

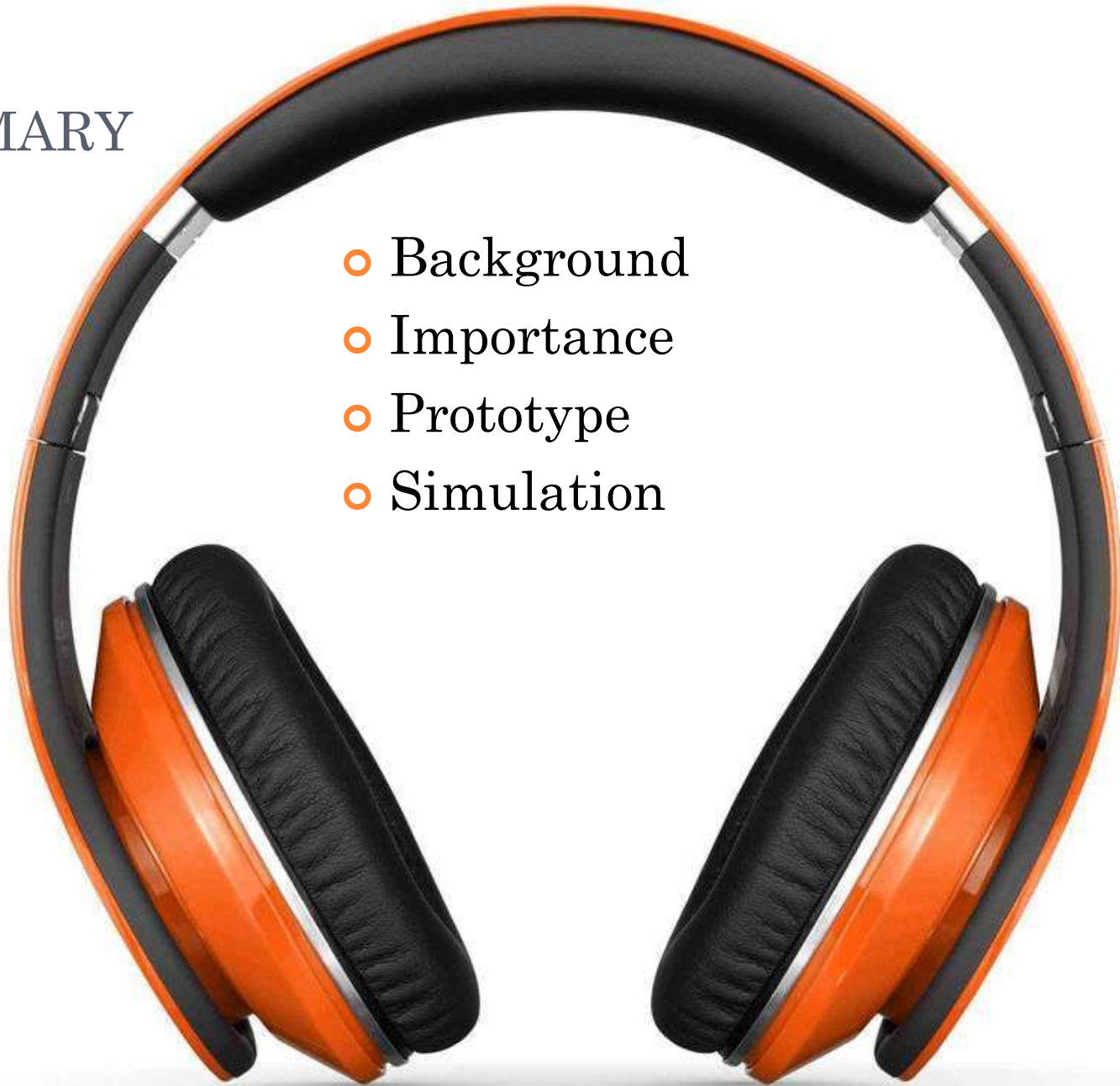


ELECTRONIC LOUDSPEAKER

A.Karthikeyan, AP/ECE

SUMMARY

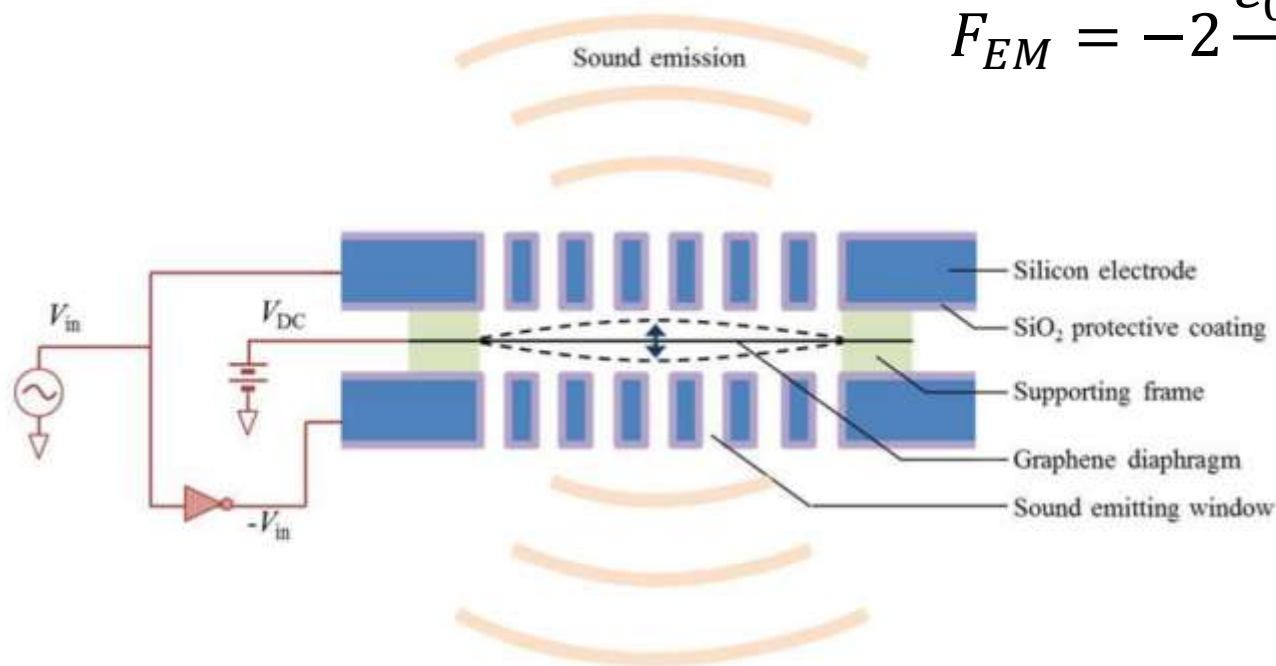
