

MatDB4Fusion

International Working Group on the Material Database for Fusion

IAEA Technical Meeting on Tritium Breeding Blankets and Associated Neutronics

September 2025

Contact: Philipp Lied (philipp.lied@fusioncatalyst.de)
Sehila M. Gonzalez de Vicente (sgonzalez@cleanairtaskforce.org)
Jay Brister (jbrister@catf-partners.org)

CATF Global Fusion Advocacy Programme

Fusion Energy Policy	De-Risking Strategies	Supply Chain Development	Awareness
<ul style="list-style-type: none"> ■ Support elected officials on policy formation ■ Advise regulators ■ Explore alternate fusion approaches ■ Describe new and existing rule sets for neutron management ■ Inform regional fusion strategies 	<ul style="list-style-type: none"> ■ Harmonize global safety requirements ■ Create materials catalogue to identify common challenges ■ Provide generic techno-economic cost analysis ■ Create tools for risk assessment 	<ul style="list-style-type: none"> ■ Produce universal catalogue of material needs ■ Maintain technology-agnostic view on workforce needs ■ Evaluate technology enablers such as AI, HPC ■ Codes and Standards development ■ Identify priority materials for supply chain security ■ Workforce development 	<ul style="list-style-type: none"> ■ Increase fusion's visibility in energy sector ■ Articulate fusion's role in the marketplace ■ Support national, regional and international fusion commercialization efforts ■ Demonstrate progress and set expectations for fusion expansion
<p>Inform policies to harmonize global safety and regulatory frameworks.</p>	<p>Identify and mitigate the uncertainties in the deployment of fusion.</p>	<p>Inform reference tools to be able to integrate fusion into the net-zero energy mix.</p>	<p>Position fusion as “clean tech” and as part of the net zero solution.</p>

