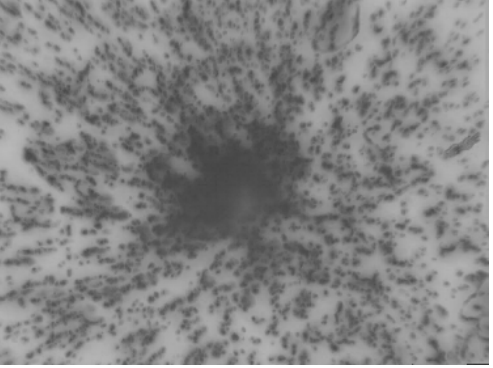
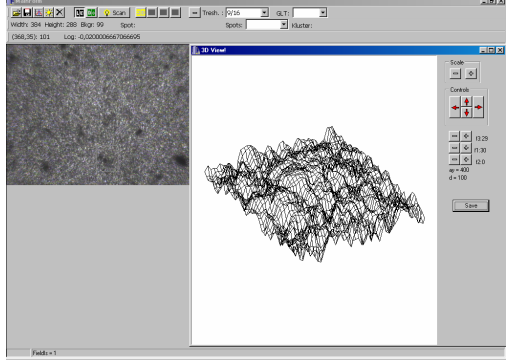
**Workshop on the Russian - Italian Cooperation**
**on the Cosmic Ray Physics and Astroparticle Physics**

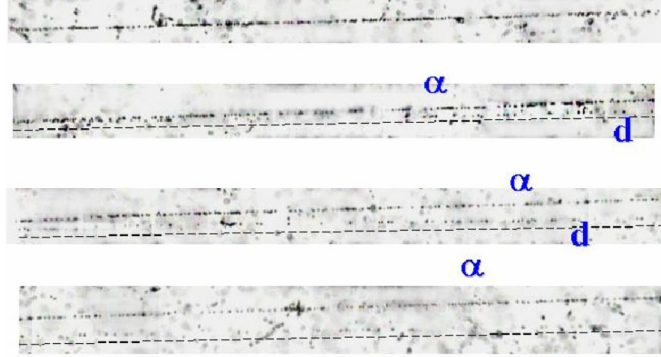
**Moscow, 17-20 October 2005.**

# Joint Research on Cosmic Ray and Neutrino Physics: Analysis of Events in Nuclear Emulsion from OPERA Experiment and Search for Tracks of Heavy and Superheavy Nuclei in Olivines from Meteorites using PAVICOM facility

PAVICOM collaboration,
N.G. Polukhina








**PAVICOM (Completely Automatized Measurement Setup) is an unique measurement setup of high efficiency which is designed for processing of the initial experimental data obtained by using the nuclear emulsions and solid-state detectors.**

**From the very beginning, it was exploited as a tool for high-tecnological processing of the data coming from the nuclear physics, high energy physics and cosmic ray experiments.**

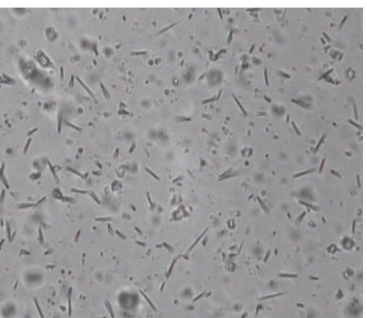
**The treatment of 9 experiments are proceed now at PAVICOM; the scientists from 6 Russian Institutes and our colleagues from Ukraine, Japan, Mongolia and Slovenia take part in such treatment.**

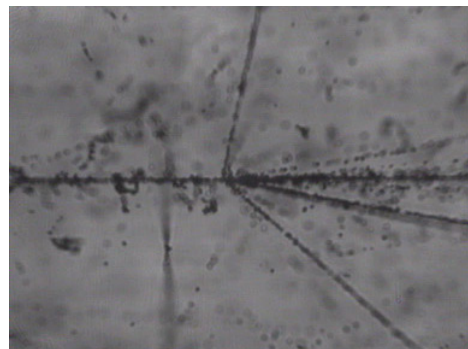
**The following operations are to be performed in the regime of total automatization:**

**search for and digitalization of the charge particle track coordinates in the body of a detector;**

**identification and tracing of the tracks under computer control;**

**ordering and primary processing of the data.**

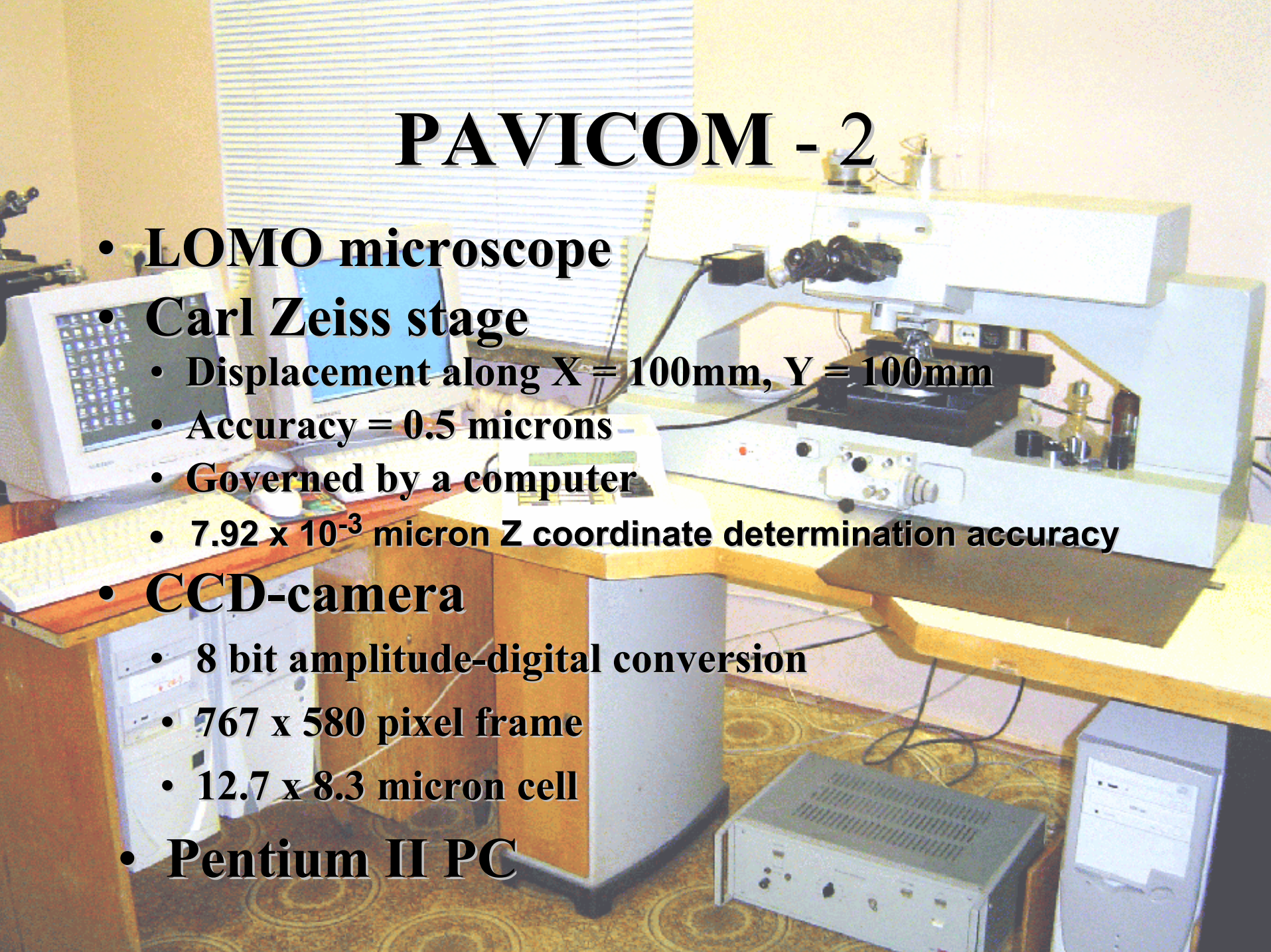





MICO

# PAVICOM - 1

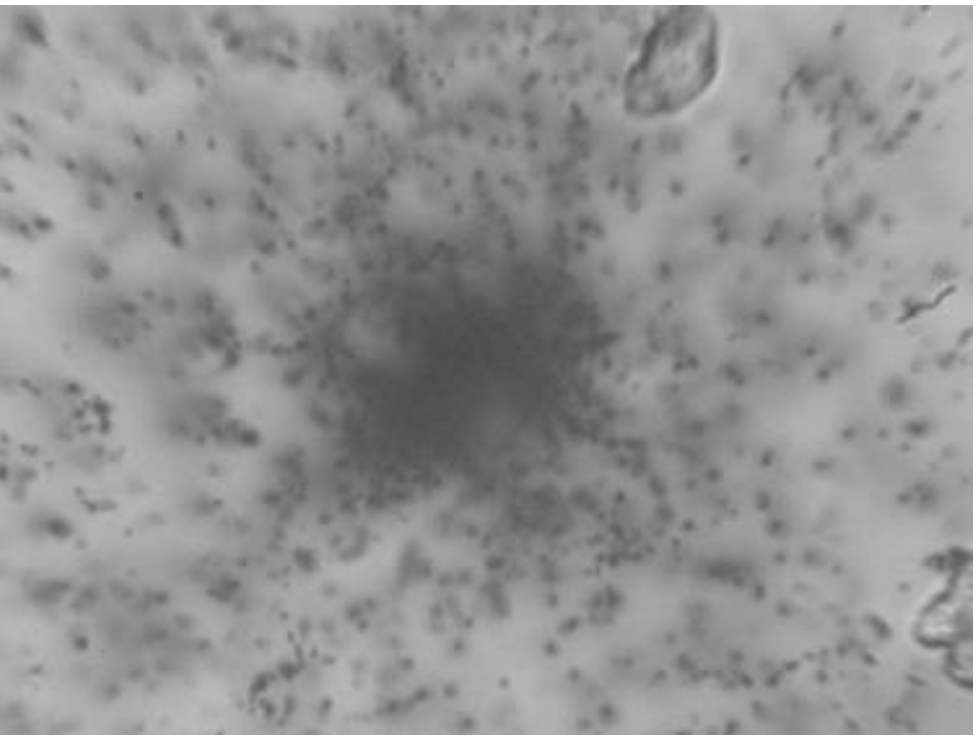
- **MICOS stage**
  - **Dimensions: 2.5m x 1.2m x 2.4m**
  - **Mass ~ 1000 kg**
  - **Displacement along X = 800 mm, Y = 400 mm, Z = 200 mm**
  - **Accuracy = 0.5 microns**
  - **Governed by a computer**
- **VS-CTT camera**
  - **10 bit amplitude-digital conversion**
  - **1360 x 1024 pixel frame**
  - **4.65 x 4.65 micron cell**
- **Pentium II PC**

