HistPresent - Easy interactive analysis within the ROOT framework

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Presented at the ROOT2005 WORKSHOP, CERN, 26.Sept.05

Introduction

HistPresent was developed within a project for online and offline data analysis, MARaBOU, to provide access to ROOT objects like histograms, graphs and ntuples as typically used in accelerator experiments. Special emphasis is placed on the simplicity of the user interface to enable unexperienced users to display histograms and do simple operations like zooming and signal/background fitting. At the same time the full functionality of ROOT is made available like e.g. fitting of slices with complicated functions by providing templates for macros. Some extra features like simultanous projections along X and Y and rotations of 2-dim histograms are built in.

HistPresent also exploits the interactive graphics capabilities of ROOT. In addition to ROOT's built-in graphics primitives like graphs, paves, curlylines etc. it allows interactive insertion of histograms, images, functions, xsplines and text files containing LaTeX code. Features for editing common objects on a grid are provided. Compound objects may be defined, extracted, stored in a file and reinserted with new scale and angle.

The MARaBOU project

MARaBOU [0] is a framework for online data acquisition and as offline analysis for nuclear physics experiments. It was developed at the Tandem Laboratory in Garching operated by the University (LMU) and Technical University (TUM) Munich. Design principle of MARaBOU is that the user only sees and communicates with a ROOT based system running on Linux whereas the hardware of the experiment is housed in CAMAC and VME controlled by processors running Lynx OS on VME processors.

Fig. 1 gives an overview on the dataflow within the system.

