What is IMAS and what is it for?

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ITER organization

Workshop on Experimental Data Mapping in IMAS
ITER Organization HQ, St. Paul lez Durance, France, 16 – 20 March 2026

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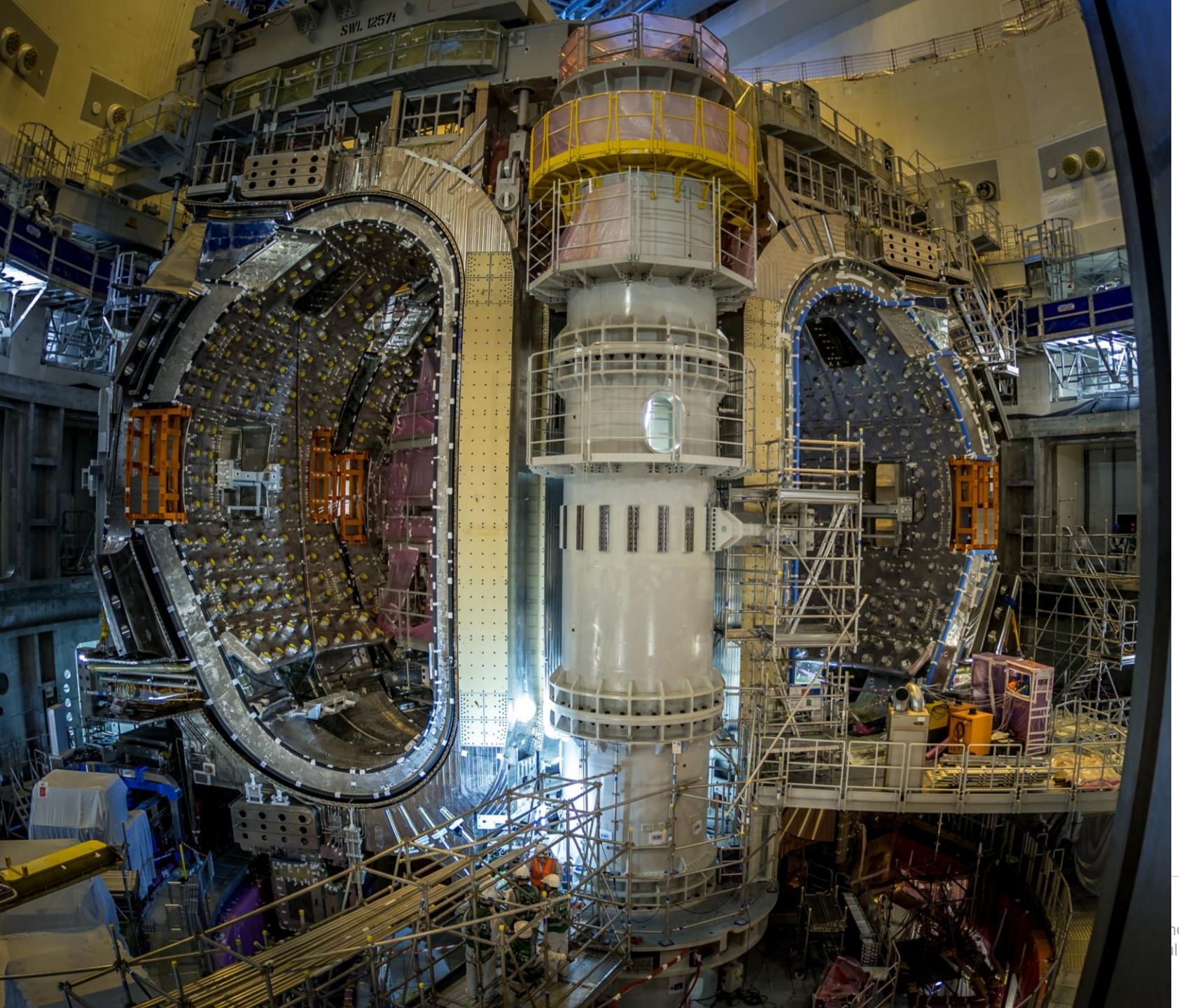


TOKAMAK MACHINE ASSEMBLY

Sector Module 7 sub-sector assembly completed March 2025 and installed in Tokamak Pit, April 2025

Sector Module 6 installed in the Tokamak Pit, June 2025

Sector Module 5 installed in Tokamak Pit, 25th November 2025

Sector Module 8 installed on 29th January 2026

All 9 by March 2027

https://www.iter.org/videos?id=33822

Cryostat arrived at ITER on 4 October 2025

NEW MAGNET COLD-TEST FACILITY

Cold testing at operating temp. (4K) has so far been limited to Central Solenoid Modules.

