Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Bundesministerium
für Bildung
und Forschung

CMS

ROOT tutorial
— part V —

1st April 2015

Adrian Perieanu

ROOT tutorial: goals

* how to install it ✓

* how to find/read documentation ✓

* perform an interactive analysis with ROOT ✓

* design and write own analysis macros ✓

* how to store results of your analysis ✘

ROOT tutorial: store your results

your histograms:

— need to have a clear content

— need to be readable without glasses from the back of any room

— need to be able to answer questions like:

what is on the X-axis?

— last, but not least:

the more complete they are the less questions you will get

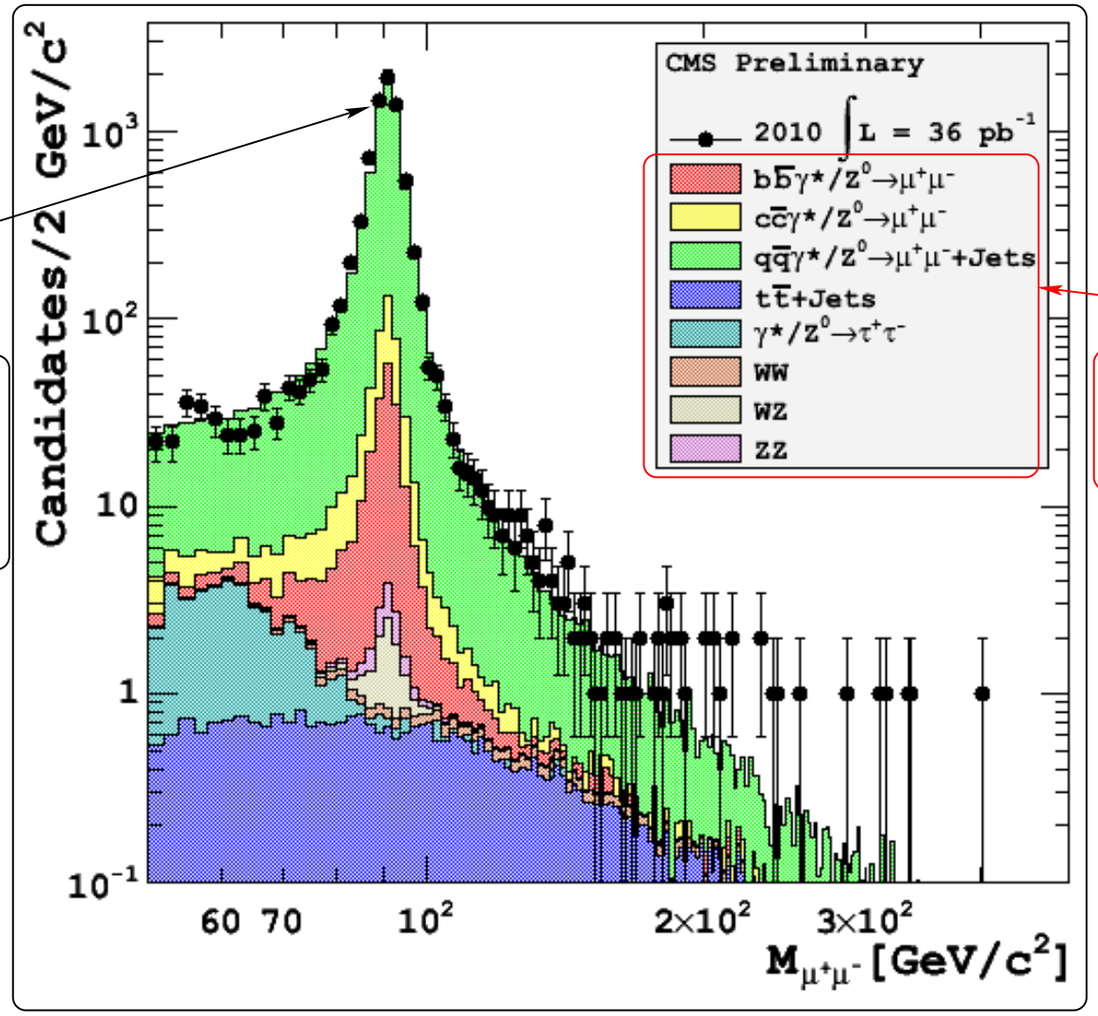
ROOT tutorial: histogram content

Physics

Feynman diagrams
integrated Luminosity
cross–sections
impact on other searches, e.g. Higgs

