Wafer-level characterization of the EMCM3 batch 2
– *The technology of choice* –

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Outline

- Summary of wafers in the EMCM3-batch 2 production

- Test structures

- Dielectric breakdown

- PXD9-like structures

- ATG test results

- Summary and conclusions

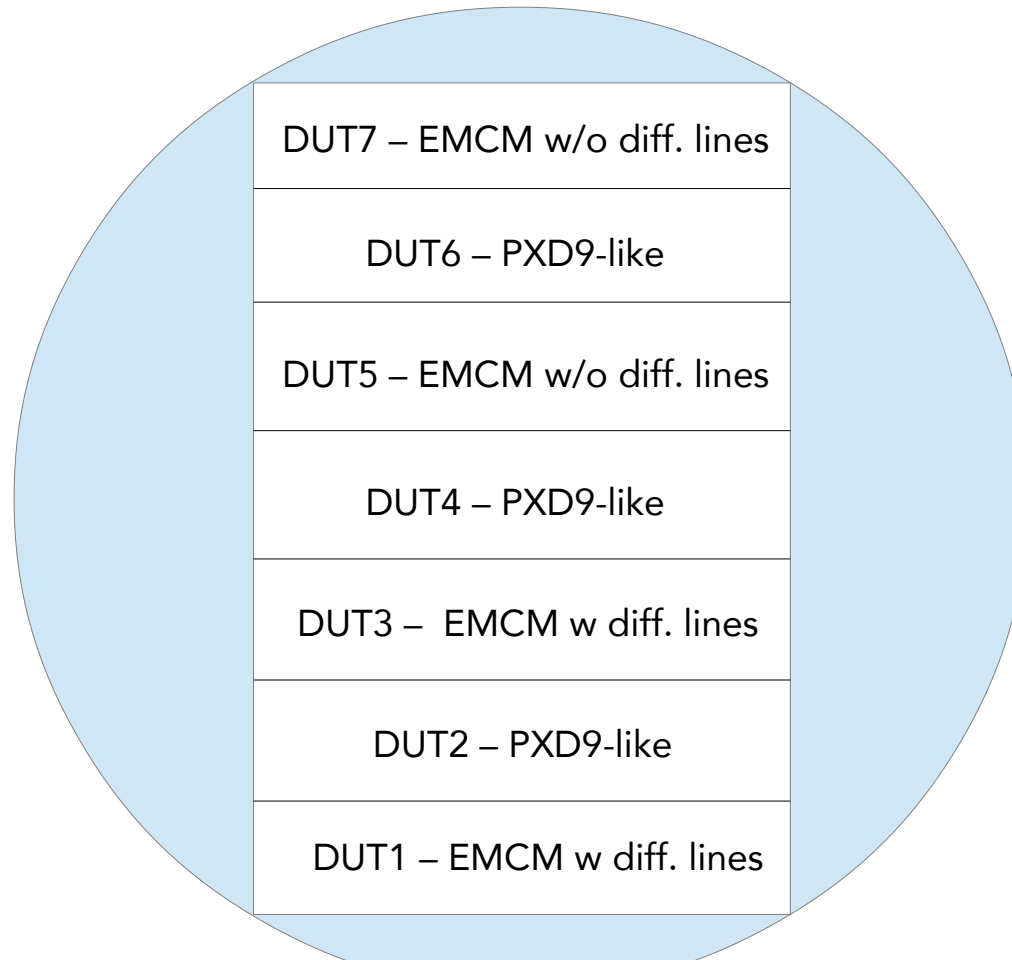| Wafer	Type	Batch
17	A	2-I
18	A	2-I
29	B	2-I
30	B	2-I
13	C	2-II
14	D	2-II
31	E	2-II
32	F	2-II

Wafers 17 and 18 show the best results: their typology has been selected as technology of choice for the final production of the PXD9
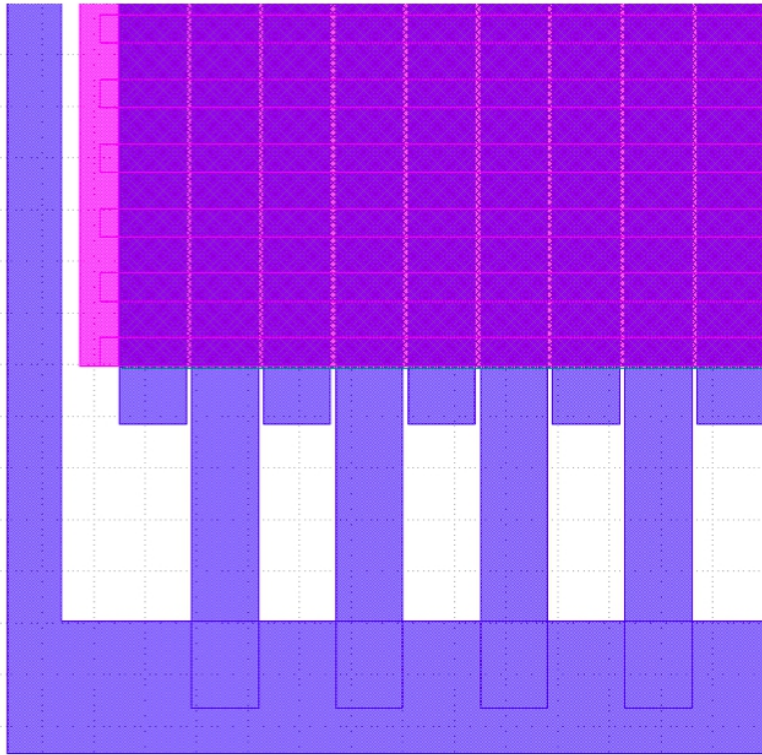
EMCM3-2 wafer layout

