BME Design-Spring 2026 - AVERY SCHUDA
Complete Notebook

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ORLA RYAN

on

Apr 29, 2026 @09:56 AM CDT

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Team contact Information

AVERY SCHUDA - Jan 23, 2026, 1:34 PM CST

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Project description

AVERY SCHUDA - Jan 23, 2026, 1:35 PM CST

Course Number: BME 402

Project Name: Intracranial EEG phantom for brain stimulation studies

Short Name: Neurosurgical Phantom

Project description/problem statement:

Intracranial electroencephalography (iEEG) is routinely used in surgical planning for individuals with uncontrolled seizures. Transcranial magnetic stimulation (TMS) may provide complementary information for mapping out critical brain regions that should be avoided during surgery, however, there are still safety concerns around the use of TMS in patients with iEEG. The major safety concerns are the induction of electrical currents, heating, and displacement of the implanted electrodes. The goal of this project is to develop a phantom that can be used to simulate the effect of TMS on electrode currents, temperatures, and changes in position.

About the client:

Dr. Raheel Ahmed, MD, is a UW Health Kids pediatric neurosurgeon and an associate professor in the Department of Neurological Surgery at the University of Wisconsin School of Medicine and Public Health. He treats children from birth to young adulthood who have neurological disorders that affect the brain and spine. Dr. Ahmed treats a wide variety of conditions such as hydrocephalus (fluid buildup in the brain), epilepsy (seizure disorder), movement disorders, brain tumors and spinal conditions that require surgery. He has a special clinical interest in pediatric epilepsy. In addition to his clinical practice, Dr. Ahmed conducts clinical research to improve pediatric epilepsy treatments.

Dr. Arun Karumattu Manattu, PhD, is a Scientist II at the Pediatric Neuromodulatory Lab at the Waisman Center, University of Wisconsin-Madison. His research is rooted in neuroimaging, biomechanics, and biomedical engineering, with a particular focus on understanding brain function and connectivity, especially in individuals with neurological impairments. Dr. Manattu utilizes multimodal neuroimaging techniques, including fNIRS, fMRI, and DTI, to explore the effects of cognitive load on postural control and brain health.

Fall 2025 BME 400 ELN

AVERY SCHUDA - Jan 23, 2026, 1:40 PM CST

BME Design-Fall 2025 - AVERY SCHUDA
Complete Notebook

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2026/04/27 - Final Client Meeting

LILLY MACKENZIE - Apr 27, 2026, 1:33 PM CDT

Title: Final Client Meeting

Date: 04/27/2026

Content by: Lilly

Present: Lilly, Helene, Avery, Dr. Ahmed, Orla, Dr. Manattu

Goals: Debrief the year's accomplishments and the goals for the following year

Content:

Recommend continuing in another year with a senior group. We are delivering all of the prototype materials and give the files into the shared Teams folder.

Testing notes:

- On temperature:
  - strap temperature probe along with the bolt to best see the temperature differences along the direction of the probe.
  - make a pilot hole, put a pilot hole into the brain and put a temperature probe and electrode in the same hole
    - here, slowly pull the probe back over the course of testing so that we can take temperature measurements along the length of the probe. Would be a one-time use
    - Dr. Manattu recommended dividing the project into two: making a whole temperature sensor project for the process, divide into current measurement setup and dedicate a longer amount of time to that.
- On displacement:
  - we had some difficulty with getting the displacement due to quality of cameras
  - defection way down into the brain is the real issue, as far away as we can get from the connection point (where the electrode is secured)
- Current
  - could be transient current, we were using uA resolution, maybe we need more sensitive equipment or maybe could look closer at Iowa paper
  - maybe an oscilloscope?
  - The setup should be pretty easy because you just have to measure across the electrodes if current was generated
- Other: bolt is titanium
  - should do testing with both bold and electrodes
- overall setup:
  - TMS with iEEG, where to put the coil?
    - how far can you get away from the head before TMS ceases working properly?
    - Dr. Ahmed doesn't have a complete idea yet, he was envisioning that we figure that out over the course of the project or future semesters
    - idea: another group can try both with and without the hardware to see if there is an affect
    - want to avoid thermal injury --> bold screwed in, shouldn't deflect, but if it there is heating the bolt could also cause heat damage
    - **18-20 electrodes**
    - for a particular intensity the current is standards
- Far future:
  - benchtop safety
  - then IRB
  - for BME design: will adapt the description as necessary, will re resubmit to Dr. P for recommendation as a senior project

Conclusions/action items:

Put all the 3DP files into the Teams folder and continue working on final deliverables. Share final poster

2026/1/23 - First Advisor Meeting

AVERY SCHUDA - Jan 23, 2026, 1:23 PM CST

Title: First Advisor Meeting

Date: 1/23/2025

Content by: Avery Schuda

Present: Avery, Lilly, Corissa, Helene, Dr Campagnola

Goals: Discuss client concerns and plans moving forward

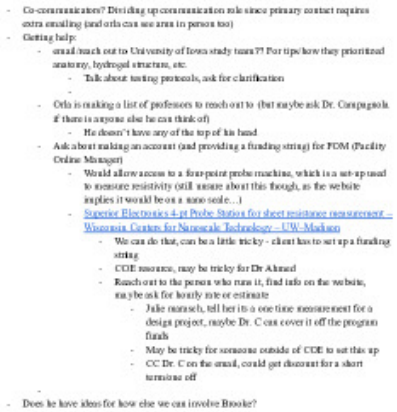
Content:

- Try emailing on Sundays again
    - If no response by Monday, Dr Campagnola can intervene
- Email Dr Walle Block to see if he has access to any to pediatric MRI
    - Dr Campagnola to reach out to make connection
- Work on refining polymer process
- Orla to take point on communication with Arun
- Send polite email to Iowa study team to discuss test methods
- Potential to set up funding string to be able to access testing equipment
- Contact Julie Morasch for quote for testing
    - Mention it is for a design project
    - "Beg and plead" - see if they will give us a break
    - CC Dr Campagnola
- Get back into contact with Dr Frack's lab for rheometry
- Preliminary presentation
    - Testing focused
    - 10-15 minute presentation
    - Only to Dr Campagnola
    - Only other whole team activity is show and tell - giving advice to juniors

Conclusions/action items:

Lilly to email Dr Campagnola Monday night if there is no response from the client. Dr Campagnola will also reach out to Dr Block. Reach out to Iowa team, Julie Morasch, and Dr Franck, continue looking for other helpful contacts.

AVERY SCHUDA - Jan 24, 2026, 7:05 PM CST


- Co-communicators? Divi ding up communication role since primary contact requires extra emailing (and orla can see arun in person too)
- Getting help:
    - email/reach out to University of Iowa study team?? For tips/how they prioritized anatomy, hydrogel structure, etc.
        - Talk about testing protocols, ask for clarification
    -
- Orla is making a list of professors to reach out to (but maybe ask Dr. Campagnola if there is anyone else he can think of)
    - He doesn't have any of the top of his head
- Ask about making an account (and providing a funding string) for FDM (Facility Online Manager)
    - Would allow access to a four-point probe machine, which is a set-up used to measure resistivity (still unsure about this though, as the website implies it would be on a nano scale...)
    - Superior Electronics 4-pt Probe Station for sheet resistance measurement – Wisconsin Centers for Nanoscale Technology – UW-Madison
        - We can do that, can be a little tricky - client has to set up a funding string
        - CODE resource, may be tricky for Dr Ahmad
        - Reach out to the person who runs it, find info on the website, maybe ask for hourly rate or estimate
            - Julie morasch, tell her it is a one time measurement for a design project, maybe Dr. C can cover it off the program funds
            - May be tricky for someone outside of CDE to set this up
            - CC Dr. C on the email, could get discount for a short turnaround off
    -
- Does he have ideas for how else we can involve Brooke?

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1_23_26_first_meeting_with_dr_campagnola_orla_notes.pdf (46.4 kB)

2026/1/30 - Second Advisor Meetings

LILLY MACKENZIE - Jan 30, 2026, 1:27 PM CST

Title: Second Advisor Meeting

Date: 01/30/2026

Content by: Lilly

Present: All

Goals: Update Dr. C on the team goals,

Content:

- Updates: got MRIs from Dr. Ahmed, going to process them - mention Orla's talk w Cameron. Made gel's yesterday lead into following bullet point, but also mention issues:
    - clumping
    - soak gelatin first? see if that changes the mechanical properties
        - likes the idea of starting it at room temperature and heat it up thereafter, doesn't think it will affect mechanical properties
    - issues with maintaining temperature?
    - Equipment is on the fritz
- Ask him about experimental design versus going through results section:
    - timeline is priority
    - get a successful composition
    - try not to be super complicated
        - He thinks making a linear regression makes more sense because it eliminates issues from potential lack of details in papers' methods
- Contacted Dr. N, Dr. Coventry about interpreting the conductivity testing protocol
    - Likes Dr. Hai as an option, he is super helpful
- Bring up journals
- Update him on outreach
- Prelim presentation:
    - don't have to invite clients necessarily
    - don't need to reiterate background
    - quick presentation, focus on plan for the semester and testing

Conclusions/action items:

Implement some of the changes to creating gelatin gels. Also, communicate w Dr. Hai (Orla meeting w him on Tuesday)

2026/02/06 - Third Advisor Meeting

AVERY SCHUDA - Feb 06, 2026, 1:30 PM CST

Title: Third Advisor Meeting

Date: 2/6/2026

Content by: Avery Schuda

Present: Avery, Orla, Lilly, Helene, Corissa, Dr Campagnola

Goals: Discuss thermal

Content:

- Touch base on Wednesday night on Zoom at 7:30pm
- Present prelim presentation Friday 2/20
- Completed outreach activity
- Talk to Dr Puccinelli
- Issues with hot plates staying consistent
- Research salt interaction with agar
- Use the milliQ water
- Orla got response from Dr Hai
    - Help with electrical conductivity
    - Also potentially can help with displacement
- Prelim report is more formatting into journal
    - Just add where stuff will go if we don't have it yet

Conclusions/action items:

Work on prelim presentation and report. Plan next steps for gels.

2026/02/11 - Fourth Advisor Meeting

AVERY SCHUDA - Feb 11, 2026, 8:00 PM CST

Title: Fourth Advisor Meeting

Date: 2/11/2026

Content by: Avery

Present: Avery, Lilly, Helene, Corissa, Orla, Dr Campagnola

Goals: Discuss project updates

Content:

- Hold off meeting with Dr Nimunkar until after meeting with Dr Hai and Dr Coventry to be respectful of everyone's time
- Pop by Dr Campagnola's office after meeting with Dr Hai between 2-3 pm to give him a recap
- Dr Campagnola to provide some GelA
- Lilly also to reach out to Dr Ahmed to order more
- BME 699 Independent study can continue project with Dr Campagnola (Avery)
- Less than satisfactory response from Iowa team
- Asking Coventry and Hai the same questions --> see where we stand
- Avery and Helene to make gelatin gels on Friday

Conclusions/action items:

Meet with Dr Coventry and Dr Hai to inform electrical testing. Avery and Helene make gels on Friday if a solid testing plan has been established. Lilly to email Dr Ahmed to order more gelatin and follow up on previous nonresponse to emails.

2026/02/20 - Fifth Advisor Meeting

AVERY SCHUDA - Feb 20, 2026, 1:44 PM CST

Title: Fifth Advisor Meeting

Date: 2/20/2026

Content by: Avery Schuda

Present: Avery, Helene, Corissa, Lilly, Orla, Dr. Campagnola

Goals: Present prelim presentation and discuss progress

Content:

- Plan on taking another week for prelim report
- Active voice is fine, can do passive in methods if you want
- Orla knock out electrical conductivity in the next couple of weeks
- Talked a lot about movies
- Feels we are in a good place

Conclusions/action items:

Work on prelim report (due a week from Wednesday). Fabricate gels for electrical testing. Avery to make 3D printed mold for those gels.

2026/02/27 - Sixth Advisor Meeting

LILLY MACKENZIE - Mar 04, 2026, 6:55 PM CST

Title: Sixth Advisor Meeting

Date: 02/26/2026

Content by: Lilly

Present: All

Goals: Discuss updates w Dr. C for fabrication, testing

Content:

- Helene, Avery making gels w MilliQ this afternoon
- Helene, Lilly testing thermal conductivity this Sunday
- Orla, Corissa, Lilly and whoever else can make it will test for electrical conductivity on Thursday. We will go over it with Orla's TA first and then test w oscilloscope in 1080
- Emailed Dr. Manattu about testing w TMS, we are aiming to have multiple dates locked down
- Thermal this weekend will help us narrow down what we're going to do for concentrations for electrical
    - not sure how the testing will go: we printed three boxes, wondering if we should have the exact same concentration/composition in each of hte boxes and run three replicates, or if we can reposition electrodes?
        - Dr. C recommends doing three separate preps, and also do separate measurements on each one. Ideally, we'd even make 4 gels
        - tuning saline concentration of "winning" gel of electrical conductivity testing
- Preliminary report:
    - figure captions can switch to longer caption, but its a matter of taste. We should probably have more than one sentence, but we don't have to go overboard or be redundant with repeating
        - one sentence describing what it is
        - one sentence going into the stats
        - include scale bars, legends etc.
    - do we have to make all the figures for the introduction?
        - In real life, we'd have to get permission to use the figures, so Dr. C would prefer us to make all the figures if possible. If necessary, we can copy and paste but we should try to avoid it.
    - For now
        - real introduction --> 2 pages double spaced text, no more than 2.5-3.
        - real methods
        - results can be an outline, go into detail where we can but leave bullet points where we cannot
        - working title
        - appendices: skip design matrices, PDS altogether, we could potentially put into an appendix but he recommends skipping it
            - instead, maybe put raw data
        - **zero** mentions of client, team, project
    - title page:
        - use whatever title we think is appropriate

Conclusions/action items:

Helene and Avery make gels after this, look at testing results.

Next week, we will aim to meet at the same time after Tong

editing and submitting preliminary report by Wednesday

2026/03/06 - Seventh Advisor Meeting

AVERY SCHUDA - Mar 06, 2026, 1:58 PM CST

Title: Seventh Advisor Meeting

Date: 3/6/2025

Content by: Avery Schuda

Present: Avery, Corissa, Helene, Lilly, Orla, Dr Campagnola

Goals: Discuss the preliminary report

Content:

- On track for parsing out final report
- Delete figure from the background
- Format of supplementary information is fine, don't need to label appendix A, B, C, etc.
- Can put pictures in SI if we think it's necessary
- Just refer in text for supplement Figure X if nee
- Orla followed the paper with electrical test set up consisting of multimeter and oscilloscope
- Adjust plugs for electrical testing box
- Could test with current thermal properties, just note that
- Dates to TMS test with Arun
- Can also utilize Ido

Conclusions/action items:

Continue with testing, goal to test with TMS during existing dates.

2026/03/13 - Eighth Advisor Meeting

LILLY MACKENZIE - Mar 13, 2026, 1:17 PM CDT

Title: Eighth Advisor Meeting

Date: 03/13/2026

Content by: Lilly

Present: All

Goals: Discuss electrical conductivity results, future planning, having printed the brain /box

Content:

- Lilly responded to Dr. Manattu this morning to confirm testing
- Avery discussed prints, should be done by the end of the weekend
- Orla went over electrical results
    - Results were lower than we were expected
        - about 0.1S/m results, we were expecting at least 0.45S/m but realistically much more
        - Going to repeat the testing: 0.1%, 0.2%, 0.4% based on calculations mentioned in last night's meeting
        - **Look more for linear trend rather than absolute values, as long as absolute values are within the same order of magnitude**
    - for remaking gels, we'll use teflon tape or the silicon ice cubes we have
    - Testing of the gels Avery makes today will be done Sunday or Monday, maybe Wednesday
- Show and tell: we will have a quick meeting at 5:30 PM over Zoom Thursday night
    - show and tell for us: we are the mentors. Go around to BME 301s and give them advice. in the next few days they will send out a bit list of 301 projects with a summary of what to do/what we can help with
    - ECB Atrium
- Before posters: write executive summary to go for awards
    - Excellence in design --> recommends this one. Faculty judges
    - Tong --> entrepreneurial product, doesn't recommend
    - choose to not participate --> doesn't recommend

Conclusions/action items:

Avery will make gels tonight, me (Lilly) and Orla will test on Sunday

2026/03/19 - Ninth Advisor Meeting

LILLY MACKENZIE - Mar 19, 2026, 5:47 PM CDT

Title: Ninth Advisor Meeting

Date: 03/19/2026

Content by: Lilly

Present: All

Goals: Discuss testing results, future plans

Content:

- Next Friday will be normal meeting
- I (Lilly) am going to pour silicone mold tomorrow
- Unsure if we're going to test with the skull model or boxes because of how the electrical testing is working out
- Orla discussed results
    - Again we ran into some issues with lower conductivities, even though we used the same compositions
    - Used a different size sample, all 6% gelatin, varied saline concentration (0.1%, 0.2%, 0.4%) and saw lower results
    - make gelatin gels 3%, 6%, 9% because we're changing the material density, single saline concentration, see if it scales as expected

Conclusions/action items:

Tomorrow we're making gels again and printing. Depending on linearity of results we will determine saline concentrations

2026/03/26 - Tenth Advisor Meeting

LILLY MACKENZIE - Mar 26, 2026, 5:44 PM CDT

Title: Tenth Advisor Meeting

Date: 0**3/26/2026**

Content by: Lilly

Present: All

Goals: Give updates on this past week's progress, outline upcoming plans for the week.

Content:

- Meeting on Zoom Tuesday after break, 5 PM
- Updates: printed skull, made brain mold. Tuesday, Corissa and Avery will make gels. We went to PNL as well to set up our testing protocols and edit
- Did additional electrical conductivity testing
    - found gel concentration
- What's left?
    - putting it all together; drilling holes for electrodes (Lilly), make brain gel (Corissa, Avery), collect all equipment (Orla, Helene), final testing
    - Continue work on final deliverables

Conclusions/action items:

Plans written above and in the schedule on google sheets in the shared drive. Continue to work on executive summary

2026/4/7 - Eleventh Advisor Meeting

CORISSA HUTMAKER - Apr 07, 2026, 5:23 PM CDT

Title: Eleventh Advisor Meeting

Date: 4/7/26

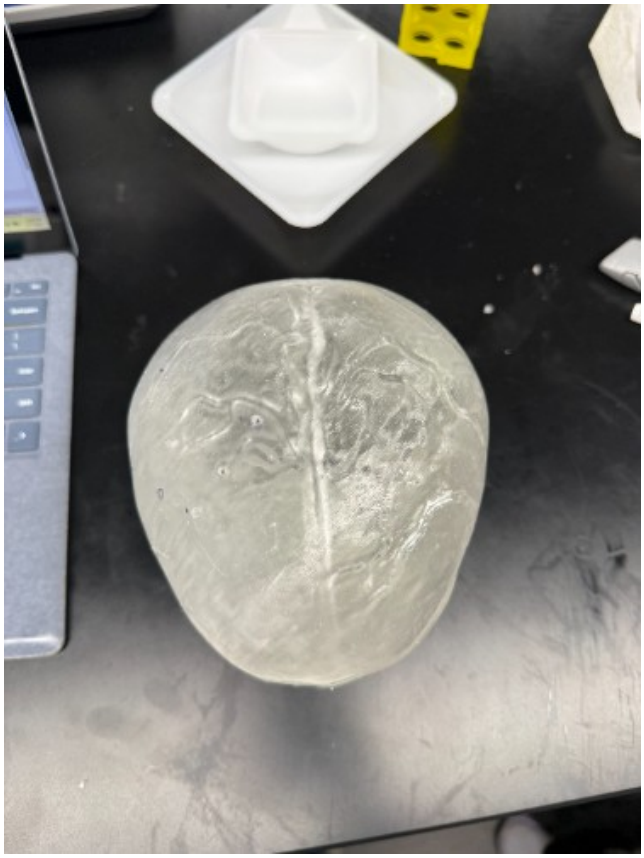
Content by: Corissa Hutmaker

Present: All

Goals: Update Dr. Campagnola on recent progress and plans for the next week and a half

Content:

- Drill extra hole for temperature probe
- Need to measure current across multiple electrodes in series
- Final report Tuesday of finals week
- Update Dr. Campagnola on testing after we do it 4/10
- Showed Dr. Campagnola current prototype as shown below



Conclusions/action items:

The team will continue working on finishing the final prototype before testing this Friday. After testing, we will focus on analyzing the testing data and preparing for final deliverables.

2026/04/17 - Twelfth Advisor Meeting

AVERY SCHUDA - Apr 17, 2026, 2:29 PM CDT

Title: Advisor Meeting ahead of poster

Date: 04/17/2026

Content by: Lilly, Avery

Present: Lilly, Avery, Helene

Goals: Go over testing results ahead of poster

Content:

- Results: we weren't super happy with the results, but we have two ways to measure displacement and can technically put results on the poster. lots of information we have to move forward in future semesters
    - recommends the project continues another year, note any important changes or improvements that we can make in our client meeting
    - some positive outcomes of the semester, lots of learning
    - We should be proud of the work we accomplished this year
    - First year projects are almost never complete at the end
- Poster content:
    - don't need to change background PDS section
    - Send him a copy a day before we print it for feedback
- Executive summary
    - said we didn't have to submit/could opt out, otherwise having headings is good
    - also signed up for TECH, there shouldn't be a separate speech for that. See Dr. P email about how to prepare different speeches for design versus Dr. C and Dr. B assessment
    - Advisor presentation should be about 15 minutes, awards presentation should be around 10 (can use same speech for both)
- Other
    - Set up meeting the week after poster
    - terrace after our last meeting!
    - Also discussed Master's programs

Conclusions/action items:

Avery to fabricate gel brain (hopefully more successfully for poster). Continue ImageJ (Helene and Lilly) and MATLAB data processing (Corissa and Orla). Prepare for poster next Friday, work on deliverables, pass info on to Orla and Corissa

2026/01/30 - Recap of Gel Fabrication

LILLY MACKENZIE - Jan 30, 2026, 1:58 PM CST

Title: Recap of Gel Fabrication

Date: 1/30/2026

Content by: Orla Ryan, Lilly

Present: Helene, Orla, Lilly, Avery, Corissa

Goals: Touch base after a busy week and come up with a plan for next week (catching Orla up after being gone as well).

Content:

- dealing with some faulty equipment in teaching lab (hot plates, etc.)
- deciding on final approach for testing different percentages of saline/agar/gelatin
- coming in on Sunday:
    - outreach (paint cardboard, make poster, 'practice')
    - thermal testing
- discussing mri scans from Dr. Ahmed and Dr. Wally Block
- bringing a couple of ideas for hydrogel fabrication approach to Dr. Campagnola for his input

After advisor meeting:

- Potentially remake gels with new salt
- **we have to split up to make everything work in time**
    - generally: Helene gelatin, Lilly agar, Avery work on processing the files.
    - things have to be evenly spaced
    - get better at documenting **everything we do**
    - Meet at 1 PM on Sunday. switch into multiple groups, half does outreach stuff and half does thermal testing
    - We will take the week before prelim presentations and do it the next week
    - Get started on prelim report (due 13th) --> reformatting report from last semester
    - Lilly will email Dr. Ahmed Sunday --> meeting with him
    - make a protocol and document where we're going to write down all the data
    - Send mold materials to Dr. Ahmed

Conclusions/action items:

We will be meeting on Sunday (and likely after the advisor meeting today). Today, we will work on fabricating more gels, and Sunday we will do both testing and preparation for outreach.

2026/02/06 - Team Meeting

AVERY SCHUDA - Feb 06, 2026, 12:59 PM CST

Title: Team Meeting

Date: 2/6/2026

Content by: Avery Schuda

Present: Avery, Orla, Corissa, Helene

Goals: Talk about next steps for testing and work through thermal conductivity MATLAB results

Content:

- Dr Hai responded to Orla and can help with electrical conductivity and potentially displacement
    - Connected us to his PhD student who has created a similar test set up
- Talked about what we need to do outreach activity report
- Thermal conductivities are higher than they should be
    - Want around 0.5 W/mK
    - Gelatin testing from poster was much closer to the desired value
    - Why is it so different between food grade and gelatin A?
    - Should we repeat the exact same experiment just with

Conclusions/action items:

Discuss this and next steps with Dr Campagnola.

