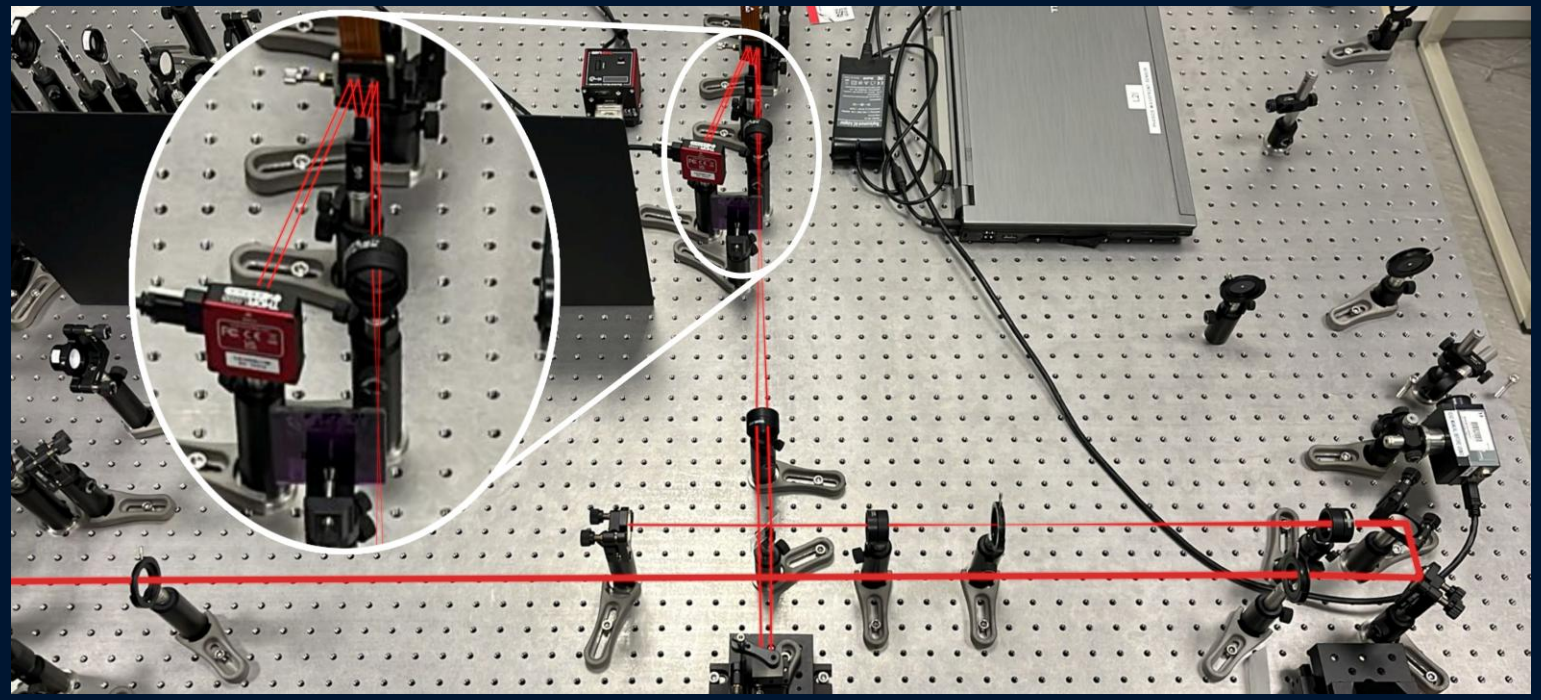
Automatic Search for Artificial Life in Nonlinear Optical Neural Networks



