BECQUEREL PROJECT

Проект БЕККЕРЕЛЬ

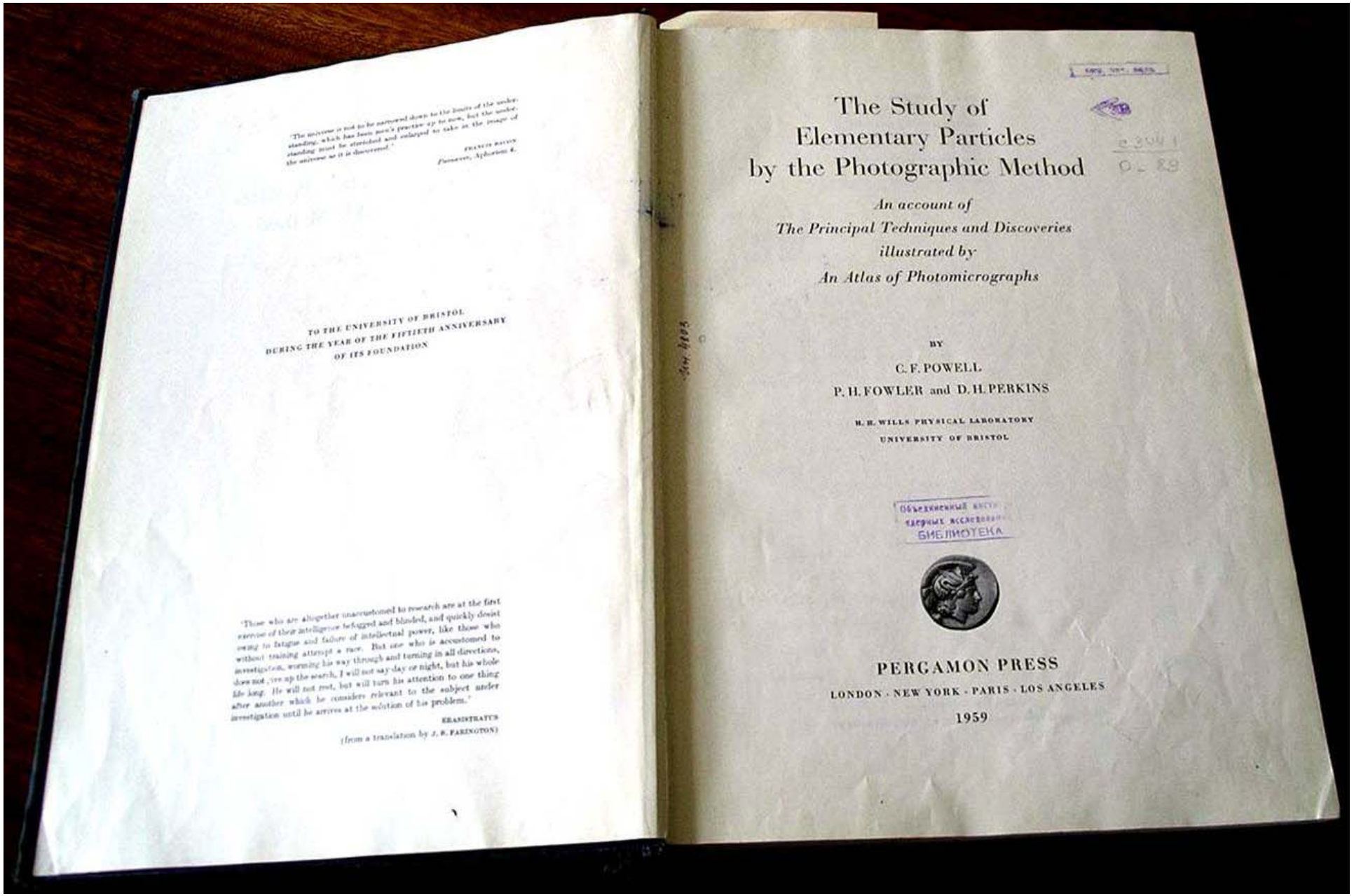
Beryllium (Boron) Clustering Quest in Relativistic Multifragmentation

http://becquerel.jinr.ru

Imaging of Nuclear Fragmentation in Nuclear Track Emulsion

I. G. Zarubina (JINR)

http://becquerel.jinr.ru



TO THE UNIVERSITY OF BRISTOL
DURING THE YEAR OF THE FIFTIETH ANNIVERSARY
OF ITS FOUNDATION

'Those who are altogether unaccustomed to research are at the first exercise of their intelligence befogged and blinded, and quickly desist owing to fatigue and failure of intellectual power, like those who without training attempt a race. But one who is accustomed to investigation, storming his way through and turning in all directions, does not give up the search, I will not say day or night, but his whole life long. He will not rest, but will turn his attention to one thing after another which he considers relevant to the subject under investigation until he arrives at the solution of his problem.'

ERASISTRATUS
(from a translation by J. S. FARINGTON)

The Study of Elementary Particles by the Photographic Method

An account of
The Principal Techniques and Discoveries
illustrated by
An Atlas of Photomicrographs

BY

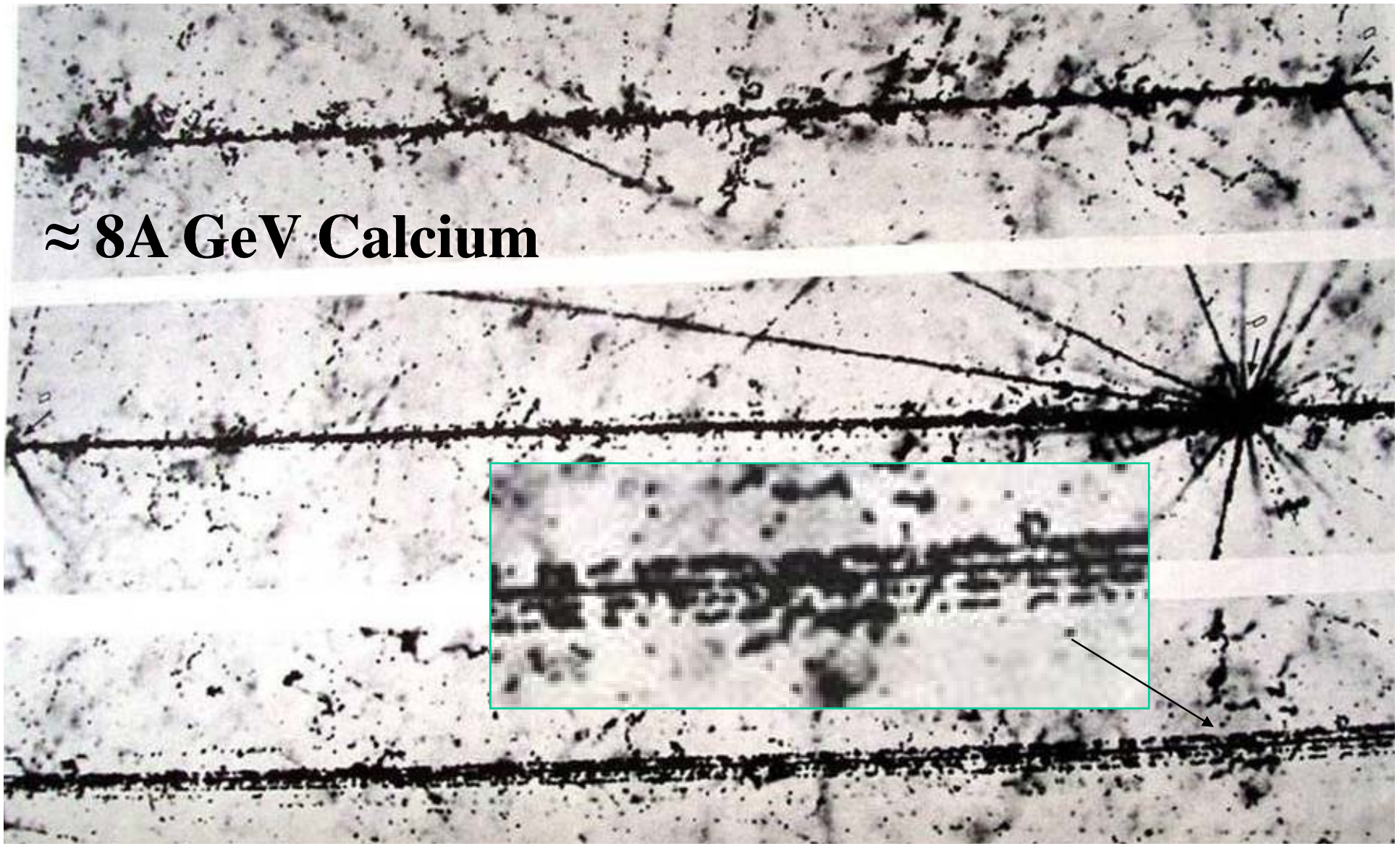
C. F. POWELL
P. H. FOWLER and D. H. PERKINS

H. H. WILLS PHYSICAL LABORATORY
UNIVERSITY OF BRISTOL

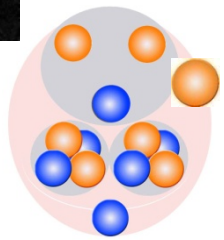
PERGAMON PRESS
LONDON · NEW YORK · PARIS · LOS ANGELES
1959

The unique collection of images in the "Emulsion Bible" by Powell, Fowler, and Perkins.

