Science Foundry

# Innovating in the MEMS Foundry Business

February 12, 2025

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# The MEMS foundry business needs innovation.

**EXPENSIVE**

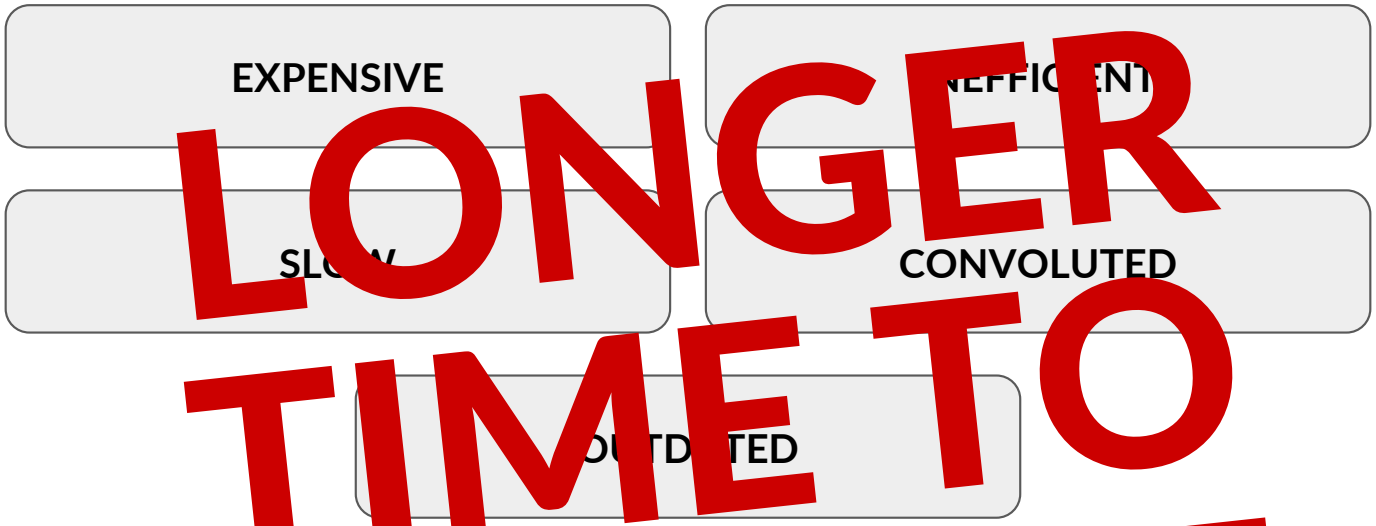
**INEFFICIENT**

**SLOW**

**CONVOLUTED**

**OUTDATED**

The MEMS foundry business needs innovation.



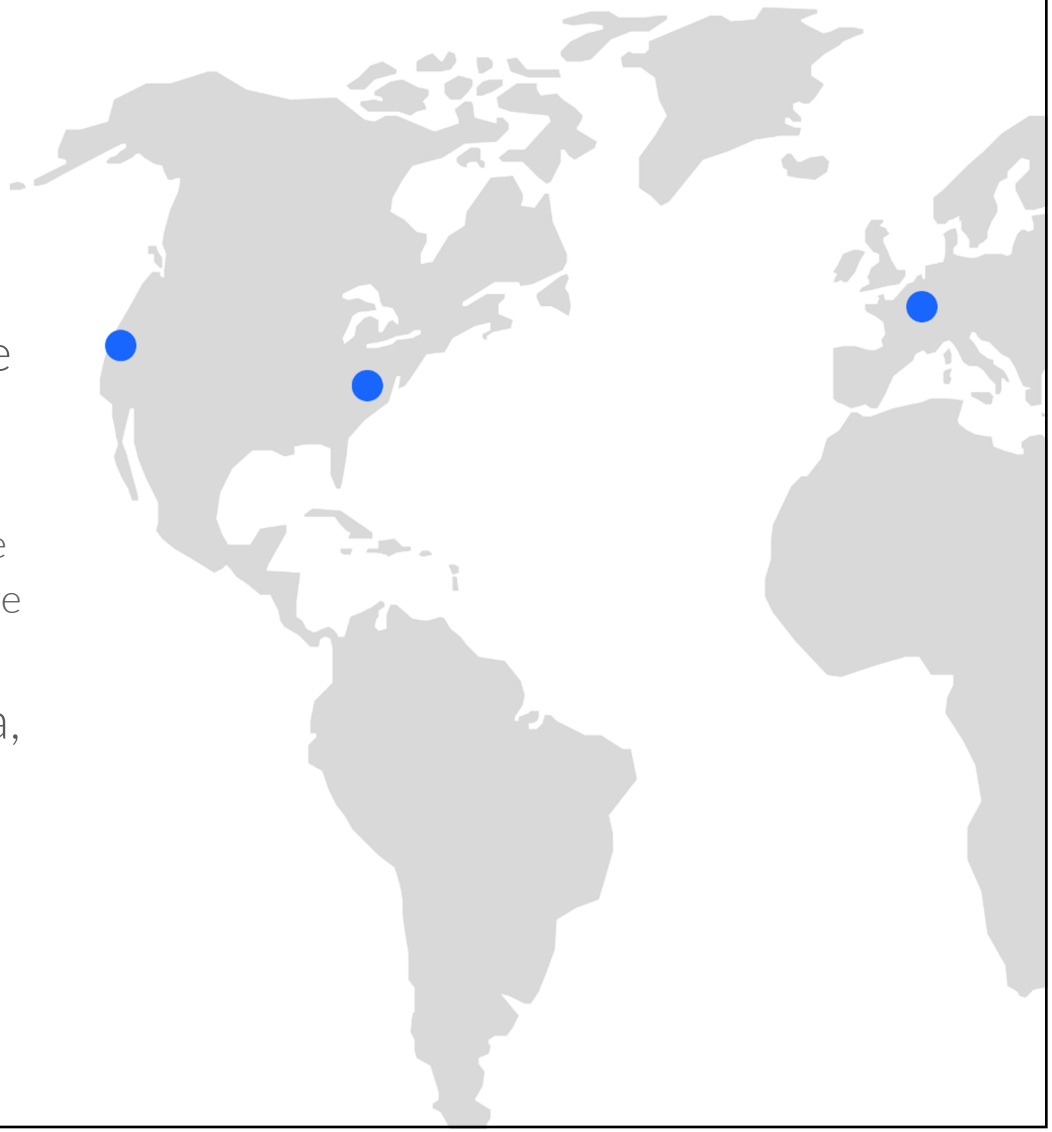
# Science Foundry addresses these pain points

~~**OUTDATED**~~ ~~**EXPENSIVE**~~ ~~**SLOW**~~ ~~**INEFFICIENT**~~ ~~**CONVOLUTED**~~

- Rapid prototyping with MEMS multi-project wafers
- Streamlined operations with a custom MES
- Scaling up capacity quickly and efficiently

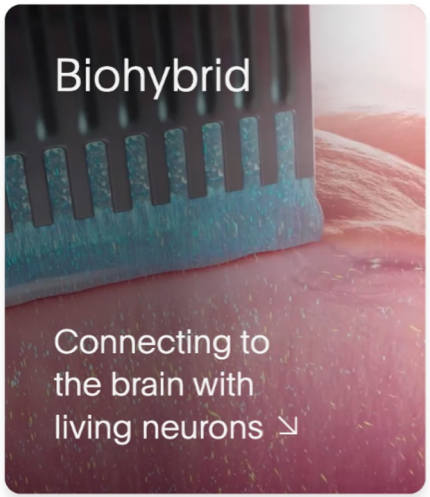
# Science Corp Overview

- Founded April 2021
- Science Corporation is a clinical-stage medical technology company
  - Dozens of patients in six countries.
  - We work to restore quality of life to those with debilitating conditions for which there are no treatment options
- Headquartered in Alameda, California, we are a global company with secondary offices in Durham, North Carolina and Paris, France.



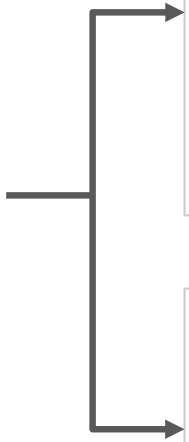
# Science A brighter tomorrow enabled by neural engineering

We are a clinical stage, vertically integrated technology company focused on solving some of neuroscience's hardest questions and most serious unmet medical needs.