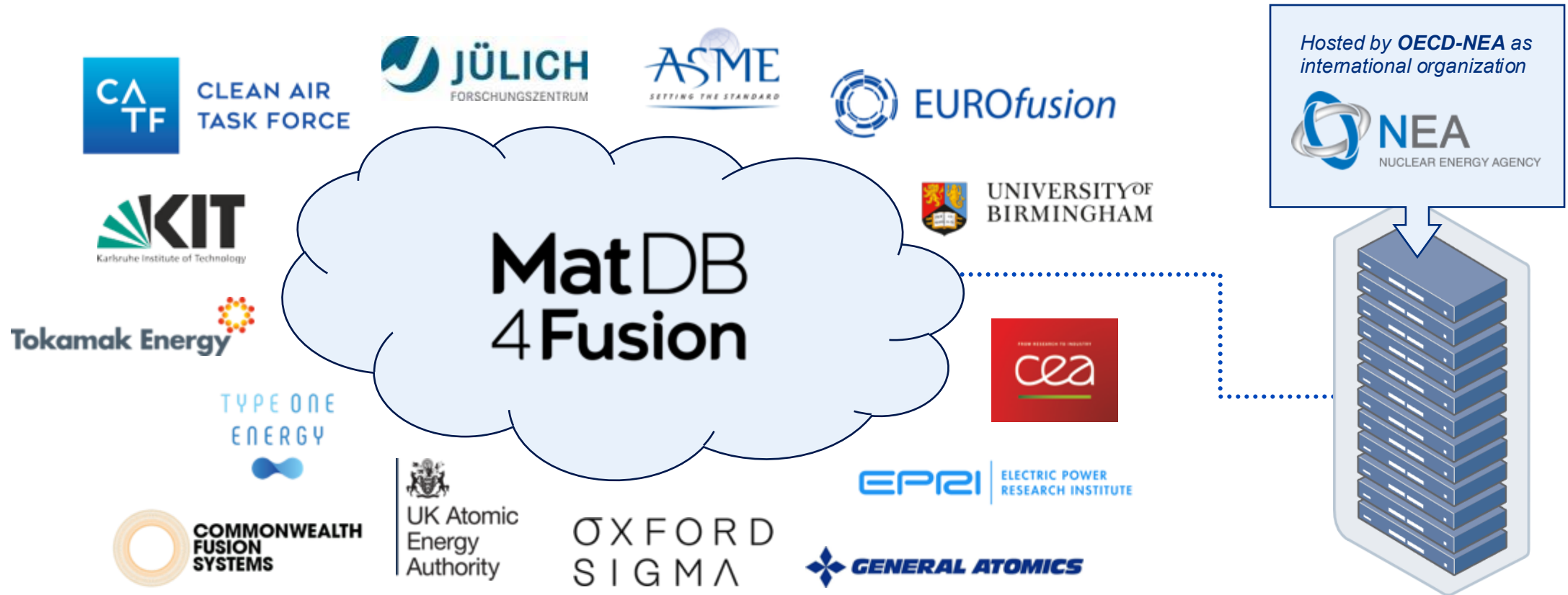
Introduction

The current situation for material science in fusion

- Recent breakthroughs in fusion technology
- Huge investments, also in private companies: Keen to accelerate development towards commercial fusion power, but relying on scientific data
- Development of basic materials suitable for fusion energy, qualified and validated in irradiation campaigns, is a matter of decades and consumes large budgets
- Scientific work of four decades created huge piles of data, however often not public
- Important material manufacturing details are often missing
- The rise of machine learning technology promises even more breakthroughs with enough data

