



Implantable Networks of Wireless Nanoelectronic Devices

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Purdue University





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Systems

Nanoelectronics

Wireless

Biosensors

Purdue University





Medical marketplace

19.5% of GDP by 2017*

*DHHS





Goal

Enable multi-pathology treatment through physically distributed networks of nanoscale wireless sensors and actuators





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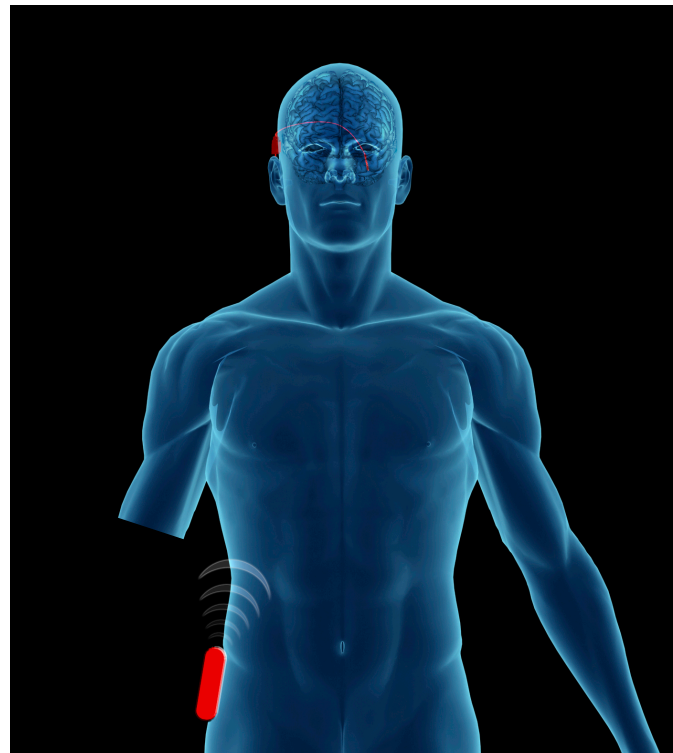
Center for Implantable Devices
at the Weldon School
of Biomedical Engineering



Outcome

A Paradigm Shift in Medical Treatment



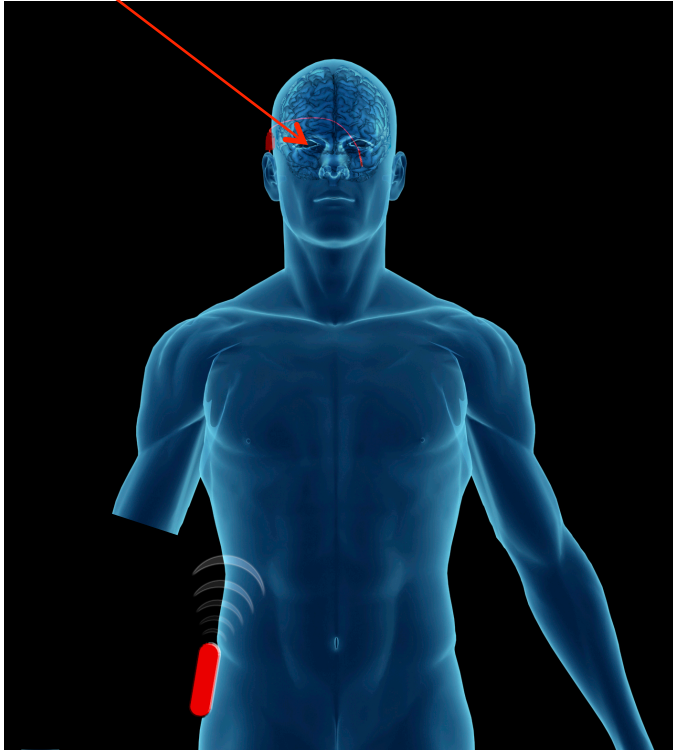
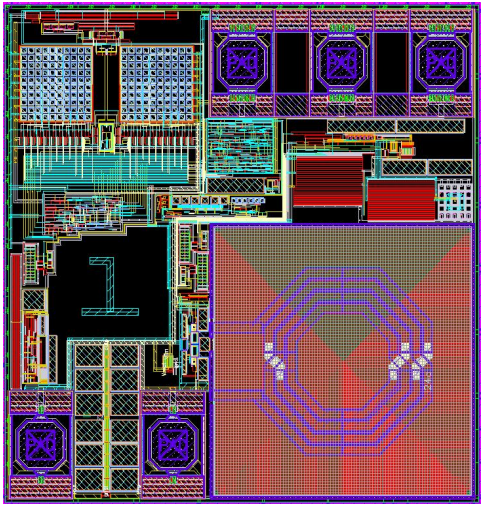


The microchips shown
were designed and
assembled at Purdue





Glaucoma IOP monitoring

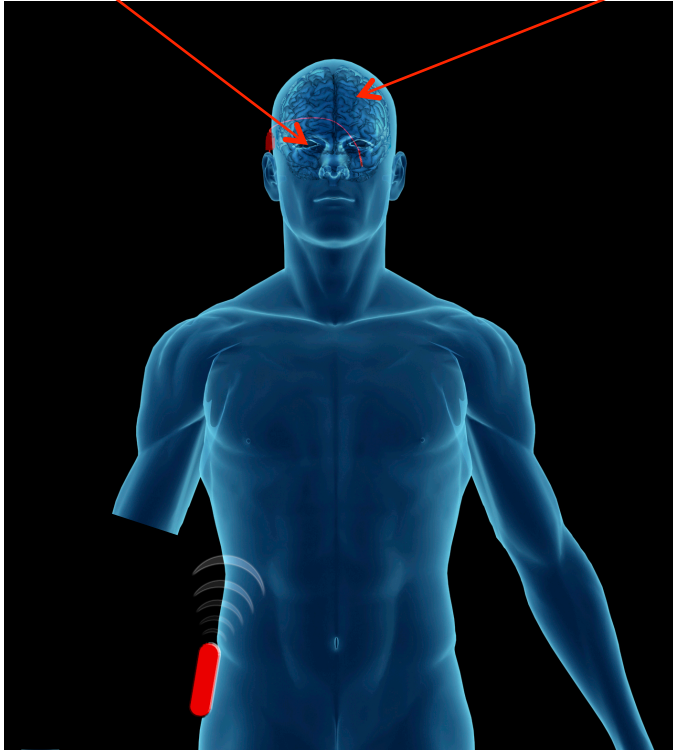
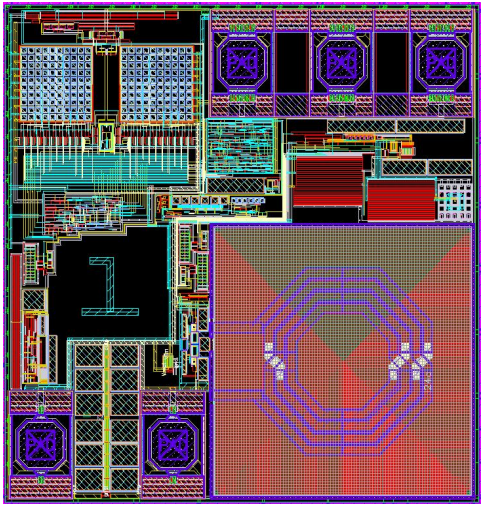


