

The image features a vertical split background. The left side is a gradient from red at the top to dark blue at the bottom, overlaid with a glowing network of nodes and lines at the top and a hexagonal grid pattern at the bottom. The right side is white with a faint, large-scale hexagonal grid pattern. The SILVACO logo is positioned in the upper left, with a horizontal line underneath the name.

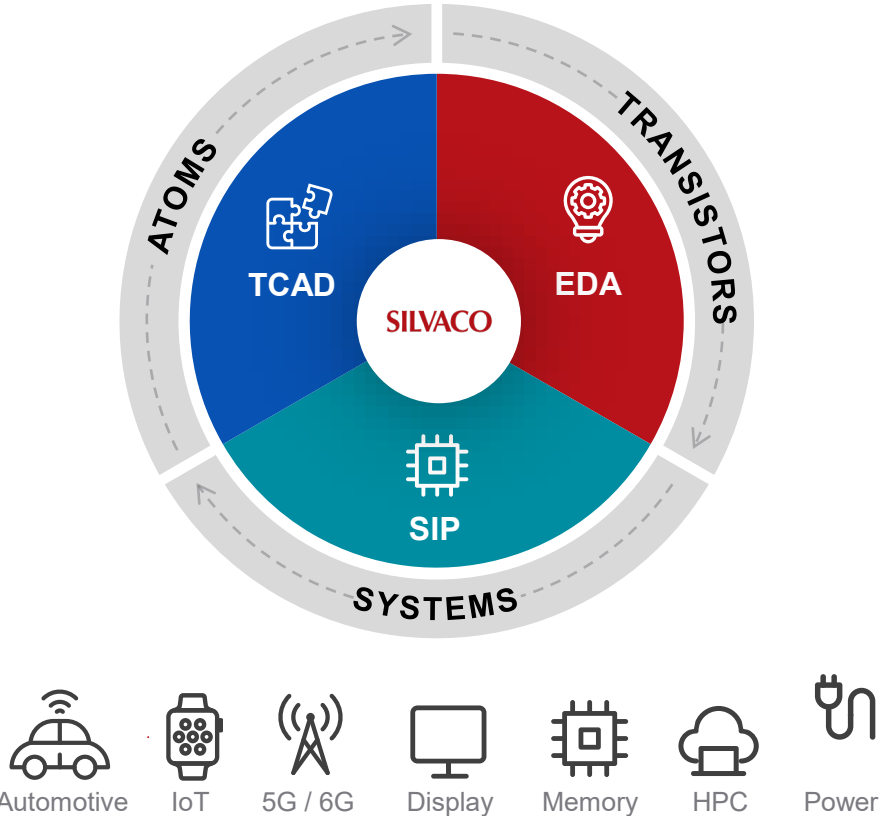
SILVACO

Applying Artificial Intelligence in Fab
Technology Co-Optimization™

Silvaco At A Glance

Enabling semiconductor innovation from atoms to systems

Design, Simulate, Analyze, and Verify
