Capital Markets Day 2024

Technology and Manufacturing

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Agenda

1 Introduction

2 Manufacturing strategy

3 Technology strategy

4 Manufacturing reshaping

5 Takeaways

ST technology and manufacturing strategy is a key business enabler

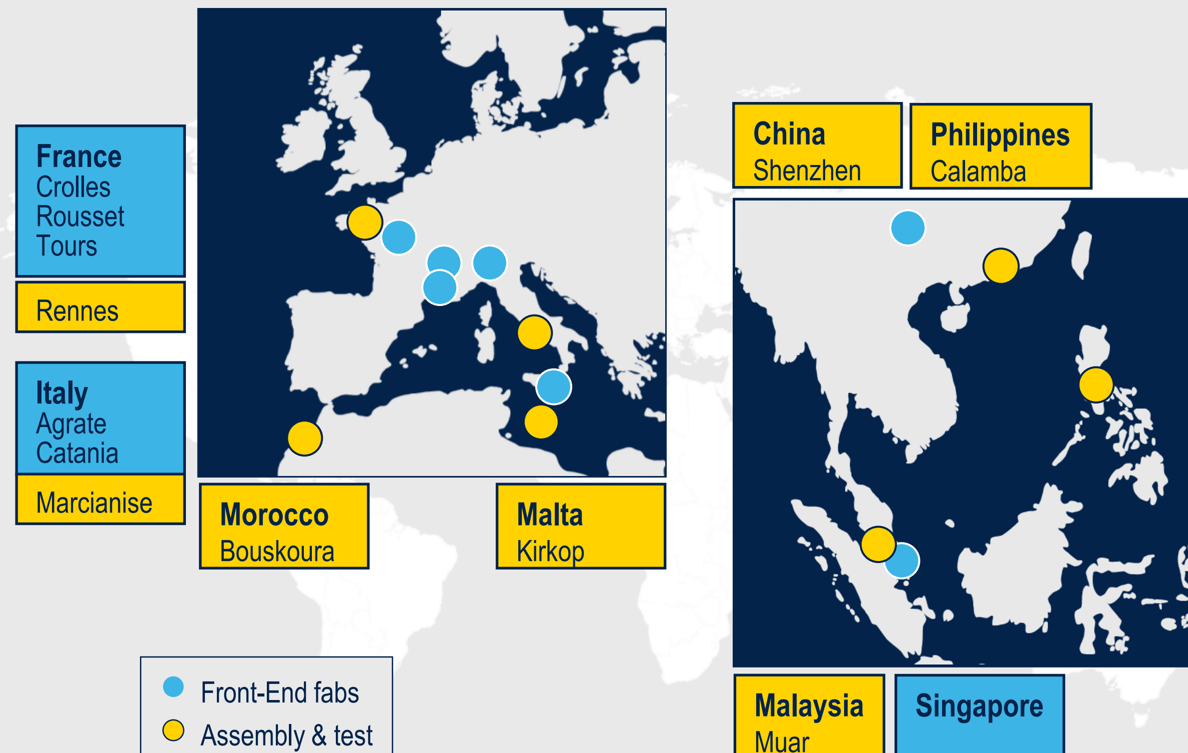
In-house manufacturing complemented by partnerships

- Agile and competitive footprint
- Reliable supply chain for our customers
- Product differentiation through proprietary technologies

Manufacturing roadmap

- Accelerating silicon capacity transition from 200 mm to 300 mm
- Test consolidation in two hubs
- Silicon Carbide – transition to 200 mm in Catania with fully vertically integrated operations and JV in China
- China-for-China supply chain

ST in-house manufacturing



High-volume manufacturing hubs

Front-end high-volume manufacturing hubs

Agrate (Italy)
300 mm Mixed Signal

Catania (Italy)
200 mm SiC (Vertical integrated)

Crolles (France)
300 mm Digital

Sanan JV (China)
200 mm SiC (Front-end)

Back-end high-volume manufacturing hubs

Muar (Malaysia)
Advanced leadframe
& Panel Level Package assembly

Shenzhen (China)
China-for-China, Power Packages
(Modules, discretes and KGD)

Kirkop (Malta)
Full industry 4.0, Advanced BGAs
and leadframe / laminate packaging

