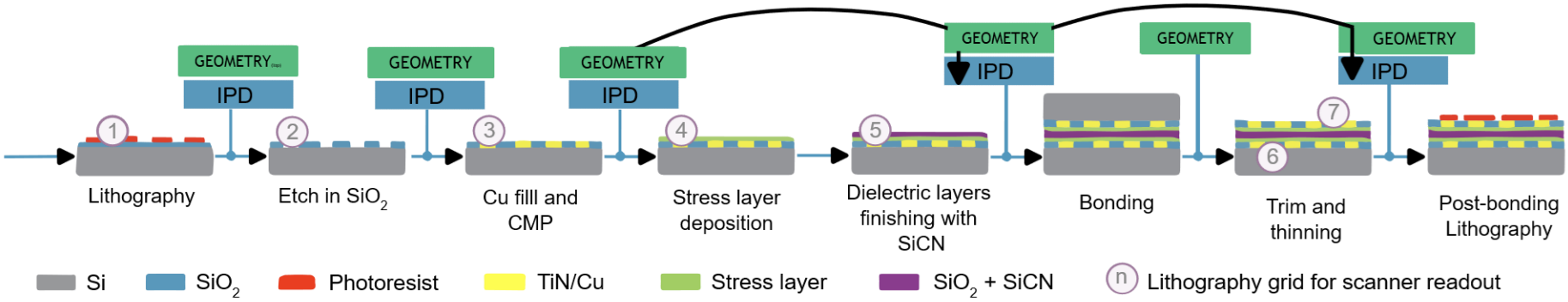
Halfgeleider productieproces optimalisatie

