BOSCH
Invented for life

KLA+
Keep Looking Ahead

The experience of almost half a century, realized in MEMS sensors, application specific ICs and IP modules

Our advanced process control and process-enabling solutions help create the electronics that support our current lives and transform our future

Markus Wiesiollek[2a], Dr. Peter Egger[1], Thomas Groos[2], Rajeev Kini[2]
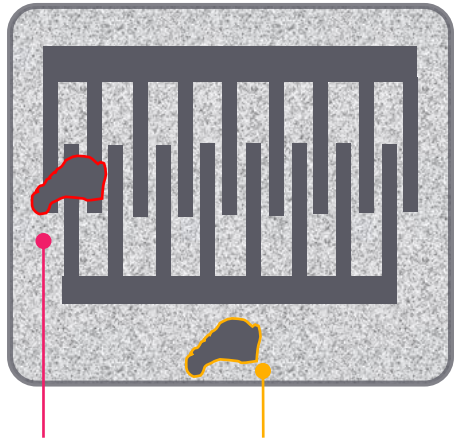**[1] Robert Bosch GmbH [2] KLA Corporation [2a] markus.wiesiollek@kla.com**

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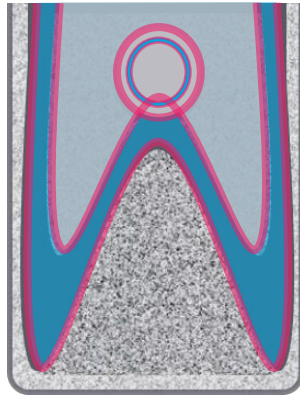# Typical challenges associated with MEMS devices

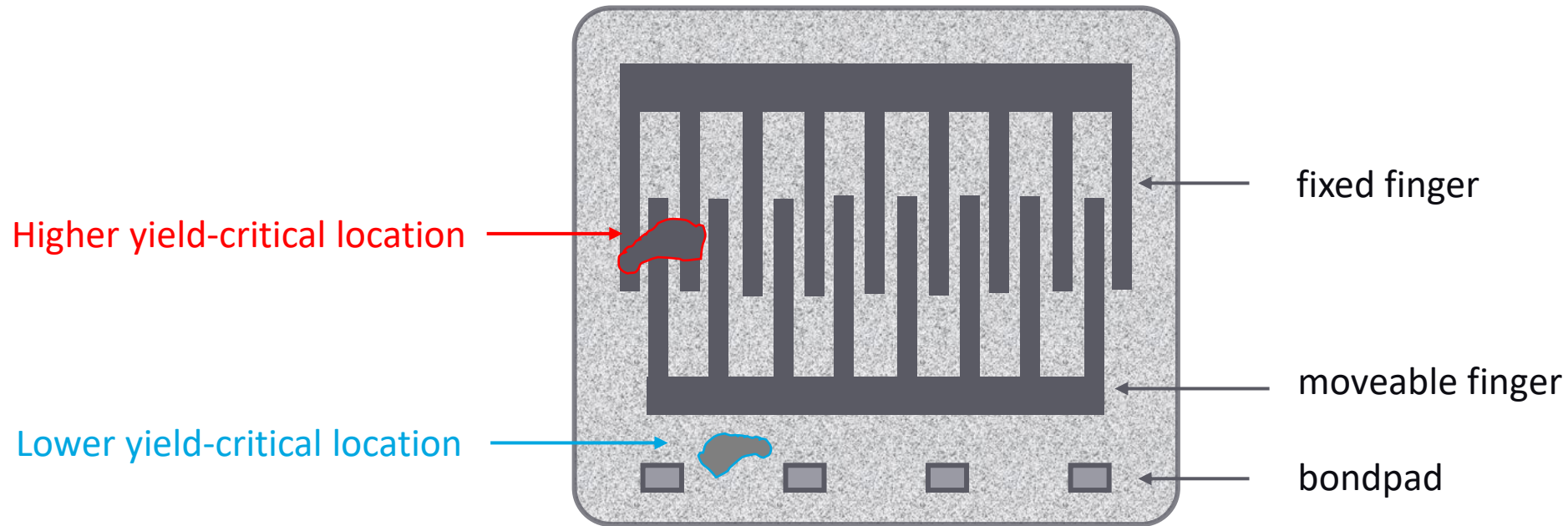| Defect location	Irregular pattern	Care Area Accuracy	MEMS Size	Real / Nuisance

critical   less critical

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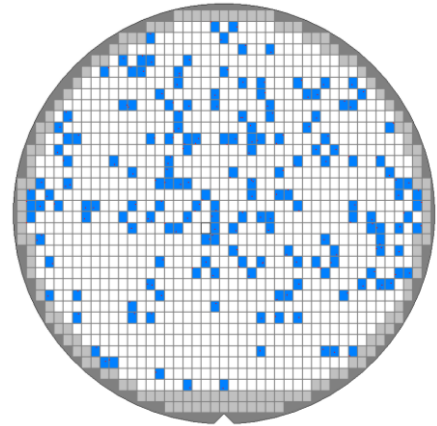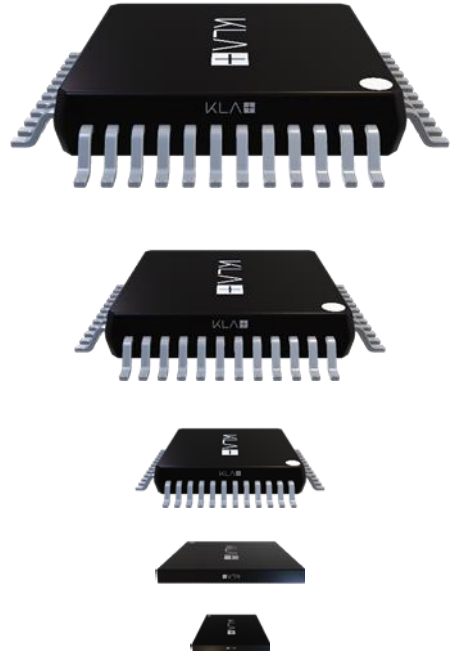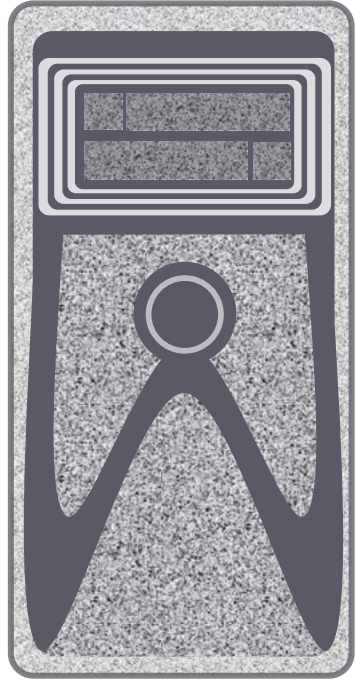
Defect classification depending on location

Defect location

fixed finger

Higher yield-critical location

moveable finger

Lower yield-critical location

bondpad

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Irregular pattern

MEMS Pattern design becomes more complex and hits the limit of legacy care area setup
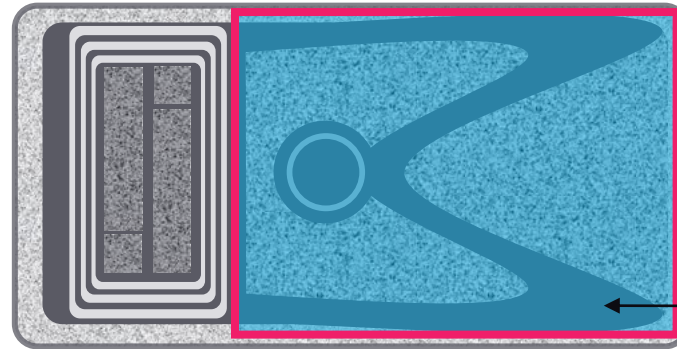
Circle array