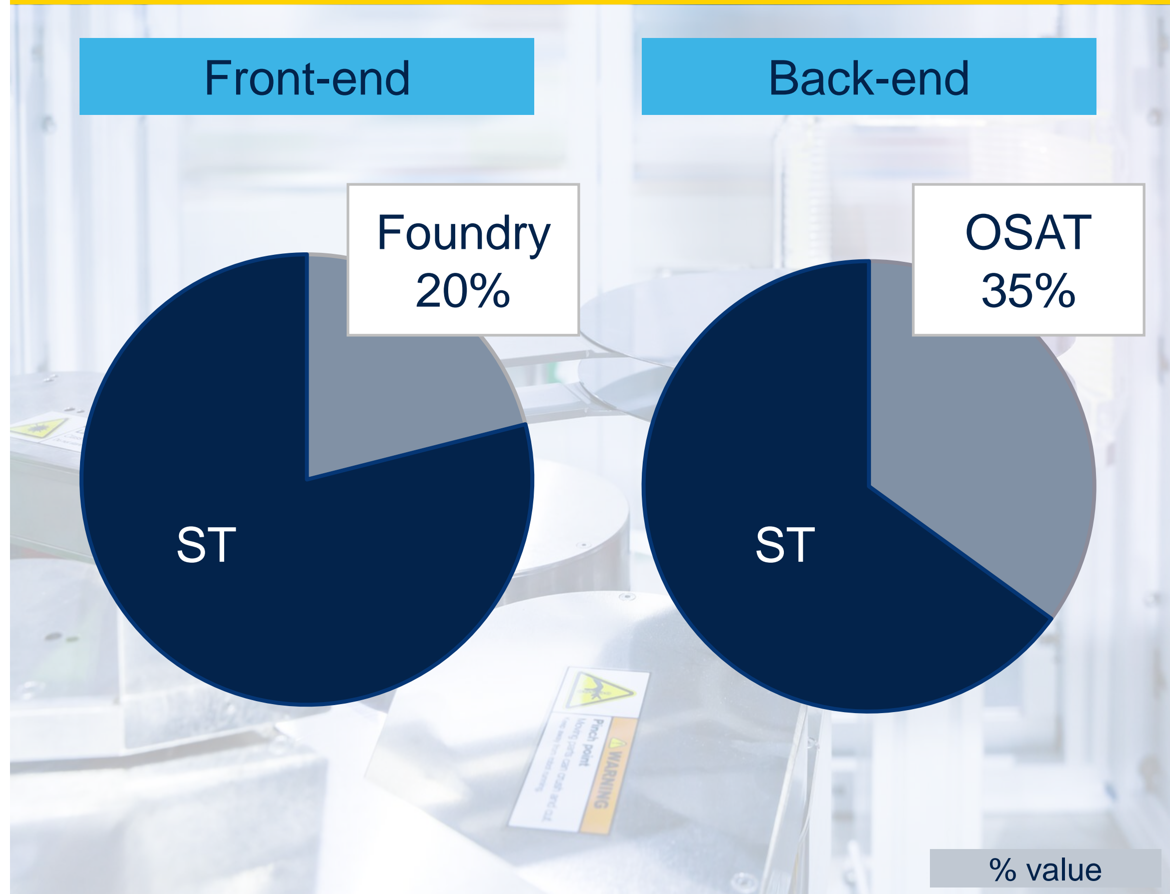
Manufacturing & technology Competence centres

Front-end competence centres	
Agrate	Front-end process development for advanced BCD and analog
Catania	Front-end process development for power technologies
Crolles	Front-end process development for digital, RF mixed signal, and imaging
Singapore	Technology hub for Silicon carbide
Tours	GaN Power MOSFET first of a kind

Back-end competence centres	
Agrate **Grenoble** **Shenzhen** **Singapore**	Assembly R&D
Grenoble	Testing R&D
Rennes	High reliability space & defence (assembly and test)
Shenzhen	Assembly and test R&D for power discrete Technology scouting centre for China-for-China supply chain

Strategic manufacturing partnerships

Model



Collaboration model

Collaboration with **leading foundries and OSATs** enables access to selected advanced technologies and geographical locations, complementing our portfolio and internal footprint