# Two Broad Mandates



## Restore Functionality

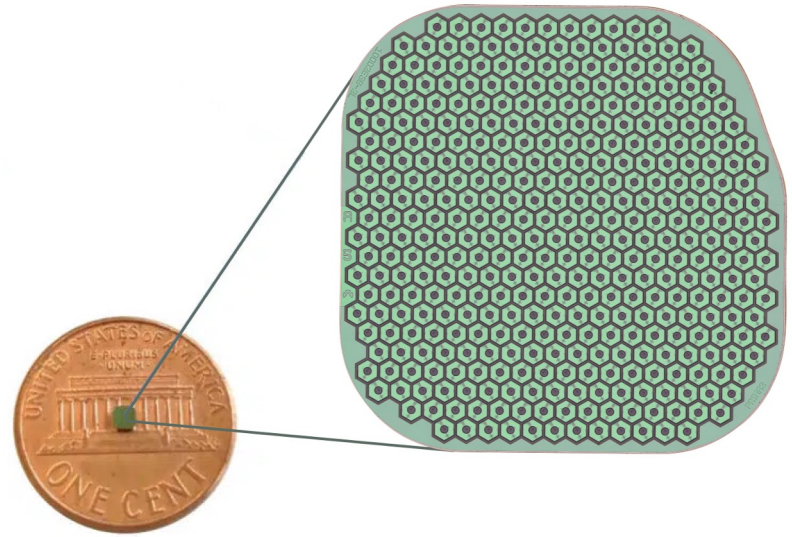
- Vision
- Cognition
- Mobility

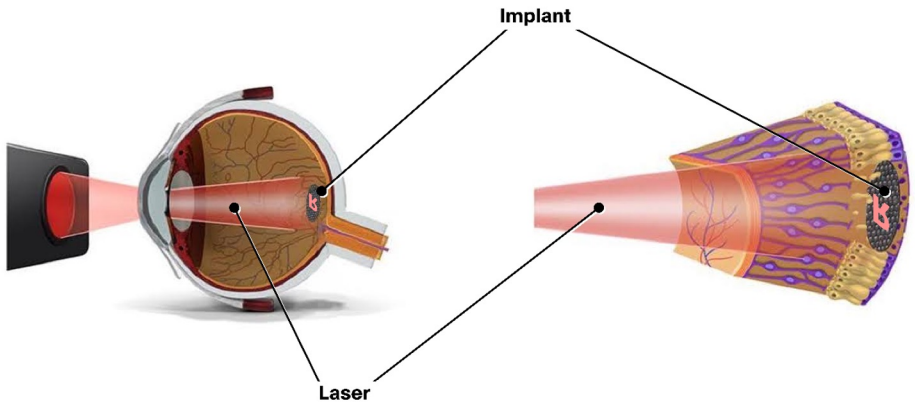
## Advance Neural Engineering

- Commercial Neural Interfaces

# **Restore Vision:** PRIMA Implant

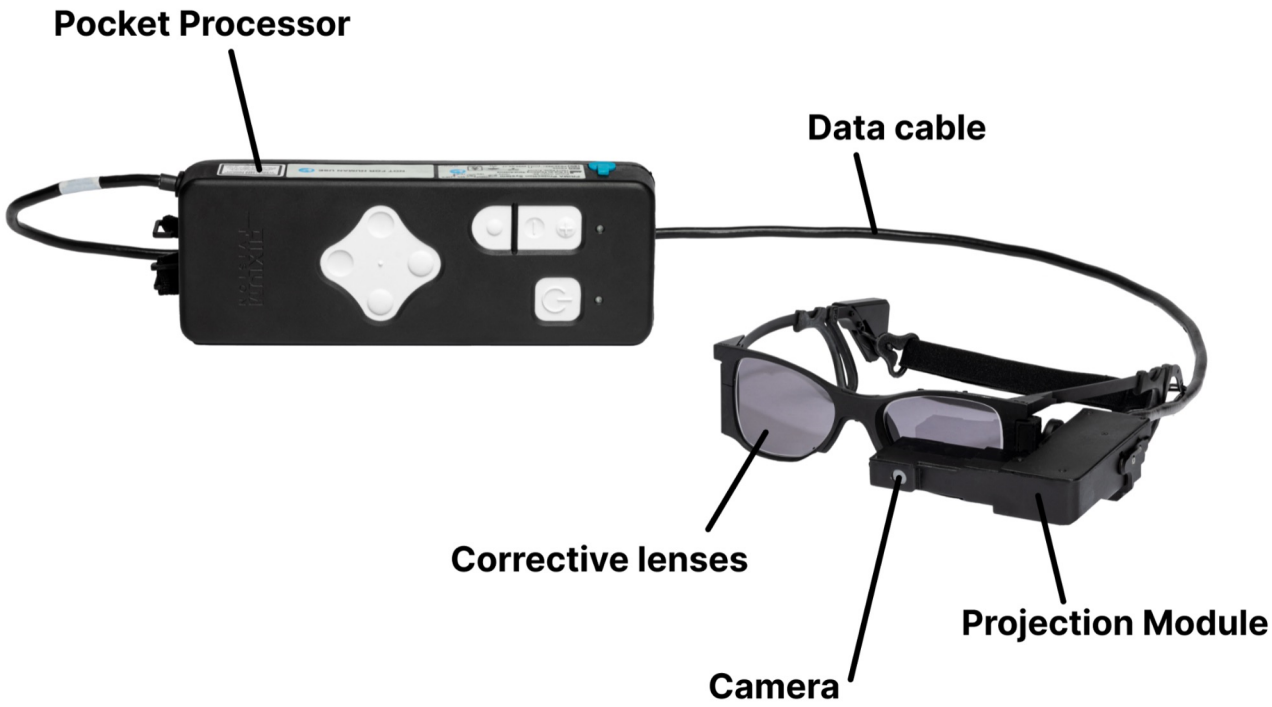
Photovoltaic device



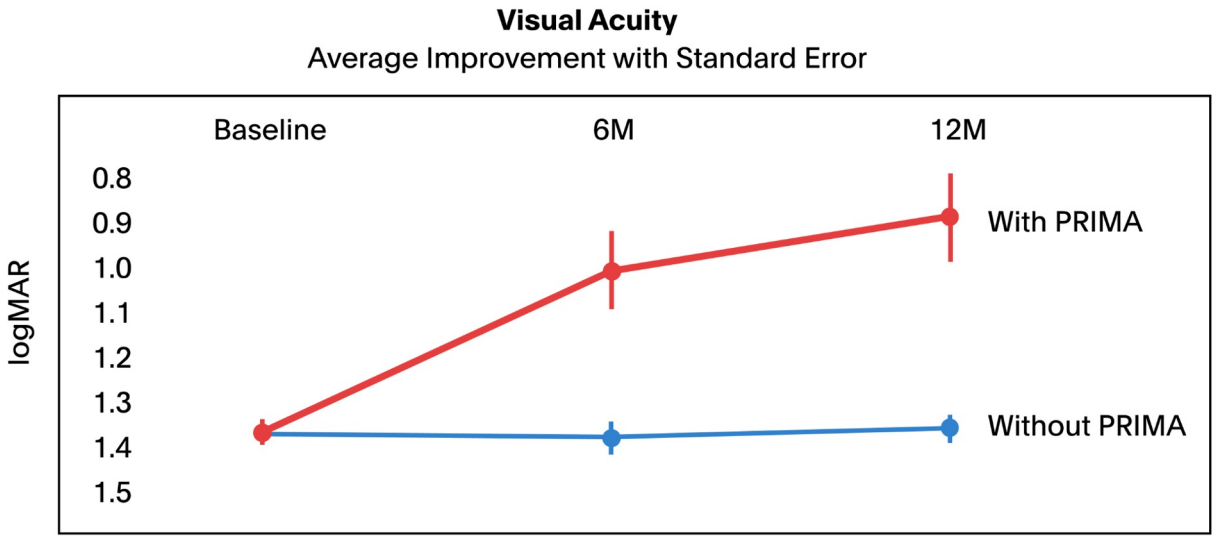
# **Restore Vision:** PRIMA Implant

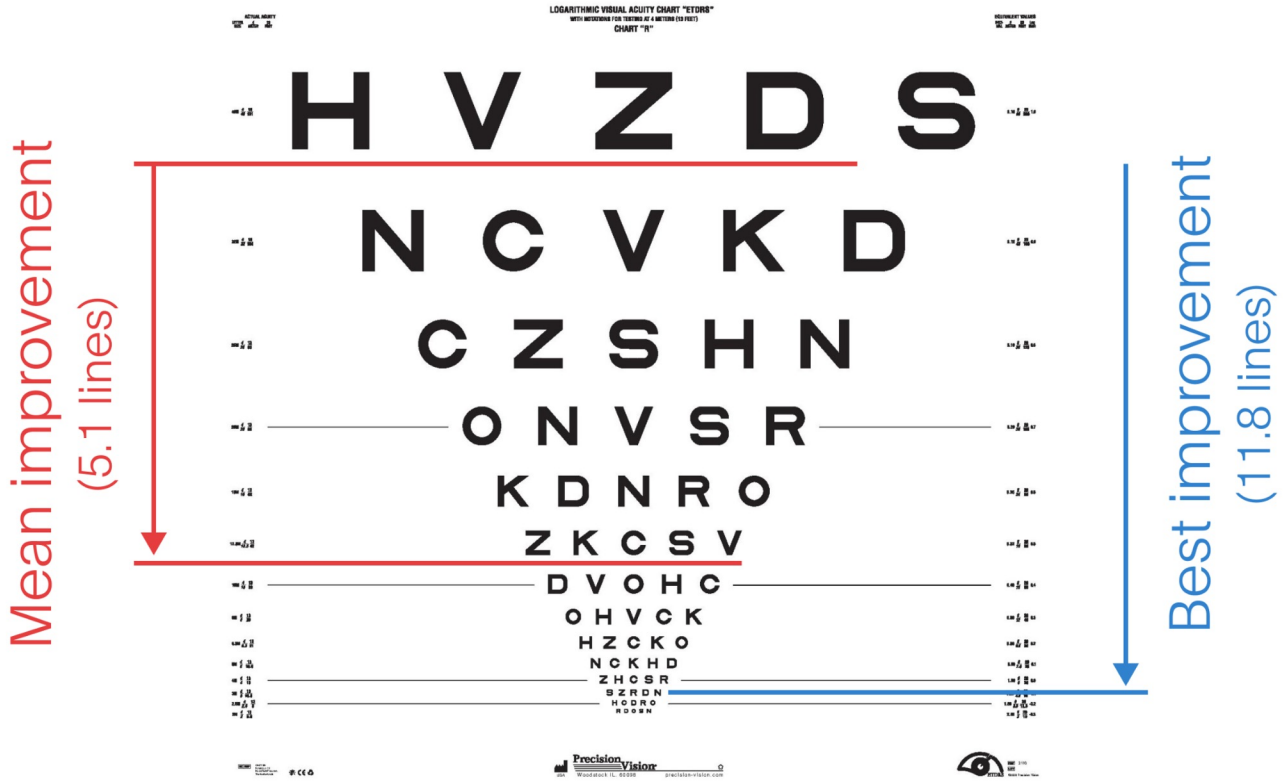
Companion



# Preliminary Clinical Trial Results

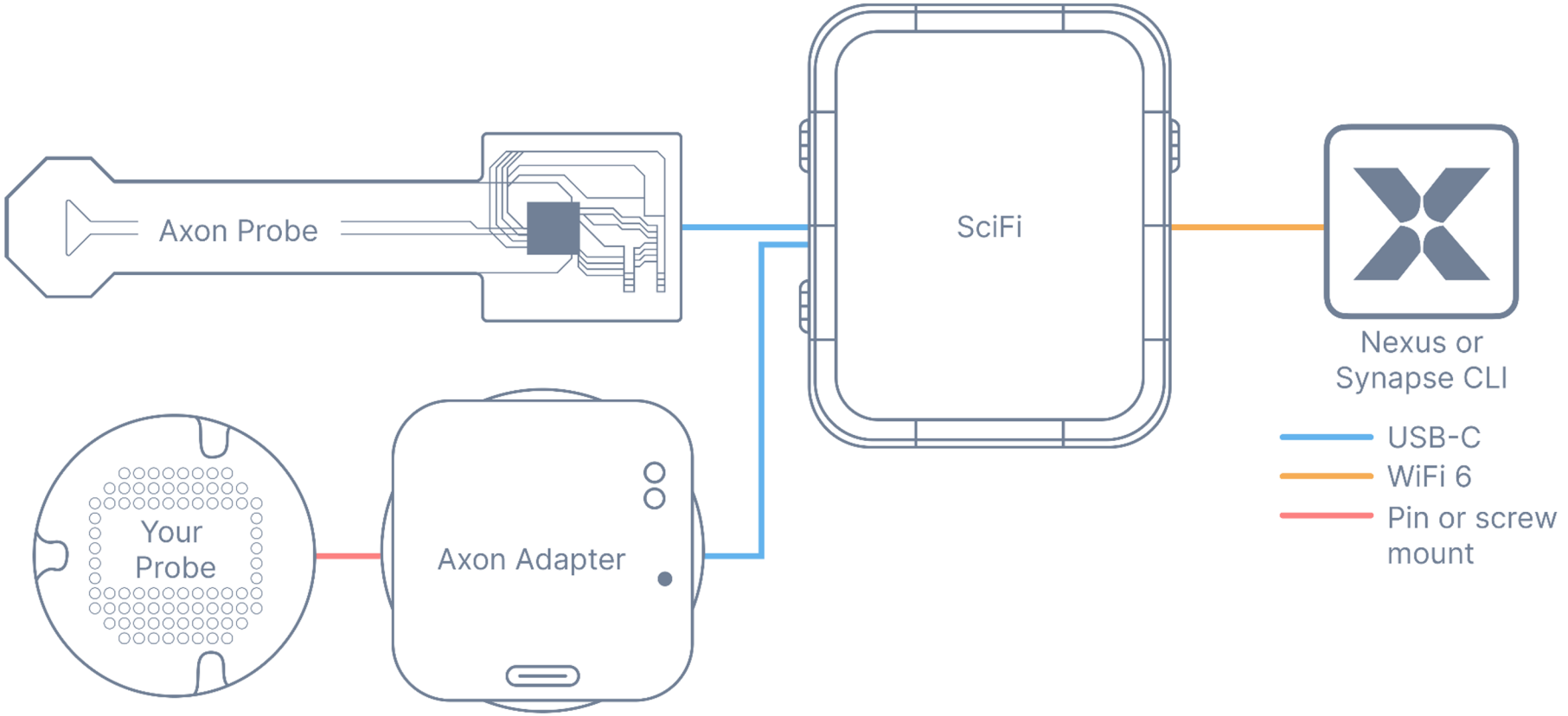
- 38 Patients
- 17 sites across 5 countries
- Over age 60, with Geographic Atrophy > 4.5mm2
- logMAR 1.2 (20/320) or worse

