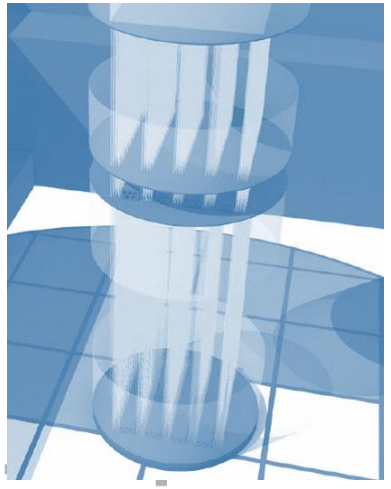
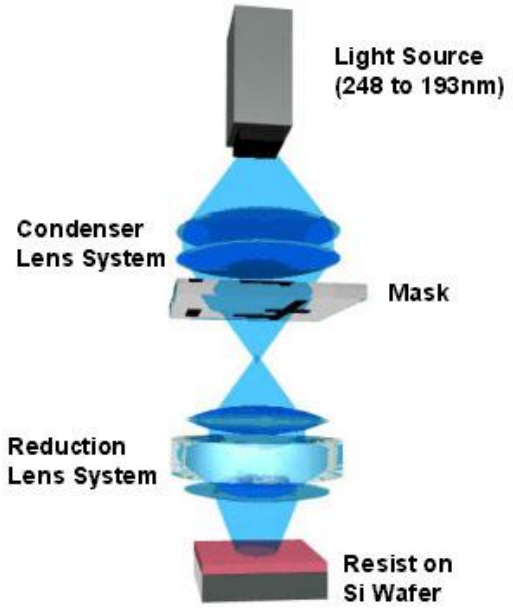


MULTI BEAM LITHOGRAPHY PROGRAM AT LETI

Lithography workshop | Leti innovation days | July 2018

Needs for a direct write patterning solution

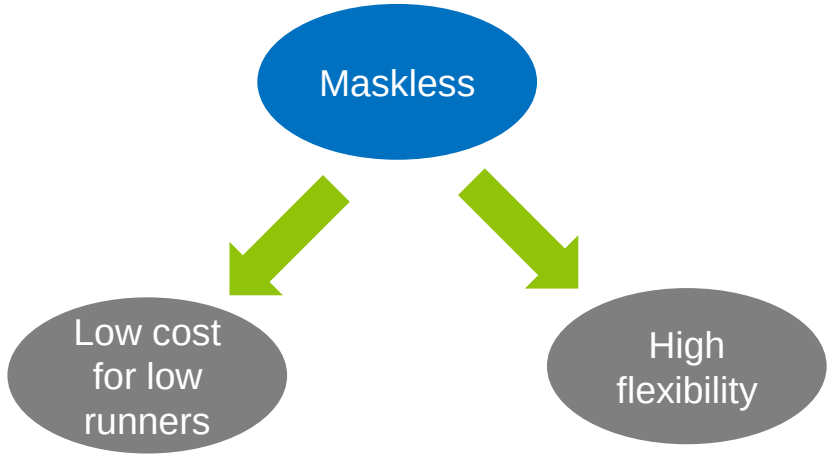
Optical lithography



- ✓ Throughput
- ✓ Mature
- × 100 k€ / mask
- × Low flexibility

Maskless direct write solution provides:

- An attractive solution for low to medium volume production
- A low CAPEX-OPEX solution
- Shorter cycle time for R&D and for pilot production
- Enabling solutions of new applications



