

Thermoelectric Improvement of a MEMS-IR-Emitter Membrane

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Motivation

MEMS-IR emitters uniquely enable miniature gas concentration measurements in the MIR spectrum (NDIR sensors). Nevertheless, existing commercial MEMS-IR emitters fall short of achieving the anticipated operational frequencies (above 20 Hz), necessary for time-dependent measurements.

With Comsol simulations, we aim to enhance our emitter design to support operation at frequencies of up to 100 Hz. These design improvements must align with the constraints of an already established manufacturing process.

Emitter Concept

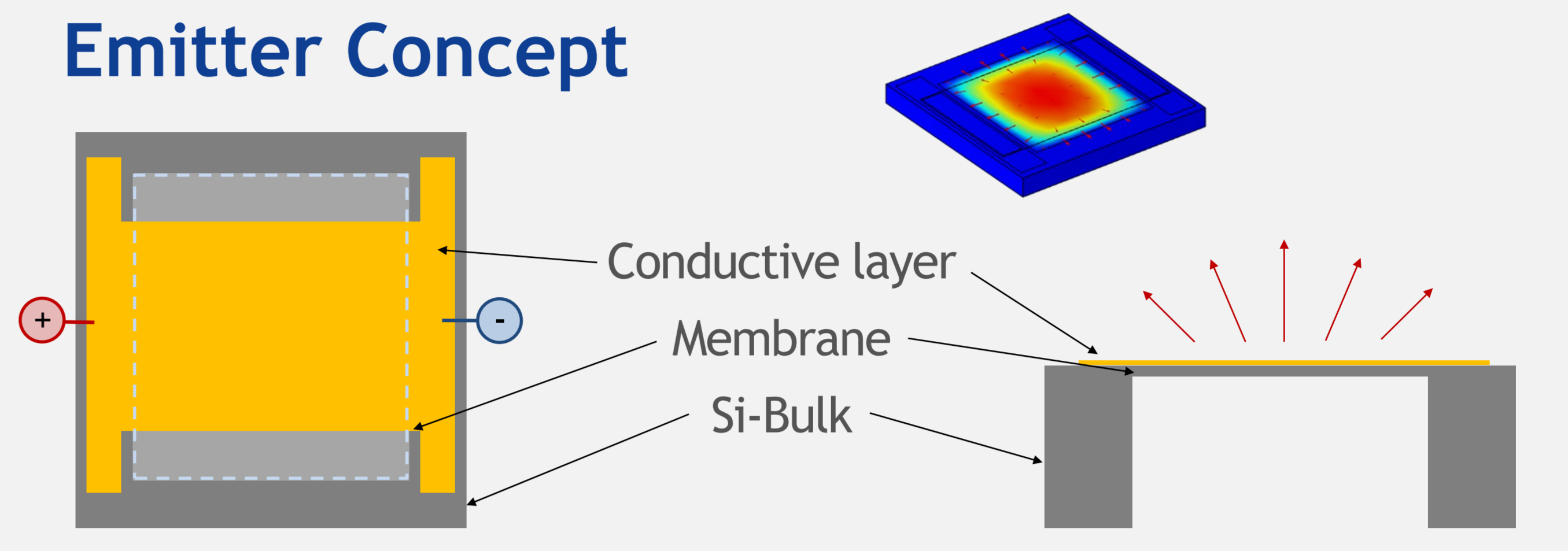


Figure of Merit

$$FOM = \frac{\Phi_{rad}}{\tau \cdot j_{max} \cdot T_{max}}$$

Φ_{rad} ... radiant flux

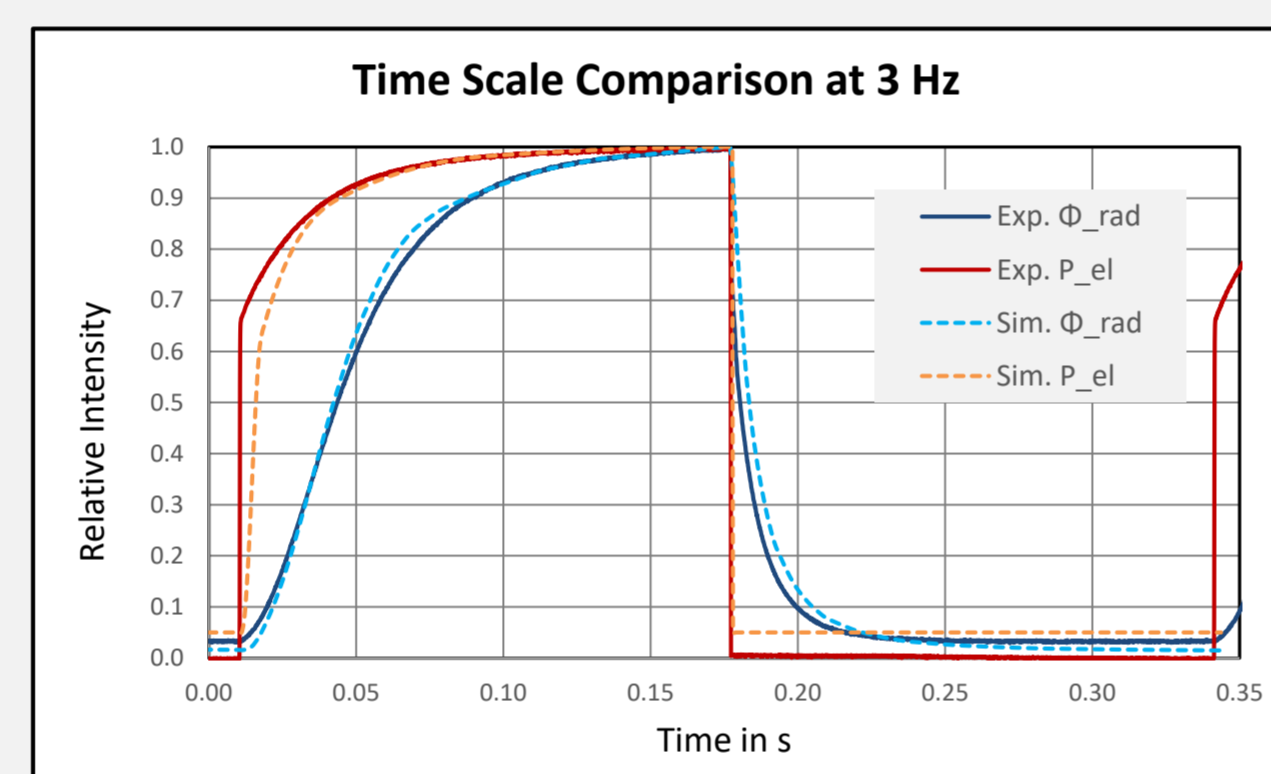
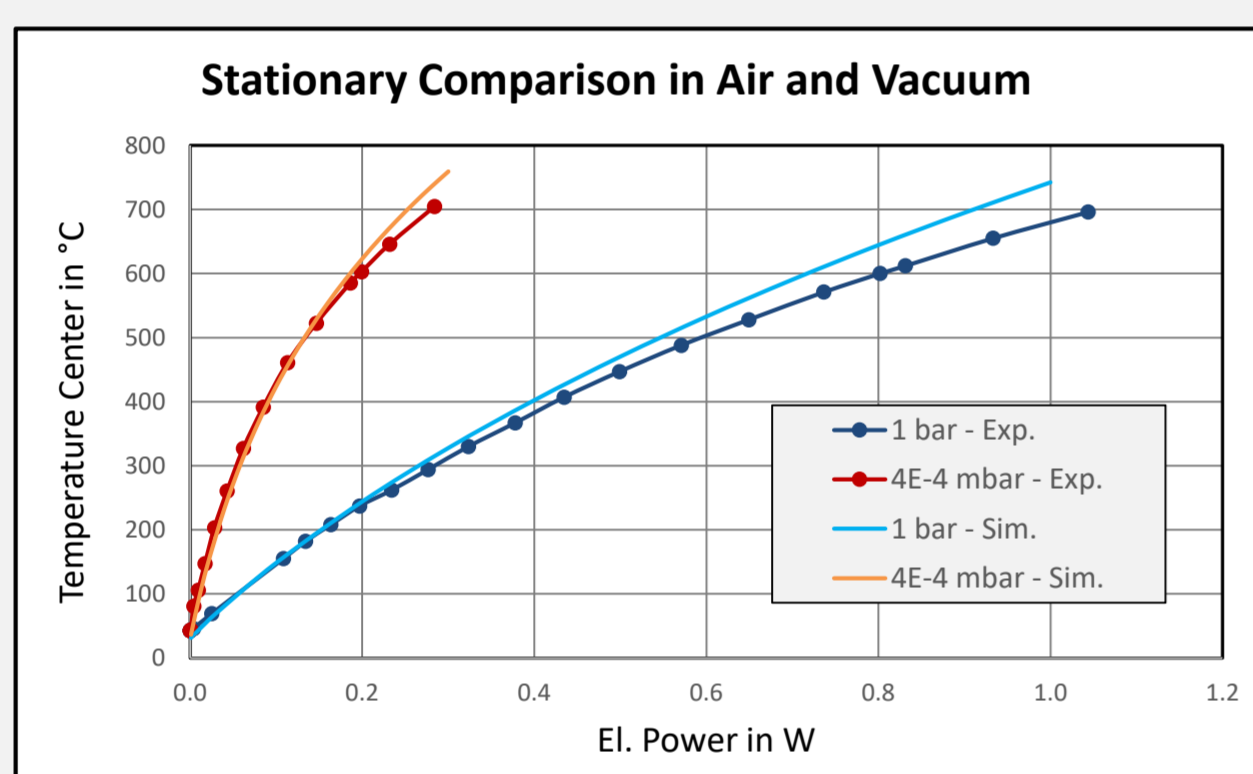
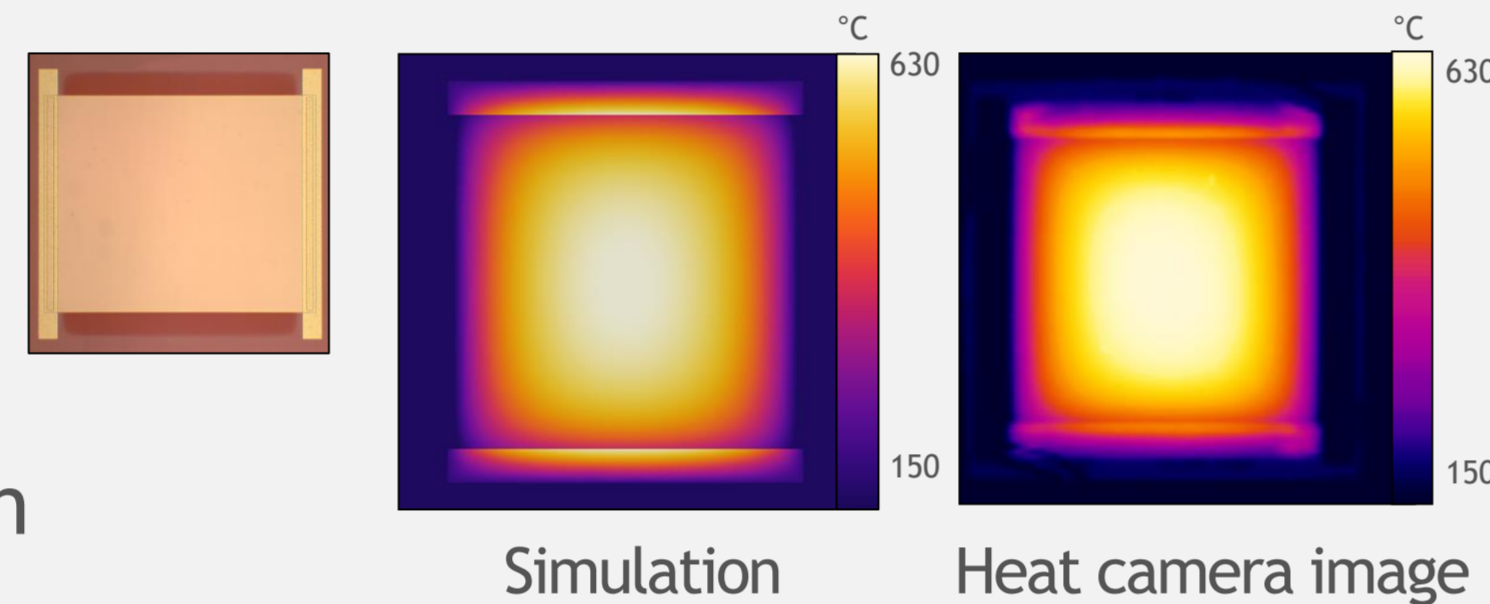
τ ... thermal time constant