- Background
- Importance
- Prototype
- Simulation



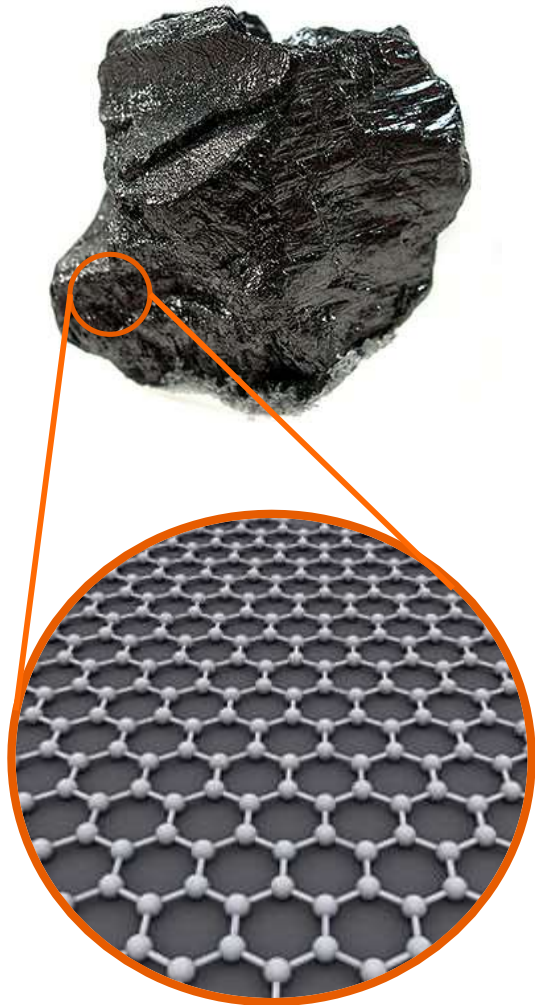
WHAT IS AN ELECTROSTATIC LOUDSPEAKER?

