FPGA-Deployed VAE for real-time SXR electron temperature reconstruction in RFX-mod2

How to reconstruct in real time the electron temperature of a fusion experiment in case of diagnostic failure

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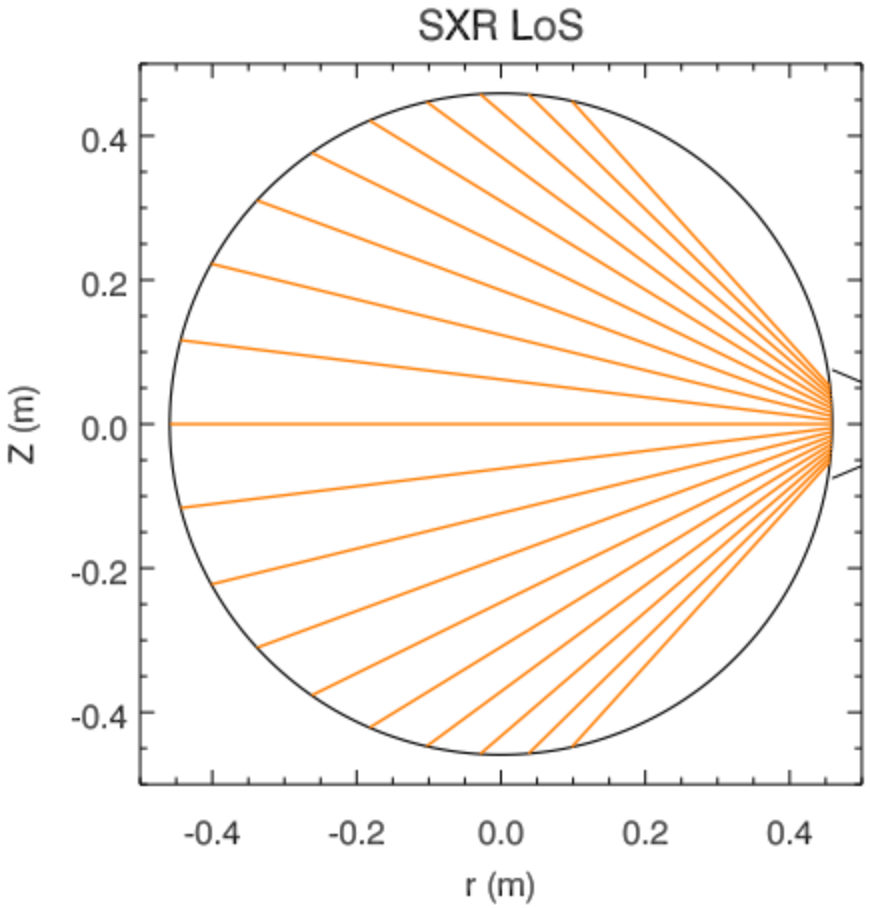
25th IEEE Real Time Conference · La Biodola · 27.05.2026

Electron Temperature measurements

Electron temperature (T_e) is a key parameter in fusion experiments.

- **Diagnostic system**: data is acquired through the Soft X-ray diagnostic
- **Problem**: the acquired data is noisy and sometimes the electron temperature computation explodes leading to missing data
- **Solution**: a **Neural Network** deployed on **FPGA** can reconstruct the temperature profile, also supplying the missing data points



Lines of sight of the Soft X-Ray diagnostic in the RFX-mod experiment.