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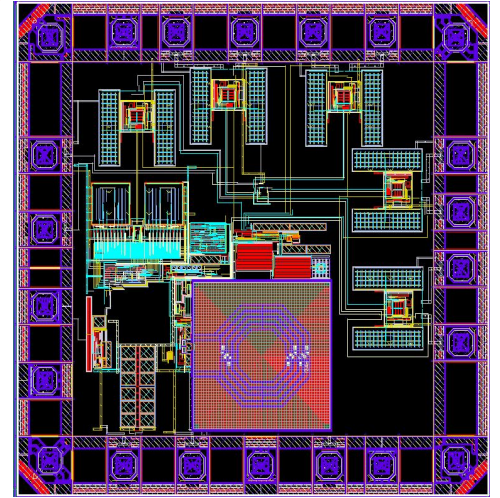




Glaucoma IOP monitoring



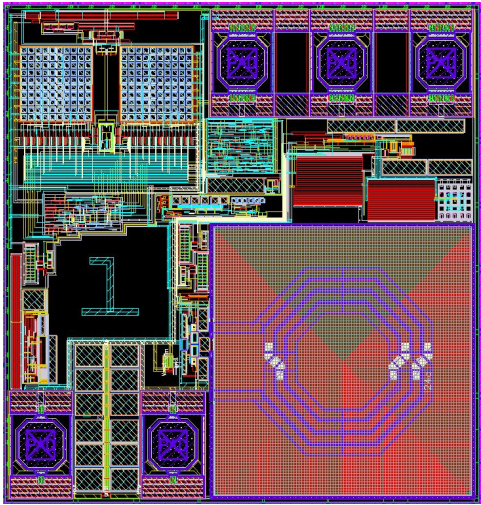
Seizure detection



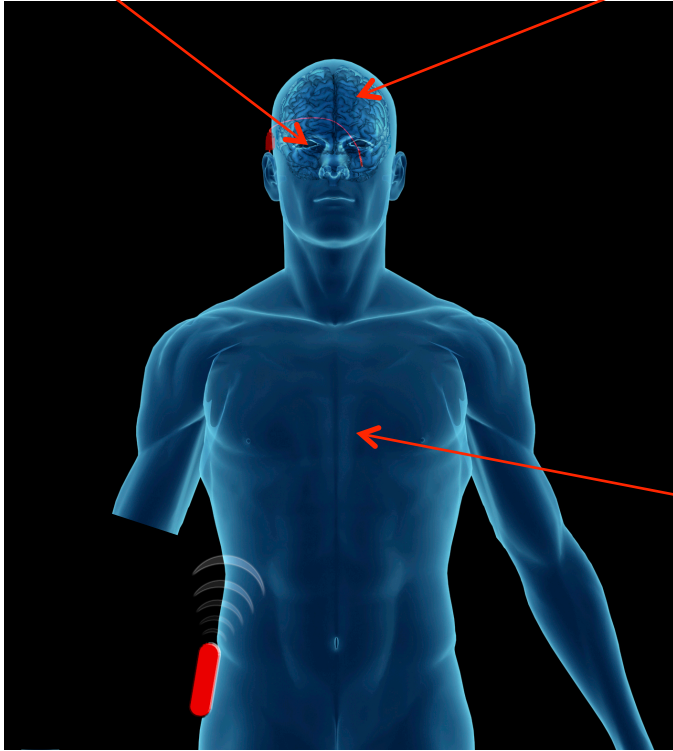
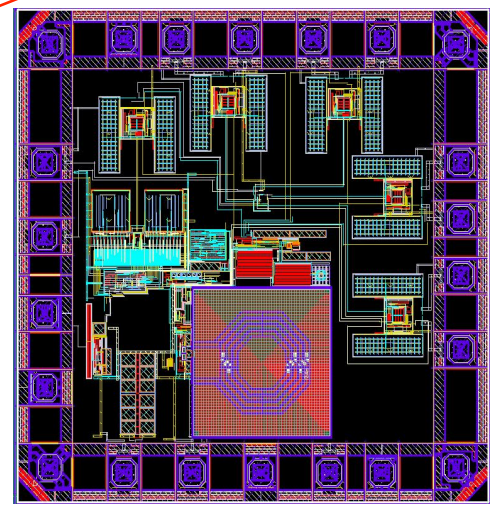
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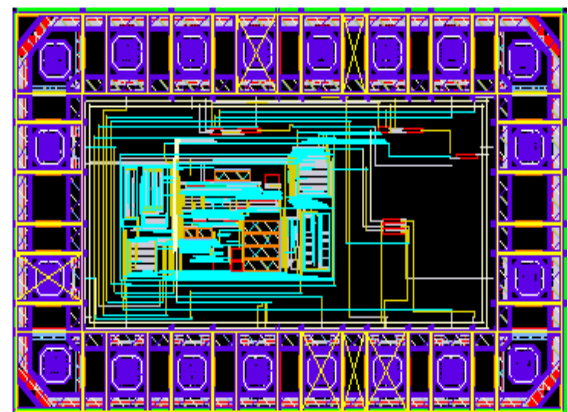
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Seizure detection



