



Robotically Assisted Cochlear Imaging and Access

Berk GONENC

- Team #1
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- Clinical Mentors: J. Niparko, W. Chien





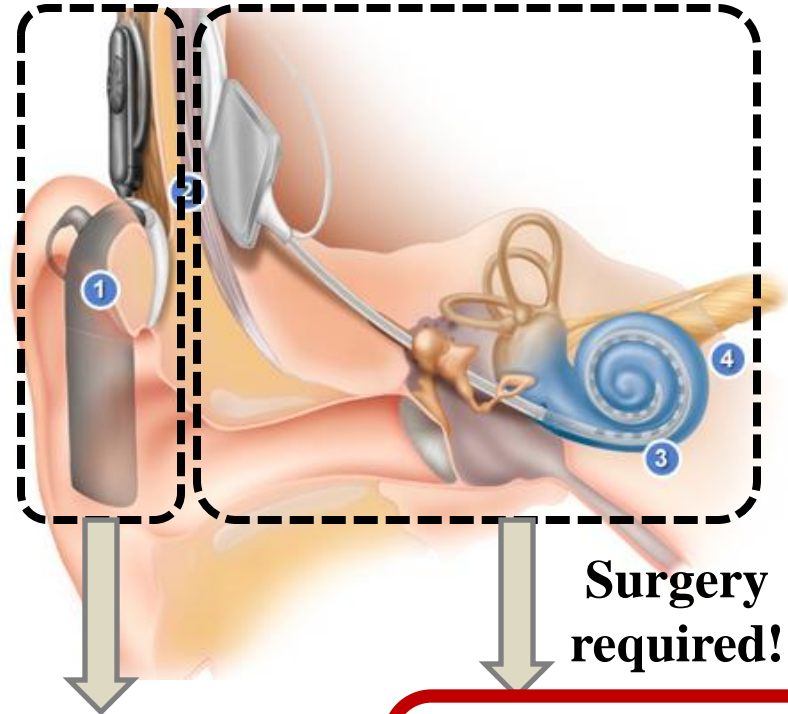
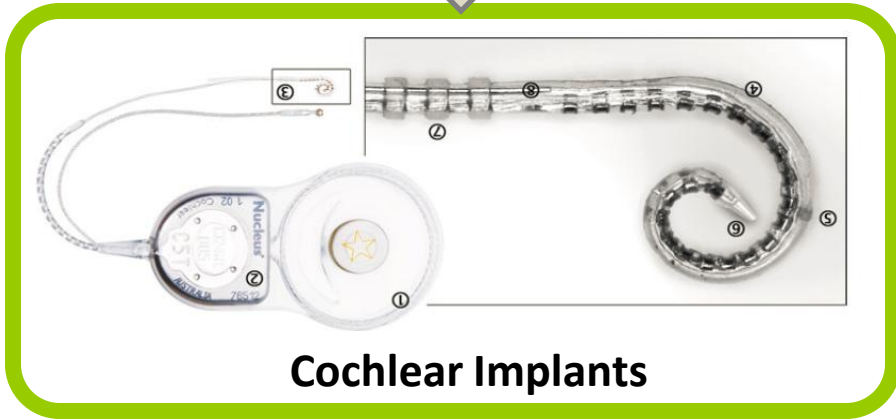
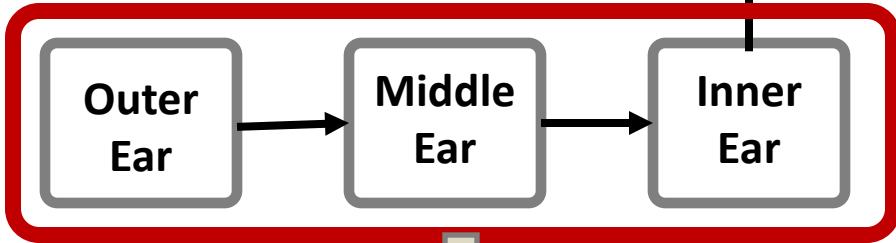
Outline

- **Background & Specific Aims**
- **Article Choice**
- **Technical Summary**
- **Experiments & Results**
- **Conclusion & Future Work**
- **Analysis**





Background & Specific Aims



External system

- Microphone
- Speech processor
- Transmitter

Internal system

- Receiver/stimulator
- Electrode array

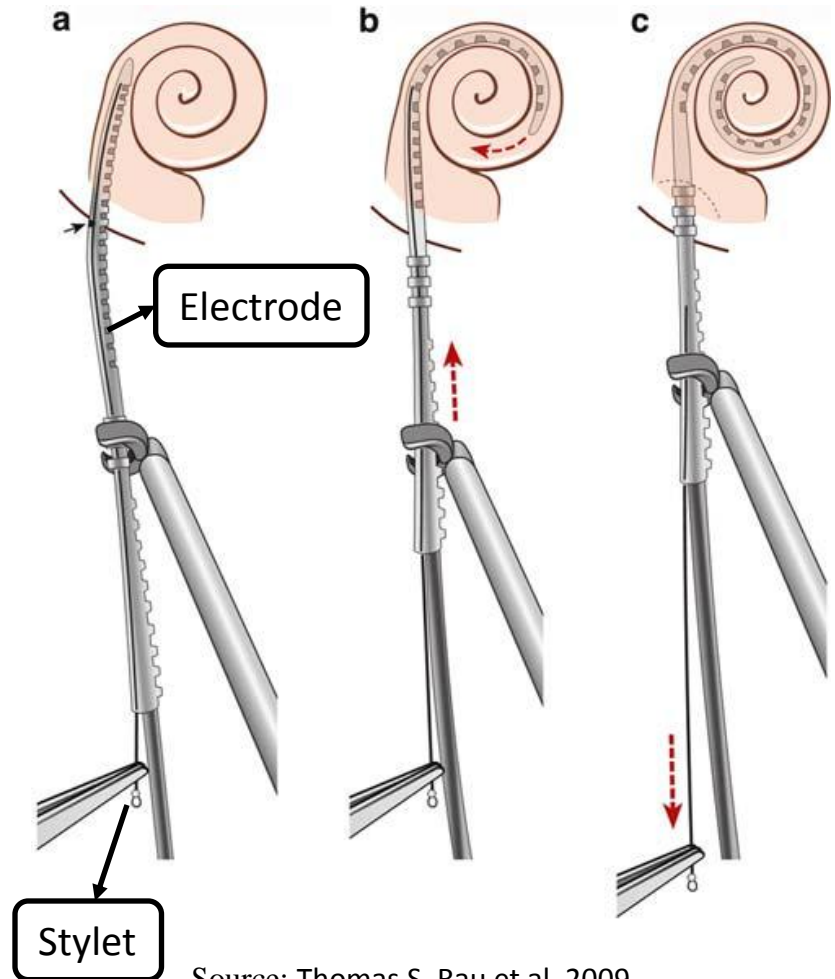
Source: www.cochlear.com





What is happening inside?