from Concept to Complete Product Yield



Silvaco Leadership

600+
Customers

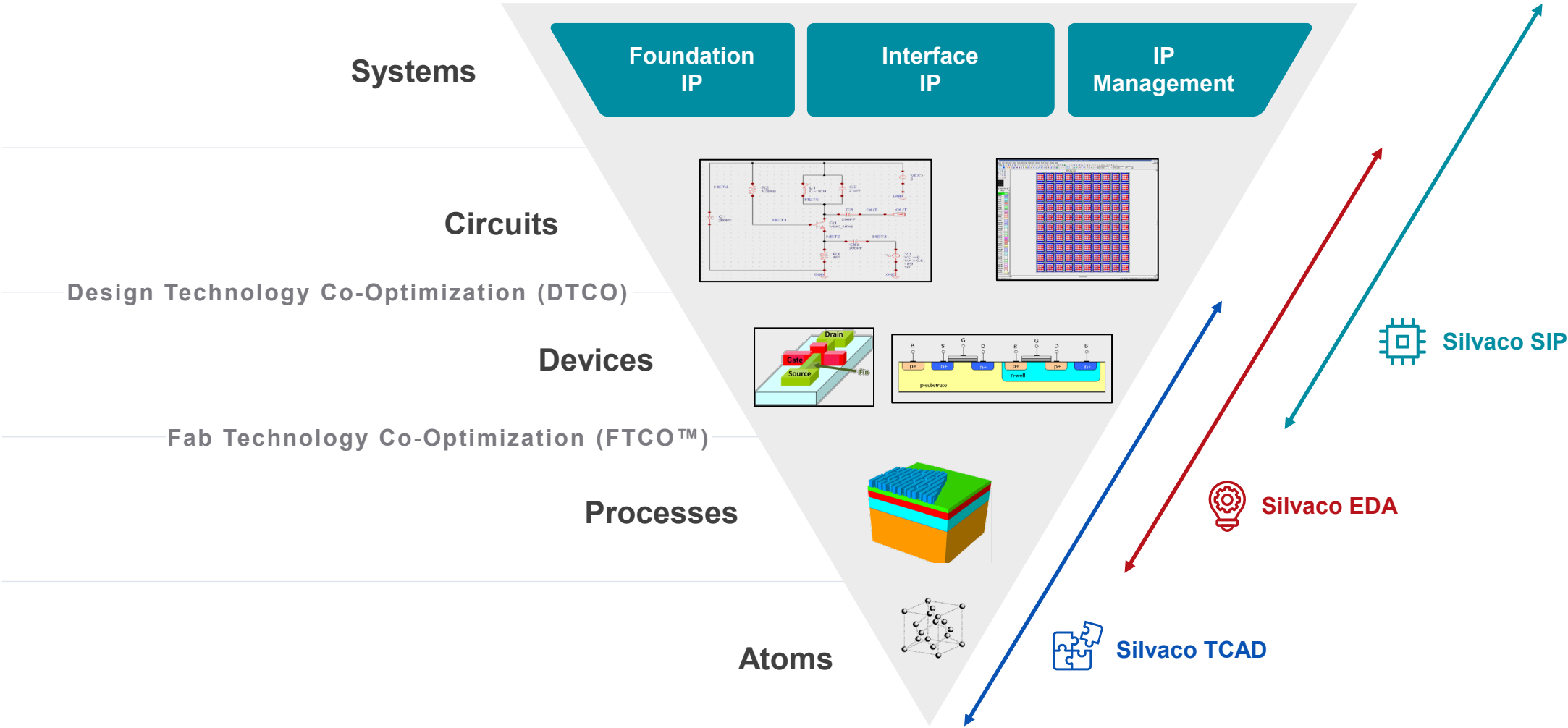
200+
University Customers

260+
Employees

Global Presence



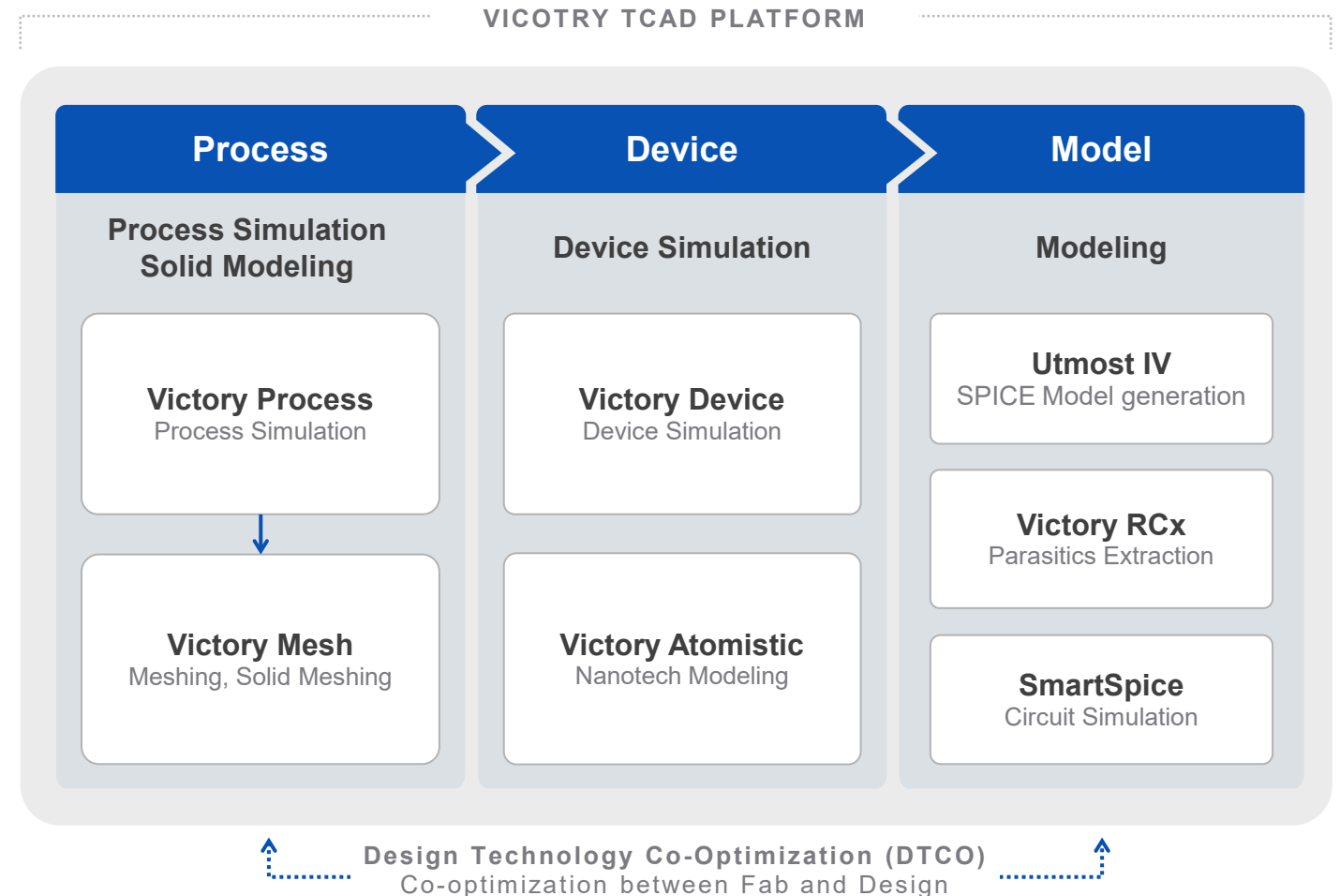
From Atoms To Systems Platform



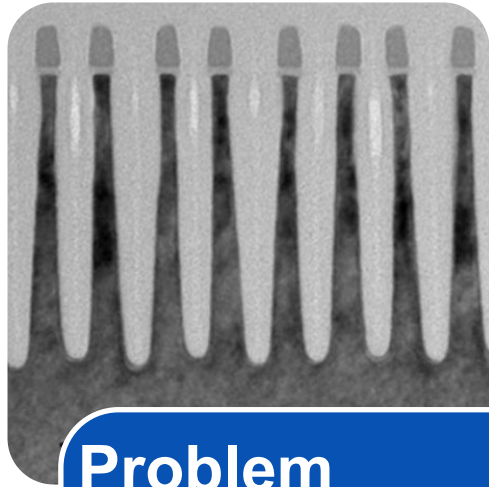
Victory TCAD Platform

Develop semiconductor processes and devices prior to and during manufacturing

- Model and simulate the manufacturing process
- Model and simulate semiconductor and photonic device behavior
- Explore trade-offs in performance, power, size and reliability
- Accelerate time to yield
