UNLOCKING EFFICIENCY, STRATEGIES FOR ENHACED PIC TESTING PERFORMANCE

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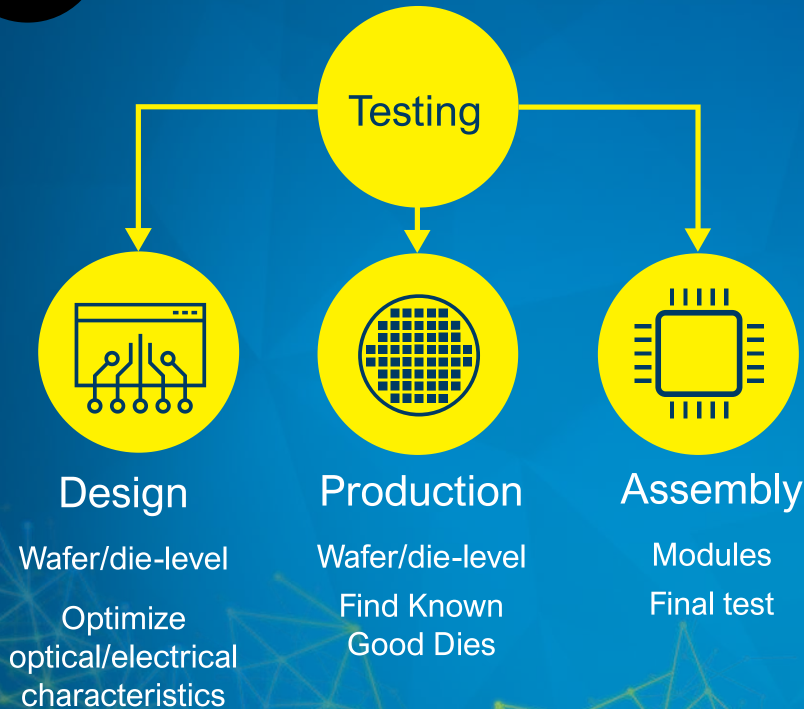
EPIC Technology Meeting on Photonic Integration and Packaging at Fraunhofer IZM

EXFO

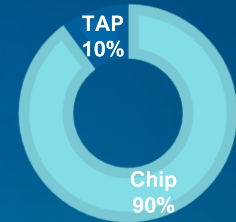
Why testing is important process in PIC technology?

1 Testing is important from wafer to die to finished component

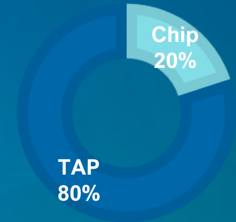


2 Testing, Assembly & Packaging (TAP) has high cost compared to electronics testing so identifying known good dies is essential

Electronics Chip $



Photonics Chip $$$



Testing process must be **repeatable, scalable and traceable** and leverage **automation** and **flexibility**

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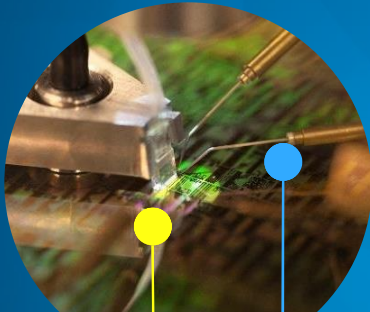
The 3 Steps of Testing

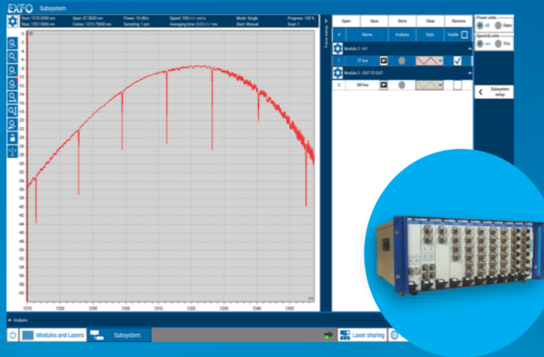
1 Optical Fiber Coupling & Electrical Probing



