



Supply Chain Security Workshop

April 28 & 29, 2021

Physical Assurance and Inspection of Electronics

Microelectronics Packaging and Test Engineering Council (MEPTEC)

Navid Asadi

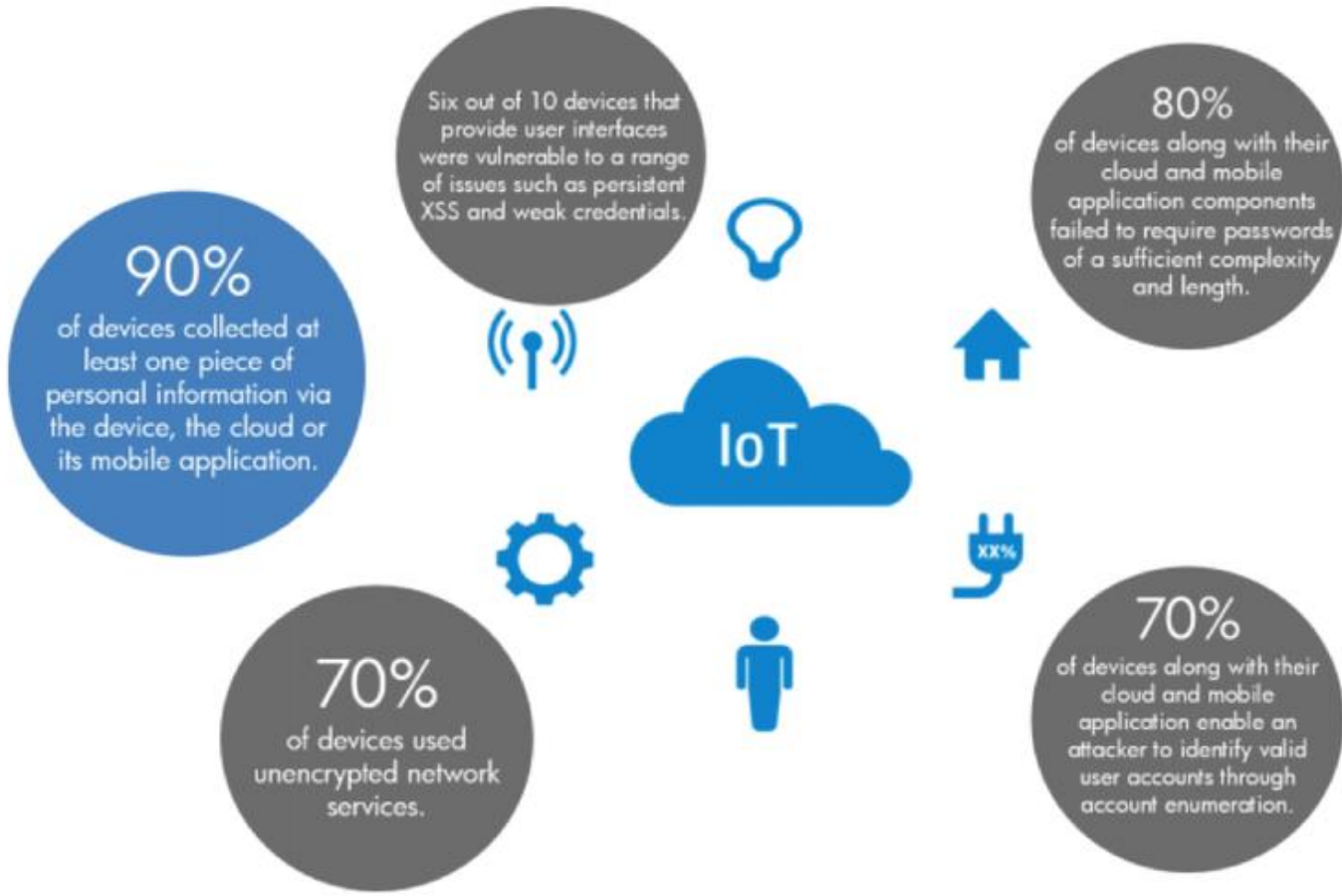
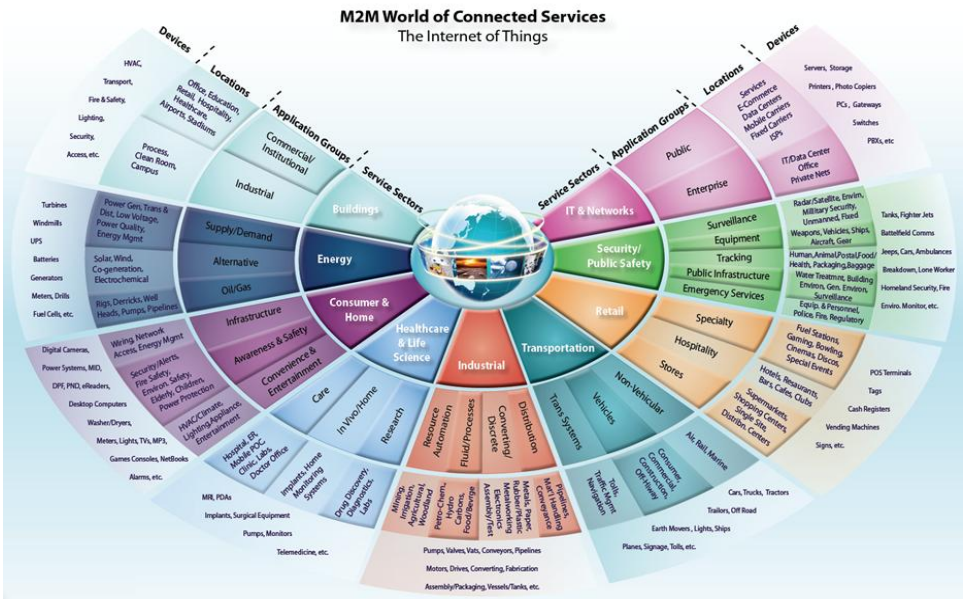
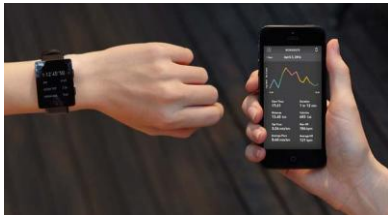
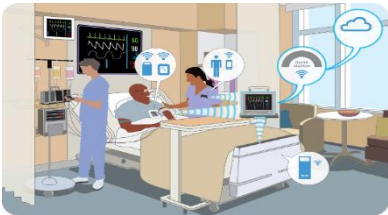
Assistant Professor

Electrical and Computer Engineering Department

nasadi@ufl.edu



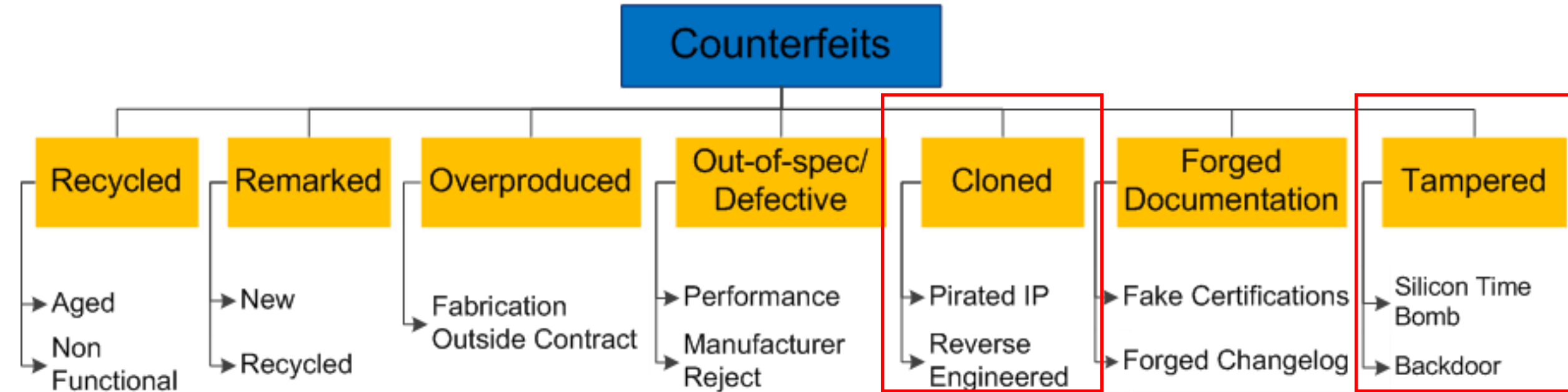
World of IOT



Horizontal Model of Fabrication



Raise of Counterfeits

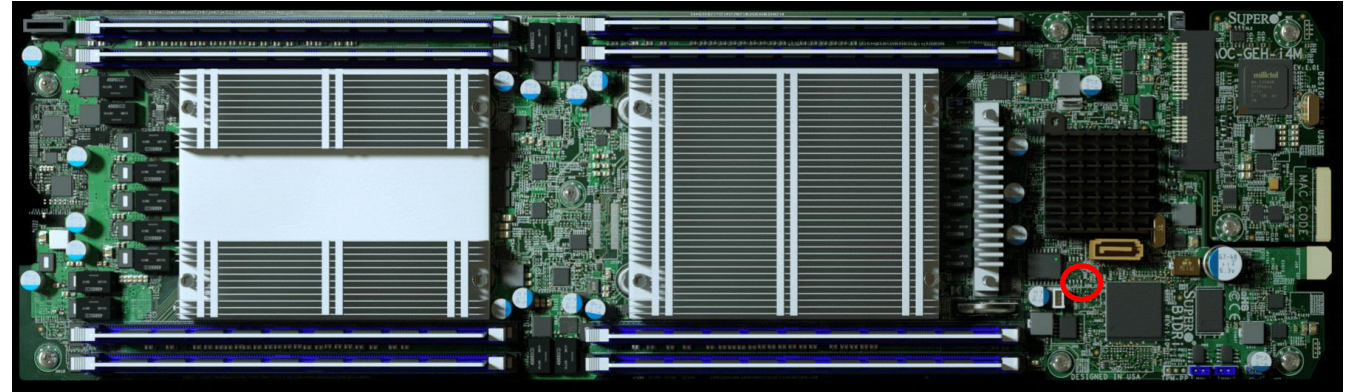


State Level Attacks



NSA's Tailored Access Operations (TAO) Unit

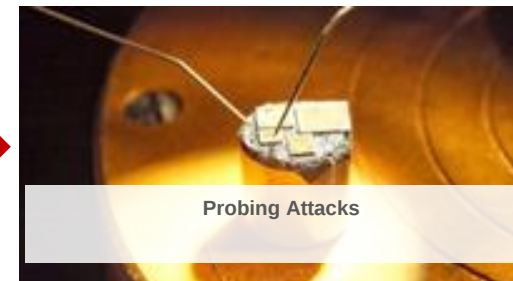
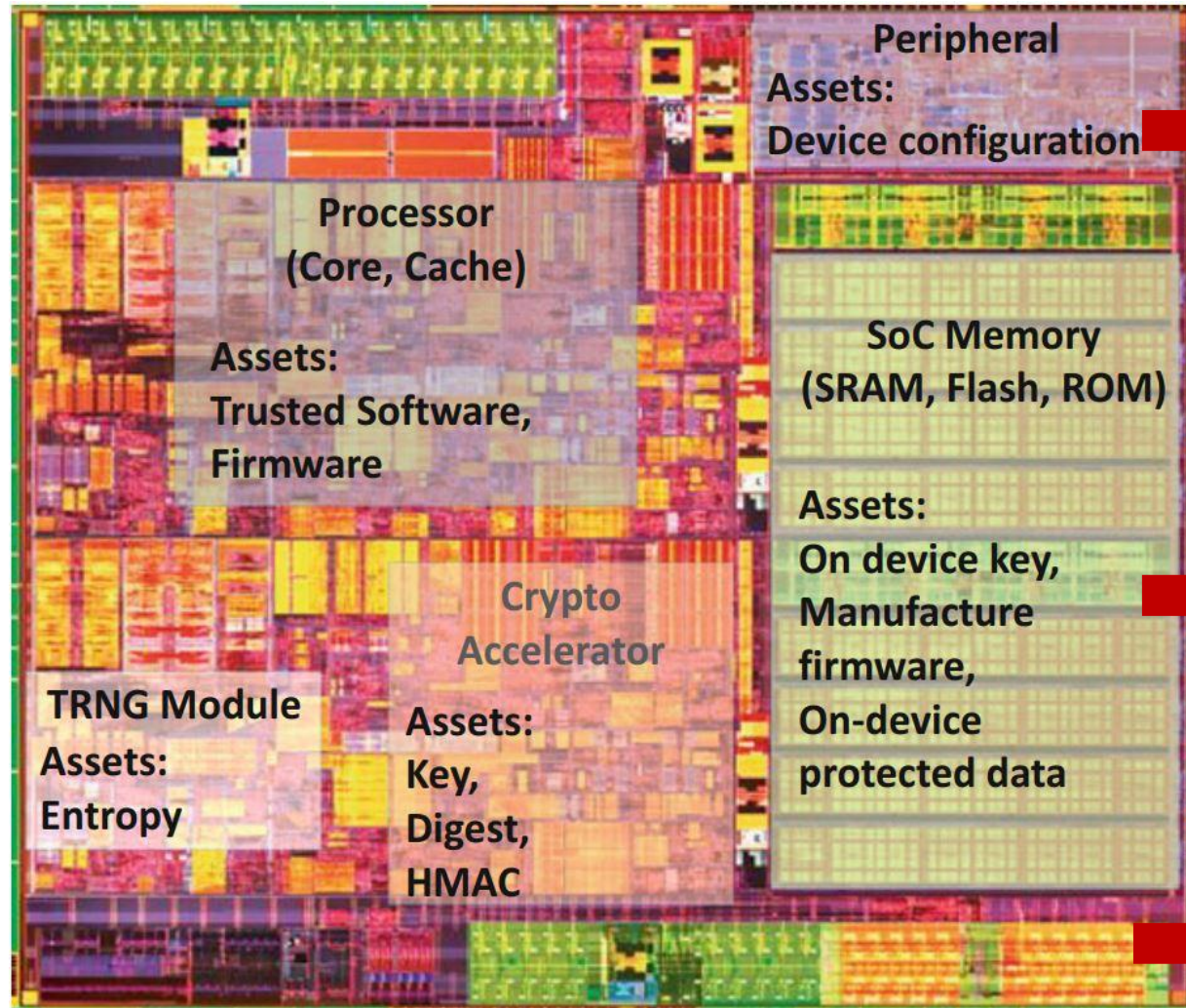
- Intercepted and tampered with Cisco products
- Installation of secret firmware to monitor communications and siphon data



