C2M spec consistency and tolerancing

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Topic, questions and answers

- Topic: C2M module output (200GAUI-4 and 400GAUI-8)
- Five requirements to the eye: Table 120E-3

Parameter	Value	Unit
Near-end eye height	70	mV
Near-end eye width (ESMW)	0.265	UI
Far-end eye height	30	mV
Far-end eye width (ESMW)	0.200	UI
Far-end pre-cursor ratio	2.5	%

- Question 1: *Can all five be fulfilled at the same time?*
- Answer 1: *Probably; but the five optima do not appear at the same module Tx-emphasis setting*
- Question 2: *Does the auxiliary far-end pre-cursor ratio requirement restrict module tuning?*
- Answer 2: *Current pre-cursor ratio requirements seems to force module Tx-emphasis to be set away from the most reliable (optimal) with respect to eye width and height*

Results Summary and Change Proposal

- In one example channel:
  - High jitter case: pre-cursor ratio and far-end eye optima (width and height) differ
  - High noise case: better alignment between optima

- Change Proposal
  - **Increase (or offset) precursor ratio limits to e.g. [-2.5%; 5%]**
  - **Relax the near end eye height limit**
    - From 70 mV to 45 mV
  - **Wording change**
    - See last slide

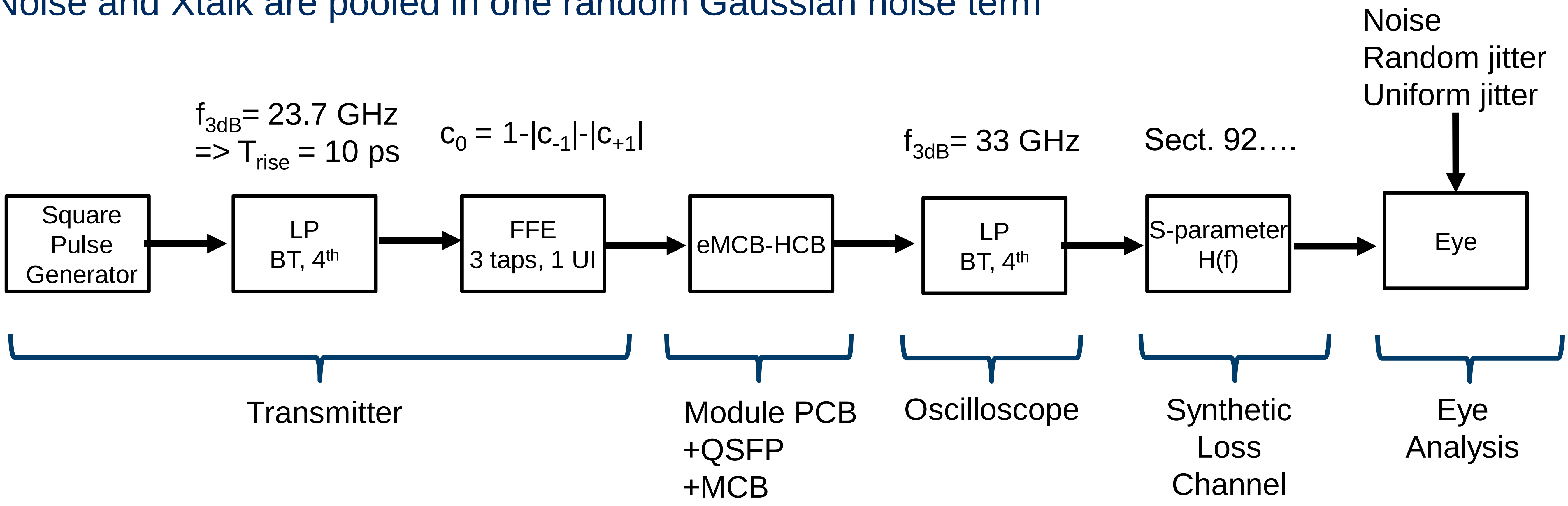
Simulation approach

- A simple illustrative example

A simplified C2M (module electrical output) framework

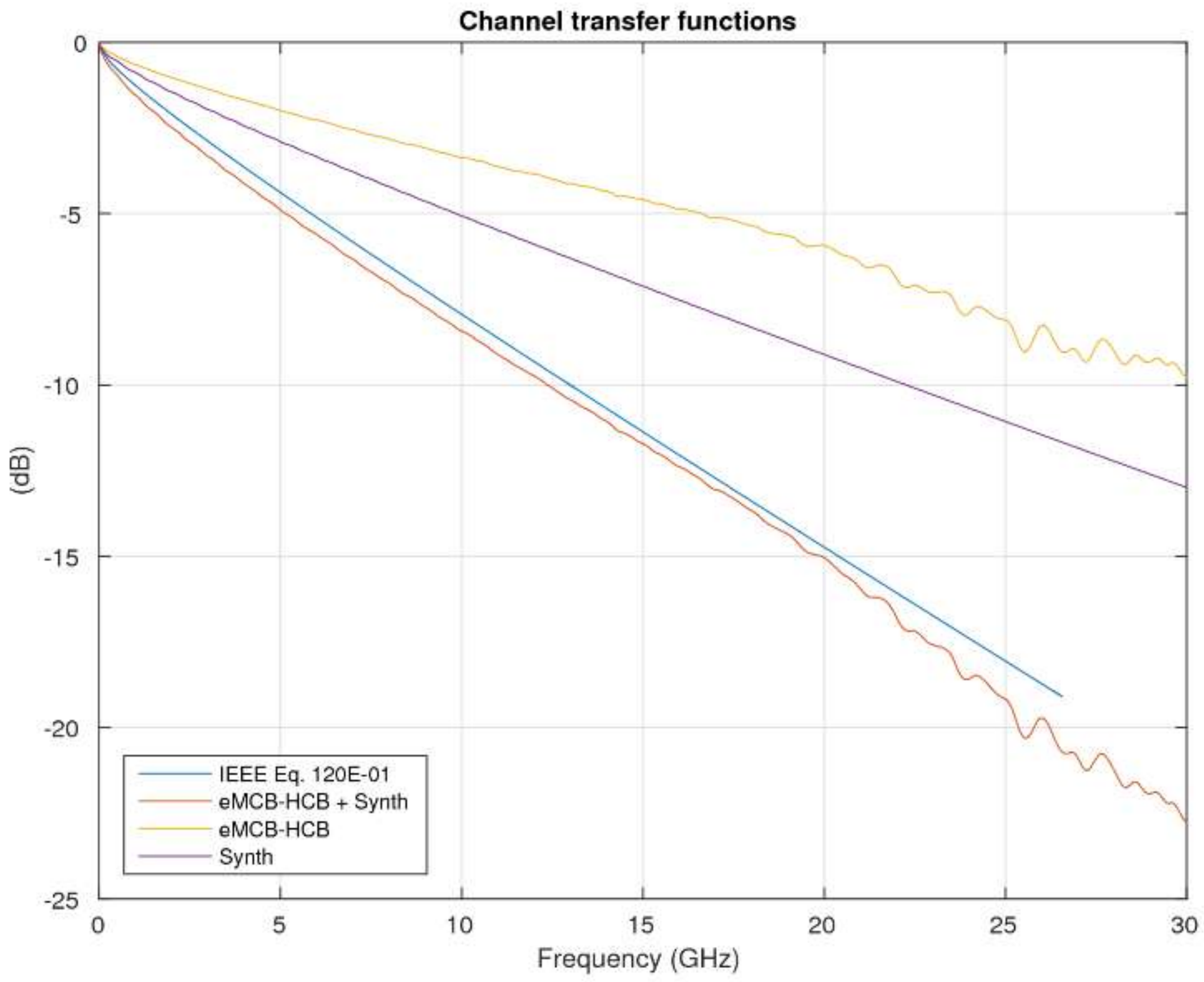
- Receiver noise: Fixed
- Xtalk "noise": Fixed
  - CTLE has fixed gain at Nyquist (802.3(bs), Table 120E-2)
  - FFE has fixed gain at Nyquist ($\Sigma|c_n|$ = constant)

