MEMS & Photonic Testing

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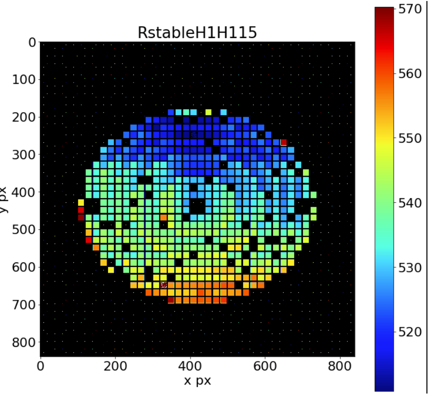

Content

- Salland Engineering at-a-glance
- More-than-Moore & Production Testing
- Examples of (Wafer) Testing Methods for MEMS & Photonics

Salland Engineering at a glance

Fast & qualified new product introduction

Industrialization of your test solutions

Test Application Solutions

ATE Instrument Solutions

Production Test & NPI/PE services

Analog and PXI(e) Bench Test Solutions

APPLICOS
a SALLAND Engineering Company

Production test from pilot runs to high volume

High precision analog solutions for T&M and ATE

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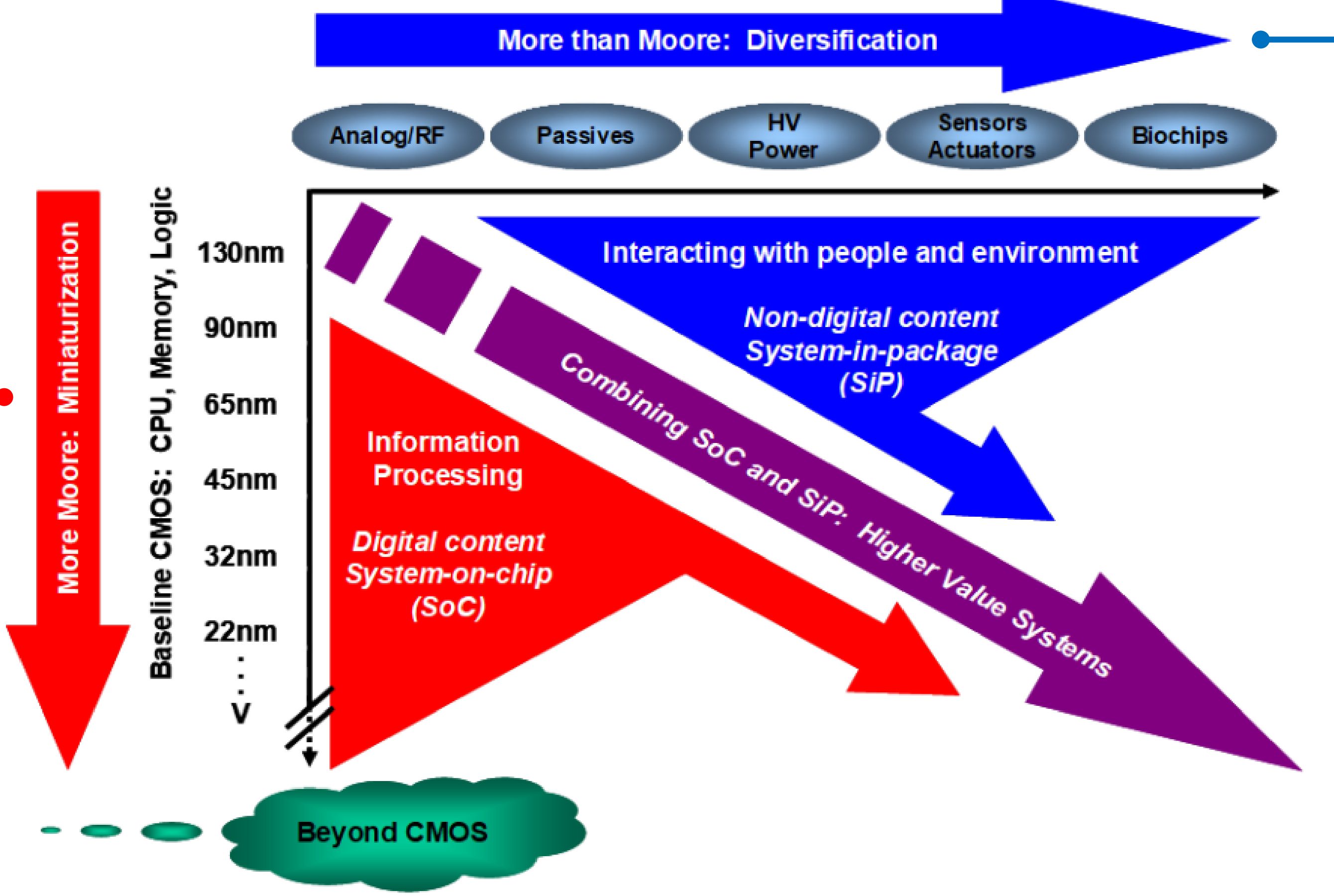
Two Flavors of Silicon Based Devices

