C2M eye width

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Introduction

- C2M, nPPI, SFI, XAUI and such specs have eye masks that protect the receiver from a signal that's closed up, either vertically or horizontally
- Including 120E (50 Gb/s/lane PAM4)
  - VEC and ESMW (eye symmetry mask width) = 6-sided mask
- But not this draft (also PAM4)
- healey_3ck_01a_1020 and D1.3 comment 41 proposed a +/- 50 mUI histogram window, equivalent to a 0.1 UI wide × 10^(VEC/20) high rectangular mask
- This draft with "Gaussian weighting" is equivalent to a 0.07 UI wide mask
- 0.07 UI leaves too little for channel and receiver impairments including jitter
  - Comments I-107, I-108, I-115, I-116, I-211, I-212, R1-55

From healey_3ck_01a_1020

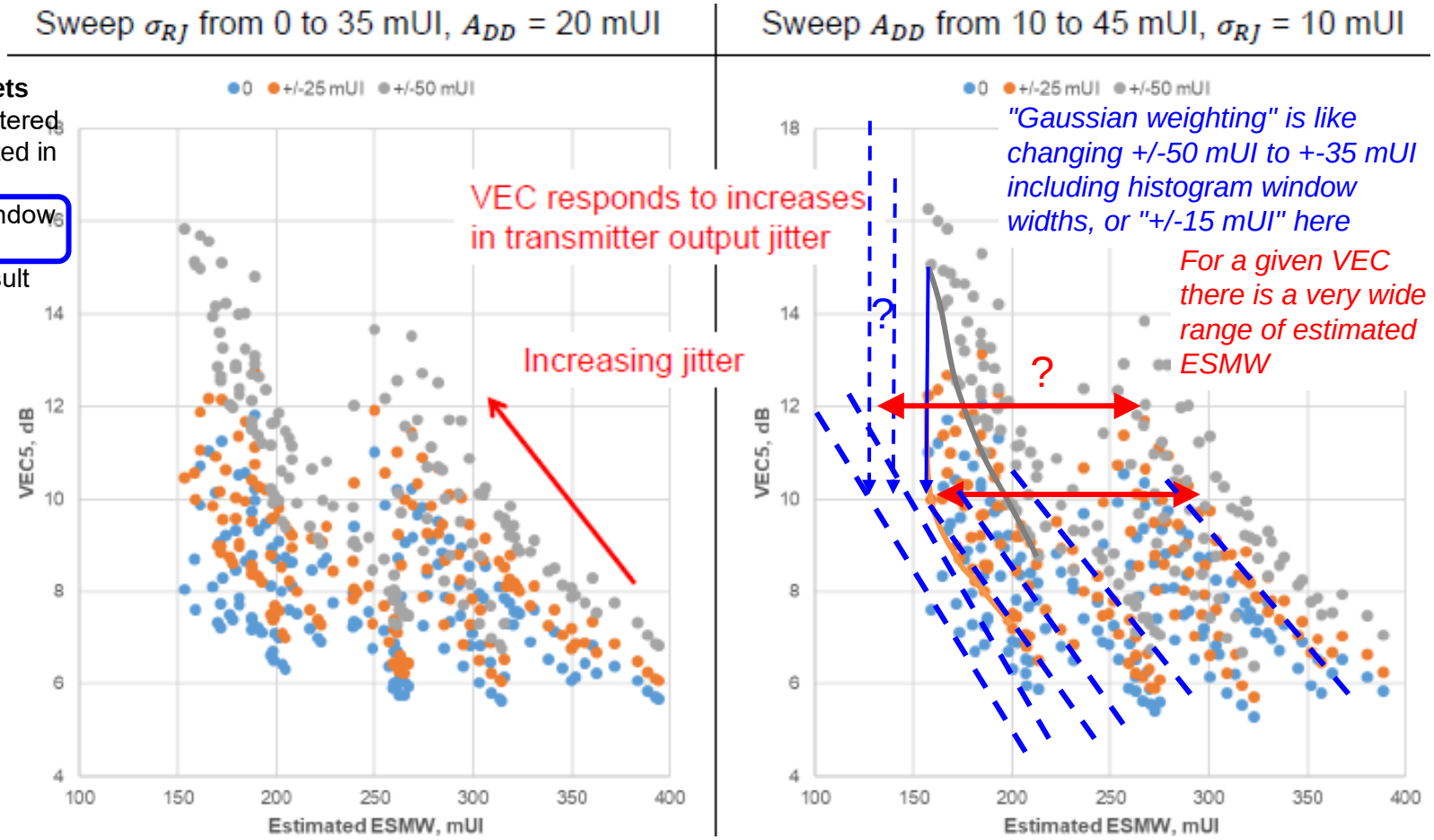
Comparison of the options

Desirable property	EH and VEC (in D1.3)	Separate jitter measurement	ESMW	This proposal (2 offsets)
Ensure margin for receiver timing uncertainty	Only considers nominal phase	Does not include DDJ		
