Computational Physics Lab

Data Analysis Frameworks: Project 9

03/19/2009

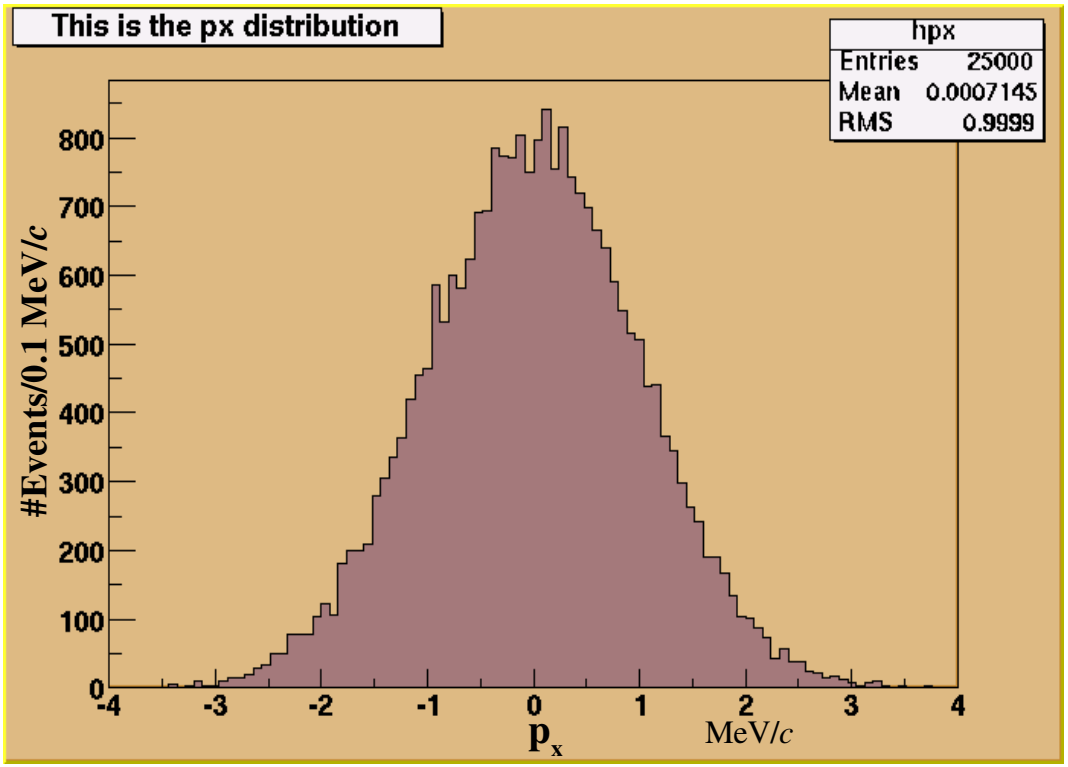
Project 9

1. Part 1
   - Creating a ROOT macro
   - Executing a macro with ROOT
     (Fitting a distribution with Breit-Wigner and Polynomial)
   - Modifying a macro and improving graph formatting
   - Interacting formatting and fitting
   - Save image of graph
2. Part 2
   - Repeat Part 1 using a 2-Gaussian fit function
3. Part 3
   - Convert macro to stand-alone program
4. Part 4
   - Document project on your Computational Physics web site