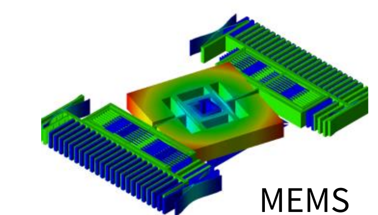
GPU / CPU / AI

MEMORY

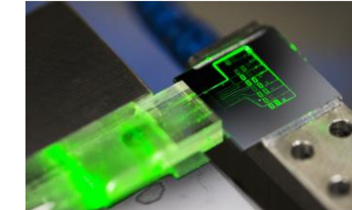
IoT / Edge



THE INTERNATIONAL ROADMAP FOR DEVICES AND SYSTEMS: 2022, IEEE



MEMS



PHOTONICS

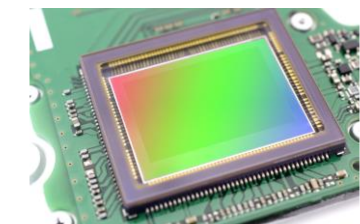
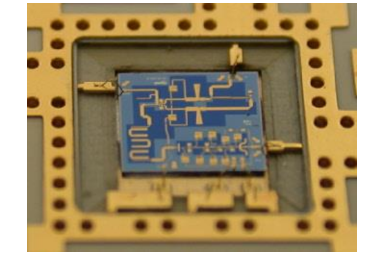


IMAGE SENSORS



MICROWAVE / RF / POWER

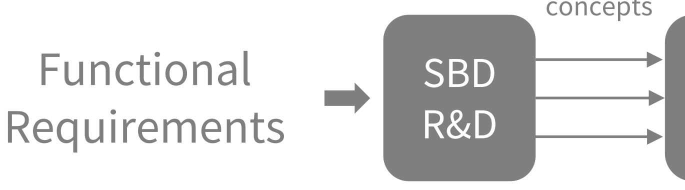
SALLAND Engineering
Test Technology Center

SBD Product Development

Foundry Selection

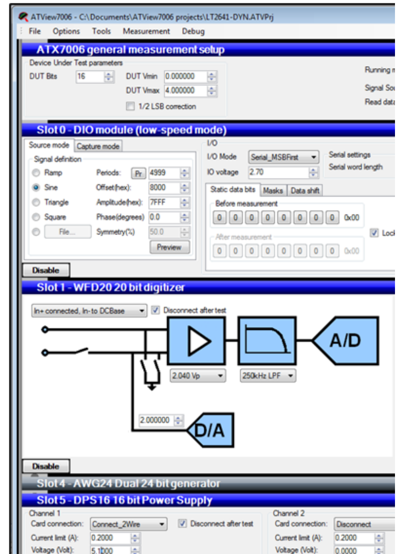
Functional Requirements → SBD R&D → (concepts) → Feasibility
- System
- Foundry

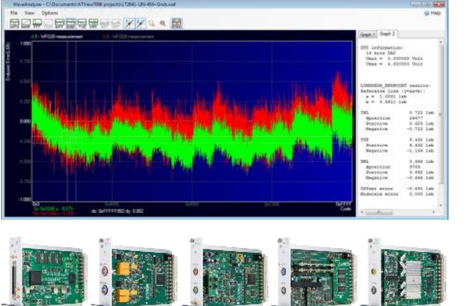
→ Proto-types → (1) → Process Development → Pilot Production → Production



FRONTEND → (3) BACKEND → ASSEMBLY → (2)

DESIGN TOOL CONNECTION

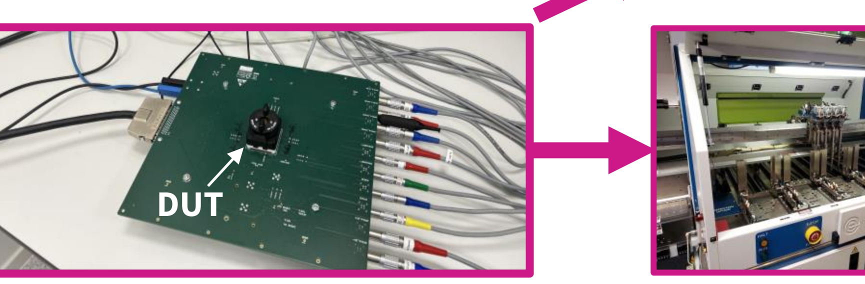




(1) BENCHTOP (lab-in-a-box)

IC: (Early) Silicon Qualification
Non-IC: Device Characterization

(3) WAFER LEVEL



(2) FINAL TEST

Yole Development CEO on MEMS: "One product, one process, one package."

Example: Photonic Multichip Laser

SiN Foundry

InP Foundry

Yield each wafer: YF
Cost per die-pair: CF

Connectorized Fiber Array Unit

Butterfly Packaging

Sub-um assembly

Yield YB
Cost per module CB

No wafer test:
Cost per module

$$\frac{C_F + C_B}{Y_F^2 \cdot Y_B}$$

Wafer test:
Cost per module

$$\frac{C_F + C_B \cdot Y_F}{Y_F \cdot Y_B}$$

Reduction of cost per module with wafertest

KGD = Known Good Die, after wafertest

R = cost advantage KGD

$$R = \frac{1}{Y_F^{M-1}} \cdot \frac{1 + \frac{C_B}{C_F}}{1 + \frac{C_B}{C_F} \cdot Y_F}$$