Problems with the Diagnostic

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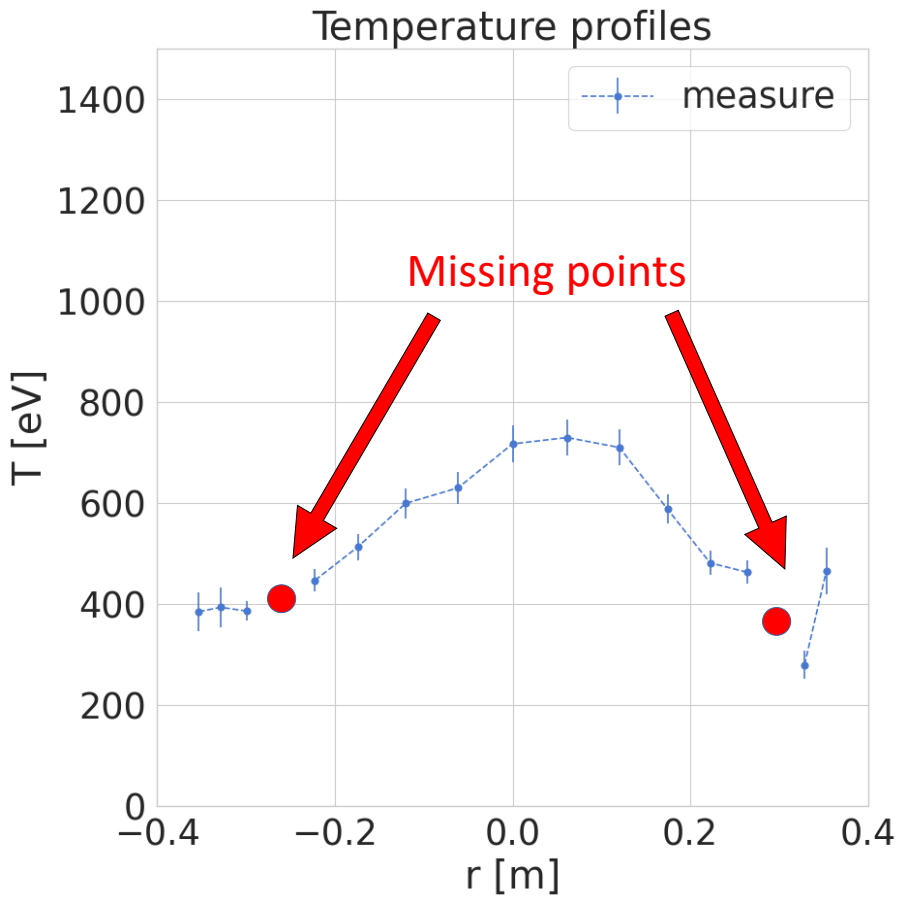

Example of missing points in the temperature profile

Reconstructing Electron Temperature Profiles

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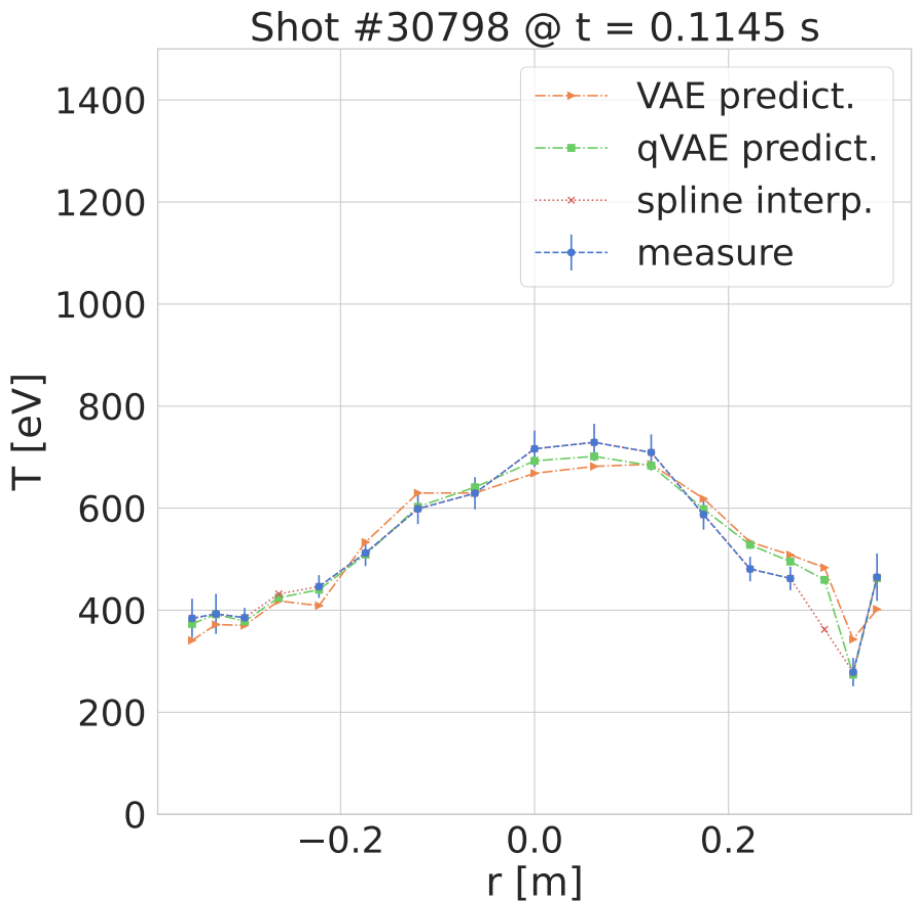
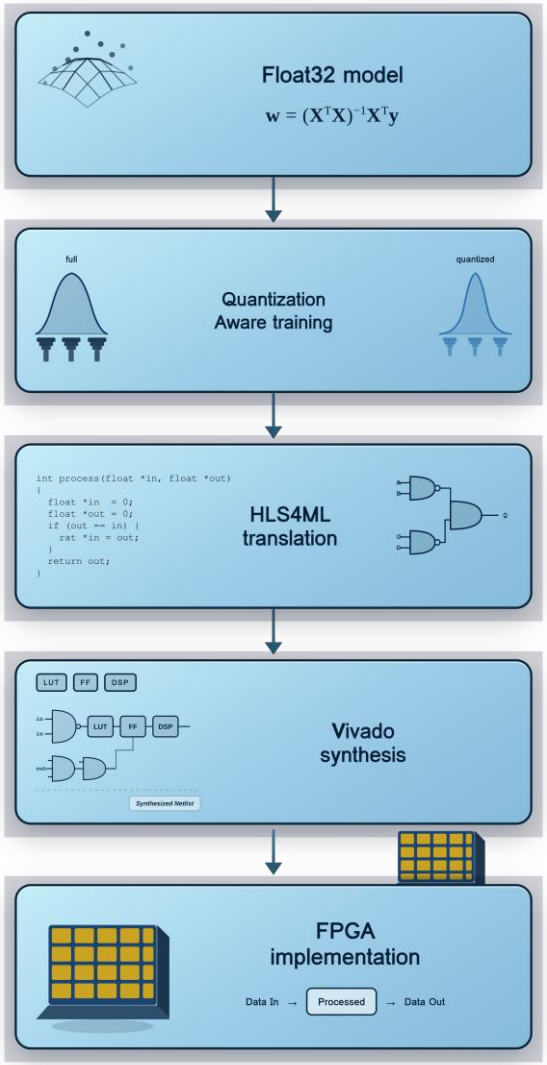
Metti immagine dell'architettura



