soitec

incize

BUILDING PARTNERSHIPS

CONNECTING THE WORLD WITH ENGINEERED SUBSTRATES

Jean-Marc LE MEIL
Mobile Communications Division Head

April 2024

Section one

INTRODUCTION

SOITEC IN NUMBERS

IN OUR SOIL GROWS AN AMAZING FUTURE

1992	391	4,083	10.8%	2200	€1.1B
Soitec is founded	Patents filed worldwide each year	Active patents	of revenue dedicated to gross R&D	Employees (34% women) industry average 20-25%	Revenue (Fiscal year 2023)

SOITEC HAS BUILT AN UNIQUE POSITION

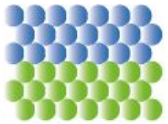
IN THE VALUE CHAIN…

BULK WAFER SUPPLIERS

soitec

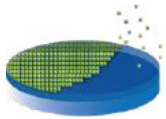
TECHNOLOGY EXPERTISE

Smart Cut™



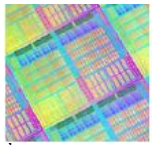
Interface engineering

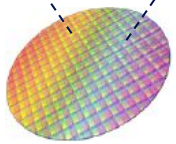
Compound



Epitaxy

FABLESS
(DESIGN HOUSE)
CIRCUIT





FOUNDRY
IDM
PROCESSED WAFER

OUTSOURCED
(INSOURCED)
ASSEMBLY & TEST

OEM
SYSTEM

MOBILE
COMMUNICATIONS

AUTOMOTIVE
& INDUSTRIAL

SMART
DEVICES

… LEVERAGING
STRATEGIC PARTNERSHIPS

IN THE ENTIRE SEMICONDUCTOR ECOSYSTEM

INCIZE AND SOITEC

A SHARED PASSION FOR RF TECHNOLOGY, TECHNICS AND INNOVATION STARTED 12 YEARS AGO

IMS
Connecting Minds. Exchanging Ideas.

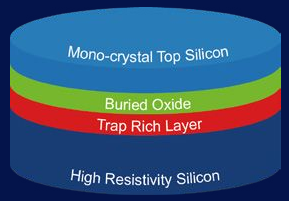
The Coolest Ideas Under the Sun
SAN DIEGO 2023