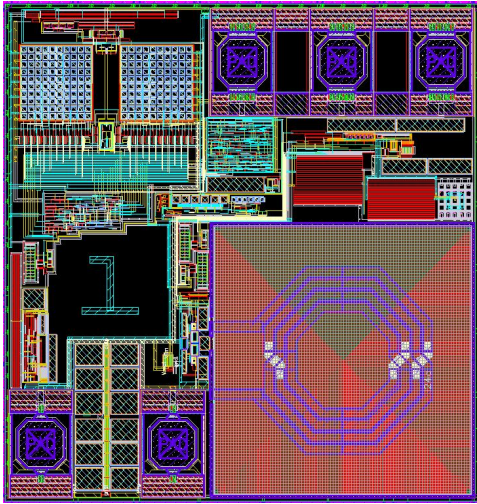
Heart failure warning



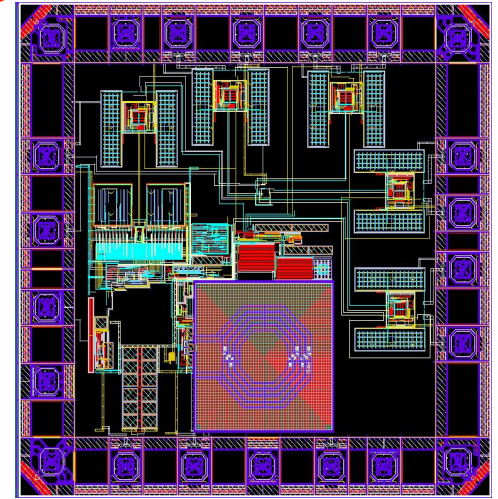
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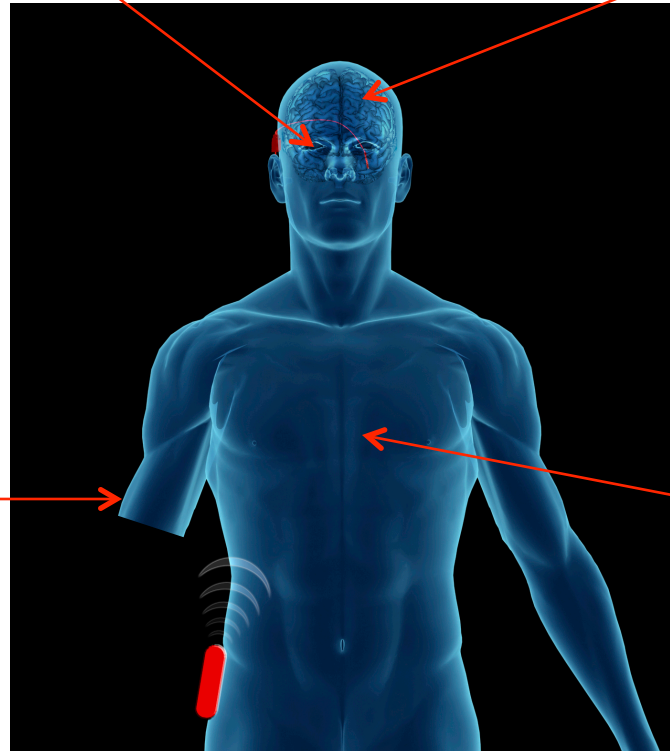
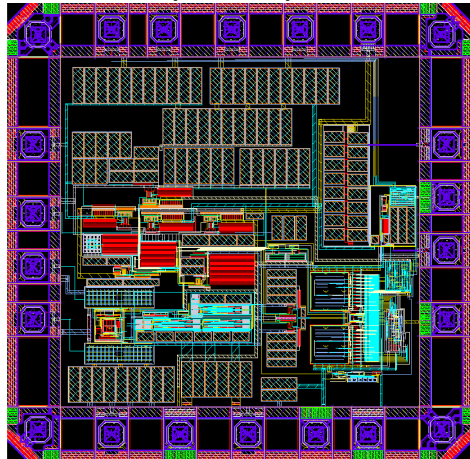
Glaucoma IOP monitoring



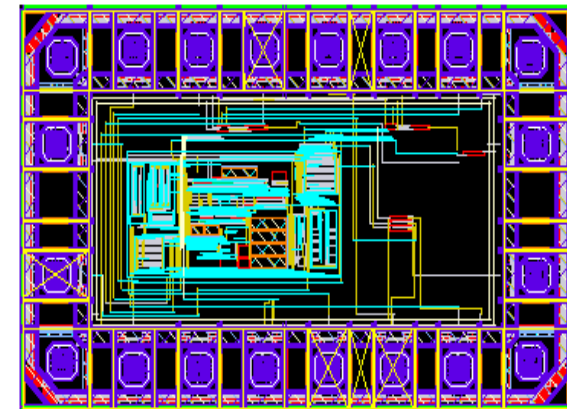
Seizure detection



Prosthetic arm control
(TMR)



Heart failure warning



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Need:

- **Network of implantable wireless devices**
- Nano-biosensors
 - CMOS compatible
- Packaging
- Energy Harvesting





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Ashraf Alam
Professor



Need:

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Mark Lundstrom
Scifres Distinguished Professor



NEEDS has a vision for a new era of electronics.

- more diverse
- less predictable
- rapidly changing
- driven by society's grand challenges



Mark Lundstrom, Lead Investigator




COMPACT MODELS

SPICE-compatible Verilog-A format supporting resources




NEEDS MODEL DEVELOPMENT PLATFORM

Environment for developing compact models



FOR USERS AND DEVELOPERS

Resources for using NEEDS models and for creating compact models with NEEDS tools and processes



SEMINARS, COURSES, ETC.

NEEDS Seminar Series, nanoHUB-U and more...



NEEDS is a resource for nanoelectronics supported by the [National Science Foundation](#)

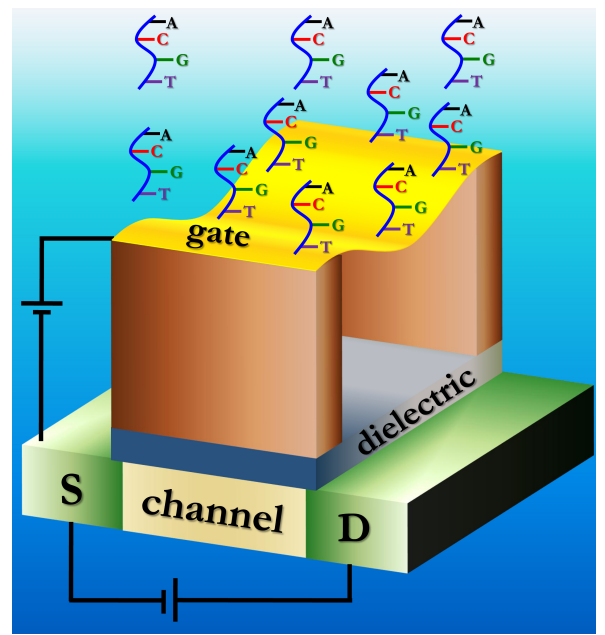
[Report Problems](#)



NEEDS: Nano Engineered Electronic Device Simulation
Lead institution: Purdue
Partners: MIT, UC Berkeley, and Stanford

Vision: A new era of electronics enabled by the new capabilities of emerging nano-devices.”

