GEORGIA INSTITUTE OF TECHNOLOGY · ECE 8803-AI4

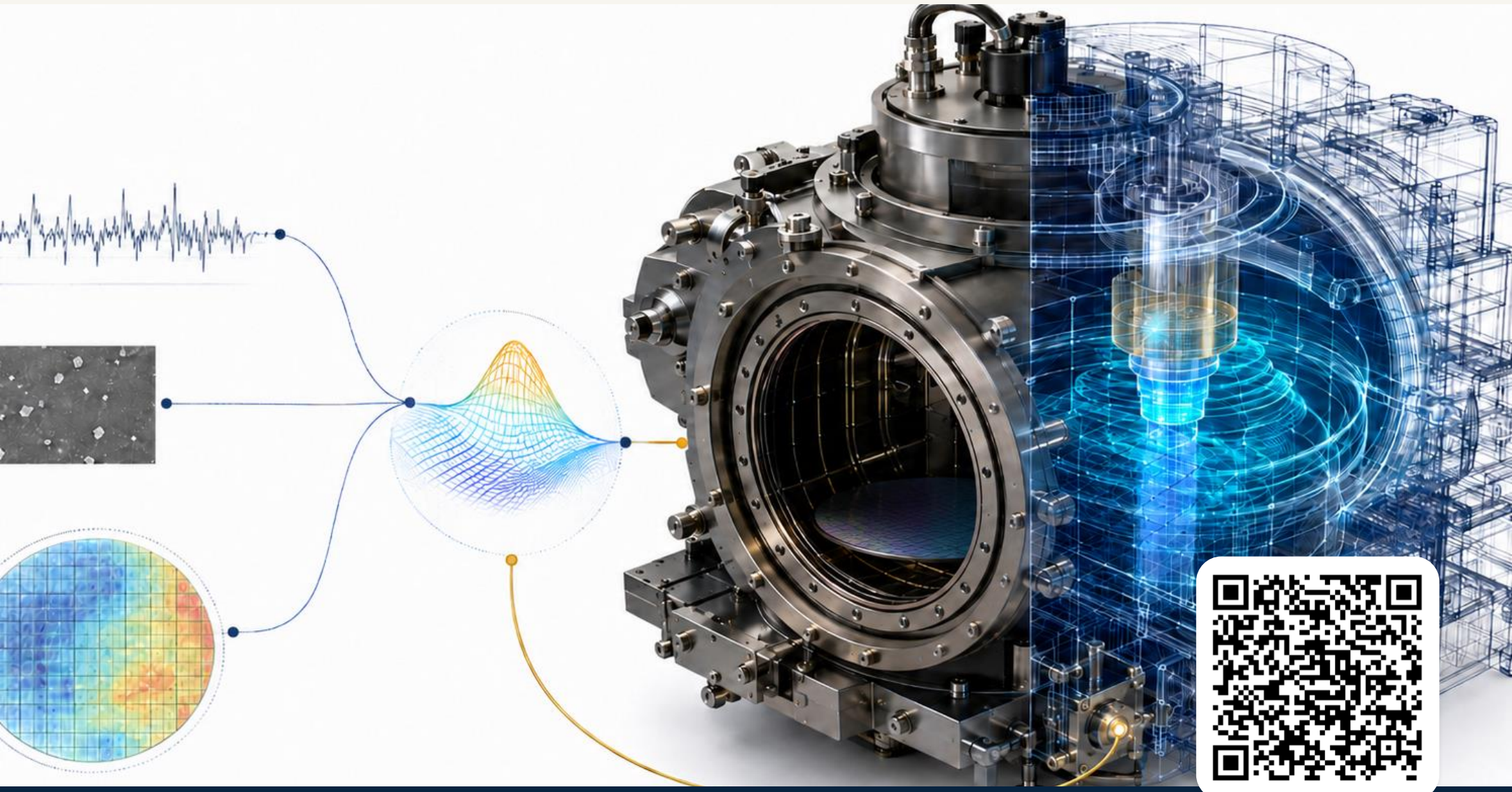
AI FOR SEMICONDUCTOR MANUFACTURING

Graduate course · Fall 2026

From process monitoring and metrology to optimization, autonomy and EDA

Prof. Asif Khan School of Electrical and Computer Engineering

https://aikhan123.github.io/khan-lab-website/ai-semiconductors-course.html



COURSE WEBSITE

SCAN OR USE THE LINK ABOVE

Course modules

Fourteen modules connect AI methods to semiconductor manufacturing problems.

MODULES 01–07

01 Introduction

02 Fault detection and classification

03 Wafer-map defect classification

04 Agentic AI as a process engineer

05 Statistical process control

06 Virtual metrology

07 Test and qualification

MODULES 08–14

08 Digital twins, toolchain and deployment

09 Transfer learning and domain adaptation

10 Generative models for limited data

11 Physics-informed machine learning

12 Bayesian optimization and DoE

13 Reinforcement learning

14 AI in design and EDA

Modules 1–7 are published. Modules 8–14 follow through December 2026.

MODULE 01

INTRODUCTION

PUBLISHED

Where does AI enter semiconductor manufacturing?

