Helical Fusion

The 107th GIST Seminar
A discussion on commercial fusion technology, timelines, and policy

Development of Helical Commercial Fusion Reactor by Helical Fusion

Speaker's Self-Introduction

Junichi MIYAZAWA

1970	Born in Okaya, Nagano, Japan
1986 – 1988	Graduated from Suwa Seiryo High School, Nagano
1989 – 1993	Bachelor Degree in Nuclear Engineering, The University of Tokyo
1993 – 1995	Master's Degree, Department of Nuclear Engineering, The University of Tokyo
1997 – 2007	Assistant Professor, NIFS (National Institute for Fusion Science), SOKENDAI
2003	Doctor's Degree, Nuclear Fusion Physic sand Engineering, SOKENDAI
2007 – 2016	Associate Professor, NIFS, SOKENDAI
2016 -	Professor, NIFS, SOKENDAI
2021 -	**President, Helical Fusion Co., Ltd.**

Small plasma experiments

Large plasma experiments

Fusion reactor design

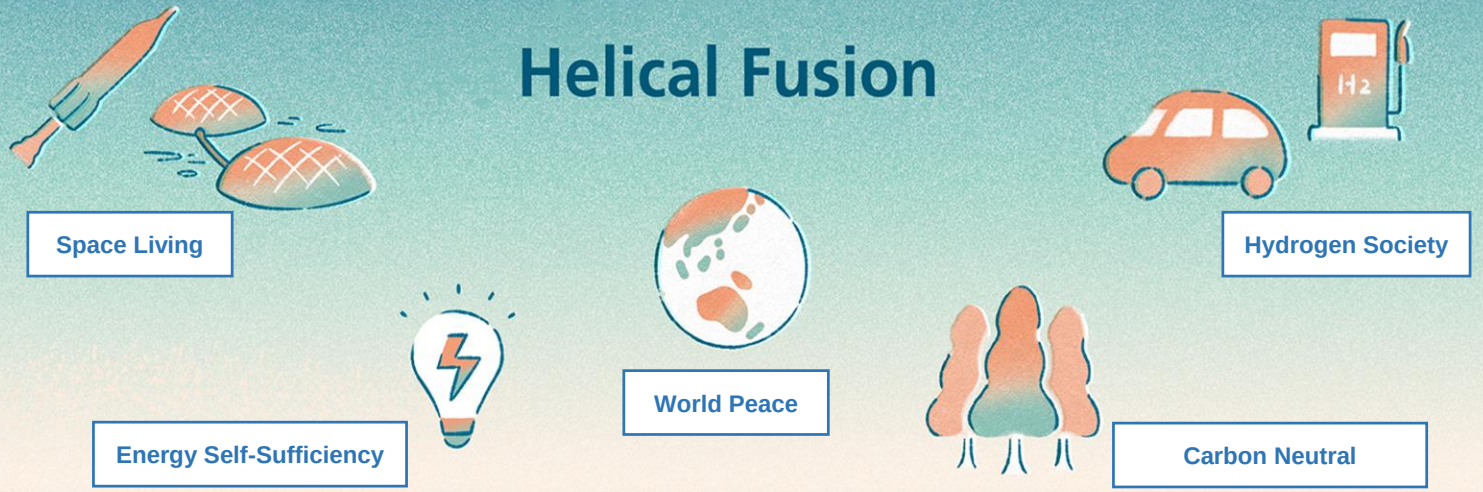
Social implementation of fusion reactor

70 years of fusion research knowledge
+ accumulation of own experience + ideas necessary to realize a fusion reactor
→ **Preparations for realizing a fusion reactor are almost complete, and in 2021, Helical Fusion finally starts up**