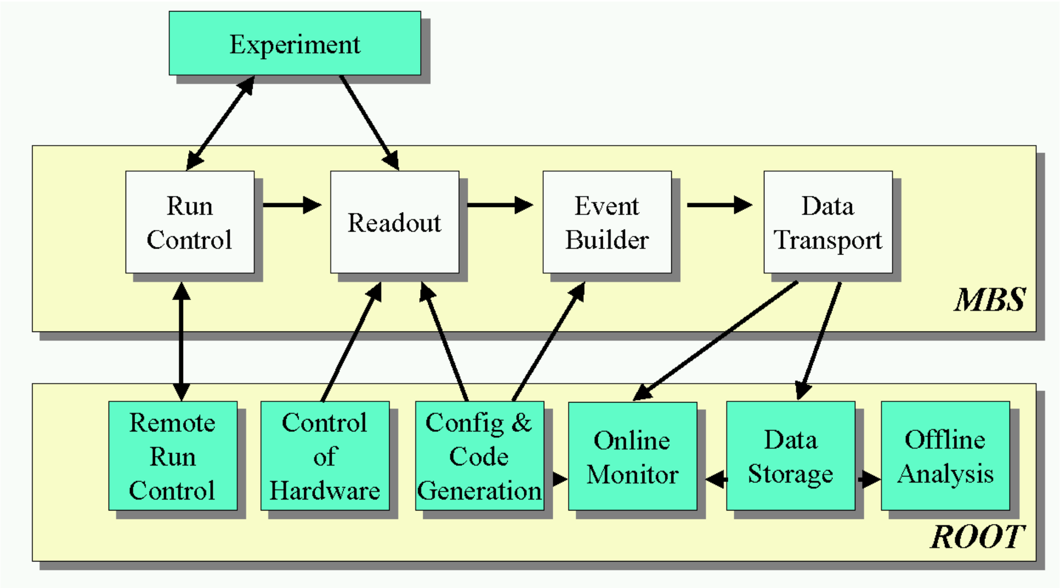


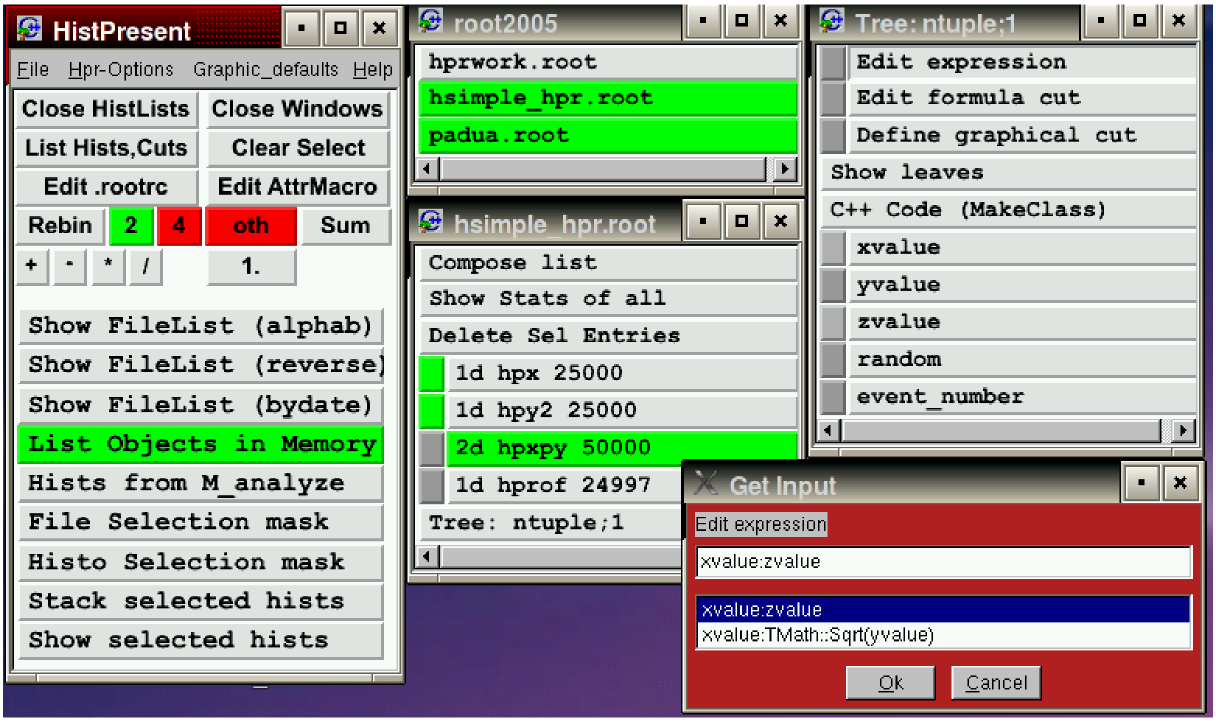
Figure 1: Marabou Tasks

Display histograms

Fig. 2 shows HistPresent's startup window, a file list , a list of a file contents and a widget displayed for a NTuple. All these widgets are implemented using `TButton` objects. Pressing the buttons triggers the obvious actions like showing the content of a ROOT file or displaying a histogram. The `grey` button left of a name is used as a selection. It turns `green` if it is active. This is used in operations like `Show all selected hists` or with the arithmetics operators. E.g. Selecting `hpx` and `hpy2` then pressing `+` would addup histograms `hpx` and `hpy2` resulting in a histogram `hpx_plus_hpy2` which is displayed and added to the objects in memory.

Showing values of a Tree can be done is several ways:

- Just pressing a name fills and shows a 1-dim histogram
- Selecting 2 or 3 names and pressing `Show leaves` fills and shows a 2 or 3-dim histogram
- With `Edit expression` any legal expression may be formed. The input widget used for that implements a history (see fig. 2) and text completion (tab key) for variable names and frequently used functions like `TMath::Sqrt`



Edit expression

xvalue:zvalue

xvalue:zvalue
xvalue:TMath::Sqrt(yvalue)

Figure 2: A sample session

A histogram is displayed in a special canvas inheriting from `TCanvas` with extra popup menus providing actions like `Expand` , `Superimpose` , `Projections` etc. Note: Up to now all operations only require the left mouse button whereas the standard ROOT actions from context dependent popup menus triggered by the right mouse button are still available.

The following picture shows examples: `Show selected hists` in same range, and a 2-dim histogram with a graphical cut (`TCutG`) applied projected on both axes.

