

PXD9-7 failure analysis using emission microscope

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Outline:

1. PHEMOS – emission microscope
2. PXD9-7 - Yield after pretests
3. Some examples of failure

● PHEMOS – emission microscope

Failure analysis tool :

General: The PHEMOS series of emission microscope is a group of semiconductor failure analysis tools that detects faint emissions caused by semiconductor device anomalies to specify the failure location.

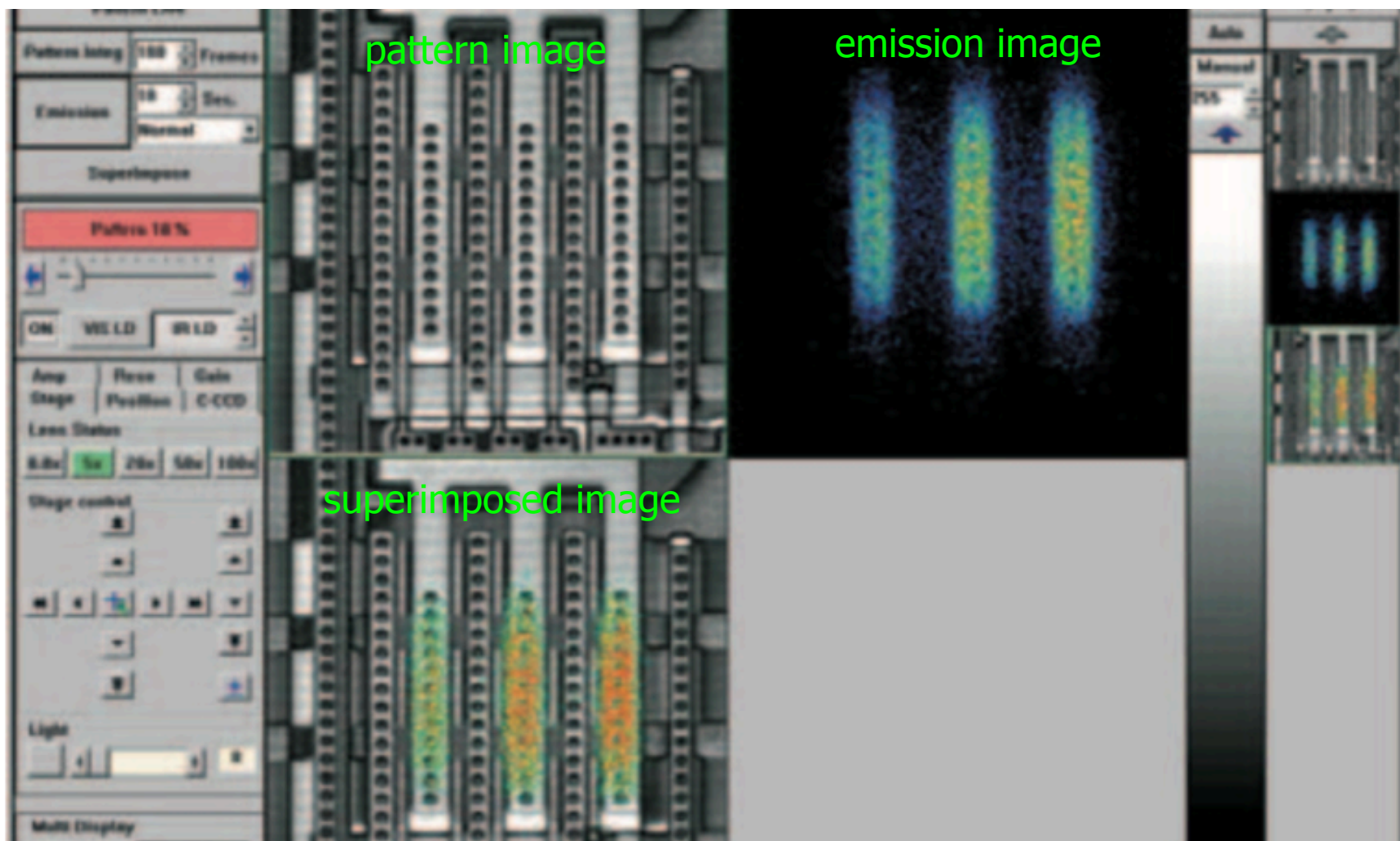
Sensors

- Detection of light caused by the avalanche process
- Detection of the recombination light

Remark

- This presentation is meant just as an illustration of a method for identification of **already known** problems

● PHEMOS 1000



● PXD9-7 pretests

4 tests:

1. All Gates vs. Common Source
2. All Clear vs. Common Source *All n-regions vs. All p-regions*
3. All Gates vs. All Clear Gate
4. All Clear Gate vs. Common Source

	W31	W37	W38	W40
IF	ok	ok	ok	ok
OF1	ok	ok	bad	ok
OF2	ok	bad	bad	ok
OB1	ok	ok	ok	ok
OB2	ok	ok	bad	ok

● PXD9-7 pretests

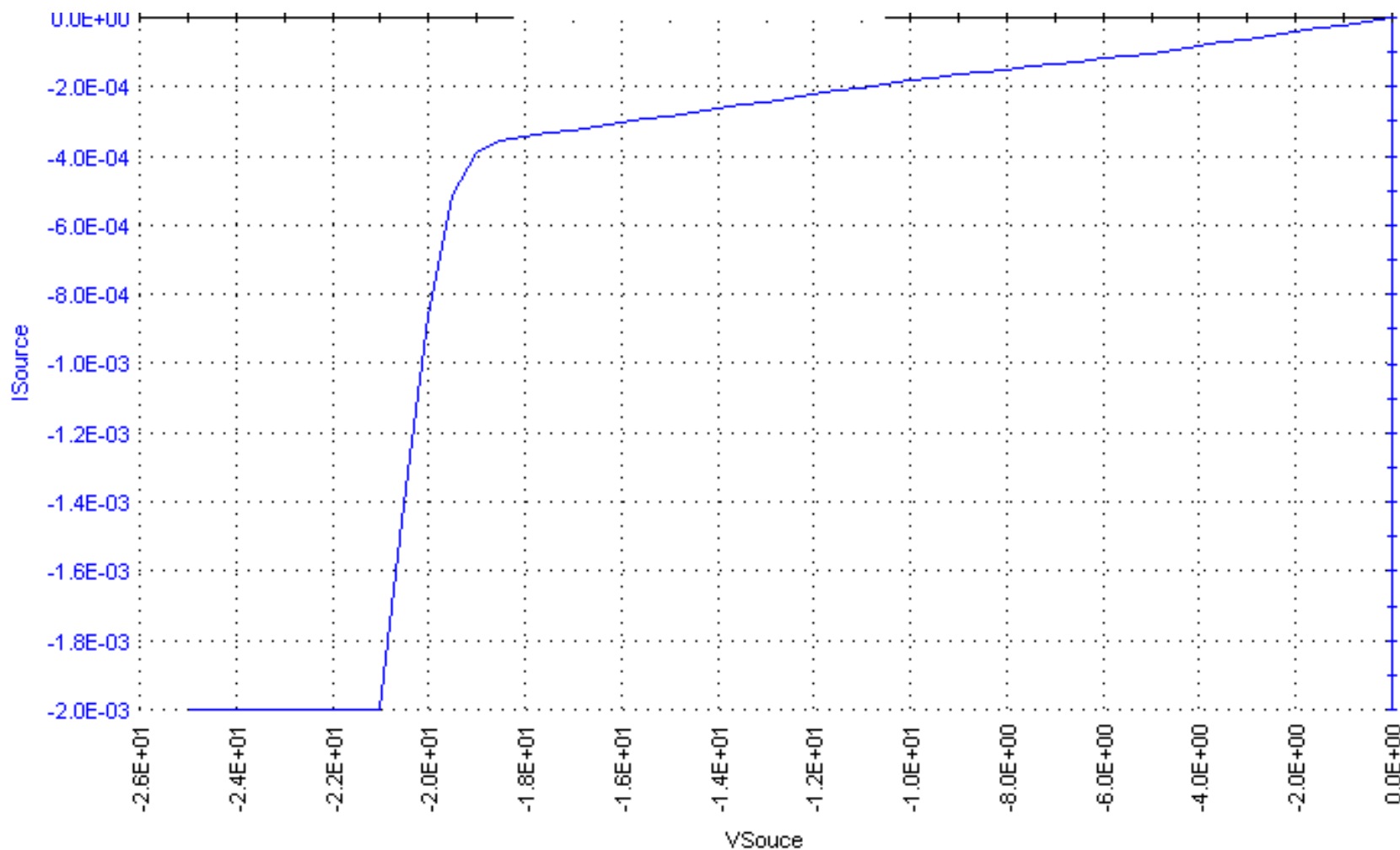
4 tests:

1. All Gates vs. Common Source
2. All Clear vs. Common Source
3. All Gates vs. All Clear Gate
4. All Clear Gate vs. Common Source

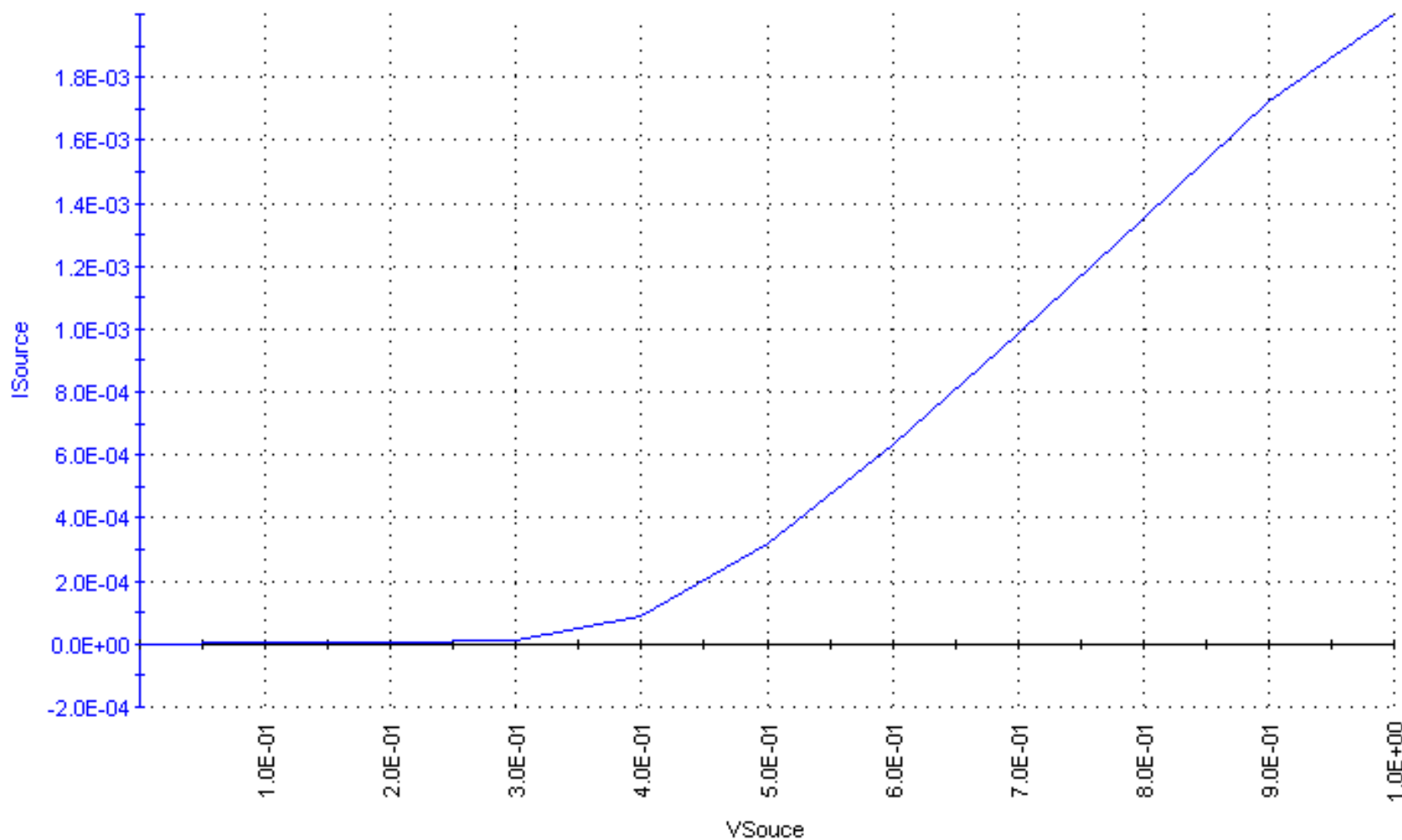
Poly shorts

	W31	W37	W38	W40
IF	1-2	2+	1-2	0
OF1	1-3	2+	2+	1
OF2	1-2	2+	2+	1
OB1	1	2+	2+	0
OB2	1	1	2+	0
IB	0	1-3	1-3	0

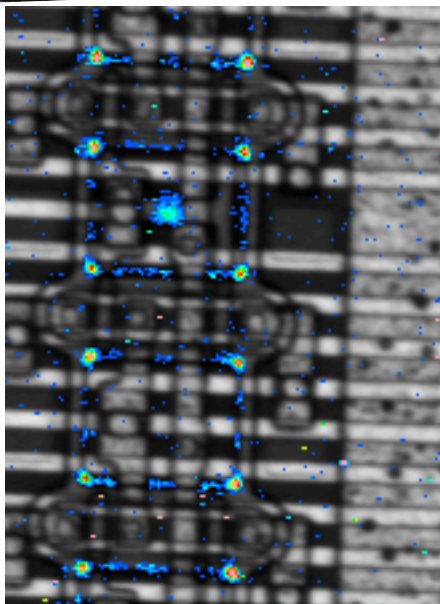
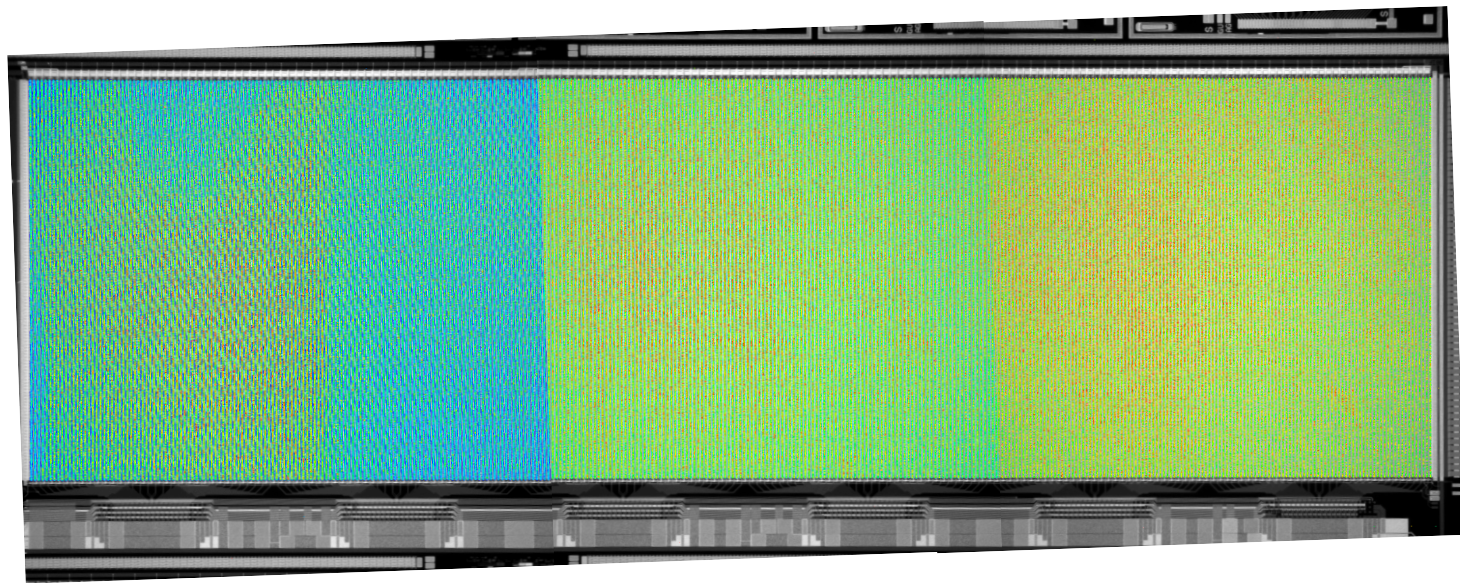
● Source vs. Clear – reverse bias