- Co-Optimize between fab and design



Motivation for Application of AI in Fab Process Optimization



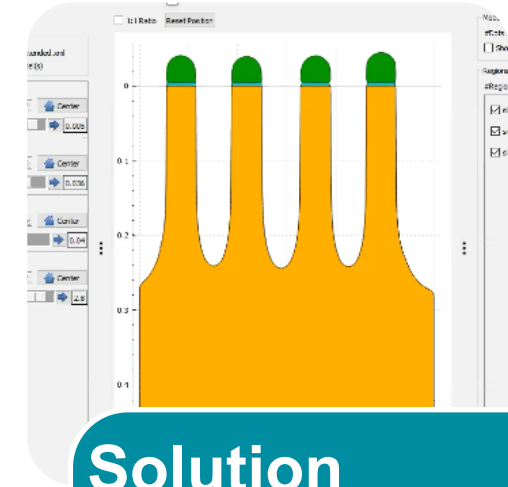
Problem

- Fabs are getting more complex
- Running DoE with wafers to optimize fabs not scaling
- No two fab lines are identical



Consequences

- Traditional methods of optimizing fab processes is slow
- Impact on time-to-yield and profitability
- Costly and time-consuming to bring up a new fab line



Solution

- Application of **Digital Twin** technology and **AI** to accelerate fab process optimization
- Saves costs and accelerates fab bring up
- Works with Memory, CMOS, SiC, GaN, etc.

