



Implanted Closed Loop System to Treat DSD Using Electrical Stimulation



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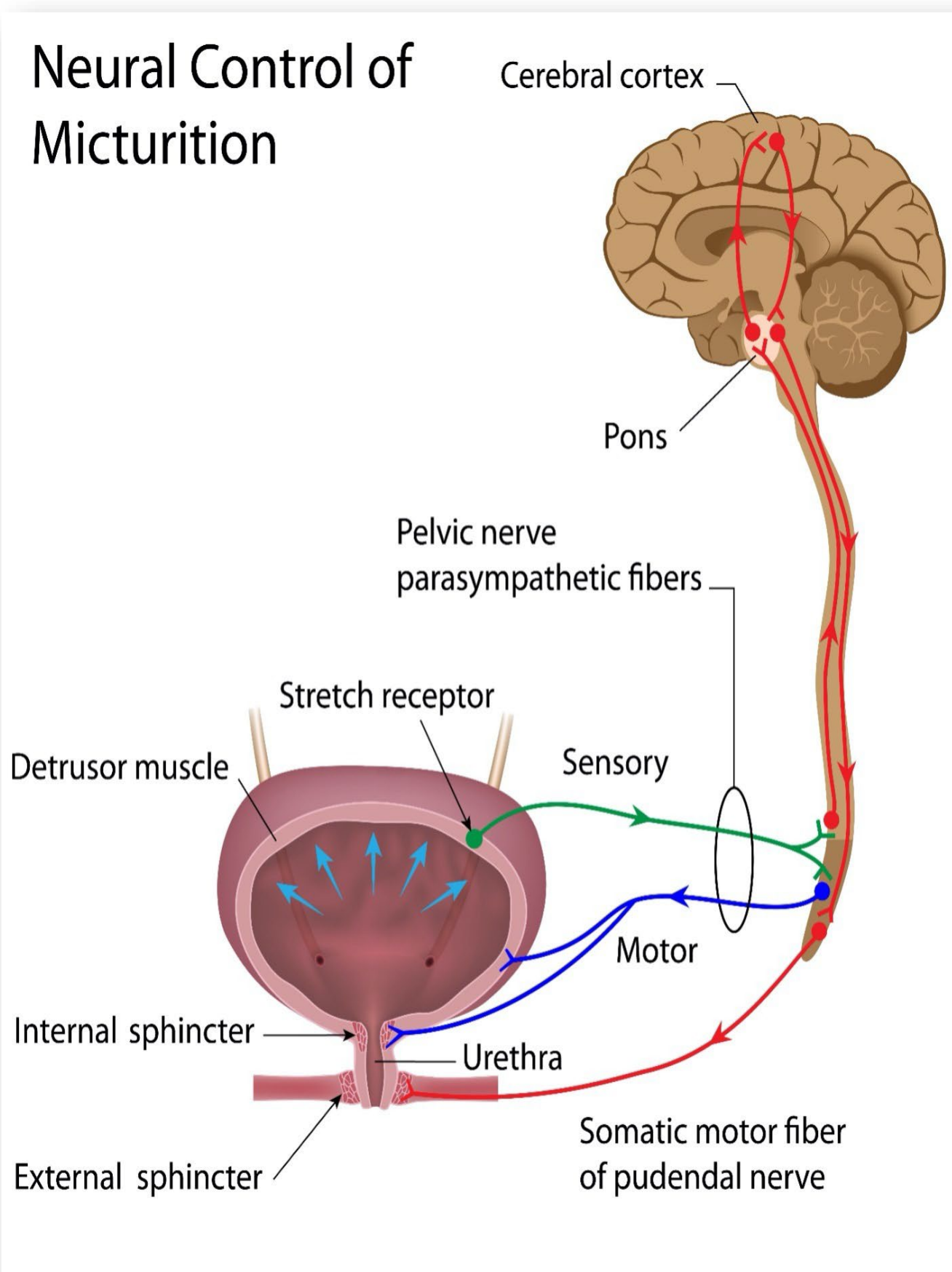
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Objective

To create an implantable bioelectronic device capable of modulating detrusor and sphincter muscle activation using electrical stimulation and based on cystometric and EMG inputs to treat patients with detrusor sphincter dyssynergia (DSD).

Background

Detrusor sphincter dyssynergia (DSD): Detrusor and external urethral sphincter (EUS) muscles do not coordinate contractions



- 70% of patients with (suprasacral) SCI lesions and 20% of MS patients develop DSD
- Other treatments:
 - **Bot. A:** 44 – 76% success rate
 - **Sacral neuromodulation:** 60% success rate

Figure 1: Bladder motor control diagram.

Methods

Activation pathway: EMG + cystometry data -> central circuit -> DSD algorithm -> stimulation electrodes -> detrusor + EUS muscle in-vitro model

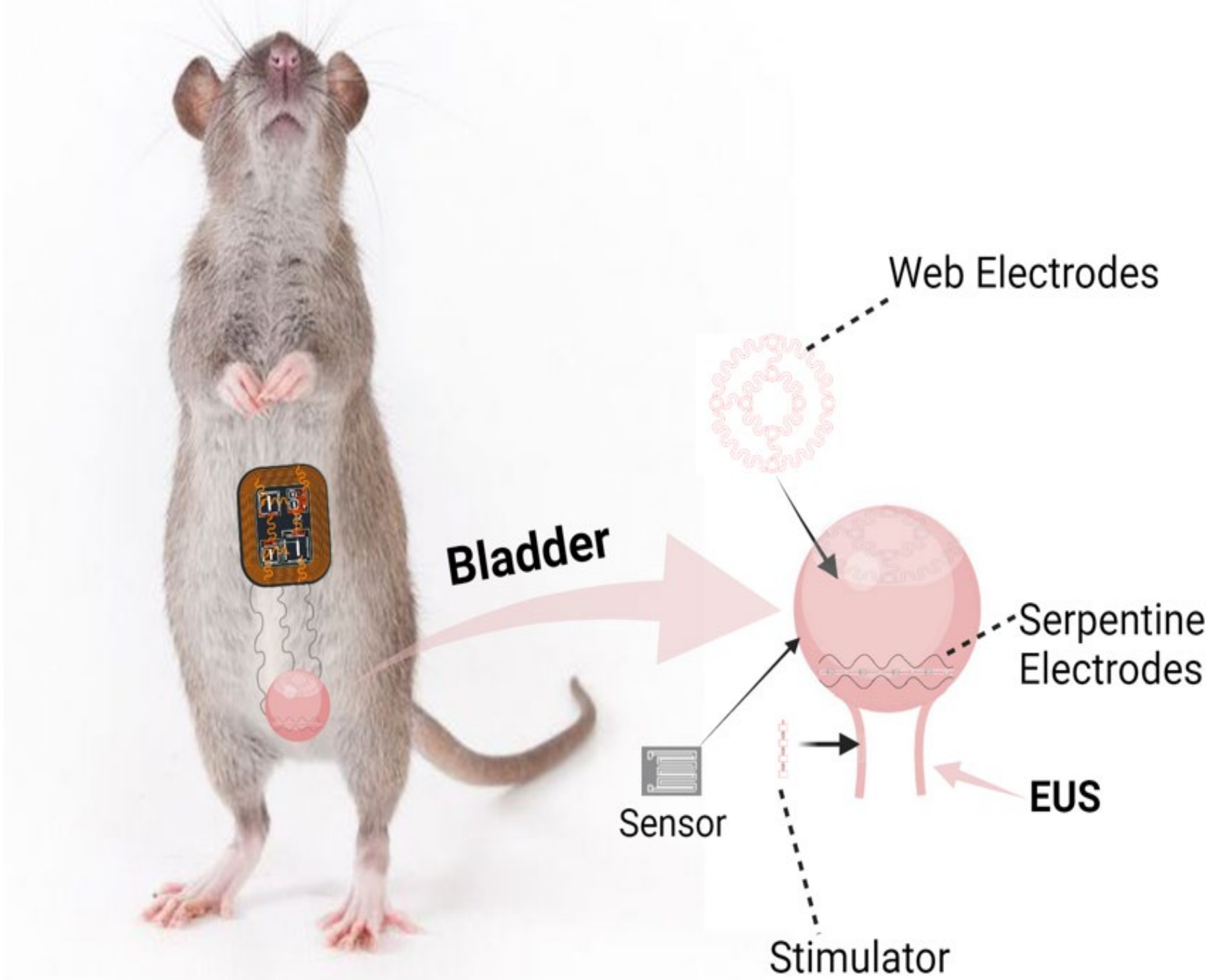


Figure 2: Overview of project deliverables integrated into an In-Vivo model

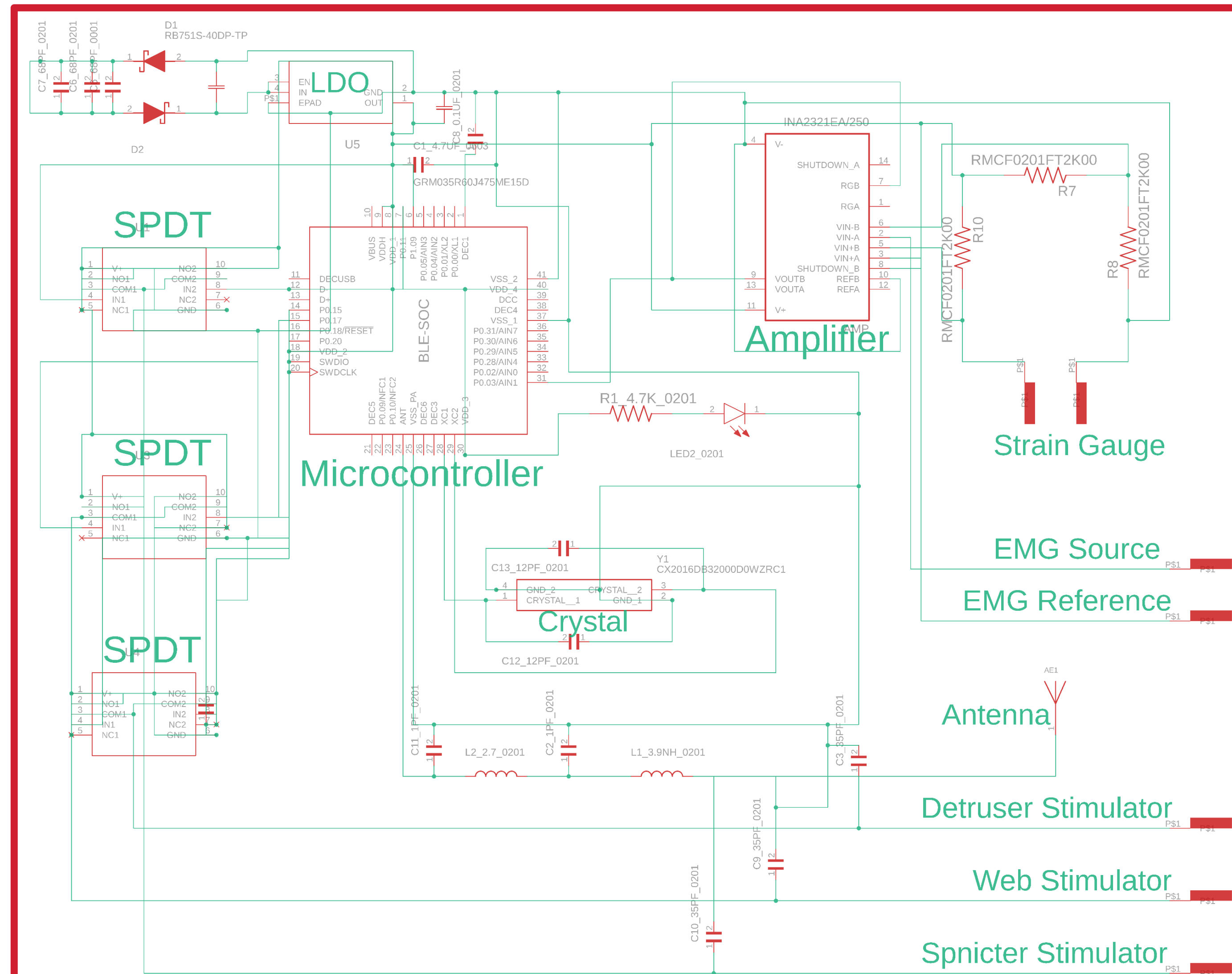


Figure 3: Final schematic for the central circuit

- Circuit is **wirelessly powered** to eliminate need for repeat surgeries
- Sensors and electrodes constructed with a **modified photolithography process** for compliance with substrate
- Substrates created by **casting EcoFlex / PDMS** to negative molds
 - Negative molds **3D printed** using clear resin

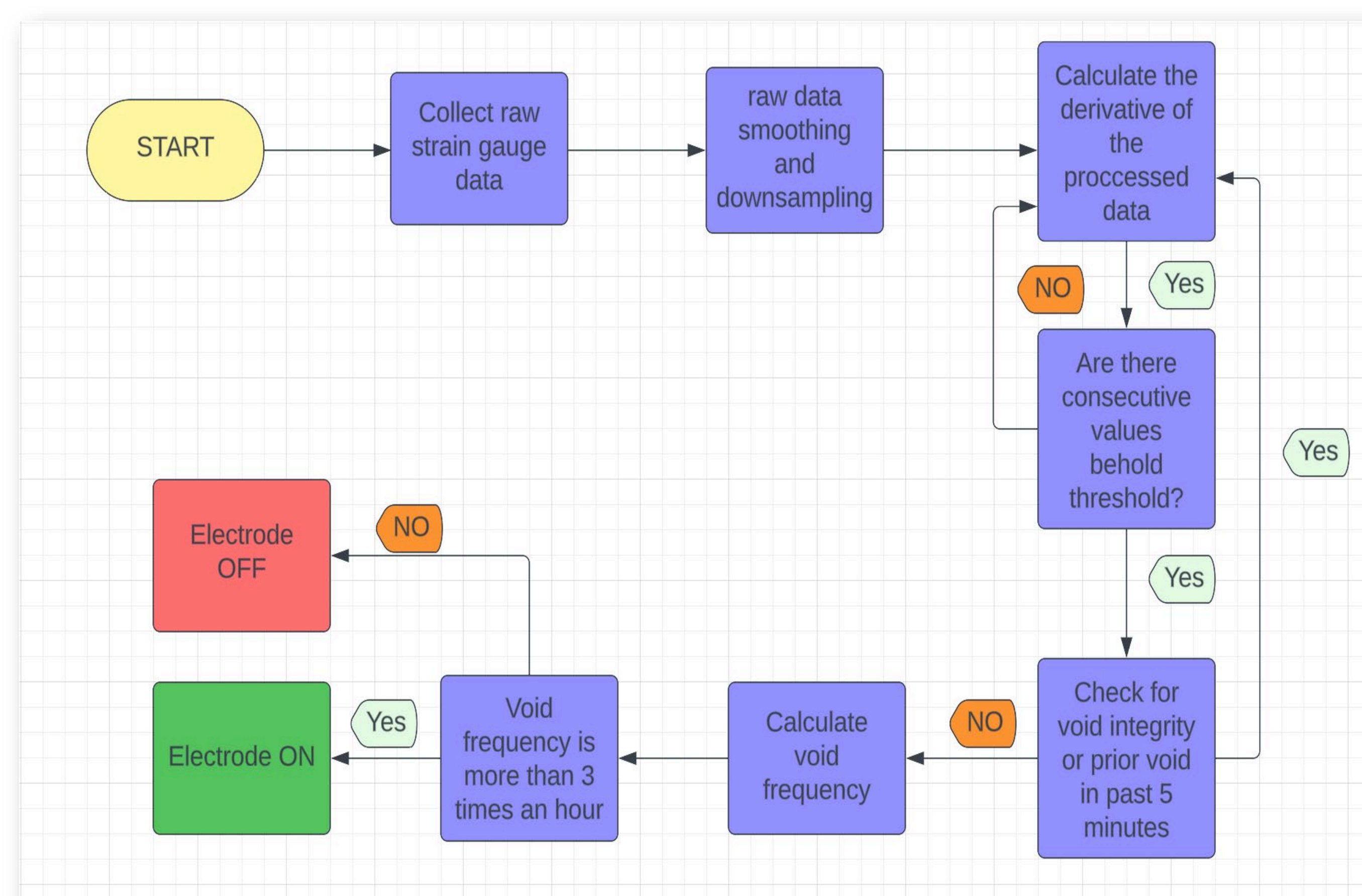


Figure 4: Logic flow chart implemented for device algorithm

Figure 5: Additional balloon testing for confirming adequate substrate flexibility



Results

- EcoFlex substrate deformation found to conform to balloon during testing
- Completed DSD algorithm identifies DSD condition given inputs
- Completed central circuit can process relevant inputs and outputs
- Completed bladder model substrate can emulate natural bladder expansion

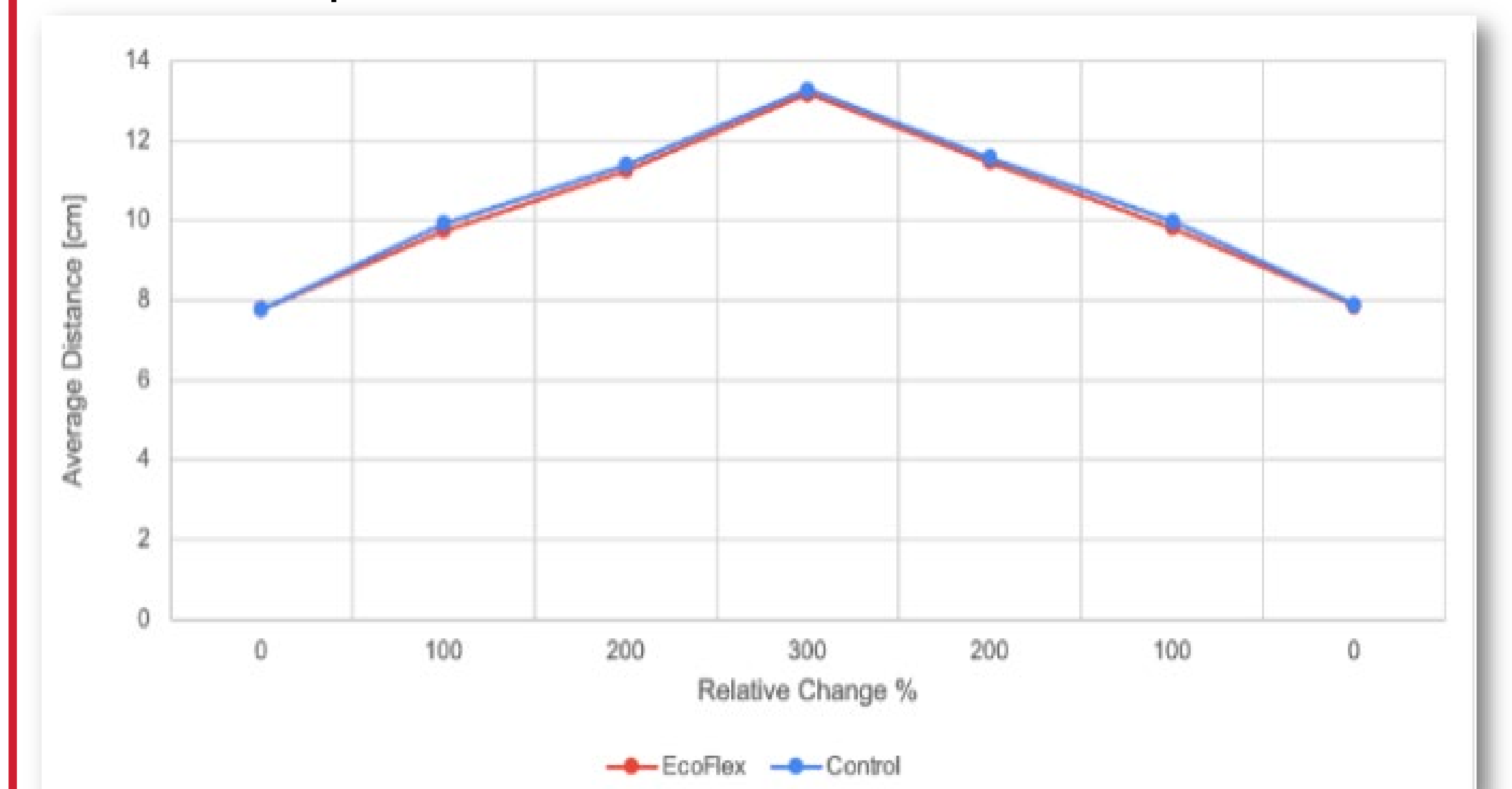


Figure 6: Flexible serpentine shaped substrate constriction analysis results.

Conclusion

The central circuit, bladder model substrate, flexible electronics component substrate, and DSD algorithms have been completed. Once flexible electronic components are fabricated, in-vitro testing will be performed to test whole-device compatibility.

Acknowledgements

Our group would like to recognize Yifan Wang, Ali Garmroudi, Tushar Ali, and Chnag Liu for their assistance and advice in this project, as well as Dr. Zhengwei Li for his help and support in this project.