



CONNECTS

Heterogeneous Integration for
Connectivity and Sustainability

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Enhanced Chip **Manufacturing** Developments

Daniele Pagano, Giuseppe Fazio - STMicroelectronics



Outline

1. STMicroelectronics at a glance
2. HiCONNECTS: Enhanced Chip manufacturing developments
3. Industry 4.0 & IoT Advanced FAB Digitalization
4. Process and Equipment Performance Optimization for Yield improvement
5. Heterogeneous integration systems data analytics demonstrator
6. Conclusions

Chapter

01

STMicroelectronics at a glance

We are creators and makers of technology



One of the world's largest semiconductor companies



Over **50,000** employees
of which **9,000+** in R&D



\$16.1 billion revenues in
2022



Over **80** sales & marketing offices
serving over **200,000** customers across
the globe

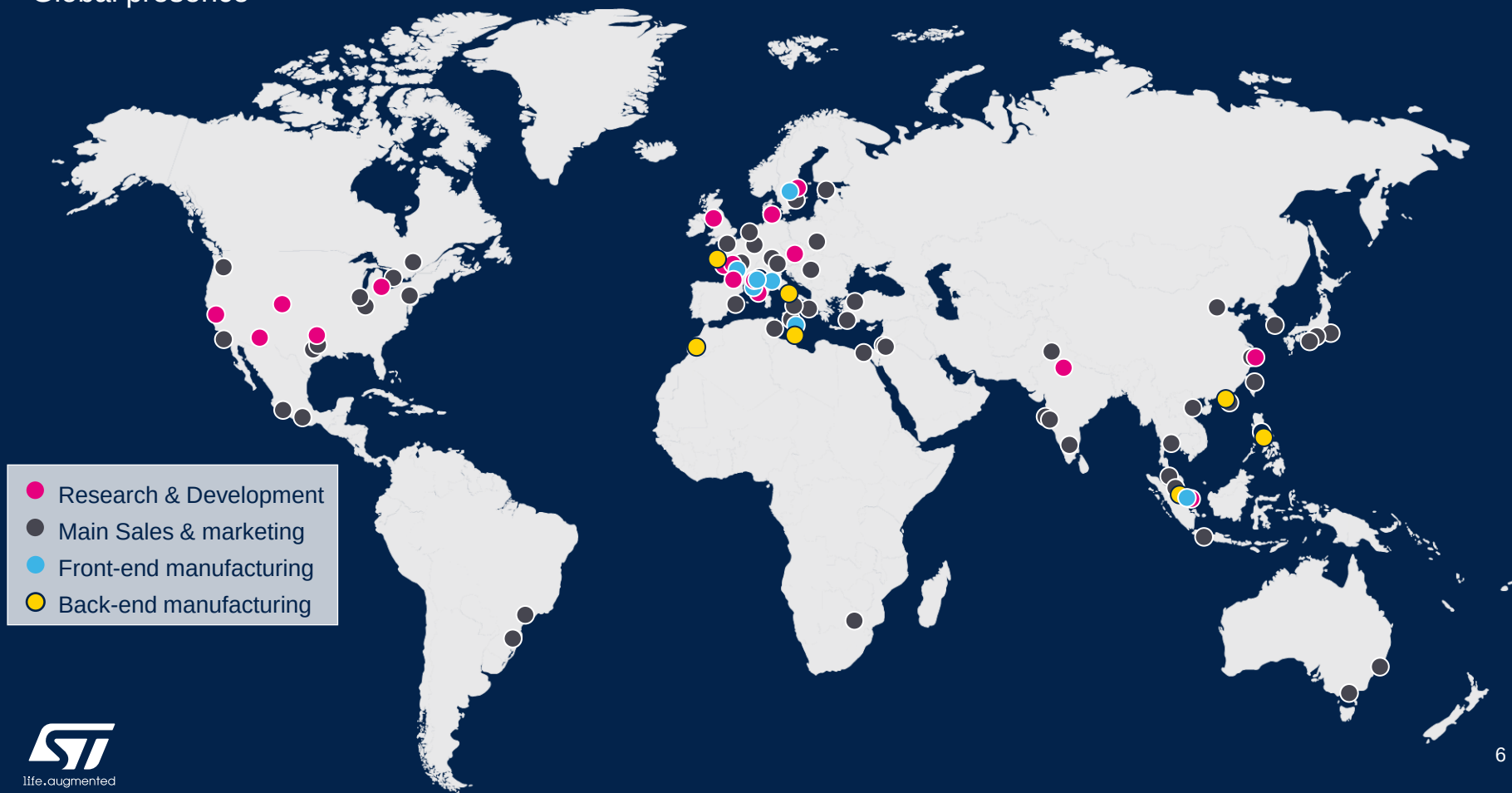


14 main manufacturing sites



Signatory of the United Nations Global Compact (UNGC)
Member of the Responsible Business Alliance (RBA)