Four Levels of AI in EDA Industry

Self-Optimizing Tools



Improve Performance of Existing Design Tools

- Training for specific capability
- Reinforcement learning
- Efficiency improvement
- Optimum results in less time

Design Assistant



Build Foundation Models From Design Experience

- Machine learning foundation models
- Learns about design and style
- Design strategy recommendations
- Understanding of intent

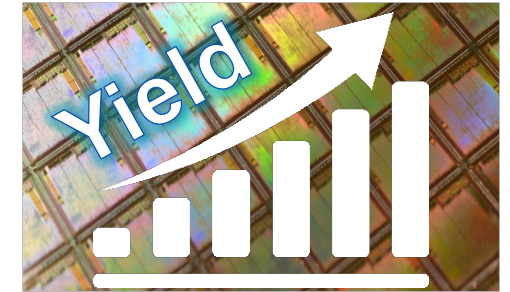
Generative Design



Expand Assistant Capabilities

- Deep learning on mega data
- Generate new data
- Self-supervised learning
- Design generated from requirements

Fab Assistant



Build Digital Twin of Fab Process

- Use manufacturing data to develop Digital Twin of Fab
- Builds a Real-Time model of Fab Process
- Fab engineers run experiments on desktop
- Identify issues that impact yield, faster and earlier

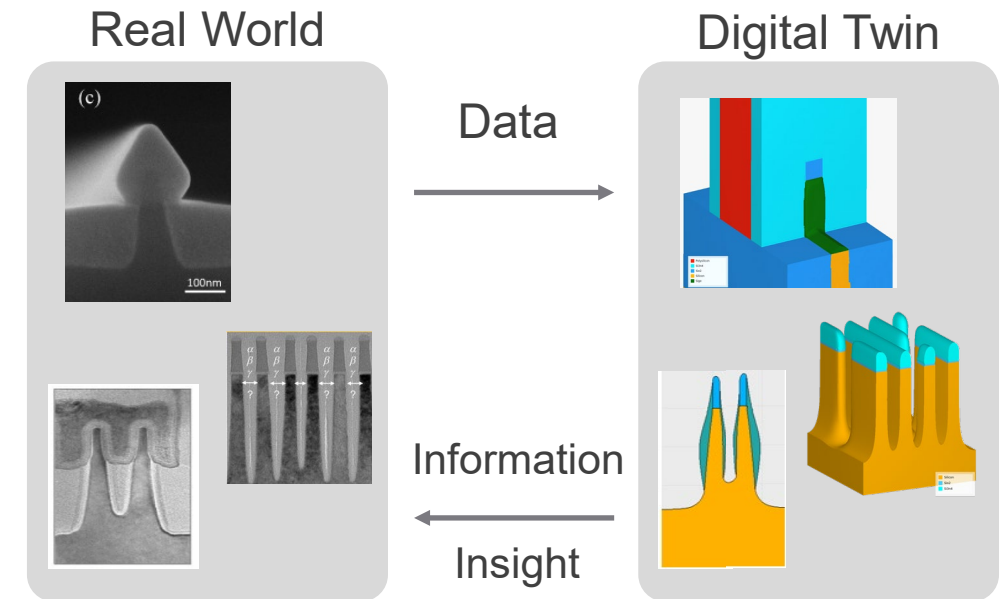
Source: DAC 2023 Keynote, Wally Rhines, President & CEO Cornami, Inc
& Silvaco independent director

Digital Twin

A physics-based digital counterpart that mirrors the form, fit and function of the physical world

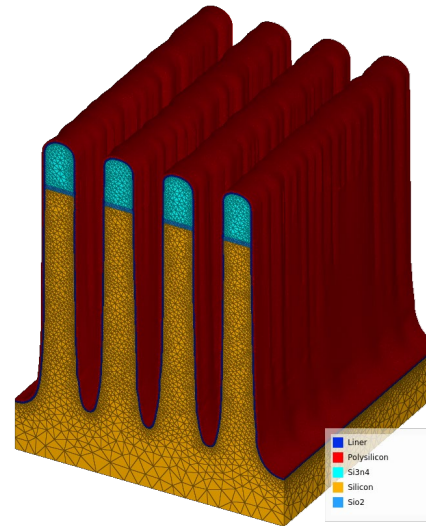
“Digital Twin” concept was introduced over 20 years ago as a product Lifecycle Management (PLM) concept.