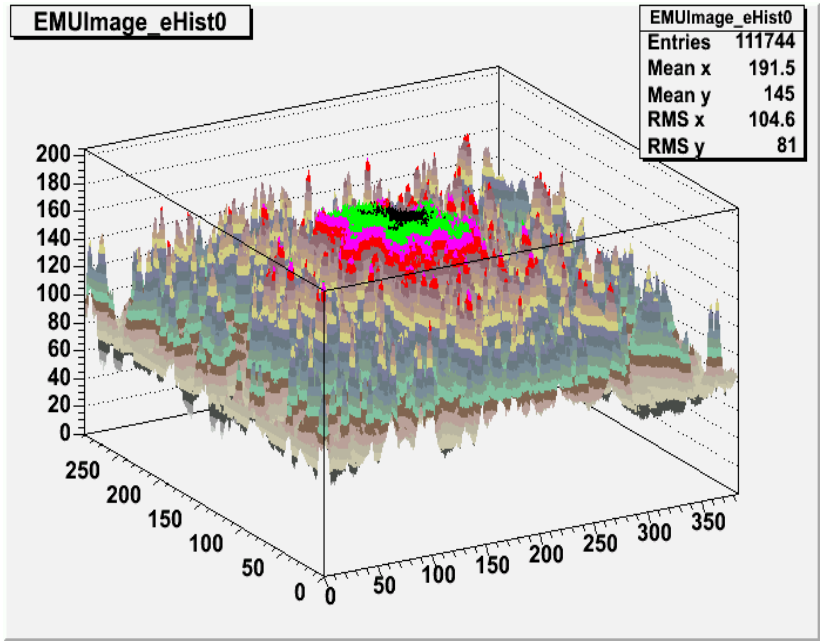


# PAVICOM - 2

- LOMO microscope
- Carl Zeiss stage
  - Displacement along X = 100mm, Y = 100mm
  - Accuracy = 0.5 microns
  - Governed by a computer
  - $7.92 \times 10^{-3}$ micron Z coordinate determination accuracy
- CCD-camera
  - 8 bit amplitude-digital conversion
  - 767 x 580 pixel frame
  - 12.7 x 8.3 micron cell
- Pentium II PC

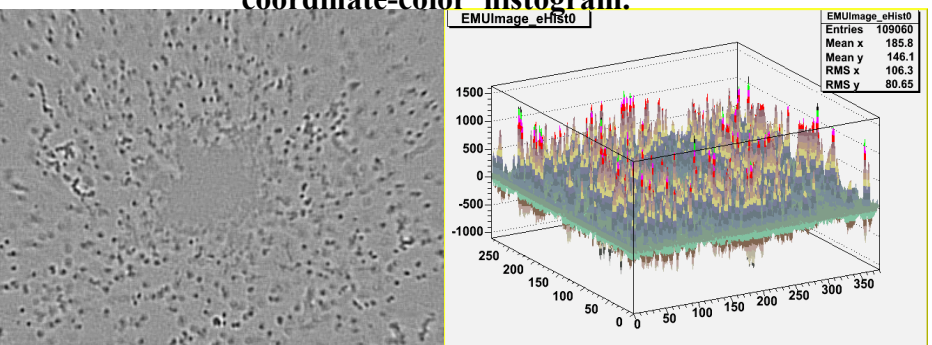
# "EMU-15" - an investigation of collective effects and peculiarities of the secondary-particle distributions in collisions of 32 TeV/nucleus incident lead nuclei with the target ones.



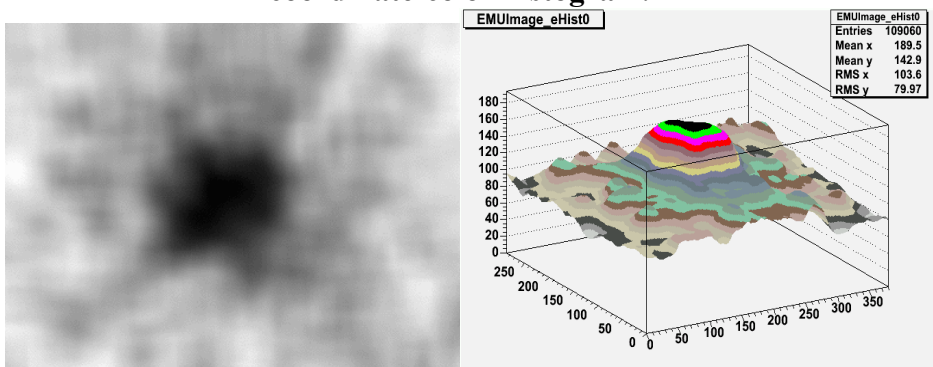


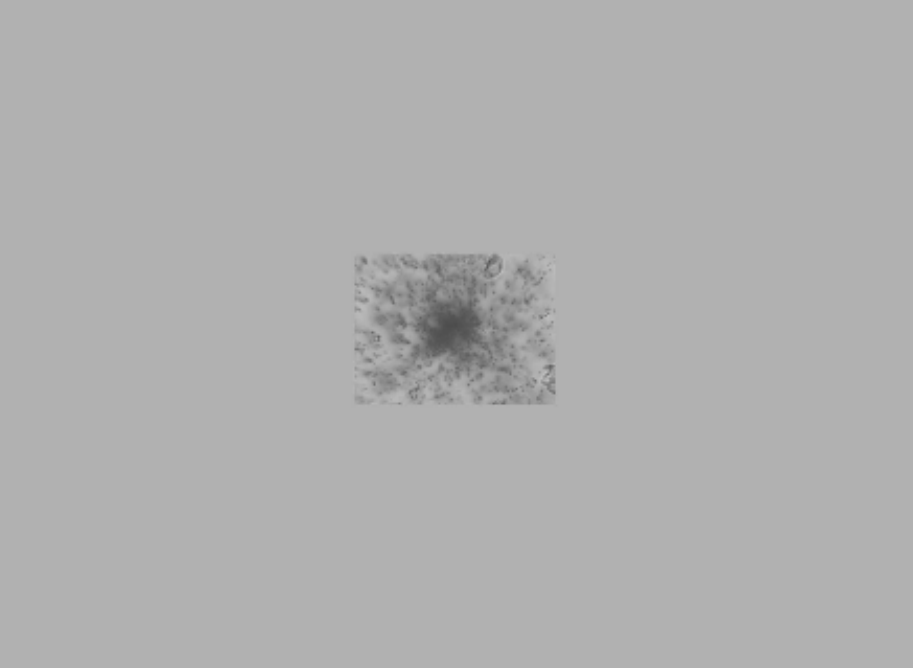

Source image and its coordinate-color histogram.

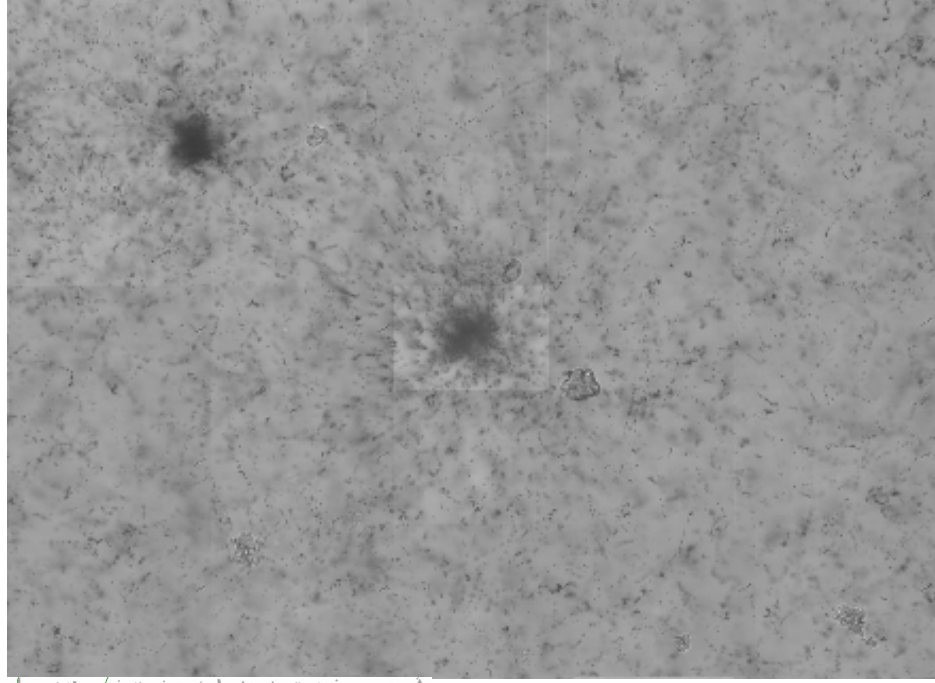
The image developed by high-frequency filter, and its coordinate-color histogram.

