

## 编写一个脚本，实现以下需求：

1. 画出一个直线形状的本底和两个相邻的高斯信号峰的直方图 (用TH1F)，并且画出它们叠加后的总直方图。

（提示：两个高斯形状和本底形状分别用不同颜色表示。）

2. 拟合叠加后的总直方图，图中显示拟合后的直方图参数。

（提示：在同一张图中画出叠加和拟合。）

3. 在脚本里保存图片 .eps 或 .png 文件。

（备注：总的统计量为10000，本底和信号的参数可以自己设定。  
要求高斯信号峰间有重叠的部分。）

## 产生 fakedata sample

通过 TF1 和 TH1F 产生 fakedata sample, 其中 gauss 等 function 可以在 TFormula 中查到

```
void hw3() {  
    //set up canvas  
    TCanvas *c1 = new TCanvas("c1", "Homework 3", 800, 600);  
  
    //define TH1F  
    TH1F *hBackground = new TH1F("hBackground", "Background", 100, 0, 20);  
    TH1F *hGauss1 = new TH1F("hGauss1", "Gaussian Peak 1", 100, 0, 20);  
    TH1F *hGauss2 = new TH1F("hGauss2", "Gaussian Peak 2", 100, 0, 20);  
    TH1F *hTotal = new TH1F("hTotal", "Total Histogram", 100, 0, 20);  
  
    //genarte samples  
    TF1 *fBackground = new TF1("fBackground", "pol1", 0, 20);  
    fBackground->SetParameters(0, 20);  
    hBackground->FillRandom("fBackground", 4000);  
  
    TF1 *fGauss1 = new TF1("fGauss1", "gaus(0)", 0, 20);  
    fGauss1->SetParameters(1000, 8, 1.5);  
    hGauss1->FillRandom("fGauss1", 2000);  
  
    TF1 *fGauss2 = new TF1("fGauss2", "gaus(0)", 0, 20);  
    fGauss2->SetParameters(2000, 10, 2);  
    hGauss2->FillRandom("fGauss2", 4000);  
  
    // add up as fake data  
    hTotal->Add(hBackground);  
    hTotal->Add(hGauss1);  
    hTotal->Add(hGauss2);  
}
```

# 拟合

1. 使用 TF1 拟合优点：简单，可以直接用产生时的函数，统计量输出方便

缺点：参数不直观显示拟合出的各项数目

---

```
//Draw option
hBackground->SetLineColor(kBlue);
hGauss1->SetLineColor(kRed);
hGauss2->SetLineColor(kGreen);
hTotal->SetLineColor(kBlack);
gStyle->SetOptFit(1111);

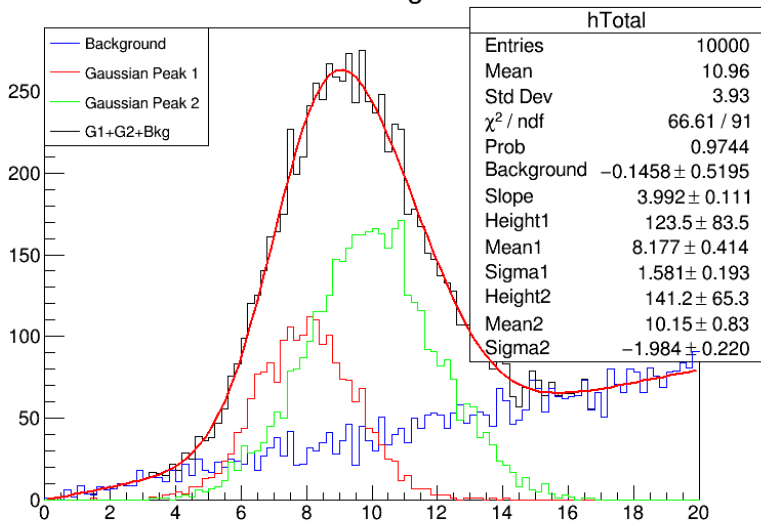
hTotal->Draw();
hBackground->Draw("same");
hGauss1->Draw("same");
hGauss2->Draw("same");

//fit the fake data
TF1 *fTotal = new TF1("fTotal", "pol1(0)+gaus(2)+gaus(5)", 0, 20); // details can be checked in TFormula
fTotal->SetParameters(0, 20, 1000, 8, 1.5, 800, 12, 2);
fTotal->SetParName(0, "Background");
fTotal->SetParName(1, "Slope");
fTotal->SetParName(2, "Height1");
fTotal->SetParName(3, "Mean1");
fTotal->SetParName(4, "Sigma1");
fTotal->SetParName(5, "Height2");
fTotal->SetParName(6, "Mean2");
fTotal->SetParName(7, "Sigma2");
hTotal->Fit(fTotal, "", "", 0, 20);

TLegend *leg = new TLegend(0.1, 0.7, 0.3, 0.9);
leg->AddEntry(hBackground, "Background", "l");
leg->AddEntry(hGauss1, "Gaussian Peak 1", "l");
leg->AddEntry(hGauss2, "Gaussian Peak 2", "l");
leg->AddEntry(hTotal, "G1+G2+Bkg", "l");
leg->Draw("same");
fTotal->Draw("same");
```