Applicable to the reference receiver output		Must account for "effect of DFE"		
Applicable to the same transmitter and receiver setting used to compute EH and VEC		Must account for "effect of DFE"		
Discriminates against transmitters with high jitter	Some EH, VEC penalty			
Discriminates against horizontal asymmetry in the reference receiver output	No trend with ESMW			
Easily included in reference receiver optimization metric			Find setting that meets all criteria	Minimize VEC (and check EH)
Allows more flexible definition of the "effect of the DFE"		Need to consider transition regions	Need to consider transition regions	

IEEE P802.3ck Task Force, October 2020 (r1) 7

From healey_3ck_01a_1020

Measure at time offsets
- 2 measurements centered at time offsets indicated in the legend
- 40 mUI histogram window except for offset 0
- Choose the worst result



Dots appear in rows, which seem to be channel/package/driver sets

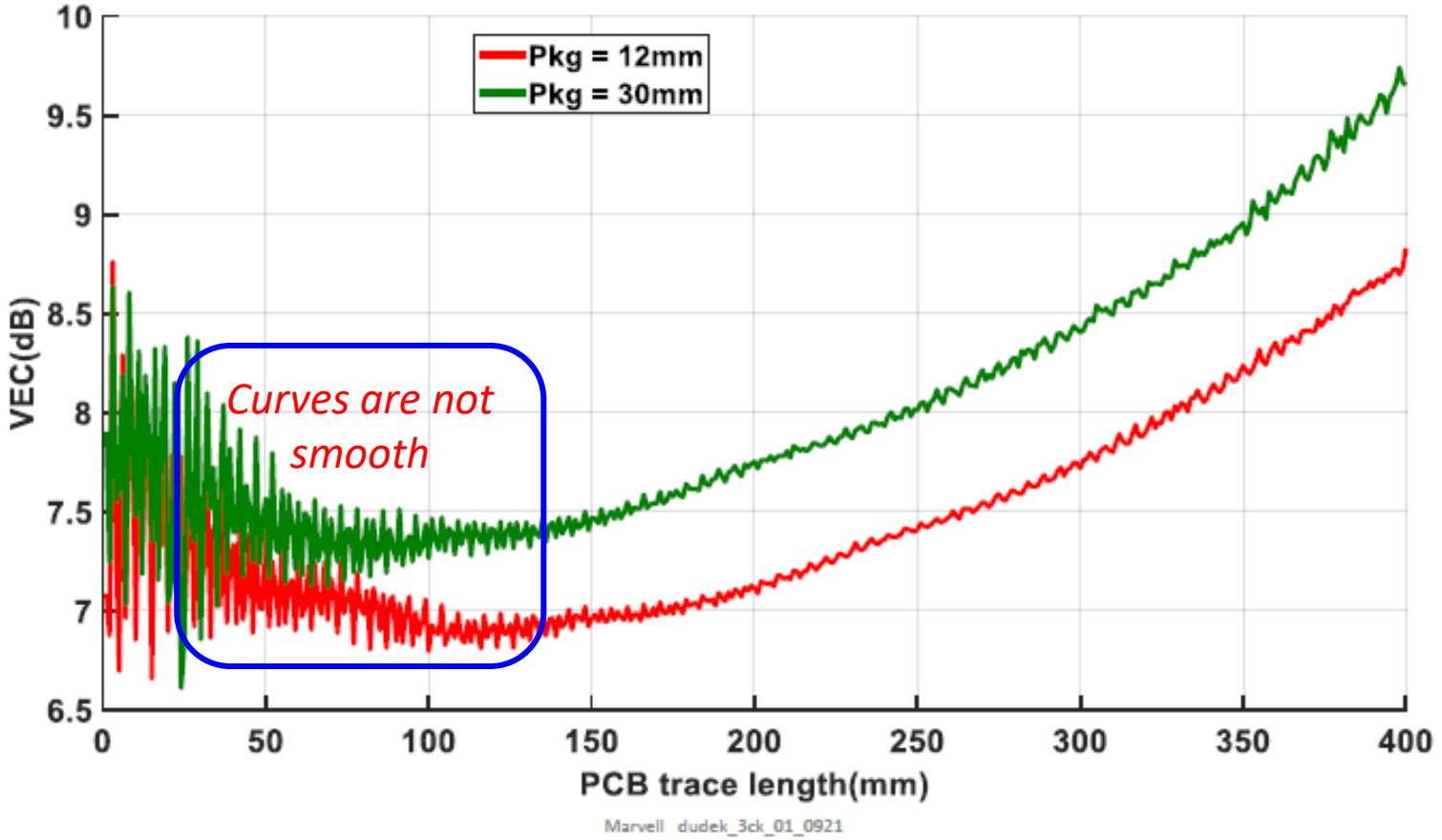
High loss on right (relatively high ESMW), low loss on left (relatively low ESMW)

