KRn return loss and test fixture

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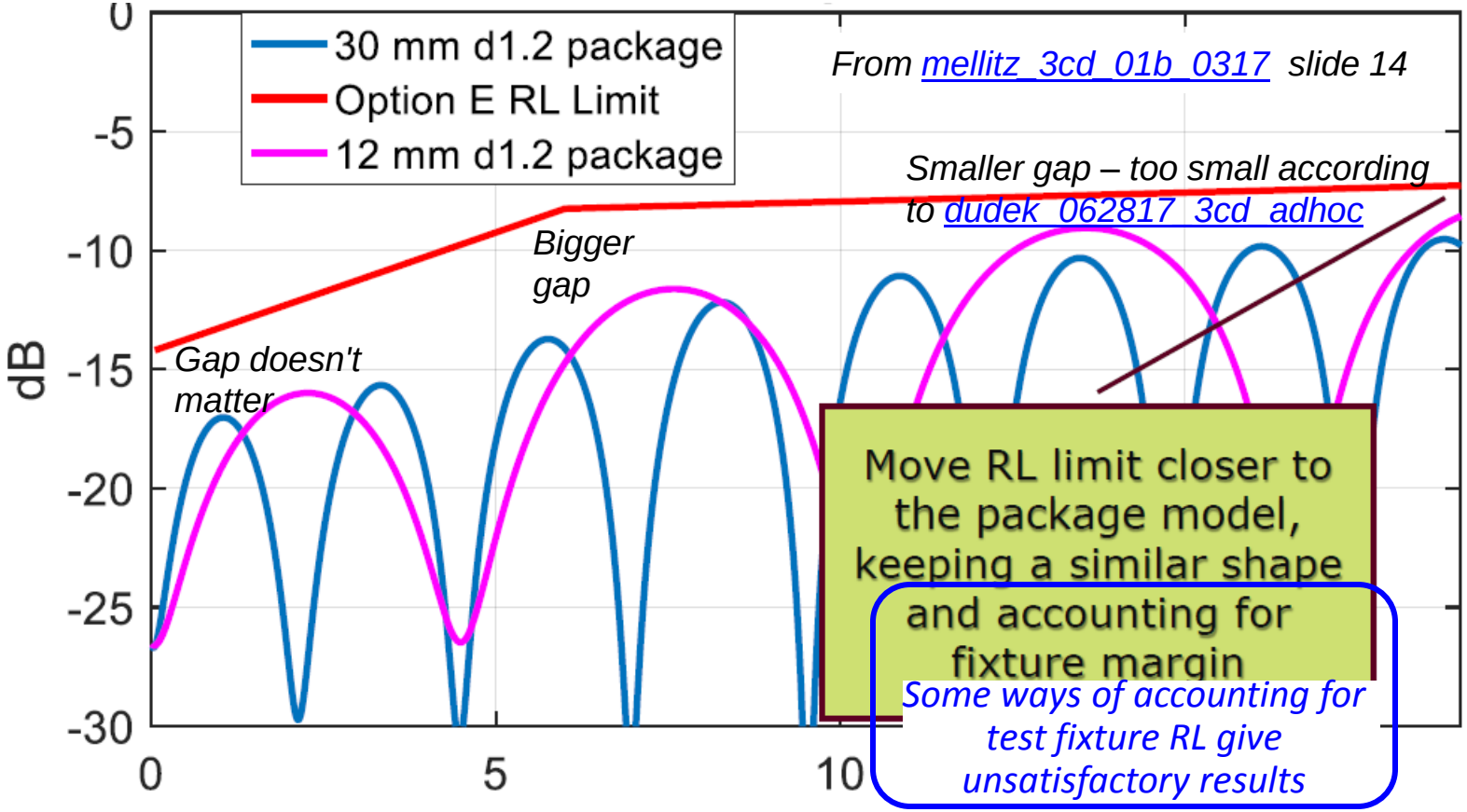
Some related issues with -KRn spec

