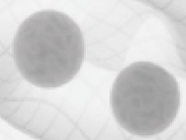
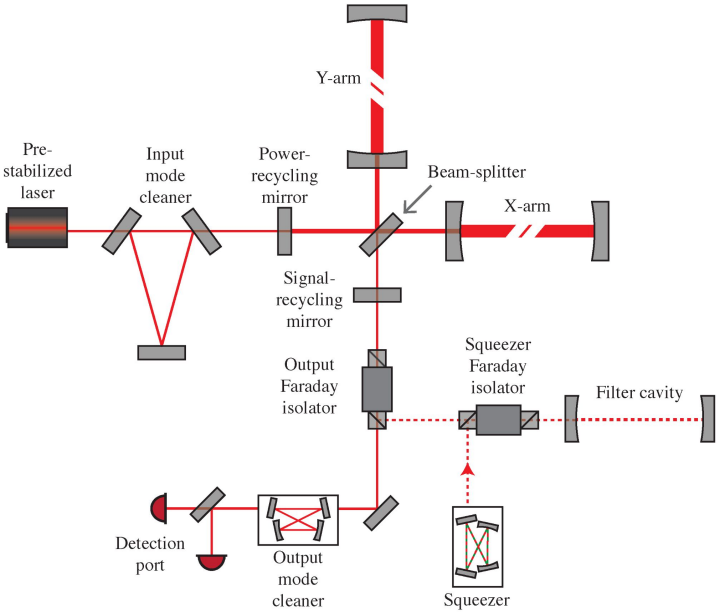
A Differentiable Interferometer Simulator for the Computational Design of Gravitational Wave Detectors

Jonathan Klimesch, Yehonathan Drori, Rana X. Adhikari, Mario Krenn

Second EuCAIFCon on June 17, 2025

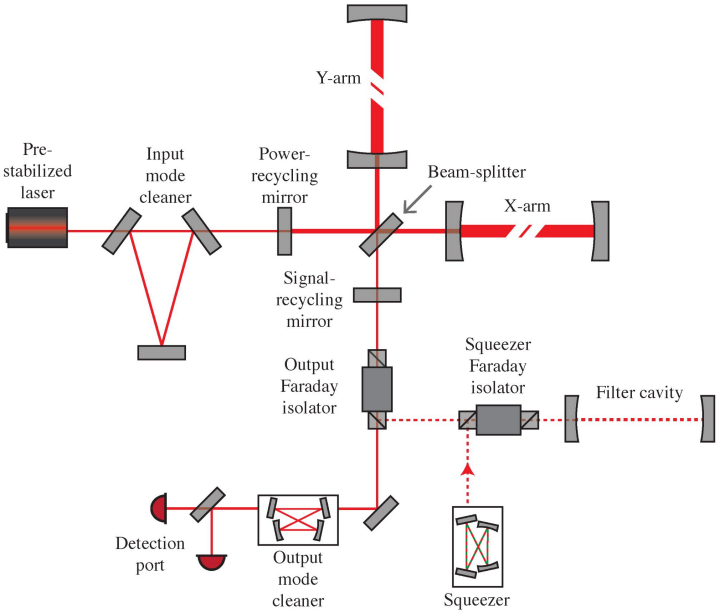


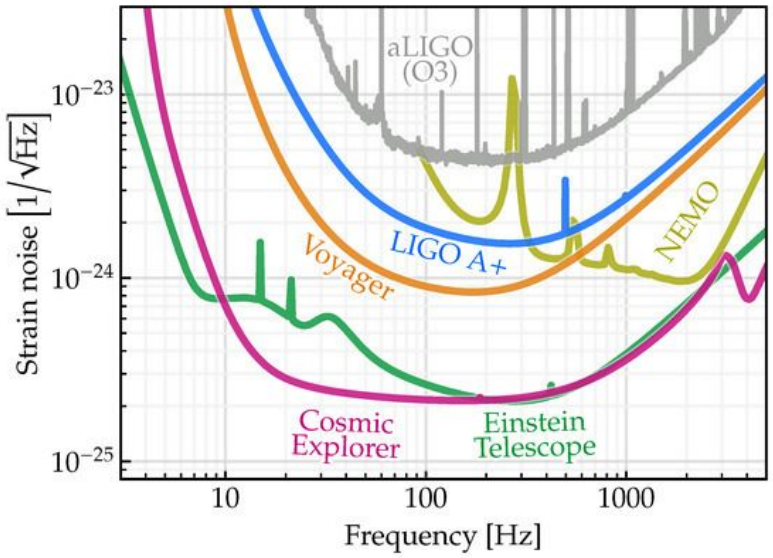
Simplified LIGO Detector



Cahillane C, Mansell G. Review of the advanced LIGO gravitational wave observatories leading to observing run four. Galaxies. 2022 Feb 15;10(1):36.