M = # of chiplets

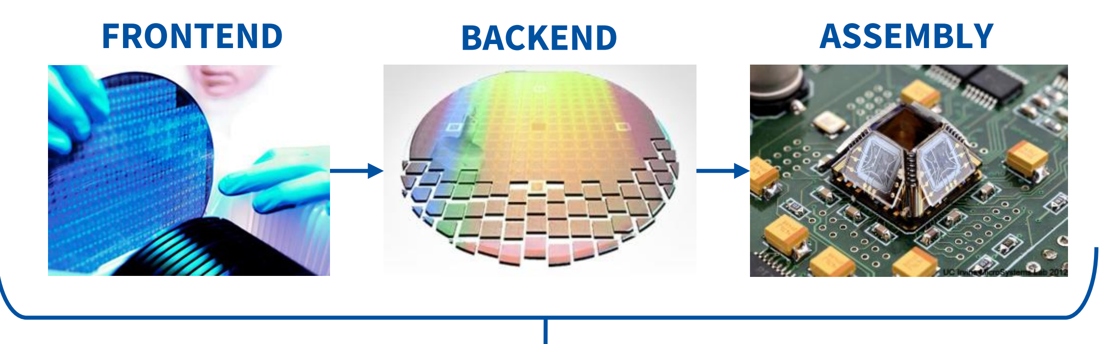
Y_F = yield frontend

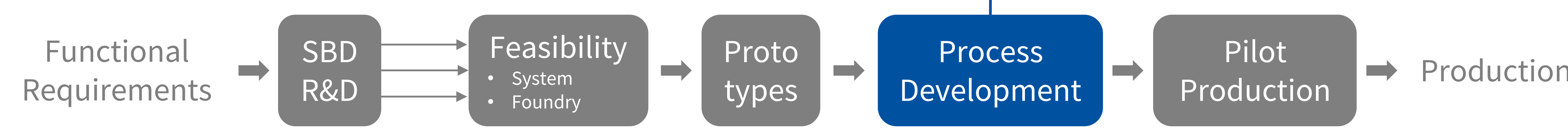
C_B = cost backend (per module)

C_F = cost frontend (per die-set)

40% frontend yield
60%
80%
3 chiplets
2 chiplets
Unit cost reduction with KGD (x)
$\frac{C_B}{C_F}$

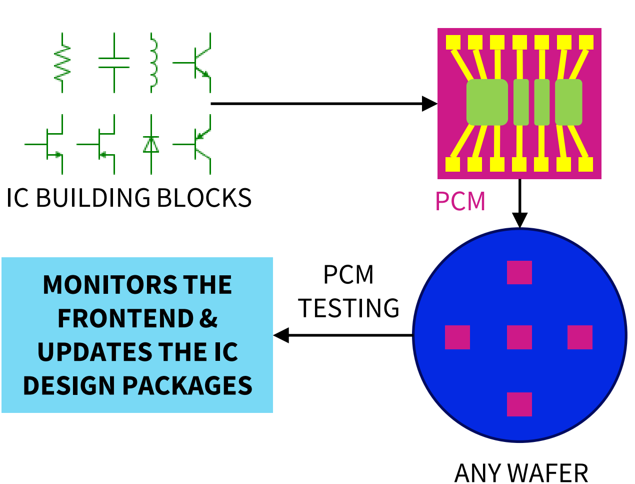
Yole Development CEO on MEMS: "One product, one process, one package."





MORE MOORE

Process-level testing
PCM: Process Control Modules

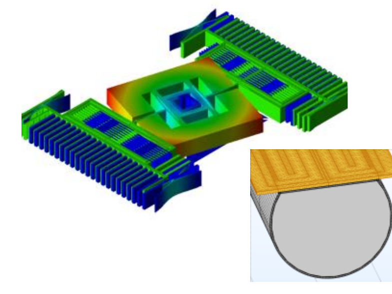


Product-level testing
Wafer and/or Final Test

INFORMS DOWNSTREAM PROCESSES "Known Good Die"

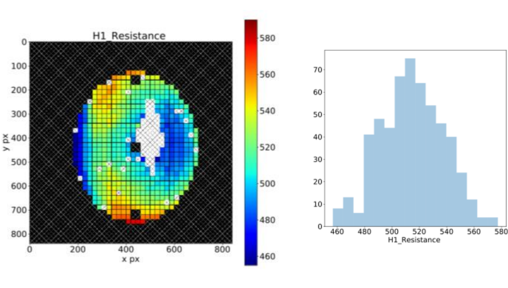
MORE THAN MOORE (MEMS)

Process-level testing
PCMs are impractical



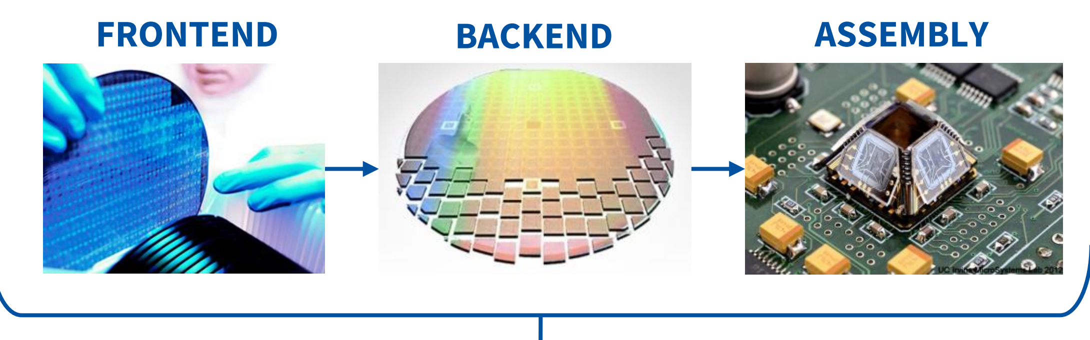
- No universal MEMS building blocks
- PCMs are uneconomical per single product

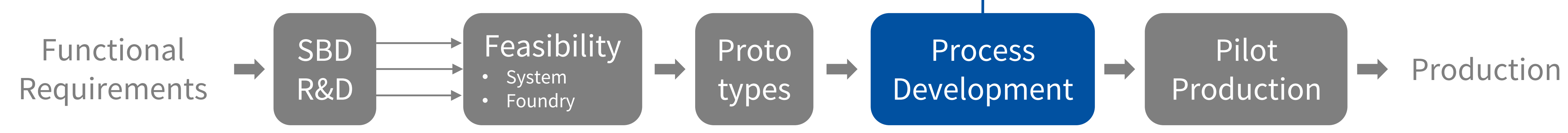
Product-level testing
Use it also for Process Monitoring



MODEL-BASED TESTING

Yole Development CEO on MEMS: "One product, one process, one package."





