



How can Track Hardware Boost Lithographic Performance?

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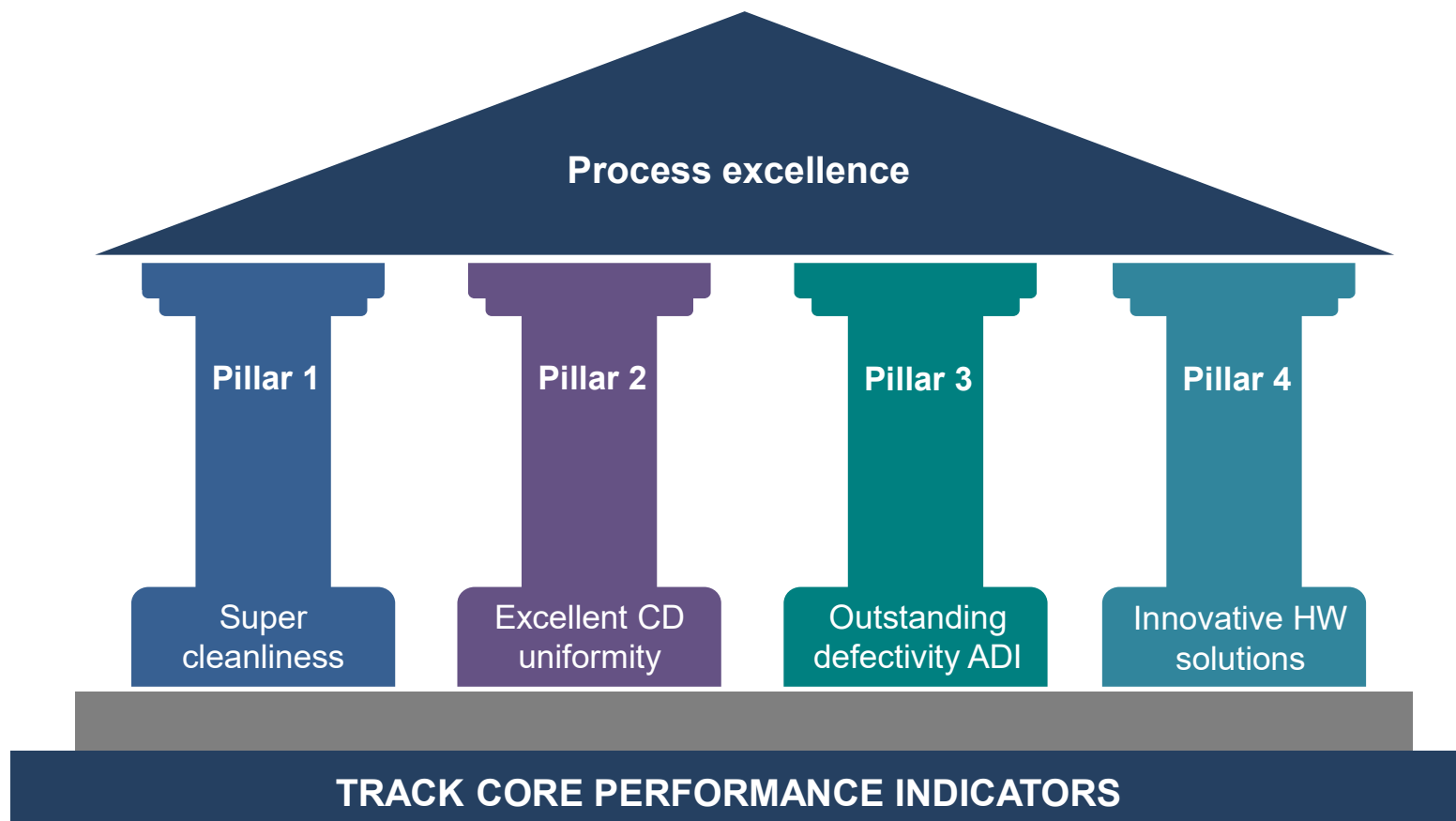
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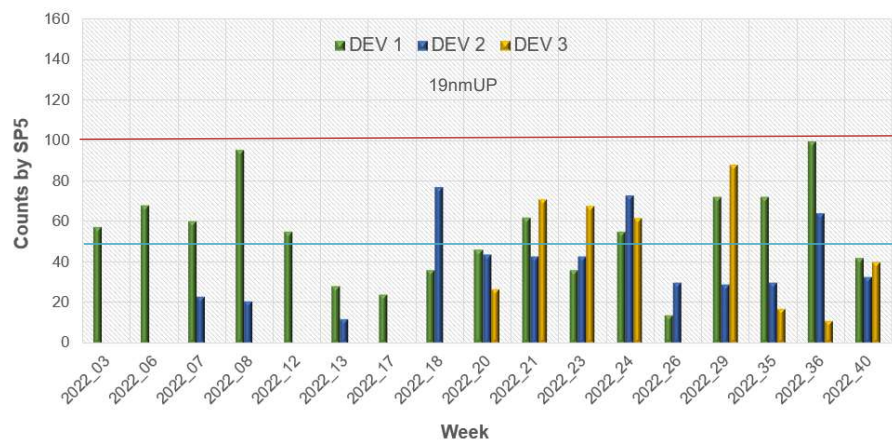
The 4 pillars for excellent track performance