  => (fairly) equalizer independent Xtalk
- Noise and Xtalk are pooled in one random Gaussian noise term



Channel components

- eMCB-HCB - orange
  - example of mated MCB-HCB
  - measured S-parameters
  - used to emulate module PCB + QSFP + MCB
- Synth - purple
  - synthetic transmission line, 151 mm
  - generated
    - using 802.3, Sect. 92.10.7.1.1, Table 92-12
    - assume two uncoupled TLs (i.e. diff. excitation)
    - driven and terminated in 100 Ohm
- Eq. 120E-01 - blue
  - the IEEE mask
  - similar to the MCB-HCB followed by the synthetic loss channel



Examples with different jitter/noise balance

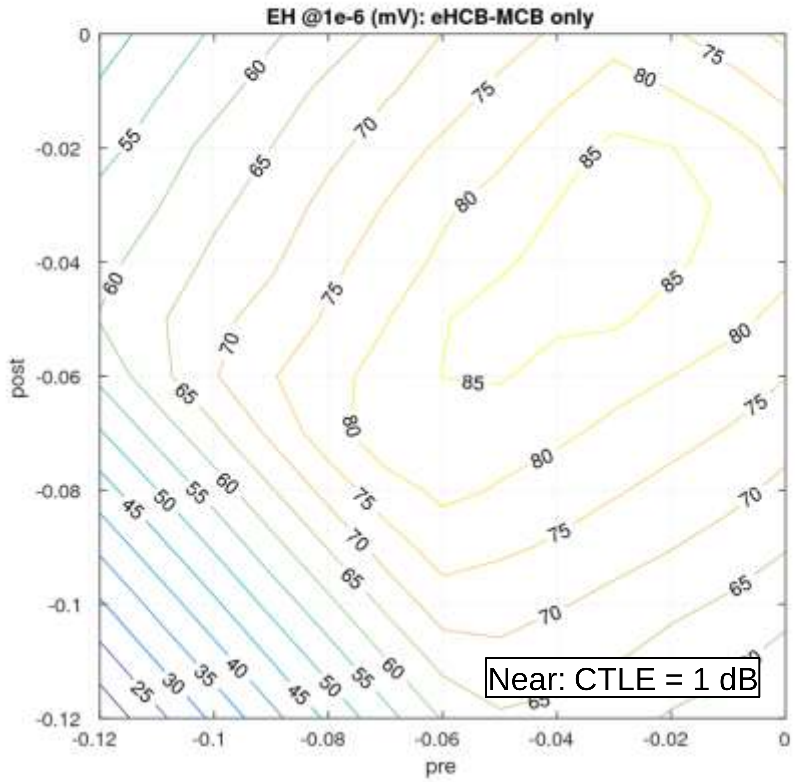
- Large jitter
  - RJ = 0.025 UI (random jitter)
  - uBJ = 0.040 UI (uniform Bounded Jitter)
  - Vrms = 2 mV (Gaussian noise)

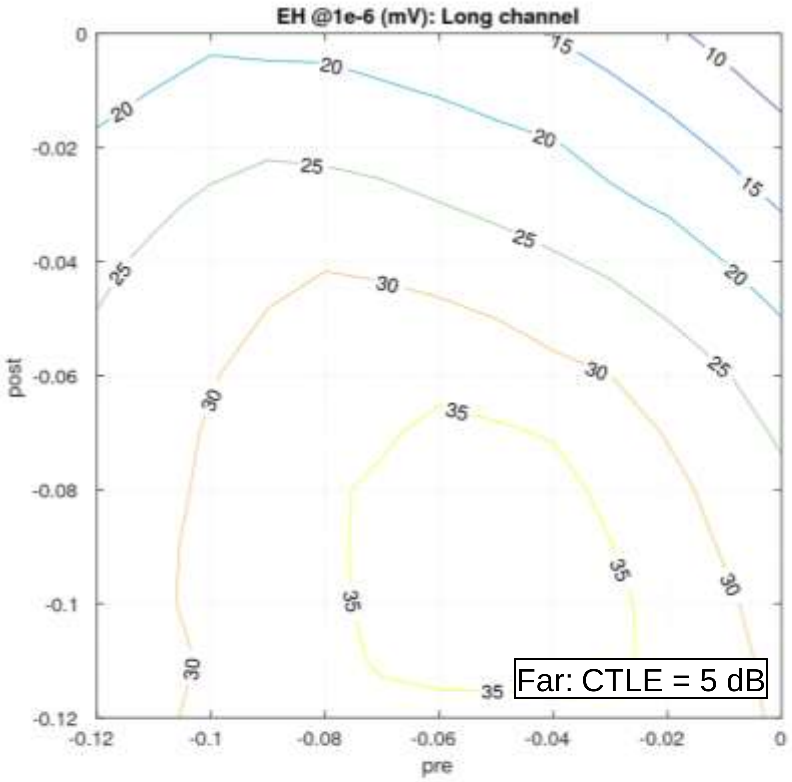
- Large noise
  - RJ = 0.010 UI
  - uBJ = 0.040 UI
  - Vrms = 4 mV