The Magnet Cold Test Bench will allow a few TF coils and PF1 to be tested before integration, by testing:

- Coil and joint performance
- High voltage ground insulation at different T
- Quench protection systems
- Fast Discharge – cryoplant integration
- Coil thermohydraulic performance

→ Generating data now

What is the Integrated Modelling & Analysis Suite (IMAS) ?

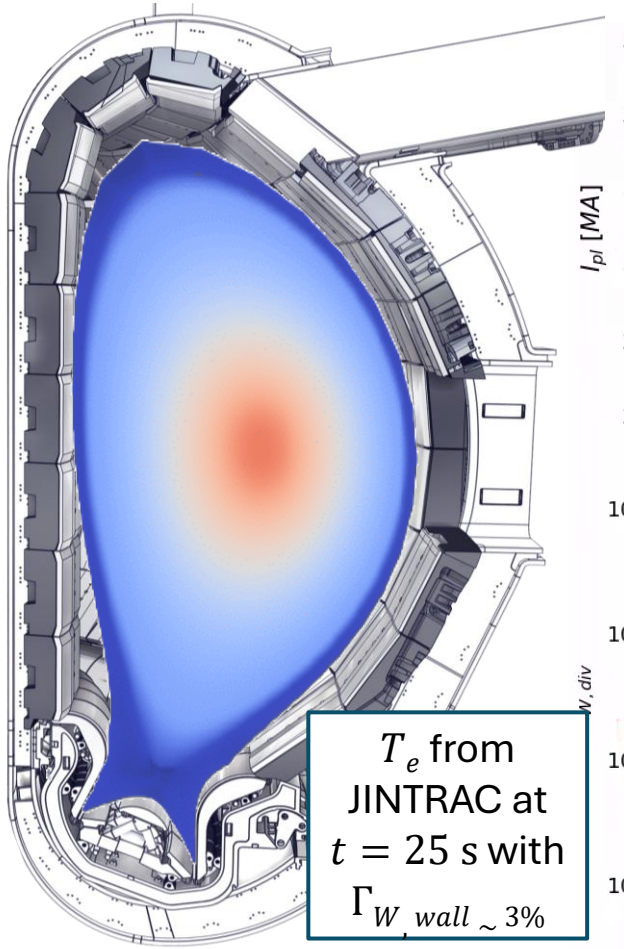
IMAS is the collection of physics software to be used for ITER, it has following layers:

- **Physics applications**
  - Standalone physics codes and multi-component workflows
  - Data processing pipelines
  - Multi-machine databases
- **Generic software tools**
  - Data access, storage and manipulation
  - Data visualisation
  - Assembling, executing and managing simulations
- **Data Model**
  - Machine independent data structures
  - Simulation and experimental data
  - Can be used for code coupling (→ integrated modelling)
  - Metadata and provenance (→ FAIR principles)

"IMAS is the collection of physics software which will be used for the systematic planning and analysis of each ITER pulse…"

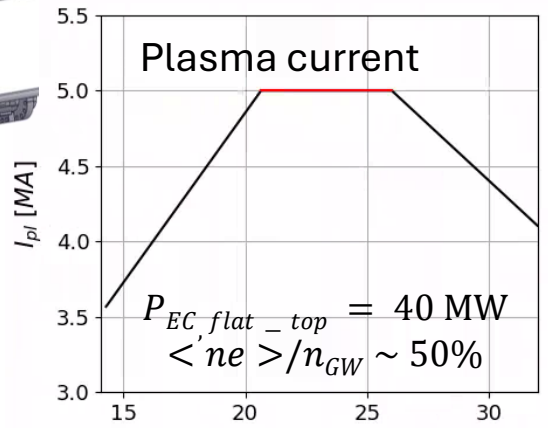
Integrated modelling applied to develop ITER Research Plan