2026/02/09 - Zoom Meeting Assigning Prelim Sections

ORLA RYAN - Feb 09, 2026, 6:27 PM CST

Title: Zoom Meeting Assigning Prelim Sections

Date: 2/9/2026

Content by: Orla

Present: Orla, Lilly, Helene, Avery, Corissa

Goals: Assign preliminary presentation sections and discuss some other tasks for the next week.

Content:

- for outreach, Orla will reach out to the Crestwood Science Night contact to confirm/double-check that they filled out the evaluation form
  - once we receive a reply, we can move forward with turning in the rest of the deliverables
- We briefly discussed the preliminary report (having chosen a journal), and will likely work on restructuring all together
- Preliminary presentation slides will be completed by next Monday (2/16) -- we have made a draft document and will be working on that collaboratively
  - at this point, we will either Zoom or meet in person to practice
- Orla talked about plans for meeting with Dr. Hai after BME 770 this Thursday
- If we approach thermal testing again, we will be sourcing DI water from a different lab in ECB

Conclusions/action items:

All of team will work on their preliminary presentation slides and figure out a time in the next month to redo testing.

2026/02/13 - Meeting with Dr Coventry

AVERY SCHUDA - Feb 13, 2026, 12:26 PM CST

Title: Meeting with Dr Coventry

Date: 2/13/2026

Content by: Avery Schuda

Present: Avery, Helene, Orla, Corissa, Dr Coventry

Goals: Discuss potential electrical testing

Content:

- Use constant current source and measure voltage at electrodes and can back calculate conductance using impedance
- AD5933 chip
- Get the development kit and it will come with the software
    - Check with Sarcopenia team, they may have one
    - Will get us most of the way there
- Designing a current source is non-trivial
- Chip has that on board already
    - AD5933 (Rev. F)
- How to test current build up or induced charges on site of TMS testing
    - Fundamentally different
    - TMS simulation? artifact
    - Graded TMS application, apply EEG along surface
    - Check linearity
- Orla talk to her PI
- Physics are very complicated

Conclusions/action items:

Coventry can walk us through if we decide to go with that chip. Meet Monday to work on report and practice for presentation. Have presentation section done by meeting on Monday.

2026/02/13 - Meeting with Ido Haber

AVERY SCHUDA - Feb 13, 2026, 4:00 PM CST

Title: Meeting with Ido Haber

Date: 2/13/2026

Content by: Orla

Present: Orla, Avery, Helene, Ido

Goals: Get advice on electrical testing from a grad student who does similar research

Content:

- Lots of experience with modeling transcranial electrical stimulation
  - Some experience with TMS as well
- Does similar testing with TES and iEEG at the hospital
- Is it appropriate to use DC?
  - He is not sure, dependent on TMS domain
- Think about if you want to stimulate with DC or TCAS
  - Even different frequencies to see if there is an impact
- If constant current source, use know voltage and resistor to get current
- Electrodes implanted into gel
  - Where to put stimulating and recording electrodes
  - Two pairs of electrodes: one is used to inject a sinusoidal wave, use oscilloscope to record
  - Need to measure the distance between the recording electrodes, surface area of the pads
- Can you just measure voltage drop across material of known dimensions and calculate resistivity
- Measuring voltage drop with an oscilloscope would be better than a multimeter
- Embed probes or skin pads as the stimulating electrodes?
  - Need to play around with this
- Conductivity for TMS is not as important as for TES
- Variability in the conductivity is something we may just have to accept
  - So much variability in the different
- For model use T1 not T2 or CT
- He has script that should be able to segment into a final STL of brain within two hours which he can share or follow up
- Take whatever measurements we can take before electrode implantation and after
- Use infrared camera
- Establish baseline without iEEG to see what the relative change is
- Just need two pads during final testing to measure electric field
- As long as you can say you're in the same ballpark it should be a good sign from a safety perspective
- Potentially mount an accelerometer to see if there is any movement
- In his lab they have TMS and experience with iEEG
  - He could connect us with people in his lab to continue
- Take NFFD file T1 okay, T2 better
- Feed it into function Sim nibs
- Can change conductivity values within this
- May handle 10-12 year old better
- Python package
- Can do TMS simulation directly onto model in sim nibs

Conclusions/action items:

Work on the electrical test setup in the near future and segmenting the scans in the near future. Reach back out for other help.

2026/02/16 - Preliminary Presentation/Report work

ORLA RYAN - Feb 16, 2026, 5:44 PM CST

Title: Preliminary Presentation/Report work

Date: 02/16/2026

Content by: Orla

Present: Orla, Avery, Lilly, Corissa, Helene

Goals: Finish up preliminary presentation slides and practice, start formatting preliminary report.

Content:

- Filled Corissa/Lilly in on meetings from Friday that they missed
- Discussed approaches for electrical testing going forward (do we look into both? leave Dr. Coventry's suggestion as a future work portion?)
- Went through and finished all of our preliminary presentation slides to showcase to Dr. Campagnola on Friday
    - did one practice presentation run
- Referenced the journal guidelines and started filling out a formatting guide
    - Guide for authors - Biomaterials Advances - ISSN 2772-9508 | ScienceDirect.com by Elsevier
    - Chosen journal is Biomaterials Advances
- Made plans to meet virtually and practice again before Friday's meeting

Conclusions/action items:

Meet later in the week, present to Dr. Campagnola on Friday, and continue to work on preliminary report.

2026/02/25 - Team Meeting Report and Planning

LILLY MACKENZIE - Feb 25, 2026, 1:54 PM CST

Title: Team Meeting to work on Report and Testing planning

Date: 02/25/2026

Content by: Lilly

Present: All

Goals: Work on preliminary report and plan times for electrical testing

Content:

- We want the report to be done by **Sunday**
- For electrical testing, Orla thinks next Thursday (3/5) could work to test with Dr. Hai/his TA after class (approximately 12:15-1:15)
    - Before then, we may do thermal conductivity testing:
        - 4, 6, 8 % gelatin with 0.17%
        - plan: Helene and Avery will make gels Friday after meeting, Lilly and Helene will test gels Sunday afternoon. depending on these results, we will determine the composition for the gels on Thursday testing
    - For electrical, we run into the issue of having to make multiple boxes for multiple conditions and/or replicates. We will bring this up with Dr. C
        - Corissa recommended we make 3 replicates (so print three boxes that Orla designs) of the same gel composition and test it. ideally, this will give us the results we want with useable data (as in, if by some miracle the conductivity value is correct we can use the data because n=3). we will move forward with this plan next Thursday

Conclusions/action items:

To do:

Before Sunday:

- Make gels for thermal testing (conditions above, which are based on the ones we did last semester, which are based on the gelatin percentages of Dr. Franck's lab along with the saline percentages of the Iowa study), and test those 9 samples for thermal conductivity.

- Finish preliminary report

Before Thursday:

- finish and print the sample holder(s) for the electrical conductivity testing

- determine gel compositions --> make 3 of the same composition (whatever has best results for thermal I bet) and take n=3 replicates. Depending on the results of this testing, we will likely repeat

2026/3/12 - Team Planning Meeting

LILLY MACKENZIE - Mar 12, 2026, 5:56 PM CDT

Title: Team Planning Meeting

Date: 3/12/2026

Content by: Lilly

Present: All

Goals: Plan future testing and recap electrical results

Content:

- We went over the testing results Orla got last week
    - average around 0.1 S/m is lower than we anticipated, we aren't quite sure why. Not only are the results in the paper for that salt value around 0.45 S/m, we used 6x the gelatin percentage. The difference we noted is that we used ballistic gelatin while they used food grade, but the trend here is the opposite as what we see with the thermal testing with food vs ballistic grade gelatin
    - We are going to retest. Based on some very quick math, we're gonna use the following salt concentrations
        - 1mg/mL because it matches the results from the paper we are basing this off of (linked below)
        - 4mg/mL because, based on the general trend in that paper that conductivity increases 0.05S/m with each 0.25mg/mL step increase in salt, this should give us a conductivity around 0.5S/m, the upper end of the range
        - 2 mg/mL, because it's between those two values and we can make a graph and see our trends
    - Avery will remake gels potentially with Helene tomorrow after our advisor meeting
    - Me (lilly) will join Orla on Sunday to redo electrical testing
- Today, me and Avery also printed the brain (ABS) and box to hold the brain during mold-making process (PLA)
    - those will probably be done on Monday. We will use acetone to smooth the sides on Monday and, as time permits, pour Ecoflex overtop to create the mold we will use for the gels. This isn't as time sensitive, as we need to figure out the gel compositions first
    - Avery will bring the acetone to the teaching lab and whoever is available can smooth the brain

Conclusions/action items:

Tomorrow we will meet with Dr. C and discuss our plans. I (lilly) will also schedule sent a follow up email to Dr. Manattu about confirming our TMS testing. Avery and maybe Helene will make more gels for Sunday's testing

Paper referenced: Comparison of electrical conductivities of various brain phantom gels: Developing a ‘Brain Gel Model’ - PMC

2026/03/19 - Team Planning Meeting

LILLY MACKENZIE - Mar 19, 2026, 9:34 PM CDT

Title: Team Planning Pre-prototype testing

Date: 03/19/2026

Content by: Lilly

Present: all

Goals: Plan this weekend and early next week so we can get prototyping and testing done

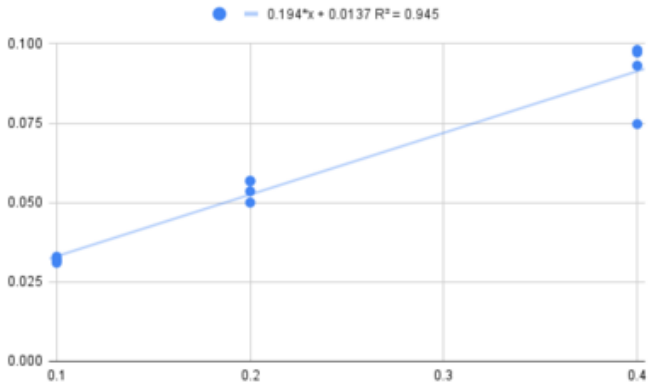
Content:

- Current plan:
  - Tomorrow, I (Lilly) will print the skull file that Avery will finish tonight. Depending on the length of the print, we will determine whether or not we'll test with the box phantom or with the actual skull phantom. Then, also tomorrow, me (still Lilly) and Helene and maybe others will make gels to test one last time before testing on Tuesday
  - Gel comp (based on the equation found in the figure in "electrical testing 3/15" and attached to this post
    - equation: 0.194x+0.0137 (r2 = 0.945)
    - for conductivity = 0.5 S/m, the salt concentration should be 2.5%
    - for conductivity = 0.25S/m, the salt concentration should be 1.2%
  - Electrical testing:
    - Results are lower than expected. We are going to retest this weekend and find a composition that we'll use to make the gelatin composition for Tuesday's testing
    - Composition: we will make a line graph and match a desired conductivity value and calculate the salt concentration from that.
  - Saturday, I (Lilly) will pour the silicone mold. I ordered a big silicone kit because the Ecoflex was not nearly enough, and that should arrive tomorrow (3/20).
  - When the skull prints, we will have to file down the veins and potentially drill holes for electrodes (TEAM lab!)
- Other:
  - I emailed Dr. Ahmed and Dr. Manattu about getting electrodes for testing

Conclusions/action items:

Meet with Dr. C to discuss results of previous testing, let him know our plans for the upcoming week

LILLY MACKENZIE - Mar 19, 2026, 9:35 PM CDT



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2026/03/26 - Team Meeting to Discuss Next Steps After Break

AVERY SCHUDA - Mar 26, 2026, 4:32 PM CDT

Title: Team Meeting to Discuss Next Steps After Break

Date: 3/26/2026

Content by: Avery

Present: Avery, Lilly, Helene, Orla, Corissa

Goals: Discuss

Content:

- Make final hydrogel brain
    - Avery, Corissa available **after 545 Tuesday** or Wednesday
- Drilling holes in skull - Lilly
- Find tripod for iphone (from library?)
- Calipers
- Tape measure
- See updated protocol
- Orla and Helene to look into cameras, tripods and other equipment

Conclusions/action items:

Update checklist of items to bring to testing and update schedule with assigned tasks.

2026/4/14 - Team Meeting for Deliverables Planning

LILLY MACKENZIE - Apr 14, 2026, 5:06 PM CDT

Title: Deliverables Planning

Date: 4/14/2026

Content by: Lilly

Present: All

Goals: Plan data analysis and divide up deliverables workload

Content:

- Due: executive summary, outreach by Friday. Orla emailed Dr. TJ P at the start of the semester and we will edit exec sum with the testing we did
- Data analysis:
  - thermal (temperature) --> Corissa
  - electrical (current) --> Orla
  - mechanical (displacement) --> Lilly, Helene
- Last semester:
  - move very briefly through testing, focus on setup, experimental design for thermal and electrical conductivity
- Framing:
  - bolts are in the skull during testing, with bandages wrapped (according to Dr. Manattu). This allows us to use the positive control of the TMS applied just above the electrodes, and the experimental control is the TMS applied at 5 cm away
  - make sure we discuss the "assay controls" of temperature monitoring
- Other:
  - poster: print by Wednesday of next week. Lilly and Avery swap sections from last semester, but everyone else remains the same
  - Simultaneously work on paper --> Orla is going to work on her sections, Lilly will try

Conclusions/action items:

Lilly will email Dr. C and ask for figures/conclusion to bring to Friday's meeting, so we can get feedback ahead of poster next week. She will also follow up with Dr. Manattu about having a final meeting.

2026/1/28 - Agar and gelatin fabrication 1

HELENE SCHROEDER - Jan 28, 2026, 11:48 AM CST

Title: Agar and gelatin fabrication for testing #1

Date: 1/28/2026

Content by: Helene Schroeder

Present: Helene Schroeder, Avery Schuda

Goals: To create agar and gelatin gels inside a mold to conduct thermal and electrical testing on in the near future.

Content:

Agar:

- 1.2%
- 0.6% (not enough mechanical strength?)

Gelatin:

- 4%

Saline concentrations:

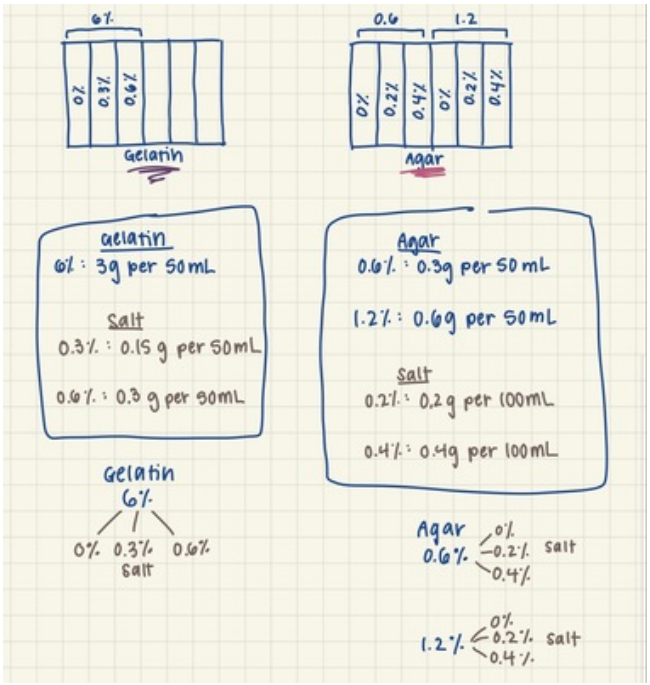
- 0 mg/mL
- 0.5 mg/mL
- 1 mg/mL (aka 0.1 g/100 mL) (aka 0.1%)

Notes:

- volume of 1 cube in ice cube tray: 12.5 mL
- 1 tray holds 300 mL of liquid

Conclusions/action items:

HELENE SCHROEDER - Jan 28, 2026, 12:17 PM CST



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HELENE SCHROEDER - Jan 31, 2026, 12:07 PM CST

Conclusion:
We were not able to fully finish fabrication this day, but we weighed out all the agar, gelatin, and sodium chloride that we need. In the future we will complete the fabrication of the gels so that we can conduct testing.

2026/1/29 - Testing Gel Fabrication

LILLY MACKENZIE - Jan 29, 2026, 1:10 PM CST

Title: Gel Fabrication for test samples

Date: 1/29/2026

Content by: Lilly

Present: Lilly

Goals: Follow the compositions set by Helene and Avery to create agar and gelatin gels to test for thermal and electrical conductivity

Content:

- I started by heating up the beakers of saline until they reached the preparation temperatures. for this, I set the agar saline at 200 C and the gelatin saline at 120 c to speed up the process until they reached 85-90 and 65 C respectively.
- Due to an insufficiency in hot plates, I left the agar saline to keep at their desired temperature until the gelatin gels had been made
- I poured the measured gelatin powder into the beakers and began stirring the mixture at 250 ish RPM, checking the temperature periodically (every 5 min or so) to ensure the saline hadnt decreased temperature too much. To do this, I had to keep the hot plates around 80C
    - in the 0% saline condition, the gelatin powder pretty immediately clumped up and it took a lot of time for it to properly dissolve. this may be because of the speed at which i poured it, because of the speed of the stir bar, or something else, but i am going to spin it until the clumps dissolve.
-

Conclusions/action items:

2026/02/27 - Gelatin Hydrogel Creation

AVERY SCHUDA - Feb 28, 2026, 3:04 PM CST

Title: Gelatin Hydrogel Creation

Date: 2/27/2026

Content by: Avery Schuda

Present: Avery, Helene, Lilly

Goals: Repeat the gelatin experiment shown on the poster with improved materials and methods

Content:

Last semester we created gelatin hydrogels at 4,6, and 8% food grade gelatin and 0.17% NaCl. While the standard deviations were high, the means thermal conductivities were quite close to the desired value (much closer than the previous experiment). We are attempting to repeat the thermal conductivity experiment with the same gels from before fall poster, but using Milli-Q water and Type A gelatin.

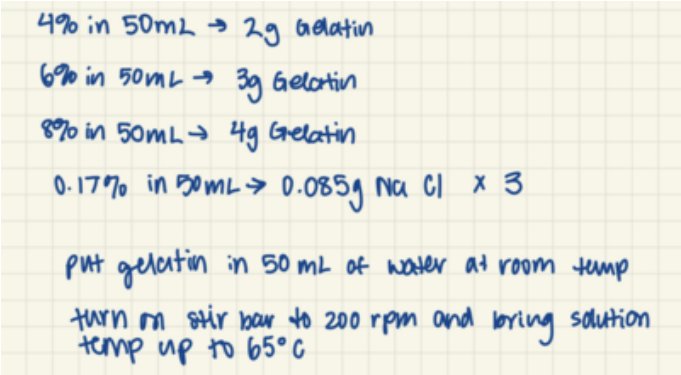
Procedure:

1. Weigh out gelatin and NaCl
    1. 4% gelatin, 0.17% NaCl - 2.045g gelatin, 0.087g NaCl
    2. 6% gelatin, 0.17% NaCl - 3.03g gelatin, 0.084g NaCl
    3. 8% gelatin, 0.17% NaCl - 4.05g gelatin, 0.086g NaCl
2. Place gelatin in 50 mL of Milli-Q water
3. Mix gelatin solution at room temperature for 5 minutes
4. Increase temp to 37 degrees C and add NaCl after 20 mins
5. Bring temp up to 65 degrees C (1 Hour)
6. Divided the 50mL into 4 gels (per 3 concentrations)
    1. Used transfer pipets to minimize bubbles and left an empty row in between each different concentration

Conclusions/action items:

Lilly and Helene to thermally test gels on Sunday 3/1. This will inform the concentration of gelatin used for the electrical conductivity testing. Avery to 3D print additional electrical conductivity boxes.

AVERY SCHUDA - Mar 01, 2026, 6:07 PM CST



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2026/03/04 - Gelatin Fabrication for Electrical Conductivity Testing

LILLY MACKENZIE - Mar 23, 2026, 11:20 AM CDT

Title: Gelatin Fabrication for Electrical Conductivity Testing

Date: 03/04/2026

Content by: Lilly

Present: Lilly, Avery, Orla

Goals: Make gelatin hydrogels for electrical conductivity testing

Content:

The thermal conductivity testing revealed pretty high values, but we trust this data as the fabrication methods were really standardized and the deviations were low. As such, to figure out the gel composition we are going to use for electrical conductivity data, we are looking toward "Comparing electrical conductivities of various brain phantom gels..." cited elsewhere in the notebook. We are going to make 4 gels of 1mg/mL concentration of NaCl based on the results of this paper. We are using this concentration, which is at the upper end of the range we are looking for, because we anticipate that we will need to decrease our gel percent for further thermal conductivity testing, so we figure that using a higher saline percent and decreasing gelatin should still leave us in a useable range. We are struggling to find information on how gelatin percentage affects conductivity, but we see sources saying that it *does*, so we figure we should start high and then as we decrease gelatin percentage to match thermal properties, we can go from there and, if need be, decrease NaCl as well.

We anticipate the results of this electrical conductivity testing to be a bit high

Measurements:

3 g gelatin and 0.05 g NaCl into 50 mL MilliQ * 4 gels

Actual measurements:

n1

gelatin 2.996

NaCl 0.050

n2

Gelatin 3.08

NaCl 0.052

n3

Gelatin 3.035

NaCl 0.050

n4

Gelatin 3.039

NaCl 0.051

We washed 400mL beakers w 3 washes of DI water before using a serological pipette to measure out 50 mL per beaker. We added the gelatin powder to the beakers and spun them at room temperature at about 400 RPM for approximately 5 minutes, before adding the salt and increasing the temperature. We covered the beakers with tin foil to help them come to temperature more quickly. The hot plates read out 85 C, but we monitored the temperature until it reached 65 C (about 45 minutes) and then decreased the hot plate setting. The gels spun for a further 10 ish minutes before we poured them into the 3D printed molds and had them set at 4 C. When we poured the gels, they leaked out of the side of the molds a bit. We attempted to mitigate this by taping the holes, but they continued to leak, so we had them set in weigh boats

Orla measured the mass of one of the casings to be 41.843 g

Conclusions/action items:

Tomorrow, we will use the gels to test for electrical conductivity following Orla's 770 class. Based on these results, we will modify gel concentration as needed to achieve our desired thermal conductivity results. In the future, we can wrap teflon tape around the plugs to prevent leakage

AVERY SCHUDA - Mar 04, 2026, 4:44 PM CST

Note from Avery: We could potentially wrap the plugs in teflon tape (like the kind you use for plumbing) before putting them in the holes to help prevent leaks. I think the gaps should self-seal pretty quickly in the fridge as the gelatin starts to gel, but something to keep in mind when doing the final calculations. Lilly and I also talked about how to create the mold for the brain. There is ecoflex and mold release available for us to use. I could 3D print two equal sized boxes. The first will be for creating the mold with the 3D printed brain, but to get the brain out without destroying the mold I think we will need to cut this box apart. To actually get the brain out we would carefully cut the mold into two equal halves. Then when we go to actually pour the gel we can use the second identically sized box to hold the two pieces of the mold together (secured with some extra tape just to make sure the two halves align properly).

2026/03/13 - Gelatin Hydrogel Fabrication for Repeat Electrical Testing

AVERY SCHUDA - Mar 13, 2026, 3:38 PM CDT

Title: Gelatin hydrogel fabrication for repeat electrical testing

Date: 3/13/2026

Content by: Avery Schuda

Present: N/A

Goals: Create 6% gelatin hydrogels with varying salt conditions to test electrical conductivity trend.

