9.2 Wiener filtering and 1/f noise

The data set contains two scans of 512 points. That labelled signal is pure Gaussian noise of $\sigma_n = 1/3.5$ scattered about a baseline of 0.0, with a Gaussian-shaped signal (spectral line?) sitting on this noisy baseline centered at $x = 128$ and of width $\sigma_x = 5$. This is exactly the scan shown in Figure 9.1. The second is a $1/f$ baseline generated from another (independent) Gaussian noise scan for which the Fourier transform amplitudes have been multiplied by the factor $1/f$. The results of adding this baseline with 3 different normalizations to the original (flat-baseline) data set are shown below.

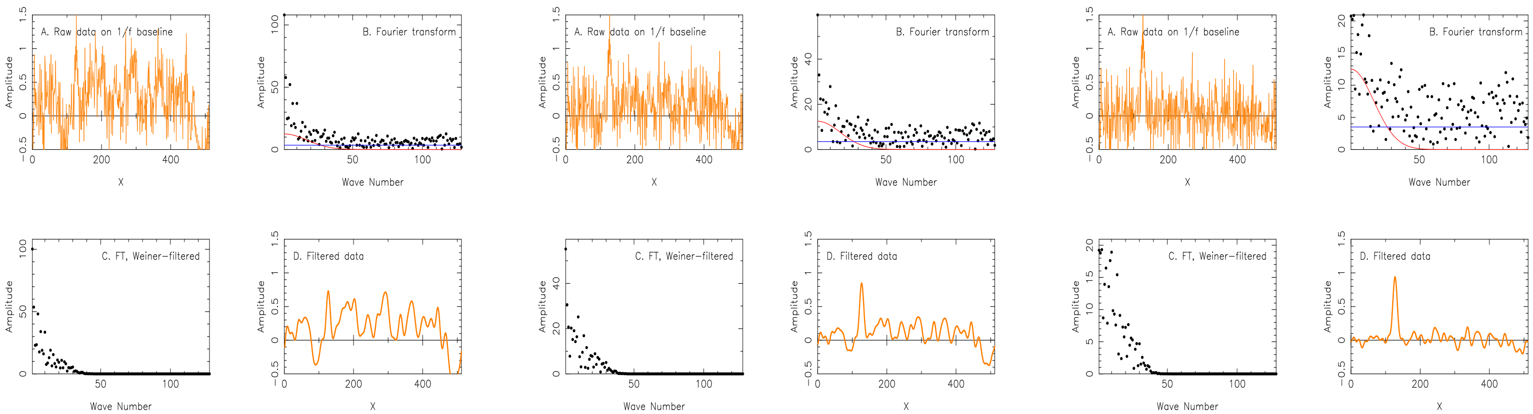

Figure 1: Starting with the raw data of Figure 9.1, a baseline created from random Gaussian noise filtered by $1/f$ has been added in proportions (left-to-right plot-sets) 10:5:1. The Wiener filtering of the example has been left untouched.

The 4-plot on the left shows that $1/f$ noise in such quantity completely wrecks this experiment in that the 'spectral line' is essentially not detectable. If the position of this signal (a frequency or wavelength say) were known, then measurement of line-profile parameters would be so badly affected as to have little physical significance. In the central 4-plot the amplitude of the $1/f$ baseline has been reduced by a factor of 2 before adding it to the pure-noise spectrum. Surprisingly perhaps this factor of 2 reduction produces a feature of signal-to-noise such that its line-profile parameters can be meaningfully measured. A factor of 10 reduction from the initial amplitude (right diagram) would result in measurement of line-profile parameters differing very little from those of the pure noise case shown in Figure 9.1.

Read this depending on your glass-half-full or glass-half-empty viewpoint. A reduction by a factor of but 2 in $1/f$ noise may result in a meaningful measurement. Or - from the $1/f$ noise being apparently of little importance (but just barely disguised by the noise threshold), a mere factor of two (from passing cloud?) wipes out your spectral measurement.