MODULE 02

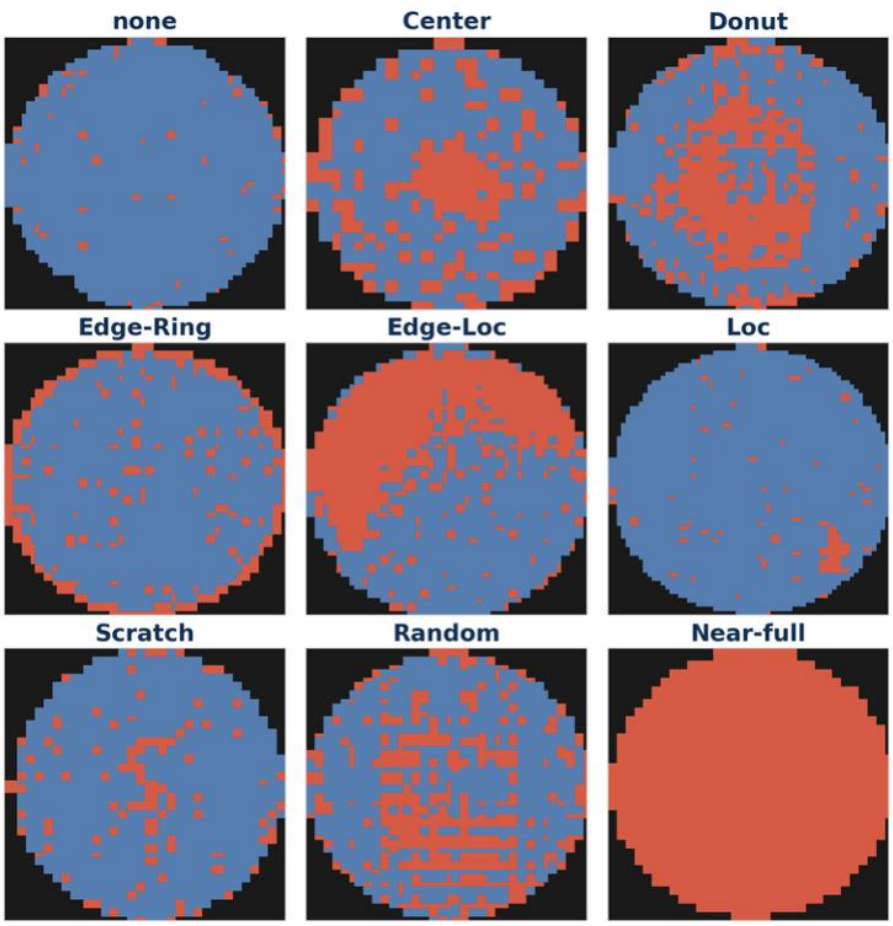
FAULT DETECTION AND CLASSIFICATION

Can sensor traces identify an excursion before the wafer moves?

MODULE 03

WAFER-MAP DEFECT CLASSIFICATION

What process failure produced this spatial pattern?



FROM FAB DATA TO SPATIAL DEFECT SIGNATURES

CORE IDEAS

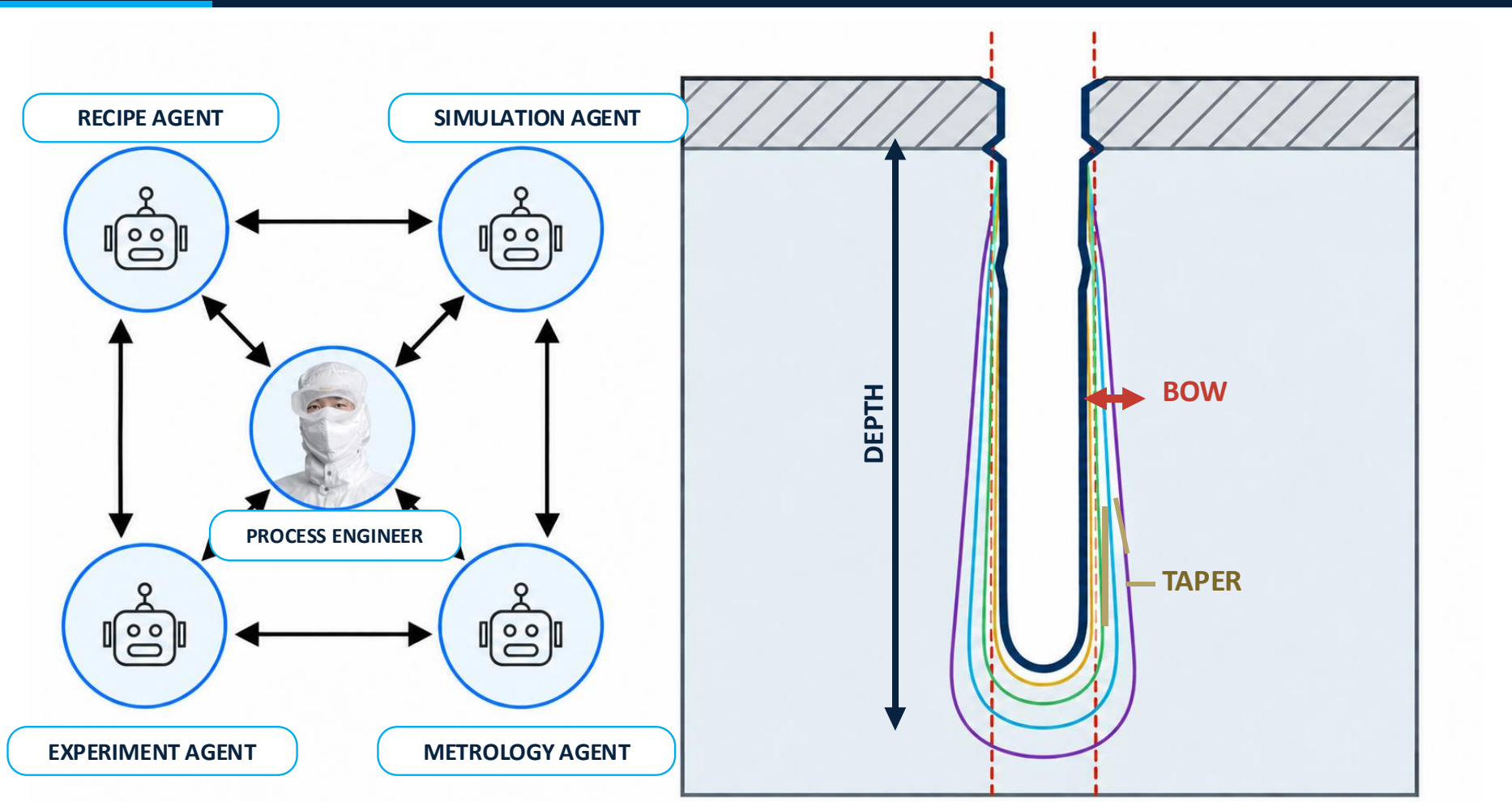
Fab data and process context · sensor traces and excursions · wafer patterns and failure mechanisms