Front-end

TSMC: Leading-edge FinFET

Samsung Foundries FD-SOI ecosystem

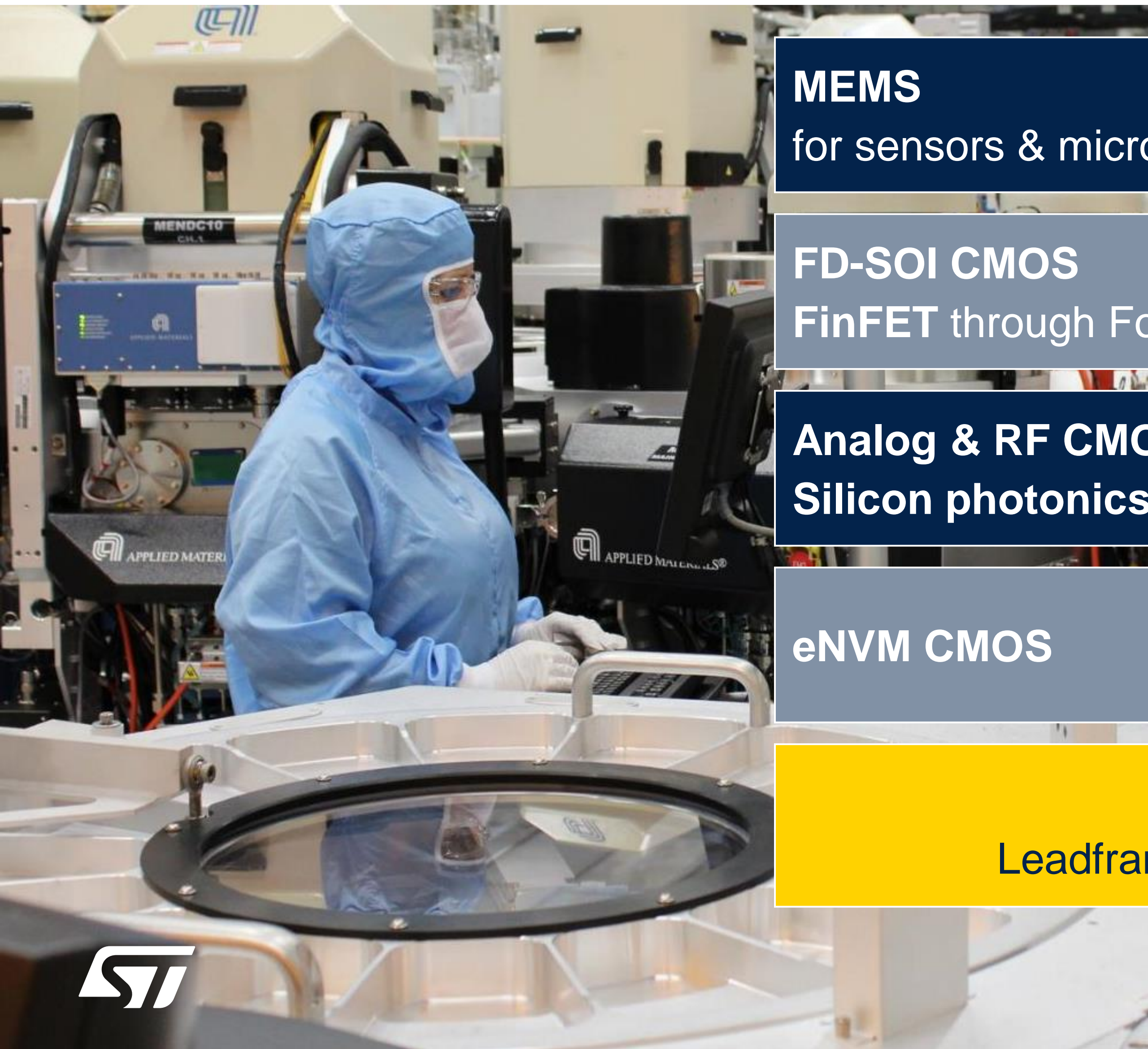
Chinese Foundries: China-for-China business

Back-end (Assembly & Test)