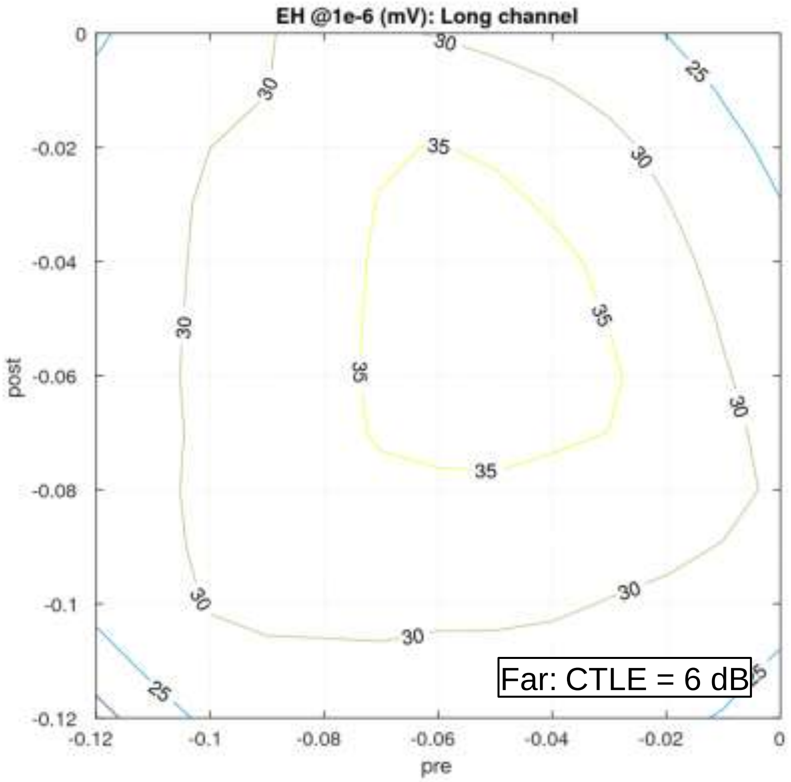
Large jitter results

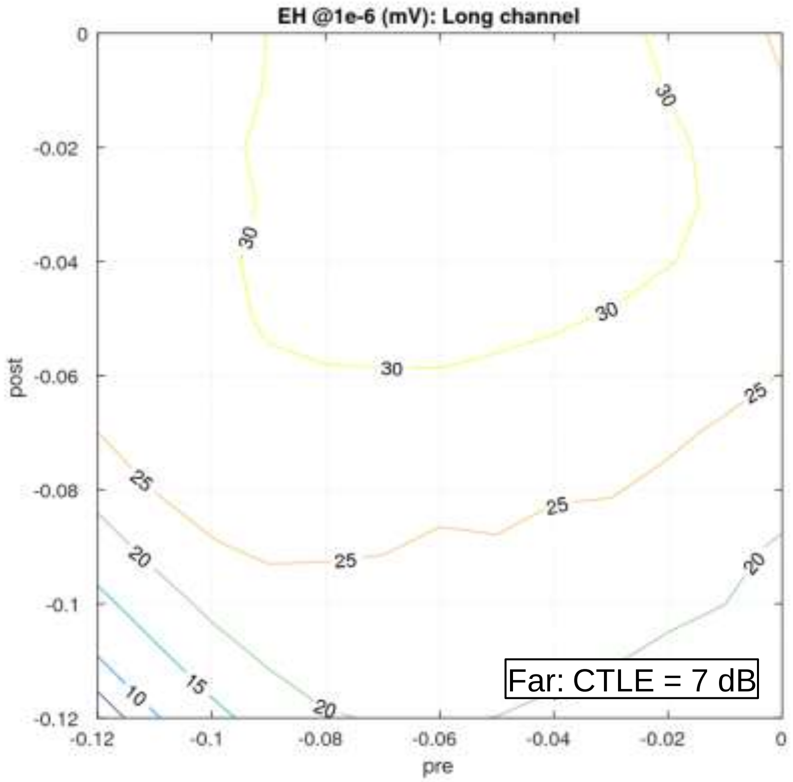
Eye height (large jitter example)