Content:

0.1% NaCl, 6% Gel in 50mL water - 0.054g NaCl, 3.012g Gel

0.2% NaCl, 6% Gel in 50mL water - 0.111g NaCl, 3.006g Gel

0.4% NaCl, 6% Gel in 50mL water - 0.219g NaCl, 3.015g Gel

1. Weighed out above salt and gelatin.
2. Transferred 50mL of milliQ water into each cleaned beaker with a serological pipet.
3. Put gelatin in each beaker and spun at ambient temperature at 200rpm for 5 minutes to hydrate the gelatin.
4. Then turned hotplate temps up to 85 degrees C, goal temp for the solutions is 65 degrees C.
5. Covered beakers with aluminum foil to prevent evaporation.
6. Added NaCl at 45 mins, all beakers around 55 degrees C.
7. Continually adjusted hotplate temperatures to ensure beakers are heating relatively evenly and checked temps every 10 mins.
8. Poured gels after an hour and 15 mins, temps were all 65 deg C.
9. Gels placed in 4 degree C fridge in purple mold.

Sigma Aldrich Type A Gelatin, lot no. 0000518727

Fisher Chemical Sodium Chloride, lot no. 193467

Conclusions/action items:

Lilly, Orla, and Corissa to test electrical conductivity on these gels over the weekend and Wednesday next week.

2026/3/17 - Vapor Smoothing the 3D Printed Brain

AVERY SCHUDA - Mar 17, 2026, 9:03 PM CDT

Title: Vapor Smoothing the 3D Printed Brain

Date: 3/17/2026

Content by: Avery Schuda

Present: Lilly

Goals: Use acetone to vapor smooth the ABS brain to remove surface texture from 3D printing

Content:

- Placed paper towels in the bottom a large glass bowl
- Poured 100% acetone into the bottom of the bowl (in the fume hood)
- Used a smaller glass container to elevate the 3D printed brain off of the acetone-soaked paper towels
- Covered with foil to prevent too much evaporation and allow vapors to build up in the bowl
- Rotated every 15 mins to make sure all sides were getting exposed equally
- The whole smoothing process took about 2 hours (this is when Lilly joined me)
- When we decided the surface was satisfactorily smoothed, we rinsed the model with water

Conclusions/action items:

The brain is now ready to make a mold of which Lilly will tackle in the next couple of days using ecoflex and the box that I 3D printed. I will continue working on the skull CAD model.

2026/3/20 - Gelatin Fabrication

HELENE SCHROEDER - Mar 20, 2026, 2:39 PM CDT

Title: Gelatin Fabrication

Date: 3/20/2026

Content by: Helene Schroeder

Present: Helene, Corissa, Lilly

Goals: To create gelatin gels to conduct electrical conductivity testing on this weekend.

Content:

Changing gelatin, constant salt in 50 mL MQ water each:

- 3% gelatin, 0.1% salt
  - 1.5 g gelatin -->. actual 1.489 g
  - 0.05 g salt --> actual 0.057 g
- 6% gelatin, 0.1% salt
  - 3 g gelatin --> actual 3.009 g
  - 0.05 g salt --> actual 0.055 g
- 9% gelatin, 0.1% salt
  - 4.5 g gelatin --> actual 4.551 g
  - 0.05 g salt --> actual 0.053 g

Constant gelatin, changing salt in 150 mL MQ water each:

- 6% gelatin, 1.2% salt
  - 9 g gelatin --> actual: 9.042 g
  - 1.8 g salt --> actual 1.852 g
- 6% gelatin, 2.5% salt
  - 9 g gelatin --> actual 9.012 g
  - 3.75 g salt --> actual 3.782 g

Sigma Aldrich Type A Gelatin, lot no. 0000518727

Fisher Chemical Sodium Chloride, lot no. 193467

1. weigh out all contents (described above)
2. add MQ water to respective labeled beakers
    1. 50 mL for 3 beakers
    2. 150 mL for 2 beakers
3. add respective gelatin to beakers and place on hot plates (no heat yet) and spin at 200 rpm
4. after 5 minutes, turn on hot plates set to 120 C and cover each beaker with aluminum foil
5. after 30 mins, add salt into each beaker and reduce temp to 60 C
6. after 1 hour, pour into respective molds

Conclusions/action items:

HELENE SCHROEDER - Mar 21, 2026, 11:14 AM CDT

Conclusion:

The gels we made are in 3 ice cube trays in the fridge in the teaching lab. This weekend (Sunday?), electrical

conductivity testing will be completed on the gels so we can hopefully determine our final gel and saline composition for TMS testing.

2026/03/21 - Brain Mold Fabrication

AVERY SCHUDA - Mar 25, 2026, 4:38 PM CDT

Title: Brain Mold Fabrication

Date: 3/21/2026

Content by: Avery Schuda

Present: Avery, Lilly

Goals: Use the 3D printed box and brain to create a mold with the silicone mold making kit

Content:

- Spray brain and box with mold release spray
- Mix equal parts of the silicone part A and part B
  - We used the entire bottle of each (70mL)
- Orient the brain within the box so that it doesn't move while drying
- We opted for an anatomical orientation because there wasn't enough silicone to cover it otherwise
- After pouring the silicone we noticed some bubbles streaming slowly out of the anterior portion of the brain where there is a defect in the print from the print plate
- The mold did fully harder but was a bit thin at the top
- We added a layer of ecoflex on top to fully cover the thin spot
  - If this is not successful we will just peel it off
- After drying a second time the mold looks good

Conclusions/action items:

Remove the brain from the mold. Our plan for this is to slice the mold carefully in half and use the box to hold the halves together while pouring/curing the gelatin.

2026/03/23 - Prototype for Testing Fabrication

AVERY SCHUDA - Mar 23, 2026, 1:29 PM CDT

Title: Fabrication of Box for Preliminary Testing

Date: 03/23/2026

Content by: Lilly, Avery

Present: Lilly, Avery

Goals: Fabricate gel in box for preliminary TMS testing tomorrow w Dr. Manattu

Content:

- Based on the results that Helene analyzed from Orla's testing yesterday, we are going to go with the 1.5% NaCl gel concentration. There was no significant difference between conductivity of gelatin percentages when salt was held constant, so we are going with 6% gelatin for consistency
- In other news, the top part of the skull printed so Avery started taking the supports off/washing that, and we are waiting for the bottom half to finish printing.

Fabrication

Gelatin percent: 6%

Saline percent: 1.5%

Total volume: 200 mL

12 g of Gelatin - actual: 12.021g

3 g of NaCl - actual: 3.020g

Procedure:

Prepare boxes: we used Teflon (PTFE) tape around the plugs and inserted them into the premade holes in the boxes. We tested with water to make sure they didn't leak and then on revision added more teflon tape as well as electrical and lab tape over top to prevent leaking.

We let gelatin soak at room temperature, spinning at 200 RPM for 5 minutes. After this, increased hot plate temperature to about 100 C to bring solution up to temperature and covered with aluminum foil to prevent evaporation, then add NaCl after about 40 minutes at 60 deg C. About 5 minutes in, we switched from a 300 mL to a 600 mL beaker, because the mixture wasn't spinning completely (the larger beaker has a much larger diameter so the gelatin can mix better). Continued spinning until gel reached 65C, about 35 minutes, then lower hot plate temperature to maintain 65 C and keep spinning for a further 10-15 minutes. Poured 50 mL into each of the prepared boxes using serological pipet. Put gels in 4 deg C fridge to chill overnight for testing tomorrow.

Conclusions/action items:

Wait for bottom half of skull to print and process when it does. Orla is going to pick up electrodes from Dr. Ahmed this afternoon. Lilly and Avery are going to work on removing and cleaning up the mold for the brain gel, but for now we are using the small boxes for testing tomorrow just to get our bearings about us.

2026/4/7 - Final Gelatin Brain Fabrication

CORISSA HUTMAKER - Apr 07, 2026, 7:39 PM CDT

Title: Final Gelatin Brain Fabrication

Date: 4/7/2026

Content by: Corissa Hutmaker

Present: All

Goals: Finish brain mold and make pour 6% gelatin 1.2% NaCl hydrogel

Content:

Fabrication

Gelatin percent: 6%

Saline percent: 1.5%

Total volume: 950 mL

57 g of Gelatin - actual: 57.026g

11.4 g of NaCl - actual: 11.451g

Procedure:

We placed the gelatin and water mixture on a hotplate at 100 C and 580 RPM for 45 minutes before increasing the heating to 120 C to expedite gelatin heating. The mixture was at 45 C after 45 minutes. After 90 minutes, the mixture was at 55 C, so we increased the temperature of the hotplate to 150 C. After 110 minutes, the mixture was at 61 C, and we added the NaCl. We have been having major issues getting the brain mold out. We had to cut the box in half, and are now having issues removing the silicone mold. We had to cut the mold into quarters to remove it. The box could not be taped back together, so we went and found a similar size cardboard box, stuffing the empty space to compress the mold. We funneled in the hydrogel at 65 C after 170 minutes of heating and stirring and placed the box into the 4 C fridge to set. The cardboard box was lined with a trashbag to hopefully prevent leaking. See photos below.



Conclusions/action items:

Avery is working on making an inverted mold, as we do not have high hopes for this setup. We threw away the original box because there was no way to put it back together. We plan to come back tomorrow to see how this iteration of the brain mold turned out and will decide if and how we will make a new prototype for testing on Friday.

2026/4/7 - Drilling Skull

LILLY MACKENZIE - Apr 07, 2026, 4:51 PM CDT

Title: Drilling Skull

Date: 04/07/2026

Content by: Lilly

Present: Lilly

Goals: Drill appropriate sized holes in skull mold to allow iEEG electrodes to be inserted for testing

Content:

I went down to TEAM Lab and talked with Jeff, Eric, and Ben about how to best drill into the skull to prevent shattering. I ended up using a 5-40 drill bit and a spot drill slowly to prevent shattering. The hardware screws in with a taper thread, so I didn't thread the holes. The holes are located toward the front side of the brain (motor cortex area), all on the right side so we can apply TMS to a single area

Conclusions/action items:

We can now insert the electrodes on the day of testing properly (as they would be in clinic), and use the setup to accurately assess TMS effects on iEEG

2026/4/9 - Final Gelatin Brain Fabrication Fixing

AVERY SCHUDA - Apr 09, 2026, 1:42 PM CDT

Title: Final Gelatin Brain Fabrication Fix

Date: 4/9/2026

Content by: Avery Schuda

Present: Avery

Goals: Fix half brain by fabricating top half

Content:

Only the top half of the mold was printed due to a mistake by the makerspace staff. I am using this top half of the mold to add a top half to our existing brain that leaked in the previous mold, since the top is the most important part. The second half of the mold should be done by 9pm tonight. At that point this brain should be done curing in the fridge and I will come back to fabricate a second brain using both halves of the mold. Everything should be cured in the fridge by 1:30 tomorrow so we have time to get to testing by 2pm.

Fabrication

Gelatin percent: 6%

Saline percent: 1.2%

Total volume: 500 mL

30 g of Gelatin - actual: 30.015g

6 g of NaCl - actual: 6.010 g

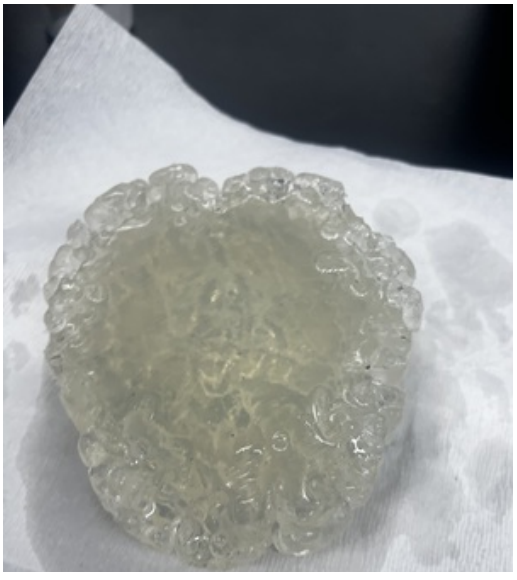
Procedure:

I placed the gelatin and water mixture on a hotplate at 150 C and 580 RPM for 45 minutes before increasing the heating to 185 C to expedite gelatin heating. The mixture was at 45 C after 30 minutes. After 45 minutes, the mixture was at 60 C, and I added the NaCl. Used a similar size cardboard box, stuffing the empty space to compress the mold. I poured in the hydrogel at 65 C after 55 minutes of heating and stirring and placed the box into the 4 C fridge to set. The cardboard box was lined with a trashbag to hopefully prevent leaking.

Conclusions/action items:

Left the brain in the 4C fridge to cure. Come back at 9pm with the second half of the mold and fabricate second brain.

AVERY SCHUDA - Apr 09, 2026, 1:36 PM CDT



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IMG_2088.jpeg (763 kB)

AVERY SCHUDA - Apr 09, 2026, 1:36 PM CDT

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IMG_2087.jpeg (3.15 MB)

AVERY SCHUDA - Apr 09, 2026, 1:36 PM CDT

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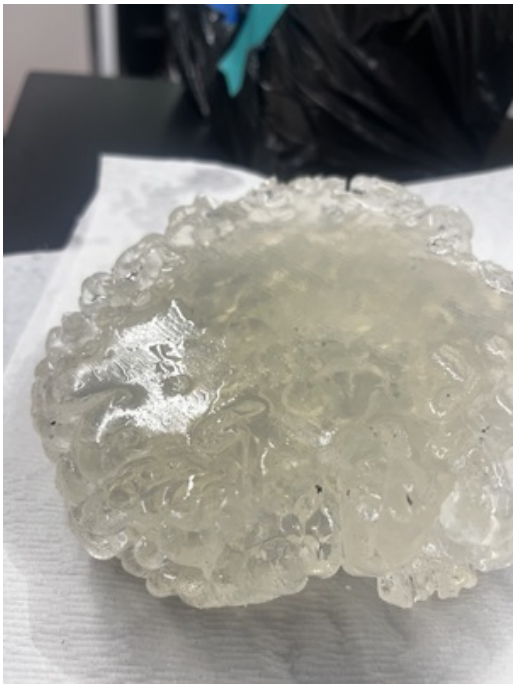
IMG_2089.jpeg (2.43 MB)

AVERY SCHUDA - Apr 09, 2026, 1:36 PM CDT



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AVERY SCHUDA - Apr 09, 2026, 1:36 PM CDT

Download

IMG_2091.jpeg (2.34 MB)

2026/4/9 - Gelatin Brain Fabrication with 3D Printed Mold

AVERY SCHUDA - Apr 13, 2026, 9:39 AM CDT

Title: Gelatin Brain Fabrication with 3D Printed Mold

Date: 4/9/2026

Content by: Avery Schuda

Present: Avery, Corissa

Goals: Fix half brain by fabricating top half

Content:

Fabrication

Gelatin percent: 6%

Saline percent: 1.2%

Total volume: 500 mL x2

30 g of Gelatin x2 - actual: 30.010g + 29.998g

6 g of NaCl x2 - actual: 6.016g + 6.001g

Procedure:

I placed the gelatin and water mixture on a hotplates at 150 C and 580 RPM for 45 minutes before increasing the heating to 185 C to expedite gelatin heating. The mixture was at 45 C after 30 minutes. After 45 minutes, the mixture was at 60 C, and I added the NaCl. I used the newly 3D printed two part mold and lined it with plastic wrap. I poured in the hydrogel at 65 C after 55 minutes of heating and stirring and placed the box into the 4 C fridge to set. We duct taped the two halves of the mold together and poured the gel into the hole in the top with a funnel. We set the mold in the 4C fridge to cure in the trash bag-lined cardboard box to catch any leakage. I attempted to unmold the other brain and it unfortunately tore. I put the two pieces in DI water in the 4C fridge.

Conclusions/action items:

Lilly with unmold the brain tomorrow morning and bring it to testing at the PNL at 2pm, unless the other brain turns out better.

2026/4/22 - Gelatin Brain Fabrication for Poster Session

AVERY SCHUDA - Apr 22, 2026, 4:16 PM CDT

Title: Gelatin Brain Fabrication with 3D Printed Mold

Date: 4/2/2026

Content by: Avery Schuda

Present: Avery

Goals: Create new gelatin brain for poster session

Content:

Fabrication

Gelatin percent: 6%

Saline percent: 1.2%

Total volume: 550 mL x2

33 g of Gelatin x2 - actual: 33.038g + 33.004g

6.6 g of NaCl x2 - actual: 6.605g + 6.625g

Procedure:

I placed the gelatin and water mixture on hotplates at 150 C and 580 RPM for 45 minutes before increasing the heating to 185 C to expedite gelatin heating. The mixture was at 45 C after 30 minutes. After 45 minutes, the mixture was at 60 C, and I added the NaCl. I used the silicon mold and newly printed box to house it and lined it with plastic wrap. I poured in the hydrogel at 65 C after 55 minutes of heating and stirring and placed the box into the 4 C fridge to set. I poured the gel into the hole in the top with a funnel. I set the mold in the 4C fridge to cure in the bag-lined 3D printed box to catch any leakage.

Conclusions/action items:

Brain is gelling in the fridge and I did not see any leakage. Tomorrow it can be unmolded.

2026/1/28 - Lilly Gel Composition Planning

LILLY MACKENZIE - Jan 28, 2026, 3:07 PM CST

Title: Gel composition planning

Date: 1/28/2026

Content by: Lilly

Present:

Goals: Create a detailed list of gel (agar and gelatin) compositions for planned testing and include papers with citations. Reasons should be clear for each composition picked from each paper's results section specifically

Content:

Attached

Conclusions/action items:

Create these gel compositions for testing. Because we will have to make modifications for each of these, even though these were successful for each of the papers' authors, we can verify which work for us specifically.

LILLY MACKENZIE - Jan 28, 2026, 3:07 PM CST

Download

1_26_2026_-_Gel_Composition.xlsx (15.6 kB)

2026/2/4: Thermal Conductivity Testing Protocol

HELENE SCHROEDER - Feb 05, 2026, 8:42 PM CST

Title: Thermal Conductivity Testing Protocol

Date: 2/4/2026

Content by: Helene Schroeder, Corissa Hutmaker

Goals: To include the thermal conducitivity protocol that was used during testing on 2/1 and 2/4.

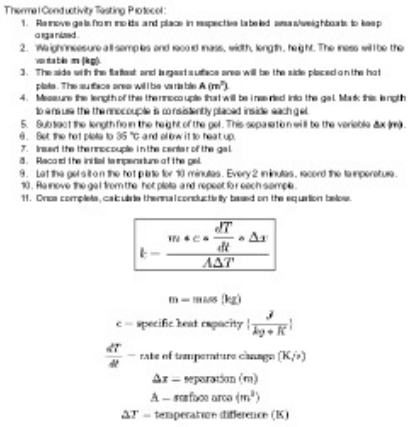
Content:

See attached file for protocol.

Conclusions/action items:

We used this testing protocol for thermal testing of our agar and gelatin hydrogels. Next, the data must be processed to find the actual thermal conductivity values.

HELENE SCHROEDER - Feb 05, 2026, 8:43 PM CST



Thermal Conductivity Testing Protocol:

1. Remove gels from molds and place in respective labeled areas/weighboats to keep organized.
2. Weigh/measure all samples and record mass, width, length, height. The mass will be the variable **m (kg)**.
3. The side with the flattest and largest surface area will be the side placed on the hot plate. The surface area will be variable **A (m^2)**.
4. Measure the length of the thermocouple that will be inserted into the gel. Mark this length to ensure the thermocouple is consistently placed inside each gel.
5. Subtract the length from the height of the gel. This separation will be the variable **Δx (m)**.
6. Set the hot plate to 35 °C and allow it to heat up.
7. Insert the thermocouple in the center of the gel.
8. Record the initial temperature of the gel.
9. Let the gel sit on the hot plate for 10 minutes. Every 2 minutes, record the temperature.
10. Remove the gel from the hot plate and repeat for each sample.
11. Once complete, calculate thermal conductivity based on the equation below.

$$k = \frac{m * c * \frac{dT}{dt} * \Delta x}{A \Delta T}$$

m = mass (kg)

c = specific heat capacity $\left[\frac{J}{kg * K}\right]$

$\frac{dT}{dt}$ = rate of temperature change (K/s)

Δx = separation (m)

A = surface area (m^2)

ΔT = temperature difference (K)

Download

2_1_2026_-_Thermal_Conductivity_Testing.pdf (63.6 kB)

2026/03/18 - Updated Electrical Protocol

ORLA RYAN - Mar 18, 2026, 8:40 PM CDT

Title: Updated Electrical Protocol

Date: 03/18/2026

Content by: Orla

Present: n/a

Goals: Uploading my rewritten protocol and data processing pipeline.

Content:

Electrical Conductivity Testing Protocol

Materials:

- Keysight 33210A Function/Arbitrary Waveform Generator 10MHz
- Keysight 34450A Digital Multimeter
- Astro AI M4KOR Digital Multimeter
- Two copper electrodes
  - Copper wire stripped approximately 2.5 cm at each end
- Additional connecting wires
  - Two sets of multimeter probes and BNC coaxial cable
- Infrared thermometer
- 4x 3D-printed PLA box of dimensions 3.474cm x 3.007 cm x 8.554 cm
- Fabricated hydrogels: 6% gelatine, 0.1% NaCl
  - Left to sit for 24 hours, minimum, refrigerated between 1°C to 4°C

Methods:

1. Collect the starting volumetric and mass measurements of gels to be tested:
    1. Mass, depth of gel within housing
    2. Take the temperature of the gel that is being tested
2. Assemble the testing set-up, focusing on one gel at a time:
    1. Insert the end of a copper electrode at each end of the gel's length, measuring depth of insertion
    2. Utilizing the two digital multimeters, complete assembly so that one is connected in series, and the other in parallel
        1. The digital multimeter in series should be set to record current, while the multimeter in parallel should be set to record AC voltage
3. Before turning power on, ensure that all devices are running and working properly.
    1. Insert troubleshooting here? I.e. check the digital multimeter by recording resistance of a resistor with known value?
4. Generate a waveform on the generator with the following specifications:

    1. Sine wave
    2. 10Vpp
    3. Frequency ranging from 100-500Hz (measurements will be noted at 100, 200, 300, 400, and 500 Hz, respectively)
5. Upon pressing “output” and generating the waveform, observe and record the reported induced voltage and current between the electrode components
6. Repeat at each frequency point in the frequency range desired above.
7. To solve for resistance of each gel, utilize Ohm’s Law and the reported induced voltage values corresponding with each signal

Governing equations:

$V = I * R$

Resistivity (ρ) = 1 / conductivity (σ)

$\rho = R * A/L$ (resistivity = resistance * length / surface area)

$\sigma = L / R*A$

Processing Steps:

1. Interpreting the data:
    1. 3 separate sheets within the “Electrical Testing 3/15” file → each sheet represents one condition
    2. 4 samples per condition, labelled at the top (relevant data is highlighted in blue, other stuff at the bottom is orla trying to do some of the calculations using Sheets formulas lol)
    3. For each sample, the following was measured:
        1. Mass, length, width, height
        2. How much of the electrode was inserted at each end
        3. Temp
        4. Voltage measured across and current measured through the sample (applied 10 Vpp at frequencies ranging from 100-500Hz)
2. To calculate:
    1. Setting up resistivity equation:
    2. “R”: Resistance in ohms of each sample (should use Ohm’s Law aka V = I*R, solve for R with the recorded Vpp and current, make sure to convert current to A from mA!!)
    3. “A”: Surface area of electrode contact points (width * height → I converted to m_2 for SI units)
    4. “L”: “Length” aka distance between electrodes (length of sample - length of electrode #1 - length of electrode #2 → again converted to m)
    5. Calculating resistivity (geometric equation, $\rho = R * A/L$):
        1. Use variables calculated above for each sample
    6. Calculating conductivity:

1. 1/ρ for each sample

Conclusions/action items:

Confer with group to see if more testing is desired/necessary.

2026/4/7: Checklist for TMS Testing with Assembled Phantom

HELENE SCHROEDER - Apr 07, 2026, 9:00 PM CDT

Title: Creating Checklist for TMS Testing at PNL Lab with Assembled Phantom

Date: 4/7/2026

Content by: Helene

Present: Helene, Orla, Lilly

Goals: Create the checklist of materials we need and ensure equipment works for testing on Friday.

