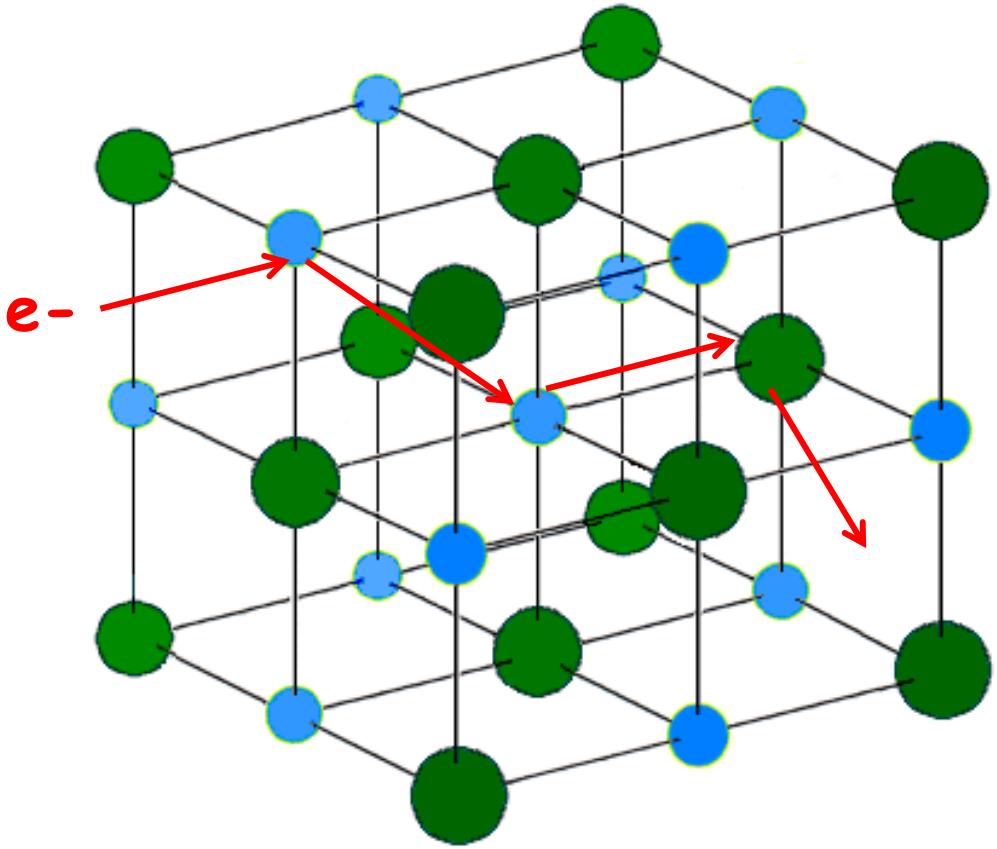
6.02 Lecture 5 – Analyzing Noise

- Noise
  - Sources of Noise
  - Why Normal (Gaussian) PDF's?
- Normal Random Variables
  - Shift invariance – two views.
  - Joint and Conditional Probability
  - Cumulative Distribution Function
- Eye Slicing
  - Combining ISI and Noise
  - Evaluating BER