The Big Hack: Supermicro Motherboards

- Chinese spies implanted chip at subcontractor facility
- Told the servers to communicate anonymous computers on the internet that were loaded with more complex code
- Preparing the server's operating system to accept new code

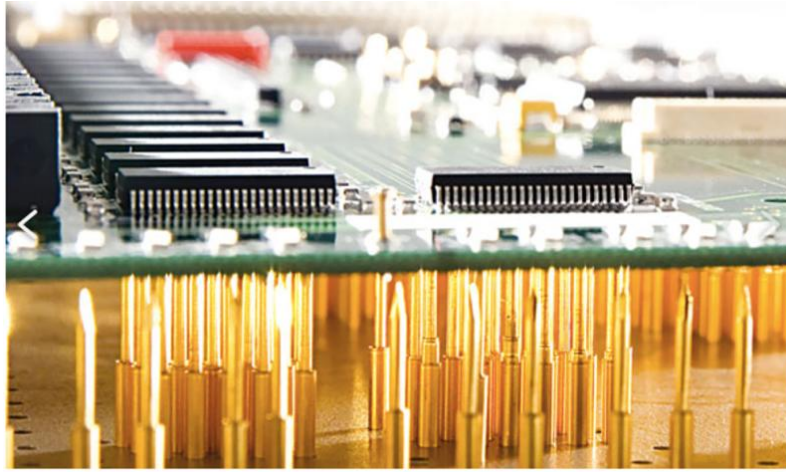
Assets on Modern Electronics



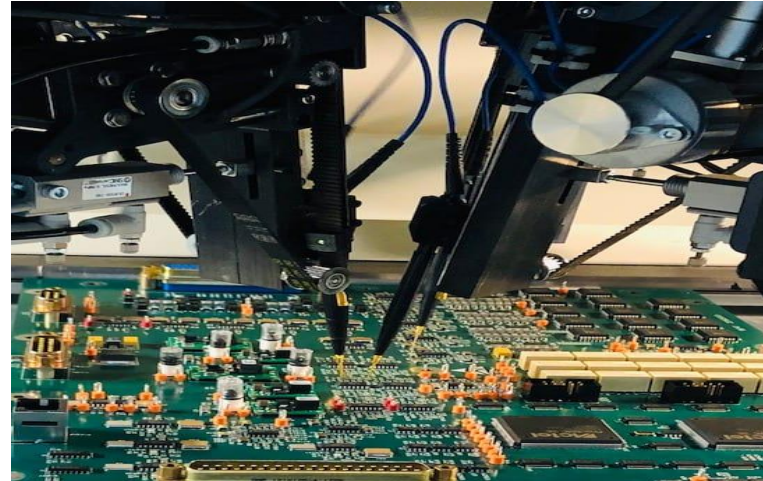
Possible with Optical analysis like

1. Photon Emission Analysis
2. Laser fault injection
3. Optical Probing

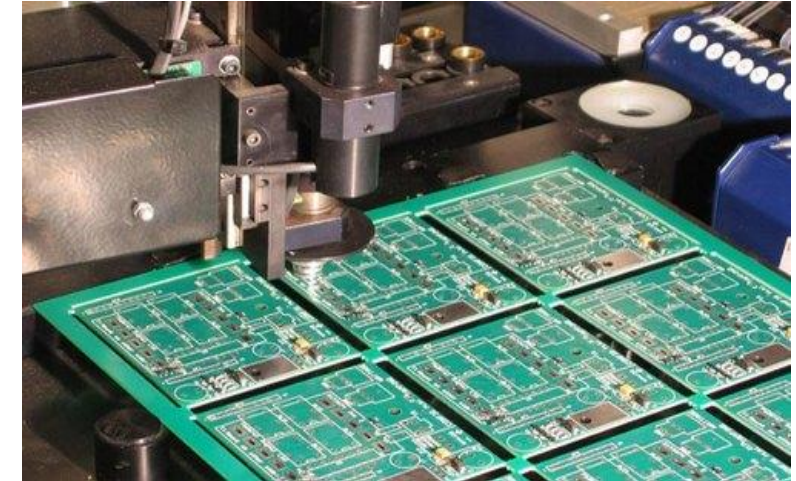
Electronic Inspection



In-Circuit Test



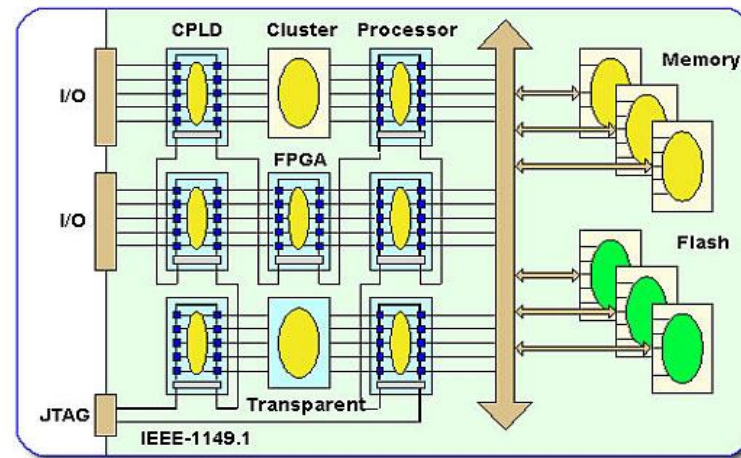
Flying Probe Test



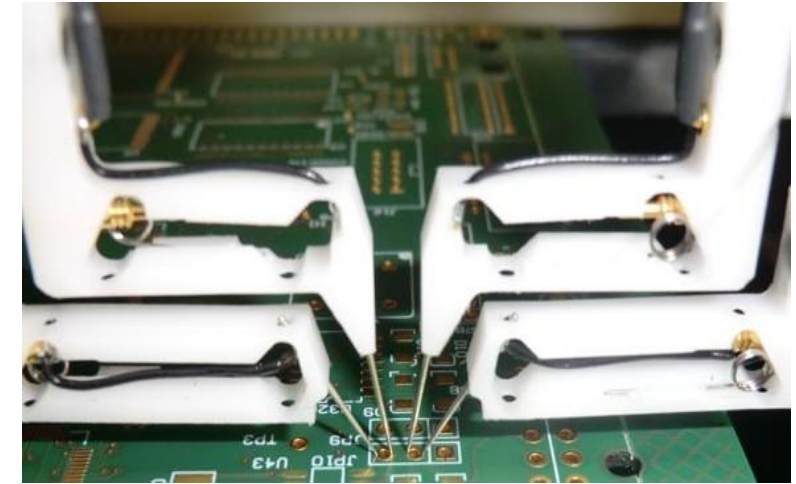
Assembly Level Test



Functional Testing

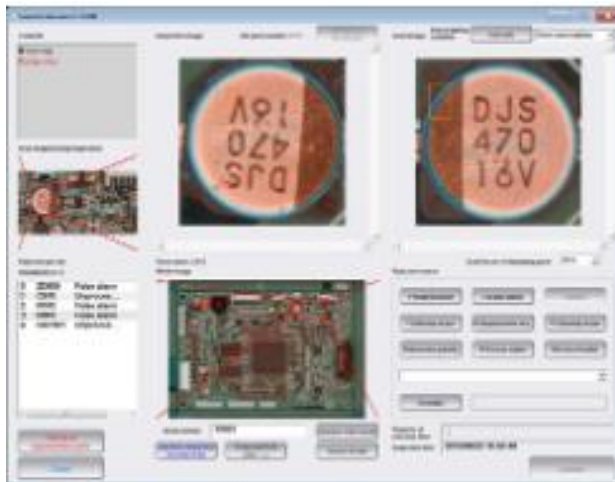
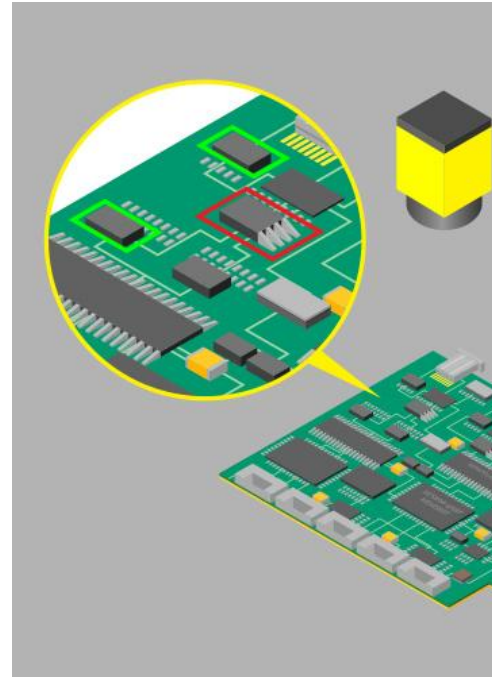


