WEPV011 RESEARCH ON CORRECTION OF BEAM BETA FUNCTION OF HLS-II STORAGE RING BASED ON DEEP LEARNING

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A、INTRODUCTION

In recent years, artificial intelligence (AI) has experienced a renaissance in many fields. AI-based concepts are nature inspired and can also be used in the area of accelerator controls. At HLS-II, there are not many studies on these procedures. We focused on HLS-II beam stability in order to get better performance. We have created a deep learning-based approach for correcting beta function. Simulation studies reveal that the method presented in this work performs well in terms of correction outcomes and efficiency, resulting in a new way to adjust the accelerator beam function.

B.FEEDBACK THEORY

1、Corrective theory for the beta function
2、Using a deep learning model to conduct beta function correction(see Figure2)

The quadrupole's focus intensity K and the storage ring's change $\Delta Q_{x,y}$ are recorded to determine the quadrupole's beta function. The theoretical formula for retaining the measured ring beta function when changing ΔK is

$$\beta_{x,y} = \pm\frac{2}{\Delta Kl}\{\cot(2\pi Q_{x,y})[1-\cos(2\pi\Delta Q_{x,y})] + \sin(2\pi Q_{x,y})\}$$

when the tune is far from the integer or half-integer resonance line, and the change value is small.

$$\beta_{\chi,\ \gamma} \approx \pm 4\pi\frac{\Delta Q_{\chi,\ \gamma}}{\Delta KL}$$

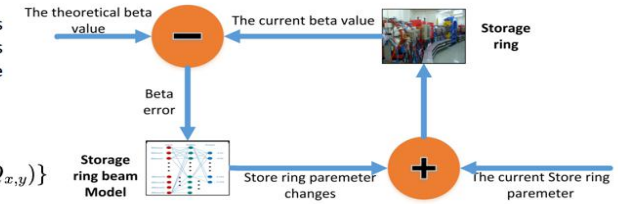

Figure 1: Schematic of the beta function correction system using a Neural network method.

C.MACHINE LEARING DESIGN STEPS

1、Five significant steps are involved in developing an ML-based beat function application (see Figure2)
2、Definition of neural network structure (see Figure3)

Figure 2: Development stages for an ML-based beta function correction.

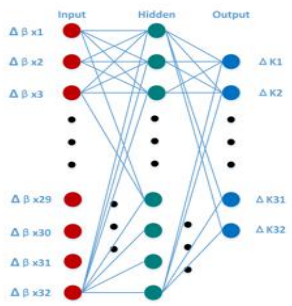

Figure 3: Feed Forward Neural Network (FFNN) topology used for ML-based beta function correction.

D.SIMULATION ANALYSIS

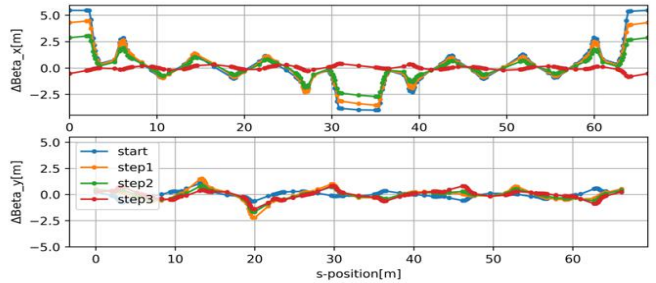

Figure: Beta parameters after iterations through the model.

The beta functions of the storage ring was measured before and after the lattice correction for comparison.A before-and-after comparison shows that the average beatx beating was 22.82% and 3.3%, respectively. However, due to the tiny fluctuation in vertical, the correction has not changed significantly.

Conclusion: Through the neural network model, the beta function is effectively corrected and has a good effect.