# 拟合结果

## Total Histogram



## 1. 使用 roofit 拟合优点：可以输出各项参数和数目 缺点：需要自行使用 TLegend 产生 label 在图上

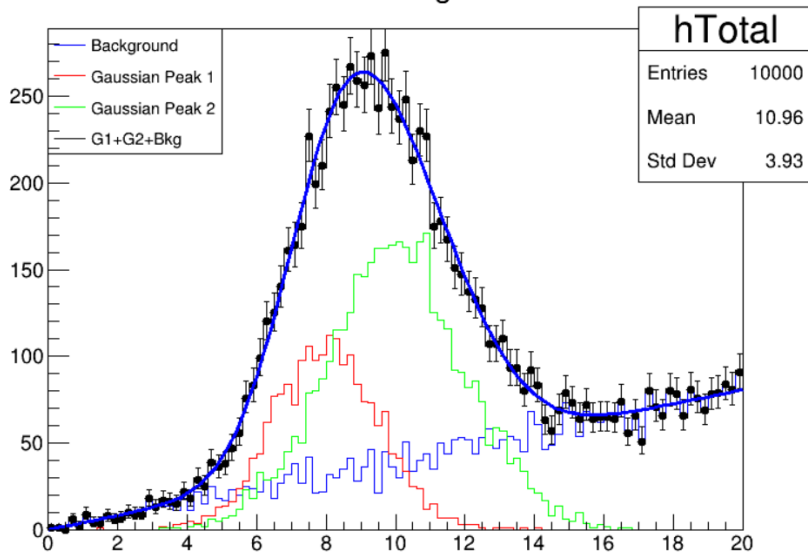
```
//fit the fake data
RooRealVar x("x", "", 1, 0, 20);
RooRealVar mean1("mean1", "", 5, 0, 20);
RooRealVar sigmal("sigma1", "", 1, 0, 20);
RooRealVar mean2("mean2", "", 5, 0, 20);
RooRealVar sigma2("sigma2", "", 1, 0, 20);
RooRealVar a("a", "", 1, 0, 20);
RooRealVar b("b", "", 1, 0, 20);
RooRealVar nsig("nsig", "", 2000, 0, 10000);
RooRealVar nbkg("nbkg", "", 3000, 0, 10000);
RooRealVar nsig2("nsig2", "", 3000, 0, 10000);
RooGaussian *sig1 = new RooGaussian("gaus1", "", x, mean1, sigmal);
RooGaussian *sig2 = new RooGaussian("gaus2", "", x, mean2, sigma2);
RooPolynomial *bkg = new RooPolynomial("bkg", "", x, RooArgList(a, b), 0);
RooAddPdf *model;
RooDataHist *kp_data;
RooPlot *xframe2 = x.frame();
kp_data = new RooDataHist("data", "", x, RooFit::Import(*hTotal));
kp_data->plotOn(xframe2);

model = new RooAddPdf("model", "", RooArgList(*sig1, *sig2, *bkg), RooArgList(nsig, nsig2, nbkg));
RooFitResult *result = model->fitTo(*kp_data, RooFit::Extended(kTRUE), RooFit::Save(kTRUE), RooFit::SumW2Error(kTRUE));
model->plotOn(xframe2);

TLegend *leg = new TLegend(0.1, 0.7, 0.3, 0.9);
leg->AddEntry(hBackground, "Background", "l");
leg->AddEntry(hGauss1, "Gaussian Peak 1", "l");
leg->AddEntry(hGauss2, "Gaussian Peak 2", "l");
leg->AddEntry(hTotal, "G1+G2+Bkg", "l");
leg->Draw("same");
xframe2->Draw("same");
```

