Tutorial for Calculation of Reflectance, Transmittance and Absorptance

with step-by-step instructions

Ver: 1.25 (2025-12-19)

ComPhysics

Symbols and abbreviations used in E2M

Symbol	Meaning
L#	Layer index
T.	Thickness
λ	Wavelength
μ'	Real part of relative permeability
μ''	Imaginary part of relative permeability
ε'	Real part of relative permittivity
ε''	Imaginary part of relative permittivity
$\tilde{k}$	Normalized wave vector
GX#	G: Group index X: separator meaning times #: Repetition num. for the group
θ	The azimuthal angle
φ	The polar angle
TE	Transverse Electric
TM	Transverse Magnetic
R	Reflectance
T	Transmittance
A	Absorptance (R + T + A = 1)
α	Thickness of a period
c	speed of light

In this tutorial, step-by-step instructions for recalculating Fig. 7.8 of reference 1 below are offered. By performing these steps, you will learn how to extract reflectance, transmittance, absorptance, and field distribution by utilizing E2M.

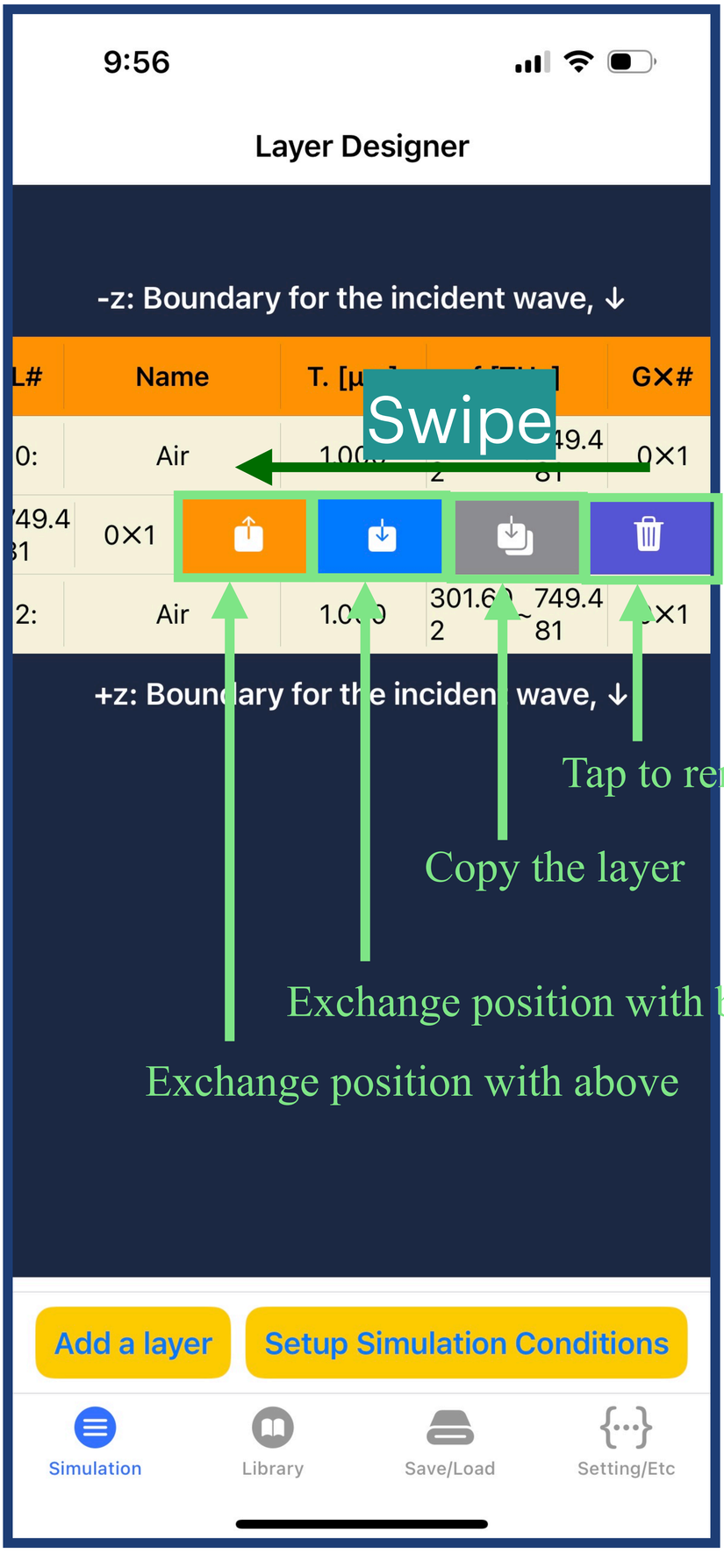
This tutorial requires creating four layers to recalculate the reference selected. Therefore, this tutorial cannot be completed in freeware mode. Since we offer a 1-week free usage period for any standard subscription, you may use this offer to follow this tutorial up.

On the next page, this tutorial will finally start.

1) Yeh, Pochi. Optical Waves in Layered Media. New York: Wiley-Interscience, 1988.

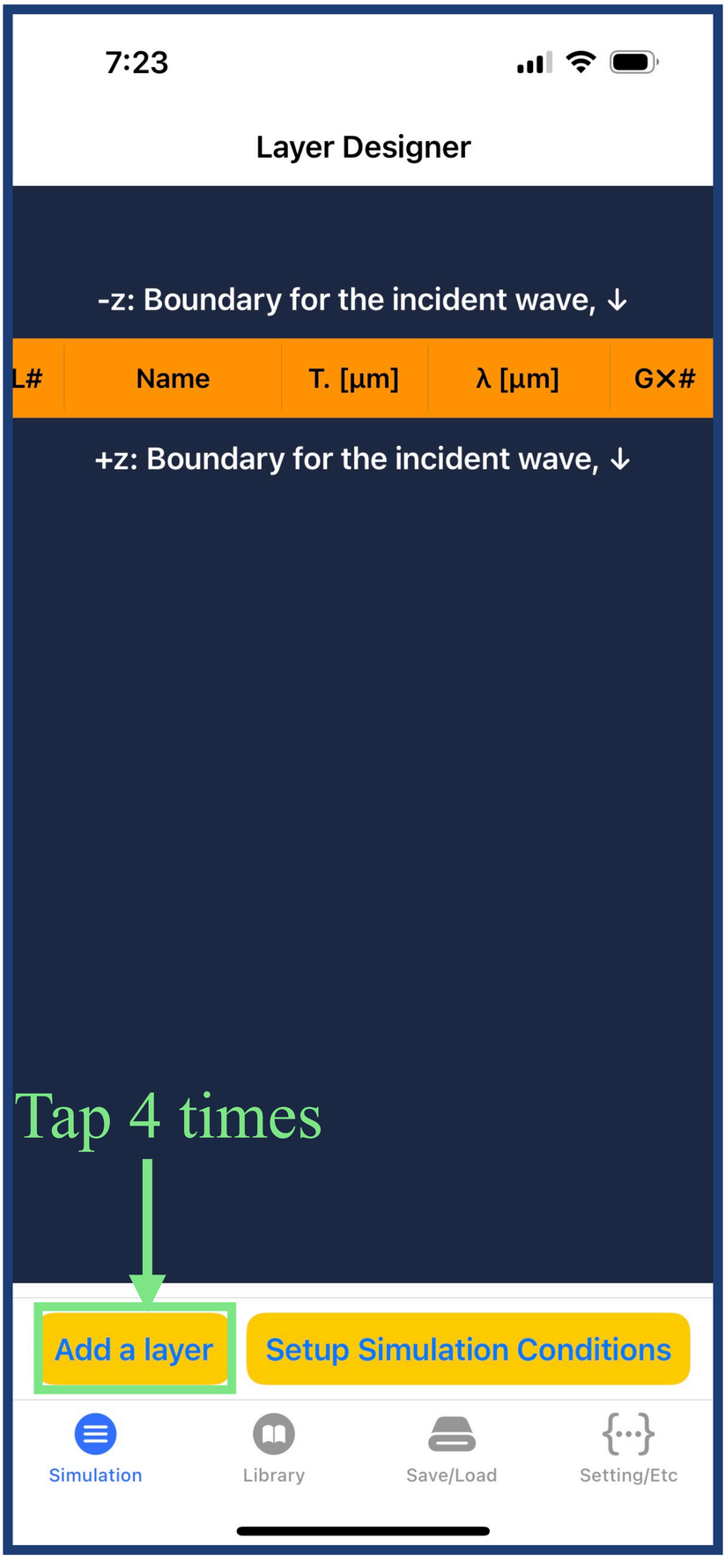
(Optional steps for users followed in performing other tutorials)

A. Users can remove a layer by swiping from right to left and tapping the “trash” icon.

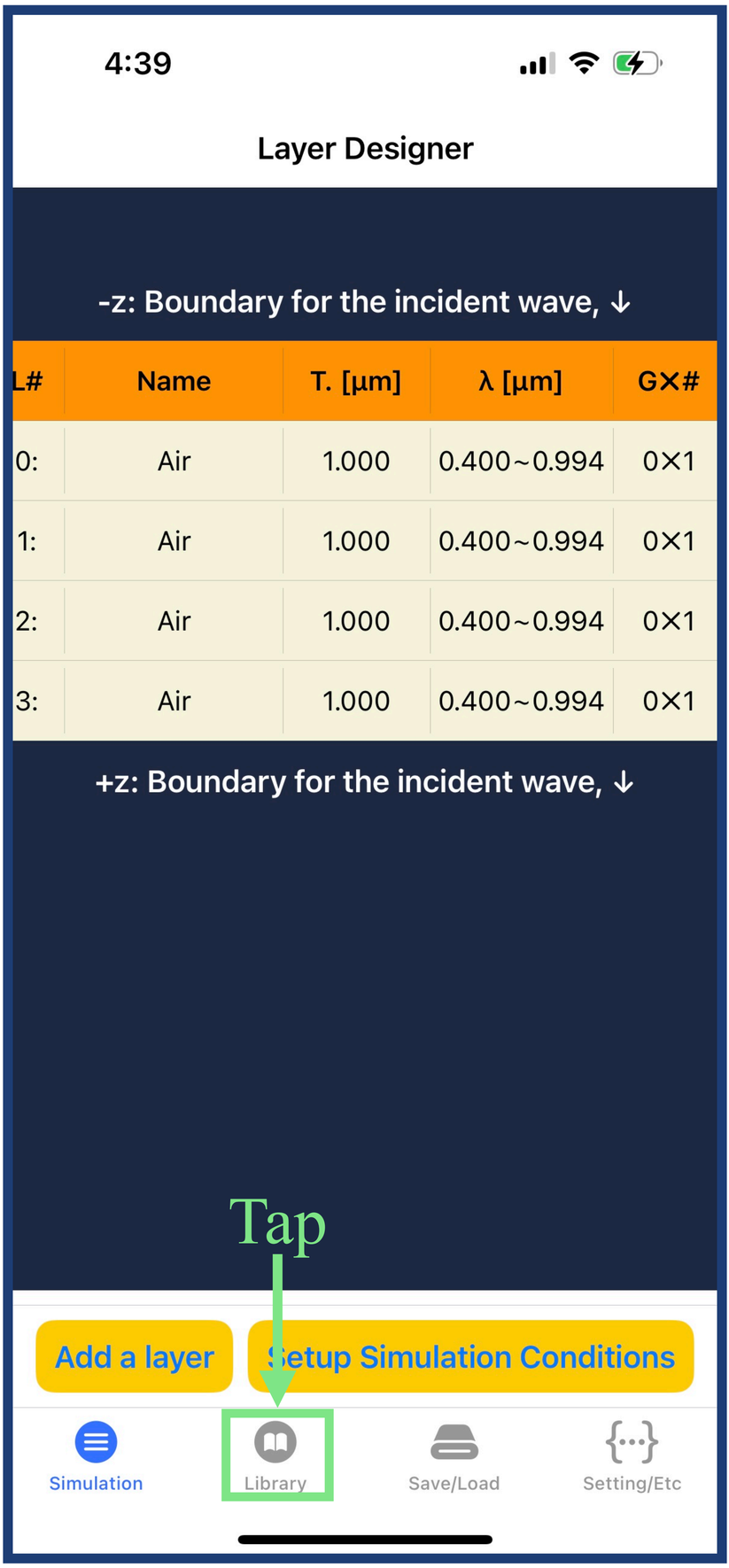


Try swiping to other types of layers on other pages.

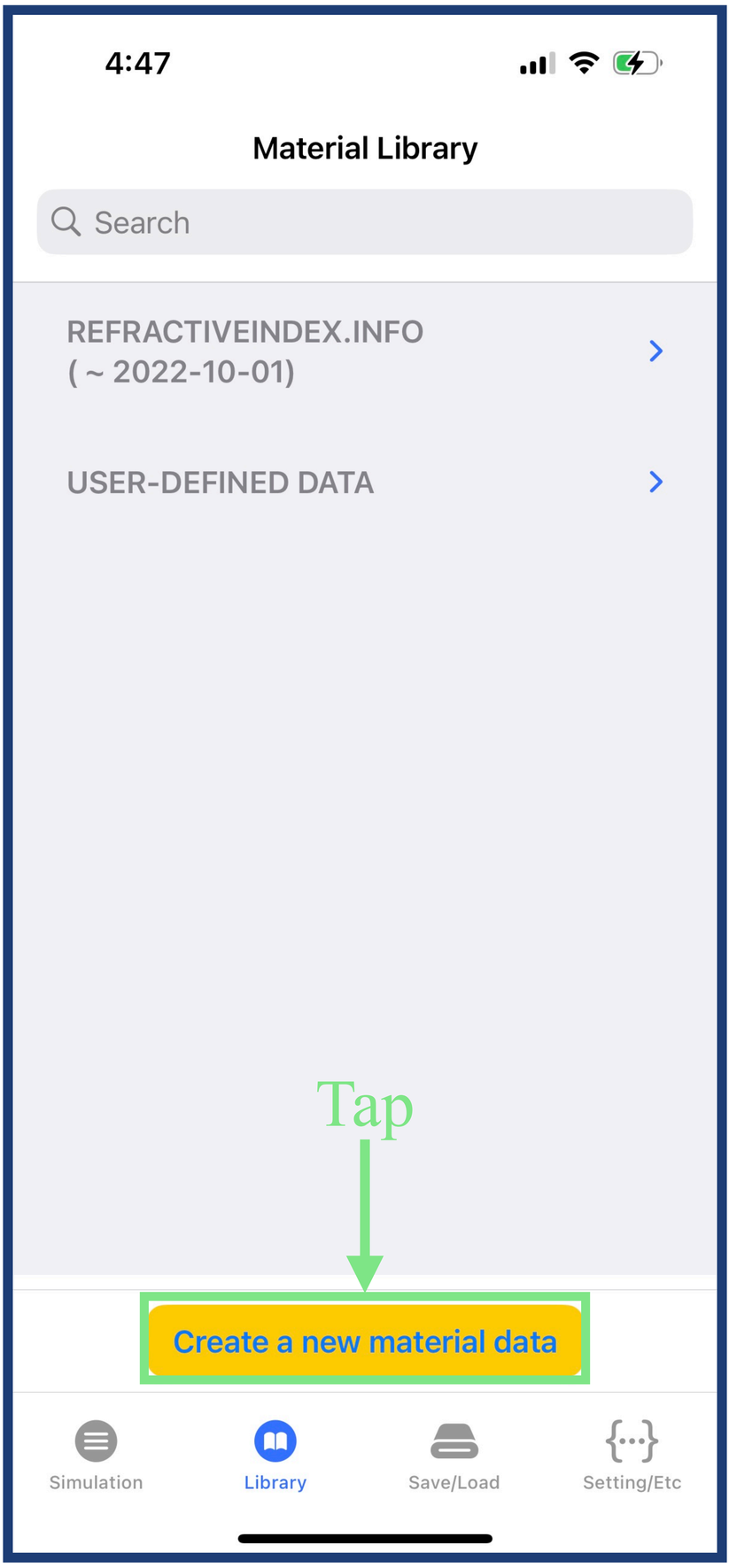
1. Tap “Add a layer” button four times to create four layers. Boundary must maintain “-z: Boundary for the incident wave, ↓” and “+z: Boundary for the incident wave, ↓”.



