FusionTwin Project Charter

A Kickstand Labs Project

Version

0.1 — Genesis

Vision

FusionTwin is an open-source platform for simulating and visualizing fusion reactors. It is designed to begin as an educational simulator and evolve into a modular digital twin framework capable of supporting engineering, experimentation, AI-assisted analysis, and community-driven research.

Our objective is not to replace professional fusion codes, but to provide an accessible, extensible platform where people can learn, prototype ideas, and contribute new capabilities.

Mission

Build the world's most approachable and extensible fusion reactor simulator.

Every design decision should balance:

- Scientific integrity
- Software quality
- Performance
- Accessibility
- Long-term maintainability

Core Principles

1. Modular First

Every subsystem should be replaceable without affecting the rest of the application.

Examples include:

- Plasma models

- Magnetic field solvers
- Heating systems
- Diagnostics
- Rendering
- AI services

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2. Physics with Transparency

Simplifications are acceptable.

Hidden assumptions are not.

Every model must document:

- What it represents
- What it ignores
- Expected accuracy
- References

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3. Beautiful Engineering

Visualization is part of understanding.

The simulator should make complex concepts intuitive through animation, interaction, and clear feedback.

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4. AI as a Guide

AI should explain, analyze, and assist.

It should never obscure the underlying simulation or invent unsupported physics.

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5. Open by Design

The project welcomes contributors from many disciplines, including:

- Software engineering
- Plasma physics
- Electrical engineering
- Controls
- Scientific visualization

- Technical writing
- Education

Initial Scope (Genesis)

The first milestone will include:

- Interactive 2D tokamak visualization
- Simplified magnetic field representation
- Plasma object
- Adjustable reactor parameters
- Live graphs
- Stable simulation loop
- Extensible architecture

No attempt will be made to simulate full plasma physics in this phase.

Future Milestones

Genesis

Interactive reactor

Ignition

Dynamic plasma

Confinement

Magnetic control

Heating

Energy systems

Stability

Instabilities and disruptions

Burn

Fusion reactions

Twin

Digital twin architecture

Atlas

Multiple reactor families

Non-Goals

FusionTwin will not initially attempt to:

- Replace research-grade plasma codes
- Model every physical process with high fidelity
- Guarantee engineering accuracy
- Optimize for supercomputers

These capabilities may come later through plugins and community contributions.

Technology Stack

Frontend

- React
- TypeScript
- Three.js

Backend

- Python
- FastAPI

Physics

- NumPy
- SciPy

Storage

- SQLite

Version Control

- Git
- GitHub

License

- Apache 2.0

Success Criteria

FusionTwin succeeds if:

- Students can learn from it.
- Developers enjoy contributing.
- Engineers can prototype ideas.
- The architecture remains clean as it grows.
- The community can extend it without rewriting it.

Motto

Simple enough to understand. Modular enough to become real.