# 拟合结果

Total Histogram



# 拟合结果

由于 nsig 和 nsig2 间有极强关联性，说明对于这个 fake data sample 来说很难用双高斯拟合出正确的结果

COVARIANCE MATRIX CALCULATED SUCCESSFULLY

FCN=-55418.5 FROM HESSE

STATUS=OK

77 CALLS

759 TOTAL

EDM=0.00103118

STRATEGY= 1

ERROR MATRIX ACCURATE

EXT NO.	PARAMETER NAME	VALUE	ERROR	INTERNAL STEP SIZE	INTERNAL VALUE
1	a	1.30915e-01	3.56052e-01	1.37402e-03	-1.40881e+00
2	b	3.33962e+00	3.44835e+00	5.00000e-01	-7.28885e-01
3	mean1	1.01238e+01	5.94948e-01	3.77001e-05	1.23771e-02
4	mean2	8.17725e+00	3.45846e-01	1.87812e-04	-1.83300e-01
5	nbkg	4.04204e+03	1.02175e+02	5.14220e-04	-1.92785e-01
6	nsig	3.54421e+03	1.37383e+03	5.75074e-04	-2.95438e-01
7	nsig2	2.41357e+03	1.37857e+03	5.65192e-04	-5.43676e-01
8	sigma1	1.99208e+00	1.75796e-01	2.61742e-04	-9.28617e-01
9	sigma2	1.58143e+00	1.60543e-01	5.56587e-05	-1.00071e+00

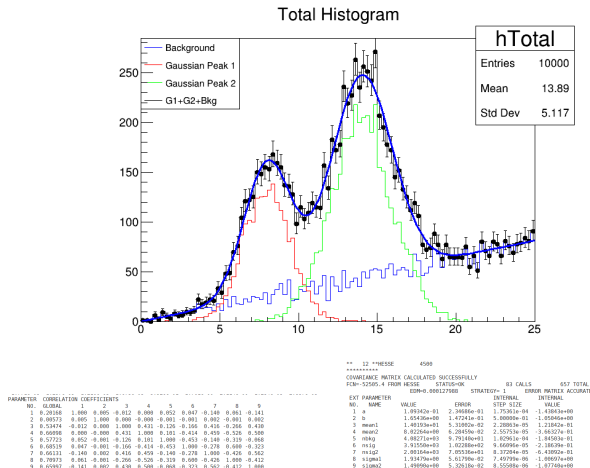
ERR DEF= 0.5

PARAMETER CORRELATION COEFFICIENTS

NO.	GLOBAL	1	2	3	4	5	6	7	8	9
1	0.19018	1.000	0.009	0.027	-0.009	0.043	-0.011	0.008	-0.034	-0.046
2	0.09568	0.009	1.000	-0.003	0.001	-0.005	0.001	-0.001	0.004	0.005
3	0.99528	0.027	-0.003	1.000	0.703	-0.073	-0.978	0.977	-0.715	0.761
4	0.98626	-0.009	0.001	0.703	1.000	-0.278	-0.813	0.827	-0.075	0.934
5	0.65040	0.043	-0.005	-0.073	-0.278	1.000	0.000	-0.124	-0.290	-0.252
6	0.99816	-0.011	0.001	-0.978	-0.813	0.000	1.000	-0.997	0.617	-0.854
7	0.99859	0.008	-0.001	0.977	0.827	-0.124	-0.997	1.000	-0.592	0.866
8	0.96201	-0.034	0.004	-0.715	-0.075	-0.290	0.617	-0.592	1.000	-0.234
9	0.95718	-0.046	0.005	0.761	0.934	-0.252	-0.854	0.866	-0.234	1.000

