

**SEMICON<sup>®</sup>  
EUROPA**

FORWARD  
AS ONE

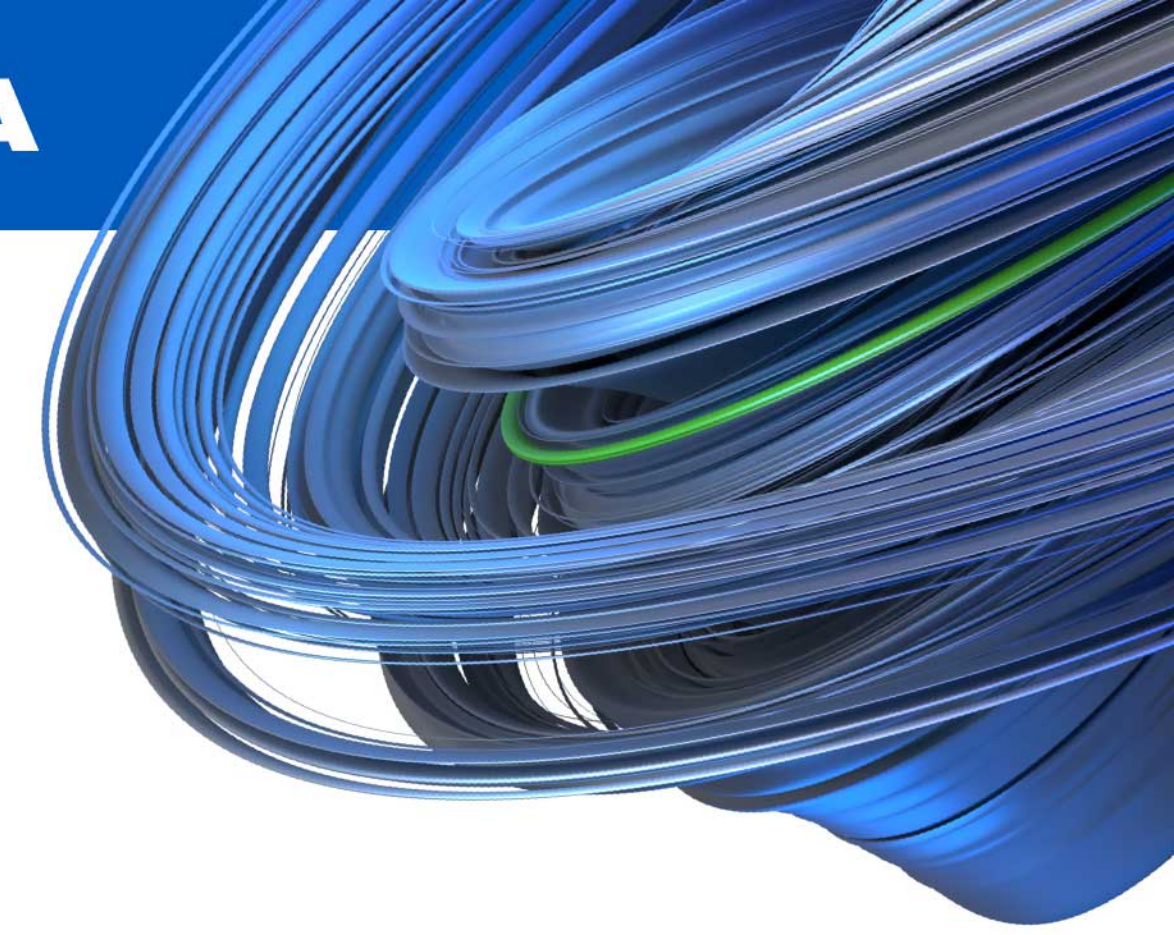
# Smart Wafering

**and other ways to increase yield  
in crystal substrate manufacturing**

Dr. Ivan ORLOV, Dr. Caroline CHEZE, Frédéric FALISE  
Scientific Visual (Switzerland)

November 15, 2022





Video



These yellow boxes indicate live video content, which cannot be embedded in a static PDF.

To watch this presentation with all videos, download the .MP4 video file from the SemiconEuropa conference website or contact the authors.

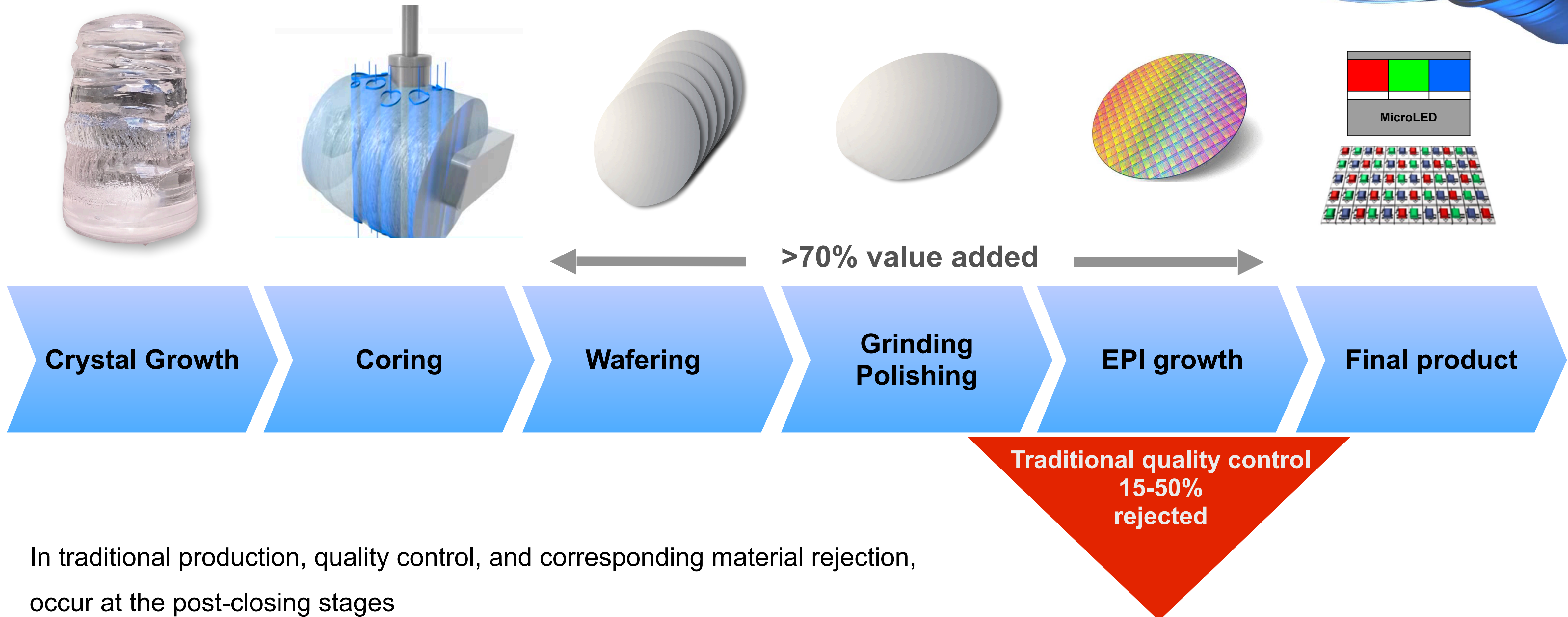
Video: Introductory words of Ivan Orlov



Dr Ivan Orlov, CEO  
Scientific Visual, Switzerland

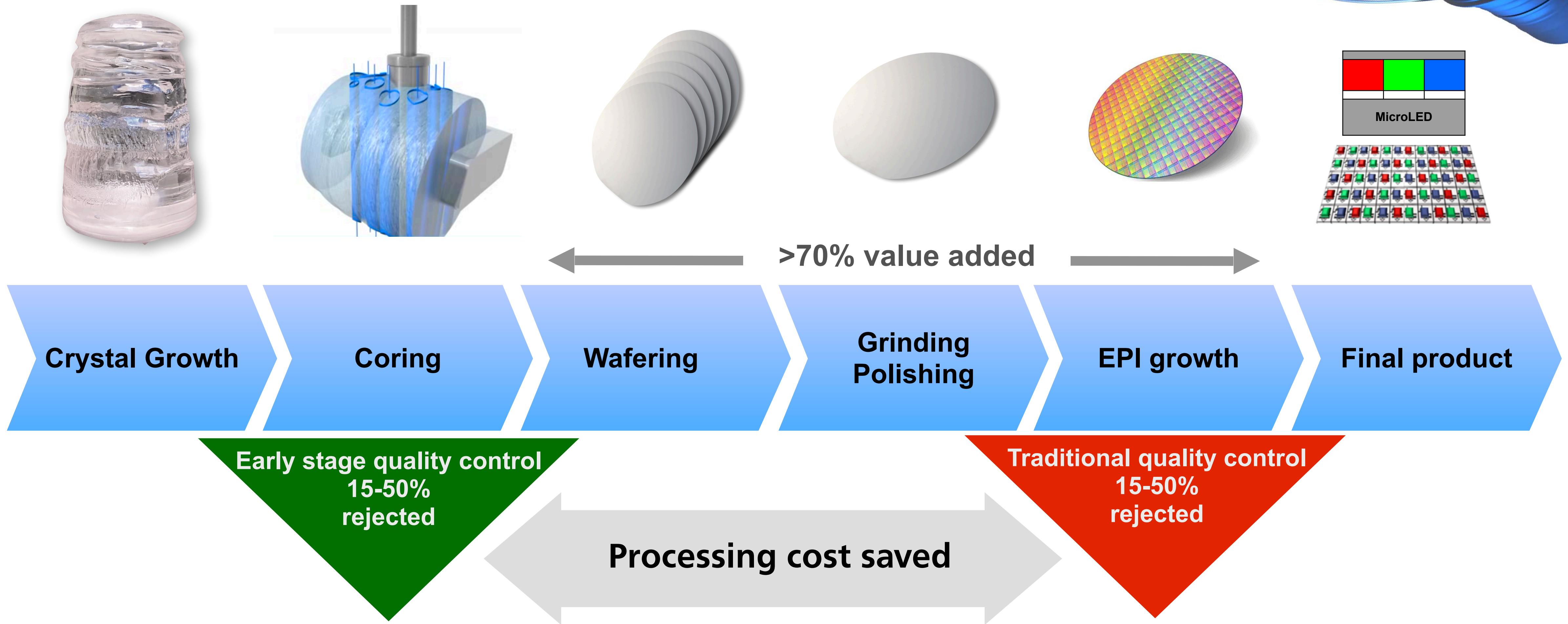


# Current substrate production

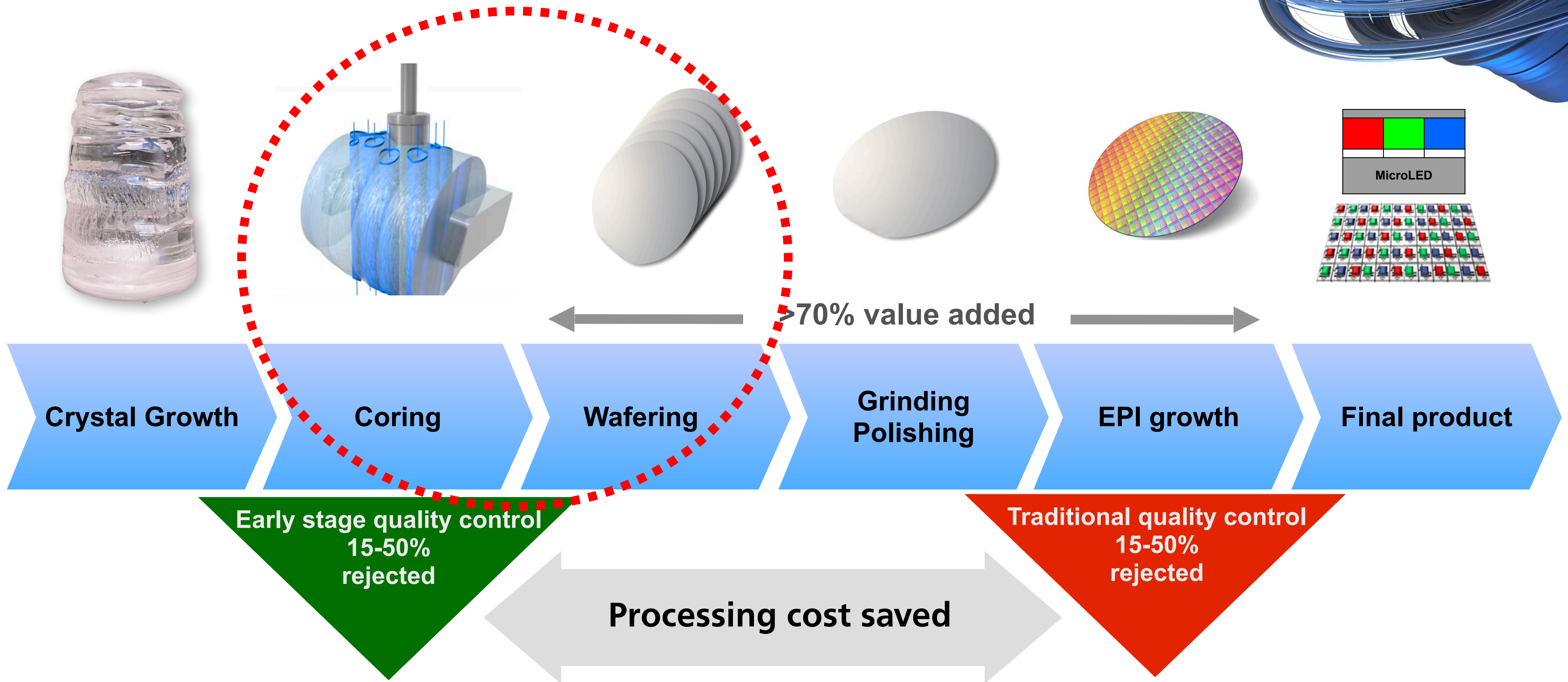


In traditional production, quality control, and corresponding material rejection, occur at the post-closing stages