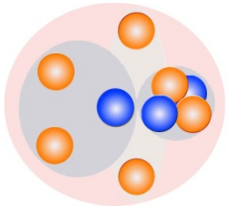
Fragmentation of relativistic nucleus of galactic origin



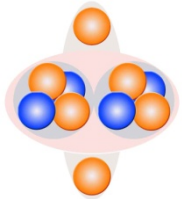
^{12}N 11.0 ms



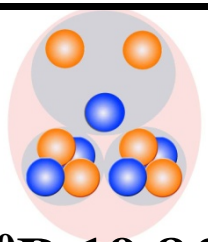
^{9}C 0.1265 s



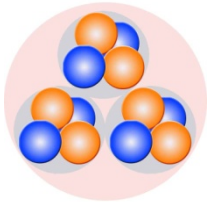
^{10}C 19.2 s



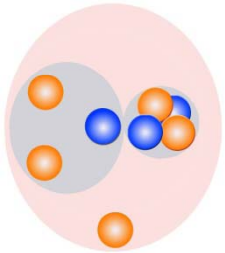
^{11}C 20.38 m



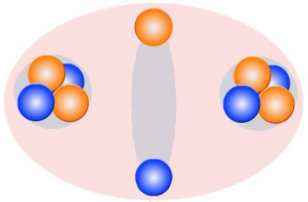
^{12}C 98.89 %



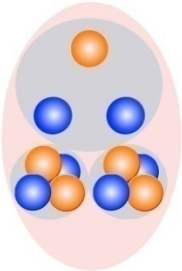
^{8}B 0.769 s



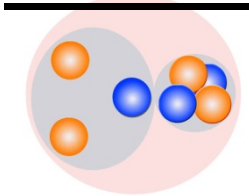
^{10}B 19.8%



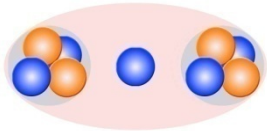
^{11}B 80.2 %



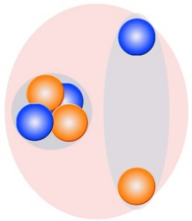
^{7}Be 53.3 d



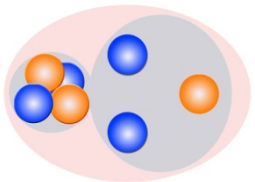
^{9}Be 100%



^{6}Li 7.5 %



^{7}Li 92.5 %




≈ 10 cm
Nuclear track emulsion:
0.5 μm resolution

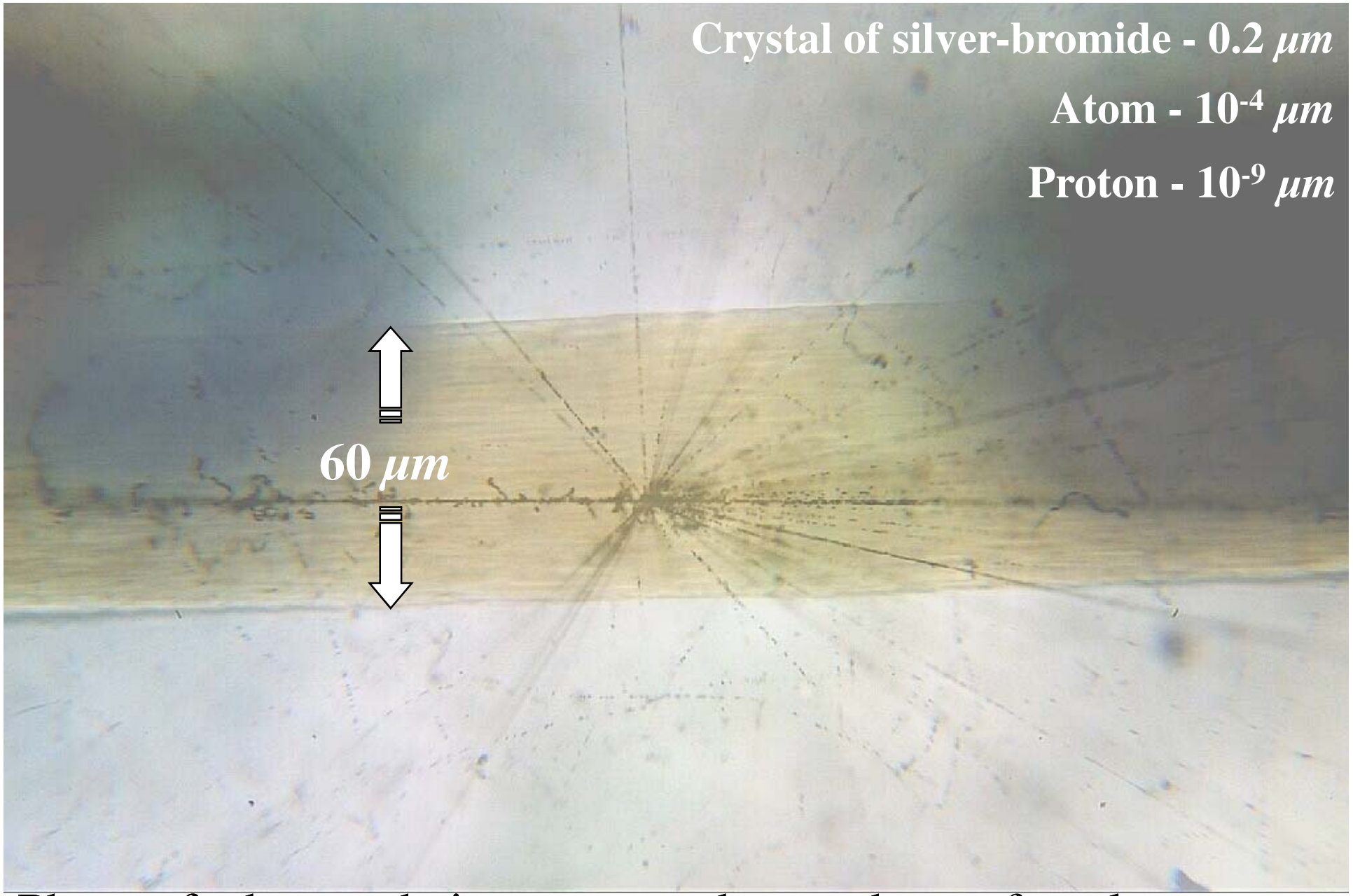


Photo of a human hair superposed on a photo of nuclear star produced by relativistic sulphur nucleus