# 拟合结果 2

如果我们将第二个 gauss 的中心值由 10 变成 14，并把平本底扩展到 25，那么：





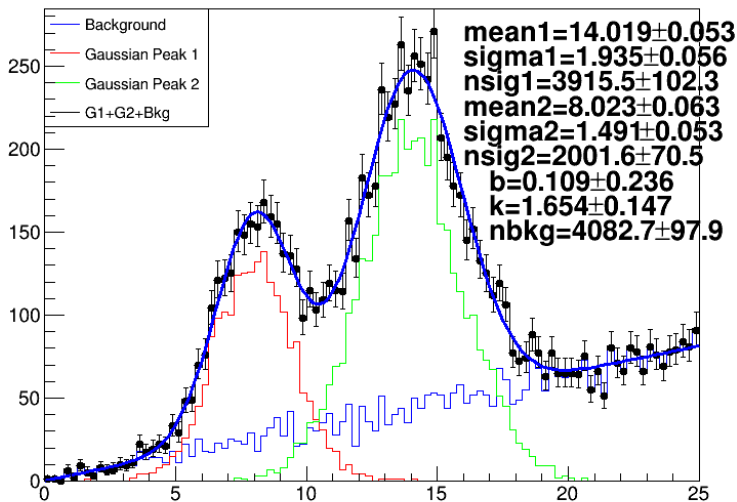
# 在图上展示拟合结果

可以使用 TLatex 和 DrawLatex 在 Canvas 上添加文字来展示拟合结果

```
TLatex *t = new TLatex();
ostream output;
output<<fixed<<setprecision(3)<<"mean1="<<mean1.getVal()<<"#pm"<<mean1.getError();
t->DrawLatex(16,265,output.str().c_str());
ostream output2;
output2<<fixed<<setprecision(3)<<"sigma1="<<sigma1.getVal()<<"#pm"<<sigma1.getError();
t->DrawLatex(16,250,output2.str().c_str());
ostream output3;
output3<<fixed<<setprecision(1)<<"nsig1="<<nsig.getVal()<<"#pm"<<nsig.getError();
t->DrawLatex(16,235,output3.str().c_str());
ostream output4;
output4<<fixed<<setprecision(3)<<"mean2="<<mean2.getVal()<<"#pm"<<mean2.getError();
t->DrawLatex(16,220,output4.str().c_str());
ostream output5;
output5<<fixed<<setprecision(3)<<"sigma2="<<sigma2.getVal()<<"#pm"<<sigma2.getError();
t->DrawLatex(16,205,output5.str().c_str());
ostream output6;
output6<<fixed<<setprecision(1)<<"nsig2="<<nsig2.getVal()<<"#pm"<<nsig2.getError();
t->DrawLatex(16,190,output6.str().c_str());
ostream output7;
output7<<fixed<<setprecision(3)<<"b="<<a.getVal()<<"#pm"<<a.getError();
t->DrawLatex(17,175,output7.str().c_str());
ostream output8;
output8<<fixed<<setprecision(3)<<"k="<<b.getVal()<<"#pm"<<b.getError();
t->DrawLatex(17,160,output8.str().c_str());
ostream output9;
output9<<fixed<<setprecision(1)<<"nbkg="<<nbkg.getVal()<<"#pm"<<nbkg.getError();
t->DrawLatex(17,145,output9.str().c_str());
t->Draw("same");
```

# 最终结果

Total Histogram



# 小结

1. 使用 TF1 和 TH1F 产生各个 sample 并组合成 fake data sample;
2. 使用 root 或 roofit 拟合 fake data sample 并提取拟合参数
3. 注意拟合参数的误差和关联, 这说明了你拟合的成功与否 (实际工作中也需注意)。