Global presence



Where you find us



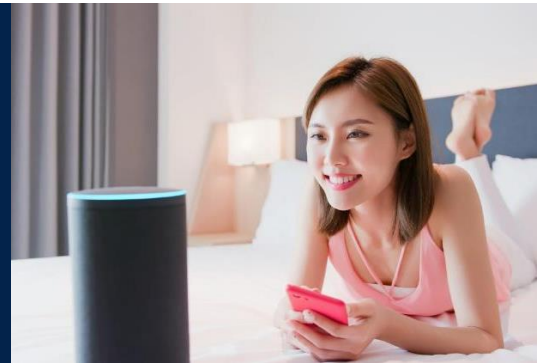
Making **driving** safer,
greener, and more connected

Enabling the evolution of
industry towards smarter,
safer, and more efficient
factories & workplaces



Making **homes & cities**
smarter, for better living,
higher security, and to get
more from available
resources

Making everyday **things**
smarter, connected,
and more aware
of their surroundings



We are drivers of your innovation

Advanced R&D centers around the world for close collaboration with operations, customers, and partners



9,000+ people working in R&D and product design

~12% of revenues invested in R&D in 2022

~200 active R&D partnerships

~19,500 active and pending patents
~600 new filings in 2022

Open innovation with startups in **15** Proof of Concept centers
70 startups engaged in our programs in 2022

Chapter

02

HiCONNECTS: Enhanced Chip
manufacturing developments



HiCONNECTS: ST-I's Partnership

Industry 4.0 & IoT Advanced FAB Digitalization



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Politecnico
di Torino



Process and Equipment Performance Optimization for Yield improvement



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TNO innovation
for life



Heterogeneous integration systems data analytics demonstrator



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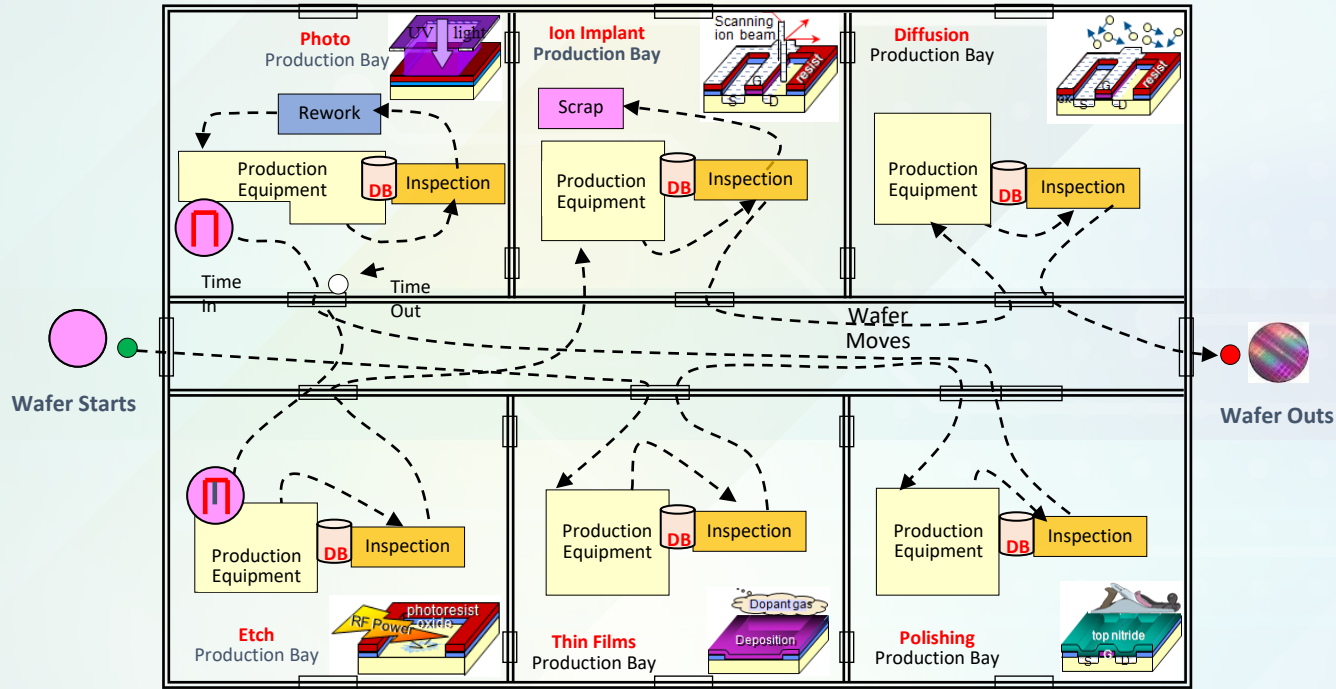