MODULE
04

AGENTIC AI AS A PROCESS ENGINEER

PUBLISHED

Can a team of AI agents develop a high-aspect-ratio etch?



A multi-agent framework coordinates process development

RECIPE	Propose process conditions under explicit engineering constraints.
SIMULATION	Predict the evolving high-aspect-ratio profile with ViennaPS.
METROLOGY	Compare profile depth, bow and taper with microscopy data.
EXPERIMENT	Choose the next run and update the shared process hypothesis.

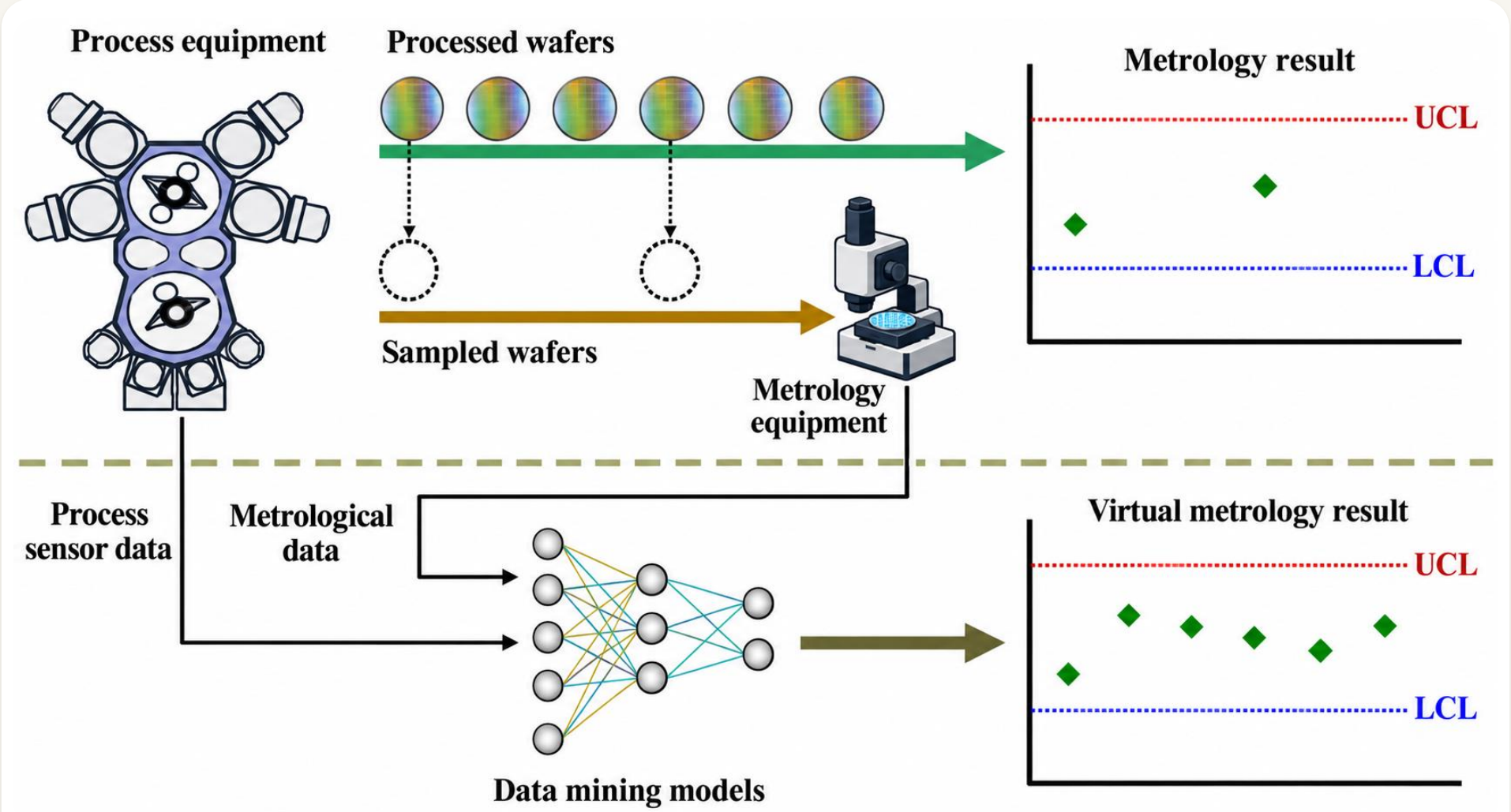
MODULE 05

MODULE 06

STATISTICAL PROCESS CONTROL AND VIRTUAL METROLOGY

PUBLISHED

Can we detect process shifts and predict every wafer?



