Transmitter Jitter Budget

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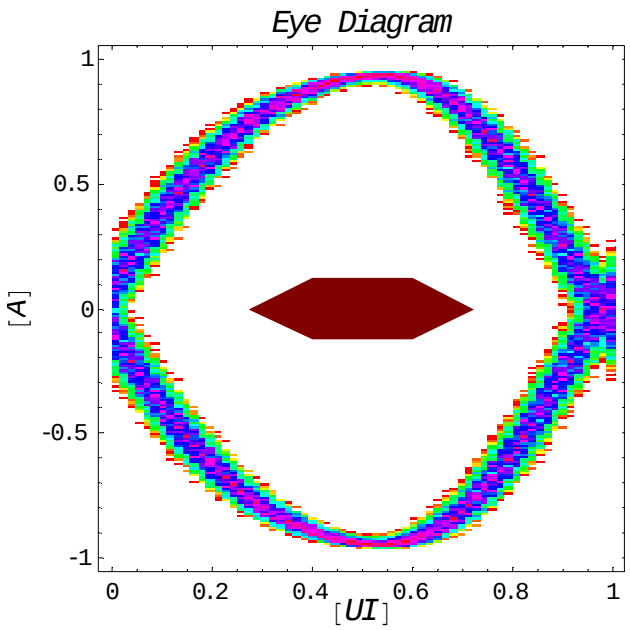
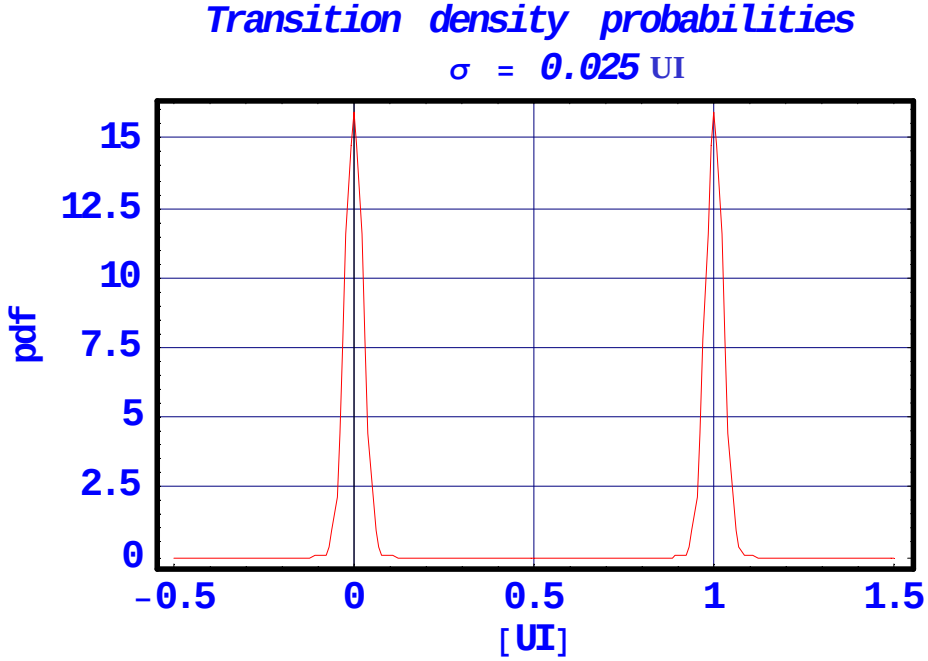
Objective

- XAUI transmit jitter spec is:
  - TJ = 0.35UI
  - DJ = 0.17UI
  - No spec on RJ, so RJ = TJ – DJ. So, RJ can be 0.18UI<RJ<0.35UI depending on measured DJ.
- Let's take a more detailed look at XAUI jitter spec and see if it supports the target 10^{-12} BER.