Curved pattern

triangle

grain

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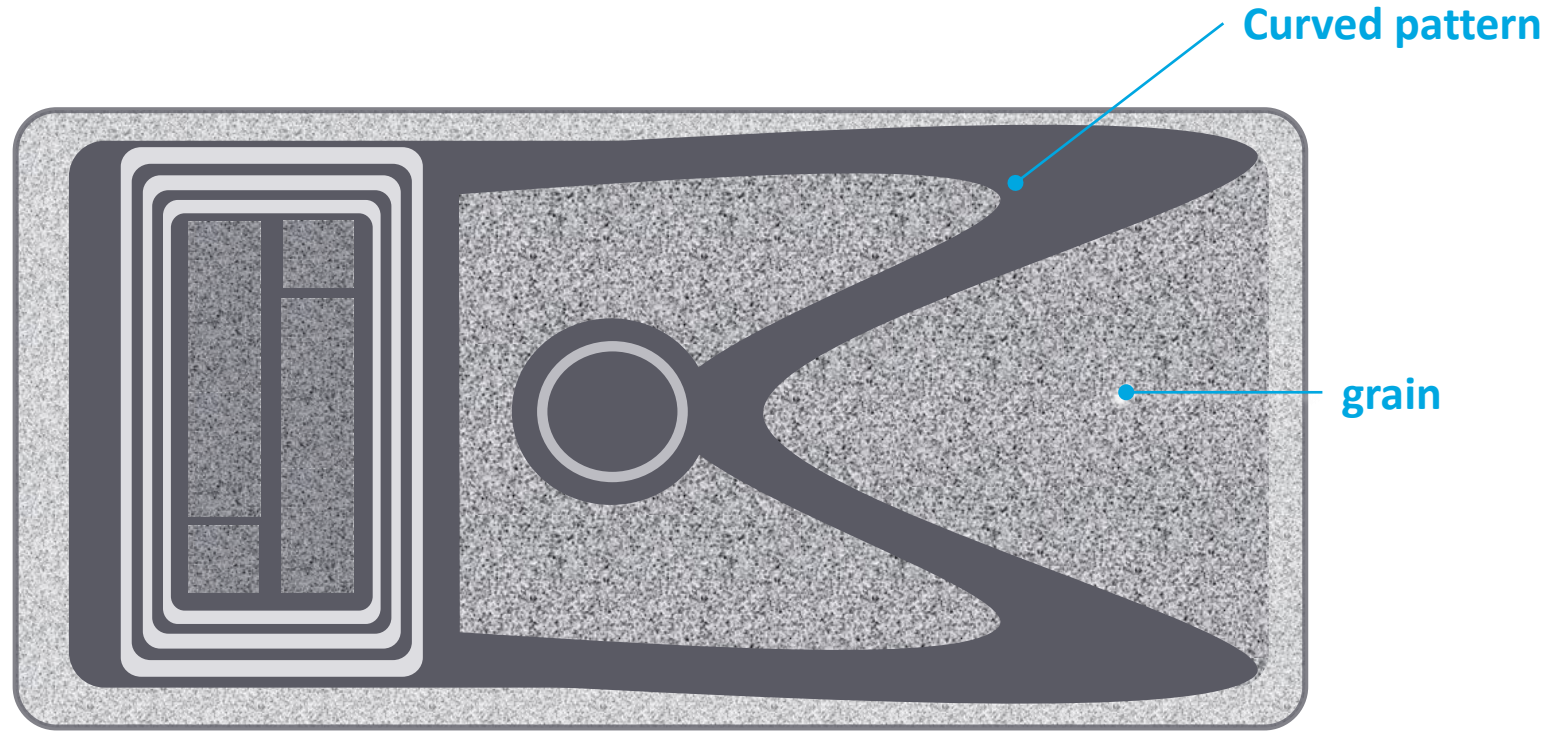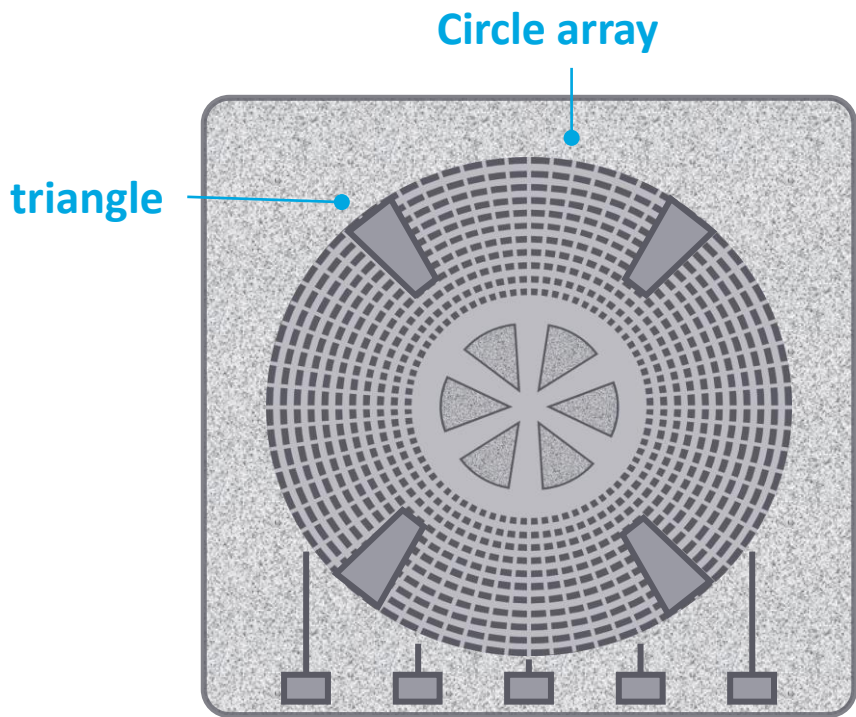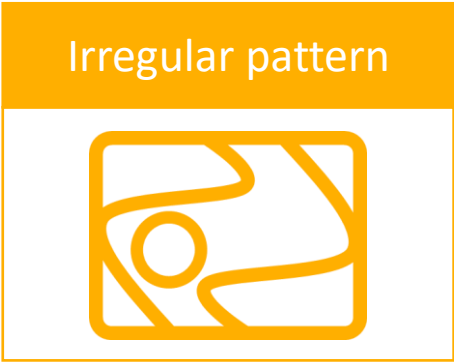
Typical challenges associated with MEMS devices

Traditional Care Area accuracy:
Less precise
Long setup time
Impacts Throughput

Care Area Accuracy

Legacy Care Area drawing on complex pattern
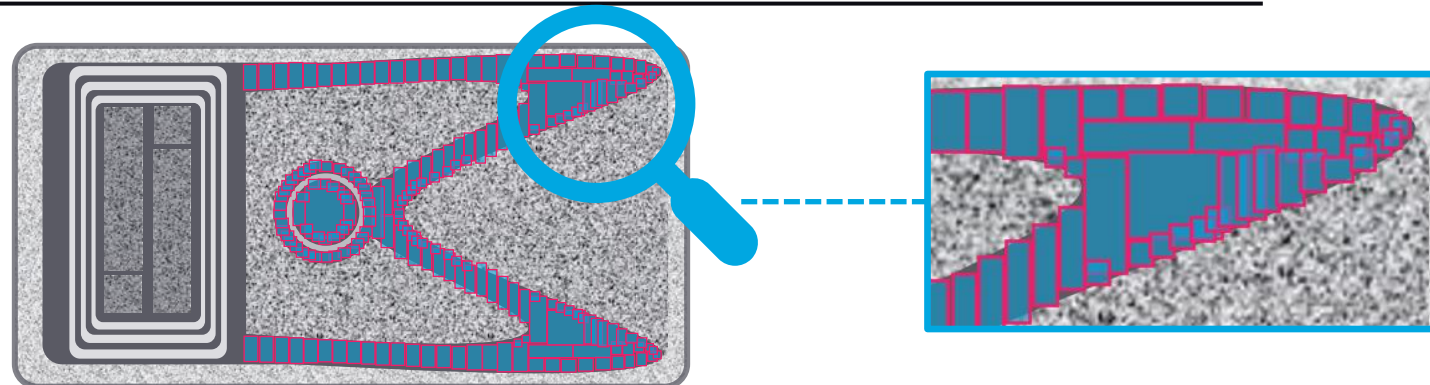
Define one large
care area to
include all pattern

Bosch DOI area

simple care area setup (fast but less precise)

OR

Define multiple
small care areas
to follow pattern
shape

care area setup (more precise but long setup time, TPT impact due to high # of care areas)

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BOSCH   MEMS device feature sizes are shrinking
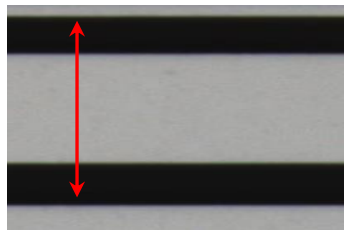
Requires more precise care area drawing accuracy in order to sufficiently separate different regions of the device
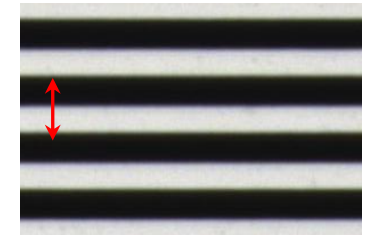
Automotive Electronics   **Consumer Electronics**
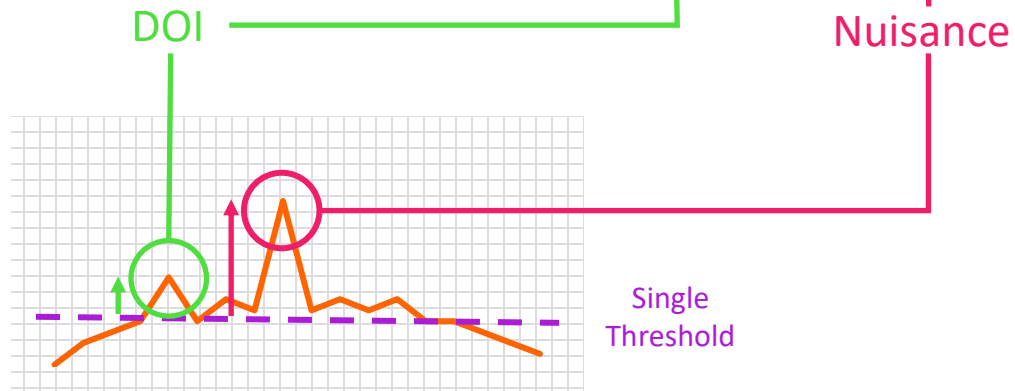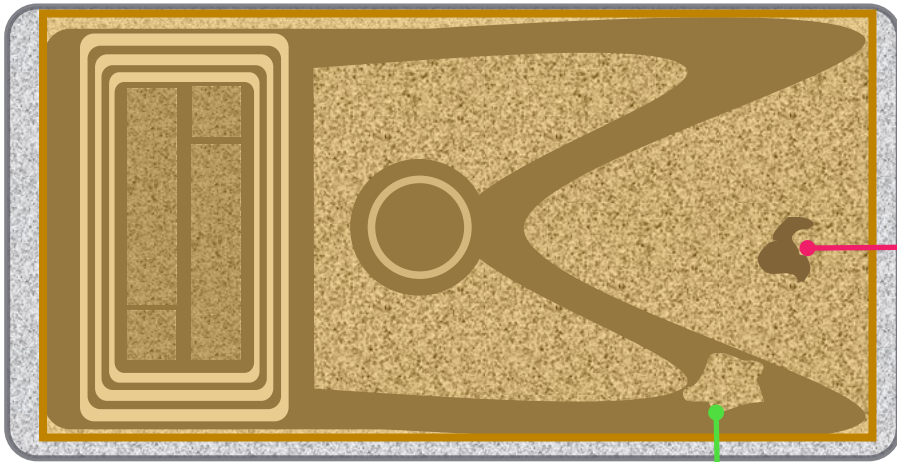

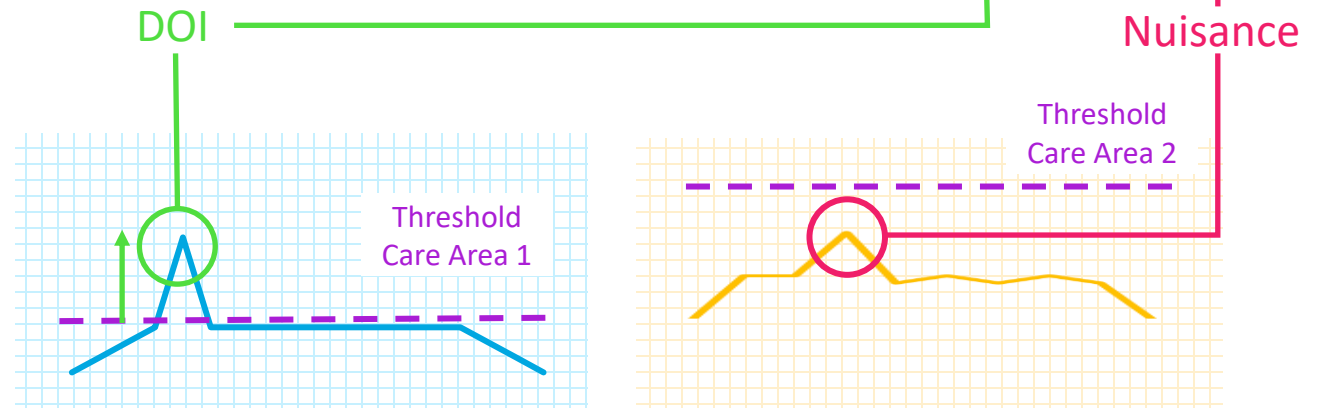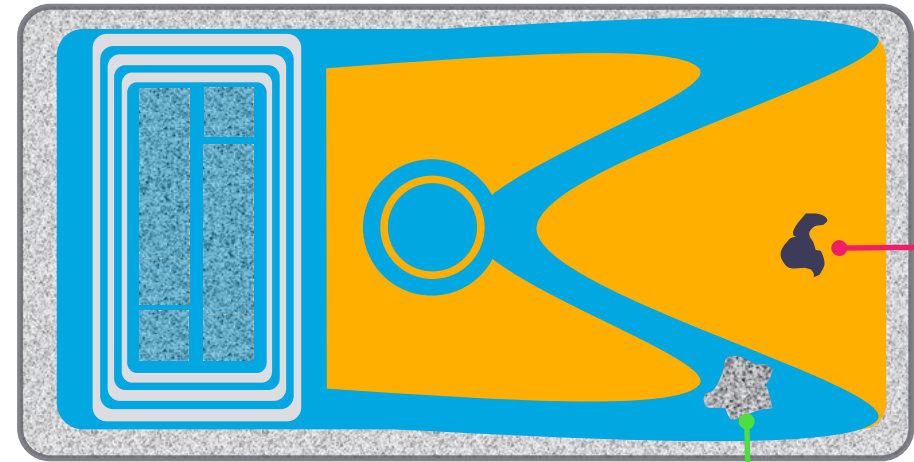Pitch 10 Pixel (inspection mag)   Pitch 4 Pixel (inspection mag)