- RJ = 0.025 UI
- uBJ = 0.040 UI
- Vrms = 2 mV



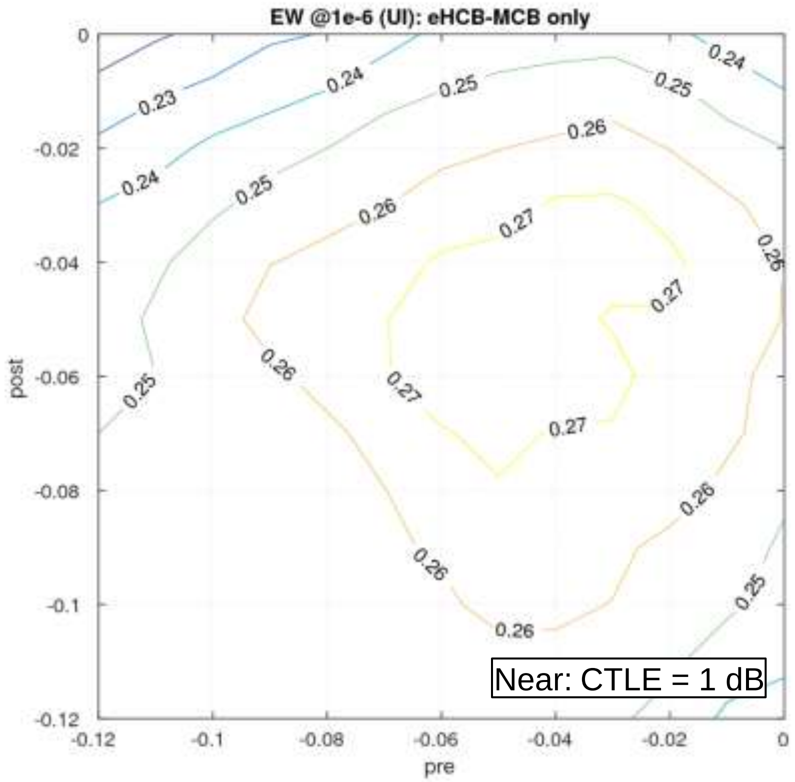


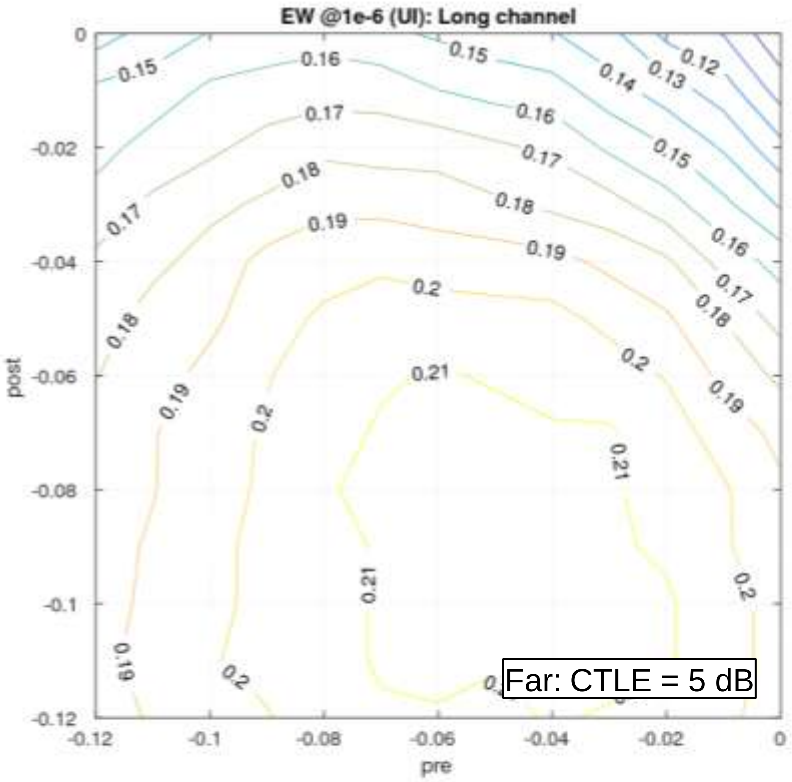


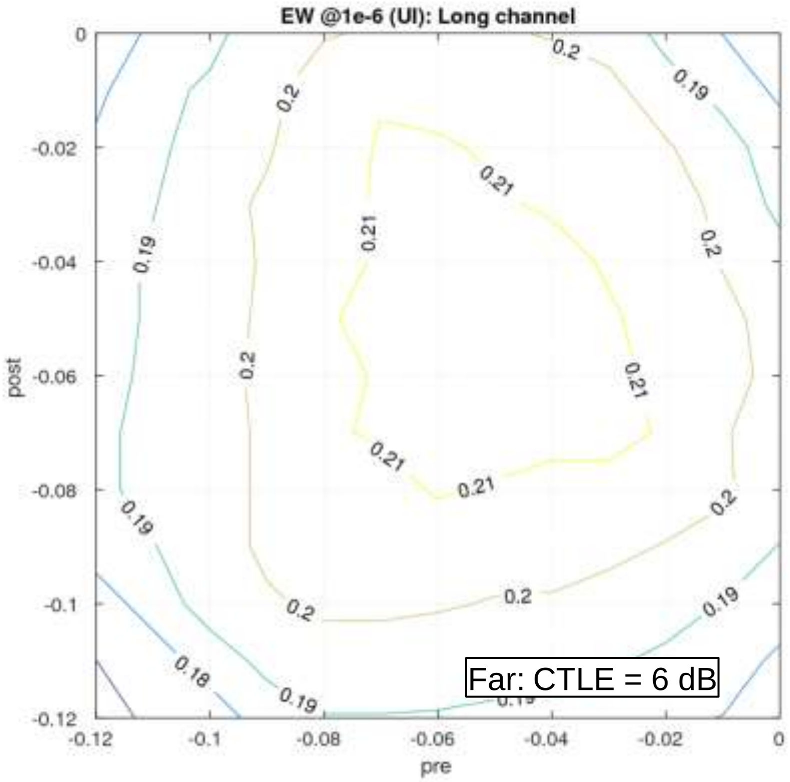


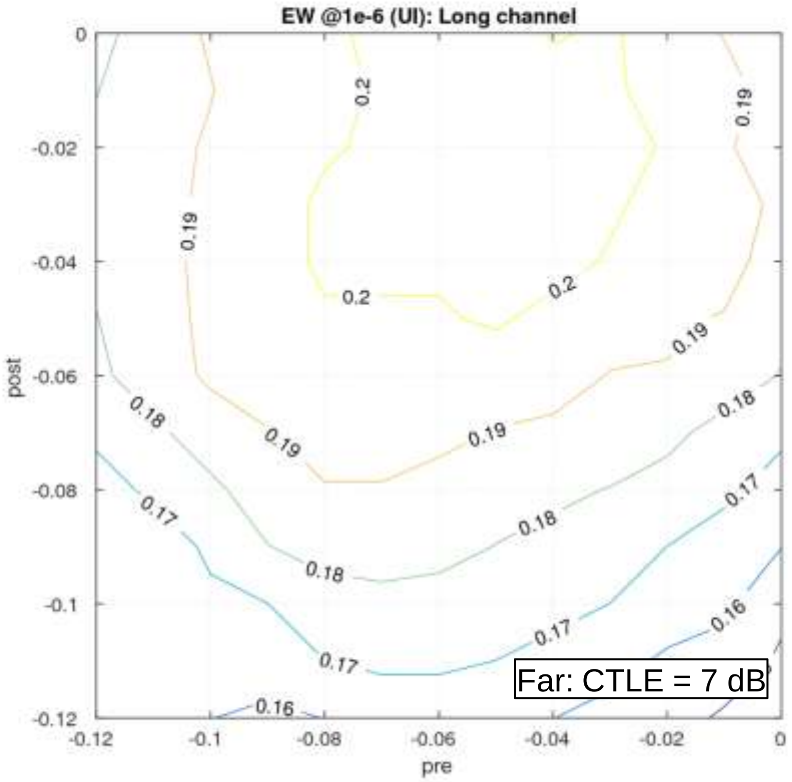
Eye Width (large jitter example)