Chapter

03

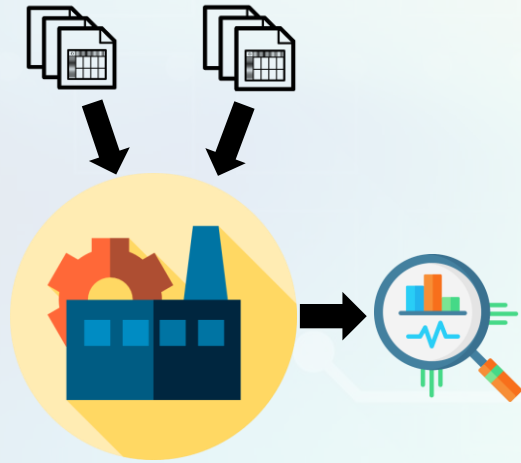
Industry 4.0 & IoT Advanced FAB Digitalization

AI-Enhanced Digital Twin Architecture for optimizing scheduling & dispatching in microelectronics facility



Objective: formation of Scheduling & Dispatching Digital twin

Industry 4.0 & IoT Advanced FAB Digitalization



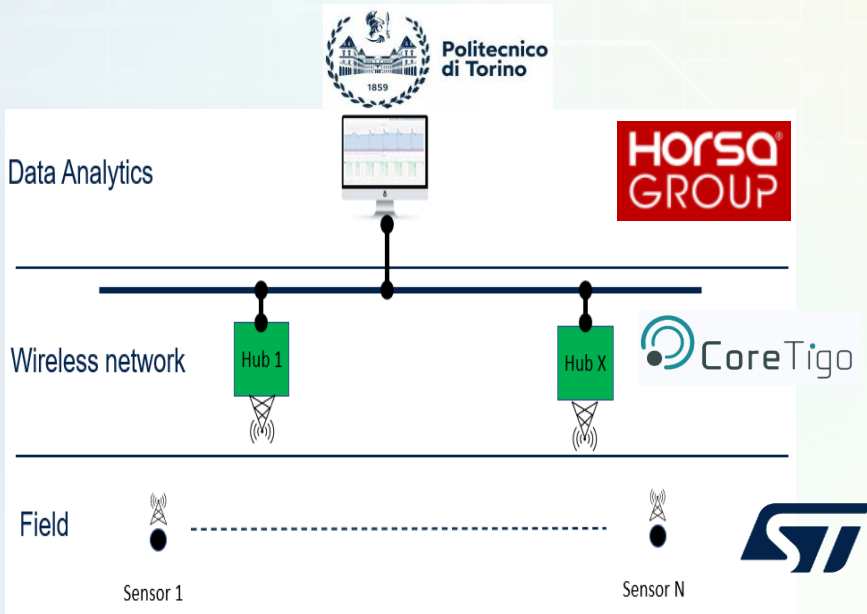
Digital twin technology is the process of using data streams to create a digital representation of a real-world asset.

The high-mix low-volume manufacturing environment requires to optimize the scheduling and dispatching forecasting per each production tool.

Expected at least 10% increase of productivity.



Industry 4.0 & IoT Advanced FAB Digitalization Summary



Design and implementation of a software infrastructure for efficient integration of data coming from sensors.

Develop new wireless solutions for integrating new smart sensors.

Variables selections and data processing to optimize production quality and productivity.

By integrating sub-fab facilities (gas, pumps, ...) to manufacturing equipment it will be possible to feed advanced process control algorithms and increase productivity.

Chapter

04

Process and Equipment
Performance Optimization for
Yield improvement



Process and Equipment Performance Optimization for Yield improvement

Objective: Correlating electrical performances to in-line process and metrology parameters to identify the main process step contributor to electrical deviations.



Combining large process and diverse metrology datasets by validating their data labels accuracy.

Developing algorithms that highlight the processes responsible for electrical drifts.

Improve electrical yield and speed up root cause identification.