MORE MOORE

Process-level testing
PCM: Process Control Modules

IC BUILDING BLOCKS

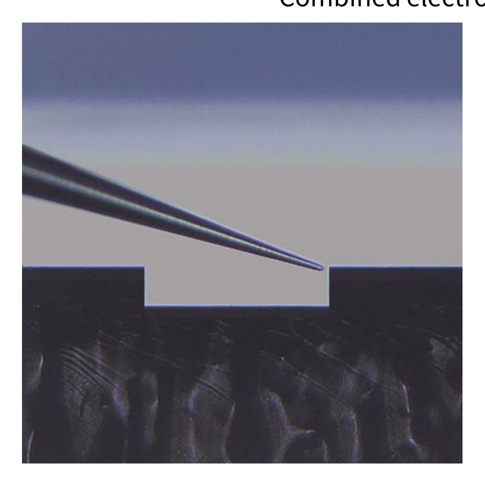
PCM

PCM TESTING

MONITORS THE FRONTEND & UPDATES THE IC DESIGN PACKAGES

ANY WAFER

Product-level testing
Wafer and/or Final Test



INFORMS DOWNSTREAM PROCESSES "Known Good Die"

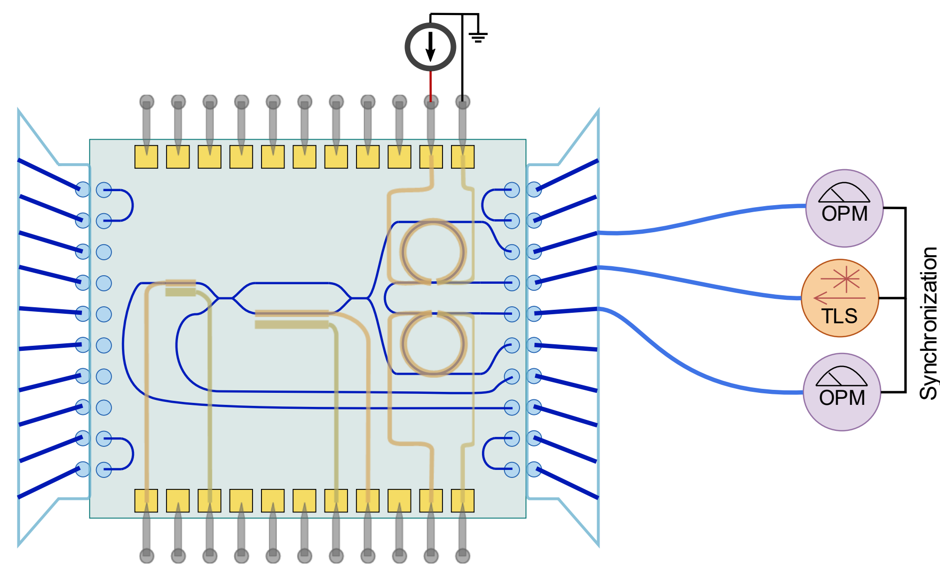
MORE THAN MOORE (PHOTONICS)

