SAND2022-4729D

Sandia National Laboratories

MATERIAL SCIENCE RESEARCH FOUNDATION

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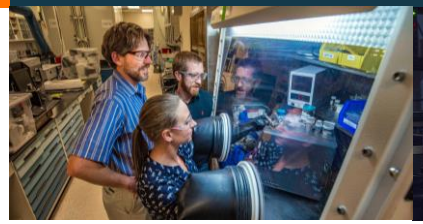
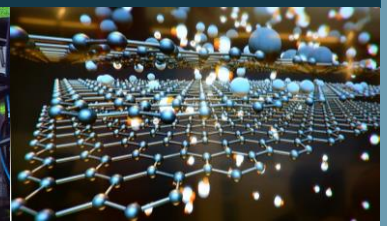
Machine learning driven autonomous control over incoherent light matter interactions





1881, Post doctoral Appointee

Prasad P. Iyer

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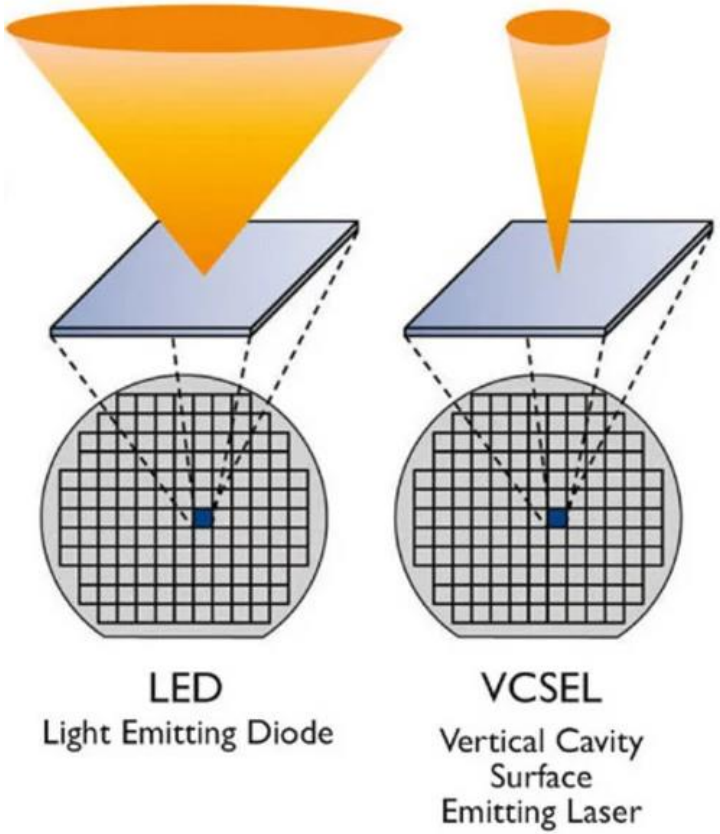
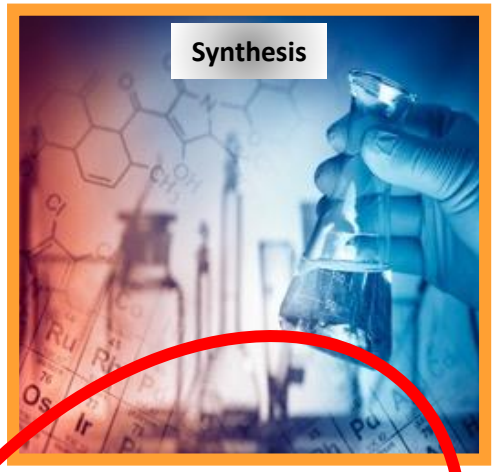
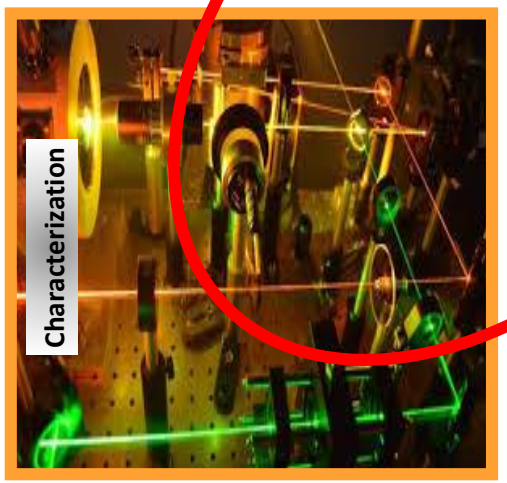
Spatiotemporal control of incoherent processes is challenging