Mapper FLX-1200 in the Leti 300mm clean room

Footprint ~ 3m²

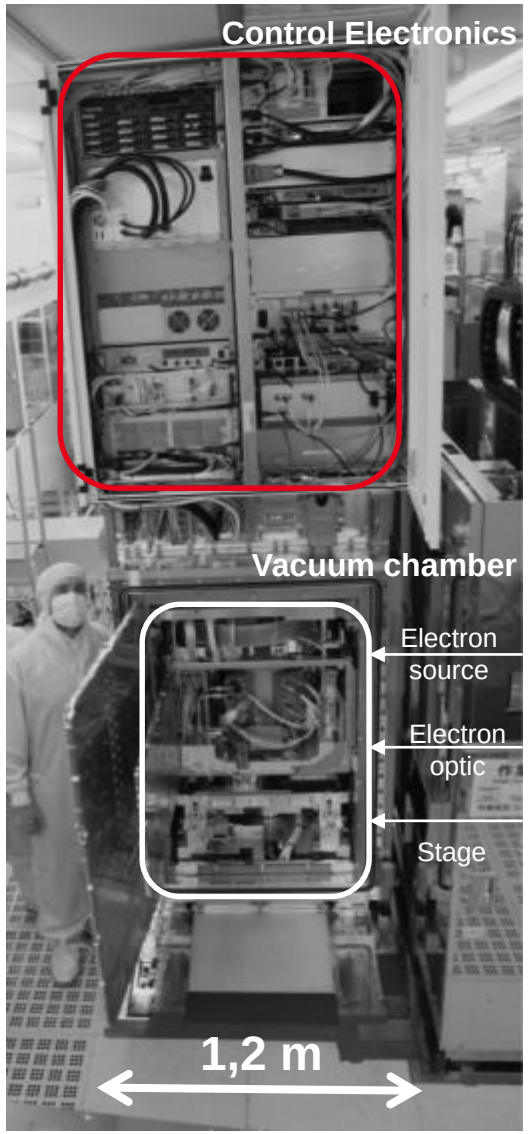
Collaboration: 2008 → 2020

IMAGINE

R&D program

LETI is the unique place for DW multibeam technology development

Mapper FLX-1200 in the Leti 300mm clean room



KEY FEATURES

- #beams : 1352x49 = **66 248**
- Spot size : 25 nm
- Beam current : 13 nA
- Total current on wafer : 17µA
- Acceleration voltage : 5 kV
- Nominal dose : 30 µC/cm^2
- Wafer size : 300mm
- Throughput : 1 wph

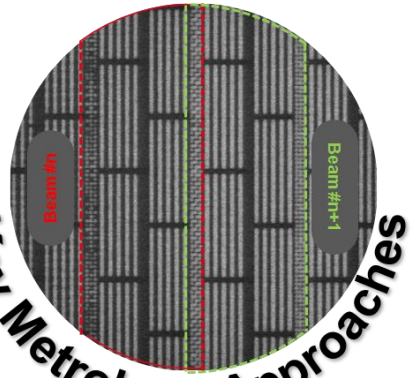
Collaboration: 2008 → 2020

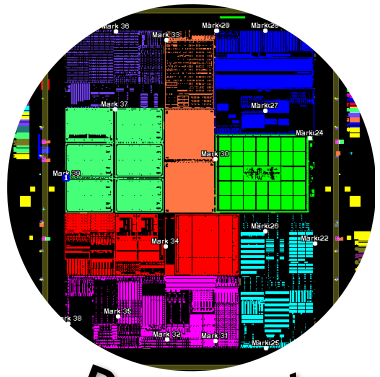
IMAGINE

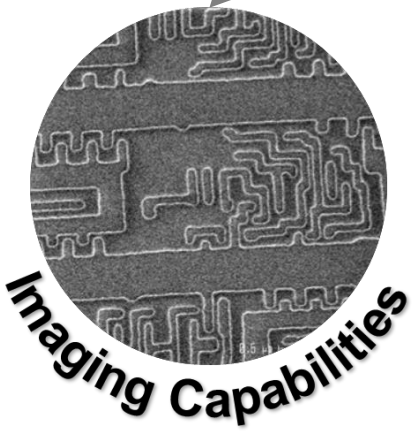
R&D program

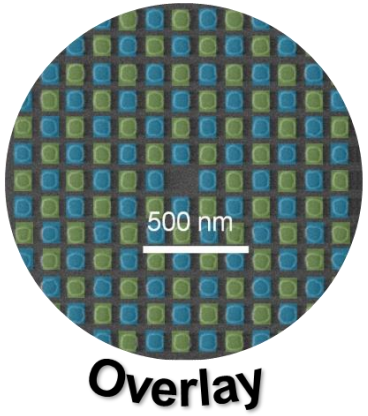
LETI is the unique place for DW multibeam technology development

