Application of Deep Learning to Reflectometry Signals in Nuclear Fusion Plasmas

2nd Cycle Integrated Project
2024/2025

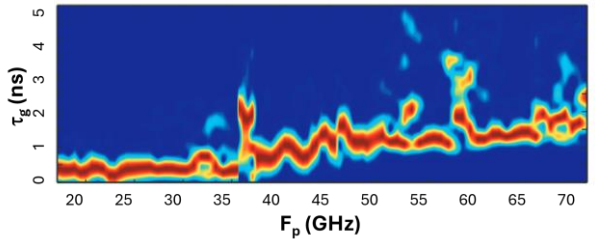
Author: Mafalda Vila Rodrigues

Supervisors: Jorge Santos, José Vicente

"Scientists say, yet again, that nuclear fusion is a few years away. Are they right this time?"

To recap...

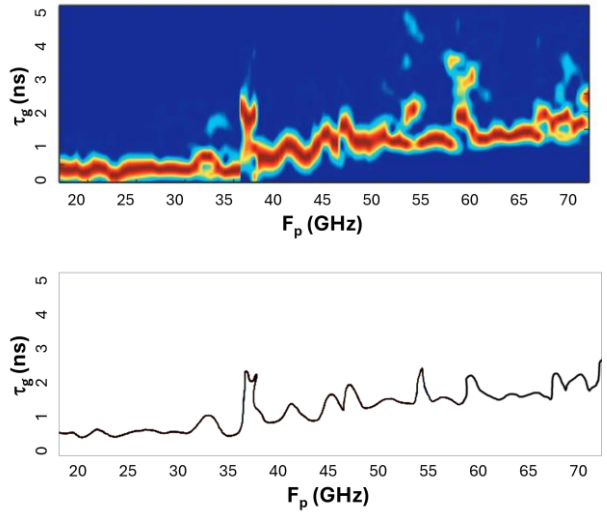
Use spectrograms of the reflectometry signals



To recap...

Use spectrograms of the reflectometry signals

Obtain more reliable group delay curves



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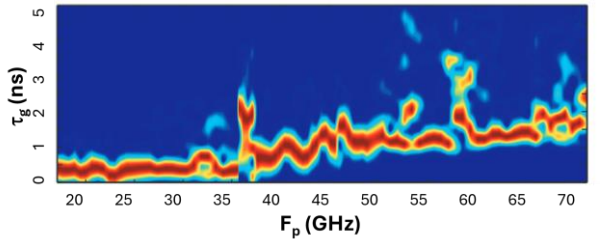
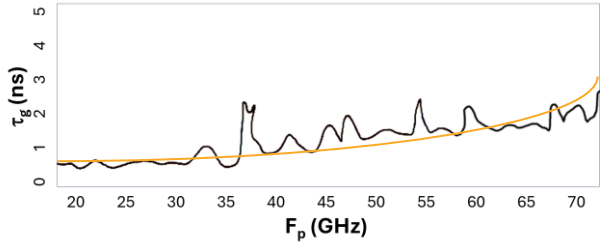
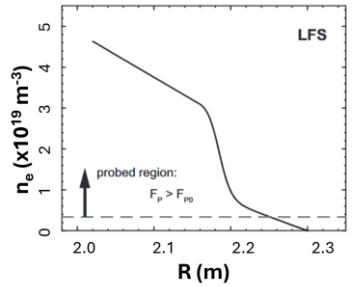
Obtain more representative density profiles