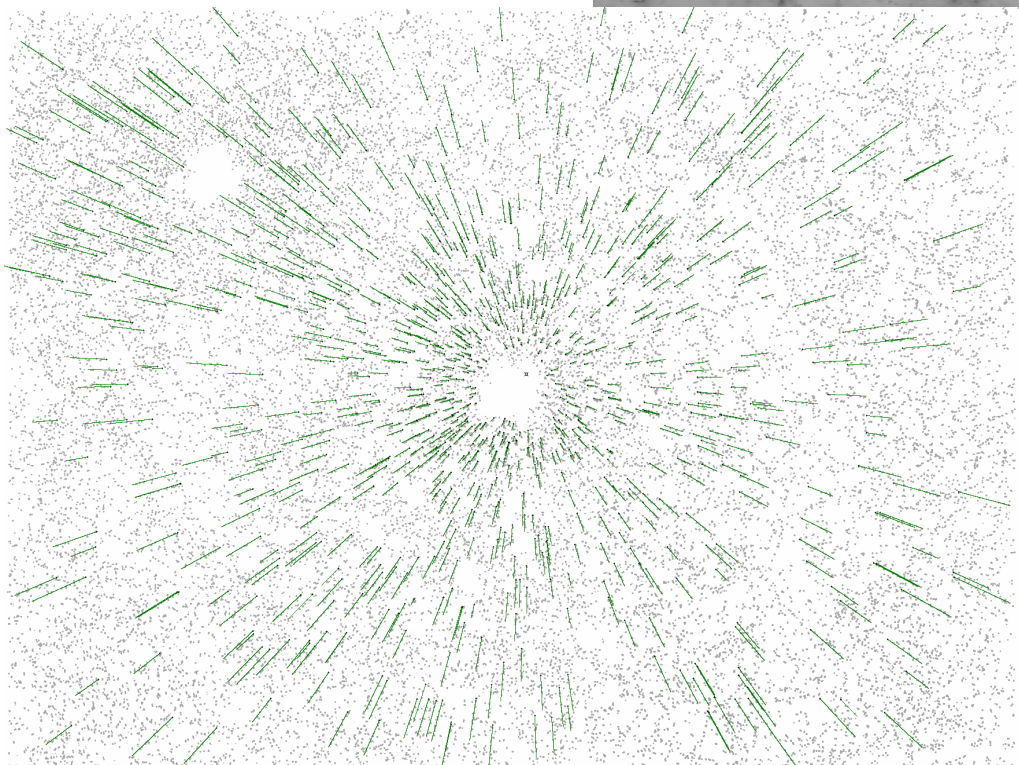


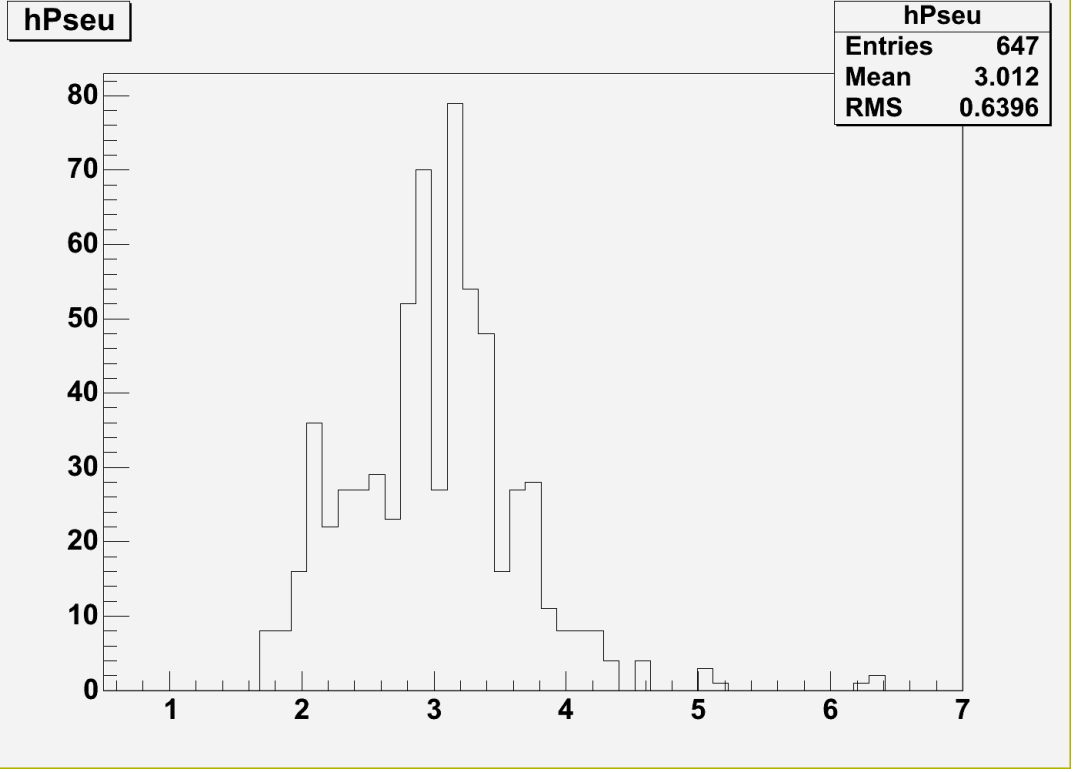

The image developed by averaging filter and its coordinate-color histogram.



