How Tignis Drives Pharmaceutical Manufacturing

A New Level of Operational Intelligence

Pharmaceutical, biopharmaceutical, and biotechnology companies are leaders in asset and process optimization, and for good reason. Dynamic market forces coupled with tight regulations compel the industry to continuously refine and improve. There is no tolerance for equipment failure, unplanned production shutdowns, product recalls, or inefficient or wasteful processes. Countering today's competition, tight profit margins, and pricing pressures demands a new level of operational intelligence.

Advanced technologies provide the means to upgrade maintenance, production, and energy management while controlling costs and ensuring high product quality. Already, tools for condition monitoring and predictive maintenance are commonplace in pharma, yet the full potential of these best practices remains out of reach for many. Real-time, sensor-based condition data and historical records will not by themselves drive actionable results. Tignis' physics-driven analytics platform provides the missing link.

"Advanced technologies provide the means to upgrade maintenance, production, and energy management while controlling costs and ensuring high product quality."

Proactive Optimization with ML and Digital Twins

Tignis analytics, fortified with artificial intelligence (AI) and machine learning (ML), automatically digest streaming and historical data, learn usage patterns, detect anomalies in processes and systems, notify responsible parties, and facilitate timely troubleshooting and corrective actions. Tignis visualizes the emerging risk or fault in a digital twin, or virtual replica, of the connected asset or system. It enables modeling of the digital twin to simulate and fine-tune resolutions before they are applied, and to predict and enhance future performance.

Applications for the Pharmaceutical Industry are Wide Ranging:

Energy Management

With pharma's pristine cleanrooms, sterile equipment, and energy-intensive conversion processes at stake, controlling energy, water, and steam consumption and associated costs are serious priorities. Applying Tignis analytics and digital twins to cleaning, ventilation, and production systems enables energy and facility managers to continually monitor power and water usage, reveal and resolve leaks, and implement valuable conservation measures.

Process Optimization

Operations teams depend on highly efficient, reliable, and flexible manufacturing processes to convert base ingredients into safe and effective packaged products. With Tignis, process engineers have better visibility into deviations and deterioration and can quickly optimize the process parameters accordingly. They can also apply predictive modeling to simulate and fine-tune new recipes and manufacturing processes, before going live, saving time and materials.

Predictive and Prescriptive Maintenance

High reliability and availability of complex equipment is mandatory in pharma, including its HVAC systems, centrifuges, bioreactors, cooling towers, spraying systems, and other crucial assets. Tignis helps to detect degrading asset and system conditions so that predictive maintenance can be scheduled in time to avoid the risks and costs of failure. It learns from each experience to enable earlier detection and prescribe better solutions, and it provides digital twin testbeds for corrective actions and design improvements. It also lends intelligence to avoid future occurrences – whether purchasing better-quality machines or components or improving preventive maintenance routines.

Pharmaceutical manufacturers have much to gain from the advanced analytics offered by Tignis, even beyond its functional applications. Tignis also helps to combat the growing industrial skills shortage by retaining institutional knowledge, automating learning, and attracting new digitally minded talent.

See what Tignis can do for your business.

For more information on applying analytics to your 24/7 monitoring data,

visit www.cohu.com/tignis | Info@cohu.com | Tel: +1 206.745.9866

AI Process Control Platform Enabling Next Generation Technology

Addressing a Growing Challenge

As feature dimensions in semiconductors continue to shrink and worldwide demand continues to expand, semiconductor equipment manufacturers need innovative ways to compete and deliver.

The Tignis PAICe Maker® physics-driven AI computational modeling platform accelerates leading-edge semiconductor manufacturing - from equipment R&D to reliable high-yield chip fabrication capability. Tignis supports your success in delivering advanced processes, high and reliable throughput, improved overall equipment efficiency, and lower cost of ownership.

Demand More from Your Process Controller

Using the latest AI and machine learning techniques, Tignis process control makes the previously impossible possible.

- **Massively Multivariate:** It can control systems in response to millions of complex measured properties while accounting for non-linear interactions.

- **Adaptive:** Machine learning continuously improves as data is collected, helping the process controller self-tune to compensate for simulation model error, environmental changes, product changes, or equipment drift.

- **Immediate:** Physics-driven AI runs millions of times faster than legacy simulations, enabling real-time wafer-to-wafer recipe recommendations.