1. 50GBASE-KR, 100GBASE-KR2, and 200GBASE-KR4 test fixture return loss is not compatible with tightened return loss spec
2. -KRn return loss spec is too tight at low frequencies

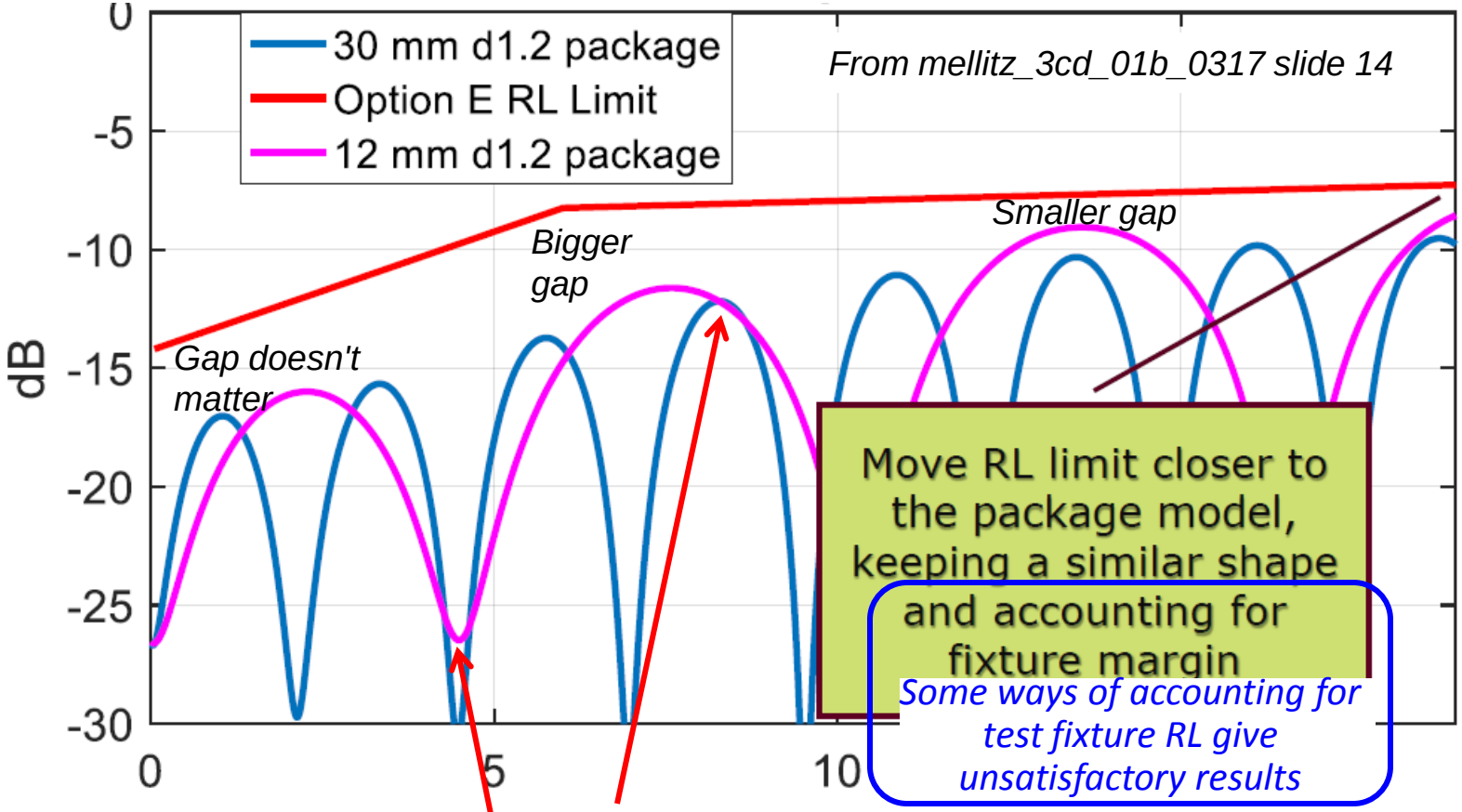
- Comments 137, 141

The situation in D2.0



- The return loss limit was moved down by 2.2 dB (mellitz_3cd_01b_0317 option E), following reduced Cp and Cd in COM, but the shape was not optimized
- It is proposed to move COM to a neutral impedance basis so it does not arbitrarily favour some channels over others. Then, aligning the RL limit to the COM scenario would not be correct