# Production with early-stage defect detection

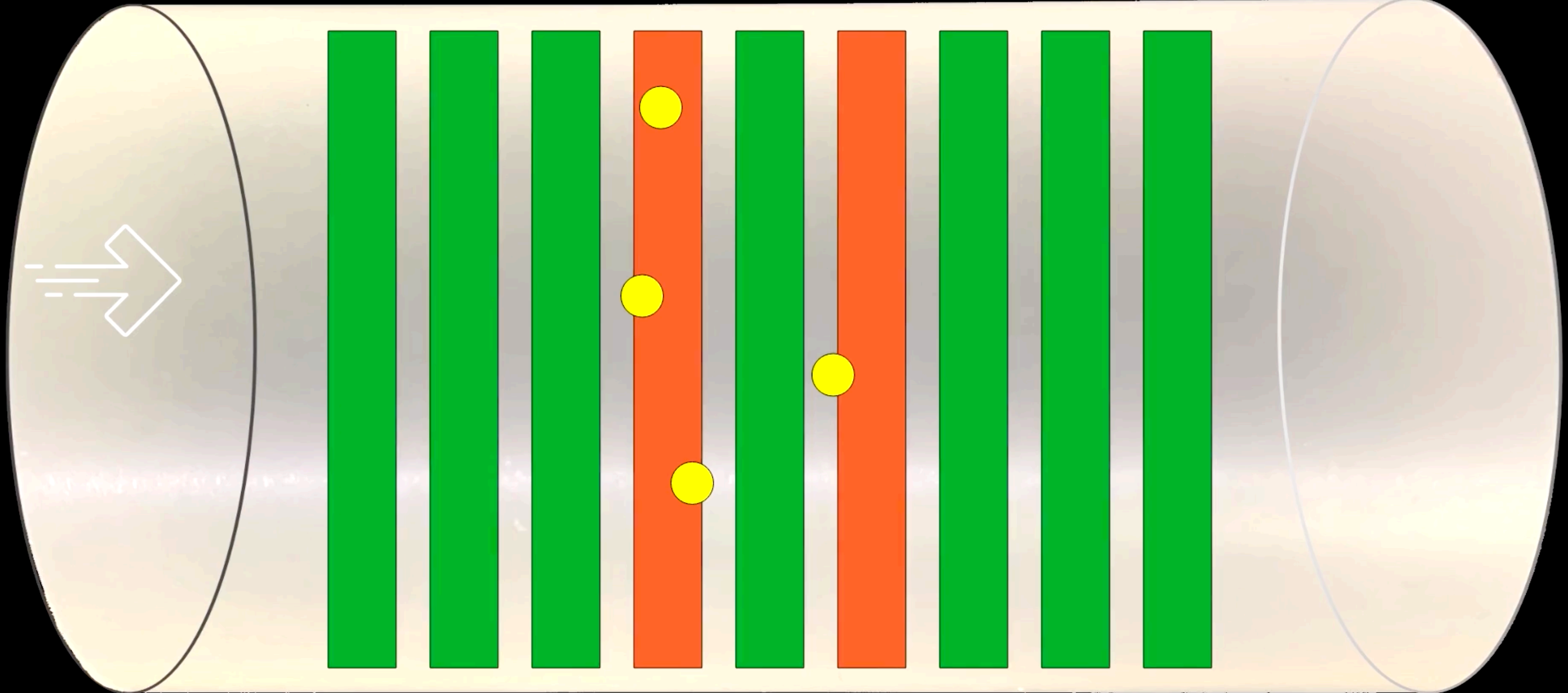


# Production with early-stage defect detection



Smart Wafering video

Regular cutting Grid



Video: Caroline Chèze presents smart wafering in SiC



06:54 | 13:55

Video player controls including a progress bar, play/pause button, and volume icon.

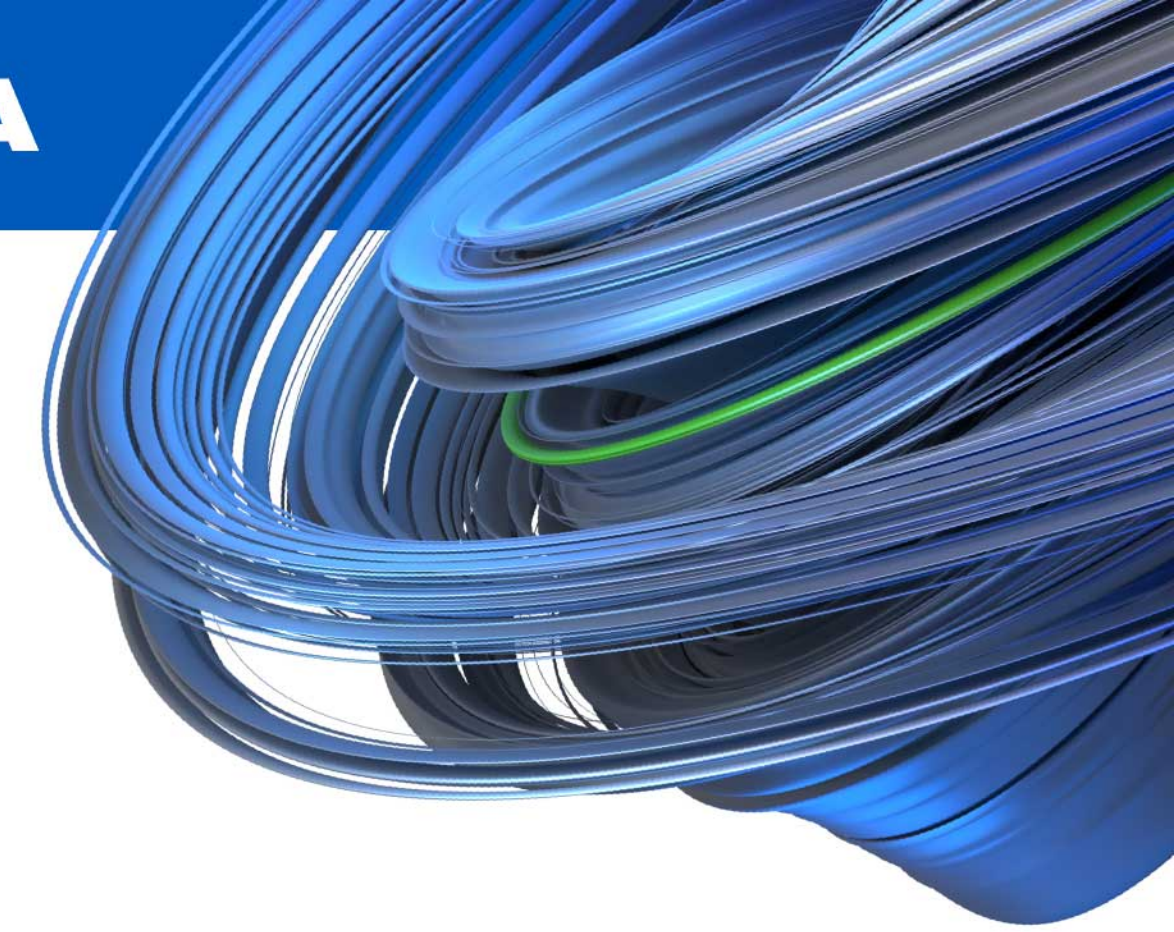
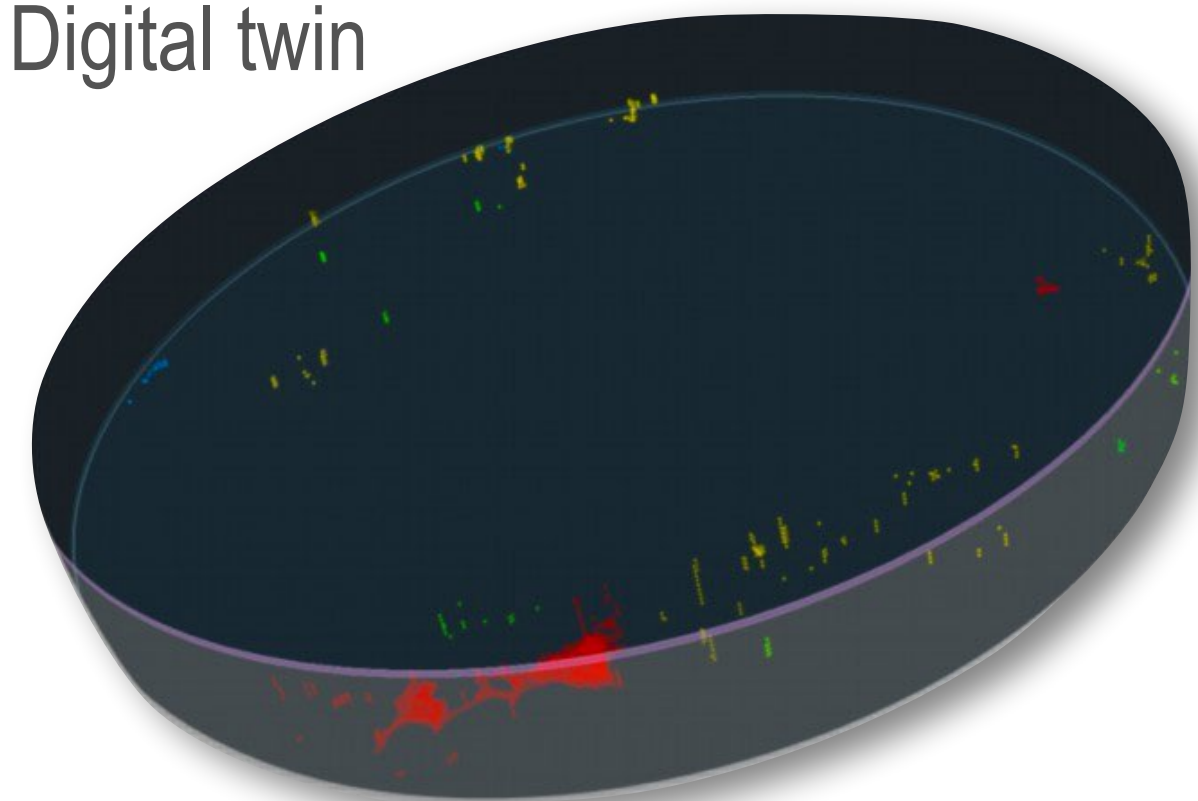
**Dr Caroline Chèze, Research Engineer**  
Scientific Visual, Switzerland

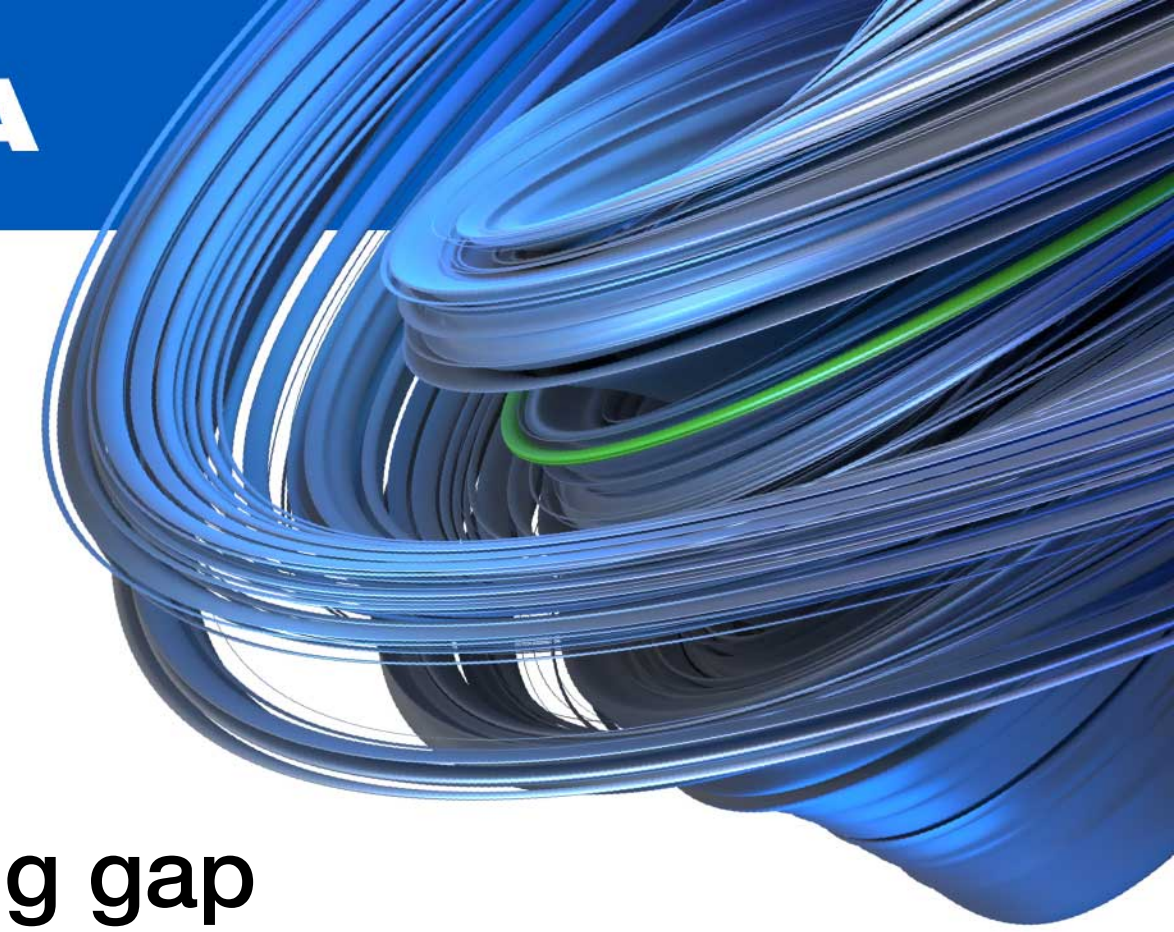
## Another example: Smart Wafering of 4H-SiC

