What is ROOT?

Answer: Why do we use it?

It makes plots.
Another function to be fit

hist2
Nent = 10000
Mean = 6.714
RMS = 4.012
$\frac{\sin(y) \sin(x)}{x^2 y}$
Can you spot the pun in this plot?
The typical analysis task that you will be asked to do:

Take variables in an **n-tuple**, perform some computations, and make **histograms**.

So what is a **histogram**, what is an **n-tuple**, and how do we perform the computations?
Anatomy of a histogram

Properties of a histogram

- Name or Identifier
- Title (to be displayed on plot)
- Number of bins
- Lower bin limit
- Upper bin limit

A ROOT command that might be used to create this histogram:

```c
TH1F hist("Example","Sample histogram",100,-3,3)
```
Don't forget the errors!

For simple histograms, the error in one bin is the square root of the number of events in that bin.
There's an art to histogram design...
Example 7
Nent = 1000
Mean = 0.0015
RMS = 0.9675

Too few bins

Measurement
-3 -2 -1 0 1 2 3
Number of events
0 50 100 150 200 250 300 350 400 450

Example 7
Nent = 1000
Mean = 0.0015
RMS = 0.9675
Anatomy of an n-tuple (a simple form of a ROOT Tree)

<table>
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<th>ebeam</th>
<th>px</th>
<th>py</th>
<th>pz</th>
<th>zv</th>
<th>chi2</th>
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<td>0.10</td>
<td>144.69</td>
<td>22.26</td>
<td>0.93</td>
</tr>
</tbody>
</table>

An n-tuple is an ordered list of numbers.

A ROOT Tree can be an ordered list of any collections of C++ objects.

Probably you'll only be asked to work with n-tuples this summer.
Why ROOT?

• It knows about n-tuples and histograms.
• It can handle large volumes of data (millions of physics events; files of gigabytes→terabytes in size).
• Multi-platform (Windows, Mac, many UNIX flavors)
• It's free.

But...

• You have to know some C++ in order to use ROOT effectively, in order to perform computations.
• What does C++ look like? Well...
#define Analyze_cxx
#include "Analyze.h"
#include <TH2.h>
#include <TStyle.h>
#include <TCanvas.h>

void Analyze::Loop() {
    // In a Root session, you can do:
    // Root > .L Analyze.C
    // Root > Analyze t
    // Root > t.GetEntry(12); // Fill t data members with entry number 12
    // Root > t.Show(); // Show values of entry 12
    // Root > t.Show(16); // Read and show values of entry 16
    // Root > t.Loop(); // Loop on all entries

    // This is the loop skeleton
    // To read only selected branches, Insert statements like:
    // METHOD1:
    //    fChain->SetBranchStatus("*",0); // disable all branches
    //    fChain->SetBranchStatus("branchname",1); // activate branchname
    // METHOD2: replace line
    //    fChain->GetEntry(i); // read all branches
    // by b_branchname->GetEntry(i); //read only this branch
    if ( fChain == 0 ) return;

    Long64_t nentries = fChain->GetEntries();

    Long64_t nbytes = 0, nb = 0;
    for (Long64_t jentry=0; jentry<nentries;jentry++) {
        Long64_t Ientry = fChain->LoadTree(jentry);
        nb = fChain->GetEntry(jentry);   nbytes += nb;
        // if (Cut(Ientry) < 0) continue;
    }
}
Web Links
(the only part you should bother to write down)

All the documents you've seen (and will see) during the class today can be found at:

http://www.nevis.columbia.edu/~seligman/root-class/

ROOT and C++ links, including links to reference books on C++ and statistics, can be found at:

http://www.nevis.columbia.edu/~seligman/root-class/links.html
The Hands-on Course:
Basic Data Analysis using ROOT

ROOT basics

You will learn how to:
• look up ROOT command references
• plot a function
• histogram a variable
• fit a histogram
• create C++ code for an n-tuple
• get a variable from an n-tuple
• apply cuts

-- but not necessarily in this order!

There's lots of optional material to help turn you into a ROOT expert. Try to go over as much of it as you can.
A Brief ROOT Demonstration