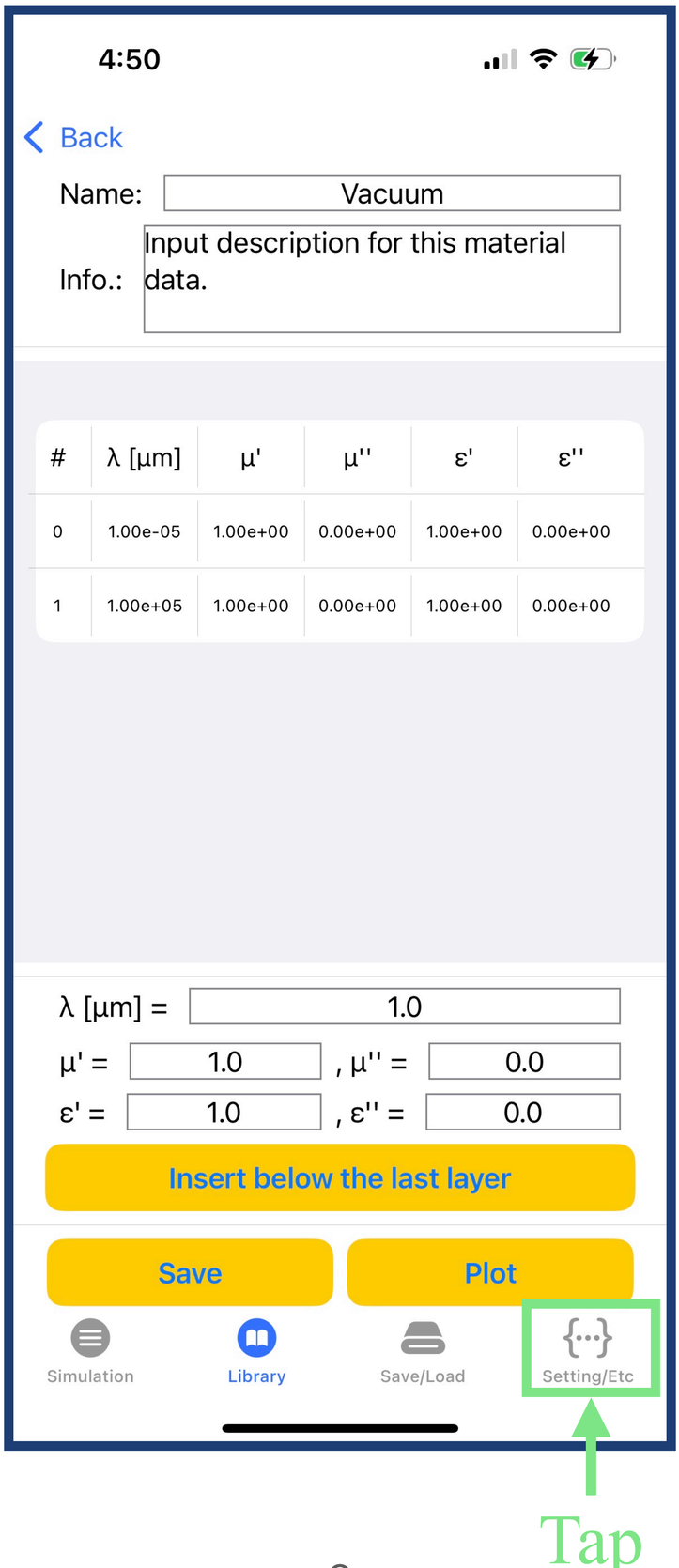
2. We need to create three new user-defined materials before inputting each layer's information. Tap the "Library" icon.



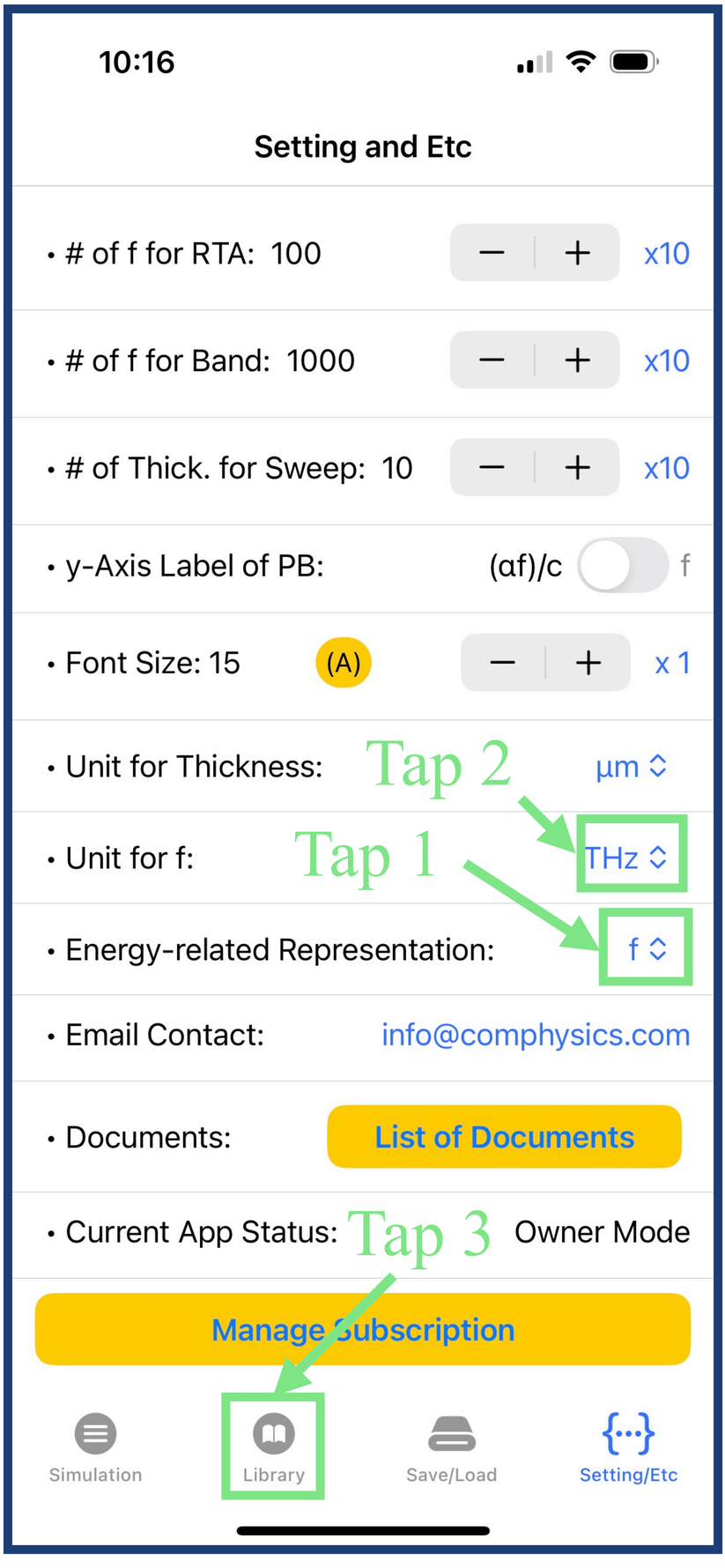
3. Tap “Create a new material data” button.



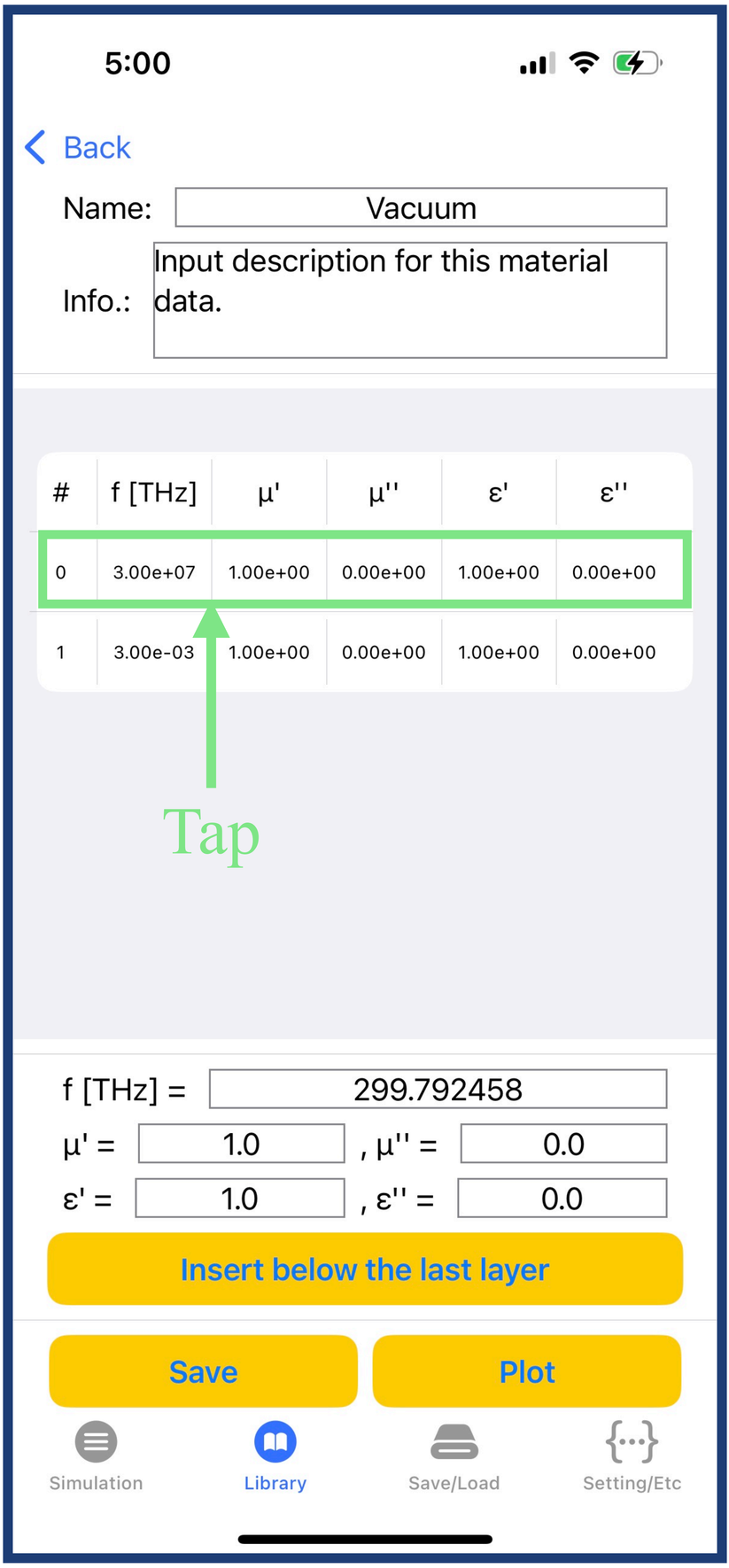
4. We are going to create three constant ε_r whose values are maintained for the frequency range of 0.1 THz and 1200 THz. Since the current table shows wavelength notation, let us change this to the frequency notation. Tap the “Setting/Etc” icon.



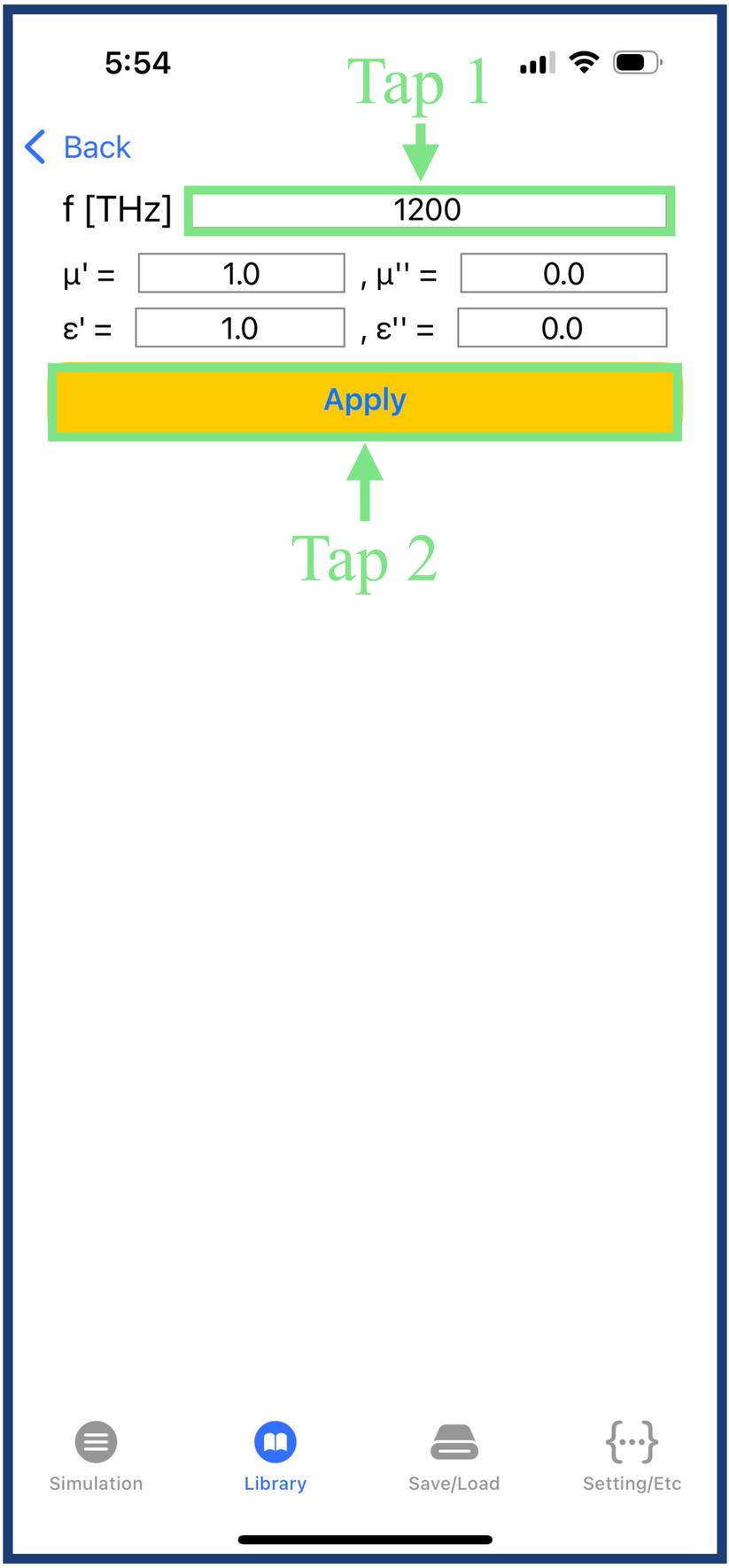
5. First, tap “Energy-related Representation” and then tap “f”. Here, f means frequency. Second, tap “Unit for f” and tap “THz”. Then, tap “Library” icon to go back.



