ディープラーニングを用いたコヒーレントビーム結合

Coherent Beam Combination via end-to-end deep reinforcement learning

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Relative phase control is the key component of power scaling via coherent beam combining, but it can also be used for beam steering, compensation of atmospheric turbulence, and mode control. In these contexts, it becomes much more demanding to derive the necessary feedback from the observation and potential complicated models are necessary. We investigated the applicability of deep reinforcement learning for phase control two channel CBC system, therefore, trained a neural-network based reinforcement learning algorithm to realize phase control.

In our experiment we used a simple two channel CBC system (Fig. 1). A PC with an AD/DA card was used to observe the current power using a photodiode and drive a piezo mounted mirror for phase feedback. The last 10 observations were fed into the neural network, which in turn returns the optimum change of the output control voltage. A picture of a monitoring oscilloscope, taken at the beginning of training, is shown in Fig 2. (left). Here, the control voltage changes almost randomly (yellow trace), resulting in strong power fluctuations. These observations are used to train the neural net using temporal difference learning. After a few hours the system converges (Fig. 2 middle and right). The RMS noise ends up at about 1% RMS. While this does not compare with hand tuned lockset locking strategies in this simple case, but reinforcement learning can greatly simplify control were effective control strategies are not readily available.

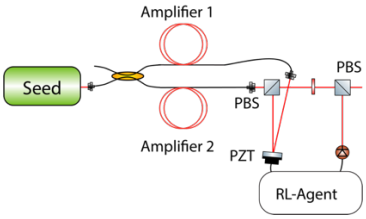

Fig. 1 Test setup

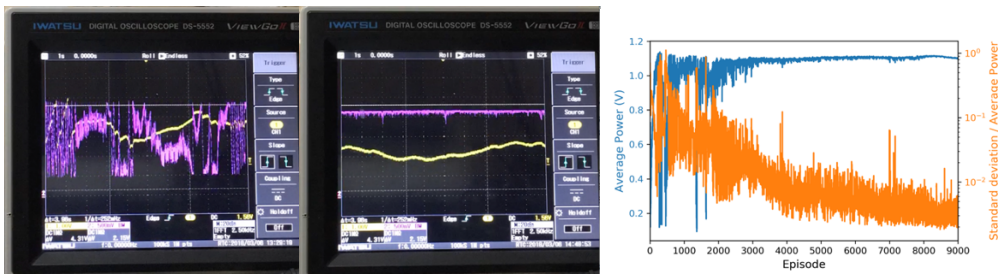

Fig. 2 Training of the RL agent, yellow: piezo control signal. (left) beginning of training (middle) after 2 hours. Average Power and power noise as in dependence of training episode (right)