BECQUEREL PROJECT
Проект БЕККЕРЕЛЬ

Beryllium (Boron) Clustering Quest in Relativistic Multif

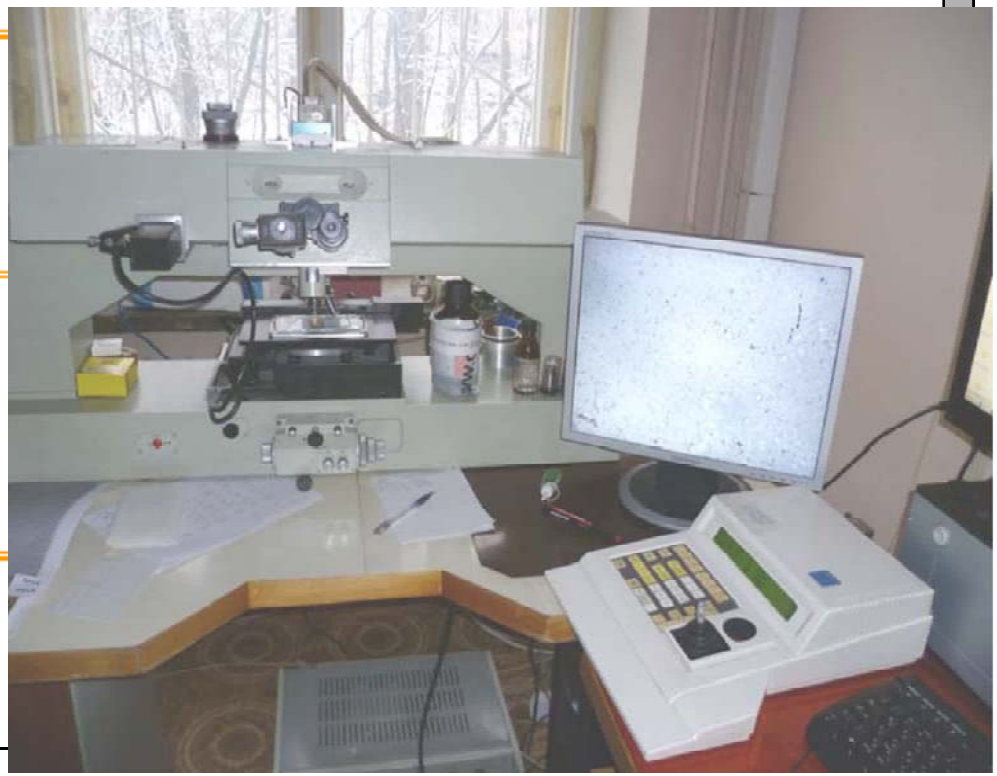
Full Collection of Movies

^{3}He (6.75A GeV/c)

■ He3-20-61-7253	H+H	avi 1.5 Mb	mov 4.3 Mb	jpg 700 kb

^{3}H (2.67A GeV/c ^{6}Li)

■ H3-2-2-2	^{3}He	avi 300 kb
■ H3-2-3-4	^{3}He+1s	avi 800 kb
■ H3-2-15-1	^{3}He+2b	avi 2.4 Mb



acta physica slovaca vol. 54 No. 4, 351 – 365 August 2004

STUDIES OF LIGHT NUCLEUS CLUSTERING IN RELATIVISTIC MULTIFRAGMENTATION PROCESSES

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[b] *P. N. Lebedev Physical Institute, Moscow, Russia*
[c] *Institute of Physics and Technology, Almaty, Kazakstan*
[d] *Institute of Experimental Physics, SAS, Košice, Slovakia*
[e] *Institute of Space Sciences, Bucharest-Maguerel, Romania*
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Received 1 March 2004, accepted 6 July 2004

