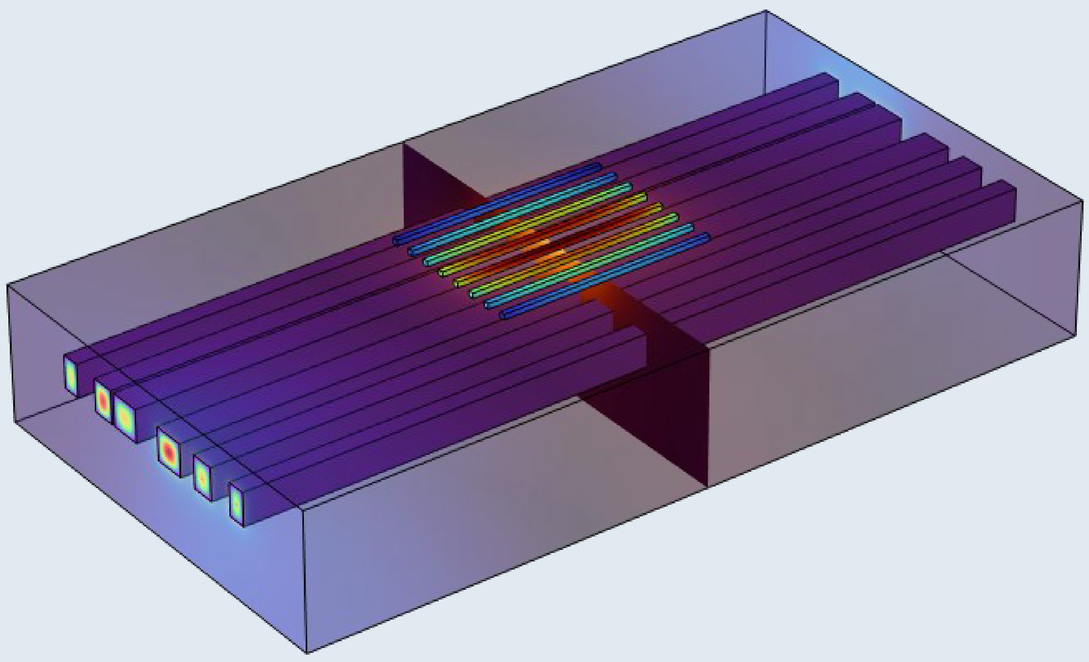


Multiphysics Analysis of Local Microchannel Blockage and Thermo-Optic Phase Robustness in an 8-Channel Silicon OPA

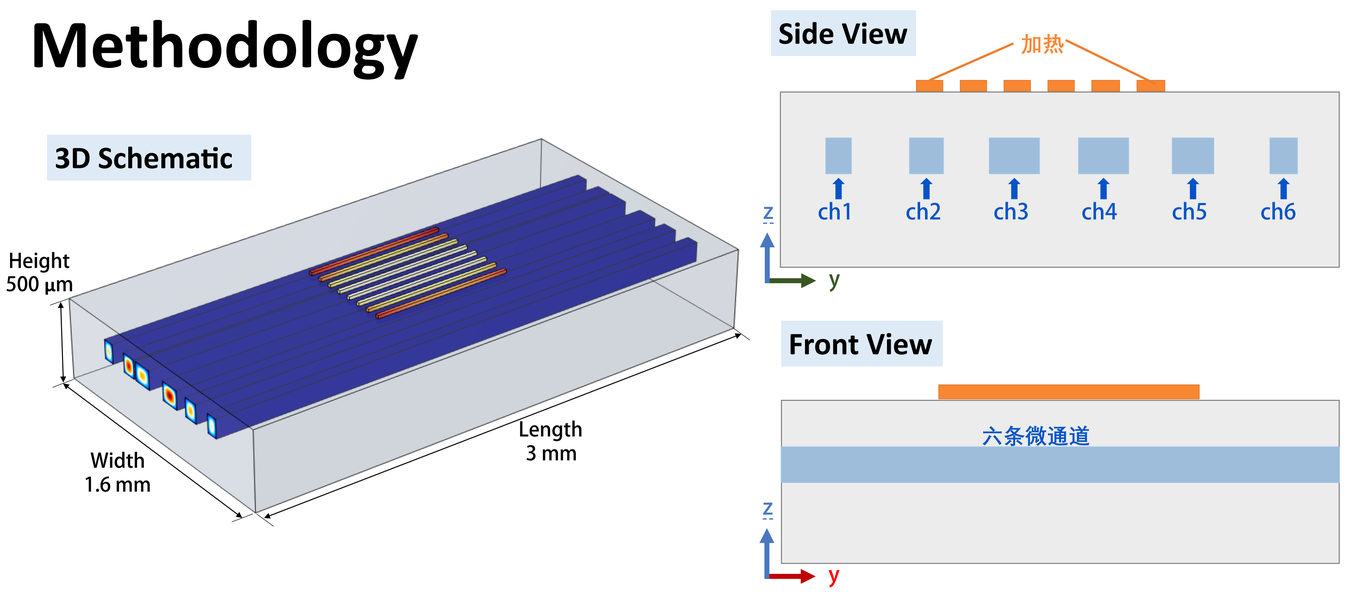
Coupled Thermo-Fluid and Thermo-Optic Analysis Based on COMSOL Multiphysics