SPC DETECTS CHANGE. VIRTUAL METROLOGY PREDICTS EVERY WAFER.

CORE IDEAS

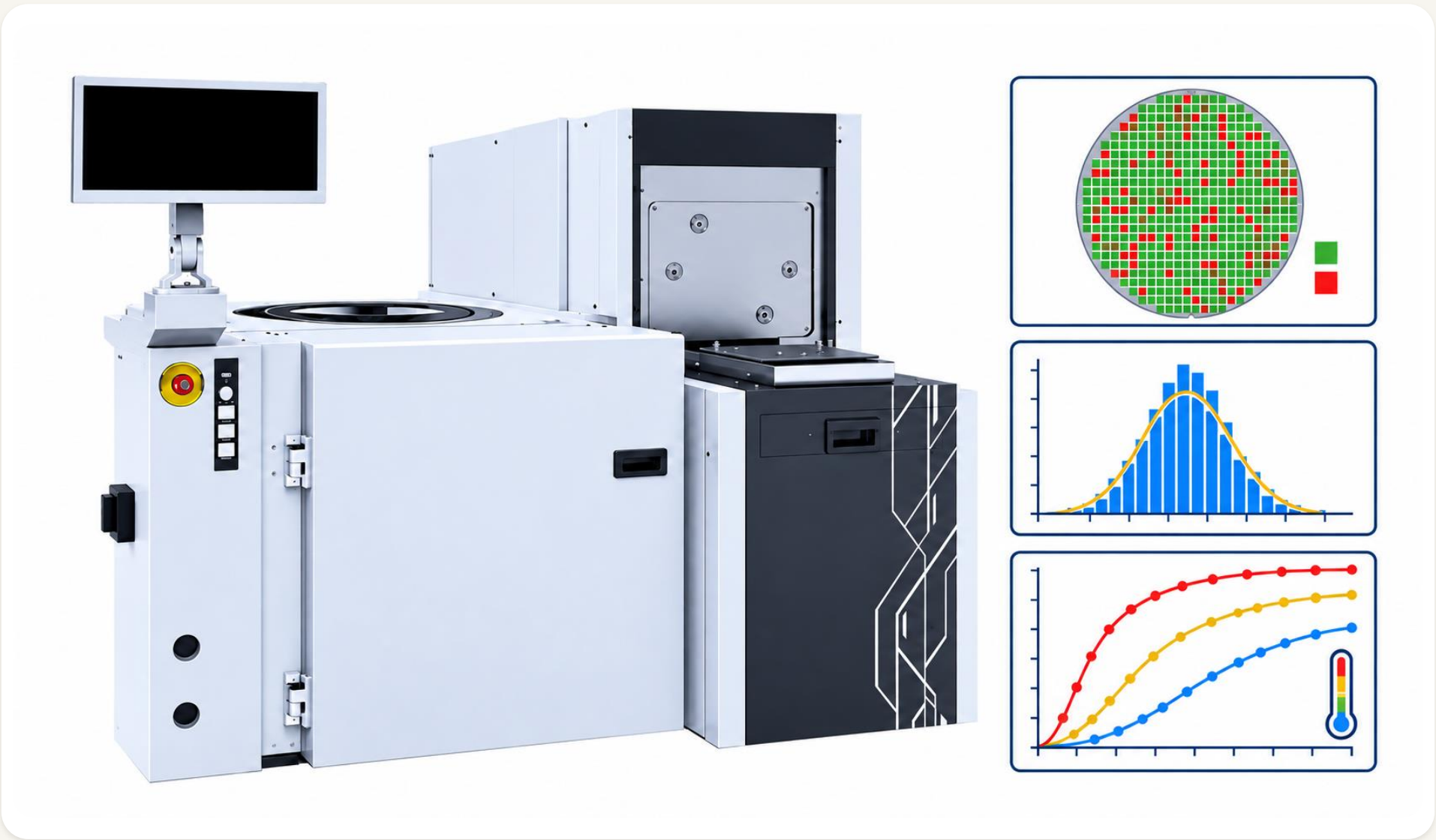
Control charts and run rules · Cp/Cpk · partial least squares · prediction intervals · drift monitoring · run-to-run control

MODULE
07

TEST AND QUALIFICATION

PUBLISHED

Will this chip work today—and years from now?