Section two

SOITEC's RF ENGINEERED SUBSTRATES VISION TO REALITY

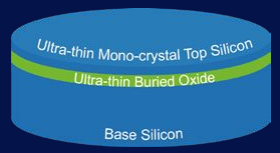
SOITEC PRODUCT PORTFOLIO ENABLES BEST-IN-CLASS CONNECTIVITY

A COMPREHENSIVE OFFER FOR Sub-6GHz & mmWave FRONT-END MODULES



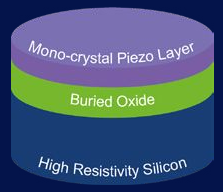
Connect RF-SOI

For highly efficient mobile communications



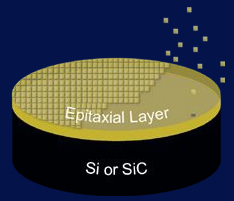
Connect FD-SOI

Integrated technology



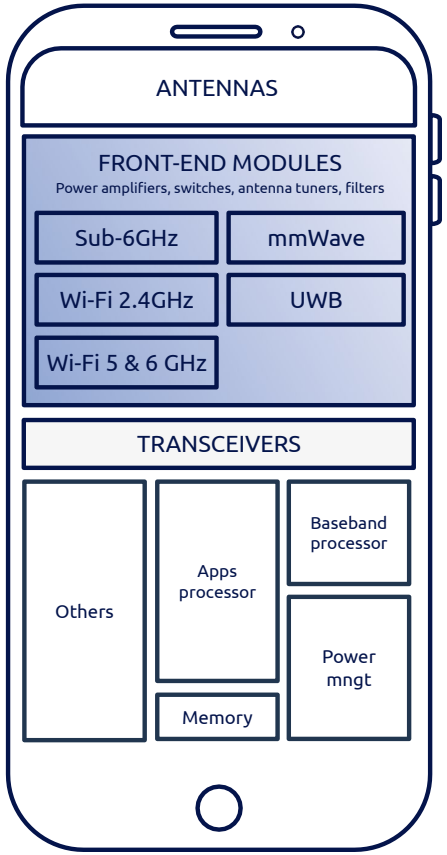
Connect POI

High performance 5G filters



Connect RF-GaN

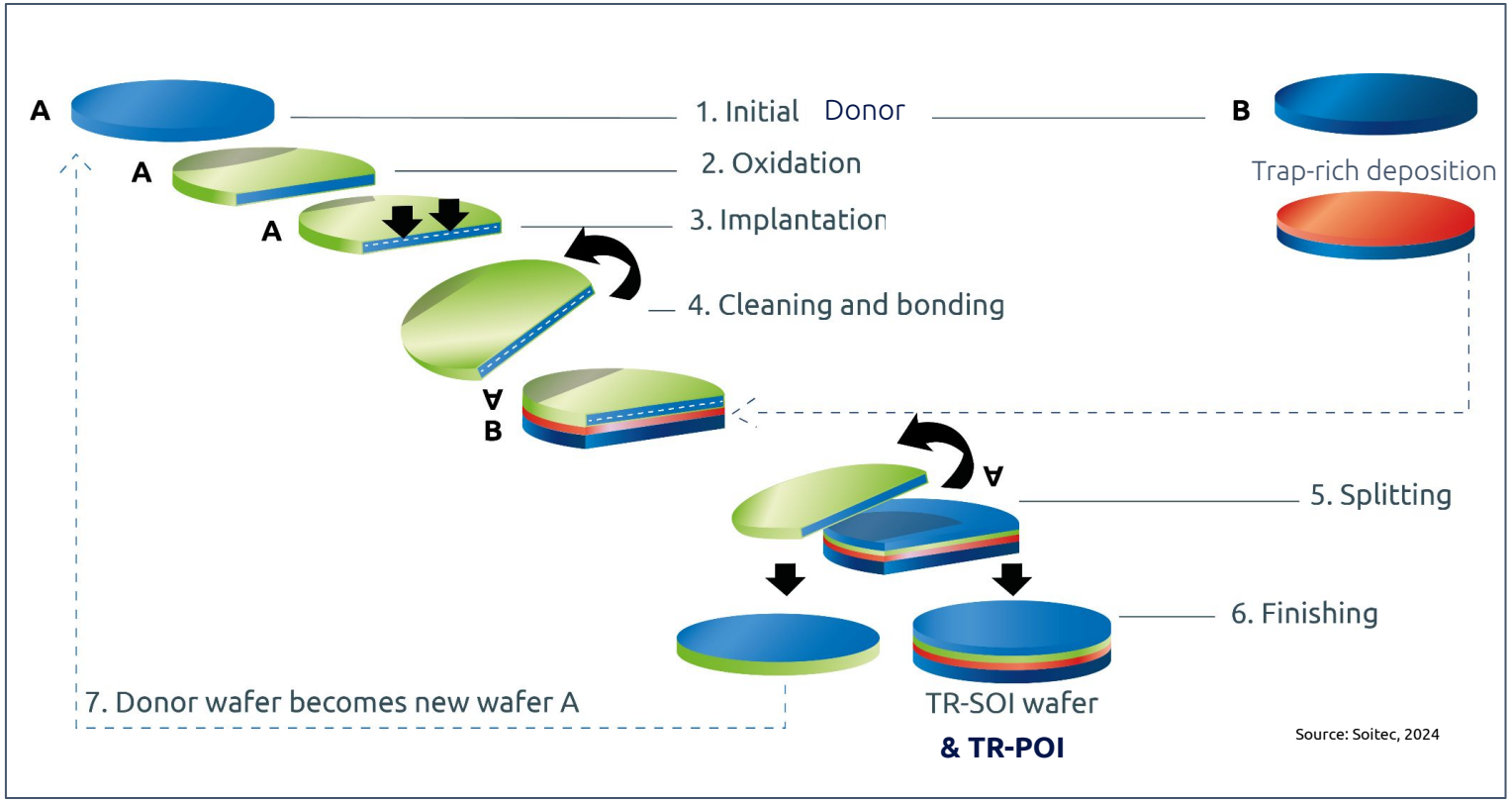
High-performance power amplifiers

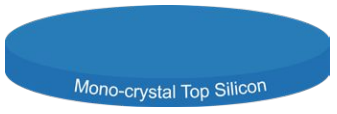


	4G / 5G Sub-6GHz	5G mmWave	Wi-Fi & UWB	6G Sub-20GHz
POWER AMPLIFIER (PA)	☐	■ ■	■	■
LOW NOISE AMPLIFIER (LNA)	■	■ ■	■	■
SWITCH	■	■	■	■
ANTENNA TUNER (AT)	■	☐	☐	■
FILTER	■	☐	■	■
ENVELOPE TRACKER (ET)	■	☐	☐	■
PHASE SHIFTER	☐	■ ■	■	■
SYSTEM ON CHIP (SoC)	☐	■	■	■
INTEGRATED FRONT-END	☐	■	■	■