Noise Can Be Due to Fundamental Processes

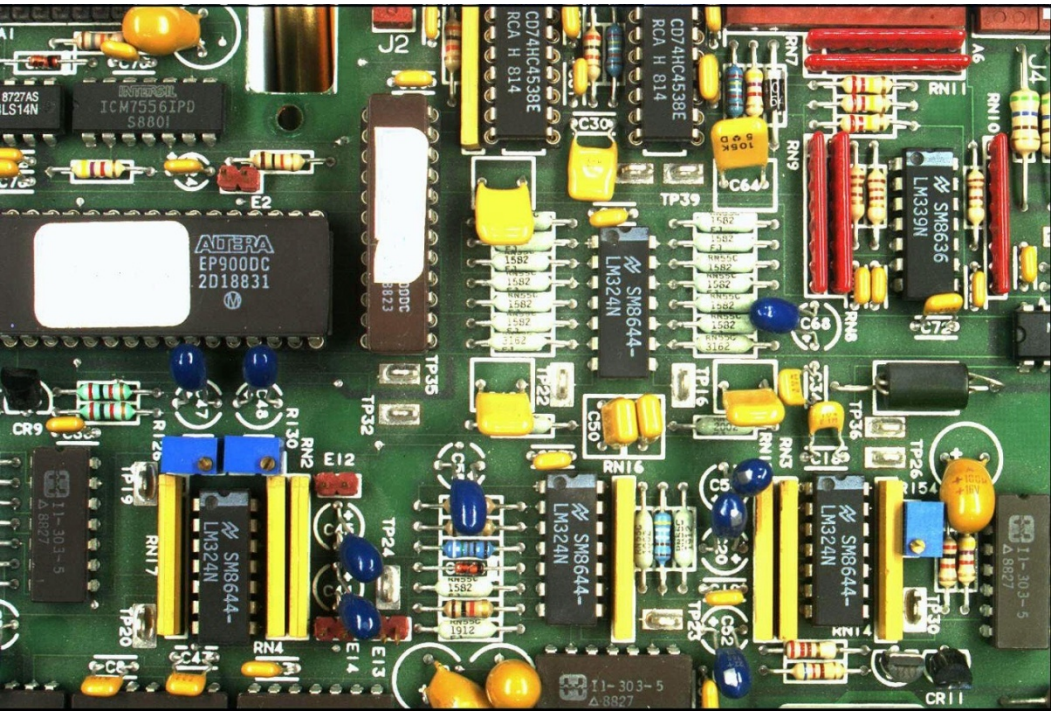
Electron Moving Through Crystal with Vibrating Atoms



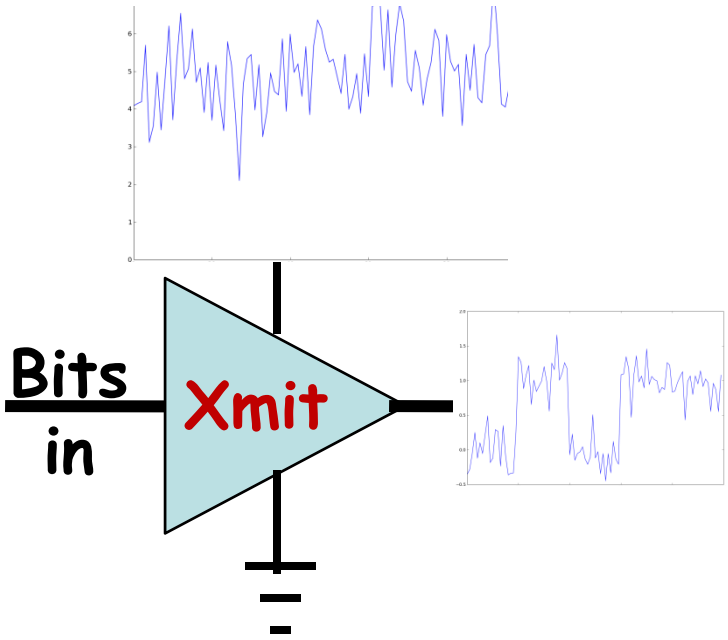
http://www4.nau.edu/meteorite/Meteorite/Images/Sodium_chloride_crystal.png

Randomized path leads to noisy current flow

Effect of Many Interactions Can Be Modeled as Noise



http://www.imageteck.net/PCB%20Board%203.JPG



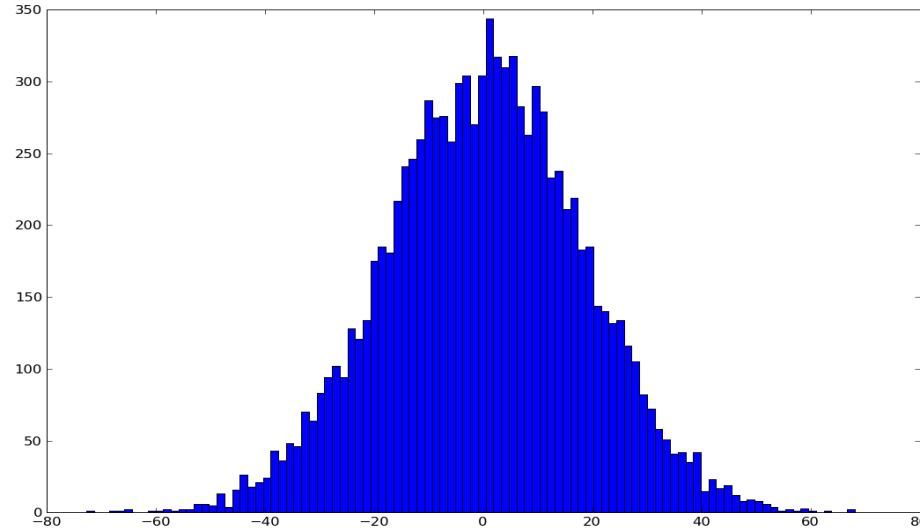
Many components connected by thin wires (that have inductance and resistance) to single power supply – 1000's of devices switching on and off creates "noisy" power supply.