ELECTRICAL TEST DATA SUPPORT SCREENING, YIELD ANALYSIS AND QUALIFICATION

CORE IDEAS

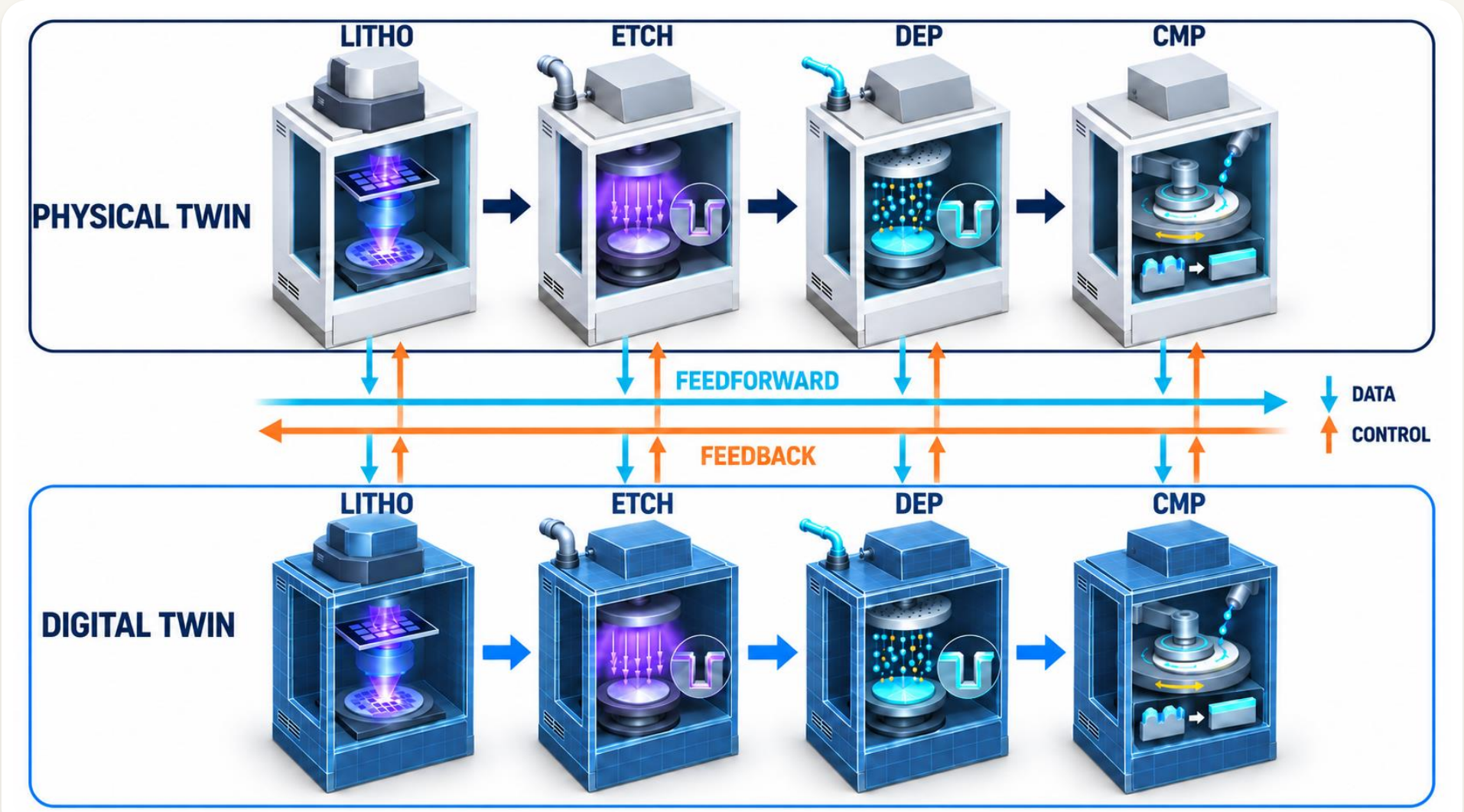
Rare-defect screening · accelerated lifetime tests · censoring · uncertainty · cost-aware ML

MODULE
08

DIGITAL TWINS, TOOLCHAIN AND DEPLOYMENT

FALL 2026

How does a digital twin connect fab data, models and control?



PHYSICAL AND DIGITAL PROCESS FLOWS EXCHANGE DATA AND CONTROL

CORE IDEAS

Digital twins · PyTorch and MLflow · versioning · monitoring · retraining · feedforward and feedback control

MODULE 09

TRANSFER LEARNING AND DOMAIN ADAPTATION

Will a model trained on one chamber work on another?