- Insertion Technique : Advance Off-Stylet
- Flexible curved electrode array (1 mm diameter) is advanced into 15-20 mm long channel in 3 steps:
 - a. The whole electrode is inserted until the white marker reaches cochleostomy site.
 - b. The stylet is held stationary, electrode is deployed off the stylet. The electrode takes its naturally curved shape.
 - c. After the ribs reach the cochleostomy site, the stylet is removed.



Source: Thomas S. Rau et al, 2009

➤ Location of these steps is very critical!

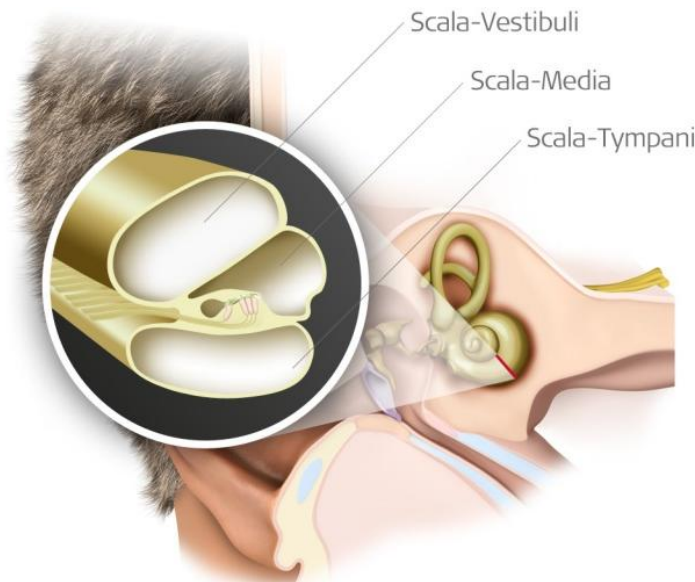




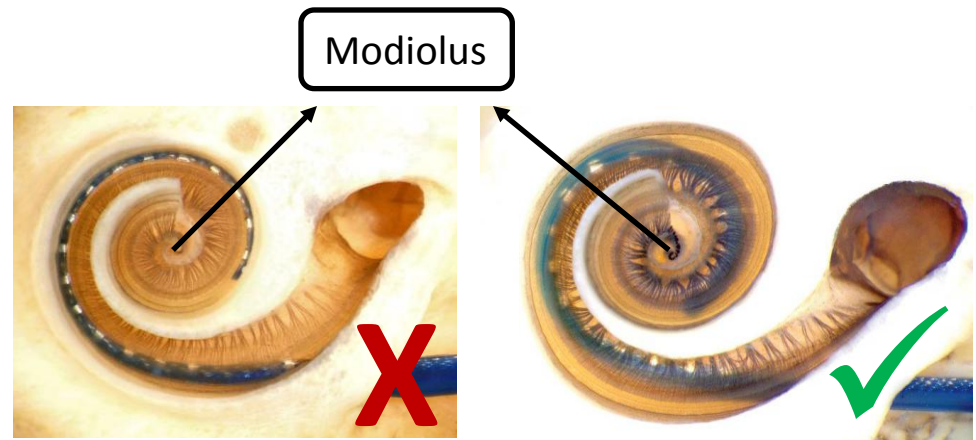
Clinical Goals

1. The electrode should travel in Scala-Tympani with **NO DAMAGE** to the basilar membrane.
2. The electrode should be located as **CLOSE TO MODIOLUS** as possible.

➤ For these, there is a critical location to begin off-styleslet technique.



Source: www.medel.com



Source: www.utsouthwestern.edu





Outline

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Paper 1: "A manual insertion mechanism for percutaneous cochlear implantation"

Authors: Daniel Schurzig, Zachariah W. Smith, D. Caleb Rucker, Robert F. Labadie, Robert J. Webster III

Presented at: Design of Medical Devices Conference (DMD2010), April 13-15 2010, Minneapolis, MN, USA

Paper 2: "Insertion of electrode array using percutaneous cochlear implantation technique: a cadaveric study"

Authors: Ramya Balachandran, Jason E. Mitchell, Jack Noble, Daniel Schurzig, Gregoire Blachon, Theodore R. McRachan, Robert J. Webster, Benoit M. Dawant, J. Michael Fitzpatrick, Robert F. Labadie

Presented at: Medical Imaging 2011: Visualization, Image-Guided Procedures, and Modeling, February 13 2011, Lake Buena Vista, FL, USA