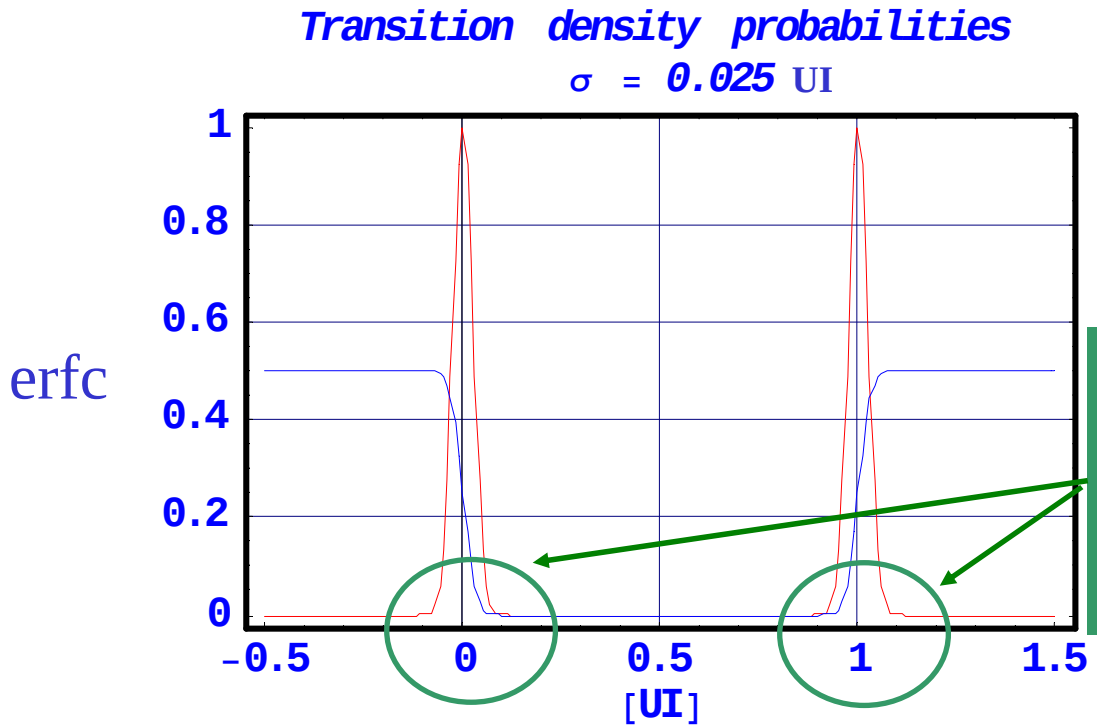
Transition Jitter model





- Random Jitter (RJ) in transmitter output is described by transition densities probability functions. The random process associated with this random jitter is assumed to be Gaussian. Any amount of RJ will produce, with a finite probability, a transition in the middle of the bit interval which, in turn, will cause an error.