DUT7 – EMCM w/o diff. lines

DUT6 – PXD9-like

DUT5 – EMCM w/o diff. lines

DUT4 – PXD9-like

DUT3 – EMCM w diff. lines

DUT2 – PXD9-like

DUT1 – EMCM w diff. lines

Test structures available

- 10 Comb Structures, 7 of which structured in Al1/Al2

- 5 Contact Chain Structures, 3 of which structured in Al1/Al2
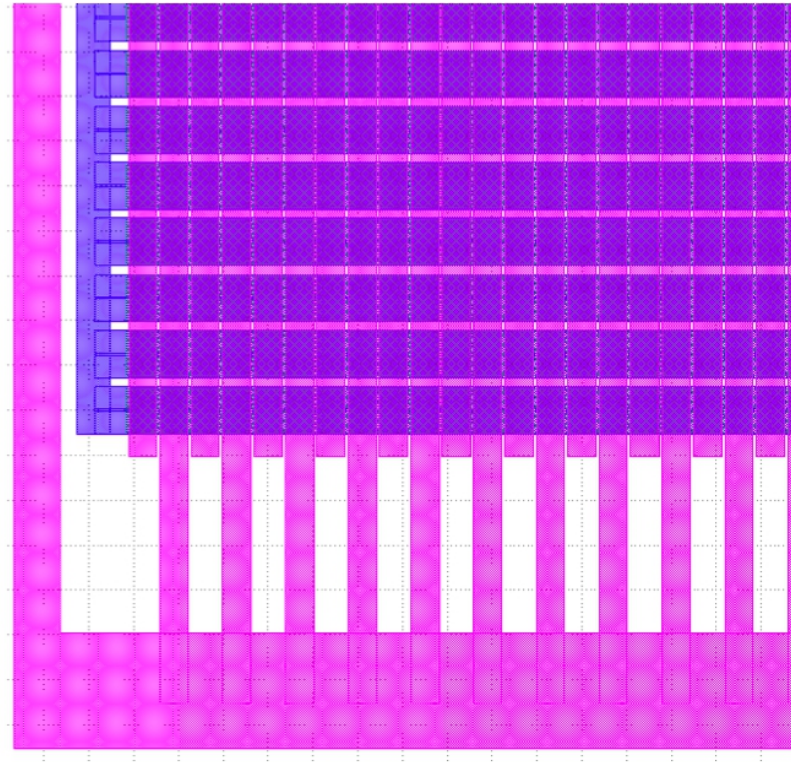
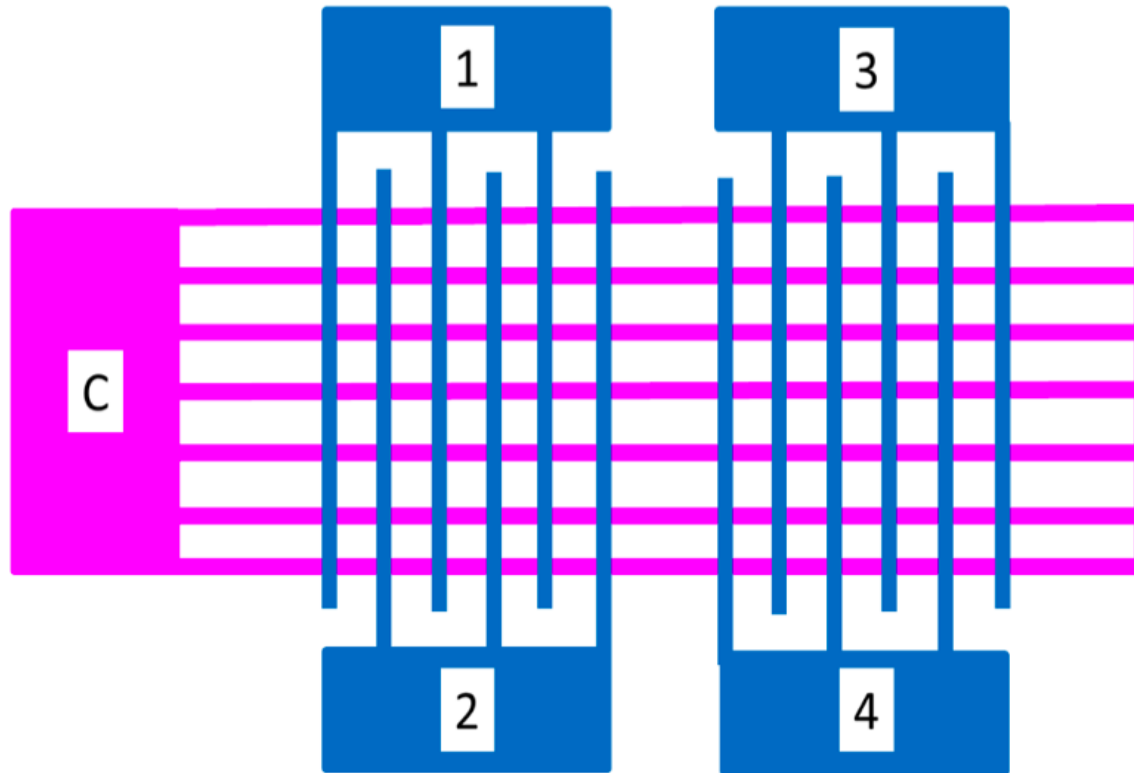- 26 Breakdown Structures, 22 of which in Al1/Al2

