

Jitter Testing Challenges For Multiple Gb/s Serial Link

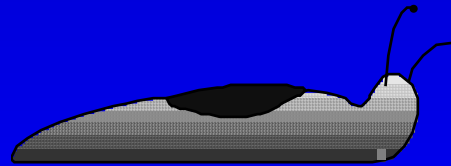
Mike Li, Ph.D.

Wavecrest

BAST03 Presentation, Feb 2003



WAVECREST

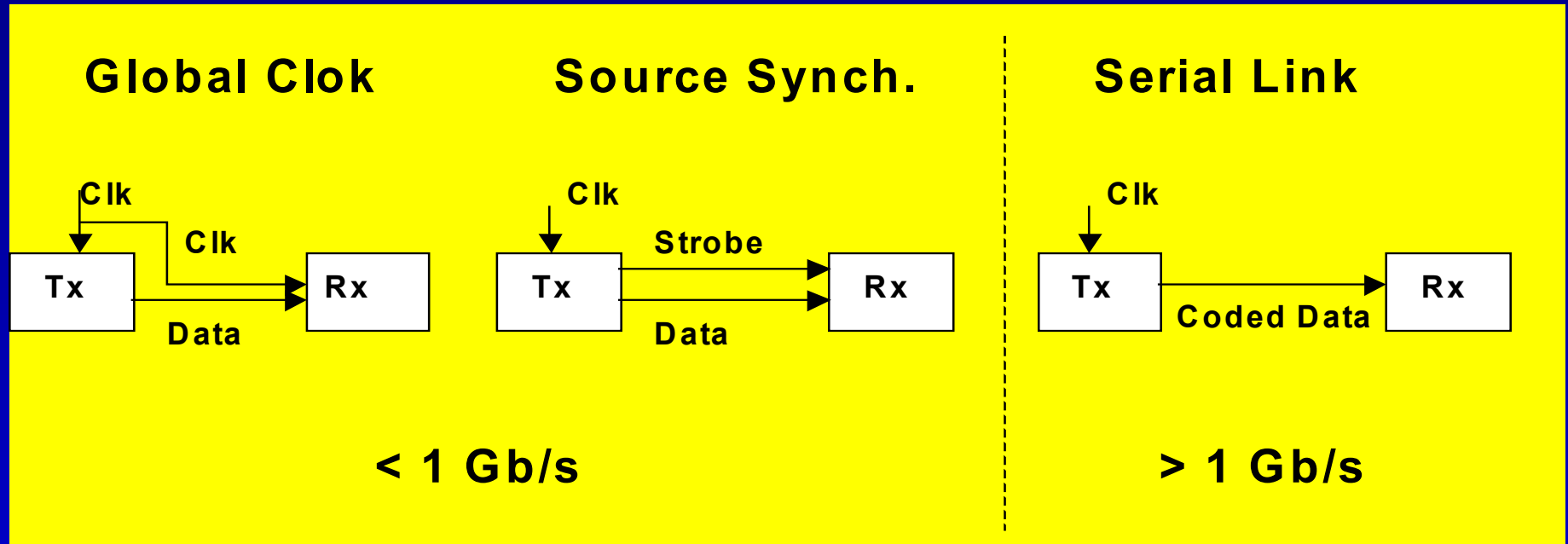


Mike Li's Biography

- Currently the CTO of Wavecrest.
- Pioneered jitter separation method (Tailfit) and DJ, RJ, and TJ concept and theory formation
- Many years experiences in semiconductor/IC test and measurement system and methodology design
- Recent interests in high performance test/measurement systems for multiple GB/s serial links (copper or optical fiber based)
- BS in physics, MSE in electrical engineering, and Ph.D. in physics.
- > 35 papers in refereed technical journals
- One granted and five pending patents



