ACCUSPARK

Steerable Needle

Deep Brain Stimulation for Parkinson's Disease

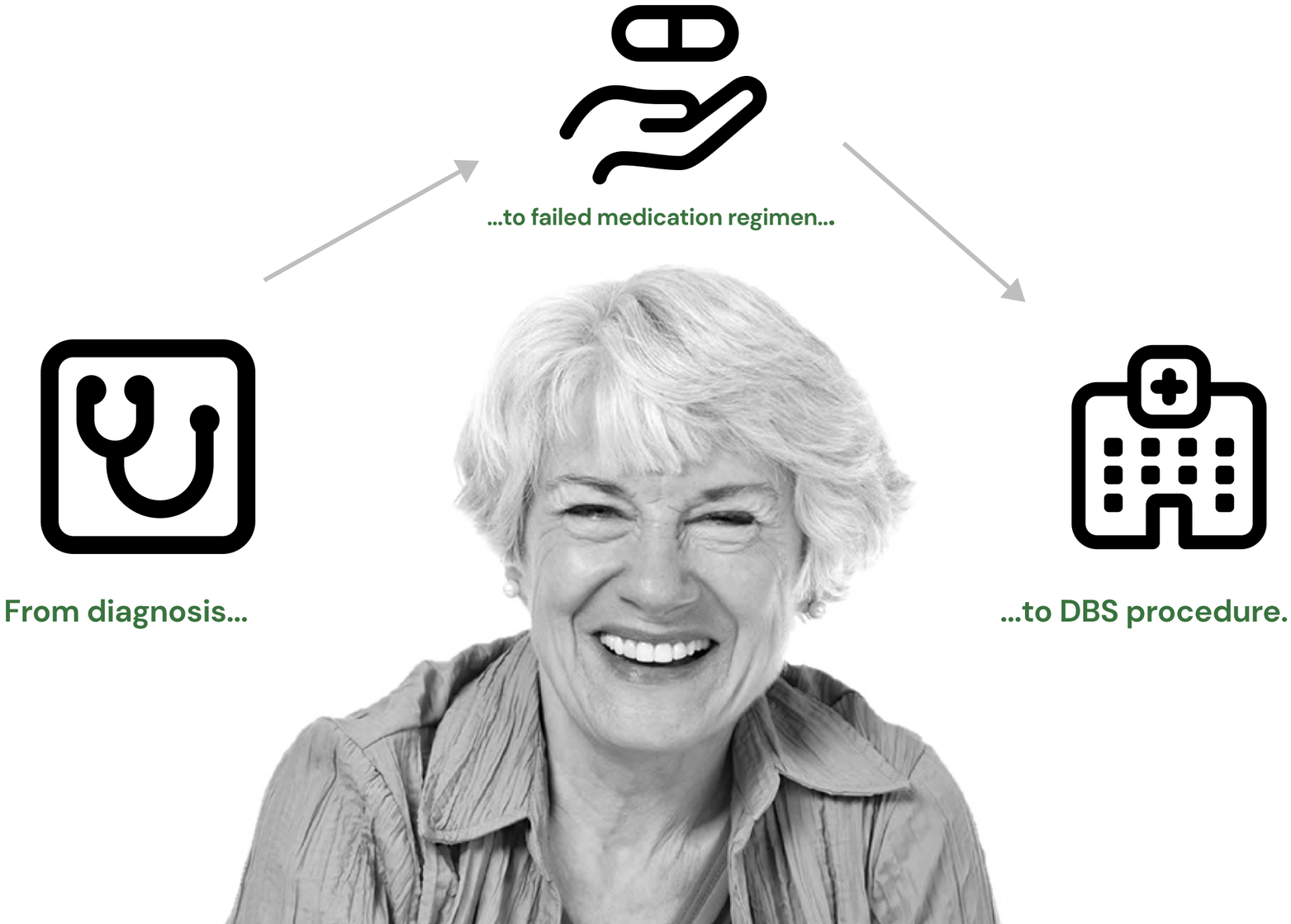
PENN I-CORPS
educate. collaborate. accelerate.

Children's Hospital of Philadelphia

PassageBio

Penn Medicine

Meet Carol.



From diagnosis...

...to failed medication regimen...

...to DBS procedure.

Slurred Speech

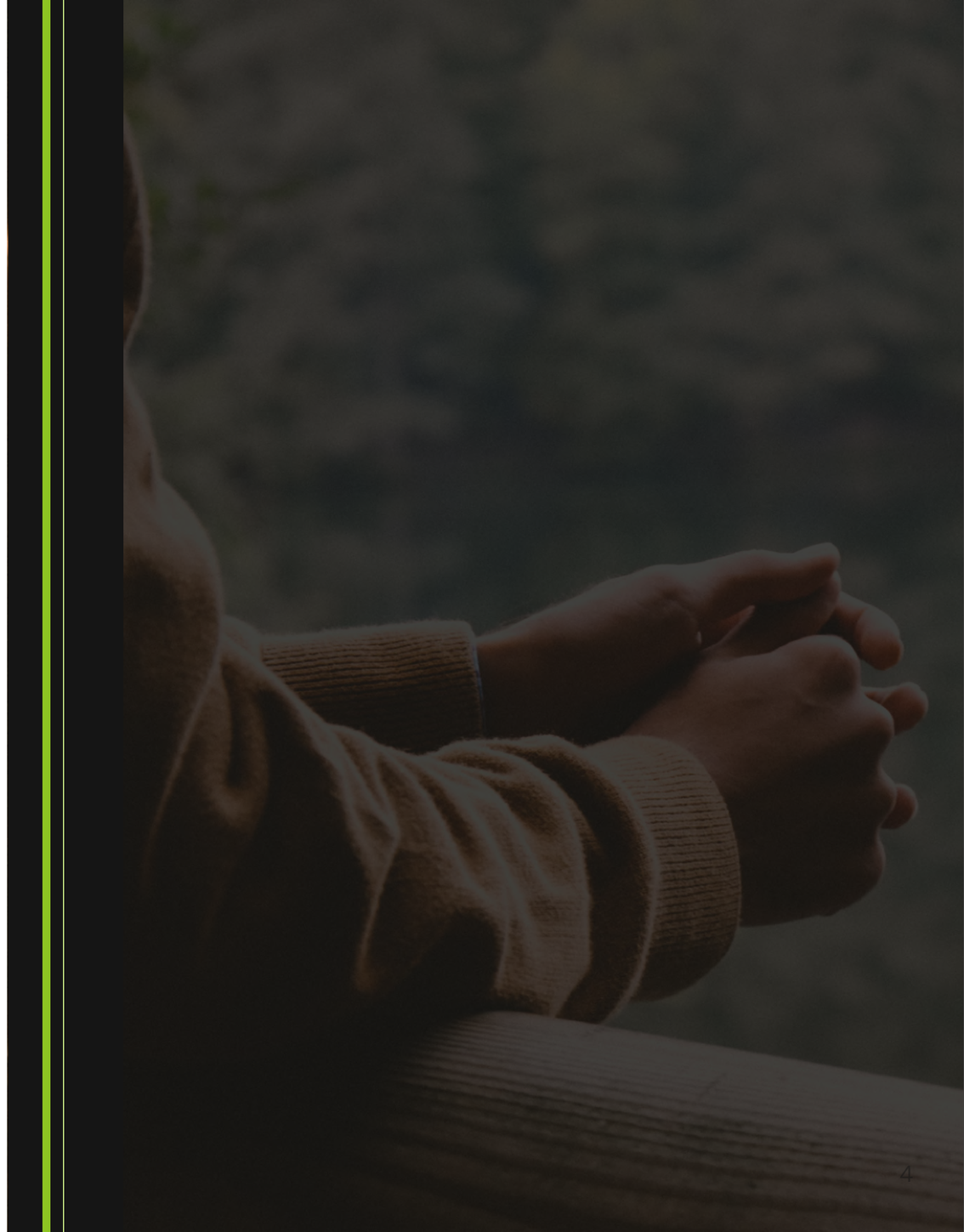
Issues with Balance

Lack of Motor Control

Worsening Cognition

Apathy

10 million people globally are living with **Parkinson's disease.**



Parkinson's Treatment Paradigm

Stage 1: Diagnose PD

PD diagnosed via patient behaviors: tremors, movement difficulties, confusion, dementia + MRI brain scans