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Real or nuisance -> Care Area separation increase sensitivity and reduces nuisance

Legacy Care Area

One care area-- >DOI Signal **reduced**

FlexPoint Care Area

Separation of care areas-- >DOI Signal **enhanced**

DOI

Nuisance

Single Threshold

DOI

Nuisance

Threshold Care Area 1

Threshold Care Area 2

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Using 8930 with FlexPoint™ option on customer provided wafer

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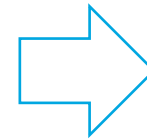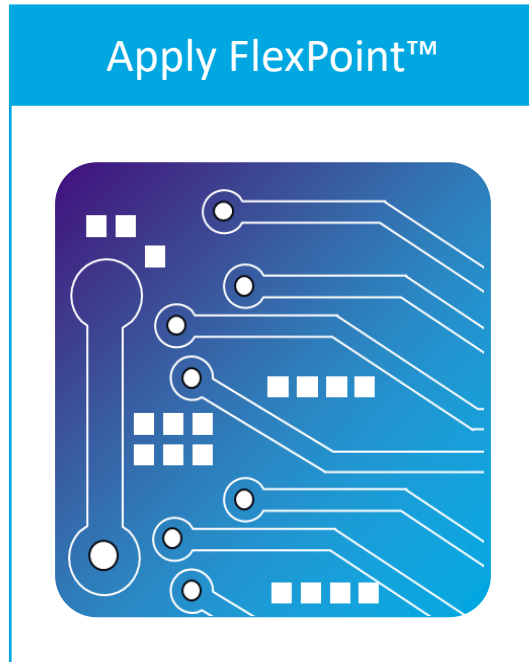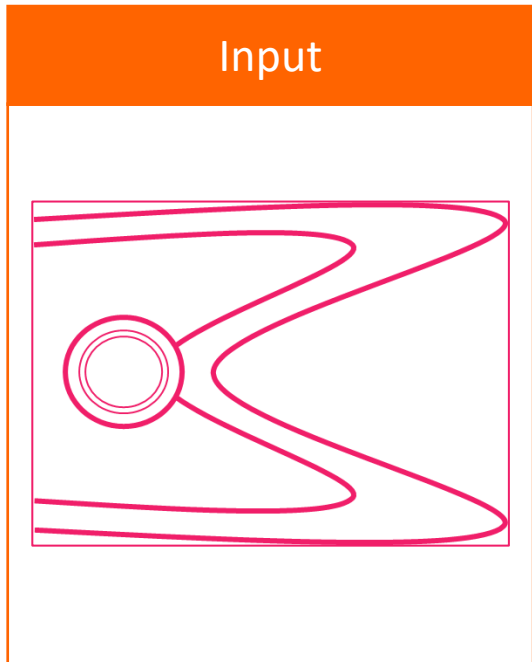| Defect location	Irregular pattern	Care Area Accuracy	MEMS Size	Real / Nuisance

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Input

Apply FlexPoint™

Output

FlexPoint runtime Care Area alignment
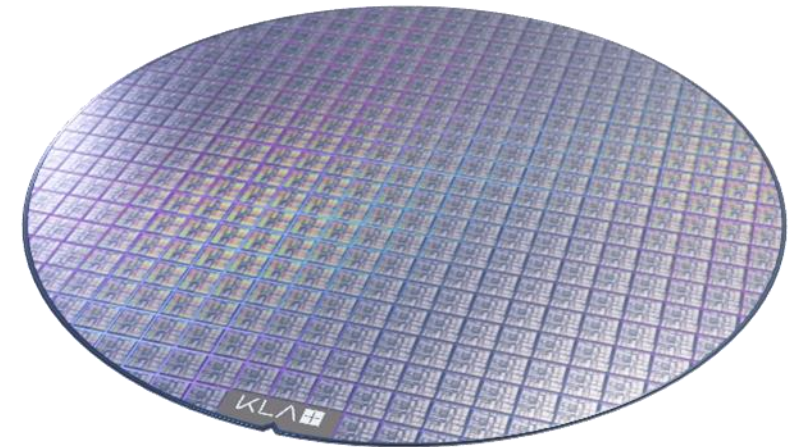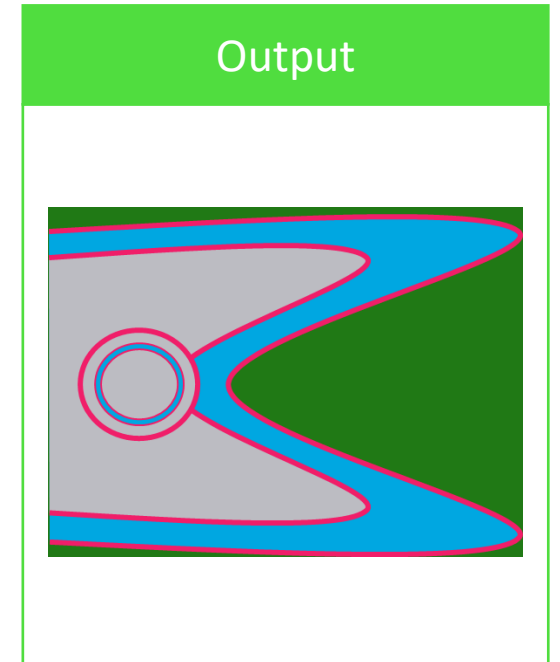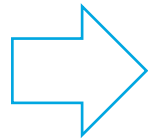
FlexPoint runtime Care Area alignment increases detection performance & location accuracy

Without FlexPoint™ Care Area runtime alignment

With FlexPoint™ Care Area runtime alignment
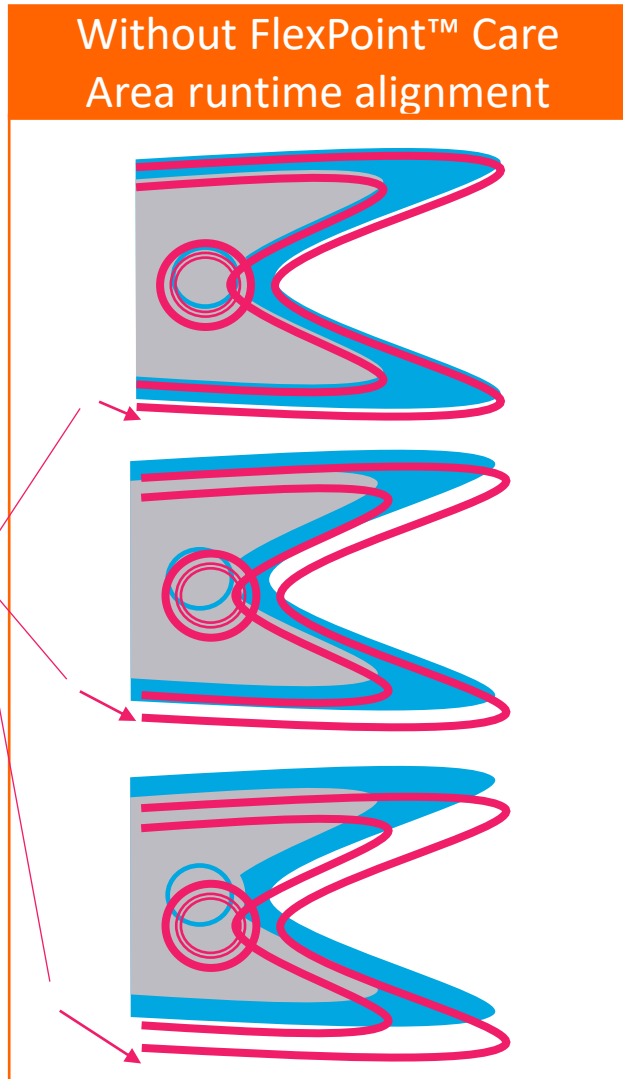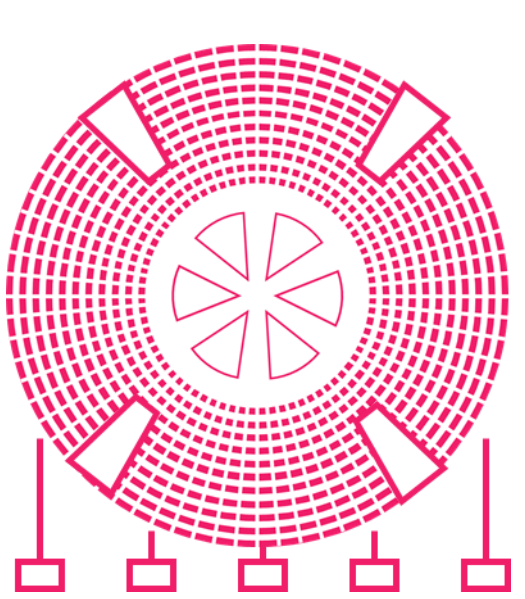
Inspected Die 1