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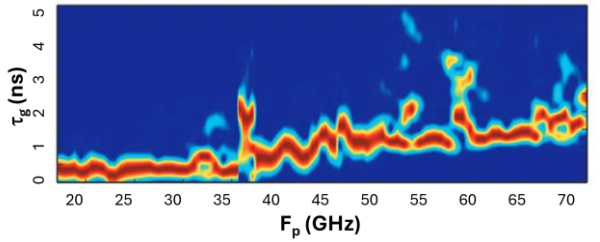
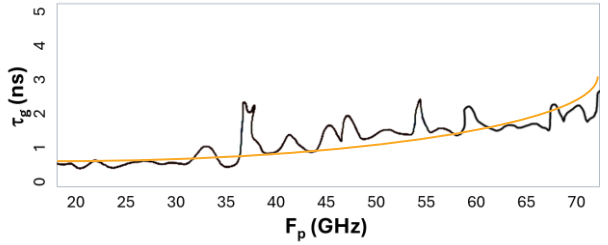
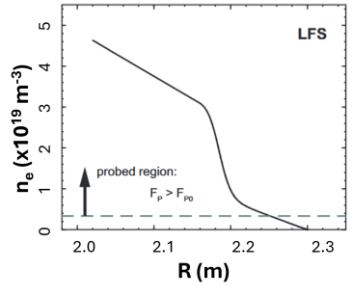
Improve the accuracy of plasma control systems







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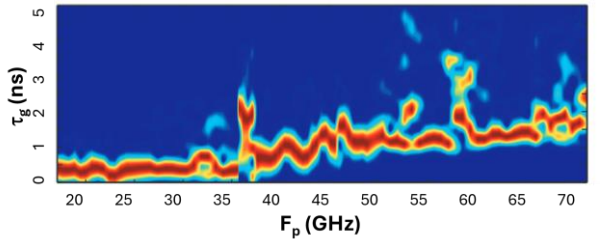
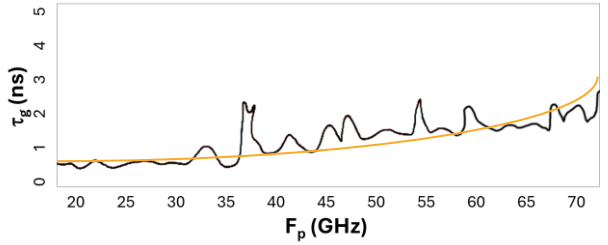
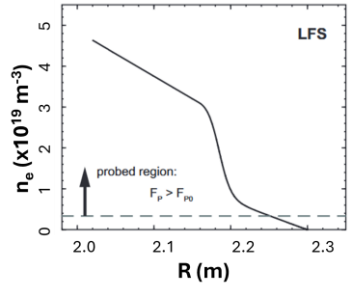
Support the broader goal of making nuclear fusion viable







But how?

Deep learning applied to signal and spectrogram analysis

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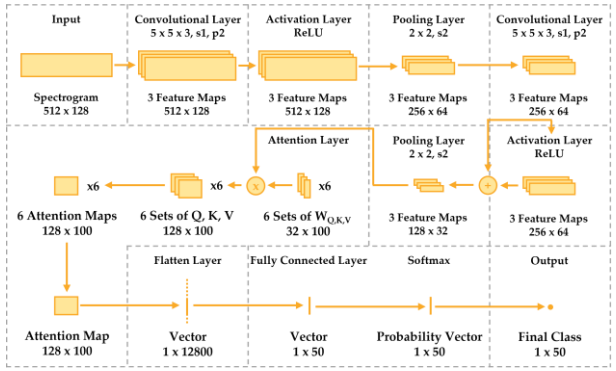
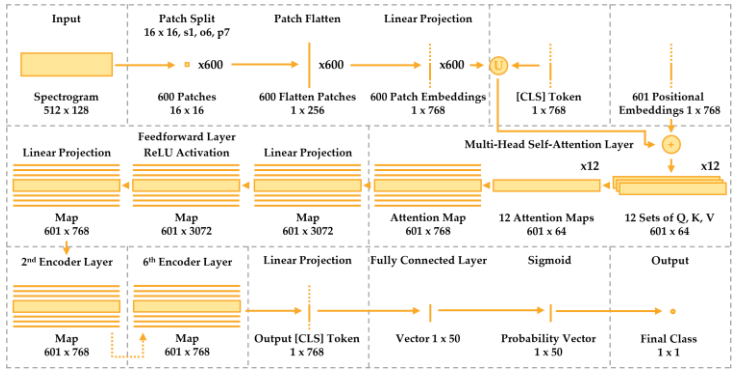


