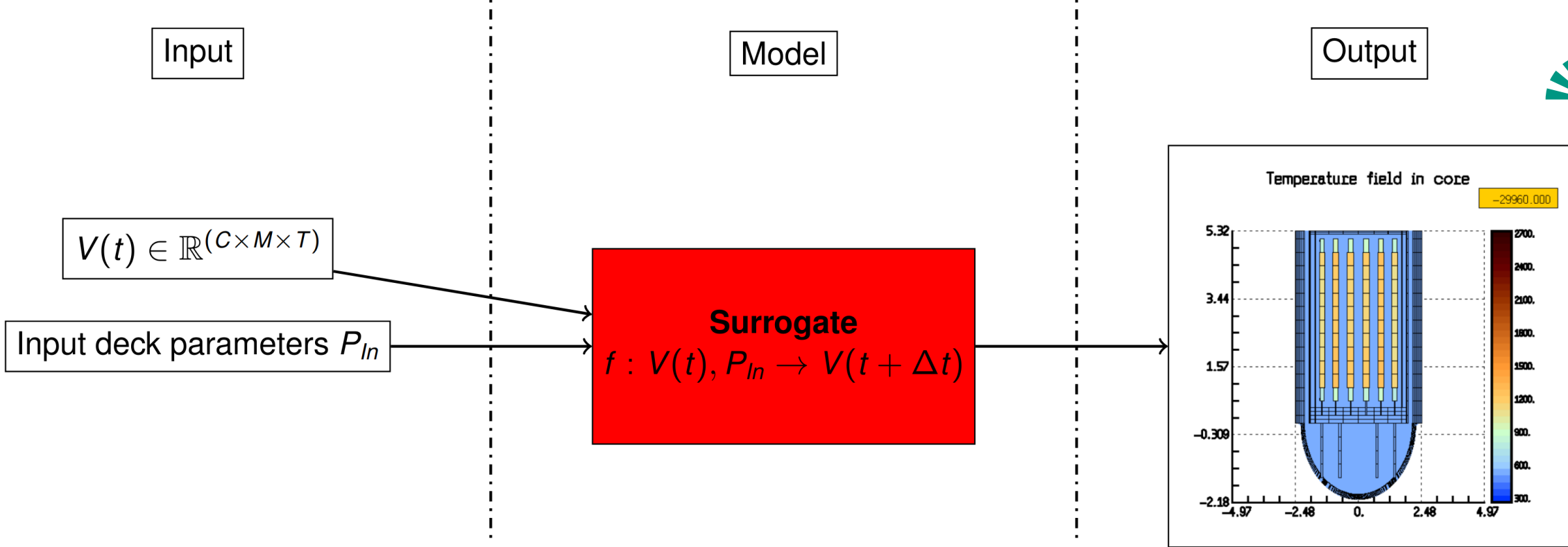




ASSAS - Data generation, storage and sharing strategy

Machine-learning for the simulation of nuclear power plants and other complex systems

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ASSAS Project Summary

ASSAS — Artificial Intelligence for the Simulation of Severe Accidents

- November 2022 – October 2026
- 14 partners
- 3.7 million € budget
- Coordinator: Bastien Poubeau `bastien.poubeau@asn.fr`

Goal – develop a prototype severe accident simulator for a Western-type PWR

To achieve this goal, significant acceleration of the ASTEC code is required:

- Input deck simplification and efficient programming
- Using machine-learning (surrogate models) to substitute parts of the reactor model (vessel, primary circuit, etc.)

Task description

Goal

Surrogate models require an extensive amount of input data for training.

⇒ Our SA simulations should cover a broad range of conditions for models to achieve good prediction quality.

- 10 operator actions have been selected
- Operator actions have constraints
- Sampling method: Sobol sequences
- Scenarios: SBO and MBLOCA
- 1000 samples per scenario

Operator Actions

Table: Parameter ranges of operator actions for SBO and LOCA scenario.