FALL 2026

MODULE 10

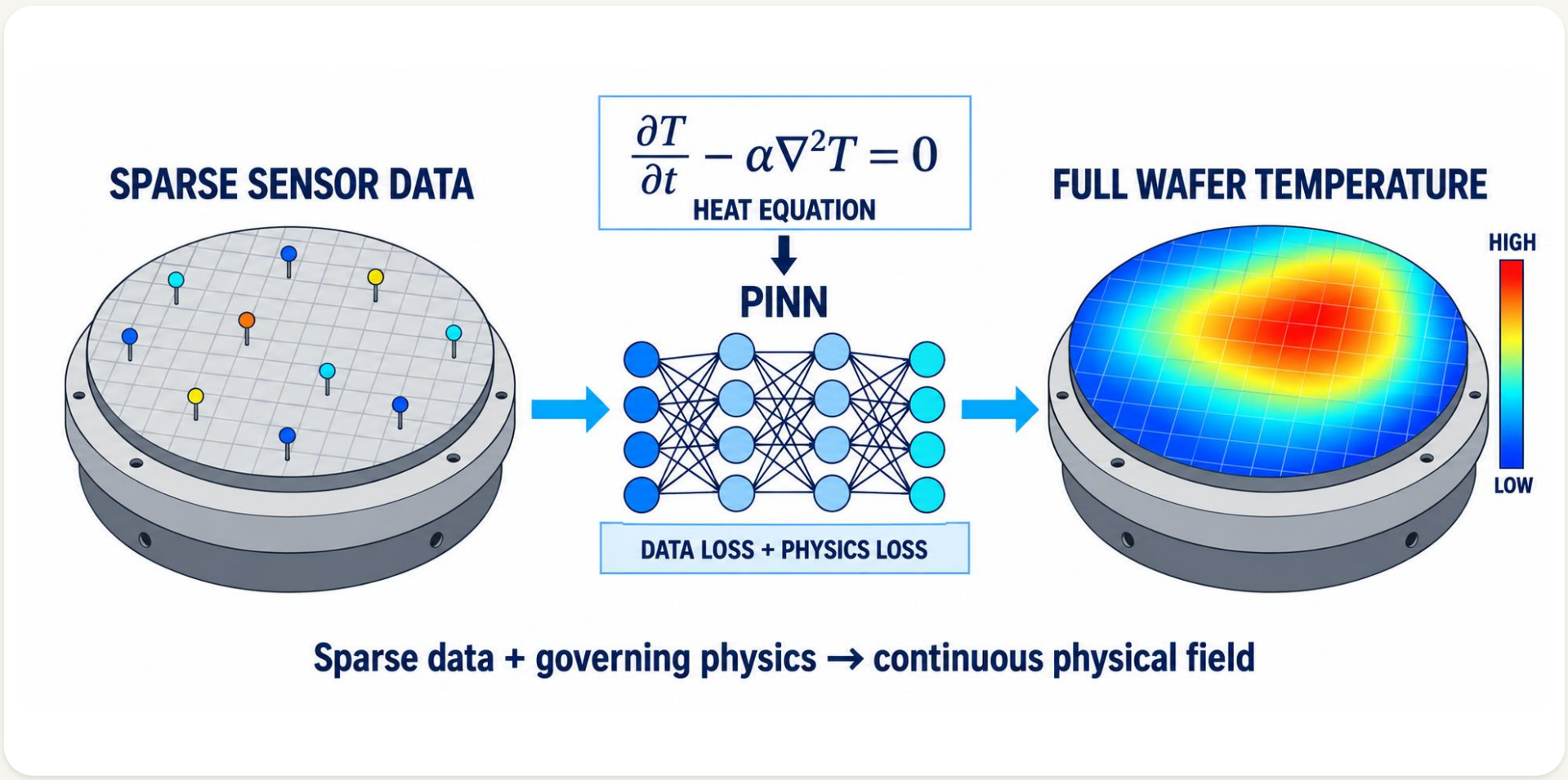
GENERATIVE MODELS FOR LIMITED DATA

Can AI create useful examples of rare defects?

MODULE 11

PHYSICS-INFORMED MACHINE LEARNING

How can a model obey known process physics?



LEARNING FROM SHIFTED, LIMITED AND PHYSICS-CONSTRAINED DATA

CORE IDEAS

Domain adaptation · synthetic data for rare cases · physics constraints · inverse models · operator surrogates

MODULE 12

BAYESIAN OPTIMIZATION AND DoE

FALL 2026

If every run is expensive, where should the next experiment go?

