Using Hit Frequency curves

Calice meeting

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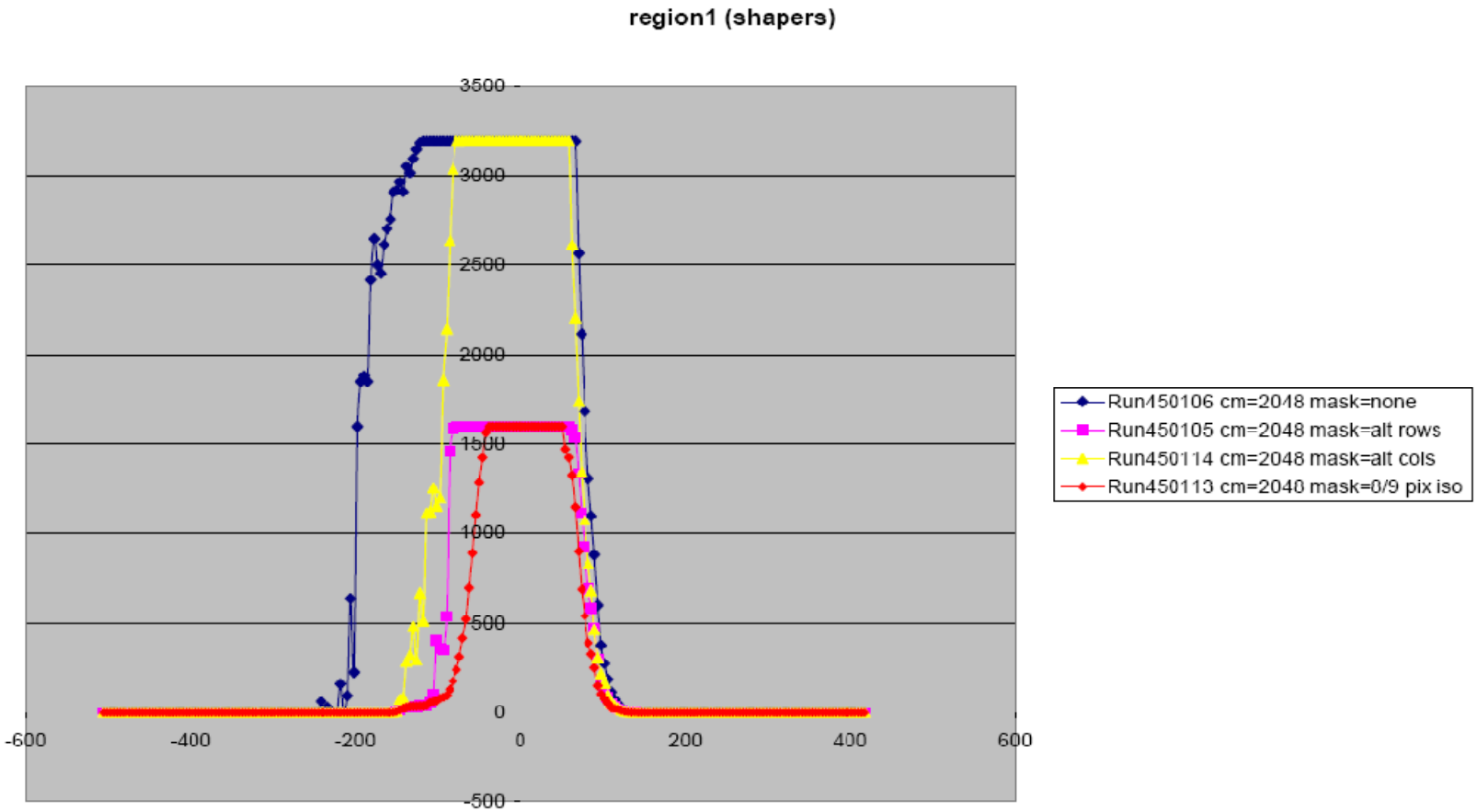
The problem

Can we use these curves to extract quantitative information about noise, gain, …



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The theory

Level-crossing problem.