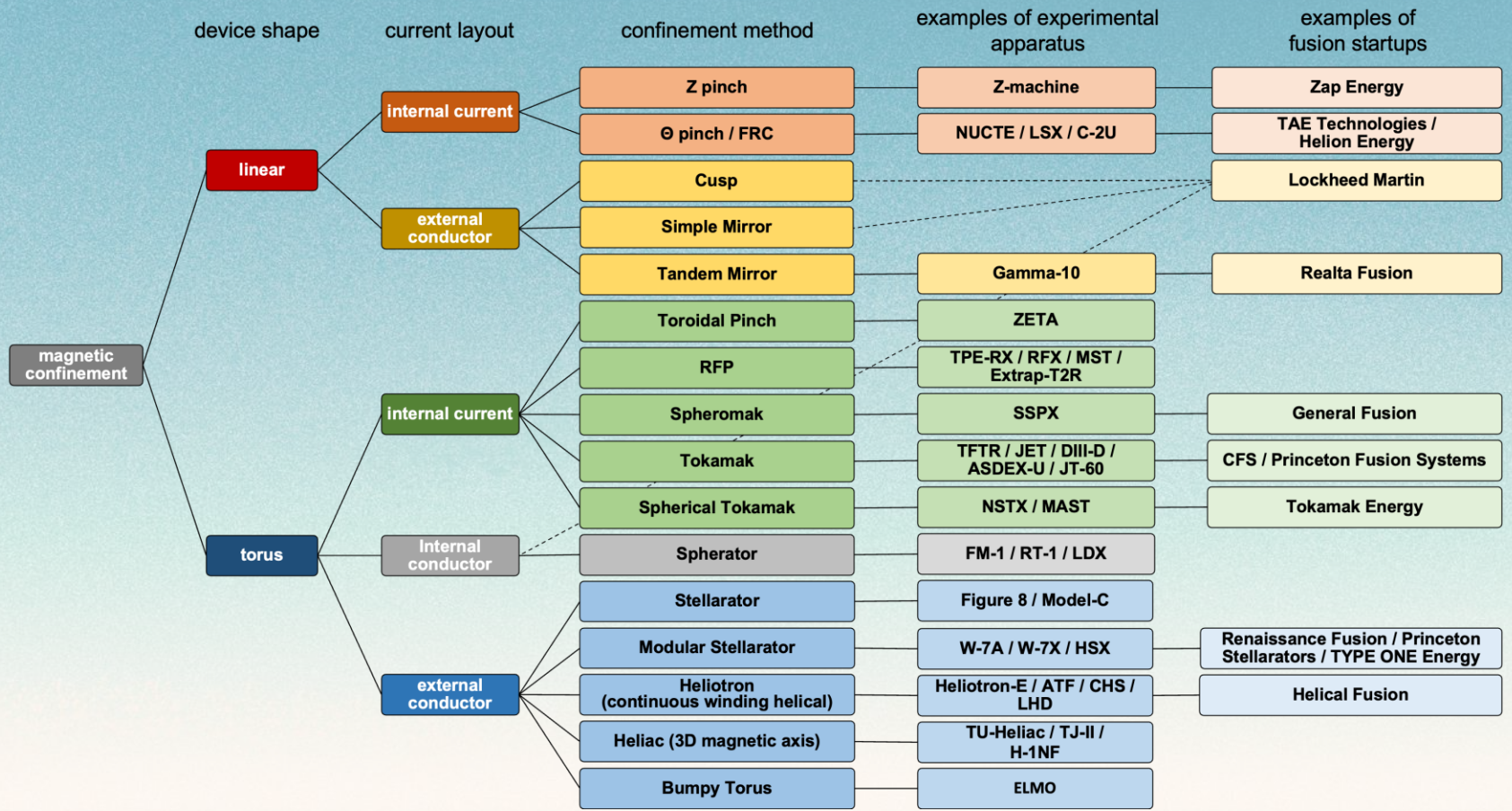
Helical Fusion's Vision

"Humanity evolves with nuclear fusion"