- AC voltage perforated capacitor
- Insulating frame
- DC voltage biased membrane

$$F_{EM} = -2 \frac{\epsilon_0 A V_{DC} V_{in}}{d^2} e^{i\omega t} \hat{z}$$



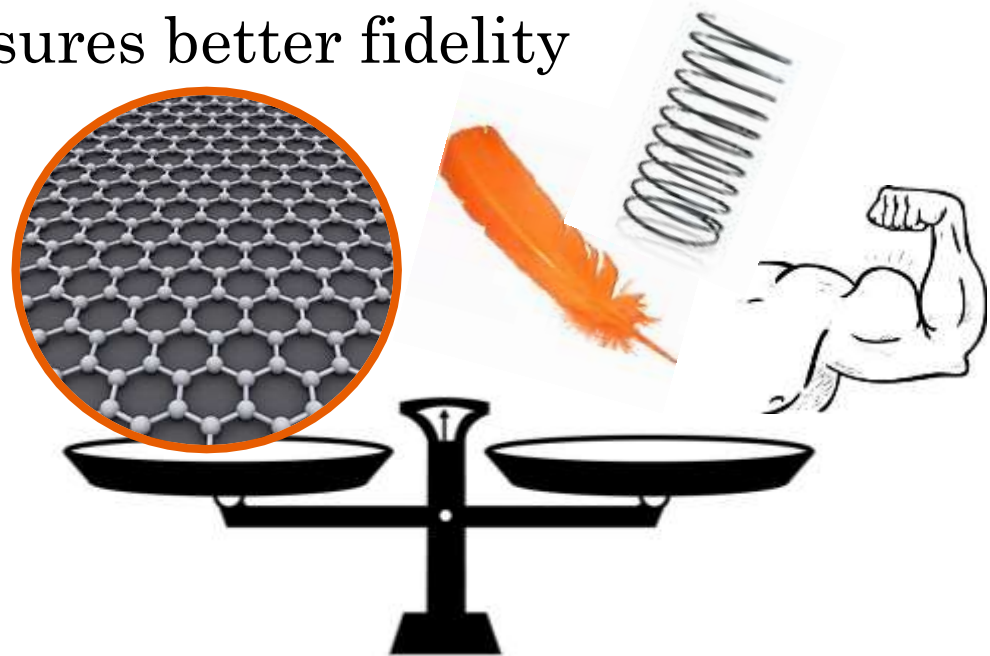
GRAPHENE



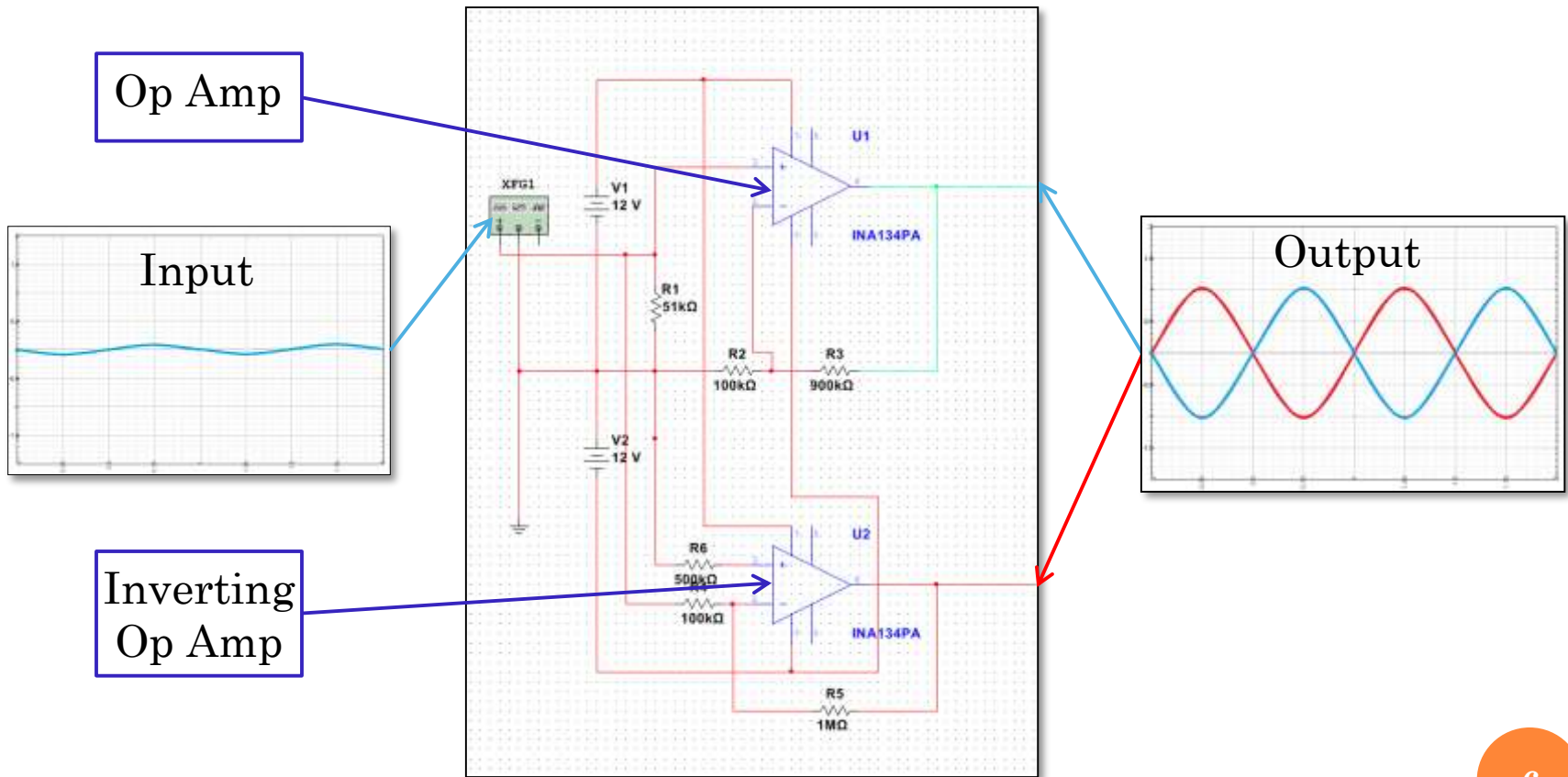
- One atom thick layer of graphite
- Hexagonal pattern of carbon atoms
- Low resistivity
- Low mass
- Low spring constant
- High strength