Random variable **x**(t), crossing a level set at *a*.

How often does a crossing occur?

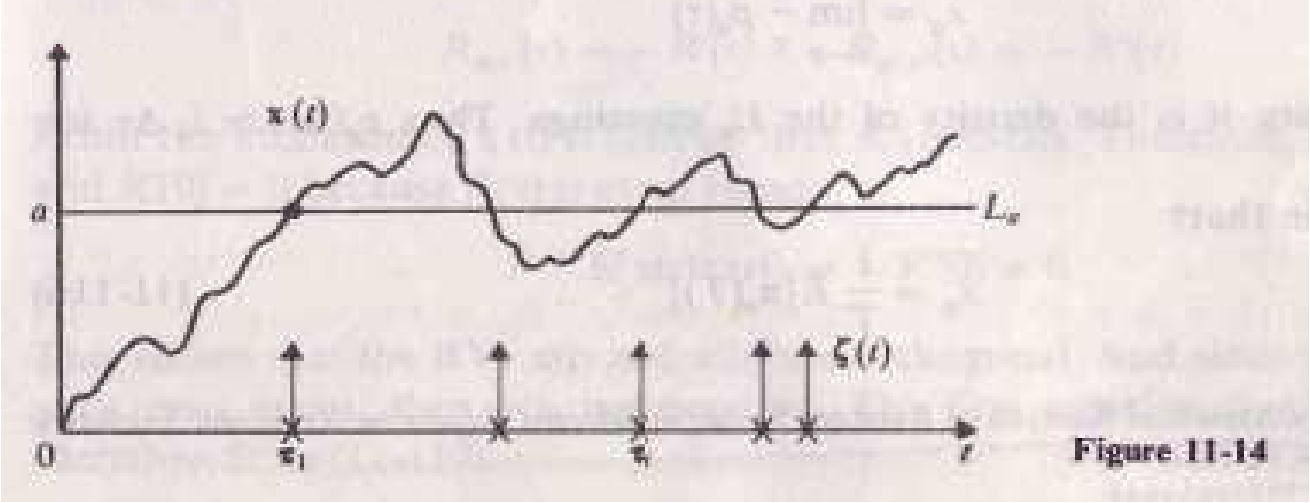

Figure 11-14

See: A. Papoulis, *Probability, Random Variables and Stochastic Processes,* section 11.4

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General result

If **x**(t) is differentiable, the level-crossing density λ_a (i.e. the average number of crossings in unit time) is

$$\lambda_a = f_x(a) \cdot E\{|x'(t)| \,|\, x(t) = a\}$$

Where $f_x(a)$ denotes the probability density for **x** and E{…} indicates expectation values.

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Gaussian distribution

For a normal process with zero mean (if this is not true, just apply a shift), the theory yields

$$\lambda_a = \frac{1}{\pi}\sqrt{\frac{-R''(0)}{R(0)}}\exp\left[-\frac{a^2}{2R(0)}\right]$$

where $R(\tau)$ is the autocorrelation function for $\mathbf{x}(t)$.

