Business plan of Helical Fusion and expectations for public-private partnership

Takuya Goto
Helical Fusion Co., Ltd.

Helical Fusion

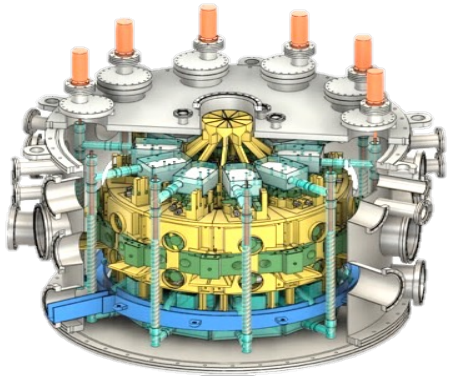
The 126th GIST Seminar
“A discussion on how to accelerate commercial deployment of fusion technology, public private partnership”
Feb. 20, 2024

- **Introduction of our company**
- Our technology and challenge
- Expectations for public-private partnership

Our Company

- Founded based on the research results developed at the National Institute for Fusion Science (NIFS).
- Aims to develop a helical fusion reactor, which originated in Japan.

- **Company Name: Helical Fusion Co., Ltd.**
- **Date of Establishment:** Oct. 2021
- **Paid-in Capital:** $0.7M
- **Locations:** Tokyo, Gifu(R&D), US(Delaware)
- **Number of Employees:** 20 (incl. subcontractors)
- **Business Model:**
  - Short&Middle term: Out-licensing of core technologies to overseas start-ups and government-led projects
  - Long term: Development of helical fusion reactors, providing design, construction, operation and maintenance technologies to power generation entities.
- **Stakeholder composition:**
  - Management: 87%
  - Investor: 13% (SBI Investment, SONY, etc.)



Helical fusion reactor

Team

Diverse members from academia, finance, and energy industries

Co-Founder, Co-CEO, Junichi MIYAZAWA
- Former Professor at NIFS, PhD
- 25+ years of LHD study - Plasma, Magnet, Blanket

Co-Founder, Co-CEO, Takaya TAGUCHI
- Startup COO
- 10+ years finance and investment at JBIC

Co-Founder, Board member, Takuya GOTO
- Former Assistant Professor at NIFS, PhD
- Fusion plant modeler

Director, Biz Dev, Yosuke KUBO
- 15 years in energy industry
- Lead business development at Mitsui

Director, Corporate Strategy, Harunori OIWA
- Venture Capitalist at Plug and Play

Key adviser

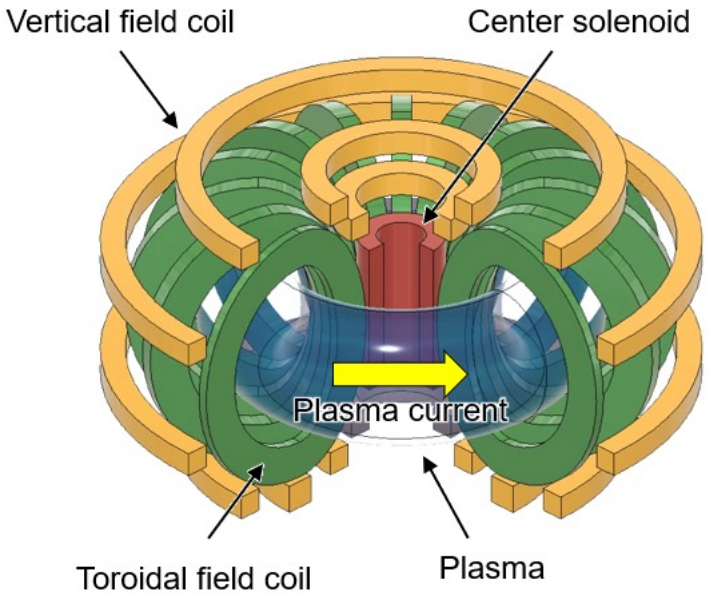
Dr. Akio SAGARA
- Former head of NIFS fusion engineering research project, Professor Emeritus
- Outstanding Achievement Award from ANS

