



# Implantation of heavy ions

$^{86}\text{Kr}$  and  $^{132}\text{Xe}$

in emulsion with energy 1.2 A MeV

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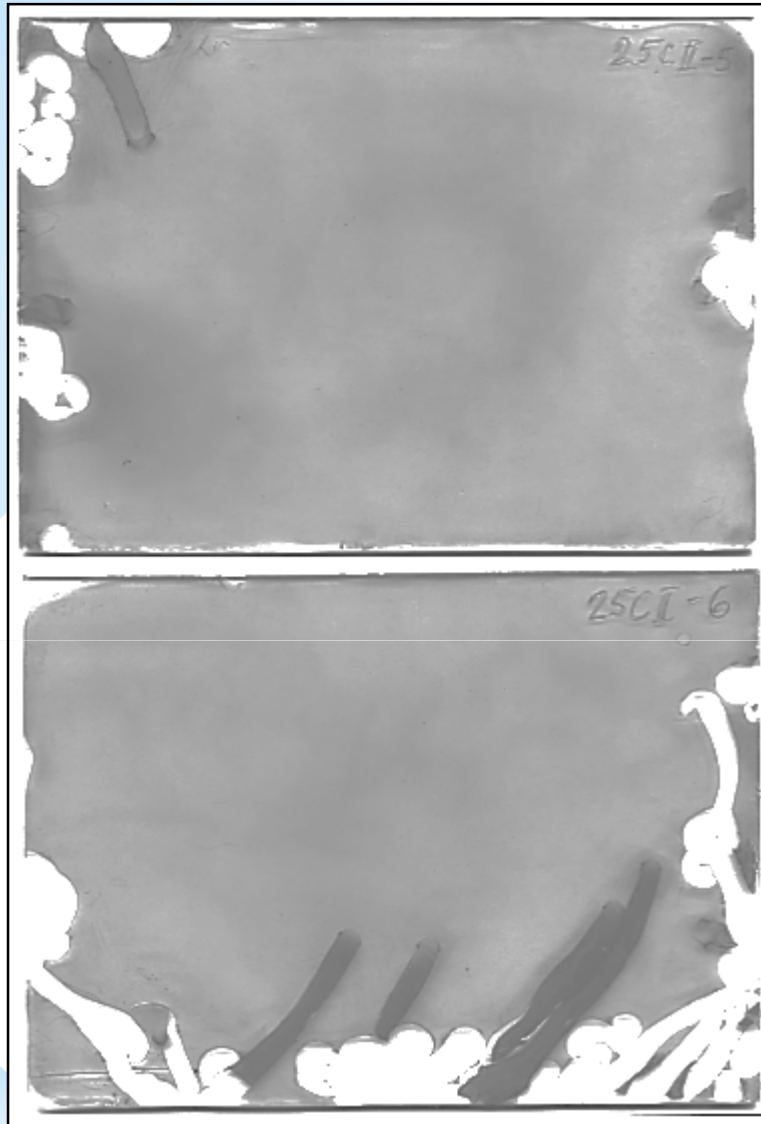
<http://flerovlab.jinr.ru/flnr/ic-100.html>