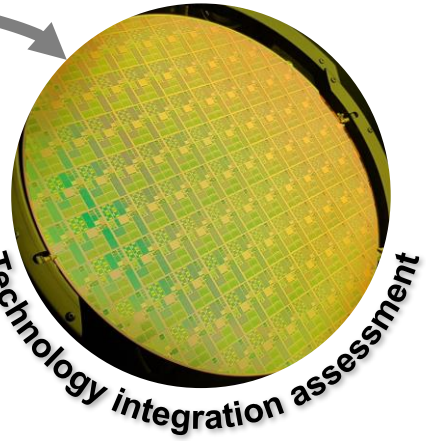
IMAGINE : Program scope





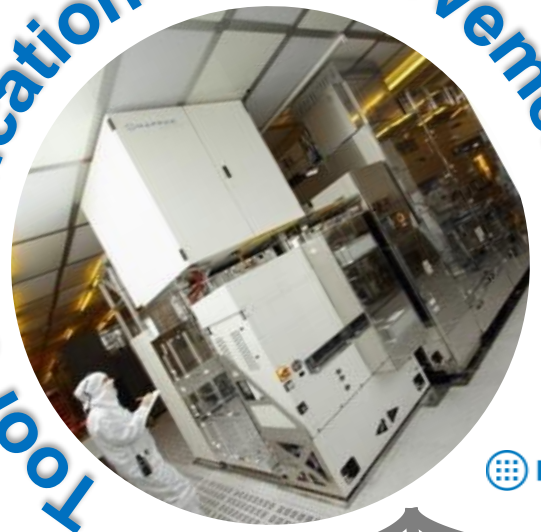






The Leti ecosystem around *IMAGINE* program

Tool Qualification & Improvements



MAPPER lithography

Key Metrology Approaches

NOVA partnering for process control

APPLIED MATERIALS

CD SEM
Scatterometry
Optical
imaging

Data Flow

Mentor Graphics

aselta NANOGRAPHICS

Data Prep
Proximity
correction
Verification

Defectivity Control

SCREEN

APPLIED MATERIALS

Ebeam
Defectivity
Process

Imaging Capabilities

Nissan Chemical

tok

JSR

SCREEN

IEL

Materials
Coat/Dev
Process

Overlay

APPLIED MATERIALS

KLA-Tencor

CD SEM
Image based
Overlay

Technology integration assessment

tsmc

leti

Product wafers
Pilot Line

Complete Data Preparation Flow on 28nm Node Full Field Design

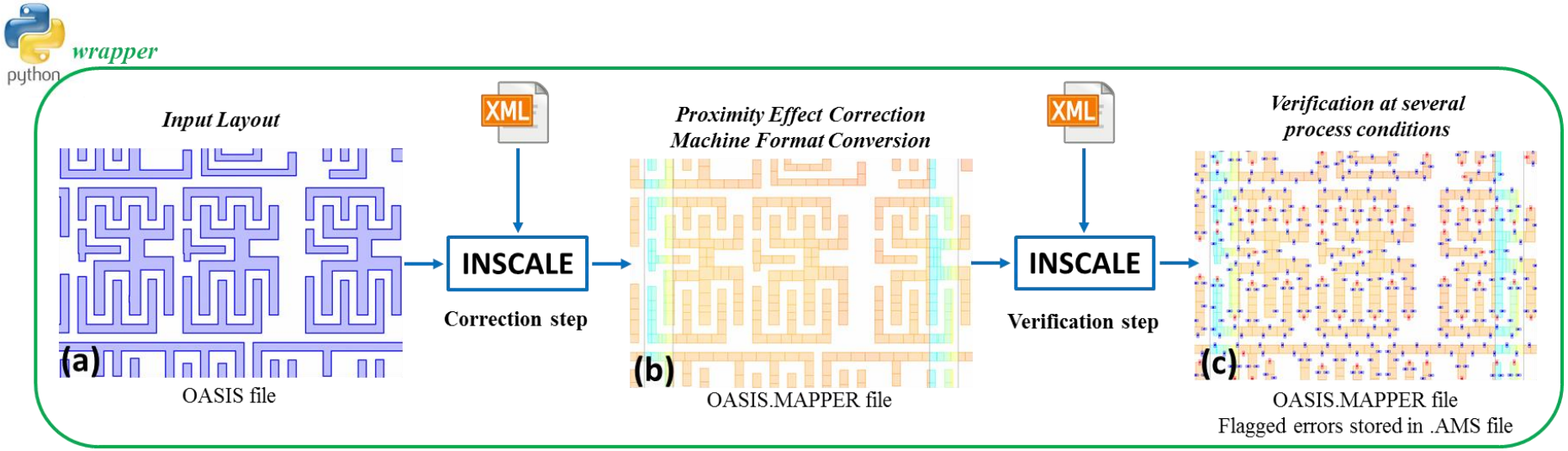
Data Flow :