Dr. Nagato YANAGI
- Professor and Leader of superconducting magnet research at NIFS

Co-founders and original member

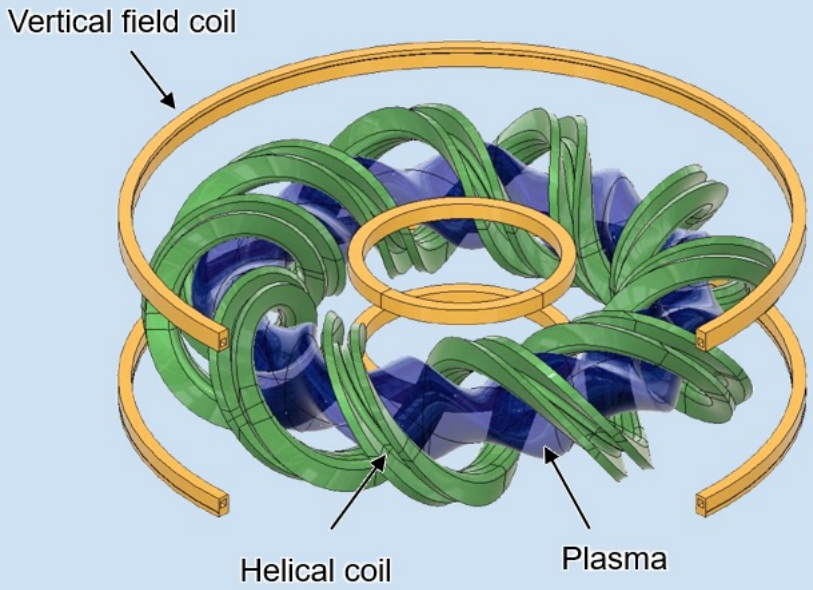
Helical is easier to operate and to control

Tokamak



Simpler, but continuous operation method still not identified.

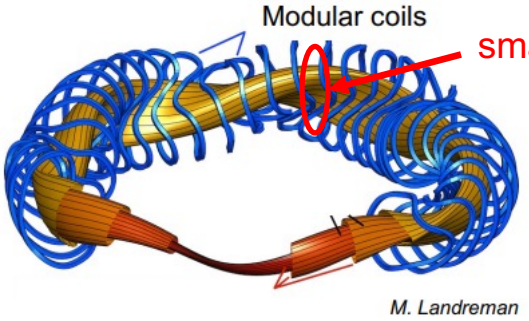
Helical



More complex, but **good at continuous operation**.