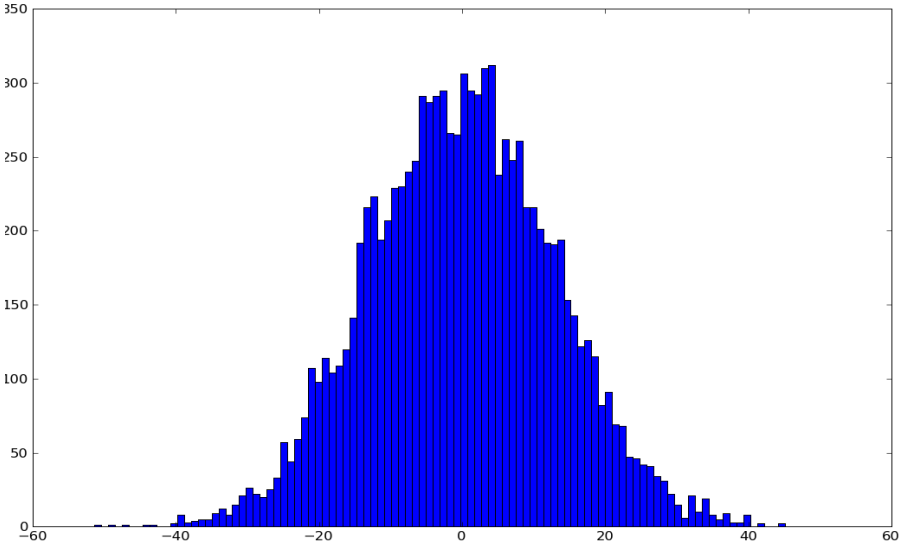
Why Use Normal (Gaussian) PDF

$$f_X(x) = \frac{1}{\sqrt{2\pi}\,\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

