

The National Science Foundation
Industry University Cooperative Research Center
Webinar Program

**The Center for Advanced Design and Manufacturing of
Integrated Microfluidics (CADMIM)**

IOWA STATE
UNIVERSITY



Strengthening
University-Industry
Partnerships

We will begin momentarily.

Webinar Logistics

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Strengthening
University-Industry
Partnerships



Center for Advanced Design & Manufacturing of Integrated Microfluidics (CADMIM)



Dr. Gisela Lin

CADMIM Deputy Director
University of California, Irvine

Center for Advanced Design and Manufacturing of Integrated Microfluidics



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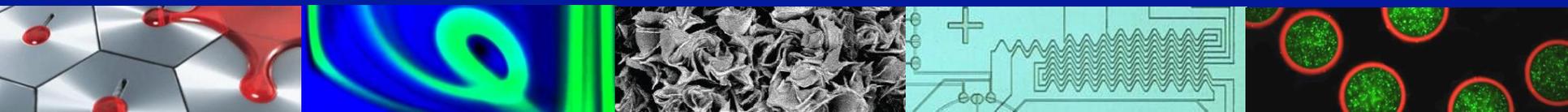
Center Deputy Director
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UCI

University of
California, Irvine



UNIVERSITY OF ILLINOIS
AT CHICAGO

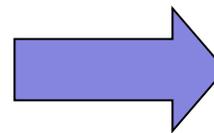




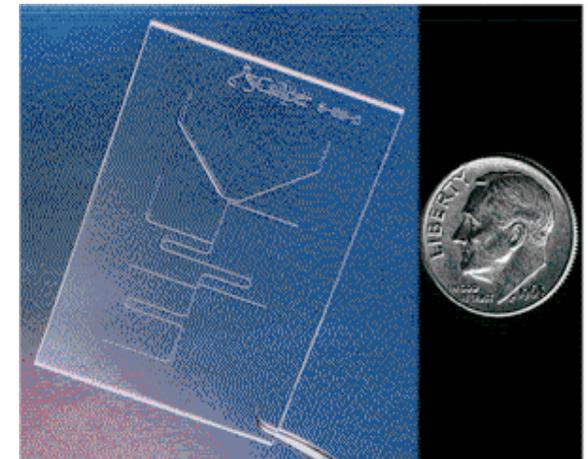
What is microfluidic technology?

■ Also known as “Lab-on-a-Chip” technology

- What? Manipulate small volumes of fluid samples on a single “chip.”
- Why? Faster, cheaper, distributed
- How?
- So what? molecular analysis, drug screening, diagnostics, biosensing, drug delivery, single cell analysis, wearable sensors...



Disposable Lab-on-a-Chip





The Leadership Team



**University of
California, Irvine**



Dr. Abraham Lee
CADMIM Director
Professor, Biomedical Eng.
UC Irvine Site Leader



**University of
Illinois at Chicago**



Dr. Ian Papautsky
CADMIM Co-Director
Professor, Bioengineering
UI Chicago Site Leader



Dr. Gisela Lin
CADMIM Deputy Director



Dr. Drew Rivers
Chronicle Research LLC
NSF Assessment
Coordinator



Industrial Members

- ALine, Inc.
- Amgen, Inc.
- Beckman Coulter
- Corning, Inc.
- Corteva Agrisciences
- ESI Group
- Genentech, Inc.
- Genomics Institute of the Novartis Research Foundation (GNF)
- GlaxoSmithKline (GSK)
- KWS SAAT SE
- Los Alamos National Lab
- VTT Technical Research Center of Finland, Ltd.