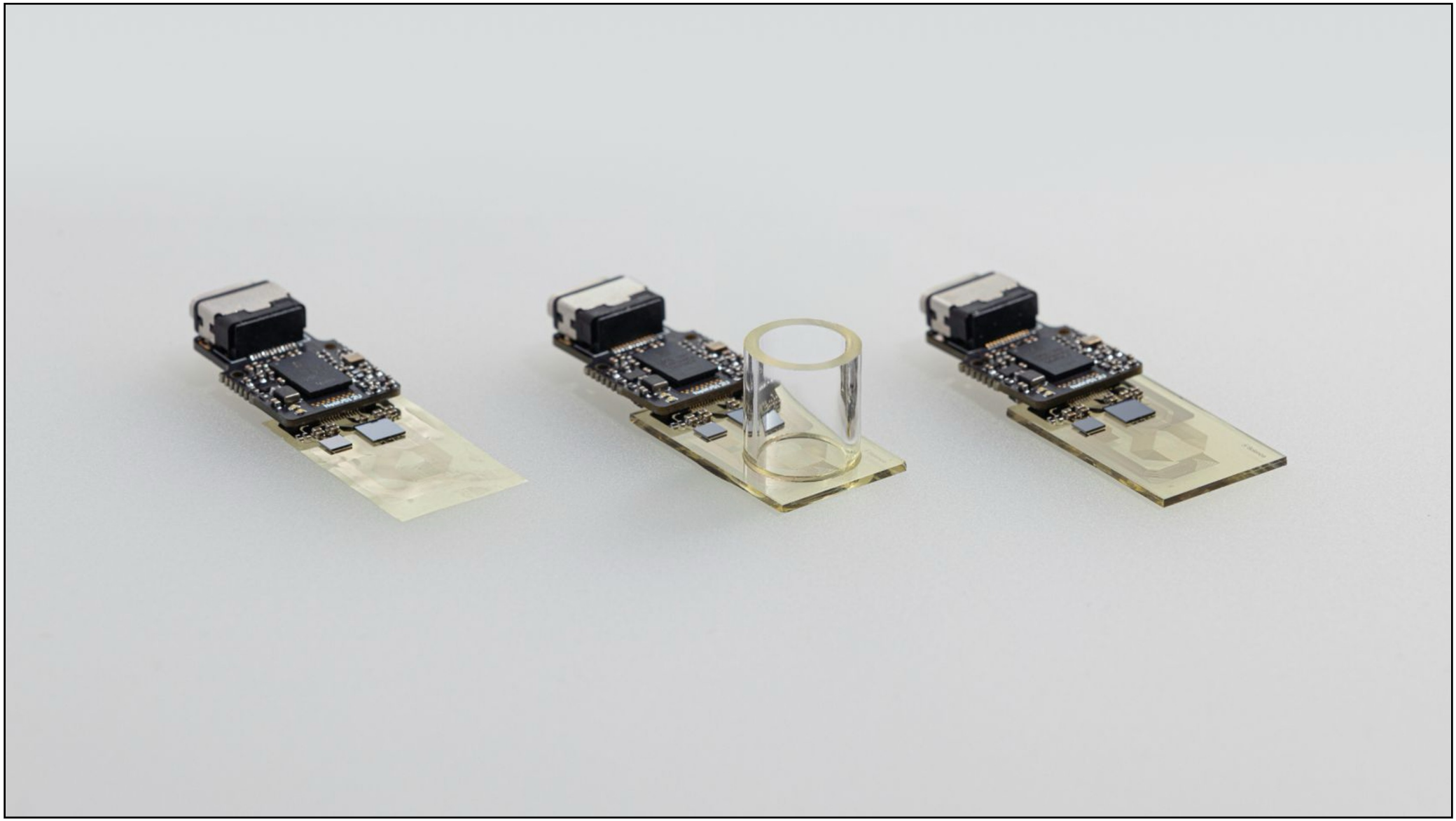





Includes use of digital zoom


Commercial Neural Interfaces


Axon Probe
SciFi
Nexus or
Synapse CLI
Your
Probe
Axon Adapter
USB-C
WiFi 6
Pin or screw
mount



# Ambitious mandates drive need for vertical integration at Science

- Need a lot of things fast
- Want to control our own destiny
- Lower barriers for others in our field
- Further neural engineering as a whole

Ambitious mandates drive need for v[illegible]ical integration at Science

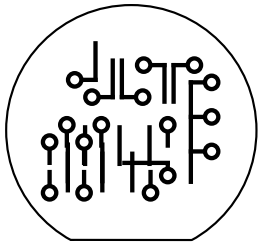
- Need [illegible]of things fast
- Want to c[illegible]
- Lower barriers
- Further

# Science Foundry Overview

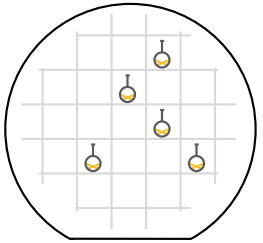
# New brand for an established fab


5000 ft$^2$ of Class 100 Cleanroom ● ISO 9001:2015 Certified ● 6” Wafer Line ● Durham, NC

Custom Processes



Multi-Project Wafer Runs



## Science Foundry is your fastest path from design to device

### Dry Etching

Reactive ion etching
Deep silicon etching
Plasma cleaning

### Wet Etching

Wet metal
Wet oxide
Silicon etching
Immersion cleaning

### Metallization

Evaporation
Au, Cu, Ti, Cr, Pt, Ni, Al
Sputtering
Cr, Au, Ti, TiW, Cu

### Lithography

Contact lithography
Projection lithography
Backside alignment

### LPCVD

Oxide
Nitride
Polysilicon
Polysilicate glass

### Polymers

Polyimide insulation
Polyimide protection

### Dicing

Silicon
Glass
Quartz
Sapphire

### Post Processing

HF liquid release
HF vapor release
Critical CO drying

### Wafer Bonding

Fusion
Glass-glass
Silicon-glass
Eutectic
Anodic

### Material Removal

Wafer polishing
Wafer grinding

### Metrology

SEM
Profilometry
Infrared inspection
Interferometry
Film analysis

# We create a wide range of complex MEMS devices

## Biomedical & Healthcare Technology

Neural Interface Devices
Microneedles
Microfluidic Chips
Ultrasound Devices

## Industrial Sensing, Control & Automation

Inertial Sensors
Pressure Sensors
Gas Sensors
Environmental Sensors

## Communications & Optoelectronics

Micro Mirrors
Imaging Devices
Optical Telecom Components
Silicon Photonics

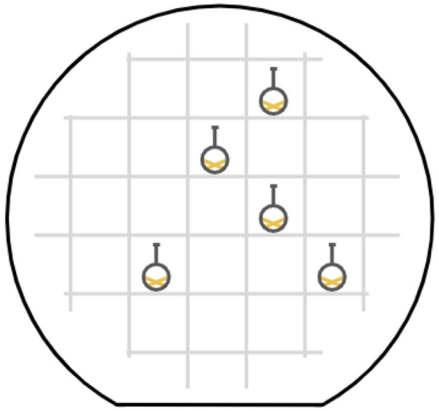
## Advanced Computing & More

Quantum Computing
Internet of Things (IoT) Devices
Wearables Sensors
Your Novel MEMS Device

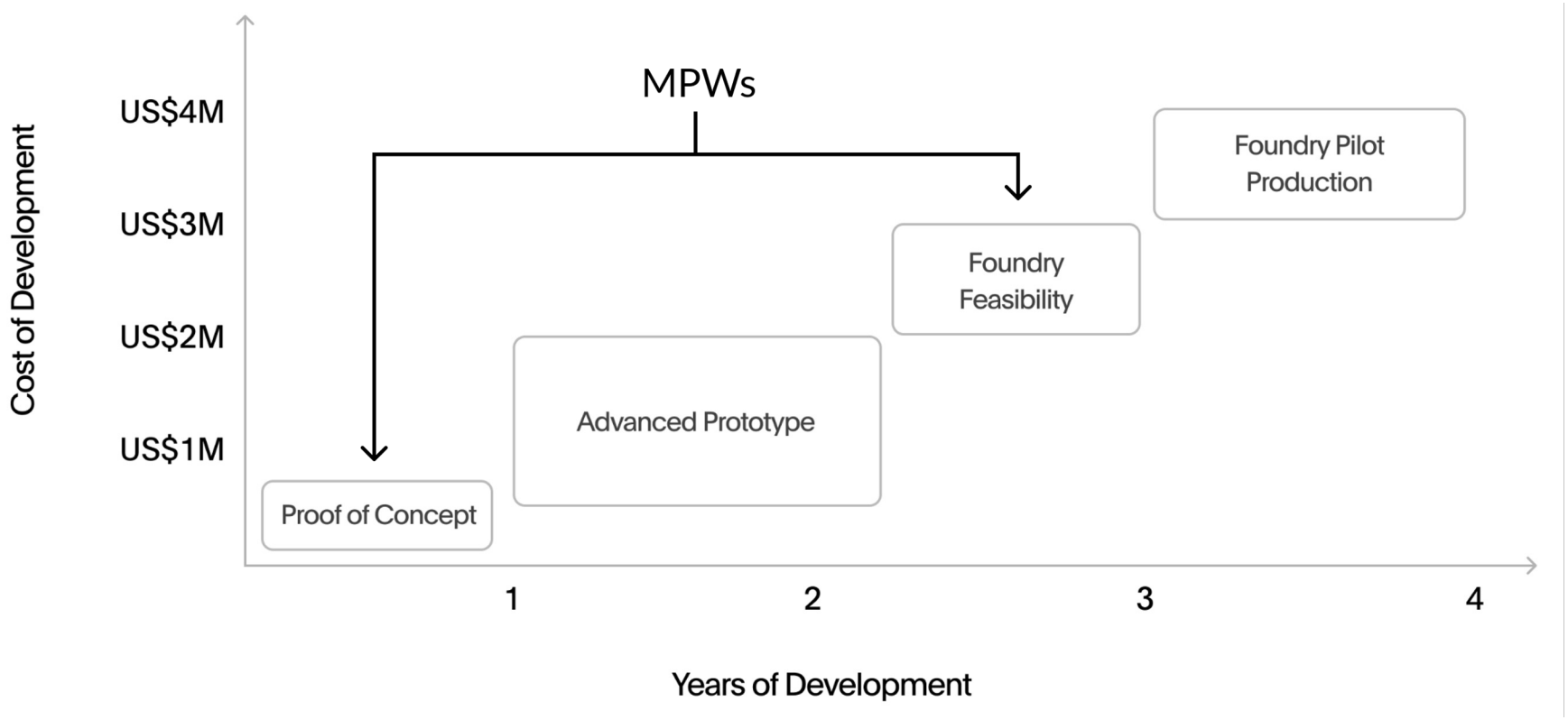
# Science Foundry innovates in three key ways:

1. MEMS Multi-Project Wafer Offerings
2. Custom Manufacturing Execution System
3. Modular Facility Expansion

# MEMS Multi-Project Wafers
# == Science Standard Technologies



# The MEMS prototyping phase is LONG

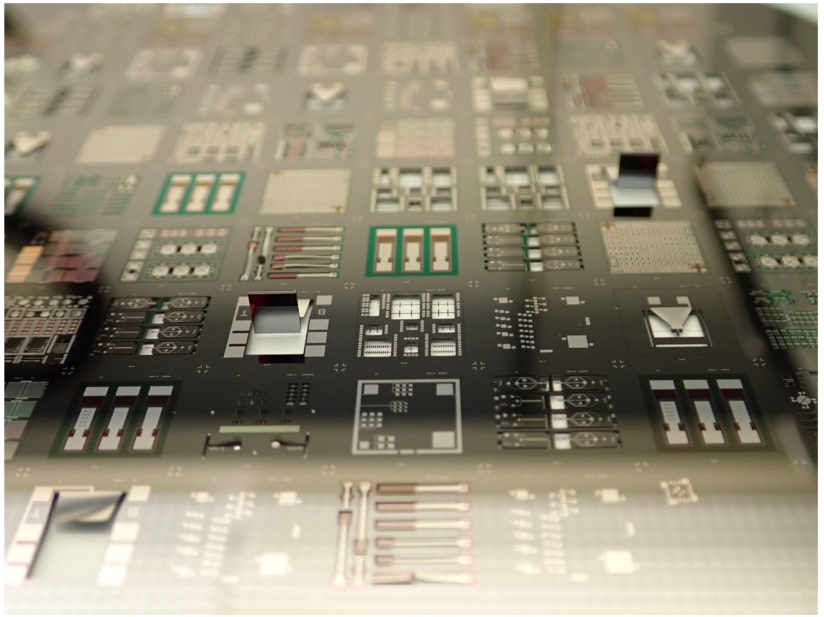


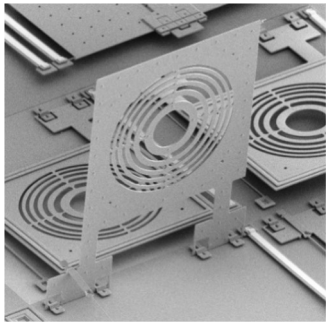

*[adapted from MEMS Product Development, Fitzgerald et. al.]*

# MEMS Multi-Project Wafers (MPW)

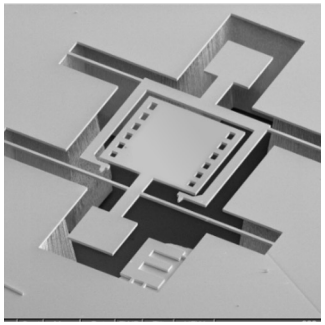
- Production quality processing
- User submitted designs
- Multiple scheduled runs/year
- 100,000s of devices shipped
- 200+ process runs

Fastest path from design to device!

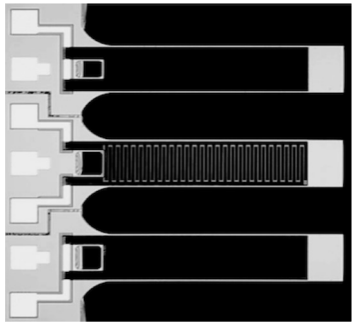




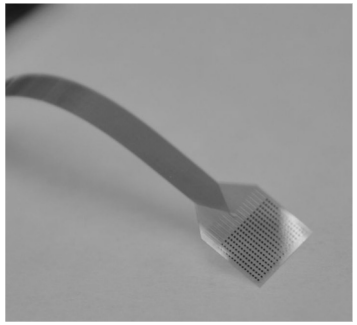
Poly



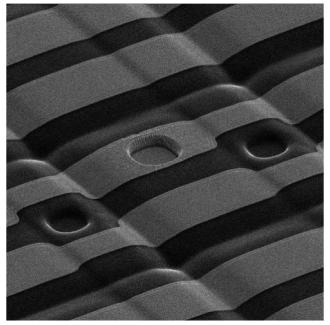
SOI



Piezo



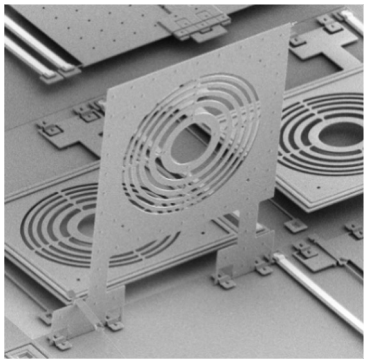
TFE



TFE+

# Polysilicon

Once per year, ~18 week cycle time



*Images courtesy of the School of Engineering Science at Simon Fraser University*

Optical neural interfaces, biometric wearables, astronomy, laser communications, maskless lithography, and ultrasound wearables.

Nitride: 0.6 µm

Polysilicon 0: 0.5 µm

Oxide 1: 0.5 µm

Polysilicon 1: 2.0 µm

Oxide 2: 0.5 µm

Polysilicon 2: 1.5 µm

Metal: 0.5 µm

Substrate

- Eight masks
- Three polysilicon layers
- One metal layer

# Silicon-on-Insulator (SOI)

3X per year, ~10 week cycle time

Pad metal: 0.52 µm

Silicon: 25 µm

Substrate: 400 µm

Buried oxide: 2 µm

Blanket metal: 0.65 µm

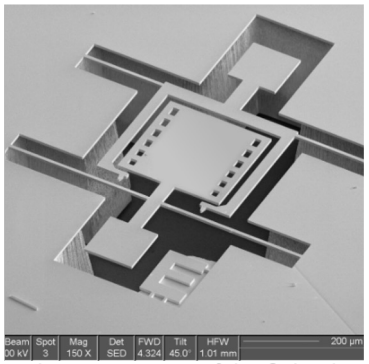


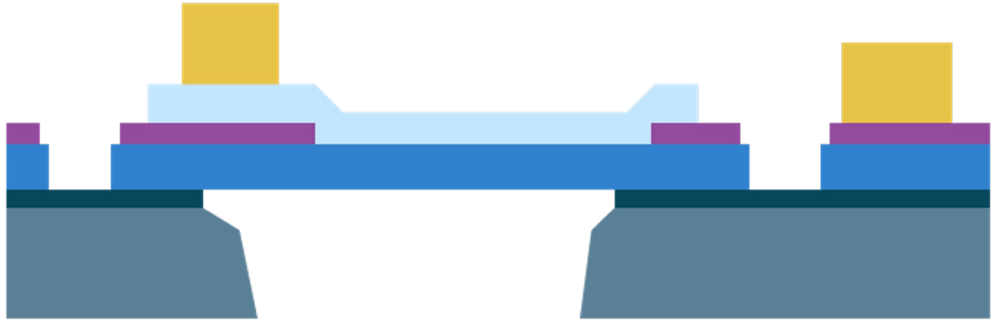

*Image courtesy of the School of Engineering Science at Simon Fraser University*

Optical fiber telecoms, automotive LiDAR, RF switches, nuclear energy, and electric grid monitoring

- Four masks
- SOI wafer
- Two metal layers

# Piezo

3X per year, ~14 week cycle time



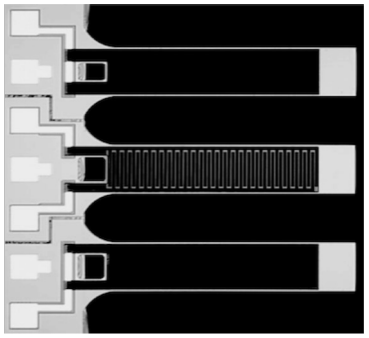


*Image courtesy of Joan Pons-Nin et al.*

Energy harvesting & timing, implantable hearing aids, atomic force microscopy, optics and photonics, and real time health monitoring.

Pad oxide: 0.2 µm

Piezoelectric film: 0.5 µm

Pad metal: 1.02 µm

Silicon: 10 µm

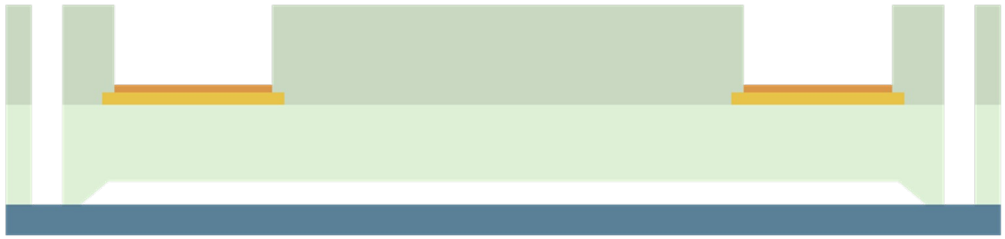
Substrate: 400 µm

Buried oxide: 1 µm

- Five masks
- SOI wafer
- Distinct metal and piezoelectric (AIN) layers

# Thin Film Electronics (TFE)

As needed, ~6 week cycle time



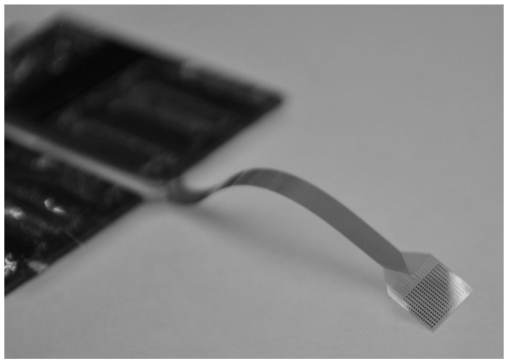
Polyimide 1: 5 µm

Metal 1: 0.24 µm

Polyimide 2: 5 µm

Top metal: 0.10 µm

- Three masks
- Two polyimide layers
- Two metal layers

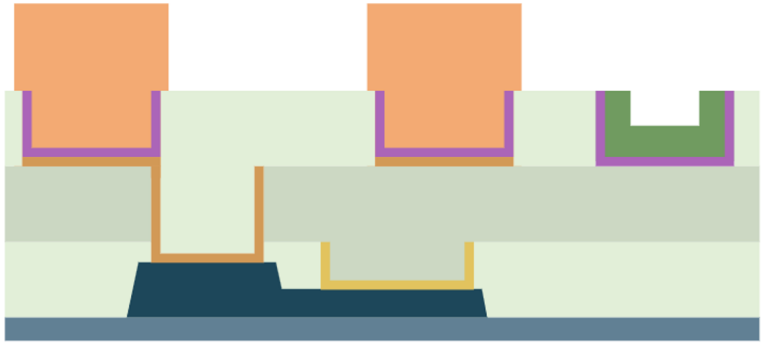


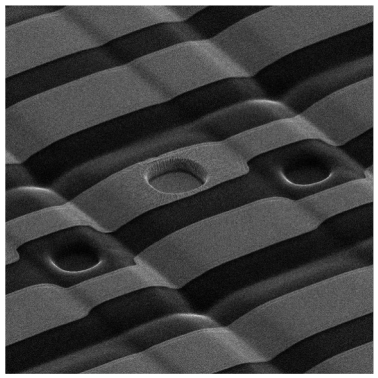
*internal 256ch µECoG array*

Flex cables, interposers, neural interface devices (NIDs)

