THE TAKE-OFF OF IMMERSION LITHOGRAPHY AT LETI

LETI DAYS LITHOGRAPHY WORSHOP | Céline Lapeyre | July 6th, 2018

WHY IMMERSION LITHO CELL TODAY @LETI ?

LETI OFFER

Customized R&D program

Dedicated integration blocks
Specific materials qualification
LETI platform access (litho platforms – metrology & defectivity)
Dedicated SW solution deployment

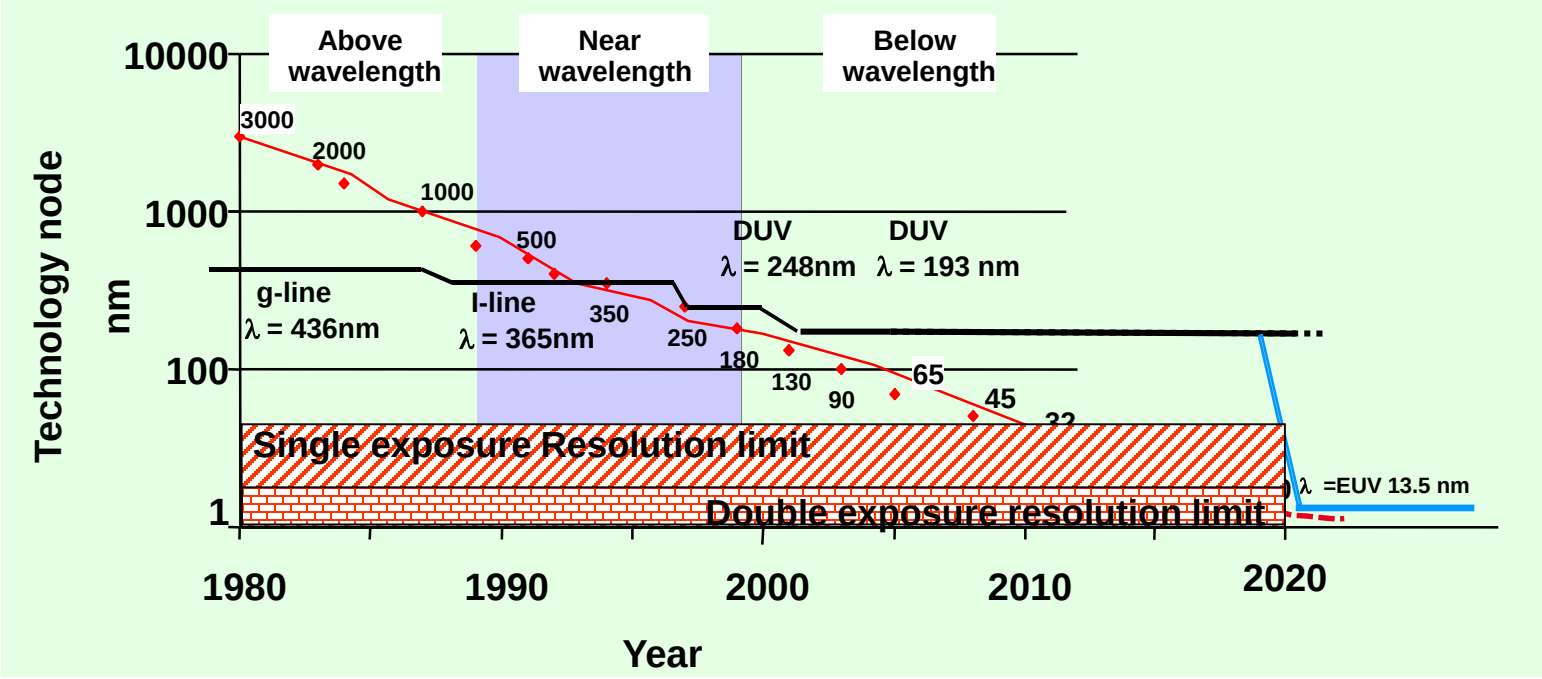
Prototyping & Service

Wafer prototyping with garanteed cycle time

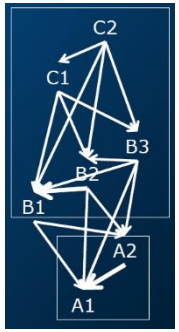
Needs :

