# Reusable RF Electrodes

Virtual Design Review 2
Team 314
Abbott
11/12/21



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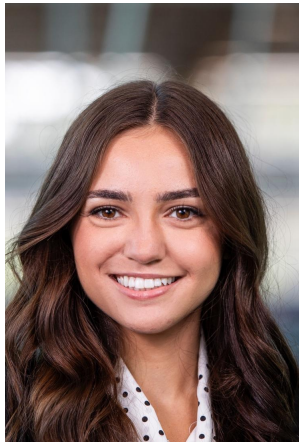

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# Sponsor & Advisor

- Sponsor: Abbott Laboratories
- Medical Device Company
- Contact: Bryan Burnett

- Advisor: Dr. Rajendra Arora
- Professor: ECE Department
- Specialty: RF and Electromagnetic Fields

# Outline



Figure 1. Product Development [1]



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# Brief Overview

**RF Ablation:**

- Radiofrequency ablation is a common procedure for relieving pain.
- It greatly benefits people suffering from chronic pain.

**How it works:**

- Electric current heats up nerve tissue and stops it from sending pain signals.

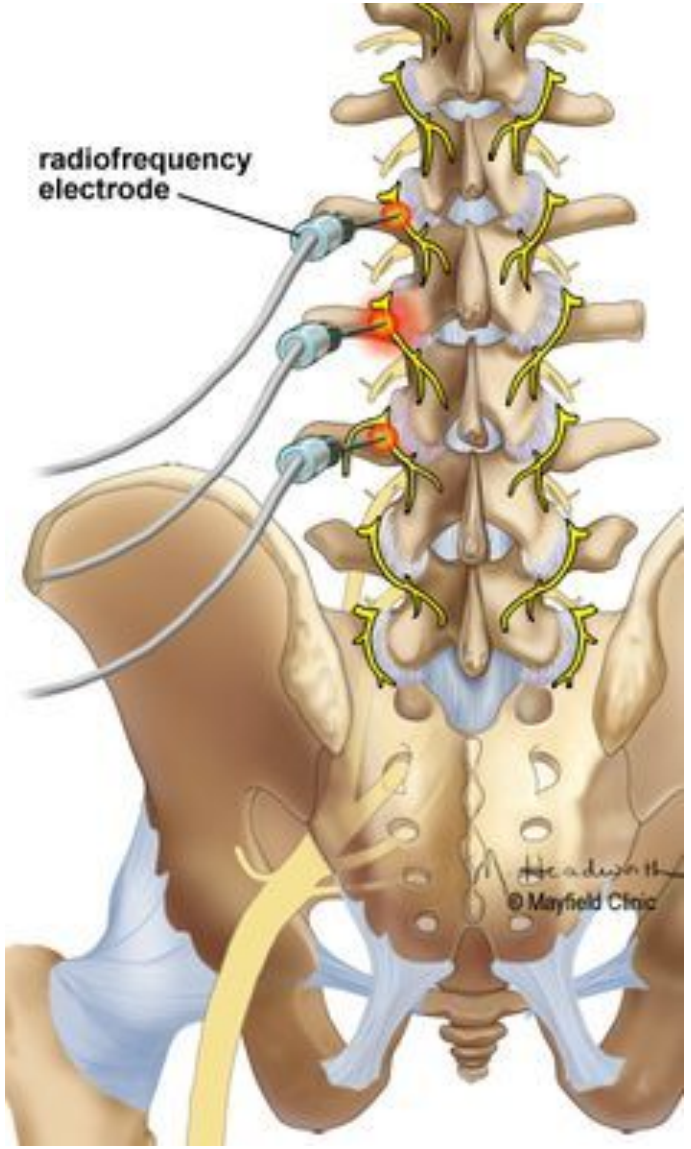


Figure 2. RF Ablation Therapy [2]