Source: www.cochlear.com





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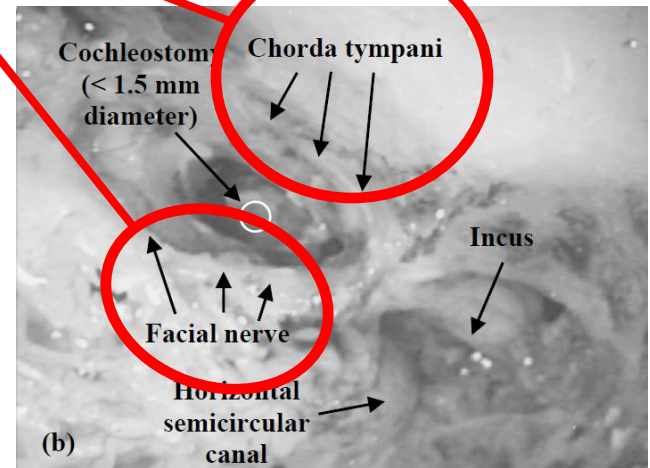
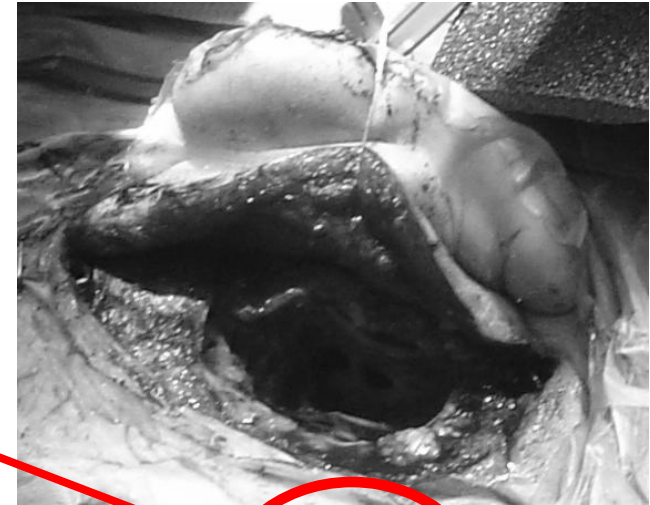
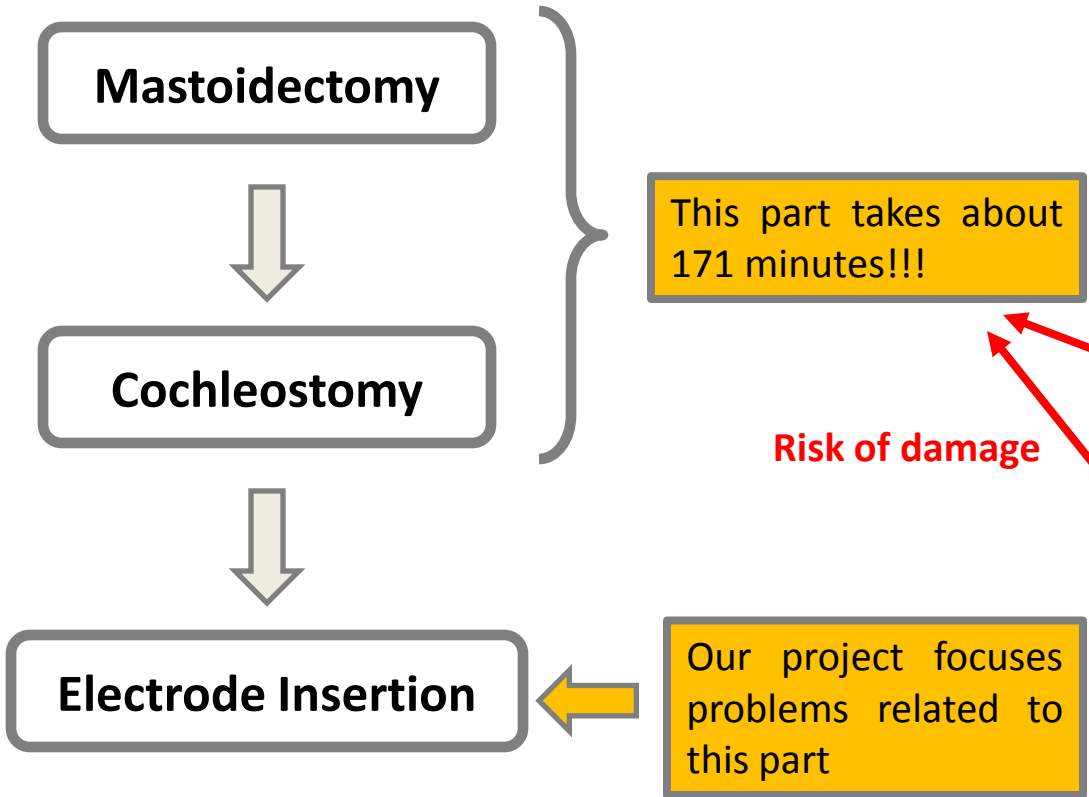


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Technical Summary

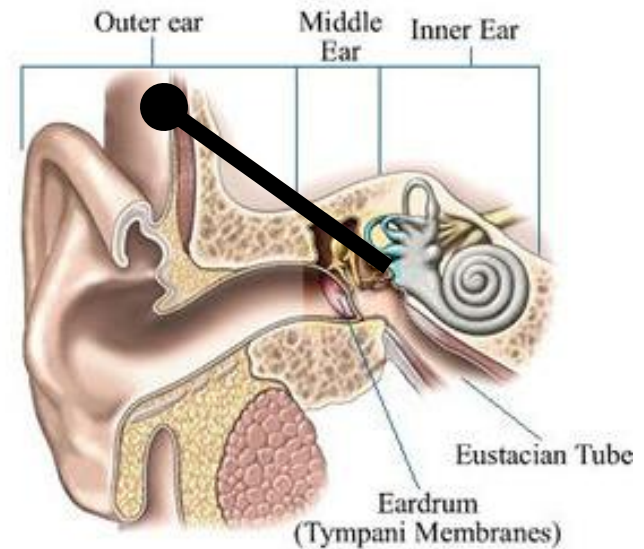
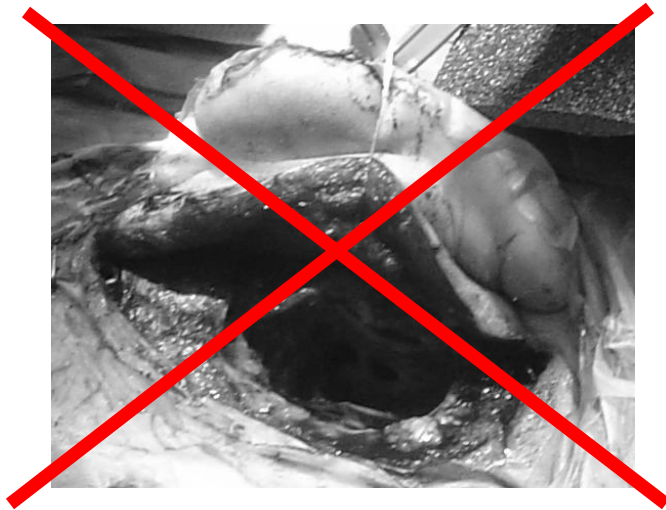


Source: Ramya Balachandran et al., 2011





Percutaneous Cochlear Implantation (PCI)