JTAG Boundary Scan Testing

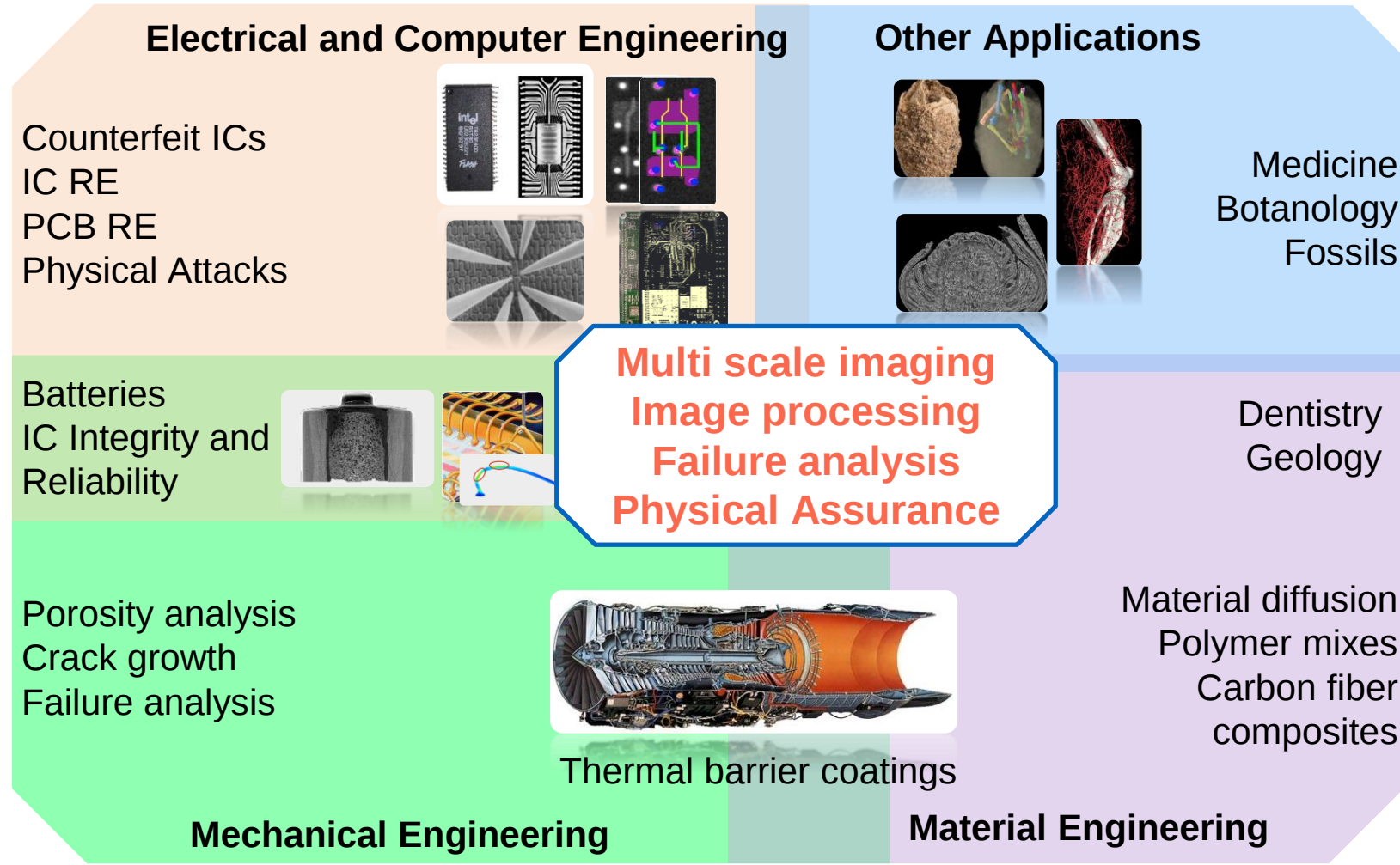


Bare Board Testing

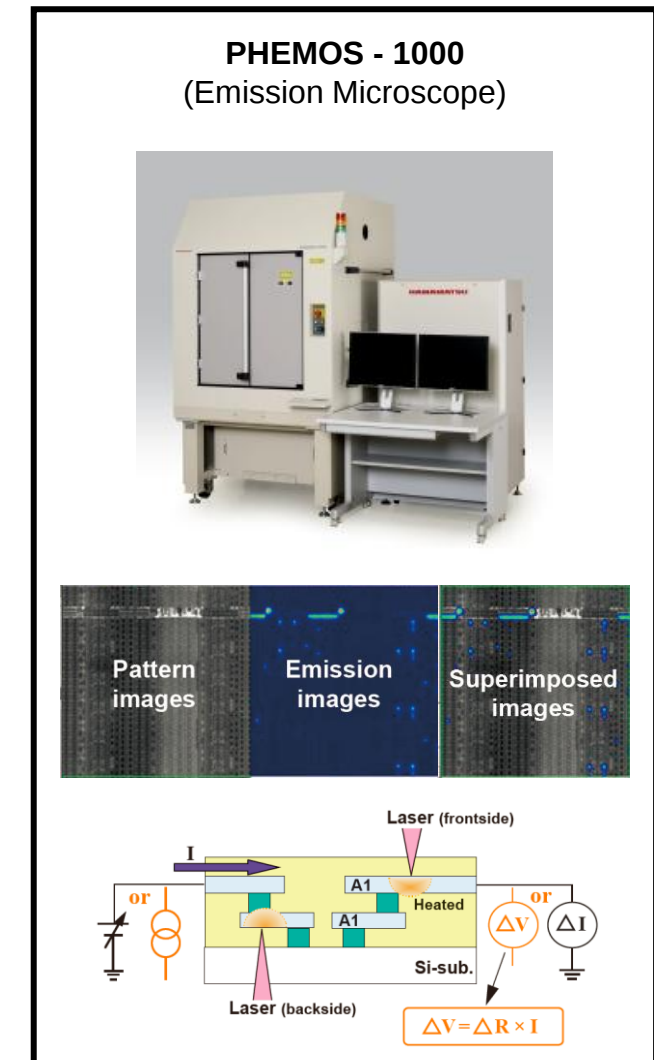
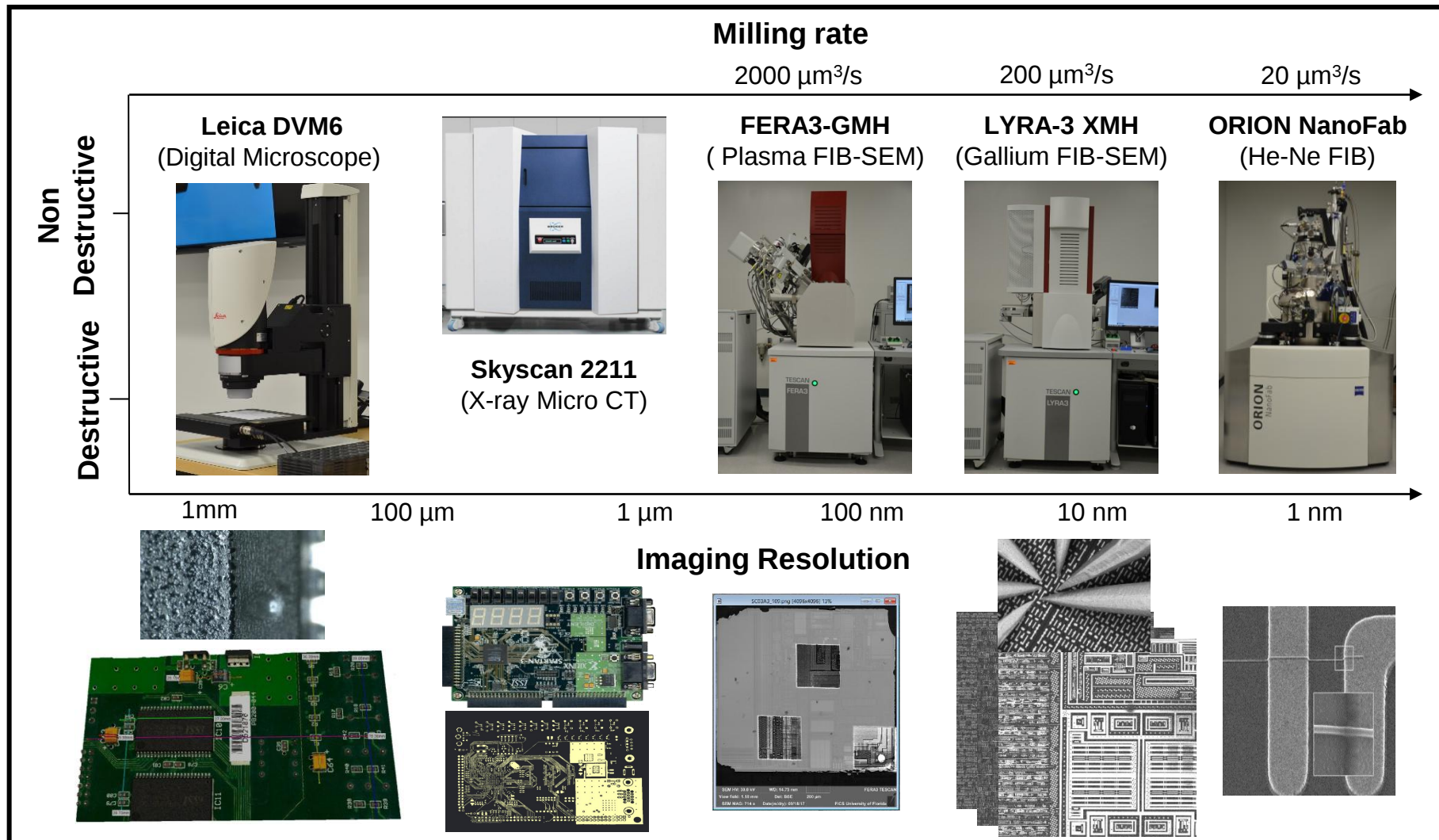
Physical Inspection



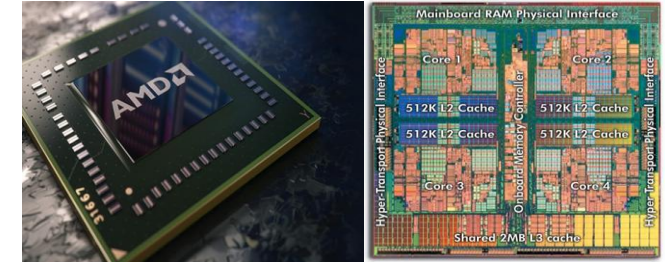
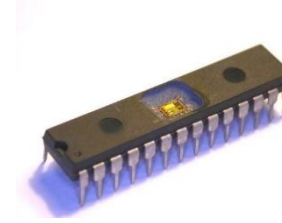
Imaging Arsenal



Experimental Lab

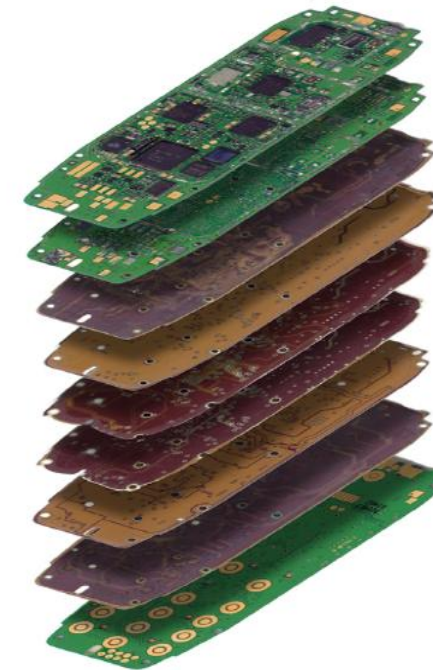


Integrated Circuits (IC)

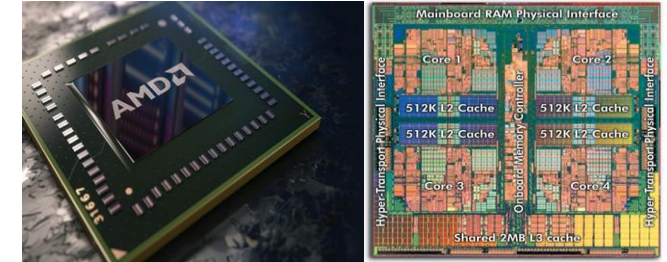
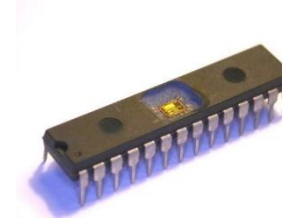


Printed Circuit Boards (PCB)

- Destructive Approaches
- Non-Destructive Approaches



Integrated Circuits (IC)