j_{max} ... maximum current density

T_{max} ... maximum temperature

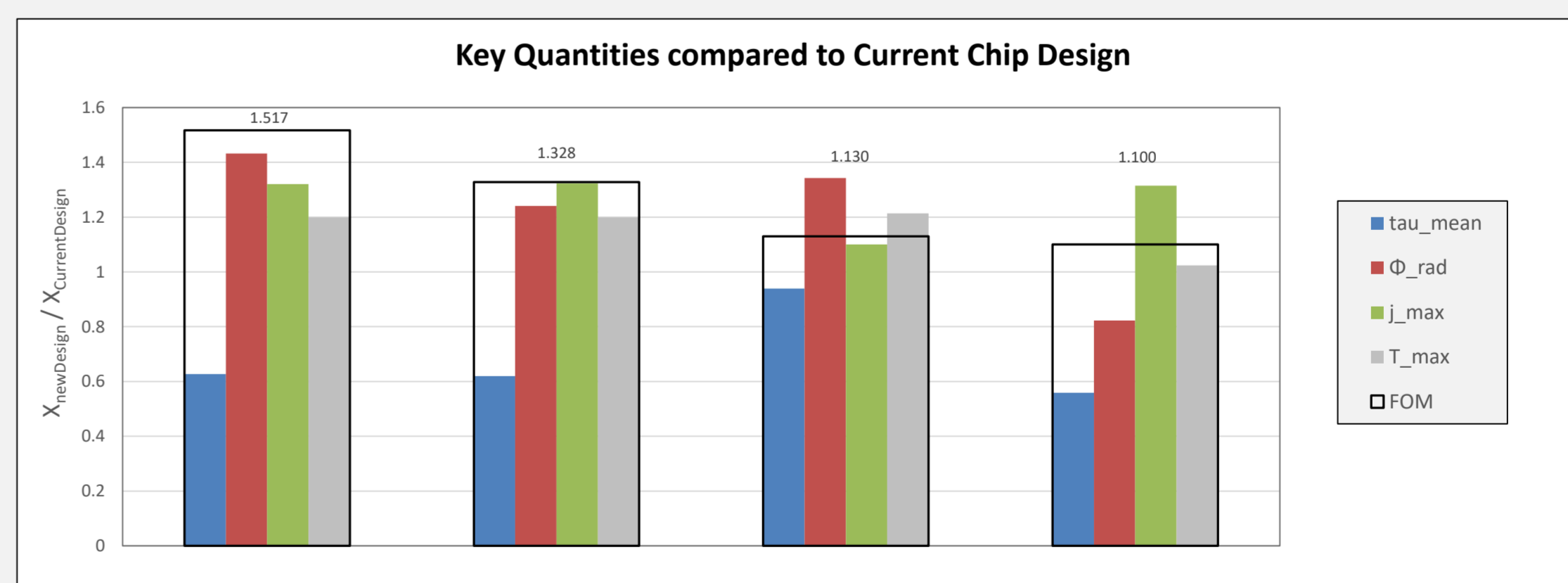
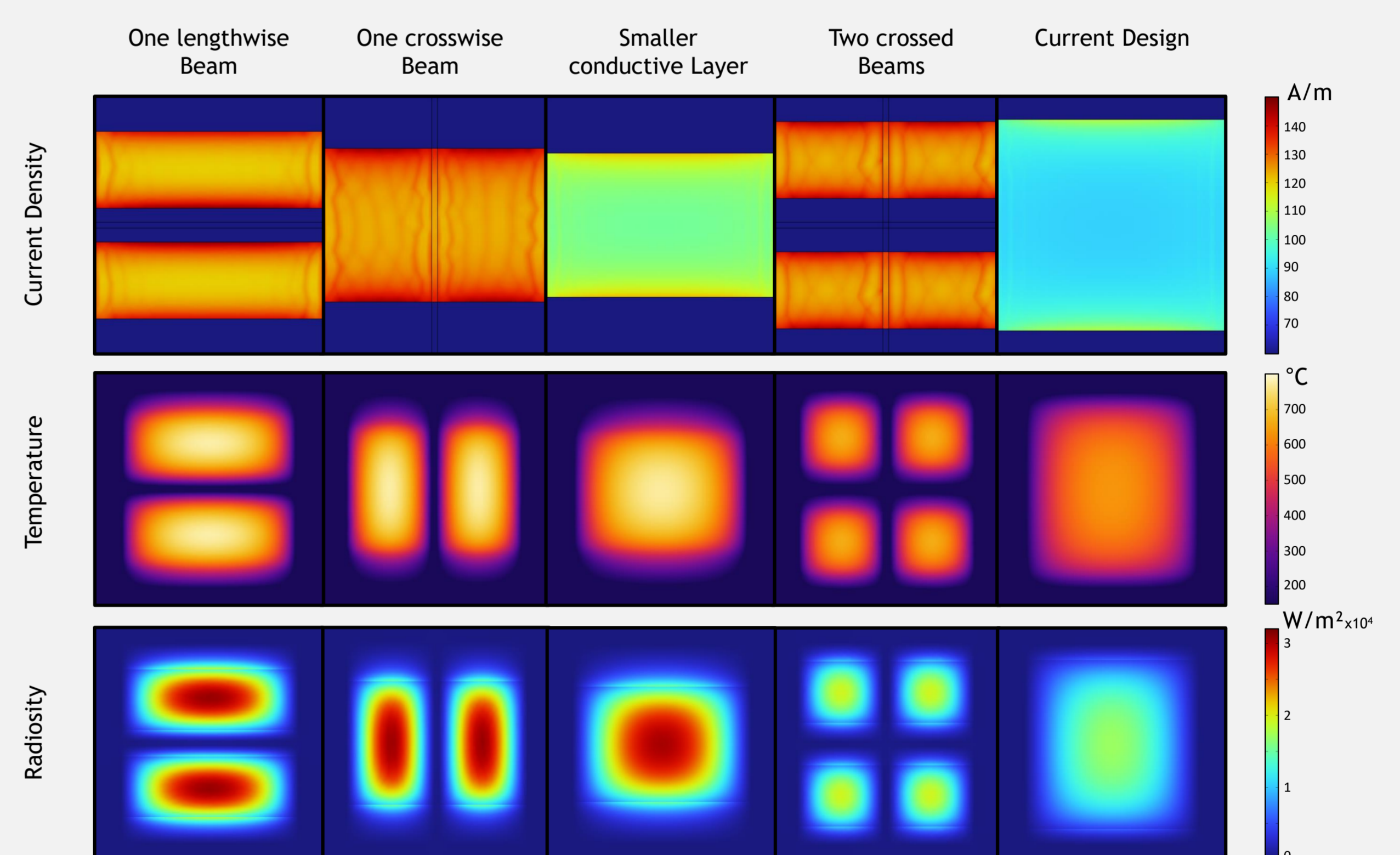
Modell Validation

