PRANOS FUSION : INDIA' S PATHWAY TO COMMERCIAL FUSION

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As the first private fusion energy startup in India, Pranos Fusion is implementing a strategic roadmap to bring magnetic confinement fusion from experimental feasibility to commercial viability. However, the pathway to a deployable fusion reactor requires overcoming scientific, engineering and policy barriers. In this work, we outline Pranos Fusion's journey, from systems design codes to a prototype fusion device, alongside the necessary policy reforms to integrate private fusion research within India's regulatory framework.

Our first step in accelerating fusion development is the creation of a systems design code that simulates key fusion plasma parameters. Using computational systems code, we optimize plasma confinement conditions, power balance, toroidal field strengths, neutron wall loading as well as rector economics with specific emphasis to the Indian context. This enables us to systematically assess various tokamak and spherical tokamak designs, setting the groundwork for an efficient prototype. In parallel, we are developing a digital twin framework—a real-time, AI-driven simulation environment that mirrors the behavior of a fusion reactor under different operating conditions. This allows iterative improvements in plasma control, diagnostics and predictive modeling for future reactor scaling.

India's Atomic Energy Act (1962) currently restricts direct private sector participation in nuclear research, posing a challenge for private fusion development. However, global trends show increasing public-private collaborations in fusion. The private sector is playing a very important role in accelerating fusion research in collaboration with the public sector, focusing on achieving fusion energy. This is already evident in other countries. We believe this private-public partnership will expedite this process in a much better way. Pranos Fusion is actively engaging with policymakers to advocate for a new regulatory framework that enables:

• Private investment in fusion R&D while maintaining national security.

• Public-private collaboration between Pranos Fusion and India's premier research institutions (e.g., IPR, BARC, ITER-India).

• Technology transfer agreements allowing Indian firms to integrate with global fusion supply chains.

These policy adaptations will position India as a global leader in private fusion commercialization while ensuring compliance with international nuclear treaties. Our first experimental device will be a low-energy spherical tokamak prototype. The goals of this device include:

• Achieving stable plasma confinement at low aspect ratios.

• Developing advanced diagnostics to study plasma turbulence and transport.

• Validating theoretical predictions from our digital twin models.

This Phase 1 prototype will not aim for breakeven conditions but will instead focus on validating design principles and developing necessary infrastructure. Following this, Phase 2 upgrades will include:

• Increasing plasma energy density.

• Implementing AI-driven plasma control for real-time adjustments.

Finally, cost-effective development and a talented human resource pool will help achieve these goals. These steps will lead to a pre-commercial fusion pilot, bridging the gap between experimental validation and full-scale energy generation.

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