Status of Sensors:

Sensors and bump-bonding

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- Status of sensor and bump-bonding
- Some observed issues
- Summary

Status

- Sensors:

  - 2 batches received from Sintef

	Batch-1	Batch-2	Sum
Nr. wafers* received	20	25	45
Nr. cut wafers	2	2	4
Nr. processed** wafers	14	0	14
Nr. remaining wafers	4	23	27

* 1 wafer → 2 sensors

** processed wafer → UBM, bump deposition (Dectris) & cut

- Bump-bonding:

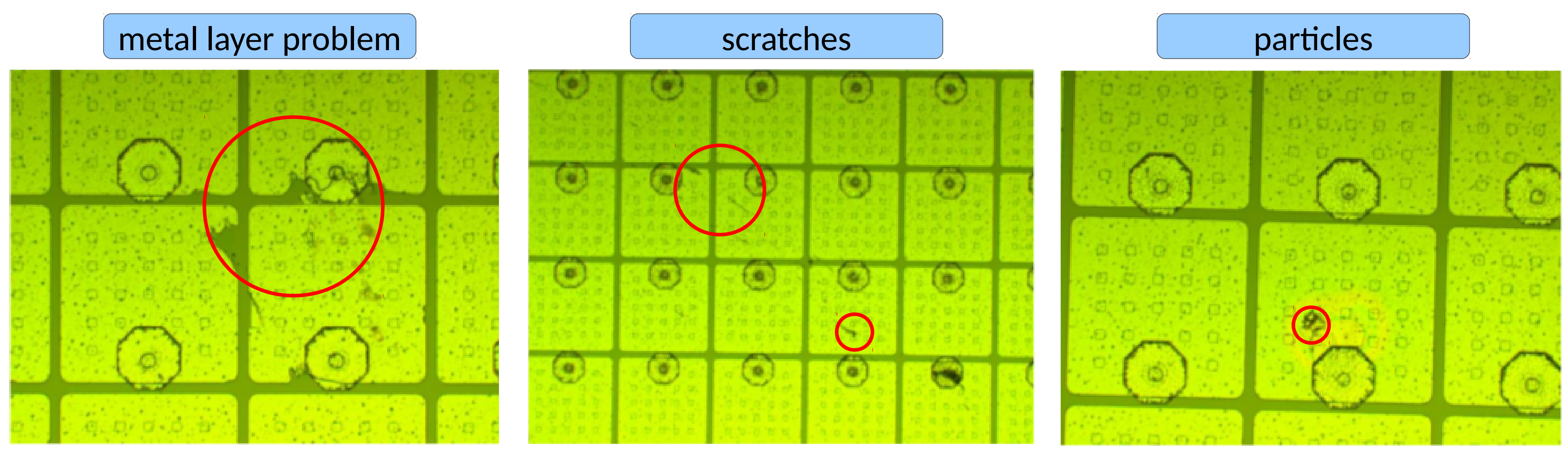
  - new bonding machine

  - effort made to make bonding properly

Some observed issues

- Issues observed in UBM & bump deposition processes (by Dectris):
  - metal adhesion
  - scratches
  - particles on/inside passivation