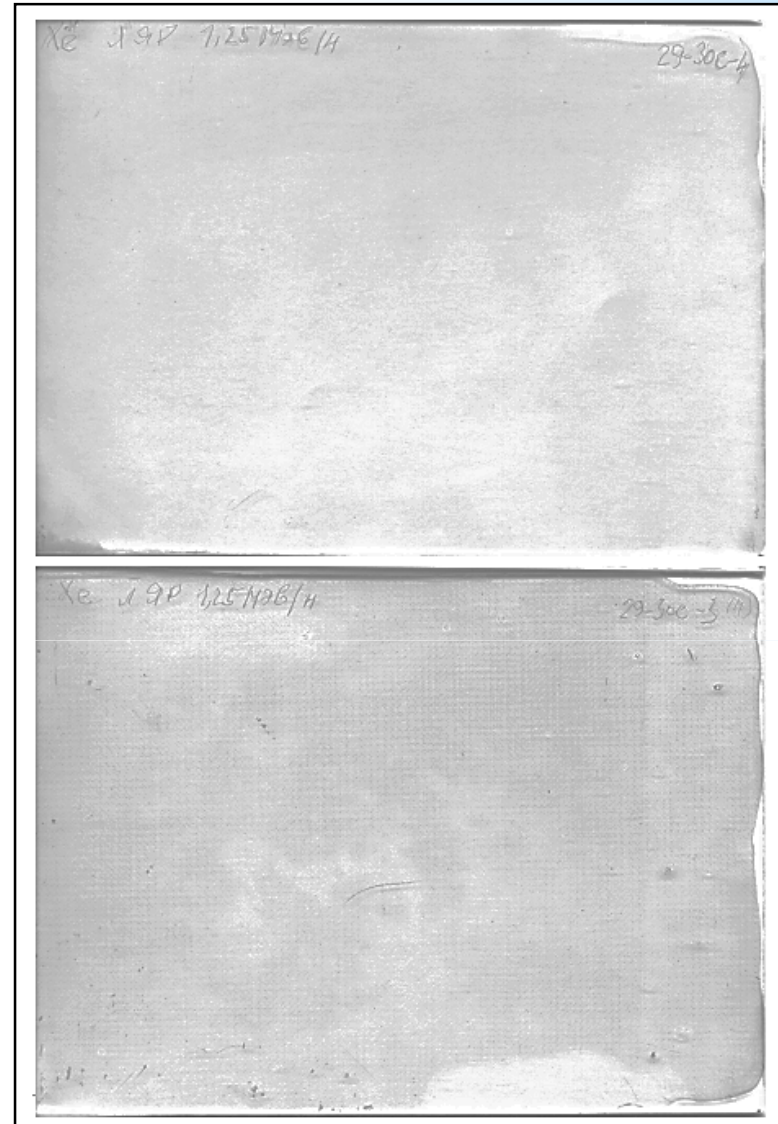
Emulsion layers with size  $9 \times 12 \text{ cm}^2$  and with thickness  $\sim 100$  (Xe) and  $\sim 180$  (Kr)  $\mu\text{m}$  on a glass substrate with thickness  $\sim 2 \text{ mm}$ , placed at an angle  $45^\circ$  to the beam axis. Tilting plate has provided observability tracks of ions in the emulsion.