System	No.	Action description	Variable	SBO		LOCA	
				Min	Max	Min	Max
Pressurizer (PORV)	1	Time in s that changes pressurizer valve mode	t_fbseb	0.0	25000.0	0.0	10000.0
Steam Generator Pressure Operated Relief Valve (SG-PORV)	2	DBA Phase: Open PORV - time opening	t1_srv	0.0	35000.0	0.0	10000.0
	3	DBA Phase: Open PORV - % Opening	opensrv	0.0	100.0	0.0	100.0
	4	SA phase: Open completely	t2_srv	0.0	35000.0	0.0	10000.0
	5	Closing PORV after SGTR	tendssg2	t_sg2tr	100.0	-	-
PES	6	RCS - Time at which the pumps are activated	tpesp	0.0	35000.0	1200.0	8380.0
	7	SG - Time at which the pumps are activated	tpessg	0.0	35000.0	-	-
Containment Spray Systems (CSS)	8	Instant at which containment spray system is recovered	tcss	-	-	3600.0	86400.0
	9	Instant at which filtered containment venting system is operated / sampling the containment pressure set-point	p_u5	5.0e5	6.0e5	5.0e5	6.0e5
SGTR	10	Time at which SGTR occurs in SG 2 or (P,T) BC	tsg2tr	10800.0	18000.0	-	-

Constraints SBO scenario:

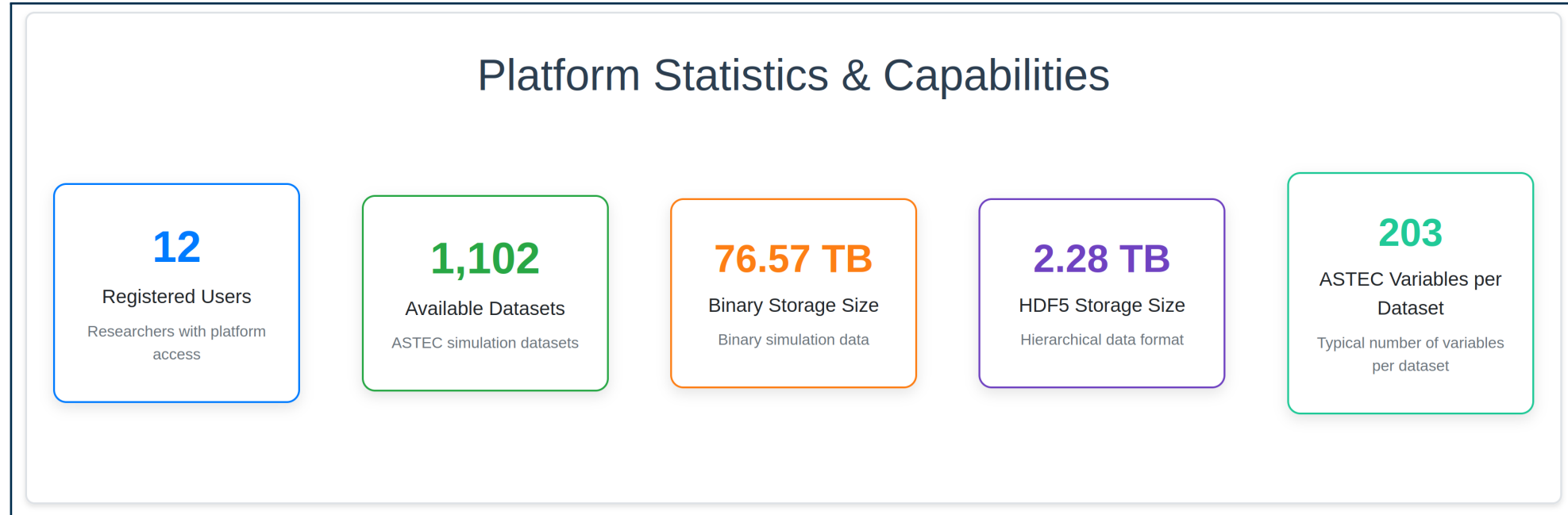
- $t1_srv < t2_srv$
- $tpesp > t_fbseb$
- $tpessg > t1_srv$
- $tsg2tr < t_fbseb$
- $tsg2tr < \max(tpessg, t1_srv)$

Constraints LOCA scenario:

- $t1_srv < t2_srv$
- $tpesp > t_fbseb$

ASSAS Data Hub — Overview

Figure: ASSAS data hub platform statistics [1].



