Multiparticle He Fragmentation of ^{22}Ne, ^{24}Mg and ^{28}Si in Emulsion at 4.1- 4.5 A GeV/c.

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BECQUEREL Collaboration

I. Experimental details.

- NIKFI BR-2 stacks of nuclear emulsions, 600μm thick, have been exposed horizontally to the α conjugate nuclei ^{22}Ne, ^{24}Mg and ^{28}Si at the DUBNA synchrophasotron.
- Only the collisions with three and more He fragments in the final state – $N_{He} \geq 3$ have been used for the analysis.
- Only the collisions with the sum charge in the narrow forward cone, been approximately equal to that of projectile one – $\Sigma Z_{fr} = Z_0 \pm 1$, have been analyzed.
- Limitation $\Sigma Z_{fr} = Z_0 \pm 1$ means that extra peripheral collisions have been selected for analyses only.
- Peripheral collisions usually have very limited number of target fragments and produced particles.

An example of ^{28}Si interaction with 6 He fragments.

The sum charge in the narrow forward cone (Θ^o<2.55^o) is equal to $\Sigma Zfr = 2x6+1 = 13$

N	Z	A	Θ^o	Ψ^o	φ^o	α^o	P,GeV/c
1.	2.	4.	0.13	224.80	-0.09	-0.09	19.4±5.0
2.	2.	4.	0.48	16.80	0.46	0.14	22.1±7.0
3.	2.	3.	0.52	35.66	0.42	0.31	13.1±3.5
4.	2.	4.	0.60	80.32	0.10	0.60	17.0±2.0
5.	2.	4.	0.74	129.49	-0.47	0.57	19.1±3.1
6.	2.	3.	1.77	75.86	0.43	1.72	12.1±2.9
7.	1.		0.30	119.27	-0.15	0.26	
8.	1.		6.48	174.58	-6.45	0.61	
9.	1.		20.85	236.59	-11.85	-17.28	

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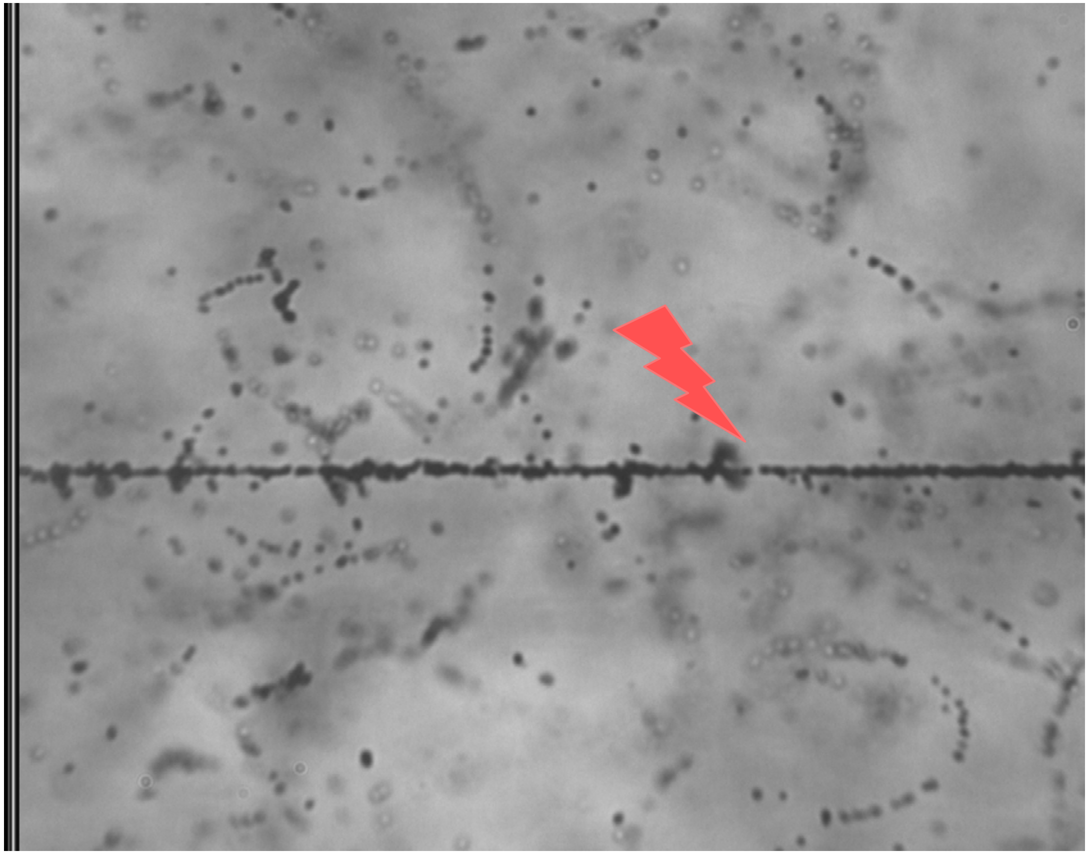
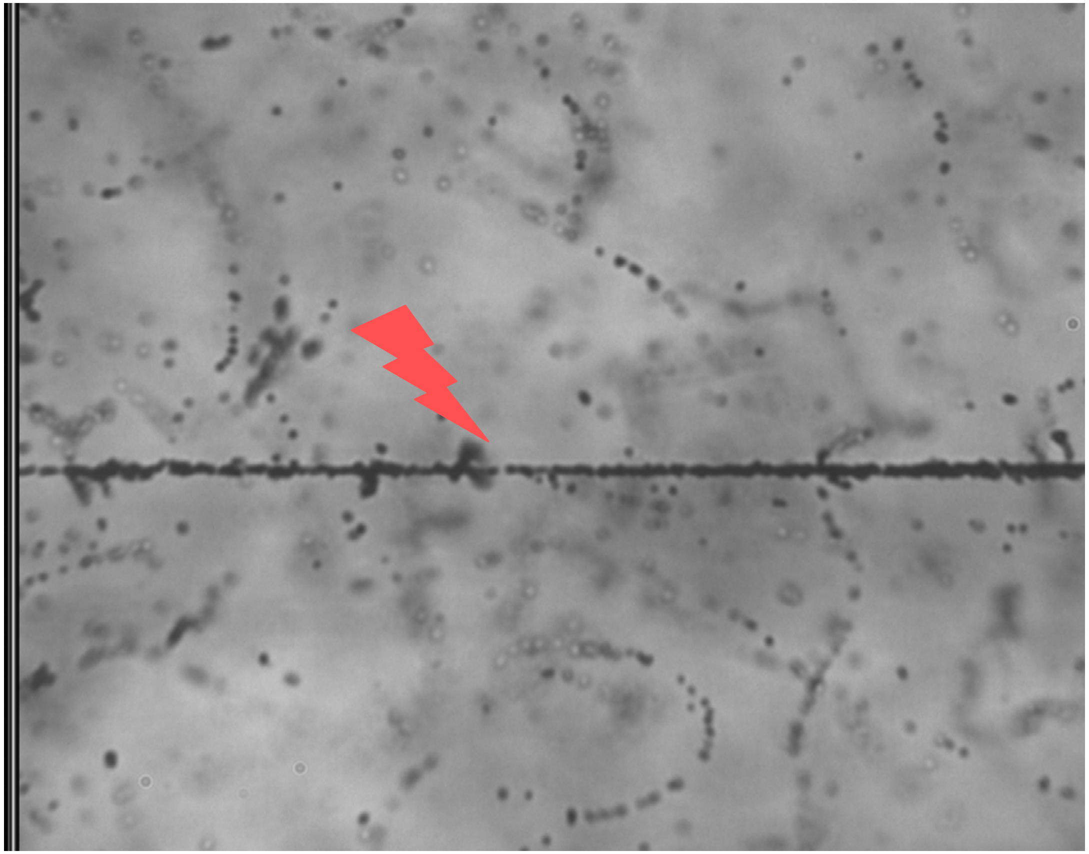
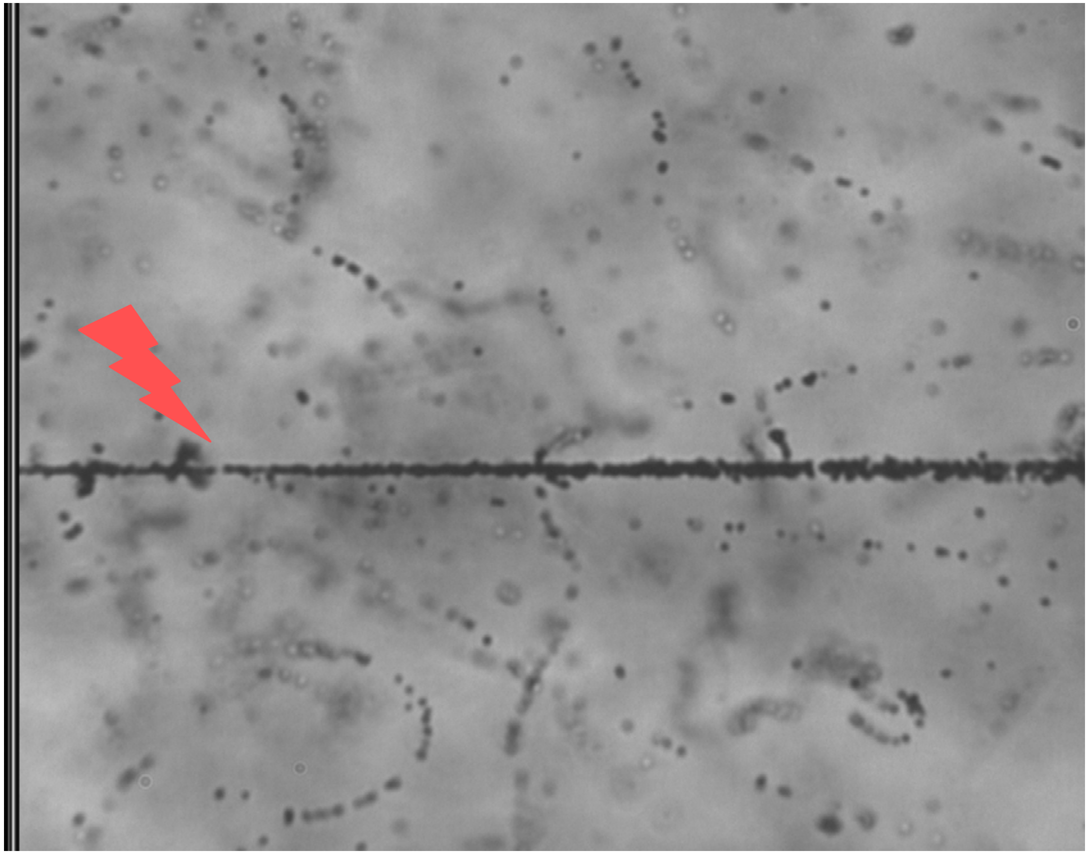
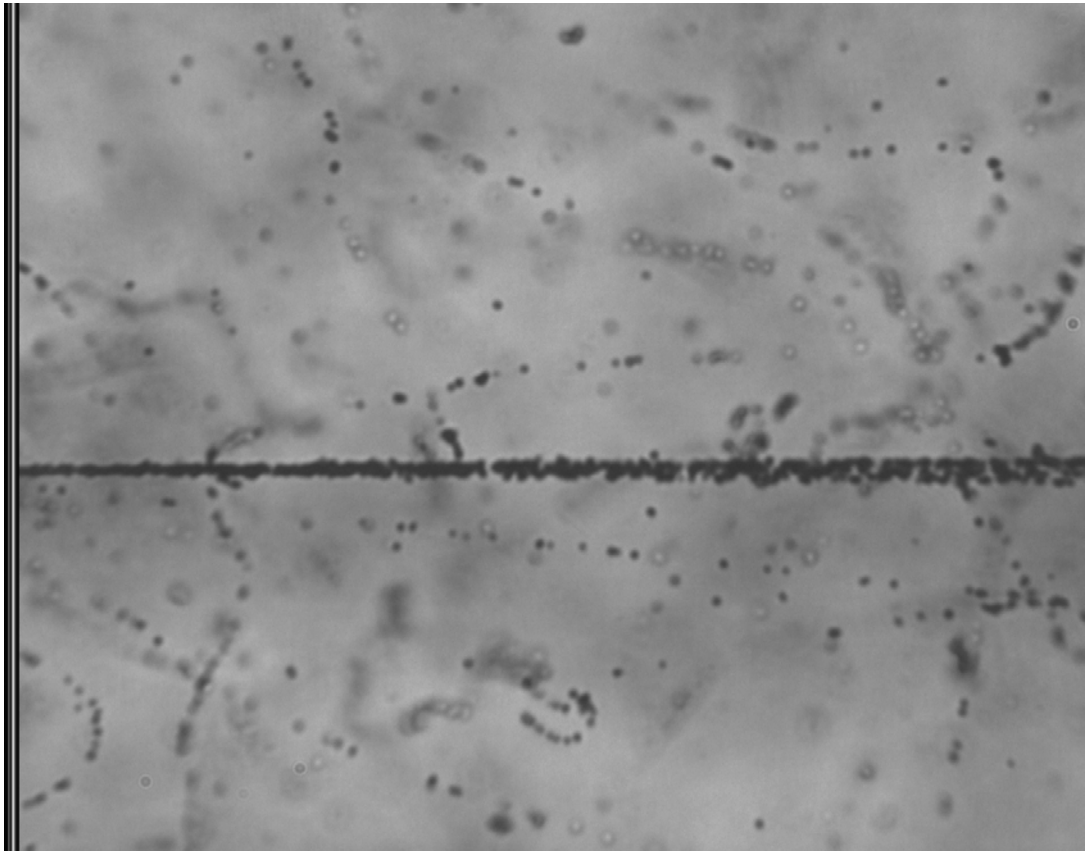
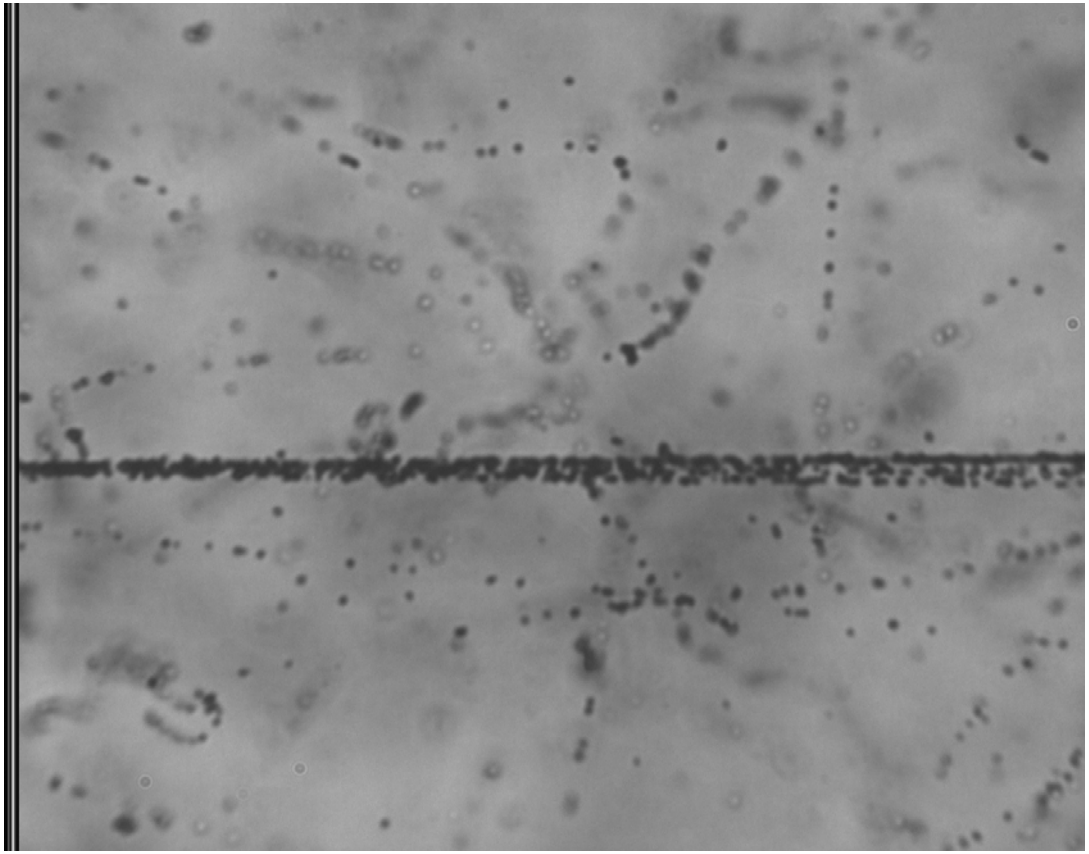
So it looks in the emulsion.

