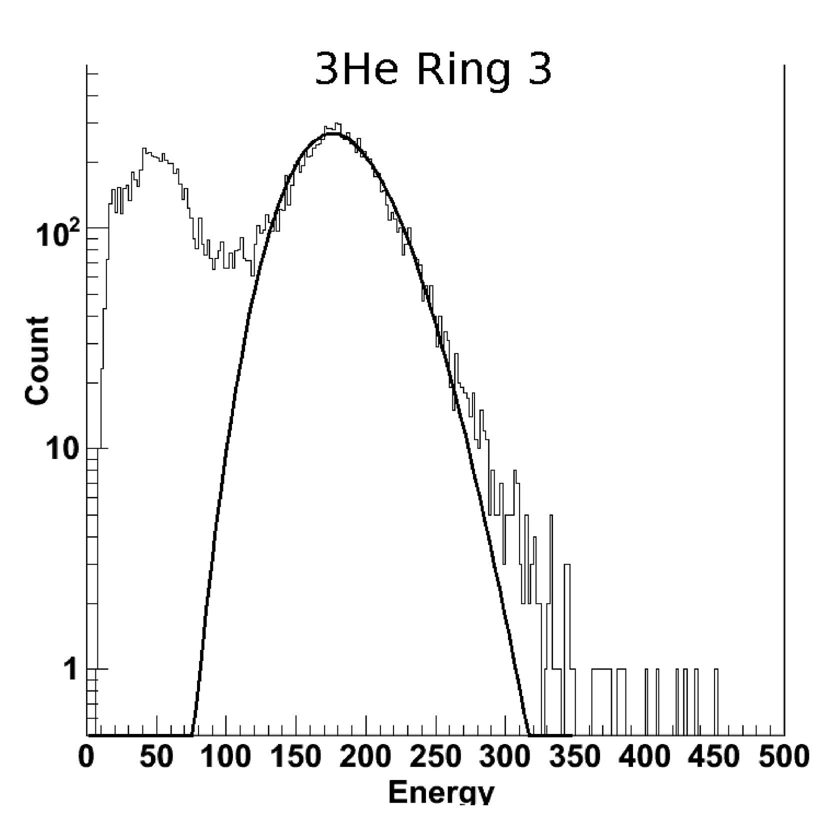
35A MeV $^{64}Zn + ^{92}Mo$

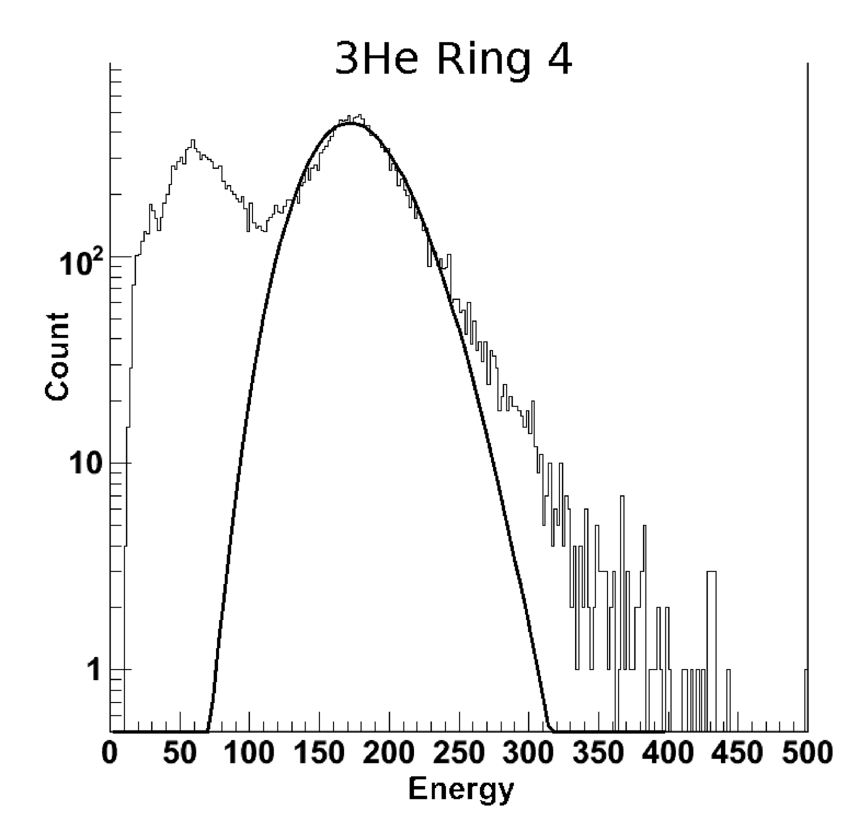




Sample data fits for two different peripheral collisions. Hydrogen emission from a 35A MeV collision, and ^{3}He emission from a 47A MeV collision. Also shown are fits from the same collision, but from detectors at different forward angles. The data fits are for the PLF.

47A MeV $^{64}Zn + ^{92}Mo$





The energy spectra of the emitted particles, after conversion to the laboratory reference frame, are represented by the equations

$$\eta(E_{LAB}) = E' \cdot e^{\frac{-E'}{T}} \cdot \sqrt{\frac{E_{LAB}}{E''}}$$

for surface emission and

$$\eta(E_{LAB}) = \sqrt{E'} \cdot e^{\frac{-E'}{T}} \cdot \sqrt{\frac{E_{LAB}}{E''}}$$

for volume emission where

$$E'' = E_{LAB} + E_{SOURCE} - 2 \cdot \sqrt{E_{LAB} \cdot E_{SOURCE}} \cdot \cos(\theta)$$

$$E' = E'' - E_c$$

The Results

By adjusting the parameters of the energy spectra equations, and trying to achieve the most accurate fit, we were able to uncover information about the temperature of the reaction and the velocity of the source beam. The results of the fits were comparable to the expected values. Emission temperatures of 1.0 MeV and velocities of 9.4 cm/ns for H and temperatures of 3.31 MeV and velocities of 10.4 for He were used for the example data fits shown here.

What's Next

The next step is to perform a muti-source analysis. This would take into consideration all three sources of particles (PLF, NN, TLF) and would result in a much better fit to the measured data. The multi-source fit would also give more accurate data than the PLF analysis done here, allowing us to understand even more about the nuclear collision.