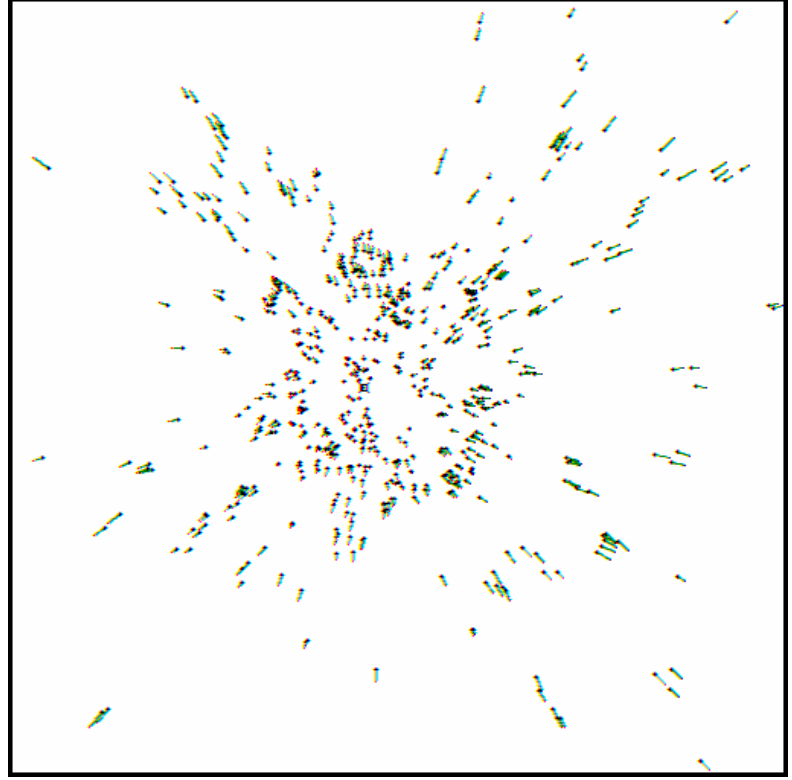






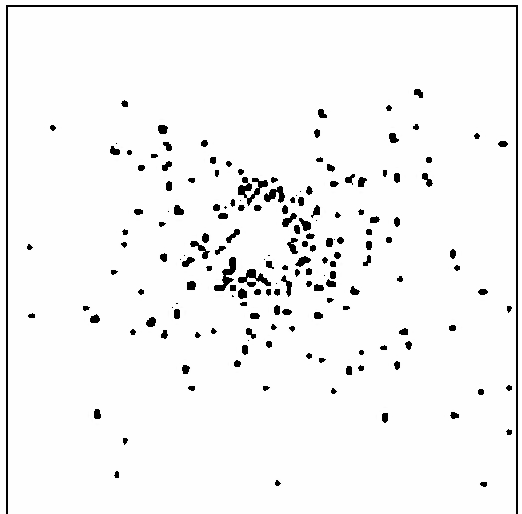


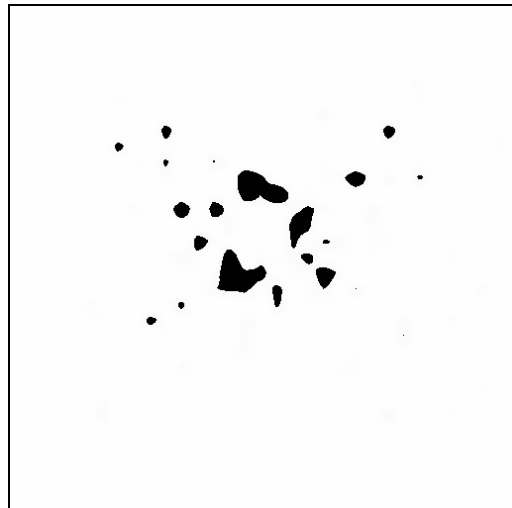

$$y = -\ln tg\frac{\theta}{2},$$

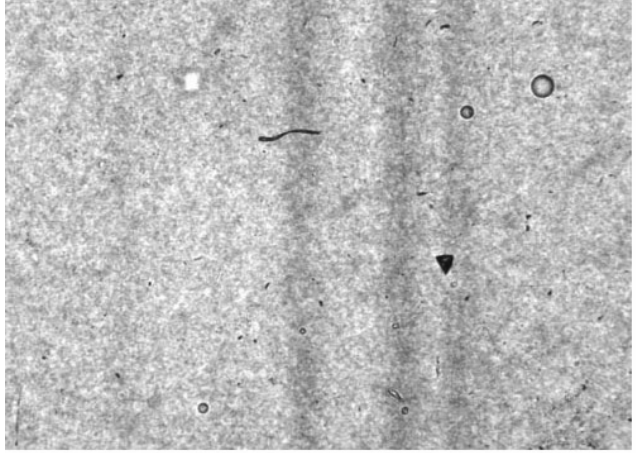


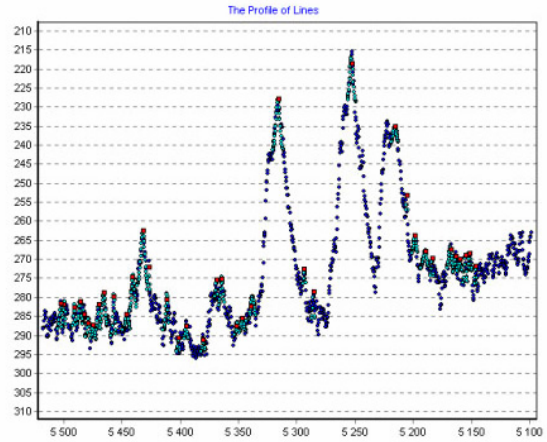
**Target diagram of secondary charged particles distribution in event 5c15e.**

**The same event after 2 and 4 back iteration of wavelet-transform. Non isotropic character of secondary particles distribution testified to possible peculiarities in particle angular distribution, also to existence of multiparticle correlations which can be expected to occur under hadronization of the excited sub-hadronic matter.**





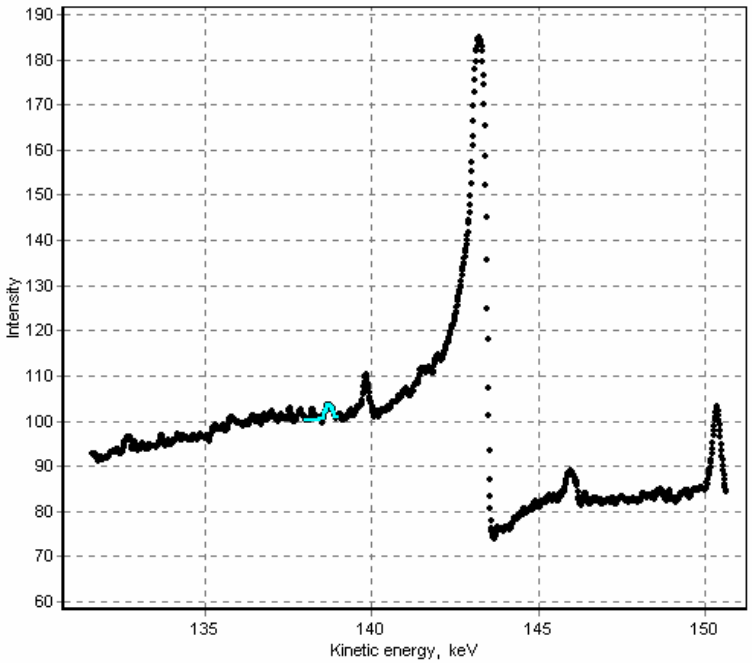




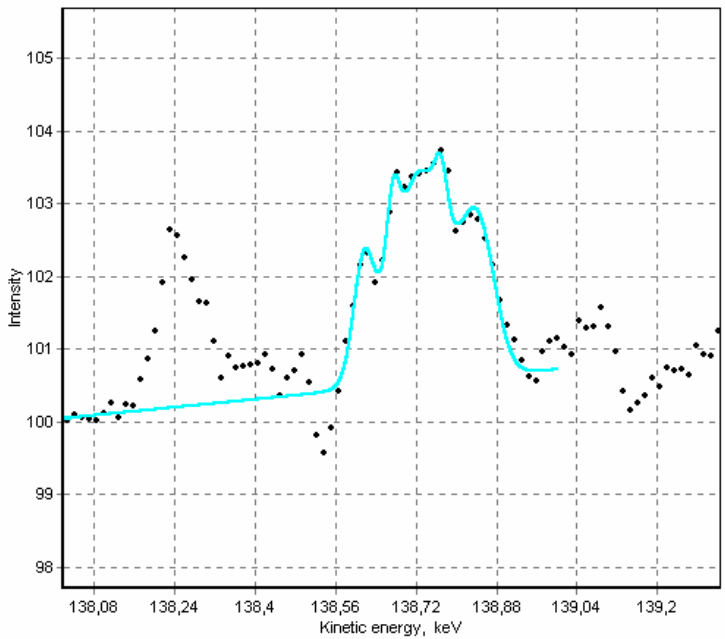

# «SPEKTR» $_{68}Er$

**ITEP, JINR - an experimental study of conversion electron spectra by nuclear spectroscopy method.**

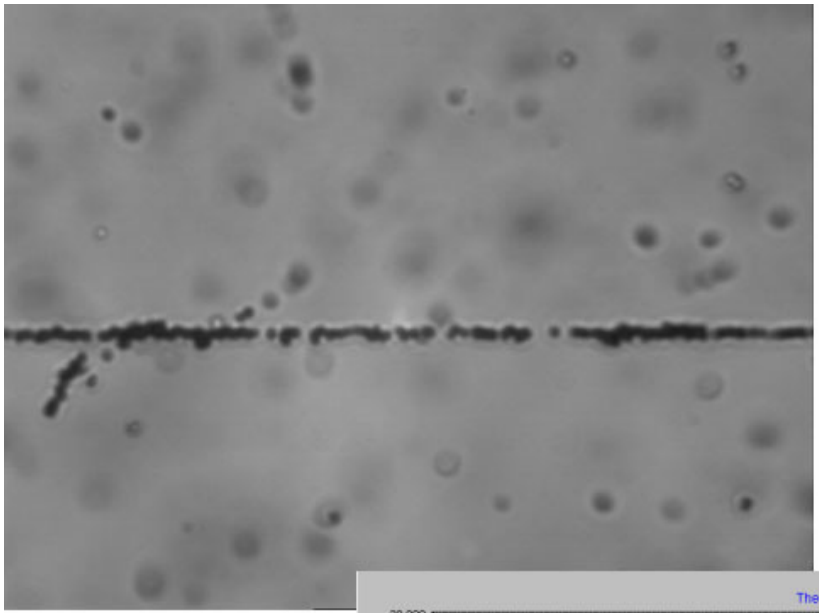
**The nuclear spectroscopy method enables to get the multiform information on the exited atomic nucleus structure, specifically: to determine the multipolarity of nuclear transitions; to get data on spin and parity of the nuclear states; to study anomalies in the internal conversion coefficient values; to find correlations between matrix elements; to conclude about the nucleus excitation character and the nuclear wave functions.**