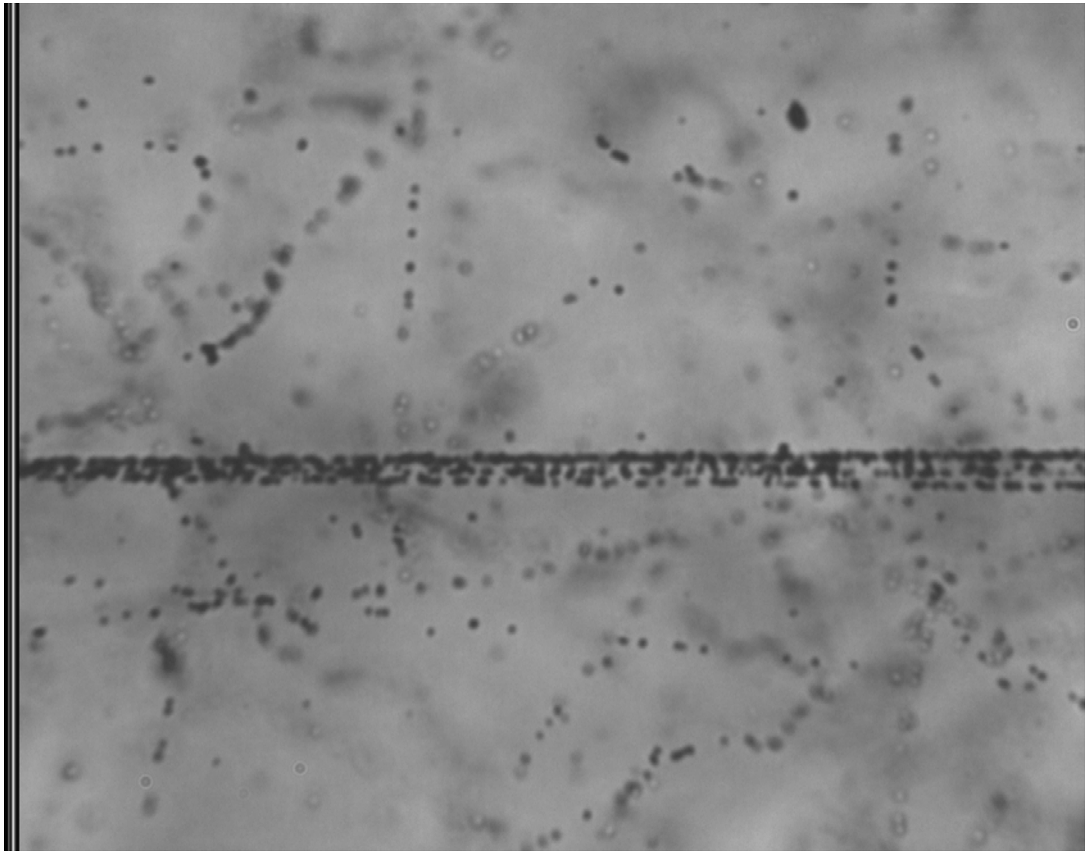


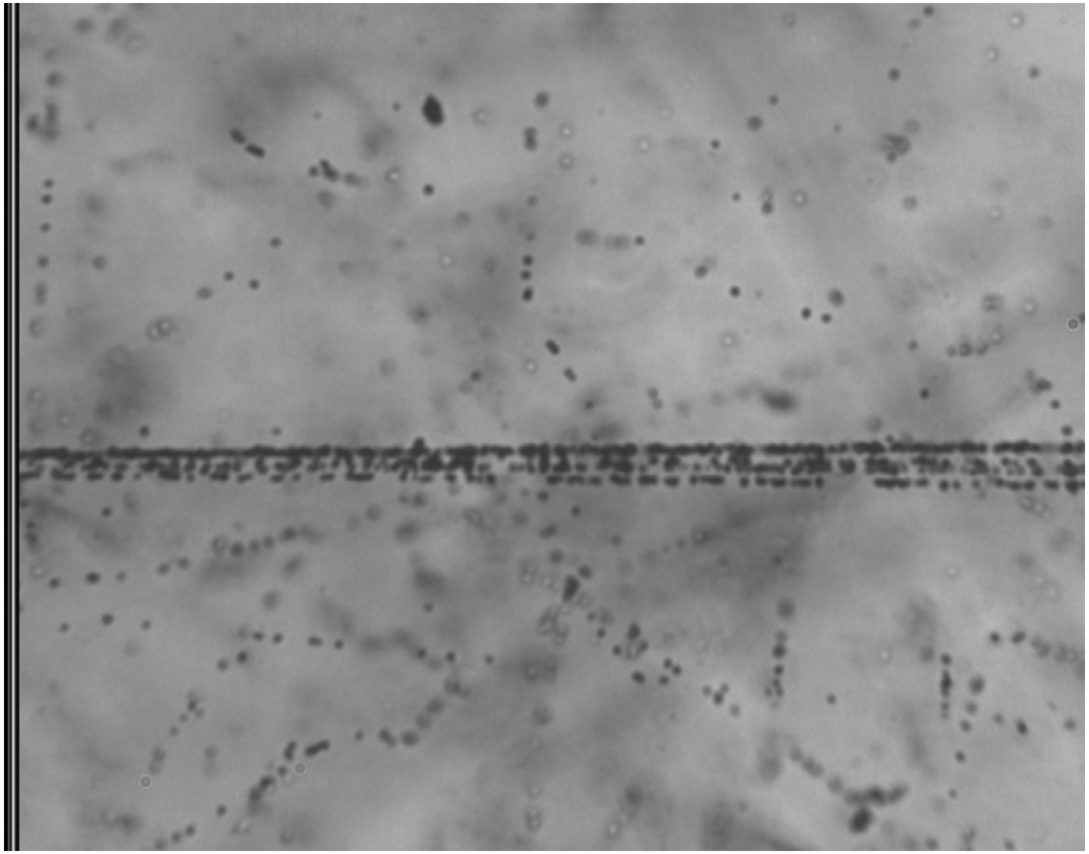


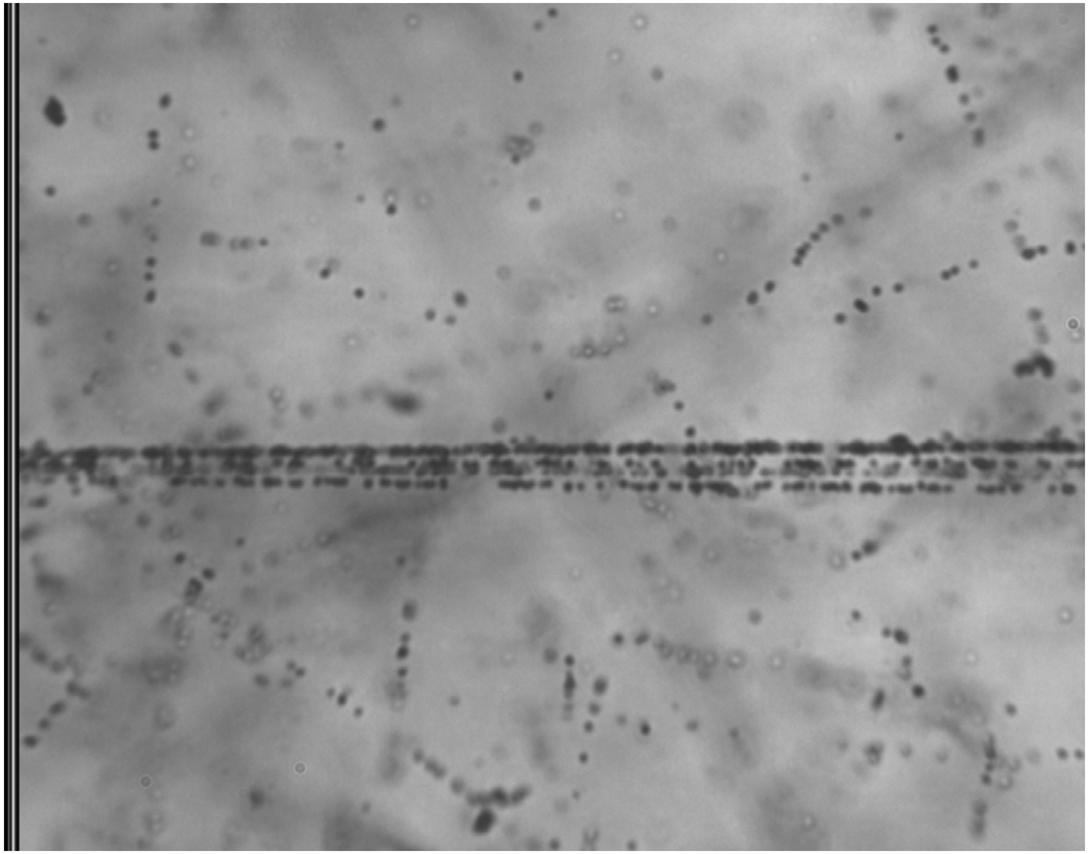




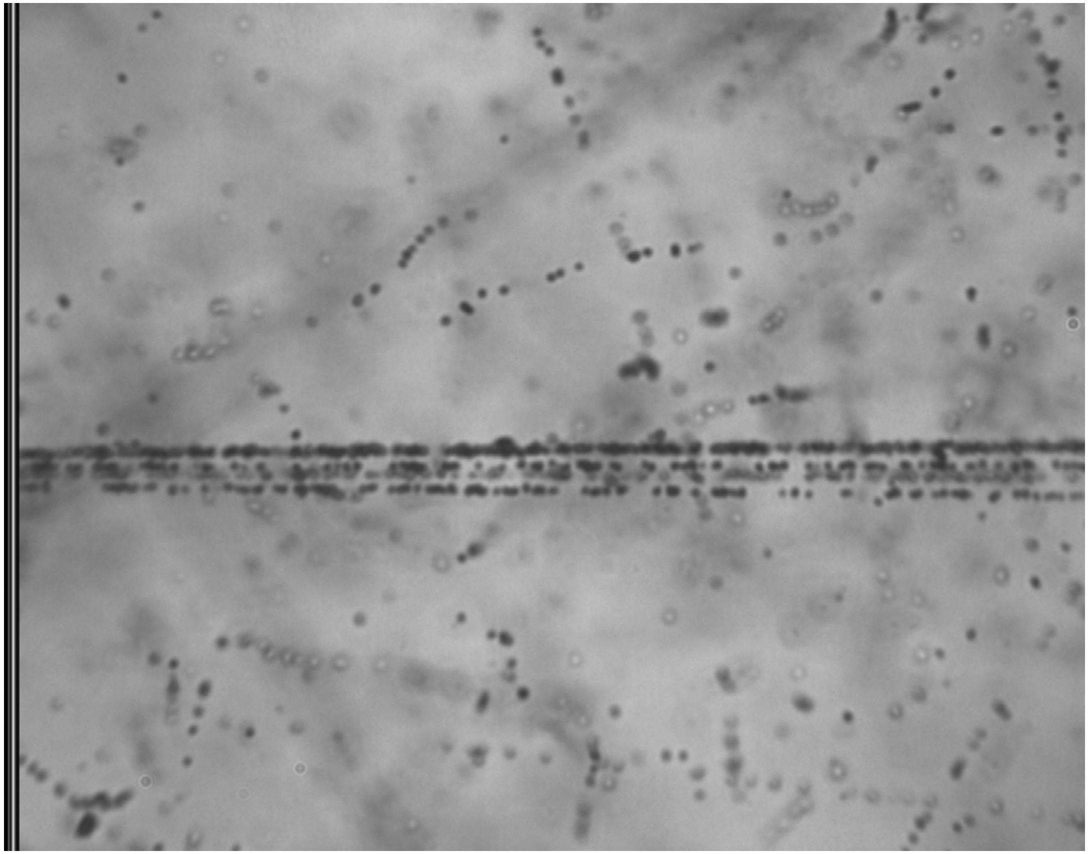








300 mkm from collision center.