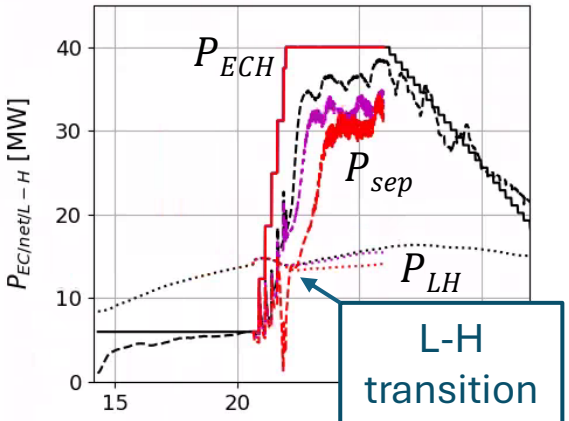
- Integrated modelling of core-edge-SOL/divertor-wall allows to model plasma evolution from limiter phase to late ramp-down
- Drive to make IMAS software open-source
  - https://github.com/iterorganization
  - Validation and application on today's machines is essential
  - Requires experimental data to be mapped to IMAS Data Model



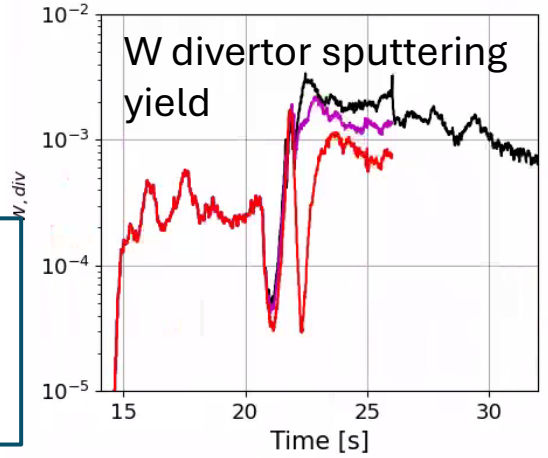
T_e from JINTRAC at $t = 25$ s with $\Gamma_{W,\,wall} \sim 3\%$

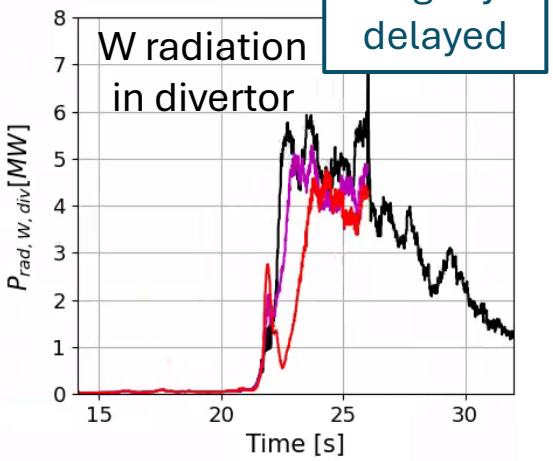
SRO scenario: 5 MA / 2.65 T





L-H transition slightly delayed





Successful transition to H-mode even at high levels of W from wall: $\Gamma_{W,wall} \sim 0\%$, 3%, 10% of $\Gamma_{W,divertor}$

