Correlation in ^{8}Be nuclei formation and α-particle multiplicities in fragmentation of relativistic nuclei

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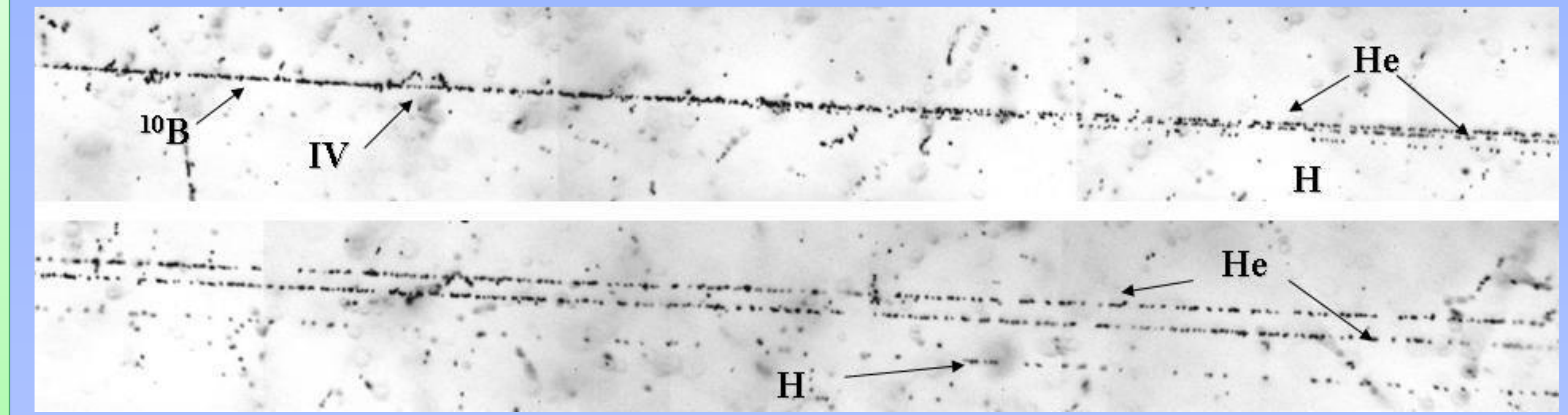
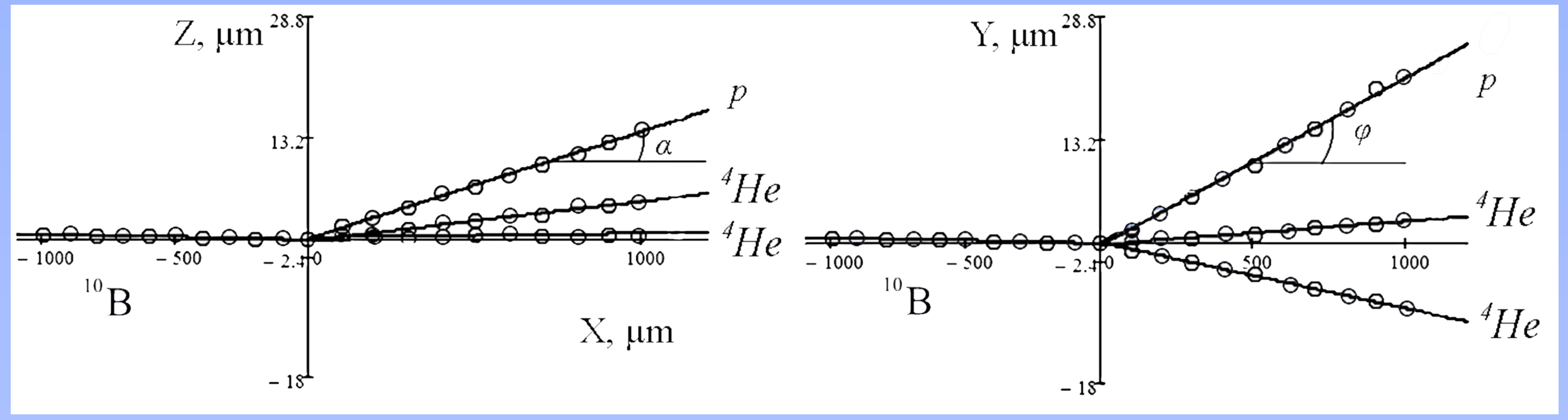
Abstract: In the events of peripheral dissociation of relativistic nuclei in the nuclear track emulsion, it is possible to study the emerging ensembles of He and H nuclei, including those from decays of the unstable ^{8}Be and ^{9}B nuclei, as well as the Hoyle state [1-3]. These extremely short-lived states are identified by invariant masses calculated from the angles in 2α-pairs, 2αp- and 3α-triplets in the approximation of conservation of momentum per nucleon of the primary nucleus. In the same approach, it is possible to search for more complex states. This poster explores the correlation between the formation of ^{8}Be nuclei and the multiplicity of accompanying α-particles in the dissociation of relativistic ^{16}O, ^{22}Ne, ^{28}Si, and ^{197}Au nuclei. On this basis, estimates of such a correlation are presented for the unstable ^{9}B nucleus and the Hoyle state. An enhancement in the ^{8}Be contribution to dissociation with the α-particle multiplicity is found. Decays of ^{9}B nuclei and Hoyle states follow the same trend.

