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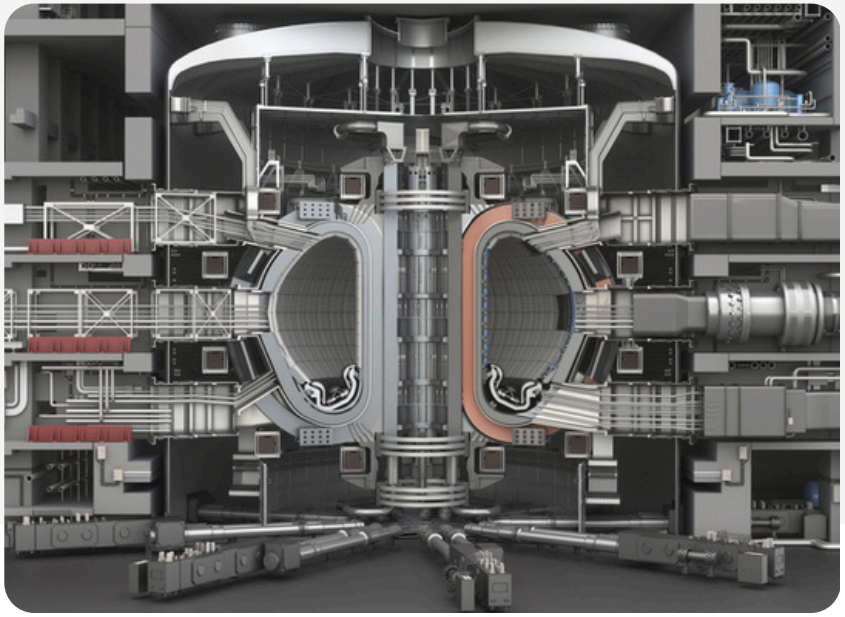

Case Study: Intelligent high-stakes sensing, powered by digiLab

Designing sensing systems to de-risk the harsh environments of fusion powerplants

Impact at a glance

Smarter, faster, and more confident decisions

Enhanced fusion performance

Safeguarding high-value assets

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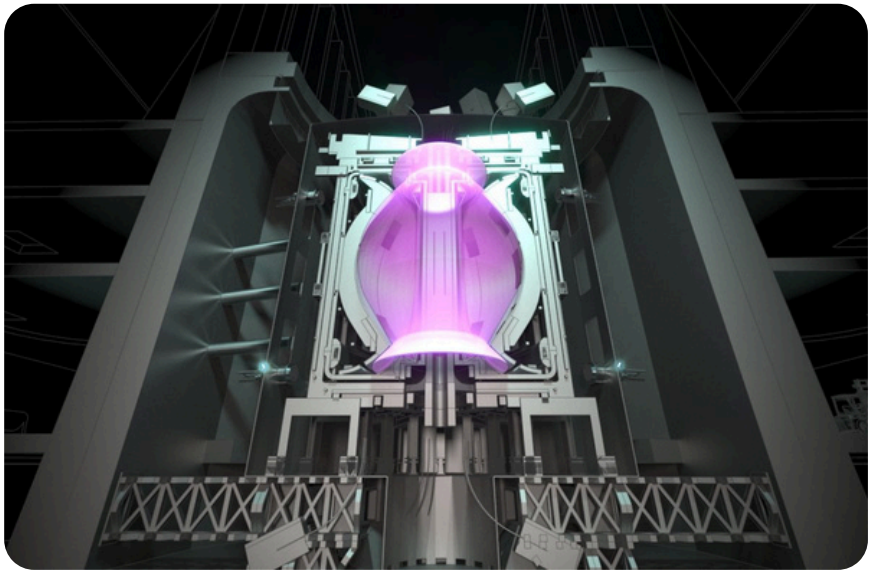
About the UKAEA

digiLab is working in partnership with the **UK Atomic Energy Authority (UKAEA)** on the **Spherical Tokamak for Energy Production (STEP)** programme. This fully government-funded initiative is on a mission to deliver **consistent, scalable fusion energy** to **power everyday life by 2040.** The programme is currently in the reactor design stage, with digiLab supporting several projects.



> digiLab brought a sharp focus on understanding our design challenges and finding ways to create practical and accessible tools. We had access to the senior technical staff and ideas from our discussions were rapidly converted into new features via their product team, maximising the benefits and impacts of the project effectively.

Adam Stephen, Head of Advanced Control Unit, UKAEA

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The Challenge

Fusion devices are extremely difficult to control. With plasma reaching more than 150 million °C, even the smallest instability can lead to lost uptime or costly machine damage. In such high-stakes environments, uncertainty in decision-making carries significant risks.

One way to address this challenge is through better sensor placement - but past approaches have often been incomplete, inconsistent, and lacking confidence.

The Approach

digiLab developed a probabilistic AI solution that uses Uncertainty Quantification (UQ) and advanced optimisation methods to intelligently assess and place sensors. By explicitly quantifying uncertainty, the tool gives engineers clarity on operational risk and how to quantitatively reduce that risk with better design decisions and sensors.

The Solution

The sensing solution evaluates the performance of complex sensor systems through a workflow that calculates the average uncertainty of observed quantities of interest. Using advanced AI methods such as Genetic Algorithms, Gaussian Processes, and Bayesian Experimental Design, the system rapidly recommends accurate, robust, and resilient sensing solutions.

With this approach, digiLab optimised the placement of imaging sensors and assessed the robustness of magnetic sensing systems against potential failures.

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The results

Optimised sensor placement

preventing late-stage redesign and saving operators tens of millions of pounds.

Better sensing systems

enhancing reactor performance and prolonging the life of a £10 billion asset.

Smarter, more confident decisions

reducing risks in design and operation.

In partnership with UKAEA, digiLab is enabling high-stakes design decisions, building confidence in operating fusion plants and helping bring clean fusion energy to the grid. Given the high uncertainty in predicting the costs of early fusion prototypes, reducing uncertainty is critical to improving safety, controlling programme costs, and accelerating the path to sustainable energy.