OSAT: Advanced BGA & WLCSP packages

Chinese OSATs: complement Shenzhen on China-for-China business

Differentiated technologies are our foundation

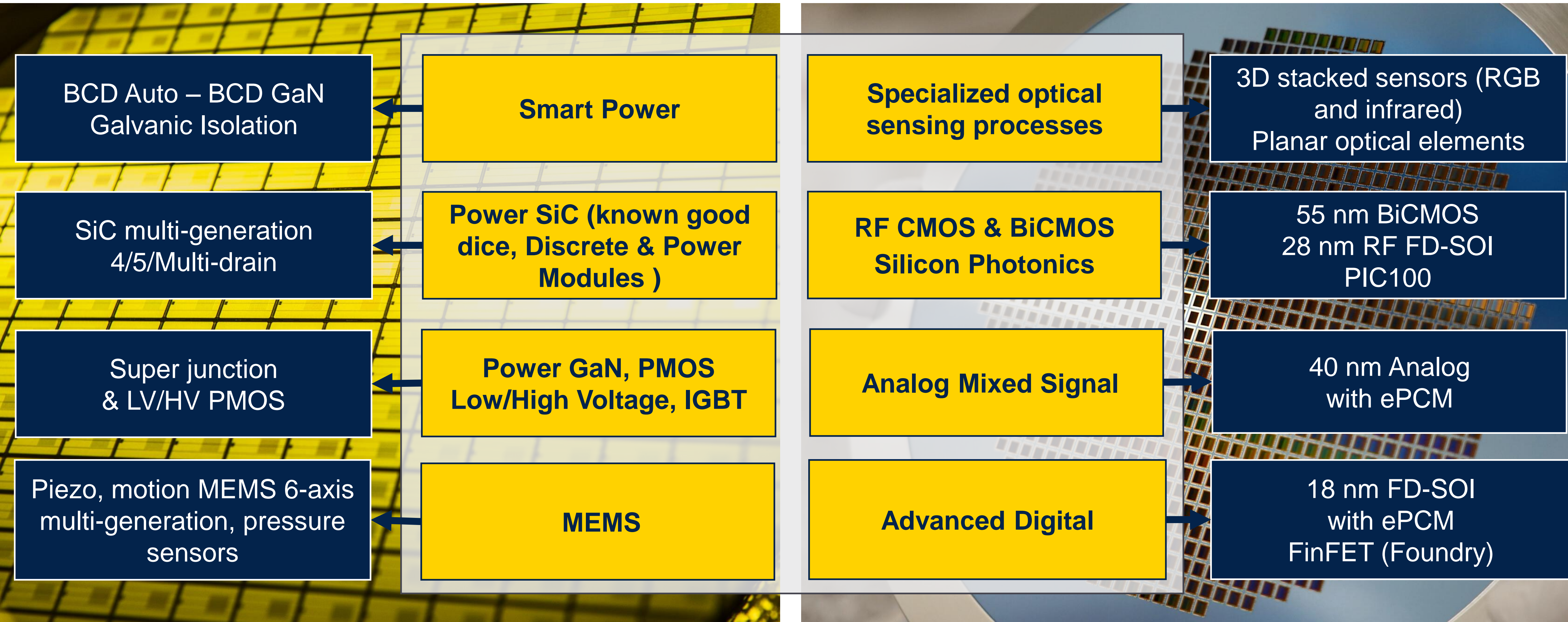


MEMS for sensors & micro-actuators	**Smart Power: BCD** (Bipolar - CMOS - Power DMOS)
FD-SOI CMOS **FinFET** through Foundry	**Discrete, Power MOSFET, IGBT** **Silicon Carbide, Gallium Nitride**
Analog & RF CMOS **Silicon photonics**	**Vertical Intelligent Power**
eNVM CMOS	**Optical sensing solutions**