● Source vs. Clear -Forward bias

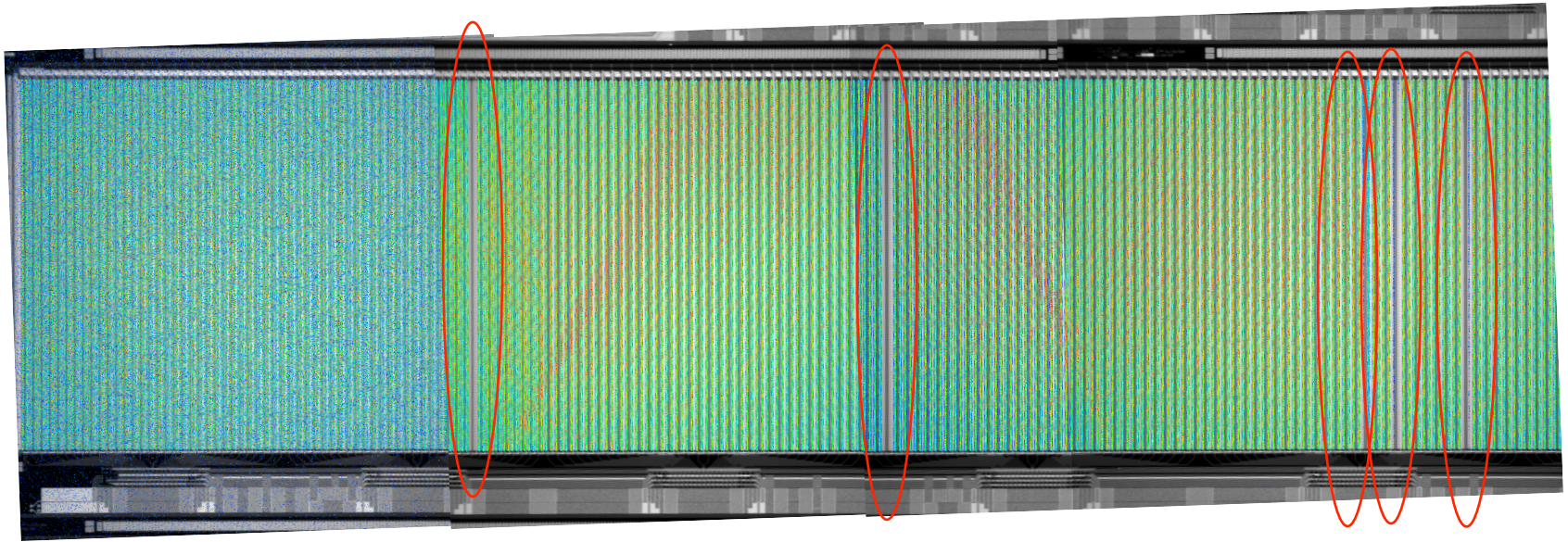


● W38 IF Source (-21V) vs. Clear (0V)



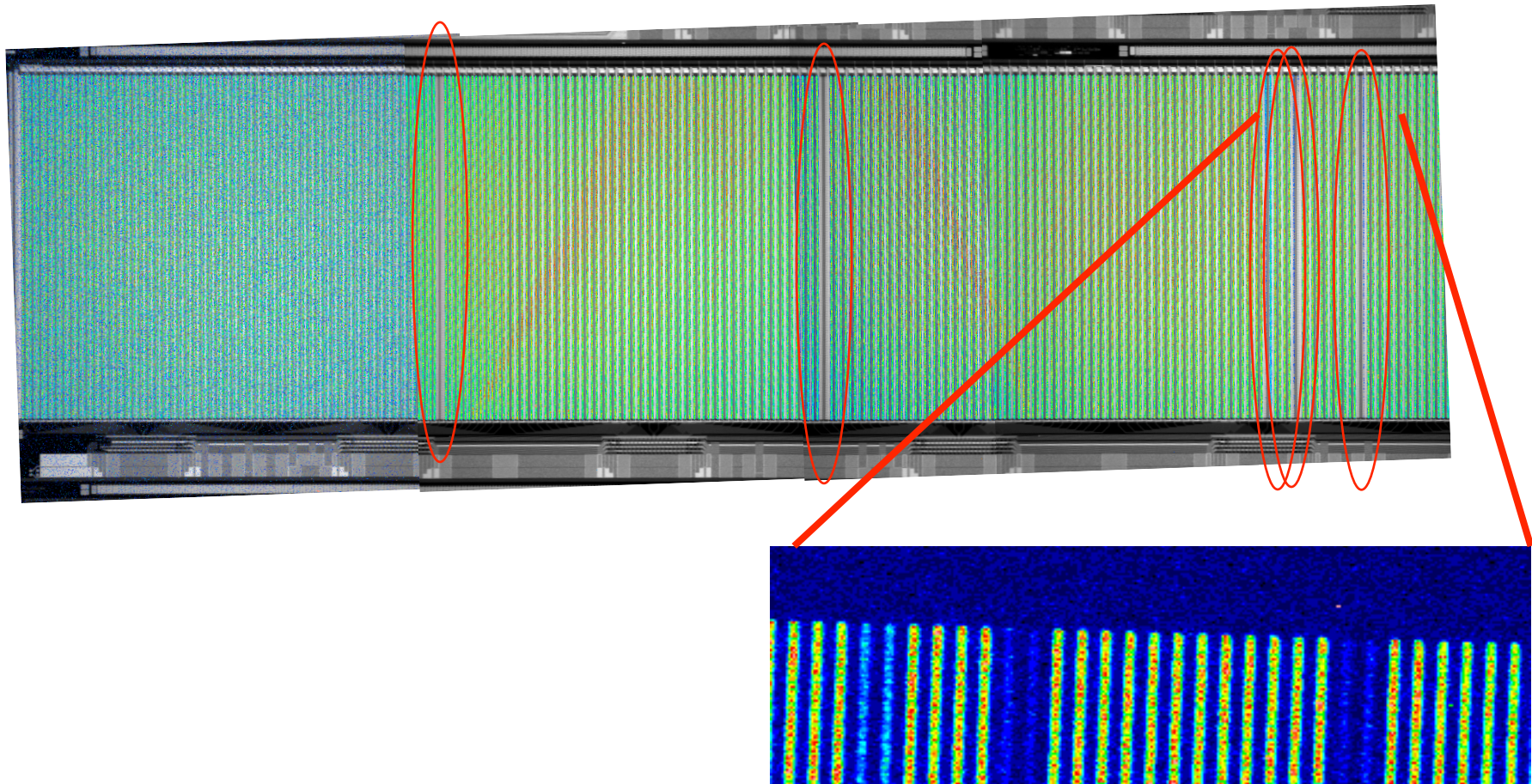
All fine as expected

● W38 OF1 Source (-25V) vs. Clear (0V)

