COM Simulation for 100G KR/CR Channels (update)

IEEE P802.3ck Task Force Ad Hoc, 12/12/2018

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Introduction

- A large number of COM simulations were conducted for all 115 KR/CR channels submitted to P802.3ck TF (including 100GEL SG) under 15 simulation conditions

- All results were consolidated into an Excel file with additional information (e.g. channel loss, equalizer settings) and interactive graphs for easy visualization
  - We are providing the excel file to Task Force for further examination and your own analysis

- This presentation explains how to use the Excel file

Simulation Conditions

Model Name		DFE (DFE-based)	PDFE (DFE + 3 pre-taps)	FFE (FFE-based)
# of taps	DFE	20	20	1
	FFE	0	4 (3-pre + 0-post)	24 (3-pre + 20-post)
	TX FIR	5 (3-pre + 1-post)		
Step	RX DFE, FFE	0%		
	TX FIR pre	1.5% / 2.0% / 2.5%	1.5% / 2.5%	1.5% / 2.0% / 2.5%
	TX FIR post	5%		
DFE b1max		0.7 / 0.85 / 1.0	0.7 / 0.85 / 1.0	0.7 / 0.85

- Label of Simulation Condition: Prefix + Model Name + Suffix
  - Prefix: step of TX FIR pre taps
    - None: 1.5%, C (coarse): 2.5%, M (Medium): 2.0%
  - Suffix: DFE b1max value
  - Example
    - CDFE0.85: DFE-based with DFE b1max=0.85 and 2.5% step of TX FIR pre taps
    - PDFE0.7: DFE + pre-taps with DFE b1max=0.7 and 1.5% step of TX FIR pre taps

Matrix of Conducted Simulation Conditions

- Simulations were done for the following 15 combinations of TX FIR pre step and DFE b1max:

TX FIR pre step	Model Name	Labels of Conducted Simulation Conditions		
		DFE b1max		
		0.7	0.85	1.0
1.5%	DFE (DFE-based)	DFE0.7	DFE0.85	DFE1.0
	PDFE (DFE + 3 pre-taps)	PDFE0.7	PDFE0.85	PDFE1.0
	FFE (FFE-based)	FFE0.7	FFE0.85	
2.5%	DFE (DFE-based)	CDFE0.7	CDFE0.85	
	PDFE (DFE + 3 pre-taps)	CPDFE0.7	CPDFE0.85	
	FFE (FFE-based)	CFFE0.7		
2.0%	DFE (DFE-based)		MDFE0.85	
	PDFE (DFE + 3 pre-taps)			
	FFE (FFE-based)	MFFE0.7		

Other Simulation Conditions

- Equalizer ranges
  - RX FFE taps
    - main_min = 0.7, pre1_max = 0.3, post1_max = 0.3, tapn_max = 0.125
  - RX CTLE
    - gDC $\in$ [-20,0], gDC2 $\in$ [-6,0]
  - TX FIR tap
    - c(-3) $\in$ [-0.105,0], c(-2) $\in$ [0,+0.105], c(-1) $\in$ [-0.3,0], c(1) $\in$ [-0.15,0]
      - This is the case of 1.5% pre tap step to align 0 on the grid
- Package Model (Tx and Rx)
  - 30mm @ 87.5Ω + 1.8mm @ 92.5Ω
  - C_d = 110fF, C_p = 70fF, R_d = 50Ω
- Noise, jitter
  - η_0=8.20E-9V^2/GHz, SNR_{TX}=32.5dB, σ_{RJ}=0.01UI, A_{DD}=0.02UI, R_{LM}=0.95
- COM Tool version
  - v2.53 + local modification to fix bugs