μ = mean or expected value

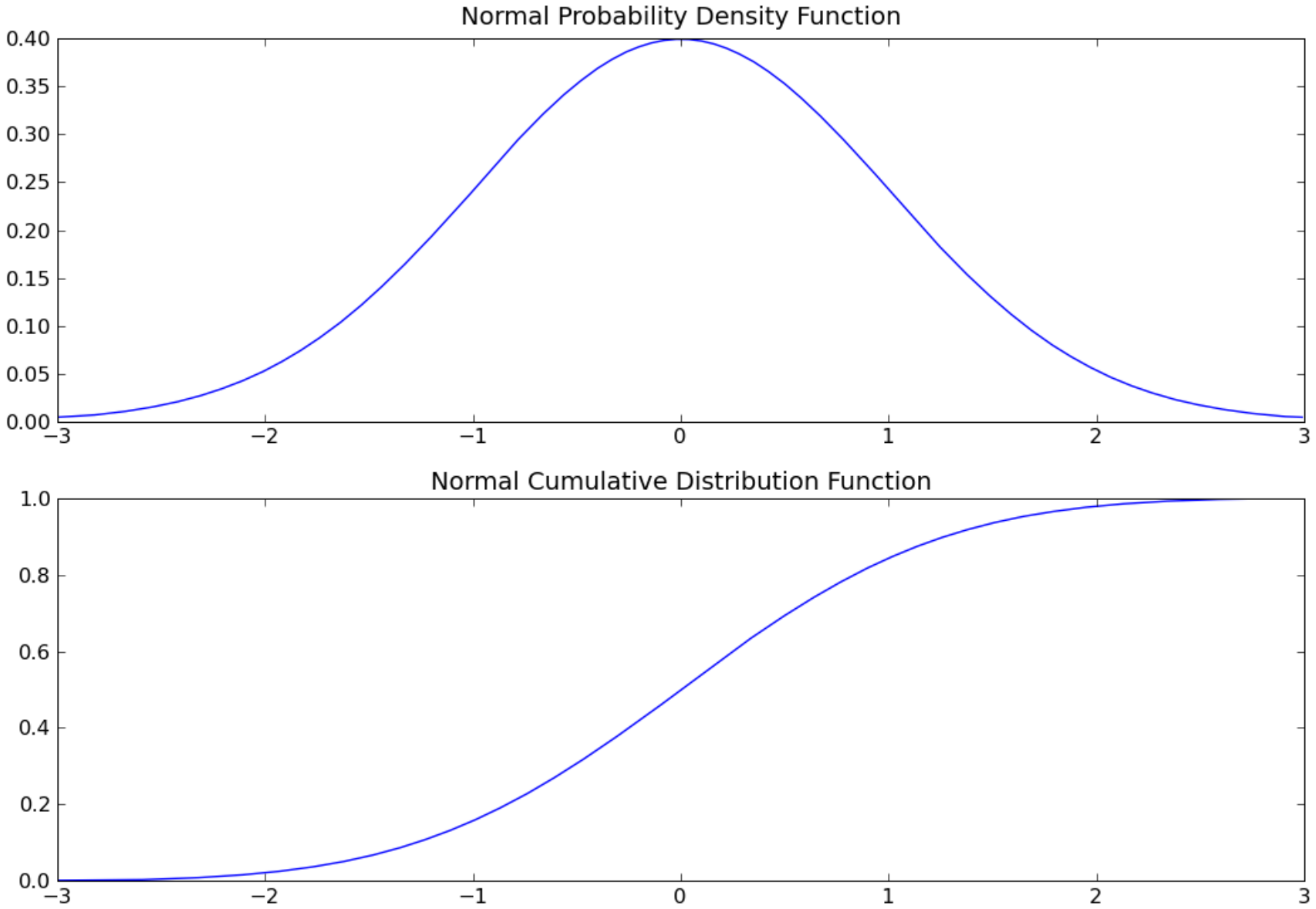
σ = standard deviation



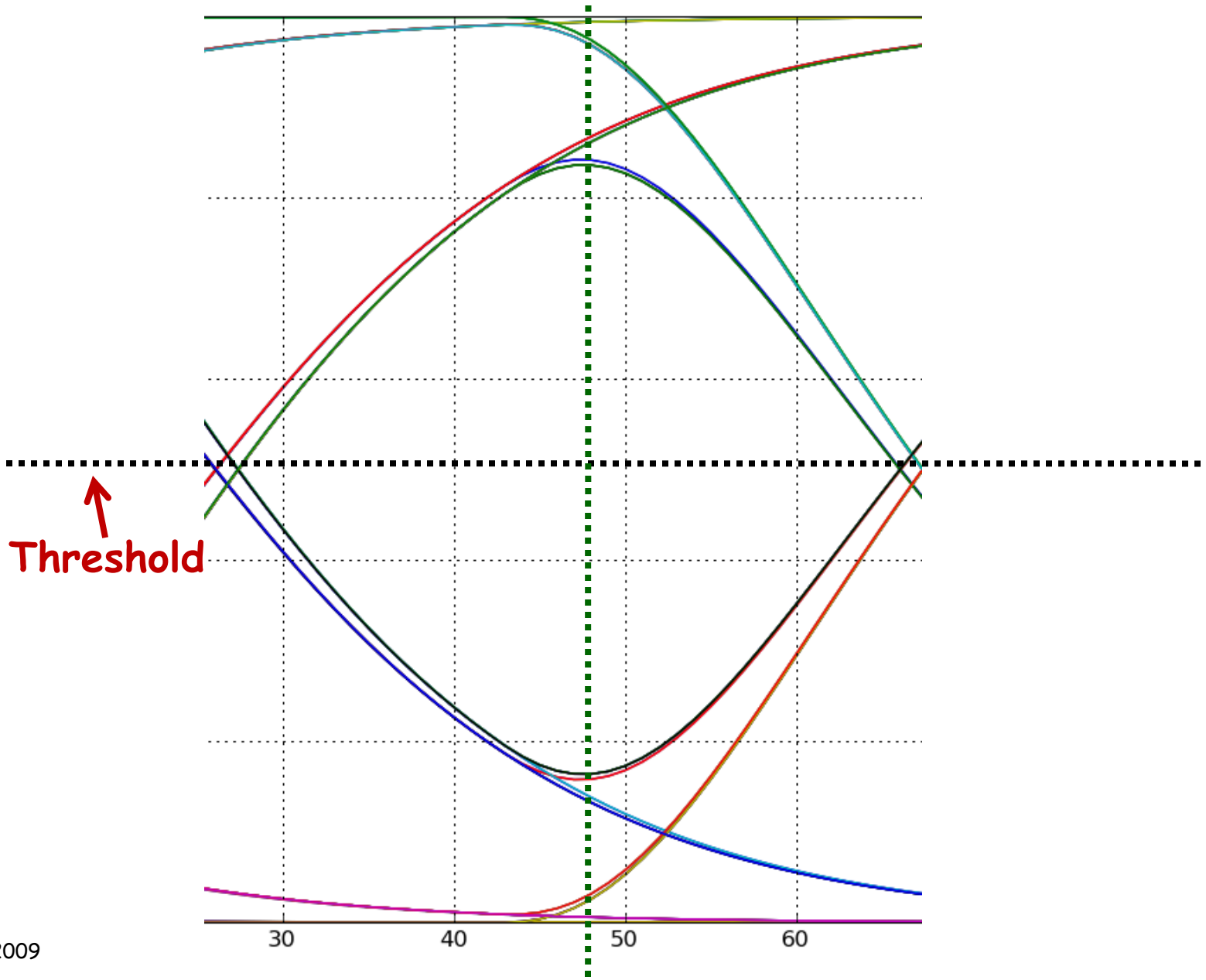


Histogram for 10000 trials of sums of 1000 uniformly (right) or triangularly (left) distributed [-1,1] random variables

