USING OF THE ROOT PACKAGE FOR PHYSICAL DATA PROCESSING

I.M. Prokhorets, S.I. Prokhorets, Y.V. Rudychev, M.A. Khazhmuradov *

National Science Center "Kharkov Institute of Physics and Technology", 61108, Kharkov, Ukraine

ROOT is object-oriented framework, which is actively developed in CERN now. In this article potential of ROOT using for more effective analysis of the data from mathematical modeling and physics experiments are considered.

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1. INTRODUCTION

In the middle 90-ies it became obvious that old Fortran libraries and software had reached their limits for data simulation and processing. Although still very popular, these tools could not scale up to the challenges offered by planned and carried out physical experiments, as the obtained data became a few orders of magnitude larger that anything see before.

At the same time had made leaps of progress especially in the area of Object Oriented Design.

So to became necessary to develop new software for data analysis and processing in nuclear physics - ROOT.

ROOT [1] - is object-oriented software for data analysis in high energy and nuclear physics. It was developed in the context of the NA49 experiment in CERN. This experiment has generated a huge amount of data, around 10 Terabytes per run. From its beginning ROOT was developed as object-oriented framework. Working inside the framework user has all necessary base elements (Fig. 1) and user can concentrate on solving his specific problem. Object-oriented approach makes ROOT usage even easier, because basic framework structure remains the same after all changes in software code.

Framework benefits can be summarized as follows:
- less time is needed for programming;
- framework makes it easier to break programs into smaller parts,
- the user is able to use and reuse majority of the existing code parts, that was written earlier.

Object-oriented programming gives the following benefits:
- objects can easily be modified and extended using sub-classing;
- class hierarchies provides a flexible mechanism for modeling real objects and relationships among them;
- objects may come and go, but the basic program structure remains relatively static, thus increasing the opportunity of reuse the design.

The disadvantage of framework is that the user in constrained to it, as you are constrained to use the routing algorithm provided by your internet-provider or telephone company.
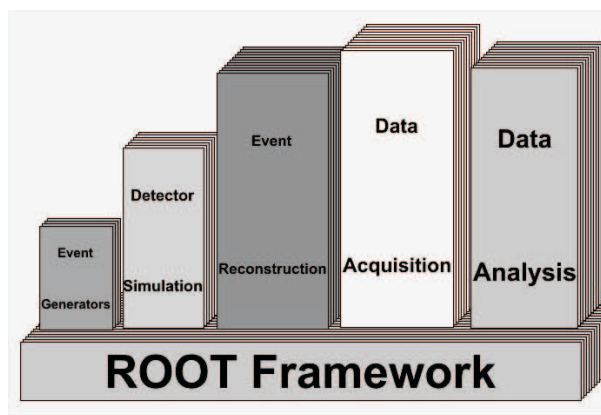
***Fig.1.** ROOT structure*

The main purpose of mathematical libraries of ROOT is providing and support of mathematical and statistical functions. Latest ROOT versions include new MINUIT version, that was redesigned and re-implemented using C++ language. Random numbers generators from range $[0 \ldots 1]$ have periods up to 10^{6000}. To generate widely used mathematical distributions such as Gauss, Breit-Wigner and Poison distributions special TRandom classes are used.

The aim of this article is studying of the possibility to use object-oriented framework ROOT for studying of the semiconductor detectors characteristics.

This task is very actual for development of methods of studying and simulation of the multi-channel detectors of nuclear radiation.

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*Corresponding author. E-mail address: khazhm@kipt.kharkov.ua

2. OBTAINING SIGNAL HISTOGRAM FROM THE MULTI-CHANNEL DETECTOR

Let's consider practical ROOT usage. To test ROOT it is more convenient to use data previously processed with other software, specifically, data from 64-channel silicon strip-detector [2]. Data files from such detector contain 256 rows (ADC channels) and 128 columns (amplifier channels). Processing task was to obtain and draw signal distributions for each channel from 128 amplifier channels [3], fitting them with Gauss distributions, storing obtained histograms and histogram parameters and possibility of further usage of the stored histogram and their parameters.