Bridging the Academia-Industry Gap

INNOVATION ← ----- → **PRODUCT**

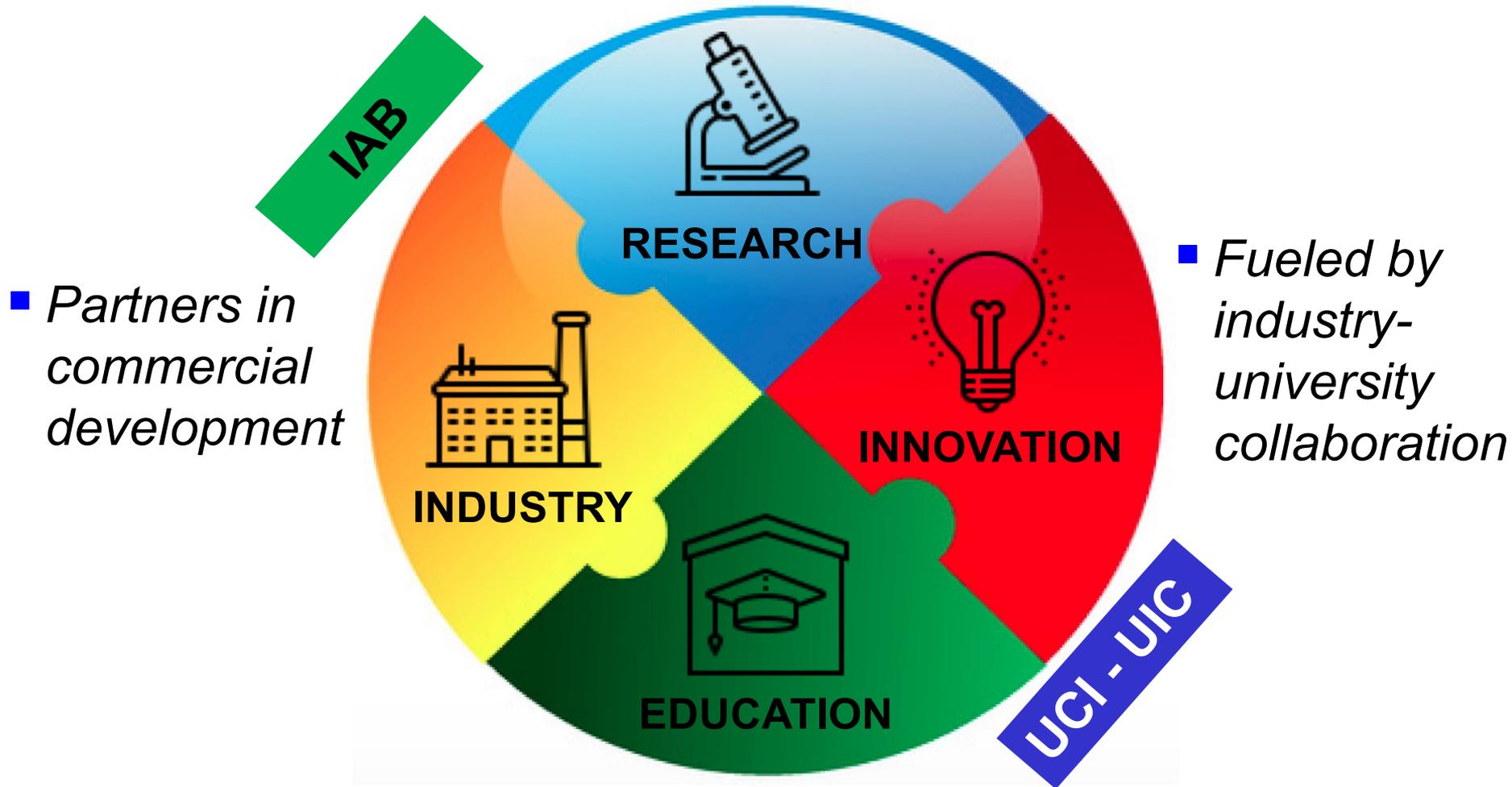


MISSION: Develop microfluidic tools and technologies aimed at simpler, faster, and cheaper analytical solutions addressing human health, agriculture, and the environment.



CADMIM Innovation Ecosystem

- *Pre-competitive, industrially relevant research*



- *Talented students, post-docs = quality hires*



CADMIM Fast Facts

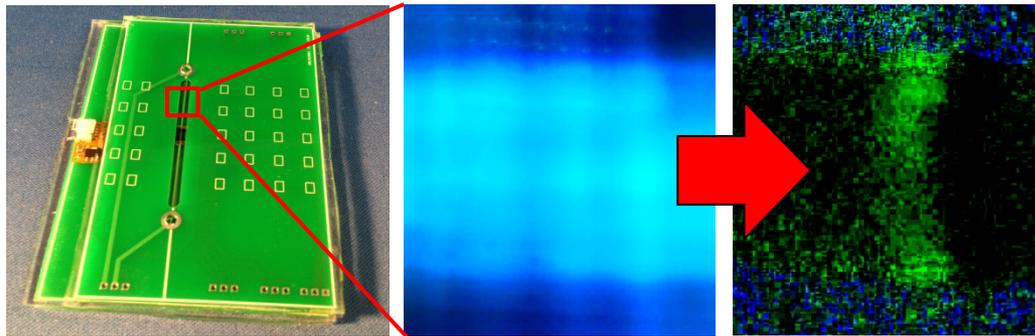
- **Initiated March 2014 (now into our 5th year)**
- **Submitted Phase 2 application June 2018**
- **Currently funding 9 projects, 17 projects concluded**
- **Since center inception:**
 - 30 journal publications, 13 conference publications
 - 14 invention disclosures, 6 provisional patents, 4 non-provisional patents
- **Student education and training:**
 - 14 post-docs, 42 PhD students, 9 master's students
 - 6 undergrads funded by NSF supplement (but many others unpaid)
 - 5 graduate student interns at IAB member companies (within the last 2 years!)

www.inrf.uci.edu/cadmim



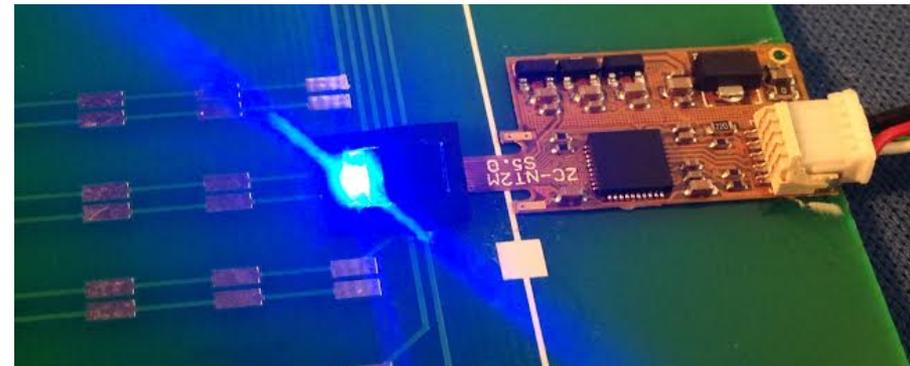
CADMIM Faculty Engagement

- 26 faculty actively engaged
- We bring in non-site faculty to solve IAB challenges
→ **Leverage larger lab-on-a-chip network!**
- **Case study: UCI/Stanford collaboration** → integrated microfluidic printed circuit boards for multiplexed DNA/RNA sequence detection from untreated, raw sample.