Kr

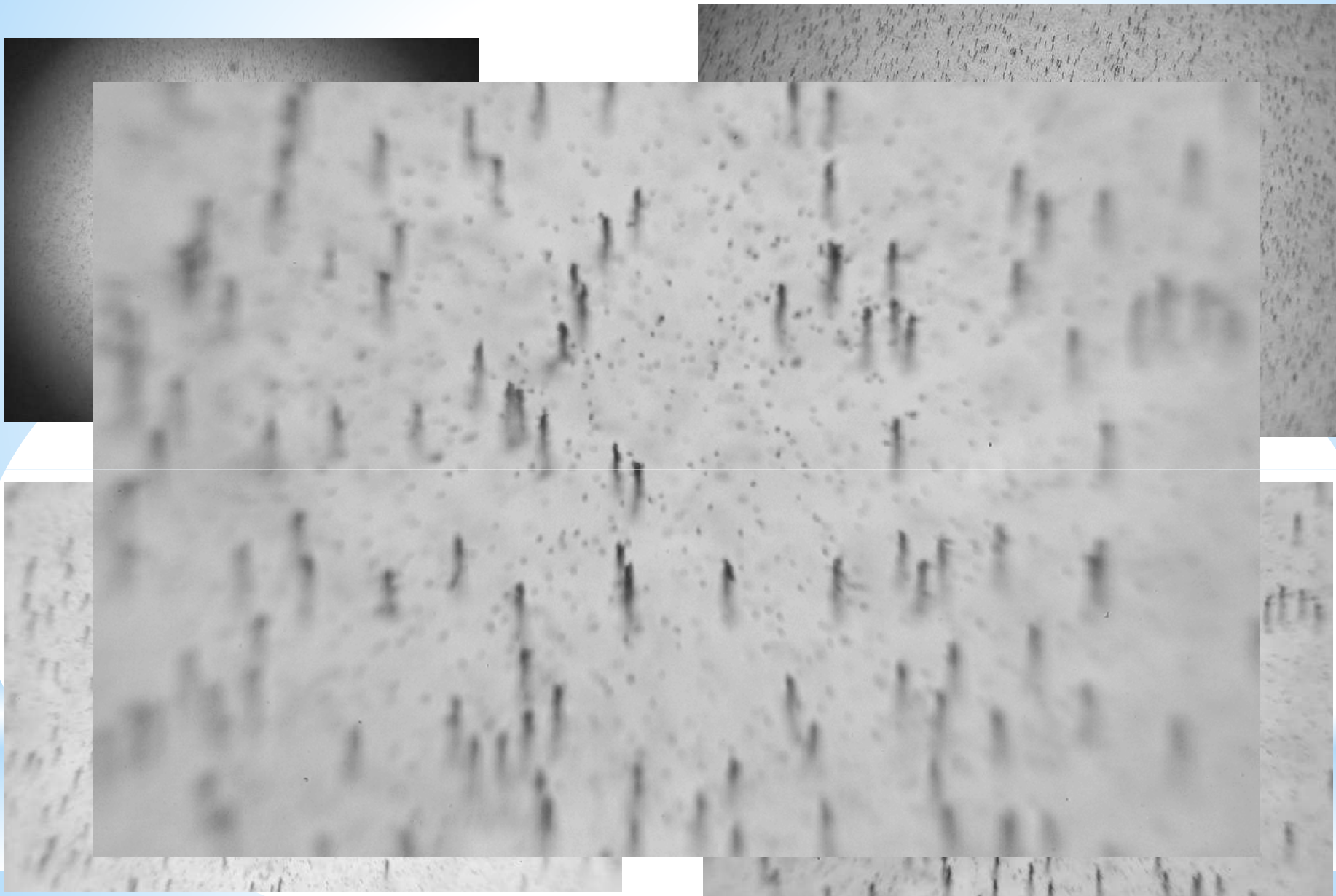


Xe



**View of emulsion layers after photochemical processing.