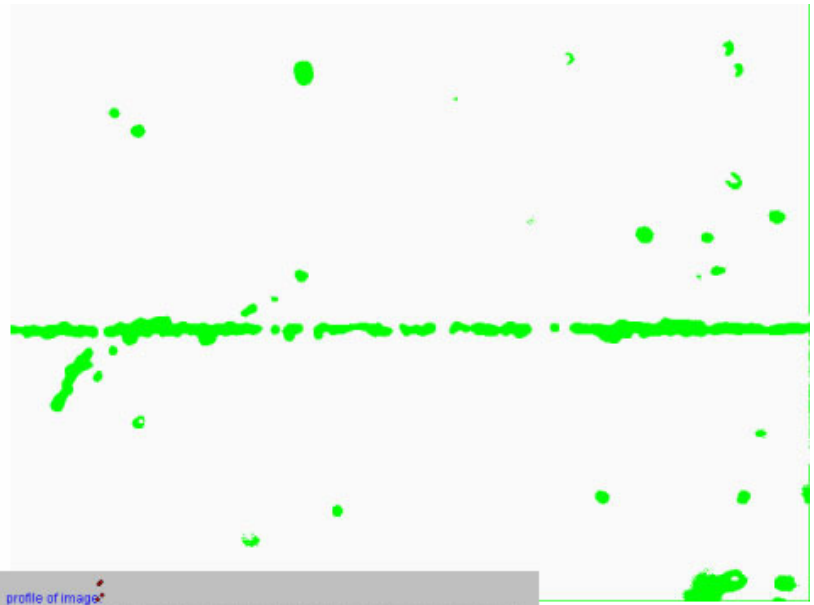


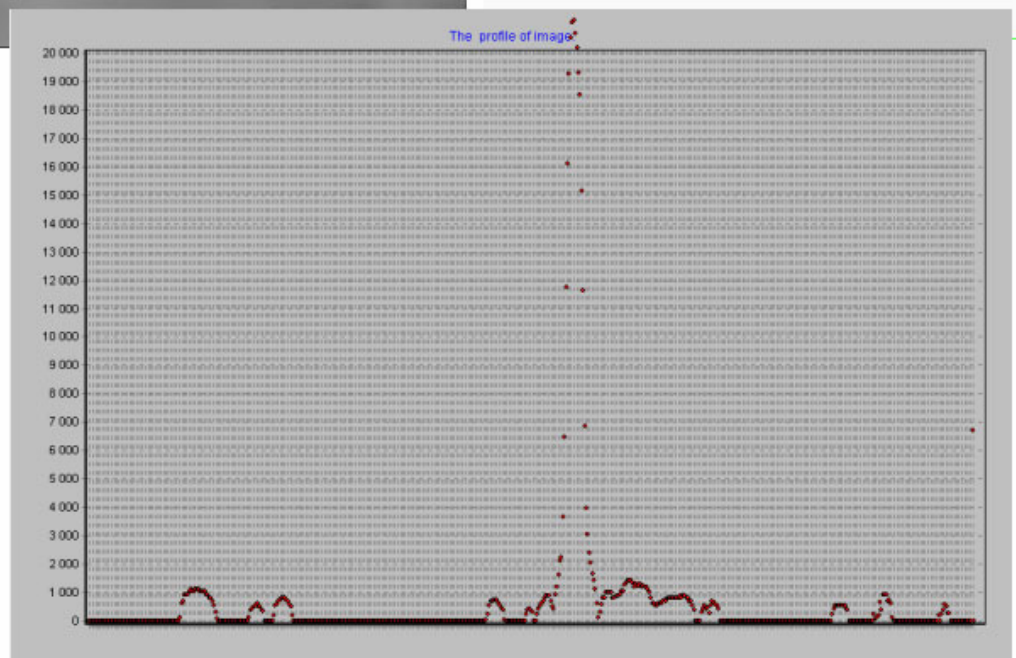

**A change from the microphotometry technique to the technique of microscope - emulsion measurements opens up the new prospects in investigation of electron internal conversion spectra. The spectrograms were obtained at the PAVICOM facility for few isotopes with resolution about 7 eV.**

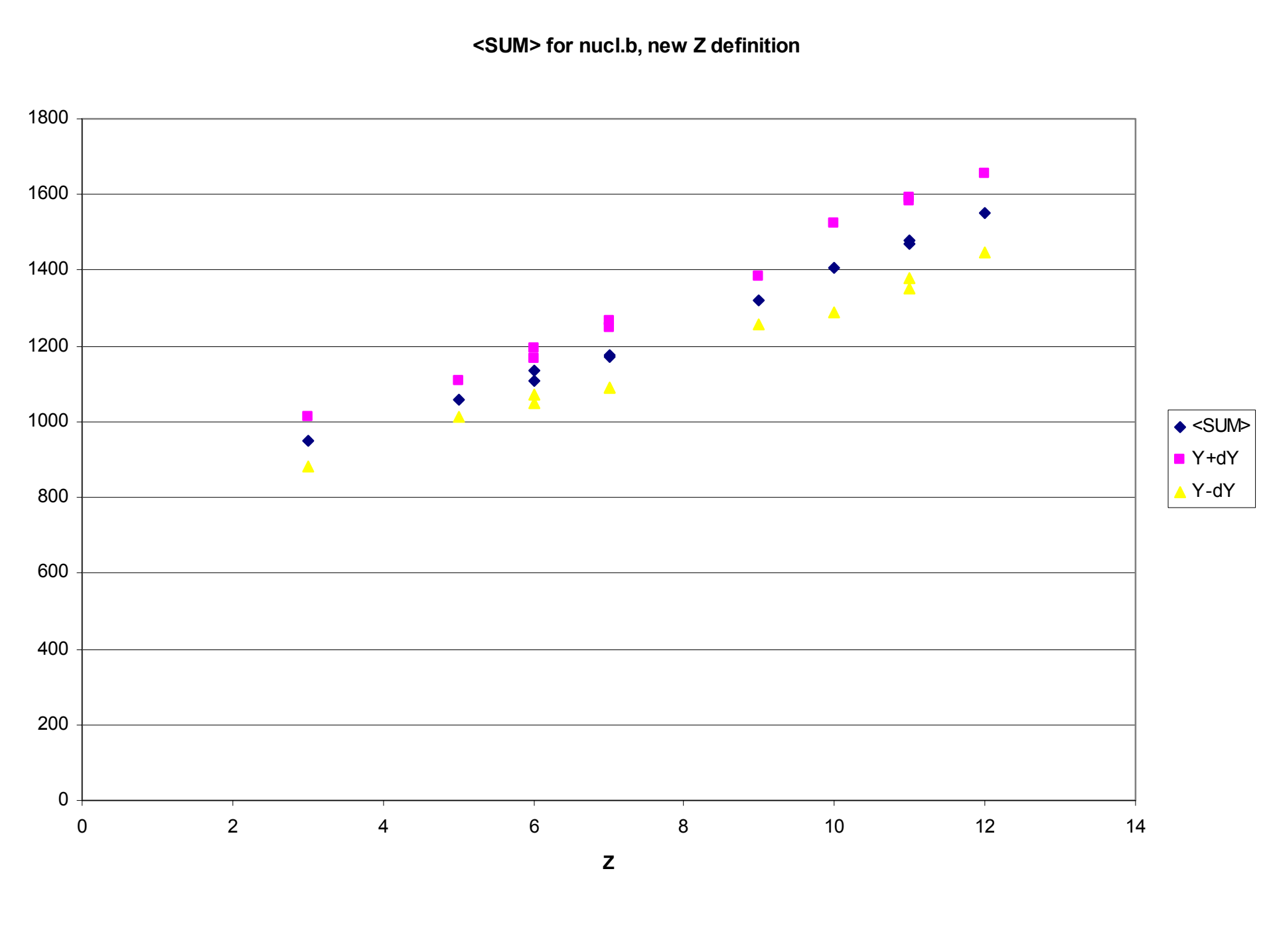


# "CHARGE" (ITEP) –
# an analysis of azimuthal anisotropy of multicharged products.





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200
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14
Z
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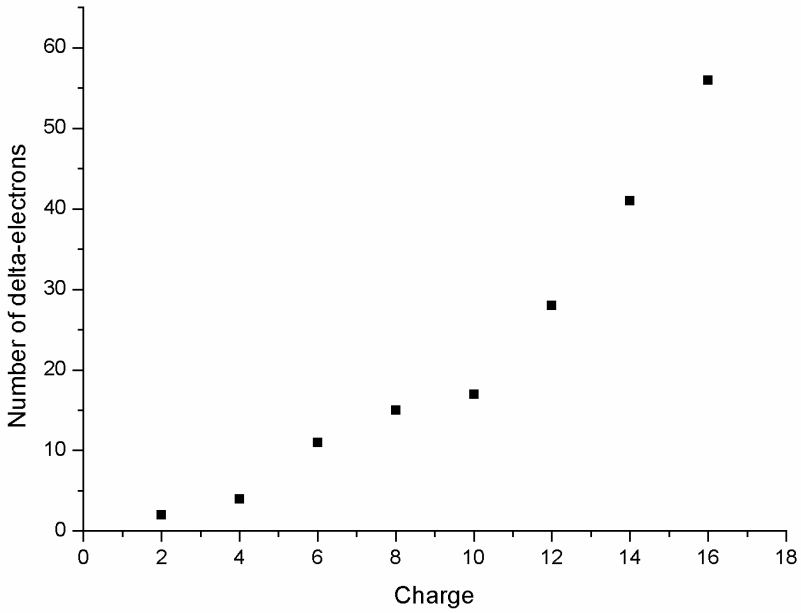
Y+dY
Y-dY


Number of delta-electrons
Charge
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20
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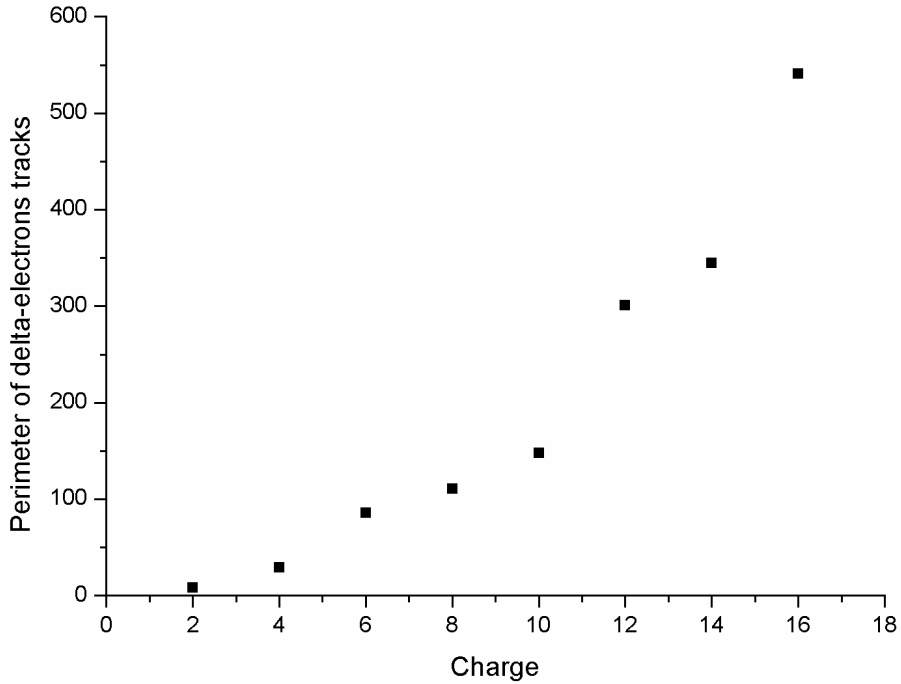
40
50
60
0
2
4
6
8
10
12
14
16
18