Stage 2: Prescribe Medication

Physician prescribes Levodopa to restore dopamine levels in the brain to pre-PD levels (dopamine agonist or MAO-B dopamine reuptake inhibitor sometimes given first)

Stage 3: Adjust Medication Dose

Modify Levodopa dosage depending on patient symptoms & PD progression

Stage 4: Attempt DBS

(Only for eligible patients): conduct DBS surgery to implant electrodes in subthalamic nucleus, globus pallidus, and/or thalamus

1/3 of surgeries fail = doctors unlikely to recommend DBS due to risks

Deep-brain stimulation (DBS) can **prevent and treat brain diseases such as Parkinson's** via electrodes that deliver a small current to reduce aberrant nerve signals.

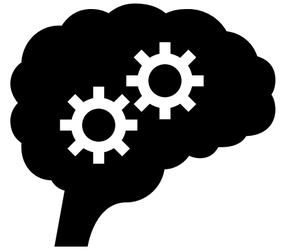
DBS has substantial promise and proven effective treatment for late-stage Parkinson's disease and a promising early-stage prevention.

However, at least **one out of every 3 patients** suffers significant and debilitating complications.

Current DBS Procedures

Weeks Later

After a few days



1. Place **bone markers**

Take MRI & CT **scans**, then place **bone markers** for rigid catheter insertion sites

2. Insert **electrodes**

Conduct DBS **electrode implantation** surgery (while patient is awake)

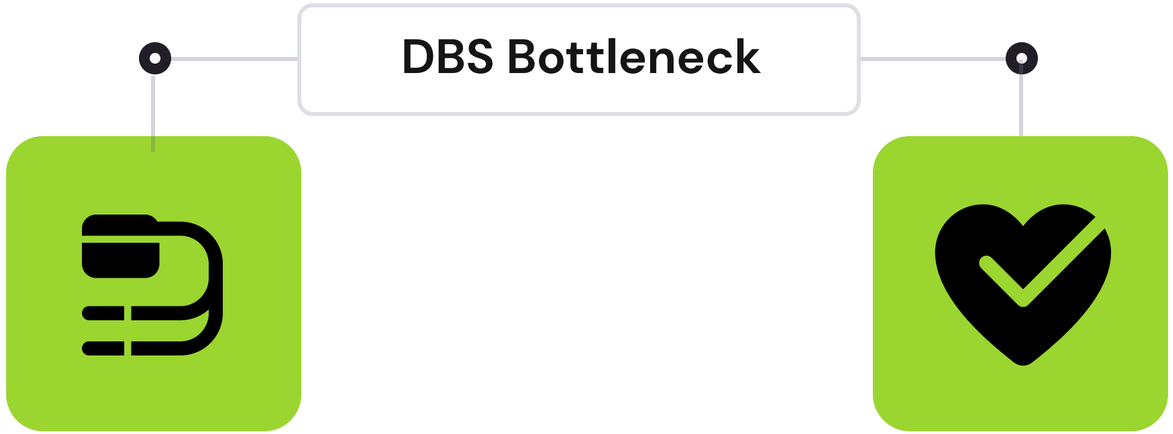
3. **Implant** the **DBS electrode battery**

Implant the **DBS electrode battery** under the collarbone (patient is under general anesthesia)

Why is DBS difficult?

Surgeons rely on **pre-operative scans** to make electrode placements. There is a **lack of real-time navigation technology** and tools to **precisely insert electrodes**.

95% of DBS placement errors are **within 2 ½ mm**, a small difference with **significant** consequences in the brain. Side effects from imprecise electrons can be modulated, but often **at the expense of resolving tremors.**

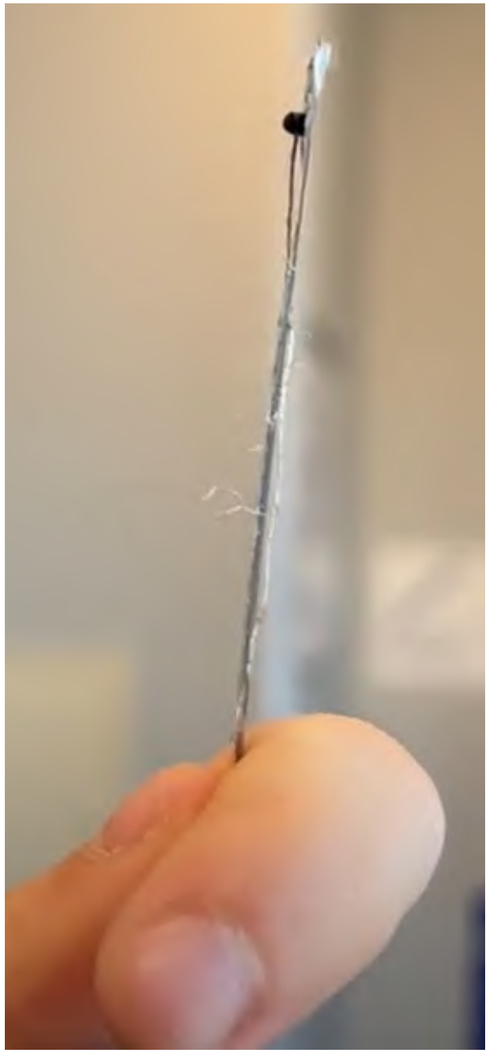


Introducing

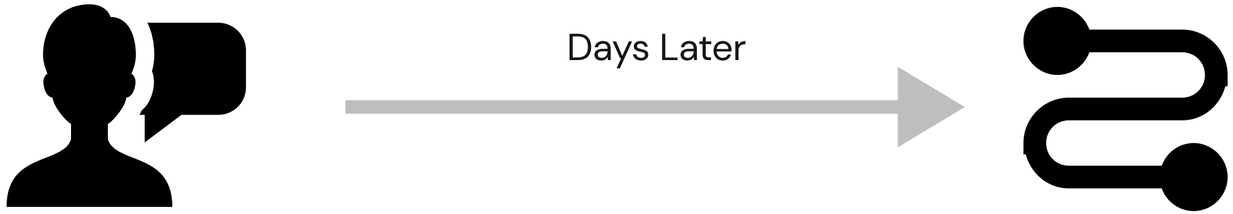
ACCUSPARK

The AccuSpark Advantage

- With a turn radius of **0.5 cm**, can **alleviate the placement error** in DBS
- Penn's steerable needle can be made with a **0.0005-0.0001 inch thick** spring-tempered steel
- Has a width of **0.5 mm** when oriented on its side, minimizing damage to nerve tracks in the brain
- A **customizable sheath** can be attached to enable double turns



AccuSpark provides **real-time feedback** and an easy way to navigate the patient's brain.



Doctor suggests DBS treatment. Minimal pre-scanning required.