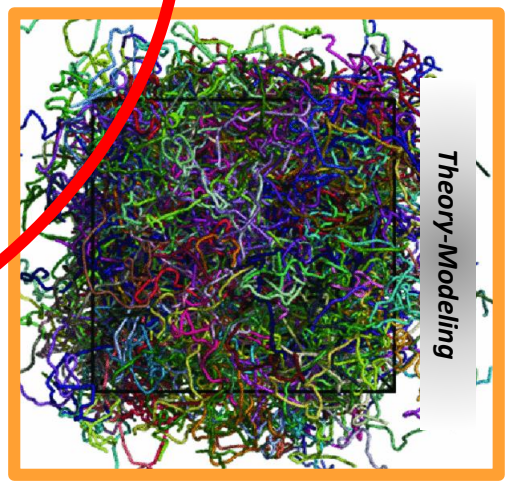


Dynamic steering of incoherent emission is considered incompatible with traditional phased array optics.

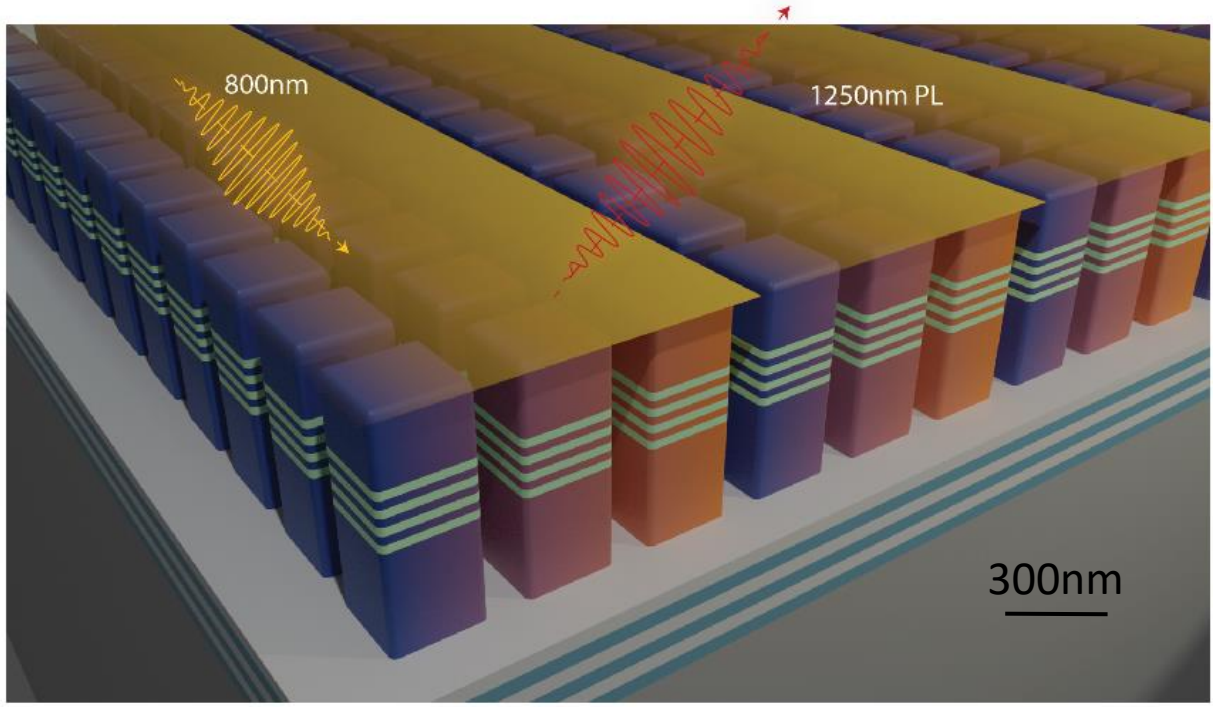


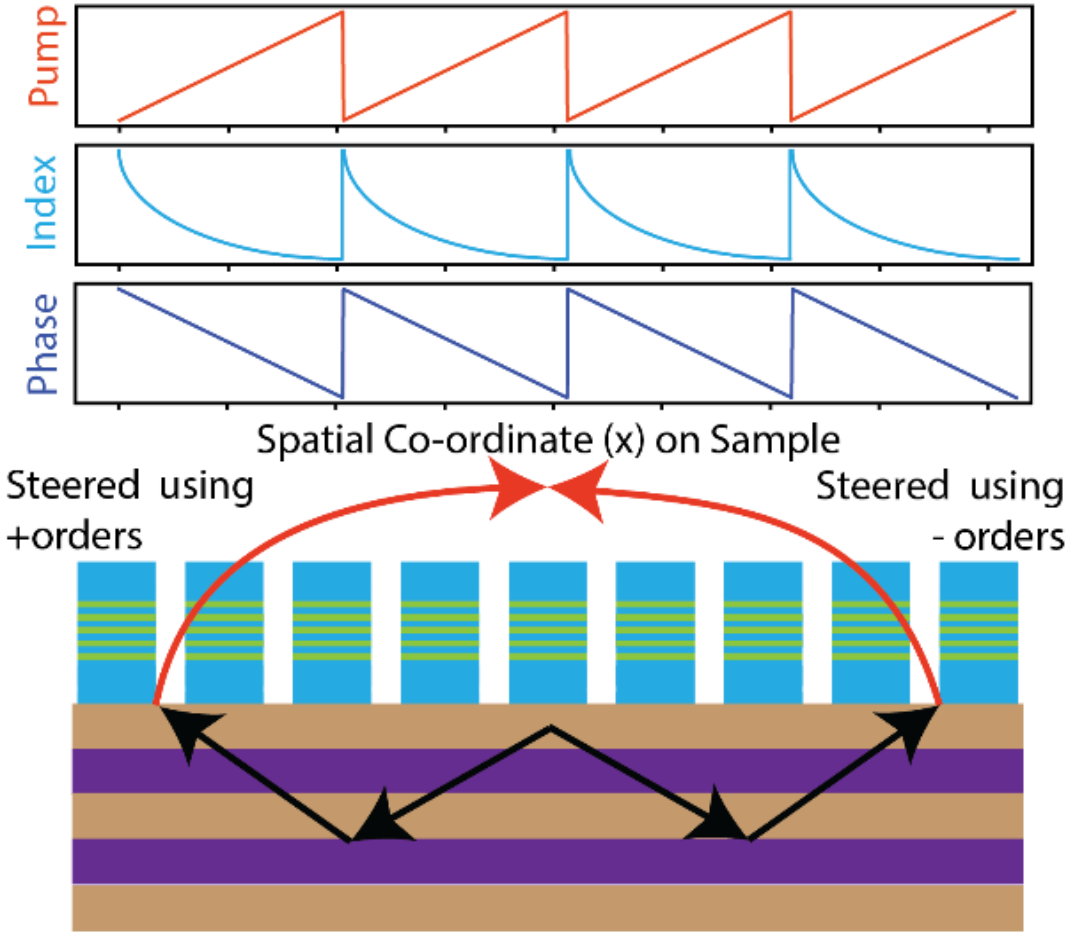
AI/ML
Instrumentation-Controls
In-/Ex-situ Characterization