Content:

- made checklist for what we need for testing
- ensured that multimeter for measuring temperature accurately changes temperature

Checklist:

- skull (with holes)
- silicone tape
- gel brain
- depth electrodes 3x
    - 6-point
    - 8-point
    - 10-point
- hardware to insert electrodes 3x
- tripod 2x (orla and corissa bring)
- phones for recording/photographing 5x
- multimeter
    - fancy ones (corissa and helene) 2x → measure temp
    - less cool ones (lilly, orla, avery) 3x → measure current
        - ORLA ask drew and LILLY bring from home
- sets of alligator clips (one red, one black) x3
- caliper (avery)
- tape measure (helene) 2x
    - soft
    - hard

Conclusions/action items:

We have most of these items and placed them in the green room on our shelf in a grocery bag. We still need to obtain 2 multimeters, 2 tripods, 2 measuring tapes, 1 caliper, and the gel brain. We have plans to obtain all of these items before Friday.

2026/02/01 - Thermal Testing and Outreach Prep

ORLA RYAN - Feb 02, 2026, 9:31 AM CST

Title: Thermal Testing and Outreach Prep

Date: 02/01/2026

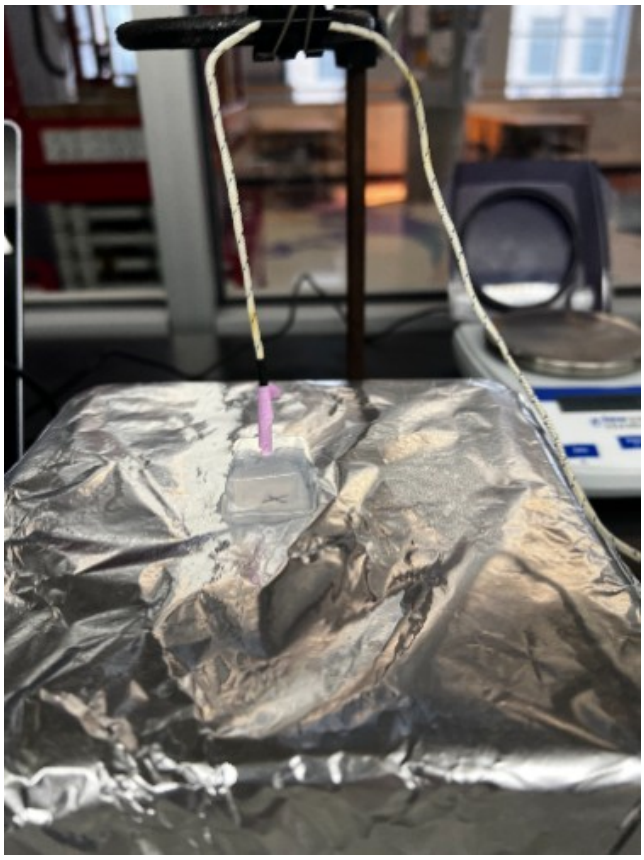
Content by: Orla, Avery

Present: Orla, Lilly, Helene, Corissa, Avery

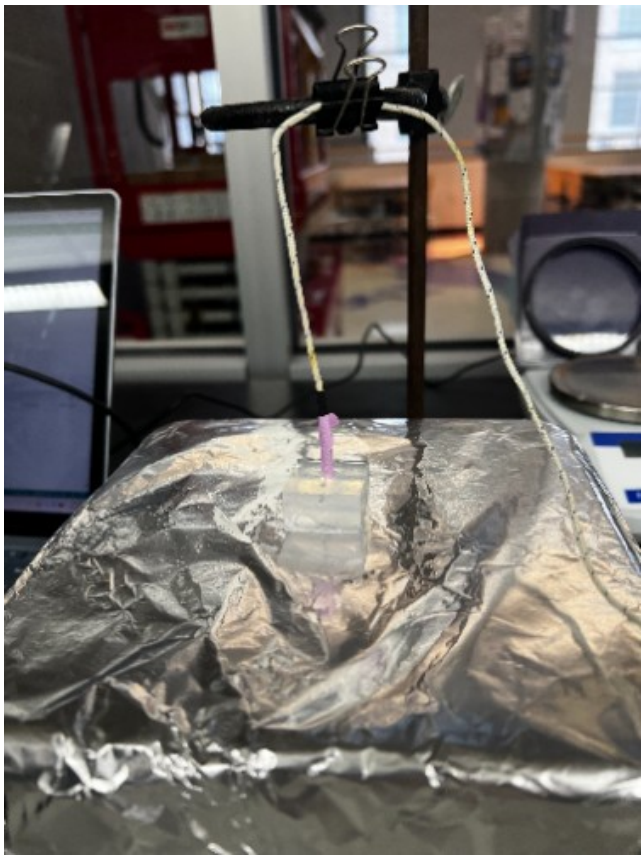
Goals: Conduct thermal conductivity testing on agar (0.6 and 1.2%) gels and gelatin (6%) gels. Additionally, we will be making materials for our outreach.

Content:

- Given the continued beeping of the fume hoods, we relocated to ECB 1070 to conduct our testing.
- We used our same set-up of a hotplate, lab stand, and binder clip to both heat up gel samples and hold the thermocouple (attached to our Arduino circuit) in place.
- At the same time, some of the group primarily focused on decorating and putting together a tri-fold poster and "puzzle pieces" for our outreach event this Tuesday, 2/3.
    - pictures of the finished materials are displayed below!
- Both 0% saline agar gels were too liquid to be able to test at all
- Interestingly the firmness of the gels went up as the amount of saline increased --> further investigation needed
- 0.6% agar notes
    - 0% saline did not become firm enough for use
    - n1 for 0.6% and 0.2% handled too long and started melting/falling apart
    - n2 also squished (past the point of being able to use)
    - n3 thermocouple malfunctioned?
    - hot plate was at ~25 C for 0.6% 0.2% samples according to IR thermometer
    - increased hot plate temp for 0.6% 0.2% n4 (50 on hotplate for 35 actual temp)
- 1.2% agar notes
    - 0% saline did not become firm enough for use
    - 0.2% saline a little fragile (corners shearing off if not super careful)
    - n=3 for 0.2% saline it took a long time to start measurements (took the gel off the hot plate while we were troubleshooting) because the arduino code didn't work while laptops were plugged in



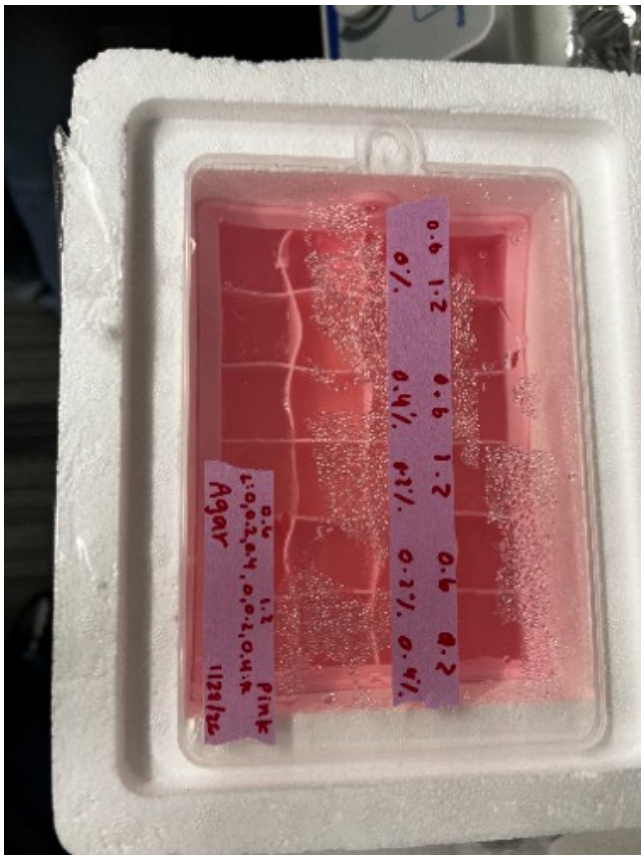
0.6% agar, 0.2% saline, n4 on hot plate during testing



0.6% agar, 0.4% saline, on hot plate during testing

Agar gels in mold pre-testing

Gelatin gels in mold pre-testing



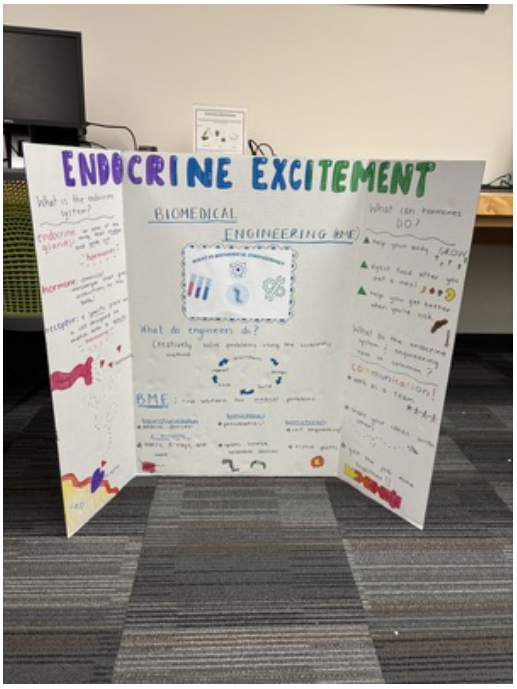
Cooling setup with ice in bottom of styrofoam cooler

Ultimately, while the majority of the gel samples were tested, there are still 8 gelatin samples remaining. The team will meet up later this week to complete this process.

Conclusions/action items:

We will meet at ECB at around 12pm on Wednesday, 2/4, to test the remaining 8 gelatin gels.

HELENE SCHROEDER - Feb 01, 2026, 4:33 PM CST



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HELENE SCHROEDER - Feb 01, 2026, 4:33 PM CST

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2026/02/04 - Thermal Testing (contd)

AVERY SCHUDA - Feb 04, 2026, 2:02 PM CST

Title: Thermal Testing (continued)

Date: 2/04/2026

Content by: Avery

Present: Avery, Lilly, Helene, Orla

Goals: Complete gelatin thermal testing

Content:

Notes: first sample (0% saline) started melting as the hot plate was at 35 C. Future runs decreased temp to 40 (should be a surface temp around 30 C)
After decreasing the plate temperature, the gels were no longer melting but were behaving odd
Note: 0.3% n=3 was weird shape (poured uneven)

Note: 0.6% n=3 was weird shape (poured uneven)

For gelatin measurements, hot plate was held around 30 C
Note: 0.3% n = 1 the code wasn't functioning so we are not using the data from this trial
code was not working also for part of 0.3% n=2, and hotplate was at 21 deg C when gel was taken off

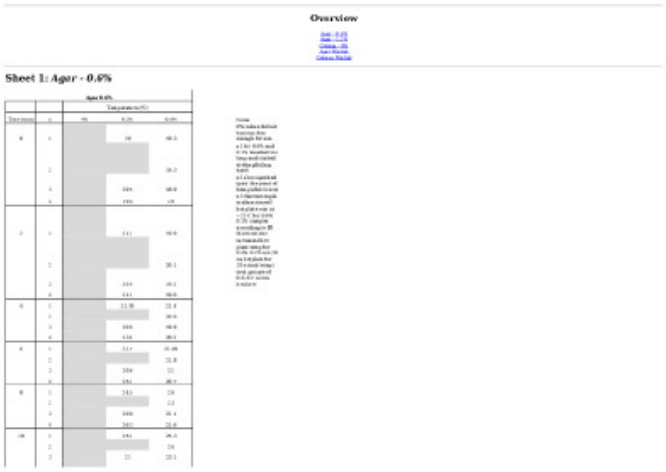
*We do not trust the measurements for these data for pretty much any of the samples. The numbers given by the code output were highly varied and we tried to take what was the most stable of those values, because there was a general upward trend

Talked about the potential of doing DSC for thermal properties (need to figure out if this would actually be useful). Having a hard time keeping the hotplate temperature consistent.

Conclusions/action items:

Look more into DSC to see if it would be useful/if we even actually have it available for us to use without fee for service. Potentially bring it up to Campagnola to see if he has insight.

AVERY SCHUDA - Feb 04, 2026, 2:03 PM CST



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2_1_2026_-_Thermal_Conductivity_Results.xlsx (17.4 kB)

2026/02/05: Thermal Conductivity MATLAB Results

HELENE SCHROEDER - Feb 05, 2026, 10:27 PM CST

Title: Thermal Conductivity Results from MATLAB

Date: 2/5/2026

Content by: Helene Schroeder

Goals: To quantify the results for the testing we did this past week on the agar and gelatin gels.

Content:

See attached file for code. Ideal value for thermal conductivity is 0.536 W/mK.

Agar Results:

0.6% Agar, 0.2% saline: 1.1645 W/mK

0.6% Agar, 0.4% saline: 1.66 W/mK

1.2% Agar, 0.2% saline: 1.9361 W/mK

1.2% Agar, 0.4% saline: 1.8563 W/mK

Gelatin Results:

6% Gelatin, 0% saline: 2.0575 W/mK

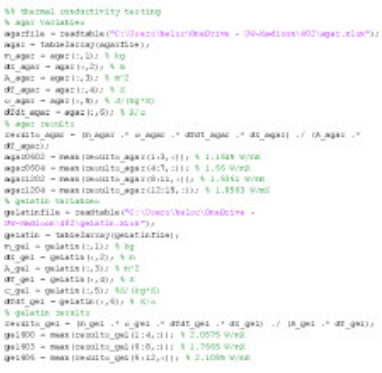
6% Gelatin, 0.3% saline: 1.7665 W/mK

6% gelatin, 0.6% saline: 2.1085 W/mK

Conclusions/action items:

These results are not very near to the ideal values. These are just preliminary results, and I may have done a calculation wrong to get the incorrect values. I will have to double check with the team to check if my calculations were correct or not.

HELENE SCHROEDER - Feb 05, 2026, 10:28 PM CST



Download

2_5_26_-_MATLAB_Code_Thermal_Conductivity.pdf (38.1 kB)

2026/03/01 - Electrical Machinery Practice

ORLA RYAN - Mar 01, 2026, 12:42 PM CST

Title: Electrical Machinery Practice

Date: 3/1/2026

Content by: Orla

Present: Orla, Corissa

Goals: Get refamiliarized with equipment available to us in ECB 1080 prior to testing.

Content:

- Unfortunately, while I had reached out to my 770 TA with the hopes of having electrodes to practice with this weekend, they were left in ECB 1036 instead of 1080.
  - We don't have keycard access to this room, so were unable to grab them to use.
- Decided to comb through user manuals for the equipment in 1080 to get familiar with how we would go about voltage drop testing:
  - Essential Benchtop Oscilloscopes: DSOX2024A | Keysight
  - http://www.home.agilent.com/agilent/product.jspx?cc=US&lc=eng&c
- Also will be going through the TMS Magstim information:
  - (Microsoft Word - Magstim 200\262 Operating Manual 3001-23-04.doc)
- Corissa found out that office hours in ECB 1036 will be taking place tomorrow at 12:30pm (I will go then to pick up electrodes)

Conclusions/action items:

Continue to work towards electrical testing.

2026/03/01: Thermal Conductivty Testing

HELENE SCHROEDER - Mar 01, 2026, 7:15 PM CST

Title: Thermal Conductivity Testing

Date: 3/1/26

Content by: Helene Schroeder

Present: Helene, Lilly

Goals: To repeat thermal conductivity testing on gelatin gels of varying concentrations with a constant saline concentration.

Content:

Materials needed:

- gelatin gels
  - 4%, 6%, 8% gelatin concentrations
  - 0.17% saline concentration
- hot plate set to 30 C
- heat gun to ensure hot plate is at correct temperature
- scale to measure gels
- calipers to measure gels
- computer with arduino IDE
- thermocouple circuit

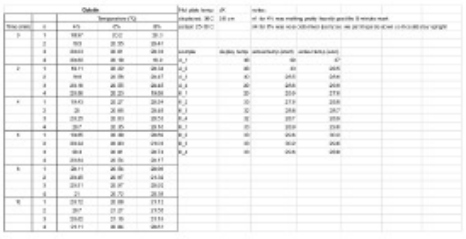
Methods/notes:

- some gels had more issues coming out of the molds than others, so we made note of that on the spreadsheet
- we had 4 replicates of each condition
- did not have any issues with the arduino code on my computer
- we also took note of the surface temperature of the hot plate using the infrared heat gun, but it mostly was consistent at around 30 C
  - if you do 35 C then the gels will metl and deform
- see attached spreadsheet for data

Conclusions/action items:

In the near future I will calculate thermal conductivity values based on the testing done today.

HELENE SCHROEDER - Mar 01, 2026, 7:16 PM CST



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3_1_2026_-_Thermal_Conductivity_Results.pdf (75.2 kB)

HELENE SCHROEDER - Mar 01, 2026, 7:33 PM CST

Results shown in attached image.

	A	B	C	D	E	F	G	H	I
	m (kg)	dx (m)	A (m^2)	dT (K)	c (J/kg*K))	dTdt (K/s)		k (W/m*K)	
	0.01006	0.011	0.000552	1.75	4000	0.002917		1.336473	
	0.01016	0.011	0.000598	1.2	4000	0.002		1.245931	
	0.00992	0.012	0.000575	0.59	4000	0.000983		1.380174	
	0.00937	0.0115	0.000529	0.49	4000	0.000817		1.357971	4%
	0.01038	0.012	0.000575	0.48	4000	0.0008		1.444174	
	0.00992	0.012	0.000552	0.72	4000	0.0012		1.437681	
	0.01045	0.011	0.000552	0.54	4000	0.0009		1.388285	
	0.0102	0.013	0.00055	0.66	4000	0.0011		1.607273	6%
0	0.01084	0.011	0.00055	0.82	4000	0.001367		1.445333	
1	0.01114	0.01	0.000624	1.14	4000	0.0019		1.190171	
2	0.01109	0.012	0.000625	0.86	4000	0.001433		1.41952	
3	0.00909	0.011	0.000552	0.71	4000	0.001183		1.207609	8%
4									
5									

2026/03/06: Initial Electrical Testing

Title: Initial Electrical Testing

Date: 3/6/2026

Content by: Orla

Present: Orla

Goals: Figure out an appropriate set-up and get some initial results.

Content:

Notes:

Calibrating:
10V pp applied, multimeter reads 7.063 V

Number 1:
End broke off
Copper wire extending 13.8 mm one side, 14.9mm other
19 C

Number 2:
End also broke off
20.1 C
8.25, 8.22 mm

Number 3:
No breakage!
Slanted gel, lowest/most leaked out
19.1 C
8.54, 10.71 mm

Number 4:
Also significant slant, but higher
19.6 C
8.6, 8.4mm

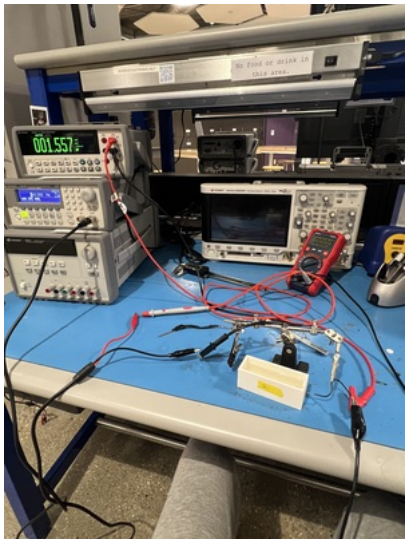
Sample 1 findings (reporting table here as an example of some results):

Frequency (Hz)	Voltage (ppV)	Current (mA)	Resistance (ohms)	Height (m)	Width (m)	Length/Distance between electrodes (m)	Surface Area of Contact zone (m^2)	Resistivit
100	6.71	6.86	978.1341108	0.01813	0.0254	0.0475	0.000460502	9.4
200	6.7	6.87	975.2547307					9.4
300	6.71	6.93	968.2539683					9.3
400	6.7	6.97	961.2625538					9.3
500	6.7	7	957.1428571					9.2

Conclusions/action items:

Share findings with the group!

ORLA RYAN - Mar 06, 2026, 12:03 PM CST



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IMG_1202.jpeg (2.62 MB)

ORLA RYAN - Mar 06, 2026, 12:03 PM CST

Download

IMG_1201.jpeg (3.15 MB)

ORLA RYAN - Mar 06, 2026, 12:03 PM CST

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IMG_1203.jpeg (3.17 MB)

ORLA RYAN - Mar 06, 2026, 12:03 PM CST

Download

IMG_1204.jpeg (1.78 MB)

2026/03/15: Round 2 Electrical Testing

ORLA RYAN - Mar 15, 2026, 2:01 PM CDT

Title: Round 2 Electrical Testing

Date: 3/15/2026

Content by: Orla

Present: Orla, Lilly

Goals: Repeat electrical testing, this time on 3 different gelatin gel conditions.

Content:

- Today, we tested on 12 gel samples in total (4 samples for three conditions: all 6% gelatin, varying NaCl concentrations of 0.1%, 0.2%, and 0.4%)
- At first, we tried to recreate a similar set-up in ECB 1080, but ran into several issues
    - Lack of Keysight Multimeter
    - Lack of waveform generator other than oscilloscopes
    - issues with set-up (finding both parallel and series configurations for handheld multimeters)
- Luckily, the Makerspace was open so we relocated with our supplies and were able to get the measurements we needed

example data (condition 1, 6% gelatin and 0.1% NaCl):

	Sample 1	Sample 2	Sample 3	Sample 4
mass (g)	10.45	11.17	10.92	10.62
length (cm)	2.44	2.51	2.41	2.31
width (cm)	2.3	2.36	2.38	2.23
height (cm)	1.78	1.92	1.89	1.87
copper electrode #1 length (cm)	0.933	0.669	0.549	0.65
copper electrode #2 length (cm)	0.584	0.85	0.826	0.599
temp (C)	19.7	19.1	19.5	19.3
100Hz: Vpp (V)	6.59	6.58	6.6	6.63
100Hz: current (mA)	9.21	9.44	8.77	8.4
200Hz: Vpp (V)	6.6	6.58	6.61	6.63
200Hz: current (mA)	9.1	9.54	8.86	8.53
300Hz: Vpp (V)	6.6	6.57	6.61	6.62
300Hz: current (mA)	9.1	9.63	8.92	8.6
400Hz: Vpp (V)	6.1	6.57	6.6	6.62
400Hz: current (mA)	9.15	9.7	8.97	8.65
500Hz: Vpp (V)	6.6	6.57	6.6	6.62
500Hz: current (mA)	9.17	9.74	9	8.69

Conclusions/action items:

Process these over the next couple days within MATLAB and see what conclusions we can come to.

2026/03/22: Third Electrical Testing

ORLA RYAN - Mar 22, 2026, 3:49 PM CDT

Title: Third Electrical Testing

Date: 3/22/2026

Content by: Orla

Present: Orla, Lilly

Goals: Continue testing to test conductivity of a variety of samples (varying both gelatin and NaCl).

Content:

- Lilly and I met to de-mold gelatin samples made on Friday and take masses in ECB.
    - The following sample types were made/tested:
        - 4 samples of **3% gelatin,** 0.1% NaCl; 4 samples of **6% gelatin**, 0.1% NaCl; 4 samples of **9% gelatin**, 0.1% NaCl
            - this is to test the impact of gelatin concentration on conductivity
        - 4 samples of 6% gelatin, **1.5% NaCl**; 4 samples of 6% gelatin, **2.5% NaCl**
            - to further test conductivity values with increasing amounts of saline
- masses were recorded, then I went to the Makerspace to go through the same testing protocol with all the samples above
- An example of a table of values is attached below (this was for the 6% gelatin, 1.25% NaCl):

	Sample 1	Sample 2	Sample 3	Sample 4
mass (g)	36.76	37.85	35.45	36.19
length (cm)	7.62	7.62	7.62	7.62
width (cm)	2.54	2.54	2.54	2.54
height (cm)	1.974	1.912	1.909	1.892
copper electrode #1 length (cm)	1.249	1.249	1.249	1.249
copper electrode #2 length (cm)	1.219	1.219	1.219	1.219
temp (C)	18.6	18.2	19	18.7
100Hz: Vpp (V)	6.14	5.07	5.32	5.5
100Hz: current (mA)	18.04	38.84	34.11	30.42
200Hz: Vpp (V)	6.12	5.03	5.28	5.47
200Hz: current (mA)	18.34	39.67	34.67	30.95
300Hz: Vpp (V)	6.11	5.01	5.27	5.46
300Hz: current (mA)	18.49	40.15	34.92	31.2
400Hz: Vpp (V)	6.11	4.99	5.26	5.45
400Hz: current (mA)	18.62	40.47	35.14	31.42
500Hz: Vpp (V)	6.1	4.98	5.25	5.44
500Hz: current (mA)	18.73	40.74	35.3	31.57

- I will let Helene know that this data is all collected, as she will be doing the processing/calculations!