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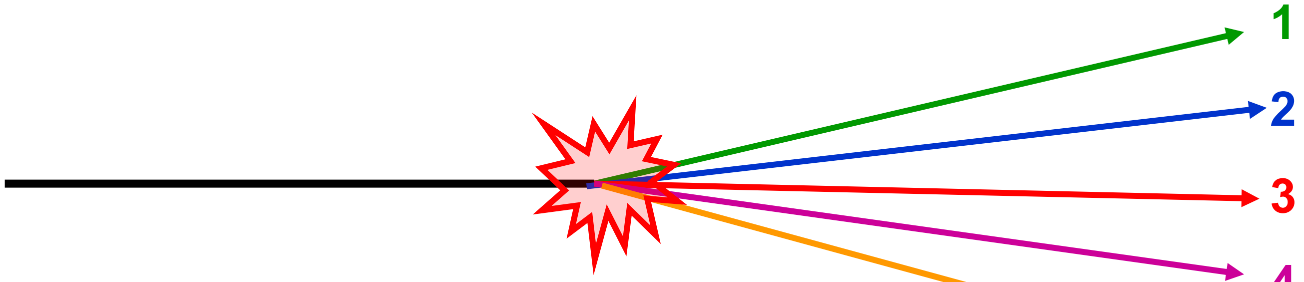
II. The statistics of collisions used for analyses.

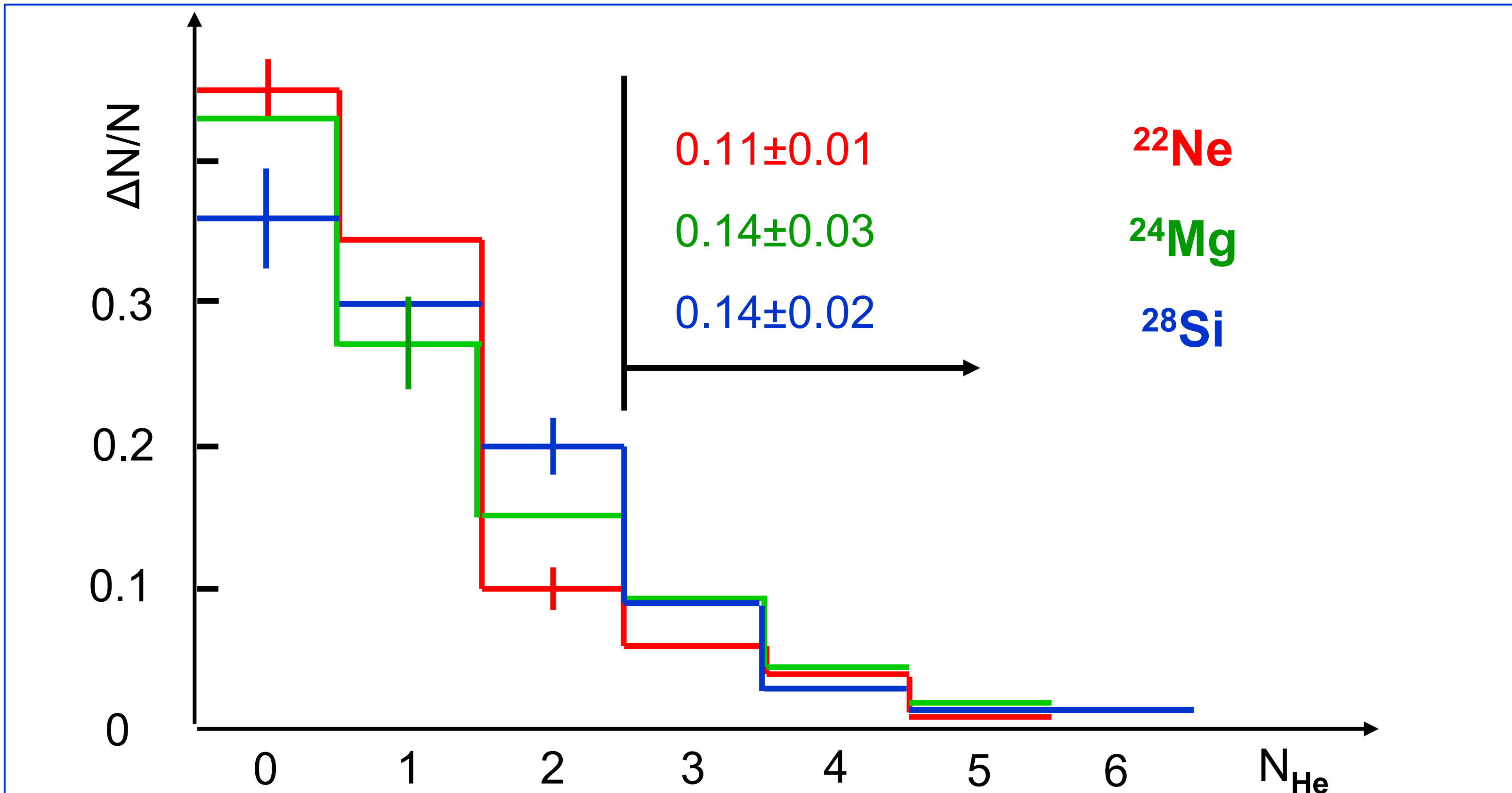
- It isn't minimum bias data set.