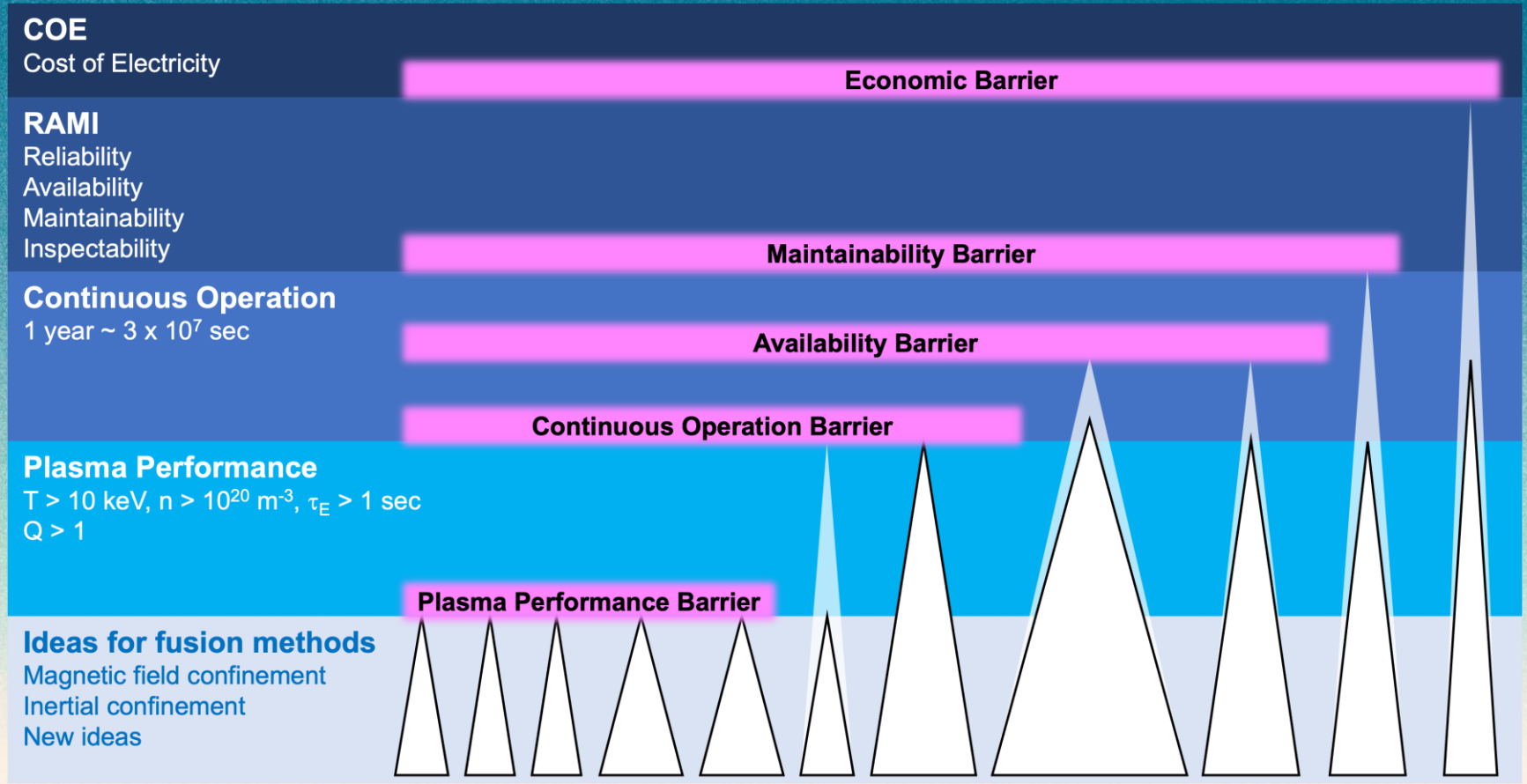
With our helical fusion reactors, we will create a sustainable and stable energy source that will enable the coexistence of humans and the Earth for the next million years.



