

# Vision and Current Status of the Informatic Research Center for Fusion Energy Research

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QST Rokkasho

# Toward DEMO

JT-60SA



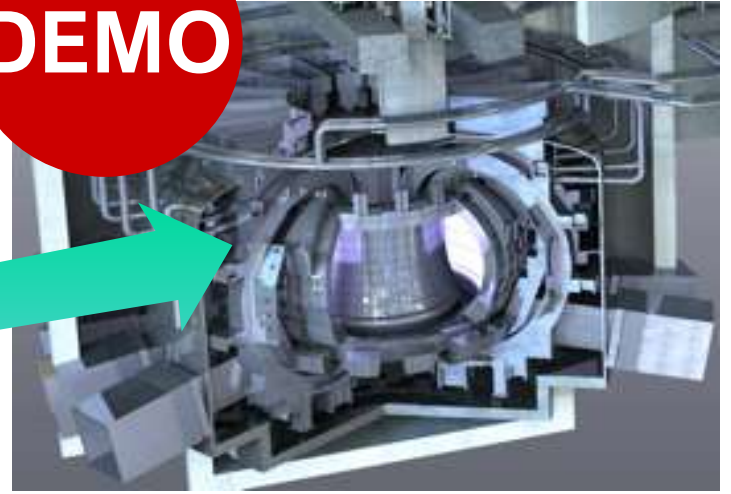
2023~

ITER



2025 2034~

DEMO

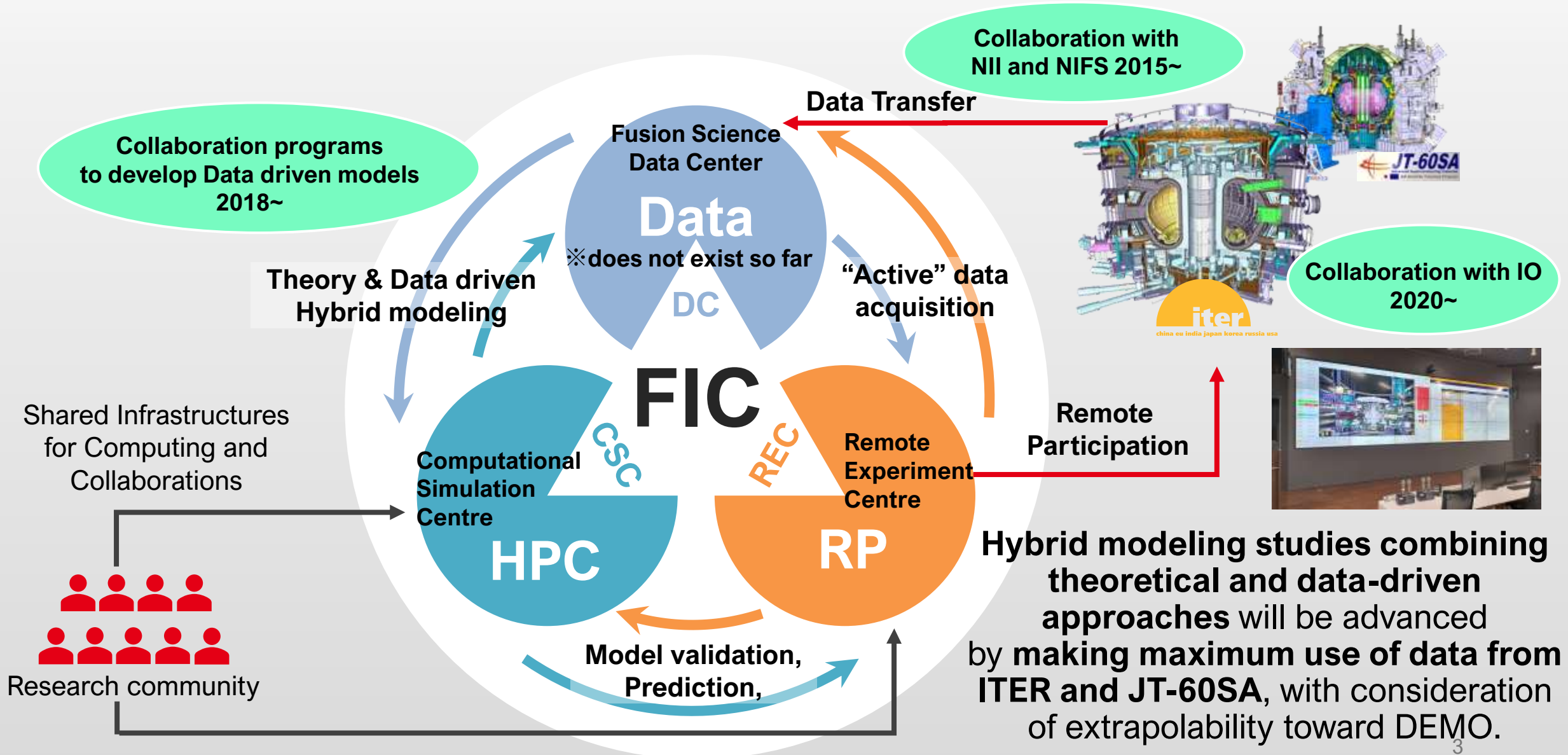


20XX~



- In Japan's fusion energy development program, several projects are ongoing in parallel **toward DEMO for probing electric power generation** in 2030's.
- Achieving DEMO requires a research strategy that effectively utilizes results from **JT-60SA**, **ITER**, and related facilities.

# Vision of *Fusion Informatics Center*



# More Specific Objectives

## Integration of experimental research and theoretical simulation:

- Integrating platforms of experiment and theoretical simulation studies to **facilitate smooth data & software sharing**
- Promote data-driven modeling to catalyze **model predictive control** development.