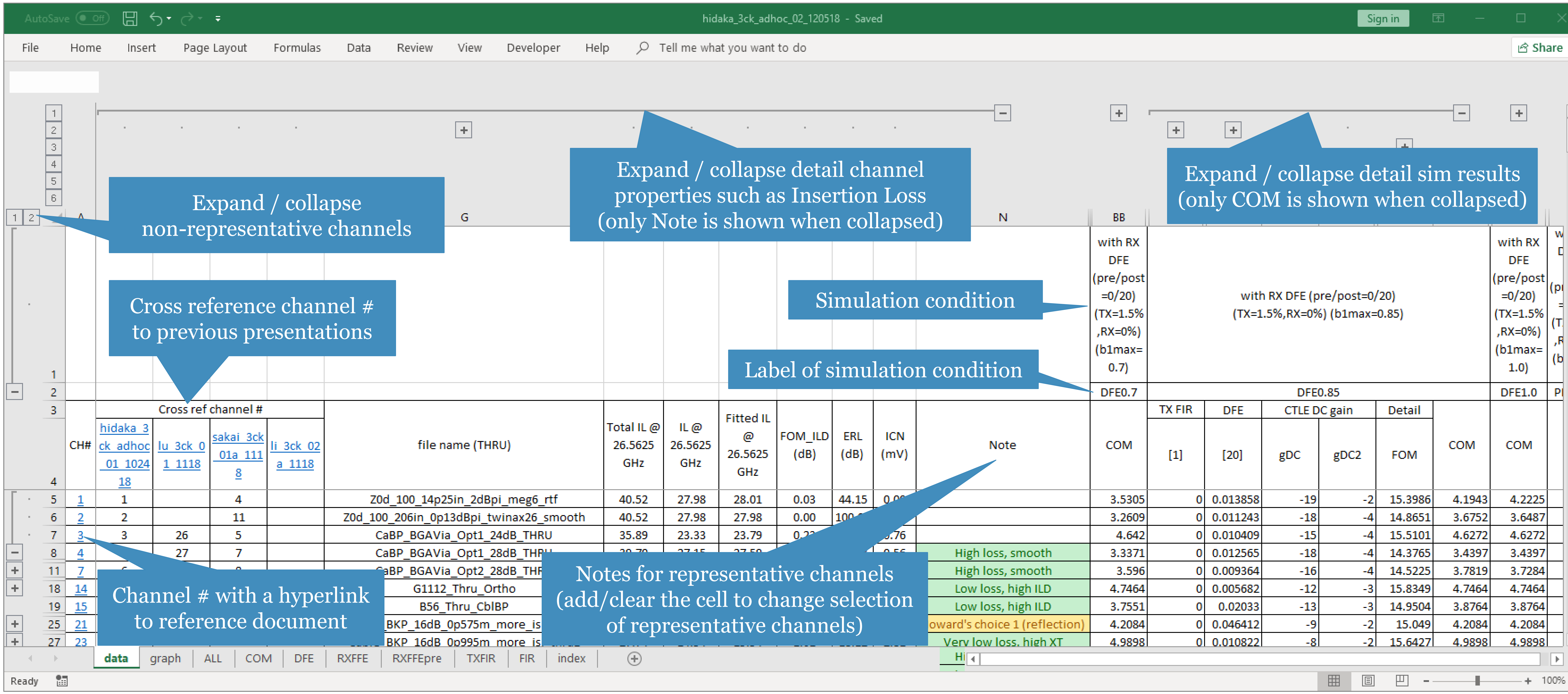
Channels Used for Simulation

➢ Simulation was done for the following publicly available 115 KR/CR channels

CH #	Group	Description	Reference Document
1-2	RM1	Two Very Good 28dB Loss Ideal Transmission Lines	mellitz_3ck_adhoc_02_072518.pdf
3-8	RM2	24/28/32dB Cabled Backplane Channels including Via	mellitz_3ck_adhoc_02_081518.pdf
9-10	RM3	Synthesized CR Channels (2.0m and 2.5m 28AWG Cable)	mellitz_100GEL_adhoc_01_021218.pdf
11-13	RM4	Best Case 3”, 13”, 18” Tachyon Backplane	mellitz_100GEL_adhoc_01_010318.pdf
14-15	NT1	Orthogonal or Cabled Backplane Channels	tracy_100GEL_03_0118.pdf
16	AZ1	Orthogonal Backplane Channel	zambell_100GEL_01a_0318.pdf
17-19	HH1	Initial Host 30dB Backplane Channel Models	heck_100GEL_01_0118.pdf
20-35	HH2	16/20/24/28dB Cabled Backplane Channels	heck_3ck_01_1118.pdf
36-54	UK1	Measured Traditional Backplane Channels	kareti_3ck_01a_1118.pdf
55-73	UK2	Measured Cabled Backplane Channels	
74-88	UK3	Measured Orthogonal Backplane Channels	
89-115	AZ2	Measured Orthogonal Backplane with Varied Impedances	zambell_3ck_01_1118.pdf

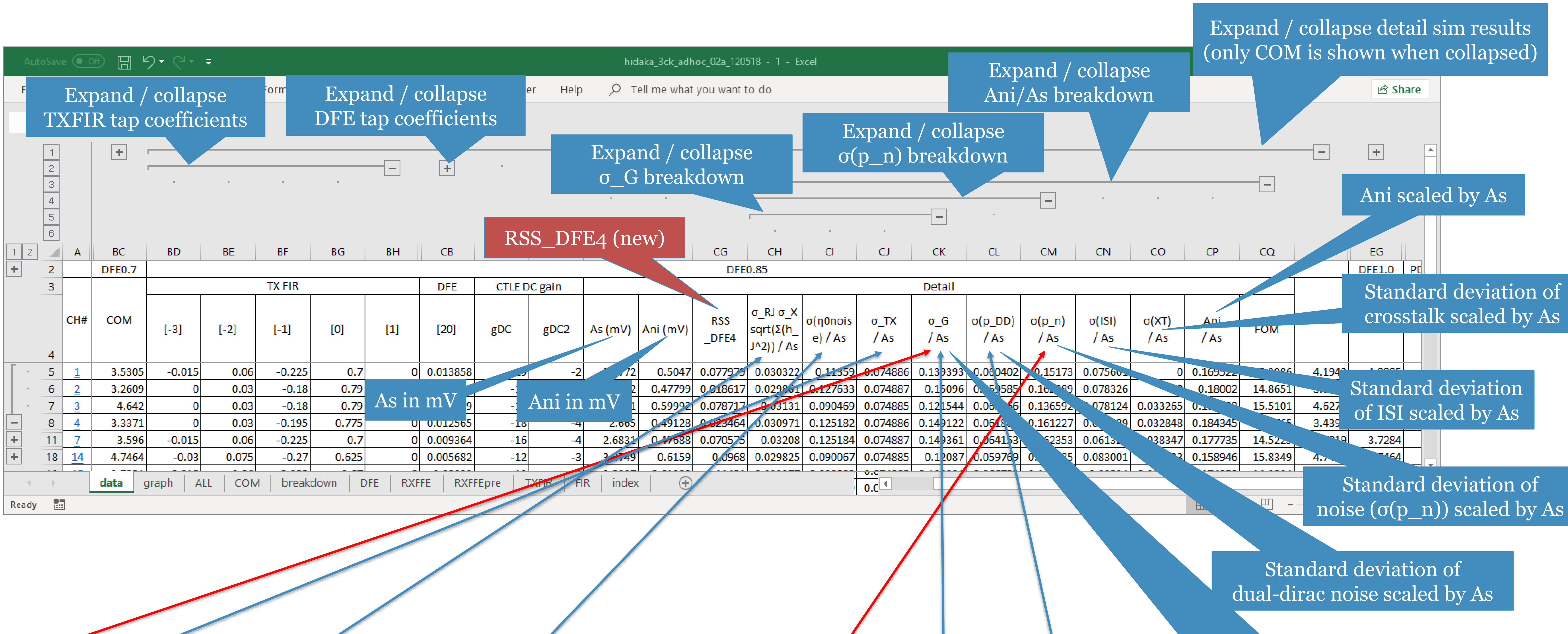
All channel data are taken from IEEE 100GEL Study Group and P802.3ck Task Force – Tools and Channels pages.
i.e. http://www.ieee802.org/3/100GEL/public/tools/index.html and http://www.ieee802.org/3/ck/public/tools/index.html

Sheet ‘data’ has all the detail data values (1/2)



➢ From this sheet, you can extract various data values for your own analysis

Sheet ‘data’ has all the detail data values (2/2) (Updated)



$$\sigma_G^2 = \sigma_{TX}^2 + \sigma_{RJ}^2\sigma_X^2\sum_n h_J^2(n) + \eta_0\int_0^\infty \left|H_r(f)H_{ctf}(f)\right|^2 df \qquad p_n(y) = p_G(y) * p_{DD}(y)$$

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Sheet 'graph' has General Interactive Graphs (Updated)