Transition Jitter PDF and Erfc

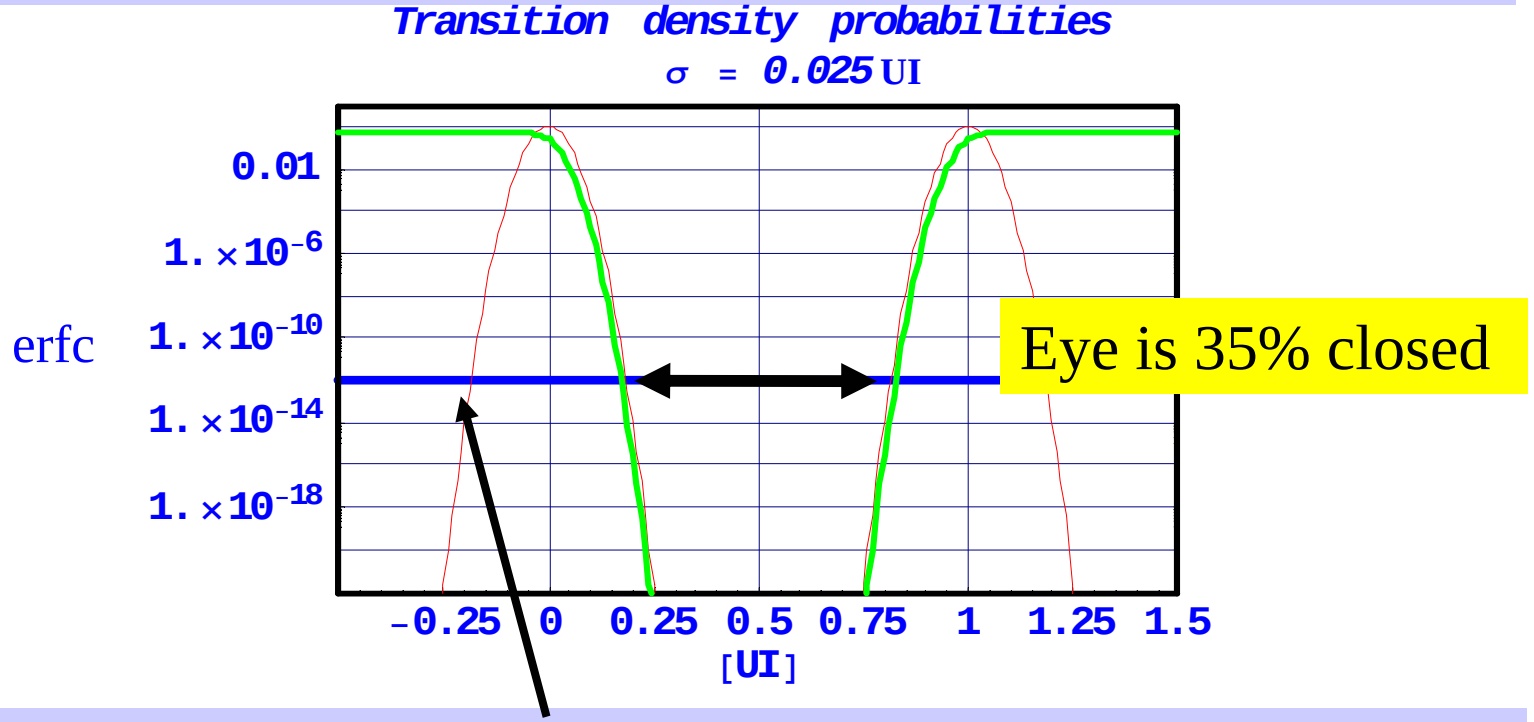


Expand this area on next slide to see BER rates close to the 10^{-12} XAUI target error rate.

- The complementary error function (Erfc) is used to characterize the probability that a Gaussian variable exceeds a certain value. In this case the Erfc is used to characterize the probability associated with a certain transmitter eye opening.