A_0	P_0, GeV/c	(N_{He}=3)	(N_{He}=4)	(N_{He}=5)	(N_{He}=6)
^{22}Ne	4.1	238	79	10	
^{24}Mg	4.5	28	45	8	1
^{28}Si	4.5	107	40	21	13

III. The multiplicities of He fragments

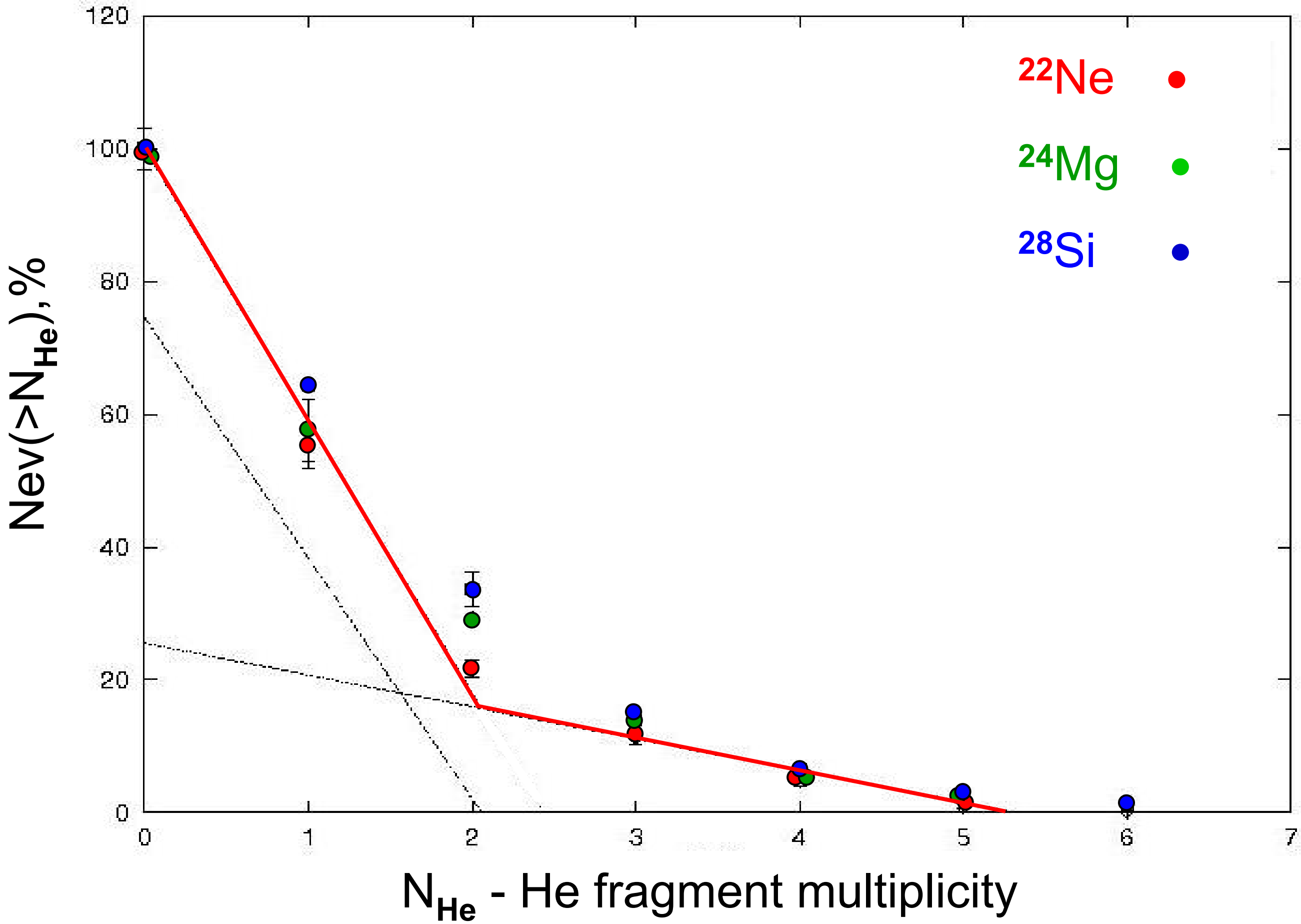


The multiplicity distributions of He fragments

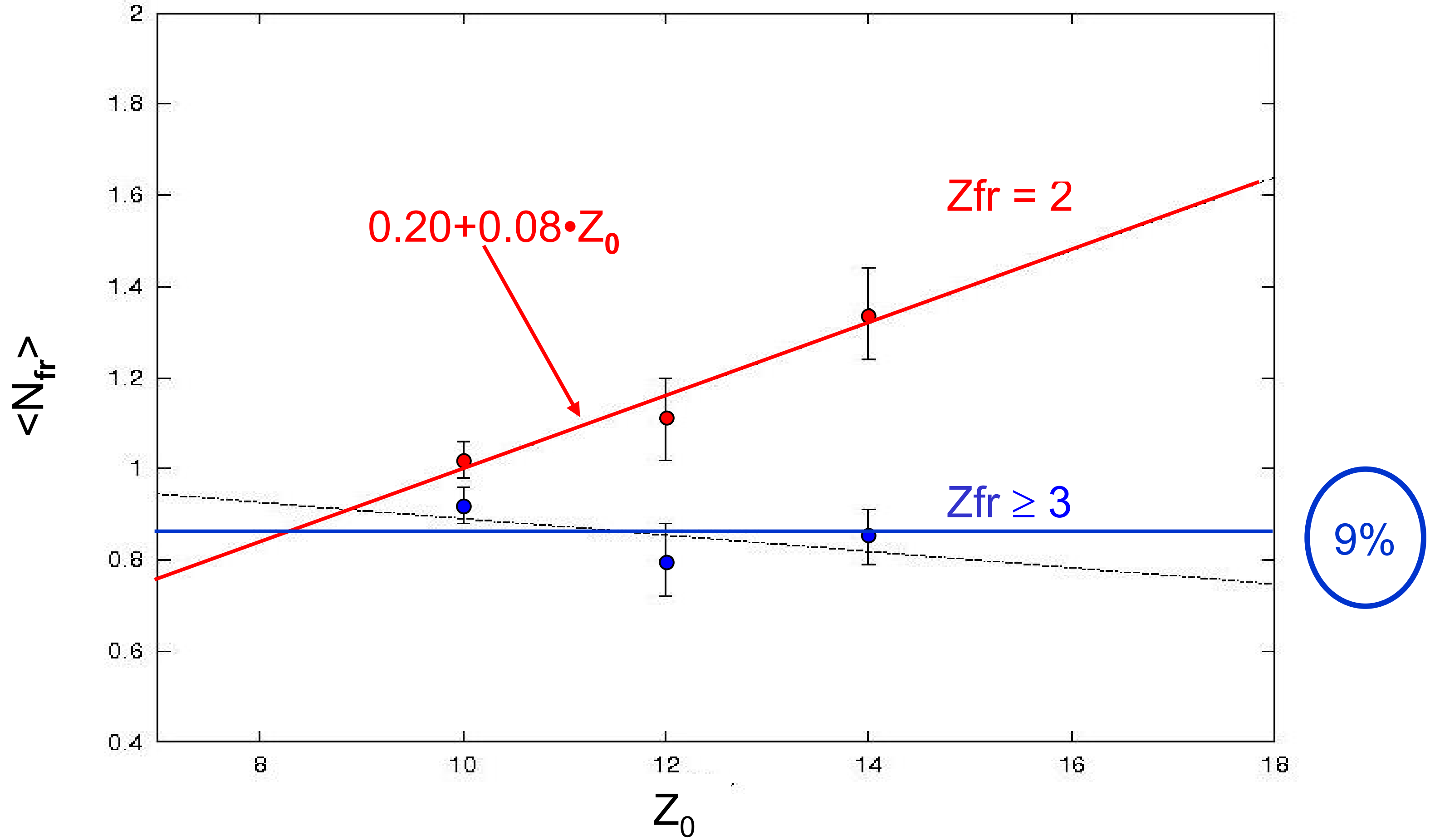


Integral multiplicity distribution of He fragments has a break at N_{He}=2 .

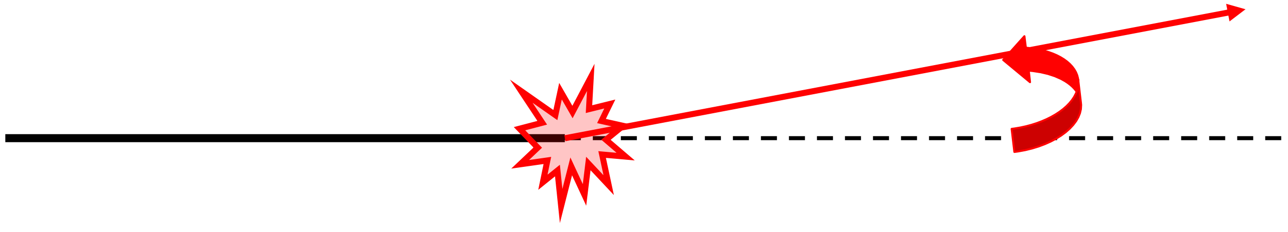
It is minimum biased data set.