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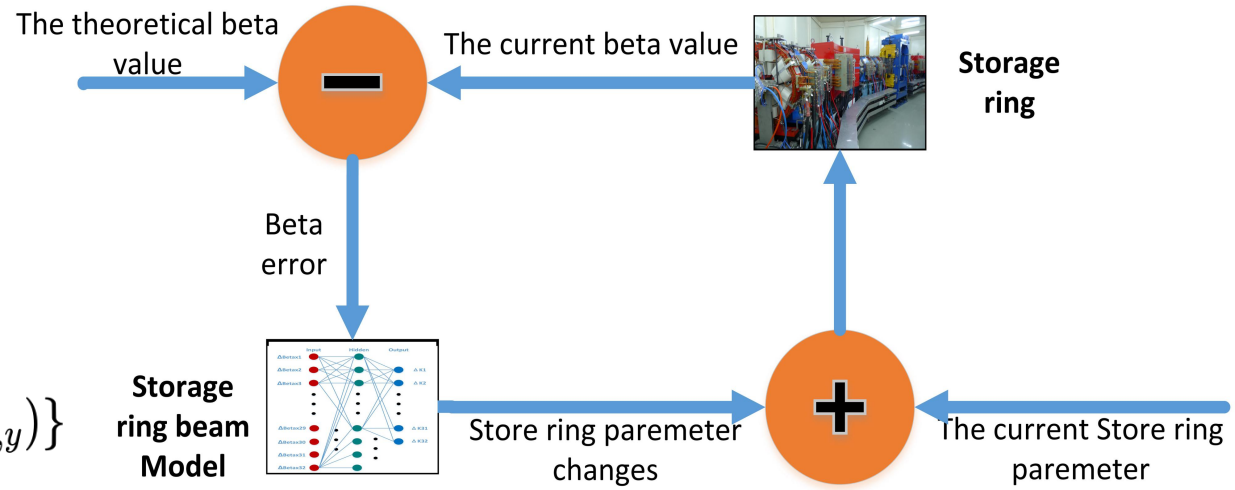

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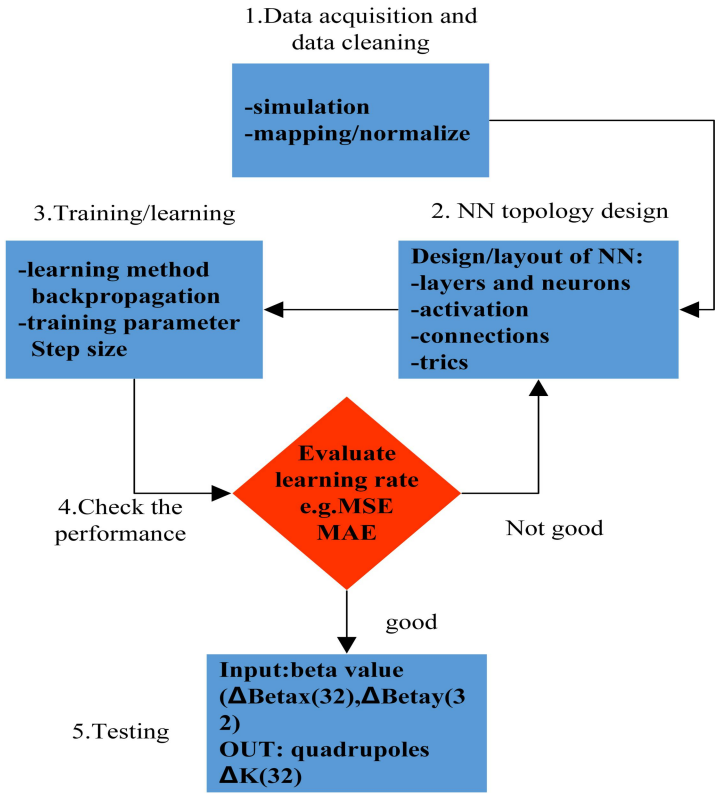