- **Destructive Approaches**
- Non-Destructive Approaches

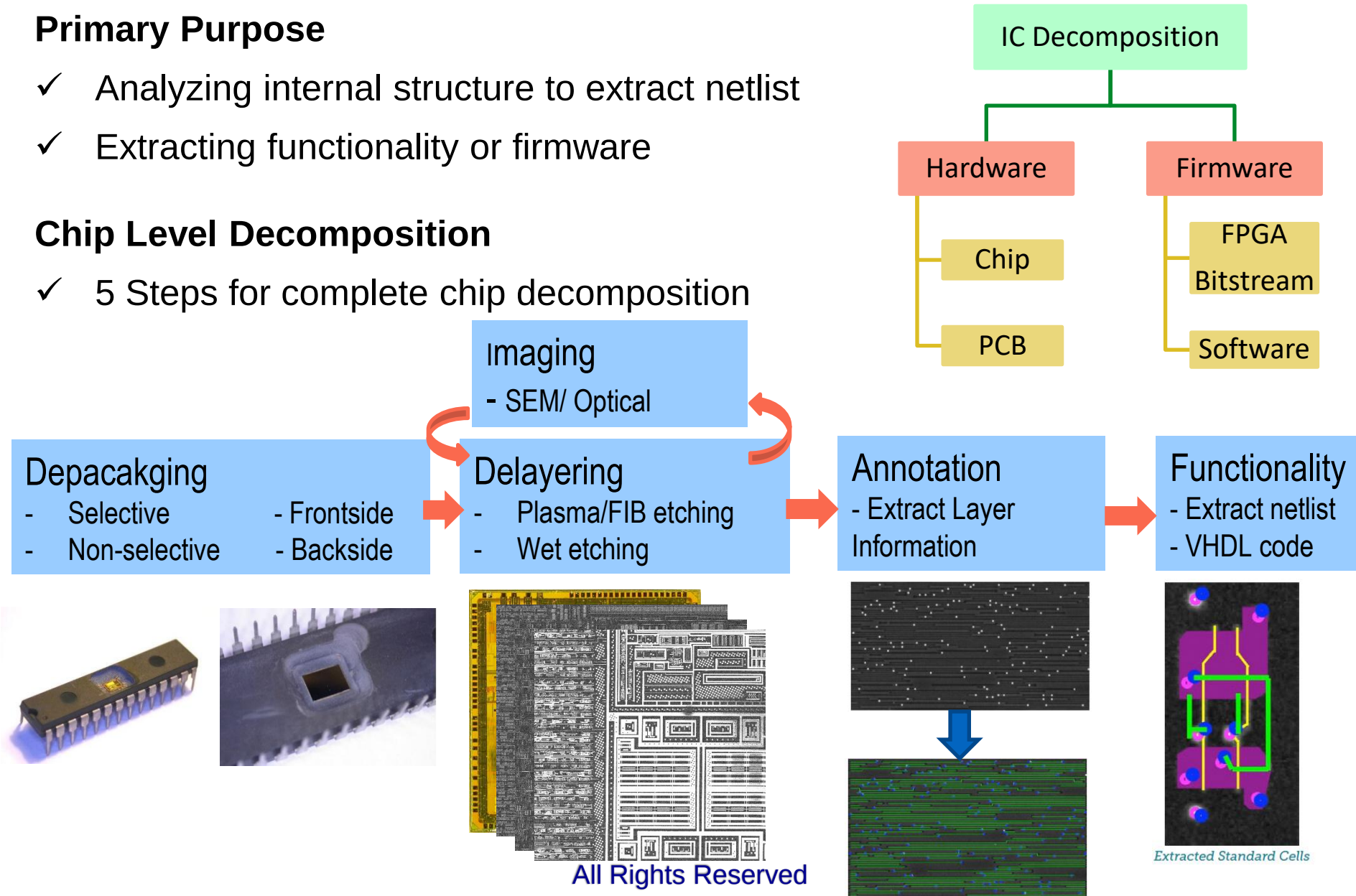
Electronic IC Decomposition

Primary Purpose

- ✓ Analyzing internal structure to extract netlist
- ✓ Extracting functionality or firmware

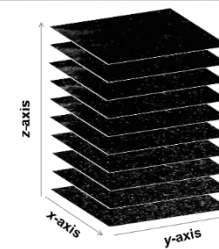
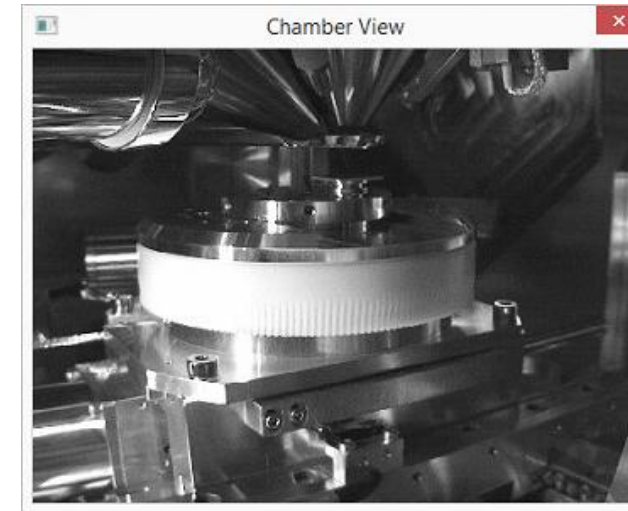
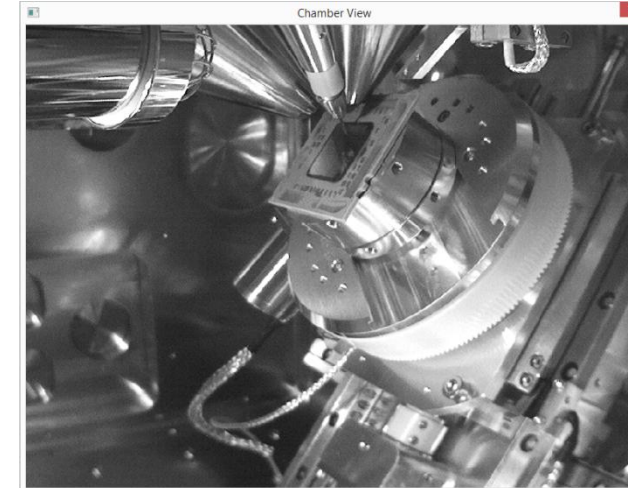
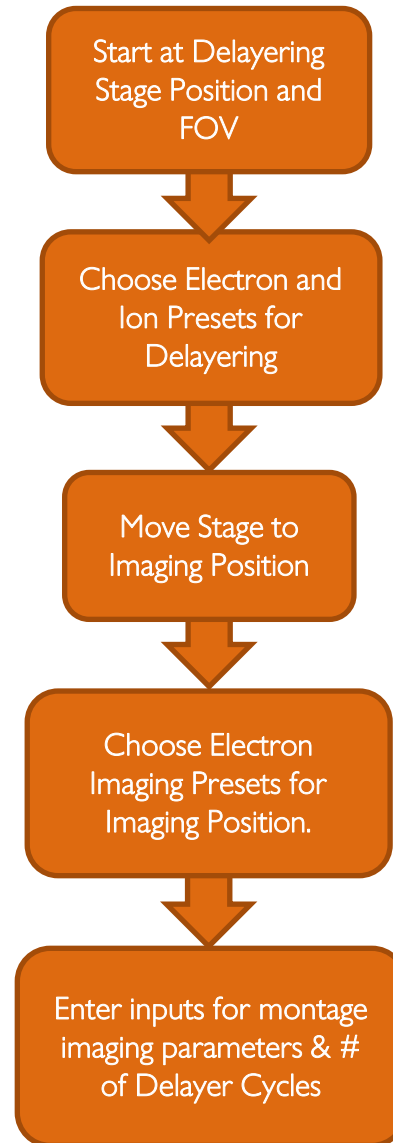
Chip Level Decomposition