# 2 Layer TFE + µLEDs

As needed, ~8-12 week cycle time





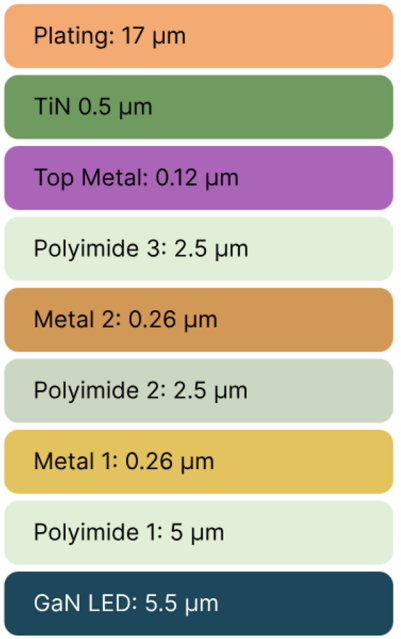
## Additions to TFE

Multi-layer routing

MicroLEDs

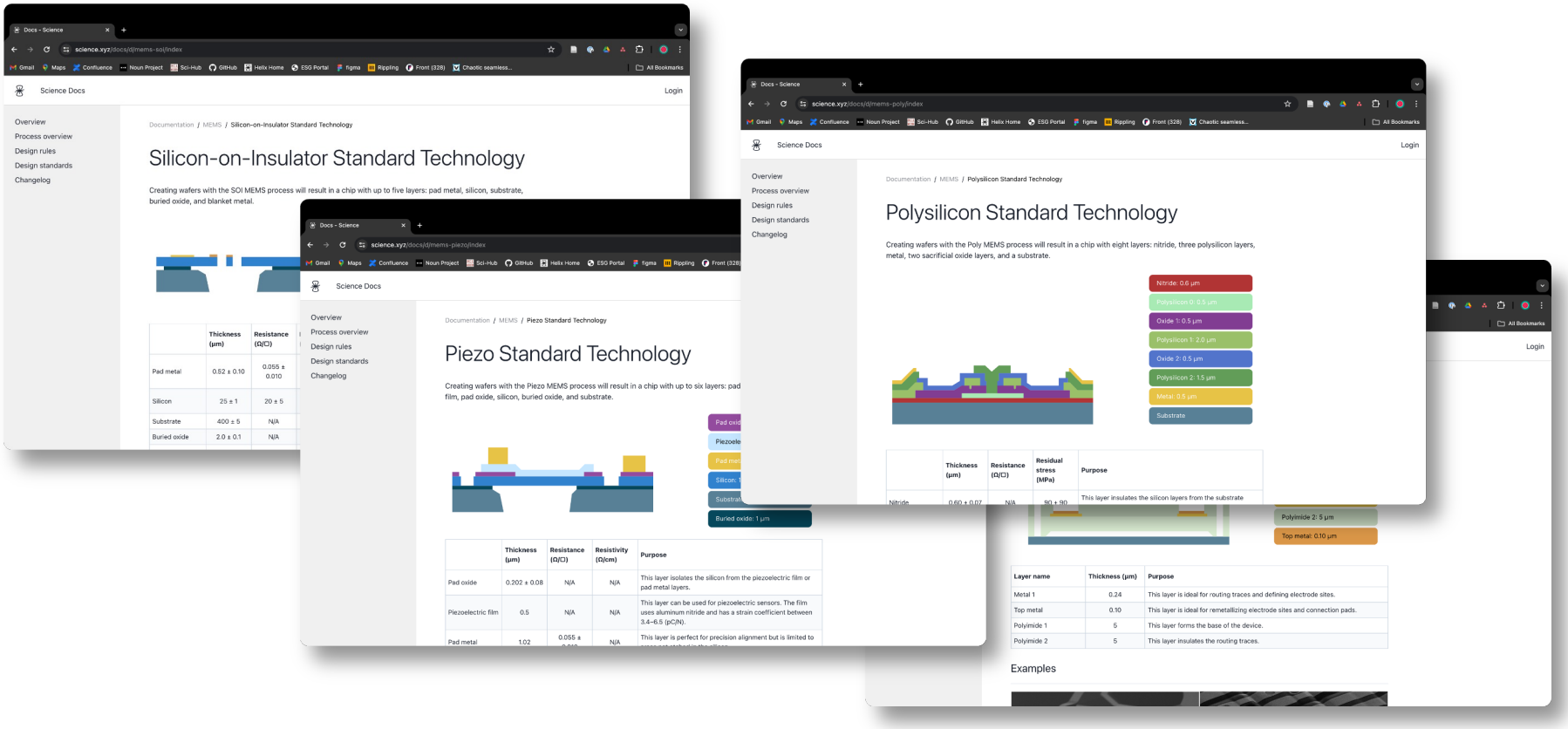
Electroplating

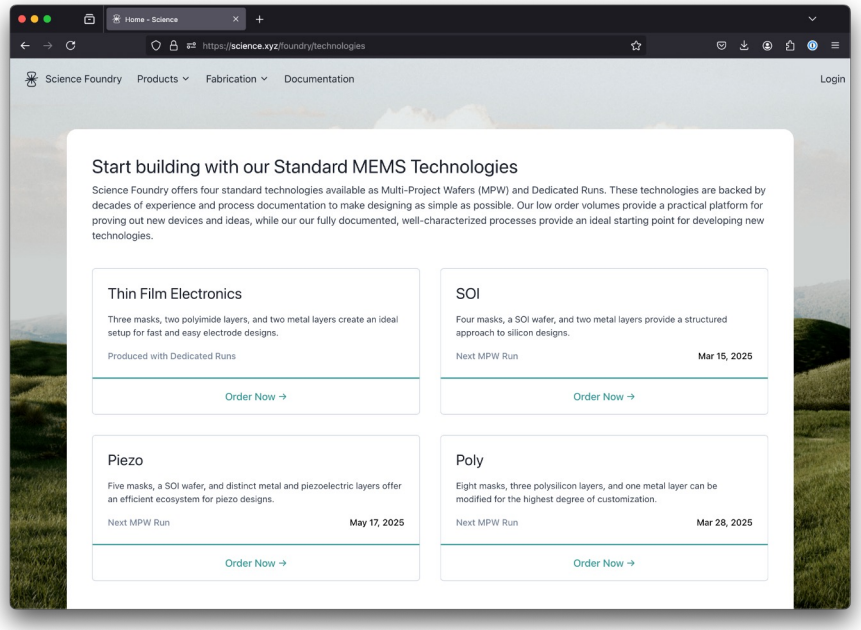
New electrode materials




- 8-11 masks
- Three polyimide layers
- Three metal layers
- Electroplating
- GaN uLEDs

# Public process documentation & design guidelines




Home - Science
https://science.xyz/foundry/technologies
Science Foundry
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Fabrication
Documentation
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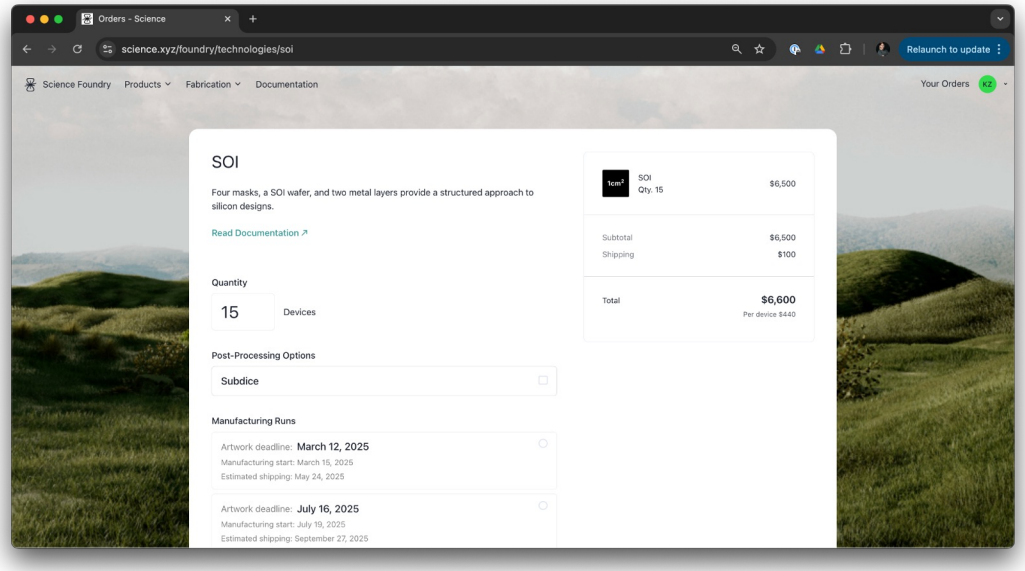
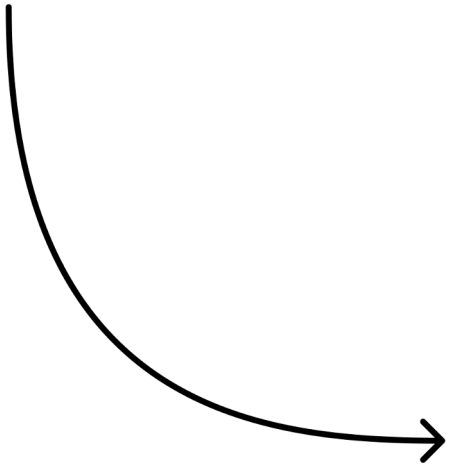
Start building with our Standard MEMS Technologies
Science Foundry offers four standard technologies available as Multi-Project Wafers (MPW) and Dedicated Runs. These technologies are backed by decades of experience and process documentation to make designing as simple as possible. Our low order volumes provide a practical platform for proving out new devices and ideas, while our our fully documented, well-characterized processes provide an ideal starting point for developing new technologies.
Thin Film Electronics
Three masks, two polyimide layers, and two metal layers create an ideal setup for fast and easy electrode designs.
Produced with Dedicated Runs
Order Now →
SOI
Four masks, a SOI wafer, and two metal layers provide a structured approach to silicon designs.
Next MPW Run
Mar 15, 2025
Order Now →
Piezo
Five masks, a SOI wafer, and distinct metal and piezoelectric layers offer an efficient ecosystem for piezo designs.
Next MPW Run
May 17, 2025
Order Now →
Poly
Eight masks, three polysilicon layers, and one metal layer can be modified for the highest degree of customization.
Next MPW Run
Mar 28, 2025
Order Now →


Orders - Science
science.xyz/foundry/technologies/soi
Relaunch to update
Science Foundry
Products
Fabrication
Documentation
Your Orders
KZ
SOI
Four masks, a SOI wafer, and two metal layers provide a structured approach to silicon designs.
Read Documentation ↗
Quantity
15
Devices
Post-Processing Options
Subdice
Manufacturing Runs
Artwork deadline: March 12, 2025
Manufacturing start: March 15, 2025
Estimated shipping: May 24, 2025
Artwork deadline: July 16, 2025
Manufacturing start: July 19, 2025
Estimated shipping: September 27, 2025
1cm²
SOI
Qty. 15
$6,500
Subtotal
$6,500
Shipping
$100
Total
$6,600
Per device $440

Adding additional Standard Technologies requires extensive process development…



Needed to figure out an efficient way to do this without sacrificing production timelines


Custom Manufacturing Execution System (MES)
Helix
Inventory
Items
Equipment
Locations
Bill of Materials
Search...
Total Inventory Items
207
ITEM NAME
BrainPhys™ Neuronal Medium
CloneR2