$R(0) = E\{\mathbf{x}(t)\mathbf{x}(t)\}$ = variance of the process

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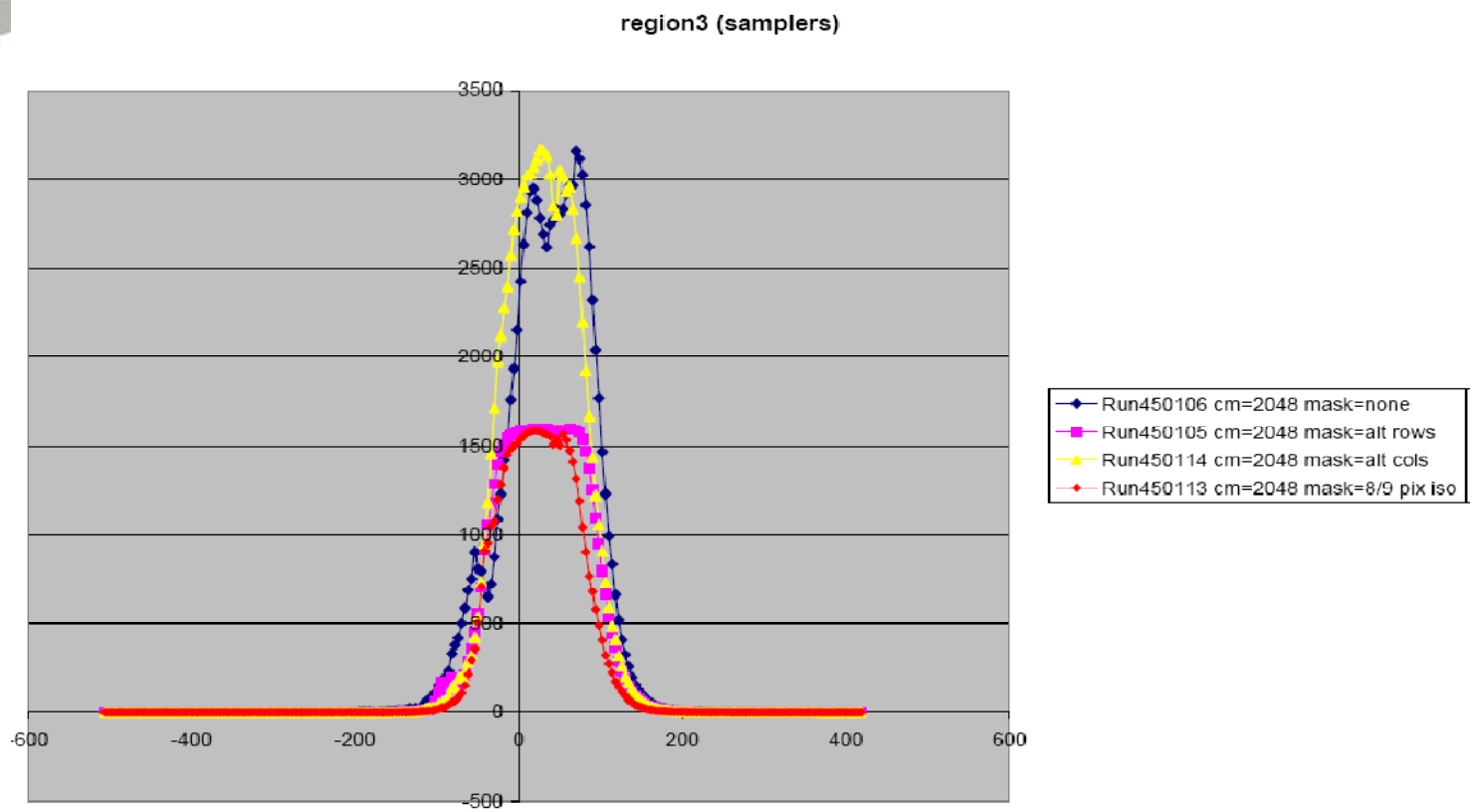
Example



It looks nice and Gaussian, but …
close to zero, memory overflow plus bandwidth limitations