► Urgent demand for a global database for fusion material properties

Formation of the International Working Group in 2023



The Material Database for Fusion

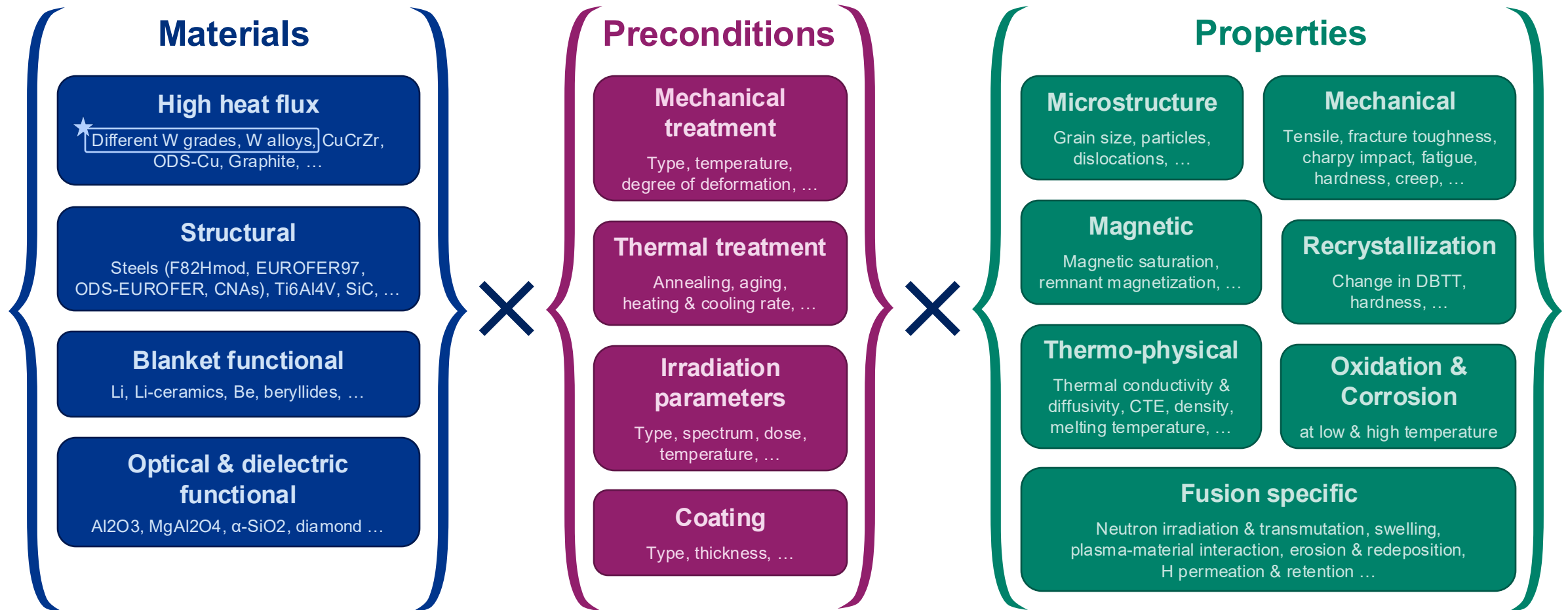
Ultimate Vision

▶ *Development started in 2024*

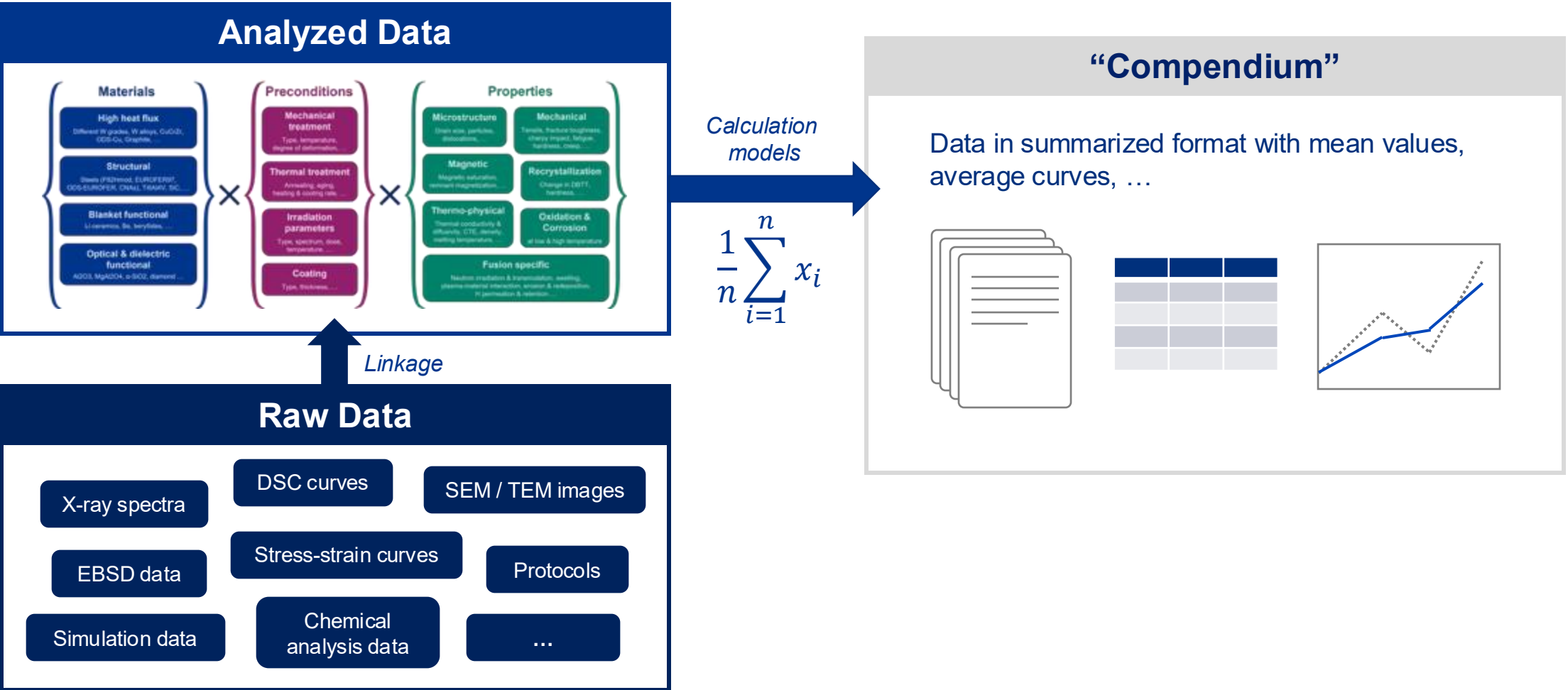
A database ...