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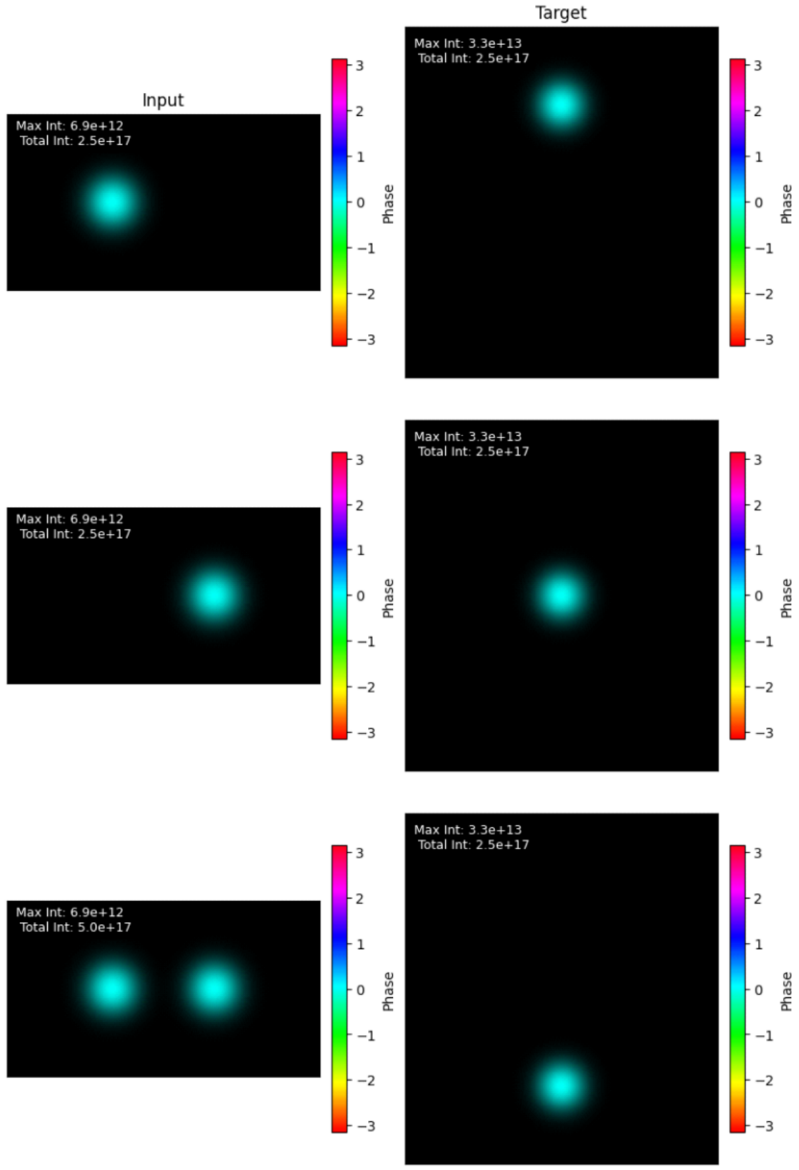