Comb structures in Al

(a) ME1

(b) ME2

Comb in Al1 (blue) and unstructured Al2 (pink) plane above it. Differences in trace width and pitch of A1 comb.

Comb in Al2 (pink) and structured Al1 (blue) below with same width and pitch traces. Differences in trace width and pitch of Al2.

- Inter-metal dielectric tested up to ± 100 V → detect presence of hillocks

- Adjacent lines tested up to ± 100 V → detect presence of lateral shorts

Test	D02 ME2	E02 ME1	E03 ME2	F03 ME2	F04 ME2	E05 ME1	D05 ME1
W17							
C vs 1	✓	✓	✓	✓	✓	✓	✓
C vs 2	✓	✓	✓	✓	✓	✓	✓
C vs 3	✓	✓	✓	✓	✓	✓	✓
C vs 4	✓	✓	✓	✓	✓	✓	✓
W18							
C vs 1	✓	✓	✓	✓	✓	✓	✓
C vs 2	✓	✓	✓	✓	✓	✓	✓
C vs 3	✓	✓	✓	✓	✓	✓	✓
C vs 4	✓	✓	✓	✓	✓	✓	✓

→ No hillocks detected

Results on adjacent lines

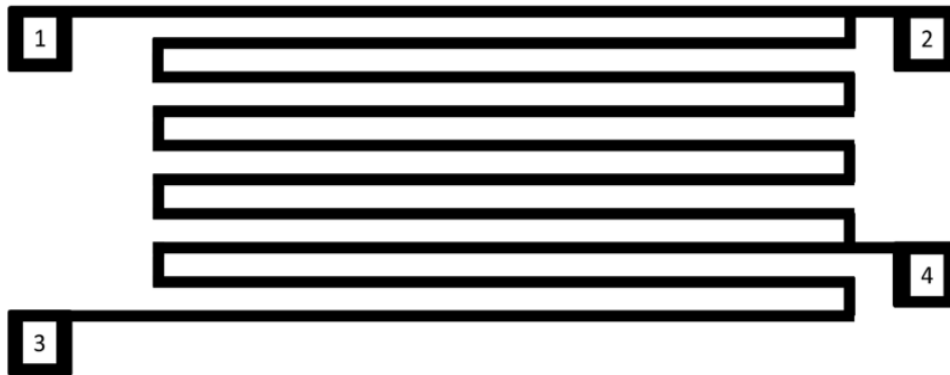| Test	D02 ME2	E02 ME1	E03 ME2	F03 ME2	F04 ME2	E05 ME1	D05 ME1
W17							
1 vs 2	✔	✔	✔	✔	✔	✔	✔
3 vs 4	✔	✔	✔	✔	✔	✔	✔
W18							
1 vs 2	✔	✔	✔	✔	✔	✔	✔
3 vs 4	✔	✔	✔	✔	✔	✔	✔