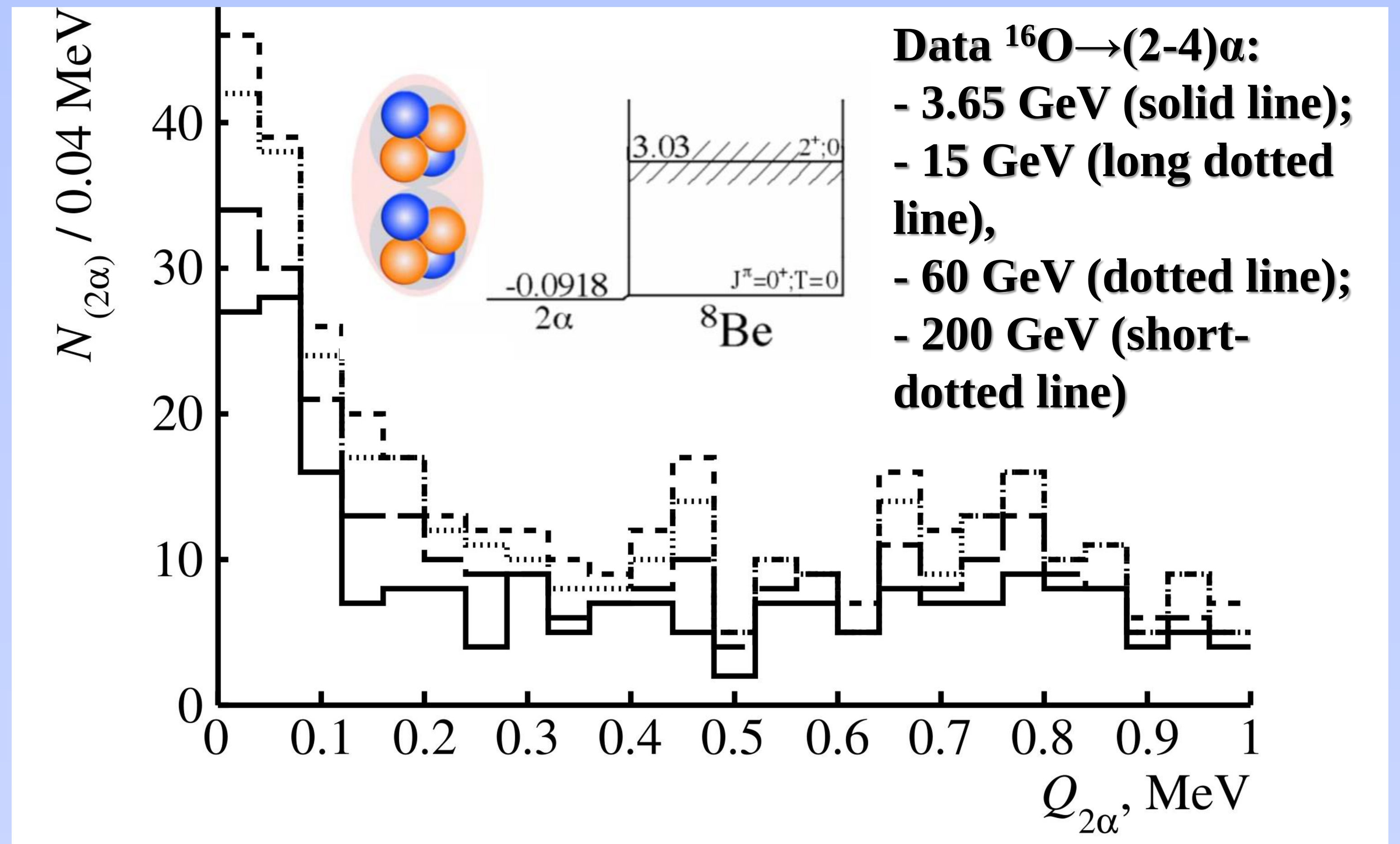


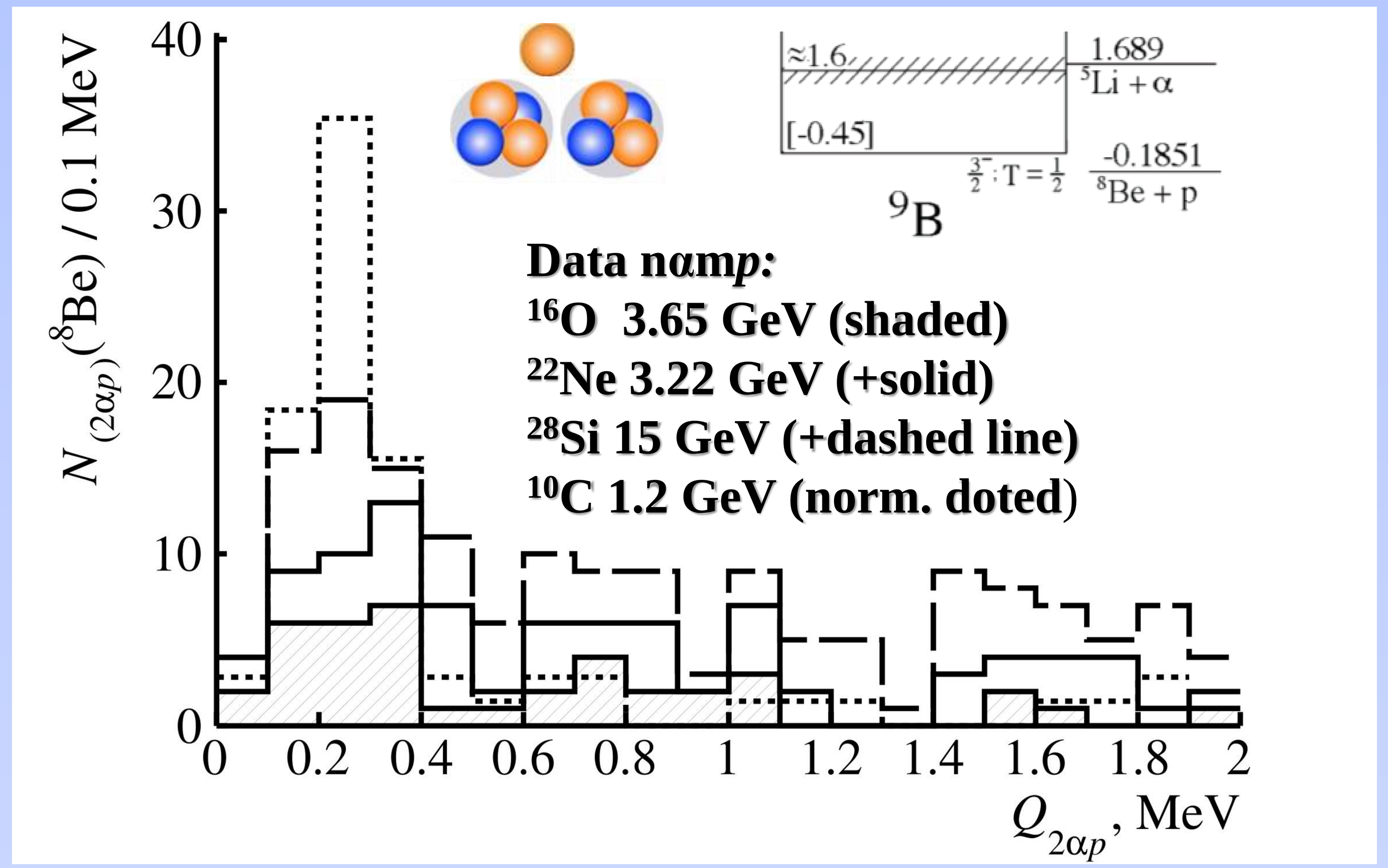
Macrophotography of the event of coherent dissociation of a ^{10}B nucleus into He and H fragments in NTE (IV is the approximate position of the interaction vertex