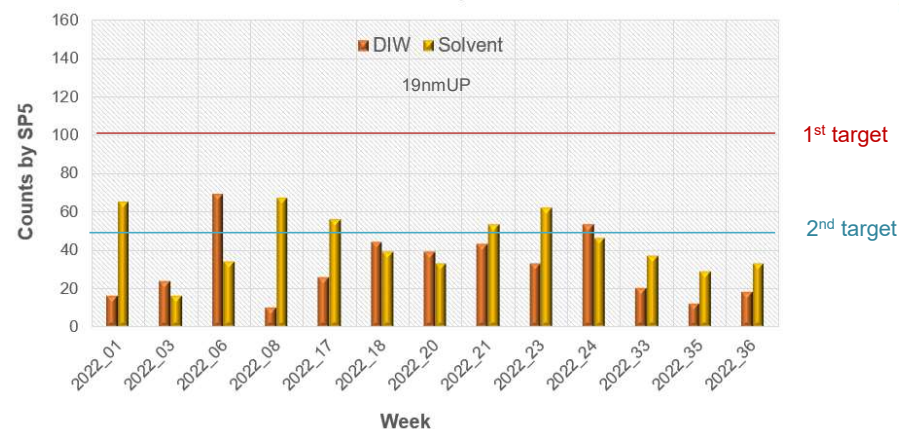
SCREEN track thrives for excellent stability, cleanliness and performance

PILLAR 1: Super cleanliness

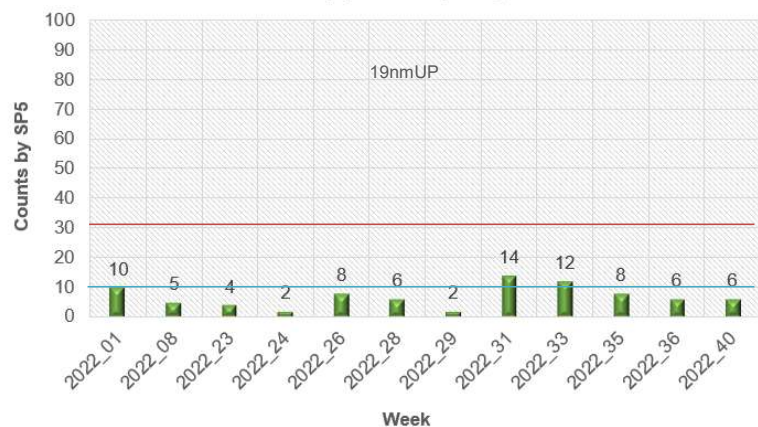
Developer dispense wet particle



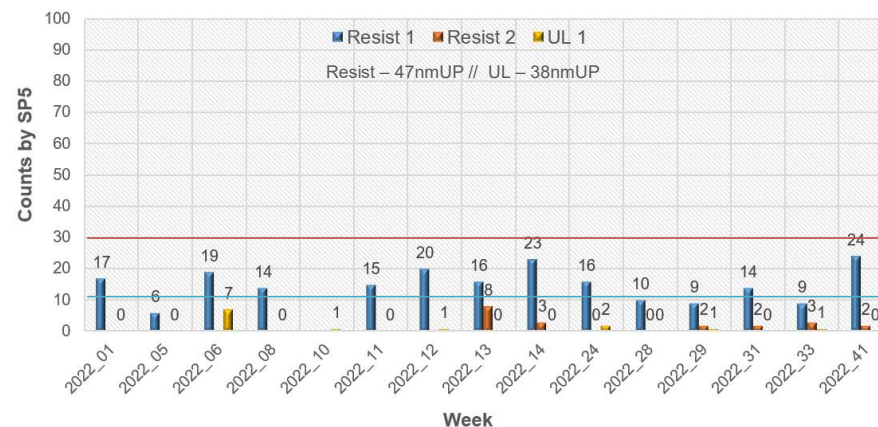
DIW and Solvent wet particles



Dry particle cycling



In-film defects



Excellent particle performance demonstrated

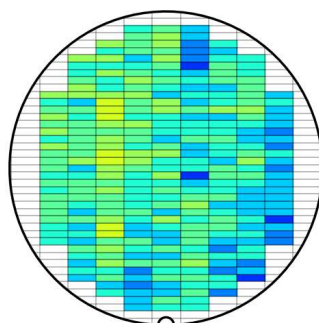
PILLAR 2: Excellent CD uniformity

SCREEN

CAR NTD 14L28P

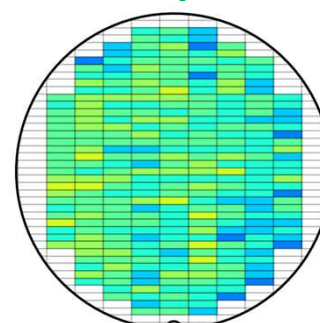
Film: SOG 11nm/CAR 35nm
Illumi.: NA 0.33/ $\sigma_{in} = 0.595$ / $\sigma_{out} = 0.817$
Reticle: TAPES3
Meas.: Hitachi 6300

Starting point

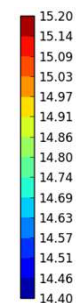


CD = 14.73nm
CDU = 0.20nm

After development
process optimization



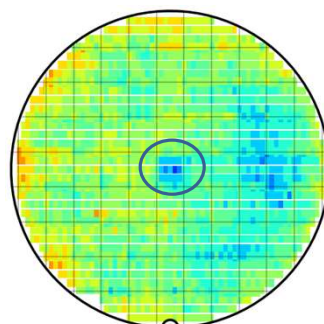
CD = 14.73nm
CDU = 0.17nm



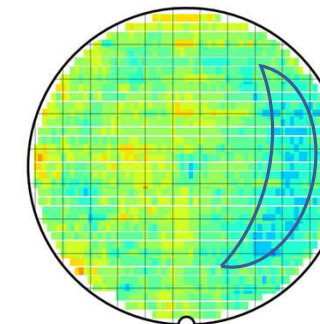
Excellent CD uniformity
across the wafer!