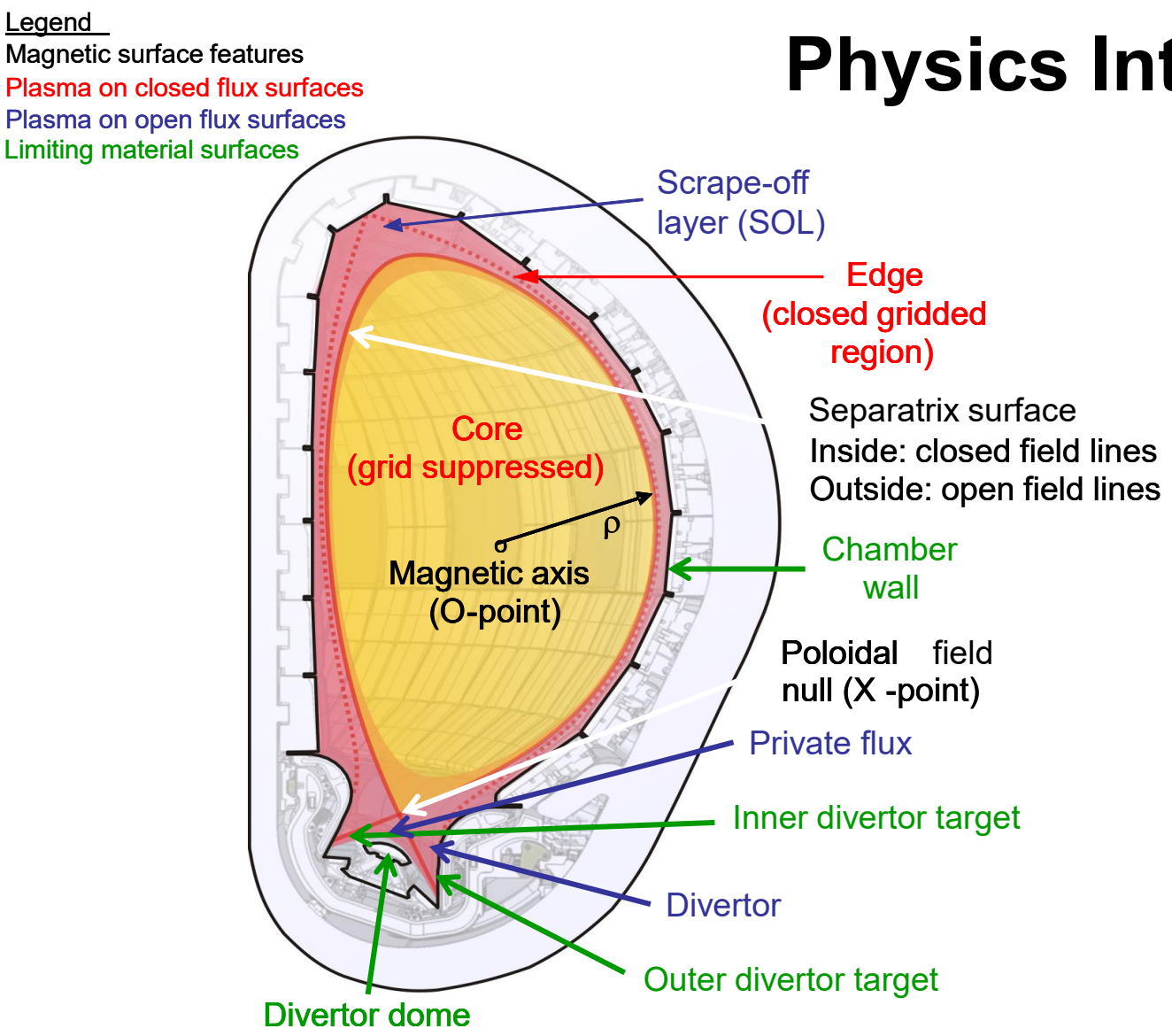
IM Programme and Integrated Modelling & Analysis Suite (IMAS)

- IMAS is the collection of (machine generic) physics software that will be used at ITER for predictive and interpretive modelling, data processing and analysis
- It aims to provide a comprehensive framework for integrated modelling and analysis of fusion plasmas, including support for benchmarking and validation
- It's built around an open standard for representing fusion data suitable for all devices (tokamaks and stellarators) → IMAS Data Dictionary
- Validation and application of IMAS tools on today's machines is an essential step in preparing for ITER operation → Needs data to be mapped to IMAS standard
- This workshop offers an opportunity to support the ITER Organization with the development and validation of IMAS physics models and workflows
- Future ITER researchers will come from today's fusion community, so important to establish close collaborations to train the future generation who will take part in executing the ITER Research Plan

In other words

- The goal of IMAS is to provide a unified, open, machine-independent modelling and data analysis framework that enables integrated and FAIR physics modelling and interpretive analysis for ITER operations and research
  - IMAS aims to support integrated, end-to-end modelling of ITER plasmas, allowing physics codes and workflows to be coupled consistently across the whole discharge lifecycle. It is intended for the systematic planning and analysis of each ITER pulse, from scenario development to interpretation of results.
  - Machine independence means IMAS is applicable to other devices and there should be a win-win benefit for us to work together and achieve more, and go further, than we can individually
- IMAS is designed to be the common, long-term modelling and data framework for ITER operations and research
  - IMAS provides a common physics software ecosystem. It is a collection of physics software, not a single code. It contains standalone physics applications, multi-component workflows, data processing pipelines, generic tools for simulation management and visualisation into a coherent, interoperable framework usable by the ITER community.