- ✓ 5 Steps for complete chip decomposition

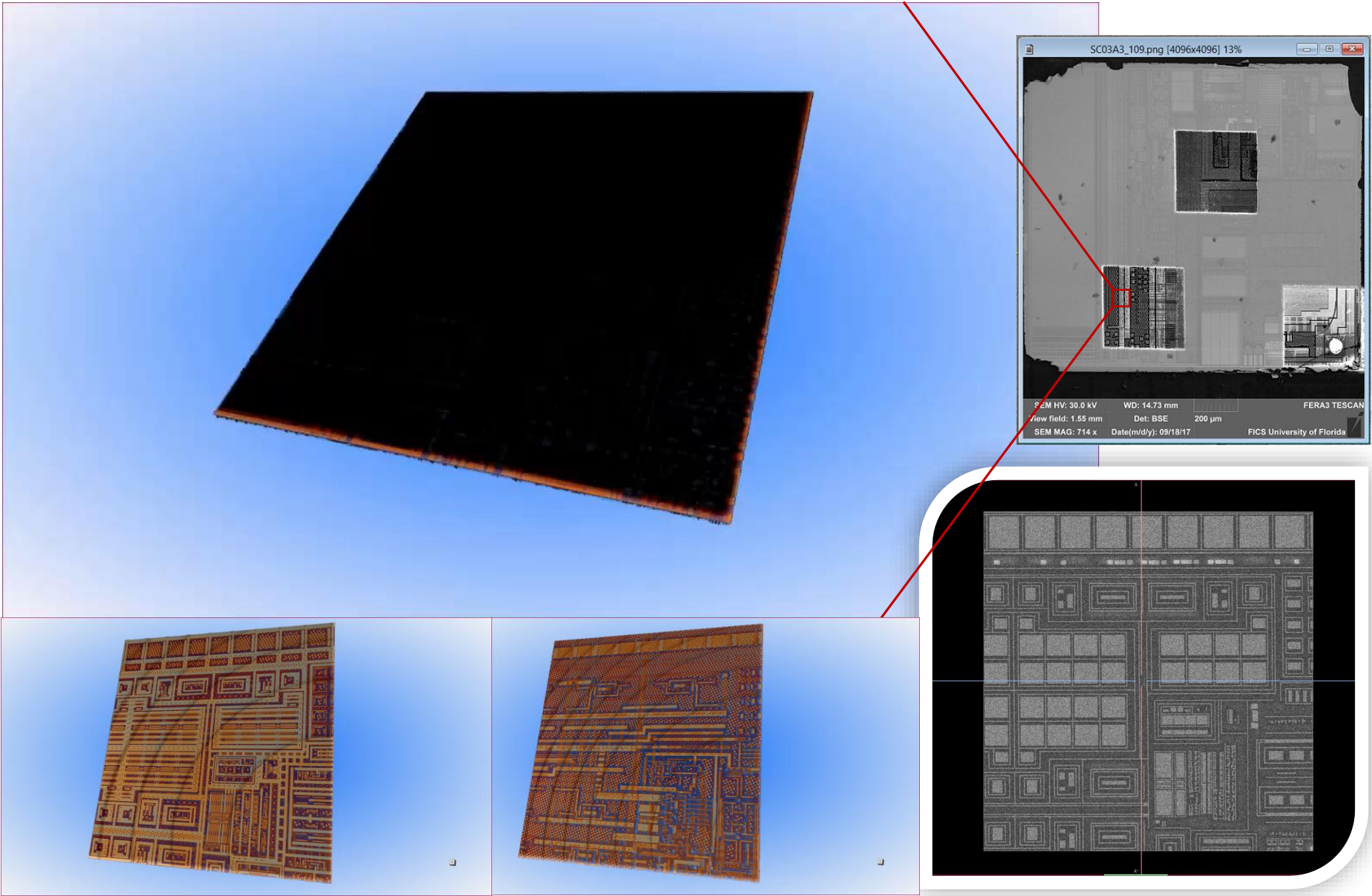


Auto Delayering Workflow

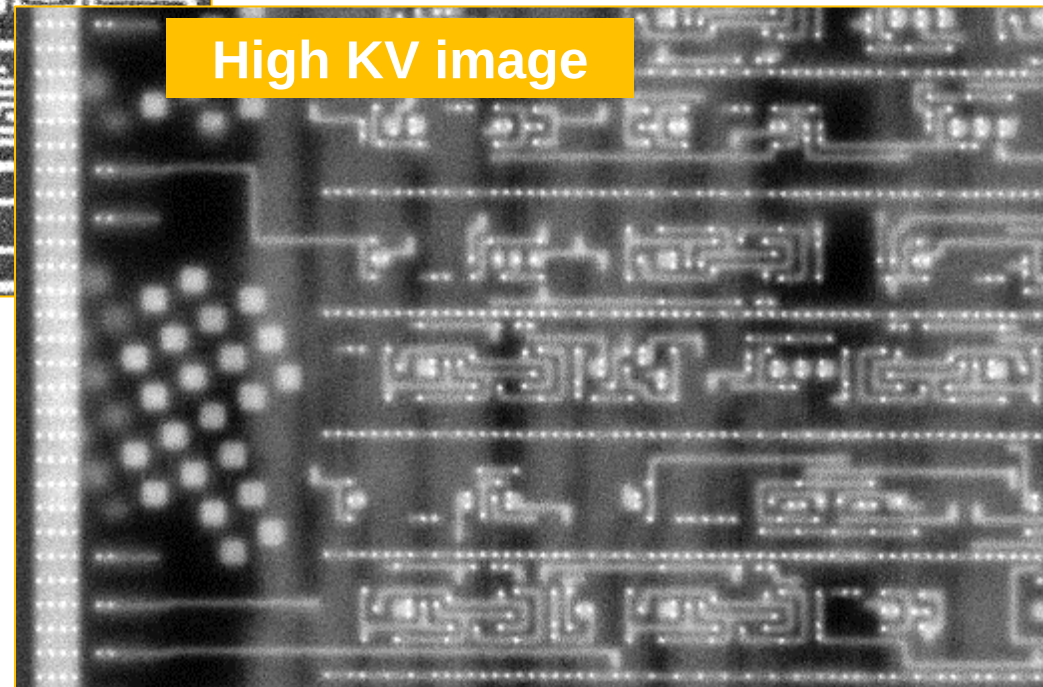
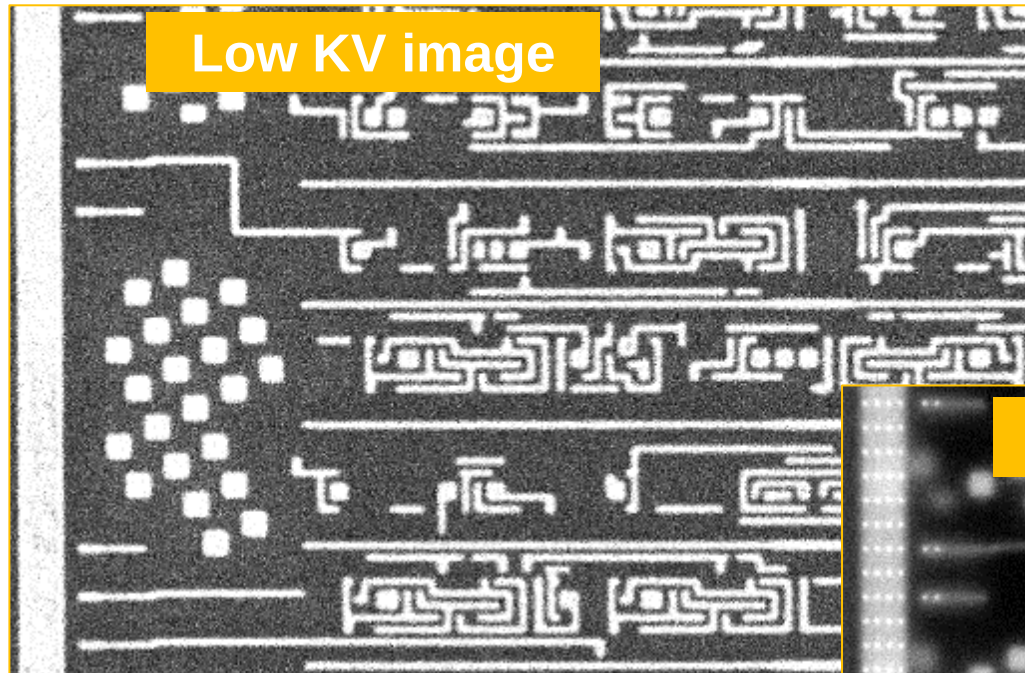
- User defined delayering position and FOV is read.
- Ion and electron presets are selected for delayering:
- Imaging stage position read:
 - Zero tilt
 - Below-the-lens BSE detector
- Multiple imaging voltages and detectors may be defined via presets.
- User-selected FOV, dwell time, pixel density & number of cycles.



Automated FIB Delayer Tomography

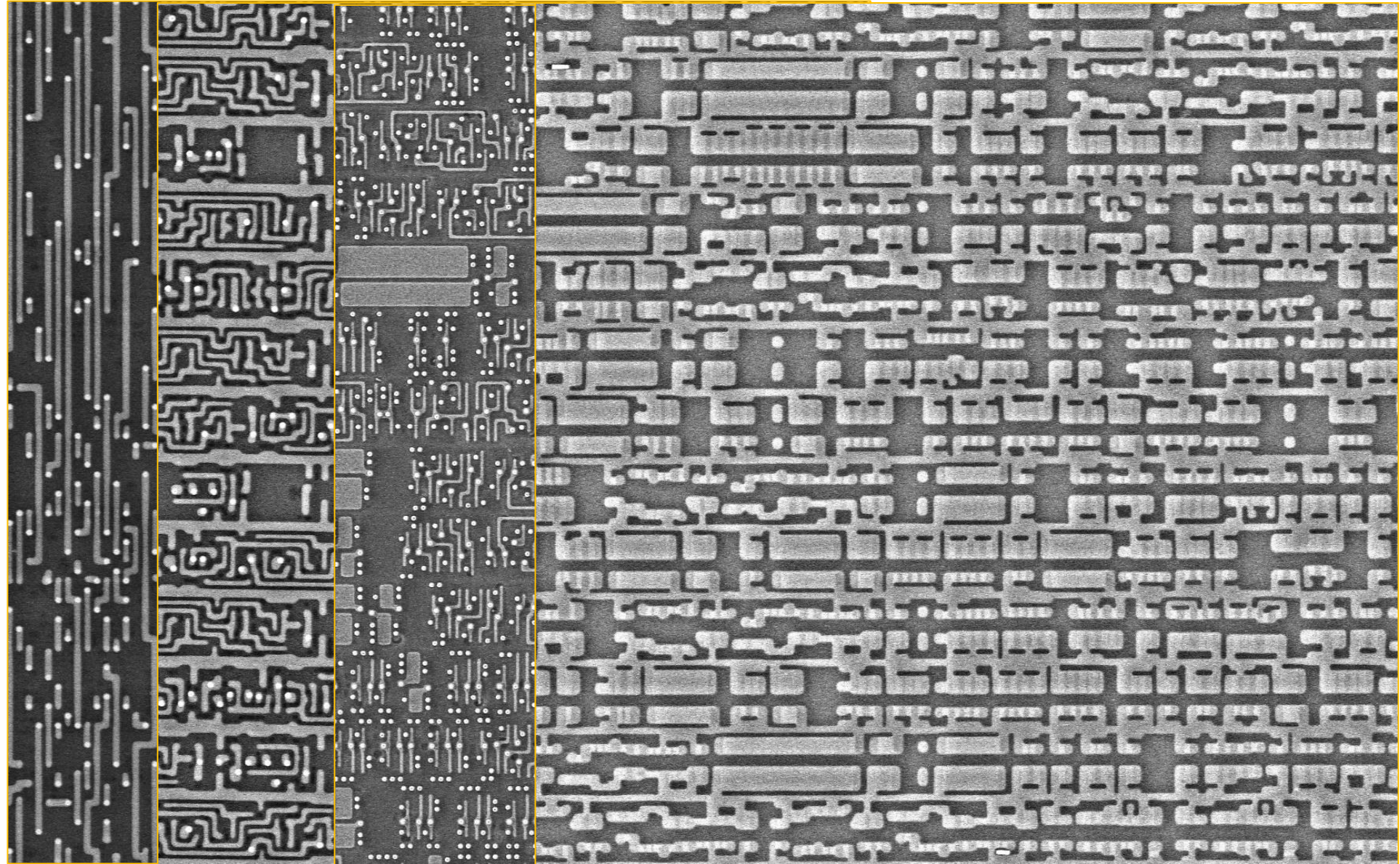


Voltage Imaging



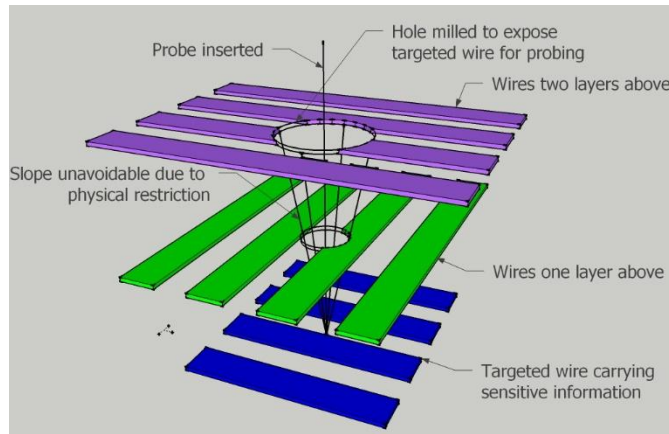
ICs

- 7nm, 10nm, 14nm, 28nm, Etc.
- TSMC, Samsung, Qualcomm, NXP, SkHynix, ETC.

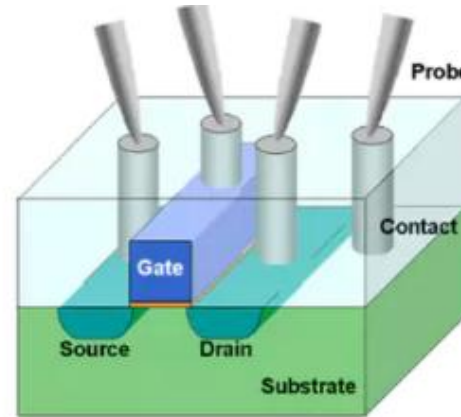


Electrical Probing and Circuit Edit

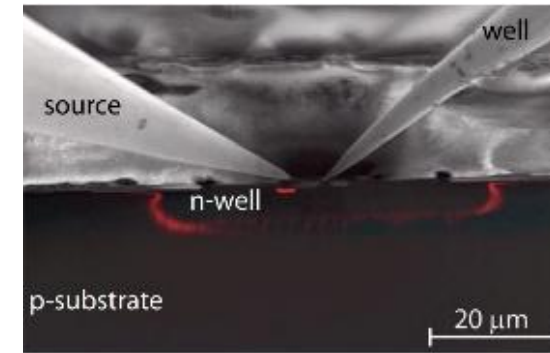
- **Probing:** circumvent encryption by probing at signal wires to extract security sensitive information



Electrical Probing from frontside

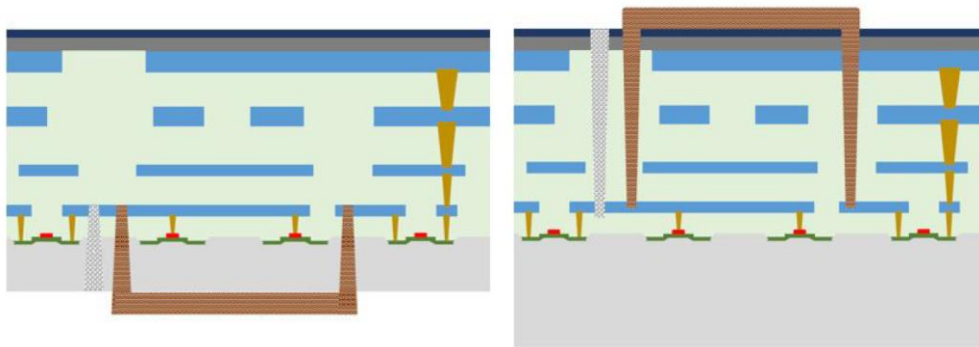


Probing from backside/frontside

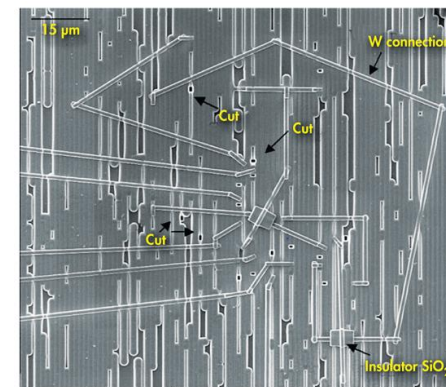


Nanoprobe

- **Circuit Edit:** Permanent change in circuit connections



Backside vs Frontside Circuit Edit

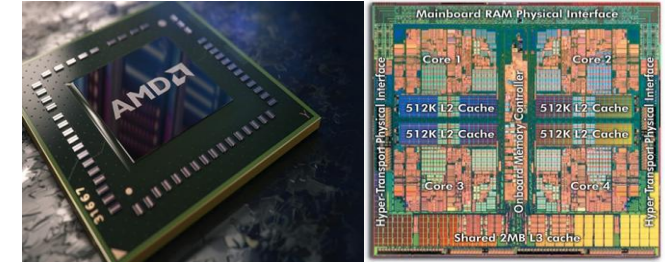
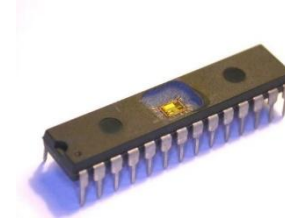