- covering all **materials, properties, supporting data** relevant to fusion device design,
- supplied by many entities from different countries,
- with **quality-controlled** data,
- contains open access data but also restricted data from different stakeholders,
- acts as a **single reference** for all fusion reactor design approaches to
 - ▶ access wealth of data that did not reach publication or attention
 - ▶ **assess data gaps** and / or reduce duplication of effort by improving focus of experimental campaigns
 - ▶ accelerate **creation of codes / standards** for qualification (data quality needed)
 - ▶ provide sufficient data for **Machine Learning** solutions (data quantity needed)

Database Content and Structure



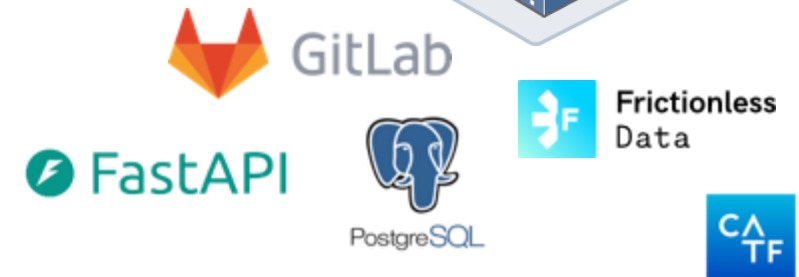
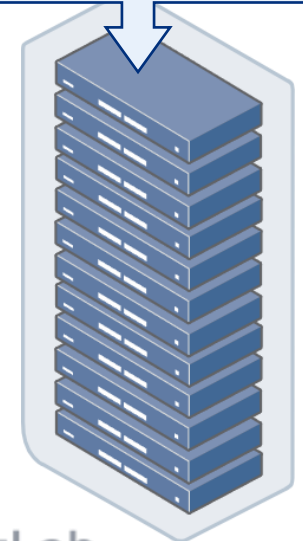
Database Content and Structure



Hosting of the Database

Partnership with OECD-NEA

- International (as being part of OECD)
- Experienced and reliable:
 - Many databases currently hosted
 - Advanced tools for data compilation and access
 - Availability of secure long-term storage of DB
 - In-house backup solutions with regular snapshots (at least daily)
- Shows strong commitment, already active development with CATF
- Account management and regulations (member states)
- Hosting:
 - GitLab system (currently used for DB development)
 - Database & Backend API (Frontend to be discussed)