MODULE 13

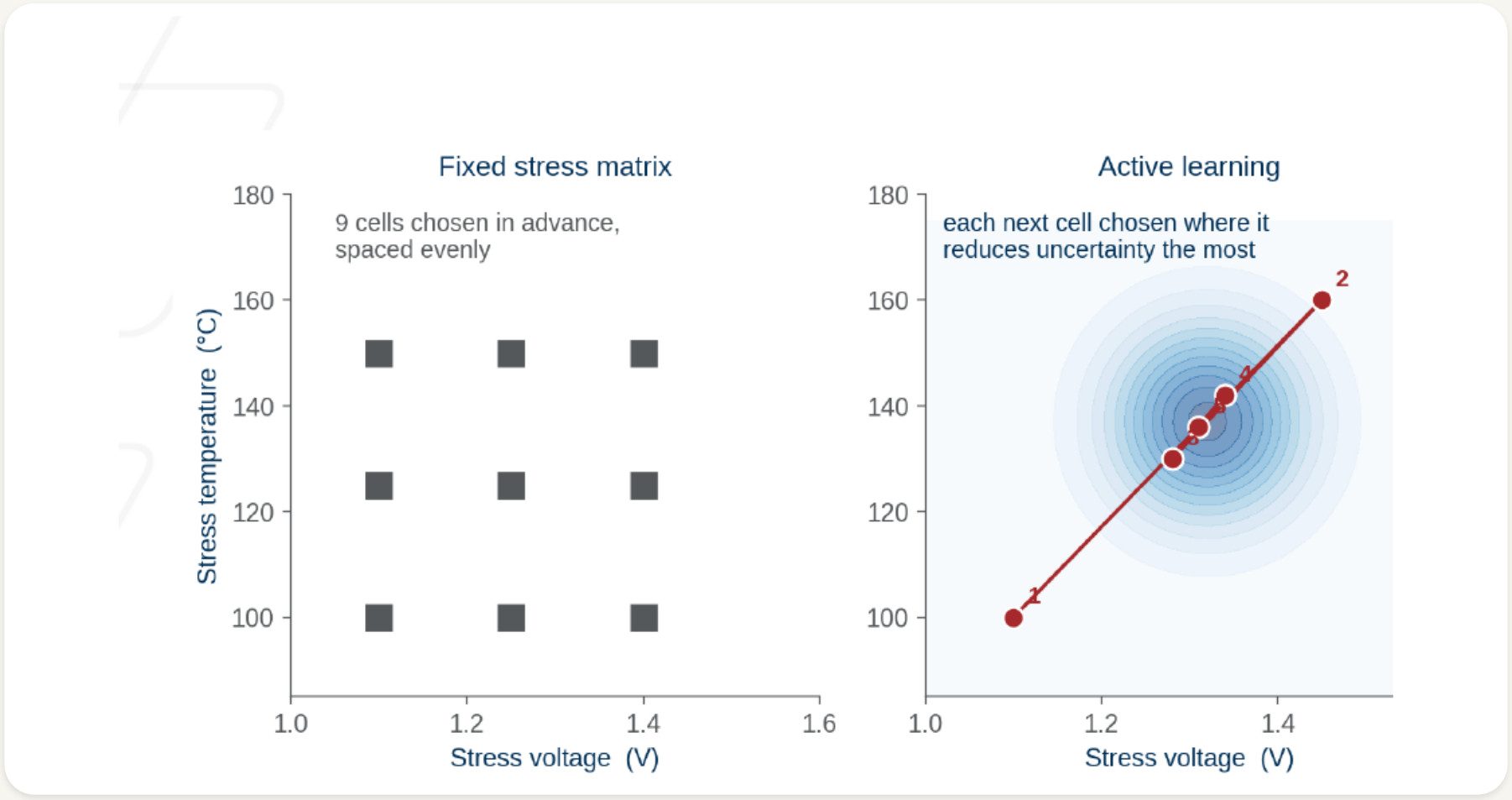
REINFORCEMENT LEARNING

What changes when optimization becomes a sequence of decisions?

MODULE 14

AI IN DESIGN AND EDA

How do manufacturing constraints flow back into chip design?



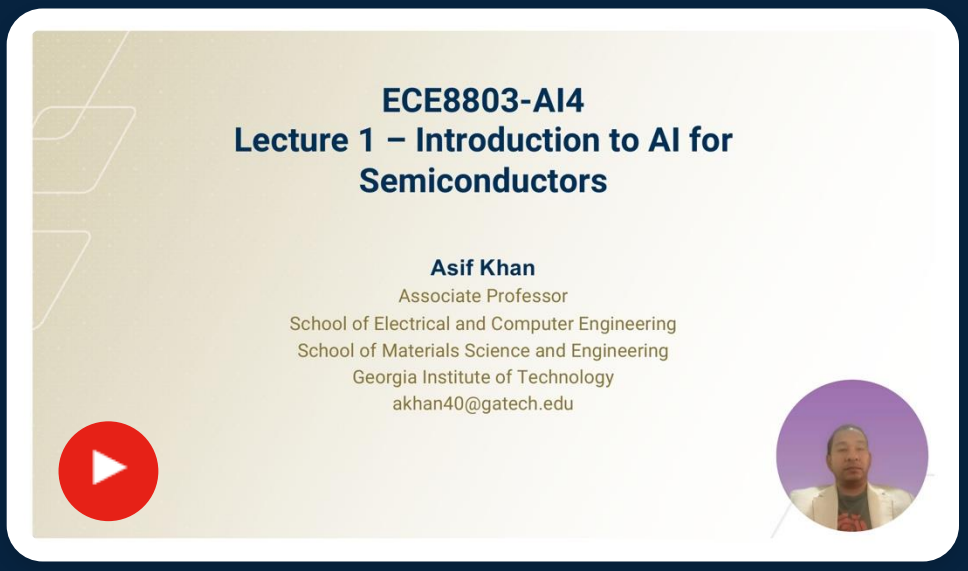
EXPERIMENT SELECTION, SEQUENTIAL DECISIONS AND DESIGN

CORE IDEAS

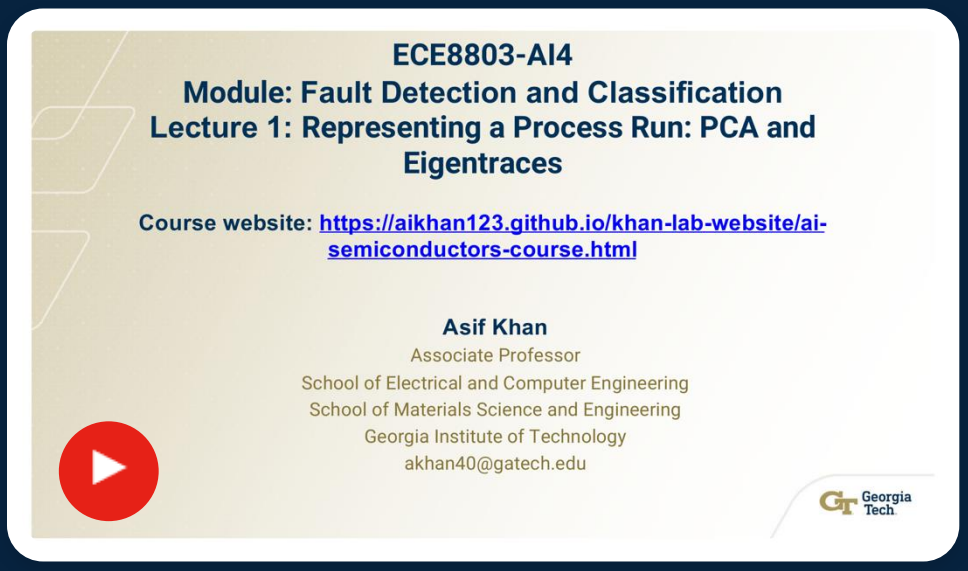
Gaussian processes and acquisition functions · policy learning · autonomous experimentation · design-technology co-optimization · computational lithography

Prefer to watch?