Mission: Connect nano-material and device research to new applications with physics-based circuit simulation models.



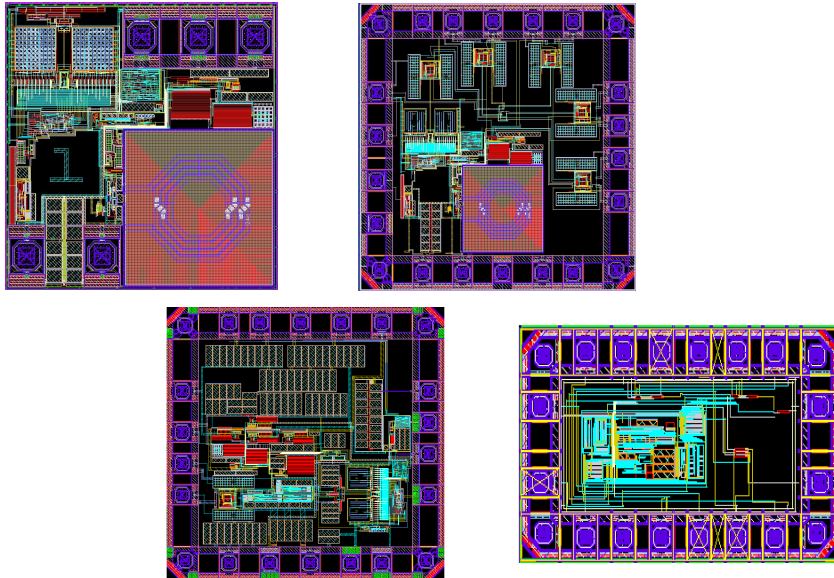
FET-based bio-sensor
Alam group



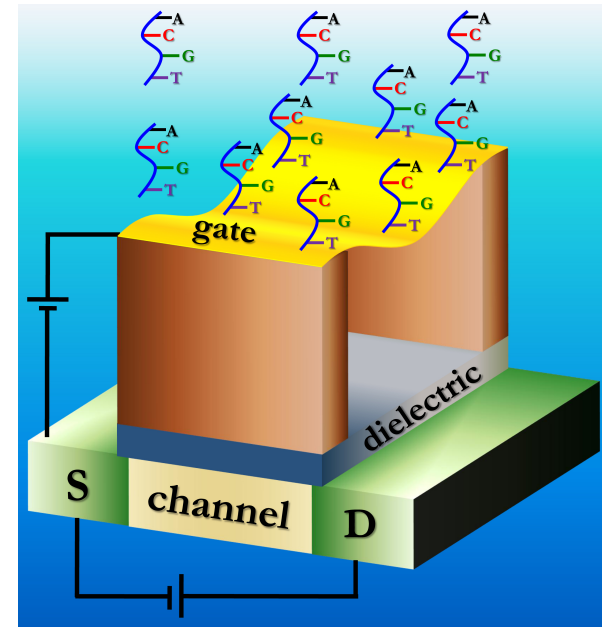


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CMOS 180 nm tapeout – Irazoqui group



FET-based bio-sensor
Alam group



NEEDS

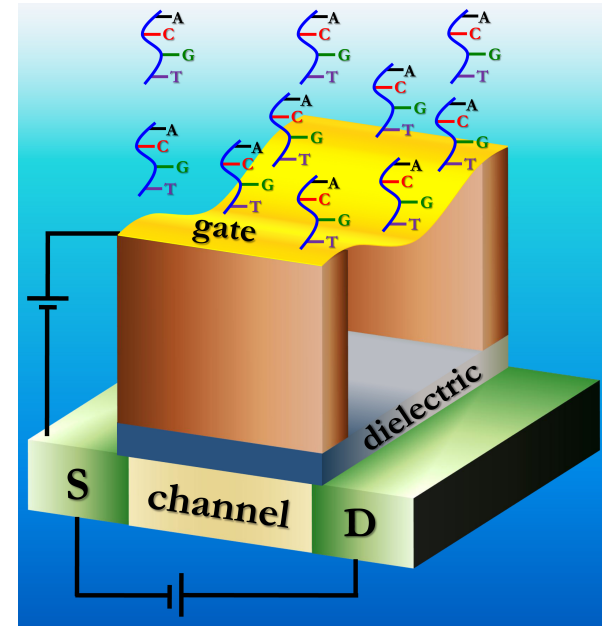
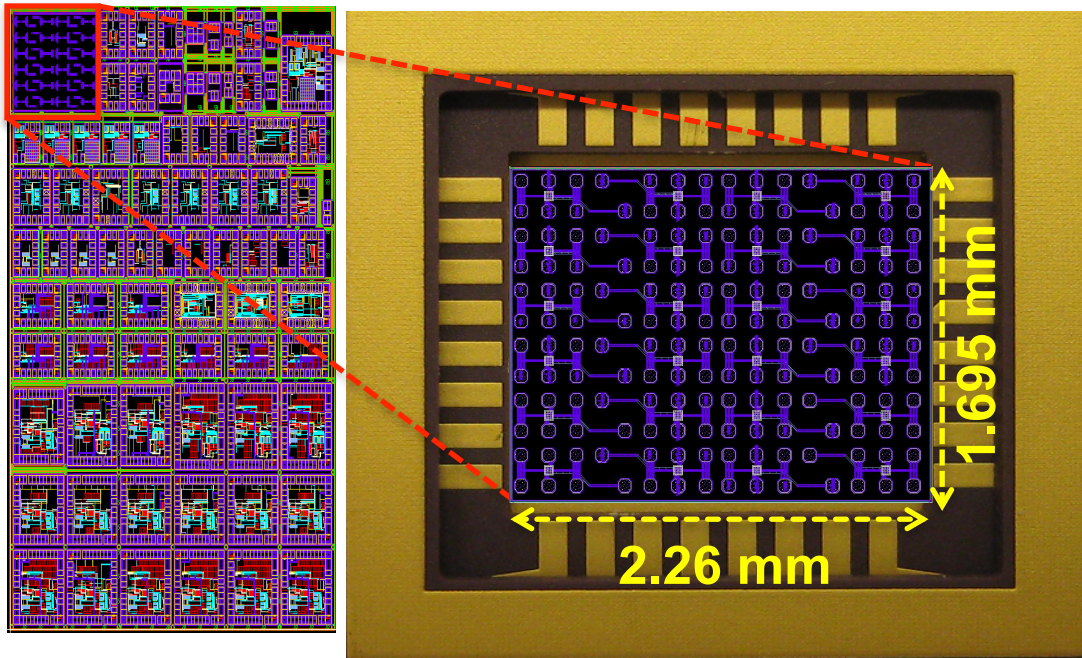
needs.nanohub.org