- Proximity Effect Correction
- oas.mapper conversion
- Multi-pass verification

26x33mm² full field
28nm node layout

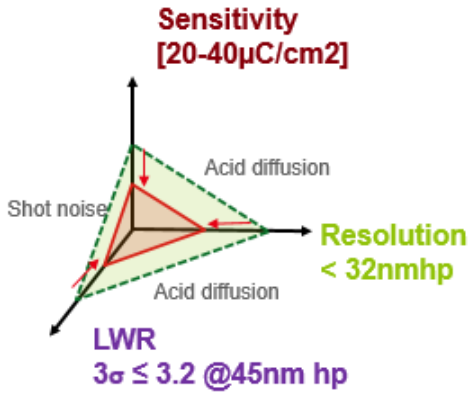
144 CPUs
12 nodes
2.66 GHz
36 GB RAM memory

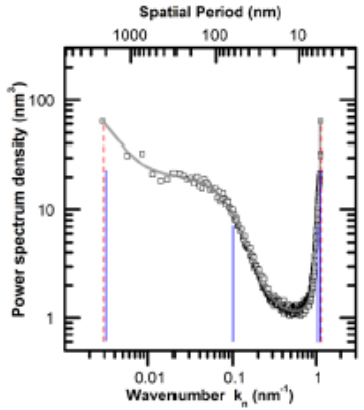
13h for PEC+conversion



Bergery et al., Proc. SPIE vol. 9777 977714, 2016

Process readiness for multi-beam exposure at 5kV





$3\sigma_{LWRrange}$ [2152-10.8nm]

4.6nm

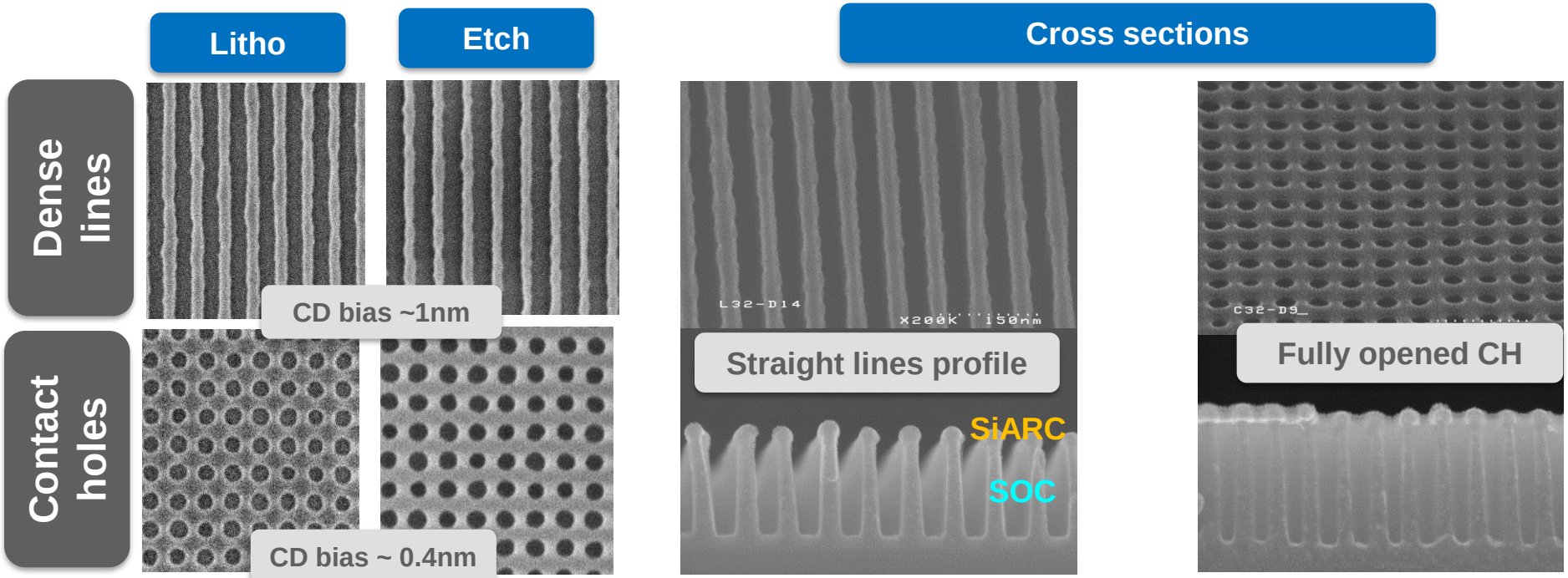
$3\sigma_{LWR\ ITRS}$ [2000-63.3nm]