Perimeter of delta-electrons tracks
Charge
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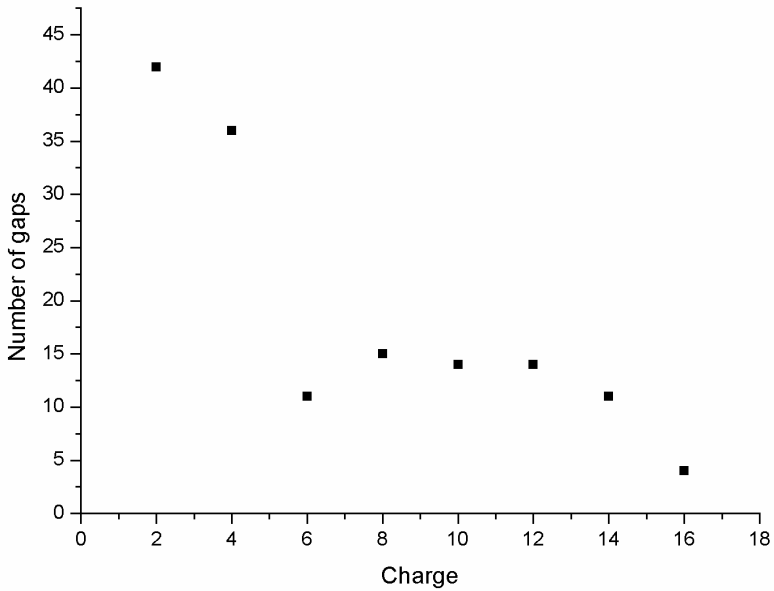
100
200
300
400
500
600
0
2
4
6
8
10
12
14
16
18


Number of gaps
Charge
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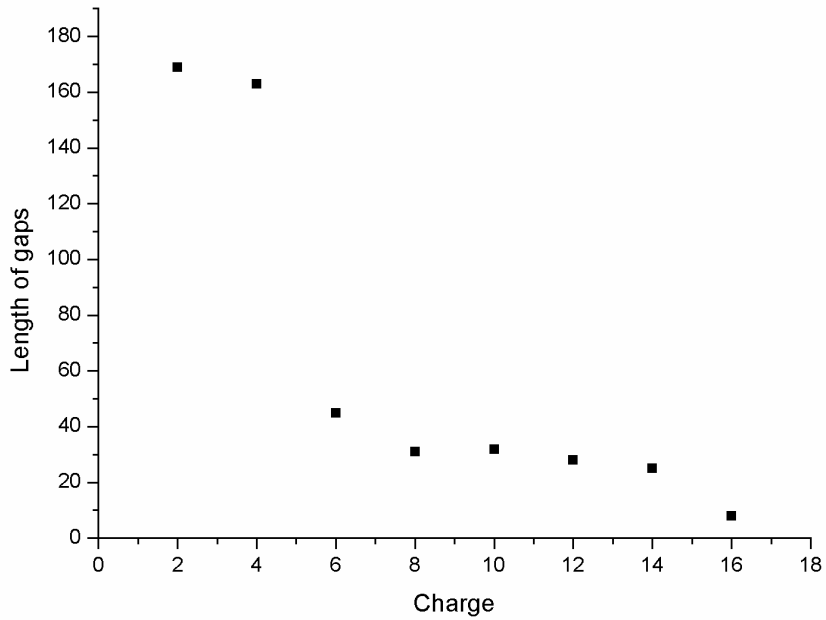
12
14
16
18


Length of gaps
Charge
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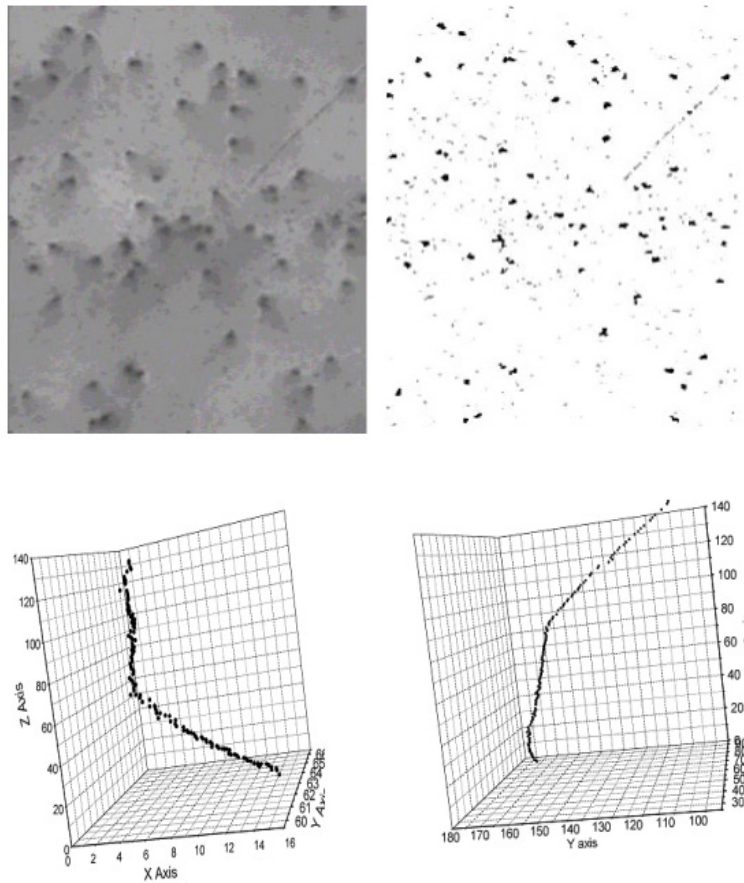
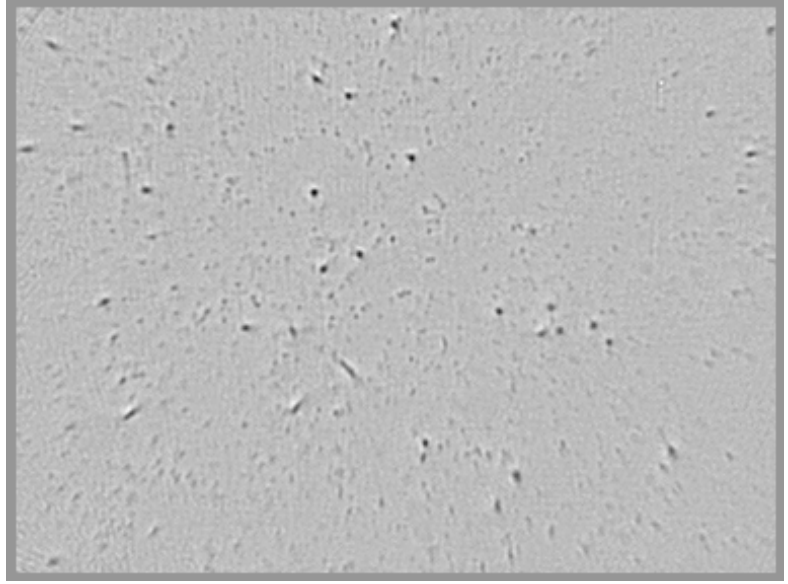
20
40
60
80
100
120
140
160
180
0
2
4
6
8
10
12
14
16
18