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FET-based bio-sensor
Alam group



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- Energy Harvesting

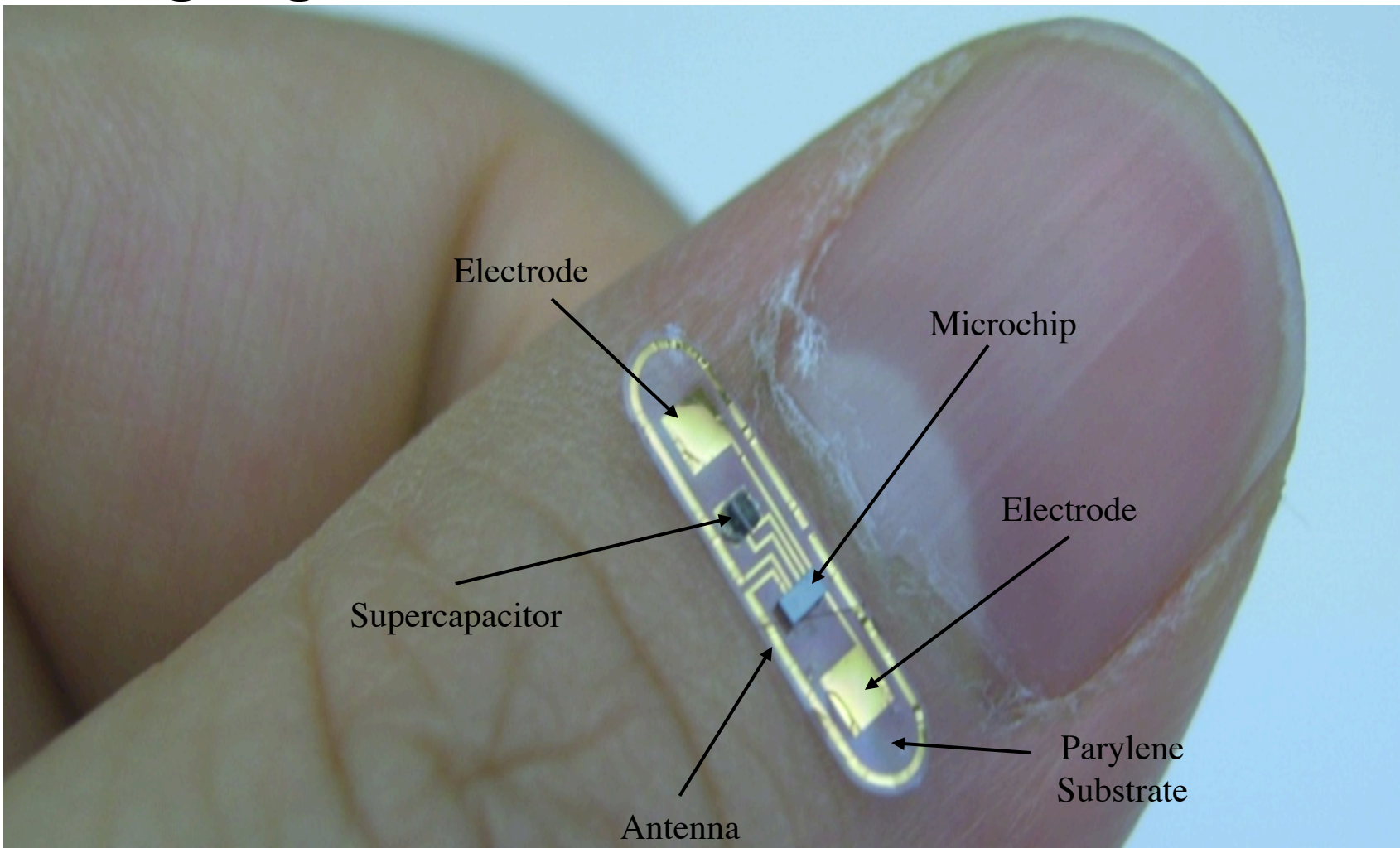


William Chappell
Professor



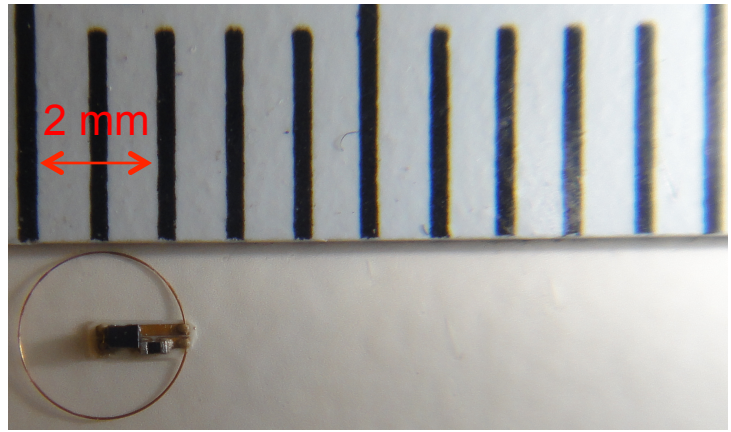


Packaging:



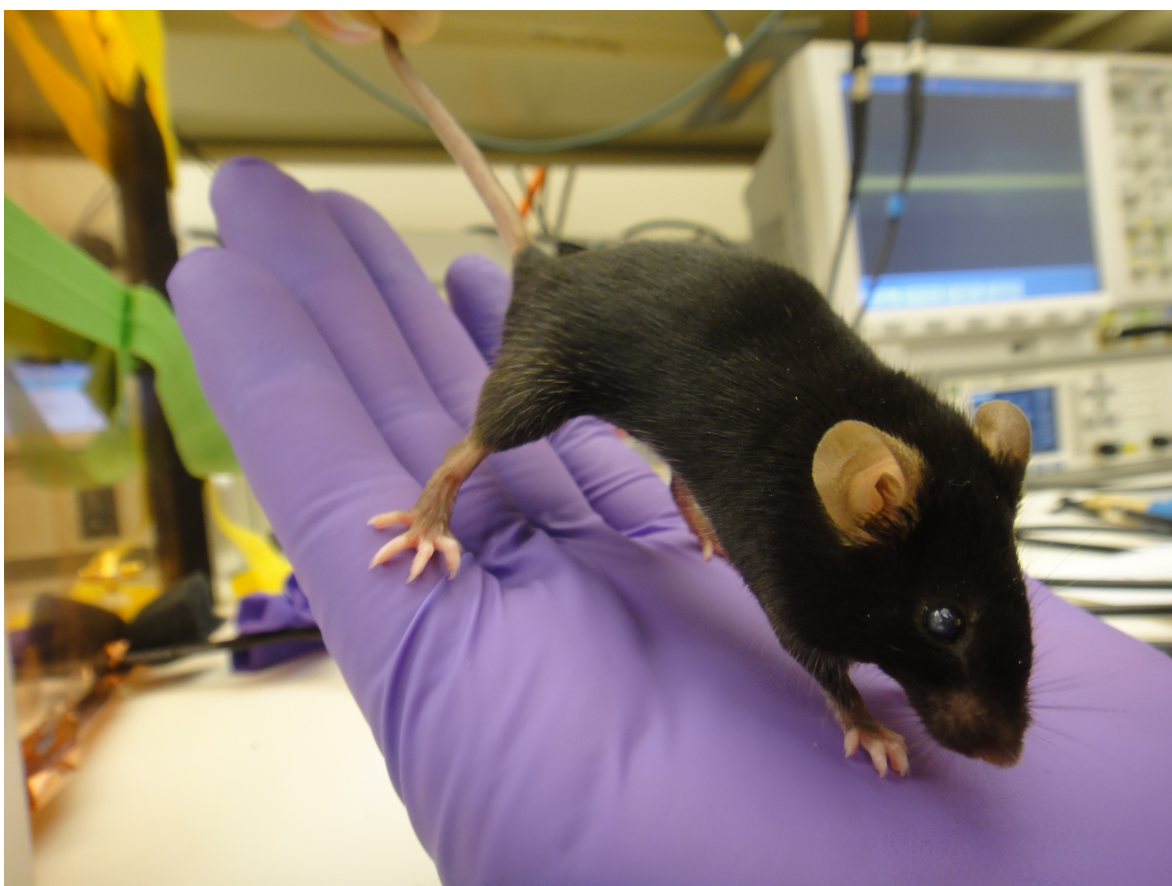
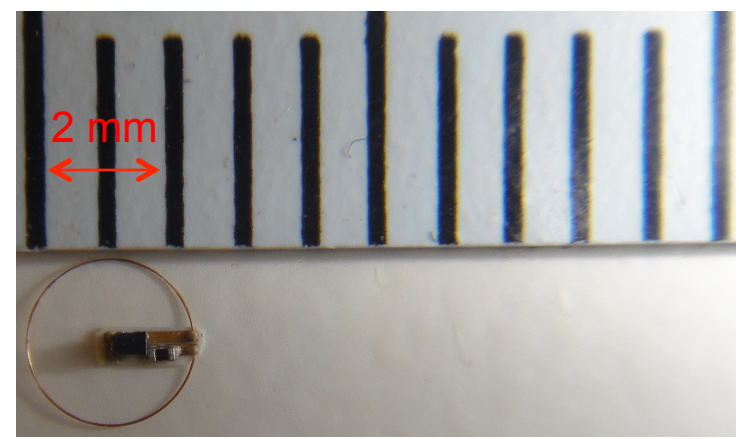


Miniaturization



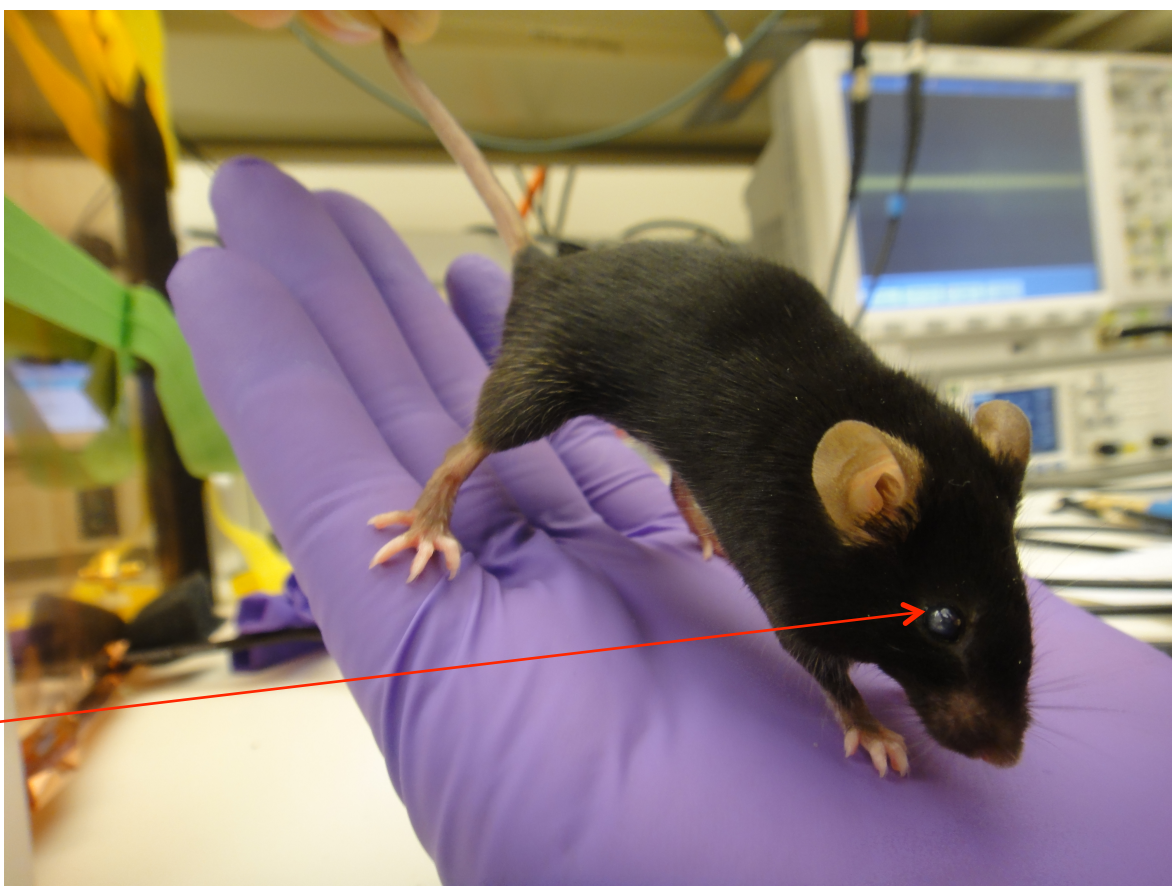
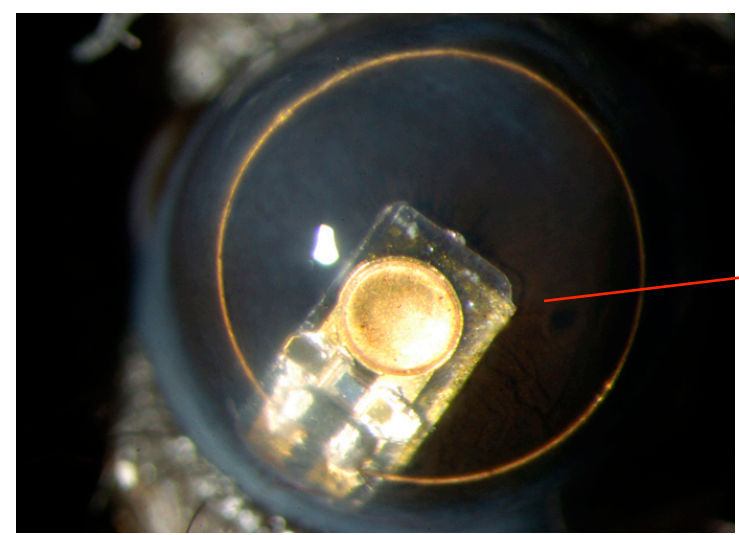
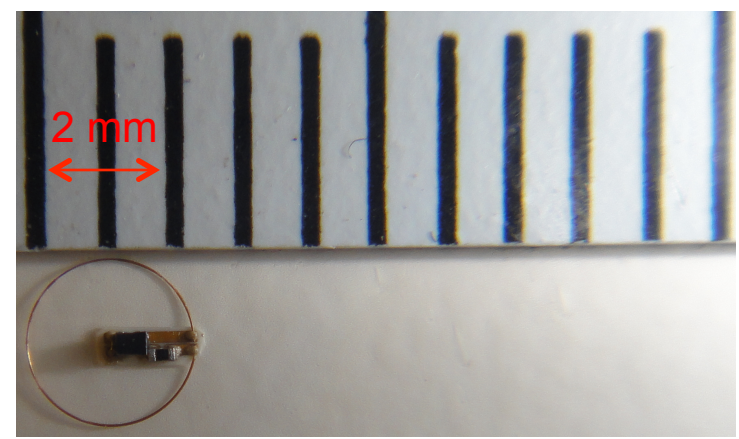