- **Full patterning autonomy to address ADVANCED PROGRAM (CMOS 28-14-10-7-5, MEMORY, …)**
- **Advanced device development at LETI**
- **Support our partners with relevant industrial patterning solution**
- **Full matching with partners lithography tool set (wafers shuttles)**

OPTICAL LITHOGRAPHY



Multipatterning : OVERLAY budget as technological driver



ALIGNMENT → more critical parameter than resolution
→ Metrology needs

IMMERSION LITHOGRAPHY : state of the art, industrial reference

1 Immersion Cell Presentation

2 Immersion Cell Ecosystem

3 Planning

4 Starting Projects & Roadmap

5 Conclusion

300MM IMMERSION LITHO CELL INVESTMENT IN 2018

Full patterning autonomy to address advanced LETI programs & support our partners with relevant industrial patterning solution

Track
Sokudo DUO
DT3000

Scanner
NXT:1970Ci

Masks, OPC & Source Optimisation

& METRO-DEF ENVIRONMENT EVOLUTION

Top view CD-SEM

APPLIED MATERIALS make possible — VeritySEM 4i

- Sub-10nm 3D CD-SEM
- high-aspect-ratio imaging, tilted electron beam

HITACHI Inspire the Next — HCG4000

- 32nm node dedicated CD-SEM
- + Design Gauge for OPC

Overlay

- Optical overlay metrology for advanced patterning processes at the 1Xnm design nodes (sub-10nm)

Patterned wafer defect inspection & review

- defect capture on 2Xnm/1Xnm memory and logic devices
- scanner defectivity monitoring (PCM)
- Litho PW centering
- Defect capture on 3D & transparent substrate

target 2 tools :
Optical inspection + SEMreview

Consultation under progress

2019

SP2-SP3 surfscan

Scanner baseline

- Scanner monitoring (Focus baselline & Overlay baseline)
- on-product overlay and focus using diffraction based overlay (uDBO) and diffraction based focus (DBF) techniques

Scatterometry

- 3D measurement
- CD measurement

TRACK & SCANNER CONFIGURATION

Track
Sokudo
DUO
DT3000

- **Coating :** 18 auto lines + 2SVD system
- **Bakes :** 2 PAHP + 4 PQBH (150°C) +4 PQHH (250°C) +2 PHHH (350°C) + 2 PVQBH (150°C)
- **Positive Tone Development unit (ECO nozzles)**
- **Negative Tone Development unit**
- **Pre-immersion unit : 1 SOAK (FS) + 2 BSP (backside cleaning)**
- **Post-Immersion Rinse unit : 1 SOAK**

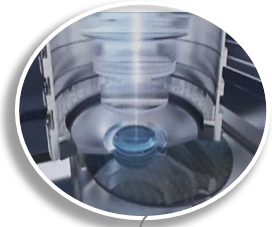
Scanner
NXT:1970Ci

- **Imaging performance : NA 1.35, best resolution in class (CD 38nm ½ pitch)**
- **Overlay performance (multi-patterning strategy)**
  - Single Machine Overlay (**SMO**) **< 2.0nm**
  - Matched Machine Overlay (**MMO**) **< 3.5 - 4.5nm**
- **Configuration**
  - Flexwave
  - Imaging optimizer
  - Overlay optimizer
  - Litho Computing Platform
  - LithoInsight