Physics Integration Challenges



- Will ultimately require:
  - Coupling of all spatial plasma domains (core, edge, scrape-off layer & divertor)
  - Dynamic coupling of individual physics models relevant to each domain
  - Interaction between plasma and PFCs
  - Models for actuators and diagnostics
  - Coupling of plasma with external circuits, H&CD, fuelling, pumping and other systems to confine and control plasma

Development and Validation of IMAS Data (and associated software)

- **Help needed to extend and revise Data Dictionary to address more Use Cases**
  - Discovery of missing data fields
  - Identification of needs for new IDSs
  - Clarification of documentation and removal of ambiguities
  - Correction of errors
- **Assemble Machine Description data and map data from today's machines to support model validation**
  - E.g. Geometry information: Location, orientation, area and number of turns of magnetic pick-up coils
  - Shape of PF coils (`pf_active`), wall (`wall`), passive conducting structures (`pf_passive`)
- **Apply and validate physics tools and workflows on present-day experimental data**
  - Diagnostic forward models – Many available
  - HFPS
  - HCD-WF
  - EP-Stability-WF
- **Validate and improve experimental data processing, analysis and interpretation tools**
  - Determination of plasma equilibrium state from magnetic and kinetic measurements
  - Inference of plasma parameters and their uncertainties from observations

Validating IMAS data interpretation pipelines for ITER

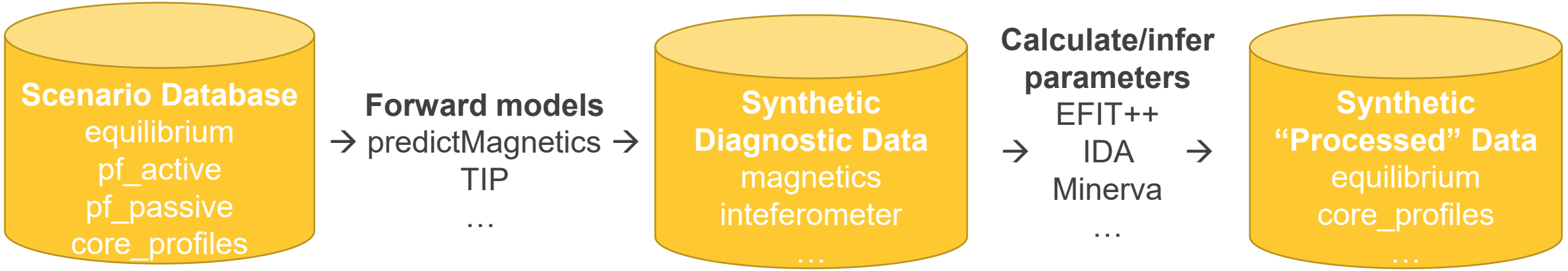
Map existing experimental measurement data to IDSs and interpret using IMAS workflows

e.g. `magnetics`, `interferometry` -> `equilibrium`, `core_profiles`, etc.

- This tests real-world robustness to real uncertainties
- Allows benchmarking with existing (local) tools and approaches

Use forward models with predictive simulations of ITER plasmas to create synthetic experimental data for ITER