WHY A GRAPHENE ELECTROSTATIC LOUDSPEAKER?

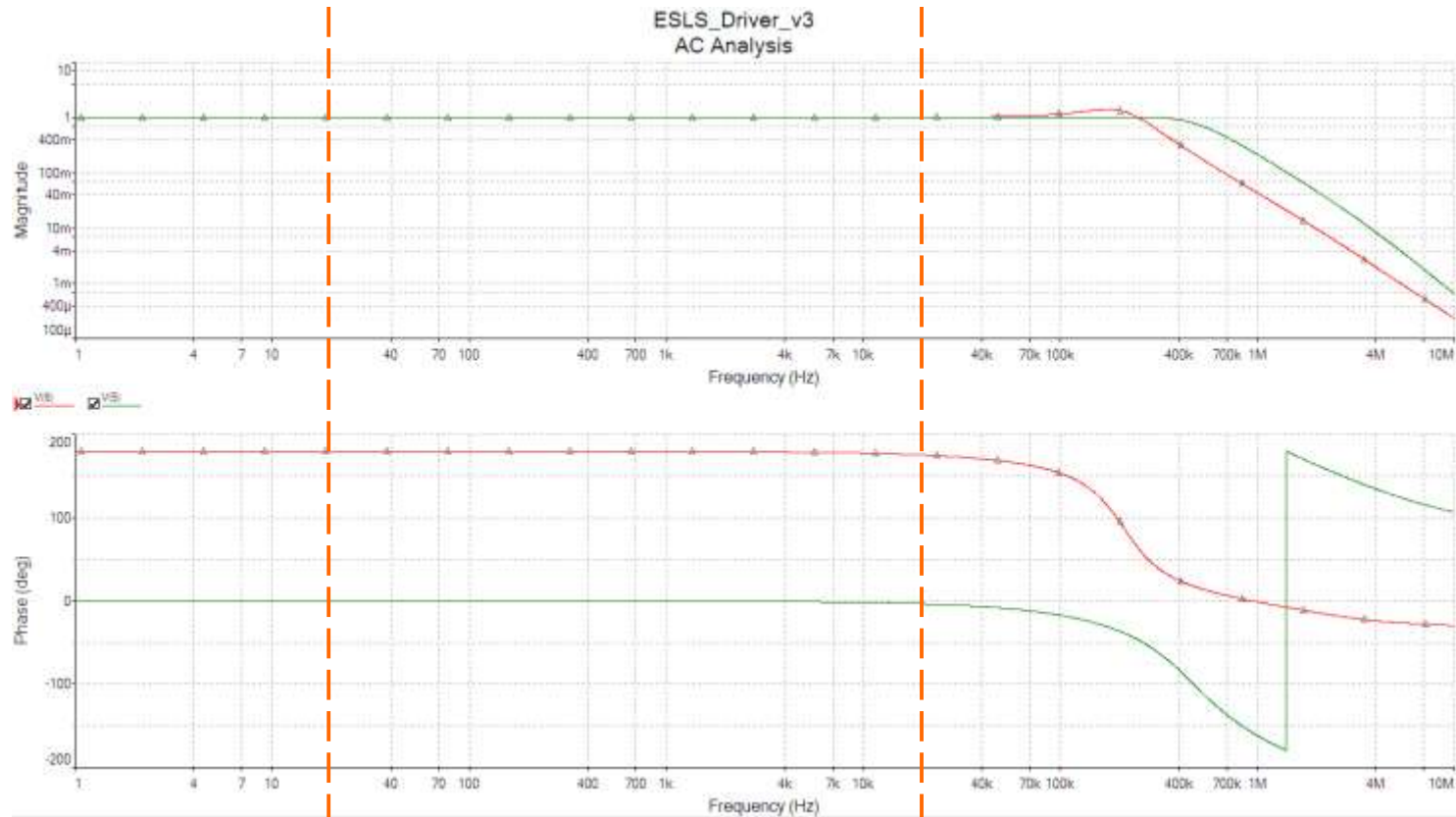
- Thinness and low mass density allow for smaller sized speaker
- Low mass, low spring constant, and high strength produces a great overall frequency response
- High strength ensures better fidelity