- RJ = 0.025 UI
- uBJ = 0.040 UI
- Vrms = 2 mV



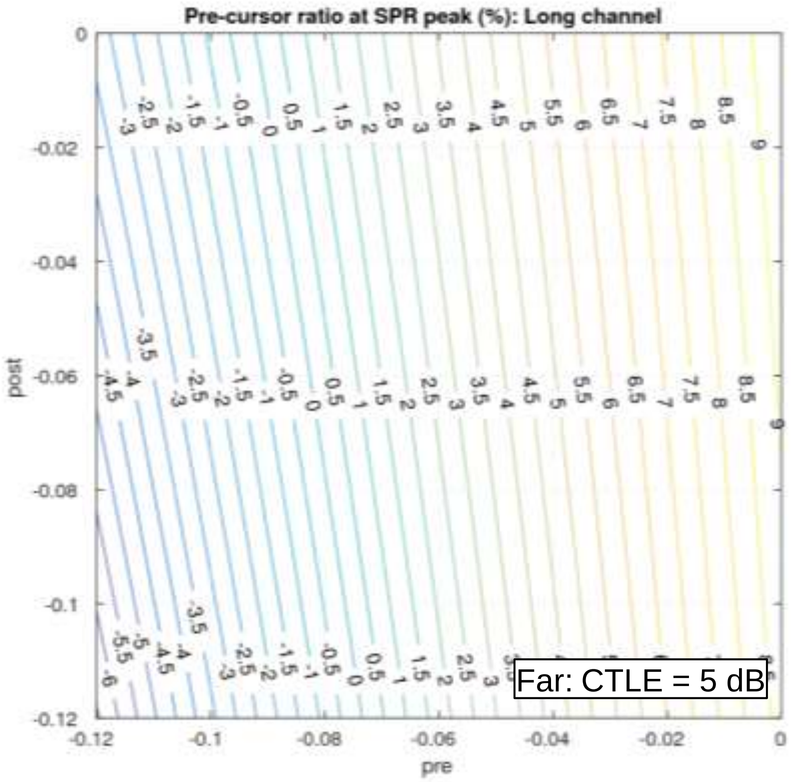


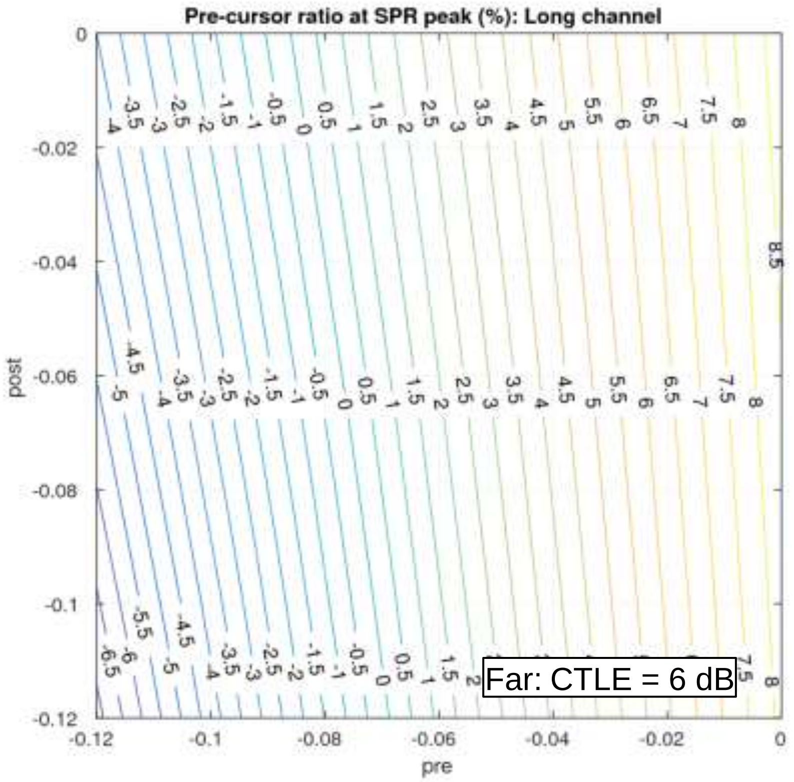


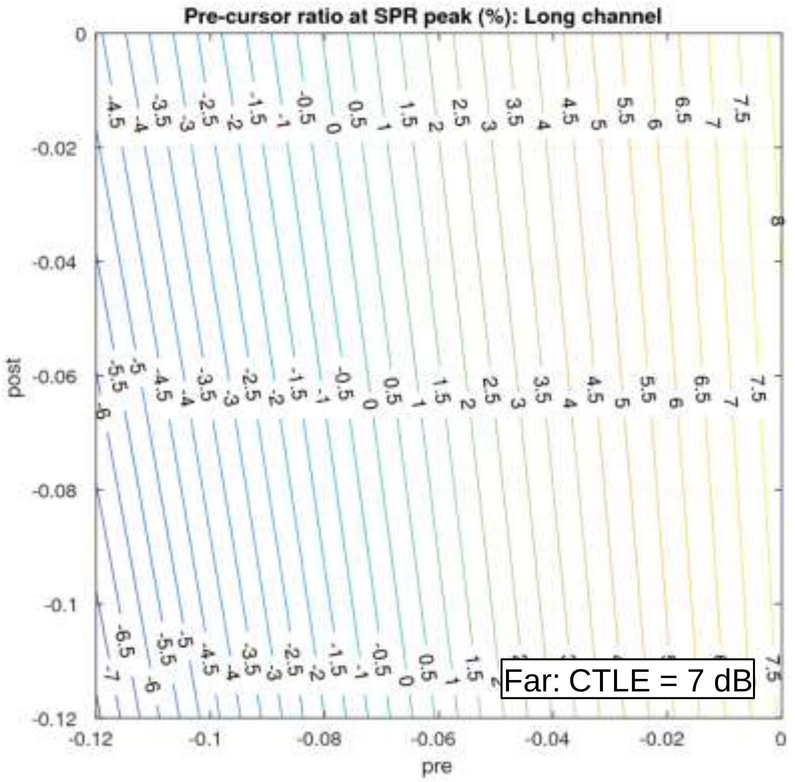


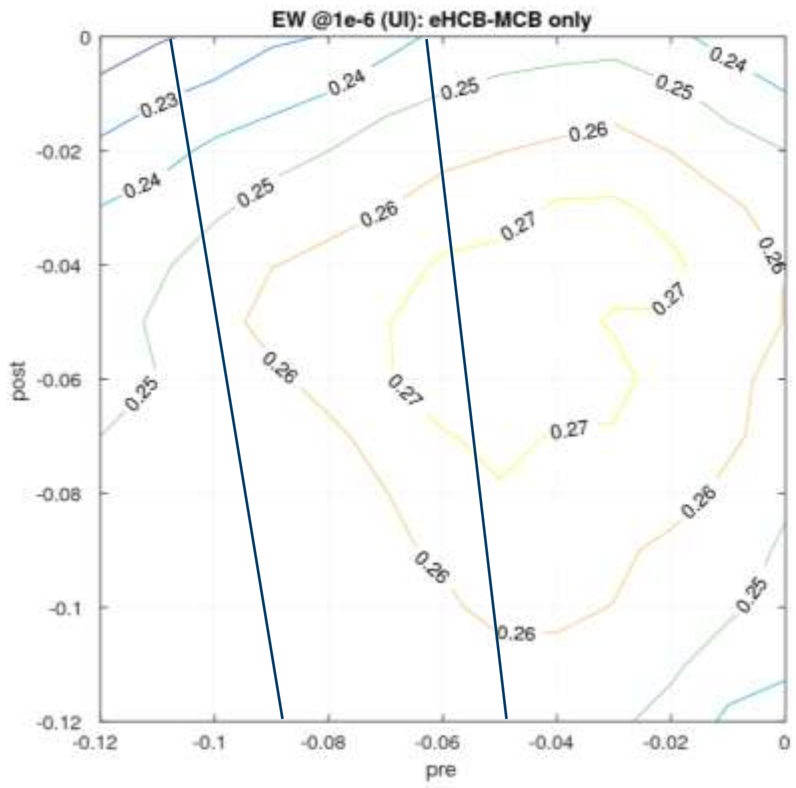
Pre-cursor ratio

- Derived from pulse response
  - Pre cursor 1 UI before the maximum value
- Independent of:
  - noise and Xtalk (Vrms)
  - jitter (here RJ and uBJ)
  - near-end CTLE