**

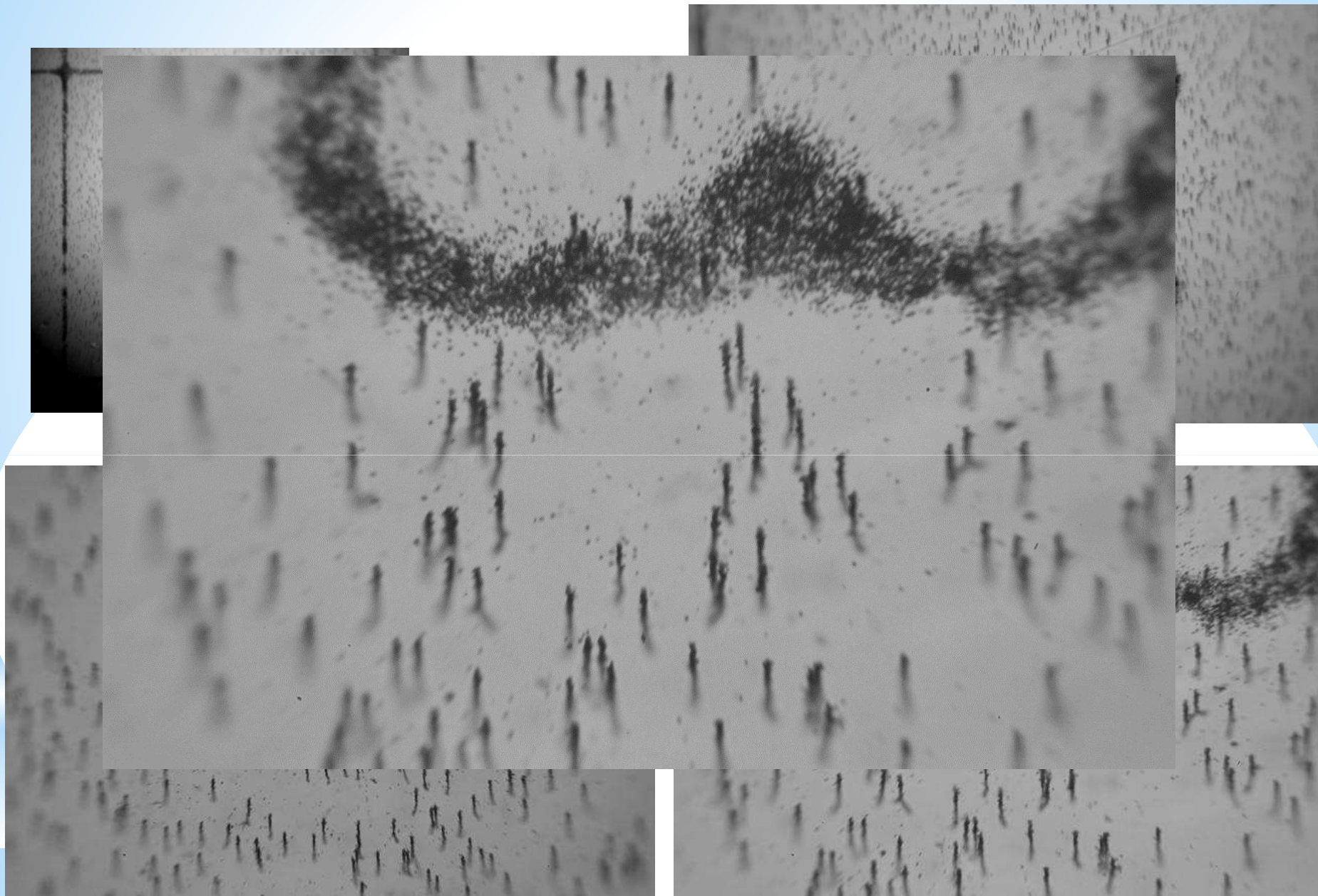
Examples of microphotograph of tracks (Kr) in emulsion.