- **Predictive:** Virtual metrology is built into the controller, enabling downstream process modification for better yield.

The Result? Your semiconductor manufacturing equipment can have the power of AI and machine learning built-in, giving your fabrication customers the best control parameters to optimize each manufacturing run or batch.

PAICe MAKER®

AT-A-GLANCE:

PAICe Maker is an embedded AI controller that learns the nuances of your equipment, configurations, and processes in order to develop the best control algorithm for the manufacturing line.
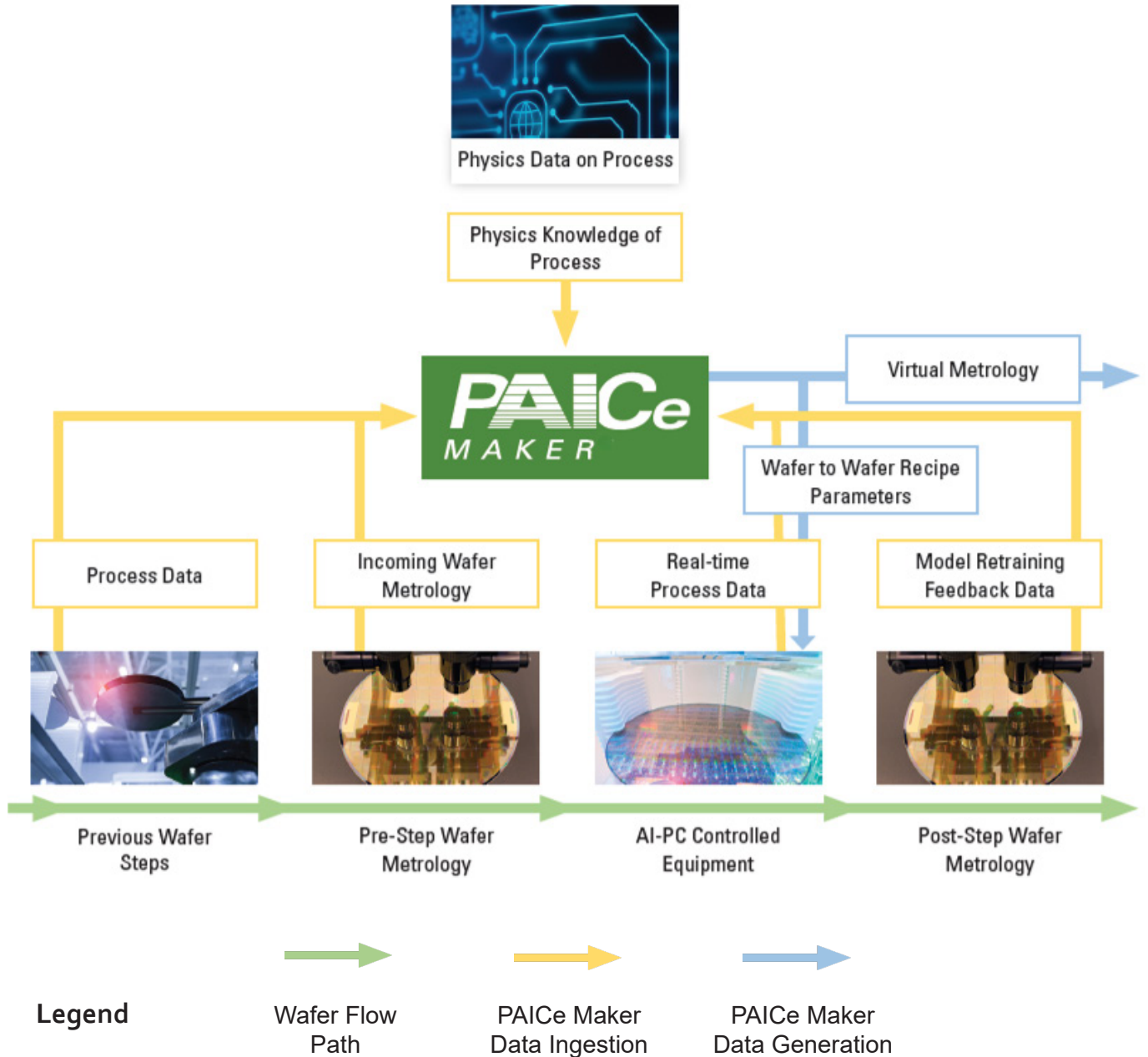
Tignis deploys machine learning-based control algorithms that drastically reduce the time and compute needed to calculate multidimensional critical inputs to semiconductor manufacturing equipment.