Conclusions/action items:

Pass on data to Helene and discuss with team what the final gel makeup should be.

2026/03/24 - Initial TMS Testing

AVERY SCHUDA - Mar 24, 2026, 5:12 PM CDT

Title: Initial TMS Testing

Date: 3/24/2026

Content by: Avery

Present: Avery, Helene, Corissa, Lilly, Dr Manattu, Cameron

Goals: Discuss test set up for final testing

Content:

- Variables to consider other than stimulation intensity
  - Should go up to 100% intensity, not 80%
- Heating depends on how quickly you are generating those pulses
  - Dispersion of heat to avoid local hot spots
- Distance of coils
  - A lot of gauze wrap?
- Is the application in question just for assessment purposes or also for application (repetitive TMS)
- Push to the extremes
- Up to 100 pulses
- Not all the testing needs to be accomplished before the end of the semester
- Units of measurement
  - Impact per pulse
  - Cumulative change over x number of pulses
- Take a sample after every pulse
  - Take an average across trials
  - Integrate across time points (cumulative change)
  - Or last sample is significantly different than first sample
- External marker on electrode to track displacement?
- More concerned about camera resolution than time resolution
- Camera orientation
- Right hand rule, figure out expected displacement direction based on that
- Iowa paper
  - All potential orientations
  - Resolution 1 mm
  - 640x480 pixel resolution
- Hook electrodes up to a multimeters
- Try measuring temperatures using multimeters
- Pick one spot
  - Primary motor or dorsal lateral
  - Motor cortex is more up down electrode
  -

Conclusions/action items:

Figure out electrode/stimulation orientation and drill holes into skull.

AVERY SCHUDA - Mar 24, 2026, 4:44 PM CDT

1. During set-up, place the phantom on a flat, stable surface that is accessible for the TMS operator. The coil will need to be as close as 10mm to the phantom for proper pulse administration. Place the tripod and filming device in a location

that offers an unobstructed view of the phantom’s surface with the depth electrodes (or semi-conductive wires) inserted. Provide a reference object in the camera’s view for later calibration.

2. While the TMS operator turns on and calibrates the Magstim machine, take a temperature reading of the brain phantom and record the observed result.
3. The coil will then be used to apply pulses across a stimulation intensity range of 20-80% machine output delivered at 10–40Hz.
    a. The number of pulses delivered should be recorded, as well as the general area to which the coil is located for each pulse.
    b. The pulses should be delivered across as wide an area of the brain phantom as possible.
4. After all pulses have been delivered, make any visual observations of the integrity of the phantom.
    a. Additionally, take a second temperature reading with the infrared thermometer and note down the results.

2026/04/10 - Notes on Gel Brain and Mold Fabrication

LILLY MACKENZIE - Apr 27, 2026, 1:32 PM CDT

Title: Notes on Gel and Mold Fabrication

Date: 04/10/2026

Content by: Lilly

Present: Lilly

Goals: Discuss some of the things the team has noticed while fabricating molds and brain phantoms to help in future iterations

Content:

Mold:

- The silicone we used to form the mold was a total of 70 Oz, which was just under the required volume. The Franck lab recommends this one (Amazon.com: STARTSO WORLD Silicone Mold Making Kit 20A,10LB Pink Platinum Liquid Silicone Rubber for Mold Making, Fast Cure & Food Safe Silicone Mold Maker, Ideal for Casting Resin Molds/Silicone Molds), which was out of stock.
- Overall the idea worked well. The print had a bit too much gyration, so the silicone went throughs spots and self-connected, which made taking the brain out difficult. Any holes in the print were also filled in, which we think contributed to the slightly-too-small volume.
- Now that the brain has silicone in some of the deeper crevices, it would probably work to pour more silicone and get a really nice, detailed but not overly detailed brain mold. I think this would also be better for the gelatin removal, which I will discuss later. Given the timeline of testing and the amount of time left in the class, we don't think moving testing and remaking this is feasible in the timeline or budget, but it is an easy fix and should only take a couple of iterations to get down really well.
    - future work: we need a box that is a better shape for the brain, and maybe removable. I think potentially using a giant bendable or silicone mold could work, or otherwise maybe even a giant bag? something where we can peel the holder off and then get the mold out. I also think that finding a way to easily separate the mold after it is poured (cut neatly in half so it fits nicely together) is also necessary, but I don't quite know how to do that right now.

Conclusions/action items:

meet with clients to discuss our plans for future work, and how we think we can best

2026/04/10: TMS Testing on Assembled Phantom

HELENE SCHROEDER - Apr 10, 2026, 4:13 PM CDT

Title: TMS Testing at PNL on Assembled Phantom

Date: 4/10/2026

Content by: Helene

Present: Helene, Orla, Avery, Lilly, Corissa, Dr. Arun Manattu

Goals: To test our assemled skull and brain phantom at the PNL using TMS equipment with electrodes implanted into the brain.

Content:

- room temperature = 17 C
- as noted from previous entries, the gel brain was not perfect due to the molds being complicated but was still usable
- 3 electrodes (6, 8, 10 point) were inserted into the brain
    - first trial included hardware to screw electrodes in
    - second trial had electrodes hanging "free"
- skull was taped together using silicone tape
- took initial temperature measurements from the 2 multimeters (distinguished as A and B in data collection)
- after electrodes were inserted, we measured how much of the electrode was external to the skull
- after testing we measured again how much of the electrode was external to the skull
- the difference between final and initial will tell us if there was displacement of the electrodes
    - it should be noted that when the TMS was applied directly over the electrodes (second trial), that could have altered the position of the electrodes
    - similarly, handling while measuring the electrodes and brain could have altered the position too (both trials)
- for current measurement, red alligator clip was attached to 10 point, black was to 8 point
- 2 trials
    - first was with hardware for electrodes, TMS was applied 5 cm away from electrodes
    - second was without hardware, TMS was applied directly above electrodes
- gelatin temperature should eventually increase due to being at room temp --> this could have been part of the reason the temperature increased
- while doing TMS testing, the displayed temp on the multimeters fluctuated
    - when testing was done and multimeters sat for 5 mins, the temp no longer fluctuated
- 5 pulses at 80, 85, 90, 95, 100% intensity
    - measured temp from multimeters after each pulse
    - measured current from multimeter after each pulse
- tripods with phones were set up to record
    - in future will do displacement imageJ measurements

Conclusions/action items:

HELENE SCHROEDER - Apr 11, 2026, 10:07 AM CDT

Conclusion:

Testing included some confounding variables that may impact our results. Next week we will analyze our data for our final deliverables.

2026/02/04 - Outreach Summary

ORLA RYAN - Feb 04, 2026, 1:15 PM CST

Title: Outreach Summary

Date: 2/4/26

Content by: Orla

Present: Orla, Helene, Avery, Corissa, Lilly

Goals: Recapping the outreach event we attended last night.

Content:

- We attended the Crestwood Elementary School science night yesterday, 2/3 from 5:30-7pm.
- I have attached below our finished poster and puzzle piece activity.
- The event was very well attended! There were a lot of kids who were too young to understand much about our topic, but they enjoyed themselves putting together the puzzle pieces.
    - We talked to several teachers/parents in attendance too, and they were happy to see college students there.
- We briefly spoke to the main contact (C Dustin Rubinstein) about the evaluation form and thanked him for putting together the event!

Conclusions/action items:

We will keep in contact with Dr Rubinstein as needed.

ORLA RYAN - Feb 04, 2026, 1:13 PM CST

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IMG_1094.jpeg (3.46 MB)

2026/04/27 - Final Poster PDF

ORLA RYAN - Apr 27, 2026, 10:16 AM CDT

Title: Final Poster PDF

Date: 4/27/2026

Content by: Orla

Present: n/a

Goals: Uploading a copy of the team's final spring poster for reference.

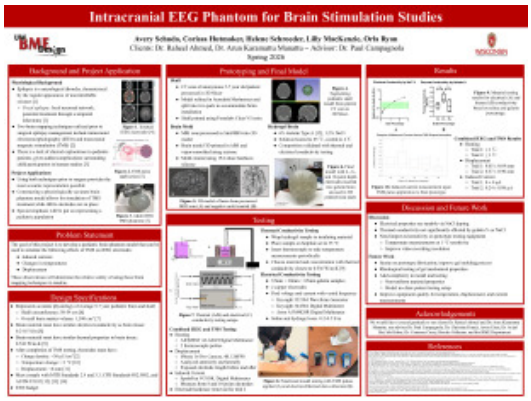
Content:

See attached PDF below; the poster is also uploaded on the team website.

Conclusions/action items:

We will have a final meeting with both our clients and our advisor to wrap up this year's work.

ORLA RYAN - Apr 27, 2026, 10:17 AM CDT



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Final_Poster_Presentation.pptx.pdf (2.79 MB)

2026/1/24 - Iowa Phantom Contact Info

AVERY SCHUDA - Jan 24, 2026, 7:03 PM CST

Title: Iowa Phantom Contact Info

Date: 1/24/2025

Content by: Avery Schuda

Present: N/A

Goals: Find contact information for authors of the Iowa phantom paper that this project is based on

Content:

Dr Jeffrey B. Wang (MD, PhD)

> Jeffrey Bond Wang | Wu Tsai Neurosciences Institute
>
> https://www.linkedin.com/in/jeffrey-wang-105939168

Dr Umair Hassan (PhD)

> uhassan1@stanford.edu

Meet the team — PNT Lab

> Jeffrey Wang and Umair Hassan co-authored the study while they were working in this lab. It looks like Umair still works in this lab as a postdoc while Jeffrey has graduated.

Corey J. Keller (MD, PhD)

> PI of the lab and is listed above and listed as joint supervisor with Aaron Boes
> ckeller1@stanford.edu

Dr Aaron D. Boes (MD, PhD)

> listed as the corresponding author
> aaron-boes@uiowa.edu

Meet the Team | The Boes Lab: Iowa's Neuroimaging & Noninvasive Brain Stimulation Lab - The University of Iowa

Conclusions/action items:

Reach out (politely) to the team to ask about the test methods they used and factors they prioritized in creating the polymer.

2026/1/27 - "A practical preprocessing pipeline for concurrent TMS-iEEG: Critical steps and methodological considerations"

AVERY SCHUDA - Jan 27, 2026, 12:32 PM CST

Title: "A practical preprocessing pipeline for concurrent TMS-iEEG: Critical steps and methodological considerations"

Date: 1/27/2026

Content by: Avery Schuda

Present: N/A

Goals: Read more recent article by the Iowa phantom team to see if they have any new insights

Link: A practical preprocessing pipeline for concurrent TMS-iEEG: Critical steps and methodological considerations - PMC

Citation: Z. Li et al., “A practical preprocessing pipeline for concurrent TMS-iEEG: Critical steps and methodological considerations,” Neuroimage, vol. 325, p. 121677, Jan. 2026, doi: 10.1016/j.neuroimage.2025.121677.

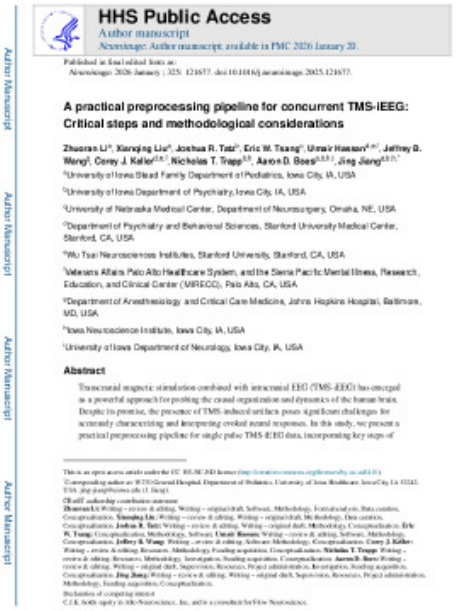
Content:

- Severe TMS-induced artifacts make preprocessing essential for valid neural signal interpretation
- Pre-processing pipeline
    - Bad contact removal
    - Re-referencing
    - Filtering
    - Artifact interpolation
    - Resampling/epoching
    - Detrending
- Re-referencing method strongly alters TMS-evoked potential (iTEP) amplitude and morphology
    - Monopolar referencing works best when contacts differ
        - Maintains highest combined sensitivity and specificity under most noise conditions
    - Bipolar and common-average referencing help when signals share noise
        - Only excel when noise and spatial spread are low
- Filtering is critical
    - Segment-based filtering - filtering only clean segments with the artifact window removed
    - Outperformed full-length filtering by reducing distortions especially around the TMS pulse
- 2-200 Hz bandpass filter preferred over 1-200Hz because it is better at suppressing drift while preserving meaningful low-frequency activity
- Artifact interpolation of a defined exclusion window (10 to +15 ms) effective replaces the unusable TMS artifact period while preserving the surrounding true signals
- Long lasting decay artifacts, up to ~150 ms, are reduced by and adaptive detrending algorithm (ADA), significantly lowering post-TMS drift
- Full preprocessing dramatically reduces high-amplitude artifacts and yields stable, contact-level iTEPs
    - Referencing and filtering choices still shape the final waveform
- The order of preprocessing steps minimally impacts results as all critical components (re-referencing, filtering, detrending) are included
- Pipeline generalized to ECoG data as well, effective attenuating TMS and non-physiological artifacts in both modalities
- Emphasis on tailoring pre-processing choices to each dataset, no universal referencing/filtering method works for all subjects and electrode configurations
- The pipeline supports future standardization of TMS-iEEG preprocessing and may enhance research on effective connectivity and neuromodulation mechanisms

Conclusions/action items:

This paper seems to be more of a clinical application of the technology, as the research group has moved on from the original phantoms to implementing TMS-iEEG in human subjects. While this is not as relevant to our specific project, the paper may prove useful for troubling shooting once the TMS testing is completed on our phantom.

AVERY SCHUDA - Jan 27, 2026, 12:33 PM CST



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Author manuscript

Neuroimage. Author manuscript; available in PMC 2026 January 20.

Published in final edited form as:

Neuroimage. 2026 January ; 325: 121657. doi:10.1016/j.neuroimage.2025.121657.

A practical preprocessing pipeline for concurrent TMS-iEEG: Critical steps and methodological considerations

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[f]Veterans Affairs Palo Alto Healthcare System, and the Sierra Pacific Mental Illness, Research, Education, and Clinical Center (MIRECC), Palo Alto, CA, USA

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Abstract

Transcranial magnetic stimulation combined with intracranial EEG (TMS-iEEG) has emerged as a powerful approach for probing the causal organization and dynamics of the human brain. Despite its promise, the presence of TMS-induced artifacts poses significant challenges for accurately characterizing and interpreting evoked neural responses. In this study, we present a practical preprocessing pipeline for single pulse TMS-iEEG data, incorporating key steps of

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CRediT authorship contribution statement

Zhuoran Li: Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Xiangjing Liu:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Joshua R. Tatz:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Eric W. Tsang:** Conceptualization, Methodology, Software. **Umair Hassan:** Writing – review & editing, Software, Methodology, Conceptualization. **Jeffrey D. Wang:** Writing – review & editing, Software, Methodology, Conceptualization. **Corey J. Keller:** Writing – review & editing, Resources, Methodology, Funding acquisition, Conceptualization. **Nicholas T. Trapp:** Writing – review & editing, Resources, Methodology, Investigation, Funding acquisition, Conceptualization. **Aaron D. Boes:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Investigation, Funding acquisition, Conceptualization. **Jing Jiang:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

C.J.K. holds equity in Alto Neuroscience, Inc. and is a consultant for Flow Neuroscience.

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nihms-2136825.pdf (2.6 MB)

2026/1/29 - Potential Journal Research

AVERY SCHUDA - Jan 29, 2026, 4:44 PM CST

Title: Potential Journal Research

Date: 1/29/2026

Content by: Avery Schuda

Present: N/A

Goals: Find potential journals for publishing our final report

Content:

Biomaterials Advances

- Biomaterials Advances | Journal | ScienceDirect.com by Elsevier
- Similar papers to ours published in Materials Science and Engineering: C (former name of journal).
- One of the things they list is “Novel approaches for characterizing and modeling materials for medical applications” → fits pretty well with our project

Biomedical Physics & Engineering Express

- Biomedical Physics & Engineering Express - IOPscience
- Currently there is an agreement between University of Wisconsin-Madison and IOP Publishing that may cover the Open Access article publication charge for this journal. During the publication process, IOP Publishing will contact the corresponding author to confirm eligibility for APC funding.
- Very receptive to phantom papers
- Faster reviews, less “prove this changes the world” pressure

Journal of Neural Engineering

- Journal of Neural Engineering - IOPscience
- Currently there is an agreement between University of Wisconsin-Madison and IOP Publishing that may cover the Open Access article publication charge for this journal. During the publication process, IOP Publishing will contact the corresponding author to confirm eligibility for APC funding.
- Need modeling, measurements, and validation of phantom

IEEE

- Transactions on Biomedical Engineering (TBME)
- Home - IEEE Transactions on Biomedical Engineering (TBME)
- Would require strong computational analysis
- IEEE Transactions on Neural Systems and Rehabilitation Engineering (TNSRE)
- Home - Transactions on Neural Systems and Rehabilitation Engineering (TNSRE)
- May be more of a stretch

Conclusions/action items:

Right now my top pick would probably be Biomedical Physics & Engineering Express because it seems the most feasible for us to publish in and may be able to have the fee waived. I will present these options to the team and Dr Campagnola for feedback.

2025/02/05 - Design + Innovation Labs Training Documentation

AVERY SCHUDA - Feb 05, 2025, 12:38 PM

Title: Design + Innovation Labs Training Documentation

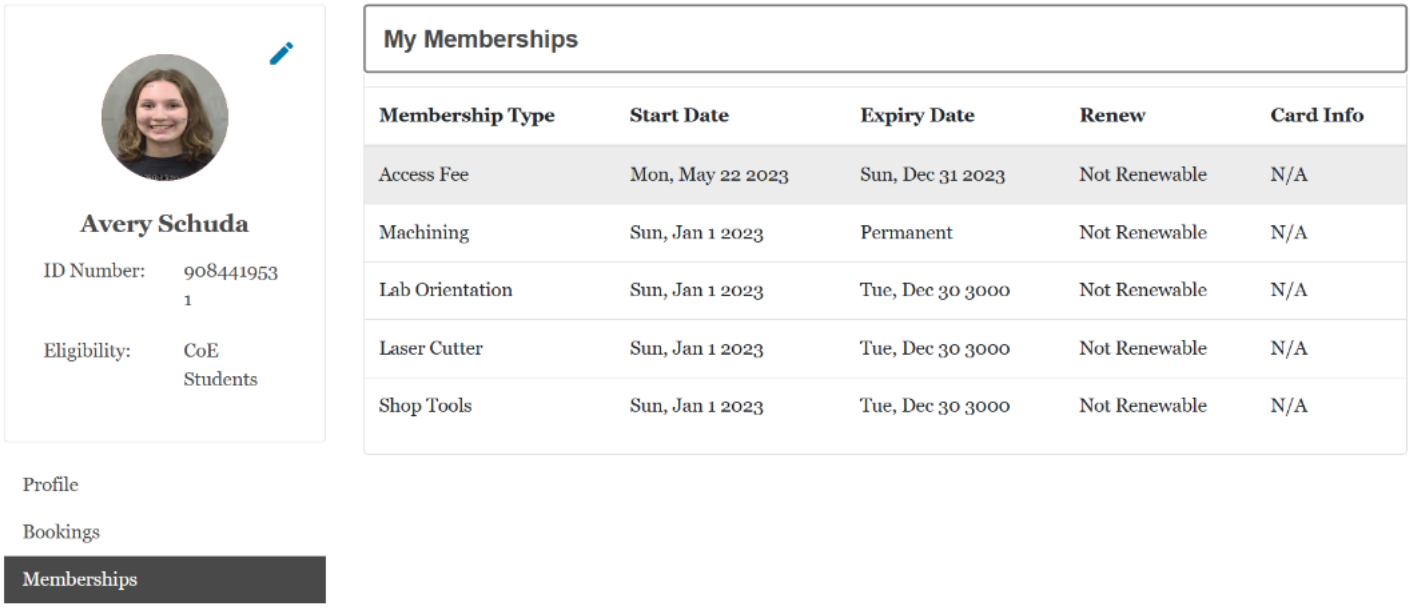
Date: 2/5/2025

Content by: Avery Schuda

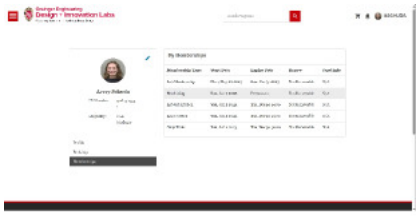
Present: N/A

Goals: Complete training at the UW Makerspace and TEAM labs for design fabrication

Content:



AVERY SCHUDA - Feb 05, 2025, 12:36 PM CST



Download

Design_Innovation_Lab_Permits.pdf (214 kB)

2025/02/05 - Biosafety/OSHA Chemical Safety Training Documentation

A\

Title: Biosafety/OSHA Chemical Safety Training Documentation

Date: 2/5/2025

Content by: Avery Schuda

Present: N/A

Goals: Complete biosafety training to be able to work safely in the tissue engineering lab.

Content:

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

This certifies that Avery Schuda has completed training for the following course(s):

Course	Assignment	Completion
Biosafety Required Training	Biosafety Required Training Quiz 2024	3/2/2024
Chemical Safety: The OSHA Lab Standard	Final Quiz	3/2/2024

Data Last Imported: 02/05/2025 12:39 PM

AVERY SCHUDA - Feb 05, 2025, 12:41 PM CST

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Biosafety_and_OSHA_Chemical_Training_Records.pdf (42 kB)

2025/10/30 - CITI Human Subjects Research Documentation

AVERY SCHUDA - Oct 30, 2025, 3:29 PM CDT

Title: CITI Human Subjects Research Documentation

Date: 10/30/2025

Content by: Avery Schuda

Present: N/A

Goals: Complete training for human subjects testing

Content:

See attached.

Conclusions/action items:

N/A

AVERY SCHUDA - Oct 30, 2025, 3:29 PM CDT

Download

citiCompletionCertificate_15027183_73267016.pdf (77.4 kB)

2026/03/12 - Responsible and Ethical Conduct of Research

AVERY SCHUDA - Mar 12, 2026, 5:19 PM CDT

Title: Responsible and Ethical Conduct of Research

Date: 3/12/2026

Content by: Avery Schuda

Present: N/A

Goals: Complete a new training for spring 2026

Content:

See attached.

Conclusions/action items:

N/A

AVERY SCHUDA - Mar 12, 2026, 5:20 PM CDT

Download

spring2026_trainings.pdf (39.6 kB)

2026/02/09 - Processing MRI Scans in 3D Slicer

AVERY SCHUDA - Mar 08, 2026, 3:19 PM CDT

Title: Processing MRI Scans in 3D Slicer

Date: 2/09/2026

Content by: Avery Schuda

Present: N/A

Goals: Process the MRI scans into a 3D model of the brain using 3D Slicer

Content:

Attempted Brain Surface Generation Using 3D Slicer Alone

Software
3D Slicer (medical image visualization and segmentation)

Import of Structural MRI Data
The structural MRI dataset was initially processed directly in 3D Slicer to attempt generation of a 3D surface model of the brain without using external segmentation tools.

The MRI scan was loaded into 3D Slicer using the DICOM import module.

Procedure:

Open 3D Slicer
Select “DICOM” from the main toolbar
Import the MRI dataset into the DICOM database
Load the T1-weighted scan into the viewer

The MRI volume was successfully displayed in axial, sagittal, and coronal views.

Attempted Brain Segmentation
An attempt was made to isolate brain tissue using the Segment Editor module in 3D Slicer.