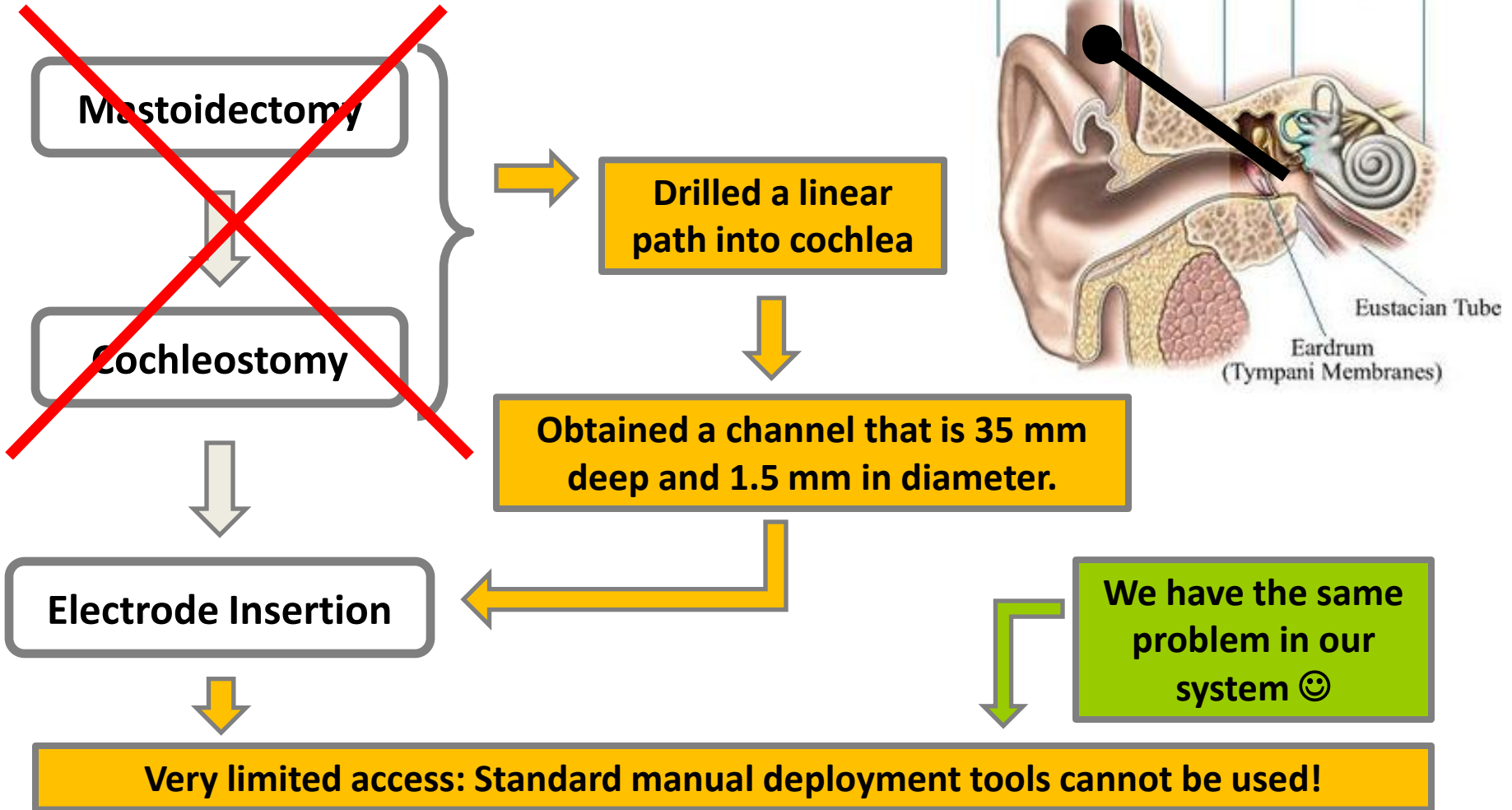


- Mastoidectomy is removed.
- A linear path from skull to cochlea is drilled by avoiding facial nerve and Chorda Tympani.
- Much quicker, less invasive.
- Submillimetric accuracy is required for implementation!





Technical Summary





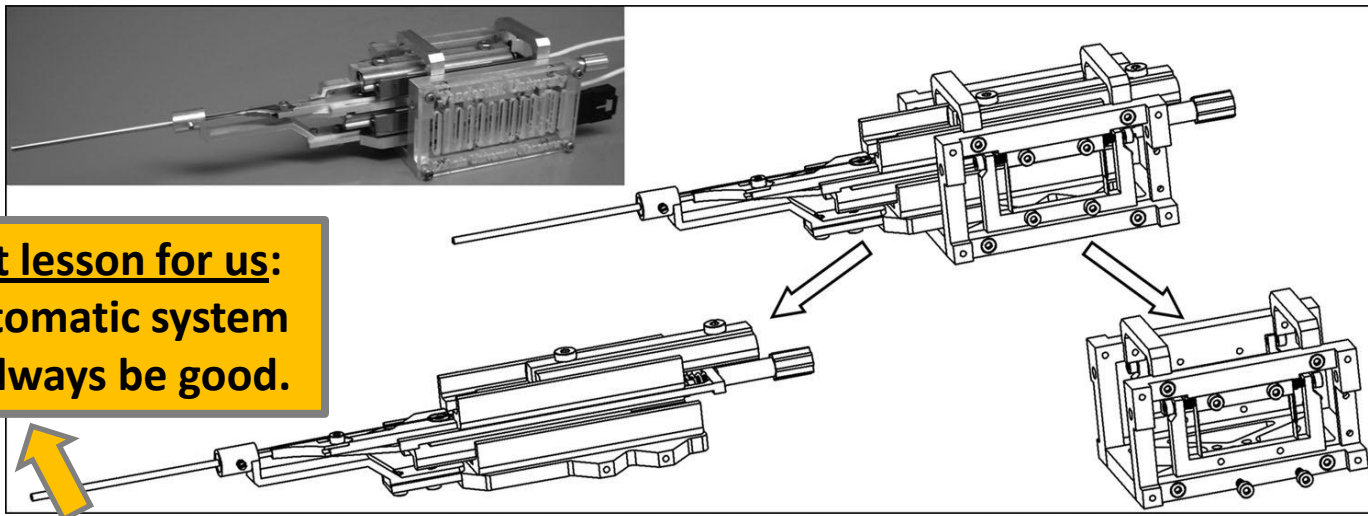
Technical Summary

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➤ A Force Sensing Automated Insertion Tool for Cochlear Electrode Implantation

Daniel Schurzig, Robert F. Labadie, Andreas Hussong, Thomas S, Rau, Robert J. Webster

IEEE International Conference on Robotics and Automation, May 2010



**Important lesson for us:
A fully automatic system
may not always be good.**

Problem: Regulatory-related challenges in applying the system to human use.