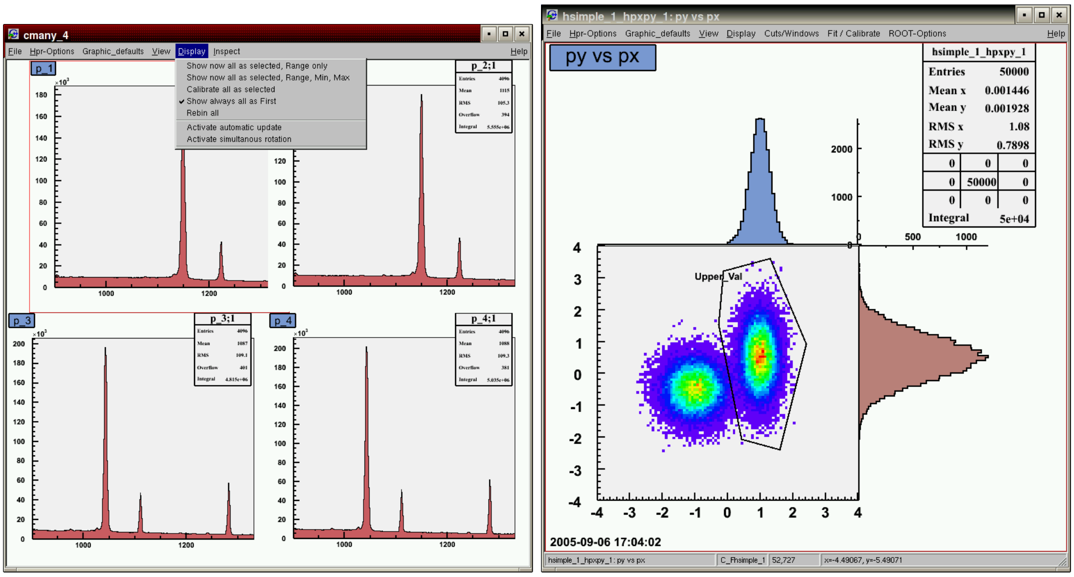
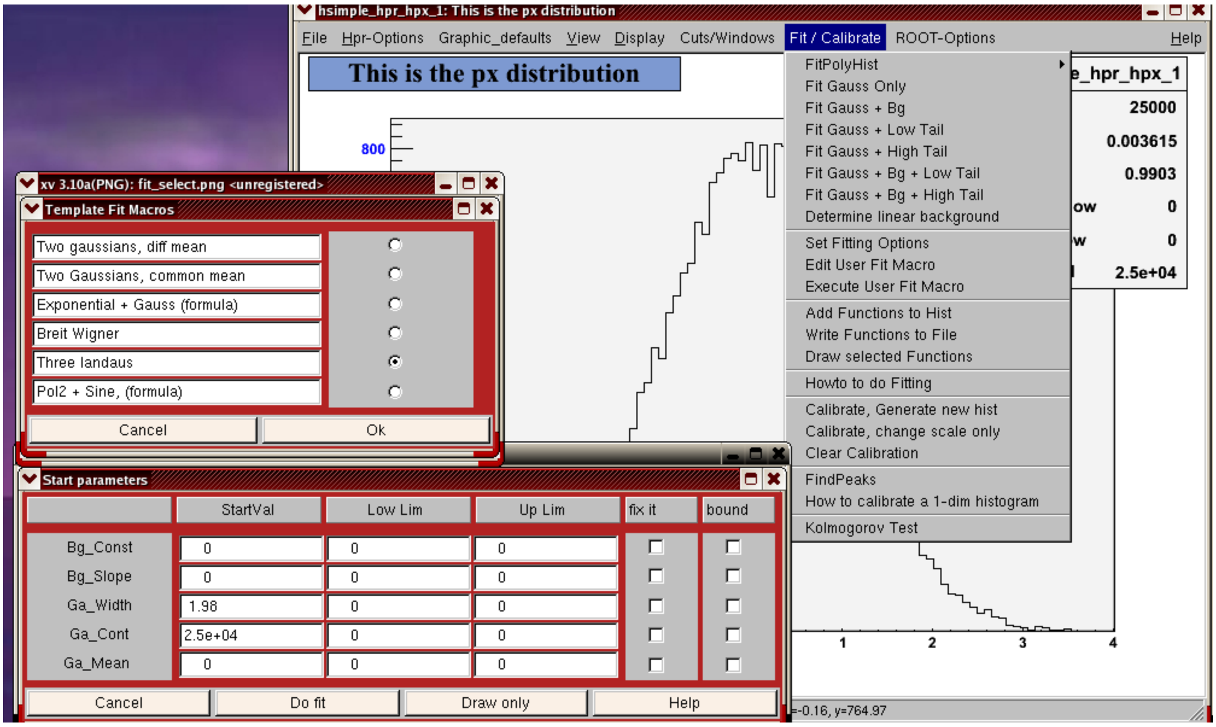