CAR PTD 22L40P

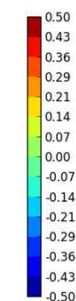
Film: SOG 10nm/CAR 35nm
Illumi.: Conv. NA 0.33/ $\sigma = 0.922$
Reticle: NXE3400MONR02A
Meas.: Yieldstar



CD = 19.9nm
CDU = 0.26 ± 0.02nm

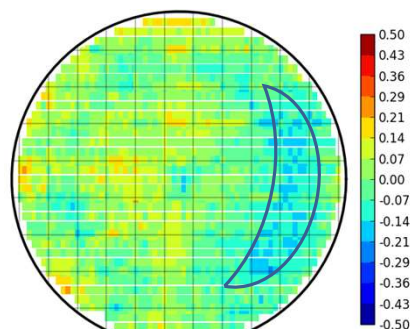


CD = 19.9nm
CDU = 0.24 ± 0.01nm



Half-moon shape signature
cannot be attenuated → **not
generated during track
process**

How to correct non-related systematic signatures?



Center spot successfully attenuated!

How can we push CDU further if half-moon shape signature is not coming from a track process?



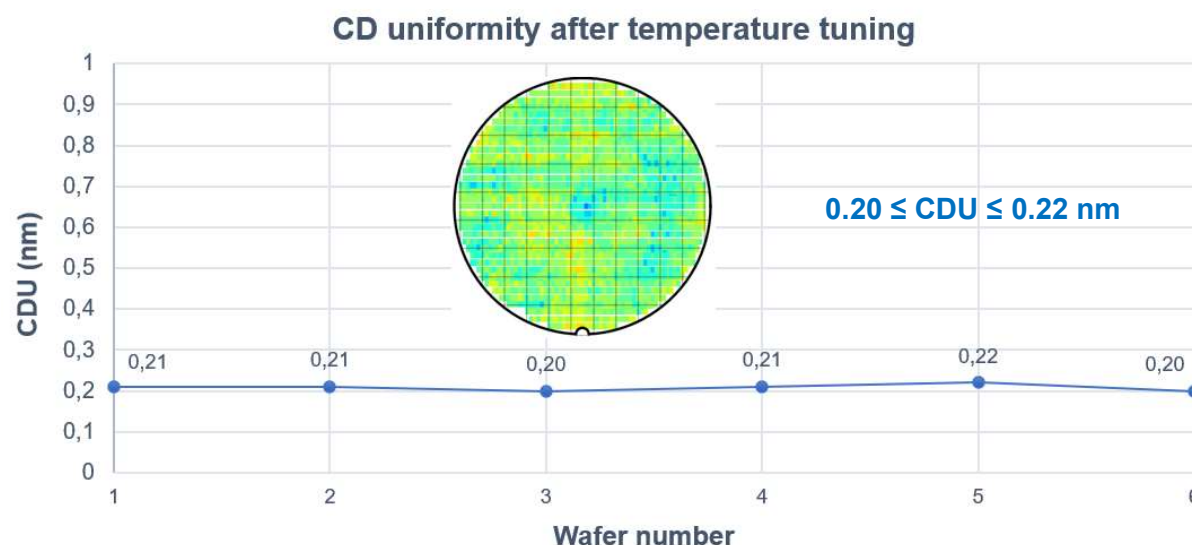
Half-moon signature corresponds to an area where the CD is slightly lower

What if we could decrease the PEB temperature on this area of the wafer to compensate CD?

PEB plate = PVQBH
(Vacuum Quick Bias Hotplate)



High precision bake with multi-zones that allow independent temperature tuning!

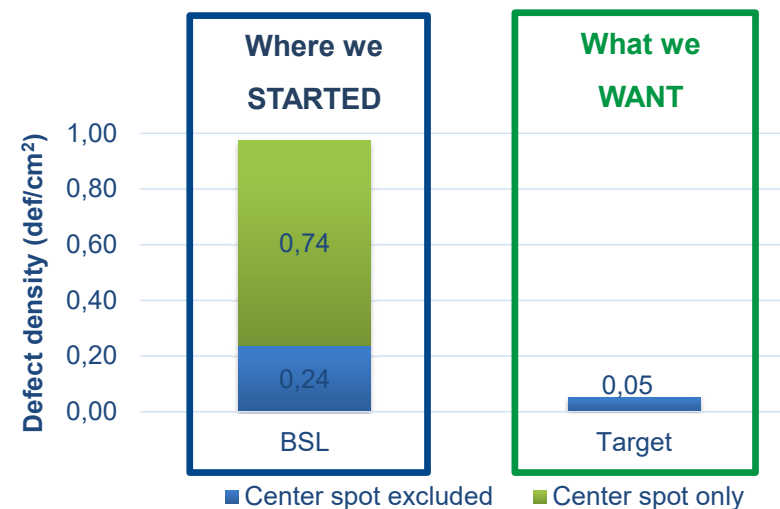
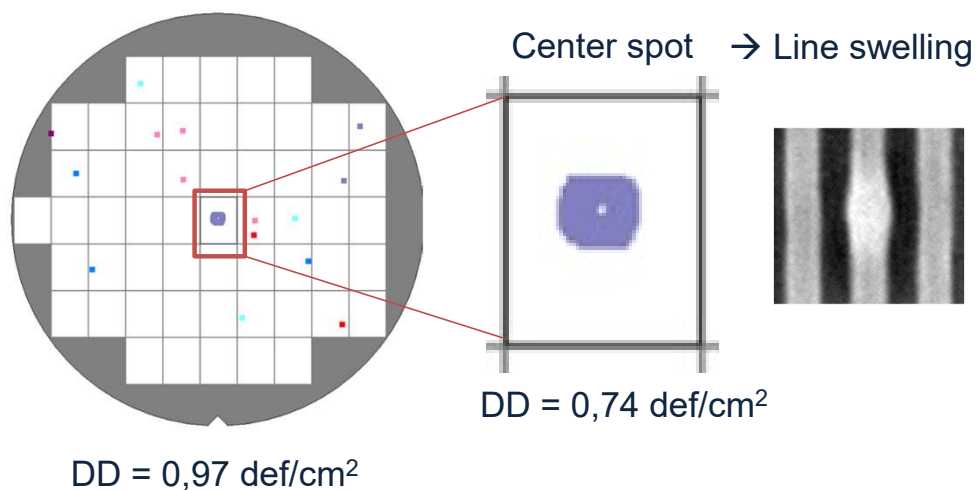


