Semiconductor Research Corporation

# Global Research Collaboration (GRC) and Calls for Research

# Meet the GRC Research Management Team

John Oakley
Science Director for AIHW, HWS, PKG, SCARF
john.oakley@src.org

Kashyap Yellai
Science Director for ESH, LMD, NMP
Kashyap.yellai@src.org

Marcus Pan
Science Director for AMS-CSD, CADT
marcus.pan@src.org

LaDonya Dooley
Program Coordinator
laDonya.dooley@src.org

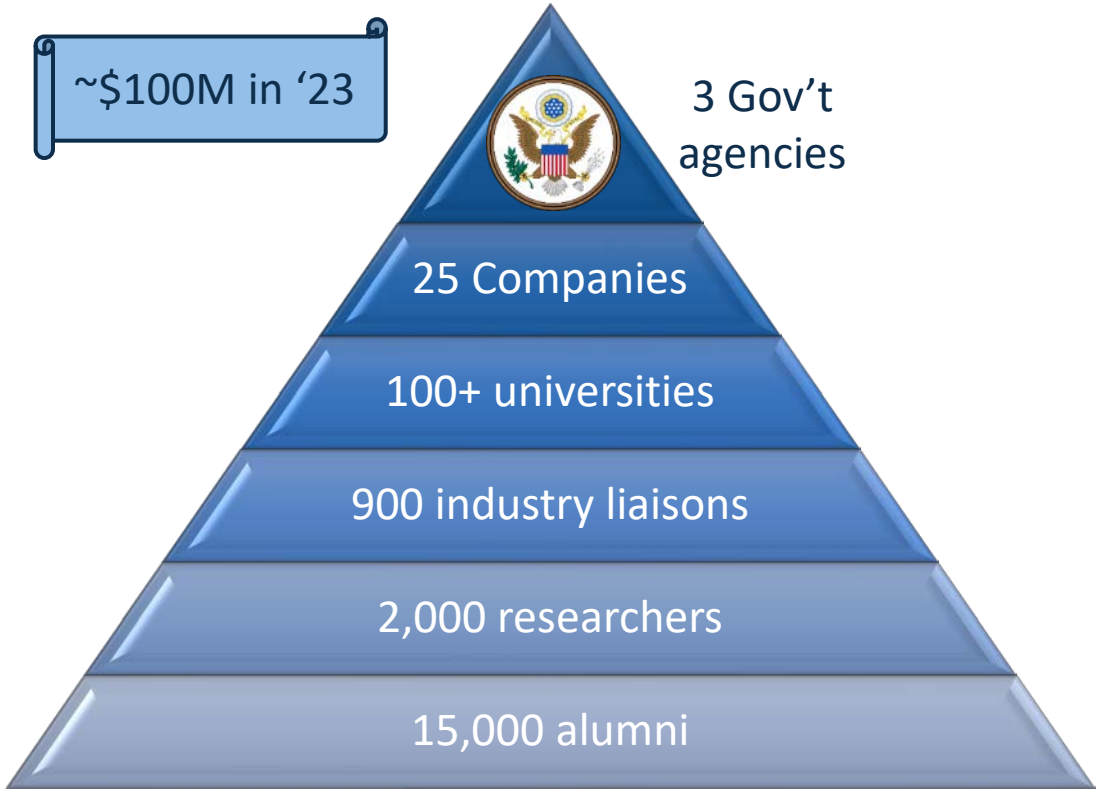
Sydney “Syd” Williams-Black
Program Coordinator
Syd.Williams-Black@src.org

LaTanya Holmes
Program Coordinator
latnya.holmes@src.org

https://www.src.org/about/chart/src-management/

# Who We Are: Premier Global Microelectronics Consortium

~$100M in ‘23




Chartered to discover and accelerate technologies and create the workforce for the semiconductor industry