Reconstruction of a temperature profile with float32 model, quantized model, Bspline and raw measure.

Work Flow



1) Start from training a float32 model

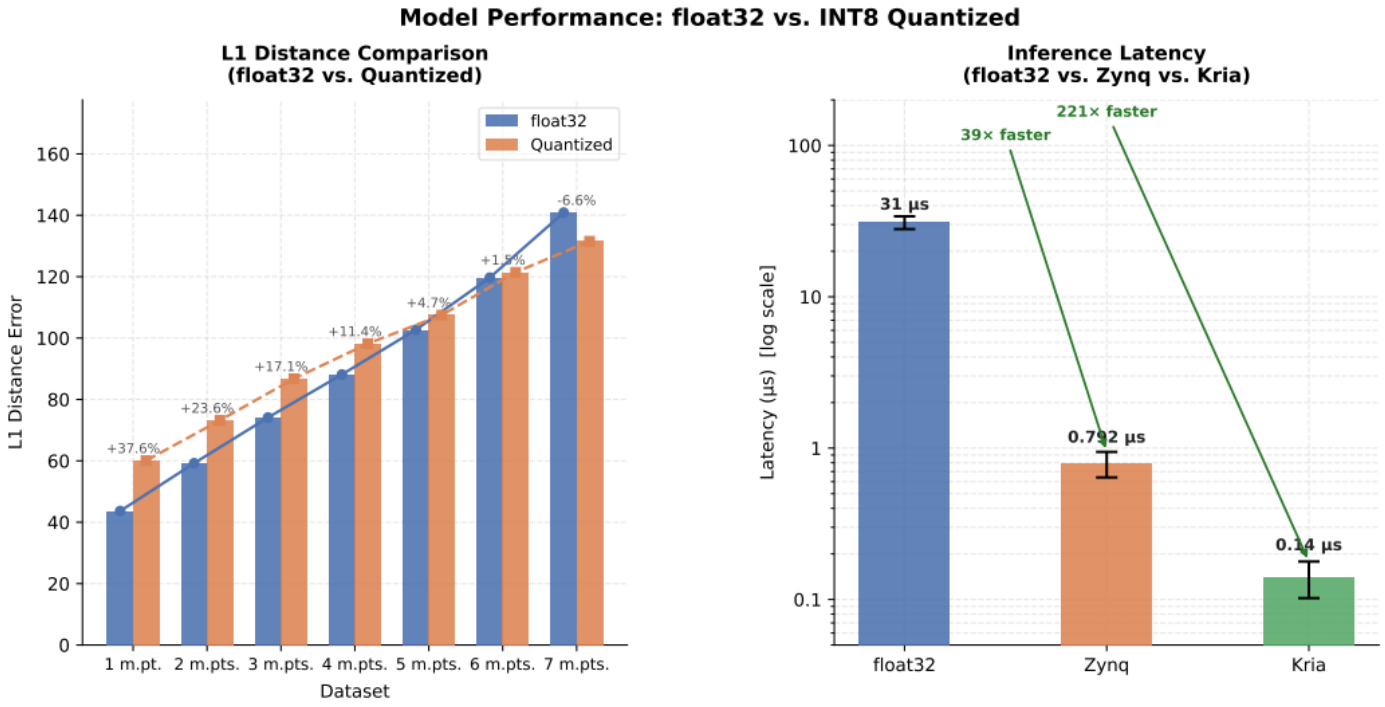
2) Apply quantization aware training with **HGQ**