CD uniformity improved and non-track signature could be attenuated!

PILLAR 3: Outstanding patterned defectivity after development

ADI is key parameter to control track defectivity performance

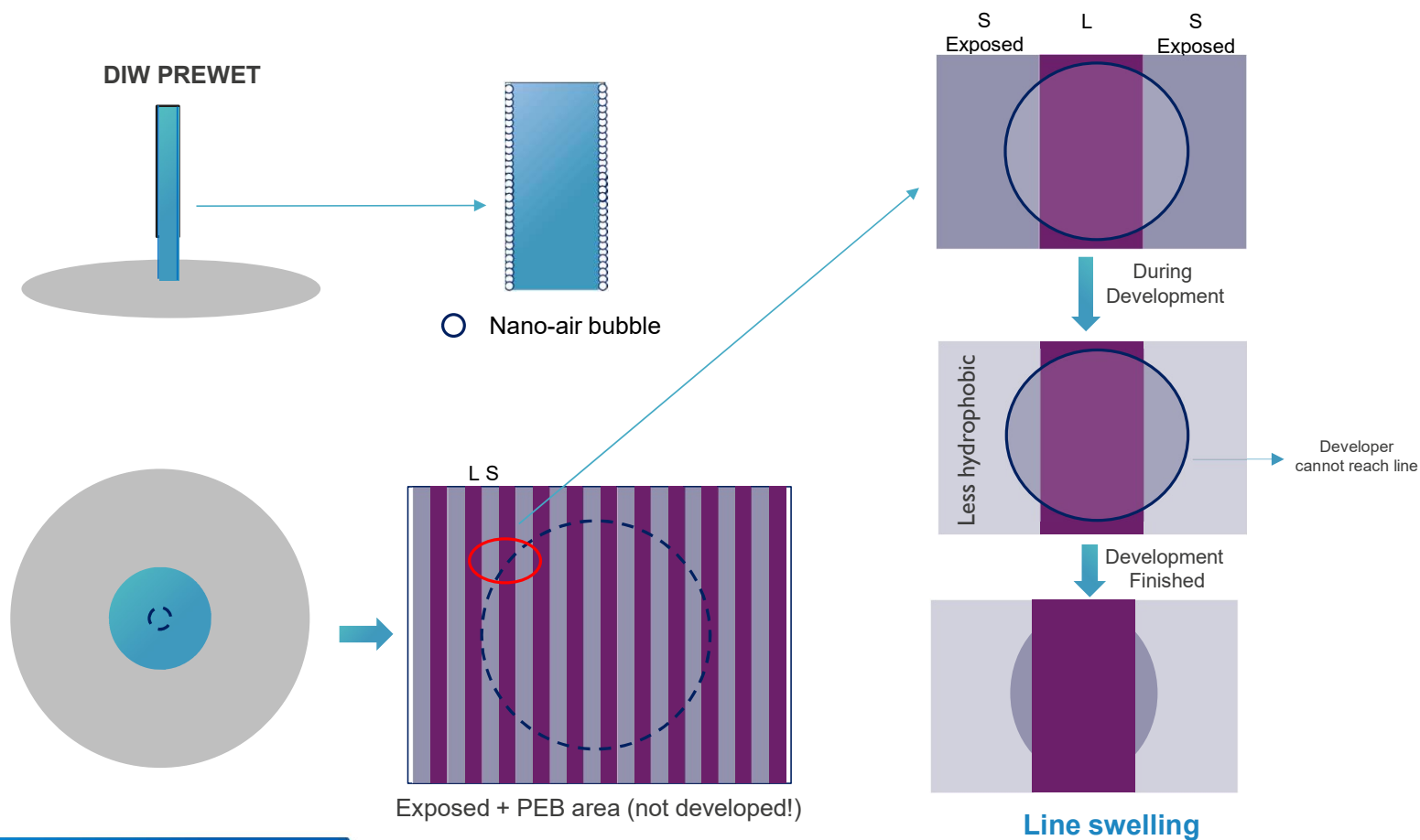
PTD CAR / 32L64P



- ✓ Focus on center spot mitigation/attenuation
- ✓ Line swelling caused during development