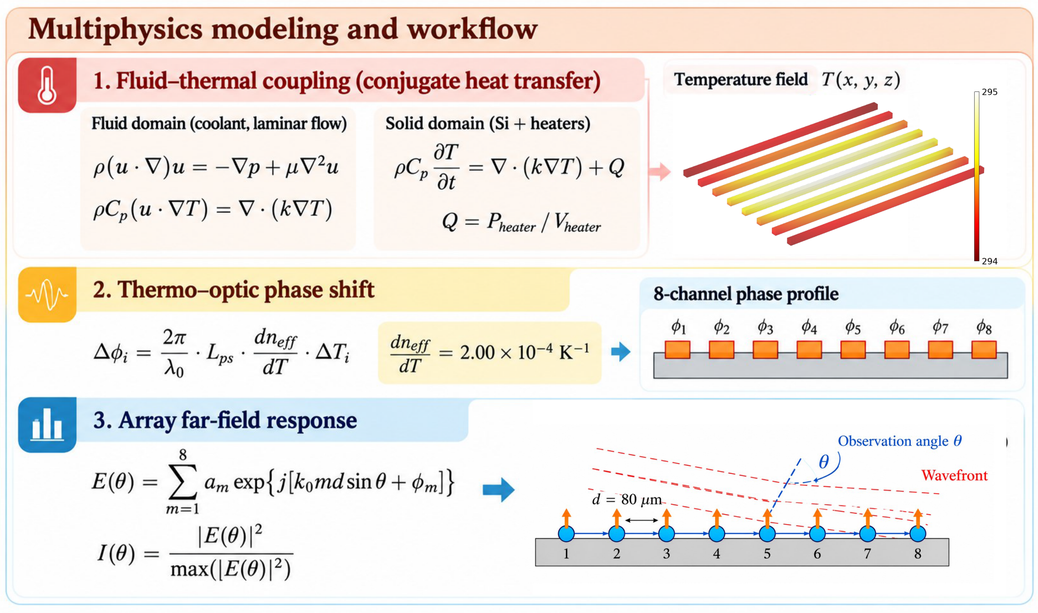
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Introduction & Goals

Silicon optical phased arrays rely on thermo-optic phase shifters for accurate phase control. Nonuniform heating and thermal crosstalk can introduce channel-dependent refractive-index changes and phase errors. Microchannel cooling provides strong local heat removal, but local hydraulic degradation does not necessarily translate directly into optical degradation. Here, we establish a coupled thermo-fluid-optic framework to quantify how microchannel flow, channel temperature and thermo-optic phase nonuniformity are linked in an 8-channel silicon OPA.