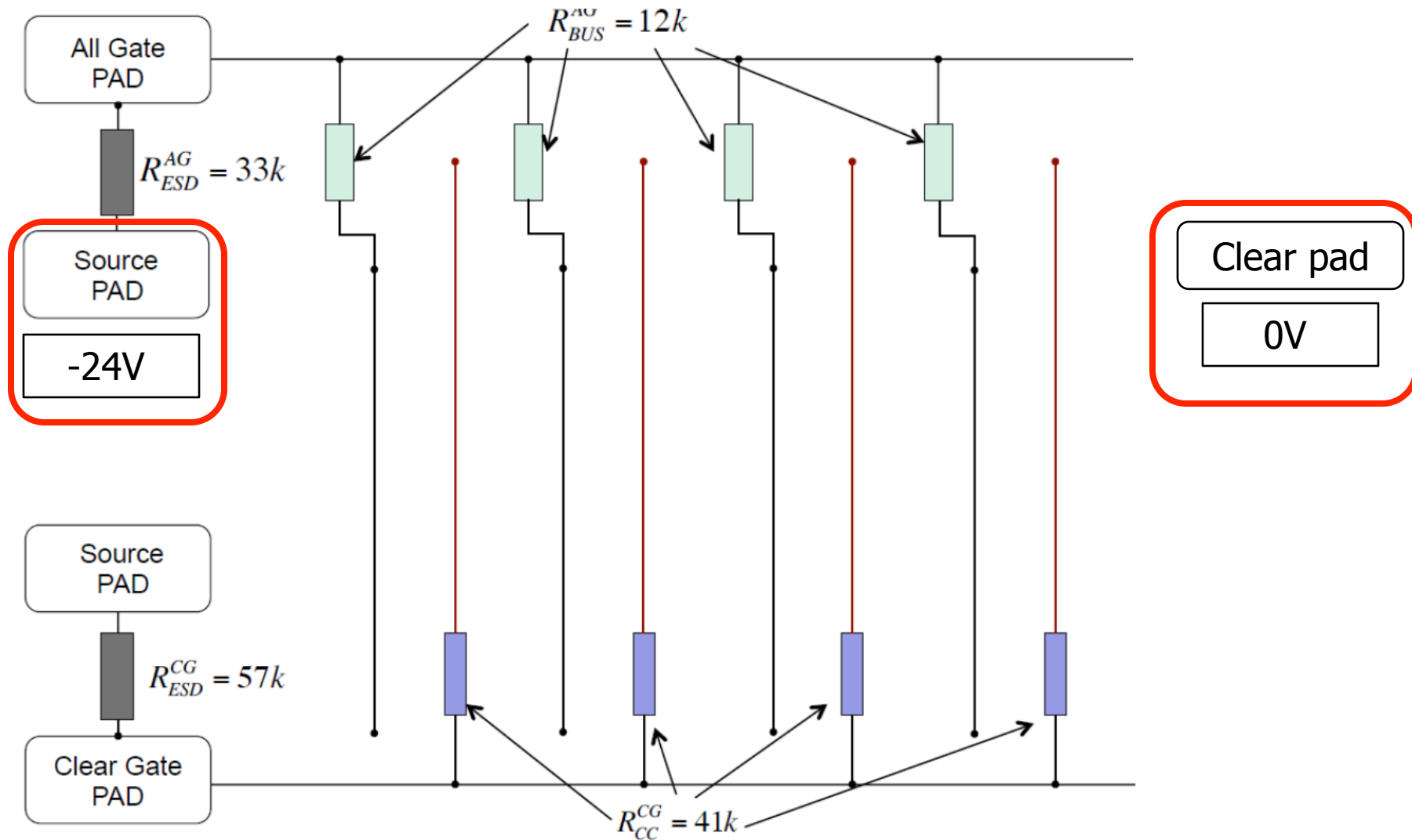


5 gate rows show reduced/no emission

● W38 OF1 Source (-25V) vs. Clear (0V)



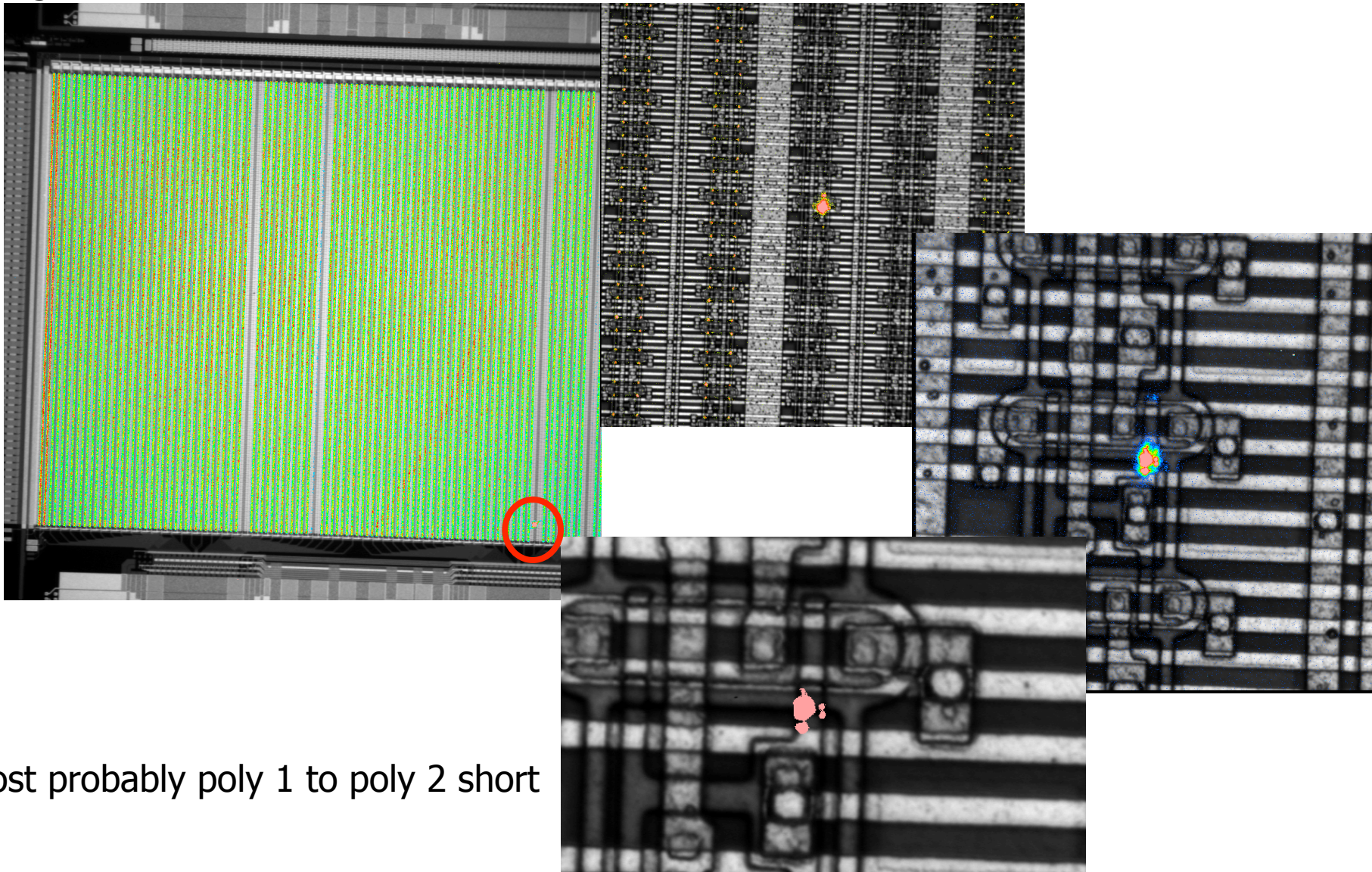
● Ladder interconnects



Picture by P. Avella

● W38 OF2 Source (-26V) vs. Clear (0V)

