

Reference test fixture S-parameters

(in support of comment R2-100 against D3.2)

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Supporters

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Abstract

- This presentation suggests two minor changes in Annex 179B:
 - Addition of **informative notes** in 179B.2.1 and 179B.3.1, pointing to **S-parameter files** that will be available for download (companion contribution).
 - Correction of a stale value in 179B.1 (**9.75 dB should be 8.75 dB** to match the normative equations).
- I do not expect these changes to be contentious.
 - But the risk of future comments should be taken into account.
 - If there isn't strong consensus, this proposal should not be adopted.

Background

- Annex 179B specified the reference IL magnitude for HCB (Equation 179B-1) and MCB (Equation 179B-2)
 - but phase or impedance profiles are not provided.
- Measurements are done using physical test fixtures...
 - 179B.3.1 states that “Differences between the insertion loss of an actual test fixture and the reference insertion loss, including those arising from other MDI connectors, **shall be accounted for** in the measurements”.
 - 179B.2.1 states similarly that “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”.
 - Non-negligible variations have been reported even across lanes of the same test fixture.
- This accounting can be done by de-embedding techniques as suggested by Heck et al. in [heck_3dj_01_2607](#).
 - However, these techniques require S-parameters for the reference test fixtures, which are not defined in the standard.
 - heck_3dj_01_2607 included a procedure for calculating S-parameters from the reference IL, but results were not provided.