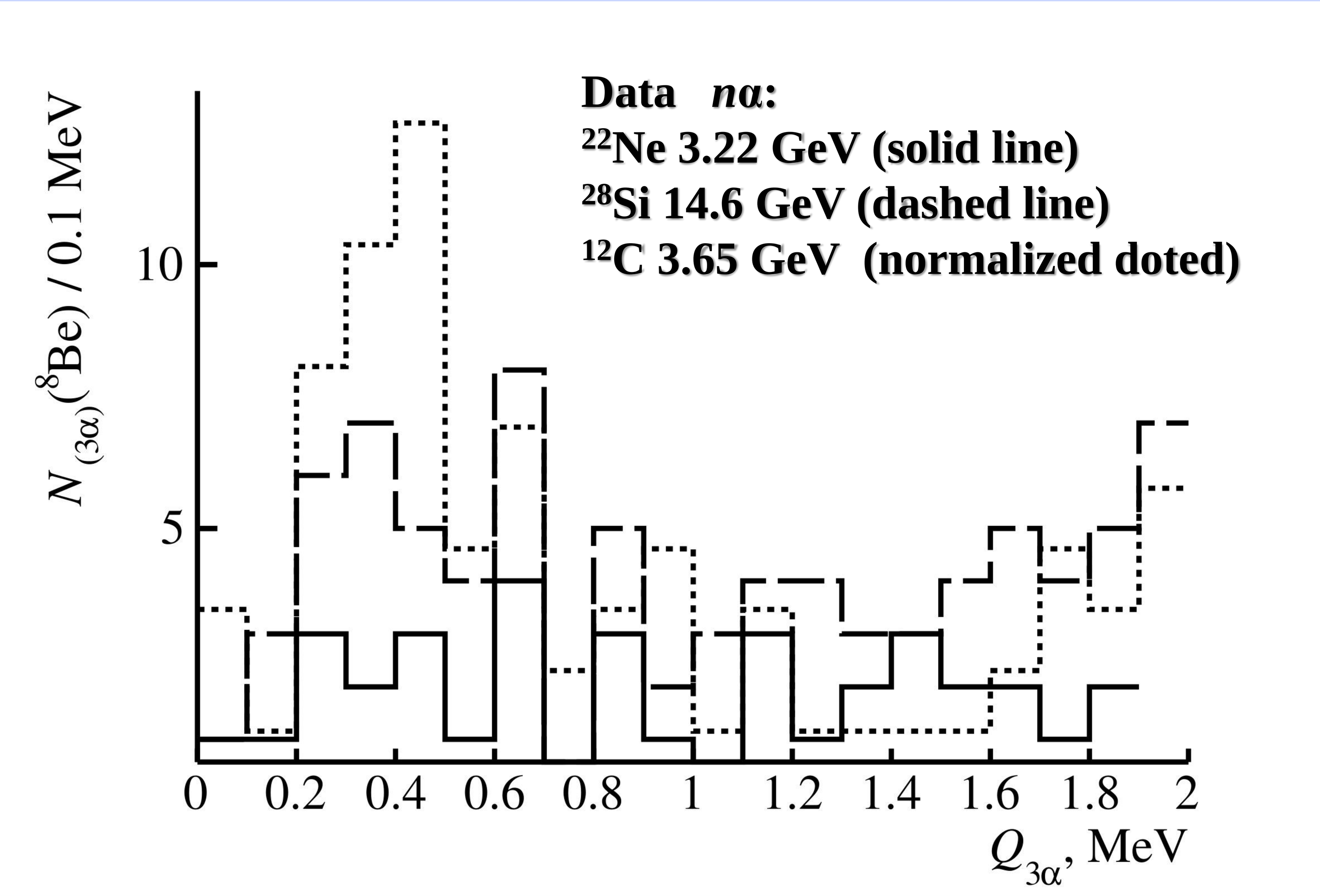


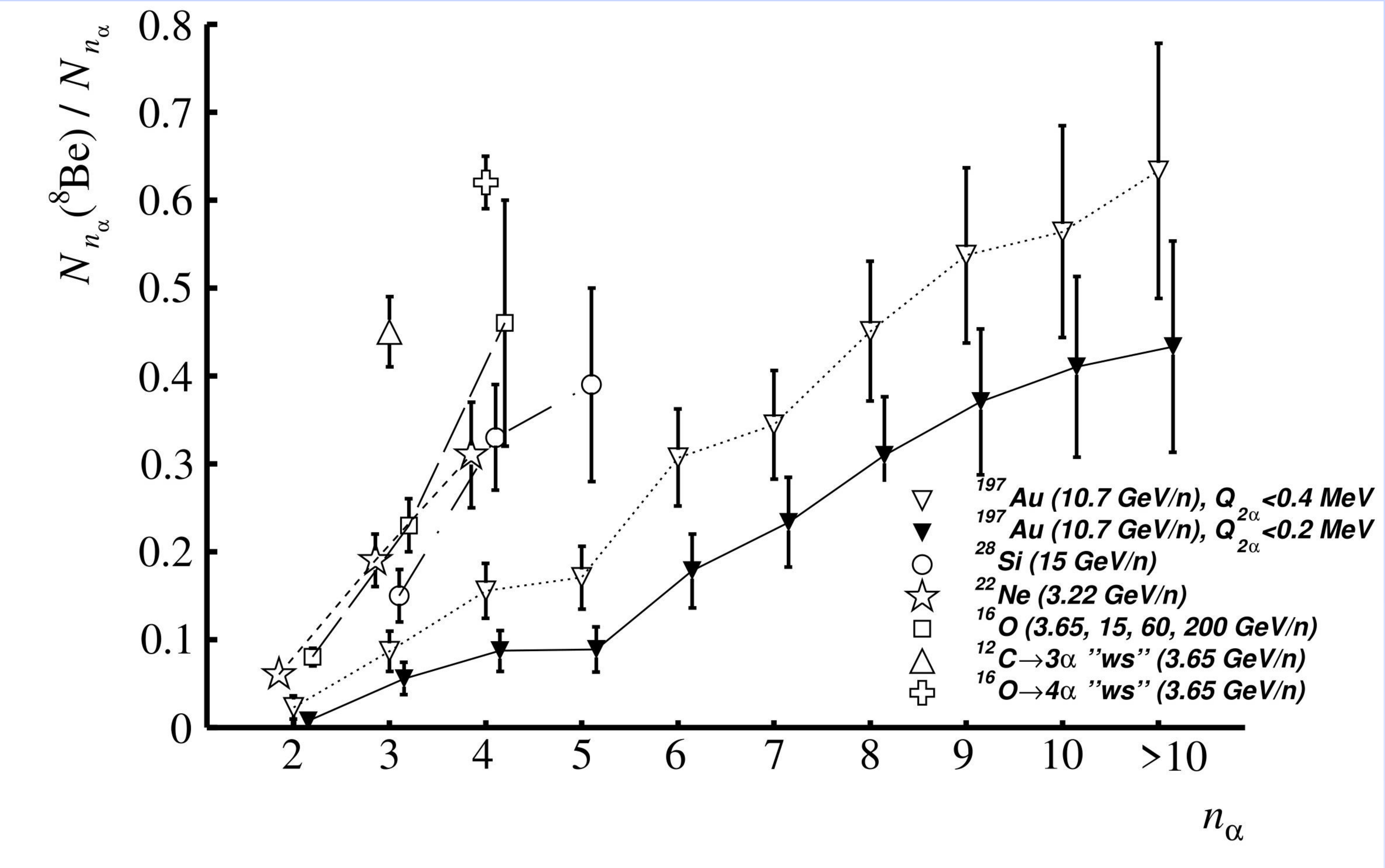
Example of the reconstructed directions of fragments in the XOZ and XOY planes in event No. 10107 in the ^{10}B → 2α + *p* channel.