Heliotron is easier to maintenance

Modular Stellarator



TYPE ONE ENERGY

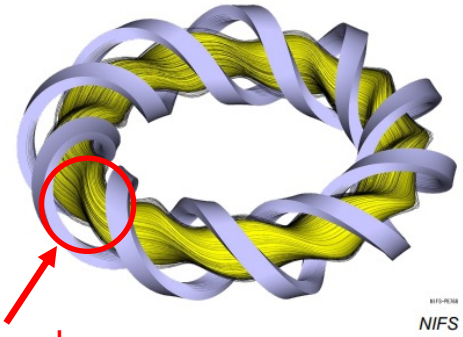
RENAISSANCE FUSION

GAUSS FUSION

THEA ENERGY

Proxima Fusion

Heliotron



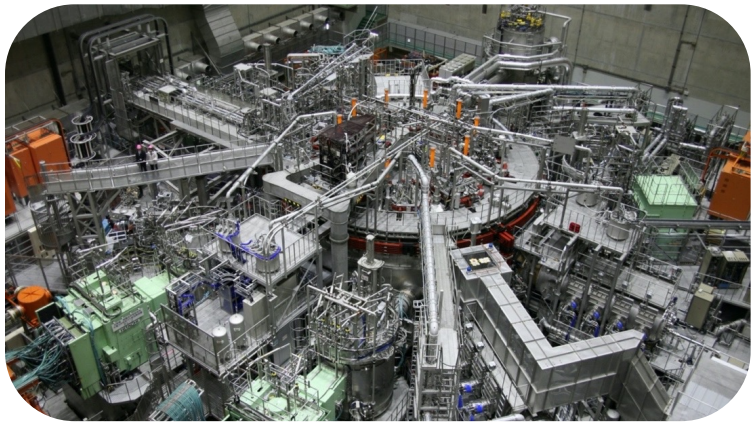
Helical Fusion

Comparable plasma performance

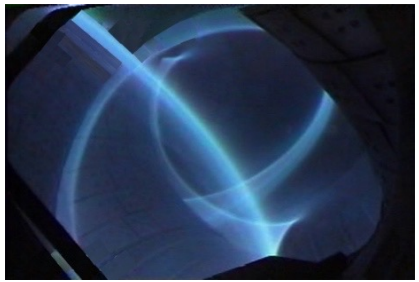
Easier maintenance (larger space between coils)

Reliable plasma performance

- More than 25 years of accumulated research by the Large Helical Device (LHD) at NIFS.
  - Plasma temperature over 100 million degrees
  - Plasma duration time over 3,000 seconds
  - Established plasma performance prediction method (physics scaling, numerical simulation)



Large Helical Device (LHD)
National Institute for Fusion Science (Toki, Gifu, Japan)