SiC puck



Digital twin



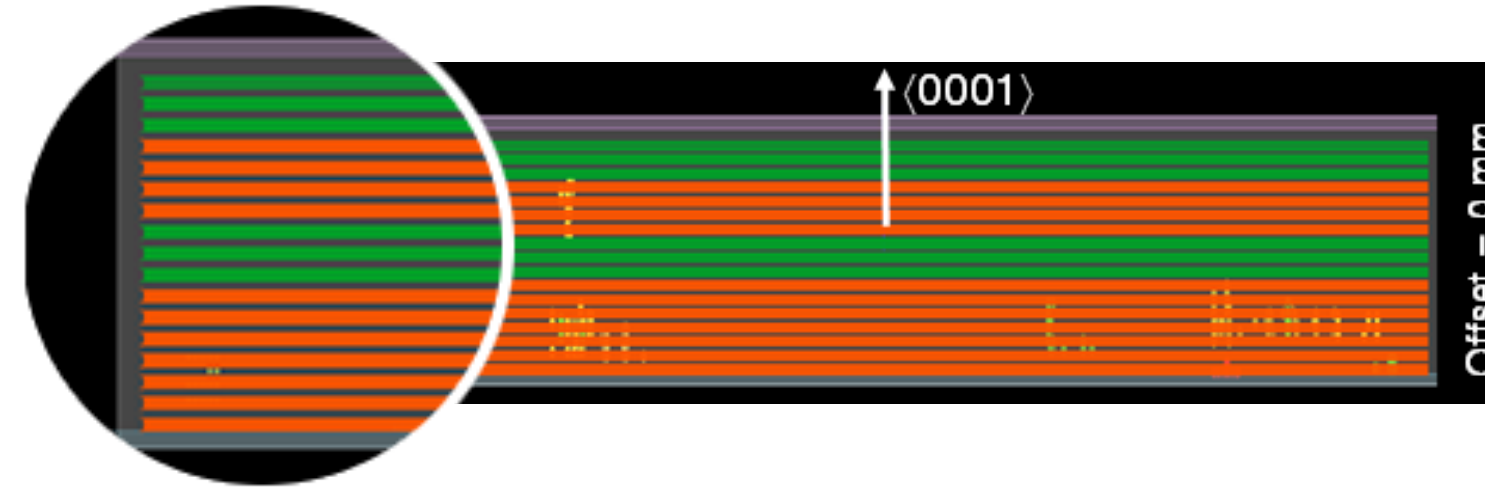


# Another example: Smart Wafering of 4H-SiC

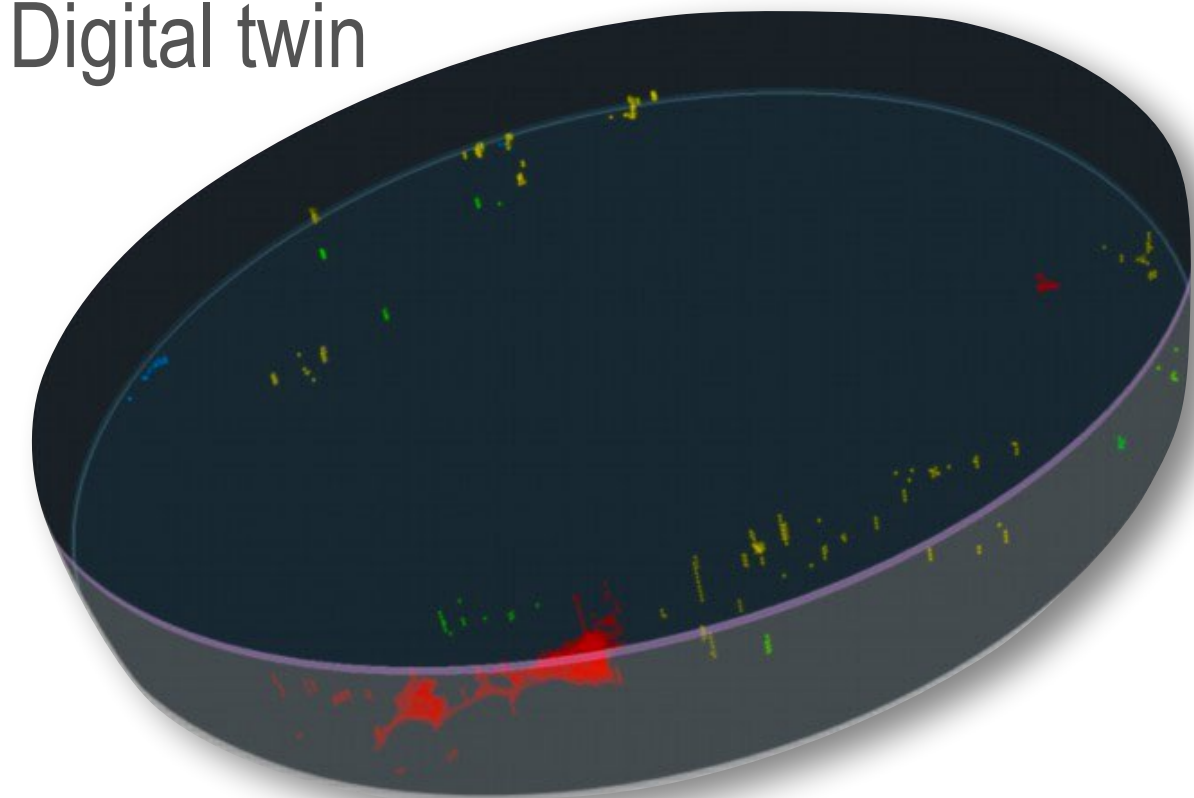
SiC puck



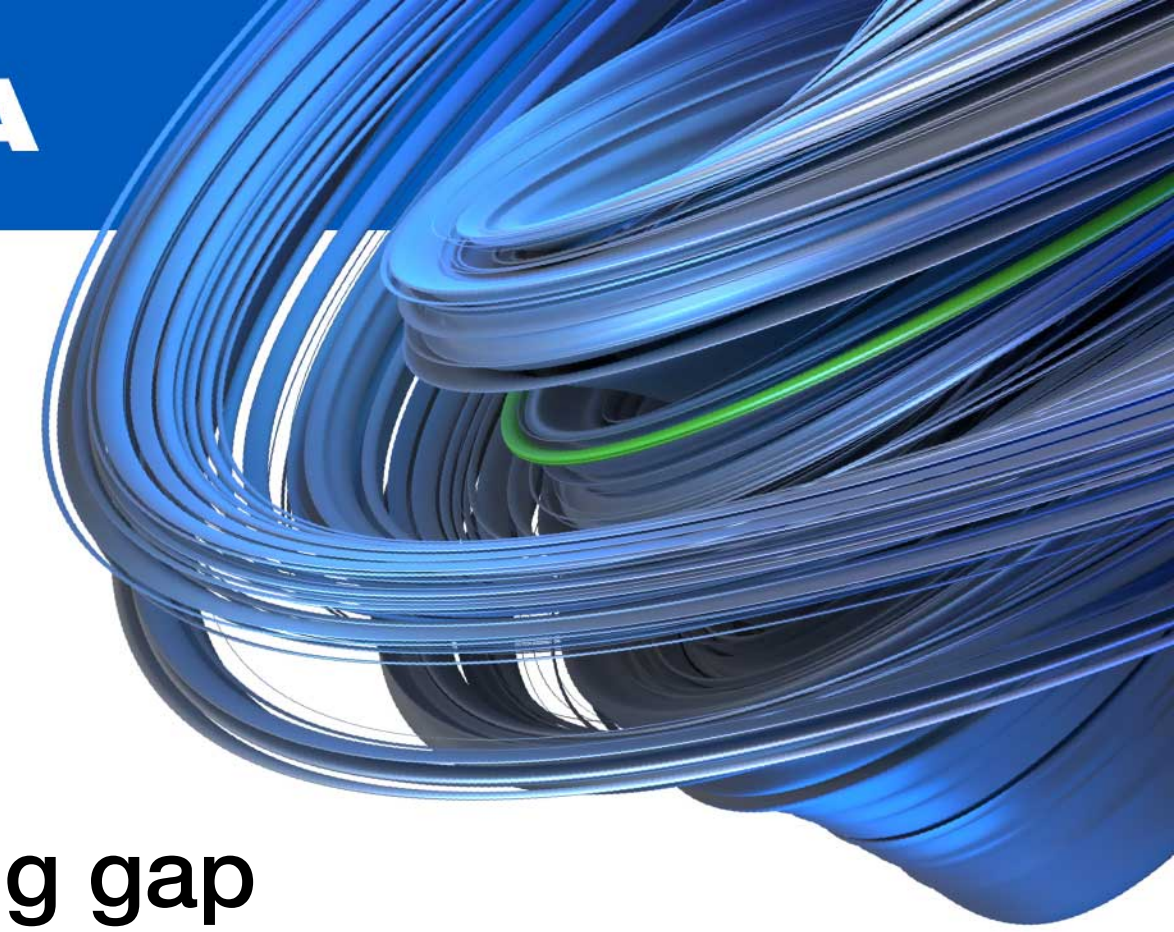
Settings: 350  $\mu\text{m}$  wafer thickness, 250  $\mu\text{m}$  sawing gap



Digital twin



Wafering	Traditional
Puck offset, mm	0.00
Quality wafers	6
Defective wafers	11
Wafering yield, %	35

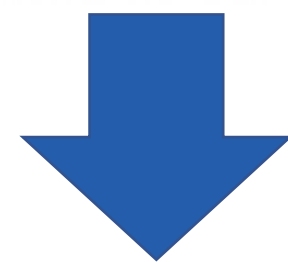
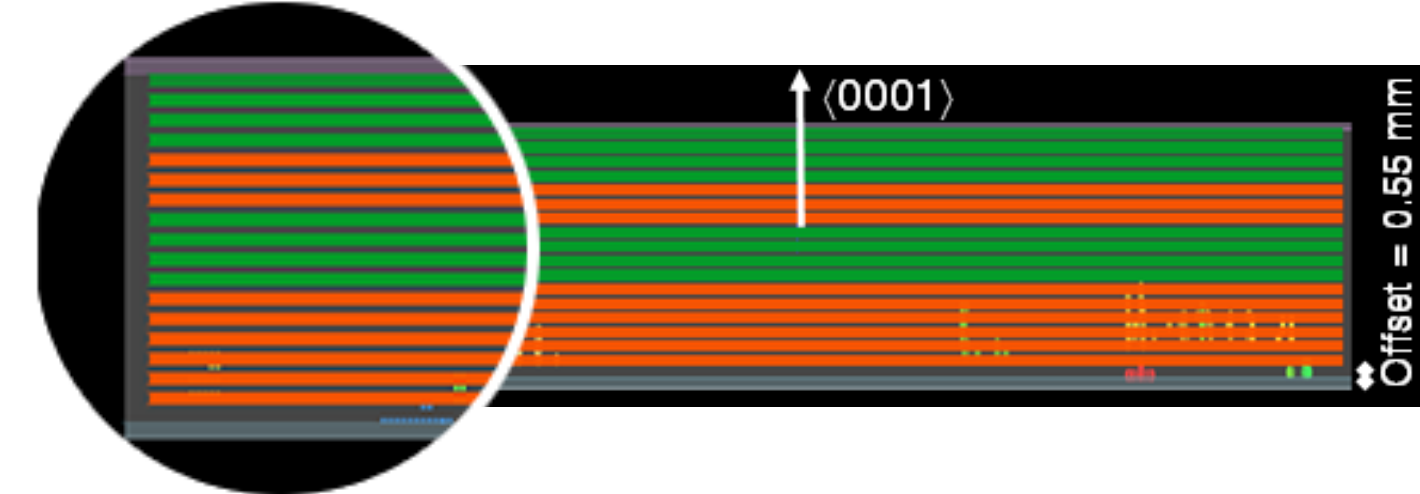
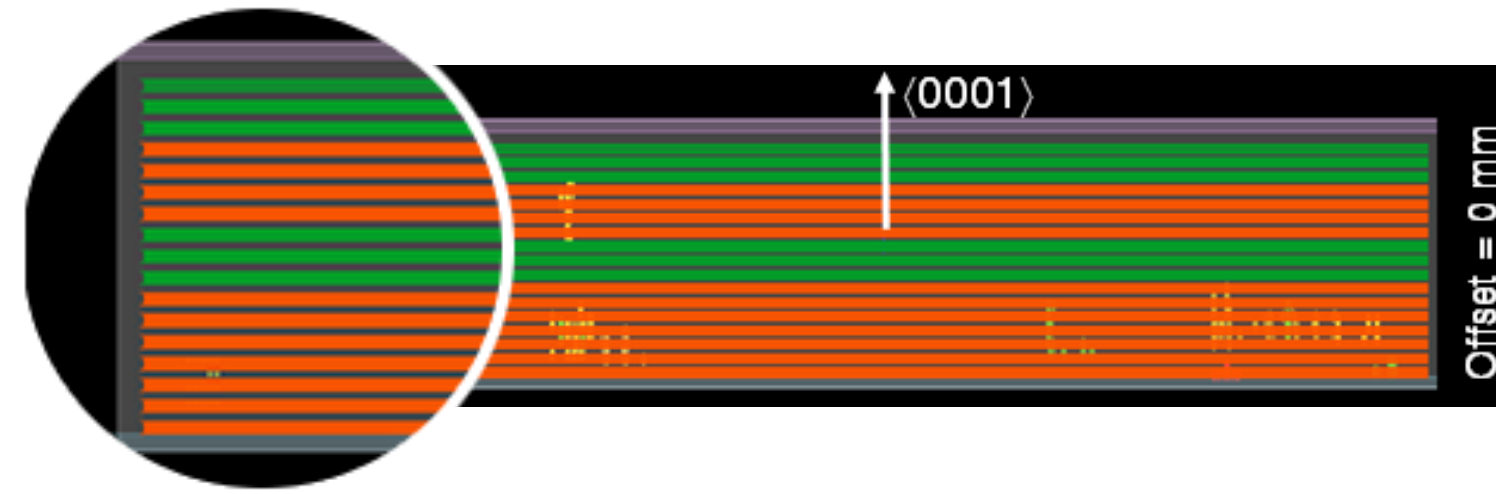


# Another example: Smart Wafering of 4H-SiC

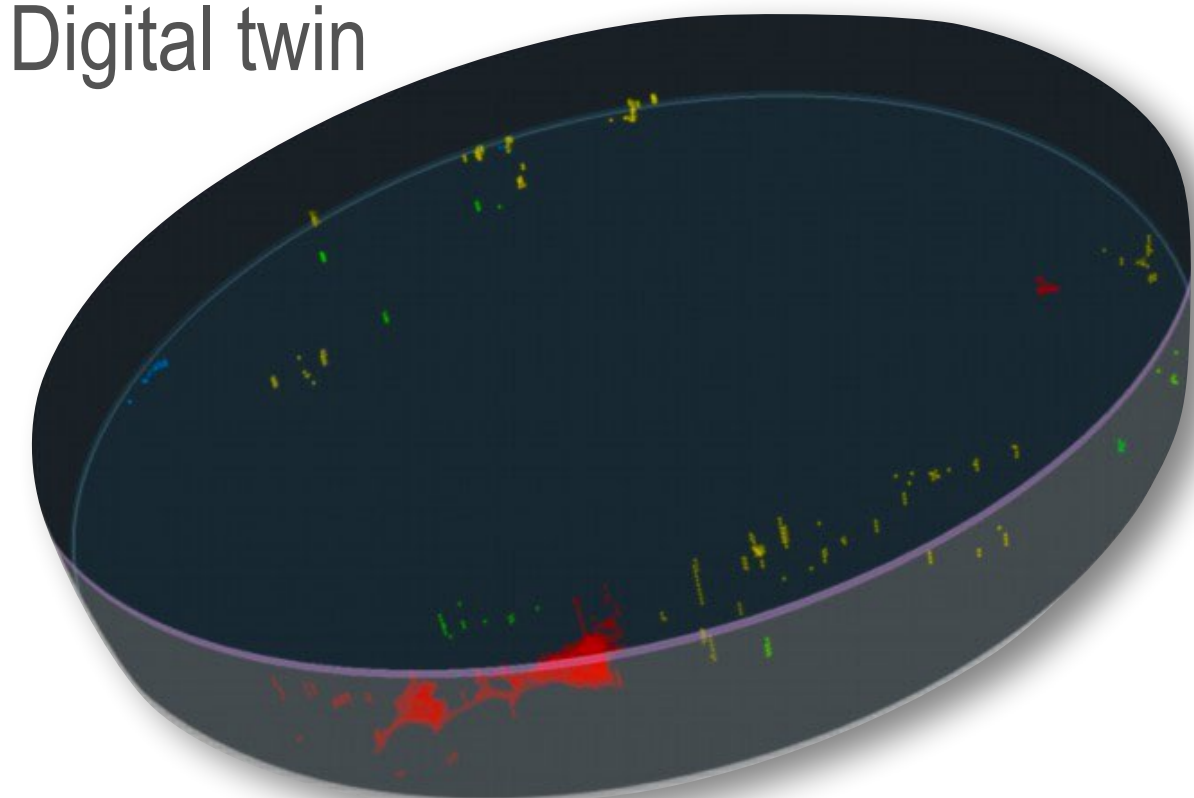
SiC puck



Settings: 350  $\mu\text{m}$  wafer thickness, 250  $\mu\text{m}$  sawing gap



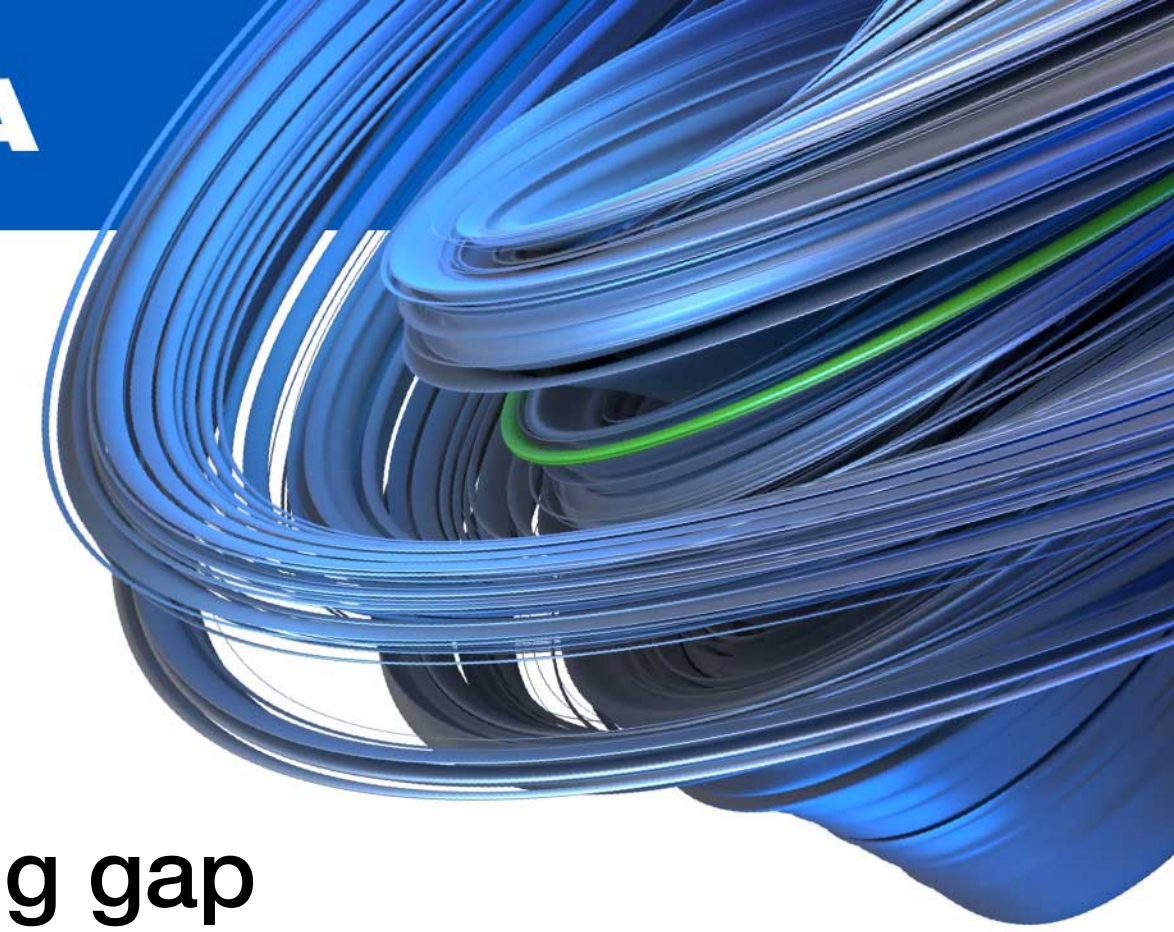
Digital twin



Wafering	Traditional	Smart
Puck offset, mm	0.00	
Quality wafers	6	
Defective wafers	11	
Wafering yield, %	35	



**Smart Wafering computes the best offset to get the maximum number of quality wafers**

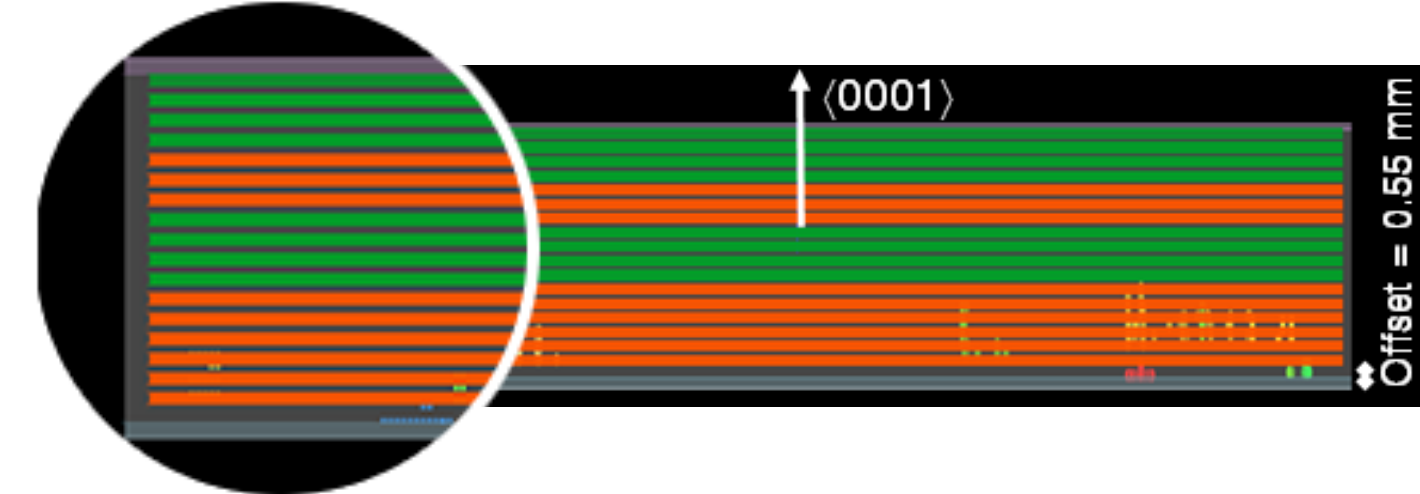
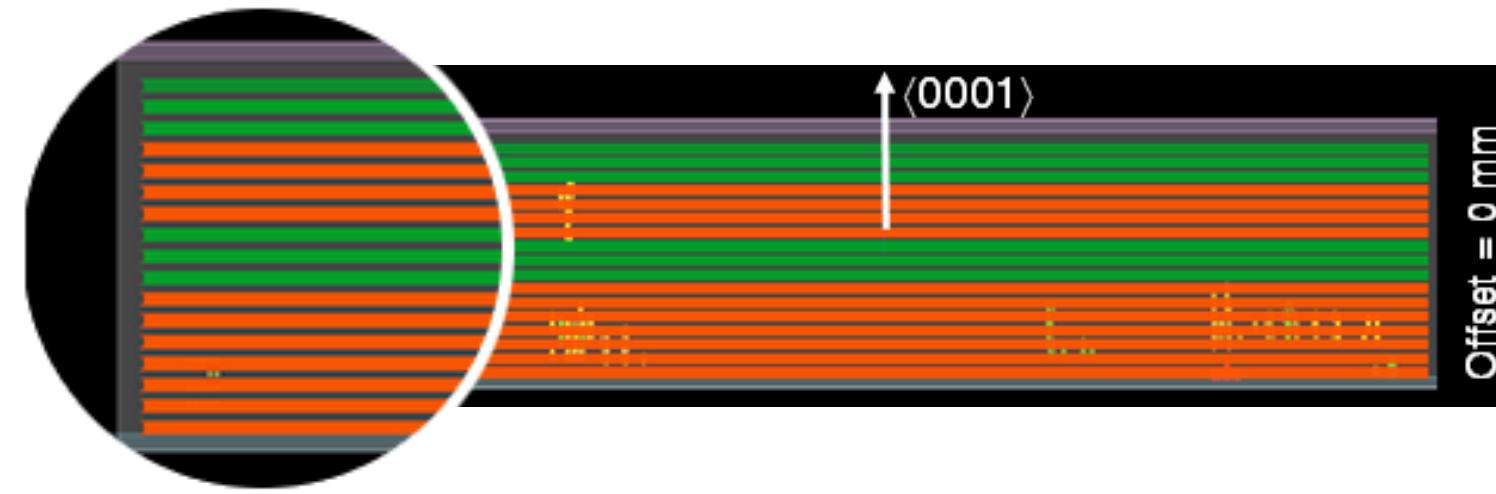


# Another example: Smart Wafering of 4H-SiC

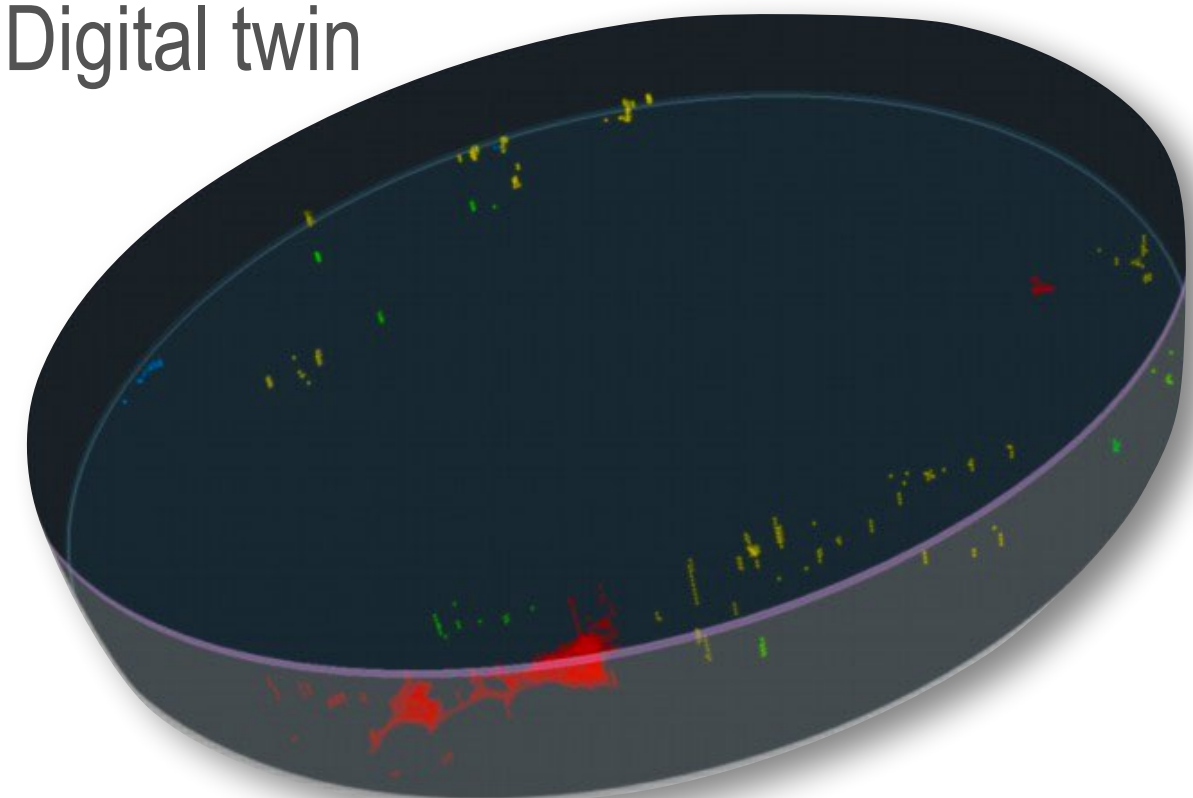
SiC puck



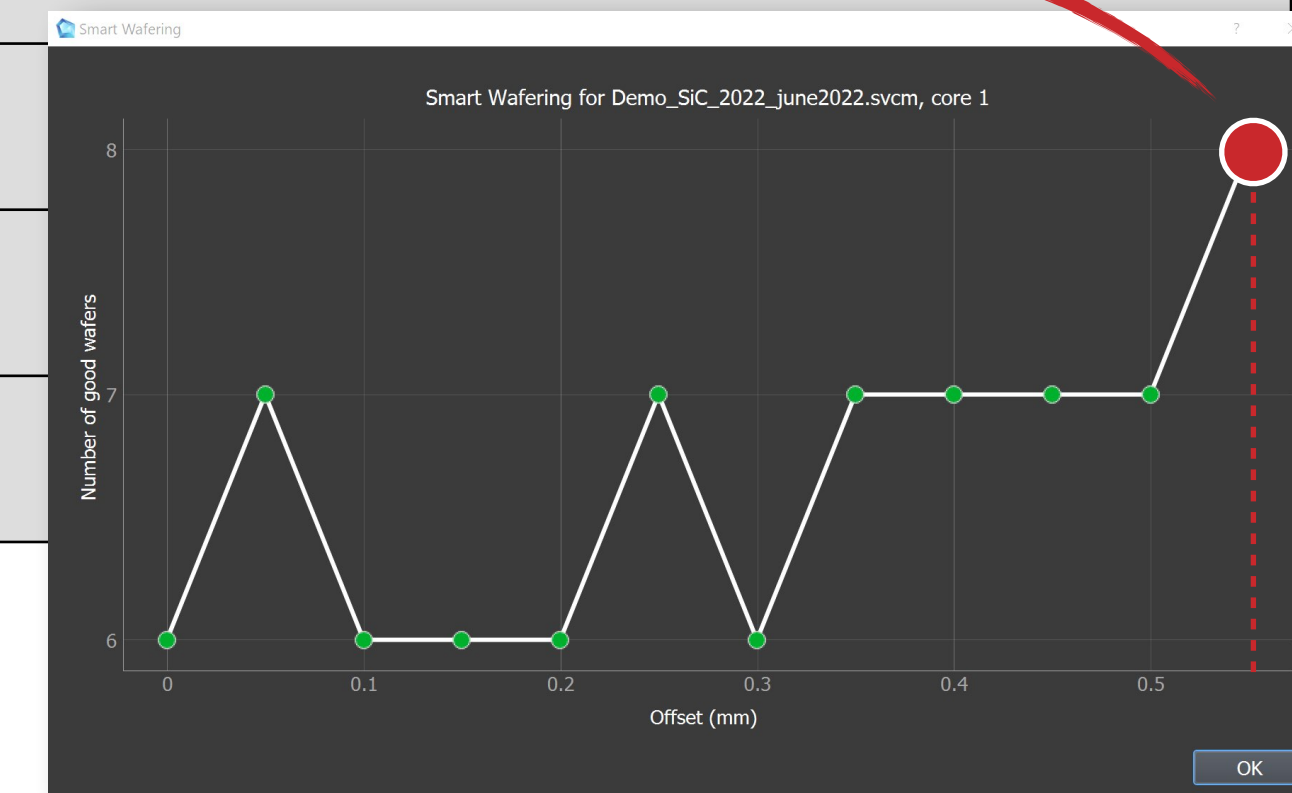
Settings: 350  $\mu\text{m}$  wafer thickness, 250  $\mu\text{m}$  sawing gap



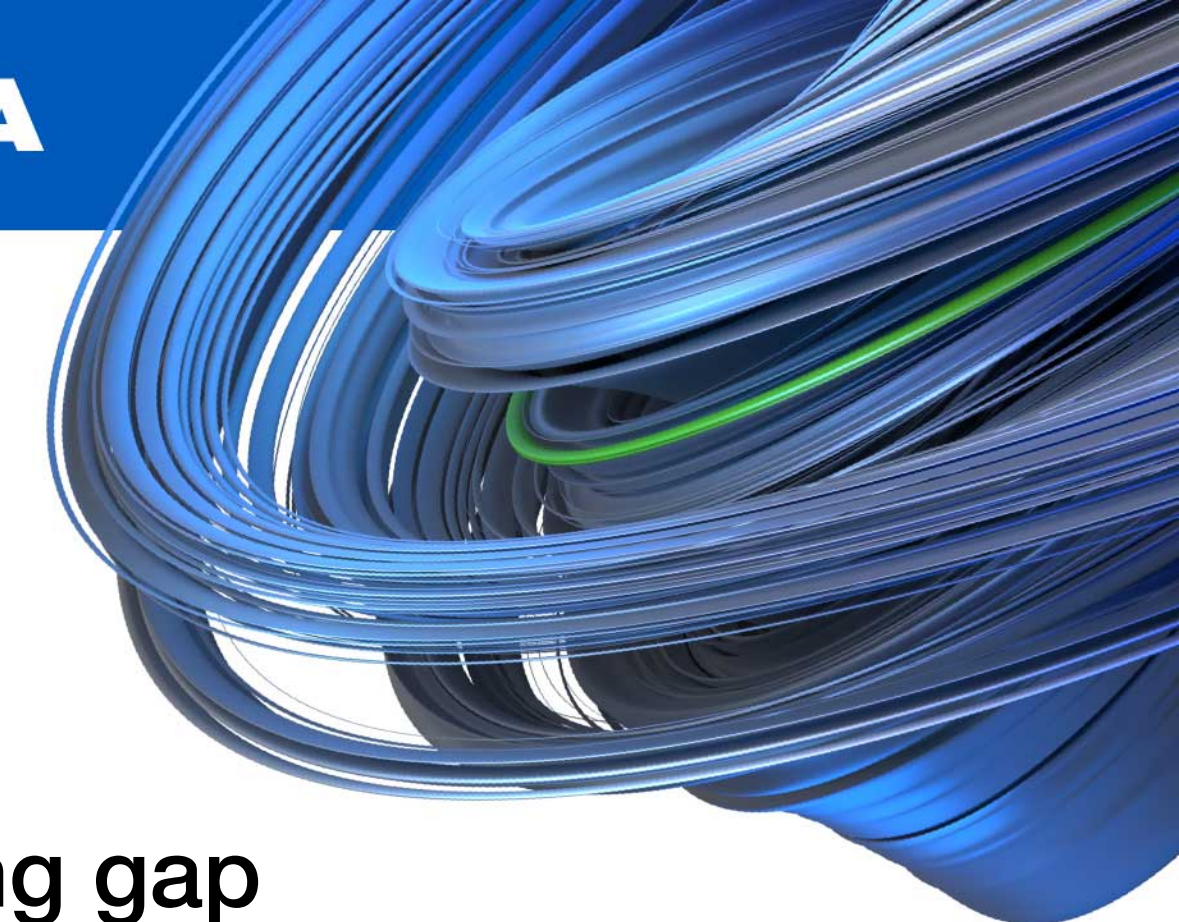
Digital twin



Wafering	Traditional	Smart
Puck offset, mm	0.00	0.55
Quality wafers	6	8
Defective wafers	11	0
Wafering yield, %	35	100



Smart Wafering computes the best offset to get the maximum number of quality wafers

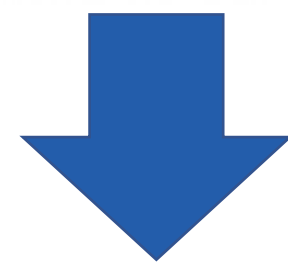
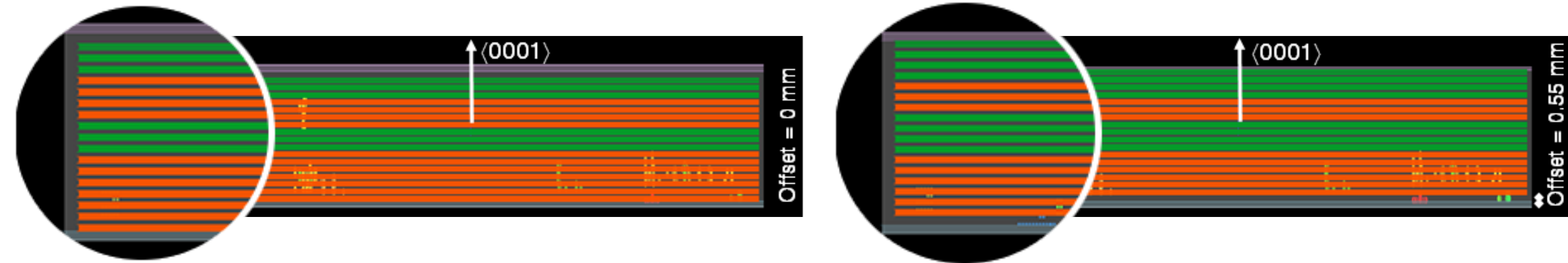


# Another example: Smart Wafering of 4H-SiC

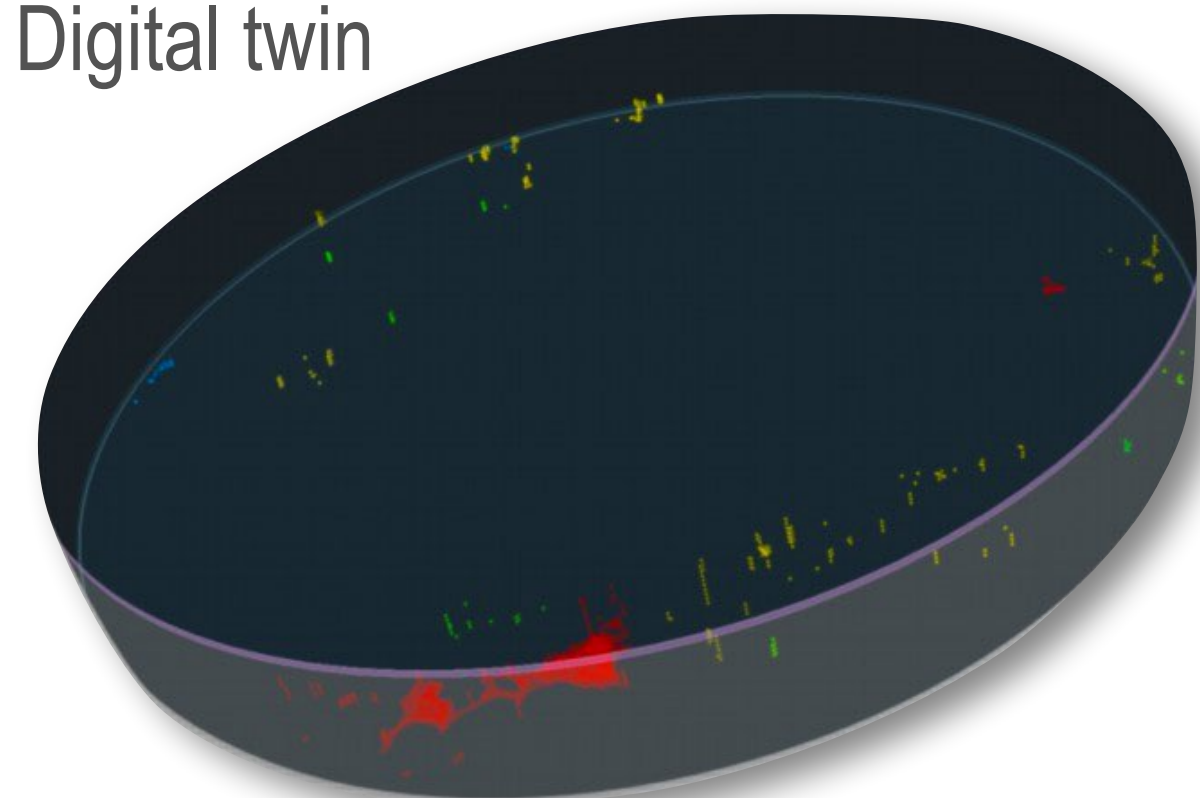
SiC puck



Settings: 350  $\mu\text{m}$  wafer thickness, 250  $\mu\text{m}$  sawing gap



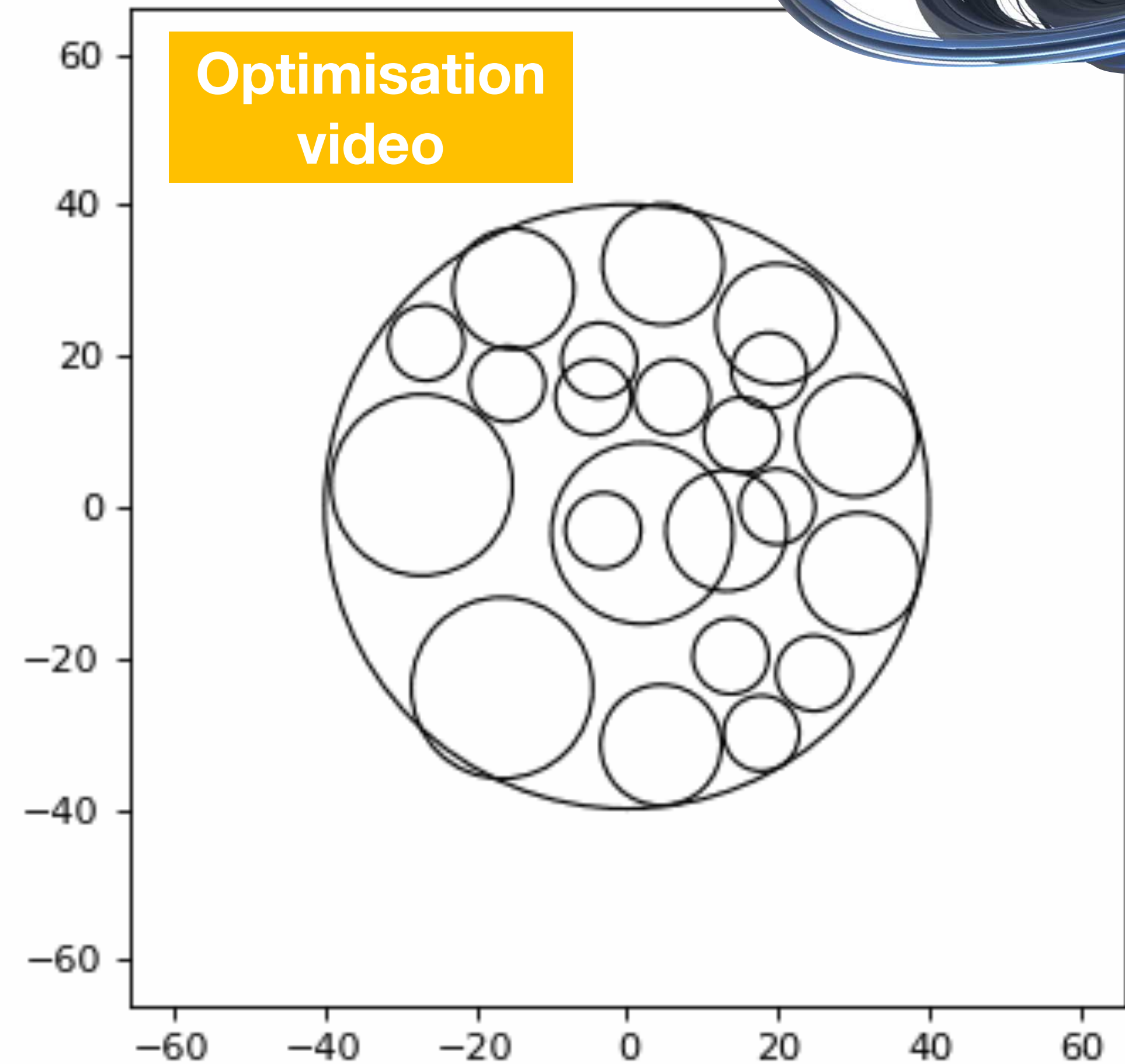
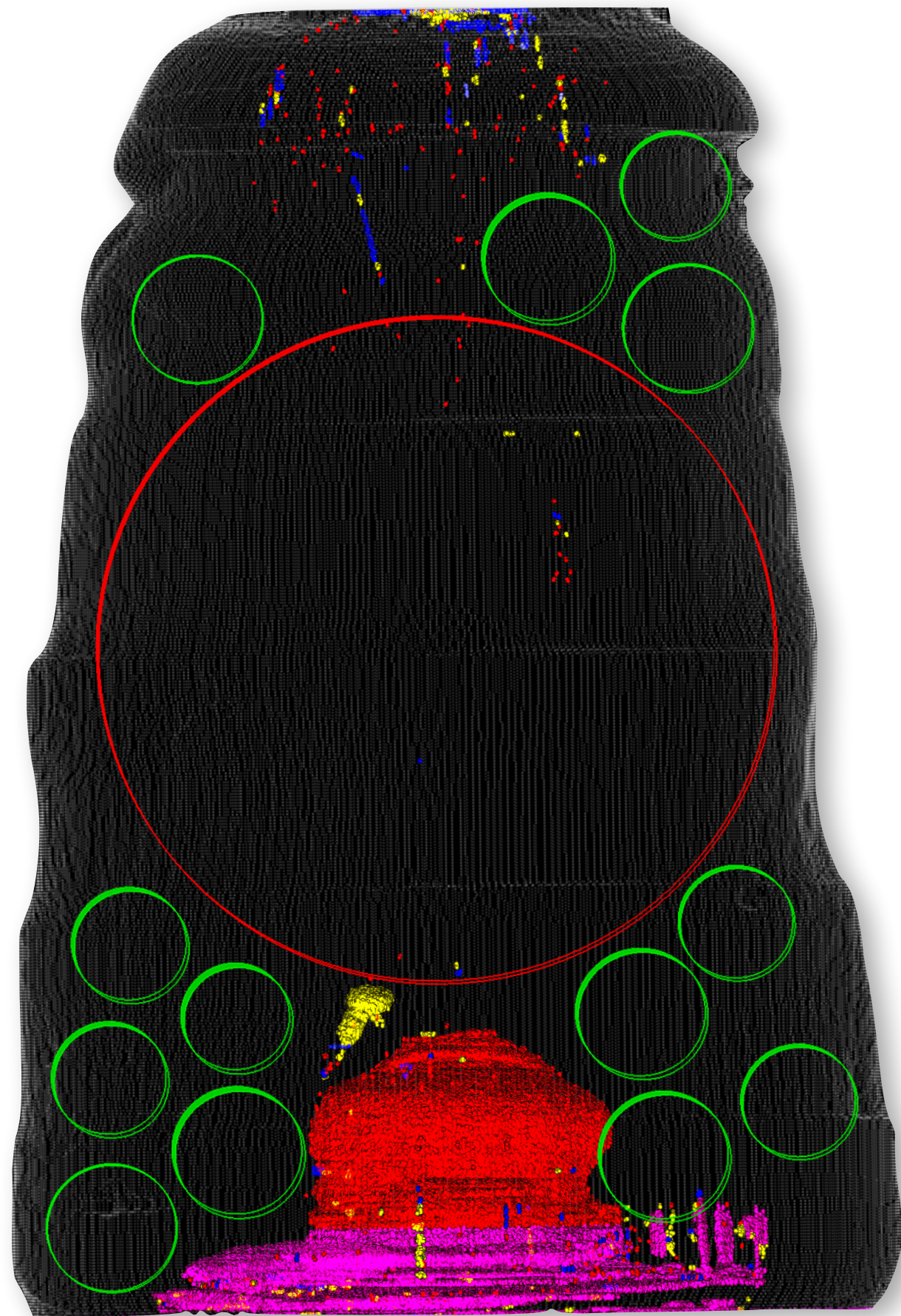
Digital twin



Wafering	Traditional	Smart
Puck offset, mm	0	0.55
Quality wafers	6	8
Defective wafers	11	9
Wafering yield	35%	47%

**Smart Wafering gain: +12% extra yield** without sourcing new crystals.

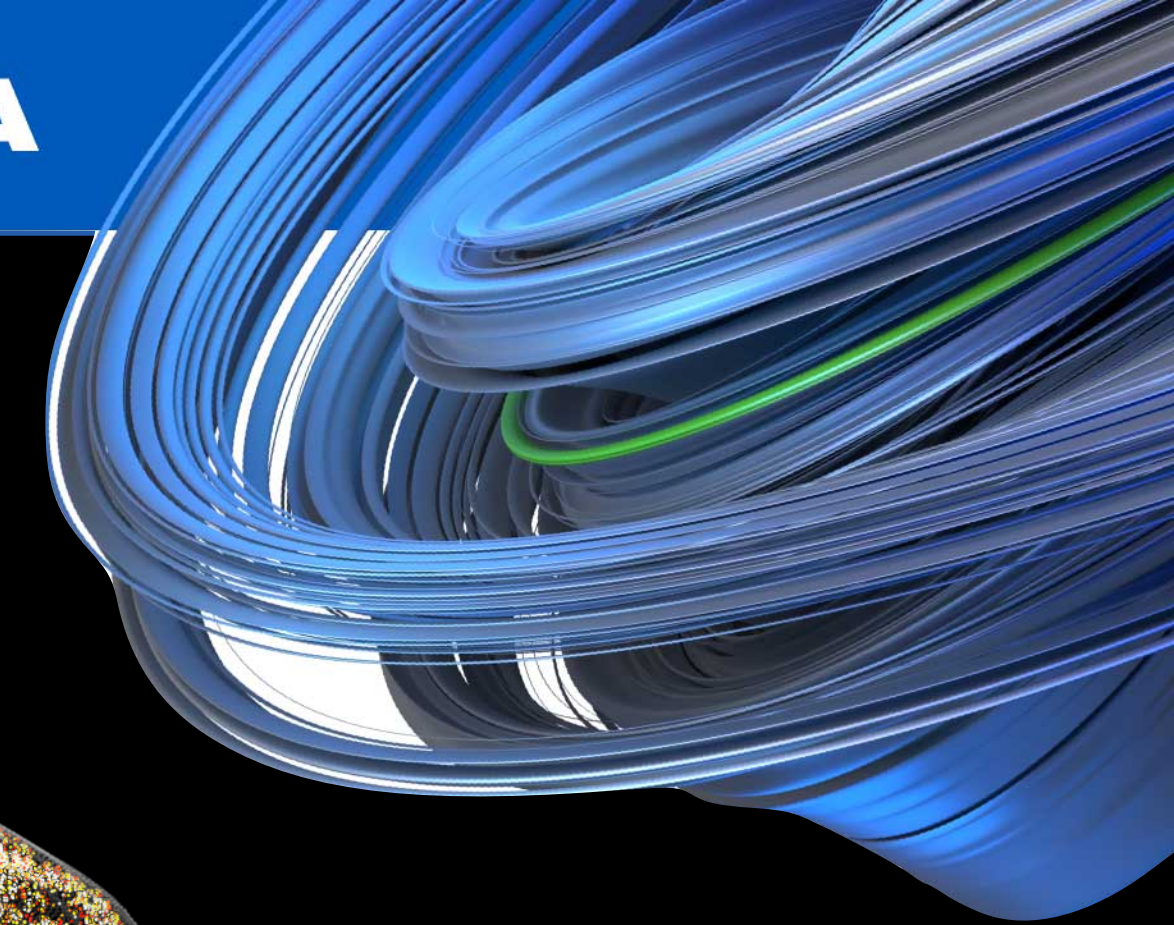
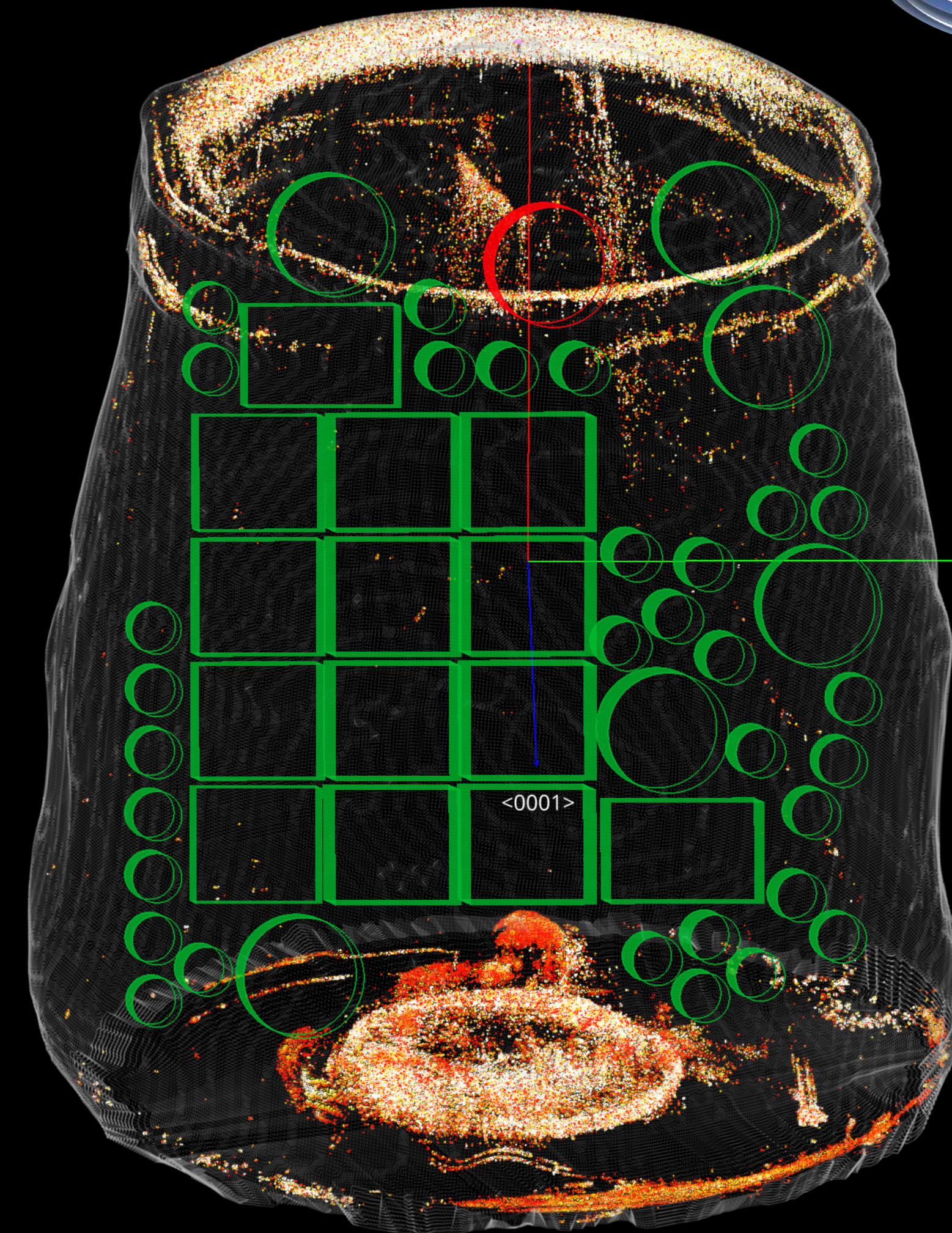
## Harvesting yet more: Smart Coring



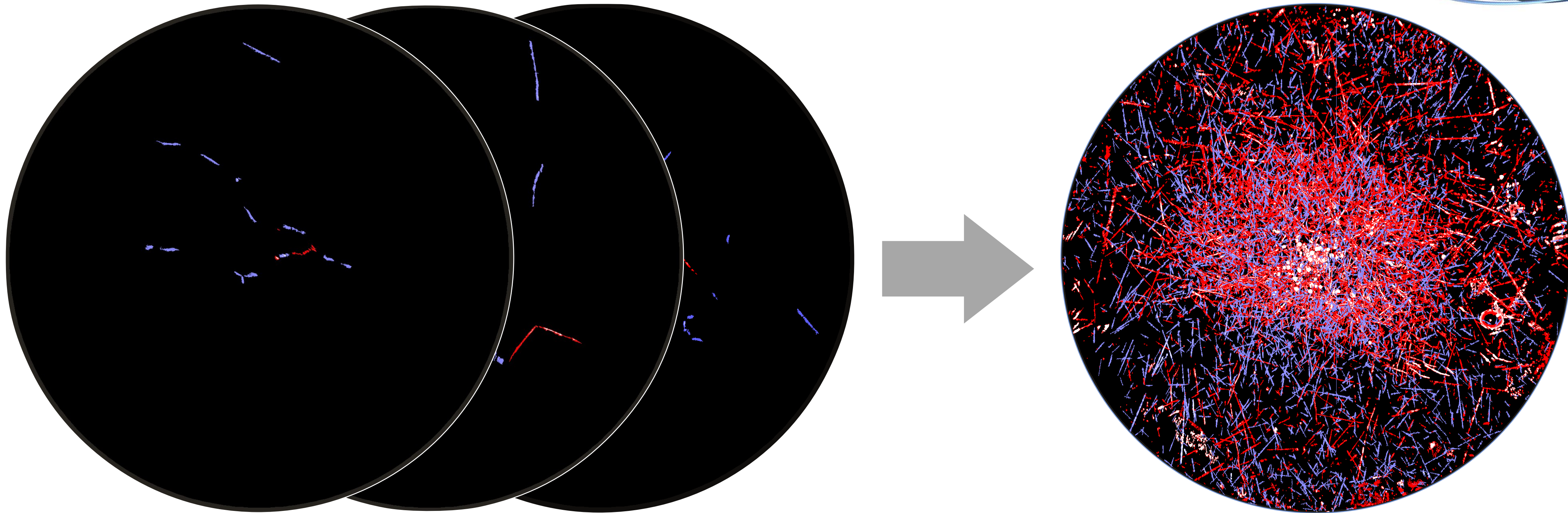
Automatically placing cores at optimal positions to avoid defects increases the yield further.

# Harvesting yet more: Smart Coring

Video of digital twin



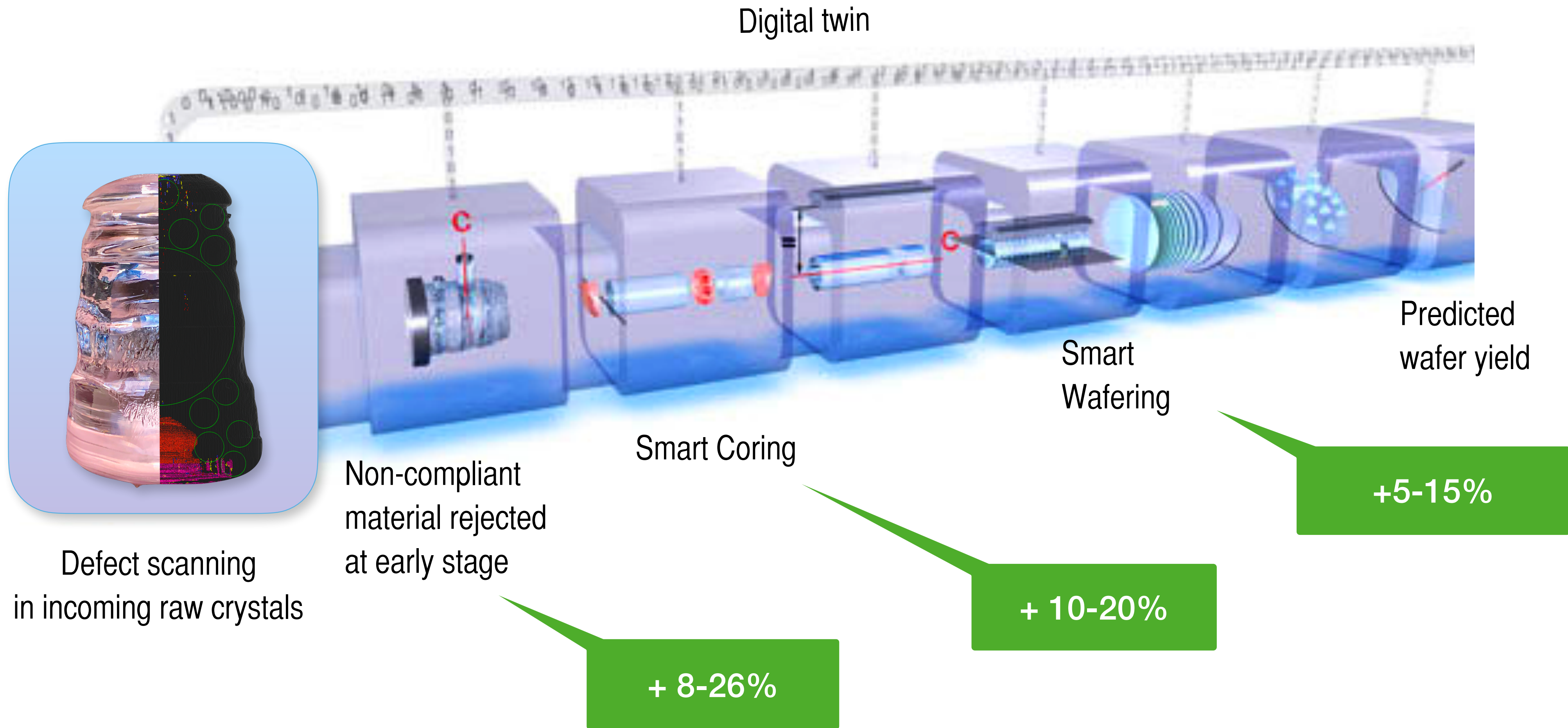
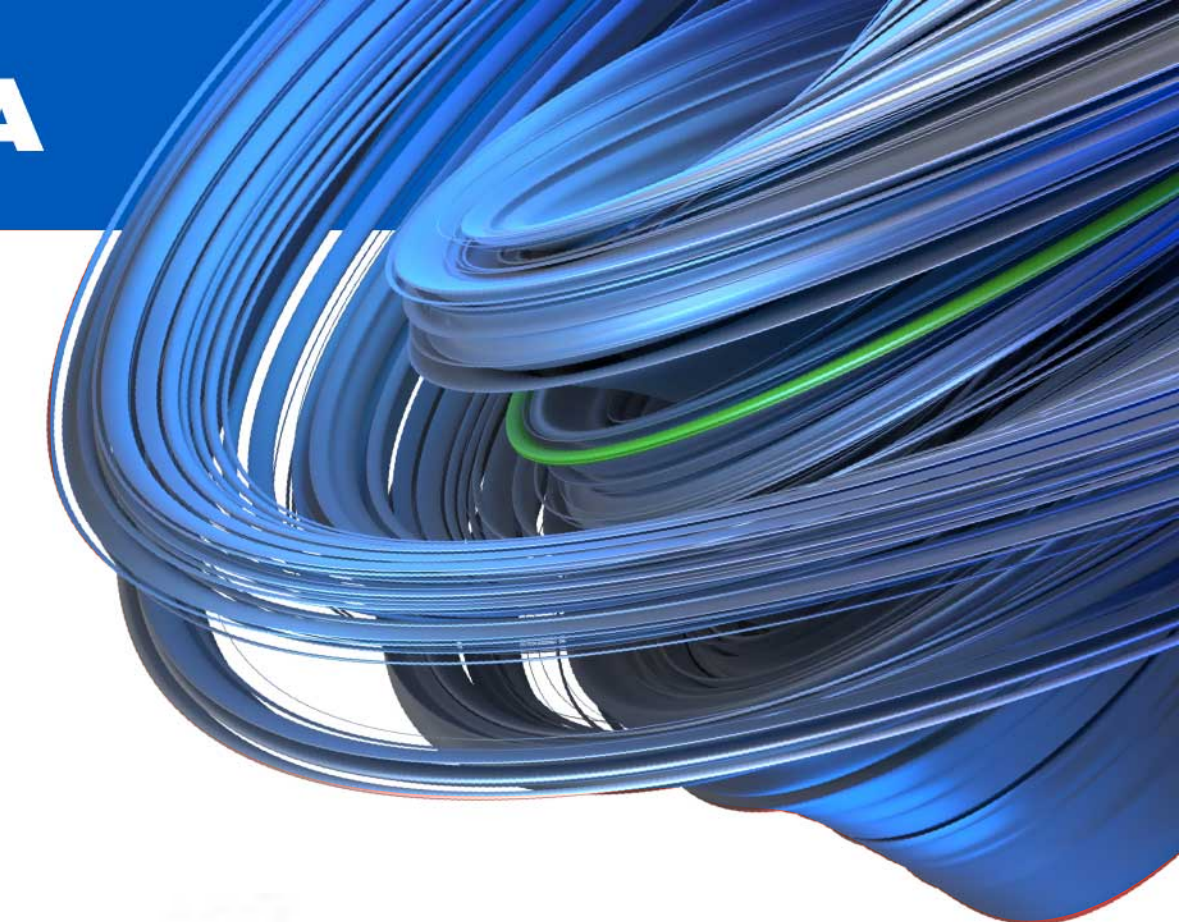
## Optimising crystal growth with objective statistics



Defects of individual crystals (ingots) are merged to produce 'production fingerprint'  
It reveals trends in defect appearance and provides feedback to optimize growth

# Vision: End-to-end digital control in crystal production

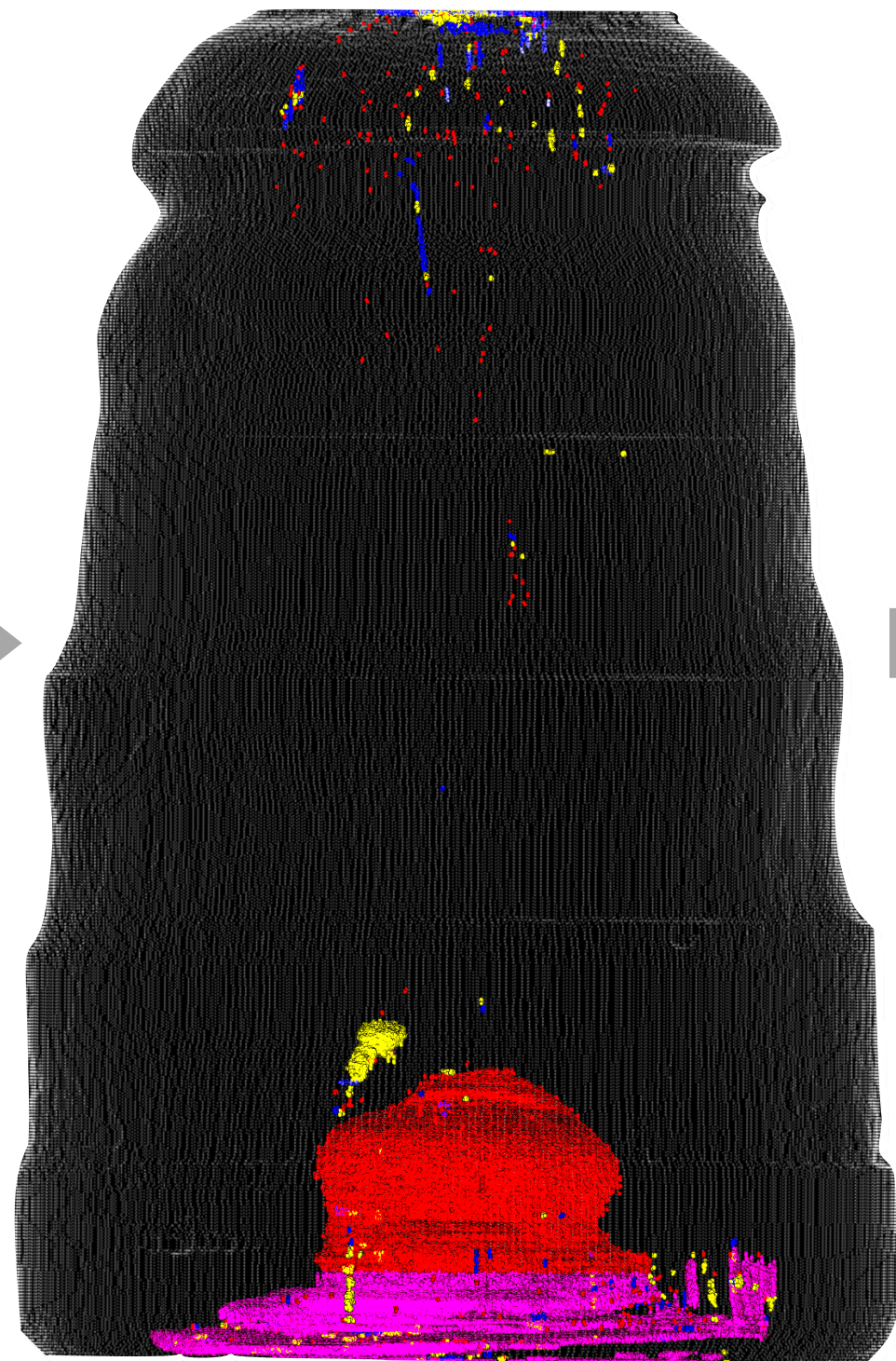
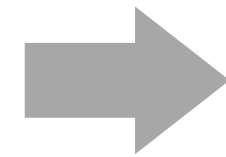
Green boxes: potential yield increase at production stages



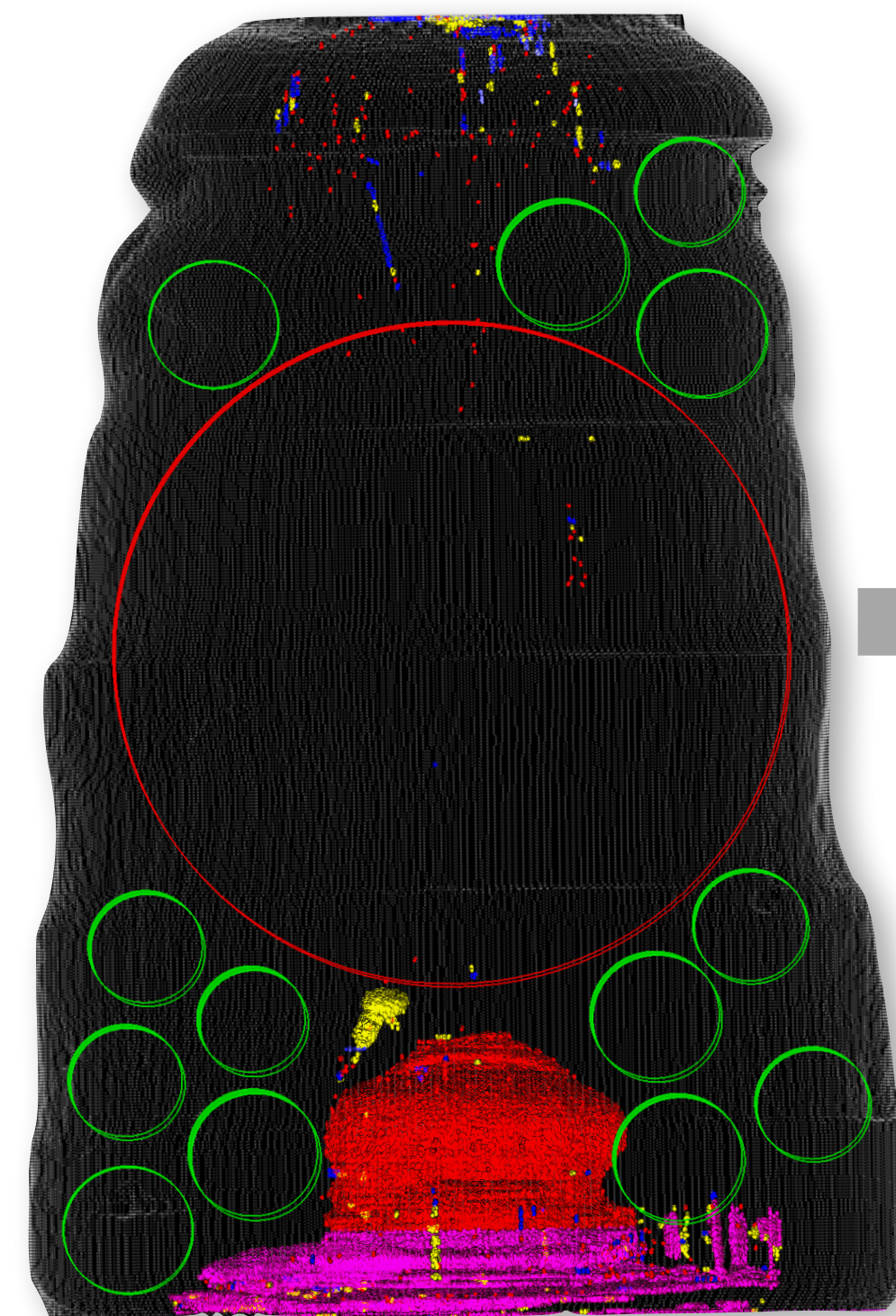
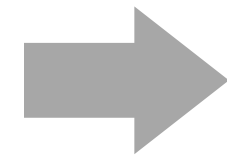
# Vision: End-to-end digital control in crystal production



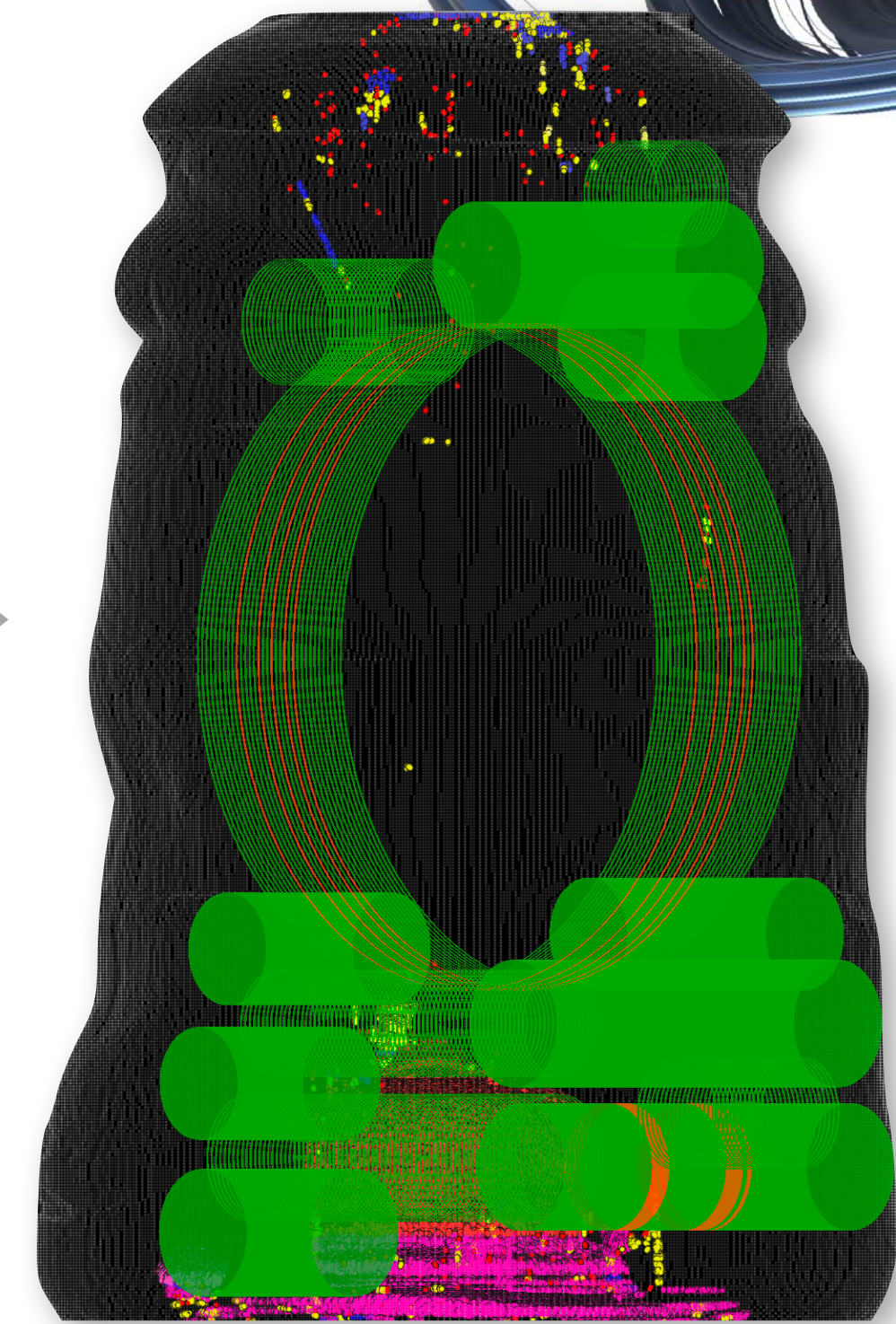
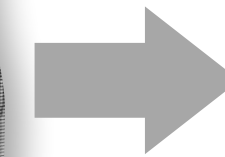
Raw crystal



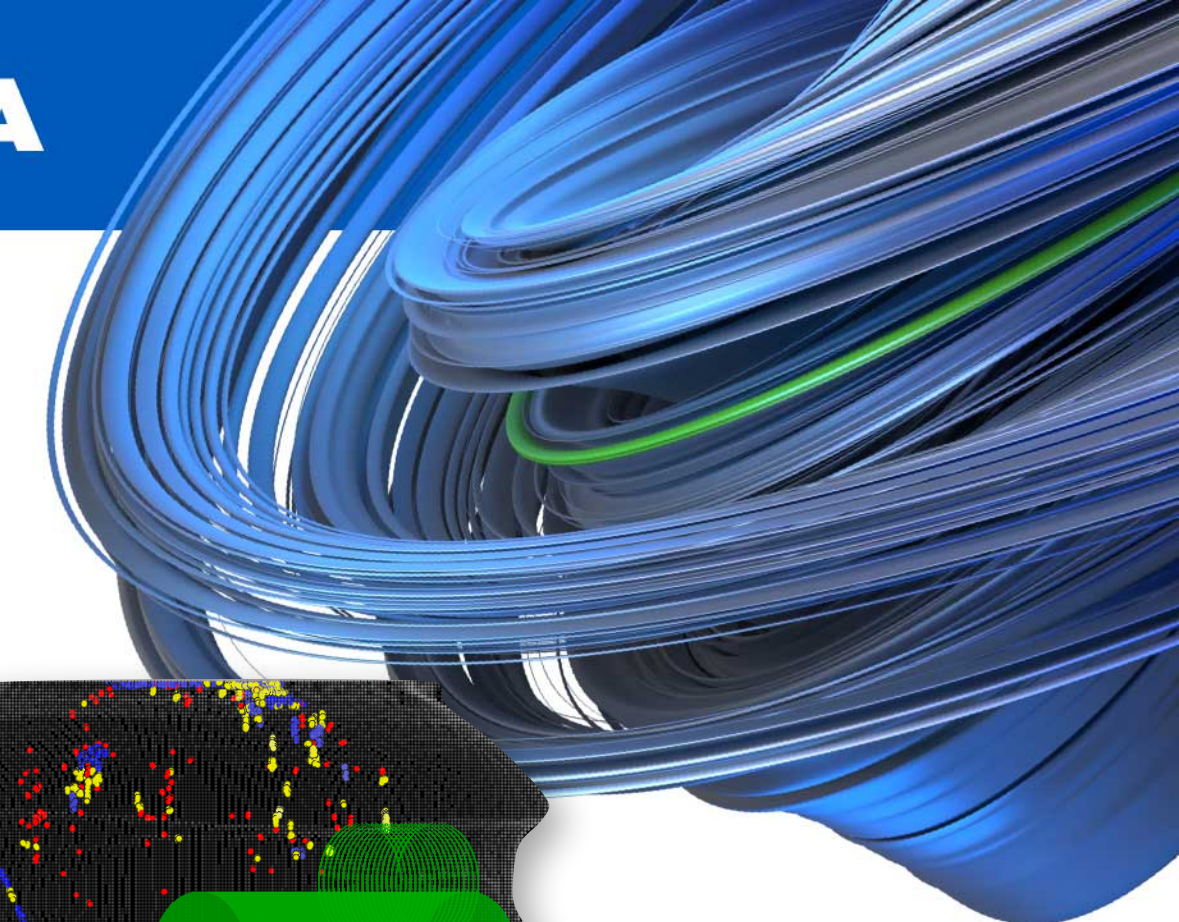
Digital twin



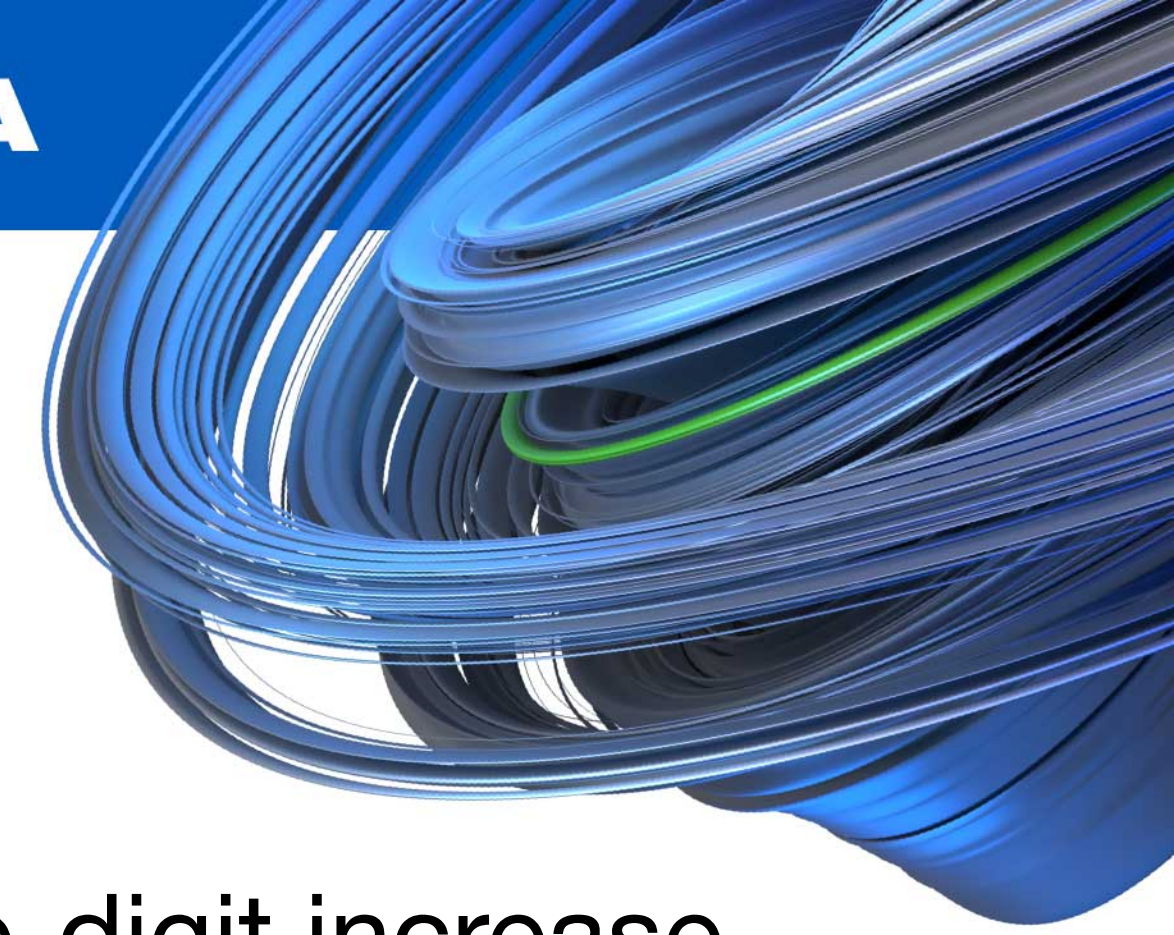
Smart Coring



Smart Wafering



- What is required ?**
- 3D scans of crystals (digital twins) with XYZ coordinates of defects
  - Coring and/or wafering system that allows offset



## Summary

- 3D defect mapping at an early stage (digital twins) allows up to double-digit increase in yield without increasing machining capacity.
- First optimisation routines to achieve such increase are:
  - **Smart Wafering:** pre-computed core shift in the wafering system
  - **Smart Coring:** positioning the cores in the crystal to extrude into the least defective volume.

# Scanners for all crystal sizes and applications



**SapphiroScan™ for small plates**



**SapphiroScope™ for LED industry**



**TotalScan™ for X-large crystals**

- Instant 3D defect visualisation in raw crystals
- Defects positions measured at  $\mu\text{m}$ -level

- Automatic defect grading with customised thresholds
- Statistical analysis for improving crystal growth production



Scientific Visual

**Scientific Visual**

+41 79 125 64 47

Chemin du Closel 5

Lausanne 1020

Switzerland

[welcome@scientificvisual.ch](mailto:welcome@scientificvisual.ch)

[www.scientificvisual.ch](http://www.scientificvisual.ch)



We are proud to be supported by EU Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101033102.