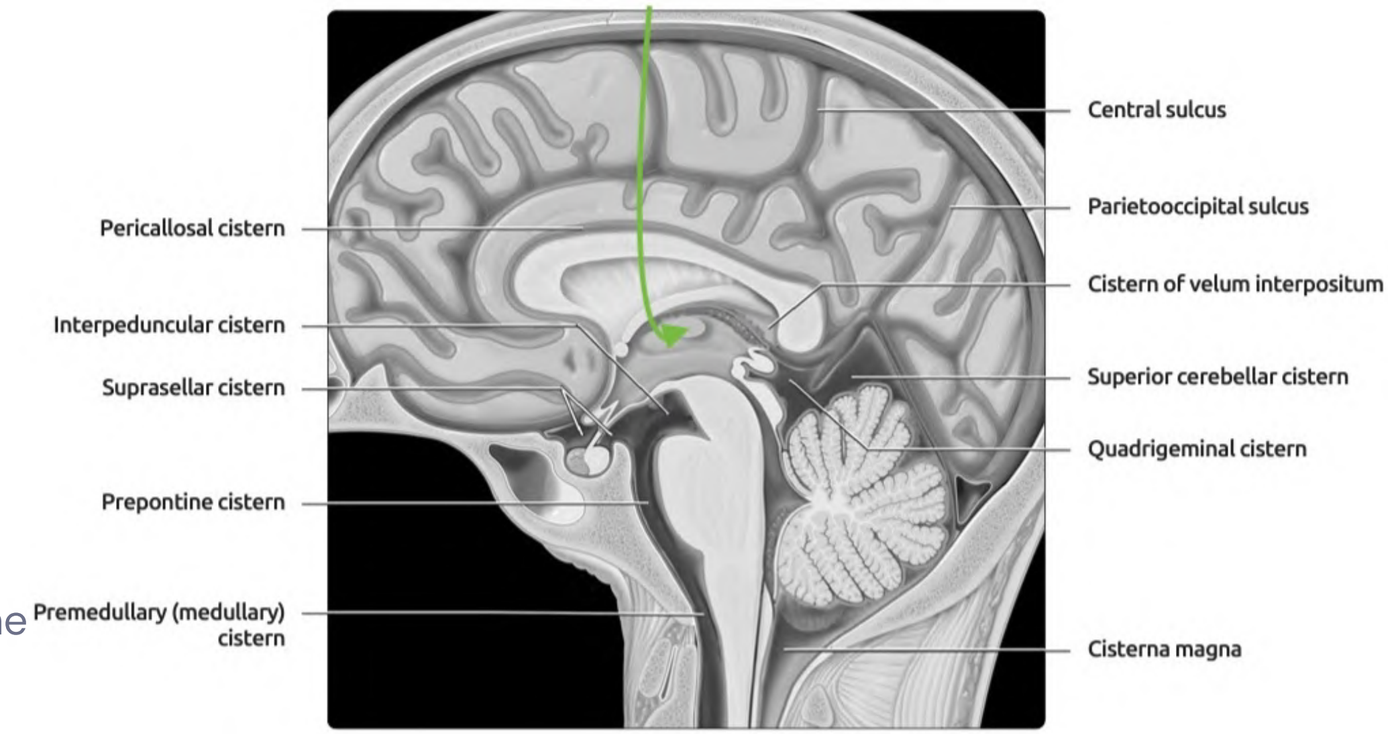
Use steerable needle for direct traversal during surgery. Reduced risk & tissue damage.

*Our steerable needle can **mitigate the side effects** of DBS and there are **no competitors** in DBS therapy space.*

Guidance Mechanism

Our steerable needle will allow for more precisely implant the electrodes for DBS, preventing adverse side effects.

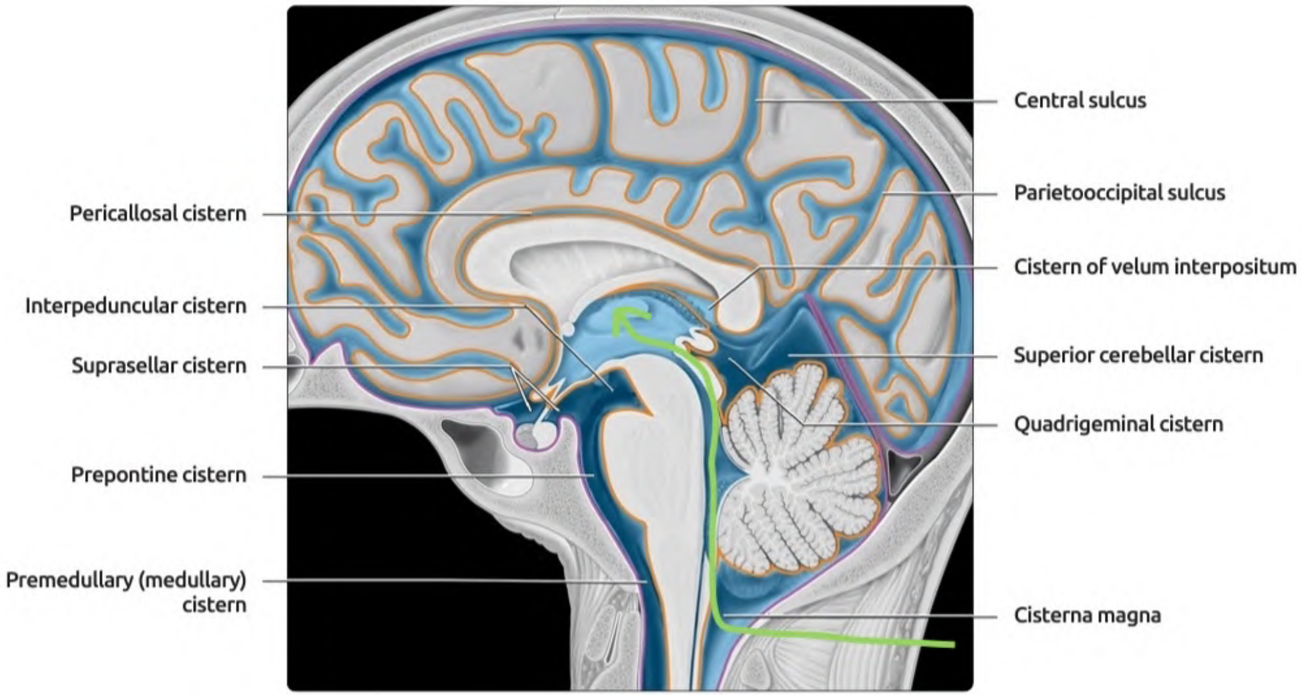
- **1.3 mm needle diameter,** which is 0.6 mm less than usual probes, further reduces tissue damage during entry
- Surgeons will navigate to the target area through a combination of pre-operative scans and tactile feedback from our steerable needle system
- Our ability for minute turns will solve the average **2.5mm** placement error that leaves other parts of the brain vulnerable to unwanted electrical stimulation
- **Parkinson's Target =** subthalmic nucleus, globus pallidus, or thalamus



Alternate Entry Route

Following clinical trials + training of surgeons, AccuSpark can traverse through the theoretically promising ventricular route.

- Almost the entire route of administration is through the cerebrospinal fluid (CSF)
- No need to cut through brain tissue apart from the target site + eliminates need for skull drilling
- 0.5 cm turning radius and 1.3 mm needle diameter allows for navigation through small openings in the ventricular system
- Surgeons will navigate to the target area through a combination of pre-operative scans and tactile feedback from our steerable needle system
- **Potential targets:** Parkinson's - subthalamic nucleus, globus pallidus interna, thalamus; Epilepsy - locus coerleus; Dystonia/tremors - globus pallidus



Inserting the electrode

Standard DBS electrode design allows for easy insertion of the electrode through the inside of the steerable needle.