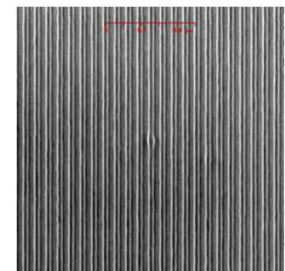
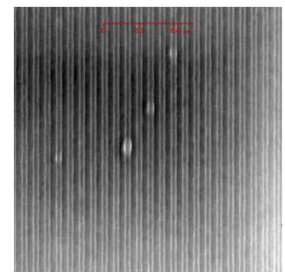
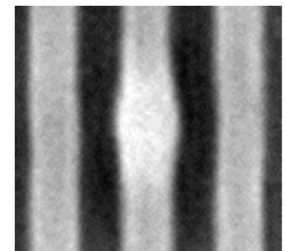
Where is the line swelling coming from?

- ◆ The ring diameter is matching DIW pre-wet nozzle size



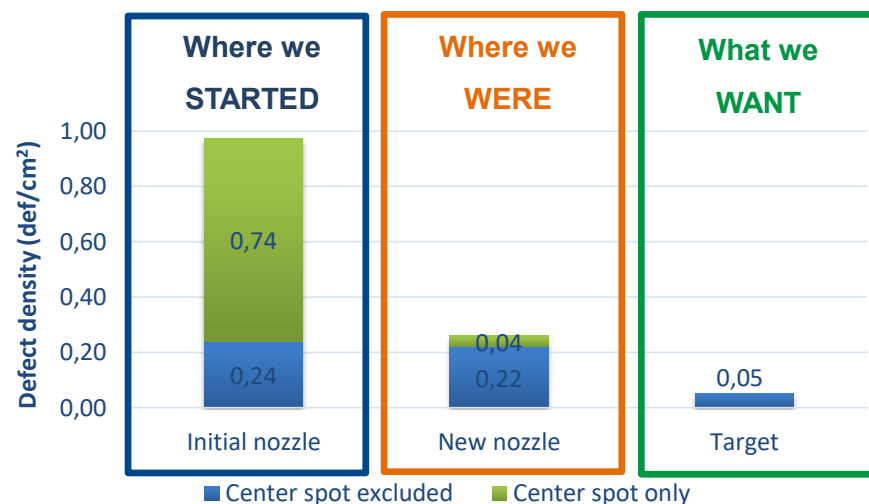
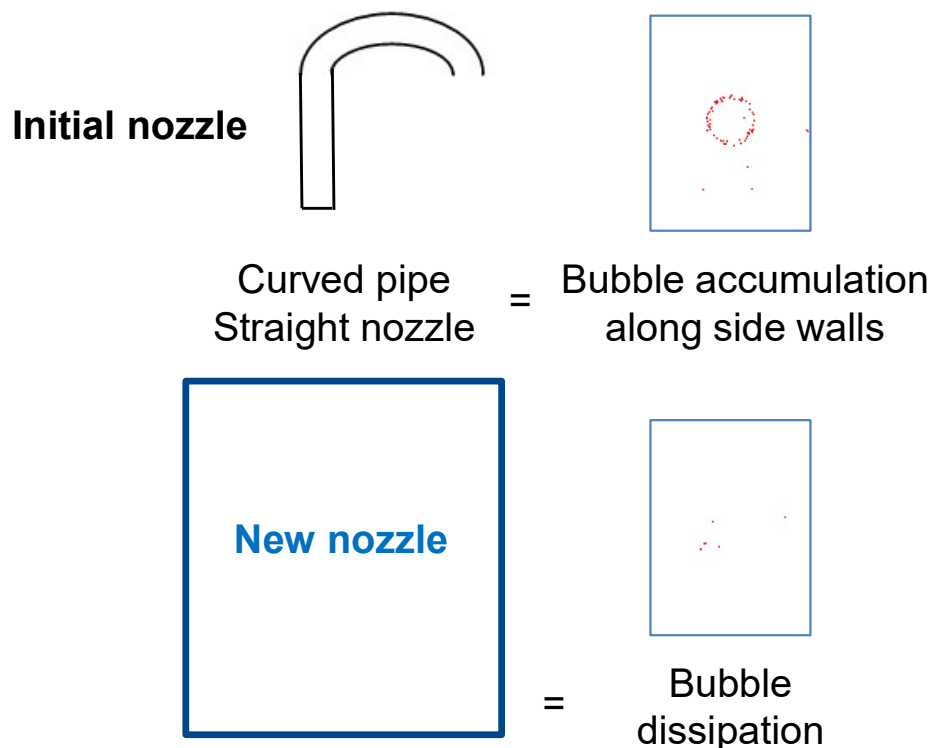
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Line swelling



How to mitigate nano-bubbles?

- ◆ Nozzle design is the key!