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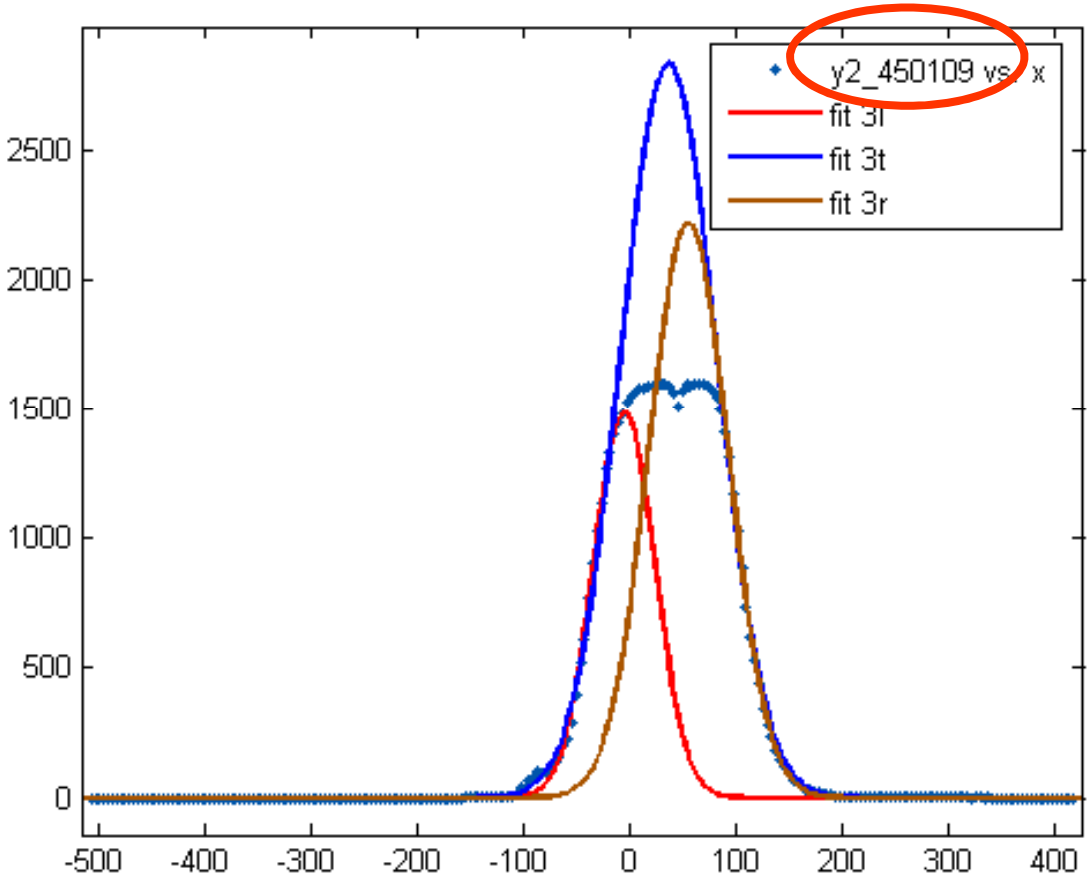
Example. 1



Fit on one or the other side or global.

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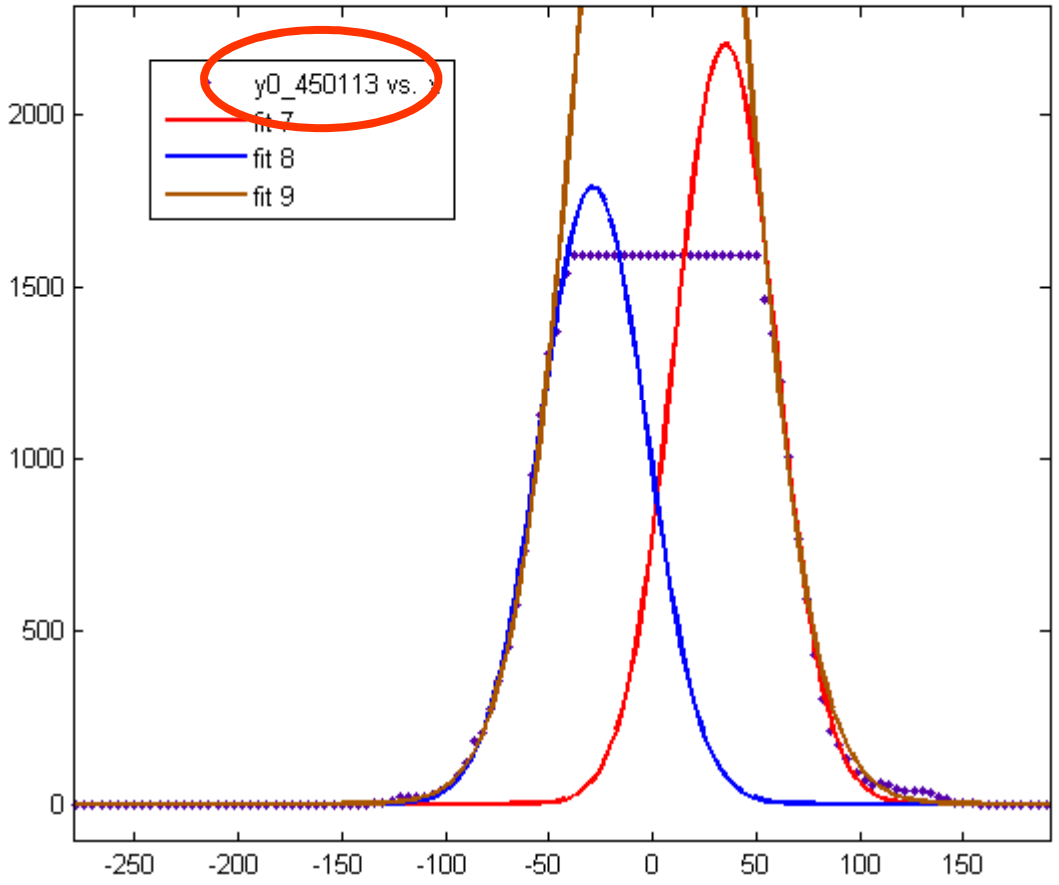
Example. 2