- A Digital Twin is a virtual representation of complex real system
 - Components, devices, or full fab process
 - Designed to model and be indistinguishable from the real-world system
 - Provides insight into how the behavior of the real system will change with variation in design
- A Digital Twin can start to form prior to the real system, and can allow for virtual prototyping
- Once formed, the digital twin allows engineers to ask the digital twin “what-if” scenarios

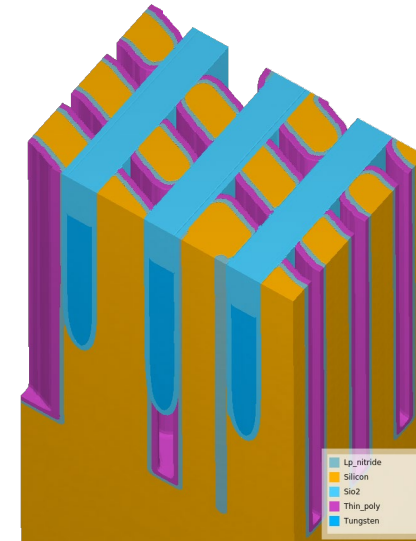


Exploring The Digital Twin Concept with TCAD

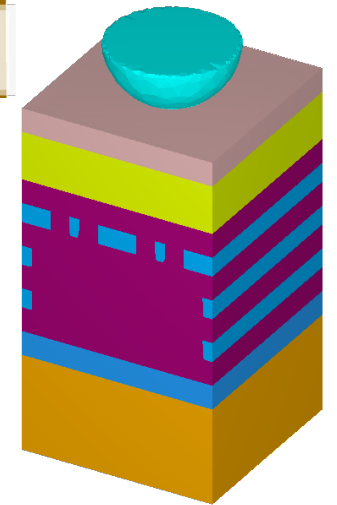
- Silvaco's physics-based simulators virtualizes semiconductor and photonics manufacturing and device characterization
- Allows organizations to maintain a “digital twin” of their semiconductor process and devices
- Accurate digital twins can focus on predictive power rather than on real time monitoring