As none of these is controlled by spec, what excludes other sets further to the left?

Faster package and driver are possible, have not been not explored? With a short channel, they will be to the left

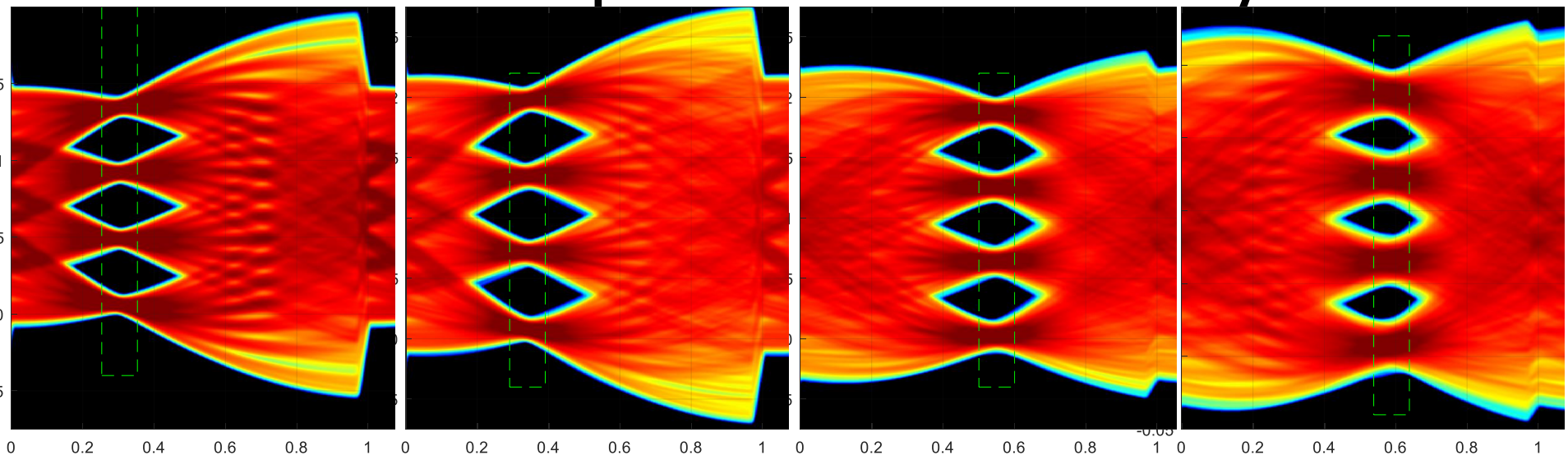
Short channels were shown to be an issue (see next slide)

From dudek_3ck_01_0921.pdf



- This shows that small changes in reflection phase make big changes in VEC
- Eye width also changes, but not necessarily in proportion