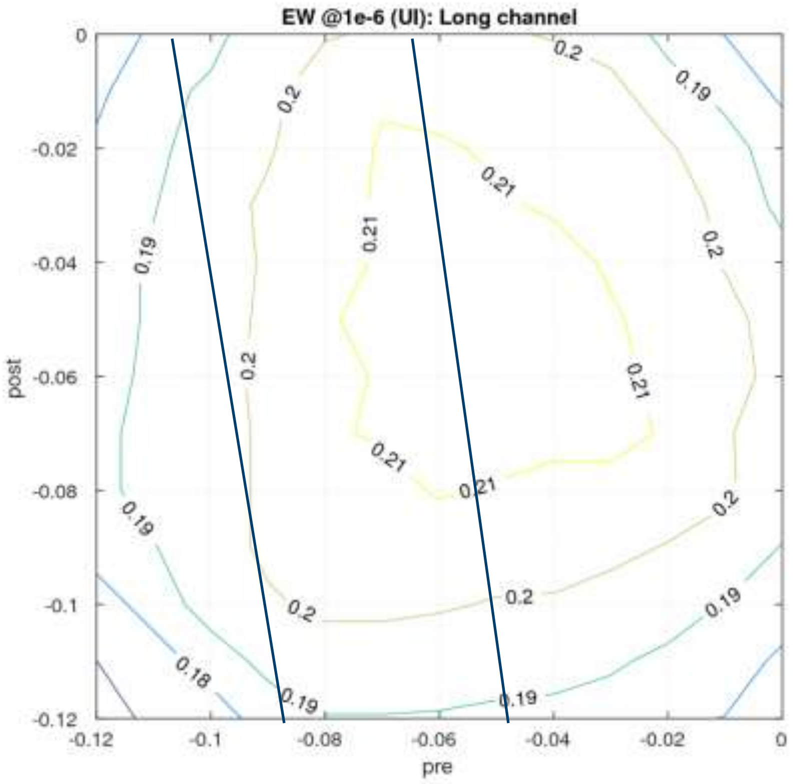


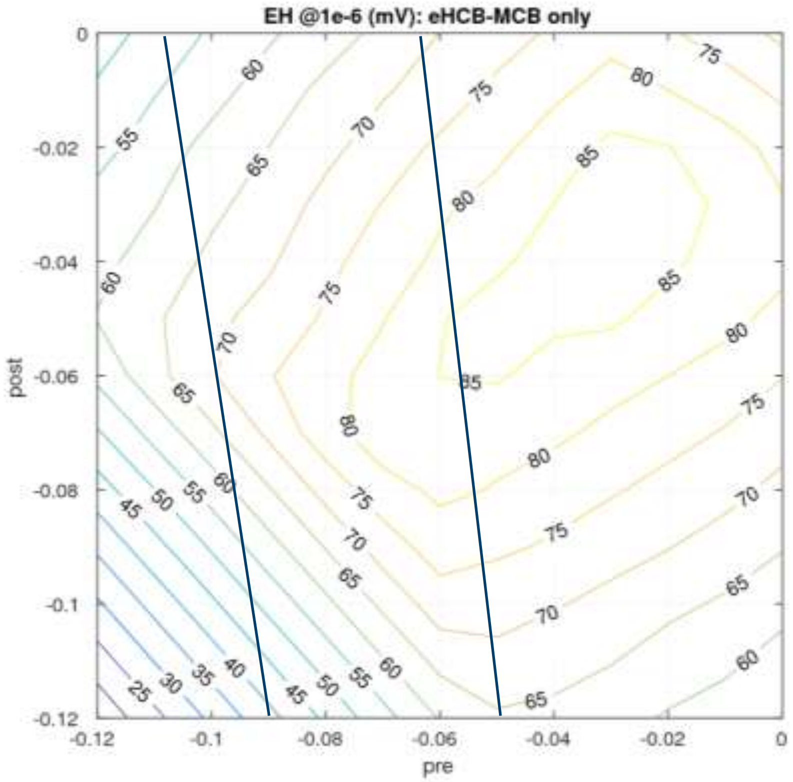


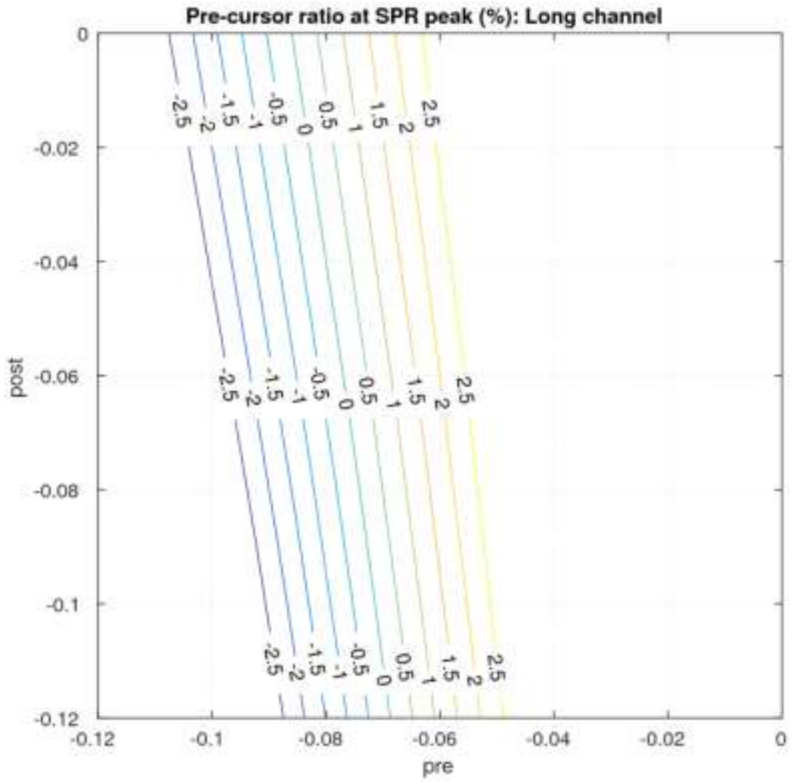


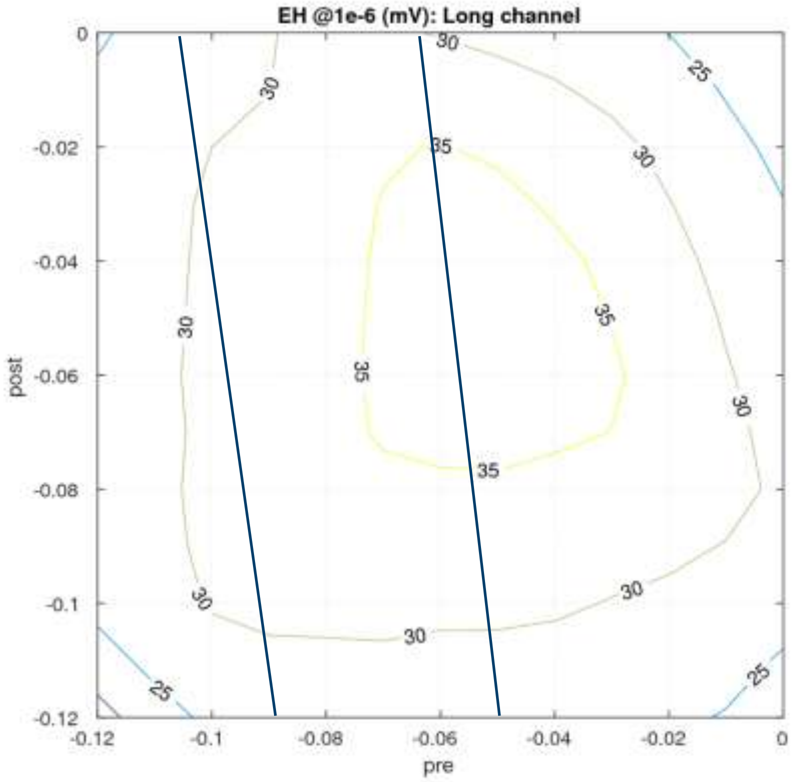
Large jitter example

Random jitter:	0.025 UI
Uniform jitter:	0.040 UI
Noise (rms):	2 mV
CTLE near:	1 dB
CTLE far:	6 dB