Modify yellow cells to customize graph

Variable of X axis

Simulation condition of X axis

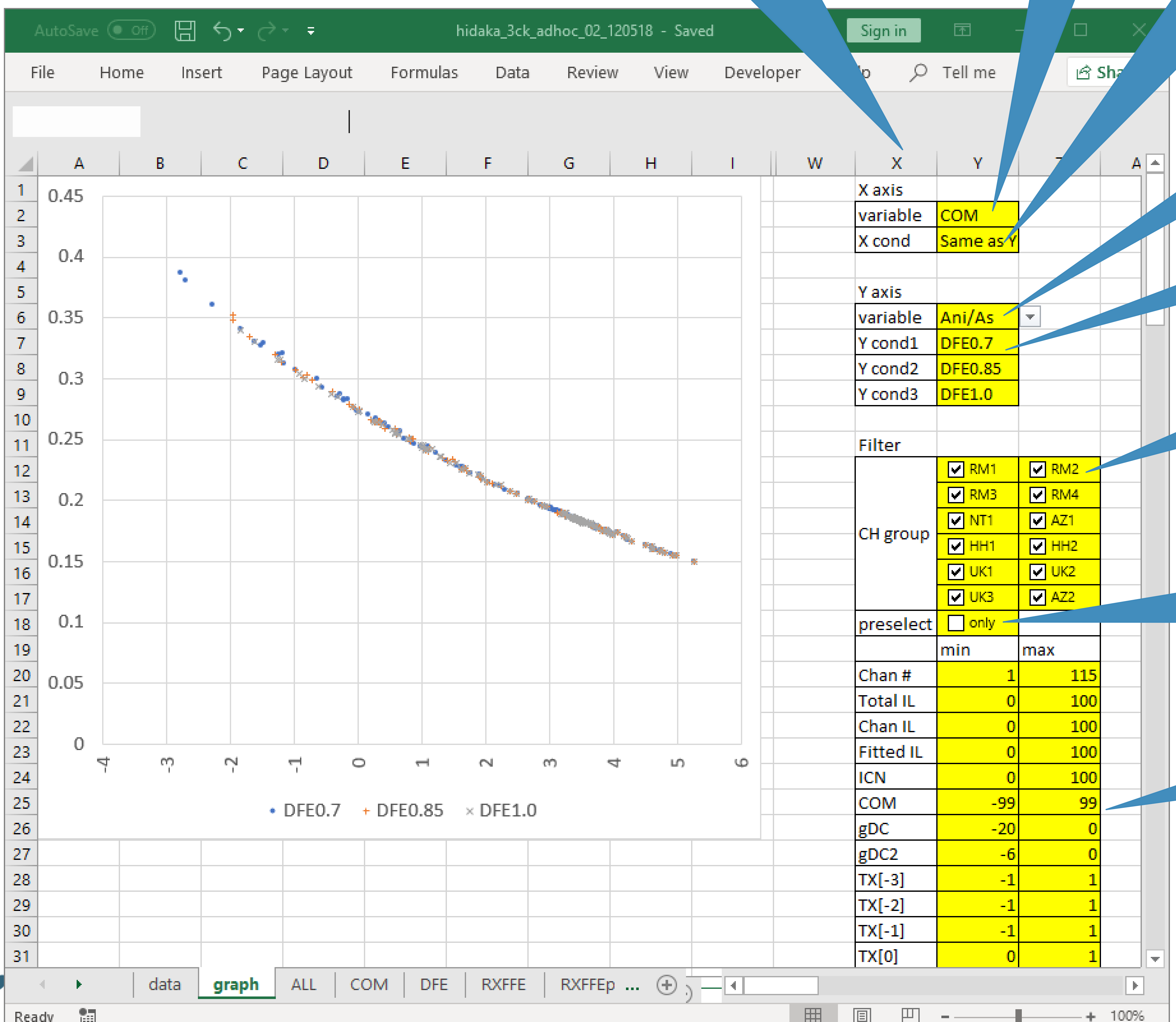
Variable of Y axis

Simulation conditions of Y axis

Check channel groups to plot

Check to plot only preselected representative channels with note

Min and max values to filter data to plot



Variables independent from simulation condition:
Chan #, Total IL, Chan IL, Fitted IL, FOM_ILD, ERL, ICN

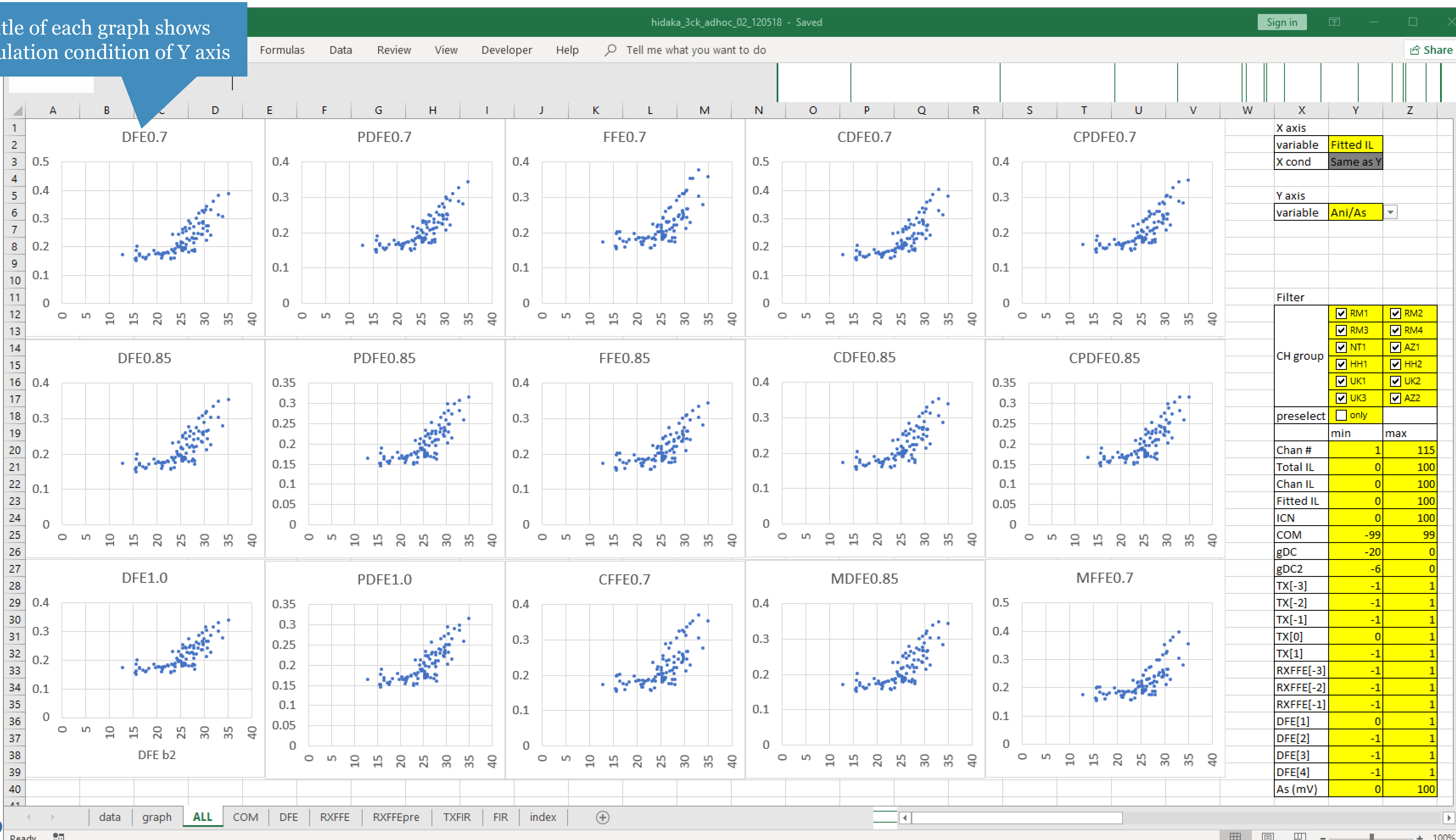
Variables depending on simulation condition:
COM, FOM, gDC, gDC2, TX[-3:1], RXFFE[-3:20], DFE[1:20], As (mV), Ani (mV), RSS_DFE4 (new), Ani/As, σ(XT)/As, σ(ISI)/As, σ(p_n)/As, σ(p_DD)/As, σ_G/As, σ_RJ σ_X sqrt(Σ(h_J^2)) / As, σ(η0noise) / As, σ_TX/As