- Comment 141 says the limit is too tight at low f, dudek_062817_3cd_adhoc says it is too strict at high f, and it appears too loose ~ 5 to 10 GHz

COM is not consistent for RL

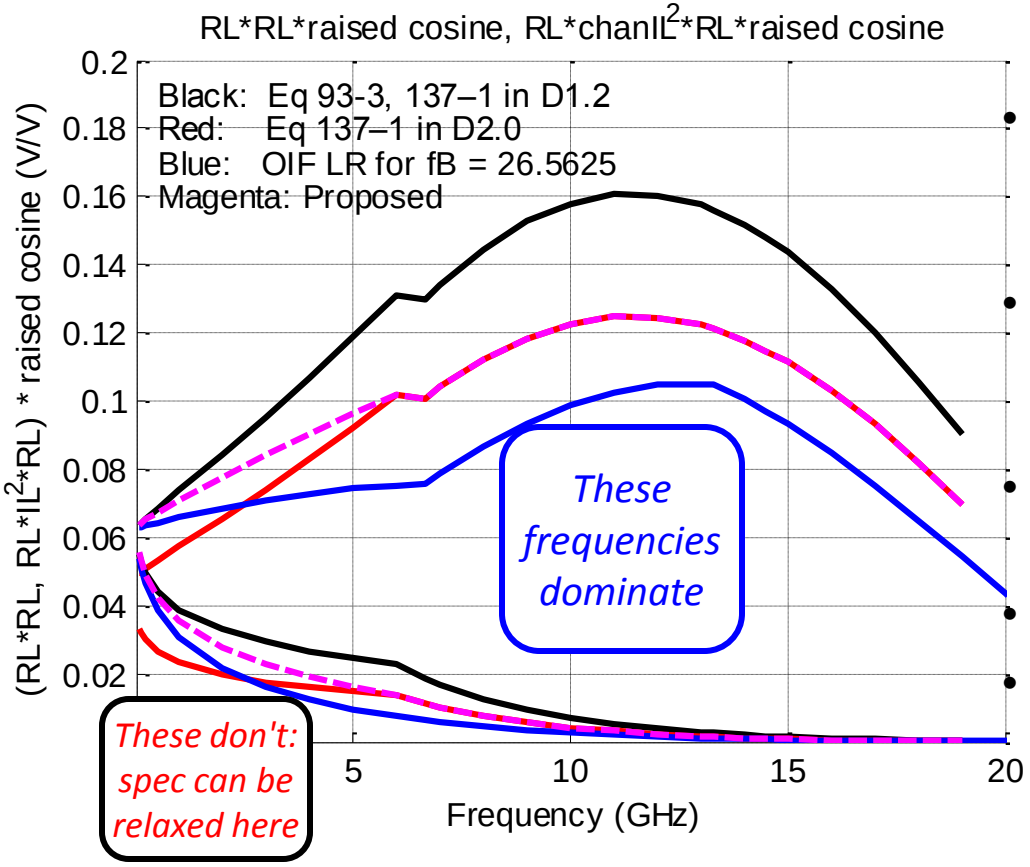


- A channel reflection at this frequency degrades that channel's long-package COM
  - as it should
- A channel reflection at this frequency is pretty much ignored by COM
- A channel RL spec is useful because it treats reflections consistently with frequency