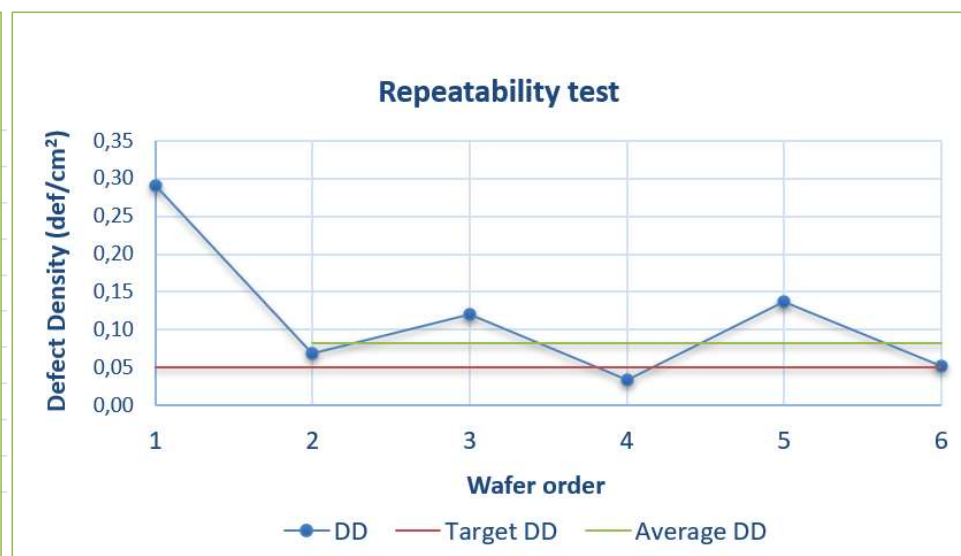
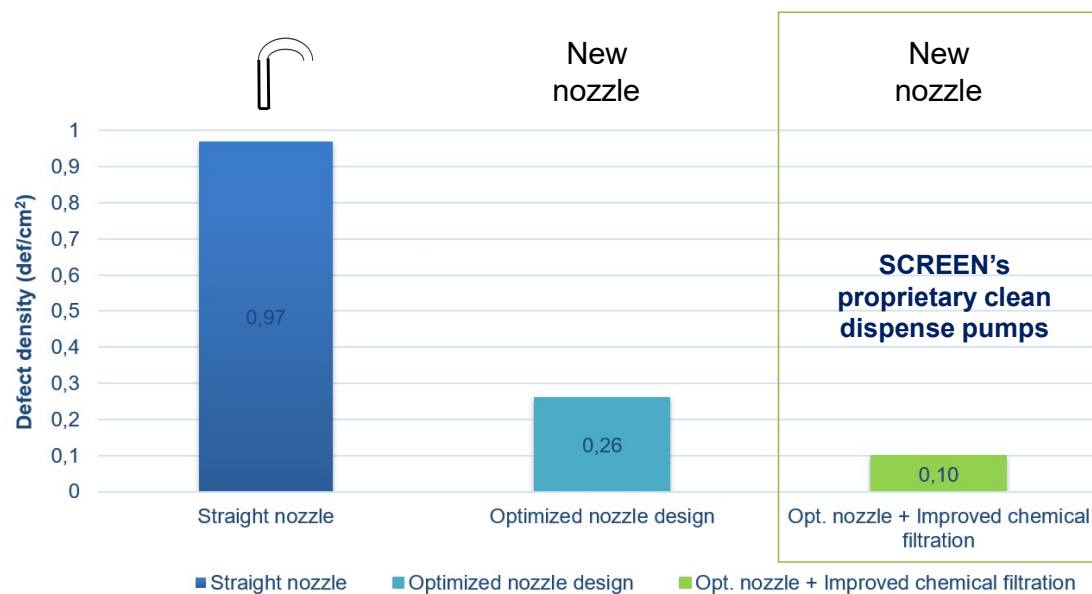


- ✓ Nano-bubbles could be drastically reduced through nozzle design
- ✓ Next step: tackle underlayer defects

70% of defect improvement achieved through the optimization of nozzle design

Working towards reducing underlayer defects

Impact of advanced filtration on material performance

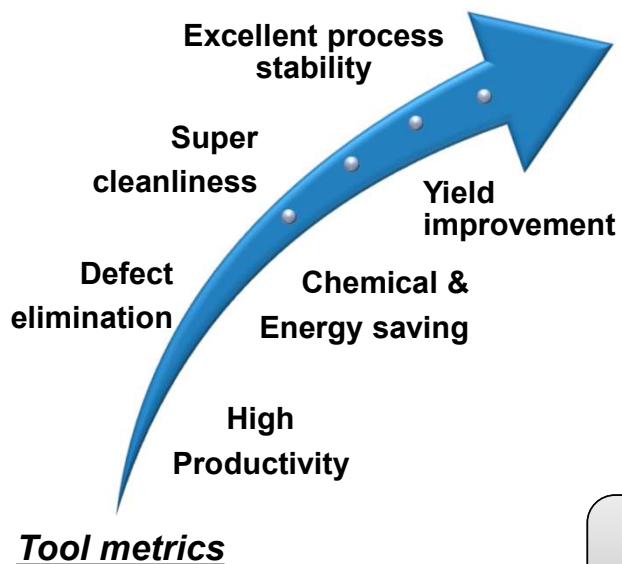


90% defect improvement ADI achieved via nozzle design optimization and exploring all the advanced filtration capabilities of SCREEN ACD proprietary pump

Defect density < 0,05 def/cm² can be achieved!

