Status of the AGIPD sensors

- Sintef delivery: 2 batches (Feb. + Nov. 2013)

	Batch-1	Batch-2	Sum
Nr. wafers received	20	25	45
Nr. cut wafers	2	2	4
Nr. wafers to PSI	14	11	25
Nr. remaining wafers	1+3	12	16

1 wafer → 2 sensors

4 deliveries to PSI: 1 + 4 + 9 + 11 (25 wafers in total)

Understanding on previous problems

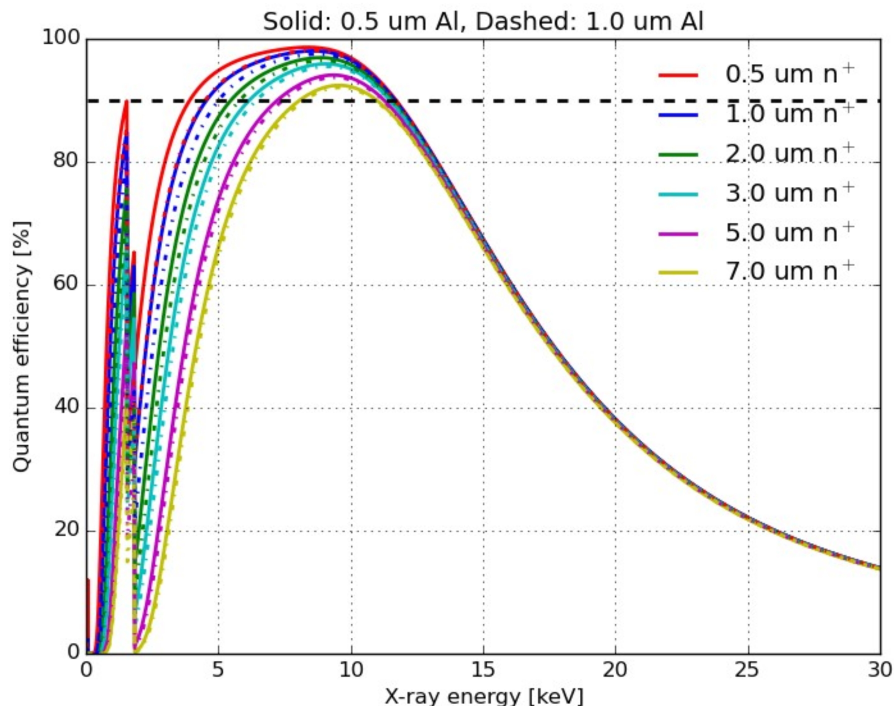
- Observed problems and proposed solution by Sintef:

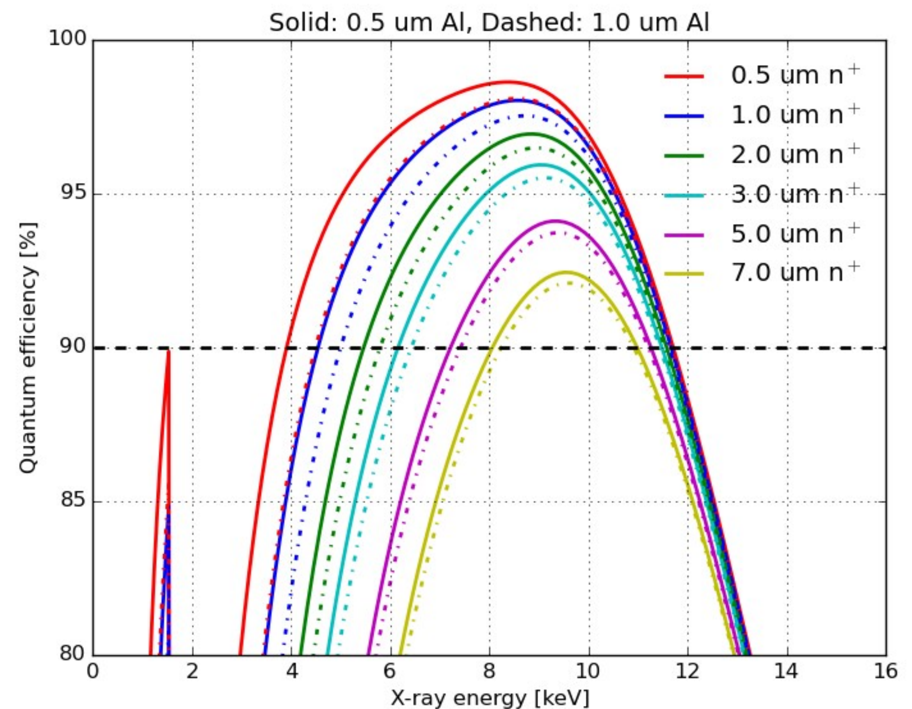
  - Dirty surface (C, O, Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, Cr, As) ← ozone + Di water