3.9nm

$3\sigma_{LWR\ Mean\ 3s}$

[For screening method]

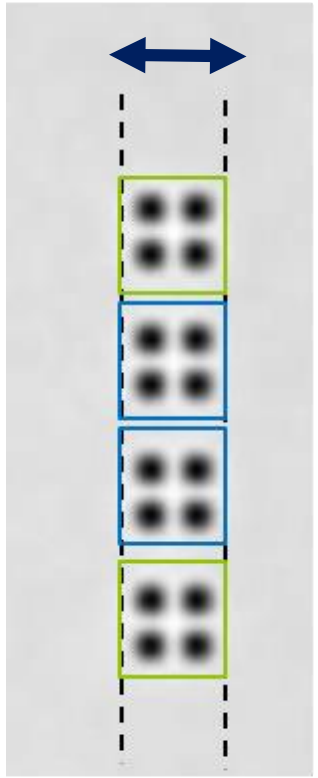
4.1nm

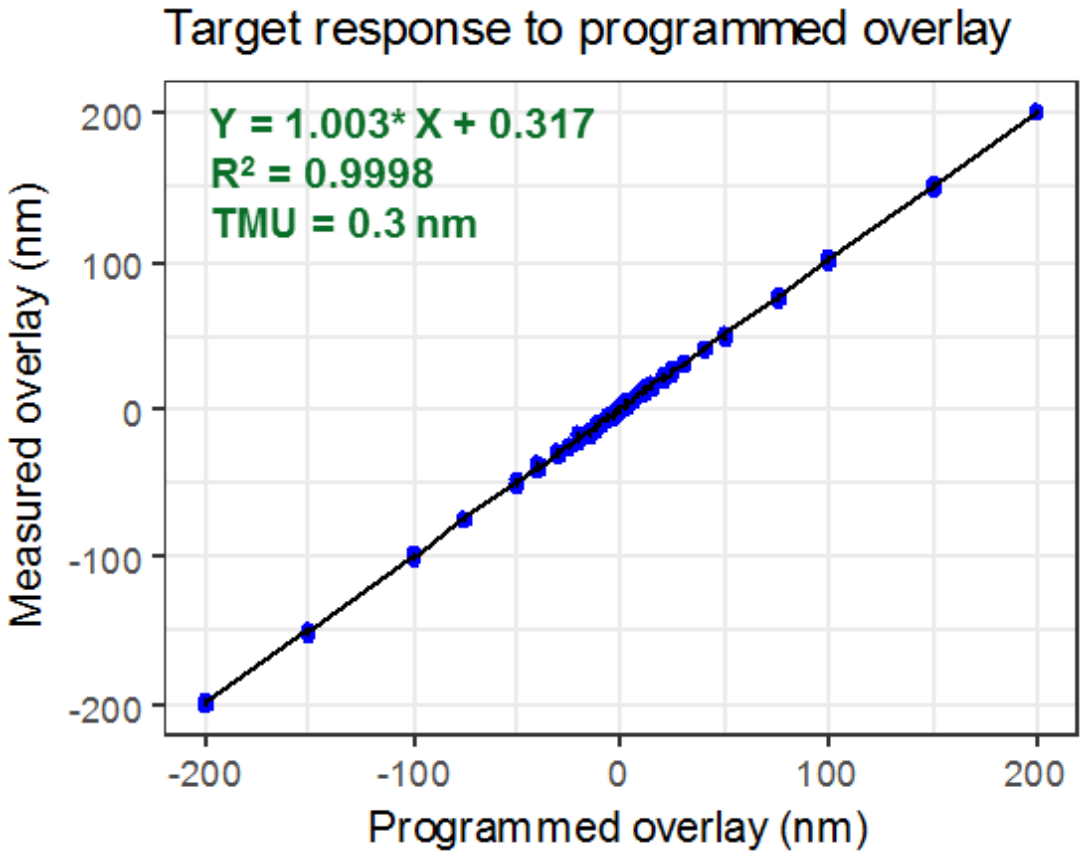


Servin et al., Proc. SPIE vol. 9423 94231C-1, 2015

Overlay and stitching metrology dedicated to Mapper exposure scheme

2µm => 1 beam



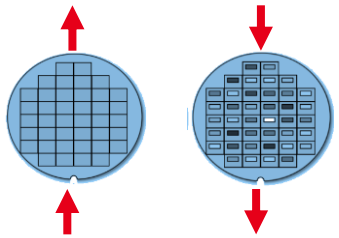


Rademaker et al.,Proc. SPIE 10585 105850U, 2018

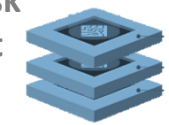
Making truly unique chips by customizing one lithography level