PAICe Maker enables a full range of capability enhancements, including:

- Deposition optimization
- Etching optimization
- Bow and warp reduction
- Computational metrology
- Process drift/recipe tuning, and more.

Cohu

PAICe Maker Flow Diagram

Tignis PAICe Maker constantly ingests vital process data and metrology, enabling it to continuously retrain and correct for process drift or any other process disturbances.

Physics Data on Process

Physics Knowledge of Process

PAICe MAKER

Virtual Metrology

Wafer to Wafer Recipe Parameters

| Process Data | Incoming Wafer Metrology | Real-time Process Data | Model Retraining Feedback Data |

| Previous Wafer Steps | Pre-Step Wafer Metrology | AI-PC Controlled Equipment | Post-Step Wafer Metrology |

Legend — Wafer Flow Path — PAICe Maker Data Ingestion — PAICe Maker Data Generation

AI Process Control Platform Enabling Next Generation Technology

Addressing a Growing Challenge

As feature dimensions in semiconductors continue to shrink and worldwide demand continues to expand, semiconductor equipment manufacturers need innovative ways to compete and deliver.

The Tignis PAICe Maker® physics-driven AI computational modeling platform accelerates leading-edge semiconductor manufacturing - from equipment R&D to reliable high-yield chip fabrication capability. Tignis supports your success in delivering advanced processes, high and reliable throughput, improved overall equipment efficiency, and lower cost of ownership.

Demand More from Your Process Controller

Using the latest AI and machine learning techniques, Tignis process control makes the previously impossible possible.

- **Massively Multivariate:** It can control systems in response to millions of complex measured properties while accounting for non-linear interactions.

- **Adaptive:** Machine learning continuously improves as data is collected, helping the process controller self-tune to compensate for simulation model error, environmental changes, product changes, or equipment drift.

- **Immediate:** Physics-driven AI runs millions of times faster than legacy simulations, enabling real-time wafer-to-wafer recipe recommendations.

- **Predictive:** Virtual metrology is built into the controller, enabling downstream process modification for better yield.

The Result? Your semiconductor manufacturing equipment can have the power of AI and machine learning built-in, giving your fabrication customers the best control parameters to optimize each manufacturing run or batch.

AT-A-GLANCE:

PAICe Maker is an embedded AI controller that learns the nuances of your equipment, configurations, and processes in order to develop the best control algorithm for the manufacturing line.
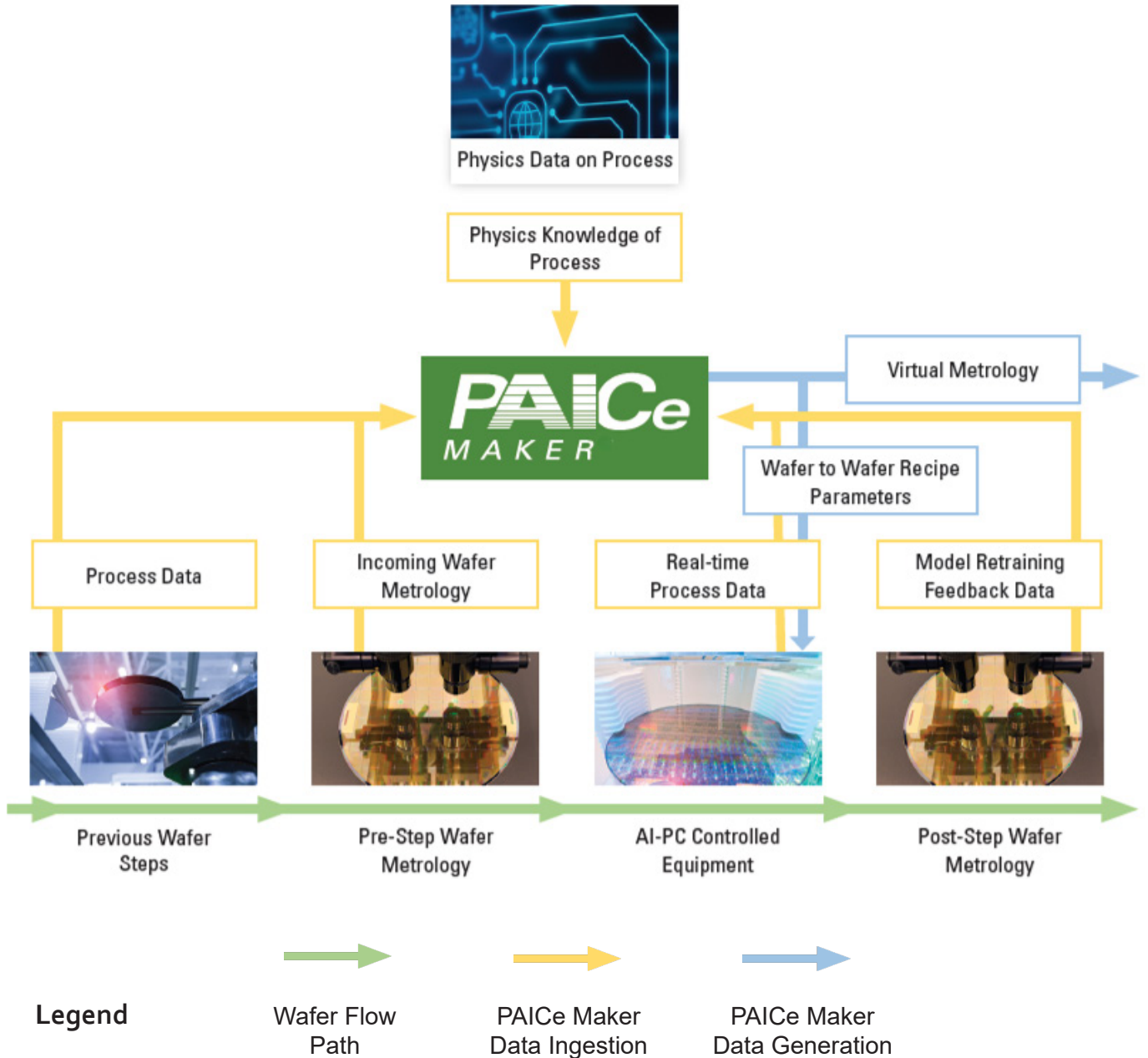
Tignis deploys machine learning-based control algorithms that drastically reduce the time and compute needed to calculate multidimensional critical inputs to semiconductor manufacturing equipment.

PAICe Maker enables a full range of capability enhancements, including:

- Deposition optimization
- Etching optimization
- Bow and warp reduction
- Computational metrology
- Process drift/recipe tuning, and more.