We give an overview of results and prospects of nuclear clustering studies on the grounds of the observations of interactions of light stable and radioactive nuclei with an initial energy above 1A GeV in nuclear emulsions. Thank to the best spatial resolution and the full solid angle acceptance provided by nuclear emulsions, such an approach allows one to obtain unique and evident observations reflecting cluster-like features in light nuclear structures. New results on dissociation of ^{7}Be in very peripheral interactions with emulsion nuclei are presented. The importance of this research for the physics of few body nuclear systems and the related problems of nucleosynthesis is noted. The paper is illustrated with characteristic images obtained by means of a microscope equipped with a CCD camera. The discussed explorations are provided with the beams of the Synchrophasotron and Nuclotron of JINR, Dubna. Future investigations are suggested to be carried out in relativistic beams of He, Be, B, C, and N isotopes.

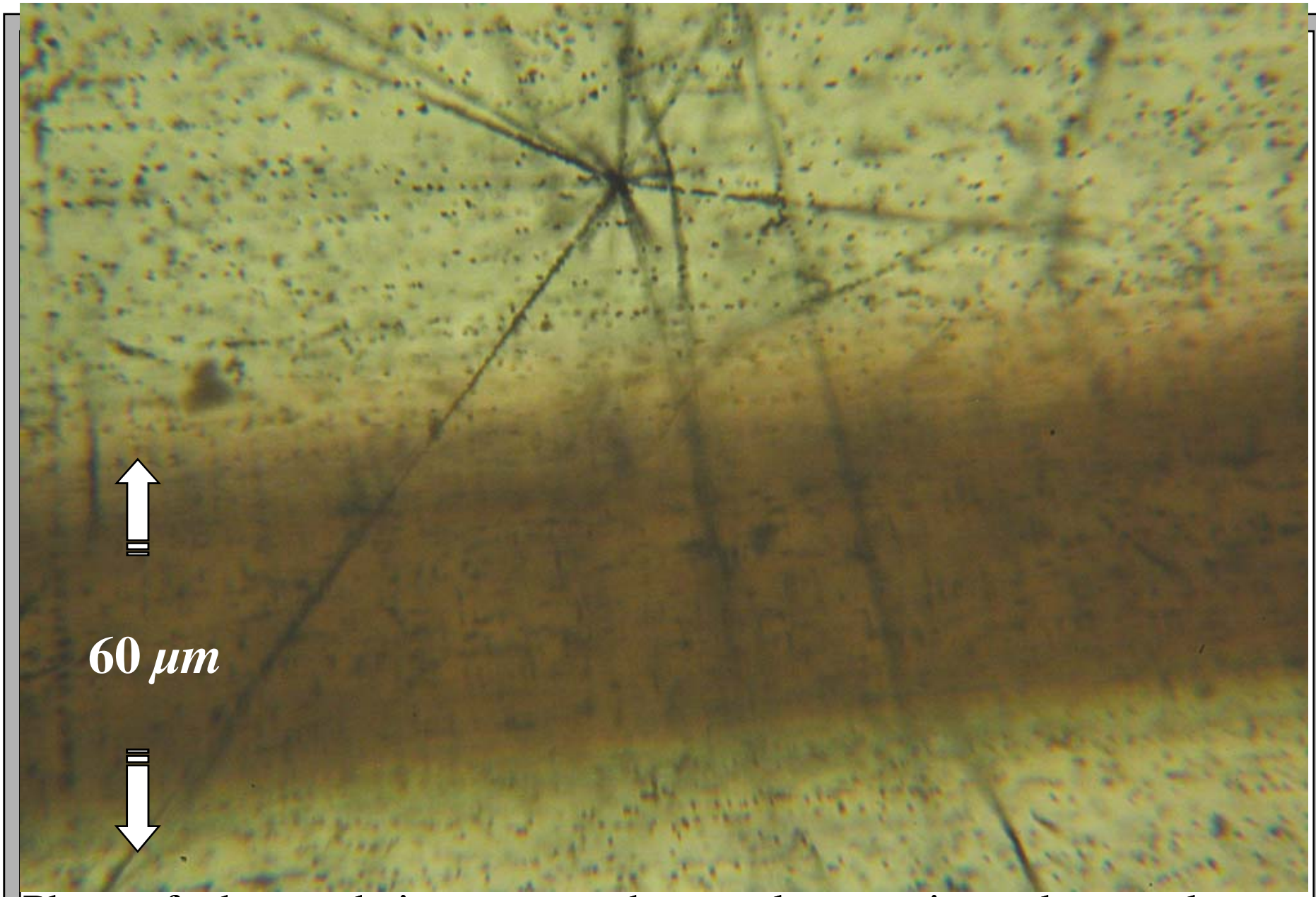
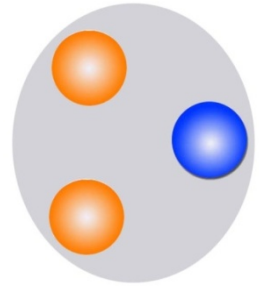
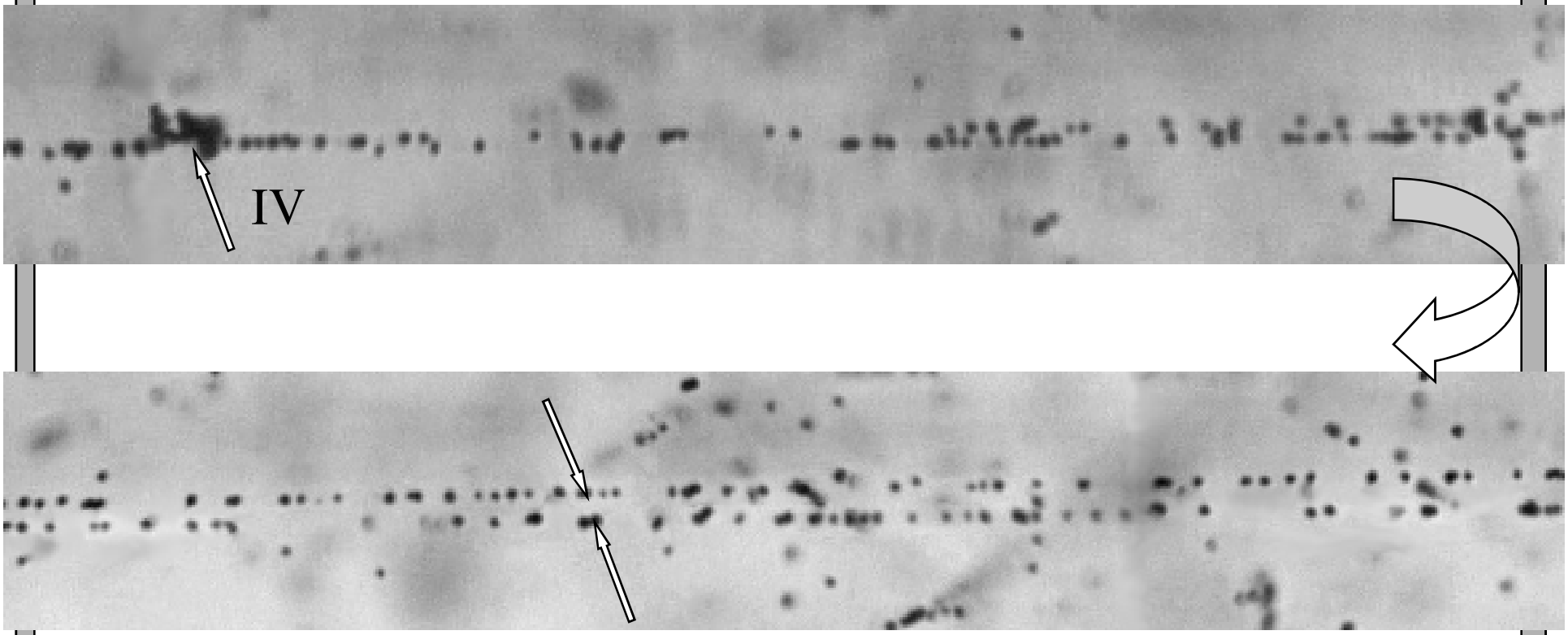
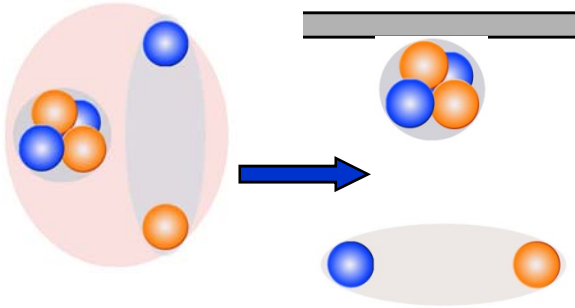