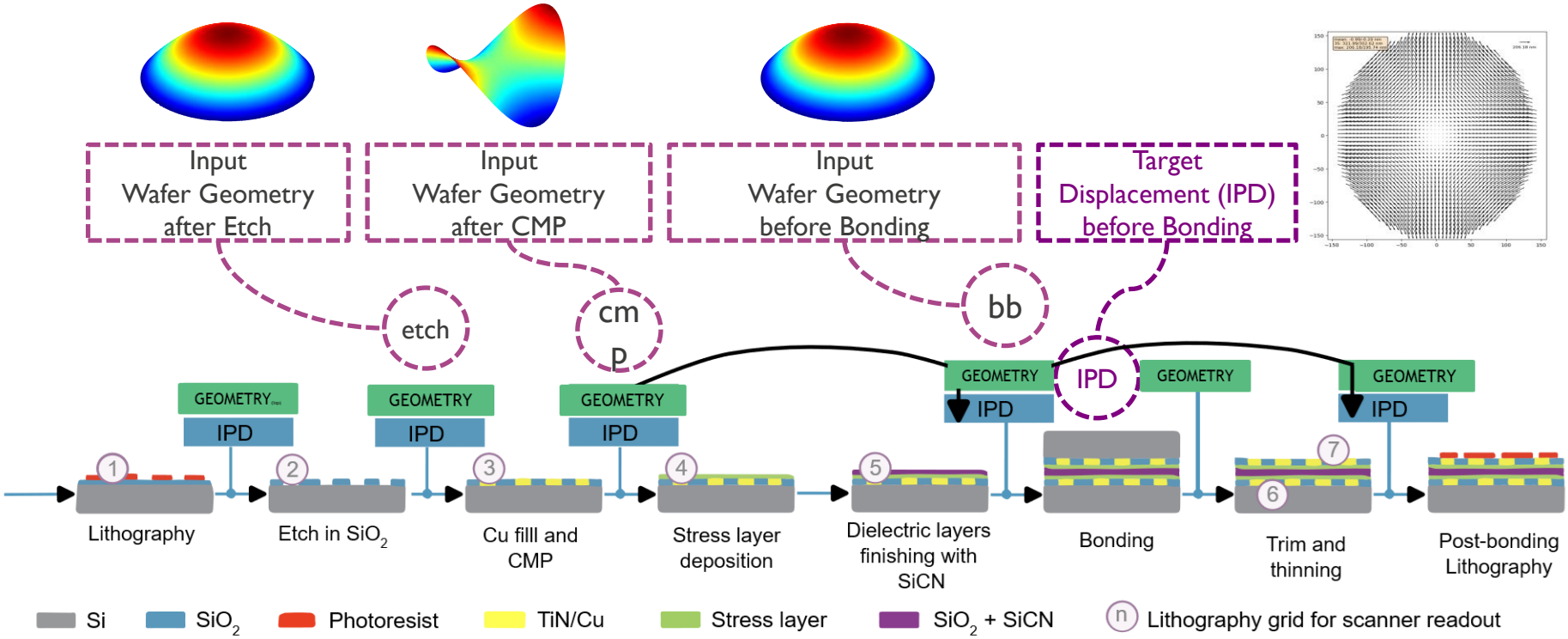
Roel Wuyts

Imec: het chiplabo van de wereld

Example CMOS workflow: many complex process steps

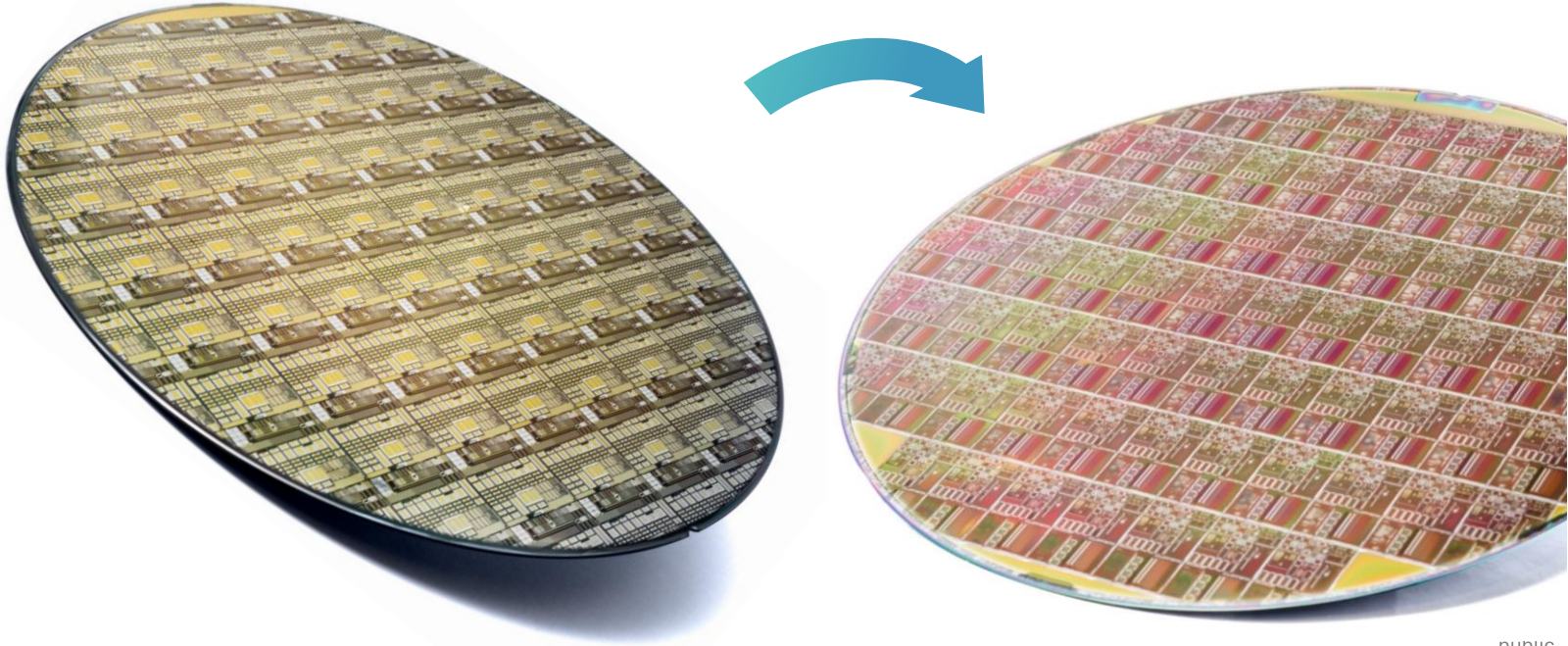


Example: (Federated) ML for Wafer Displacement



Wafer Bonding

Optimize overlay when putting one wafer on top of another



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Using AI to model wafer bonding is hard

Go for Hybrid AI to model wafer bonding

Black-box models
(eg Neural Networks)

White-box models
(eg Finite Element Modeling)

Loss function

Constraining physical quantities
- Encoding conservation laws
- Auxiliary tasks
  - Encoding governing equations

Hybrid ML

Hybrid approaches
- Residual modelling
- Differential physics
- Neural differential equations
- In-the-loop methods

Architecture

Adding physical variables
- Encoding symmetries
  - Physics-inspired NAS
- ML inspired by Koopman theory
- Physically constrained GPs