Paradigm Shifting In Data Tx and Rx



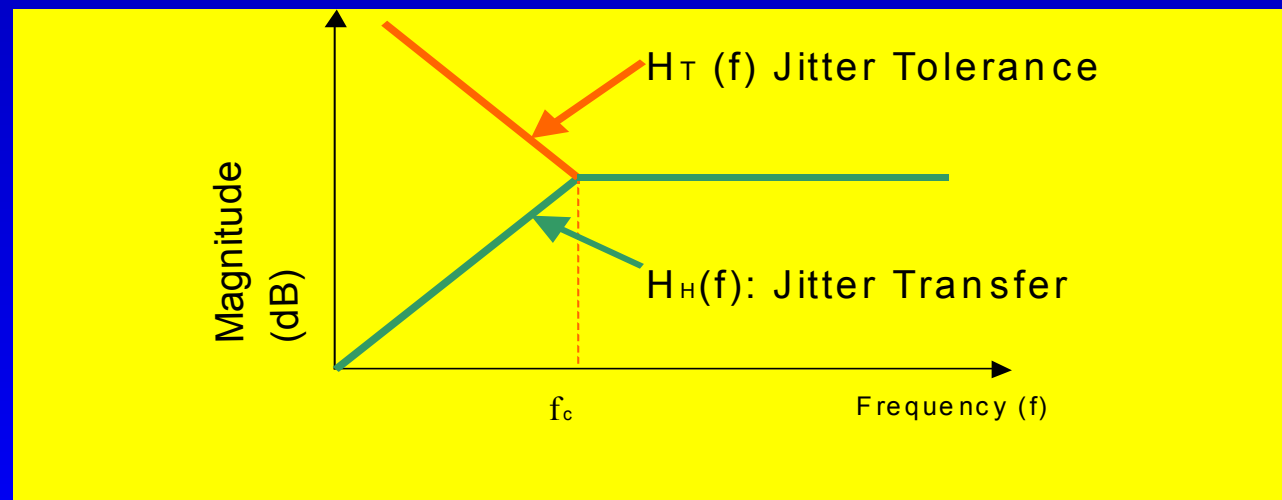
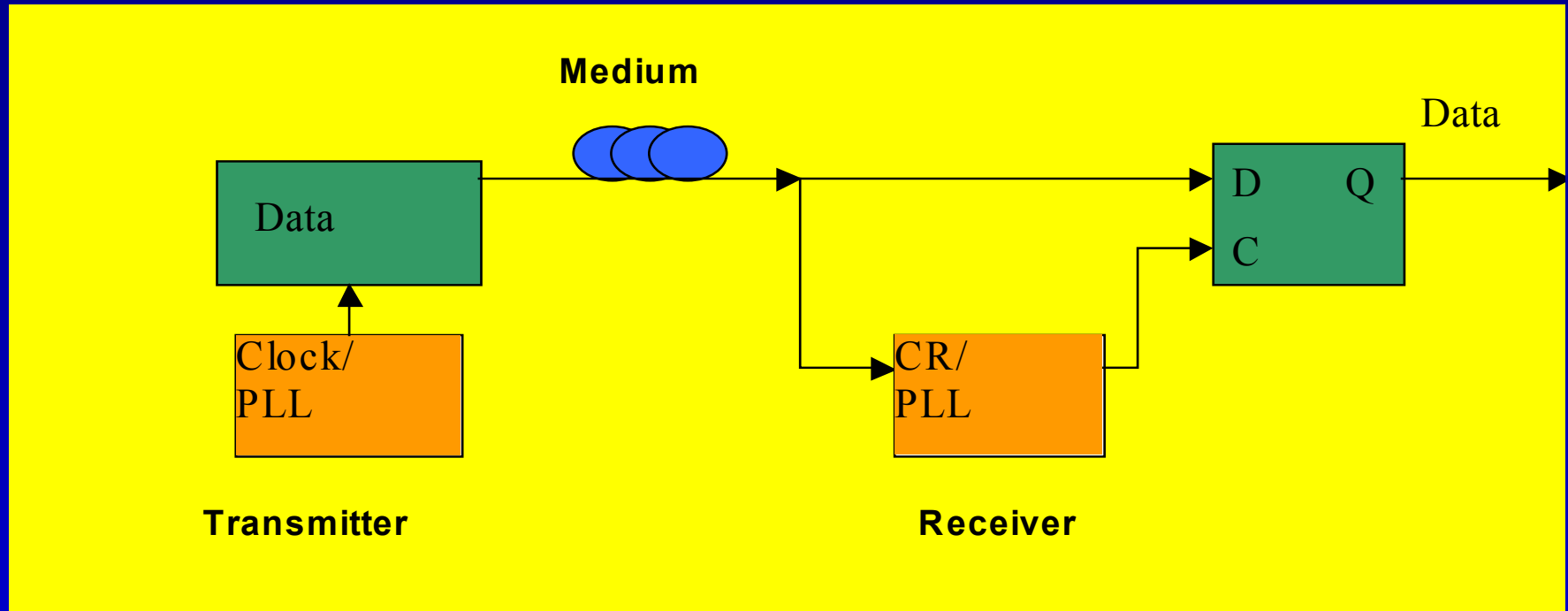
- Skew
- Flight time