- Surgeons will guide AccuSpark through the brain ventricles until reaching the target site
- After the needle reaches the target, the electrode (with its wire attached) can simply be slid through the center of the needle until reaching the target
- The electrode is then turned on and tested to make sure the correct site was reached and the intended effect on the (awake) patient is observed

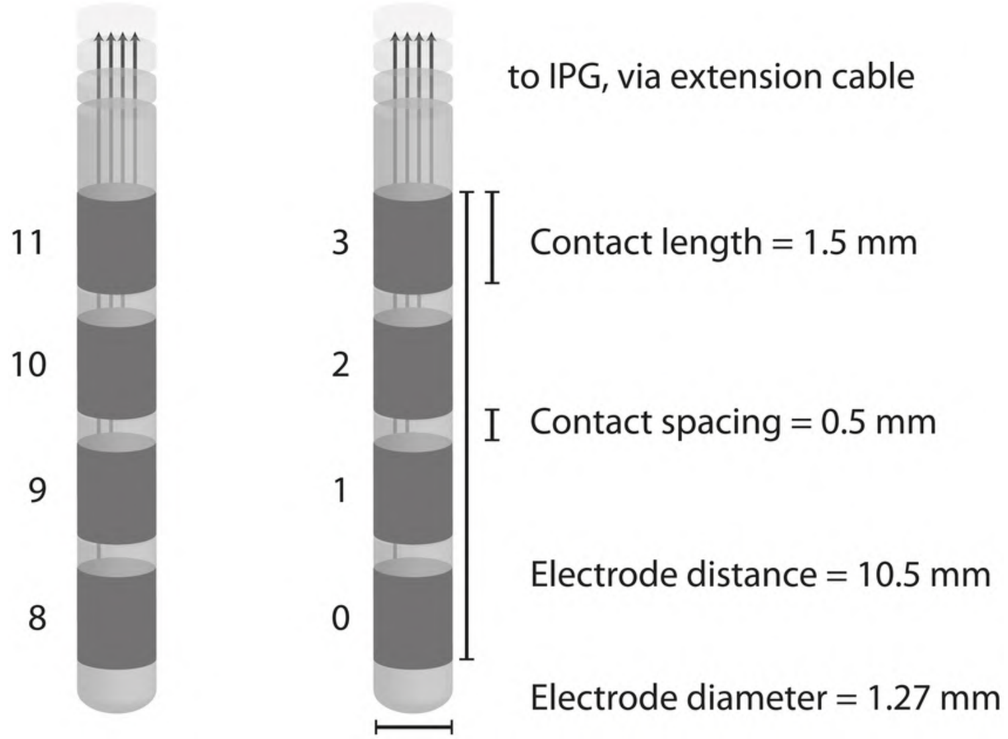


Photo Credit: PLoS One

"There's a lot of value, particularly as you get to small brain regions with difficult terrain to navigate" - Dr. Forman, Passage Bio

*"**Visualization is key**" - Dr. Pukenas, interventional neuroradiologist at Penn Medicine*

Our Solution

Precision
Accurate implantation of DBS electrodes

Versatility
Customizable to individual brain anatomy

Minimizes Tissue Damage
Better targeting & do not need to apply force on tissue for steering

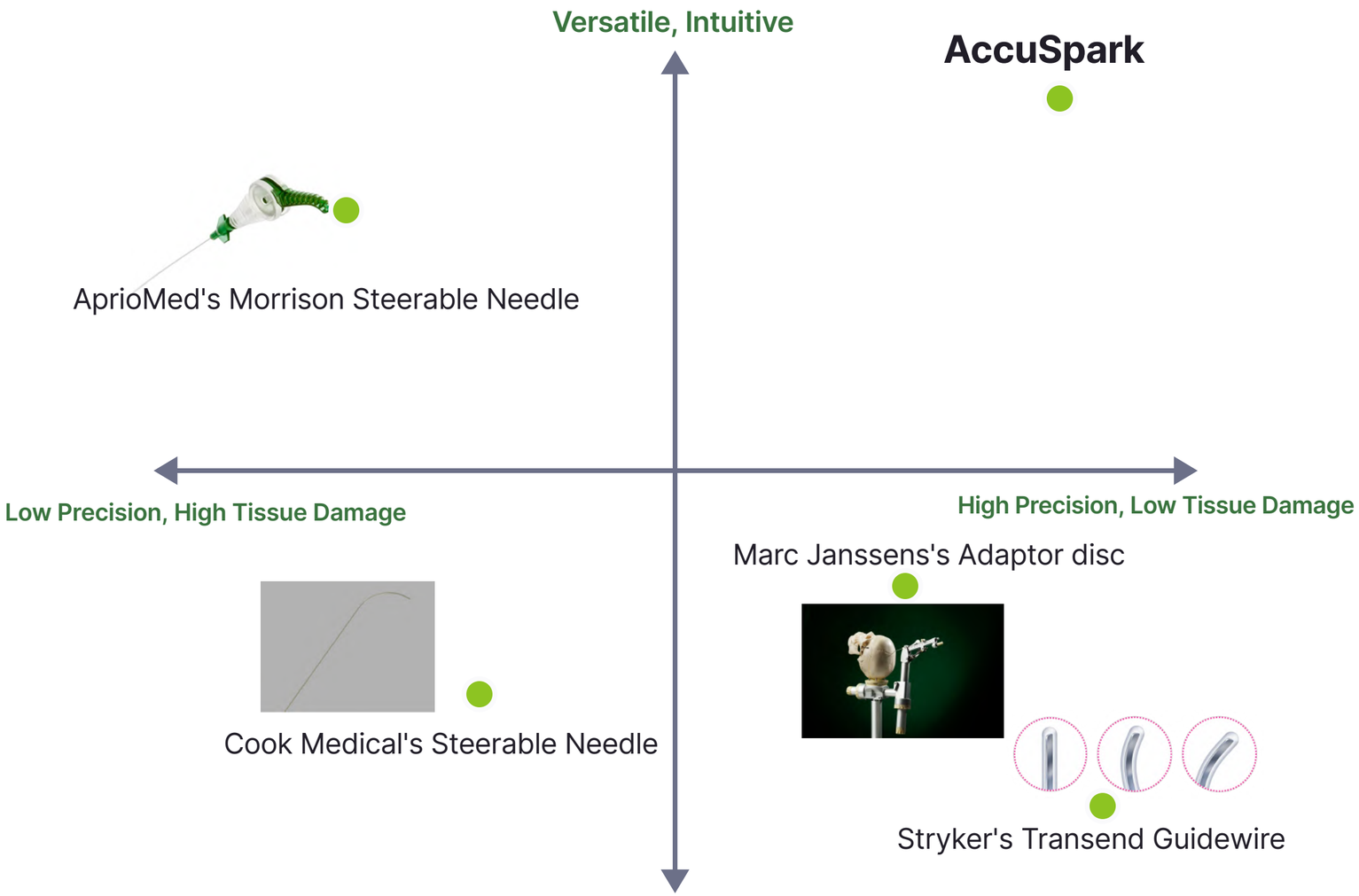
Ease of Use
Intuitive & real-time navigation by surgeons for increased success rate

- Precise procedure; easy to use via steering
- Minimal tissue damage: **diameter is 1.3 mm** for traversal; **turning radius of 0.5 cm**

Alternative/Competing Solutions

- Status quo method: **1/3 of procedures fail** due to the slightest bit of imprecision
- Pre-bent steerable needle: difficult to use with lack of customizable turning radius