x60

x90

Examples of microphotograph of tracks (Xe) in emulsion.



x60

x90

Help

Animate

Continue

Change TRIM

100% ION ENERGY 0%

Now: 140 of 99999 Ions

ION  
 Ion Type Xe 131.90 amu  
 Ion Energy 158 MeV  
 Ion Angle 0 degrees  
 Completed 139 of 99999  
 SHOW LIVE DATA HELP

TARGET DATA  
 ? Xe (10) into Layer 1 (1 layers, 7 atoms)

Layer Name	Width (A)	Density	Ag (107.8)	Br (79.904)	C (12.011)	O (15.999)
1 Ilford G_5	400000	3.907	0.48531	0.35630	0.07065	0.0
Lattice Binding Energy			3	3	3	
Surface Binding Energy			2.97	2	7.41	

Calculation Parameters  
 Backscattered Ions 0  
 Transmitted Ions 0  
 Vacancies/Ion 70865.2

ION STATS  

	Range	Straggle
Longitudinal	20.2 um	1.32 um
Lateral Proj.	1.34 um	1.68 um
Radial	2.07 um	1.09 um

Type of Damage Calculation  
 ? Quick: Kinchin-Pease

Stopping Power Version  
 ? SRIM-2008

% ENERGY LOSS  

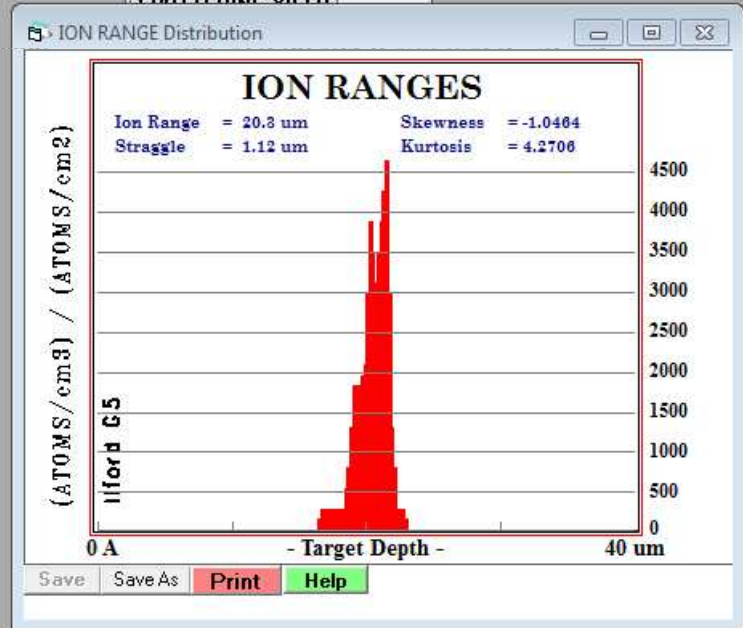
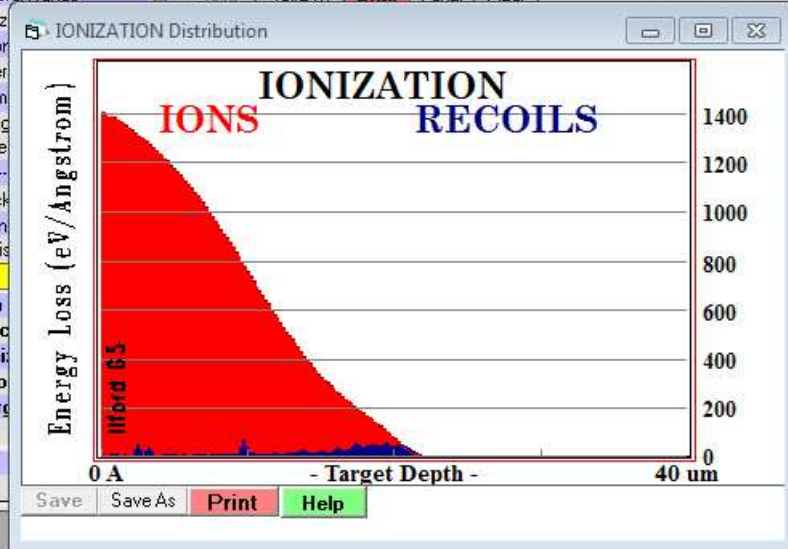
	Ions	Recoils
Ionization	94.91	2.27
Vacancies	0.00	0.13
Phonons	0.01	2.67