Packaging technologies

Leadframe – Laminate – Sensor module – wafer level

Our proprietary front-end technologies enable product differentiation

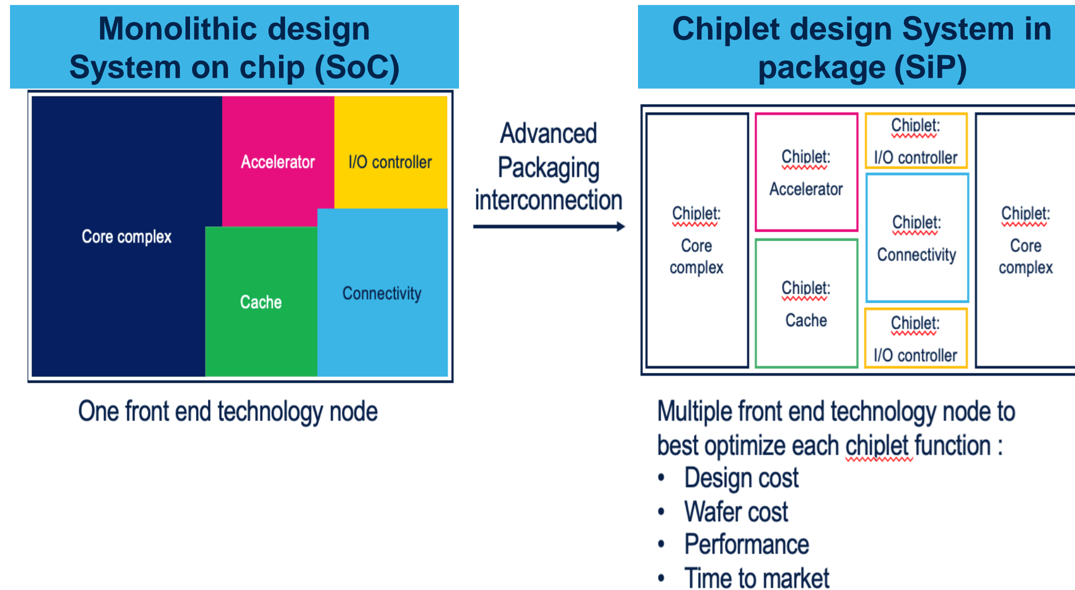


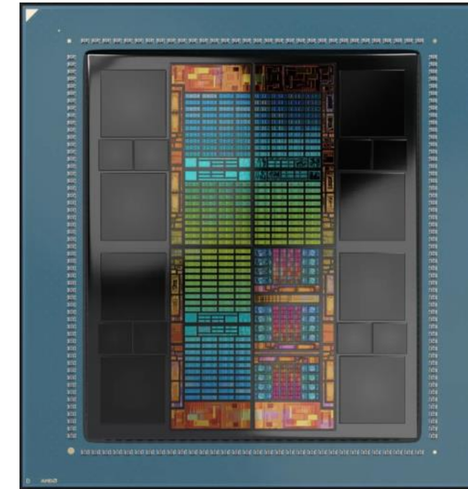
Packaging technology roadmap

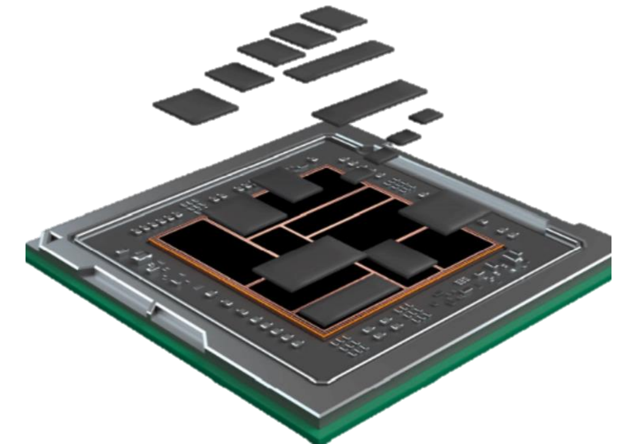
Power

	Established	Industrialization	Scouting	
Power module	IPM, Potted module	Molded module, Power box	Embedded interconnect, Immersion cooling	**Power density Reliability Cooling efficiency**
Power discrete	TOxxx, HU3Pak, STPak	Top side cooling, Hi creepage > 1200V	Diffusion soldering	
Leadframe package	QFP, PSSO, QFN, SOIC	QFN SiP	Direct Copper Interconnect	**Heterogenous integration**
Laminate package	BGA wire bond, BGA flip Chip	SiP / MCP	3D hybrid bonding (W2W / D2W)	**Towards Chiplet**
Chip Size Package (CSP)	Fan in 1RDL/2RDL, Panel Level CSP	Fan out 2RDL/3RDL	SiP Fan out	**Interconnect density**
Sensor packaging	MEMS LGA, Optical module	Optical TSV CSP, Glassless	MEMS WLCSP	**Miniaturization Accuracy**

Chiplet: a new scalable, innovative, efficient way to approach integration







Chiplet enablers

Chip modular design maximizing technology performance and lowering cost

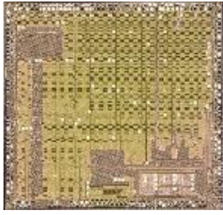
Heterogeneous integration: Fan-In/Fan-Out, Direct Copper Interconnection (DCI), high reliability & performance

Panel Level Package (PLP) Technology utilizing front-end, back-end substrates capabilities

Status and planning

Strategic initiative: dedicated R&D center to cover device architecture design, design and design kit for chips, substrates and interconnections, pilot line on PLP Gen2

Pilot line: 1,300 sqm clean room, front-end fab facilities, advanced test lab, 500-panel/month capacity opening by 2026



18 nm FD-SOI Phase Change Memory (PCM) Technology breakthrough for MCUs

Competitive advantages

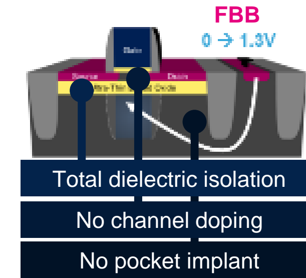
- Outstanding energy efficiency through FD-SOI body biasing capability
- Robust embedded non-volatile memory (eNVM) qualified in automotive
- Advanced analog performance for mixed signal and RF design