Primary Competitors



Competitor Analysis

Device:	Needle Diameter	Turning Radius	Number of Turns	Length	Ease of Use	Cost
AccuSpark (steerable needle)	1.3 mm	0.5 cm	∞	∞	✓	$1
AprioMed (steerable needle)	0.82 mm	8 cm	1	167 mm	✓	$5
Marc Janssen (disc for improved rigid needle placement)	14 mm	N/A	0	N/A	X	N/A
Stryker (guidewire)	0.36 mm	<2 cm	1	300 cm	X	$45
Cook Medical (steerable needle)	>3.4 mm	<2 cm	1	~20 cm	X	$6

Economics

Current Market: $154,872,000/yr

DBS Surgeries Annual Demand

- **Number of DBS surgeries conducted per year: 4,000**
- **Current cost of surgeries: $38,718**

Low demand due to:

- High risk of **severe side effects**
- **Difficulty** of current procedure

Total Market Potential: $537,893,686,800/yr

Parkinson's + Prospective DBS-Treatable Diseases

Parkinson's - 10,000,000 (63% DBS-indicated cases)

Prospective DBS-Treatable Diseases

- Tourette's - 135,000 (44% DBS-indicated cases)
- Epilepsy - 3,400,000 (30% DBS-indicated cases)
- OCD - 2,200,000 (50.6% DBS-indicated cases)
- Paralysis - 5,400,000 (100% DBS-indicated cases)

Total: 13,892,600 patients

Business Plan

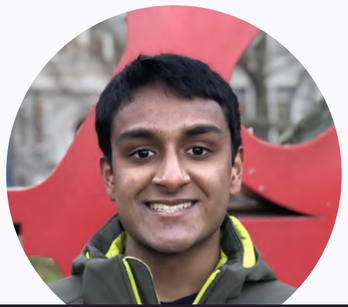
LSM&T: Intersection of Life Sciences, Management, and Technology

Adanna Mogbo

LSM (Computational Biology, Finance and Business Economics & Public Policy)

Qijia "Joy" Liu

M&T (Computer Science, Finance and Business Analytics)



Aravind Krishnan

LSM (Molecular & Cell Biology, Healthcare Management & Policy, and Statistics)

Shraavasti Bhat

M&T (Systems Engineering, Marketing & Operations Management)

Short Term	Medium Term	Long Term
Biology: Clinical trials, research on physiological effects **Engineering:** Configuring camera and optics **Business**: Collaboration with Passage Bio	**Biology**: Training surgeons in operation, optimizing surgical procedures **Engineering:** Optimize production of optical fiber and DBS electrode wire attachment. **Business**: Manufacturing and shipment to hospitals	**Biology**: Studying long-term benefits or impacts of AccuSpark **Engineering:** improve surgeon experience & needle control **Business**: Establish AccuSpark as the standard DBS surgical method, partnerships & production for scaling

Collaborators/Mentors: **Dr. Mark Forman** (*CEO of Passage Bio*), **Dr. Bryan Pukenas** (*Penn Medicine Neurosurgeon*), **Dr. Mark Yim** (*GRASP Lab Director*), **Omar Abdoun** (*GRASP Lab Researcher*), **Dr. Casey Halpern** (*Penn Medicine DBS Researcher*), **Hansell Stedman** (*Penn Medicine Surgeon*), **Beverly Davidson** (*CHOP Researcher*), **Manzar Ashtari** (*Penn Medicine Researcher*), **Dr. Meredith Spindler** (*Penn Medicine Researcher*), **Dr. Robert Epstein**

Execution Plan

Vision:

1. Capture **~100% of DBS therapy market** ($570 million in revenue by 2028)
2. Aim to **restore life expectancy** of Parkinson's disease patients to pre-diagnosis levels
3. **Expand to all DBS-treatable CNS diseases**