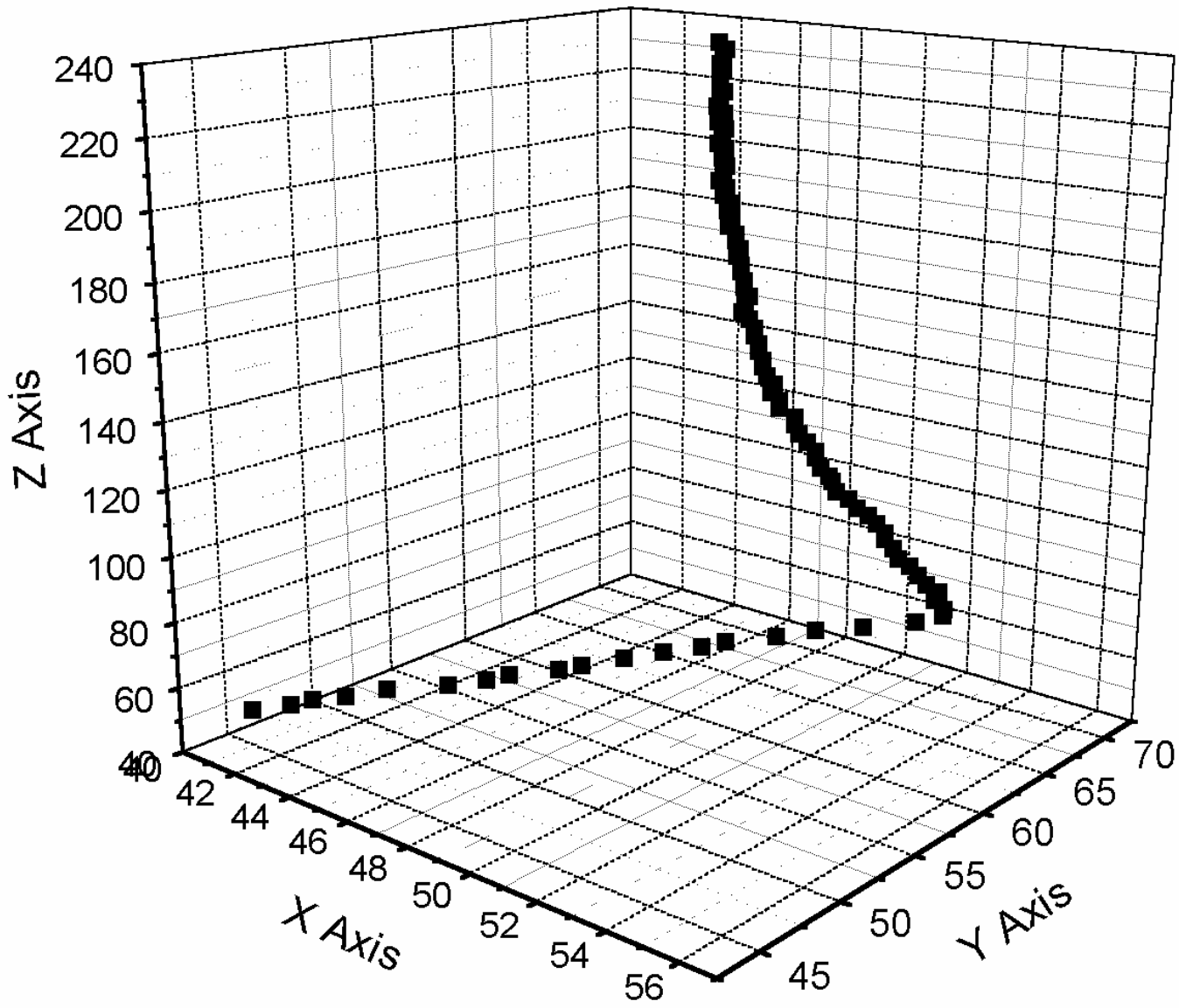
# "NUCLEI" (INR)

**To study two neutron transfer reaction 6He+A→4He+B, nuclear photoemulsion were irradiated by 6He beam with energy ~ 15 MeV/n. As target-nucleus the elements included in nuclear photoemulsion (12C, 14N, 16O, 79,81Br, 107,109Ag) were used.**

**Search of events of transfer reaction and further processing was performed using automated measuring setup PAVICOM. In this setup the images of consecutive (with step of several μm) emulsion layers using CCD-camera and interface were obtained and transferred to computer. At further processing of these images, we select darkening areas (globes) with darkening degree, shape, and size inherent for tracks of given charged particle (4,6He). Coordinates (x, y) of centers of mass of all globes in each layer (z-coordinate) are determined and stored. Then, particle trajectories Xi(z) and Yi(z) are determined by center-of-mass coordinates in consecutive layers of emulsion.**






240
220
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160
140
120
100
80
60
40
Z Axis
42
44
46
48
50
52
54
56
X Axis
45
50
55
60
65
70
Y Axis

*Doklady Physics, Vol. 50, No. 6, 2005, pp. 283–285. Translated from Doklady Akademii Nauk, Vol. 402, No. 4, 2005, pp. 472–474.*


PHYSICS

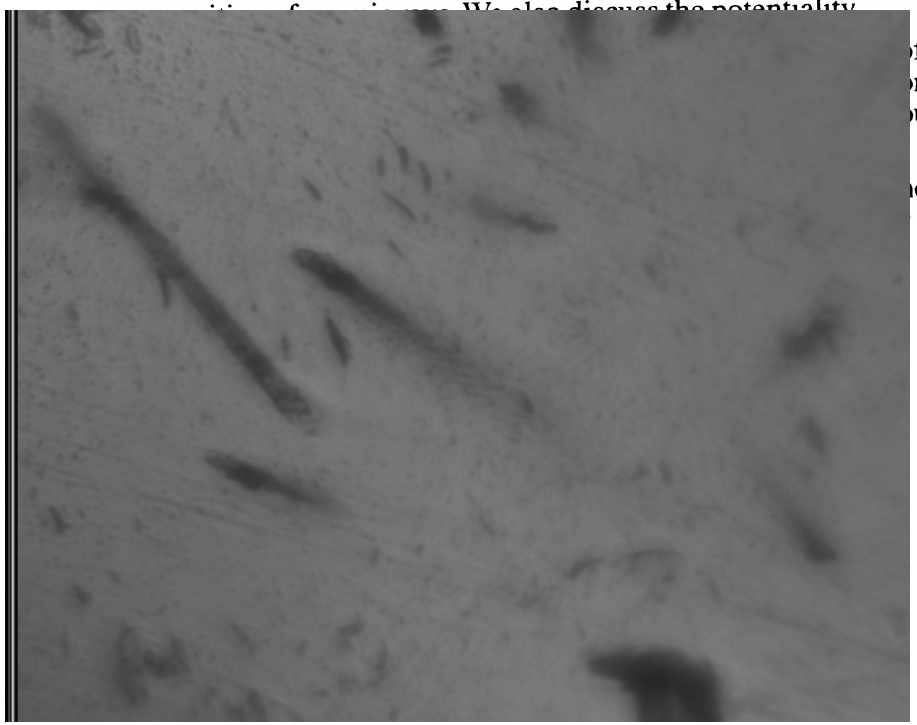
# Problems and Horizons of the Search for Tracks of Heavy and Superheavy Nuclei in Olivine Crystals from Meteorites (OLIMPIYA Project)

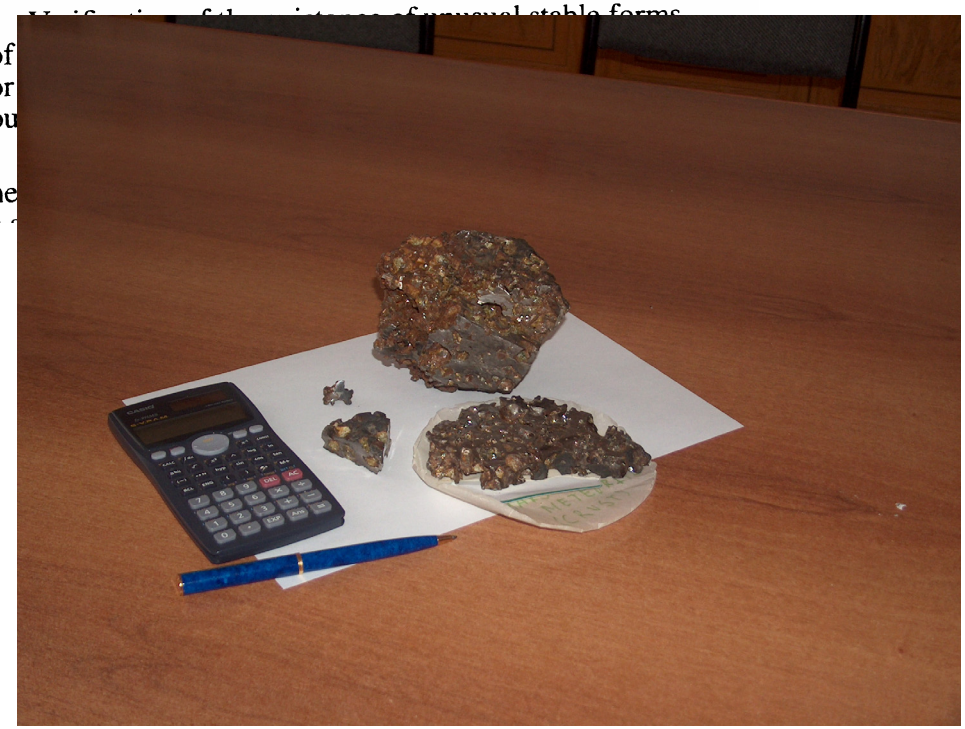
**Academician V. L. Ginzburg, Academician E. L. Feĭnberg, N. G. Polukhina, N. I. Starkov, and V. A. Tsarev**

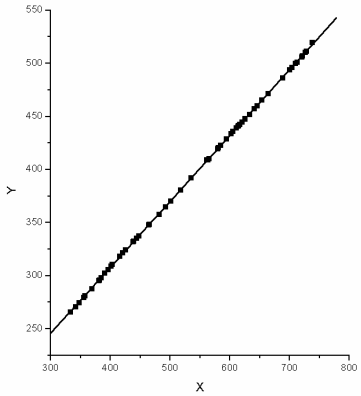
Received February 1, 2005

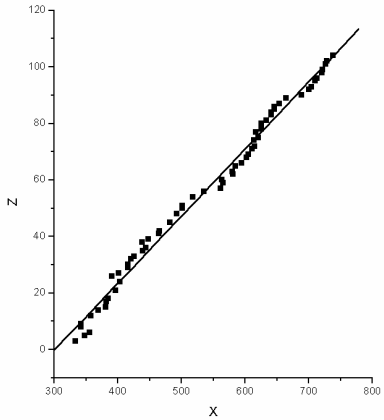
In this paper, we consider the nuclear-physical and astrophysical aspects of investigations associated with the search for heavy and superheavy nuclei in the com-

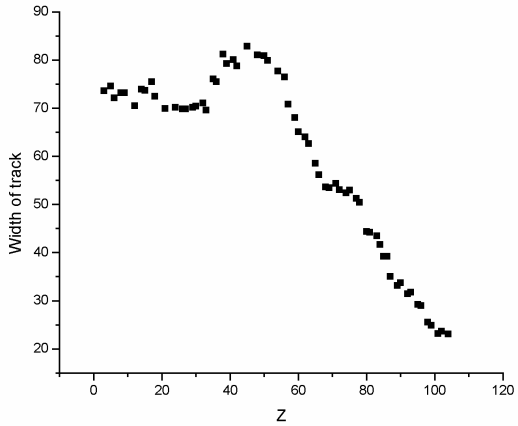
tinue to hold for very large values of $N$ and $Z$, the existence of stability islands for even heavier nuclei must not be ruled out.