DARPA NSF NIST

AMD ANALOG DEVICES APPLIED MATERIALS arm ASM INTERNATIONAL

BOEING Chemonics EMD ELECTRONICS GlobalFoundries

HRL LABORATORIES IBM intel MEDIATEK

Micron NXP qorvo QUALCOMM

RTX SAMSUNG SIEMENS SK hynix

TEL Texas Instruments tsmc Veeco

Members are large companies across the supply chain

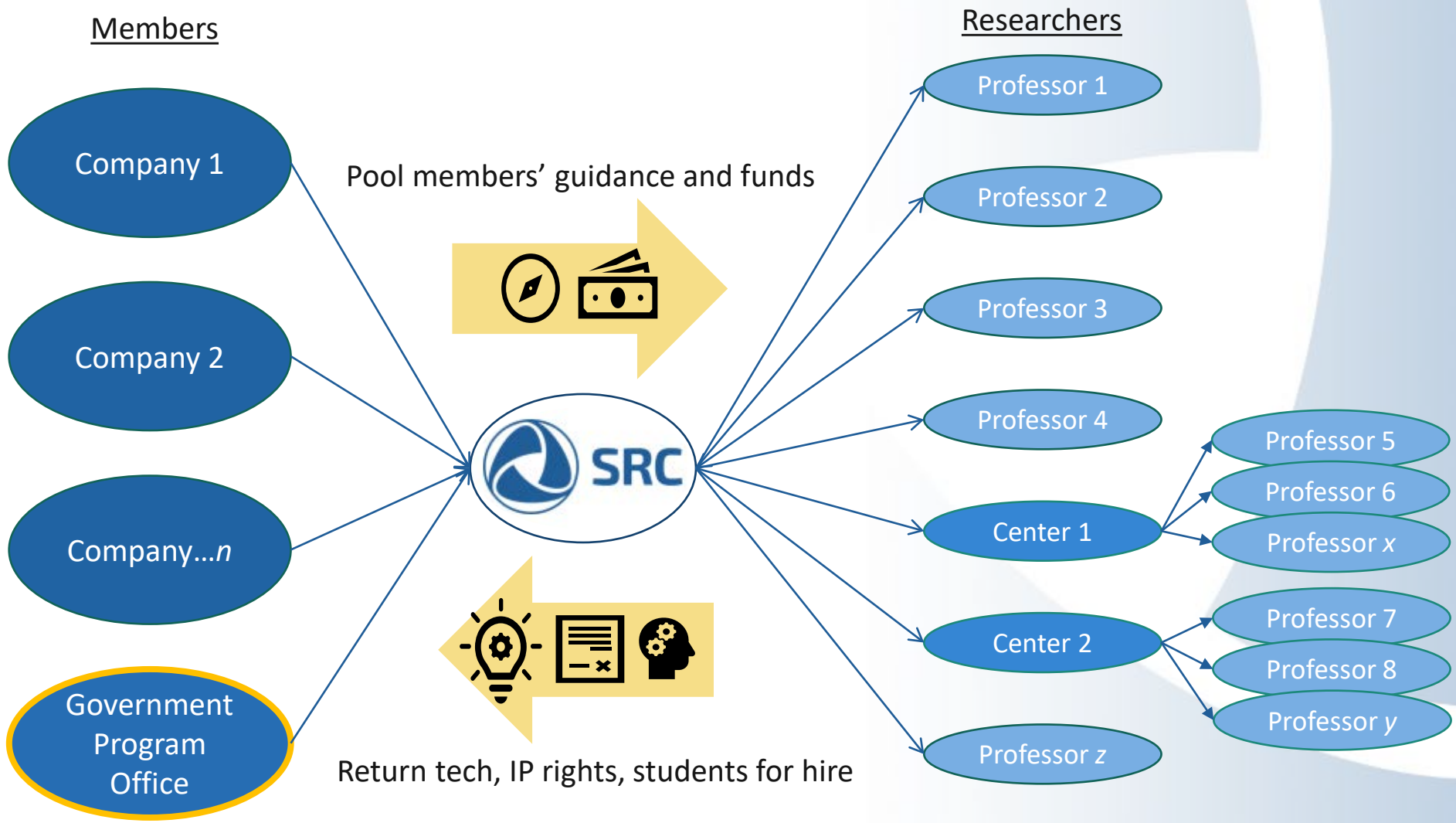
https://www.src.org/src/member/roster/

# What We Do: Manage Collaborative R&D Programs

SRC manages research programs on behalf of members;

- Recruit members
- Run solicitations
- Manage performance
- Ensures tech transfer to members

In-house Contracting, Legal, Event Production, Billing, MarCom, web portal, etc.



