

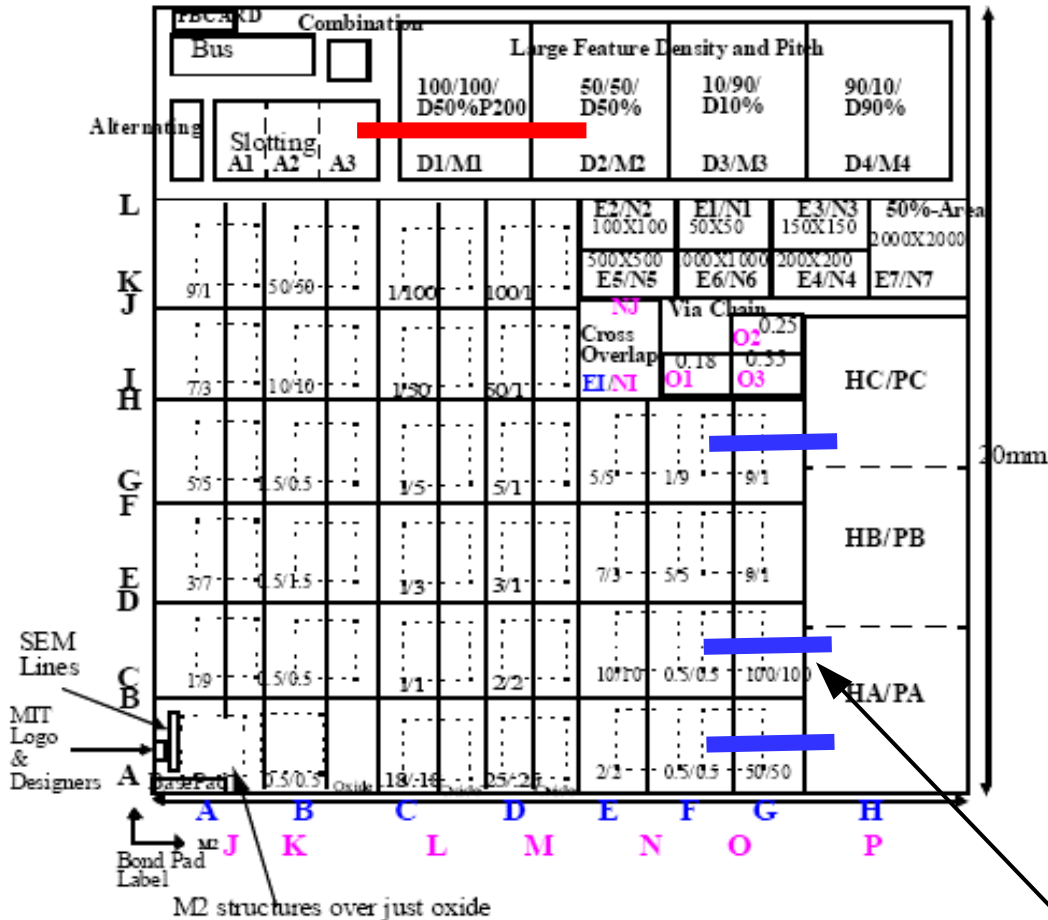
ATR35 Wafer Specification

SKW ASSOCIATES, INC.

3370 Victor Court, Santa Clara, CA 95054

Tel: 408-919-0094, Fax: 408-919-0097

Sematech 754 Layout



Sematech 754
Documentation

- Samsung dishing structure
- Sematech dishing structures

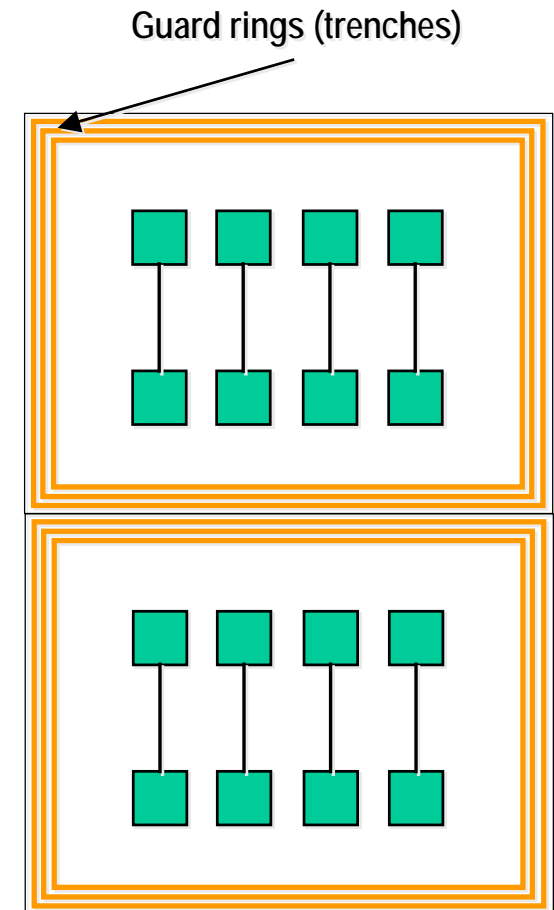
- The typical Sematech dishing structure used is the 100/100 array

ATR35 Capabilities

Key BU's :
➤ All

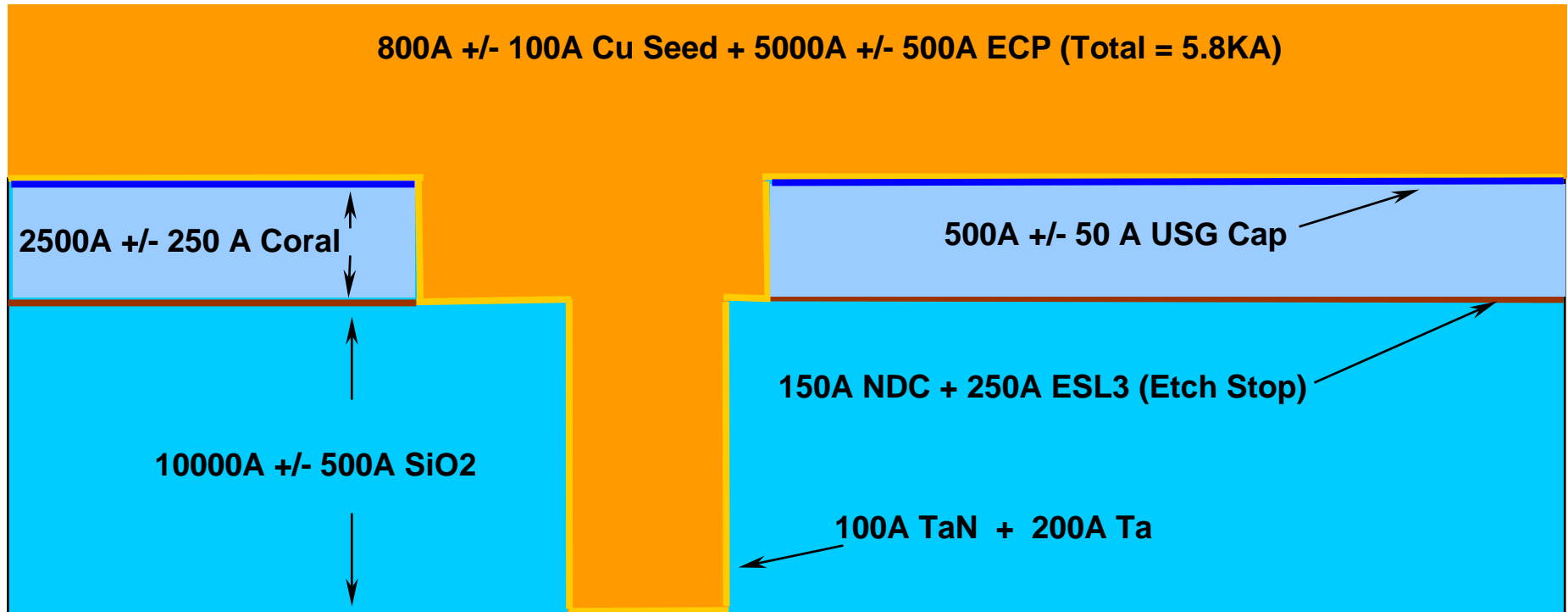
ATR35 Description

- ➔ Reduction in critical dimensions
 - Minimum metal line width: 60nm
 - Via sizes down to 80nm
 - Via chains with up to ~10 million vias
- ➔ Expanded and improved set of reliability testers
 - Guard rings added to prevent low-k moisture adsorption



Structures down to 45nm node

ATR M1 Film Stack



- Barrier CMP Target: Remove USG Cap + 200A Coral

ATR35 only available with Coral films

ATR Process Flow (up to M1 CMP)

Step	Operation	Hold? (Y)	Non-Std? (Y)	Split? (Y)	Recipe Name	Tools	Specification	date In	wfrs In	date Out	wfrs Out	Oper	Comments
1L 001	STARTING MATERIAL												
1L 002	DIELECTRIC DEP.												
1L 002a	Isolation dielectric				BL_USG_10kA_V1	13A or 14B	SiO ₂ , 10000 ± 500 Å						
1L 002b	Etch stop layer				BL_kStop_400A_V1	Bay 14B	H ₂ / 150Å NDC / 250Å ESL3						
1L 002c	Line dielectric (M1)				BL_HMSCORAL_2500A_V2	Bay 14A	HMS Coral, 2500 ± 250 Å						
1L 002d	Adhesion treatment				BL_HePlasma_V1	Bay 14B	He plasma, static mode, 20"						
1L 002e	Cap layer				BL_TEOS_500A_V1	13A or 14A	TEOS, 500 ± 50 Å						
1L 002f	Defect measurement				USG_8633A_160nm_HS_M2M	SP1	TBD						Map to map with pre
1L 003	PHOTOLITHOGRAPHY (M1 TRENCH)												
1L 004	DIELECTRIC ETCH / STRIP / CLEAN (M1 TRENCH)												
1L 006	PVD B/S - Verify Cu electrofill is up before processing Time restriction: <5 days between PVD B/S and Cu fill Contact owner if time restriction exceeded.												
	Flow				BL_PVD_140H_V1	Inova XT	Flow name						
	Degas				(BL_350C_90s_V1)	Inova XT	350 °C, 90"						
	Barrier				(BL_Ta_BKM4_V1)	Inova XT	100Å TaN - 150Å + 200Å Ta - 50Å						
	Seed				(BL_Cu_BKM4b_800A_V1)	Inova XT	800 + 100 Å						
1L 007	Cu ELECTROFILL- Time restriction: <24 hours between Cu fill and Cu anneal Contact owner if time restriction exceeded												
	Cu fill				BL_ECu_5000A_V4	Sabre XT	5000 + 250 Å						
	Anneal					Sabre XT	225 °C, 90 sec.						
1L 009	METAL POLISH - Verify PECVD is up before processing Time restriction: <72 hours between Cu CMP and M2 Coral stack dep. Contact owner if time restriction exceeded												
	Cu CMP				BL140H_M1_V2	Xceda	Stop on barrier						
	TaN CMP					Xceda	Remove TEOS cap + ~200Å Coral						
	Clean					Xceda	Surfaces clean						
	Inspection						No residual metal or particles						

ATR Test Structures

- Topography test structures
- Fang test structures
- Electrical test structures

Typical CIC Profilometry Locations

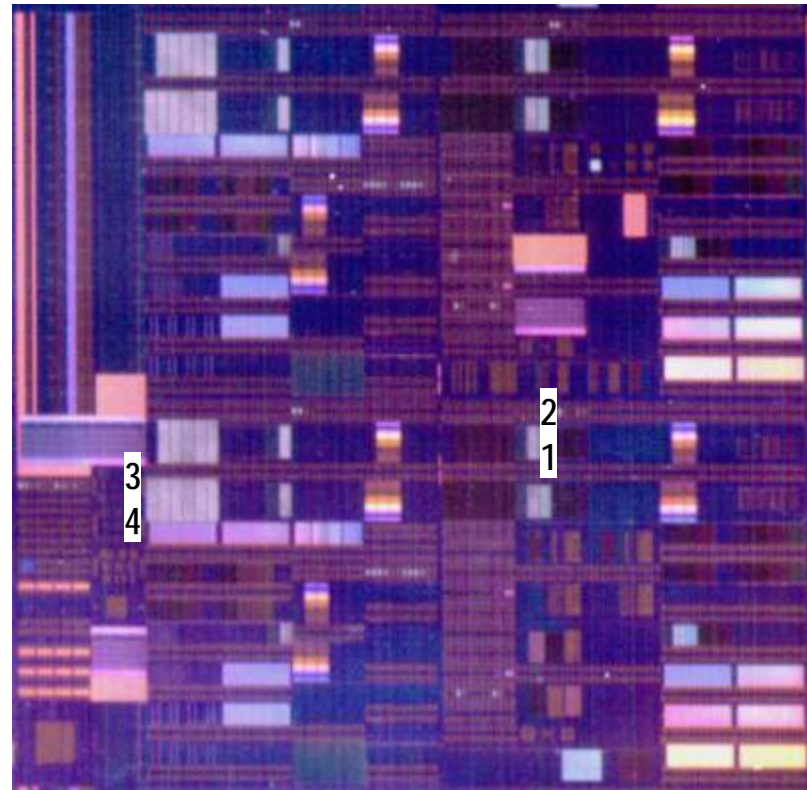
- New profilometry recipe was created to measure large and small E-test comb/serp structures in addition to CMP test structures.

New structures profiled:

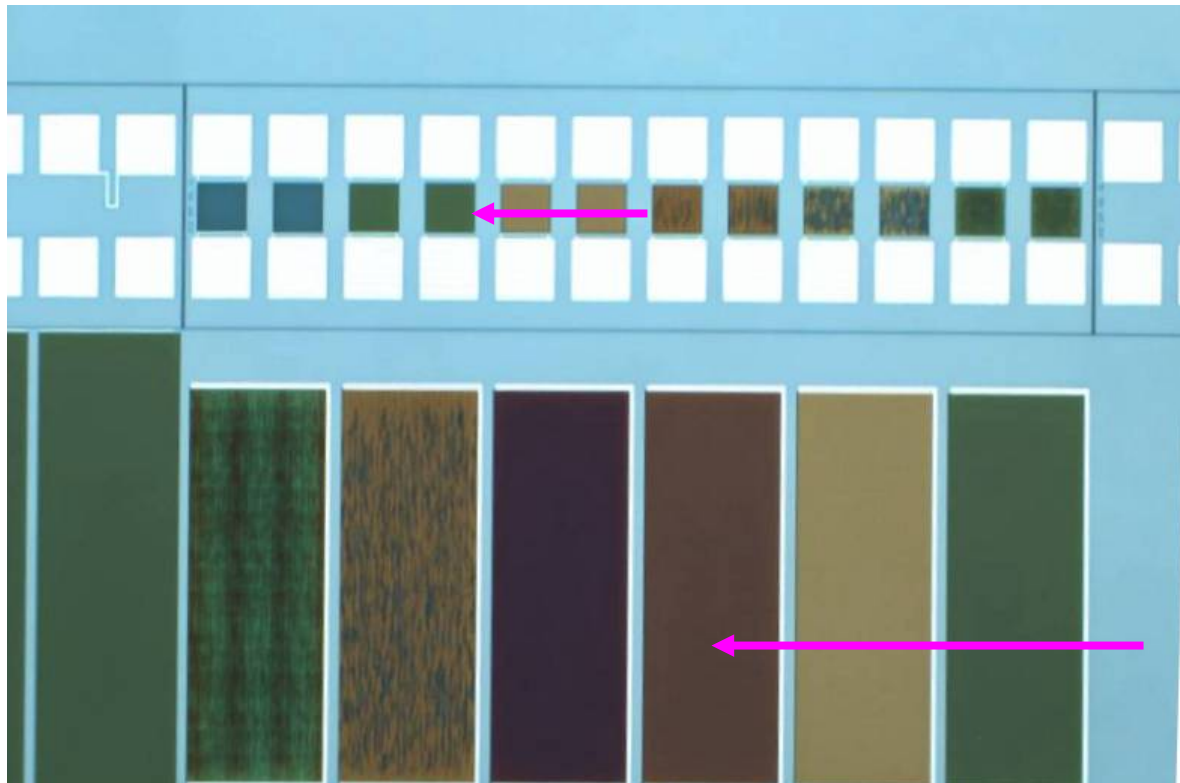
1. CMB_SRP_LRL_M1
2. CMB_SRP_SRL_M1

CMP test structures profiled:

3. FANG1 single line structures
4. FANG2 small pitch arrays



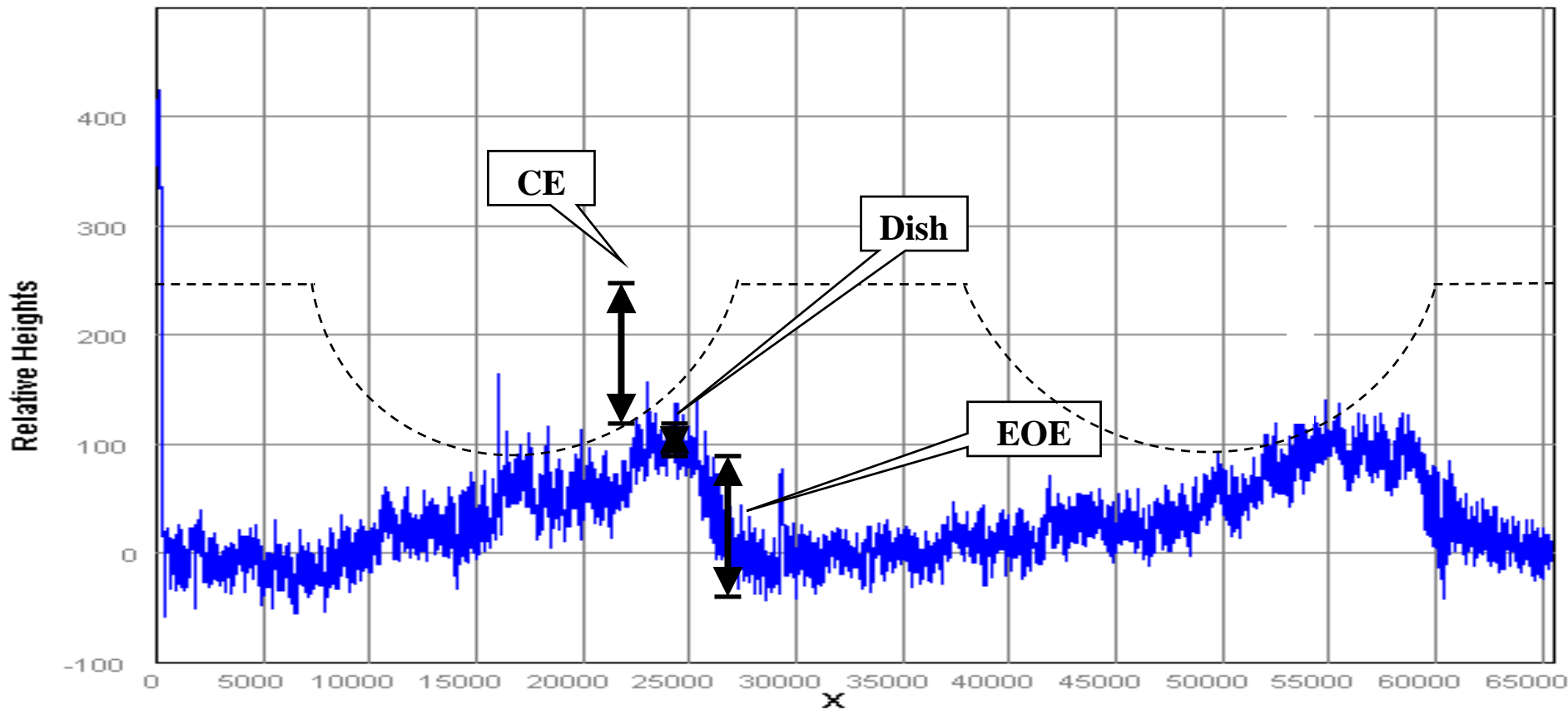
Serp/Comb Scan Locations



CMB_SRP_SRL_M1
DUTs 5 & 6 scanned
(140x140 nm)

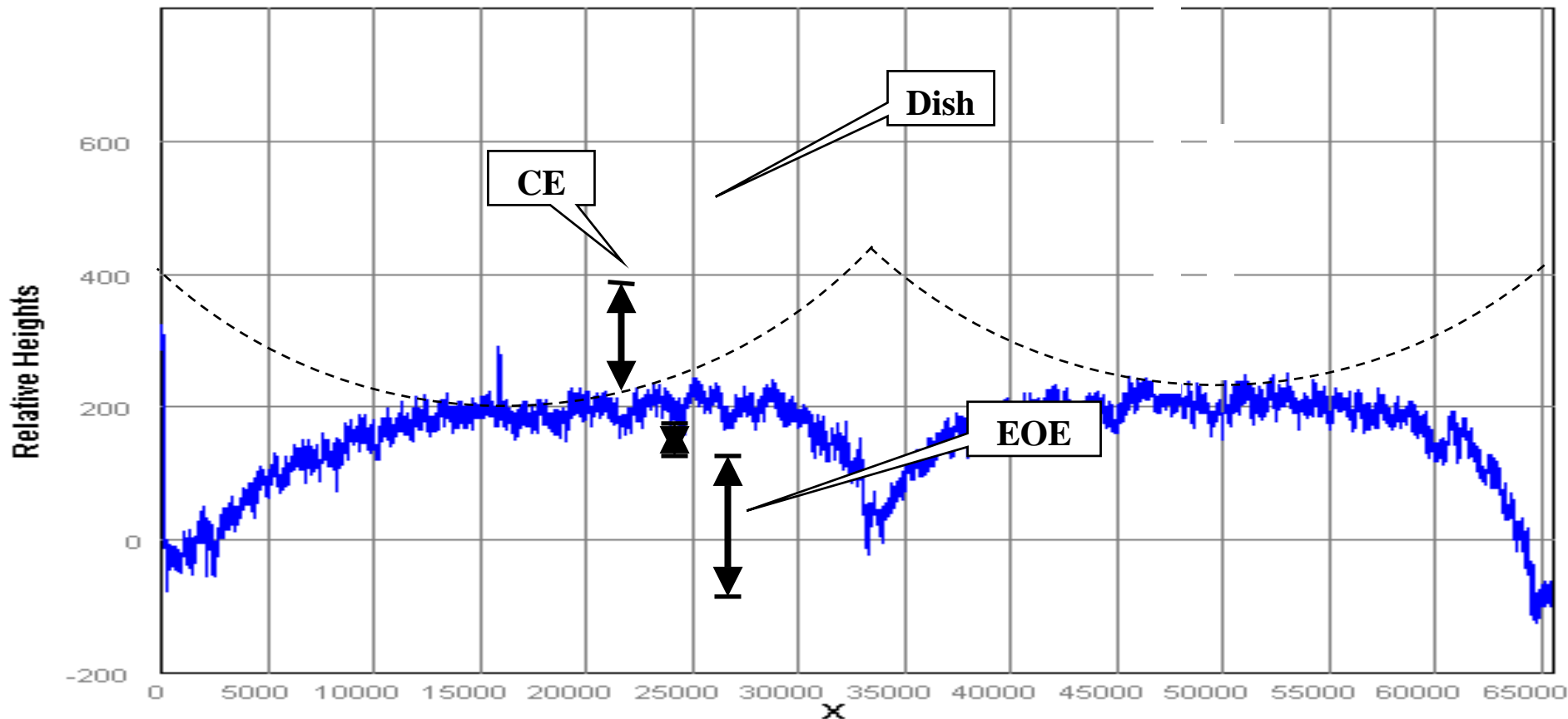
CMB_SRP_LRL_M1
DUTs 11 & 12 scanned
SERPs (140x140 nm,
180x180 nm)

CMB_SRP_SRL_M1 Surface Profile Scan

provided by **ChampiAn**

Dish (\AA)	EOE (\AA)	CE (\AA)
46	114	83

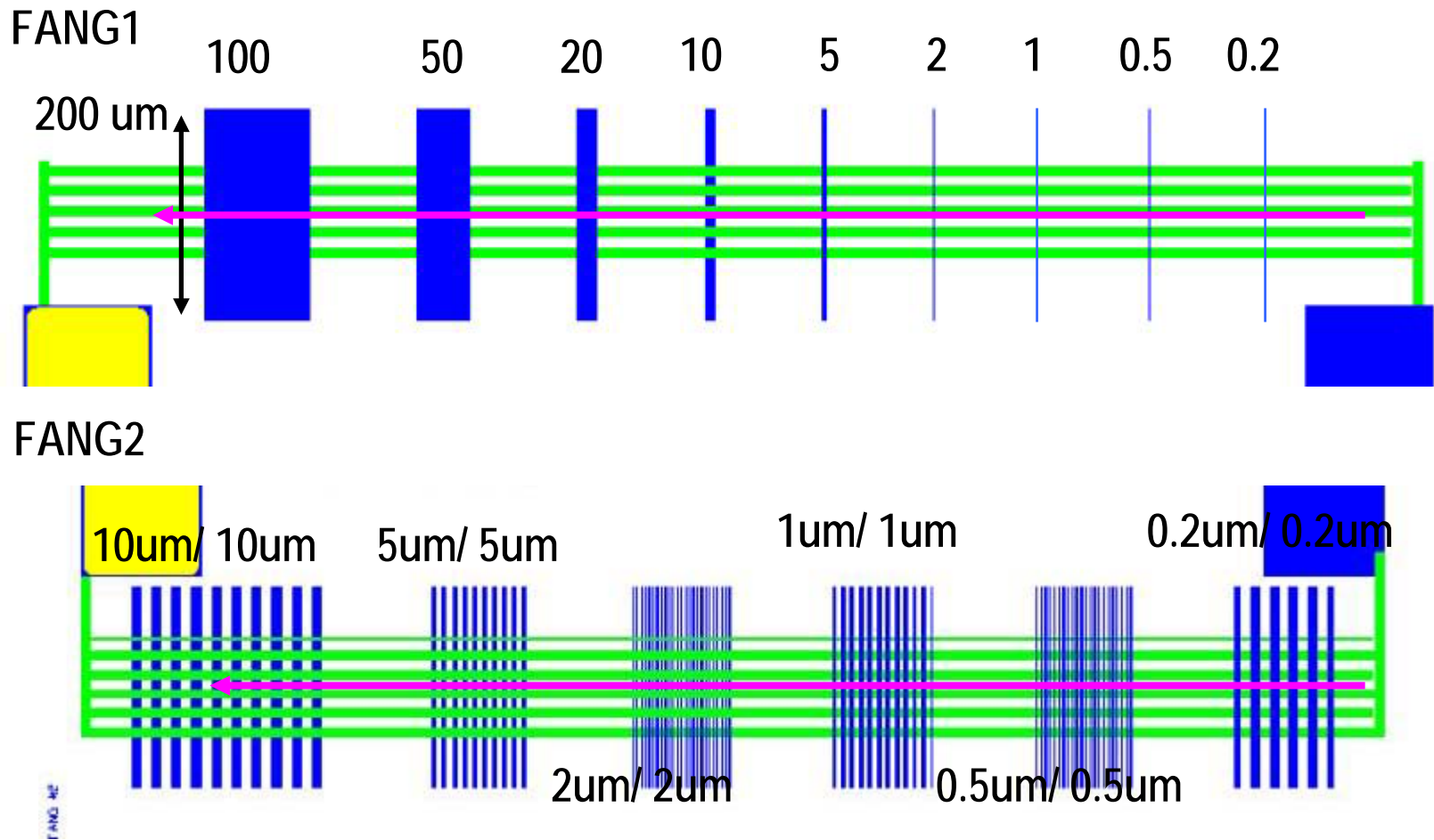
CMB_SRP_LRL_M1 Surface Profile Scan



Dish (\AA)	EOE (\AA)	CE (\AA)
75	311	265

provided by **ChampiAn**

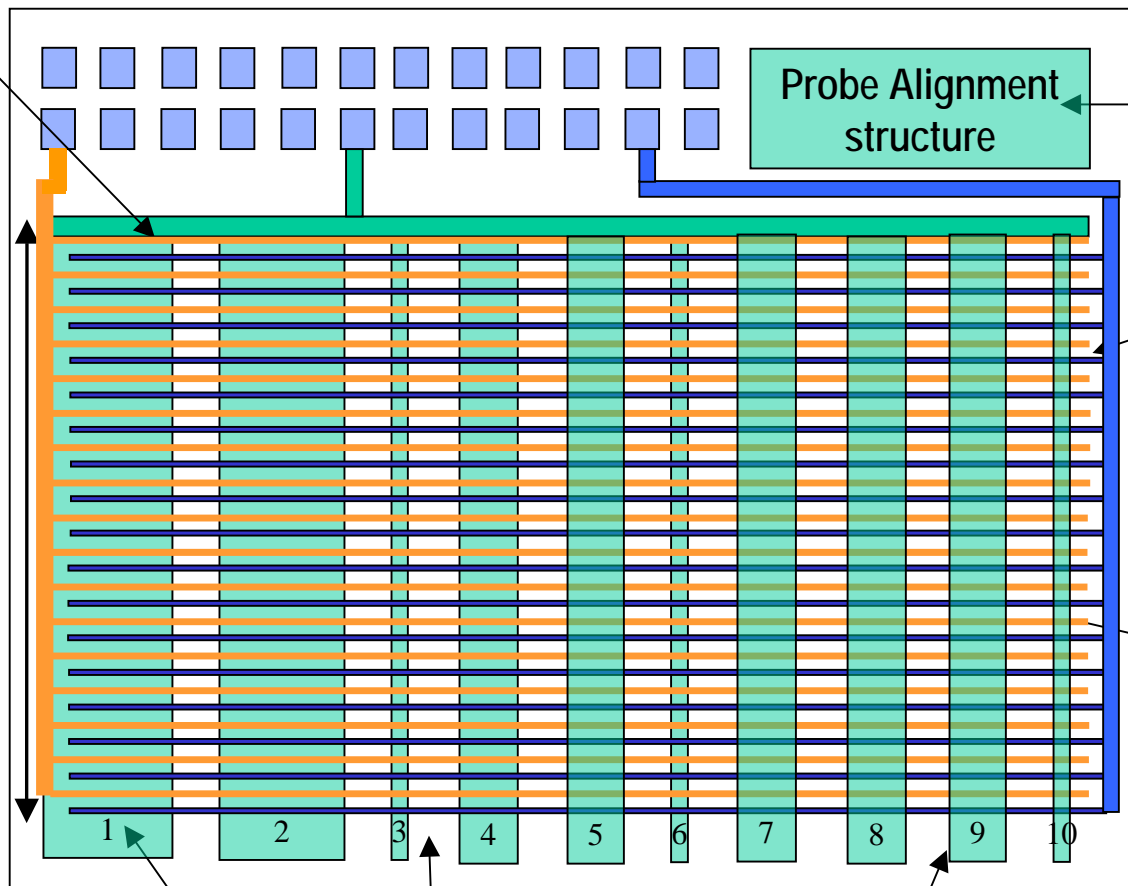
CMP Test Structure Scan Locations



Topo Test Structures

CMP Topo Tester (in place of via_chn_250_m3_upper)

M1 backbone 10um



Probe Alignment structure

~250um space around all sections between sections

M2 comb ~700um

M2 comb .14 l/s (10 um backbone)

Section #

250um space between sections

M1 topo sections (750 um vertical trenches /spaces)