We constructed a COMSOL model using experimental data, followed by a comparison - with satisfying agreement.



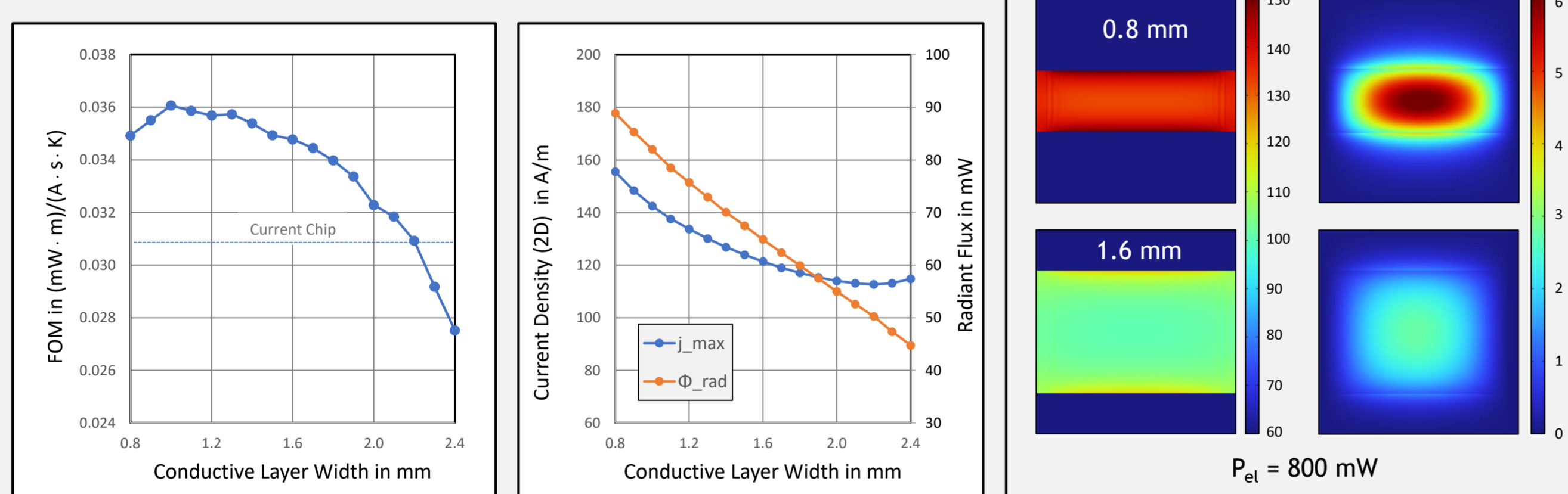
Improvement Attempts in Comparison

Constraints: Power Source, $j_{max} < 150 \text{ A/m}$, $T_{max} < 800^\circ\text{C}$

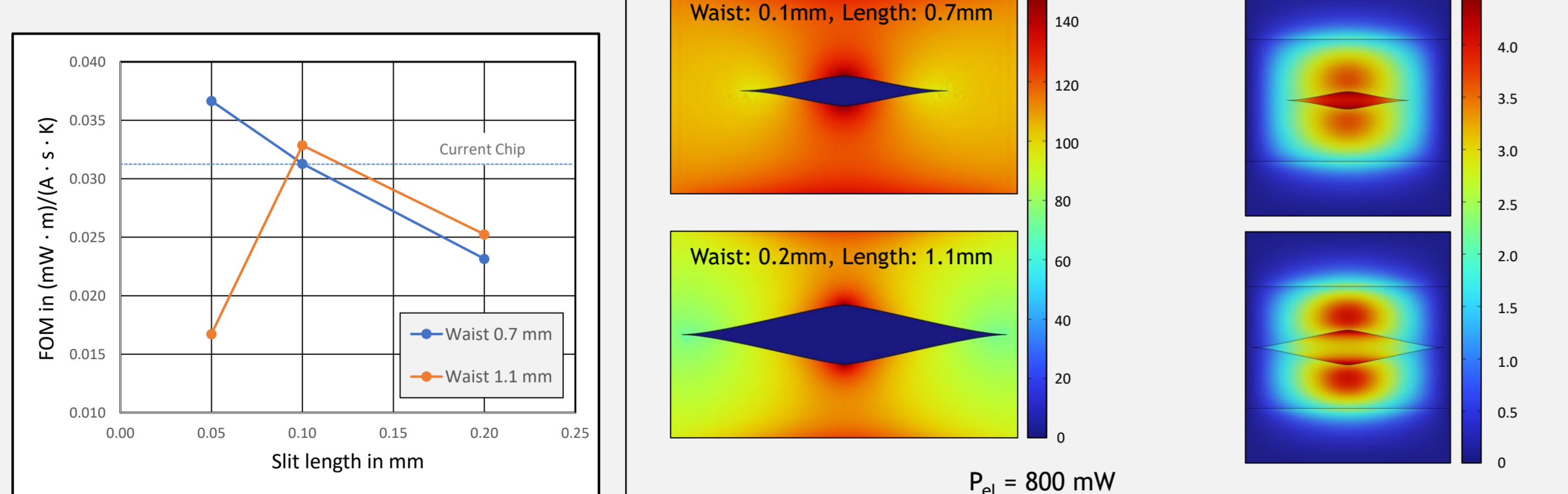


Conductive Layer

Simple Rectangle



Slit in Rectangle



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Conclusion

Thermoelectrical simulations have identified the most promising chip designs from over a hundred configurations, significantly reducing the number of variants to be manufactured in the time-consuming microfabrication process.



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