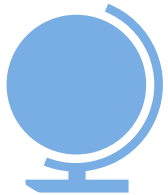

SRC members jointly define research needs, fund selected projects, and reap the rewards
**PI will directly engage with experts and conduct research relevant to industry applications**

# Evidence of Success: 40+ Years of Technology & Workforce

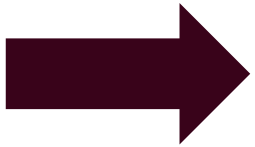
**Historic Model**

$2.2B of collaborative research

700+ patents issued from 2,000 research projects



15,000 SRC sponsored students at 250 universities globally



**Providing critical technology**

- Nanosheets for GAA transistors
- FinFET
- High K Dielectrics
- Cu interconnect
- MRAM
- Scalable FLASH Memory
- Simulation, verification tools
- CMOS mm wave circuit design
- Quality and cost of testing
- Many more!

Chartered to discover and defining the future's technologies and create the workforce critical for the success of semiconductor industry

SRC

Semiconductor Research Corporation

# Industry and Academia Collaboration

# After Winning a SRC Research Contract: SRC Intellectual Property Requirements

**SRC desires to protect intellectual property rights vesting in you and your University emanating from sponsored research. In return for sponsoring the research, SRC receives certain Intellectual Property (IP) rights.** The primary goal of SRC's IP policy is to provide Members and Participants freedom to practice results of the sponsored research. SRC's Science Directors and industry representatives assist researchers in the identification of inventions that may be formally protected.

The sponsored research agreement (SRA) provides for IP license rights, which are sublicensed to Members and Participants. The license grant is worldwide, non-exclusive, non-transferrable, royalty free and includes the right to make, have made, use, or sell inventions, and to prepare software derivative works. In addition, SRC retains an option to negotiate an exclusive license. The University retains ownership of the IP and is free to license the IP to companies that are not SRC Members or Participants, subject to SRC's option for an exclusive license.

This license includes all IP that can be protected by patent, copyright, or other form of protection, including inventions, works of authorship, and mask works.

# Value in Engagement of Academia and Industry Liaison


Highlights technological challenges in the domain

Provides direction on the relevance of research

Provide an out of the box approach and diversity in perspective to address challenges

Enhance industry R&D that enables a differentiated product for the marketplace

https://www.src.org/liaison/

# Researcher Own Industry Interactions

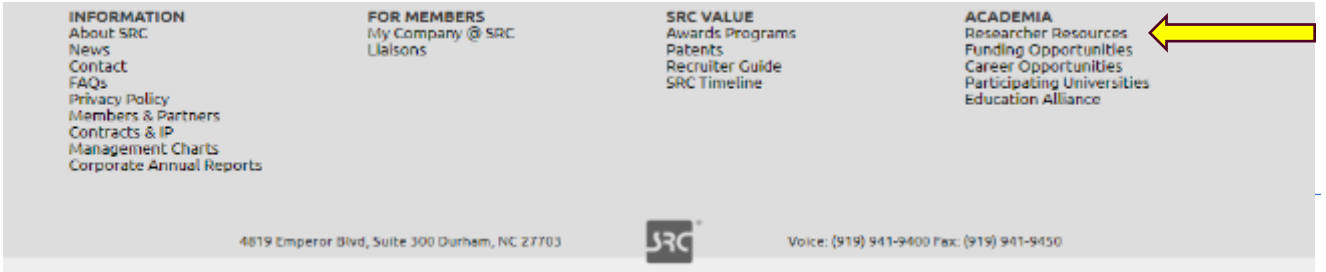
- Setup Regular Liaison Calls & Student Participation
  - Requires researcher-liaison calls every 4 to 8 weeks for GRC projects.
  - The university researchers own the interaction format and frequency of these meetings based on the feedback from the liaisons

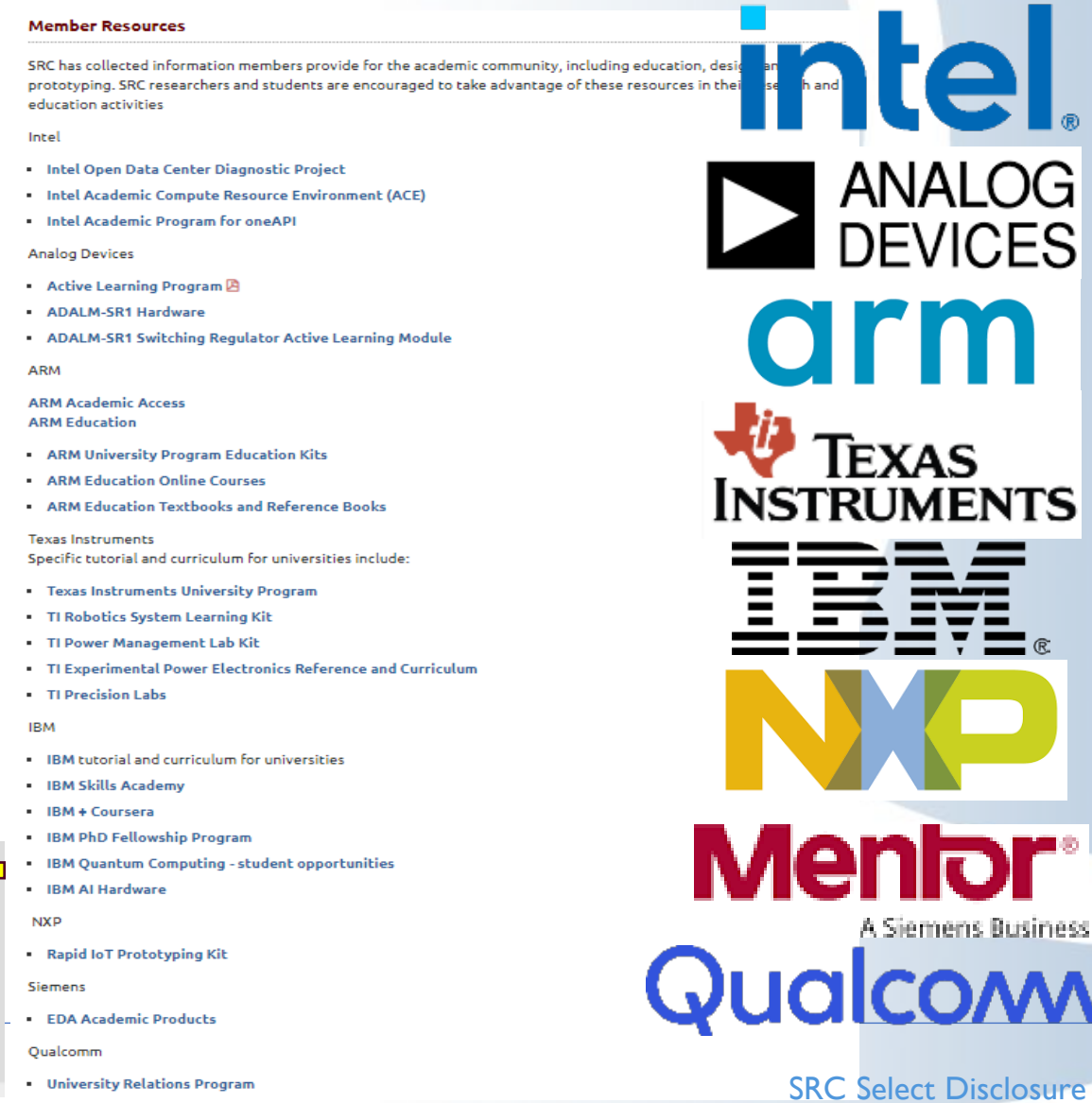
**Project leader should encourage students to present results in these meetings**

# Resources that Help Academics Evaluate, Adopt, and Amplify Emerging Member Solutions

## Member Resources

- SRC has collected information members provide for the academic community, including education, design, and prototyping
- SRC researchers and students are encouraged to take advantage of these resources in their research and education activities
- Link to the resources: https://www.src.org/program/grc/guide/researcher/guidelines/



**Member Resources**

SRC has collected information members provide for the academic community, including education, desig[illegible] prototyping. SRC researchers and students are encouraged to take advantage of these resources in thei[illegible]se[illegible]h and education activities

Intel

- Intel Open Data Center Diagnostic Project
- Intel Academic Compute Resource Environment (ACE)
- Intel Academic Program for oneAPI

Analog Devices

- Active Learning Program
- ADALM-SR1 Hardware
- ADALM-SR1 Switching Regulator Active Learning Module

ARM

ARM Academic Access
ARM Education

- ARM University Program Education Kits
- ARM Education Online Courses
- ARM Education Textbooks and Reference Books

Texas Instruments
Specific tutorial and curriculum for universities include:

- Texas Instruments University Program
- TI Robotics System Learning Kit
- TI Power Management Lab Kit
- TI Experimental Power Electronics Reference and Curriculum
- TI Precision Labs

IBM

- IBM tutorial and curriculum for universities
- IBM Skills Academy
- IBM + Coursera
- IBM PhD Fellowship Program
- IBM Quantum Computing - student opportunities
- IBM AI Hardware

NXP

- Rapid IoT Prototyping Kit

Siemens

- EDA Academic Products

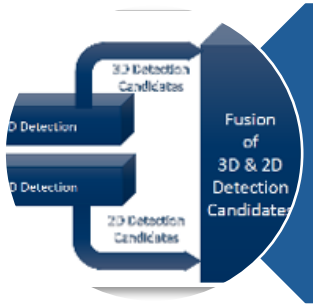
Qualcomm

- University Relations Program

Semiconductor Research Corporation

# Highlighting Relevant Technology Transfers from Researchers

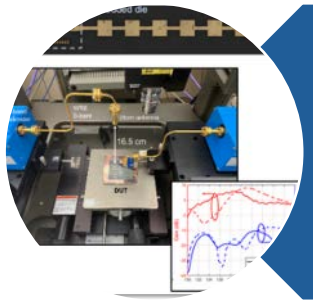
# 2023 - 1H: Technology & Workforce Development Highlights




**January: Auto**

Michigan State Univ: Development of multi-level and detection framework,…for autonomous vehicles

Prof. Hayder Radha, Prof: Su Pang



**February: ComSenter + ASCENT**

Georgia Tech: World's 1st Embedded Die with D-Band Integrated Antenna in a Glass Interposer Transferred to SHIP

Prof. Madhavan Swaminathan

**March: nCORE, Ne[illegible]s**

Stanford Univ: Selec[illegible] 2D TMD Ma[illegible]

Prof. Stac[illegible]Bent

Diversity

**April: CADT**

Univ of Arizona: [illegible] Vehicles

Prof. Sule [illegible]zev

Diversity

**May: ADA**

Univ of Washington: [illegible] Level of Detail (LoD), [illegible]

Prof. Zachary Tatlock, Dr. Bill Zorn

Talent Transfer

**June: Artificial Intelli[illegible]ce HW**

Univ of [illegible]

Hyperdimensio[illegible] (HDC), Your[illegible]

Prof: Mo[illegible]en Imani

Young Faculty

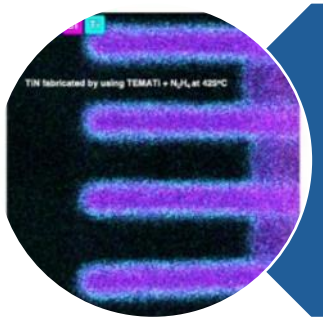
https://www.src.org/newsroom/newsletter/

# 2023 - 2H: Technology & Workforce Development Highlights

July: CONIX

Carnegie Melon Univ: AV Management for Extended Reality Video Conferencing

Prof. Anthony Rowe



October: ASCENT

Univ of California, SD: Methods of Forming Low Resistivity Titanium Nitride Thin Film in Horizontal Vias and Related Devices

Prof. Andrew Kummel

Augus

Univ of Minnesota: Tra
Universal Multi-Purpo
Start

Prof. Kate Adama, Dr. Judee Sharon

Woman Entrepreneur

November: FS

Cornell Univ: s
photolithography waste
hire

Prof. Damian Helbli . Paige

Diversity & Talent Transfer

Sept

Columbia Univ: advanced e ural-network (DNN) assisted d ntrol systems to improve efficie DC-DC Converters, li engagement

Prof. Mingoo Seok, Dr. Ram K Krishnamurthy

Liaison Engagement

December: CONIX

Univ of California, SD: Hardening Development Toolchains Against Emergent Execution Engines (HARDEN) for DARPA

Prof. Deian Stefan

https://www.src.org/newsroom/newsletter/

Semiconductor Research Corporation

# GRC Research Programs

# GRC Programs Solicitation for Research is Described and Guided by

## Five Seismic Shifts Described in Decadal Plan for Semiconductors

Smart Sensing

Memory & Storage

Communication

Security

Energy Efficiency

1. **Fundamental breakthroughs in analog hardware are required to generate smarter world-machine interfaces that can sense, perceive, and reason.** Investment throughout this decade to pursue analog-to-information compression/reduction with a practical compression/reduction ratio of $10^5$:1 for practical use of information more analogous to the human brain.
2. **The growth of memory demands will outstrip global silicon supply, presenting opportunities for radically new memory and storage solutions.** Investment throughout this decade to develop emerging memories/memory fabrics with >10-100X density and energy efficiency improvement for each level of the memory hierarchy. Discover new storage systems and storage technologies with >100x storage density capability.
3. **Always-available communication requires new research directions that address the imbalance of communication capacity vs. data-generation rates.** Investment throughout this decade for communication enabling data movement of 100-1000 zettabyte/year at the peak rate of 1Tbps@ <0.1nJ/bit. Develop intelligent and agile networks that effectively utilize bandwidth to maximize network capacity.
4. **Breakthroughs in hardware research are needed to address emerging security challenges in highly interconnected systems and AI.** Investment throughout this decade for privacy and security hardware advances that keep pace with new technology threats and use cases (e.g., trustworthy AI systems, secure hardware platforms, and emerging postquantum and distributed cryptographic algorithms).
5. **Ever-rising energy demand for computing vs. global energy production is creating new risk, and new computing paradigms offer opportunities to dramatically improve energy efficiency.** Investment throughout this decade to discover computing paradigms/architectures with a radically new computing trajectory demonstrating >1,000,000x improvement in energy efficiency.

https://www.src.org/about/decadal-plan/

## 11 Chapters in MAPT Roadmap


https://srcmapt.org/wp-content/uploads/2024/01/SRC-MAPT-Roadmap-2023-v2.pdf

# Global Research Collaboration (GRC) Research Programs

| | |
|---|---|
| Logic and Memory Devices | **Defining the future of transistor technology including exploration of augmenting the advanced CMOS technology with emerging alternative concepts such as multiferroics, spintronics, photonics, and 3D integration.** |
| AI Hardware | **Pushing the frontiers of artificial intelligence across a broad spectrum of applications from the edge to the cloud.** |
| Packaging Technology | **Spanning from small, flexible, mobile interconnected consumer devices to cloud based computing requiring high compute density in data centers.** |
| Hardware Security | **Developing strategies, techniques, and tools to provide assurance that electronic systems will perform as intended. Assurance depends on processes and tools across all steps of design, manufacture, and distribution.** |
| Nano Materials and Processes | **New materials and processes for scaling digital and analog device fabrication. Addresses challenges in patterning, nanoengineered materials, deposition/ etch processes, process integration, metrology, and ESH.** |
| Analog/Mixed-signal Circuits | **Creating fundamental innovations in integrated circuits and systems that improve energy efficiency, health care, public safety, and security.** |
| CAD and Test | **Leading electronic design automation techniques, and tools for the design and test of advanced electronic circuits and systems.** |
| **Environment Safety & Health** | **Develop sustainable and environmentally benign processes for semiconductor manufacturing.** |

SRC

https://www.src.org/program/grc/

# GRC Upcoming Solicitations

**Welcome to the SRC OpenWater portal**

## Semiconductor Research Corporation

## 2024 Call for Research

| Research Thrust | Call Opens | Papers Due | Program Manager | Program Coordinator |
|---|---|---|---|---|
| Nanomanufacturing Materials and Processes | Apr 9 | May 7 | Kashyap Yellai | Syd Williams-Black |
| Packaging / Packaging Chirp | Apr 9 | May 7 | John Oakley | LaDonya Dooley |
| Hardware Security | May 7 | Jun 4 | John Oakley | LaDonya Dooley |
| Computer-Aided Design and Test | May 7 | Jun 4 | Marcus Pan | LaTanya Holmes |
| Environment, Safety, and Health | May 7 | Jun 4 | Kashyap Yellai | Syd Williams-Black |

- Each program runs solicitation every 2 out of 3 years
- 2024 solicitations (1/1/2025 start) will create new research for CADT, ESH, HWS, NMP, and PKG
- The 2024 solicitations use a $105k/yr to $135k/yr. for three years starting 1-Jan-25 starts

SRC

https://src.secure-platform.com/a

# Hardware Security Research Program Overview

HWS

**Call Opening May 7**

Program Objective:
- Developing strategies, techniques, and tools to provide assurance that electronic systems will perform as intended. Such assurance is a function of processes and tools integrated across design, architecture, manufacturing, and distribution.

Size:
- Steady state annual budget >$1.5M/year supporting 17 current research tasks

Members:
- AMD, Analog Devices, IBM, Intel, Siemens EDA, Texas Instruments

**HWS Metrics**

**Current**

17 Projects
13 Universities
40 Research Scholars
21 Faculty Researchers
40 Liaisons

Research topics

- Trusted Architectures and Hardware Security
- Security Techniques for Advance Technologies and Packaging
- Security Aspects of Embedded Software, Firmware, and Soft IP
- Security Assurance, Protection, and Verification
- Authentication, Attestation, and Provisioning

https://www.src.org/program/grc/hws/

# Packaging Research Program Overview

PKG

Program Objective:

- Create and explore advanced evolutionary and revolutionary packaging technologies for reliably encapsulating and efficiently integrating microsystems

Size:

- Steady state annual budget at $2.7M/year supporting 40 current research projects
- CHIRP has significant cost sharing with 1:1 matching from universities for 13 projects

Members:

- IBM, Intel, MediaTek, NXP, Samsung, SK hynix, Texas Instruments

**Call Opening April 9**

**PKG Metrics**

**Current**

| | |
|---|---|
| 38 | Projects |
| 23 | Universities |
| 128 | Research Scholars |
| 50 | Faculty Researchers |
| 117 | Liaisons |

Research topics

- Design Enablement and Tools
- Interconnects including photonics
- Power Delivery and Thermal Management
- Metrology and Modeling
- Materials
- Heterogeneous Integration (HI)

https://www.src.org/program/grc/pkg/

# Pilot Program for Seed Grants

PKG

**Proposal**

- $25k grants (gifts) for 1yr for exploratory ideas
  - Grants have no IP rights and minimal deliverables (only optional final report)
  - And no university overhead (dollars go farther)
  - Successful seeds could migrate to full 2-year projects on next solicitation with normal project parameters

**Criteria**

- Research thrust must:
  - Have greater than $1M solicitation
    - Currently AMD-CSD, LMD, NMP, PKG and AIHW are eligible
  - Be in year 1 of back-to-back solicitation years

**Pilot**

- 2024 Solicitation in Packaging will have 6 seed grants

SRC

# Computer Aided Design and Test (CADT) Program

CADT

Program Objective

Provides research leadership in electronic design automation by making available to members leading-edge university research results, techniques, and tools for the design and test of advanced electronic circuits and systems.

**Call Opening May 7**

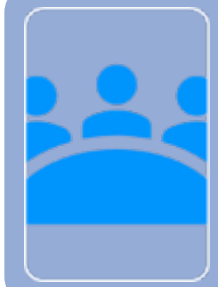
Size

Steady state annual budget of $1.47M supporting 26 current research tasks

**CADT Metrics**

**Current**

25 Projects
16 Universities
54 Research Scholars
26 Faculty Researchers
81 Liaisons



Members

IBM, Intel, Siemens EDA, Texas Instruments

| Research Topics | Subsection |
|---|---|
| Functional Safety Tools and Techniques | F1. Safe System |
| | F2. Data Mining and Failure Prediction |
| | F3. Design for Functional Safety |
| System, Logics and Physical Design Tools | S1. System Tools |
| | S2. Tools for Design Robustness |
| | S3. Analog Tools |
| Test, Yield and Post-Silicon Validation | T1. Test of Machine Learning Systems |
| | T2. Test Cost Quality and Yield Improvement |
| | T3. High Level Test, Validation, Diagnosis and Repair |
| | T4. Analog, Mixed Signal, RF, High-Speed Test |
| Verification | V1. Verification for Machine-Learning Systems |
| | V2. Machine Learning Techniques for Verification |
| | V3. System-Level Verification |
| New Frontier for Scalable, Correctness-Assured Hardware Design | N1. Raise Level of Abstraction in HW design as a continuation of SW development |
| | N2. Design Implementation through Trusted Complier/Behavior Synthesis Transformations |
| | N3. Provably Correct Design Construction |
| | N4. Verification as an integral part of Design Evolution |

SRC

https://www.src.org/program/grc/cadt/

# Environment, Safety and Health Research Program Update

ESH

Program Objective:

Supports an overall mission of enabling the development of more environmentally preferable processes used in integrated-circuit manufacturing

Size:

Steady state annual budget of $1.49M supporting 13 current research tasks

Members:

EMD Electronics, Global Foundries, IBM, Intel, Micron, Texas Instruments

**Call Opening May 7**

**ESH Metrics**

**Current**

13 Projects
8 Universities
29 Research Scholars
20 Faculty Researchers
53 Liaisons

**PFAS**
- **Characterization in FAB wastewater**
- **Treatment methods**
- **Hazard and toxicity assessment**

**Environmentally Preferable HFC etchants and CMP slurries**

**Assessment of energetics in exhaust and control mechanisms**

**Abatement of NO2 and NOx**

SRC

https://www.src.org/program/grc/esh/

# Nanomanufacturing Materials and Processes Research Program

NMP

**Program Objective:**

- Explores new materials and processes for scaled digital and analog device fabrication

**Size:**

- Steady state annual budget of $2.3M supporting 30 current research tasks

**Members**

- ASM, IBM, Intel, Samsung, Siemens, SK Hynix, TEL, TSMC, Veeco

**Call Opening April 9**

**NMP Metrics**

**Current**

29 Projects
21 Universities
48 Research Scholars
31 Faculty Researchers
110 Liaisons

**Research Topics**

**Patterning (9)**
- EUV resists & masks
- Area-selective deposition
- Directed Self-Assembly

**Front-End Process (9)**
- ALD, ALE
- TMD channels and gate oxides
- NMP metrology
- Selective spin-on polymer deposition
- Agile manufacturing systems

**Back-End Process (11)**
- Narrow high-conductivity interconnects
- BEOL Transistors
- Novel Characterization Techniques
- Low Temp. CVD
- Integrated Si Photonics
- Cu ALE

SRC

https://www.src.org/program/grc/nmp/

# Helpful Suggestions for Submitting to the Call

1. Read and review SRC's MAPT Roadmap (https://srcmapt.org/) as these will be referenced in the upcoming calls for research
2. White Papers or Proposals will standout if anticipated results from research can be benchmarked against the State of the Art
3. Leverage our pilot program of seed grant (packaging this year) to gain visibility for your research with industry sponsors
4. Build upon member resources to improve impact
5. Have clear deliverables planned over the project (at least 1 per year)
   - Can be adjusted later with agreement of Program Manager and liaisons
6. Consider collaborating with larger universities to improve white papers
7. Submit white papers, proposals, and future deliverables on time ☺


ACADEMIA • INDUSTRY •
• GOVERNMENT