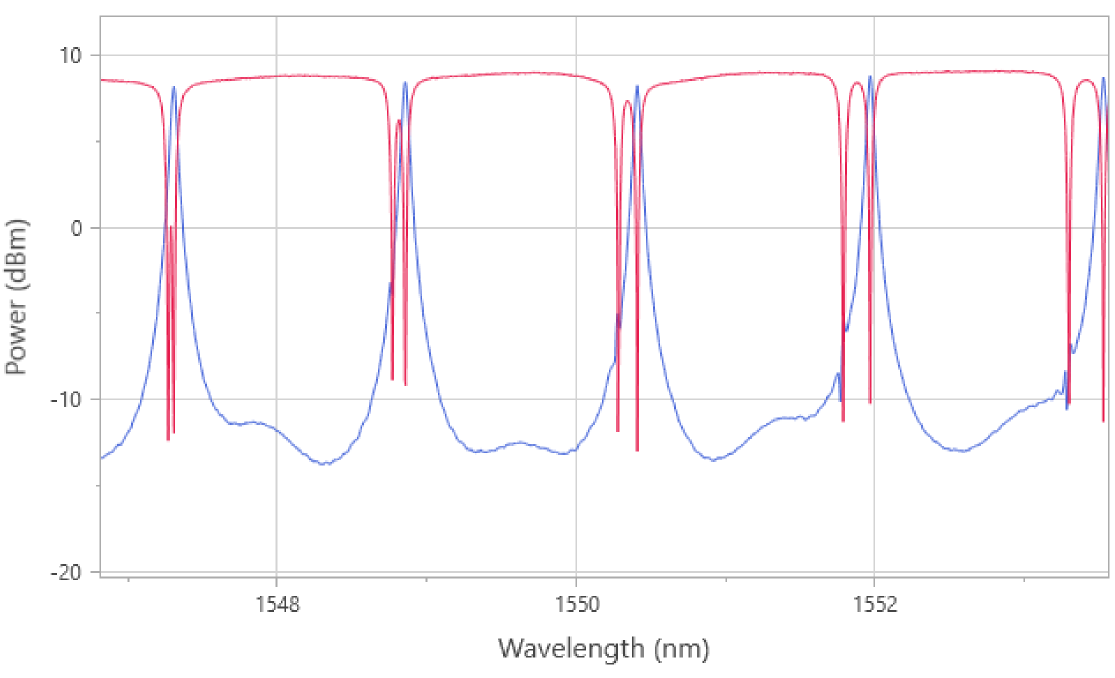
Process-level testing
On diced chips…

Product-level testing
Combined electro-optical probing needed

Images from FormFactor

Example: PTX





- *Fast Wavelength scan on Through and Drop ports of Ring Resonator.*
- *Electro-Optical Test to characterize Extinction Ratio, Linewidth, Free Spectral Range and electrical power required to shift 1 FSR.*

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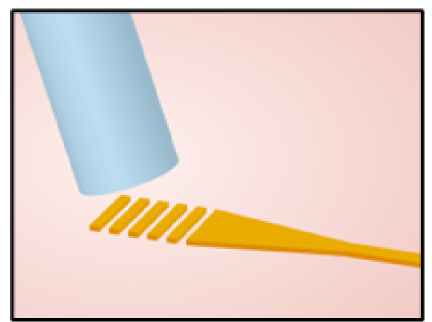
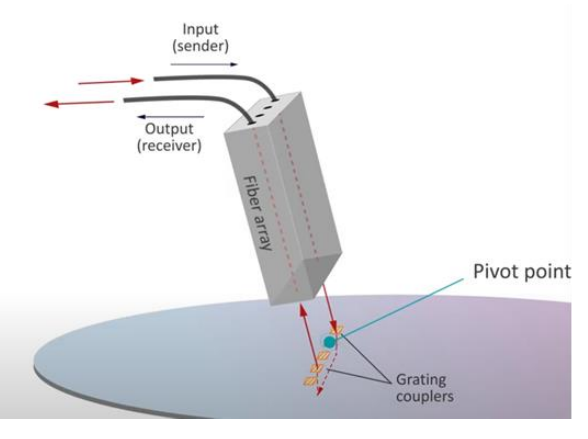
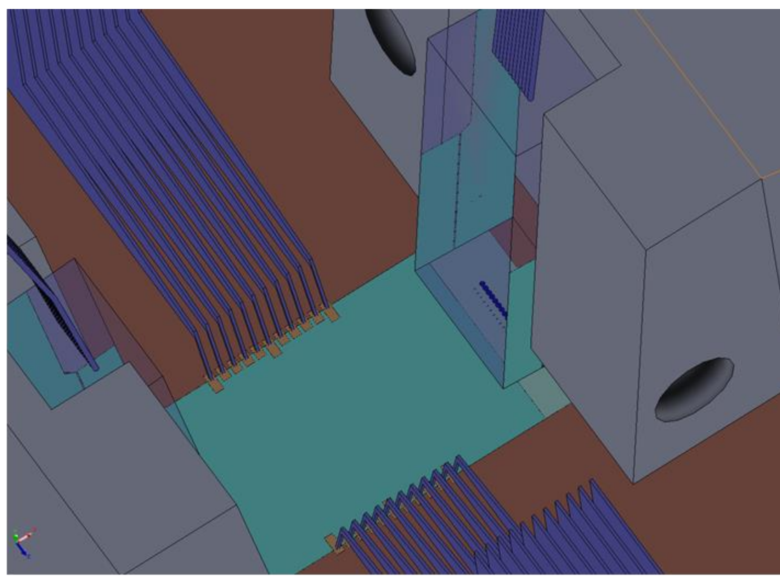
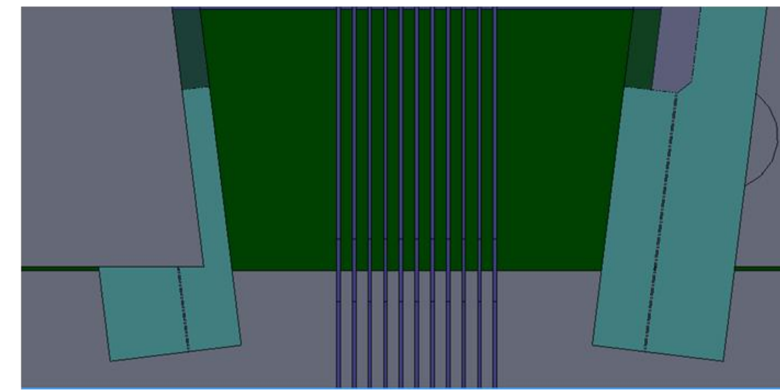
Example: Photonic Wafer Probing