  - Metal conjunction and displacement ← minor event

  - Particles in metalisation ← detailed inspection + redo metalisation

  - Hot pixels ← in-house diffusion instead of implantation



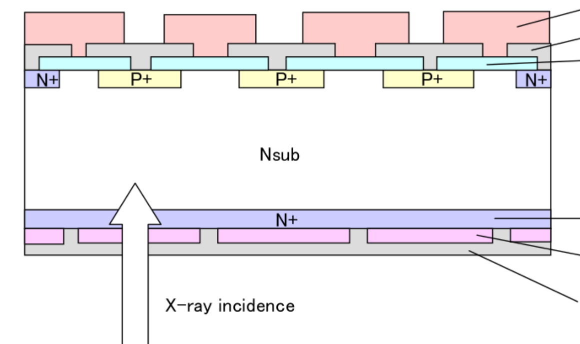


Sintef vs. Hamamatsu (An alternative)

- A comparison regarding to AGIPD tech. requirements

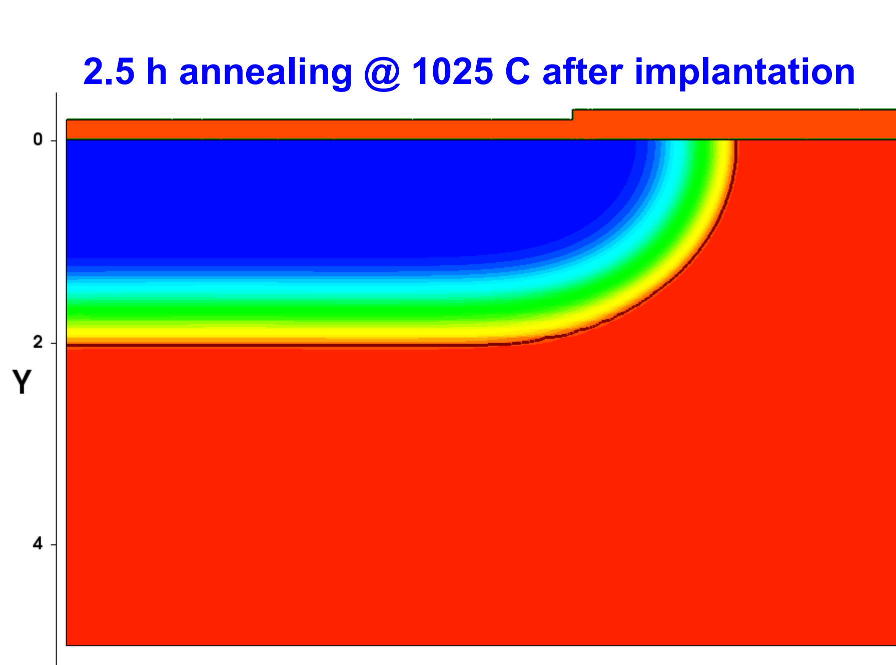
Key parameters	Sintef	Hamamatsu	Comment
Oxide thickness	250 nm	250 nm*	* Adaptable from 700 nm down
Pixel implant profile	2.4 um	2 um**	** Breakdown requirement
Entrance window	Implant 2 um Diffuse 5-6 um	1 um	QE