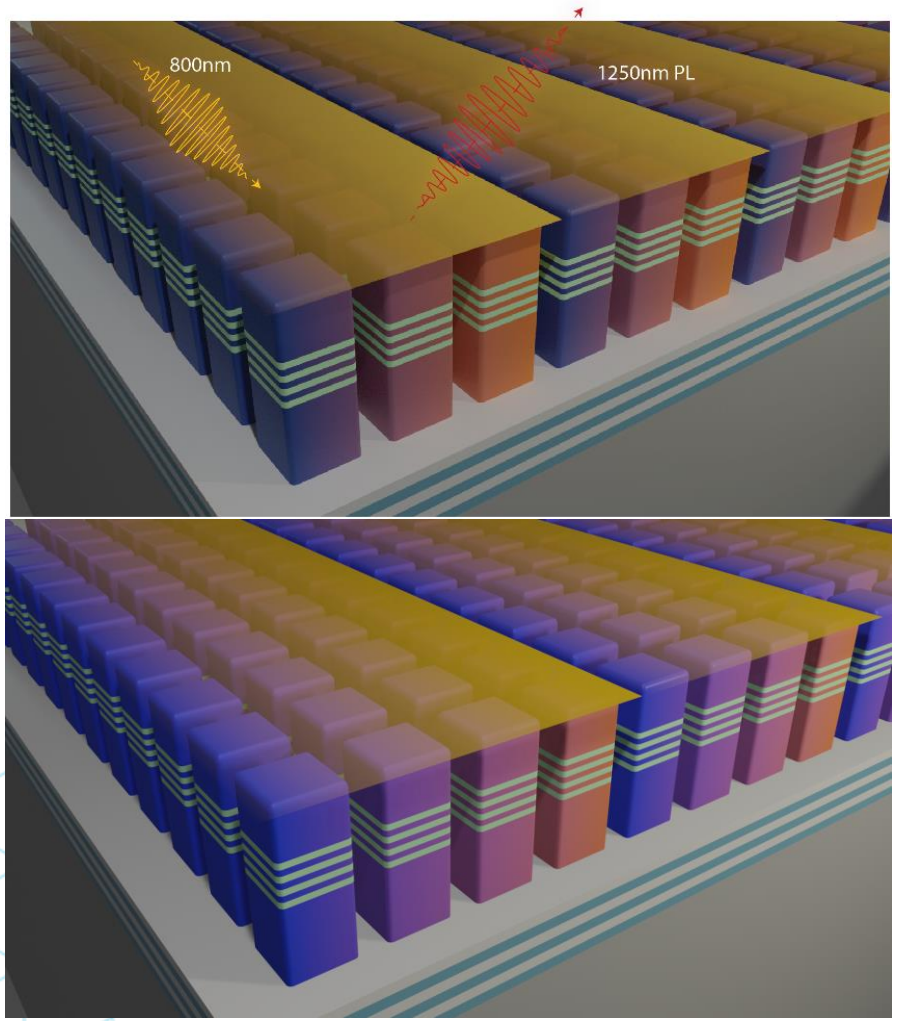


Light emitting metasurfaces under structured optical pumping

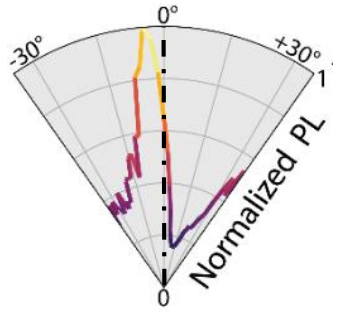




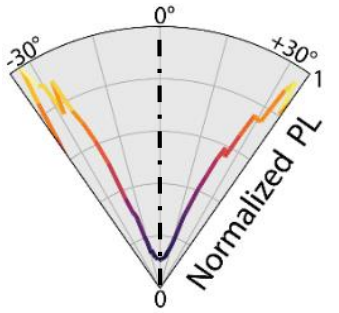
Dynamic PL steering through structured pumping of metasurfaces