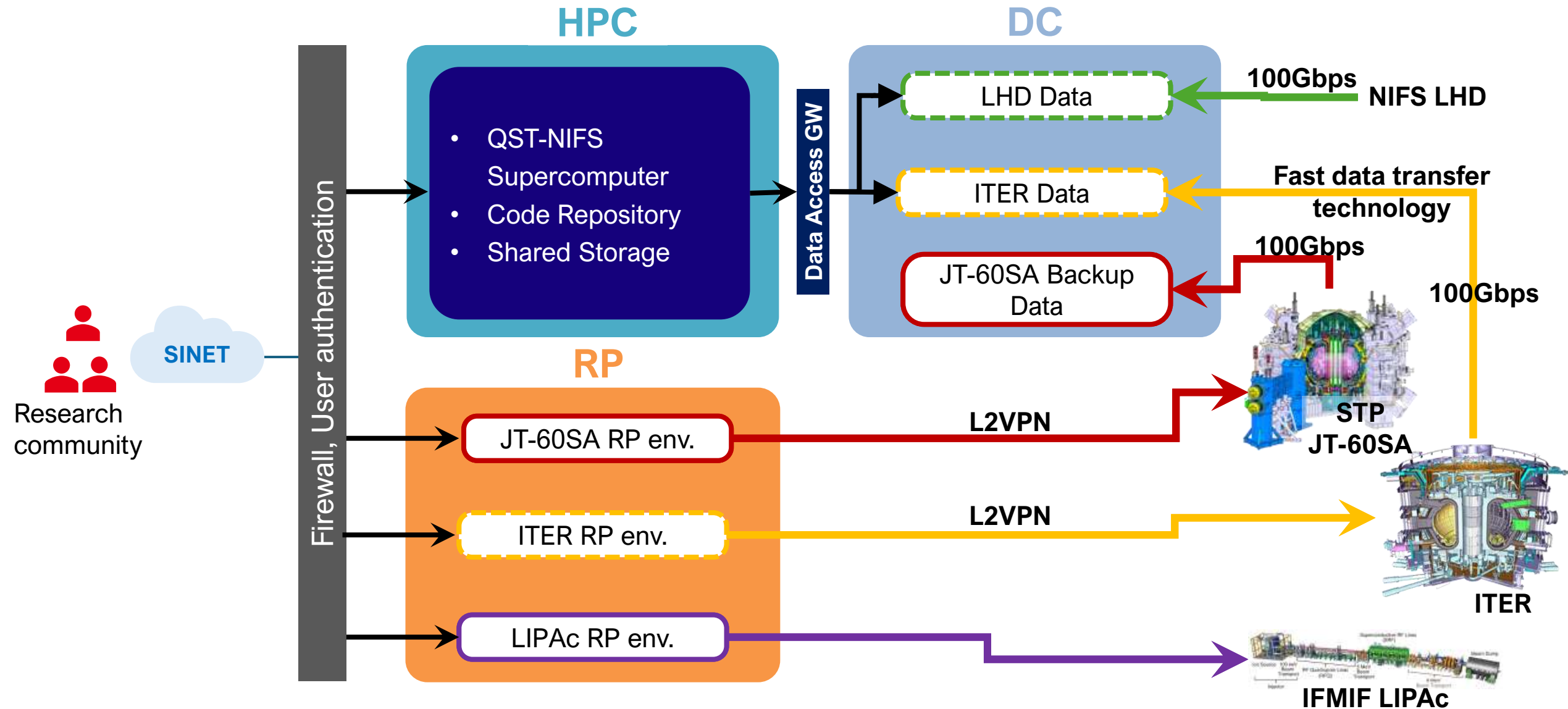
## Organized / Project-oriented code development:

- Establishing shared code repositories and doc servers as a **collaboration infra**,
- Shifting away from individual, artisanal code development toward **project-based workflows**,
- **Separation of modeling and coding**, broader participation by students and industry, facilitating component reuse, modernization of legacy codes

## Standardization of data formats:

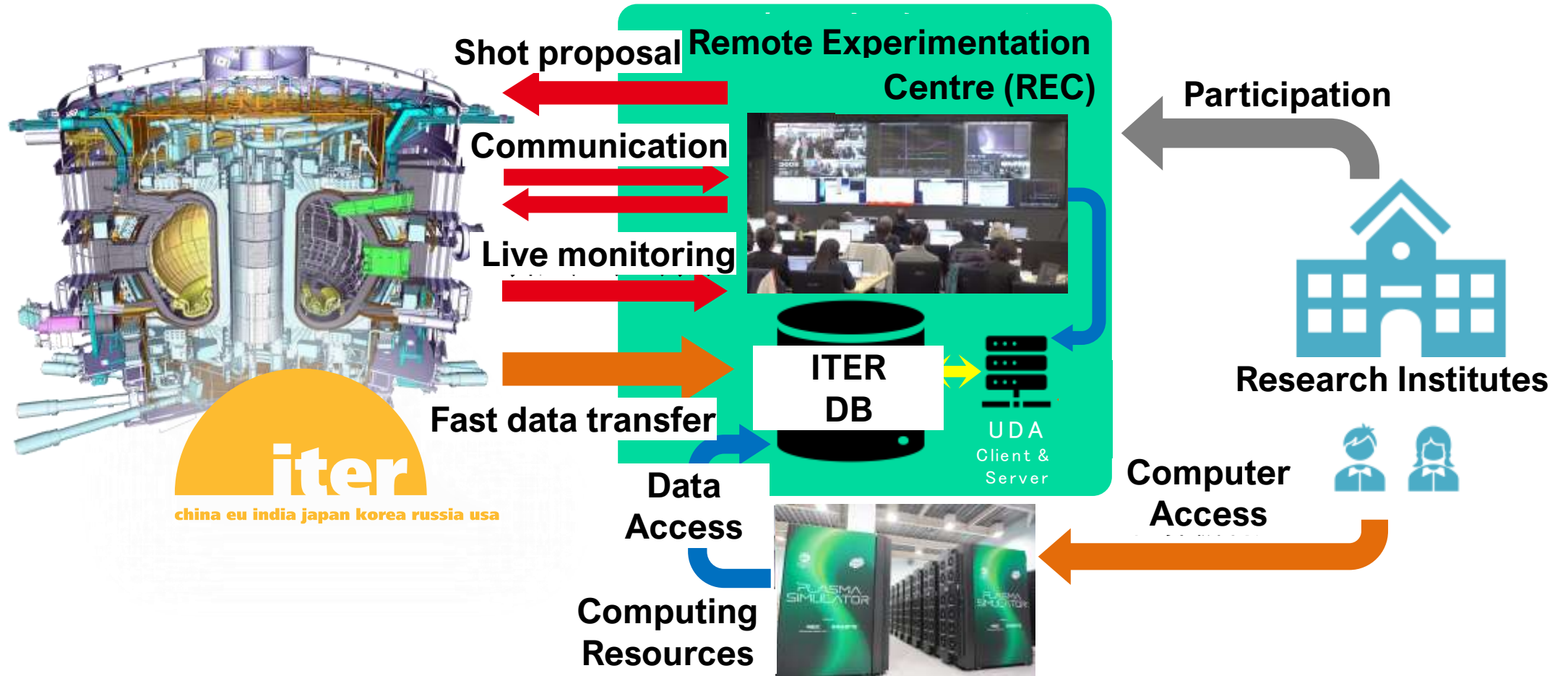
- Establishing a **unified entry point for data access** and enabling **direct data access from large-scale computing systems**,
- **Commonization of data formats**—an essential enabler of effective data utilization.