Remedy: Replace the automated tool with a manual tool 😊



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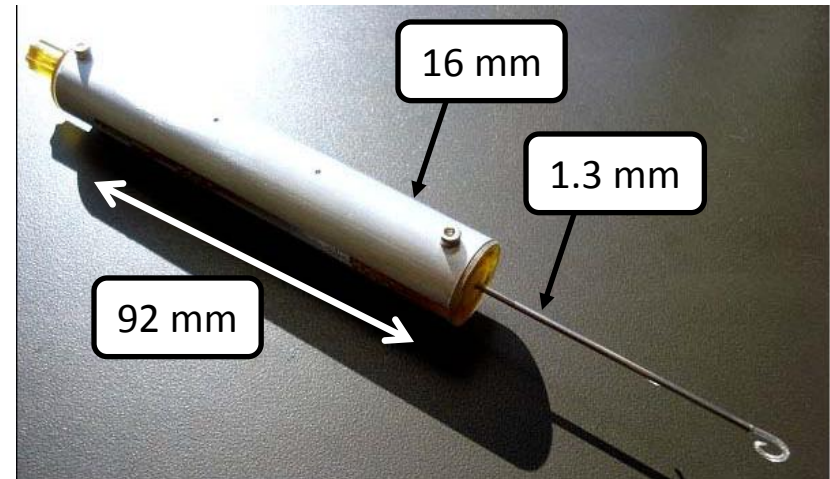
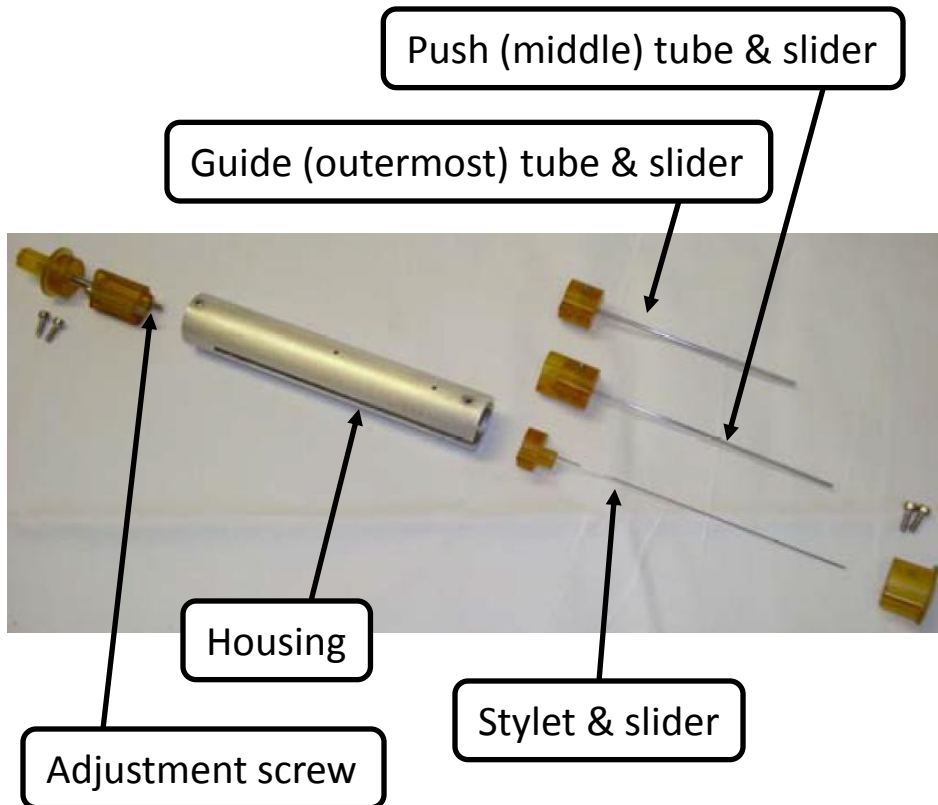


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Manual PCI Insertion Tool Design



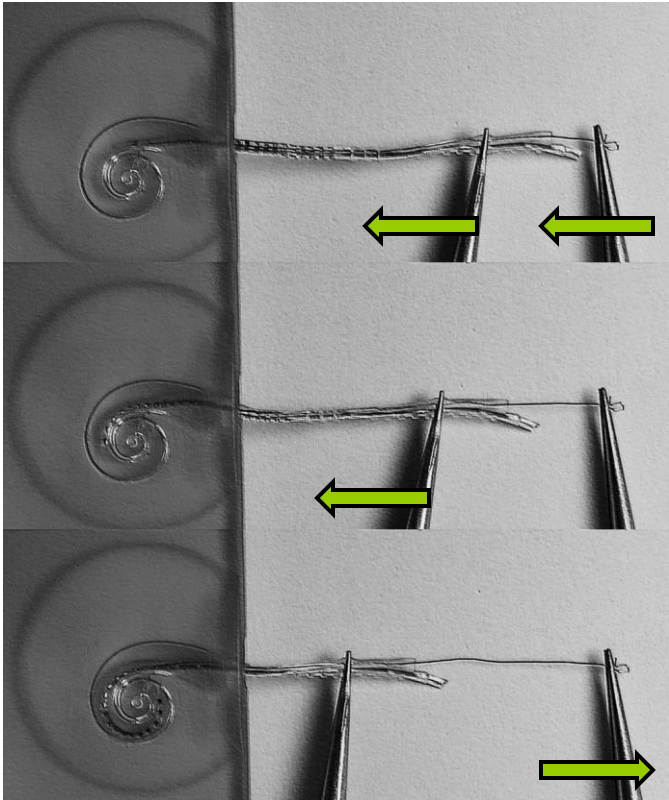
Source: Daniel Schurzic et al., 2011

- Used concentric tube approach to enter 1.5 mm channel easily.
- Very compact mechanical pencil-like actuation is obtained.