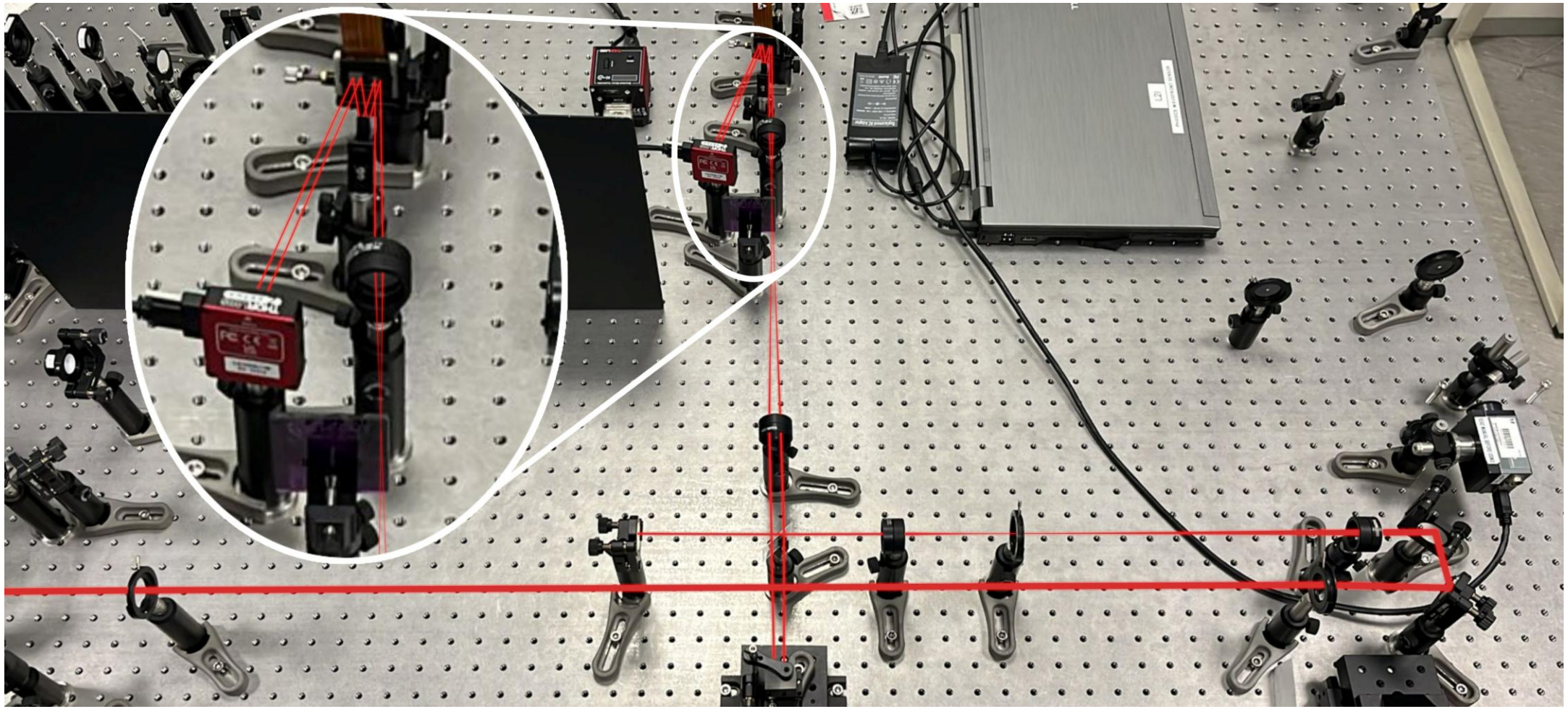
Optical Decoder