cmany_4
File Hpr-Options Graphic_defaults View Display Inspect Help
Show now all as selected, Range only
Show now all as selected, Range, Min, Max
Calibrate all as selected
✓ Show always all as First
Rebin all
Activate automatic update
Activate simultanous rotation
p_1
p_2;1
Entries 4096
Mean 1115
RMS 105.3
Overflow 394
Integral 5.555e+06
p_3
p_3;1
p_4
p_4;1
×10³
1000
1200
hsimple_1_hpxpy_1: py vs px
File Hpr-Options Graphic_defaults View Display Cuts/Windows Fit / Calibrate ROOT-Options Help
py vs px
hsimple_1_hpxpy_1
Entries 50000
Mean x 0.001446
Mean y 0.001928
RMS x 1.08
RMS y 0.7898
0 0 0
0 50000 0
0 0 0
Integral 5e+04
2000
1000
0
500
1000
Upper_Val
4
3
2
1
0
-1
-2
-3
-4
2005-09-06 17:04:02

Figure 3: Show selected hists, Display_both option with graphical cut

Fitting functions

Among others HistPresent's canvas provides a popup menu `Fit/Calibrate` (see fig. 3). Several predefined functions like `Polynomials` and `Gauss+High Tail` are available. In this case marks which are activated with the middle mouse button are used to define limits and approximate means for a fit. Start parameters are estimated and editable by the user.

A second more general way is to use a ROOT macro. Commands `Edit User Fit Macro` and `Execute User Fit Macro` are provided for this. If with `Edit User Fit Macro` a non existing file name is given the user can choose from a few examples as templates. Again this is to put the entrance threshold to use ROOT as low as possible.



```
e_hpr_hpx_1
            25000
         0.003615
           0.9903
ow              0
w               0
l         2.5e+04
```

Template Fit Macros

- Two gaussians, diff mean ○
- Two Gaussians, common mean ○
- Exponential + Gauss (formula) ○
- Breit Wigner ○
- Three landaus ●
- Pol2 + Sine, (formula) ○