Reconstructed unstable nuclei in dissociation of light relativistic nuclei









Statistics of events containing at least one ^{8}Be, ^{9}B or HS decay, or at least two ^{8}Be provided $Q_{2\alpha}$ (^{8}Be) ≤ 0.4 MeV among the events $N_{n\alpha}$ of ^{197}Au fragmentation with multiplicity n_α

n_α	$N_{n\alpha}(^8\mathrm{Be})/N_{n\alpha}$ (% $N_{n\alpha}$)	$N_{n\alpha}(^9\mathrm{B})$ (% $N_{n\alpha}(^8\mathrm{Be})$)	$N_{n\alpha}$(HS) (% $N_{n\alpha}(^8\mathrm{Be})$)	$N_{n\alpha}(2^8\mathrm{Be})$ (% $N_{n\alpha}(^8\mathrm{Be})$)
2	3/133 (2 ± 1)	-	-	-
3	14/162 (9 ± 3)	1 (7)	-	-
4	25/161 (16 ± 4)	7 (28 ± 12)	2 (8 ± 6)	-
5	23/135 (17 ± 4)	5 (22 ± 11)	-	1 (4)
6	31/101 (31 ± 7)	9 (29 ± 11)	2 (6 ± 4)	-
7	31/90 (34 ± 7)	6 (19 ± 9)	2 (6 ± 4)	3 (10 ± 6)
8	32/71 (45 ± 10)	8 (25 ± 10)	2 (6 ± 4)	2 (7 ± 5)
9	29/54 (54 ± 13)	9 (31 ± 12)	3 (10 ± 6)	5(17 ± 8)
10	22/39 (56 ± 15)	4 (18 ± 10)	-	5(23 ± 12)
11	10/15 (67 ± 27)	3 (30 ± 20)	1 (10)	2(20 ± 16)
12	2/5	1	-	1
13	2/4	1	-	1
14	3/3	1	-	1
15	1/1	-	-	-
16	1/2	1	1	1

CONCLUSION: The preserved and recently supplemented data on the relativistic fragmentation of ^{16}O, ^{22}Ne, ^{28}Si, and ^{197}Au nuclei in a nuclear track emulsion helped us to identify decays of ^{8}Be, ^{9}B nuclei and Hoyle state in the invariant mass distributions of 2α-pairs, 2α*p*-and 3α-triplets. The determination of the invariant mass from the fragment emission angles in the velocity conservation approximation turns out to be an adequate approximation. Starting with the ^{16}O fragmentation, the presented analysis has indicated a relative enhancement in the ^{8}Be contribution while increasing in the number of relativistic α-particles per event and remaining proportional contributions of HS and ^{9}B. In the ^{197}Au fragmentation, the tendency is traced up to at least 10 relativistic α-particles per event. This observation has assumed the development of the theory of relativistic nucleus fragmentation taking into account the α-particle interactions, that is characteristic for low-energy nuclear physics.

References

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