Consider what the return loss specs are for

- To control echoes between e.g. Tx and channel that cause ISI that COM does not know about
  - See dawe_3bs_02_0517 for some initial calculations on this
  - Two kinds of reflection: end-to-end and end-to-channel
  - It turns out that the end-to-end reflections are insignificant in comparison to end-to-channel; except for channels with minimal loss, the channel insertion loss, which appears twice in an echo path, makes them much smaller than end-to-channel reflections
    - See next slide
  - At very low frequencies they could have equal spectral density, but few hertz, and in practice at *very* low frequencies the channel RL is much better than spec
- For practical RL limits, it seems that the 5-15 GHz range is the important area

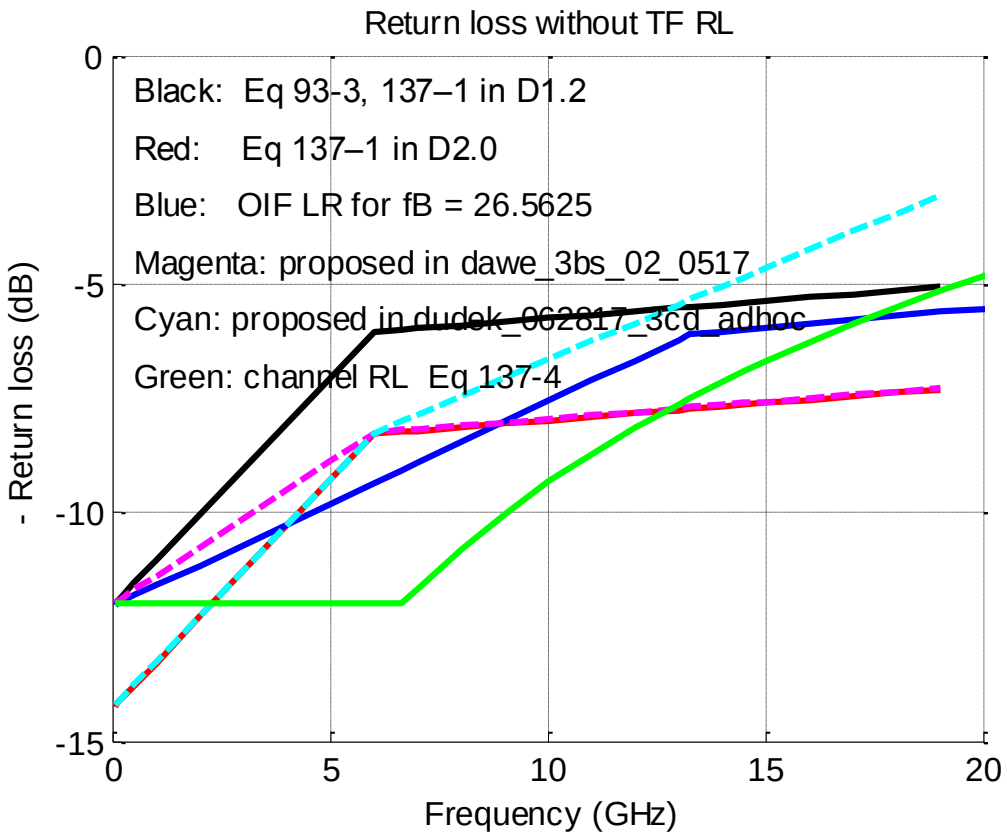
Finding the effect of RL



See dawe_3bs_02_0517 for step by step graphs

- Assuming that Tx and Rx roughly equalize the channel to a raised cosine response
  - The exact shape doesn't matter
- The humped curves show possible spectra of ISI caused by reflections between end and channel
- The lower curves show possible spectra of ISI caused by reflections between two ends
- Imagine a "power sum": area under the square of each curve
- End-to-channel dominates
- Some end-to-channel reflections could fall within the range of the DFE, but the RL spec doesn't enforce that
  - COM does, but inconsistently
- So we have to assume that they don't