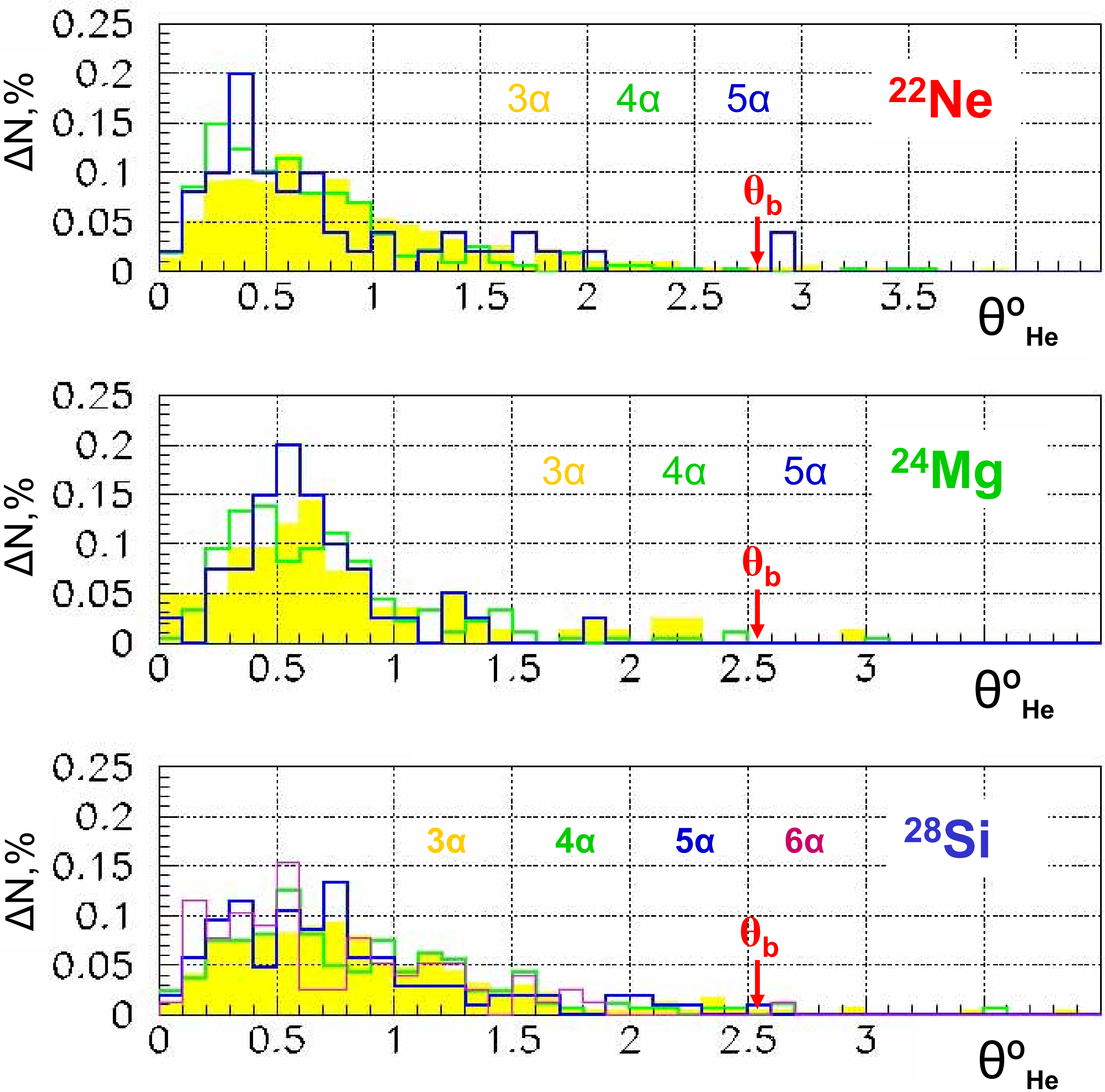


Dependence of average number of projectile fragments with **Zfr = 2** and **Zfr ≥ 3** on the projectile charge Z_0.



IV. The angles of He fragments



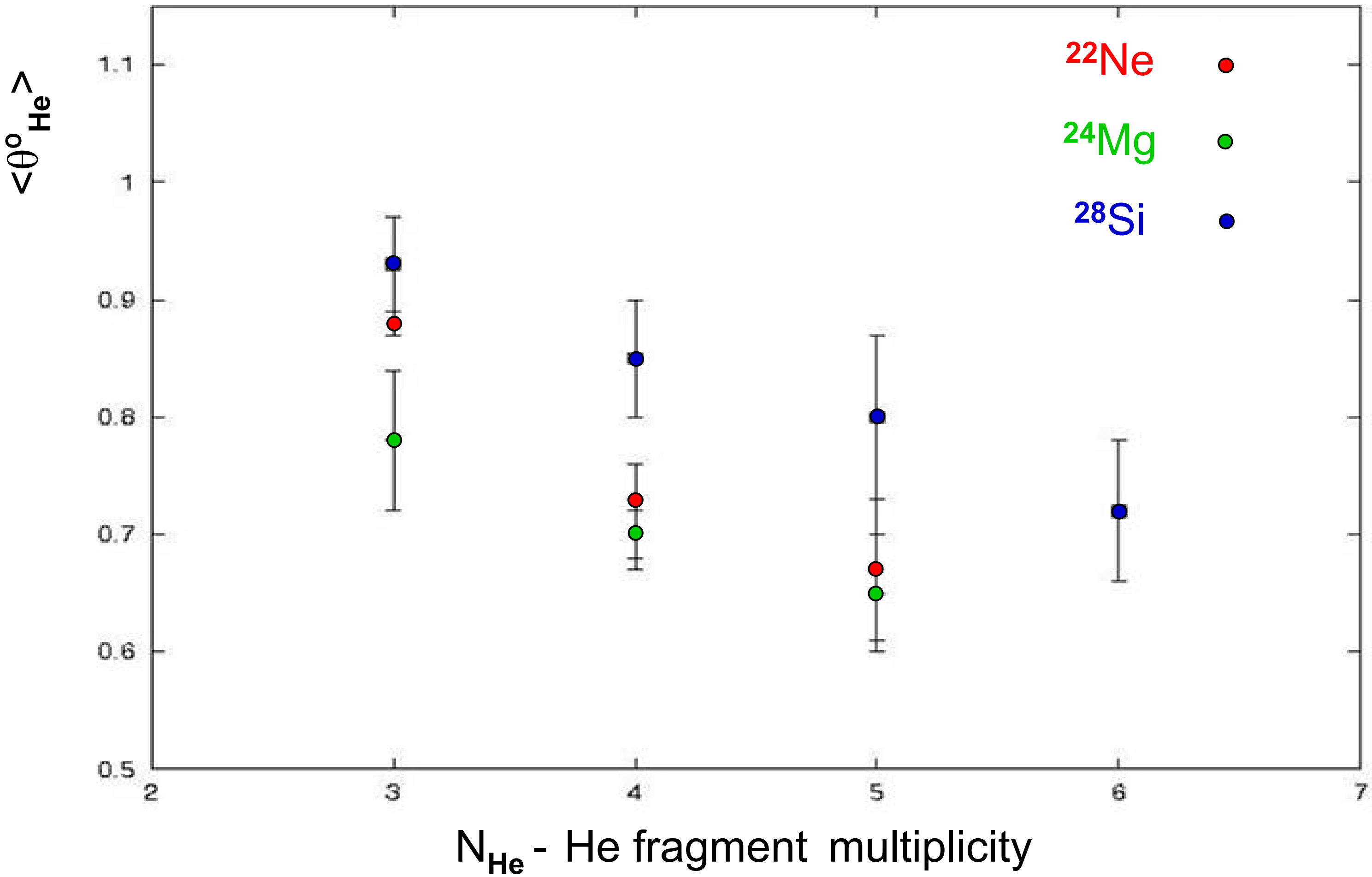


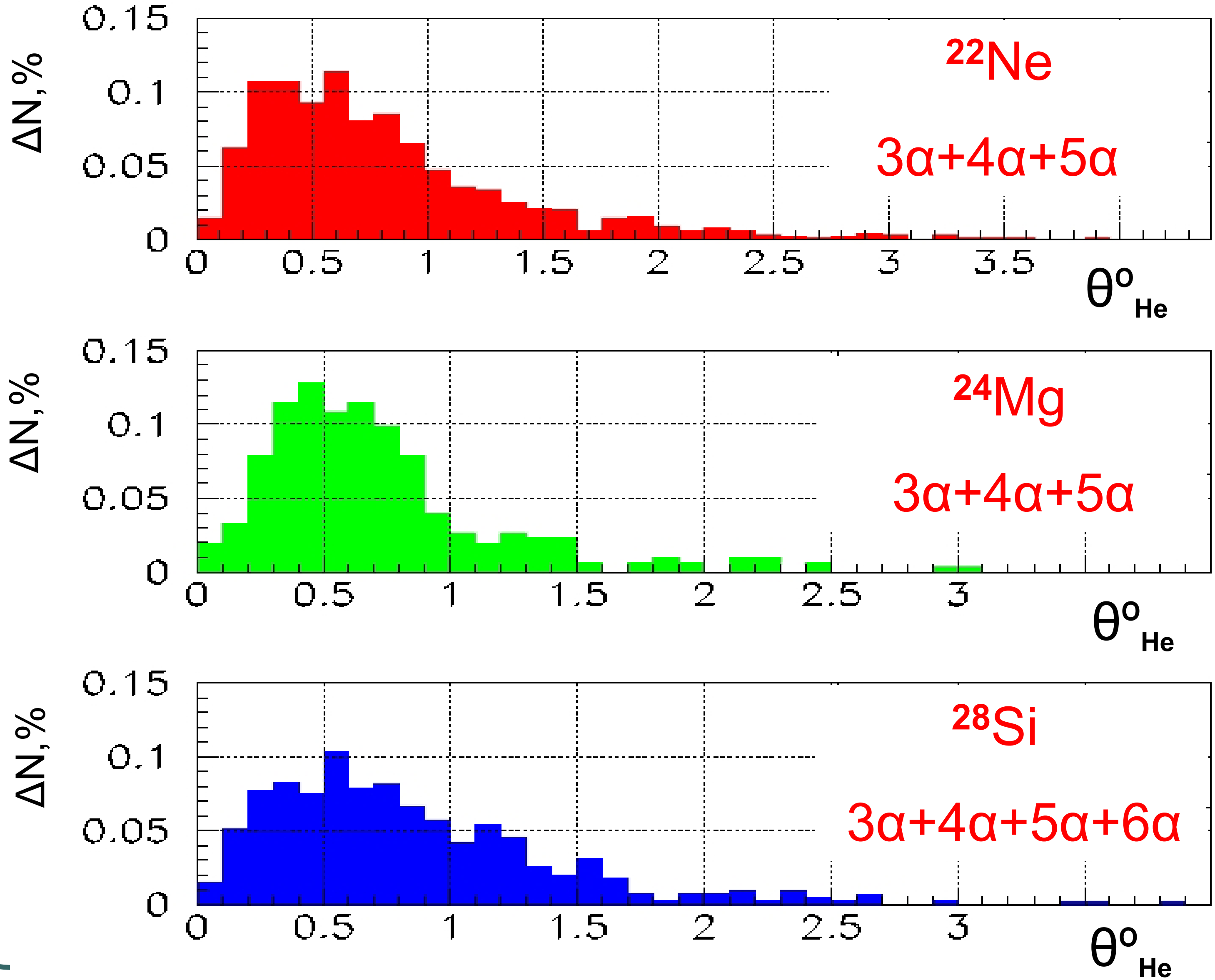
Angular distributions of He fragments

The projectile fragmentation cone is defined by a boundary angle θ_b:

$$\sin\theta_b = 0.2/P_o .$$

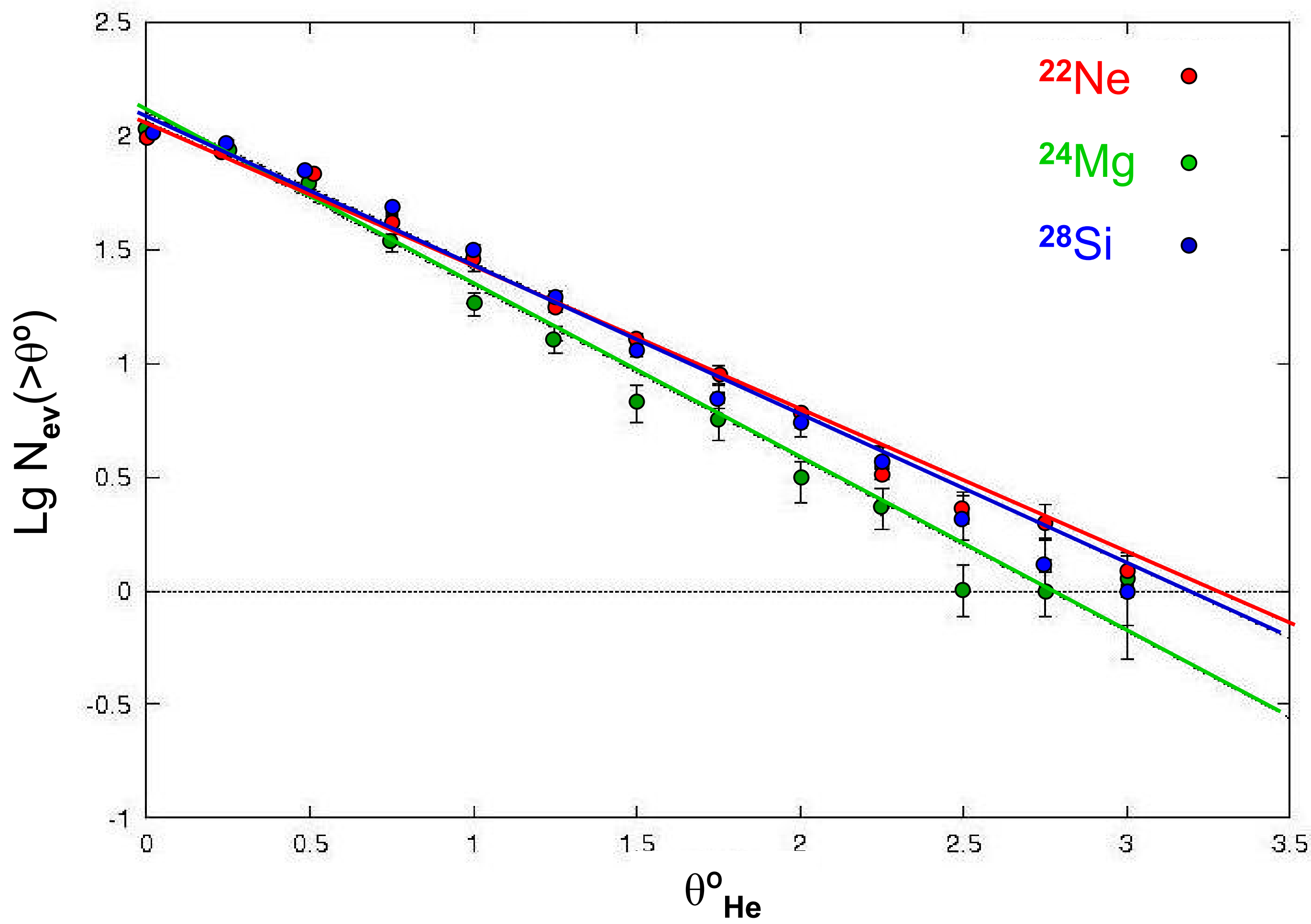
Angles of He fragments decreases with increasing of He fragment multiplicity in collision.

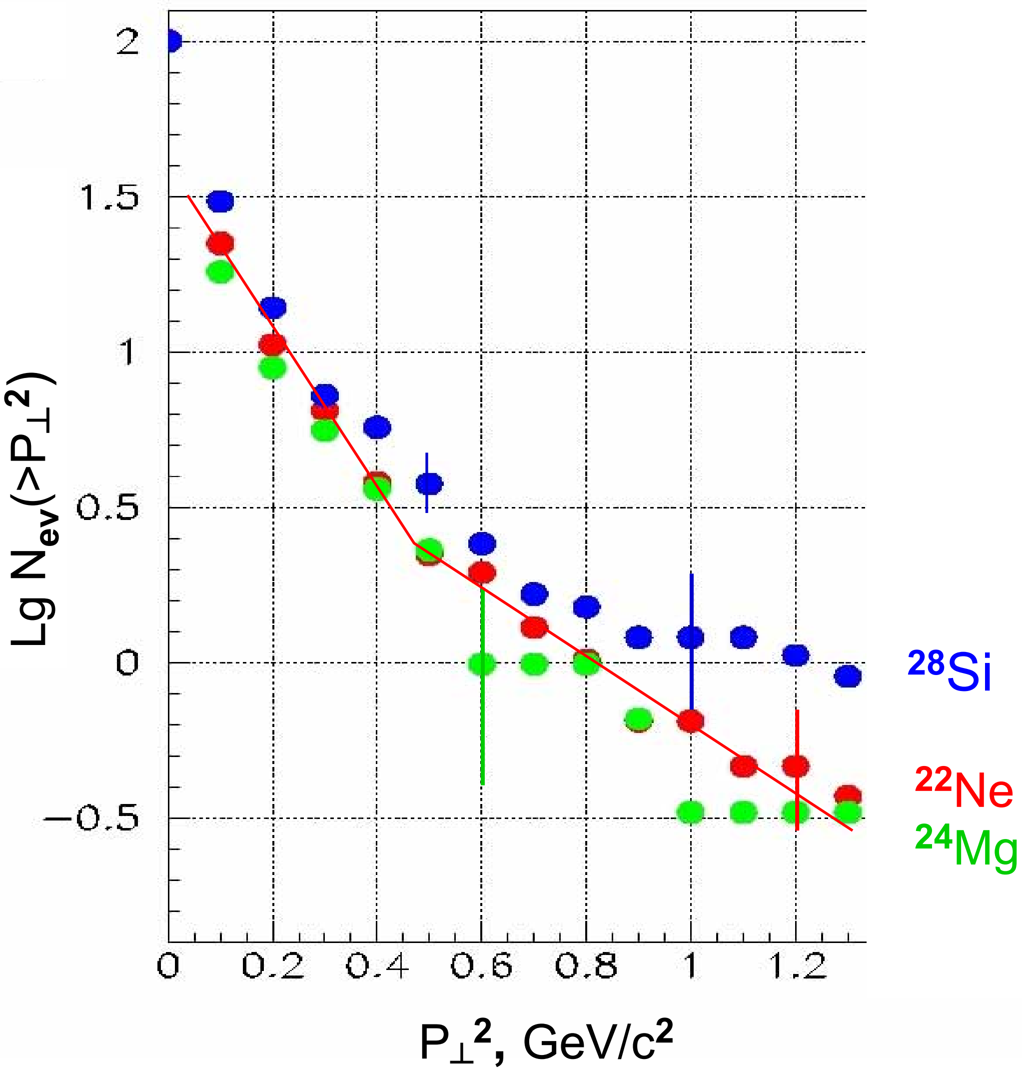




ΔN,%
0.15
0.1
0.05
0
0
0.5
1
1.5
2
2.5
3
3.5
θ^o_{He}
^{22}Ne
3α+4α+5α
ΔN,%
θ^o_{He}
^{24}Mg
3α+4α+5α
ΔN,%
θ^o_{He}
^{28}Si
3α+4α+5α+6α

Integral angular spectrum of He fragments may be fitted by a line.



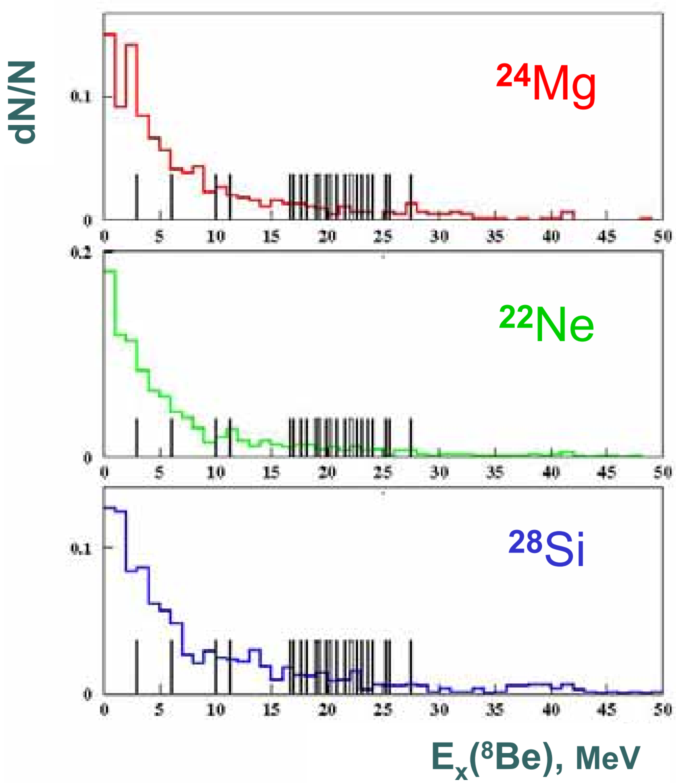


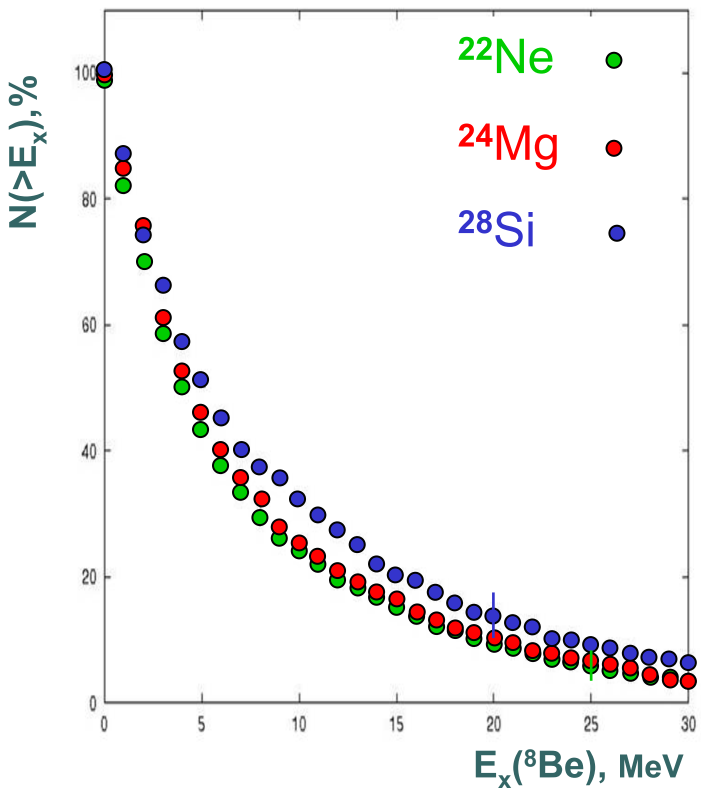
Integral $P_{\perp}^2$ distributions of He fragments may be fitted by a line with break at $P_{\perp}^2 \approx (0.5 - 0.6)$ GeV/c^2.