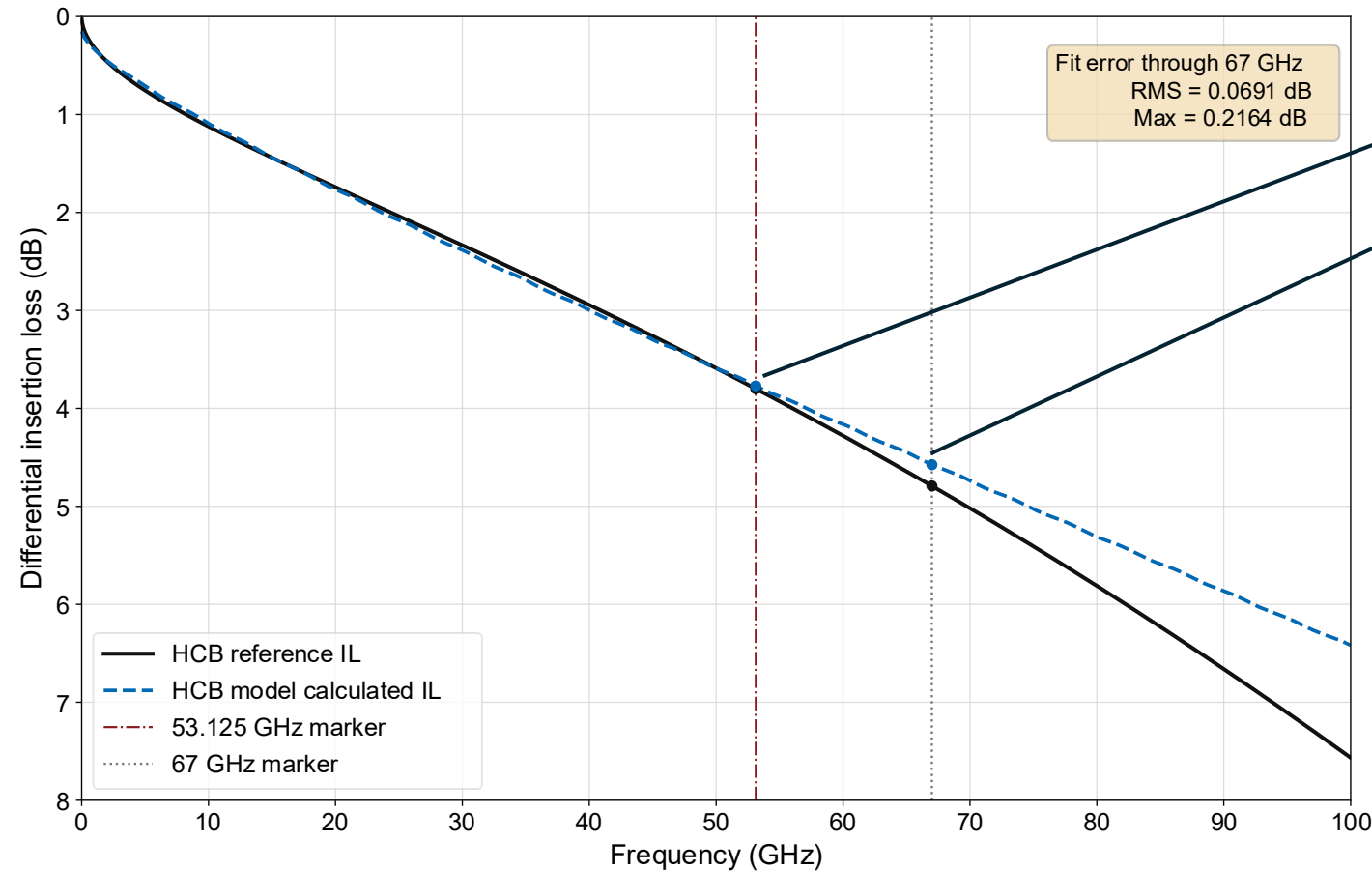
Goals of this contribution

- Provide S-parameters that approximate the reference IL for HCB and MCB over the specified frequency range.
- The S-parameters are generated from models comprising **cascaded 2-port elements of the type used frequently in 802.3 specifications** (93A.1.2.2 and 93A.1.2.3). Frequency-sampled Touchstone (s4p) files are provided alongside this presentation.
- Having these s4p files will enable users of the standard to “account for the differences” using de-embedding techniques, to effectively calibrate out the specific test fixture and replace it with the reference.
 - The area of de-embedding is subject of considerable research. Specific procedures are implemented in test equipment and details may vary.
 - Further guidance on de-embedding is beyond the scope of the standard.

Notes on the underlying models

- The lengths of the transmission line elements were chosen based on estimates of physical dimensions of MCBs and HCBs.
- Other parameters were selected based on assumptions of per-unit-length loss and propagation delay, and by numerical optimization of the fit.
 - The models do not attempt to match specific test fixtures (especially since the IL of contributed test fixtures deviates from the reference)
 - The reference IL magnitude equations do not uniquely determine the underlying model, phase response, and impedance profile.
- The models create **differential insertion loss closely matching the reference equations up to 67 GHz**. They are passive, reciprocal and causal.
 - The models have specific return loss profiles (for which there is no reference).
 - Mode conversion and crosstalk are not modeled.
- The sum of the insertion losses at 53.125 GHz is 8.75 dB, as expected.
 - The cascaded MTF model has an IL of 8.64 dB – not equal but close enough.
 - Note that 179B.1 erroneously states “The reference insertion loss of the mated test fixtures is **9.75 dB** at 53.125 GHz using Equation (179B–5)”. This is not mentioned in comment R2-100, but is worth fixing.