DATA

detector
trigger
RECO:
reconstructed objects
event display

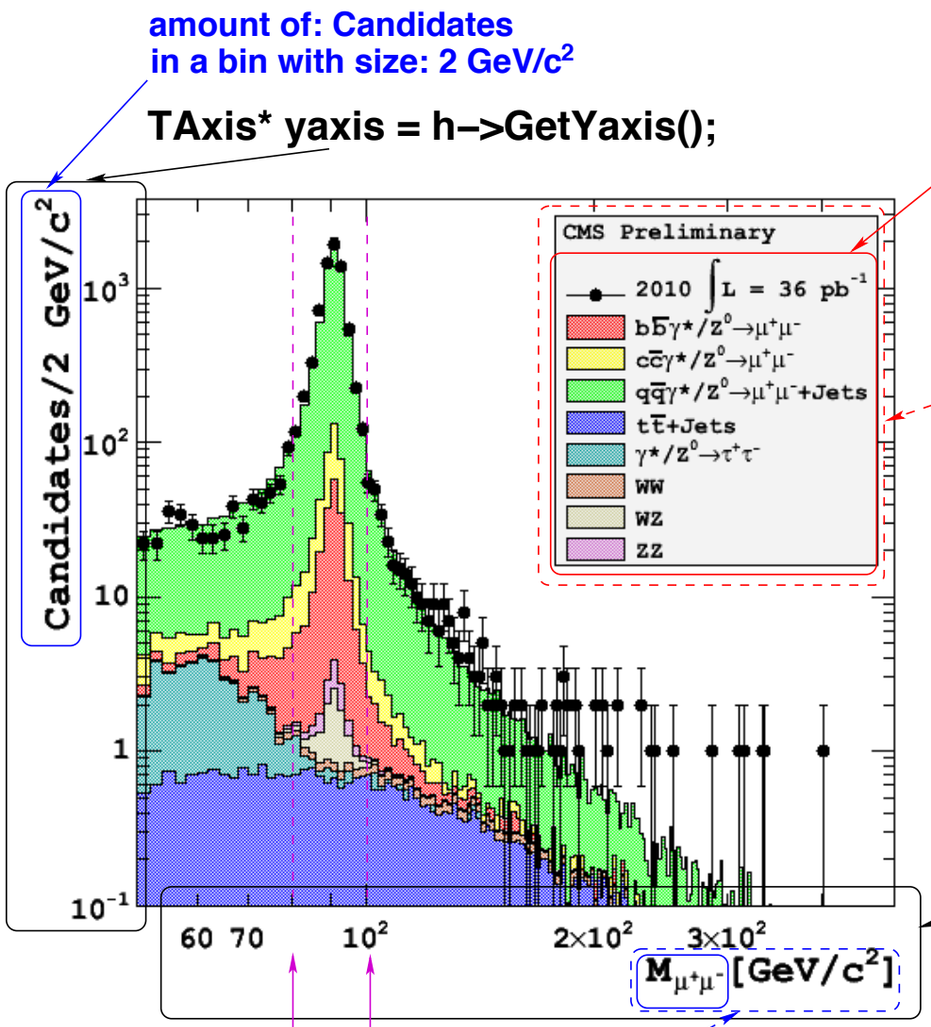


Monte Carlo

GEN: generated physics processes
SIM: simulated detector response
RECO: reconstructed objects, e.g muons

ROOT tutorial: histogram tuning

h - is an object of the TH1 class or an inherited class as TH1D/TH2D/TH3D
`http://root.cern.ch/root/html528/TH1.html`



amount of: Candidates in a bin with size: 2 GeV/c^2

TAxis* yaxis = h–>GetYaxis();

same distribution: data Monte Carlo simulations

TLegend* myLegend = new TLegend(0.6, 0.55, 0.97, 0.97, NULL,"brNDC");
x1 y1 x2 y2

`http://root.cern.ch/root/html528/TLegend.html`

* in ~90% of the cases in a rehearsal
the feedback will like:
“I cannot read the x-axis, can you make the title larger”