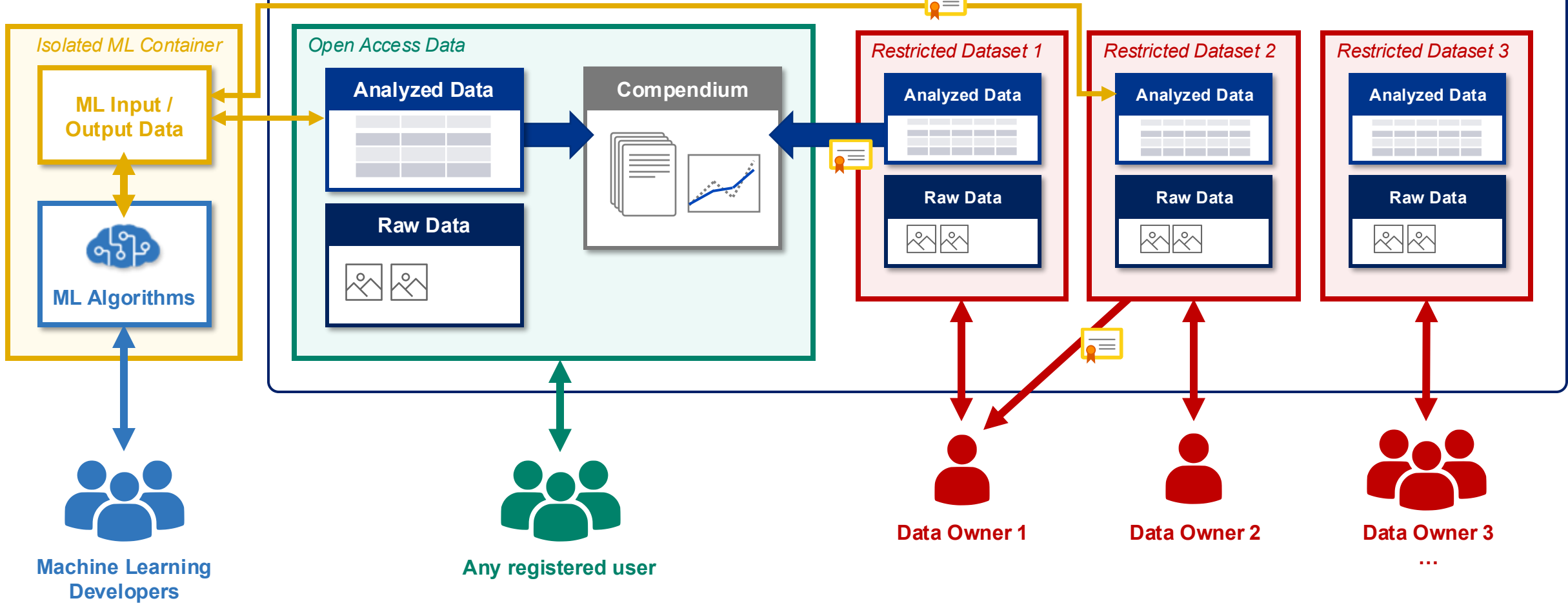
Database Access

Provided & maintained
by **CATF**
**CLEAN AIR
TASK FORCE**

Hosted by **OECD-NEA**
NEA
NUCLEAR ENERGY AGENCY

Supervised by
**Steering
Committee**

 = Separate License Agreement



Machine Learning

Where it can make a difference

- Knowledge extraction (collaboration with Google started)
- Property prediction/interpolation to unknown regions of data in terms of important parameters such as irradiation damage and temperature
- Physics-informed models to constrain predictions
- Identification of important features in materials for different applications
- Anomaly identification
- Uncertainty quantification for component design
- Links well with optimization techniques as they can behave as surrogate models

Key Aspects:

**Knowledge
Extraction**

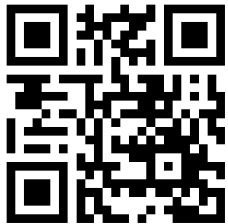
Data Analysis

**LLM Search
Function**

Web Interface

Features

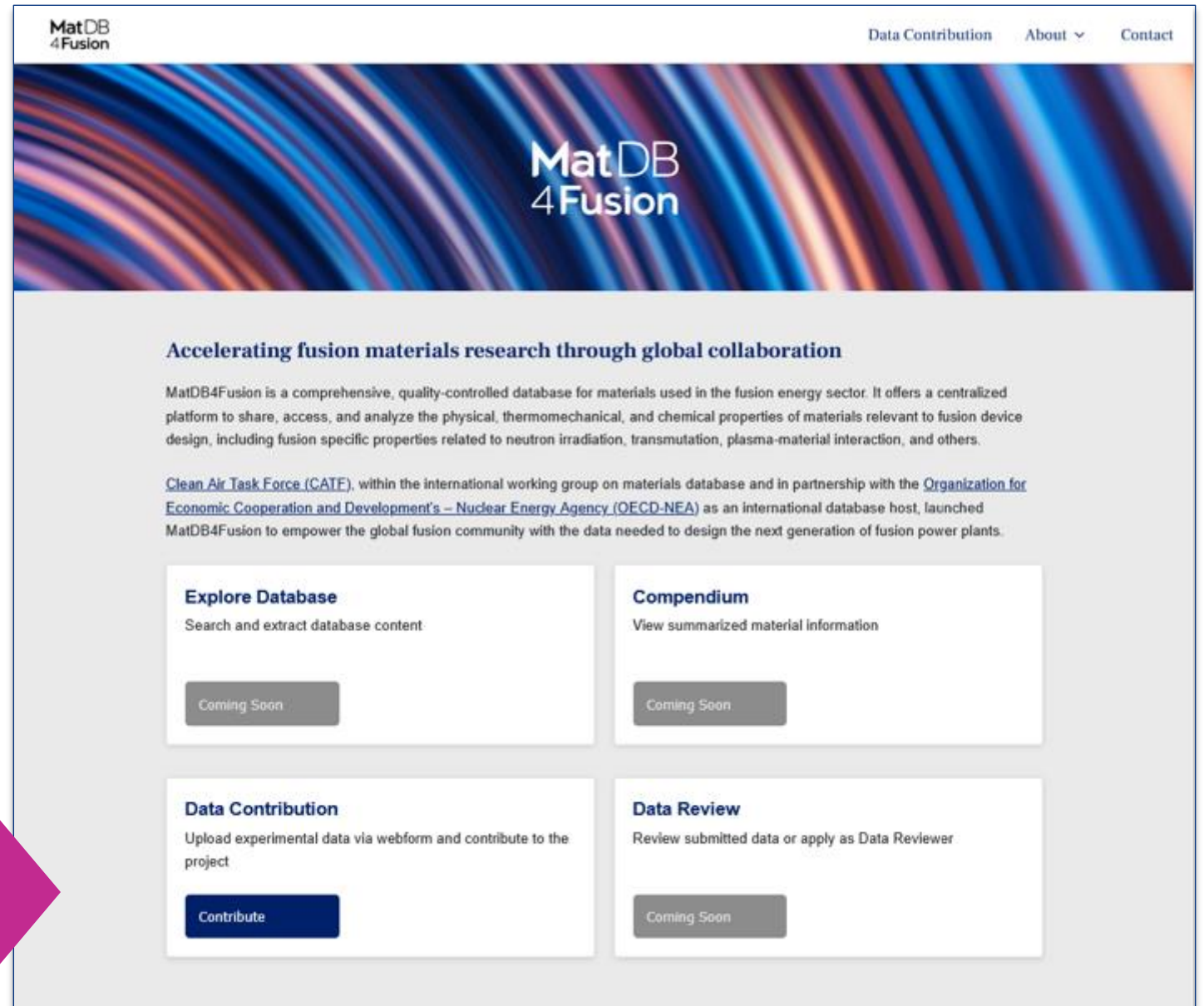
- Data Explorer (Table)
 - Data Filtering
 - Data selection & export
 - Data plotting
- Compendium
- Tools for
 - Data contribution
 - Data review



Visit

www.MatDB4Fusion.app

... and subscribe for updates!



Fusion Codes and Standards

Harmonisation of Codes and Standards for an Emerging Industry

Learning from Other Sectors and Working with Industry

- Industries with huge societal benefits have established platforms to further a uniform commercialization of their technologies by aligning around common standards for the delivery of the technologies
- Independent international organizations, funded by government and private sector have been established to administer the standards
- Fusion is very similar in its potential for societal benefit and harmonization of standards supporting the most rapid commercialization of the technology is warranted
- The Clean Air Task Force is leading an effort to establish a first of a kind international working group on the development of standards for fusion technology.
 - Working with government, fusion technology developers, industry and international organizations today to get this important next step for fusion started
 - Working with Industry to meet the evolving needs of this developing technology
- The Clean Air Task Force is also on the ASME Division III Section 4 Special Working Group for Fusion Stakeholders

Global Efforts Focused on Codes and Standards for Fusion



Summary of Global Efforts by Organization



UK Atomic
Energy
Authority

Longest involvement in exploring codes and standards for commercialization of fusion engaging AFCEN, ASME, IAEA and SDC-IC

Fusion specific standards to include both Fusion reactor components and power generation process plant

Also engaging with regulator regarding off-site transportation of radioactive material and nuclear safeguards for Fusion plants.



