Canada's National Design Network (CNDN) and Tapping into Nanolabs

2nd Annual Meeting of the NNCI

Philadelphia, PA

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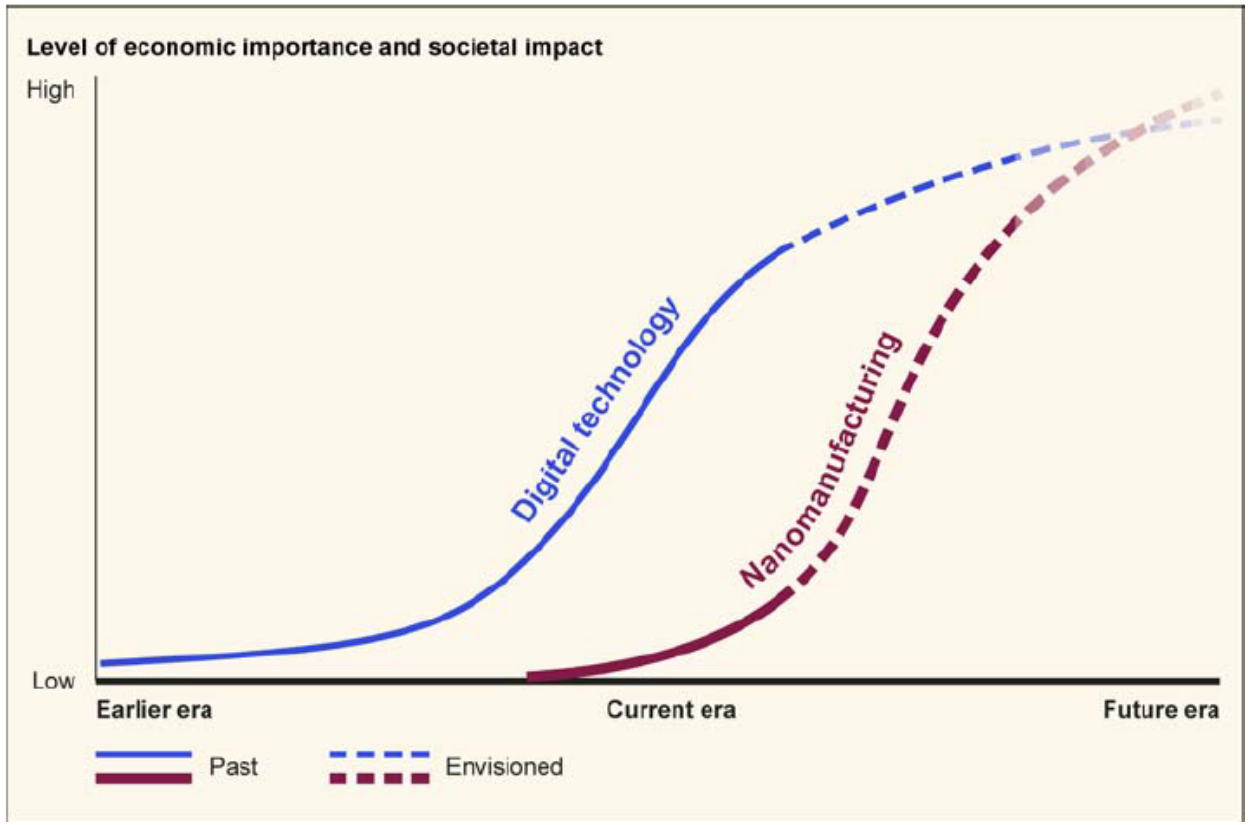
Client Technology Advisor for Microsystems and Nanotechnology

Nanomanufacturing: It's gonna be big!

Figure 3: Conceptualization of Nanomanufacturing and Digital Technology as Megatrends, Based on Statements of Some Forum Participants



- Basis of a future wave of wealth creation.
  - Will future workforce be ready?
  - What disciplines and skills needed?
  - What is the role of nanofabrication labs?

Nanomanufacturing: Emergence and Implications for U.S. Competitiveness, the Environment, and Human Health; 2013 Forum, Gov Accountability Office, May 2014 (Figure 3)

Presentation topics

- CMC Microsystems and Canada’s National Design Network
  - Technology platform

- Opportunities for nanofabrication labs
  - FACT Network of labs
  - Example service projects and network activities