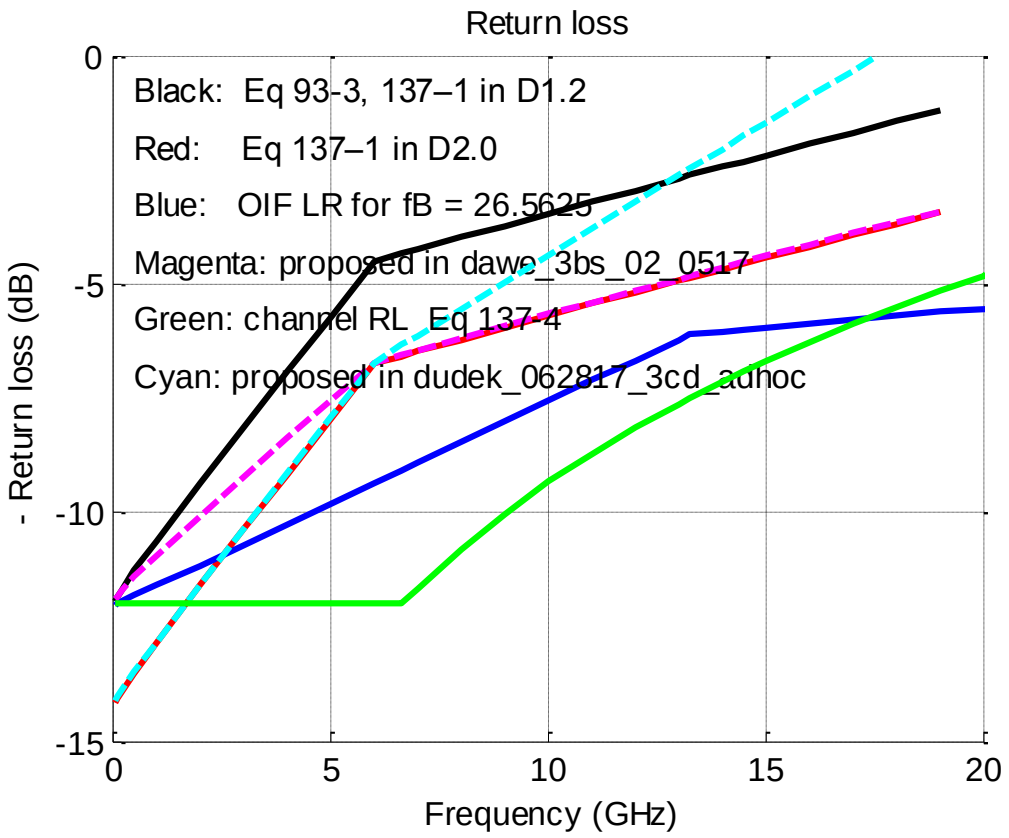
Comparing "nominal" return loss limits



Nominal return losses: channel and OIF at IC, others at test fixture

- D2.0 is unusually tight at low f
- If OIF is even half right, the limit should be straighter
- Channels have lower return loss than this at very low frequencies – but that doesn't mean we need to adjust the spec there. It appears that the older specs were set on the basis that 12 dB is good enough