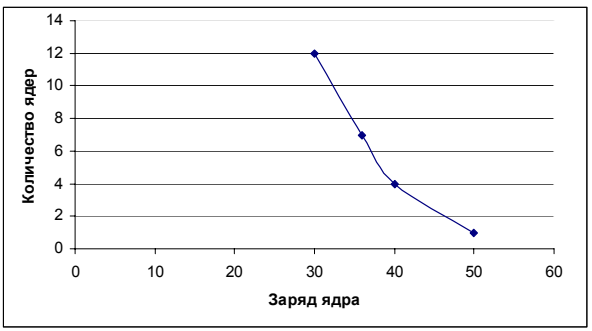




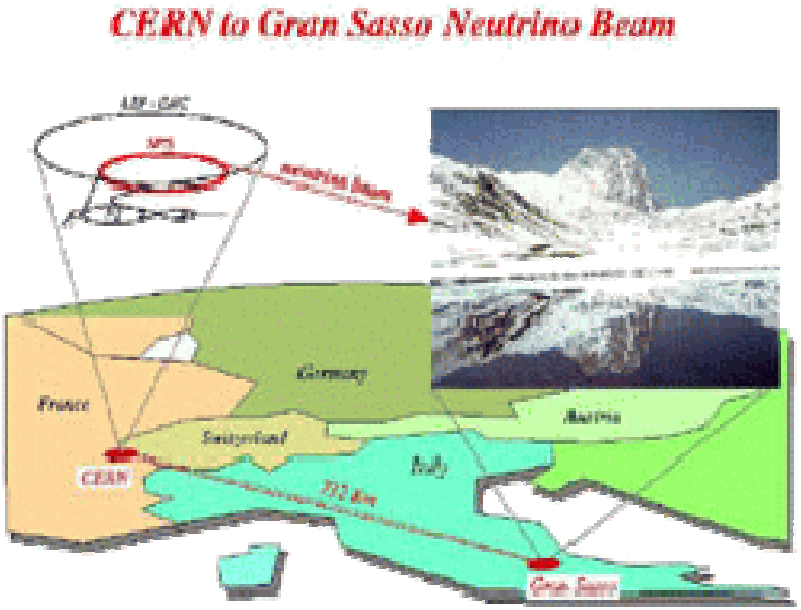




**The development and treatment of first 13 olivine crystal with radius about 1 mm each are started now. The first test measurements are made up to 100 microns depth at each crystal. 155 nuclei are registered. The preliminary charge valuation was made for 42 nuclei which stopped inside this crystal depth.**



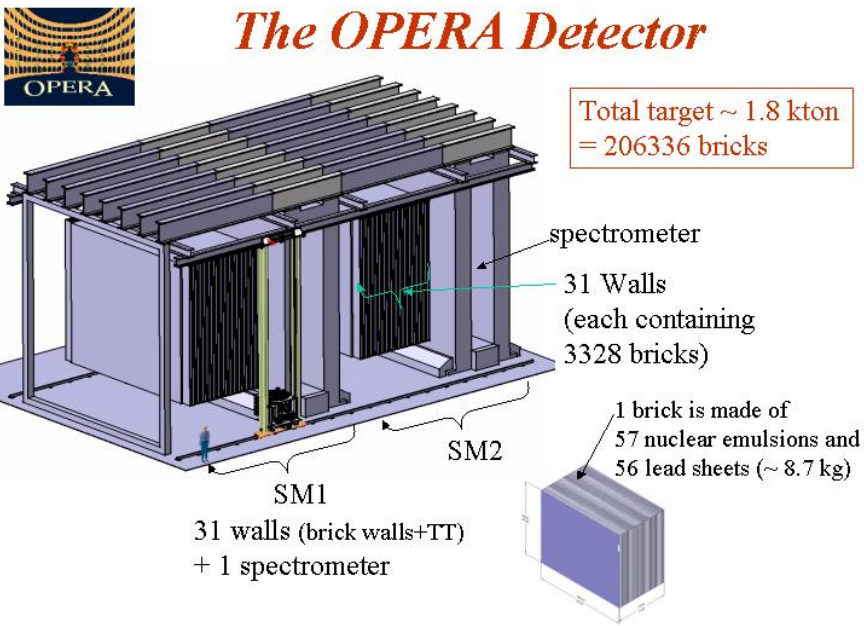

**Preliminary valuation are next:**
**All 42 nuclei have charge more than 28.**
**12 nuclei have 28<Z<30, 14 nuclei c Z>30, 7 nuclei c Z>36, 4 nuclei c Z>40, 1 nucleus c Z>50.**
**So evaluation of track density for Z>40 и Z>50 is:**
**ρ(Z>40) ≈100 tr. sm-2 and ρ(Z>50) ≈25 tr. sm-2**

**Average track density for VH-nuclei (23<Z<28) ρ(VH) ~ (1-5)10**6 tr. sm-2 . It follows that estimation for prevalence ratio for nuclei with Z>40 и Z>50 relatively VH-group is:(1-0.2)10**(-4) и (2.5-0.5)10**(-5).**

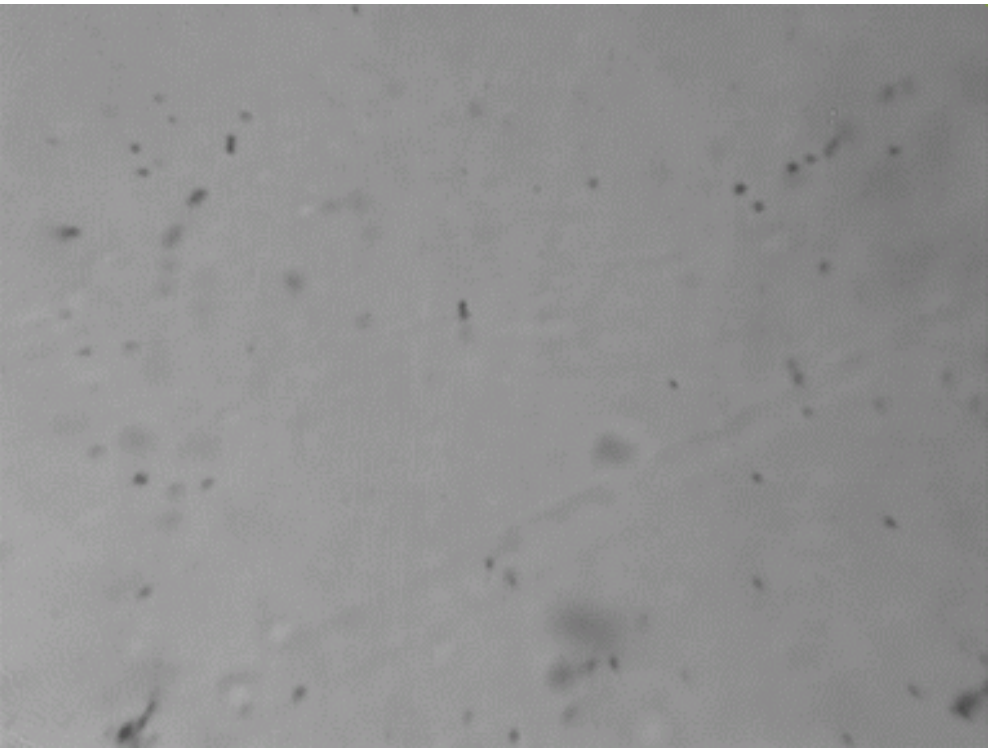



**The search and investigation of oscillation muon neutrino to tau and electron neutrino.**

**39 Institutes and 13 countries; 206336 Pb-emulsion blocks include to detector.**




Adaptation of PAVICOM setup to OPERA tasks presents the unique possibility for Russian physicists to participate in data treatment at one of the ambitious international experiment. This experiment results will be very important for elementary particle physics and astrophysics.



**For successfully solving of OPERA emulsion treatment in Russia it is large reserve:**

**1).** Rich experience in solid-state detector treatment at PAVICOM.

**2).** Close contact with international emulsion community: members of PAVICOM group worked in frame of CHORUS experiment (produce software and data treatment), and during last 3 years – in Naples. Part of standard OPERA software – namely transition from one emulsion layer to next layer – was elaborated by our scientists.

**3).** PAVICOM group has 4 test beam OPERA emulsion layers for testing software.

**4).** Corresponding hardware. Additionally in this year we bought new high speed scanning system totally as OPERA standard, including

1. CMOS videocamera MC1310 (“Mikrotron”);
2. Video card MATROX ODYSSEY Xpro (interface PCI-X);
3. PC of special integration (2-processor working station on base Intel Pentium 4 Xeon 3.6 ГГц, chip Intel SE7505VB2 with PCI-X support, Matrox Millenium G550 AGP, hard disk Maxtor SCSI, 120 Гб, 2 Гб DDR).

**5).** Lebedev Physical Institute now discuss with CERN technical details of procedure passing to Russia (SINP MSU, JINR and LPI) 3 automated setup on base MICOS stage.

**http://www.lebedev.ru/wwwsites/pavicom**