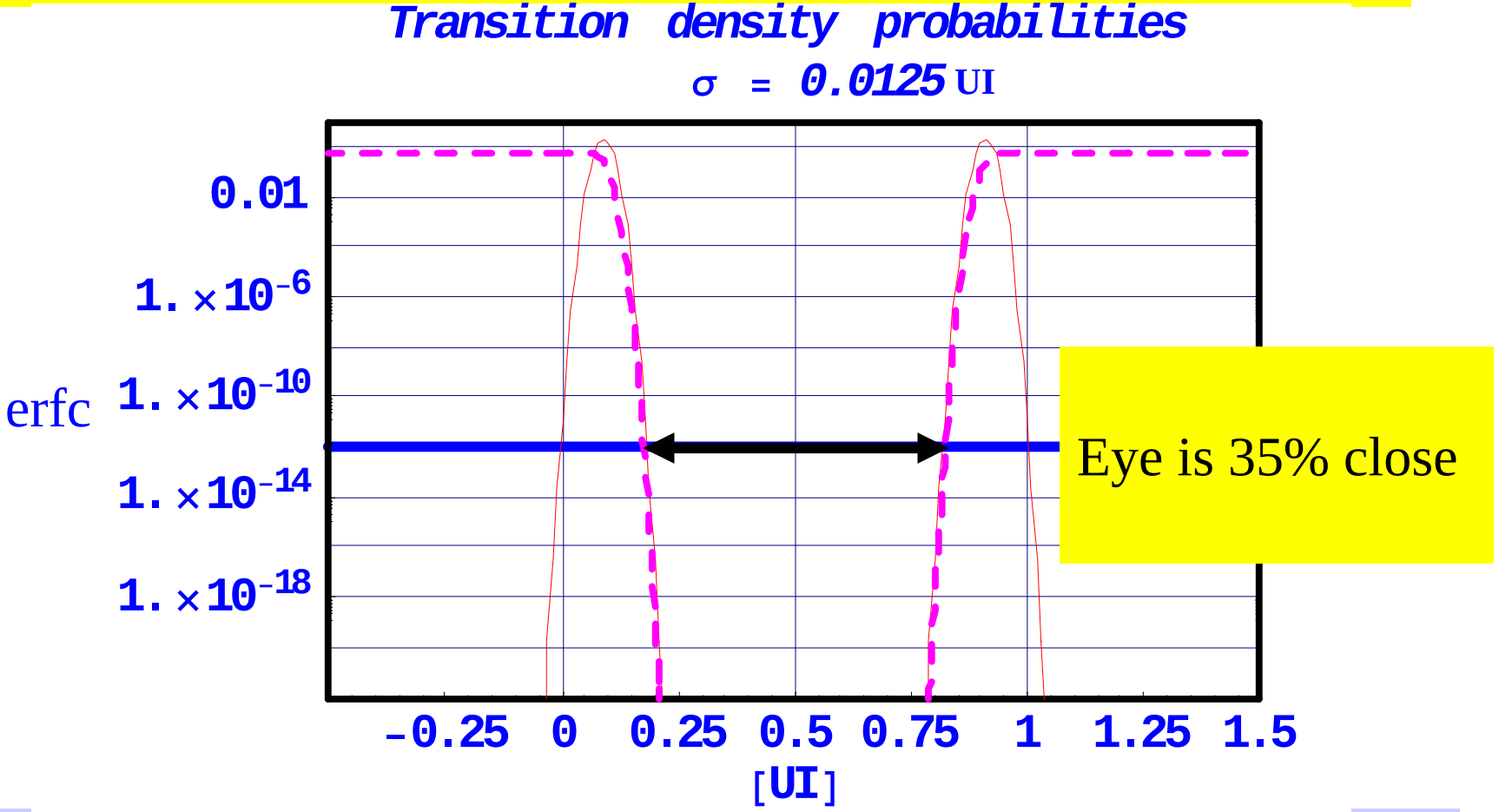
Erfc Expanded: RJ only

- For probability values comparable to the target error rate, a log scale is preferable.



For target BER of 10E-12, a sigma of 0.025UI will produce an eye closure of 0.35UI.

Erfc Expanded: RJ + DJ



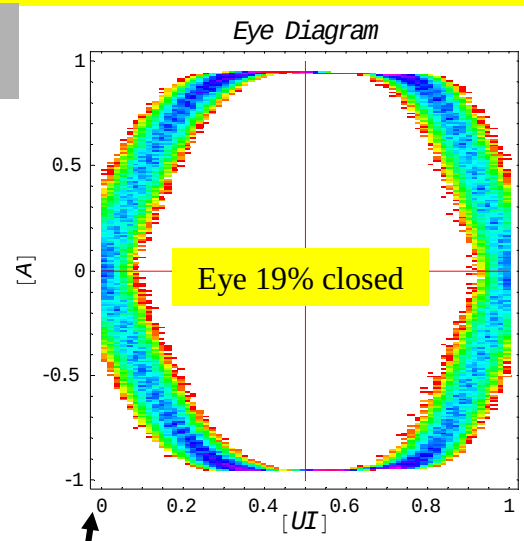
- If DJ=0.17UI added, then to keep the same target BER=10E-12, the RJ sigma has to be halved.

