Tightening Channel Variation by Nominal Impedance Values for COM Package Model

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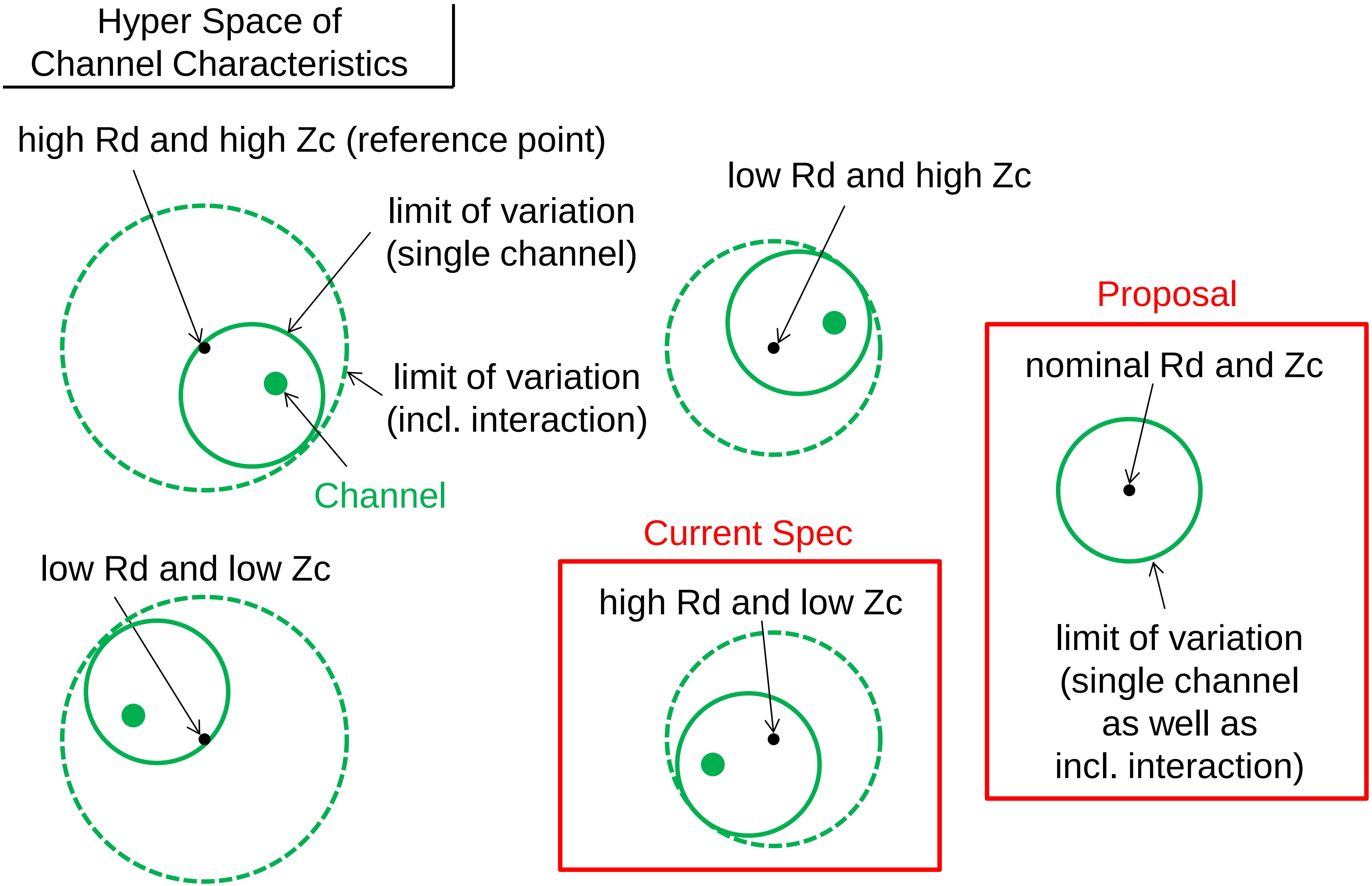
Abstract

- Regardless of whether interoperability margin is enough or not, there are problems to use high Rd and low Zc
  - Problems to use high Rd and low Zc
    - It is not the worst case at all
    - It is biased positive to some channels, negative to some channels, and neither positive or negative to many channels
      - It increases variation of channel characteristics, degrading margin for interoperability
    - It gives misleading impression and illusion of max impedance tolerance
  - Advantages to use nominal Rd and nominal Zc
    - It is not biased to any channels
      - It reduces variation of channel characteristics, improving margin for interoperability
    - It gives a warning that max impedance tolerance is not specified
- The effects on COM values by nominal Rd and nominal Zc were confirmed for Annex 120D, Clause 137, and Clause 136

Tightening Variation by Nominal Reference



COM Parameters for Annex 120D (Common)

Table 93A-1 parameters			
Parameter	**Setting**	**Units**	**Information**
f_b	26.5625	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.8e-4 1.8e-4]	nF	[TX RX]
z_p select	[1]		[test cases to run]
z_p (TX)	[30]	mm	[test cases]
z_p (NEXT)	[12]	mm	[test cases]
z_p (FEXT)	[30]	mm	[test cases]
z_p (RX)	[30]	mm	[test cases]
C_p	[1.1e-4 1.1e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[55 55]	Ohm	[TX RX]
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.15:0.05:0]		[min:step:max]
c(1)	[-0.25:0.05:0]		[min:step:max]
g_DC	[-15:1:0]	dB	[min:step:max]
f_z	10.625	GHz	
f_p1	10.625	GHz	
f_p2	53.125	GHz	
A_v	0.44	V	
A_fe	0.44	V	
A_ne	0.63	V	
L	4		
M	32		
N_b	10	UI	
b_max(1)	0.5		
b_max(2..N_b)	0.2		
sigma_RJ	0.01	UI	
A_DD	0.02	UI	
eta_0	2.60E-08	V^2/GHz	
SNR_TX	31	dB	
R_LM	0.95		
DER_0	1.00E-05		
Operational control			
COM Pass threshold	3	dB	
Include PCB	0	Value	0, 1, 2
g_DC_HP	[-4:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	0	logical
Display frequency domain	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\V165_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	V164	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
IDEAL_TX_TERM	0	logical
T_r	1.30E-02	ns
T_r_meas_point	0	logical
T_r_filter_type	1	logical

Non standard control options		
INC_PACKAGE	1	logical
IDEAL_RX_TERM	0	logical
INCLUDE_CTLE	1	logical
INCLUDE_TX_RX_FILTER	1	logical
COM_CONTRIBUTION	0	logical

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 1.734e-3 1.455e-4]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	90	Ohm

Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	[0 4.114e-4 2.547e-4]	
board_tl_tau	6.191E-03	ns/mm
board_Z_c	110	Ohm
z_bp (TX)	151	mm
z_bp (NEXT)	72	mm
z_bp (FEXT)	72	mm
z_bp (RX)	151	mm

- Yellow cells were changed as the following slide

COM Parameters for Annex 120D (Difference)

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- Based on slide 9 of hidaka_060717_3cd_adhoc-v2.pdf
  - Tx Amplitude for Zc90/93/95/100 were calibrated at TP0a

