Mass and Excitation Energy of Projectile Spectators ^{B,G}

E.Zude for the **ALADIN**/**LAND**-Collaboration

Projectile fragmentation in relativistic heavy ion collisions is ideally suited to investigate thermally induced fragmentation of nuclei [1]. In the present study of Au+Au collisions at 600 A·MeV nearly all charged decay products, except for H-isotopes, were detected by means of the **ALADIN**-spectrometer [2]. The interpretation of the observed fragmentation pattern requires the knowledge of mass and excitation energy of the decaying system. The mass- and energy-balance for the projectile spectator suggested by Campi et al. [3] was improved by taking into account the information on the emitted neutrons. Multiplicity and momentum distributions of neutrons, which emerge from the projectile spectator or its fragments, were measured by means of the **LAND**-detector. The neutron multiplicity was derived from the number of observed interactions (hits) in the detector [4]. The rapidity distribution of hits in LAND (Fig. 1) is well described by a sum of two gaussian distributions, folded with the detector response (full line). The detector response was determined by using monoenergetic neutrons from deuteron break-up [4]. The two gaussian distributions represent neutron emission from the fireball and the projectile spectator or its fragments, respectively. The contribution of fireball neutrons in LAND is about 2% of the total yield, which is in agreement with a calculation using the participant-spectator model (Fig. 1, top).

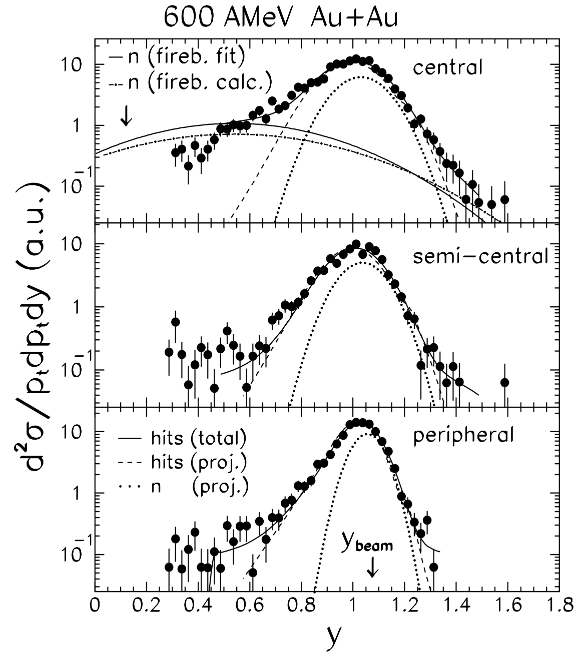

Figure 1: Rapidity distribution of hits with transverse momentum 20 MeV/c$\leq p_t \leq$25 MeV/c in LAND . The dotted line represents the rapidity distribution of neutrons, emitted from the projectile spectator source.

A comparison of the width of the y-distribution with the width of the transverse momentum distribution indicates an isotropic emission of neutrons in the rest frame of the projectile spectator.

Combining the neutron multiplicity with the information on the fragment mass numbers, which were calculated from the fragment charges using a parametrization of measured data [5],

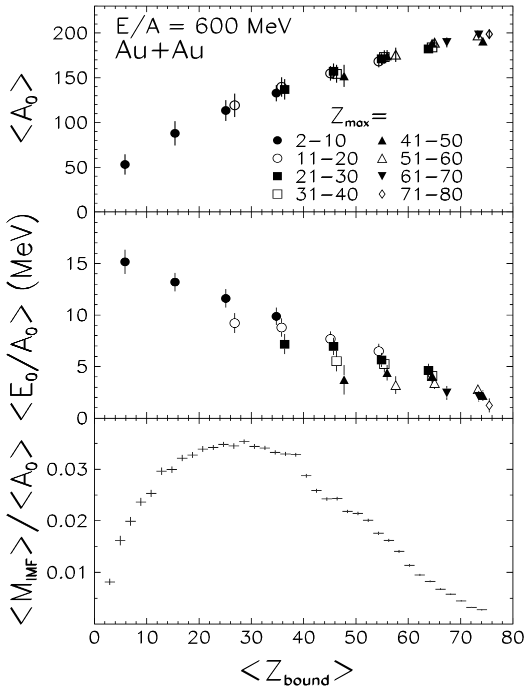

Figure 2: Mean mass number A_0 (top), mean initial excitation energy per nucleon E_0/A_0 (middle) and mean multiplicity of intermediate mass fragments M_{IMF}, normalized to the projectile spectator mass number A_0 (bottom), versus Z_{bound}.

a complete mass balance of the projectile spectator was performed. The events were selected using the biggest charge Z_{max} and Z_{bound}, which is the sum of charges of all detected fragments of the projectile spectator, except for the H-isotopes. For a given Z_{bound}, the mean mass number $< A_0 >$ of the projectile spectator does not depend on Z_{max}, thus proving Z_{bound} as a good characterization of the collision geometry (Fig. 2, top). The total initial excitation energy of the projectile spectator E_0 (Fig. 2, middle) is calculated by adding up mean kinetic energy of all fragments and the Q-value, extracted from a mass table. For a given Z_{bound}, the excitation energy per nucleon increases with decreasing Z_{max}.

Going from peripheral reactions to more central collisions, the mean multiplicity of intermediate mass fragments (IMFs, 3$\leq$Z$\leq$30), normalized to the mass number of the projectile spectator, increases and reaches its maximum near E_0/A_0=10 MeV. For excitation energies above $\sim$ 10 MeV per nucleon, the projectile spectator prefers breaking up into smaller pieces than IMFs, thus indicating a "true fall of multifragmentation" (Fig. 2, bottom).

References

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