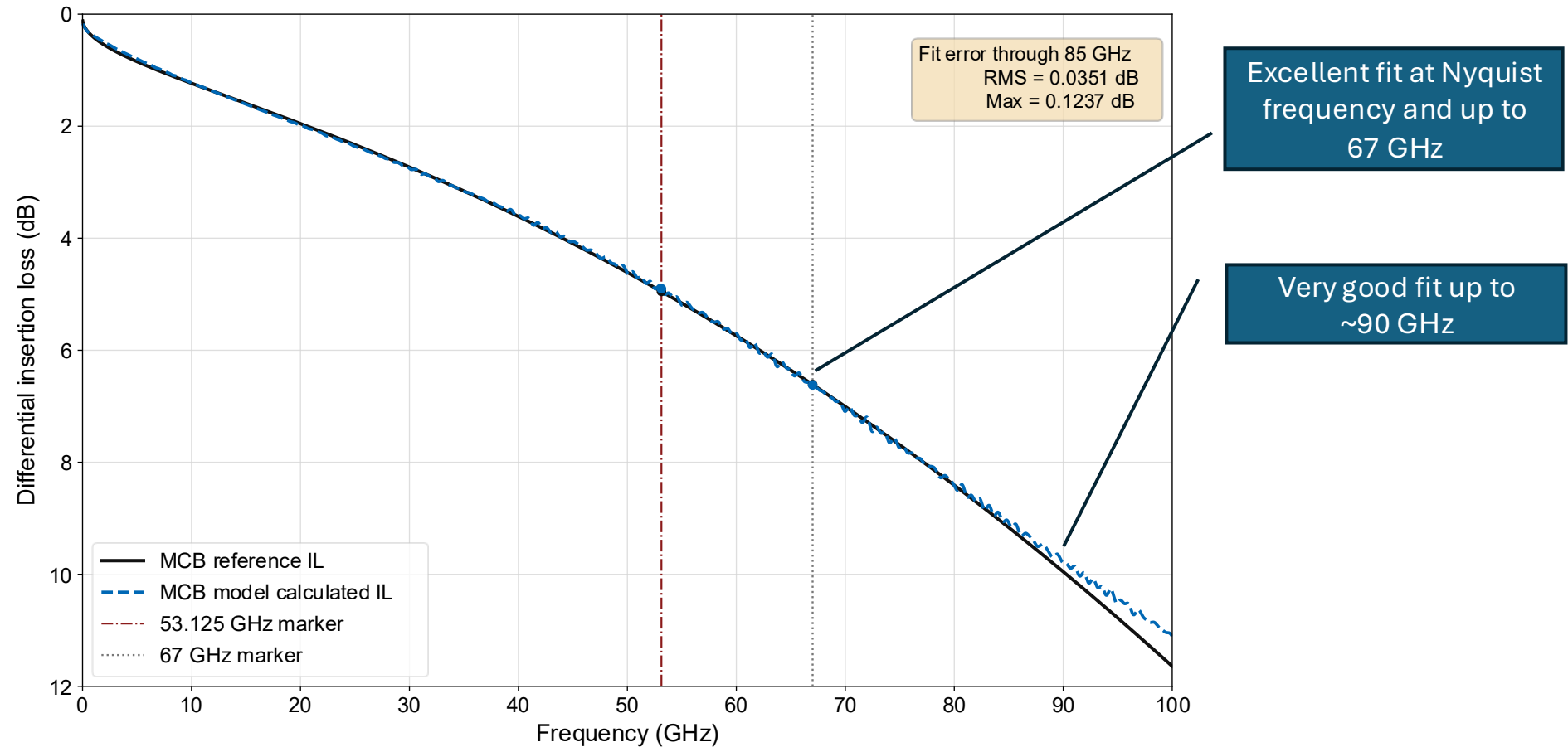
HCB model fit to reference



Excellent fit at Nyquist frequency

Very good fit up to 67 GHz, the upper limit for MTF specifications

MCB model fit to reference



HCB model parameters

	TL1	TL2	TL3	Units
Element type	TL	TL	TL	
Length (zp)	24	100	121	mm
Impedance (Zc)	97.8	92.2	92.5	Ohm
gamma0	2.56e-5	4.63e-5	8.56e-5	1/mm
a1	2.77e-5	5.02e-5	9.29e-5	ns ^{1/2} /mm
a2	9.08e-6	1.64e-5	3.04e-5	ns/mm
tau	4.83e-3	4.83e-3	4.83e-3	ns/mm