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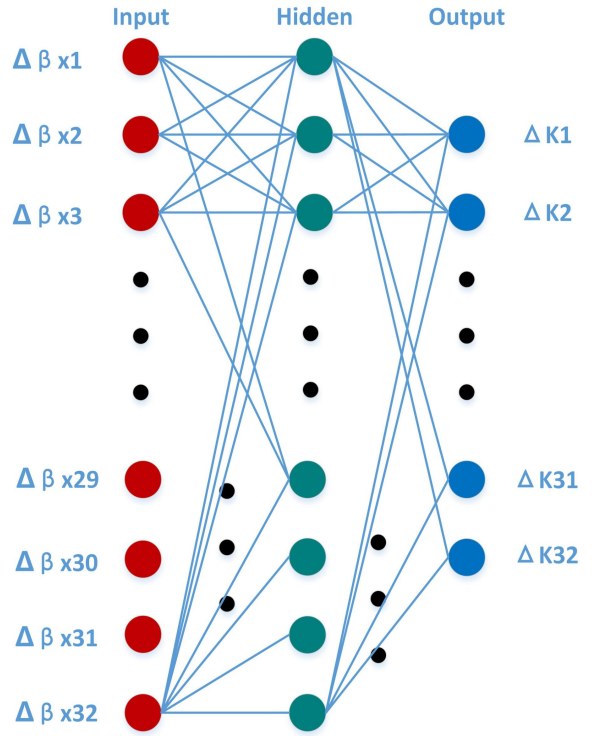

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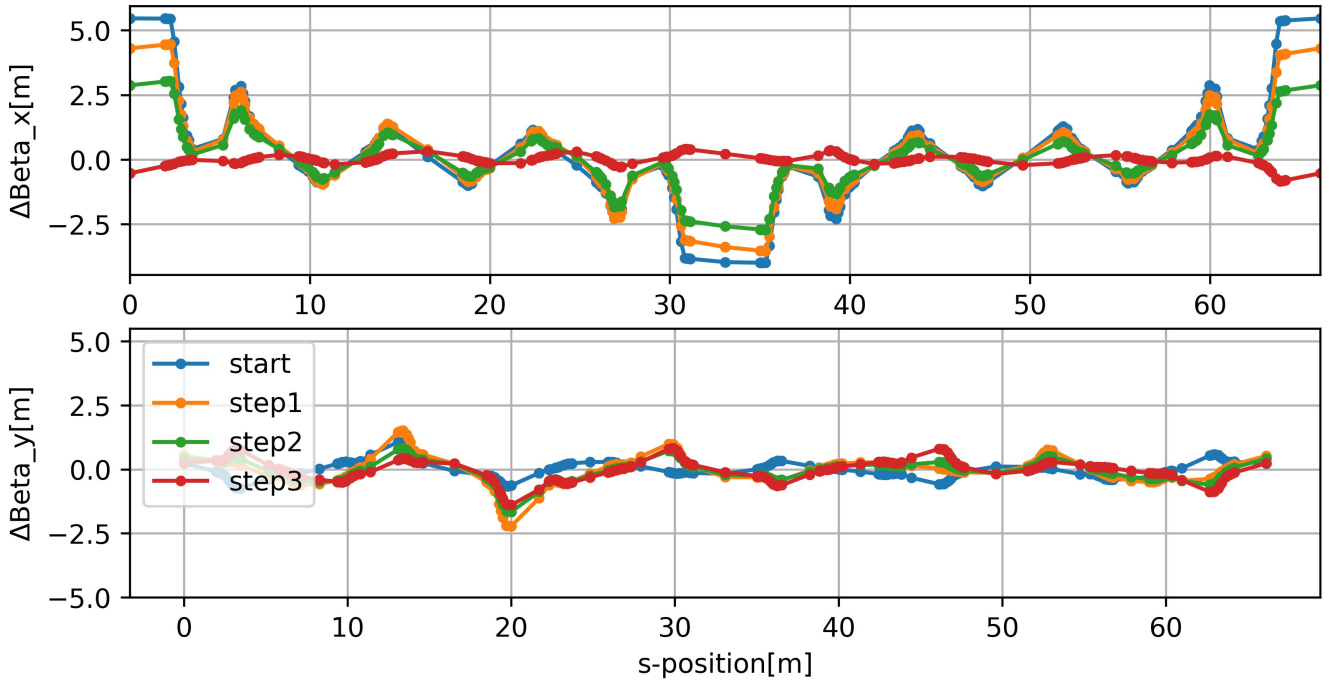

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