FLX-1200 platform installed at CEA-Leti

Making chips Truly unique with Mapper



Mask Set



Wafers

Standard chip manufacturing flow

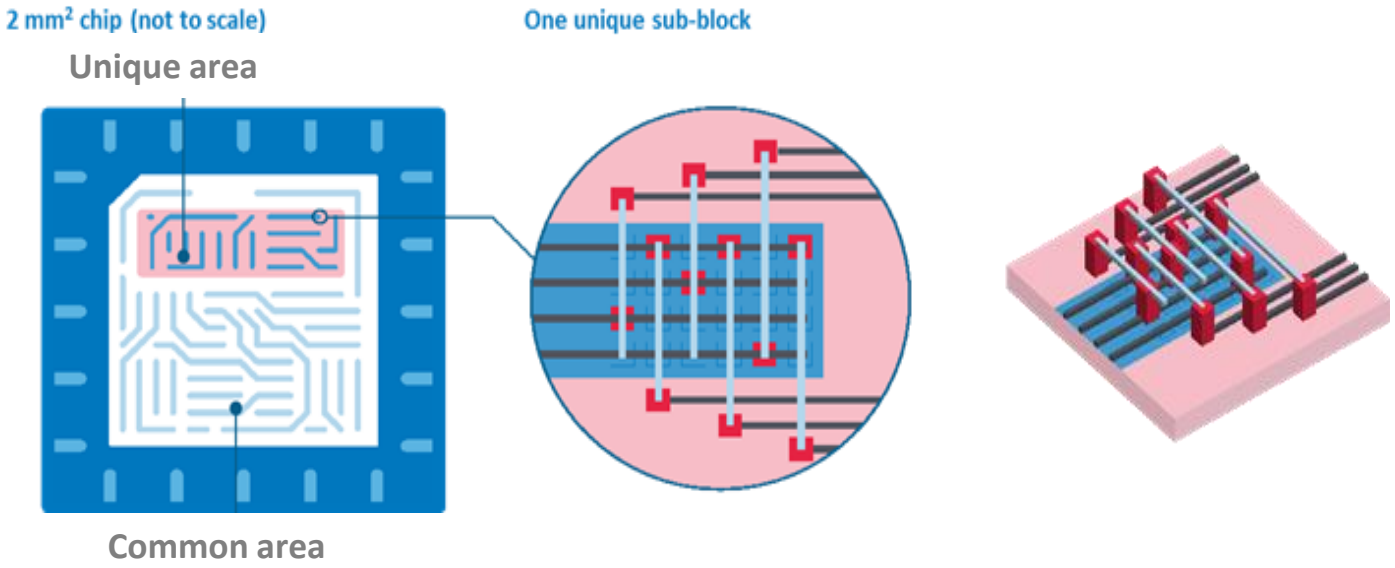
Standard chip manufacturing flow

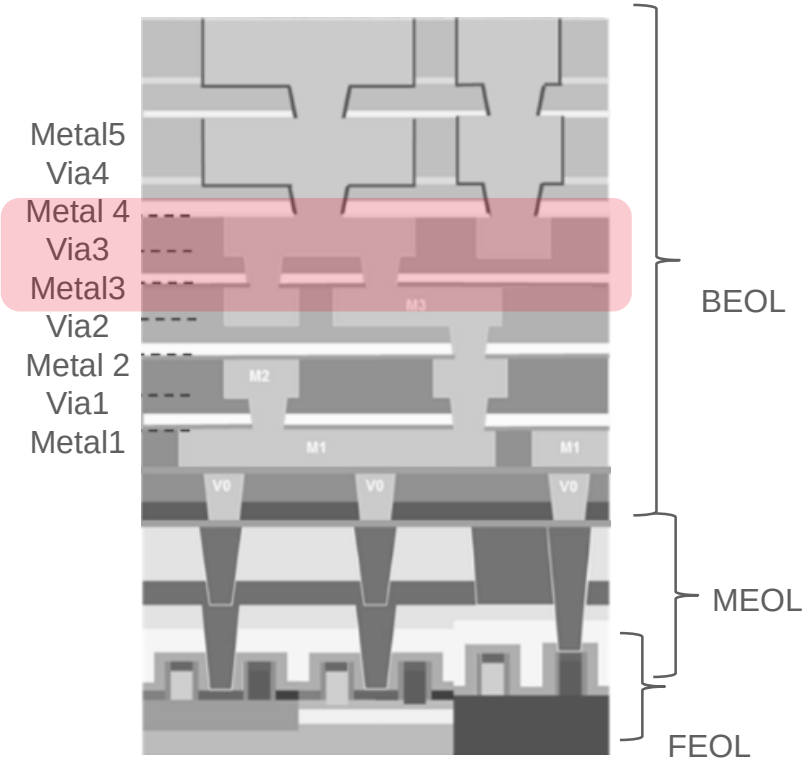
Device with Truly Unique Chip inside

High demands for unique chips manufacturing, in the field of IoT, tracability, anti-counterfeiting…

Servin et al., Proc. SPIE 10584-36, 2018