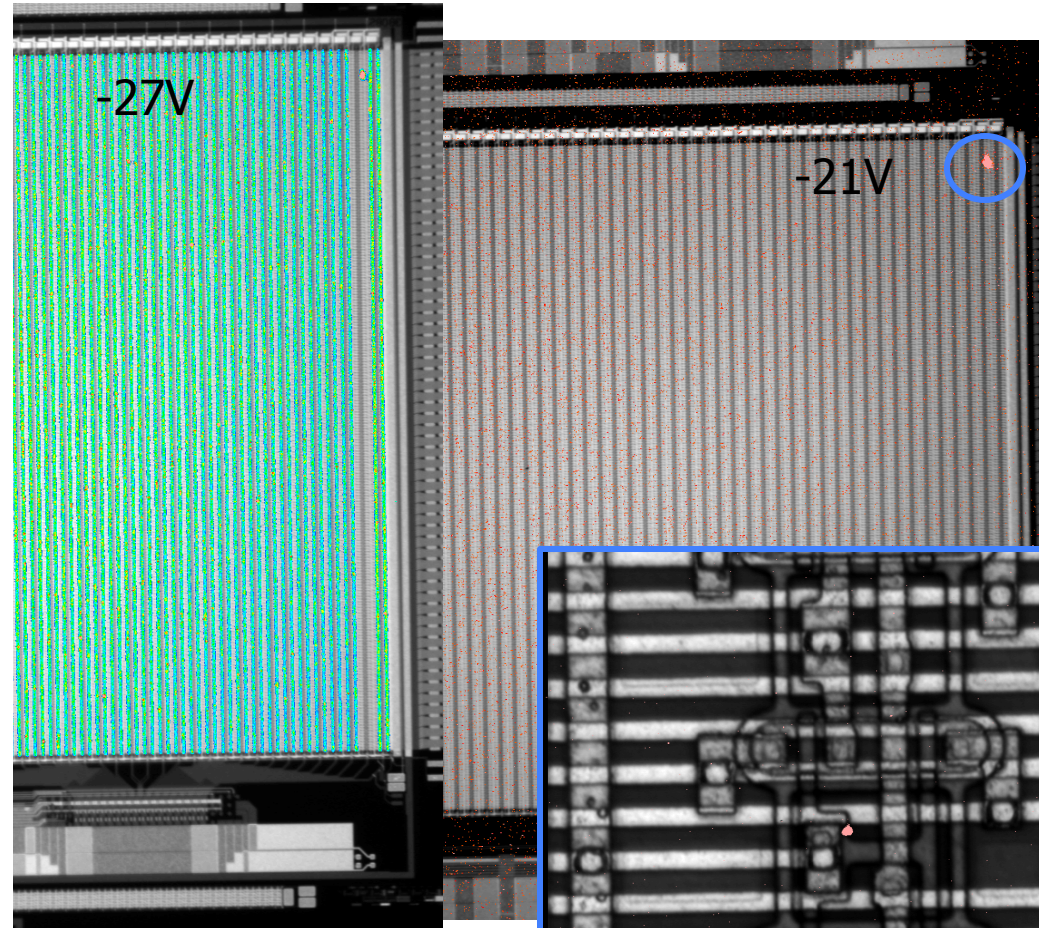
8 gate rows show reduced/no emission



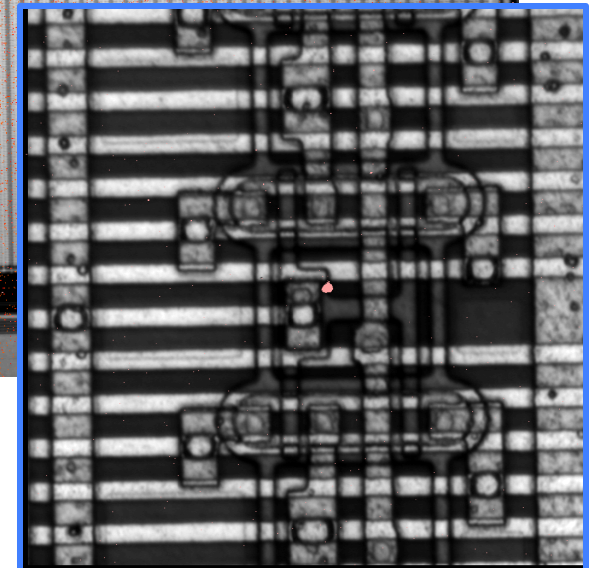
Most probably poly 1 to poly 2 short

● W38 OB2 Source (-X V) vs. Clear (0V)

- 6 gate rows show reduced/no emission
- 2 hot spots at V lower then avalanche start

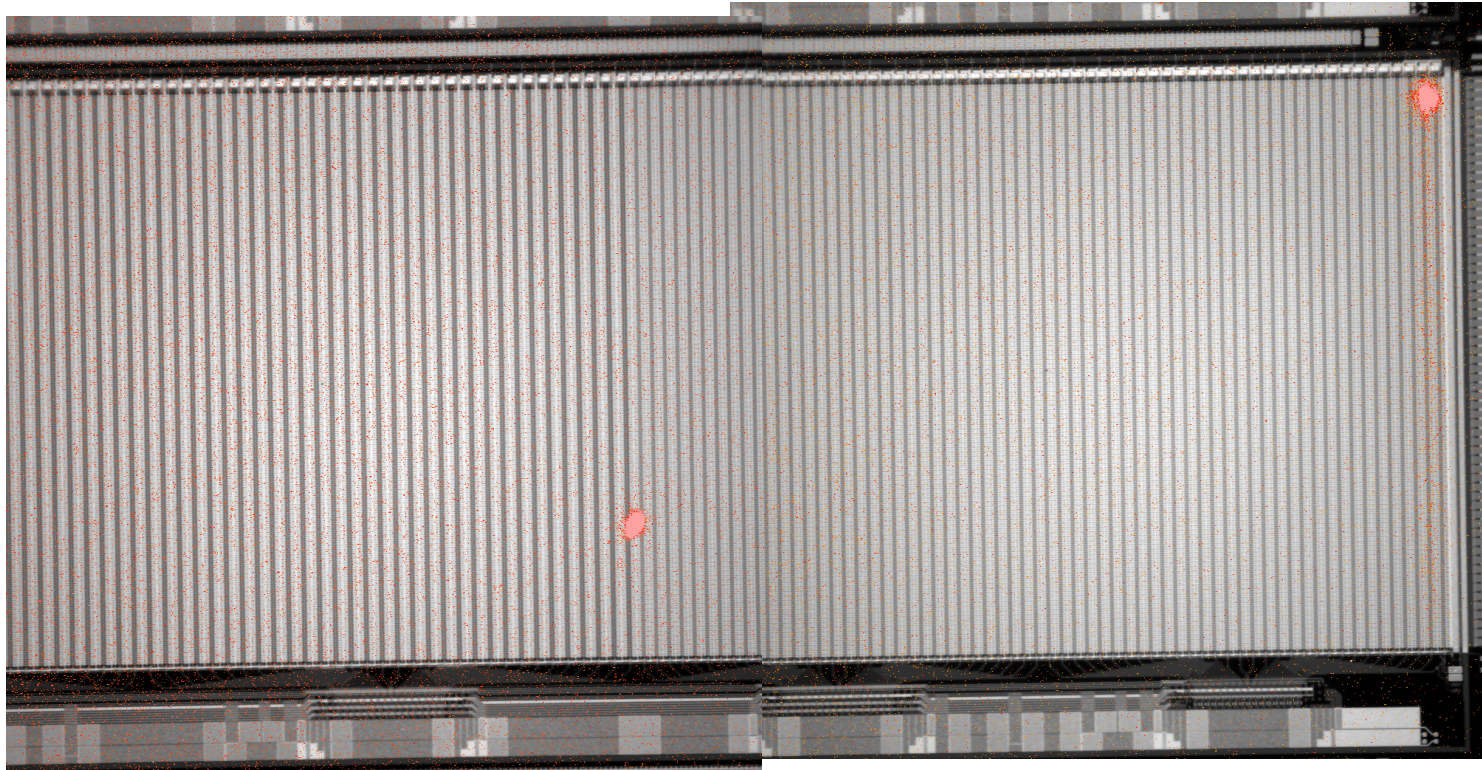


Poly 1 to poly2 or to bulk?

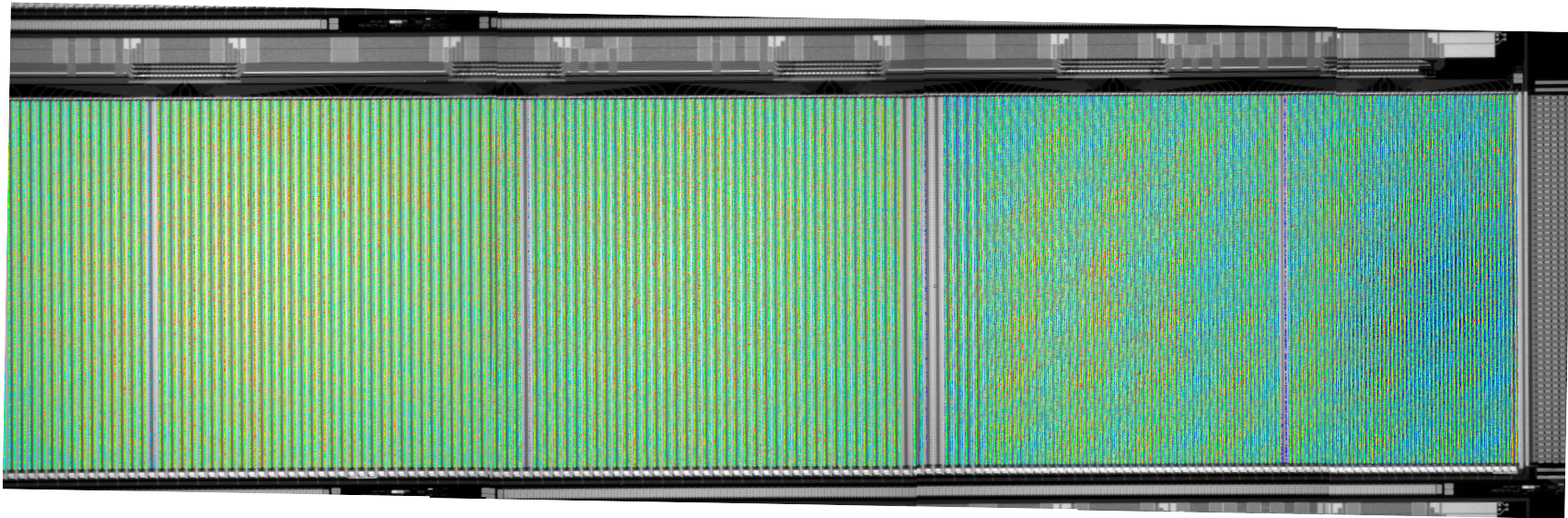


● W38 OB2 Clear gate (10V) vs all gate (0V)