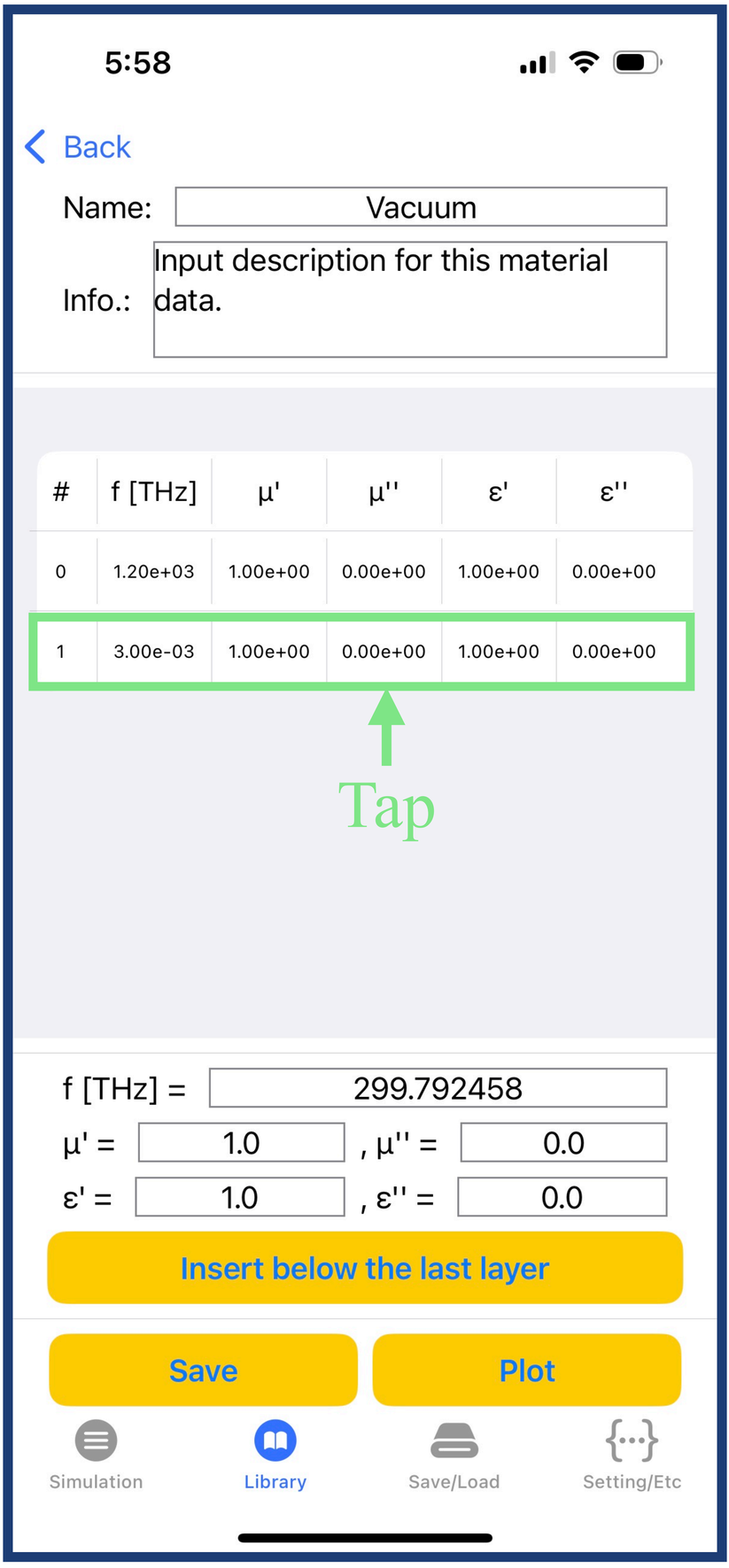
6. We can see the changed symbol and unit from λ [μm] to f [THz]. Tap #0 row of the table.



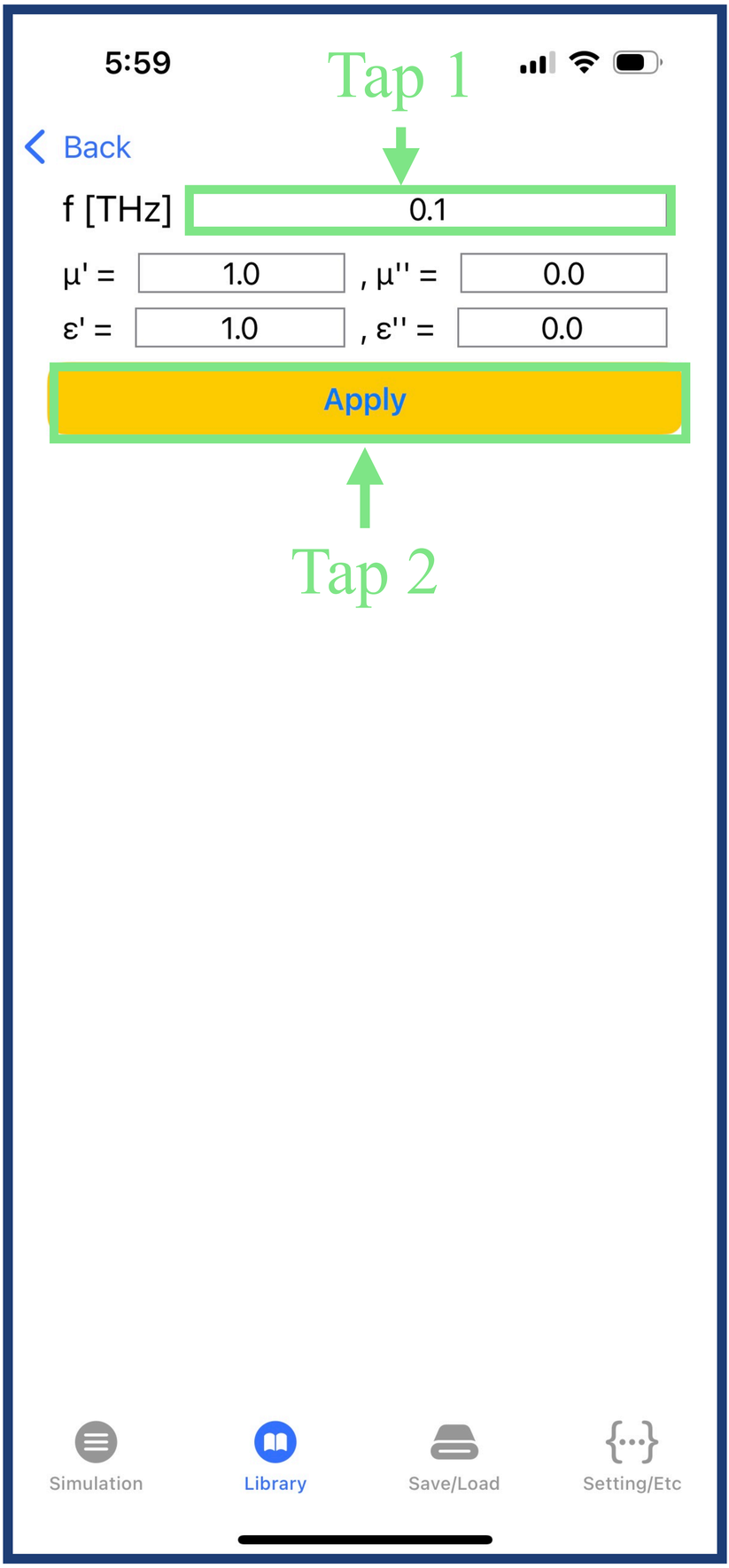
7. Tap the field f and input 1200. Then, tap “Apply” button to apply the changed value.



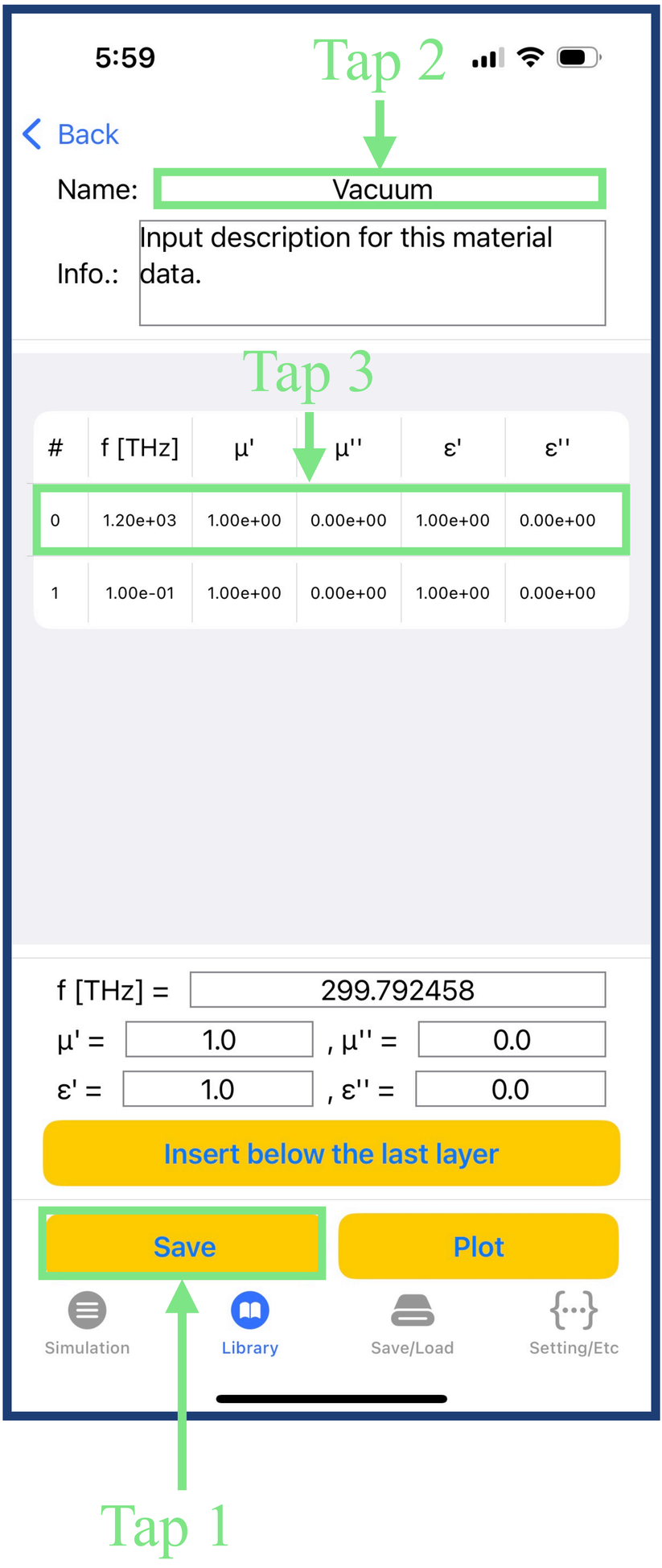
8. We can confirm the changed f value in the #0 row of the table. Tap the #1 row of the table.



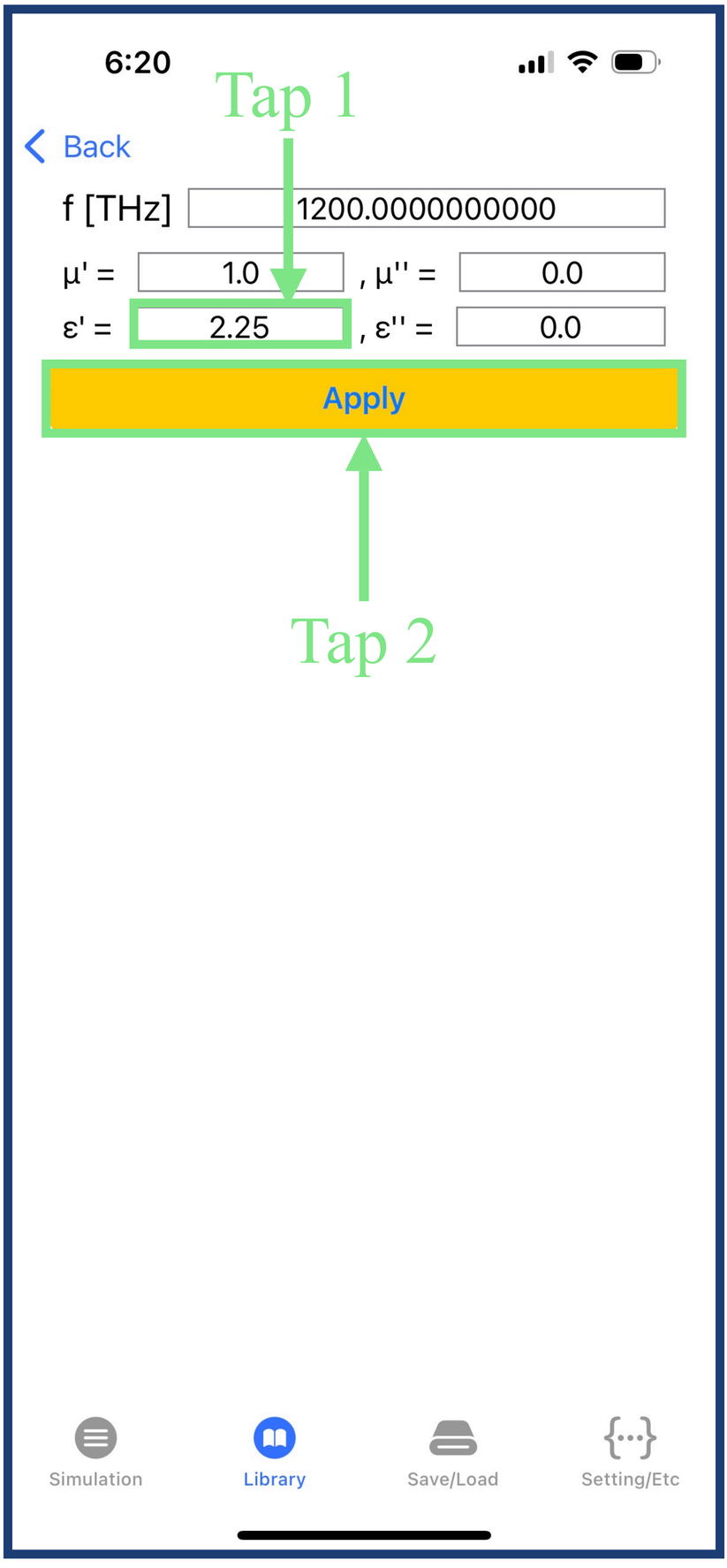
9. Input 0.1 after tapping f field. Then, tap “Apply” button to go back.