Making truly unique chips by customizing one lithography level





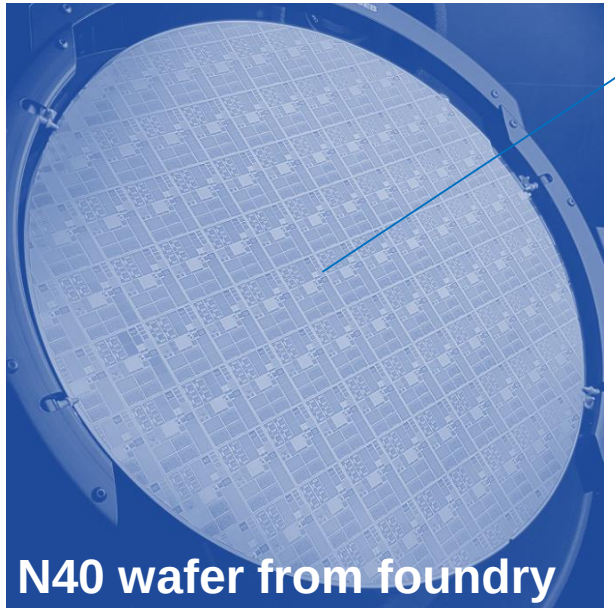
Scheme of IC cell

Focus on Single Via-3 layer in N40 for chip individualization

Servin et al., Proc. SPIE 10584-36, 2018

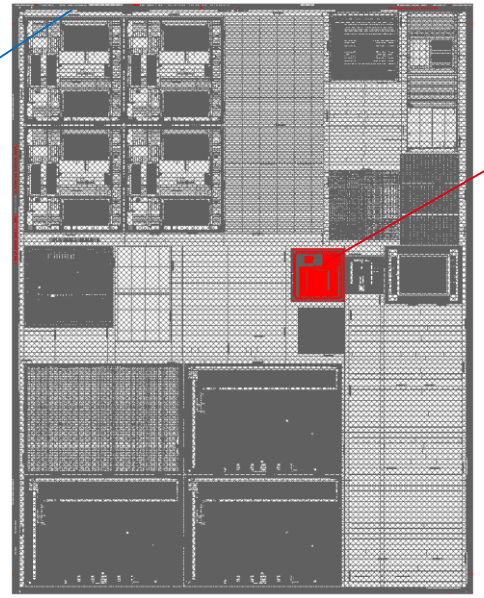
Making truly unique chips by customizing one lithography level

300mm



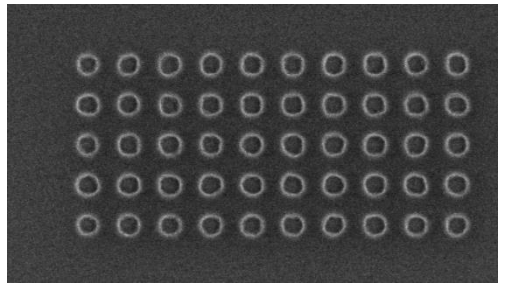
N40 wafer from foundry
before litho VIA 3