■ Connect RF-SOI ■ Connect FD-SOI
■ Connect POI ■ Connect RF-GaN

INDUSTRY BEST TRAP-RICH SUBSTRATE FOR RFeSI™ AND SAW FILTER-POI ENABLED BY SMART CUT™





Active layer

Insulator layer

Passivation layer

Silicon handle

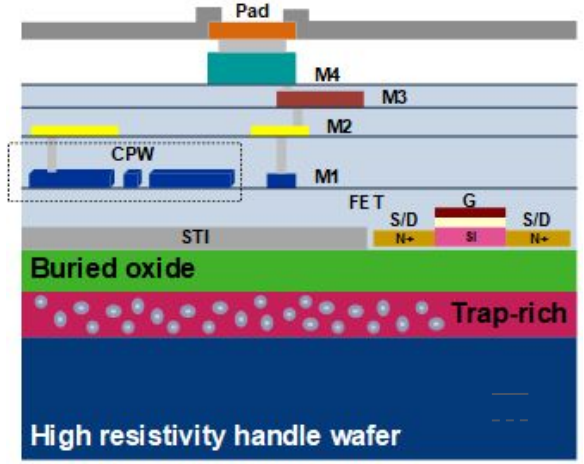
TECHNOLOGY

- Industrial manufacturability – high yield
- Drastic improvement in uniformity & quality
- Re-use of donor wafer increases cost efficiency
- Flexibility of material integration

