Modular Diagnostics Platform

End-to-end solution for next-gen MCF devices and future FPPs, fully supported and standardized for industrial deployment.

THE CHALLENGE

Commercial fusion devices demand diagnostics beyond research-grade systems. Existing practices lack standardization across machine types, are ill-suited to industrial supply chains, and are not designed to withstand a high-energy neutron environment. Critically important plasma profiles (e.g. T_e and n_e) cannot be fully measured directly in high magnetic field and burning plasma environment, making intelligent plasma parameters reconstruction a core requirement, not an option. Private MCF builders need a solution that is compact yet sufficient to enable reliable plasma control and ensure device safety — with standardized, off-the-shelf, fast-replaceable components that guarantee controlled costs and continuous operation.

MDP SOLUTION ARCHITECTURE

01 Sensors

Focused on microwave diagnostics (ECE, profile reflectometer, collective Thomson scattering, and radial interferometer-polarimeter). Other types are on the roadmap — with third-party sensor support via standardized interfaces.

02 Hardware

Modular port-plug assembly consolidating all front-end hardware. Radiation-hardened design with neutron & gamma shielding, thermal management, and vacuum boundaries. Designed to minimize footprint and simplify maintenance.

03 VIDA

Versatile Integrated Data Acquisition (VIDA) system covering acquisition & control boards, industrial chassis, networks, and software, designed to integrate both native MDP and third-party sensors via standardized interfaces.

04 Real-Time Data

Delivers validated, high-integrity real-time data directly to the Plasma Control System and device safety systems. Hybrid model-based and ML architecture ensures reliable plasma state reconstruction and uncertainty quantification.

05 Supply Chain Ready

Built entirely on standardized, off-the-shelf, fast-replaceable components. A purpose-built supply chain covering sensor hardware, electronics, and rad-hard components — ensuring controlled costs and availability.

06 Commissioning & Lifecycle

Factory acceptance testing, on-site commissioning, and calibration services included. Long-term support and maintenance ensure the MDP performs across the full device lifetime — from first plasma to decommissioning.

Why Microwaves?

Microwave diagnostics are uniquely suited for next-generation MCF devices: they are non-perturbative, require no in-vessel calibration targets, and operate reliably in high magnetic field and neutron environments. Together they cover a broad range of core plasma parameters — from electron temperature and density profiles to current drive and fast ion diagnostics — making microwaves the backbone of any compact, industrial-grade diagnostic suite.

Next-Gen Magnetics

Standard Hall sensors face severe degradation in next-generation MCF devices and FPPs — D-T neutron fluences of 10^{20}–10^{22} cm^{-2}, temperatures up to 773 K, and restricted maintenance access push existing solutions beyond their viable lifetimes. We are developing epitaxial graphene-on-SiC Hall sensors with intrinsic low cross-section for neutron-induced displacement damage and a thermally-activated self-healing response, restoring transport properties after irradiation within standard operating range.

MDP IMPLEMENTATION ROADMAP

1. Measurements Clarification
2. Feasibility Study
3. Solution Design
4. Manufacturing & Procurement
5. Deployment & Commissioning
6. Operation & Support

WHY MDP

Reduced CAPEX

Standardized modules and unified acquisition platform cut engineering, procurement, and integration costs.

Faster Commissioning

Pre-qualified, plug-and-play assemblies with factory acceptance testing reduce on-site integration time.

Lower OPEX

Flexibility, maintainability and remote handling support minimize downtime and in-vessel intervention requirements.

Single Vendor I&C

Hardware, data acquisition, and real-time processing in one integrated solution with one support contact.

Early Engagement

Diagnostics, control, and safety co-designed from the start — avoiding costly retrofits post-construction.

Proven Physics Basis

Developed by physicists with hands-on experience at ITER, WEST, JET, DIII-D, ST40, MAST, TJ-2, and other devices.

INSIDE MDP

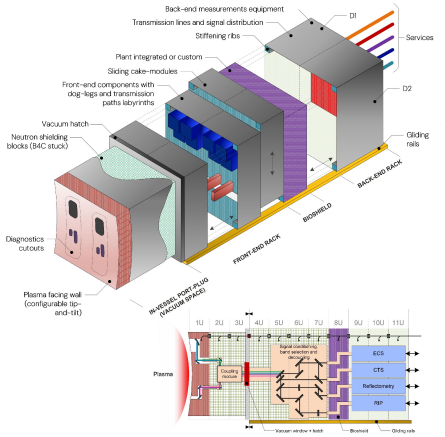

Fig. 1. MDP port-plug and rack assembly: in-vessel port-plug, front-end rack, bioshield, and back-end rack.

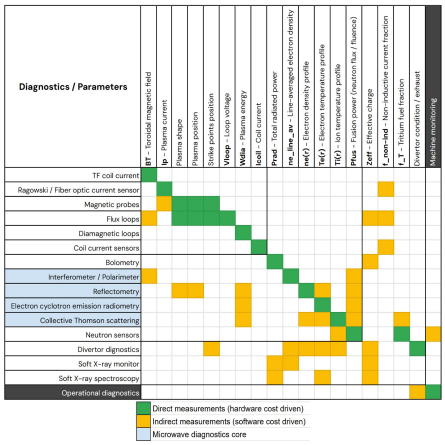

Fig. 2. Diagnostics-to-parameters mapping: direct and derived plasma parameters covered by MDP and third-party sensors.

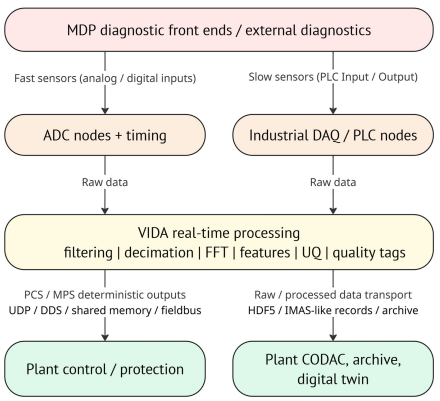

Fig. 3. VIDA architecture: from front-end sensors through real-time processing to plant control, protection, and archiving.

COMPANY & SUPPLIERS

→ Founded in 2023 — Luxembourg HQ, UK office, distributed team across Europe

→ Plasma physicists, fusion engineers, diagnostics developers, software and ML specialists

→ Integrated modeling and plasma control expertise complementing diagnostics

→ Conventional and ML-based real-time data reconstruction and delivery

MDP COLLABORATORS & TESTBEDS

UCSD | UCLA | UC Davis | DIII-D | TCV | IMiF

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Building a new device? Talk to us at the design stage.