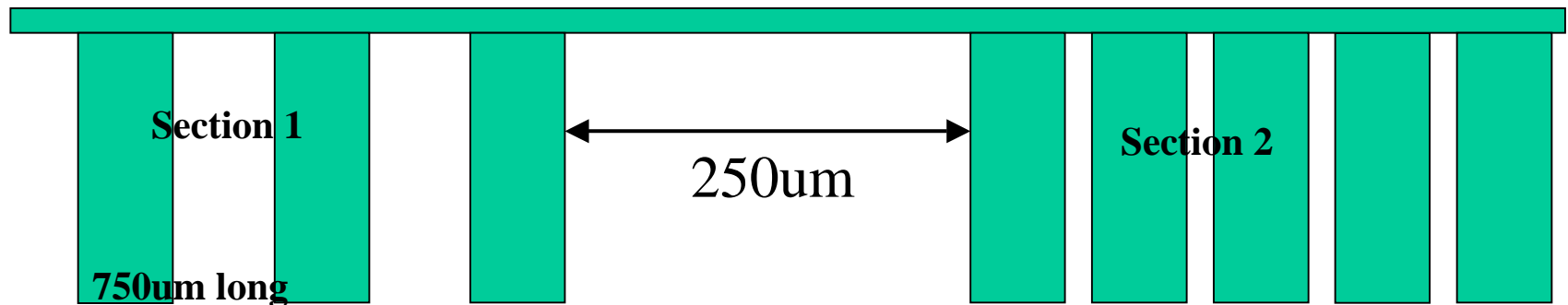
ATR35 CMP Topo Tester

(in place of via_chn_250_m3_upper)

M1 topo

CMP Topography tester (replace via_chn_250_m3 in top portion)						tester width (mm) 5.58			
0.25		mm space between sections							
M1 topo (no vias)			M2 comb 140nm trench/140nm sp perpendicular to test for shorts (see ppt diagram)						
section	trench (nm)	space (nm)	pitch (nm)	metal density	# repeats	tester x dim (mm)	total x dim (mm)	y-dim (um)	
1	90000	90000	180000	0.5	4	0.720	1.22	750	
2	90000	10000	100000	0.9	7	0.700	2.17	750	
3	10000			0.5	1	0.020	2.44	750	
4	10000	10000	20000	0.5	14	0.280	2.97	750	
5	9000	1000	10000	0.9	27	0.270	3.49	750	
6	2250			0.5	1	0.005	3.74	750	
7	2250	2250	4500	0.5	61	0.275	4.27	750	
8	2250	250	2500	0.9	110	0.275	4.79	750	
9	250	250	500	0.5	550	0.275	5.32	750	
10	250	250	500	0.5	7	0.004	5.57	750	

- Use a scaled version of this pattern as the topo sections under combs/serps (CS topo)
- use horizontal trenches in these testers



CMP_TOPO_Tester



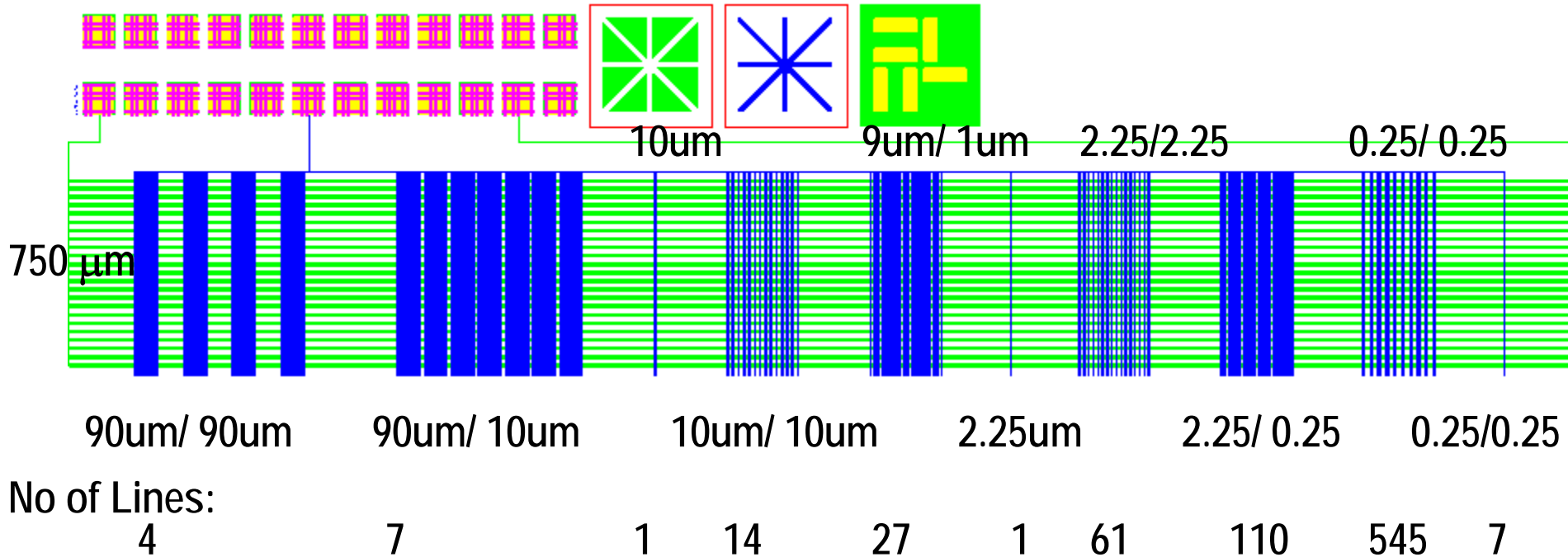
Metal 1



Metal 2



Pad



Metal 2 COMB:
0.14 μm / 0.14 μm L/S

CMP Pad Tester

left border	left sections	density	trench	space	height	pitch	# repeats	width
250	top border	0	0		200	0		
250	1 left	9.9	0.11	1	250	1.11	225	249.75
250	space	0	0		200	0		0
250	2 left	50	1	1	250	2	125	250
250	space	0	0		200	0		0
250	3 left	90	9	1	250	10	25	250
250	space	0	0		200	0		0
250	4 left	99	49	1	250	50	5	250
250	bot border	0	0		200	0		0
	total				2000			

left side testers



space (between lt & rt sect)	right sections	density	trench	space	pitch	# repeats	width	right border
234	space	0	0					250
234	1 right	100	250	0	250	1	250	250
234	space	0	0		0		0	250
234	2 right	50	0.2	0.2	0.4	625	250	250
234	space	0	0		0		0	250
234	3 right	90	1.8	0.2	2	125.000	250	250
234	space	0	0		0		0	250
234	4 right	99	9.8	0.2	10	25	250	250
234	space	0						250

Right side testers



Large pad



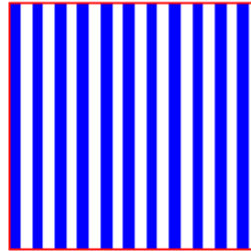
Get Topo vs. Pattern Density and Line Width

CMP Pads at Metal 1

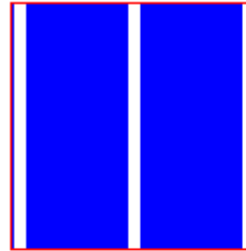
500 μm



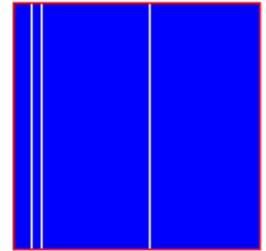
0.2 μm / 0.2 μm



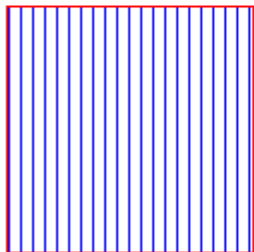
1.8 μm / 0.2 μm



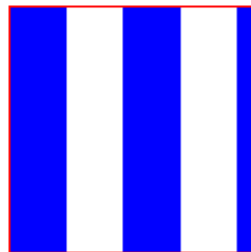
9.8 μm / 0.2 μm



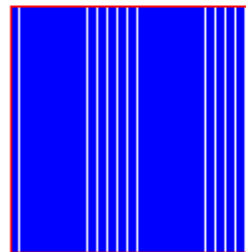
0.11 μm / 1 μm



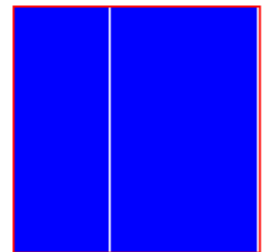
1 μm / 1 μm



9 μm / 1 μm



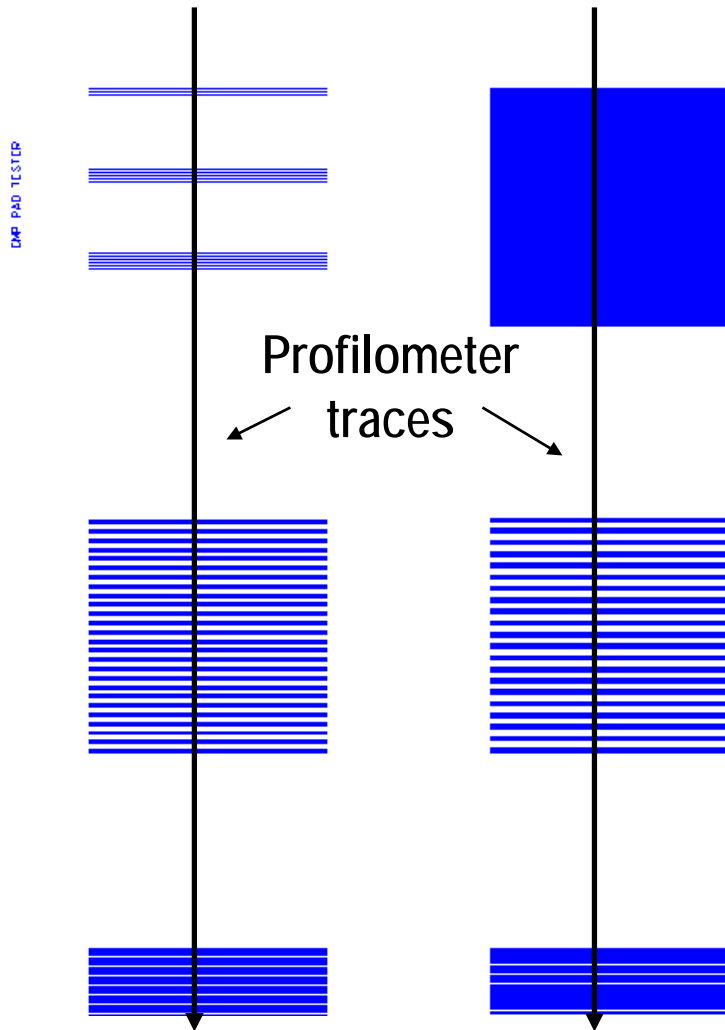
49 μm / 1 μm



CMP PAD TESTER

Dense and Iso pad structures

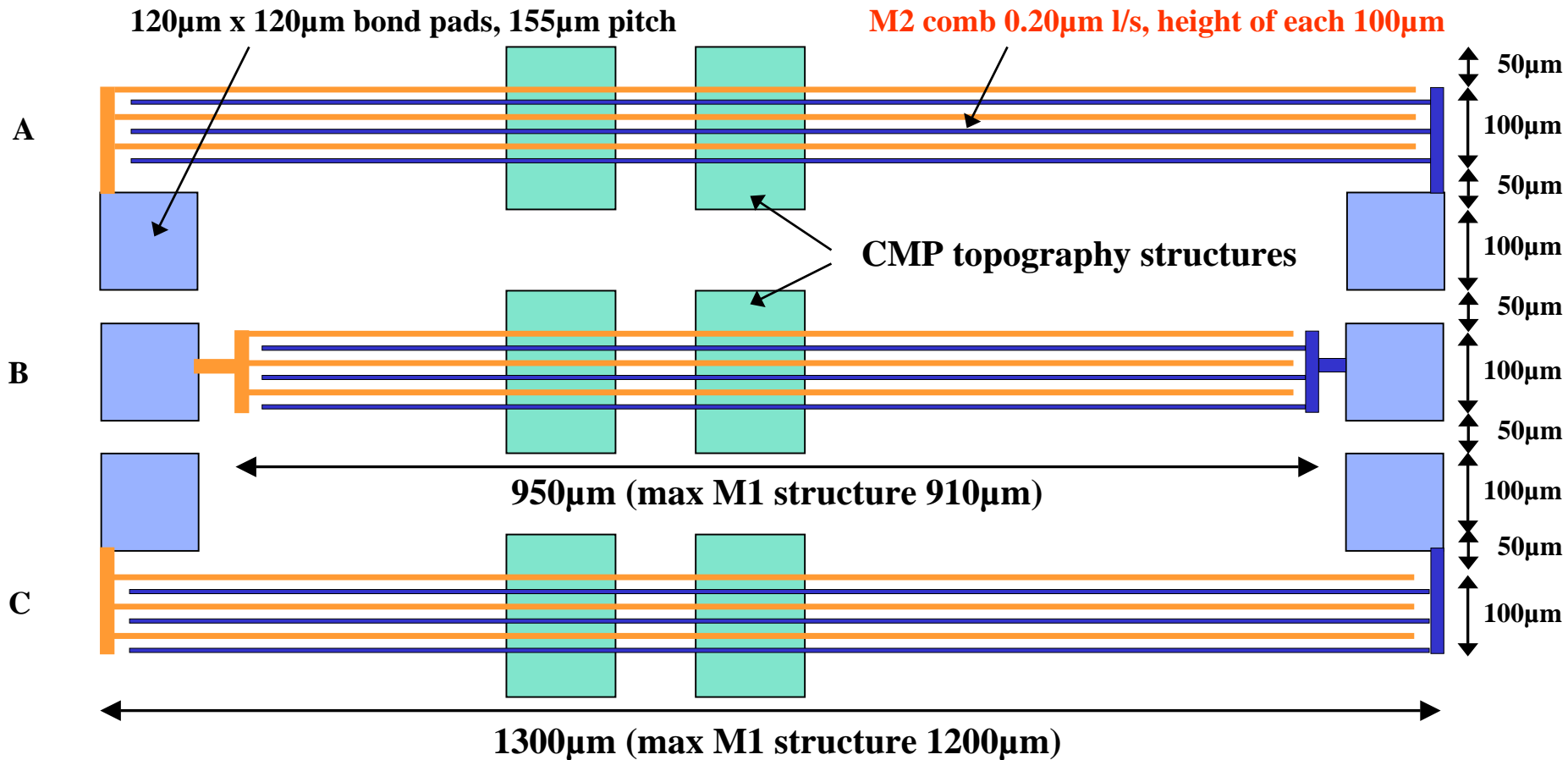
CMP Pad Testers



- 4 “pads” measured in 1 trace

Fang Test Structures

CMP Fang Tester Diagram



Use A, B, C for fang structures 1, 2 and 3

Use B for fang structure 4

CMP Fang Testers

- Metal 2 COMBs over Metal Topography:
 - Metal 2 COMB dimensions: 0.2 μm line / 0.2 μm space
 - Metal 1 topography dimensions: see each page for detail.



Metal 1

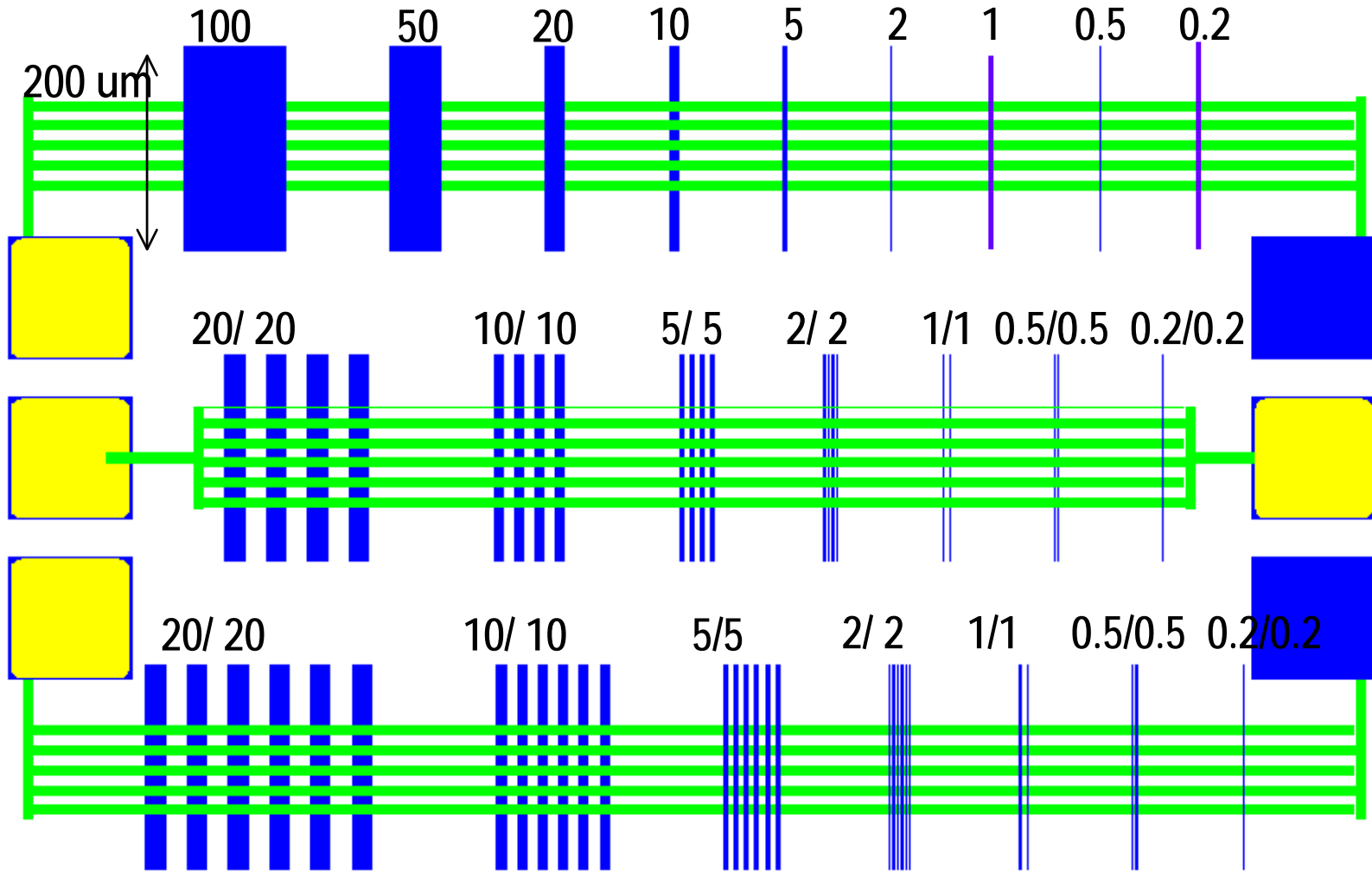


Metal 2



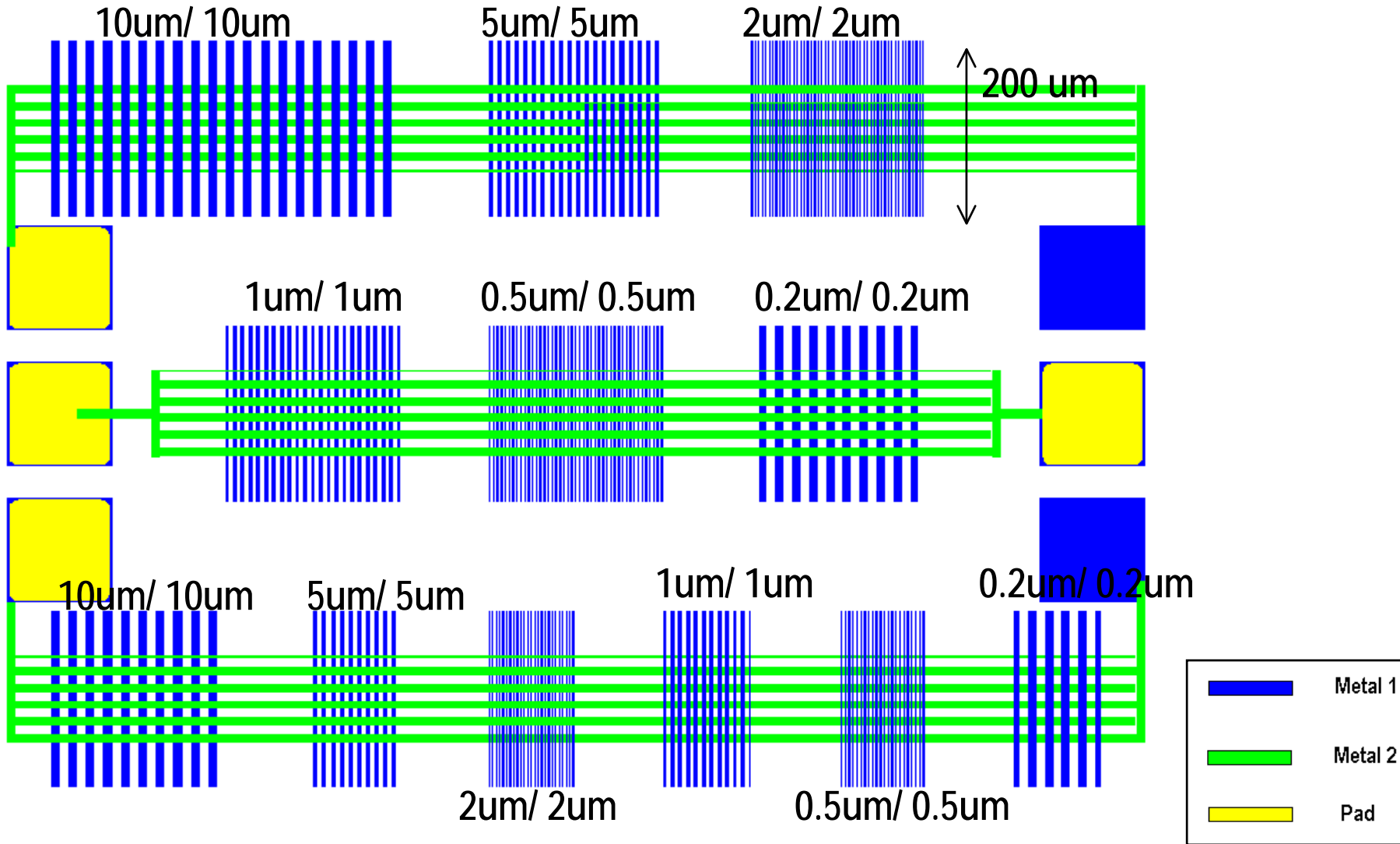
Pad

CMP Fang 1 Tester



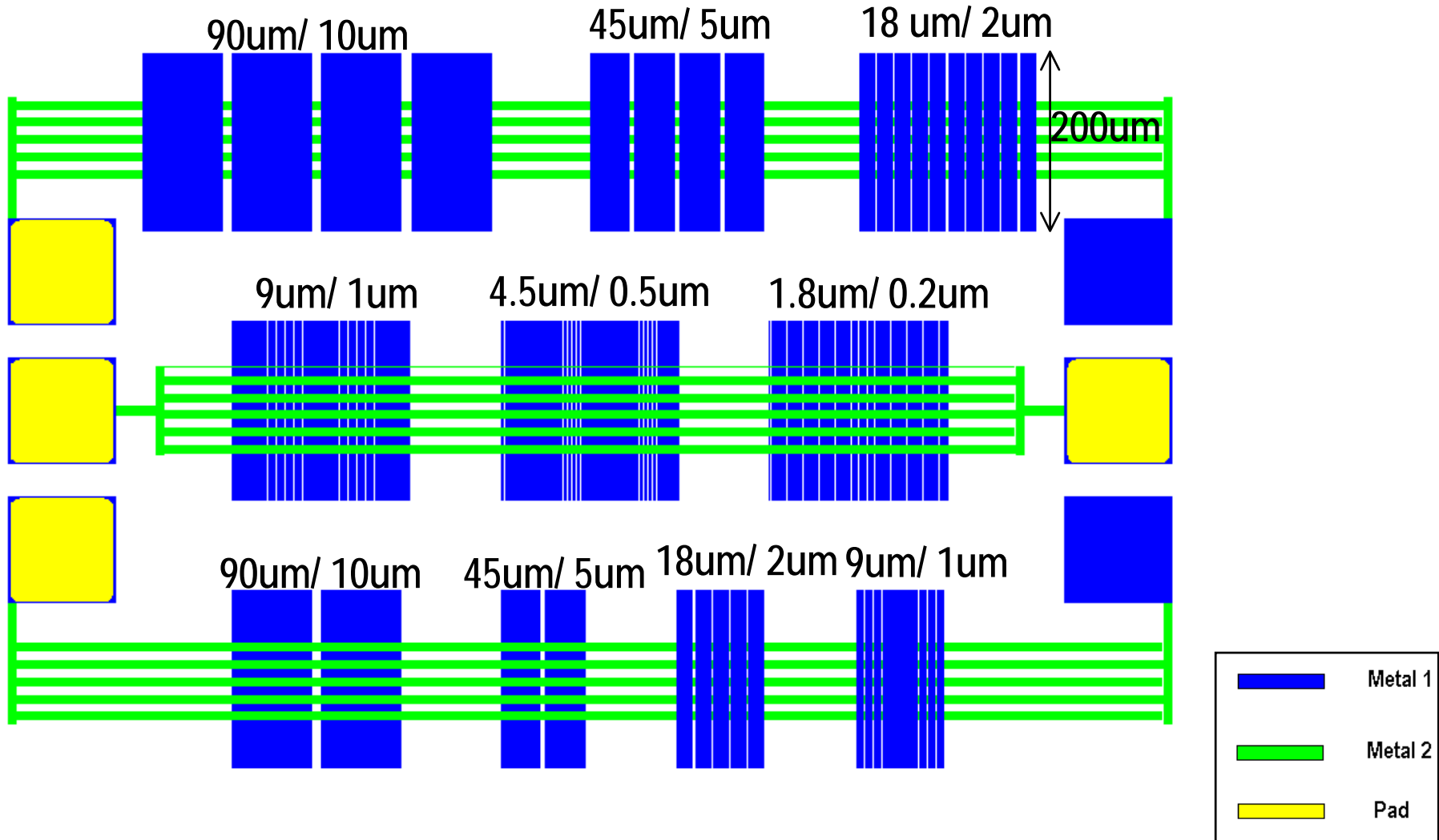
The unit is um.