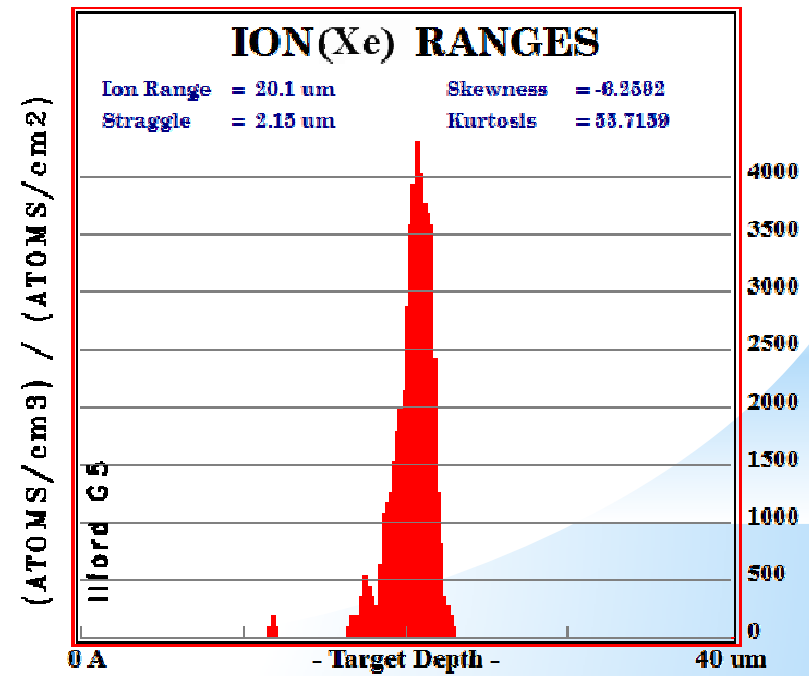
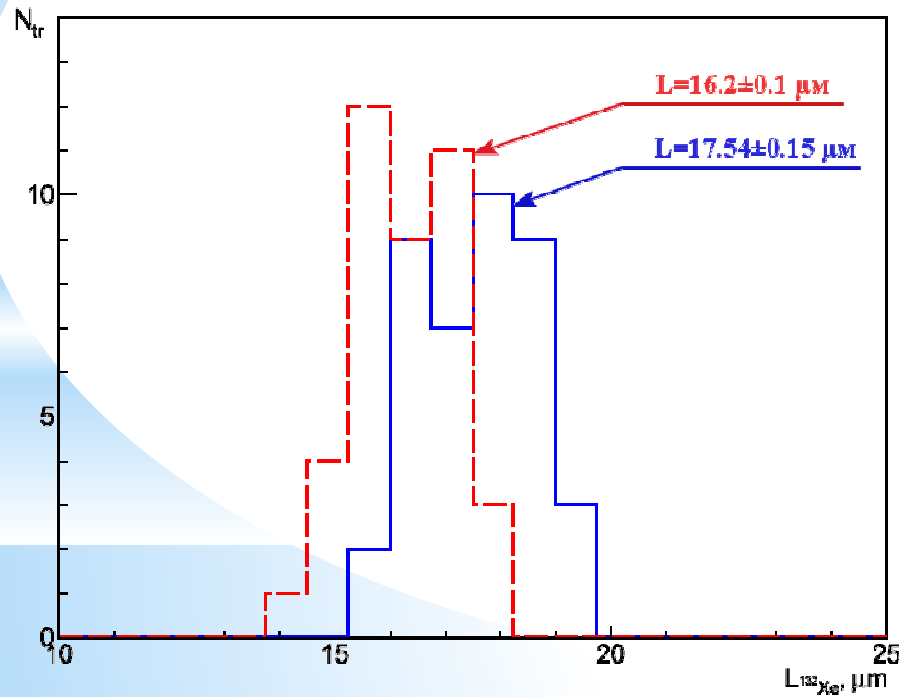
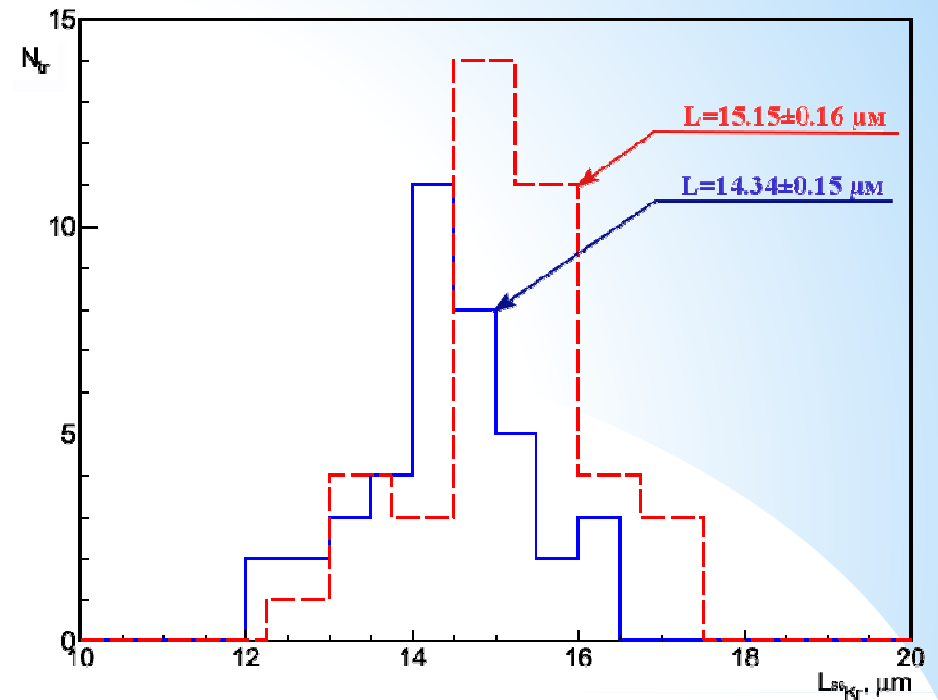
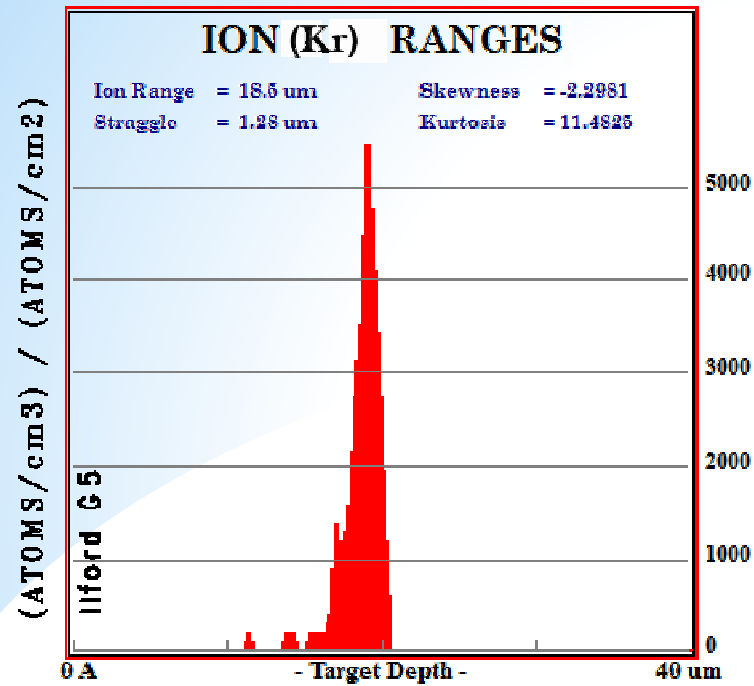
Plots  
 PLOT Window  
 0 A - 400000 A  
 Max Target Depth 400000