*FIB Deposition of
Tungsten/Platinum for
Creating Interconnects [EAG Labs]*



*State-of-the-Art
Sub 10-nm FIB [Zeiss]*

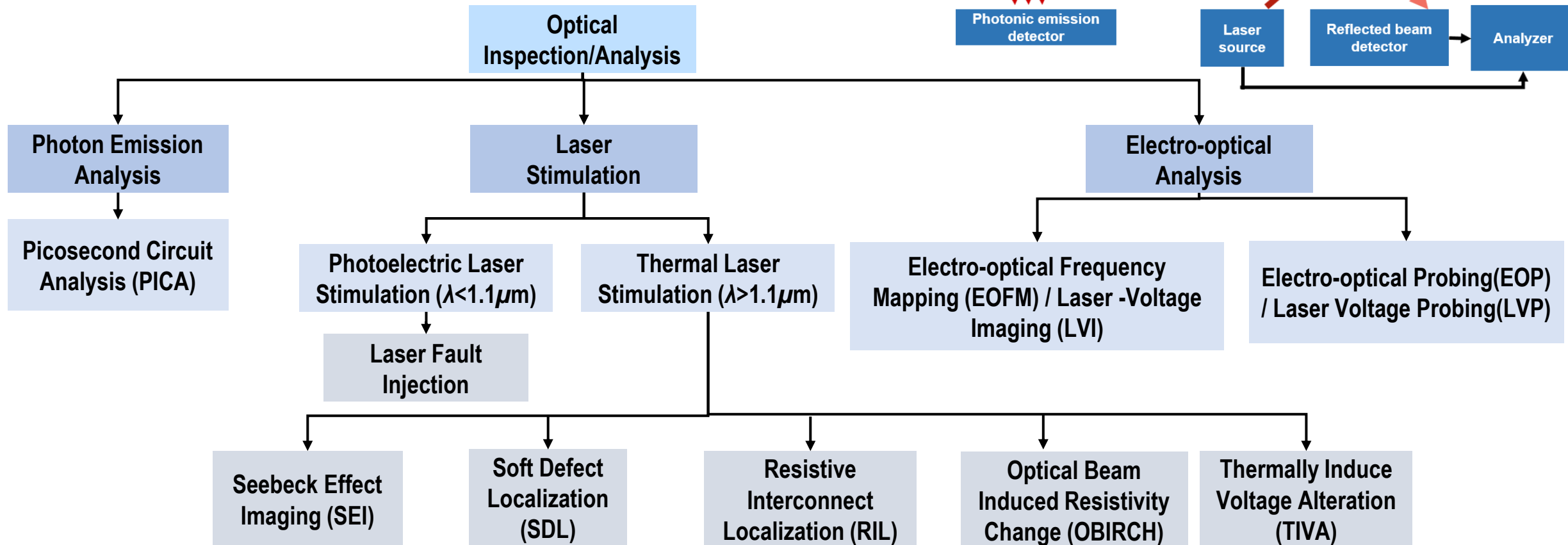
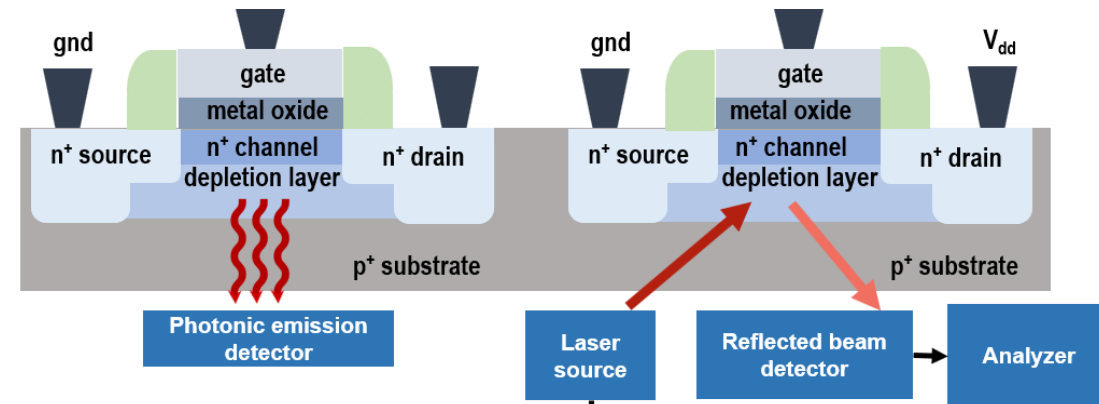
Integrated Circuits (IC)



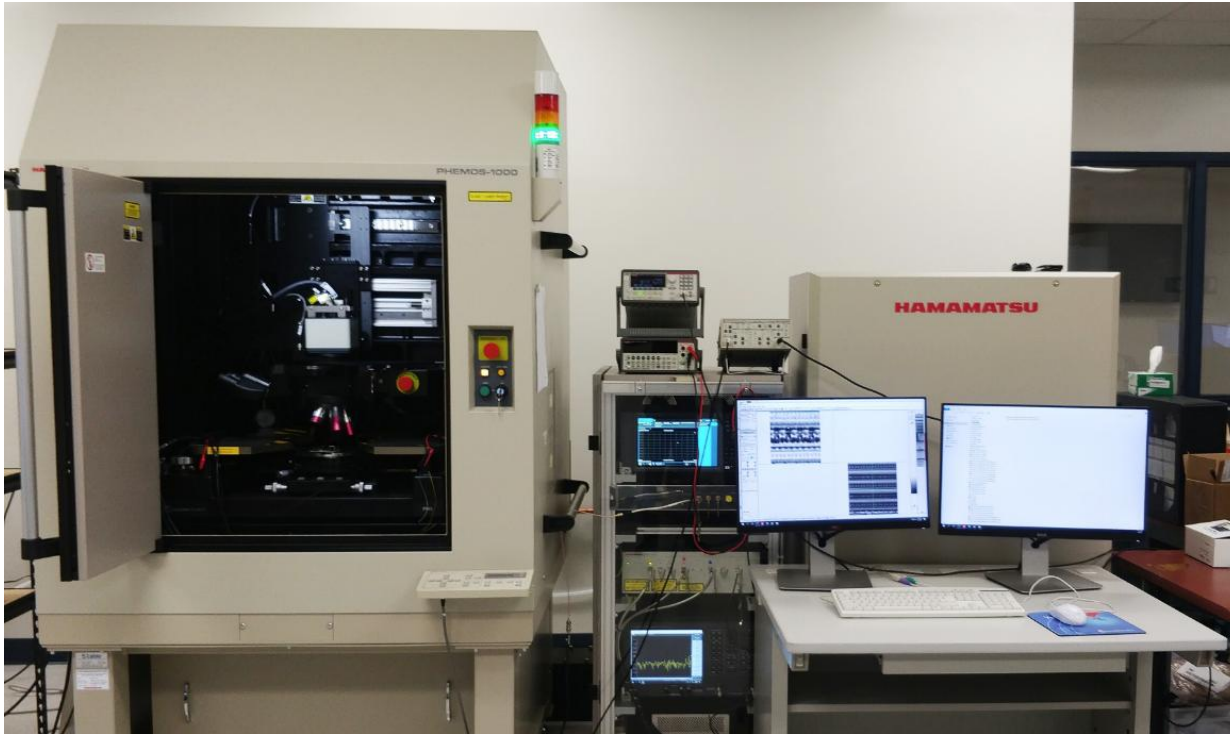
- Destructive Approaches
- **Non-Destructive Approaches**

Optical Attacks/Inspection Methods

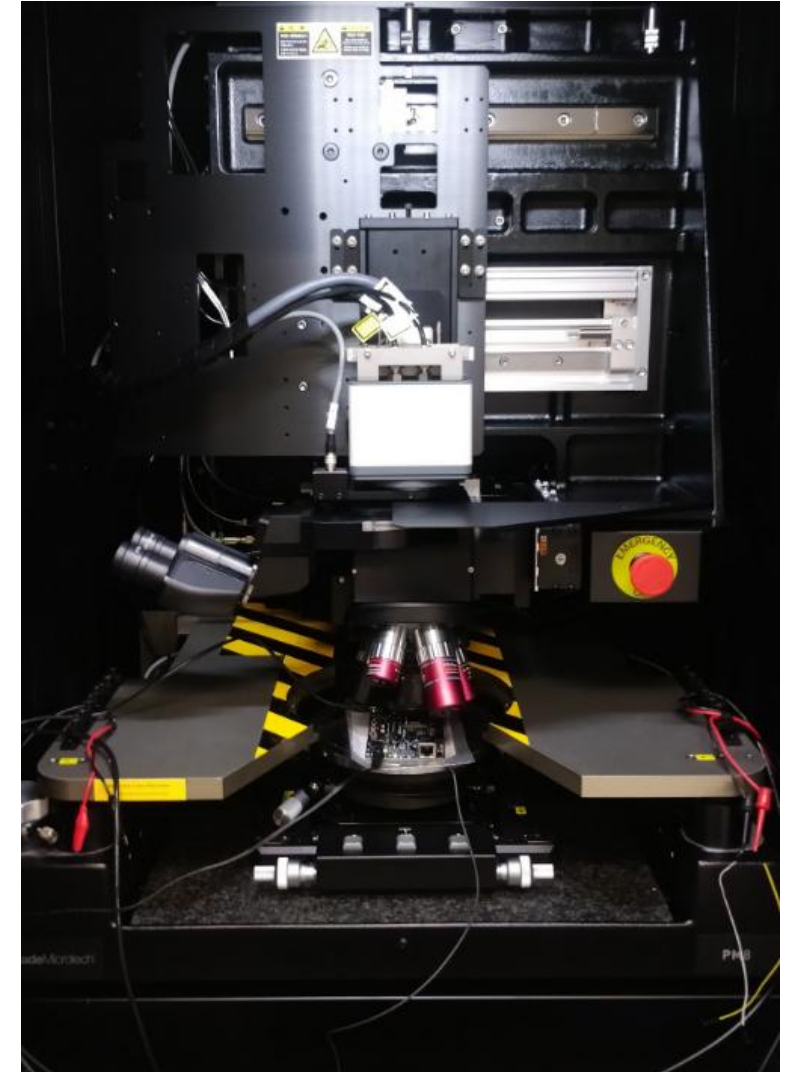
- Silicon transparent to near-infrared photon
- Requires physical access to device