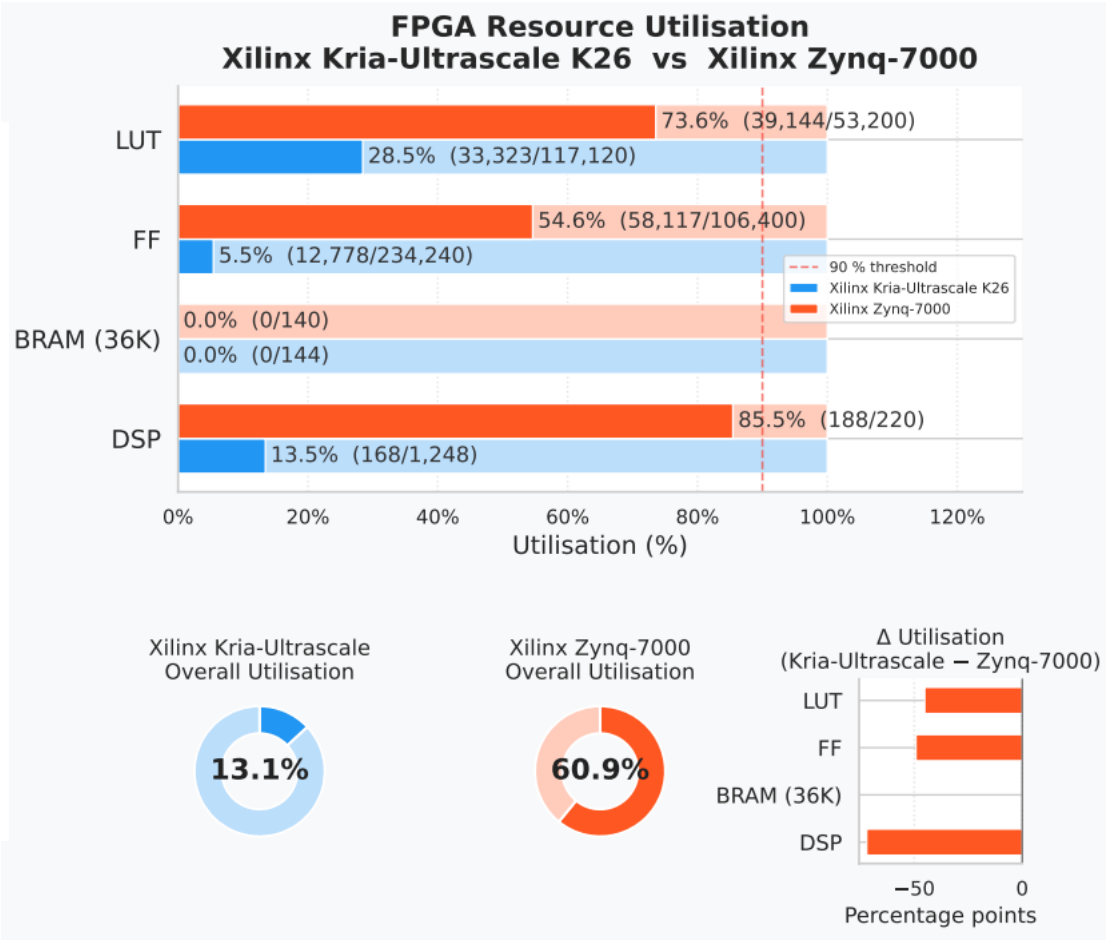
3) Translate the model to HLS with **HLS4ML**

4) Synthesize it using Vivado

5) Deploy it on your FPGA of choice

Accuracy and Resource utilization on FPGA





Thank you!

Also many thanks to the co-authors:
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