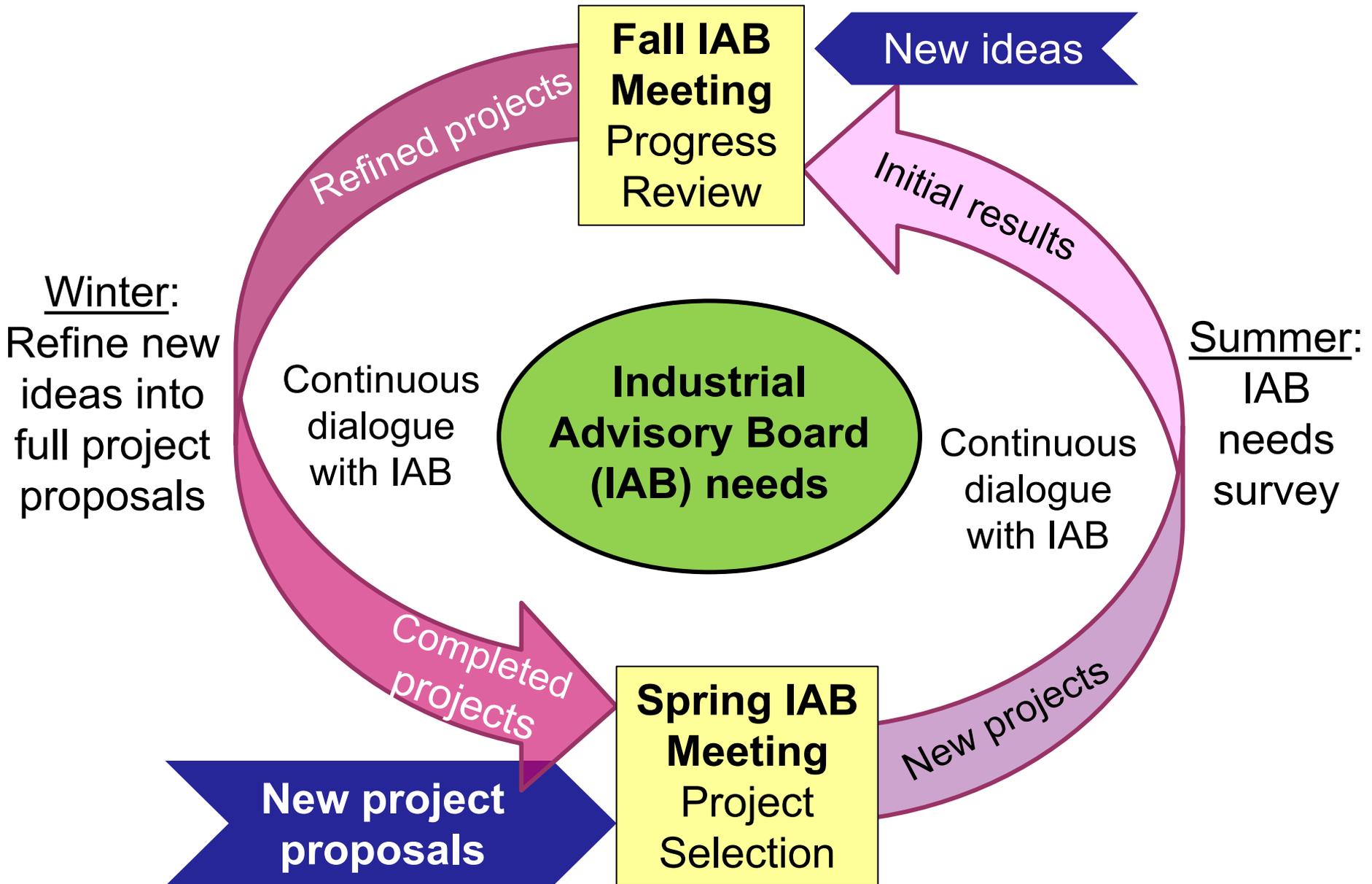
IAB challenges in sample preparation addressed via new method of molecular purification in a low-cost format (PCB).

Technology contributed to 2 start-ups:





Research Project Cultivation Process





Center for Advanced Design & Manufacturing of Integrated Microfluidics (CADMIM)



Dr. Abraham Lee

CADMIM Director

Professor, Biomedical Eng.

UC Irvine Site Leader



Dr. Ian Papautsky

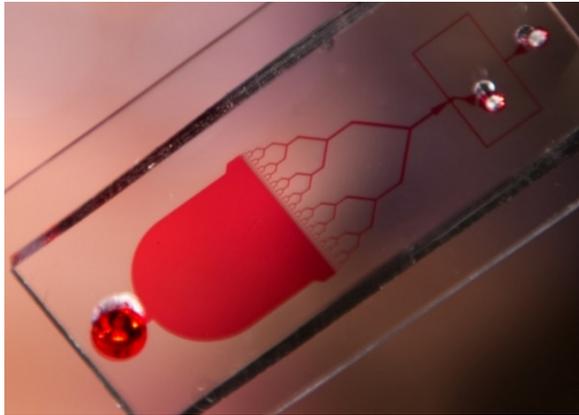
CADMIM Co-Director

Professor, Bioengineering

UI Chicago Site Leader

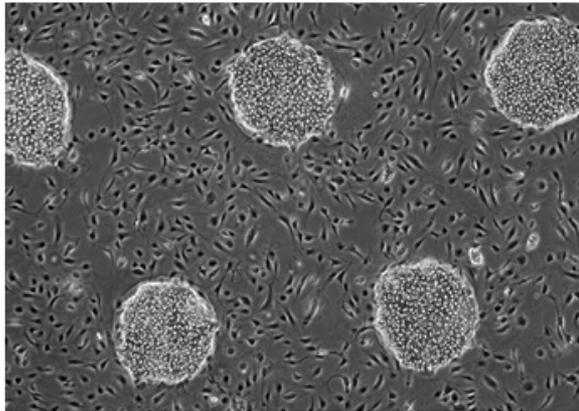


CADMIM Core Competencies



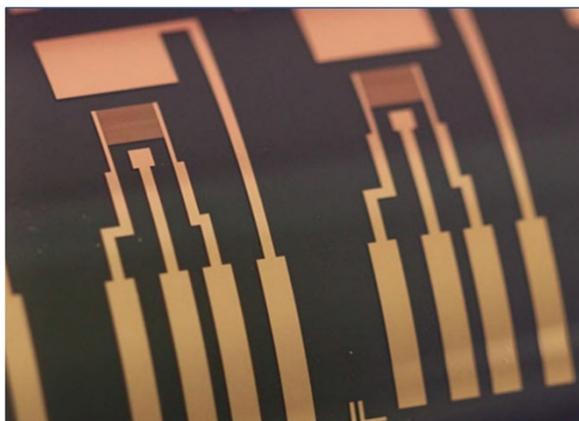
Fundamental Research

sensing (chemical, biological, physical)
actuation (pumps, valves, mixing)
sample processing (biofluids, plants, water)
surface science
detection, imaging and sensing