Procedure:

Open the Segment Editor module
Create a new segmentation
Select the MRI volume as the source image

Basic segmentation tools such as Threshold and Paint were tested to isolate brain tissue. The threshold tool was used to attempt separation of brain tissue from surrounding skull and scalp.

Generation of Surface Model
After creating a segmentation, the segmentation was converted to a 3D model using the “Show 3D” option within the Segment Editor.

Procedure:

Enable the “Show 3D” button within the segmentation panel
Generate a 3D surface from the segmented region

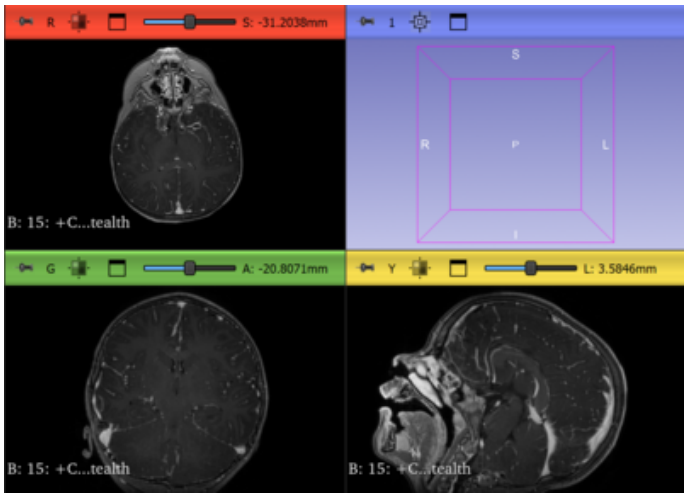
The resulting 3D model included multiple structures and did not clearly separate cortical surfaces from other tissues.

Limitations Encountered
The segmentation produced using manual thresholding did not accurately isolate the cortical structures. The generated surface model contained mixed tissues, including portions of skull and surrounding structures.

Conclusions/action items:

Because the segmentation tools in 3D Slicer were not optimized for automated cortical surface reconstruction, the resulting models lacked anatomical accuracy and required extensive manual editing. Next steps are to reach out to Arvin Chen for assistance or find another method of processing the scans. Orla was also unsuccessful in using the Python script provided by Dr. Block and his colleague to process any scans.

AVERY SCHUDA - Mar 08, 2026, 3:20 PM CDT



Download

Screenshot_2026-03-01_160052.png (531 kB)

2026/02/19 - Segmenting and processing MRI through SimNIBS

AVERY SCHUDA - Mar 08, 2026, 3:15 PM CDT

Title: Segmenting and processing MRI through SimNIBS

Date: 2/19/2026

Content by: Avery Schuda

Present: N/A

Goals: Process the MRI scans through SimNIBS to get a whole head model that can be used to make a model of just the brain for 3D printing

Content:

Initial Processing of Brain MRI Data Using 3D Slicer and SimNIBS

Software
3D Slicer (medical image visualization and preprocessing)
SimNIBS (MRI segmentation and head model generation)

Import of Structural MRI Data
The structural brain MRI data were first imported into 3D Slicer for visualization and initial inspection. The T1-weighted MRI file was loaded using the DICOM import module.

Procedure in 3D Slicer:

Open 3D Slicer
Select “DICOM” from the main toolbar
Import the MRI dataset into the DICOM database
Load the T1-weighted scan into the viewer

The scan was visually inspected to confirm that the dataset was complete and properly oriented.

Verification of Image Quality and Orientation
The MRI data were examined in axial, sagittal, and coronal views to verify image quality and anatomical coverage. The following checks were performed:

Confirmation that the entire head was included in the scan
Verification that no significant motion artifacts were present
Confirmation that voxel resolution and orientation were appropriate for segmentation

If necessary, the volume was reoriented or resampled using the Volume module in 3D Slicer to ensure compatibility with the segmentation pipeline.

Export of MRI Volume
Once verified, the MRI volume was exported from 3D Slicer in NIfTI format for use in the SimNIBS processing pipeline.

Procedure:

Select the loaded volume in the Data module
Open the Save dialog
Export the volume as a NIfTI file (.nii or .nii.gz)

The resulting file served as the input for SimNIBS segmentation.

SimNIBS Segmentation Pipeline
The MRI volume was processed using the SimNIBS segmentation pipeline to generate a subject-specific head model and cortical surface reconstructions.

Processing was performed from the SimNIBS command prompt using the segmentation tool.

Example command:

charm stealth T1.nii.gz

In this command, “stealth” specifies the output subject name and T1.nii.gz is the structural MRI input file.

The SimNIBS pipeline performs the following steps automatically:

Skull stripping and bias-field correction
Tissue segmentation (gray matter, white matter, CSF, skull, scalp)
Generation of cortical surfaces
Creation of a finite element head mesh

Generation of the Subject Model Directory
After processing completed, SimNIBS generated a subject-specific directory:

m2m_stealth

This directory contains all segmentation outputs, including tissue masks, cortical surfaces, and mesh files.

Important subdirectories include:

m2m_stealth/surfaces/ – cortical surface meshes
m2m_stealth/ – segmentation outputs and head mesh files

Output Files
The segmentation process generated multiple anatomical surfaces and masks. Relevant outputs include:

lh.central.gii – left hemisphere central cortical surface
rh.central.gii – right hemisphere central cortical surface
lh.pial.gii – left hemisphere pial surface
rh.pial.gii – right hemisphere pial surface

Conclusions/action items:

Additional files include volumetric tissue masks (NIfTI format) representing structures such as cerebellum and subcortical regions. These outputs will be used for mesh conversion and surface model generation in later steps.

AVERY SCHUDA - Mar 08, 2026, 3:04 PM CDT

Download

lh.central.gii (4.93 MB)

AVERY SCHUDA - Mar 08, 2026, 3:04 PM CDT

Download

rh.central.gii (4.87 MB)

AVERY SCHUDA - Mar 08, 2026, 3:04 PM CDT

Download

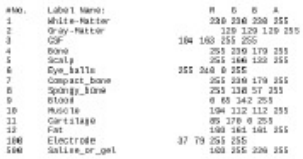
lh.pial.gii (2.56 MB)

AVERY SCHUDA - Mar 08, 2026, 3:05 PM CDT

Download

rh.pial.gii (2.55 MB)

AVERY SCHUDA - Mar 08, 2026, 3:05 PM CDT



Download

final_tissues_LUT.txt (612 B)

AVERY SCHUDA - Mar 08, 2026, 3:07 PM CDT

Download

stealth.msh (221 MB)

AVERY SCHUDA - Mar 08, 2026, 3:07 PM CDT

Download

stealth.msh.opt (2.43 kB)

2026/03/02 - Electrical Testing Boxes

AVERY SCHUDA - Mar 12, 2026, 12:18 PM CDT

Title: Electrical Testing Boxes

Date: 3/02/2026

Content by: Avery Schuda

Present: N/A

Goals: Create containers to hold hydrogel for electrical conductivity testing

Content:

Orla provided me with in inner and outer dimensions she wanted for the boxes (see drawing). The only dimension I updated was thinning the wall thickness by changing the outer dimensions of the box but kept the inner volume the same. I created the boxes by making an extruded box and then made extruded cuts for the inner volume and holes on each end to allow the electrodes to be inserted into the gel. Because the gel needs to be poured into these molds, I created removable plugs for the holes so that the gel wouldn't leak out while curing.

Conclusions/action items:

3D print four copies of the boxes and 8 copies of the plugs and create gelatin hydrogels with consistent w/v% gelatin and NaCl for electrical conductivity testing.

AVERY SCHUDA - Mar 12, 2026, 12:19 PM CDT

Download

electrical_box_plug.SLDPRT (154 kB)

AVERY SCHUDA - Mar 12, 2026, 12:19 PM CDT

Download

electrical_box_plug.STEP (56.5 kB)

AVERY SCHUDA - Mar 12, 2026, 12:19 PM CDT

Download

electrical_testing_box_all_parts.3mf (100 kB)

AVERY SCHUDA - Mar 12, 2026, 12:19 PM CDT

Download

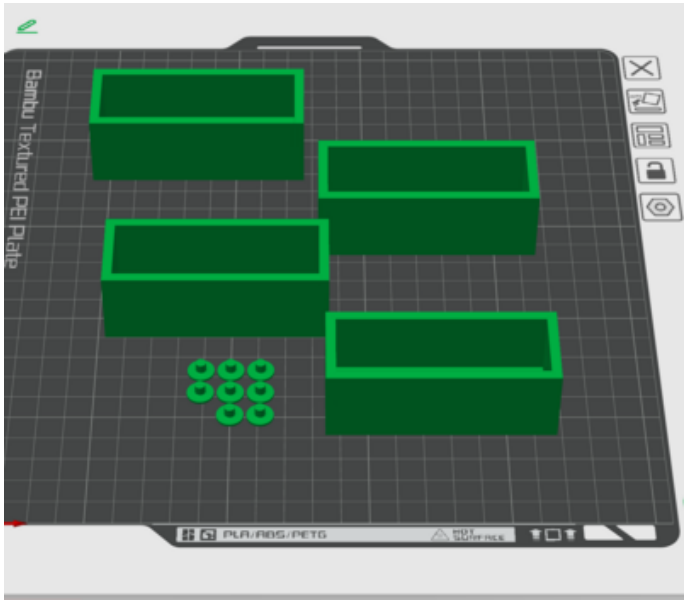
electrical_testing_box.SLDPRT (103 kB)

AVERY SCHUDA - Mar 12, 2026, 12:19 PM CDT

Download

electrical_testing_box.STEP (33.9 kB)

AVERY SCHUDA - Mar 12, 2026, 12:19 PM CDT



Download

Screenshot_2026-03-02_113021.png (107 kB)

2026/03/07 - Processing SimNIBS Files into Brain STL

AVERY SCHUDA - Mar 08, 2026, 2:47 PM CDT

Title: Processing SimNIBS Files into Brain STL

Date: 3/07/2026

Content by: Avery Schuda

Present: N/A

Goals: Take the whole head model I previously processed in SimNIBS and segment and export relevant brain tissues

Content:

Generation of Central and Pial Cortical Surface Models

Software
SimNIBS (neurostimulation modeling and MRI segmentation)
Gmsh (finite element mesh visualization and export)

Structural MRI Segmentation
A T1-weighted structural MRI was processed using the SimNIBS segmentation pipeline to generate a subject-specific anatomical model. The segmentation produced a model directory named:

m2m_stealth

This directory contains cortical surfaces, tissue masks, and the full head mesh. Cortical surface files are located in:

C:\Users\avery\m2m_stealth\surfaces\

Relevant surface files generated during segmentation include:

lh.central.gii – left hemisphere central cortical surface
rh.central.gii – right hemisphere central cortical surface
lh.pial.gii – left hemisphere pial cortical surface
rh.pial.gii – right hemisphere pial cortical surface

These files are stored in GIFTI (.gii) format, which is commonly used for cortical surface representations in neuroimaging.

Conversion of GIFTI Surfaces to Gmsh Mesh Format
To visualize and export the surfaces, the GIFTI files were converted to Gmsh mesh format (.msh) using the SimNIBS Python environment. Conversion was performed from the command prompt using the SimNIBS mesh_io module.

Central surface conversion:

python -c "from simnibs import mesh_io; m=mesh_io.read_gifti_surface(r'C:\Users\avery\m2m_stealth\surfaces\lh.central.gii'); mesh_io.write_msh(m,r'C:\Users\avery\lh_central.msh')"

python -c "from simnibs import mesh_io; m=mesh_io.read_gifti_surface(r'C:\Users\avery\m2m_stealth\surfaces\rh.central.gii'); mesh_io.write_msh(m,r'C:\Users\avery\rh_central.msh')"

Pial surface conversion:

python -c "from simnibs import mesh_io; m=mesh_io.read_gifti_surface(r'C:\Users\avery\m2m_stealth\surfaces\lh.pial.gii'); mesh_io.write_msh(m,r'C:\Users\avery\lh_pial.msh')"

python -c "from simnibs import mesh_io; m=mesh_io.read_gifti_surface(r'C:\Users\avery\m2m_stealth\surfaces\rh.pial.gii'); mesh_io.write_msh(m,r'C:\Users\avery\rh_pial.msh')"

These commands convert the cortical surface meshes from GIFTI format to Gmsh mesh format.

Visualization of Meshes
The resulting mesh files were opened in Gmsh for visualization.

First, one hemisphere was opened using:

File → Open → lh_central.msh

The opposite hemisphere was then added using:

File → Merge → rh_central.msh

The same procedure was used for the pial meshes.

Export to STL
After both hemispheres were loaded and displayed in Gmsh, the meshes were exported as STL surface models.

File → Export → STL

The resulting files represent full cortical surface models suitable for visualization, CAD software, or 3D printing.

Output Files
The final files generated during this procedure include:

lh_central.msh
rh_central.msh
lh_pial.msh
rh_pial.msh
central_brain.stl
pial_brain.stl

Conclusions/action items:

Central surfaces represent the midpoint between the white matter and pial boundaries of the cortex. Pial surfaces represent the outer boundary of the cortical gray matter at the interface with cerebrospinal fluid.

AVERY SCHUDA - Mar 08, 2026, 2:48 PM CDT

Download

lh_pial.msh (7.8 MB)

AVERY SCHUDA - Mar 08, 2026, 2:49 PM CDT

Download

rh_pial.msh (7.7 MB)

AVERY SCHUDA - Mar 08, 2026, 2:50 PM CDT

Download

lh.central (3.7 MB)

AVERY SCHUDA - Mar 08, 2026, 2:50 PM CDT

Download

rh.central (3.65 MB)

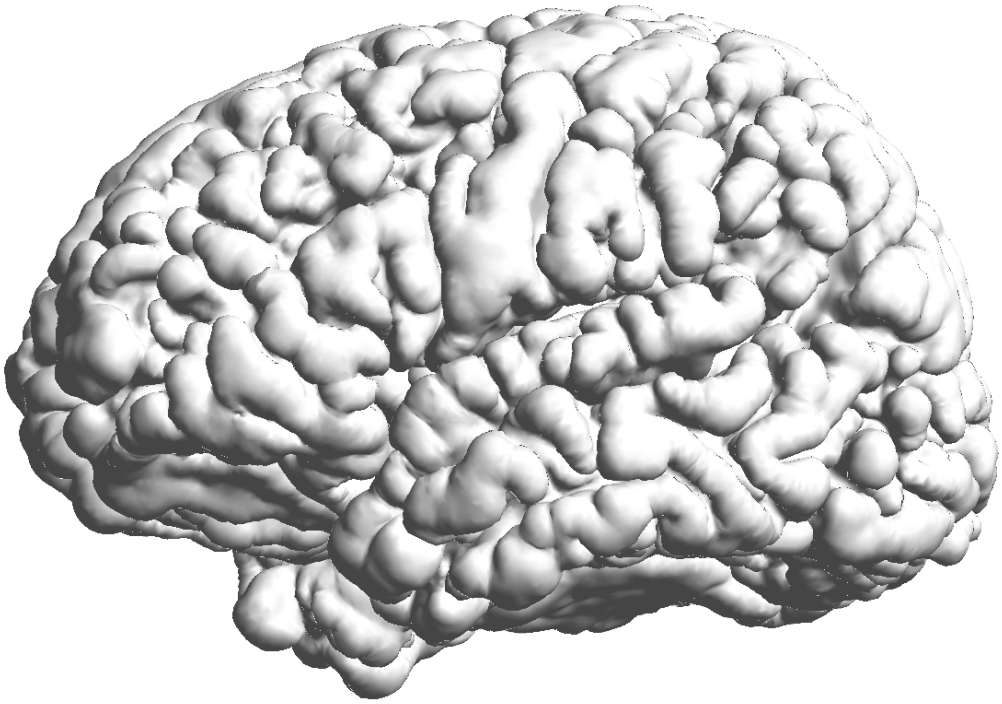
AVERY SCHUDA - Mar 08, 2026, 2:50 PM CDT

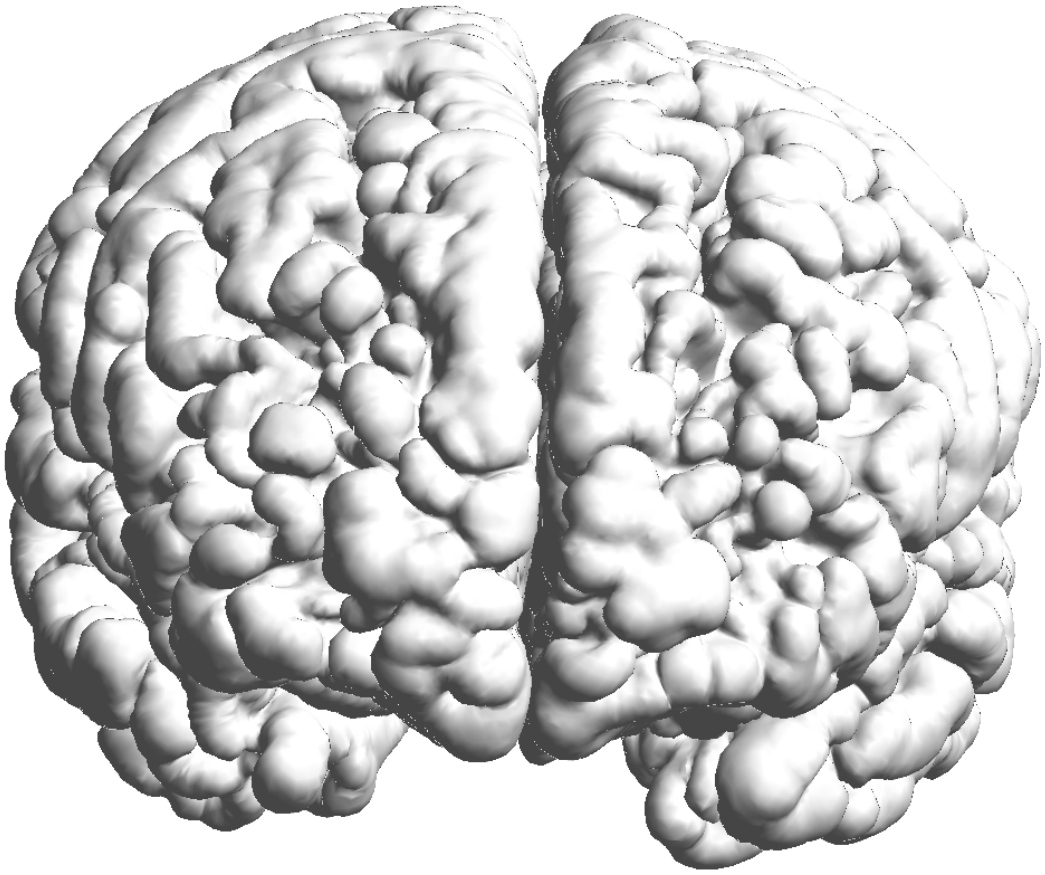
Download

stealth_central.msh (15.5 MB)

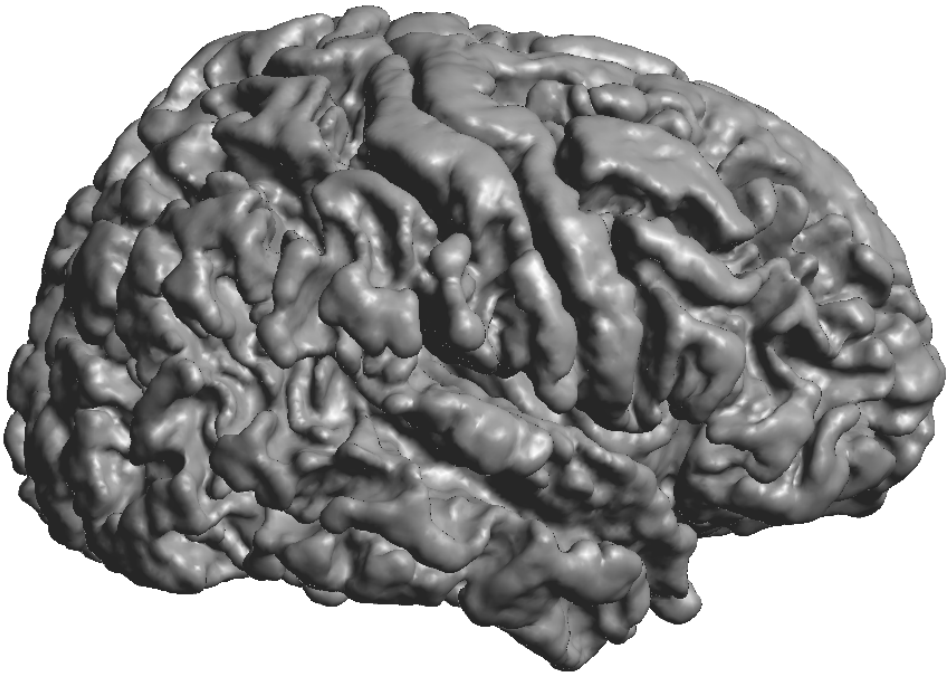
AVERY SCHUDA - Mar 08, 2026, 2:52 PM CDT

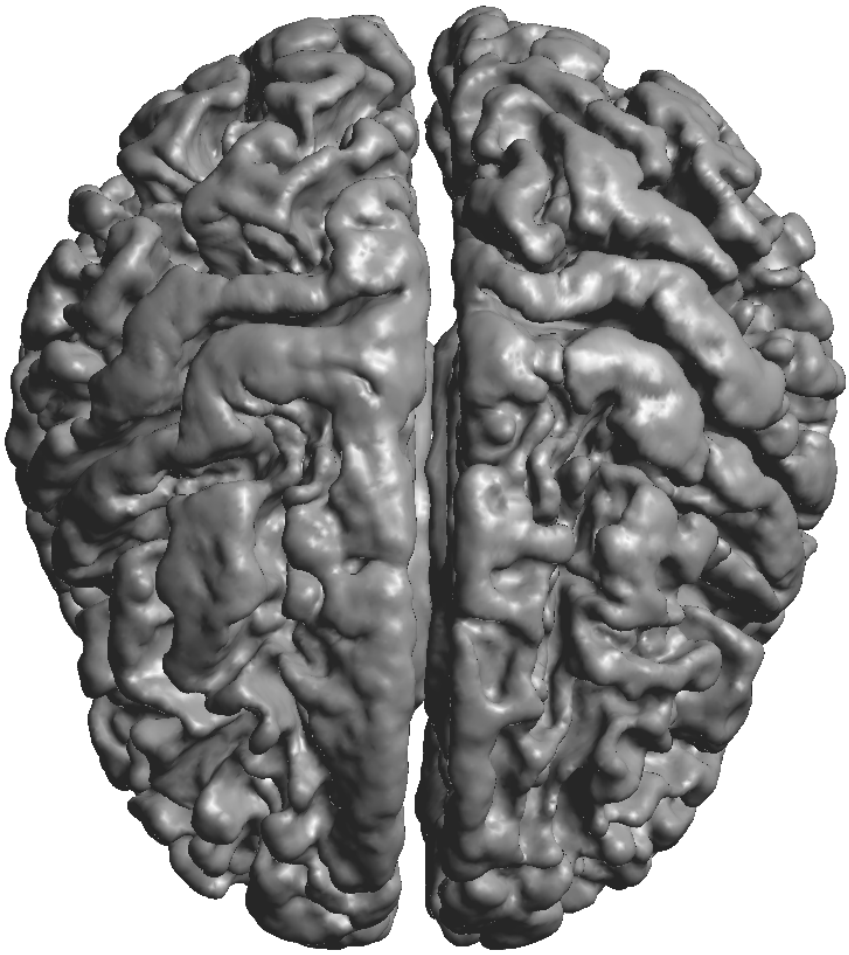
Outer brain surfaces (pial):