CMP Fang 2 Tester

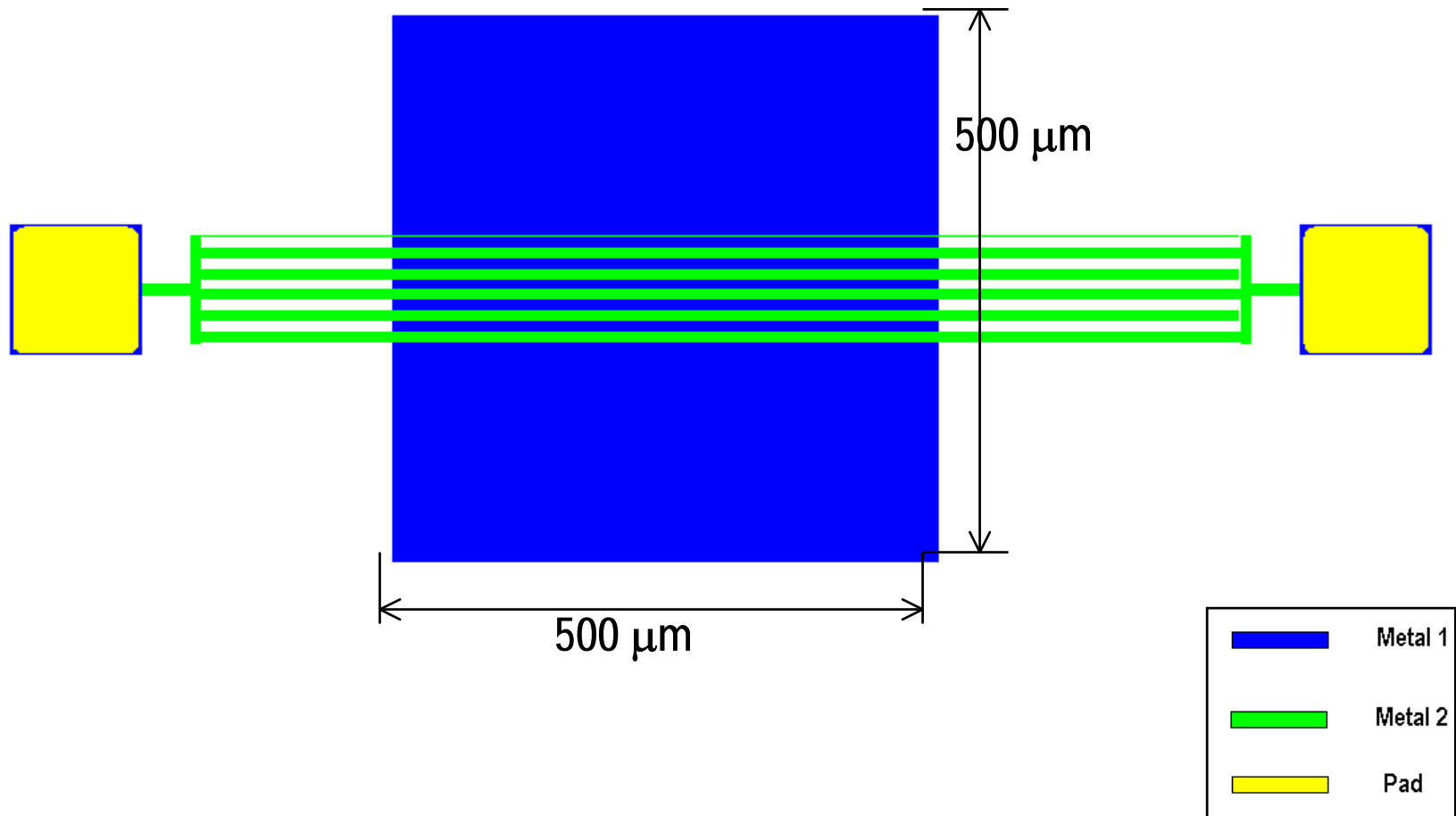


FANG 4E

CMP Fang 3 Tester



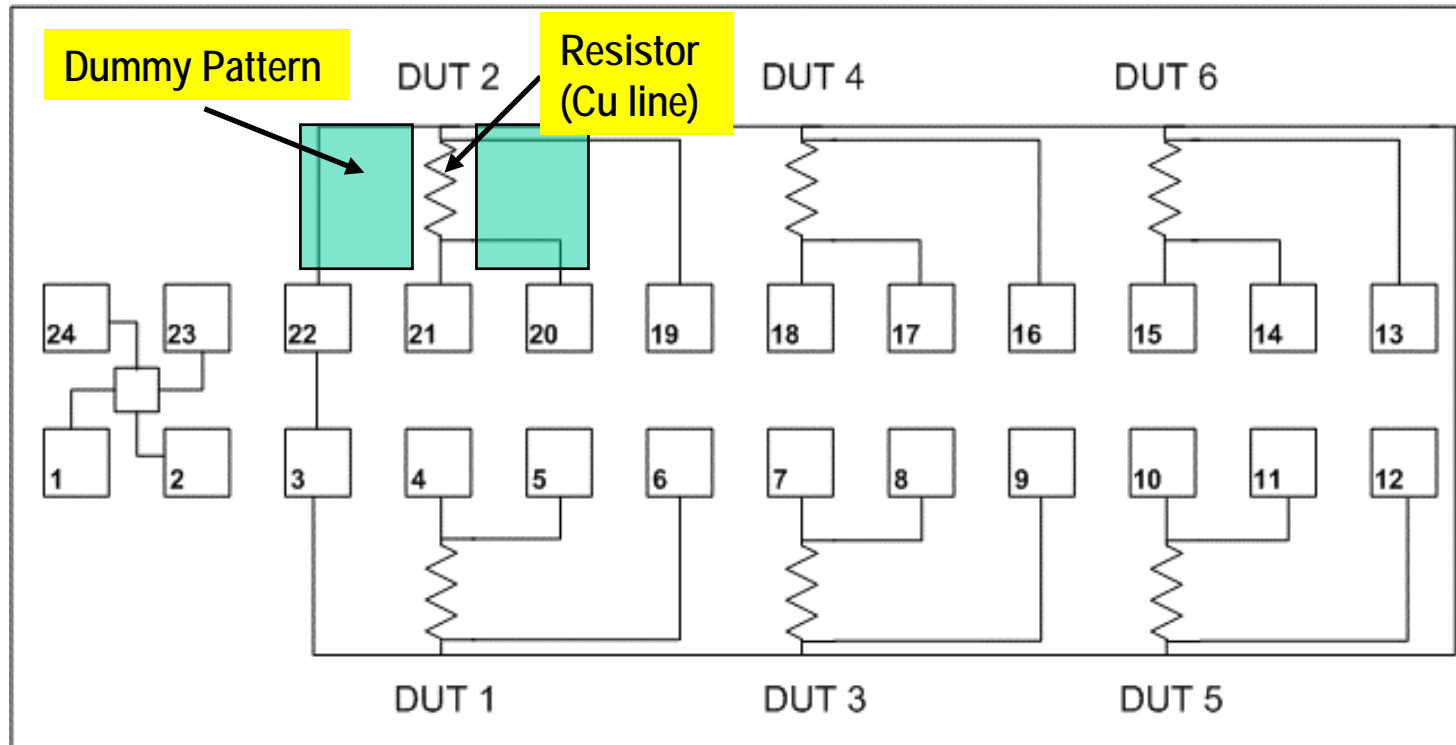
CMP Fang 4 Tester



FANG #4

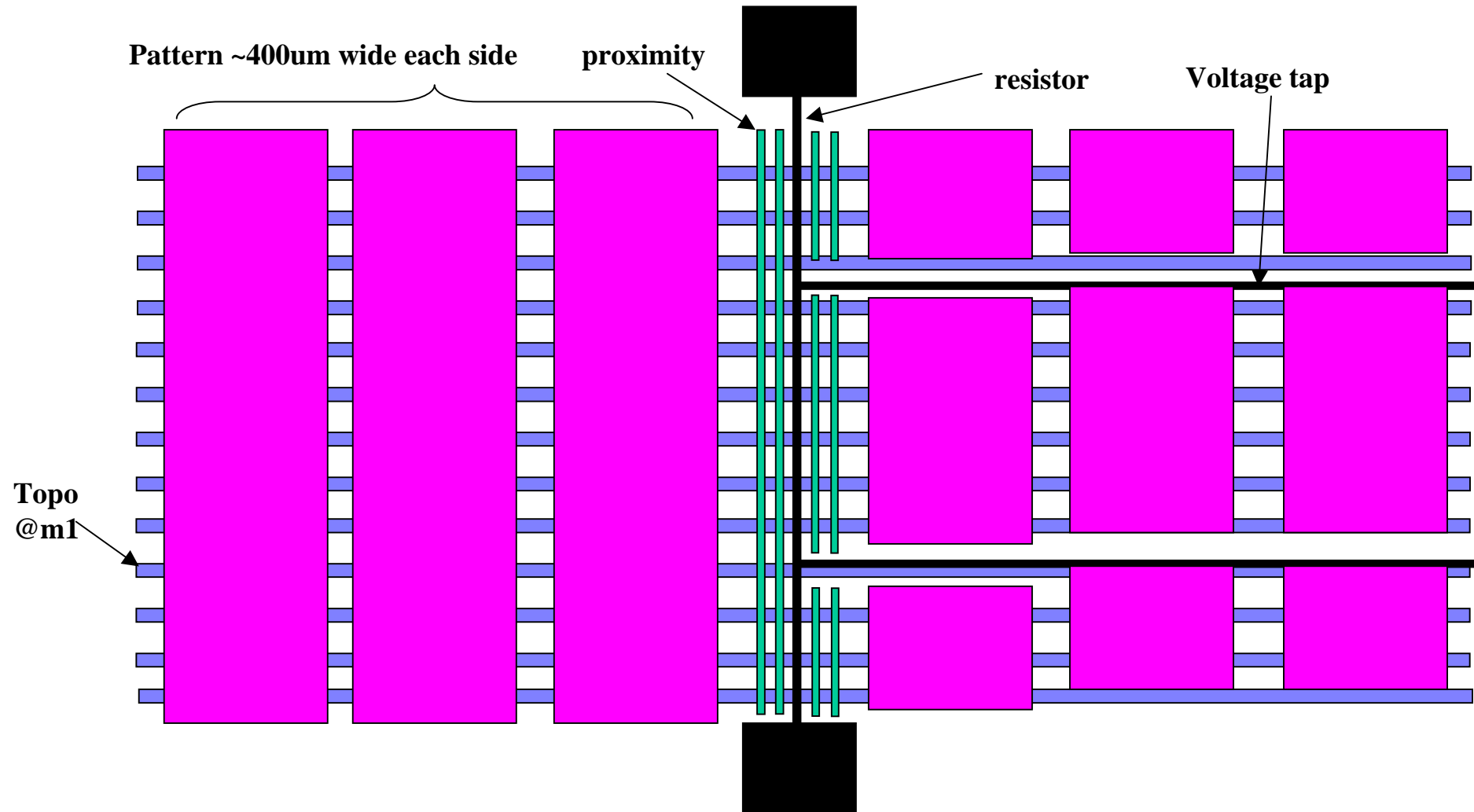
E-Test Structures

CMP Tester Layout



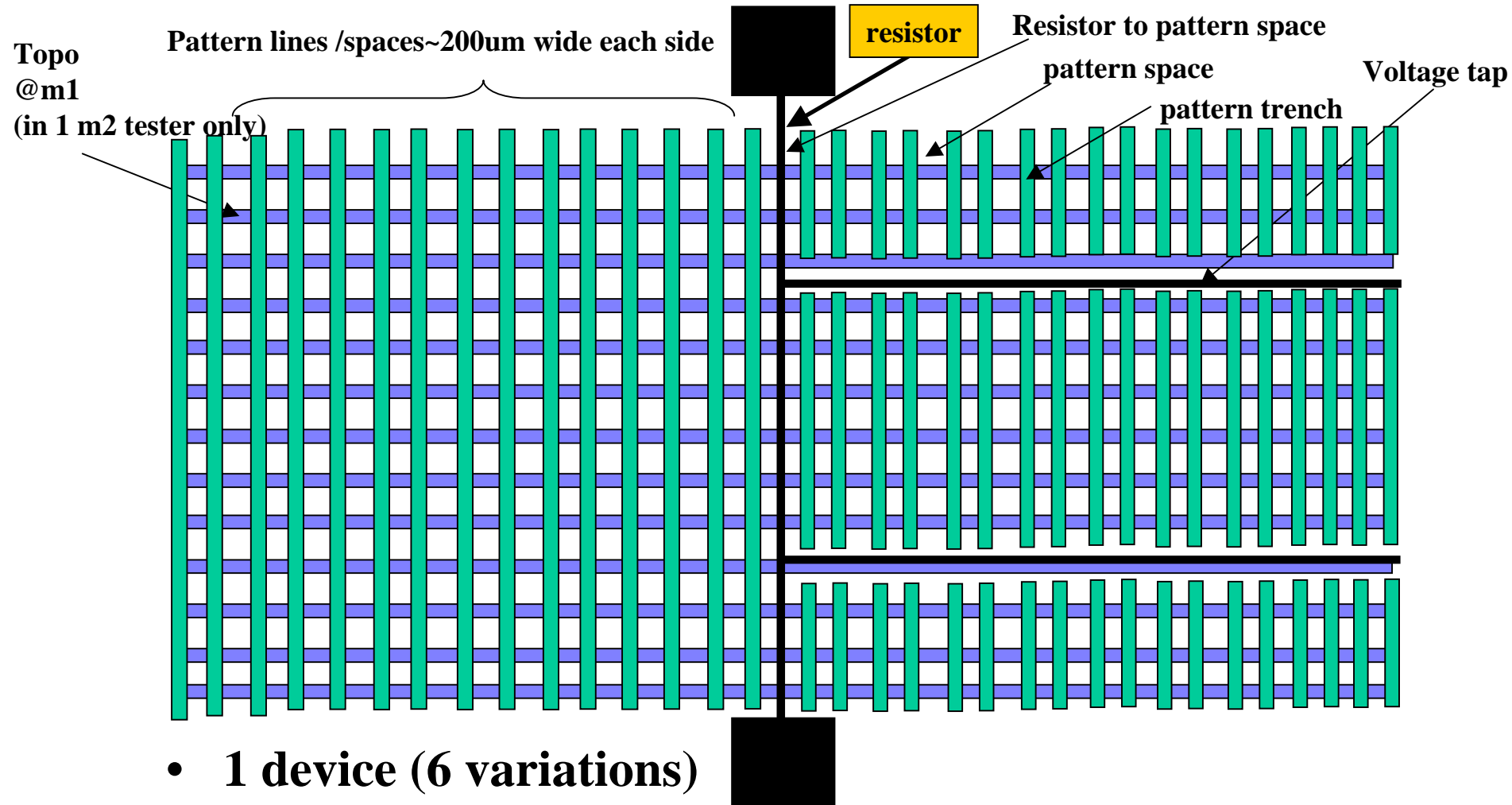
- Measure impact of dummy pattern on line resistance (dishing / erosion)
 - Each device (DUTs) has different dummy pattern or line width

ATR35 - CMP Resistance Testers



- 1 device (6 variations + 1 VDP per test module)

ATR35 - CMP Resistance Testers



- 1 device (6 variations)
+ 1 VDP per test

module)

ATR35 - M1 CMP Resistance Testers

CMP_M1_a (replace CMP_m1_top section)								
length lines = 750um			width in um	width in um	width in um	width in um	width in um	width in um
DR	Description	VDP	DUT1	DUT2	DUT3	DUT4	DUT5	DUT6
1	Resistor line-width		0.2	0.2	0.2	0.2	0.2	0.2
2	Resistor to pattern line spacing		0.2	0.2	0.2	0.2	0.2	0.2
3	Pattern line-width		1	0.2	10	50	200	90
4	Pattern spacing		0	0.2	10	0	0	10
5	# pattern l/s on each side of resistor		1	500	10	1	1	2
6	total width (um)		2.6	401	401	101	401	401
7	resistor line length		600	600	600	600	600	600
8	pattern density		<1	50.00	50.00	99.00	99+	90.00
9	VDP line width	10	iso		fang	dishing	dishing	
CMP_M1_b (replace CMP_M3_top section)								
DR	Description	VDP	DUT1	DUT2	DUT3	DUT4	DUT5	DUT6
1	Resistor line-width		10	10	10	10	10	10
2	Resistor to pattern line spacing			0.2	10	0.2	0.2	10
3	Pattern line-width			0.2	10	10	90	90
4	Pattern spacing			0.2	10	10	10	10
5	# pattern l/s on each side of resistor		0	488	9	10	2	2
6	total width (um)		10	401	390	410	410	430
7	resistor line length		600	600	600	600	600	600
8	pattern density		<1	50.00	50.00	50.00	90.00	90.00
9	VDP line width	50	iso		fang		dishing	dishing

ATR35 M2 CMP Resistance Testers

CMP_M2_a (replace CMP_m2_top section)								
length lines = 750um			width in um	width in um	width in um	width in um	width in um	width in um
DR	Description	VDP	DUT1	DUT2	DUT3	DUT4	DUT5	DUT6
1	Resistor line-width		0.2	10	0.2	10	0.2	10
2	Resistor to pattern line spacing			0.2	4.9	10	0.2	0.2
3	Pattern line-width			0.2	10	10	200	90
4	Pattern spacing			0.2	10	10	0	10
5	# pattern l/s on each side of resistor		0	488	10	9	1	2
6	total width (um)		0.2	401	410	390	401	410
7	resistor line length		600	600	600	600	600	600
8	pattern density		<1	<1	50.00	50.00	98.00	90.00
9	VDP line width	10	iso	iso	fang	fang	dishing	dishing

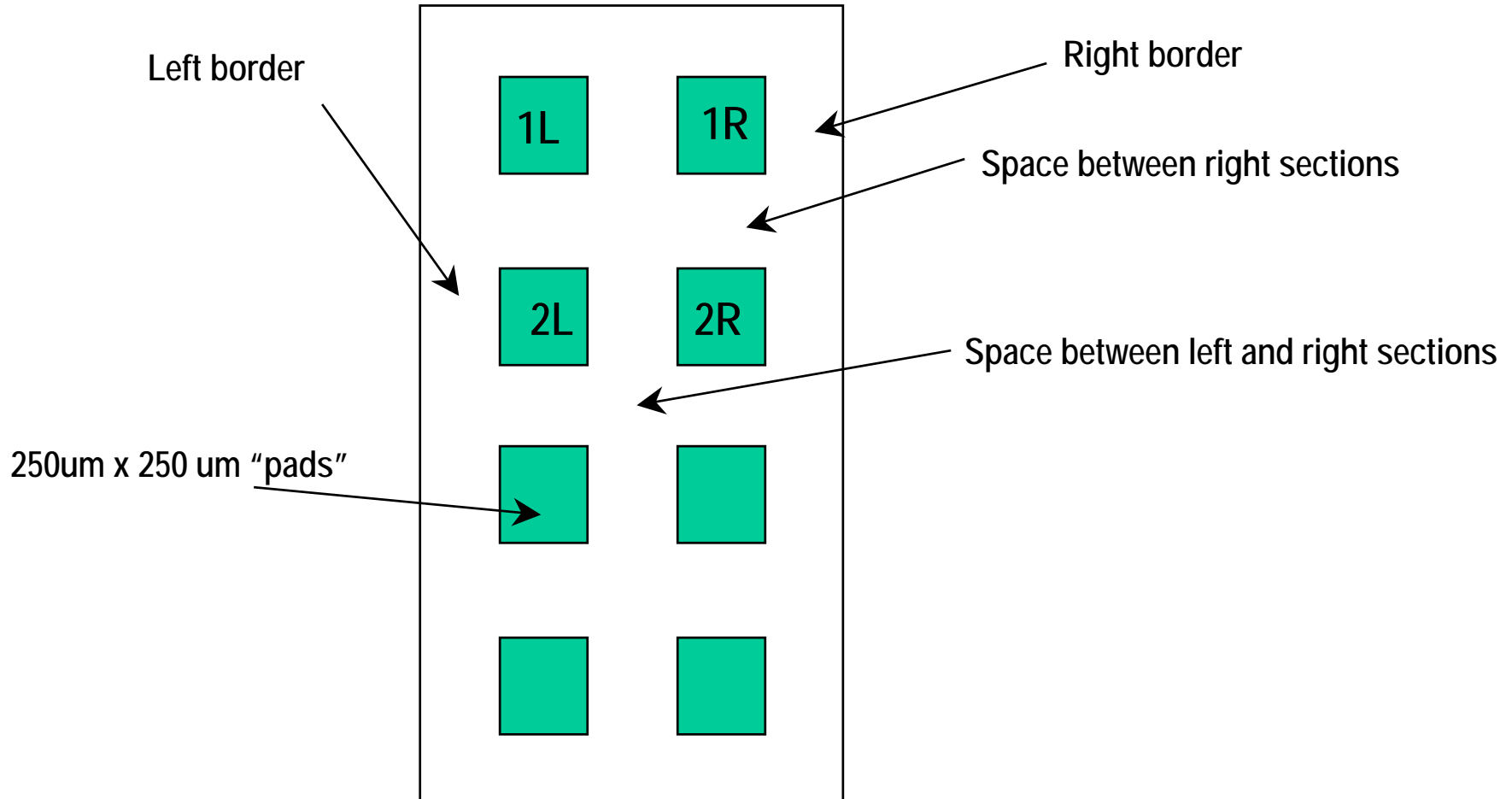
CMP_M2_b - with underlying topo (replace CMP_M2 in bottom section)

DR	Description		DUT1	DUT2	DUT3	DUT4	DUT5	DUT6
1	Resistor line-width		0.2	0.2	0.2	10	10	10
2	Resistor to pattern line spacing		0.2	0.2	0.2	0.2	0.2	0.2
3	Pattern line-width		0.2	0.2	0.2	0.2	0.2	0.2
4	Pattern spacing		0.2	0.2	0.2	0.2	0.2	0.2
5	# pattern l/s on each side of resistor		500	500	500	488	488	488
6	total width (um)		401	401	401	401	401	401
7	resistor line length		600	600	600	600	600	600
8	pattern density		50.00	50.00	50.00	50.00	50.00	50.00
9	M1 topo (l/s) - horizontal		.2/.2	10/10	90/10	.2/.2	10/10	90/10
10	VDP	50						

CMP Pad Tester Diagram

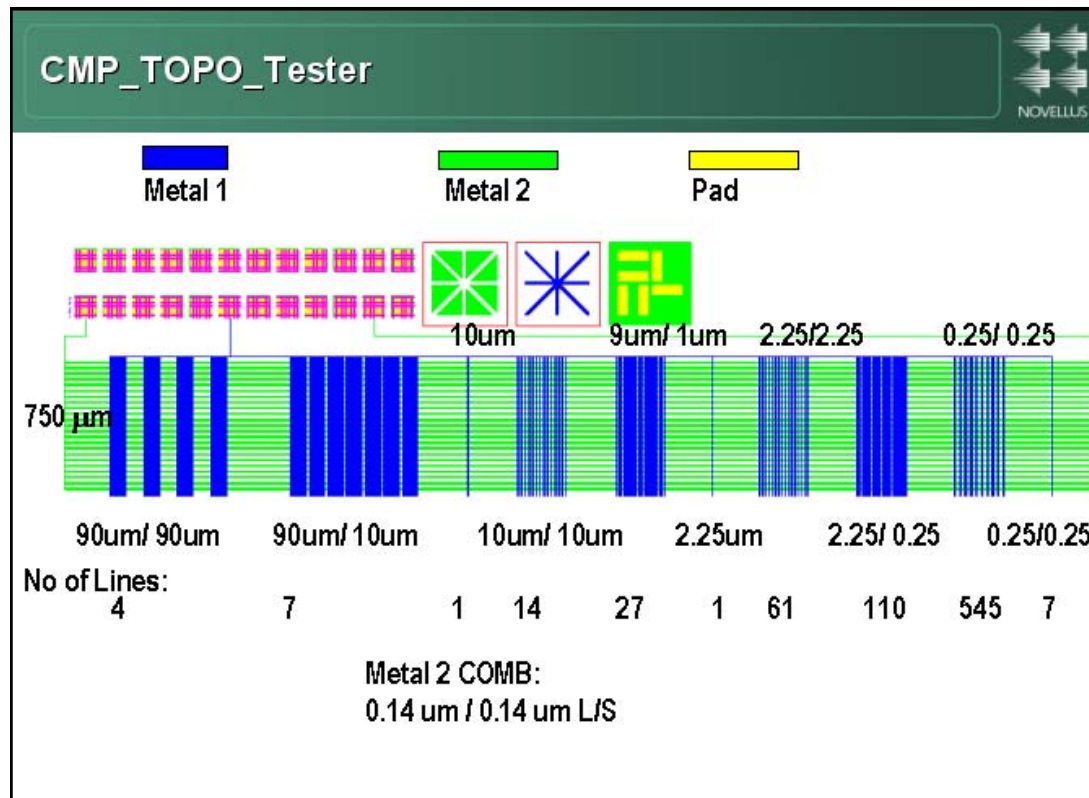
- different pattern in each "pad"

- Horizontal trenches spaces in each section

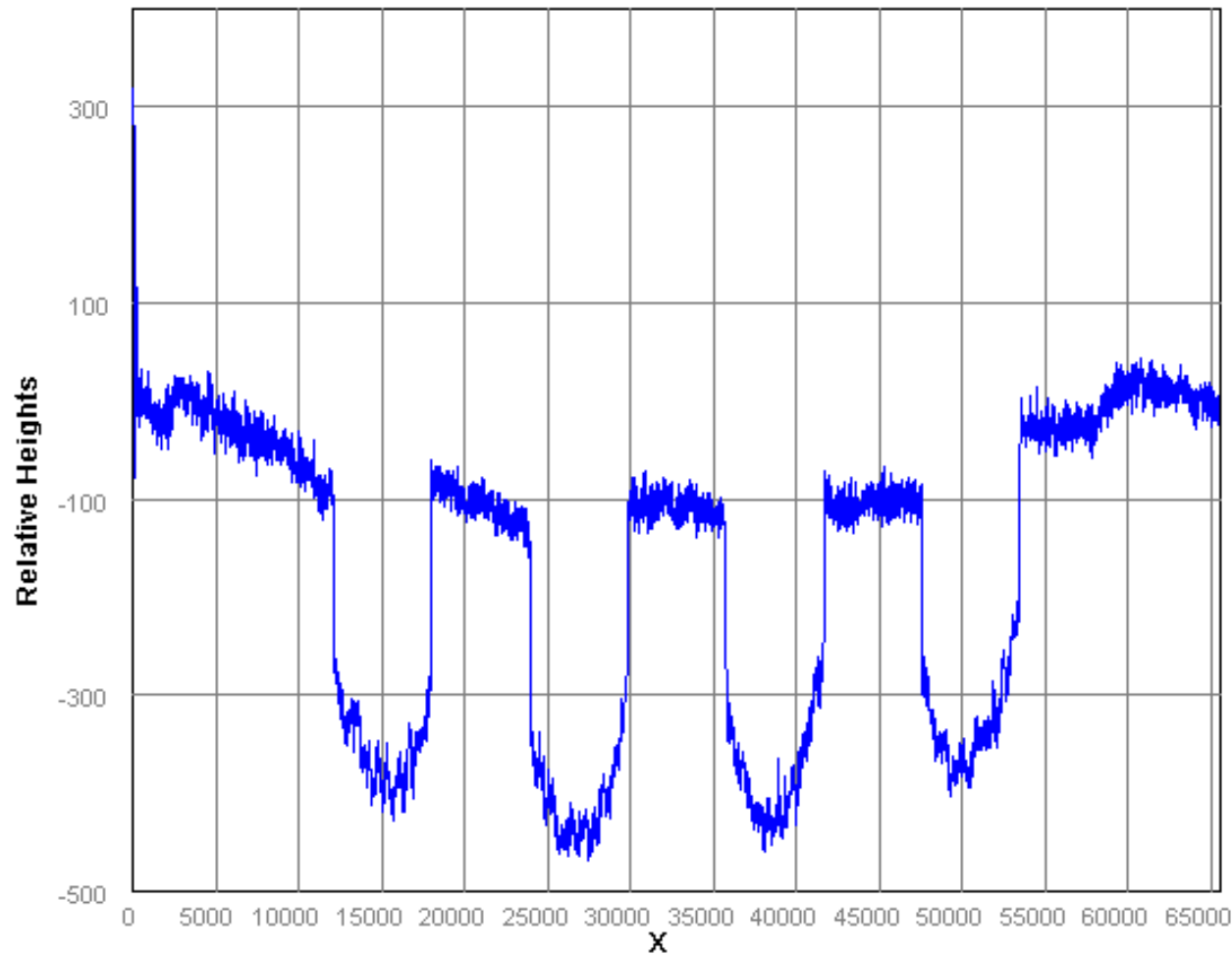


Recommended ATR35 Structure

- The structure on ATR35 which most closely matches the 100/100 structure on Sematech is the 90/90 structure
 - Refer to slide 13



CMP_TOPO_Tester 90um/90um Line Profile



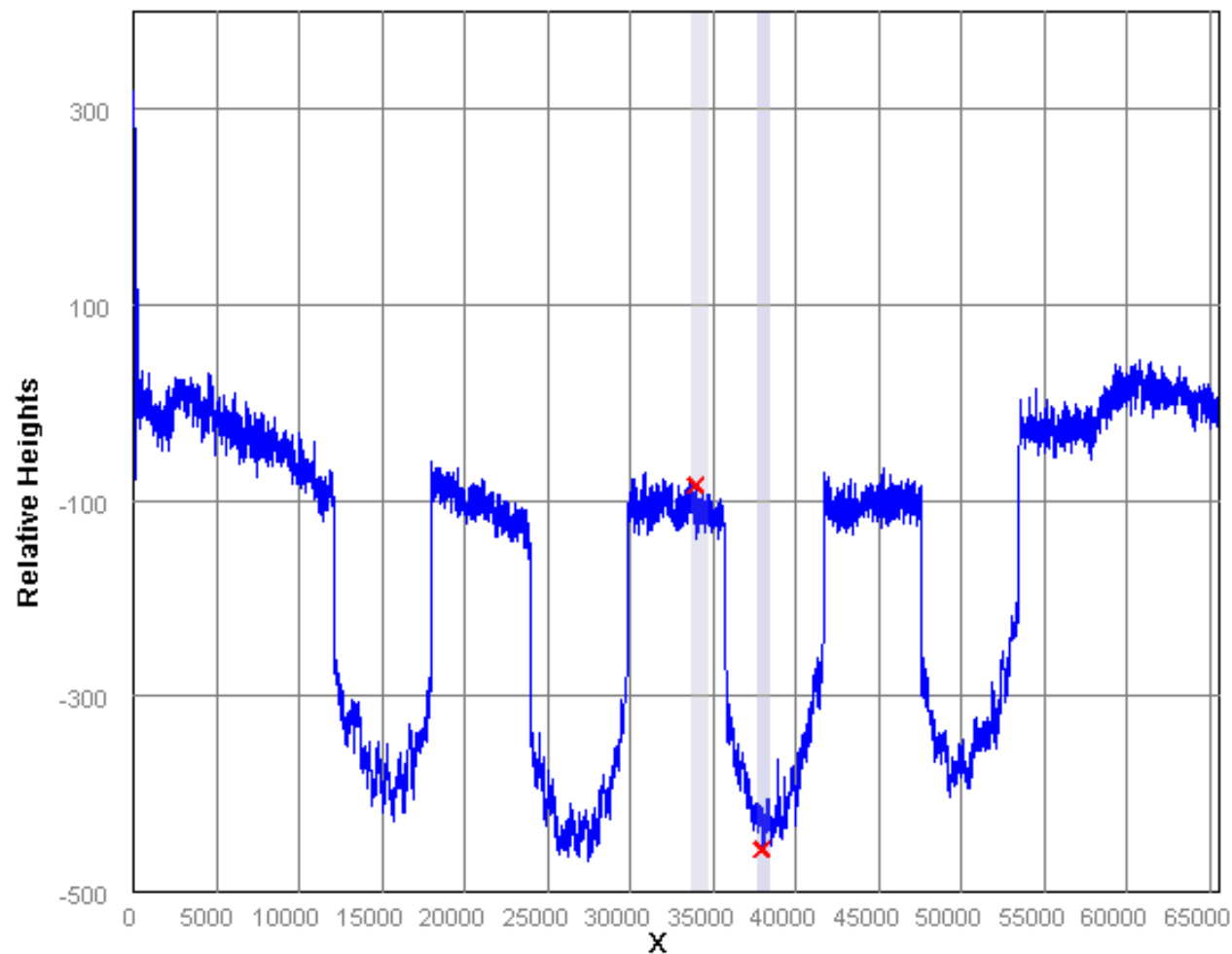
SCAN INFO

Recipe	
Samples	9363
# of Features	2

RESULT

Dishing	374.0053
Erosion	87.2454

CMP_TOPO_Tester 90um/90um Line Profile



SCAN INFO

Recipe	
Samples	9363
# of Features	1

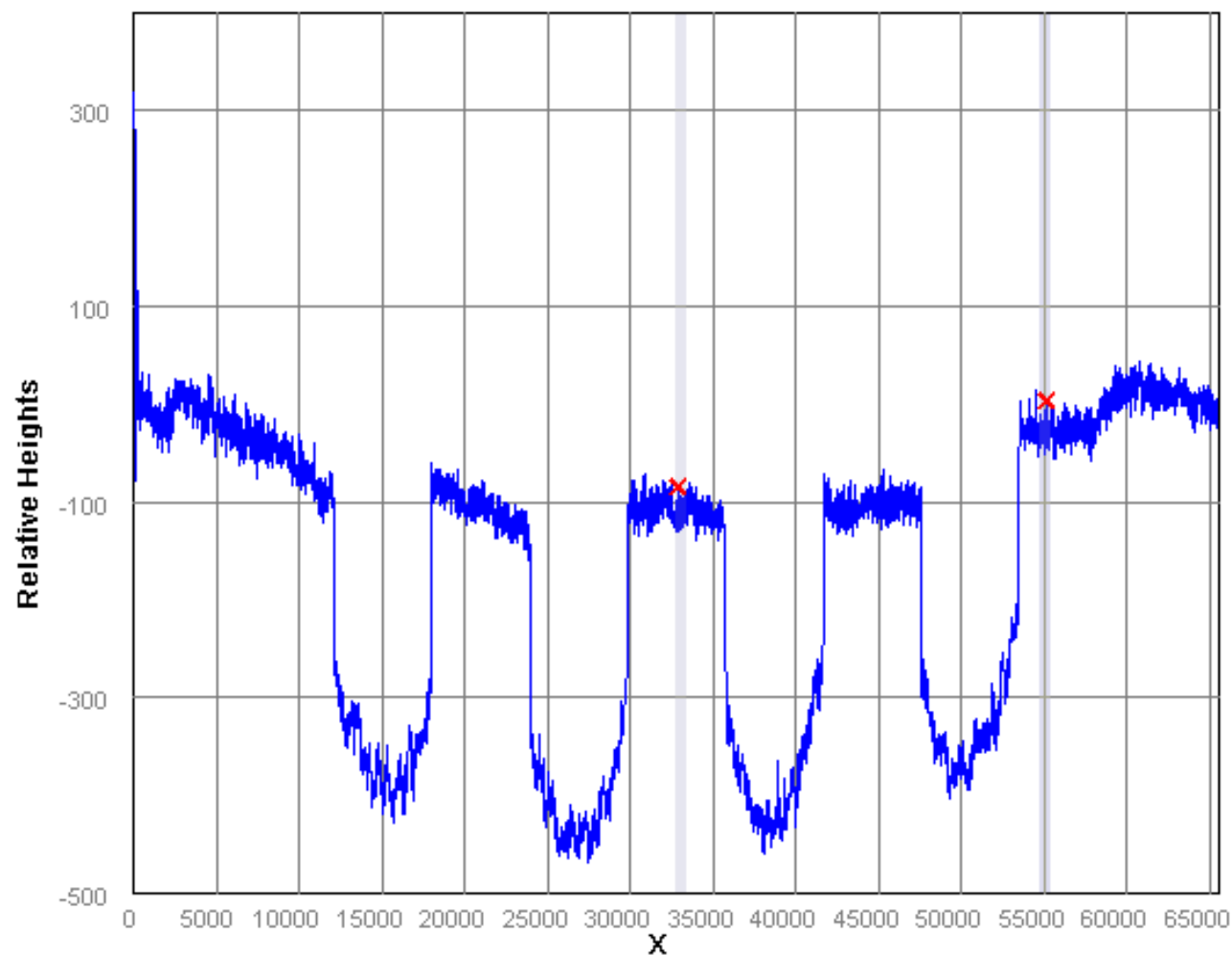
LEVEL

Slope	-1.2758
LL	528.508
LR	1189.143
(LL-LR)	660.635
RL	64345.857
RR	65006.492
(RL-RR)	660.635

DISHING

Dishing	371.6104
LL	33699.909
LR	34765.518
(LL-LR)	1065.61
RL	37695.945
RR	38495.152
(RL-RR)	799.207