PILLAR 4: Innovative hardware solutions

TRADITIONALLY



DT-3000 track

**SCREEN provides custom solutions
for different chemistries**

PRESENT

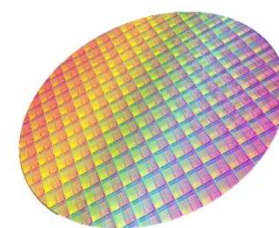
Extended
developer
temperature

UV treatment

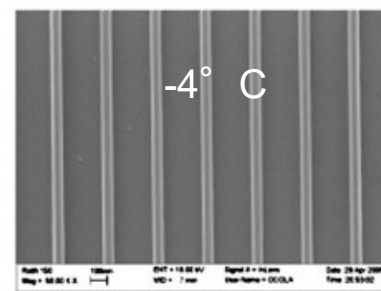
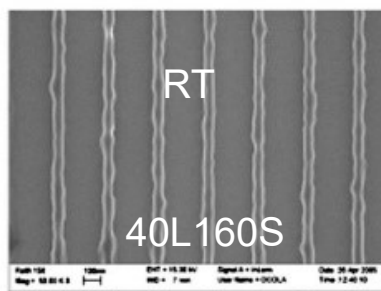
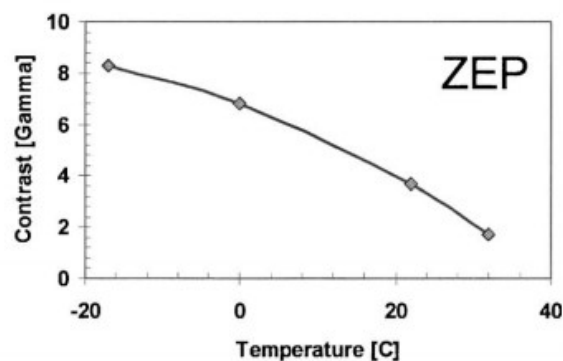
Bake atmosphere
control

Solvent vapor
annealing

**Enablement of
different chemistries**



Impact of developer temperature on lithography performance

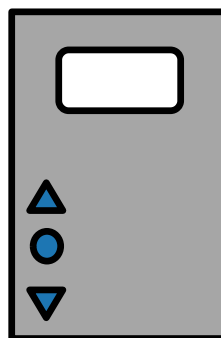
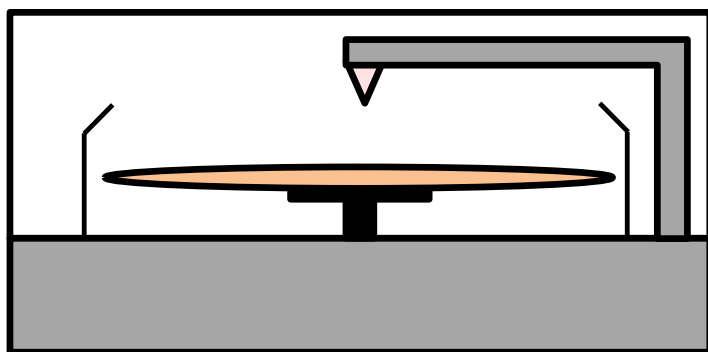


Developer externally cooled down and heated up

L. E. Ocola, A. Stein, J. Vac. Sci. Technol. B 24 (6) (2006) [DOI: 10.1116/1.2366698]

Experimental tool

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High range developer temperature

- Inline process flow to control the temperature of developer & rinsing chemicals;
- Available for PTD & NTD process.

Impact of developer temperature on litho performance

16nmL32nmP

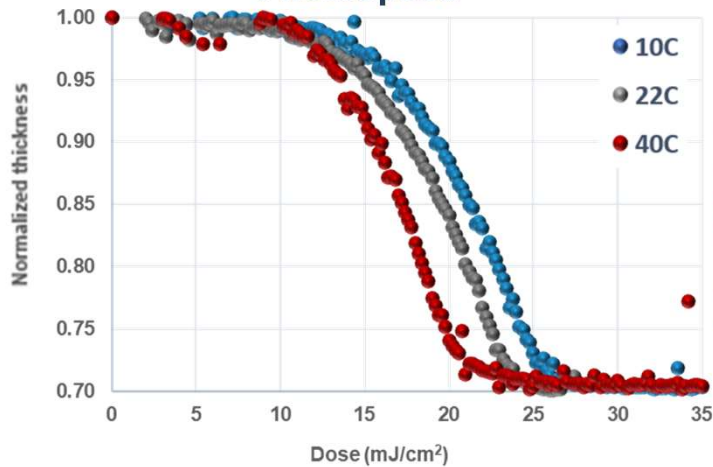
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ZER02#03 – 35nm