COLLISION PLOTS  
 Ion/Recoils (XY) All  
 Ion/Recoils (XZ) None  
 Ions (no recoils) Tile  
 Lateral View (YZ) Clear  
 Background color White/Black



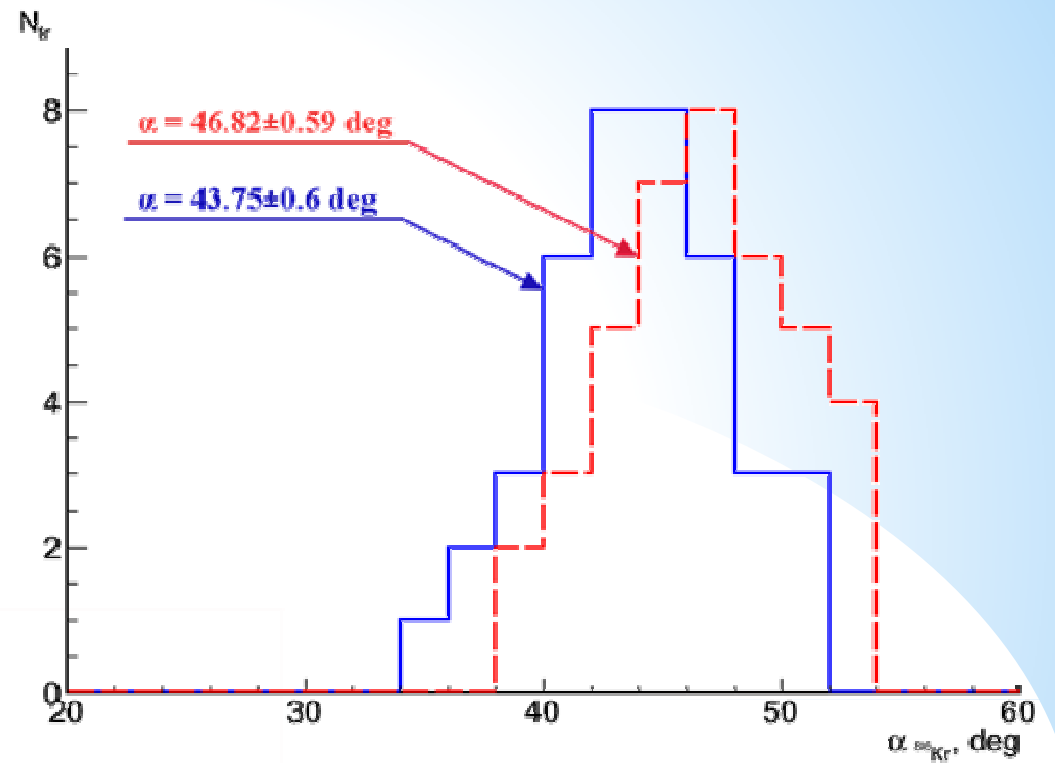
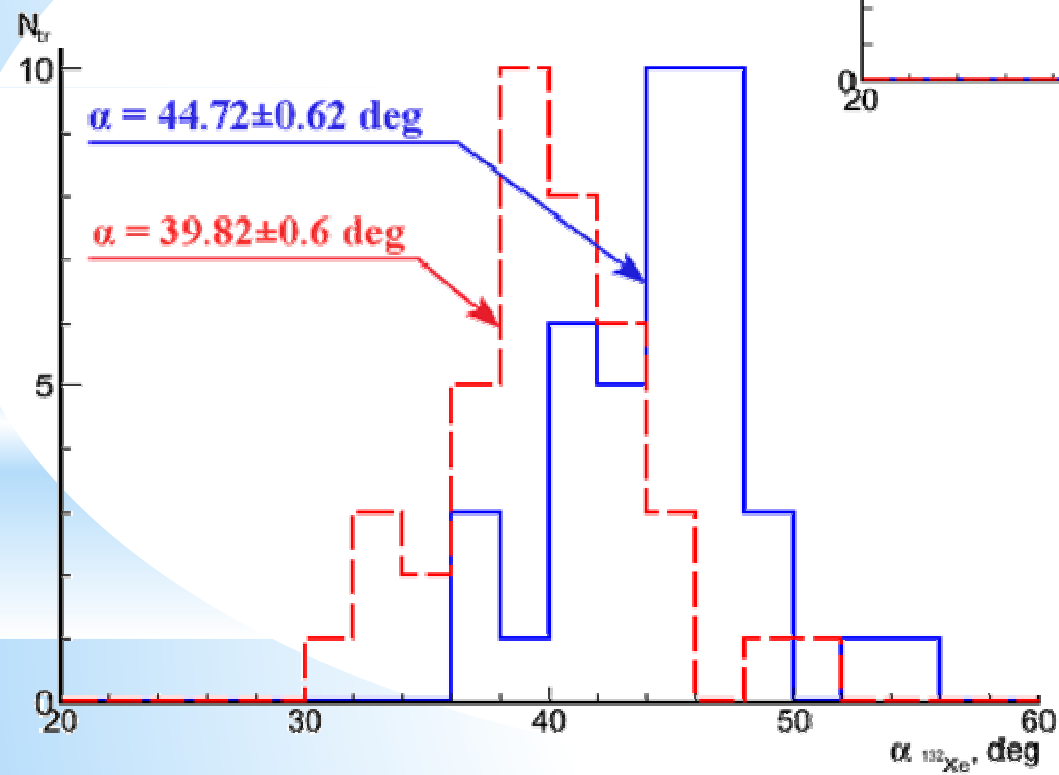
- DISTRIBUTIONS
- Ion Distribution
  - Ion/Recoil Distribution
  - Lateral Range
  - Ionization
  - Phonons
  - Energy
  - Damage
  - Inter
  - Diff
  - Back
  - Tran
  - Collis
- 3-D Plots
- Ion
  - Rec
  - Ion
  - Pho
  - Tar