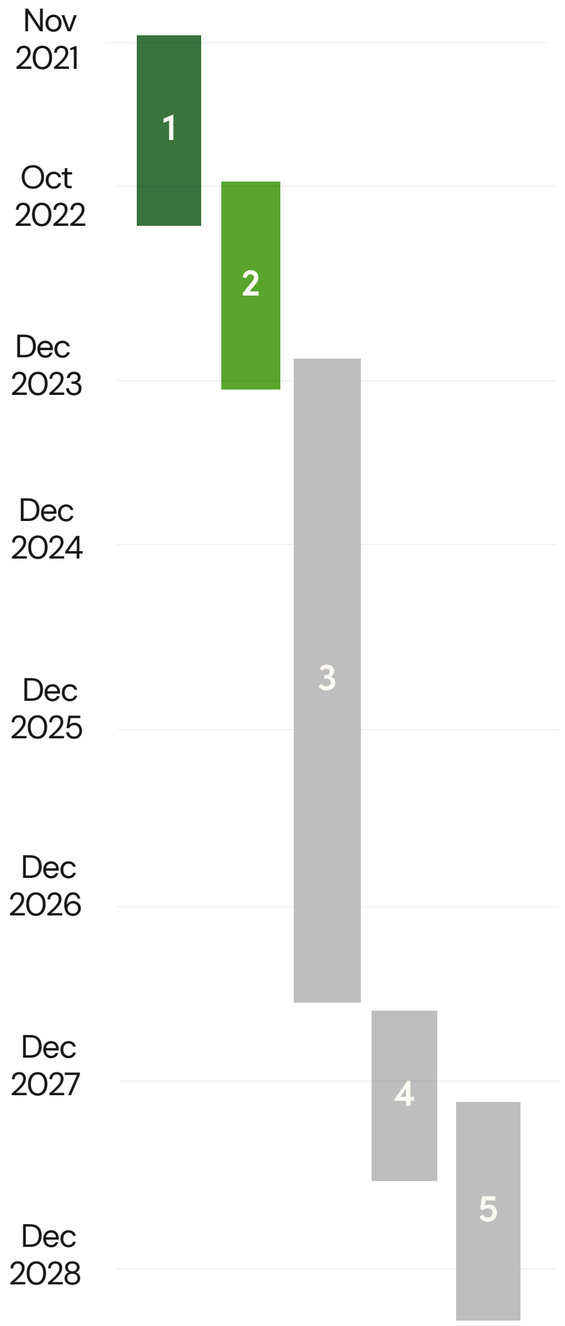
1. Prototyping & Testing

2. Production & Logistics

3. Market Validation & Clinical Trials

4. Early-Stage Rollout

5. Scale AccuSpark's Reach

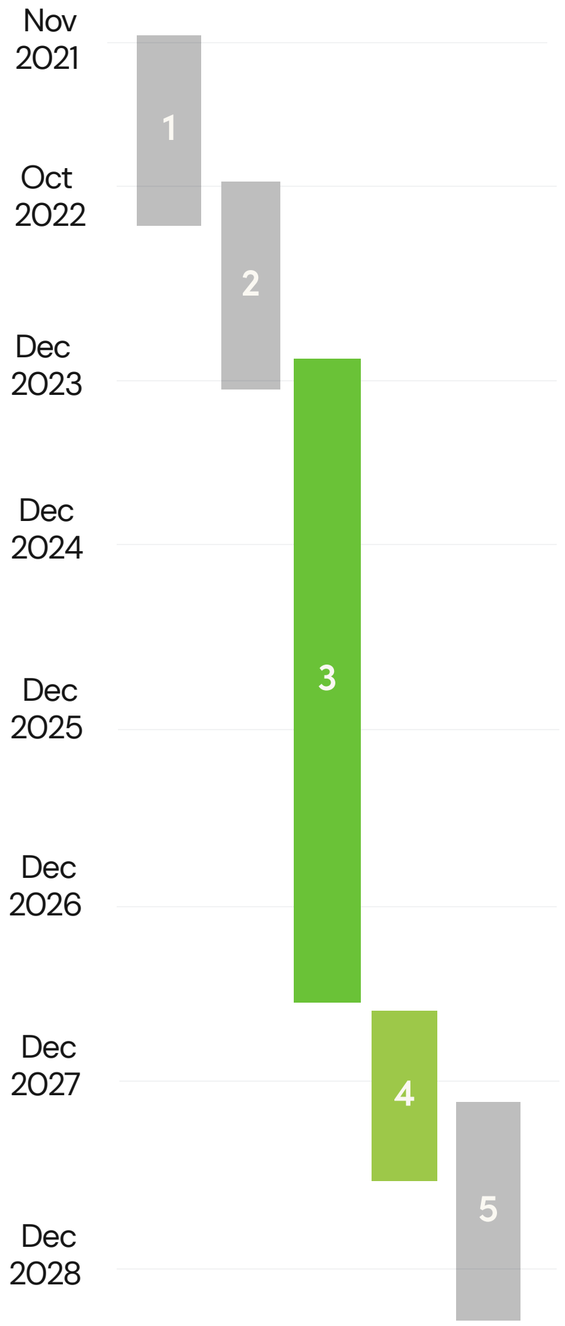


1. Prototyping & Testing:

- Iterate different steerable needle designs to optimize for traversing through and around brain structures
- Analyze different steering mechanisms and determine the best method with the highest ease-of-use

2. Production & Logistics

- Conduct experiments with the GRASP lab to optimize engineering design for AccuSpark
- Collaborate with potential manufacturers to refine AccuSpark into an even more cost-effective, optimized product

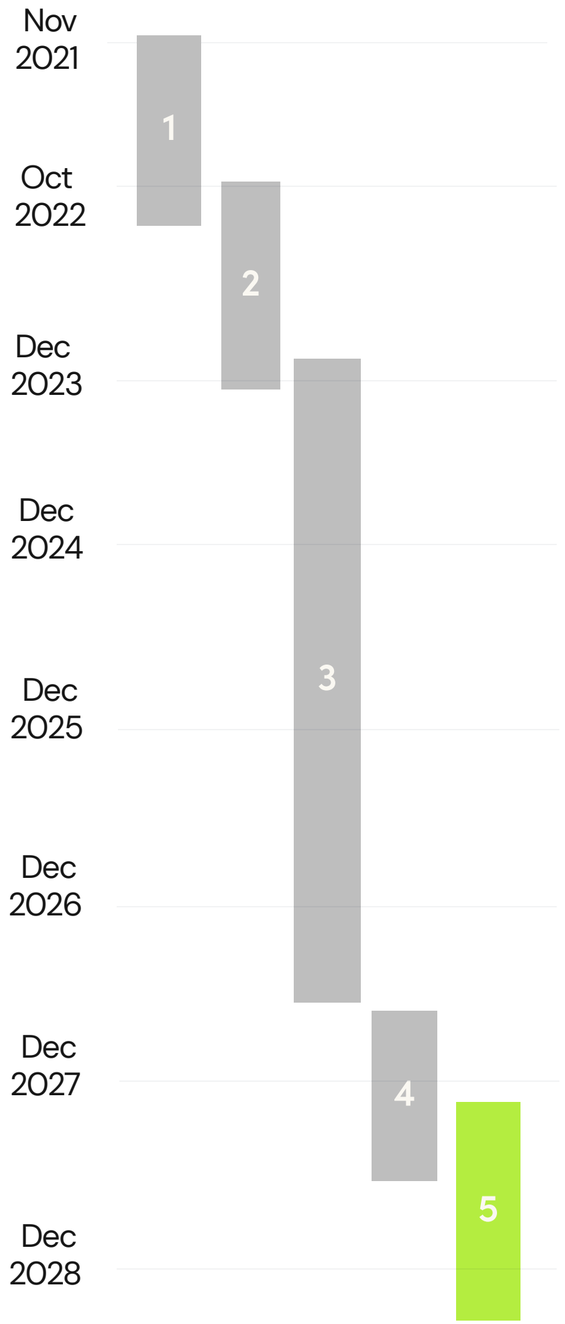


3. Market Validation & Clinical Trials

- Work with Penn Medicine to conduct clinical trials for Parkinson's disease patients using the final version of AccuSpark.
- Gather feedback and validation from surgeons through tests
- File 510(k) submission after successful clinical trials

4. Early Stage Rollout

- Set up 2-3 Day Training Programs throughout the year for surgeons across all the hospital we are working with
- Distribute AccuSpark to partner hospitals and institutions
- Gather feedback on device and continue to iterate on the design
- Follow FDA's medical device Premarket Approval (PMA) pathway (expect result within 180 days)



5. Scale AccuSpark's Reach

- Establish AccuSpark as the standard surgical method for DBS electrode implantation, by
  - increasing marketing of AccuSpark to providers (hospitals) and payers (insurance companies) after 510k approval
  - partnering with an existing large medical device manufacturer to further decrease production costs
  - Partnering with / sell to large medical device distributors (McKesson, AmerisourceBergen, Henry Schein) to expand reach and integrate into existing medical device supply chain
  - Continue evaluating patient outcomes and continue iterating new versions to improve performance over time & increase value for users

Strategies

Sales & Distribution

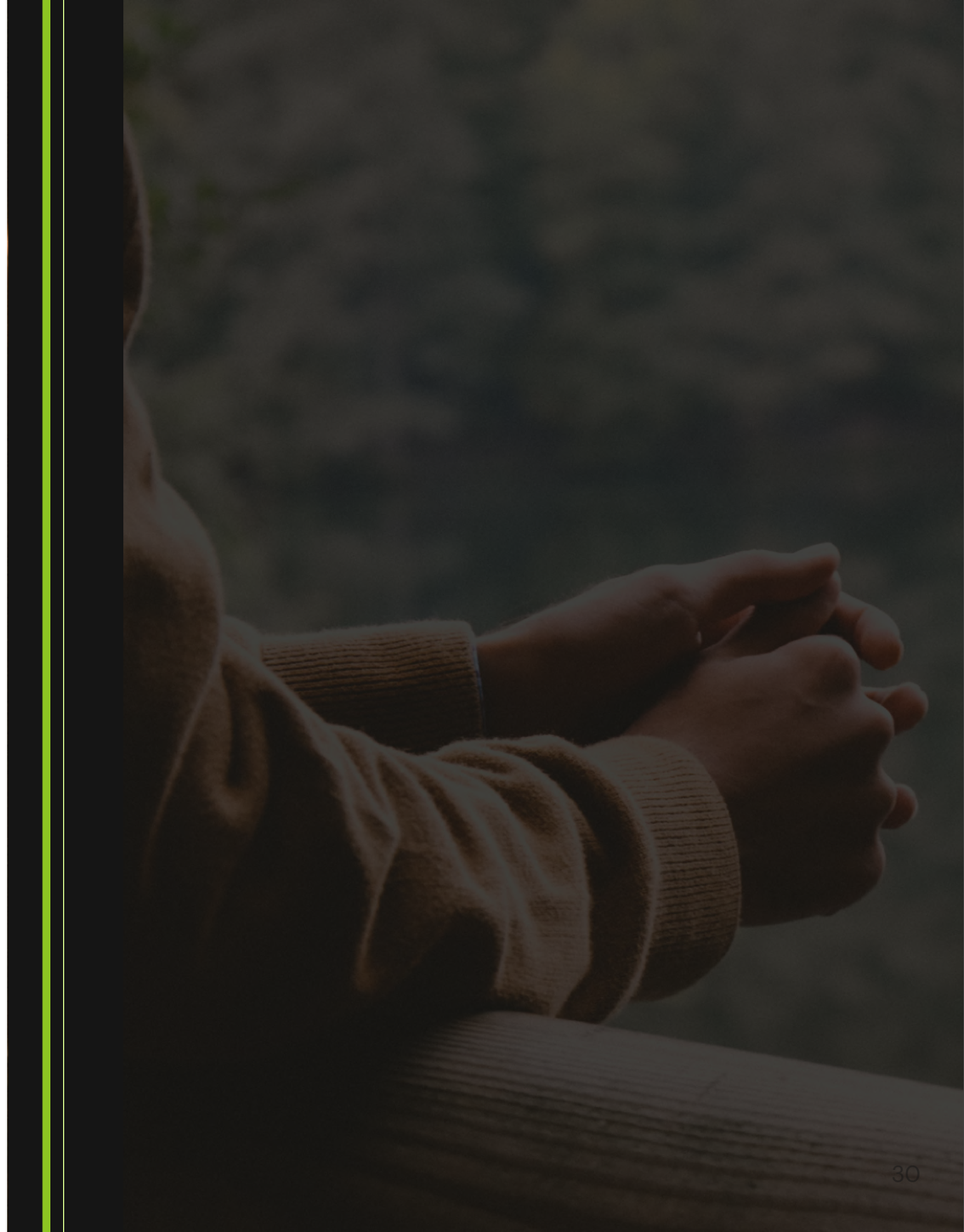
Short-term
Integrate AccuSpark with existing electrode placement method through the cerebellum Get surgeons familiar with AccuSpark's placement mechanism
Long-term
Introduce an alternative path through cisterna magna only possible with Penn's steerable needle