PAICe Maker Flow Diagram

Tignis PAICe Maker constantly ingests vital process data and metrology, enabling it to continuously retrain and correct for process drift or any other process disturbances.
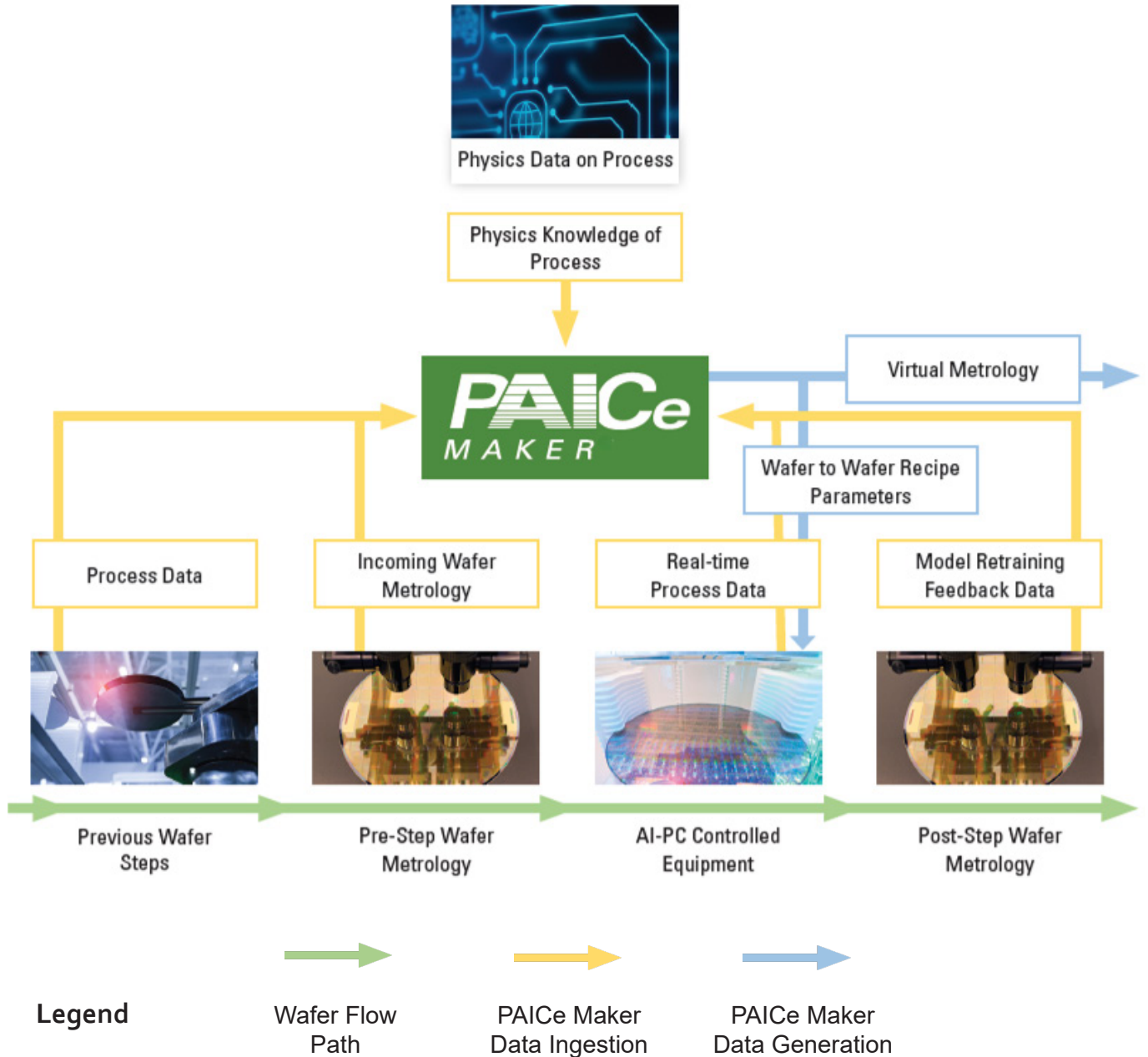

Physics Data on Process

Physics Knowledge of Process

PAICe MAKER

Virtual Metrology

Wafer to Wafer Recipe Parameters

Process Data	Incoming Wafer Metrology	Real-time Process Data	Model Retraining Feedback Data

Previous Wafer Steps	Pre-Step Wafer Metrology	AI-PC Controlled Equipment	Post-Step Wafer Metrology

Legend

Wafer Flow Path

PAICe Maker Data Ingestion

PAICe Maker Data Generation

PAICe Maker Flow Diagram

Tignis PAICe Maker constantly ingests vital process data and metrology, enabling it to continuously retrain and correct for process drift or any other process disturbances.

Legend

Wafer Flow Path

PAICe Maker Data Ingestion

PAICe Maker Data Generation

AI Process Control Platform
Enabling Next Generation Technology

Addressing a Growing Challenge

As feature dimensions in semiconductors continue to shrink and worldwide demand continues to expand, semiconductor equipment manufacturers need innovative ways to compete and deliver.

The Tignis PAICe Maker® physics-driven AI computational modeling platform accelerates leading-edge semiconductor manufacturing - from equipment R&D to reliable high-yield chip fabrication capability. Tignis supports your success in delivering advanced processes, high and reliable throughput, improved overall equipment efficiency, and lower cost of ownership.

Demand More from Your Process Controller

Using the latest AI and machine learning techniques, Tignis process control makes the previously impossible possible.

- **Massively Multivariate:** It can control systems in response to millions of complex measured properties while accounting for non-linear interactions.

- **Adaptive:** Machine learning continuously improves as data is collected, helping the process controller self-tune to compensate for simulation model error, environmental changes, product changes, or equipment drift.

- **Immediate:** Physics-driven AI runs millions of times faster than legacy simulations, enabling real-time wafer-to-wafer recipe recommendations.

- **Predictive:** Virtual metrology is built into the controller, enabling downstream process modification for better yield.

The Result? Your semiconductor manufacturing equipment can have the power of AI and machine learning built-in, giving your fabrication customers the best control parameters to optimize each manufacturing run or batch.

