**S4 detail of ablation study**

To validate the effectiveness of the proposed vertical one-hot encoding strategy, we conducted ablation studies. In the absence of employing the vertical one-hot encoding strategy, we assigned numerical identifiers to each component type and arranged them in a 2D tensor, which was then combined with the layout matrix and initial burnup matrix to form a 3-channel tensor. We fed both scenarios into our network model and recorded their performance on the FQ and F∆H datasets. The experimental results are presented in Table [below.](#bookmark61)

**Table 2:** Ablation study on vertical one-hot encoding strategy. The bold results demonstrate excellency of the encoding.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Use Vertical  One-hot Encoding | FQ | FQ (MRD) | F∆H | F∆H (MRD) |
| x  / | 5.7e-3 | 0.101 | 6.2e-3 | 0.0862 |
| 5.8e-4 | 0.020 | 5.3e-4 | 0.0199 |

As shown in Table, it is demonstrated that the proposed vertical one-hot encoding strategy significantly enhances the learning performance of the network. This is attributed to its ability to represent semantic information among different components more effectively, thereby enabling the network to extract features more efficiently. The experimental results also indicate that the vertical one-hot encoding strategy may apply to more complex representations of nuclear reactor cores.