TRAP-RICH HIGH RESISTIVITY RFeSI™ and SAW Filter-POI

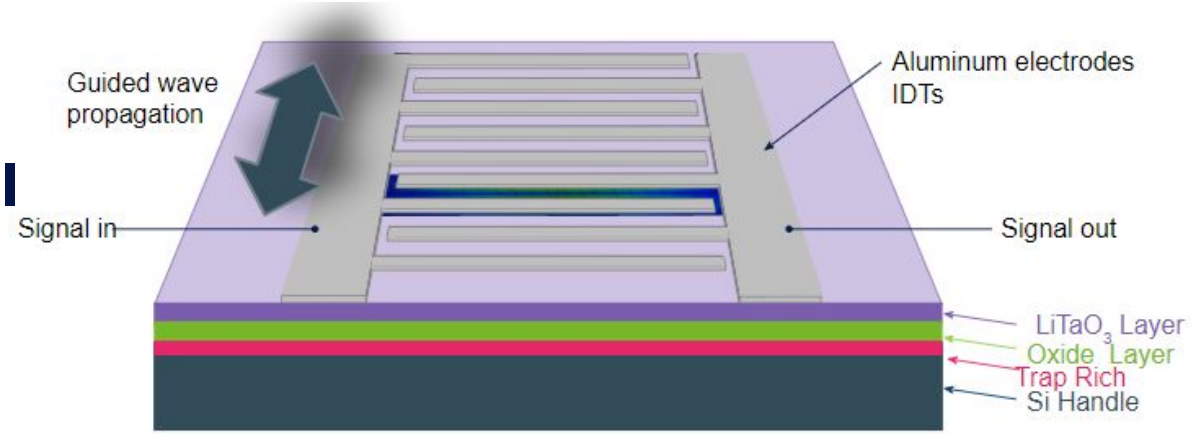
THE STANDARD FOR MOBILE RFFE

CMOS RF-SOI

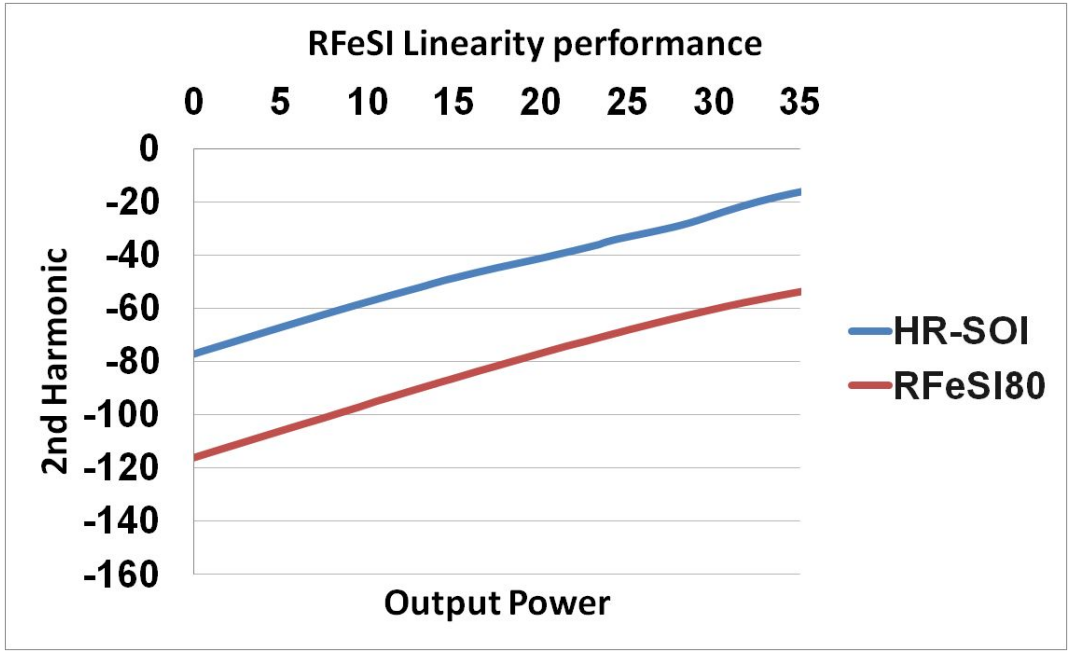


Source: Soitec, 2023

SAW on POI

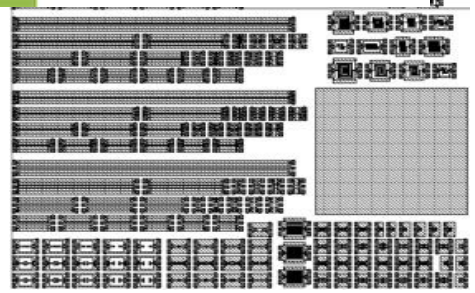


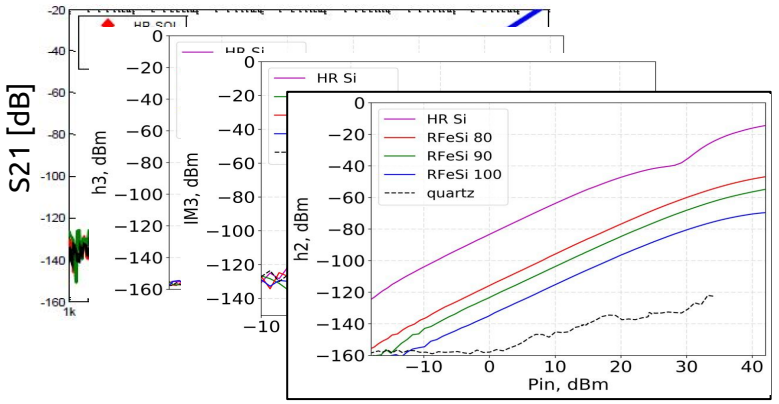
- Due to Parasitic Surface Conduction (PSC), harmonic reduction stops working at resistivities >500Ω.cm without a trap-rich Layer
- Thanks to the Trap-rich layer, substrate keeps its high resistivity at the RF Front End operating conditions neutralizing the PSC's associated mobile charges and preventing resistivity to drop below the BOX



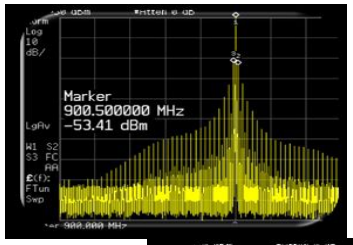
EXTENSIVELY CHARACTERIZED BY OUR PARTNERS & LARGELY VALIDATED BY OUR CUSTOMERS ADOPTION

