# Gaussian Pulse-shaping

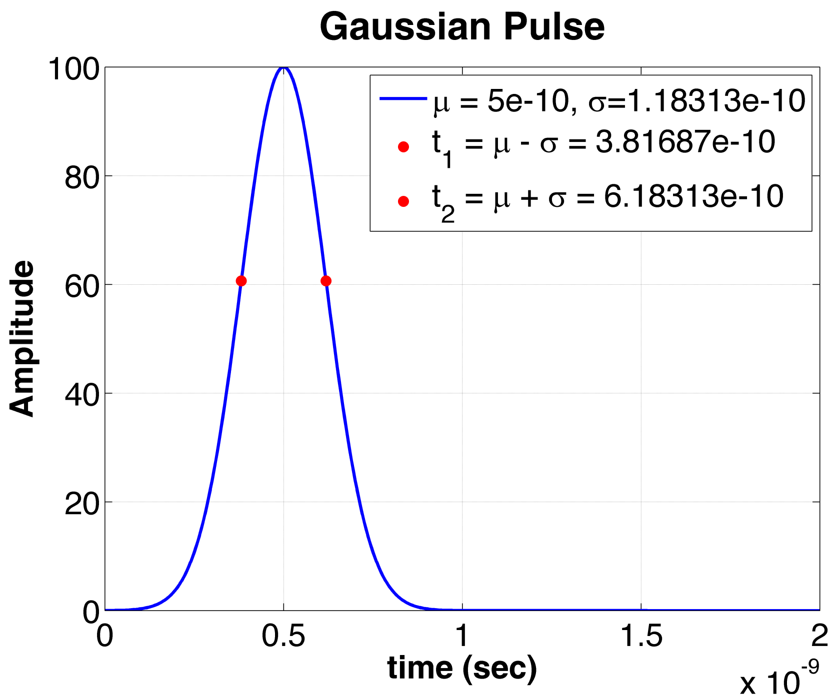


Figure 1: Gaussian-shape Pulse can be considered as the impulse response of a continuous-time Gaussian filter

The Gaussian signal in Fig. 1 is given by:

$$g(t) = \frac{\sqrt{\pi}}{a} e^{-\dfrac{\pi^2 t^2}{a^2}}$$

**Probabilistic:**

$$g(t) = \frac{1}{\sigma\sqrt{2\pi}} e^{\dfrac{-(t-\mu)^2}{2\sigma^2}},$$

where $a$ is related to the sigma as:

$$\sigma = \frac{1}{\sqrt{2}\,\pi} a \qquad \text{or} \qquad a = \sqrt{2}\,\pi\sigma.$$

Let $f_{(\mathbf{3dB})}$ be the $-3dB$ frequency of the signal then (e.g.)

$$\sigma = \frac{\sqrt{\ln 2}}{2\pi f_{(\mathbf{3dB})}}.$$

There are two approximation errors in the design: a truncation error and a sampling error. The truncation error is due to a finite-time (FIR) approximation of the theoretically infinite impulse response of the ideal Gaussian filter. The sampling error (aliasing) is due to the fact that a Gaussian frequency response is not really band-limited in a strict sense (i.e. the energy of the Gaussian signal beyond a certain frequency is not exactly zero). This can be noted from the transfer function of the continuous-time Gaussian filter, which is given as below:

Frequency content of the signal,

$$G(f) = e^{-a^2 f^2}$$

or equivalently

$$G(f) = e^{-2(\pi\sigma)^2 f^2}.$$