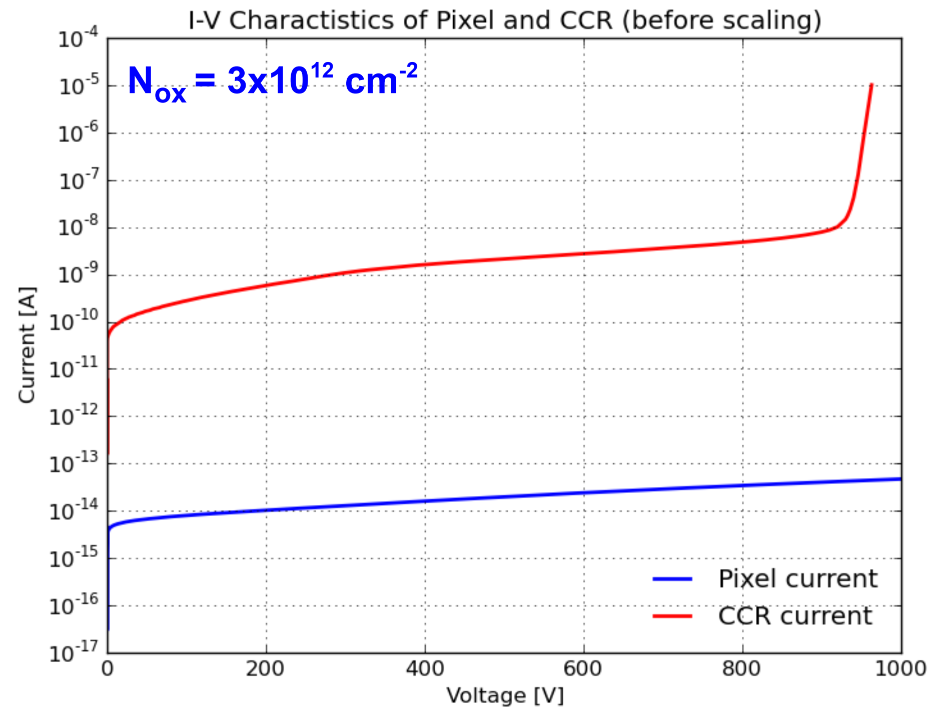
- Both Hamamatsu and Sintef can achieve AGIPD requirements.



Sintef vs. Hamamatsu (An alternative)