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# Problem Statement

**Project Scope:**

- Improve Reusability

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**Customer Needs:**

1. Biocompatible Materials
2. Withstand at least 100 uses
3. Propagate RF signals (2 Hz - 460 kHz)
4. Measures temperature
5. Repeated sterilization
6. Repeated procedure stress
7. Production cost less than $200
8. Pass FDA approval



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# Targets

- Signals from 2 Hz to 460 kHz can be transmitted
- Voltage ranges between 1.845 V and 7.2 V
- Thermal energy between 50 - 110 degrees C
- Range of temperature between 50 degrees C and 110 degrees C

Figure 3. Target [3]

# Metrics

- Signal is successfully transmitted from the RF generator to the tissue
- Voltage is successfully transmitted from the RF generator to the tissue
- RF signal is converted into thermal energy when the tissue heats up
- Reads in the tissue temperature


Figure 4. Metrics [4]

# Concept Generation

- Generated 108 possible concepts using a morphological chart
- High Fidelity Concepts:
  - Shaft: 304 SS; Hub: PESU
  - Shaft: 304 SS; Hub: PCT
  - Shaft: 304 SS; Hub: PSU

| Durability of Materials | |
|---|---|
| **Shaft Material (12)** | **Hub Material (9)** |
| 304 Stainless Steel | Polyethersulfone (PESU) |
| 316 Stainless Steel | Polycyclohexylenedimethylene Terephthalate (PCT) |
| Tungsten | Polysulfone (PSU) |
| 308 Stainless Steel | Polyaryletherketones (PAEK) |
| 309 Stainless Steel | Polyetherimide (PEI) |
| 310 Stainless Steel | Syndiotactic Polystyrene (SPS) |
| 321 Stainless Steel | Polyphenylsulfone (PPSU) |
| 330 Stainless Steel | Polyphenylene Sulfide (PPS) |
| 403 Stainless Steel | Polyphthalamide (PPA) |
| 420 Stainless Steel | |
| 422 Stainless steel | |
| 442 Stainless Steel | |



Presenter: Carolina Hau

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# Concept Selection

**Analytical Hierarchy Process (AHP)**

- Shows and quantifies the relationship of the customer needs.
- Final result will rank each customer need based on priority/importance.

$$Geometric\ Mean = \sqrt[n]{\prod_{i=1}^{n} a_i}$$

$$Normalized\ Weight = \frac{Geometric\ Mean}{Sum\ of\ all\ Means}$$

| | | Biocompatible materials | Propagate RF Signals (2Hz - 465kHz) | Measure temperature | Withstand repeated sterilization | Final production cost of $200 | FDA approval | Geometric Mean | Normalized Weight |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Biocompatible materials | 1 | 6/5 | 3/2 | 3 | 6 | 2 | 2.004 | 0.29 |
| 2 | Propagate RF Signals (2Hz - 465kHz) | 5/6 | 1 | 5/4 | 5/2 | 5 | 5/3 | 1.670 | 0.24 |
| 3 | Measure temperature | 2/3 | 12/30 | 1 | 2 | 4 | 4/3 | 1.336 | 0.19 |
| 4 | Withstand repeated sterilization | 1/3 | 2/5 | 1/2 | 1 | 2 | 2/3 | 0.668 | 0.10 |
| 5 | Final production cost of $200 | 1/6 | 1/5 | 1/4 | 1/2 | 1 | 1/3 | 0.334 | 0.05 |
| 6 | FDA approval | 1/2 | 3/5 | 3/4 | 3/2 | 3 | 1 | 1.002 | 0.14 |

# Concept Selection

**Pugh Chart**

- Use of customer needs, weighted by the AHP decision matrix, to determine the viability of each of our high-fidelity concepts

| | W | Baseline (PET With 304 Stanless Steel) | PESU (Polyethersulfone) With 304 Stainless Steel | PPSU (Polyphenylensulfone) With 304 Stainless Steel | PSU (Polysulfone) With 304 Stainless Steel |
|---|---|---|---|---|---|
| Biocompatable Materials | 6 | - | 0 | 0 | 0 |
| Propogate RF Signals | 5 | - | 0 | 0 | 0 |
| Measure Temp | 4 | - | 0 | 0 | 0 |
| Withstand Repeated Sterilizations | 2 | - | +1 | +1 | +1 |
| Final Cost ≤ $200 | 1 | - | -1 | +1 | +1 |
| FDA Approval | 3 | - | 0 | 0 | 0 |
| Score | | - | 0.05 | 0.15 | 0.15 |
| Continue? | | NO | NO | YES | YES |

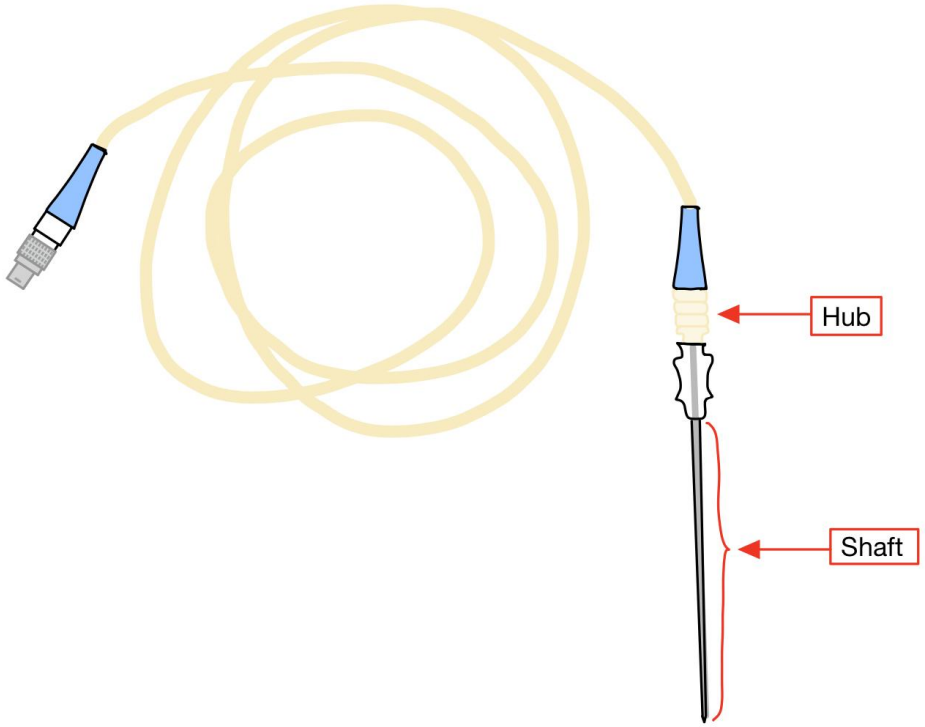


Presenter: Carolina Hau

# Final Concept

- 304 Stainless Steel shaft
  - ± Material currently in use

- PPSU (Polyphenylsulfone) Hub material
  - \+ Virtually unlimited steam sterilization
  - \+ Better chemical resistance than PET
  - \+ Biocompatible
  - \+ Already in use in the medical field
  - – Higher Cost



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# Future Plans

- Finalize NDA
  - Acquire current schematics
- Begin developing prototype
  - Manufacture small batch
- Start testing of prototype
  - Determine if PPSU is the right material for the job.

Figure 5. Brainstorming

# Summary

- Sponsor: Abbott Laboratories
- Product: Reusable RF Electrode
- Use: RF ablation for chronic pain
- Targets and Metrics
- Concept Generation
- Concept Selection
- Final Concept

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- Dr. Rajendra Arora (Project Advisor)
- Bryan Burnett (Abbott)
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- Dr. Hooker (ECE Professor)
- Dr. Naroozi (ECE SD SD Professor)
- Hebert Lopez (ECE SD TA)


Figure 7. Problem solving techniques



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# Questions?

Figure 8. Customer Insight