- As a benchmark for the experimental setup, we are implementing an all-optical decoder
- This example is a simple example of a nonlinear operation
- The simulation of the PNN is trained to find phase masks to implement this behavior



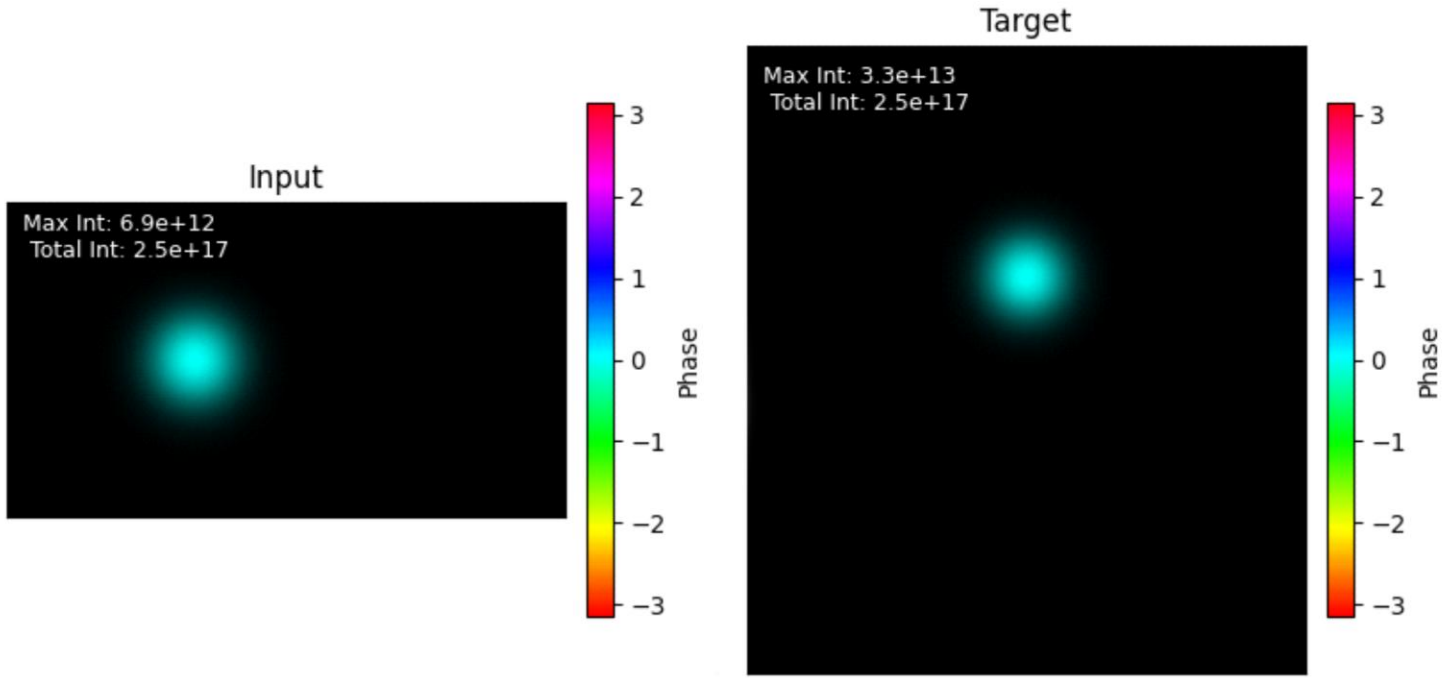
Experimental Setup

- We rebuilt the setup to get more consistent alignment



Linear Shifts

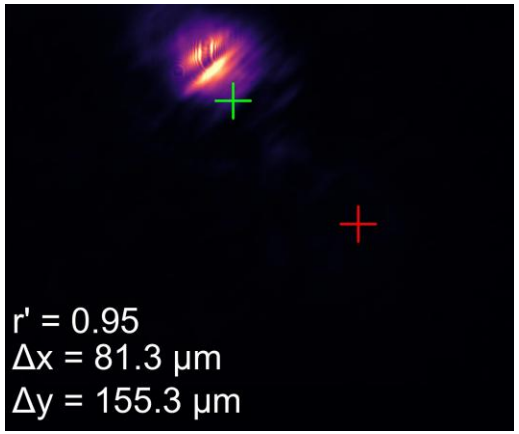
- For now we aren't trying the full optical decoder yet, we train the network to just shift the beams



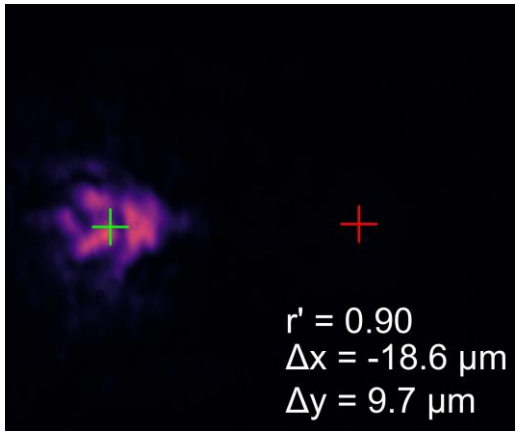
Experimental Results

- Red cross: Original beam position
- Green cross: Target position
- Δx, Δy: Shift from measured position to desired position
- r': Pearson correlation coefficient, after misalignment is corrected