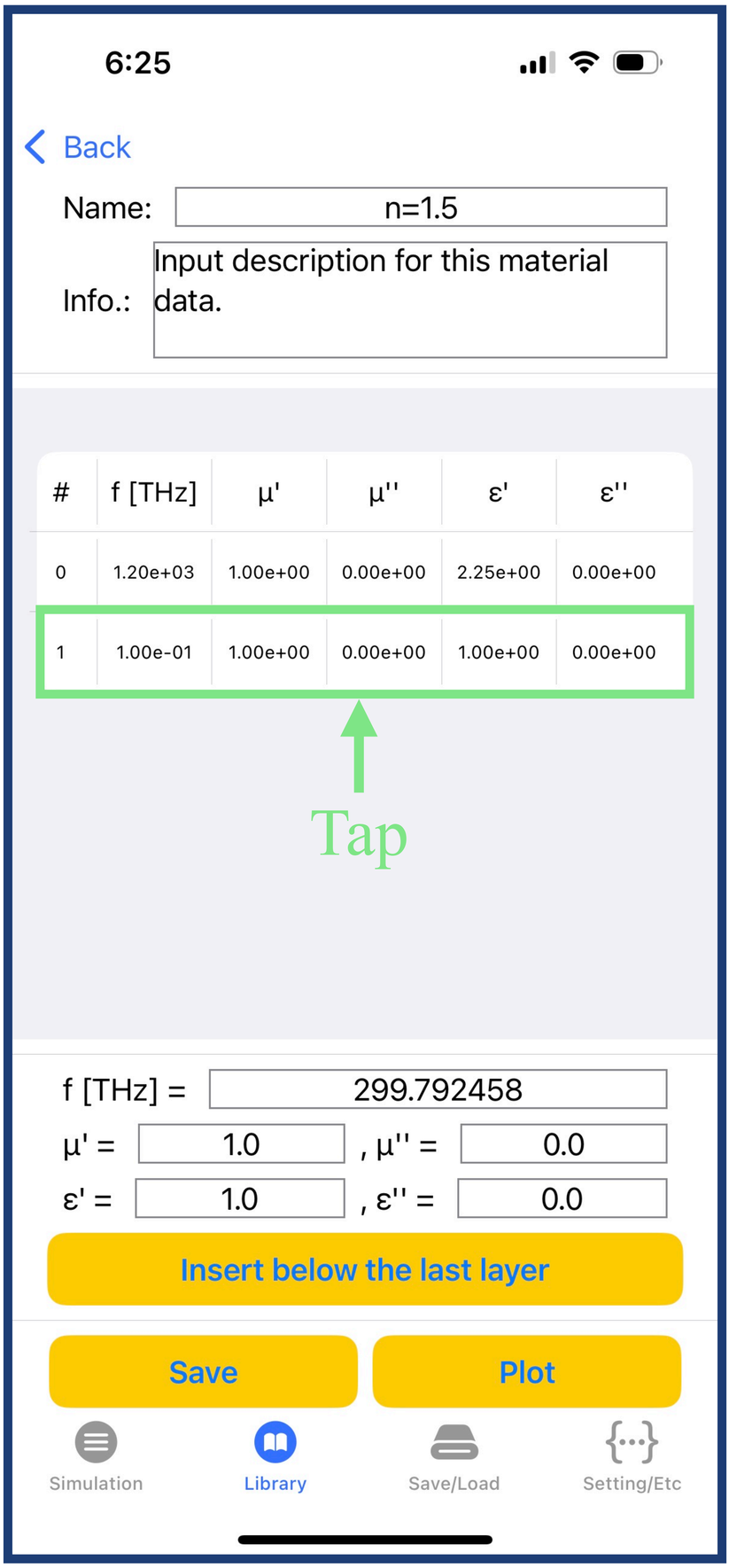
10. Tap the “Save” button to save all input information. Next, tap the Name field and enter “n=1.5”. Then tap the first row of the table, which is #0.



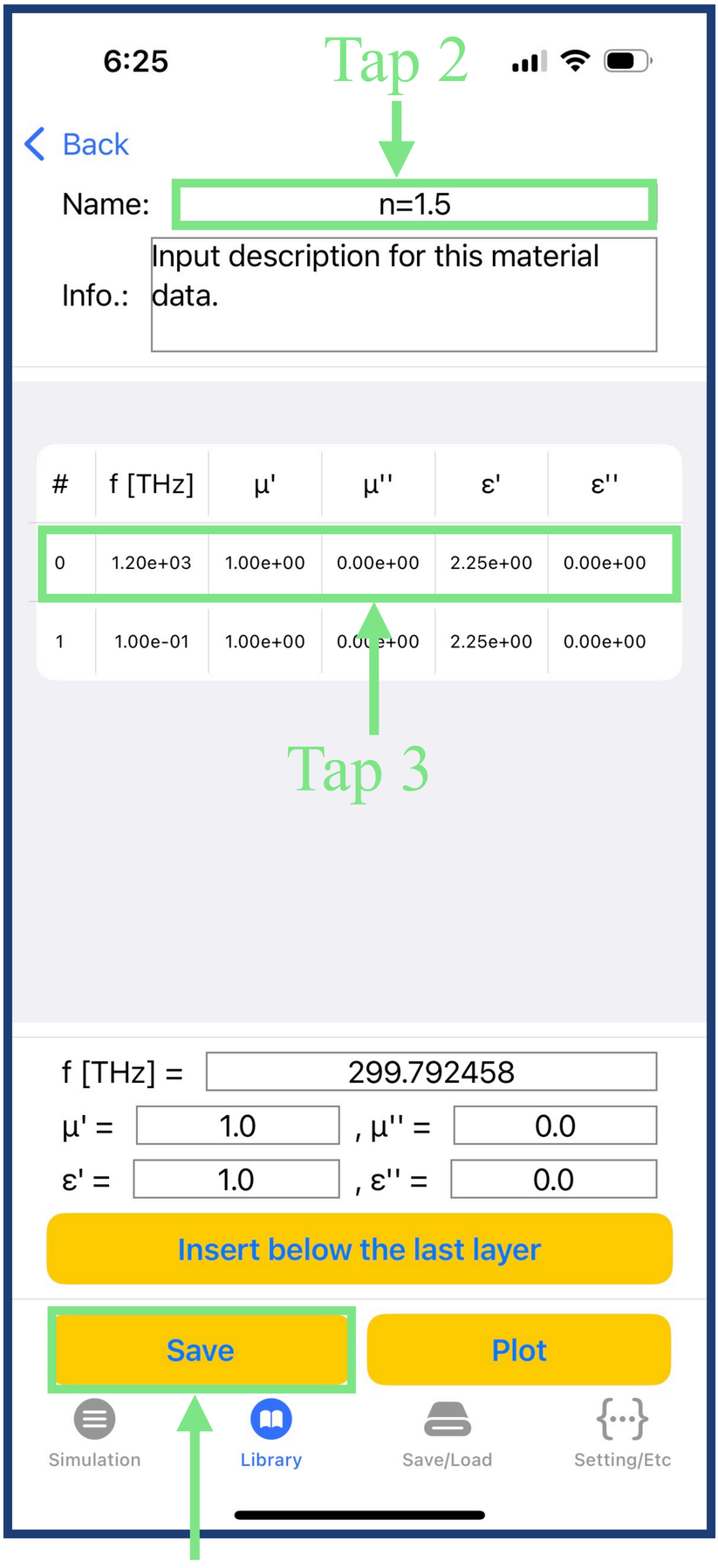
11. After tapping ε′ field, input 2.25, which is identical to the n=1.5 with non-magnetic material assumption. Next, tap “Apply” button to go back.



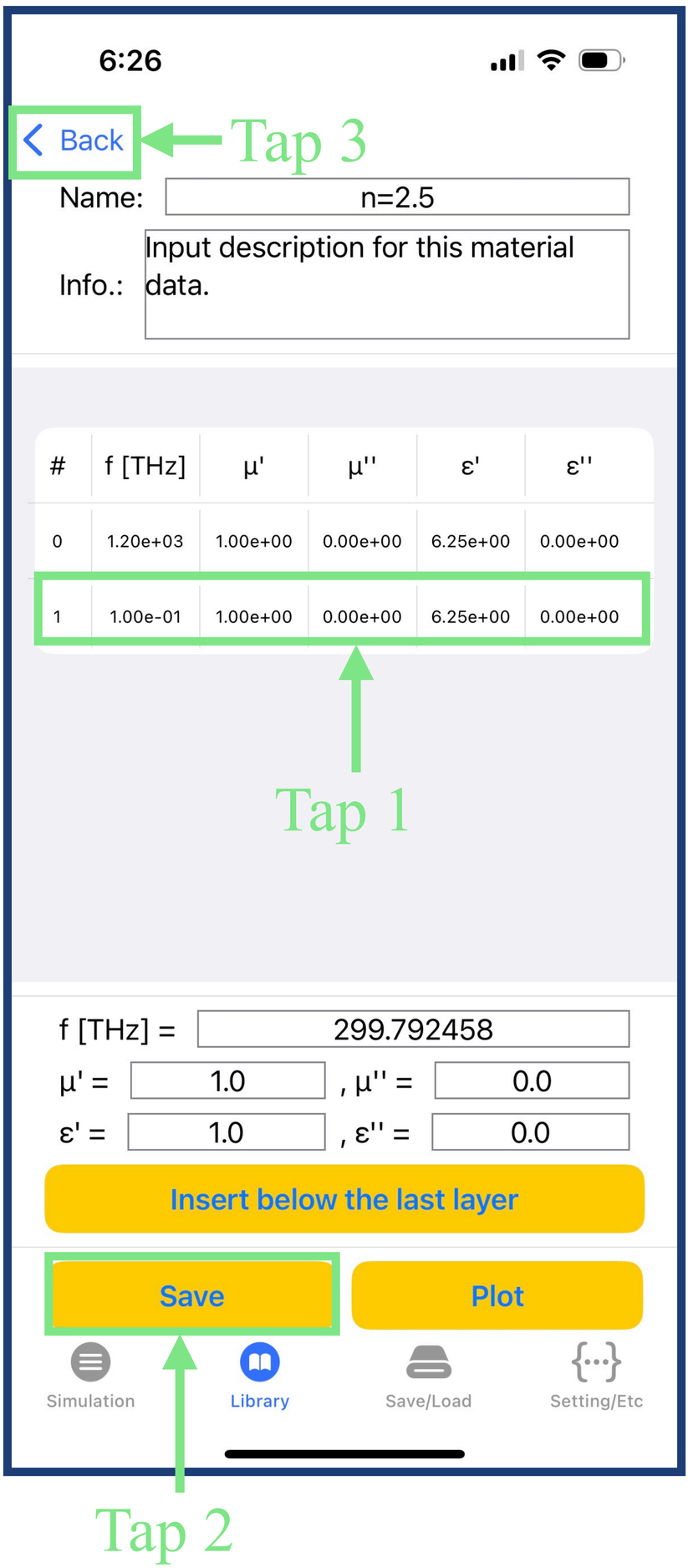
12. Tap the #1 row and change ε' to 2.25 as before. Tap the “Apply” button after that.



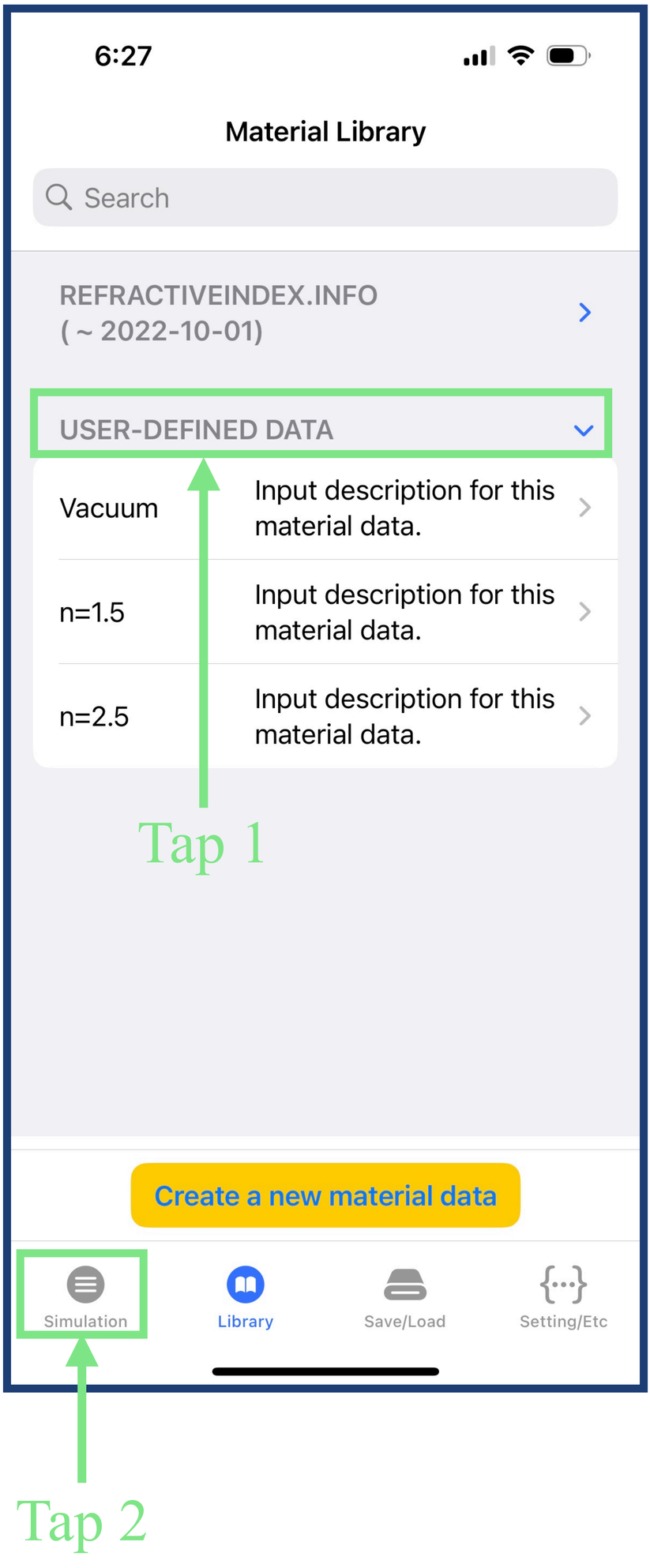
13. Tap the “Save” button to save the user-defined material with n=1.5. Next, tap the Name field and enter “n=2.5”. Next, tap the table’s #0 row. After that, change the value of ε' to 6.25 and tap the “Apply” button.