Methodology





Results

The baseline thermo-fluid simulation shows a nonuniform temperature distribution across the eight thermo-optic phase shifters. A channel temperature range of 0.620 K is mapped through the calibrated thermo-optic relation to an RMS phase spread of 7.93°, with only a −0.083 dB broadside power penalty. Under local blockage, the Channel-4 flow decreases to 36.9% of its healthy value at β=0.40, while the RMS phase spread remains near 8°.The optical response of the OPA is governed by the resulting channel-to-channel temperature and phase distributions rather than by local flow loss itself. Therefore, phase uniformity should be treated as a direct performance metric for microchannel thermal management in silicon OPAs.

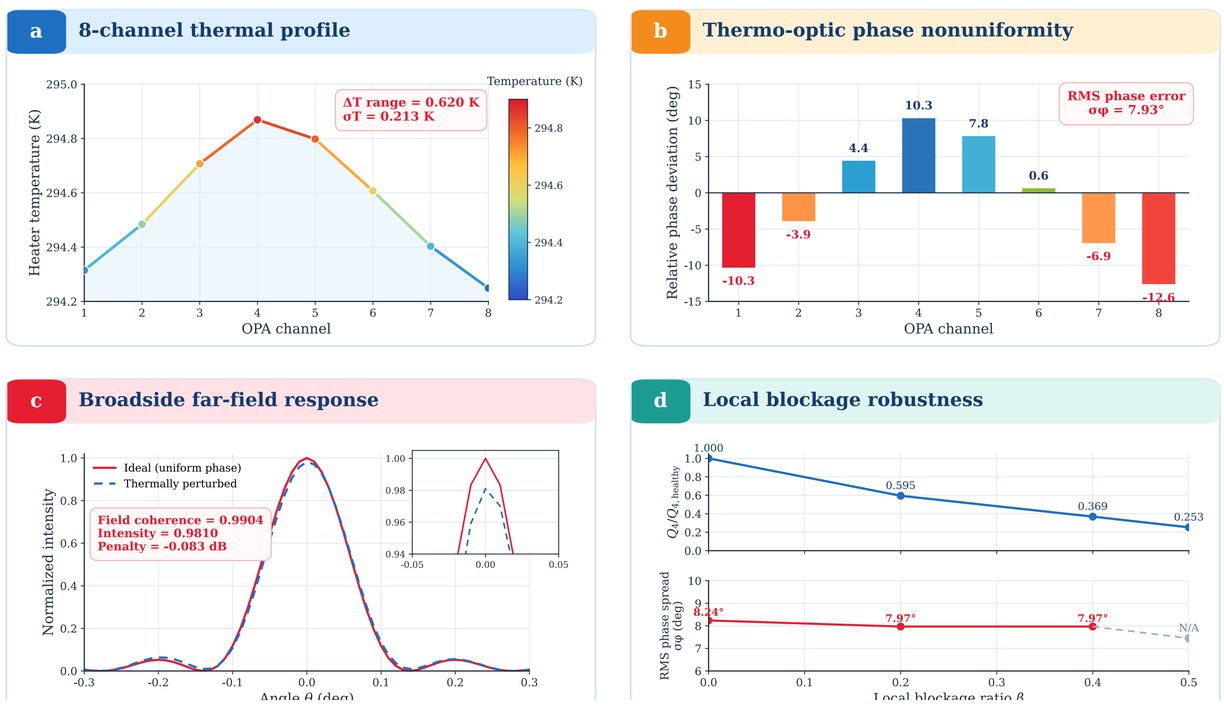


FIGURE 2. Thermo-fluid, thermo-optic phase, and local-blockage responses of the 8-channel silicon OPA.

REFERENCES

[1] W. Wang, L. Lu, L. King, et al., “Subarray Design and Thermal Crosstalk Optimization for Power-Efficient Optical Phased Array,” CLEO 2023, paper SM4P.8, 2023.

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