# Outline of the FIC System



# Collaborations with ITER Organization

# Remote Participation in ITER experiment



- Build a RP environment **comparable to on-site presence in the ITER Main Control Room.**
- An infrastructure integrating remote experiment facilities, the ITER database, and computational resources will **enable easy access to ITER data for data-driven modeling.**

# Progress of RP env. preparation

Read-only access from REC to the operator interfaces (**OPI**) which is **identical to the one used by on-site operators in the ITER MCR** was established, enabling access to information equivalent to that available in the MCR.



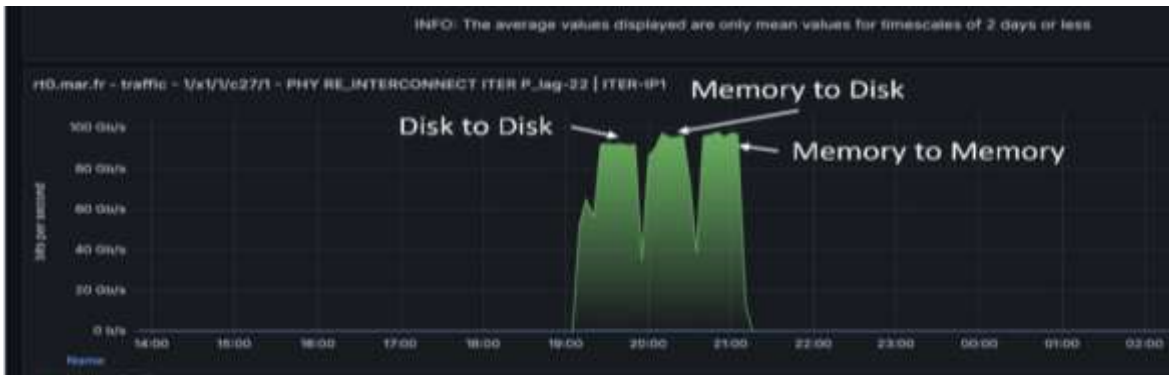
# ITER-REC 100Gbps Data transfer test

Enable transferring ITER data (2PB/day!)

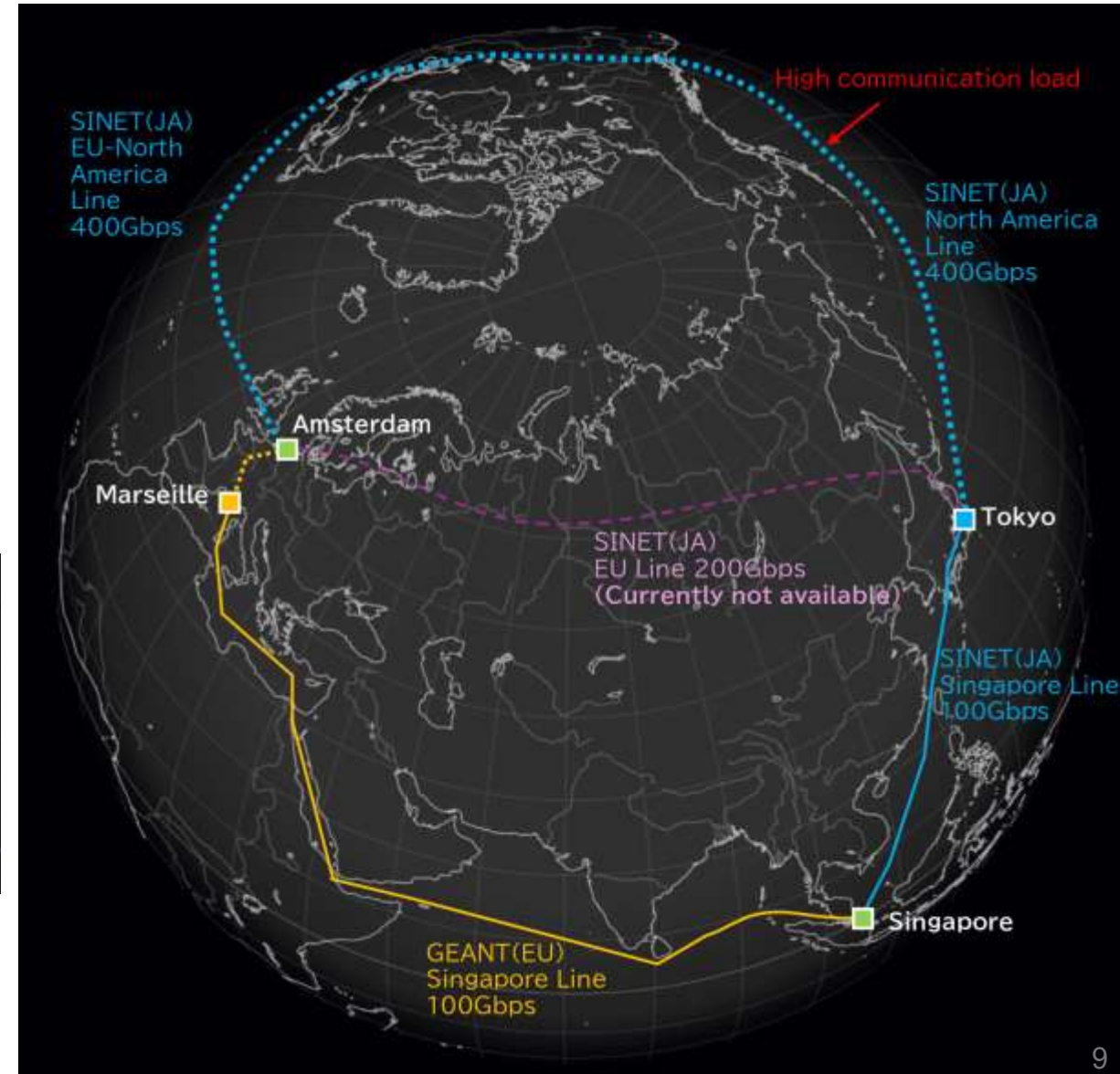
2024 **IDDC (ITER Data Distribution Center)** in Marseille became operational.  
ITER=Marseille upgraded to 100Gbps