Canada’s National Design Network (CNDN) and CMC Microsystems

Canada's Nanotechnology Ecosystem at a Glance

National Institute for Nanotechnology

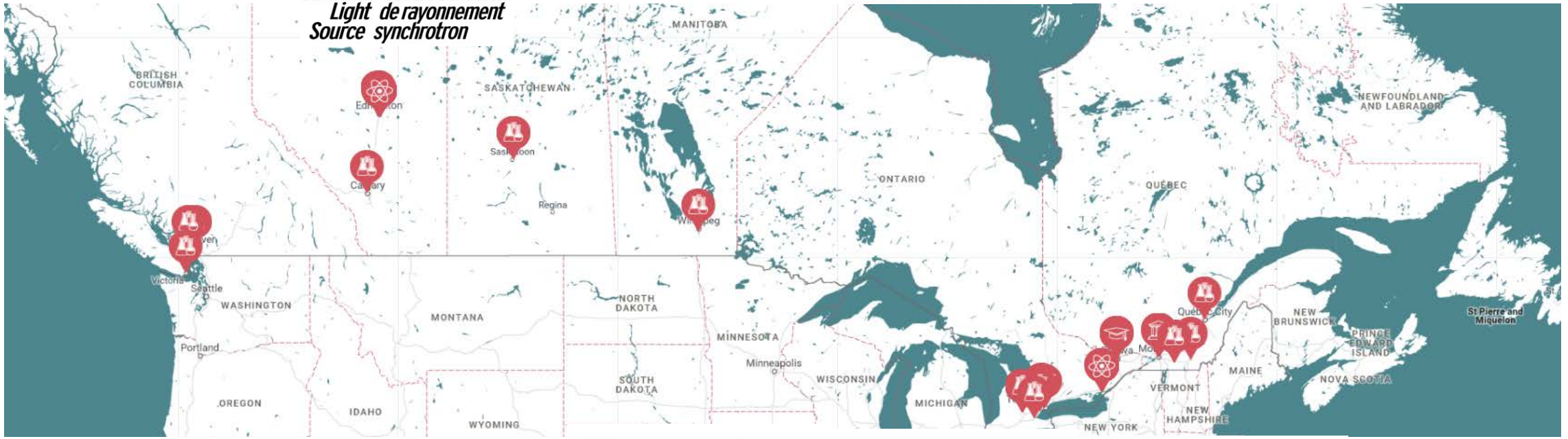
Canadian Centre canadien Light de rayonnement Source synchrotron

NanoCanada

CMC MICROSYSTEMS

INO

C2MI Reinventing innovation



Nanotech BC

acamp ALBERTA CENTRE FOR ADVANCED MNT PRODUCTS

nanoCluster Alberta

nano ontario

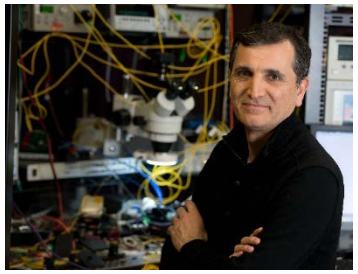
PRIMA PÔLE RECHERCHE INNOVATION MATÉRIAUX AVANCÉS

nanoAtlantic

What is CMC, and what is its role?

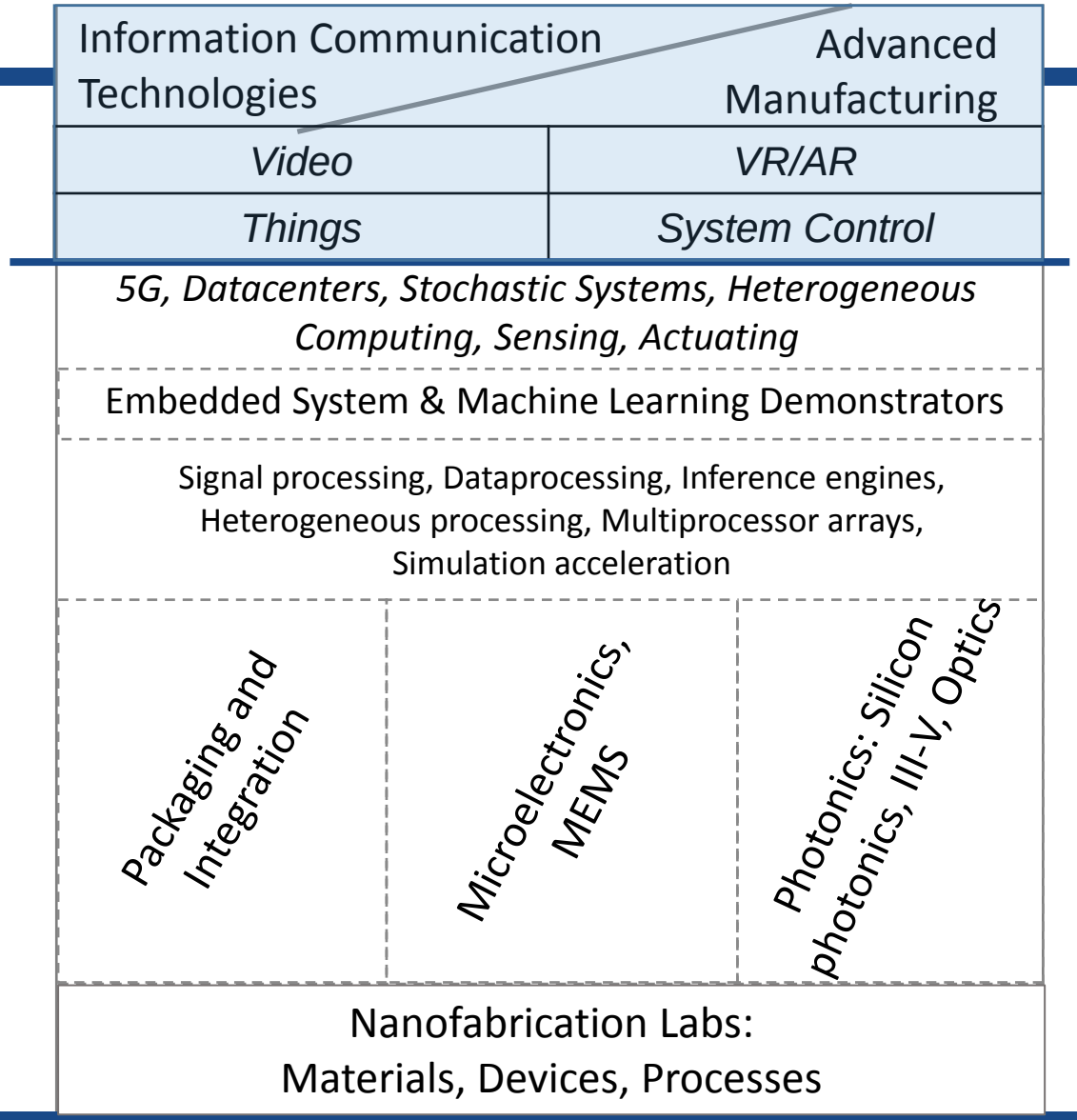
- Not-for-profit corporation, federally incorporated 1984
- Creator and Manager of Canada's National Design Network (CNDN)
- Delivers core micro-nano innovation capability to every region of Canada:

1. Design tools (software)
2. Fabrication and integration services to create working prototypes
3. Characterization and test services
4. Training and support
5. Strategy, roadmapping, network management



Users from industry and academia

Technology Space of CNDN

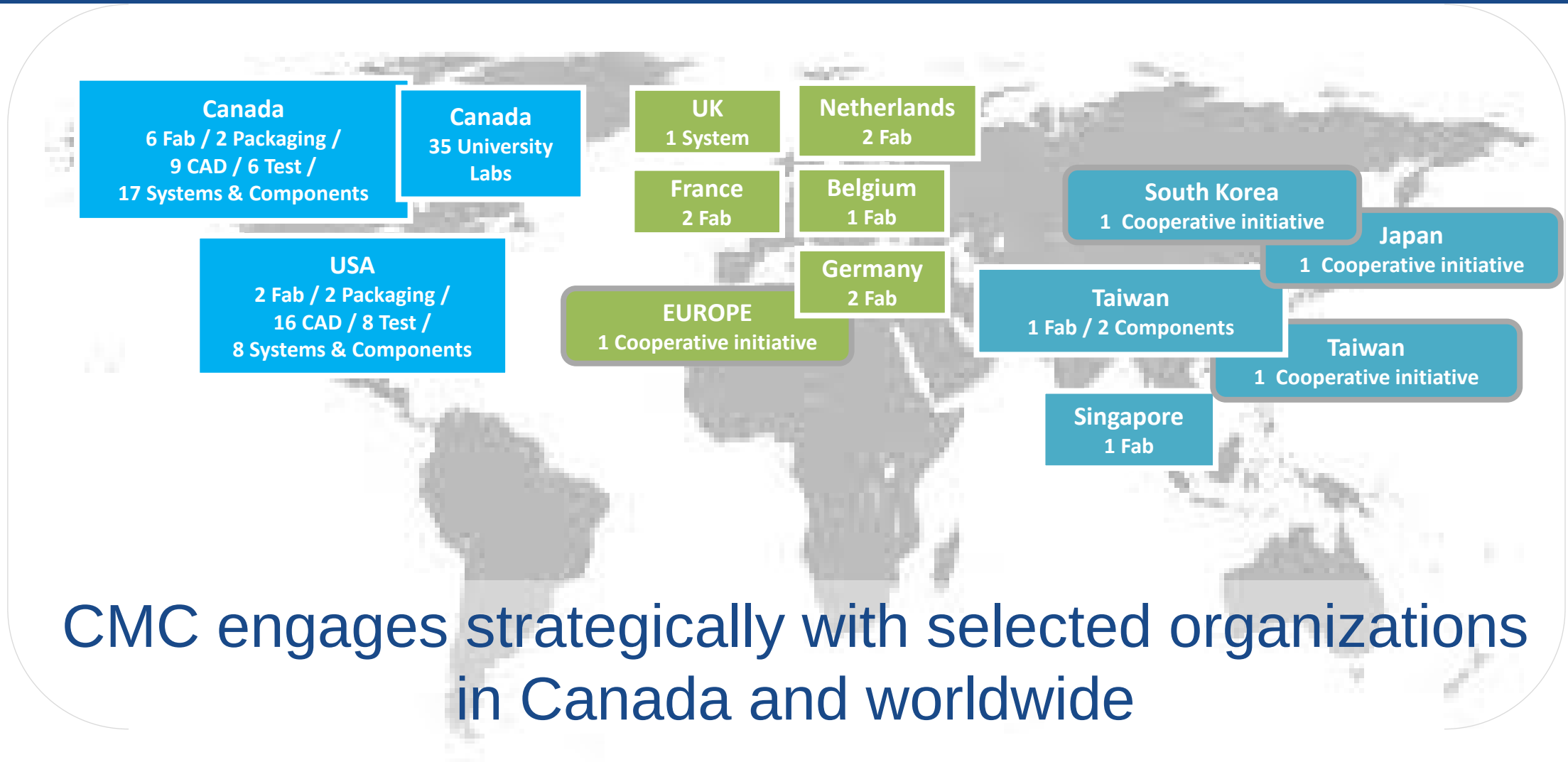


Sectors of relevance

R&D applications

CNDN space for research, technology development and demonstration

CMC sources essential microsystems technology to support research excellence



CMC engages strategically with selected organizations in Canada and worldwide

CAD Tools: Access and Support

- Licenses
  - Cloud distributed
  - Time-shared
- Over 500 CAD tools and modules
- PDK, training, support
- Over 5000 individual users annually