CMP_TOPO_Tester 90um/90um Line Profile



SCAN INFO

Recipe	
Samples	9363
# of Features	1

LEVEL

Slope	-1.276
LL	528.508
LR	1189.143
(LL-LR)	660.635
RL	64345.857
RR	65006.492
(RL-RR)	660.635

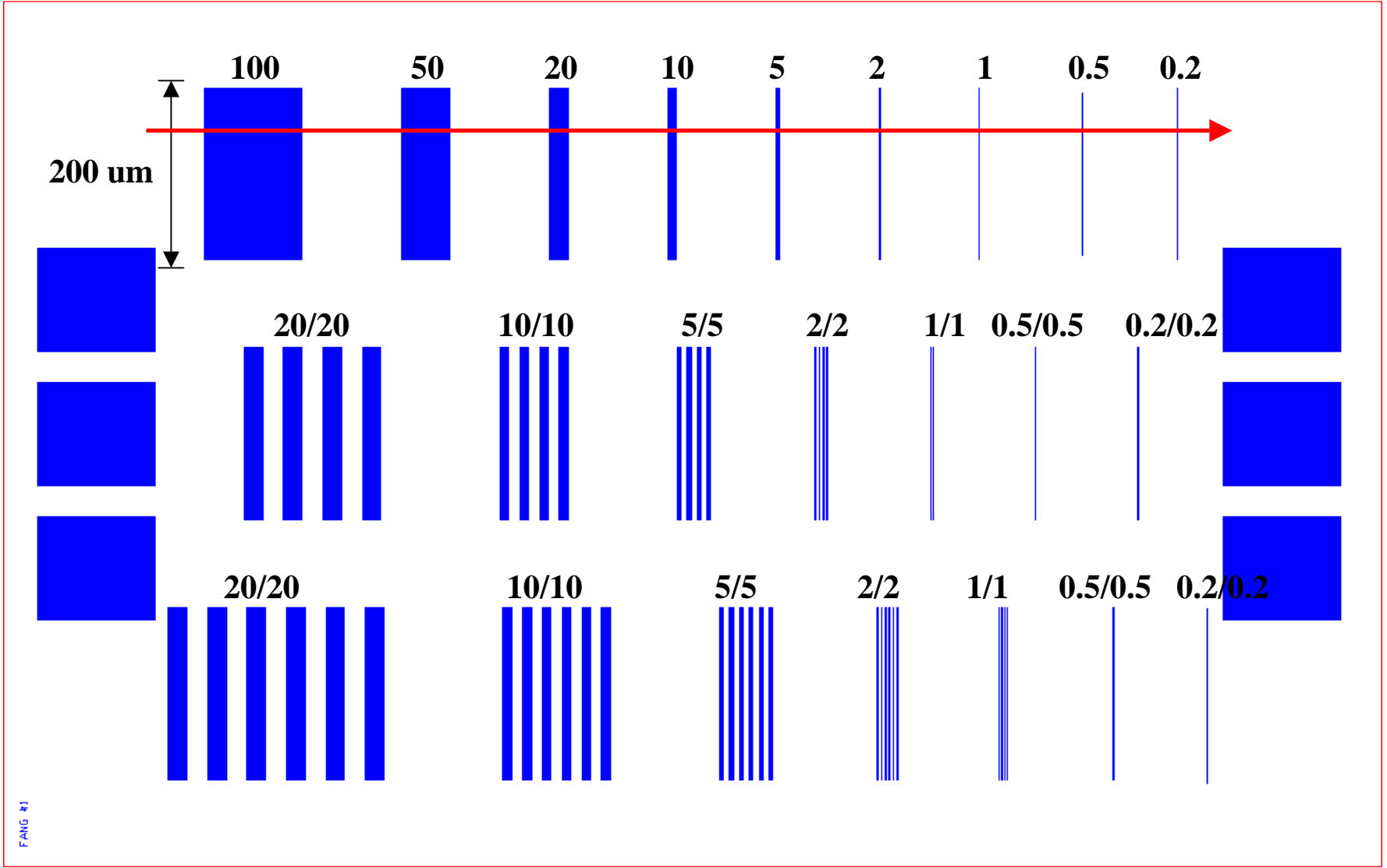
EROSION

Erosion	87.245
LL	32832.13
LR	33478.432
(LL-LR)	646.302
RL	54806.391
RR	55452.692
(RL-RR)	646.302

ATR35 Summary

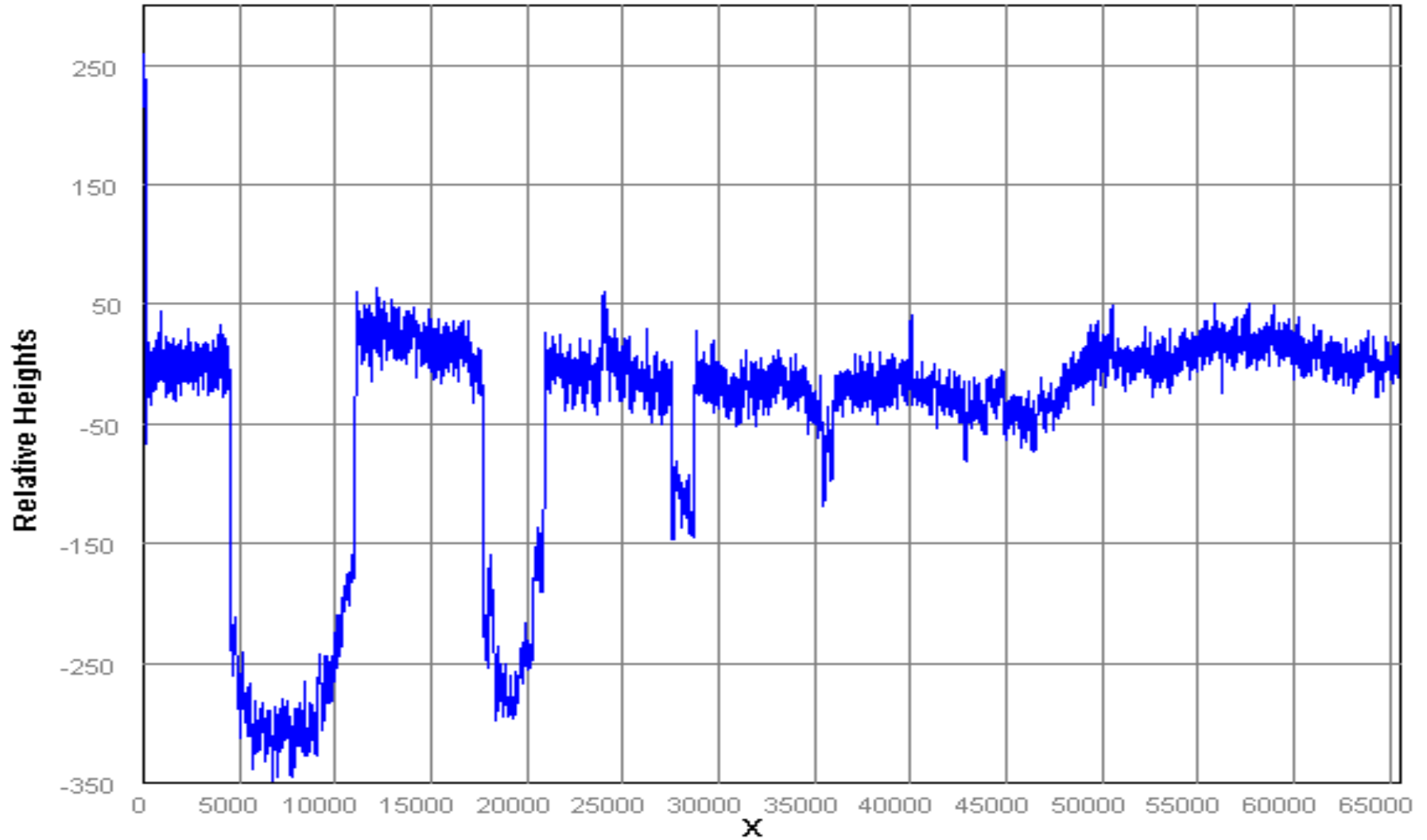
- Design rules at 140nm and 90nm
- Multiple CMP test physical and electrical test structures

CMP_FANG1 Die Floor Plan

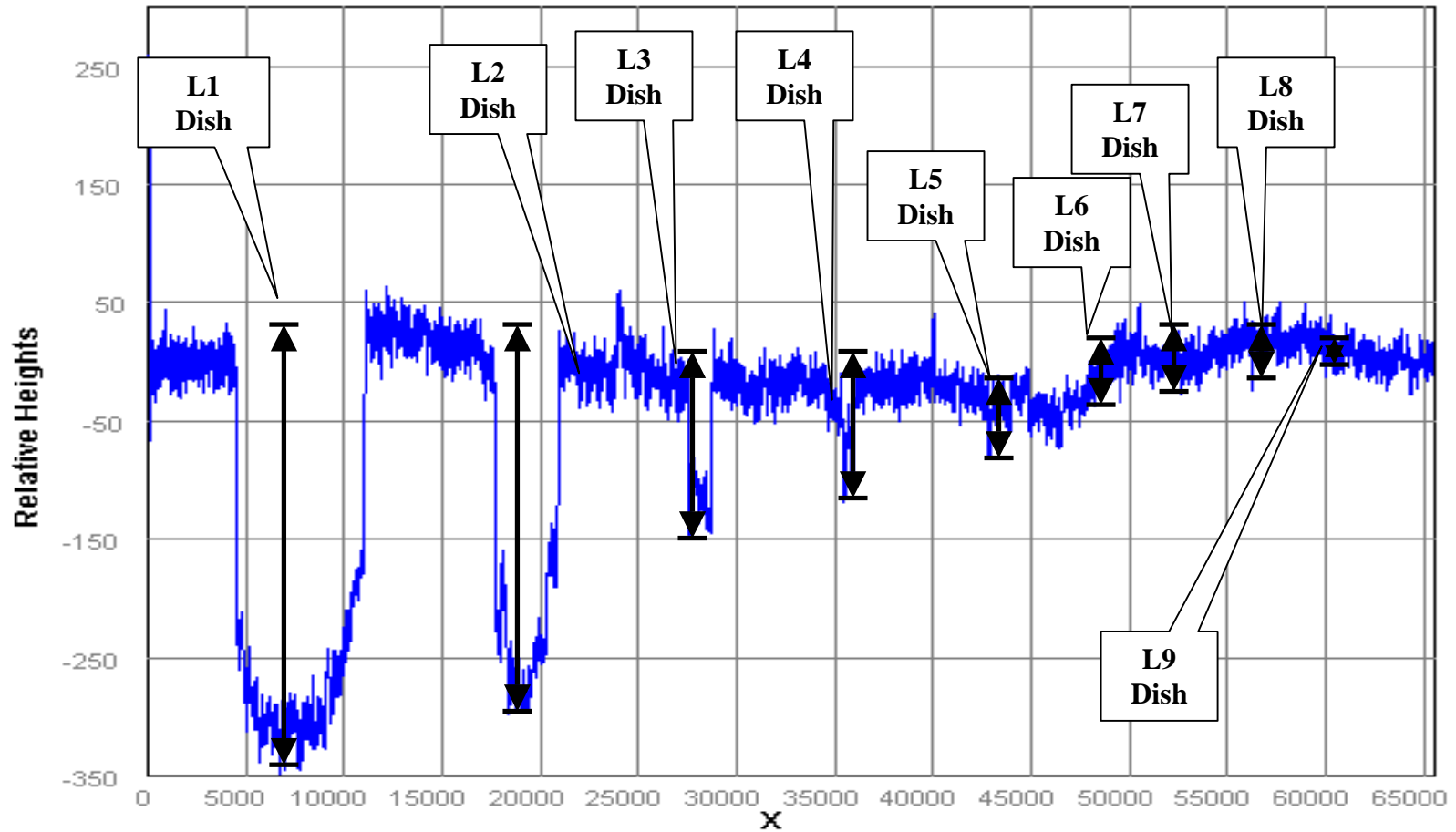


FANG #1

CMP_FANG1 Row 1 Line Profile

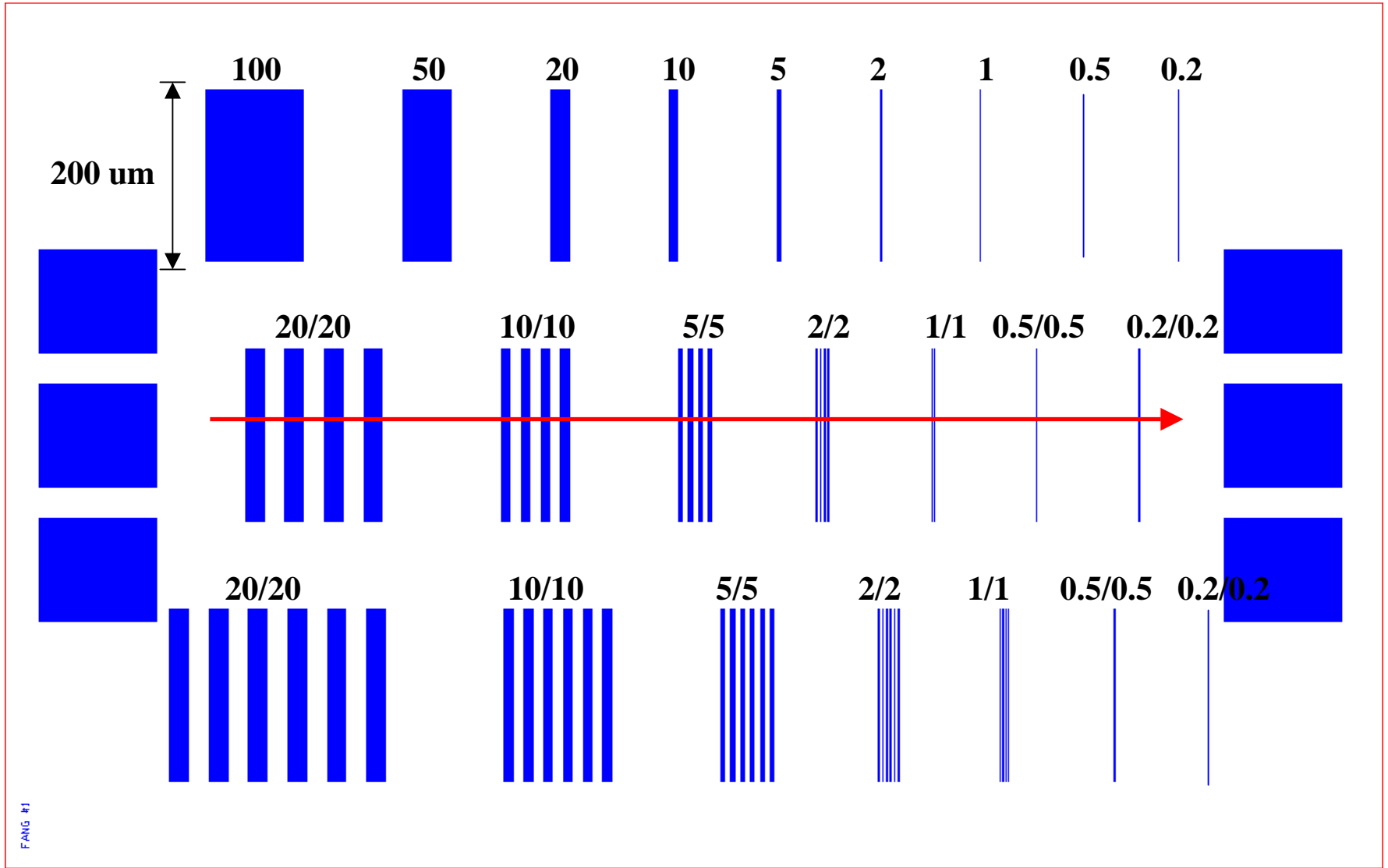


CMP_FANG1 Row 1 Line Profile

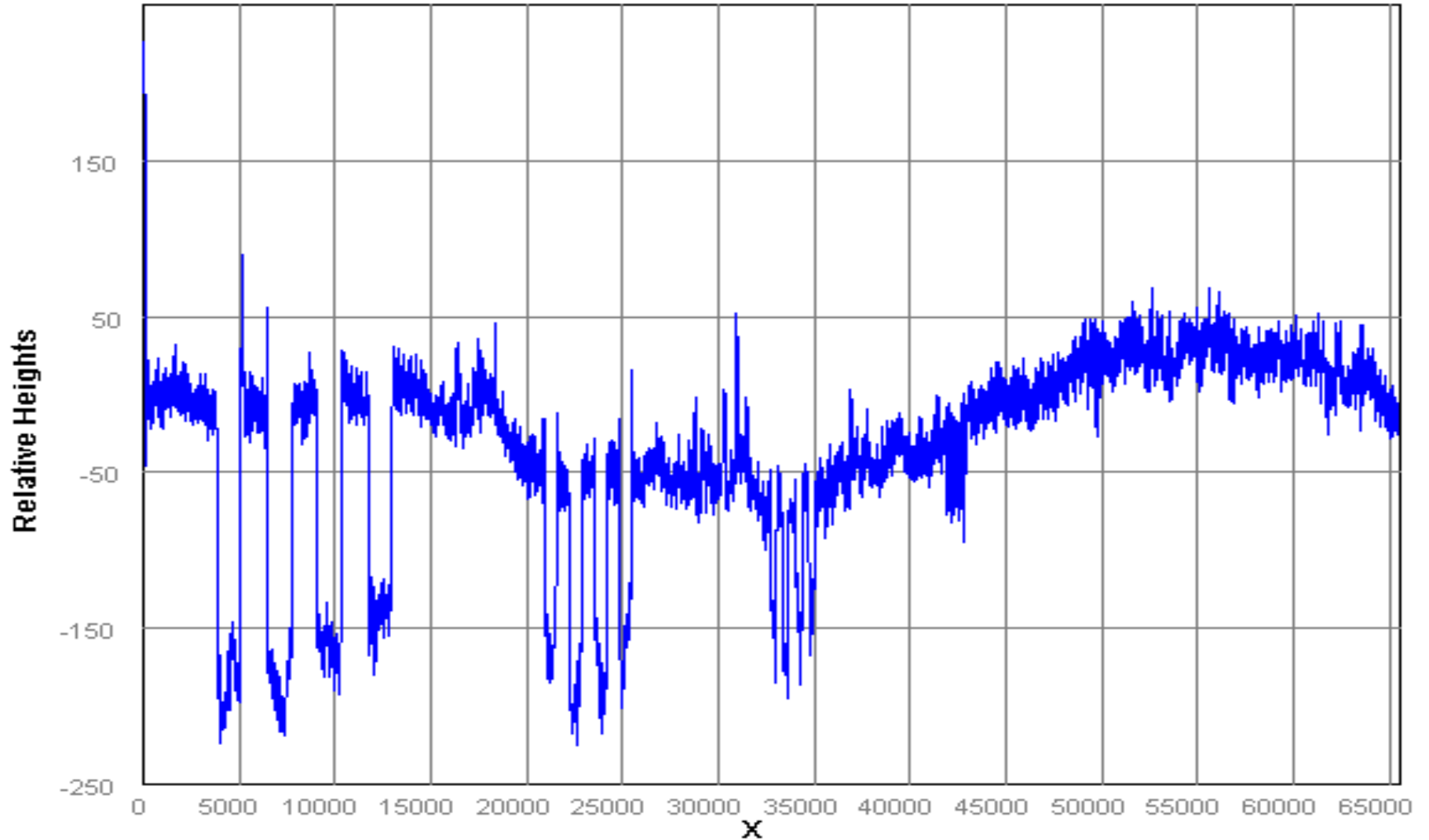


L1 Dish (Å)	L2 Dish (Å)	L3 Dish (Å)	L4 Dish (Å)	L5 Dish (Å)	L6 Dish (Å)	L7 Dish (Å)	L8 Dish (Å)	L9 Dish (Å)
370	309	148	90	67	48	36	23	6

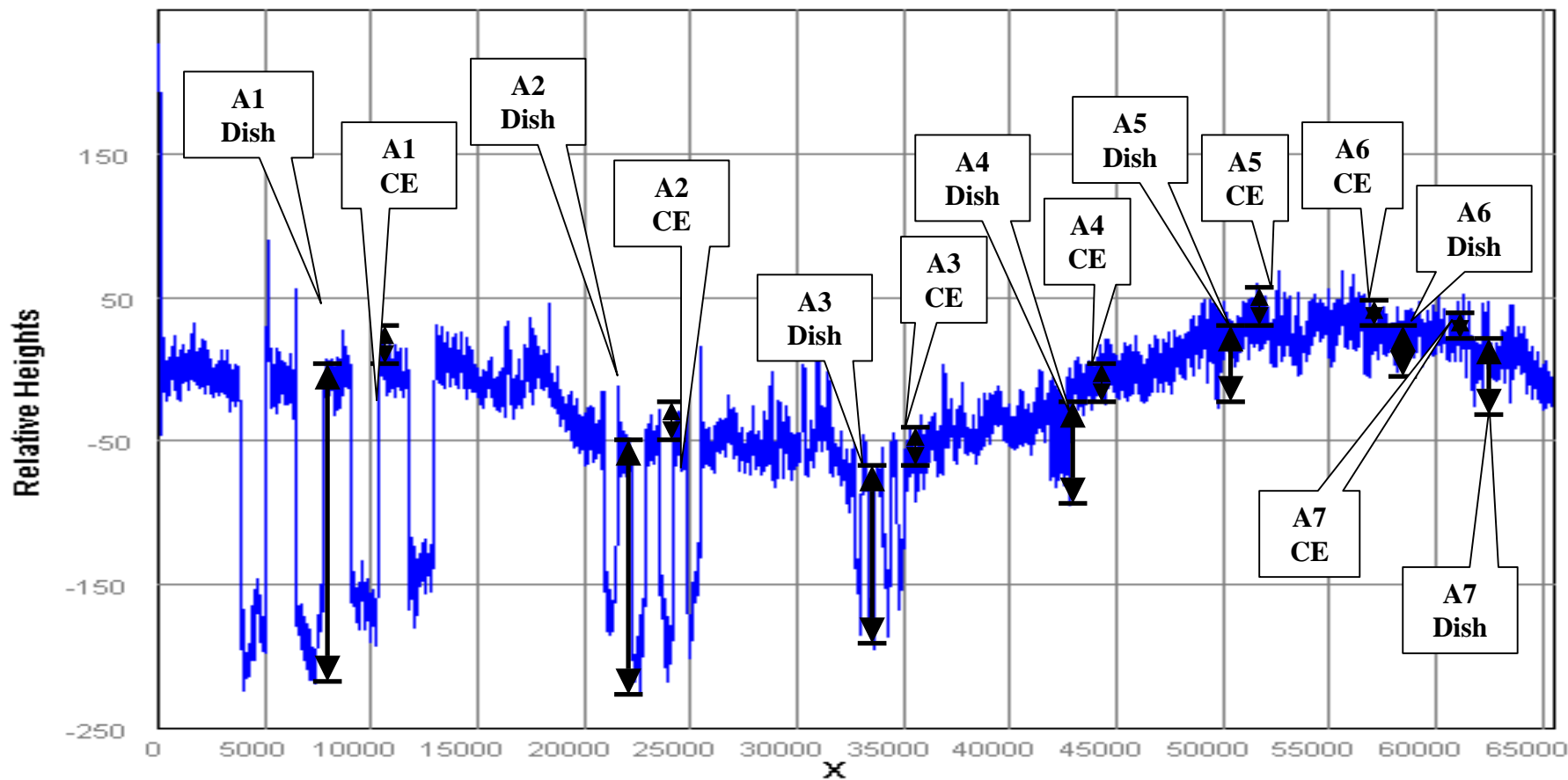
CMP_FANG1 Die Floor Plan



CMP_FANG1 Row 2 Line Profile

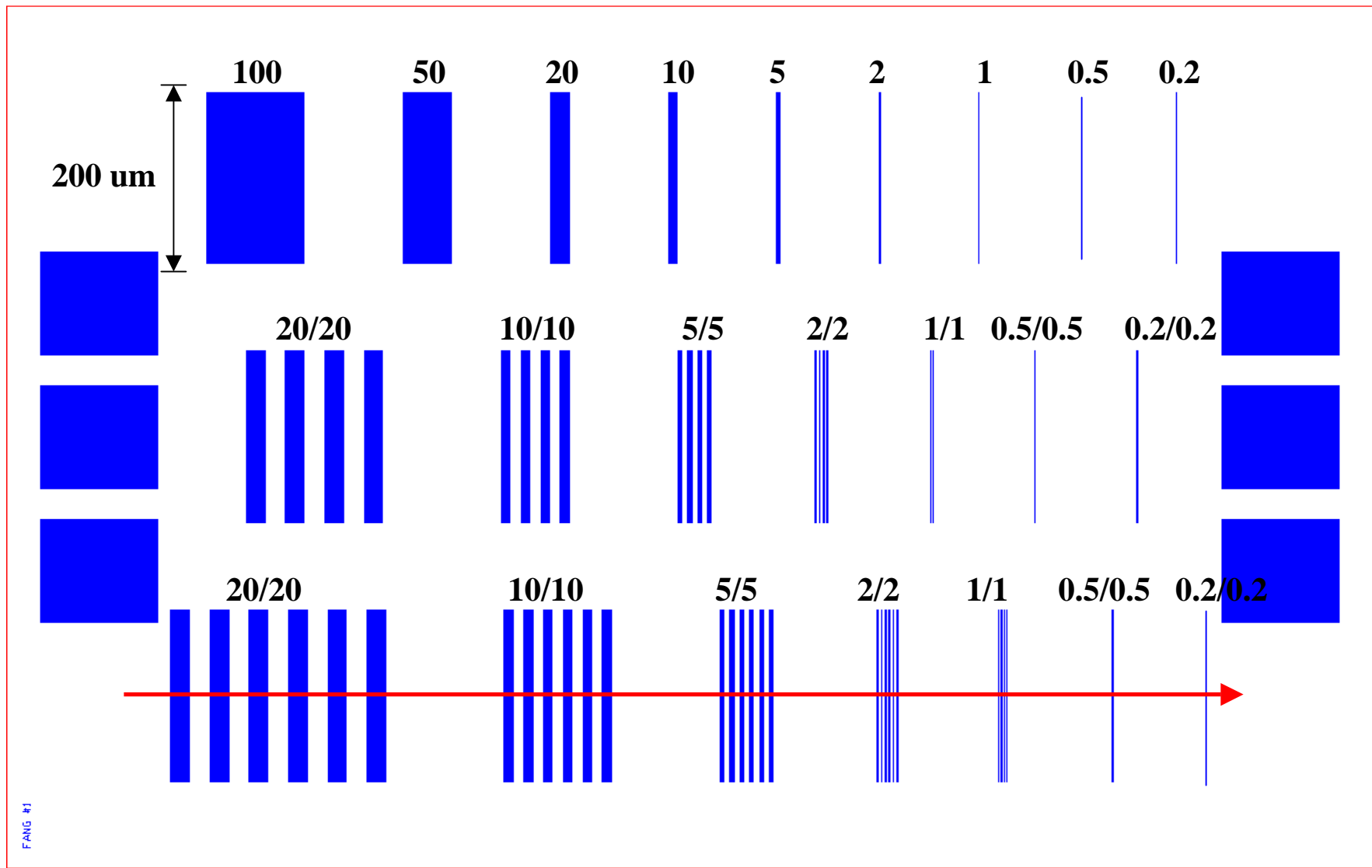


CMP_FANG1 Row 2 Line Profile

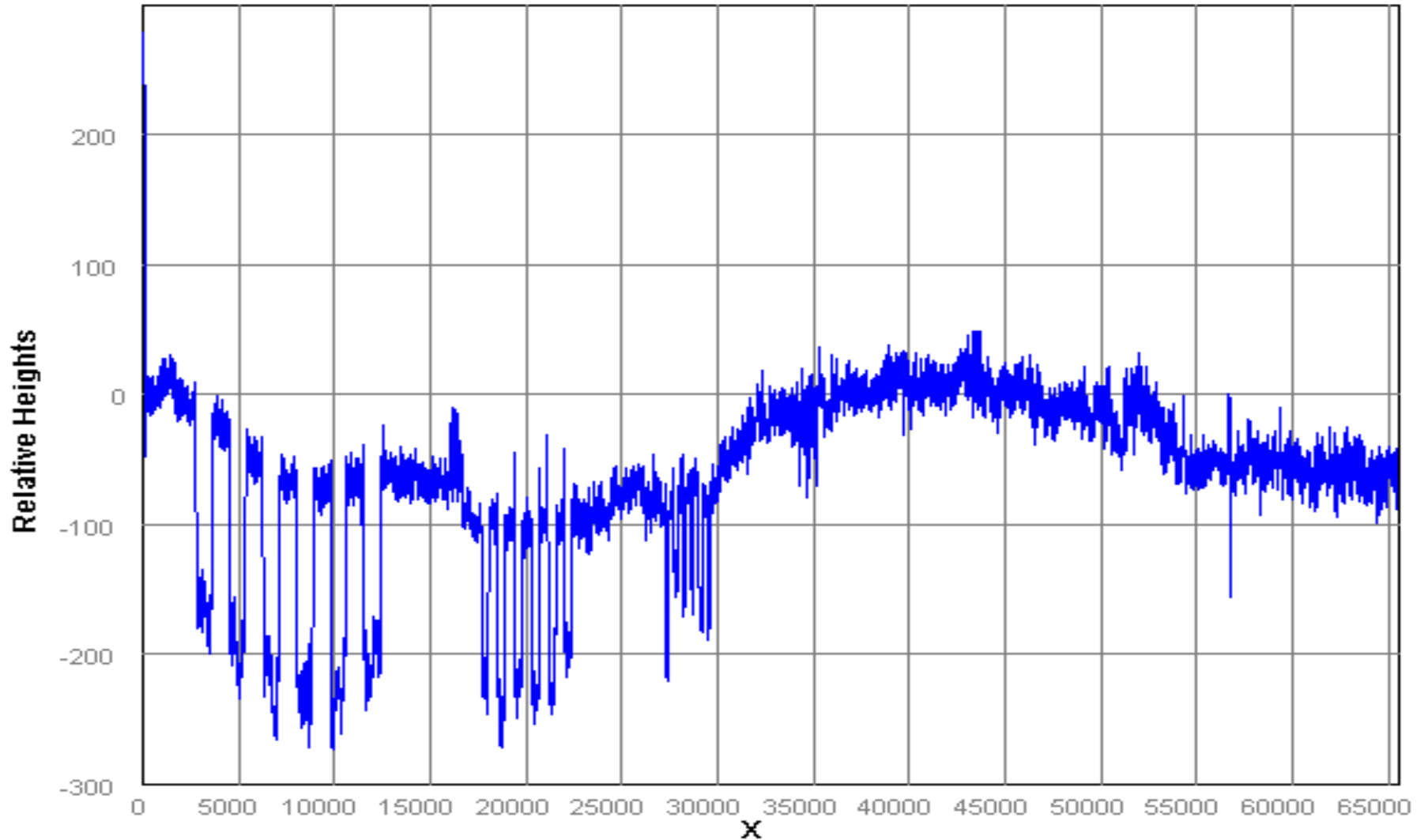


A1 Dish (Å)	A1 CE (Å)	A2 Dish (Å)	A2 CE (Å)	A3 Dish (Å)	A3 CE (Å)	A4 Dish (Å)	A4 CE (Å)	A5 Dish (Å)	A5 CE (Å)	A6 Dish (Å)	A6 CE (Å)	A7 Dish (Å)	A7 CE (Å)
228	18	180	18	112	36	70	27	60	17	43	9	27	4