Cost efficiency

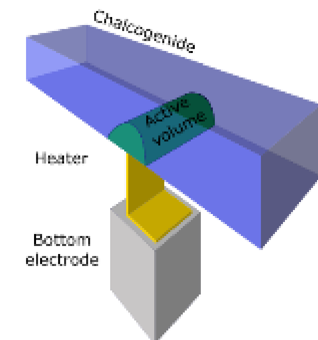
- Highest digital & SRAM density of any planar technology (competition on 22 nm)
- Smallest eNVM cell on the market (half the size vs 22 nm)
- Lower structural cost than FinFET solutions

Resilient supply chain

Dual source with Samsung Foundry, Korea and ST Crolles, France



FD-SOI



PCM

Panel level packaging in volume production in ST today
A first of a kind

Producing 4+ million units per day in internal manufacturing line - First line in the world

Strategic manufacturing programs update

Leveraging 300 mm investments

Crolles

High-volume manufacturing for advanced CMOS nodes and optical products. Capacity up to 20 kwpw*

Agrate

High-volume manufacturing for digital, advanced BCD
Capacity up to 9 kwpw*

Leveraging Silicon Carbide investments

Catania

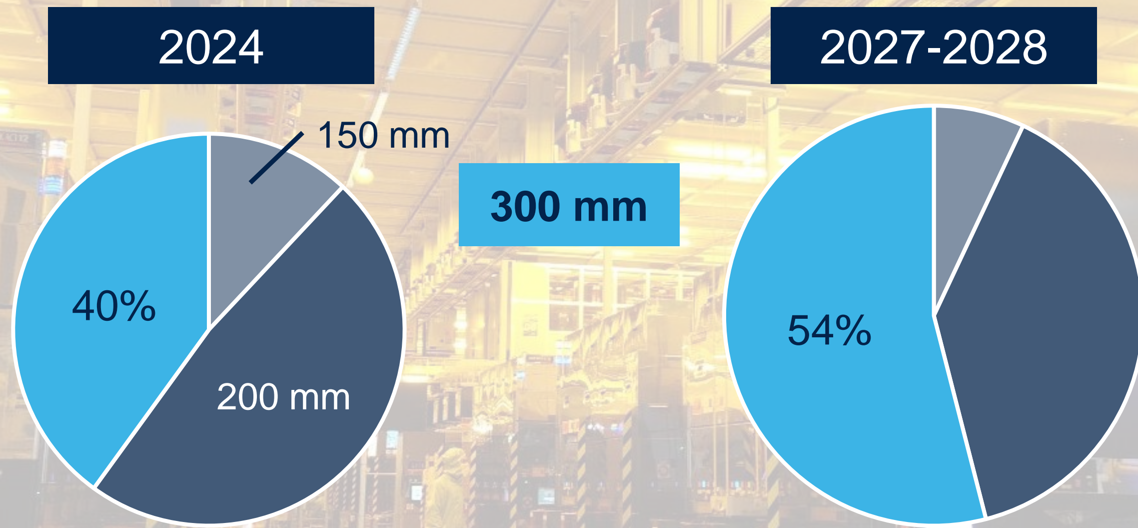
Fully vertically integrated high-volume 200 mm campus
Capacity up to 15 kwpw*

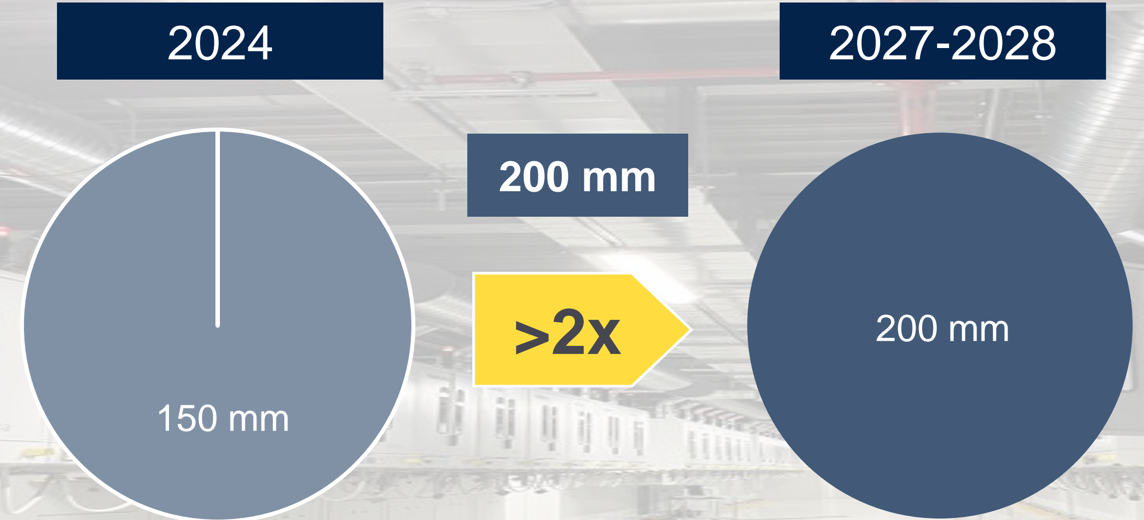
Chongqing (Sanan JV)