LETI ECOSYSTEM AROUND IMMERSION PROGRAM

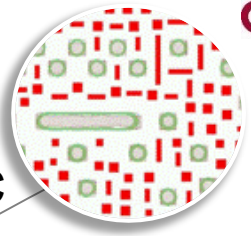
ASML

SCREEN



LITHOGRAPHY

Mentor Graphics



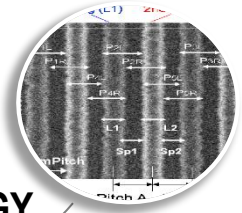
OPC

KLA-Tencor

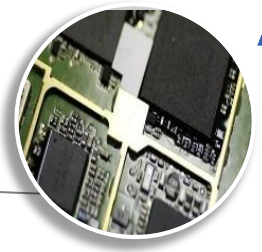
NOVA

ASML

APPLIED MATERIALS



METROLOGY



END USERS

GLOBAL FOUNDRIES

IMMERSION TOOLS INSTALLATION PLANNING

2018

	Apr	May	June	Jul	Aug	Sept	Oct
YST	Delivery&Move-in 23/04		Reception				
			Installation & Tests				
NXT		Delivery & move-in Subfab 08/05	mainbody 15/05		Reception		
			Installation & Integration phase		Acceptance tests	Production	
TRACK			Delivery & move-in 30/05		Reception		
			MA	Hook -up	Installation & Tests	Production	
A600				Delivery & move-in 10/07	Reception		
				Installation & Tests		Production	
PROCESS					Monitoring set-up, learning phase		
						PROCESS DEVELOPMENT	

STARTING PROJECTS

PCRAM

CMOS ST + PCM Leti

- **WALL**

FDSOI

- GATD
- GATE
- CNT
- M1

Photonics on Si

- Si Wave Guide
- Grating
- →2D curved structures

Display

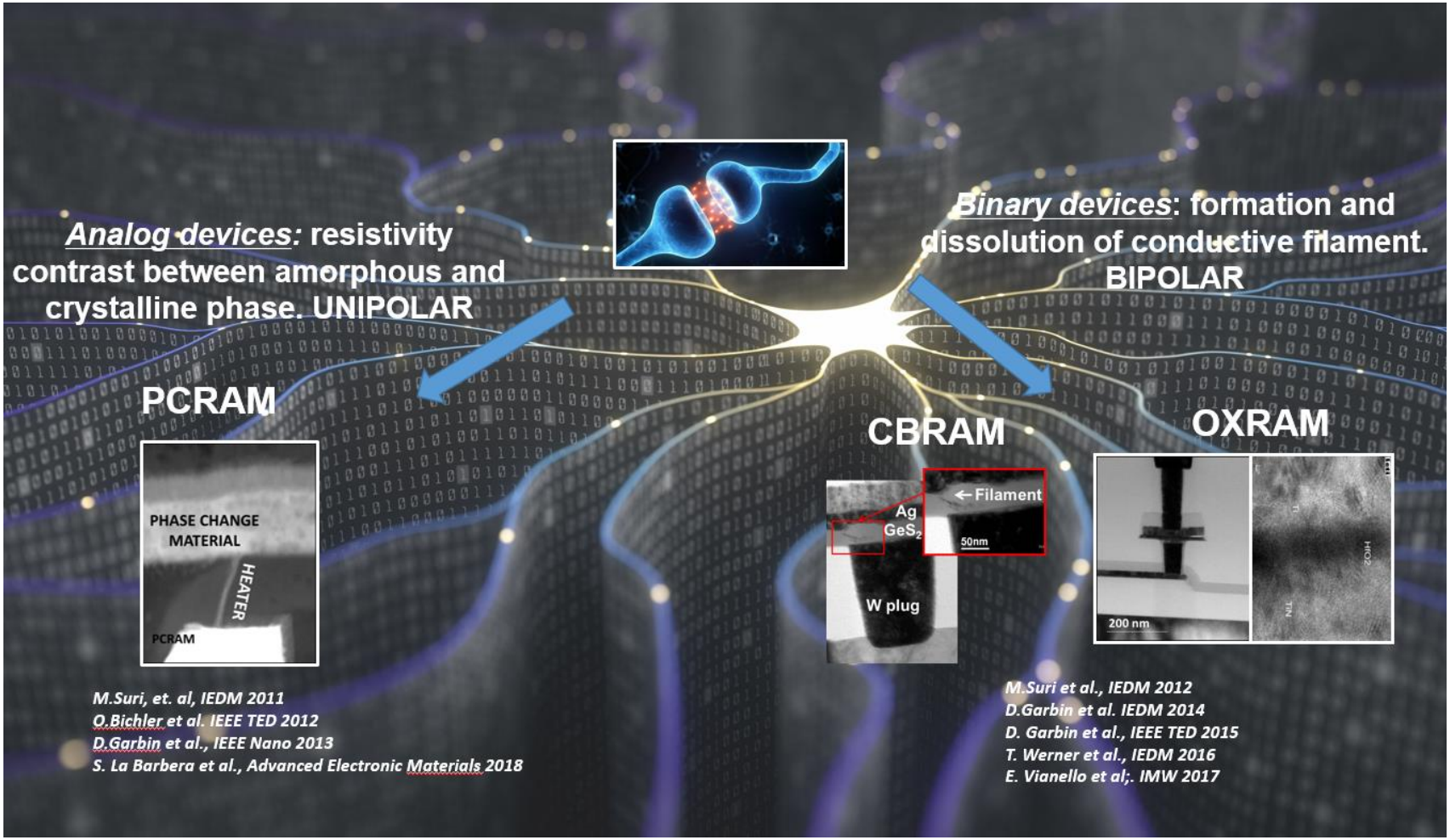
- Polarizer, Masters for display : Large dimension network patterns
- Work around stitching