Prototyping: Industrial Foundry Runs

A global supply chain enabling access to advanced microelectronics, photonics, MEMS, microfluidics, and embedded systems technology

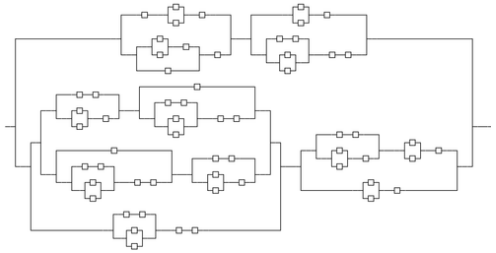
Design Kit or Process
MICROELECTRONICS
Analog/Mixed Signal Design
STM 28nm CMOS FD SOI
STM 28nm CMOS LP
TSMC 65nm CMOS GP
TSMC 65nm CMOS LP
TSMC 90nm CMOS
IBM 0.13µm CMOS
TSMC 0.18µm CMOS
AMS 0.35µm CMOS
TSMC 0.35µm CMOS
Teledyne DALSA 0.8µm CMOS
2.5GHz Bipolar Linear Array
NRC GaN150

Design Kit or Process
PHOTONICS
CMC/CPFC III-V
Mentor Graphics Pyxis
MEMS
Teledyne DALSA MIDIS
Micralyne MicraGEM-Si
Univ. of Waterloo UW-MEMS
MEMSCAP PiezoMUMPs
MEMCAP PolyMUMPs
MEMCAP MetalMUMPs
MEMCAP SOIMUMPs
MICROFLUIDICS
Micronit Sensonit
FlowJEM

For a list of CAD Tools Supported or Required, see http://www.cmc.ca/WhatWeOffer/Design/Kits.aspx

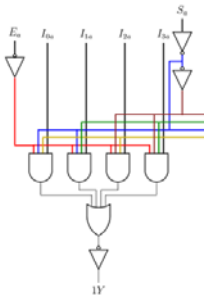
National Design Network platform reduces risk and time to market

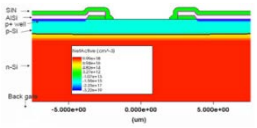
Concept



Canada's National Design Network

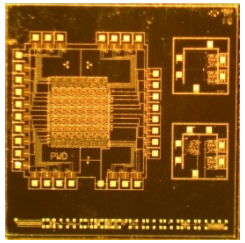
Design, Simulate

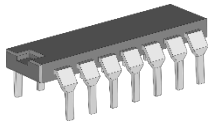




Make, Fabricate, Package

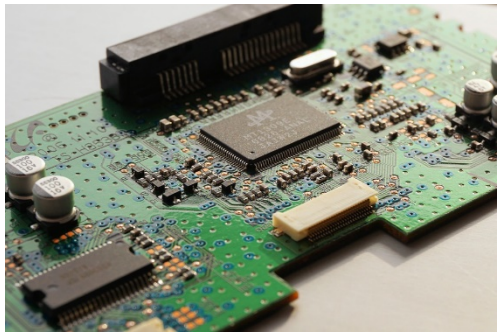
(Incl. nanolabs)





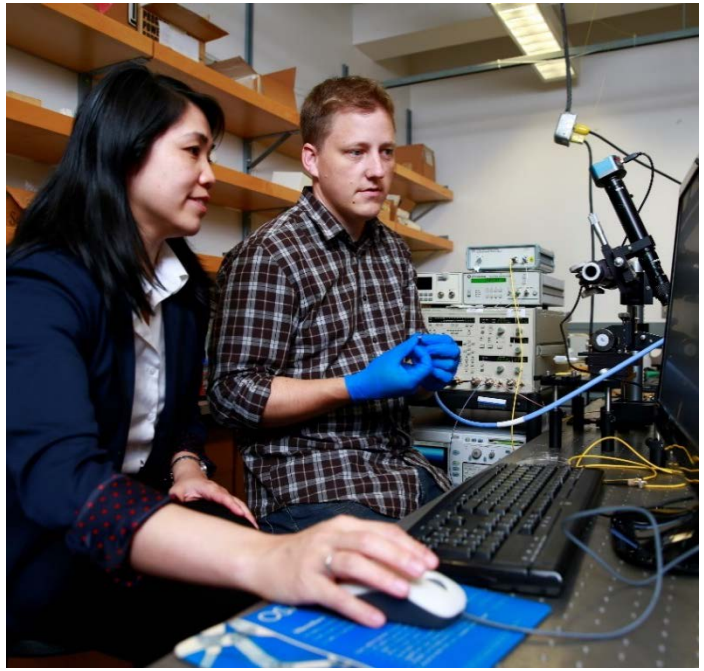
Test, Verify

Prototype



Reduced risk (TRL++) and project timeline

Innovation through collaboration: Dr. Karen Cheung, Jonas Flueckiger



CMC value-adds: Design tools, Fabrication support

- Novel biosensing system combined photonics and microfluidics
  - lacked overall simulation models
- Collaboration with Lumerical
  - custom prototype
  - new simulation models and improvements to the software tool
- Models now shared with other researchers
- 3 papers so far; spinoff potential