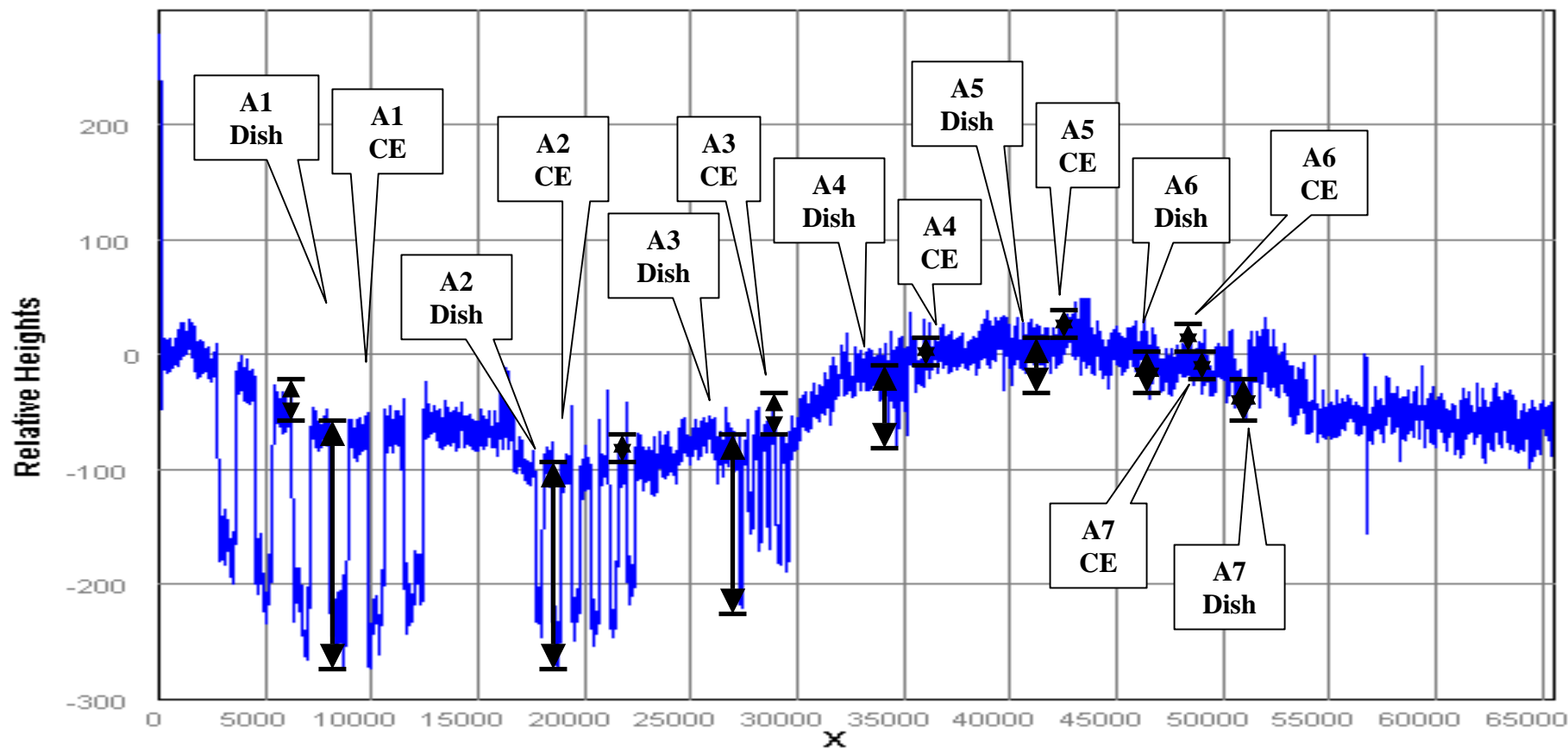
CMP_FANG1 Die Floor Plan



CMP_FANG1 Row 3 Line Profile

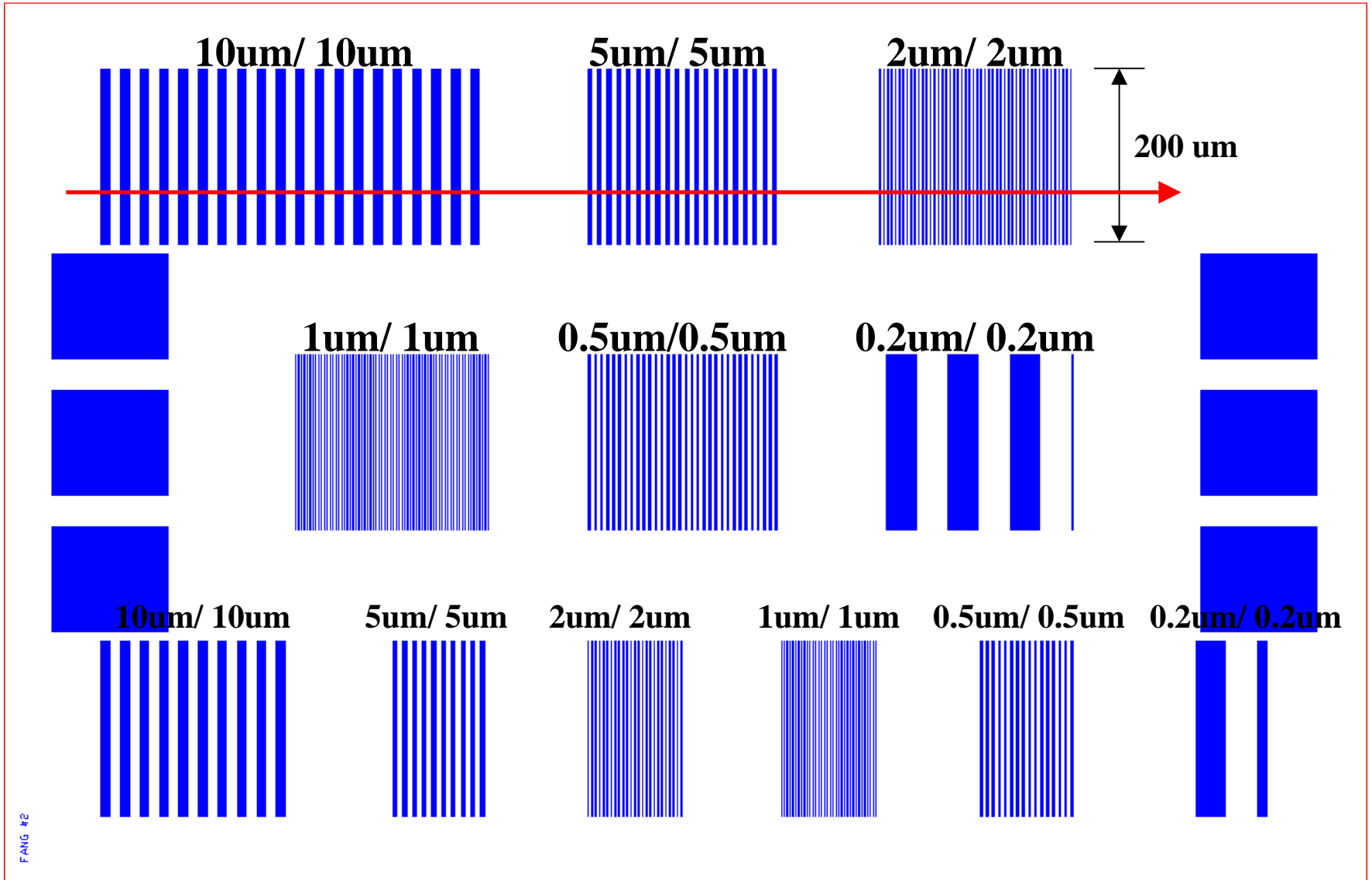


CMP_FANG1 Row 3 Line Profile

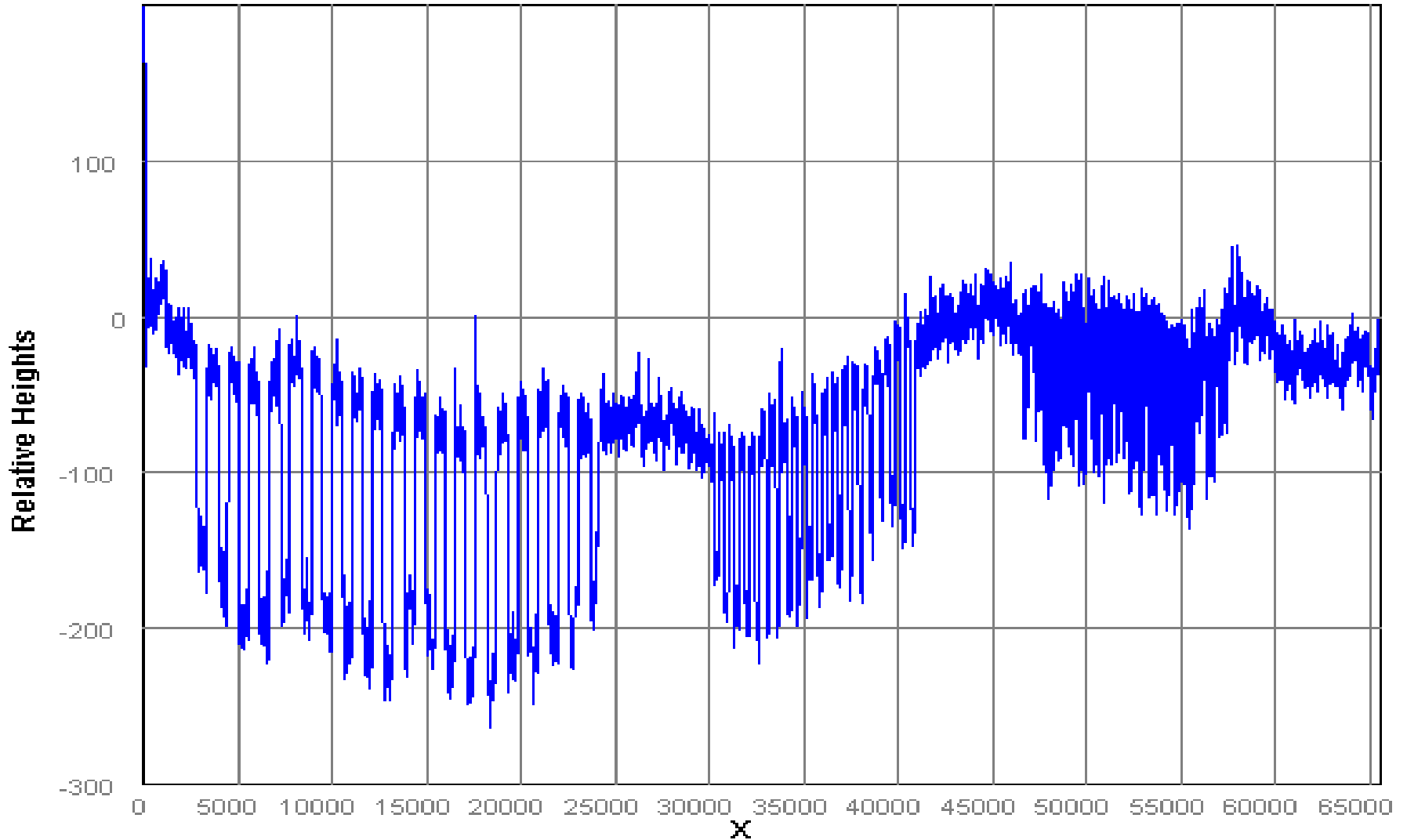


A1 Dish (Å)	A1 CE (Å)	A2 Dish (Å)	A2 CE (Å)	A3 Dish (Å)	A3 CE (Å)	A4 Dish (Å)	A4 CE (Å)	A5 Dish (Å)	A5 CE (Å)	A6 Dish (Å)	A6 CE (Å)	A7 Dish (Å)	A7 CE (Å)
211	35	170	19	136	18	73	9	48	9	26	8	13	6

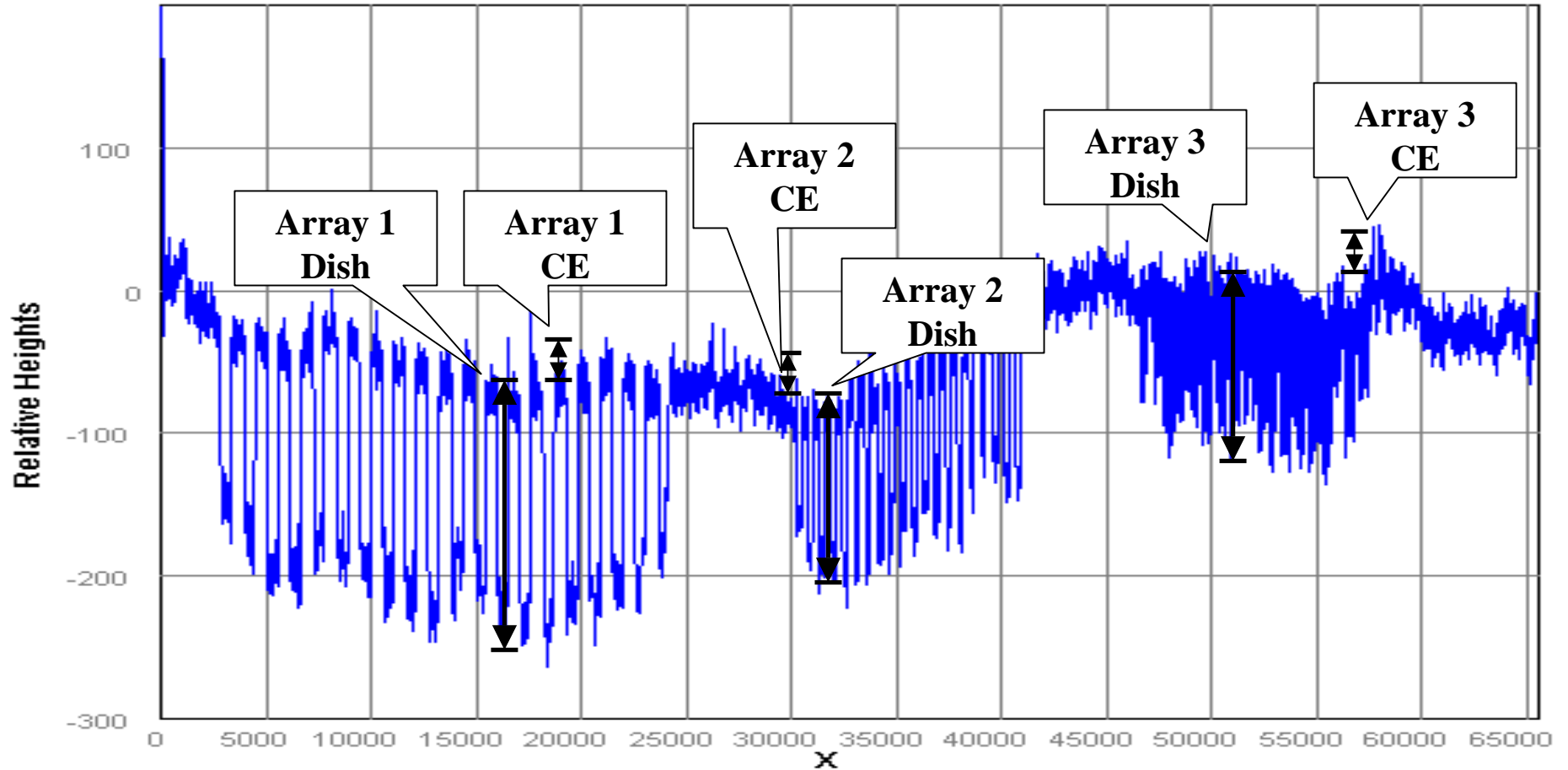
CMP_FANG2 Die Floor Plan



CMP_FANG2 Row 1 Line Profile

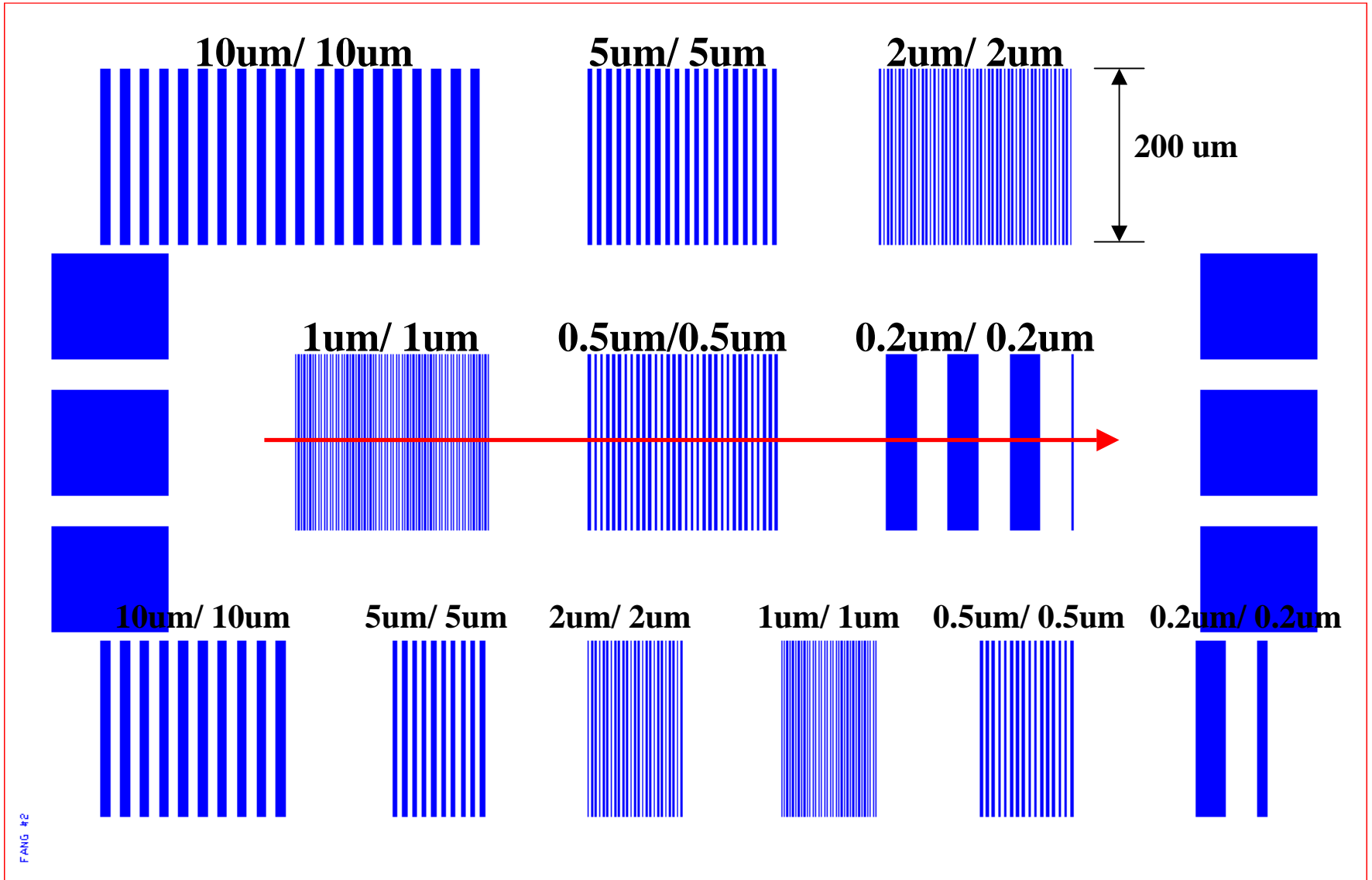


CMP_FANG2 Row 1 Line Profile

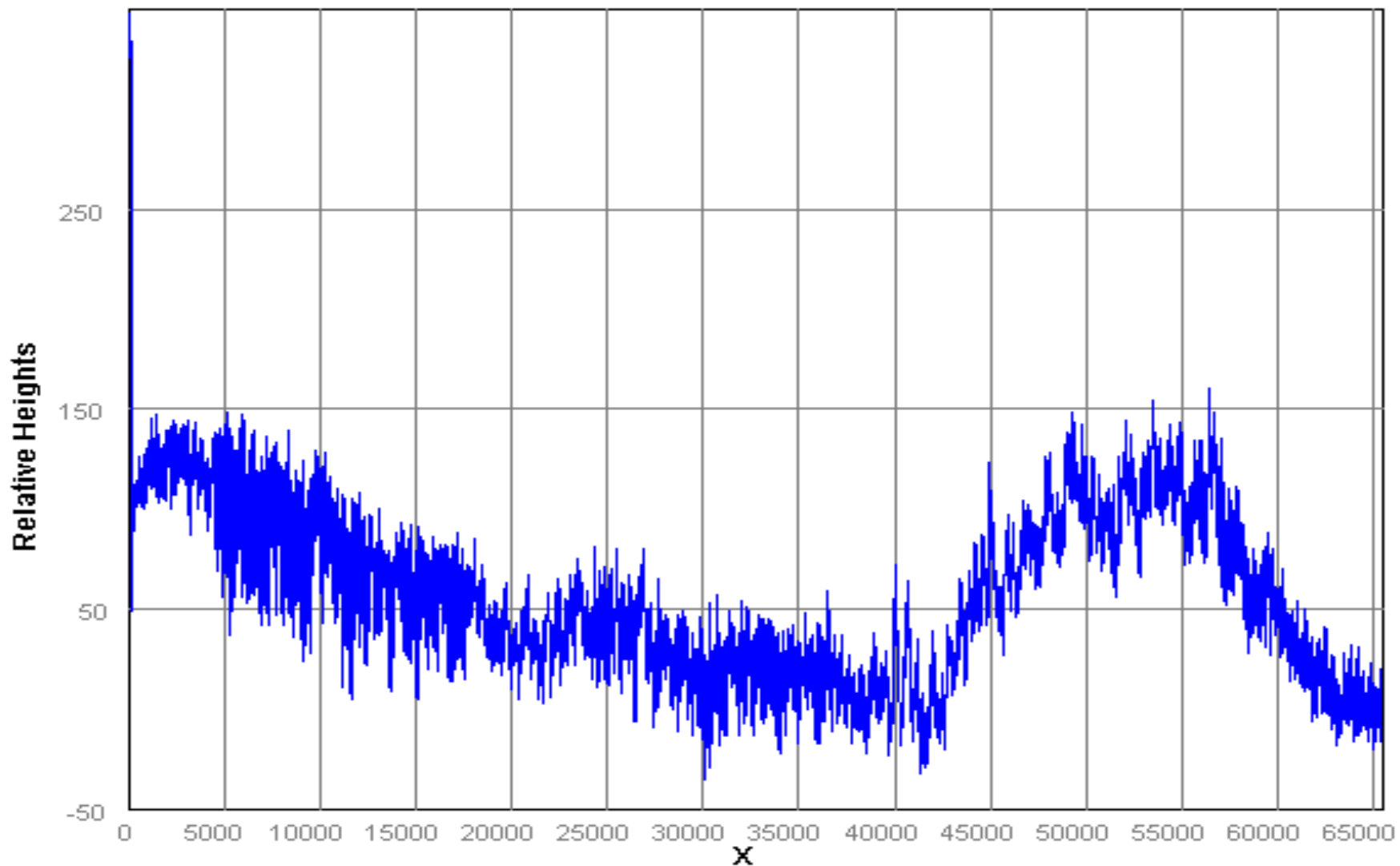


Array 1 Dish (A)	Array 1 CE (A)	Array 2 Dish (A)	Array 2 CE (A)	Array 3 Dish (A)	Array 3 CE (A)
182	18	142	48	126	64

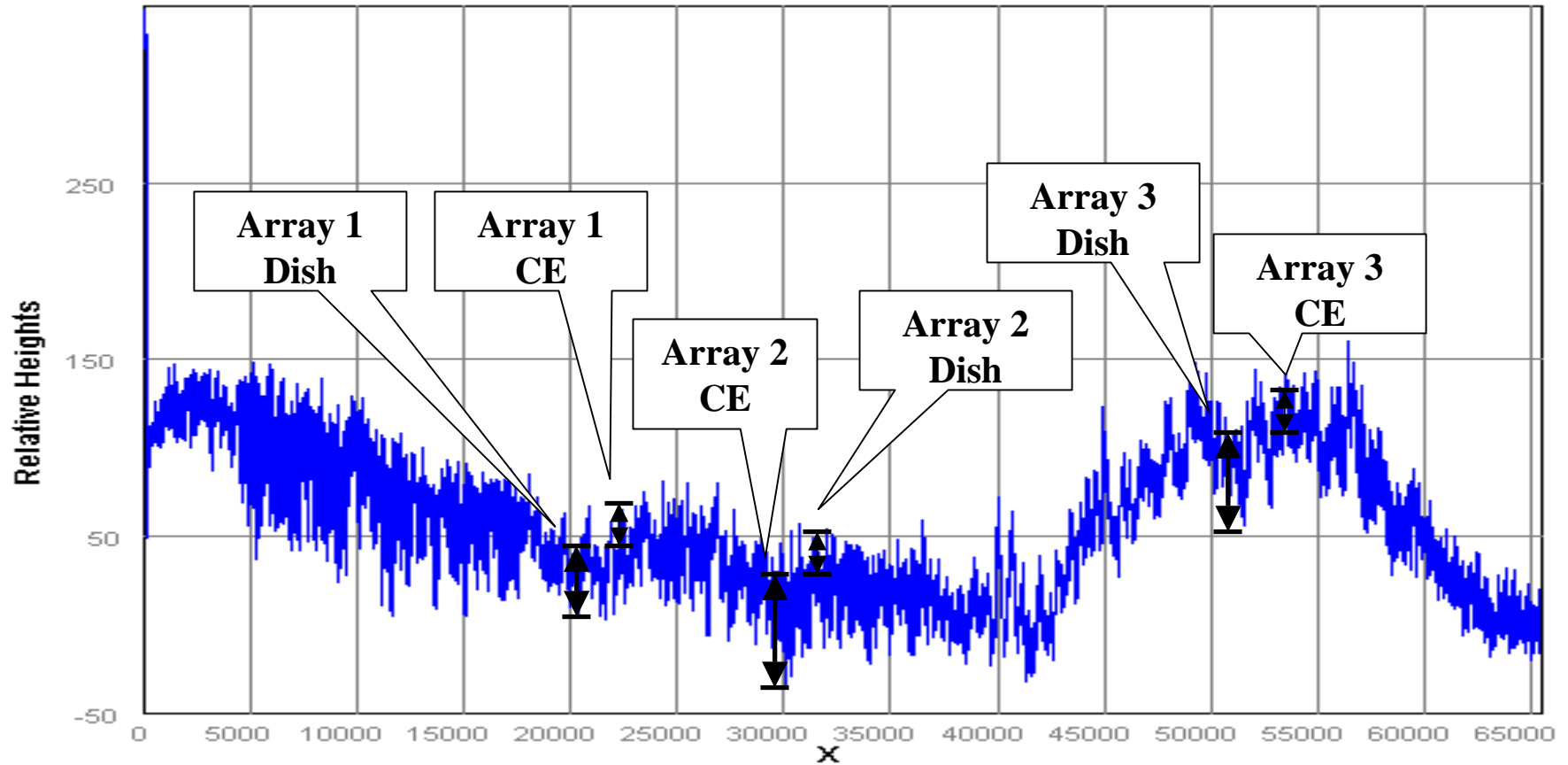
CMP_FANG2 Die Floor Plan



CMP_FANG2 Row 2 Line Profile

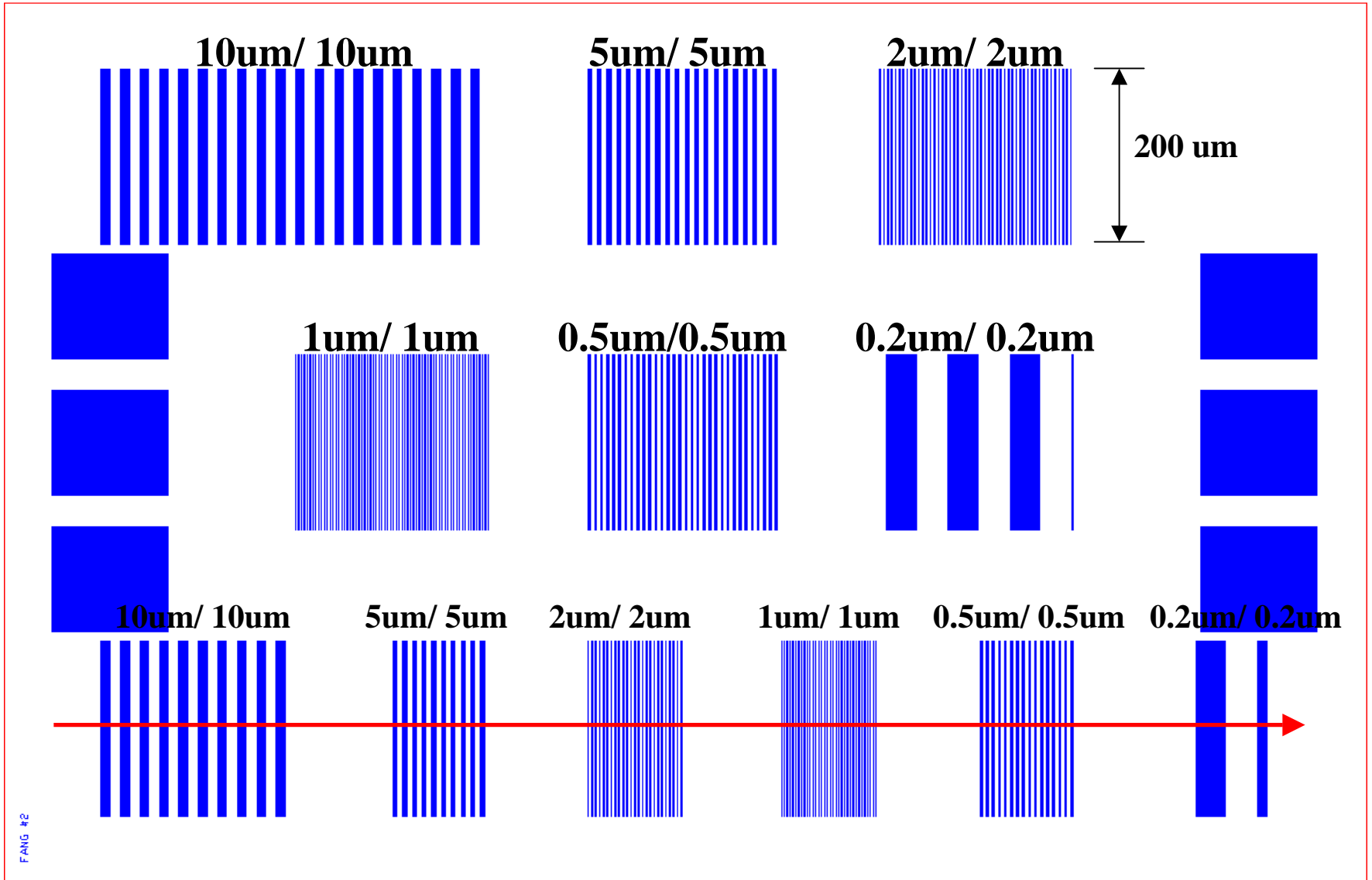


CMP_FANG2 Row 2 Line Profile

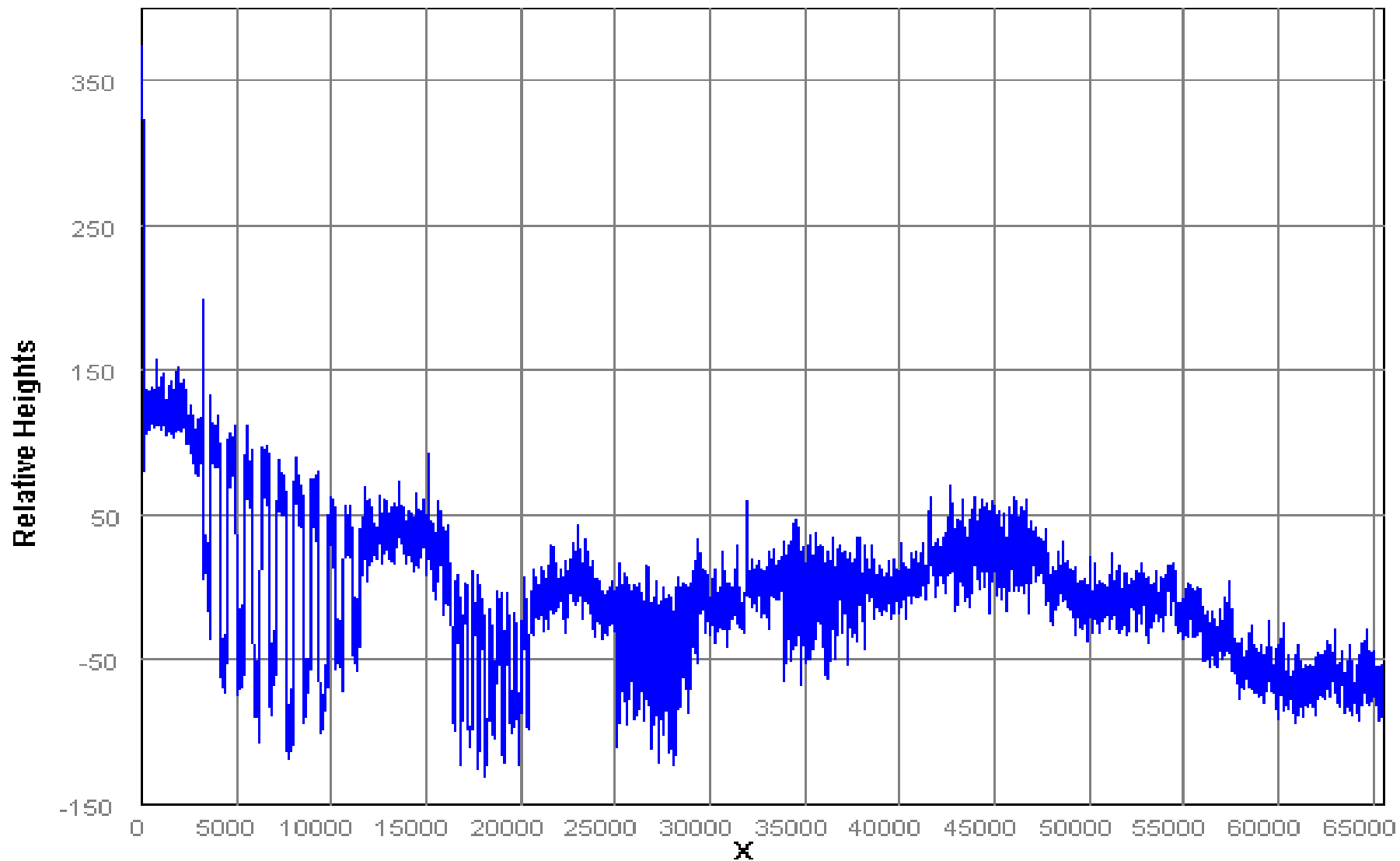


Array 1 Dish (A)	Array 1 CE (A)	Array 2 Dish (A)	Array 2 CE (A)	Array 3 Dish (A)	Array 3 CE (A)
87	78	55	86	36	95