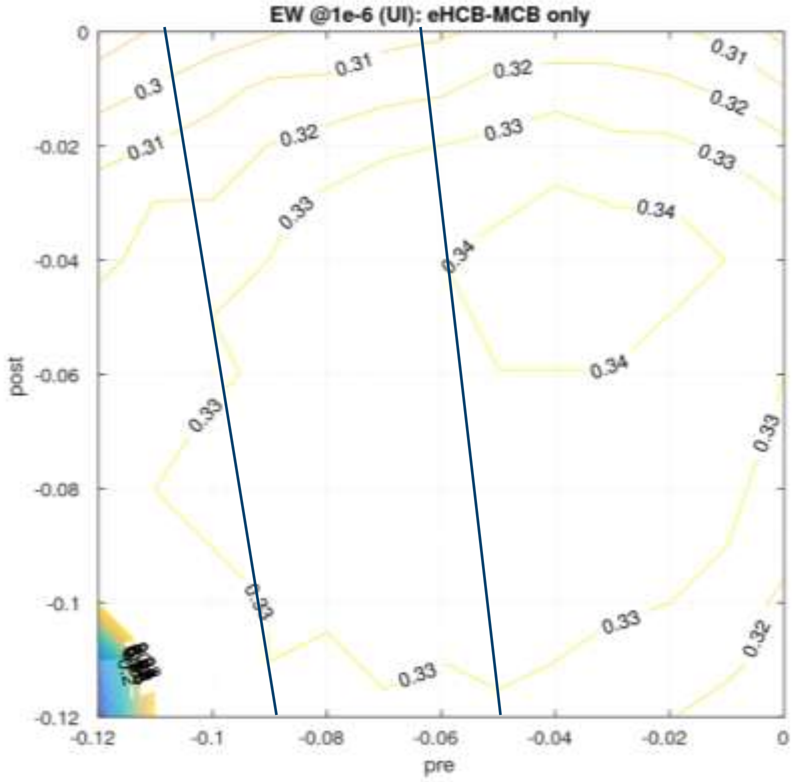






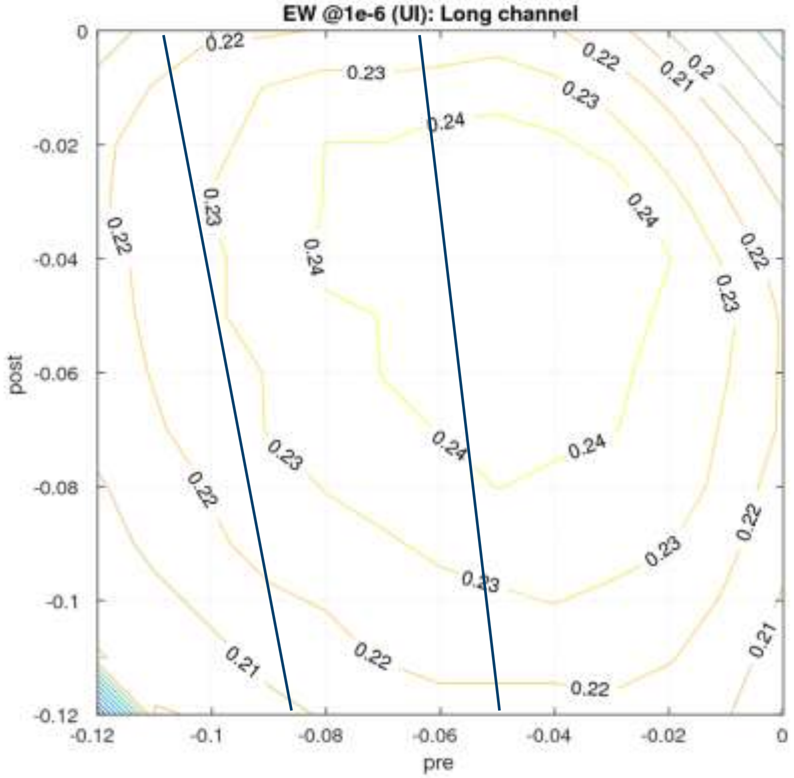
Large noise results

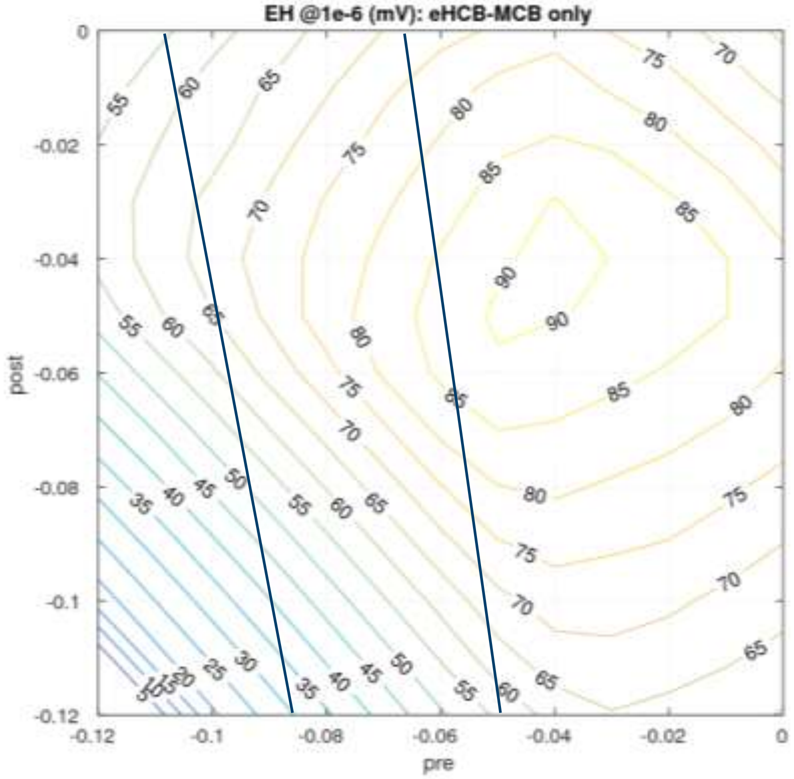
Large noise example

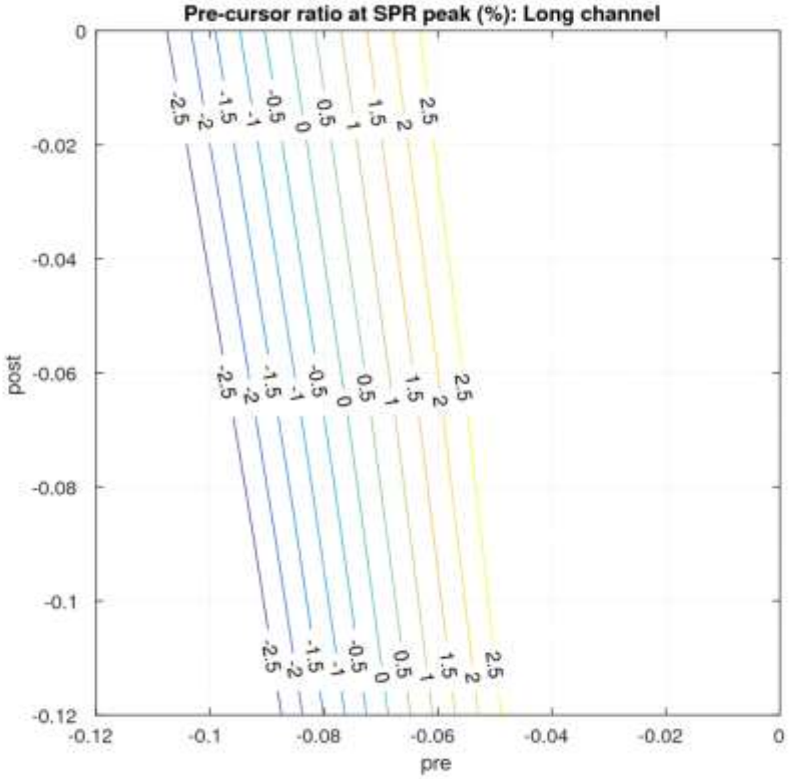


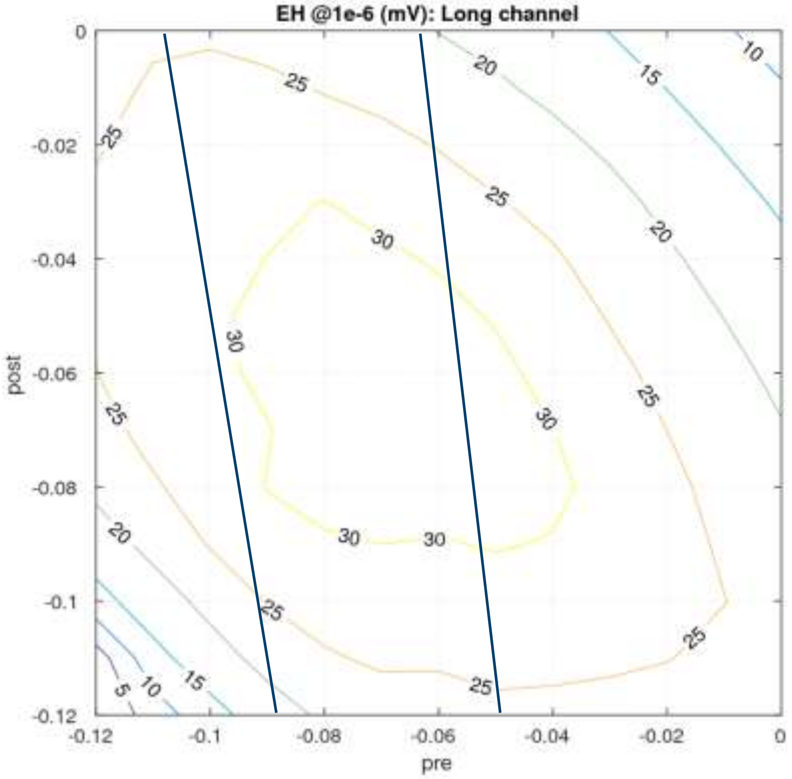
Random jitter: 0.010 UI
Uniform jitter: 0.040 UI
Noise (rms.): 4 mV

CTLE near: 1 dB
CTLE far: 6 dB









Wording

- *120E.3.2.1.1 Reference receiver for module output eye width and eye height evaluation*
  - *Any of the equalizer settings from Table 120E–2 may be used.*
- *120E.3.2.2 Far-end pre-cursor ratio*
  - *The setting of the reference CTLE is the same used to measure eye width and height.*
- This implies that the tester chooses **one** peaking value that works for eye width and height, then checks to see if it passes precursor ratio. We do not believe this is the intention.

- Change
- "… The setting of the reference CTLE is the same used to measure eye width and height."
- To
- "… Any setting of the reference CTLE for which the eye width and height satisfy the limits in Table 120E-3, may be used."

- Consider changing the headings to make it clear that the tests go together:
- 120E.3.2.1 Module output eye width and eye height <u>and far-end pre-cursor ratio</u>
- 120E.3.2.1.1 Reference receiver for module output eye width and eye height evaluation
- 120E.3.2.<u>**1.**</u>2 Far-end pre-cursor ratio