Simulation conditions:
Same as Y (only for X axis),
DFE0.7, DFE0.85, DFE1.0,
PDFE0.7, PDFE0.85, PDFE1.0,
FFE0.7, FFE0.85,
CDFE0.7, CDFE0.85,
CPDFE0.7, CPDFE0.85,
CFFE0.7, MDFE0.85, MFFE0.7

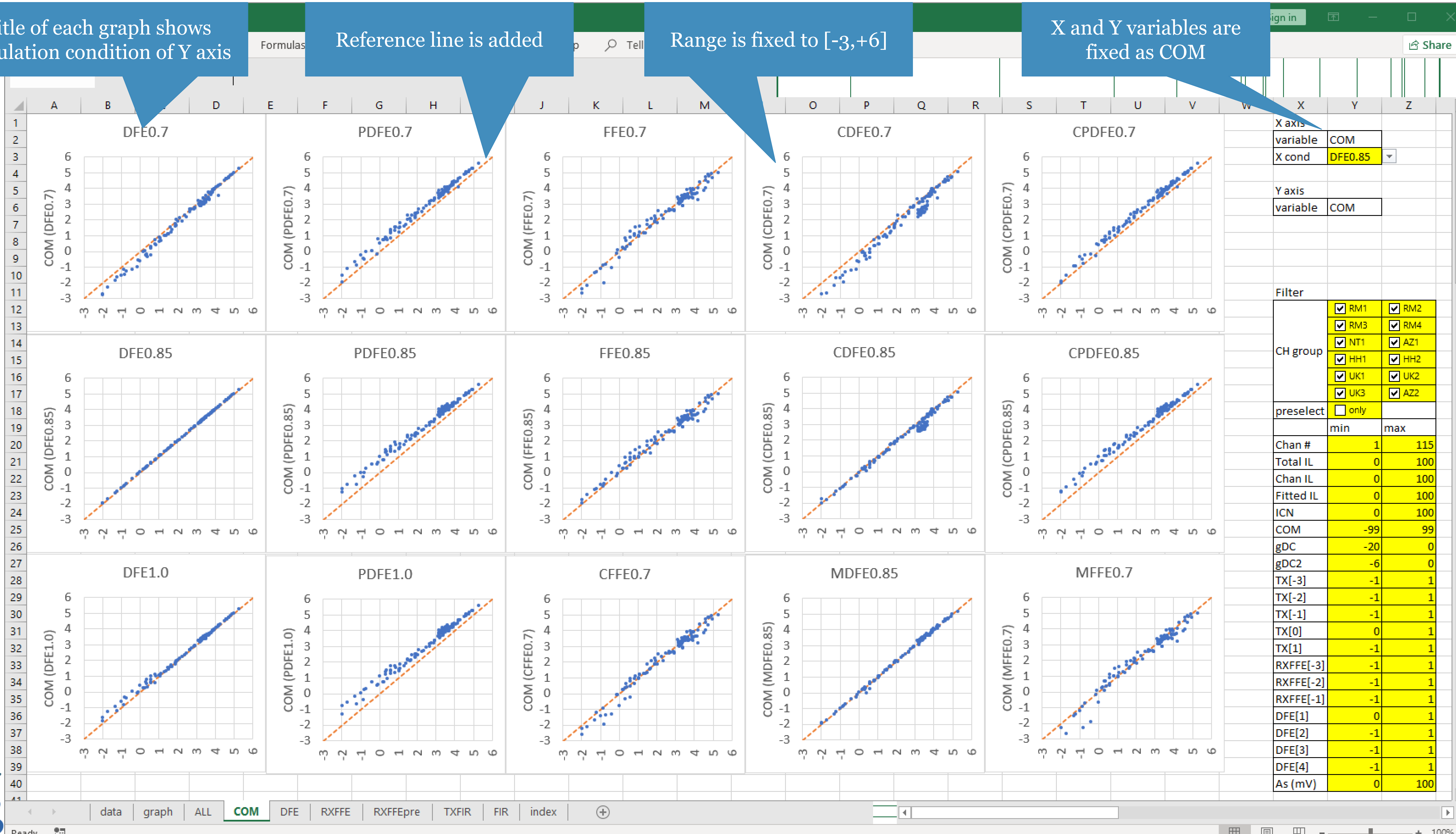
Simulation condition is shaded if variable is independent from simulation condition.