2025 Back-up route (Singapore) between IDDC and REC has been established.

Fast data transfer technology (MMCFTP) probed disk-to-disk 91.1Gbps data transfer. (Sep. 2025)



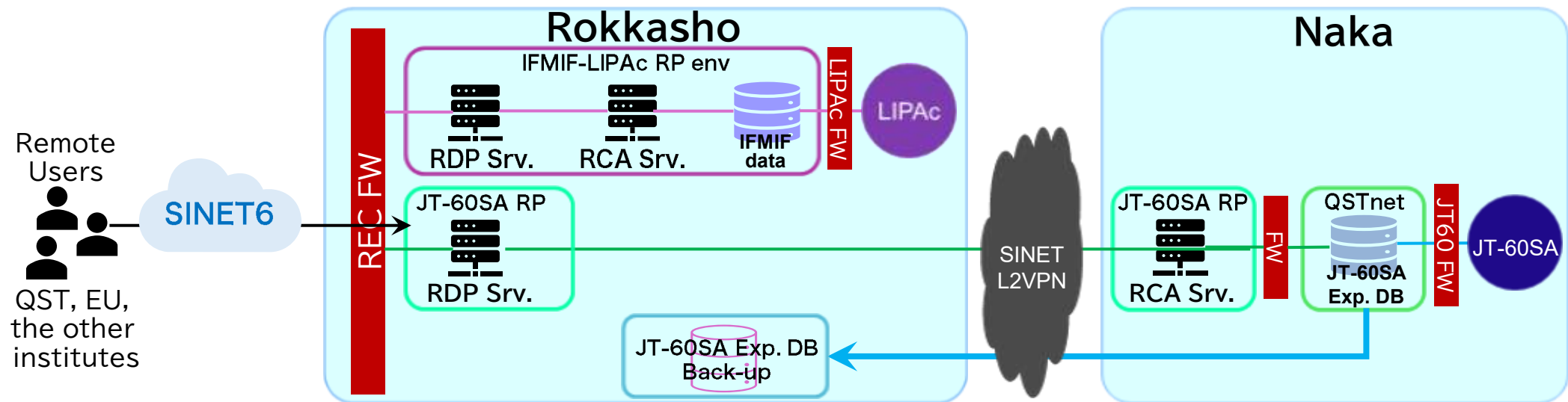
- Preparation of the Unified Data Access system in REC is ongoing to enable access from computing resources to the transferred data.