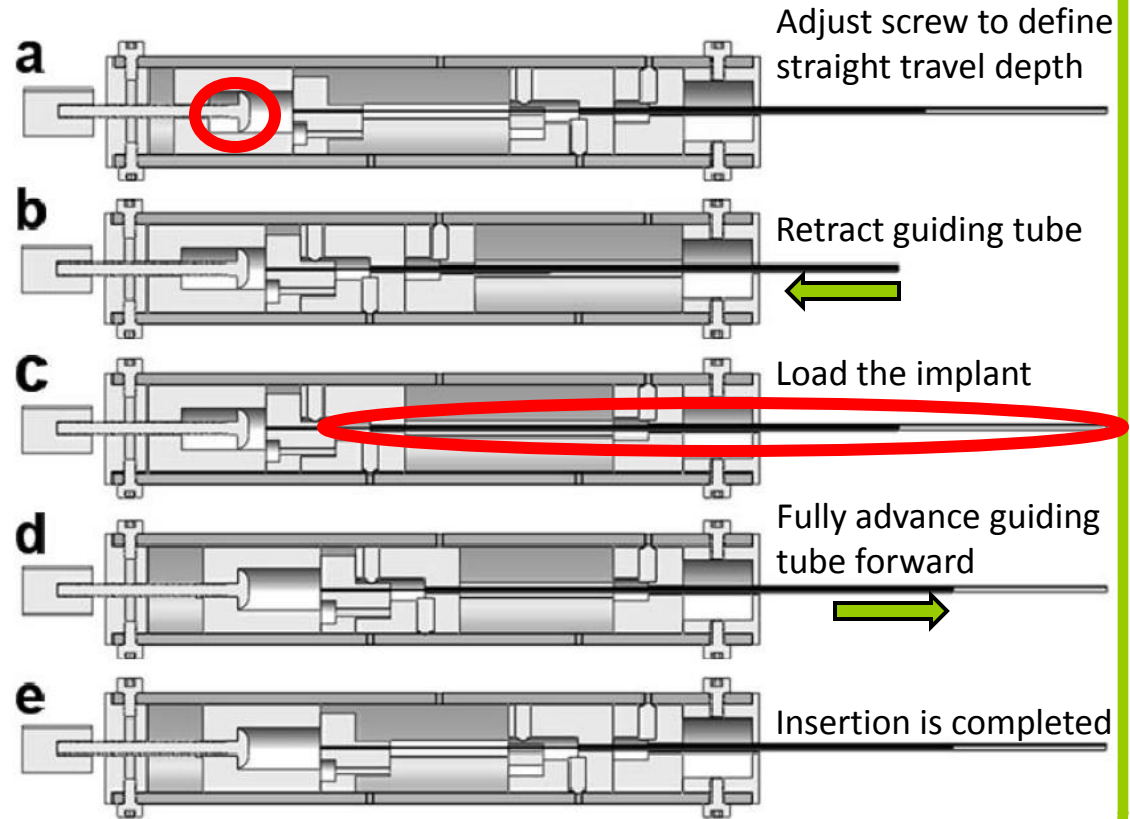




Using Tweezers



Using PCI Tool



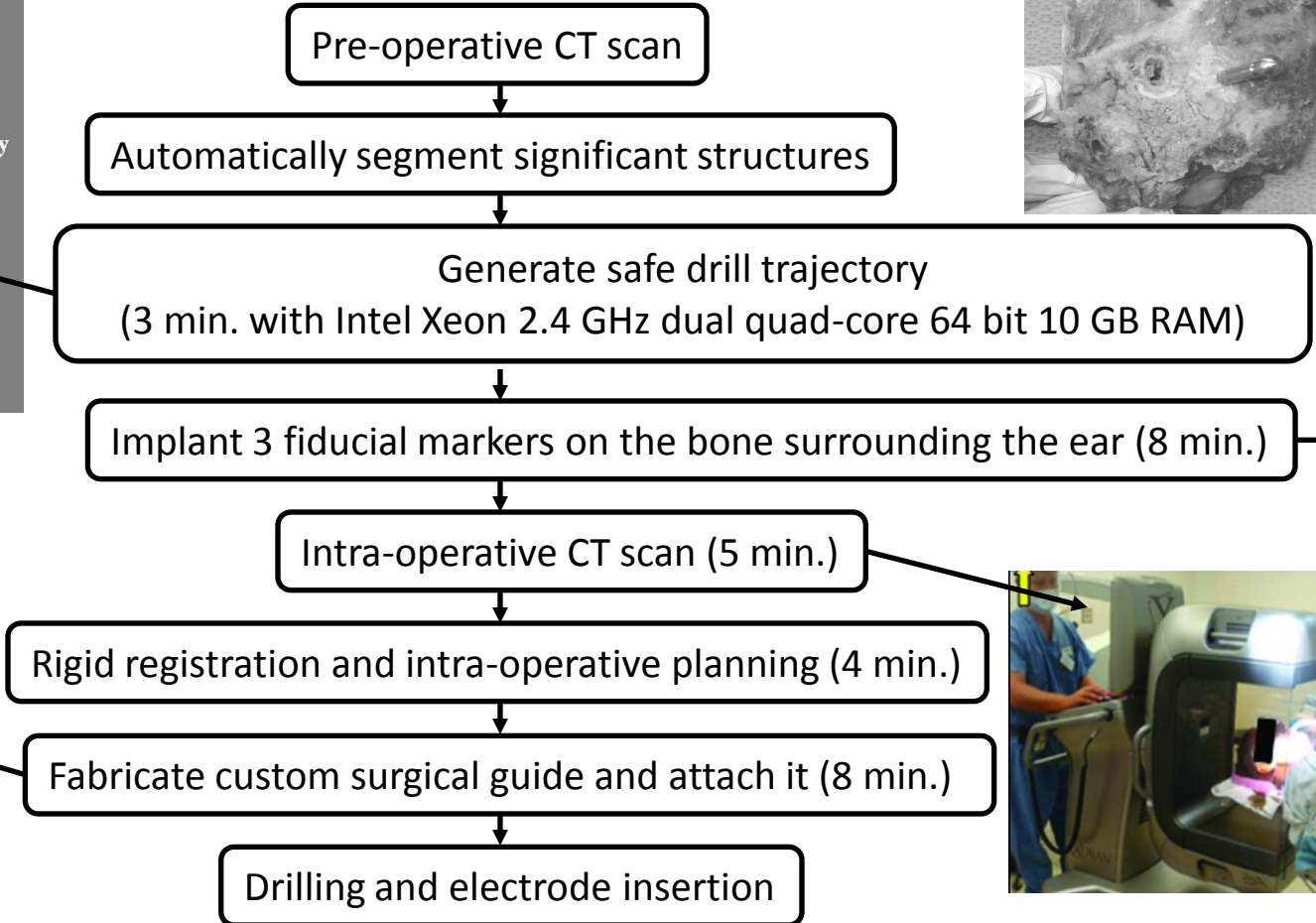
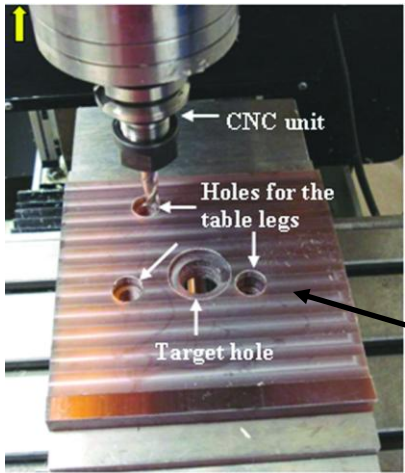
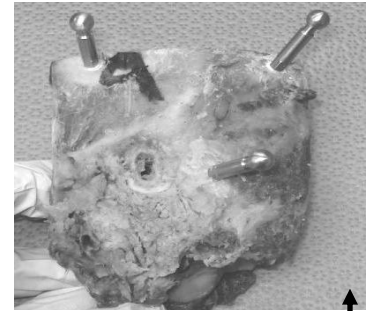
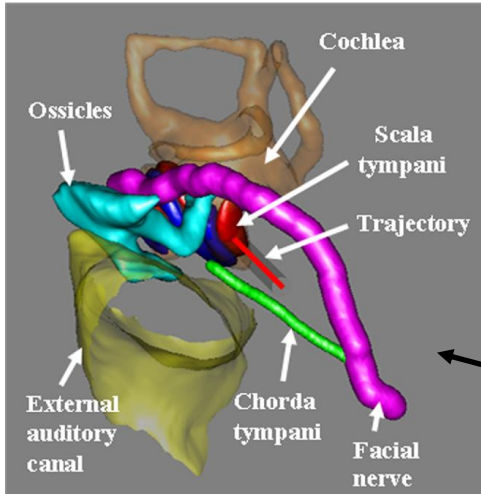
Source: Daniel Schurzig et al., 2011