Capturing Opportunities for Nanolabs: Remote work and network technology development

FACT Services: Take your idea from a sketch to a successful prototype

Dedicated R&D projects

R&D clients

Collaboration, consultation

CMC MICROSYSTEMS

FACT Network of Labs

- Quality protocols
- design environment

Quality service

THE nanoFAB UNIVERSITY OF ALBERTA
Fabrication | Characterization | Expertise

GCM

4D LABS

INSTITUT INTERDISCIPLINAIRE D'INNOVATION TECHNOLOGIQUE (3IT)

TNFC

... more labs expected

Pre-production partners

Mfg. partners

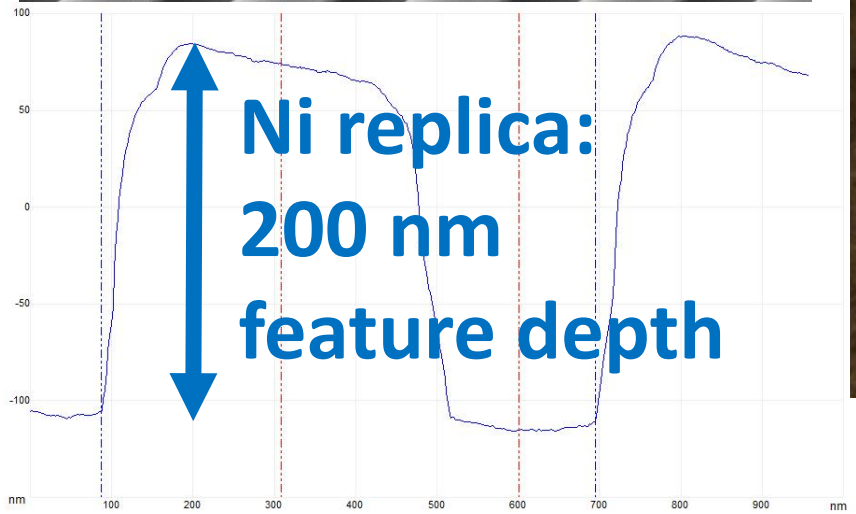
Low-volume production with a path to manufacturing

- Custom fab expertise
- Lab for process development
- Low-volume production
- A path to manufacturing

www.cmc.ca/FACT

Example Service Engagement: Hot Embossing Molds for Optical Grating Coupler

- Client request: embossing mold for optical grating couplers in polymer.
- CMC: identifies service labs for e-beam, etch, mold replica, embossing; manages project and billing; prepares layout.
- Labs deliver: Feasibility test, fabrication of Si master mold and Ni replica, test imprinting in PMMA.
- Client progressing to low-volume delivery.



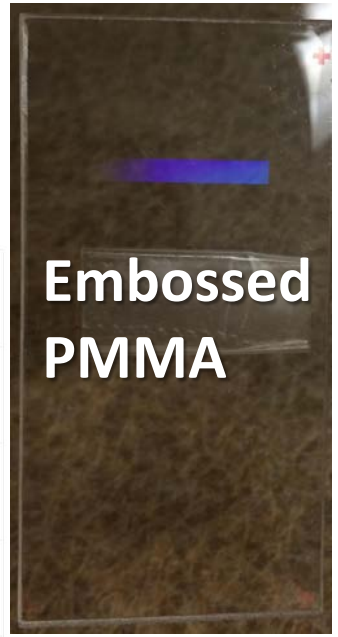
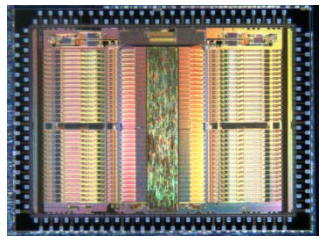


