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Visualising Fusion: Connecting Data, Design, and Discovery

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Fusion energy is one of the most ambitious undertakings in all of science, generating vast amounts of heterogeneous data, ranging from CAD models and real-time diagnostics to multiphysics simulations and AI-enhanced predictions. To comprehend this kind of information across disciplines, one needs more than mere computation; it needs thoughtful integration, interface design, and clear communication.

In this talk, the Fusion Information Visualisation for Experience Design (FIVExD) framework is introduced. The framework is an assembly of a modular, extensible set of building blocks that guide the creation of responsive, interoperable, and stakeholder-aware visualisation workflows. The crucial bit is that FIVExD is not meant to be a prescriptive architecture but rather a truly flexible framework that teams can adapt and customise. It gives visual design a shared language while allowing room for fitting technical architectures tailored to local tools, goals, and user needs.

At UKAEA, we have been working on employing this framework to integrate and visualise data across our major fusion facilities of MAST-U, Chimera, HIVE, and LIBRTI, among others (Fig. 1). Our implementation brings together NVIDIA Omniverse, ParaView, Blender, WebXR, and AI Dashboard interfaces, coordinated through automated data workflows that convert diverse outputs into standardised USD-based formats. These pipelines are increasingly supported by AI copilots that assist in managing complexity, streamlining visualisation setup, and adapting content to different stakeholder needs. This stack supports AR/VR immersion, photorealistic simulation, interactive dashboards, and digital twin systems backed by fusion data.

We'll explore specific use cases that will demonstrate interactive, multimodal access to complex fusion data. These involve photorealistic renderings and scientific visualisation of digital twins; AI-powered dashboards and annotation tools for enhanced live monitoring, contextual analyses, and collaborative review; and fully immersive, collaborative workflows for digital twins in NVIDIA Ommiverse, supporting stakeholder engagement, engineering coordination, and multidisciplinary decision-making [1][2]. These examples demonstrate how our framework supports an application base ranging from scientific insight and design optimisation to training, outreach, and adaptive system interaction and remain open for future expansion and extensions as new tools, use cases, and data sources present themselves.

Driven by high-performance computing, GPU-accelerated rendering, and platforms like OVX that enable scalable, real-time data exploration, modern technologies now support more detailed and intelligent visualisations. But we must remember that images shape understanding. How people perceive systems, form beliefs, and make decisions is deeply influenced by how information is visually communicated. FIVExD helps create the systems that make this possible, but it ultimately comes down to how we use them and how we connect people to data and insight in meaningful, mindful ways.

References

[1] Bhatia, Nitesh, et al. "Advanced techniques for fusion data visualisation." Frontiers in Physics 13 (2025): 1569248.

[2] Bhatia, Nitesh, et al. "Visualizing digital twins of fusion power plants using NVIDIA Omniverse." AIP Advances 15.4 (2025)

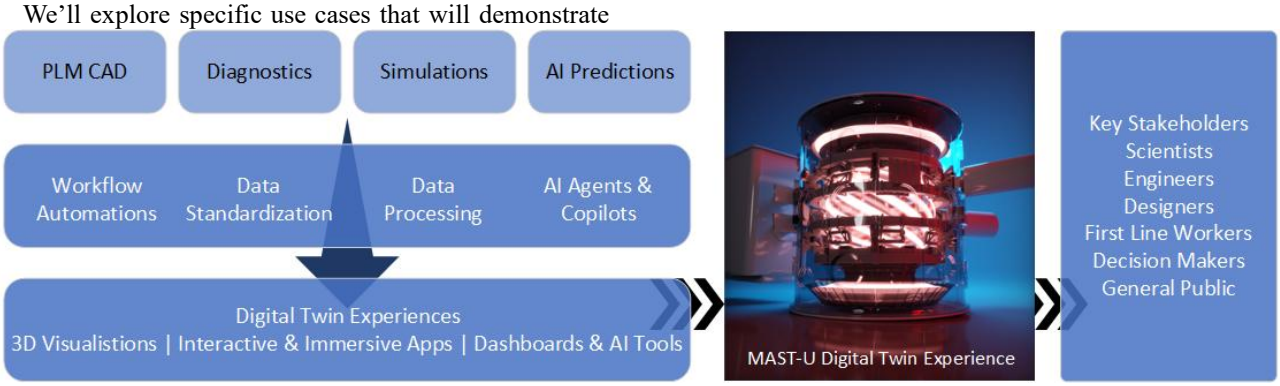

Fig. 1 This figure illustrates how fusion data from CAD, diagnostics, simulations, and AI predictions flows through automated workflows, standardisation, and processing to generate digital twin experiences. These are delivered to key stakeholders through 3D visualisation, immersive applications, and AI-enabled tools.