Convolutional neural networks

Transformers



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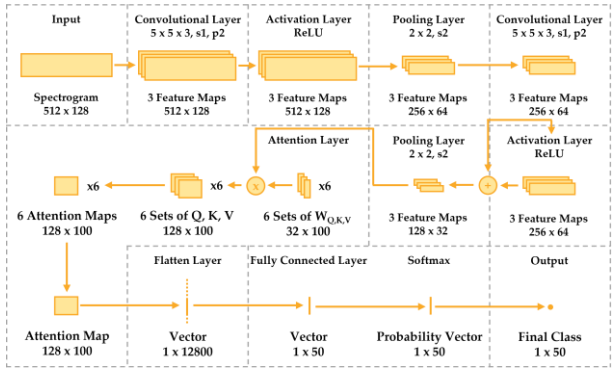

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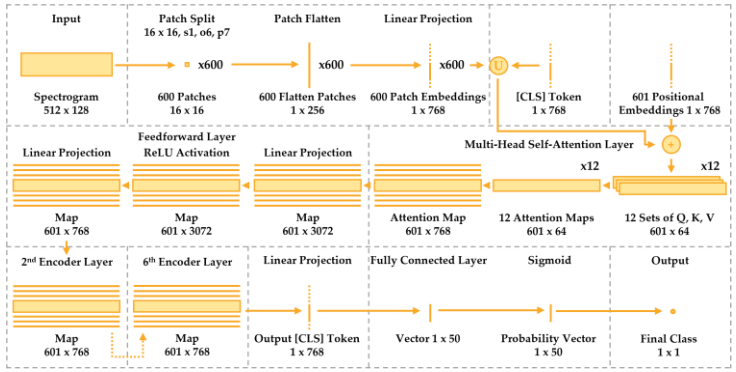

Convolutions: local patterns within the signal

Attention mechanisms: long-range patterns and focus on relevant parts within the signal

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Step 0

Create datasets

But how?

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Step 1
Explore DL architectures