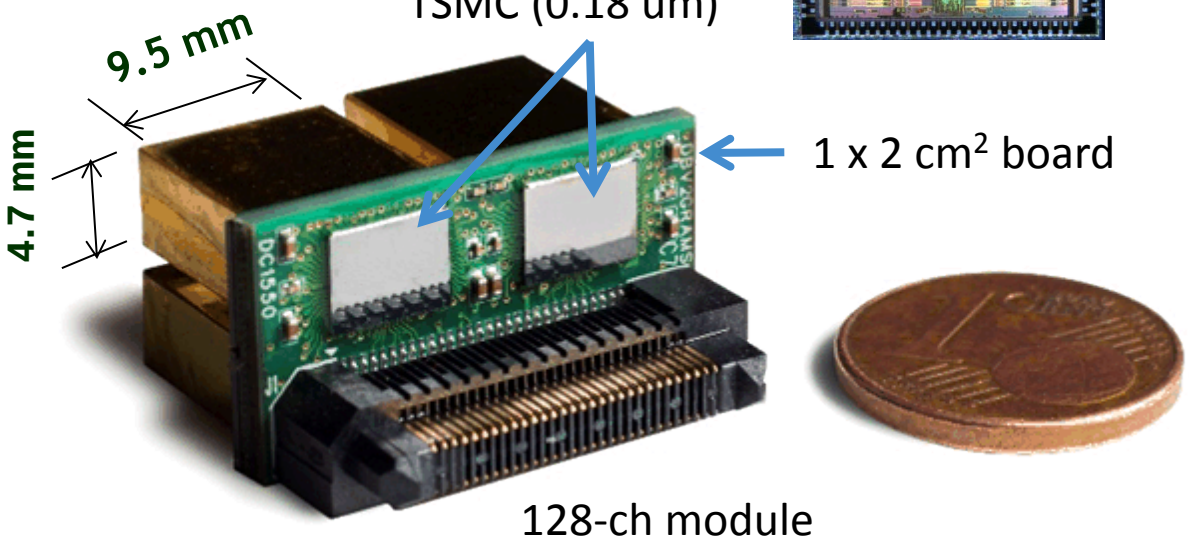
Image courtesy S. Mittler

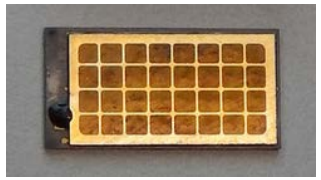
Example Service Engagement: Flip-chip Assembly for a PET Detector

INSTITUT INTERDISCIPLINAIRE D'INNOVATION TECHNOLOGIQUE (3IT)



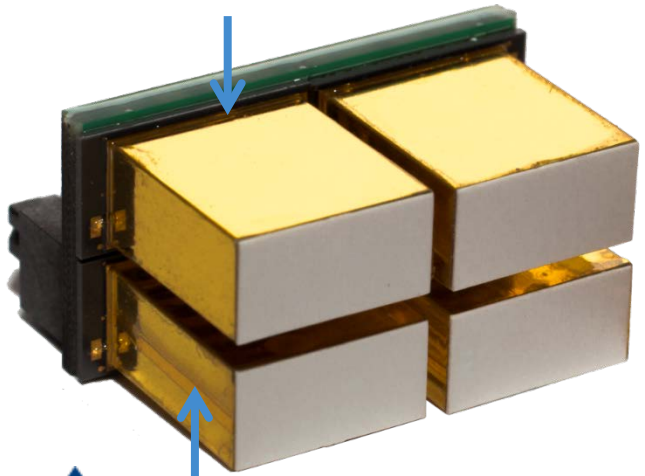
ASICs
TSMC (0.18 um)





EXCELITAS TECHNOLOGIES®

4 x 32 APD array



AGILE TECHNOLOGIES

4 x 32
LYSO scintillator array

Images courtesy R. Fontaine, GRAMS Research Group, Université de Sherbrooke

Collaborative projects with nanolabs for technology development

Desktop Nanofabrication Process Design for Virtual Prototyping

Lab engineers

R&D lab users

Nanofabrication process design environment

Database and GUI

Process Steps

(Machine name, material type, run parameters, rules)

Process Flows

(Maskset, sequence of steps with rule check)

XperiDesk

Custom Process Design Kit (PDK)

TCAD Tools, Methodologies

Process Verification

Is process feasible in the lab?

Virtual Prototyping

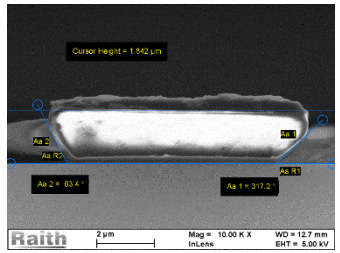
Will the result meet specification?

softMEMS

SYNOPSYS

COVENTOR

Searchable database of materials, process flows by facility, machine-specific parameters



Seamless integration with multiple technology computer-aided design (TCAD) suites