DSA Guide

- Lamellar approach

ADVANCED MEMORIS @ Leti TO EMULATE SYNAPSES

EMBEDDED MEMORY

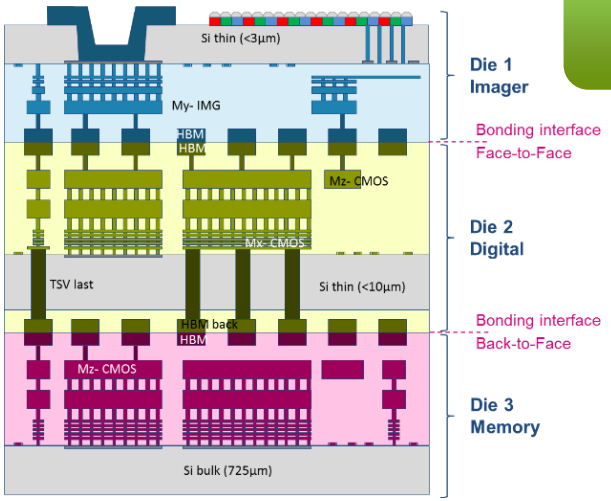


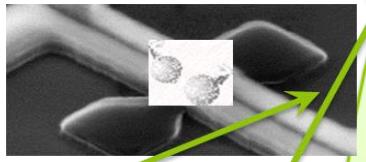
Support these developments with agressive resolution

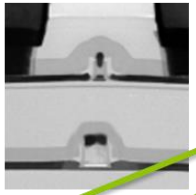
MORE THAN MOORE INNOVATIVE FIELDS

FDSOI

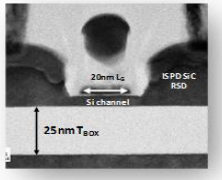
INTEGRATE & STACK FUNCTIONALITIES
28nm – 12nm technology nodes baselines