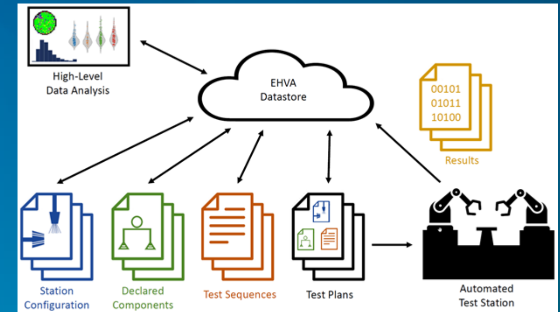
Optical fiber array

Electrical probe

2 Optical & Electrical Testing



3 Data Management and Analysis



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PIC Testing Bottlenecks

1. **Time to align fiber**
   Manual processes
2. **On-chip navigation**
   Moving next component to the probes
3. **Pick and place**
   Loading dies one-by-one onto the probe station
4. **Test time**
   Time to control and run test instruments

5. **Disconnected interfaces**
   Motion control, test instruments, data handling on multiple platforms from different vendors

6. **Data handling**
   traceability throughout process chain, completeness of data including all parameters, experimental conditions etc.

6. **No standardization**
   Variety of components require flexible test setups

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Enhancing Testing Efficiency

Full automation of motion control, instrument drivers and database from single interface

Test orchestrated from single software interface

Big data

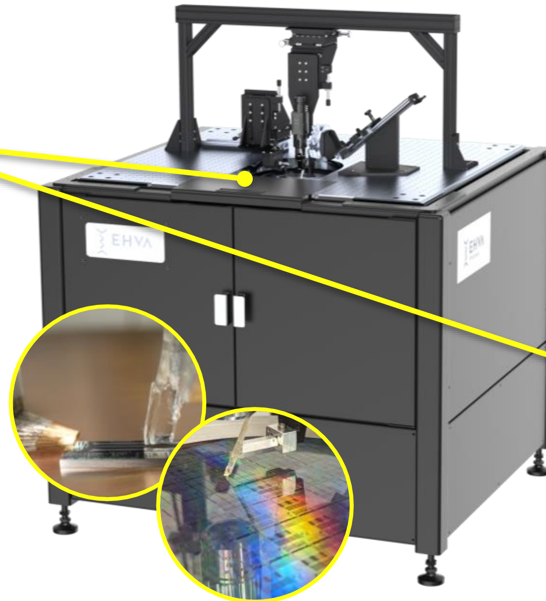
Data analysis

Artificial intelligence

Business intelligence

Station configuration · Component · Sequence · Test Plan · Results

Flexible single-die, multi-die or wafer tester



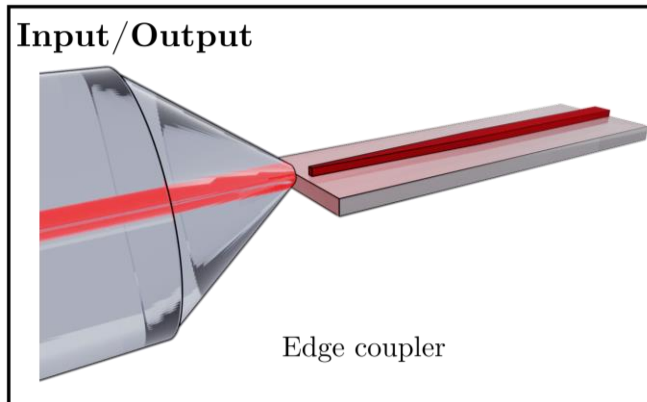
Instrumentation for full characterization

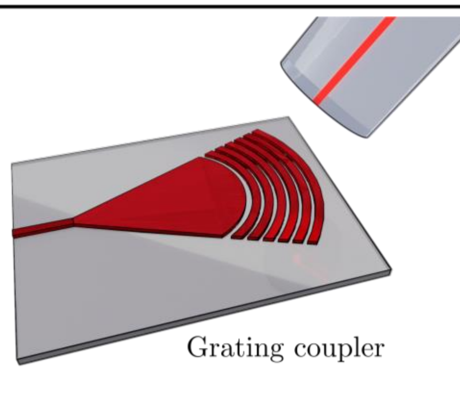
3rd party instruments

Optical Fiber Coupling: Surface vs. Edge

Edge coupling

Surface coupling





Pros: high coupling efficiency, broad bandwidth, polarization independent

Cons: need cleaved facets, large spot-size converters to match mode size to fiber