incize

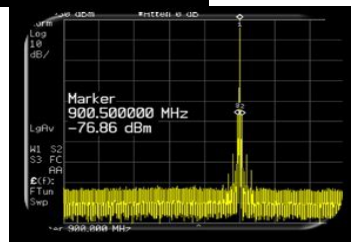




RFeSI™ reduces digital substrate noise



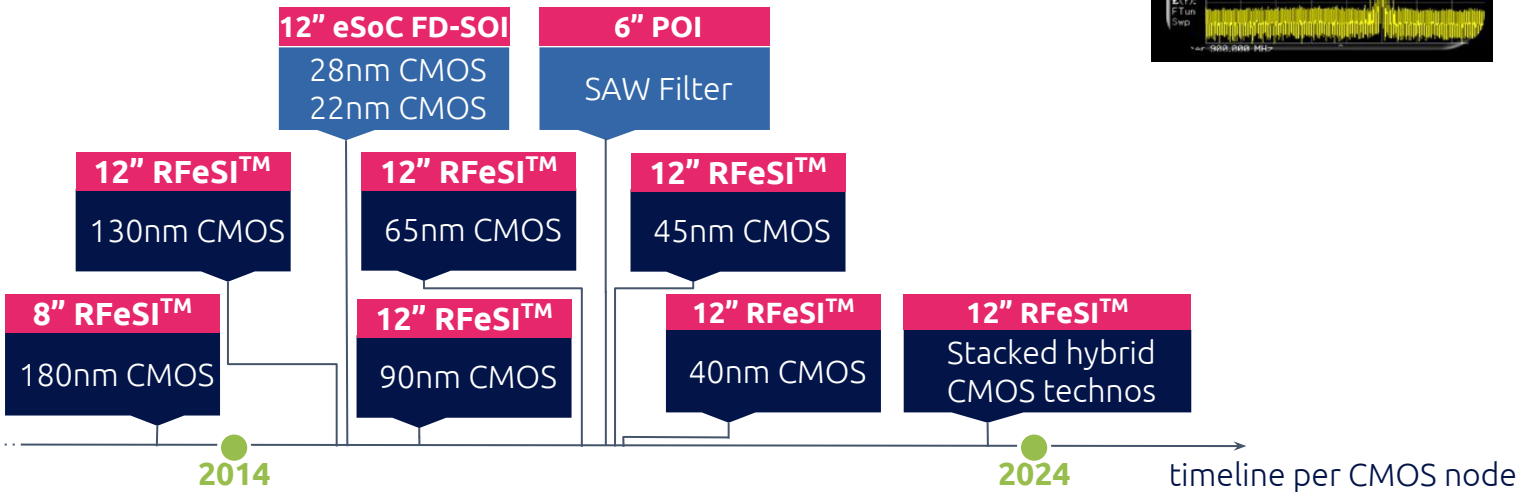
HR-SOI



RFeSI™

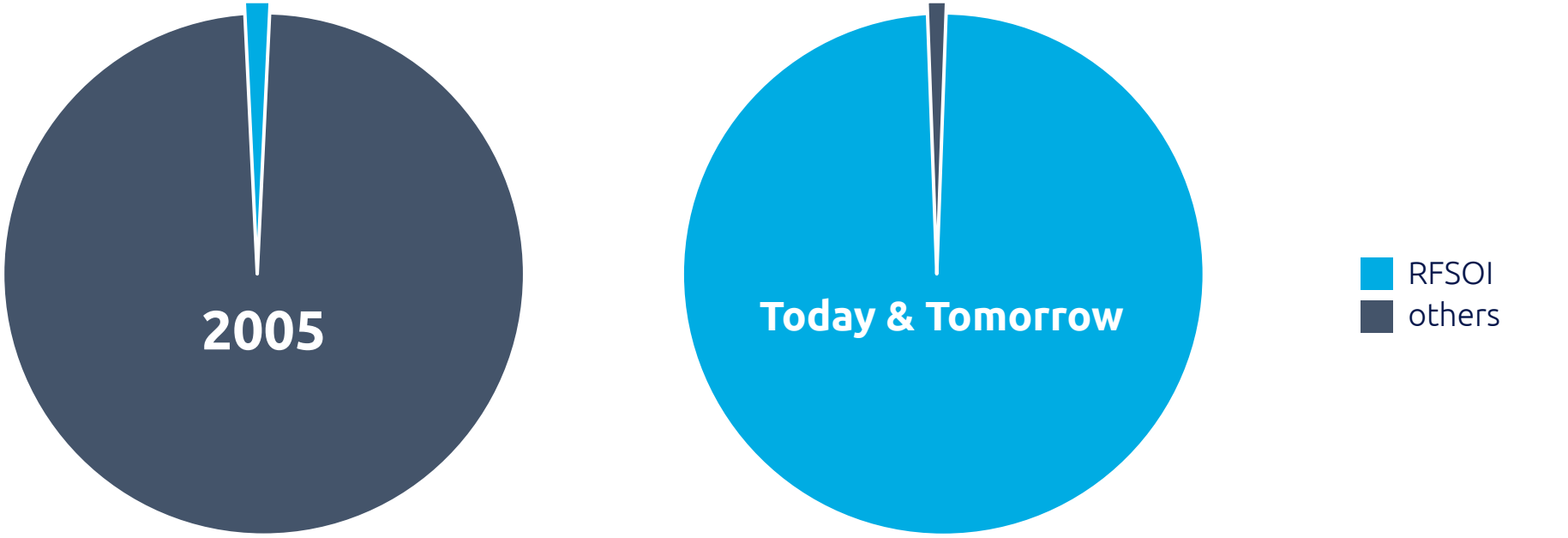
soitec

with all major worldwide RF foundries since **2010**



RF-SOI TECHNOLOGY IMPACT

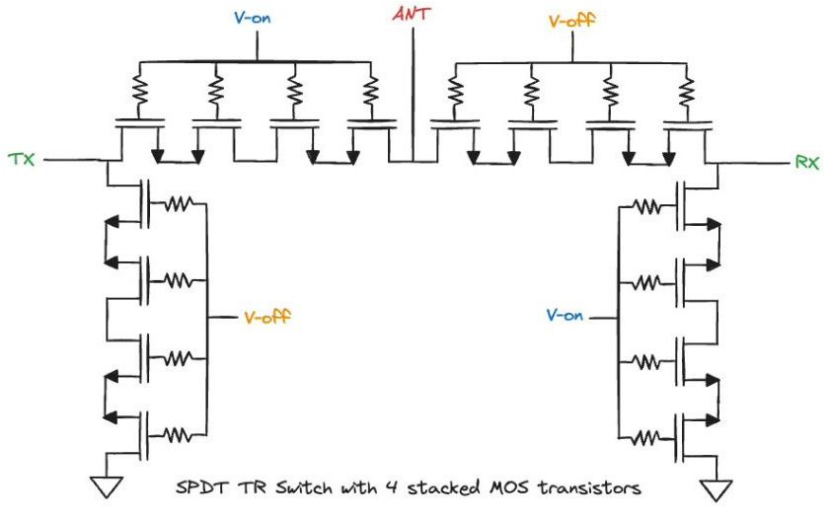
CELLULAR SWITCH + LNA MARKET SHARE



*Adapted from **J. Cable**, 30 Years of RF SOI Past, Present and Future, 2019*

IT ALL STARTED WITH THE NEED FOR A SWITCH

… THE BEST-IN-CLASS CMOS INTEGRATED RF SWITCH



REASONS WHY SILICON-ON-INSULATOR TECHNOLOGY IS THE WORKSHORSE OF RF FRONT END SWITCHING

⚡ *Low parasitic allows transistor stacking*	→ *voltage handling*
⚡ *Low ON resistance and OFF capacitance*	→ *wide bandwidth*
⚡ *Oxide layer insulating from silicon*	→ *no latch up issues*
⚡ *Oxide + high resistivity silicon substrate*	→ *high linearity*
⚡ *Silicon*	→ *control circuits can be implemented*
⚡ *Better radiation hardness*	→ *good for space stuff*

Other technologies have their uses in specific applications too.

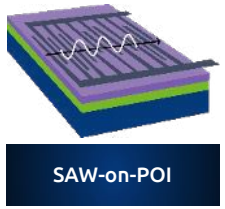
*But **SOI switches are just awesome**.*

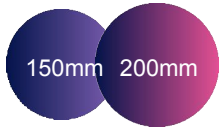