FIN Process Flow with LER



DRAM Process Flow

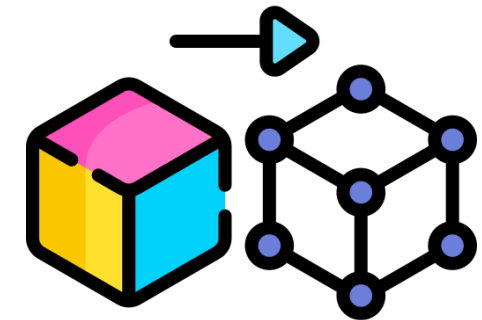


BEOL Process Flow

Silvaco's Machine Learning Accelerates Semiconductor Digital Twin Development



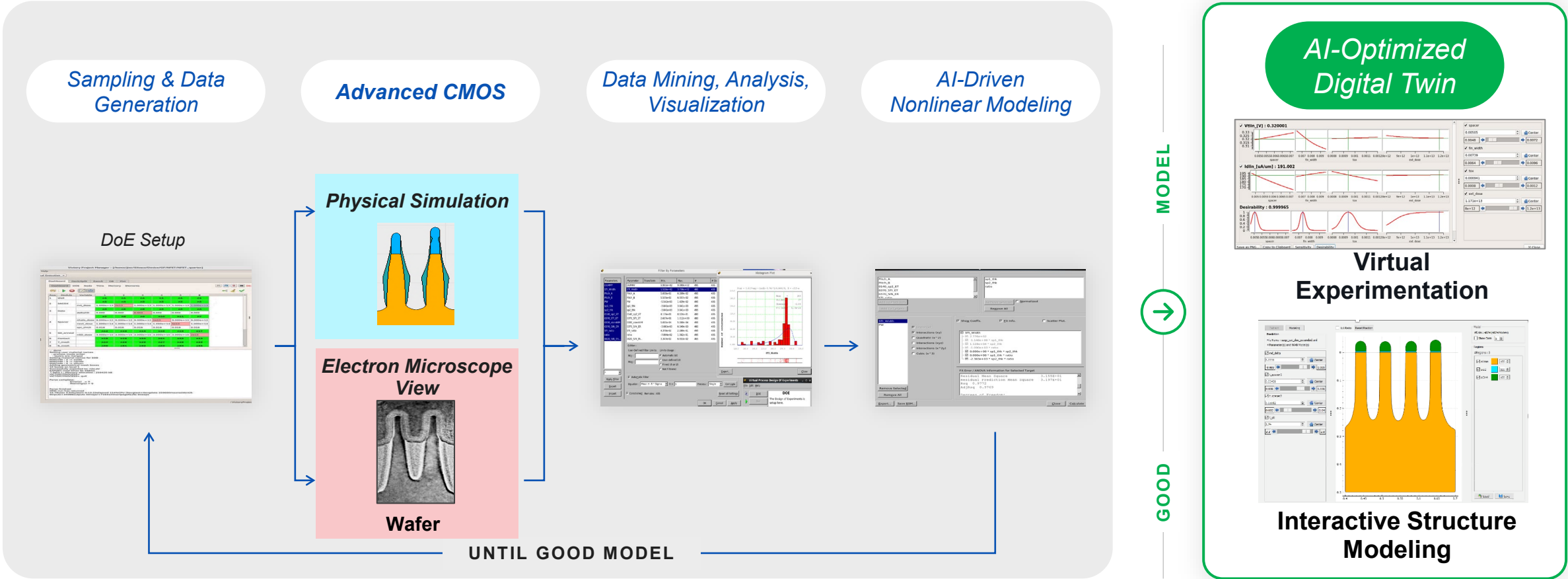
- Real Fab/Electrical Data and Physics-Based Simulation generates training data
 - ML training is done using simulated structure or real fab data
 - Simulation-efficient state of art DoE algorithm
 - Advanced 3D metrology (min distance, overlap area, hotspot ...etc.)
- ML algorithms help refine digital twin model accuracy
 - Advanced neural network
 - Decision tree algorithm for outlier detection
 - Dominant input screen by advanced statistical method
- Integrated solution
 - Both simulation and ML analysis are under the same GUI framework



Silvaco's AI-Driven Fab Technology Co-Optimization (FTCO™)

Removing cost of trial-and-error using AI-driven models through digital twins

- AI customizes solutions for fabs automatically
- Broad application in the semiconductor processes
 - CMOS, SiC, GaN, Memory



FTCO™ Solution Platform

Tool Components

ML/AI Analysis Tools

Victory Analytics

- Machine Learning analytics solution designed for the semiconductor industry. Tool is comprised of data visualization, input feature selection and data training, modeling, optimization and DOE.