- Paths Match

Jitter



A Serial Data Communication System

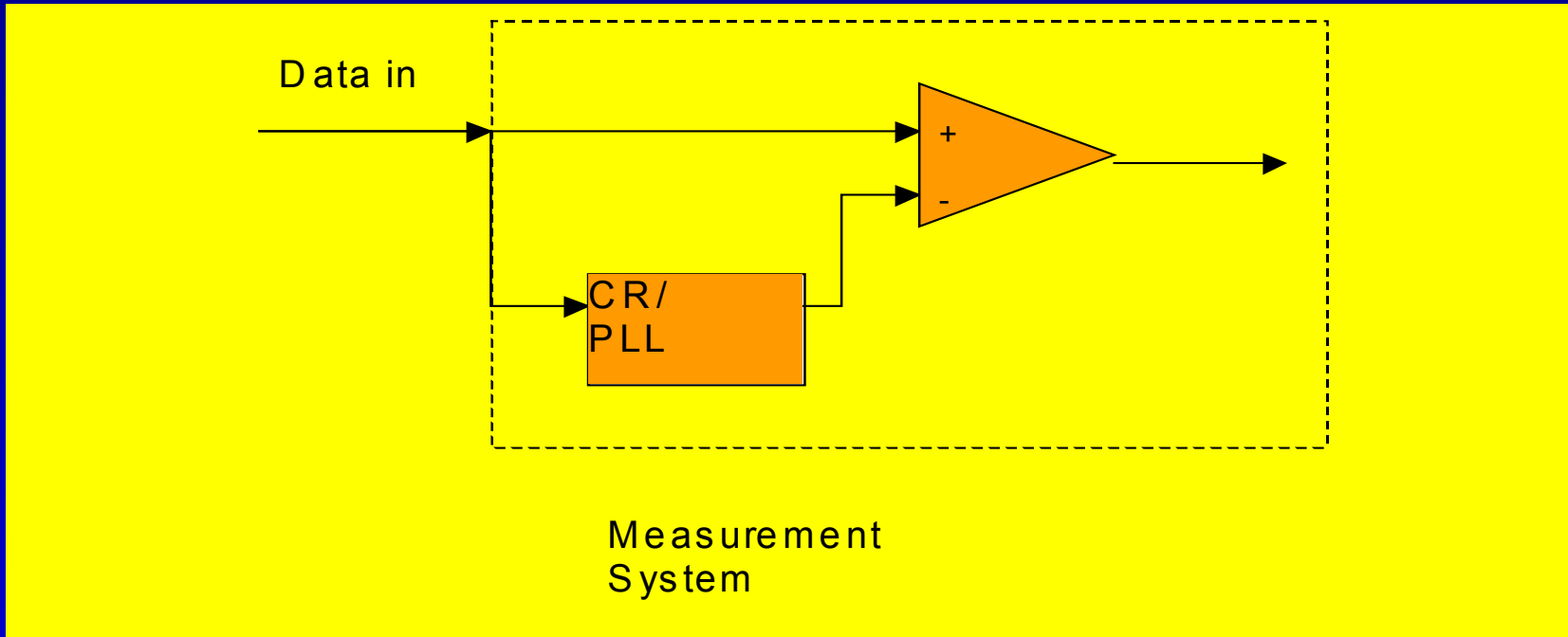


How Does A Receiver See Jitter?