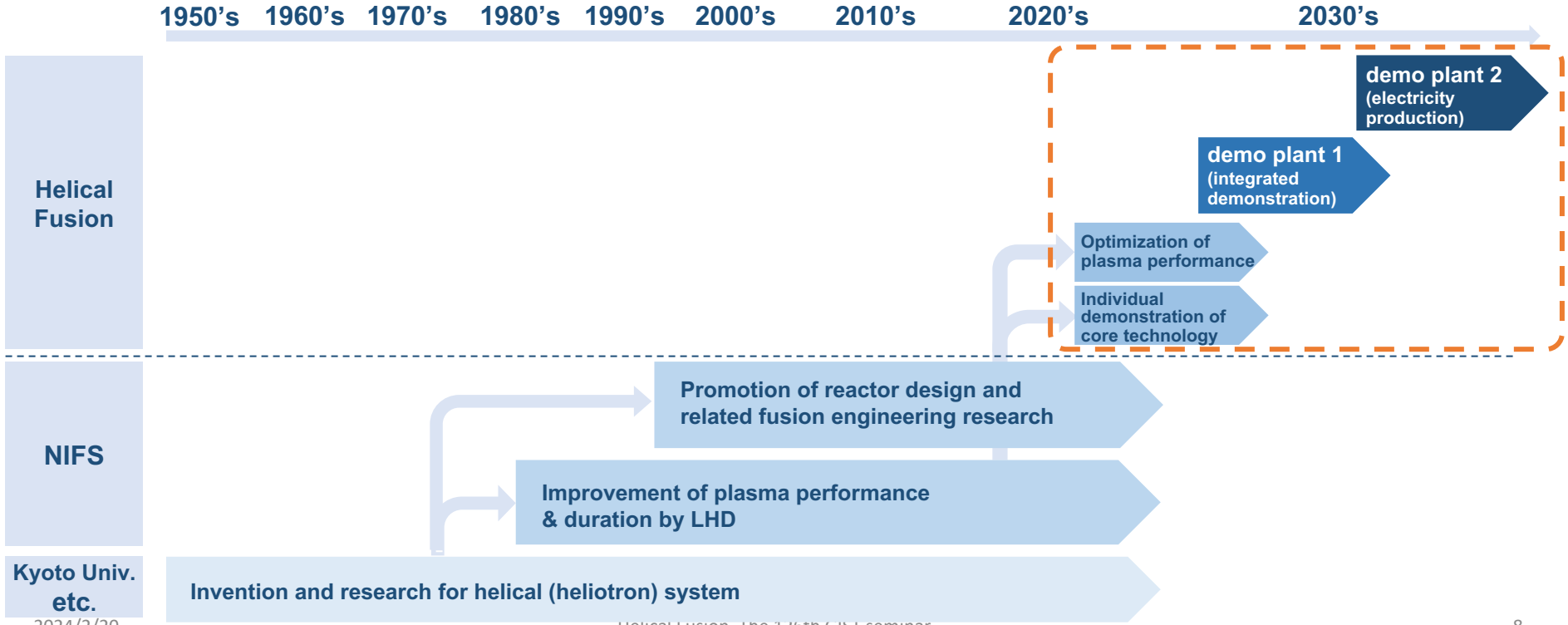
Helical plasma

Video

Source: National Institute for Fusion Science

Our developmental plan

We are in the final stage of commercialization by taking over a nearly 70-year, billion-dollar research



Helical Fusion

- Introduction of our company
- **Our technology and challenge**
- Expectations for public-private partnership

Our key technologies

Development of key elemental technologies for fusion reactors

1

Plasma with high temperature, high density

generates energy by nuclear fusion

(Generally proven in LHD)

2

High-temperature superconducting magnet

creates a strong magnetic field to confine plasma

3

Liquid metal blanket

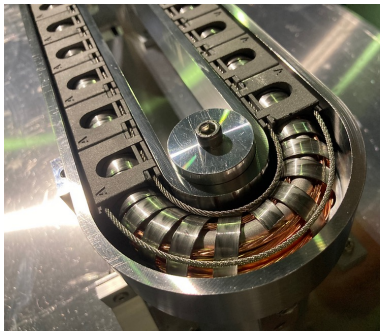
receives fusion fast neutrons and plays a role in radiation shielding, fuel production, and energy conversion