Pros: grating couplers can be integrated anywhere on PIC, no cleaving needed

Cons: limited wavelength range, polarization dependent, higher coupling loss

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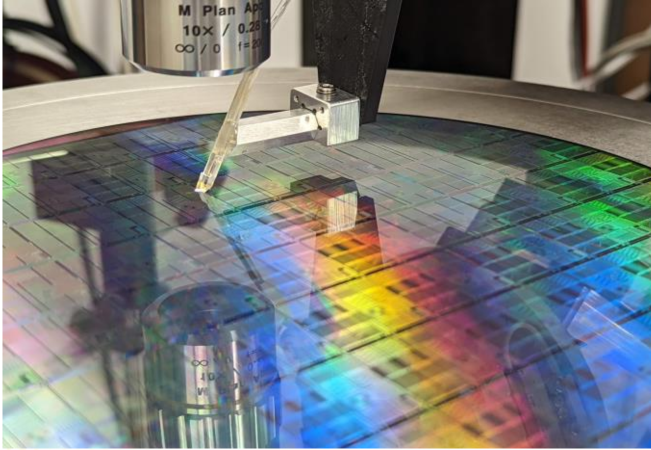
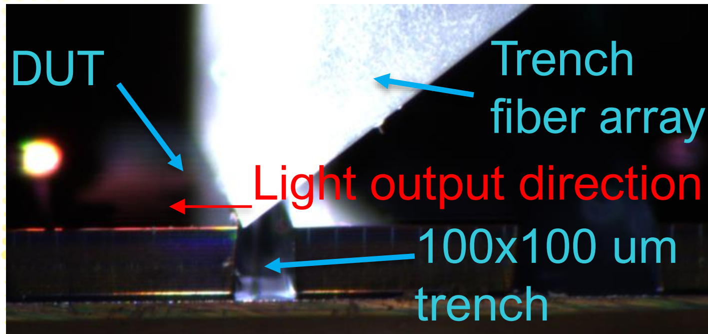
Wafer-Level Edge Coupling