Start parameters

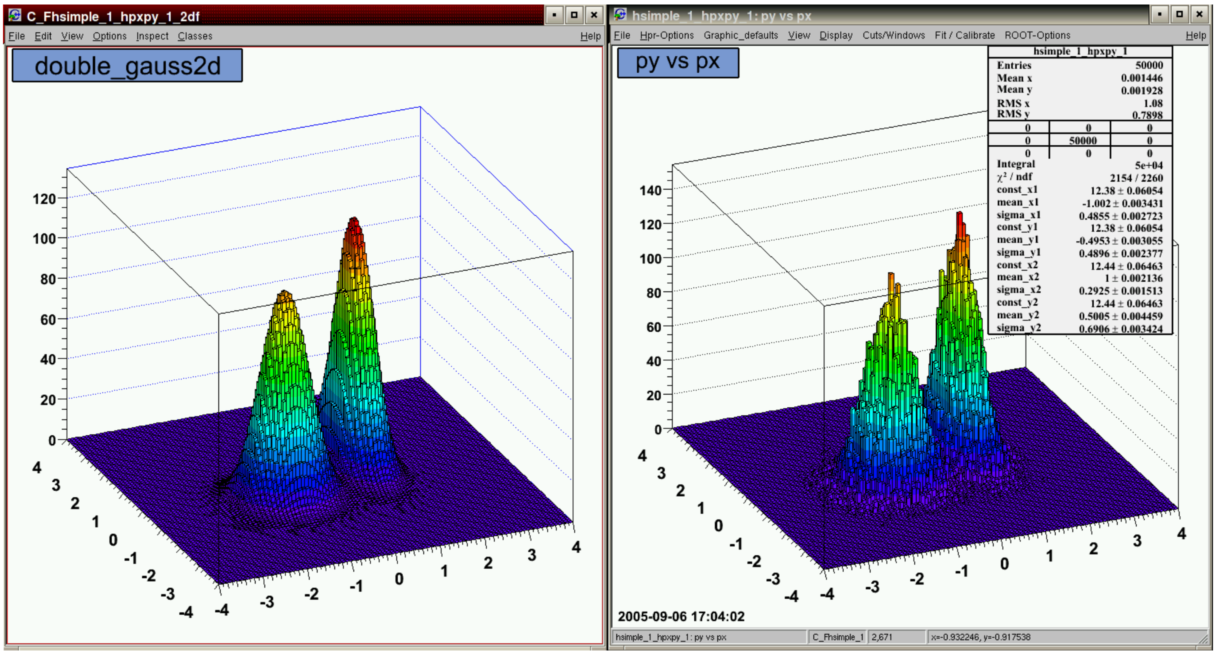
	StartVal	Low Lim	Up Lim	fix it	bound
Bg_Const	0	0	0	☐	☐
Bg_Slope	0	0	0	☐	☐
Ga_Width	1.98	0	0	☐	☐
Ga_Cont	2.5e+04	0	0	☐	☐
Ga_Mean	0	0	0	☐	☐

x=-0.16, y=764.97

Figure 4: Widgets used with Fitting

For 2-dim histograms hooks are provided to fit slices and 2d functions. Also here examples are provided to start with.

Fig. 5 shows the 2-dim histogram from the builtin tutorial and the result of the example fit macro.



```
hsimple_1_hpxpy_1
Entries                 50000
Mean x               0.001446
Mean y               0.001928
RMS x                    1.08
RMS y                  0.7898
     0   |    0    |    0
     0   |  50000  |    0
     0   |    0    |    0
Integral                5e+04
χ² / ndf          2154 / 2260
const_x1     12.38 ± 0.06054
mean_x1    -1.002 ± 0.003431
sigma_x1   0.4855 ± 0.002723
const_y1     12.38 ± 0.06054
mean_y1   -0.4953 ± 0.003055
sigma_y1   0.4896 ± 0.002377
const_x2     12.44 ± 0.06463
mean_x2          1 ± 0.002136
sigma_x2   0.2925 ± 0.001513
const_y2     12.44 ± 0.06463
mean_y2    0.5005 ± 0.004459
sigma_y2   0.6906 ± 0.003424
```