VEC doesn't predict ESMW very well



1: typical mid-loss host

2: one low-loss host

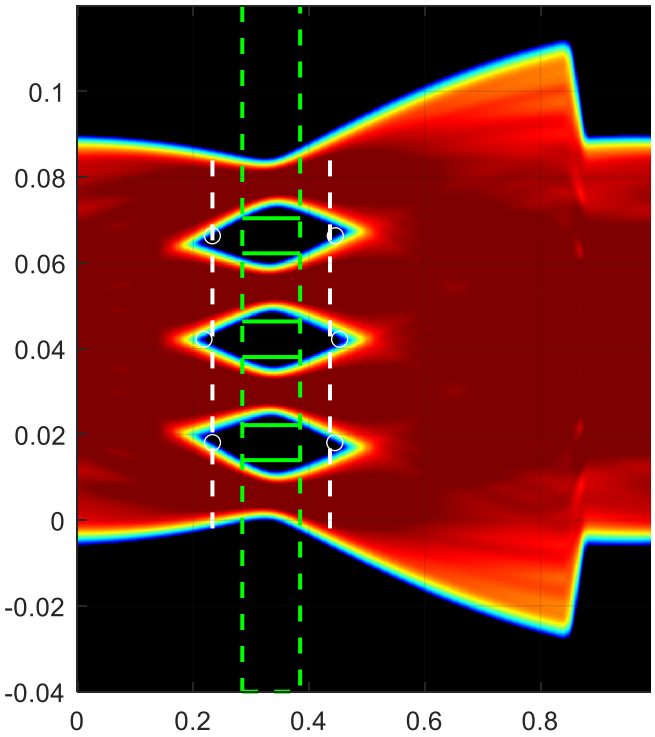
3: another low-loss host

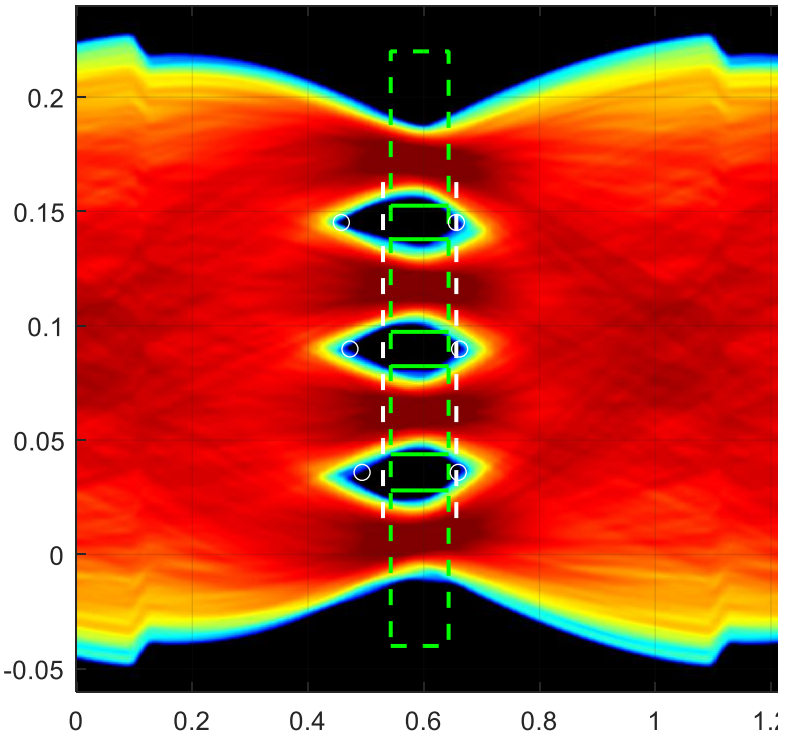
4: yet another

- Eyes at TP1a are simulated with little noise and clutter for clarity, no module reflections. 31 mm COM package, 53.125 GBd. For each signal, VEC and width would be vary in proportion depends on edge rate of that signal
- Steepest edges are late sides of eyes in right signals. For the same de-weighted VEC, this signal has worse ESMW
- Eye sides can be curved, further reducing ESMW
- Module output can do this too if not forbidden. Worse signals can exist (e.g. short package, worse reflections...)

New slide

Adding dimensions...