Histograms

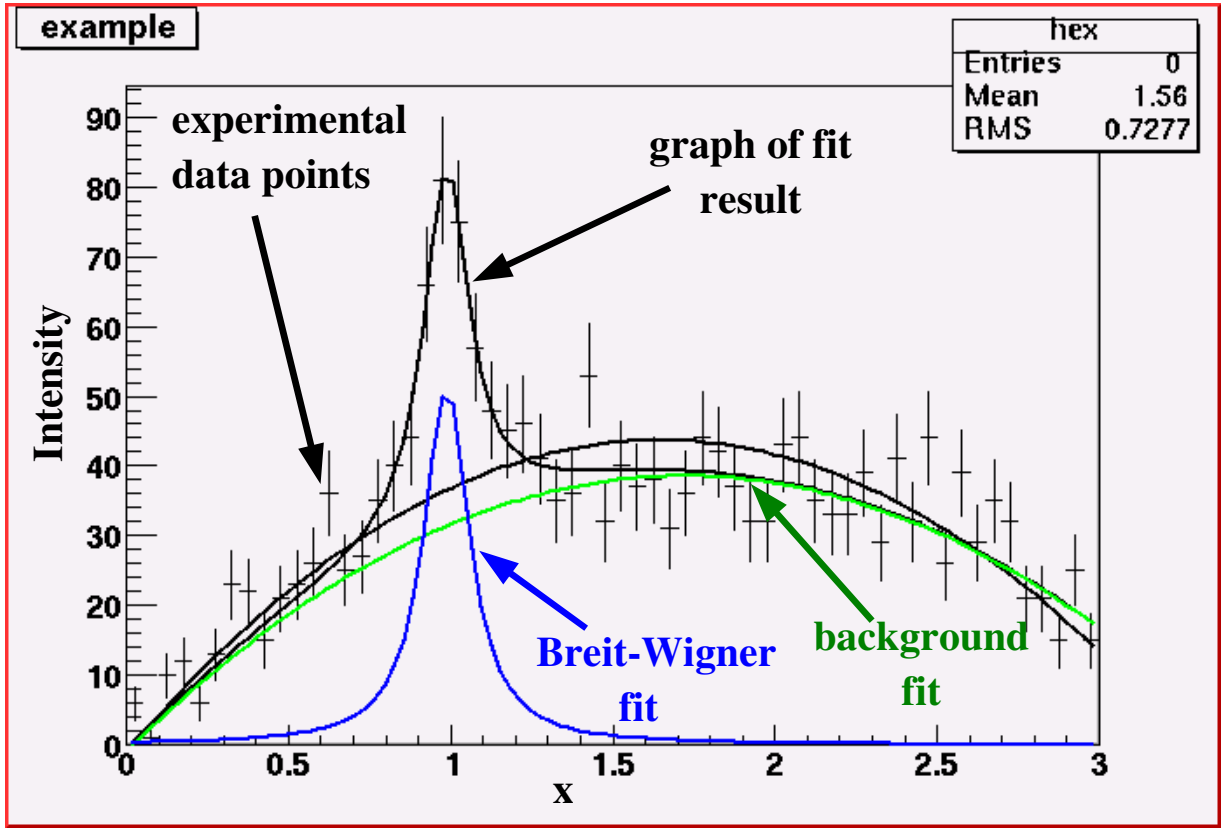
Histograms are graphs representing statistical distributions

- Projections from large volumes of data
- Heights of the bars represent observed frequencies



Fitting Histogram Data

Breit-Wigner Resonance plus a polynomial background



$$BreitWigner(x) = \frac{1}{2\pi} \frac{I_o \Gamma}{(x - M_0)^2 + 0.24\,\Gamma_o^{\,2}}$$

$$Background(x) = a_o + b_o x + c_o x^2$$

parameters of the fit: a_o, b_o, c_o, I_o, M_o, Γ_o

Part 1: ROOT Macro Creation

Create a text file called “histoFit.C” with editor

Add the following user-defined functions:

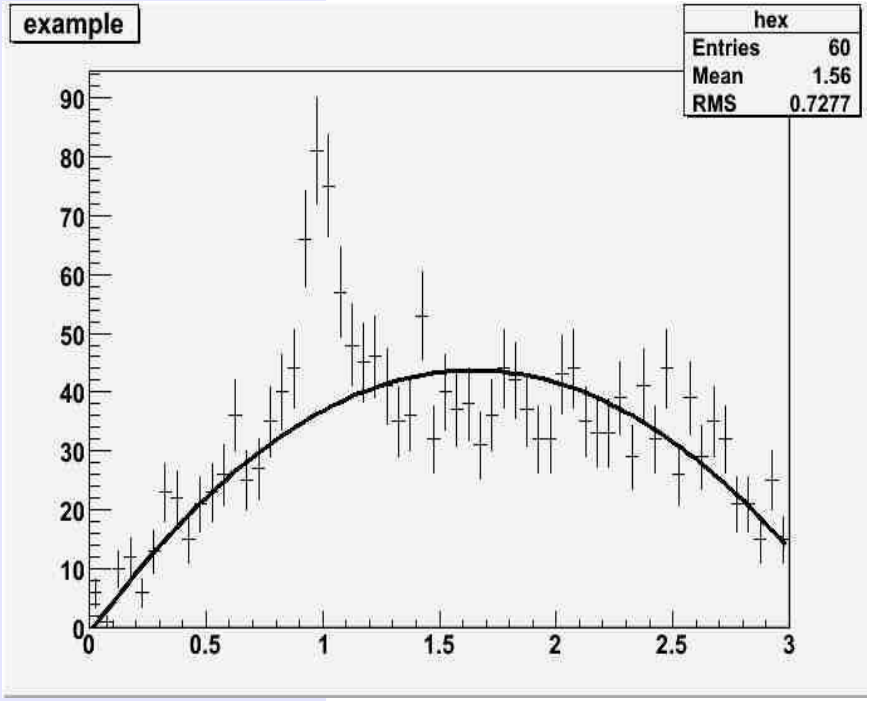
```
double background(double *x, double *par) {
  return par[0] + par[1]*x[0] + par[2]*x[0]*x[0];
}

double breitWigner(double *x, double *par) {
  return ( 0.5*par[0]*par[1] / TMath::Pi() ) /
    TMath::Max( 1e-10, (x[0] - par[2]) * (x[0] - par[2]) +
    0.24*par[1]*par[1] ); }

double fitFunction(double *x, double *par) {
  return background(x, par) + breitWigner(x, &par[3]);
}
```