***V. Sekar**, Qualcomm Experienced RF Engineer and Enthusiast SOI Promoter, 2024*

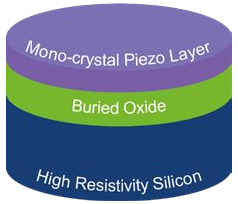
BEYOND SOI,
RF-GaN & POI ENGINEERED SUBSTRATES FOR PA & SAW FILTER

LEVERAGING A RICH EXPERIENCE AND EXPERTISE FOR THE BENEFIT OF THE RFFE INDUSTRY

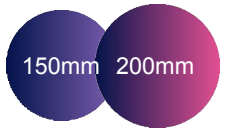
NEW 5G CHALLENGES	FILTER CHALLENGES	SOITEC CONNECT POI
x10 Filter paths	More multiplexing	Multiplexer die integration
x2 Bandwidth	High quality factor & better coupling factor	x2 quality factor
x2 Power requirement	Better insertion losses	Coupling factor up to 20%
	Better temperature stability	Insertion losses <1dB
	Manufacturing cost	x2 lower temperature drift
		Simpler manufacturing process
		200mm scaling

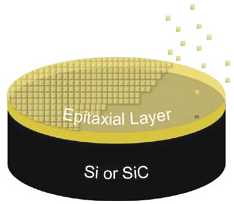






Source: Soitec, 2024





Source: Soitec, 2024

SOITEC CONNECT RF-GaN SOLUTION FOR MOBILE AND INFRASTRUCTURE

Unique expertise to capture **GaN-on-Si** long-term trend for **Mobile and Infrastructure**

Strong experience to serve high volume manufacturing markets

Long-term roadmap to meet higher RF performances with **SmartGaN**

WIRELESS CONNECTIVITY ECOSYSTEM

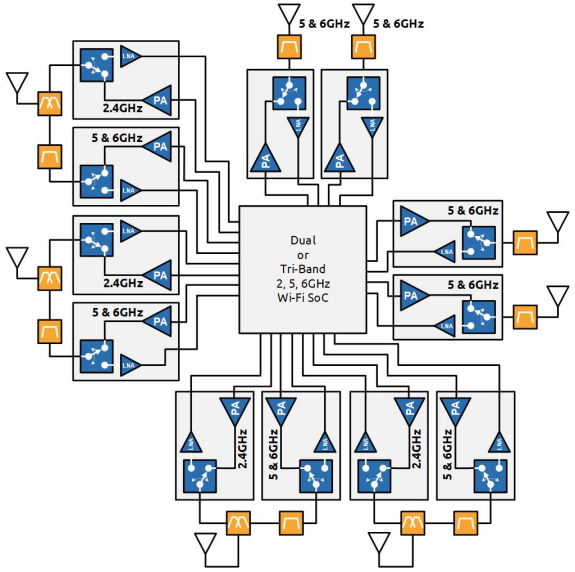
TIME-TO-MARKET WITH UNBEATABLE TOTAL COST OF OWNERSHIP DELIVERED BY SOITEC RF ENGINEERED SUBSTRATES