# A standard MEMS Fab is already a complex beast

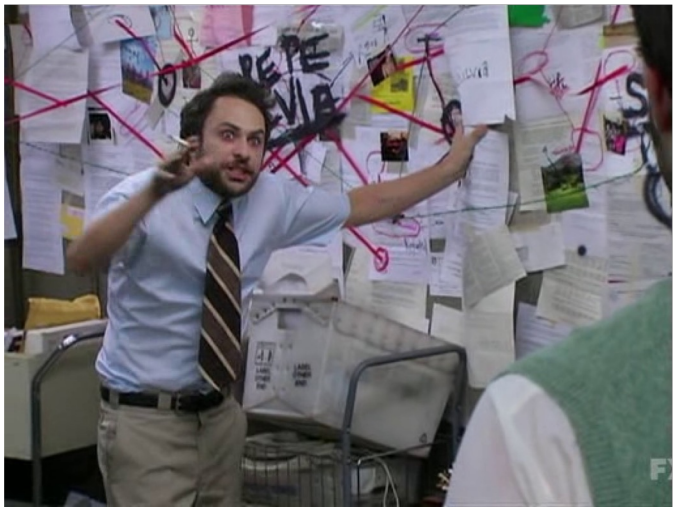
High-Mix Manufacturing

→ Wide variety of products

→ Mixed Volumes

→ Frequent Process Adjustments

→ High Degree of Customization

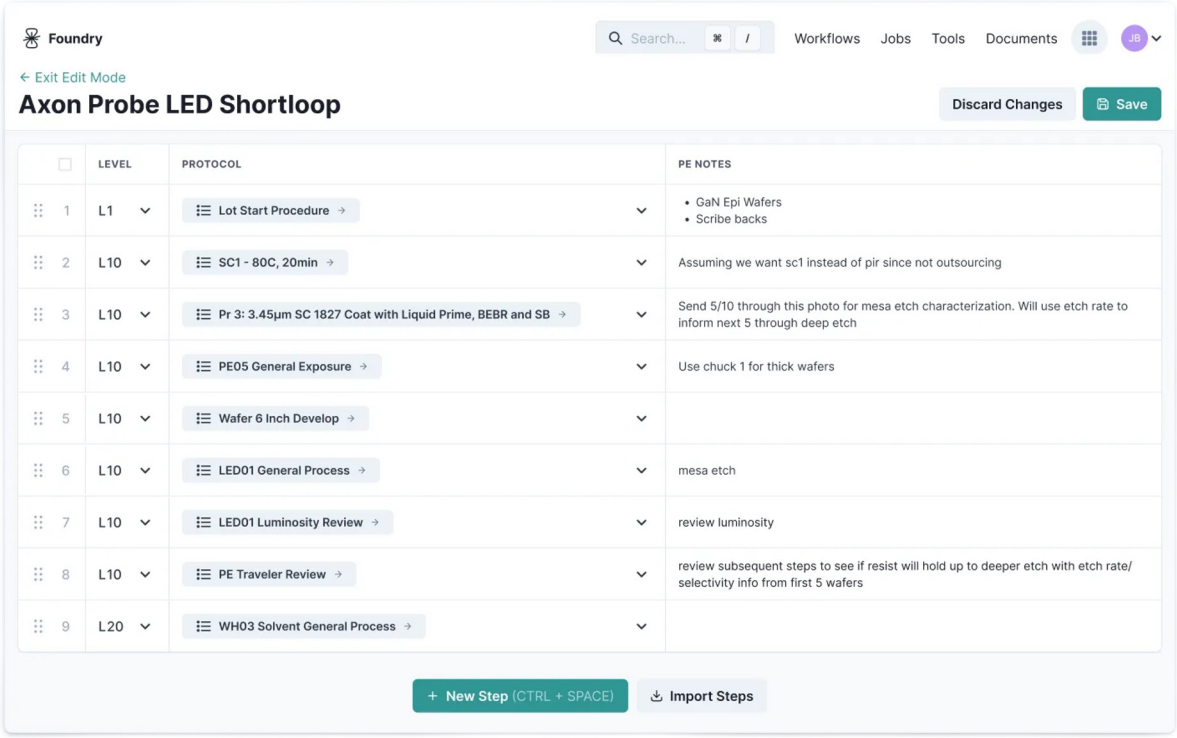


*Throw in R&D and it only gets worse!*

## Science Foundry's Solution: Model the entire fab in software

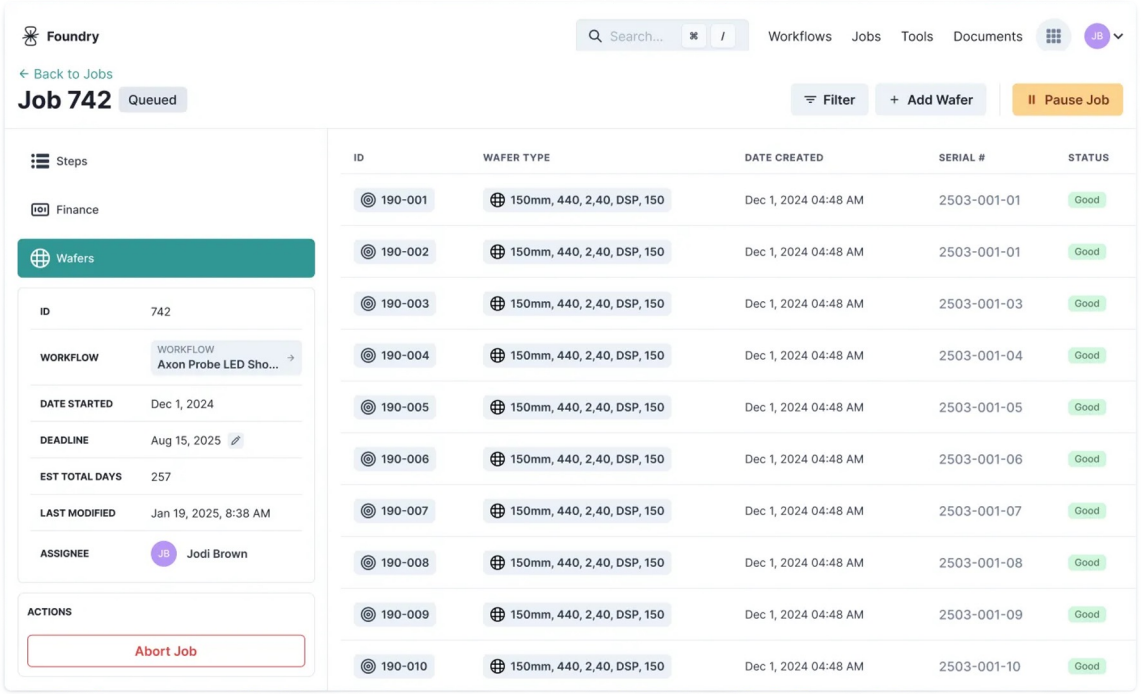
- Protocols
- Jobs
- People
- Tools
- Shifts
- Raw Materials
- Deadlines