Label	D3.0	D3.1	D3.2	Zc90	Zc93	Zc95	Zc100
R_d	55	55	55	50	50	50	50
Z_c	85	90	90	90	93	95	100
A_v	0.45	0.45	0.44	0.419	0.418	0.418	0.417
A_fe	0.45	0.45	0.44	0.419	0.418	0.418	0.417
A_ne	0.63	0.63	0.63	0.604	0.604	0.604	0.604
C_d	2.8E-4	1.8E-4	1.8E-4	1.8E-4	1.8E-4	1.8E-4	1.8E-4
f_p2	1E+99	2*f_b	2*f_b	2*f_b	2*f_b	2*f_b	2*f_b
z_p	30	30	30	30	30	30	30

18 Channels for Simulation for Annex 120D

Category	CH #	IL 13.28G	Description	Channel Data Source
A	4	20.9dB	Cisco Backplane	P802.3cd 50/100/200GbE TF (Cisco_Backplane_channel_data.zip)
B	17,18,19	~20dB	Intel 100Ω Backplane	50G/NGOATH Study Group (mellitz_01_021716_20dB_6_channels.zip)
C	32,33,34	~20dB	Intel 85Ω Backplane	
D	42	21.8dB	TE Backplane	P802.3cd 50/100/200GbE TF (TEC_STRADAWhisper27in_Meg6_*.zip)
E	44, 45	~19dB	Cavium Backplane	P802.3cd 50/100/200GbE TF (Cavium_20dB_H*.zip)
F	48	19.6dB	Intel Mezzanine Channel	P802.3bs 200/400GbE TF (mellitz_3bs_*_0714.zip)
	49	14.7dB		
	50	6.9dB		
	51	19.5dB		
	52	17.4dB		
	53	11.0dB		
	54	9.2dB		
G	55	18.6dB	TEC ARMOR Mezzanine	P802.3bs 200/400GbE TF (TEC/shanbhag_01_0914.zip)

Results for Annex 120D

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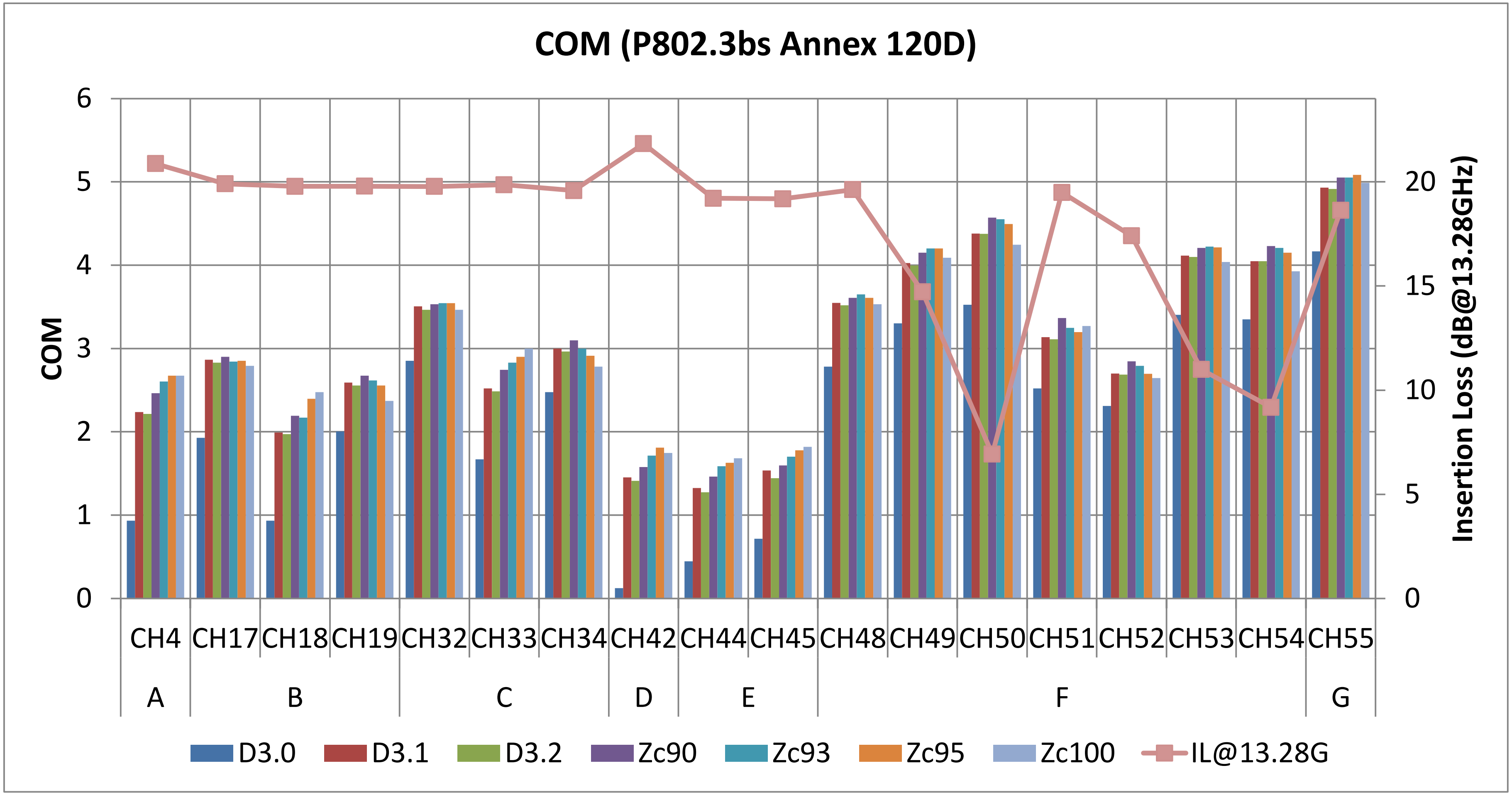

- F and G have one mezzanine connector (relevant for 120D)
- A thru E have two backplane connectors (only for information)

Results for Annex 120D (ΔCOM from D3.0)