- Breakdown with 2 um pixel implant profile

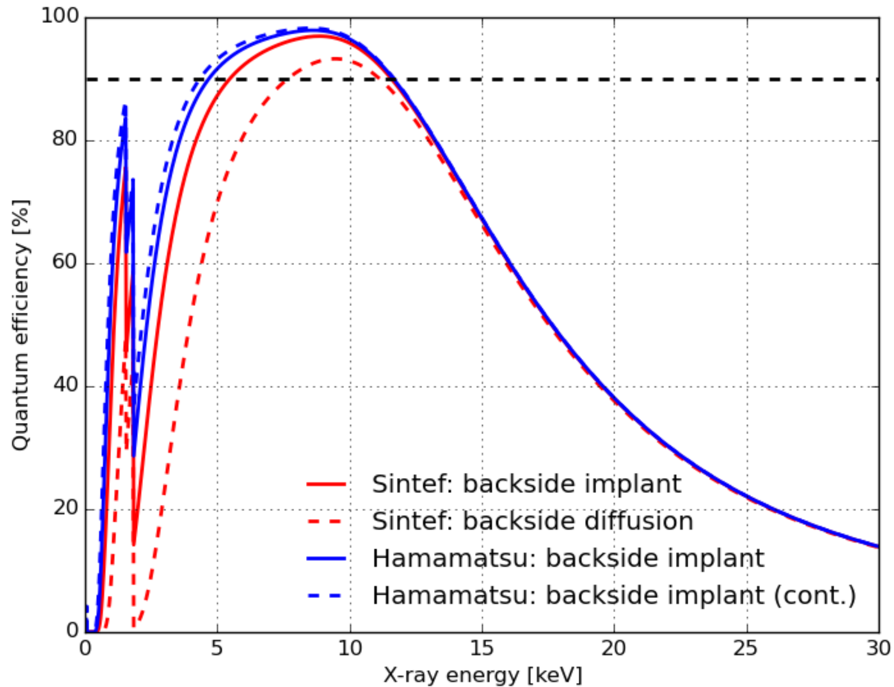


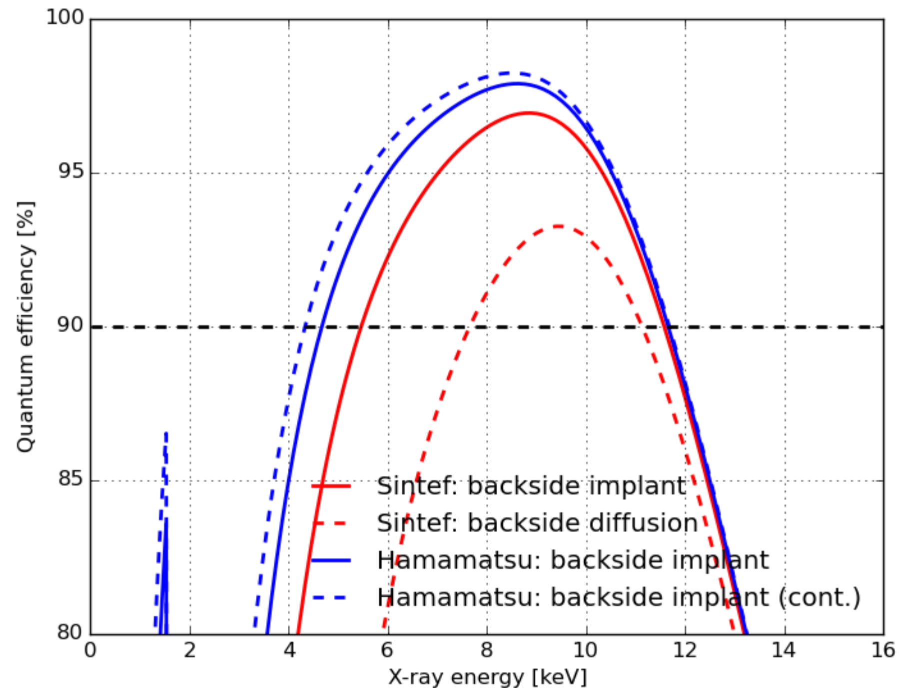


- No breakdown for pixel and CCR up to 900 V with Hamamatsu para.

Sintef vs. Hamamatsu (An alternative)

- Quantum efficiency





- To achieve a good QE for low-E, backside implantation is essential

Specifications

Parameter	Value	Comment
dimensions	$107{,}600\ \mu m \times 28{,}000\ \mu m$	$+50\ \mu m$ for dicing line
mechanical thickness	$500 \pm 10\ \mu m$	quantum effeciency (QE)
flatness (wafer level)	$< 30\ \mu m$	maximal deviation from a fit plane
distance last pixel to cut edge	$1200\ \mu m$	dead space of large area tiled detector
n-doping/resistivity	3-8 kΩ·cm	depletion voltage, side depletion
entrance window n^+-side	$< 0.5\ \mu m$ Al $< 2.0\ \mu m\ n^+$-implant	minimize but no influence on V_{bd}
doping non-uniformity	< 10%	distortion of electric field and non-consistent charge collection
pixel dimensions	$200\ \mu m \times 200\ \mu m$	Medipix-compatible
polarity	$p^+ - n$	hole collection
coupling	DC	
nominal operating voltage	500 V	
max. particle inside metalisation	$< 5\ \mu m$	bump-bonding & surface roughness
max. particle above passivation	$< 5\ \mu m$	bump-bonding
dead pixels	< 0.1%	hot pixel + cold pixel
dead pixel clusters	< 3 clusters	
max. number pixels in cluster	< 5 pixels	
max. number short pixels	< 3 pairs	metal sputtering problem
electrical properties at 20 °C in humidity RH < 50%, 0-1 GGy X-ray dose		
breakdown voltage, V_{bd}	> 900 V	after X-ray irradiation to 10 MGy 1000 V expected without irradiation
interpixe capacitance, C_{int}	< 200 fF	noise, ENC(e^- r.m.s.) < 80
total sensor leakage@500V	$50\ \mu A$	power consumption
max. leakage/pixel@500V	50 nA	pixel noise
max. leakage CCR@500V	$20\ \mu A$	
electrical properties at 20 °C in humidity RH < 50%, without irradiation		
total sensor leakage@500V	200 nA	quality Si-wafer
max. leakage/pixel@500V	20 nA	quality Si-wafer
max. leakage CCR@500V	200 nA	quality Si-wafer