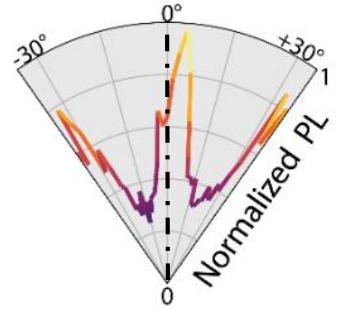
Pump Grating of +40



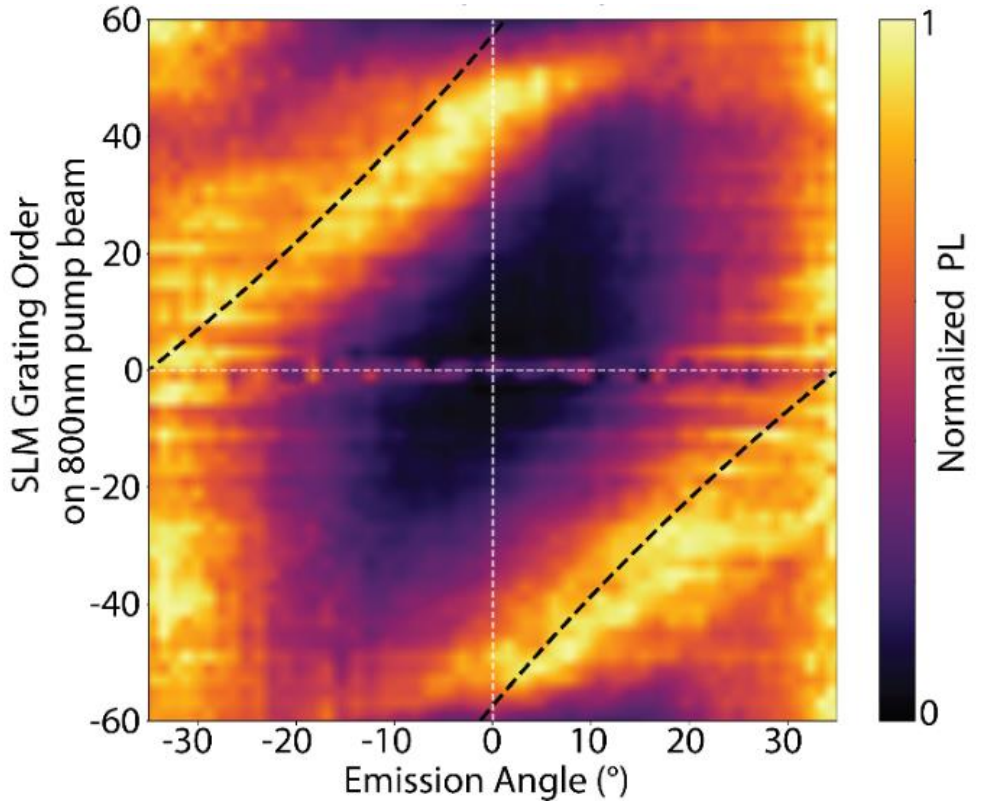
Flat Pump



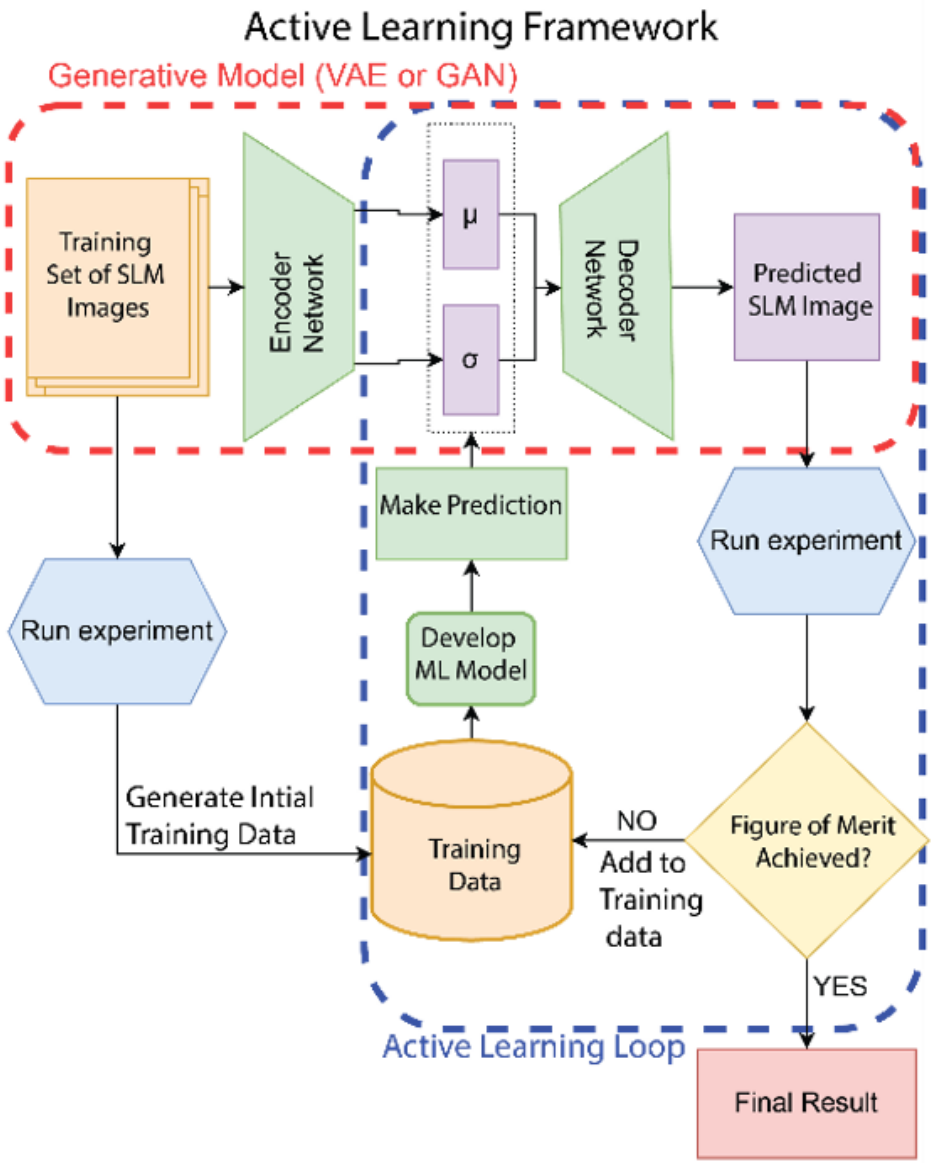