Photo of a human hair superposed on nuclear star in nuclear track emulsion

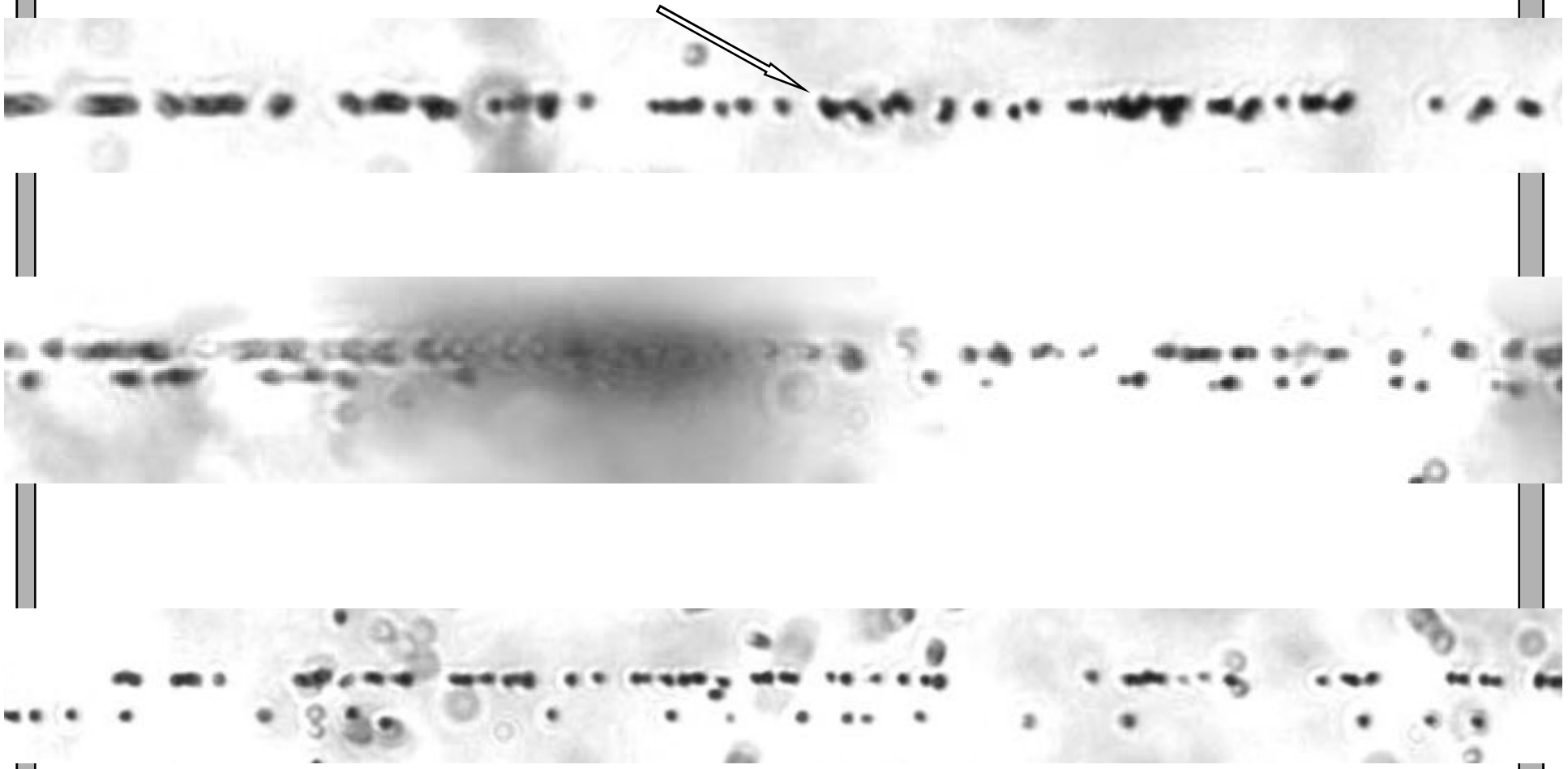


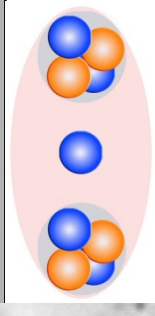
^{3}He dissociation 2=1+1





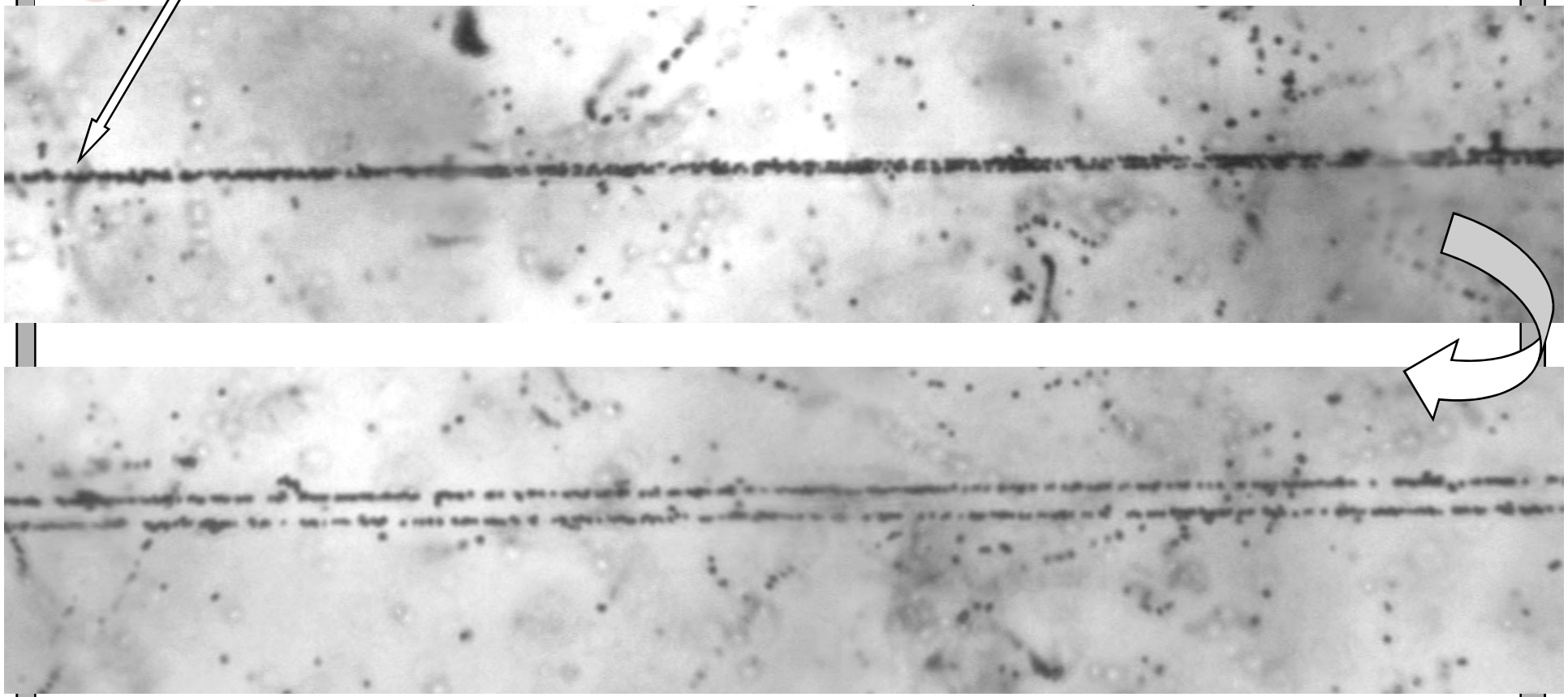
$^{6}Li \rightarrow He + H$



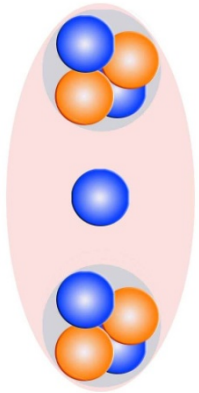


^{9}Be→2He @1.2A GeV

“white” star

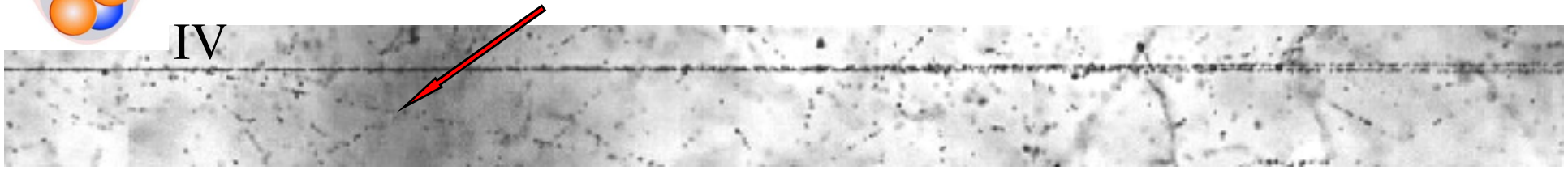


This star is called “white” because it is not accompanied by fragments of target nuclei or mesons.

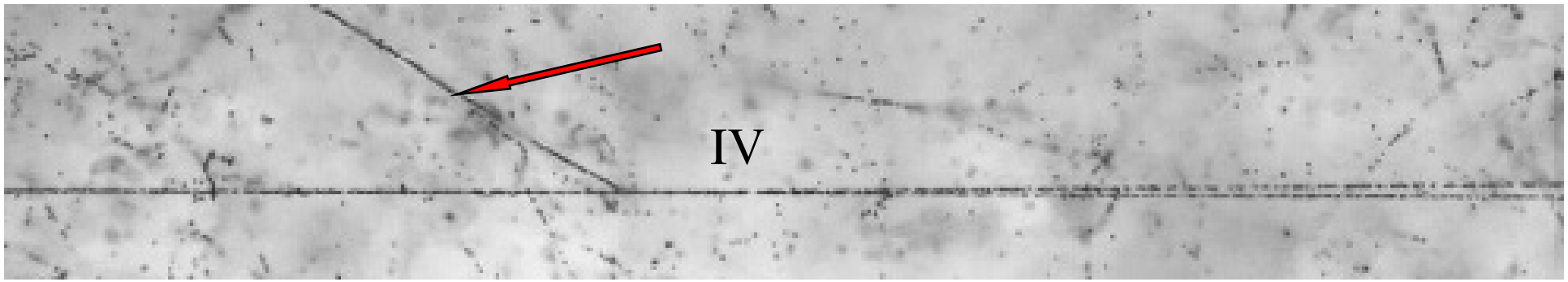


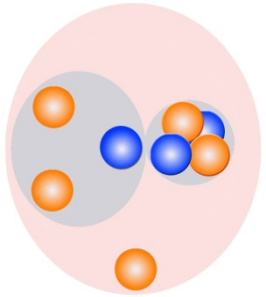
^{9}Be→2He @1.2 A GeV

A star with proton recoil (s-particle)



A star with the production of one b-particle
(heavy fragment of target nucleus)