Sheet ‘ALL’ has 15 graphs for all sim conditions

Title of each graph shows simulation condition of Y axis

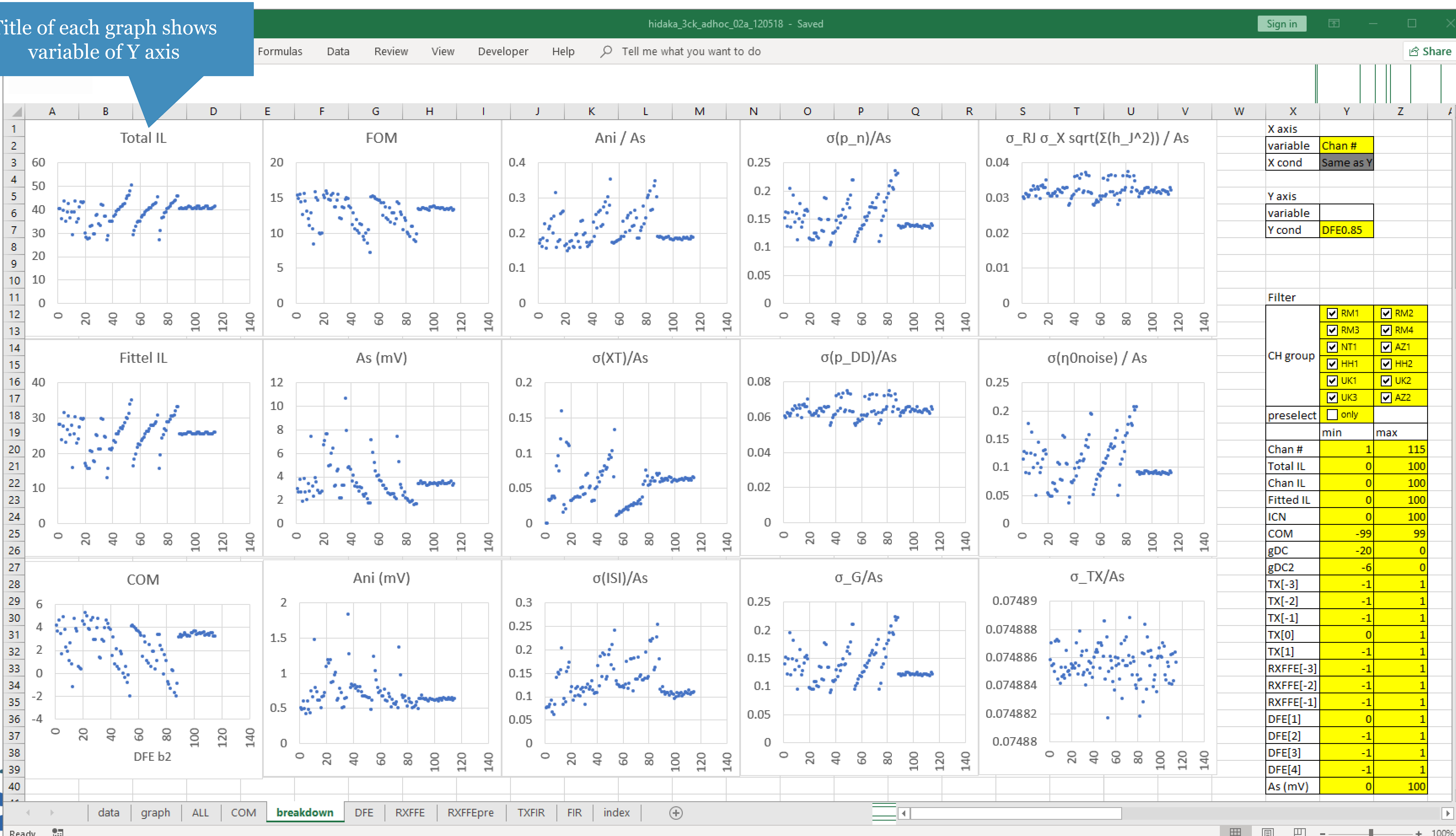


Sheet 'COM' has COM vs COM graphs

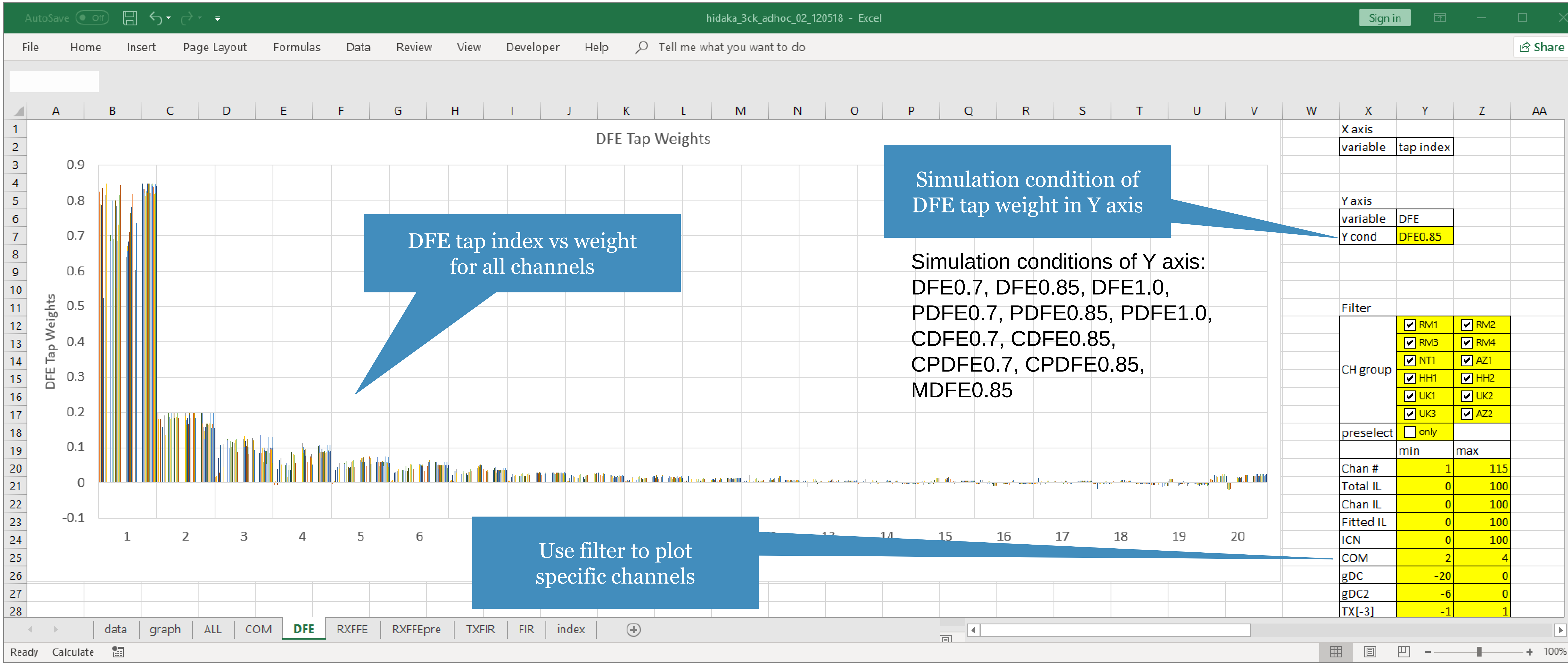


Sheet ‘breakdown’ shows components of COM (New)