Poly 1 to poly 2

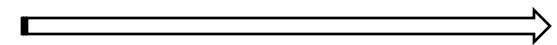
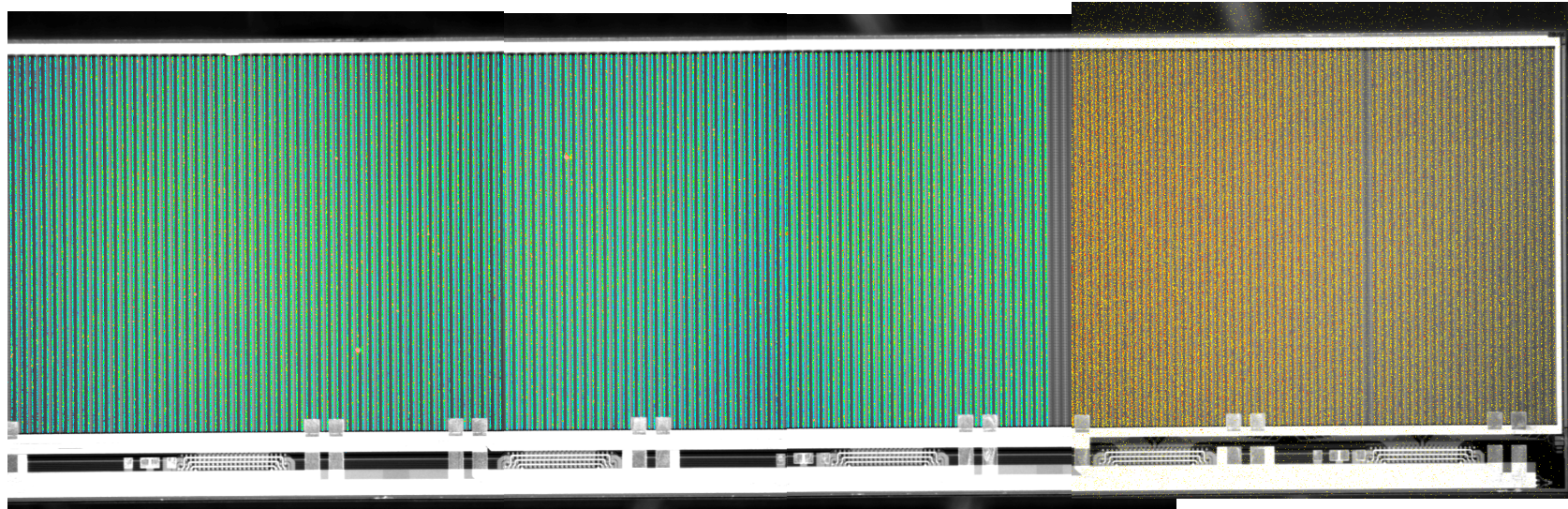


● W37 OF2 Source (-25V) vs. Clear (0V)



6 shorts total

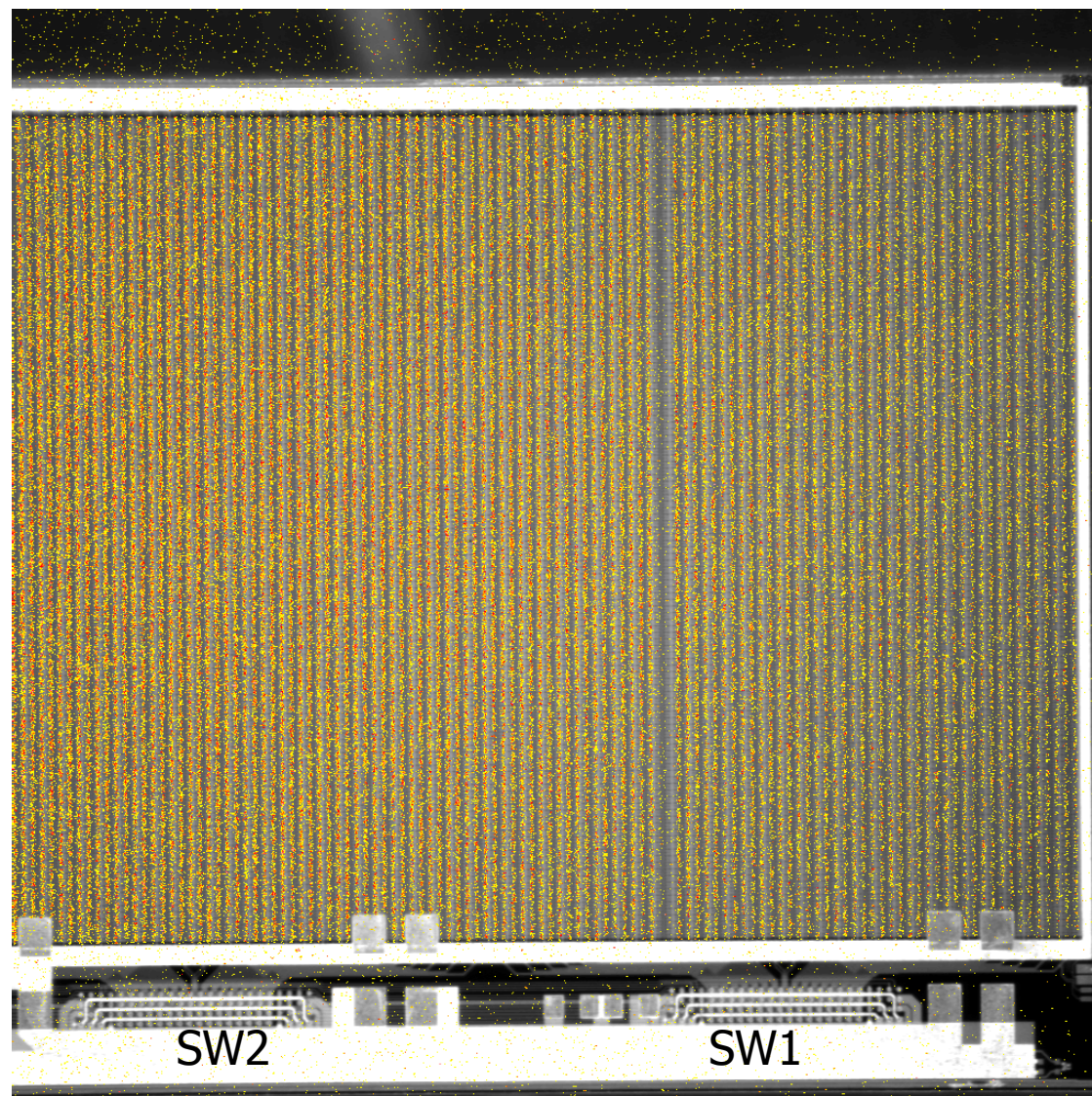
● W35 OB2 Source (-22.5V) vs. Clear (0V)