DoE Environment

Victory DoE

- Project Manager and Design of Experiment tool

Core Data for building a Digital Twin

Victory Process

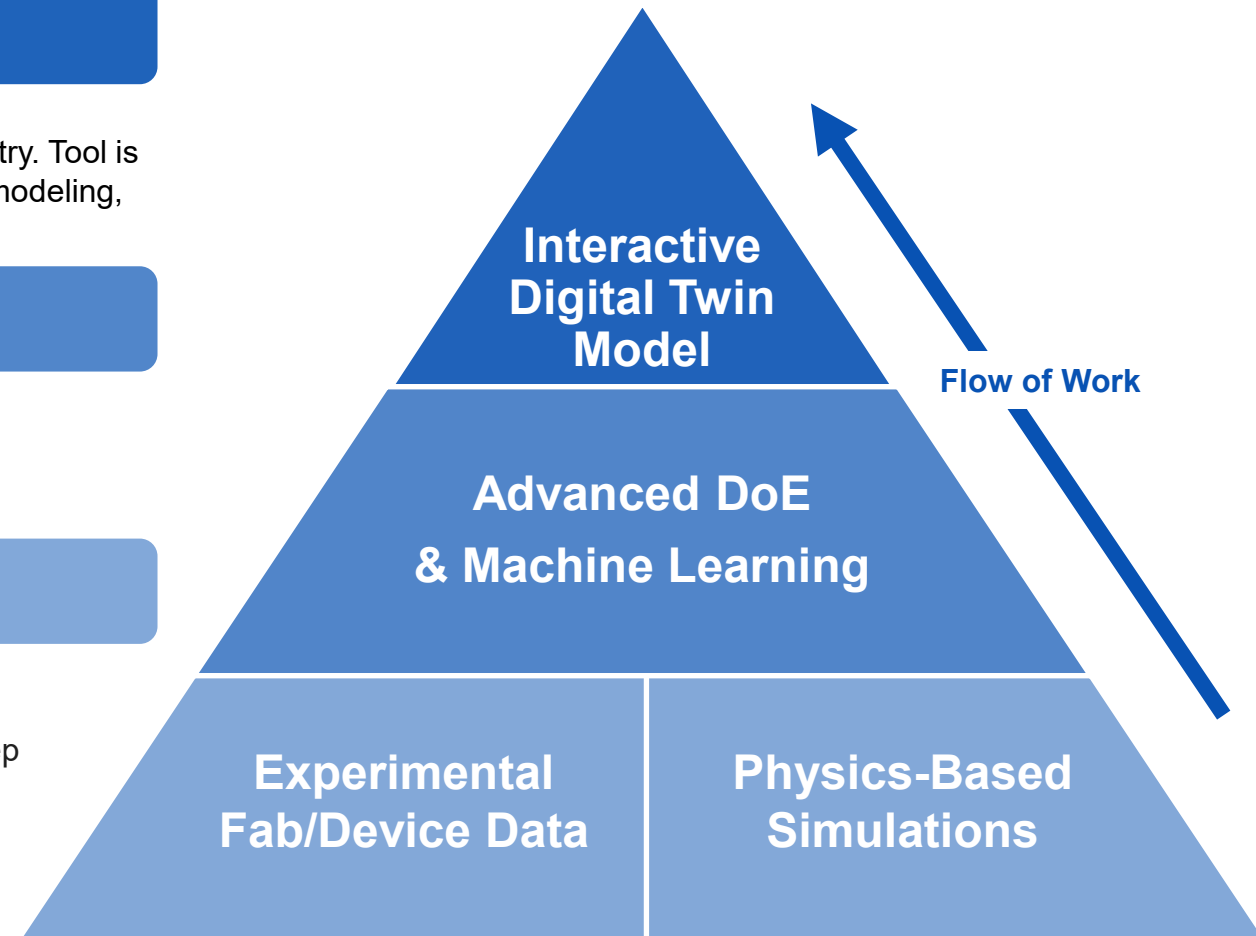
- Process Simulator - Build virtual fab flows of devices and components
- Stress Simulator - Understand how stress impacts the fab flow step-by-step

Victory Device

- Device Simulator – Understand Electrical Characteristics of the Devices

Victory RCx

- Parasitic Field Solver that explores fine details of the BEOL process



FTCO™ Development Partnership with Micron

“*Micron is excited to strengthen our partnership with Silvaco. Silvaco’s AI and digital twin solution is enabling us to accelerate our groundbreaking advancements in memory and storage.*”

Dr. Gurtej Sandhu

Principal fellow of Technology Pathfinding
Micron Technology, Inc.

SILVACO[Tools](#)[IP](#)[Solutions](#)[Services](#)[Resources](#)

Silvaco Announces Expanded Partnership with Micron Technology

SANTA CLARA, April 16, 2024

Silvaco Group, Inc. (“Silvaco”), a provider of TCAD, EDA software, and SIP solutions that enable semiconductor design and AI through software and innovation, today announced an enhanced partnership with Micron Technology, Inc. (Nasdaq: MU) (“Micron”), which includes:

- Expanding the scope and extending the term of our software license and support services.
- Securing a \$5.0 million investment from Micron in the form of a senior subordinated convertible promissory note, reflecting our partnership with Micron for the development of Silvaco’s FTCO™ digital twin modeling tools.