Title of each graph shows variable of Y axis



Sheet 'DFE' has DFE Tap Weight Graph



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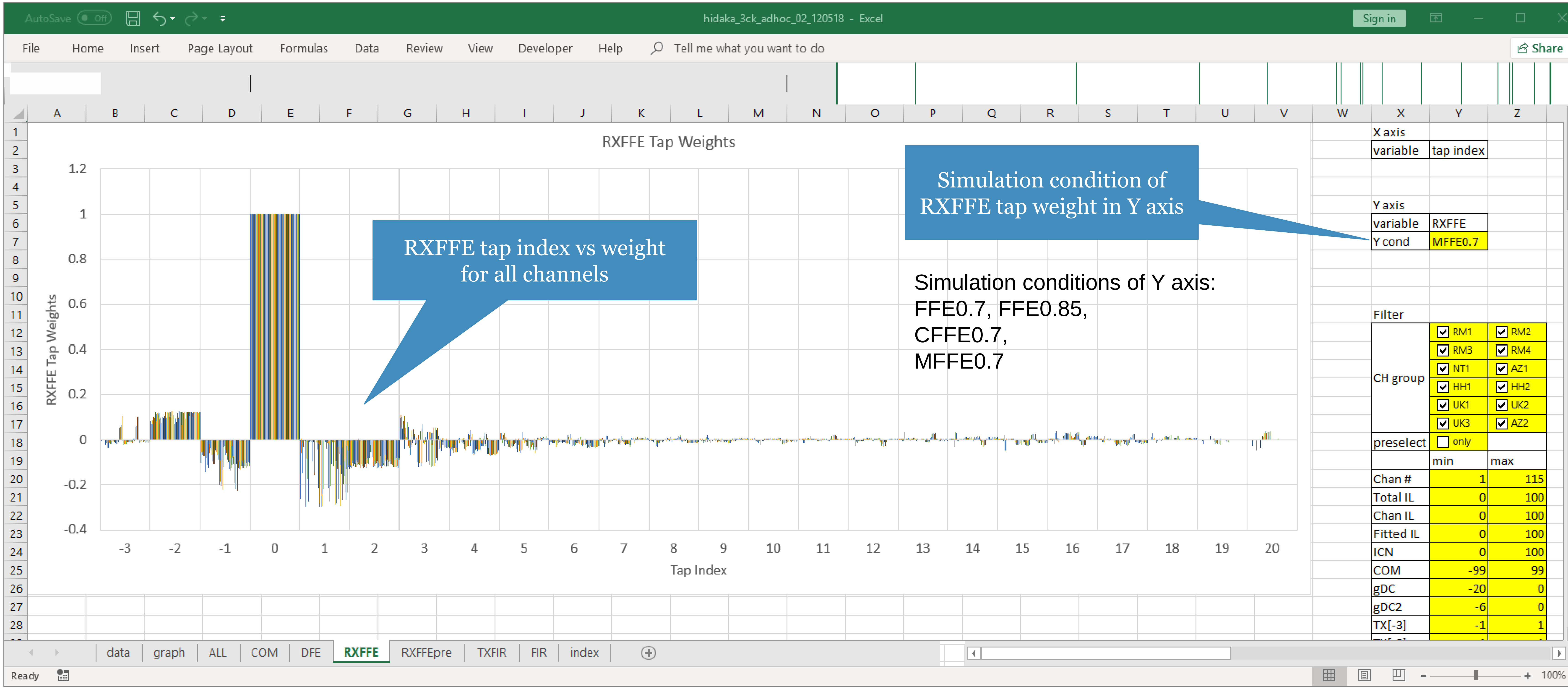
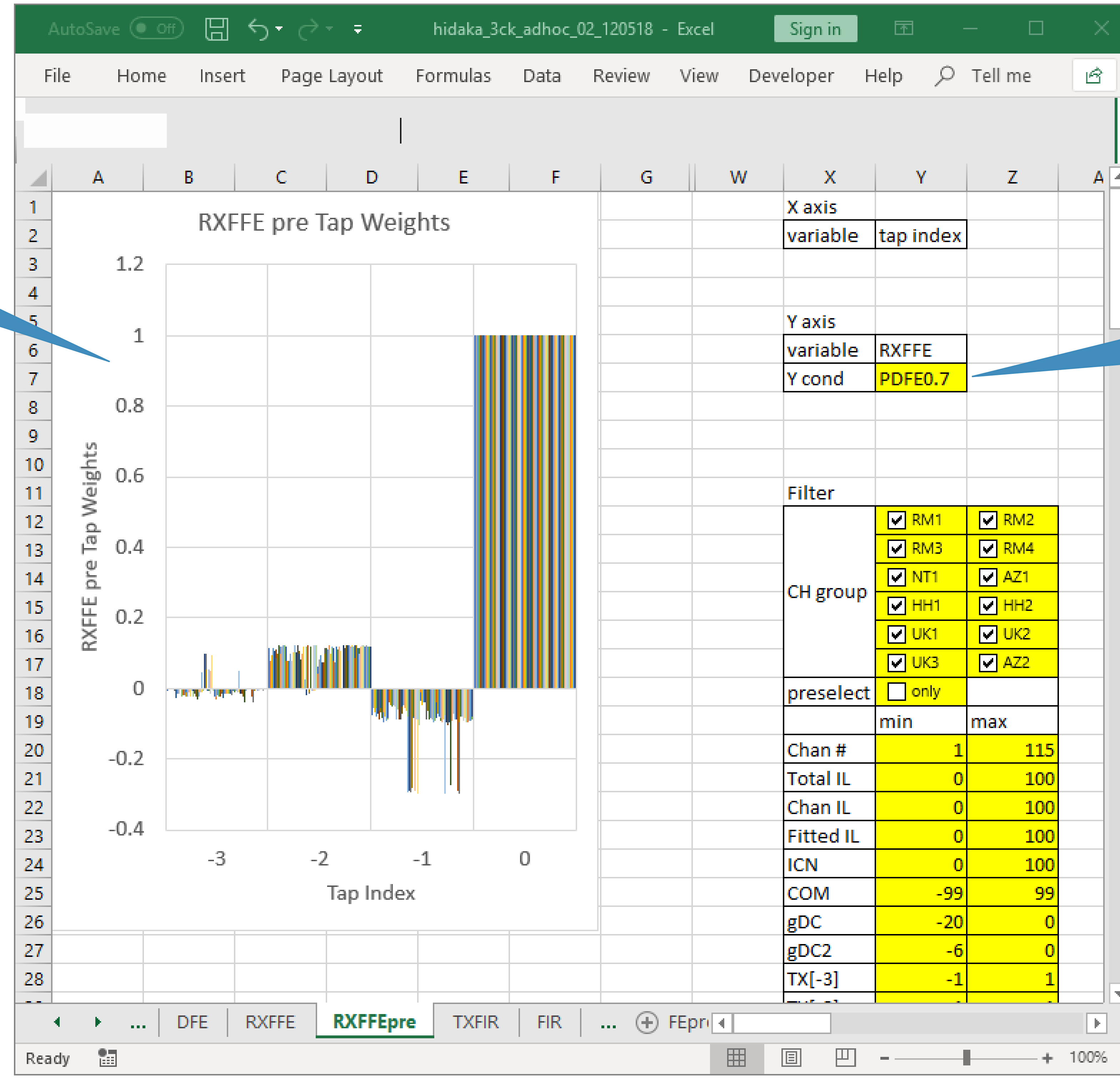
Sheet 'RXFFE' has RXFFE Tap Weight Graph