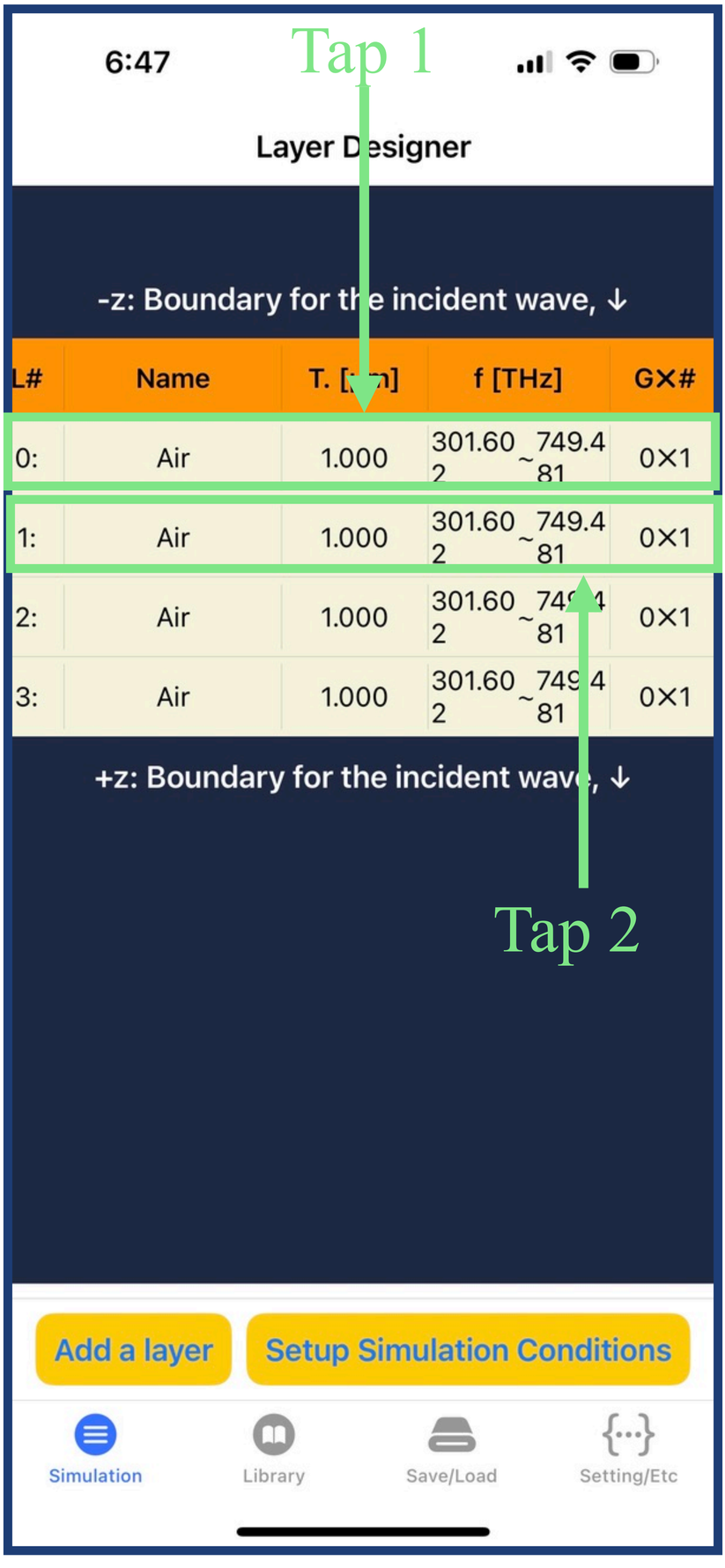
14. Perform the identical procedure for #1 row of the table. Then save it by tapping the “Save” button. Finally, a third user-defined material is created. Tap the “Back” button.



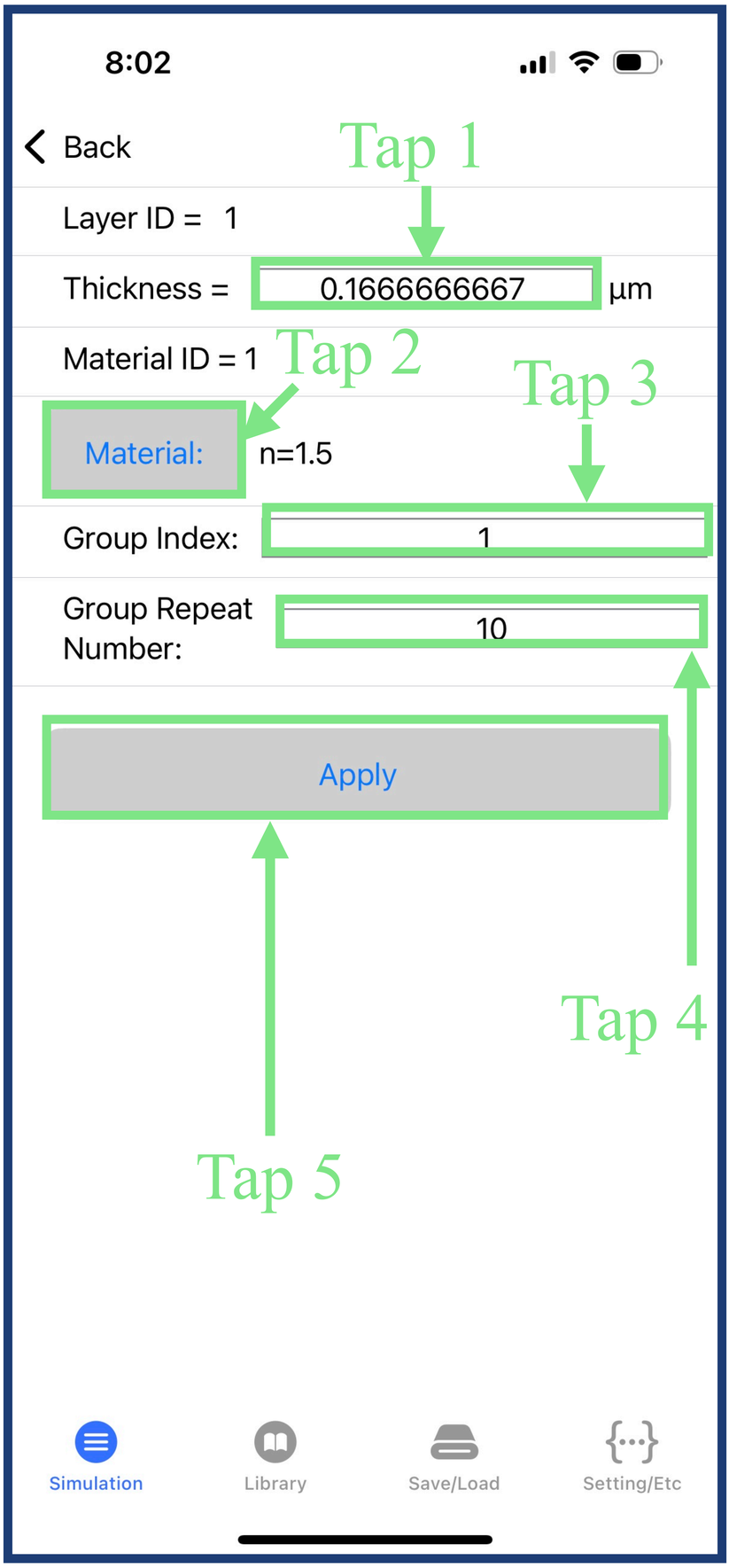
15. By tapping the USER-DEFINED DATA section, we can confirm the three newly created materials. Tap the “Simulation” icon.



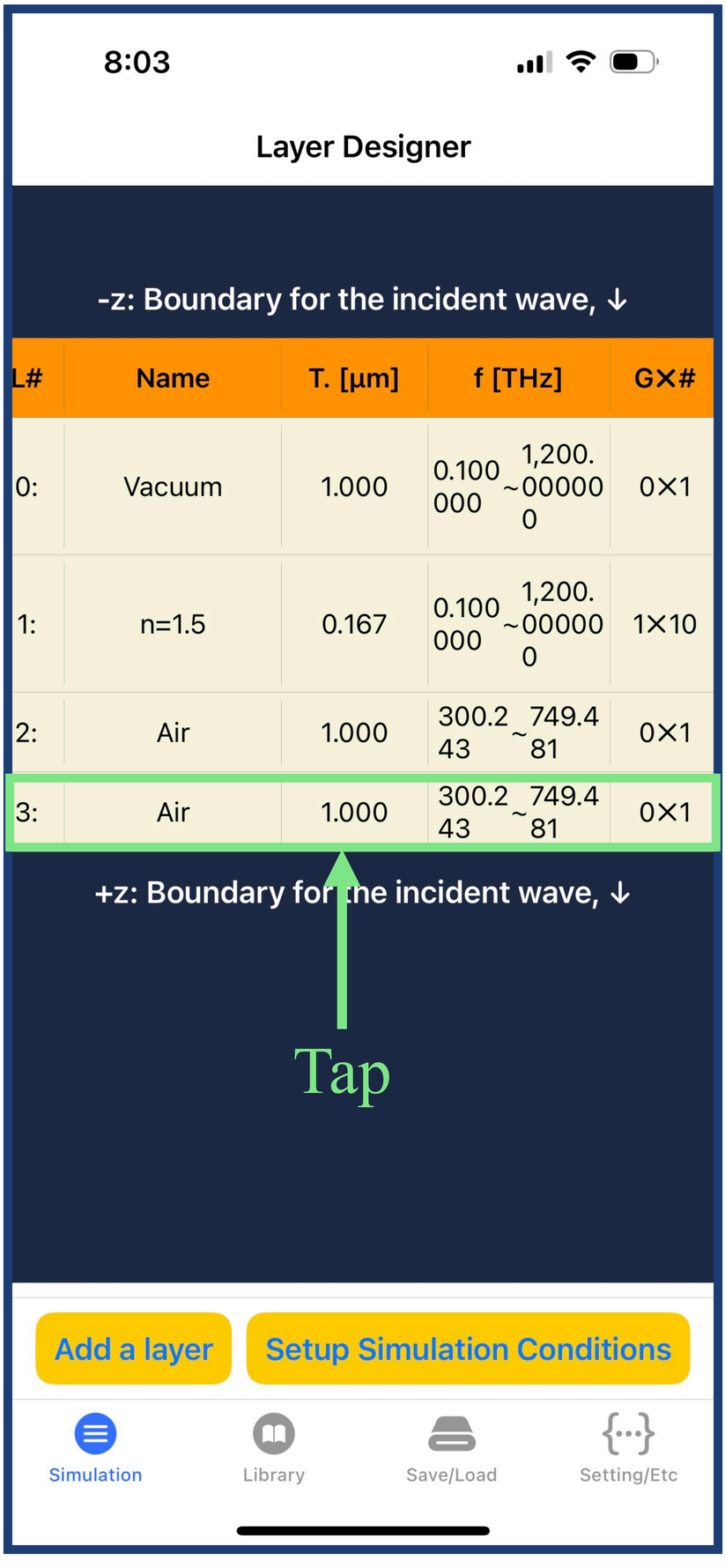
16. Change “Air” to the newly created “Vacuum” for L#0 layer after tapping it. Then tap layer L#1. L#0 becomes boundary material, and it must be lossless in E2M.



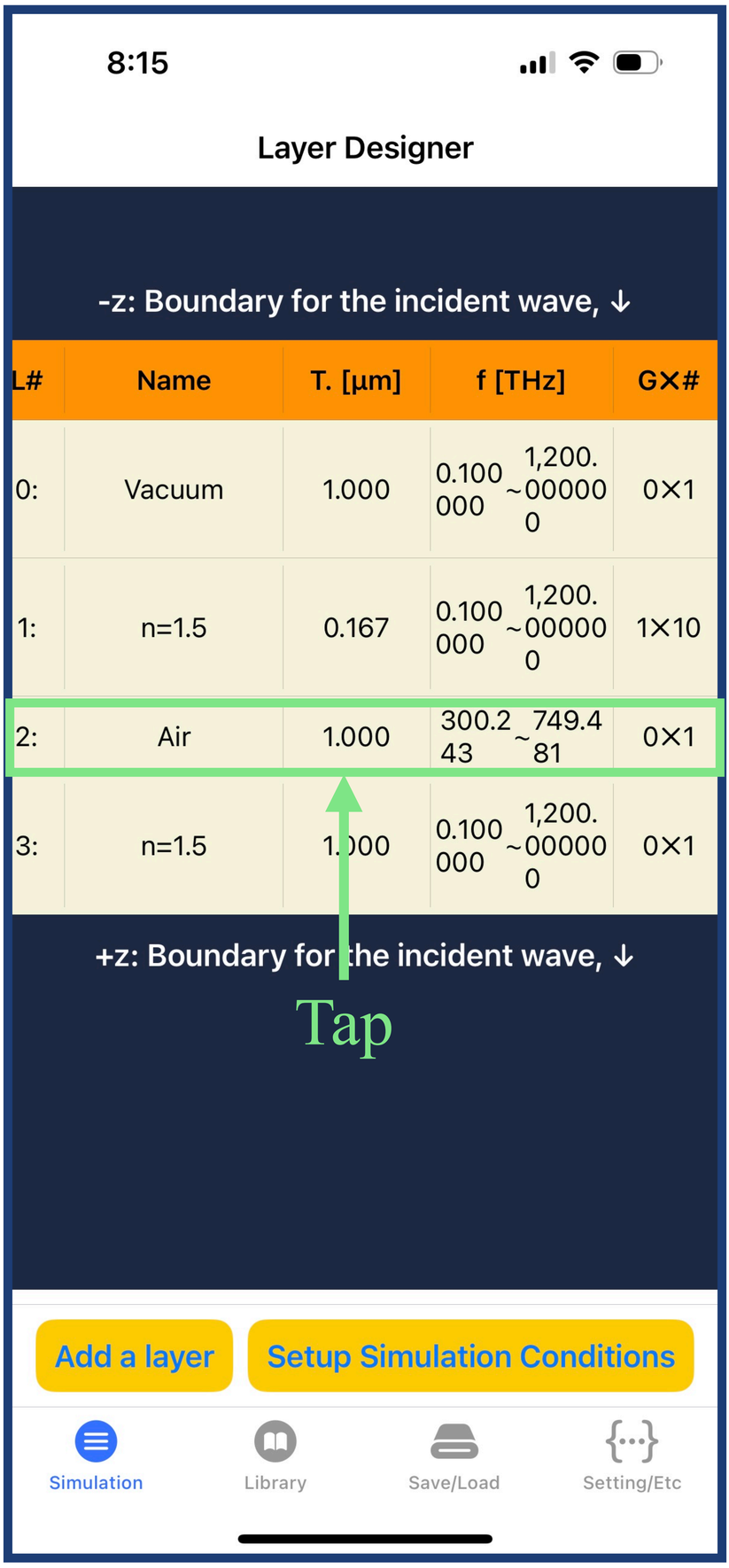
17. Tap the “Thickness” field and enter 0.1666666667. After you tap “Material”, select “n=1.5” to choose the material. Then, change “Group Index” to 1 and “Group Repeat Number” to 10. After that, tap “Apply” button.