Wafer-level edge coupling using OPAL-EC





No need to separate wafer into dies for testing

Safe time, cost and effort to manually pick, place and test dies individually

Leverage best coupling performance of edge coupling

High accuracy and repeatability key to assure no collisions during wafer test

Multi-port edge coupling for parallel testing

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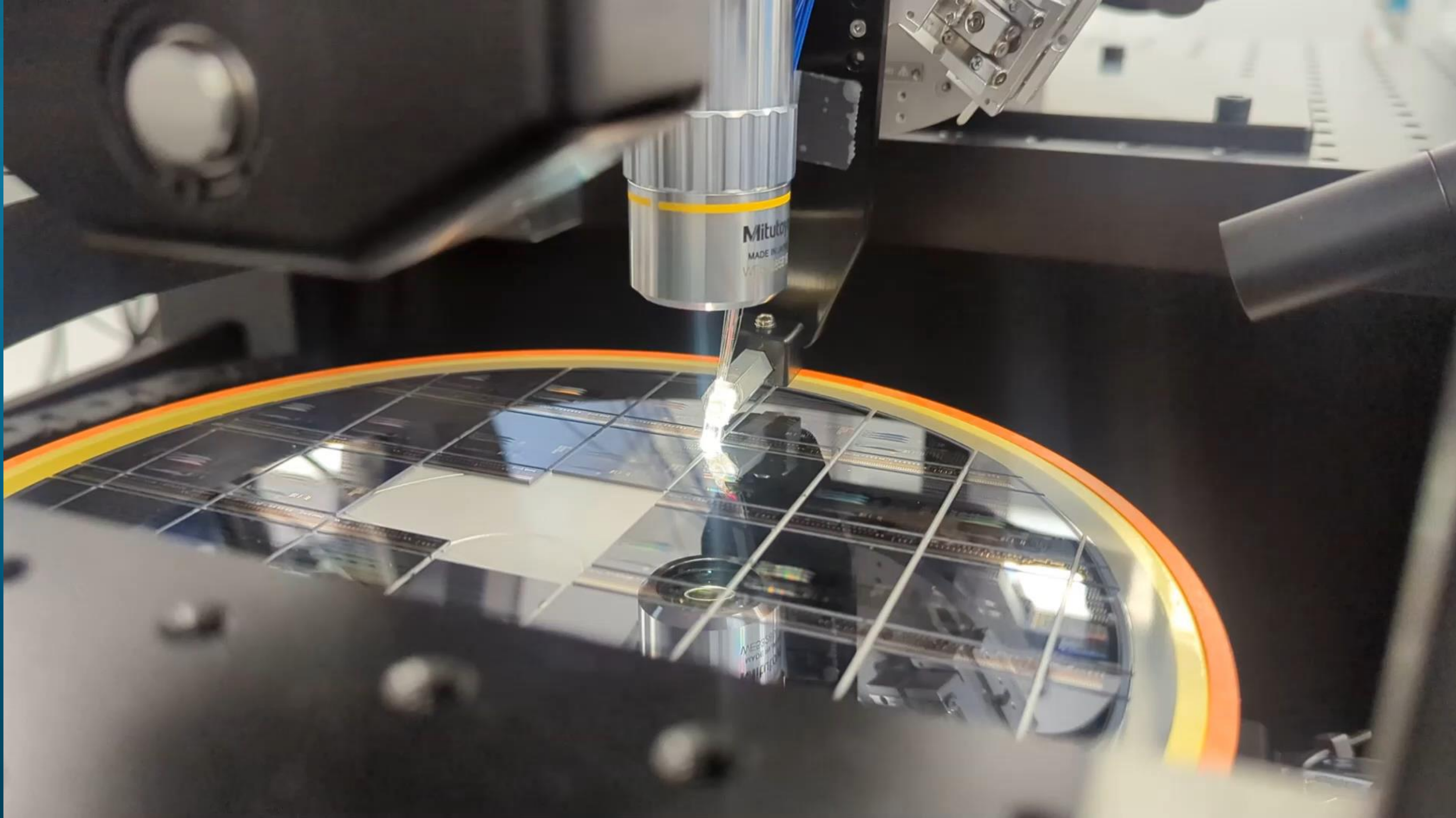
Running Automated Test Plans



Link: https://cdn.jwplayer.com/previews/n0j3TUSV-xpehj8NL

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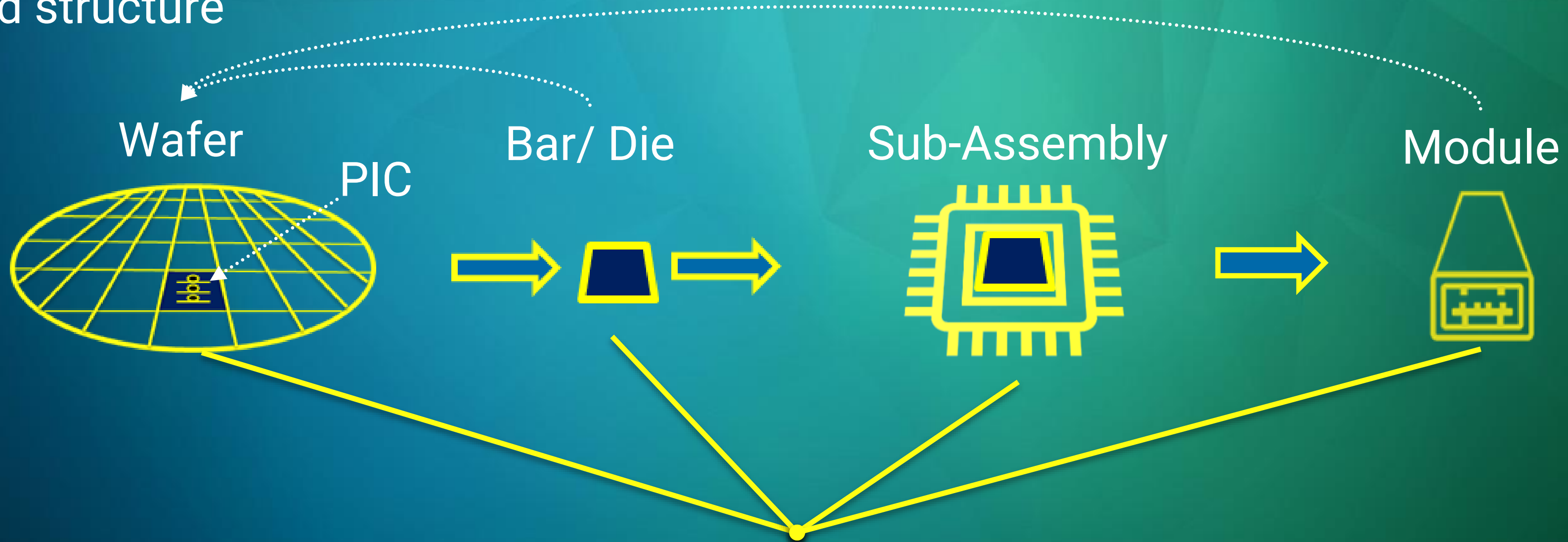
Life of PIC - from wafer to module