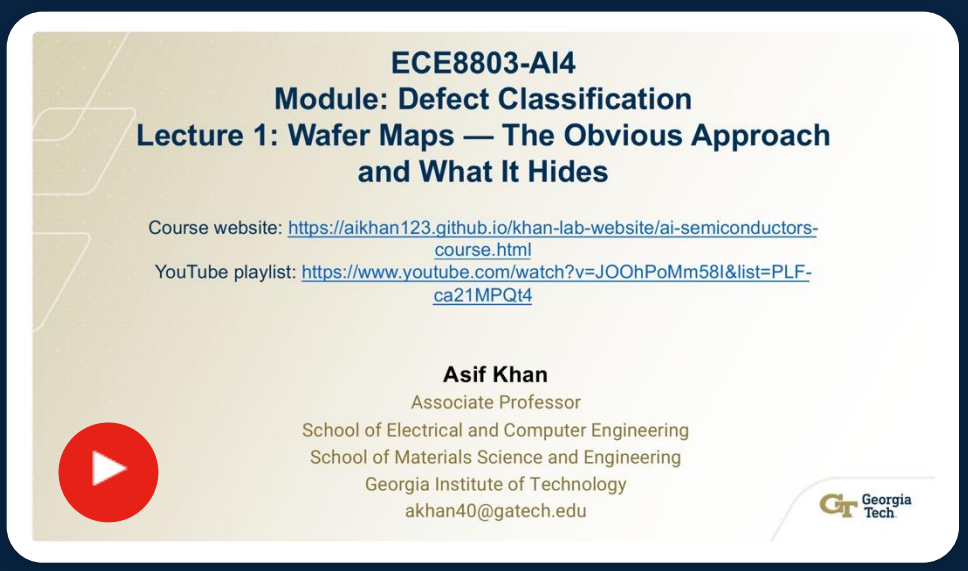
Recorded lectures are available on YouTube



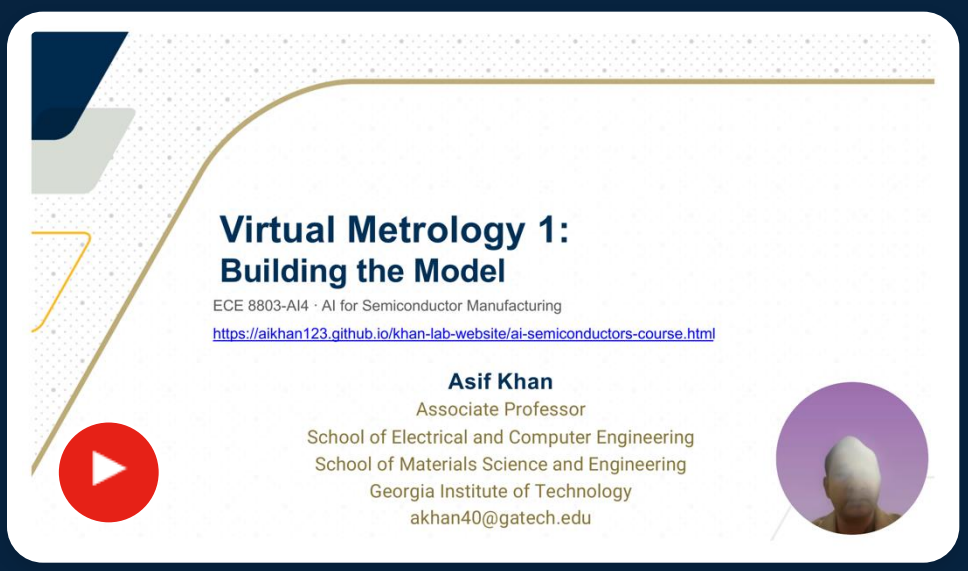
WHERE AI ENTERS THE FAB



FAULT DETECTION + PCA



WAFER-MAP CLASSIFICATION



VIRTUAL METROLOGY

New lectures added throughout Fall 2026

OPEN THE YOUTUBE PLAYLIST

youtube.com/playlist?list=PLF-ca21MPQt4

Course materials

ECE 8803-AI4 · Georgia Institute of Technology · Fall 2026

Each module connects the underlying methods to a semiconductor manufacturing problem.

LECTURE NOTES

Slides and derivations

RECORDINGS

Module lectures on YouTube

LABS

Colab-ready Python notebooks

DATA

Public benchmark datasets

SIMULATION

Open-source process simulators

ASSESSMENT

Homework and applied exercises

CURRENT SEMESTER

Modules 1–7 are available. Modules 8–14 will be added through December 2026.

Feedback from colleagues in industry, academia and national laboratories is welcome.

PROF. ASIF KHAN

School of Electrical and Computer Engineering · Georgia Tech

aikhan123.github.io/khan-lab-website/ai-semiconductors-course.html