TAxis* xaxis = h–>GetXaxis();

`http://root.cern.ch/root/html528/TAxis.html`

parameter: invariant mass of $\mu^+\mu^-$ combinations

xaxis–>SetTitle("M_{#mu^{+}#mu^{–}} [GeV/c^{2}]");

M in the range between 80 and 100 GeV/c^2 (10 bins)

PDG: 91.187± 0.002 GeV/c^2

`http://pdg.lbl.gov/2010/listings/rpp2010-list-z-boson.pdf`

ROOT tutorial: define a good style

* one option is to use the CMS “recommended” style — if you can setup a better one don’t hesitate

* the advantage: — one sets the dimensions once and for all

tdrstyle.C

```
#include "TStyle.h"

// tdrGrid: Turns the grid lines on (true) or off (false)

void tdrGrid(bool gridOn) {
  tdrStyle->SetPadGridX(gridOn);
  tdrStyle->SetPadGridY(gridOn);
}

// fixOverlay: Redraws the axis

void fixOverlay() {
  gPad->RedrawAxis();
}

void setTDRStyle() {
  TStyle *tdrStyle = new TStyle("tdrStyle","Style for P-TDR");

// For the canvas:
  tdrStyle->SetCanvasBorderMode(0);
  tdrStyle->SetCanvasColor(kWhite);
  tdrStyle->SetCanvasDefH(600); //Height of canvas
  tdrStyle->SetCanvasDefW(600); //Width of canvas
  tdrStyle->SetCanvasDefX(0);   //POsition on screen
  tdrStyle->SetCanvasDefY(0);

// For the Pad:
  tdrStyle->SetPadBorderMode(0);
  // tdrStyle->SetPadBorderSize(Width_t size = 1);
  tdrStyle->SetPadColor(kWhite);
  tdrStyle->SetPadGridX(false);
  tdrStyle->SetPadGridY(false);
  tdrStyle->SetGridColor(0);
  tdrStyle->SetGridStyle(3);
  tdrStyle->SetGridWidth(1);

// For the frame:
  tdrStyle->SetFrameBorderMode(0);
  tdrStyle->SetFrameBorderSize(1);
  tdrStyle->SetFrameFillColor(0);
  tdrStyle->SetFrameFillStyle(0);
  tdrStyle->SetFrameLineColor(1);
  tdrStyle->SetFrameLineStyle(1);
  tdrStyle->SetFrameLineWidth(1);

-:---  tdrstyle.C     Top L15     (C++/l Abbrev)
```