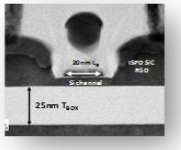


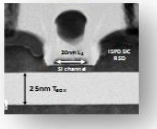


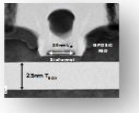


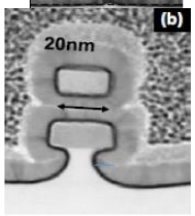
28nm
22nm
14nm
10nm
7nm
5nm

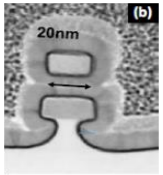


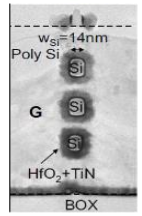












Early system/ device interactions

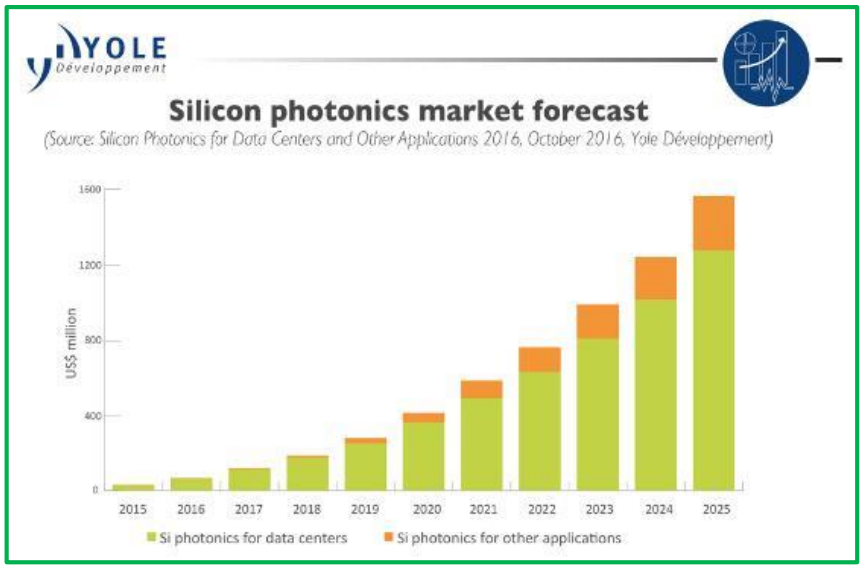
Early design/ device interactions

Early material/ device interactions

A CHALLENGING PERSPECTIVE AROUND PHOTONIC ?