Instruments for Optical Attacks/Inspection



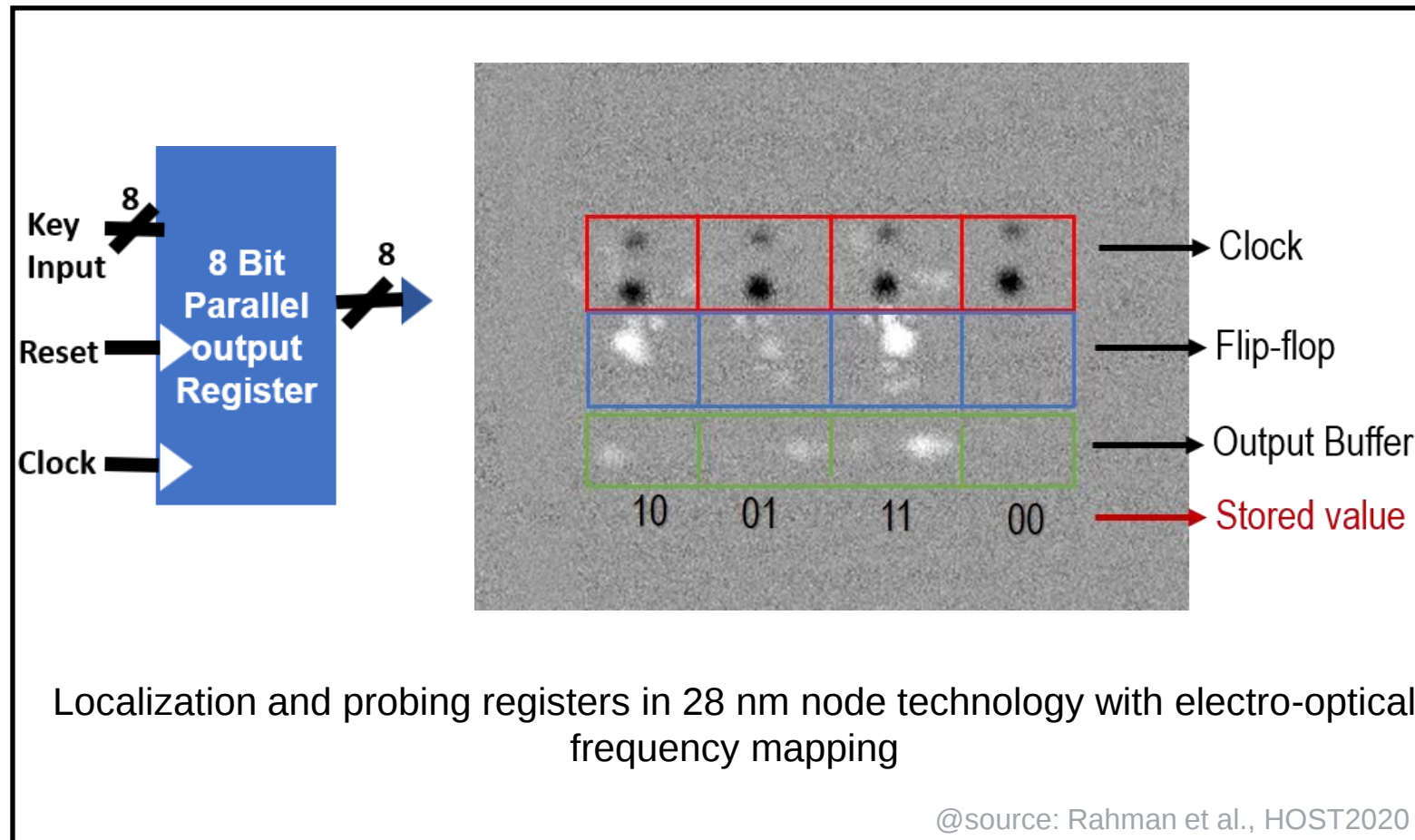
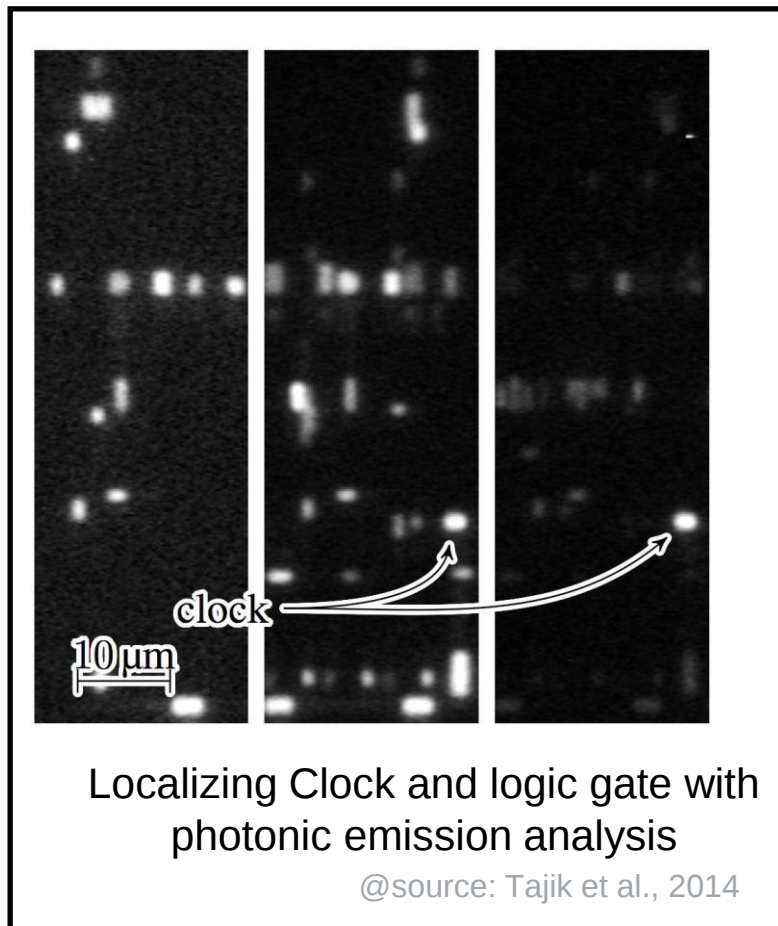
- Laser stimulation microscope
- Photon emission microscope
- Integrated in microscope like PHEMOS-1000



@source: FICS, UF

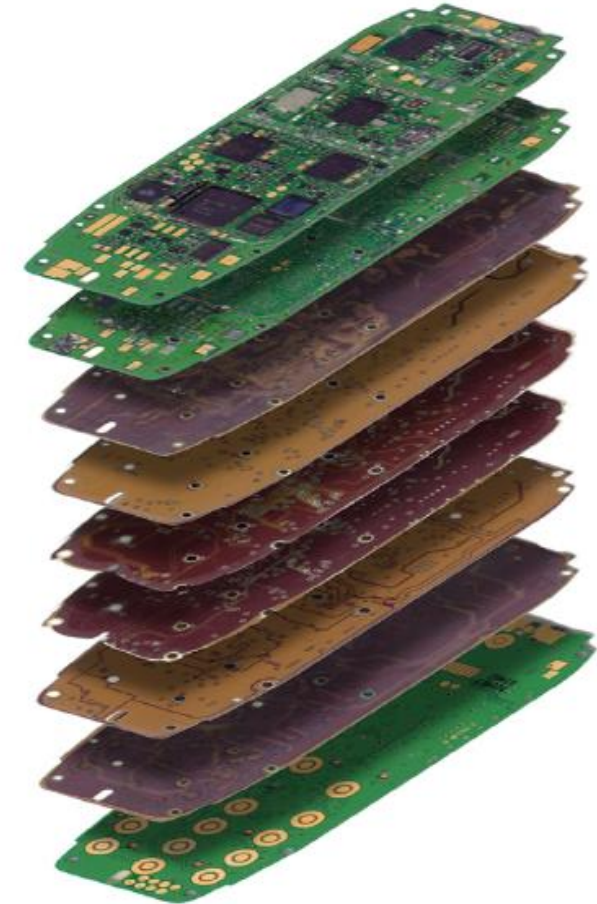
Non-invasive Register Data Exposing

- Localizing and probing register expose all on-device protected assets



Printed Circuit Boards (PCB)

- Destructive Approaches
- **Non-Destructive Approaches**



PCB Assurance

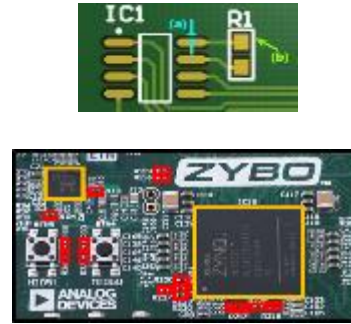


Image Modalities

- Optical
- X-ray tomography
- Thermal imaging
- Etc.

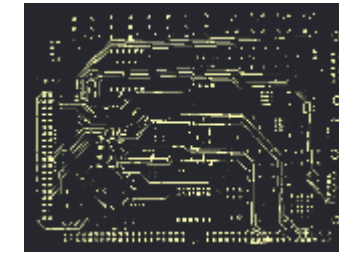
Image Processing

- Thresholding
- Filtering
- Morphology
- Segmentation
- Contouring



Machine Learning

- Clustering
- Neural Network
- SVM
- Decision Trees
- Etc.

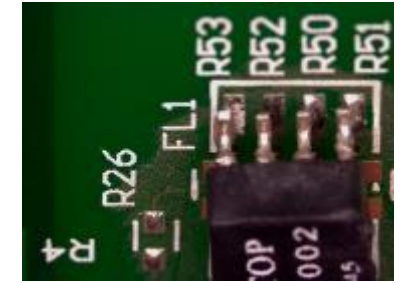


Extract Bill of Material

- ICs
- Resistors
- Capacitors
- Etc.

Board layout

- CAD
- Netlist



Analysis and Defect Recognition

- Counterfeit Components
- Missing / Replaced
- Solder fault
- Contacts fault
- Etc.

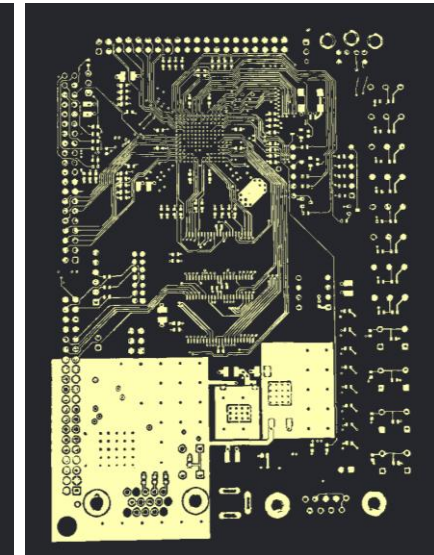
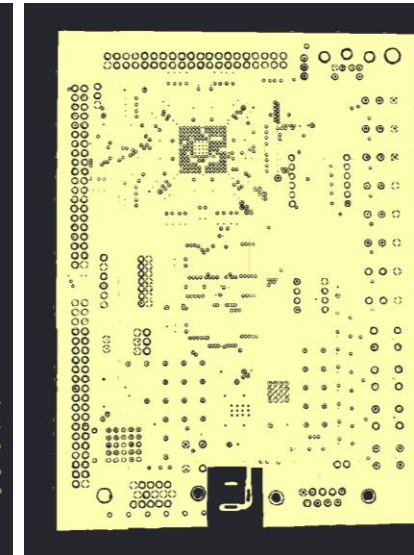
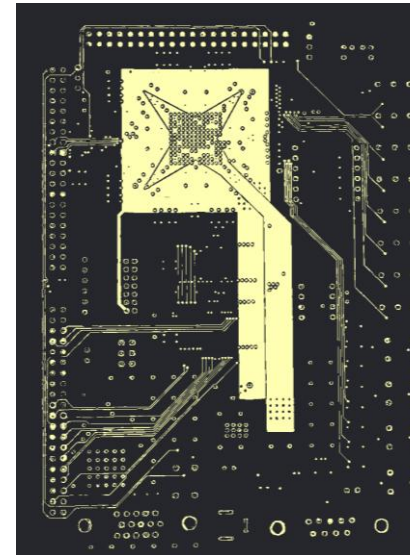
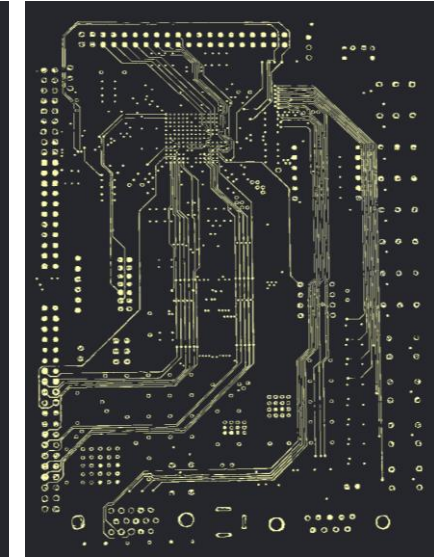
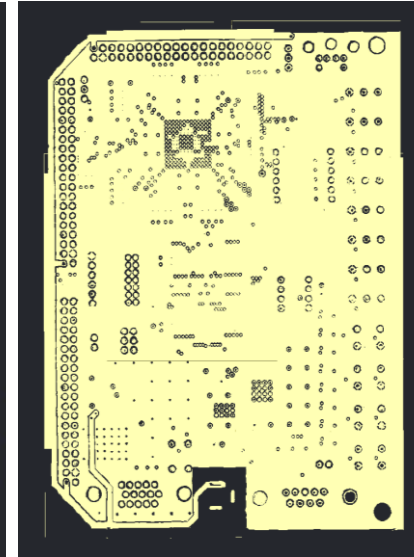
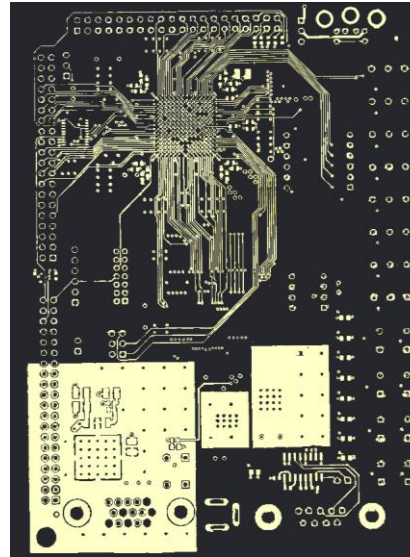
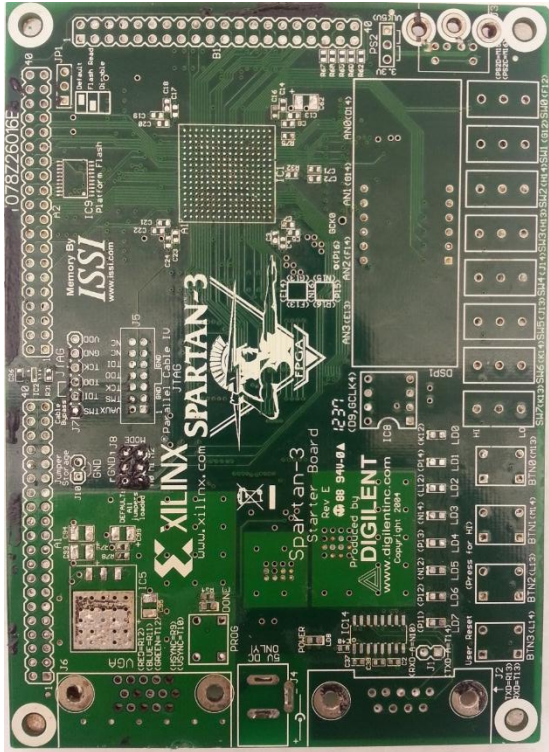
Image Acquisition