→ No lateral shorts detected

- 18 sub-structures with 8 different contact sizes
- Total length (for each substructure): 1.79 m
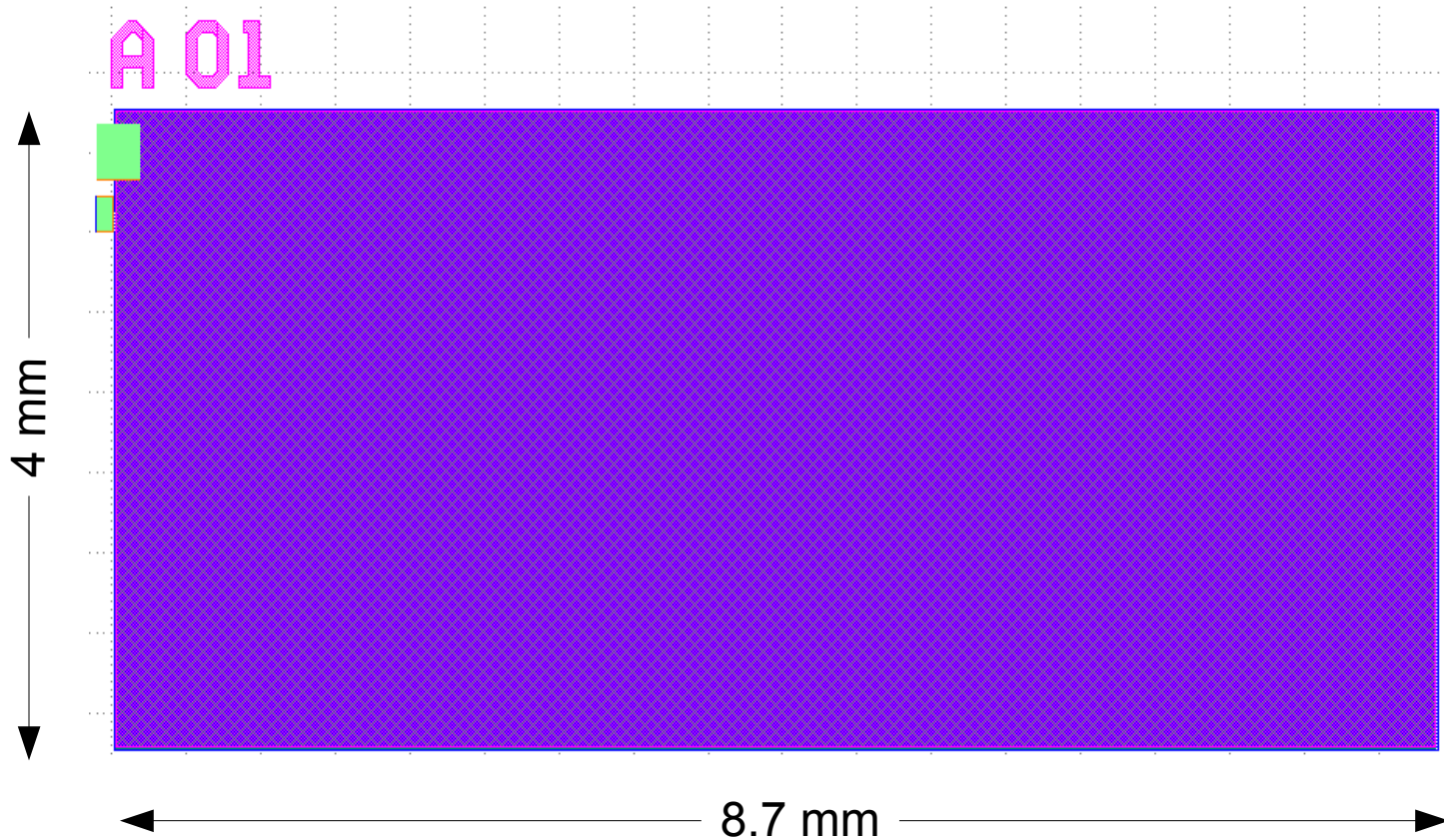- Total number of contacts (for each substructure): 5980

Tested up to ± 10 V

W17			
	D01	D04	F05
1 vs 2	2 µm	ok	2 µm
1 vs 4	2 µm	H2x3 µm	2 µm
2 vs 4	2 µm	H2x3 µm	2 µm
W18			
	D01	D04	F05
1 vs 2	ok	ok	ok
1 vs 4	ok	ok	ok
2 vs 4	ok	ok	ok