Reusable and connected test environment from wafer to module

Flexible definition of test/analysis scripts, wafer/reticle/die parameters, locations and structure



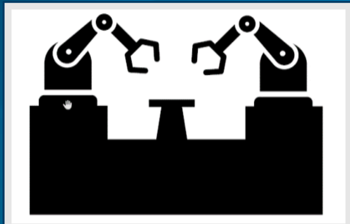
De-coupled concepts and responsibilities (users, apps):
Everything links together

Machine learning to Cut Test Time and Costs

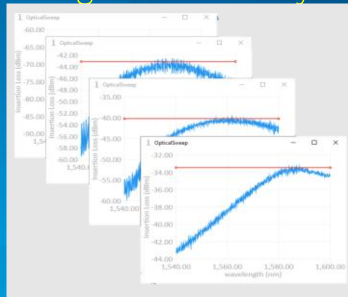
Data-driven live decision-making flow

Skip predicted bad circuits

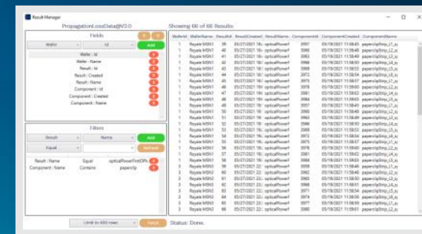
1. Collect test results

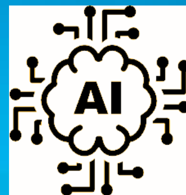


2. Extract figures of merit using batched analysis

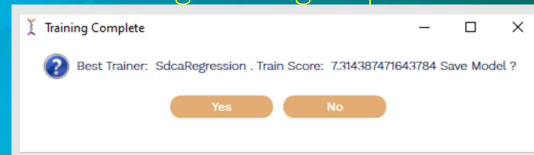


3. Build custom datasets from database

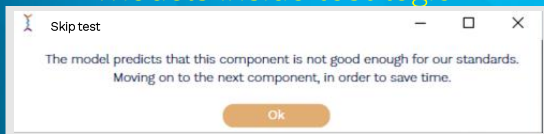




4. Train predictive models with machine learning training sequences



5. Consume predictive models inside test logic



Thank you!

Third-party instrumentation

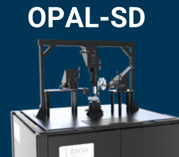
PILOT – Full-Automation Software

STATIONS

OPAL-EC
Edge & Surface
Wafer & die
PIC testing

OPAL-MD
Edge & Surface
Multiple & single-die
PIC testing

OPAL-SD
Edge & Surface
single-die
PIC testing



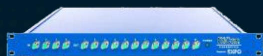
LAB-ON-A-RACK – PASSIVE + ACTIVE

Optical test Platform
Light sources, VOA, opt. switch, OSA, power meters

LTB-12

OSICS

Matrix Switch



MXS-9100

Array of VOA

MOA-3800

SPECTRAL – PASSIVE COMPONENT

Swept tunable lasers

T200S

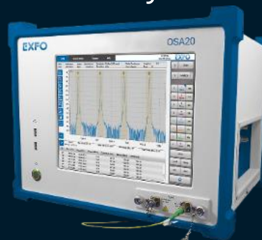
T500S

Passive optical component tester

CTP10 **CT440**

SPECTRAL – ACTIVE COMPONENT

Optical spectrum analyzer



OSA20

Tunable filters

XTA-50

XTM-50

TRAFFIC ANALYSIS

BER tester

BA-4000

Sampling scope

EA-4000

Clock recovery

CD-4000

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