  } ► influence on imaging quality

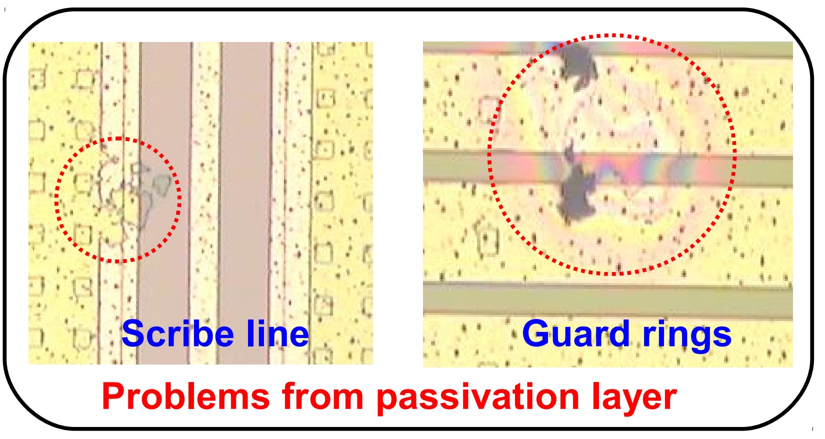


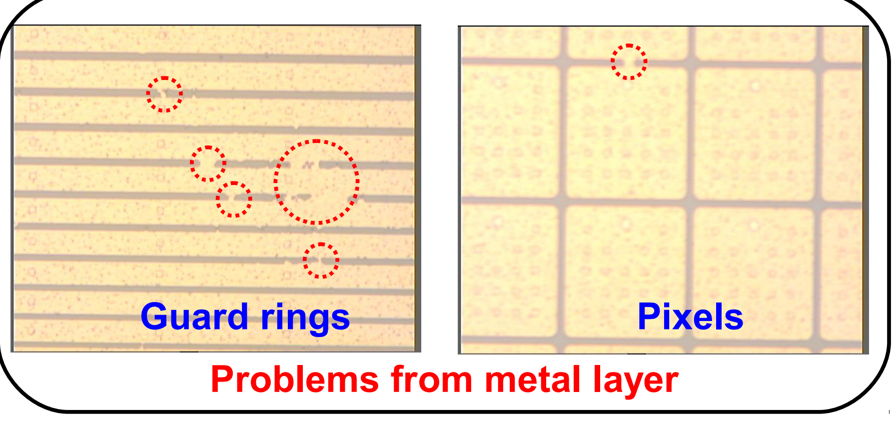
Similar observations through visual inspection at UHH!

Reminder: Visual inspection

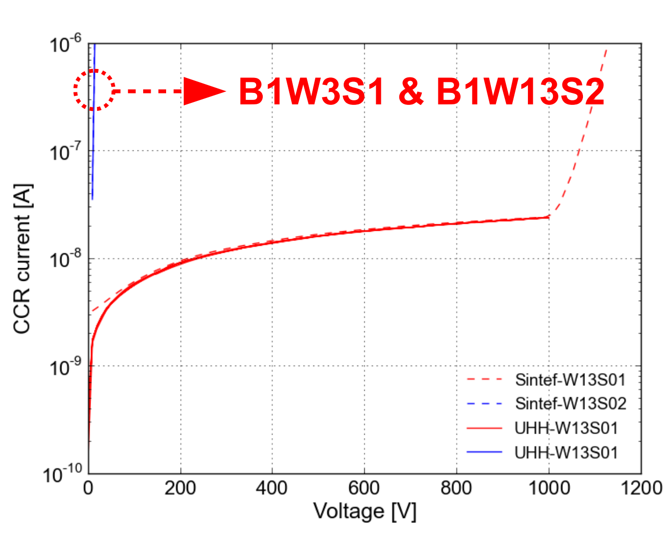
AGIPD

- Visual inspection for pixels and guard-ring structure of ~ 10 wafers
  - problems observed for passivation and metalisation





- Judged as bad sensor by Sintef from I-V measurement; actual problems observed through visual inspection at HH
- Information stored (12k images/sensor) → "trace back" in case problem



Metal adhesion:
- in GRs: early breakdown (2 sensors)
- in pixels: loss spatial resolution (2/65536 pixels)

Bad pixels

- Bad pixels (= sensor pixels + ASIC pixels + unbonded bumps)
  - flat-field image
  - dark-field corrected
  - ADC gain corrected

X-ray image of module with “contaminated” sensor

~ 0.6% bad pixels (estimate):

→ <0.1% from ASICs

→ ~0.2% from unbonded bumps:
 * 0.08% due to bonding
 * 0.12% due to size of indium ball

→ ~0.3% from sensor:
 * <0.2% hot pixel
 * others

Statistic of all pixels

normal pixels

dead pixels

double sized pixels

Occurance

ADC unit

“Trace back” sensor inspection:

→ metal adhesion: 1

→ scratch: 0

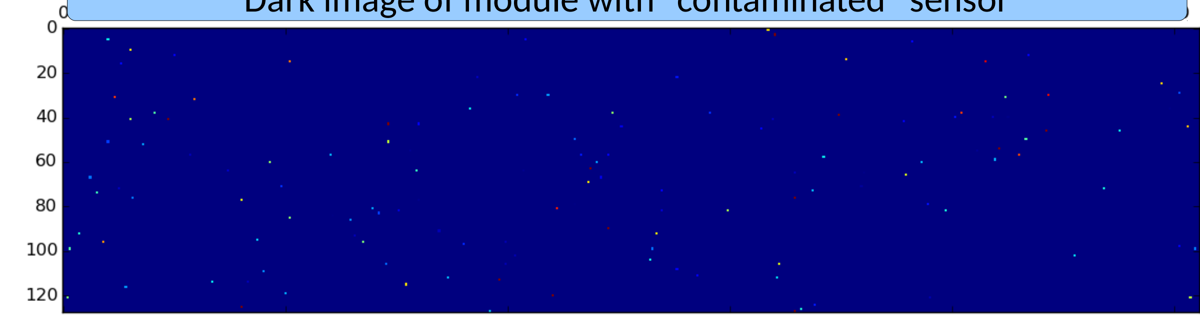
→ particles: ~ 604

“Contaminated” sensor (more sticky particles)! → check other modules!