Sheet ‘RXFFEpre’ has RXFFE pre Tap Weight Graph

RXFFE pre-tap index vs weight for all channels

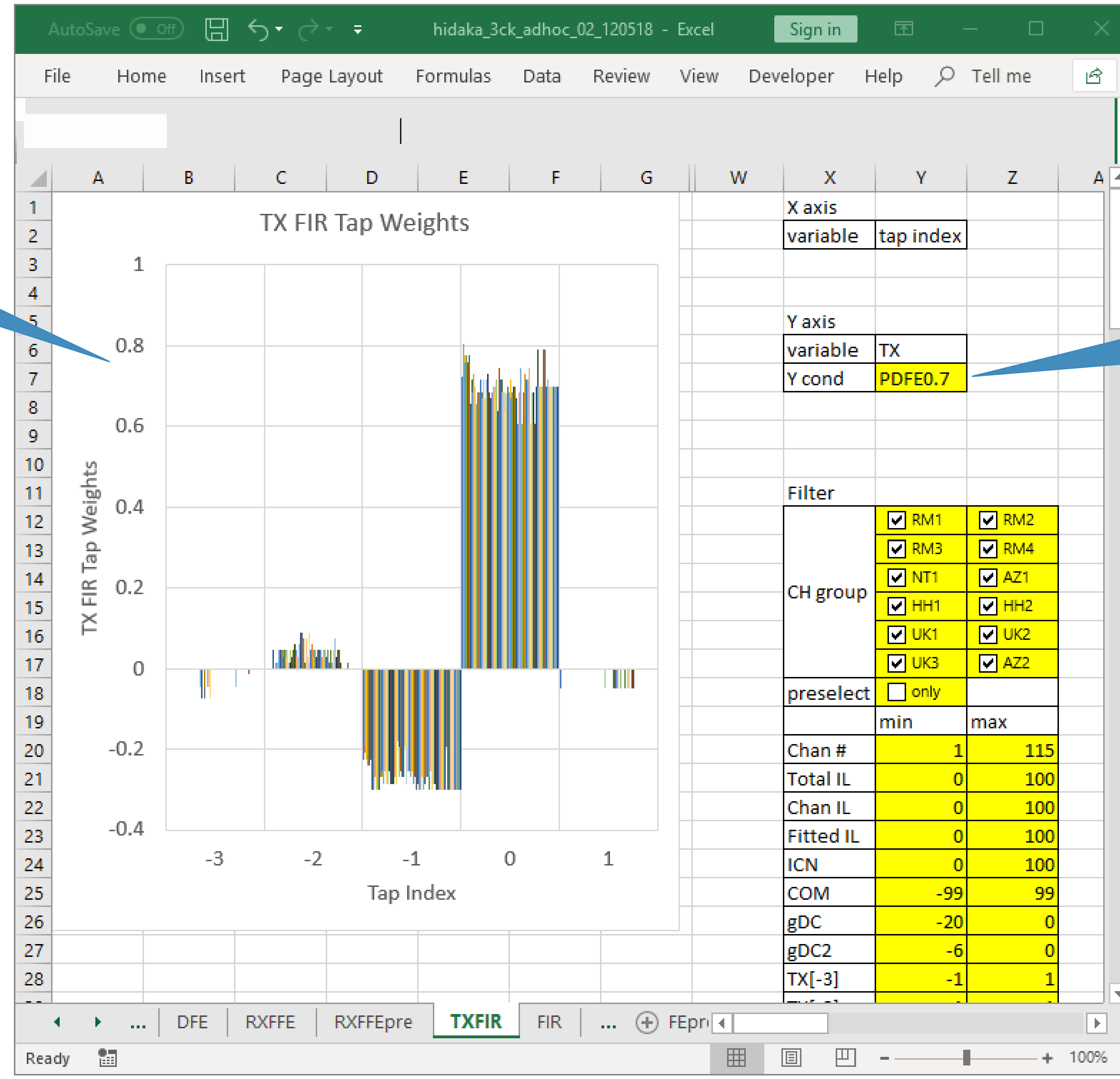


Simulation condition of RXFFE pre-tap weight in Y axis

Simulation conditions of Y axis:
PDFE0.7, PDFE0.85, PDFE1.0,
FFE0.7, FFE0.85,
CPDFE0.7, CPDFE0.85,
MFFE0.7