# Multi-Step Workflows



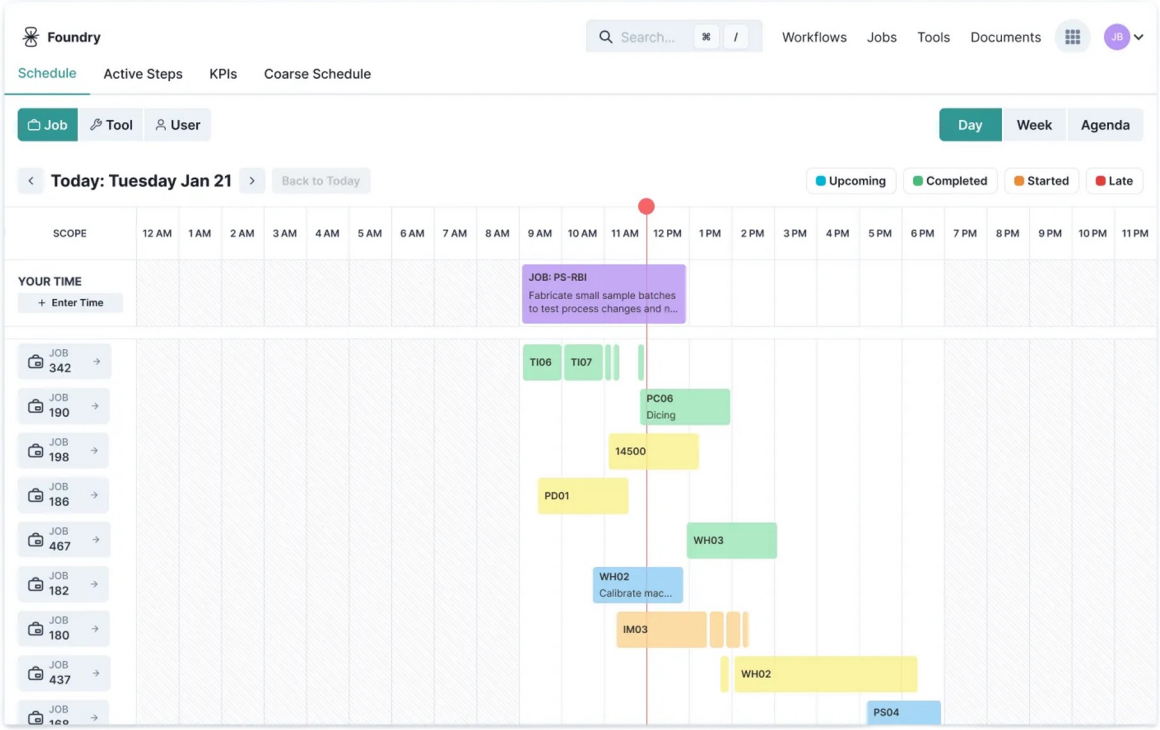

Select and insert protocols and sequences of protocols

# Tight integration with inventory and procurement systems



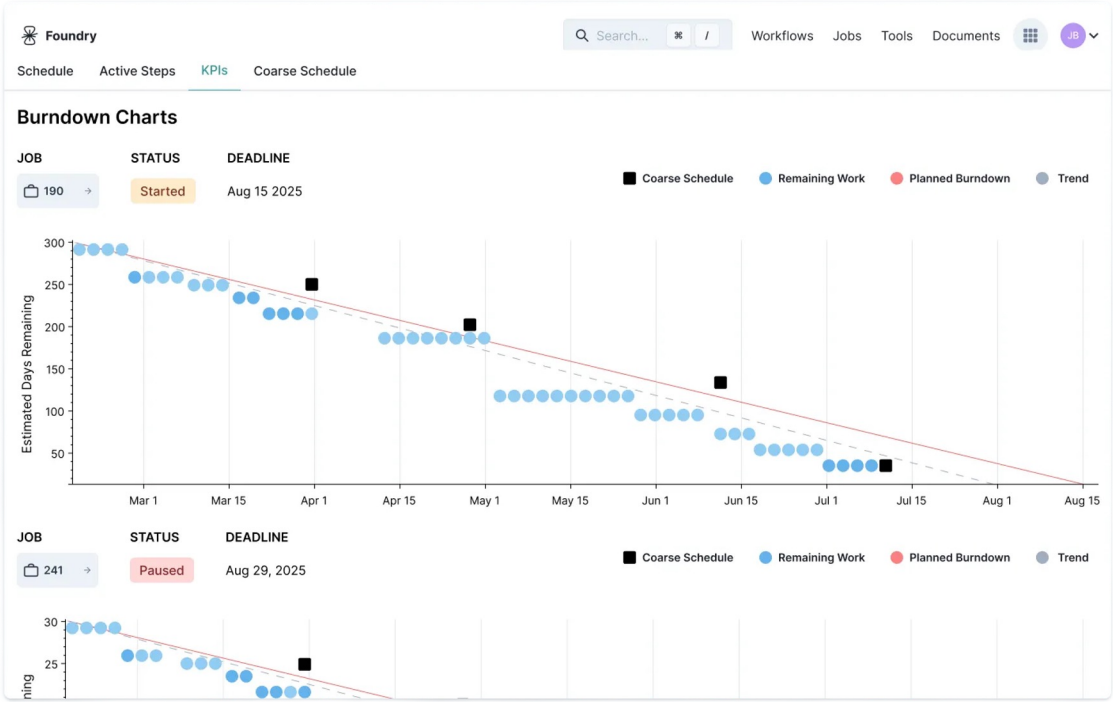

Manage inventory levels through to shipping finished products

# Timeline-based schedule for each day




Scheduling algorithm optimizes for productivity and predictability

# Burndown charts

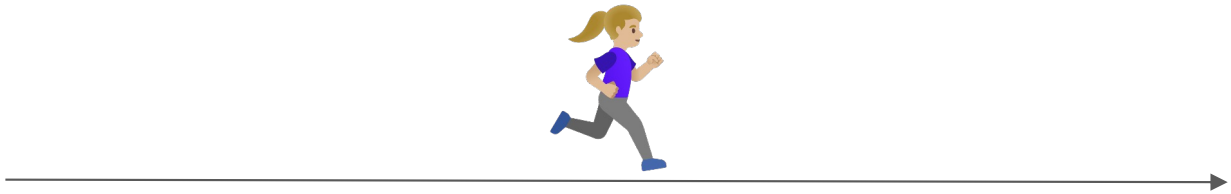



Monitor job adherence to expected schedule and adjust accordingly

# What does this mean for our customers?

# Software has enabled a more versatile Foundry

- Science Foundry is a commercial foundry that specializes in smaller volume, early-stage development
- Our streamlined interface for planning and developing new processes captures all of the information required while also providing flexibility during the development process



| Early Stage Development | Production Process Development | Volume Production |
|---|---|---|
| ● Prove out a design<br>● Smaller wafer lots<br>● Development support | ● Robust and repeatable production process development<br>● Multiple development lots | ● Process validation<br>● Produce wafers in volume<br>● 10s to 1000s wafers per year |

# Bridging the gap from development to production

Universities - R&D Facilities

- Shared tools
- Unstable processes
- Non-production environment
- Once proof of concept/prototype developed, still costly transfer to commercial foundry

**Science Foundry**

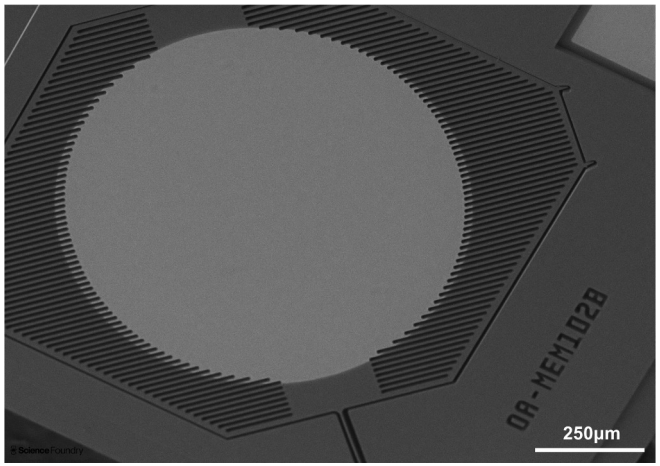
- Commercial foundry with production tools
- R&D capacity to support development
- Allows for smaller development runs
- Development support
- Quick turn on development
- Supports volume production from 10s to 1000s wafers

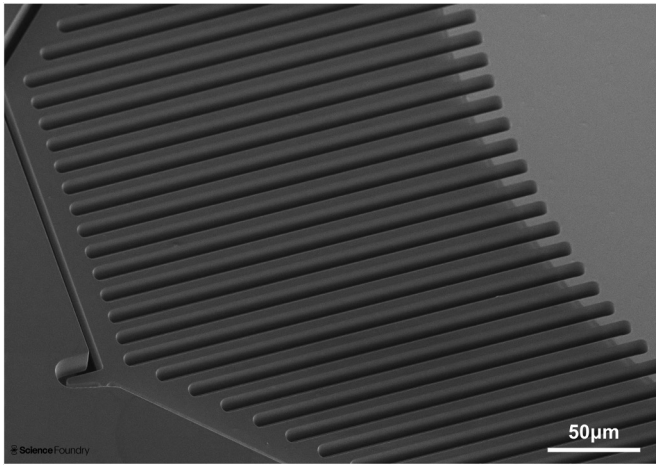
Typical Commercial Foundry

- Large minimum spend required
- Want proven design and process flow
- Limited R&D capacity
- Longer time for development

# Variable Optical Attenuators - MEMSCAP

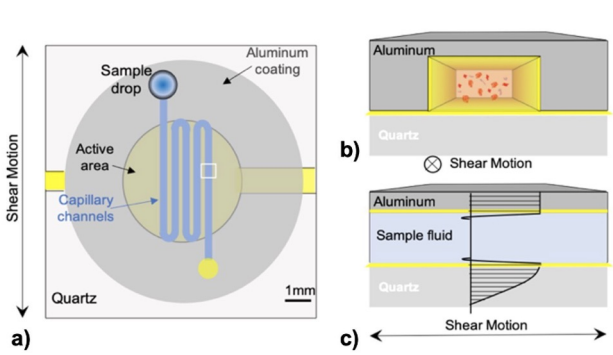
## Volume Production



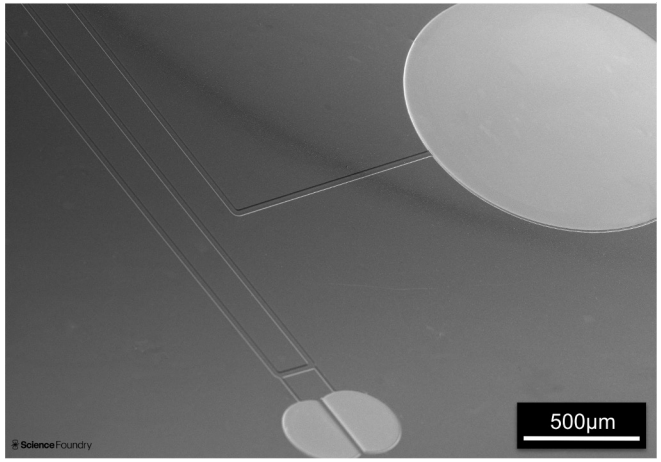



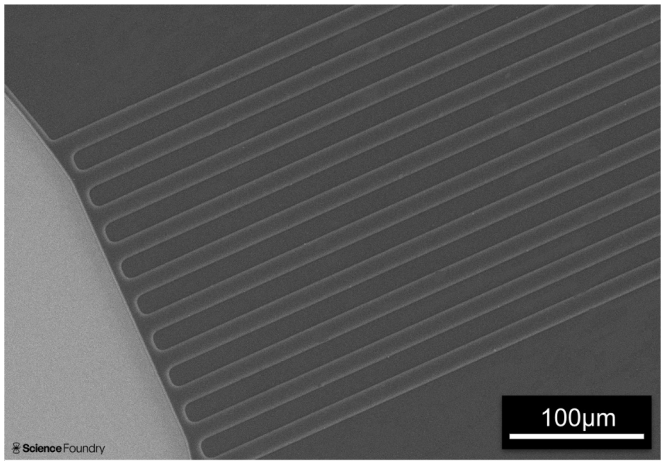
# Microfluidics - Qatch Technologies

## Late-stage development/ Pre-production



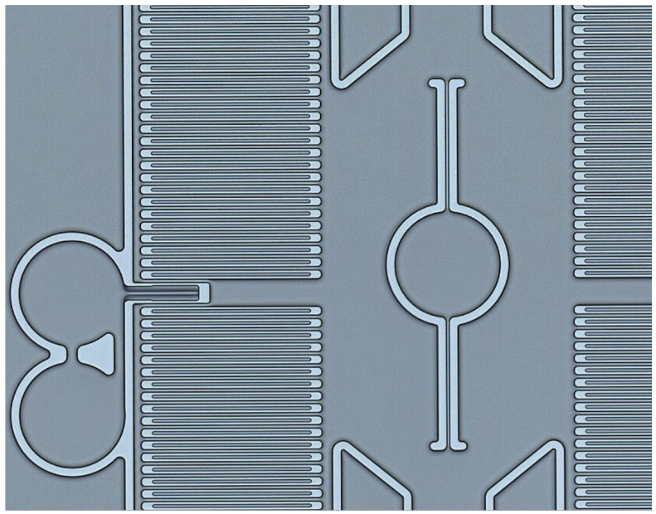

**a)** Top view, **b)** side view, looking into a single microfluidic channel with fluid, **c)** side view of a channel with shear motion indicated. (drawings not-to-scale in this depiction)

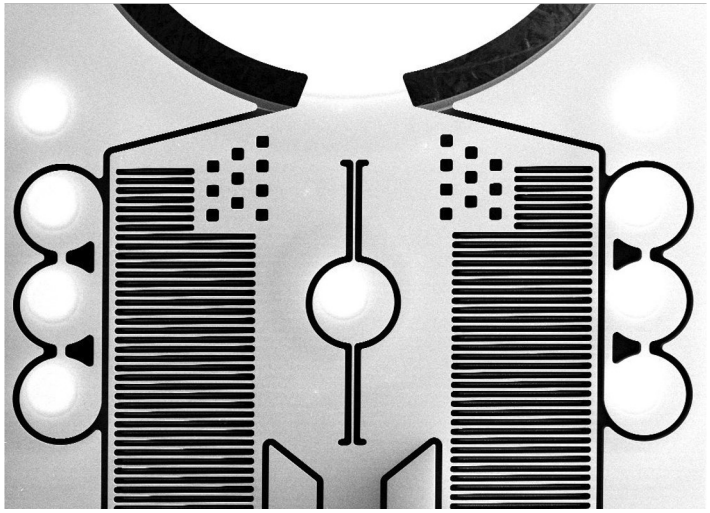


# µMirrors for LiDAR - Omnitron Sensors

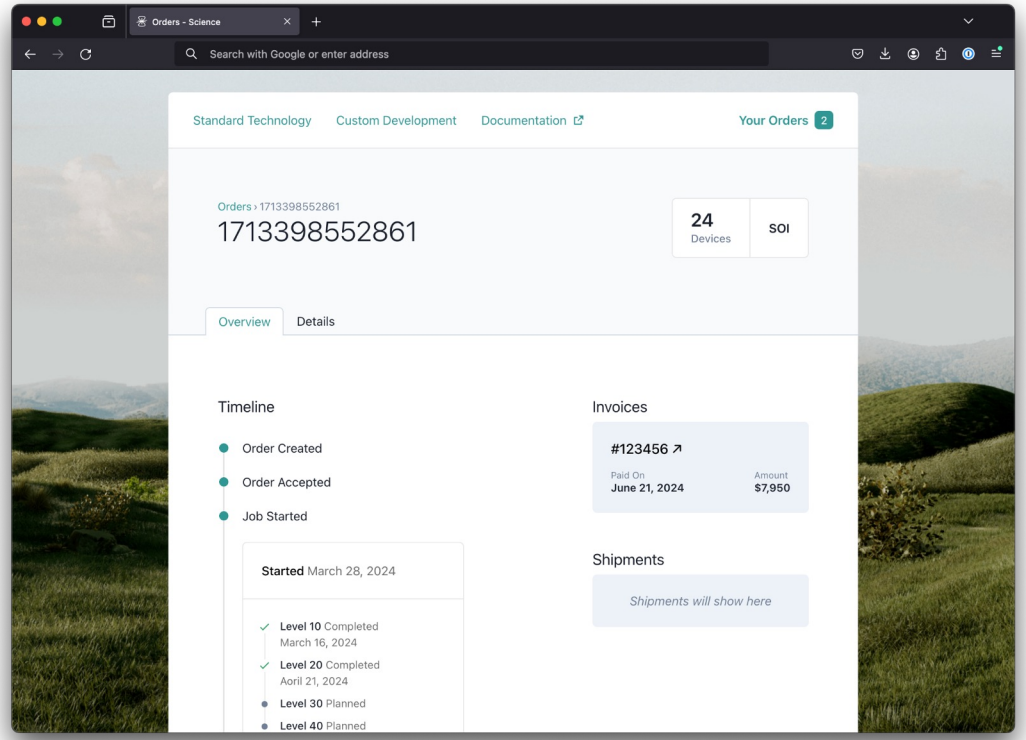
Early feasibility





At every stage, we provide transparency & predictability to customers.