2005-09-06 17:04:02

hsimple_1_hpxpy_1: py vs px | C_Fhsimple_1 | 2,671 | x=-0.932246, y=-0.917538

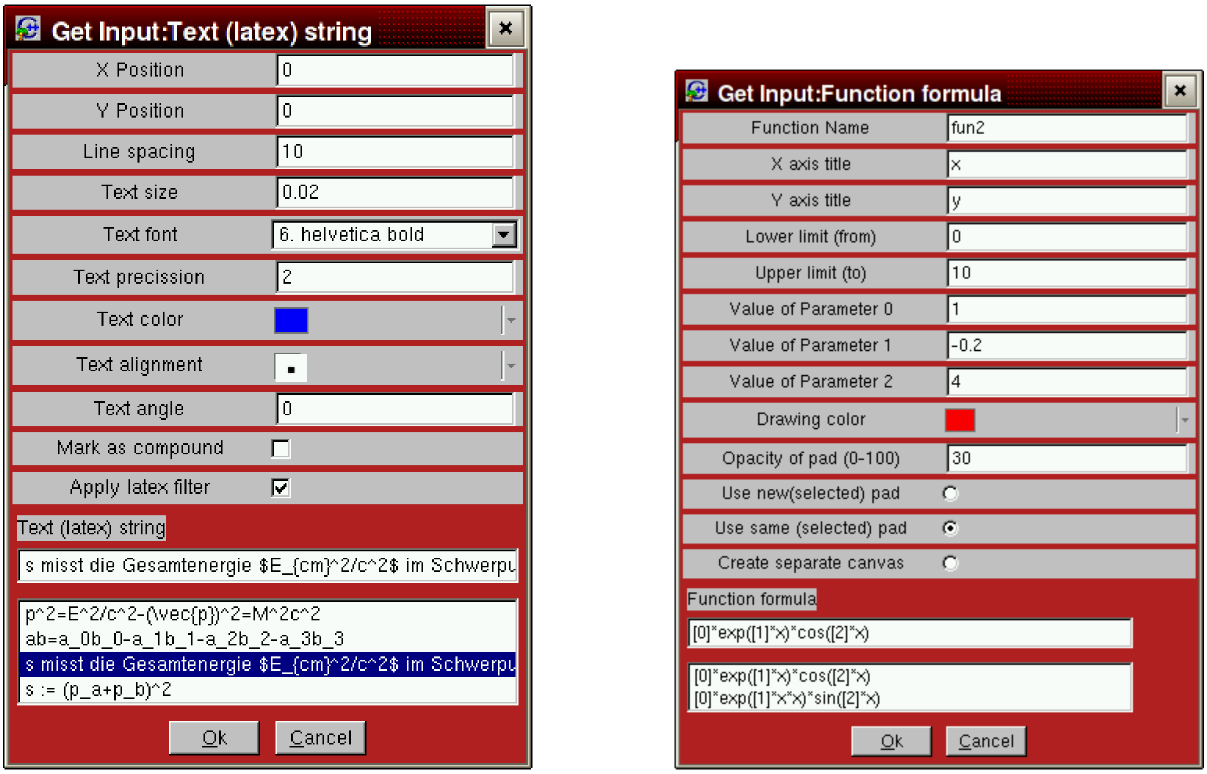
Figure 5: Example of 2d fit

The graphics editor

A graphics editor canvas is invoked from the `File` popup in the startup window. For convenience three sizes are predefined: A4-portrait, A4-landscape and user. In the canvas an edit grid is provided. This is implemented by overloading `TCanvas::HandleInput` by forcing mouse click coordinates on the user defined grid. To overcome the problem of the finite pixel resolution a method is provided to align all objects (selectable by type) in the canvas at the grid. Global editing facilities (e.g. change color of all CurlyLines, `Delete enclosed objects` and zooming are available.

In addition to ROOT's builtin graphics primitives like `TArcs`, `TCurlyLines` the following features / objects are accessible by a menu (see fig. 7):

- `Insert images (TASImage), histograms, graphs` . The user has to define a Pad as container for the object.
- `Insert a function` . After giving the number of parameters a widget (fig. 6) allows input of the needed values.
- `Insert Text / Latex from file or keyboard` . This widget facilitates input of Text / LaTeX by implementing input from and providing a history facility for input from keyboard. Text attributes may be adjusted from the widget (see fig. 6). Optionally a filter which tries to convert standard LaTeX to ROOTs Latex may be switched on.
- `Insert compound object` . Compound objects may be defined by enclosing graphic elements by a `TCutG` and saved on file. They can be reinserted applying a scale and rotation.
- `Draw a XSpline` . XSplines [0] as used e.g. in XFig [0] are very simple to control by moving the controlpoints or changing the shapefactors between -1 and 1. HistPresent provides a Control Graph Mixer for that. Parallel graphs, optionally with railway like filling, may be added.