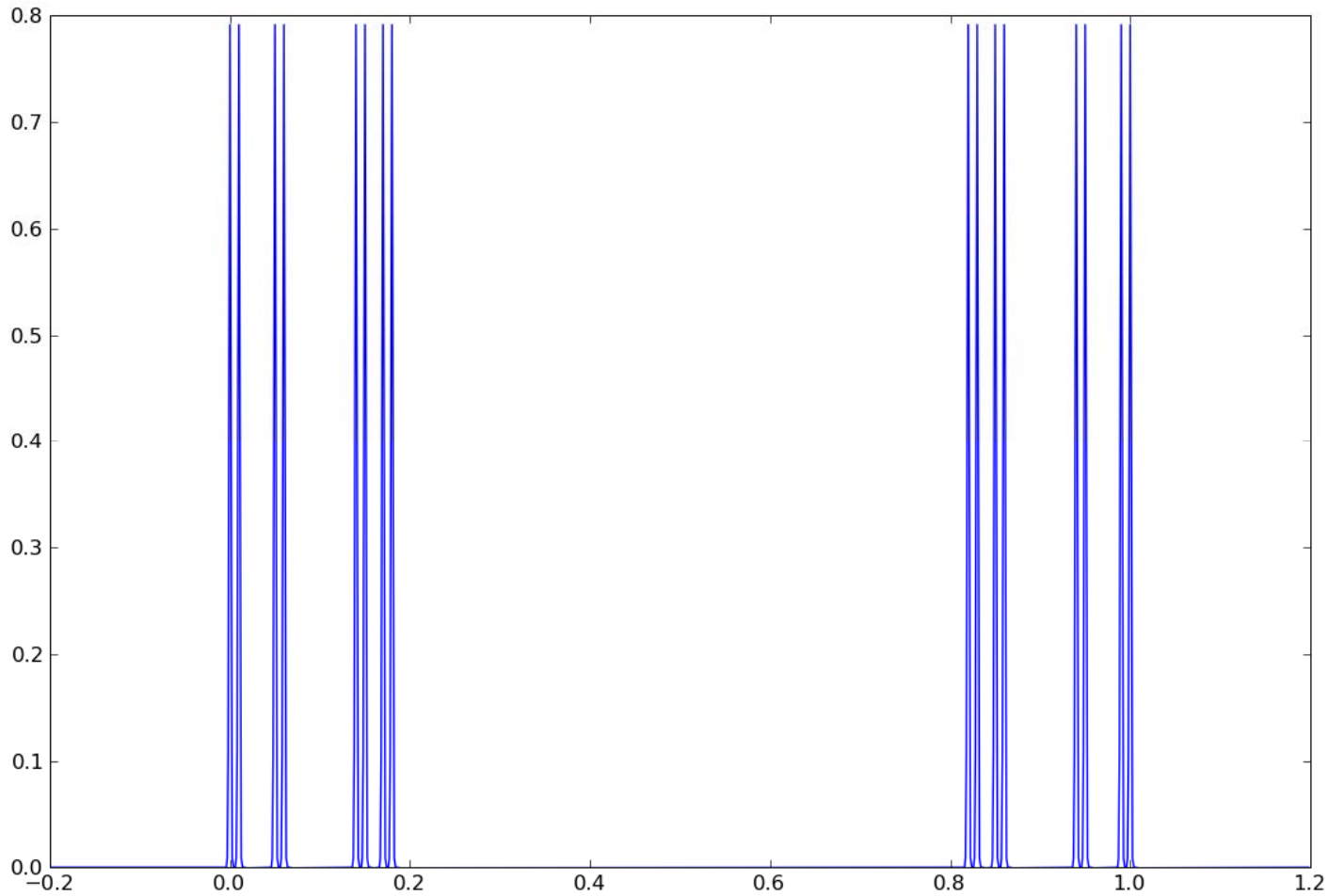
Cumulative Distribution Function



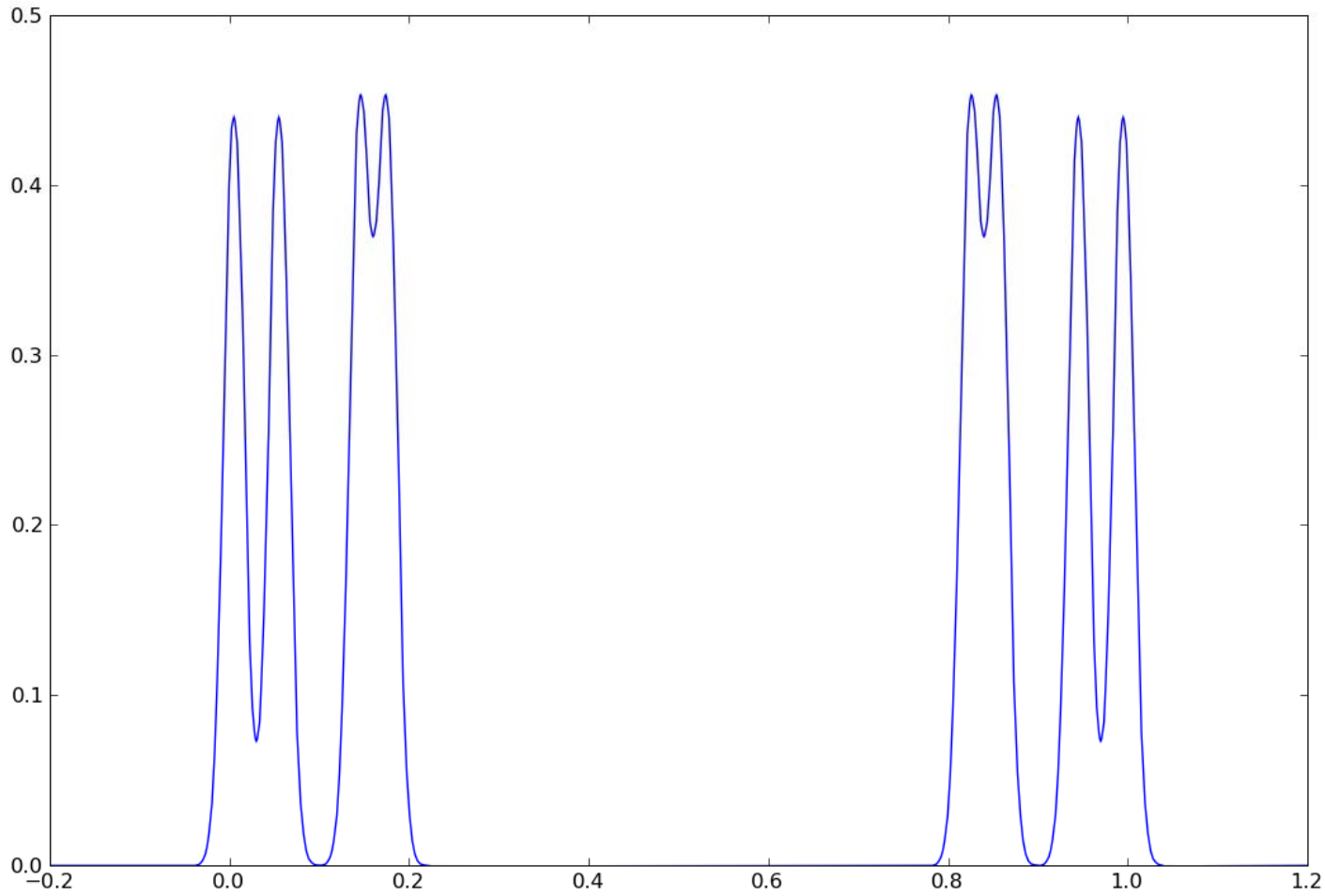
Eye diagram slice



Slice PDF (std=0.001)



Slice PDF (std=0.01)



Slice PDF (std=0.1)