Eye Diagrams

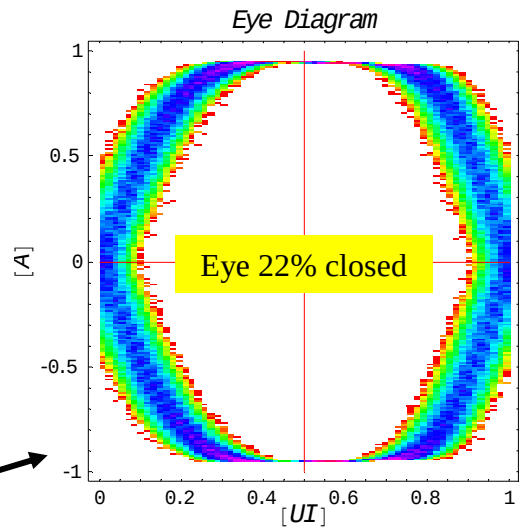
- Have shown that probability of meeting target BER of 10^{-12} is same for the two XAUI cases of: (1) RJ=0.35UI + DJ=0, (2) RJ=0.18UI + DJ=0.17UI.
- Now let's do some eye diagram simulations to validate the statistics for both cases developed. See next two slides

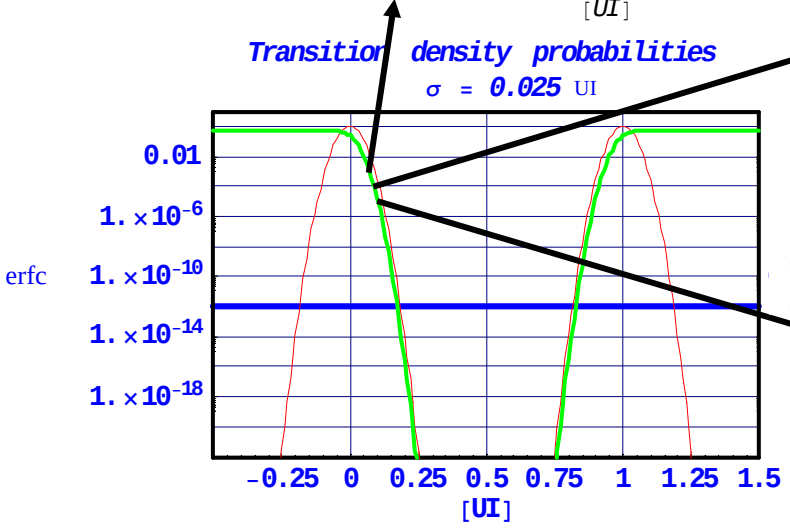
Eye diagrams: RJ only

100 Kbit

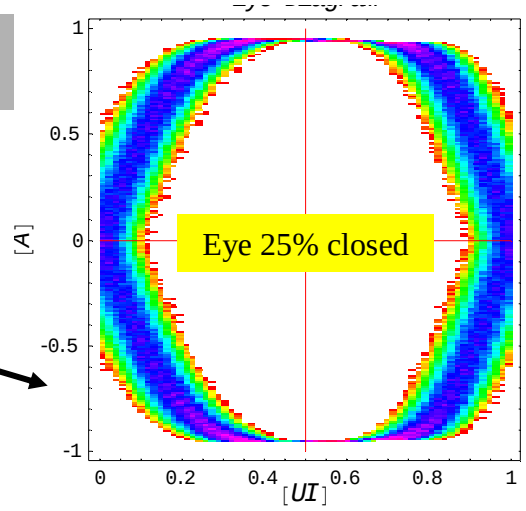


1 Mbit



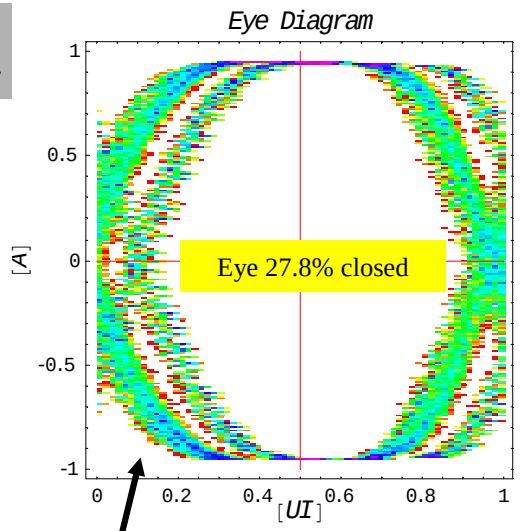


10 Mbit

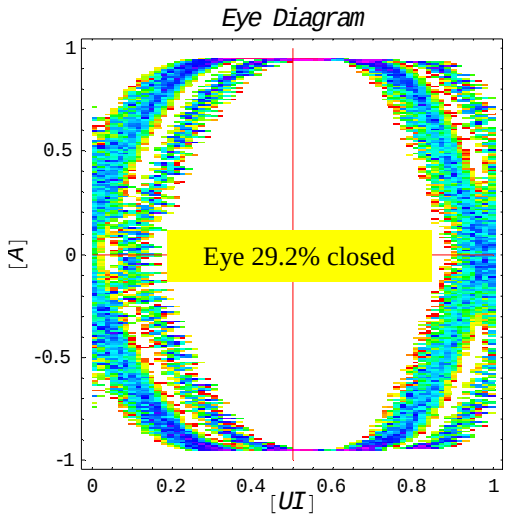