Coax reference
plane

Mating
interface

MCB model parameters

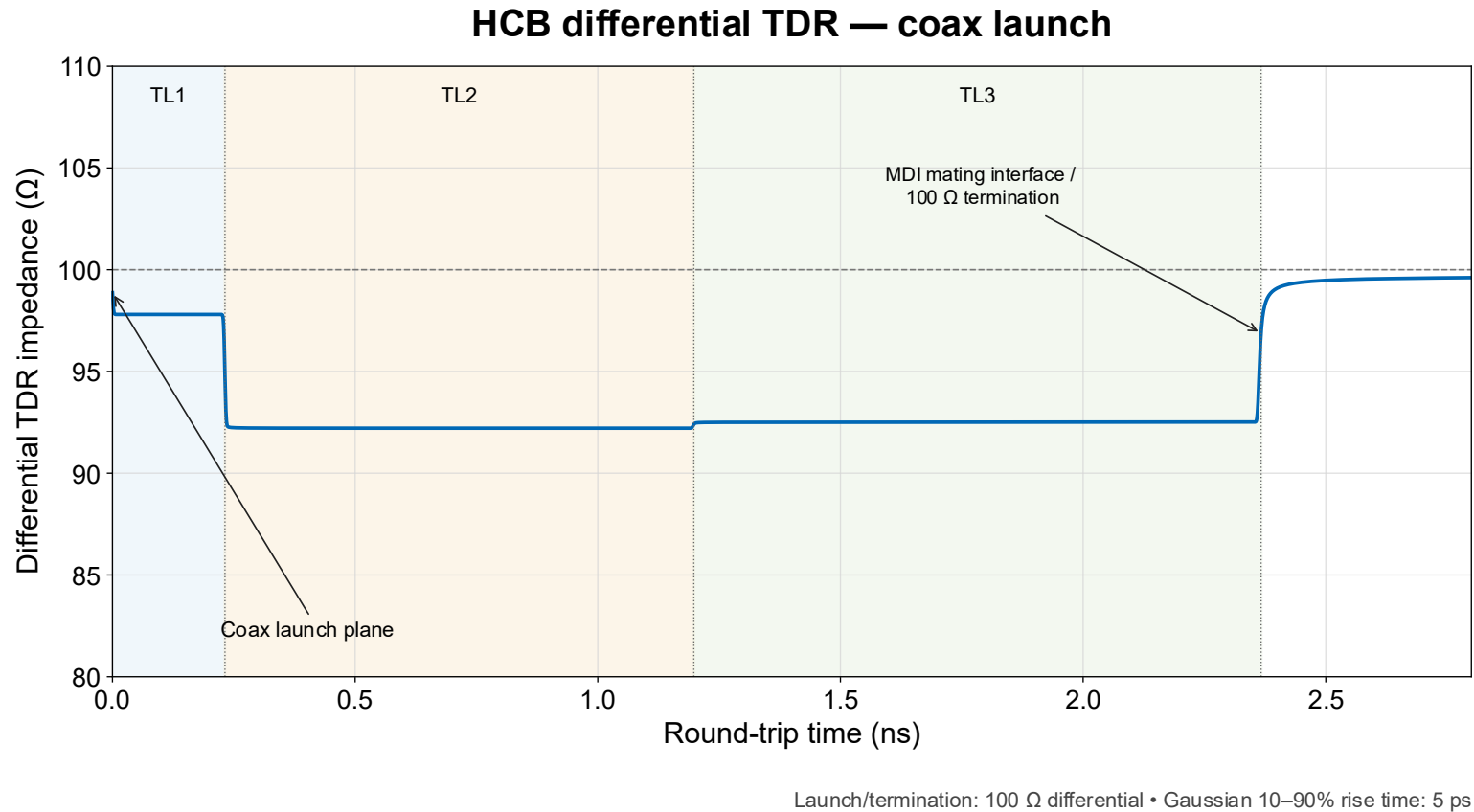
	TL1	TL2	C1	TL3	TL4	TL5	Units
Element type	TL	TL	Cap	TL	TL	TL	
Length (zp)	10	120		0.5	69.5	13	mm
Impedance (Zc)	94.8	96.9		145	89.8	91	Ohm
gamma0	8.24e-5	8.24e-5		8.24e-5	8.24e-5	8.24e-5	1/mm
a1	8.94e-5	8.94e-5		8.94e-5	8.94e-5	8.94e-5	ns ^{1/2} /mm
a2	2.93e-5	2.93e-5		2.93e-5	2.93e-5	2.93e-5	ns/mm
tau	4.83e-3	4.83e-3		4.83e-3	4.83e-3	4.83e-3	ns/mm
C			4.78e-5				nF

