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Adapting and testing PAVICOM facility for treatment of OPERA experimental data

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The Completely Automatic Measuring Complex (PAVICOM) was constructed in 2000th year in the Lebedev Physical Institute and started for track-detector data processing in the field of nuclear, high energy and cosmic ray physics. Here an improvement of PAVICOM facility that enabled processing OPERA experiment data is presented. The scanning facility hardware was upgraded as well as new microscope controlling software was developed. Now it consists of LOMO microscope; Carl Zeiss scanning stage (Movement range: X = 120mm, Y = 100mm, accuracy 0.25um for X, Y and 3.46 x 10-3um for Z); MCU-26 stage controller; CMOS - camera Mikrotron MC1310; a server with 2 Xeon processors for data treatment, equipped with Matrox Odyssey Xpro board for image grabbing and first processing. Data treatment and reconstruction software was adapted to work with the standard OPERA data on PAVICOM and provides now ability for on-line emulsions detectors treatment: while one field of view is processed, the next one is scanning. Because the main resource-intensive operation is now carried out on the Matrox board, the processing time is limited only to the speed of the stage. This is what allows using PAVICOM for OPERA emulsion data processing. Also some test processing results of OPERA emulsions are presented.

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1. Applications of PAVICOM

PAVICOM facility is/was used for measurements in a rather big amount of experiments, such as **EMU-15** (Investigating properties of the multiparticle-generation process, in particular, search for manifestation of quark-gluon plasma in central collisions of ultrarelativistic heavy nuclei)[2]; **RUNJOB** (Study of nuclear composition and primary cosmic-ray spectrum)[3]; **BECQUEREL** (investigation of the light radioactive nucleus fragmentation, obtaining data on secondary particle charge states)[4]; **OLIVIN** (measurements of superheavy cosmic ray nucleus spectra and search for trans-fermi nuclei with Z >110 [5]; **OPERA** [6] and others.

2. Software package PAVICOM

Main concept of PAVICOM software package was chosen based on number of application, and simplicity of possible future updates of our complex as well as using for new tasks. Such flexibility is achieved by introducing independent modules for each hardware part of the facility and modules for each different task.

A processing module was developed for treatment of OPERA emulsions. It is functionally identical to the libACQ program used in Bern scanning laboratory providing hardware filtering, clustering, and micro tracking steps, and gives *.root files in standard for OPERA scanning laboratories format. Micro tracking is carried out using libEMC library, that was developed by Napoli group and we are now improving it and testing on PAVICOM complex. Processing module receives scanned images in internal format. Then they are filtered on the Matrox Odyssey board. Then clustered using “Fire in step” algorithm and tracked using libEMC library. All data is saved in standard edb format.

A program that provides “offline” data processing was developed: it loads alredy scanned images and passes them to processing module. It means, that one can process them on any computer without any special equipment.

3. Tests

We have tested our reconstructing software on generated events as well as on emulsions exposed by pions. Generated events consist of tracks and fog. Different track angles, track density and fog density were checked. Clustering efficiency is approximately 100%. Threshold was chosen to minimize number of depth at witch on real blob is seen. Now it is 1 for ~60% of signal clusters, 2 for 28% and 3 for rest 11%. Grain finding procedure reconstructs these repeated clusters to one grain. Grain finding efficiency depends on fog density and for real emulsion is approximately 96%. These grains come to microtrack reconstruction. For that histogrammic method is used. Its efficiency depends on fog density and track slope. It is shown in *Table 1*. One can see that it is rather low for big theta. We are working on this problem. Also total efficiency will be increased after calibrating refitting procedure. It takes care on elimination fog clusters from selected microtracks. On *Image 1* one can see reconstructed tracks in generated event, on *Image 2* - in real emulsion. One (green) of two tracks found. Blue-marked one was not recognized. 2 red lines are dead pixels.

4. Conclusions

New CMOS Mikrotron MC1310 camera and a server with 2 Xeon processors for data treatment, equipped with Matrox Odyssey Xpro board for image grabbing and first processing was successfully installed on PAVICOM. OPERA emulsion data processing module for PAVICOM software package was developed. It is functionally identical to libACQ, except that

it can be used for offline image processing without special equipment and takes into account some features of our scanning equipment. libEMC tracking library first developed in Napoli by Valeri Tiukov is now tested and improved at our complex in contact with Napoli group. Special Al plate for fixing of OPERA emulsion on our stage was manufactured. This means that PAVICOM group is ready for treatment of OPERA emulsions data.

Table 1

Angle; fog density, 10^{-3}um	10˚; 5	30˚; 3	45˚; 0	45˚; 3	45˚; 5
Efficiency, %	83	82	100	68	40

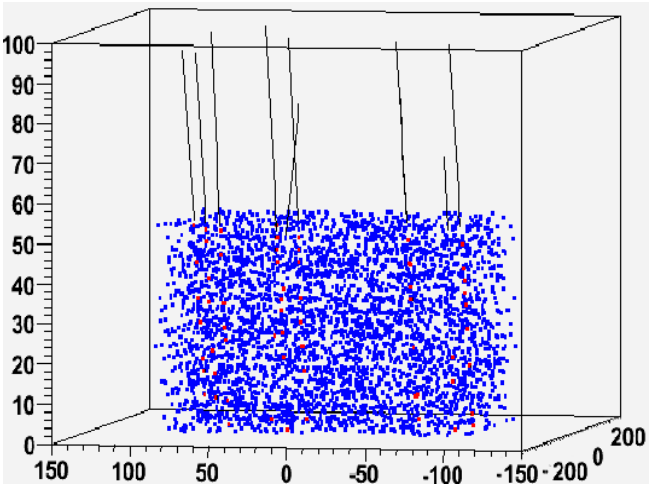

Image 1: generated event, 8 tracks of 10 found correctly (one at wrong angle-incorrect)

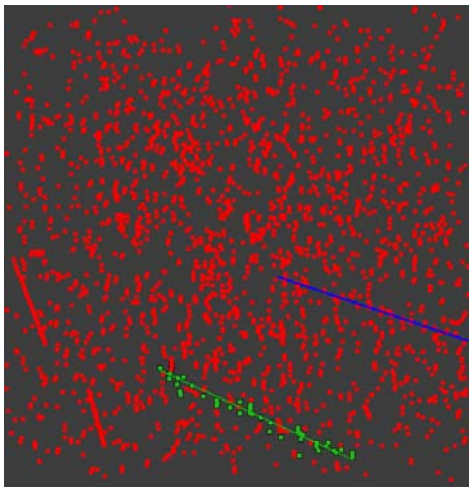

Image 2: Exposed emulsion. One of two tracks found

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