Phylogeny of magnetic confinement fusion

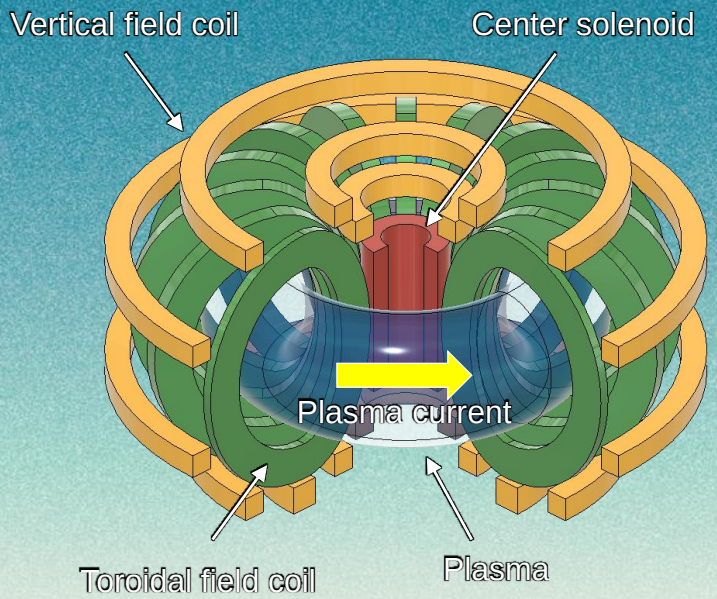


Barriers We Have Overcome and Need to Overcome



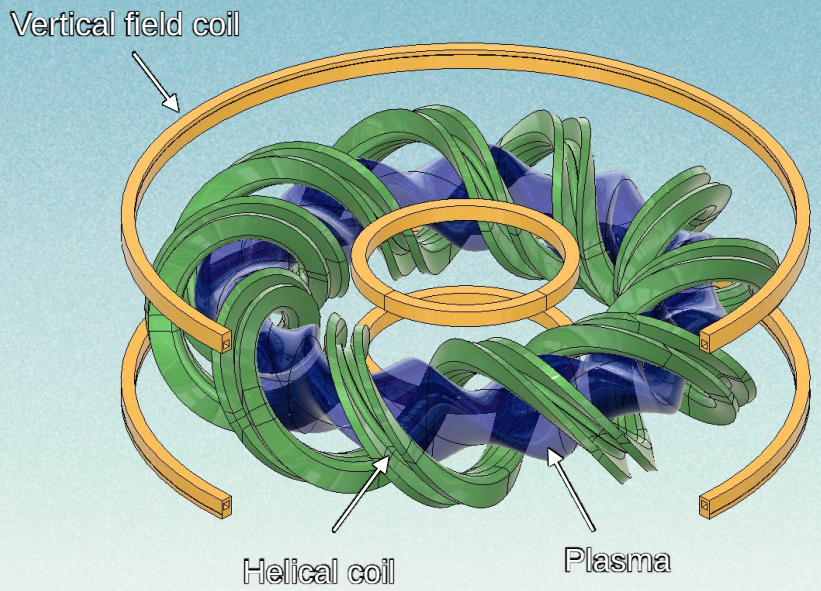
Our Choice

Tokamak



- **Simple structure, but difficult to operate**

Helical

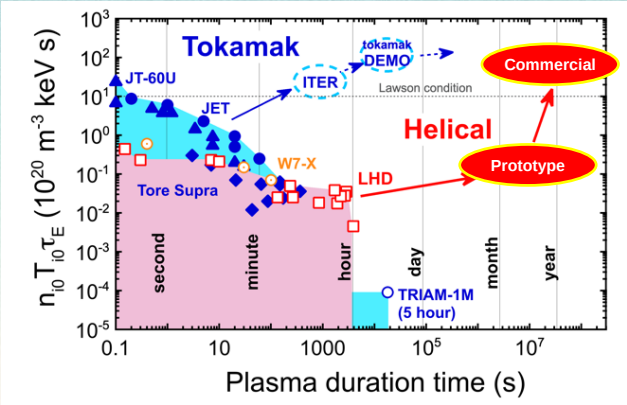


- **Complex structure, but easy to operate**

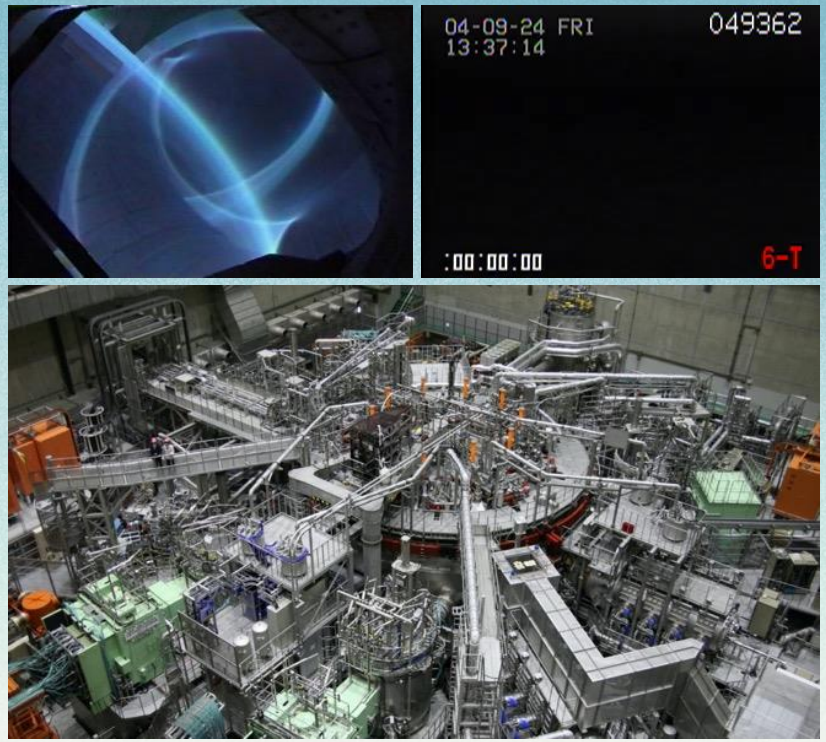
→ We chose Helical, because we want a long-lived plasma as the Sun on Earth

Based on the Public Knowledge Accumulated in LHD

LHD is the only device in the world that has achieved;
Central ion temperature, T_{i0}, higher than 10 keV