Photonic

- Si Wave Guide
- Grating
→2D curved structures

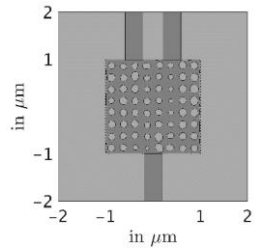


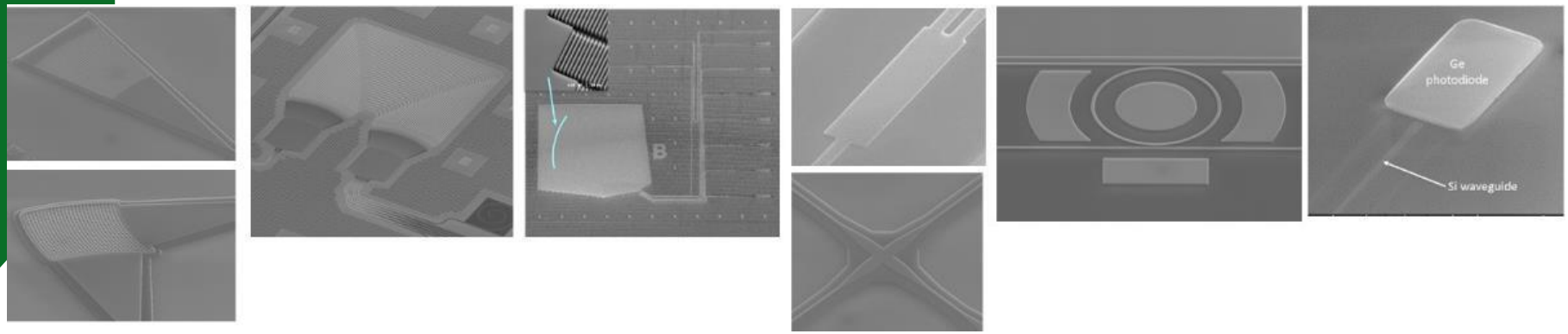
RESOLUTION

ROUGHNESS

2D CURVES RET

SPECIFICATION & TOLERANCES



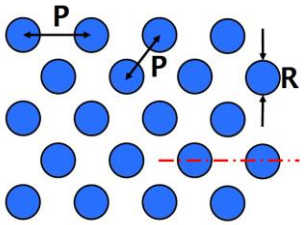


DISPLAY

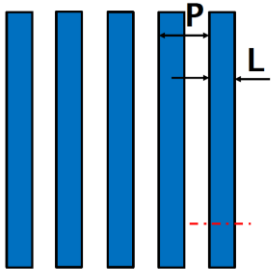
Display

- Large surface master
- Grating
- Stitching

DESIGN OBJECTIVES

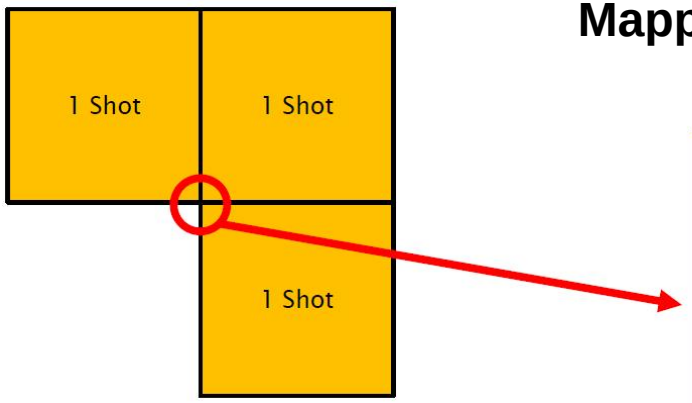


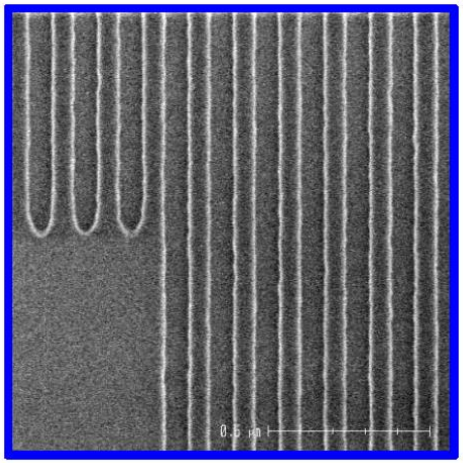
P=180nm
R=90nm



P=80nm,90nm,100nm,140nm
L=40nm,45nm,50nm,70nm

Mapping : full 300mm coverage



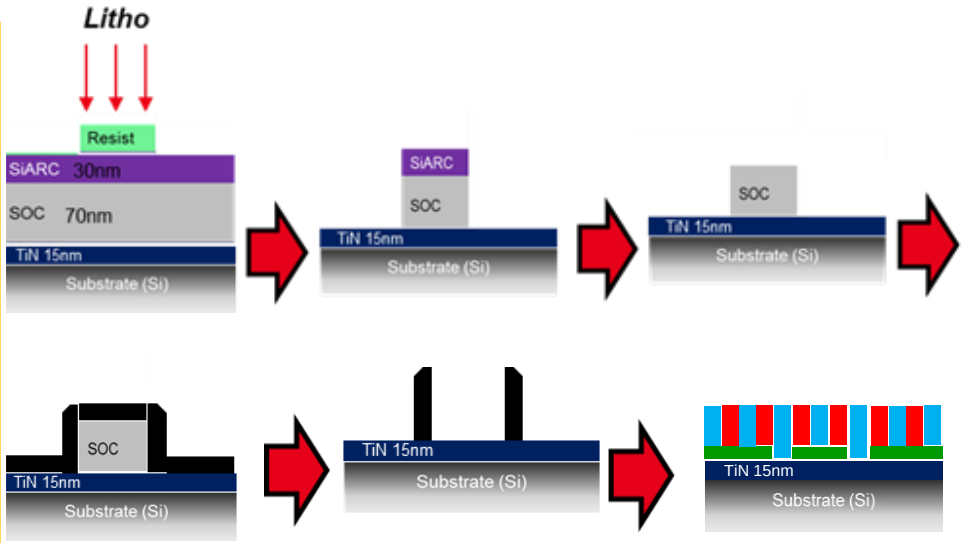