RFFEs

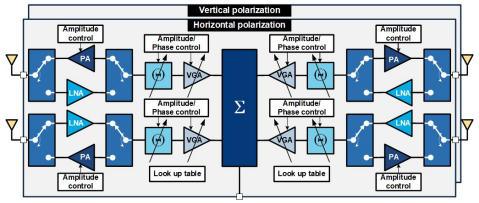
- 1000s of switch branches
- 1000s of filter paths
- 100s of LNAs
- 100s of PAs

- Soitec Connect RF-SOI
- Soitec Connect FD-SOI
- Soitec Connect RF-GaN on Si
- Soitec Connect POI
- Soitec R&D

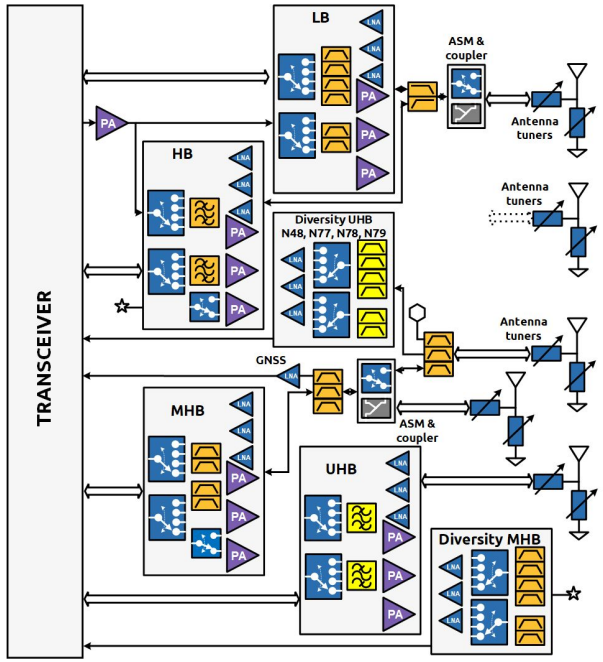
Wi-Fi
CPE, Router, gateway,etc
2.4, 5, 6GHz



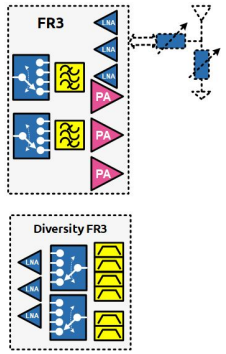
mmWave
CPE, FWA, smartphone, etc
5G & proprietary



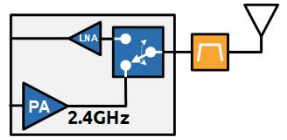
5G sub-6GHz
Smartphone, etc



5G 10GHz
Smartphone, etc



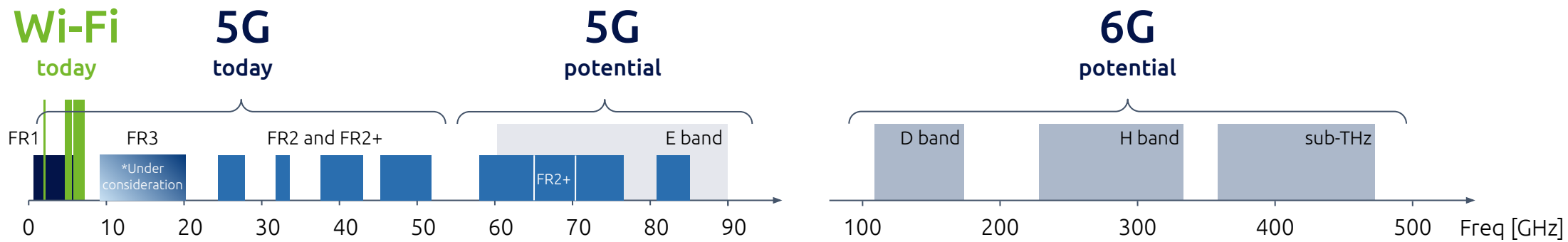
2.4GHz multi-protocol
Wearables, IoT, etc
BT, Zigbee, proprietary, etc