Get Input:Text (latex) string

X Position	0
Y Position	0
Line spacing	10
Text size	0.02
Text font	6. helvetica bold
Text precission	2
Text color	🟦
Text alignment	▪
Text angle	0
Mark as compound	□
Apply latex filter	☑

Text (latex) string

s misst die Gesamtenergie E_{cm}^2/c^2 im Schwerpu

```
p^2=E^2/c^2-(\vec{p})^2=M^2c^2
ab=a_0b_0-a_1b_1-a_2b_2-a_3b_3
s misst die Gesamtenergie $E_{cm}^2/c^2$ im Schwerpu
s := (p_a+p_b)^2
```

Get Input:Function formula

Function Name	fun2
X axis title	x
Y axis title	y
Lower limit (from)	0
Upper limit (to)	10
Value of Parameter 0	1
Value of Parameter 1	-0.2
Value of Parameter 2	4
Drawing color	🟥
Opacity of pad (0-100)	30
Use new(selected) pad	○
Use same (selected) pad	●
Create separate canvas	○

Function formula

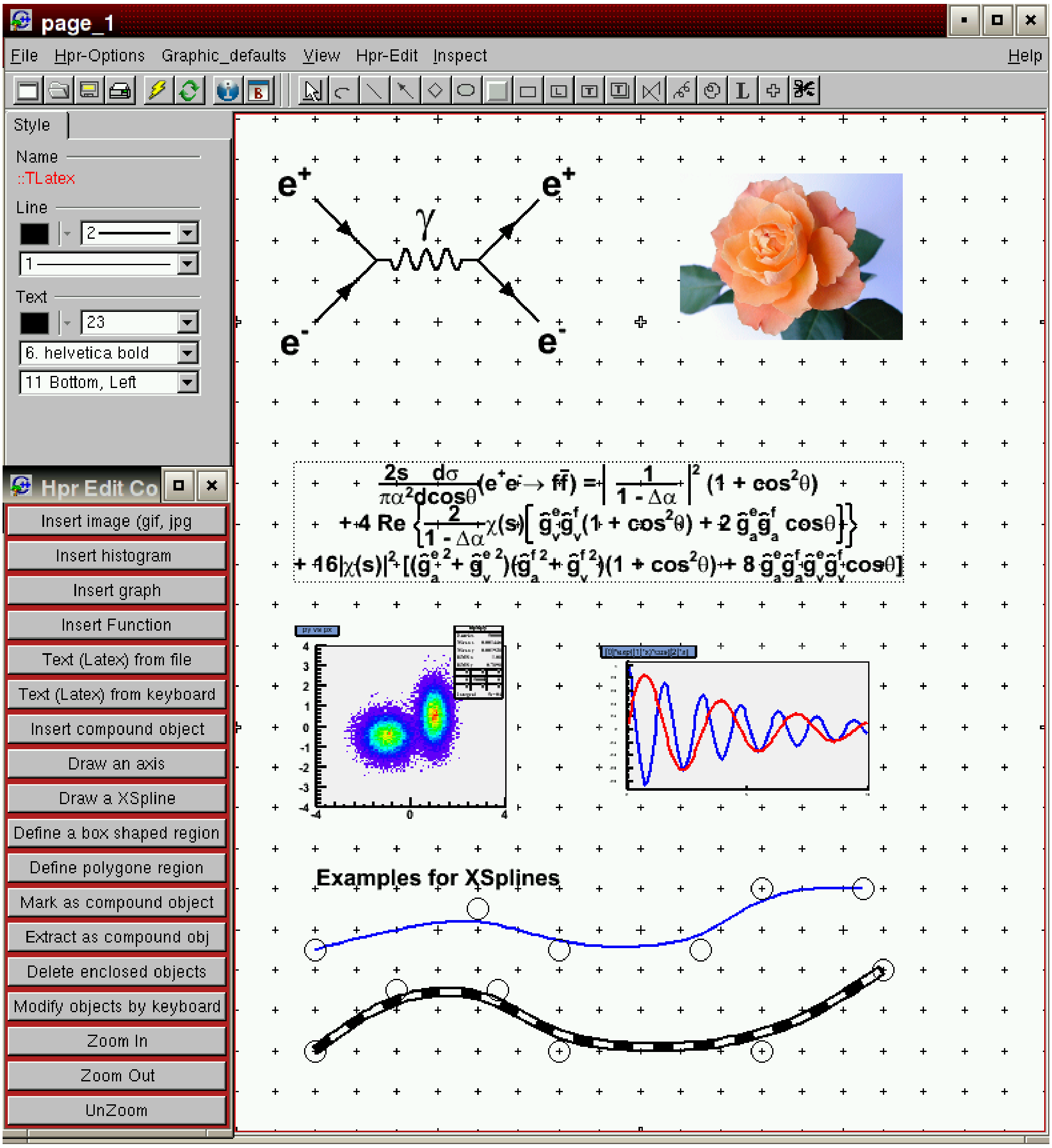
[0]*exp([1]*x)*cos([2]*x)

```
[0]*exp([1]*x)*cos([2]*x)
[0]*exp([1]*x*x)*sin([2]*x)
```