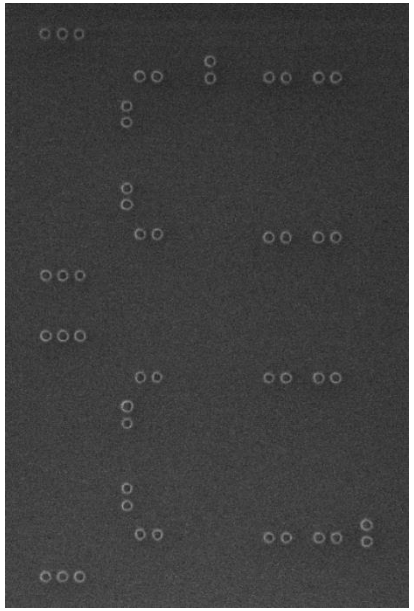
26 x 33 mm²

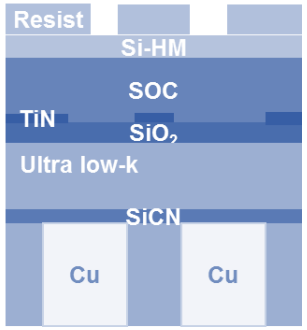


2x2 mm²

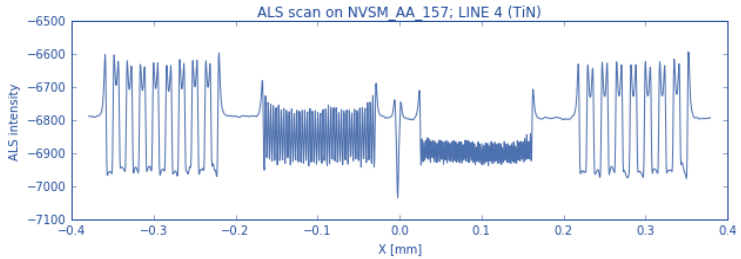
N40-VIA3
exposed with
FLX-1200 at Leti







Alignement on standard markers



Key achievements :

- Wafer clamping on BEOL wafer
- Read alignment marks from metal 4
- Align and expose the layout of real product

Servin et al., Proc. SPIE 10584-36, 2018

Where we are ?

The Mapper FLX-1200 is exposing 300mm wafers at CEA-Leti :

- 50% of exposure slots dedicated for performance monitoring
- Customer Demo wafers : 100 fields of 5x5mm² on 300mm wafers
- Applications wafers : first N40 single VIA layer for security applications successfully exposed.

It is a prototype multibeam exposure tool, with improving performances :

FLX-1200 specifications goals :	FLX-1200 validated performances:
3 exposures per day, 15 days per month	H1-2018 : 28 exp./month (incl. upgrade time)
100 fields of 5x5mm² exposed in 1hour	OK
CDU 10nm (3σ) ; LWR 6nm	CDU <10nm (3σ) ; LWR ITRS 5nm, raw 9nm
Stitching 15nm (µ+3σ)	X: 22nm (calibration not robust), Y: OK (11nm µ+3σ)
Overlay 25nm (µ+3σ)	wo correction 100nm; w correction X 35nm (3σ), Y 15nm (µ+3σ)
Image yield : 100%	Image yield : 75%

What next ?

Ramp up ! :

- Stabilize performances
- Increase demo and application wafers
- Upgrade to FLX-1300 (26x33mm², full wafer coverage)

If you want your design printed on the FLX-1200, please contact

Mapper Lithography
B.J. Kampherbeek
Bert.Jan.Kampherbeek@mapper.nl

CEA-Leti
L. Pain
laurent.pain@cea.fr

External Partners

Common evaluation

IMAGINE Platform

CEA-LETI

MAPPER Lithography

All associated partners
ASELTA Nanographics, MENTOR Graphics
STMicroelectronics, TSMC, SOKUDO,
NOVA, Applied Materials

Leti, technology research institute
Commissariat à l'énergie atomique et aux énergies alternatives
Minatec Campus | 17 rue des Martyrs | 38054 Grenoble Cedex | France
www.leti-cea.com