Bad pixels

- Bad pixels (= sensor pixels + ASIC pixels + unbonded bumps)
  - flat-field image
  - dark-field corrected
  - ADC gain corrected

Dark image of module with "contaminated" sensor



~ 0.6% bad pixels (estimate):

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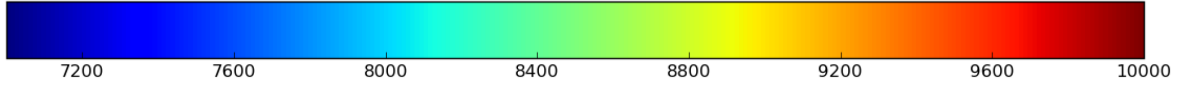
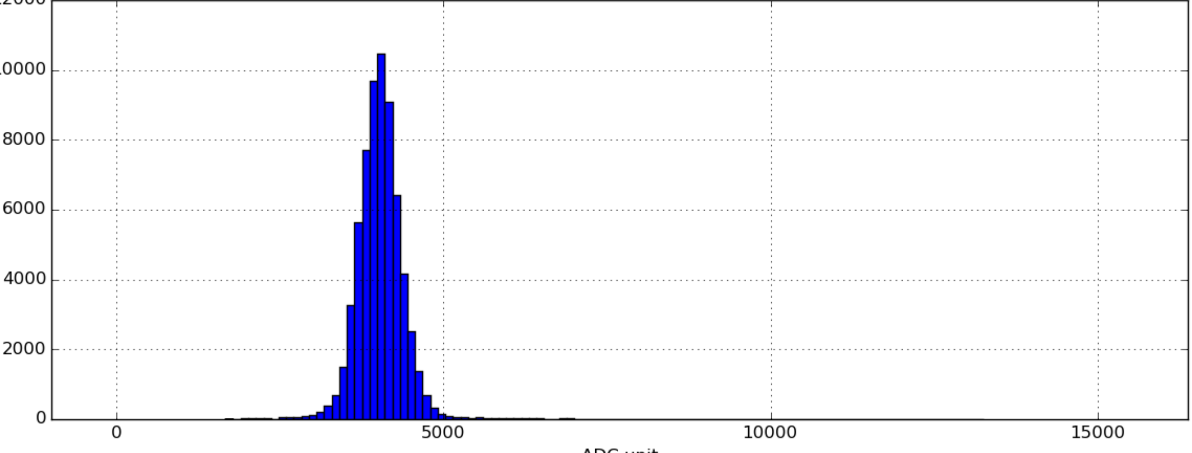


"Trace back" sensor inspection:

→ metal adhesion: 1
→ scratch: 0
→ particles: ~ 604



"Contaminated" sensor (more sticky particles)! → check other modules!

Summary

- **Issues observed for sensors (by Dectris & previously@UHH)**
- **Measurement for sensor after bump-bonding:**

  - bad pixel: ~ 0.6% for a "contaminated" sensor
    - ~ 0.4% non-working pixels
    - ~ 0.2% hot (noisy) pixels

Be aware: statistic is 1!

- **Following work and plan:**

  - check results for "non-contaminated" sensors
  - quick inspection on sensor before bump-bonding
  - optimize bump-bonding process and improve bonding yield
  - discuss the issue with sensor vendor

Sensor wafer (100 mm)

CMOS wafer (200 mm)

Aluminium

Passivation

(a) (i)

Resist spin–on and exposure

Spin coating (lift-off-resist) and printing of photoresist

Mask

Photo Resist

"LOR"

(b) (j)

Resist development

(c) (k)

Sputtered UBM

(d) (l)

Wet lift–off

(e)

Evaporated Indium

(f) (m)