V. Distributions of the excitation energy

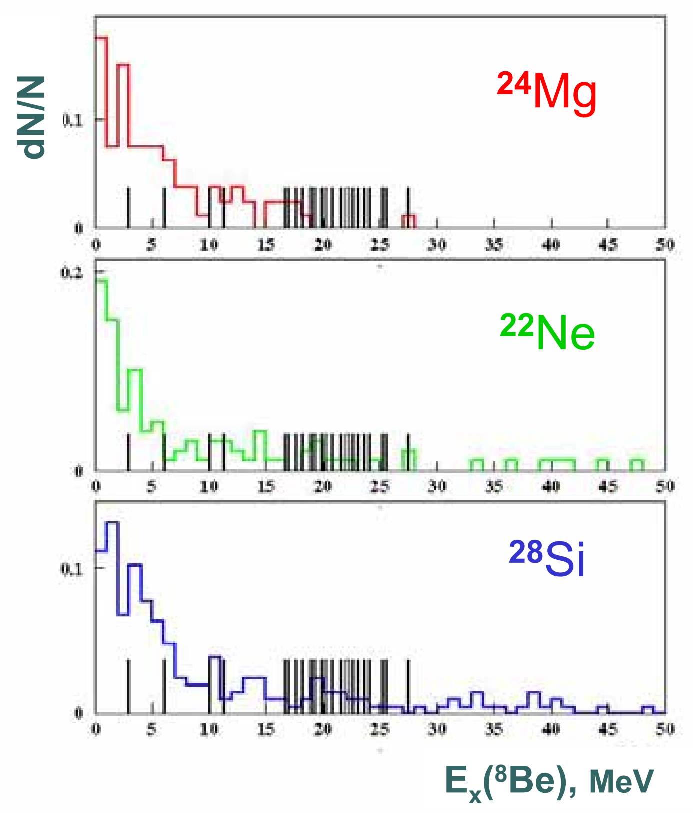
- The reconstructed excitation energy spectrum for decays $^{8}Be \rightarrow 2\alpha$ and $^{12}C \rightarrow 3\alpha$ with respects to the ground state of the nuclei ^{8}Be and ^{12}C have been analyzed.
- The comparison with the exited levels of the nuclei ^{8}Be and ^{12}C have been done.

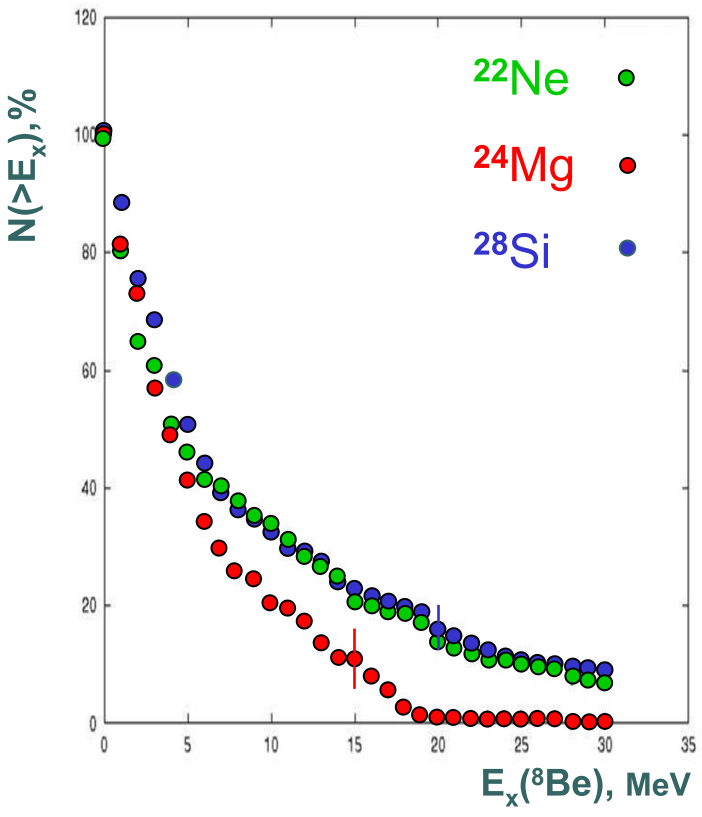
Excitation energy spectrum for decay $^{8}Be \rightarrow 2\alpha$.
Sum of channels with ≥3α in final state.





Excitation energy spectrum for decay $^{8}Be \rightarrow 2\alpha$.
Channels with 5α in final state.





Excitation energy spectrum for decay $^{8}Be \rightarrow 2\alpha$.
Interaction of ^{22}Ne at 4.1 A GeV/c.

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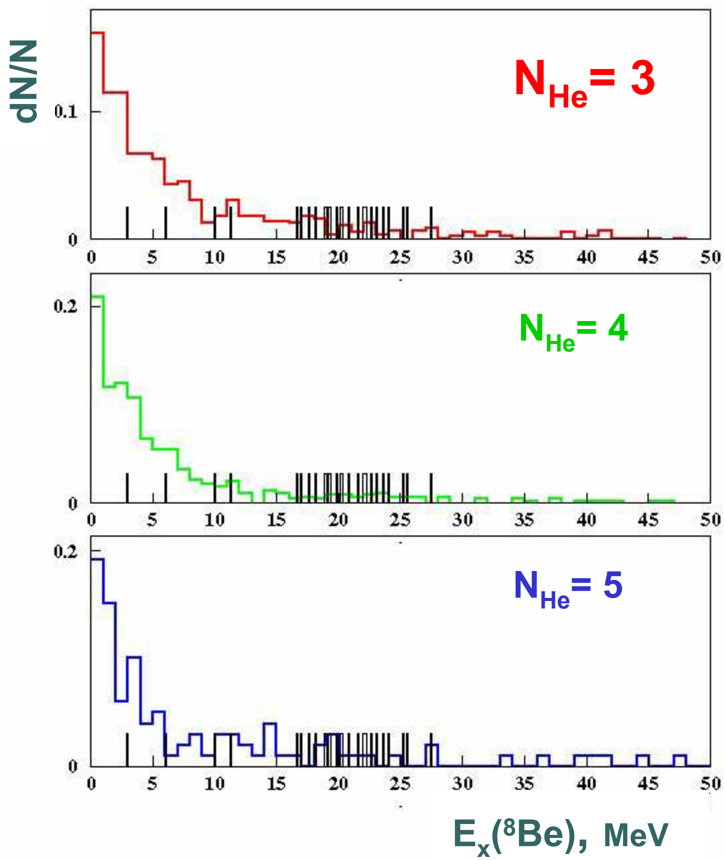
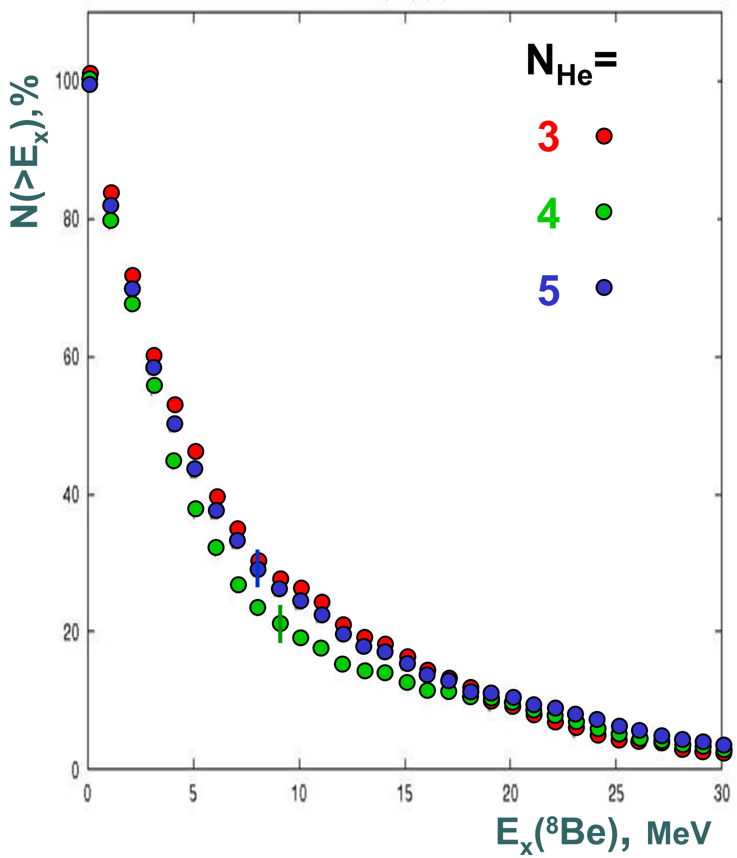
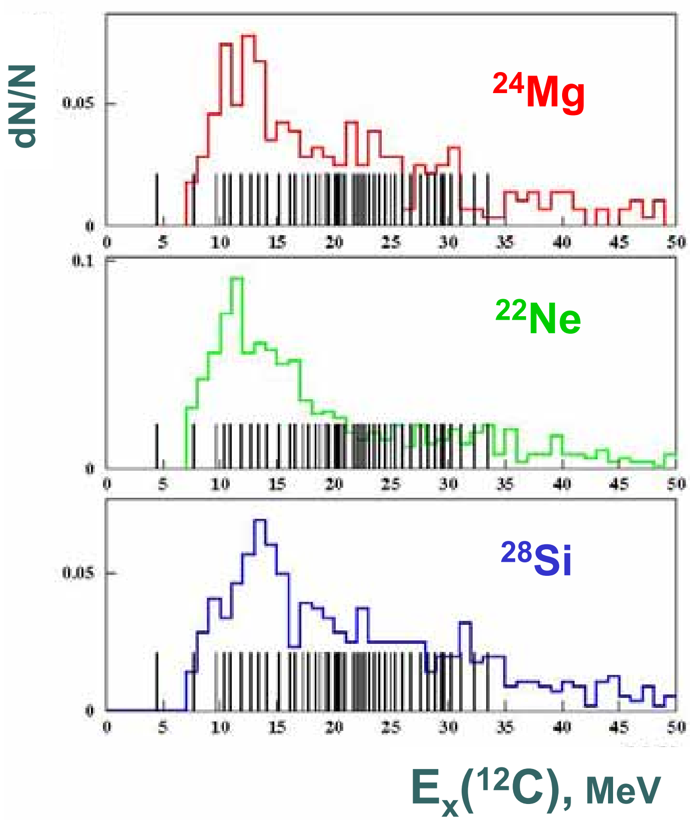
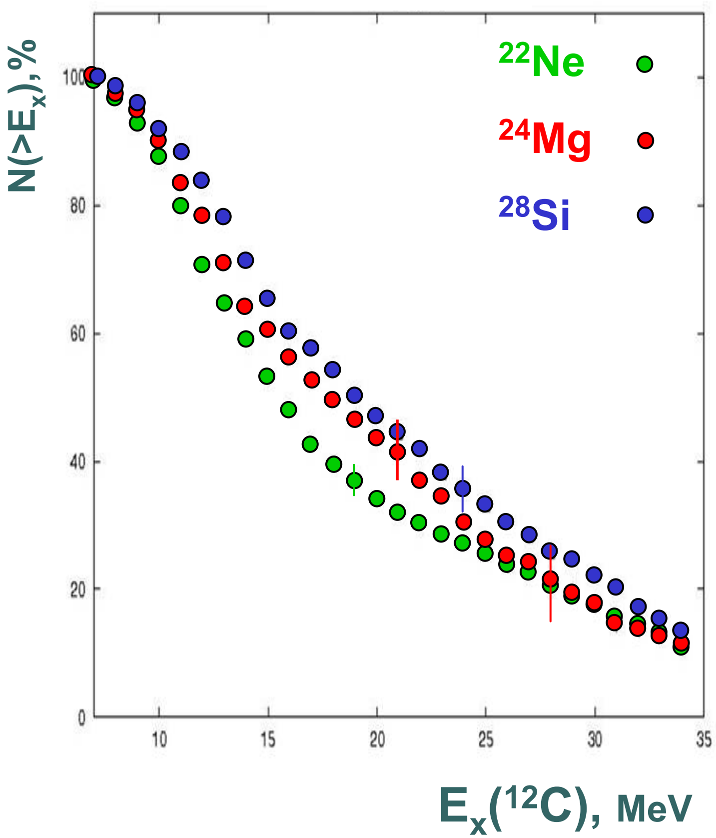