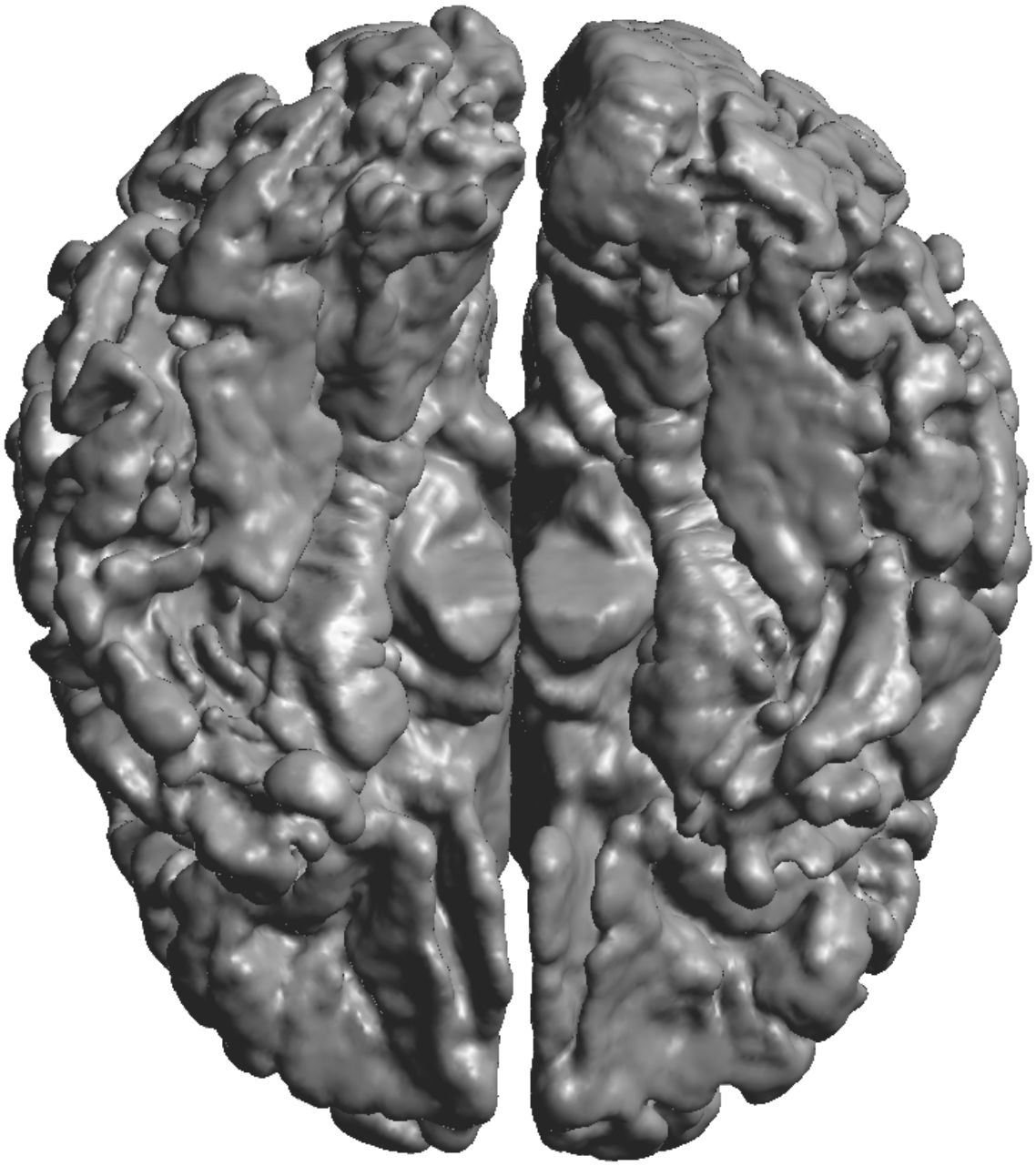




Central brain:







Download

outer_brain_surface_final.stl (115 MB)

AVERY SCHUDA - Mar 08, 2026, 2:54 PM CDT

Download

stealth_central.stl (115 MB)

2026/03/12 - Box for brain mold creation

AVERY SCHUDA - Mar 12, 2026, 12:04 PM CDT

Title: Box for brain mold creation

Date: 3/12/2026

Content by: Avery Schuda

Present: N/A

Goals: Create a box that can be used to house the 3D printed brain for mold creation

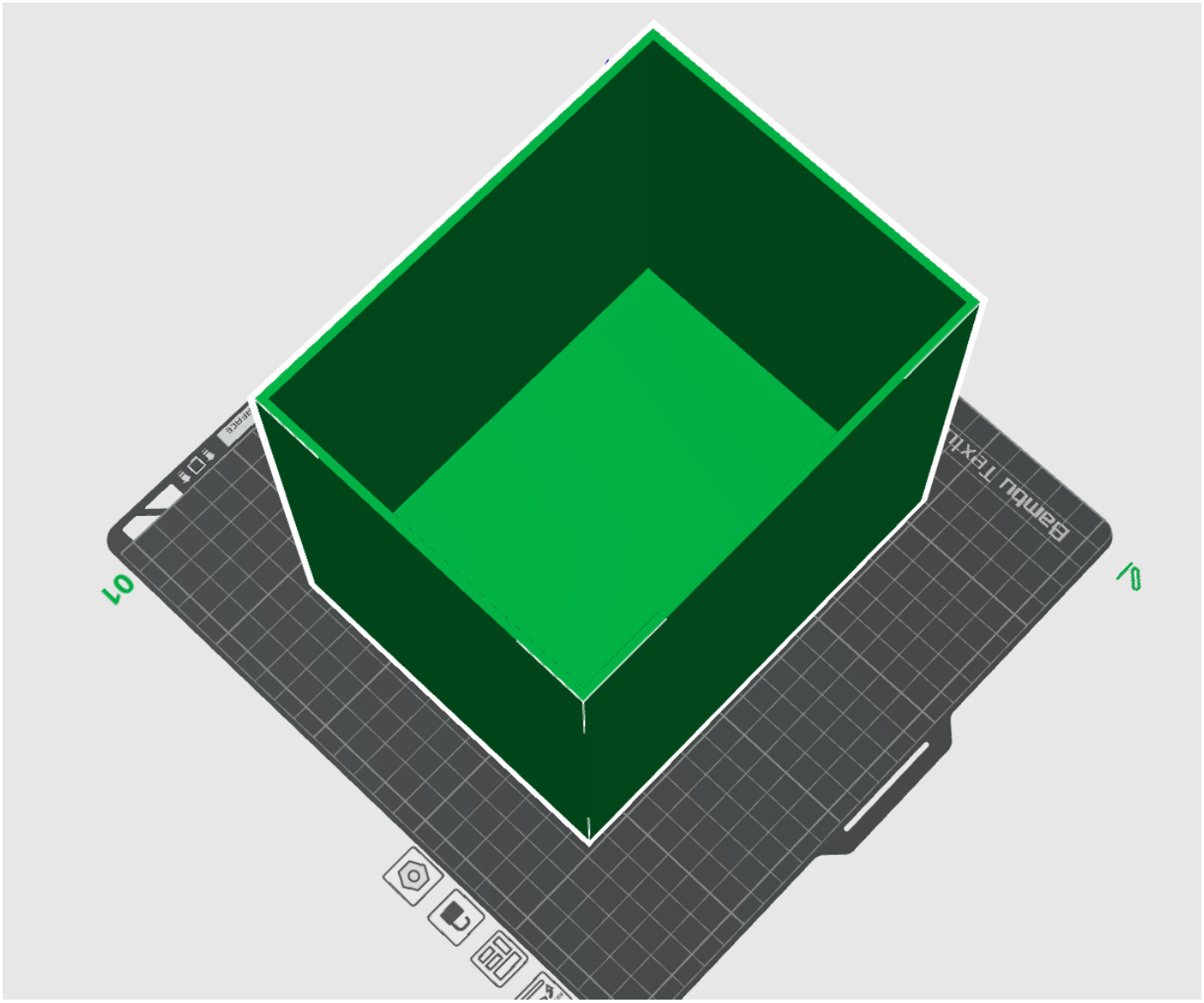
Content:

This is a super simple box that has outer dimensions 175x175x137.5 mm outer dimensions with 3 mm wall thickness created using an extruded box and an extruded cut in SolidWorks. The idea is to print two copies, the first will be used to hold the brain while the ecoflex is poured around it to create the initial mold. This box will likely need to be cut off of the mold to get the brain out in one piece. The mold will be sliced in half as perfectly as possible to get the brain out without damaging the mold. The second box then is used to hold the two cut halves while the hydrogel is poured into the mold.

Conclusions/action items:

3D print two copies of this box and prepare to create the mold of the brain.

AVERY SCHUDA - Mar 12, 2026, 12:07 PM CDT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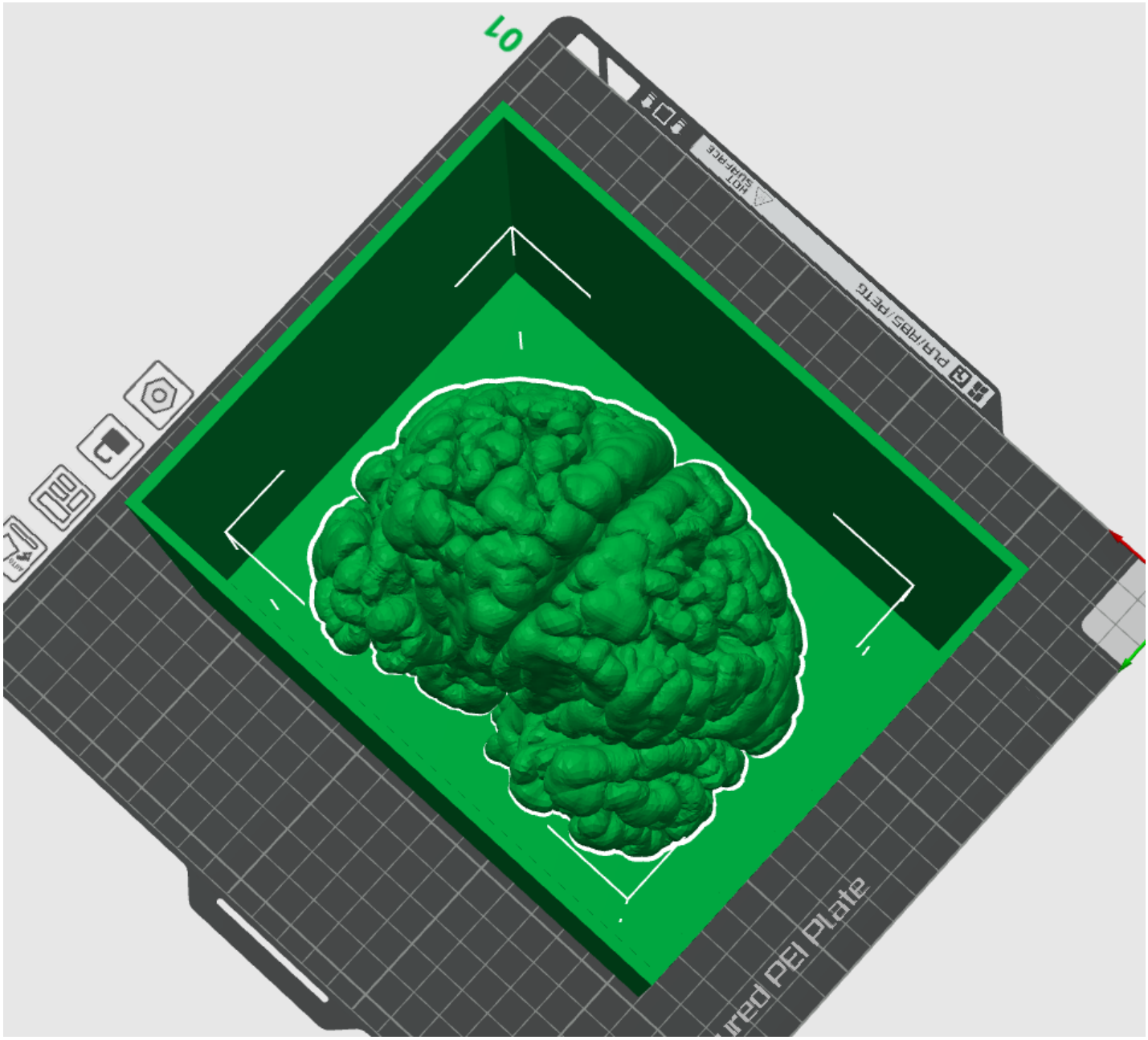

AVERY SCHUDA - Mar 12, 2026, 12:05 PM CDT

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brain_mold_box.SLDPRT (87.2 kB)

AVERY SCHUDA - Mar 12, 2026, 12:05 PM CDT

Download

brain_mold_box.STEP (23.2 kB)

2026/03/16 - Skull CT Processing in 3D Slicer

AVERY SCHUDA - Mar 16, 2026, 4:40 PM CDT

Title: Skull CT Processing in 3D Slicer

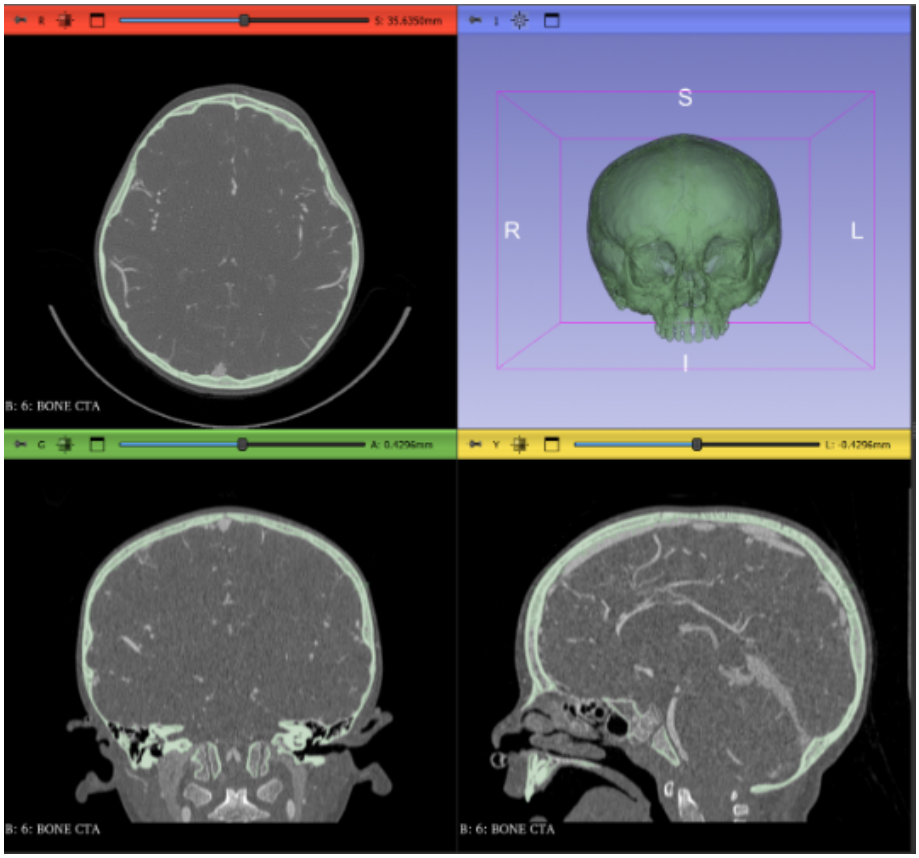
Date: 3/16/2026

Content by: Avery Schuda

Present: N/A

Goals: Process CT scans into an STL of the skull in 3D Slicer

Content:



Software
3D Slicer

Procedure:

Open 3D Slicer
Select “DICOM” from the main toolbar
Import the CT dataset into the DICOM database (pre-surgery, there is also a CT of implanted electrodes)
Load the scan into the viewer

The CT volume was displayed in axial, sagittal, and coronal orientations to confirm that the entire head was visible and properly aligned.

Creation of a Segmentation
A new segmentation was created to isolate the skull from surrounding tissues.

Procedure:

Open the Segment Editor module
Click “Add” to create a new segment
Select the CT volume as the source volume

This created a segmentation layer that could be edited using the available segmentation tools.

Skull Isolation Using Thresholding
The Threshold tool was used to identify regions corresponding to dense bone tissue.

Select the Threshold tool in the Segment Editor
Adjust the lower and upper threshold values to capture the high-intensity voxels corresponding to skull bone
Apply the threshold to generate the initial segmentation

Threshold values: 854.82 - 3071.00

This step produced an initial mask that included portions of the skull and other high-intensity structures.

Segmentation Cleanup
The initial segmentation was refined using additional tools within the Segment Editor.

Use the Erase tool to remove unwanted regions that were incorrectly included in the thresholded segmentation
Use the Paint tool to manually add missing skull regions where necessary
Apply the Islands tool to remove small disconnected components that were not part of the skull

These steps were repeated until the segmentation visually represented the skull structure.

Generation of 3D Surface Model
Once the skull segmentation was completed, a three-dimensional model was generated.

Enable the “Show 3D” option within the Segment Editor
3D Slicer automatically generated a triangulated surface representation of the segmented skull

The resulting model was visually inspected to ensure that the skull structure was continuous and accurately represented.

Export of Skull Model
The skull segmentation was exported as a surface model for use in other software.

Open the Segmentations module
Select “Export”
Choose “Export visible segments to models”
Save the model as an STL file

Conclusions/action items:

The resulting STL file represents a 3D surface mesh of the skull that can be used for visualization, analysis, or further processing in external software. Next steps are to use Autodesk Fusion 360 to further clean up the model and close remaining holes.

AVERY SCHUDA - Mar 16, 2026, 4:41 PM CDT

Download

skull_3Dslicer_export.stl (150 MB)

2026/03/19 - Final Skull Model Processing

AVERY SCHUDA - Mar 25, 2026, 4:48 PM CDT

Title: Final Skull Model Processing

Date: 3/19/2026

Content by: Avery Schuda

Present: N/A

Goals: Create a 3D printable model of the skull for the final model

Content:

Software:
3D Slicer
Meshmixer
Autodesk Fusion 360

Part 1: Import STL and prepare for editing in 3D Slicer

1. Open 3D Slicer.
2. Import the STL file using drag and drop or Add Data.
3. Go to the Segmentations module.
4. Select Import model to convert the STL into a segmentation.
5. Click Specify geometry and set the geometry to fit the imported segment.
6. Set voxel size to approximately 0.5 to 1 mm to preserve detail.

Part 2: Initial cleaning in 3D Slicer

1. Open Segment Editor and select the created segmentation.
2. Ensure geometry is defined; source volume can remain None.
3. Apply Smoothing with the Closing method.
4. Start with a kernel size of 1 mm and increase gradually up to about 2 mm if needed to fill holes.
5. Inspect the model in 3D view to confirm small holes are filled.
6. If larger holes remain, install the SurfaceWrapSolidify extension.
7. Use Wrap Solidify with outer surface mode and smallest detail set to approximately 1 to 2 mm.
8. Remove remaining artifacts using the Scissors tool in 3D mode or Islands to remove small disconnected regions.

Part 3: Export cleaned model from 3D Slicer

1. Return to the Segmentations module.
2. Select Export to models.
3. Save the output as an STL file.

Part 4: Refinement in Meshmixer

1. Open Meshmixer and import the cleaned STL.
2. Go to Analysis and select Inspector.
3. Run Auto Repair All to detect and fill remaining holes.
4. For more control, select individual holes and apply Smooth Fill.
5. Inspect the mesh for remaining holes and surface irregularities.
6. Apply light smoothing if necessary, avoiding excessive detail loss.
7. Perform a plane cut to separate into the top half (delete bottom). Repeat for the bottom so that two separate models of the two halves of the skull are achieved.
8. Remove remaining vasculature inside the brain using the shrink/smoothing tools.
9. Export the final cleaned STL.

Part 5: Import into Fusion 360

1. Open Fusion 360.
2. Upload the STL file.
3. Insert the mesh into the workspace.
4. Switch to the Mesh workspace if needed.
5. Use Repair and Close Holes to fix any remaining minor defects.
6. Optionally remesh or convert to BRep if further CAD operations are required.

Notes

Avoid aggressive smoothing or opening operations in 3D Slicer because they can remove thin bone structures.
Use Wrap Solidify for large or complex holes to maintain anatomical continuity.
Meshmixer provides better curvature-based hole filling than Fusion 360 for organic geometries.
Fusion 360 is best used for final inspection and minor repairs rather than primary anatomical cleanup.

Conclusions/action items:

3D print the final skull using the two halves created on the Formlabs 3D printers in clear resin and fabricate the final model.

2026/3/9-Training Throughout the Curriculum

CORISSA HUTMAKER - Mar 09, 2026, 8:47 AM CDT

Title: Updated Training Throughout the Curriculum

Date: 3/9/2026

Content by: Corissa Hutmaker

Present: NA

Goals: Document new trainings done this semester as per BME 402 requirements

Content:

See below screenshot or attached pdf for updated trainings. Cryogen Safety Training (part 1 and 2) as well as Disposing of Hazardous Chemicals were completed 1/27/2026, fulfilling the assignment requirements.

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This certifies that Corissa Hutmaker has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	2/5/2024	2/5/2029
Chemical Safety: Cryogen Safety Training	Part 1 Final Quiz	1/27/2026	1/27/2031
Chemical Safety: Cryogen Safety Training	Part 2 Final Quiz	1/27/2026	1/27/2031
Chemical Safety: The OSHA Lab Standard	Final Quiz	5/17/2023	
Disposing of Hazardous Chemicals	Final Quiz	1/27/2026	1/27/2031
Environmental & Occupational Health	Animal Contact Risk Questionnaire	8/23/2024	8/28/2025
EXPIRED Radiation Safety 101 2022-2023	Radiation Safety 101 2022-2023	5/17/2023	
EXPIRED Radiation Safety 102: Annual Refresher 2023-2024	Radiation Safety 102: Annual Refresher 2023-2024	10/19/2023	
Risk Communication in Animal Facilities	Risk Communication in Animal Facilities Quiz 2023	7/31/2023	
RS 102 Radiation Safety Refresher 2025-2026	Radiation Safety 102 Quiz	10/29/2025	
RS 102: Radiation Safety 102 2024-2025	Radiation Safety 102 Quiz	10/14/2024	
Safety for Personnel with Animal Contact	Animal Contact Personnel Quiz 2023	10/19/2023	10/19/2028
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	10/29/2025	10/29/2028

Data Last Imported: 03/09/2026 07:55 AM

Conclusions/action items:

I have completed all required trainings. TeamLab trainings are attached in a pdf as well as the above screenshot.

CORISSA HUTMAKER - Mar 09, 2026, 8:49 AM CDT

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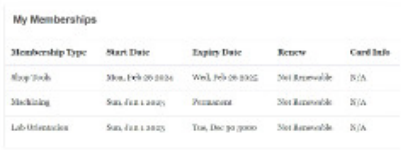
Hutmaker_Corissa-TrainingBME402.pdf (258 kB)

CORISSA HUTMAKER - Mar 09, 2026, 8:49 AM CDT



Download

TEAM_Lab_Trainings.pdf (95.6 kB)

2026/2/1: Biosafety Cabinet Use Training Documentation

HELENE SCHROEDER - Feb 01, 2026, 4:22 PM CST

Title: Completed Biosafety Cabinet Use Training Documentation

Date: 2/1/2026

Content by: Helene Schroeder

Goals: To show documentation of my training, specifically the Biosafety 105: Biosafety Cabinet Use training.

Content:

Screenshot of completed training as of 2/1/2026. See the most recent training completed on 1/31/2026 titled "Biosafety 105: Biosafety Cabinet Use".

OVCR Training Information Lookup Tool — University of Wisconsin-Madison

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This certifies that Helene Schroeder has completed training for the following course(s):

Expand All | Collapse All

Course	Assignment	Completion	Expiration
2024-2025 HIPAA Privacy & Security Training	2024-2025 HIPAA Privacy & Security Training	5/4/2025	
Biosafety 102: Bloodborne Pathogens for Laboratory and Research	Biosafety 102: Bloodborne Pathogens Safety in Research Quiz 2025	8/20/2025	8/20/2026
Biosafety 105: Biosafety Cabinet Use	Biosafety 105: Biosafety Cabinet Use Quiz	1/31/2026	No Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2023	9/4/2023	9/4/2028
Chemical Safety: Hazard Communication - Identifying Chemical Hazards	Final Quiz	9/4/2023	9/4/2028
Chemical Safety: The OSHA Lab Standard	Final Quiz	9/3/2023	
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	9/25/2025	9/25/2028

Data Last Imported: 02/01/2026 03:53 PM

Conclusions/action items:

Shown above is my completed training, including my newest training to fulfill the requirements for the semesterly training through the cirriculum requirement.