Adjusting for test fixture IL but not its RL

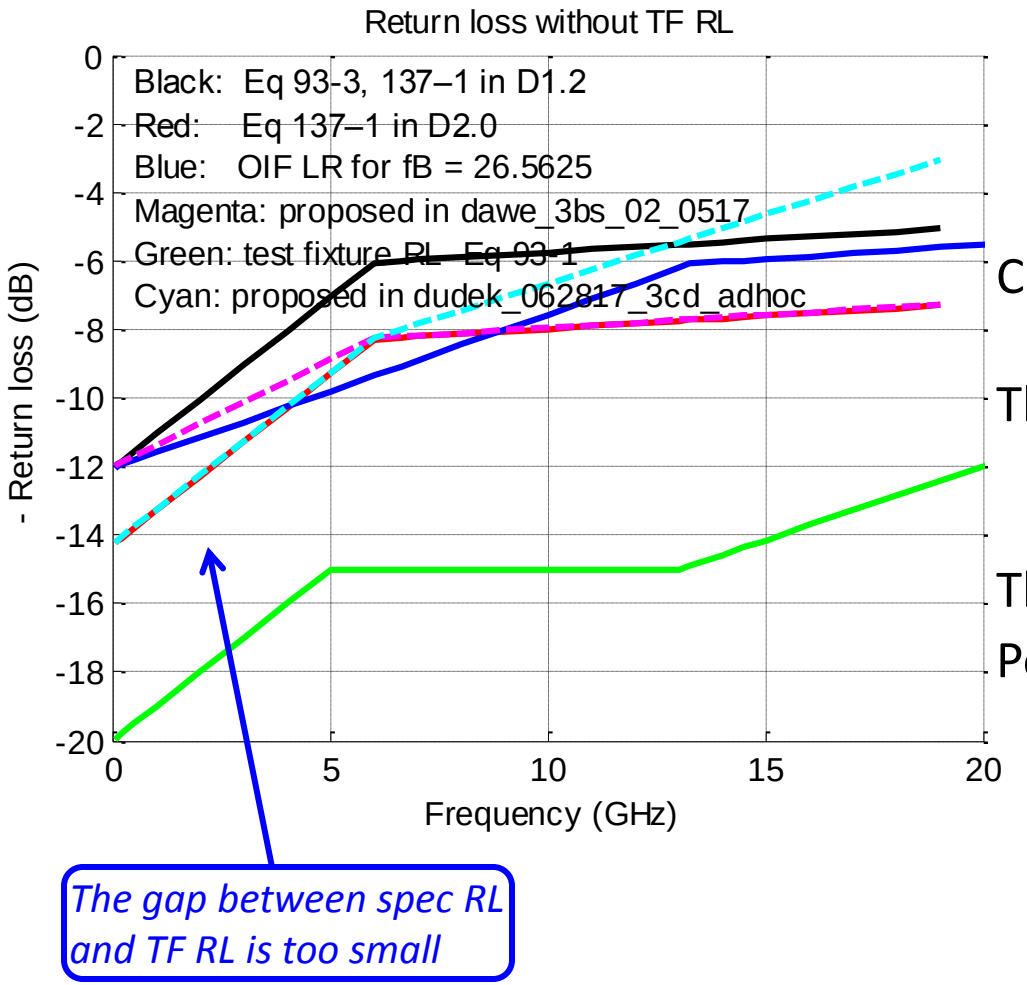


- Compare previous slide
- IL of test fixture makes a big difference
- Red and cyan are too tight at low f
- Cyan is too loose at high f
- Black is too loose at mid f
- Above 3 GHz, OIF limit is tighter than all the 802.3 ones – but are the 802.3 ones deliberately relaxed to allow for the test fixture?

Test points and test fixtures

- 802.3bs C2C, 802.3cd -KRn, and OIF CEI-56G-MR-PAM4 and CEI-56G-LR-PAM4 define the channel insertion loss from package ball to package ball (TP0 to TP5)
- Three of them have channel return loss limits, to same test points
- 802.3bs C2C and 802.3cd -KRn specify return loss of transmitter or receiver as observed through a test fixture: at TP0a and Tp5a
  - This test fixture has specified insertion and return loss
  - It is not the same as a C2M compliance board

1. Backplane/C2C test fixture RL



If the apparent RL is given by the red line, and the test fixture has allowed reflections per green line, the IC on the test fixture has to be **much** better than intended