Macro: Add a “doFit()” Function

```
void doFit() {    // Get the text for doFit() at ~/crede/root/doFit.txt
  const int nBins = 60;
  double data[60] = { 6, 1, 10, 12, 6, 13, 23, 22, 15, 21, 23, 26, 36,
            25, 27, 35, 40, 44, 66, 81, 75, 57, 48, 45, 46, 41, 35, 36,
            53, 32, 40, 37, 38, 31, 36, 44, 42, 37, 32, 32, 43, 44, 35,
            33, 33, 39, 29, 41, 32, 44, 26, 39, 29, 35, 32, 21, 21, 15,
            25, 15 };

  // Look up TH1F at http://root.cern.ch/root/Reference.html
  TH1F *histogram = new TH1F(“histo”,”title”, 60, 0, 3);

  for (int i = 0; i < nBins; i++) {
    histogram->SetBinContent(i+1, data[i]);
    histogram->SetBinError(i+1, TMath::Sqrt(data[i]));
  }

  // Look up TF1 at ROOT Refrence page
  TF1 *fitFcn = new TF1(“fitFcn”, fitFunction, 0, 3, 6);

  // Try fitting wo/ starting values for the parameters
  histogram->Fit(“fitFcn”);
}
```

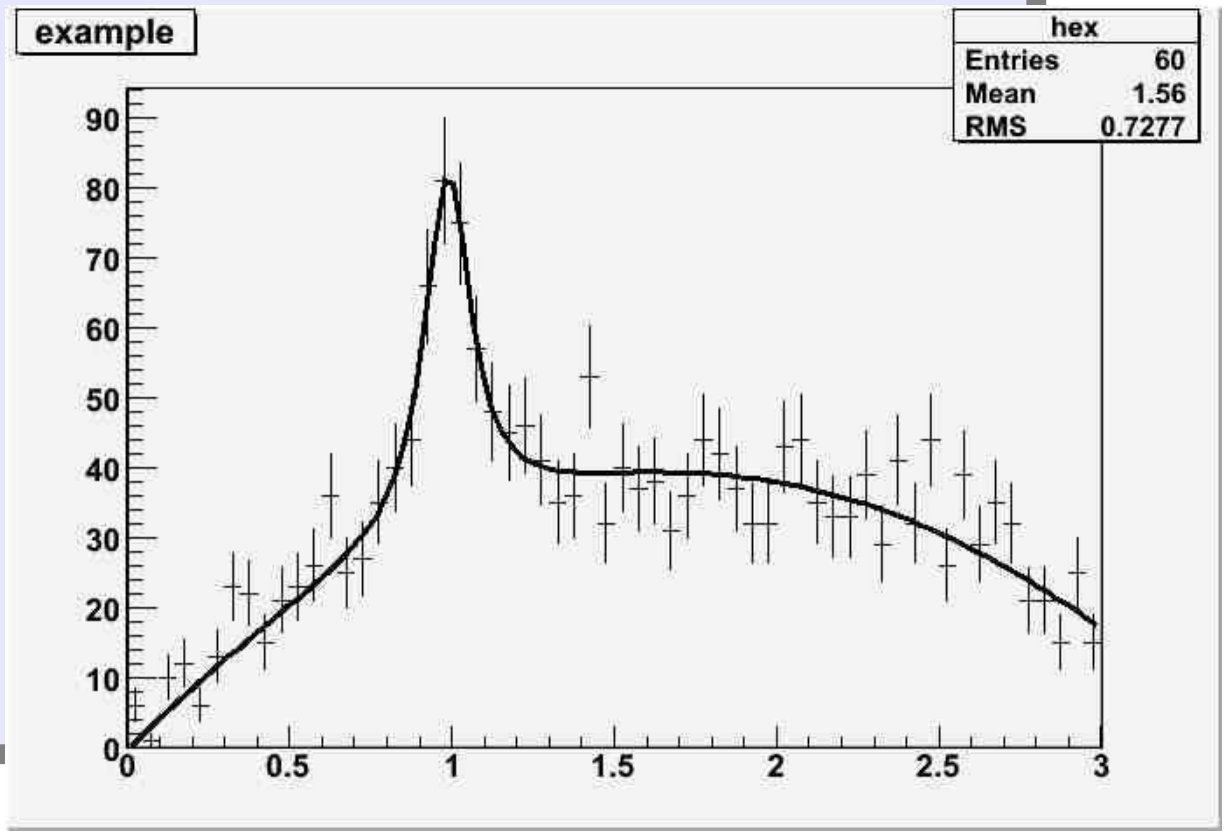
Execute Macro w/ CINT/ROOT

```
gluon 25% root
 ********************************************
 *
 *       W E L C O M E  to  R O O T
 *
 *   Version   5.14/00       14 Dec 2006
 *
 *  You are welcome to visit our Web site
 *         http://root.cern.ch
 *
 ********************************************

Compiled for linux with thread support.

CINT/ROOT C/C++ Interpreter version 5.16.16, Nov 2004
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0] .L  histoFit.C
root [1] doFit()
```