PAICe MAKER®

AT-A-GLANCE:

PAICe Maker is an embedded AI controller that learns the nuances of your equipment, configurations, and processes in order to develop the best control algorithm for the manufacturing line.

Tignis deploys machine learning-based control algorithms that drastically reduce the time and compute needed to calculate multidimensional critical inputs to semiconductor manufacturing equipment.

PAICe Maker enables a full range of capability enhancements, including:

- Deposition optimization
- Etching optimization
- Bow and warp reduction
- Computational metrology
- Process drift/recipe tuning, and more.

Cohu®

TIGNIS
A Cohu Analytics Solution

AI Process Control Platform Enabling Next Generation Technology

Addressing a Growing Challenge

As feature dimensions in semiconductors continue to shrink and worldwide demand continues to expand, semiconductor equipment manufacturers need innovative ways to compete and deliver.

The Tignis PAICe Maker® physics-driven AI computational modeling platform accelerates leading-edge semiconductor manufacturing - from equipment R&D to reliable high-yield chip fabrication capability. Tignis supports your success in delivering advanced processes, high and reliable throughput, improved overall equipment efficiency, and lower cost of ownership.

Demand More from Your Process Controller

Using the latest AI and machine learning techniques, Tignis process control makes the previously impossible possible.

- **Massively Multivariate:** It can control systems in response to millions of complex measured properties while accounting for non-linear interactions.

- **Adaptive:** Machine learning continuously improves as data is collected, helping the process controller self-tune to compensate for simulation model error, environmental changes, product changes, or equipment drift.

- **Immediate:** Physics-driven AI runs millions of times faster than legacy simulations, enabling real-time wafer-to-wafer recipe recommendations.

- **Predictive:** Virtual metrology is built into the controller, enabling downstream process modification for better yield.

The Result? Your semiconductor manufacturing equipment can have the power of AI and machine learning built-in, giving your fabrication customers the best control parameters to optimize each manufacturing run or batch.

PAICe MAKER®

AT-A-GLANCE:

PAICe Maker is an embedded AI controller that learns the nuances of your equipment, configurations, and processes in order to develop the best control algorithm for the manufacturing line.
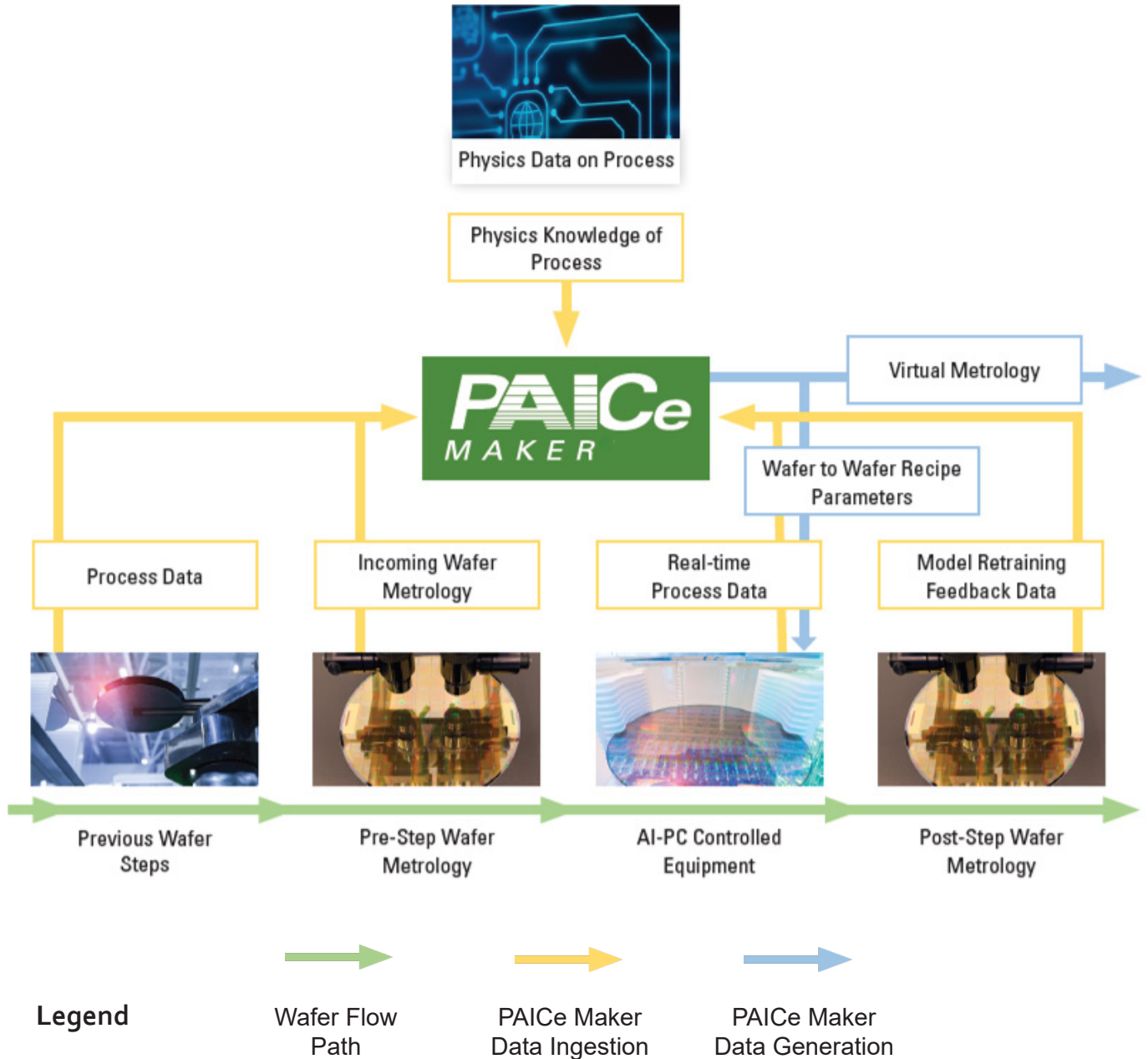
Tignis deploys machine learning-based control algorithms that drastically reduce the time and compute needed to calculate multidimensional critical inputs to semiconductor manufacturing equipment.