SOG#1 – 23.5nm

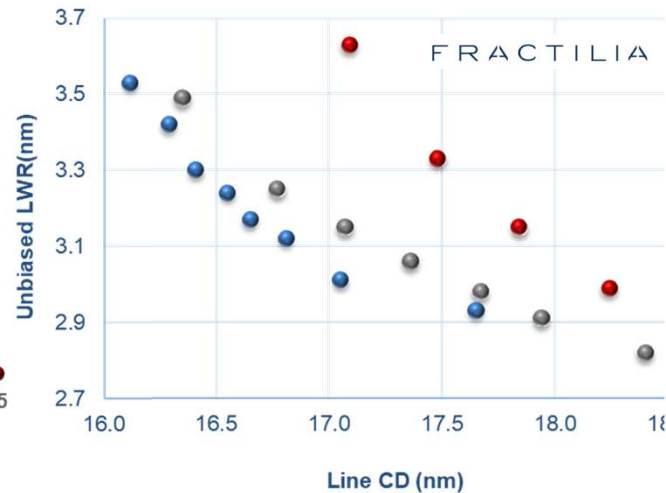
SOC - 60nm

Photospeed



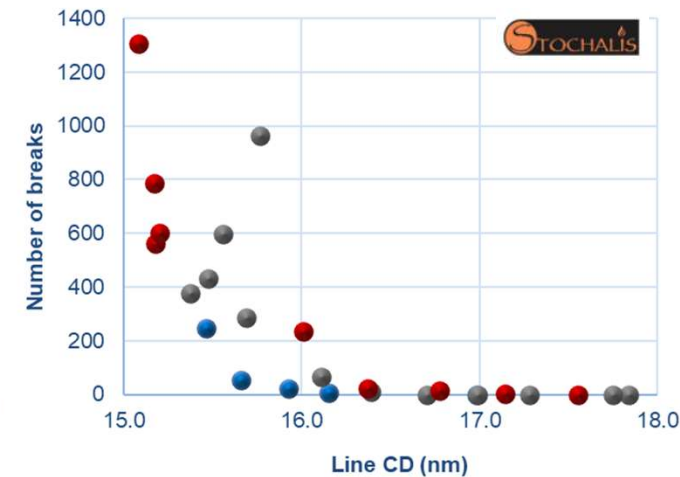
Higher development temperatures significantly contribute to dose reduction

Line width roughness



Development temperature tuning is an effective parameter to improve line roughness

Printing failures



Printing failures are reduced by developing at lower temperatures

Developer temperature control can be an effective tool to improve different lithographic metrics

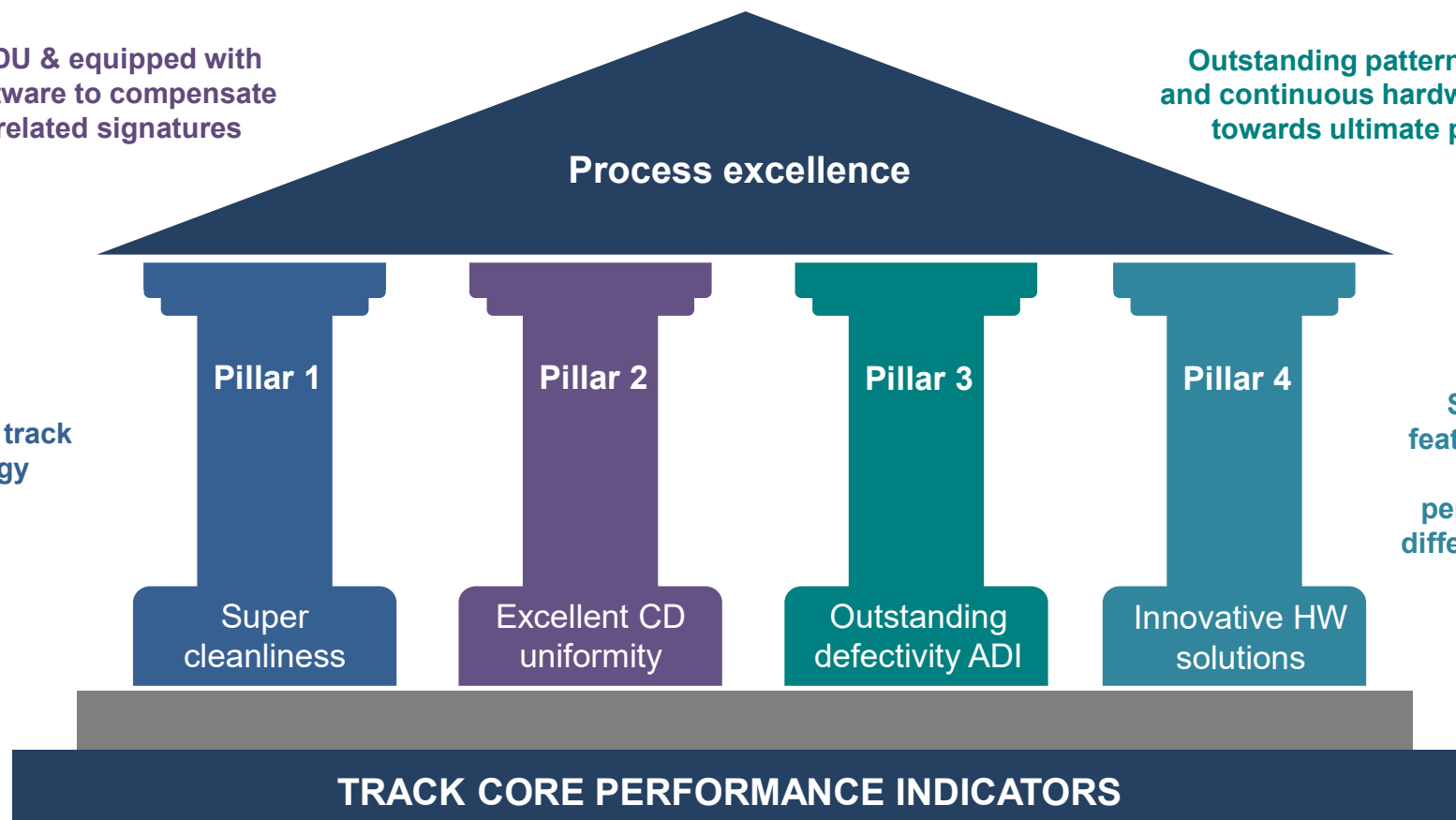
SCREEN tracks:

Excellent CDU & equipped with powerful software to compensate non-track related signatures

Outstanding patterned defectivity and continuous hardware exploration towards ultimate performance

Super clean track technology

Special HW features to boost the litho performance of different materials



SCREEN track thrives for excellent stability, cleanliness and performance

Acknowledgements

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Waut Drent

Hyo Seon Suh

Philippe Foubert

Sandip Halder



Akihide Shirotori

And all the material vendors that made this work possible!

Thank you for your attention!

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