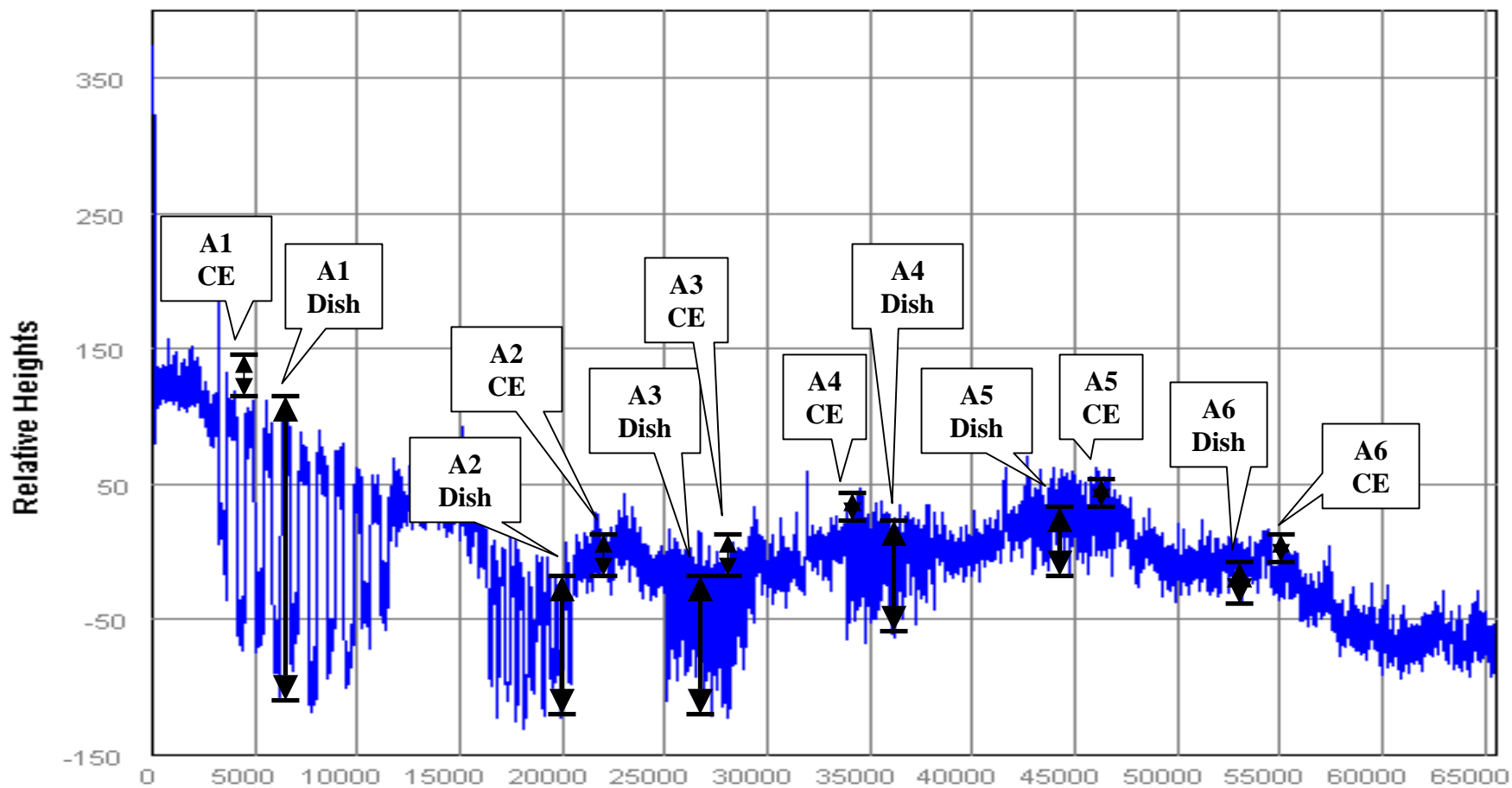
CMP_FANG2 Die Floor Plan



CMP_FANG2 Row 3 Line Profile

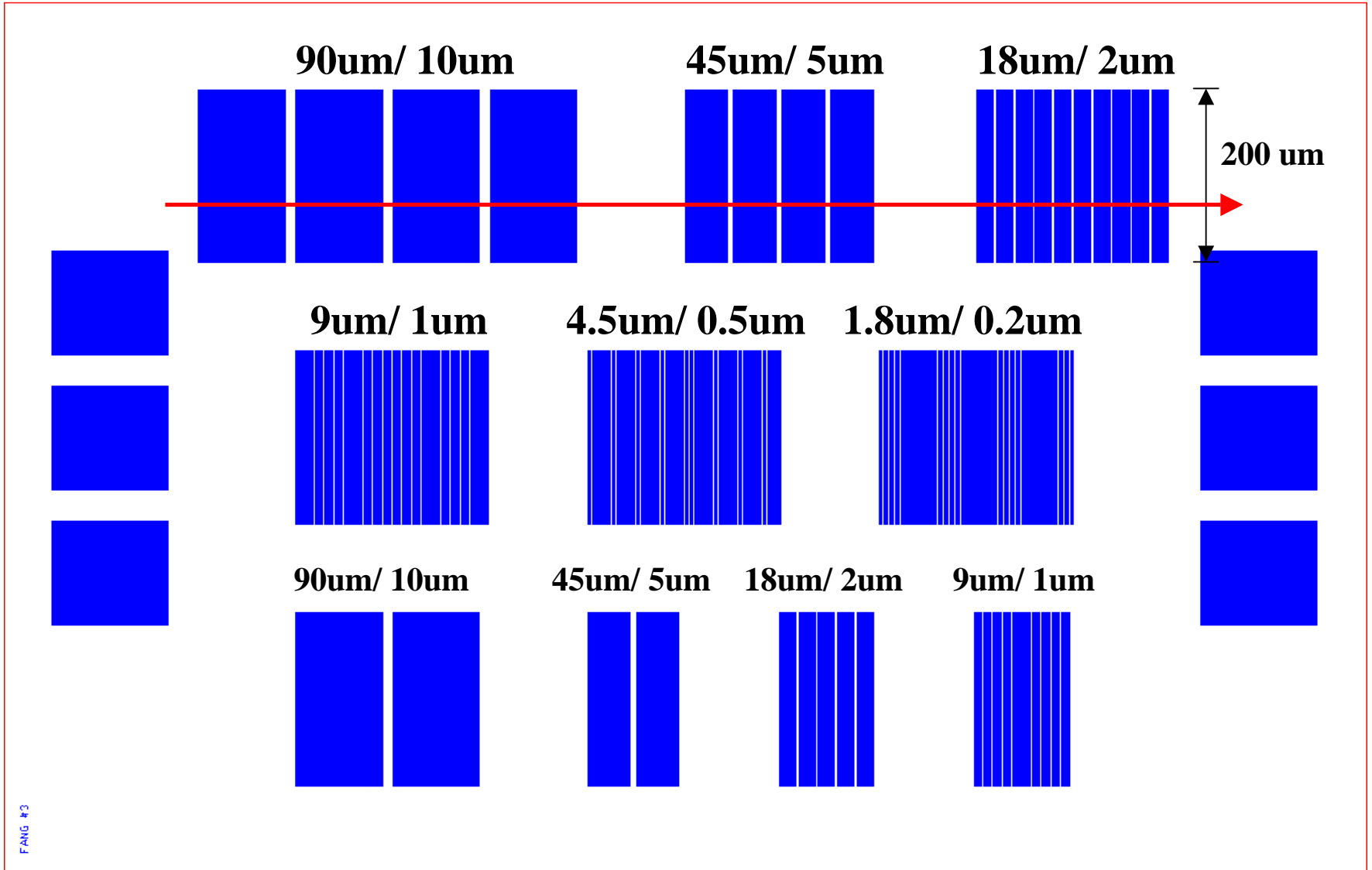


CMP_FANG2 Row 3 Line Profile



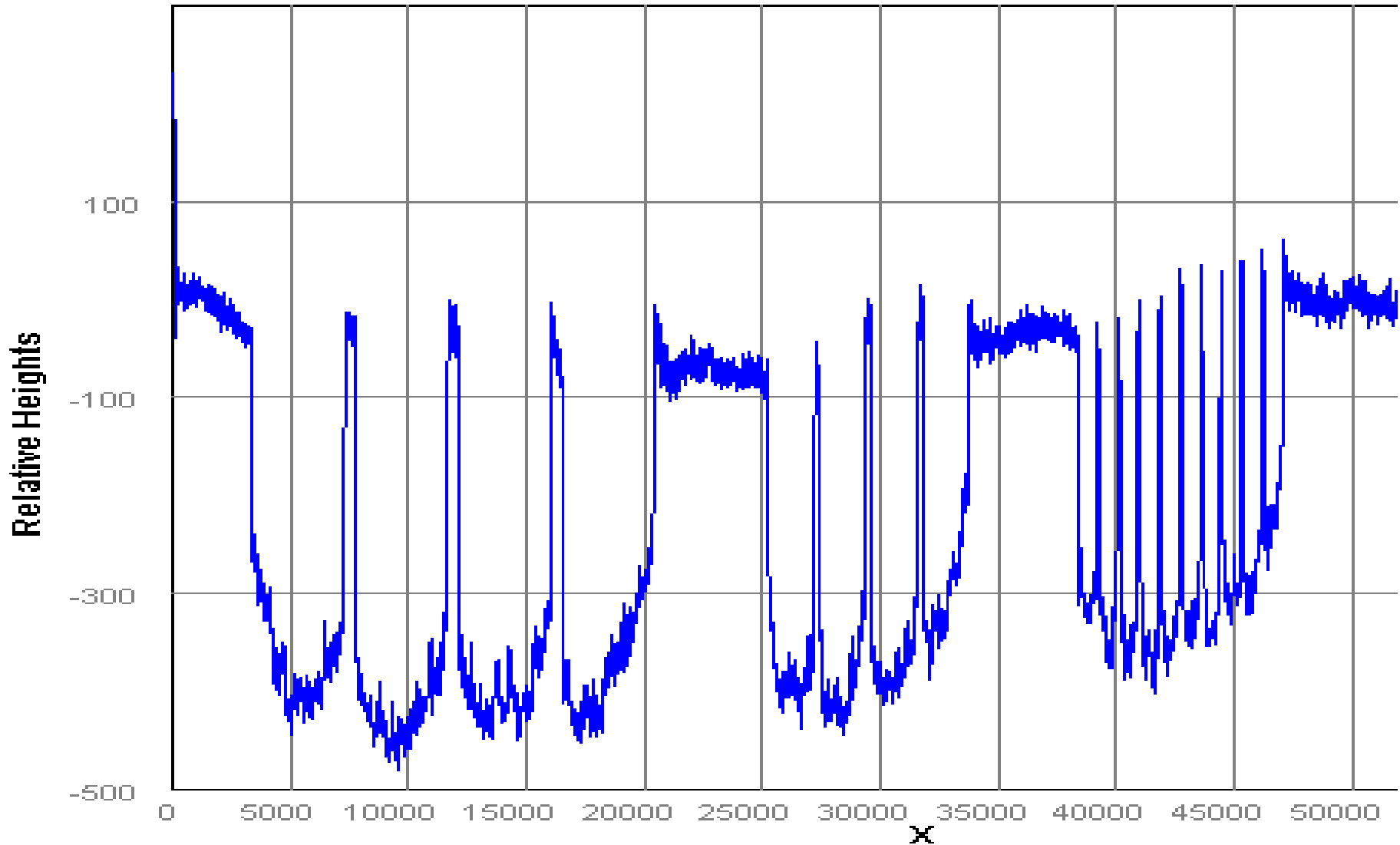
A1 Dish (Å)	A1 CE (Å)	A2 Dish (Å)	A2 CE (Å)	A3 Dish (Å)	A3 CE (Å)	A4 Dish (Å)	A4 CE (Å)	A5 Dish (Å)	A5 CE (Å)	A6 Dish (Å)	A6 CE (Å)
203	13	110	38	110	26	78	12	52	15	30	12

CMP_FANG3 Die Floor Plan

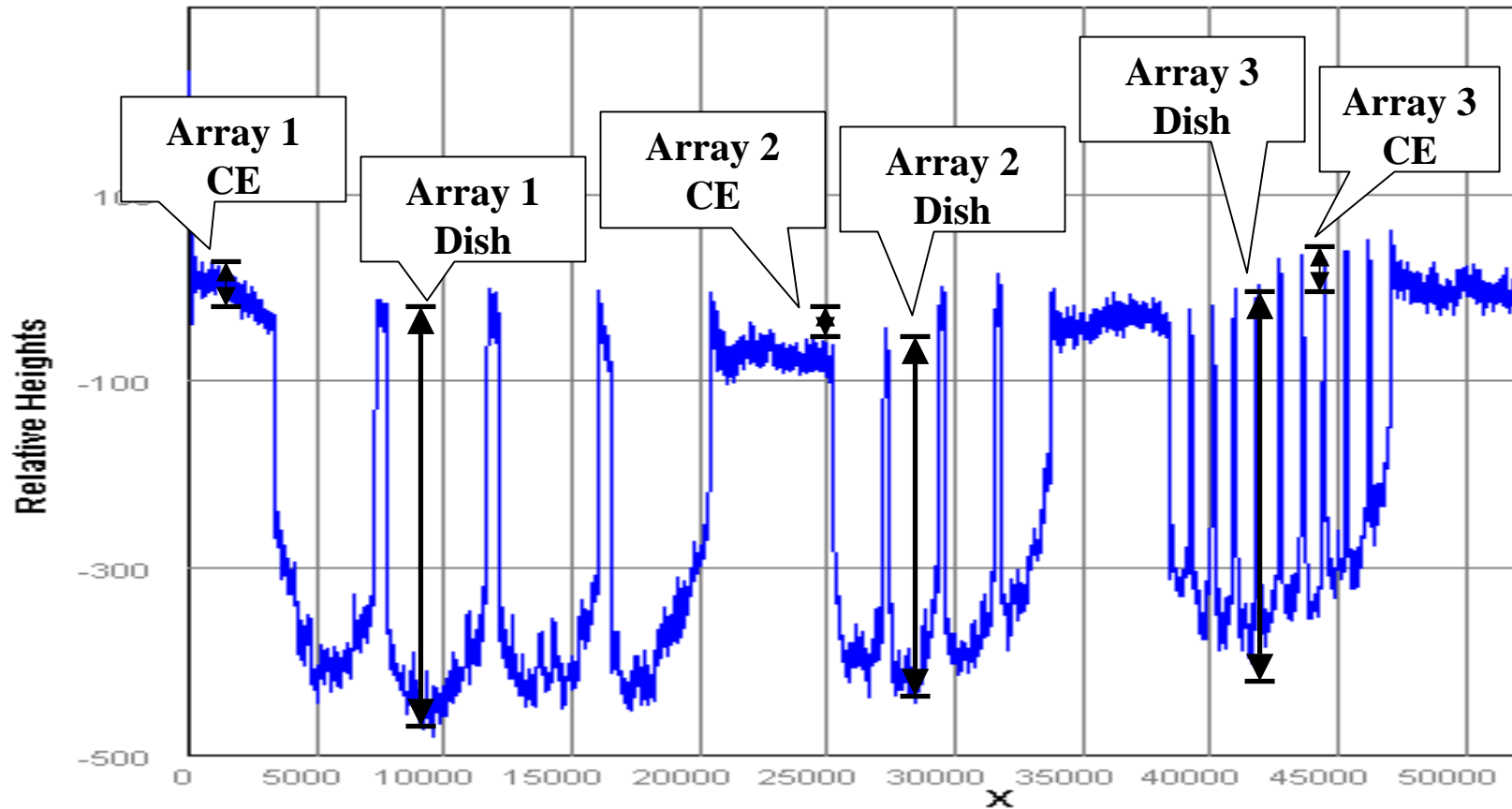


FANG #3

CMP_FANG3 Row 1 Line Profile

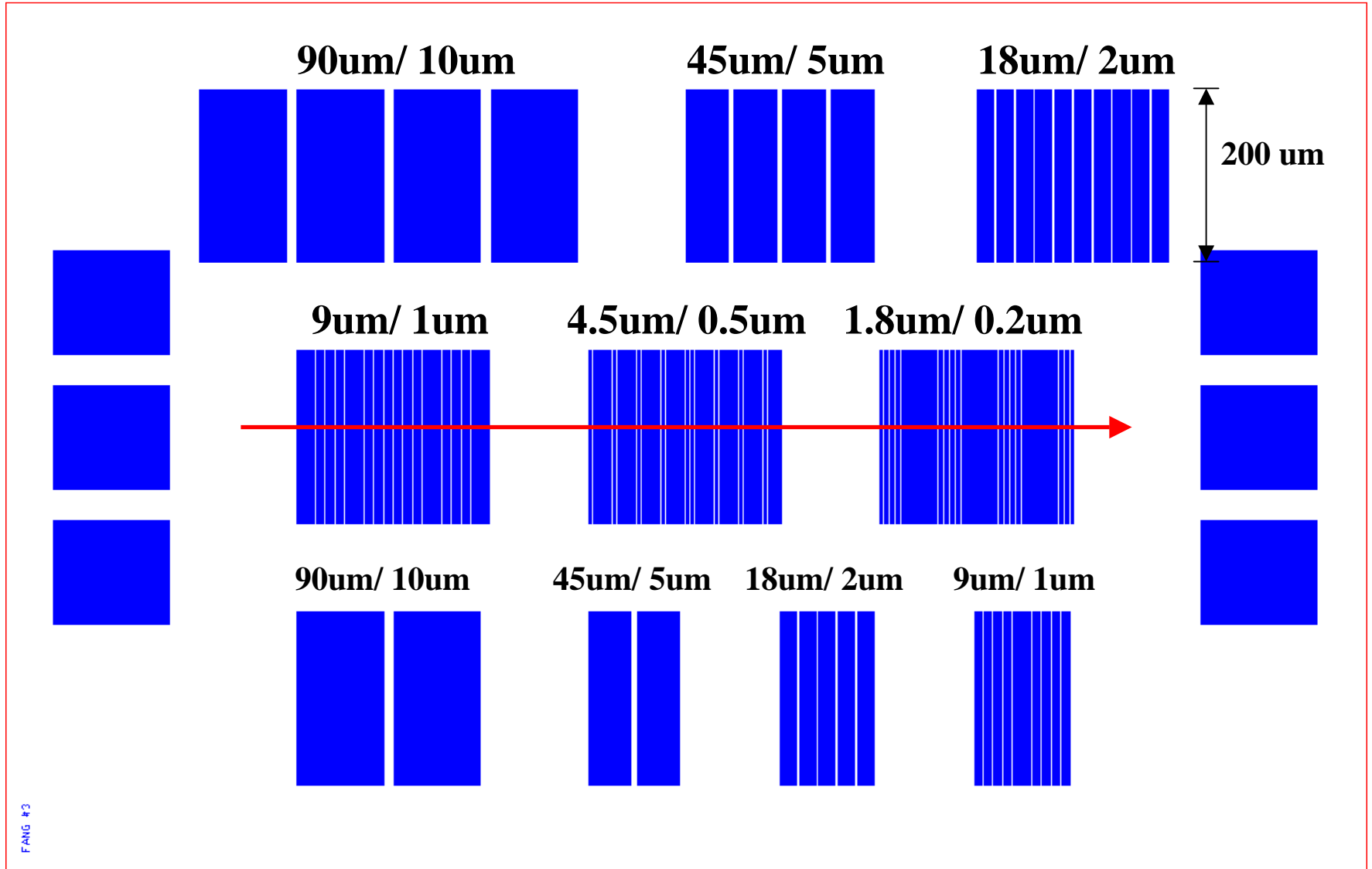


CMP_FANG3 Row 1 Line Profile



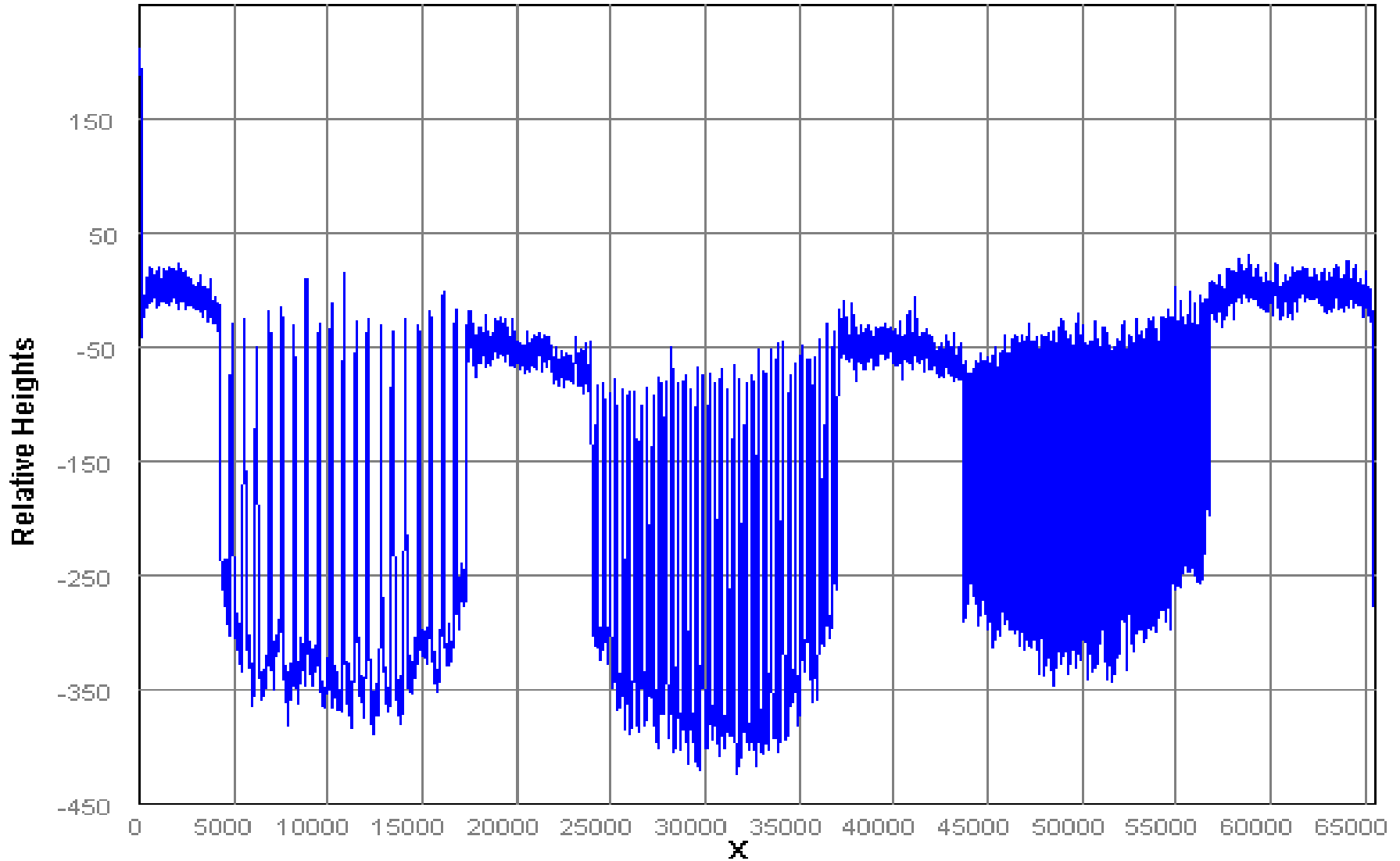
Array 1 Dish (A)	Array 1 CE (A)	Array 2 Dish (A)	Array 2 CE (A)	Array 3 Dish (A)	Array 3 CE (A)
419	35	397	12	397	18

CMP_FANG3 Die Floor Plan

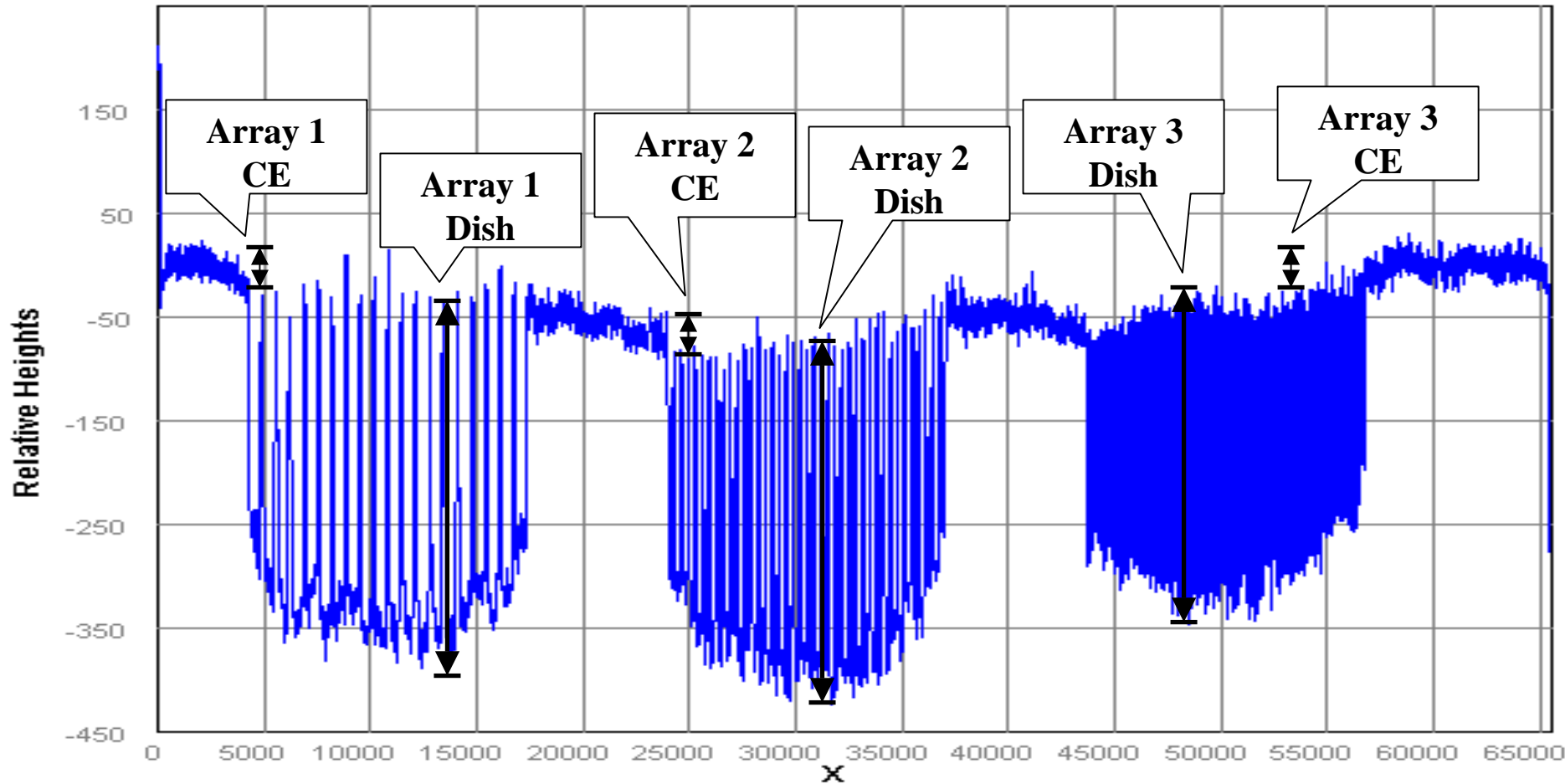


FANG #3

CMP_FANG3 Row 2 Line Profile

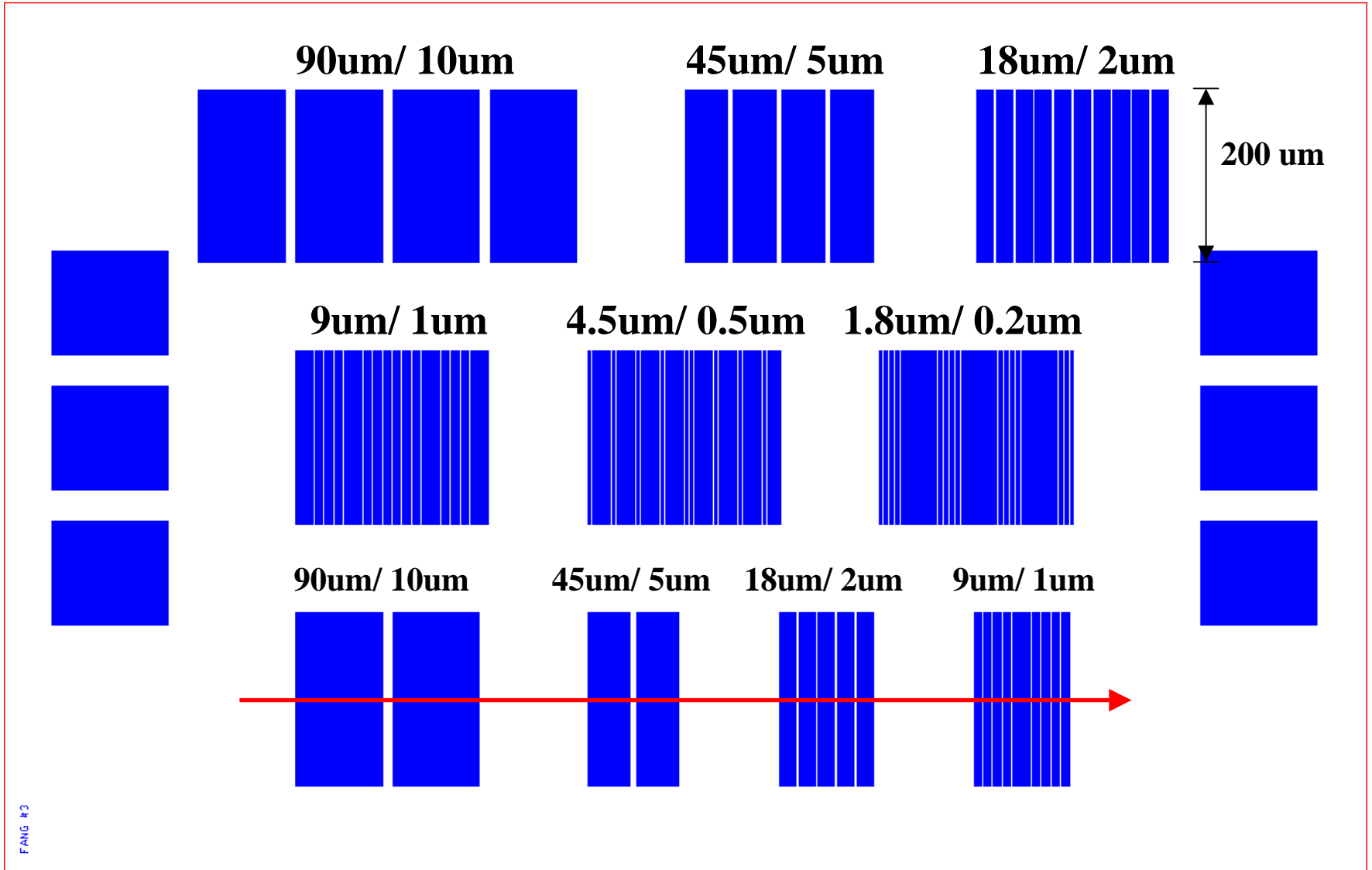


CMP_FANG3 Row 2 Line Profile

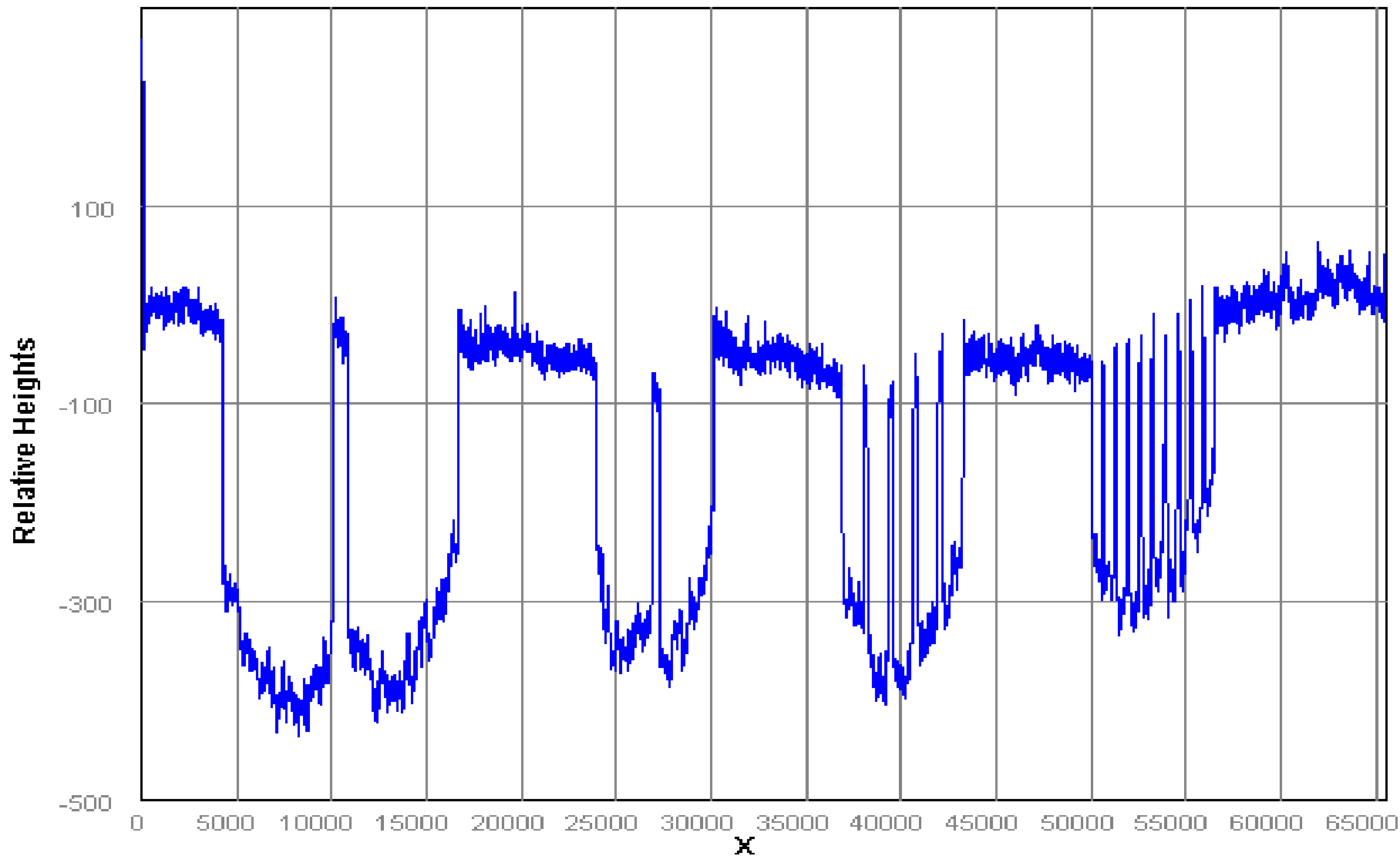


Array 1 Dish (A)	Array 1 CE (A)	Array 2 Dish (A)	Array 2 CE (A)	Array 3 Dish (A)	Array 3 CE (A)
348	25	342	33	311	46