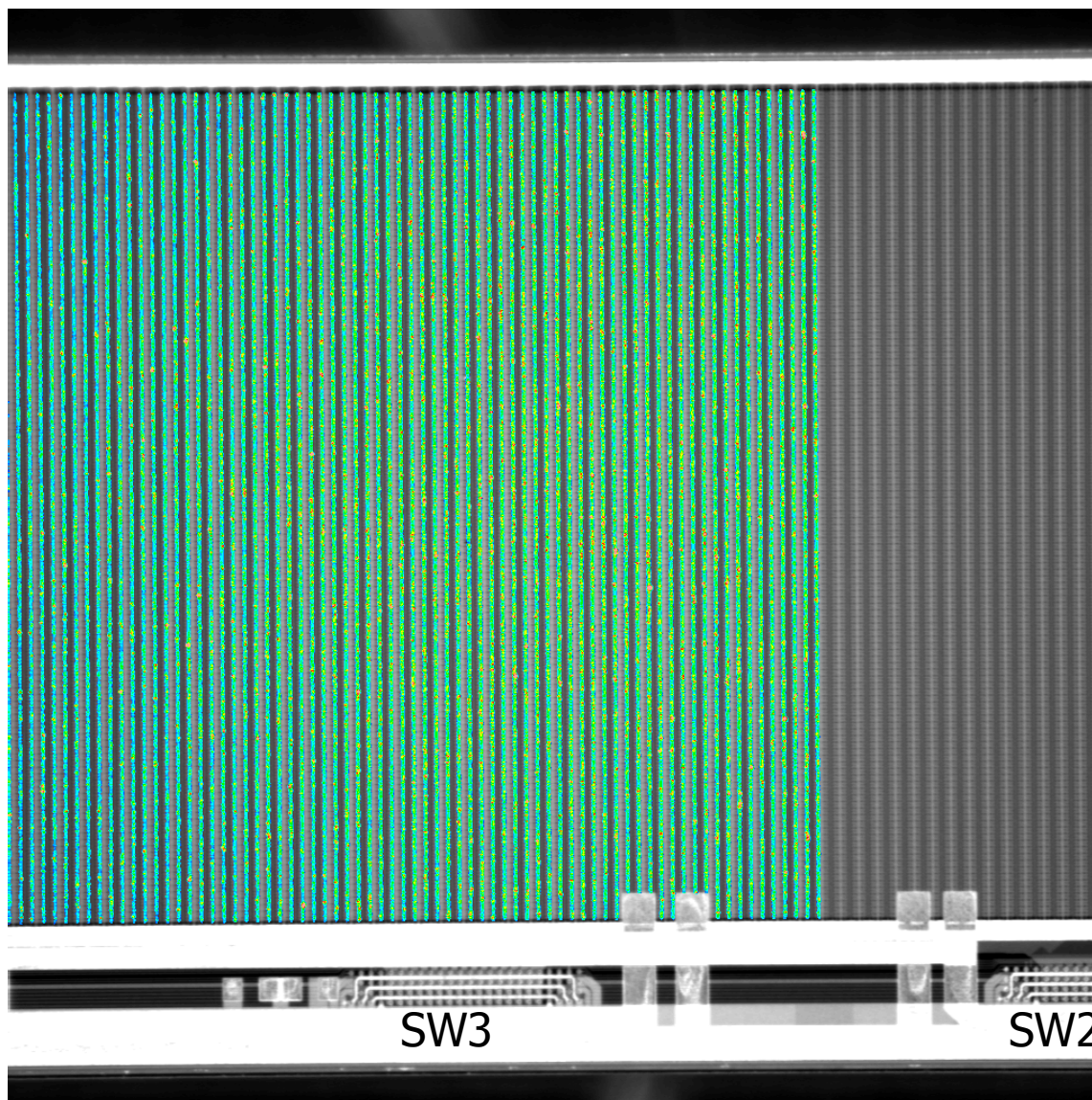
Lower light level

- 2 gate rows show reduced/no emission
- Region SW1 and SW2 lower emission
- 2 hot spots within the matrix

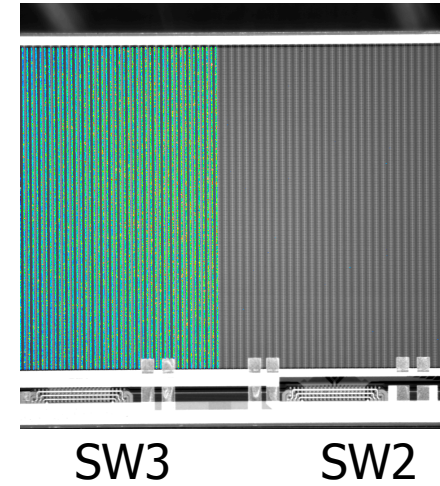
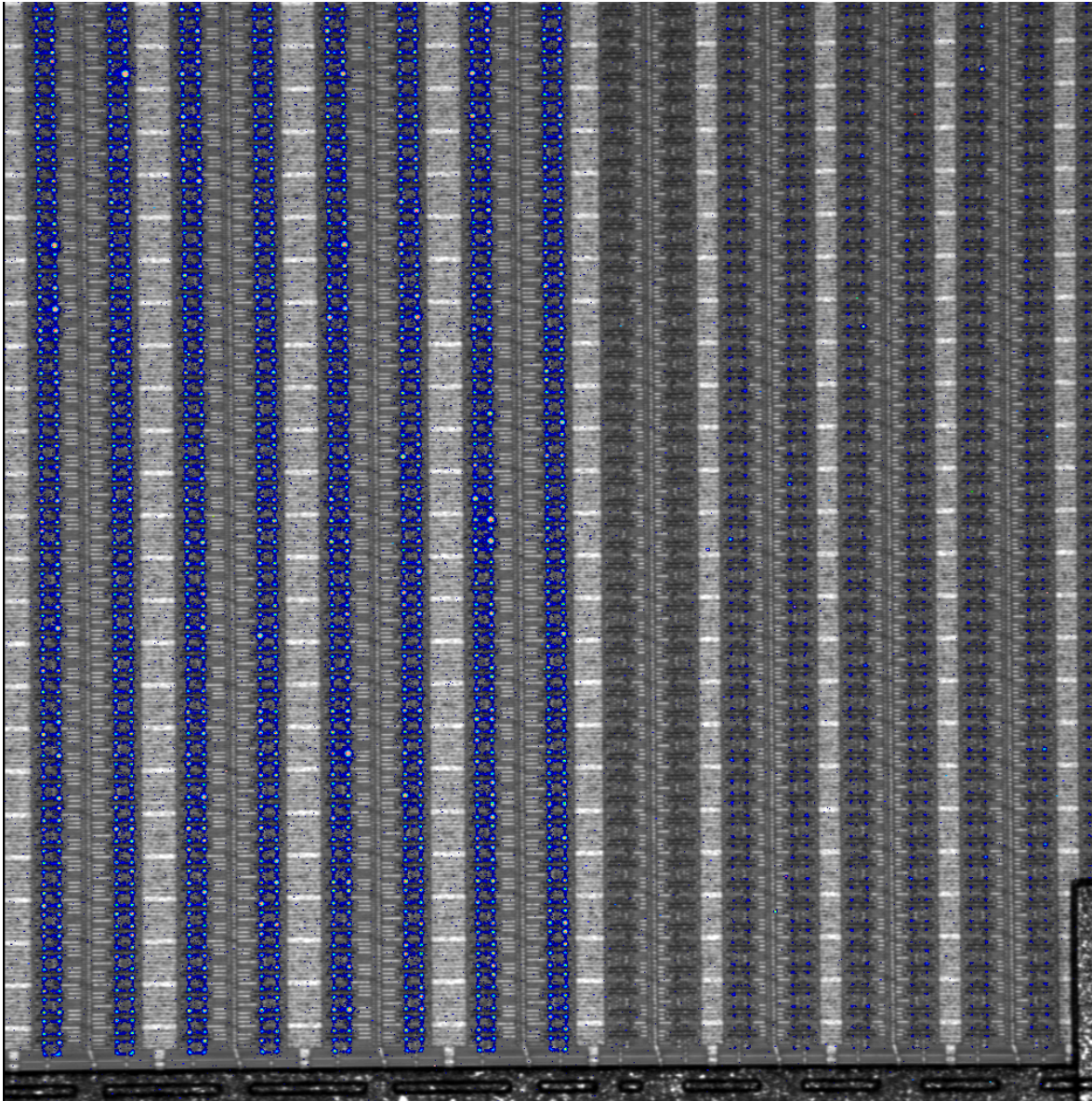
- Source (-22.5V) vs. Clear (0V)