Microfluidic Specialties

droplet fluidics
inertial microfluidics,
autonomous fluidic circuits
multiphysics modeling

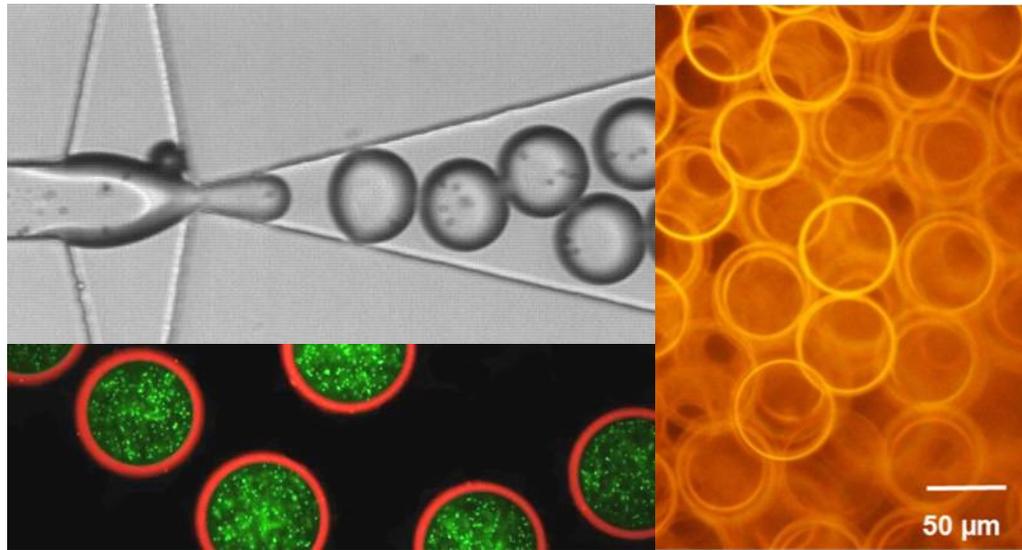


Application Portfolio

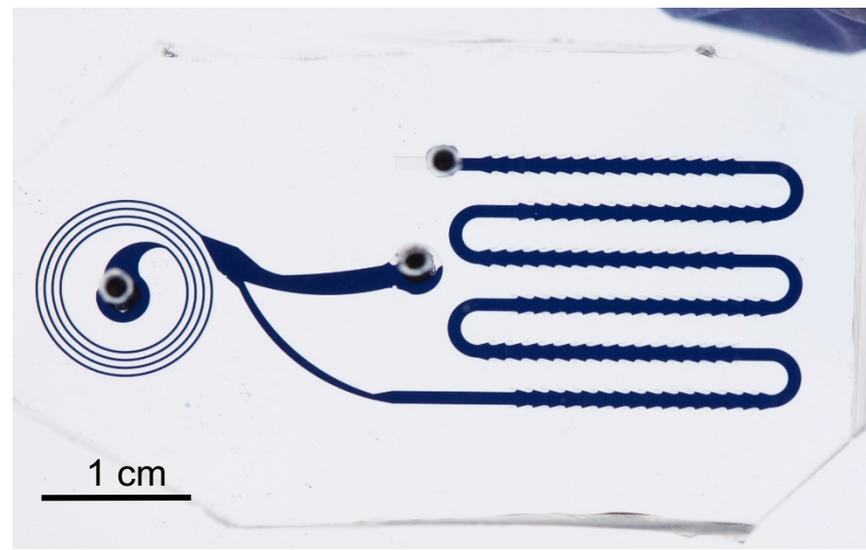
liquid biopsy, blood bioassays
single cell analysis
tissue dissociation
organ-on-a-chip
wearable sensors (sweat, stress, heart)
drug molecular interaction screening,
electrochemical environmental sensing



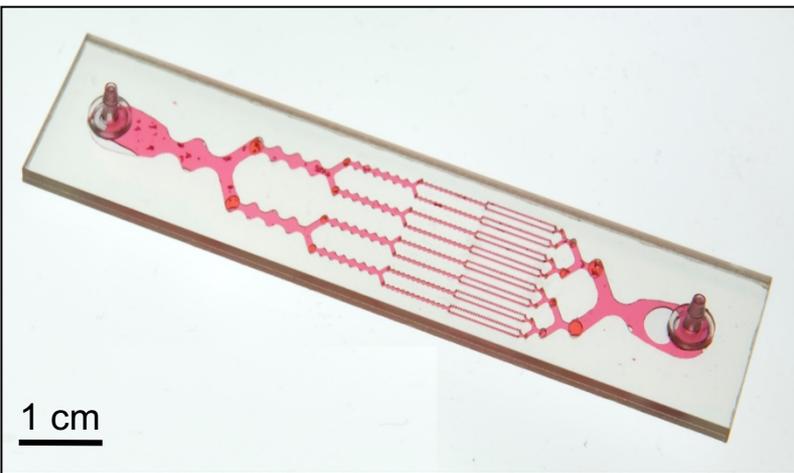
Technology Collage (1)