Stitching : not visible

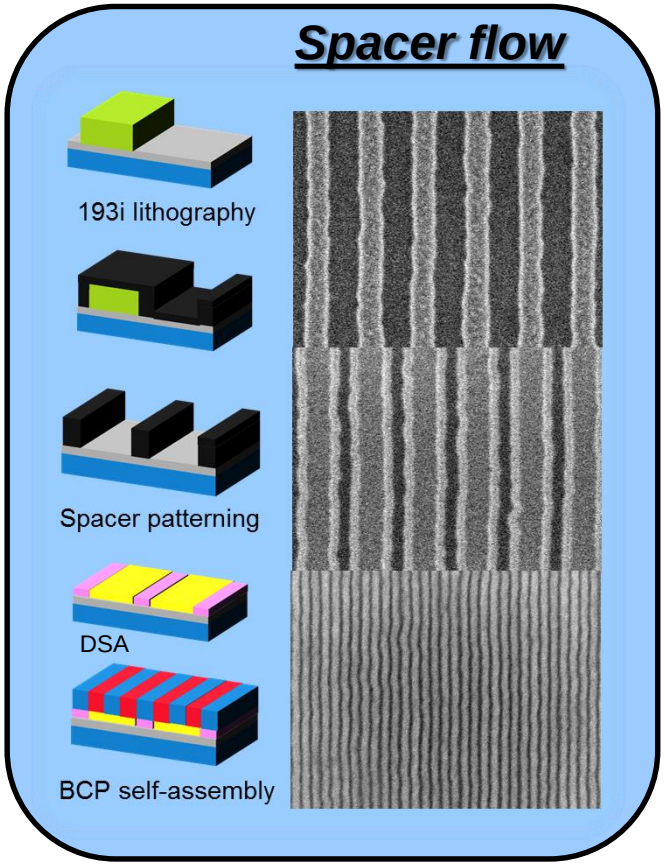
DSA CHEMOEPITAXY INTEGRATION

DSA Guide

Lamellar approach

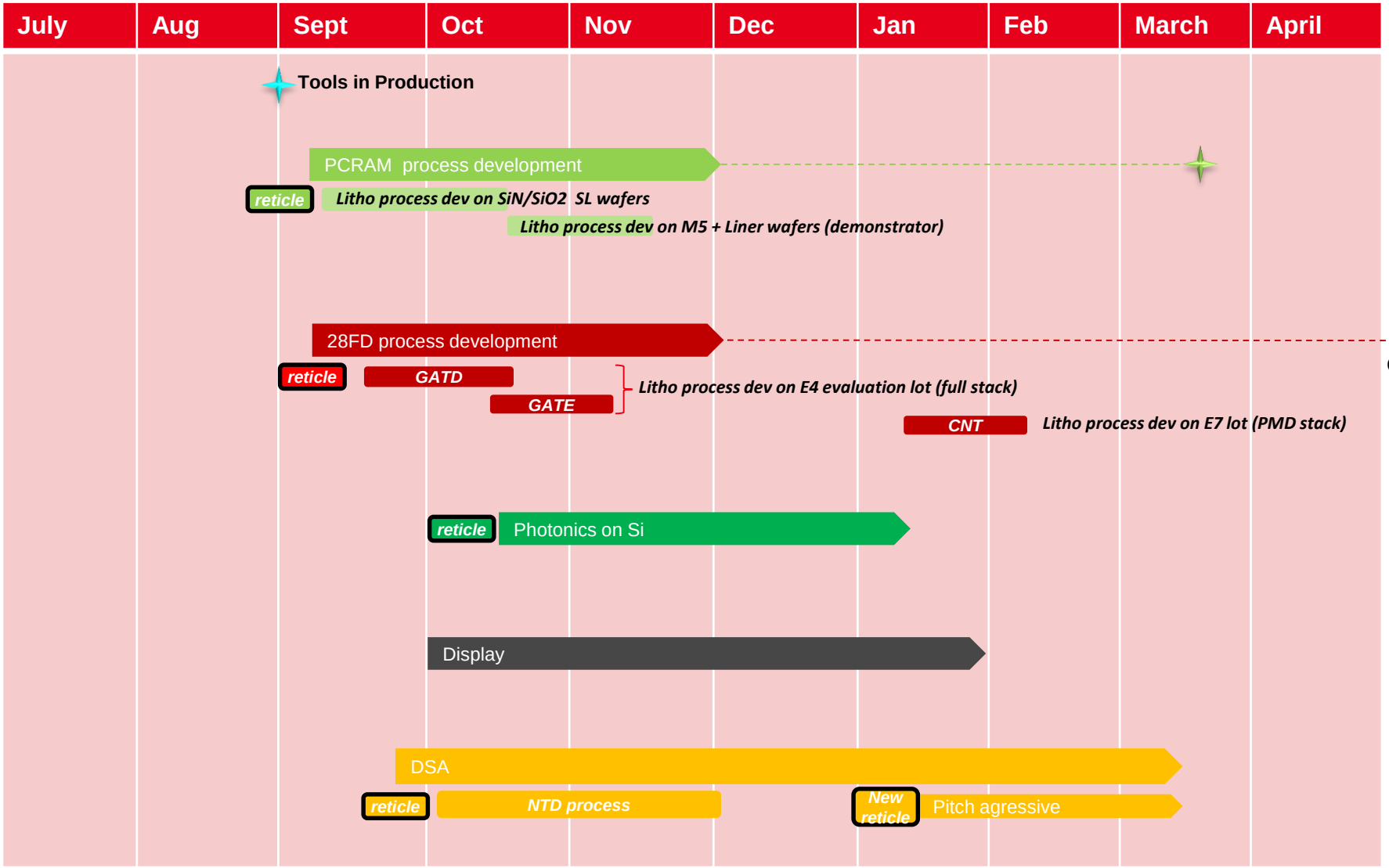


L18	x2	x3	x4
CD_{line} (nm)	27	45	63
Pitch (nm)	72	108	144



Goal: Implement a vehicule test for chemoepitaxy of High-χ BCP (L_0 < 20 nm)

IMMERSION CELL : 1ST PROGRAM STARTUP

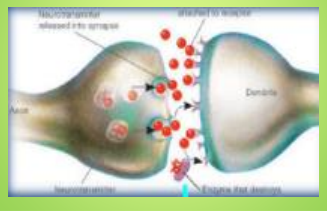


CONCLUSION

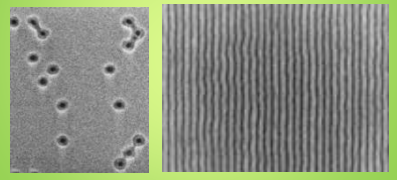
- Immersion cell investment @LETI is a big challenge
- Strong start-up in September with challenging projects

Our objective :