- **Jitter** is referenced to a recovered bit clock
- Receiver has a jitter **transfer function**
- “Intrinsic” jitter referenced to an ideal bit clock is **not** the jitter “seen” by the receiver
- **BER** of the system should be estimated based on jitter “seen” by the receiver
- Jitter **overestimation** will cause serious **yield degradation**



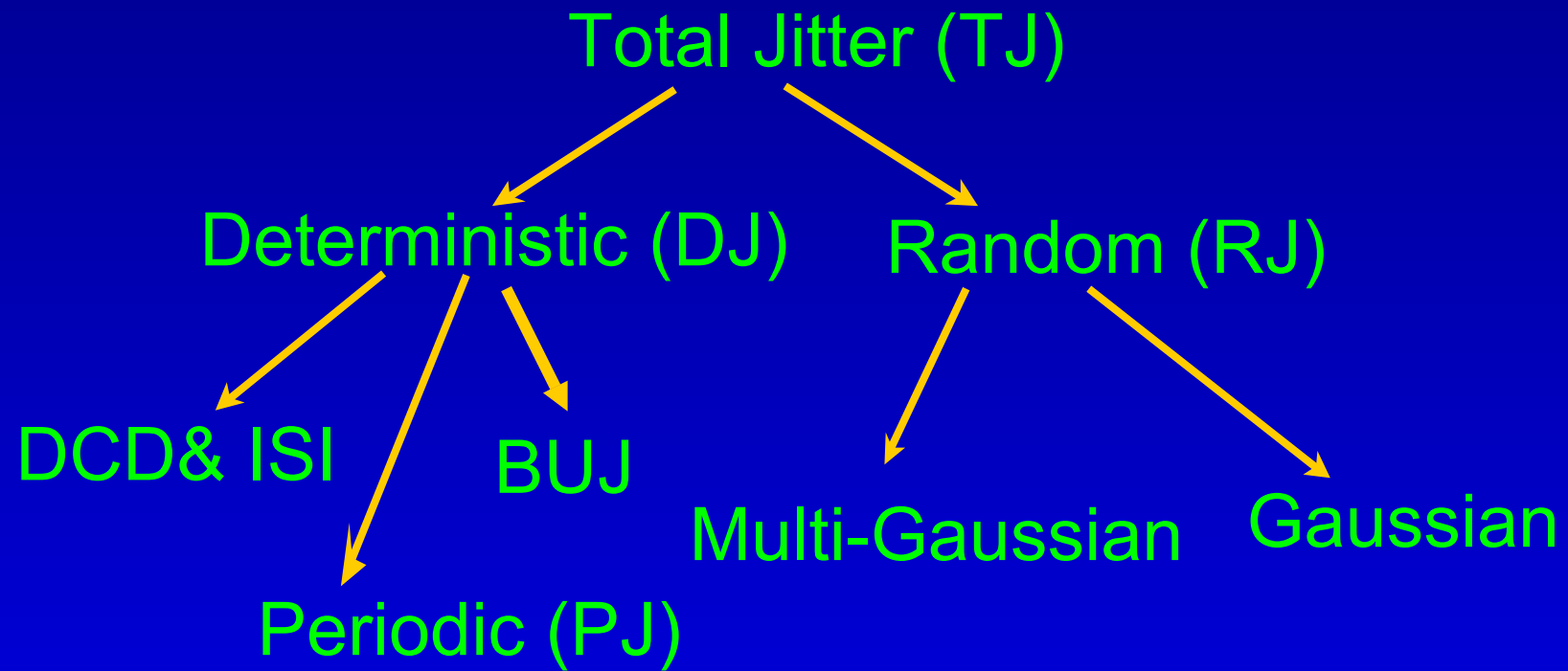
Challenge I: What Constitutes A Valid Jitter Testing/Validation Method?