VOLTAGE DRIVER DESIGN



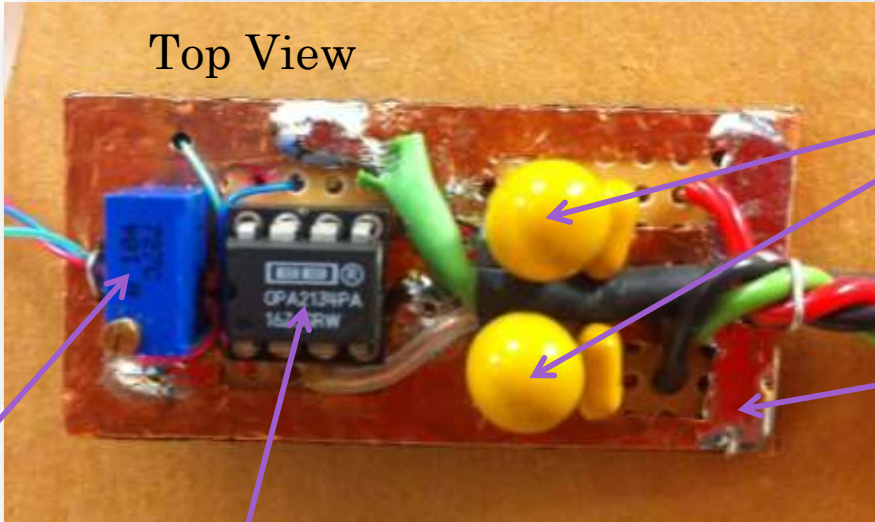
FREQUENCY AND PHASE RESPONSE OF DRIVER



Range of hearing

VOLTAGE DRIVER

Top View



Capacitors

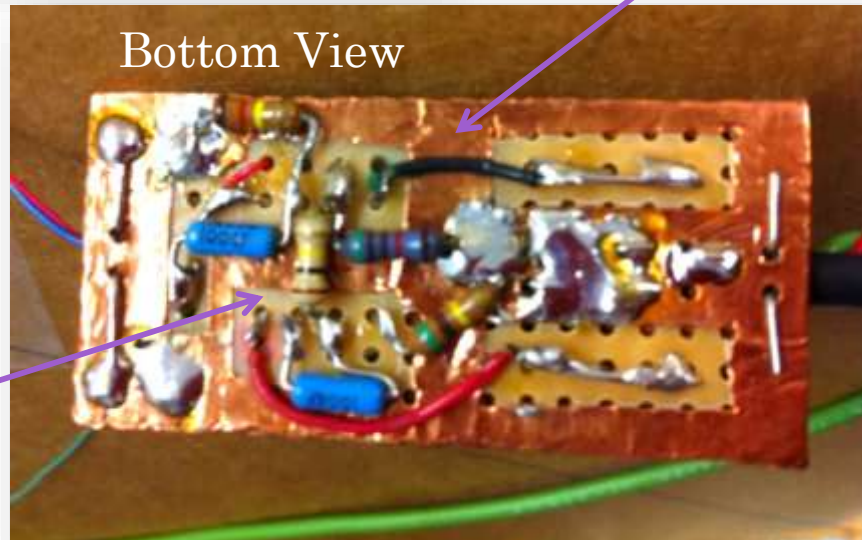
Copper Foil
Grounding Plane

Trimpot
Resistor

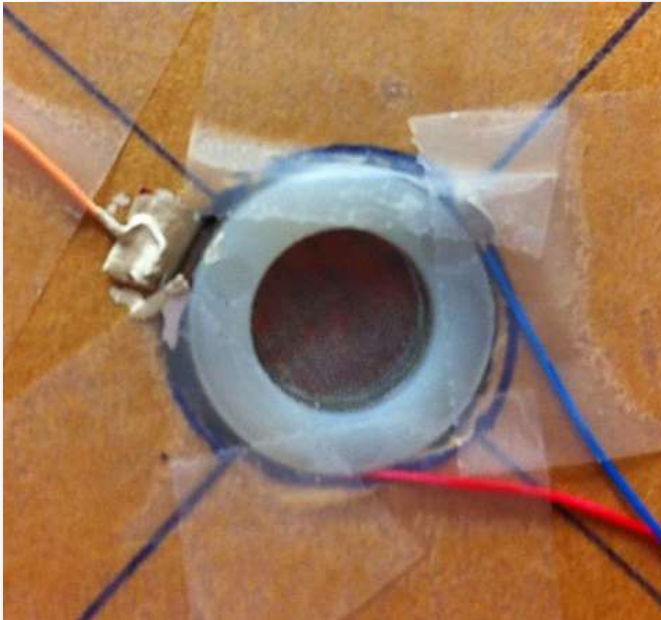
Op Amp
Electronic
Component

Resistors