Dr. Babak Taheri, Silvaco’s CEO remarked, “We have combined our expertise in semiconductor technologies with machine learning and data analysis to develop an artificial intelligence-based solution named fab technology co-optimization, or FTCO™, for wafer-level fabrication facilities.” Dr. Taheri continued, “FTCO™ uses manufacturing data to perform statistical and physics-based machine learning software simulations to create a computer model or ‘digital twin’ of a wafer that can be used to simulate the fabrication process. Customers can utilize this model to run simulation experiments to understand and enhance wafer yield without the need to run physical wafers which can be time-consuming and expensive.”

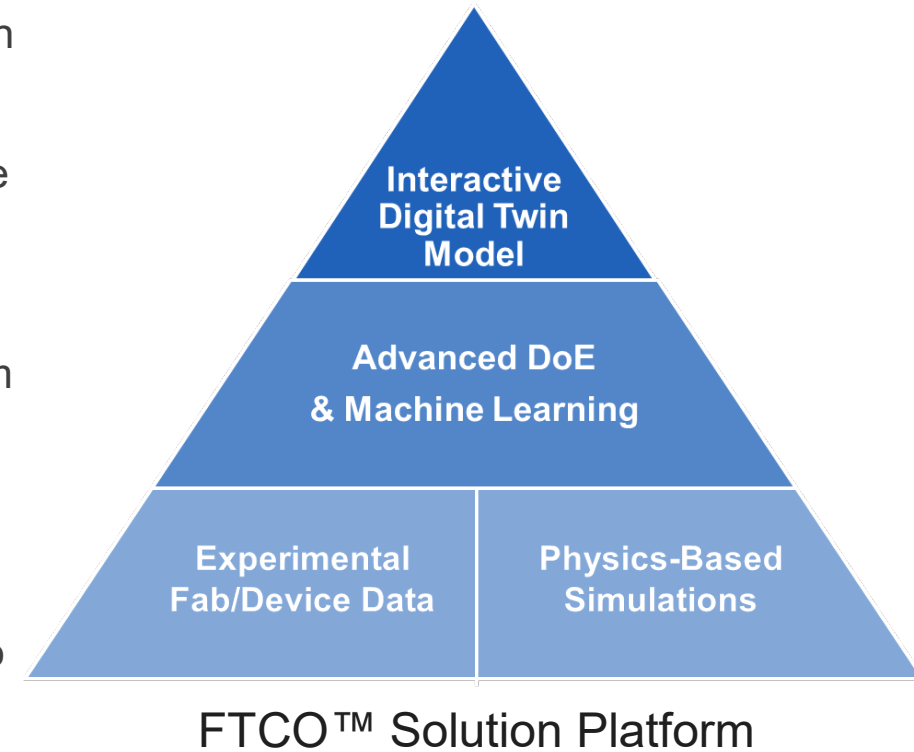
“Micron is excited to strengthen our partnership with Silvaco,” said Dr. Gurtej Sandhu, principal fellow of Technology Pathfinding at Micron Technology. “Silvaco’s AI and digital twin solution is enabling us to accelerate our groundbreaking advancements in memory and storage.”

About Silvaco

Silvaco is a provider of TCAD, EDA software, and SIP solutions that enable semiconductor design and AI through software and innovation. Silvaco’s solutions are used for process and device development across display, power devices, automotive, memory, high performance compute, photonics, internet of things, and 5G/6G mobile markets for complex SoC design. Silvaco is headquartered in Santa Clara, California and has a global presence with offices located in North America, Europe, Brazil, China, Japan, Korea, Singapore, and Taiwan.

FTCO™ Summary

- The growing fab complexity requires a new approach to process optimization
- We have combined our deep TCAD expertise and semiconductor knowledge with AI to develop a unique platform for fab process optimization
- We partnered with Micron Technology for the development of FTCO Platform
- FTCO Platform accelerates process and yield optimization
- FTCO saves cost by enabling fast experimentation and reducing the need to run physical wafers
- FTCO has broad application in the semiconductor processes - CMOS, SiC, GaN, Memory



The background of the image is a close-up, high-angle shot of a microchip. The chip's intricate circuitry is visible, with various rectangular and circular components. The lighting is dramatic, with a strong red glow on the left side and a blue glow on the right side, creating a bokeh effect with out-of-focus light spots. The text "Thank you. | SILVACO" is overlaid on the left side of the chip.

Thank you. | **SILVACO**