Technical Summary

Surgical Workflow





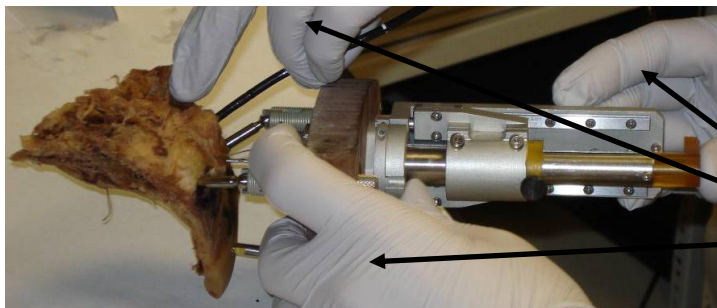
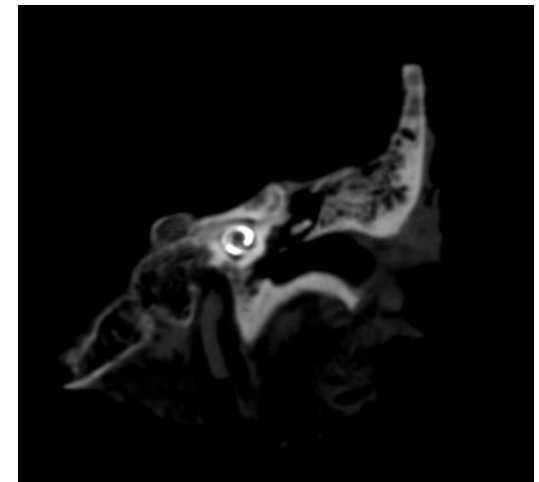
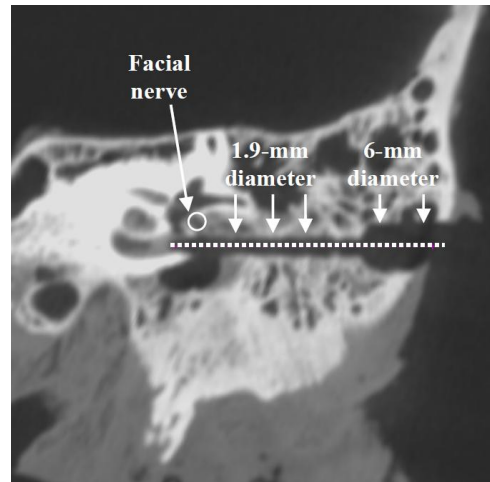
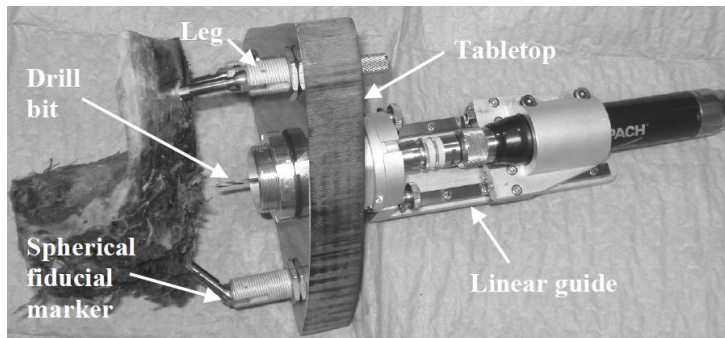
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Experiments & Results

- Tests were done on 3 cadaveric bones.
- In all specimens, the drill reached the cochlea without damaging the facial nerve.
- In all specimens, the insertion was satisfactory based on the post-insertion CT scans.



3 hands????