- Curated ASTEC simulation datasets in NetCDF4 format
- FAIR-compliant metadata, persistent identifiers
- Programmatic access: REST API v1 (datasets, files)



https://assas.scc.kit.edu/assas_app

ASSAS Data Hub - Available Datasets 1

State of Dataset	Amount	Size binary	Size hdf5	Reduction	Reduction Rate
Overall	1102	76.57 TB	-	-	-
VALID	1045	68.93 TB	2.28 TB	28.24	96.33%
INVALID	3	629.51 GB	-	-	-
CONVERTING	20	5.32 TB	-	-	-
UPLOADED	34	1.70 TB	-	-	-

Table: Available datasets on the ASSAS LSDF Project.

- VALID: Dataset converted and ready for download
- INVALID: Dataset not accessible via pyodessa interface
- CONVERTING: Dataset is converting
- UPLOADED: Dataset is in intermediate state and ready to process

ASSAS Data Hub - Available Datasets 2

ASTEC Calculation	Samples	Valid Samples	Contributor
SBO_KIT_init_*	215	202	KIT (INR)
LOCA_KIT_init_*	220	220	KIT (INR)
SBO_ENEA_*	221	182	UNIBO
CIEMAT-test_*	368	364	CIEMAT
SBO_KIT_CESAR_in_ou_*	20	19	KIT (INR)
LOCA_KIT_CESAR_in_ou_*	20	20	KIT (INR)
CIEMAT-test_*_CESAR-IO	38	38	CIEMAT
Overall	1102	1045	-

Table: Available ASTEC calculation campaigns.

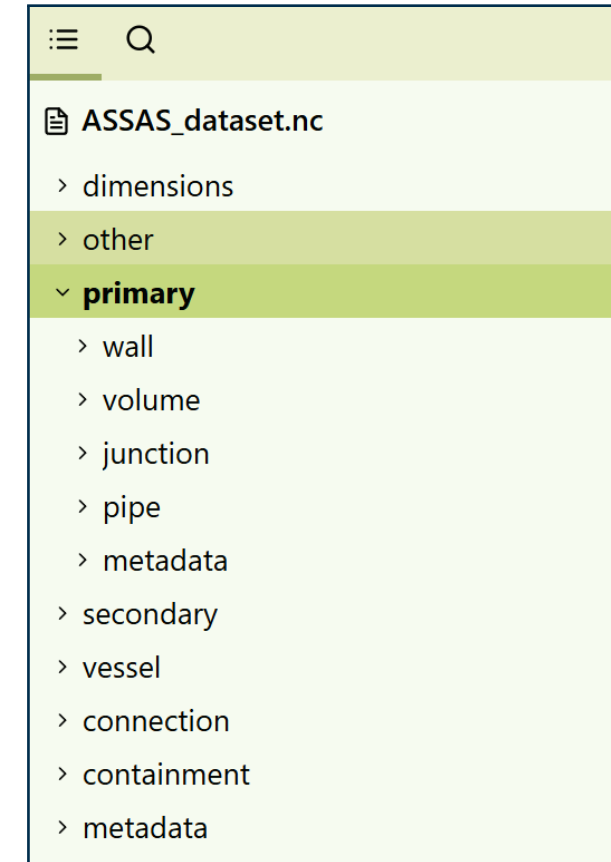
ASSAS Data Hub - Data Model 1

ASSAS Dataset based on a netCDF datamodel [2]

ASTEC Domains as groups in netCDF dataset:

- **primary**, subgroups: wall, volume, junction, pipe
- **secondary**, subgroups: wall, volume, junction
- **vessel**, subgroups: general, mesh, face
- **containment**, subgroups: conn, wall, dome, pool, zone, environ, general
- **connection**, subgroups: connecti, connecti_fp
- **other**, subgroups: global, private, cavity, lower_plenum

Figure: Group structure of ASSAS dataset.