Inspected Die 2

Inspected Die 3

Alignment Error
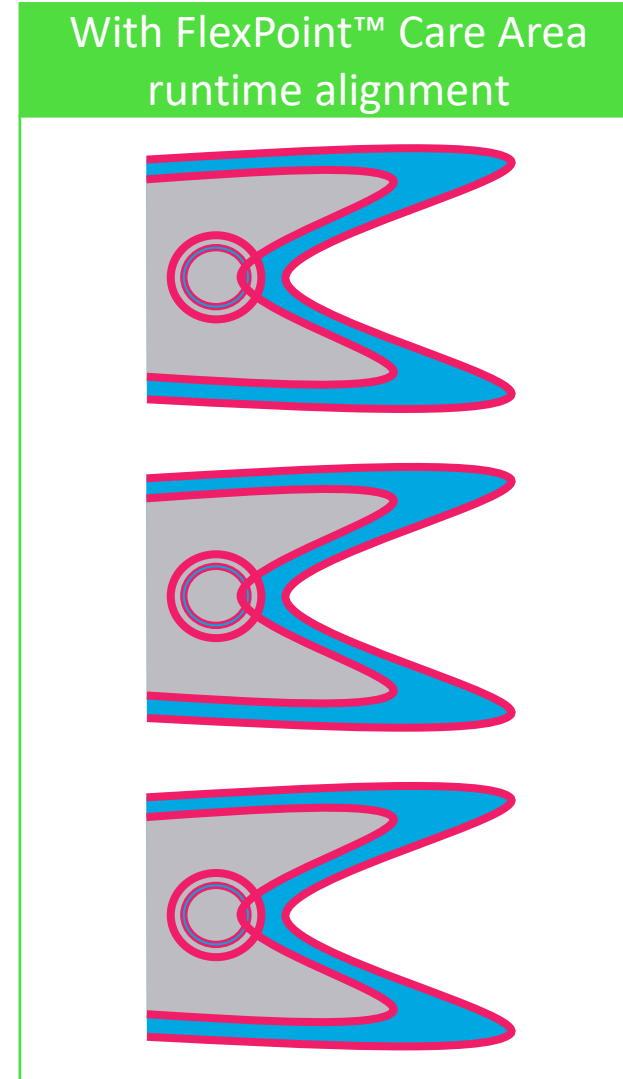
Bosch products used during data collection:

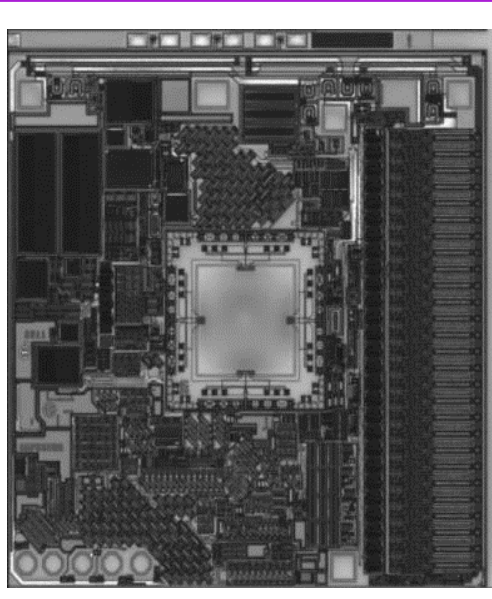Bosch MEMS **Product A**
Die Layout
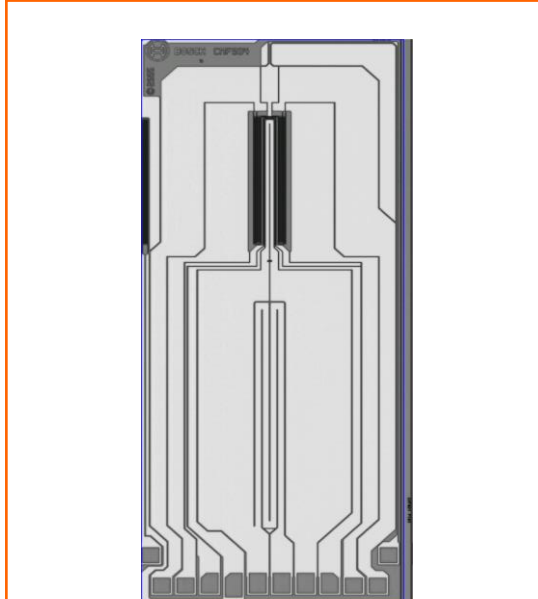
150mm Wafer

Bosch MEMS **Product B**
Die Layout

200mm Wafer

Bosch MEMS **Product C**
Die Layout

200mm Wafer

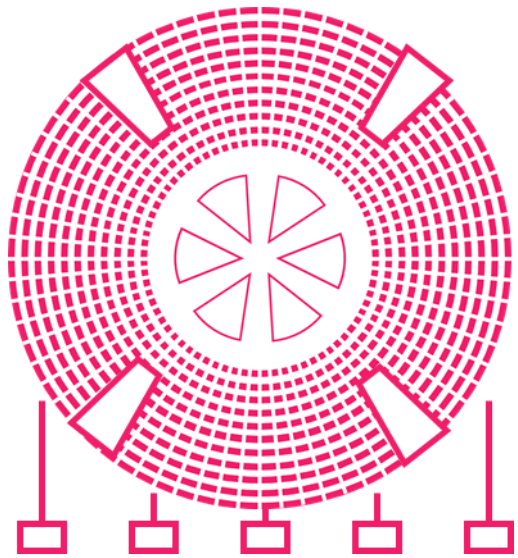Bosch MEMS **Product D**
Die Layout
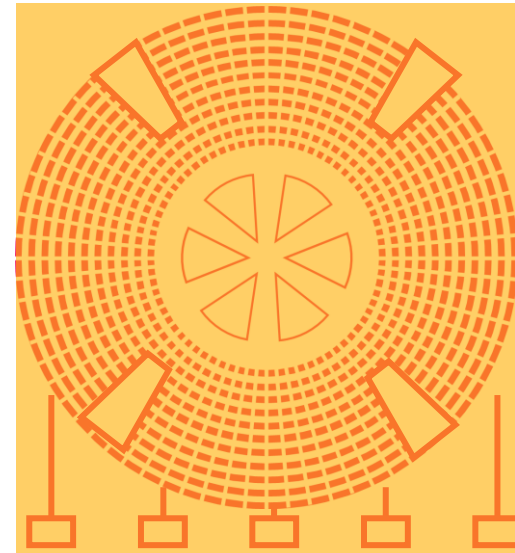
150mm Wafer

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Evaluation result Bosch Product A

BOSCH Evaluation Product A

Die Layout

Challenge
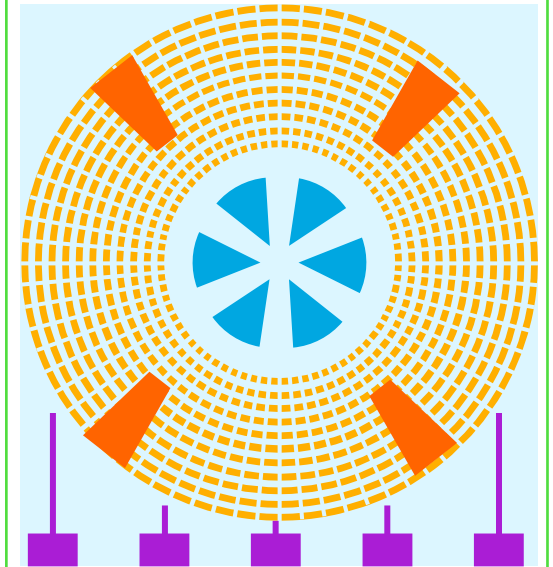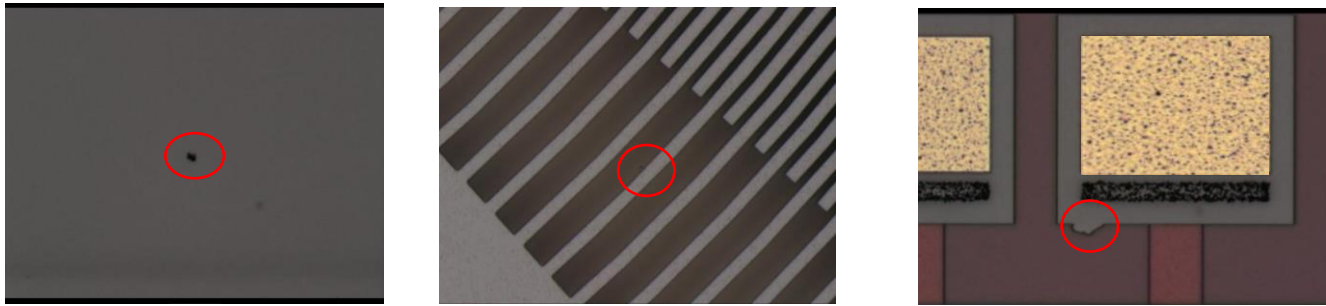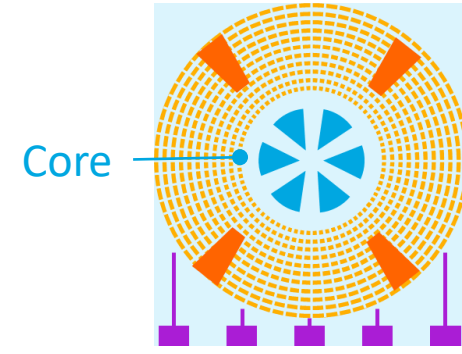
High Nusiance Rate
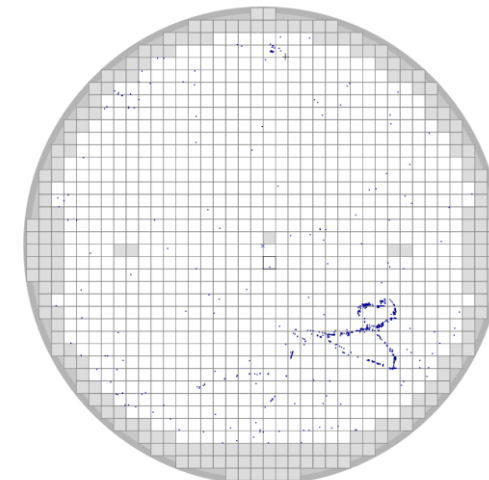
Legacy Care Area

8930 FlexPoint

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FlexPoint improves defect capture rate on core region by **>400%**