$^{8}B \rightarrow {}^{7}Be+H$ @ 1.2A GeV

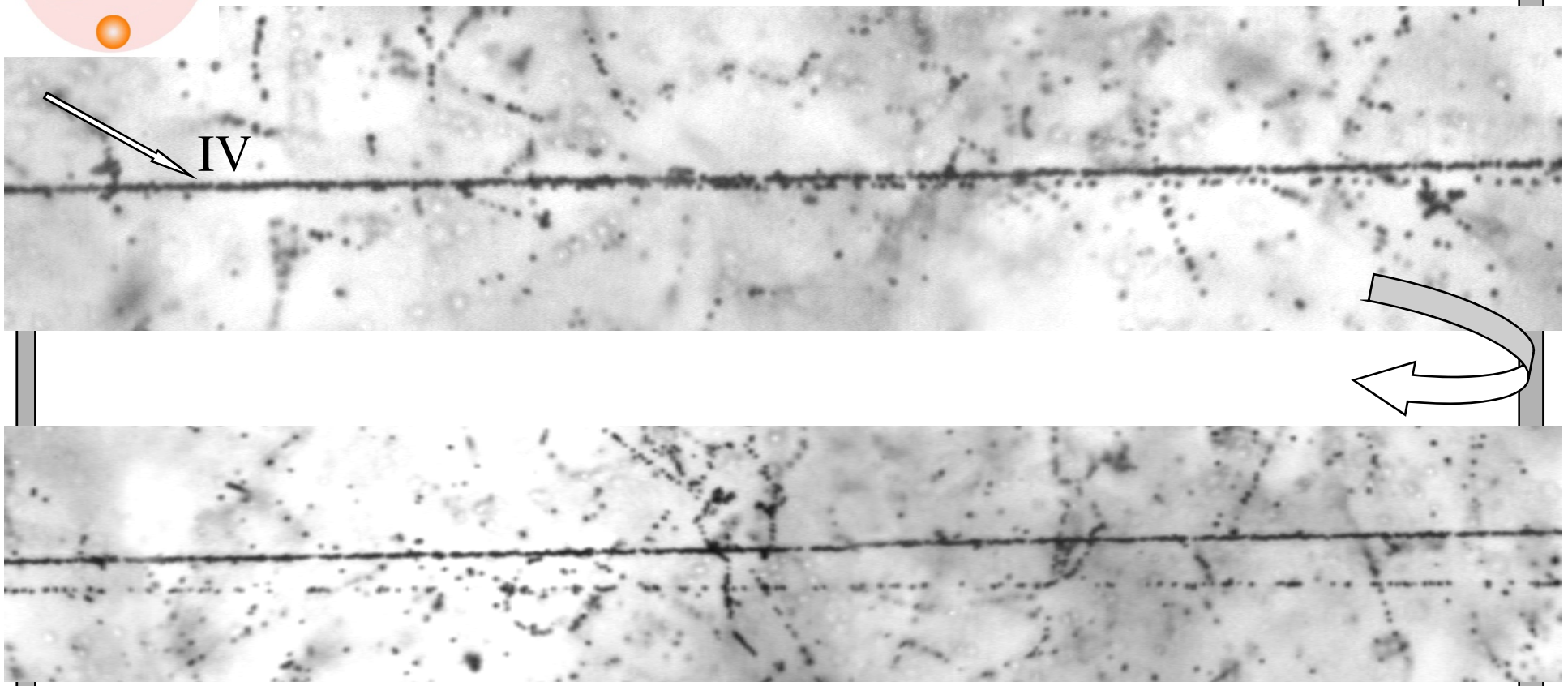
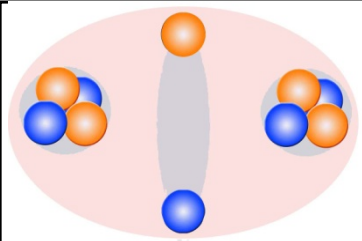
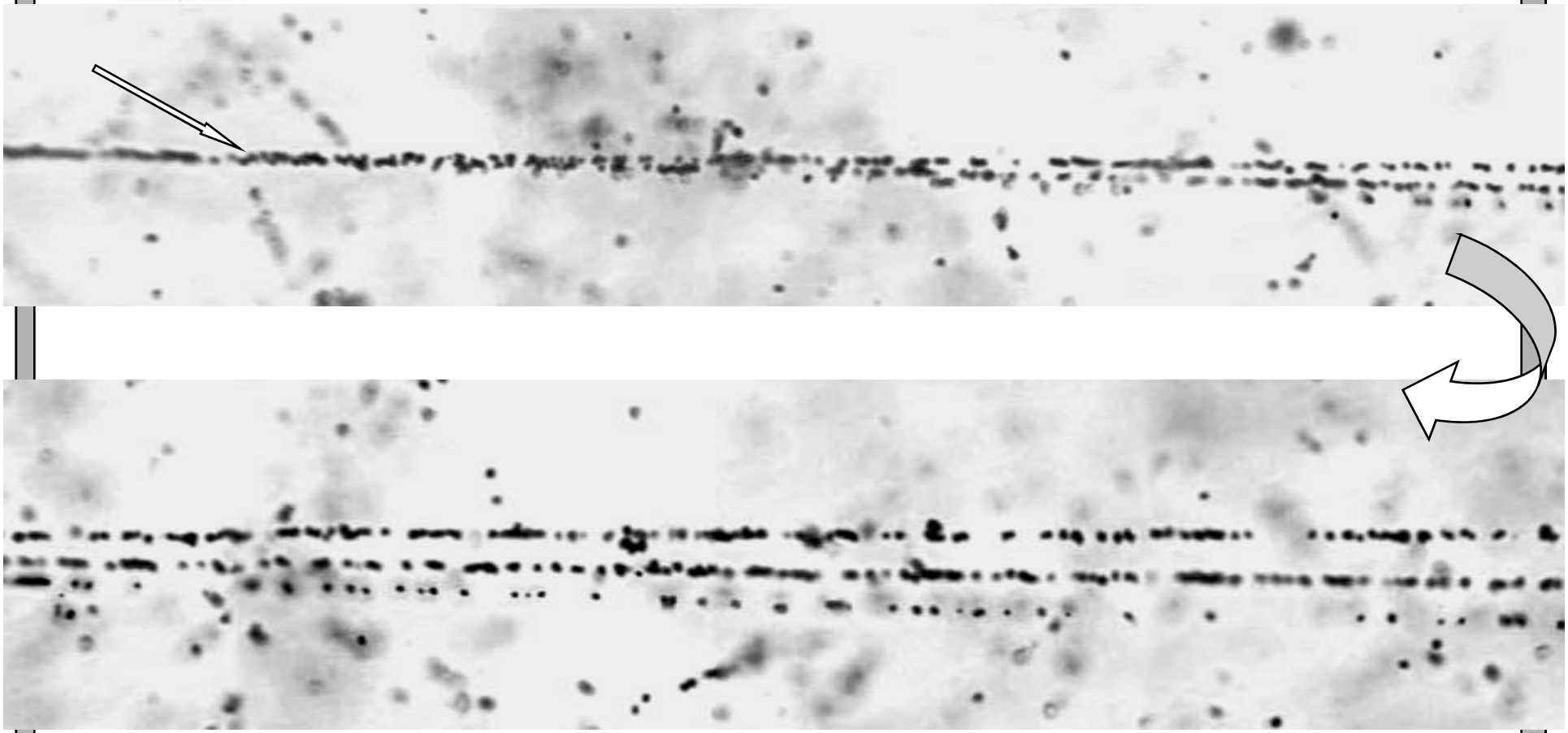
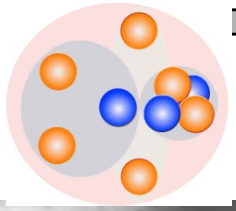


FIG. 1: Example of peripheral interaction of a 1.2 A GeV $^{8}B \rightarrow {}^{7}Be+p$ in a nuclear track emulsion ("white" star). The interaction vertex (indicated as **IV**) and nuclear fragment tracks (**H** and **Be**) in a narrow angular cone are seen on the upper and bottom microphotograph.