Source: Ramya Balachandran et al., 2011





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Conclusion

- The compact manual insertion tool served the ability to access through deep narrow holes. This enabled the PCI technique.
- The presented PCI technique reduced average operation time from 171 minutes to 60 minutes.
- The cadaver study is the first reported study demonstrating the insertion of electrode array using PCI.

Future Work

- Sterilization of the device (most probably gas sterilization)
- Proceed rapidly to clinical use





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Our project

- For improving traditional cochlear implant surgery.
- Use intra-operative OCT images.
- No mounting on the patient.

- Pre-curved electrode is inserted via Advance Off-Stylet technique.
- Limited cochlea access ports, and thus seeking compact insertion tools.

Their project

- For improving percutaneous cochlear implant surgery.
- Use pre and intra-operative CT images.
- The tool is rigidly fixed to the bone of the patient.

- Pre-curved electrode is inserted via Advance Off-Stylet technique.
- Limited cochlea access ports, and thus seeking compact insertion tools.





Strengths

- The problem statement is strong.
- The improvement in operation-time is significant.
- Surgical workflow is presented in detail, which can be beneficial for our project since we need to have one as well.
- Mechanism design criteria, restrictions and requirements are well stated, which has shaped and will guide our designs.

Weaknesses

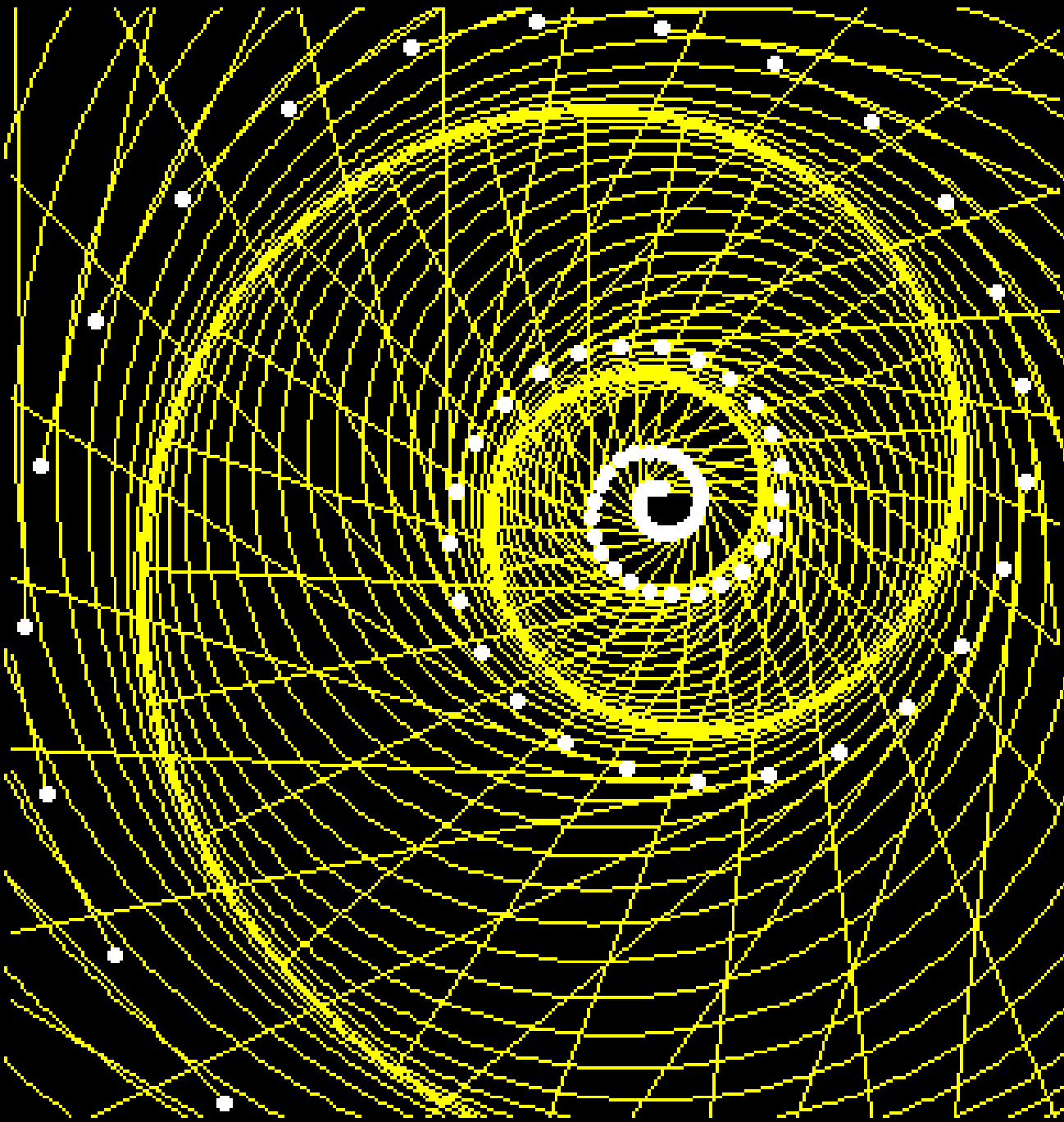
- The mechanism functionality and drawings are not clear.
- It is not clear how the tool is removed after the insertion is completed. (This is why we hadn't used concentric tube approach for our design.)
- Verification of the electrode placement in cadaver experiments is not clear. (based on the presented OCT images.)





- Daniel Schurzig, Zachariah W. Smith, D. Caleb Rucker, Robert F. Labadie, Robert J. Webster III, A manual insertion mechanism for percutaneous cochlear implantation, Design of Medical Devices Conference (DMD2010), April 13-15 2010, Minneapolis, MN, USA
- Ramya Balachandran, Jason E. Mitchell, Jack Noble, Daniel Schurzig, Gregoire Blachon, Theodore R. McRachan, Robert J. Webster, Benoit M. Dawant, J. Michael Fitzpatrick, Robert F. Labadie, Insertion of electrode array using percutaneous cochlear implantation technique: a cadaveric study, Medical Imaging 2011: Visualization, Image-Guided Procedures, and Modeling, February 13 2011, Lake Buena Vista, FL, USA
- Daniel Schurzig, Robert F. Labadie, Andreas Hussong, Thomas S, Rau, Robert J. Webster, A Force Sensing Automated Insertion Tool for Cochlear Electrode Implantation, IEEE International Conference on Robotics and Automation, May 2010





Questions & Comments