- W17 presents some contacts not open mainly in the smallest size available
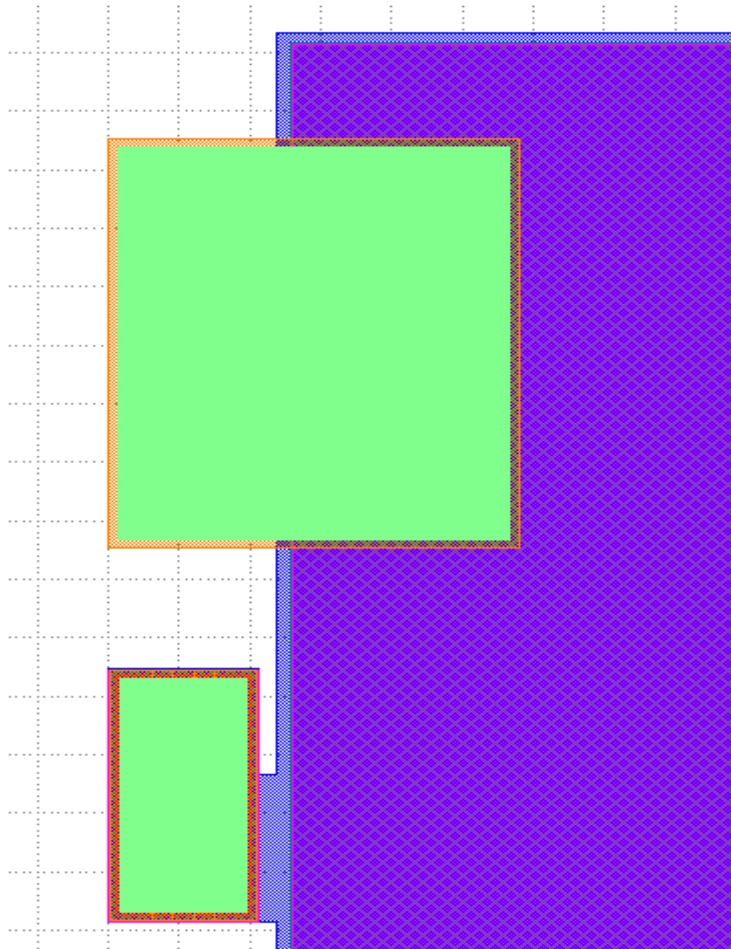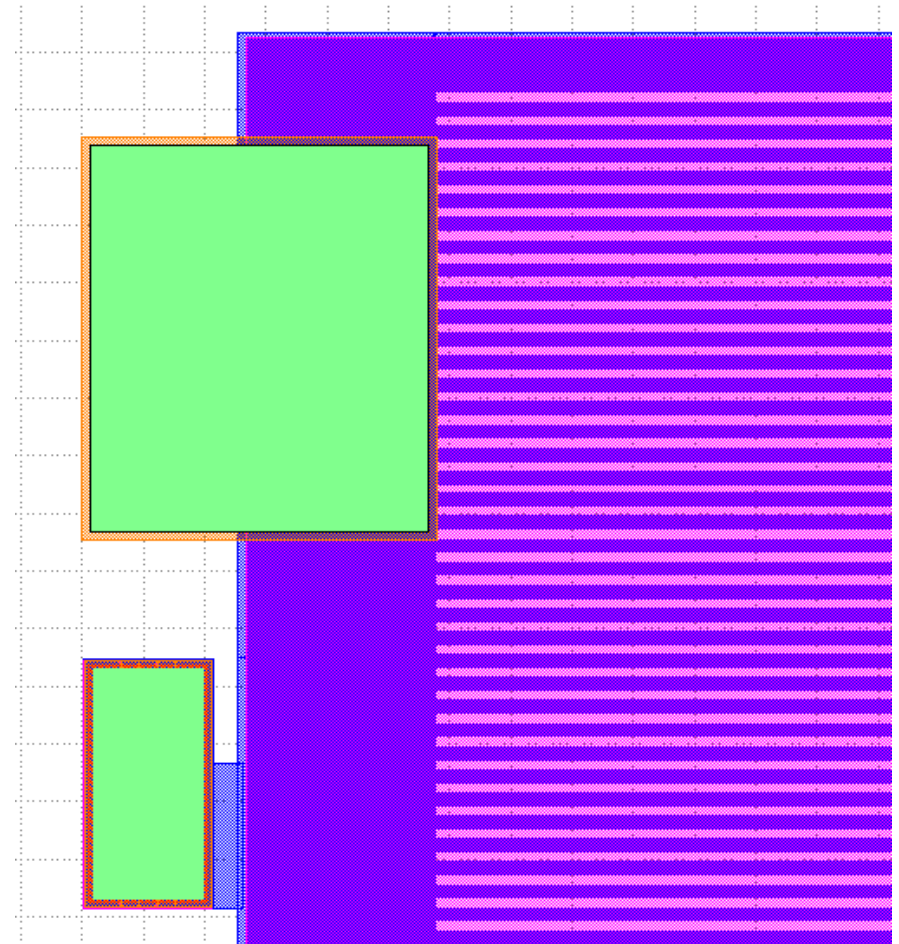
- W18 has all contacts open