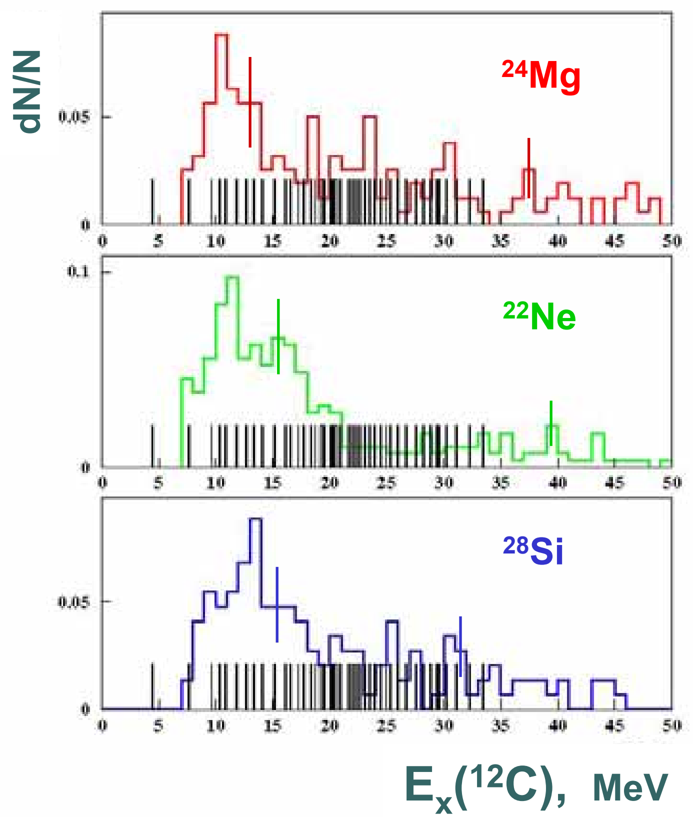


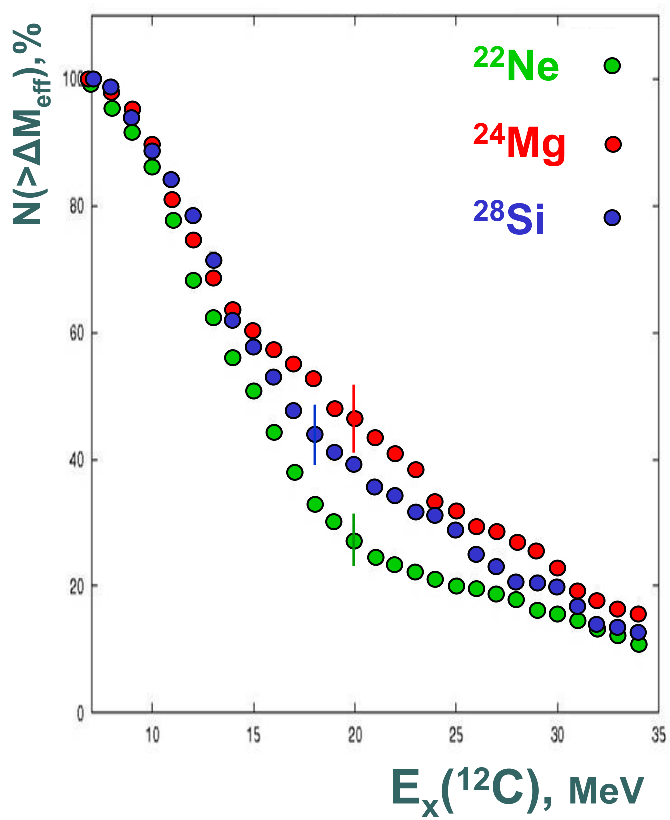
Excitation energy spectrum for decay $^{12}C \rightarrow 3\alpha$.
Sum of channels with $\geq 3\alpha$ in final state.



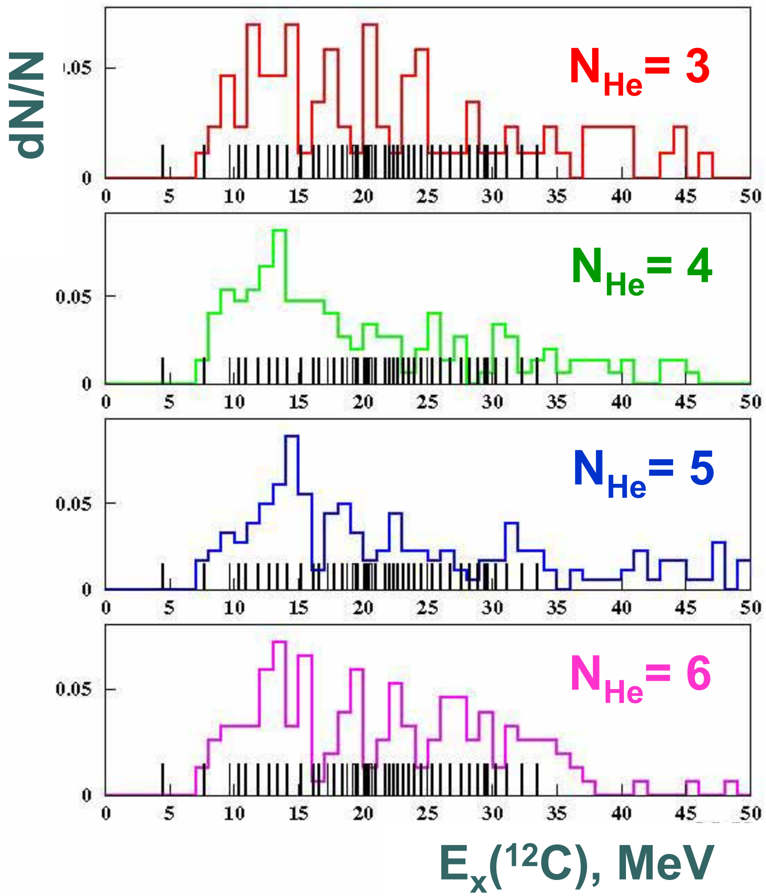


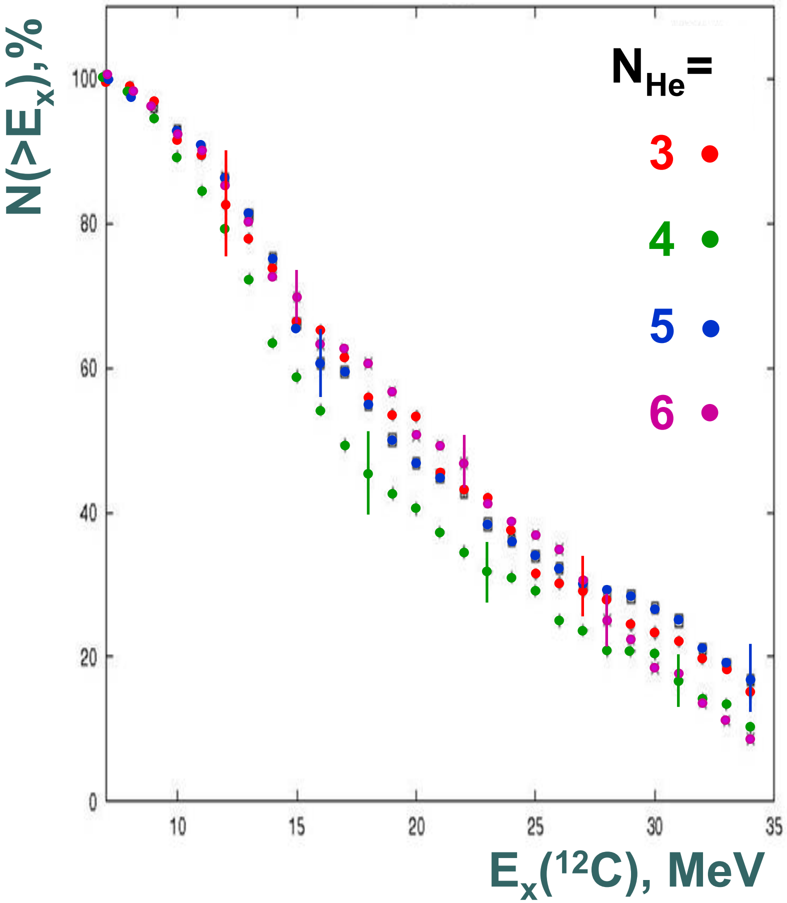
Excitation energy spectrum for decay $^{12}C \rightarrow 3\alpha$.
Cannels with 4α in final state.





Excitation energy spectrum for decay $^{12}C \rightarrow 3\alpha$.
Interaction of ^{28}Si at 4.5 A GeV/c.





VI. Conclusions.
Multiplicity.

- Characteristics of projectile He fragments from collision of ^{22}Ne, ^{24}Mg and ^{28}Si in emulsion at 4.1- 4.5 A GeV/c have been studies. Only the collisions with $\geq$3 He fragments and with the sum charge in the forward narrow cone, been equal to that of projectile one, have been analyzed.
- Integral multiplicity distribution of He fragments may be fitted by a line with a break at $N_{He}=2$.
- In the region under investigation average number of He fragments increases with increasing of projectile charge as $0.20+0.08 \cdot Z_0$; at the same time average number of fragments with $Z_{fr} \geq 3$ is approximately constant.
- It means, that increasing of projectile fragments number with increasing of projectile charge is due to number of fragments with charges 1 and 2.

VI. Conclusions.
Angles.

- Angles of He fragments decrease with increasing of He fragment multiplicity in collision.
- Integral angular spectrum of He fragments may be fitted by a line.
- There is no difference in angles of He fragments from ^{22}Ne, ^{24}Mg and ^{28}Si interaction.

VI. Conclusions.

Excitation energy.

- The first four excited levels (E_x<15 MeV) are mostly responsible for $^8Be \rightarrow 2\alpha$ decays in our experiment.
- There is no differences in the excitation energy spectrum for decays $^8Be \rightarrow 2\alpha$ for ^{22}Ne, ^{24}Mg and ^{28}Si collisions from one side and for channels with 3, 4, 5 and 6 He fragments in final states from other.
- The exited levels in the interval E_x< 15-20 MeV are mostly responsible for $^{12}C \rightarrow 3\alpha$ decays in our experiment. The first available level O^+ - 7.65 MeV is represented weakly.
- There is no significant difference in the excitation energy spectrum for decays $^{12}C \rightarrow 3\alpha$ for ^{22}Ne, ^{24}Mg and ^{28}Si collisions from one side and for channels with 3, 4, 5 and 6 He fragments in final states from other.