- Left: high loss host — Right: low-loss host as slide 7

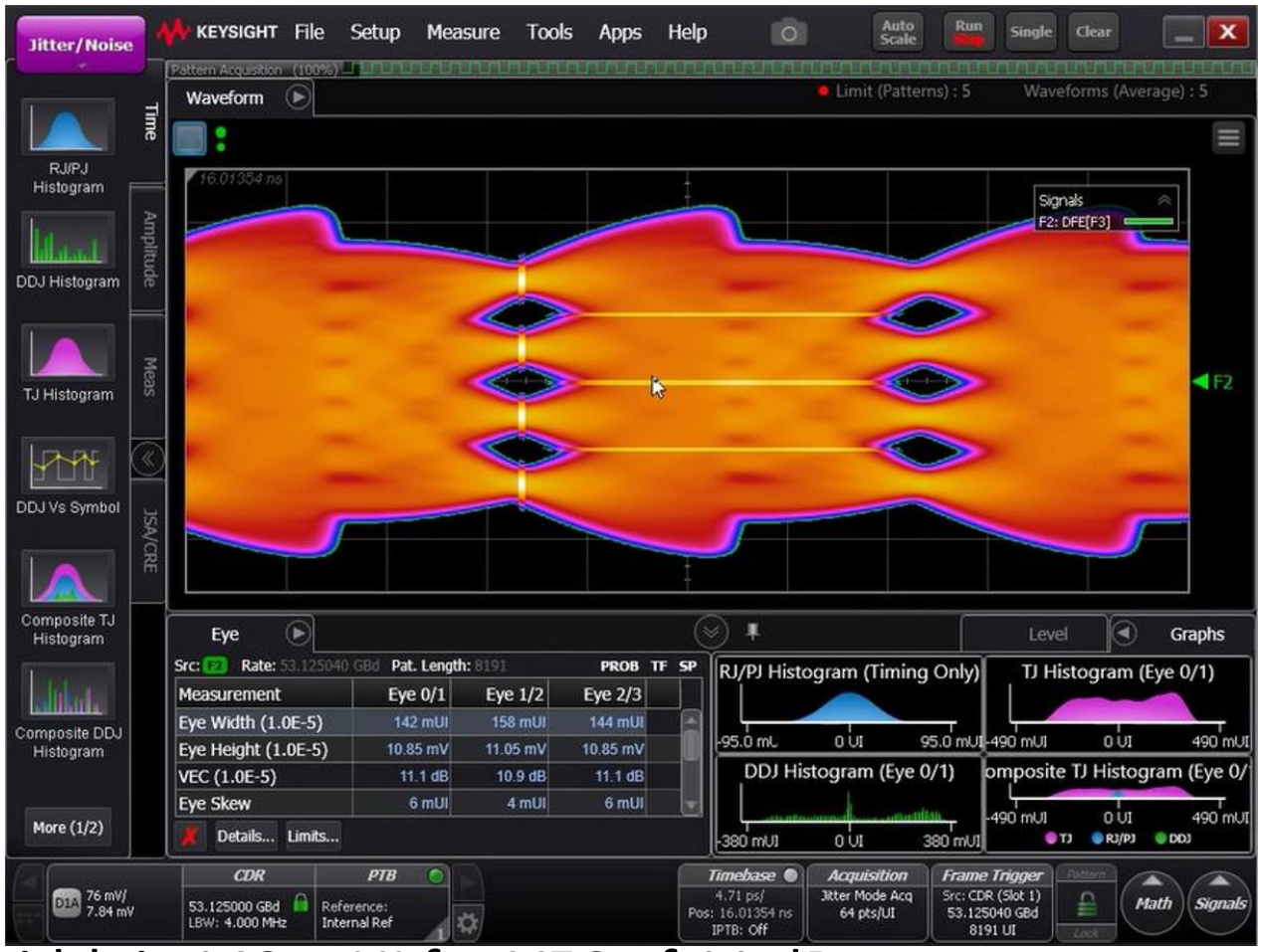
VEC	9.6	11.4	dB
ESMW	0.203	0.127	UI
ESMW scaled to 12 dB VEC	0.154	0.119	UI

- 30% difference – and there is more variety than this, as on slide 5

Can we predict the eye with COM?

- COM looks for the worst crosstalk phase and applies it at the sampling time
  - This predicts the best possible eye width for any VEC
- COM makes other simplifications such as not using the exact pattern, nonlinearity doesn't affect eye shape, jitter is linearised...
- Close, but can be optimistic for eye width
- Previous slide is from simulation, not COM

Measured "TP1a" signal from pattern generator, loss board and test fixtures



- Eye width is 142 mUI for VEC of 11 dB
  - Implies 127 mUI at 12 dB if eyes are diamonds, slightly more if curved
  - This is less than any of the COM predictions, and this "host" has good reflections and crosstalk; a barely compliant one could be worse

Action needed

- Eye opening can be enforced by:
  1. +/-50 mUI histogram without weighting = 0.1 UI wide rectangular mask
  2. 10-sided mask as proposed previously
  3. ESMW spec as in 120E
- Option 3 is less satisfactory but familiar and already provided in oscilloscopes
- Proposed limits:

	R2-19	R2-17	Unit
Host output / module input (TP1a)	135	120	mUI
Module output / host input (TP4)	185	130	mUI

Remarks

- ESMW (eye symmetry mask width) is twice the smaller of the distances from the reference time to each 1e-5 point on a horizontal histogram (cumulative probability distribution)
- In this clause, the reference time is t_s
  - in 120E it's TCmid
- ESMW definition assumes that DFE feedback signal is a voltage that steps abruptly at t_s+0.5 UI and is flat between steps
  - We rely on this assumption already to find VEC
- Don't tune stressed input signal for ESMW
  - But stressed signal must pass this spec, as for all its properties. This is expected to happen naturally, as the stressed signal does not have worst reflections and crosstalk