8 Breakdown Structures tested per wafer

Tested up to ± 100 V → no hillocks detected

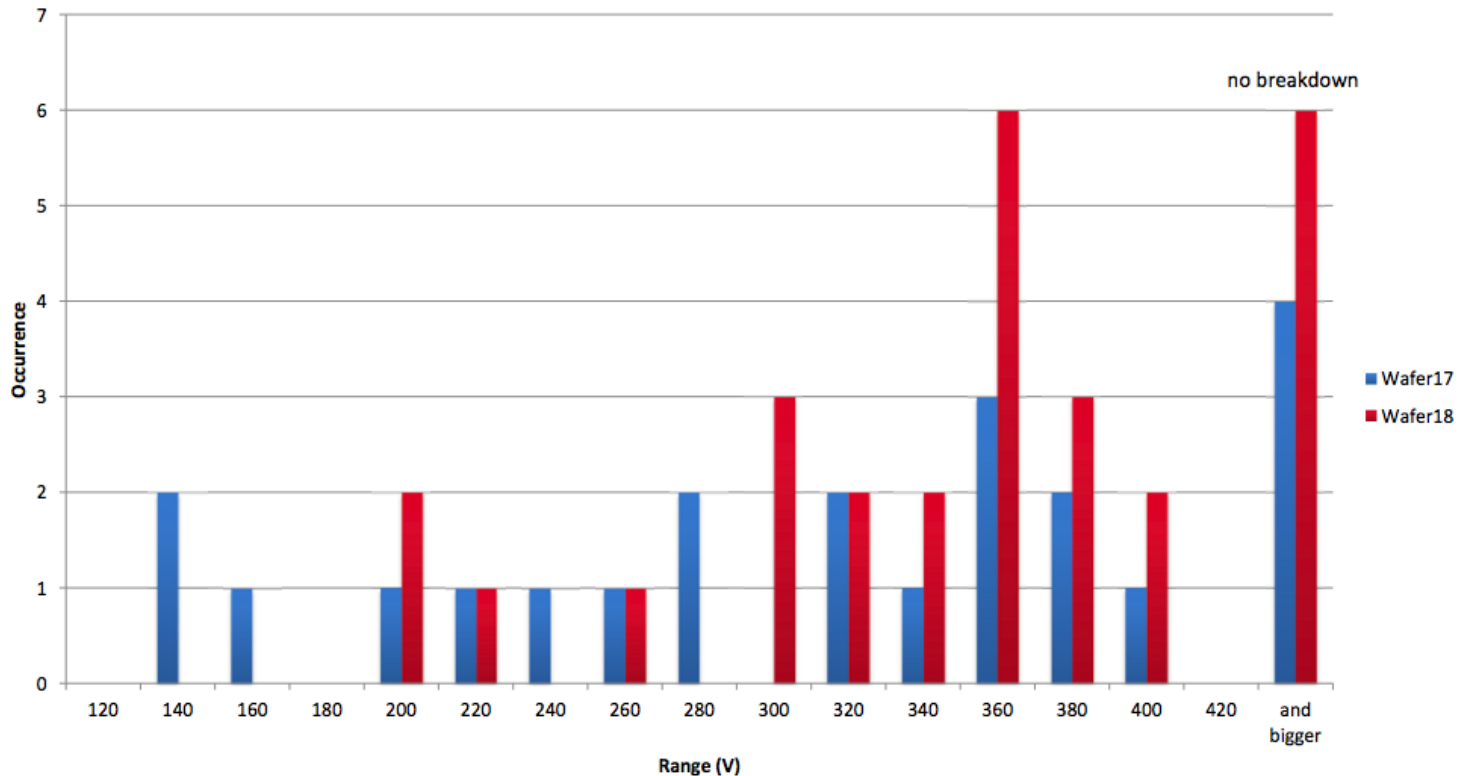# Breakdown Structures – a closer look

Al2 sheet over Al1 sheet

Al2 sheet over
structured Al1 sheet

Breakdown Voltage of Wafer 17+18
(Comb+Flat Structures)

Breakdown Structures and Comb Structures tested up to +420 V

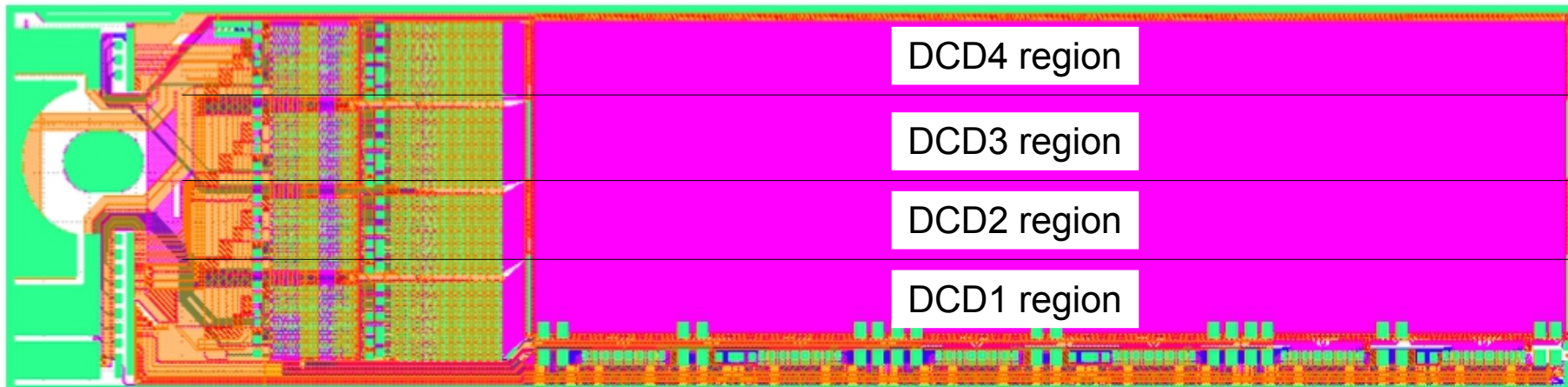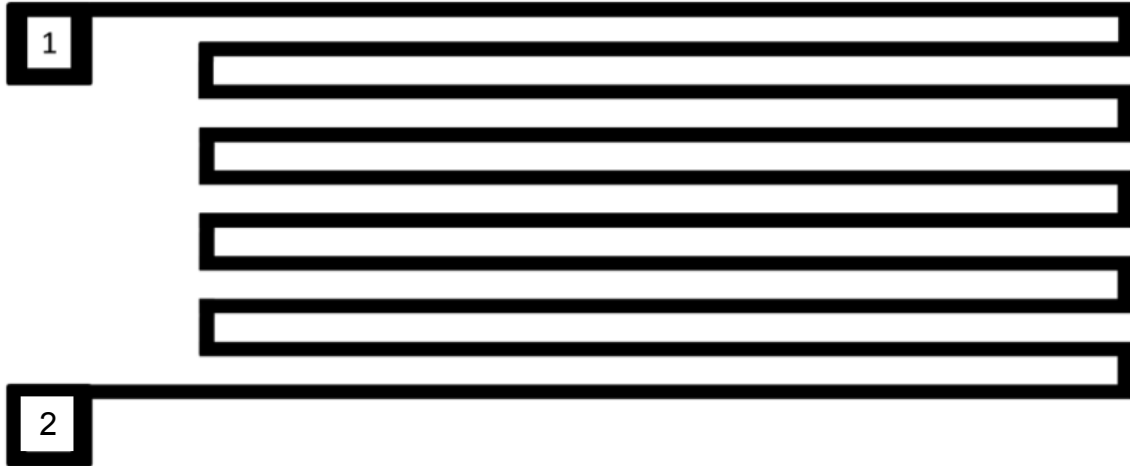The PXD9-like Structures allow to detect:

- Discontinuities in the long drain lines (Al2)

- Lateral shorts between neighboring lines (Al2)

- Inter-metal shorts between overlapping lines (Al2 on Al1)

DCD4 region

DCD3 region

DCD2 region

DCD1 region

Discontinuities in the drain lines

Even DCD regions

- Each drain line is 45 mm long.

- 16 or 18 drain lines are connected between two pads in a snake-like fashion

- Pads #12 and #13 are connected to ~57 drain lines

Tested at ±2 V → no discontinuities detected

Setup for the detection of lateral and inter-metal shorts.
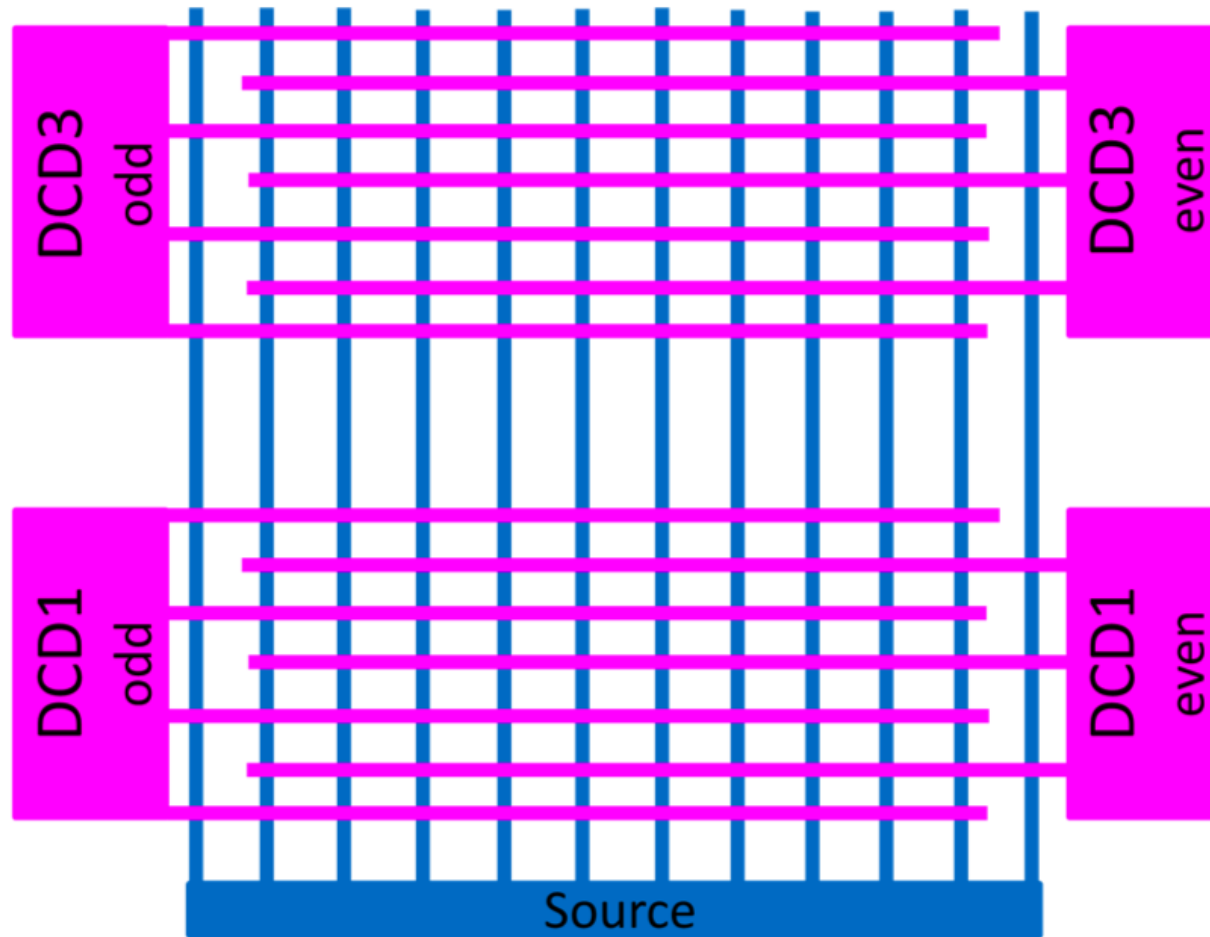
Odd lines pad