High-volume front-end 200 mm manufacturing SiC devices
Capacity up to 5 kwpw in phase 1, 10 kwpw in phase 2*

* **kwpw**: kilo wafers per week at full build out. Capacity tailored to market demand

Manufacturing reshaping





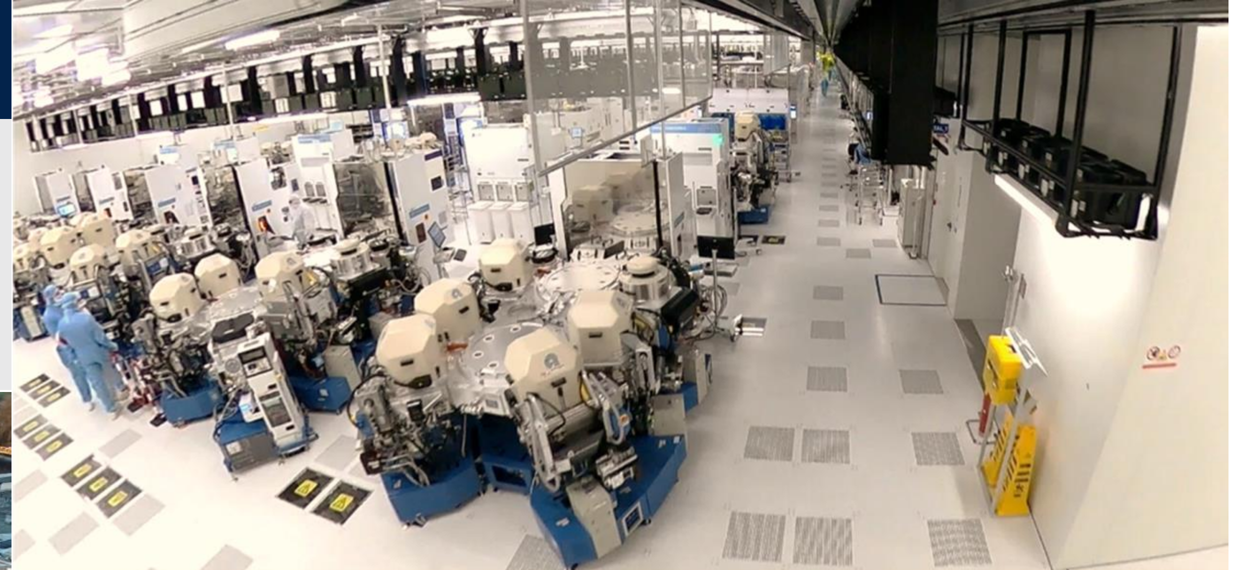
Agrate 300 mm fab evolution

Status and planning

Line **fully qualified**, move to production

Capacity growth **tailored to demand**

Advanced **BCD, HCMOS** for personal electronics, automotive



300 mm competence centre synergy

Seamless interoperability
Twin fabs Agrate and Crolles 300 mm

Roadmaps
Analog mixed signal, smart power (Advanced BCD), HCMOS and VIPower

Crolles 300 mm fab evolution

Status and planning

State-of-the-art production line with modular facilities and capacity approach

20% capacity output increase by H2 2026

Advanced device technology for imaging

Integration of 18 nm FD-SOI with ePCM technology for automotive, industrial, and consumer electronics

300 mm competence center synergy

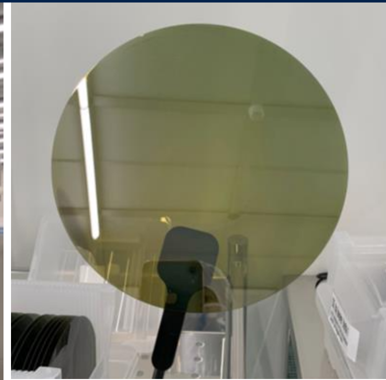
Seamless interoperability
Twin fabs Agrate and Crolles 300 mm