Coax reference
plane

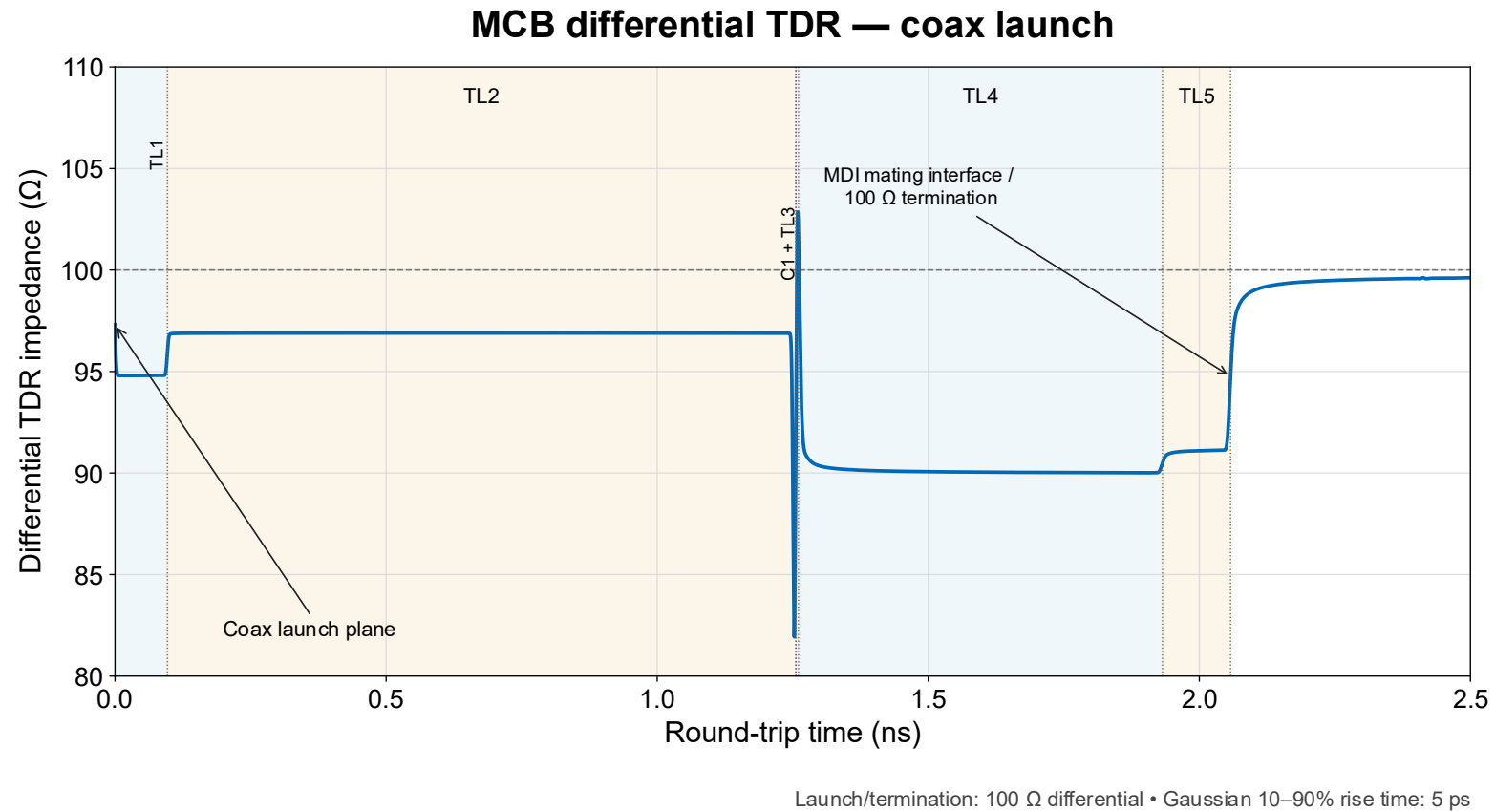
Mating
interface

HCB TDR

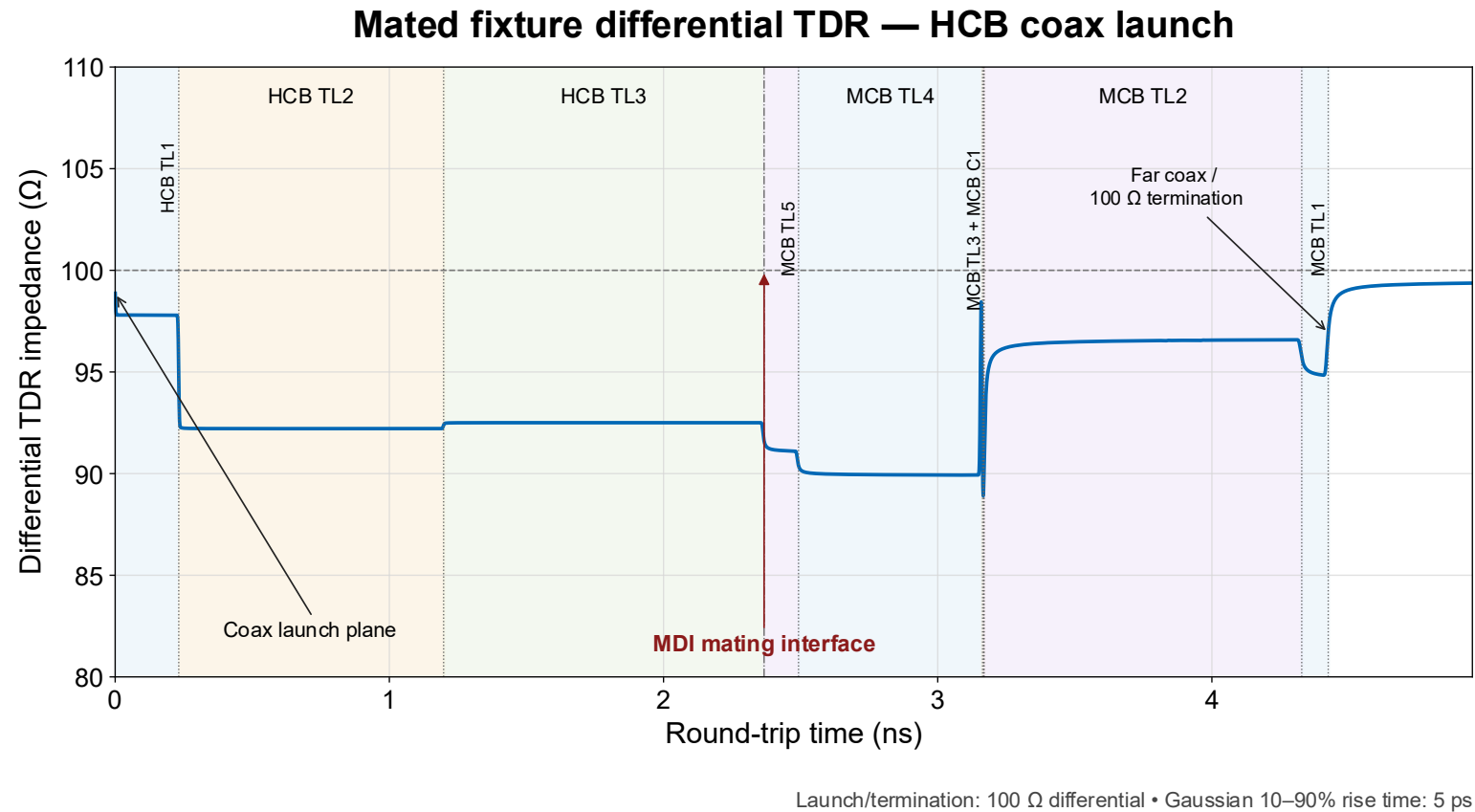
TDRs were calculated from the analytic model up to 300 GHz to minimize Gibbs ringing with a 5 ps rise time.



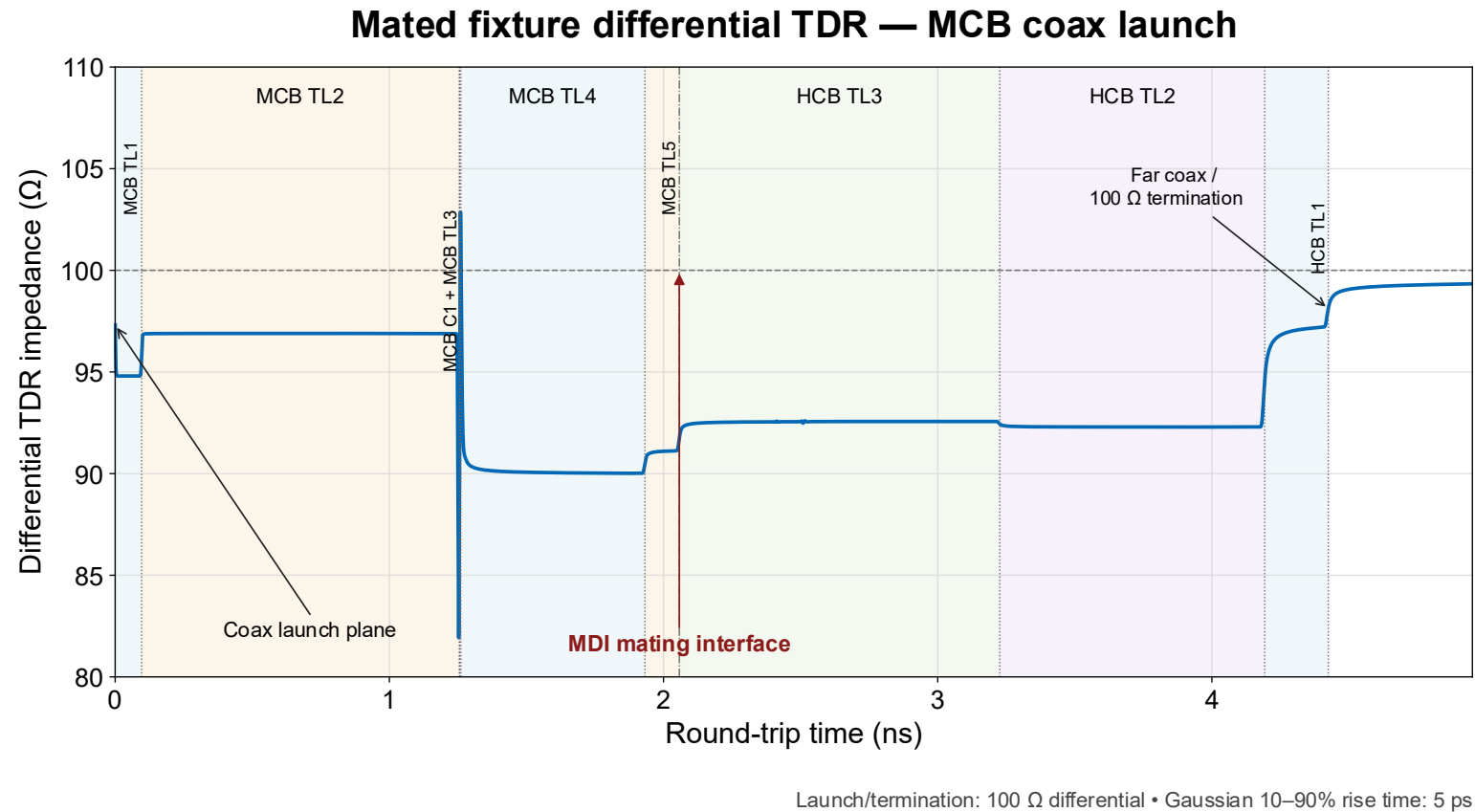
MCB TDR



MTF TDR from HCB side



MTF TDR from MCB side



Provided Touchstone files

- Files in [ran_3dj_adhoc_01_260827.zip](#):
Annex_179B_reference_HCB.s4p and
Annex_179B_reference_MCB.s4p
- Port order in both files: (1,3) are coax connectors, (2,4) are the mating interface
- Linear-step frequency scale from 0.01 to 100.00 GHz.
- Reference impedance is 46.25 Ohm single-ended (92.5 Ohm differential).
- File header sections include the model parameters.

Proposed D3.3 changes

- In 179B.1, change 9.75 dB to 8.75 dB.
- In each of 179B.2.1 and 179B.3.1 add the following informative NOTE:

“A Touchstone file containing S-parameters that approximate the reference insertion loss is available at <https://standards.ieee.org/downloads/802.3>”.

(with editorial license)

That's all!

Questions?