CLEAN AIR
TASK FORCE

Establish a first of a kind international working group on the development of standards for fusion technology.

Work with government, fusion technology developers, industry and international organizations today to get this important next step for fusion started.

This position can lead to a new independent organization that will administer fusion standards.

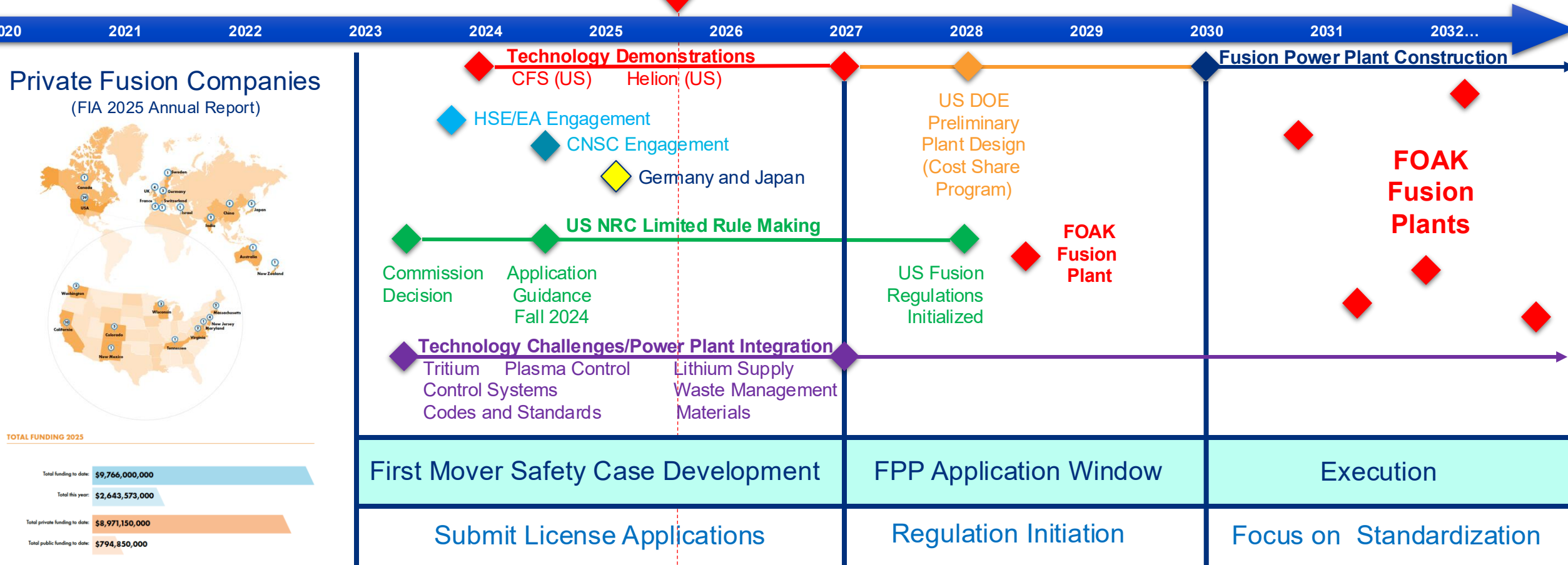


IAEA are collating a spreadsheet on the codes and standards for fusion development and deployment

Eventually converted into a database which will help to identify gaps in C&S which need to be developed by standards organizations or where existing C&S from other industries can be used

Open to all Member States involved or interested in the research and development of fusion technology, including government organizations (policymakers, analysts, regulators, and R&D agencies) and industry stakeholders (vendors, engineering companies, plant operators and technology developers).

Fusion Technology and Regulation Development: Landscape 2025 and Outlook



Thank you!



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Role and Structure of the Steering Committee (SC)