Roadmaps

Digital, eNVM, Imaging technologies

SiC manufacturing ecosystem

ST SiC leadership leverages a multi-site manufacturing network



SiC raw substrate supply mainly from Catania and Sanan

Wafer processing in Catania, in Chongqing JV, Singapore Technology Hub

Testing and assembly in Catania and in Shenzhen expanded campus

Ingot and wafering R&D in Norrkoping

Front-end process R&D in Catania SIC Campus

Back-end process R&D in Shenzhen Campus

First of a kind for mass production of 200 mm SiC devices

Fully vertically integrated: ingot growth, wafering, epitaxial growth, front-end wafer fabrication, test, packaging, KGD, module assembly

Scale and synergies enabling innovation in high-volume manufacturing capacity, leveraging full automated robotization. WIP, tools and process management - powered by AI - secure **efficiency** and **quality**

Process flow on **SiC MonoSiC** and thin **MonoSiC over Poly SiC**

Architect's rendering of complete campus

Catania SiC Campus
Progressing for start of production in 2025

Status and planning

Q4 2024: **200 mm SiC line qualified** (mini-line)

High-volume manufacturing tools installation in progress, **production start by Q4 2025**

Designed for an **extensive use of robots**, AI-based manufacturing processes, machine learning for predictive reliability and qualification

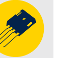
Catania – Singapore synergy

Singapore Technology hub

To drive SiC 150 to 200 mm conversion
To support ST - Sanan JV

China-for-China operating model to support domestic China growth

Operate locally to support fast-changing and highly-competitive China market

Shenzhen 

Back-end assembly & test

Chongqing

SiC Front-end manufacturing

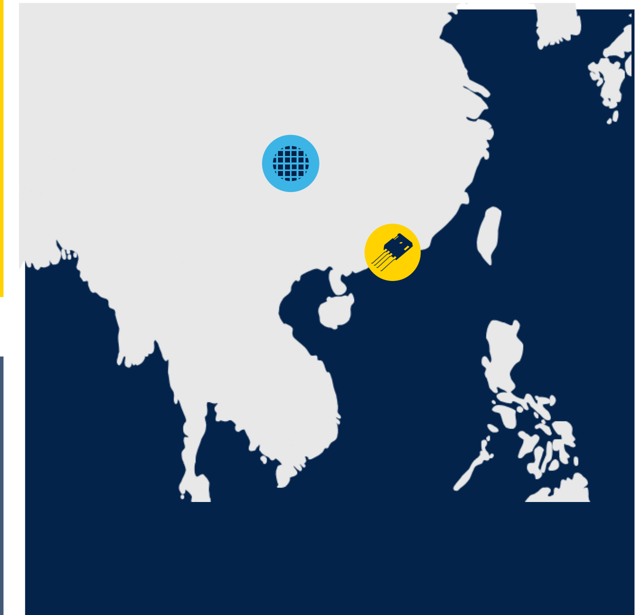
Fully localized, scalable integrated device manufacturing

Front-end manufacturing for Silicon Carbide with ST-Sanan JV

Captive capacity corridor in partnership with HHGrace on 40 nm, OFT, BCD/IGBT

Back-end manufacturing extended Shenzhen Campus (Manufacturing assembly & test, R&D assembly & test, world-class failure analysis and reliability labs).

Application center in Shanghai



Cost-effective & resilient supply chain

Selective use of local equipment vendors, predominant use of local materials vendors to minimize possible geopolitical constraints

OFT: Oxide Filled Trench

Manufacturing and technology – Takeaways

Accelerating the reshaping of our silicon manufacturing footprint
Focus on Crolles and Agrate 300 mm high-volume manufacturing fabs
Rebalance 200 mm capacity
Concentrate 150 mm silicon based legacy products in Singapore

Silicon carbide manufacturing ecosystem
200 mm: Migration to mega-fab in Catania, Front-end in Chongqing (China).
200 mm: Technology hub in Singapore
Assembly and test hub for SiC in Shenzhen

China-for-China
Support China with localized scalable manufacturing networks, world-class failure analysis and reliability labs. Application centers

State-of-the art technologies
BCD-VIPower, Power, MEMS and Imaging, HCMOS BiCMOS, eNVM and digital
Extended assembly and testing roadmap
Develop multi-technology integration through chiplet architecture

Our technology starts with You

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