# Collaboration with Satellite Tokamak Project

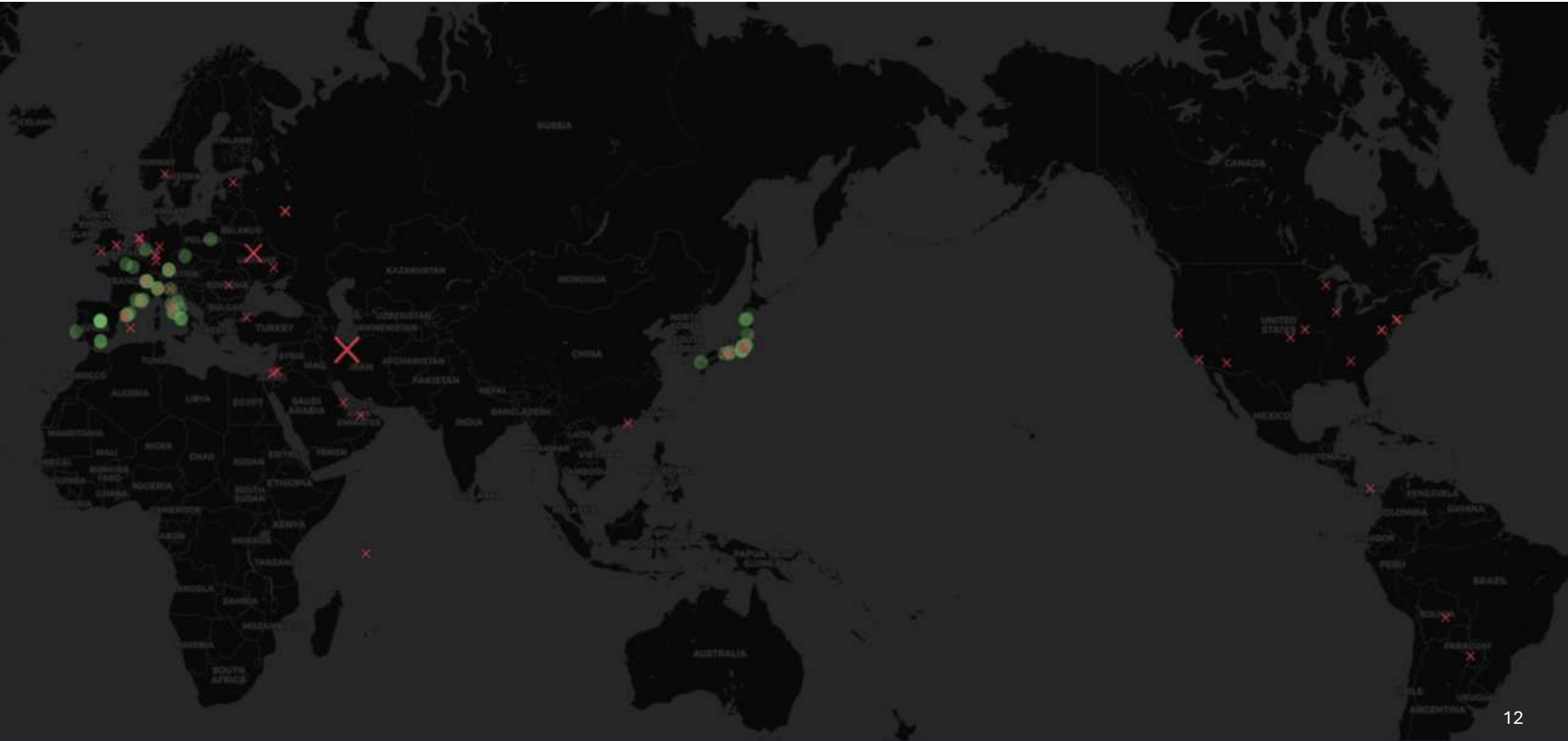
# Collaboration with JT-60SA

- JT-60SA has been constructed based on JA-EU collaboration (BA).
  - Remote participation (RP) environment for participants from EU is demanded.
- IFERC-network (basis of FIC) was extended to Naka using SINET L2VPN in 2025.
- **Secure remote access to JT-60SA analysis server** became operational since Aug. 2025.
- **Remote backup of JT-60SA experiment data to Rokkasho** also started.