Support the next wave of innovations with best-in-class lithography option

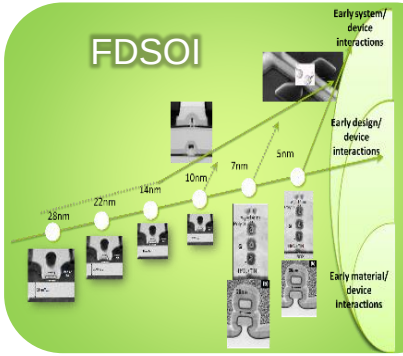
Memory



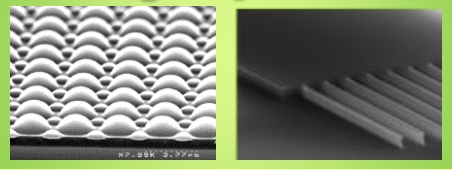
DSA



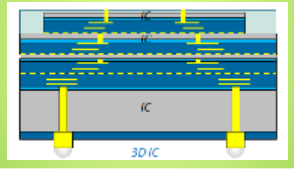
FDSOI



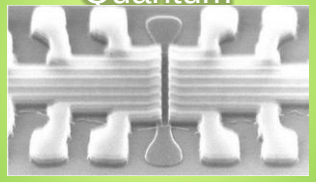
Imager & photonic



3D



Quantum



Cybersecurity

Other

Biochips
Mastering

ACKNOWLEDGMENTS

CEA and LETI employees acknowledge Auvergne Rhône Alpes Region for major investments that have been made in LETI microelectronic 300mm line under NANO2022-IPCEI program.

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