

Commercial Fusion Power Using an Electron Storage Ring

Fusion Harmony Inc.

1. Current Challenges in Fusion Development

Mainstream fusion methods, such as Tokamak and laser fusion, require ultra-high temperatures exceeding 100 million degrees Celsius to fuse deuterium and tritium. However, such extreme temperatures are not absolutely necessary. For instance, the Sun achieves fusion at around 15 million degrees. Current projects rely heavily on 'high-temperature plasma approaches,' but these are only one of several possible technological pathways. Fusion Harmony (FH) aims to achieve compact, low-temperature fusion through an entirely new concept.

2. Fusion Harmony's Innovative Approach

Fusion Harmony proposes a groundbreaking fusion method using an ultra-compact electron storage ring, 'MIRRORCLE.' Developed by Professor Emeritus Hironari Yamada of Ritsumeikan University, this Electron Storage Ring (ESR)-based system uses relativistic electron beams to trigger nuclear fusion reactions. This technology defines a new category known as 'Electron Storage Ring Fusion (ESRF).'

3. Technical Principle

Inside the ESR, high-speed circulating electron beams collide with residual gas molecules in a vacuum, generating ions. This phenomenon, known as ion trapping, is well established in physics. Unlike conventional systems where ions were considered impurities, FH intentionally accumulates them to create a high-density ion environment suitable for fusion. In essence, FH aims to achieve fusion not by compressing plasma, but by accumulating ions—a fundamentally new approach.

4. Why Ions Instead of Plasma

Traditional Tokamak and laser fusion systems use plasma, a mixture of electrons and ions, to facilitate fusion. However, fusion occurs between nuclei (ions), not electrons. By focusing directly on ion fusion rather than plasma, FH enables higher efficiency and better controllability.

5. The World's Smallest Electron Storage Ring: MIRRORCLE

Developed by Professor Hironari Yamada, MIRRORCLE is the world's smallest electron storage ring, measuring just 1.2 meters in diameter. Using a patented 'resonant injection method,' it allows electrons to circulate efficiently in a perfect circular orbit. Despite its compact size, it can generate 20 MW-class current—ideal for fusion research. It was recognized as a high-brightness X-ray generator, adopted in Japan's COE program, and supported by 1.5 billion yen in government grants. MIRRORCLE serves as the technological core of FH's fusion system.

6. Historical Background of Beam-Type Fusion

Between the 1960s and 1980s, the U.S. developed several ion-beam fusion systems, such as 'Migma IV,' using multi-meter-scale accelerators and 1 MeV ion collisions. While they did not reach practical energy output, they laid the foundation for beam-driven fusion research. FH modernizes this concept using advanced electron-beam technology and compact ring structures, achieving fusion in just 100 square meters of space.

7. Global Beam Fusion Ventures

In the U.S., several companies are exploring similar technologies:

- Avalanche Energy (Seattle) – 'Orbitron,' an electrostatic-beam hybrid compact fusion cell (www.avalanchefusion.com)
- SHINE Technologies (Wisconsin) – Accelerator-driven neutron source fusion (www.shinefusion.com)

FH differentiates itself through its operational prototype and ultra-compact system design.

8. FH's Fusion Development Roadmap

Phase 1: Conduct neutron-generation experiments using deuterium and tritium fuel.

Neutron yield can be precisely controlled by adjusting gas flow.

Phase 2: Develop a 1 MW prototype fusion power generator.

Final Phase: Construct a 20 MW commercial fusion reactor.

9. Required Funding and Current Progress

The MIRRORCLE-20 system has been transferred from Ritsumeikan University to FH's research facility and remains physically available. However, its power and control systems have aged and must be renewed. To resume operations, the following steps are required:

- Replacement of outdated electrical and control equipment
- Construction of a neutron-shielded bunker

Required funding: approximately 400 million yen (detailed estimate available).

10. Partnership Opportunities

Investor Partners:

- Those who share FH's mission and wish to participate from the demonstration phase
- Investors seeking to diversify beyond Tokamak-centric fusion projects
- Investors aiming for faster commercialization and practical outcomes

Business Partners:

- Power and control equipment manufacturers
- Energy and power generation companies
- Trading and strategic partners for global expansion

11. Company Overview

Company: Fusion Harmony Inc.

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Business: Development of fusion power generation using electron storage ring technology
Founder & CEO: Prof. Hironari Yamada (Ritsumeikan University, Emeritus)
Directors: Yutaka Osawa, Chye C. Tan, Edward Mantey, Reiko Yamada

12. Frequently Asked Questions (FAQ)

Q: How is fusion verified?

A: Fusion is verified through neutron emission. Comparing neutron yield before and after fuel injection confirms fusion reactions. Neutrons are slowed in water tanks, converting kinetic energy to heat for power generation.

Q: What temperature is required?

A: Ion kinetic energy is independent of temperature. The fusion process occurs at near-room temperature inside the device.

Q: What pressure is needed?

A: Ion confinement is achieved through the electron beam, not by high-pressure plasma. A vacuum chamber capable of withstanding atmospheric pressure is sufficient.