- Research infrastructures in Naka and Rokkasho are gradually getting closer. 11

# Usage Status of JT-60SA RP environment

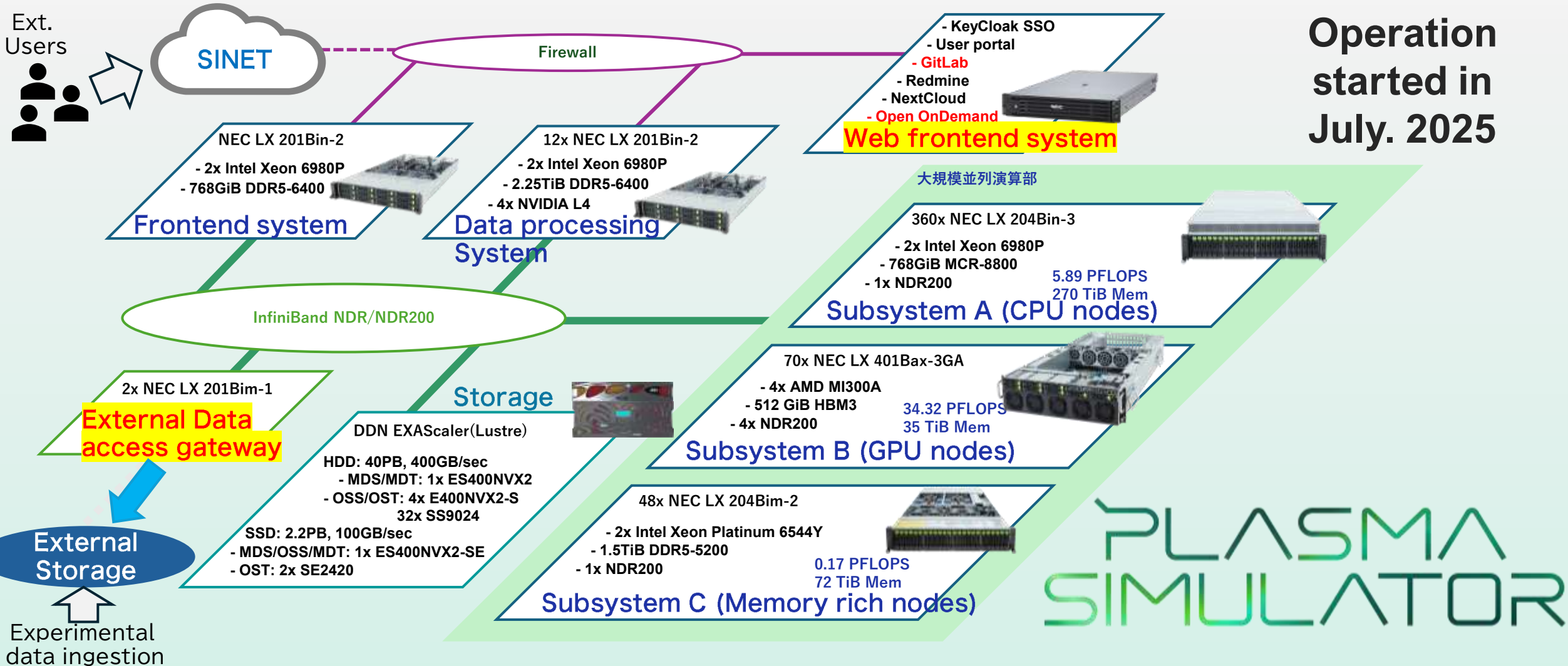


# New Supercomputer in Rokkasho

# New supercomputer (QST-NIFS joint procurement)

## Plasma Simulator in Rokkasho

Operation started in July. 2025

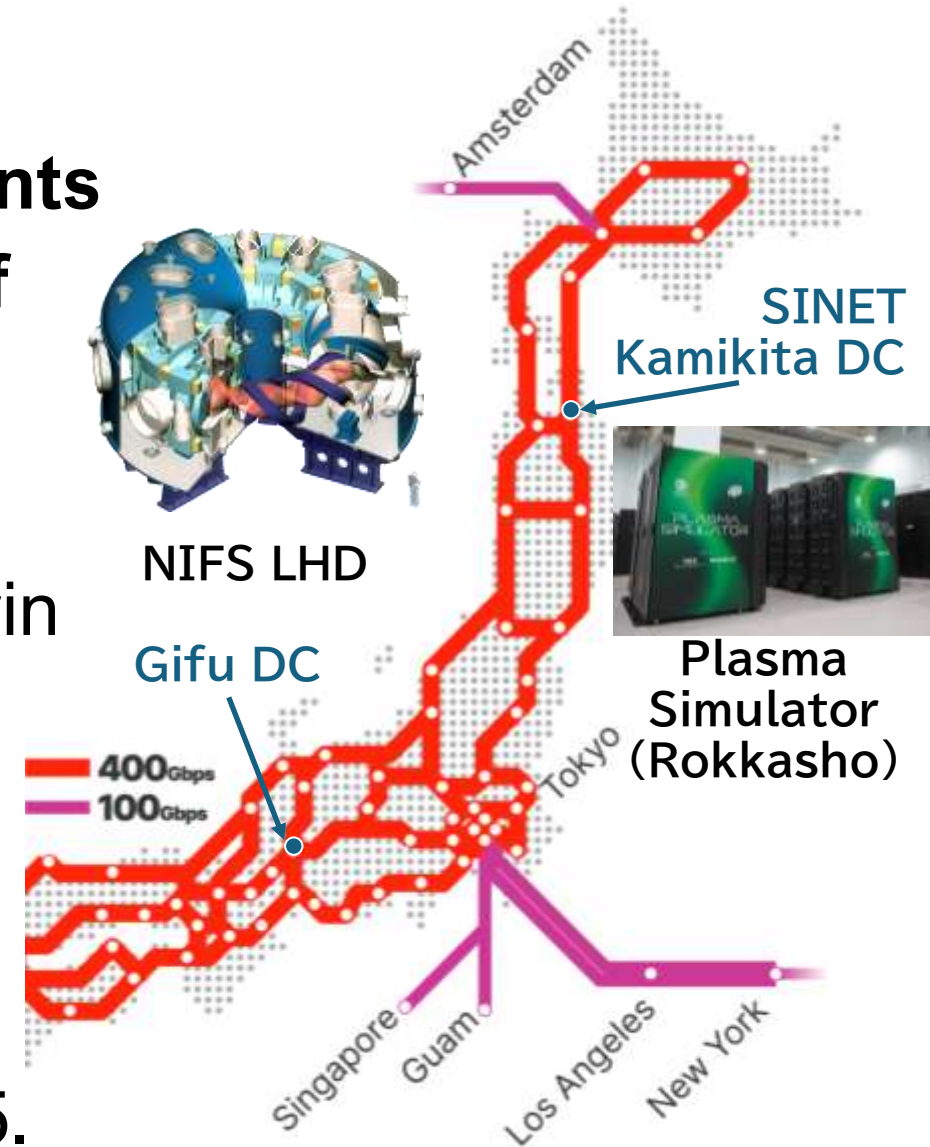


PLASMA SIMULATOR

Interaction with Ext. data, UI modernization, Collaboration infra.