Changing from black to red made this issue worse

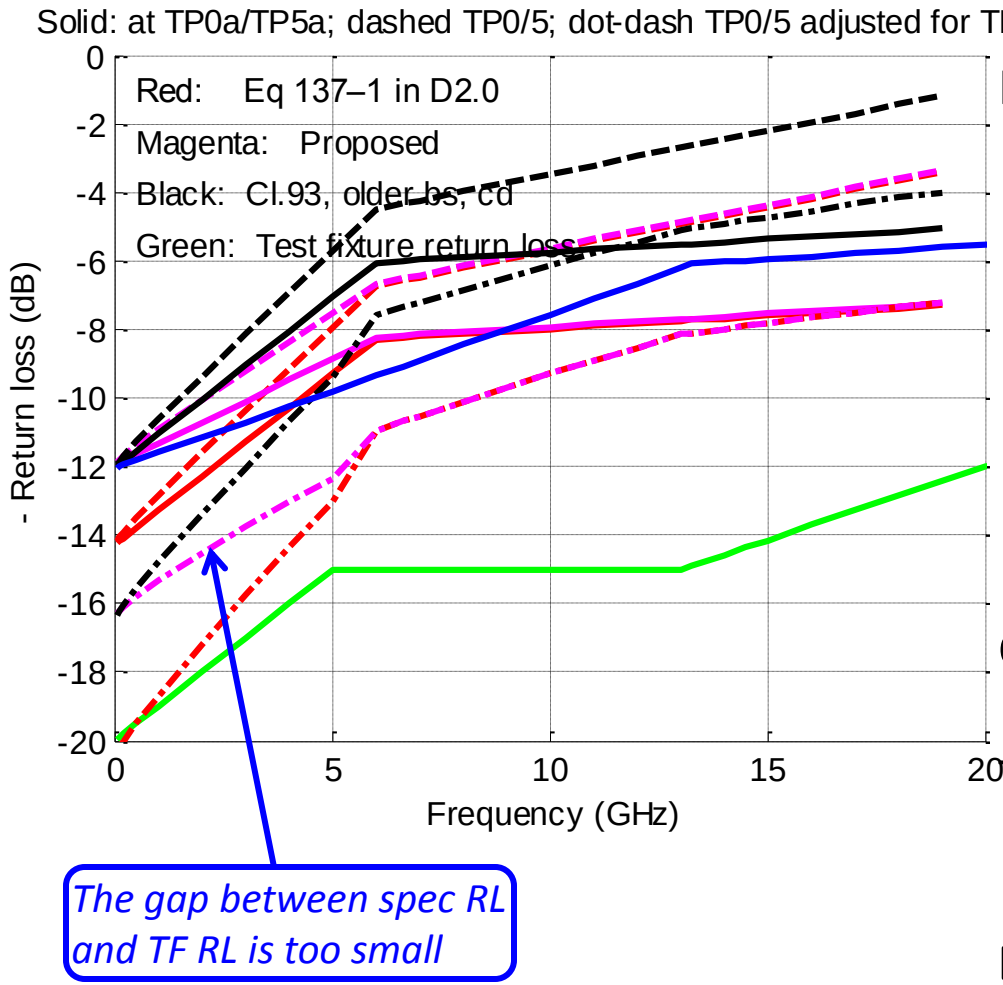
The problem is worst at low frequencies, and for the red and cyan lines

The test fixture also has insertion loss

Per 93.8.1.1, "The effects of differences between the insertion loss of an actual test fixture and the reference **insertion** loss are to be accounted for in the measurements"

De-embed the return loss differences too, or tighten the TF RL spec?

1. Backplane/C2C test fixture RL



If the apparent RL is given by the solid lines, and the test fixture has allowed reflections per green line, the IC on the test fixture has to be **much** better than intended

- Dash-dot lines
- Compare OIF limit (blue)
- This graph used a simple calculation method that might not show the full effect

Changing from black to red made this issue worse

The problem is worst at low frequencies, and for the red and cyan lines (cyan not plotted)

De-embed the return loss differences, or tighten the TF RL spec?