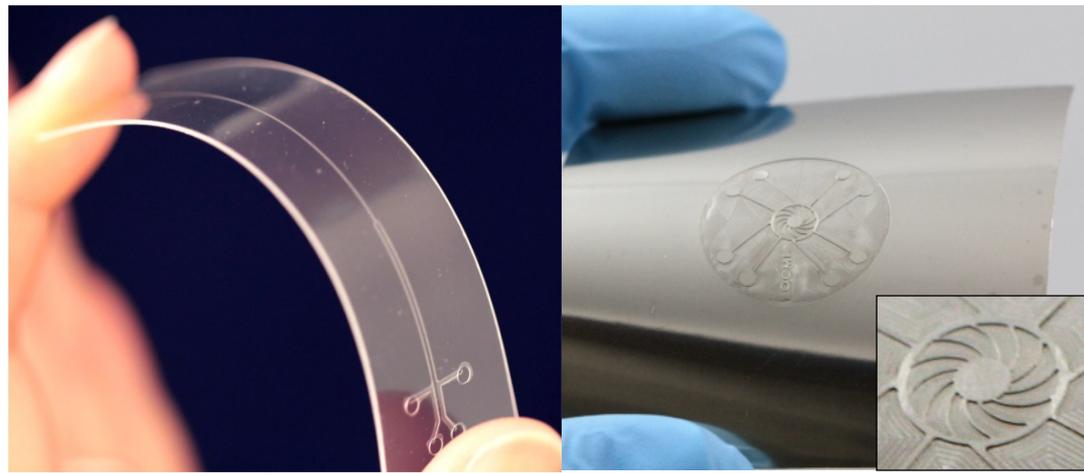
Droplet-based labs-on-a-chip



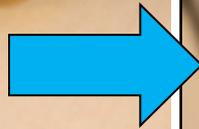
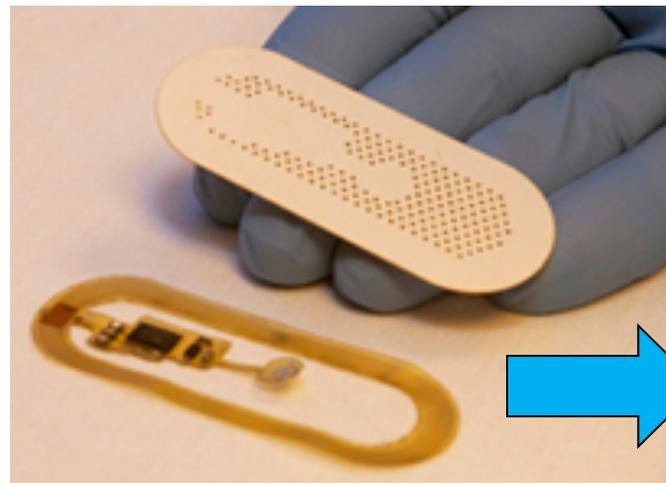
Integrated cell sorting & enrichment



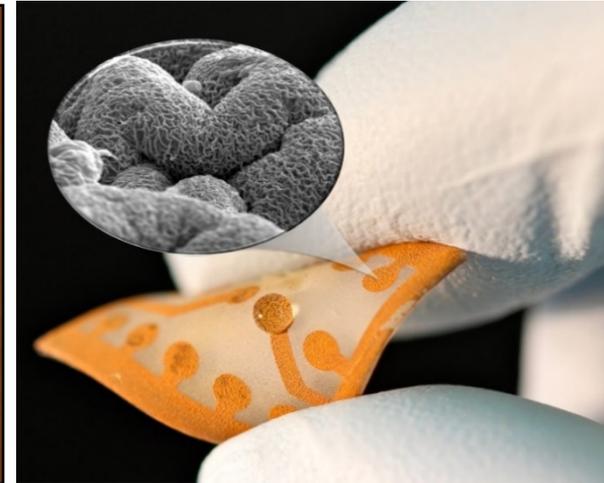
Laminated plastic microfluidics for preparation of tissues & cells



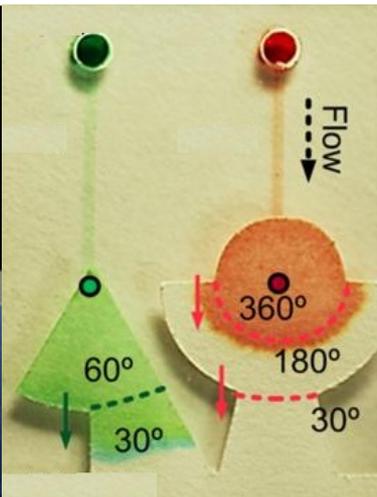
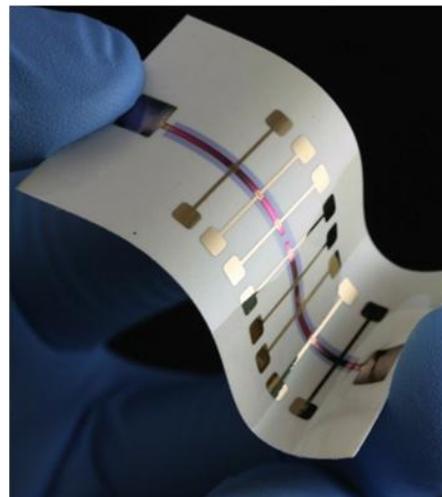
Automated roll-to-roll processes – flexible molds & commercial plastic replicas



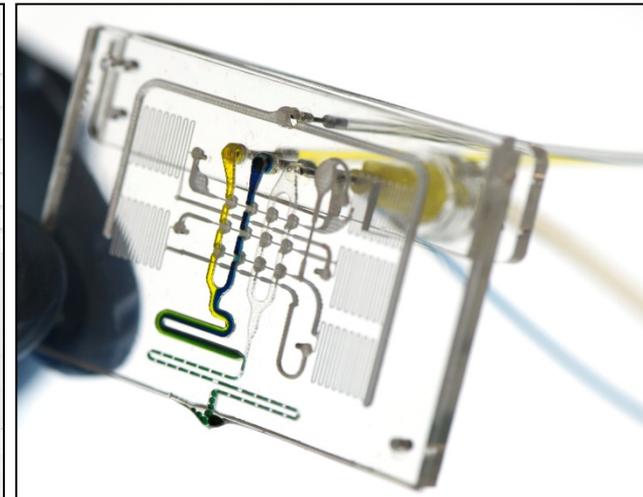
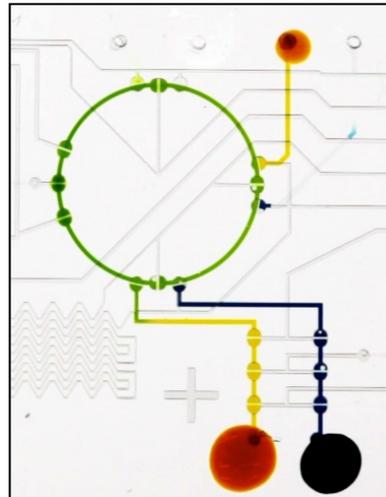
Wearable Sensors (sweat analysis)



Flexible, shrink-induced high-surface area electrodes



Paper-based diagnostics, fluid handling & electronics

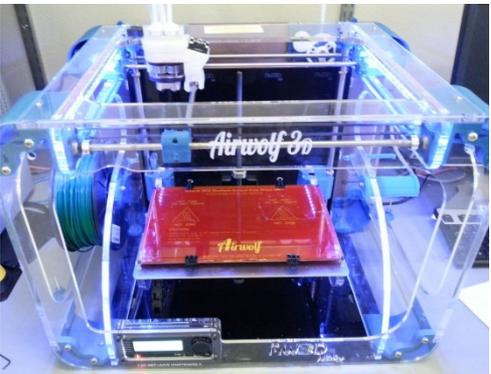
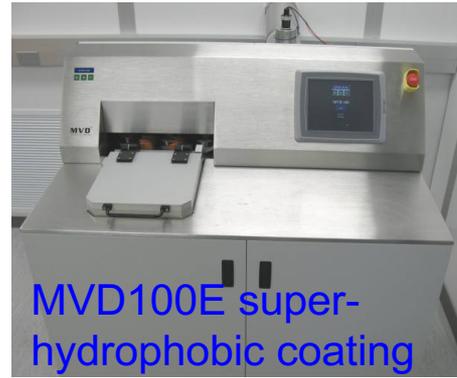


Automated, self-driving microfluidic platforms



Facilities – U. California, Irvine (UCI)

- **Integrated Nanosystems Research Facility (INRF):** state-of-the-art 8,600 sq. ft. multidisciplinary clean room space with class 100/1000/10000 areas.
- **Bio-Organic Nanofabrication facility (BiON):** 4,000 sq. ft. , class 1000 R&D cleanroom dedicated to micro-nano devices using biological and organic materials.
- **FABWorks & RapidTech:** Advanced manufacturing labs with 3D printing, milling, laser cutting, electronics development, sintering, stereolithography, bioprinting.



3D printing



Laser Micromachining



CNC milling

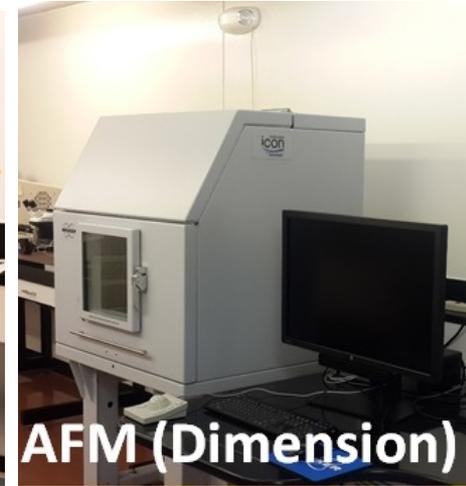
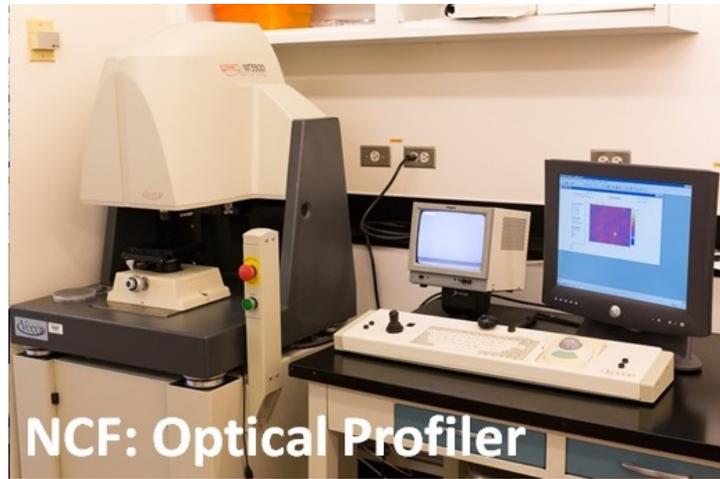
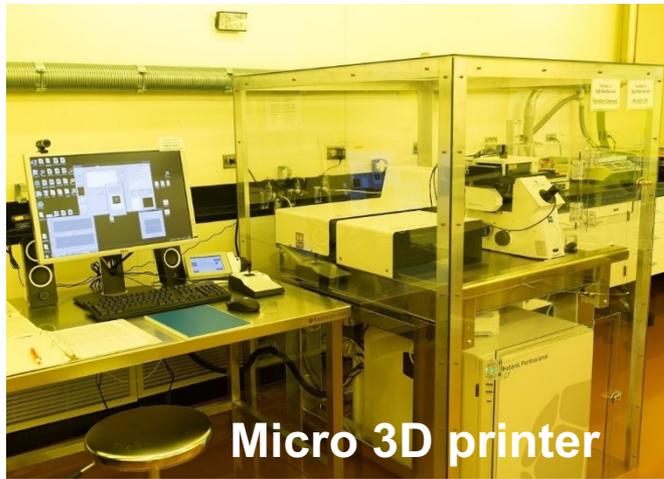


Hot embossing



Facilities – U. Illinois at Chicago (UIC)

- **Nanotechnology Core Facility (NCF):** state-of-the-art 4,000 sq. ft. multidisciplinary clean room and laboratory space with MEMS & microfluidic processing equipment, including a Nanoscribe micro 3D printer (100nm resolution)
- **Rapid Prototyping at the UIC Innovation Center:** 1,102 sq. ft. prototyping lab with 3D printing, CNC milling, laser cutting, electronics development, etc.



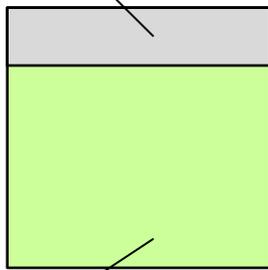


Membership fees leveraged 33:1

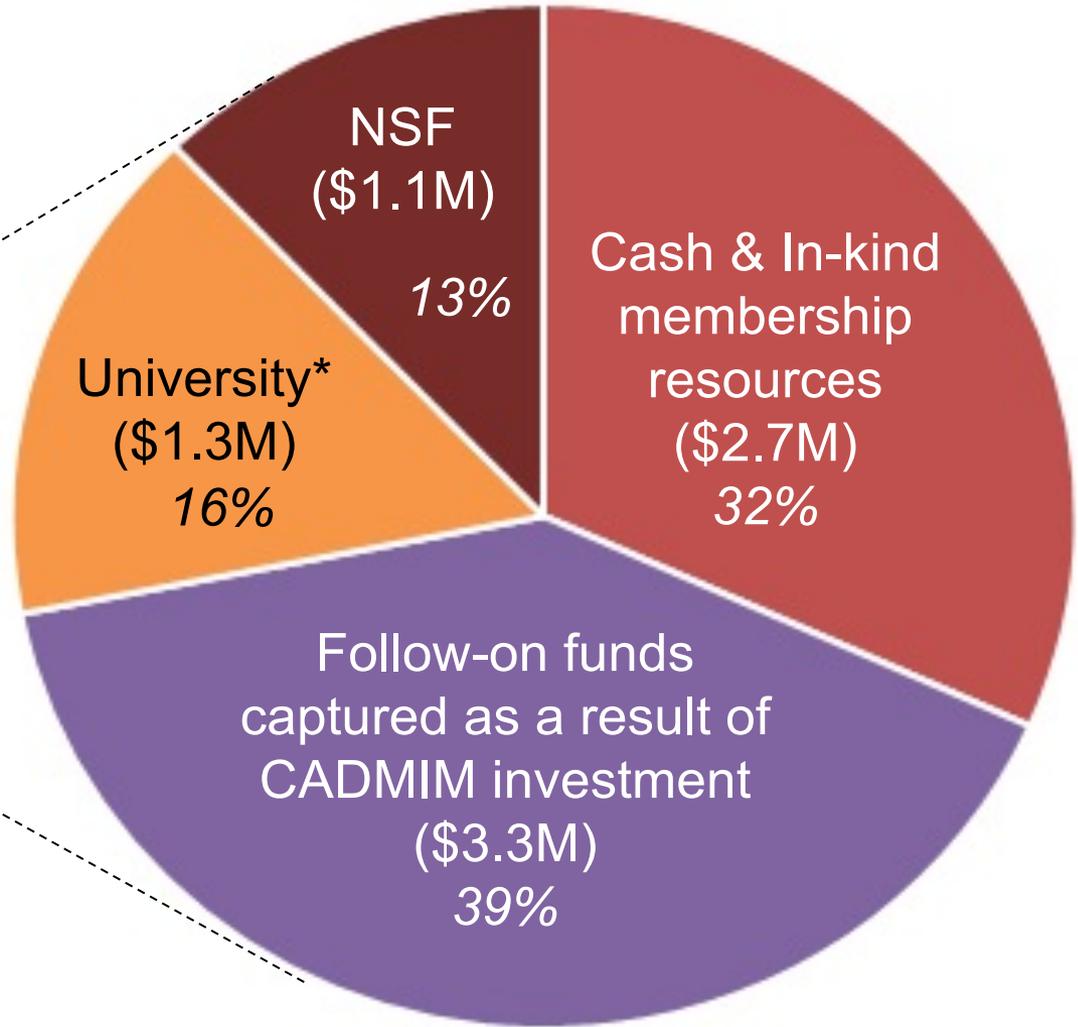
Center initiated research budget to date: \$8.4M

Initial investment: \$50,000/year

Indirect Cost 10%



Research 90%



* University contribution = re-investment of full indirect costs less 10% + additional infrastructure support



Y1 Project Guarantee for New Members

- **New members only!**
- **First year's membership fees are directed towards a project defined by the new member (with IAB approval).**
- **Membership fees are subject to only 10% overhead (compared to 50% - 60% at most universities).**
- **New member gains entry into the center and can take full advantage of the CADMIM innovation ecosystem and all the benefits.**





Product Development via CADMIM

CADMIM

Scalable
prototyping
at university
sites

Manufacturing

Scale up via
CADMIM IAB
members
(ALine, VTT)
and others.

Product Launch

Corporate
product
development,
tech transfer,
licensing, spin-off





Center for Advanced Design & Manufacturing of Integrated Microfluidics (CADMIM)



Dr. Tim Dawes

CADMIM IAB Chair
Senior Scientific Manager
Genentech, Inc.

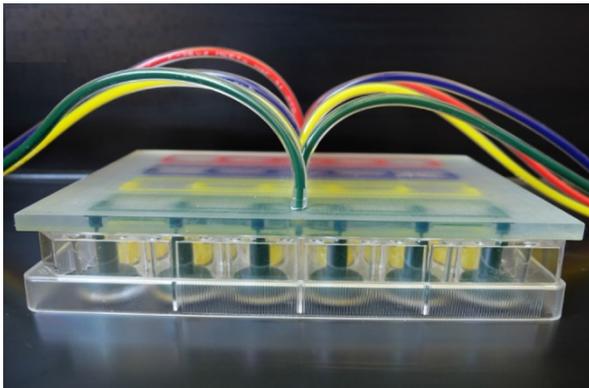


Dr. Dirk Heckel

CADMIM IAB Member
Vice President R&D Global Innovation
Beckman Coulter



Key Benefits to Joining CADMIM



■ Cutting-Edge Science

- Expertise, facilities, manufacturing
- Early access to pre-competitive research discoveries

■ Advancing Relationships

- Partnerships in technology translation
- First dibs at hiring students, post-docs

■ Economic Development

- Cost-effective way to initiate new research, proof-of-concept studies
- Learning opportunities for corporate scientists and engineers
- Reduce time to market

Competitive edge over your competitors!



Contact us!

■ **Center Director:**

- Dr. Abraham Lee
- UC, Irvine (UCI)
- (949) 824-8155,
aplee@uci.edu

■ **Center Co-Director**

- Dr. Ian Papautsky
- UI at Chicago (UIC)
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■ **Center Deputy Director**

- Dr. Gisela Lin
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Additional information on our website:

www.inrf.uci.edu/cadmim

Find us on:



More information about NSF IUCRCs: <https://www.nsf.gov/eng/iip/iucrc>

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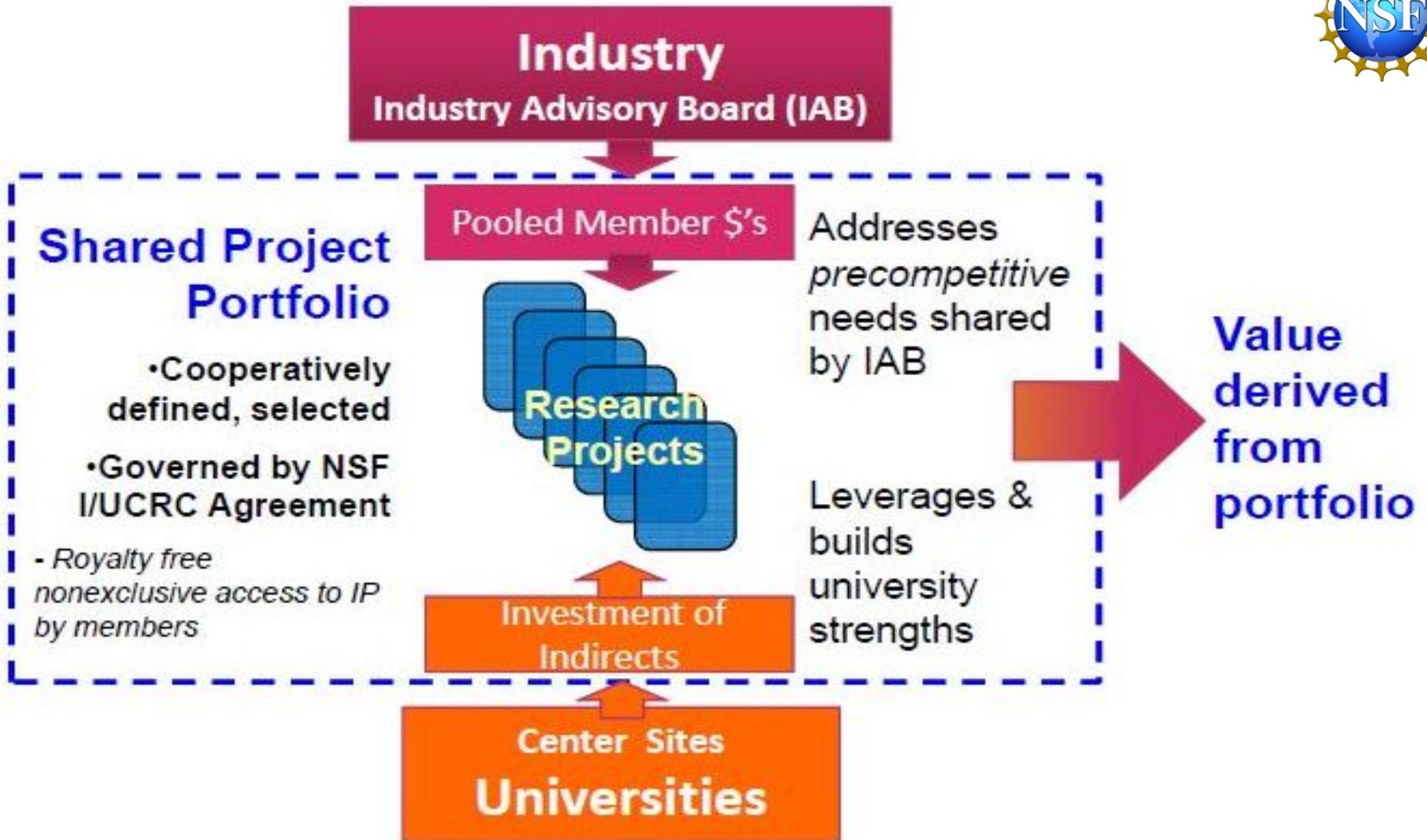


Additional Information



Precompetitive, Industrially Relevant Research

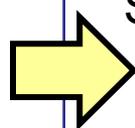
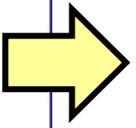
CADMIM = NSF Industry/University Cooperative Research Center (I/UCRC)





Commercialization Strategies

	Phase 1 (CADMIM)	Phase 2	Phase 3
Research Type	Precompetitive Applied Research (first prototypes, first level integration, etc.) ⇒ Faculty	Towards products (higher integration, scale-up, etc.) ⇒ Faculty + industry	Commercial product development ⇒ Industry
Funding Source	CADMIM membership fees	<div style="color: blue; text-align: center;">NSF grant: I-Corps, PFI-AIR, GOALI supplement</div> <div style="color: blue; text-align: center;">Industry: Sponsored Research</div> <div style="color: blue; text-align: center;">Other federal, state, private sources</div>	<div style="text-align: center;">Federal, state, industry, and private</div> <div style="text-align: center;">SBIR/STTR grants</div> <div style="text-align: center;">Start-up company</div>





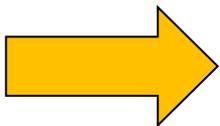
Research Cost Avoidance (RCA):

money saved by doing research through an I/UCRC

$$\text{Firm's Cost} = \text{Number of Projects} \times \text{Number of Scientist-months} \times \text{Cost per Scientist-month}$$

$$\text{RCA} = \text{Firm's Cost} - \text{Membership cost}$$

- Estimated cost of a scientist-month \approx \$15,000
- Average number of projects = 2.4 projects
- Average number of scientist-months = 16 months



Median RCA per center = \$318,000 per year

Total reported RCA across all I/UCRCs = \$278M annually