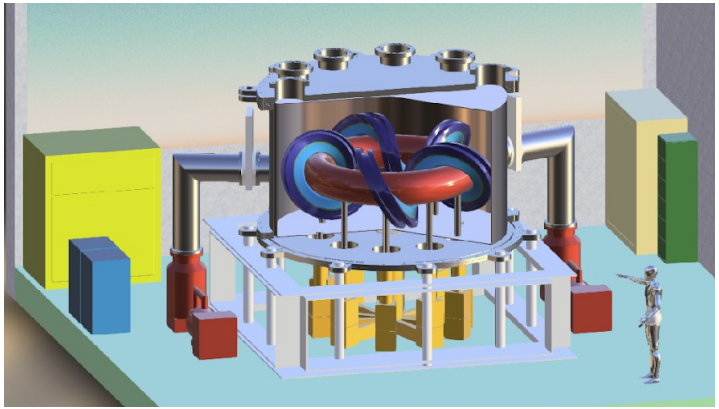
4

Liquid metal wall / divertor

Receives high-temperature plasma and exhausts impurities

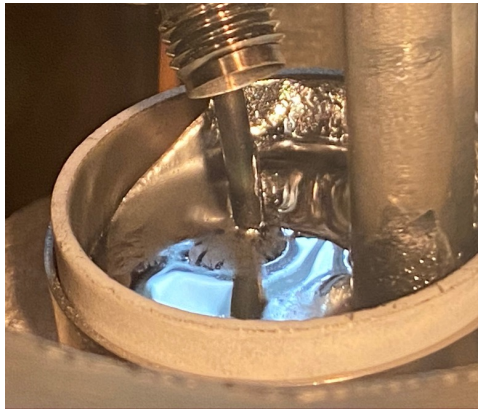
Our key technology (1) – HTS magnet



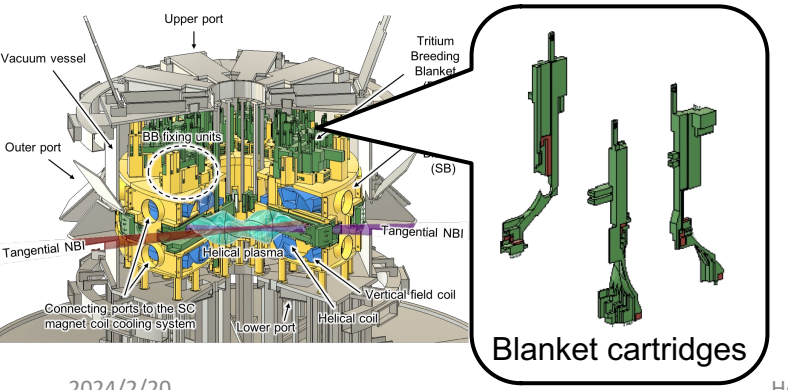


- **Features**
  - Easy to wind
  - High current density
  - Advanced quench protection (no insulation)
- **Demonstration requirements**
  - Large current carrying capacity under a high magnetic field
  - Resistance to high electromagnetic force
  - Fabrication of coils with complex geometry
  - Quench resistance

Our key technology (2) – Liquid metal blanket



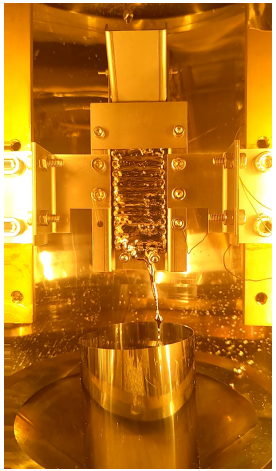
- **Features**
  - Protection of blanket first wall and divertor region by free surface flow
  - Tin-based breeder/coolant with low vapor pressure
  - Blanket casing with non-magnetic reduced activation material
  - Replacement of all breeding blanket modules from upper ports



Demonstration requirements

- Stable formation of liquid metal free surface flow
- Circulation and heat removal characteristics of liquid metal
- Compatibility of liquid metal and casing material
- Tritium breeding and neutron shielding performance

Collaboration with NIFS & universities



HTS magnet development / Liquid metal experiment & simulation
(NIFS)

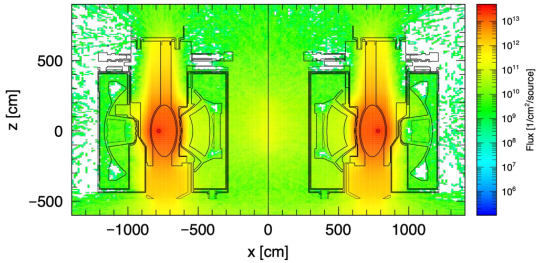
National Institute for Fusion Science

Remote maintenance
(Aoyama Gakuin Univ.)

青山学院大学
AOYAMA GAKUIN UNIVERSITY

Non-magnetic reduced activation material
(Tohoku Univ.)

TOHOKU UNIVERSITY



3D neutron transport simulation
(Tokushima Univ.)

徳島大学
Tokushima University

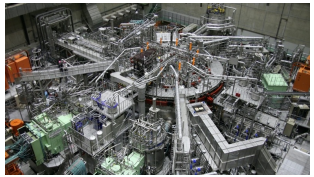
Collaborative R&D with other universities and companies are in preparation

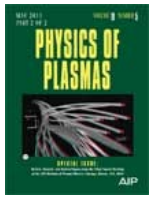
Our plan to commercialize fusion energy

Helical Fusion

✓ **COMPLETED**

- LHD experiments for >25 years and record-breaking results
- Reactor design study and Fusion engineering research