Photoresist stripping and wet etching

Wet lift–off

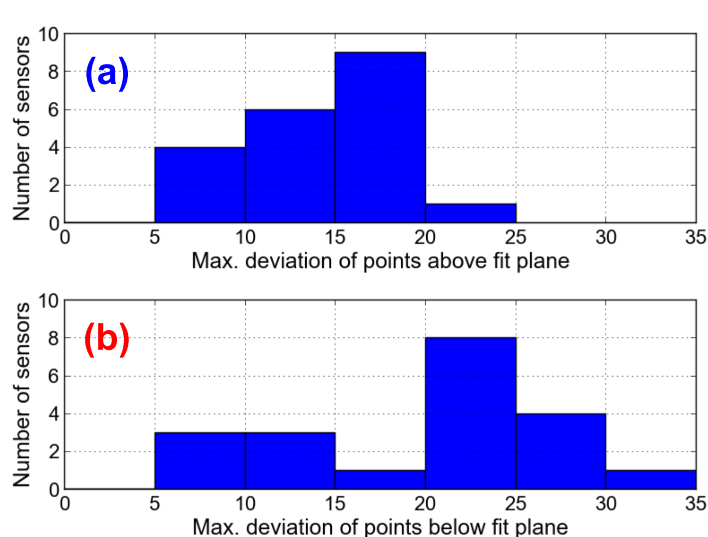
(g) (n)

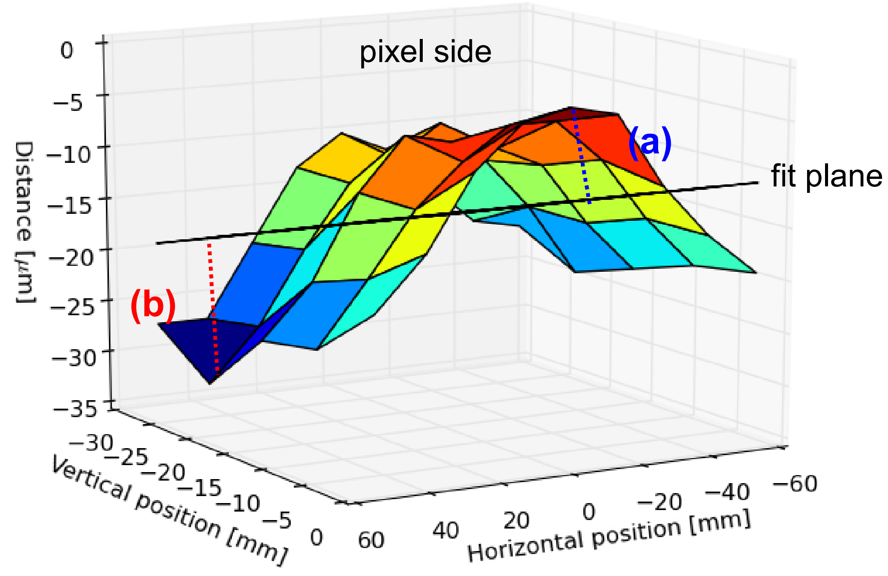
Reflow

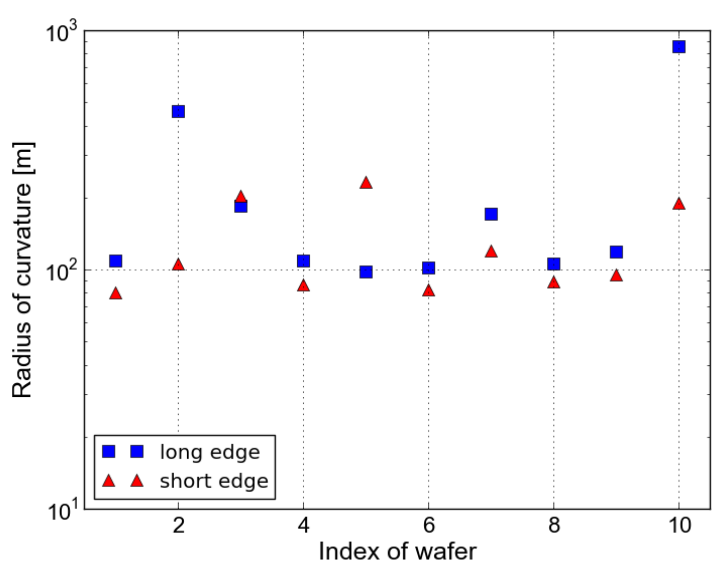
(h)

Sensor flatness

- Flatness measurement
  - fit to a plane for individual sensor:
  - radius of curvature: ~ 100 m
  - max. force on a bond pad (0.01 – 0.1 mN)
    (bonding force: , de-bonding:)







Electric field

Pixel_des_des

ElectrostaticPotential (V)

1.500e+01
1.250e+01
1.000e+01
7.500e+00
5.000e+00
2.500e+00
0.000e+00

Bonded pixel

Unbonded pixel

Y

-5
0
5

90
100
110

X

Weighting potential

2D simulation

Bonded pixel **Unbonded pixel** **Bonded pixel**