Image Analysis

Authentication

PCB X-ray Image Analysis

Xilinx Spartan 3

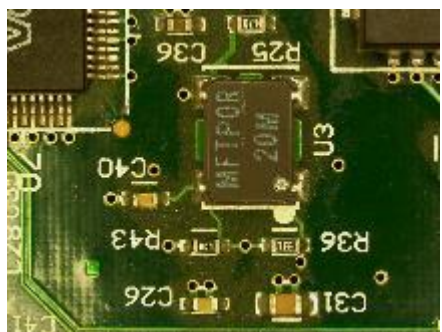


Imaging Modalities for PCB Assurance

Surface Level Imaging

Reflective Surface Imaging

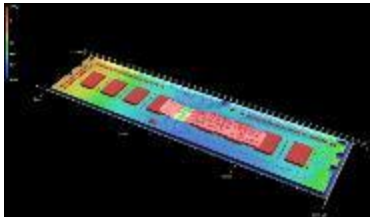
Digital Optical Microscope



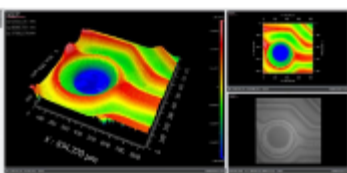
Cameras



Patterned Light



White Light / Laser Interferometry



Thermal Imaging

Penetrative Surface Imaging

Terahertz Imaging

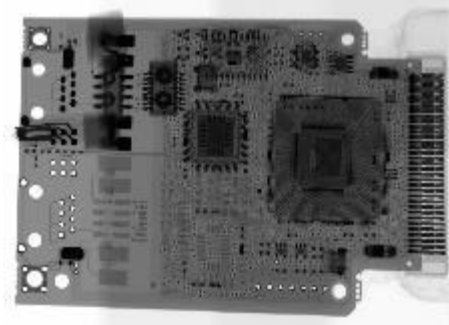


Scanning Acoustic Imaging

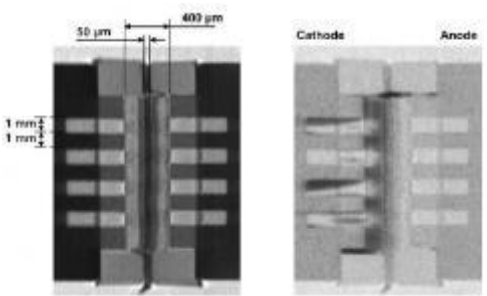


Volumetric Imaging

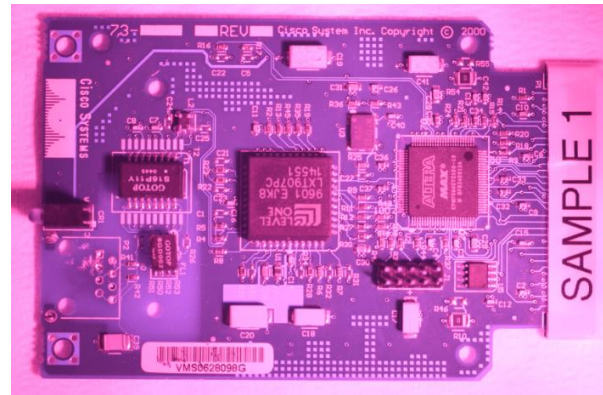
X ray Imaging



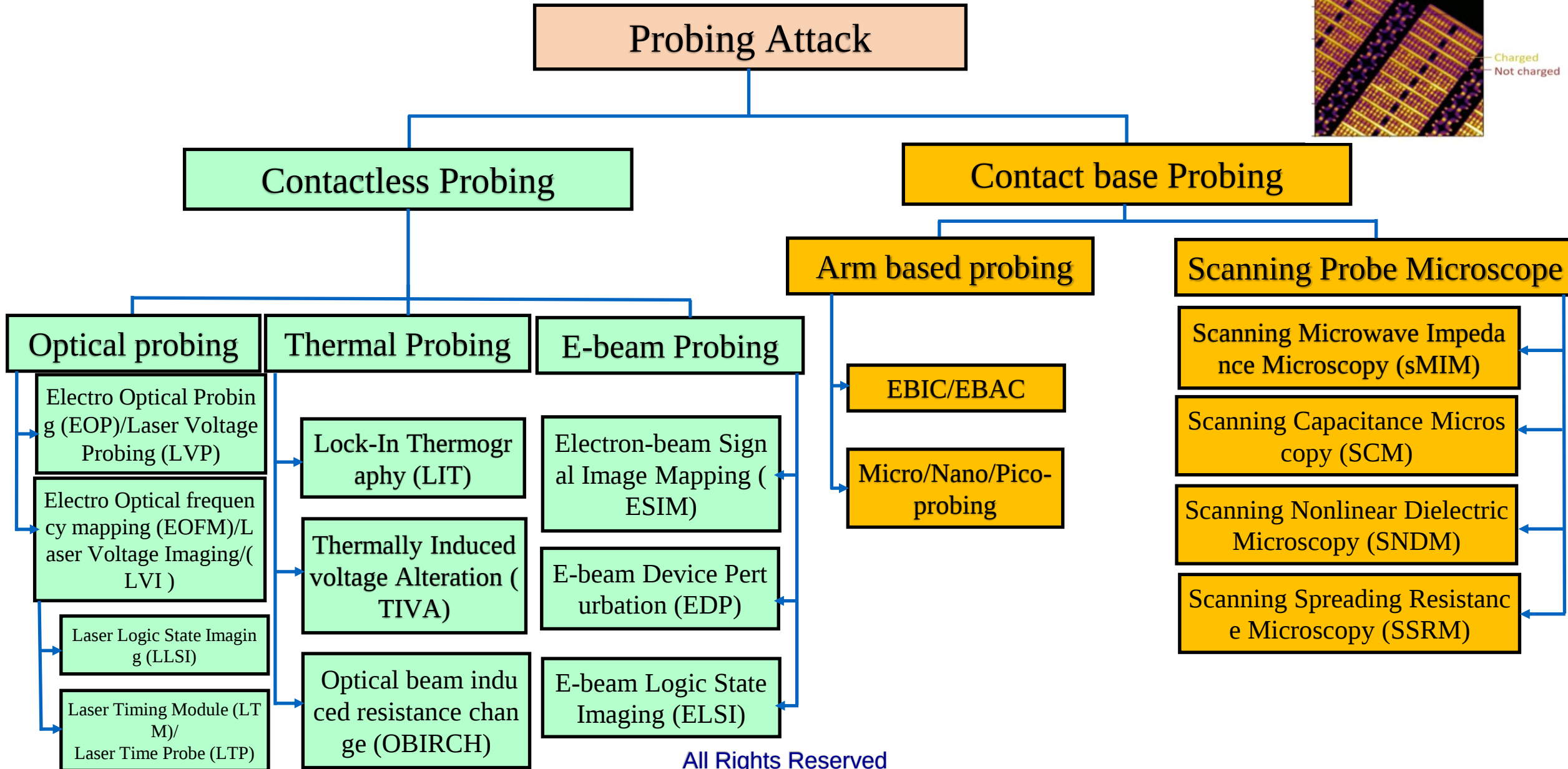
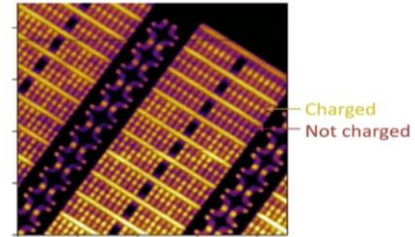
Neutron Imaging



-



Taxonomy of Physical Inspection/Probing



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Thank you!

Questions?
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Global Companies Rate Advantest THE BEST ATE Company 2020



Advantest receives highest ratings from customers in annual VLSIresearch Customer Satisfaction Survey.

Advantest received an overall score of 9.5 out of 10, with highest ratings in categories of:

**Technical Leadership – Partnership –
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Recommended Supplier**

“Year-after-year the company has delivered on its promise of technological excellence and it remains clear that Advantest keeps their customers’ successes central to their strategy. Congratulations on celebrating 32 years of recognition for outstanding customer satisfaction.”

— **Risto Puhakka**, President VLSIresearch

Technical Program Committee (TPC)



Ivor Barber
Advanced Micro Devices



Jeff Demmin
Keysight Technologies



Ira Feldman
Feldman Engineering

Virtual Event Schedule

Join us for two online sessions

Wednesday	April 28, 2021	8:00 - 11:00 am PDT
Thursday	April 29, 2021	8:00 - 11:00 am PDT

Your personal Zoom link is the same for both days.
Zoom will send you a reminder before the start of each session.

Speakers April 28



[Saverio Fazzari](#)

Booz Allen Hamilton

**Supply Chain Challenges
for Defense Systems**



[Sridhar Swamy](#) & [Akash Malhotra](#)

Advanced Micro Devices

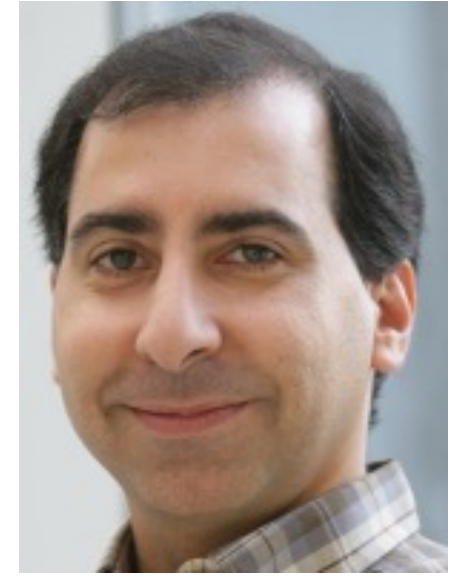
Securing Supply Chain



[Nader Sehatbakhsh](#)

University of California
Los Angeles (UCLA)

**Hardware and
Supply Chain Security
in the era of Advanced
Heterogenous Integration**



[Michael Azarian](#)

University of Maryland

**Hardware Trojans and
Counterfeit
Microelectronics:
Detection and Diagnosis**

Speakers April 29



[Matthew Arenio](#)

Intel

**Identifying Supply Chain Threats –
An Honest Assessment**



[Ajay Sattu](#)

Amkor Technology, Inc.

**Automotive Semiconductor Unit Level
Traceability**



[Navid Asadi](#)

University of Florida

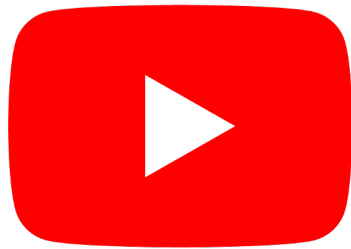
**Physical Assurance and Inspection of
Electronics**

Reminders

Slides & Videos will be posted next week

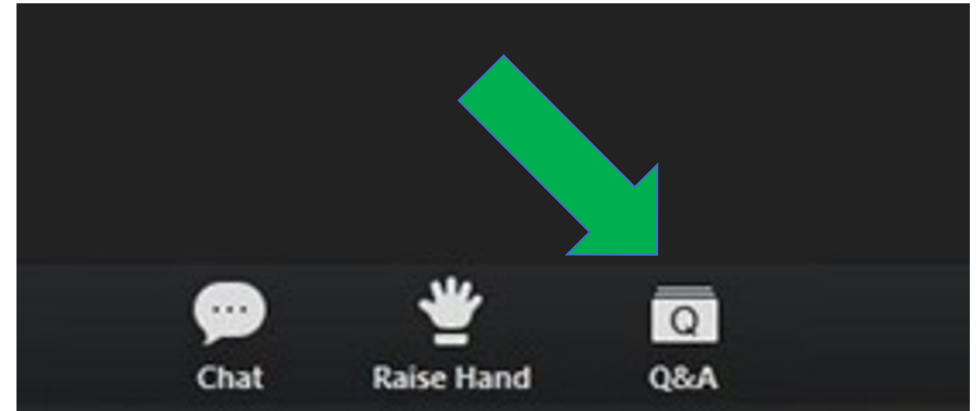


[http://events.meptec.org/
supply-chain-security-
2021 /](http://events.meptec.org/supply-chain-security-2021/)



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Please use the Q&A window for your questions



Speakers April 29



[Matthew Arenó](#)

Intel

**Identifying Supply Chain Threats –
An Honest Assessment**



[Ajay Sattu](#)

Amkor Technology, Inc.

**Automotive Semiconductor Unit Level
Traceability**



[Navid Asadi](#)

University of Florida

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Quality

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Execution
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