Sheet 'TXFIR' has TXFIR Tap Weight Graph

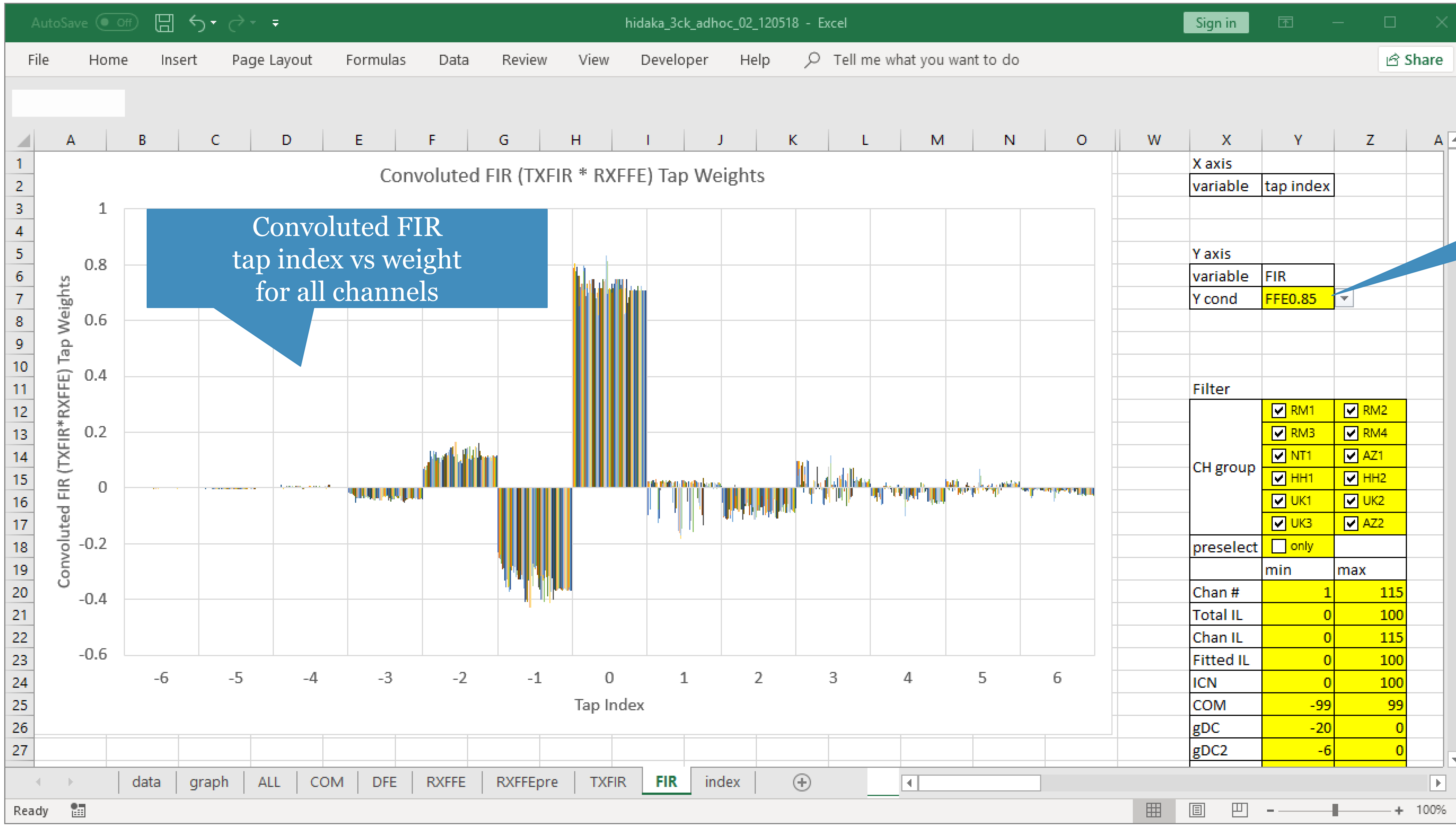
TXFIR tap index vs weight for all channels



Simulation condition of TXFIR tap weight in Y axis

Simulation conditions of Y axis:
DFE0.7, DFE0.85, DFE1.0,
PDFE0.7, PDFE0.85, PDFE1.0,
FFE0.7, FFE0.85,
CDFE0.7, CDFE0.85,
CPDFE0.7, CPDFE0.85,
CFFE0.7,
MDFE0.85, MFFE0.7

Sheet 'FIR' has Convoluted FIR Tap Weight Graph



Simulation condition of convoluted FIR tap weight in Y axis

Simulation conditions of Y axis:
DFE0.7, DFE0.85, DFE1.0,
PDFE0.7, PDFE0.85, PDFE1.0,
FFE0.7, FFE0.85,
CDFE0.7, CDFE0.85, CPDFE0.7, CPDFE0.85,
CFFE0.7,
MDFE0.85, MFFE0.7

- Convoluted FIR: effective FIR filter as convolution of TXFIR and RXFFE
  - Convoluted FIR[-6] = TXFIR[-3] * RXFFE[-3]
  - Convoluted FIR[-5] = TXFIR[-3] * RXFFE[-2] + TXFIR[-2] * RXFFE[-3]
  - Convoluted FIR[-4] = TXFIR[-3] * RXFFE[-1] + TXFIR[-2] * RXFFE[-2] * TXFIR[-1] * RXFFE[-3]
  - and so on

Back up

Detail COM Parameters (DFE0.7)

Table 93A-1 parameters			
Parameter	**Setting**	**Units**	**Information**
f_b	53.125	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.1e-4 1.1e-4]	nF	[TX RX]
z_p select	2		[test cases to run]
z_p (TX)	[12 30; 1.8 1.8; 0 0 ; 0 0]	mm	[test cases]
z_p (NEXT)	[12 30; 1.8 1.8; 0 0 ; 0 0]	mm	[test cases]
z_p (FEXT)	[12 30; 1.8 1.8; 0 0 ; 0 0]	mm	[test cases]
z_p (RX)	[12 30; 1.8 1.8; 0 0 ; 0 0]	mm	[test cases]
C_p	[0.8e-4 0.8e-4]	nF	[TX RX]
C_v	[0 0]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.41	V	
A_fe	0.41	V	
A_ne	0.6	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.3:0.015:0]		[min:step:max]
c(-2)	[0:.015:0.105]		[min:step:max]
c(-3)	[-0.105:0.015:0]		[min:step:max]
c(-4)	[0]		[min:step:max]
c(1)	[-0.15:0.05:0]		[min:step:max]
N_b	20	UI	
b_max(1)	0.7		
b_max(2..N_b)	0.2		
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	21.25	GHz	
f_p1	21.25	GHz	
f_p2	53.125	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	
ffe_pre_tap_len	**0**	UI	
ffe_post_tap_len	0	UI	
Include PCB	0	logical	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	\results\100GEL_WG_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	KR2_ev al1_	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
DER_0	1.00E-04	
T_r	6.16E-03	ns
FORCE_TR	1	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	1000	
TDR_Butterworth	1	logical
beta_x	1.70E+09	
rho_x	**0.18**	
fixture delay time	0	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	8.20E-09	V^2/GHz
SNR_TX	32.5	dB
R_LM	0.95	

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 1.0404e-3 4.201e-4]	
package_tl_tau	6.325E-03	ns/mm
package_Z_c	[87.5 87.5; 92.5 92.5; 100 100; 100 100]	Ohm (tdr sel)

Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 3.8206e-04 9.5909e-05]*	
board_tl_tau	*5.790E-03*	ns/mm
board_Z_c	90	Ohm
z_bp (TX)	*115*	mm
z_bp (NEXT)	*115*	mm
z_bp (FEXT)	*115*	mm
z_bp (RX)	*115*	mm