Core
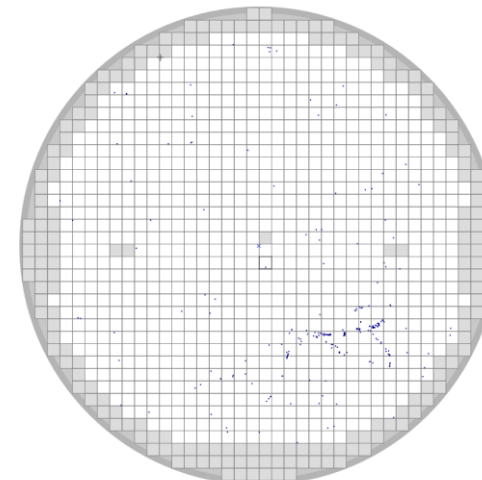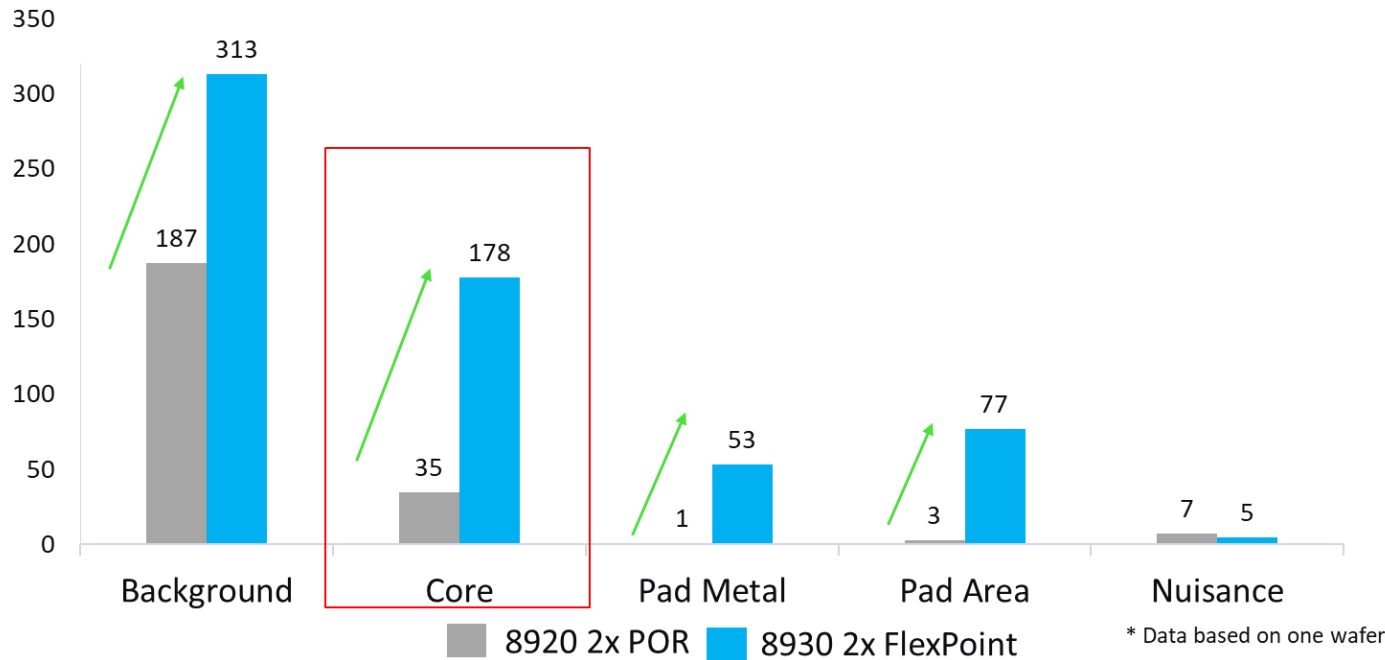
**POR
2x Mag**

**FlexPoint
2x Mag**

Defect Count increases by 170%

Legend: ■ 8920 2x POR   ■ 8930 2x FlexPoint

Category	8920 2x POR	8930 2x FlexPoint
Background	187	313
Core	35	178
Pad Metal	1	53
Pad Area	3	77
Nuisance	7	5

* Data based on one wafer

KLA

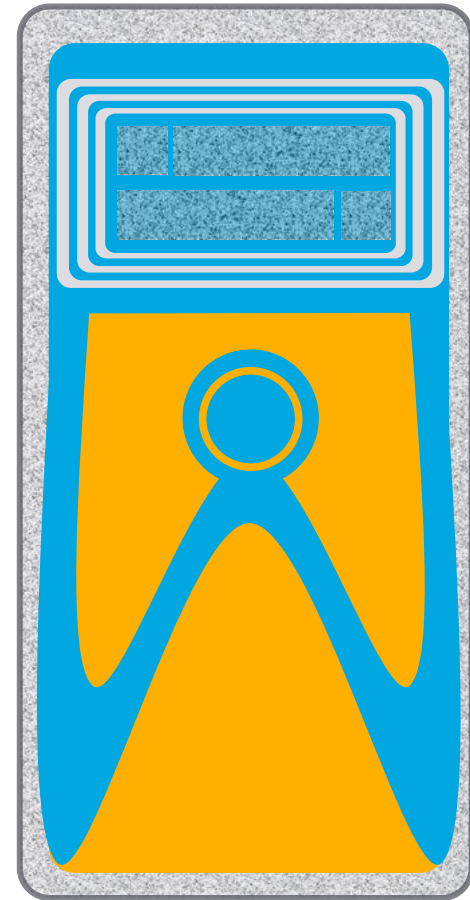# Evaluation result Bosch Product B

Rough and quiet areas, nuisance

Die layout and challenge

Legacy Care Area

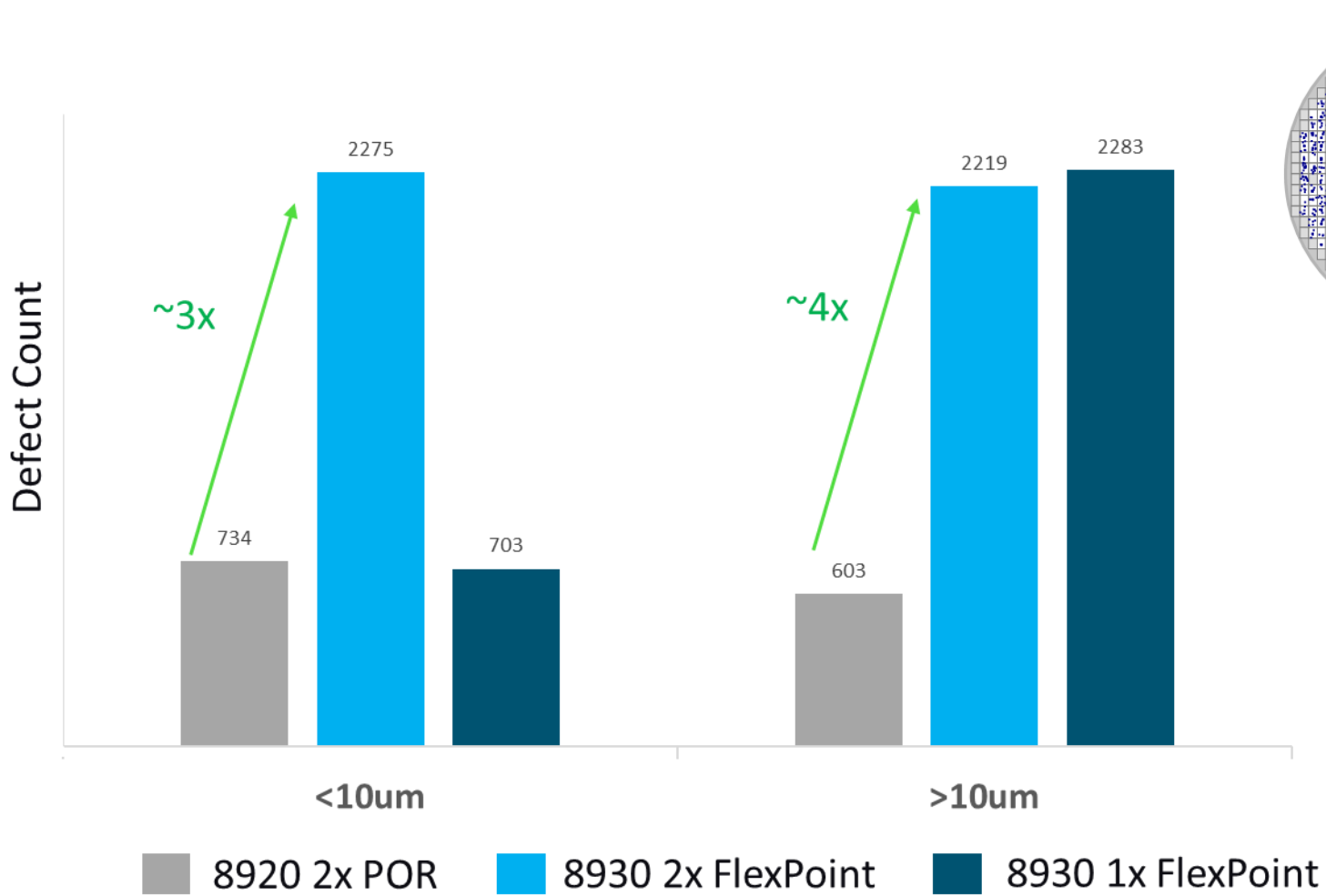8930 FlexPoint

FlexPoint enables 2.2x higher sensitivity @ 1.5x higher throughput (1x mag)

FlexPoint 2x Mag POR 2x Mag FlexPoint 1x Mag

High sensitivity with 1x Mag delivers a 46% throughput increase Vs 2x Mag

2x (30w/h*) ~1.5x 1x (44w/h*)

* IDSP recipe with 2 tests

Defect Count

~3x 734 2275 703

~4x 603 2219 2283

<10um   >10um

■ 8920 2x POR   ■ 8930 2x FlexPoint   ■ 8930 1x FlexPoint

* Data based on single wafer

Evaluation Product B MEMS legacy Vs FlexPoint

FlexPoint enables optimized sensitivity per region of interest due to accurate separation of care areas
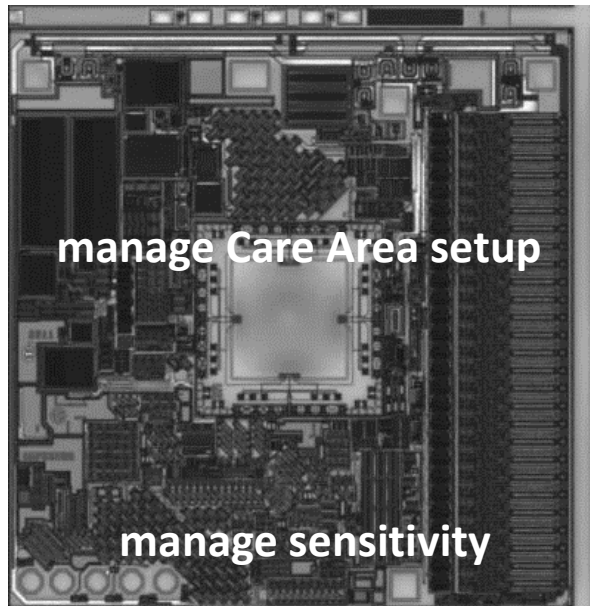
* KLA Klarity DSA used to superimpose defect locations