Process Optimization

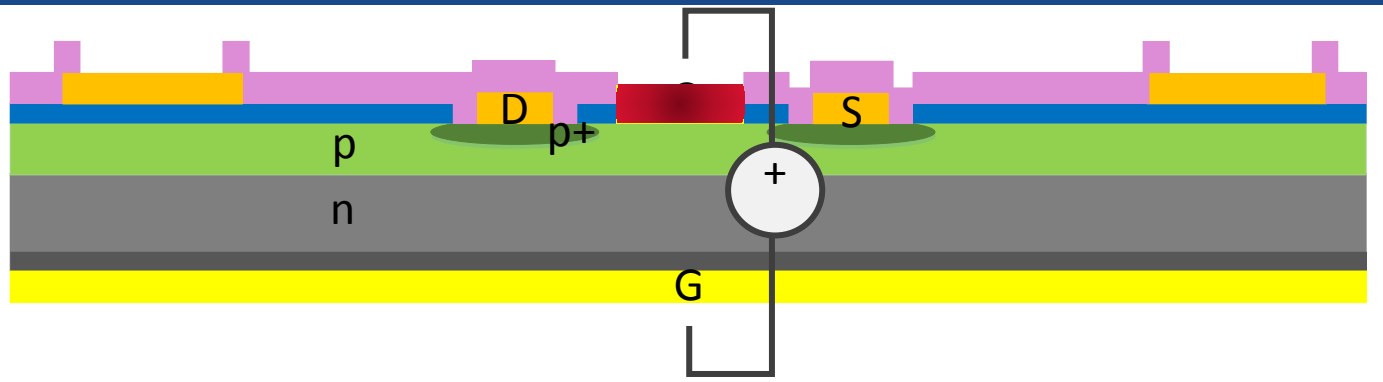
Process control, integration

Characterization and Test

Platform: Silicon JFET Transistors for Integration of Soft Materials

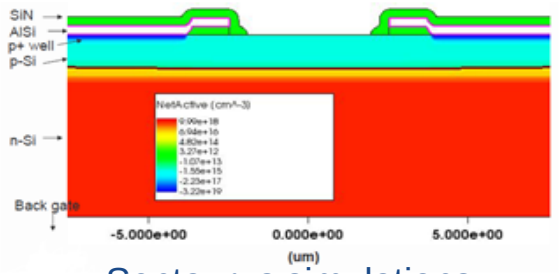
Junction field effect transistors with an open upper gate

- for integration of functional materials
- platform for the development of hybrid material systems in silicon and CMOS-compatible detectors.

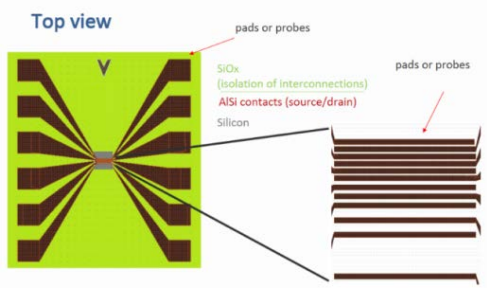


Services

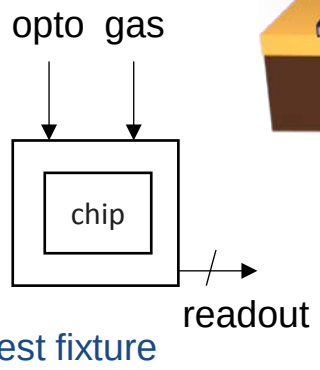
- Process design kit, Reference design of IR light detector using quantum dots
- Engineering support for OGSi-JFET design
- Microfabrication of OGSi-JFET ready for spin-on post-processing