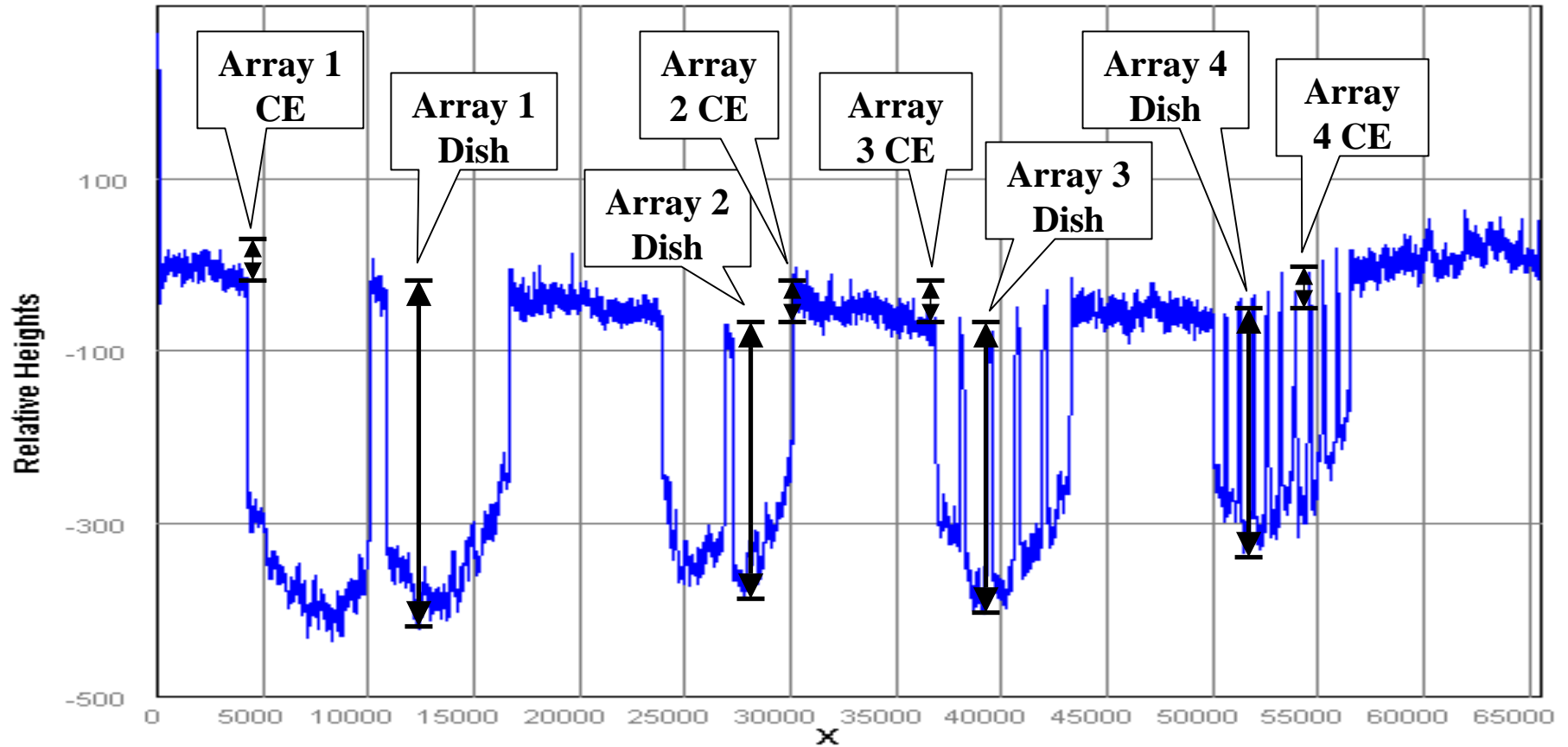
CMP_FANG3 Die Floor Plan



CMP_FANG3 Row 3 Line Profile

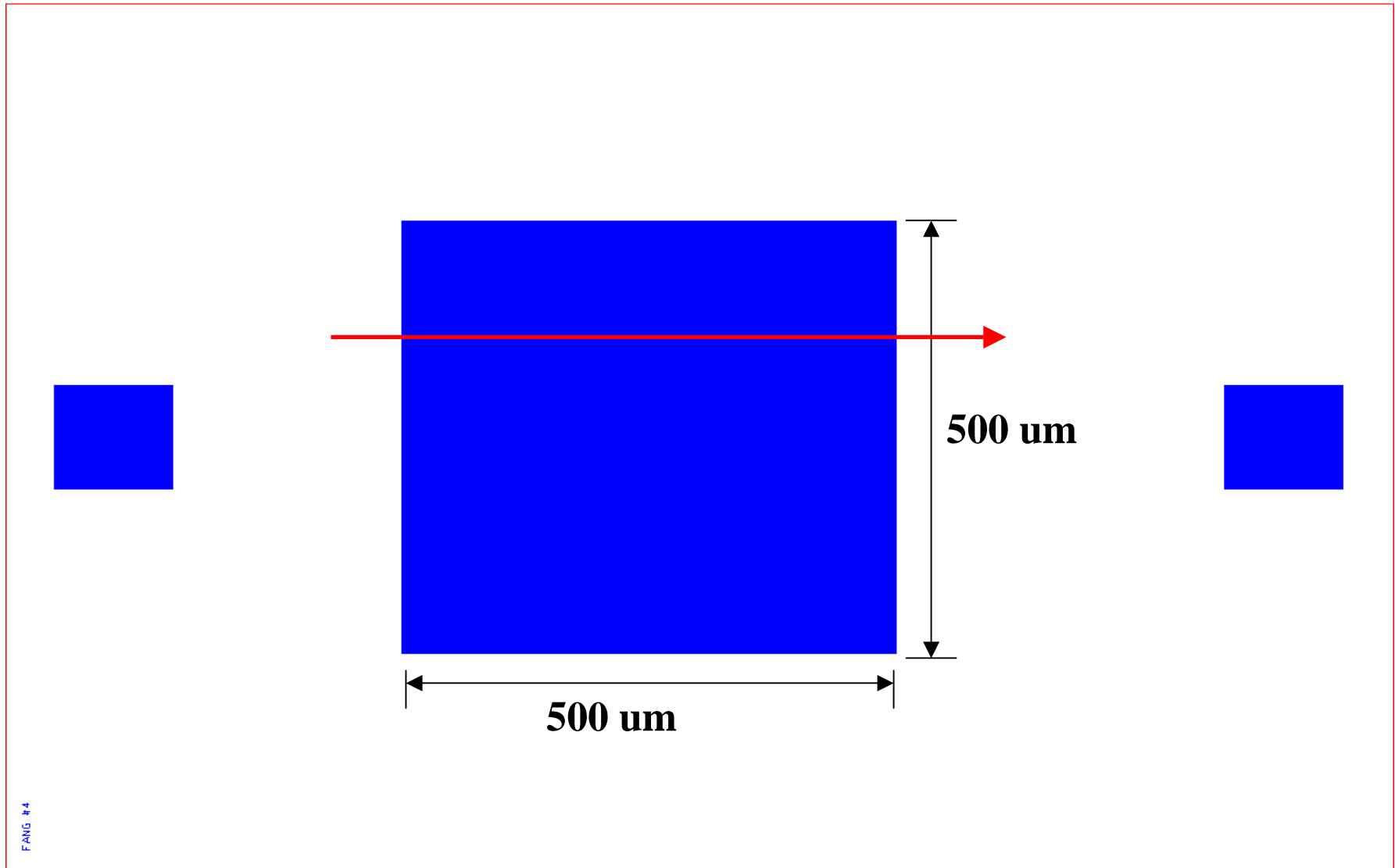


CMP_FANG3 Row 3 Line Profile



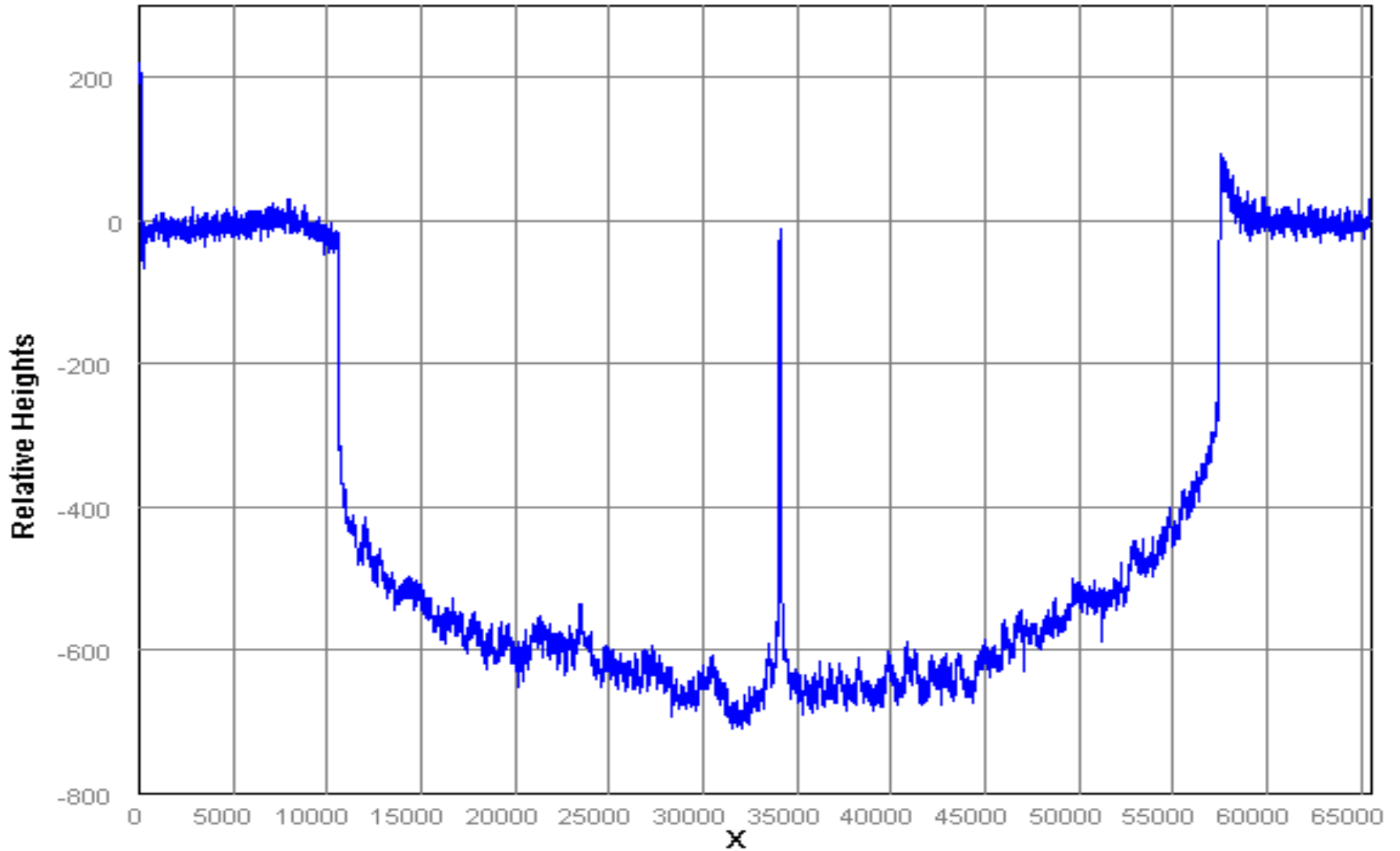
Array 1 Dish (A)	Array 1 CE (A)	Array 2 Dish (A)	Array 2 CE (A)	Array 3 Dish (A)	Array 3 CE (A)	Array 4 Dish (A)	Array 4 CE (A)
415	30	313	34	303	48	280	56

CMP_FANG4 Die Floor Plan

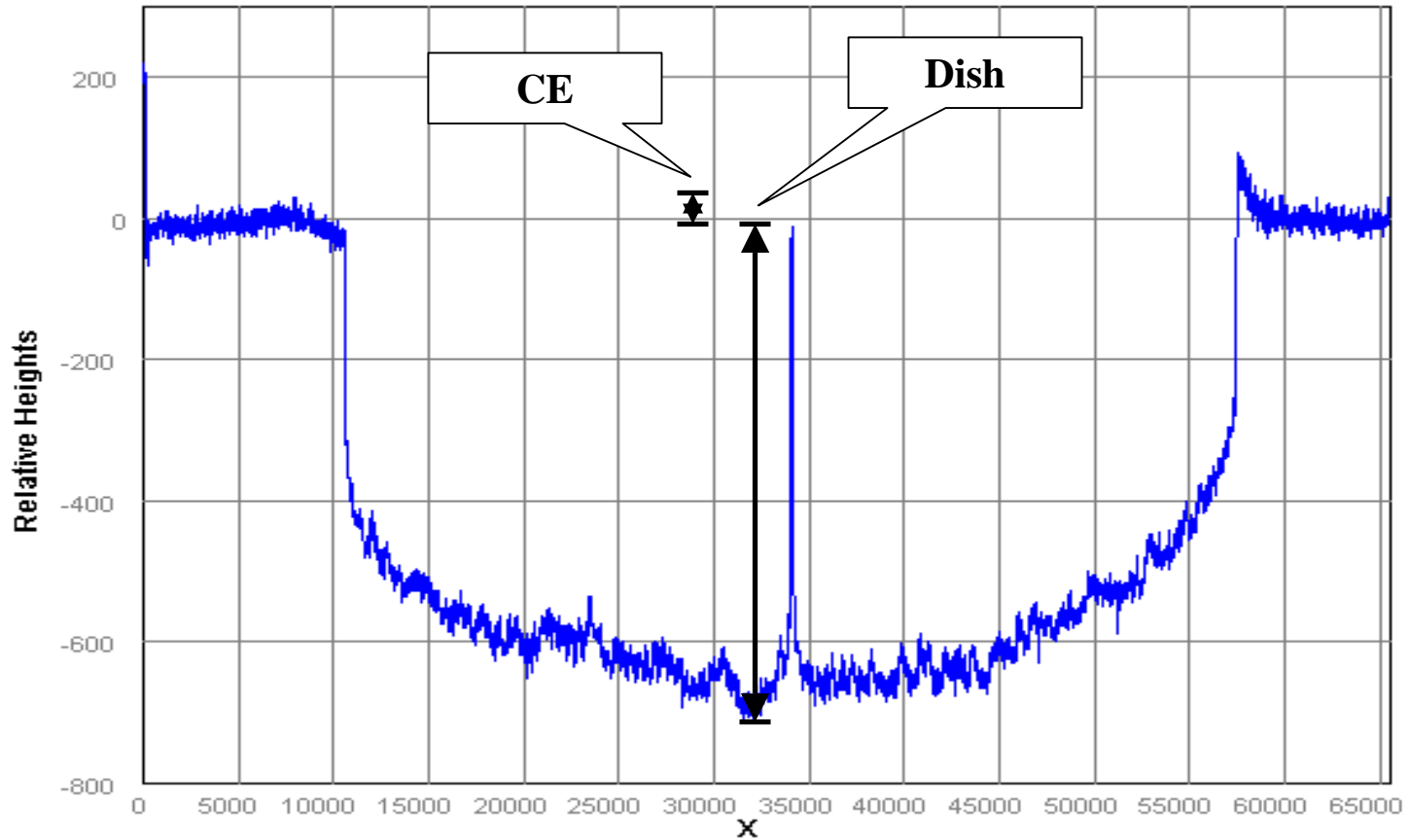


FANG #4

CMP_FANG4 Row 1 Line Profile

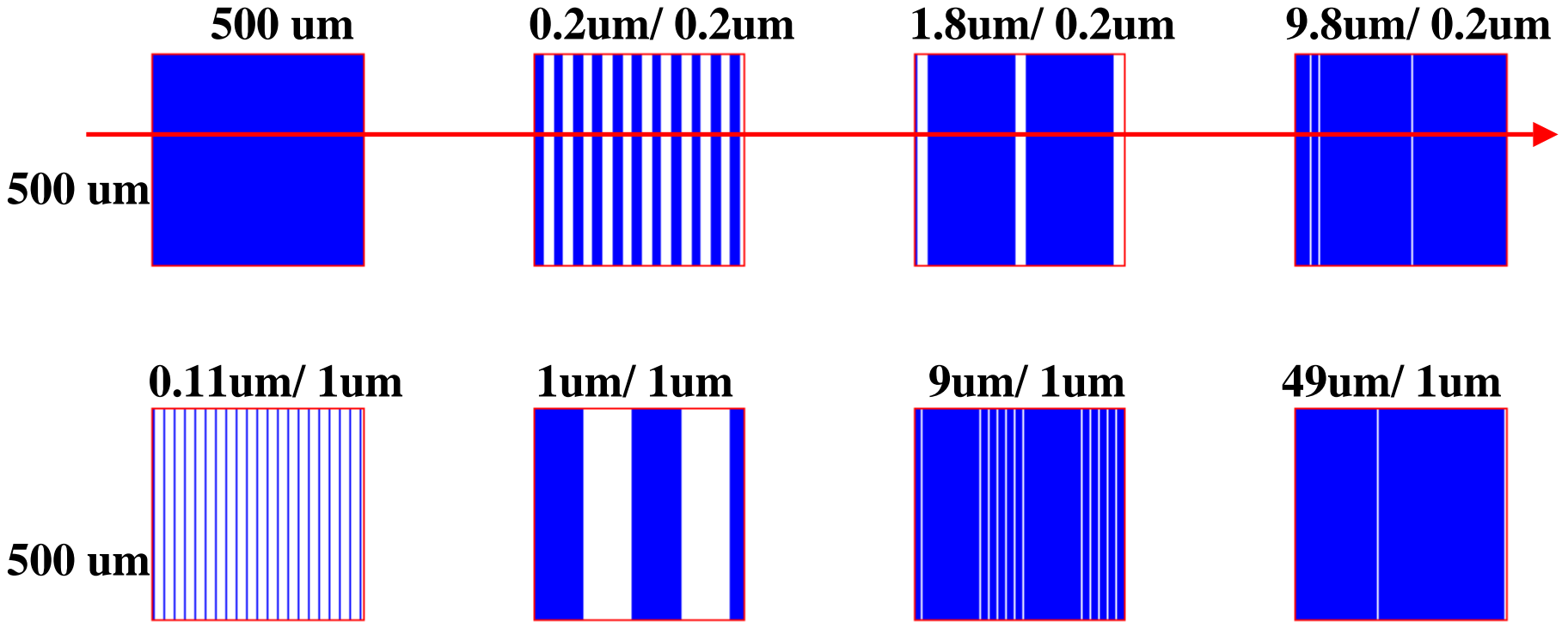


CMP_FANG4 Row 1 Line Profile



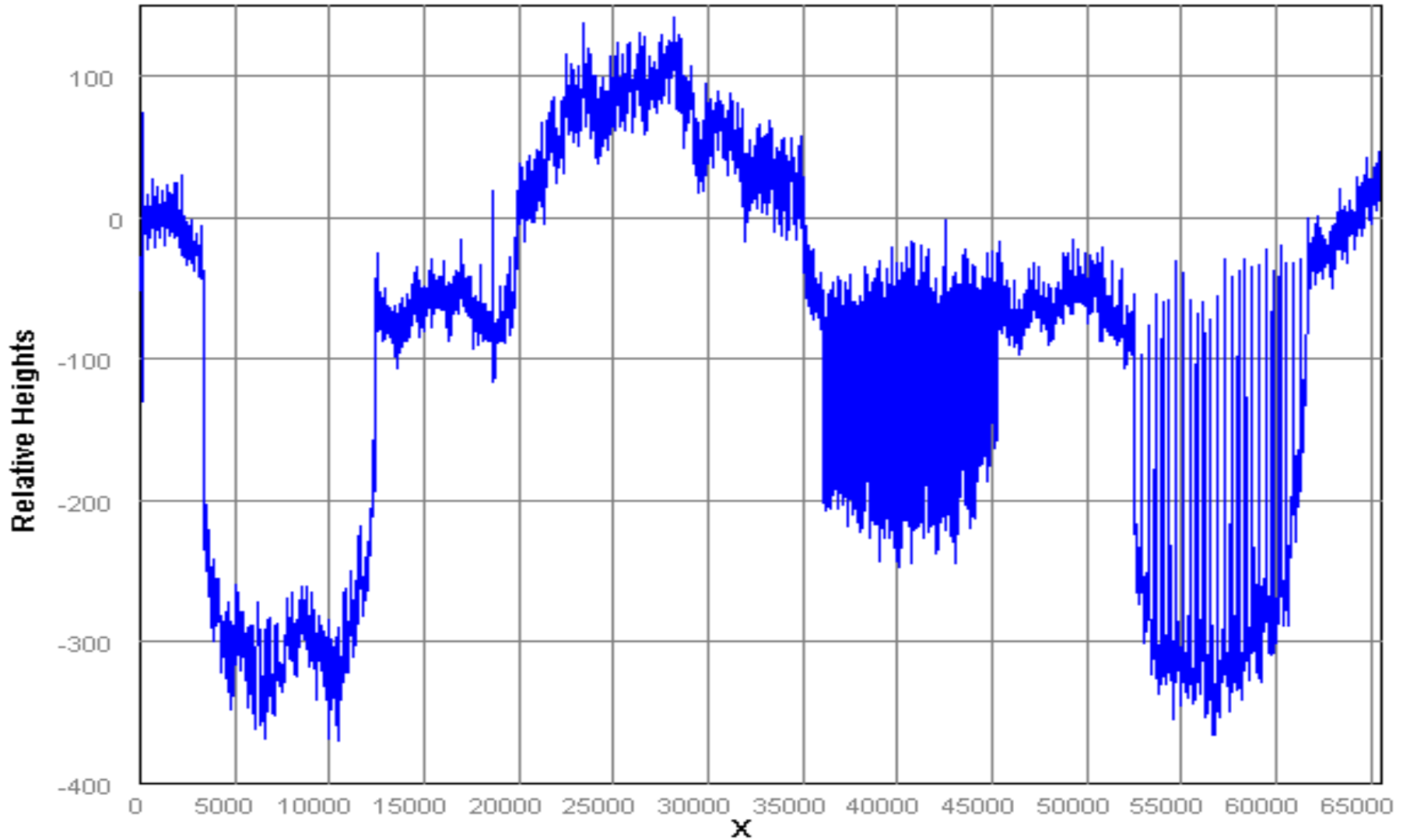
Dish (A)	CE (A)
692	30

CMP Pads at Metal 1

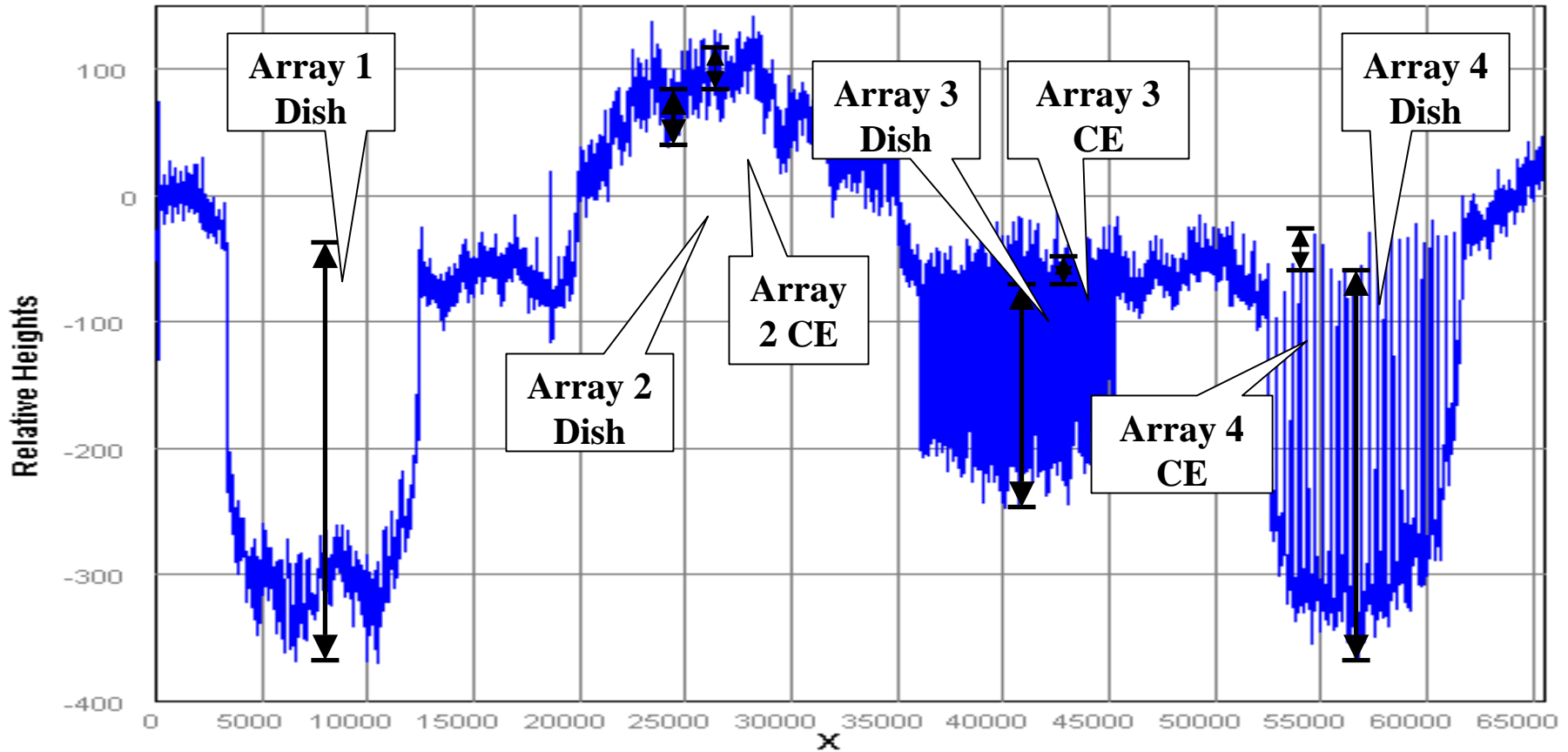


CMP PAD TEST STEP

CMP Pads Row 1 Line Profile



CMP Pads Row 1 Line Profile



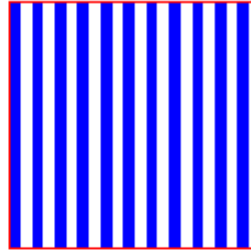
Array 1 Dish (A)	Array 2 Dish (A)	Array 2 CE (A)	Array 3 Dish (A)	Array 3 CE (A)	Array 4 Dish (A)	Array 4 CE (A)
335	36	95	180	21	292	34