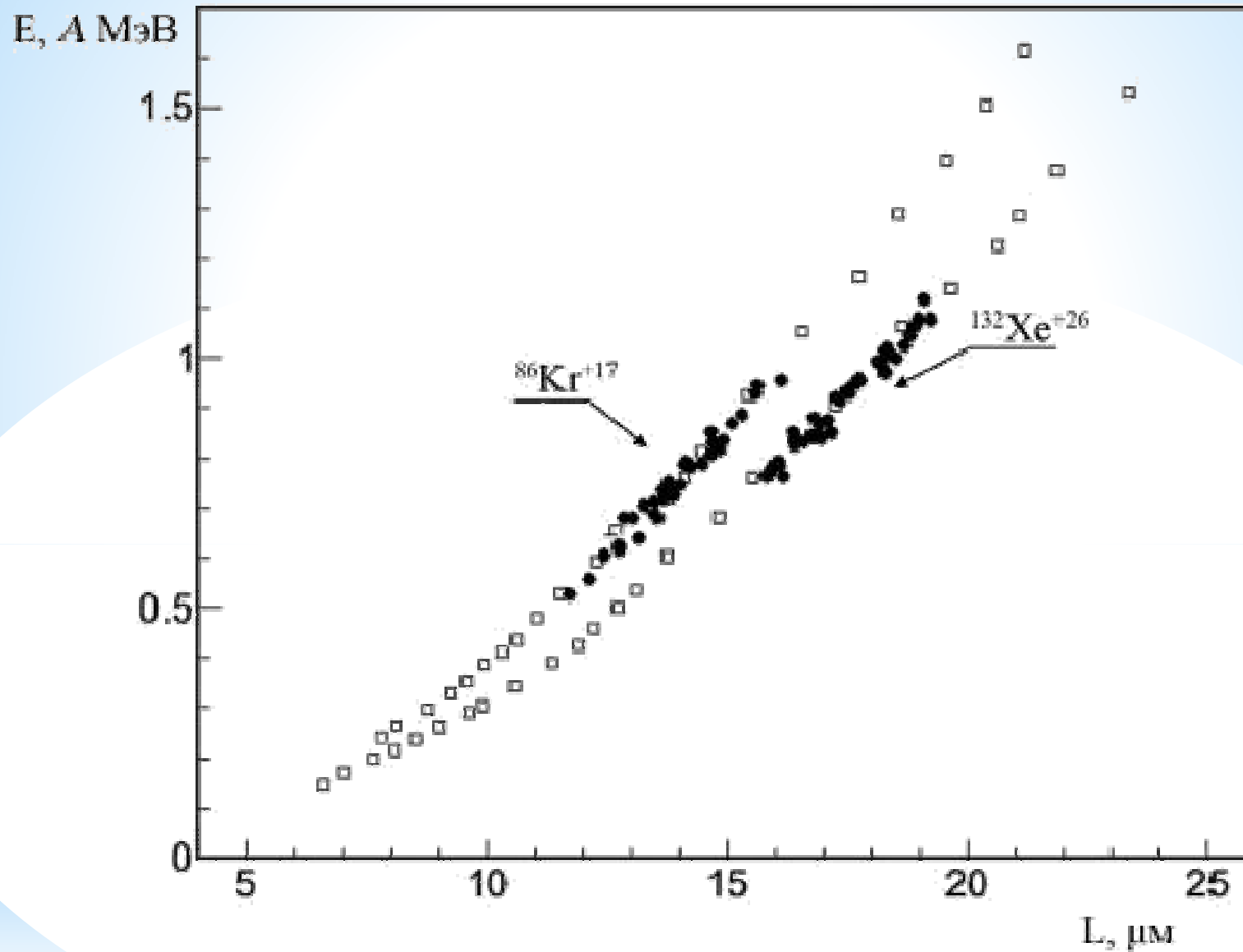






Irradiation angle before (red) and after (blue) correction shrinkage ratio.





Definition energy of ions  $^{86}\text{Kr}$  and  $^{132}\text{Xe}$  by the measured track length.  
Dots - experimental data, squares - calculation by the model SRIM.

# Conclusion:

- Demonstrated the possibilities of the newly reproduced nuclear emulsion for research with heavy ions at extremely low energies ( $^{86}\text{Kr}$  and  $^{132}\text{Xe}$ ).
- Defined angular spread of ions in the beam, which amounted 3.8 and 3.9 for Kr and Xe, respectively.
- Measured ion range at the energy 1.2 A MeV in the emulsion amounted ( $L_{\text{Kr}} = 14.34 \pm 0.15 \mu\text{m}$ ,  $\text{RMS} = 0.9 \mu\text{m}$ ) and  $L_{\text{Xe}} = 17.54 \pm 0.15 \mu\text{m}$ ,  $\text{RMS} = 0.99 \mu\text{m}$ ), which corresponds to the calculated value obtained by the model SRIM.
- The results of this experiment are interest as a calibration for future research on the physics of nuclear fission, laser plasma, search for particles of dark matter, as well as applied purposes.

- The present work is result of collaboration with specialists of accelerator IC-100, LNR, JINR.

***THANK YOU ATTENTION!***