sens=sensitivity

8920 2x POR   8930 2x FlexPoint
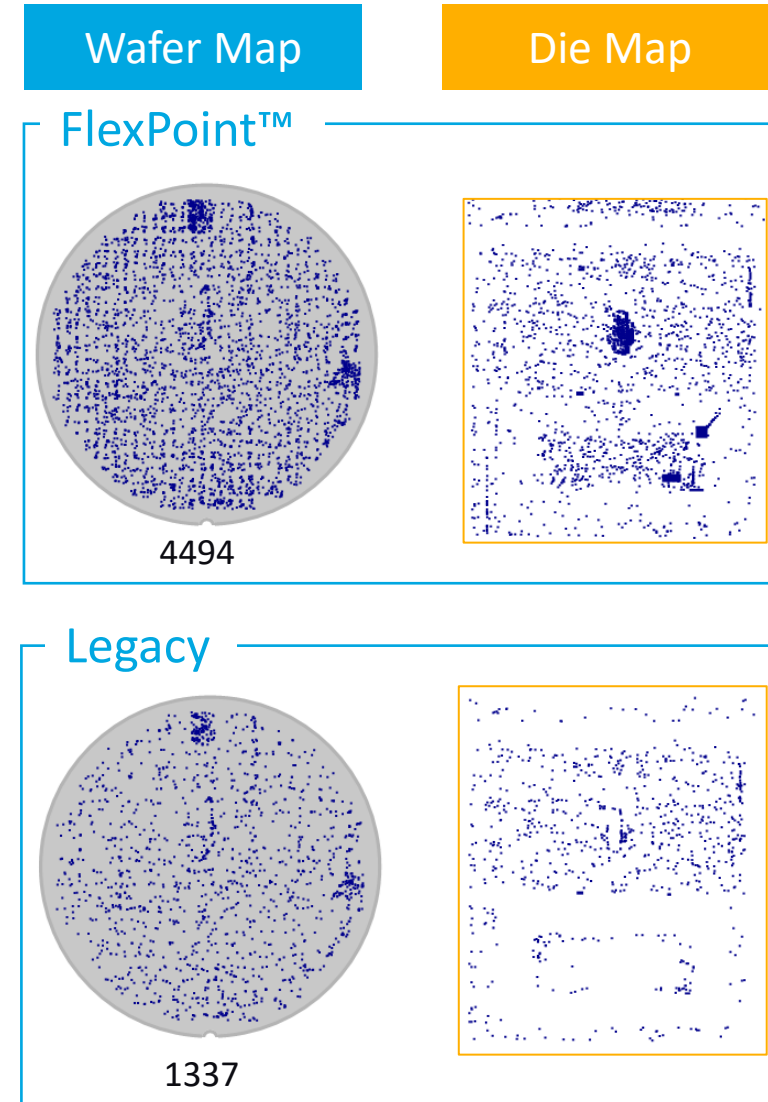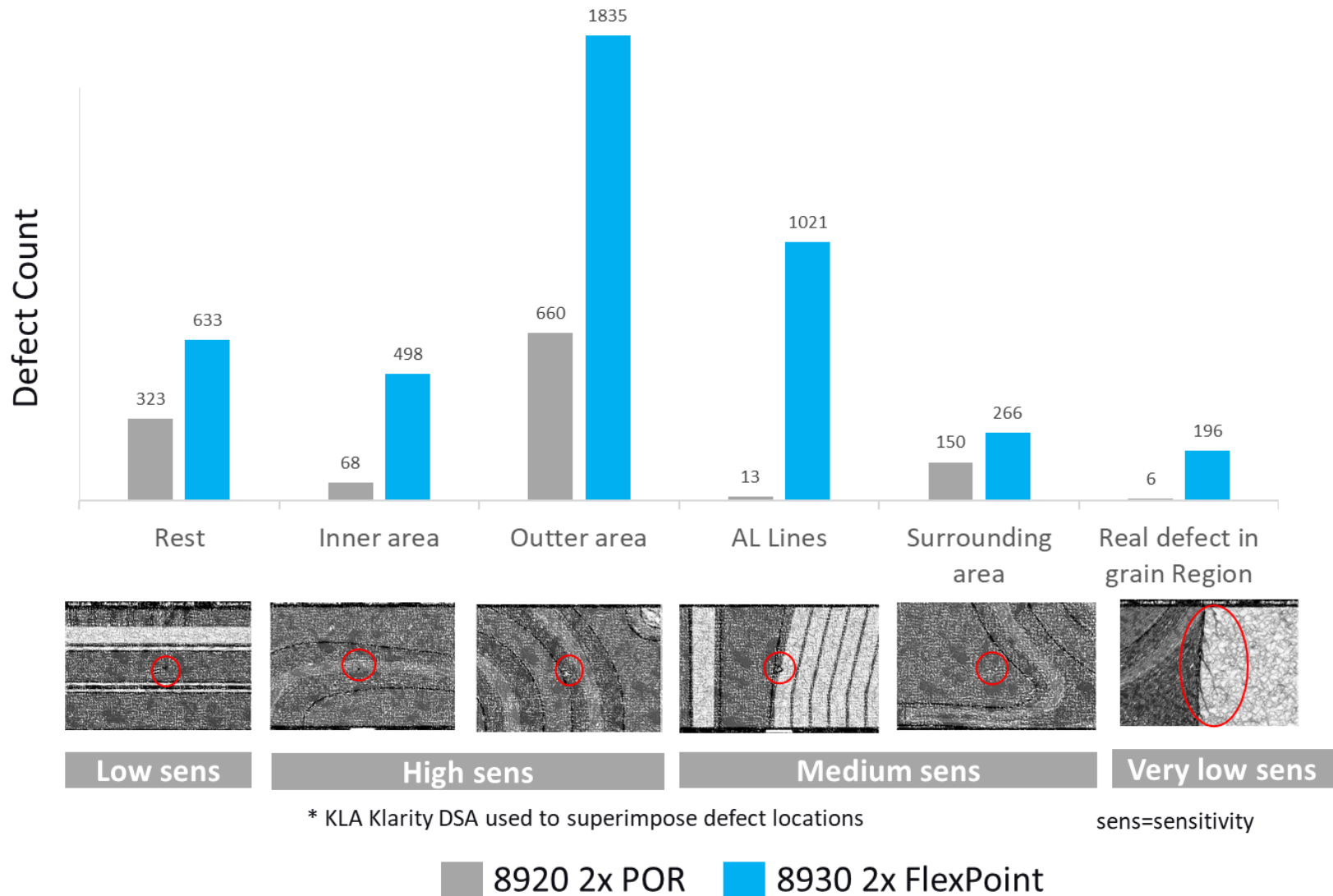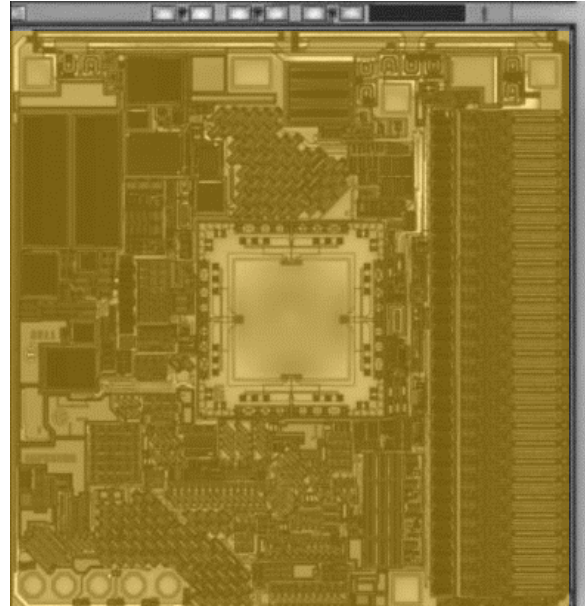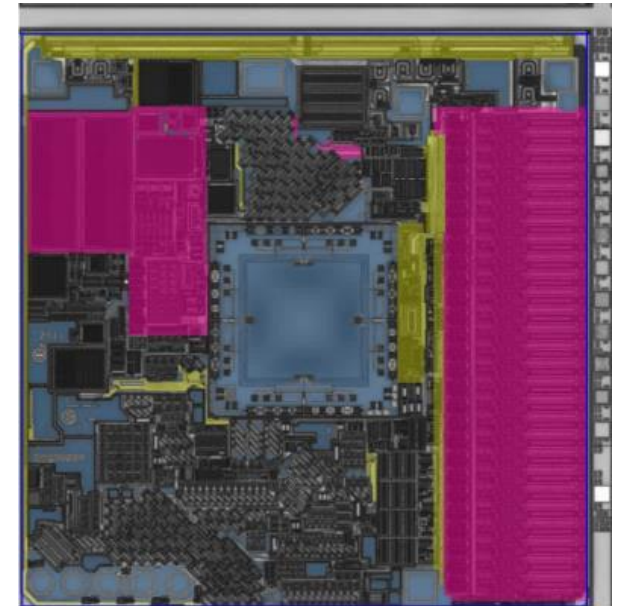
Evaluation result Bosch Product C