Marketing

- Provide feedback mechanism to improve value proposition
- Attend global medical conferences
- Promote technology in medical journals
- Work towards getting 510k for other use cases

Into the Future

DBS and other brain implants are also highly promising for **Tourette's**, **epilepsy**, **OCD**, and even **paralysis**, impacting about 339 million people globally.



Brain Implants for Paralysis

The latest brain implants can not only deliver electrical impulses, but also sense the brain's own action potential firing patterns (leading example is Elon Musk's Neuralink)

- Steerable needle would allow **more targeted placement** of brain impulse sensors
- Similar **improvement in the risk-benefit profile** as for DBS (implantation currently uses a similar procedure to that of DBS)
- More accurate placement of sensors improves the ability to collect signals, allowing for fine motor control of artificial limbs, speaking devices, and other prosthetics

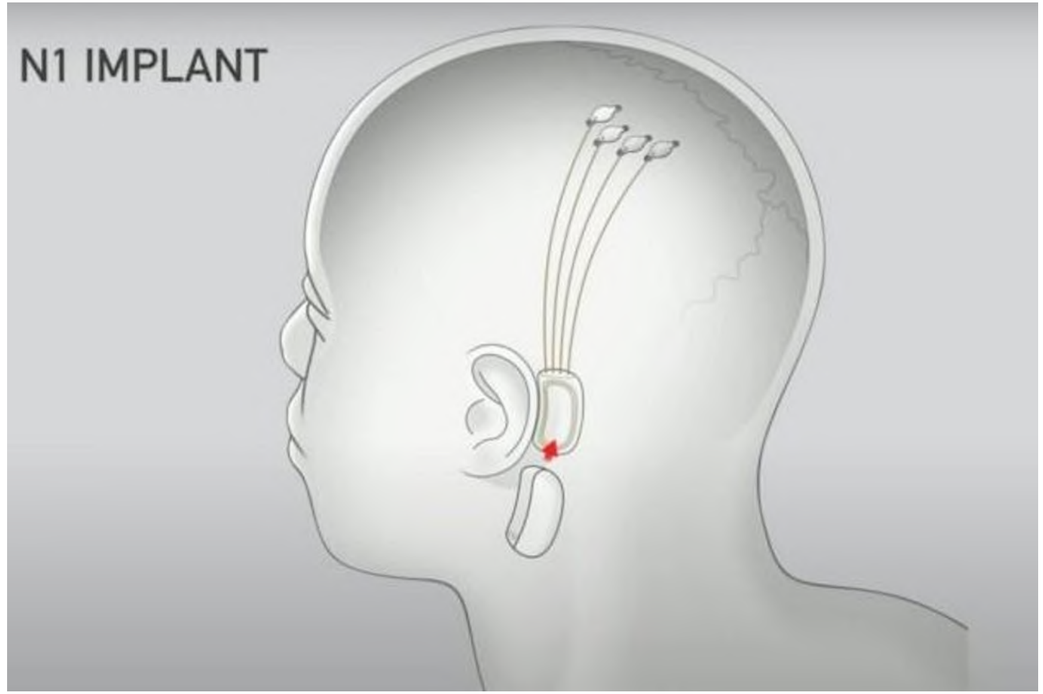
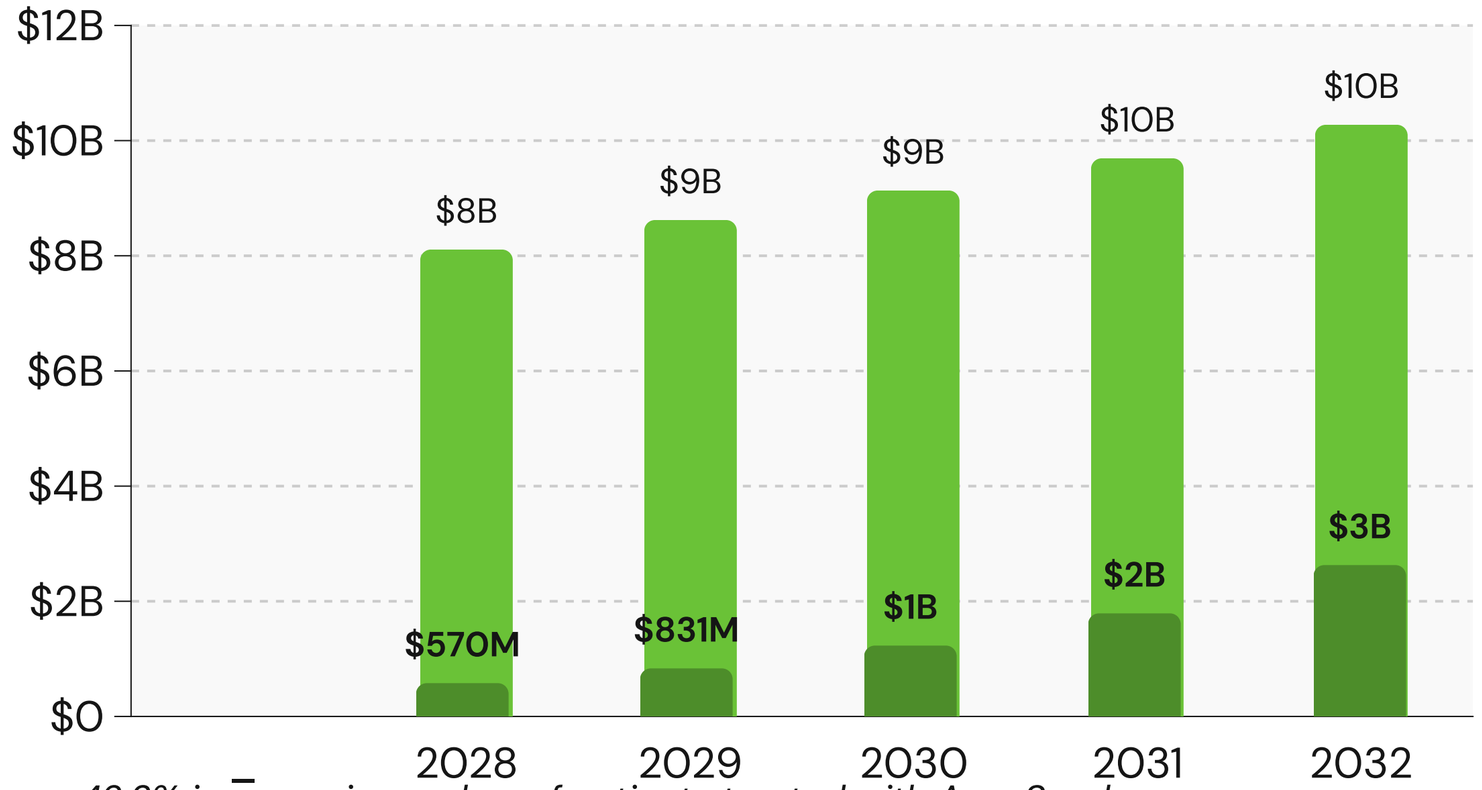