Central electron density, n_{e0}, higher than 1.2 x 10^{21} m^{-3}
Energy confinement time, τ_E, of 0.23 s
Fusion triple product, $n_{e0}T_{e0}\tau_E$, of 0.52 x 10^{20} m^{-3} keV s
Plasma duration time, $\tau_{duration}$, of 3,000 s
(although these were achieved individually)



T. Seki et al., PFR **10** (2015) 3405046 (modified)



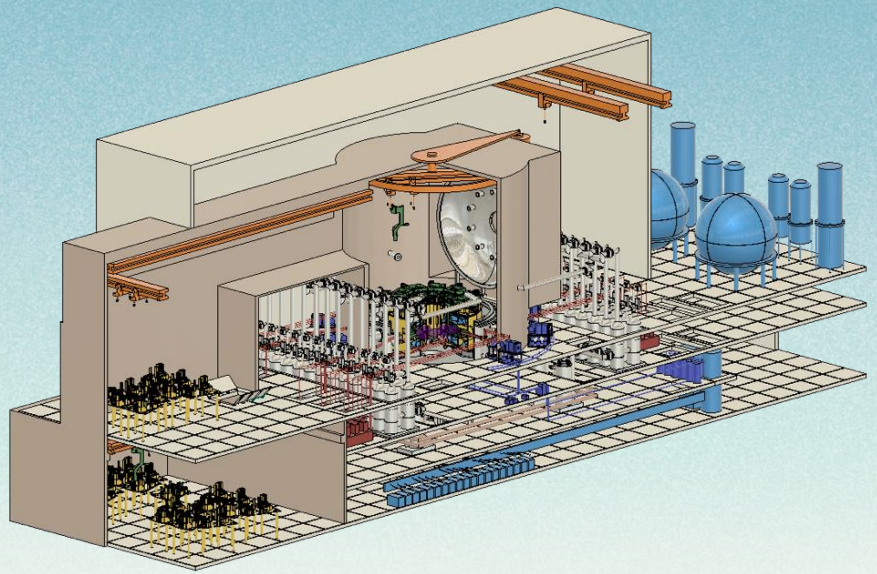
LHD (Large Helical Device)
National Institute for Fusion Science (Toki, Gifu)
https://www-lhd.nifs.ac.jp/pub/LHD_Project.html

Major Specifications of Our Helical Fusion Reactor

Helical Fusion is developing a 50 MWe-class steady-state fusion reactor.