- Measure the jitter as the receiver “sees” !!!
- CR/PLL and difference functions or their equivalents are required



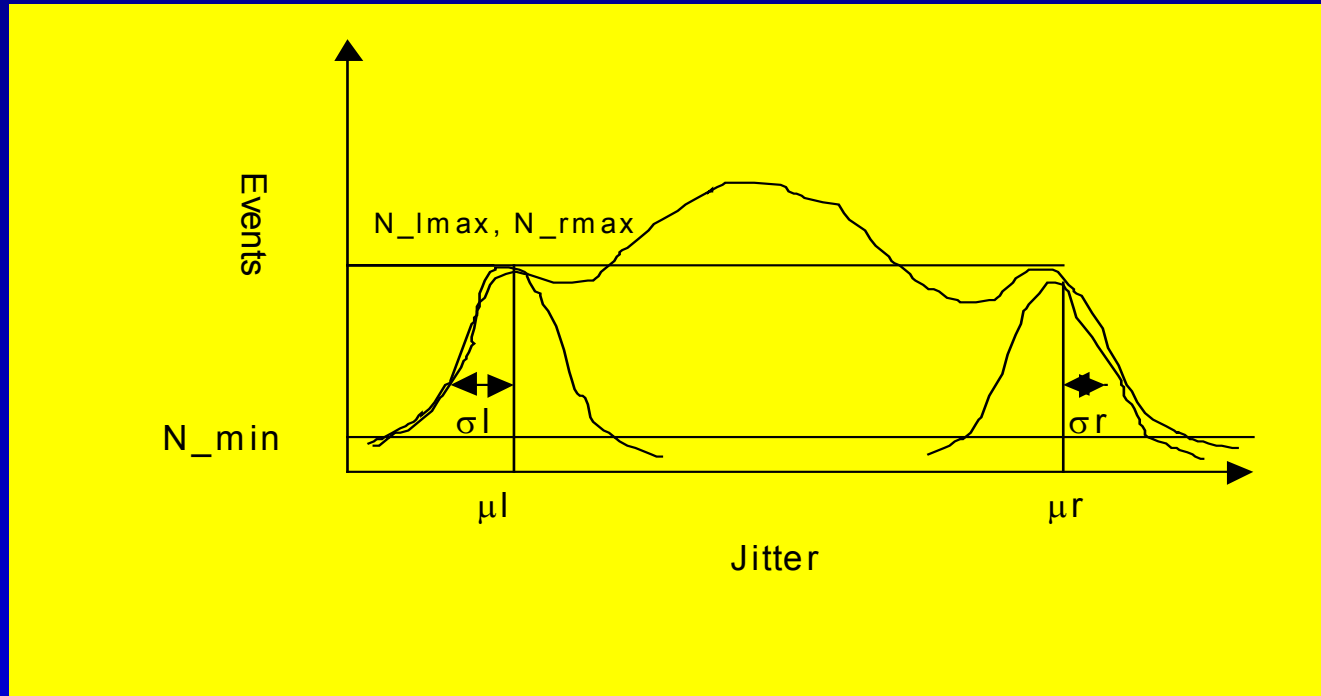
Jitter Classification Scheme (Stochastic Process Based)



BUJ: Bounded uncorrelated Jitter



Challenge II: How to Separate DJ and RJ Correctly ?