Photo Credit: Neuralink

Post-Development Gross Revenue Projections



42.3% increase in number of patients treated with AccuSpark every year

6.1% CAGR from 2017 to 2022

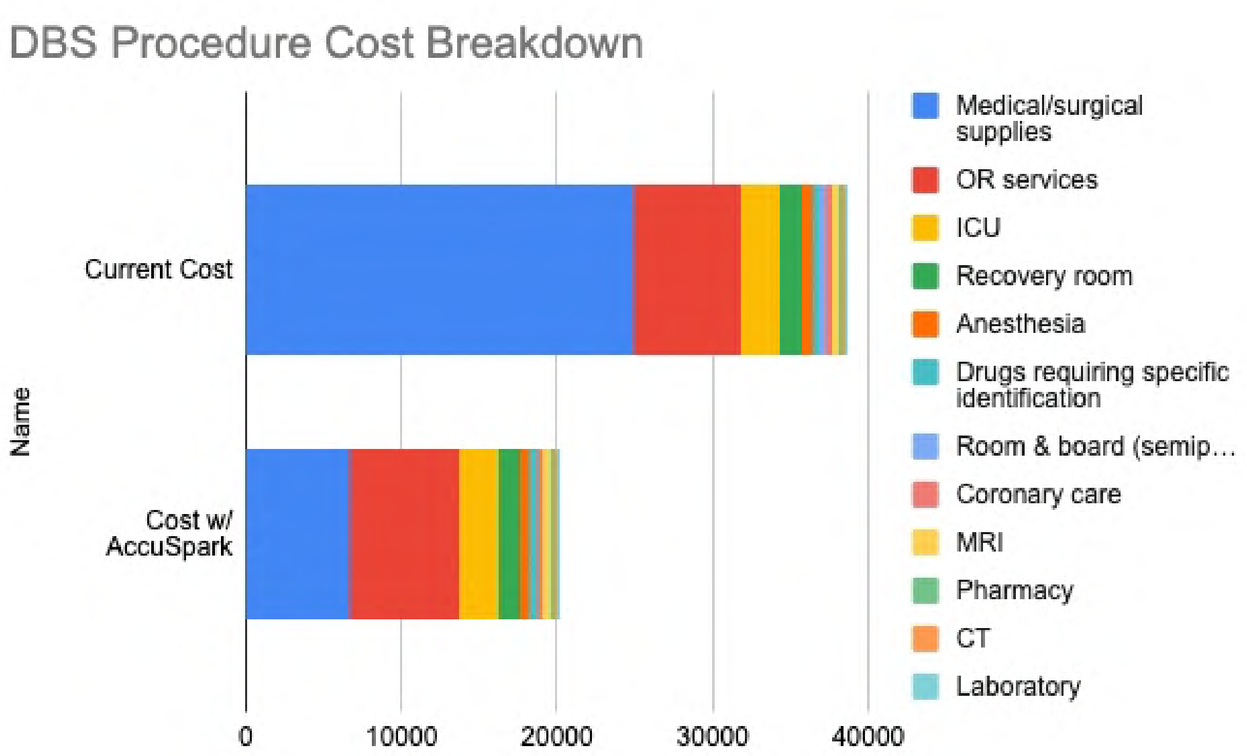
Estimated value of USD 5.69 billion in 2022

Cost Savings per Patient

Current Cost per Patient: **$38,718**

Cost w/ AccuSpark: **$20,149**

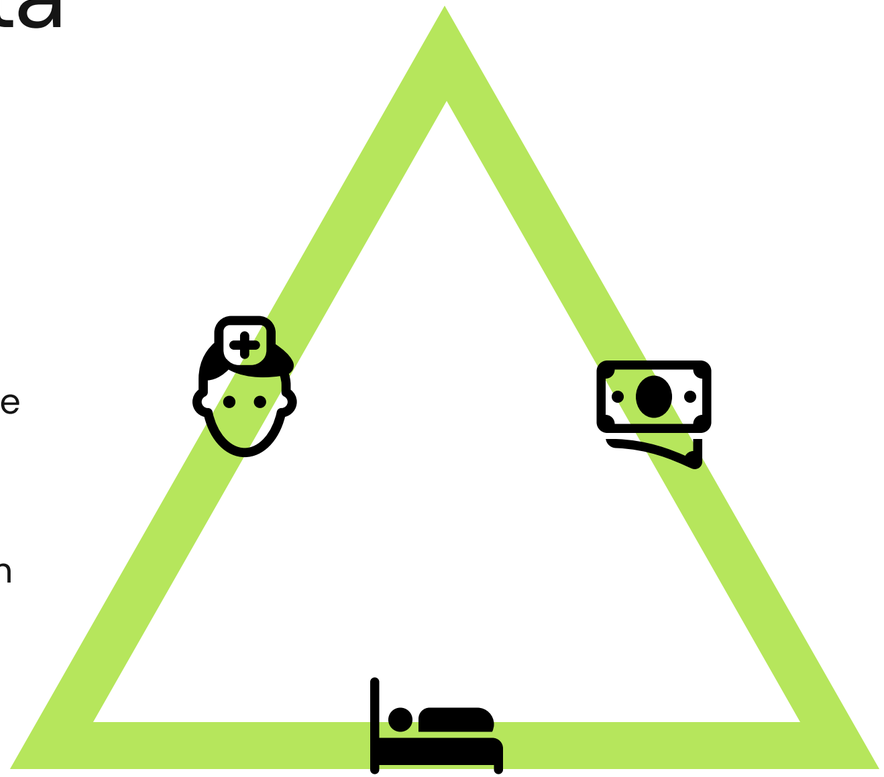
AccuSpark **decreases** the **medical/surgical supplies** costs by **73%** & **eliminates** the need for the current **2-day hospital stays**— resulting in an average **savings** of **$18,569** per patient.



Providers, Patients, Payers: AccuSpark's Benefits in the Healthcare Trifecta

Surgeons

- **Lower costs** of DBS procedure
- **Increase success rate** of DBS procedure for Parkinson's disease
- Surgeons are **more confident** in their electrode placement
- More likely to recommend DBS in the future



Insurers

- **$18,569+ savings** per patient with proposed alternate route of entry
- **Scalability** to many disease indications for DBS

Patients

- **Improve quality of life**
- **Increase satisfaction** with surgery
- **Decrease costs** out-of-pocket
- **Minimize** expensive hospital stays

How will we use the $10,000?

$ 2,000
Prototyping

$2,000
Optimization

$ 6,000
Experimental Trials

ACCUSPARK

ACCESSING THE INACCESSIBLE

PENN I-CORPS
educate. collaborate. accelerate.

Children's Hospital of Philadelphia

PassageBio

Penn Medicine