Pump Grating of -40

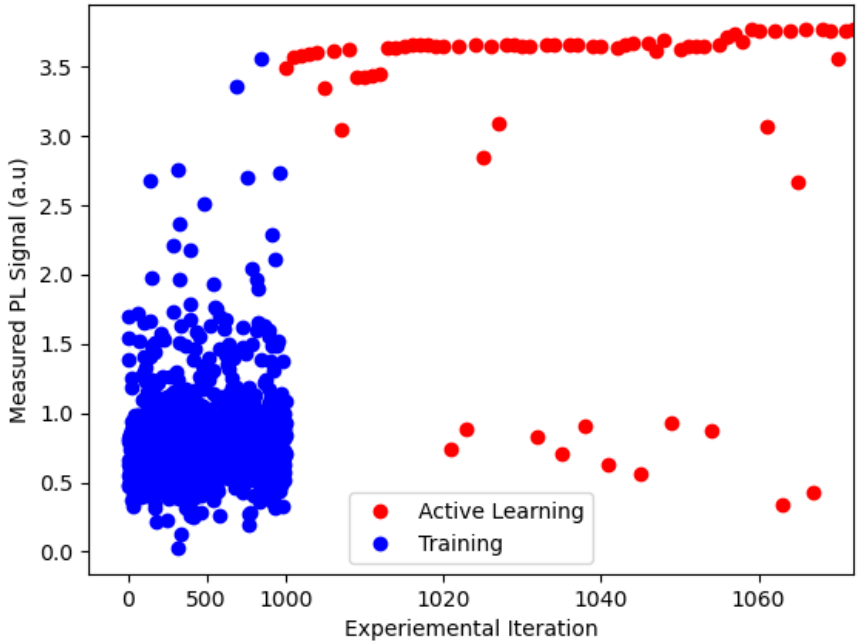


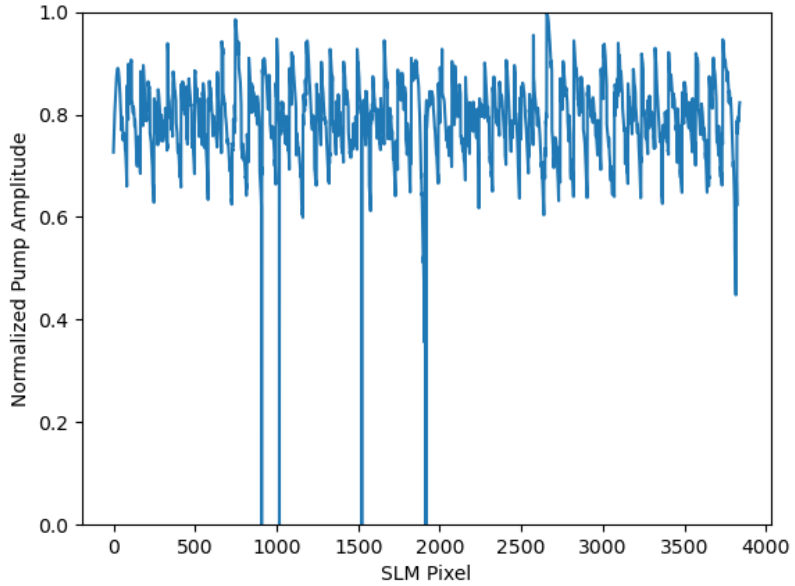
Continuous Unidirectional Steering over 70°