CMP Pads at Metal 1

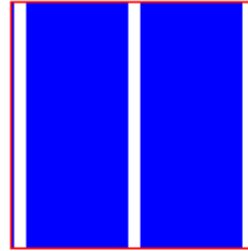
500 um



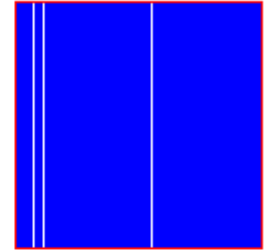
0.2um/ 0.2um



1.8um/ 0.2um

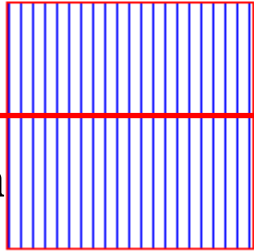


9.8um/ 0.2um

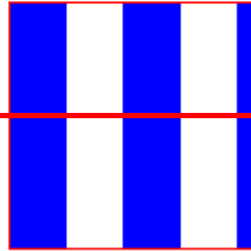


500 um

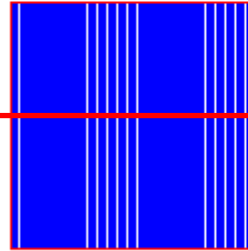
0.11um/ 1um



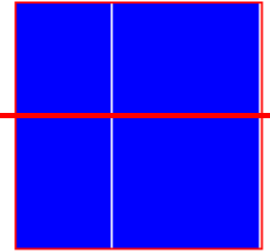
1um/ 1um



9um/ 1um



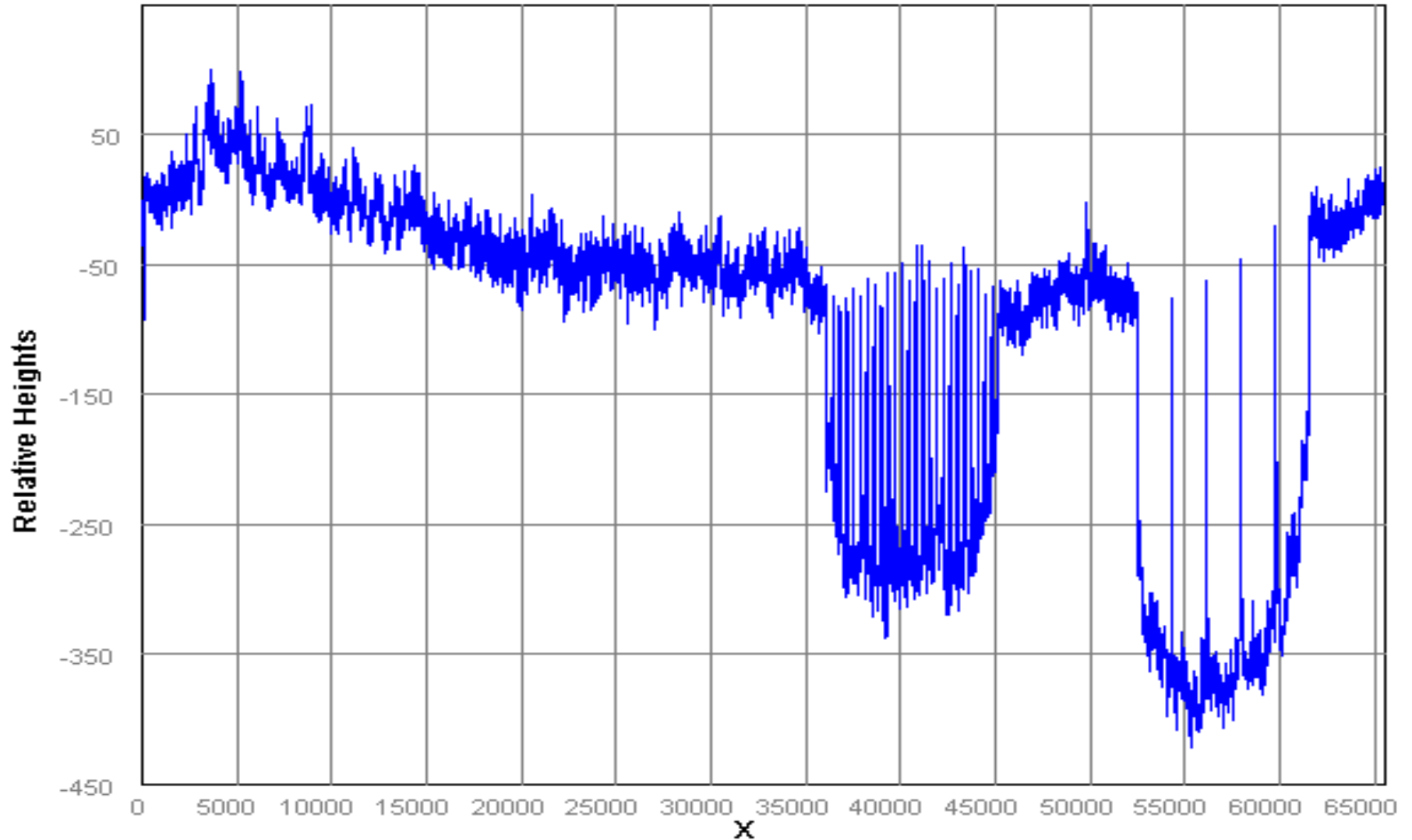
49um/ 1um



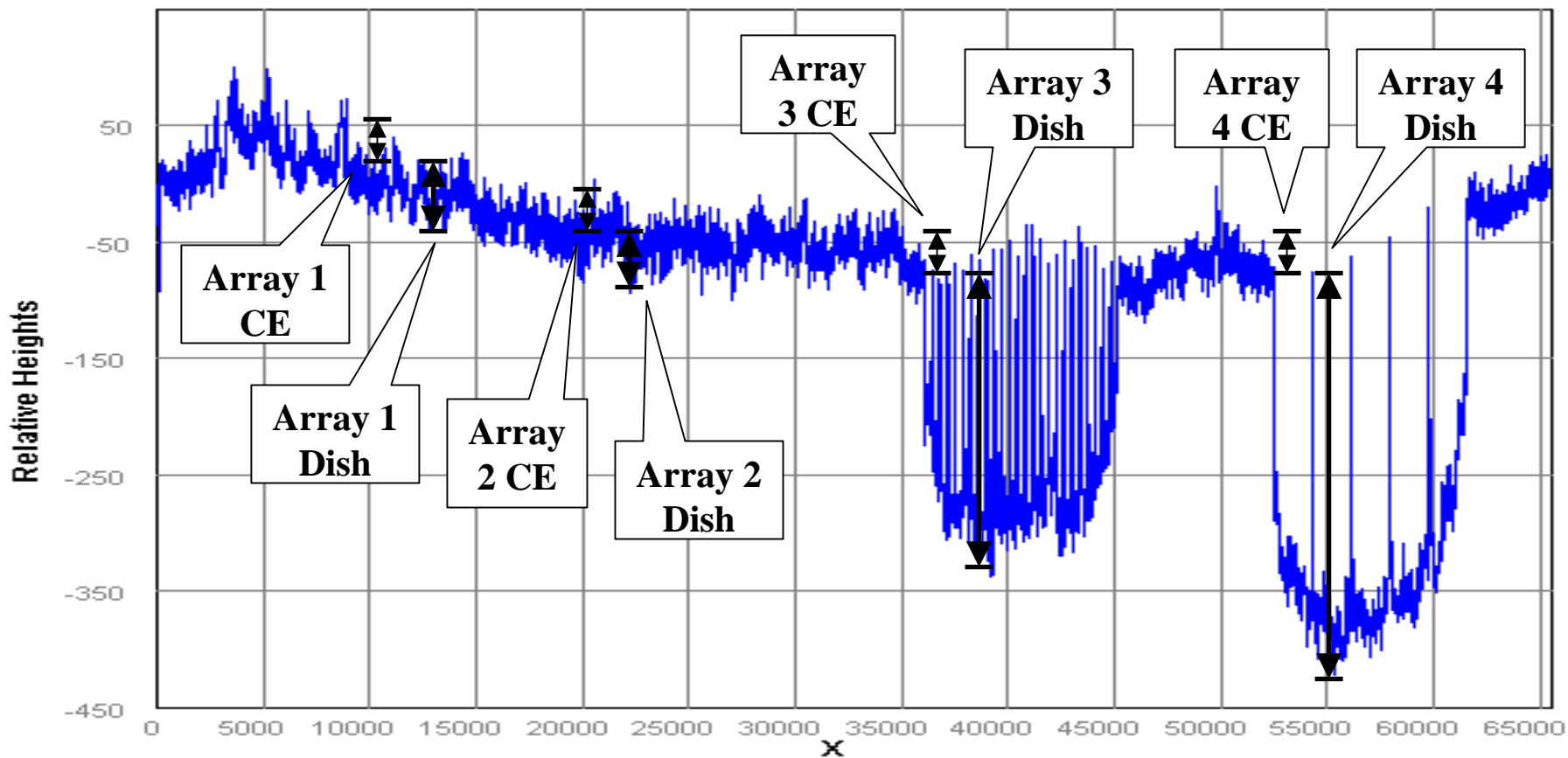
500 um

CMP PAD TESTER

CMP Pads Row 2 Line Profile

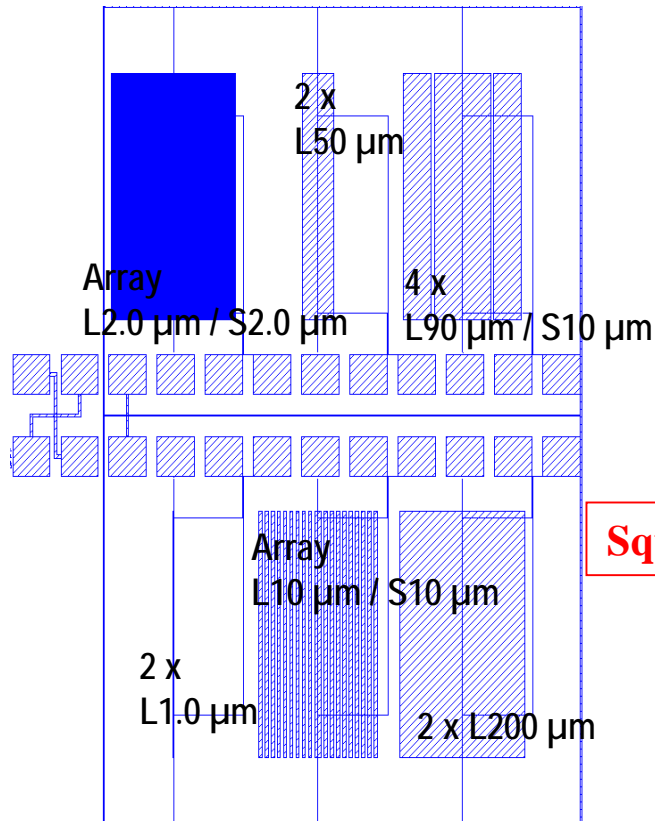


CMP Pads Row 1 Line Profile

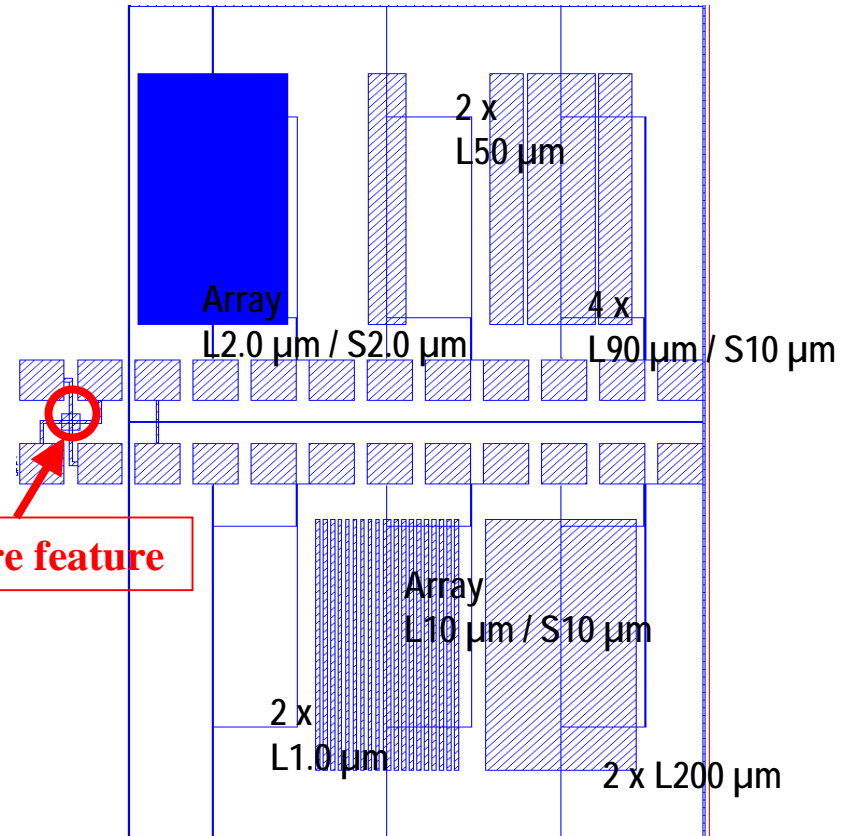


Array 1 Dish (A)	Array 1 CE (A)	Array 2 Dish (A)	Array 2 CE (A)	Array 3 Dish (A)	Array 3 CE (A)	Array 4 Dish (A)	Array 4 CE (A)
59	4	50	10	247	17	349	40

CMP_M1_A



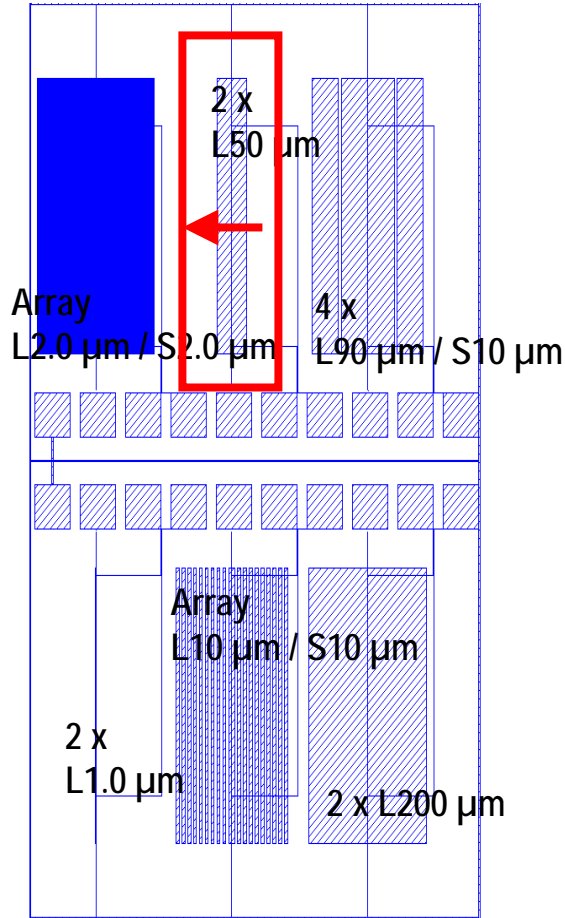
CMP_M1_B



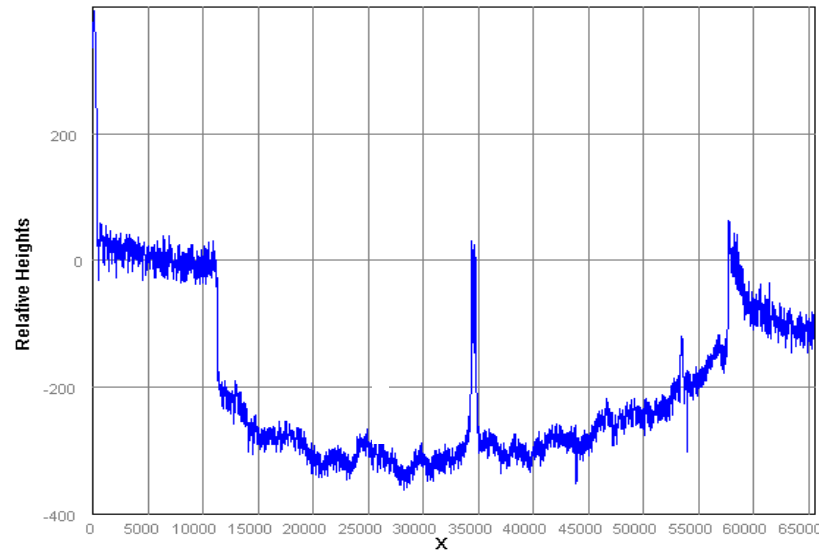
CMP_M1_B and CMP_M1_A have same array dimensions.

CMP_M1_B has a square feature, as is shown above, whereas CMP_M1_A does not. CMP_M1_A exhibits a greater amount of dishing after CMP, as is shown on the following pages.

2 x L50 um Structure



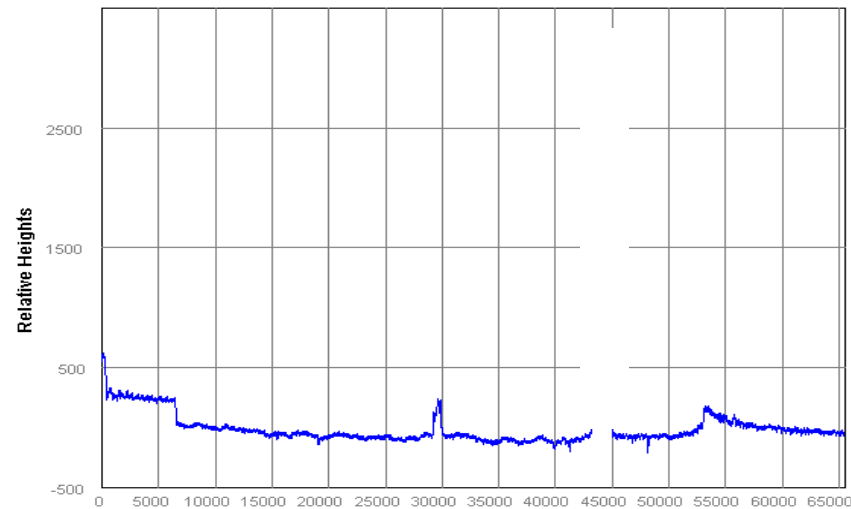
Note: Graphs not to scale



CMP_M1_A 2 x L50 Profile

SCAN INFO	
Recipe	
Samples	9363
# of Features	1
RESULT	
Dishing	391.6097

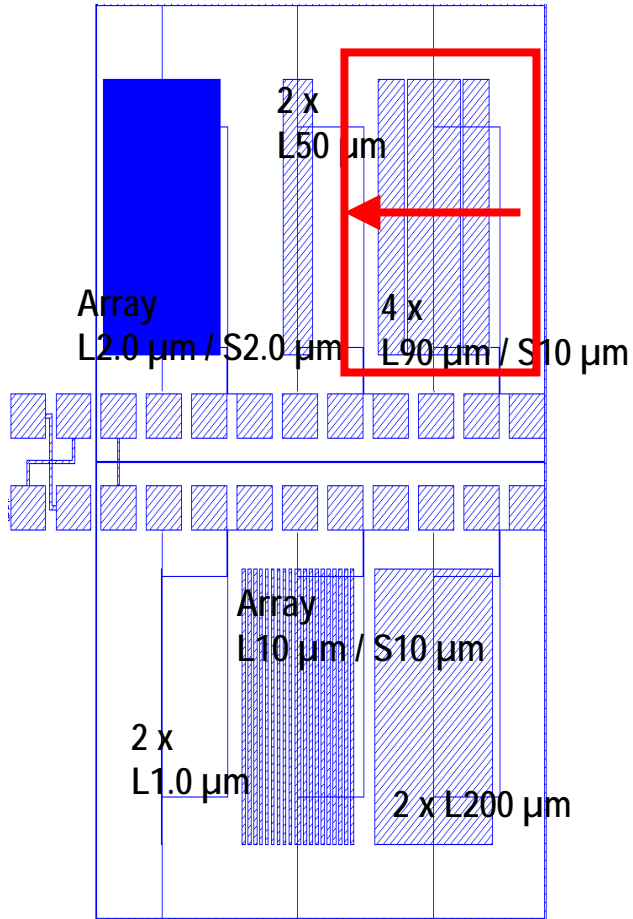
CMP_M1_A shows 18% more dishing



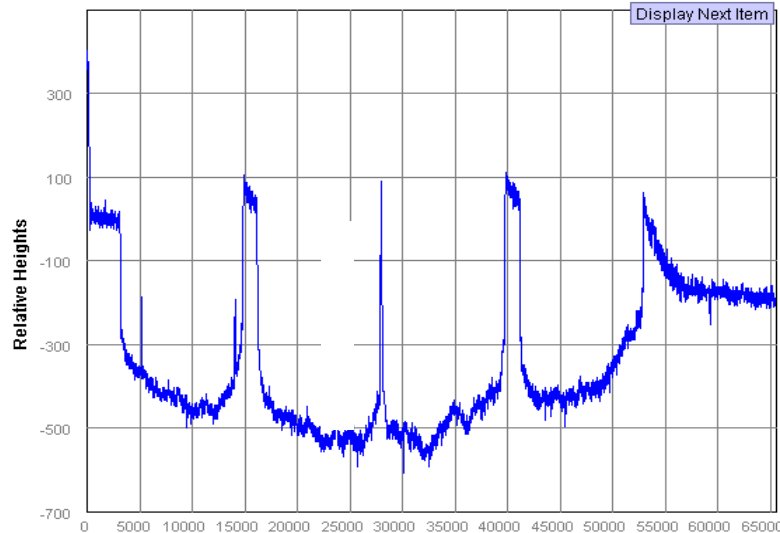
CMP_M1_B 2 x L50 Profile

SCAN INFO	
Recipe	
Samples	9363
# of Features	1
RESULT	
Dishing	333.379

4 x L90 / S10 um Structure



Note: Graphs not to scale

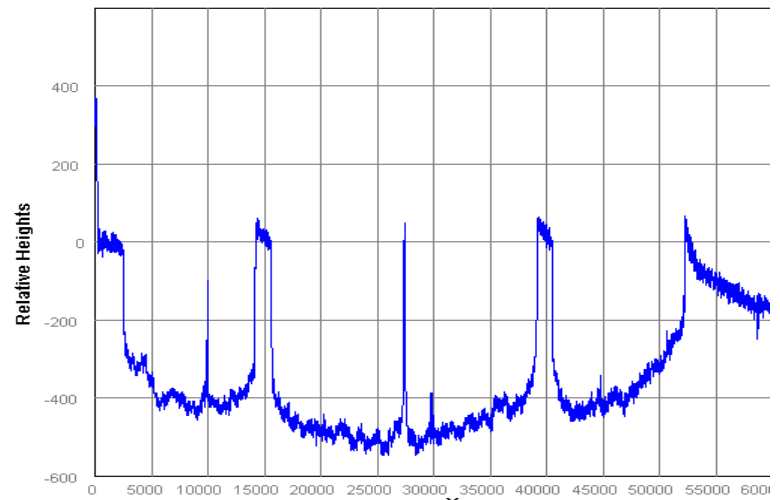


CMP_M1_A 2 x L90/S10um Profile

SCAN INFO	
Recipe	
Samples	9363
# of Features	1

RESULT	
Dishing	664.692

↑
CMP_M1_A shows 11% more dishing than CMP_M1_B

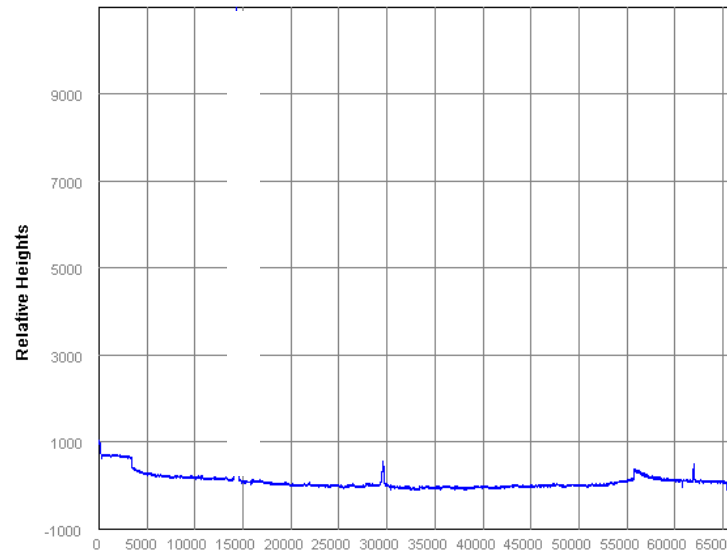
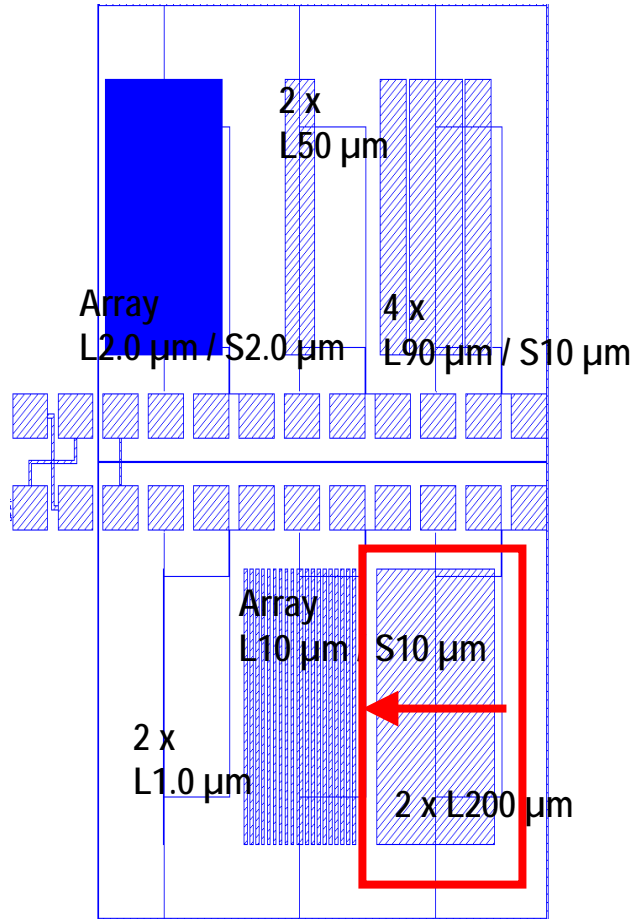


CMP_M1_B 2 x L90/S10um Profile

SCAN INFO	
Recipe	
Samples	9363
# of Features	1

RESULT	
Dishing	596.215

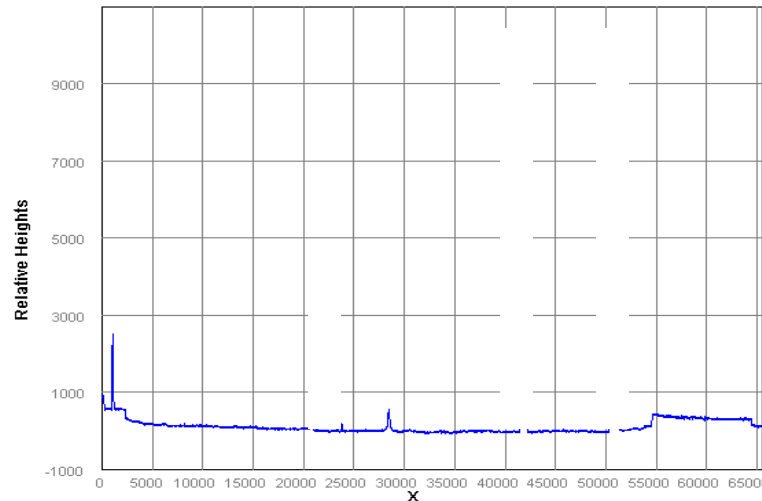
2 x L200 um Structure



CMP_M1_A 2 x L200 Profile

SCAN INFO	
Recipe	
Samples	9363
# of Features	1
RESULT	
Dishing	750.007

CMP_M1_A shows 22% more dishing than CMP_M1_B

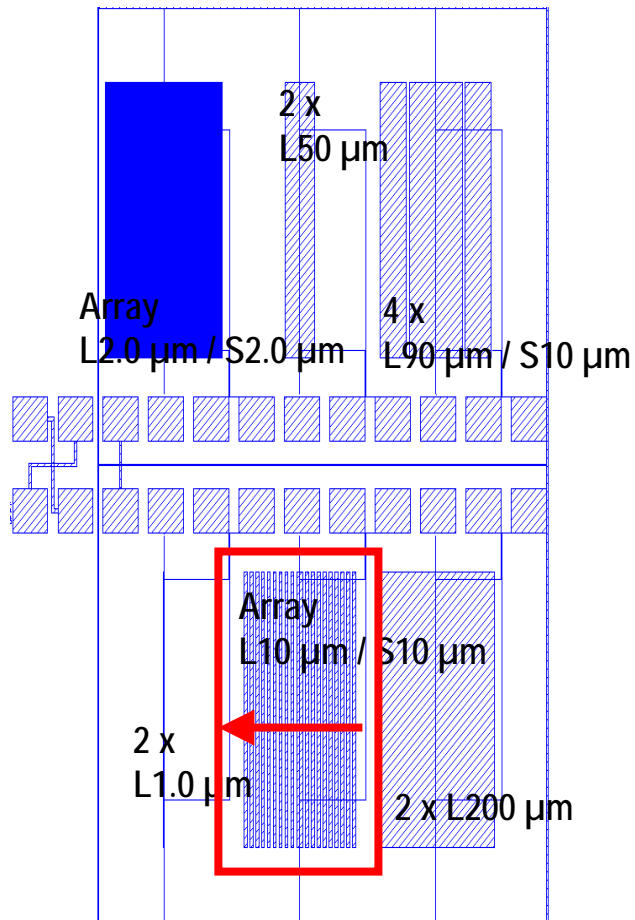


CMP_M1_B 2 x L200 Profile

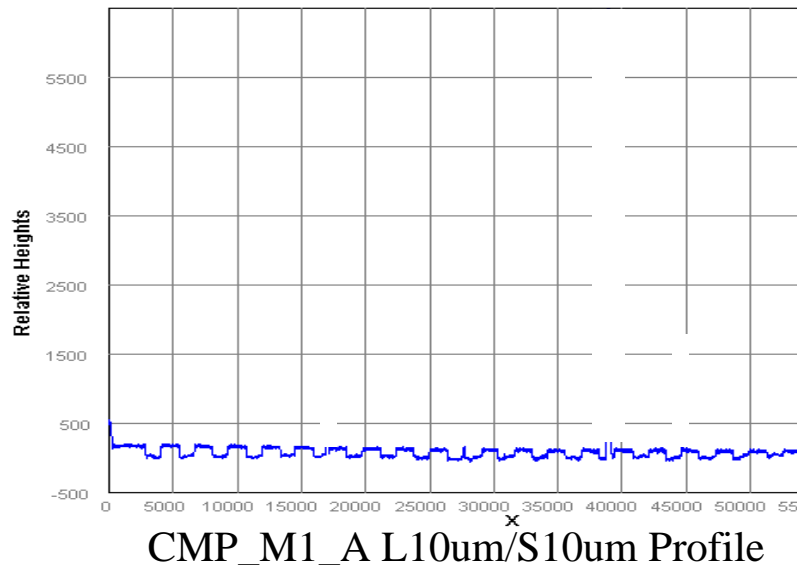
SCAN INFO	
Recipe	
Samples	9363
# of Features	1
RESULT	
Dishing	622.519

Note: Graphs not to scale

L10 μm/ S10 μm Array Structure



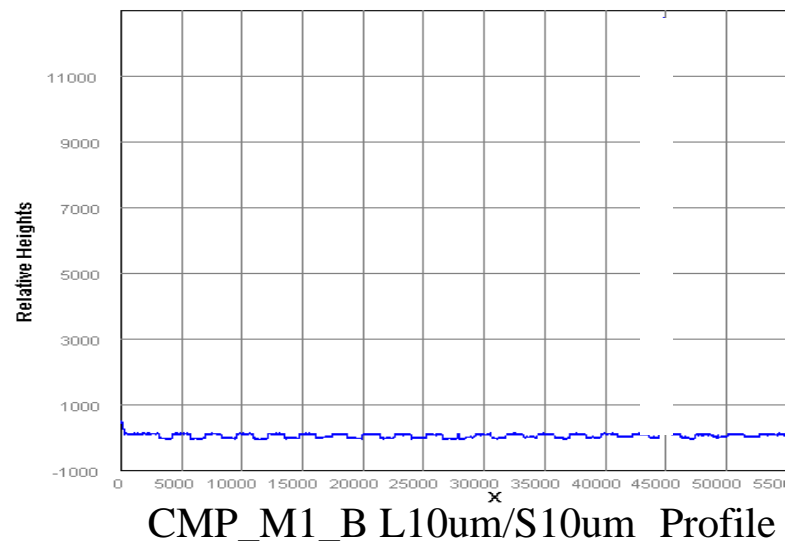
Note: Graphs not to scale



SCAN INFO	
Recipe	
Samples	9363
# of Features	1

RESULT	
Dishing	184.424

CMP_M1_A shows 18% more dishing than CMP_M1_B



SCAN INFO	
Recipe	
Samples	9363
# of Features	1

RESULT	
Dishing	160.2173