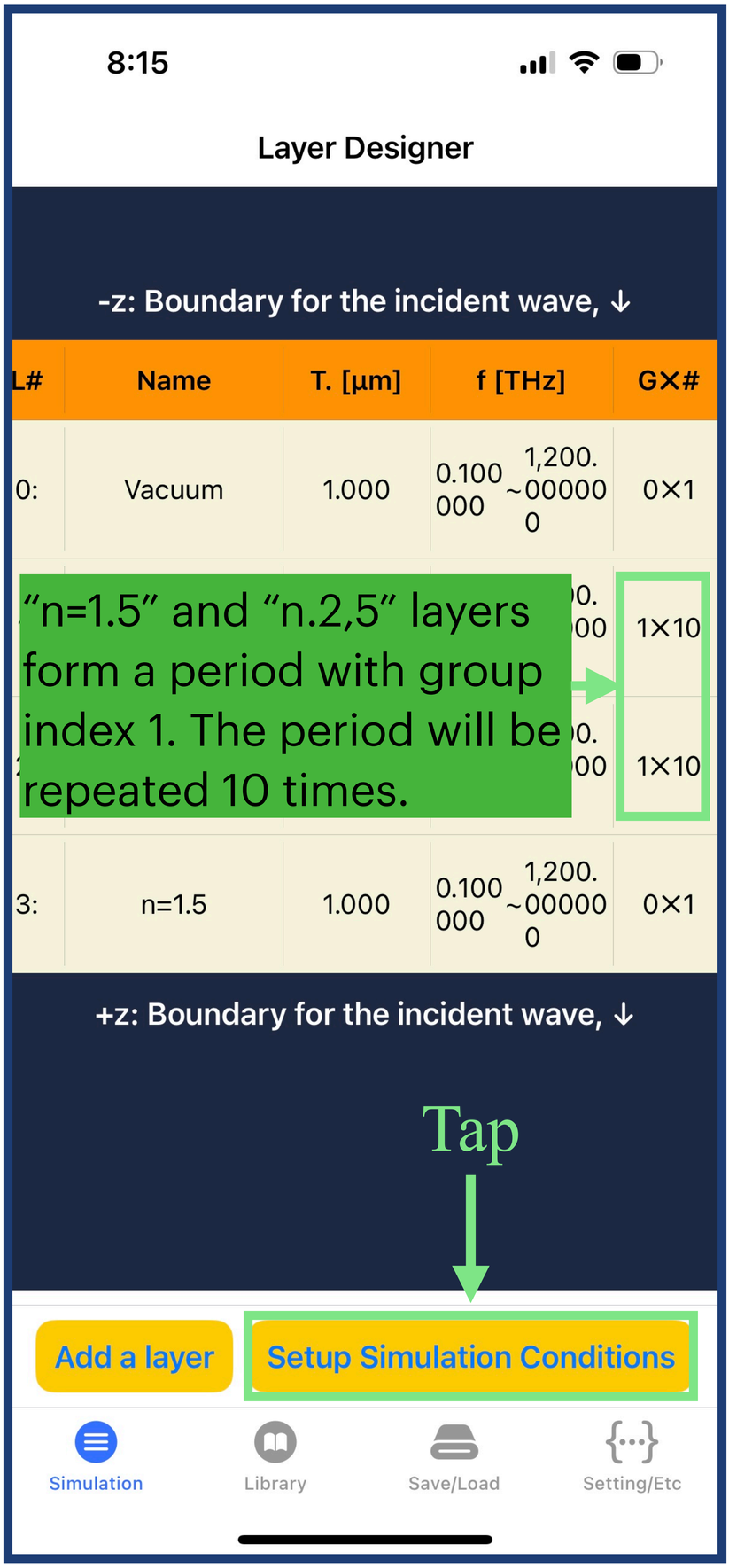
18. Tap row L#3 and then select the material named “n=1.5”. It becomes the boundary material for +z direction. It can be thought of as an infinite substrate in this tutorial.



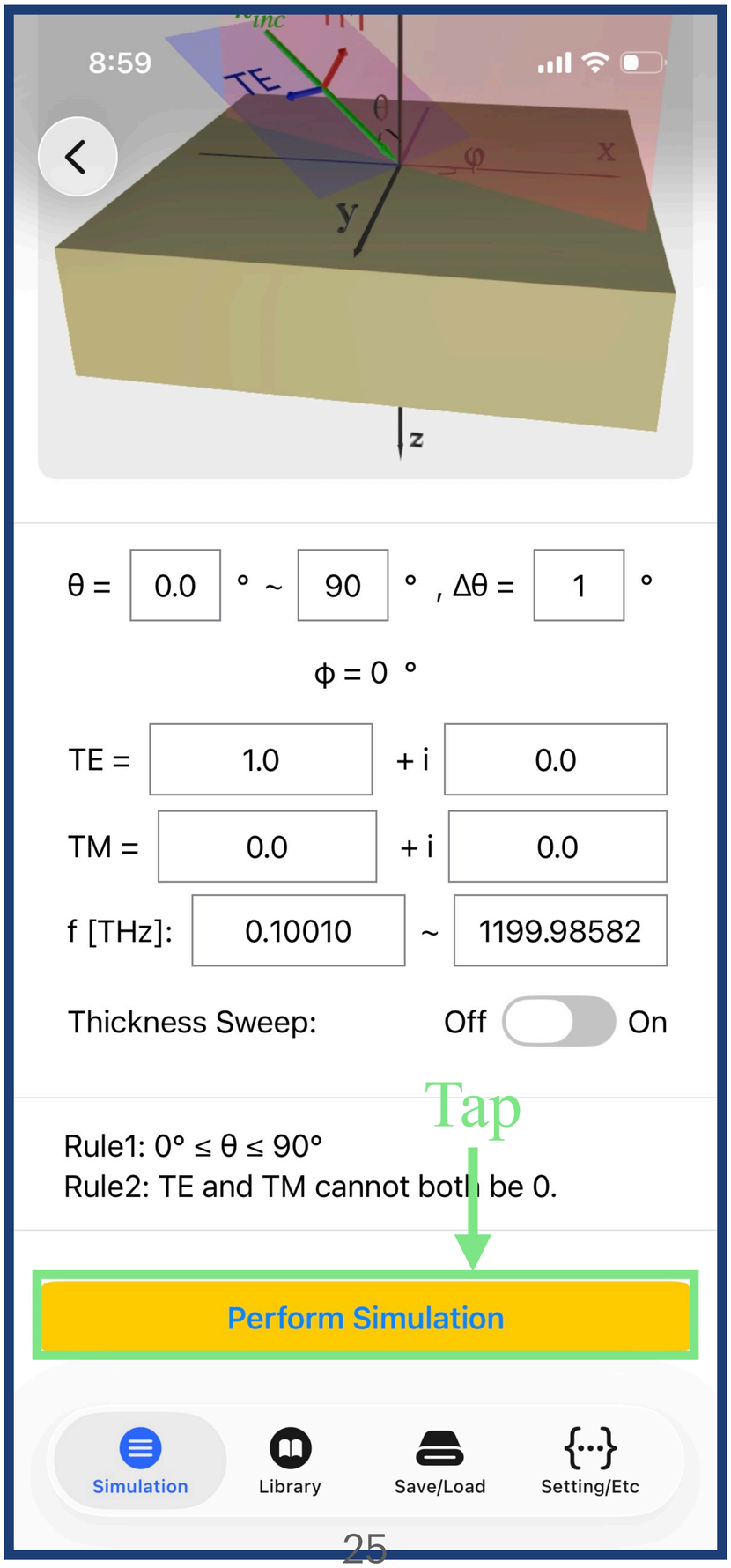
19. Choose the material “2.5” after tapping the L#2 row. Also, change the thickness to 0.1, set the group index to 1, and set the group repeat number to 10.



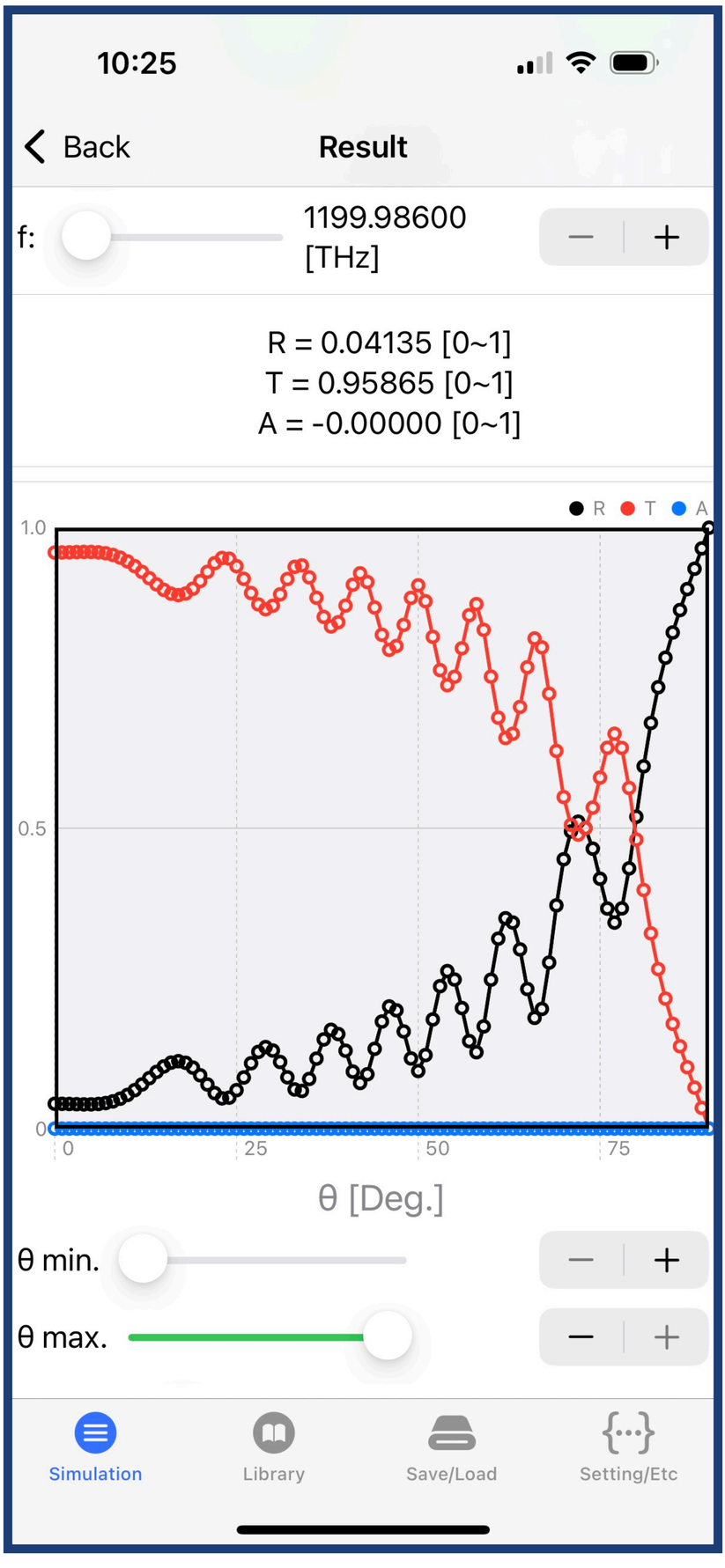
20. When identical group indices exist adjacently right below or above, a periodic structure is internally created. Such a period is repeated as the group repeat number. Tap the “Setup Simulation Conditions” button.



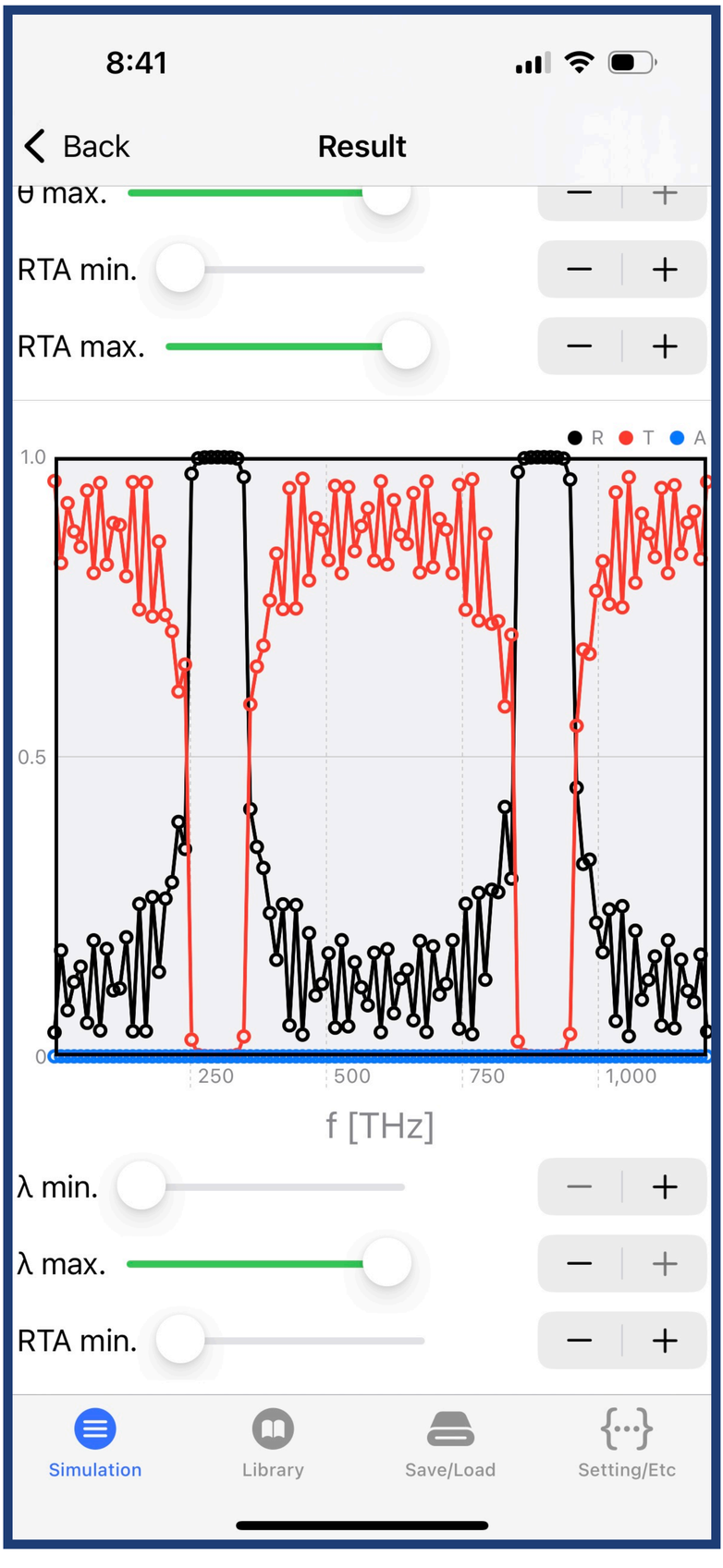
21. Simulating only for $\theta = 0.0^\circ$ is enough to recalculate the target reference. However, we fill in $\theta = 0.0^\circ \sim 90.0^\circ$ with $\Delta\theta = 1^\circ$ to practice more features of E2M. TE polarization is kept to 1.0. After all settings are configured, tap “Perform Simulation” button.