PAICe Maker enables a full range of capability enhancements, including:

- Deposition optimization
- Etching optimization
- Bow and warp reduction
- Computational metrology
- Process drift/recipe tuning, and more.

Cohu®

PAICe Maker Flow Diagram

Tignis PAICe Maker constantly ingests vital process data and metrology, enabling it to continuously retrain and correct for process drift or any other process disturbances.

AI Process Control Platform Enabling Next Generation Technology

Addressing a Growing Challenge

As feature dimensions in semiconductors continue to shrink and worldwide demand continues to expand, semiconductor equipment manufacturers need innovative ways to compete and deliver.

The Tignis PAICe Maker® physics-driven AI computational modeling platform accelerates leading-edge semiconductor manufacturing - from equipment R&D to reliable high-yield chip fabrication capability. Tignis supports your success in delivering advanced processes, high and reliable throughput, improved overall equipment efficiency, and lower cost of ownership.

Demand More from Your Process Controller

Using the latest AI and machine learning techniques, Tignis process control makes the previously impossible possible.

- **Massively Multivariate:** It can control systems in response to millions of complex measured properties while accounting for non-linear interactions.

- **Adaptive:** Machine learning continuously improves as data is collected, helping the process controller self-tune to compensate for simulation model error, environmental changes, product changes, or equipment drift.

- **Immediate:** Physics-driven AI runs millions of times faster than legacy simulations, enabling real-time wafer-to-wafer recipe recommendations.

- **Predictive:** Virtual metrology is built into the controller, enabling downstream process modification for better yield.

The Result?
Your semiconductor manufacturing equipment can have the power of AI and machine learning built-in, giving your fabrication customers the best control parameters to optimize each manufacturing run or batch.

PAICe MAKER®

AT-A-GLANCE:

PAICe Maker is an embedded AI controller that learns the nuances of your equipment, configurations, and processes in order to develop the best control algorithm for the manufacturing line.
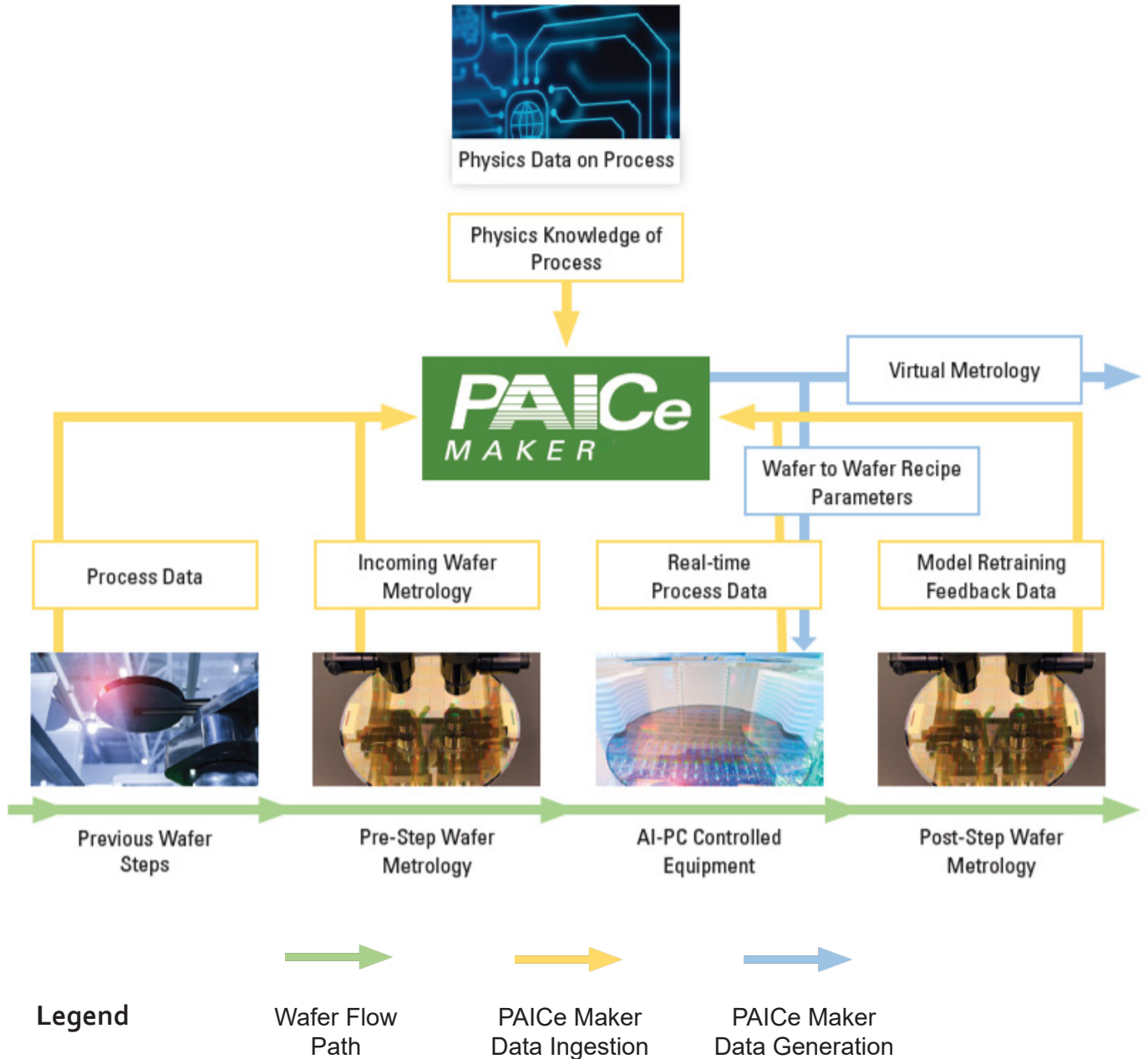
Tignis deploys machine learning-based control algorithms that drastically reduce the time and compute needed to calculate multidimensional critical inputs to semiconductor manufacturing equipment.

PAICe Maker enables a full range of capability enhancements, including:

- Deposition optimization
- Etching optimization
- Bow and warp reduction
- Computational metrology
- Process drift/recipe tuning, and more.

Cohu®

PAICe Maker Flow Diagram

Tignis PAICe Maker constantly ingests vital process data and metrology, enabling it to continuously retrain and correct for process drift or any other process disturbances.

Physics Data on Process

Physics Knowledge of Process

PAICe MAKER

Virtual Metrology

Wafer to Wafer Recipe Parameters

Process Data	Incoming Wafer Metrology	Real-time Process Data	Model Retraining Feedback Data

Previous Wafer Steps	Pre-Step Wafer Metrology	AI-PC Controlled Equipment	Post-Step Wafer Metrology

Legend

Wafer Flow Path

PAICe Maker Data Ingestion

PAICe Maker Data Generation

Cohu