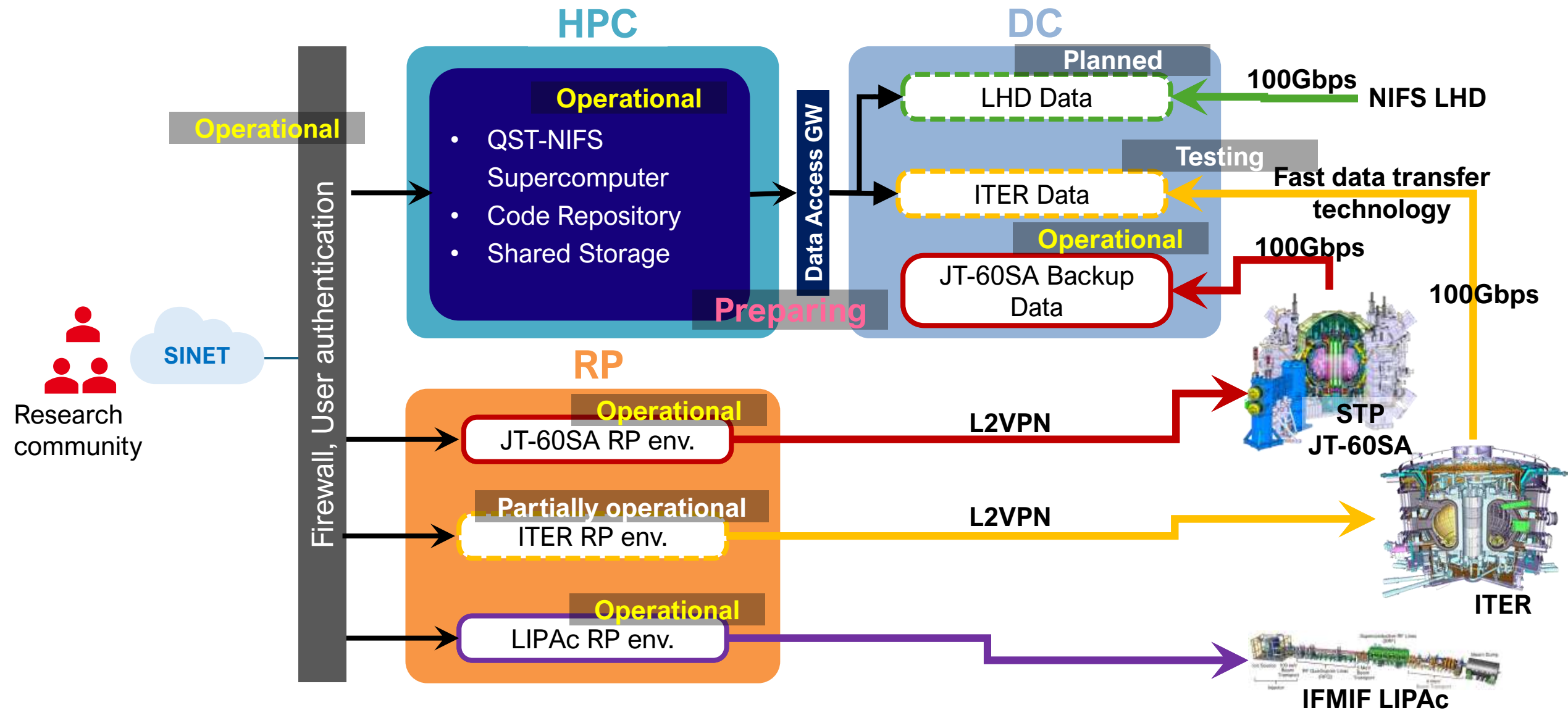
# PS-LHD Remote control test based on Digital Twin

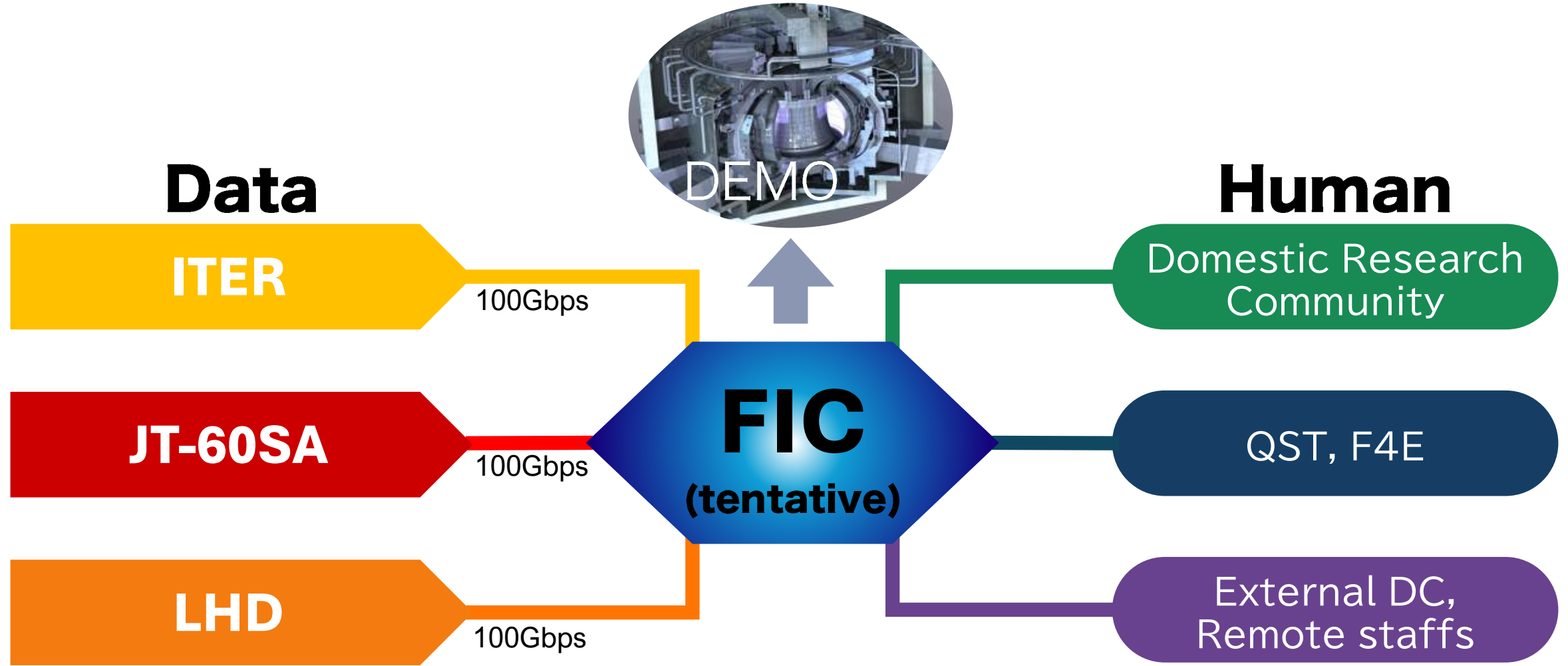
- **Model Predictive Control (MPC)** that accounts for the complex, self-organized behavior of burning plasmas is essential in DEMO.
- Using the LHD at NIFS and the ASTI digital twin (Kyoto University), optimal control is derived from **massively parallel real-time predictions on the Plasma Simulator** and applied to the LHD experiment.
- It has successfully demonstrated in Dec. 2025.