Macro: Improving the Fitting

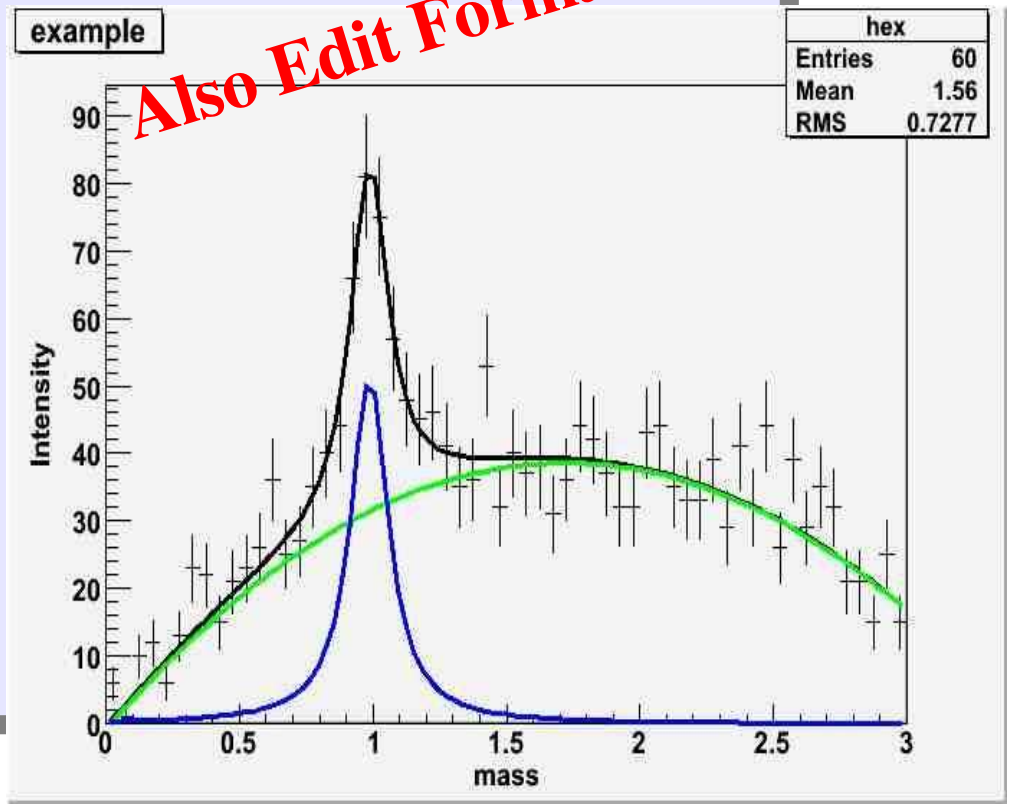
```
// Add these commands to the doFit() function
// now set start values
fitFcn->SetParameter(4,0.2); //width
fitFcn->SetParameter(5,1);  // peak

histogram->Fit("fitFcn","V+");
```