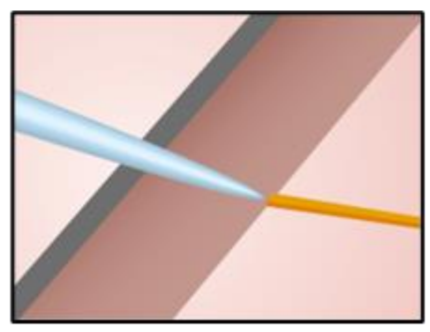


Surface coupling

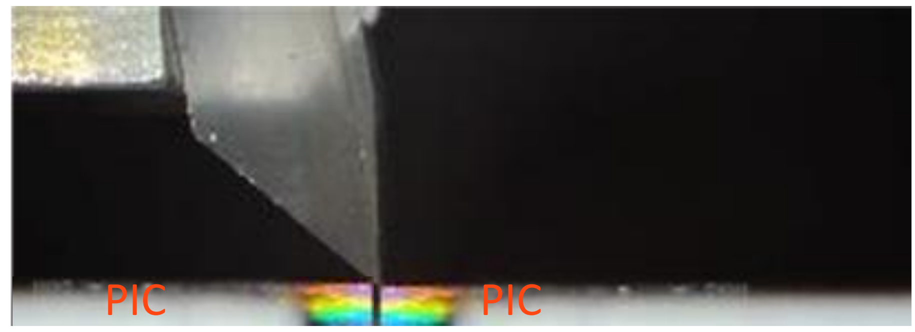


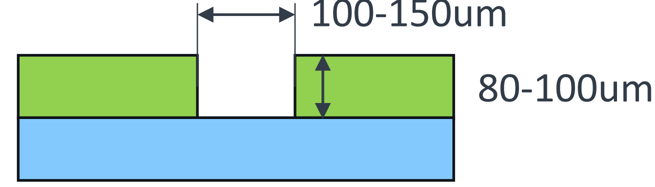




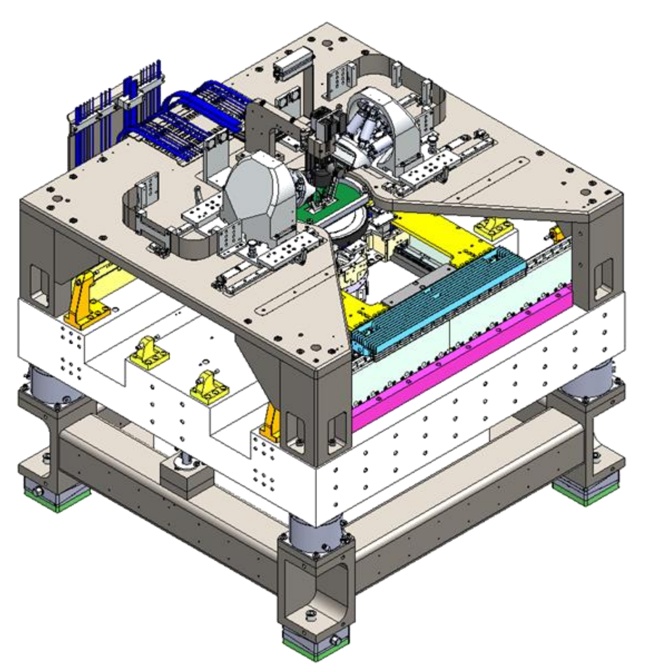


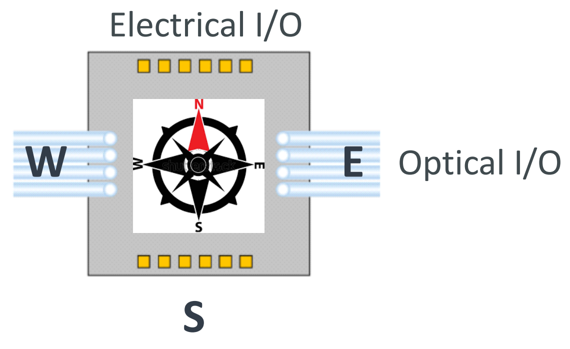
Trench coupling

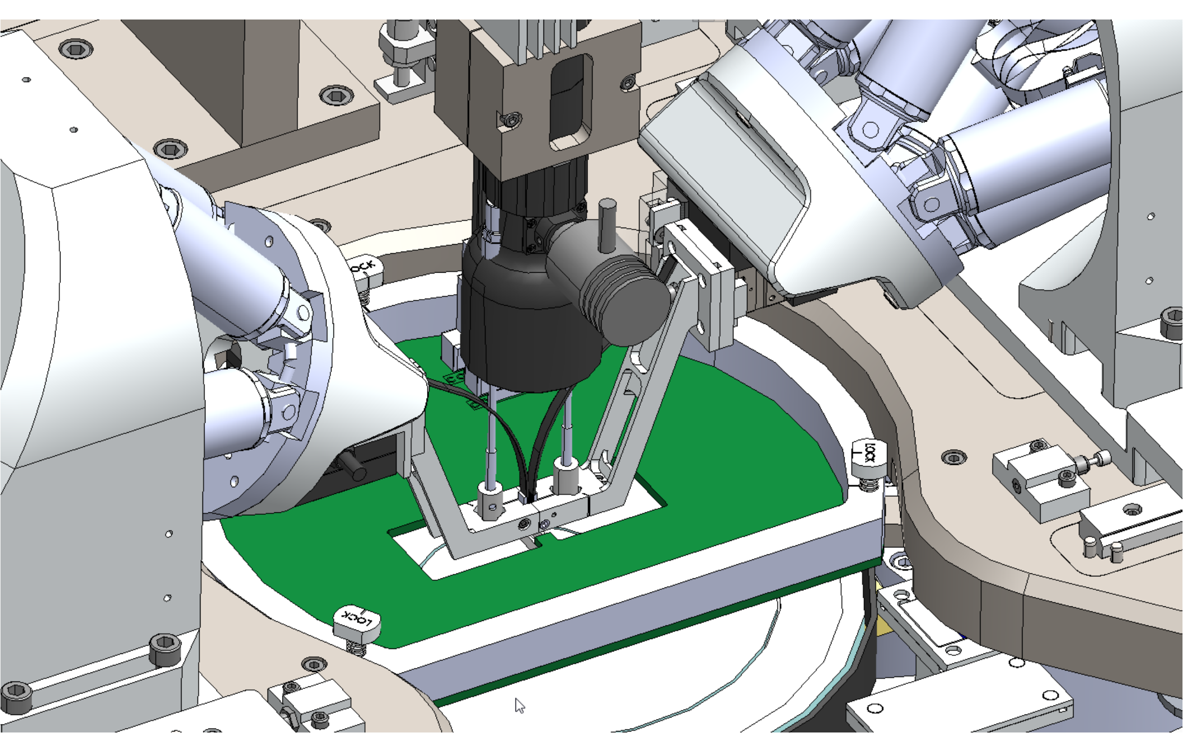


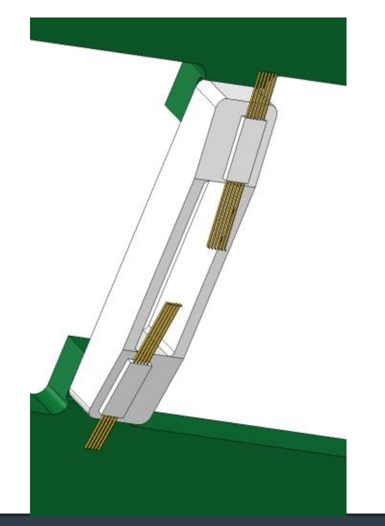


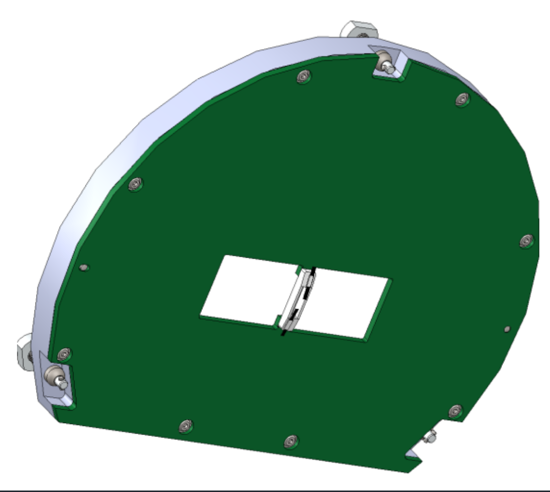
IMS Example: Photonic Wafer Probing





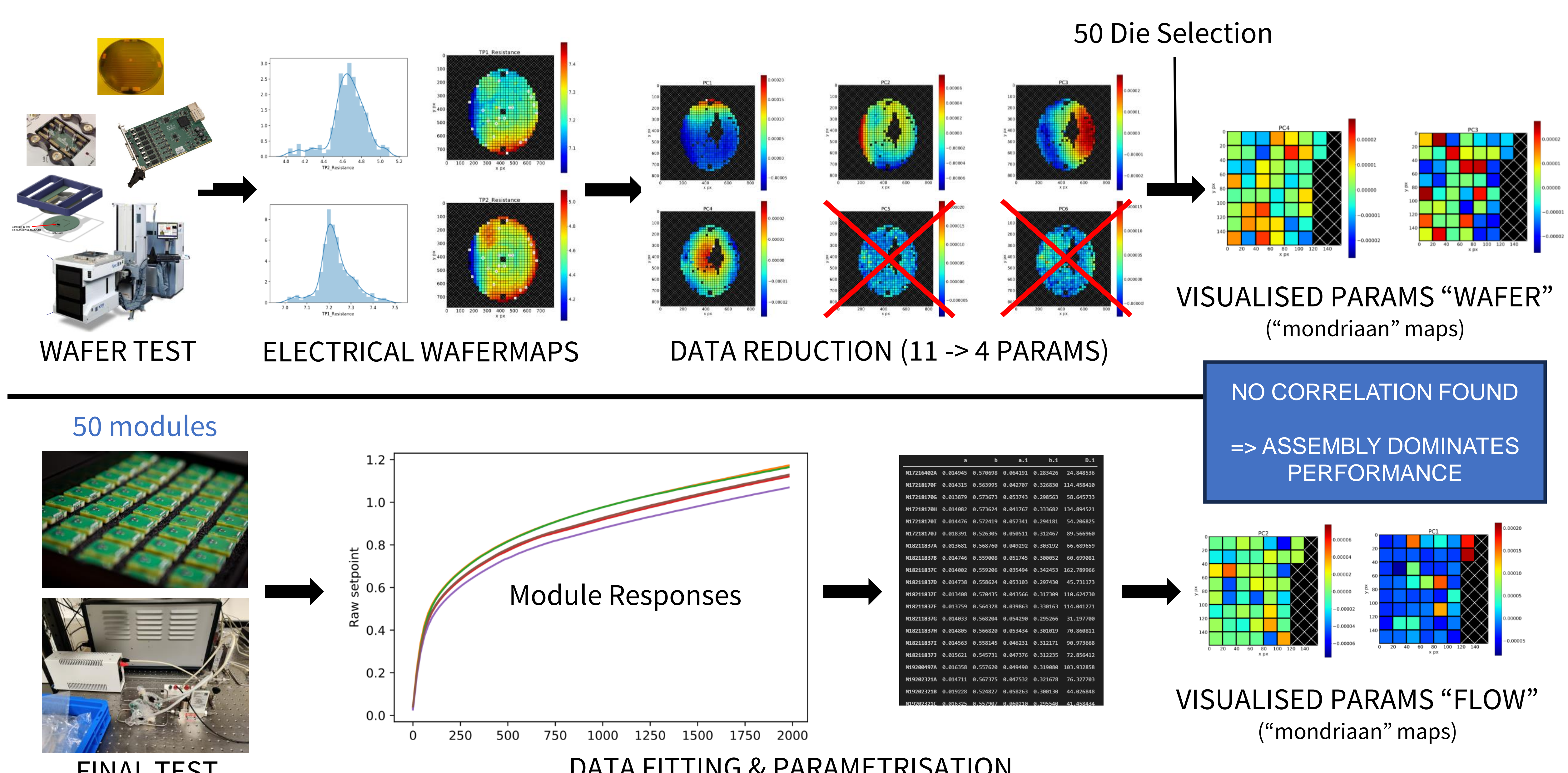






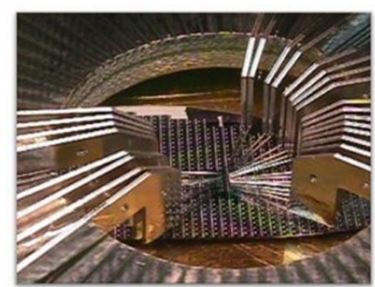
- Quick exchange of probes and probe cards
- Probecard cutouts for optical probing

Example: Wafer Testing of a Flow Sensor



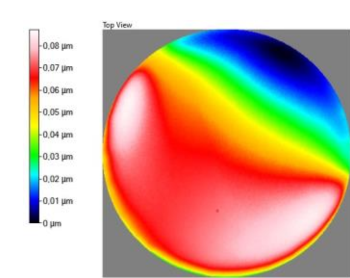
	a	b	a.1	b.1	D.1
M17216402A	0.014945	0.570698	0.064191	0.283426	24.848536
M17218170F	0.014315	0.563995	0.042707	0.326830	114.458410