ROOT tutorial: call your style

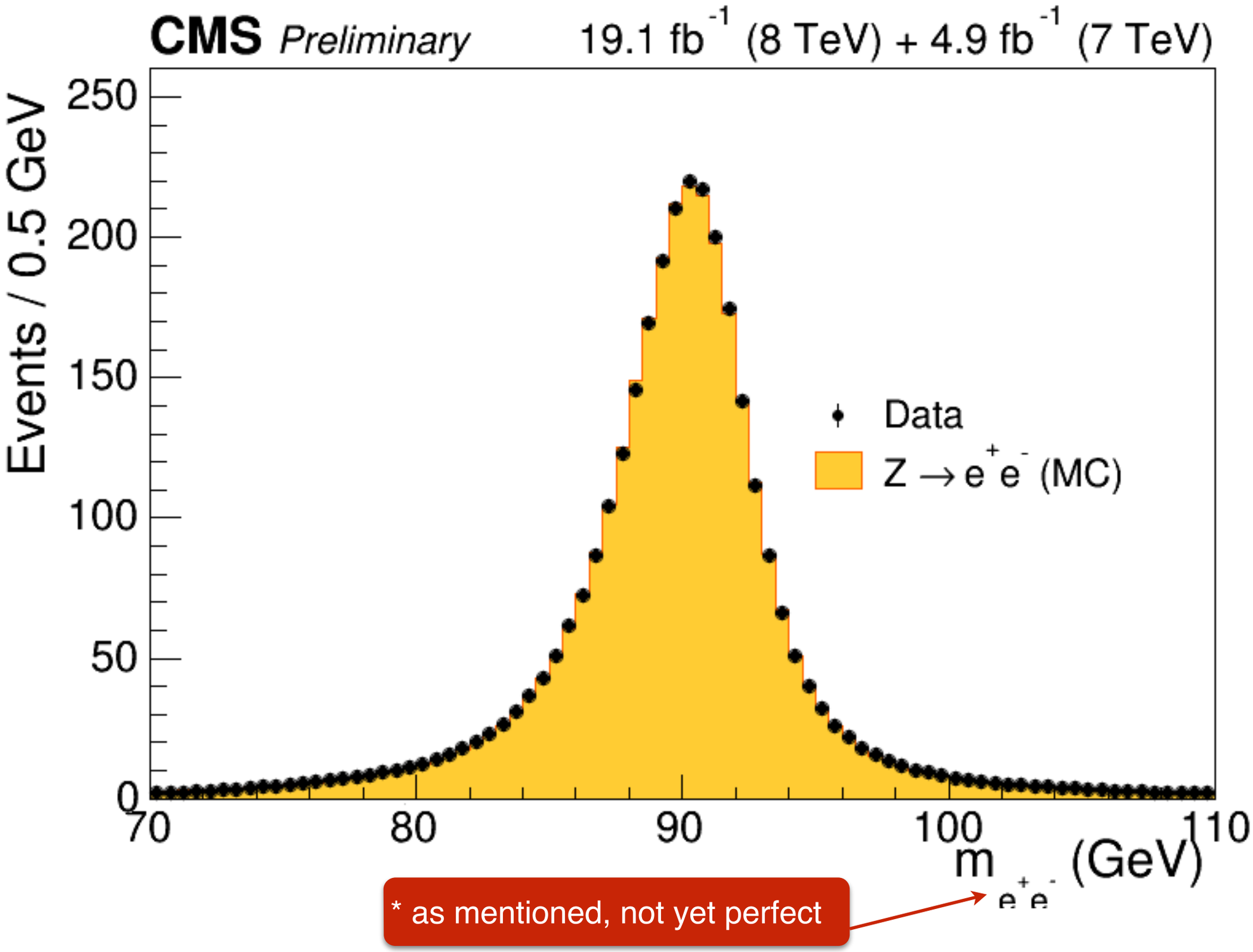
myMacro.C

```
void myMacro()
{
  gROOT->LoadMacro("tdrstyle.C");
  setTDRStyle();

  gROOT->LoadMacro("CMS_lumi.C");

  writeExtraText = true;       // if extra text
  extraText  = "Preliminary";  // default extra text is "Preliminary"
  lumi_8TeV  = "19.1 fb^{-1}"; // default is "19.7 fb^{-1}"
  lumi_7TeV  = "4.9 fb^{-1}";  // default is "5.1 fb^{-1}"

  int iPeriod = 3;    // 1=7TeV, 2=8TeV, 3=7+8TeV, 7=7+8+13TeV

  // second parameter in example_plot is iPos, which drives the position of the CMS logo in the plot
  // iPos=11 : top-left, left-aligned
  // iPos=33 : top-right, right-aligned
  // iPos=22 : center, centered
  // mode generally :
  //   iPos = 10*(alignement 1/2/3) + position (1/2/3 = left/center/right)

  example_plot( iPeriod, 0 );   // out of frame (in exceptional cases)
  //  example_plot( iPeriod, 11 );  // left-aligned
  //  example_plot( iPeriod, 33 );  // right-aligned

  //  writeExtraText = false;       // remove Preliminary

  //  example_plot( iPeriod, 0 );   // out of frame (in exceptional cases)

  //  example_plot( iPeriod, 11 );  // default: left-aligned
  //  example_plot( iPeriod, 22 );  // centered
-:---  myMacro.C      Top L1     (C++/l Abbrev)
```