Macro: Improving the Graph

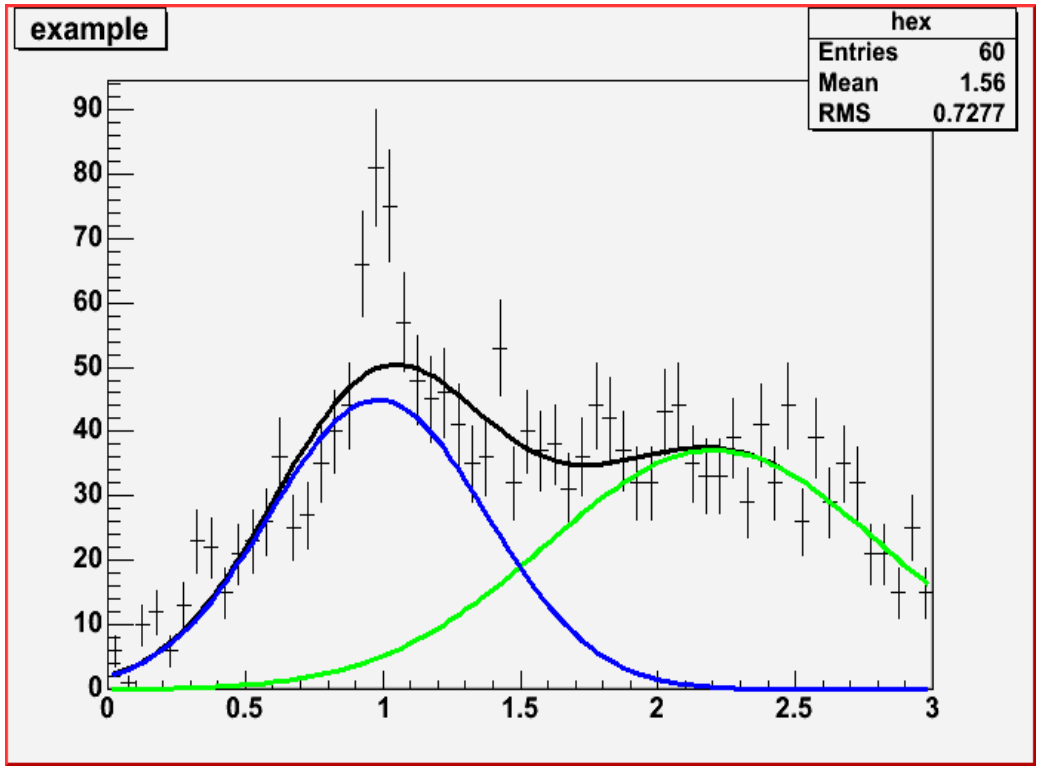
```
// Add these commands to the end of the doFit() function
// improving the figure
 TF1* backFcn = new TF1("backFcn",
                        background,0,3,3);
 backFcn->SetLineColor(3);
 TF1* bwFcn = new TF1("bwFcn", brietWigner,0,3,3);
 bwFcn->SetLineColor(4);

 double par[6];
 fitFcn->GetParameters(par);

 backFcn->SetParameters(par);
 backFcn->Draw("same");

 bwFcn->SetParameters(&par[3]);
 bwFcn->Draw("same");
```

Also Edit Format Interactively!



Part 2: Fit Histogram to Gaussian plus Gaussian

$$G(A, \sigma, \overline{x}) = \frac{A}{\sigma\sqrt{2\pi}} \mathrm{e}^{\frac{-(x-\overline{x})^2}{2\sigma^2}}$$



Part 3: Making a Stand-Alone Application

Get the Makefile

➜ Type: cp /export/home/crede/root/Makefile .

Create fit.cc source

1. Type: cp histoFit.C fit.cc
2. Add includes & main() function
3. Modify source code to adhere to coding conventions

Add at Beginning:

```
#include “TApplication.h”
#include “TH1.h”
#include “TF1.h”
#include “TMath.h”
#include <iostream>

using namespace std;
```

Add at End:

```
int main(int argc, char **argv) {
  TApplication theApp(“App”, &argc, argv);
  doFit();
  theApp.Run();
}
```

Part 4: Document Project 9

Post Project 9 to your computational physics web site. Create a `html` page for this project. Create a link from your main project web page to this `html` page. It should include the following heading information: project title, project number, your name, & today's date.

The main content of this page should include the following:

- A short description of the project
- A link to the macro code for part 2
- A text region which contains the actual macro code for part 2
- An image for a formatted plot for part 3
- A link to the stand-alone code for part 3
- A text region which contains the course code for part 3

For text regions use the `html` object tag; example:

```
<object width="600" height="400" type="text/plain"
                    data="yourProgram.cc" border="0"></object>
```