New added

Summary

- Sintef actively reacting and proposing solutions

  - Backside diffusion to form n+

  - Visual inspection after metalisation

  - Surface cleaning

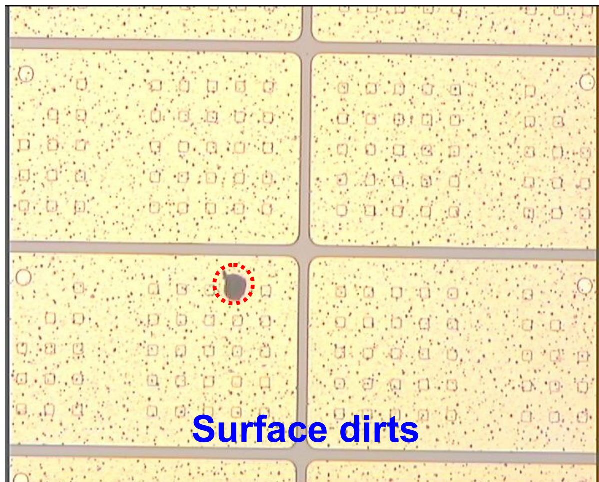
- Hamamatsu can be an alternative, but sth. still to be understood:

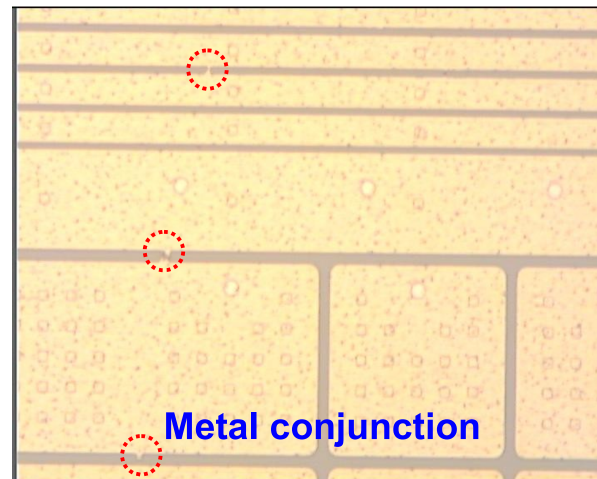
  - Influence of thin entrance window on breakdown

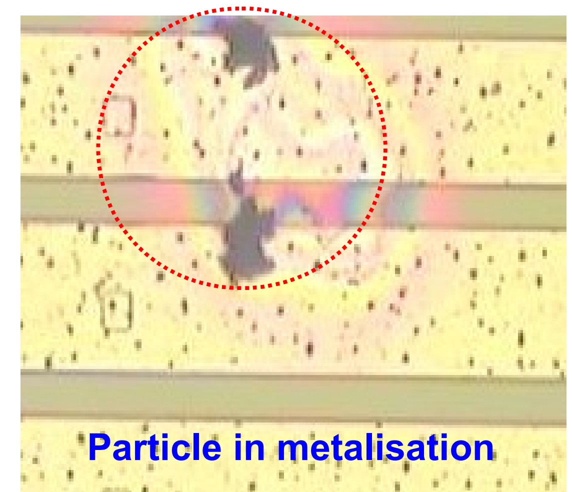
  - How backside vias arranged in a way results in homogen. QE

Previous problems

- Problems from Batch-1:
  - Dirty surface (surface particles ~ hundreds)
  - Metal conjunction and displacement
  - Particles in metalisation
  - Hot pixels







Visual inspection Batch-1 at Sintef

- Wafer-16 of Batch-1

  - Enormous surface particles: a few hundreds

  - Particle analysis: O, C, Mg, Cl, Ar … (Sintef lab & external contamination)