Source: Soitec, 2024

SOITEC RF ENGINEERED RF SUBSTRATES

FOR TODAY'S AND TOMORROW'S RF SOLUTIONS



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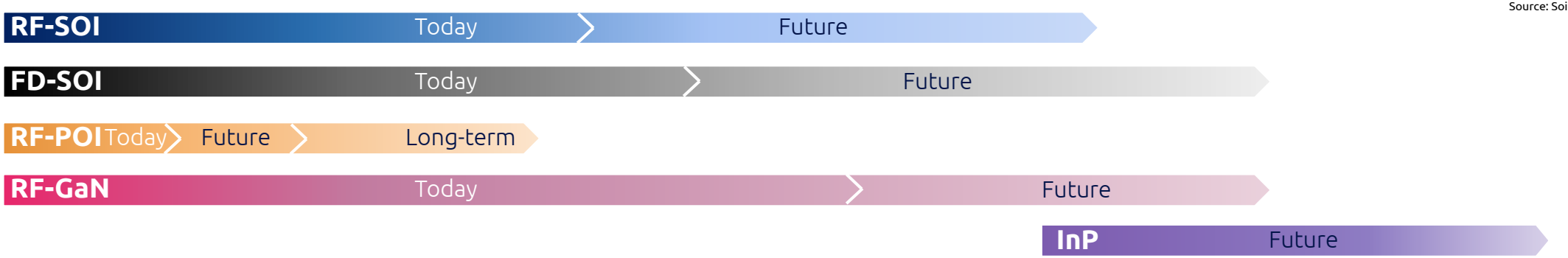
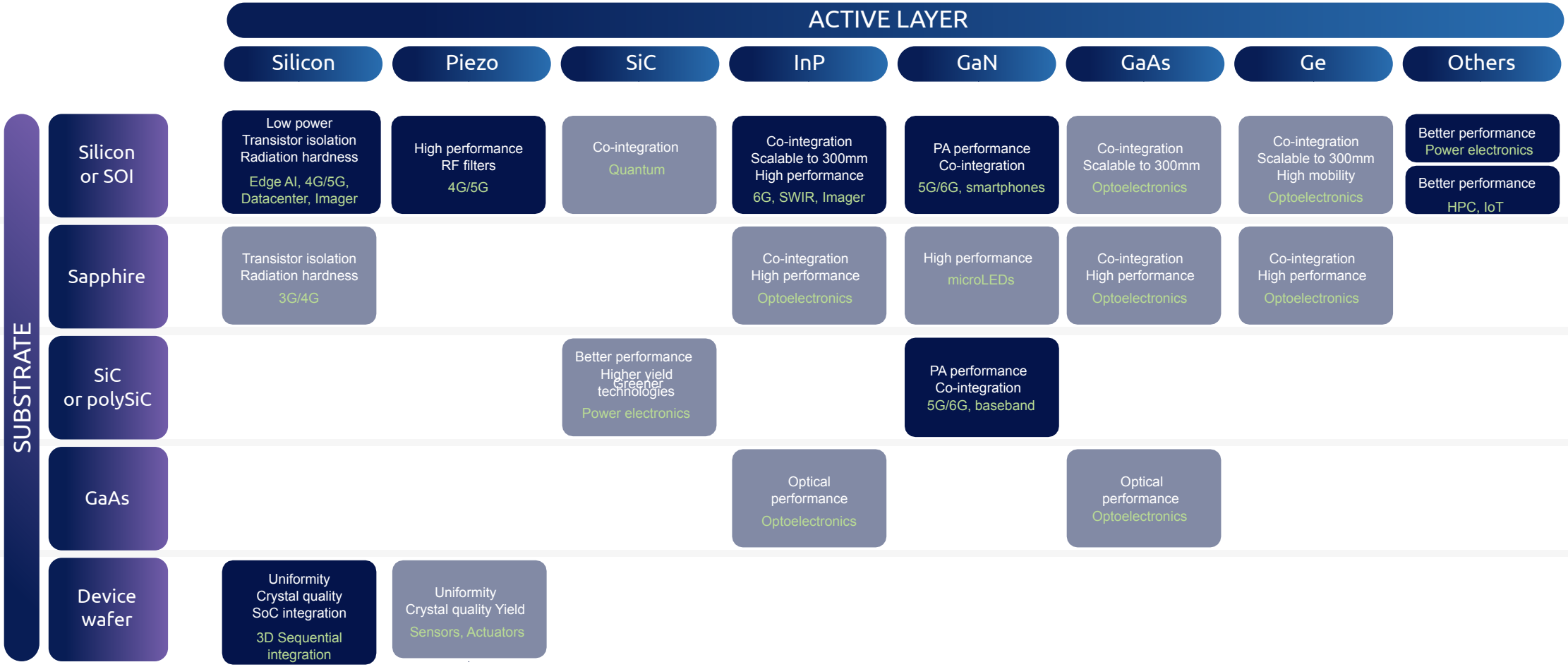


Several other factors than frequency range determine the choice of the right engineered substrate material

- Power handling, power efficiency, linearity, mechanical strength, heat dissipation, high volume manufacturing compatibility, cost are among several more

ANYTHING-ON-ANYTHING - SOITEC INNOVATION DNA

ENABLING NEW PROPERTIES FOR SPECIFIC APPLICATIONS



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