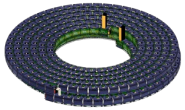


✓ **COMPLETED**

Published peer-reviewed development plan in Physics of Plasma

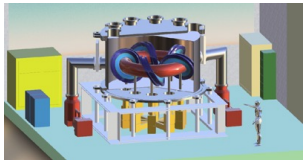
IN PROGRESS

Development of HTS magnet, liquid blanket and other core components



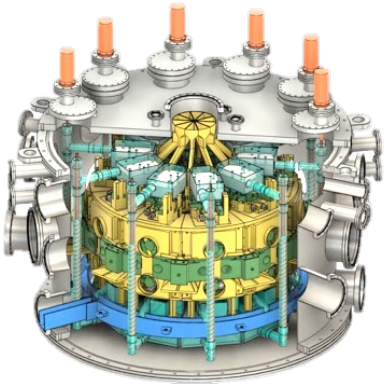
End 2020s

Development of *"demo plant 1"*



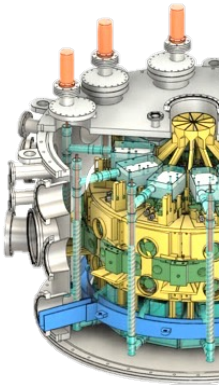
By 2034

Development 50-100MW *"demo plant 2"* first reactor



2040s

Commercial reactors



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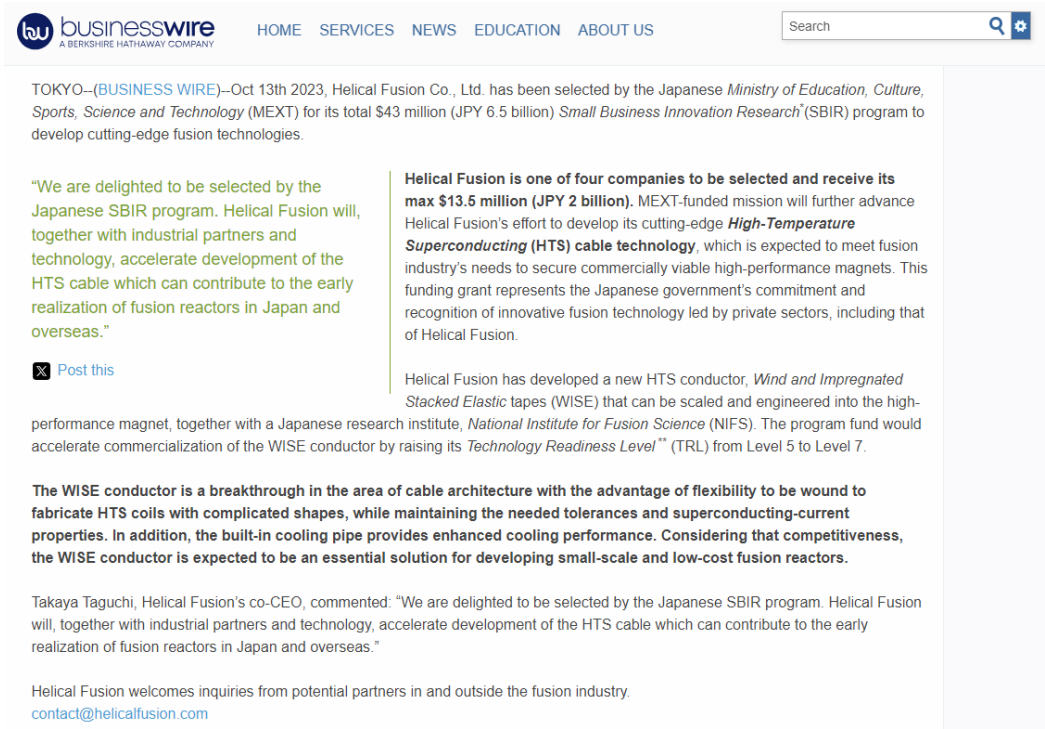
SBIR program accelerates our HTS conductor development



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TOKYO--(BUSINESS WIRE)--Oct 13th 2023, Helical Fusion Co., Ltd. has been selected by the Japanese *Ministry of Education, Culture, Sports, Science and Technology* (MEXT) for its total $43 million (JPY 6.5 billion) *Small Business Innovation Research*(SBIR) program to develop cutting-edge fusion technologies.