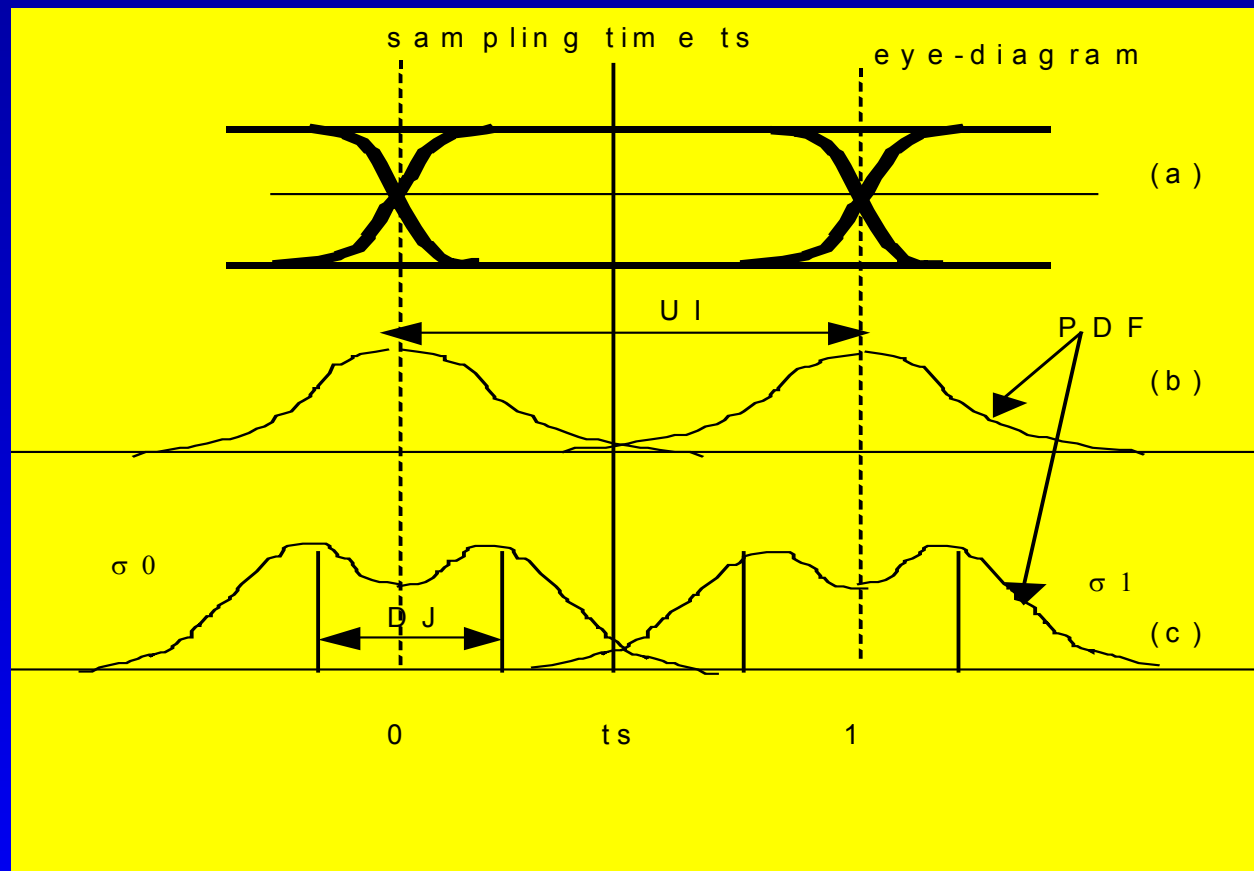
$$DJ = \mu_r - \mu_l$$

$$\sigma_{RJ} = (\sigma_l + \sigma_r) / 2$$



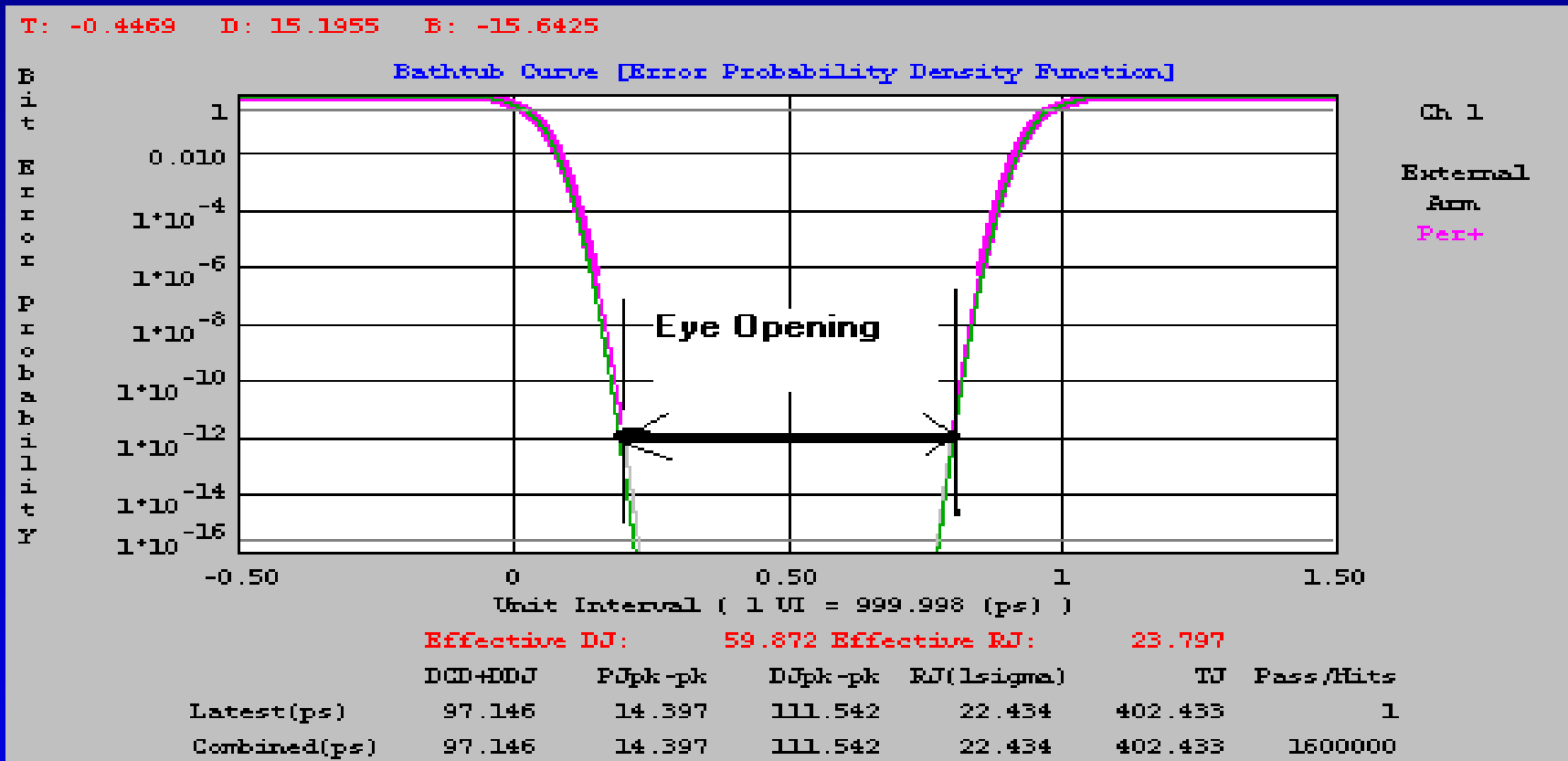
Jitter PDF and BER Function

- **Convolution** of DJ and RJ PDFs gives TJ PDF
- BER: metric for overall system performance
- BER: cumulative density function (CDF)



Challenge II: How To Measure TJ at BER $\leq 10^{-12}$

- Total jitter = UI – eye opening @ 10^{-12}



A Valid Jitter Testing Method For Serial Data Communication

Measure total jitter PDF via an
appropriate bit clock reference

Measure or extrapolate
BER function to $< 10^{-12}$

Measure total jitter @
BER = 10^{-12} or smaller

Pass/Fail



Challenge IV: Test Jitter In Production

- Is the synchronous ATE ready for > Gb/s Asynchronous SERDES Jitter test?
 - ◆ Jitter and BER **MUST** be tested in production
 - ◆ A clock recovery unit/function is required
 - ◆ BER needs to be tested down to $< 10^{-12}$
 - ◆ ~ps accuracy, > 5HGz BW, multiple channel, diff.
 - ◆ Test time needs to be ~ seconds or less
- Is there a solution?
 - ◆ Open architecture (soon enough?)
 - ◆ Integration of exiting technologies
 - ◆ A hybrid approach (model + *in situ* test)