3. COMPUTER CODE FOR PROCESSING THE DATA FROM THE DETECTOR FILES

Part of the program for processing the data from detectors and their storing for further usage is given below.

```
#include "TString.h"
#include "TCint.h"
#include <fstream>
#include "TH1.h"
#include "TGraphSmooth.h"
#include "TCanvas.h"
#include "TSystem.h"
```

```
#include "TFile.h"
void Red11s2(){
...
TFile *f = new TFile("chn5s1.root","RECREATE");
TTree *T = new TTree("ntuple","data from ascii file");
Float_t v5[256];
Double _t par[3];
// Reading data
printf(" found %lld points\n",nlines);
TH1F *h1[128];
for(Int_t j=0; j<128; j++)
{
h1[j]= new TH1F(n[j],n[j], nlines,0,nlines);
T->SetBranchAddress(n[j], &v5[j]);
for (Int_t i=1; i<=nlines; i++)
{
T->GetEntry(i);
h1[j]->SetBinContent(i,v5[j]);
}
printf(n[j]);
printf("\n");
h1[j]->Draw();
h1[j]->Fit("gaus");
h1[j]->Write();
gaus->GetParameters(par);
c1->Update();
}
}
```
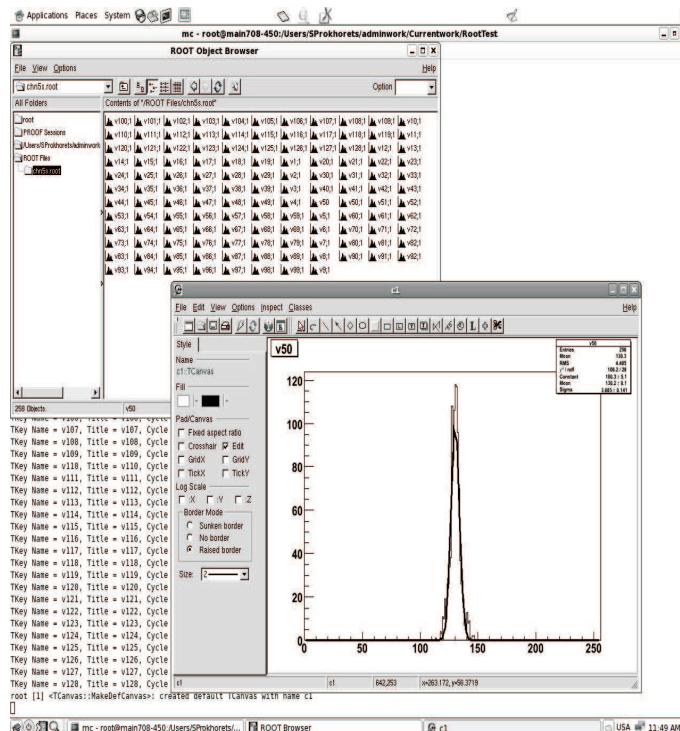

Fig.2. *Example of work with histogram of the signal from the strip 50 using ROOT Object Browser*

In ROOT it is possible to use saved histograms and their parameters for further work. ROOT Object Browser serves for this purposes. Via this Browser you can open files, where histograms were saved, by mouse double click. Then you can work with histogram using interactive panels (fig. 2), and, for example, prepare histogram for your publication in scientific journal. If you find that these interactive panels are insufficient for your demands, you can write program, similar to shown above, and continue your data processing.

4. STATISTICAL PROCESSING OF THE RESULTS OF COMPUTER EXPERIMENT

Statistical processing of the experimental data was done after their full registration. Advantage of such approach is possibility to use for analysis all statistical methods, and therefore all experimental information can be extracted from the obtained data. During primary data processing all misses and failures we analyzed and culled all misses and failures that were the results of detector defects; also all data was grouped. At the final stage of data statistical processing the mathematical model of the studied object was developed.

To estimate average of distribution we experimental data sampling has to be represented as histogram from m columns and appropriate bin width. Validity of the number of histogram bins and their width choosing was considered in many references concerning mathematical statistics [4, 5, 6]. In [4, 5, 6] Sturges rule is used for determining the number of bins $m = \log_2 n + 1 \cong 3, 31 \lg n + 1$, where n - sample capacity. R. Storm [7] and other authors for determining of the optimal number of intervals propose to use Brooks-Krauzers rule in form of $m = 5 \lg n$. I. Heinhold and K. Gaede [8] recommend for these purposes simple rule $m = \sqrt{n}$.

From the review made in [4] it follows that for small m and n (in our experiment $n = 60$, i.e. was equal to non-defective detector strips), optimal number of intervals equals 8.

5. CONCLUSIONS

Flexible object-oriented framework ROOT, as it is obviously seen from the carried out investigations and literary references, is very powerful convenient and useful tool for processing the data from full-scale and computer experiments in different branches of science and technology. ROOT application at the NSC KIPT is advisable and should be supported.

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ИСПОЛЬЗОВАНИЕ ПАКЕТА ROOT ДЛЯ ОБРАБОТКИ ФИЗИЧЕСКИХ РЕЗУЛЬТАТОВ
И.М. Прохорец, С.И. Прохорец, Е.В. Рудычев, М.А. Хажмурадов

ROOT - это объектно-ориентированная оболочка, которая сейчас активно разрабатывается в CERN. В этой статье рассматривается возможность использования ROOT для более эффективного анализа данных математического моделирования и физических экспериментов.

ВИКОРИСТАННЯ ПАКЕТУ ROOT ДЛЯ ОБРОБКИ ФІЗИЧНИХ РЕЗУЛЬТАТІВ
І.М. Прохорець, С.І. Прохорець, Є.В. Рудичев, М.А. Хажмурадов

ROOT - це об'єктно-орієнтована оболонка, яка зараз активно розроблюється в CERN. В цій статті розглянуто можливість використання ROOT для більш ефективного аналізу даних математичного моделювання та фізичних експериментів.