Figure 6: Input Latex, Input function

Documentation, Availability, Download

The documentation of HistPresent can be found here:
`http://www.bl.physik.uni-muenchen.de/marabou/html/hpr`
HistPresent is part of MARaBOUs CVS repository. The structure of directories and the Makefile is similiar to the ones of ROOT itself. It was only used and tested on Linux type systems.
To install HistPresent please consult this URL:
`http://www.bl.physik.uni-muenchen.de/marabou/html/UpdateHprFromCVS.html`



page_1
File Hpr-Options Graphic_defaults View Hpr-Edit Inspect Help
Style
Hpr Edit Co
Insert image (gif, jpg
Insert histogram
Insert graph
Insert Function
Text (Latex) from file
Text (Latex) from keyboard
Insert compound object
Draw an axis
Draw a XSpline
Define a box shaped region
Define polygone region
Mark as compound object
Extract as compound obj
Delete enclosed objects
Modify objects by keyboard
Zoom In
Zoom Out
UnZoom
e^+
e^+
γ
e^-
e^-
$\frac{2s}{\pi\alpha^2}\frac{d\sigma}{d\cos\theta}(e^+e^- \to f\bar{f}) = \left|\frac{1}{1-\Delta\alpha}\right|^2 (1+\cos^2\theta)$
$+4\,\mathrm{Re}\left\{\frac{2}{1-\Delta\alpha}\chi(s)\left[\hat{g}_v^e\hat{g}_v^f(1+\cos^2\theta)+2\hat{g}_a^e\hat{g}_a^f\cos\theta\right]\right\}$
$+16|\chi(s)|^2\left[(\hat{g}_a^{e2}+\hat{g}_v^{e2})(\hat{g}_a^{f2}+\hat{g}_v^{f2})(1+\cos^2\theta)+8\hat{g}_a^e\hat{g}_a^f\hat{g}_v^e\hat{g}_v^f\cos\theta\right]$
4 3 2 1 0 -1 -2 -3 -4
-4 0 4
Examples for XSplines

Name
::TLatex

Line
2
1

Text
23
6. helvetica bold
11 Bottom, Left

Figure 7: Example of an Editor page

References

[1] R. Lutter, O. Schaile, K. Schöffel, K. Steinberger, P. Thirolf, and C. Broude,
”MARaBOU- A MBS and ROOT Based Online/Offline Utility”
Proceedings of the 11th IEEE Real Time Conference, Santa Fe, NM, June 14-18, 1999
see also http://www.bl.physik.uni-muenchen.de/marabou/html

[2] Carole BLANC and Christophe SCHLICK, ”X-splines : A Spline Model Designed for the End User”
Proceedings of SIGGRAPH ’ 95
see also: http://dept-info.labri.fr/∼blanc/abst.html#sig95

[3] http://www.xfig.org/userman/