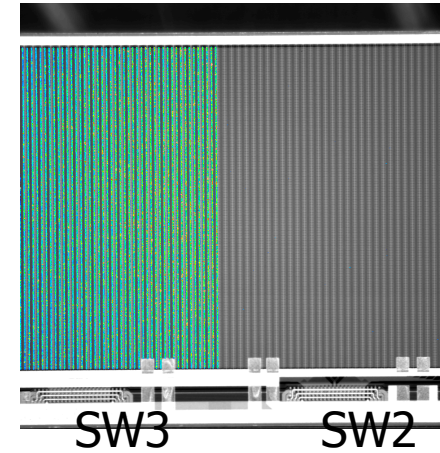
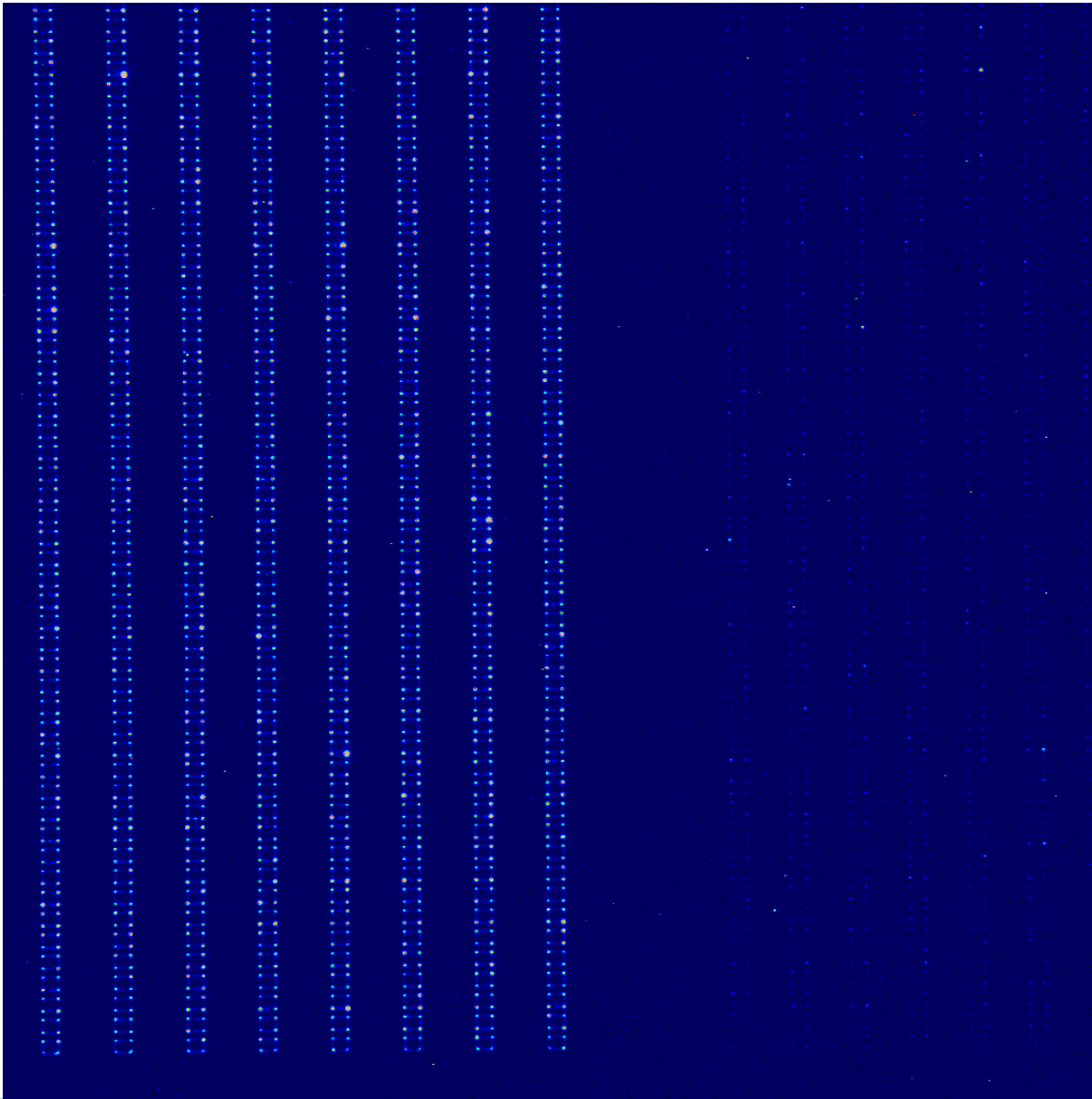
- Source (-22.5V) vs. Clear (0V)



● Source (-24.5V) vs. Clear (0V)

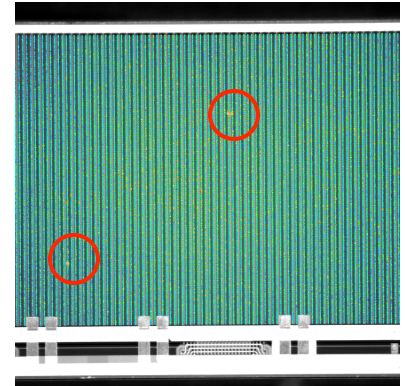
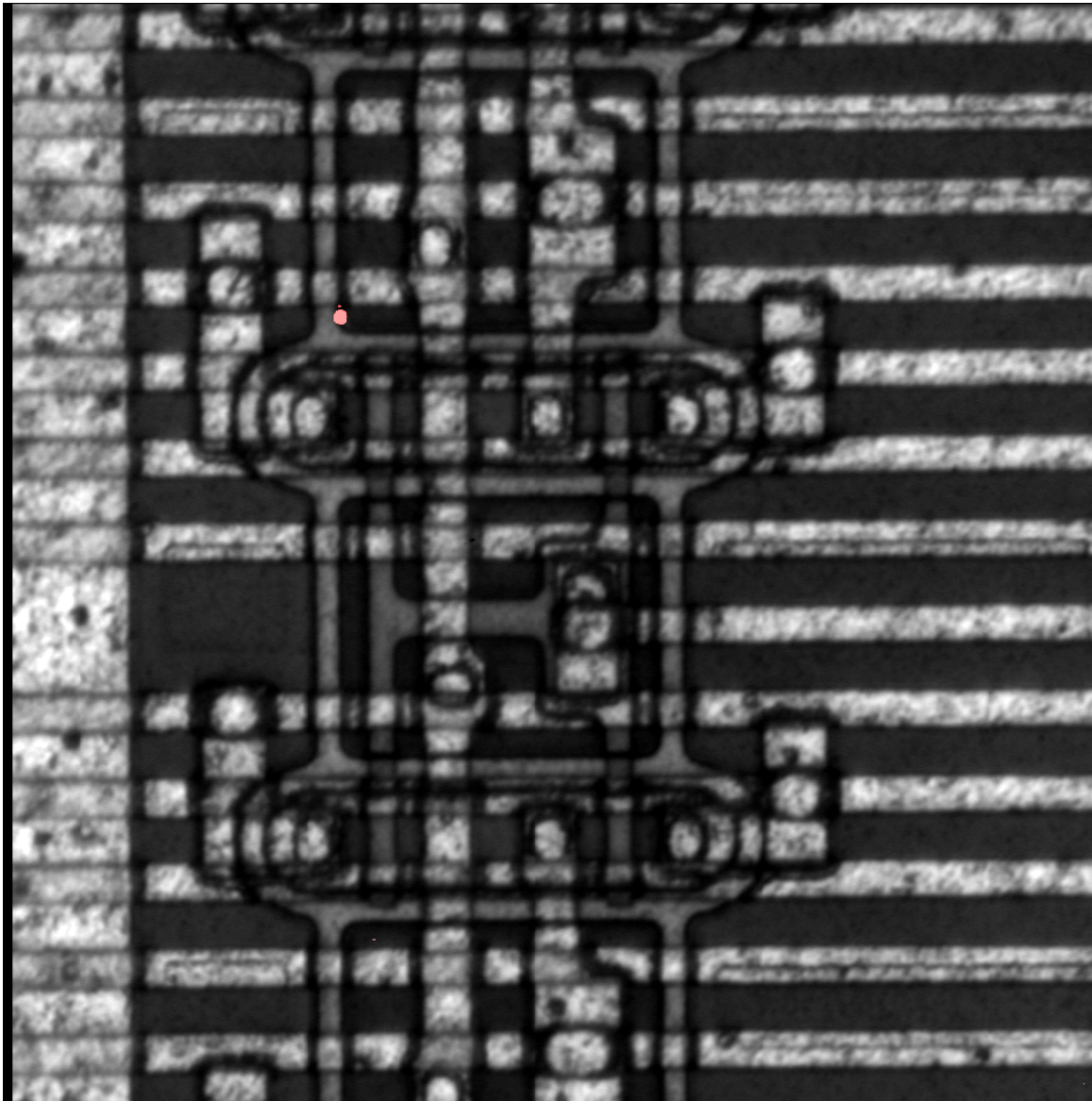


● Source (-24.5V) vs. Clear (0V)



● Source (-23V) vs. Clear (0V)

SPOT 2



Both spots not visible
at voltages below
avalanche start

● Summary

- PXD9-7
 - All killer shorts investigated
 - Three possible causes identified and confirmed previous expectations
 - Poly1 to poly 2 shorts
 - Poly 1 to bulk
 - Al1 to Al2
- Time consuming measurements → More measurements are planned once processing is finished.
- In the meantime PXD9-6 failure investigation ongoing
- In PXD9-6 and PXD9-7 not all common contacts are available for probe station testing @ end of processing
- PXD9-8 will have more options available.