Miniaturization





Miniaturization



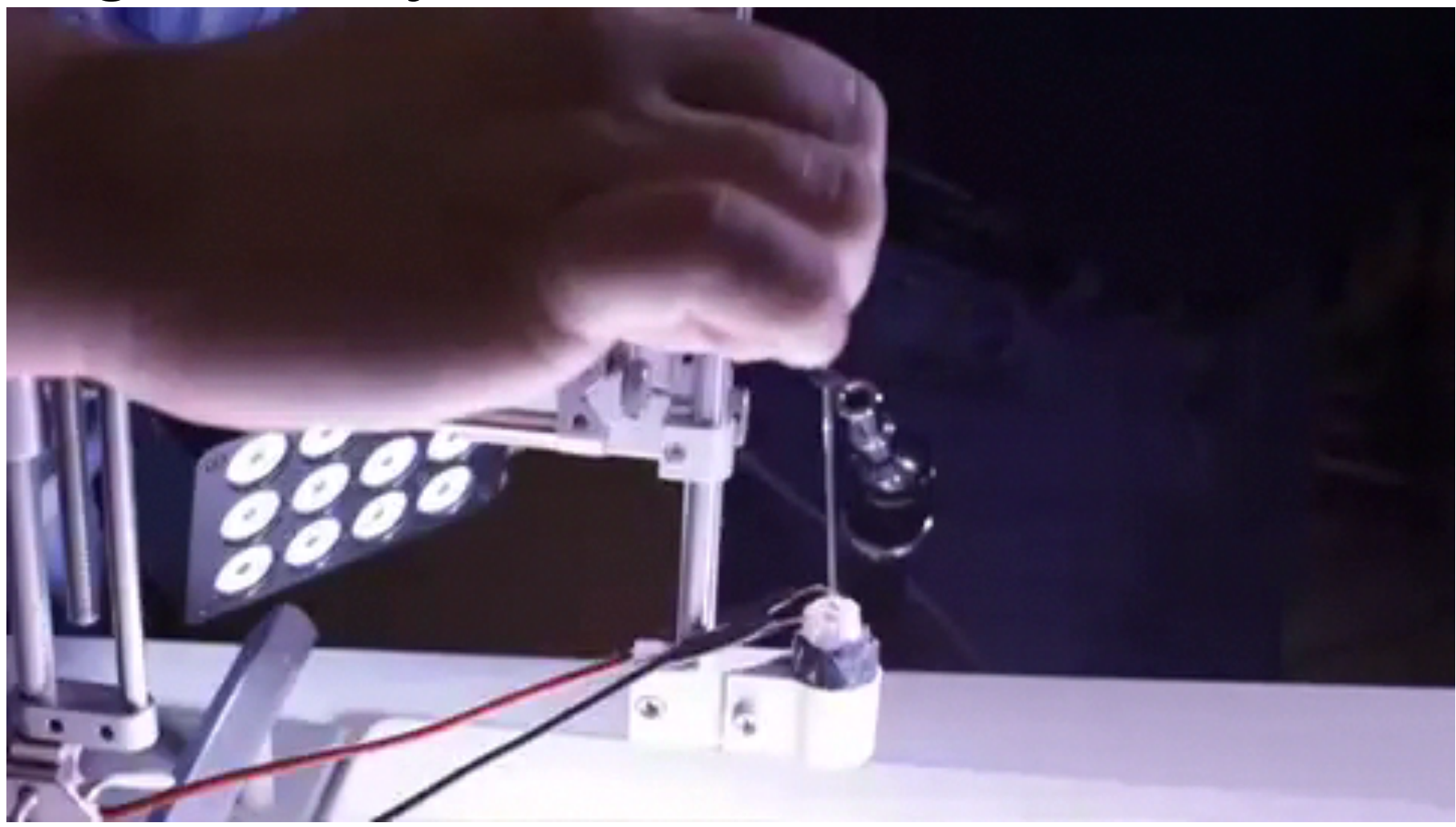


Further miniaturization



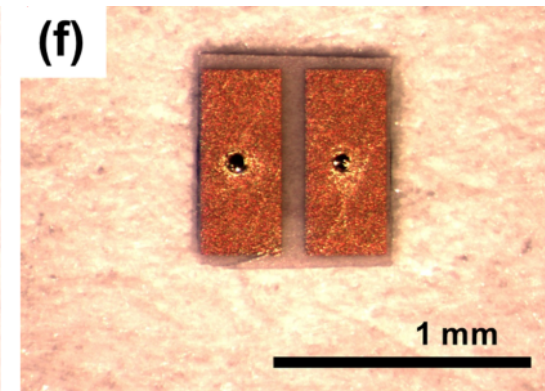
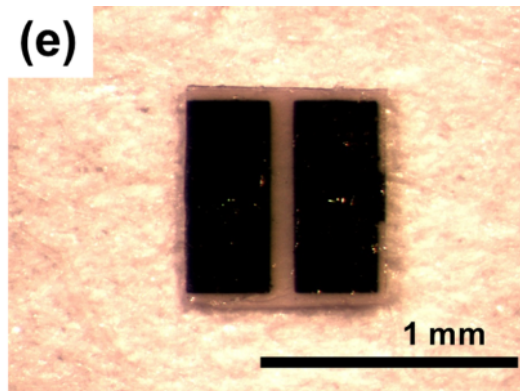
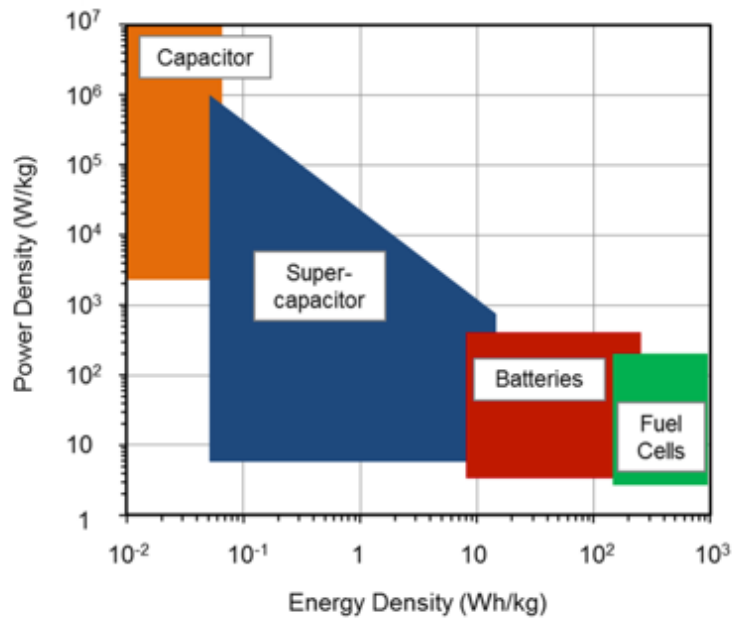
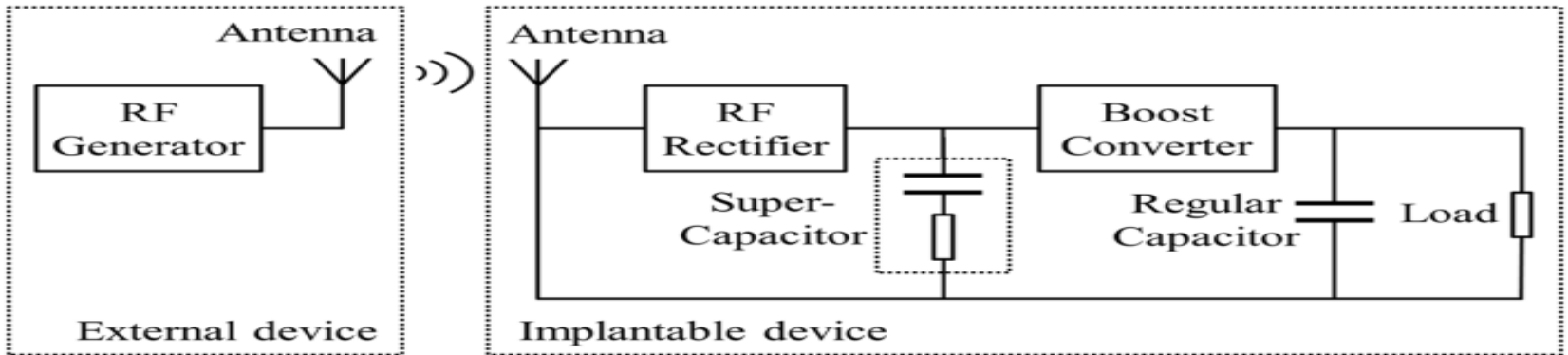


Magnetically driven insertion





Energy harvesting





Energy harvesting





Why

- **Our idea?**
 - **Combine Purdue:**
 - Implantable devices
 - Nanotechnology
 - Clinical partnerships