  - Clean method:

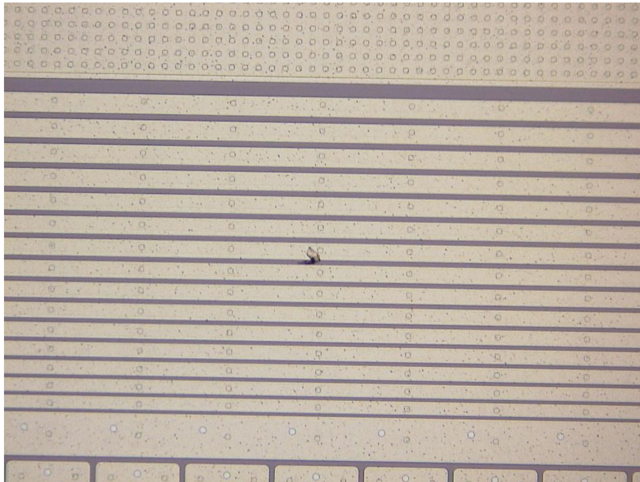
- Comment: Not a problem for bump-bonding but rather the particle in metalisation

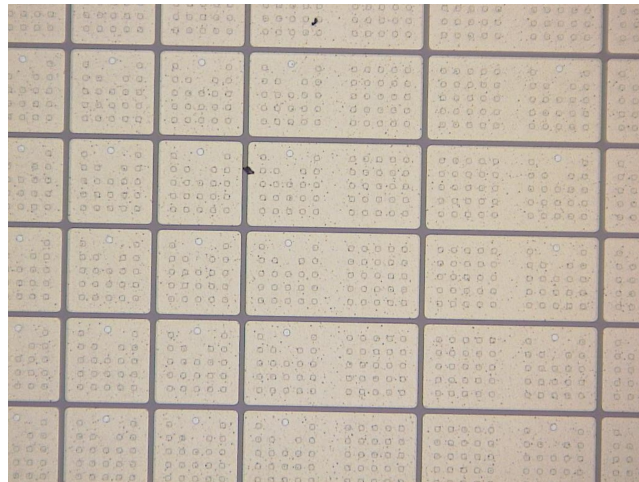
Visual inspection Batch-2 at HH

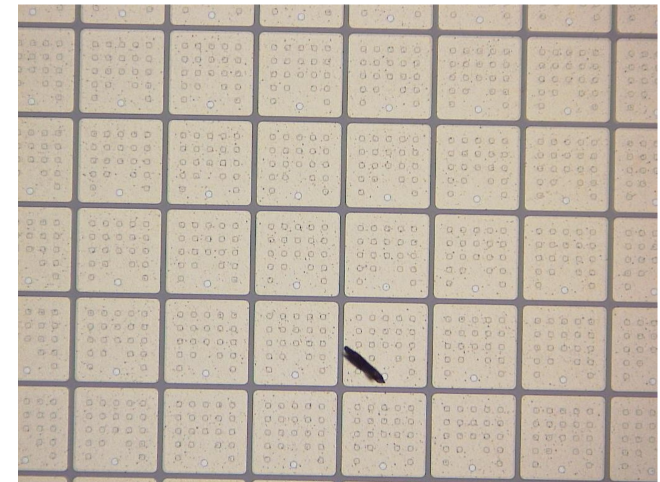
- Inspection of sensors from Batch-2

  - Surface particles: ~ 50-60 per sensor area (10 time less than Batch-1)

  - Tiny pieces: ~ 10-20 um for most of them; 100 um for very little







- Comment: Much better than Batch-1

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- A comparison regarding to AGIPD tech. requirements

Key parameters	Sintef	Hamamatsu	Comment
Oxide thickness	250 nm	250 nm*	* Adaptable from 700 nm down
Pixel implant profile	2.4 um	2 um**	** Breakdown simulation has to be done with 2 um
Entrance window	Implant 2 um Diffuse 6 um	1 um	QE

- Both Hamamatsu and Sintef can achieve AGIPD requirements.