Bottom View



ELECTROSTATIC LOUDSPEAKER PROTOTYPES



Aluminized Mylar Membrane

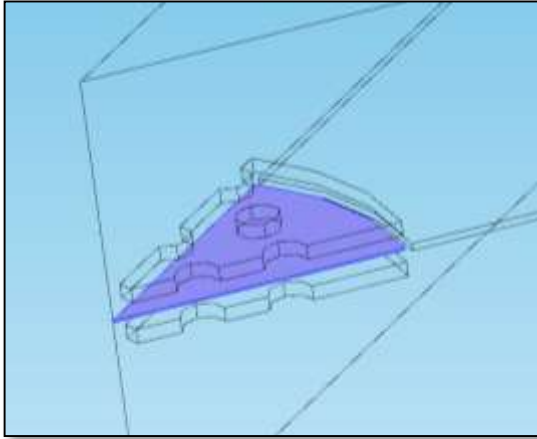
- Steel mesh capacitor plates
- Nylon washer spacers (1.676 mm)

Graphited Mylar Membrane

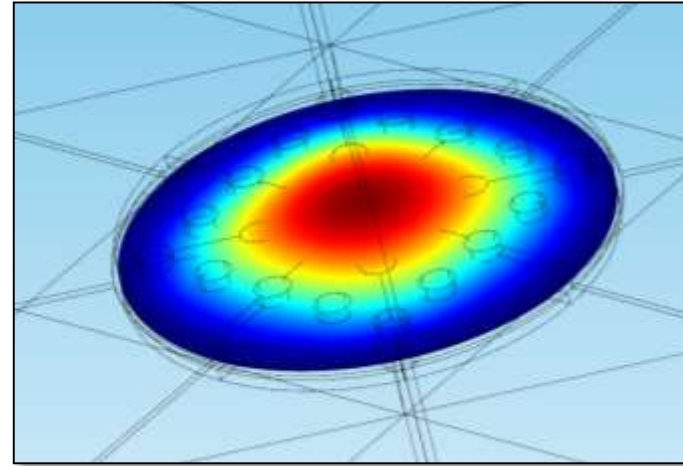
- Steel mesh capacitor plates
- Hole punch reinforcement sticker spacers (0.127 mm)