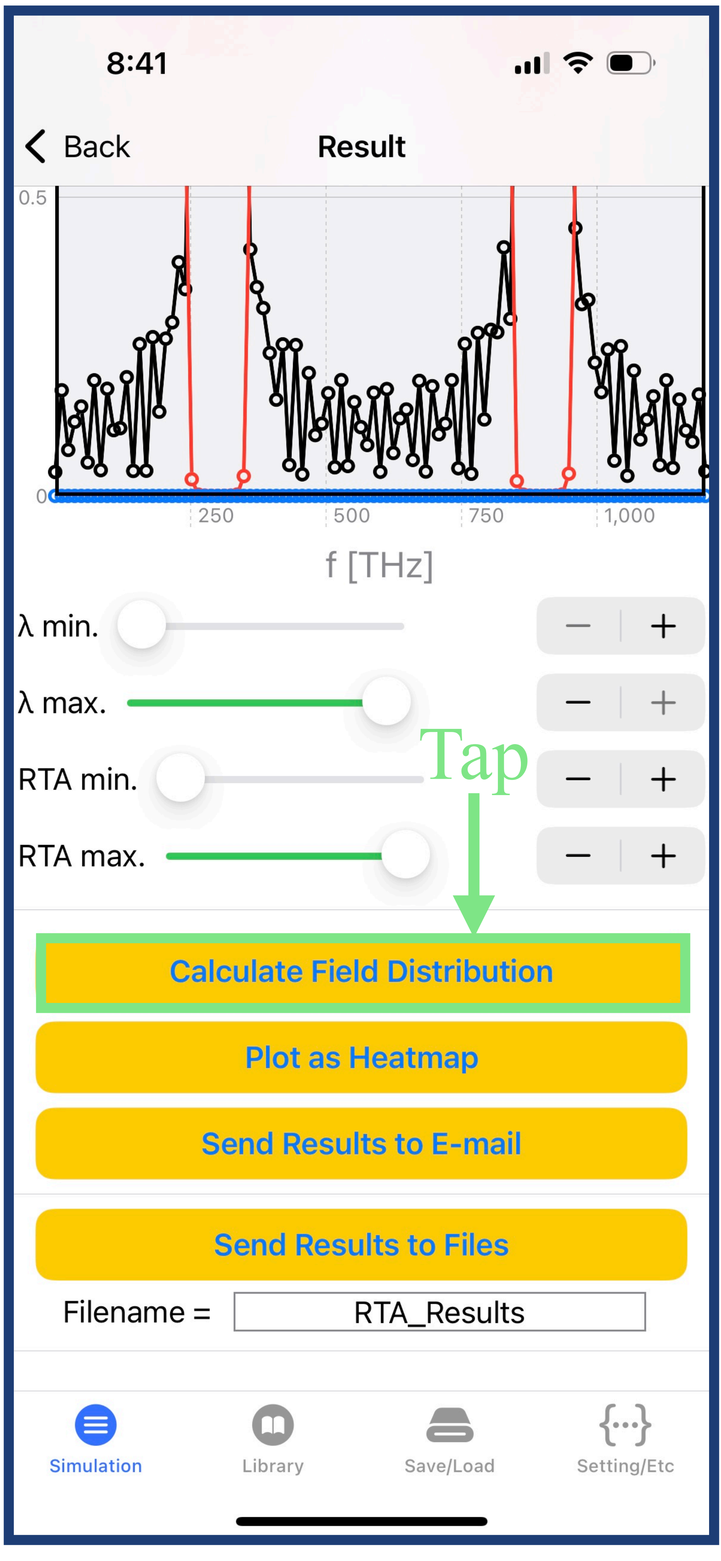
22. By slightly swiping up, we can see the RTA vs. θ figure. If users control the slide bar or −/+ buttons for f, then the RTA vs. θ figure will be redrawn to present the result as a function of frequency.



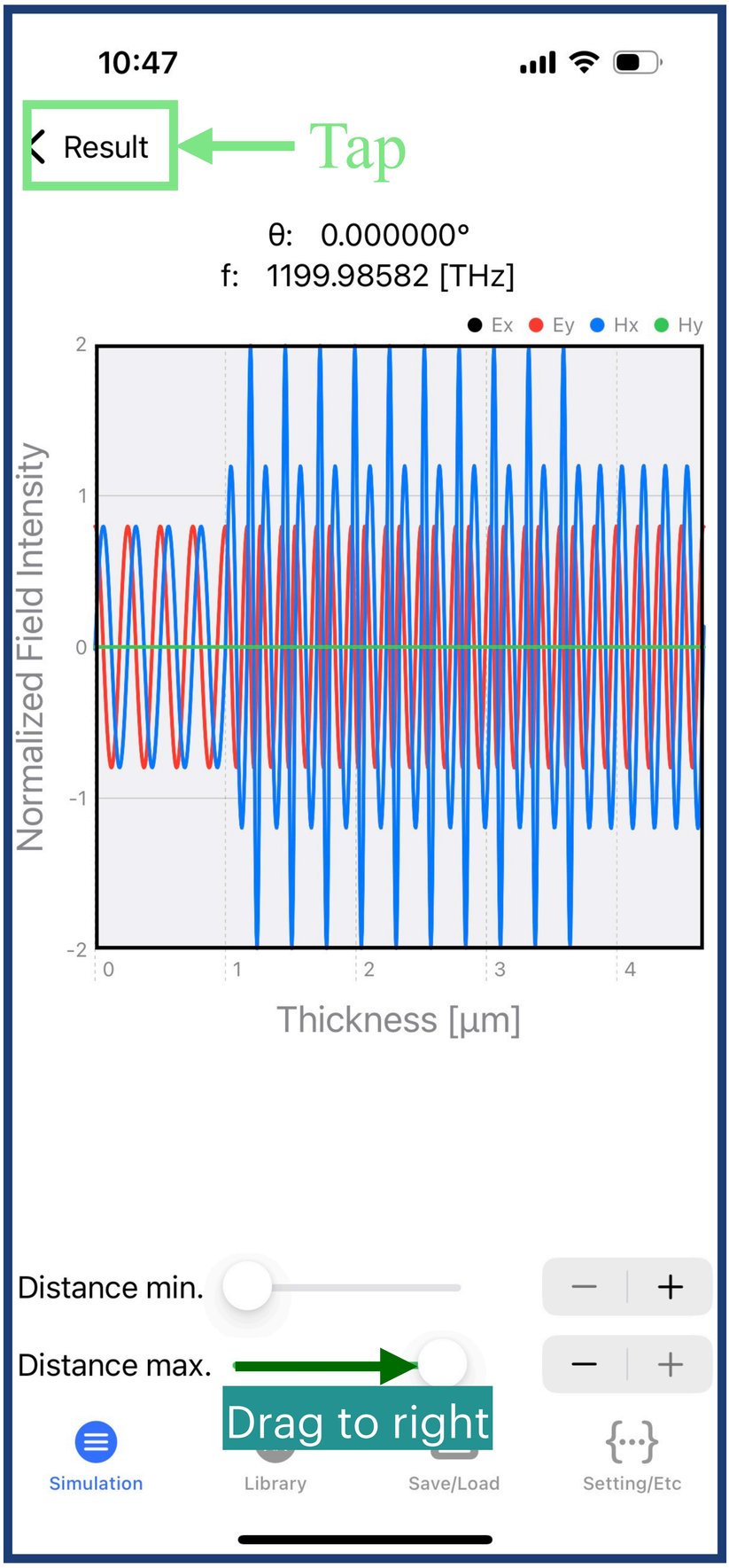
23. By swiping up more, we can see RTA vs. f figure. It shows very similar R result with the reference's lower-side figure. If you want to observe a better matching result, increase the "# of f for RTA" after tapping "Setting/Etc" icon.



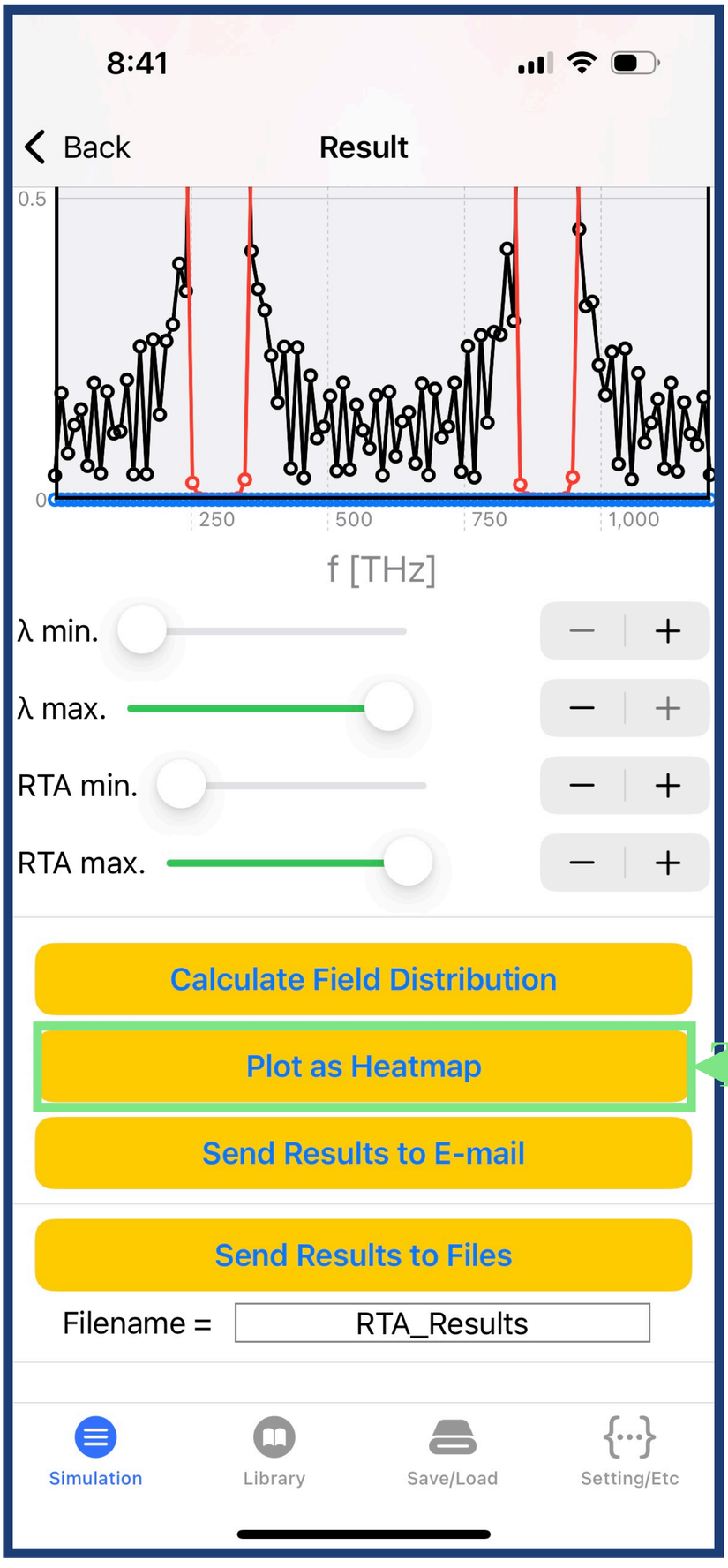
24. By swiping up more, we can see several buttons. Among those, tap “Calculate Field Distribution”. Then, E_x, E_y, H_x, and H_y field distributions are calculated as functions of depth. Before tapping, users may try to control the not-introduced sliders and −/+buttons freely.



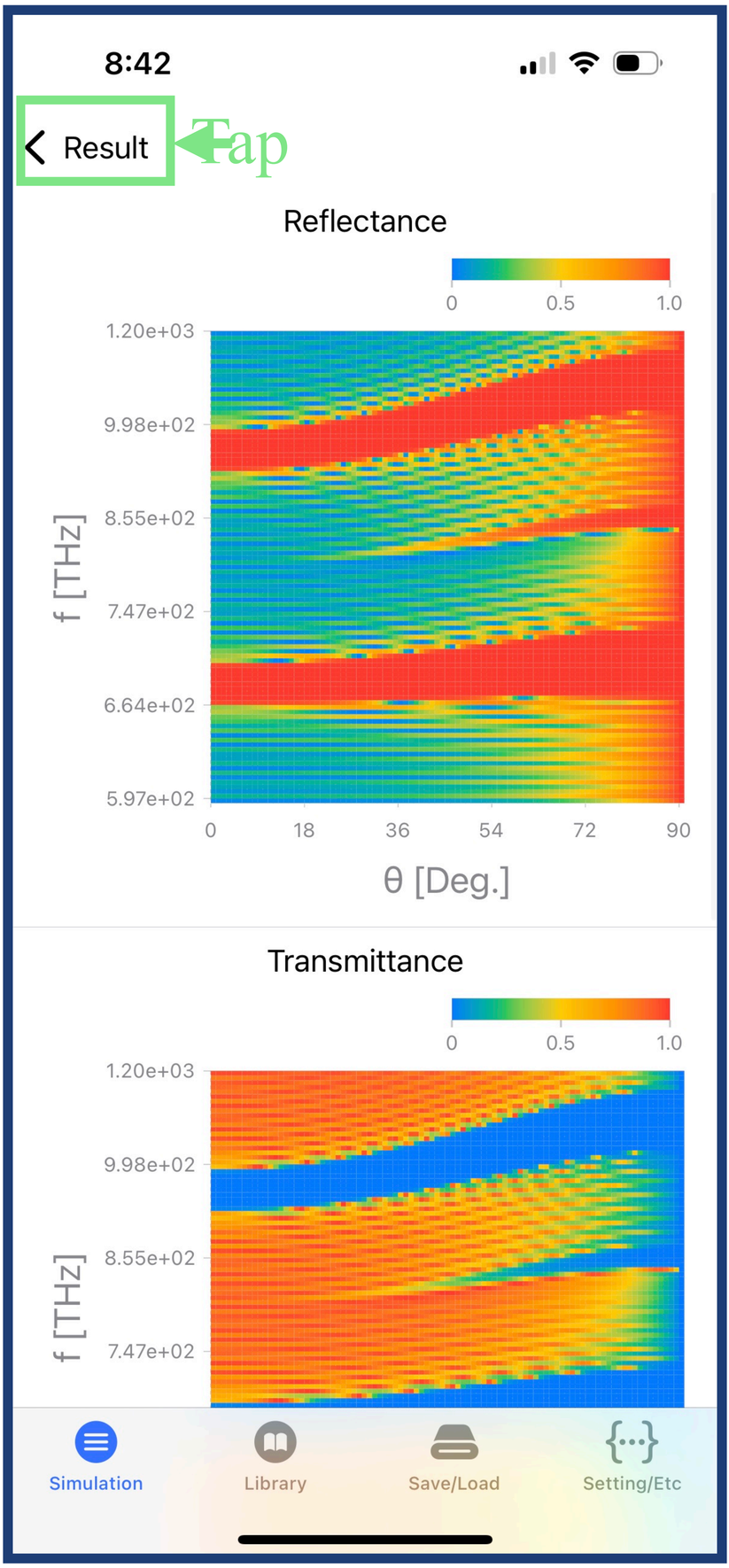
25. Drag the “Distance max.” slider to the far right. Then, you may observe the field distribution. Each field is shown in a normalized state. After observation, tap the “< Result” button.