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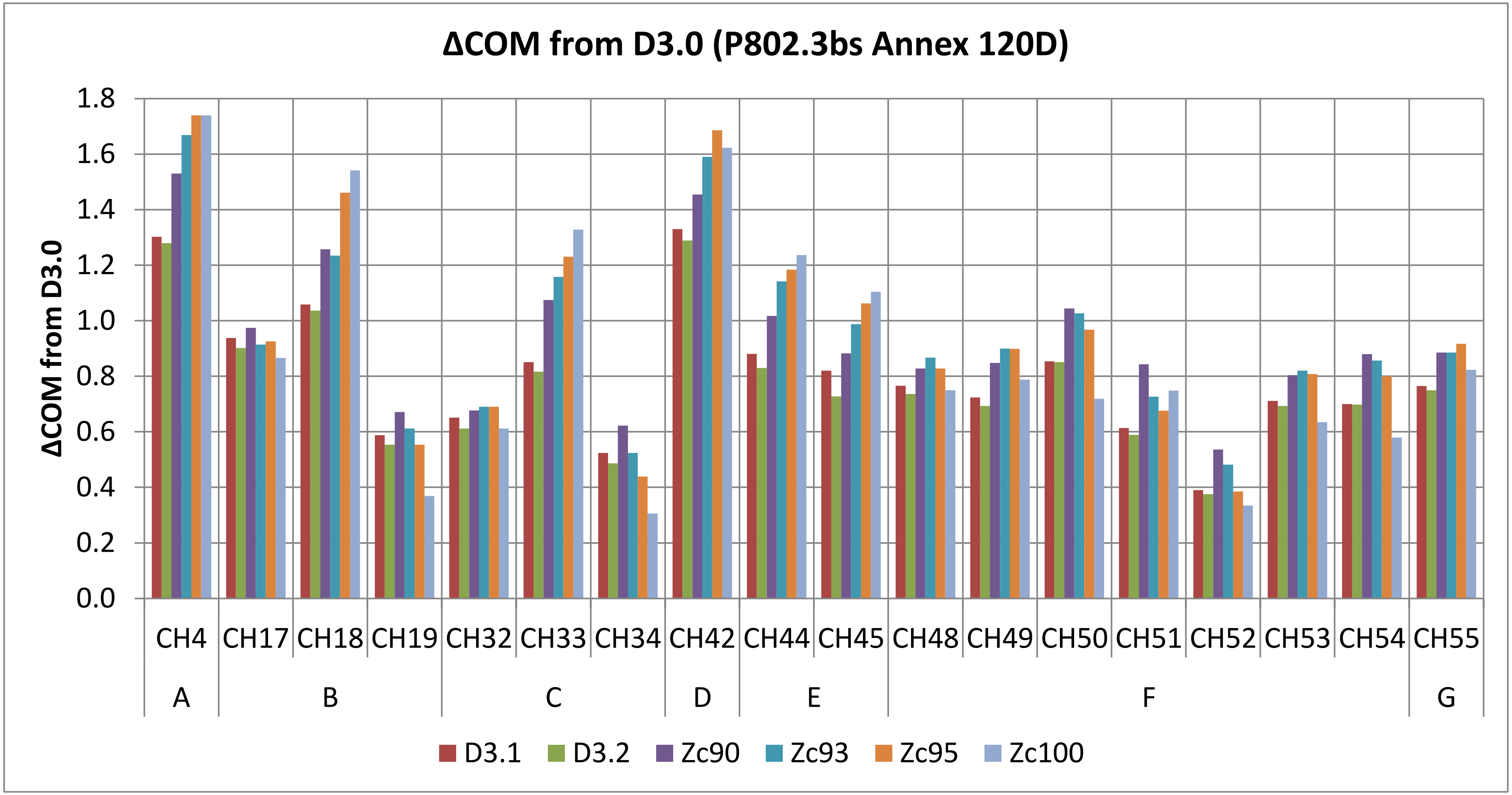

- Large improvement (~0.8dB) mainly due to Cd (280fF→180fF)
  - Since COM was not changed, it was budget transfer from Rx to channel
- This is only for information, and not used for my proposal

Results for Annex 120D (ΔCOM from D3.2)

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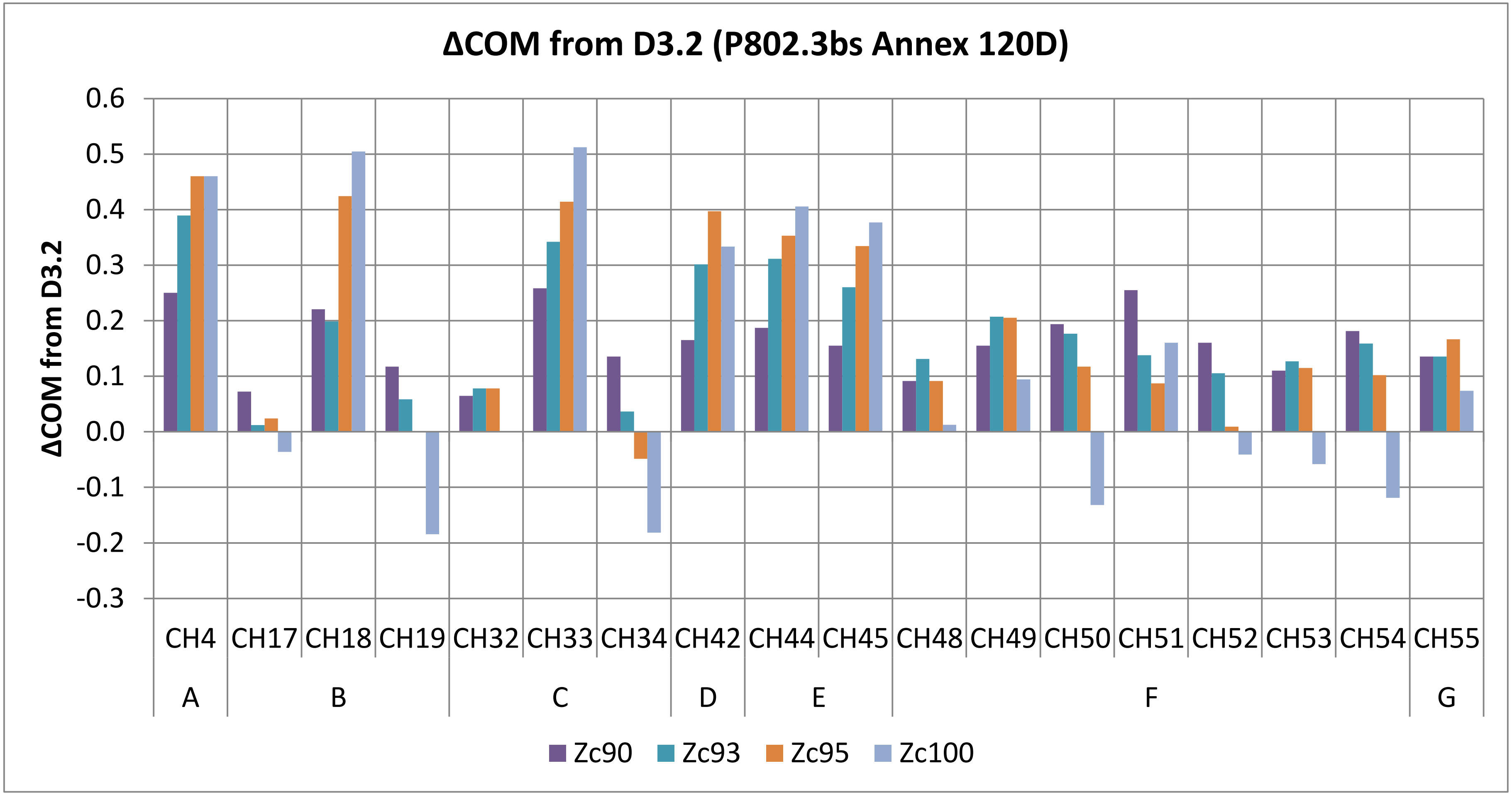

- Zc = 95Ω and COM = 3.1dB seems a reasonable choice
  - Looking at the results of F and G which are relevant for Annex 120D
  - My proposal for Annex 120D is based on this result

COM Parameters for Clause 137 (Common)

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Table 93A-1 parameters			
Parameter	Setting	Units	Information
f_b	26.5625	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.8e-4 1.8e-4]	nF	[TX RX]
z_p select	[1]		[test cases to run]
z_p (TX)	[30]	mm	[test cases]
z_p (NEXT)	[12]	mm	[test cases]
z_p (FEXT)	[30]	mm	[test cases]
z_p (RX)	[30]	mm	[test cases]
C_p	[1.1e-4 1.1e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[55 55]	Ohm	[TX RX]
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.15:0.05:0]		[min:step:max]
c(-2)	[0:0.025:0.1]		[min:step:max]
c(1)	[-0.25:0.05:0]		[min:step:max]
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	10.625	GHz	
f_p1	10.625	GHz	
f_p2	53.125	GHz	
A_v	0.45	V	
A_fe	0.45	V	
A_ne	0.63	V	
L	4		
M	32		
N_b	12	UI	
b_max(1)	0.7		
b_max(2..N_b)	0.2		
sigma_RJ	0.01	UI	
A_DD	0.02	UI	
eta_0	1.64E-08	V^2/GHz	
SNR_TX	32.5	dB	
R_LM	0.95		
DER_0	1.00E-04		
Operational control			
COM Pass threshold	3	dB	
Include PCB	0	Value	0, 1, 2
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	0	logical
Display frequency domain	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\V165_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	V164	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
IDEAL_TX_TERM	0	logical
T_r	1.20E-02	ns
T_r_meas_point	0	logical
T_r_filter_type	1	logical

Non standard control options		
INC_PACKAGE	1	logical
IDEAL_RX_TERM	0	logical
INCLUDE_CTLE	1	logical
INCLUDE_TX_RX_FILTER	1	logical
COM_CONTRIBUTION	0	logical

Table 93A–3 parameters		
Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0 1.734e-3 1.455e-4]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	90	Ohm

Table 92–12 parameters		
Parameter	Setting	
board_tl_gamma0_a1_a2	[0 4.114e-4 2.547e-4]	
board_tl_tau	6.191E-03	ns/mm
board_Z_c	110	Ohm
z_bp (TX)	151	mm
z_bp (NEXT)	72	mm
z_bp (FEXT)	72	mm
z_bp (RX)	151	mm

- Yellow cells were changed as the following slide

COM Parameters for Clause 137 (Difference)

FUJITSU

- Based on slide 10 of hidaka_060717_3cd_adhoc-v2.pdf
  - D2.0mod and Zc90/93/95/100 were calibrated at TP0a
  - D2.0mod is same as D2.0 except Tx amplitude for fair comparison

Label	D2.0	D2.0mod	Zc90	Zc93	Zc95	Zc100
R_d	55	55	50	50	50	50
Z_c	90	90	90	93	95	100
A_v	0.45	0.438	0.416	0.415	0.415	0.414
A_fe	0.45	0.438	0.416	0.415	0.415	0.414
A_ne	0.63	0.634	0.604	0.604	0.604	0.604
z_p	30	30	30	30	30	30

16 Channels for Simulation for Clause 137

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Category	CH #	IL 13.28G	Description	Channel Data Source
A	8	30.1dB	Cisco Backplane	P802.3cd 50/100/200GbE TF (Cisco_Backplane_channel_data.zip)
B	23,24,25	~30dB	Intel 100Ω Backplane	50G/NGOATH Study Group (mellitz_01_021716_30dB_6_channels.zip)
C	38,39,40	~30dB	Intel 85Ω Backplane	
D	43	32.0dB	TE Backplane	P802.3cd 50/100/200GbE TF (TEC_STRADAWhisper40in_Meg6_*.zip)
E	46, 47	~30dB	Cavium Backplane	P802.3cd 50/100/200GbE TF (Cavium_30dB_H*.zip)
H	56	28.7dB	Amphenol FCI BP (Link 1)	P802.3cd 50/100/200GbE TF (Amphenol_Link_?.zip)
	57	29.6dB	Amphenol FCI BP (Link 2)	
	58	26.0dB	Amphenol FCI BP (Link 3)	
	59	29.6dB	Amphenol FCI BP (Link 4)	
	60	28.0dB	Amphenol FCI BP (Link 5)	
	61	29.8dB	Amphenol FCI BP (Link 6)	

- CH56,57,58 are claimed as not expected to pass

Results for Clause 137

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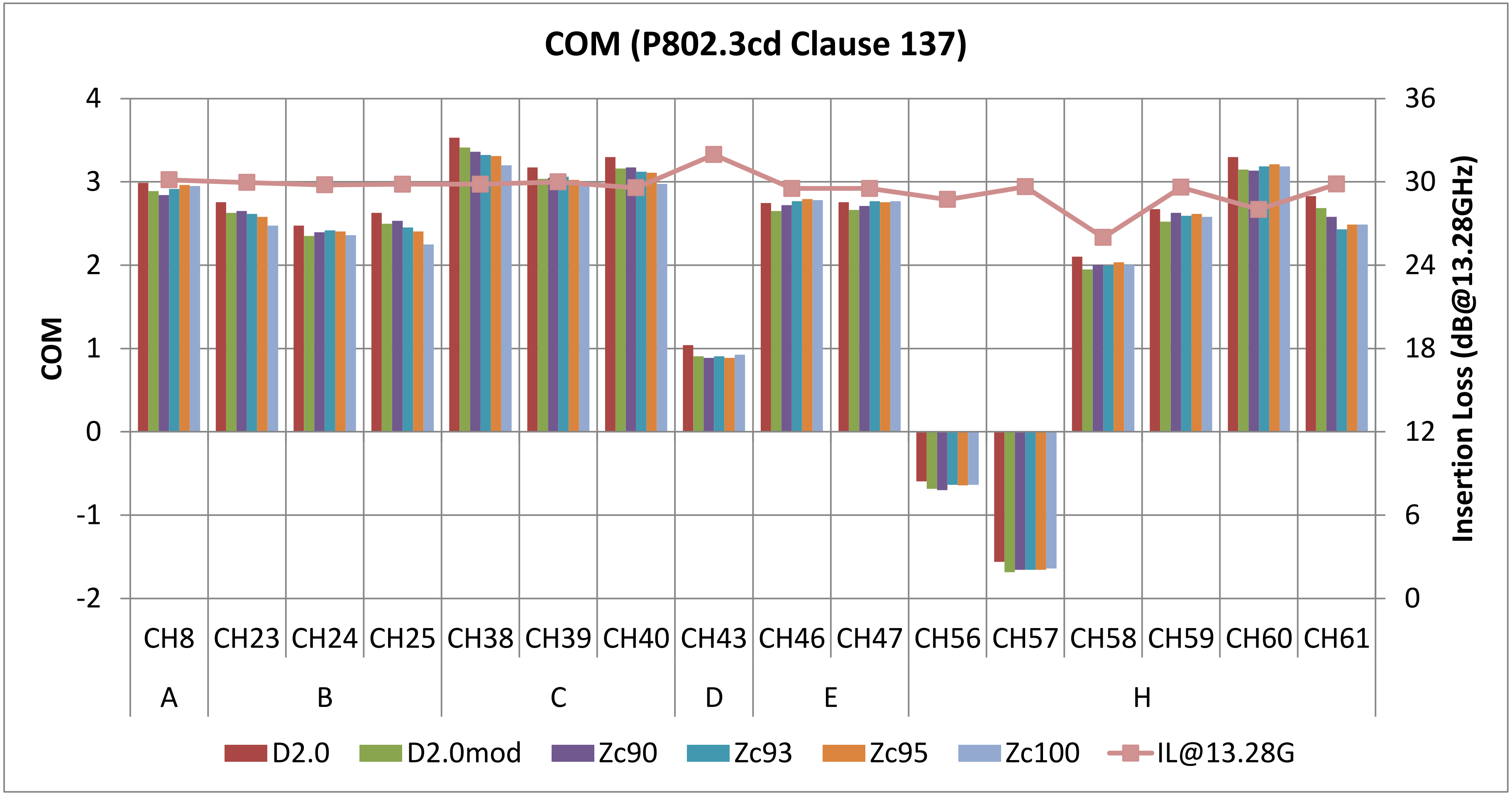

- Some channels have lower COM than others, mainly due to
  - CH43 : Extra insertion loss
  - CH56,57,58 : Extra crosstalk and extra reflection

Results for Clause 137 (ΔCOM from D2.0mod)

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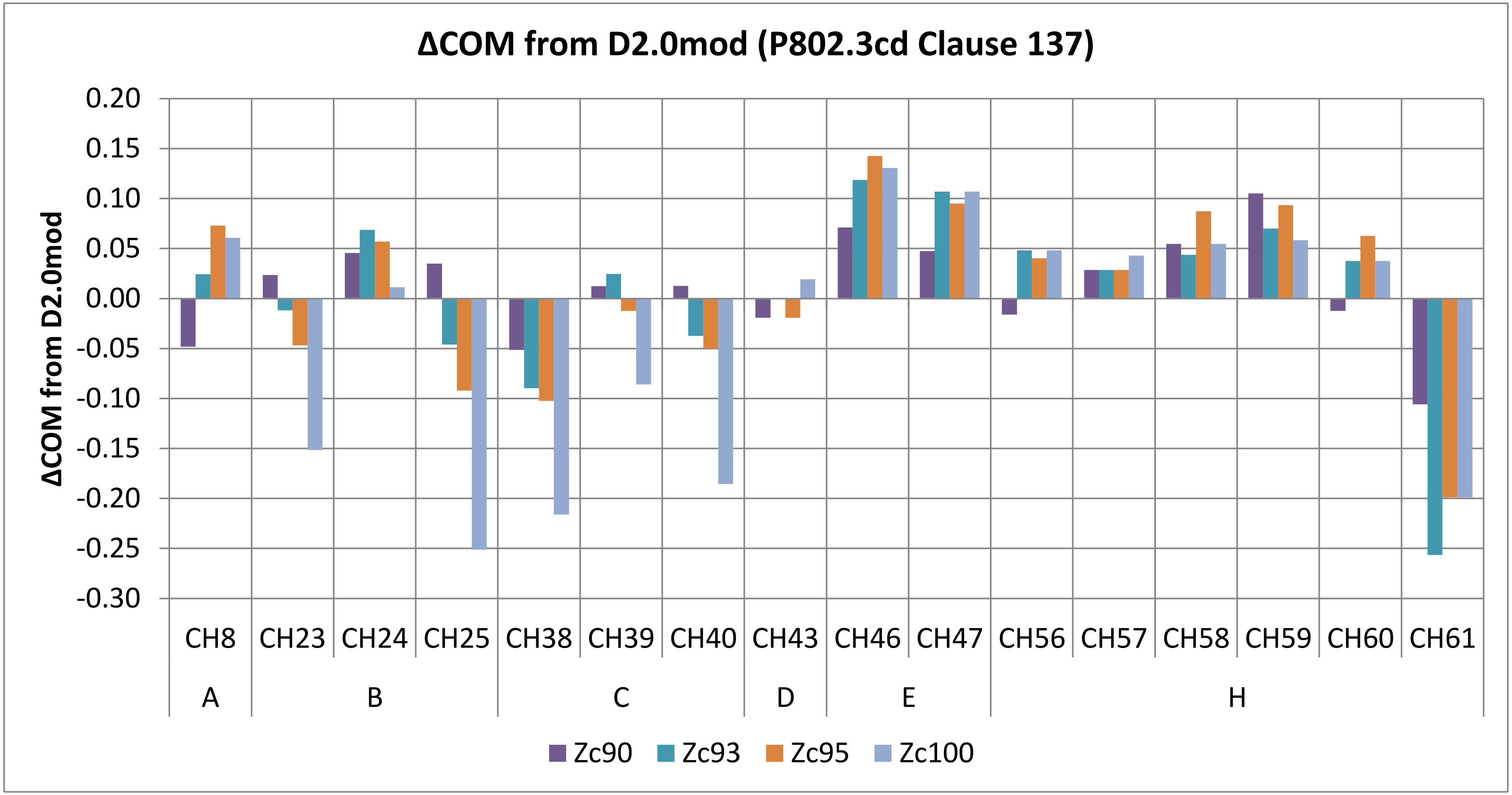

- Zc = 95Ω and COM = 3.0dB seems a reasonable choice
  - My proposal for Clause 137 is based on this result

COM Parameters for Clause 136 (Common)

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Table 93A-1 parameters			
Parameter	Setting	Units	Information
f_b	26.5625	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.8e-4 1.8e-4]	nF	[TX RX]
z_p select	[1]		[test cases to run]
z_p (TX)	[30]	mm	[test cases]
z_p (NEXT)	[12]	mm	[test cases]
z_p (FEXT)	[30]	mm	[test cases]
z_p (RX)	[30]	mm	[test cases]
C_p	[1.1e-4 1.1e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[55 55]	Ohm	[TX RX]
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.15:0.05:0]		[min:step:max]
c(-2)	[0:0.025:0.1]		[min:step:max]
c(1)	[-0.25:0.05:0]		[min:step:max]
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	10.625	GHz	
f_p1	10.625	GHz	
f_p2	53.125	GHz	
A_v	0.45	V	
A_fe	0.45	V	
A_ne	0.63	V	
L	4		
M	32		
N_b	12	UI	
b_max(1)	0.7		
b_max(2..N_b)	0.2		
sigma_RJ	0.01	UI	
A_DD	0.02	UI	
eta_0	1.64E-08	V^2/GHz	
SNR_TX	32.5	dB	
R_LM	0.95		
DER_0	1.00E-04		
Operational control			
COM Pass threshold	3	dB	
Include PCB	1	Value	0, 1, 2
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	0	logical
Display frequency domain	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\V165_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	V164	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
IDEAL_TX_TERM	0	logical
T_r	8.00E-03	ns
T_r_meas_point	0	logical
T_r_filter_type	1	logical

Non standard control options		
INC_PACKAGE	1	logical
IDEAL_RX_TERM	0	logical
INCLUDE_CTLE	1	logical
INCLUDE_TX_RX_FILTER	1	logical
COM_CONTRIBUTION	0	logical

Table 93A–3 parameters		
Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0 1.734e-3 1.455e-4]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	90	Ohm

Table 92–12 parameters		
Parameter	Setting	
board_tl_gamma0_a1_a2	[0 4.114e-4 2.547e-4]	
board_tl_tau	6.191E-03	ns/mm
board_Z_c	109.8	Ohm
z_bp (TX)	151	mm
z_bp (NEXT)	72	mm
z_bp (FEXT)	72	mm
z_bp (RX)	151	mm

- Yellow cells were changed as the following slide

COM Parameters for Clause 136 (Difference)