Commercial fusion power plant will be a 100 MWe-class steady-state helical fusion reactor.

- Helical coil major radius, R_{ax} : 7.8 m
- Magnetic field strength at R_{ax} : 6.6 T
- DT fusion reactor
- Net electricity: 50 MWe
- Continuous operation time: 1 year
- Availability: > 80 %
- Construction cost: ~5 billion USD



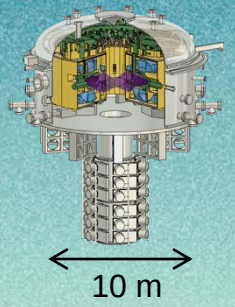
Overall view of the commercial helical fusion reactor

Phased Development Plan

2023 – 2026
Individual function demonstration

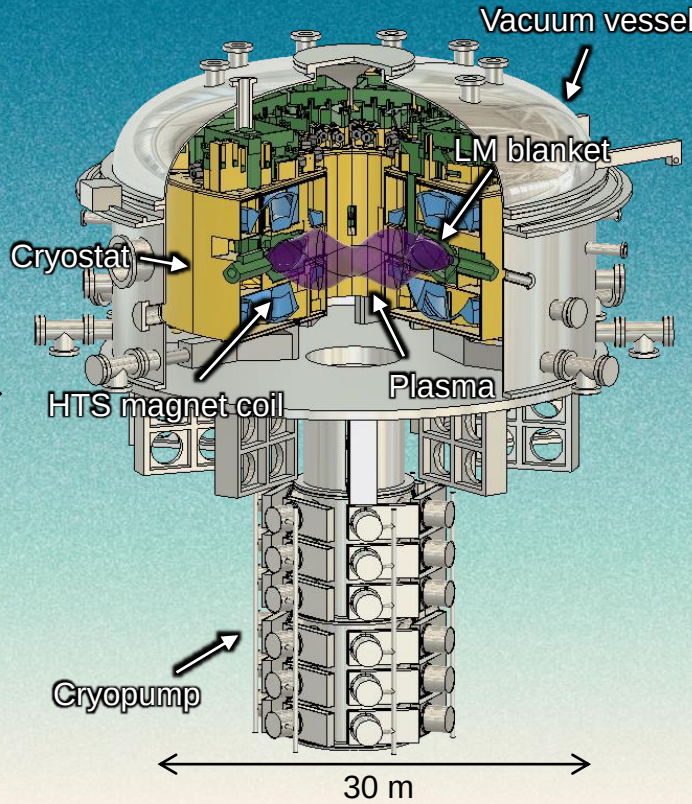
- magnetic configuration optimization
- HTS WISE conductor
- small continuous coil winding device
- small WISE helical coil
- large continuous coil winding device
- HTS STARS conductor
- small joint-winding device
- small STARS helical coil
- large joint-winding device
- High-power CW gyrotron
- 30 barrel pipe-gun DT pellet injector
- direct recycling system
- SCO_2 gas turbine generator
- solar powered H_2 generation system
- H_2 gas turbine generator
- H_2 liquefaction and storage system

2024 – 2027
Prototype construction and operation



Prototype

2028 – 2033
Commercial reactor construction and operation



50 MWe-class Commercial Helical Fusion Reactor

Final Remarks

We are the only company in the world aiming at the realization of a helical fusion reactor.

Helical does not require the plasma current drive.

Helical has no disruption.

Helical does not require precise plasma position control as in tokamaks.

Helical has large maintenance ports.

Helical is the only fusion method that has the prospect of steady-state operation for one year.

Helical is the only fusion method that has no fatal problem difficult to solve.

We have a fast track without the need of developing divertor systems and NBI systems.

We develop a new HTS magnet and unique liquid metal blanket equipped with liquid metal first wall.

These are applicable to other fusion reactors including tokamaks, ICF, and others.

We believe that helical is the fastest way for mankind to realize the sun on earth.

(Not only the fastest but probably the only way...)

That's why we are confident and proud to be developing the helical fusion reactor.