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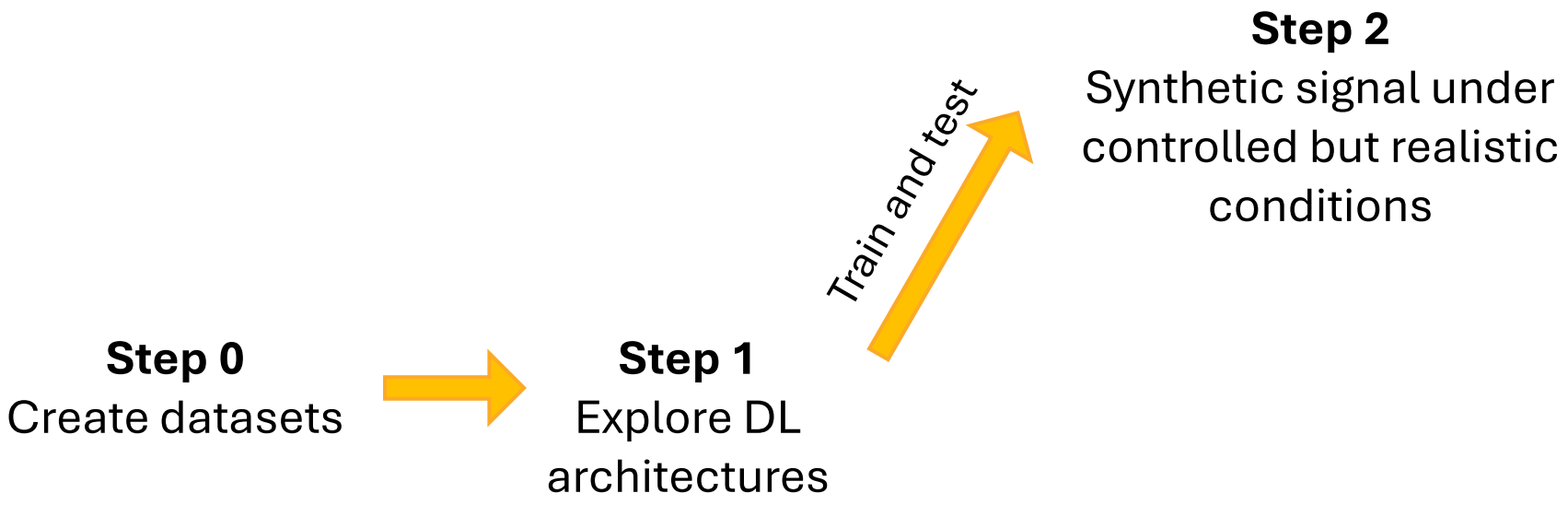
Step 2
Synthetic signal under controlled but realistic conditions
Train and test
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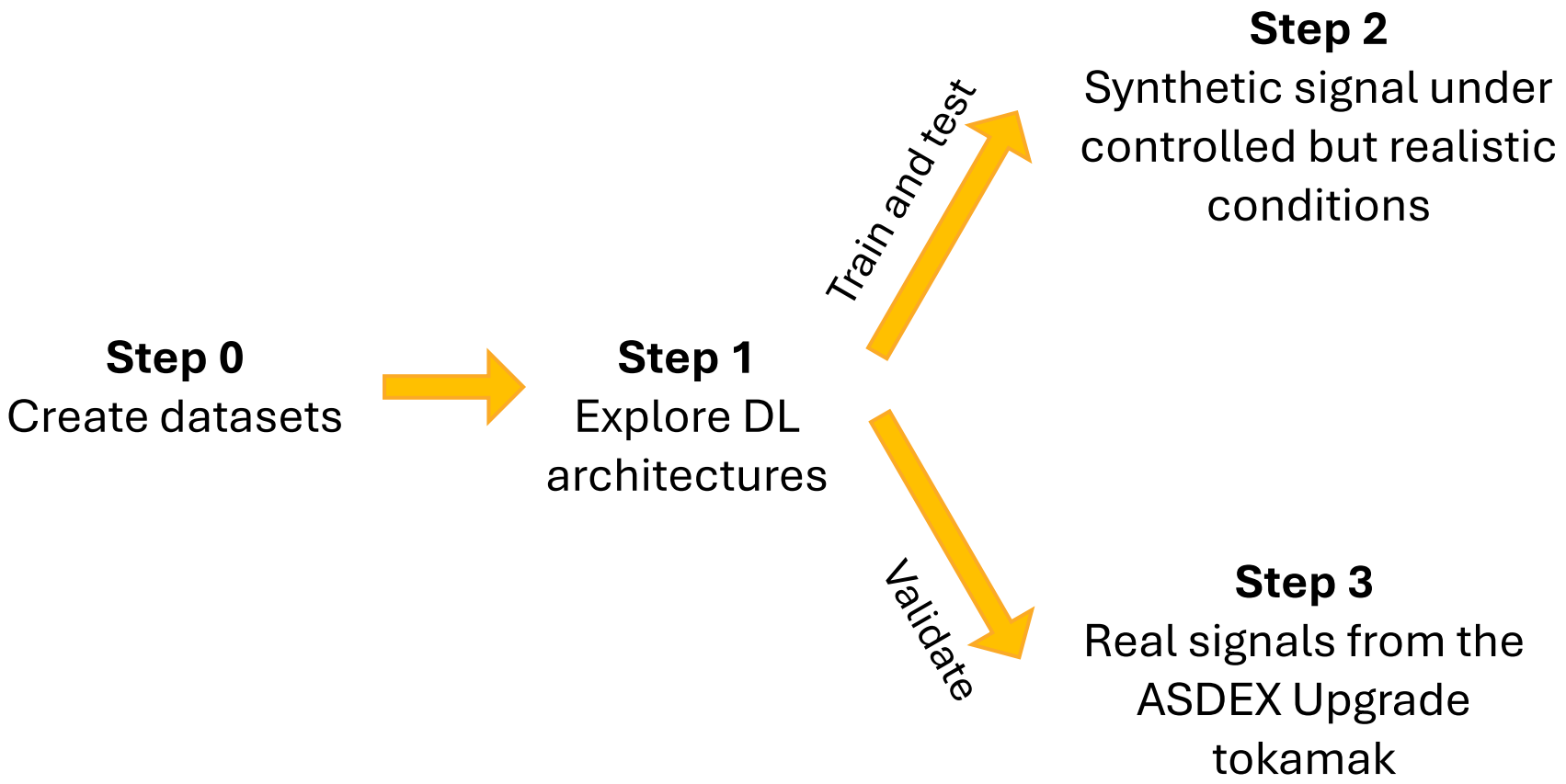