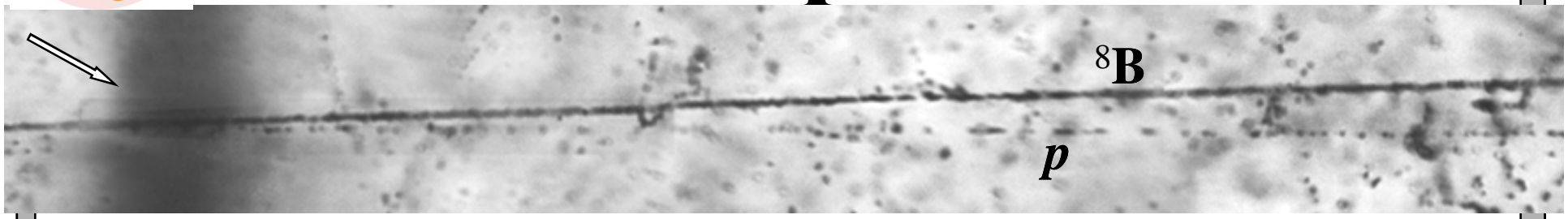


$^{10}B \rightarrow 2He + H$ @ 1A GeV

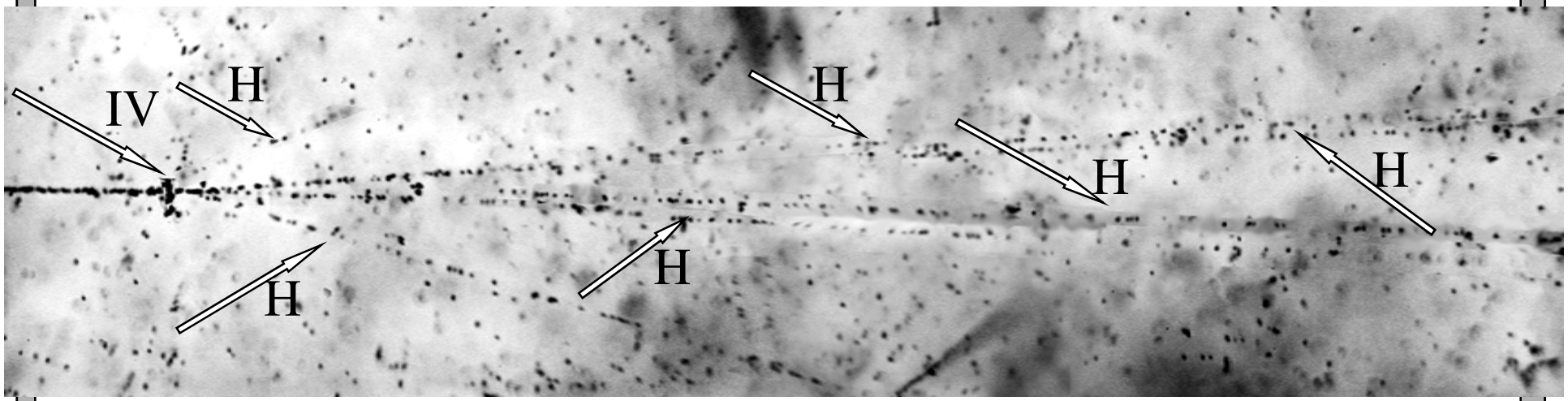




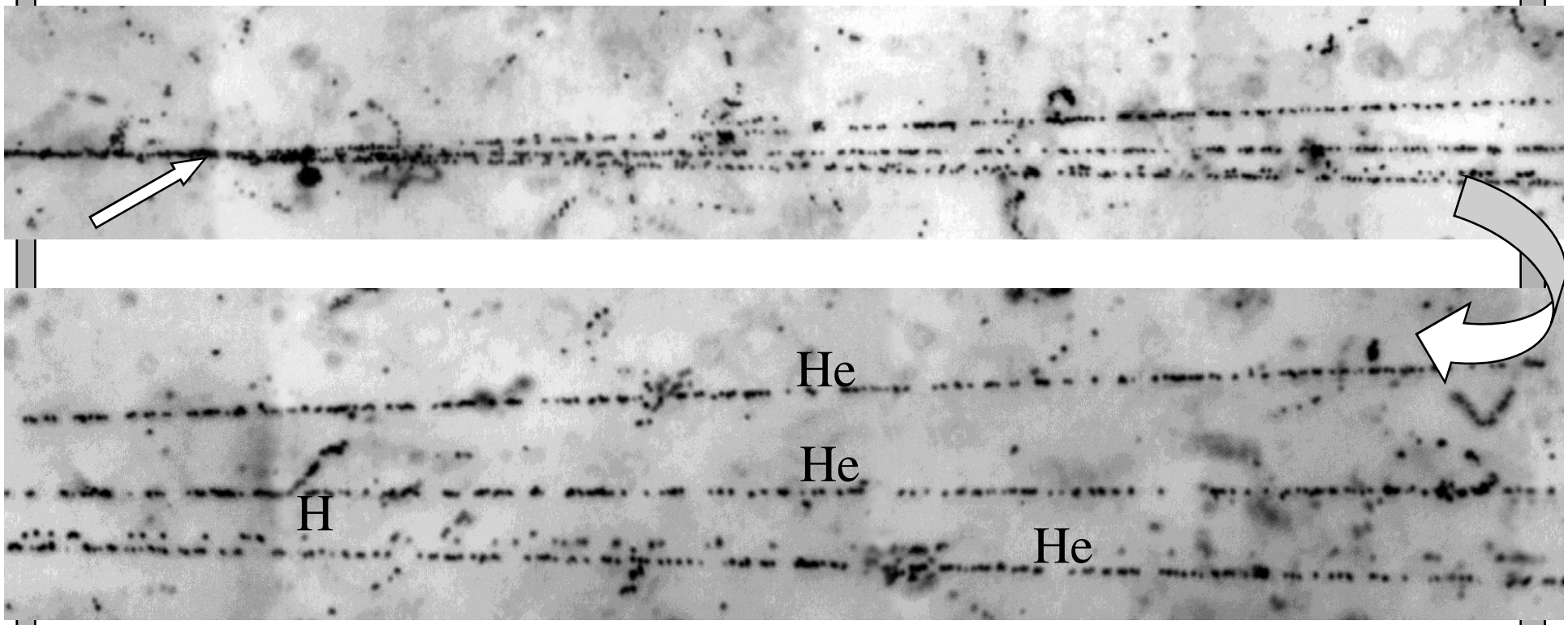
$^{9}C \rightarrow {}^{8}B + p$ @1.2A GeV



$^{9}C \rightarrow 6H$ @1.2A GeV

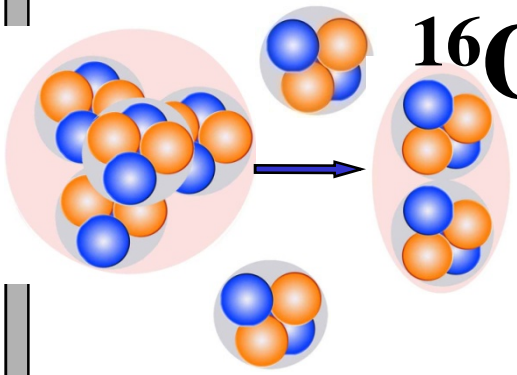


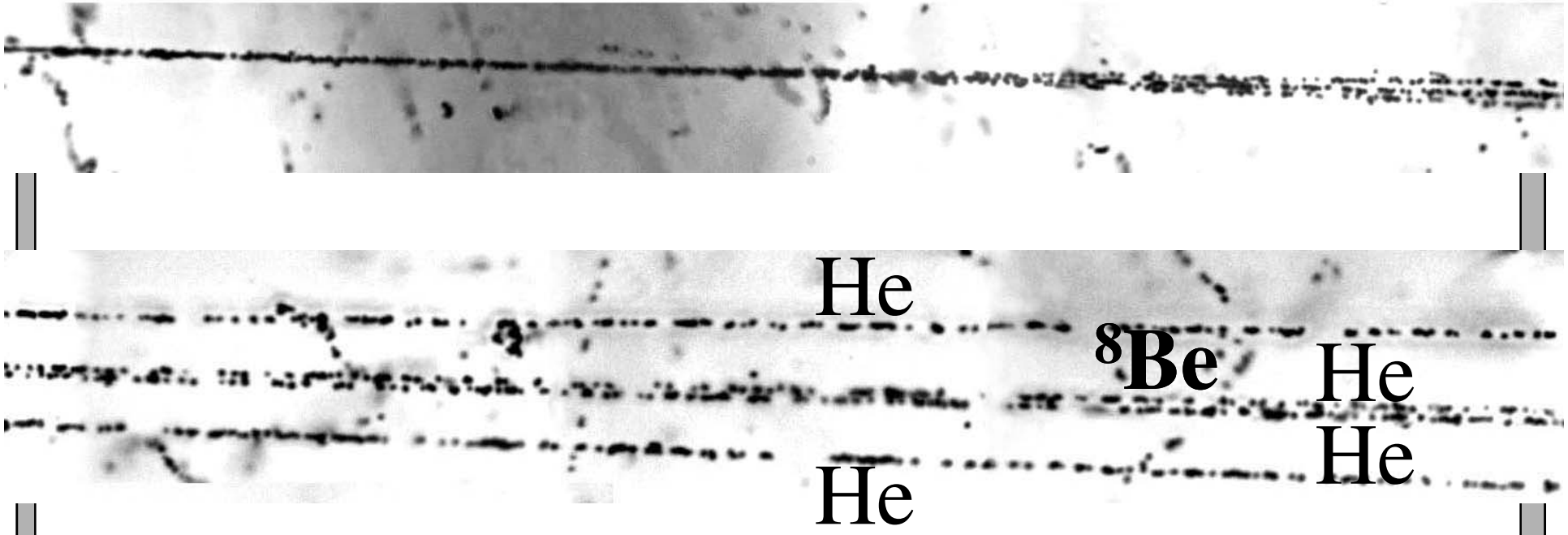
$^{14}N \rightarrow 3He+H$ @ 2A GeV



Event of dissociation of a N nucleus in peripheral interaction into three He and one H fragments. Total charge is equal to 7.