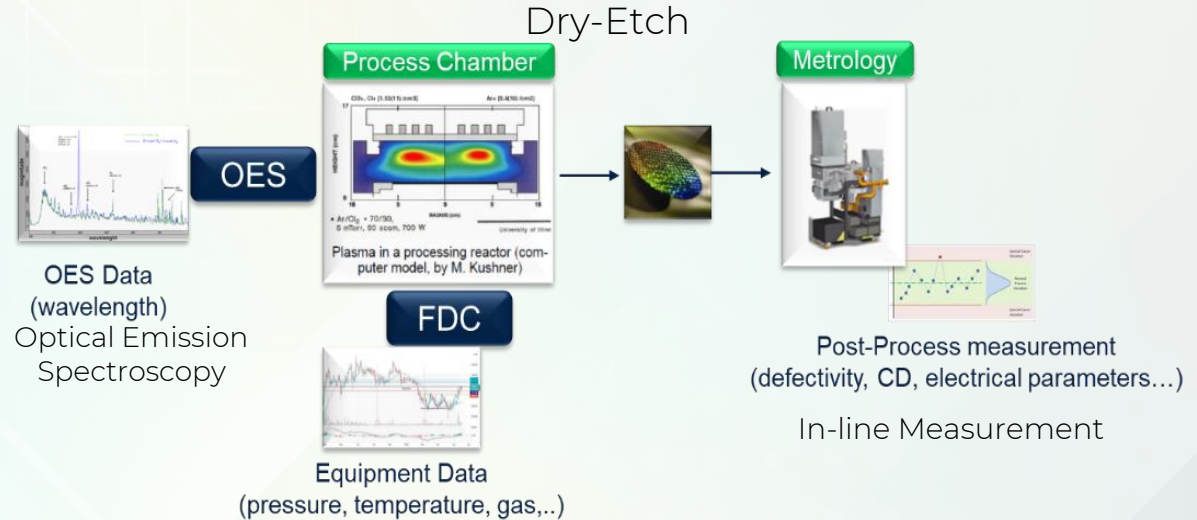
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Process Performance Optimization for Quality improvement

For critical new products, standard APC is not capable to catch equipment drifts. New algorithms are needed, based on in-situ and in-line measurement.



Chasing abnormalities on time series for Advanced Process Control.

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Metrology tools development to support Process and Equipment Performance Optimization

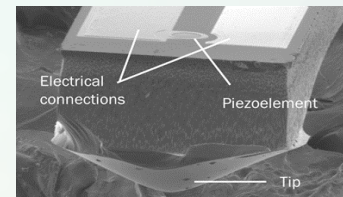
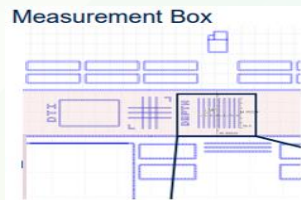
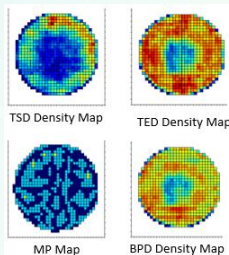
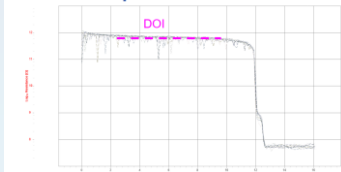
Highly sensitive resistivity measurement in SiC bulk for process characterization

High resolution X-rays imaging analysis to replace destructive analysis

High Aspect ratio optical measurement for process optimization

Deep subsurface metrology for defectivity applications to replace destructive analysis

Calibration samples scenario #1



GHz Half Wavelength
Contact Acoustic Microscopy

Chapter

05

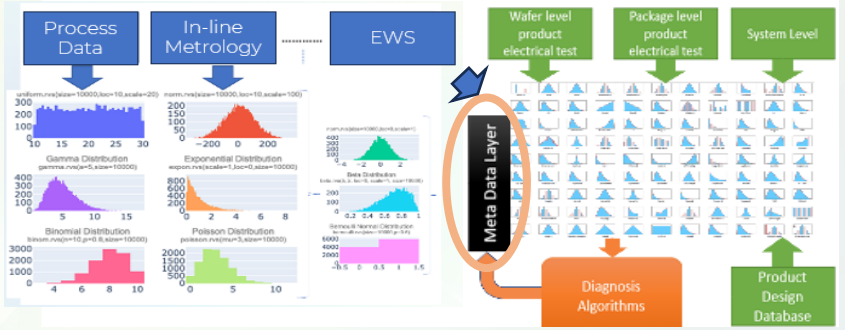
Heterogeneous integration
systems data analytics
demonstrator

Heterogeneous integration systems data analytics demonstrator Summary



Objective: integrating large diverse datasets related to the whole production chain it will be possible to identify failure root cause on heterogeneous devices.

Development of new SW tool based on modular approach by Siemens EDA.



Enabling correlation between the chip level and the complete product family performances.



Summary

Advance manufacturing 1: AI-Enhanced Digital Twin for improving scheduling and dispatching based on coming physical production environment data.

Advanced manufacturing 2: New reusable approaches for investigating innovative processes.

Advanced manufacturing 3: speed up new products qualification and improve equipment availability by reducing the Cost of Ownership

Acknowledgments

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