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A machine learning approach to the inverse scattering problem

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Single-chord interferometry is widely used in plasma physics to obtain the line-integrated density of a plasma. In this work, we propose the use of a (deep) neural network (NN) to assist in the development of a novel diagnostic technique which allows the estimation of the plasma density profile from a single interferometry measurement. The purpose of the NN is to solve the inverse-scattering problem of a high frequency microwave beam that penetrates a similar-sized plasma. The NN is applied to an atmospheric plasma torch [1] and is trained on data obtained from a Finite-Difference Time-Domain full-wave simulation code [2]. The data provided for the training are the transverse profiles of the wave electric field of the probing microwave beam after traversing the plasma. The plasma density profile can be arbitrarily set in the simulation domain, which enables a wide range of scenarios to be explored. Ideally, the NN is then capable of linking the scattering profile to the plasma density profile. To test the validity of the simulations, experiments were performed with a similar setup: a wave power profile is obtained by moving the receiving antenna (using a stepping motor) of an interferometer in the plane perpendicular to the plasma torch. Finally, the experimental result is fed into the NN, which estimates the real density profile of the plasma torch.

References
[1] M. Leins *et al*, Contrib. Plasma Phys. **54**, 1 (2014).

[2] A. Köhn *et al*, Plasma Phys. Control. Fusion **50**, 085018 (2008).

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