Closed loop AI control accelerates learning of PL steering process



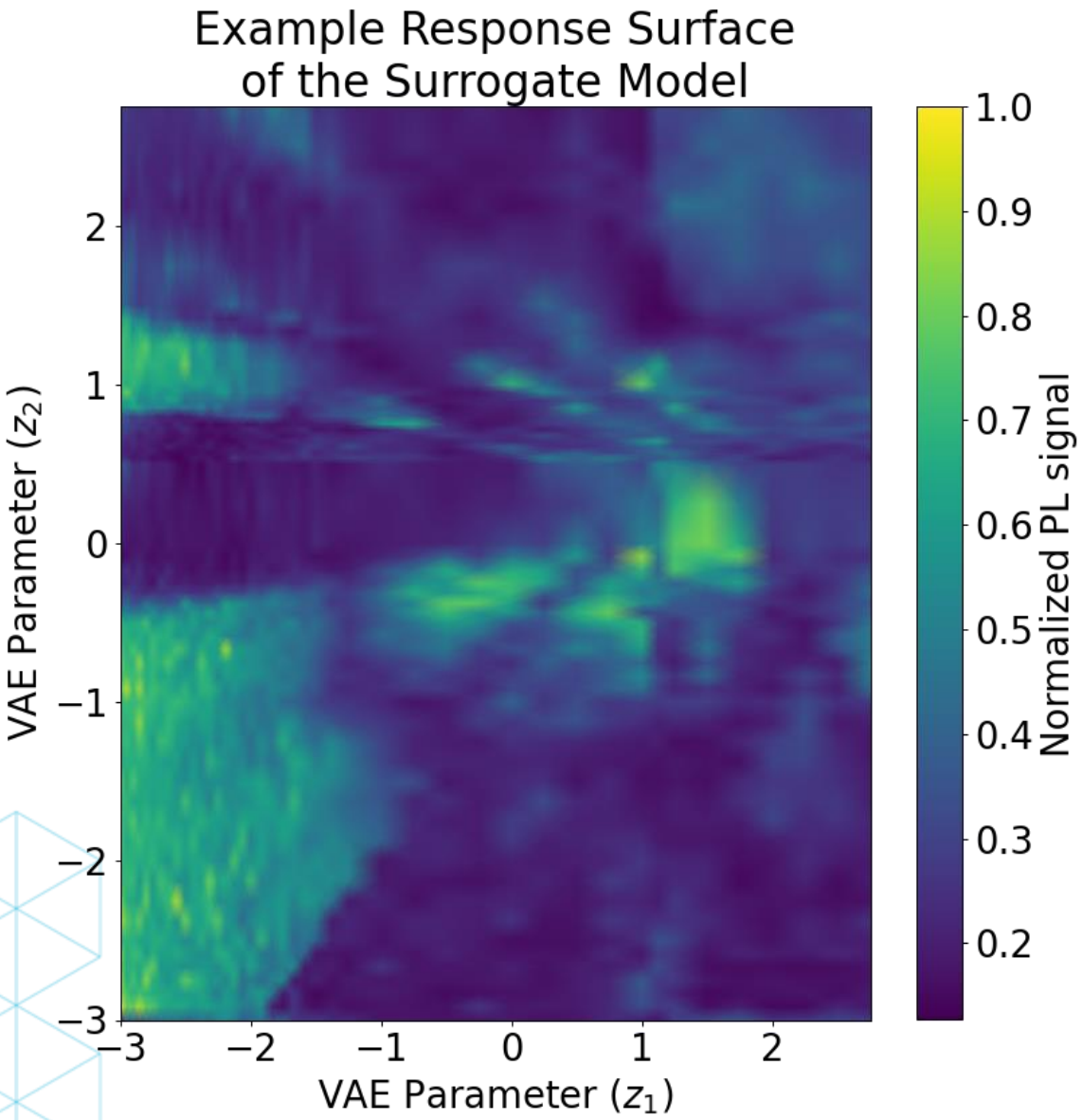




Active learning + VAE **improved the steering efficiency by a factor 27.5** w.r.t saw tooth grating pump pattern

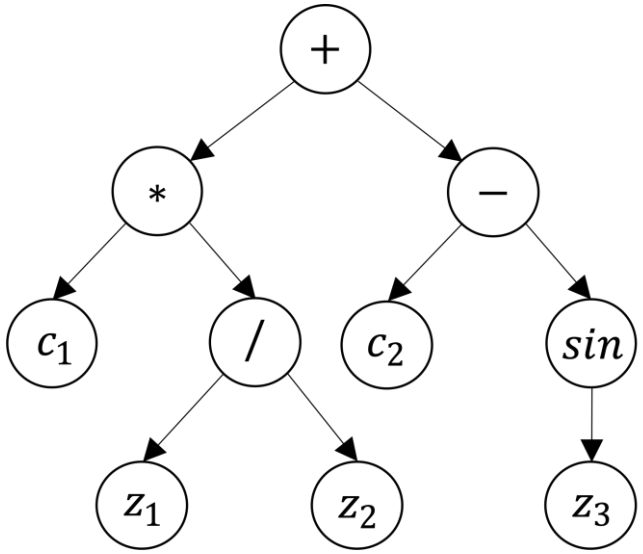
The optimal pump pattern produced by VAE **goes beyond human intuition**

Extracting the governing equations for the pump patterns



Finding 'f' in y = **f(**z_i**)** using physics informed equation learners

Symbolic regression example



$$y = c_1 \frac{z_1}{z_2} + c_2 - \sin(z_3)$$

Accelerated discovery and characterization of PL steering

- Unidirectional dynamic PL steering is possible with a combination of structured materials and structured optical pumping
- AI driven autonomous experimentation improved the steering efficiency by more than an order an magnitude with pump patterns beyond human intuition
- Machine learning techniques enables us understand the fundamental governing equations dictating this structure property relationship
- Currently exploring technology transfer opportunities with industry partners for AR and VR displays
- Team – Saaketh Desai, Remi Dingreville, Sadhvikas Addamane, (1800), Igal Brener (5200)