FUJITSU

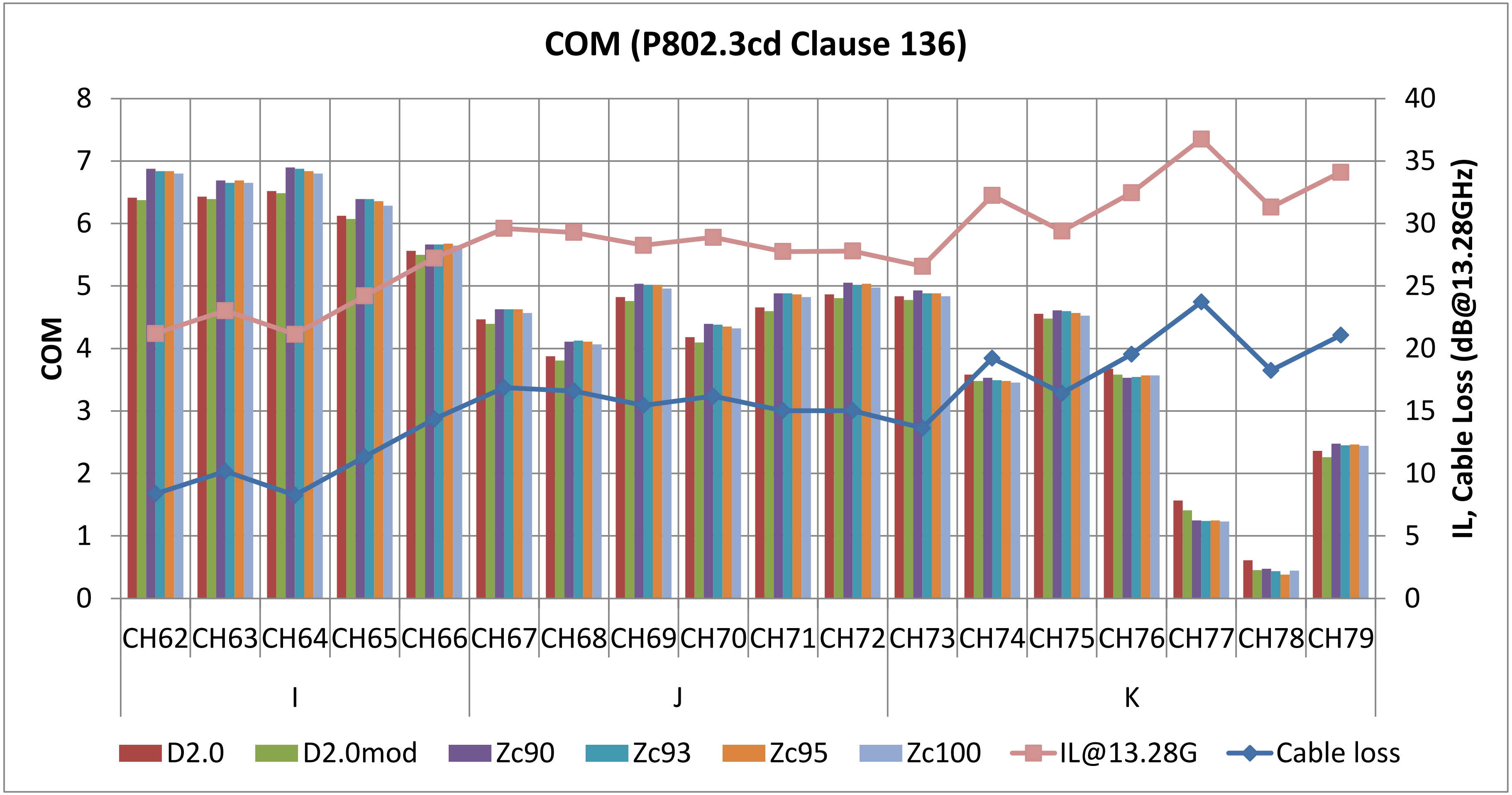
- Based on slide 12 of hidaka_060717_3cd_adhoc-v2.pdf
  - D2.0mod and Zc90/93/95/100 were calibrated at TP0a per Clause 136A
    - Assuming Tx spec of Clause 136 will be calibrated to align with Clause 136A
  - D2.0mod is same as D2.0 except Tx amplitude for fair comparison

Label	D2.0	D2.0mod	Zc90	Zc93	Zc95	Zc100
R_d	55	55	50	50	50	50
PKG Z_c	90	90	90	93	95	100
PCB Z_c	109.8	109.8	100	100	100	100
A_v	0.45	0.438	0.416	0.415	0.415	0.414
A_fe	0.45	0.438	0.416	0.415	0.415	0.414
A_ne	0.63	0.634	0.604	0.604	0.604	0.604
z_p	30	30	30	30	30	30

18 Channels for Simulation for Clause 136

Category	CH #	Cable Loss 13.28G	Description	Channel Data Source
I	62	8.4dB	Molex zQSFP (.5m AWG32)	50G/NGOATH Study Group (Molex_zQSFP-zQSFP_*.zip)
	63	10.2dB	Molex zQSFP (1m AWG30)	
	64	8.3dB	Molex zQSFP (1m AWG26)	
	65	11.3dB	Molex zQSFP (2m AWG26)	
	66	14.4dB	Molex zQSFP (3m AWG26)	
J	67,68	~17dB	TEC QSFP (3m AWG26)	P802.3by 25GbE TF (TE_QSFP_QSFP_3m_*.zip)
	69,70	~16dB	TEC QSFP (3m AWG25)	
	71,72	~15dB	TEC QSFP (3m AWG24)	
K	73	13.6dB	Molex zQSFP (2m AWG30)	P802.3bj 100GbE Cu TF (bugg_02_0511.zip)
	74	19.2dB	Molex zQSFP (3m AWG30)	
	75	16.4dB	Molex zQSFP (3m AWG26)	
	76	19.5dB	Molex zQSFP (4m AWG26)	
	77	23.7dB	Molex zQSFP (5m AWG26)	
	78	18.2dB	Molex zQSFP (5m AWG24 A)	P802.3bj 100GbE Cu TF (cablea_bugg_0[23]_0312.zip)
	79	21.1dB	Molex zQSFP (5m AWG24 B)	

Results for Clause 136



- All cables up to 4 meter significantly exceed 3dB COM
  - CH77, 78, 79 are 5 meter cables

Results for Clause 136 (ΔCOM from D2.0mod)

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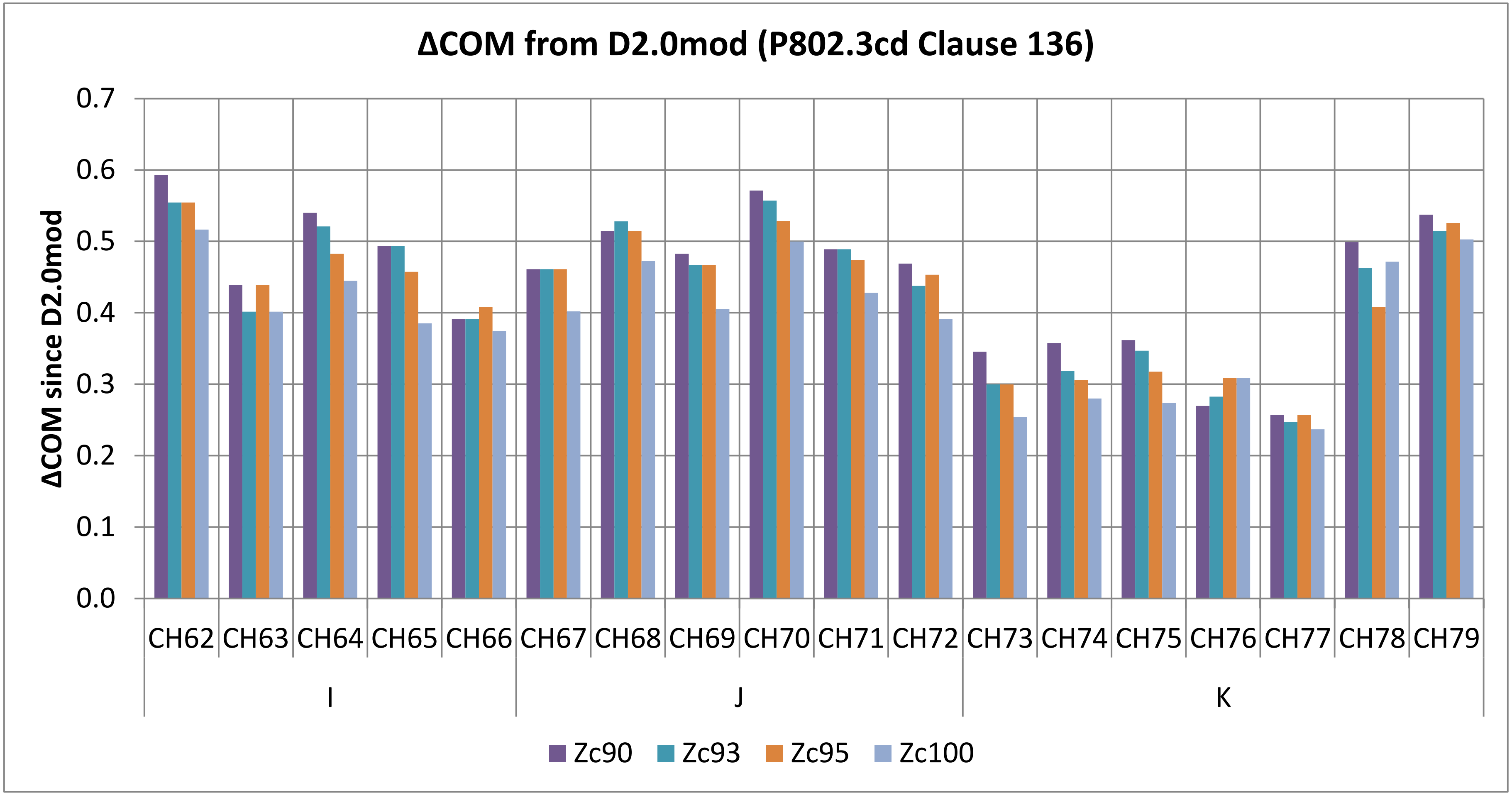

- Zc = 95Ω and COM = 3.3dB seems a reasonable choice
  - My proposal for Clause 136 is based on this result

Conclusions

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- COM often goes up a little, but goes down in some cases
  - This is due to the unpredictable bias of COM value, positive or negative depending on the channel, caused by interaction with reference Rx
- Nominal Rd and Zc tightens channel variation by minimizing interaction between reference Rx and channel
- COM values in my proposal is chosen not to change pass/fail status
  - COM value itself is not the focus of this proposal
- My proposal

	Annex 120D	Clause 137	Clause 136
Rd	50 Ω	50 Ω	50 Ω
PKG Zc	95 Ω	95 Ω	95 Ω
PCB Zc	N/A	N/A	100 Ω
Av	0.418 V	0.415 V	0.415 V
Afe	0.418 V	0.415 V	0.415 V
Ane	0.604 V	0.604 V	0.604 V
Channel COM	3.1dB	3.0dB	3.3dB

Back up Slides

- Results for Annex 120D (ΔCOM from D3.1)
- Results for Clause 137 (ΔCOM from D2.0)
- Results for Clause 136 (ΔCOM from D2.0)

Results for Annex 120D (ΔCOM from D3.1)

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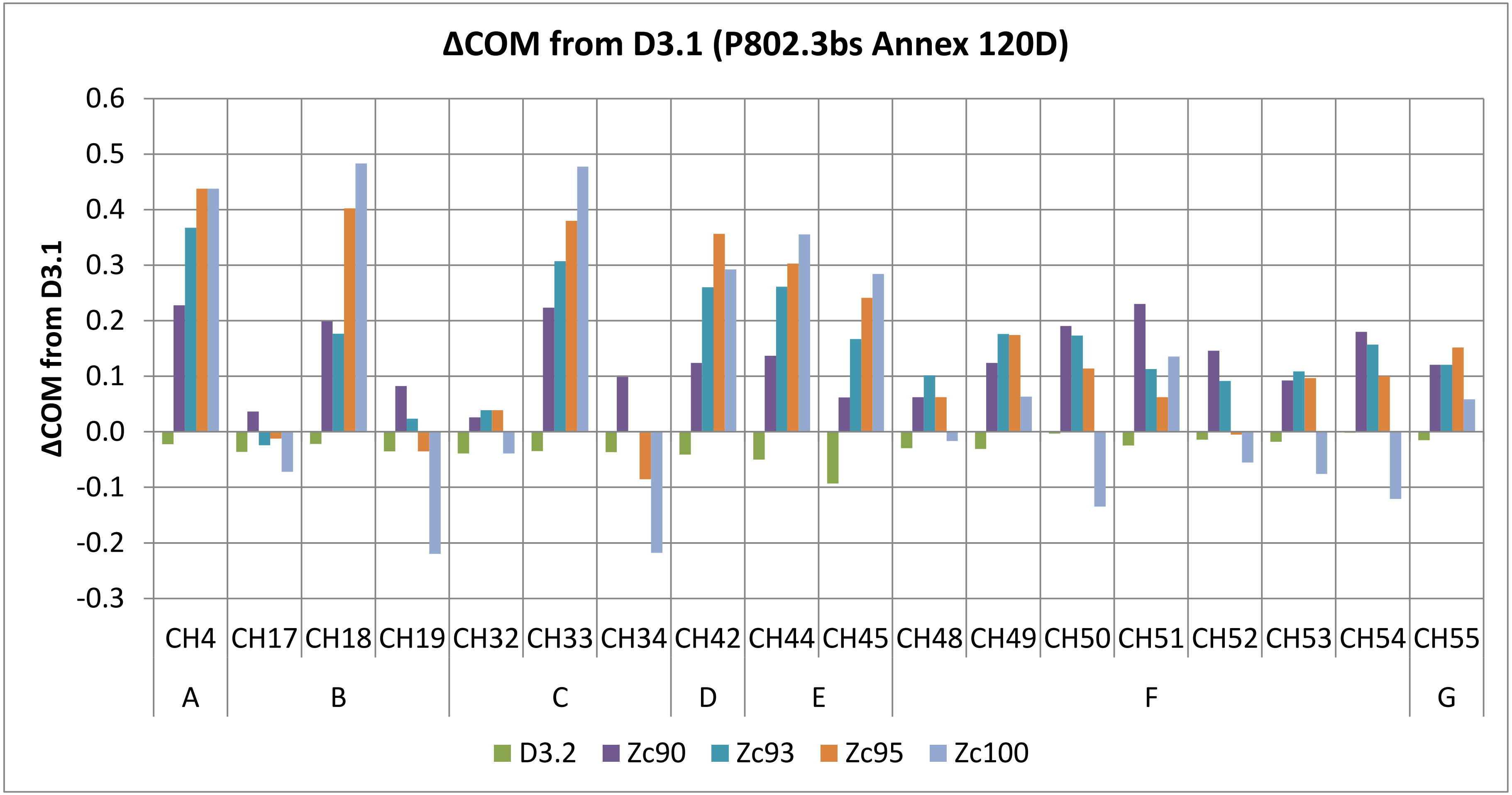

- Small degradation (~0.03dB) due to reduction of Av from D3.1

Results for Clause 137 (ΔCOM from D2.0)

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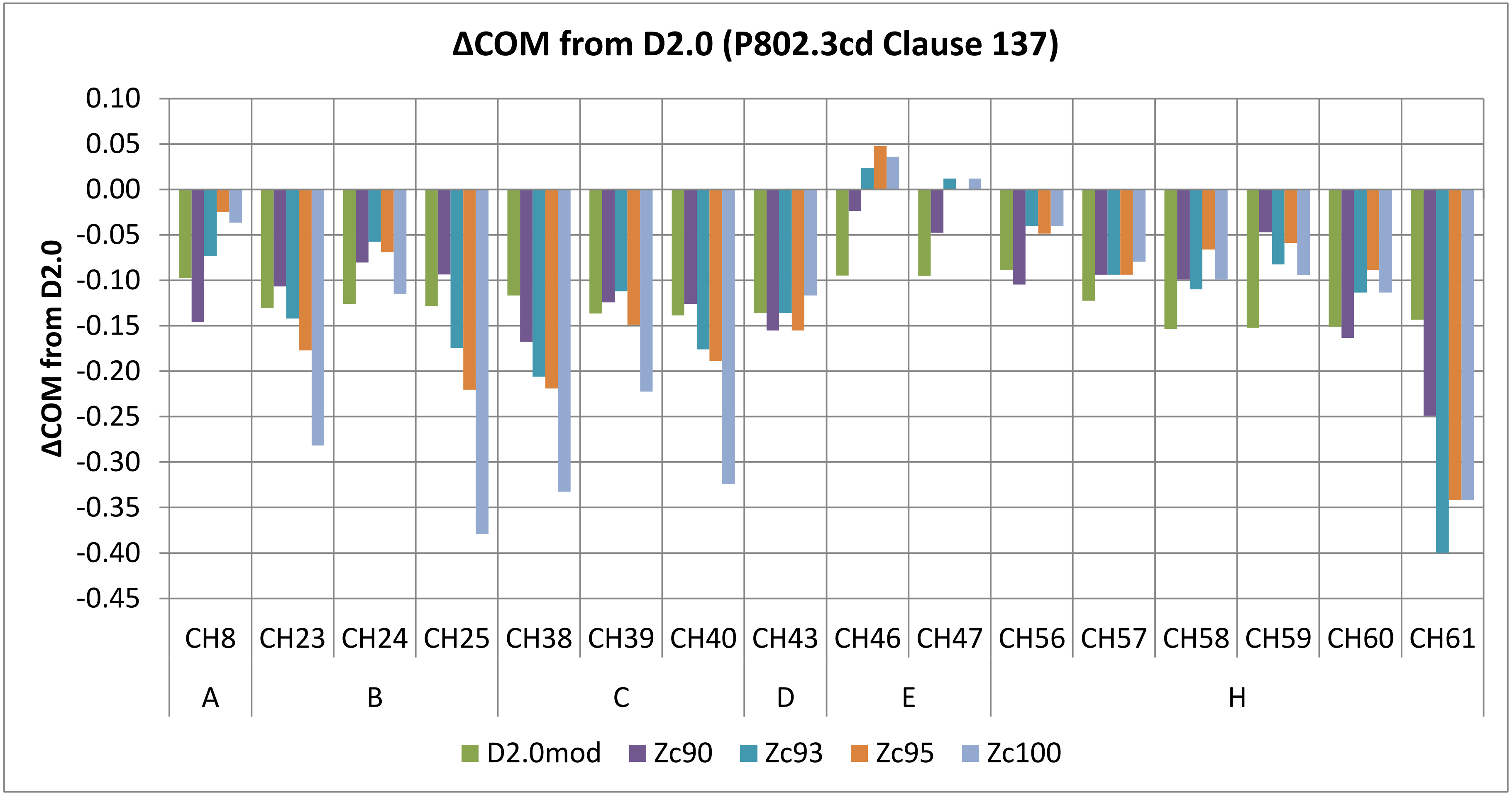

- Degradation (~0.13dB) due to reduction of Av from D2.0

Results for Clause 136 (ΔCOM from D2.0)

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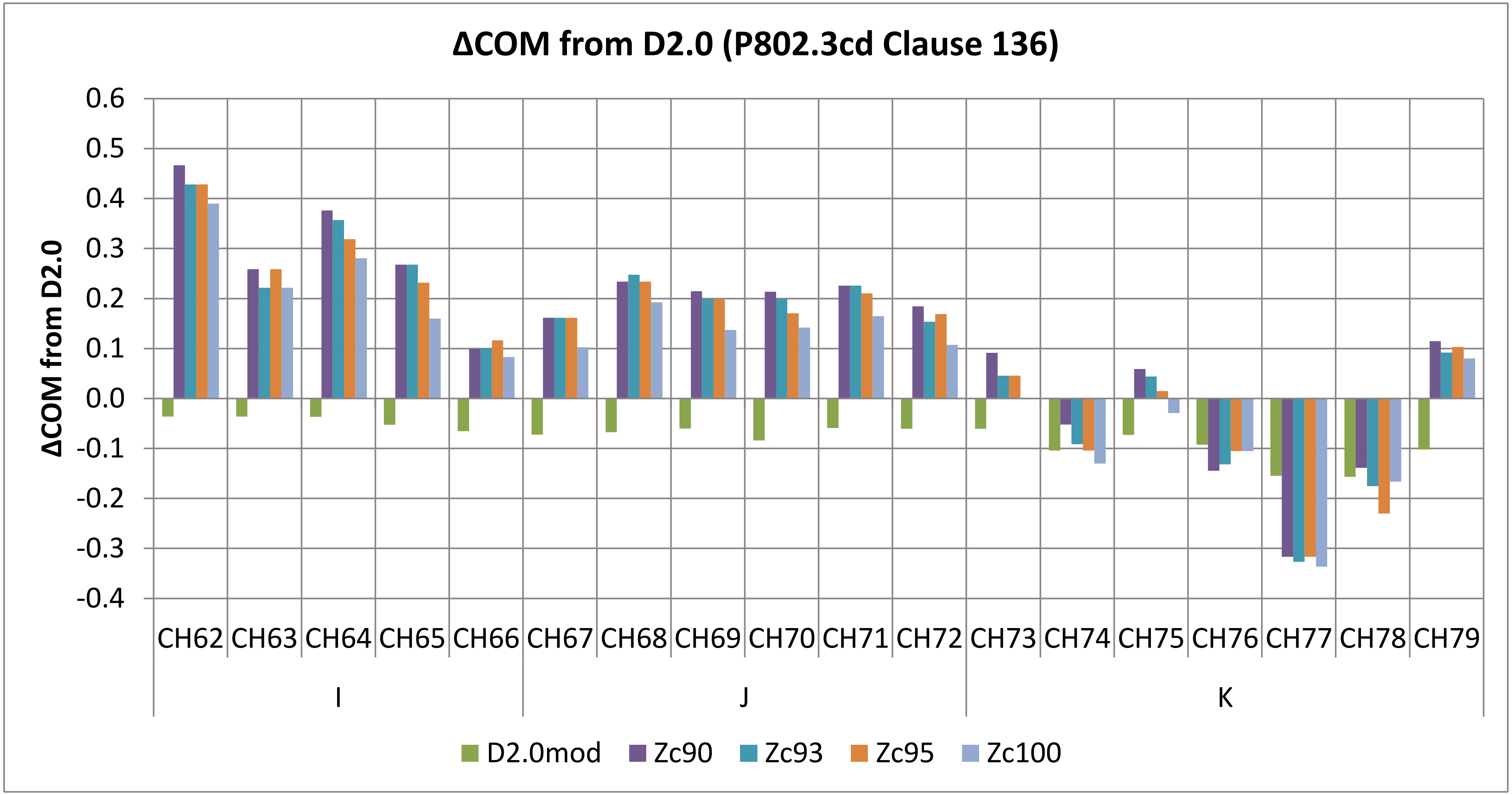

- Degradation (~0.08dB) due to reduction of Av from D2.0

Thank you