Die layout

manage Care Area setup

manage sensitivity

Legacy Care Area

8930 FlexPoint

Evaluation Product C
FlexPoint enables accurate Care Area separation

Inspection area

Care Area includes nuisance regions

Nuisance

Nuisance

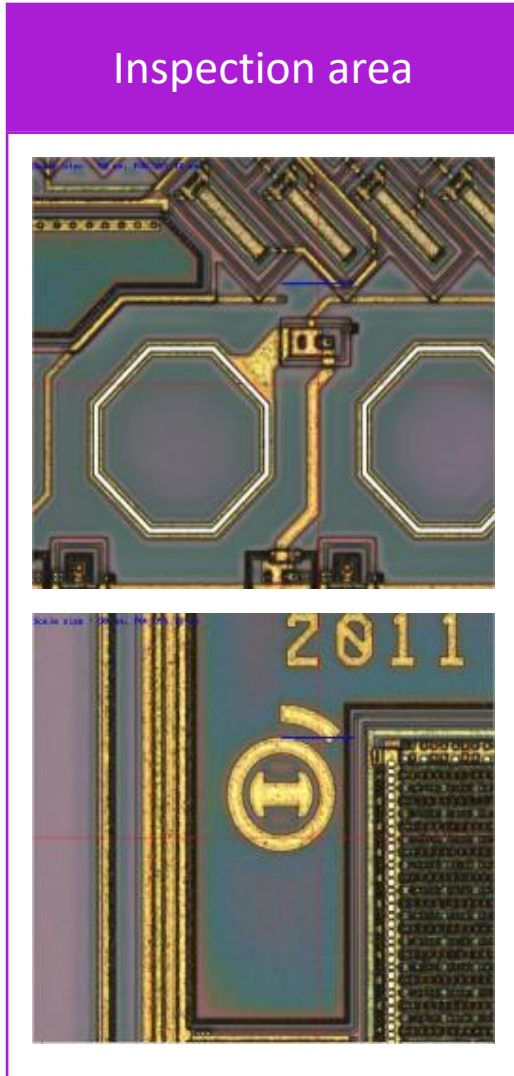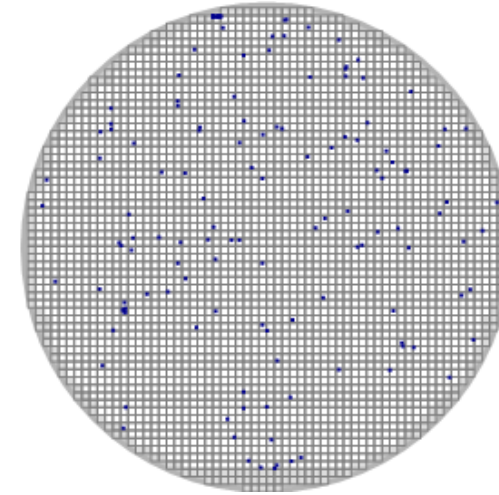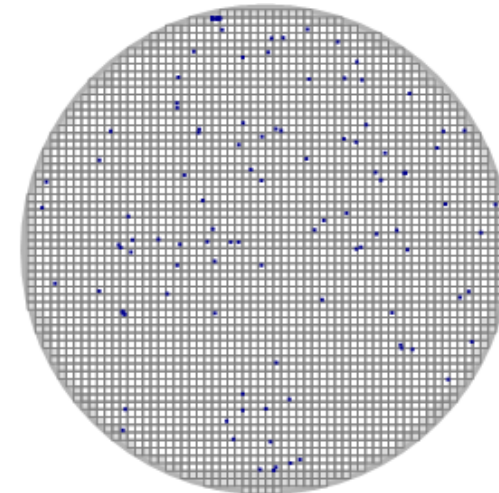FlexPoint excludes nuisance regions
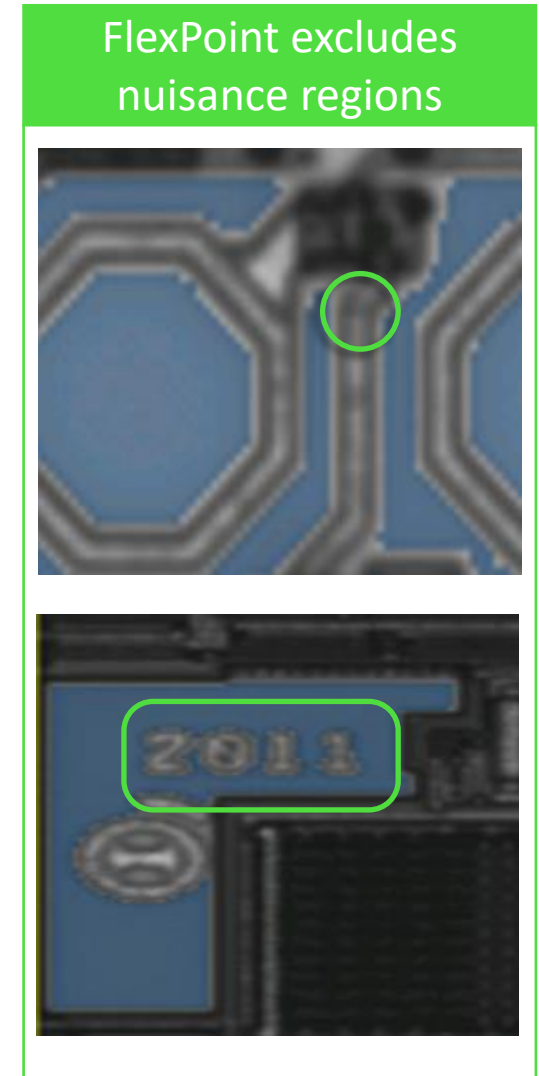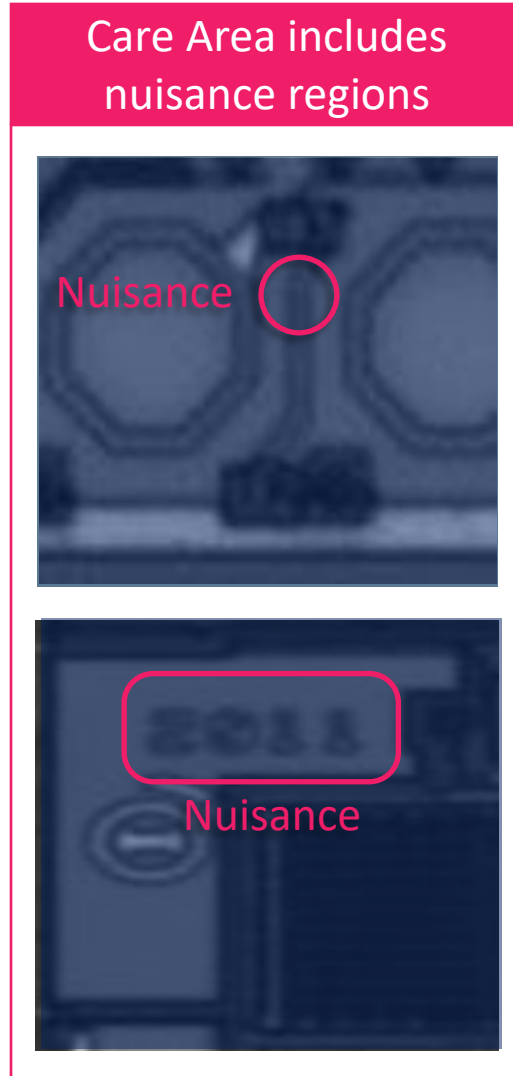
Evaluation Product C

FlexPoint enables 2x higher DOI detection @ 2.6x lower nuisance rate

Evaluation Product C

FlexPoint enables precise defect separation into different Care Areas

Care Area Separation

Care Area 4

Care Area 3

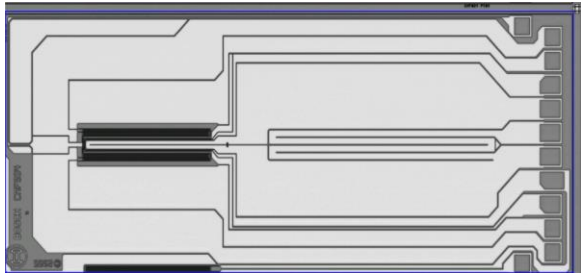Care Area 2
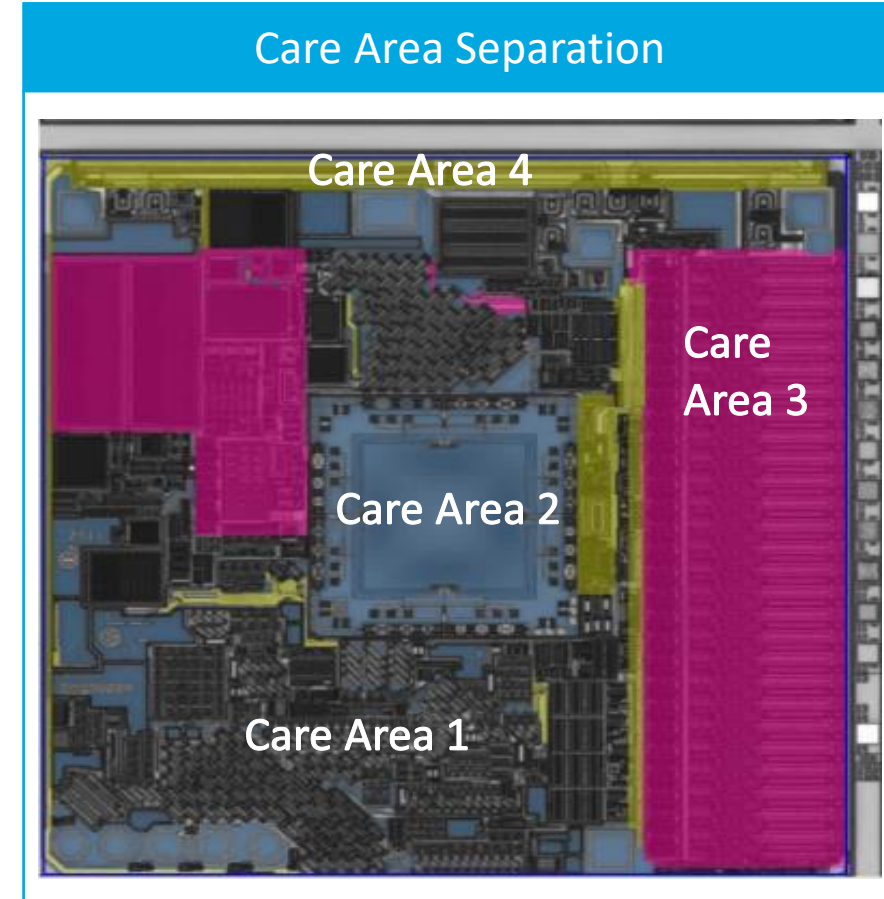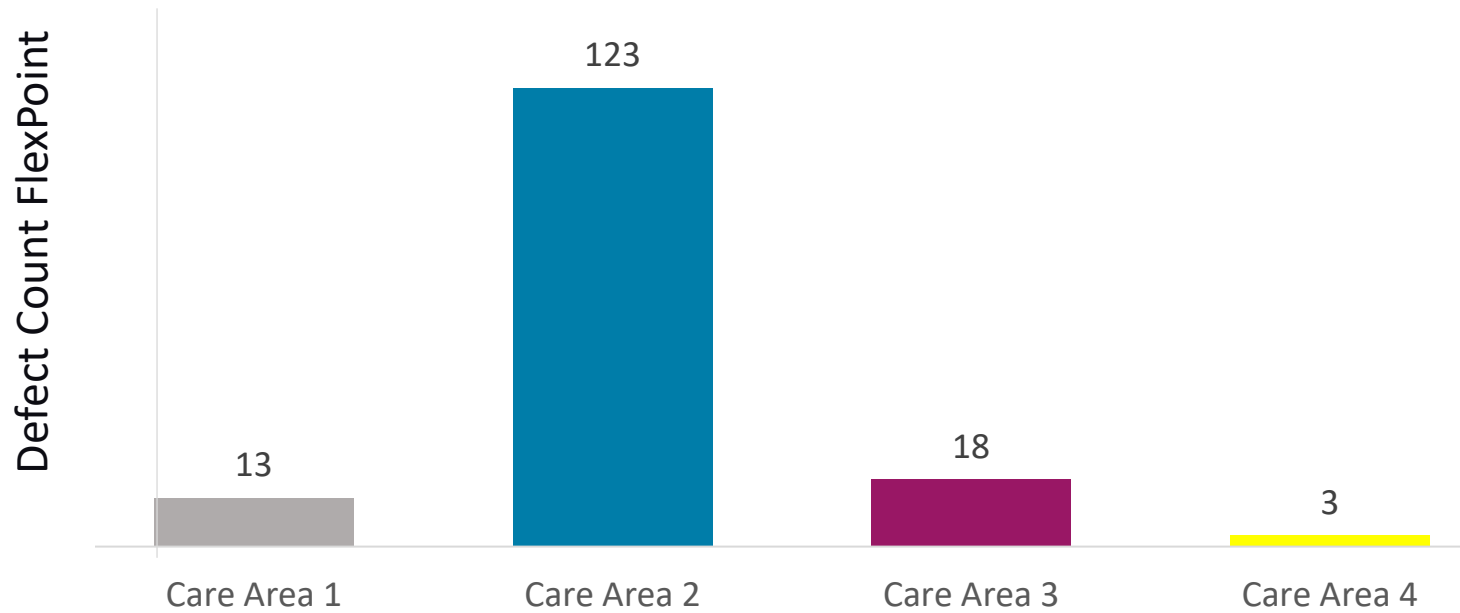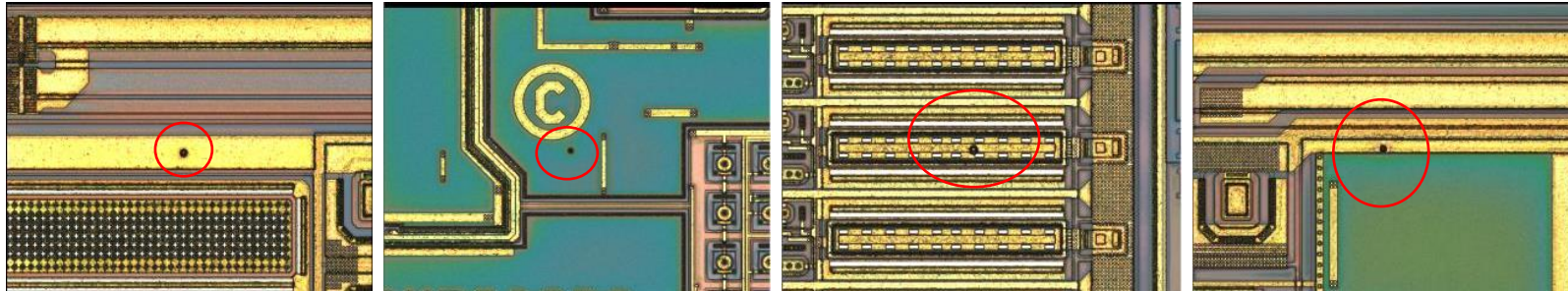
Care Area 1