- Compare calculated / inferred parameters with original simulation database

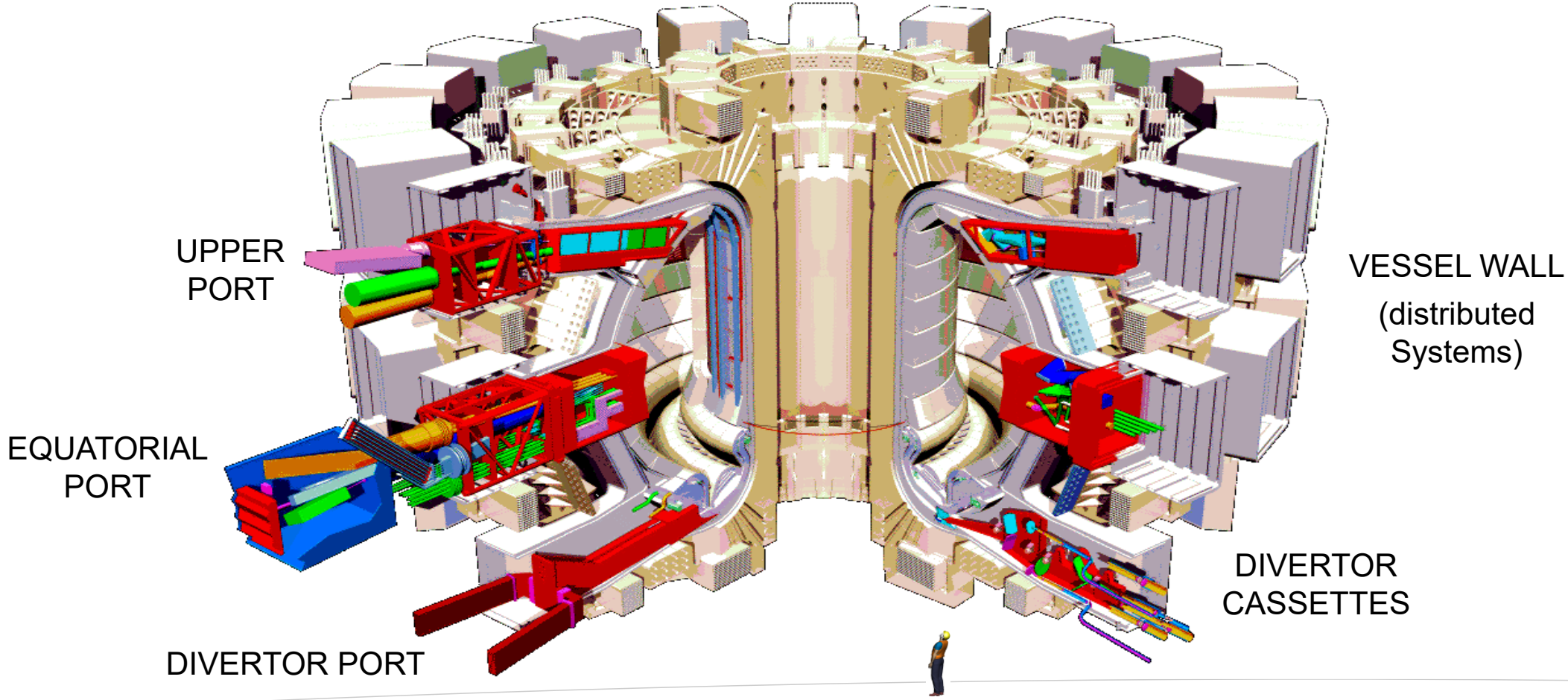


To support Bayesian inference of plasma parameters, diagnostic forward models must be performant (many calls)

ITER diagnostics will generate Big Data

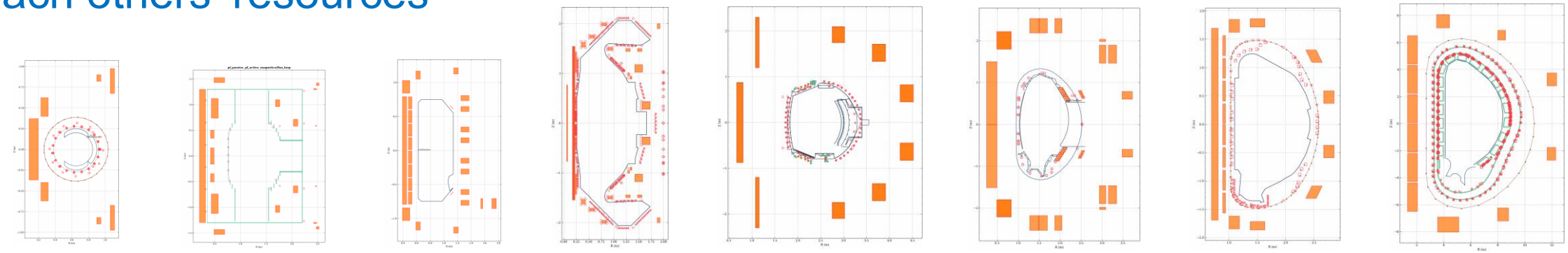
About 40 major diagnostic systems (= very well diagnosed)

- For **machine protection**, **control** and **physics studies**
- Will produce 0.3 – 3 PB of raw data per day → ~1 EB data / year



Summary

- ITER is assembling the Integrated Modelling & Analysis Suite to satisfy all it's needs for physics modelling, data processing, analysis and interpretation
- IMAS is built around a standard representation of data expressed through the IMAS Data Dictionary
- Experimental data, mapped to the IMAS Data Model, is essential to validate physics models against real-world observations and to prepare the data processing pipelines and inference tools for ITER operation
- Establishing common approaches to mapping data benefits everyone by leveraging each others' resources



Thank you for your support to ITER in the area of IMAS

IO HQ, 3 March. 2026
IDM UID: FKV7D4

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