Fit on one or the other side or global.

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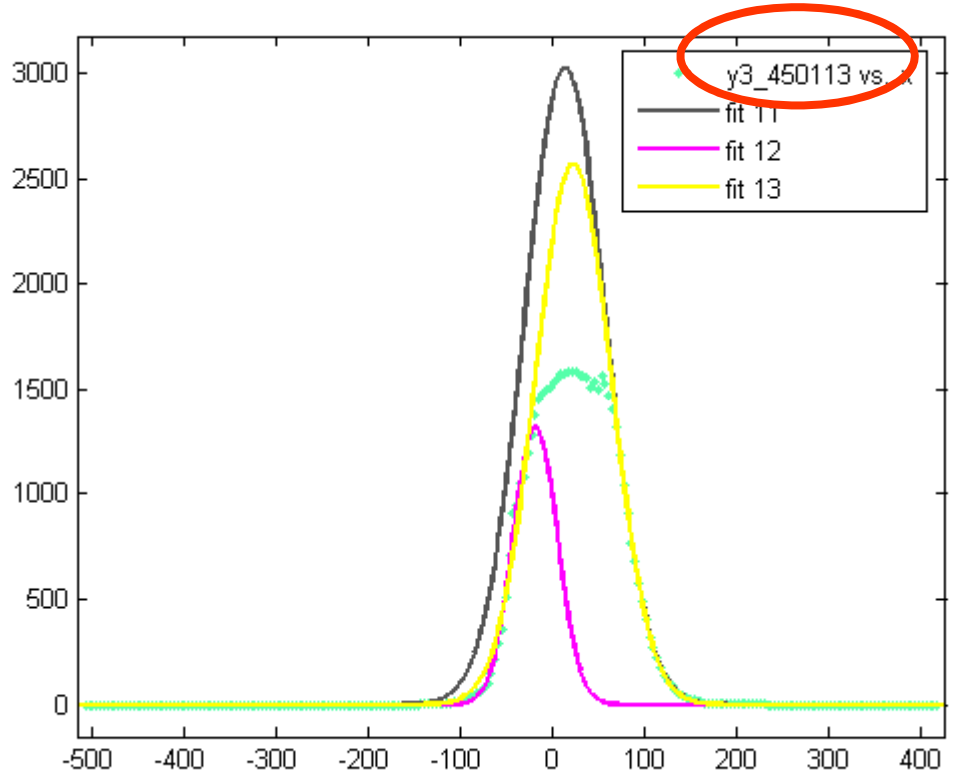
Example. 3



Fit on one or the other side or global.