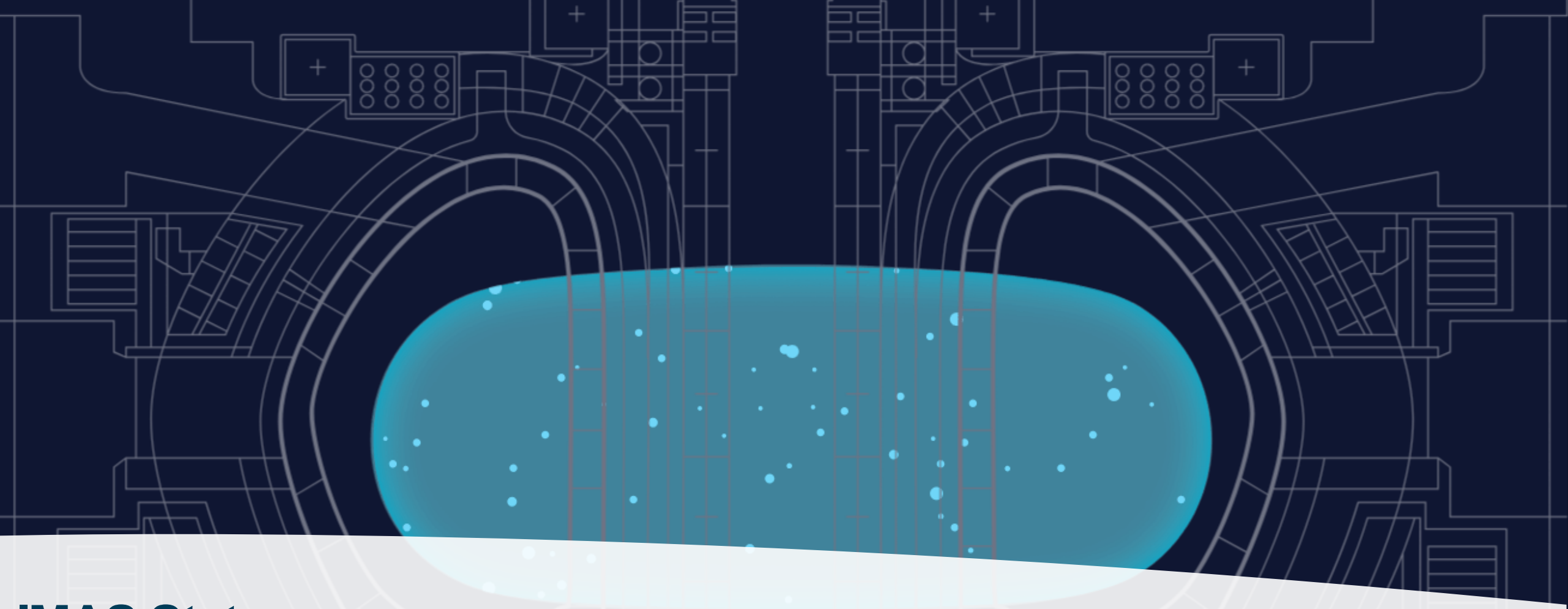
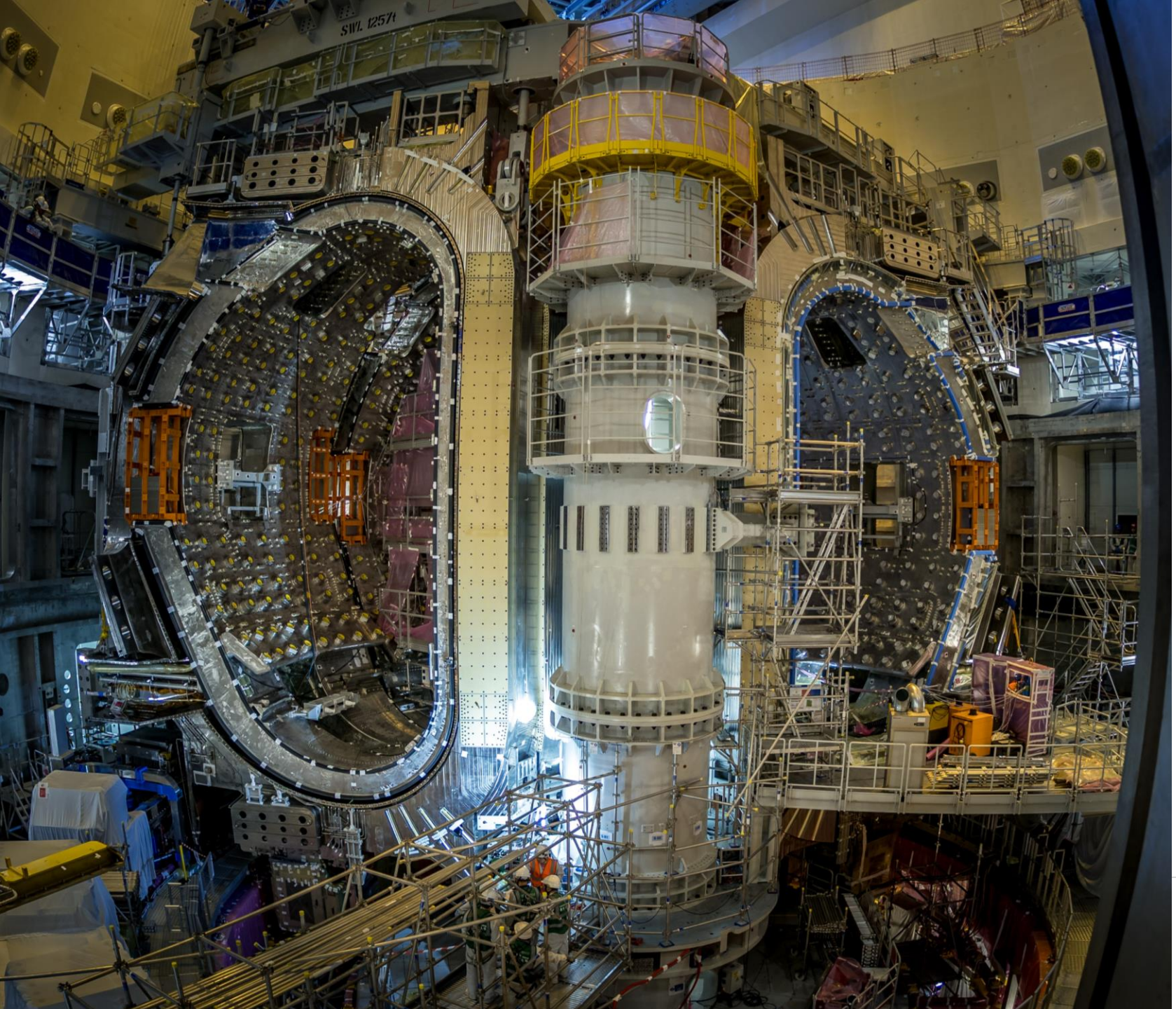


IMAS Status

Simon Pinches, O. Hoenen, S. McIntosh, P. Sawantdesai, D. Maroo, P. Abreu, M. Schneider, S.H. Kim, F. Koechl, M. Dubrov, H. Masanari, F. Poli, X. Bonnin, D. Mewar
ITER organization

EUROfusion E-TASC General Meeting #2 , 12 February 2026

china eu india japan korea russia usa



TOKAMAK MACHINE ASSEMBLY

Sector Module 7 sub-sector assembly completed, March 2025.

Then 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

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

Cryostat arrived at ITER on 4 October 2025

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

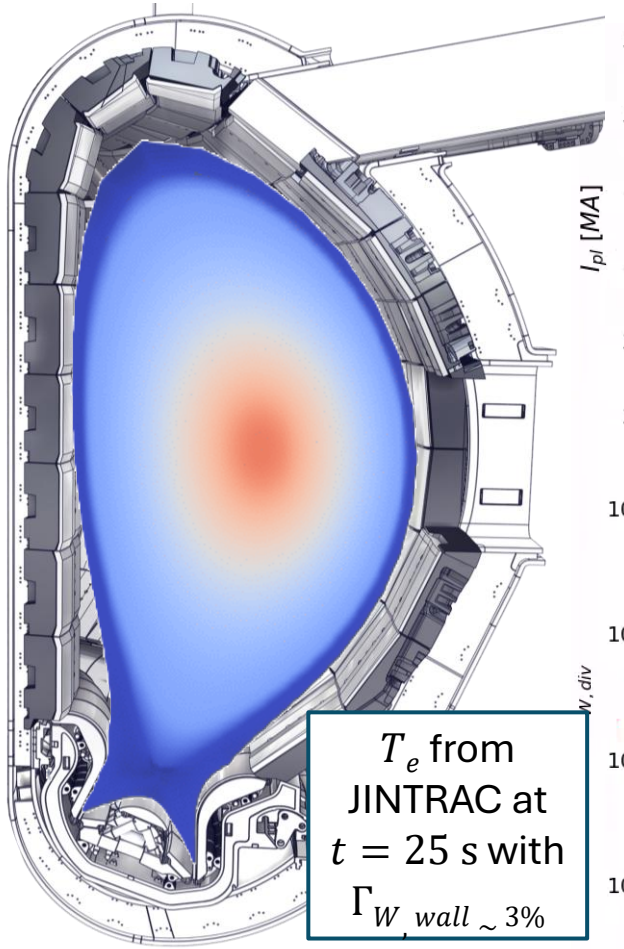
IMAS is the collection of physics software to be used for ITER, it has following layers:

- **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…*

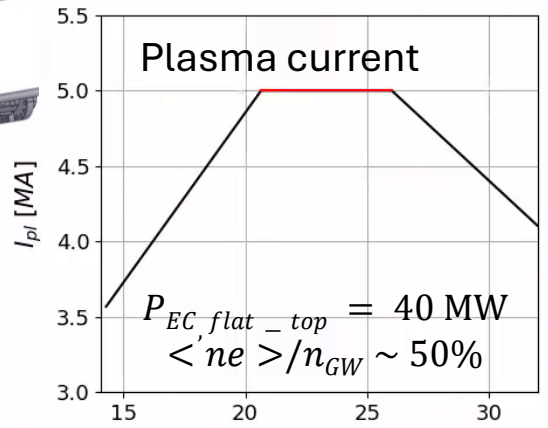
Integrated modelling applied to develop ITER Research Plan

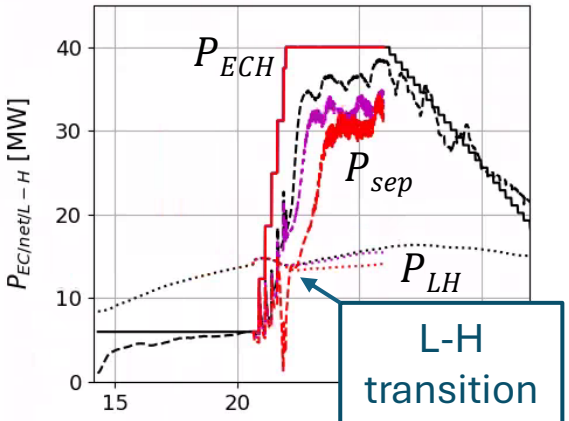
- Integrated modelling of core-edge-SOL/divertor-wall allows to model plasma evolution from limiter phase to late ramp-down
- Drive to make IMAS software open-source
  - https://github.com/iterorganization
  - Validation and application on today's machines is essential
  - Requires experimental data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



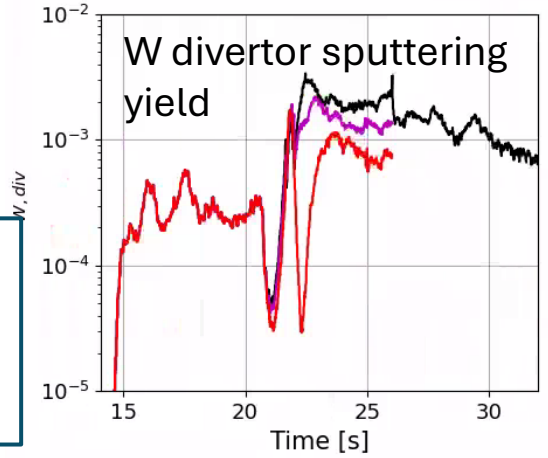
T_e from JINTRAC at $t = 25$ s with $\Gamma_{W,\,wall} \sim 3\%$

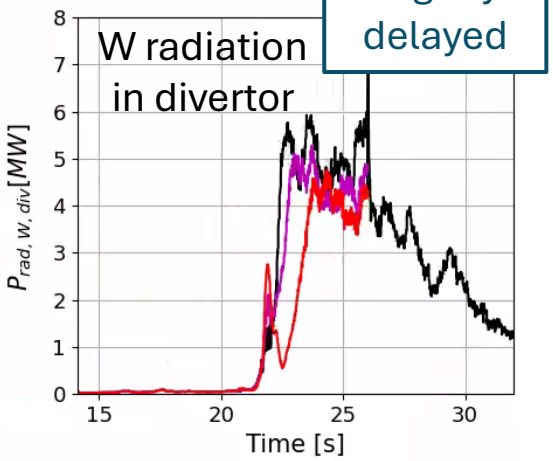
SRO scenario: 5 MA / 2.65 T





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 → 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
- EUROfusion programme offers an opportunity to support the ITER Organization with the development and validation of IMAS physics models
- 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

Open sourcing IMAS

- In November 2024, the ITER Organization Director General approved the release of IMAS software under open-source licenses *«to make it a world-wide standard for fusion research and to lower the barriers to develop, validate, apply and contribute to the software»*
- To allow such release, the ITER Organization sought permission from the owners of any Background Intellectual Property (BIP) upon which IMAS is based

IO software and agreed BIP now released under open-source licenses at https://github.com/iterorganization →

> *"ITER Organization DG approved the release of IMAS software under open-source licenses"*

> *"… permission from the owners of background IP for software to be included in IMAS"*

IMAS Data Dictionary: IDS Coverage (4.1.0)

Diagnostics

barometry bolometer
bremsstrahlung_visible calorimetry
camera_ir camera_visible camera_x_rays
charge_exchange ece focs hard_x_rays
interferometer langmuir_probes **magnetics**
mse neutron_diagnostic
operational_instrumentation polarimeter
reflectometer_fluctuation
reflectometer_profile refractometer
soft_x_rays spectrometer_mass
spectrometer_uv spectrometer_visible
spectrometer_x_ray_crystal
thomson_scattering

Physics phenomena

disruption gyrokinetics_local mhd
mhd_linear ntms plasma_initiation radiation
runaway_electrons sawteeth turbulence

H&CD

distribution_sources distributions
ec_launchers
ic_antennas lh_antennas **nbi** waves

Fuelling

gas_injection gas_pumping
pellets spi

Core transport

core_instant_changes **core_profiles**
core_sources **core_transport**

Electro-Magnetics

b_field_non_axisymmetric
coils_non_axisymmetric em_coupling
equilibrium ferritic iron_core
pf_active pf_passive pf_plasma **tf**

Edge transport

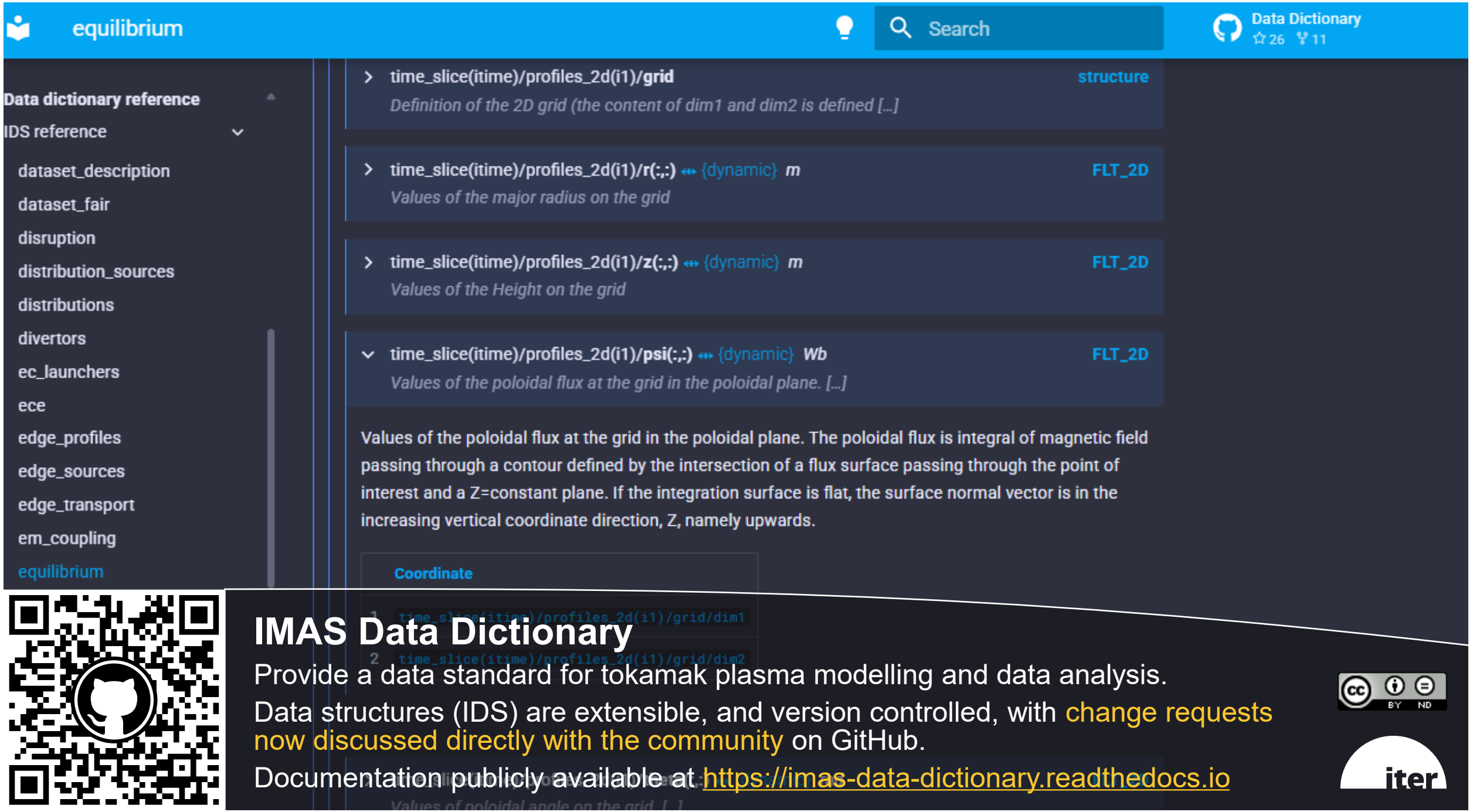
plasma_profiles plasma_sources
plasma_transport
edge_profiles **edge_sources**
edge_transport

Data Management

amns_data controllers dataset_fair
pulse_schedule real_time_data **summary**
temporary transport_solver_numerics workflow

Other plant systems

balance_of_plant breeding_blanket
cryostat divertors **wall**



IMAS Data Dictionary

Provide a data standard for tokamak plasma modelling and data analysis.

Data structures (IDS) are extensible, and version controlled, with change requests now discussed directly with the community on GitHub.

Documentation publicly available at https://imas-data-dictionary.readthedocs.io

iter

Python distribution package openly available at https://pypi.org/project/imas-python.

imas-python 2.1.0.post1

✓ Latest version

```
pip install imas-python
```

Released: Dec 12, 2025

Project links

homepage

Meta

- **License:** GNU Lesser General Public License v3 (LGPLv3) (GNU LESSER GENERAL PUBLIC LICENSE)
- **Author:** ITER Organization
- **Requires:** Python >=3.7
- **Provides-Extra:** all, docs,

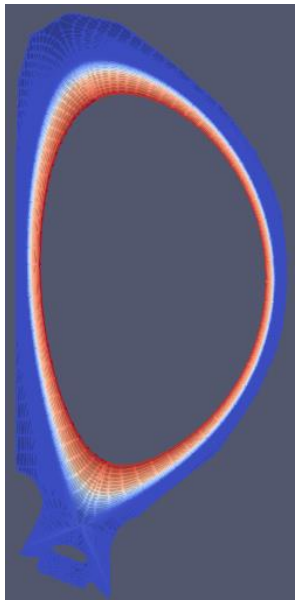
```python
import imas
factory = imas.IDSFactory()
equilibrium = factory.equilibrium()
print(equilibrium)

equilibrium.ids_properties.homogeneous_time = imas.ids_defs.IDS_TIME_MODE_HOMOGENEOUS
equilibrium.ids_properties.comment = "testing"
equilibrium.time = [0.01]

with imas.DBEntry("imas:hdf5?path=./testdb", "w") as dbentry:
    dbentry.put(equilibrium)

# or without imas_core dependency
with imas.DBEntry("./test.nc", "w") as dbentry:
    dbentry.put(equilibrium)
```

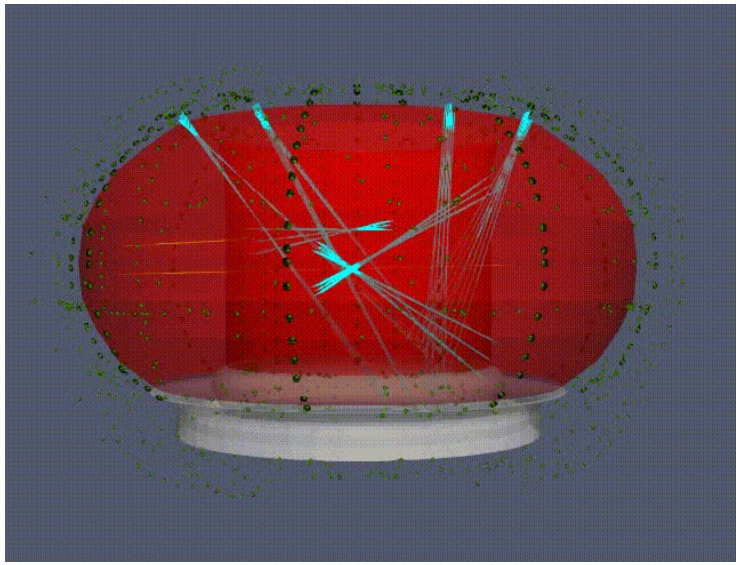
IMAS-Python

Data access API to read/write/manipulate objects from the Data Dictionary (DD).
Install with pip, support for MDSplus, HDF5, UDA (via IMAS-Core), netCDF4, Xarray, lazy loading. Conversion between DD versions.
Documentation publicly available at https://imas-python.readthedocs.io.

IMAS-ParaView

https://github.com/iterorganization/IMAS-ParaView
https://imas-paraview.readthedocs.io
https://pypi.org/project/imas-paraview

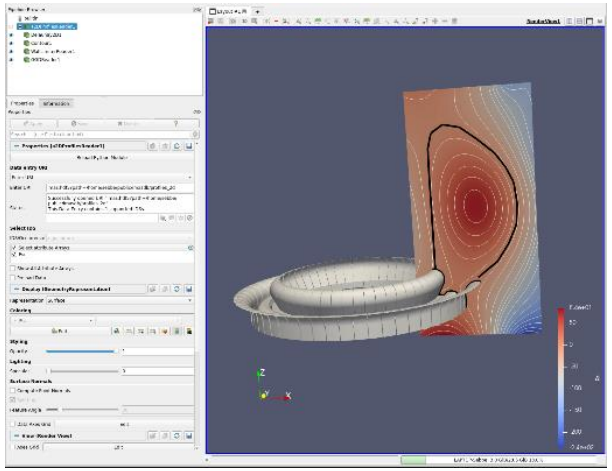


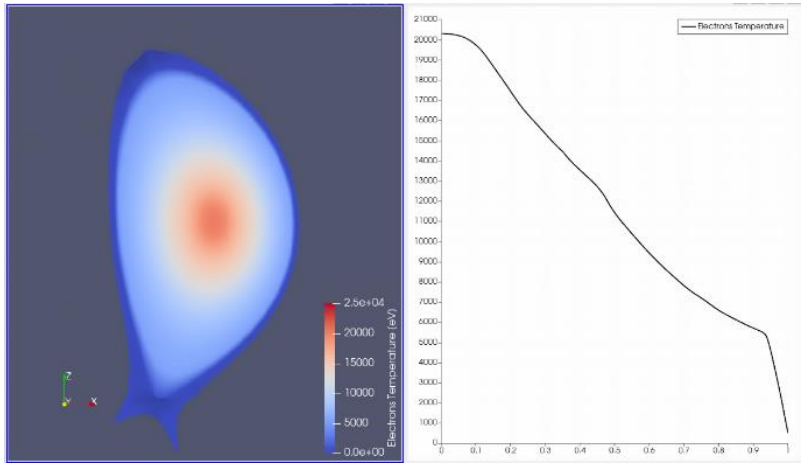


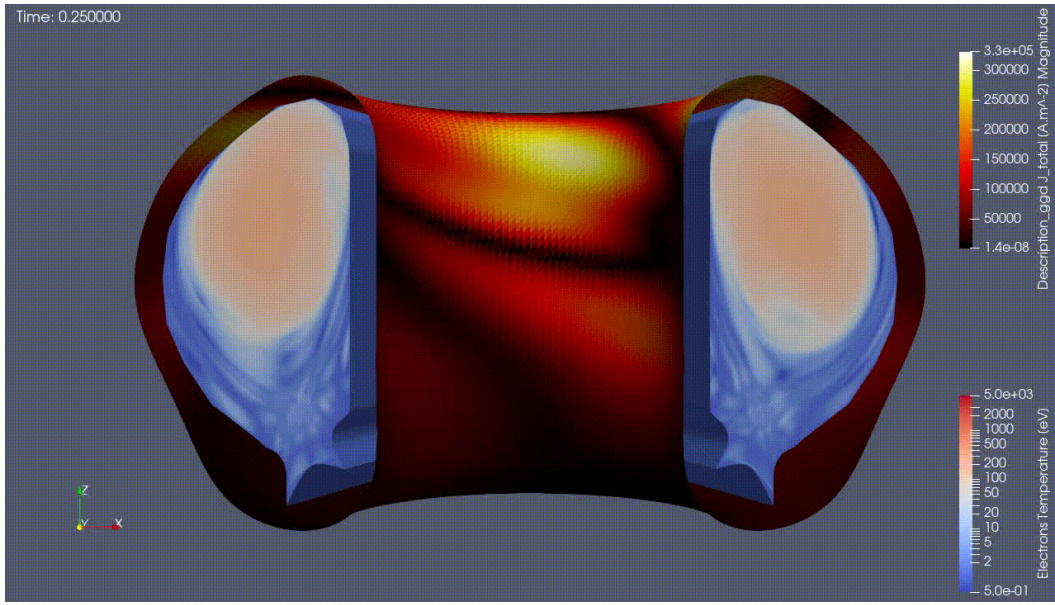
New features in **2.1**

- Training material and examples
- `ggd2vtk imas:hdf5?path=./mydb#edge_profiles output_dir`
- New readers (in addition to usual GGD)
  - 1D/2D profiles
  - MD (LoS, beam, position, wall)
  - JOREK (Bezier FEM)
- New filter: 1D profiles to 2D flux grid

```
output_dir/
├── edge_profiles_0/
│   ├── edge_profiles_0_0_0.vtu
│   ├── edge_profiles_0_1_0.vtu
│   ├── edge_profiles_0_2_0.vtu
│   ⋮
└── edge_profiles_0.vtpc
```





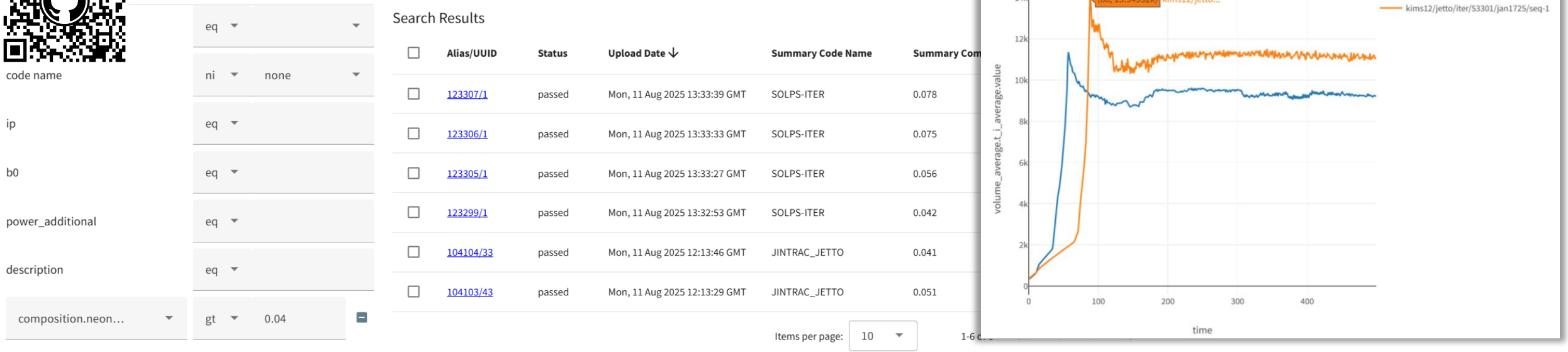


SimDB

https://github.com/iterorganization/SimDB
https://simdb.readthedocs.io
https://pypi.org/project/imas-simdb

```
$ simdb remote query composition.neon.value=gt:0.04 -m code.name -m global_quantities.ip.value
alias      composition.neon.value code.name      global_quantities.ip.value
-------------------------------------------------------------------------
104103/43 0.051                   JINTRAC_JETTO [-7500000.00]
104104/33 0.041                   JINTRAC_JETTO [-7500000.00]
123299/1  0.042                   SOLPS-ITER    [-15000000.00]
123305/1  0.056                   SOLPS-ITER    [-15000000.00]
123306/1  0.075                   SOLPS-ITER    [-15000000.00]
123307/1  0.078                   SOLPS-ITER    [-15000000.00]
```

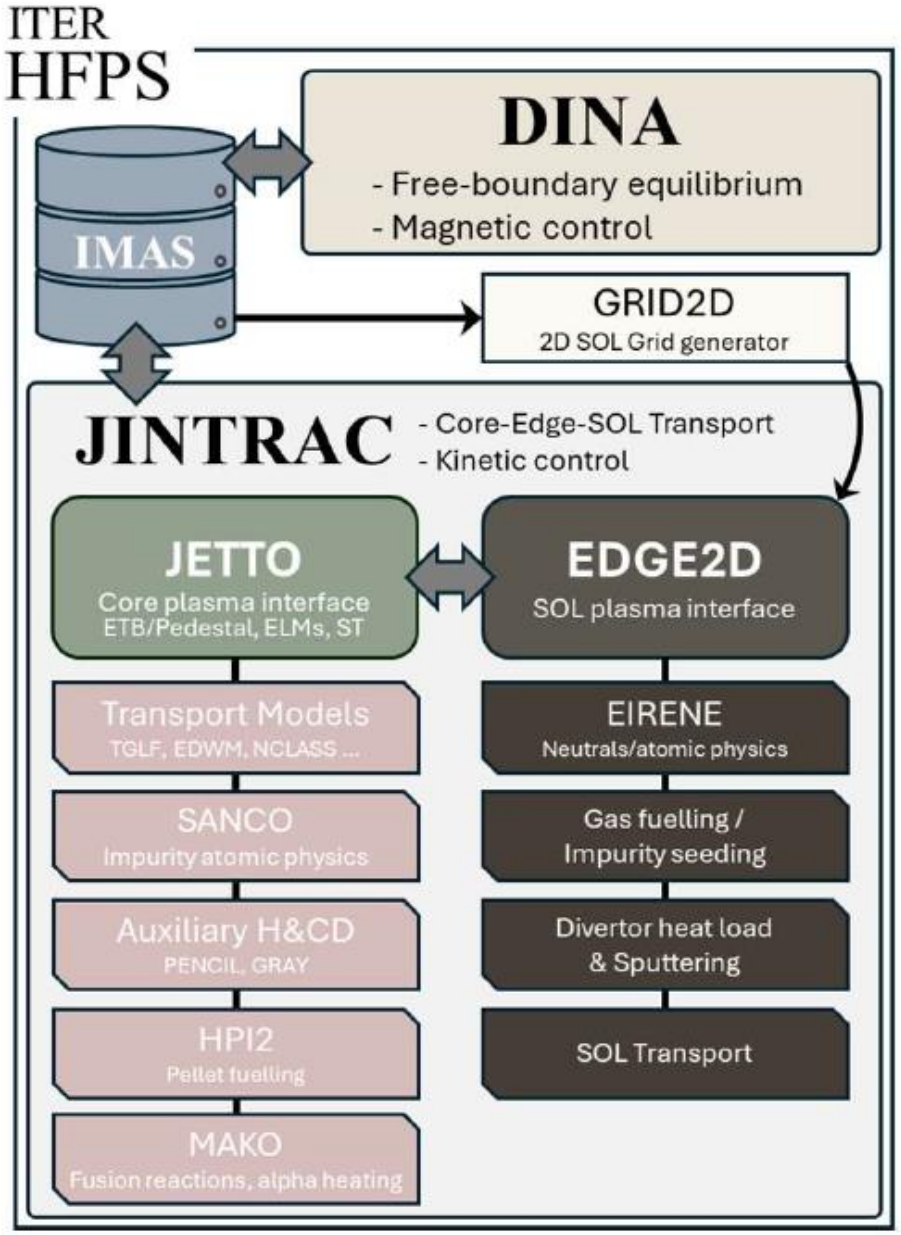
https://github.com/iterorganization/SimDB-Dashboard



Now in production for ITER scenarios: https://simdb.iter.org

High-Fidelity Plasma Simulator (HFPS)

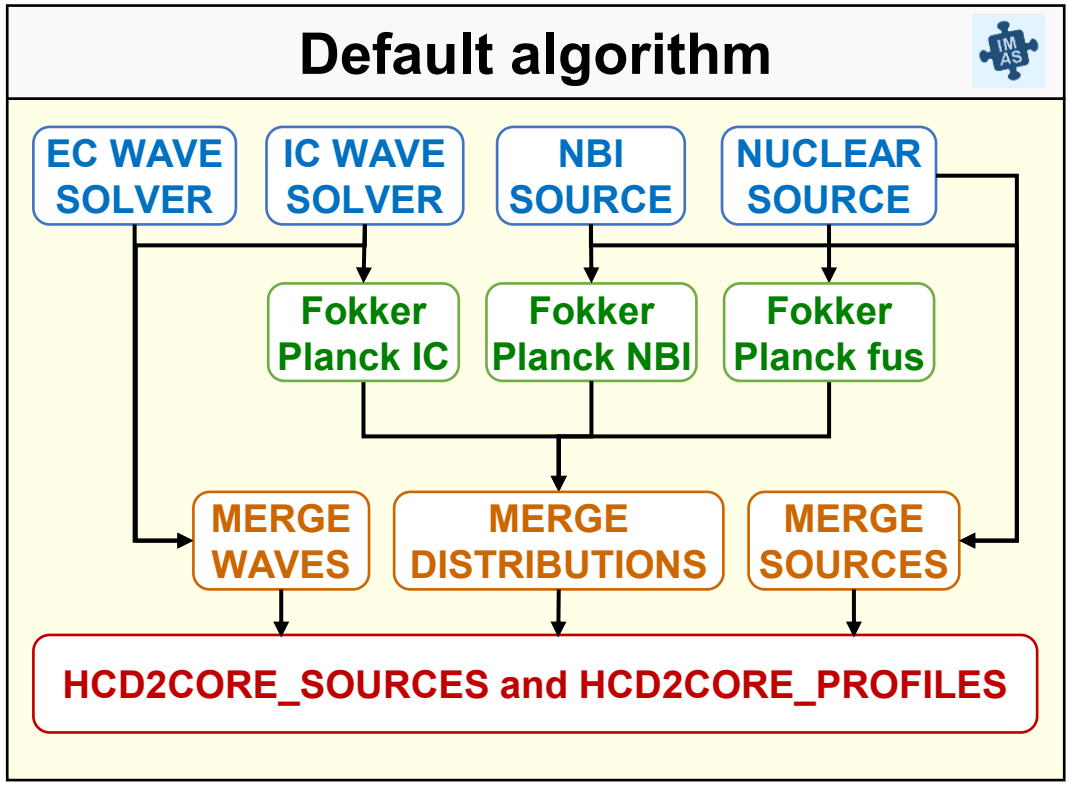
- HFPS required to model integrated ITER scenarios, including core-edge-SOL transport, sources and stability, plasma-wall/target interactions, and magnetic/kinetic control
  - To prepare ITER scenarios for the ITER Research Plan (IRP)
  - To support validation of ITER systems and components
  - To perform interpretive modelling of ITER pulses and physics studies
- ITER HFPS development activities are based on integration of
  - **JINTRAC** (core-edge-SOL transport with sources and exhaust, and kinetic control)
  - **DINA** (free-boundary magnetic equilibrium evolution and magnetic control)
- HFPS including free-boundary evolution & core transport has been developed by applying loose and close coupling schemes
- Demonstrations of edge/SOL-divertor modelling for 15MA case
- New conservation scheme being implemented to model plasma evolution

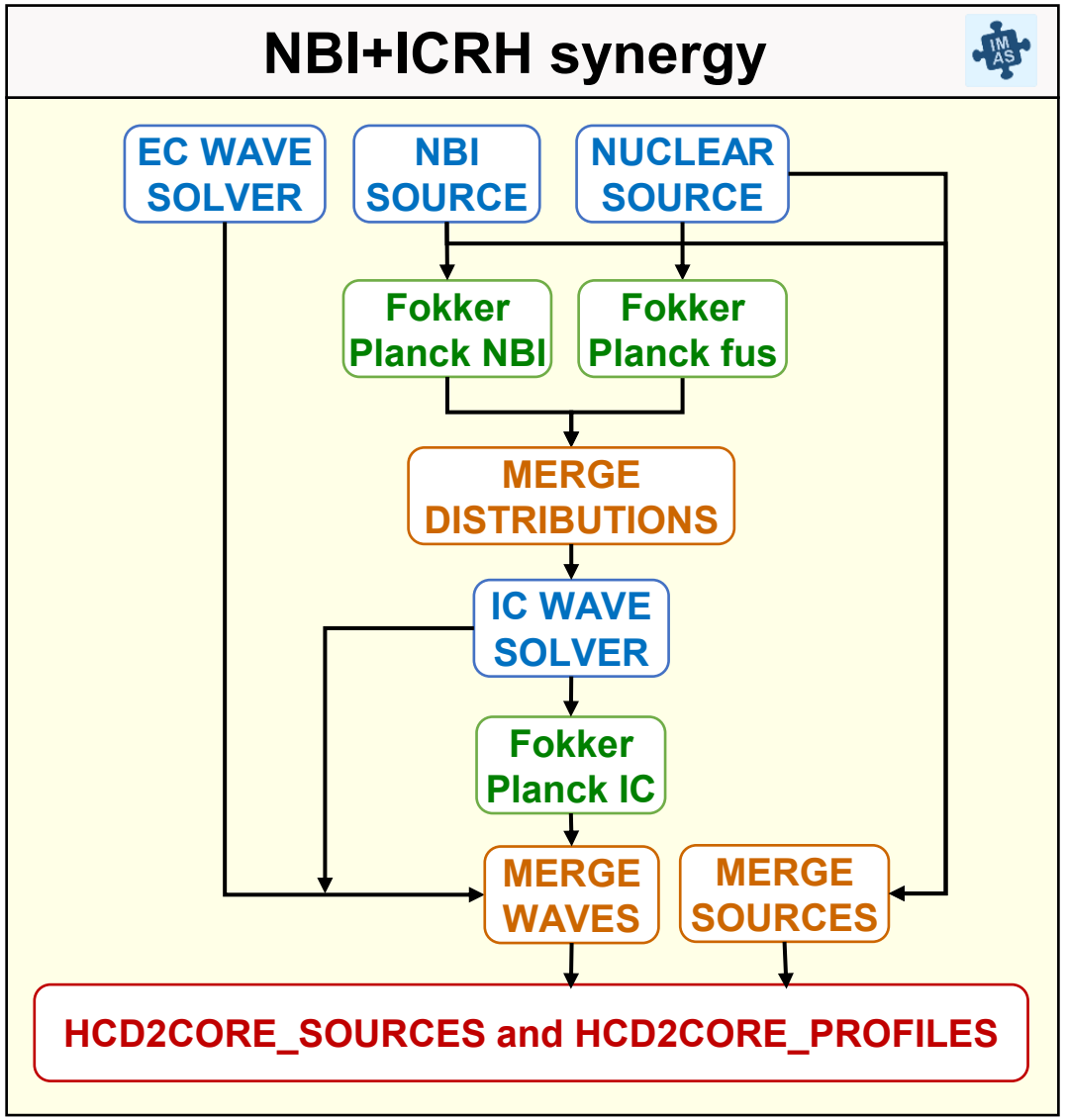


→ Open source waiting for final approval from EU Commission

S.H. Kim et al., APS-DPP 2023
S.H. Kim et al., IAEA FEC 2025, J. Lee et al., APS 2025

IMAS Heating & Current Drive Workflow





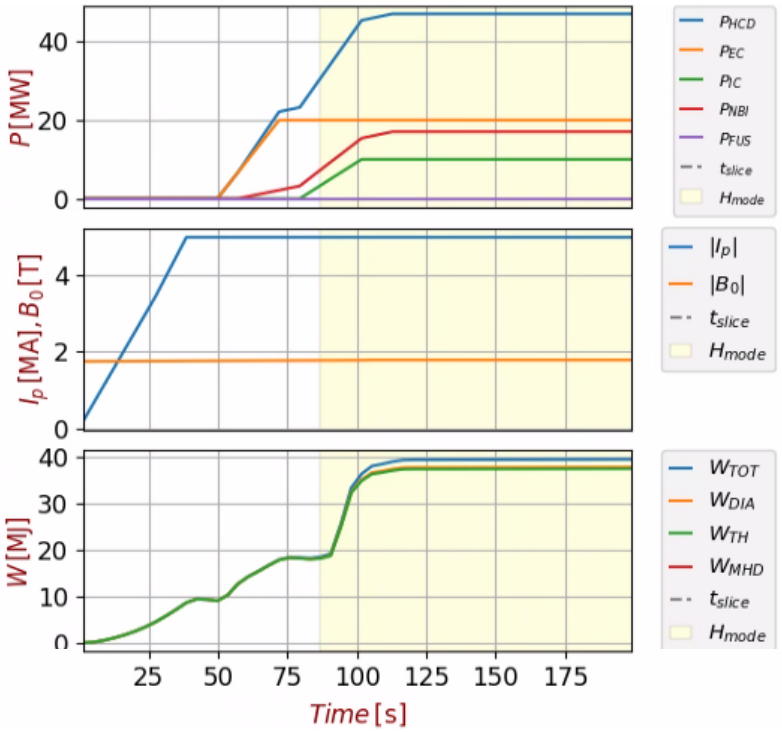
- Flexible workflow approach facilitates implementation of various different algorithms
- Used to calculate fast ion distribution → Essential to evaluate stability

→ Availble at https://github.com/iterorganization/HCD-WF

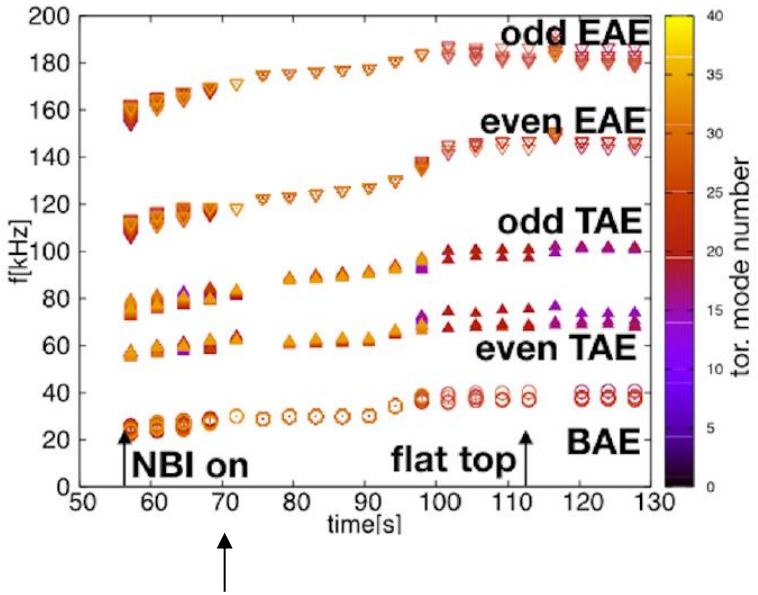
Workflow to describe EP-driven mode evolution

- A workflow to assess EP stability of plasma scenarios has been developed based upon the LIGKA and HAGIS physics codes
  - EP-Stability-WF
- Ramp-up of 5 MA / 1.8 T H-plasma

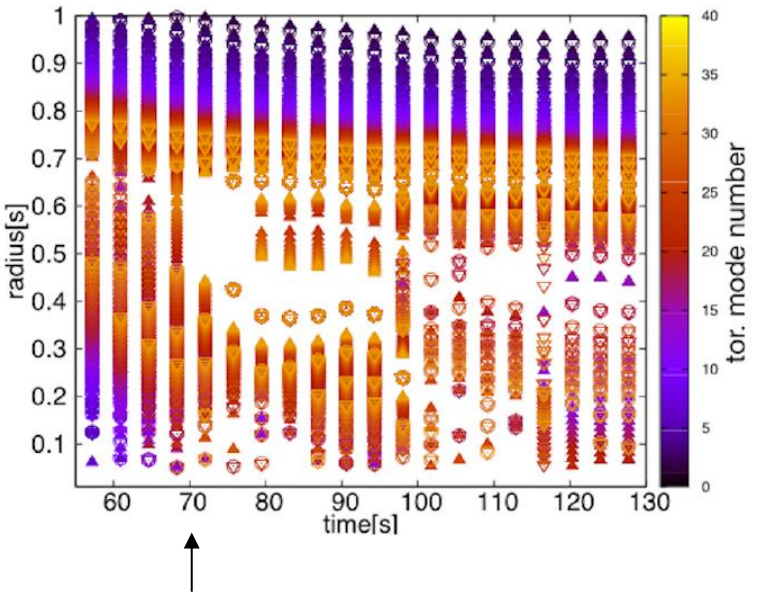
IMAS Scenario database: #100015,1



Frequency of Alfvén Eigenmodes (stable and unstable)



Radial location of Alfvén Eigenmodes



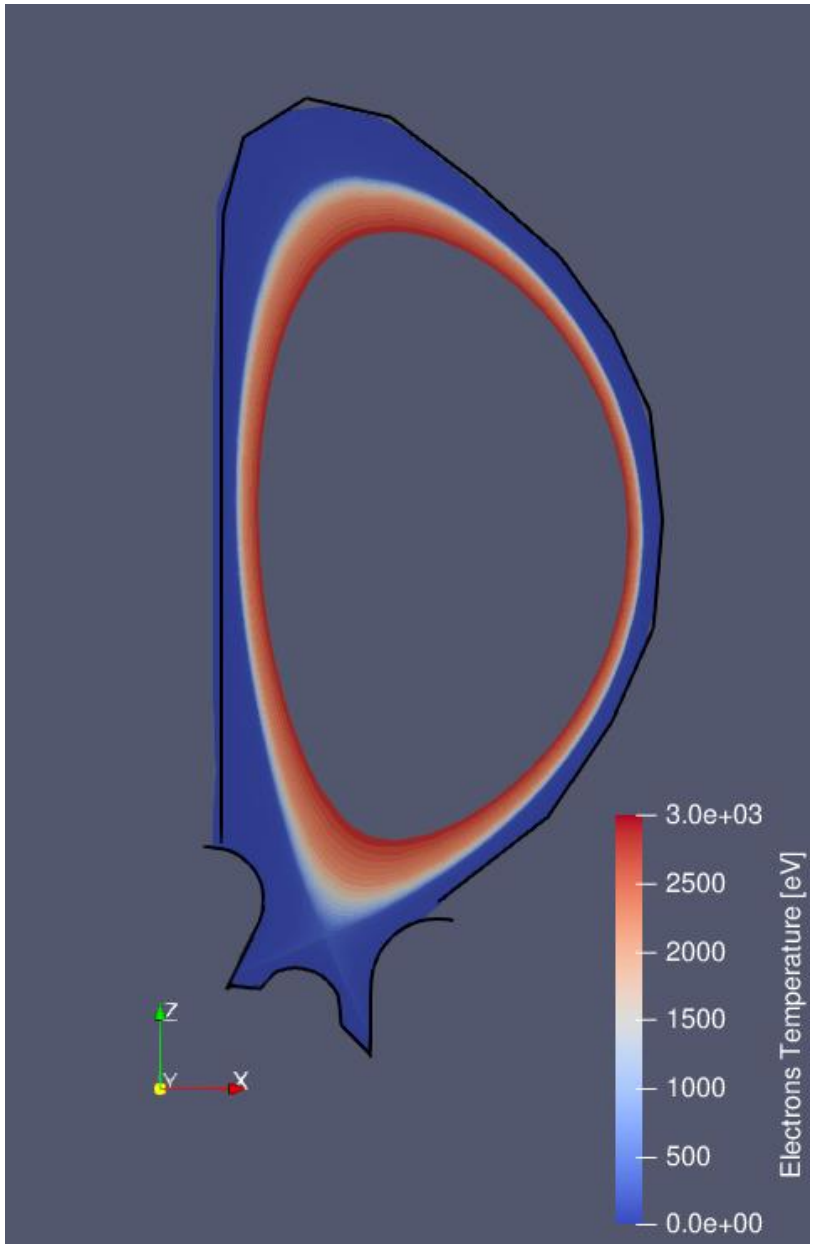
Steep fast ion gradient region

q=1 surface enters plasma

SOLPS-ITER: General code suite for plasma edge modelling

- Main edge plasma solver: B2.5-Eirene
  - B2.5: 2D multi-fluid plasma solver (Finite Volumes)
  - Eirene: Kinetic neutral particle transport code (Monte Carlo)
- Case build-up (DivGeo/Uinp)
- Grid generation chain (CARRE/TRIA/TRIAGEOM)
- Real-time and post-run analysis scripts
- Post-processing (b2plot)
- Run archival/retrieval (b2md/b2rd)
- Converters between various SOLPS versions (b2xd/b2sxdr/b2yt)
- Documentation and manuals
- Adapted to IMAS data model
- Recent extension to wide grids covering full vacuum vessel

→ Available at https://github.com/iterorganization



Summary of IO's IMAS Software Released as Open-Source

- Since the first releases in November 2024, the IO has now released the following software
  - IMAS-Data-Dictionary
  - IMAS-Python
  - IMAS-Cpp
  - IMAS-Fortran
  - IMAS-Java
  - IMAS-Matlab
  - IMAS-Validator
  - IMAS-ParaView
  - IMAS-MUSCLE3
  - IMAS-MCP
  - iWrap
  - IDStools
  - IBEX
  - IMAS-Data-Mapping
  - IMAS-Streams
  - SimDB
  - SimDB-Dashboard
  - Waveform-Editor
  - SOLPS-ITER
  - B2.5
  - CARRE
  - DivGeo
  - EIRENE
  - MSCL
  - SOLPS-GUI
  - HCD-WF
  - EP-Stability-WF
  - DINA-IMAS
  - Fusion-Conventions
  - IMAS-Standard-Names
  - Waveform-Editor
  - PCSSP
  - PFC-Tritium-Transport
  - IMAS contributions to TORAX
  - TORAX-MUSCLE3
  - IMAS-Data-Dictionaries
- All this software (and more) has been made openly accessible on GitHub
  - https://github.com/iterorganization
  - https://github.com/search?q=%23imas+%23fusion+-org%3Aiterorganization&type=repositories

IO has written to Members requesting to make their BIP open-source

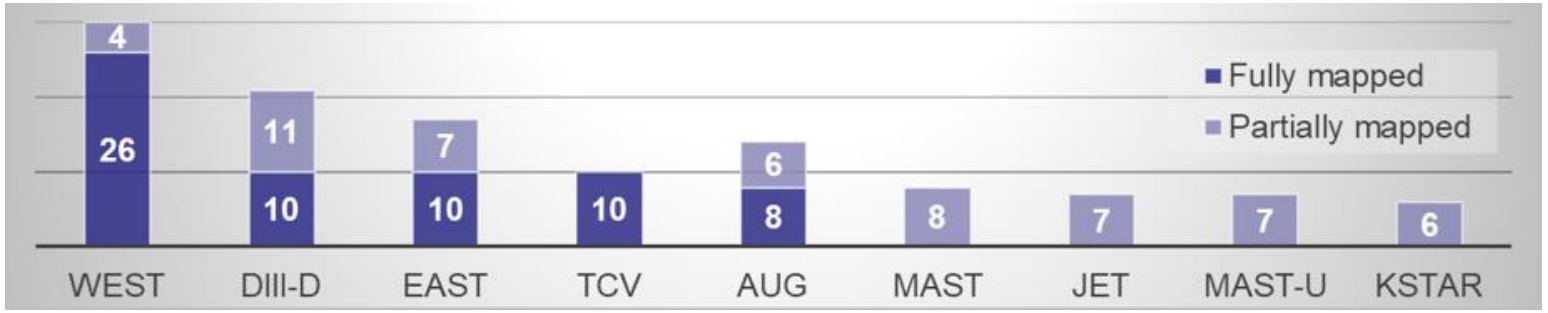
- ASCOT (VTT, EU)
- EIRENE (FZJ, EU)
- GRAY (ENEA, EU)
- NGPS (RFX / CEA, EU)
- HPI2 (CEA, EU)
- QuaLiKiz (CEA, EU)
- GACODE (GA, US)
- RITM (FZJ, EU)
- TCI (Chalmers, EU)
- EDWM (Chalmers, EU)
- Weiland (Chalmers, EU)
- RFOF (KTH, EU)
- FRANTIC (LAPSSA, US)
- MMM (Lehigh University, US)
- GLF23 (GA, US)
- IFS/PPPL (PPPL, US)
- Kadmostev/Porcelli sawtooth model (PPPL, US)
- NCLASS (ORNL, US)
- Porcelli Sawtooth Trigger Module (Lehigh Uni., US)
- BDSEQ (IPP-Garching, EU)
- CAXE / KINX (EPFL, EU)
- CHEASE (EPFL, EU)
- CORE-EDGE (IPP, EU)
- CYRANO (LPP-ERM-KMS)
- ETS-CORE (Many, EU)
- GKMHD (IPP-Garching, EU)
- ILSA (IPP-Garching, EU)
- LION (EPFL, EU)
- MARS (ENEA, EU)
- MODTRANSP (FZJ / IPP, EU)
- NBISIM2 (Chalmers, EU)
- NEOWES (IPP, EU)
- STIXREDIST (LPP-ERM-KMS)
- TCI_ANALYTICAL (Chalmers)
- TORAYFOM (FOM-DIFFER)
- XMLLIB (IPP/VR/ENEA, EU)
- INTERPOS (EPFL, EU)
- LIBBDS (IPP, EU)
- COCOSTRANSFORM (EPFL)
- PSPLINE (PPPL, US)
- NUBEAM (PPPL, US)
- EFIT++ (GA / UKAEA)
- ETNA (UKAEA)
- NOVA (UKAEA)
- SMARDDA-LIB (UKAEA)
- SMARDDA-PFC (UKAEA)
- FOPLA (LPP-ERM/KMS, EU)
- FUSREAC1D (LPP-ERM/KMS)
- NTM-module (EPFL, EU)
- RAPTOR (EPFL, EU)
- SOLPS-ITER coupling (F4E)
- B2.5 (IPP-Garching, EU)
- METIS (CEA, EU)
- RISK (CEA, EU)
- NEMO (CEA, EU)
- SPOT (CEA, EU)
- EVE (CEA, EU)
- C3PO (CEA, EU)
- LUKE (CEA, EU)
- ASTRA (IPP, EU)
- EMC3 (IPP, EU)
- HAGIS (UKAEA / IPP, EU)
- IDA (IPP, EU)
- LIGKA (IPP, EU)
- RABBIT (IPP, EU)
- STARWALL (IPP, EU)
- TORBEAM (IPP, EU)
- TORIC (IPP, EU)
- JINTRAC (EU)
- JETTO (EU)
- EDGE2D (EU)
- JAMS (EU)
- NIMBUS (EU)
- GRID2D (EU)
- COCONUT (EU)
- SANCO (EU)
- PION (EU)
- PENCIL (EU)
- Y. B. Lower Hybrid Module (EU)
- ESCO (EU)
- HELENA (EU)
- MISHKA (EU)
- STATS (EU)
- UTC (EU)
- CPLOT (EU)
- EPROC (EU)
- FLUSH (EU)
- JOREK (Many, EU)

- Key: Agreed

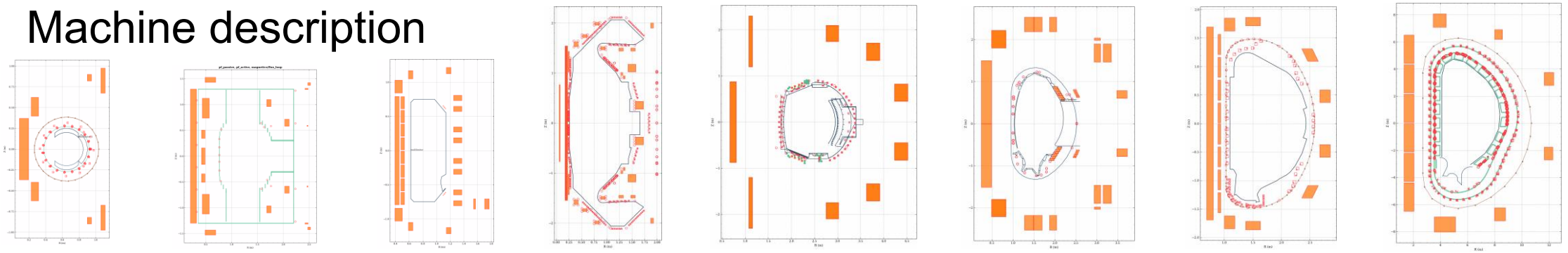
Standardizing representation of data between machines

Mapping experimental data to IMAS data model enables software portability

- Allows validation of ITER tools over a range of present devices
- Experimental data (survey 2023)



- Databases
  - ITPA H-mode confinement, 45% in 2021 (tool and mapping in IDStools)
  - GKDB and MGKDB → both efforts follow the `gyrokinetics_local` IDS
- Machine description



→ Mapping needs local experts and a joint effort

Engagement in Data Mapping

Open platform to centralize knowledge

- https://github.com/iterorganization/IMAS-Data-Mapping
- Update status, list of IDS, tools, …
- Monthly online meetings
- Promote open mapping, data samples
- Collect feedback, data needs
- Dedicated workshop will be organized at ITER (16 – 20 March 2026)

Aim at a **unified syntax** for data mapping
https://indico.iter.org/e/imas-data-mapping-2026

Support application validation effort

Prepare ITER CODAC→IMAS mapping

README | Code of conduct | Contributing | CC-BY-SA-4.0 license

Tokamak data mapping status

Experiment	Contact person	Mapping information	List of mapped IDSs
AUG	@DavidPCoster	from `trview` and `readaug`	`core_profiles`, `dataset_description`, `equilibrium`, `ic_antennas`, `magnetics`, `nbi`, `pf_active`, `pulse_schedule`, `summary`, `tf`, `wall`
DIII-D	@AreWeDreaming	with OMAS	`bolometer`, `charge_exchange`, `coils_non_axisymmetric`, `core_profiles`, `dataset_description`, `ec_launchers`, `ece`, `em_coupling`, `equilibrium`, `gas_injection`, `interferometer`, `langmuir_probes`, `magnetics`, `mse`, `nbi`, `neutron_diagnostics`, `pf_active`, `summary`, `thomson_scattering`, `tf`, `wall`
EAST	@simpla-fusion	with FyTok	`core_profiles`, `equilibrium`, `magnetics`, `pf_active`, `tf`, `wall`
ITER	@MasanariHosokawa	only machine description (e.g. DOI 10.5281/zenodo.15525525 IMAS-Data-Mapping)	`bolometer`, `camera_visible`, `coils_non_axisymmetric`, `ec_launcher`, `ece`, `ic_antennas`, `interferometer`, `magnetics`, `nbi`, `neutron_diagnostic`, `pf_active`, `pf_passive`, `polarimeter`, `refractometer`, `spectrometer_visible`, `spectrometer_x_ray_crystal`, `soft_x_rays`, `tf`, `thomson_scattering`, `wall`
WEST	@JorgeAMorales	with UDA and WEST plasma reconstruction chain	`bolometer`, `bremsstrahlung_visible`, `camera_ir`, `camera_x_rays`, `calorimetry`, `core_profiles`, `ece`, `equilibrium`, `gas_injection`, `hard_x_rays`, `ic_antennas`, `interferometer`, `langmuir_probes`, `lh_antennas`, `magnetics`, `neutron_diagnostic`, `pf_active`, `pf_passive`, `polarimeter`, `pulse_schedule`, `reflectometer_profile`, `soft_x_rays`, `spectrometer_visible`, `spectrometer_x_ray_crystal`, `summary`, `tf`, `wall`

Summary

- Releasing IMAS software as open source has removed barriers to developing, validating and exploiting the software
- Validation and use of IMAS software relies upon data + machine description mapped to IMAS data standard available together
  - Workshop in March to support data owners
- EUROfusion can help validate physics codes (VVUQ)
  - IMAS helps by making software portable (device generic)
- After open sourcing of software, IO starting to publish datasets for community use, benchmarking, etc.
  - ITER MD data: https://zenodo.org/records/17113713
  - ITER simulations: https://zenodo.org/records/17062700
- Finally, thanks to all IP holders who have made this possible!

Opportunities

- ITER Postdoctoral Fellowships
  - https://www.iter.org/public/education/international/monaco/iter-and-iter-postdoctoral-fellowships
- Internships
  - https://www.iter.org/public/jobs/internships

Thanks for contributing to IMAS: Mapping data and validating/using physics software

IO HQ, 3 December 2025

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