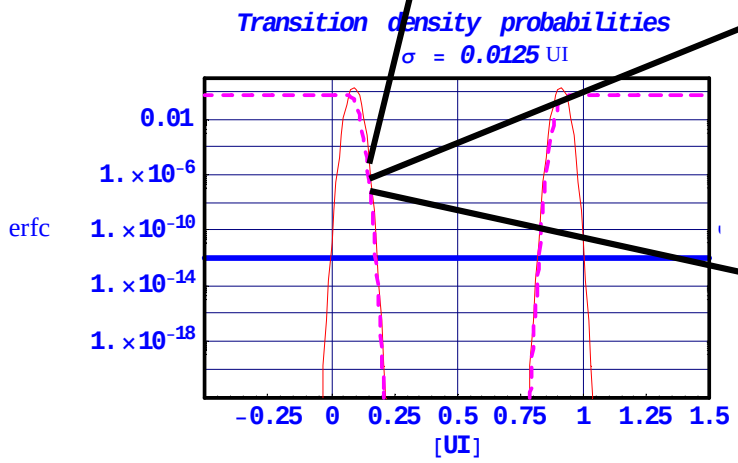
Eye diagrams: : DJ + RJ

100 Kbit

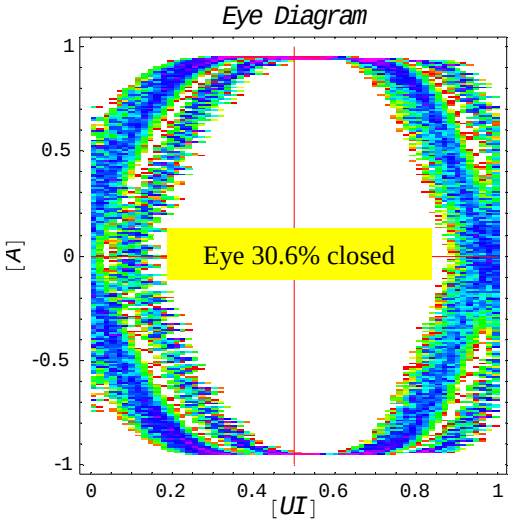


1 Mbit





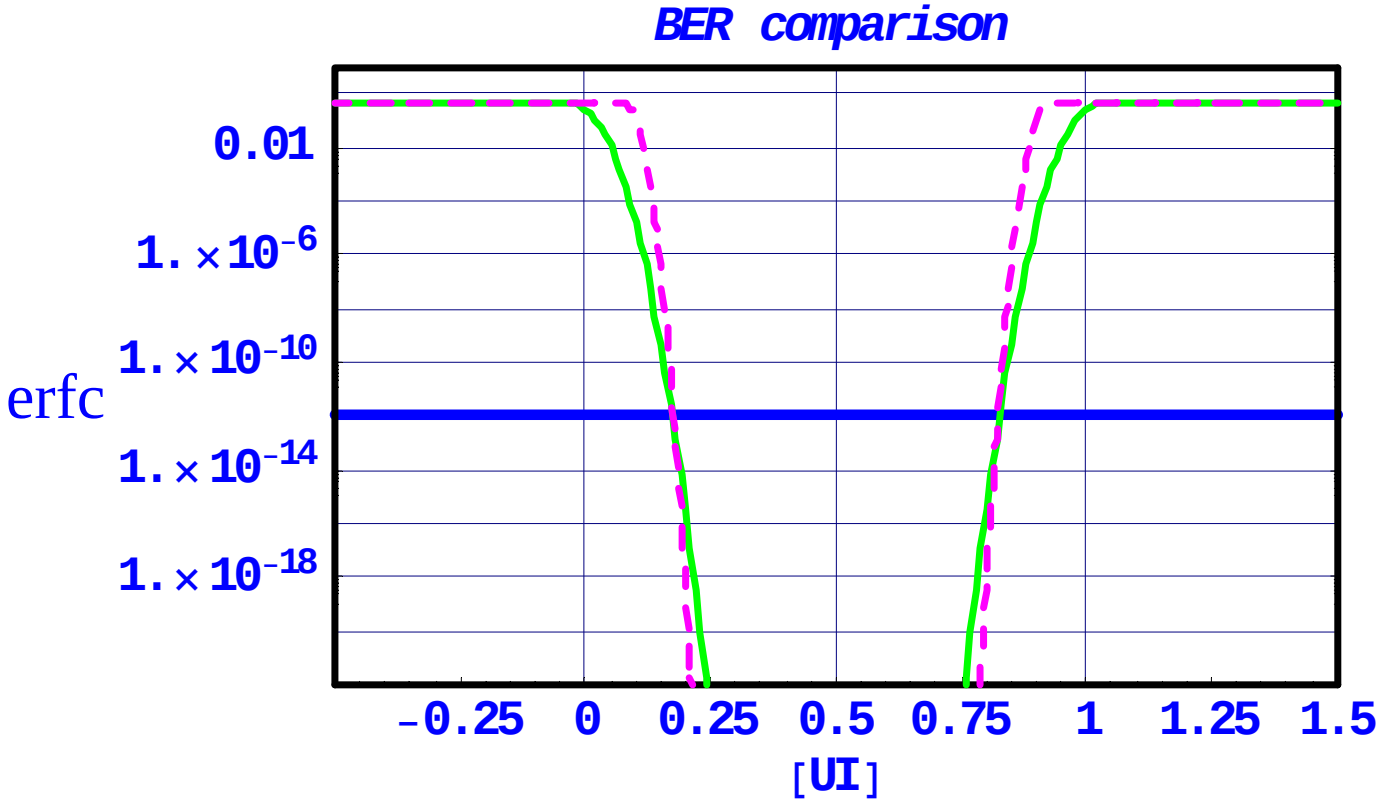
10 Mbit



Eye diagram ***do*** validate Erfc plots

- Eye diagrams match Erfc plots for both RJ/DJ cases at 3 different BER points.
- Erfc plot can be used to accurately predict eye closure due to jitter given a target BER.

Erfc plots comparison:
RJ vs DJ+RJ



- The two curves indicate that the transmitter eye has the same statistics at BER=10^{-12} for both cases of RJ only and RJ+DJ.

Conclusions

- XAUI standard specifies the maximum amount of deterministic jitter (DJ) and the total jitter (TJ). So by default, RJ is difference of the two (RJ =TJ – DJ).
- Different combinations of DJ and RJ can yield same TJ with identical statistics (and therefore support target BER).
- Have shown that probability of meeting target BER is identical for the two cases: (1) RJ=0.35UI, (2) RJ=0.18UI + DJ=0.17UI.
- XAUI methodology for specifying transmitter jitter is valid and equally applicable to CX4 and should be maintained for CX4.