# Summary

# Current status of the FIC System



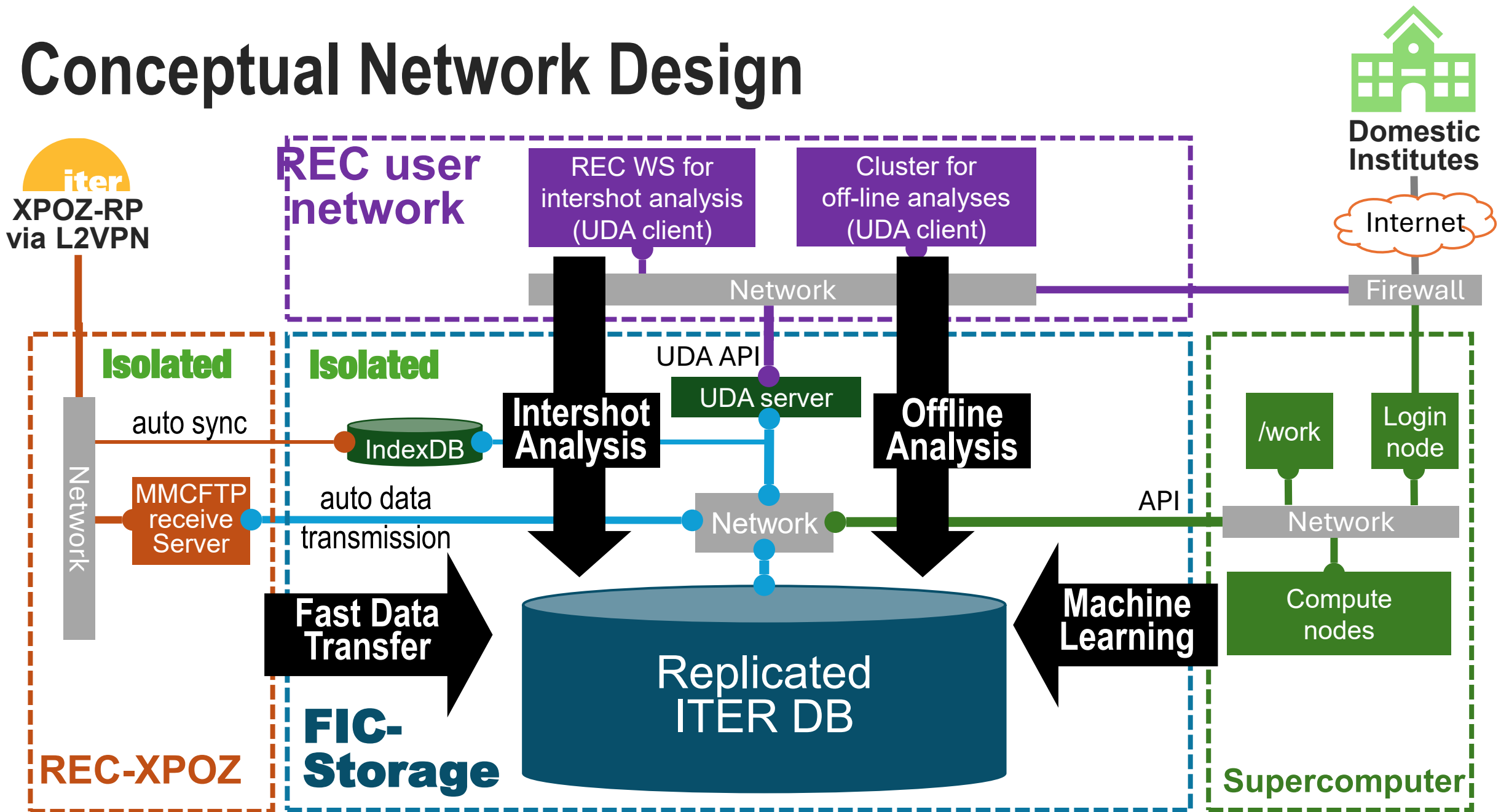


- ✓ A research information infrastructure (tentatively FIC) is being developed as a nexus linking devices and researchers to efficiently leverage limited human resources and accelerate the integration of experiment and theory toward a prototype reactor.

# 新スパコンの性能

システム	サブシステムA	サブシステムB	サブシステムC	データ処理部	JFRS-1
ノード数	360	70	48	12	1370
プロセッサ	Intel Xeon 6980P (2.0GHz/128C)	AMD MI300A (APU)	Intel Xeon Platinum 6544Y (3.6GHz/16C)	Intel Xeon 6900 (2.0GHz/128C)	Intel Xeon Gold 6148 (2.4GHz/20C)
プロセッサ数/node	2	4	2	2	2
演算性能 (PF)	5.898PF	34.328PF	0.176PF	0.1966PF	4.208PF
FLOPS/Node	16.384TF	490.4TF	3.6864TF	16.384TF	3.072TF
FLOPS/Node(HPL)	13.1TF*	176.544TF*			2.045TF
総主記憶容量	270TiB	35TiB	72TiB	3TiB	256TiB
GB/Node	768GiB	512GiB	1536GiB	2304GiB	192GiB
GB/Core	3GiB	-	48GiB	9GiB	4.8GiB
Bandwidth/Node	1689.6GB/s	5.3TB/s**	665.6GB/s	1228.8GB/s	255.94GB/s

# Conceptual Network Design



REC-XPOZ and FISC-Storage are isolated from the other networks.

# Necessity of Digital Twins for DEMO

- **In DEMO, the available diagnostic information will be severely limited** (due to the need to allocate sufficient surface area to tritium breeding blankets and to withstand intense heat and neutron fluxes).
- Under such conditions, controlling strongly self-organizing burning plasmas will **require control strategies based on the inference of unmeasurable quantities and the prediction of autonomous plasma responses.**
- The core value of a digital twin is to provide reality-anchored simulations through continuous data ingestion and **to integrate diverse measurements and theoretical models in a mutually consistent and complementary way into a consistent representation**, enabling the inference of unobservable quantities and robust model validation and calibration.