M17218170G	0.013879	0.573673	0.053743	0.298563	58.645733
M17218170H	0.014082	0.573624	0.041767	0.333682	134.894521
M17218170I	0.014476	0.572419	0.057341	0.294181	54.206825
M17218170J	0.018391	0.526305	0.050511	0.312467	89.566960
M18211837A	0.013681	0.568760	0.049292	0.303192	66.689659
M18211837B	0.014746	0.559008	0.051745	0.300052	60.699081
M18211837C	0.014002	0.559206	0.035494	0.342453	162.789966
M18211837D	0.014738	0.558624	0.053103	0.297430	45.731173
M18211837E	0.013408	0.570435	0.043566	0.317309	110.624730
M18211837F	0.013759	0.564328	0.039863	0.330163	114.041271
M18211837G	0.014033	0.568204	0.054290	0.295266	31.197700
M18211837H	0.014805	0.566820	0.053434	0.301019	70.860811
M18211837I	0.014563	0.558145	0.046231	0.312171	90.973668
M18211837J	0.015621	0.545731	0.047376	0.312235	72.856412
M19200497A	0.016358	0.557620	0.049490	0.319080	103.932858
M19202321A	0.014711	0.567375	0.047532	0.321678	76.327703
M19202321B	0.019228	0.524827	0.058263	0.300130	44.026848
M19202321C	0.016325	0.557907	0.060210	0.295540	41.458434

Model-Based Testing Approach for MEMS/Photonics



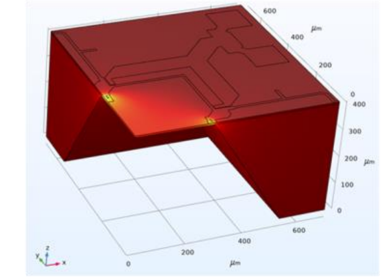
CONTACT PROBING

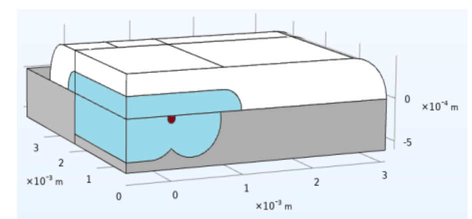
- Electrical
- Optical/Photonic
- Mechanical
- Fluidic



NON-CONTACT PROBING

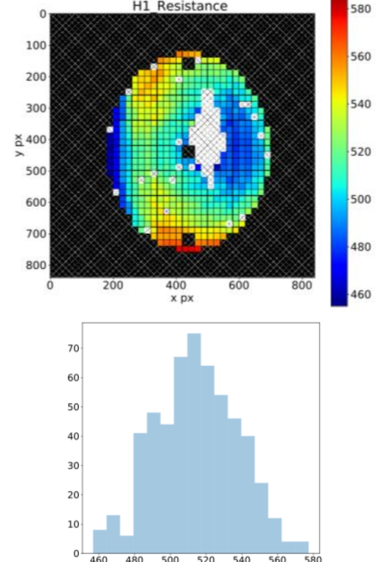
- Visual
- Thermography
- 3D Interference
- Reflectometry





SBD MODELS

- FEM Databases
- Inverse Calculations
- Process Models & Parameters



UNDERLYING PHYSICS

- Data Processing
- Data Visualization
- Machine Learning & Patterns
- Inference of Die Quality

Questions?