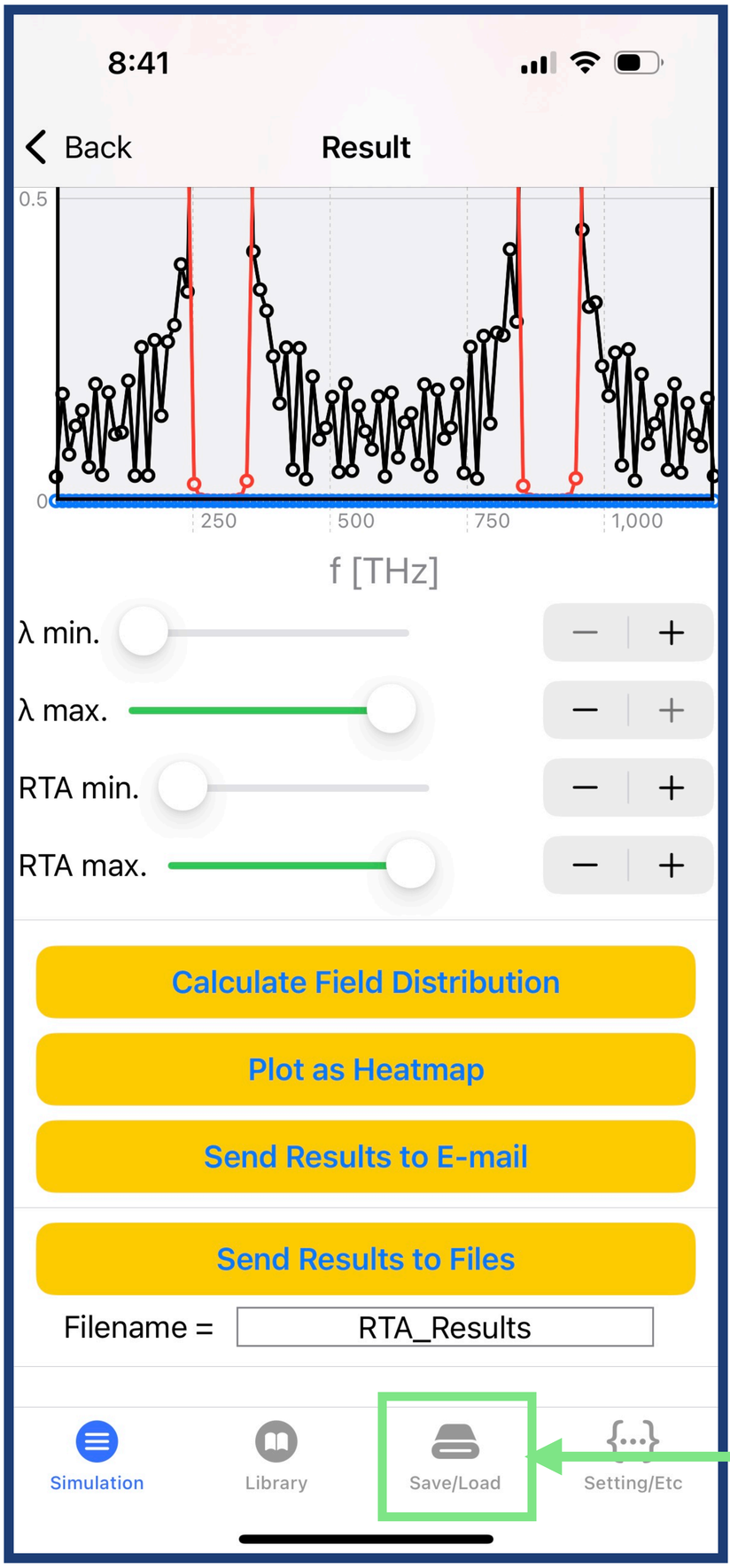
26. As a next, tap the “Plot as Heatmap” button.



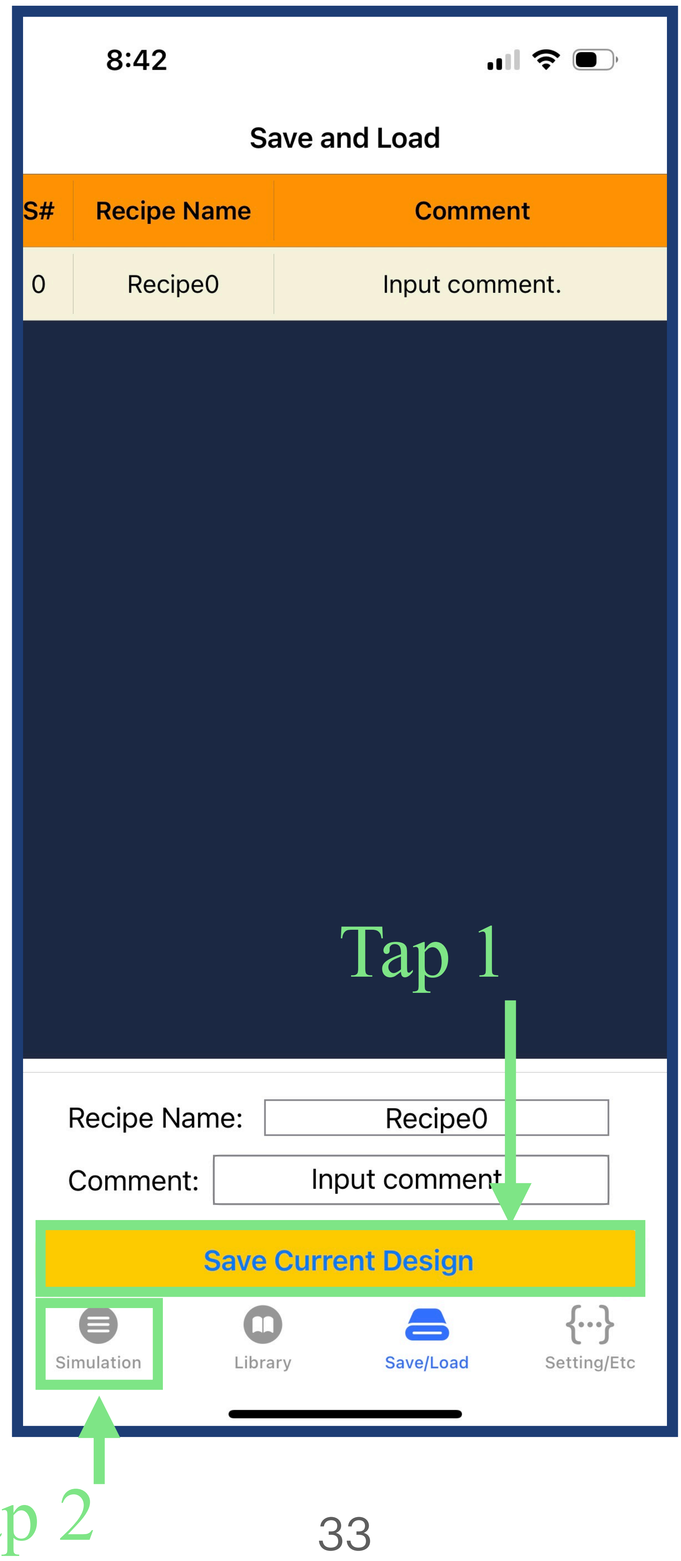
27. Observe heatmap plots of reflectance, transmittance and absorptance by swiping up and down. Then tap the “< Result” button to go back.



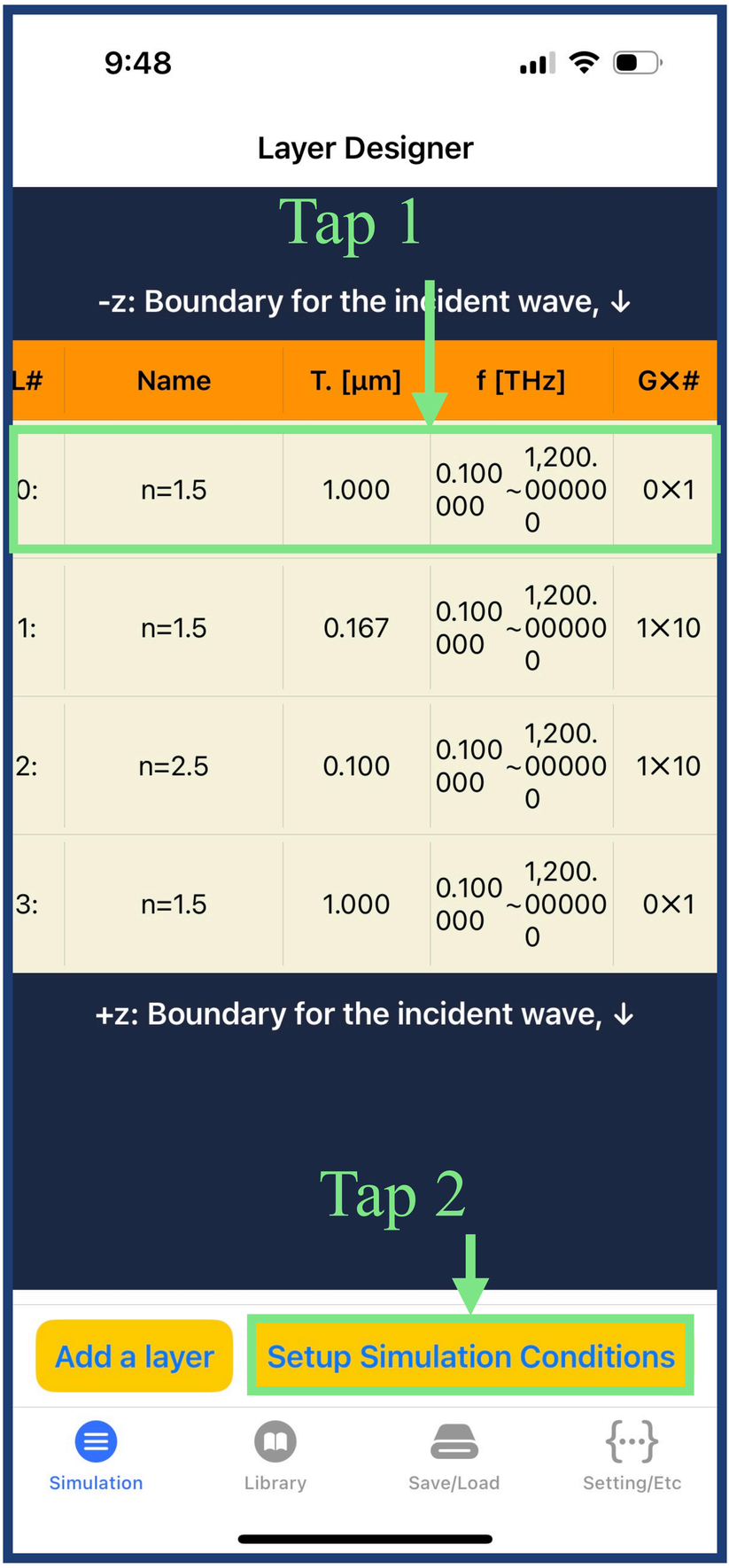
28. Raw data and figures can be exported. To export, tap “Send Results to E-mail” or “Send Results to Files”. Also, designed layers and simulation conditions can be saved in E2M. Tap the “Save/Load” icon.



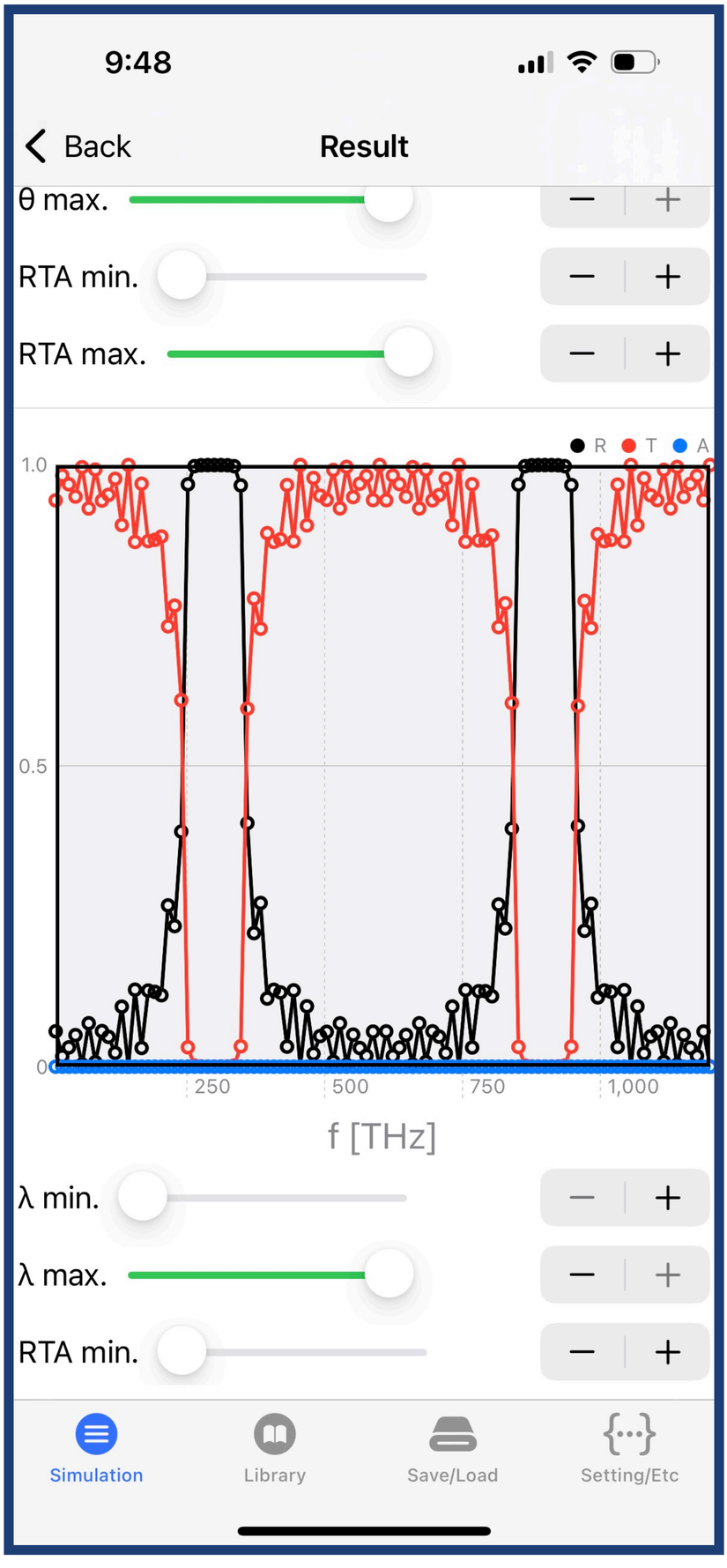
29. Input “Recipe Name” and “Comment” fields. Afterward, tap the button labeled “Save Current Design”. If you want to load your previously saved design, tap a row of S# what you want to load, then tap the “Load This Recipe” button. We have one more figure of reference to recalculate. Tap the “Simulation” icon after saving.



30. Go to the “Layer Designer” page. Next, tap row L#0, and change the material from “Vacuum” to “n=1.5” as shown below. After that, perform a simulation under the identical conditions performed before.



31. After performing the simulation, we can observe the RTA vs. f spectrum as below. Extracted results show identical results to the upper-side figure of the reference.



(For Polarization States)

In the simulation settings, users can input complex polarization states for TE and TM modes. Utilizing this feature makes it possible to generate any polarization type (linear, elliptical or circular) to analyze how light interacts with the device. However, in v1.25, the polarization states of reflected or transmitted light can only be analyzed indirectly by exporting the result data to ".csv" files. The export includes frequency domain field components. Users can reconstruct the polarization characteristics by multiplying the results by $e^{-j\omega t}$. The next version of E2M-iOS will include integrated visual analysis tools for polarization.