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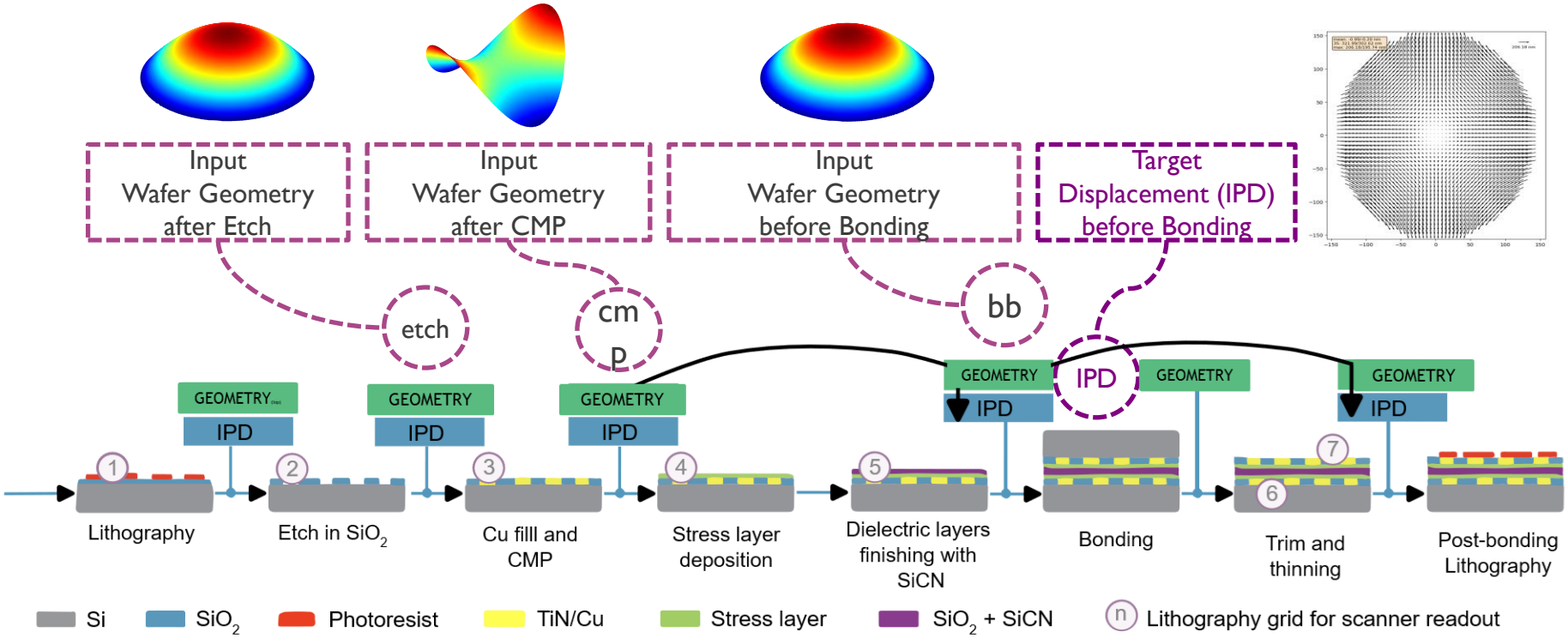
(Federated) ML across the process



Overview of Hybrid AI research applications

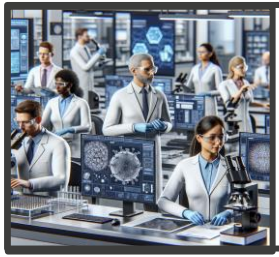
(non-exhaustive)

INSPECTION & CONTROL:

- **Hybrid unsupervised learning** for failure detection and classification of electrical defects
- **Multivariate physics-inspired AI models** for efficient testing & design of photonic components

TECHNOLOGY PATHFINDING:

- Accelerating or replacing **rigorous simulations** or **experimental iterative** processes with combined data-driven & physics models
- Accelerating traditional FEM simulations with **Surrogate modelling**, **PINN**s.



DRUG DISCOVERY RESEARCH → MATERIALS DISCOVERY:

- Active Learning Hybrid ML to complete, accelerate or replace atomistic simulations
- Multi-fidelity optimization / ranking of molecules
- HW/SW - co-optimizing the compute budget

High Performance Compute for hybrid AI workloads (HW/SW Codesign)

Applied research in combining physics and data-driven methods

AutoML
Automation in Machine Learning

SUMO
SUrrogate Modeling

GenAI + RL
(for molecule generation)

PI-ML
Physics-Informed ML

Active learning
hybrid ML (MD)

DE-ML
Data-Efficient ML

X-ML
eXplainable ML

High performance compute

Semiconductor Manufacturing

Applied research in combining physics and data-driven methods

AutoML
Automation in Machine Learning

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Active learning
hybrid ML (MD)

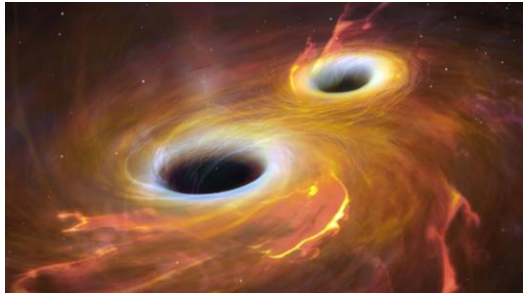
DE-ML
Data-Efficient ML

X-ML
eXplainable ML

High performance compute

Semiconductor Manufacturing

Einstein Telescope

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