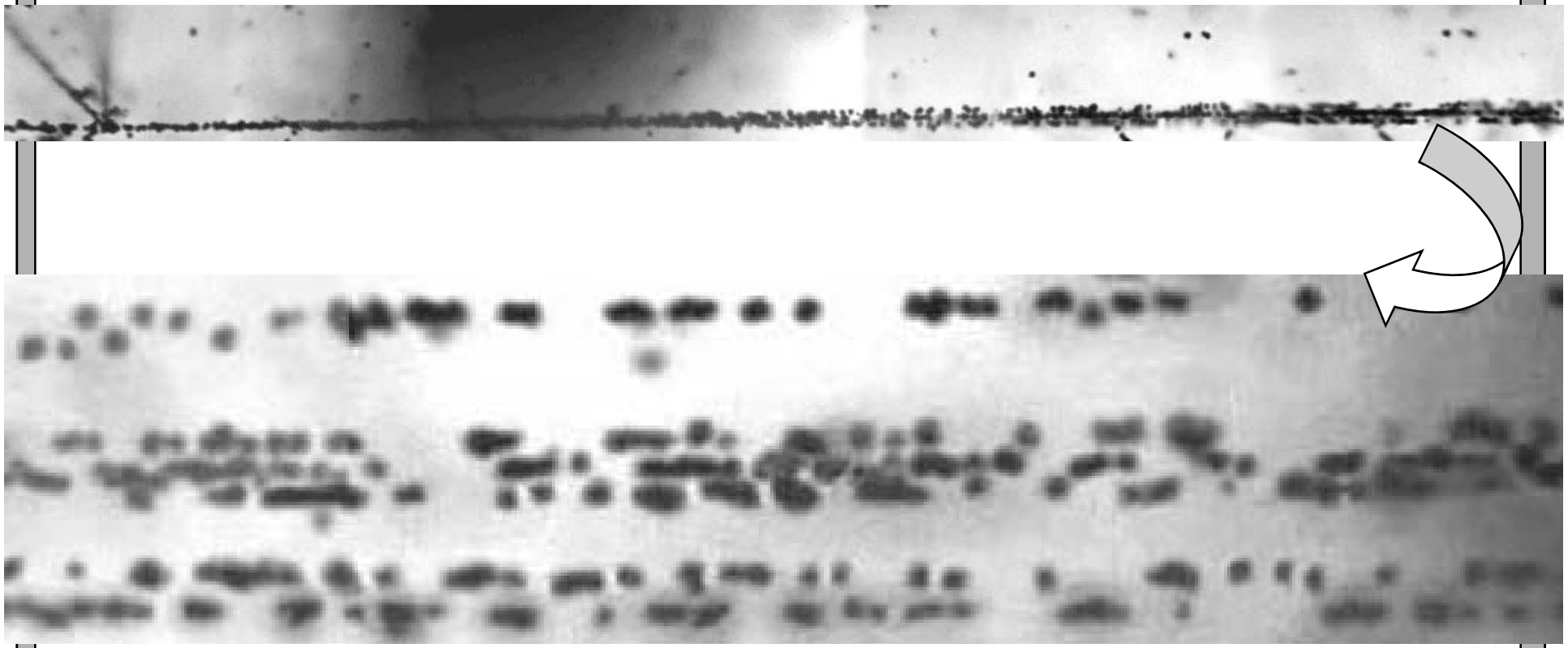
$^{16}O \rightarrow (^{8}Be) + 2He$ @3.65 A GeV





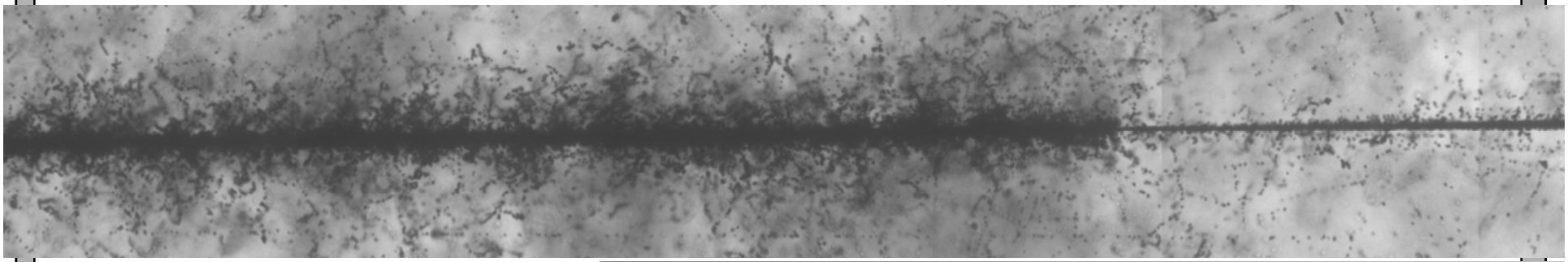
Event of dissociation of oxygen nucleus in peripheral interaction into four He fragments. This narrow pair was identified as a relativistic ^{8}Be decay.

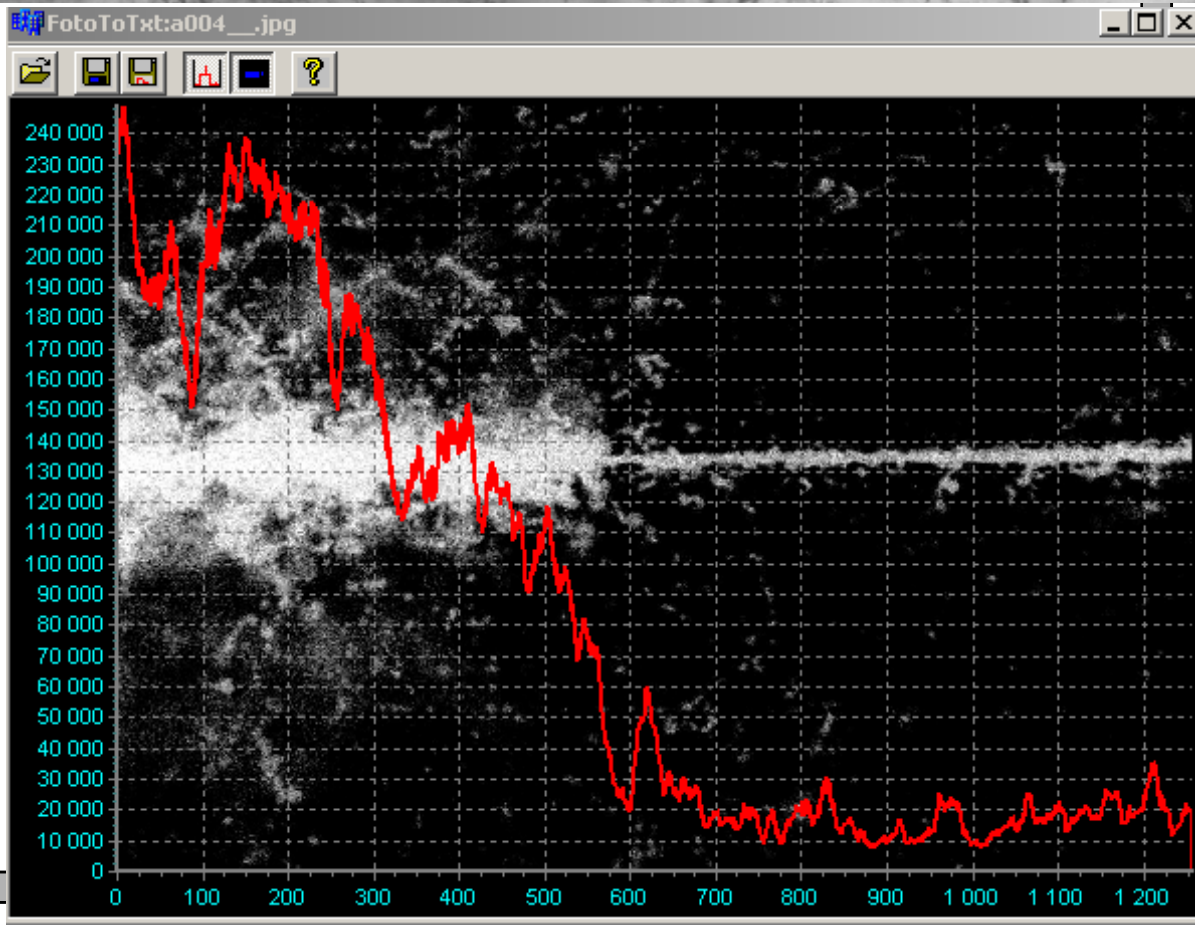
^{24}Mg→2+2+2+2+2+2 @3.65A GeV



Event of dissociation of a Mg nucleus in peripheral interaction into six He fragments.

Au @10.7 A GeV

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240 000
230 000
220 000
210 000
200 000
190 000
180 000
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160 000
150 000
140 000
130 000
120 000
110 000
100 000
90 000
80 000
70 000
60 000
50 000
40 000
30 000
20 000
10 000
0
0
100
200
300
400
500
600
700
800
900
1 000
1 100
1 200

Conclusions

An extensive collection of macrophotos and videos about the interactions of relativistic nuclei is created.

For its development is required to move from step photography to a continuous video recording.

Current level of collection requires a new level of logistics for accessing to files or new software interface.

Our purpose consisted in drawing attention to the evergrowing collection. Our materials can be easily accessed and used for development of intuition, thinking about new researches and pedagogical work.

Thank you for your attention!

^{124}Xe