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Using neural network and multi-objective algorithm to design variable polarization TDS with dual-mode

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Currently SSRF/SXFEL is ongoing to develop the advanced transverse deflecting structure TTDS（Two-mode operation transverse deflecting structure) to carry out variable polarization based on the design of dual-mode RF structure. Driven by two different RF power sources, this novel TDS can work on both HEM11 and HEM12 modes in vertical and horizontal deflecting directions simultaneously, and consequently it is ultra-fast to fix and change linear polarization, in particular circular and elliptic polarizations as well by flexible vector combination of these two modes, actually in engineering which is very practically realized by amplitude and phase modulation from LLRF. The work presented in this paper is focused on analysis and design of the variable polarization TDS, consisting of dual-mode cells and two dual-mode couplers. Considering the complexity of dual-mode design and optimization, the advanced optimization procedure based on both neural network and multi-objective algorithms, is successfully developed to improve the accuracy and efficiency of the RF structure design. After many iterative optimizations, the dual-mode cells in the final design can work on high impedance and similar RF performance for both HEM11 and HEM12, in particular the two couplers for RF power input and output are also approached to the ideal design as well. Based on the optimized design and RF sensitivity analysis, the engineering design is finally completed and ready for manufacture.

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