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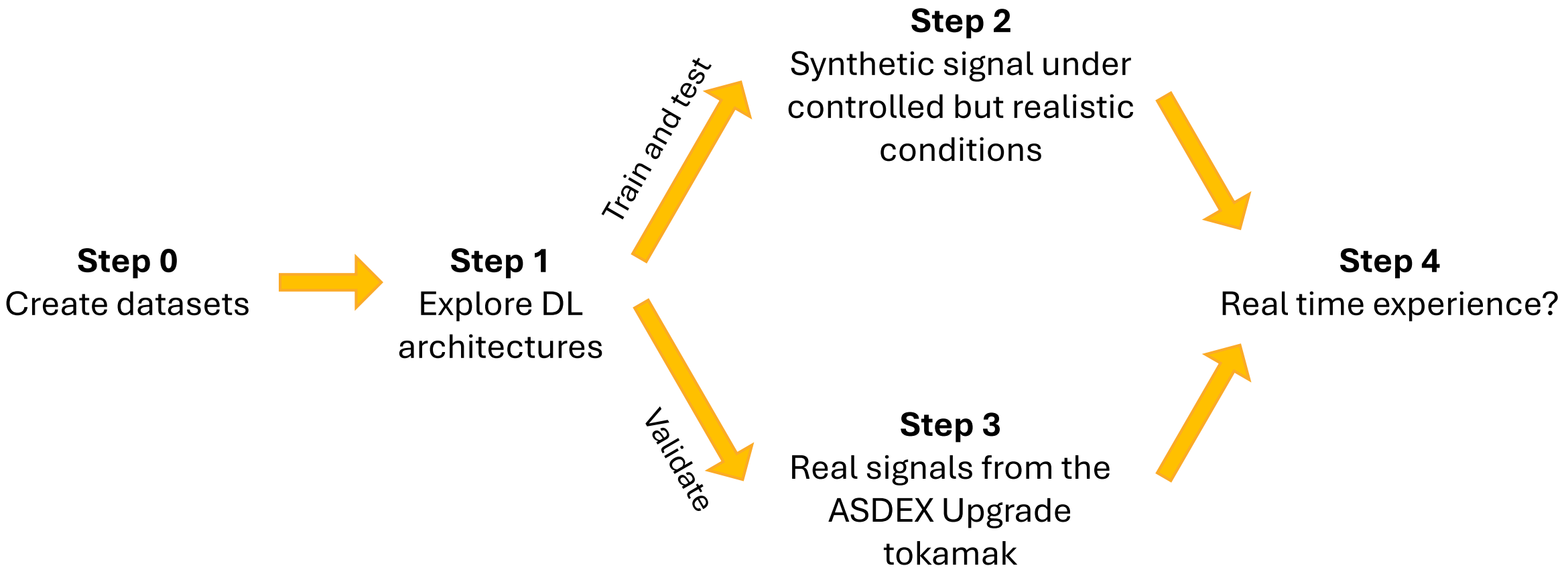
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Step 4
Real time experience?

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