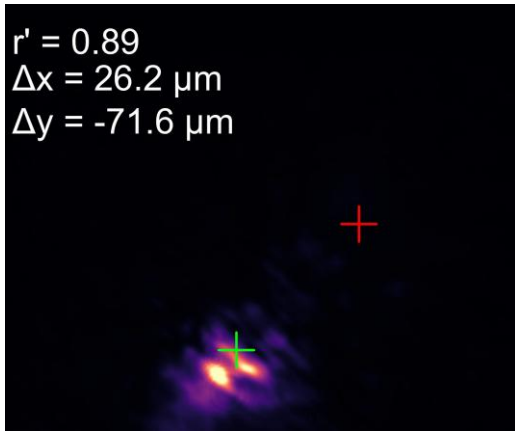
Left Beam Up



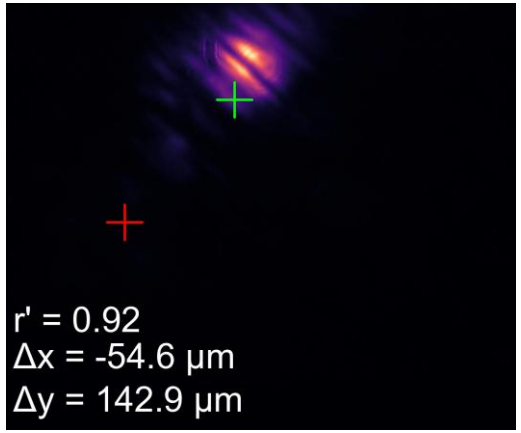
Left Beam Side



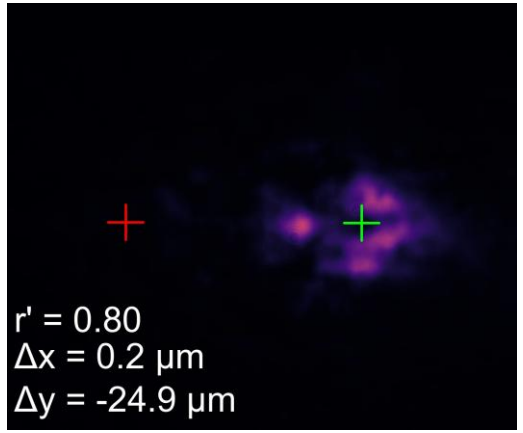
Left Beam Down



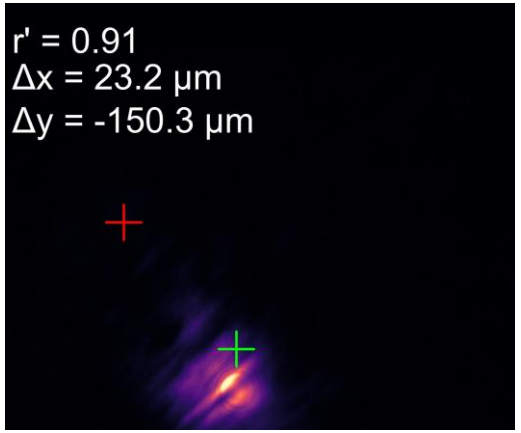
Right Beam Up



Right Beam Side



Right Beam Down



ASAL Substrate

- Each substrate corresponds to a parametrized simulation, ASAL seeks to optimize those parameters. Each substrate has the following:
  - $\mathbf{Params}_\theta$: Set of all the parameters that ASAL seeks to optimize
  - $\mathbf{Init}_\theta$: Initial state of the simulation
  - $\mathbf{Step}_\theta$: How the state evolves.
  - $\mathbf{Render}$: Visualize current state so CLIP can evaluate it.
- The work of rewriting our ONN code to work with ASAL is done and validation tests were performed
- Now that we are confident that the code is working, we have to start testing more sets of hyperparameters and architectures

Conclusions and outcomes

- The optical setup was rebuilt
- A new and improved alignment procedure was used and the linear shifts were measured
- We found the system still has misalignments that need to be improved
- For the Artificial Life, now that the simulation are properly implemented, we can start seriously trying to find complex evolving simulations using the all-optical neural network