ASSAS Data Hub - Data Model 2

Table: Exemplary variables with all attributes, dimension none means no additional dimension beside time dimension. The complete table with 245 ASTEC variables is available here [3]. Each variable must be configured with a extraction strategy.

name	long_name	name_odessa	unit	domain	strategy	dimension
Q_H2_cavity	hydrogen mass flow rate of cavity generated by MCCI	284	[kg/s]	cavity	sensor	none
T_cavity	temperature of cavity zone	285	[K]	cavity	sensor	none
m_cavity	mass of the corium in cavity zone	286	[kg]	cavity	sensor	none
T_cavity_cor	temperature of cavity corium	287	[K]	cavity	sensor	none
m_oxide_cavity	mass of oxide layer located in cavity	360	[kg]	cavity	sensor	none
P_H2_vessel	pressure of hydrogen in the vessel	P_h2	[Pa]	vessel_mesh	vessel_mesh_ther	mesh
P_steam_vessel	pressure of steam in the vessel	P_steam	[Pa]	vessel_mesh	vessel_mesh_ther	mesh
T_gas_vessel	gaseous phase temperature	T_gas	[K]	vessel_mesh	vessel_mesh_ther	mesh
T_liq_vessel	liquid phase temperature	T_liq	[K]	vessel_mesh	vessel_mesh_ther	mesh
T_sat_vessel	saturation temperature	T_sat	[K]	vessel_mesh	vessel_mesh_ther	mesh
m_gas_vessel	mass of gaseous phase in the volume	m_gas	[kg]	vessel_mesh	vessel_mesh_ther	mesh

ASSAS Data Hub - Datasets API

Datasets API to discover, inspect and extract ASTEC datasets,
available under https://assas.scc.kit.edu/assas_app/datasets

- GET request for all datasets: /datasets
- Filters: name, status, user, created_after, created_before
- Pagination: limit, offset
- GET request for dataset metadata: /datasets/<uuid>

Data inspection endpoints:

- GET /datasets/<uuid>/metadata: Dataset metadata and file paths.
- GET /datasets/<uuid>/variables: List variables with filters group and domain.
- GET /datasets/<uuid>/variables/<name>: Dataset metadata and file paths.
- GET /datasets/<uuid>/data: Extracts data with time slicing.
- GET /datasets/<uuid>/group: Extracts group structure.

ASSAS Data Hub - Files and Authentication API

Files API to serve dataset-related files (hdf5 file, DataCite json), available under `https://assas.scc.kit.edu/assas_app/files`

- GET `/files/download/<uuid>`: Returns hdf5 file (executes `send_file()`).
- GET `/files/datacite/<uuid>`: Returns DataCite json file.

Auth API to get user information, available under `https://assas.scc.kit.edu/assas_app/auth`

- GET `/auth/user`: Returns current user info.
- GET `/auth/status`: Returns boolean authenticated and user object (if authenticated).

References

- [1] Helmholtz AI Energy. *ASSAS platform statistics*. https://assas.scc.kit.edu/assas_app/home. Accessed: 2025-11-06. 2025.
- [2] CF contributors. *NetCDF Climate and Forecast (CF) Metadata Conventions*. 2023. URL: <https://cfconventions.org/Data/cf-conventions/cf-conventions-1.12/cf-conventions.html>.
- [3] Helmholtz AI Energy. *ASSAS variable index*. https://github.com/Helmholtz-AI-Energy/assas_database/blob/main/assasdb/astec_config/assas_variables_wp2_report.csv. Accessed: 2025-07-23. 2025.