SIMULATION

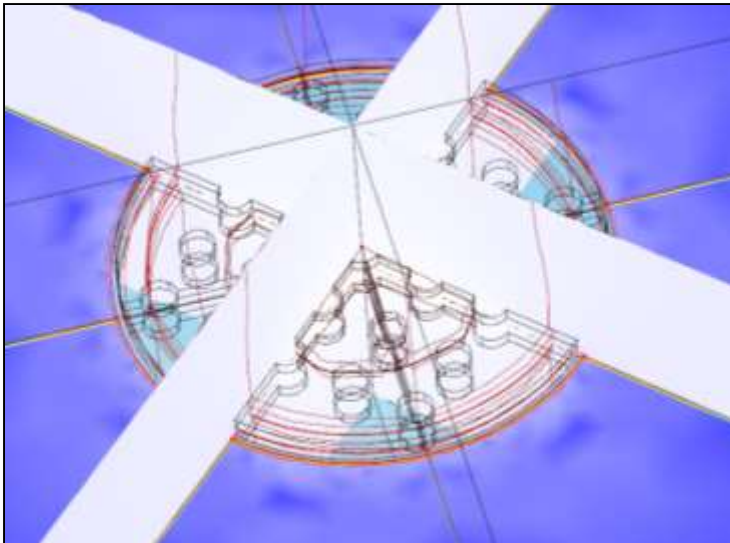
Geometry



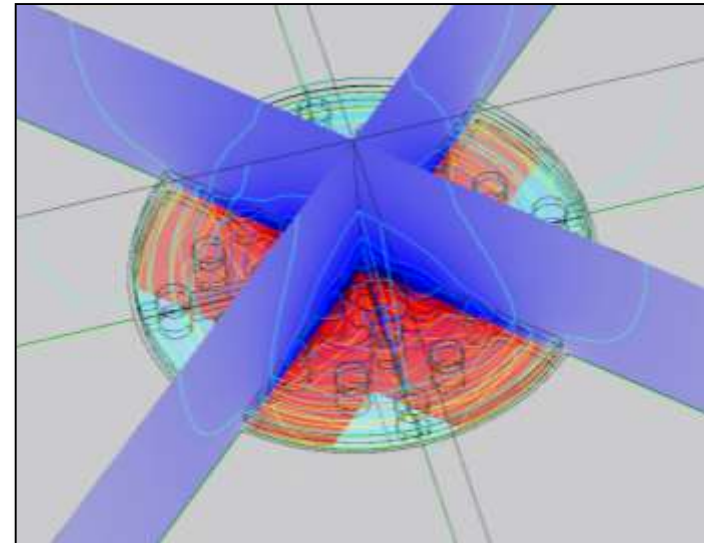
Displacement at 766.5 Hz



Sound Pressure Level at 1kHz



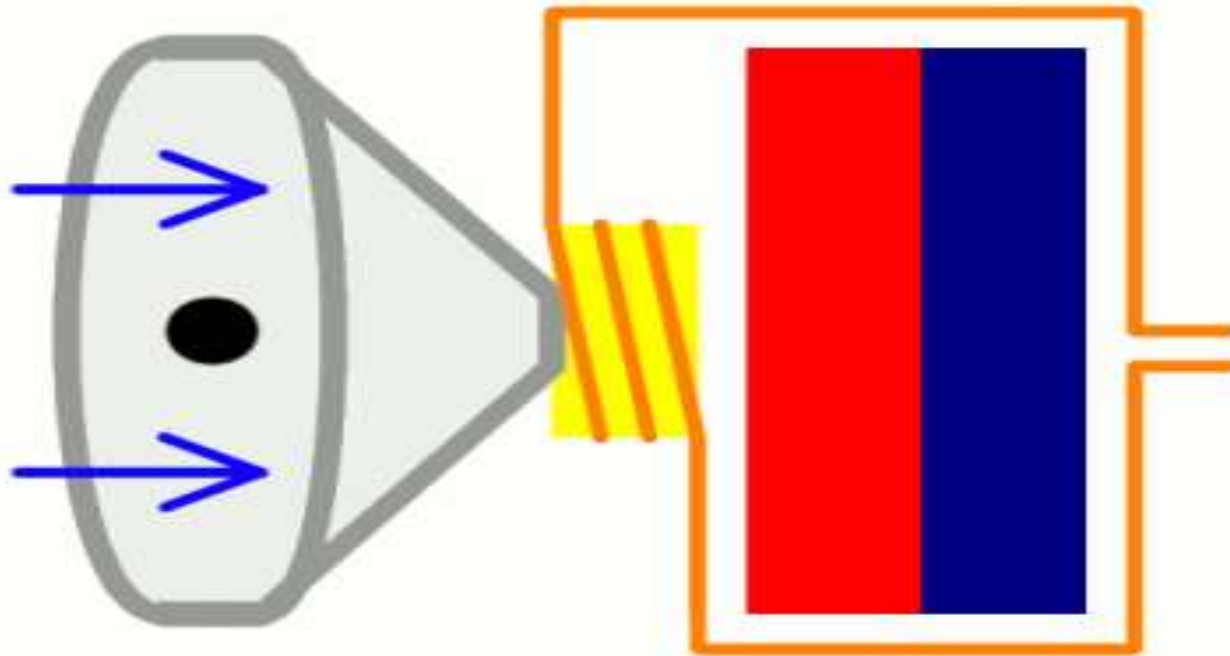
Acoustic Pressure Field at 1kHz



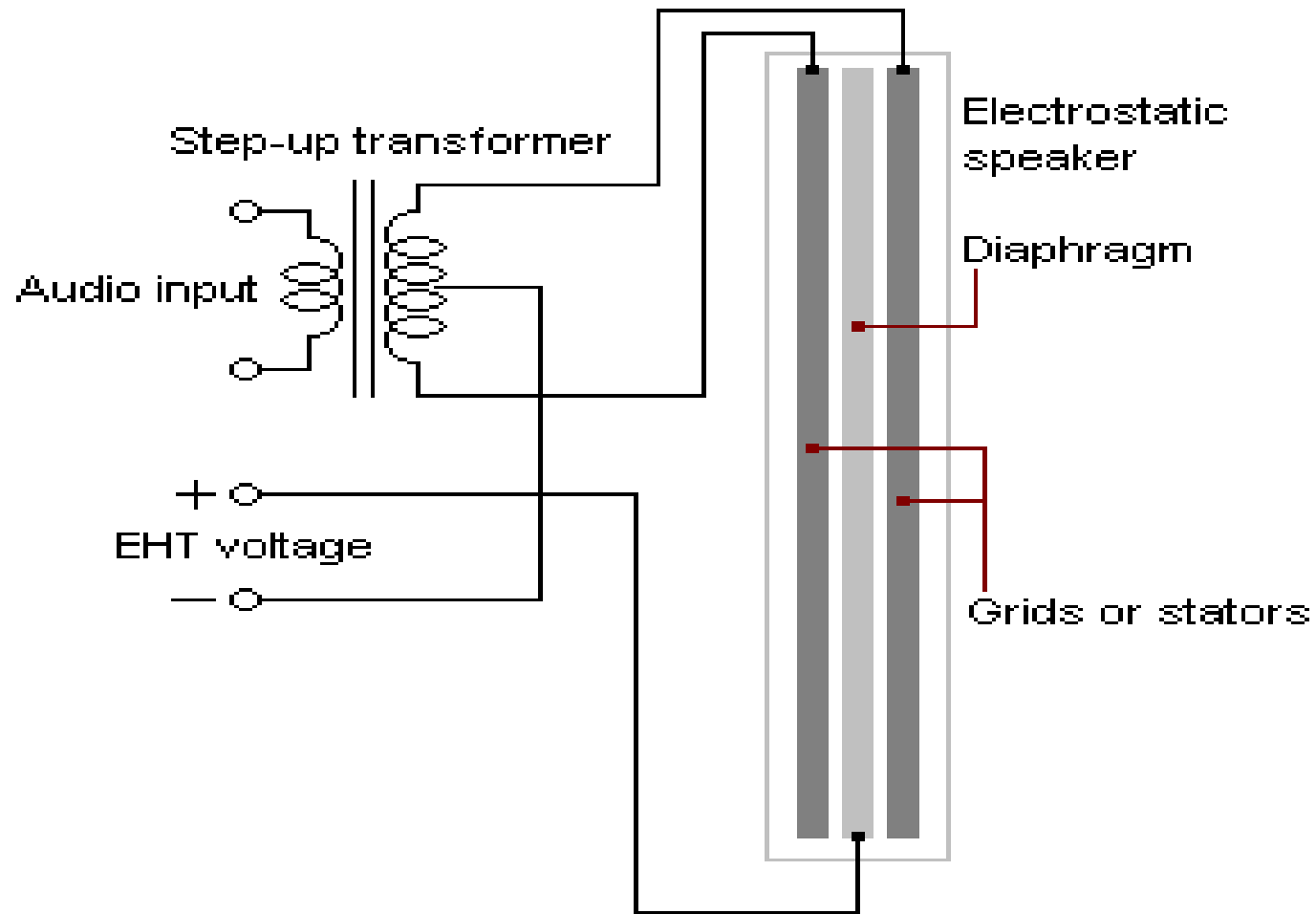
Cone

Coil

Magnet



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CONCLUSIONS

- Graphene electrostatic loudspeakers should theoretically be better than current headphone speakers
- The voltage driver circuit we made works well
- The simulation produces results we expected
- The prototypes produce results we expected
- Now we just need the graphene sheet...