 - **Fill key gaps in**
 - Faculty
 - Facilities
 - **Preeminence**





Center for Implantable Devices
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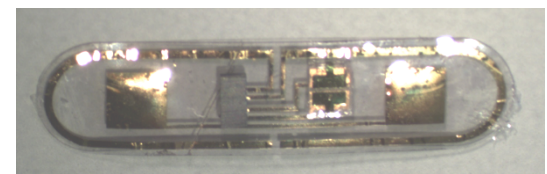
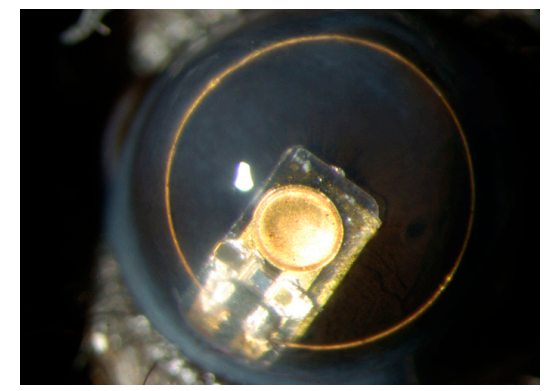
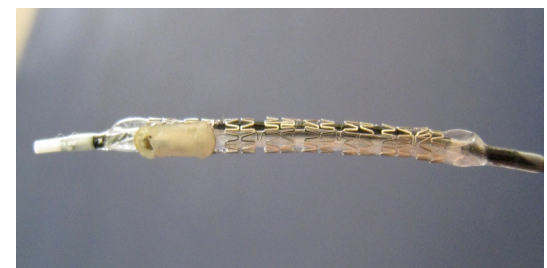


New faculty





Networked wireless nano-implants



Courtesy of DEKA Research & Development and
The Rehabilitation Institute of Chicago





Networked wireless nano-implants