Even lines pad

Odd DCD regions

	Mod. 1		Mod. 2		Mod. 3	
	DCD1	DCD3	DCD1	DCD3	DCD1	DCD3
W17						
	✓	Ω	✓	✓	✓	✓
W18						
	✓	✓	✓	✓	✓	✓

- Mod. 1 = DUT6
- Mod. 2 = DUT4
- Mod. 3 = DUT2

Tested at ± 100 V → No lateral shorts detected

Test	Mod. 1		Mod. 2		Mod. 3	
	DCD1	DCD3	DCD1	DCD3	DCD1	DCD3
W17						
odd vs Source	✓	✓	✓	✓	✓	✓
even vs Source	✓	✓	✓	✓	✓	✓
W18						
odd vs Source	✓	✓	✓	✓	✓	✓
even vs Source	✓	✓	✓	✓	✓	✓

Mod. 1		Mod. 2		Mod. 3	
DCD2	DCD4	DCD2	DCD4	DCD2	DCD4
W17					
✓	✓	✓	✓	✓	✓
W18					
✓	✓	✓	✓	✓	✓

Tested up to ± 100 V → No inter-metal shorts detected

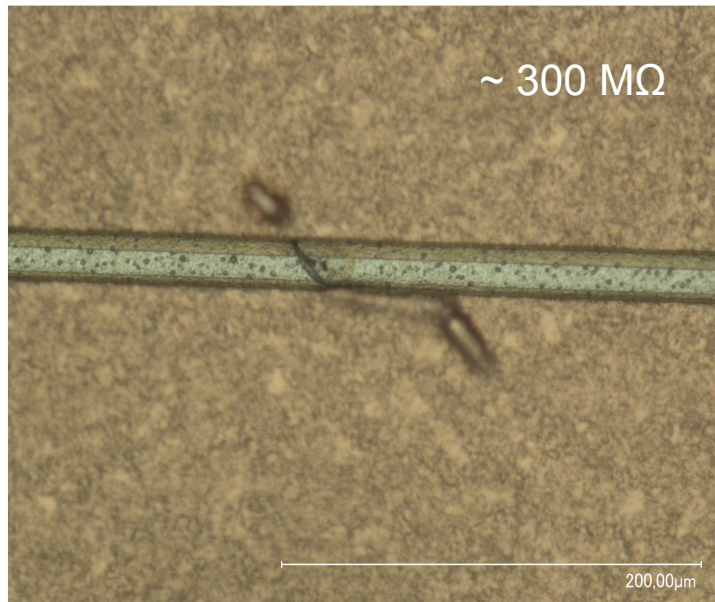| W	DUT1		DUT2		DUT3		DUT4		DUT5		DUT6		DUT7		Tot
	O	S	O	S	O	S	O	S	O	S	O	S	O	S	
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7/7
18	0	0	0	0	0	0	0	0	0	0	0	0	0	1*	7/7
29	0	5‡	0	1	0	0	0	0	0	0	0	5	0	0	4/7
30	0	0	0	0	0	0	0	5	0	0	0	0	0	0	6/7
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
14	0	0	0	0	0	0	0	0	2	0	0	2	0	1!	5/7
31	0	0	3	5	0	0	0	1!	0	0	0	0	4	0	5/7
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7/7

* High Ohmic short ~ 300 MΩ.
‡ Shorts in the Cu layer.

GateOn1 – GateOn2 shorted

~ 300 MΩ

Summary and conclusions

Wafers #17 and #18 tested thoroughly:

- No inter-metal or lateral shorts in the comb structures

- Very few contacts not open in #17

- High breakdown voltages (> 200 V)

- No discontinuities in the very long drain lines

- No inter-metal or lateral shorts in the matrix region

- No opens/shorts in the periphery

→ Sample of the technology of choice for PXD9

Thank you!