Sentaurus simulations

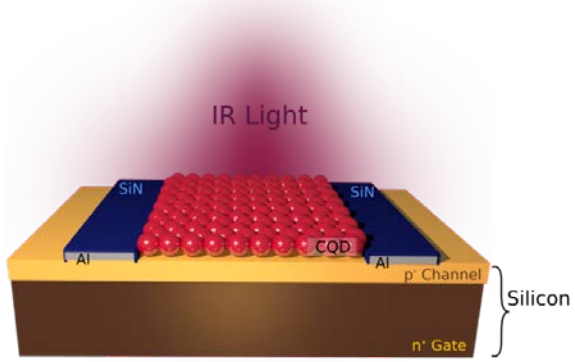


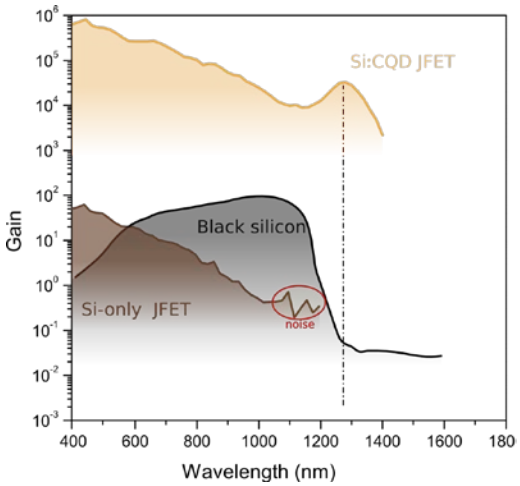
Layout design



Test fixture

Example application: quantum dot IR photodetector

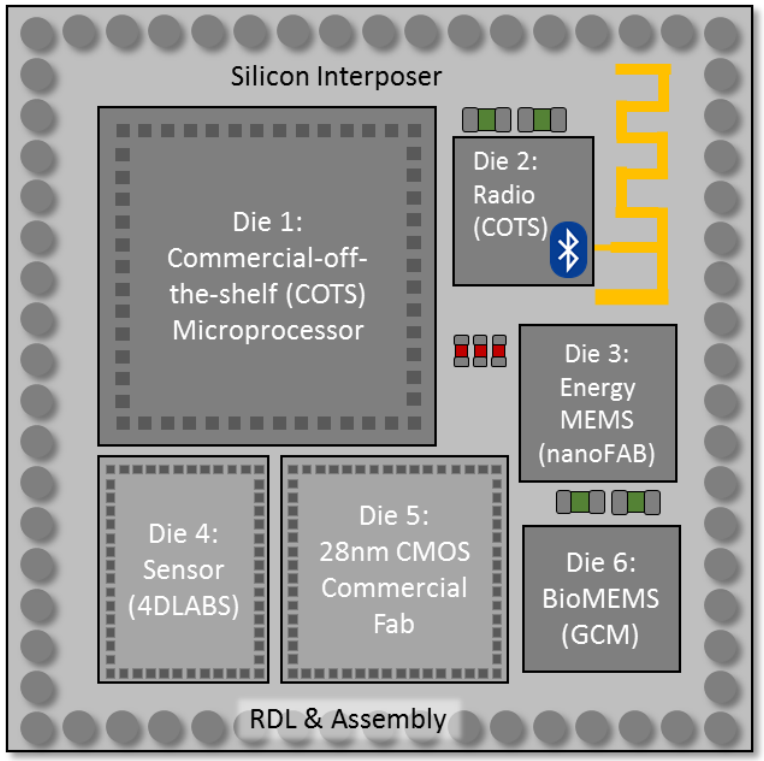


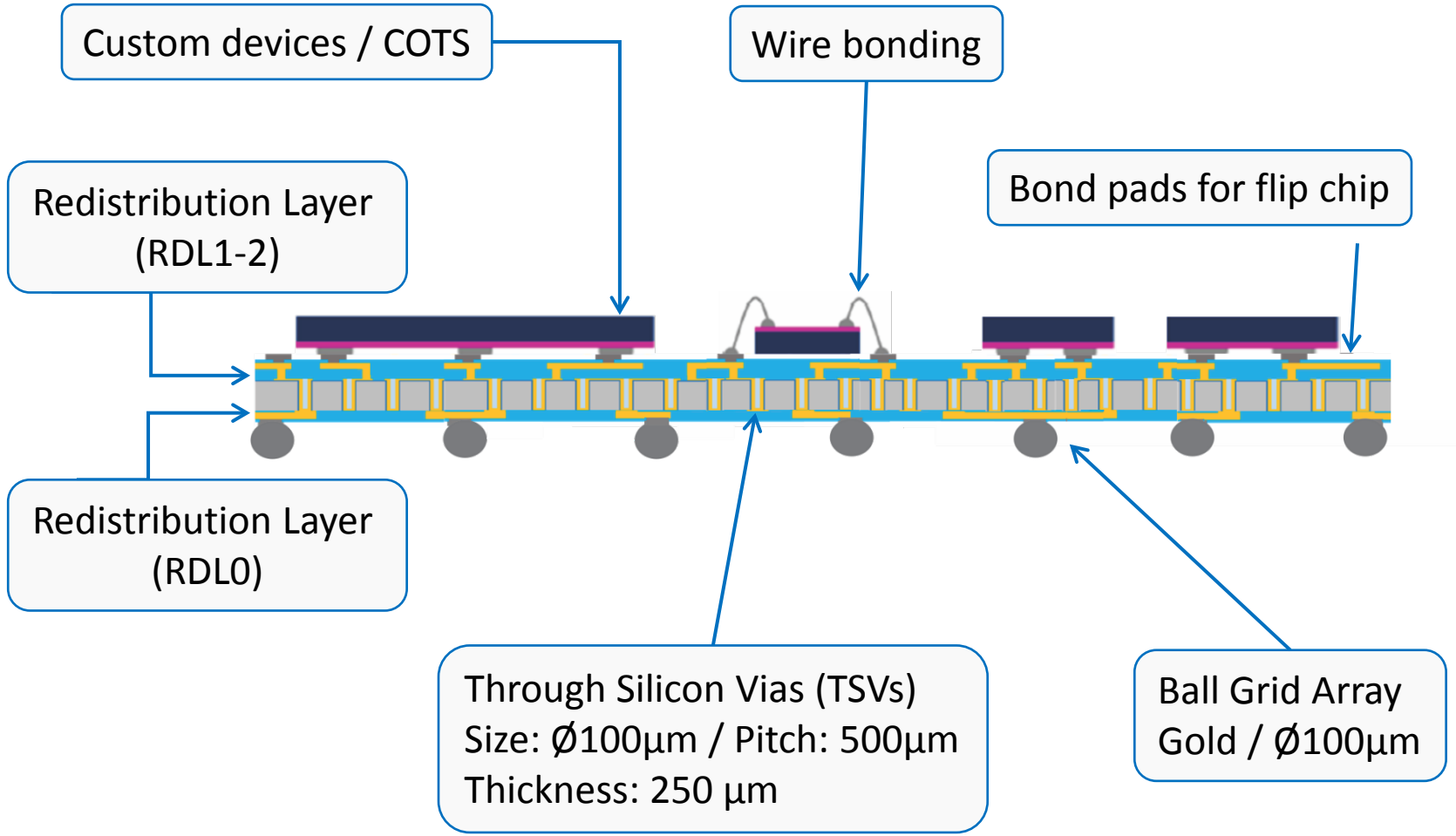


Adinolfi et al. Nature, 2016

Platform: Silicon Interposer for Multi-technology Integration

Concept





Lab2Fab Workshop

Integration for Innovation

September 27-28, 2017
Montréal and Bromont, Québec

Lab2Fab Nanofabrication Workshop

Convenes strategic leaders to guide key decisions in the development of manufacturing of microsystems and nanotechnology innovations.

- University-based and government fabrication and characterization centres
- Manufacturers and supply chain
- Technology developers
- Company builders
- Stakeholders in collaborative innovation

www.Lab2Fab.ca

Summary of Goals and Opportunities for Cross-border Collaborations

- Nanofabs can be an essential part of workforce training for nanomanufacturing era.
- Nanofabs can play a part in commercialization. Can they be a working part of a larger technology supply chain?
- FACT Network emphasizes technical operations, service readiness, paths to technology scale-up.
- Opportunities for cross-border exchanges: best practices, transfer of recipes, access to platform technologies?