Evaluation result Bosch Product D
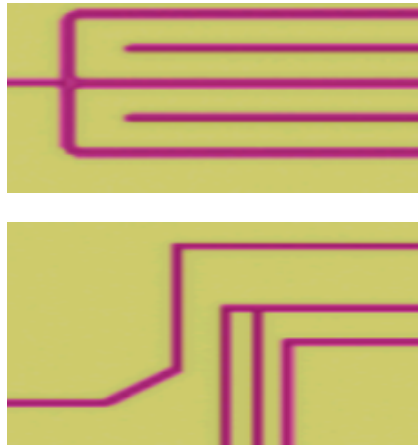
Evaluation Product D

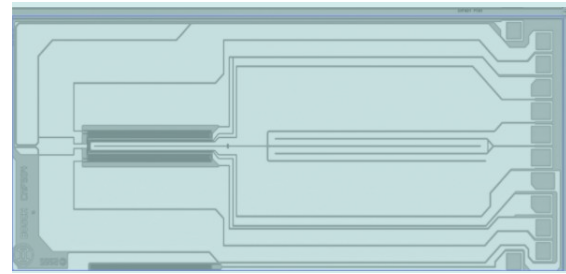## FlexPoint enables defects separation of background Vs pattern
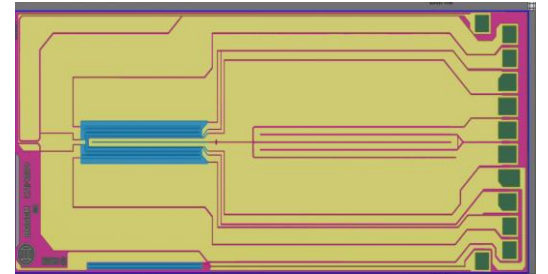
Product Design

Challenge

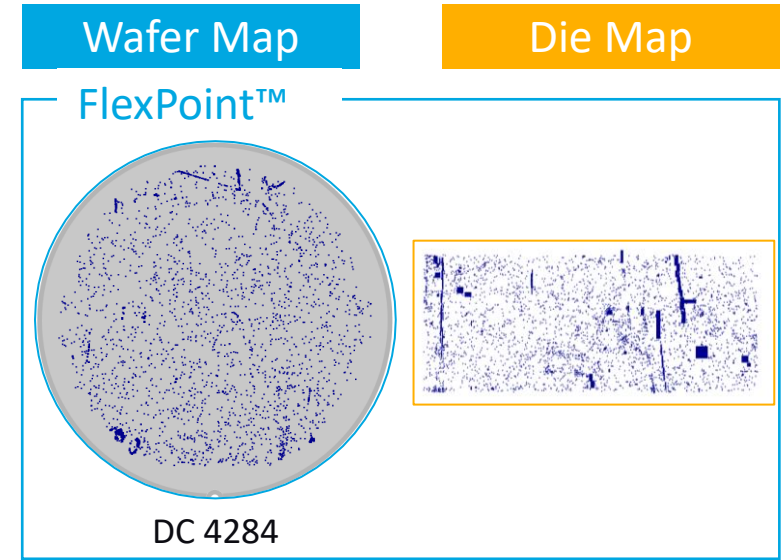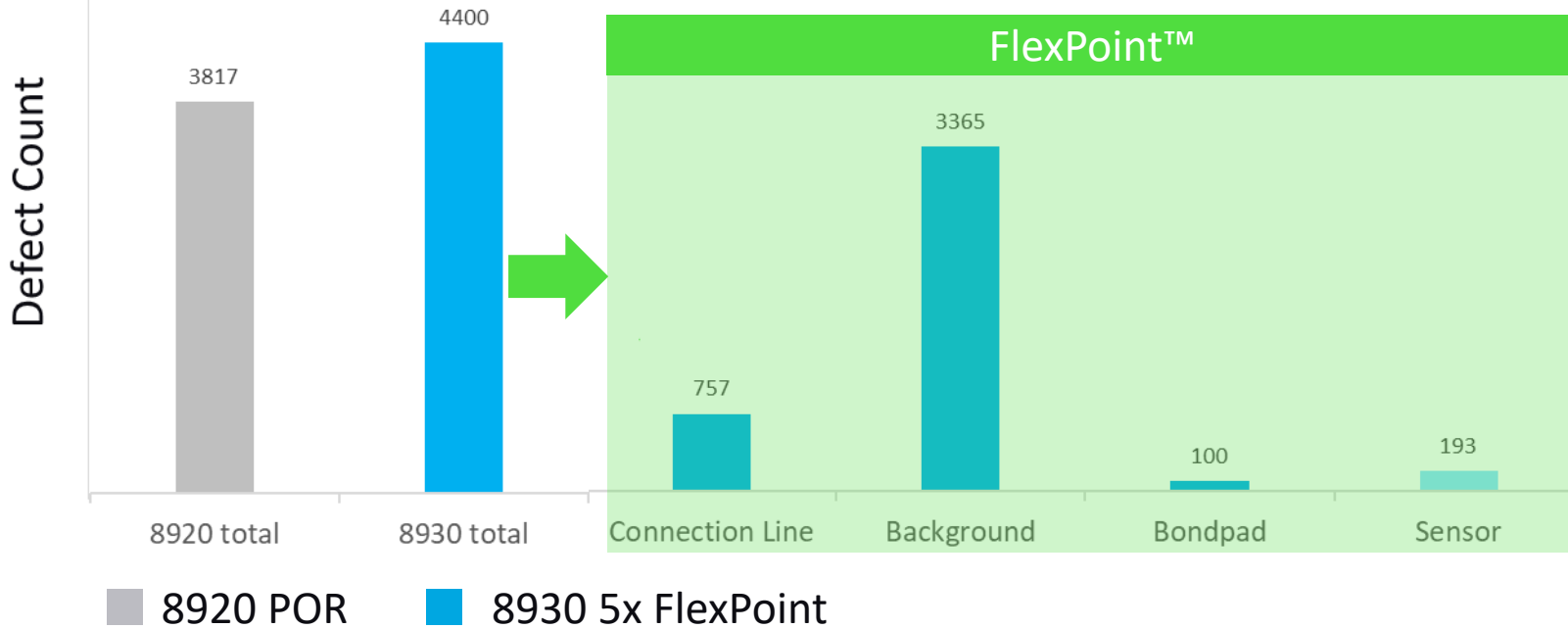**Small features ~10um**

Legacy Care Area

8930 FlexPoint

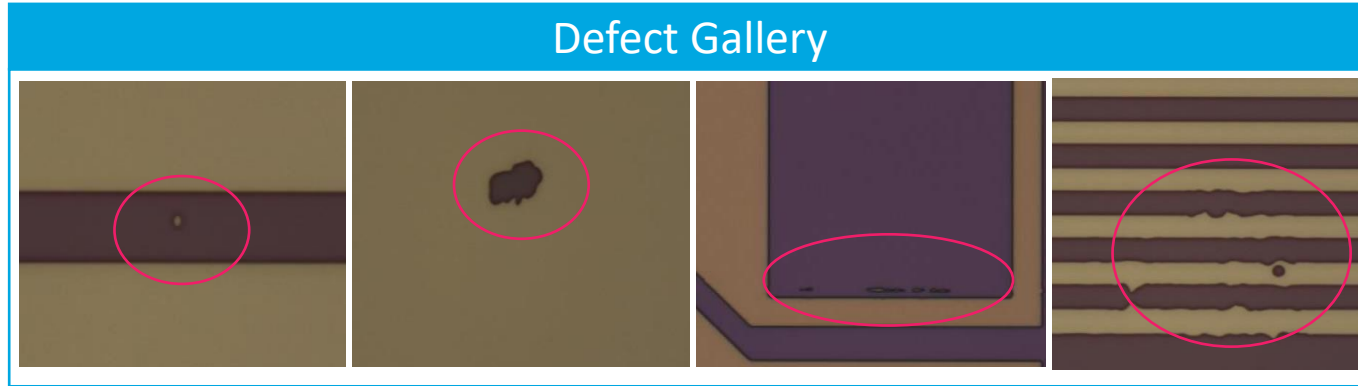# Evaluation Product D Legacy Vs FlexPoint

FlexPoint enables optimized sensitivity per region of interest due to accurate separation of Care Areas

Defect Gallery

Wafer Map

Die Map

FlexPoint™

DC 4284

FlexPoint™

Defect Count

3817 — 8920 total
4400 — 8930 total

757 — Connection Line
3365 — Background
100 — Bondpad
193 — Sensor

■ 8920 POR   ■ 8930 5x FlexPoint

Conclusion

8930 patterned wafer inspection system with FlexPoint™ successfully addresses all Bosch MEMS challenges
Single pixel precision and accuracy

Defect location	Irregular pattern	Care Area Accuracy	MEMS Size	Real / Nuisance

FlexPoint enables accurate defect location reporting

FlexPoint Care Areas can be applied to any irregular shaped pattern
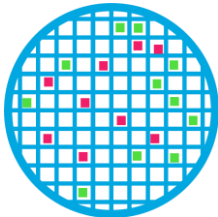
FlexPoint Care Areas are applied with high precision

FlexPoint PMA helps to inspect on MEMS devices with small features

FlexPoint increases sensitivity and reduces nuisance

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Thank You