* call your style

* call the CMS_lumi class

ROOT tutorial: outcome



* as mentioned, not yet perfect

ROOT tutorial: if you want to save time preparing slides

* from ROOT macro to PDF slides

- as usual, first some definitions

```
void extract_ROOTTree_PDF(){
  gStyle->SetPalette(1);
  gStyle->SetOptStat(0);
  // define the invariant mass histogram
  TH1D* myMass    = new TH1D( "myMass", "myMass", 60, 60., 120.);
  myMass->GetXaxis()->SetTitle("M_{e^{+}e^{-}} [GeV/c^{2}]");
  myMass->GetYaxis()->SetTitle("Candidates/1.0 GeV/c^{2}");
  myMass->GetYaxis()->SetTitleOffset(1.3);
  TH1D* myMass_pTE25 = new TH1D( "myMass_pTE25", "myMass_pTE25", 60, 60., 120.);
  myMass_pTE25->GetXaxis()->SetTitle("M_{e^{+}e^{-}} [GeV/c^{2}]");
  myMass_pTE25->GetYaxis()->SetTitle("Candidates/1.0 GeV/c^{2}");
  myMass_pTE25->GetYaxis()->SetTitleOffset(1.3);
  TH1D* myMass_pTE30 = new TH1D( "myMass_pTE30", "myMass_pTE30", 60, 60., 120.);
  myMass_pTE30->GetXaxis()->SetTitle("M_{e^{+}e^{-}} [GeV/c^{2}]");
  myMass_pTE30->GetYaxis()->SetTitle("Candidates/1.0 GeV/c^{2}");
  myMass_pTE30->GetYaxis()->SetTitleOffset(1.3);
  TH1D* myMass_pTE35 = new TH1D( "myMass_pTE35", "myMass_pTE35", 60, 60., 120.);
  myMass_pTE35->GetXaxis()->SetTitle("M_{e^{+}e^{-}} [GeV/c^{2}]");
  myMass_pTE35->GetYaxis()->SetTitle("Candidates/1.0 GeV/c^{2}");
  myMass_pTE35->GetYaxis()->SetTitleOffset(1.3);
  TH1D* myMass_pTE40 = new TH1D( "myMass_pTE40", "myMass_pTE40", 60, 60., 120.);
  myMass_pTE40->GetXaxis()->SetTitle("M_{e^{+}e^{-}} [GeV/c^{2}]");
  myMass_pTE40->GetYaxis()->SetTitle("Candidates/1.0 GeV/c^{2}");
  myMass_pTE40->GetYaxis()->SetTitleOffset(1.3);
```

* then fill your histograms

ROOT tutorial: prepare canvas

*** your canvas should come closer to A4 size**

- define a canvas

```
// define canvas
TCanvas *myCanvas = new TCanvas("myCanvas", "myCanvas", 1020, 520);
myCanvas->SetFillColor(0);
myCanvas->SetBorderMode(0);
myCanvas->SetLeftMargin(0.14);
myCanvas->SetRightMargin(0.16);
myCanvas->SetBottomMargin(0.14);
// divide the canvas
myCanvas->Divide(2,2);
```

ROOT tutorial: setup pages

- let's make the first page in our PDF file

```
// prepare to save the PDF file
TString pdfFileName = "myResultInPDFTalk.pdf";
TString nameBegin = pdfFileName;
nameBegin.Append("["); // no actual print, just open the PDF file
////////////////////////////////////////////////////////
// first page
////////////////////////////////////////////////////////
// fill first TPad
myCanvas->cd(1);
// draw the histogram
myMass->SetMarkerStyle(20);
myMass->Draw("e1");
// fill second TPad
myCanvas->cd(2);
// draw the histogram
myMass_pTE25->SetMarkerStyle(20);
myMass_pTE25->Draw("e1");
// fill third TPad
myCanvas->cd(3);
// draw the histogram
myMass_pTE30->SetMarkerStyle(20);
myMass_pTE30->Draw("e1");
// fill fourth TPad
myCanvas->cd(4);
// draw the histogram
myMass_pTE35->SetMarkerStyle(20);
myMass_pTE35->Draw("e1");
// no actual print, just open the PDF file; only once
myCanvas->Print(nameBegin);
// give a bookmark name; without space after "Title:"
myCanvas->Print(pdfFileName, "Title:my first page");
```

summary: store analysis results

* make sure the all needed information is added to your histograms

* labels and titles should have the appropriate size

* make pdf slides directly from your root macro if you want to save time

ROOT tutorial: summay

* how to install it ✓

* how to find/read documentation ✓

* perform an interactive analysis with ROOT ✓

* design and write own analysis macros ✓

* how to store results of your analysis ✓

we did it!

there is more to discover, use this tutorial as a starting point