Data-driven, tightly aligned partnerships to accelerate time-to-market for MEMS devices.




# Modular Fab Expansion

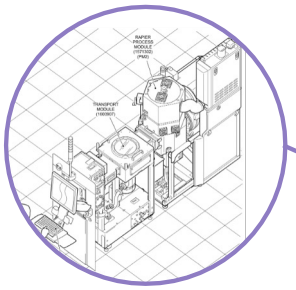
## Modular infrastructure has many advantages

- Goes up quickly
- Simplifies design
- Allows for phased movement
- Rinse & repeat

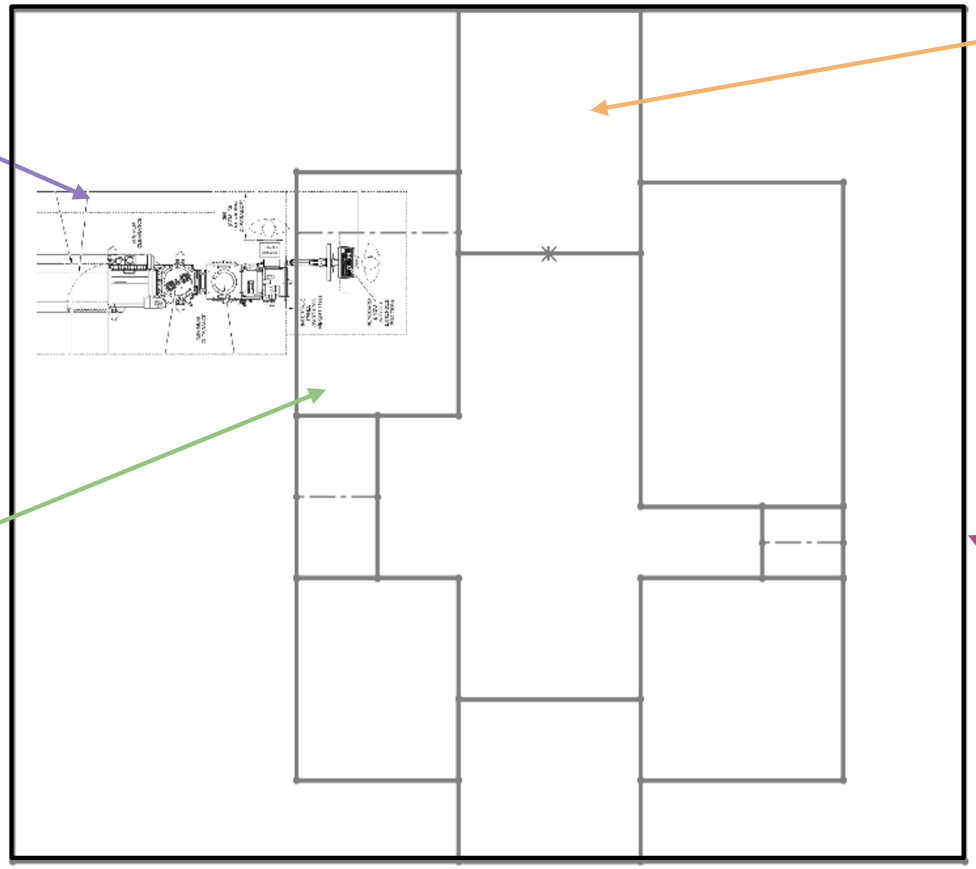
# Nondescript location


There are 10s of thousands of distribution warehouses throughout the US

# Configurable base unit



Tools

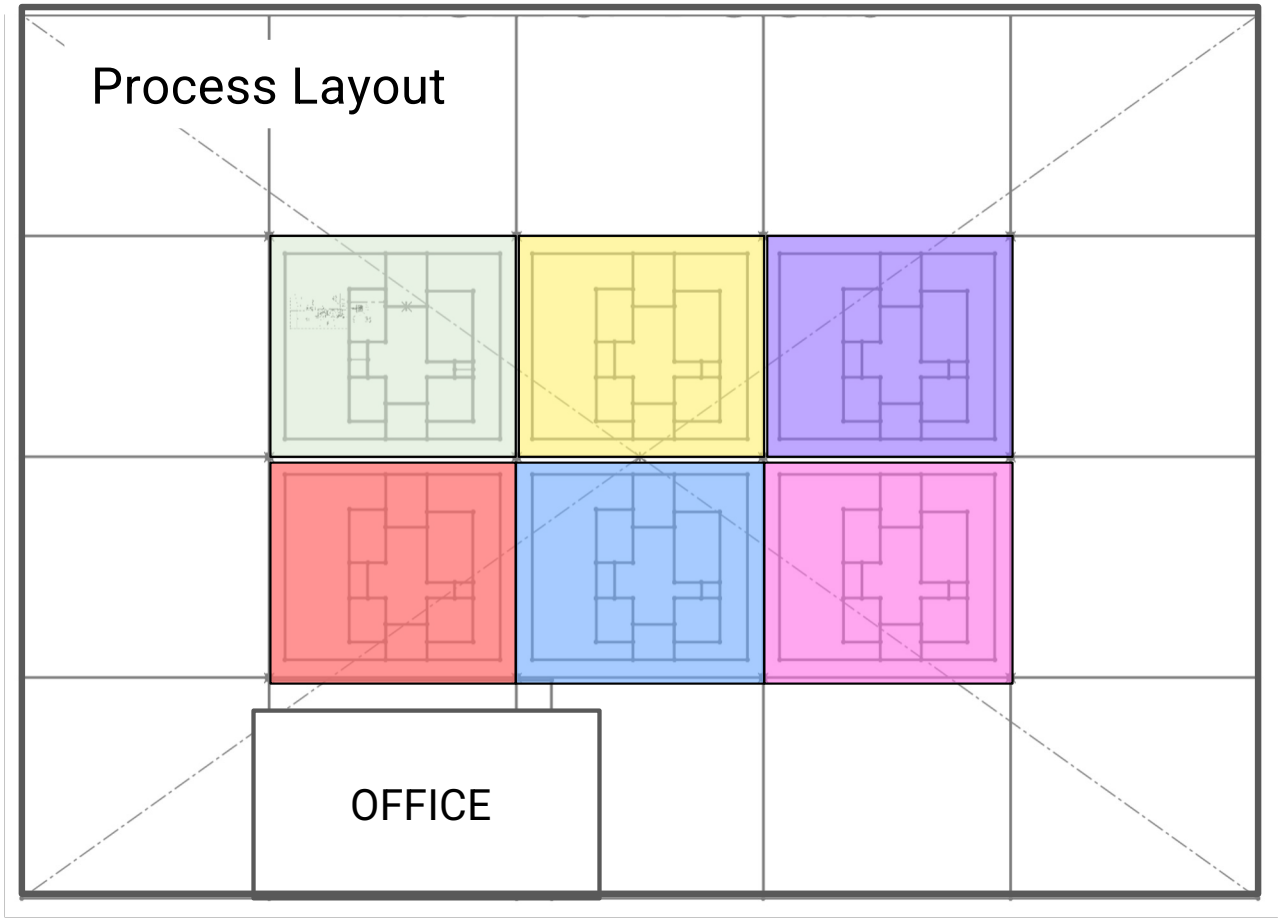


Softwall Gown Room & Hallway

Softwall Cleanroom

Steel Insulated Barn (Chase)

# Separate modules by process capability




1 = Non-Toxic Dry Etch

2 = Photolithography

3 = Wafer Level Testing

4 = Toxic Dry Etch & PECVD

5 = Diffusion & LPCVD

6 = Wet Chemistry

# First module operational this month!

# Thinking about infrastructure differently allows for flexibility and agility

- Science will continue to vertically integrate and leverage internal needs for the benefit of our customers
- Developing a “kit of parts” for rapid execution of more manufacturing space allows us to remain nimble in times of uncertainty

# The MEMS foundry business has innovation.

~~EXPENSIVE~~

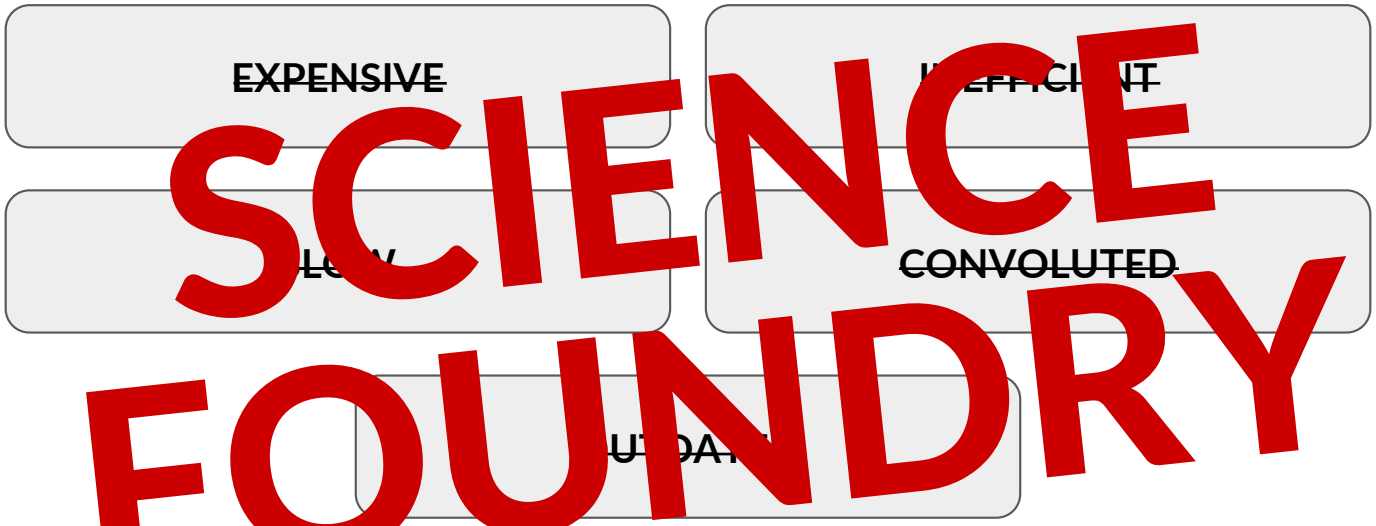
~~INEFFICIENT~~

~~SLOW~~

~~CONVOLUTED~~

~~OUTDATED~~

The MEMS foundry business has innovation.



# Thank you!

science.xyz/sws

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