Strain Sensitivity Measures Detector Quality





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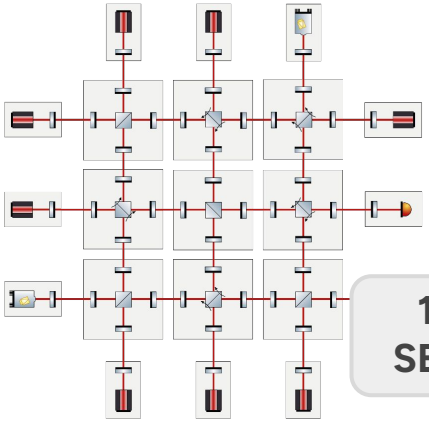
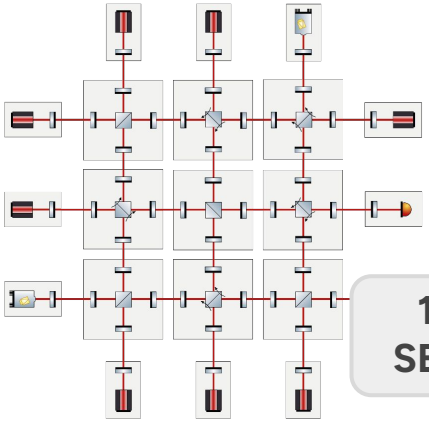
Can we use algorithms to find unorthodox, but useful layouts?

We Let Algorithms Design Superior Detector Layouts ...



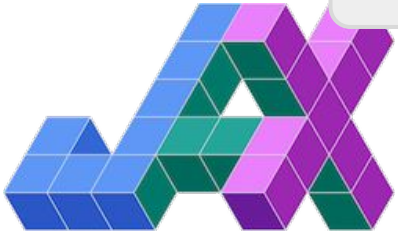
1) DETECTOR SEARCH SPACE

… Using Differentiable Programming



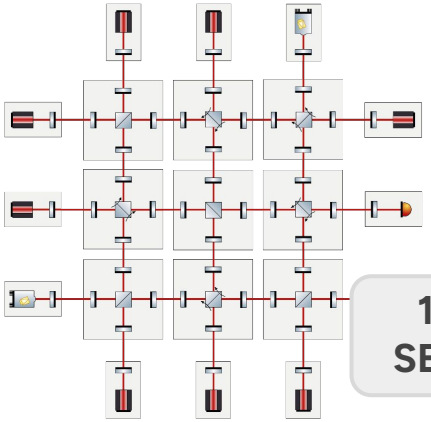
1) DETECTOR SEARCH SPACE

2) DIFFEROMETOR



Differentiable Inter**ferome**ter Simula**tor**

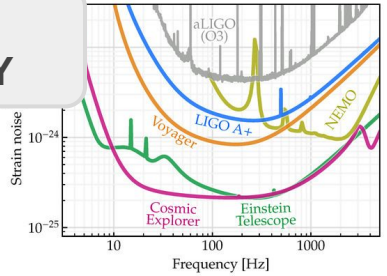
… Using Differentiable Programming



1) DETECTOR SEARCH SPACE

2) DIFFEROMETOR

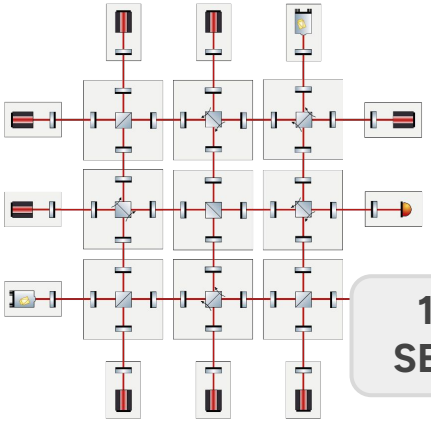
3) STRAIN SENSITIVITY



Differentiable Inter**ferome**ter Simula**tor**

$$\mathcal{L}_{\text{Strain}} = \int_{f_0}^{f_1} \log(S(f))df$$

… Using Differentiable Programming

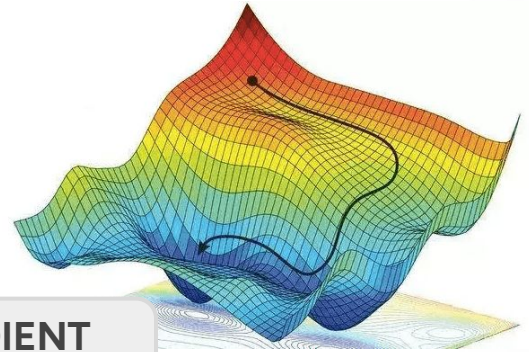


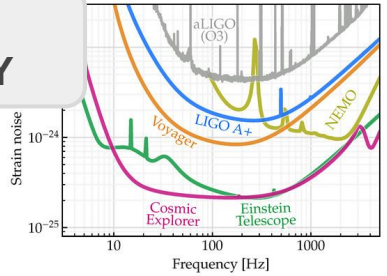
1) DETECTOR SEARCH SPACE

2) DIFFEROMETOR

3) STRAIN SENSITIVITY

4) GRADIENT DESCENT





Differentiable Inter**ferome**ter Simula**tor**

$$\mathcal{L}_{\text{Strain}} = \int_{f_0}^{f_1} \log(S(f))df$$

See you in Thursday's Poster Session!