"We are delighted to be selected by the Japanese SBIR program. Helical Fusion will, together with industrial partners and technology, accelerate development of the HTS cable which can contribute to the early realization of fusion reactors in Japan and overseas."

Post this

Helical Fusion is one of four companies to be selected and receive its max $13.5 million (JPY 2 billion). MEXT-funded mission will further advance Helical Fusion's effort to develop its cutting-edge ***High-Temperature Superconducting* (HTS) cable technology**, which is expected to meet fusion industry's needs to secure commercially viable high-performance magnets. This funding grant represents the Japanese government's commitment and recognition of innovative fusion technology led by private sectors, including that of Helical Fusion.

Helical Fusion has developed a new HTS conductor, *Wind and Impregnated Stacked Elastic* tapes (WISE) that can be scaled and engineered into the high-performance magnet, together with a Japanese research institute, *National Institute for Fusion Science* (NIFS). The program fund would accelerate commercialization of the WISE conductor by raising its *Technology Readiness Level*** (TRL) from Level 5 to Level 7.

The WISE conductor is a breakthrough in the area of cable architecture with the advantage of flexibility to be wound to fabricate HTS coils with complicated shapes, while maintaining the needed tolerances and superconducting-current properties. In addition, the built-in cooling pipe provides enhanced cooling performance. Considering that competitiveness, the WISE conductor is expected to be an essential solution for developing small-scale and low-cost fusion reactors.

Takaya Taguchi, Helical Fusion's co-CEO, commented: "We are delighted to be selected by the Japanese SBIR program. Helical Fusion will, together with industrial partners and technology, accelerate development of the HTS cable which can contribute to the early realization of fusion reactors in Japan and overseas."

Helical Fusion welcomes inquiries from potential partners in and outside the fusion industry.
contact@helicalfusion.com

- Small Business Innovation Research (SBIR) program for fusion started last year.
  - The first grant for fusion start-ups in Japan
  - Total JPY 6.5bil. ($43mil.) by Japanese MEXT(Ministry of Education, Culture, Sports, Science and Technology)
  - Requested to raise TRL of cutting-edge fusion technologies from 5 to 7 within 5 years
- Helical Fusion is 1 of 4 companies awarded and will receive the highest amount per company of **JPY 2 billion ($13.5 million)**.

New grant is also being prepared, but …

- Fusion energy has been set as the 10th goal of the “Moonshot research & development program”.
- Innovative confinement methods other than tokamak, which can contribute to the downsizing and sophistication of fusion power plants, will be eligible for support.
- The total budget is expected to be JPY 20 billion ($133 million) for the first 5 years.
- On the other hand, even a small engineering integration demonstration device will cost tens of billions of JPY.

Expectations for public-private partnership

- Startups are taking risks and pursuing innovative R&D. These initiatives
  - could complement the national fusion project that is premised on a large tokamak based on ITER technology.
  - will lead to the development and expansion of the fusion industry and contribute to to increase the feasibility of fusion and accelerate its social implementation
- The only way to demonstrate the continuous extraction of fusion energy is to construct a fusion reactor, which will require a budget of at least several hundred billion JPY.
  - Support from various grants will be a great help, but the current budget is insufficient.
  - It is also difficult to raise all necessary funds from the private sector.
- Large-scale, flexible public support is desirable (milestone-based support based on achievement like aerospace field is acceptable).
- We also expect strong leadership from the government not only in terms of funding but also in terms of legislation.

“Humanity evolves with nuclear fusion.”

Helical Fusion