2026/02/07 - Temporal Interference Stimulation

ORLA RYAN - Feb 07, 2026, 12:35 PM CST

Title: Temporal Interference Stimulation

Date: 2/7/2026

Content by: Orla

Present: n/a

Goals: Reading through an article shared by Dr. Hai which may have some cross-over with our project goals.

Content:

- Temporal interference (TI) stimulation --> non-invasive brain stimulation method that selectively targets deep brain structures and minimizes off-target stimulation
    - this paper describes the development of a software platform that can accomplish the neuroimaging data process using this method
- TI stimulation is different than "traditional" transcranial electrical stimulation (tES) modalities in that it offers better "stimulation focality" for targeting deep brain structures
    - I am assuming that TMS falls under this umbrella
- Researchers want to know the electric field exposure
    - mentions some studies that take advantage of "depth electrodes" for cohorts with surgical implants, so as to tune field distribution towards a desired target
- A lot of this article focused on algorithm development, etc. (not expressly relevant for our purposes), but I may ask more about the specific process of 'electrode mapping'
- " in reality the fields exhibit spatial gradients and hotspots that may have differential physiological effects depending on the specific neural circuits engaged "
- Tissue composition plays a critical role in determining field exposure patterns
- Can possibly look into a couple of the referenced open-source softwares for our own testing?

[1] I. Haber, A. Jackson, A. Thielscher, A. Hai, and G. Tononi, “TI-Toolbox: An open-source software for temporal interference stimulation research,” *Brain Stimulation*, vol. 19, no. 1, p. 103016, Jan. 2026, doi: 10.1016/j.brs.2025.103016.

Conclusions/action items:

I may reach out to Ido Haber (the main author) for some of his thoughts on our brain phantom approaches.

2026/02/12 - Brain/Human Body Modeling

ORLA RYAN - Feb 12, 2026, 9:01 PM CST

Title: Brain/Human Body Modeling

Date: 2/12/2026

Content by: Orla

Present: n/a

Goals: Doing an introductory dive into this brain modeling textbook prior to meeting with Ido Haber tomorrow.

Content:

- Main areas/topics of interest to us:
  - "New practices in computational human modeling for neuroelectromagnetics, electromagnetic safety, and exposure evaluation"
  - "Cellular-level interactions between the human body and electromagnetic fields"
  - "Construction and application of computational human models"
- Non-invasive brain stimulation (NIBS) has been studies more frequently in recent years via "realistic anatomical head models" for numerical evaluation of the electrical fields produced
- Individualized modelling is not (yet) a standard practice, with development of simulations seeming like the most likely way forward
- We can possibly apply some of these principles (considering TMS coil type, angle/position relative to our model, pulse power, etc.) when we conduct TMS testing later this semester

S. Makarov, M. Horner, and G. Noetscher, Eds., *Brain and Human Body Modeling: Computational Human Modeling at EMBC 2018*. Cham: Springer International Publishing, 2019. doi: 10.1007/978-3-030-21293-3.

Conclusions/action items:

Go into tomorrow's meeting with Ido prepared with questions and ready for a discussion.

2026/02/12 - Conductivity Uncertainty Analysis

ORLA RYAN - Feb 12, 2026, 9:11 PM CST

Title: Conductivity Uncertainty Analysis

Date: 2/12/2026

Content by: Orla

Present: n/a

Goals: Looking into one more article shared by Ido on electric field calculations/considerations.

Content:

- This paper again emphasizes that electric fields generated through TMS (and another form of stimulation, tDCS), can be difficult to predict due to a number of factors
- A note is made that "TMS fields are generally less affected by conductivity variations than tDCS fields" (variations referring to differences between types of tissue)
- "TMS fields were predominantly influenced by gray and white matter conductivity"
- We can at least adopt some of this uncertainty framework/suggest possibility for error when holding our testing on the brain phantom later on

G. B. Saturnino, A. Thielscher, K. H. Madsen, T. R. Knösche, and K. Weise, “A principled approach to conductivity uncertainty analysis in electric field calculations,” *NeuroImage*, vol. 188, pp. 821–834, Mar. 2019, doi: 10.1016/j.neuroimage.2018.12.053.

Conclusions/action items:

Apply these concepts in the report for this semester (namely, suggest uncertainties/differences between our generalized model and individual brains)

2026/02/12 - Other Biophysical Modelling Studies

ORLA RYAN - Feb 12, 2026, 9:08 PM CST

Title: Other Biophysical Modelling Studies

Date: 2/12/2026

Content by: Orla

Present: n/a

Goals: Look into another general study/review shared by Ido Haber on the topic of biophysical modelling.

Content:

- There is a high "importance of the anatomical and human biophysical parameters and computational methods" in regard to modelling human structures for the purposes of TMS studies
- It can be difficult to understand the "exact brain target" of a TMS pulse
    - The tool's generated electric field exhibits a non-uniform distribution
    - This is largely due to the complicated and subject-dependent brain anatomy and the lack of biomarkers that can quantify the effects of TMS in most cortical areas
- "The estimated regions by TMS may vary according to different parameters, such as the variations in the type of magnetic coil, its position and orientation over the scalp, and the current waveform injected into the coil"
    - these are all factors that we can likely ask our client and secondary contact about (what they intend to use/what is ideal for their purposes, etc.)
- Usage of "dosimetry" and developing customizable computational models is common
- This is a very high level of specificity to strive for, and we will probably have to set our overall sights lower (at least for this semester)

J. Gomez-Tames, I. Laakso, and A. Hirata, “Review on biophysical modelling and simulation studies for transcranial magnetic stimulation,” *Phys Med Biol*, vol. 65, no. 24, p. 24TR03, Dec. 2020, doi: 10.1088/1361-6560/aba40d.

Conclusions/action items:

Ask Ido how to apply principles of computational modelling/analysis into a more simplified anatomical representation and collection of methods to gather data.

2026/01/29 - Different Electrode Set-ups

ORLA RYAN - Jan 29, 2026, 7:39 AM CST

Title: Different Electrode Set-ups

Date: 1/29/2026

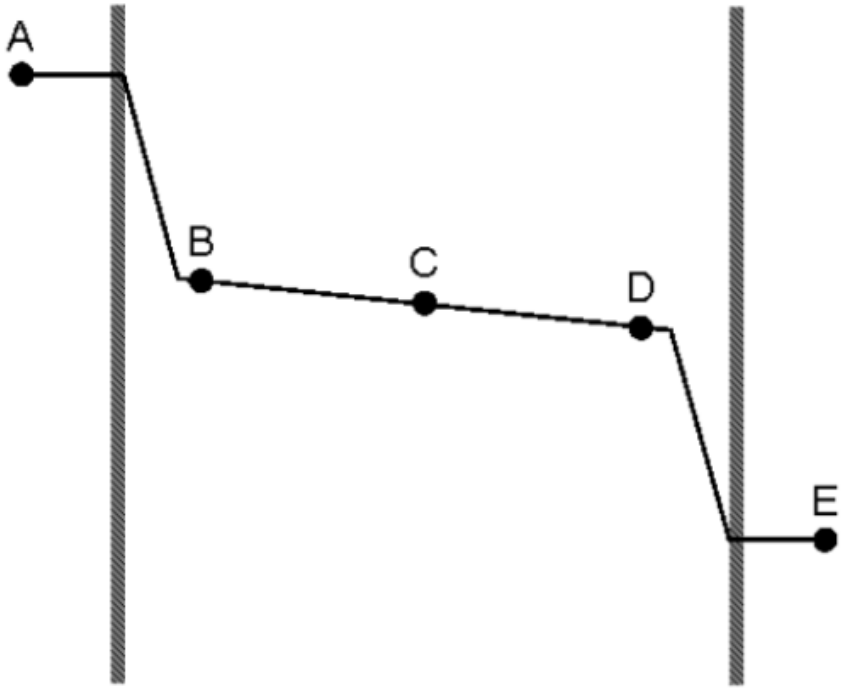
Content by: Orla Ryan

Present: n/a

Goals: Since electrode setups used in tandem with a wave generator may be accessible for us for testing conductivity, I am hoping to garner some more information about different techniques.

Content:

- "N-electrode" mode experiments (considering different numbers of electrodes/probes used)
  - electrode = "semi-conductive solid that interfaces with a solution"
  - can be working, reference, or counter
  - working = designated electrode for studying (ex: in corrosion experiments, this is the material that is corroding), commonly gold, platinum, or carbon
  - counter/auxiliary = electrode in the cell that completes the current path (typically made of relatively inert materials)
  - reference = electrodes serving as experimental reference points (i.e. the reference for potential measurements, so should hold a constant potential during testing)
  - any conductive material can be used as a reference electrode
- Two-electrode experiments: simplest cell setups, but can yield far more complex results/necessitate complex analysis
  - current and sense leads connected together
  - measures the whole cell (complete voltage dropped by current across the working electrode --> electrolyte --> counter electrode)



- used generally in systems that exhibit very low currents
- Three electrode experiments:

    - reference lead separated from the counter, then connected to a third electrode (positioned to measure a point very close to the working electrode)
    - measures **one half** of the cell (independent of changes that occur at counter electrode)
- Four electrode experiments:
    - measures the effect of an applied current on the ***solution itself*** (or some barrier in the solution), rather than the potentials at the various electrodes
    - measures impedance across a solution-phase interface (THIS MAY BE IDEAL FOR US)

Source:

> “Two,Three,Four Electrode System Gamry 4-Probe Potentiostats Gamry Instruments.” Accessed: Jan. 29, 2026. [Online]. Available: https://www.gamry.com/application-notes/instrumentation/two-three-four-electrode-experiments/

Conclusions/action items:

I will continue to work with the team on determining our ideal electrical testing set-up, and will consider reaching out to labs here on campus that may have spare electrodes for us to use.

2026/02/15 - Analog AD 5933 Information

ORLA RYAN - Feb 15, 2026, 4:33 PM CST

Title: Analog AD 5933 Information

Date: 2/15/2026

Content by: Orla

Present: n/a

Goals: Looking into the analog device mentioned by Dr. Coventry at our meeting on Friday.

Content:

- When we met with Dr. Coventry on Friday, 2/13, he mentioned the possibility of utilizing an existing analog device to measure electrical conductivity over a range of frequencies.
    - If suitable, this could likely accomplish some of the set-up work for us (integrating a current source and providing two measurement points, etc.)
- I have linked a description of the tool below. Once we discuss this more, we may look into obtaining or borrowing one for testing purposes.
- It is "designed to measure the impedance of a device under test (DUT) across a wide frequency range"
    - the device integrates a frequency generator, analog to digital converter, and digital signal processor to calculate/measure impedance.
- It essentially functions through generation of a sine wave and analysis of the resulting voltage and phase shift
- On this site, several common uses for the device are named:
    - "Bio-impedance measurements for medical devices
    - Material characterization in research and development"
- If we do go forward with this device, Dr. Coventry has offered to meet with us again and show us how to operate the corresponding software

[1] C. Design, “Cirkit Designer Tutorials.” Accessed: Feb. 15, 2026. [Online]. Available: https://docs.cirkitdesigner.com

Conclusions/action items:

I'll discuss this as a possibility with the team in our meeting tomorrow!

2026/02/22 - BME Equipment Available for Use

ORLA RYAN - Feb 22, 2026, 4:03 PM CST

Title: BME Equipment Available for Use

Date: 2/22/2026

Content by: Orla

Present: n/a

Goals: Looking through the available facilities/materials to make a concrete plan for testing either this week or next.

Content:

- hoping to make use of:
  - Keysight MSOX3024T Mixed Signal Oscilloscope (200 MHz, 4 Analog Plus 16 Digital Channels) --> data sheet
    - can generate waveforms and act as a digital multimeter
  - Keysight 33210A 10 MHz --> data sheet
  - Keysight 34450A Digital Multimeter --> data sheet
  - Keysight E3631A DC power supply --> data sheet
- We also have 3 or 4 instrumentation kits between us, with the necessary alligator clips and breadboard jumper wires
- The equipment used by the Iowa study team to measure induced voltage (and thus calculate the induced current) included:
  - Tektronix TDS2022 200 MHz scope; Beaverton, OR, USA
    - 2-channel scope
  - Agilent 54642D 500 MHz; Santa Clara; CA; USA
    - oscilloscope
- Peak-to-peak voltage was measured with an oscilloscope probe, and current applied through electrode contact pairs
  - we should be able to replicate this in ECB 1036 (Bioinstrumentation lab) with silver electrodes, the Keysight 200Mhz oscilloscope, and the Keysight 10 MHz function generator
  - will have to decide on an appropriate frequency range at which to test (again, will likely ask for help with this part)

Conclusions/action items:

Work with team to fabricate gels and complete this final characterization testing.

2026/03/20 - Noting Sources of Error in Electrical Testing

ORLA RYAN - Mar 20, 2026, 5:04 PM CDT

Title: Noting Sources of Error in Electrical Testing

Date: 3/20/2026

Content by: Orla

Present: n/a

Goals: Looking into some possible sources of error for conductivity testing to explain unexpected results we have gotten.

Content:

As we've been performing several rounds of testing to characterize the electrical properties of our various hydrogel samples, there have been several instances where we have received unexpected results (typically much **lower** conductivity values than we are expecting). I am looking into a few sources that might explain where these discrepancies are coming from.

- Our approach is similar to that of the "Van der Pauw" approach [1]. Some factors that may contribute to unexpected results include frequency-dependence, proper interface housing, temperature dependence, and interpretation of data [1].

- The second source lists some similar suggestions as well as a few new considerations. The temperature of the samples can "significantly affect the measurement", as well as ensuring the cleanliness of the copper electrodes (I can try and utilize ethanol to clean the copper wires between each sample). This source also claims that "the larger the... sample, the more accurate the result", meaning that maybe part of our noted differences came from the tiny samples we used. I can also incorporate some calibration of all the components used prior to testing next time [2].

- [1] A. Sharma, “A Comprehensive Analysis Of Semiconductor Electrical Characterization Techniques And Their Impact On Device Applications,” vol. 11, no. 5, 2024.
- [2] Kalstein, “The most common errors when measuring Conductivity in the Laboratory,” Kalstein EU. Accessed: Mar. 20, 2026. [Online]. Available: https://kalstein.eu/the-most-common-errors-when-measuring-conductivity-in-the-laboratory/?lang=en

Conclusions/action items:

I will keep these factors in mind both during the next round of testing and during my final report write-up.

2026/01/25 - Outreach for Professor Assistance

ORLA RYAN - Jan 25, 2026, 8:08 AM CST

Title: Outreach for Professor Assistance

Date: 1/25/2026

Content by: Orla

Present: n/a

Goals: Curating a list of UW professors to reach out to for possible testing assistance.

Content:

- I went through UW Madison faculty pages to accumulate a list of possible contacts
- We've had difficulty with testing (set-up, finding proper equipment, ensuring accuracy, etc.), so reaching out to UW Madison faculty who have tenured experience or advice could possibly be a resource
    - Kip Ludwig
      Coventry
      Justin Williams
      Aarushi Bhargava
      Chris Brace
      Aviad Hai
      Filiz Yesilköy

Conclusions/action items:

I will be drafting emails to send out to these professors/faculty members.

2026/02/07 - Recap of Communications with Dr. Hai

ORLA RYAN - Feb 07, 2026, 12:22 PM CST

Title: Recap of Communications with Dr. Hai

Date: 2/6/2026

Content by: Orla

Present: n/a

Goals: Going over my communications with Dr. Aviad Hai about any help he can provide for our project.

Content:

- I am enrolled in BME 770 this semester, taught by Dr. Aviad Hai.
    - He has a lot of experience in nanotechnologies, neuroscience, and neuromodulation techniques, possibly making him a good resource
- After speaking briefly this past week and explaining our current hang-ups (mainly on how to determine electrical conductivity while staying within our budget), I sent on the Iowa study and other resources we had been looking at
- He has a PhD student working on something similar (I believe in the vein of recreating brain tissue), and linked a paper that I will make note of in my research notes
- similarly, he thought that the testing we wanted to accomplish should be doable using just the equipment available to us in ECB 1036 (I will specify what exactly we are looking for)

Conclusions/action items:

I will meet with Dr. Hai after lecture this week with a more specific/direct list of questions.

2026/02/25 - Box for Electrical Testing

ORLA RYAN - Feb 25, 2026, 8:33 PM CST

Title: Box for Electrical Testing

Date: 2/25/26

Content by: Orla

Present: n/a

Goals: Sharing my sketch of a box to be printed for electrical conductivity testing.

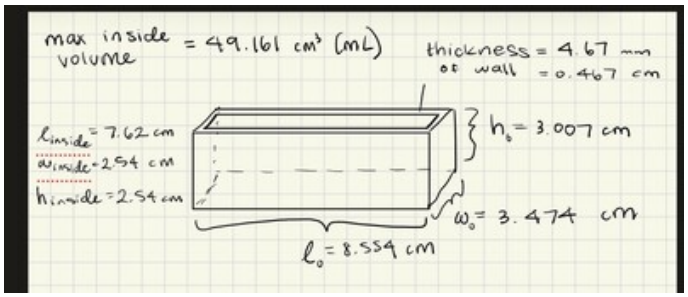
Content:

See attached PDF!

Conclusions/action items:

Meet with Corissa this weekend to get familiar with electrical equipment available in ECB.

ORLA RYAN - Feb 25, 2026, 8:37 PM CST



Download

printbox.jpg (169 kB)

2026/04/15 - Figure for TMS Testing

ORLA RYAN - Apr 15, 2026, 5:10 PM CDT

Title: Figure for TMS Testing

Date: 4/15/2026

Content by: Orla

Present: n/a

Goals: Sharing a figure I made depicting observed electrical current.

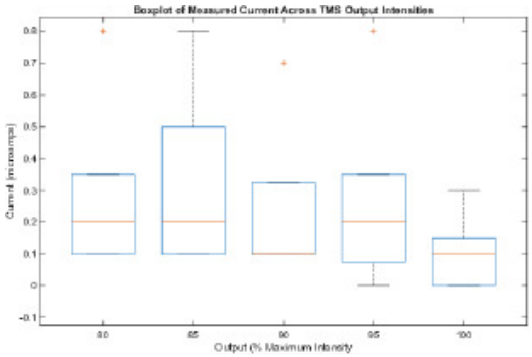
Content:

- see attached PDF!

Conclusions/action items:

The team will work on deliverables and sharing our results with Dr. Campagnola and the clients.

ORLA RYAN - Apr 15, 2026, 5:11 PM CDT



Download

boxplotTMScurrentvsintensity.pdf (18.6 kB)

2026/01/30 - Python Script for Segmentation

ORLA RYAN - Jan 30, 2026, 8:39 AM CST

Title: Python Script for Segmentation

Date: 1/30/2025

Content by: Orla

Present: n/a

Goals: I'm starting to go through a python script shared with us by a resource on campus to try and ascertain which section(s) are relevant.

Content:

- below is a block that seems to describe creating a hollow shell based upon the sulci noted in an MRI scan
- I have highlighted the most pertinent portions of the code

```
import numpy as np
import scipy.ndimage as ndi
from skimage.morphology import ball
from skimage.morphology import disk


def make_sulci_shell_from_csf(csf_mask, voxel_sizes,
                              shell_thickness_mm=2.0,
                              restrict_to_brain_mask=None):
    """
    Create a 3D-printable sulci shell derived from the *edges* of the CSF mask.

    - csf_mask: binary CSF mask (sulcal + ventricular CSF).
    - voxel_sizes: (dx, dy, dz) voxel dimensions in mm.
    - shell_thickness_mm: approximate wall thickness (mm).
    - restrict_to_brain_mask: optional brain mask to clip shell to cortex only.

    The result is a hollow 'shell' that hugs the CSF boundaries (including
    penetrating sulci). Gel can be poured inside in the physical phantom.
    """
    # Optionally restrict CSF to inside the brain (avoid extracranial CSF)
    if restrict_to_brain_mask is not None:
        csf_mask = csf_mask & restrict_to_brain_mask

    # Clean CSF a bit, but DON'T drop small sulcal components inside the brain
    csf_clean = ndi.binary_opening(csf_mask, structure=ball(1))

    # If no brain mask is provided, fall back to largest connected component
    # to remove obvious junk / extracranial blobs.
    if restrict_to_brain_mask is None:
        csf_clean = largest_cc(csf_clean)

    # ------------------------------------------------------------------
    # EDGE DETECTION ON CSF MAP (3D MORPHOLOGICAL GRADIENT)
    # ------------------------------------------------------------------
    csf_uint8 = csf_clean.astype(np.uint8)
    csf_edges = ndi.morphological_gradient(
        csf_uint8,
        footprint=ball(1)
    ) > 0


    # Convert shell thickness (mm) -> approximate radius in voxels
    min_vox_mm = min(voxel_sizes)
    radius_vox = max(int(round(shell_thickness_mm / min_vox_mm)), 0.5)
    selem = ball(radius_vox)
```

```
    # Thicken the detected edge voxels to get a shell of desired thickness
    sulci_shell = ndi.binary_dilation(csf_edges, structure=selem)

    # Keep shell in parenchyma (outside pure CSF) so CSF/sulci remain as cavity
    sulci_shell = sulci_shell & (~csf_clean)

    # Remove skull / extracranial regions by clipping to brain mask if provided
    if restrict_to_brain_mask is not None:
        sulci_shell = sulci_shell & restrict_to_brain_mask

    # Connect any remaining small gaps in the shell (helpful for 3D printability)
    sulci_shell = ndi.binary_closing(sulci_shell, structure=ball(1))

    # If no brain mask, keep the largest contiguous shell as a sanity check
    if restrict_to_brain_mask is None:
        sulci_shell = largest_cc(sulci_shell)

    # ------------------------------------------------------------------
    # NEW: connect only "side" neighbors (in-plane), not far regions
    #     -> do 2D closing slice-by-slice with a small disk
    # ------------------------------------------------------------------
    nz = sulci_shell.shape[2]  # assuming z is the last axis
    for k in range(nz):
        slice_k = sulci_shell[:, :, k]
        slice_k = ndi.binary_closing(slice_k, structure=disk(1))
        sulci_shell[:, :, k] = slice_k

    cut = nz * 1 // 2        # integer index at 3/8 of slices
    sulci_shell[:, :, :cut] = 0

    return sulci_shell
```

- there are additional sections that describe creating mesh components, "cleaning up" the brain mask for purposes of 3D printing, and dealing with complex geometries
    - a couple sections may not be needed (more intense segmentation, given that we just want general shape and aren't considering grey vs white matter)

Conclusions/action items:

I will work with the team to try and figure out how to convert the MRI scans (and templates) using this code, making changes as needed.

2026/02/04 - Training for Spring 2026

ORLA RYAN - Feb 04, 2026, 2:30 PM CST

Title: Training for Spring 2026

Date: 2/4/2026

Content by: Orla

Present: n/a

Goals: Updating my training records for this semester.

Content:

I completed the Fume Hood safety training for this semester. See the picture below!

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

This certifies that Orla Ryan has completed training for the following course(s):

Course	Assignment	Completion	Expiration
2023-24 HIPAA Privacy & Security Training	HIPAA Attestation	1/24/2024	
2024-2025 HIPAA Privacy & Security Training	2024-2025 HIPAA Privacy & Security Training	10/23/2024	
2025-2026 HIPAA Privacy & Security Training	2025-2026 HIPAA Privacy & Security Training	11/4/2025	
Biosafety Required Training	Biosafety Required Training Quiz 2024	1/24/2024	1/24/2029
Chemical Safety: Fume Hood Safety Training	Fume Hood Final Quiz	2/4/2026	2/4/2031
Chemical Safety: The OSHA Lab Standard	Final Quiz	1/23/2024	
Good Clinical Practice for Drug/Device Researchers	Good Clinical Practice	1/24/2024	1/24/2027
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	1/24/2024	1/24/2027

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Conclusions/action items:

I will use what I learned to operate in the ECB Teaching lab safely.

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: