Computer Exercise: Toy-experiments of fits of a constant

Macro p0toyf.C, accessible at

http://www.desy.de/~obehnke/stat/school_apr14/p0toyf.C

generates toy experiments for the fit of a constant ("p0-fit") from several measurements of the same resolution. A physics example for this would be the determination of the (average) vertical position of a horizontal flying track in track-detectors. Additional Problem: the detectors are noisy, for each detector sometimes instead of a good signal hit a broadly distributed noise hit is observed.

- Steering parameters in the macro:
  - $Ntra$ = Number of repeated toy experiments (Default is 1000)
  - $Ndet$ = Number of measurements (Default is 10)
  - $frac\_noise$ Average fraction of noise hits (Default is 0.)
- Output
  - Histo $p0d$ - Distribution of residual: fitted constant - true value
  - Histo $chi2d$ - χ^2 distribution from the $p0$-fits
  - Histo $pchi2d$ - χ^2-probability distribution from the $p0$-fits
  - Histo a - shows the p0-fit for the last toy experiment

<u>Tasks:</u>

- Take a deep breath and have a few minutes look in the code and try to understand what's going on

a) Run the macro as it is with .x p0toyf.C and plot the histograms by p0d→ Draw(); chi2d→ Draw(); pchi2d→ Draw(); a→ Draw(); Fill the RMS value of the $p0d$ histogram in the table below (first row) and also the mean values of the $chi2d$ and $pchi2d$ distributions.

b) Now edit the macro and set $frac\_noise$=0.1;

   - run the macro again and fill the obtained values in the table (second row).
   - How much has the RMS of the residuals increased?
   - Can you identify the bad track-fits in the $pchi2d$ distribution?

c) <u>Rejection of tracks with bad χ^2-probability:</u> Book another residual histogram $p0d\_rej$ in the macro:

   - fill it only for the case that the χ^2-probability is not too small (see also hints in the code)
   - fill in the third row of the table how many tracks survive this selection and the resulting RMS of the residuals.

d) <u>Hit-outlier-rejection: Advanced method for super experts!</u>

   Book another three histograms $p0d\_iter$, $chi2d\_iter$ and $pchi2d\_iter$ in the macro and

   - try hit outlier rejection and repeating the track-fit (see detailed instructions in the code);

- fill the resulting RMS of $p0d\_iter$ into the fourth row of the table.
- How does the RMS results of this method compare to the other cases a)-c)?

- Repeat the above exercises b)-d) for increased $frac\_noise$=0.5 and fill the results in the table. How much are the RMS results worse in this case?
- If time permits repeat the above exercises a)-d) for different number of detectors $ndet = 5$ and study how the results change qualitatively.

Task	$Ndet$	$frac\_noise$	Outlier rejection	Resid.-distr.	#tracks	Resid. RMS	chi2d mean	pchi2d mean
a)	10	0.0	No	p0d	1000			
b)	10	0.1	No	p0d	1000			
c)	10	0.1	Reject tracks with bad pchi2	p0d_rej			–	–
d)	10	0.1	Outlier hit-rejection and repeated track-fit	p0d_iter	1000		–	–
b)	10	0.5	No	p0d	1000			
c)	10	0.5	Reject tracks with bad pchi2	p0d_rej			–	–
d)	10	0.5	Outlier hit-rejection and repeated track-fit	p0d_iter	1000		–	–